

# **Tyre Compounding for Improved Performance**

*M.S. Evans*

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## RAPRA REVIEW REPORTS

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Source of original article	→	<i>Item 1</i> <b>Macromolecules</b> 33, No.6, 21st March 2000, p.2171-83	
Title	→	<b>EFFECT OF THERMAL HISTORY ON THE RHEOLOGICAL BEHAVIOR OF THERMOPLASTIC POLYURETHANES</b> Pil Joong Yoon; Chang Dae Han	← Authors and affiliation Akron, University
		The effect of thermal history on the rheological behaviour of ester- and ether-based commercial thermoplastic PUs (Estane 5701, 5707 and 5714 from B.F.Goodrich) was investigated. It was found that the injection moulding temp. used for specimen preparation had a marked effect on the variations of dynamic storage and loss moduli of specimens with time observed during isothermal annealing. Analysis of FTIR spectra indicated that variations in hydrogen bonding with time during isothermal annealing very much resembled variations of dynamic storage modulus with time during isothermal annealing. Isochronal dynamic temp. sweep experiments indicated that the thermoplastic PUs exhibited a hysteresis effect in the heating and cooling processes. It was concluded that the microphase separation transition or order-disorder transition in thermoplastic PUs could not be determined from the isochronal dynamic temp. sweep experiment. The plots of log dynamic storage modulus versus log loss modulus varied with temp. over the entire range of temps. (110-190C) investigated. 57 refs.	← Abstract
Location	→	GOODRICH B.F. USA	← Companies or organisations mentioned
		<i>Accession no.771897</i>	

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# **Tyre Compounding for Improved Performance**

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# Contents

<b>1. Scope</b> .....	3
<b>2. Introduction</b> .....	3
<b>3. Tyres</b> .....	3
3.1 Invention .....	3
3.2 Components .....	4
3.2.1 Inner Liner .....	4
3.2.2 Carcass .....	4
3.2.3 Bead .....	5
3.2.4 Apex .....	5
3.2.5 Sidewall .....	5
3.2.6 Belt .....	5
3.2.7 Cap-Ply .....	6
3.2.8 Tread .....	6
<b>4. Tyre Performance</b> .....	6
4.1 Traction .....	7
4.2 Coefficient of Rolling Friction (Rolling Resistance) .....	8
4.3 Treadwear and Durability .....	9
4.4 Noise .....	10
4.5 Global Properties .....	11
<b>5. Ingredients</b> .....	11
5.1 Polymers .....	11
5.1.1 Natural Rubber .....	11
5.1.2 Styrene-Butadiene Rubber .....	12
5.1.4 Butadiene Rubber .....	12
5.1.5 Butyl Rubbers .....	12
5.2 Fillers .....	13
5.2.1 Carbon Black .....	13
5.2.2 Silica .....	13
5.2.3 Other Fillers .....	14
5.3 Process Aids .....	15
5.4 Antidegradants .....	15
5.5 Adhesion Promoters .....	15
5.6 Curatives .....	16
5.7 Fabric .....	16
5.8 Processing .....	17
<b>6. Compound Properties</b> .....	18
6.1 Rheometry .....	18

6.2	Ingredient Dispersion .....	18
6.3	Physical Properties .....	18
6.4	Adhesion .....	19
6.5	Viscoelasticity .....	19
<b>7.</b>	<b>Future</b> .....	<b>20</b>
7.1	Smart Materials and Tyres .....	20
7.2	Run-Flat Tyres and Deflation Warning Systems .....	21
7.3	Mathematical Modelling .....	21
7.4	Environmental Issues .....	22
	7.4.1 Chemicals .....	22
	7.4.2 Rubber Recovery from Scrap Tyres .....	22
	<b>References from the Rapra Abstracts Database</b> .....	<b>23</b>
	<b>Subject Index</b> .....	<b>119</b>

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## **1 Scope**

This is an overview of the factors a tyre compounder or tyre engineer has to consider when developing compounds for tyres to meet the demanding performance needs of the 21st century.

Tyre products include:

- small implement tyres, through bicycle to motorcycle tyres.
- the more abundant motorsport, passenger car and truck tyres (where most of the emphasis for this review is placed)
- the range extends up through large agricultural and earthmoving vehicle tyres to the field of aviation tyres.

The subject matter to be covered will include the tyre itself and how the needs and hence the formulations of each component within the tyre vary. The many apparently conflicting needs placed on tyre compounds by users of tyres and the range from which ingredients can be selected are discussed. This review will also consider the tyre performance characteristics themselves, how they are measured and understood in terms of the technology of the tyre, and how the compound formulations play an important role in determining the ultimate performance of tyres.

The future for tyres and materials is not static but continuously evolving as commercial, environmental, legislative and technical needs dictate. A few ideas for the future are explored.

## **2 Introduction**

Compounders like to think that the creation of rubber formulations is somewhat akin to the art of cooking. Using selected ingredients they carefully blend and cook them in such a way as to produce the desired effects. Science can explain most if not all of the chemistry and mathematical modelling is now going a long way towards predicting performance from material properties. In the end, however, the skill and experience of the raw material supplier and the tyre compounder is the only sure way to push back the frontiers of tyre performance. Novel and exciting materials appear at frequent intervals offering new opportunities to the compounder and continually raising the levels of tyre performance to new heights.

Compounders try to understand how the various ingredients combine to produce certain material properties through carefully designed experiments. Years of experience of testing and experimentation are employed to evaluate speculative options. After this early laboratory stage the problems start. To magnify laboratory mixes up to factory scales adds a whole new dimension. Finally, when the tyres are produced, the performance may be evaluated in a whole gamut of ways. It is almost impossible to track all the many subjective and objective tyre ratings back to those original simple laboratory tests let alone the raw material formulations themselves. Vast databases and ‘intelligent’ software packages may offer some hope in the future to link raw material recipes to the processability of components and finally to tyre performance, but in the end it is down to the experience of compounders to interpret the results of tyre tests.

The following review is therefore intended to show how experts skilled in the art have, and are still attempting, with a reasonably high degree of success, to propose formulations that offer ultimate performance to all the components within a tyre’s structure. It then goes on to show how some recent advances in materials and processes are being exploited to further enhance the performance of tyres.

## **3 Tyres**

### **3.1 Invention**

The idea of a solid wheel has been around for well over 5000 years but a Scotsman, Richard Thompson 1822-1873, first patented the concept of a pneumatic tyre in 1845. His invention was for an elastic bearing to be fitted around a carriage wheel so that it could be filled with springs, stuffed with horsehair or even inflated with air. The claim was for the carriage on which it was fitted to be drawn along using less power and to make it less noisy when in motion. This original idea was soon forgotten but then in 1888 it was reinvented by another Scottish gentleman, John Boyd Dunlop. He designed a new bicycle tyre that would roll more smoothly. Dunlop invented and patented a system where air is contained within a rubber and fabric tube fitted to the edge of a wheel. During the testing stage the tyre was found to roll well over cobbles, going further and more smoothly than the conventional solid tyres. The most valuable material of all in the development history of the tyre is therefore that free and abundant gas that is all around us, air. Air contained within the tyre provides additional

support to the wheel enabling it to more easily follow the rough contours of a road. The potential risks from loss of air delayed the initial acceptance of the invention, a problem that has been continually tackled by compounders and tyre designers ever since.

In 1895, only 9 years after Daimler produced the first commercial automobile, the Michelin brothers applied pneumatic tyre technology to four-wheeled vehicles as a commercial product. Since then tyres and wheels have gone through a slow period of evolution with just an occasional discrete revolution such as the advent of the radial ply tyre in 1948 or the early attempts at run-flat technology in the mid 1970s.

As a component the tyre is often abused; regularly forgotten and only replaced under duress. Despite the quite outstanding improvements which changes have yielded (a modern family saloon could lap a racetrack faster than racing cars of the 1950s), it looks to all outward appearances very much like its antecedents, black and round, but appearances can be deceptive.

A tour round the tyre components will reveal many compounds each with its own recipe and performance requirements. Each component will be reviewed in turn to explore the technology used and some future developments that are under consideration. Taking the components in the order in which they are usually applied at the building machine, we can see how the compounding philosophies differ. The range of ingredients mentioned will be discussed in more detail in a later section. **Figure 1** illustrates the components found in a vehicle tyre.

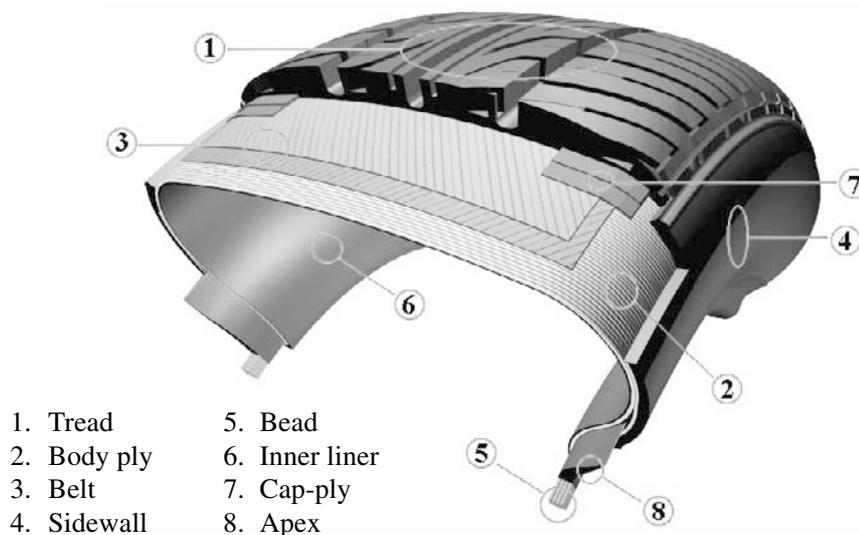
## 3.2 Components

### 3.2.1 Inner Liner

The inner liner forms the vital internal membrane which will hold the inflation medium at an elevated pressure within the structure of the tyre. In earlier days the liner was a separate tube of natural or butyl rubber but modern tubeless tyres use a thin film of butyl or more particularly, halobutyl rubber compound (144, 204) as an integral part of the tyre structure. Adhesion levels of butyl compounds can be critically low requiring an insulating or barrier layer of a natural rubber compound to act as an interface between the liner and the casing. Additionally the difficult process of joining the liner is vital to ensure air integrity within the whole tyre cavity. The medium for inflating a tyre is traditionally air and this should be as dry as possible to prevent moisture ingress. Companies have experimented with other inflation media such as nitrogen to eliminate the harmful effects of oxygen or carbon dioxide and to provide a larger, less permeable gas molecule.

### 3.2.2 Carcass

The carcass or body ply of the tyre is made up of fabric yarns, typically of steel, nylon, rayon or polyester, twisted into parallel weftless cord layers known as plies. These plies are coated with a natural rubber based compound loaded with adhesion promoters to generate a bond between the cord surface and other tyre components. The calendering process, whereby rubber



**Figure 1**

Tyre cross-section (*reproduced courtesy of Kumho Tires*)

is rolled onto and between the continuous warps of cord requires a stiff compound to match the cord modulus, but with a sufficiently low green (uncured) compound viscosity to provide good rubber penetration into the cord structures. Any open tubes remaining within the cords may lead to wicking of air or moisture along the cord length. Rubber penetration together with intimate bonding between additives in the compound and substrates on the surface of the cord provide good long-term adhesion within the tyre structure. The compound may reach high temperatures when it is calendered as a thin skim film onto the fabric necessitating a scorch resistant cure system. Care must also be taken that the necessary high loadings of sulphur or other additives do not bloom to the surface of the calendered sheet since good tack levels must be maintained throughout the building stage. For this reason, thermally stable, insoluble sulphur and bloom resistant adhesion additives are required.

The role of the carcass is to allow the inflated tyre to take up the desired profile and to bear the stresses as the tyre is loaded and deformed. The choice of carcass material, the spacing between cords and the number of plies will determine the tyre's strength and stiffness. Most radial car and truck tyres will have one ply with the cords running at 90 degrees to the circumference, i.e., radially from one bead to the other. By comparison, agricultural or large commercial aircraft tyres (however there is strong a drive here towards radials) may have a great number of plies placed at opposing bias angles for each successive layer.

### **3.2.3 Bead**

The bead is usually a wound hoop of high-strength monofilament steel wire coated with rubber, providing the tyre with a secure fitment to the wheel rim such that it does not move or dislodge as the vehicle undergoes severe manoeuvres. Traditionally the bead coil consists of a single wire wound several times around in a hoop to make up a layered complex. In truck tyres the finished cross-sectional shape of the bead coil may be more hexagonal than rectangular to improve the tyre component profiles. Two beads, one on each side of the tyre, also act as anchors for the carcass cords, which are wrapped around each bead. Large cross ply tyres may have more than one bead coil on each side to retain the many ply layers.

Work by suppliers to produce higher tensile materials may offer the opportunity to reduce the amount of steel required and hence the cost and weight of the tyre. Some tyre companies have developed this component

from a different direction looking at hollow tubes or non-cylindrical wire shapes. Some companies have even tried to exploit the weight saving advantages of aramid cords as substitutes for steel in the bead coil.

### **3.2.4 Apex**

The apex or filler insert components provide the gradual shape and stiffness reduction from the rigid bead coil to the flexible mid-sidewall of the tyre. These components need to be very hard to provide good vehicle handling and to reduce the risk of flexural fatigue at component endings. As tyre aspect ratios continue to reduce, the distance between the bead coil and the centre of the tyre sidewall becomes so short that accurate formation of the apex becomes critical within the building process and also to the vehicle's handling. High loadings of filler or reinforcing resins make such components difficult to process and notoriously dry, lacking in tack. Tackifying additives and process aids (343) may therefore be required to help in the tyre manufacturing process.

### **3.2.5 Sidewall**

The sidewall rubber provides protection for the body plies and in the case of heavy-duty bus tyres may be of significant gauge in areas where abrasion or damage from kerb strikes is a likely occurrence. Sidewall compounds cover the thinnest part of the tyre where most of the flexing occurs as the tyre deflects. They therefore need to have a high degree of flex cracking resistance, particularly where the sidewall markings and identification labels are sharply moulded into the structure of the component. Sidewall compounds contain additional ingredients to prevent oxidative or ozone attack since this part of the tyre will be particularly exposed to the sun and the elements. Antidegradants are used together with a wax carrier, or a substitute (113), that produces a thin protective film on the surface of the tyre sidewall, although discolouration may be a problem where large quantities are required. The chemical structure of the wax (329), especially the carbon number, determines the effectiveness. Static and dynamic tests under UV (81, 411) and ozone are employed to determine the efficacy of sidewall formulations in resisting the ravages of sun and weather.

### **3.2.6 Belt**

In radial tyres, sets of belts or breakers made from brass coated steel cords are layered at alternative bias angles to provide a trellising effect, to stiffen the area under

the tread and also to prevent growth under inflation or high speed rotation. These belts provide a rigid support to the tread offering a more controlled contact with the road. They therefore play an important role in the wear of tyres and the handling and stability of vehicles. The design of the belt package should give sufficient flexing and enveloping capability to provide a smooth ride with minimum energy loss, but with sufficient stiffness to prevent undue movement within the contact area causing irregular or rapid tyre wear. Again, as with the carcass plies, rubber penetration is critical (401).

### **3.2.7 Cap-Ply**

Tyres may also have additional pre-stressed cap-ply or plies, made traditionally of nylon, although more novel materials are being considered, as discussed later. Cap-plies are more commonly used on high performance car tyres. Having a circumferential cord direction they provide an additional contractive force to resist any growth of the belt edges due to centrifugal forces. They are also found more often now in normal performance tyres where they can act as a barrier layer between the tread and the casing to restrict migration of chemicals from the tread into the belt. Cap-plies can be either single or multiple sheets covering the whole belt or just the belt edges. To eliminate large cap-ply overlap joints which may give rise to non-uniformity vibrations, narrow strips of just a few cords width can be wrapped continuously round the casing in a spiral fashion moving slowly across from one belt edge to the other. By this technique it is possible to build up profiled layers which emulate the various cap-ply and edge strip constructions but without the need for a heavy overlap.

One potential service problem possibly associated with the cap-ply material is known as flatspotting. When a warm tyre ends its journey and the vehicle parks overnight, the nylon material will be warm and perhaps close to its thermoplastic softening point. As the tyre cools the pressure in the contact area will cause the cap-ply to set into a flat state. This deformation in the contact patch may remain for a period of time after the vehicle restarts. The effect is apparent as a non-uniform vibration that takes a short while to run out as the tyre warms up again. Improved materials have been evaluated to minimise or eliminate this problem.

### **3.2.8 Tread**

The tread is probably the most critical component of the tyre in determining the final performance. This is reflected in the very high number of references within

the Rapra Abstracts database dedicated to compounding ingredients used in tyre treads. The tread is also the thickest component of the tyre and it is also from here that material is lost through abrasion during the life of the tyre. Since it is the largest component it will be the one which contributes most to any cyclic energy losses (the energy lost each cycle as the tyre rolls causing tread deformation), which in turn will cause a rise in the tyre's running temperature and an increase in fuel consumption for the vehicle. The compound will also be called upon to work together with the deep-water drainage grooves and block patterns moulded into its surface to provide grip in all conditions of dry, wet, ice or snow but with minimum noise generation. Trying to balance the three main apparently conflicting needs of wear, wet grip and rolling resistance, together with the many other performance requirements leads to a wide range of tread formulations covering several natural and synthetic rubbers combined in different ratios with alternative filler types. It is in this area of the tyre that most diversification occurs in compounding philosophy as discussed later.

A natural rubber rich undertread layer can enhance the adhesion between belt or cap-ply and tread whilst a thicker subtread compound may be included to offer some additional benefits of low hysteresis for car tyres and low heat generation for truck tyres within the bulk of a thick section.

The selection of compounding ingredients for the tread and other components is discussed in a later section, but first it is important to understand the performance requirements placed upon the tyre and its components.

## **4 Tyre Performance**

Just think for a moment about what goes on when one drives a car. Each tyre, and there are only four on cars; a few more on trucks, touches the ground on an area not much larger than the average person's footprint. First of all the tyre will be called upon to support the load of the vehicle. The tyre must then transmit the driving, braking and cornering forces applied by the vehicle as it accelerates, brakes and goes round corners over a wide range of speeds in dry and wet conditions, even in atrocious storms, snow and ice. It must carry this out without generating excessive noise within the environment. Roads may be covered in potholes, ramps, sharp objects, debris and all other manner of obstacles. The tyre must be capable of passing these obstacles without detracting from the ride comfort of the occupants or sustaining any damage that may cause

it to fail. Tyres must reliably get their users from the start to the finish of their journey for tens of thousands of miles, hundreds of thousands in the case of truck tyres. Finally there is the vexed issue of what to do with the tyre at the end of its life: retread, burn, bury or reclaim it. Some of these options will be discussed in the final section.

There are several performance criteria the designer and compounder must consider; not all are mutually exclusive or even helpful to each other. In addition the difficult global economic climate often demands year on year relative cost reductions for the product.

There are a lot of different terms used in the tyre and vehicle industry to define performance and it is not always clear what is the correct way, if any, to measure those values. Some can be related to tyre compound properties. This section will attempt to give an explanation of what some of the terms mean and how they are measured.

At each tyre company, vehicle manufacturer and at many independent research establishments there are test tracks, vehicles and instruments which attempt to quantify tyre performance. As well as the normal laboratory tyre test machines for endurance and dynamic forces there are also laboratory machines that are designed to evaluate road performance (219, 380). The systems employed differ greatly and the conditions of the tests vary just as widely. Testing methodology for truck tyres (426) may differ from car tyres although many of the key performance indicators are similar. It is important therefore for the compounder and tyre designer to understand what is happening to the tyre under each of these tests in terms of the tyre's design and materials. It is virtually impossible to interpret the effects of different compound formulations from test results unless the mechanisms of the test themselves are understood. In the final analysis no amount of laboratory or track testing can emulate all eventualities for end users, but a sufficiently wide range of tests should give an adequate guide to determine the performance of a tyre or of a material benchmarked against another known product.

Many properties are worth considering when reviewing compound developments for tyres but of major concern to most car tyre makers is the effect known as the magic triangle. The three most important parameters of rolling resistance, wear and wet grip have been well studied and reported by Grosch (413). They are often viewed as having conflicting solutions where it is possible to improve one or two, but with a risk of deteriorating the third. Rarely does any technology offer the

opportunity to improve all three simultaneously although it has proven possible to improve two whilst maintaining the third. Novel materials, intelligent tyres and active vehicle suspensions together with a holistic approach to tyre design principles may challenge the tenet of the magic triangle in the future. The following section is a review of these and other tyre properties, and how compounding ingredients affect them.

## **4.1 Traction**

Tyre test engineers refer to traction (387) as the ability of a tyre to transmit torque from the engine and drive train through the tyre contact patch to generate motion in a straight line or through controlled curves. In the dry a maximum area of contact will enable the maximum frictional force to come into play hence the reason why some racing tyres have slick, not worn out or bald, tread surfaces. Friction for rubber does not follow the classical laws of force being proportional to the vertical load through the coefficient of friction; the friction mechanism involves several components including adhesion, deformation, tearing and a viscous component. These in turn are related to the sliding speed, the temperature in the interface and time.

Under more adverse and unfortunately in many countries, more typical conditions, roads are not always dry. The idea of wet traction or winter traction becomes the key parameter. Tyres have several fairly large grooves moulded along and across the surface. These typically occupy around 25 percent of the surface area within the contact patch, a term known as the sea to land ratio of a tread pattern. Once the pattern's macrotexture has done its job of removing bulk water it is then the work of micro-slots in the tread pattern and the compound itself to squeeze out any residual water, snow or ice and so form an intimate contact between the rubber and the road. Road surface microtexture too plays a vital role in wet traction, as it does for many other performance properties, but road surface technology is such a large topic it could occupy a whole review.

Objectively the tyre's wet grip and handling performance can be measured with instruments that record the lateral and longitudinal forces at various cornering speeds. A measure of the tyre's subjective performance may also be given through a rating of how confident a driver feels when making certain manoeuvres or how fast he can perform a manoeuvre.

On moving in a straight line or through a curve, if the tyres run through deep standing water, any loss of grip

is a phenomenon known as aquaplaning. If the tyre is unable to remove excess water from under the full contact patch quickly enough then, once a critical area is reached (409), the tyre will begin to lift off the ground and be supported by hydrostatic pressure. The tyre will then have almost no grip or traction and the vehicle could easily go out of control.

Under cornering conditions the tyre contact patch is distorted away from the centre line. The force generated by the tread rubber and the belt package attempting to recover from this distortion provides the lateral cornering power needed to drive the vehicle around a curve. Since the action of this lateral force is displaced a little behind the centre line of the tyre (known as the pneumatic trail) it offers the driver an opposing force or feedback sensation through the steering wheel known as self-aligning torque, that a force is still being generated by the tyres at the contact patch. When water is present under the contact patch the driver may sense a decline in the lateral aquaplaning resistance and wet handling performance. A tyre's internal structure, tread pattern and compound recipe all work together to provide the maximum lateral force and self-aligning torque for a given steering angle, such that the driver feels confident that the vehicle is in control.

The opposite of a tractive force involves braking. One critical tyre performance characteristic related directly to vehicle safety is the minimum distance that is required by a vehicle to come to rest from a given speed. Here again a simple parameter becomes a grey subject when we ask some basic questions. What is the depth of the water? What is the texture of the road surface? What are the environmental conditions such as humidity or air temperature? Does the vehicle have an anti-lock braking system? Are there any influences from different vehicles, such as suspension types or weight distribution? All are important and valid factors, but how does the compounder address these effects when developing a single formulation in a laboratory to suit many vehicles in many operating environments?

To brake a vehicle in the wet the tread pattern must first remove the bulk water then, as the speed reduces, the compound must provide the grip to the road surface (420, 425). Again the texture of the road will dictate the balance between pattern and compound influences on the total stopping distance.

Winter tyre performance (77, 188) can be viewed in a similar way by assessing (408) the ability to maintain traction and control in snow and ice conditions. Here again there are problems of definition and consistency since snow and ice conditions are variable and differ

significantly with global location. For example, in Europe the conditions which prevail in northern Scandinavia differ greatly from those in the central alpine regions. There are basically four states for snow including: new, powdered, and compacted through to ice - although the Eskimos have a whole language to describe it. The tyre and compound designers have to take many environmental conditions into consideration when developing tyres for each of these territories. Very low operating temperatures will critically influence the choice of polymers. Also, since snow packing and ice grip are very different from wet grip, winter tyres have many knife blade shapes or sipes moulded into the tread pattern to offer extra edges for grip. In some locations studs or spikes may be fitted to gain extra grip. In this case compound strength to resist tearing may be an important consideration.

#### **4.2 Coefficient of Rolling Friction (Rolling Resistance)**

The second critical factor arising from friction is better known as rolling resistance, or the energy required to roll a tyre along a road under a given vehicle load. The rolling resistance coefficient is calculated by dividing the drag force by the applied load. When a vehicle moves, energy is lost in the engine, transmission and vehicle aerodynamics. A small but significant portion of the energy is also lost through deflection of the tyre. Tyres, hence tyre compounds and structures, have therefore become a strong focus for the reduction of fuel consumption in vehicles. The rolling resistance force is usually quoted as a percentage of the vertical load and for most tyres on smooth roads it is typically of the order of 1%. Following the launch by Michelin in 1992 of their silica filled 'green tyre' offering a potential fuel saving of around 0.5 litres per 100 km of travel (223), there has been a steady move towards tyres known variously as 'Green', 'Energy', 'Fuel Saver', etc. Rolling resistance values for car tyres have now begun to fall below 1%, although truck tyres with natural rubber based treads have always been down at around 0.5%. In the passenger car field the carmakers are striving to produce vehicles with lower levels of fuel consumption. This has set up a technology pull for original equipment (OE) tyres to be more fuel-efficient (237), whilst meeting all the other demanding technical requirements. Modern electric or hybrid vehicles may need even greater reductions in drag forces to maximise the running times and distances between battery recharging.

Various attempts have been made to determine the contribution which each tyre component makes to the

energy loss, but all studies show that the tread compound is the dominant factor contributing between 30 to 50% towards the total energy loss within the tyre. The apex, however, may be the strongest contributor on a basis of energy loss per unit volume. Much research has investigated the relationship between rolling resistance and fuel consumption with various figures quoted that energy saving tyres with a certain reduction in rolling resistance can offer a pro rata reduction in fuel usage. Generally the ratio is quoted as being around 5 to 1 between rolling resistance and fuel consumption.

Many factors can influence the actual rolling resistance. Some are in the operator's control such as speed of travel (at average speeds 1 kph relates to 1% on fuel), tyre inflation pressure (a loss of 0.3 bar relates to 1% on fuel) and the severity of driving, braking and cornering forces applied. Others are in the hands of the tyre designer. Factors include the tyre's deflection under a given load; the recommended operating pressure; the stiffness of the tyre structure; the volume of rubber used in components; the weight of the tyre (50 g relates to 1% on fuel although this depends very much upon where in the tyre the weight is reduced) and the level of hysteretic loss for each compound. From a compounder's viewpoint this comes down to a balance of energies. Under deformation, the viscoelastic nature of rubber means that the tyre absorbs energy. That is what gives tyres their ride comfort, their low noise and their ability to grip the road. If the bulk energy stored is not efficiently released once the rubber leaves the contact patch then there will be a resultant energy loss. This loss of energy results in an unnecessary use of fuel. Coupled to the energy loss, a corresponding level of heat generation may also be detrimental to the integrity of the tyre structure.

For motorsport tyres, rolling resistance is an important parameter since it may limit the maximum speed out of corners and on long straights. The compounder must therefore make the compound as elastic as possible whilst considering other, often conflicting, tyre requirements.

A measurement of rolling resistance is commonly made with a tyre running under equilibrium operating conditions against the surface of a smooth or slightly textured steel drum. This is somewhat artificial since it does not represent real road surface conditions. It has been possible to determine the effects of road texture by testing against simulated surfaces. Rolling resistance coefficients here are somewhat higher. Some companies prefer to look at vehicle coast-down measurements, i.e., the distance covered as a free

rolling vehicle is allowed to coast to a halt. Alternatively instruments can be used to accurately monitor the fuel consumption under defined driving conditions. This aspect is particularly pertinent for owners of large fleets of trucks where fuel cost is the major operating expenditure. Again a compounder has the task to look at laboratory properties to predict the likely effects of hysteresis on rolling resistance. To a slightly lesser degree, other tyre components like the sidewall, apex or casing will, through their hysteresis, contribute to the overall rolling resistance and so must also be considered by the compounder. Many compounding options have been developed to offer improved rolling resistance, these will be discussed later.

Finally the inner liner plays its part in the fuel consumption through its ability to retain air over long periods. Checking of tyre pressures by users is not always as regular as it should be. If, during the intervening period, pressure is lost, then rolling drag hence the fuel consumption will increase. Pressure maintenance is as important to fuel consumption as it is to safety. Seasonal changes in ambient temperature can lead to significant shifts in tyre pressure hence fuel consumption. The option to design tyres which run at higher inflation pressure (429) may give benefits of reduced rolling resistance, but here again there is a down side in poorer ride comfort.

A parameter closely coupled with rolling resistance is tyre weight. The use of less material will ensure there is a reduced level of heat build-up due to hysteretic energy loss. Lighter tyres also mean less energy is required to start and maintain them in a rolling state. Many attempts have been made to produce lighter tyres through reduced component gauges, thinner, stronger cord materials and the use of alternative lightweight materials, such as aramids in place of steel.

### **4.3 Treadwear and Durability**

Of vital importance to many users is the question, 'how long will my tyres last?' That becomes even more important to a truck fleet operator and the tyre service engineer for an airline. Tyre life may be defined in many ways. Firstly, a tyre should never fail structurally. Secondly, for truck and aircraft tyres, the casing should be structurally sound at the end of its first life and capable of being retreaded. The concept of retreading for car tyres is a feasible but moot subject, one that will grow in importance as tyre disposal problems and costs gain a higher profile. Perhaps retreads may find their way to become standard as spare tyres. Thirdly, the tyre tread pattern should not wear out at an excessive rate.

Tyre wear itself is again a complex topic to define. There are many factors impacting on treadwear including the environment, the harshness and condition of the road surface, longitudinal and lateral movements of the tyre while rolling, tread pattern design, vehicle drive axle configurations and driving habits. In addition, the minimum tread depth limits set for safety lead to a demand for even wear across the tread surface. Excessive wear around certain parts of the tyre, possibly due to poor contact pressure distribution, may cause customer dissatisfaction that some value for money has been lost. Towards the end of a tyre's pattern life there are increasing dangers from loss of control or from penetration of sharp objects into the belt structure. It has often been considered that current minimum tread depth limits should be increased on the grounds of safety in the wet (3 mm has been suggested). This may be a challenge to compounders in the future to achieve greater wear resistance to compensate for the reduced usable pattern depth, or perhaps to aim for a constant level of tyre performance (313) as the tread depth reduces.

For the compounder, many factors come into play when developing good wearing compounds including the correct selection of filler type, the state of cure of the compound through the whole tread pattern depth and, in conjunction with other properties, the grade of polymer. It is generally believed that polymers with high glass transition temperatures ( $T_g$ ) offering improved grip are more prone to rapid wear. Firstly though, how does one assess wear? On a road the effect is a relevant measure, but the time and expense involved in carrying out controlled tests, usually convoy tests, may be prohibitive.

Thus people seek laboratory tests to indicate likely levels of abrasion. These tests may indicate a compound's potential abrasion rate but they are not always totally reliable predictors of treadwear under all circumstances. Placing tyres with large fleet operations where driving routes and conditions offer some degree of repeatability is another very suitable way to assess wear of tyre compounds.

The tyre's structural durability as a measure of life is affected by many factors including the compounding ingredients (121, 226, 253, 254) and methods used in manufacture as well as the type and conditions of use. Tyre components may be exposed to temperature cycles from  $-40\text{ }^\circ\text{C}$  to  $+60\text{ }^\circ\text{C}$  or greater, with continual flexing over perhaps 50 million cycles. Appropriate antioxidants must be used to protect compounds from thermal degradation over the lifetime of the tyre. Low hysteretic compounds are also desirable to aid in low

heat build-up with a resulting improvement in durability. Oxygen, moisture, ozone in the air and UV light can also degrade rubber, and antiozonants are employed to minimise this effect.

Improper assembly of tyre components, contamination, lack of building tack and poor adhesion of components can also cause premature failure in the field. Operating conditions such as under- or over-inflation, overloading the vehicle and improper wheel alignment can also contribute to early failure of a tyre. For off-road tyres, cut and tear resistance is important and special fillers, additives or cure mechanisms may be used to improve this.

Changes to tyre legislation in the wake of claims against failed tyres could mean far more focus being paid to the testing of tyres and components for structural integrity under many conceivable conditions. Quality and integrity must therefore be paramount right through the supply chain and manufacturing process.

#### **4.4 Noise**

Noise is another form of environmental pollution that is gaining a growing interest from lobby groups and legislative bodies. Final agreement was reached in 2001 through a European Parliament directive (2001/43/EC) to set limits for coast-by noise generated by tyres on a so called smooth (ISO10844, 1994) road surface. The mechanisms for noise generation and transmission have been widely studied, but generally the sound pressure level depends upon the way in which the tyre tread pattern, there to remove water, impinges on the road surface. The process starts with the rubber impacting on the road, air pumping from any sealed chambers between the pattern and road surface texture, followed by the elastic recovery of tread blocks as they spring out of the contact area. All these contribute to the airborne and structural noise generation. Randomised, open tyre tread pattern designs, the structural stiffness of the tyre and compound modulus or damping must all be considered when designing tyres with reduced noise in mind. However, the designer must not reduce noise at the detriment of tyre safety, a factor also under consideration in the new noise directive.

On the other side of the argument the road surfaces themselves play an even greater role in the generation of noise (427) as they do likewise on grip and rolling resistance. Roads vary widely in their texture, roughness and general state of repair giving differences in pass-by noise greater than those between different

tyre patterns. The concept of porous road surfaces not only offers benefits of reduced noise but also of improved water removal, which can be beneficial both for wet grip improvements and also for spray suppression. As yet these road surfaces have seen only marginal acceptance in many countries.

#### **4.5 Global Properties**

The concept of a global tyre for a global vehicle is a dream of many seeking to rationalise production, but in each territory the needs of customers are subtly different. End user replacement tyre needs differ depending upon the place they are used. Vehicle manufacturers (Original Equipment) each have their own tyre requirements to suit the characteristics of the particular vehicle. Not only is a global tyre a difficult objective to realise, but for one size and type of tyre which fits many vehicles, a common tyre may not even be possible.

In Central Europe where higher speeds prevail, the wet grip performance of a vehicle is paramount, leading to the use of special polymers and fillers.

Tread wear is territory dependent with expectations being almost twice as high in the USA as Europe. This is due to straighter, slower roads and a generally less aggressive driving style. In some countries prone to cyclic periods of heavy rainfall followed by dry weather, road surfaces may become more abrasive and so increase wear rates.

Fuel consumption is vital where economies are affected by fuel costs. The relative importance of this parameter rises and falls with recessions and booms in local economies.

Low noise tyres may be demanded by European users, but will be of little benefit in territories where road surface maintenance leaves much to be desired. Here the compounder will be more concerned with tyre damage resistance and structural durability than reducing the noise by a few decibels.

The designer will seek to use as much commonality within the structures and materials of the tyre as possible, in order to reduce production and raw material purchasing complexities, and improve productivity. However, diversification is what sells tyres to a discerning and demanding public leading to a great variety of tread compounds and a few other vital components of the tyre.

## **5 Ingredients**

It is not an uncommon misconception for the lay person to consider that a tyre is simply black and round and made of rubber. Tyres are conventionally black, almost. They are almost round and rubber is the most suitable material for their manufacture. Rubber is an elastic material that can undergo high levels of deformation with low heat generation. It can generate high levels of frictional grip on most surfaces and it is impermeable to gases. Its lack of ultimate strength means that the raw polymer alone is insufficient to meet the other demanding requirements for tyres. Fillers, chemicals and special reinforcing cords are all required to produce the necessary strength and performance.

In fact typical tyres are only around 45% rubber with about 25% inert filler and 15% speciality chemicals. The remaining 15% is fabric although in the case of truck tyres, which are predominantly reinforced with steel wires, this level may be somewhat higher on a weight basis.

The main objective of a compounder is to develop a formulation with optimum properties to perform in the required component, at minimum cost and in such a way that it can be efficiently processed. Each of the compounding ingredients plays a vital role in generating the desired properties and so no single ingredient has been left undeveloped over the past century since the tyre was first patented. However, the polymers and fillers have had the closest attention paid to their chemistry, both as ingredients and within the mixing process, to extract the last element of performance. The work goes on as witnessed by the many new materials being presented at conferences and in the literature.

### **5.1 Polymers**

All polymeric materials used in tyres are elastomers which are high molecular weight ingredients consisting of long chains of one or more repeating types of molecules, known as monomers. The selection of monomers, the polymerisation technique and the architecture of the polymer backbone all play a crucial role in determining the final properties of the compound. Within the rubber industry there is a wide range of polymer types, but tyre technologists have found value from just a few basic elastomer types.

#### **5.1.1 Natural Rubber**

Natural rubber is a renewable polymer from a natural source, the *Hevea brasiliensis* tree. Natural rubber is still the traditional workhorse material used in many

tyre components. It is a very high molecular weight material offering excellent fatigue performance. The other advantages over synthetic polymers are reduced build-up of heat from flexing and greater resistance to tearing when hot. Truck tyre treads and internal tyre components, particularly bonding compounds, are predominantly natural rubber based. Controlled viscosity natural rubber is now being employed, at a limited level, to aid processing. In some cases the synthetic version of natural rubber, polyisoprene, is being seen as offering some benefits as a full or partial substitute due to its close similarity to natural rubber.

### **5.1.2 Styrene-Butadiene Rubber**

Research was originally carried out in the 1930s to produce the first synthetic polymers.

Nowadays, copolymers of styrene and butadiene (SBR) are the most commonly used synthetic elastomers in tyres, because of their suitable properties to meet performance needs particularly in treads of passenger car tyres. The normal technique for producing SBR is by radical polymerisation in emulsion. SBRs can be produced with different levels of styrene. As the styrene level increases from about 20% to 40% so the material becomes less rubbery as the glass transition temperature (T<sub>g</sub>) rises.

Another technique of polymerising is in solution using organic metal catalysts. This opens up many further opportunities to modify the architecture of the polymer backbone (186, 207, 303). The macrostructure of a polymer is defined by the molecular weight, the molecular geometry (linear or branched), the order in which the monomers are incorporated (block or random), the functionality along the chain and how the polymerising chain is terminated. Through the solution polymerisation process it is possible to vary the position in which the butadiene monomer polymerises. The ratio of the 1,2 vinyl to the 1,4 *cis*-polymerised content in the butadiene part of the polymer can be adjusted. Some critical performance characteristics, such as rolling resistance and wet grip, can thereby be improved without detriment to others, such as tyre wear.

To further improve wet grip, a parameter of vital importance particularly to European carmakers, the industry has developed terpolymers based on SBR. Here a third monomer such as isoprene (SIBR) (263) or acrylonitrile (NSBR), is incorporated into the SBR backbone to raise and broaden the T<sub>g</sub>, so offering improved wet grip with no loss in wear rate. Such terpolymer technology can be used to design so called

integral or multi-T<sub>g</sub> polymers, which can significantly affect the balance of tyre properties. The acrylonitrile may alternatively be incorporated as a copolymer with butadiene in the form of acrylonitrile-butadiene rubber, (NBR) which can be added at low loadings to an SBR polymer to supplement tyre performance (42, 363). Even at around 5 parts per hundred rubber loading, the CN group on the acrylonitrile will have a greater affinity for the hydroxyl groups on the surface of the silica filler so improving dispersion, reducing viscosity and enhancing final properties. Additionally, since the acrylonitrile is basic in nature it will counter the negative effects of the inherently acidic silica surface to accelerate a slow cure whilst retaining scorch safety.

Another new polymer type, brominated isobutylene-*p*-methylstyrene, (BIMS) is finding applications as blends in tread compounds (259, 344), especially for winter conditions (88, 157), and also in tyre sidewalls (104, 146, 336, 390, 391).

### **5.1.4 Butadiene Rubber**

Butadiene rubber (BR) is another elastomer that finds interest for tyre compounders. In tread compounds, BR is usually blended at about 10% to 20% with SBR to obtain a good balance of performance characteristics. Using various catalysts it is possible to control the levels of 1,4 *cis*-polybutadiene in the polymer. There are BR grades available with a very high (>98%) *cis* level (300, 305), which can be used to minimise treadwear whilst maintaining maximum resilience through their low T<sub>g</sub> values. However, ultimate traction and braking depends upon energy absorption in higher T<sub>g</sub> polymers. BR is also used in higher loadings as a blend with NR in sidewall (205) or truck tread compounds to enhance damage resistance.

Other technologies now involve the manufacture of higher 1,2 vinyl polymerised butadiene rubber (400) leading to higher T<sub>g</sub> polymers with the potential to balance improved wet grip and rolling resistance.

### **5.1.5 Butyl Rubbers**

Butyl rubber (IIR), first produced in 1940, is a copolymer of an isobutylene and a very low percentage of a diene, such as isoprene, to facilitate sulphur crosslinking. These rubbers are valuable because of their good heat resistance and low gas permeability. Improved impermeability butyls now incorporate a low percentage of halogen atoms like chlorine (CIIR) or bromine (BrIIR) along the polymer backbone (44, 352, 407). These polymers

are more difficult to process but offer significant improvements in pressure retention and hence the potential to employ lighter, thinner gauge components.

## **5.2 Fillers**

Inorganic fillers are traditionally added to reinforce the properties of the gum polymers (38). The filler types vary from low reinforcing clays, to mineral fillers like aluminium trihydrate (125), to carbon black and more recently silica (310). Stiffness at low strains comes from a combination of:

- the strength of the cured rubber network
- the hydrodynamic effect of mixing solid particles in an elastomeric medium
- elastomer entanglements
- polymer to filler interactions and
- any residual filler to filler networking.

As higher strains (perhaps above 8% to 10%) are applied to the matrix, any initial filler to filler links are broken leaving polymer to filler links then finally, before breakage at high strain amplitudes, the strength comes from the covalent links in the elastomeric chain.

### **5.2.1 Carbon Black**

Traditionally carbon black started its life in China by burning a flame deficient in oxygen to produce soot or lamp black. Technology has moved on a long way since carbon black was first recognised as a useful filler for rubber by Mote in 1904. Now the elemental carbon particles produced have a wide range of structures, shapes, particle sizes and surface activity. The type and range of properties offered make it a very desirable choice of filler in many tyre compounds. There are various grades of carbon black defined by a three numeric scale (ASTM D-1765). The first digit defines the particle size of the carbon, the second and third digits define the surface area or structure of the particles. The viscoelastic properties of a polymer-carbon black network depend strongly on the size, shape and structure of the carbon black particles, their interaction with each other and the polymer chain (118, 156, 160). Carbon black is effective in its reinforcement since the polymer to filler interaction is greater than the filler to filler interaction. For each grade there will

be an optimum loading (318) depending on which properties are most critical. Blending different carbon blacks may not realise the benefits of each (371).

Large particle size, low structure blacks (173, 319) can be used in the inner liner at quite high loadings to offer good processing with reinforcement and enhanced impermeability.

Within the casing, medium structure and medium surface area blacks are easy to process and also offer low hysteresis loss for cooler running. These are even finding their way into tread compounds to improve rolling resistance.

In the sidewall and treads, high abrasion resistant fillers are used. These very fine particle blacks offer tread compounds good grip and wear, but as the loading increases to provide higher reinforcement, so there is a trade off in poorer processing and increased energy loss hence rolling resistance. An understanding of the viscoelastic properties, discussed later (Section 6.5), is important (324) when tackling the problems of the magic triangle.

More recently, as silica has forged a new role in tyre compounding, carbon black makers have been generating many new grades (180, 189, 281) to compete with the benefits of silica. The nanostructure of the carbon black surfaces together with the surface activity have been modified to improve the ability of the filler to interact with the polymer chain (107, 172, 225, 244, 337, 368, 378).

### **5.2.2 Silica**

Silica filler is prepared through the reaction of a soluble sodium silicate with an acid. The precipitated amorphous silica particles of the order 10 to 100 nanometres in diameter aggregate together as structured particles.

Silicas have now been used in tyres for many years with the aim to improve damage resistance in applications such as on and off road truck treads. There was an early unsuccessful attempt to introduce silica into tyres as an alternative to carbon black. However, it was not until the late 1980s when efficient bi-functional organo-silane coupling agents (97, 112, 174, 175, 243, 397, 403), such as bis-(triethoxysilyl-propyl)-tetrasulphane (TESPT) or the more heat resistant bisulphide variants (73) were produced, that silica found new levels of success (238, 402). Unlike carbon black, the filler to filler interaction of the hydrophilic silica can be stronger than the polymer to filler

interaction. Additives enable the non-polar rubber molecules to physically bond or couple with active polar elements on the silica surface offering a stronger polymer-filler interaction. Improvements through the substitution of carbon black by silica have been explained by the decrease in the loss modulus of the compound above room temperature, a factor related to the tyre's rolling resistance. The benefits of significant improvements in rolling resistance led to the so-called 'green' tyre revolution, because the use of silica was regarded as a means of reducing energy consumption, also silica is not an oil-based product.

Having recognised the difficulties in manufacturing of incorporating silica into the polymer matrix, modern highly dispersible silicas (74, 111, 133, 149, 161, 201, 316) have been developed that can be more readily incorporated into the compound mix. This in turn offers further improvements in rolling resistance, wear and other tyre properties. These highly dispersible silicas have successfully been used in car tyre applications, such as winter tyres (105) where improved ice and snow grip can be achieved.

The ability to produce tyre compounds without the traditional black filler opened up a whole new aesthetic opportunity for compounders to produce tyres with coloured treads, although there will be an additional requirement here to use non-staining antidegradants (124). This happened in the bicycle field many years ago, but now there is a trickle of marketing ploys that offer tyre colours matched to the vehicle bodywork. The concept could be attractive at vehicle exhibitions but may never take on wholesale for many reasons, not least of which is the logistics nightmare it would present in replacement tyre warehouses.

Every benefit in the industry appears to bring with it a downside. Silica compounds are expensive and notoriously difficult to process. The silica structure and surface area will influence (248) the viscosity of the compound and hence its processability. Conventional internal mixers were designed to mechanically blend ingredients. With silica a time and temperature dependent chemical reaction (102, 129, 147), known as silanisation, must take place to couple the filler to the polymer whilst guarding against unwanted pre-crosslinking. It has also been reported that moisture is a critical variable influencing the silanisation reaction (119, 202). Water or moisture inhibits the silica to silica interactions whilst promoting the reaction with silanol coupling agents.

These manufacturing problems have led to a range of new processing techniques, equipment and chemical

aids, discussed in a later section, highlighting again the ingenuity of raw material suppliers and compounders to exploit any new development no matter how negative it appears on first evaluation.

In the finished product where full replacement of carbon black by silica has been introduced, the resultant treads are highly resistant to the dissipation of electric charges that build up in vehicles (428). This is prevalent now that many more static generating electronics are being employed on board vehicles. Typical levels of material resistivity for antistatic tyres are less than 10<sup>7</sup> (whereas silica filled tread compounds can have values as high as 10<sup>12</sup>). Novel solutions and patents have been published on dealing with static. Some other ideas include the use of conductive inserts built in between the tread surface and the internal components. Others include thin films of rubber or paint coatings on the tread surface running out to the sidewall. Still others describe conductive bridges. Each method is intended to allow static electricity to dissipate from the vehicle through the tyre to the road surface (233, 412).

Many tyre makers have opted to partially substitute carbon black with silica to gain the benefits from both fillers. Suppliers of filler materials are also offering hybrid or dual phase fillers (148, 224, 249, 354, 367, 373, 375, 381, 404, 405) with a modified morphology that contains elements of both carbon black and silica in one structure. Advantages are claimed both for tread compounds and for improved adhesion in wire skim compounds.

### **5.2.3 Other Fillers**

Silica may have been the new filler at the end of the 20th century but even now there are rumblings in the industry that a corn starch (41, 230, 236, 314, 328, 356) biopolymeric filler could be the next generation to silica. Will this be the filler of the new millennium? Only time will tell.

In an attempt to gain extra performance many companies have explored the idea of adding short strand fibres to a rubber mix. Materials such as aramid (37, 195, 334, 382), natural fibres like rice husks, chopped steel strands and many others, incorporated into a polymer matrix have been used in order to offer isotropic reinforcement.

Other filler types include reinforcing resins (322, 399). Here an application may be in the triangular apex component that offers a graduated reduction in stiffness from the bead coil to the sidewall. This is a

component that must be extremely hard and is hence difficult to process. Reinforcing resins or short strand fibre may be of use in generating the required component properties.

### **5.3 Process Aids**

When high filler loadings are required by the formulation, oil is one substance typically used as a process aid. In addition it may offer other advantages, such as wet grip enhancement, to tread compounds. This is particularly so for wet grip motorsport compounds where oil levels can be extremely high. Many polymers are sold in the oil extended form mitigating the problems of adding too much free oil in the first stage of mixing. Masterbatches of oil and carbon black or oil, carbon black and polymer may be used to help incorporate very high loadings of oil.

Most oils are of the paraffinic, naphthenic or aromatic types. The use of distilled aromatic extract (DAE) oils in tyre treads is attractive due to the similarity in glass transition temperature to the SBR polymer, especially when this polymer is to be oil extended. However aromatics have attracted close environmental scrutiny of late. The oils used in the rubber industry are predominantly classed under the EU dangerous substances directive as, R45, carcinogenic (361). This is due to the traces of polycyclic aromatics (PCAs) that they contain. It is claimed that these may present a potential hazard to human health, since if they can be leached out of worn tyre debris they may pass through crops in nearby fields and enter the food chain. Although not proven, as a responsible industry the manufacturers of oils, oil filled polymers and tyres have produced, by several techniques, (80, 98, 183, 228, 274, 276, 360) new 'non-labelled oils'. These are considered environmentally safer and contain acceptably low levels of PCAs as measured according to the dimethylsulphoxide extraction method IP 346.

Other process aids are used to help the manufacturing process enabling faster mixing and processing of thinner, sharper edged and more accurate components. There has been a revolution in the field of process aids (171, 200, 246, 271, 311, 320, 323, 347) for silica filled tread compounds, although the process conditions and the timing of additions is critical (341). Many additives are now available which offer improved or faster filler dispersion, enhancements to the silica coupling process and help with the downstream processability, to provide more accurate and consistent tyre components.

### **5.4 Antidegradants**

The industry has been using antioxidants and antiozonants since it was first realised that chemicals can attack the covalent bonds along the polymer chains. Various grades are widely used in both internal and external components to protect the whole tyre (342). A problem lies in the requirement for these additives to be active over very long product cycles, but without the risk of surface discolouration. In the tyre sidewall where antidegradants are most necessary, a sufficient sink or reserve of antidegradants is required which slowly migrate to the surface over the life of the product. This means thicker than desirable components must be designed. Could time-delayed micro-encapsulation of these ingredients find a future application here?

Companies have experimented with blends of saturated terpolymers of ethylene and propylene (EPDM) together with a small amount of a diene (87, 92, 126, 309, 376) to eliminate the need for antidegradants in sidewall compounds. This also offers the opportunity to apply a thin veneer to the casing, an application that has seen use in the retreading of tyres.

Antidegradants can also improve treadwear (349, 362, 393) by improved stabilisation of the tread compound. They can enhance high temperature performance in aircraft tyres (291, 339) and help prevent reversion when high temperature curing is required (289).

### **5.5 Adhesion Promoters**

Of vital importance to the safety of tyre users is the structural integrity of the product. For retreaders, their concern is the value of the casing at the end of its first life. To be of value it must be capable of being retreaded once or even several times. There is a legal requirement for aircraft tyres to have holographic validation of their internal integrity. In the end casing life is determined by the longevity of the bonds that exist between the rubber compounds and the textile or steel cords.

The metal wires used in tyre structures are brass coated with copper concentrations in the brass at around 60% to 70%. A compound that bonds to the brass will rely on sulphur to form copper sulphide links between the rubber molecules and the copper on the wire surface. For this reason careful consideration must be given to the reaction rates, the choice of higher levels of sulphur (heat stable (377) insoluble grades to prevent bloom) and the type of accelerator used. In addition, many types

of adhesion promoters can be used to control the reaction and preserve the integrity of the bonds throughout the life of the tyre.

Much activity has been devoted, especially for steel cords, to understanding and improving the way in which the brass coating on the steel wire surface and rubber adhere. Heat, fatigue, moisture, penetration of foreign bodies, salt and many other aggressive environments may attack the rubber to brass bond. Organic cobalt salts are now generally added to promote adhesion, whilst silica is also known to favourably influence the adhesion stability during ageing (307, 424). New adhesion promoters (76, 90, 91, 220, 298, 353) often appear in the market and tyre compounders evaluate these to seek improvements of the brass to rubber bond. However, there is always a careful reluctance to change such critical compounds without first carrying out extensive laboratory then field tests.

One novel approach (56, 96) to improve adhesion to zinc plated steel cords is the use of argon plasma etching followed by plasma polymerisation to coat the surface and promote improved adhesion to the skim compound.

Rubber to metal bonding has been the subject of an earlier Rapra Review Report (292), which goes into much more detail about theories of bonding systems. More recently a handbook has been published on rubber bonding (4).

### **5.6 Curatives**

Vulcanisation, or curing, has been reviewed elsewhere (432). This process produces chemical links between sulphur and the loosely coiled polymeric chains. Elasticity occurs because the chains can be stretched whilst the crosslinks prevent chain slippage such that they can spring back into place when the stress is released.

The traditional chemistry of rubber vulcanisation dates back to 1838 when Charles Goodyear discovered the reaction between sulphur and rubber. A few years later in 1905 George Oenslager discovered the improved benefits for vulcanisation of using accelerators. Since then faster, safer accelerators have been developed for the industry but generally the chemistry in this area has remained much as it was. The health and safety requirements to eliminate chemicals that generate *N*-nitrosamines (295) have meant the elimination of some older grades of accelerator in favour of newer materials with novel benefits (169, 229, 290, 327).

The compound designer has to be aware of the cure kinetics of each compound. The cure system needs to process safely with no risk of surface scorch or early curing which may negate tack or adhesion. Once in the press, however, the compounds throughout the tyre need to cure rapidly and consistently to shorten cure cycles and improve tyre productivity. With a continual drive within the industry to improve productivity and where tyre curing is the critical process in the chain, higher curing temperatures with shorter cure times are being demanded. This leads to the need for more stable compounds (191, 289) or even the use of novel curing systems like peroxides (346).

Sulphur, together with the activators and accelerators, reacts with the covalent bonds along the polymer backbones to form sulphur links. The number of sulphur atoms across each link and their density along the chains determine the final properties of the compound and in some critical components, the resistance to damage or ageing. Novel curing systems are being introduced (106, 163) which are claimed to control the crosslink length and thereby improve reversion resistance.

### **5.7 Fabric**

The field of reinforcing materials themselves is outside the scope of this present review but it is worth mentioning the important role these materials play in achieving the desired tyre performance.

Fibres have existed naturally for thousands of years but over the past 50 years or so man-made fibres have been developed which offer significant advantages. In the case of tyre fabric, clusters of individual fibres are twisted together to form yarns and one, two or more of these are twisted again to produce cords. These are lain up parallel to each other as warp cords with little or no weft cords between them. Any weft cords used are only there to retain cord spacing until the fabric is calendered.

Car tyre casing materials in the USA and Asia tend to be polyester. In the case of many European tyre makers and especially when it comes to very high performance car tyres, the dimensional stability of natural rayon finds more favour. The polyester makers are now marketing new high modulus low shrinkage (HMLS) polyesters (265, 383) aimed to match more closely the benefits of rayon.

The concept of using steel in the belts of tyres as a tread stiffening layer for radial tyres was introduced

by Michelin in the 1940s. In the belt area of all radial tyres and in the casing of truck tyres, steel is still the dominant reinforcing material. Despite all the possible demerits of fatigue, fretting and poor adhesion at cut ends or where moisture ingress occurs, the alternatives of aramid or other more exotic fibres have still not seen great inroads, perhaps due to cost. Steel cords are basically made from high carbon steel rods, coated in brass and drawn into fine wires. Technology has evolved over the years to improve the tenacity of the original steel rod, the drawing process, the stranding methods, the configuration of the filaments, the fatigue resistance of the cords and, more importantly, the chemistry of the brass surface. Recent studies have investigated the option of using other more novel coatings (301, 317). The way in which cord-reinforcing layers are constructed, the cord density and the angles at which the cords are set all control the behaviour of tyres. Much of the new technology here is seeking simpler but stronger constructions offering both weight and cost benefits.

Tyre makers have been evaluating the potential of newer cord types like polyethylene naphthalate (PEN) (430) or polyketone (POK) (312) as sources of material for tyre reinforcement, but as yet only small market penetration has been identified.

### **5.8 Processing**

There is an equal emphasis being put into the processing (120, 153) of tyre compounds as into the design of the recipes. Mixer technology has, until recently, remained unchanged for many years with major companies reluctant to invest in expensive new plant. Many of today's compounds, however, require modern mixers with alternative rotors to the tangential designs, intermeshing (159), interlocking (196) or a combination (299), together with superior computerised control systems, which help in the temperature control. Much work with computer models and neural networks (262, 355) is now finding application to help in understanding how processes and mixer operations can improve the quality and efficiency of ingredient incorporation and hence the resulting performance of the compound.

Downstream, extruders are producing more complex multiple components (240, 280) at faster rates, which has again led to a revolution in equipment design. Modern equipment manufacturers are now attempting to integrate mixing into the extrusion

process to facilitate a single continuous (266, 284) rather than batch processing technique, even considering cold mixing (138) technology. New ingredients are being developed, where the filler is combined with the polymer at the polymerisation stage to generate a powdered rubber material (39, 103), suitable for continuous mixing through an extruder rather than an internal mixer.

The concept of precuring components using electron beam radiation (EBR) (418, 431) has been utilised to prevent movement of cords within their bonding compound and to shorten cure times.

All these techniques may be of use, especially with the current move towards integrated modular tyre manufacture, which has such acronyms as MIRS (95), Impact and C3M (421), etc. Here small space and energy efficient, self-contained production units deliver compounds and components to building machines in a fast and highly flexible configuration. Again, the whole subject of tyre manufacturing technology could be the subject of another review.

For tyre compounders, new process technology opens up fresh opportunities of study in the formulation of tyre compounds.

A range of ancillary materials have been developed to support the tyre manufacturing process, anti-tack solutions (63, 321), tack promoters, internal and external release agents (369, 370), paints and sprays. Here again there are many conflicting needs which material suppliers and users have had to balance. Productivity with reduced scrap needs to be balanced against cost and environmental impact. Over the past few years there has been a strong drive throughout the whole rubber industry to eliminate solvents or volatile organic compounds (VOCs) from the basket of process chemicals. Either substitution with water based (221) materials or the complete elimination of these materials has occurred, in a major initiative to create a cleaner healthier environment.

Tyre surface quality when it leaves the mould is becoming more important in the eyes of customers. Materials added during processing must not discolour the outer surface of tyres. More than that, the moulding process can now even enhance the final appearance of the tyre. Clean black and smooth product surfaces make tyres attractive on a vehicle. This has also led to a whole new interest in additives (213), mould cleaning (62, 187) and techniques of mould surface design.

## **6 Compound Properties**

Tyre compounders carry out a range of conventional compound tests aimed at determining the downstream processability of a compound and to predict final tyre performance. The tests include those traditional to the rubber industry with a few more novel tests developed specifically to help tyre compounders.

### **6.1 Rheometry**

The rheological behaviour of a compound, normally defined by Mooney viscosity will determine the energy required to process a component. If the viscosity is too high there may be a risk of surface scorch thereby reducing component tack (398) and giving rough extrudates (212). It is vital, however, to know the stiffness of the green compound as measured at typical processing rates of shear, which may be orders of magnitude greater than those found in most conventional laboratory rheometers. Many new tyre compounds are becoming more demanding on processing. Stiffer components are required to give support to the tyre whilst weight reductions are dictating thinner and more sharply defined component shapes. Processability in large volumes has produced a gamut of new process aids to support the compounder.

New equipment for assessing processability, like the Rubber Process Analyser (RPA) from Alpha Technologies, are being introduced into the control laboratories of factories to monitor the more sensitive parameters of raw component viscosity and compound elasticity (331, 332, 338, 345, 419). Interpretation of these traces will indicate many useful factors to help the compounder understand the various physical and chemical actions that take place during mixing.

Once processed the tyre components must be cured to obtain the final shaped crosslinked tyre. A moving die rheometer (MDR, developed by Monsanto now Alpha Technologies) is generally used to track the compound stiffness against time as it cures at an elevated temperature. The trace will monitor the margin of processing safety, the rate at which the compound cures and the final stiffness at optimum cure. Each parameter can be used firstly to develop a compound cure system with the desired process characteristics and then within a factory environment to monitor the ongoing consistency of each successive mix. The demand for high productivity means cure times are becoming ever shorter. Faster curing formulations are needed but they must process safely leading to a balance of slow cure

initiation followed by rapid cure rates. In thick components of truck or earthmover tyres the internal components will be critical in reaching the desired state of cure. Long times are sometimes required for the necessary temperature rise to be achieved deep within a tyre section whilst guarding against overcure at the surface which could result in less than optimum performance. Finite element computer models are now available which can call upon non-isothermal cure data, Arrhenius reaction rates, tyre shapes and mould characteristics to predict cure times and carry out 'what if' scenarios to help reduce overall cure times.

### **6.2 Ingredient Dispersion**

In the early stages of mixing it is important to ensure that all ingredients are well-dispersed (150), since this will have a critical effect on downstream processing and ultimate tyre performance. Good dispersion offers more contact area between the polymer and filler molecules and also influences the mobility of the polymer chains. Optical techniques (269, 372, 389) have been developed using transmission or reflection microscopes to evaluate the dispersion of ingredients within a compound. High dispersion levels are needed for most performance characteristics, whilst poor dispersion may be indicative of problems in the mixing stage or with raw material handling.

### **6.3 Physical Properties**

Compounders still use classical measurements of tensile strength, modulus, tear strength, hardness, abrasion, permeability, heat build-up, fatigue, skid resistance (379), resilience, etc., to determine the properties of various tyre components. These techniques have already been reviewed (5, 79, 422). The results are key indicators about how a compound is likely to perform but they reveal little about some of the more complex tyre performance characteristics that may be experienced in the field. From stress-strain curves, much of the more fundamental data required by finite element analysis models can be obtained.

Newer techniques are available offering a wider range of data, some of which can be used to relate more closely to final tyre performance. The techniques for assessing the strain energy density applied and the tear energy as it relates to component fatigue, have led to the introduction of new methods (145) and test rigs such as the tear analyser (357, 359). This rig can be used to determine more precisely the fracture

mechanics data for compounds. Again such data may be required where finite element modelling is being used to assess structural durability.

Wear, or the slow loss of material from the surface of a rubber product is not a simple mechanism, it is the composite effect of several factors. Abrasive wear occurs as the rubber is dragged across sharp asperities that cut or tear the compound. Fatigue wear can occur as compound is repeatedly stressed until it fails through microscopic crack propagation. Adhesive wear occurs under the slip-stick mode of grip where the rubber is momentarily bonded to another surface then, as it is removed, tiny pieces tear away from the main body of material. Each mechanism can occur in the contact patch depending upon the mode under which the tyre is operating. Predicting tyre wear from a single condition test only (108) is fraught with dangers. Fundamental wear test rigs such as DIN, Taber or PICO (296, 297), whilst still being used for pre-sorting, are now being superseded by new machines tests like the Lambourn (333, 416), Grosch (99, 351, 366, 388, 414), FKK (155) or even whole tyre test drums (203). Each claim to assess wear under a wider range of conditions likely to be experienced in the real world. Properties versus performance maps can be produced to predict wear potential under a wide range of operational conditions. Crossovers in performance have been established which highlight the risk of judging performance from single condition tests.

For sidewall compounds it is valuable to have some understanding of the resistance to ozone under static or dynamic conditions. In some places around the world sunlight or UV light is intense, and tyres may be exposed to high concentrations of ozone. Laboratory ozone cabinets (394) can quickly determine whether or not there is likely to be a problem for the sidewall compound.

Permeability is of particular importance when developing the inner liner. If any oxygen or moisture is contained within the inflation air and permeates into the carcass, attack of adhesive bonds may begin to occur. A simple rig with a diaphragm of rubber separating two sides of a cell can be employed to monitor a pressure gradient or flow rate as a measure of permeability or diffusion. Alternatively, and more realistically, the pressure loss over time of an inflated tyre can be used to assess the permeability of the liner assembly itself.

There is an additional test in which a hypodermic needle attached to a pressure gauge is carefully inserted into the tyre casing to measure casing pressure build-up.

## **6.4 Adhesion**

The integrity of a tyre in service depends upon the ability of components to stay bonded to each other even after long severe conditions of heat and stress. The most critical components for adhesion are the compounds that bond to the continuous reinforcing cords of nylon, rayon, polyester and more critically steel (brass coated). Numerous tests have been devised to simulate ageing by heat, humidity, salt, high oxygen concentrations, etc. These have been coupled with many static and dynamic test modes to determine how the cord to rubber interface may weaken. Compounders use many tests to evaluate any new formulations that may offer improved adhesion, particularly after ageing. Studies also involve tests of surface chemistry to explain the mechanisms of adhesion and to show how ingredients can counter the chemical failures that may occur at the interface. Scanning electron microscopy (325) of surface elements indicates how the dendritic structures and chemistry within the interface play a part in determining the durability of the bond.

Here again is another physical property where finite element modelling is gaining credence, through its ability to predict stress concentrations and heat build-up within tyre structures. Fatigue and even possible structural failure may now be modelled in the computer so that compound properties can be used to pre-test prior to building tyres and carrying out field trials.

Nuclear magnetic resonance (NMR) hydrogen ion imaging is a new technique (315) that is being used to track the rubber ageing process.

## **6.5 Viscoelasticity**

The rubber used in products is inherently, but not entirely, elastic. When a strain cycle is applied to a rubber component the behaviour is therefore not completely Hookian. During the application and release of the stress, the strain lags slightly due to hysteresis losses within the molecular structure.

Using dynamic tests it is possible from the stress-strain curves to resolve the elastic, viscous and hence the complex moduli of the compound. The loss tangent ( $\tan \delta$ ) is the ratio of the elastic to the viscous moduli.

Each of these properties is temperature and frequency dependent as the material changes from a plastic to an elastic form. They are important parameters that strongly influence the performance of the final product.

Many workers (67, 86, 396) have attempted to explain how laboratory measurement of viscoelasticity can offer insights into the potential performance of tyres under various test conditions.

Below a critical temperature or above a critical frequency the ability of side groups on the molecular chain to rotate becomes inhibited. The material then behaves like a plastic. Conversely at higher temperatures or lower frequencies the chains are more mobile and the material behaves like a rubber. The temperature at which this change occurs is defined as the glass transition temperature ( $T_g$ ) of the polymer or compound. Passing through the transition, the hysteretic energy loss, as defined by  $\tan \delta$ , goes through a maximum.

In winter environments where temperatures are well below 0 °C, polymers like natural rubber offer the best elasticity retention. As ambient temperatures rise, the SBR polymers work more effectively to provide a good balance of properties. Some of the new polymers are either high in their glass transition temperature or possess a broad transition over quite a wide temperature range.

There are several types of equipment on the market to evaluate the viscoelastic properties of compounds, each operating in its own way. They use various modes of motion, cyclic or pulsed (100), different sample shapes and each has its own options for strain modes, strain rates, amplitudes, etc. Various modes: tensile, compression and shear, have been used to try and improve the correlation with tyre performance. The classic Williams, Landel and Ferry (WLF) transposition of temperature and frequency into single master curves (326, 340) requires that, for simplicity of operation, many test rigs evaluate compound viscoelastic properties over a range of temperatures either side of the glass transition point. The transposition theory defines a decrease in temperature as being related to a corresponding increase in frequency. The test principle is to measure the changes in elastic and viscous stiffness levels over a range of strains and temperatures and assume these are equivalent to appropriate changes in frequency of deformation.

Various models (83, 143, 417) have been proposed in the literature, but generally it is accepted that the lower the hysteresis, as measured by the  $\tan \delta$  value at tyre running temperatures (60 °C to 70 °C), the lower the energy loss. This in turn leads to a lower drag force as the tyre rolls and hence a lowering of the fuel consumption for the vehicle. Making compounds more elastic therefore improves rolling resistance. Additionally a low  $T_g$  compound may exhibit good wearing characteristics under normal operating conditions.

A proposed mechanism for wet grip is one where the tread compound envelops road surface asperities. The more the enveloping power and the slower the compound is to release its hold on the asperity, the greater the grip. Here the mechanism is a very high frequency phenomenon (MHz), related to the tread surface moving across the small microtexture of the road surface. In order to achieve this the compound needs to exhibit high hysteresis or  $\tan \delta$  high frequencies, hence lower test temperatures are used (-20 °C to 0 °C). A higher glass transition temperature for improved wet grip at high frequencies (78, 158, 208, 384, 406, 410) may therefore be detrimental to rolling resistance and wear. Other workers claim that modelling molecular relaxation processes (130) is another important aspect in predicting tyre performance or, alternatively, an understanding of the polymer to filler interactions (181, 182, 210). The characteristics of a filler may be used (122) to explain its reinforcing properties.

Compounders are continually seeking new polymer structures; novel fillers like silica and improved filler to polymer coupling in order to enhance each of the critical viscoelastic performance criteria with little or no compromise.

## **7 Future**

It is difficult to envisage what the future holds in store, but from the emerging technologies it is possible to briefly predict some of the future trends which are likely to influence thinking in the field of tyre materials.

### **7.1 Smart Materials and Tyres**

Vehicle electronic systems are growing and improving as every new model is launched. Much new technology has already been incorporated into the tyre and vehicle performance characteristics (antilock braking systems, traction control, pressure warning systems and even surface friction sensors, etc.). The properties of tyre materials and in particular those in the contact patch area, determine much about the vehicle handling and safety characteristics. If the data from the contact patch can be fed back to the vehicle electronics, the tyre will then play an even greater role in determining or even controlling vehicle performance.

The Continental tyre company have demonstrated a Sidewall Torsion Sensor concept (218, 235) in which alternately polarised strips of ferromagnetic powder are

orientated within the tyre sidewall, such that they can be used to detect tyre shape changes occurring during operation. Information is processed by on board computers to indicate pressure loss, steering anomalies, slip and wear, thus providing feedback to shorten braking distances and improve driver control on poor roads.

Electrostatically charged tread surfaces have been suggested to improve snow grip. Here the attractive forces between oppositely charged particles are exploited to increase the grip between the tyre surface and ice.

Nanocomposites (61) are just beginning to find a foothold in tyre compound developments and it is perhaps this field which may show the most promise for smart tyres and materials in the future. Carbon black manufacturers are exploring the novel possibility (211) of plasma surface modifications to black particles in an SBR matrix.

Each of these new and exciting fields will offer future compounders the chance to revolutionise not only compound properties, but also the opportunity to develop an integrated response system for the whole vehicle.

## **7.2 Run-Flat Tyres and Deflation Warning Systems**

The spare tyre is a heavy, and in many cases, unnecessary weight to be carried around in the vehicle. Tyres are becoming more reliable and durable, but punctures can still occur. Companies have been studying techniques for eliminating the spare tyre for many years. There was an early launch of Dunlop's Denovo with its re-inflating insert chemistry. More recently the use of sealant technology (348) and instant mobility systems have been demonstrated (335). A space saving, temporary spare is an option finding favour with some carmakers. Most of the major tyre companies now have products that will run for a defined safe distance and speed when the air is lost. Self-supporting tyres with heavy sidewall inserts (227, 392) have required compounders to formulate new recipes that are stiff enough to support the load, but also resistant to the excessive temperatures that are generated as the tyre over deflects. Ultra high tensile steel cords (374) may replace or supplement the conventional polyester or rayon carcass of run-flat car tyres. The downside of this insert philosophy, which is not required for a very high percentage of the tyre's life and in most cases never at all, is that it is a heavy addition detracting from weight, rolling resistance and ride comfort.

Other run-flat systems have been developed that incorporate a separate internal support ring of novel

materials and designs, which prevents the tyre from over distorting and hence dislodging from the rim.

The market is still reluctant to adopt these run-flat tyres until there is an integral system that warns the driver of pressure loss. Many new 'smart' developments are hitting the markets that monitor tyre temperatures and pressures. This type of monitoring is also beneficial to fleet operators who need to measure and maintain tyre operating pressures to minimise tyre wear and fuel consumption.

In order for reliable run-flat or run-on tyres to be fully accepted as a means of eliminating the spare tyre, a fresh look may be required into how materials and components can perform well under the rare circumstance of duress. This must be set against the fact that for most, if not all of their life, the new compounds or structures should not detract from the tyre's performance under normal operating conditions

## **7.3 Mathematical Modelling**

In order to improve speed to market, scientists are trying to carry out as much rapid prototyping on virtual products as early as possible in the development cycle. This topic has been the subject of an earlier review (179). Numerous mathematical techniques are being developed using the power of modern supercomputers running finite element modelling to predict tyre performance.

The main thrust of the work has been to either predict the stresses and temperature profiles within a rolling tyre, or to predict the performance characteristics such as wet grip, rolling resistance, noise or handling. The road surface, tyres, suspensions and vehicles are now being integrated into single models which provide the development engineers with a view of the entire vehicle's performance long before it becomes a reality.

The coding and theory for all these models is advancing rapidly but any model requires good, accurate data and in the case of tyres this is geometry and material properties. Since compounders are supplying basic data (330) on compound properties to drive these models, new modes, even multiple modes of deformation are required to produce the necessary material parameters. New test rigs and methods are being devised to feed the models with the appropriate data. How long will it be before the desired tyre performance properties from these models are fed back to the compounder, who will have to produce a compound, or even to raw material suppliers who will have to develop an ingredient with a specific set of properties?

Compounders are also using modern analytical techniques like neural networks (262, 358, 423) and fuzzy logic (365) for compound property optimisation. Scientists can model polymers and other ingredients at a molecular level to study the effects of changing the molecular building blocks or the way in which the polymer chains crosslink. Mixing and extrusion processes have been modelled (45, 115, 176). Modelling final material or even tyre properties from raw ingredient data must be a logical progression to this advance in performance prediction.

## **7.4 Environmental Issues**

### **7.4.1 Chemicals**

The need to produce safer, cleaner environments is driving the generation of new 'environmentally friendly' materials. Many potentially harmful materials such as nitrosamine generating chemicals have been eliminated from the ingredient basket of tyre companies. Heavy metal elements have all but been eliminated, with zinc as the next possible target for reduction or elimination. As an activator, zinc oxide has seen a long history in the rubber industry but from where will its successor come? More recently attention has been paid to finding alternatives to polycyclic aromatic oils to reduce the possible risks of cancer. The use of solvents is also being reduced or eliminated to produce a cleaner working environment. The work will inevitably continue as each ingredient in turn comes under the environmental microscope.

### **7.4.2 Rubber Recovery from Scrap Tyres**

When rubber ingredients are mixed, processed and cured, the products or any cured scrap produced along the way cannot be just put back into the mixer and reprocessed like some thermoplastics. As the old saying goes, 'you can't unbake a cake into its constituent ingredients of flour, eggs and so on'.

Millions of tyres are removed from vehicles every year producing an estimated 2.5 million tonnes of scrap in Europe alone. This has provoked a growing interest in recycling within the industry (415). The whole subject of end-of-life tyres has been studied in depth and reported in a Rapra Industry Analysis Report in January 2001 (31).

Prior to 1986 there was, apart from truck tyre retreading, virtually no scrap tyre recycling industry.

Conventionally tyres were disposed of by landfill or burning. Tyres present a valuable source of materials and also, tyre-derived fuel contains a high calorific source of energy. At the end of their lives, tyres can be burnt although the process has raised concerns over further pollution problems (386). Many tyres are still dumped in landfill sites but this has led to serious problems such as fires raging out of control for years. Whole tyres have also been successfully used to build coastal sea defences, but again it has been suggested, although not substantiated, that there could be risks that chemicals may leach out or that biological infestation may occur.

Burning and landfill techniques may no longer be allowed in the not too distant future, since there is to be more stringent control over emissions from incinerators and a total ban on landfill, even of shredded tyres, by 2006. The industry is therefore addressing the problem of how to dispose of scrap tyres with even greater urgency, with reclaim now becoming a more favoured option. There is also a growing interest in the EU end-of-life vehicle directives and how to dispose of scrap tyres from old cars, as well as the many other components on a vehicle. This has led to a growing emphasis being placed on the whole subject of material usage by the industry, government bodies and environmental monitoring groups.

There is an opportunity for tyres to be ground into a fine mesh crumb (75, 192). Devulcanisation (395), ultrasonics (193, 285), bioreactions (385), cryogenics (136) or pyrolysis (65, 350) may break a compound down to its constituent parts. Reclaimed rubber crumb has already found many novel applications. These include a bitumen additive for road surfaces (53, 128, 135, 197, 364), when coated in a trans-polyoctenamer (TOR), flooring, sports surfaces, and even as a raw material to be recycled back at fairly small loadings into new tyre or other components (198). Rubber crumb is an inert filler, but it may be possible to activate (46, 69, 194, 199, 278, 308) the crumb to provide a more chemically integrated addition.

Whilst on the subject of end-of-life tyres, an interesting final question which may be asked is not 'why do tyres fail?', but 'why do some tyres last so long?' Evolution in the natural world is believed to arise through survival of the fittest. If a compounder were to study all the attributes of these long life tyres, taking into consideration the operating environment, then perhaps much could be learnt to produce other tyres with the same longevity characteristics.

## References from the Rapra Abstracts Database

*Item 1*

**Tyres & Accessories**

No.5, May 2001, p.75

**VREDESTEIN PROTRAC 2 SI**

Features are described of Vredestein's latest tyre, the Protrac 2 Si. The tyre combines enhanced safety characteristics with reductions in both the environmental and financial costs of motoring. Improved safety characteristics have been achieved by innovative use of silica. By combining wet silica solution 1 to the tread compound, the company claims to have reduced braking distances by a further 5-10%. This has provided better steering reaction in both dry and wet surfaces. In addition, the sidewall construction has been improved, leading to enhanced suspension which gives better stability. The tyre also contains the dual anti-aqua formula to prevent aquaplaning and the double safety system based on directional tread and robust shoulder construction. Environmental benefits are obtained through improved fuel economy.

VREDESTEIN NV

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

*Accession no.828628*

*Item 2*

**Luntai Gongye**

21, No.8, 2001, p.480-1

Chinese

**APPLICATION OF ACTIVE ZINC OXIDE WITH  
LARGE SPECIFIC SURFACE TO SHOULDER  
PAD**

Wei T-X

The results are reported of a study of the effect of using 5 phr of active zinc oxide instead of 8 phr of conventional zinc oxide on the Mooney viscosity, scorch time, Shore hardness, tensile strength, 300% modulus, elongation at break, Goodrich heat build-up and tear strength and costs of vulcanisates for tyre manufacture.

CHINA

*Accession no.827113*

*Item 3*

**Tyres & Accessories**

No.8, Aug.2001, p.68

**GOODYEAR GT3 - GOODYEAR'S GREENEST-  
EVER TYRE**

June saw the official launch of Goodyear's GT3 tyre, an environmentally-friendly tyre that uses maize-derived starch as a tyre filler. BioTred biopolymeric filler has a spherical particle shape which minimises mechanical energy and reduces rolling resistance. Compared to the GT2, the new tyre has improved aquaplaning resistance,

by 5%, and 10% better wet braking. It is also 30% quieter than the previous model and is 100g lighter. Better fuel consumption means a lower output of carbon dioxide. The production of BioTred is itself environmentally friendly, requiring less energy. Also, maize is a renewable resource and, while it is growing, it converts carbon dioxide to oxygen via photosynthesis to the extent that Goodyear estimates that it could account for 17% of the car manufacturers' CO2 reduction objectives.

GOODYEAR

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

*Accession no.826833*

*Item 4*

Shawbury, Rapra Technology Ltd., 2001, pp.x, 386,  
25cm, 9(12)4

**HANDBOOK OF RUBBER BONDING**

Edited by: Crowther B

This book is the first for many years to be solely devoted to the subject of rubber bonding. The book presents a series of papers written by a variety of authors with practical expertise within the field who have been engaged in improving the bonded product to meet the ever increasing demands placed on composites and components manufactured from rubbers bonded to metals, fabrics, fibres and plastic substrates. Chapter titles include: Substrate preparation methods; Rubber to metal bonding; Rubber to metal and other substrate bonding; Bonding rubber to metals with waterborne adhesive systems; Rubber to rubber bonding; Rubber to Brass bonding; Review of tyre cord adhesion; Rubber to metal bonding using metallic coagents; Rubber to fabric bonding; Bonding rubber with cyanoacrylates; Bonding silicone rubber to various substrates; failures in rubber bonding to substrates. Each chapter is well referenced.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
INDIA; UK; USA; WESTERN EUROPE

*Accession no.826525*

*Item 5*

Shawbury, Rapra Technology Ltd., 2001, pp.vi, 156,  
25cm, 93

**PRACTICAL GUIDE TO THE ASSESSMENT OF  
THE USEFUL LIFE OF RUBBERS**

Brown R P

This book provides practical guidance on assessing the useful service life of elastomers. It covers test procedures and extrapolation techniques together with the inherent limitations and problems. The information can be applied to help maximise the effectiveness of a durability testing programme. The results of a project studying 40 years of natural rubber ageing and an accelerated testing

programme conducted by Rapra have been drawn on to indicate the limiting factors for particular materials and methods. The book is split into three parts. The main headings in Part One - Basics are: Introduction; The problems; The choice of approaches; Degradation agents; Degradation mechanisms; Time dependent limitations; Critical factors; Parameters to monitor degradation; Preparation of test pieces. The main headings in Part Two - Product Tests and Experience are: Simulating service; Experience; Principles of product testing. The main headings for Part Three - Accelerated Tests are: Fundamental problems; Designing an accelerated test programme; Effect of temperature; Effect of liquids; Effect of gasses; Weathering; Fatigue; Abrasion; Other degradation agents; Service conditions; Prediction techniques; Limitations and pitfalls in accelerated testing. (35 refs.)

RAPRA TECHNOLOGY LTD.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.826524

*Item 6*

**Kautchuk und Gummi Kunststoffe**

54, No.6, 2001, p.308/14

**EFFECT OF 1,3**

**BIS(CITRACONIMIDOMETHYL)BENZENE IN  
SILICA CONTAINING COMPOUNDS**

Datta R N; Hondeveld M G J

Flexsys BV

The effect of the antireversion agent 1,3 bis(citraconimidomethyl)benzene(Perkalink 900) was investigated in silica-containing off-the-road(OTR) and 'green tyre' compounds. It was shown that, by using Perkalink 900, it was possible to reduce the level of silane coupling agent, bis(3-triethoxysilylpropyl)tetrasulphide, both in OTR and in 'green tyre' compounds, providing either equivalent or better performance characteristics such as improved reversion resistance, lower heat build-up and enhanced blow-out times. The polymer-filler and filler-filler interaction parameters remained virtually unchanged, indicating no detrimental effect on reinforcement characteristics. Network studies indicated that Perkalink 900 provided better heat resistance because of the incorporation of thermally stable as well as flexible C-C crosslinks during the reversion regime. 24 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.825066

*Item 7*

159th ACS RUBBER DIVISION MEETING - SPRING 2001. Held Rhode Island. 24th-27th April 2001.

Akron,Oh., 2001, Paper No.57, 012

**REDUCED SILANE USAGE IN WET TRACTION  
ORIENTED COMPOUNDS THROUGH HIGH  
SURFACE ACTIVITY-REDUCED SURFACE**

**AREA HIGHLY DISPERSIBLE SILICA OR  
THROUGH HIGH DENSITY FILLER BLENDS**

Gatti L

Huber J.M.,Corp.

(ACS,Rubber Div.)

Comparison was made between a standard 150 CTAB highly dispersible(HD) silica and a 90 CTAB High Geminal Content(HGC) HD silica, a 90 CTAB HGC HD silica blended with carbon black and a surface-treated barium sulphate blended with carbon black, based on the constant energy filler system approach. Tyres were tested for rolling resistance, wet traction, low and high speed handling and ride comfort, wheel durability and treadwear. Generally favourable results were obtained with some need for compound optimisation. The three new compounds provided compounds with reduced or eliminated use of silane coupling agents which would provide a material cost reduction and improvement in manufacturing process issues. 2 refs.

USA

Accession no.824970

*Item 8*

159th ACS RUBBER DIVISION MEETING - SPRING 2001. Held Rhode Island. 24th-27th April 2001.

Akron,Oh., 2001, Paper No.55, pp.38. 012

**NEW GENERATION CARBON-SILICA DUAL  
PHASE FILLER. I. CHARACTERIZATION AND  
APPLICATION TO PASSENGER TIRE**

Meng-Jiao Wang; Kutsovsky Y; Ping Zhang; Murphy L J; Laube S; Mahmud K

Cabot Corp.

(ACS,Rubber Div.)

A new carbon-silica dual phase filler(CSDPF) 4000 was developed for use in passenger tyres. This filler featured higher levels of silica at the surface of the aggregate and higher silanol contents than the CSDPF 2000 ECOBLACK family of products introduced previously. From the compounding point of view, this new dual phase filler showed higher polymer-filler interaction on the carbon domains and lower filler-filler interaction relative to the conventional fillers used in tyre tread compounds. The new filler showed significant improvement in wet skid resistance over the earlier products. When this filler was used in passenger tyre tread compounds, the trade-off between rolling resistance, wear resistance and wet skid resistance of the tyre could be significantly improved compared with conventional fillers. 19 refs.

USA

Accession no.824968

*Item 9*

159th ACS RUBBER DIVISION MEETING - SPRING 2001. Held Rhode Island. 24th-27th April 2001.

Akron,Oh., 2001, Paper No.53, pp.38. 012

**IMPROVED PROCESSING WITH THERMOPLASTIC BOUND SILANE COUPLING AGENTS**

Tisler A L  
Rhein Chemie Corp.  
(ACS,Rubber Div.)

The advantages of using thermoplastic-bound silane coupling agents are discussed with reference to easy dispersion, rapid first pass coupling reactions with a silica filler, cleanliness in handling and resistance to moisture absorption. A model tread compound was used to demonstrate the application of various product forms, i.e. bis(3-triethoxysilylpropyl)tetrasulphide in thermoplastic pastille form and disulphide-bridged silane (bis(3-triethoxysilylpropyl)disulphide). The results showed opportunities for major cost savings when the improved product form was used to achieve better mix in less time and improved physical properties in the final compound. 6 refs.

USA

Accession no.824966

*Item 10*

159th ACS RUBBER DIVISION MEETING - SPRING 2001. Held Rhode Island. 24th-27th April 2001.

Akron,Oh., 2001, Paper No.37, pp.26. 012

**HIGH MOLECULAR WEIGHT TETRA ALKYL THIURAM DISULFIDE(TATD) IN TIRE COMPOUNDS TO INCREASE CURE RATE WITHOUT SACRIFICING SCORCH SAFETY AND DYNAMIC PROPERTIES**

Hong S W; Hannon M J; Kounavis J; Greene P K  
Uniroyal Chemical Co.  
(ACS,Rubber Div.)

The use of TATD in various tyre compounds was evaluated with the aim of increasing cure rate and maintaining properties. Comparison was made with the use of tetrabenzylthiuram disulphide(TBzTD). TATD provided equivalent scorch time to TBzTD in NR compounds, lower modulus and higher elongation. Tetramethylthiuram disulphide gave the fastest cure, but worst scorch safety, lowest elongation and higher modulus. TBzTD provided equivalent scorch time to the control, but reduced elongation and increased modulus. TATD had similar properties to the control with faster cure. Abrasion resistance with TBzTD and TATD was much better than the control compound without a secondary accelerator. 4 refs.

USA

Accession no.824952

*Item 11*

**Rubber World**

224, No.4, July 2001, p.34-9

**MIXING OF SILICA COMPOUNDS FROM THE**

**VIEW OF A MIXER SUPPLIER**

Berkemeier D; Haeder W; Rinker M; Heiss G  
Krupp Elastomertechnik GmbH; Krupp Rubber Machinery Inc.

Trends in the use of silica in tyre formulations as a coupling agent are discussed with reference to developments in mixing machinery to best process the compounds. Because of the chemical reaction during the mixing process, the internal mixer acts as a chemical reactor in which the batch temperature control must be very accurate. In addition to the dispersion of filler in the compound, the reaction must be achieved. An overview is presented of current mixing available mixing equipment for producing silica compounds and the different demands placed on the mixing process are examined. Different mixer systems are compared and further requirements of the mixer itself and the control system are discussed. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.824399

*Item 12*

**International Polymer Science and Technology**

28, No.5, 2001, p.T/47-53

**MATERIALS TECHNOLOGY FOR REDUCING ROLLING RESISTANCE**

Muramatsu R; Takahashi H

Materials technology research and development, aimed at reducing fuel consumption by the reduction of rolling resistance in tyres is discussed, and with particular reference to the considerations which have to be made regarding the trade-off between rolling resistance and wet skid resistance, and the growing use of silica tyres. Reduced rolling resistance materials are examined with particular reference to solution polymerised butadiene rubber (S-SBR). The chief design factors for S-SBR are microstructure, molecular weight distribution and branching, and molecular modification by end-modification techniques. Silica tread compounds together with fuel efficient carbon blacks and other compounding materials are examined. 37 refs. (Article translated from Nippon Gomu Kyokaishi, No.2, 2000, p.103)

JAPAN

Accession no.824318

*Item 13*

**International Polymer Science and Technology**

28, No.5, 2001, p.T/13-5

**INTERACTION BETWEEN CARBON BLACK AND RUBBERS WITH FUNCTIONAL GROUPS IN THE MACROMOLECULE**

Shmurak I L  
NIIShP

The interaction between rubbers and fillers containing functional groups on the particle surface, is investigated

with respect to the performance of tyres and other rubber goods, and with special reference to the effects on bond strength between impregnated cord and rubber. This present work investigates the interaction of the functional groups of the carboxyl-containing butadiene latex, butadiene-methylvinylpyridine latex, butadiene-styrene-2-vinylpyridine latex, butadiene-acrylonitrile copolymer, butadiene-diethylaminoethylmethacrylate copolymer, and epoxidised butadiene latex containing 2.2% of epoxide groups with the active groups on the surface of particles of channel black. Results obtained are claimed to provide evidence of interaction between the functional groups of the latex polymers from the adhesive and active groups on the surface of the filler particles, thus opening up the possibility of improving the mechanical and adhesion properties of rubbers by intensifying the interaction between the rubber and the carbon filler. 11 refs. (Article translated from *Kauchuk i Rezina*, No.5, 2000, p.28)

RUSSIA

Accession no.824309

*Item 14****International Polymer Science and Technology***

28, No.5, 2001, p.T/7-9

**PLASTICISING EFFECT OF AROMATIC SOFTENERS OF DIFFERENT STRUCTURAL-GROUP COMPOSITIONS**

Pankratov V A; Maiorov G A; Emel'yanov D P; Yanson E F

Yaroslavl', State Technical University

The influence is investigated of the use of two types of softeners, (DVC and DAT), one containing light and medium aromatic hydrocarbons and one composed of heavy aromatic hydrocarbons on the properties of tyre tread rubber compounds with reference to the physical and mechanical characteristics of vulcanisates. The DVC softener was obtained by furfural extraction of distillate from vacuum cuts of petroleum and the DAT softener was obtained by furfural extraction of de-asphalted tar. (Article translated from *Kauchuk i Rezina*, No.5, 2000, p.23)

RUSSIA

Accession no.824307

*Item 15****Tire Science and Technology***

29, No.2, Apr./Jun. 2001, p.91-107

**TORSIONAL CRACK GROWTH TEST TO SIMULATE BELT EDGE DEFORMATION**

Fleischman T S; Kerchman V; Ebbott T G

Goodyear Tire &amp; Rubber Co.

The development of a test to simulate crack growth in shear (mode III), which involves testing a rubber disk with a circumferential pre-crack in cyclic torsion to simulate belt edge interlaminar shear cycles, is reported. The test geometry was analysed using linear and finite element techniques and calibrated using an experimental

procedure. Fatigue crack growth tests were carried out on rubber compounds, including NR and SBR containing different carbon black levels, and the failed fracture surfaces examined to explain a marked slowing down of crack growth rate at the end of the test in some instances. 7 refs. (Nineteenth Annual Conference, Tire Society, Akron, Ohio, April 25-26, 2000)

USA

Accession no.823141

*Item 16****Journal of Adhesion Science and Technology***

15, No.6, 2001, p.689-701

**PROMOTION EFFECT OF A CHLOROTRIAZINE DERIVATIVE ON THE ADHESION BETWEEN RUBBER COMPOUNDS AND A BRASS-PLATED STEEL CORD**

Jeon G S; Seo G

Damyang, Provincial College; Chonnam, National University

The effect of a chlorotriazine derivative, as an adhesion promoter, on the adhesion between rubber compounds and brass-plated steel tyre cord was investigated. The physical properties, cure characteristics and adhesion of the chlorotriazine derivative-loaded rubber compounds were determined and the adhesion interphases characterised. Depth profiles of copper and sulphur and zinc and oxygen for unaged and humidity-aged rubber compound/brass film adhesion samples as a function of chlorotriazine derivative are illustrated. 25 refs.

SOUTH KOREA

Accession no.823101

*Item 17****Tire Technology International***

June 2001, p.23-5

**CALL REINFORCEMENTS**

Scarlett M

The latest technology in tyre reinforcement is examined, paying particular attention to the situation with regard to carbon black and silica and reinforcing filler trends within the tyre industry.

USA

Accession no.823037

*Item 18****Kautchuk und Gummi Kunststoffe***

54, No.5, 2001, p.256-9

**IMPROVED RUBBER PROPERTIES BY USING N-T-BUTYL-2-BENZOTHAZOLE SULFENIMIDE (SANTOCURE TBSI)**

Datta R N; de Hoog A J

Flexsys BV

The use of SANTOCURE TBSI primary amine-based accelerator in a NR/SBR 70/30 tyre compound requiring

long scorch safety combined with a moderately slow cure rate was studied. The properties of the vulcanisates examined included cure and processing characteristics, physical properties after overcure and ageing, tear strength, compression set, heat build-up and crosslink density distribution. Attempts were made to correlate these properties with the network structure. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.820513

*Item 19*

IRC 2001. Proceedings of a conference held  
Birmingham, 12th.-14th. June.  
Birmingham, IOM Communications, 2001, p.627-635.  
012

**POLYMER DEVELOPMENTS TO IMPROVE  
TYRE LIFE AND FUEL ECONOMY**

Engehausen R; Sumner A J M; Trimbach J  
Bayer AG  
(Institute of Materials)

A modern tyre has to meet constantly increasing requirements with regard to safety, environmental protection and economy. This paper describes how the key factors of tyre life and fuel economy can be improved by using modern synthetic rubbers. Developments are examined with respect to a new polymer for tyre innerliners, and low rolling resistance tyres. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.820093

*Item 20*

IRC 2001. Proceedings of a conference held  
Birmingham, 12th.-14th. June.  
Birmingham, IOM Communications, 2001, p.484-495.  
012

**IMPROVED DYNAMIC PROPERTIES IN  
TRUCK AND OFF-THE-ROAD TYRES**

Datta R In; Ingham F A A  
Flexsys BV  
(Institute of Materials)

The problems of heat build-up are discussed with reference to large truck and off-the-road tyres which are frequently required to operate at high loads and high speeds for extended periods of time. As a consequence of excessive running temperatures, reversion in compound components may occur, which may in turn lead to reduced tyre durability or, in extreme circumstances, to tyre failure. Much effort has been expended over the years to improve the dynamic properties of tread compounds such that tyre running temperatures and rolling resistance can be reduced and stabilised throughout the lifetime of the tyre. An established approach is the use of so-called semi-efficient cure systems comprising reduced sulphur levels and increased accelerator levels. However, though

effective in improving viscoelastic properties, this approach is only partially successful since lowering of sulphur levels negatively influences other desirable properties such as tear and flex/fatigue life. This paper reports laboratory results concerning modifications to truck and off-the-road (OTR) tread compounds, with special reference to the antireversion agent Bis(citraconimidomethyl)benzene (Perkalink 900), aimed at maintaining dynamic mechanical properties following overcure or ageing. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.820080

*Item 21*

IRC 2001. Proceedings of a conference held  
Birmingham, 12th.-14th. June.  
Birmingham, IOM Communications, 2001, p.297-306.  
012

**PREDICTIVE TESTING (ROLLING  
RESISTANCE) FOR RUBBER COMPOUNDS  
WITH THE METHOD OF DYNAMIC  
MECHANIC THERMAL SPECTROSCOPY -  
CORRELATION BETWEEN TYRE RANKING  
AND TAN DELTA**

Deckmann H  
GABO Qualimeter Testanlagen GmbH  
(Institute of Materials)

The development of new tyres with improved properties (e.g. optimised rolling resistance) is a main target of the research departments in the tyre industry. A method of dynamic mechanic thermal spectroscopy (DMTS) provides now a new useful tool in order to reduce the amount of drum tests required, by the application of a predictive test procedure. The discussed test procedure is able to simulate the energy loss within the compound. The results of the DMTS test are very well comparable with the results obtained through the drum test, it is claimed. The new dynamic test procedure is available for sample loading in the compression or tensile mode. Advantages of its use are examined, and include the ability to test a pre-selection of convenient compounds in an early phase of the development process so as to avoid many drum tests or tests on the road. The testing method must be able to simulate the load conditions of a rolling tyre. It applies a pulse recovery sequence of 4 Hz with a pulse frequency of 20 Hz. This method is used to investigate 4 different compounds coming from the tread of different tyres. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
UK; WESTERN EUROPE

Accession no.820063

*Item 22*

IRC 2001. Proceedings of a conference held  
Birmingham, 12th.-14th. June.  
Birmingham, IOM Communications, 2001p.289-96. 012

**TIRE PERFORMANCE PREDICTION FROM THE VISCOELASTIC PROPERTIES OF FILLED RUBBER COMPOUNDS**

Money Penny H; Hardy D; Nieuwenkamp D; Couturier G  
Money Penny Tire & Rubber Consultants; Cabot Leiden Technical Centre; Cabot Carbon Ltd.  
(Institute of Materials)

Tyre testing is extremely expensive, and as a consequence considerable resources have been expended by the tyre industry in trying to develop laboratory tests to predict tyre performance. One major area of investigation has been the viscoelastic properties of the various tyre components and how these impact tyre behaviour characteristics. Rubber compound viscoelastic properties measurement have been utilised in this study for the prediction of tyre performance with respect to rolling resistance, (km travelled/litre of fuel), and wet traction, (vehicle stopping distance when brakes applied). This paper discusses how the measurement of compound viscoelastic properties of the tyre tread component, as a function of strain and temperature at constant frequency, may be utilised to predict the above tyre performance characteristics. 29 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; UK; WESTERN EUROPE

*Accession no.820062*

*Item 23*

IRC 2001. Proceedings of a conference held Birmingham, 12th.-14th. June.  
Birmingham, IOM Communications, 2001, p.256-266.  
012

**NATURAL RUBBER COATED CARBON BLACK**

Aziz J; Hamzah M; Sarkawi S S  
Malaysian Rubber Board  
(Institute of Materials)

The use of fillers in rubber is discussed, with particular reference to the importance of carbon black in rubber products, where its function is to impart relevant properties. In the tyre industry the use of carbon black improves abrasion resistance, increase the tensile strength of rubber etc. However, the mixing of carbon black into rubber has always been a problem especially in two-roll mixing, and can cause contamination and pollution. The Malaysian Rubber Board has developed a natural rubber coated carbon black (RCCB) which is claimed to be easy to use and eliminates air pollution. In this study carbon black powder (CB) of grades N110, N220 and N330 was used as a control and evaluated against a rubber coated carbon black (RCCB) containing N110, N220. The use of rubber-coated carbon black is demonstrated to provide benefits in ease of mixing, and energy saving during the incorporation of this material, and provides a means of solving the problems associated with carbon black pollution in the rubber product manufacturing industry, especially the tyre sector, which consumes a large volume

of powdered carbon black. The good properties of rubber vulcanisates such as low heat build up and good abrasion resistance is beneficial to the tyre industry. The lower specific gravity of the rubber compound with rubber-coated carbon black allows material savings in the course of fabrication of rubber products, especially in the era of open market economy. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

*Accession no.820058*

*Item 24*

IRC 2001. Proceedings of a conference held Birmingham, 12th.-14th. June.  
Birmingham, IOM Communications, 2001, p.78-90.  
012

**RUBBER TRIBOLOGY AND TYRE TRACTION**

Roch P  
Goodyear Technical Center  
(Institute of Materials)

Rubber friction and tyre traction are related both to the hysteretic and adhesive properties of the rubber and the road surface. Being strongly dependent upon the test conditions, the first step in traction prediction is to determine the mission profile of the tyre and to translate this into the solicitations seen by the tread compound. Subsequently the rubber may be characterised in the laboratory under these same conditions, or the concept of time-temperature super position may be applied. To date most studies have focused only on the contribution of the hysteretic loss. Since finite element analysis is used extensively for tyre performance prediction, data relating to viscoelastic properties for different temperatures & frequencies, as a function of stress & strain and strain history are required. Thermal properties are required such that the correct temperatures can be predicted, which in turn affects the viscoelastic properties, thus the use of finite element analysis is an iterative process in which material viscoelastic properties need to be updated for a subsequent run of the model based on the operating parameters estimated from the previous run. The role of the tribologist in the prediction of tyre traction is to complement the above material models with friction models, defining the friction between two surfaces as a function of contact pressure, sliding speed, temperature and surface wetting. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
LUXEMBOURG; UK; WESTERN EUROPE

*Accession no.820044*

*Item 25*

*Nippon Gomu Kyokaishi*  
74, No.1, Jan.2001, p.6-11  
Japanese

**A NEW WEAR TESTER - FOR EVALUATING TREADS WEAR RESISTANCE IN LABORATORY TESTS**

Koike A; Kobayashi N; Furuta I; Yamazaki S

The reproducibility of tyre wear test results, the FKK tester, test materials, compound preparation, tyre fabrication and preparation of test pieces and the comparison of laboratory tests with field tests. 31 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.819971

Item 26

**Rubber and Plastics News 2**

22, No.12, 26th March 2001, p.6

**GOODYEAR: LET IT SNOW**

Slaybaugh C

Goodyear is hoping that the harsher winter and its Ultra Grip family of winter tyres will revitalise the market, tripling the company's share of the winter tyre market within three years. It may be working. Jay Halvorson admits he guessed wrong in May when placing his winter-tyre order with Goodyear for the current selling season. Now, as the Minnetonka, Minn., dealer looks back on a winter that brought the area at least 66 in. of snow and his dealership more than a 50% increase in snow tyre sales, the co-owner of Samaritan Tire realises that he ordered too many units of Goodyear's low-priced Concorde line and not enough of its high-end Ultra Grip Ice tyres. Goodyear's Ultra Grip family consists of the top-of-the-line Ultra Grip Ice, which has a silica-reinforced tread compound designed to maintain flexibility at low temperatures; the Eagle Ultra Grip GW2, targeted at the performance tyre market; the Ultra Grip, which is pinned to facilitate metal studs; and the Wrangler Ultra Grip for sport-utility vehicle and light truck applications. Details are given.

GOODYEAR TIRE & RUBBER CO.

USA

Accession no.818092

Item 27

**Luntai Gongye**

21, No.3, 2001, p.131-4

Chinese

**EFFECTIVE FACTORS ON ROLLING RESISTANCE OF RADIAL PASSENGER CAR TIRE**

Wu Gui-zhong; Zheng Guang-liang; Qu Xue-xin  
Beijing, Research & Design Inst. of Rubber Ind.;  
Chengshan Tire Co. Ltd.

The factors affecting the rolling resistance of radial passenger car tyres were analysed. It was shown from the hysteresis losses resulting from the tyre deformation and the material itself that the tyre structure, the reinforcing materials in carcass ply and belt, the tread compound, as well as the inflation pressure and load of

tyre, were the effective factors for the rolling resistance of passenger car tyres. The rolling resistance of the tyre could be reduced by decreasing the aspect ratio of the tyre, increasing the diameter of the rim, using materials with high modulus in the belt and materials with low hysteresis, such as S-SBR and silica, in the tread compound. 2 refs.

CHINA

Accession no.817876

Item 28

**Polymer Testing**

20, No.5, 2001, p.539-44

**STUDY OF TWO TYPES OF STYRENE BUTADIENE RUBBER IN TIRE TREAD COMPOUNDS**

Pham Thi Hao; Ismail H; Hashim A S

Universiti Sains Malaysia

Two rubbers, Krynol 1721 and Buna VSL 5025-1, were evaluated against Krynol 1712 (general purpose SBR) with the aim of improving the wet grip property of a motorcycle tyre tread compound which contained Krynol 1712 and NR at a 50:50 ratio. Krynol 1721 and Buna VSL 5025-1 were also SBR but their Tg values were significantly higher than that of Krynol 1712 due to the higher styrene and vinyl-butadiene contents in their structure. Rebound resilience was used as an indicator of hysteresis. Other properties studied included tensile properties, tear strength, compression set, abrasion resistance, cure characteristics and Mooney viscosity. 14 refs.

BAYER AG

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; MALAYSIA; WESTERN EUROPE

Accession no.817828

Item 29

**Polymer Reaction Engineering**

9, No.1, 2001, p.19-36

**MODEL COMPOUND STUDIES OF THE DEVULCANIZATION OF RUBBER VIA PHASE TRANSFER CATALYSIS**

Milani M; Schork F J; Liotta C L; Poehlein G W  
Georgia, Institute of Technology

Results are reported of preliminary attempts to develop a low cost process for recycling of tyres using phase transfer catalysis to cleave the sulphur crosslinks in vulcanised rubber. Model compounds and SBR were used to study the cleavage of both disulphide and monosulphide bond via phase transfer catalysis. Although the chemistry proved to be capable of cleaving sulphur bonds in model compounds, the work on SBR was inconclusive, presumably because the extreme reaction conditions induced various undetermined side reactions. 8 refs.

USA

Accession no.817601

*Item 30*

**Rubber and Plastics News**

30, No.21, 14th May 2001, p.16/25

**VULCANISATE AGEING USING THE RUBBER PROCESS ANALYZER**

Dick J S

Alpha Technologies Inc.

When rubber vulcanisates are subjected to repetitive high-amplitude sinusoidal straining, changes in physical properties can occur. This paper investigates the nature of these changes. A wide range of different rubber formulations were subjected to isothermal dynamic ageing conditions with the RPA 2000 Rubber Process Analyzer to determine how measured changes relate to other physical property changes. Comparisons were made with static ageing tests. Also the effects of temperature were measured. These experiments suggest optimal test conditions for measuring these changes. 14 refs.

USA

*Accession no.816789*

*Item 31*

Shawbury, Rapra Technology Ltd., 2001, pp.200. 30 cms., 1/6/01. Rapra Industry Analysis Series

**END-OF-LIFE TYRES - EXPLOITING THEIR VALUE**

Dufton P W

Rapra Technology Ltd.

The management of scrap tyres is examined, including methods of exploiting their value, with reference mainly to trends and developments in North America, the UK and the EU. The report follows a tyre through its life and considers the various options for its subsequent management, recovery and recycling. A brief description is given of the tyre's construction and design, accompanied by a discussion of trends in tyre manufacturing which may affect subsequent recycling. The retread industry and its relevance to the recycling issues is examined in detail. The different routes that a non-retreadable tyre may possibly take are considered, and include use as a material, a source of energy, non-rubber physical uses, and some disposal options. Technologies and processes that provide a secondary material are covered, with individual sections dealing with rubber crumb, pyrolysis, and reclaim rubber and other chemical and/or thermal processes. Energy recovery techniques are reviewed, and applications for end-of-life tyres in some physical inert form, such as for breakwaters and barriers are described

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.815477*

*Item 32*

**Tire Science and Technology**

29, No.1, Jan./March 2001, p.56-64

**EFFECTS OF VARIATIONS IN GEOMETRY AND**

**MATERIAL ON THE NON-UNIFORMITY OF TIRES**

Meijuan Y; Yuankan D; Gall R; Rodriquez N D  
Shanghai Tyre & Rubber Co.Ltd.

Finite element analysis is used to predict radial force variations caused by geometry and material imperfections in the tyre. Imperfections such as a change in tread compound modulus or an increase in product thickness, are applied in a 180 degree section of the tyre model. The radial load variation for a given deflection is then computed. Experimental studies are carried out to confirm the numerical results. Further studies investigate the influence of the inflation pressure and address the application of results to other tyre designs. 5 refs.

CHINA

*Accession no.815371*

*Item 33*

**Tire Science and Technology**

29, No.1, Jan./March 2001, p.44-55

**TEST TO EVALUATE FATIGUE CRACK GROWTH IN RUBBER COMPOUNDS UNDER MIXED MODE LOADING**

Giuliani G P; Medri G; Pironi A

Pirelli Pneumatici SpA; Parma, University

A method to evaluate the crack growth rate in rubber compounds under mixed mode loading is described, which has the aim of ranking and predicting crack growth performance of laboratory compounds designed for the steel-belted tyres, prior to field tests. The results obtained from different compounds showed that the ranking obtained from laboratory tests is the same as that from road tests, and therefore the method can be successfully applied in the design of truck tyres, it is claimed. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.815370*

*Item 34*

**Tyres & Accessories**

No.4, 2001, p.66-7

**BRIDGESTONE POTENZA S-03 POLE POSITION: 'THE FORMULA 1 TYRE FOR THE STREET'**

A new high performance tyre from Bridgestone/Firestone Europe has been launched. The Potenza S-03 Pole Position incorporates technology and design features based on the company's Formula 1 experience. The new tyre incorporates UNI-TAQ II technology, which provides greater resistance to wear by use of Super Long Link carbon, use of Particle Z new filler, and its Hydro Evacuation Surface, which is claimed to reduce hydro-resistance and improve water flow. Details of these features are given, together with information relating to tread and compound construction and design.

BRIDGESTONE/FIRESTONE EUROPE

*Accession no.815367*

Item 35

**Kautchuk und Gummi Kunststoffe**

54, No.4, 2001, p.153-8

**TIRE COMPOUND MATERIALS INTERACTIONS**

Gerspacher M; O'Farrell C P

Richardson S.,Carbon Co.

The interaction of tyre compound materials is examined with reference to the effect of the interaction on the properties of the final tyre compound and the ultimate performance of the tyre. The nature of both the carbon black and the rubbers employed is examined, and their interaction with reference to filler-filler interactions and filler-polymer interactions is discussed. The importance of filler dispersion is also investigated. 17 refs.

USA

Accession no.815357

Item 36

**Iranian Journal of Polymer Science & Technology**

13, No.4, Winter 2000, p.17-25

Persian

**STUDY ON THE ADHESION OF CUSHION GUM TO CARCASS IN RETREADED TYRE**

Bakhshandeh G R; Soltanilinegad M A

Iran Polymer Institute

In order to determine the optimum conditions of adhesion of cushion gum to carcass, after preparation of the compound for the gum under the same conditions, this compound was cured on the surface of a reference elastomeric sheet, a system similar to tread and the carcass compound. After preparing the test sample, they were tested by the T-peel test method (ASTM1876-93). Using these test results, the effect of several surface treatment methods before curing, type of accelerator used in curing system and the effect of blending of NR with a synthetic rubber (SBR, polybutadiene) were evaluated. Initial compounds were mixed using a Banbury with a maximum capacity of 1.5L and then masticated using a two-roll mill until an average Mooney viscosity of 22.75 was obtained and finally cured with a heating plated press. Useful surface treatment methods before curing could increase bond strength of cushion to carcass. With increase of accelerator efficiency, curing time decreased and bond strength increased. A high level of adhesion strength could be achieved by using an optimum blending condition. 21 refs.

IRAN

Accession no.813794

Item 37

**Rubber World**

224, No.1, April 2001, p.35-40

**COMPOUNDING WITH PARA-ARAMID FIBER ENGINEERED ELASTOMERS**

Tsimpris C W; Wartalski J; Ferradino A G

DuPont Advanced Fibers Systems; Vanderbilt R.T.,Co.

Kevlar engineered elastomer provides the compounder with a vehicle to bring the benefits of para-aramid pulp reinforcement to rubber. Problems traditionally associated with the dispersibility of short fibres in rubber compounds have been overcome by the use of new technology developed by DuPont for dispersing aramid pulp into an elastomer matrix. Products made via this new technology enabled dispersion of pulp into rubber so well that it was given the name of Kevlar engineered elastomer. The superior reinforcement properties are claimed to be based on superior dispersion, the microstructure of para-aramid fibre, the presence of 'bound rubber' in engineered elastomer and the process used to manufacture engineered elastomer. These aspects are examined, followed by applications which have benefited by the use of rubber compounds reinforced with aramid pulp. 11 refs.

USA

Accession no.812645

Item 38

**Rubber World**

224, No.1, April 2001, p.18/26

**INTRODUCTION TO MINERAL FILLERS FOR RUBBER**

Evans L R

Huber J.M.,Corp.

An introduction is presented to the use and types of mineral fillers available for rubber applications. An historical overview is given of the use of fillers, followed by an overview of non-black fillers and mineral fillers. Two trends in the use of fillers have dominated the industry: smaller particle sizes and the change from naturally occurring materials to materials that have specific shapes which enhance the interaction with the rubber matrix. Mineral fillers discussed include calcium carbonate, baryte, ground crystalline silica, biogenic silica, kaolin clay, talc, titanium dioxide, aluminium trihydrate, and precipitated calcium carbonate. The effects of filler loading on Mooney viscosity, hardness, compression set, modulus, and tensile strength are indicated. 7 refs.

USA

Accession no.812642

Item 39

**Rubber World**

223, No.6, March 2001, p.42-7

**POWDER RUBBER - A NEW RAW MATERIAL GENERATION FOR SIMPLIFYING PRODUCTION**

Goerl U; Schmitt M

Pulverkautschuk Union GmbH

The characteristics, processing and end-use applications of E-SBR/carbon black and NR/carbon black powders suitable for continuous compounding in the rubber

industry, particularly the tyre industry, are compared and discussed. Particular attention is paid to the type of NR, viscosity, molec.wt. and MWD of NR, type of filler (fluffy carbon black), powder production and filler loadings. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.812386

*Item 40*

**Rubber Asia**

15, No.2, March/April 2001, p.81-3

**ENVIRONMENTAL PROBLEMS DOMINATE  
TYRE TECHNOLOGY**

Miyake I

Bridgestone Corp.

The importance of environmental impacts on the tyre industry is considered, with respect to developments in tyre technology which are helping manufacturers comply with environmental requirements. The importance of life cycle assessment for the quantitative analysis and evaluation of tyre production, use and waste management is examined, and in particular, the work of the environmental committee of the Japan Rubber Manufacturers' Association. According to the association, the most important considerations are carbon dioxide emission during the life of the tyre, and the need to reduce fuel consumption to limit this, coupled with an extension of service life and a reduction of tyre weight. Rolling resistance, processing energy, and the use of silica compounds are discussed.

JAPAN,RUBBER MANUFACTURERS ASSN.  
JAPAN

Accession no.811229

*Item 41*

**Tire Technology International**

March 2001, p.14-7

**GIVE US THIS DAY OUR DAILY TREAD**

Challen J

Goodyear's GT3 tyre uses an organic compound as a polymer filler within the chemical construction of the tyre. The new filler, BioTRED, has been bioengineered as an environmentally-friendly and renewable alternative to carbon black and silica. The Goodyear GT3 is the world's first tyre to use a new corn filler and also features a brand new tread pattern. 3D-BIS (3D Block Interlocking System) is a system with hemispherical shapes in the blades. The number of blades has been increased compared with other tyres to provide traction when needed, together with stiffness of the block for handling.

GOODYEAR EUROPE  
EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
WESTERN EUROPE

Accession no.810035

*Item 42*

**Journal of Applied Polymer Science**

79, No.6, 7th Feb.2001, p.1127-33

**IMPROVEMENT OF PROPERTIES OF SILICA-  
FILLED STYRENE-BUTADIENE RUBBER  
COMPOUNDS USING ACRYLONITRILE-  
BUTADIENE RUBBER**

Choi S S

Kumho R&D Center

Both uncured and cured properties and cure characteristics of a silica filled styrene-butadiene rubber (SBR) compound can be improved by the addition of acrylonitrile-butadiene rubber (NBR) at approximately 5 parts per hundred rubber. Viscosity of NBR containing compounds were lower, with reduced bound rubber content, and cured compound properties including modulus, tensile strength, abrasion resistance, heat build up, crack resistance, wet traction and rolling resistance were improved. Comparisons were made to carbon black filled SBR compounds. 13 refs

KOREA

Accession no.808788

*Item 43*

Shawbury, Rapra Technology Ltd., 2001, pp.132. 29  
cms. 15/3/01. Rapra Review Rept. Vol.11, No.11, 2001.  
NALOAN

**FAILURE OF POLYMER PRODUCTS DUE TO  
THERMO-OXIDATION**

Wright D C

Edited by: Dolbey R

(Rapra Technology Ltd.)

Rapra.Review Rept. No. 131

This mechanism of thermooxidative failure is examined, together with the use and efficiency of stabilising additives. A series of case studies are included which demonstrate the failure of polymer products through thermooxidative degradation in a variety of end-use applications. The case studies include LDPE cable insulation, rubber expansion joints, tyres, flexible hose, connectors, pump diaphragms, hot water bottles, PP laminated steel sheet, and acrylic bulkhead light covers. 403 refs. Photocopies and loans of this document are not available from Rapra.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.808767

*Item 44*

**Kautchuk und Gummi Kunststoffe**

54, Nos.1-2, 2001, p.36-43

**TUBELESS TYRE INNER LINERS  
MORPHOLOGY AND PHYSICAL. PROPERTIES  
OF ELASTOMERIC BLENDS**

Turturro A; Falqui L; Loprevite M; Giuliani G;

Mowdood S; Serra A

Genova, University; Pirelli Pneumatici SpA

Cure kinetics, morphology and gas permeability constants of CIIR/NR, BIIR/NR blends are examined as functions of elastomer viscosities. Scorch time and mixing extent decrease on increasing the viscosity of the components; scorch time is also negatively affected by the presence of BIIR in the blend. Values of gas permeability constant of the blends do not linearly depend on the composition and are affected by the viscosity of the components, which determines the morphology and the carbon black distribution in the blend. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

Accession no.808579

Item 45

**Rubber Technology International**

2000, p.51-4

**CFD ASSISTANCE IN RUBBER PREPARATION FOR TIRES**

Rubin Y; Waucquez C  
Polyflow SA

Computational fluid dynamics (CFD) is a computer-based process for solving the governing equations of fluid flow and heat transfer. Computer modelling through CFD is used in many of the steps involved in making a tyre. Recently, better software has enabled CFD to be studied in the batch mixing of rubber: heating, pressurising, mixing and conveying by single-screw or twin-screw extruders; extrusion of the tyre tread; curing the compounds after shaping; and some product performance analysis such as aquaplaning. No refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION;  
WESTERN EUROPE

Accession no.807891

Item 46

**Rubber Technology International**

2000, p.48-50

**NATURAL ADDITIVES FOR IMPROVED RECYCLING**

Kaufman H; Hesse B F  
Polymer Process Technologies Inc.; RTC America Inc.

Three additives have been developed which allow the incorporation of up to 50% post-consumer ground rubber (PCGR) in new compounds, including tyre formulations. The authors state that these additives have been "developed through the use of plant polymers, gums, polyoxy-compounds and other natural ingredients". PPT-SYS(R) is a compatibiliser which has the potential to increase the use of PCGR in compound formulations from the best in the year 2000 of approximately 10% to over 35% PCGR. Adding a dispersion aid, PPT-RNU, in combination with PPT-SYS(R) allows quantities of up to 50% PCGR to be incorporated. A third additive, PPT-

ETAK, can be mixed with one or both materials to process high durometer PCGR. 4 refs.

EU; EUROPEAN COMMUNITY; EUROPEAN UNION; USA;  
WESTERN EUROPE-GENERAL

Accession no.807890

Item 47

**Macromolecular Materials and Engineering**

Vols.284-5, Dec.2000, p.64-9

**QUALITY ASSURANCE IN THE RUBBER MIXING ROOM - PREDICTION OF THE RUBBER COMPOUND PROPERTIES THAT ARE RELEVANT FOR THE ELASTOMER PRODUCT PROPERTIES**

Ryzko P; Haberstroh E  
IKV

Quality assurance in rubber processing is discussed. A process parameter based method was developed for choosing the rubber compound characterisation methods that are relevant for predicting the compound properties which are relevant to the properties of the finished products. 19 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.807877

Item 48

**European Rubber Journal**

183, No.3, March 2001, p.25

**HOT FORMER UNVEILED**

Goodyear's hot former is a new machine which creates and assembles up to seven tyre carcass components into one large system component. Everything from the inner liner to the Apex 4 is laid down in a series of steps and assembled hot, with no need for talc or tackifiers to improve adhesion between the various components. Goodyear has developed a seven-station unit for truck tyres and a four-station unit for car tyres. Each station, described as mini-contour calenders, comprises two cylindrical rollers, one with a profiled surface. Compound is forced into the pattern in the profiled roll. As the roll rotates, the rubber profile separates from the roller and is deposited on a moving track bed running underneath the manufacturing stations. Once all the components have been laid down, the system component is rolled onto a large spool and transported to the building area.

GOODYEAR TIRE & RUBBER CO.  
USA

Accession no.806879

Item 49

**Elastomery**

4, No.5, 2000, p.10-4

**LUVOCOUP AND LUVOCOUP R/HS - SUITABLE ADHESION PROMOTERS FOR RUBBER COMPOUNDS**

Stehr J  
Lehmann & Voss & Co.

The physical and chemical properties of Luvocoup silane and Luvocoup R/HS silane Luvocoup on carbon black N-339 are discussed and the use of these silanes as adhesion promoters for rubber compounds is considered, particular attention being paid to the use of Luvocoup R/HS in tyre tread compounds. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.805165

Item 50

**Elastomery**

4, No.5, 2000, p.3-9

Polish

**MODIFIED MELAMINE RESINS AS RESORCINOL-FREE PROMOTERS FOR ADHESION OF RUBBER TO STEEL CORD**

Hehn Z; Rajkiewicz M; Sajewicz J

Kedzierzyn-Kozle Institute; Instytut Przemysłu Gumowego Stomil Piastow

A melamine-formaldehyde resin which contained additional methylene groups was obtained by further condensation of Melasil P etherified melamine-formaldehyde resin. Melasil P was also subjected to reaction with melamine. The resin produced was supported on calcium silicate and its applicability was evaluated under static and dynamic conditions using the test method developed by the Rubber Research Institute at Piastow. The rubber compound obtained with the use of Amelan M was found to exhibit the best adhesion to steel cord, both before ageing and after ageing, under all the conditions studied, but it required slightly longer time for vulcanisation. The use of Amelan M resin in rubber compounds eliminated the need for the use of toxic resorcinol. 17 refs.

EASTERN EUROPE; POLAND

Accession no.805164

Item 51

**Luntai Gongye**

21, No.1, 2001, p.32-5

Chinese

**APPLICATION OF NDBR TO TIRE CROWN COMPOUND**

Zou Ming-Qing; Fu Jian-Hua; Li Yong-Chi

Guangzhou Pearl River Tire Co.Ltd.

The physical properties, particularly the abrasion resistance and heat build-up, were shown to be improved by replacing neodymium-catalysed BR with the same amount of nickel catalysed BR in tyre crown compound. The mixing process had, however, to be adjusted because of the poor processability and lower carbon black dispersivity. It was found by means of the tread life test that the tyre with neodymium-catalysed BR crown compound possessed better wear resistance.

CHINA

Accession no.805077

Item 52

**Revista de Plasticos Modernos**

79, No.526, April 2000, p.441-8

Spanish

**USE OF THE CARBON-SILICA DUAL PHASE FILLER IN TRUCK TYRE COMPOUNDS**

Hardy D; Money Penny H; Vicario P

Cabot Leiden Technical Centre; Cabot SA

Ecoblack CRX 2000 and 2002 carbon-silica dual phase fillers (Cabot) were evaluated in NR truck tyre compounds in comparison with conventional carbon black grades. Studies were made of the cure characteristics of the compounds, viscoelastic properties, heat generation, wear resistance, rolling resistance, and adhesion of NR to steel cords before and after exposure to different ageing conditions. 13 refs.

CABOT CORP.; BEKAERT NV SA; MALAYSIAN RUBBER PRODUCERS' RESEARCH ASSN.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; SPAIN; UK; USA; WESTERN EUROPE

Accession no.803912

Item 53

Antec 2000.Conference proceedings.

Orlando, Fl., 7th-11th May, 2000, paper 573

**RECLAMATION OF RUBBER CRUMB FROM ARMY'S DISCARDED TIRES**

Sharma K R

Fairfax,George Mason University (SPE)

The recycling of scrap tyres, including use as a filler in thermoplastics, and as an additive to asphalt for road surfacing applications, is briefly reviewed. 30 refs.

USA

Accession no.803870

Item 54

**International Polymer Science and Technology**

27, No.12, 2001, p.T/50-3

**DEVELOPMENTS OF METHODS FOR IMPROVING THE BOND STRENGTH BETWEEN THE ELEMENTS OF PLIED-UP RUBBER-CORD COMPOSITES**

Vashchenko Y B; Sokolova G A; Shcherbakov A B;

Onishchenko Z V

Ukraine,State Chemico-Technological University

Methods are proposed for increasing the bond strength between the elements of plied-up rubber-cord composites by using highly effective additives. Procedures are described using UV spectroscopy, which make it possible to select the most appropriate adhesion promoting additives. The use of adhesion promoters, surface

treatment of the metal cord, and modification of the rubbers are considered with respect to improvements in rubber to metal bonding. Compositions were developed based on sulphur-containing emulsions in oils, containing activating additives. A dimensionless parameter is used as a model criterion of interphase interaction, and the relationship between this parameter and the adhesion of plied-up elastomeric systems was established, which makes it possible to predict the behaviour of adhesive substances under real conditions. 12 refs. (Translated from *Kauchuk i Rezina*, No.3, 2000, p.24).

UKRAINE

Accession no.803072

## Item 55

*International Polymer Science and Technology*

27, No.12, 2001, p.T/47-9

**COHESIVE AND ADHESIVE STRENGTH OF RUBBER-METAL CORD SYSTEMS MODIFIED WITH OLIGOMERIC ALKENYLATED ALKYLRESORCINOLS**

Talantov S V; Rossinskii A P

Vyatka, State Technical University

The replacement of scarce resorcinol with more accessible, cheaper and less toxic alkenylated oligomeric alkylresorcinols in tyre formulations is investigated. Tests were carried out for the modification of resins of the AP series in the coating rubber mix for the metal cord breaker and in the tread rubber mix. The modifiers investigated are products of the phosphoric acid alkenylation by 1,3-pentadiene of shale alkylresorcinols with a 5-methylresorcinol content of 50-90%, condensed by urotropin or paraformaldehyde resin. Performance improvements are reported, with particular reference to the adhesive strength of the metal cord systems, and the cohesive strength of the elastomer phase, especially in layers adjacent to the brass surface. 3 refs. (Translated from *Kauchuk i Rezina*, No.3, 2000, p.21)

RUSSIA

Accession no.803071

## Item 56

ACS Polymeric Materials: Science and Engineering.

Fall Meeting 2000. Volume 83.

Washington, D.C., 20th-24th Aug.2000, p.386-7

**PLASMA ETCHING AND PLASMA POLYMERISATION COATING OF STEEL TYRE CORDS**

Yoon T H; Kang H M; Kaang S Y

Kwangju, Institute of Science &amp; Technology;

Chonnam, National University

(ACS, Div. of Polymeric Materials Science &amp; Engng.)

Zinc plated steel tyre cords are subjected to RF plasma polymerisation coating of acetylene or butadiene in order to enhance adhesion to rubber compounds. Plasma polymerisation is carried out as a function of plasma

power, treatment time and gas pressure. Argon plasma etching prior to plasma polymerisation, and argon carrier gas are utilised in order to improve the adhesion. 11 refs.

KOREA

Accession no.802669

## Item 57

*Polymer International*

49, No.12, Dec.2000, p.1684-92

**EFFECT OF REPLACEMENT OF CASTOR OIL AND POLYCHLOROPRENE BY CHLORINATED PARAFFIN IN BUTYL COMPOUNDS OF TYRE-CURING BLADDER**

Sreekanth B P; Shriharsha B; Raghavendra D;

Ananathapadmanabha G S; Shashidhara G M

Mysore, S.J. College of Engineering

Ways are explored to increase the life and to reduce the cost of tyre-curing bladders by improving their mechanical and ageing properties. Nine formulations are designed which involve the partial replacement of polychloroprene (PC) and castor oil (CO), both individually and simultaneously, by chlorinated paraffin (CP) in the butyl bladder compound. The compounds are tested for various cure properties such as initial torque, minimum torque, scorch time, optimum cure time, cure rate, maximum torque and reversion time. The vulcanised samples are tested for mechanical properties such as tensile stress at 300% elongation, tensile strength at break, ultimate elongation, rubber deterioration by dynamic fatigue test and Shore-A hardness before and after ageing. The results show that tensile strength at break and ultimate elongation decrease, while tensile stress at 300% elongation increase except in one case (when PC is partially replaced by CP). Simultaneous and individual replacement of CO by CP results in a decrease in hardness of up to 3 phr (base recipe CO 5 phr) whereas further replacement of CO by CP results in an increase in hardness. Tensile stress at 300% elongation and Shore-A hardness increase up to a limit while tensile strength at break and ultimate elongation decrease with ageing. 11 refs.

INDIA

Accession no.802576

## Item 58

*Polymer Plastics Technology and Engineering*

39, No.5, 2000, p.793-806

**EFFECT OF BONDING SYSTEMS ON THE ADHESION OF NITRILE RUBBER TO NYLON CORD**

Darwish N A; Lawandy S N; El-Shazly S A; Abou-

Kandil A I

Egypt, National Institute for Standards;

Alexandria, University

A tri-component system composed of resorcinol, hexamethylene tetramine (HMT) and hydrated silica is

used as an adhesion promoter with an NBR mix. The resorcinol is replaced by o-aminophenol, m-aminophenol, p-aminophenol or m-phenylene diamine. The rubber-textile cord samples are subjected to ageing or exposed to ionising, radiation and their adhesions are examined. The effect of the crosslink density of different NBR mixes on the adhesion is also studied. The results show that aminophenols and m-phenylene diamine used have an effect on adhesion. However, their adhesion levels are lower than those obtained by resorcinol. The results also show that, on ageing, n-aminophenol and m-phenylene diamine have either better stability or enhancement of adhesion levels than other bonding systems. On exposure to radiation, the results show that the bonds formed between NBR mixes, containing different types of bonding material and undipped nylon cords are more stable than those formed with dipped ones. 13 refs.

EGYPT

Accession no.802531

Item 59

**Chemical and Engineering News**

79, No.1, 1st Jan.2001, p.12-4

**FIRESTONE'S TIRE PROBLEM**

Reisch M S

We are told that US tyre manufacturing giant, Firestone, has admitted that design and manufacturing problems contributed to tyre failures resulting in 148 traffic accident deaths in the USA. This article discusses in detail the possible causes of failure of the three brands of tyres - the Firestone ATX, ATXII, and Wilderness AT. It is argued that the failures were due to a combination of design faults, poor rubber to metal bonding, and underinflation

FIRESTONE; CALIFORNIA,UNIVERSITY;  
US,GOVERNMENT; US,NATIONAL HIGHWAY  
TRAFFIC SAFETY ADMINISTRATION; FORD  
MOTOR CO.; BRIDGESTONE/FIRESTONE;  
BRIDGESTONE CORP.

JAPAN; SAUDI ARABIA; SOUTH AMERICA; USA

Accession no.802406

Item 60

West Conshohocken, Pa., 2000, pp.7. NALOAN

**ASTM D 4303-. TEST METHOD FOR STRAP  
PEEL ADHESION FOR REINFORCING CORDS  
OR FABRICS TO RUBBER COMPOUNDS**

American Society for Testing & Materials

ASTM 4393-

Version 2000. Photocopies and loans of this document are not available from Rapra.

USA

Accession no.801063

Item 61

**Industria della Gomma**

44, No.2, March 2000, p.38-41

Italian

**NANOSTRUCTURED MATERIALS AT MILANO  
BICOCCA**

De Tuoni E

A review is presented of topics discussed at a conference on nanostructured materials held in Milan in January 2000. These included the structural features of such materials, new materials based on supramolecular architectures, the production and properties of nanomagnets, the preparation of nanomaterials by intercalation, and applications of rubber matrix nanocomposites in tyre manufacture.

MILANO-BICOCCA,UNIVERSITA DEGLI STUDI;  
STRASBOURG,UNIVERSITE LOUIS PASTEUR;  
FIRENZE,UNIVERSITA;  
CAMBRIDGE,UNIVERSITY; PIRELLI  
PNEUMATICI SPA

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
ITALY; UK; WESTERN EUROPE

Accession no.800878

Item 62

**Tire Technology International**

Dec. 2000, p.60-2

**LASERS CLEAN UP**

Jetter J

JET Lasersysteme GmbH

The advantages are described of laser mould cleaning for use by tyre moulders. Laser technology allows moulds to be cleaned without being removed from the press, and cleaning of a complete mould takes only 45-90 minutes depending on the amount of residue and the rubber compound's structure. In addition, there is no wear on the surface of the mould. The operation of the system is described, together with details of the design of the cleaning system. The principles of the laser process are explained, and the method is compared with the only other competing in-press cleaning process of dry ice blast cleaning.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.799312

Item 63

**Tire Technology International**

Dec. 2000, p.41-2

**ANTI-TACKS - WHICH ONE IS FOR YOU?**

McDonald H

Stephenson Process Chemicals

The function and proper selection of antitack agents for use in rubber compounding applications is discussed. Classes available include water-soluble liquid antitacks, dispersion-types, which are mixtures of surfactant and naturally occurring inert fillers, and powders for dispersion in water by the use. Factors influencing

selection are examined and reference is made to the Alkon range of products from Stephenson Process Chemicals.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.799309

*Item 64*

**Kautchuk und Gummi Kunststoffe**

53, No.12, Dec. 2000, p.730-4

**BUTYL RECLAIM IN INNERLINER APPLICATIONS**

Manuel H-J; Dierkes W; Hendriks A  
Vredestein Rubber Resources BV

The introduction of reclaimed butyl rubber on the processing behaviour and properties of halobutyl innerliner compounds is examined. Particular improvements in impermeability, ageing resistance and flex fatigue resistance after ageing are noted. The reduction in permeability allows a parallel reduction of the innerliner thickness, with positive influence on tyre weight and on raw material costs. The results of an investigation of increased butyl reclaim loading on the overall properties of various butyl compounds and halobutyl compounds are discussed. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.799303

*Item 65*

**Scrap Tire News**

14, No.12, Dec.2000, p.19

**CARBON BLACK UPGRADING PROCESS INTRODUCED**

Svedala Industries Process Research & Test Center has introduced its new Tire Pyrolysis/Carbon Black upgrading process. Extensive field testing is now in progress. In the upgrading section, the material is ground and classified to produce a carbon black with the appropriate size distribution. The company says a major tyre manufacturer has made a prototype run with the upgraded carbon black.

SVEDALA INDUSTRIES  
USA

Accession no.799206

*Item 66*

**China Synthetic Rubber Industry**

23, No.3, 2000, p.183

**USE OF NBR TO IMPROVE WET GRIP AND ROLLING RESISTANCE OF TIRE TREAD**

Ning Kaijun; Jia Demin; Wang Xiaoping; Xue Feng  
Guangzhou, South China University of Technology

NBR was used to partially replace NR in a model NR/BR compound. Both rolling resistance and wet grip properties were found to be improved with the addition of NBR. 2 refs.

CHINA

Accession no.799131

*Item 67*

**Rubber Chemistry and Technology**

73, No.4, Sept./Oct. 2000, p.578-606

**RUBBER FRICTION ON SELF-AFFINE ROAD TRACKS**

Kluppel M; Heinrich G  
DIK; Continental AG

A theory of rubber friction for tyre tread compounds on hard and rough surfaces based on hysteretic energy losses in the rubber alone is developed and described. Results based on this theory are shown to be in agreement with previously work by Grosch relating to friction coefficient and sliding speed. The effects of the surface roughness are discussed with relation to tyre/surface contact and fractal analysis of the rough surface and it is shown that the broadness of the roughness scale of the surface and broadness of the broadness of the friction coefficient are related. Application to ABS braking systems is discussed. 45 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.798617

*Item 68*

**Gummi Fasern Kunststoffe**

53, No.7, July 2000, p.464-7

German

**STUDIES OF THE ENVIRONMENTAL RISKS GENERATED BY INDUSTRIAL RUBBER PRODUCTS**

Buettner R; Rakus S; Taeger E

Industrial rubber products, particularly tyres and conveyor belts, are abraded by use. Antioxidants, residues of vulcanisation accelerators and reaction products arising from vulcanisation are leached by water from the products themselves and from the abraded particles. These substances are partly toxic and pose a risk to the environment. 6 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.797676

*Item 69*

**Plastics, Rubber and Composites**

28, No.10, 1999, p.500-4

**PROMISING APPROACH TO FUNCTIONALISATION OF GROUND TYRE RUBBER - PHOTOCHEMICALLY INDUCED GRAFTING**

Fuhrmann I; Karger-Kocsis J  
Kaiserslautern, University

A novel grafting process to incorporate various chemical functional groups onto the surface of ground tyre rubber

was developed. The process used methacrylic acid and photoinitiated polymerisation. The properties of the modified rubber incorporated into polyamide, epoxy and polyurethane compounds were assessed by tensile and Charpy impact testing. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.794352

*Item 70*

**Plastics, Rubber and Composites**

28, No.10, 1999, p.482-6

**THERMAL DIFFUSIVITY OF RUBBER COMPOUNDS**

Bafnec M; Juma M; Troman J; Jurciová J; Kucma A  
Slovak, Technical University

Because of the high temperature generated in tyres during repeated deformations it is very desirable to know the thermal diffusivity data of the rubber being used. A method has been devised to determine the required diffusivity data of thick rubber/fibre composite materials. The content and type of rubber together with the carbon black were found to determine the thermal diffusivity. 5 refs.

SLOVAK REPUBLIC; SLOVAKIA

Accession no.794349

*Item 71*

158th ACS Rubber Division Meeting - Fall 2000.  
Conference preprints.

Cincinnati, Oh., 17th-19th Oct.2000, paper 138  
**INNOVATIVE TECHNOLOGY OF MAKING  
NON-PNEUMATIC BICYCLE TIRES**

Gong R

Shanghai Gaoju Rubber Tires Co.Ltd.  
(ACS,Rubber Div.)

The production of dual density non-pneumatic bicycle tyres by injection moulding with thermoplastic materials is described. The tyres are made from an elastomeric thermoplastic polymer alloy. It is an interpenetrating polymer network which contains a specially treated mineral filler. The construction is a solid skin around a foam inner core. The foam core provides ride quality, whilst the outer solid skin provides wear resistance. Advantages of non-pneumatic dual density bicycle tyres over traditional pneumatic and solid tyres are examined, property data are discussed, and tyre production methods are detailed. 12 refs.

CHINA; USA

Accession no.794239

*Item 72*

158th ACS Rubber Division Meeting - Fall 2000.  
Conference preprints.

Cincinnati, Oh., 17th-19th Oct.2000, paper 119  
**QUANTITATIVE EVALUATION OF STEEL**

**REINFORCEMENT TO RUBBER ADHESION BY  
ELECTROCHEMICAL METHODOLOGY**

Su Y-Y; Shemanski R M

Amercord Inc.; RMS Consulting Inc.  
(ACS,Rubber Div.)

Details are given of an innovative technology, developed to measure the adhesion of steel reinforcement to rubber in a tyre structure. The method can be used to determine bonding rate, scorch time, and bond formation during the vulcanisation. The technology is based on an electrochemical methodology which is used to investigate the interfacial interactions occurring between steel reinforcement and rubber during vulcanisation. It allows for parameters such as vulcanisation temperature, chemical composition of coating on steel reinforcement, oxide structure and oxide thickness on coating to be quantitatively analysed. 32 refs.

USA

Accession no.794224

*Item 73*

158th. ACS Rubber Division Meeting - Fall 2000.  
Conference preprints.

Cincinnati, Oh., 17th.-19th. Oct. 2000, paper 59

**OPTIMISING THE USE OF DISULPHIDE  
SILANE IN A SILICA 'GREEN TYRE' TREAD  
COMPOUND**

Stone C R; Menting K-H; Hensel M  
Schill & Seilacher GmbH & Co.  
(ACS,Rubber Div.)

The use is discussed of disulphide silane coupling agents for use in silica-reinforced SBR/BR passenger tread compounds. These silanes are reported to be more resistant to thermal degradation than tetrasulphide silanes usually used. However, the use of disulphide silanes requires the addition of considerable extra sulphur in order to match the properties of those achieved with tetrasulphide silanes. This paper uses a statistically designed experimental approach to optimise the levels of sulphur and disulphide silane. Data is shown that indicates that disulphide silane can be used in these compounds to achieve properties comparable to those of the compound using the tetrasulphide silane, and that in addition, these compounds have significantly improved scorch properties. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
USA; WESTERN EUROPE

Accession no.794164

*Item 74*

158th. ACS Rubber Division Meeting - Fall 2000.  
Conference preprints.

Cincinnati, Oh., 17th.-19th. Oct. 2000, paper 57

**EFFECT OF HIGH DISPERSIBLE-HIGH  
STRUCTURE SILICA ON RUBBER  
PROPERTIES**

Gatti L

Huber J.M.,Corp.  
(ACS,Rubber Div.)

Highly dispersible silicas (HDS) were evaluated in six model formulations and the results reported. Comparisons were made with similar surface area silicas to compare the differences between HDS and classical silica. The formulations contained various silica loading levels and two of them used silane coupling agents to bond the silica to the rubber matrix. Dispersion photographs are included. Applications studied included a nitrile roll compound, an EPDM Linesman blanket compound, Neoprene V-belt tensile gum compound, an earthmover tyre tread compound, passenger tyre tread compound, and a passenger/light truck steel skim adhesion compound. 5 refs.

USA

Accession no.794162

*Item 75*

158th. ACS Rubber Division Meeting - Fall 2000.  
Conference preprints.

Cincinnati, Oh., 17th.-19th. Oct. 2000, paper 16

**POWDER TIRE CRUMB REJUVENATE  
DESIGNED FOR NEW TIRE APPLICATIONS**

Chandra H; Pillai C R

Quantum Polymer USA Inc.

(ACS,Rubber Div.)

A new recycled tyre crumb-based rubber rejuvenate has been developed for use in new tyre applications. It is, unlike existing recycled/de-vulcanised rubbers, used as a polymer substitute rather than a filler or extender. Its cost is said to be comparable to finer grades of tyre crumb, making it attractive from an economic point of view. A review is presented of work carried out in testing the product for use in passenger car formulations. 2 refs.

USA

Accession no.794126

*Item 76*

158th. ACS Rubber Division Meeting - Fall 2000.  
Conference preprints.

Cincinnati, Oh., 17th.-19th. Oct. 2000, paper 5

**NEW DEVELOPMENTS IN RUBBER-STEEL  
BONDING PROCESSES**

Van Ooij W J

Cincinnati,University

(ACS,Rubber Div.)

The bonding of sulphur vulcanised rubber compounds to metals is investigated, with reference to the use of a mixture of bistrimethoxysilylpropyl amine and bistrimethoxysilylpropyl tetrasulphide for imparting adhesion between various sulphur-cured rubber compounds and different methods. Results are presented of experiments in which brass, steel and electrogalvanised steel were bonded to a typical tyre cord skim compound, with and without cobalt additive. The new silane treatment

was found to be as effective or better than brass adhesion to cobalt-containing rubber compounds. The superior corrosion protection offered by the silanes was also demonstrated using DC corrosion and polarisation resistance measurements. The structure of the silane film on a metal substrate is studied, and a model is proposed for a possible mechanism of adhesion of rubber compounds with silane-coated metals. 21 refs.

USA

Accession no.794117

*Item 77*

**Gummibereifung**

75, No.11, Nov.1999, p.75-6

German

**TECHNICAL LINK BETWEEN SMOOTHNESS,  
COLDNESS AND WETNESS: THE CHALLENGE**  
Backfisch K P

The performance of winter car tyres is examined regarding optimum force transfer in snow, ice and wet weather, including temperatures between - 20C and 15C. Such demands require expensive solutions. The V winter tyre launched by Dunlop, Goodyear, Michelin and Pirelli at the end of 1999 runs up to 240 km/h. It is claimed the interface between summer and winter tyres lies with V. The use of super soft rubber mixtures as soft compounds is explored as well as the application of silica and soot. In this technical context, running, road holding, distance between tread blocks, sipe edges and the angle of belting are some concepts examined regarding the new high-performance H and V Dunlop Winter Sport M3 winter tyre, the Goodyear Eagle Ultra Grip available in some V sizes, the Pirelli Winter Snowsport released on the Porsche, the Continental ContiWinterContact TS 780 with its directional tread and new sort of honeycomb sipes and the Michelin Pilot Alpine winter tyre.

CONTINENTAL AG; PIRELLI SPA; GOODYEAR  
TIRE & RUBBER CO.; DUNLOP; MICHELIN  
GROUP  
WORLD

Accession no.792837

*Item 78*

**Rubber and Plastics News**

30, No.5, 2nd Oct.2000, p.12-4

**HIGH-FREQUENCY VISCOELASTICITY OF  
POLYMER BLENDS**

Yang H-H; Nikiel L; Gerspacher M; O'Farrell C P  
Richardson S.,Carbon Co.

It has been reported that the wet traction of tyres is associated with the high-frequency viscoelasticity of tyre compounds. An automated acoustic spectrometer was built to measure the high-frequency viscoelastic properties of filled BR/NR and SBR/BR blends. The effects of carbon black loading, polymer blend composition, blend system and mixing technique on the high-frequency

viscoelasticity of rubber vulcanisates were studied. The compositional dependence of attenuation coefficient at room temperature depends on the miscibility of polymer blends systems studied. 18 refs.

USA

Accession no.792654

*Item 79*

Handbook of Polymer Testing.

New York, N.Y., Marcel Dekker Inc., 1999, p.285-308

**TESTING OF RUBBER**

Lewis P M

Tun Abdul Razak Research Centre

Edited by: Brown R

(Rapra Technology Ltd.)

Small-scale laboratory tests for rubber are used in material and product specifications and for such activities as compound development, component design, factory quality control and life prediction. Many of these tests have been shaped by the distinguishing features of rubber, rubber products and their means of manufacture. Aspects covered include requirements for rubber, test development, popularity of rubber tests, sources of information, strength and stiffness properties, hardness, tensile stress-strain properties, tear strength, other strength measures, measurement of modulus, fatigue and wear processes, fatigue cracking, crack growth, heat generation tests, wear testing, time-dependent properties, creep, stress relaxation, compression set, tension set, determination of temperature effects, environmental properties. 69 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.792410

*Item 80*

**Indian Rubber Journal**

50, Sept./Oct.2000, p.94-100

**IMPACT OF NON-TOXIC EXTENDER OIL ON SBR STRUCTURE**

Arcoleo C; Bowman I; Soddu L; Tortoreto P  
Enichem

At present, SBR types used for tyre manufacture are extended with highly aromatic oil, which is classed as toxic and will eventually have to be replaced with a "safe" oil. This paper presents a study on the effects on the properties of SBR of two candidate safe oils, TDAE and MES. Materials and methods are detailed, results are presented and discussed, and conclusions drawn. 5 refs.

INDIA

Accession no.791999

*Item 81*

**Plastics, Rubber and Composites**

28, No.6, 1999, p.277-87.

**PRELIMINARY STUDY OF STRESS AIDED PHOTODEGRADATION OF RUBBER**

Marcos Maillo C; White J R

Newcastle-upon-Tyne,University

Photodegradation of a car tyre sidewall rubber (a blend of natural rubber and butadiene rubber) exposed to ultraviolet irradiation whilst under tensile stress was studied. The study examined rubber with and without antioxidant, and with and without carbon black. Zhurkov equation analysis was used to give approximate values for activation volumes for the degradation process. 40 refs

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.791778

*Item 82*

**Tire Science and Technology**

28, No.3, July-Sept. 2000, p.196-208

**EFFECT OF FATIGUE STEP LOADING SEQUENCE ON RESIDUAL STRENGTH**

Sun C; Gent A; Marteny P

Goodyear Tire & Rubber Co.

The applicability of Miner's rule to typical rubber compounds subjected to repeated tensile strains was evaluated. Tests were carried out on NR and SBR filled with carbon black to determine the effects of loading sequence on residual energy to break, breaking elongation and flaw growth. A model is proposed to predict flaw (crack) growth under mixed strain cycles and the influence of loading sequence on the order of durability rankings of the rubber materials investigated. It was found that Miner's rule did not hold for the fatigue failure of these rubber compounds but the relative rankings of the rubber compounds remained the same in both step-up and step-down strain sequences. (Eighteenth annual conference of the Tire Society, Akron, Ohio, 27-28 April, 1999). 5 refs.

USA

Accession no.791577

*Item 83*

**Tire Science and Technology**

28, No.3, July-Sept. 2000, p.178-95

**RELATIONSHIPS BETWEEN THE FRICTION AND VISCOELASTIC PROPERTIES OF RUBBER**

Amino N; Uchiyama Y

Yokohama Rubber Co.Ltd.; Kanazawa,University

The relationship between the viscoelastic properties (loss tangent and storage modulus) and wet skid resistance of various silica- or carbon black-filled styrene-butadiene rubbers was investigated. Specimens were rubbed against silicon carbide cloths having different abrasive grain sizes to vary the deformation frequencies during sliding. Comparisons are made of the wet skid resistance-frequency curves with the viscoelasticity-frequency curves of the various materials and the differences in the wet skid resistance of the filled rubbers discussed.

(Eighteenth annual conference of the Tire Society, Akron, Ohio, 27-28 April, 1999). 21 refs.

JAPAN

Accession no.791576

Item 84

**Gummibereifung**

75, No.10, Oct.1999, p.61

German

**OHTSU TIRE SHOWS CLASS**

This report reviews the Japanese tyre firm Ohtsu Tire's new racing-sport tyre for cars on the ordinary road, the Falken FK 451. It examines the new tread design, the angular centre grooves, the asymmetrically spaced side grooves for exceptional control of aquaplaning lengthwise and crosswise and wet handling. Other features discussed include abrasion and low-vibration roll, as well as the silica-rubber mixture, optimum surface road contact and an especially short braking distance. Steel belting and nylon banding are discussed along with speed rating, stability and grip.

OHTSU TIRE & RUBBER CO.LTD.

JAPAN

Accession no.790934

Item 85

**Gummibereifung**

75, No.10, Oct.1999, p.44-6

German

**WINTER TYRE WITH RACING SPORT IMAGE**

Schmidt P

This report reviews Pirelli's new Snowdome V-index winter tyre, examining speed, dimensions and wet grip properties. It compares it with Continental's Conti TS 790. T and H index qualities are discussed along with braking, comfort, silica mixture and design. For its Snowsport V version Pirelli claims not only a highest speed of 240 km/h but offers an optimised performance capability on wet and dry surfaces. Pirelli's sales target for this tyre is also surveyed.

PIRELLI SPA

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

Accession no.790931

Item 86

**Industria della Gomma**

44, No.5, June 2000, p.16-23

Italian

**NOTES ON THE VISCOSITY OF RUBBER. I.**

Bassi A C

The viscoelastic properties of rubbers and aspects of simple harmonic motion, complex modulus and viscous dissipation are examined, and the influence of the combination of viscous and elastic properties on the behaviour of rubbers is discussed.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

Accession no.790900

Item 87

**Rubber World**

222, No.6, Sept.2000, p.55/60

**DESIGN OF EPDM FOR BLENDS WITH NR/BR FOR TIRE SIDEWALLS: INFLUENCE OF MOLECULAR STRUCTURE AND CARBON BLACK DISTRIBUTION ON PROPERTIES**

Van de Ven P M; Noordermeer J W M

DSM Elastomers

The inclusion of EPDM in tyre compounds is discussed, with respect to the design of a compound for tyre sidewalls incorporating blends of NR and BR, and the effect of the addition of EPDM on carbon black distribution and final tyre properties. A study is carried out to determine which molecular parameters of EPDM govern the fatigue and cut growth resistance in tyre sidewall blends. Physical properties, and in particular, tear and tensile strength of vulcanisates based on NR/BR/EPDM blends are studied as a function of the EPDM's structural parameters. The experiments show that the ethylene content of EPDM is dominant over molecular weight and unsaturation level with respect to optimal tear and tensile properties, and that the influence of the filler distribution plays a more important role than the degree of crosslinking. In addition, it is determined that the carbon black distribution over the individual NR/BR/EPDM phases are controlled by the structural parameters of the EPDM. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.790283

Item 88

**Rubber World**

222, No.6, Sept.2000, p.36/42

**IMPROVED TRACTION WITH BIMS**

Waddell W H; Poulter R R

ExxonMobil Chemical

A model all-season tyre tread formulation containing brominated isobutylene-co-para-methylstyrene, (BIMS) blended with BR and sSBR (20/25/55) is shown to afford improved lab dynamic properties compared to the BR/sSBR (25/75) control. Increased values of G'' at -30 degrees C, G'' at 0 degrees C, tangent delta at -30 degrees C and tangent delta at 0 degrees C, afford evidence of the potential improvement in tyre winter and wet traction properties using the BIMS elastomer. 21 refs.

USA

Accession no.790281

Item 89

**Rubber World**

222, No.6, Sept.2000, p.25/30

**HIGHLY DISPERSIBLE SILICA IN NON-TIRE FORMULATIONS**

DiMauro P J; Byers J; Uhrland S  
Degussa-Huels

Property improvements brought about by the use of Ultrasil 7000 GR dispersible silica in non-tyre formulations are examined. The production process of precipitated silicas is described together with the effect of process variations on the changes in properties. A special testing technique has been adopted as a quality control method to measure the ease of de-agglomeration of highly dispersible silicas, which is described and demonstrated. Tyre tread formulations are compared with mechanical rubber goods formulations. The silicas were compared in an NBR formulation at the 50 phr level with no silane, and with 3 phr silane coupling agents. Resultant properties are discussed with reference to compound viscosity, cure rate, modulus, hardness, rebound, tensile strength and tear strength, compression set, dispersion, angle abrasion, and Pico abrasion. 5 refs.

USA

*Accession no.790279*

*Item 90*

Rubber Bonding 2000. Conference proceedings.  
Amsterdam, Netherlands, 15th-16th May 2000, paper 12

**NEW RESINS TO IMPROVE ADHESION OF RUBBER TO BRASS COATED WIRE**

Silberzan I; Lebraud S; Stuck B L  
Elf Atochem SA; Sovereign Chemical Co.; CECA SA  
(Rapra Technology Ltd.)

Over the years, resorcinol or resorcinol-formaldehyde resins have been widely used in combination with methylene donors as a system for bonding rubber compounds to brass coated steel wire. This is the common adhesion means for adhesion in steel-belted radial passenger and truck tyres and other brass coated wire reinforced rubber compounds. However, resorcinol is a hazardous chemical that may generate some health concerns. CECA offers an alternative to impart good adhesion with new resins that contain very low amounts of free hazardous chemicals. The data presented show that these alternative resins make it possible to obtain good original and aged adhesion values as well as good reinforcement properties of rubber. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
USA; WESTERN EUROPE

*Accession no.790038*

*Item 91*

Rubber Bonding 2000. Conference proceedings.  
Amsterdam, Netherlands, 15th-16th May 2000, paper 2

**NEW ADHESION SYSTEMS FOR BONDING ZINC COATED CORDS TO RUBBER**

Mauer D; Lang P; Najari A; Garnier F

Bekaert NV SA; CNRS  
(Rapra Technology Ltd.)

The development of an alternative approach for rubber to metal bonding is described. This new approach calls for the use of functionalised organosilanes as coupling agents between the polymeric phase and the metallic reinforcement. Organofunctional silanes are hybrid organic-inorganic compounds that have found widespread use as coupling agents in several industrial applications, e.g. GRP composites and in 'silica tyre' technology. Silane coupling agents are bifunctional compounds that act as a bridge between a mineral surface and a polymer. The first reactive group (the alkoxy silane group) is able to develop strong bonds with the hydrated oxide layer of the metallic surface. The second reactive group is specifically chosen to react with specific reaction sites in the polymeric phase. In the absence of specific reaction sites to react with, the organosilane may be selected to form an interpenetrating network (IPN) with the polymeric phase. 3 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION;  
FRANCE; WESTERN EUROPE

*Accession no.790028*

*Item 92*

EPDM: Supply and demand into the next decade.  
Conference proceedings.  
Brussels, 11th May 2000, paper 9

**NEXT GENERATION EPDM**

Annicelli R A  
Uniroyal Chemical Co.  
(Rapra Technology Ltd.; European Rubber Journal)

EPDM, is the most versatile speciality elastomer in commercial use today. Main attributes include its outstanding resistance to oxidation, ozone and the effects of weathering. It is highly extendible, allowing high levels of filler and plasticisers to be added while still maintaining good physical properties. Its low specific gravity combined with its high extendibility allow for inexpensive functional parts to be produced. There is a wide range of EPDM types available, varying in Mooney viscosity, molecular weight, ethylene/propylene ratio and cure rate. The different types are designed for optimum performance in specific applications, allowing compounding latitude in choosing the best polymer for their particular processing and product requirements. EPDM has found wide use in applications that take advantage of its excellent ageing characteristics, as well as low temperature flexibility and chemical resistance. Articles made from EPDM include automotive weatherseal, hoses, tyre sidewalls, single-ply roof membranes, and wire and cable insulation. EPDM is used in electrical insulation due to its excellent dielectric properties, superior resistance to weather, ozone, corona, water and heat, and its resistance to flow at elevated temperatures. Uniroyal Chemical has introduced RoyalEdge EPDM in response to growing customer needs for a high performance EPDM for automotive weatherstripping and for medium voltage

insulation markets. The characteristics and physical properties of the material applications in these applications are discussed.

USA

Accession no.790014

Item 93

**Plastics, Rubber and Composites**

29, No.2, 2000, p.92-5

**STUDIES ON ADHESIVES FOR BONDING RUBBER TO RUBBER. II. RECLAIMED LATEX PRODUCT FOR ADHESIVE, ADDITION OF ULTRA-ACCELERATOR AND USE OF SOLUBLE SULPHUR**

Job L; Joseph R

Kerala,University

One process for retreading tyres involves coating the buffed casing with a solution of NR compound (dough), covering it with a thin layer of solid adhesive, and then applying the precured tread, also coated with dough. Reclaimed material from waste latex products is used to prepare the adhesive. It is also shown that the addition of an ultra-accelerator to the dough just prior to its application can reduce the bonding time, and hence reduce heat ageing of the tread. In the adhesive strip, a small fraction of the insoluble sulphur can be replaced with soluble sulphur, without significant reduction in bond strength. 6 refs.

INDIA

Accession no.789915

Item 94

**European Rubber Journal**

182, No.10, Oct.2000, p.21

**VREDESTEIN WANTS MAJOR ROLE AS COMPOUNDER**

White L

Vredestein Rubber Resources BV's plans to expand its Maastricht custom compounding activities and perhaps to set up another compounding operation elsewhere in Europe, are discussed. The company is reported to be striving to become one of the dominant players in this very competitive market. The trend in the rubber industry is to buy in compounds rather than invest in equipment to compound internally, in order to work within very tight margins, particularly in the tyre industry, it is maintained.

**VREDESTEIN RUBBER RESOURCES BV**

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.787682

Item 95

**Industria della Gomma**

44, No.1, Jan./Feb.2000, p.35-7

Italian

**FROM PIRELLI, THE MIRS PROCESS FOR HIGH PERFORMANCE TYRES**

The MIRS (modular integrated robotised system) technology developed by Pirelli for the manufacture of high performance tyres is described.

PIRELLI PNEUMATICI SPA;

MILANO,UNIVERSITA STATALE; PIRELLI TIRE CORP.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA;  
WESTERN EUROPE

Accession no.787197

Item 96

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 83

**PLASMA ETCHING AND PLASMA POLYMERISATION COATING OF STEEL TYRE CORDS**

Yoon T H; Kang H M; Kaang S Y

Kwangju,Institute of Science & Technology;

Chonnam,National University

(Nordic Council of Rubber Technology)

Tyre performance is strongly dependent on the interfacial adhesion between tyre cords and rubber, and of course on the mechanical properties of tyre cords and rubber compounds. In general, steel tyre cords are preferred over polyester, nylon, rayon or aramid due to their low cost and good mechanical properties, despite having to be coated with brass which is considered by far the best method of improving adhesion to rubber. Unfortunately, the brass plating process generates chemical wastes that can cause environmental pollution. Moreover, brass-plated steel cords are vulnerable to corrosion. Therefore, a number of researchers have tried to develop alternative methods to replace brass plating. Thus, surface modification by plasma etching and plasma polymerisation coating has received great attention for meeting these needs. Plasma etching is utilised to clean and/or provide functional groups to various substrates. A distinct advantage of this method is no environmental pollution. In addition, plasma polymerisation could be utilised not only for coating purpose to enhance adhesion, but also for membrane and micro-electronic applications. Zinc plated steel tyre cords are subjected to RT plasma polymerisation coating of acetylene or butadiene in order to enhance adhesion to rubber compounds. Plasma polymerisation is carried out as a function of plasma power, treatment time and gas pressure. Argon plasma etching prior to plasma polymerisation, and argon carrier gas were utilised in order to improve the adhesion. 11 refs.

KOREA

Accession no.787113

Item 97

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 72

**VULCANISATION BEHAVIOUR OF DISULPHIDIC AND POLYSULPHIDIC ORGANIC SILANES**

Hasse A; Luginland H D; Huls D

Degussa-Huls AG

(Nordic Council of Rubber Technology)

Bifunctional organosilanes, particularly bis-(triethoxysilylpropyl)tetrakisulphane (Si69) are very efficient silica-rubber coupling agents and for 25 years state of the art. The combination of precipitated silica and sulphur-functional organosilanes is used to reduce rolling resistance and enhance wet traction, especially in tyre tread compounds. The excellent in-rubber performance of such silica filled compounds is achieved by the strong chemical bond between the silica filler and the rubber matrix. Investigations concerning the coupling reaction of the sulphur group of Si69 with the polymer under curing conditions to form rubber to filler bonds have previously been made. While the reactive polysulphane group already reacts with the rubber at high mixing temperatures (pre-scorch), the disulphane bond is more thermally stable and processing safety during mixing is much improved. Due to the higher stability of the disulphane group not only is pre-scorch stability improved, the vulcanisation behaviour is also changed. Compounds with VPSi75 show a longer scorch time and faster cure rate, but the in-rubber performance of the vulcanisate is comparable to those with Si69. The reasons for the changed curing characteristics of disulphane silanes, such as VPSi75 compared to Si69, are discussed. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.787104*

*Item 98*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 71

**IMPACT OF NON-TOXIC EXTENDER OIL SBR STRUCTURE**

Arcoleo C; Bowman I; Soddu L; Tortoreto P

EniChem Elastomeri SpA

(Nordic Council of Rubber Technology)

Emulsion SBR types 1712 and 1721 have been the workhorses of the tyre industry for many years. Both 1712, with 23.5% styrene, and 1721, with 40%, are extended with highly aromatic oil. This oil is classed as toxic and will probably have to be replaced with a so-called 'safe oil' at some point. This is despite the fact that the oil is not biologically available in oil extended rubber, rubber compounds or vulcanisates. There are two candidate oils, TDAE, produced by re-extracting the current oil, and MES, produced as the raffinate of a solvent extraction. Both have lower glass transition temperatures (Tg) than aromatic, but MES is significantly lower and so it has a more marked effect on raw rubber and vulcanisate properties. Thus if MES is used, it will be

more difficult to reformulate rubber compounds for equivalent properties. A study is undertaken to provide information to make this task a little less difficult. The aim is to examine how the new oil affects the rubber Tg, how the Tg can be moved by varying styrene and oil content and how it affects important properties such as wet grip, abrasion resistance and rolling resistance. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.787103*

*Item 99*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 48

**PROPOSAL FOR GENERAL LABORATORY TEST PROCEDURE TO EVALUATE ABRASION RESISTANCE AND TRACTION PERFORMANCE OF TYRE TREAD COMPOUNDS**

Grosch K; Heinz M

VMI Holland BV; Degussa-Huls AG

(Nordic Council of Rubber Technology)

With the Laboratory Abrasion Tester 100 (LAT 100) it is possible to determine the abrasion resistance of tyre tread compounds using a rotating rubber wheel. The mass loss is given as a function of the energy input and the speed. Regression analysis allows the plot of either the abrasion loss or the relative rating as a three-dimensional energy-speed-field corresponding to different severities of a tread wear. By comparing the results of different road tyre tests with the results of the LAT 100, good correlation for the abrasion is found. This makes prediction of a relative ranking of the abrasion resistance of tyre treads compounds in road tests possible. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; NETHERLANDS; WESTERN EUROPE

*Accession no.787082*

*Item 100*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 46

**NEW METHOD FOR THE INVESTIGATION OF DYNAMIC VISCO-ELASTIC PROPERTIES OF ELASTOMERS**

Deckmann H

GABO Qualimeter Testanlagen GmbH

(Nordic Council of Rubber Technology)

The development of new tyres with improved properties (e.g. optimised rolling resistance) is a main target of the research departments in the tyre industry. From the very beginning, the compounding, up to the final step, the first prototype of the new tyre, a very costly and time consuming basic work has to be done. In order to determine the rolling resistance, a very common method is the application of the drum test. The test result indicates the uniform energy loss within the tyre. Unfortunately, in a not negligible manner, the desired properties are not

obtained in all cases. Dynamic mechanical thermal spectroscopy now provides a new useful tool in order to reduce the amount of drum tests by the application of a predictive test procedure. This test procedure is able to simulate the energy loss determined with the drum test on the tread with a new dynamical test procedure available for sample loading in the compression or tensile mode. The benefit is quite obvious. A pre-selection of convenient compounds in an early state of the development process avoids a lot of drum test - or tests on the road. Nevertheless, this method will not be able to completely substitute practical tests done on the tyre. This procedure is only intended to accelerate the development process in order to save time and money.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.787080

*Item 101*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 41

**INTERACTION BETWEEN FUNCTIONAL GROUPS IN RUBBER MACROMOLECULES AND CARBON BLACK**

Shmurak I

Moscow, Tire Industry Research Institute  
(Nordic Council of Rubber Technology)

Rubbers with functional groups in macromolecules obtained by copolymerisation of conjugated diene and unsaturated monomer with such groups or by interaction between diene rubber and a reactive compound are well known. An important field for these rubber latices is adhesives for bonding tyre cord to rubber. The rubbers with functional groups in these macromolecules may be used in rubber compounds of different purpose. Therefore the interaction between these rubbers and fillers which also contain functional groups on their particles surface may influence essentially the performance of tyres and other rubber articles. The interaction between functional groups which are on the silica surface and carboxyl, phenolic and pyridine groups of latex rubber with the formation of covalent and 'onium' bonds has been shown by IR spectroscopy. The interaction between active groups on the particles surface of channel carbon black K-354 and functional groups of some latex polymers is investigated. 10 refs.

RUSSIA

Accession no.787075

*Item 102*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 39

**REACTIVE MIXING OF RUBBER AND SILICA**

Reuvekamp A E M; Ten Brink J W; Van Swaaji P J; Vancso G J; Noordermeer J W M  
Twente, University

(Nordic Council of Rubber Technology)

For most applications, rubbers are reinforced with active fillers. Usually carbon blacks or silica particles are used to enhance properties and service life. An advantage of silica compared to carbon black is: silica gives lower hysteresis loss, which for tyre applications leads to a lower rolling resistance and consequently fuel savings. The compatibility of hydrophilic silica with the hydrophobic polymer matrix is low. Filler-matrix compatibility can be enhanced by adding a bi-functional coupling agent. The filler surface will only be partly activated, and this can create problems for the properties of the final product. The objective is to examine the influence of processing parameters during mixing and vulcanisation - fill factor, rotor speed, order of adding ingredients - on the filler-matrix-coupling. Irreproducible conditions, combined with different possibilities of adding the coupling agents to the filler/rubber substrate are no doubt major factors in the reproducibility of silica-reinforced rubber compounds. Strong evidence is obtained that the ultimate temperature during the mixing stage governs the reaction mechanism of the coupling agent: formation of a silica-rubber bond vs. the action as a curing agent. This evidence is obtained via mechanical and dynamical testing. 21 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.787073

*Item 103*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 37

**POWDER RUBBER - A NEW RAW MATERIAL GENERATION FOR THE SIMPLIFICATION OF THE PRODUCTION PROCESSES IN THE RUBBER INDUSTRY**

Gori U; Schmitt M

Pulverkautschuk Union GmbH

(Nordic Council of Rubber Technology)

The development of continuous compounding process for power-efficient and low-cost production of rubber compounds of high and consistent quality is a great challenge, as well as a chance for the rubber industry. A prerequisite for this is to convert the rubber and filler into a state in which both components are present in already homogeneously dispersed form in one phase. The development and production of free-flowing rubber/filler batches in powder form - powdered rubber - is certainly one of the most promising approaches to achieve these objectives. The various development methods leading to the various powder rubber systems as they are necessary for wide introduction of this new product form and processing technology into the rubber industry require an individual treatment of the different rubber/filler variants as regards raw material selection, production and compounding technology. Investigations of the E-SBR/carbon black system have been described; this presentation is based on these results and the experience gained, with

emphasis on the introduction of a new powder rubber system based on NR/carbon black. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.787071

*Item 104*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 24

**EXXPRO™ POLYMER: MATERIAL TO MEET THE GROWING TRENDS IN THE TYRE INDUSTRY**

Wong W K; Mills T A

ExxonMobil Chemical

(Nordic Council of Rubber Technology)

The demand of tyre performance from car manufacturers is ever increasing. Today's tyres not only need to fulfil the functional requirements of low rolling resistance, high wet traction and wear resistance; criteria such as tyre noise and handling as well as cosmetic become more and more important. Exxpro, a copolymer of isobutylene and paramethylstyrene that is subsequently brominated, is today being used commercially for tyre sidewalls. One of the main advantages of using Exxpro in tyre sidewall compound is that the tyre retains its fine shiny black colour. Due to its high stability, no antioxidant or antiozonant is needed in tyre sidewall compound that contains Exxpro as one of the elastomer components. Therefore discolouration of normal general purpose rubber tyre sidewall that is associated with the blooming of these additives does not take place. The use of proper silane and mixing conditions to obtain silica filled Exxpro with higher tan delta at 0-10 deg.C and lower tan delta at 50-70 deg.C, when compared with similar compounds filled with N220 or N660 black, is reported. 5 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

Accession no.787061

*Item 105*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 23

**POTENTIAL OF LOW SURFACE AREA SILICA IN TYRES**

Blume A; Uhrlandt S; Wehmeier A

Degussa-Huls AG

(Nordic Council of Rubber Technology)

The increasing demands on the 'high tech product' tyre require novel tread compounds, which improve rolling resistance, wet grip, winter performance and service life. These targets could be met at the beginning of the 1990s using tread compounds with special polymers and high loadings of a silica/silane reinforcement system instead of carbon black. To reach a further reduction in rolling resistance of about 20%, which enables a reduction of the fuel consumption of approximately 5%, a new silica for the use in the tyre body is developed. Additionally a

longer tyre carcass life, especially in truck tyres, by the reduction of the heat build-up is achieved. Further investigations also show a potential of this silica for winter/ice tyres. The determination of the most suitable analytical properties of this silica and the effect of its use in different tyre parts are discussed. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.787060

*Item 106*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 22

**PASSENGER CAR TREAD COMPOUNDS WITH IMPROVED PERFORMANCE BY USING VULCUREN TRIAL PRODUCT KA 9188 - A NEW BIFUNCTIONAL CROSSLINKER**

Jeske W; Dr.Buding; Dr. Weidenhaupt

Bayer AG

(Nordic Council of Rubber Technology)

Most passenger car tyre tread compounds are based on SBR or SBR/BR blends and crosslinked with a cure system containing sulphur and various accelerators. Synthetic rubber vulcanisates are not as sensitive to reversion as NR vulcanisates but nevertheless they are subject to alterations due to changes in the crosslink structure during vulcanisation at high temperatures or during ageing. Such alterations should be avoided as the tyre performance could be negatively affected. The effectiveness of 1,6-bis(N,N-dibenzylthiocarbamoyl-dithio)hexane, a bifunctional crosslinker, is investigated in passenger car tread compounds. It is found that it can be used to advantage in cure systems for SBR-based vulcanisates. The vulcanisate properties, dynamic behaviour at optimum cure and the retention of properties after ageing can be considerably improved.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.787059

*Item 107*

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 21

**ECORAX - THE CONCEPT TO EXTEND THE MAGIC TRIANGLE**

Frohlich J; Messer P; Niedermeier W

Degussa-Huls AG

(Nordic Council of Rubber Technology)

A new class of furnace carbon blacks is developed for the use in various rubber compositions for tyres and is particularly well suited to truck tyre compounds. It is generally desirable to utilise carbon blacks which impart high levels of abrasion resistance and low levels of rolling resistance. Especially high surface area blacks, which impart improved abrasion resistance in particular under high severity conditions, provide high hysteresis and

therefore large heat generation. To overcome this dilemma a class of novel furnace carbon blacks is produced by a physical modification of the reactor process in order to increase the surface activity. These nanostructure blacks are characterised by a high surface roughness and surface activity leading to decreased filler-filler and enhanced filler-polymer interaction. They show excellent hysteresis properties (low heat build-up), abrasion resistance at the same level of improved blacks whilst still maintaining all other in-rubber properties. With these novel carbon blacks it is now possible to overcome the limitation imposed by the 'magic triangle' of tyre performance. The low hysteresis combined with the excellent abrasion resistance is the best qualification of the nanostructure blacks for the general use in truck tyres. 25 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.787058

*Item 108*

IRC 2000. Conference proceedings.  
Helsinki, Finland, 13th-15th June 2000, paper 20  
**CORRELATION BETWEEN TRUCK HIGHWAY  
TREADWEAR AND TREAD COMPOUND  
LABORATORY CRACK GROWTH  
CHARACTERISTICS**

Money Penny H; Hardy D; Couturier G; Brown P;  
Gelling I; Roberts A; Wallace I  
Cabot Leiden Technical Centre; Cabot Carbon Ltd.;  
Tun Abdul Razak Research Centre  
(Nordic Council of Rubber Technology)

A project was initiated by a number of retread companies and research institutes to investigate the possibilities for the improvement in quality control and performance of retreaded tyres. One of the objectives was to develop a method of tread wear prediction through an improved methodology of an existing abrader and/or the development of a new prototype abrader. The efforts to modify test conditions for the existing DIN and Akron abrasers to improve tread wear predictability are described. Additionally, the fracture mechanical behaviour of a number of filled truck tyre tread compounds is compared to their tread wear performance under different severity levels. The tyre performance characteristics of three Cabot carbon blacks are confirmed and efforts to relate tread wear, rolling resistance and heat build-up behaviour to laboratory tests including abrasion, crack growth and viscoelastic response of the tread compound are discussed. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; UK; WESTERN EUROPE

Accession no.787057

*Item 109*

IRC 2000. Conference proceedings.  
Helsinki, Finland, 13th-15th June 2000, paper 14  
**INFLUENCE OF BUTYL RUBBER RECLAIM**

**AND FILLERS ON THE PROPERTIES OF  
BROMOBUTYL INNER LINERS**

Manuel H J  
Vredestein Rubber Resources  
(Nordic Council of Rubber Technology)

Butyl rubber reclaim is produced by a few companies around the world. The material is mainly used in tyre inner liners, due to the fact that it lowers cost price without seriously affecting most of the properties. Indeed some properties are even improved quite distinctly. In earlier studies with test recipes for halobutyl inner liners, flex life and ageing resistance have been shown to be improved by incorporating butyl rubber reclaim. New examples for recipes with higher filler loadings are given. The results show that the conclusions of earlier studies are still valid for these new recipes as well. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.787053

*Item 110*

**Tire Technology International**  
2000, p.135/42  
**IN THE MIX**

Wood P  
Tire Technology International

This article is intended to be a reference and a guide to good mixing room practice, and of particular relevance to tyre manufacturers. Aspects of the mixing process considered include raw materials consistency; compound preparation and weighing; the importance of process control; material transfer and feeding; batch size and fill factors; use of different rotor speeds during mixing; and control of mixing.

Accession no.785690

*Item 111*

**Tire Technology International**  
2000, p.73-4  
**REINFORCEMENT WITH PRECIPITATED  
SILICA**

Dodane B; Pina E  
Glassven

Properties and applications are described for the five available grades of Rubbersil precipitated silicas from Glassven. The products are improved conventional and high dispersible grades, which find application in the rubber industry, mechanical rubber goods and tyres. Grades RS-200G, RS-150G, RS-120G, RS-3000 TG and RS-5000 TG are discussed.

VENEZUELA

Accession no.785681

*Item 112*

**Tire Technology International**

2000, p.67-70

**SILANES AMONG THE SILICA**

Ansarifar M A; Nijhawan R  
Loughborough, University

The use is discussed of bifunctional organosilanes in tyre compounds with a high loading of precipitated silica, to reduce viscosity and improve cure properties. The addition of bifunctional organosilanes in sulphur cure systems, reduce viscosity by weakening or diminishing silica-silica interactions, and improve cure characteristics by preventing acidic silica from interfering with the reaction mechanism of sulphur cure system. The aim of this study was to investigate how a progressively increasing amount of triethoxysilylpropyl tetrasulphane (TESPT) as a coupling agent in natural rubber tyre compound highly loaded with precipitated silica, influenced Mooney viscosity and cure properties. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.785680

Item 113

**Tire Technology International**

2000, p.59-66

**IN FULL BLOOM - FINDING ALTERNATIVES TO WAXING OVER THE CRACKS**

Hong S W; Greene P K; Lin C  
Uniroyal Chemical Co.

Substitutes for wax to provide protection of tyre sidewalls against static ozone cracking are examined. The use of low levels of wax or its complete elimination in the tyre sidewall by combinations with dialkyl paraphenylene diamine (77PD) or 2,4,6-tris - (N-1,4 dimethyl pentyl-p-phenylene diamino) 1,3,5 triazine (TAPDT) is discussed for the long term resistance to dynamic ozone crack resistance. In addition, a mechanism is proposed to explain how ozone reacts with antiozonants, which involves a scavenging function. 5 refs.

USA

Accession no.785679

Item 114

**Tire Technology International**

2000, p.50-2

**ZINC OXIDE IN NBR**

Hillmer J; Henschel D; Rothman H; Berghofer J  
Continental AG; ContiTech; Brueggmann KG

A comparison is made of the performance of zinc oxide RAC and the zinc oxide French process in a lightly filled NBR compound. Production of the samples was performed by internal mixer. Properties of the two compounds are compared, with reference to degree of dispersion, viscosity, crosslink density, reversion stability, and vulcanisation properties.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.785677

Item 115

**Tire Technology International**

2000, p.18-23

**GO WITH THE FLOW**

Rubin Y; Waucquex C  
Polyflow SA

The potential value is discussed of computational fluid dynamics in the design and manufacture of tyres. In particular, the following phases of product life are examined: batch mixing of rubber; heating, pressurising, mixing and conveying by single- or twin-screw extruders; extrusion of the tyre tread; curing the compounds after shaping; and some product performance analysis such as aquaplaning. A case study is included to which demonstrates the applicability of numerical simulation in the improvement of the extrusion process. The project aimed to reduce by half the number of trials required for modification of the geometry of the Alliance 1200R20 444 model tyre used for trucks and buses

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION;  
WESTERN EUROPE

Accession no.785674

Item 116

**Rubber World**

222, No.4, July 2000, p.25/36

**MCTD EXTRUDERS: FROM THEORY TO PRACTICE**

Fischer F W; Hohl M W  
A-Z Formen- & Maschinenbau GmbH

Screw conveying systems, or screw extruders, have been used by the rubber industry as a means of mixing, homogenising, plasticising and shaping a great variety of elastomeric compounds since the early 1900s. One of the mixing, homogenising and plasticising systems able to perform by itself and not in conjunction with a variety of different other sections is the MCT or Multicut Transfermix from A-Z. The MCT extruder relies on a highly interactive screw and barrel design, or transfer zone, to mix and blend the rubber compound intensively. The development of new tyre tread compounds is leading towards carbon black/silica modified elastomers with increasing levels of fillers. The MCT and MCTD range of extruders have proven to be successful at mixing a variety of these modified elastomers. The introduction of a new throttle system has enabled the Transfermix extruder to process even nery natural rubber adequately. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.785173

Item 117

**Rubber World**

222, No.4, July 2000, p.23-4

**NEW LIFE FOR HOT FEED EXTRUSION LINES**

Sheehan E  
Akron Steel Fabricators Co.

As tyre industry requirements become more reliant on multiple compound extrusions, the old hot feed extruders which make single profiles are become obsolete. Akron Steel Fabricators suggests users look at a modernisation programme which can take the old equipment and transform it to new technology. The old single or opposed extrusion head can be replaced with a state-of-the-art triplex, or even quadraplex, unit specifically designed for the multi-compound profiles required. The heads are manufactured by A-Z Formen- und Maschinenbau. In conjunction with the new head, one or more of A-Z's Multicut Transfermix cold feed extruders are added for the new profile flow paths.

A-Z FORMEN- & MASCHINENBAU GMBH  
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
USA; WESTERN EUROPE

Accession no.785172

*Item 118*

ACS Polymeric Materials: Science &  
Engineering.Spring Meeting 2000.Volume  
82.Conference proceedings.  
San Francisco, Ca., 26th-30th March 2000, p.224-7

**POLYMER/FILLER INTERFACE**

Gerspacher M; O'Farrell C P  
Richardson S.,Carbon Co.  
(ACS,Div.of Polymeric Materials Science & Engng.)

The carbon black used in tyres consists of aggregates of crystallites and amorphous carbon. The strain energy associated with the deformation experienced by a tyre during rolling may be momentarily stored whilst the remainder is dissipated, the partitioning of the strain energy depending upon the carbon black, the polymer and the interface between the two. The viscoelastic behaviour of carbon-filled polymers at both low and high frequency is described, and it is shown that the surface structure of the carbon black is responsible for its interactions with neighbouring aggregates and the polymer chain. The interactions depend upon the polymer, and the aggregate size and shape. 23 refs.

USA

Accession no.783129

*Item 119*

**Rubber Chemistry and Technology**

73, No.2, May-June 2000, p.240-52

**THE EFFECTS OF CERTAIN RECIPE  
INGREDIENTS AND MIXING SEQUENCE ON  
THE RHEOLOGY AND PROCESSABILITY OF  
SILICA- AND CARBON BLACK-FILLED TIRE  
COMPOUNDS**

Schaal S; Coran A Y; Mowdood S K  
Akron,University; Pirelli Tire LLC

The work was carried out to study the effects of curing agents, fillers such as silica and the effects of mixing

sequence and scheme on the rheological and processability characteristics of tyre compounds stored at different temperatures prior to testing. 15 refs.

USA

Accession no.783003

*Item 120*

**Rubber Chemistry and Technology**

73, No.2, May-June 2000, p.225-39

**THE RHEOLOGY AND PROCESSABILITY OF  
TIRE COMPOUNDS**

Schaal S; Coran A Y-  
Akron,University

The work was carried out to define the parameters which define both the rheology and processability of tyre compounds. Using a wide range of shear rates the rheology was characterised and the processability was taken as the inverse of the extrusion appearance from the Monsanto Processability Tester. Correlation was found between the Mooney peak and extrudate roughness. A physical descriptive model was also proposed to describe filler-rubber structures. 26 refs.

USA

Accession no.783002

*Item 121*

**Kautchuk und Gummi Kunststoffe**

53, No.6, June 2000, p.358-64

**INFLUENCE OF COMPOUNDING MATERIALS  
ON TYRE DURABILITY**

Niziolek A W; Nelsen J G; Jones R H  
Bayer Corp.

The influence of the choice of polymers, stabilisers and curing agents used in innerliner, sidewall and belt skim compounds on component properties, such as weather resistance, fatigue resistance, hysteresis, adhesion and permeability, and in turn on the durability of tyres is discussed. Data demonstrating the contributions made by a new bromobutyl rubber in innerliners and a neodymium catalysed BR in sidewalls to tyre durability are presented. 5 refs. (ACS,Rubber Div.Meeting, Chicago, Il., USA, April 1999).

USA

Accession no.779842

*Item 122*

**Kautchuk und Gummi Kunststoffe**

53, No.6, June 2000, p.338/45

**ANALYTICAL PROPERTIES OF SILICA - KEY  
FOR UNDERSTANDING SILICA  
REINFORCEMENT**

Blume A  
Degussa-Huels AG

The relationship between different silica properties and their effects on the performance of tyre tread

formulations were investigated. Tests were carried out on 37 silicas to obtain the widest range of physical properties. Parameters important for improving the dispersion behaviour, dynamic stiffness and cure rate of the formulations were identified as the WK-coefficient, specific silanol group density and surface activity and, in particular, a combination of BET surface area and DBP value. 15 refs. (ACS,Rubber Div.Meeting, Chicago, 13-16 April, 1999).

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.779839

*Item 123*

**International Polymer Science and Technology**

27, No.4, 2000, p.T/52-T/57. (Translation of Kauchuk i Rezina, No.6, 1999, p.30)

**HEXACHLORO-P-XYLENE IN VULCANISATES: EXPERIENCE AND FUTURE PROSPECTS**

Kandyrin K L

Lomonosov Institute of Fine Chemical Technology

Hexachloroparaxylene (HCPX) as a polyfunctional ingredient in rubber formulations is discussed, with reference to its benefits and shortcomings, in the form of a literature review. The product is non-toxic, has good solubility in rubbers, and improves several parameters of rubber mixes and vulcanisates, being particularly effective as a component of vulcanising and modifying systems. It is currently being used in significant quantities only in tyre rubbers for the coating of polyamide cord, but if its noted shortcomings are overcome, it is argued that it could also be used for high-modulus rubbers in the mechanical rubber goods industry. 70 refs.

RUSSIA

Accession no.779709

*Item 124*

**Indian Rubber Journal**

Vol.45, Jan./Feb.2000, p.91

**UNIROYAL DEVELOPS NEW ADDITIVE**

CK Witco's Uniroyal Chemical has developed Durazone 37 non-staining rubber additive that is claimed to provide both antioxidant and antiozonant protection to natural and synthetic rubbers and blends thereof. The additive is able to protect tyres and other rubber products from the degrading effects of ozone, heat, oxygen and flex fatigue without the staining often seen with p-phenylenediamines, and can be used in rubber compounds that are adjacent to white or coloured compounds. Its use with a p-phenylenediamine type antioxidant is said to provide better protection against ozone effects than could have been obtained by using either one singly.

CK WITCO CORP.

USA

Accession no.778528

*Item 125*

**Rubber Chemistry and Technology**

72, No.5, Nov./Dec.1999, p.960-8

**IMPROVED TIRE WET TRACTION THROUGH THE USE OF MINERAL FILLERS**

Mouri H; Akutagawa K

Bridgestone Corp.

Aluminium trihydrate, a new mineral filler in the tyre industry, was evaluated as a replacement for silica. It was shown to provide good wet traction, rolling resistance and tread wear, without some of the disadvantages of using silica compounds. Aluminium trihydrate did not require a coupling agent, thus reducing compound cost compared with silica formulations. It also reduced the variability encountered in processing because it was less sensitive to variations in mixing temp. The mechanism responsible for the good wet traction was found to be the difference in the WLF shift factor of aluminium trihydrate and silica compared with carbon black. The mechanism was consistent with that previously proposed for the improved wet traction of silica compared with carbon black. 11 refs. (ACS Rubber Division, Spring Meeting, Indianapolis, USA, May 1998)

JAPAN

Accession no.778386

*Item 126*

157th ACS Rubber Division Meeting - Spring 2000. Conference preprints.

Dallas, Tx., 4th-6th April 2000, paper XXV11

**DESIGN OF EPDM RUBBER FOR BLENDS WITH NR/BR FOR TYRE SIDEWALLS: INFLUENCE OF MOLECULAR STRUCTURE AND CARBON BLACK DISTRIBUTION ON PROPERTIES**

Van De Ven P M; Noordermeer W M

DSM Elastomers

(ACS,Rubber Div.)

Due to its positive effect on ozone resistance and appearance, the use of EPDM as an admixture to NR and BR for tyre sidewall purposes continues to raise interest. One of the main stumbling blocks encountered is a decrement of the cut-growth resistance of the sidewall after EPDM addition. Factors determining the cut-growth of such blends are: strength of the individual rubber phases and the interfacial adhesion of these phases, which in turn are controlled by filler level and distribution, resp. the crosslink density and distribution over the different rubber phases. The traditional approach is to design an EPDM for an optimal EPDM-strength and crosslink density; thus aiming for high molecular weight and high unsaturation levels. However, this leads to difficulties in mixing and thus poor morphology of the blends. A new approach to this problem is described, where the EPDM-structural parameters are optimised to control the filler distribution rather than the vulcanisation properties. This proves that contrary to what is commonly believed, a regular Mooney

EPDM-type with a high ethylene-content and with a low unsaturation level performs the best. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.778121

Item 127

**Elastomery**

4, No.1, 2000, p.15-22

Polish

**ADHESION OF ELASTOMERS TO FIBRES**

Marasek T; Slusarski L; Zaborski M; Parasiewicz W  
Instytut Polimerow Politechniki Lodzkiej; Instytut  
Przemyslu Gumowego Stomil Piastow

The effect of promoters with epoxy groups on the adhesion of polyester and polyamide cords to the typical rubber mix applied in tyre technology has been studied. The mix was modified with epoxidised NR or epoxy resin. Different hardeners were used. For the purpose of comparison, cords were also impregnated with an RFL bath. A positive effect of the promoters, particularly of the epoxidised NR, on adhesion of cords to the vulcanisates was observed. An increase in pulling force in the "H" test in the case of polyester cord reached 68%. After impregnation with the RFL bath it was possible to obtain an increase in pulling force in the range 112%. However, the modification of a rubber mix is a much simpler operation in comparison to the impregnation of cords with an RFL bath. 8 refs.

EASTERN EUROPE; POLAND

Accession no.777203

Item 128

**Elastomery**

4, No.1, 2000, p.9-14

**PAVEMENTS FROM ASPHALTS MODIFIED  
WITH GROUND TYRE RUBBER**

Diedrich K M; Burns B J  
Degussa-Huls AG; Creanova Inc.

High quality pavements can be prepared by mixing trans-polyoctenamer (TOR) with ground tyre rubber (GTR) in asphalt. As little as 3-6% of TOR causes efficient dispersibility of fillers, compatibility and crosslinking in asphalt GTR mixtures. Mixture preparation and methods of usage are described in detail. In addition, practical examples of the cost calculations for several roads are presented. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
USA; WESTERN EUROPE

Accession no.777202

Item 129

**Indian Rubber Journal**

Vol.48, 2000, p.122-8

**MIXING OF SILICA/SILANE FILLED RUBBER  
COMPOUNDS**

The mixing of highly filled silica rubber is discussed with reference to the linking of a bifunctional organosilane to the silica. The reaction mechanism is investigated for four different silanes for the in-situ modification of silica. A study is made of the silane reaction following the ethanol formation; the influence of the dump temperature, the influence of silane concentration, the silica/silane reaction following the shear modulus tan tones, and consequences for compounders. 23 refs.

DEGUSSA-HUELS

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.776981

Item 130

**Kautchuk und Gummi Kunststoffe**

53, No.3, March 2000, p.126-8

**MEASUREMENT AND MOLECULAR  
MODELING OF ROLLING RESISTANCE IN  
TYRE TREADS**

Wrana C; Eisele U; Kelbch S  
Bayer AG

Rolling resistance is a key tyre property considered in the design and manufacturing of tyres. Usually rolling resistance is measured by an expensive quantitative tyre test using a prototype final product. In order to speed up the development, efforts have been made to predict rolling resistance using samples rather than prototype tyres. One such attempt is to correlate the mechanical loss factor tan ( $\delta$ ) to rolling resistance. However, this method is quite empirical and not useful if the influence of factors like polymer structure or filler on the rolling resistance is of interest. Especially for silica filled compounds or hybrid systems the correlation of rolling resistance with the loss factor is not successful. Combining dynamic mechanical measurements with the master curve technique and the separation and modelling of molecular relaxation processes yields an improved technique for predicting the rolling resistance. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.776692

Item 131

**Iranian Journal of Polymer Science & Technology**

12, No.3, Autumn 1999, p.11-21

Persian; English

**EFFECT OF CURING SYSTEM ON ADHESION  
OF POLYESTER CORD TO RUBBER IN RADIAL  
TYRES**

Kobabi M; Soltani Nejad S; Abbasi Abyaneh A  
Tarbiat Modarres University; Kerman Tire & Rubber Co.

Rayon fibres are conventionally used to produce radial tyres. There have been some attempts to replace rayon fibres of regenerated cellulose by the synthetic materials in order to avoid the destruction of forests, the main source

of cellulose, and prevent environmental disasters. Polyester fibres, with reasonable physical and mechanical properties, have several advantages such as high dimensional stability and tensile strength, as well as low weight and cost. Disadvantages are low cord to rubber adhesion and poor mechanical properties during the service conditions or the curing stages at high temperature. Hydrolysis and aminolysis of polyester chains in the cord surfaces are the main reasons for deterioration in properties. The curing system is the basic source of amine in the rubber compound. An attempt is made to identify and sort the factors which cause problems in adhesion of polyester cord to rubber and eliminating or reducing them in the curing system. By using experimental design, the effect of the compound resorcinol-hexamethylene tetramine on adhesion of polyester cord to rubber in radial tyres are systematically investigated. 5 refs.

IRAN

Accession no.776667

Item 132

**International Polymer Science and Technology**

27, No.3, 2000, p.T/39-T/41. (Translation of Kauchuk I Rezina, No.5, 1999, p.20)

**FEATURES OF THE MODIFICATION OF CARCASS RUBBERS BY BLOCKED POLYISOCYANATE AND M-PHENYLENEBIS(MALEIMIDE)**

Puchkov A F; Ogrel' A M; Turenko S V; Reva S V  
Volgograd, State Technical University

The modification of tyre carcass rubbers by blocked polyisocyanate and m-phenylenebis(maleimide) (MPBM) is studied. MPBM is shown to act as adhesion promoter in rubber-cord systems, and also to promote a reduction in the susceptibility of rubber mixes to scorching, and a similar complex action on the vulcanisation process and the properties of vulcanisates can be also be rendered by blocked diisocyanates, in particular those based on 4,4'-diphenyl-methane diisocyanates (BKPIC). Failure analysis was carried out on specimens in the form of a rubberised single strand using both systems as modifiers. 5 refs.

RUSSIA

Accession no.775892

Item 133

**Tire Technology International**

June 2000, p.43-5

**HIGHLY DISPERSIBLE SILICAS IN TYRES**

Cochet P  
Rhodia Silica

In 1989, Rhodia launched Zeosil 1165 MP (micropearl) into the marketplace as the first highly dispersible silica (HDS). Fuel-saving tyres based on HDS are now sold by most tyre manufacturers. Zeosil 1165 MP gives the best compromise between wear resistance/rolling resistance/

wet traction, required for fuel saving tyres. The company is introducing a new generation of HDS Zeosil MPS which has been designed to show an increased reactivity towards the coupling agent used in the formulation.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
WESTERN EUROPE

Accession no.775777

Item 134

**Tire Technology International**

June 2000, p.20/8

**IN THE MIX**

Wood P

This article is intended to be a reference and a guide to good mixing room practice. The mill room environment, compound preparation, material transfer and feed, batch size and fill factor, effective use of the mixer, feeding the mixer, use of different rotor speeds during mixing and control of mixing are discussed.

USA

Accession no.775774

Item 135

**Gummi Fasern Kunststoffe**

53, No.3, March 2000, p.178-83

German

**PLASTICISING OF ELASTOMER MATERIALS**

Stein G

The particular chemical properties of trans-polyoctenamer (TOR) facilitate the surface coating of ground rubber waste, e.g. ground tyre rubber by a simple technique. Such modified ground rubber can be added as filler material to virgin rubber compounds and causes less deteriorated physical properties than uncoated rubber waste does. Alternatively the modified ground rubber can be directly moulded to new rubber goods. The parameters of the rubber waste, which influence the final properties of the rubber goods, are discussed. A new application of TOR in combination with ground scrap rubber is found in asphalt production. Every year ground rubber is added to asphalt in growing amounts. Small amounts of TOR result in a better dispersion of the ground rubber. Additionally TOR crosslinks the rubber flour to the asphalt as well as reducing the tackiness of the compound dramatically. This allows an earlier compacting of the asphalt with steel and rubber rollers at higher temperatures and saves a lot of working time. The ability of TOR to crosslink the ground rubber to the asphalt provides a rubberised matrix in the paving that prevents premature cracking, rutting and shoving. 9 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.773790

Item 136

**Rubber and Plastics News 2**

21, No.16, 8th May 2000, p.6

**TIREX ADJUSTS RECYCLING SYSTEM,  
ENTERS ALLIANCE**

Moore M

Tirex claims it has made additional adjustments and improvements to its TCS-1 cryogenic tyre recycling system in preparation for commercialising the process. The yield of clean, uncontaminated crumb rubber is the best result the TCS-1 has produced to date, the company says. Tirex has signed an agreement with Michel DeBlois Technologies and former Recyc-Quebec official Francois Lafortune to joint Tirex at its Montreal facility to produce unique moulding materials using its Rutex-brand crumb rubber.

TIREX CORP.; M.D.TECHNOLOGIES  
CANADA

*Accession no.773776*

*Item 137*

**Macplas**

24, No.213, Nov.1999, p.39-40

Italian

**OUT FROM THE WRECKAGE**

West European initiatives in the recycling of plastics from scrap cars and in the use of recycled materials in automotive components are reviewed. Brief consideration is also given to the disposal and recycling of scrap tyres.

EU; EUROPEAN COMMUNITY; EUROPEAN UNION;  
WESTERN EUROPE-GENERAL

*Accession no.773248*

*Item 138*

**European Rubber Journal**

182, No.2, Feb.2000, p.30-1

**HOLROYD TO INTRODUCE NEW MIXER**

Shaw D

Holroyd Associates has built a working prototype of its new-style continuous mixing machine for rubber. The unit has been built using a conventional 90mm extruder drive and a specially-designed screw. In addition, it has two patented mixing elements which ensure the unit can incorporate carbon black and other ingredients with good dispersion and good distribution. A critical aspect of the unit is that it is designed to work at very low temperatures, from 0C up to around 50C. Initially, the company is targeting tyre companies as possible collaborators on the mixing project, but it appears that the machine may well be suited to many other types of compound.

HOLROYD ASSOCIATES LTD.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

*Accession no.772734*

*Item 139*

**European Rubber Journal**

182, No.2, Feb.2000, p.22-5

**CHEMICALS PROGRESS EXTENDS  
ELASTOMER TYPES USED IN HOSE &  
BELTING**

White L

Improved compounding ingredients for better formulations for hose and belting applications were a major focus of speakers at RubberChem '99. In tyre compounding, the silica revolution is still having repercussions, with compounding developments aimed at good processing and improved cure rate without scorch. New ingredients on offer included a new antiozonant from Duslo and a new insoluble sulphur grade from Flexsys.

WORLD

*Accession no.772732*

*Item 140*

**International Polymer Science and Technology**

26, No.11, 1999, p.T/47-T/50. (Translation of Kauchuk i Rezina, No.4, 1999, p.31)

**EFFECT OF FINE COLLOIDAL SILICA ON THE  
SLIP RESISTANCE OF TREAD RUBBERS**

Maksimova N S; Sizikov N N

Russia,Scientific Research Institute of the Tyre Industry

To determine more precisely the role of silicate fillers in tread rubbers for winter tyres, a study was made of the influence of the content of semi-reinforcing fine colloidal silica on the properties of rubbers based on a combination of cis-isoprene and cis-butadiene rubbers in a 50:50 ratio. At the same time, the content of semi-reinforcing carbon black, paraffinic-naphthenic oil and vulcanisation accelerator was varied in accordance with a half-replica of a full factorial experiment for four variables. The slip resistance of the studied rubbers against wet asphalt and ice was tested, and by means of regression equations, it was found that the replacement of 20 parts carbon black with fine colloidal silica led to a considerable increase in slip resistance against ice at -3 degrees C, but hardly affects its value at -17 degrees C and the slip resistance against wet ice. It is concluded that the formulation of tread rubbers must take account of the fact that increase in the content of fine colloidal silica is necessary to improve the slip resistance against ice when the relative hysteresis is reduced, and to improve the slip resistance against wet asphalt when the relative hysteresis is increased. 12 refs.

RUSSIA

*Accession no.772340*

*Item 141*

**Nippon Gomu Kyokaishi**

73, No.2, 2000, p103-9

Japanese

**MATERIAL TECHNOLOGY FOR REDUCING  
ROLLING RESISTANCE**

Muramatsu R; Takehashi H

The effect of adding carbon blacks and silica fillers to styrene-butadiene rubber tyres on rolling resistance is studied. 37 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.771846

Item 142

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 62

**BUTYL RECLAIM IN INNER LINER APPLICATIONS. II. INFLUENCE OF NON-REINFORCING FILLER**

Manuel H-J

Vredestein Rubber Resources BV

(ACS,Rubber Div.)

Butyl rubber reclaim (RBR) has been introduced in several inner liner recipes based on bromo-, chloro- and regular isobutylene-isoprene polymers (BIIR, CIIR and HR). It was found that most of the physical properties for inner liner applications were influenced to a minor degree. In fact the most important properties permeability, flex life and adhesion were improved by addition of RBR. Some comments about the research were directed to the fact that the recipes tended to be too sophisticated/expensive. A part of the work therefore is repeated with a BIIR compound with an increased amount of filler (in casu china clay). With this recipe the influence on the properties is examined, to see if the conclusions of the first investigation still hold for this recipe as well. It is found that the introduction of extra filler material (and RBR) improve the overall permeability and price performance. The flex life after ageing is decreased with extra filler, but can be enhanced by introducing RBR into the recipe, as it did in the first experimental series. Most of the other properties follow the trends of the earlier investigations. With this it is concluded that RBR can be used in inner liner compounds used throughout the industry, even in the compounds optimised for property/price performance. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.771694

Item 143

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 58

**DIFFERENTIAL DYNAMIC MODULUS OF SILICA FILLED AND CARBON BLACK FILLED SBR VULCANISATES IN CYCLES OF LARGE SHEARING DEFORMATION AND RECOVERY**

Isono Y; Tamada M; Kawahara S

Nagaoka,University

(ACS,Rubber Div.)

The use of silica in tread applications is increasing. This is because of not so different rolling resistance for silica

filled and carbon black filled rubbers, and of higher wet skid resistance for the former than the latter. Such difference should be attributed to the variation in viscoelasticity. It is, however, still unknown what viscoelastic function should be used as a predictor. At the place to be in contact with the road, a tyre tread rubber undergoes a large deformation on which small oscillations are superposed. Hence differential dynamic modulus measured by intermittently superposing small oscillations on a large deformation may provide useful information. Nonlinear viscoelastic properties of carbon black and silica (plus coupling agent) filled SBR vulcanisates are studied in cycles of large shearing deformation ( $\gamma = 2$ ) and recovery ( $\gamma = 0$ ) on which small shear oscillations ( $\gamma_{osc} = 0.005$ ) are superposed. CB filled SBR shows different responses in deformed and recovered states: values of tan delta are lower in deformed state than in recovered state. However, silica filled one shows no change in tan delta in the two states. In the deformed state, silica system shows higher tan delta than CB system. The results agree with experience of higher wet skid resistance for silica than for CB, showing validity of differential loss tangent, tan delta ( $w, \gamma; t$ ) as the predictor. 16 refs.

JAPAN

Accession no.771692

Item 144

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 56

**INNER LINERS FOR TRUCK TYRES A REVIEW**

Jones G E

Exxon Mobil Chemical Co.

(ACS,Rubber Div.)

Medium truck tyre inner liners and their properties are reviewed, starting with a brief history of bias tyres followed by emphasis on medium radial truck tyres. Properties such as permeability, adhesion and long-term durability of halobutyl innerliners are discussed and their importance to tyre performance. Because of the viscoelastic nature of butyl polymers they have always been difficult to process. Comments on liner compound processability including modified polymers for improved processing are presented, as is an inner liner for severe service applications. 4 refs.

USA

Accession no.771690

Item 145

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 54

**CUT GROWTH TESTING AND IMPROVEMENT IN RUBBER COMPOUNDS**

Wampler W; Yang H; Gerspacher M; O'Farrell C P

Richardson S., Carbon Co.  
(ACS, Rubber Div.)

Crack growth resistance of rubber compounds is an important parameter for modern truck tyres. It is shown that by using a pure shear specimen it is possible to evaluate the influence of carbon black on rubber compound cut propagation upon periodical strain energy input. In particular, the role of the carbon black type, loading and dispersion is examined in both homopolymer and blends systems. Also, a novel approach using carbon black blends is discussed with positive results shown using this technique. 5 refs.

USA

Accession no. 771688

*Item 146*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 53

**OZONE RESISTANCE OF BIMS-DIENE  
RUBBER BLENDS: CHAOTIC OR SIMPLY  
COMPLEX**

O'McEirath K; Cross J P; Tse M F; Mintz D  
Exxon Mobil Chemical Co.  
(ACS, Rubber Div.)

A relatively new elastomer class, brominated isobutylene-paramethylstyrene terpolymer (BIMS), has been used commercially in tyre sidewalls for over three years. The technology developed for that use has focused on the use of BIMS to replace staining chemical antiozonants and thereby impart a 'stay black' appearance attribute. Recent work has focused on the 'non-cracking' durability attribute of BIMS-diene rubber blends for tyre sidewalls and other applications. The aim is to develop compounds which will last indefinitely in certain applications. The approach is to design compounds beyond certain fatigue, cut growth and ozone resistance limits. For example, one specific goal is the development of a sidewall compound for medium radial truck tyres that will last a million miles, or roughly one billion flex cycles. If successful, this would eliminate one of the limits to continuous retreading of truck tyres. Emphasis is placed on one aspect of the long-term durability of these compounds, resistance to ozone cracking. Fundamental models are developed and advanced characterisation tools are used to understand the complex behaviour of ozone cracking in these blends. These models and tools are presented and their use in developing improved compounds explained.

USA

Accession no. 771687

*Item 147*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 34

**PROCESSING OF SILICA/SILANE FILLED**

**TREAD COMPOUNDS**

Luginsland H D; Hasse A  
Degussa-Huls AG  
(ACS, Rubber Div.)

The preparation of highly filled silica rubber compounds within narrow production tolerances and with excellent performance is still a challenging task, especially in the tyre industry. Since the in situ modification of silica with a bifunctional silane like the tetrasulphane silane TESPT is a chemical process, some important reaction parameters have to be considered. To complete the silanisation reaction in an acceptable mixing time, the silica should have a moisture content of about 5%. Furthermore the mixing temperature should be high enough to speed up the reaction with the silica, but excessive temperatures, which lead to an unwanted pre-crosslinking, must be avoided. In the case of TESPT a mixing temperature in the range of 145-155 deg.C is advisable, while the use of a disulphane silane tolerates a broader temperature range which results in an improved process safety. 24 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no. 771672

*Item 148*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 32A

**CARBON-SILICA DUAL PHASE FILLER, A NEW  
GENERATION REINFORCING AGENT FOR  
RUBBER. IX. APPLICATION TO TRUCK TYRE  
TREAD COMPOUND**

Wang M J; Zhang P; Mahmud K  
Cabot Corp.  
(ACS, Rubber Div.)

The application of carbon-silica dual phase fillers (CSDPF) to NR compound is investigated. It is found that these new fillers give significantly better overall performances in comparison with the conventional fillers - carbon black and silica. In a typical truck tread compound, due to its high polymer-filler interaction and lower filler-filler interaction, the CSDPF E shows a comparable laboratory abrasion resistance and more than 40% reduction in tan delta at 70 deg.C, a parameter for rolling resistance, compared compound filled with its carbon black counterpart, N110. These properties can, to a certain degree, be further improved by the addition of a small amount of coupling agent TESPT. In the case of wet skid resistance measured using the British Portable Skid Tester, the data show that CSDPF gives better performance than the conventional fillers, with and without coupling agent. 22 refs.

USA

Accession no. 771670

*Item 149*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 32

**DEVELOPMENT OF HD SILICAS FOR TYRES -  
PROCESSES, PROPERTIES, PERFORMANCE**

Blume A; Uhrlandt S

Degussa-Huls AG

(ACS,Rubber Div.)

Simultaneous improvements of seemingly contradictory tyre properties, e.g. rolling resistance, wet grip, service life and winter performance are the major requirements from the automotive industry especially for original equipment (OE) passenger car tyres. In the beginning of the 1990s, these demands could be met using tread compounds with special polymer and high loading of silicas with silanes as coupling agents as a partial replacement for carbon black. It is found out that the use of special S-SBR polymers together with high dispersible (HD) silicas leads to the best improvement of rolling resistance and additionally wet traction without any compromise in tread wear. The development of HD silicas for tyres requires detailed knowledge about the different process steps of the silica production and the influence of each process step on the silica properties, e.g. structure of the silica. Different methods are developed and discussed to investigate conventional, semi HD and new HD silicas with different surface areas and structures and their high potential of HD silicas in different parts of passenger and truck tyres. 17 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

*Accession no.771669*

*Item 150*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 31

**FILLER DISPERSION, NETWORK DENSITY  
AND TYRE ROLLING RESISTANCE**

Nikiel L; Gerspacher M; Yang H; O'Farrell C

Richardson S.,Carbon Co.

(ACS,Rubber Div.)

Filler dispersion is an essential rubber compound characteristic. Traction, tread wear and rolling resistance are affected by filler dispersion. The quantification of dispersion is a length scale phenomenon. The existing experimental tools, which are capable of measuring dispersion, for example transmission electron microscopy, mechanical scanning microscopy, optical microscopy and reflectometry, have limitations and the information they provide may not probe the relevant scale length. The recent advance in instrumentation allows electrical measurements in the arsenal of tools available to quantify the dispersion. The range of dispersion measurements is reviewed and the correlation with compound dynamic properties presented. 22 refs.

USA

*Accession no.771668*

*Item 151*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 30

**CHEMICALLY MODIFIED E-SBR FOR SILICA  
TIRE**

akamura M; Takagishi Y

Nippon Zeon Co.Ltd.

(ACS,Rubber Div.)

S-SBR has largely been focused on as a rubber for low fuel consumption tyre, because of its chemical modification and easy controllability of microstructure. On the other hand, despite its long history, significant improvements of E-SBRs have not been done. E-SBRs are produced by radical polymerisation which make it possible for them to be copolymerised with many kinds of polar monomers and give a variety of structure designs. This is a significant advantage of the radical system, which is different from the solution system with organic metal catalysts. E-SBRs copolymerised with polar monomers having a strong interaction with silica are studied in silica formulations. The novel E-SBRs mixed with silica exhibit a better performance on hysteresis loss than conventional E-SBRs. This is a new approach to realise a suitable rubber for silica tyres. 4 refs.

JAPAN

*Accession no.771667*

*Item 152*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 17

**RECENT DEVELOPMENTS IN THE  
EXTRUSION OF TYRE COMPONENTS**

Gohlisch H J

Troester P.,Maschinenfabrik

(ACS,Rubber Div.)

Over recent years there have been no revolutionary inventions in the field of rubber compound plastification and profile shaping (such as multi-component heads, roller head and single roll roller die units or pin extruders). However, there have been many very interesting developments and improvements to almost all line components, resulting in better handling and use of the line and, most of all, better tyre component quality. The most important changes are summarised and explained.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

*Accession no.771658*

*Item 153*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 14

**ON THE DEPENDENCY OF TYRE  
PERFORMANCE AND THE DEGREE OF MIXING**

van Raepenbusch P; Pessina R; Nichetti D  
Pirelli Pneumatici SpA  
(ACS,Rubber Div.)

Tyre performance is not only related to its architecture and compound formulations, but more so on the way the compound ingredients are mixed together and its process history downstream. The processing engineer has to define not only the order in which ingredients are introduced but also specific time/temperature and or energy profile the compound must be subjected to produce the desired and repeatable tire performance. Mixing equipment needs more sophisticated controls enabling complex recipe to be performed including enough artificial intelligence capabilities to 'adapt and steer' the recipe in a real time mode for any materials or process variations. 'Black book' science is just not good enough anymore. The process engineer today relies on sound statistical design of experimentation to build up the base knowledge to feed predictive tools to assist in his day-to-day task. The final viscoelastic properties of silica tread compounds are correlated to the degree of mixing. Some light is also shed on the relationship between input mixing energy and tyre properties, such as rolling resistance, wet and dry grip. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

*Accession no.771654*

*Item 154*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 12

**FRICION AND WEAR OF RUBBER. I.  
EFFECTS OF DYNAMICALLY CHANGING SLIP  
DIRECTION AND THE DAMAGE  
ORIENTATION DISTRIBUTION FUNCTION**

Gerrard D P; Padovan J

Akron,University; Goodyear Tire & Rubber Co.  
(ACS,Rubber Div.)

Results of an experimental and analytical study are offered which examined the effects of a dynamically changing slip direction on a rubber surface's friction and wear performance and on the properties of an industrial abrasive. For a filled SBR compound, it is found that a dynamically changing slip direction has a small effect on the friction/traction performance but a substantial beneficial effect on the surface's wear performance. The abrasive's ability to generate wear is found to be strongly dependent on the accumulation of side slip over the life of the abrasive. The concept of an oriented damage distribution function is offered to describe the statistical nature of the oriented damage generated on a slipping rubber surface. The experimental results are shown to be predictable based on several simple assumptions regarding the effects that changing slip orientation has on the response of the distribution function. 22 refs.

USA

*Accession no.771652*

*Item 155*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 11

**DEVELOPMENT OF NEW TYPE FKK WEAR  
TESTER**

Koike A; Kobayashi N; Furuta I P; Yamazaki S  
JSR Corp.; Japan,Automobile Research Institute  
(ACS,Rubber Div.)

Wear resistance is one of the most important properties of tyre performances as well as rolling resistance and grip power. The wear resistance is known to be difficult to evaluate by laboratory tests, because laboratory test results are sometimes different from field test results. One of the reasons of this fact may be that most ordinary wear testers such as Lambourn, DIN, etc., execute under the condition of constant slip rate or slip speed, not under the condition of field tests in which a tyre is apparently under constant frictional force. A new type 'FKK' Wear Tester is introduced which evaluates precisely the wear resistance of various rubber compounds for tyres under the condition of constant frictional force. This wear tester is equipped with a flat belt, temperature control units of both atmosphere and the abrasive belt surface, and the device for setting up slip angle. As a result, the tester can reproduce exactly the field test result of the wear resistance at Japan Automobile Research Institute. The FKK tester also has the possibilities of using as the mu-S tester, which is based on the fact that the dry grip test result of the tyre with varying slip rates is in accordance with the result with FKK tester. 2 refs.

JAPAN

*Accession no.771651*

*Item 156*

157th ACS Rubber Division Meeting - Spring 2000.  
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 9

**REINFORCEMENT MECHANISM IN THE  
RUBBER MATRIX BY ACTIVE FILLERS**

Frohlich J; Luginsland D; Niedermeier W  
Degussa-Huls AG  
(ACS,Rubber Div.)

Today's tyres are highly sophisticated and have to fulfil contradictory dynamic properties like improved tread wear, better handling and traction as well as good energy efficiency (rolling resistance). The role of active fillers like carbon black and silica has been studied in the rubber matrix for a better understanding of the tyre performance and the mechanism of reinforcement. In particular the influence of basic properties of carbon blacks, such as surface area, structure and surface activity on the Payne effect, is investigated with the Rubber-Process-Analyser, which allows a testing of the strength of the filler network and the filler-polymer interaction in the green compound as well as in the vulcanisate in a large shear range. A comparison between carbon black and the silica-silane

system leads to further scientific findings for the understanding of the dynamic behaviour of filled rubber compounds. These investigations provide a deep insight into the mechanism of reinforcement of active fillers in the rubber matrix and may enable a further improvement of the tyre performance. 28 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.771649

*Item 157*

157th ACS Rubber Division Meeting - Spring 2000. Preprints.

Dallas, Tex., 4th-6th April 2000, paper 8

**IMPROVED TREAD COMPOUND WET/WINTER TRACTION USING BROMINATED ISOBUTYLENE-CO-PARA-METHYLSTYRENE**

Waddell W H; Napier R C; Poulter R R

Exxon Mobil Chemical Co.

(ACS,Rubber Div.)

Use of brominated isobutylene-co-para-methylstyrene (BIMS) improves the laboratory dynamic properties predictive of wet and winter traction of formulations modelling all season, winter and high-traction passenger tyre treads. Blends of BIMS with cis-polybutadiene, NR and solution polymerised SBRs with varying microstructures are studied in silica-filled compounds. Selective substitution of the BIMS elastomer is made in order to evaluate the impact on abrasion resistance and temperature-dependent tangent delta values. Use of BIMS requires adjustments to the curative system. By reducing both sulphur and accelerator(s) levels, compound cure and mechanical properties can be maintained. The level of silane coupling agent can also be reduced when using the BIMS elastomer. 29 refs.

USA

Accession no.771648

*Item 158*

157th ACS Rubber Division Meeting - Spring 2000. Preprints.

Dallas, Tex., 4th-6th April 2000, paper 7

**TRACTION PREDICTIVE RUBBER COMPOUNDS HIGH-FREQUENCY VISCOELASTICITY AND TRIBOLOGY**

Yang H H; Gerspacher M; Nikiel L; O'Farrell C P

Richardson S.,Carbon Co.

(ACS,Rubber Div.)

Tyre traction is an energy dissipative process. Both viscoelastic properties of the tread compound and the interfacial adhesion between the tread and the road surface contributes to tyre traction. The viscoelastic component involved is estimated to be in a frequency range of around 1 MHz. An acoustic spectrometer is used for the measurement of high frequency viscoelastic properties. For a given tyre construction and tread design, the wet

traction is found to correlate well with the attenuation coefficient of tread compounds at room temperature and 1 MHz, particularly at high speed of vehicle and on a relatively rough surface. The use of both high-frequency viscoelastic properties along with friction coefficient of tread compounds improves the tyre traction prediction. 15 refs.

USA

Accession no.771647

*Item 159*

157th ACS Rubber Division Meeting - Spring 2000. Preprints.

Dallas, Tex., 4th-6th April 2000, paper 6

**MIXING OF SILICA COMPOUNDS FROM THE VIEW OF A MIXER SUPPLIER**

Berkemeier D; Haeder W; Rinker M; Heiss G  
Krupp Elastomertechnik GmbH; Krupp Rubber Machinery Inc.

(ACS,Rubber Div.)

The introduction of tyre tread compounds with high silica loadings together with the application of silane in the early nineties demanded an adapted mixing process for such compounds. Silane as an additional chemical ingredient in the recipe is used as a coupling agent between silica and polymer. During mixing the silane reacts with the silica and develops open movable chemical bridges which are able to bond filler and polymer during curing. Because of the temperature dependency of the chemical reaction the temperature history of the batch during the mixing process is now of crucial importance. Historically, tangential internal mixers are used in the tyre industry for the production of tread compounds. On the other hand, intermeshing systems are preferred in the technical rubber industry. Referring to a defined empty volume inside the mixer, these machines have a larger cooling surface compared with tangential mixers of equal size. Therefore, intermeshing internal mixers demonstrate a better heat sensitivity, and the batch temperature can be controlled more efficiently. This feature gives the intermeshing internal mixers a considerable advantage for the production of silica tread compounds in the tyre industry, as well. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.771646

*Item 160*

**International Polymer Science and Technology**

26, No.5, 1999, p.60-8

**EFFECT OF CARBON BLACK ON TYRE TREAD FRICTION AND ABRASION PROPERTIES**

Sone K

The particle size, structure, quantities and the interaction of carbon black with rubber are discussed with respect to

the wear of rubber compounds. 24 refs. Translation from Nippon Gomu Kyokaiishi, No.3, 1999, p.171

JAPAN

Accession no.771235

Item 161

**Rubber World**

222, No.1, April 2000, p.32-8

**SILICA/SILANE - A WINNING REINFORCEMENT FORMULA**

Schwaiger B; Blume A

Degussa-Huels AG

The silica/silane filler system for tyre tread compounds is discussed with reference to its use in green tyres. With this filler system, simultaneous improvements of seemingly contradictory tyre products such as wet grip and rolling resistance are achieved, whilst maintaining the service life. Degussa-Huels offers a tailor-made silica product for improved dispersibility, a precondition for treadwear. Tests to determine dispersion behaviour are discussed. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.771113

Item 162

**Rubber World**

222, No.1, April 2000, p.24/6

**DISPERSION AID FOR SILICA FILLER IN RUBBER COMPOUNDS**

Jividen D; Kaufman H

Western Reserve Chemical; Polymer Process Technologies

The effect is investigated of a polar material on the dispersion of silica fillers in rubber tyre tread formulations. PPT-HDI is an effective low cost dispersion aid that significantly improves mixing, and may allow a reduction in the level of coupling agent required relative to its role in reducing filler to filler interaction. In addition, it also is shown to dissipate static charges very effectively. Cure characteristics and dynamic properties are examined.

USA

Accession no.771111

Item 163

**European Rubber Journal**

182, No.5, May 2000, p.25

**NEW CURING AGENT FROM BAYER**

Shaw D

A novel curing agent called Vulcuren has been developed by Bayer, which is claimed will improve quality and eventually reduce costs in the moulding of large rubber products and tyres. Vulcuren creates crosslinks in diene rubbers in which the crosslink is made of carbon rather than sulphur atoms. Benefits

reported, include a reduction in reversion, and an ability to control the length of the crosslink in order to achieve the desired dynamic properties. The product is currently undergoing lab-scale trials.

BAYER AG

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.771086

Item 164

**Gummibereifung**

75, No.5, May 1999, p.90-1

German

**NOT A MOTOR CYCLE OFF THE PEG**

Schmidt P; Voigt A

This report looks at the new Ducati Monster M600 motor cycle, its performance and construction, in relation to a range of suitable tyres produced by the four top motor cycle tyre producers. The tyres reviewed in this context cover fifteen different designs and brands. They include radial construction and aramid belting for the Dunlop Sportmax, steel belting and optimized silica mixture for the Metzeler ME range, the radial construction and handling of the Michelin range and the high performance and steel belting of the Pirelli selection.

DUCATI; DUNLOP; METZELER; MICHELIN;

PIRELLI

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.770588

Item 165

**Gummibereifung**

75, No.5, May 1999, p.34-5

German

**PIRELLI IS ANSWERING THE QUESTIONS OF THE FUTURE**

Mutz K

Pirelli's new high-performance P6000 'Powergy' tyre combines power and energy. It is suitable for sporty cars like the Jaguar S-type, the Audi TT, the Saab 9-3 and the VW Golf or Beetle. Design criteria for this new tyre include rolling noise, low roll resistance, high running performance and improved wet running properties. Its modified, wave-shaped tread pattern is discussed, as well as its eight-percent larger contact surface and silica proportions. Its belting is examined, as well as its use of deep grooves, nylon in its belting and its effects on ABS braking. It is an all-year tyre. Its suitability for the American market is reviewed, along with its sales performance and radius of curvature.

PIRELLI SPA

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.770572

## Item 166

**Gummibereifung**

75, No.5, May 1999, p.32

German

**'BIBENDUM' IS THE BEST AMBASSADOR**

Mutz K

This report summarises an interview with Dr. Klaus Neb, spokesman for the French tyre firm Michelin in Germany. Its main theme is to look into the reasons why Michelin decided to site their first 'Bibendum' exhibition in Leipzig. The city of Leipzig was seen as the door to Eastern Europe and accordingly a signal for markets whose economic upswing is directed to the transport of goods. Here the reasons for Michelin's exhibition are explored, along with comments on Michelin's perception of innovation. Development was the most important purpose behind Michelin's exhibition, including its use of soot, silica fillers, rolling resistance and fuel savings. Other issues cover customer expectations from increased performance in Michelin's tyres.

MICHELIN DEUTSCHLAND

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.770570

## Item 167

**Gummibereifung**

75, No.5, May 1999, p.13

German

**SUBTLE ALTERNATIVE**

With its SP Sport 300 tyre the firm Dunlop GmbH has introduced a new tyre on the market for mid- to top-range cars. According to the manufacturer it stands out because of its low running noise. This is produced by its silica running surface mixture devised by computer calculations along with its damping ratio and new tread with tread blocks designed with a steep tangent angle. Aquaplaning properties are discussed as well as low rolling resistance and higher comfort. Also reviewed are speed properties, shoulder construction and twin shift variation.

DUNLOP GMBH

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.770561

## Item 168

**Kautchuk und Gummi Kunststoffe**

53, Nos.1-2, Feb.2000, p.30-4

**EFFECTS OF DIFFERENT INGREDIENTS AND CURE PARAMETERS ON THE PHYSICAL PROPERTIES OF TYRE TREAD COMPOUND**

Karak N; Gupta B R

The effects of polymer blends, viz. NR/BR, NR/SBR and SBR/BR, and cure parameters such as cure time and cure temperature, on the hardness of a tyre tread compound are investigated. Along with the hardness, other physical

properties are also measured with variation of the above blend compositions and cure parameters. The empirical relationships of the hardness with weight fraction of individual component of the blends, cure time and cure temperature are established. 11 refs.

INDIA

Accession no.769315

## Item 169

Rubberchem '99. Conference proceedings.

Antwerp, Belgium, 22nd-23rd Nov.1999, paper 21

**BALANCED NETWORK WITH SULPHENAMIDE/TETRABENZYL THIURAM DISULPHIDE (TBZTD)**

Datta R; Mori T

Flexsys BV

(Rapra Technology Ltd.)

The major objective of the tyre industry is to improve productivity and to extend tyre life. Tyre durability requires heat resistance, antiflex properties, antioxidation and antiozonation. A proper balance of network is important for flex and heat ageing properties. The use of binary system of accelerators such as sulphenamide and commonly used thiuram such as MTD improves cure efficiency but suffers from the adverse effect of scorch and flex properties. The possibility of an N-nitrosamine safe thiuram such as tetrabenzyl thiuram disulphide (TBzTD) is explored to obtain improvement in cure efficiency and a balanced network. The effect of lower amount of TBzTD is studied in sulphenamide cure to obtain better balance of performance characteristics. A crosslink study is done to correlate the properties to the fine structure of the network.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.769263

## Item 170

Rubberchem '99. Conference proceedings.

Antwerp, Belgium, 22nd-23rd Nov.1999, paper 19

**LONG LASTING PROTECTION OF TYRES**

Lehocky P; Syrový L; Ma...ak I

Duslo AS

(Rapra Technology Ltd.)

Results of testing prove that N-phenyl-N'-(alpha-methylbenzyl) p-phenylenediamine (SPPD) is the antiozonant offering diffusion coefficient value decrease, increase in resistance to extractive water effect, volatility decrease, decrease of immediate effect of ozone (the low migration speed is the reason, which especially appears with SBR rubber) and resistance to a premature consumption by reaction with oxygen. In general, SPPD can be characterised as a standard antiozonant which can be recommended for application where long-term protection of rubber products is required and for operation in demanding conditions, e.g. tyres. SPPD proves the said

properties thanks to its structure, in which priorities of alkyl-aryl-p-phenylenediamines are joined together. It is marked by moderate accelerated effect on a vulcanisation, analogically as other alkyl-aryl p-p-phenylenediamines. 21 refs.

SLOVAK REPUBLIC; SLOVAKIA

Accession no.769261

*Item 171*

Rubberchem '99. Conference proceedings.

Antwerp, Belgium, 22nd-23rd Nov.1999, paper 18

**IMPROVED PROCESSING OF CARBON/SILICA  
DUAL PHASE FILLER IN 'GREEN TYRE'  
TREAD FORMULATIONS**

Hensel M; Menting K-H

Schill & Seilacher GmbH

(Rapra Technology Ltd.)

In 1991 the concept of using highly dispersible silica as the sole filler, together with a silane coupling agent, for the tread compound of low rolling resistance tyres was patented by Michelin. Since it found great interest in the tyre industry, carbon black manufacturers developed various concepts to match the performance of silica with new types of carbon blacks. One interesting approach is the joint combustion of mineral oil and a silicon compound in a modified furnace process which results in particles having silica domains dispersed in the carbon phase. Several grades with varying silica content have since been made available. The performance of these Ecoblack fillers is very close to that of the new grades of highly dispersible silicas. Unfortunately these silicas show some disadvantages in processing like high compound viscosities, storage hardening and extrusion difficulties like high pressure and temperature, scorch and poor surface quality, especially at the edges of the treads. It has previously been shown how selected processing promoters help to overcome these disadvantages without any negative influence on the final physical properties. The aim is to find out whether the processing of the Ecoblack materials shows similar trends, and if yes, whether or not processing promoters being efficient in silica also improve the processing. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.769260

*Item 172*

Rubberchem '99. Conference proceedings.

Antwerp, Belgium, 22nd-23rd Nov.1999, paper 8

**SIGNIFICANT EXPANSION OF THE 'MAGIC  
TRIANGLE' FOR TRUCK TYRES**

Niedermeier W

Degussa-Huls AG

(Rapra Technology Ltd.)

Nanostructure blacks are a new carbon black family produced by a modified furnace reactor process. In

comparison to conventional ASTM blacks, these novel blacks are characterised by a high surface roughness leading to enhanced filler-polymer interaction. These nanostructure blacks show excellent hysteresis properties and therefore low heat build-up whilst still maintaining all other in-rubber properties. With these carbon blacks, it is now possible to overcome the limitation, given by the 'magic triangle' of tyre performance. Low hysteresis combined with excellent abrasion resistance is the best qualification of these blacks for their use in truck tyre tread compounds. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.769250

*Item 173*

Rubberchem '99. Conference proceedings.

Antwerp, Belgium, 22nd-23rd Nov.1999, paper 2

**INFLUENCE OF LOW SERVICE AREA CARBON  
BLACKS ON AIR PERMEATION AND  
FRACTURE MECHANICAL BEHAVIOUR OF  
TYRE INNERLINER COMPOUND**

Hardy D; Money Penny H; Holderied M; Harris J;

Campion R; Morgan G

Cabot Corp.; Cabot GmbH; Materials Engineering

Research Laboratory Ltd.

(Rapra Technology Ltd.)

Cabot has developed new oil furnace technology for producing large particle, low structure carbon blacks. Products from this process have morphological properties between those of thermal process carbon blacks and SRF oil furnace grades, and are characterised by relatively broad aggregate size distributions. A product of this process, Regal 85 carbon black, has been evaluated for inner liner applications at 100 phr loading in a 100% bromobutyl formulation. Air permeability properties are compared with Sterling V (N660 GP17 at 60 phr) carbon black and Regal SRF (N772 at 60 phr) carbon black. In addition to having low diffusivity to gases, another important performance characteristic of tyre inner liners is good flex resistance over a wide temperature range, with a limited number of cycles when a vehicle starts at temperatures which can be as low as -300 deg.C and millions of cycles under normal operating temperatures, around 60 deg.C. Consequently the fatigue crack growth behaviour of the compounds loaded with the various carbon blacks is also determined. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
NETHERLANDS; UK; WESTERN EUROPE

Accession no.769244

*Item 174*

***Tire Technology International***

March 2000, p.52/9

**PROCESSING OF ORGANO POLYSULFANE  
SILANES**

Hasse A; Luginsland H D

Degussa AG

The introduction of tyre tread compounds with high silica loadings has demanded new mixing processes for those compounds. In addition to the physical distribution and dispersion of the fillers, an additional chemical process is now of crucial importance, namely, the linking of a bifunctional organosilane to the silica to make the polar silica surface hydrophobic and enabling the formation of filler-to-rubber bonds during curing. Four different silanes were investigated in silica-filled compounds for the in-situ modification of silica in an internal mixer. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.768093

Item 175

**Tire Technology International**

March 2000, p.47-50

**SILANES AMONG THE SILICA**

Ansarifar M A; Nijhawan R  
Loughborough, University

A study was carried out to examine how a progressively increasing amount of TESPT silane (bis(3-triethoxysilylpropyl)-tetrasulphane) coupling agent in a tyre formulation influences the Mooney viscosity and cure properties of some natural rubber compounds containing a high loading of precipitated silica. Five conventional accelerator/sulphur compounds were tested, and it was shown that when up to 10pphr TESPT silane is added to a conventional accelerator/sulphur compound of natural rubber containing 60 pphr precipitated amorphous white silica-type Ultrasil VN3, the viscosity and cure properties are profoundly affected. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.768092

Item 176

**Tire Technology International**

March 2000, p.40-5

**GO WITH THE FLOW**

Rubin Y; Waucquez C  
Polyflow SA

The value of computational fluid dynamics, (CFD) for solving the governing equations of fluid flow and heat transfer are discussed, with reference to its use in tyre making and design. The introduction of better software has recently allowed engineers to study CFD in the following phases of product life: batch mixing of rubber, heating, pressurising, mixing and conveying by single or twin-screw extruders, extrusion of the tyre tread, curing the compounds after shaping, and some product performance analysis such as aquaplaning. These areas are examined, and a case history is included in the development of the Alliance 1200R20 444 model tyre for trucks and buses.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

Accession no.768091

Item 177

Akron, Oh., 2000, 51 papers

**157TH ACS RUBBER DIVISION MEETING -  
SPRING 2000. HELD DALLAS, TX., 4TH-6TH  
APRIL 2000. PAPERS 1-20,25-44,46-47,50,53-58,61-62**  
ACS, Rubber Div.

51 papers are published on rubber-related themes. Topics include frontiers in rubber science, rubber technology for the 21st century, science and technology of rubber processing, tyre traction and handling, basic tyre technology, the 'green' tyre - influences on rolling resistance, fillers, engineering materials - designing long term service life, and truck tyre materials and performance.

Accession no.768020

Item 178

**Luntai Gongye**

20, No.3, March 2000, p.159-63

Chinese

**STUDY OF TYRE CURING CHARACTERISTICS  
WITH ANISOTHERMAL ANALYSIS**

Zhuang J-D; Yang M

The characteristics of anisothermally cured compounds from different parts of the tyre were analysed utilising a RPA-2000 rheometer using, as a basis, the anisothermal temperature-time curve of the compound at different parts of the tyre measured during vulcanisation. Overcure of the corresponding compound was calculated and suggestions for improving the formulation offered.

CHINA

Accession no.767763

Item 179

Shawbury, Rapra Technology Ltd., 2000, pp.118. 30 cms. 27/3/00. Rapra Review Report Vol.10, No.9, 2000. NALOAN

**RAPID PROTOTYPING, TOOLING AND  
MANUFACTURING**

Hague R J M; Reeves P E

Mackenzie E., Consulting

Edited by: Dolbey R

(Rapra Technology Ltd.)

Rapra.Review Rept.No.117

A review is presented of current rapid prototyping, tooling and manufacturing techniques. Techniques described include stereolithography, selective laser sintering, fused deposition modelling, solid ground curing, and laminated object manufacturing. Tooling techniques discussed include indirect soft tooling such as silicone rubber, castable resins and ceramics, spray metal tooling and plaster moulds. Indirect hard tooling methods include

electroforming, aluminium and zinc kirksite tooling, investment casting, the Keltool process and the use of metal coated RP models as EDM electrodes. Direct tooling methods examined include stereolithography tooling, laser sintered tooling and laminated tooling. 479 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.766270

*Item 180*

**Industria della Gomma**

43, No.9, Nov.1999, p.16-21

Italian

**NEW CARBON BLACKS FOR IMPROVED PERFORMANCE OF RUBBER PRODUCTS**

Ramm H; Aquilino N

Columbian Chemicals Co.

A number of new carbon black grades developed by Columbian Chemicals are described, with particular reference to applications in tyre and hose formulations. The influence of these carbon blacks on the mechanical and rheological properties of rubber compounds is examined.

USA

Accession no.765339

*Item 181*

**International Polymer Science and Technology**

26, No.8, p.T/69-T/73. (Translation of Nippon Gomu Kyokaishi, No.9, 1998, p. 583)

**FILLERS IN RUBBER COMPOUND**

Makiura M

A study is described of the effect of fillers such as carbon black and silica on the rolling resistance and wet skid resistance of rubber tyres, and ultimately on the fuel economy of tyre designs. Use of silica has enabled tyre manufacturers to balance the requirements of safety and fuel economy. Properties and tyre performance are examined with reference mainly to polymer-filler interactions. 8 refs.

JAPAN

Accession no.764657

*Item 182*

**International Polymer Science and Technology**

26, No.8, p.T/62-T/68. (Translation of Nippon Gomu Kyokaishi, No. 9, 1998, p.571)

**INTERACTION BETWEEN RUBBER AND FILLER IN TYRE TREAD COMPOUNDS**

Kaido H

This article focuses on the control of tan delta of tyre treads, examining the interaction of rubber and filler in tyre tread rubbers. The structure of carbon gel, the rubber molecule mobility and tan delta is discussed. The hysteresis properties of carbon black reinforced rubber is

shown to be affected not only by the combination of materials and degree of dispersion, but also by the filler distribution in the blend phases and the structure of the carbon gel. 20 refs.

JAPAN

Accession no.764656

*Item 183*

**Kautchuk und Gummi Kunststoffe**

52, No.12, Dec.1999, p.799/805

**SAFE PROCESS OILS FOR TYRES WITH LOW ENVIRONMENTAL IMPACT**

Null V

The global market place is increasingly demanding safe process oils to reduce the environmental impact of tyres. The replacement of classified distillate aromatic extracts by non-carcinogenic MES, TDAE or naphthenic process oils will reduce the PAH emissions from tyres by more than 98%. Rubber tests back-to-back with DAE with carbon black and silica filled vulcanisates show a slight shift in wet grip performance and an improvement in rolling resistance for all alternative oils. MES type oils from different crude oils and refineries are fully interchangeable in rubber and compound formulations. MES have already been made on commercial scales in various parts of the world. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.764400

*Item 184*

**Rubber Chemistry and Technology**

72, No.2, May-June 1999, p.343-56

**TOPOLOGY OF WEAR PARTICLES**

Padovan J; Prasad N; Gerrard D; Park S W; Lindsley N Akron,University

Using a belt type of abrader on an aircraft tyre tread compound, the mechanisms of wear were studied with particular reference to the shape of the particles abraded from the sample at both its leading and trailing edges. The effects of the grit size, slip rate and contact length were considered with respect to the formation and aggregation of wear particles. The distribution of particle sizes and amount of aggregation was considered at various locations along the sample and in the wake from the sample, and the figures obtained were compared to statistical expectations. Good agreement was obtained. Photomicrographs of the various wear entities are included in the article. 19 refs

USA

Accession no.763829

*Item 185*

Shawbury, 1999, 21 papers

**RUBBERCHEM '99. PROCEEDINGS OF A CONFERENCE HELD ANTWERP, BELGIUM,**

**22ND-23RD NOV. 1999**

Rapra Technology Ltd.

Twenty-one papers are published following the international rubber chemicals and compounding conference. Papers focus on rubber chemicals - past, present and future, particulate fillers as compatibilisers in rubber blend compounds, modern fluoroelastomers, peroxide crosslinking of saturated polymers and improved processing of carbon/silica dual phase filler in 'green' tyre tread formulations.

*Accession no.762154*

*Item 186*

**International Polymer Science and Technology**

26, No.6, 1999, p.T/19-T/27. (Translation of Nippon Gomu Kyokaiishi, No.6, 1998, p.315)

**SOLUTION-POLYMERISED STYRENE-BUTADIENE RUBBER**

Saito A

The compounding of solution SBR with carbon black and silica fillers is discussed, and some examples are shown of improvements in the mechanical properties of tyre tread compounds by means of the use of tin-based coupling agents. Other examples are reviewed of ways in which mutually conflicting performance requirements can be balanced by the use of a wide range of techniques to improve tyre tread performance without loss of processability. 19 refs.

JAPAN

*Accession no.762032*

*Item 187*

Thermoset Retec. Conference proceedings.

Research Triangle Park, N.C., 15th-17th March 1999, p.165-74

**BENEFITS OF PLASTIC BLAST CLEANING MEDIA**

Golubski M A

Maxi-Blast Inc.

(SPE,Piedmont Coastal Section; SPE,Thermoset Div.)

Various types of deflashing media have now been around for over thirty years and have seen wide acceptance for about the last fifteen. However, new granulated plastic medias made from thermoset plastics have opened the door to many new and exciting applications which save the moulder large amounts of time and therefore give them a more efficient operation. Media manufactured from compounds such as melamine, urea, polyester and acrylic are used for applications that involve non-abrasive cleaning of surfaces. These new applications are ones such as mould cleaning, screw cleaning, paint stripping from many types of aircraft and military and aerospace parts. They have also found uses that are not in the mainstream such as the balancing of truck tyres, stripping of powder coatings, etching the surface of aluminium frying pans, etc. Emphasis is placed on the application of plastic media

for plastic moulders. A very new application for plastic blast cleaning media is the cleaning of screws for injection moulders and extrusion machines. It is discovered that a screw, when placed in a pressure blast unit designed for plastic media, can be quickly cleaned without any damage or edge rounding.

USA

*Accession no.761122*

*Item 188*

**Gummibereifung**

73, No.10, Oct.1997, p.54-5

German

**WE'RE TIGHTENING UP ALL THREADS**

Schmidt P

Karl Peda, Head of Development for car replacement tyres at Continental AG, is interviewed about the latest development trends in winter car tyres. This interview probes the advantages of silica as a filler in rubber mixtures, its higher costs and greater expenditure during production. The impact of this technology on tyre running surfaces and rolling resistance is examined. Continental's development in winter tyres is moving towards greater application of 3D sipes rather than rubber variations. This marks the difference between winter and summer tyres. Also discussed here is the use of steel sheeting as well as tread patterns. Emphasis is placed on three main threads: mixture, tread and sipes.

CONTINENTAL

EUROPE-GENERAL; EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE; WORLD

*Accession no.760952*

*Item 189*

**Angewandte Makromolekulare Chemie**

Vol. 270, Sept. 1999, p. 81-6

**CARBON BLACK NITRATION AND NITROSATION AND ITS APPLICATION TO IMPROVE THE MECHANICAL HYSTERESIS OF A RUBBER TREAD COMPOUND**

Cataldo F

Soc.Lupi arl

The chemical structure of a conventional N234 carbon black was carried out using dinitrogen trioxide, nitrogen oxide and dinitrogen tetraoxide in a low temperature treatment. The chemical structure of the resulting black was studied by FT-IR spectroscopy. Extensive nitrosation, nitration and oxidation of the black's surface was found. Raman spectroscopy showed that the bulk structure was substantially unchanged. In testing in a conventional tread compound, tan delta at 70 degrees centigrade was found to be reduced by some 14%, without significant losses in traction performance. 25 refs

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.760475*

*Item 190*

Hazards in the European Rubber Industry. Conference proceedings.

Manchester, 28th-29th Sept.1999, paper 4

**SILICA DUSTS**

Bomal Y; Sartre A; Cornillon G; Hendrickx B; Leplay A  
Rhodia SA; Rhone-Poulenc SA

Precipitated silicas are traditionally used as reinforcement fillers in rubber applications. A new-generation Rhodia silica has, due to its excellent dispersion capacity, made it possible to develop 'green tyres' which have low rolling resistance, while maintaining or improving their longevity and adherence. Any person who handles silicas may legitimately enquire about the risks entailed. However, confusion between the various classes of finely divided silicas needs to be avoided, as they differ greatly with respect to their biological properties after inhalation. The issue is particularly acute when they are handled in powder form, to be incorporated into elastomers. Some precaution is thus necessary when handling them, even though precipitated silicas do not cause silicosis or cancer. An attempt is made to clearly distinguish between the known health effects caused by the inhalation of the different forms of silicas and to recommend safety practices when handling solid powders such as precipitated silica. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
WESTERN EUROPE

*Accession no.760311*

*Item 191*

**Kautchuk und Gummi Kunststoffe**

52, No.11, Nov.1999, p.758-62

**HIGH TEMPERATURE CURING OF  
PASSENGER TYRES BY USING 1,3 BIS-  
(CITRACONIMIDOMETHYL)BENZENE**

Datta R N; Ingham F A A

Flexsys BV

The effect of the above compound (Perkalink 900), as an anti-reversion agent, in a passenger tyre tread based on SBR/BR blends was investigated with the aim of increasing cure temp. such that cure times can be reduced, thus improving productivity. It was found that this compound reacted by scavenging dienes and trienes in the reverted network, thereby compensating for a reduced level of sulphidic crosslinks observed at increased cure temps. It did not affect compound cure characteristics or compound viscosity. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

*Accession no.759951*

*Item 192*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 137

**REUSE OF GROUND RUBBER WASTE - A REVIEW**

De S K

Indian Institute of Technology

(ACS,Rubber Div.)

Disposal of worn out tyres and rubber products is a global problem. They are not biodegradable. As they are crosslinked, they can not be reprocessed like thermoplastics. Keeping environmental and economic factors in mind, it is envisaged that the disposal problem could be solved by incorporating ground waste rubber into virgin polymer matrices.

INDIA

*Accession no.759725*

*Item 193*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 136

**APPLIED RESEARCH ON ULTRASONIC  
DEVULCANISATION OF CRUMB RUBBER**

Boron T; Klingensmith W; Forest C; Shringarpurey S

Ulramer Inc.; Akron Consulting Co.; USA TACOM

(ACS,Rubber Div.)

Recycled rubber derived from scrap tyres continues to reflect interest from both scientific and business communities. A rubber processing technology using ultrasonics as a stimulus for devulcanisation is investigated for practical resulting material properties and economic merit. The applied research is evaluating the requirements to take the process from a lab scale to a production scale process. Experiments are performed to determine the effects of process variables including extruder screw speed, material feedrate, sonication control volume, crumb rubber particle reduction method (ambient vs cryogenic) and particle size. The processed materials are tested for response features such as rheology and mechanical properties. Results of select experiments are presented. Analysis of experimental data correlates process variables with resultant material responses. The process offers, if scaled up effectively, a means of taking whole tyre grind and retread buffings, and producing a product that can be reincorporated back into virgin rubber compounds at substantial quantities without deterioration of performance properties. The results of incorporation of ultrasonically, devulcanised rubber into tyre treads are reported. 19 refs.

USA

*Accession no.759724*

*Item 194*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 134

**PHYSICO-CHEMICAL CHANGES DURING  
REACTIVATION OF DIFFERENT TYPES OF  
VULCANISED RUBBER**

Kostanski L K; MacGregor J F; Pattenden T W;

Kolinski A; Haber A

McMaster University; NRI Industries Inc.  
(ACS,Rubber Div.)

An attempt is made to enhance understanding of physicochemical changes taking place during reactivation of vulcanised rubber products by a process developed by NRI Industries. Modification of tyre rubber crumb gives a very complex yet active revulcanisable product (Symar-D). Application of the process to a high NR content compound is also successful. Numerous batches of rubber crumb at different degrees of modification are compared by means of fractionation, equilibrium swelling and miscellaneous instrumental methods. The results show that with increasing total process energy, crosslinks are gradually severed, whereas soluble decrosslinked polymers show increasing molecular weights. However, the trends are different for different starting materials. Solution and solid-state NMR as well as FTIR studies show that even at the highest total process energies there is a negligible amount of cis-trans isomerisation. 6 refs.

CANADA; USA

Accession no.759722

*Item 195*

156th ACS Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 118

**PARA ARAMID CHOPPED FIBRES AND PULP  
MASTERBATCHES: ALTERNATE  
CONSIDERATIONS FOR RUBBER  
COMPOUNDER**

Doherty M A

Twaron Products

(ACS,Rubber Div.)

A combination of high tenacity, low shrinkage, chemical and heat resistance have allowed para aramids to serve as the primary strength member in high performance rubber products such as racing tyres, brake hoses and transmission belts. The success of aramid in all these applications reflects that the fibre is in the form of either a continuous cord or fabric. As discontinuous fibres, i.e. chopped fibres or pulp, para aramids are finding acceptance as reinforcement fillers of rubber stock. Their presence improves the modulus, wear and abrasion characteristics of the matrix rubber. The production of both chopped fibres and aramid pulp masterbatch is reviewed. Adhesion and dispersion mechanisms are discussed in detail. In all cases the successful application of the hifillers requires a compatibility and dedication to the rubber matrix they are meant to reinforce.

USA

Accession no.759709

*Item 196*

156th ACS Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 113

**OPERATIONAL CHARACTERISTICS OF THE  
FARREL SHAW INTERMIX INTERNAL MIXER**

McGuinness A; Ghafouri S N

Farrel Ltd.

(ACS,Rubber Div.)

The various features made to date in the design, processing and operational characteristics of the interlocking rotor system using the Farrel Shaw Intermix internal mixer are described. The harmful by-product of high speed mixing is the rapid rise of mixed material temperature, and for the purpose of maintaining a high viscosity and level of shear stress, considerable emphasis is placed upon cooling efficiency for effective mixing. The advantages of the NR5 rotors with improved cooling capacity are discussed and an insight given into its compounding practice. The interlocking rotor technology is undoubtedly the most efficient for technical rubber producers. By way of analogy the tyre manufactures using tangential rotor technology have also found interlocking rotor technology interesting and offers new mixing concepts, particularly with the development of silica compounds. The continued increase in the utilisation of silica in the tyre manufacturing industry has raised questions regarding traditional processing techniques. It is explained why the Intermix can provide an efficient way for handling silica-filled compounds. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.759704

*Item 197*

156th ACS Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 108

**POSSIBILITIES OF GROUND TYRE RUBBER  
RECYCLING WITH TRANS-POLYOCTENAMER**

Diedrich K M; Burns B J

Degussa-Huls AG; Creanova Inc.

(ACS,Rubber Div.)

The chemical properties of trans-polyoctenamer (TOR) facilitate the coating of the surface of ground rubber waste, i.e. ground tyre rubber (GTR), by a simple technique. A ground rubber modified in this way can be added as filler material to virgin rubber compounds and causes less deteriorated physicals of the vulcanisates than uncoated rubber waste does. Alternatively, the modified ground rubber can be directly moulded into new rubber compounds. The parameters of the rubber waste influencing the final properties of the rubber goods are discussed. A new application of TOR in connection with GTR is found in asphalt production. Every year GTR is used in greater amounts in rubberised asphalt. Small amounts of TOR result in better dispersion of the GTR and crosslinks the GTR to the asphalt. In addition, the TOR drastically reduces tackiness of the mixture caused by the GTR addition. This allows earlier compacting of the asphalt with steel and rubber rollers at higher

temperatures and saves a lot of time. The ability of the TOR to crosslink the GTR to the asphalt provides a rubberised matrix in the asphalt paving that prevents premature cracking, rutting and shoving. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.759700

*Item 198*

156th ACS Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 106

**MODIFIED TYRE-RUBBER CRUMB AS A BASE COMPOUND FOR RUBBER PARTS MANUFACTURING**

Kolinski A; Barnes T; Paszkowski G; Haber A  
NRI Industries Inc.  
(ACS,Rubber Div.)

Tyre rubber crumb is used in small concentrations as an inactive filler in rubber compounding. Even the best available methods of particle size reduction have been unable to overcome practical limits to the amount of crumb that can be added before the compound can no longer be processed. A thermomechanical process developed by NRI Industries modifies tyre rubber crumb (mesh size between 4 and 20) into Symar-D, a processable and revulcanisable product effectively reused as a base compound for a variety of automotive and industrial rubber parts. This is a cost-effective method to dramatically increase the post-consumer rubber content (25 to 100%) as compared to further reduction of crumb particle size (5 to 25%). The advantage of modified tyre rubber crumb is in its processing properties. It can be milled, compounded, extruded and calendered. It has also been found that 100% modified crumb can be effectively moulded by injection. A series of experiments has allowed optimisation of compound recipes as well as processing parameters. Parts containing significant amounts of modified rubber crumb meet existing product specifications at reduced cost. 6 refs.

CANADA

Accession no.759698

*Item 199*

156th ACS Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 84

**SURFACE TREATED RECYCLED CRUMB RUBBER**

Stark F J; Wagner D P; Fesus E; Jakush E  
Rubber Research Elastomerics Inc.  
(ACS,Rubber Div.)

One of the better methods of recycling vulcanised rubber is reported to be to mechanically reduce the rubber objects to a ground particulate and then chemically modify the surface of the particulate so that it is as chemically reactive

as a rubber compound that has been mixed with the necessary curatives to achieve the necessary physical properties for the performance of the part or object made from the vulcanised rubber. It has been proposed that if reactive particulates are blended with a host compound any level of reactive particulate can be used. This proposal has been proved over the years of work treating particulate. The treatment of the particulate with low molecular weight polymers has proven to be effective without exception. The specificity of the treatment has become the critical point if optimisation of the performance of the compound is required. The concentration of the particulate is not the deciding factor. The completeness of the chemical reaction is the deciding factor for the development of the optimum physical properties. The design of the low molecular weight polymers which serves as the activation factor is the critical element. Emphasis is placed on the preparation of the particle and optimising properties by adapting surface treatments to the specific particulate. Some particulate is so contaminated by the mixing of different rubber compositions that there is only a limited number of uses for such material regardless of how it is surface treated. Case histories are presented of work done with actual samples carried through to commercial implementation. 21 refs.

USA

Accession no.759679

*Item 200*

156th ACS Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 77

**IMPROVING THE SILICA 'GREEN TYRE' TREAD COMPOUND BY THE USE OF SPECIAL PROCESS ADDITIVES**

Stone C R; Menting K-H; Hensel M  
Schill & Seilacher GmbH & Co.  
(ACS,Rubber Div.)

When mixing these silica reinforced SSBR/BR passenger tread compounds, the best silane coupling is achieved by a special mixing procedure. Only the polymers, filler, silane and oil are mixed in the first stage followed by a second stage when the zinc oxide, stearic acid, antidegradant and wax are added. Unfortunately, while this gives the best silane coupling, poor filler dispersion and silane degradation may result. There is also a problem of poor mix pick-up at the start of the remill caused by the lubricating effect of the low melting point materials added. Mixes are prepared using both regular and special mixing procedures, without process additives and with special process additives in the first stage. The special mixing process mixes are prepared both with and without a surfactant type process additive in the second stage. The first stage process additives are specially developed not to influence silane coupling. The poor mixing at the start of the remill, due to the lubricating effect of the

additives, is shown to be improved by the surfactant process additive replacing stearic acid. Viscoelastic dynamic tests on the uncured compounds enable the different aspects of mixing quality to be separately quantified. These data clearly show the beneficial effects, on both silica dispersion and silane coupling, of the process additives used in both mixing stages. Physical property data also show the benefits of these process additives. Viscoelastic dynamic tests on cured samples are used to give an indication of tyre performance characteristics and again show the benefits of using these process additives. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.759672

*Item 201*

156th ACS Rubber Division Meeting - Fall 1999. Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 76

**INTEREST OF HIGHLY DISPERSIBLE PRECIPITATED SILICA IN TYRE APPLICATIONS**

Cochet P; Petit D; Barriquand I; Dejean B; Bomal Y  
Rhodia SA  
(ACS,Rubber Div.)

Tyre material designers appear to be successful in obtaining both low rolling resistance and high wet traction performance, using precipitated silica together with solution polymers and coupling agent in tyre treads. Using highly dispersible silica in place of standard silica gives better processing and improves wear resistance. There is still a need to decrease rolling resistance further. Again precipitated silica could be part of the answer. Compounding with precipitated silica and particularly of high dispersibility decreases rolling resistance and improves properties in other parts of the tyre. It is shown how it could be used to help to meet new low rolling resistance requirements not only in passenger tyres, but also in other tyre lines. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.759671

*Item 202*

156th ACS Rubber Division Meeting - Fall 1999. Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 75

**EFFECTS OF CERTAIN RECIPE INGREDIENTS AND MIXING SEQUENCE ON THE RHEOLOGY AND PROCESSABILITY OF SILICA- AND CARBON BLACK-FILLED TYRE COMPOUNDS**

Schaal S; Coran A Y; Mowdood S K  
Akron,University; Pirelli Tire LLC  
(ACS,Rubber Div.)

The effects of curing ingredients, filler such as silica and its moisture content, mixing sequence, and mixing scheme

on the rheology and the loss of processability of the tyre compounds at different storage temperatures are studied. Rheology is characterised over a wide range of shear rates. For the retardation of the development of poor processability during storage of the compound (assumed to be caused, at least in part, by filler particle reagglomeration), the most effective ingredients are DPG, PEG and CBS, the latter being even more effective if the storage temperature is not too high (e.g. lower than 70 deg.C). Two orders of mixing are considered: Y-mixing (the mixing of a silica-filled masterbatch with a carbon black-filled masterbatch), and all-in-one mixing (the mixing of the rubbers and fillers all at the same time, in a single batch). It is observed that the Mooney peak (peak stress in low strain rate start-up flow) and extrudate roughness (indication of poor processability) increase much more slowly with ageing time for the Y-mixed compound than it does for the all-in-one mixed compounds. Low moisture level in the silica leads to poor processability, as does high-temperature heat treatment during the mixing stage. 14 refs.

USA

Accession no.759670

*Item 203*

**International Polymer Science and Technology**

26, No.7, 1999, p.T/33-41. (Translation of Nippon Gomu Kyokaishi, No.11, p.739)

**EVALUATION AND IMPROVEMENT TECHNOLOGIES FOR TYRE WEAR AND IRREGULAR WEAR**

Togashi M; Mouri H

This article examines wear evaluation technology, mechanisms and improvement technology from the standpoint of both the tyre product and the tread rubber. Evaluation methods using indoor testers are explained, with emphasis on the choice of contact surface in the indoor tester, prevention of abraded tread rubber deposition, and correction for the effect of drum curvature. This is followed by a review of wear test methods and their limitations with respect to the tread compound. 22 refs.

JAPAN

Accession no.759579

*Item 204*

156th ACS Rubber Division Meeting - Fall 1999. Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 185

**BUTYL DEVELOPMENT AND OPTIMISATION FOR TYRES**

Sumner A J M; Engehausen R  
Bayer AG  
(ACS,Rubber Div.)

Butyl rubber has been in commercial production for over 50 years. The main use initially was for tyre inner tubes

to replace NR. This was found to be advantageous because of the much better gas impermeability. The next step was to make tyres from butyl rubber, but although there was much investment in this project, the effort failed due to unacceptably poor wear. Then came the tubeless revolution and the halogenation of butyl rubber to make it adhere to unsaturated polymers. Chlorobutyl rubber was the first type, but the better balance of properties, particularly for truck tyres, was found with inner liners based on bromobutyl rubber. In developed countries the replacement of all tyres by tubeless types is nearing completion, except for isolated sectors like cycle tyres and some crossply truck tyres. The development of the industry is described, together with a new range of bromobutyl rubbers with an improved balance of processing and performance properties when used in inner liner compounds for tyres. Inner liner compounds demonstrating improved key performance properties are prepared with these new bromobutyl rubbers. Further studies are made showing how this material can also be compounded to give lower cost inner liners and its utility in a blend with NR. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no. 759441

*Item 205*

156th ACS Rubber Division Meeting - Fall 1999. Conference preprints.

Orlando, Fl., 21st-23rd Sept. 1999, paper 184

**ON THE REASON THAT PASSENGER TYRE SIDEWALLS ARE BASED ON BLENDS OF NATURAL RUBBER AND CIS-POLYBUTADIENE**

Kim H J; Hamed G R

Akron, University  
(ACS, Rubber Div.)

Sidewalls of passenger tyres are commonly based on blends of equal proportions of NR and cis-polybutadiene. These blends are known to be heterogeneous. Suitable compositions must be designed to withstand 'extremes' of tyre service. Not only must a sidewall have outstanding resistance to catastrophic crack growth under severe service conditions, e.g. when a tyre runs into a kerb or hits a deep hole, it also must resist crack growth over long times at smaller strains experienced during 'normal' rolling. Moreover, sidewalls must resist both types of crack growth over a wide range of temperatures, and after ageing for many years. A typical sidewall formulation, C, is given in Table 1; it contains 50 phr of moderate sized carbon black, 10 phr of process oil, a high level of amine antidegradants, and conventional accelerator-sulphur cure levels. Composition A is like C, except that it contains no antidegradants; composition D has non-stereoregular (~45% cis, 45% trans, 10% vinyl) BR substituted for cis-BR. Two other compositions, B and N, are formulated like C, but are based solely on cis-BR or NR, respectively. In all cases, curative levels are

adjusted to keep low strain moduli similar, while maintaining the ratio of sulphur to accelerator at 2:1. An attempt is made to understand why composition C is used in sidewalls of passenger tyres, rather than compositions B, N, A or D. Conditions of crack growth are selected to include the extremes which sidewalls might experience. It is apparent from the results that composition C possesses the best overall resistance to fracture. 10 refs.

USA

Accession no. 759440

*Item 206*

156th ACS Rubber Division Meeting - Fall 1999. Conference preprints.

Orlando, Fl., 21st-23rd Sept. 1999, paper 181

**MODELLING NON-LINEAR VISCOELASTICITY IN FILLED, CROSSLINKED RUBBERS**

Joshi P G; Leonov A I

Akron, University  
(ACS, Rubber Div.)

Filled polymer systems have been a subject of interest for rheologists for many decades. Their applications range from paints and pigments to high performance composite materials. Tyres come under a special class of applications wherein the type of filler used, its reinforcing abilities, traction improvement capabilities and cost effectiveness enormously control the final end use. There is a lack of complete understanding of the behaviour of these materials under different load conditions. Moreover there is a lack of a comprehensive theory, which can describe the rheology of filled rubbers, their chemorheology and their behaviour in the final fully cured state simultaneously. An attempt is made to capture a wide range of rheological/viscoelastic properties of filled rubbers with one set of constitutive/kinetic equations and a flexible relaxation spectrum. 15 refs.

USA

Accession no. 759437

*Item 207*

156th ACS Rubber Division Meeting - Fall 1999. Conference preprints.

Orlando, Fl., 21st-23rd Sept. 1999, paper 158

**SYNTHESIS OF RANDOM, LOW VINYL SSBR USING DISTRIBUTED MONOMER FEED SYSTEMS**

Kerns M L; Xu Z G; Christian S

Goodyear Tire & Rubber Co.  
(ACS, Rubber Div.)

The versatility of solution SBR (SSBR) synthesis relative to the synthesis of emulsion SBR, including control of molecular weight, macrostructure, microstructure and functionalisation, is well established. Performance advantages arising from this versatility have led to an acceleration of the replacement of emulsion SBR in the

tyre industry, and an expansion in the market for random, low vinyl SBR for use in tyre compounds. These developments have stimulated Goodyear's interest in developing technology for commercial production of random, low vinyl SSBR. Although anionic initiated synthesis of random medium and high vinyl SSBR is easily accomplished by the addition of Lewis bases, these polar modifiers generally promote randomisation at the expense of increased vinyl content. Due to the large differences in monomer reactivity ratios of butadiene and styrene, measures must be taken to promote random incorporation of styrene into low vinyl SSBR. In the absence of such measures, the polymerisation leads to a tapered block copolymer with inferior elastomeric performance characteristics. A method to prevent the formation of tapered block SSBR in unmodified polymerisations using standard continuous stirred tank reactors (CSTRs) is developed and evaluated. 22 refs.

USA

*Accession no.759417**Item 208*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 157

**HIGH-FREQUENCY VISCOELASTIC PROPERTIES OF FILLED POLYMER BLENDS**

Yang H H; Nikiel L; Gerspacher M; O'Farrell C P

Richardson S.,Carbon Co.

(ACS,Rubber Div.)

The wet traction of tyres has been reported to be associated with the high-frequency viscoelasticity of tyre compounds. An automated acoustic spectrometer is built to measure the high-frequency viscoelastic properties of filled BR/NR and SBR/BR blends. The effects of carbon black loading, polymer blend composition, blend system and mixing technique on the high-frequency viscoelasticity of rubber vulcanisates are studied. The compositional dependence of attenuation coefficient ( $\alpha_L$ ) at room temperature depends on the miscibility of polymer blends system studied. The  $\alpha_L$  of filled BR/NR blends as a function of temperature appears to follow a linear additive rule with blend composition. For filled SBR/BR blends,  $\alpha_L$  is found to have a negative deviation from linearity with blend composition. The mixing technique used is found to have only a small effect on the attenuation coefficient of filled SBR/BR blends. 18 refs.

USA

*Accession no.759416**Item 209*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 146

**CURE KINETICS FOR SILANE COUPLED SILICA FILLED SBR COMPOUNDS**

Moon C-W; Leonov A I; Quirk R P

Akron,University

(ACS,Rubber Div.)

Silane modified silica filled rubber compound systems are considered as a new technology to provide a green tyre by decreasing rolling resistance. To develop a model kinetic equation, a cure mechanism for the modified silica filled SBR system is investigated considering three kinds of cure reaction mechanisms: bulk, filler surface and filler to bulk. Model kinetic parameters are determined by curemeter studies at different temperatures and confirmed by crosslink density measurements using the swelling method. Mixing properties are calculated using the cure kinetic equation combined with independently determined filler surface properties. Modified silica surface properties are characterised by rheological experiments with different different kinds of silanes: a sulphur containing silane (Si-69) and a non-sulphur containing silane (Si-203). The system with the shorter, non-sulphur containing silane (Si-203) reaches a steady state viscosity earlier than the silane with the longer one containing sulphur (Si-69). However, the steady state viscosity values are affected by the use of different silica surface modifiers. By comparison of dynamic mechanical properties of silica and carbon black filled SBR systems, it is found that the silica filled system shows lower stress softening than the carbon black system. 21 refs.

USA

*Accession no.759408**Item 210*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 145

**MECHANISM OF DUAL CARBON BLACK REINFORCEMENT IN TYRE TREAD**

Chakraborty S; Pal P K; Dutta B; Ghosh

Smukhopadhyay B; Gireesan K G

Phillips Carbon Black Ltd.

(ACS,Rubber Div.)

For improved dynamic properties, low rolling resistance, better road wear, tread compounds are designed. The mechanism of reinforcing dual carbon black particles is investigated by the strain energy measurement through viscoelastic properties in dynamic application. A close correlation is observed between kinetic study of reinforcement with loss modulus and network density. The tyre wear model is based on Schallamach's abrasion pattern analysis both in tension and compression mode and Thomas mechanism of crack growth through fatigue failure. Worn tear surfaces are examined by scanning electron microscopy. The observed ridges and its spacing bear a relation with lattices morphology studied through X-ray crystallography. The rolling resistance and heat build-up are the function of lattices defects and reinforcement parameter whose activation energy varies

with ratio change in tread/carcass black and reaction kinetics. 11 refs.

INDIA

Accession no.759407

*Item 211*

**Polymer**

40, No.26, 1999, p.7417-22

**SOME PERFORMANCE CHARACTERISTICS OF PLASMA SURFACE MODIFIED CARBON BLACK IN THE (SBR) MATRIX**

Akovali G; Ulkem I

Middle East, Technical University

Performance of carbon black reinforced elastomers strongly depend on the adhesion at the filler-matrix interface. Surface characteristics of carbon blacks can be changed by use of a number of different techniques each with certain advantages and disadvantages and as regards to these. Plasma surface modification is a novel one. The limits of applicability of plasma surface modification of carbon black to be used in the tyre manufacturing industry are checked. For this purpose, RF range cold plasma is used in styrene or butadiene atmospheres. Tensile strengths and percent elongations of vulcanisates are found to respond differently if modified fillers are used as compared with those prepared by the unmodified fillers. Glass transition temperatures of vulcanisates are found to correlate well with the results of mechanical properties. Findings are also supported by the SEM pictures. 18 refs.

TURKEY

Accession no.758995

*Item 212*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 46

**RHEOLOGY AND PROCESSABILITY OF TYRE COMPOUNDS**

Schaal S; Coran A Y

Akron, University

(ACS, Rubber Div.)

An attempt is made to define the parameters affecting the rheology of tyre compounds as well as their processability. Rheology is characterised over a wide range of shear rates. Processability is defined inversely as the roughness of the extrudate from the MPT capillary rheometer. Roughness is measured using image analysis of the extrudate surface contour. A good correlation is found between the extrudate roughness and the size of the Mooney peak (peak in apparent Mooney viscosity plotted against time for very small shear rates in a start-up flow experiment). The Mooney peak can be represented as a yield stress. The effects of storage time and temperature on the size of the Mooney peak (i.e. its increase as a function of storage time) is studied. The kinetics of degradation of processability are not found to follow an

Arrhenius type of behaviour. Finally, a physical descriptive model is proposed to represent filler-rubber structures. 17 refs.

USA

Accession no.758342

*Item 213*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 39

**MOULD FOULING INHIBITOR**

Fraser C; Hoover J

Flow Polymers Inc.

(ACS, Rubber Div.)

As rubber products, including tyres, are vulcanised in hot moulds, the moulds, gradually build up a residue of materials (oils, waxes, zinc, sulphur, etc) from the rubber. This is commonly called mould fouling. When moulds become too fouled, they must be removed from service and cleaned. A material has been found which, when added to rubber compounds, reduces mould fouling significantly. This inexpensive material does not affect the green or cured characteristics of compounds. Extending the interval between mould cleaning should benefit the producers of vulcanised rubber products by reducing cost and increasing capacity.

USA

Accession no.758336

*Item 214*

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 37

**NEW BIFUNCTIONAL CROSSLINKER FOR DIENE RUBBER**

Jeske W; Buding H; Weidenhaupt H-J

Bayer AG

(ACS, Rubber Div.)

The reduction or elimination of reversion in vulcanisates, particularly NR vulcanisates, by the incorporation of specific additives or crosslinkers is a general demand of the rubber processing industry. Reversion is the anaerobic ageing of a polysulphidic rubber network which takes place not only at high vulcanising temperatures and during long vulcanisation times, but also in use if the vulcanisate is subject to dynamic stress. Reversion reduces the crosslink density of the vulcanisate that causes a deterioration in the mechanical and dynamic vulcanisate properties. The performance of 1,6-bis(N,N'-dibenzylthiocarbamoyldithio)-hexane is investigated as a bifunctional crosslinker for truck tyre compounds in comparison with conventional and semi-efficient vulcanising systems. The different technological profiles of the vulcanisates obtained are discussed in terms of static and dynamic properties before and after ageing. It is found that vulcanisates with 1,6-bis(N,N'-dibenzylthio-

carbamoyldithio)-hexane as the crosslinker have excellent reversion and heat stability with no deterioration in the dynamic properties. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.758334

*Item 215*

156th ACS Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 31

**STABILISATION OF TYRE COMPOUNDS WITH QUINONEDIIMINES**

Ignatz-Hoover F; Daata R

Flexsys America LP; Flexsys NV

(ACS,Rubber Div.)

In NR compounds, 30-40% of added quinonediimine becomes polymer bound during vulcanisation. This bound antidegradant provides persistent antioxidant characteristics. However, since it is bound to the polymer backbone, it may not contribute to the degradation of the polysulphidic crosslinks. It is determined whether a quinonediimine antidegradant provides better network stabilisation than the corresponding para-phenylene diamine. The network stabilisation is assessed in terms of retention of the polysulphidic network and the retention of dynamic mechanical properties upon ageing under aerobic conditions. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; USA; WESTERN EUROPE

Accession no.758329

*Item 216*

156th ACS Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 27

**IMPROVED FLEX FATIGUE AND DYNAMIC OZONE CRACK RESISTANCE THROUGH THE USE OF ANTIDEGRADANTS OR THEIR BLENDS IN TYRE COMPOUNDS**

Hong S W; Lin C-Y

Uniroyal Chemical Co.Inc.

(ACS,Rubber Div.)

Tyre companies have tried to develop improved flex fatigue properties for tyre components and improved cracking resistance in dynamic ozone for tyre exterior components such as sidewall, tread and chafer, to produce longer lasting tyres. Various antioxidants and their blends are used to improve flex fatigue properties of interior components and are evaluated to recommend a proper selection of antioxidant and antiozonant blends. A mechanism for prevention of oxidation failure by antioxidants is proposed together with how ozone reacts with the antiozonant, including laboratory test results. Various antidegradants used in the tyre components are also presented. 13 refs.

USA

Accession no.758325

*Item 217*

156th Rubber Division Meeting - Fall 1999.  
Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 6

**NEW INSIGHTS INTO THE CURE AND AGEING OF RESIN VULCANISED BUTYL CURING BLADDER COMPOUNDS**

Hopkins W; Neilsen J G

Bayer Inc.; Bayer Corp.

(ACS,Rubber Div.)

Two reactions are observed in a cure rheograph of a resin cured butyl curing bladder compound. It is shown that the second reaction is related to the 'hardening' that occurs during the high temperature, 180 deg.C, ageing of such compounds. This reaction is at least partially dependent upon the structure of the phenol formaldehyde resin, and a mechanism is proposed. The effect of different resins and ageing times and environments on the high temperature ageing of curing bladder compounds is shown. The effect of isoprene content (unsaturation) on unaged and aged stress strain is also examined. 1 ref.

USA

Accession no.758307

*Item 218*

**Rubber and Plastics News 2**

21, No.4, 22nd Nov.1999, p.3

**CONTI TYRE LISTED AMONG TOP 1999 SCIENCE DEVELOPMENTS**

Davis B

Continental claims its "sidewall torsion sensor" concept will provide more useful data faster to a car's electronic traction and braking control systems. The SWT concept is based on monitoring a tyre's reaction to various driving forces, including acceleration, braking and cornering. Metal powder is compounded into the sidewall rubber and magnetised into alternating positive and negative polarities. Electronic monitors mounted on the car then can measure tyre sidewall deformation and these signals can be translated by on-board computers into data to be interpreted by the vehicle's dynamic control functions.

CONTINENTAL AG

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.758056

*Item 219*

**Tire Science and Technology**

27, No.4, Oct./Dec.1999, p.202-26

**LABORATORY DEVICE TO MEASURE THE INTERFACIAL PHENOMENA BETWEEN RUBBER AND ROUGH SURFACES**

Garro L; Gurnarni L Nicoletto G; Serra A

Pirelli Pneumatici SpA; Parma,University

The interfacial phenomena between tread rubber compounds and rough surfaces are responsible for most

of the behaviour of a tyre on the road. A new device was developed for the investigation of these phenomena in the laboratory. It consists of a fully instrumented road wheel on which a simple geometry specimen is driven. The possibilities offered by this device allow tyres to be tested at a constant slip or at constant torque on both wet and dry surfaces with complex cycles. The machine allows the measurement of slip, tangential forces and temperature on the specimen, and computer software allows the application of Fourier analyses on force, road wheel speed and specimen speed data. Other possibilities offered by the road wheel are to change the road surface, the load on the specimen and the water rate. The description of a complete experiment is detailed in the paper showing the correlation of data with actual tyre performances. Paper presented at the seventeenth annual conference of the Tire Society, Akron, Oh., April 28-29th, 1998. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

*Accession no.757714*

*Item 220*

**China Rubber Industry**

46, No.12, 1999, p.717-9

Chinese

**PROMOTING EFFECT OF COBALT BORACYLATE ON ADHESION BETWEEN RUBBER AND BRASS-PLATED STEEL CORD**

Jia Z; Yuxiang W; Huating L; Qijun P

Beijing, Research & Design Inst. of Rubber Ind.

The promoting effect of cobalt boracylate on the adhesion between rubber and brass-plated steel cord was investigated. The results showed that the adhesion between the rubber and brass-plated steel cord was significantly improved by adding cobalt boracylate RC-B16 and RC-B23, particularly after salt water ageing and thermal humidity ageing. The adhesion promoting effect of RC-B16 and RC-B23 was found to be comparable to that of Manobond C-16 and Manobond 680C respectively.

CHINA

*Accession no.757710*

*Item 221*

**Tyres & Accessories**

No.12, Dec.1999, p.22

**WATER-BASED ADHESIVE PERFORMS WELL IN TEST**

In a move to provide the retreading industry with total assurance that water-based adhesive is at least equal to, or better than, solvent-based adhesive, Dunlop Adhesives commissioned an independent test programme and evaluation to compare the two types of adhesives. During processing, there was no difference observed between the building tack provided by water-based adhesive and solvent-based adhesive. There is no evidence that the use of water-based adhesive in any way adversely affected

the bond normally achieved between filler rubber and exposed areas of steel crown ply or tread material and buffed surface.

DUNLOP ADHESIVES LTD.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

*Accession no.756709*

*Item 222*

**International Polymer Science and Technology**

26, No.3, 1999, p.15-20

**HIGH-PERFORMANCE NON-CONTACT LASER SENSORS IN THE TYRE INDUSTRY**

Wicklund P; Johannsson

Selcom AB; Selcom Inc.

Non-contact laser systems for measurement applications in the tyre industry are described. Applications include: determination of the thickness and cross-section profiles of extruded, unvulcanised compounds; thickness measurements at calenders; the tracking of features such as lines, ribs and grooves; the control of joint displacement and overlapping; the measurement of radial and lateral run out in tyre blanks and finished tyres; the location of faults in side walls, such as bulges or dents; and the measurement of wear in service. Translation of Gummi Fasern Kunststoffe, No.2, 1999, p.128.

SCANDINAVIA; SWEDEN; USA; WESTERN EUROPE

*Accession no.756153*

*Item 223*

Tyretex '99. Conference proceedings.

Prague, 27th-28th Sept.1999, paper 16

**USE OF EASY DISPERSIBLE SILICA IN GREEN TYRE MANUFACTURING**

Hulshof W T

Akzo-PQ Silica

(Rapra Technology Ltd.; European Rubber Journal)

In 1992, Michelin surprised the tyre industry by launching the so called 'green tyre', a tyre with reduced roll resistance without a reduction in wet grip. The use of silica as raw material solved the technical contradiction between rolling resistance and wet grip. High hysteresis develops under pressurised circumstances of rolling tyres, which means energy is transferred into heat giving increased grip. At low frequencies, much less heat is developed and the rolling resistance goes down. If the tyre rolls easier, less petrol is used. Compared to high level wet-grip tyres, the claimed saving can be 0.5 l petrol per 100 km for a medium-sized car. Silica has the unique property of reducing hysteresis.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

*Accession no.755785*

*Item 224*

Tyretex '99. Conference proceedings.

Prague, 27th-28th Sept.1999, paper 15

**UTILISATION OF CARBON-SILICA DUAL PHASE FILLERS IN TRUCK TYRE COMPONENTS**

Hardy D; Money Penny H; Lanoye T; Mauer D  
Cabot Corp.; Cabot Europe Ltd.; Bekaert NV SA  
(Rapra Technology Ltd.; European Rubber Journal)

A new generation rubber reinforcing agent, carbon-silica dual phase filler (CSDP filler), has been developed to provide the ability to enhance the physical properties of elastomers, especially reduced hysteresis. Characterisation of the CSDP filler has determined that this filler consists of two phases, a carbon phase with a finely divided silica phase (domains) dispersed therein. In comparison with conventional carbon blacks, the CSDP filler is featured by high ash content, higher surface roughness and lower tinting strength. From the compounding point of view, dual phase fillers are characterised by higher filler-polymer interaction in relation to a physical blend of carbon black and silica at the same silica content, and lower filler-filler interaction in comparison with either conventional carbon black or silica having comparable surface area. The CSDP filler, CRX 2002, is compared in a NR wire skim formulation, to a Regal 300 carbon black control, for original and aged wire adhesion, viscoelastic properties and fracture mechanical behaviour. The influence of a cobalt salt, cobalt neodecanoate, is also investigated. 14 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION;  
FRANCE; NETHERLANDS; WESTERN EUROPE

*Accession no.755784*

*Item 225*

Tyretex '99. Conference proceedings.  
Prague, 27th-28th Sept.1999, paper 14

**NANO-STRUCTURE BLACKS: A NEW CARBON BLACK FAMILY TO MEET TRUCK TYRE PERFORMANCE DEMANDS**

Niedermeier W; Schwaiger B  
Degussa-Huls AG  
(Rapra Technology Ltd.; European Rubber Journal)

Nanostructure blacks are a new carbon black family produced by a modified furnace reactor process. In comparison to conventional ASTM blacks, these novel blacks are characterised by a high surface roughness leading to enhanced filler-polymer interaction. These nanostructure blacks show excellent hysteresis properties and therefore low heat build-up whilst still maintaining all other in-rubber properties. With these carbon blacks it is now possible to overcome the limitation, given by the 'magic triangle' of tyre performance. The low hysteresis combined with the excellent abrasion resistance is the best qualification of these blacks for their use in truck tyre tread compounds. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

*Accession no.755783*

*Item 226*

Tyretex '99. Conference proceedings.  
Prague, 27th-28th Sept.1999, paper 13  
**USE OF VARIOUS ACCELERATORS AND ANTIDEGRADANTS IN RADIAL TYRE COMPONENTS FOR IMPROVED PERFORMANCE**

Hong S W  
Uniroyal Chemical Co.Inc.  
(Rapra Technology Ltd.; European Rubber Journal)

Pneumatic passenger radial tyres usually contain a variety of rubber compositions, each designed for a specific function requiring different physical properties. The method of construction for a pneumatic tyre also varies between tyre companies. Usually, the simplest construction using the minimum number of components is the most favourable approach. However, durability, handling, riding, dry/wet traction, rolling resistance, flex fatigue resistance and speed rated performance, force tyre companies to develop more sophisticated constructed tyres with various antidegradants to improve performance. Internal tyre components such as apex, carcass, wire breaker, cushion, base tread and bead compounds are protected by antioxidants and should be cured faster than the outside components such as the sidewall, chafer and cap tread compounds, which are protected by antiozonants and also should be vulcanised without severe reversion due to over curing. Tyre durability is directly related to the antidegradants and the stable crosslink system. Therefore, it is important to select the proper antidegradants and accelerators for the optimum performance for each tyre component. The correct solution and/or amount of antidegradants and accelerators to improve the performance of tyres are described. Longer lasting tyres and lower production cost of tyres are the primary goals of the tyre producers. 10 refs.

USA

*Accession no.755782*

*Item 227*

Tyretex '99. Conference proceedings.  
Prague, 27th-28th Sept.1999, paper 9  
**DEVELOPMENT IN RUN FLAT TYRES**  
Kim N J; Chang D H; Kim J K

Kumho Tire Co.Ltd.  
(Rapra Technology Ltd.; European Rubber Journal)

The design concepts necessary and problems encountered in the development of sidewall reinforced run-flat tyres are studied. Despite the disadvantages in aspects of ride comfort due to the thick sidewall, sidewall reinforced run flat tyres, compared to other types of run flat tyres, have more advantage in use of commercially available rims, easy assembly of tyre and rim and manufacturing processability. Kumho's main aims in development of sidewall reinforced run flat tyres are to understand run flat tyres, to obtain ideas for new concept run-flat tyres and to prepare for the run-flat tyre world market of the

21st century. Finite element analysis is widely used to understand the basic mechanism and to design the construction of the run-flat tyres. In the development of run flat tyres, there are certainly several difficulties for us to overcome. The core concerns for designing sidewalls are: how to select compounds and sidewall constructions to support the bending force in the tyre sidewalls. The bending force also causes a problem of bead unseating from the rim. In addition to that, another problem is how to solve the manufacturing problems resulting from thicker sidewall compared to the conventional radial tyres. Higher section height makes higher bending deformation which is the main challenge to be solved. The higher the tyre series, the more difficult the run flat tyre development. Emphasis is placed on the development of 60 series run flat tyres. 16 refs.

KOREA

Accession no.755778

*Item 228*

Tyretex '99. Conference proceedings.  
Prague, 27th-28th Sept.1999, paper 6

**NEW UNLABELLED PROCESS OILS FOR THE TYRE AND RUBBER INDUSTRY**

Wadie J

Mobil Oil Co.Ltd.

(Rapra Technology Ltd.; European Rubber Journal)

To date, the tyre and rubber industry has predominantly used distillate aromatic extracts (DAE) for the oil extension of synthetic rubbers and plasticising rubber compounds in tyre manufacture. However, several studies have been conducted that found certain DAEs cause skin tumours in mouse skin painting assays. Mobil is well established as the leading supplier of process oils to the European tyre and rubber industries and has a long relationship of working closely with the industry on health and safety issues. To meet the technical, labelling and supply criteria set by BLIC (Bureau de Liaison des Industries du Caoutchouc de l'U.E.), Mobil is unique in offering both a Treated Distillate Aromatic Extract (TDAE) and a Mild Extraction Solvate (MES) product to address individual customer needs. Mobil Tyrex 20 is the most aromatic unlabelled and readily available process oil. It is a TDAE product demonstrating performance benefits over other types of unlabelled oils. It balances the benefits of higher aromaticity to give good rubber compatibility and performance, with low polycyclic aromatics (PCA) content. Mobil Prorex 15 is a MES product. It exhibits lower aromaticity than Mobil Tyrex 20 but meets specific customer requirements. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.755776

*Item 229*

Tyretex '99. Conference proceedings.  
Prague, 27th-28th Sept.1999, paper 5

**NEW CURING SYSTEMS FOR THE TYRE INDUSTRY**

Schuch A; Fruh T

Rhein Chemie Rheinau GmbH

(Rapra Technology Ltd.; European Rubber Journal)

For technical and environmental reasons, the tyre industry is interested in finding substitutes for hazardous materials. In the field of accelerators, dithioates could replace many critical curing agents. In SBR it has been shown that dithioates do not simply substitute MBS, they also improve heat build-up and provide higher network stability. The results were related to literature and a recent patent. The possible technical background of the patent claim is explained by a simplified model. The advantages of dithioates, like reversion resistance and reduced heat build-up, are even more obvious in NR than in SBR and indicate improvements in thick and/or dynamically loaded tyre elements and their production. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.755775

*Item 230*

Tyretex '99. Conference proceedings.  
Prague, 27th-28th Sept.1999, paper 3

**RENEWABLE SOURCE OF MATERIAL IN THE APPLICATION: FICTION OR REALITY?**

Corvasce F

Goodyear Technical Center

(Rapra Technology Ltd.; European Rubber Journal)

The ecological aspect of a tyre has become one of the major challenges of the nineties. Reduction in tyre rolling resistance, weight and noise have already contributed to reduce energy consumption, vehicle exhaust pipe emissions and environmental nuisance. Another important aspect is also the usage of raw materials obtained from natural renewable sources as replacement of existing petrochemical based materials. Advanced studies on polysaccharide-based materials are motivated by the aim of providing novel polymeric materials whose unique physicochemical properties allow them to fit into new commercial markets. Goodyear has developed a new filler based on starch, a biological, renewable raw material for its tyre compounds. Tyre tread formulations have been developed by replacing partially carbon black or silica as reinforcement and provides significant reduction in tyre rolling resistance combined with improved performances on wet roads. This filler helps to reduce tyre weight, offers wear resistance equal to current energy-saving silica tyres and helps the environment through fuel savings and the reduction of CO<sub>2</sub>. The environment receives an additional benefit because corn is a natural and renewable resource. Details of Goodyear's advances in this field are presented.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
LUXEMBOURG; WESTERN EUROPE

Accession no.755773

*Item 231*

**Modern Tire Dealer**

80, No.9, Sept.1999, p.50

**GOODYEAR REVS ITS ENGINE**

Manges M

Two new tyre lines have been launched by Goodyear: a high performance Z-rated Eagle HP Ultra Plus ultra-high performance summer-only radial, and a co-branded tyre Eagle #1 S-rated performance radial tyre for the sport truck tyre market. The former is claimed to have been designed for customers who insist on value, has a directional tread design for quick water evacuation, high net/gross contact area, ventless mould technology and a multi-polymer tread compound for optimal wet/dry traction and longer wear. Goodyear plans to cash in on the National Association of Stock Car Auto Racing (NASCAR) craze with its co-branded Eagle #1, which has gold lettering similar to the company's NASCAR race tyres, plus the racing organisation's logo on its sidewall.

GOODYEAR TIRE & RUBBER CO.

USA

*Accession no.755421*

*Item 232*

**Tire Business**

17, No.13, 27th Sept.1999, p.T16-8

**HOW THE MODERN PNEUMATIC TIRE CAME TO BE**

A brief history of the pneumatic tyre is presented from the discovery in 1495 of natural rubber by Christopher Columbus on Haiti to the present day and the current consolidation within the industry.

USA

*Accession no.755409*

*Item 233*

Patent Number: US 5898047 A 19990427

**TIRE WITH OUTER CARBON BLACK REINFORCED RUBBER STRIP FOR STATIC REDUCTION**

Howald J A; Garber G B; Nowacki M C

Goodyear Tire & Rubber Co.

Describes a rubber tyre having a rubber tread intended to be ground-contacting which is relative electrically insulating and which has at least one thin, narrow, carbon black reinforced rubber strip integral the outer surface, or face, of said tread, each strip extending laterally across the tread to each of the tyre's carbon black reinforced sidewalls. In one aspect, this outer rubber strip, extends laterally across the outer surface of the tread which is designed to be ground contacting and connects with carbon black reinforced tyre sidewalls to provide a path of reduced electrical resistance from the outer surface of the tyre tread to the bead portion of the tyre carcass and, thereby, such a reduced electrical resistance path from a

vehicle to the road surface. In another aspect, the said rubber tread intended to be ground-contacting, is primarily reinforced with silica.

USA

*Accession no.754796*

*Item 234*

**Industria della Gomma**

43, No.8, Oct.1999, p.17-20

Italian

**POLYFUNCTIONAL PRODUCT WITH PERMANENT ANTIOXIDANT ACTION**

Datta R; Ingham F; Mignanelli E

Flexsys BV

An examination is made of the antioxidant and antiozonant effects of Q-Flex QDI, a quinone diimine produced by Flexsys, in sulphur vulcanised unsaturated rubbers. It is also shown that this additive acts as a scorch retarder and viscosity modifier in NR compounds, and that it modifies the viscoelastic properties of NR compounds resulting in reduced rolling resistance of tyre treads. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.754684*

*Item 235*

**European Rubber Journal**

181, No.11, Suppl., Nov.1999, p.22-3

**CLEVER TYRES RELY ON MAGNETIC RUBBER**

White E

Continental recently unveiled a new sidewall torsion (SWT) measurement system that will help its current aim of becoming a chassis expert, rather than just a tyre maker. The German tyre maker's SWT uses sensors to pick up signals from magnetised strips in the rotating tyre's sidewall. Continental incorporates a ferromagnetic powder in the sidewall rubber compound during mixing to form the alternating magnetic strips. Fed into ESP systems, the data gives shorter braking distances and good control in poor road conditions. Details are given.

CONTINENTAL AG

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.754420*

*Item 236*

**European Rubber Journal**

181, No.11, Suppl., Nov.1999, p.16-7

**GOODYEAR INTRODUCES STARCH FILLER**

Shaw D

In a paper authored and presented by Dr. Filomeno Corvasce of Goodyear Tire and Rubber at TyreTech, the assembled delegates had an opportunity to hear about yet

another filler for use in the tyre and rubber industry. The main points of Dr Corvasce's presentation, and the ensuing debate are summarised.

GOODYEAR TIRE & RUBBER CO.; NOVAMONT SPA  
USA

Accession no.754415

Item 237

**European Rubber Journal**

181, No.12, Dec.1999, p.26-30

**GREEN TYRE USE PULLS SILICA FORWARD GLOBALLY**

White E

Demand for silica for tyres has been 'pulling the whole industry for several years', and silica use in OE car tyre treads in Europe is now standard, with this market at near saturation, according to the president of tyre and rubber chemicals for Rhodia SA. Use of silica has developed so that now some 100 ktpa of silica is used in this application, much of it in Europe. Silica use is so great in OE tyres in Europe, as the tax pressure on fuel is so high that car makers have a 'big incentive' to reduce fuel consumption. This in turn puts pressure on the tyre makers to develop green tyres for low rolling resistance and low fuel consumption. These rules are now 'so tight that no new car can be homologated without green tyres'. Details are given.

PPG INDUSTRIES INC.; SMITHERS SCIENTIFIC SERVICES; RHODIA SA  
WORLD

Accession no.754387

Item 238

**International Polymer Science and Technology**

26, No.2, 1999, p.26-34

**RECENT PATENTS ON SILICA REINFORCED POLYMERS**

Fujimaki T; Morita K

Silica reinforcing filler in tyre tread rubbers gives better lower loss properties and wet skid resistance than carbon black, but has inferior performance for reinforcement-related properties such as rupture strength and wear resistance, due to poor particle-rubber bonding. A satisfactory bonding may be achieved by the use of silane coupling agents, but this is a relatively expensive solution. Technical developments of alternative strategies are reviewed, as reflected in recent patents, concentrating on polymer modification technology for enhancing silica reinforcement by anionic polymerisation. Modifications of chemical bonding reviewed include: amine or amide; alkoxysilane; amine plus alkoxysilane; and epoxy. Also reviewed are patents relating to improving the dispersion of silica, so improving processability and properties. 23 refs. Translation of Nippon Gomu Kyokaiishi No.9, 1998, p.562

Accession no.753442

Item 239

**Chimica e l'Industria**

81, No.6, July/Aug.1999, p.733-8

Italian

**COMPOUNDING TECHNIQUES FOR TYRES**

Martin M

Pirelli Pneumatici SpA

An examination is made of the various components used in tyre construction, and of types of rubbers and additives (particularly carbon black and silica fillers) and mixing processes employed in the manufacture of tyre compounds.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.752739

Item 240

**Rubber World**

221, No.1, Oct.1999, p.22/53

**PRESENTATION OF A MODERN TRIPLEX EXTRUSION SYSTEM FOR BLACK AND SILICA MIXTURES**

Nijman G; Luscalu R

Vredestein Banden BV; Krupp Elastomertechnik GmbH

Car tyres produced according to the silica concept have been on the European market for some time. The treads of these tyres are made of a mixture that is reinforced partly or completely with silicic acid instead of carbon black. However, production and processing of silica mixtures are much more difficult than production and processing of carbon black mixtures. This article discusses how silica mixtures behave during the mixing process and subsequent treatment, and the additional requirements silica mixtures impose on a tread extrusion line. A modern tread and sidewall extrusion line for black and silica mixtures is presented.

WESTERN EUROPE

Accession no.752583

Item 241

Shawbury, Rapra Technology Ltd., 1999, 15 papers. 30cms

**TYRETECH '99. PROCEEDINGS OF A CONFERENCE HELD PRAGUE, 27TH-28TH SEPT. 1999**

Rapra Technology Ltd.; European Rubber Journal

A collection of 15 papers focuses on developments affecting the tyre industry worldwide. Papers include globalising trends in the world tyre industry, trends in truck tyre steel cord constructions, the use of various accelerators and antidegradants in radial tyre components for improved performance, and the use of easily dispersible silica in green tyre manufacturing.

Accession no.752458

## Item 242

**International Polymer Science and Technology**

26, No.4, 1999, p.T/1-8

**STRUCTURE, PROPERTIES AND PRACTICAL BEHAVIOUR OF RUBBER FROM THE POLYMER NETWORK TO DYNAMICALLY STRESSED TYRES. I.**

Heinrich G

Continental AG

A review is presented of state-of-the-art molecular models and material laws describing the rubber elasticity of statically and dynamically deformed elastomers. The main aim is to describe and discuss questions relating to the physical properties of polymers and their solutions and new models for describing rubber elasticity, viscoelasticity, and polymer-filler and filler-filler interactions. Selected examples from the tyre industry are used to demonstrate possibilities for predicting product properties, e.g. rolling resistance and wet grip, from the dynamic mechanical characterisation of rubber with the aid of physical models. 36 refs. (Full translation of Gummi Fas.Kunst., No.9, 1997, p.687)

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.752000

## Item 243

**Kautchuk und Gummi Kunststoffe**

52, No.9, Sept.1999, p.588/98

**INVESTIGATIONS ON THE REACTION SILICA/ ORGANOSILANE AND ORGANOSILANE/ POLYMER. PART 4: STUDIES ON THE CHEMISTRY OF THE SILANE-SULFUR CHAIN**

Gorl U; Munzenberg J; Luginsland D; Muller A

Huels AG-PKU GmbH; Degussa AG

This last paper in a series of four concerning the reaction system silica/organosilane/polymer, deals with the reaction behaviour between the sulphur chain of polysulphidic organosilanes such as bistriethoxysilyl-propyltetrasulphane (TESPT) and the polymer matrix. The sulphur group reacts with the rubber chains during vulcanisation and in the presence of fillers with silanol groups, leads to the formation of rubber-to-filler bonds. An attempt is made to explain the possible reaction behaviour of the TESPT sulphur function during vulcanisation and the effects which are caused due to the use of TESPT. These effects are responsible for the increase in use of the silica/TESPT system in rubber applications, including tyre treads. 23 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.751769

## Item 244

**Kautchuk und Gummi Kunststoffe**

52, No.10, Oct.1999, p.670-6

**NANO-STRUCTURE BLACKS. A NEW CARBON****BLACK FAMILY DESIGNED TO MEET TRUCK TIRE PERFORMANCE DEMANDS**

Niedermeier W; Freund B

Degussa AG

Nanostructure carbon blacks called Ecorex are characterised by a rough surface and enhanced filler-polymer interaction. Consequently, the slippage of the polymer molecules along the rough nanostructure surface which is the major hysteresis mechanism in rubber compounds is hindered and hysteresis is significantly reduced. It was demonstrated that aggregate size distribution (ASD) does not directly correlate with hysteresis. Hence narrow ASD carbon blacks with strong polymer interaction have been achieved, and their value in improving treadwear in truck tyre formulations is proven. 23 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.751761

## Item 245

**Plastics and Rubber Weekly**

No.1808, 15th Oct.1999, p.10

**NEVER TIRING OF THE DRIVING PRESSURE**

James B

Natural rubber continues to yield market share in the tyre market to various synthetic polymers. The state of the tyre building process is reviewed.

WORLD

Accession no.751250

## Item 246

**Indian Rubber Journal**

No.42, July-Aug.1999, p.119-24

**IMPROVED PROCESSING OF CARBON/SILICA DUAL PHASE FILLER IN 'GREEN TIRE' TREAD FORMULATIONS**

Hensel M; Menting K H

Schill &amp; Seilacher GmbH

Ecoblack fillers are produced by the joint combustion of mineral oil and a silicon compound in a modified furnace process which results in particles having silica domains dispersed in the carbon phase. Several grades are available, and their performance is said to be very close to that of the new grades of highly dispersible silicas. This study concentrates on the processing of Ecoblack materials in green tyre tread formulations, and sets out to establish whether the use of processing aids will be beneficial. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.750826

## Item 247

**Rubber News**

38, No.10, July 1999, p.17-24

**CONCEPT ON PERMEABILITY**

Majumdar S

The nature of and factors influencing the permeability of rubber with reference to tyre structures, is examined. Gas permeability is discussed with reference to the polymer structure, permeability theory, compounding factor and environmental factor. Concerning the polymer structure, parameters such as the presence of methyl group, polar group and degree of unsaturation are considered. The permeability of different rubbers is compared and expressed as a percentage relative to butyl rubber. 9 refs.

INDIA

Accession no.750456

*Item 248*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 73, pp.26

**ANALYTICAL PROPERTIES OF SILICA: A KEY FOR UNDERSTANDING SILICA REINFORCEMENT**

Blume A

Degussa-Huels AG  
(ACS,Rubber Div.)

A number of silicas were characterised for particle size distribution, specific silanol group density, surface activity and dispersion coefficient, and relationships between these filler properties and the performance of tyre tread compounds were investigated. Effects on rheological and mechanical properties and cure rate were examined, and parameters for the improvement of dispersion, dynamic stiffness and vulcanisation behaviour were identified. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.749885

*Item 249*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 72, pp.23

**CARBON BLACK TREATED WITH SILICA IN AQUEOUS SYSTEM FOR TIRE TREAD COMPOUNDS**

Kawazura T; Yatsuyanagi F; Kawazoe M; Ikai K; Kaidou H

Yokohama Rubber Co.Ltd.  
(ACS,Rubber Div.)

Carbon black was treated with silica by a hydrolysis reaction of sodium silicate with sulphuric acid in a carbon black slurry. The fillers obtained were characterised by several techniques, and their influence on the performance of tyre treads was investigated by studies of the viscoelastic properties and electrical resistivity of SBR compounds. 24 refs.

JAPAN; USA

Accession no.749884

*Item 250*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 65, pp.28

**USE OF DIALKYL PARAPHENYLENE DIAMINE OR 2,4,6-TRIS-(N-1,4-DIMETHYLPENTYL-P-PHENYLENE DIAMINE)-1,3,5 TRIAZINE FOR A LONG TERM STATIC OZONE CRACK RESISTANCE IN TIRE BLACK SIDEWALL**

Hong S W; Greene P K; Lin C Y

Uniroyal Chemical Co.Inc.  
(ACS,Rubber Div.)

Dialkyl paraphenylenediamine and 2,4,6-tris-(N-1,4-dimethylpentyl-p-phenylenediamino)-1,3,5 triazine antiozonants were evaluated as partial or complete replacements for wax in NR and NR/polybutadiene tyre sidewall compounds. A mechanism for the reaction of ozone with the antiozonants was proposed. Results are presented of tests which confirmed the proposed mechanism and allowed the optimisation of antiozonant levels for long-term static and dynamic ozone crack resistance. 5 refs.

USA

Accession no.749878

*Item 251*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 64, pp.12

**HEAT, OXIDATIVE AND OZONE STABILITY OF BIMS/DIENE RUBBER BLENDS**

Cross J P; McElrath K O; Tse M F

Exxon Chemical Co.  
(ACS,Rubber Div.)

An examination is made of factors influencing the heat and ozone resistance and oxidative stability of tyre sidewalls based on blends of brominated isobutylene-methyl styrene copolymers with NR and polybutadiene.

USA

Accession no.749877

*Item 252*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 63, pp.25

**DIFFERENCES AMONG THIURAM ACCELERATORS THAT CAN AFFECT TIRE DURABILITY**

Chasar D W

Goodrich B.F.,Co.  
(ACS,Rubber Div.)

Two thiuram accelerators developed by Goodrich, Cure-rite IBM tetraisobutylthiuram monosulphide and Cure-rite IBT tetraisobutylthiuram disulphide, were evaluated along with other commercial thiurams as co-accelerators for benzothiazole sulphenamides in the vulcanisation of

NR and SBR/polybutadiene tyre compounds. The effects of these thiurams on scorch safety and cure rates during vulcanisation and on the reversion resistance of vulcanisates were investigated, and differences in the types of sulphur crosslinks developed by the various thiurams were examined. 6 refs.

USA

Accession no.749876

*Item 253*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 61, pp.15

**INCREASED TRUCK TIRE DURABILITY THROUGH COMPOUND MODIFICATIONS**

Ignatz-Hoover F; To B H

Flexsys America LP

(ACS,Rubber Div.)

Compounding approaches to the improvement of truck tyre properties including heat build-up, heat resistance, chipping and chunking resistance and steel cord adhesion are reviewed. The influence of antidegradants, curing systems, fillers and adhesion promoters on tyre performance is discussed. 10 refs.

USA

Accession no.749874

*Item 254*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 59, pp.38

**INFLUENCE OF COMPOUNDING MATERIALS ON TIRE DURABILITY**

Niziolek A W; Jones R H; Neilsen J G

Bayer Corp.

(ACS,Rubber Div.)

The influence of polymers and additives on the service life of non-tread tyre components is discussed on the basis of results obtained from studies of inner liner, belt and sidewall compounds. The effects of the bromine content of bromobutyl rubbers on the performance of inner liners, and of sulphenamide accelerators on the adhesion of NR belt compounds to brass coated steel cords were investigated. The mechanical properties and ageing and ozone resistance of black sidewall compounds consisting of NR blends with neodymium catalysed polybutadiene protected with different antioxidants and antiozonants were also evaluated. 5 refs.

USA

Accession no.749872

*Item 255*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 51, pp.21

**MALEINIZED POLYBUTADIENE LATEX FOR FIBER TO RUBBER ADHESION**

Estrin A S; Nalepa R W

Ricon Resins Inc.

(ACS,Rubber Div.)

Ricon Resins' Ricobond water-borne adhesives based on maleinised low molecular weight polybutadiene are described. Results are presented of studies in which these adhesives were used in bonding polyester cords to peroxide cured EPDM and a number of sulphur cured unsaturated rubbers and in bonding aramid cords to EPDM and hydrogenated nitrile rubber. 8 refs.

USA

Accession no.749864

*Item 256*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 43, pp.41

**RUBBER FRICTION ON SELF-AFFINE ROAD TRACKS**

Kluppel M; Heinrich G

Deutsches Institut fuer Kautschuktechnologie eV;

Continental AG

(ACS,Rubber Div.)

An advanced physical concept of rubber friction on rough surfaces is presented. It is shown that this concept, which relates frictional force to dissipated energy of the rubber during sliding stochastic excitations, is of high relevance to tyre traction and allows prediction of the likely friction level of tread compounds on the basis of viscoelastic data. The impact of the frequency dependent loss and storage moduli on frictional force during sliding of tyres on rough road tracks is quantitatively demonstrated for different sliding velocities. The effect of the surface roughness of tracks is described by three characteristic surface descriptors, i.e. the fractal dimension and the correlation lengths parallel and normal to the surface. 32 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.749859

*Item 257*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 41, pp.12

**PREDICTIVE FRACTURE MECHANICS FOR TIRES**

Nicholson D W

Central Florida,University

(ACS,Rubber Div.)

The application of fracture mechanics to tyres is discussed, and an examination is made of data required for the prediction of fracture, including the location and size of cracks, the toughness of the material or interface where the crack is located, and the stresses acting on the zone

containing the crack. Finite element methods for determining stresses are reviewed. 16 refs.

USA

Accession no.749857

*Item 258*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 38, pp.32

**DAMAGE MONITORING OF CORD-RUBBER COMPOSITES BASED ON ACOUSTIC EMISSION**

Lee B L; Hippo P K; Liu D S; Ku B H  
Pennsylvania,State University  
(ACS,Rubber Div.)

Acoustic emission (AE) activities were monitored to assess damage in angle-ply cord-rubber composites, i.e. two model steel wire-reinforced composites and an aircraft tyre carcass reinforced with nylon cords. Under cyclic loading with a constant stress amplitude, the cumulative values of AE counts, events and energy initially increased in almost linear fashion and then went through a transient region, eventually reaching a steady-state region of constant rate in which the predominant modes of damage accumulation were cord-matrix debonding and matrix cracking, joined later by partial delamination. Fatigue life was inversely proportional to the accumulation rate of AE activities in the steady-state region. An analogy between AE activities and cyclic strain suggested a preset level of cumulative AE for gross failure. A correlation was found between residual tensile strength and residual AE activities for damaged specimens previously subjected to cyclic loading. 36 refs.

USA

Accession no.749854

*Item 259*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 32, pp.29

**PHASE MIXING OF BROMINATED ISOBUTYLENE-CO-PARA-METHYLSTYRENE WITH PRECIPITATED SILICA TO ENHANCE THE PROPERTIES OF A TIRE TREAD COMPOUND**

Waddell W H; Poulter R R  
Exxon Chemical Co.  
(ACS,Rubber Div.)

A four-step phase mixing process was used to improve the mechanical and dynamic mechanical properties of a passenger tyre tread compound consisting of a blend of a brominated isobutylene-p-methylstyrene copolymer (BIMS), cis-polybutadiene and a solution SBR and carbon black and precipitated silica fillers. Selective masterbatching of BIMS with silica gave increased tensile strength, elongation at break, abrasion resistance and

dynamic properties in comparison with compounds prepared by a normal three-step process. Tapping mode atomic force microscopy showed that the BIMS domains of the BIMS/silica masterbatch had a significantly higher filler content than a three-pass mix or a BIMS/carbon black masterbatch. 23 refs.

USA

Accession no.749848

*Item 260*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 30, pp.12

**CHEMICALLY SENSITIVE IMAGING OF TIRE BLENDS USING X-RAY MICROSCOPY**

Dias A J; Urquhart S G; Ade H; Smith A P; Stevens P  
Exxon Chemical Co.; North Carolina,State University;  
Exxon Research & Engineering Co.  
(ACS,Rubber Div.)

Results are presented of experiments in which scanning transmission X-ray microscopy and near edge X-ray absorption fine structure spectroscopy were used in the morphological characterisation of tyre compounds based on blends of a brominated isobutylene-methylstyrene copolymer and polybutadiene, and in the study of the distribution of carbon black and silica fillers in the blends. 7 refs.

USA

Accession no.749847

*Item 261*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 13, pp.19

**NEW EMULSION SBR TECHNOLOGY. II. SILICA-FILLED MODEL COMPOUND STUDY**

Dailey L R; Colvin H; Lewandowski L; Senyek M;  
Johnson E  
Goodyear Tire & Rubber Co.,Chemicals Div.  
(ACS,Rubber Div.)

A summary is presented of the results of studies of the properties of silica filled compounds based on emulsion SBR prepared by blending high and low molecular weight polymers with different styrene-butadiene compositions. The mechanical and dynamic mechanical properties and extrusion characteristics were investigated and compared with those of solution SBR and conventional emulsion SBR.

USA

Accession no.749830

*Item 262*

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 6, pp.26

**QUALITY CONTROL OF THE DISCONTINUOUS COMPOUNDING PROCESS IN A RUBBER INTERNAL MIXER BY REGRESSION AND NEURAL NETWORKS PROCESS MODELS**

Ryzko P; Haberstroh E  
IKV  
(ACS,Rubber Div.)

Mathematical models of the internal mixing process for the on-line prediction of rubber compound viscosity and viscoelastic properties were developed on the basis of multiple linear regression and artificial neural networks. The models gave high levels of accuracy when applied to predicting the properties of SBR and NR/SBR/polybutadiene compounds produced using mixers of three different sizes. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.749824*

*Item 263*

155th ACS Rubber Division Meeting, Spring 1999.  
Conference Preprints.  
Chicago, Il., 13th-16th April 1999, Paper 1, pp.34

**NEW ELASTOMERS FOR TIRE APPLICATIONS**

Halasa A F  
Goodyear Tire & Rubber Co.  
(ACS,Rubber Div.)

Performance requirements for rubbers used in tyre construction are examined, and details are given of an anionically polymerised styrene-isoprene-butadiene terpolymer developed by Goodyear, and which is claimed to give reduced rolling resistance and improved wet traction and wear characteristics in tread applications.

USA

*Accession no.749819*

*Item 264*

**Gummibereifung**

75, No.4, April 1999, p.139

**THERE'S NO BETTER TYRE FOR SPORTY DRIVERS**

Mutz K

Bridgestone has launched the new Potenza RE 720 tyre which is reported to have particular strengths in wet road conditions. Tread and contour were optimised by Bridgestone's patented Comprehensive Tyre Design Method. Rounded tread bar edges increase the actual contact area of the tyre with the road. A two-component tread compound makes a more adhesive compound with more silica emerging to the surface as the tread wears down, thus maintaining the adhesive properties of the tyre longer than before. The article also covers the B330 and B320 tyres.

BRIDGESTONE TIRE CO.LTD.

JAPAN

*Accession no.745594*

*Item 265*

**Tire Technology International**

Sept.1999, p.64/6

**TWIST OF CORD**

Lawson J

The man-made tyre cord arena is currently going through a period of change. Polyester, rayon and nylon 66 are all still in demand, but shifts in the technological requirements of the tyre companies as well as shifts in the marketplace itself are altering the proportions produced. Conventional polyester is still in production at firms such as Dutch materials specialist Acordis Industrial Fibers, although it accounts for less than 5% of the entire polyester output used for speed-rated tyres. The newer high-modulus, low-shrinkage polyester is taking over as the major choice for most clients. This material, despite having the same constituent ingredients as the conventional material, differs in its manufacturing and is therefore completely different in its physical properties. Details are given.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.745580*

*Item 266*

**Tire Technology International**

Sept.1999, p.60-3

**CONTINUOUS PRODUCTION ON TWIN-SCREW EXTRUDERS**

Capelle G  
Berstorff GmbH

The most serious disadvantages in daily production are the bale-shaped aggregate form of most rubber polymers, which results in additional expenditure on the pelletising process, and the lack of flexibility specific to most continuous mixing systems with regard to the processing of a large range, of different rubber compounds. It was because of the high raw material costs in particular that polymer producers failed to introduce newly-developed types of powdered rubber into the rubber industry between 1975 and 1980. Further development of twin-screw extruders for use in the plastics sector, combined with the development of new technologies in the case of the split-feed technique, also opened up promising new opportunities for continuous production of rubber compounds. In addition to this, the modular design of the screw and liner of this twin-screw extruder allows the processing section to be easily adapted to various processing tasks. Details are given.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.745579*

*Item 267*

**Tire Technology International**

Sept.1999, p.54-9

### **EXTRUSION TRENDS IN THE TYRE INDUSTRY**

Wood P

Extrusion is one of the major contributors to the required consistency of the product in the tyre industry. Developments in cold feed extrusion over the last 35 years have resulted in a wide choice of extruder types, each being designed to warm and soften a rubber compound to allow consistent extrusion of an accurate profile. Recent developments have introduced machinery that takes up less space while having claimed improvements in productivity and extrusion quality. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.745578*

*Item 268*

***International Polymer Science and Technology***

26, No.1, 1999, p.T/42-6

### **MIXING WITH A COMBINATION OF BANBURY MIXER AND ROLLS**

Yamaguchi Y

According to Twelve Lectures in Applied Rubber Processing Technology, 'Rubber is a big, broad-minded character. Whatever powder and oil we throw in, it unflinchingly swallows the lot and carries on much as before'. In the rubber factory, it is possible to be assisted and sometimes frustrated by this intriguing propensity of rubber. Recently, however, the advent of new fillers and polymers and increases in productivity has complicated matters. The latest trends in tyre rubber formulation and some improvements in rubber mixing aimed at improving quality and productivity in relation to these trends are described. 3 refs.

JAPAN

*Accession no.745524*

*Item 269*

***Tire Technology International***

Annual Review, 1999, p.104-5

### **TYRE COMPOUND CONTROL**

Larsson M

OptiGrade AB

OptiGrade's DisperGrader system for carbon black and silica dispersion testing supports standard test methods for filler distribution rating and large agglomerate detection. Applications range from testing for research and development purposes to continuous process control for mixing economy optimisation. Compound and mixing cycle development, and process control, are described.

SCANDINAVIA; SWEDEN; WESTERN EUROPE

*Accession no.743863*

*Item 270*

***Tire Technology International***

Annual Review, 1999, p.69/73

### **SIMULATION OF SOOT**

Hayashi S

Nippon Steel Chemical Co.Ltd.

Understanding chemistry at a small scale is the key to understanding the broader properties. A new simulation method of the AMP model based on particle and aggregate mean free path has been developed. Aspects discussed include benzene pyrolysis, the simulation method of cluster-cluster aggregation, a comparison of simulated and experimental soot, a comparison of peripheral fractal dimension and aggregate area, relation between average particle number per aggregate and peripheral fractal dimension, and application to high-performance tyres. 3 refs.

JAPAN

*Accession no.743857*

*Item 271*

***Tire Technology International***

Annual Review, 1999, p.49-54

### **IMPROVED PROCESSING OF CARBON/SILICA DUAL-PHASE FILLER IN GREEN TYRE TREAD FORMATIONS**

Hensel M; Menting K-H

Schill & Seilacher GmbH & Co.

In 1991 the concept of using highly dispersible silica as the sole filler, together with a silane coupling agent for the tread compound of low rolling resistance tyres, was patented by Michelin. Since it attracted great interest in the tyre industry, carbon black manufacturers have developed various concepts to match the performance of silica with new types of carbon blacks. One interesting approach is the joint combustion of mineral oil and a silicone compound in a modified furnace process, which results in particles having silica domains dispersed in the carbon phase. Several grades with varying silica content have since been made available. Performance of these Ecoblack fillers is very close to that of the new grades of highly dispersible silicas. Unfortunately these silicas show some disadvantages in processing, such as high compound viscosities, storage hardening and extrusion difficulties, for example high pressure and temperature, scorch and poor surface quality, especially at the edges of the treads. In a previous study it was shown how selected processing promoters help to overcome these disadvantages without affecting the final physical properties. The aim of this study is to determine whether processing of Ecoblack materials shows similar trends, and if so, whether processing promoters efficient in silica also improve the processing here. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.743853*

*Item 272*

***Tire Technology International***

Annual Review, 1999, p.36-7

**PRECIPITATED SILICA: FOR TYRE REINFORCEMENT**

Glassven

Despite its long-established use, silica continues to evolve and can be delivered in a variety of versions. Precipitated silica has found growing use in the area of mechanical rubber goods (MRG), as a reinforcing filler or in combination with carbon blacks. Glassven's Rubbersil silicas can offer important advantages to MRG manufacturers. They combine reinforcing ability with easy processing in rubber compounds. They are used in the manufacture of tyres, gaskets, rice rollers and shoe soles, to improve bonding to yarns and wires of conveyor belts and hoses in manufacturing, and in the production of green tyres. Rubbersil precipitated silicas have found a wide range of applications in the rubber industry and MRG, as well as tyres. These products are pure, synthetic, inert and colourless, and can be supplied in powder or granular form. Details are given.

VENEZUELA

*Accession no.743850**Item 273****Tire Technology International***

Annual Review, 1999, p.26/30

**PROCESSING BENEFITS OF QUINONE DIIMINE ANTIDEGRADANTS**

Ignatz-Hoover F

Flexsys America LP

Reductions in the viscosity of NR and its blends can reduce energy and compound costs, but the process does require some stabilisation. Flexsys America's Q-Flex QDI offers substantial benefits through its ability to be both an antioxidant and an antiozonant. 9 refs.

USA

*Accession no.743848**Item 274****Tire Technology International***

Annual Review, 1999, p.21-5

**RUBBER TESTS WITH SAFER EXTENDER OILS**

Null V

Shell Global Solutions

The global marketplace is increasingly demanding non-carcinogenic process oils to replace distillate aromatic extracts. Some treated distillate aromatic extract, mild extraction solvate and naphthenic oils have been evaluated in typical tyre tread formulations. All resulted in a slight shift of wet grip performance. However, ongoing global restructuring of refinery designs is forecast to reduce future availability of feedstock for TDAE. A study is carried out to examine the impact of safer process oil types on typical rubber and tyre characteristics. Three MES oils, one tDAE and a naphthenic process oil are evaluated in a reference tyre tread formulation based on an emulsion

SBR copolymer. Typical DAE-based compounds are used as a benchmark. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.743847**Item 275****Tire Technology International***

Annual Review, 1999, p.14/9

**EFFECTS OF REINFORCEMENT IN SBR/BR BLENDS**

Nakamura M

Nippon Zeon Co.Ltd.

Depending on the severity of the test, different compounds perform in different ways. Blending silica and carbon black is said to give the best overall abrasion performance. In recent years, a considerable number of studies has been conducted on silica compounds. A change of viscoelastic properties in SBR/NR blends has been reported; this change is said to have been caused by the microstructure of the polymers, the silane coupling agent and the surface area of the silica. Oil-extended SBR/BR blend systems have been adopted in Europe. It has been reported that green tyres are made of oil-extended SBR, BR, silica and a coupling agent. Tyre performance, measured as abrasion, viscoelastic and tensile properties, is studied in three reinforcing systems: carbon black; carbon and silica; and silica, with various SBRs blended with a high-cis BR. 2 refs.

JAPAN

*Accession no.743846**Item 276****Tire Technology International***

Annual Review, 1999, p.10-2

**OILS WITHOUT LABELS SAFER PROCESS OILS FOR EXTENSION AND PLASTICISATION**

To date, the tyre and rubber industry has predominantly used distillate aromatic extracts (DAEs) for the oil extension of synthetic rubbers and for plasticising rubber compounds in tyre manufacture. While these high aromatic DAEs impart excellent rubber solubility, several studies have indicated that DAEs are potential carcinogens. Treated distillate aromatic extract and mild extraction solvate process oils can be used as replacements for DAEs in the oil extension of synthetic rubber and for plasticising tyre compounds. However, concerns have been voiced in the past over their availability. Two new unlabelled process oils from Mobil are now on the market. 6 refs.

MOBIL EUROPE LUBRICANTS LTD.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.743845**Item 277****Luntai Gongye***

19, No.6, 1999, p.347-9

Chinese

**APPLICATION OF S-SBR TO TYRE TUBE**

Hongqin L

Tianjin Tire & Rubber Industry Corp.Ltd.

An experimental study on the application of S-SBR to tyre tubes is made. The results show that the most physical properties of the test S-SBR compound are similar to those of the original SBR compound and some are slightly better; the test compound possesses good processability and the performance of finished product meets the requirements in national standards; the cost of the test compound is reduced by 0.14 yuan/kg -1.

CHINA

Accession no.742026

Item 278

**Elastomery**

3, No.1, 1999, p.18-25

Polish

**RECYCLED RUBBER: A VALUABLE RAW MATERIAL**

Dierkes W

Vredestein Rubber Resources

A description is given of the optimisation of the production of Ecorr NR and butyl rubber reclaims through a continuous production process, and characterised by high quality, consistency and purity. A broadening of the variety of recyclable polymers (NR, SBR, NBR, EPDM, polychloroprene) was achieved through the introduction of a surface-activated rubber crumb (SURCRUM), crumb and reclaim based on whole tyres as well as compounds. Cooperation between manufacturers has led to development and introduction of custom-designed recycled rubber products in terms of feedstock, chemical composition, quality and price. The influence of recycled rubber on the processing behaviour and properties of different compounds is illustrated and multiple recycling discussed.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.740335

Item 279

**Kauchuk i Rezina (USSR)**

No.1, 1999, p.28-31

Russian

**COMPARISON OF THE PROTECTIVE PROPERTIES OF NERATEN 30+ SYNTHETIC WAX WITH PROPERTIES OF KNOWN INDUSTRIAL WAXES**

Kavun S M; Modenkova I A; Genkina Yu M  
Moscow, Tire Industry Research Institute

The effectiveness of the wax Neraten 30+, based on alpha-olefin fraction C30 is studied in rubber compounds containing SKI-3 polyisoprene and SKD polybutadiene for car tyre sidewalls and SKI-3, SKD and butadiene-styrene rubber for sidewalls of truck radial tyres in comparison with

some other waxes. Data are given on mechanical properties, ageing and ozone resistance. 1 ref. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

RUSSIA

Accession no.738755

Item 280

**Tire Technology International**

June 1999, p.56/61

**MODERN TRIPLEX EXTRUSION SYSTEM FOR BLACK AND SILICA MIXTURES**

Nijman G; Ludvslu R

Vredestein Banden BV; Krupp Elastomertechnik GmbH

Advantages of silica mixtures in tyre tread compounds are described with reference to improved tyre performance. The production and processing considerations are discussed which are necessary to deal with the extrusion of silica mixtures which is more difficult than for carbon black mixtures. The need for a silane coupling agent and the silanisation process is explained, and also the effect of this process on the rheological behaviour of a silica mixture. The use of a triplex extrusion line is suggested, which can facilitate the extrusion of both carbon black and silica mixtures on the same line.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
NETHERLANDS; WESTERN EUROPE

Accession no.736658

Item 281

**Tire Technology International**

June 1999, p.50/5

**BLACK TO THE FUTURE**

Locatelli J L; De Puydt Y

Pirelli Pneumatici Spa

The role of carbon black in tyre formulations is discussed, and the nature of its functions in optimising tyre performance is described. The growing use of silica in place of carbon black is examined and the advantages it affords are outlined. These advantages to the tyre user are weighed against the disadvantages to the manufacturer in terms of mixing, production costs, formulation modifications, and investment in expensive research and machinery. Such factors have led carbon black producers to develop new products which attempt to meeting the performance of silica, with modifications of surface morphology and chemistry to produce chemically active fillers.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

Accession no.736657

Item 282

**Tire Technology International**

June 1999, p.43/9

### ENERGY AT THE INTERFACE

Gerspacher M; O'Farrell C P  
Richardson S., Carbon Co.

Energy storage and dissipation factors associated with carbon black filled rubber compounds are studied. The partition of energy is shown to depend on the carbon black and the polymer, and on the interface between these two main components of a tyre. The surface structure of carbon black is examined by various test methods and its interactions with neighbouring aggregates and/or polymer chains are studied. 29 refs.

USA

Accession no. 736656

Item 283

*Journal of Applied Polymer Science*

72, No.12, 20th June 1999, p.1513-22

### SPECIFIC HEATS OF RUBBER COMPOUNDS

Changwoon Nah; Je Hwan Park; Choon Tack Cho;  
Young-Wook Chang; Shinyoung Kaang  
Damyang, Provincial College; Kumho Tire Co.;  
Hanyang, University; Chonnam, National University

The specific heats of various compounding ingredients and their compounds for tyres were determined by DSC in the temp. range from 45 to 95C. The values found were compared with previously-published results for NR, SBR, polybutadiene rubber and butyl rubber. The effects of carbon black loading and vulcanisation on the specific heats were investigated. The measured specific heats of the compounds were compared with the calculated values based on the fractional summation of the specific heat of each compounding ingredient. 18 refs.

SOUTH KOREA

Accession no. 736594

Item 284

*Industria della Gomma*

42, No.10, Dec.1998, p.16-9

Italian

### CONTINUOUS PRODUCTION WITH TWIN-SCREW EXTRUDERS

Capelle G  
Berstorff GmbH

The use of twin-screw extruders in the continuous mixing of rubbers is discussed. Results are presented of a comparative study of EPDM compounding using a twin-screw extruder and an internal mixer.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no. 736318

Item 285

*Rubber and Plastics News*

28, No.19, 19th April 1999, p.10

### BREAKING LINKS

Begin S

Ulramer and the US Army Tank Automotive & Armaments Command are jointly researching an ultrasonic devulcanisation process to break down scrap tyre crumb rubber. The resultant "virgin rubber" will be less expensive than the original compounds used to make moulded parts if the groups can clear cost and technological hurdles to commercialising the process. The recycled rubber has been re-compounded and re-cured for use in prototype automotive parts such as floor mats and tyre retreads.

ULTRAMER INC.; US, ARMY TANK AUTOMOTIVE  
COMMAND

USA

Accession no. 735635

Item 286

*Rubber News*

38, No.7, April 1999, p.18-21

### HEAT RESISTANCE CHLOROBUTYL INNER TUBE

Majumdar S

With the available road conditions in India, it is reported that the shoulder temperature of a truck tyre may reach 170C or more during summer. Chlorobutyl rubber inner tubes have been shown to do well due to the material's better heat resistance than butyl or butyl/EPDM blend. Processing and properties of chlorobutyl are outlined. 7 refs.

INDIA

Accession no. 735616

Item 287

*Kautchuk und Gummi Kunststoffe*

52, No.5, May 1999, p.322/8

### STEEL CORD ADHESION. EFFECT OF 1,3-BIS(CITRACONIMIDOMETHYL)BENZENE AND HEXAMETHYLENE-1,6-BIS(THIOSULPHATE), DISODIUM SALT, DIHYDRATE

Datta R N; Ingham F A A  
Flexsys BV

Results of studies are examined regarding factors affecting the adhesion of steel cord to rubber. The adhesion is balanced with improved aged compound characteristics and reduced compound heat build-up through the use of 1,3-bis(citraconimidomethyl)benzene, and hexamethylene-1,6-bis(thiosulphate) disodium salt dihydrate. This combination of chemicals not only improves the properties of steel cord skim compounds, but also can be used effectively to replace the bonding system based on resorcinol and hexamethoxymethylmelamine, it is found. 19 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no. 735014

Item 288

**Progress in Rubber and Plastics Technology**

15, No.1, 1999, p.1-27

**ADVANCES IN PRECIPITATED SILICAS FOR PASSENGER AND TRUCK TYRE TREADS**

Okel T A; Patkar S D; Bice J-A E

PPG Industries Inc.

Amorphous precipitated silica has emerged as a major contributor to the reduction of tyre tread rolling resistance. The challenge of obtaining a low rolling resistance, energy efficient compound with minimal compromise in traction and tread wear has been addressed by emerging silica/coupling agent technology. Because of the increasing use of silica in tread applications, there has been greater emphasis on the mechanistic understanding of silica-elastomer viscoelastic properties in addition to compound optimisation. Composite model formulations are developed from a review of the recent patent literature pertaining to NR truck tread and SBR/BR passenger tread formulations. An attempt is made to: quantify the effects of silica area and silica loading in perturbing the cure system of the truck tread of formulation; determine the effect of silane coupling agent on compound cure, physical and dynamic properties both in the absence and presence of compensation for this cure perturbation with additional accelerator; and evaluate the effects of coupling agent, silica loading and silica surface area on the dynamic properties of a model SBR/BR tread under varying strain and temperature conditions. 20 refs.

USA

Accession no.734807

Item 289

International Rubber Exhibition and Conference 1999.

Conference proceedings.

Manchester, 7th-10th June 1999, Materials paper 10.

**HIGH TEMPERATURE CURING OF PASSENGER TYRES BY USING 1,3 BIS-(CITRACONIMIDOMETHYL) BENZENE**

Ingham F A A; Datta R N

Flexsys BV

(Crain Communications Ltd.)

The tyre industry is continually striving to improve productivity whilst maintaining a high level of product quality and product performance. Reduced tyre cure time will aid in improving productivity, and one way to achieve this is by increasing cure temperatures. However, the use of higher cure temperatures may give rise to the onset of cure reversion leading to a deterioration of physical properties and, possibly, reduced tyre performance. 1,3 bis-(citraconimidomethyl)benzene (Perkalink 900), an extremely effective anti-reversion agent, maintains the physical properties of vulcanisates that are overcured. Laboratory results obtained in a passenger tread compound are reported that demonstrate the feasibility of improving productivity by increasing cure temperature. 14 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.734471

Item 290

International Rubber Exhibition and Conference 1999. Conference proceedings.

Manchester, 7th-10th June 1999, Materials paper 2.

**IMPROVED RUBBER PROPERTIES BY USING N-T-BUTYL-2-BENZOTHAZOLE SULPHENAMIDE**

de Hoog A J; Datta R N

Flexsys BV

(Crain Communications Ltd.)

TBSI, N-t-butyl-2-benzothiazole-sulphenimide, is a primary amine-based accelerator which is finding a growing market in applications requiring long scorch safety combined with a moderately slow cure rate, providing good properties, including improved heat build up. Recently investigations have been carried out demonstrating the advantages in typical tyre compounds. Physical and dynamic mechanical properties in various compounds are summarised. Attempts are made to correlate these properties with the network structure. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.734465

Item 291

**Rubber and Plastics News**

28, No.17, 22nd March 1999, p.16/9

**ANTI-REVERSION AGENTS WORK TOGETHER**

Kuebler T P

Kumho Tire Co.Inc.

It is explained that if extreme heat builds up in aircraft tyres it can lead to reversion of the compounds and tyre failure. This paper traces the development of work done in which the combination of two anti-reversion agents used in an aircraft carcass compound provided a synergistic improvement in reversion resistance. Materials and methods are detailed, results are presented and discussed, and conclusions drawn.

AMERICAN SOCIETY FOR TESTING & MATERIALS; FLEXSYS

USA

Accession no.733809

Item 292

Shawbury, Rapra Technology, 1996, pp.96. 12 ins. 20/2/96. Rapra Review Rept. No. 87, vol.8, no.3, 1996.

NALOAN

**RUBBER TO METAL BONDING**

Crowther B G

Rapra Technology Ltd.

Edited by: Dolbey R

(Rapra Technology Ltd.)  
Rapra.Review Rept.No.87

Developments in the rubber to metal bonding industry are reviewed and addressed from the standpoint of factory practices. Bonding theory is explained, and methods of bonding rubbers to metals are discussed. Bonding agent systems are examined, with particular reference to waterborne adhesive systems. The production of bonded parts is described and metal pretreatments are included, followed by the manufacture of rubber to metal bonded components by compression moulding and injection moulding. Post vulcanisation bonding is also discussed, and a section is devoted to metal reinforced rubber products and bonding mechanisms in tyre and non-tyre applications. 377 refs. This document is available only by purchase from Rapra Technology.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.733688

Item 293

**Chemical Week**

161, No.17, 5th May 1999, p.27-8

**TYRE TECHNOLOGY TREADS CAREFULLY**

Wood A

It is possible to buy a tyre that rides quietly, has excellent grip, low rolling resistance for increased gas mileage, can run flat, and will last for the life of the car - but not all for the same wheel. The challenge for tyre makers and suppliers is to combine all of these properties into a single tyre that will cost no more than today's best technology. The basics of tyre making have changed little since radial tyres were launched in the 1960s. In a complex, multi-step process, a blend of SBR, polybutadiene and NR, along with additives and carbon black and silica fillers, is formed over a carcass made from high-strength fibres and steel cord. The rubber, however, is the focus of most technology development. The recent developments are outlined.

GOODYEAR TIRE & RUBBER CO.  
USA

Accession no.731791

Item 294

**Tire Technology International**

March 1999, p.55-6

**HOT PROPERTIES**

Schiesser W

Schiesser Rubber Technology

Edited by: Wood P R

Solutions are offered to tyre manufacturers to problems which have existed for many years. Examples are given relating to porosity in thick calendered rubber sheets used in the tyre industry. It is suggested that the problem can be eradicated by feeding the calender using porosity-free compound or by using an extrusion method for calender feeding that will ensure totally porosity-free sheet. A further

example is described where a change in technique or technology can eliminate problems which have existed for many years. This is in the manufacture of steelcord sheet, and concerns the penetration of the cord by the rubber.

SWITZERLAND; WESTERN EUROPE

Accession no.729842

Item 295

**International Polymer Science and Technology**

25, No.7, 1998, p.67-70

**WAYS OF SOLVING THE PROBLEM OF  
NITROSOAMINES IN THE PRODUCTION OF  
TYRES AND MECHANICAL RUBBER GOODS**

Novopol'tseva O M; Novakov I A; Krakshin M A  
Volgograd, State Technical University

The carcinogenicity of nitrosamines, compounds which are formed during vulcanisation by the reaction of amines produced during the thermal decomposition of certain vulcanisation accelerators with nitrosating agents, is discussed. Methods of eliminating conditions where nitrosamines may be formed and enter the human body are considered. Particular attention is paid to the elimination of the possibility of formation of nitrosamines and/or the creation of conditions for reactions of nitrosamines with certain reactants with the formation of non-toxic compounds and to the replacement of vulcanisation accelerators and other rubber mix ingredients that are capable of forming nitrosamines with amine-free compounds or with compounds containing primary amines instead of secondary amines. 30 refs. (Full translation of Kauch.i Rezina, No.2, 1998, p.5)

RUSSIA

Accession no.727056

Item 296

**Tire Science and Technology**

26, No.4, Oct.-Dec.1998, p.258-76

**EFFECT OF COHESION LOSS FACTOR ON  
WET SKID RESISTANCE OF TREAD RUBBER**

Takino H; Isobe N; Tabori H; Kohjiya S  
Toyo Tire & Rubber Co.Ltd.; Kyoto, University

The effect of cohesion loss factor on wet skid resistance was studied in relation to adhesion, hysteresis and cohesion. Two different abrasions, PICO and British Portable Skid Tester (BPST), as the cohesion loss factor were investigated for different polymers, carbon black grades and carbon black/oil loadings. These two abrasion mechanisms were quite different and BPST abrasion was thought to be more suitable as a cohesion loss factor for the BPST (wet skid resistance) and tyre wet traction. From the difference between PICO and BPST abrasions, superior material factors were analysed from the viewpoint of the compatibility of both abrasion life and wet skid resistance of tyres. 32 refs.

JAPAN

Accession no.725238

Item 297

**Tire Science and Technology**

26, No.4, Oct.-Dec.1998, p.241-57

**EFFECTS OF CARBON BLACK AND PROCESS OIL ON VISCOELASTIC PROPERTIES AND TIRE SKID RESISTANCE**

Takino H; Takahashi H; Yamano K; Kohjiya S  
Toyo Tire & Rubber Co.Ltd.; Kyoto,University

Wet skid resistance for rubbers with a wide range of carbon black loadings and process oil loadings was investigated from the viewpoints of viscoelastic properties and abrasion properties. An analysis of wet skid resistance by the factors of T(alpha) (the temps. that are the peaks of tan delta of the rubbers) and British Portable Skid Tester(BPST) abrasion, which was effectively performed on a wide range of polymers in a previous report, gave a poor correlation in this study. In the case of a wide range of carbon black loadings and process oil loadings, the factors of tan delta and BPST abrasion had a good relationship with wet skid resistance. In this study, tan delta at 7C was found to be a suitable factor corresponding to adhesion loss and hysteresis loss in rubber friction. By the evaluation of abrasions, BPST abrasion and PICO abrasion were estimated to be governed by different mechanisms. 15 refs.

JAPAN

Accession no.725237

Item 298

Rubber Bonding Conference. Conference proceedings.  
Frankfurt, 7th-8th Dec.1998, paper 4. 012

**RECENT DEVELOPMENTS IN COBALT ADHESION PROMOTERS**

Fulton W S; Gibbs H W; Hawkins I M; Labarre D  
Rhodia Ltd.; Rhodia Recherches  
(Rapra Technology Ltd.; European Rubber Journal)

Currently accepted bonding mechanisms of rubber to brass-coated steel cord are reviewed along with the effect that ageing has upon the rubber-metal interface. The influence of cobalt on bond strength and particularly on the retention of strength after ageing is also discussed. Recent studies on real and model systems are described, which confirm the key role of cobalt in maintaining the adhesion between NR and brass-coated steel tyre cord. These studies have led to the development of a new range of compounds which show improved adhesion relative to conventional cobalt carboxylates. Results obtained from the new cobalt compounds are presented for comparison. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; UK;  
WESTERN EUROPE

Accession no.725082

Item 299

**Industria della Gomma**

42, No.5, June 1998, p.16-20

Italian

**CONTINUOUS PROCESSING OF HIGH VISCOSITY COMPOUNDS**

Pomini L  
Pomini SpA

The structure and mode of operation of the LCM long continuous mixer developed by Pomini for rubber mixing are described, and applications in the formulation of low viscosity cable compounds and high viscosity tyre tread compounds are examined. A new rotor design combining both tangential and intermeshing geometry and its advantages in the processing of high viscosity formulations are discussed.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

Accession no.721791

Item 300

**Indian Rubber Journal**

No.38, Jan./Feb.1999, p.108-12

**UPGRADING TECHNICAL GOODS USING EUROPRENE NEOCIS**

Busetti S; Mistrali F  
EniChem Elastomeri

EniChem neodymium polybutadiene (Europrene NEOCIS BR40) is compared with high-cis polybutadienes manufactured using titanium and cobalt Ziegler-Natta catalyst. Physicochemical properties are tabulated. The main application for polybutadiene is tyre manufacture. Blends of polybutadiene, NR and SBR are used in tyre tread, sidewall, carcass and abrasion strip, both for bus and passenger tyres. It is also used in camelback compounds for retreading. Relationships between polymer structure and properties, and applications in solid tyres, shoe soles, and golf ball cores are described. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

Accession no.721422

Item 301

**Design Engineering**

March 1999, p.53

**STRONGER, LONGER LASTING TYRES**

Tyres equipped with a new kind of steel cord have been developed by Pirelli, Rhone Poulenc Chemie and partners in a Brite-Euram project. The focus of the project was on a critical characteristic of the steel cord, its adhesion to the vulcanised rubber of the tyre tread. Wire-rubber adhesion technology based on a coating consisting of zinc cobalt improved both adhesion and corrosion resistance properties.

PIRELLI SPA  
EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

Accession no.718652

Item 302

*Journal of Applied Polymer Science*  
71, No. 7, 14th Feb. 1999, p.1197-202

**STUDIES ON RUBBER-TO-NYLON TYRE CORD BONDING**

Job L; Joseph R  
Cochin, University of Science & Technology

Nylon tyre cord (1680/2) was dipped in different adhesives based on resorcinol formaldehyde resin and latex (RFL) and was bonded to NR-based compounds. The resin-rubber ratio in the RFL adhesive was optimised. The variation of pull-through load was studied by varying the drying and curing temperature of the dipped nylon tyre cord. RFL adhesive based on vinylpyridine latex was found to have better rubber-to-nylon tyre cord bonding, compared with one based on NR latex. Addition of a formaldehyde donor (hexamethylenetetramine or paraformaldehyde) into the RFL adhesive/rubber compound improved adhesion. 15 refs.

INDIA

Accession no.718469

Item 303

*Nippon Gomu Kyokaishi*  
71, No.6, 1998, p.315-23

Japanese  
**SOLUTION-POLYMERISED STYRENE-BUTADIENE RUBBER**

Saito A  
Asahi Kasei KK

The compounding of solution SBR with carbon black and silica fillers is discussed, and some examples of improvements in mechanical properties of tyre tread compounds by means of tin-based coupling agents are shown. 19 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN

Accession no.716694

Item 304

*Luntai Gongye*  
19, No.1, 1999, p.17-8

Chinese  
**APPLICATION OF BR TO TYRE TUBE COMPOUND**

Lu Yucui  
CHINA

Accession no.716379

Item 305

*Luntai Gongye*  
19, No.1, 1999, p.14-6

Chinese  
**EXPERIMENTAL STUDY ON NDBR PROPERTIES**

Yang Shutian  
Liaoning Tire Group Co.Ltd.

The properties of raw NdBR and its compound were studied by use of conventional NiBR as control. The results obtained showed that the molec.wt. of NdBR was significantly higher than that of NiBR and that the thermooxidative stability of NdBR compound was better than that of NiBR compound. The processability of the tread compound with 50 parts of NdBR-3 was poorer than that of the equivalent NiBR tread compound, but it could reach or exceed that of the latter by adjusting the processing conditions. The wear resistance, fatigue properties, flex cracking resistance and hot air ageing properties of NdBR vulcanisate were better than those of NiBR vulcanisate. The wear resistance of 9.00-20 test tyre made with NdBR was 16.9% higher than that of NiBR control tyre. 3 refs.

CHINA

Accession no.716378

Item 306

*Luntai Gongye*  
19, No.1, 1999, p.9-13

Chinese  
**PROCESSABILITY AND PHYSICAL PROPERTIES OF TRANS-1,4-POLYISOPRENE-CONTAINING TYRE COMPOUND**

Song Jingshe; Fan Ruliang; Huang Baoshen; Feng Min; Tian Bin; Wang Mingdong  
Qingdao, Institute of Chemical Technology;  
Beijing, Research & Design Inst. of Rubber Ind.

trans-1,4-Polyisoprene(TPI)-containing tread and sidewall compounds were tested. The results obtained showed that the TPI-containing compound featured good banding characteristics and capillary rheology and the extended curing induction period and scorch time which were beneficial to safe processing. From the viewpoint of processability, it was practical to use a small amount (20 parts) of TPI instead of NR for preparing tread and sidewall compounds without changing existing tyre manufacturing equipment, technology and formula. The TPI-containing compound possessed higher modulus, lower rolling resistance and compression heat-build-up, better fatigue properties and higher wear resistance and friction coefficient both on dry and wet roads when compared with the conventional compound. 3 refs.

CHINA

Accession no.716377

Item 307

*Journal of Adhesion Science and Technology*  
13, No.2, 1999, p.153-68

**ENHANCING ADHESION PROPERTIES BETWEEN RUBBER COMPOUND AND BRASS-PLATED STEEL CORD BY INCORPORATING SILICA INTO RUBBER**

Jeon G S; Han M H; Seo G  
Damyang, Provincial College; Kumho Tire Co.Ltd.;  
Chonnam, National University

The effect of adding silica to NR and BR compounds on their adhesion to brass-plated steel cord was investigated. The mechanism describing how silica loading influences adhesion stability under various ageing treatments was also studied. 19 refs.

KOREA

Accession no.716180

Item 308

**International Polymer Processing**

13, No.4, Dec.1998, p.358-64

**UTILISATION OF RECYCLED CRUMB RUBBER AS A COMPOUNDING TOOL**

Kim J K

Gyeongsang, National University

The disposal of used car tyres has become a major environmental problem, and although there are obvious environmental reasons for recycling waste tyres, to date it has not taken place because it is not cost-effective. An attempt is made to find a more effective method of recycling. This is done by comparing the methods of using vulcanised crumb rubber as a filler, and investigation of the effect of surface treatment with microscopic examination of the fracture morphology of the filled crumb rubber elastomers. The experimental results indicate that crumb rubber filled end-product properties are enhanced by the chlorination of crumb rubber, and by developing a crumb rubber incorporation method. It is found that much improvement of the mechanical performance of the crumb rubber filled elastomer compounds can be achieved by developing a better crumb rubber incorporation technique. 15 refs.

KOREA

Accession no.714125

Item 309

**Rubber Chemistry and Technology**

71, No.3, July/Aug.1998, p.590-618

**TIRE BLACK SIDEWALL SURFACE DISCOLORATION AND NON-STAINING TECHNOLOGY: A REVIEW**

Waddell W H

Exxon Chemical Co.

A review is presented of the literature describing the surface discolouration problem of tyre black sidewalls and approaches to the formulation of a black sidewall compound to eliminate this surface discolouration upon exposure to ozone. Methods include use of non-staining antiozonants and use of elastomers with saturated backbones such as EPDM, halobutyl rubbers and brominated isobutylene-co-para-methylstyrene. 67 refs.

USA

Accession no.713768

Item 310

**Rubber Chemistry and Technology**

71, No.3, July/Aug.1998, p.323-41

**BLACK AND WHITE FILLERS AND TIRE COMPOUND**

Donnet J B

Haute-Alsace, Universite

The present state of the understanding of the role of fillers in elastomeric compounds, particularly in tyre compounds, is reviewed and discussed. Unpublished results from the author's laboratory are also presented, with particular reference to observations of silica by atomic force microscopy and scanning probe microscopy and to TEM studies of furnace black and its formation mechanism. 100 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
WESTERN EUROPE

Accession no.713763

Item 311

**Gummi Fasern Kunststoffe**

50, No.10, 1997, p.782-8

German

**PROCESSING ADDITIVES IN THE PROCESSING OF "GREEN TYRE" TREAD MIXES**

Hensel M; Menting K-H; Umland H

Schill & Seilacher GmbH

The authors show how the use of special processing aids, i.e. Struktol EF 44, a modified zinc soap acting as dispersion agent and lubricant; Struktol DT 95, containing a special hydrocarbon resin, which acts as a dispersion agent and homogeniser; Struktol Aktivator 73 A, a mixture of zinc soaps of aromatic and aliphatic fatty acids, acting as a crosslinking agent and lubricant; Struktol VP 1215, similar to Struktol Aktivator 73 A; and Exp 1 and Exp 2, homogenisers which improve the compatibility of the two elastomers, can improve the processing properties and final mechanical properties of vulcanised tyres based on silica-filled tread compounds of solution SBR and BR or NR. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.713667

Item 312

**European Rubber Journal**

181, No.1, Jan.1999, p.22-3

**POK: AN OPPORTUNITY IN INDUSTRIAL FIBRES FOR THE 21ST CENTURY**

Van Miltenburg J G M

Akzo Nobel has been testing and developing polyketone as a promising tyre cord fibre. In the search for new materials, fibre-makers aim for low-cost, high strength,

thermal stability, low creep, - and easy, cheap processing. New polyketone fibres currently fulfil all these criteria bar the processing. Akzo Nobel has been working hard on this aspect and hopes to launch the new polyketone fibre as a tyre cord material replacing the more traditional fibres. This comprehensive article supplies a detailed assessment of the properties and advantages of this engineering plastic in tyre cord applications.

AKZO NOBEL BV  
EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE  
*Accession no.712076*

*Item 313*

***Tire Technology International***

Sept.1998, p.7

**BORN GRIPPY**

This article highlights the incorporation of several new technologies into the product range of tyres manufactured by Bridgestone/Firestone, in an attempt to overcome the problems associated with wear. Brief details are provided of EPC (Extended Performance Compound), and Dual Layer Tread (a higher grip tread underneath standard spec rubber).

BRIDGESTONE/FIRESTONE  
USA  
*Accession no.711338*

*Item 314*

***Tire Technology International***

Sept.1998, p.7

**CORN TIRE FILLER**

It is announced in this article that Goodyear is the first tyre manufacturer to take advantage of the reinforcing capabilities of an engineered biopolymeric filler derived from corn starch. Starch represents an ecological alternative to silica or carbon black. Full details are given.

GOODYEAR  
EUROPEAN COMMUNITY; EUROPEAN UNION;  
LUXEMBOURG; WESTERN EUROPE  
*Accession no.711337*

*Item 315*

***Angewandte Makromolekulare Chemie***

Vol.261/262, Dec.1998, p.123-33

**USE OF NMR RELAXATION AND NMR IMAGING IN STUDYING THE AGEING OF RUBBER**

Knorgen M; Heuert U; Menge H; Schneider H  
Halle, Martin-Luther-Universität

NMR was used to study the ageing of rubber filler materials. The methods used are spin-echo hydrogen ion NMR including variable echo times and parameter-selective NMR hydrogen ion imaging (materials properties imaging). The decay of the echo-magnetisation

is discussed on the basis of a single chain model with a distribution of dipolar interactions. This model is based on the influence of a very fast but anisotropic local motion as well as larger and slower motions, which are liable to diminish the residual dipolar interaction. Carbon black filled NR as well as silica and carbon black filled emulsion- and solution-SBR and milled tyre rubber are the systems under investigation showing some characteristic features of the ageing course observable by NMR. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE  
*Accession no.711102*

*Item 316*

IRC '98. Conference Proceedings.  
Paris, 12th-14th May 1998, p.99-100. 012  
French

**REINFORCEMENT OF ELASTOMERS WITH PRECIPITATED SILICA**

Bomal Y; Ladouce L; Labarre D; Cochet P  
Rhodia Recherches; Rhodia Chimie  
(AFICEP; Societe de Chimie Industrielle)

Processes used in preparing precipitated silica fillers are described, and an examination is made of the performance in tyre compounds of Z1165 MP, a high dispersibility silica developed by Rhodia. The influence of coupling agents and filler dispersibility on the mechanical properties of vulcanisates is discussed, and comparisons are made between silica and carbon black. 9 refs.

RHODIA SA  
EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
WESTERN EUROPE  
*Accession no.710608*

*Item 317*

***Nippon Gomu Kyokaishi***

70, No.1, 1997, p.50-6

Japanese

**ADHESION BETWEEN NATURAL RUBBER AND NICKEL-PLATED STEEL CORD DURING VULCANISATION**

Hachisuka S; Takahashi O; Mori K; Hirahara H; Oishi Y  
Tokyo Sekiyo Co.Ltd; Iwate, University

Direct adhesion between natural rubber and nickel-plated steel cords during vulcanisation was investigated with a view to developing new types of steel cord for tyres. Poor adhesion was found with NR compounds containing sulphur and sulphenamide type accelerators, and good adhesion was found when the cords were treated with monosodium salt of triazine trithiol. 10 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN  
*Accession no.710061*

*Item 318*

Second International Conference on Carbon Black.  
Conference proceedings.

Mulhouse, 27th-30th Sept. 1993, p.373-4. 51B

**CARBON BLACK-ELASTOMER INTERACTION  
MODELLING**

Tokita N; Shieh C-H; Ouyang G B

Cabot Corp.

(Societe Francaise de Chimie; CNRS; Haute-  
Alsace, Universite; Societe Industrielle de Mulhouse;  
Ecole Nationale Superieure de Chimie de Mulhouse)

The simultaneous improvement of abrasion resistance, reduction of hysteresis and increase in wet/dry traction performance have been requested consistently in tread compound development. As far as the contribution of carbon black to these performance properties is concerned, the reinforcing characteristics such as abrasion cut/chip/tear and fatigue resistance are the most important roles of carbon black for the tread compounds. The subjects of hysteresis loss and friction should be examined under an umbrella of reinforcement satisfaction. It is well known that there exists an optimum loading of each carbon black grade for any failure property. Extended abstract only.

USA

*Accession no. 709145*

*Item 319*

Slovak Rubber Conference '97. Conference  
proceedings.

Puchov, 20th-21st May 1996, p.217-28. 4

Slovak

**LOW SURFACE AREA BLACKS FOR LOWER  
AIR PERMEABILITY AND GREATER HEAT  
CONDUCTION**

Kliment J; Novakocki D

Cabot Corp.

(Matador AS)

Cabot has developed and patented a highly modified furnace black process, which allows the manufacture of products of much lower surface area and structure than existing furnace black. This new carbon black, Regal 85, can be used at much higher loading than that of N 772/N 660 at their usual 50-60 phr loadings. This then gives the compounder a number of interesting choices: improvement of permeability of inner liner by 30-50%, thus improving tyre performance; reduction of the inner liner gauge, thus maintaining the overall permeability inner liner/tyre while enjoying cost savings; replacement of a small amount of the expensive halobutyl polymer with NR, gaining processing benefits and a small material cost reduction; better flex life; and 20% better thermal conductivity. This all makes this black highly effective in inner liners, inner tubes and curing bladder applications.

CZECH REPUBLIC

*Accession no. 708399*

*Item 320*

Slovak Rubber Conference '97. Conference  
proceedings.

Puchov, 20th-21st May 1996, p.210-6. 4

**PERKASIL KS 409 - AN EASY PROCESSING  
SILICA**

Hovius H W; Leo N

Flexsys BV

(Matador AS)

To facilitate the mixing of highly filled silica compounds, processing aids are used. Numerous processing aids are commercially available. An attempt is made to find a relationship between the structure and the performance of processing aids. An optimal molecular structure is found comprising a polar head and an apolar tail. One such processing aid selected for further study is found to be more effective when coated on silica, before addition to the rubber mix, compared to separate addition to the rubber compound. An optimum dosage level of 2 wt.% on silica is established.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

*Accession no. 708398*

*Item 321*

Slovak Rubber Conference '97. Conference  
proceedings.

Puchov, 20th-21st May 1996, p.117-24. 4

**THE ROLE OF ANTI-TACKS IN THE TYRE AND  
RUBBER COMPOUNDING INDUSTRIES**

Reid J; Fowles P J

Stephenson Group

(Matador AS)

Anti-tack agents perform a crucial role in the processing of uncured rubber compounds and to prevent stacked sheets, strips, pellets and calendered sheets from adhering to each other in storage. The role of anti-tacks is described, examining the historical perspective and the development and application of the three types of anti-tack agents available today - liquids, dispersants and powders.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

*Accession no. 708388*

*Item 322*

Slovak Rubber Conference '97. Conference  
proceedings.

Puchov, 20th-21st May 1996, p.96-107. 4

**REINFORCING RESINS IN A HARD, LOW  
ROLLING RESISTANCE SUBTREAD  
FORMULATION**

Morel-Fourrier C; Souchet J-C

CECA

(Matador AS)

Reinforcing phenol formaldehyde-novolac can be used in rubber compounds to increase compound hardness

without the undesired effects of levels and short scorch times usually associated with high hardness compounds. The phenolic-novolac reinforcing resins can be used in various tyre components including bead area compounds, sidewalls, tread and sub-tread compounds. The tread area (sub-tread/base and tread cap) of a typical passenger car tyre contributes about 65% of the total tyre compound hysteresis. It follows then that a reduction in either the tread cap compound or the sub-tread compound would reduce the overall tyre rolling resistance. A high hardness low hysteresis sub-tread compound can be an advantage in low rolling resistance car tyres in two different ways: the high hardness contributes to better cornering stability and hence better tyre handling, while the low hysteresis gives low tyre rolling resistance. A high performance, low rolling resistance, hard sub-tread with various phenolic reinforcing resin is examined, compares properties with the following types of car tyre sub-treads: standard soft sub-tread, low rolling resistance sub-tread, hard high performance sub-tread and a hard high performance sub-tread with styrene resin.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
WESTERN EUROPE

Accession no. 708386

#### Item 323

Slovak Rubber Conference '97. Conference proceedings.

Puchov, 20th-21st May 1996, p.92-5. 4

#### **PROBLEM SOLVING WITH PROCESSING PROMOTERS FOR SILICA AND CARBON BLACK COMPOUNDS - AKTIPLAST ST**

Schulz H

Rhein Chemie GmbH

(Matador AS)

The use of silica as a reinforcing filler in tyre tread compounds has been adopted by all major tyre manufacturers. The advantages of silica/solution SBR over standard carbon black/emulsion SBR are too good to miss. However, the processing of silica compounds and the production of silica tyres is still a tremendous challenge for the tyre industry. Rhein Chemie has been improving processing problems of silica compounds from the very beginning. Its new processing promoter Aktiplast ST dramatically increases the flow properties of silica-containing compounds, supports the dispersion of silica in the polymer, prolongs the time to scorch and improves wet traction without negative influence on rolling resistance. Examples of the potential of Aktiplast ST are presented. Its use with a solution SBR/emulsion SBR/BR compound with a mixture of silica and carbon black, and a solution SBR/BR blend with only silica as reinforcing filler, is described. Finally the influence of processing promoters on a standard carbon black/NR compound is described.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no. 708385

#### Item 324

IRC '98. Conference proceedings.

Paris, 12th-14th May 1998, p.107-12. 012

#### **DYNAMIC STUDIES OF COMPOUNDS - LATEST RESULTS**

Gerspacher M; O'Farrell C P

Richardson S., Carbon Co.

(AFICEP; Societe de Chimie Industrielle)

Today tyres are required to have many qualities, i.e. good tread wear, low rolling resistance and superior traction, to mention only the most stringent requirements. These three properties are sometimes assigned to a so-called magic triangle, referring to the concept that if one improves one of these parameters, the others worsen. By studying tyre compound dynamic properties, it is shown that this 'magic' may be overcome. 13 refs.

USA

Accession no. 706202

#### Item 325

IRC '98. Conference proceedings.

Paris, 12th-14th May 1998, p.87-8. 012

#### **XPS AND XRD STUDY OF PHENOMENA AT RUBBER-STEEL CORD INTERFACE UNDER DIFFERENT AGEING CONDITIONS**

Dujko E; Cerelast S C

Bucharest, Research Institute for Rubber Processing

(AFICEP; Societe de Chimie Industrielle)

It has been shown that chemical and crystallographic structure of rubber-brass plated cord interface is critical for adhesion strength. The analysis of the compounds formed at interface during vulcanisation and of the structure modification during post-vulcanisation under degradation conditions could offer interesting and useful information about the rubber compounds and cord parameters. Surface and interface analytical techniques are developed for the study of composite structure of rubber-cord layer and to establish possible correlations between certain diffusion phenomena to interface of the adhesion bonds-determining elements, adhesion strength, bonding resistance under degradation conditions. Two rubber compounds typically for bonding to brass-plated cord are studied with different adhesive systems.

EASTERN EUROPE; ROMANIA

Accession no. 706197

#### Item 326

IRC '98. Conference proceedings.

Paris, 12th-14th May 1998, p.397-8. 012

#### **APPLICATION OF THE SUPERPOSITION PRINCIPLE TO FILLED ELASTOMERS**

Schramm J; Alshuth T; Schuster R H

Deutsches Institut fuer Kautschuktechnologie eV

(AFICEP; Societe de Chimie Industrielle)

The time-temperature and frequency-temperature superposition principle and the Williams-Landel-Ferry

(WLF) equation have been known for some years. They are successfully used in research on polymer rheology as well as on viscoelasticity of elastomers. Furthermore, attempts have been made to apply the superposition principle and the WLF equation for predictions of certain mechanical properties of elastomers under service conditions. Examples are long-term predictions of stress relaxation of sealing materials by means of short-term data at elevated temperatures and predictions of wet skid resistance of tyre tread materials on the basis of dynamic mechanical properties at low temperature. Some of these predictions are reported to be of limited accuracy which has led, besides theoretical considerations, to a general discussion whether the WLF concept can be applied to filled elastomers. Recent systematic investigations on filled elastomers have shown that the usual horizontal  $aT$  shifts and additional vertical shifts  $f_v$  result in a good superposition of viscoelastic properties and reasonable master curves. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.706022

*Item 327*

IRC '98. Conference proceedings.

Paris, 12th-14th May 1998, p.333-4. 012

**ADVANTAGES OF DITHIOPHOSPHATES IN THICK SECTION ARTICLES AND DYNAMICALLY HIGH LOADED PARTS**

Fruh T; Schulz H

Rhein Chemie Rheinau GmbH

(AFICEP; Societe de Chimie Industrielle)

Cure systems based on dithiophosphates offer a variety of advantages to the user. Due to their chemical structure, dithiophosphates cannot generate N-nitrosamines. Furthermore, they give superior vulcanisate properties compared to traditional curing systems. In NR or blends with NR they lead to extraordinary reversion stability. The unique network structure leads to very good dynamic properties and a low heat build-up. These properties make dithiophosphates in general ideal candidates for thick section articles and dynamically high loaded parts. This is true for tyres as well as technical rubber goods. Examples for important applications are presented. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.706000

*Item 328*

IRC '98. Conference proceedings.

Paris, 12th-14th May 1998, p.263. 012

**USAGE OF BIOPOLYMERIC FILLERS IN TYRE FORMULATION**

Corvasce F

Goodyear Technical Center

(AFICEP; Societe de Chimie Industrielle)

The ecological aspect of a tyre has become one of the major challenges of the nineties. Reduction in tyre rolling

resistance, weight and noise have already contributed to reduce energy consumption, vehicle exhaust pipe emissions and environmental nuisance. Another important aspect is also the usage of raw materials obtained from natural renewable sources as replacement of existing petrochemical-based materials. Goodyear innovates in taking advantage of the reinforcing capabilities of biopolymeric fillers produced from a renewable agricultural based material 'starch'. Goodyear has developed a super low hysteresis, low weight tread by introducing such a type of filler, into a tread compound formulation. Extended abstract only.

EUROPEAN COMMUNITY; EUROPEAN UNION; LUXEMBOURG; WESTERN EUROPE

Accession no.705990

*Item 329*

**Kautchuk und Gummi Kunststoffe**

51, No.11, Nov.1998, p.797-802

**ANTIOZONANT EFFECT OF PARAFFIN WAXES BASED ON THEIR HYDROCARBON CHARACTERISTICS**

Pysklo L; Glijer T; Parys T

The properties of ten wax compositions recommended for rubber goods, especially for tyres, are evaluated. Routine test methods and high temperature GC and DSC are applied. A typical NR/SBR rubber compound and two tyre sidewall compounds are used. Ozone accelerated tests are carried out in an ozone chamber and a refrigerator equipped with an ozone generator at temperatures of 40 and 0 deg.C. The antiozonant effect of waxes is related to their chemical structure, e.g. carbon number distribution of normal and branched paraffins. The most effective wax compositions at high and low temperature are selected. 6 refs.

EASTERN EUROPE; POLAND

Accession no.705822

*Item 330*

**Tire Science and Technology**

26, No.3, July-Sept.1998, p.132-48

**MATERIAL MODEL FOR SIMULATION OF THE HYSTERETIC BEHAVIOUR OF FILLED RUBBER FOR ROLLING TYRES**

Becker A; Dorsch V; Kaliske M; Rothert H

Continental AG; Hannover,Universitat

The hysteretic behaviour of tyre rubber compounds is investigated by tension/compression tests at different strains and strain rates, dynamic tests with varying frequencies and amplitudes, and tests with small cycle loading and unloading. According to these effects, a material model is developed that considers the complex frequency dependent (viscoelastic) as well as the rate independent (elastoplastic) inelastic behaviour of filled rubber. This model combines different rheological elements representing viscous and plastic effects. The

approach is valid for large strains. The hysteretic model is implemented in an in-house FE code to analyse tyre behaviour assuming a constant driving velocity. The numerical algorithm is robust and shows excellent convergence, making it suitable even for large tyre models. In computations for rolling tyres, the consideration of the hysteresis yields a direct calculation of rolling resistance and energy dissipation, thus the new material law should prove useful in simulations of wear and durability. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.705727

*Item 331*

**European Rubber Journal**

180, No.12, Dec.1998, p.24-6

**RPA FOR EFFICIENT SENSITIVE TESTS**

Stevens C; Burhin H  
Alpha Technologies

The versatile Rubber Process Analyser developed by Alpha Technologies can be used to test for raw polymer uniformity, mix rheology and cure characteristics, and vulcanisate properties. The automated RPA is an oscillating dynamic mechanical rheometer that can obtain viscoelastic properties at different shear rates, at different temperatures and also during stress relaxation, as a function of applied strain.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.705138

*Item 332*

**European Rubber Journal**

180, No.12, Dec.1998, p.20-1

**REPEATABLE TESTS GETTING CLOSER**

White L

Variability has been a continuing difficulty in rubber testing over the years. Current developments in automation and in software for machine control and data acquisition are improving test repeatability. Alpha Technologies has launched an automated handler for its Rubber Process Analyser. Wide area networking and low-cost software versions for small users are current and continuing areas of effort for Eclipse Technical Software Services.

WESTERN EUROPE-GENERAL

Accession no.705136

*Item 333*

**Nippon Gomu Kyokaishi**

68, No.7, 1995, p.497-505

Japanese

**STUDIES OF RUBBER ABRASION: LAMBOURN ABRASION AND THE PHYSICAL PROPERTIES OF RUBBER**

Mitsuhashi K; Kaidou H; Shinohara A  
Yokohama Rubber KK

To evaluate the abrasion of a tyre, the authors investigated which properties of the rubber compound would correlate with the abrasion in a Lambourn abrasion test. Abrasion tests of the rubber compound containing SBR, carbon black and oil in different ratios were carried out in the temperature range -5 to 70C. 9 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN

Accession no.704951

*Item 334*

**Gummi Fasern Kunststoffe**

48, No.6, June 1995, p.379-86

German

**SHORT FIBRE REINFORCEMENT OF ELASTOMERS**

van der Pol J F; de Vos L J  
Akzo Fibre Group/Aramide Mij

The authors give an overview of the advantages and consequences of reinforcing rubber compounds with Twaron p-aramid fibrillated short fibres and with p-aramid adhesive-activated chopped fibres. The type of adhesion of the former is mechanical in nature, whereas that of the latter is physico-chemical. Advantages, particularly in physical and mechanical properties, of these types of products in applications such as drive-belts, low-pressure hoses, high-pressure hoses, tyres and seals are discussed. 1 ref. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; NETHERLANDS; WESTERN EUROPE

Accession no.704131

*Item 335*

**Gummibereifung**

73, No.4, April 1997, p.116

German

**REVOLUTIONARY SYSTEM REPLACES SPARE WHEEL**

Mutz K

With the new BMW M-Roadster a vehicle rolls along the road, but consequently can do without a spare tyre and has on board as standard in place of it a revolutionary tyre sealing system. The system, which was developed by SP Reifenwerke and called the Instant Mobility System (IMS), is well suited to the claims made for the M-Roadster. It consists of a bottle which is filled with a newly developed, non-toxic, safe and environmentally friendly latex-based sealing compound. It is also fitted with a 12-volt electronic compressor. These are assembled in a box. Also analysed along with this new invention are statistics

covering the number of incidents of flat tyres in Western Europe and the associated problems which IMS will help to solve.

BMW; BMW-M-GMBH; DUNLOP; SP  
REIFENWERKE GMBH  
WESTERN EUROPE

Accession no.702837

*Item 336*

154th ACS Rubber Division Meeting - Fall 1998.  
Conference preprints.  
Nashville, Tn., 29th Sept.-2nd Oct.1998, paper 49. 012  
**EFFECTS OF BROMINATED ISOBUTYLENE-  
CO-PARA-METHYLSTYRENE STRUCTURE ON  
THE PROPERTIES OF A TYRE BLACK  
SIDEWALL COMPOUND**  
Waddell W H; Chung D Y; Solis S C  
Exxon Chemical Co.  
(ACS,Rubber Div.)

The effects that bromine functionality and paramethyl styrene comonomer content of brominated isobutylene-co-para-methylstyrene (BIMS) elastomers have on the performance of a non-staining passenger tyre black sidewall formulation are studied. BIMS polymers are synthesised to afford a statistical design constituting three levels of each of the two variables. Each BIMS elastomer is compounded with cis-polybutadiene (50:50), N660 carbon black, processing aids and curatives to afford the same model black sidewall compound. Compound cure and cured physical, ageing and dynamic properties are measured. Regression analyses are used to identify the relationships between compound performance and the bromine and paramethyl styrene structural changes designed into the BIMS elastomers. Statistically significant results are obtained, allowing selection of a BIMS elastomer to impact the relevant properties of a non-staining passenger tyre black sidewall. 14 refs.

USA

Accession no.701885

*Item 337*

154th ACS Rubber Division Meeting - Fall 1998.  
Conference preprints.  
Nashville, Tn., 29th Sept.-2nd Oct.1998, paper 28. 012  
**NANO-STRUCTURE BLACKS - A NEW CARBON  
BLACK FAMILY DESIGNED TO MEET TRUCK  
TYRE PERFORMANCE DEMANDS**  
Niedermeier W; Freund B  
Degussa AG  
(ACS,Rubber Div.)

Nano-structure blacks are a new carbon black family produced by physical surface modification in a furnace reactor. Various grades with altered specific surface areas and structure levels are now available. Main characteristic of these novel blacks is an unusually rough surface which leads to enhanced interaction forces with rubber polymers.

Due to a narrow aggregate size distribution with limited amounts of large aggregates not only hysteresis but also tread wear is improved compared to conventional blacks. This makes nano-structure blacks particularly suitable for use in truck tyre applications. 19 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.701865

*Item 338*

154th ACS Rubber Division Meeting - Fall 1998.  
Conference preprints.  
Nashville, Tn., 29th Sept.-2nd Oct.1998, paper 19. 012  
**NEW INSIGHTS INTO THE MIXING PROCESS**  
Stone C R; Menting K H; Hensel M  
Flow Polymers Inc.; Schill & Seilacher GmbH & Co.  
(ACS,Rubber Div.)

Some compounding ingredients tend to be included out of habit. Stearic acid is such an ingredient. Little is published and it is suspected that little is known about the influence of stearic acid on the mixing process. Whilst developing mixing cycles to achieve the maximum benefit from process aids for silica filled SBR/BR blend passenger tread compounds, the surprisingly critical function played by stearic acid is discovered. A study of the mixing energy versus time graphs and the relationship between total mix energy and dump temperature of fixed time mix cycles clearly shows the critical nature of the influence of stearic acid. An aliphatic zinc soap used in place of stearic acid is found to improve filler dispersion and the processing properties of the compound, while having little or no adverse effects on the physical properties. Rapid viscoelastic testing is carried out using an RPA machine from Alpha Technologies. The techniques developed by Coran and Donnet are also applied. The data generated gives extra information regarding the filler dispersion and rheological properties of the compounds. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.701857

*Item 339*

154th ACS Rubber Division Meeting - Fall 1998.  
Conference preprints.  
Nashville, Tn., 29th Sept.-2nd Oct.1998, paper 17. 012  
**USE OF TWO ANTI-REVERSION AGENTS TO  
GREATLY ENHANCE COMPOUND REVERSION  
RESISTANCE**  
Kuebler T P  
Kumho Technical Center  
(ACS,Rubber Div.)

Aircraft tyres can endure severe service which builds up extreme heat causing reversion of the compounds leading to possible tyre failure. Development of high reversion resistant aircraft compounds is an important goal. Details are given of the development work carried out in which

the combination of two anti-reversion agents - 1,3-bis(citraconimidomethyl benzene (BCI-MX), Perkalink 900, and a mixture of zinc salts of one or more C8-C10 aliphatic carboxylic acids, Activator 73 - used in an aircraft carcass compound provide a synergistic improvement in reversion resistance. Data are presented which show the reversion resistance improvement with each of the two subject chemicals separately and together, the work done to arrive at the most effective concentration levels, and other changes made to maintain physical properties. Reversion resistance is measured using the BFG Flexometer operated under blowout conditions as described in ASTM D623 and the Oscillating Disk Rheometer. As a result, US Patent 5,623,007 is granted on April 22, 1997.

USA

Accession no.701855

*Item 340*

154th ACS Rubber Division Meeting - Fall 1998. Conference preprints. Nashville, Tn., 29th Sept.-2nd Oct.1998, paper 15. 012  
**COMPARISON BETWEEN SILICA AND CARBON BLACK LOADED COMPOUNDS AS A TYRE TREAD IN TERMS OF TIME-TEMPERATURE SUPERPOSITION OF LOSS TANGENT**

Kobayashi N; Furuta I; Akema H; Isono Y  
JSR Corp.; Nagaoka, Technological University (ACS, Rubber Div.)

Shear storage modulus (G) and loss tangent (tan delta) are carefully measured at low strain amplitude over a wide range of frequency and temperature on SBR vulcanisates filled with carbon black and silica where filler content, oil content and microstructure of SBR vary. The data are shifted along the frequency scale. The data points of the individual tan delta curve are found to be able to overlap with the adjacent curves, resulting in a single composite master curve for all the samples studied. Same set of shift factors obtained from tan delta can be used to construct G' master curves. It is found that all the data of shift factor, aT, make a single WLF curve irrespective of the differences in filler, loading content of filler/oil and microstructure of SBR, if the reference temperatures are chosen at the respective temperature where tan delta of the individual sample show peak value. The results may suggest the laboratory indices customarily used for rolling resistance and wet skid resistance of a carbon black filled SBR vulcanisate could be applicable to those of a silica filled one. 10 refs.

JAPAN

Accession no.701854

*Item 341*

ITEC '96 Select. Conference proceedings. Akron, Oh., 1996, p.237-241. 6T  
**OPTIMIZED SILICA MIXING SEQUENCE AIDS PASSENGER TREAD PROPERTIES**

Patkar S D; Evans L R; Waddell W H  
PPG Industries Inc.  
(Rubber & Plastics News)

An optimised mixing sequence is proposed for an all-silica model passenger tyre tread compound, along with a discussion on the effects of the silanisation/coupling reactions. It is shown that for an all-silica compound, the addition of silica and coupling agent in the first and second pass, respectively, along with a higher cure temperature, improves the physical and dynamic properties relevant to a passenger tread. The challenge of obtaining a low rolling resistance and high wet traction compound with minimal compromise in treadwear has been addressed by emerging silica/coupling agent technology, leading to the development of a new generation of precipitated silicas, having a more uniform and narrow pore size distribution. The silica used in this evaluation is PPG's Hi-Sil 2,000 11 refs.

USA

Accession no.701560

*Item 342*

ITEC '96 Select. Conference proceedings. Akron, Oh., 1996, p.144-153. 6T  
**ANTIDEGRADANTS CAN HELP IMPROVE TIRE PERFORMANCES, IF USED RIGHT**  
Hong S W; Mazzeo R A  
Uniroyal Chemical Co.Inc.  
(Rubber & Plastics News)

The use of antidegradants in tyre rubber formulations is discussed. The mechanism for antioxidants and antiozonants is explained, and their function in extending the life of tyres is described. Internal components such as carcass, apex, liner, breaker, cushion, base tread, and bead compounds are protected by antioxidants, and external tyre components such as sidewall, rim flange/chafer, toe strip and tread which are exposed to oxygen, sunlight and ozone, are protected by chemical antiozonants and wax. Details are given of the various types of antiozonants and antioxidants, and their use in each of the tyre components mentioned is examined, together with an explanation of the antidegradant mechanism to provide this protection. 7 refs.

USA

Accession no.701545

*Item 343*

ITEC '96 Select. Conference proceedings. Akron, Oh., 1996, p.137-143. 6T  
**VESTENAMER OFTEN HELPFUL TO OFFSET POOR PROCESSABILITY, SHRINKAGE**  
Diedrich K M  
Huels AG  
(Rubber & Plastics News)

Results are presented which serve to illustrate the ways in which Vestenamer trans-polyoctenamers can improve

the manufacturing and properties of certain tyre compounds which are often difficult to process. These improvements are described, and are based on the dual character of Vestenamer as a polymer and a processing aid. Details are given of its unique four structural features; double bond strength, crystallinity, low viscosity above the melting point, and a high proportion of macromolecules. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.701544

*Item 344*

ITEC '96 Select. Conference proceedings.

Akron, Oh., 1996, p.125-29. 6T

**NEW GENERATION OF ELASTOMERS OFFERS BETTER TRACTION, LESS WEAR**

Rogers J E

Exxon Chemical Co.

(Rubber & Plastics News)

Exxpro Specialty Elastomers from Exxon Chemical Co. are evaluated and tested in tyre tread compounds. The characteristics are described of this class of elastomer, which is based on an isobutylene backbone. It is a bromo-co-(isobutylene-p-methylstyrene) polymer (BIMS), which primarily consists of isobutylene, and hence has similar dynamic properties to butyl rubber, including its high damping properties at low temperatures. Its properties are compared to those of butyl rubber. Laboratory tests have shown that the dynamic properties of compounds containing BIMS indicate improved wet traction with no sacrifice in rolling resistance, and reduced treadwear performance. Tyre tests also confirm these results, details of which are given. 3 refs.

USA

Accession no.701542

*Item 345*

ITEC '96 Select. Conference proceedings.

Akron, Oh., 1996, p.111-24. 6T

**CHARACTERIZING SILICA'S AFFECT ON CURED, UNCURED TIRE TREADS**

Dick J S; Pawlowski H

Alpha Technologies

(Rubber & Plastics News)

The compound effects from different types of silica were studied in the uncured state, while curing and in the uncured state using a Rubber Process Analyzer, RPA 2000. In the uncured state, the effects of variation in silica loading, particle size and structure on the formation of 'networks' were studied, and comparisons were made with the formation of carbon black networks. Silica loading effects on the critical strain were also studied. The non-Newtonian and thixotropic nature of silica loaded compounds were also investigated. The RPA was also used to study the effects of 'heat treatment' and the addition of an organosilane

coupling agent on the mixing process for silica loaded compounds and their resulting processing and scorch properties as well as the effects on cured dynamic properties at lower temperatures. Finally, the effects of silica on thermal conductivity and its implications for variable temperature cure were reviewed. 49 refs.

USA

Accession no.701541

*Item 346*

ITEC '96 Select. Conference proceedings.

Akron, Oh., 1996, p.101-6. 6T

**PEROXIDE-CURED COMPOSITIONS CAN CAUSE CHANGE IN SCORCH TIME**

Class J B

Hercules Inc.

(Rubber & Plastics News)

Peroxide vulcanisation of tyre compounds is examined and compared to sulphur vulcanisation in terms of curing mechanism and compounding considerations. The elimination of cure reversion with peroxides will allow tyres to be cured at higher temperatures, resulting in improved productivity, and the excellent aging properties expected for peroxide cures are claimed to be suitable for high mileage tyres. In addition, reduced compression set can improve the running performance of tyres.

USA

Accession no.701539

*Item 347*

ITEC '96 Select. Conference proceedings.

Akron, Oh., 1996, p.93-100. 6T

**NEW PROCESSING PROMOTER AIDS IN MANUFACTURING FLOW PROPERTIES**

Johansson A H; Graf H; Steger L

Rhein Chemie Corp.; Rhein Chemie Rheinau GmbH

(Rubber & Plastics News)

The use and advantages are described of Aktiplast ST processing promoter for use in tyre compounds based on silica technology. The process aid enables the manufacture of tyres with improved rolling resistance and traction, but also provides processability, the main disadvantage of silica filled rubbers. Advantages of using Aktiplast ST include an increase in flow properties, improved dispersion of silica in the polymer, longer scorch times, and improved wet skid resistance. Its use in an S-SBR/E-SBR/BR blend with silica and carbon black, and in a S-SBR/BR blend totally reinforced with silica is examined. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.701538

*Item 348*

**Rubber and Plastics News**

28, No.3, 7th Sept.1998, p.40

**UNIROYAL GOODRICH TOUTING NAILGARD TYRE**

Begin S

Uniroyal Goodrich Tire Co. has taken 20-year-old sealant technology and applied it to its best broad-line tyre, creating the Tiger Paw NailGard. Uniroyal is marketing the tyre as the affordable option in continued mobility products. Consumers initially interested in more expensive run-flat tyres are put off by the dashboard retrofitting their cars must undergo and the 30 US dollars plus cost associated with the sensor system needed to monitor zero-pressure tyres. Lined with a self-sealant rubber compound, the NailGard permanently can reseal punctures up to 3/16 of an inch in diameter, the size of a large nail screw. That type of tread puncture accounts for about 90% percent of all punctures, according to Uniroyal. Details are given.

UNIROYAL GOODRICH TIRE CO.  
USA*Accession no.699942**Item 349***Kautchuk und Gummi Kunststoffe**

51, No.10, Oct.1998, p.662/9

**IMPROVING TREAD WEAR WITHOUT INCREASING HEAT BUILD-UP BY USING 1,3-BIS(CITRACON-IMIDOMETHYL)BENZENE**

Datta R N; Ingham F A A

The anti-reversion agent 1,3-bis(citraconimidomethyl) benzene (Perkalink 900) reduces heat build-up in vulcanisates under dynamic conditions. It functions by a crosslink compensation mechanism that maintains compound physical and dynamic properties on overcure or during service. The conventional approaches to improving tread wear - partial replacement of NR with BR, increased carbon black level or use of higher reinforcing blacks - lead to increased heat build-up. This has limited the application of these approaches in practice. However, by incorporating Perkalink 900 together with these compound modifications the increased heat build up can be prevented, thus allowing improvements in tread wear to be realised. This is shown by laboratory data. 27 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE*Accession no.699766**Item 350*

Enercomp '95 International Conference on Composite Materials and Energy. Conference proceedings.

Montreal, Canada, 8th-10th May 1995, p.441-8. 627-63Ene

**VACUUM PYROLYSIS OF USED TYRES**Roy C; Darmstadt H; Benallal B; Chaala A;  
Schwerdtfeger A E

(Canadian Association for Composite Structures &amp; Materials)

The vacuum pyrolysis of used tyres enables the recovery of useful products, such as pyrolytic oil and pyrolytic

carbon black (CBp). The light part of the pyrolytic oil contains dl-limonene which has a high market price. The naphtha fraction can be used as a high octane number component for gasoline. The middle distillate demonstrates mechanical and lubricating properties similar to those of the commercial aromatic oil Dutrex R 729. The heavy oil is tested as a feedstock for the production of needle coke. It is found that the surface morphology of CBp produced by vacuum pyrolysis resembles that of commercial carbon black. The CBp contains a higher concentration of inorganic compounds than commercial carbon black. Pyrolysis process feasibility looks promising. One scrap tyre can generate, upon vacuum pyrolysis, incomes of at least 2.25 US dollars with a potential of up to 4.83 US dollars/tyre upon further product improvement. The process has been licensed to McDertnott Marketing Services for its exploitation in the USA. 14 refs.

CANADA

*Accession no.698329**Item 351*

Tyretech '98. Conference proceedings.

London, 15th-16th June 1998, paper 14. 6T1

**LABORATORY ASSESSMENT OF TRACTION AND WEAR OF TYRE TREAD COMPOUNDS AND ITS RELATION TO ROAD PERFORMANCE**

Grosch K A

VMI Holland BV

(Rapra Technology Ltd.; European Rubber Journal)

Traction and wear evaluation of tread compounds suffer from the fact that not only absolute values but relative ratings and even rankings depend strongly on the experimental conditions under which they are obtained in road tests. A meaningful laboratory evaluation has to take account of this. It is now well established that the frictional force which determines the traction capability of a tread compound is dominated by its viscoelastic properties. The coefficient of friction is a function of the contact temperature and sliding speed. This function can be obtained experimentally and represented by a master curve as function of the combined temperature and speed variable  $\log aTV$  which describes the total friction behaviour of that compound on the surface on which the experiments are being carried out. It has been shown that master curves can also be obtained if the side force of a cornering sample wheel is measured at a suitably large slip angle. Details are given of the hardware required to carry out traction and abrasion experiments with suitable testing conditions and software to enable both correlation calculations with existing road data, the simulation of road test conditions and predictions of compound ratings under these road testing conditions. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE*Accession no.697375*

*Item 352*

Tyrettech '98. Conference proceedings.  
London, 15th-16th June 1998, paper 3. 6T1

**DEVELOPMENTS IN IMPROVED  
PERFORMANCE BROMOBUTYL RUBBERS**

Suner A J M  
Bayer AG  
(Rapra Technology Ltd.; European Rubber Journal)

One of the main uses of bromobutyl rubbers is in tyre inner liners. The purpose of the tyre inner liner is to maintain the air pressure inside the tyre, and the rubber has been gaining increasing market share over the last few years. Bromobutyl rubber has a particular advantage in low rolling resistant tyres as it offers the maximum impermeability for a given weight. Lower weight or a thinner carcass translates directly into lower rolling resistance. As well as good impermeability, there are other performance characteristics required of tyre inner liners. These are adhesion to the carcass, which prevents the hot liner being pulled from the tyre at the end of the cure, and good fatigue performance. Fatigue is especially important for long life tyres, and particularly truck tyres designed for a guaranteed long life with up to three retreads. Resistance to ageing is also important for truck tyre liners, together with good low-temperature properties, which enable the liners to be used in tyres operating in very cold climates. A laboratory test is developed to measure fatigue performance and is shown to correlate with inner liner performance in tyres. This test is used to find the optimum level of bromine in bromobutyl for innerliner applications. It is shown how these bromobutyl rubbers give improved processing and performance properties when tested in inner liner compounds for truck tyres. Further study shows how this material can be compounded to give more economic inner liners for car tyres where fatigue is not so important. It can also be used to improve rolling resistance. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

*Accession no.697364*

*Item 353*

Tyrettech '98. Conference proceedings.  
London, 15th-16th June 1998, paper 2. 6T1

**INFLUENCE OF COBALT SALT ON ADHESION  
BETWEEN STEEL CORD AND RUBBER**

Labarre D; Duffour T; Hawkins I; Tessier L; Sartre A;  
Bomal Y; Gibbs H W; Wilson J C  
Rhodia Research; Rhodia Ltd.  
(Rapra Technology Ltd.; European Rubber Journal)

For successful use of steel cords in radial tyres, the attainment and maintenance of good rubber to metal bonds is vital. Cobalt systems are used, alone or in combination with resin systems, in the rubber compound for the promotion and maintenance of good adhesion between brass and rubber. Today they appear to be the most efficient additives and are considered essential in the manufacture

of steel radial tyres. In general, existing levels of adhesion are satisfactory, but improved performance is still required in some areas. Principal development targets are to maintain existing adhesion levels at lower cost and with enhanced physical properties, and to offer better adhesion retention in some areas such as high humidity for tropical climates or multiple retreading for truck tyres. Recently, novel cobalt adhesion promoters have been developed which perform better at lower levels than existing promoters, especially after steam ageing. A background to the rubber-brass adhesion mechanism is presented, and the effects of cobalt salts, including different results from model system studies carried out in the laboratory, are described. The adhesion data obtained from Rhodia's new adhesion promoters are discussed. It is shown that the new promoters give the best balance of initial/steam aged adhesion and that this best balance is obtained for a lower level of cobalt. 13 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; UK;  
WESTERN EUROPE

*Accession no.697363*

*Item 354*

Tyrettech '98. Conference proceedings.  
London, 15th-16th June 1998, paper 1. 6T1

**APPLICATION OF CARBON-SILICA DUAL  
PHASE FILLERS TO TRUCK TYRE TREAD  
COMPOUNDS**

Hardy D; Moneypenny H; Couturier G; Wallace I  
Cabot Corp.; Cabot Carbon Ltd.; Malaysian Rubber  
Producers' Research Assn.  
(Rapra Technology Ltd.; European Rubber Journal)

Carbon-silica dual phase (CSDP) fillers are unique fillers for rubber reinforcement, especially for tyre applications. Based on the understanding of the characteristics of these new materials, particularly their lower filler-filler interaction and higher polymer-filler interaction, the application of two commercially available CSDP fillers - CRX 2000 and CRX 2002 - in combination with a silane coupling agent, (TESPT), is investigated in truck tyre tread compounds. Compared with a Vulcan 7H carbon black control, the CSDP fillers in a truck tyre tread compound evaluation give no significant difference in low severity wear rating on the drive axle of a rigid vehicle in highway service, superior rolling resistance characteristics and lower heat build-up, leading to decreased running temperatures which should result in improved durability and retreadability. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA;  
WESTERN EUROPE

*Accession no.697362*

*Item 355*

RubberTech China '98. Conference proceedings.  
Shanghai, China, 24th-26th March, 1998, paper 21. 012

**COMPUTER CONTROLLED RUBBER FACTORY**

Urbanik D  
ECLIPSE Technical Software Service BV

(Rapra Technology Ltd.; Crain Communications Ltd.)

The use of computer control in the rubber factory is examined with particular reference to computer software products from ECLIPSE. The new computerised techniques will aid the development and testing of new compounds, and also improve quality control systems through integrated networks with manufacturing resource planning systems and laboratory information systems. Data acquisition from production equipment, control production equipment and new techniques involving neural networks are discussed.

CHINA

Accession no.696404

Item 356

**Rubber and Plastics News**

28, No.1, 10th Aug.1998, p.6

**GOODYEAR TESTS STARCH AS FILLER ALTERNATIVE**

Davis B

Goodyear has developed an "engineered biopolymeric filler", a modified starch which it expects to become a cost-effective, renewable alternative to carbon black and/or silica in rubber compounds. The filler, covered by patents and patents pending globally, has been used to develop super-low hysteresis, low-weight tread compounds that reduced rolling resistance in test tyres by 8-10%.

GOODYEAR INC.

USA

Accession no.695030

Item 357

Polymer Testing '97. Day 4: Durability of Rubber.

Conference proceedings.

Shawbury, 7th-11th April 1997, Paper 7. 9T

**PREDICTING SERVICE LIFE BY ANALYSIS OF TEAR AND FATIGUE PROPERTIES**

Trim R; Neureiter K-H

RT Technology; Coesfeld GmbH

(Rapra Technology Ltd.; Plastics & Rubber Weekly; European Plastics News)

An important criterion in the assessment of dynamically loaded elastomeric materials is their resistance to crack growth, fatigue and ageing. These properties are influenced not only by the choice of polymer, filler and crosslinking system, but also to a high degree by the type and amounts of chemicals that are added to inhibit fatigue and ageing. Commercial methods for ascertaining the fatigue resistance of elastomers have so far been restricted to measurement of a test specimens time to failure, for which a number of machines are available, or to test procedures where the testing is interrupted and the degree of damage appraised visually in a qualitative manner as a function of the integral load. As the crack growth under

dynamic load and the resistance to fatigue and ageing are essentially important properties of elastomers, an instrument has been developed - the Tear Analyser - for quantitative analysis of mechanico-dynamic crack growth processes under the influence of specific degradation parameters. The Tear Analyzer can reliably predict crack growth development in rubber compounds used in tyres and other rubber goods. Details are given.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; UK; WESTERN EUROPE

Accession no.694724

Item 358

**Polymer Science Series B**

40, Nos.5-6, May-June 1998, p.175-6

**KERR EFFECT IN A RADIATION CROSS-LINKED LIQUID-CRYSTALLINE COMB-SHAPED POLYMER**

Merekalov A S; Zubarev E R; Tal'roze R V; Plate N A  
Russian Academy of Sciences

Data is given for the equilibrium Kerr constant obtained in the vicinity of the nematic-isotropic melt phase transition for a comb-shaped liquid crystalline polymer cross-linked using gamma-radiation. The usual experimental difficulties were avoided by preparing networks with low background anisotropy and by using a compensation technique for the measurement of the equilibrium Kerr constant. 6 refs.

RUSSIA

Accession no.694404

Item 359

NRC 98 - Nordic Rubber Conference 1998. Conference proceedings.

Halmstad, Sweden, 4th-5th June 1998, paper 16

**PREDICTIVE TESTING FOR RUBBER KEY PROPERTIES**

Kelbch S

Bayer AG

(Sveriges Gummitekniska Forening; NGTR)

One of the most difficult to determine properties of rubber are fatigue or crack growth resistance. Bayer has developed a new versatile test system, the Tear Analyser, to measure the dynamic crack growth resistance under near real test conditions. The service performance of tyre components, as well as the fatigue resistance of technical rubber articles, can be predicted with this instrument. 2 refs.

SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.692122

Item 360

NRC 98 - Nordic Rubber Conference 1998. Conference proceedings.

Halmstad, Sweden, 4th-5th June 1998, paper 5. 012

**REPLACEMENT OF HIGH AROMATIC OIL IN THE TYRE INDUSTRY**

Russell R M

Continental AG

(Sveriges Gummitekniska Forening; NGTR)

The present status of high aromatic oil in the European tyre industry is reviewed and qualification requirements for a replacement product established. Candidate alternatives are identified and evaluated against requirement criteria. The main effects on compound properties are described and an overall assessment of the various products made. 13 refs.

SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.692112

Item 361

**European Rubber Journal**

180, No.9, Sept.1998, p.39

**AROMATIC OILS ON THE WAY OUT**

White L

Tyre makers across Europe are seeking an adequate replacement for high aromatic process oils in tyre compounds. One compelling reason is the protection of process workers from contact with these oils or with fumes from hot rubber containing the oils, which are now classified as "potential human carcinogens".

CONTINENTAL AG

WESTERN EUROPE-GENERAL

Accession no.690651

Item 362

**Rubber Asia**

12, No.4, July/Aug.1998, p.55-7

**NEW SOLUTION TO IMPROVE TREAD WEAR**

Ebell P C; Datta R N; Ingham F A A

Flexsys

Abrasion resistance and tear resistance of black filled compounds can be improved by higher loading or raising the fineness of the black. However, these changes result in increased hysteresis. Increased black structure improves abrasion too but again at the expense of hysteresis, which negatively affects heat build-up and ultimately the rolling resistance of the tyre. The unique feature of Perkalink 900 is the heat build-up reduction and improvement in blow out resistance it confers on vulcanisates. Details are given.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; SINGAPORE; WESTERN EUROPE

Accession no.690159

Item 363

**China Synthetic Rubber Industry**

21, No.4, 1998, p.242

**DYNAMIC MECHANICAL PROPERTIES OF NATURAL RUBBER/BUTADIENE-**

**ACRYLONITRILE RUBBER BLENDS**

Zhao Xusheng; Jia Demin; Luo Yuanfang; Niu Yuhua;

Fu Weiwen

South China,University of Technology

Dynamic mechanical spectroscopic studies were conducted of a tread compound based on NR/NBR blend containing a modifier. Tan delta of blends with different component ratios was determined at different temps. and the results obtained are discussed in relation to rolling resistance and wet grip. 2 refs.

CHINA

Accession no.688746

Item 364

**Polymer Recycling**

3, No.1, 1997/98, p.17-28

**MODIFICATION OF BITUMEN WITH SCRAP TYRE PYROLYTIC CARBON BLACK.**

**COMPARISON WITH COMMERCIAL CARBON BLACK. II. MICROSCOPIC AND SURFACE SPECTROSCOPIC INVESTIGATION**

Chebil S; Chaala A; Darmstadt H; Roy C

Sherbrooke,University; Quebec,Universite Laval;

Institut Pyrovac Inc.

The possibility of using pyrolytic carbon black(CBp), a by-product of scrap tyre pyrolysis, as a reinforcing agent in bitumen was investigated. Conventional and CBp-modified bitumens were compared. The performance of CBp-modified mixtures was shown to be improved before and after Strategic Highway Research Program ageing tests. The CBp exhibited a high storage stability in the bitumen matrix. ESCA and secondary ion mass spectroscopic techniques revealed that some bitumen compounds were strongly adsorbed on the CBp surface, which explained the high interactions between the CBp and the bitumen matrix. It was found that the rutting potential, the effect of water and the thermal susceptibility were reduced in the concrete mixture by CBp addition. 14 refs.

CANADA

Accession no.688689

Item 365

**Tire Technology International**

1998, p.122-5

**FUZZY SET - A DESIGN TOOL FOR COMPOUND OPTIMISATION**

Thomas T K; Mattam C; Premkumar S; Ramakrishnan S

Apollo Tyres Ltd.

Fuzzy sets is a statistical modelling technique that can be used to develop mathematical models that bear good correlation with primary data linguistic or semantic descriptions. This comprehensive article supplies a detailed explanation and analysis of fuzzy sets and provides examples of how the technique of fuzzy sets can be applied to arrive at the most appropriate compound

recipe for tyres, using a number of given variables. Information is included on the advantages of using this particular design tool for compound optimisation. 6 refs.

INDIA

Accession no.685072

Item 366

*Tire Technology International*

1998, p.119-20

**COMPOUND TESTING MADE SIMPLE**

VMI EPE Holland BV

In the past, laboratory testing of new tyre compounds was not considered to produce good enough results to eliminate the need for actual on-the-road test programmes. This comprehensive article supplies details of the advantages and features of a new test apparatus, launched by VMI EPE Holland BV, for examining the abrasion and skid resistance of tread compounds. Information on the test apparatus, named LAT 100, includes the new test methods and the construction and use of the test bed. An optional software program, the LAT-Explorer, which runs with Windows 95, is also available.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.685071

Item 367

*Tire Technology International*

1998, p.33/40

**CARBON-SILICA DUAL-PHASE FILLER**

Patterson W J; Wang M; Mahmud K

Cabot Corp.

A carbon-silica dual-phase filler - Ecoblack - developed by Cabot Corp. of the USA, offers tyre manufacturers substantially reduced rolling resistance and improved traction without negative impacts on wear resistance. This comprehensive article supplies detailed information of studies carried out on three grades of Ecoblack to show the effect of surface area and silica contents on the properties of passenger tyre tread compounds, and highlighting their advantages in comparison to traditional fillers. 8 refs.

USA

Accession no.685055

Item 368

*Tire Technology International*

1998, p.25/32

**PROGRESS IN THE DEVELOPMENT OF  
INVERSION CARBON BLACKS**

Niedermeier W; Freund B

Degussa AG

Demand for increased safety and longer service life from passenger vehicle and truck tyres is driving the development of improved wet grip performance and the

reduction of rolling resistance to reduce tyre tread wear. By adding newly developed reinforcing blacks, known as inversion blacks, it is possible to meet these rolling resistance targets. This comprehensive article supplies detailed analytical data, including characterisation, mechanical and physical properties, of the inversion blacks in comparison to the conventional carbon blacks. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.685054

Item 369

153rd ACS Rubber Division Meeting - Spring 1998.

Conference preprints.

Indianapolis, In., 5th-8th May,1998. Paper 44. 012

**SERVICE CHEMICALS FOR THE TYRE  
INDUSTRY RELEASE AGENTS**

Schulz H; Breining M; Becker C

Rhein Chemie Rheinau GmbH

(ACS,Rubber Div.)

In addition to the optimisation of the rubber compound according to the properties of the final article, adaption to the processing machinery of the individual rubber plants is the major focus of the rubber compounder. Release agents and tyre paints, most important in the case of tyre producers, make a significant contribution to product quality, factory output, reject rate and environmental issues that often is not taken into account. The right choice of these 'service chemicals' will improve productivity and reduce production costs. The Rhenodiv product range from Rhein Chemie is claimed to offer all the advantages that rubber factories can expect from modern, high technology release agents.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.683261

Item 370

153rd ACS Rubber Division Meeting - Spring 1998.

Conference preprints.

Indianapolis, In., 5th-8th May,1998. Paper 42. 012

**SILICONE RUBBER BLADDER COATING  
SYSTEM AS A PROCESS AID FOR CURING  
TYRES**

Schuttringer E C

Wacker Silicones Corp.

(ACS,Rubber Div.)

Tyre curing bladders undergo some of the most abusive operating conditions. These include high temperatures, severe flexing, co-vulcanisation and migration of curatives from the unvulcanised tyre. Its productive lifetime is a major influence on the operating efficiency of a tyre plant. Room temperature vulcanised silicon rubber is described, as it is currently used to extent bladder life. Field successes have been due to the extremely anti-

adhesive surface property of the silicone rubber. This feature has been most important in preventing covalent crosslinking of new bladders to the tyre. The bladder coating contains a silicone fluid that is not sufficient to provide lubrication beyond several cures. The bladder coating is therefore supplied as a system with water based silicone emulsions. Studies are conducted to establish release, lubricity and abrasion resistant properties of silicone rubber as a coating to tyre curing bladders. These properties are evaluated using repetitive cure cycles with unvulcanised butyl inner liner and chafer compounds. The method does not flex nor stretch the butyl material, but utilises similar temperatures, cure times and pressure conditions to those in the production of passenger tyres. The performance of the bladder coating, with and without inside tyre release agents using ten-minute cures at 360 deg F, is discussed. Migration of curatives from the chafer compound is shown severe to both the butyl bladder and the silicone rubber coating. 2 refs.

USA

Accession no.683259

*Item 371*

153rd ACS Rubber Division Meeting - Spring 1998. Conference preprints.

Indianapolis, In., 5th-8th May, 1998. Paper 25. 012  
**PERFORMANCE DIFFERENCES BETWEEN SINGLE CARBON BLACKS AND CARBON BLACK BLENDS FOR CRITICAL INDUSTRIAL RUBBER APPLICATIONS**

Monthey S; Reed T  
Cabot Corp.  
(ACS, Rubber Div.)

The blending of different carbon blacks during compound mixing to achieve a combination or balance of performance properties in industrial rubber products is quite common. The practice is based on a hypothesis that carbon black analytical properties are additive, which can be true in the analytical sense but may not be valid in the performance of rubber compounds. In fact, significant differences exist between a single carbon black and the resulting product of a blend of carbon blacks. Aggregates in single blacks have essentially the same primary particle size, whereas blends of different blacks give distributions of aggregates with different primary particle sizes as well as distributions of different sized aggregates. Since blacks of significantly different particle sizes incorporate into the rubber compound at different rates, undispersed domains of the smaller particle size black could exist in the compound. It is also possible that the rubber compound will exhibit a non-uniform distribution of blacks, thereby lessening any intended benefits of blending. Past studies have shown that blending of carbon blacks with significantly different primary particle sizes can result in poorer performance in tyre applications than when single blacks have been used. It is shown that the blending of carbon blacks with significantly different particle sizes

likewise cannot match many of the important performance properties of a single carbon black in several critical industrial rubber applications. 9 refs.

USA

Accession no.683243

*Item 372*

**Rubber Chemistry and Technology**

71, No.1, March-April 1998, p.17-25

**REFLECTOMETRY - A NEW METHOD OF MEASURING FILLER DISPERSION**

Gerspacher M; Nikiel L; Yang H H; O'Farrell C P  
Richardson S., Carbon Co.

A new method of measuring carbon black dispersions in rubber is presented. The method is based on measurement of the light reflectivity from the rubber sample using standard equipment used in the evaluation of tint strength of carbon black (ASTM D3265). The method can be used for cured and uncured samples. It was shown that samples with better dispersed carbon black reflect less light compared with samples with poor carbon black dispersion. 7 refs.

USA

Accession no.682552

*Item 373*

**Kautchuk und Gummi Kunststoffe**

51, No.5, 1998, p.348/60

**CARBON-SILICA DUAL PHASE FILLER, A NEW GENERATION REINFORCING AGENT FOR RUBBER. PART 1. CHARACTERISATION**

Wang M J; Mahmud K; Murphy L J; Patterson W J  
Cabot Corp.

Carbon-silica dual phase filler, produced by Cabot Corp. and commercialised as Ecoblack is claimed to improve the temperature dependence of hysteresis of filled rubber, especially tyre tread compounds. It is demonstrated to impart substantially lower rolling resistance and improved traction without sacrificing wear resistance, relative to conventional carbon blacks. The filler consists of a silica phase distributed in a carbon phase. A summary is presented of its features and reinforcing ability for elastomers. 14 refs

USA

Accession no.681310

*Item 374*

**Rubber and Plastics News 2**

19, No.10, 16th Feb.1998, p.7

**GOODYEAR UNVEILS STEEL CAR TYRE CORD**

Whitford M

Goodyear Tire & Rubber Co. has developed a new steel tyre cord that improves fatigue resistance, uniformity, treadwear and vehicle handling. This article supplies

details of the features and advantages of the new patented tyre cord, dubbed Ultra-Tensile Steel, which will replace rayon and polyester and expand options in the company's tyre compounds, components and designs. Initially, the firm will use the lightweight steel cord in its Eagle F1 Steel EMT line and its Aquasteel brand run-flat tyres.

GOODYEAR TIRE & RUBBER CO.

USA

Accession no.680914

*Item 375*

Polymer Technology for the New Millennium.

Conference proceedings.

Blue Mountains, Australia, 12th-15th Oct.1997, paper 21. 012

**ECOBLOCK CARBON BLACK-SILICA DUAL PHASE FILLER, A NEW GENERATION REINFORCING AGENT FOR RUBBER**

Wang M-J; Brown T A; Patterson W J; Francis R A

Cabot Corp.; Cabot Australasia Pty.Ltd.

(Australasian Plastics & Rubber Institute)

Ecoblock filler is a new generation rubber reinforcing agent developed to enhance the physical properties of elastomers. It differs in many aspects from the traditional fillers currently used to reinforce rubber compounds. Its main features in terms of morphology, surface characteristics, as well as filler-filler and filler-polymer interactions are discussed. The basic compounding characteristics of this filler are presented, emphasising its effect on the viscoelastic properties of a passenger tyre tread compound. With proper mixing and compound formulation, when compared to carbon black and silica compounds, the new filler can provide a much improved balance of hysteresis in terms of higher tan delta at low temperature and lower tan delta at higher temperature, with increased abrasion resistance. In terms of tyre performance, this approach provides the capability to significantly reduce rolling resistance while improving tread wear resistance and maintaining the traction level of conventional carbon black. 17 refs.

AUSTRALIA; USA

Accession no.679815

*Item 376*

Polymer Technology for the New Millennium.

Conference proceedings.

Blue Mountains, Australia, 12th-15th Oct.1997, paper 17. 012

**USE OF EPDM WITH HIGH DIENE RUBBER IN BLENDS FOR IMPROVED BLACK TYRE SIDE WALL APPEARANCE**

Ferrandino M; Hong S W

Uniroyal Chemical Co.

(Australasian Plastics & Rubber Institute)

The tyre industry has been on a quest for a blend of EPDM and high diene rubbers that will provide an improved

appearance and longer lasting tyre black sidewall with no sacrifices in performance relative to the other traditional industry standards. Understanding the characteristics of each polymer and the resulting blend is essential to overcome the hurdles faced when blending these polymers. The processing characteristics, curing differences and physical properties of each polymer provide valuable clues for improving the performance of a sidewall compound based on EPDM blends. Each polymer component is examined in terms of cure characteristics and physical properties. The information gained from studying the individual polymer components is used to form an explanation of the EPDM blend mixing and cure system relationships demonstrated by promising laboratory data. 10 refs.

USA

Accession no.679811

*Item 377*

Tyretch Asia 96. Conference proceedings.

Singapore, 3rd-4th June 1996, paper 20. 6T

**INSOLUBLE SULPHUR IN TYRE COMPOUNDING**

Ingham F A A; To B

Flexsys Pte.Ltd.; Flexsys America LP

(Rapra Technology Ltd.; European Rubber Journal)

Insoluble sulphur is a high molecular weight polymeric form of sulphur mainly used as a replacement for ordinary sulphur to prevent sulphur bloom in unvulcanised rubber compounds. Commercially available insoluble sulphur is stable at ambient temperature with minimal loss of activity for up to one year from the date of manufacture. However, when insoluble sulphur is exposed to high temperatures (greater than 40 deg.C) for long periods of time, it will convert to the more stable, soluble rhombic form. In addition, exposure of insoluble sulphur to certain basic materials, such as amines, will also convert it to the soluble form. Flexsys is the leading supplier of insoluble sulphur from production units in Brazil, France, Germany, Japan and the USA. Ten different grades of insoluble sulphur are available.

SINGAPORE; USA

Accession no.679294

*Item 378*

Tyretch Asia 96. Conference proceedings.

Singapore, 3rd-4th June 1996, paper 15. 6T

**SILICAS: CHALLENGE FOR SYMBIOSIS TO CARBON BLACKS**

Freund B; Tan E-H

Degussa AG

(Rapra Technology Ltd.; European Rubber Journal)

Tyre tests of tread formulations with ultra-high surface area/structure experimental blacks show good results for the ultra-high structure black. However, the overall performance of the silica compound can not be matched.

A new generation of tread blacks (inversion blacks) giving significantly lower tan delta at 60 deg.C without affecting tan delta at 0 deg.C is discussed. A model for reinforcement is given. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.679289

Item 379

**Rubber Chemistry and Technology**

70, No.4, Sept./Oct.1997, p.585-94

**VISCOELASTIC PROPERTIES OF ELASTOMERS AND TIRE WET SKID RESISTANCE**

Takino H; Nakayama R; Yamada Y; Kohjiya S; Matsuo T  
Toyo Tire & Rubber Co.Ltd.; Kyoto,University;  
Kyoto,Institute of Technology

The wet skid resistance of eighteen sulphur-curable polymers which could be used for automobile tyres was evaluated using the British Portable Skid Tester. The results obtained were analysed in relation to the viscoelastic properties of the polymer systems. Analysis of wet skid resistance in terms of the peak value of tan delta over a prescribed temp. range and abrasion loss (derived from the theory of rubber friction) was found to give a better general relationship for a wide range of polymers. 8 refs.

JAPAN

Accession no.679128

Item 380

**International Polymer Science and Technology**

24, No.9, 1997, p.T/16-21

**FRICITION PROPERTIES OF STUDLESS TYRES ON ICY ROADS: COMPARISON OF FRICTION PROPERTIES OF STUDLESS TYRES AND LABORATORY-PREPARED SAMPLES**

Mitsuhashi K; Hiroki E; Midorikawa S; Shinoda S

A comparison was made of frictional tests conducted on studless tyres and a laboratory internal drum tester. The mechanism of friction in the running of studless tyres on icy roads was investigated using data for rubber hardness and pulsed NMR. 16 refs. Translated from Nippon Gomu Kyokaishi, No.3, 1997, p.140

JAPAN

Accession no.676849

Item 381

**Rubber and Plastics News**

27, No.14, 9th Feb.1998, p.12/22

**EXAMINING CARBON-SILICA DUAL PHASE FILLERS**

Wang M-J; Patterson W J; Brown T A; Money Penny H G  
Cabot Corp.

Edited by: Herzlich H

Carbon-silica dual phase filler is a unique filler for rubber reinforcement, especially for tyre applications. Based on the understanding of the characteristics of this new materials, specifically its lower filler-filler interaction and higher polymer-filler interaction, and the interaction between different ingredients in the compound, the application of this material to tread compounds, passenger tyre in particular, are investigated. It is found that, when comparing carbon black and silica compounds, the new filler can provide a much improved balance of hysteresis in terms of higher or comparable tan delta at low temperature and lower tan delta at higher temperature, with increased abrasion resistance. In terms of tyre performance, this approach provides the capability to significantly reduce rolling resistance, while improving tread wear resistance and maintaining traction. In addition, its good processability and reduced coupling agent requirement in relation to a silica compound would impart a significant economic benefit. 14 refs.

USA

Accession no.675516

Item 382

**Tyres & Accessories**

No.10, Oct.1997, p.73

**KEVLAR AIDS PERFORMANCE**

This article reports on a new, patented technology from DuPont that allows short fibres of "Kevlar" brand fibre to be integrated into the rubber compound of vehicle tyres. The result is Kevlar Elastomeric Composite, a system providing tyre manufacturers with a fibre-reinforced rubber composition offering enhanced performance, safety, and durability.

DUPONT

Accession no.665018

Item 383

**Rubber World**

217, No.2, Nov.1997, p.23-6

**IMPORTANCE OF DIMENSIONAL STABILITY IN THE TYRE CARCASS**

Pomies F; Burrows J

AlliedSignal Fibers

Reinforcement fibres with dimensionally stable properties, high modulus and low shrinkage, have made an important contribution to tyre performance in recent years. The dimensional stability characteristics of a thermoplastic fibre are examined and how different types of tyre cord affect tyre properties outlined. Manufacturing tyres with advanced polyester cord and laboratory evaluation of a new polyester are discussed. 8 refs.

USA

Accession no.664890

Item 384

**Elastomery**

No.4, 1997, p.27-36

Polish

**DYNAMIC TG AS A CRITERION FOR THE WET SKID BEHAVIOUR OF TREAD COMPOUNDS**

Heinrich G; Rennar N; Dumler H  
Continental AG

Details are given of an estimation of static and dynamic Tg of a series of rubbers by means of DSC, dynamic mechanical analysis and NMR. Wet skid resistance was also estimated. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.663234*

*Item 385*

**Scrap Tire News**

11, No.12, Dec. 1997, p.14

**NEW TECHNOLOGY RECYCLES OLD TIRES FOR NEW USES**

Siuru B

A new technology has been developed by researchers at the Department of Energy's Pacific Northwest National Laboratory and Rouse Rubber Industries for rubber tyre recycling, which increases the surface reactivity of the ground tyre rubber. The process enables the used rubber to be incorporated into a virgin rubber matrix. Brief details are given of the technology which involves the use of a bioreactor where sulphur-loving microorganisms modify carbon/sulphur crosslinking in finely ground waste rubber, changing the material from a non-reactive to a reactive filler.

US,DEPT.OF ENERGY; PACIFIC NORTHWEST LABORATORIES; ROUSE RUBBER INDUSTRIES INC.

USA

*Accession no.662770*

*Item 386*

**Scrap Tire News**

11, No.11, Nov.1997, p.11

**CIWMB ACCEPTS TDF EMISSIONS DATA**

The California Integrated Waste Management Board (CIWMB) has accepted the findings of two reports it commissioned last year to look at air emissions and health risks using tyre-derived fuel (TDF). In the first report, Dames & Moore, an environmental consulting firm surveyed changes in emissions and by-products from 28 facilities to develop a comparison of the emissions and health risks within facilities once they began using TDF. The facilities surveyed included 15 cement kilns, three energy generators, eight pulp and paper mills, and two industrial boilers. According to the CIWMB, the study found that for the most parameters measured at cement kilns (criteria pollutants, particulate matter, metals, dioxin/furan, organic/inorganic compounds), the increase or decrease was not statistically significant when using TDF in comparison to the baseline fuel. Meanwhile, Carnot was commissioned to conduct emissions testing for

criteria pollutants, toxic samples and ash by-products at Air Products Manufacturing. Details are given.

CALIFORNIA INTEGRATED WASTE MANAGEMENT BOARD; DAMES & MOORE  
USA

*Accession no.662271*

*Item 387*

**Rubber News**

36, No.5, Feb.1997, p.29-36

**TYRE TRACTION**

Majumdar S

Exxon Chemical Eastern Inc.

When an attempt is made to move two bodies held in mutual contact by a force, normal to their surfaces, a tangential force is required to produce movement. This tangential force is ordinarily termed frictional force. The term frictional force is most often used in cases of geometrically simple bodies. When more complex bodies are involved, the above tangential force is frequently called tractive force and the phenomenon is termed as traction. For example, the tangential force involved between rail and engine is popularly called railway traction. Tyre traction is, therefore, tyre-road traction and is an interaction between the tyre and the road, resulting in reaction forces acting in the plane of road at the tyre-road interfaces. The reaction forces result from control inputs like braking and acceleration torque and steer angle. Tyre traction is a complex subject. This is not only because tyre traction is a fraction of tyre construction, tyre compound, tread pattern, road texture (nature of pavement), tyre speed, tyre load, temperature (atmospheric condition), cornering, braking and driver behaviour. The tyre itself is a pressured, composite, toroidal structure with cords and rubber interacting in many complex ways not yet well understood. A definition of tyre traction is presented, together with its performance with respect to different pavements. 17 refs.

INDIA

*Accession no.661790*

*Item 388*

152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints.

Cleveland, Oh., 21st-24th Oct.1997, Paper 119, pp.28. 012

**NEW WAY TO EVALUATE TRACTION AND WEAR PROPERTIES OF TIRE TREAD COMPOUNDS**

Grosch K A

VMI Holland BV

(ACS,Rubber Div.)

Details are given of computer controlled instrumentation developed by VMI-Lang for evaluating the traction and wear performance of tyre tread compounds. Slip angle, load, speed and abrasive surface structure can be varied

to give a wide range of severities. An automatic dust supply can be adjusted by computer input, and debris are removed by suction. An IR thermometer monitors the sample surface temperature during the test. The computer generates tables of surface temperatures, compound ratings as a function of energy dissipation and speed, and weighted average ratings for simulated road test conditions. 6 refs.

VMI-LANG

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; NETHERLANDS; USA; WESTERN EUROPE

Accession no.659561

Item 389

152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints. Cleveland, Oh., 21st-24th Oct.1997, Paper 102, pp.39. 012

**OPTIMIZING MIXING PERFORMANCE THROUGH FILLER DISPERSION CONTROL**

Andersson L O; Sunder J; Persson S; Nilsson L  
OptiGrade AB; RADO Gummi GmbH; Svedala-Skega AB  
(ACS,Rubber Div.)

Results are presented of studies undertaken to evaluate the use of filler dispersion control as a means for optimising rubber mixing processes. By image analysis of a freshly cut uncured rubber surface and classification of the number and size of agglomerates, it was possible to predict the extrusion performance of a compound, and a clear relationship was established between the maximum agglomerate size and the extrusion performance. 40 refs. EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; SCANDINAVIA; SWEDEN; USA; WESTERN EUROPE

Accession no.659546

Item 390

ACS,Rubber Division Meeting, Fall 1997. Conference Preprints. Cleveland, Oh., 21st-24th Oct.1997, Paper 66, pp.35. 012

**NEW GRADES OF BIMS FOR NON-STAIN TIRE SIDEWALLS**

Tisler A L; McElrath K O; Tracey D S; Tse M F  
Exxon Chemical Co.  
(ACS,Rubber Div.)

Three new grades of Exxpro brominated isobutylene-paramethylstyrene copolymers (Exxon Chemical) were added to NR/polybutadiene tyre sidewall compounds to improve their ozone resistance. Effects on resistance to ozone and flex cracking were investigated and related to the structural characteristics of the copolymers and blend morphology. 7 refs.

USA

Accession no.659515

Item 391

152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints. Cleveland, Oh., 21st-24th Oct.1997, Paper 62, pp.55. 012

**TIRE BLACK SIDEWALL SURFACE DISCOLORATION: A REVIEW**

Waddell W H  
Exxon Chemical Co.  
(ACS,Rubber Div.)

A review is made of the literature describing the surface discoloration of black tyre sidewalls caused by exposure to ozone and formulation studies undertaken to overcome this problem. Methods examined include the use of non-staining antiozonants and blending inherently ozone resistant rubbers such as EPDM, halobutyl rubbers and brominated isobutylene-paramethylstyrene copolymers with NR and/or polybutadiene. 67 refs.

USA

Accession no.659512

Item 392

**European Rubber Journal**  
179, No.10, Nov. 1997, p.16

**GOODYEAR BRINGS EMT TO EUROPE**

Advantages of the extended mobility tyre (EMT) from Goodyear are described. The company plans to introduce the first tyre into Europe in Spring 1998 in low profile and high speed ratings, and gradually bring into the market lower performance products as the year progresses. The use of dithiodipropionic acid to coat the carbon black particles is discussed, which gives them low friction and reduced heat build-up. This compound is used to produce an insert in the sidewall which is able to support the weight of the car.

GOODYEAR TIRE & RUBBER CO.  
EUROPE-GENERAL

Accession no.658405

Item 393

IRC '97. Conference proceedings. Kuala Lumpur, 6th-9th Oct.1997, p.427-35. 012

**IMPROVING TREADWEAR WITHOUT INCREASING HEAT BUILD-UP BY USING 1,3-BIS(CITRACONIMIDOMETHYL)BENZENE (PERKALINK 900)**

Datta R N; Ingham F A A  
Flexsys BV  
(Rubber Research Institute of Malaysia)

The anti-reversion agent 1,3-bis(citraconimidomethyl) benzene (Perkalink 900) reacts by a unique crosslink compensation mechanism. In doing so, the crosslink density of vulcanisates can be maintained during overcure or during ageing as encountered during service life. As a result, the mechanical properties are stabilised, thereby

controlling heat build-up. The anti-reversion effect of Perkalink 900 can be applied in tread compounds in which improved abrasion resistance is sought through the incorporation of an increased level of black or addition of a polymer of lower Tg (e.g. polybutadiene). Under normal circumstances, excessive heat build-up during service conditions may prohibit the application of this compound modification. However, heat build-up can be controlled by incorporating Perkalink 900, thereby achieving the desired effect of improved tread wear with no penalty of increased heat build-up. The effect of Perkalink 900 on model NR tread compounds is described. Cure characteristics, mechanical, dynamic mechanical and flex properties are illustrated together with laboratory abrasion data. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.658319

*Item 394*

**Rubber Technology International**

1997, p.141-3

**OZONE TEST CHAMBERS FOR RUBBER AGEING IN AUTOMOTIVE INDUSTRY**

Nonnenmacher K

Anseros Klaus Nonnenmacher GmbH

The task for rubber manufacturers is identify rubber additives that can to be used either singly or in conjunction to produce rubber parts to a high quality and with the high levels of ozone resistance needed for a long service life. Examples of the types of product for which this is expected include windscreen wipers, door and window seals and tyres. Accelerated static and dynamic tests can be carried out in a chamber with a controlled ozone dosage that is monitored to ensure compliance with standard test conditions. Performances of rubber compounds and additives are assessed through comparison of both appearance and mechanical properties after various levels of ozone exposure, for various times, as specified in the test procedure.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.657660

*Item 395*

**Industria della Gomma**

39, No.12, Dec.1995, p.40/57

Italian

**SKS REACTION FOR REVERSIBILITY OF VULCANISATION**

An account is given of the De-Link devulcanisation process (STI-K Polymers), based on the SKS (Sekhar-Kormer-Sotnikova) reaction, and its potential use in the recycling of sulphur vulcanised rubbers.

RUBBER RESEARCH INSTITUTE OF MALAYSIA;  
STI-K POLYMERS SDN.BHD.; STI-K POLYMERS

AMERICA INC.; CUSTOM CRYOGENIC  
GRINDING CORP.; PRAXAIR INC.  
CANADA; MALAYSIA; RUSSIA; USA

Accession no.643016

*Item 396*

NRC '96. Conference proceedings.

Helsinki, 23rd-24th May,1996, paper 17. 8

**CARBON BLACK AND COMPOUND DYNAMIC BEHAVIOUR**

Hardy D; Money Penny H

Cabot Corp.

(Finnish Association for Rubber Technology; Nordic Council of Rubber Technology)

Tyre testing is very costly, and as a consequence, considerable resources have been expended by the tyre industry in order to predict tyre performance characteristics such as rolling resistance, wet traction and ice traction by means of laboratory dynamic property testing of tread compounds. The tread component has been shown to be a significant contributor to the hysteresis of the tyre, under normal operating conditions, and therefore on rolling resistance behaviour. The expected tyre performance of tread compounds containing carbon blacks of differing surface area/structure levels, is evaluated, based on the measurement of their viscoelastic response as a function of temperature. 13 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;  
NETHERLANDS; WESTERN EUROPE

Accession no.641394

*Item 397*

NRC '96. Conference proceedings.

Helsinki, 23rd-24th May,1996, paper 14. 8

**BIFUNCTIONAL ORGANOSILANES - HOW DO THEY FUNCTION?**

Wolff W; Goerl U; Hunsche A; Muenzenberg J

Degussa AG

(Finnish Association for Rubber Technology; Nordic Council of Rubber Technology)

Recent developments in tyre compounding have contributed to a significant rise in silica and silane consumption in the rubber industry. The target to combine long tyre life with high security and low fuel consumption has prompted tyre engineers to develop new compounding concepts in which high vinyl solution polymerised styrene-butadiene copolymers, silicas and bistrithoxysilylpropyl tetrasulphane (TESPT) are used. This has allowed a better compromise between hysteresis and wet grip without loss in wear. Two factors are responsible for the properties achieved with these raw materials. Firstly, the triethoxysilyl groups of TESPT react with the silanol groups of the silica surface, which takes place during mixing under formation of ethanol. Secondly, the rubber-reactive tetrasulphane groups of the silane form rubber-to-filler bonds during vulcanisation. In order to

obtain optimum vulcanisate properties, it is essential to ensure both reactions to take place under specific conditions. An attempt is made to summarise current knowledge about the mechanisms and kinetics of the chemical reactions between silica, organosilane and rubber. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.641391

Item 398

**Rubber News**

36, No.6, March 1997, p.38-42

**RUBBER TACK**

Majumdar S

Exxon Chemical Eastern Inc.

This paper explains the term "tack" - the property of uncured rubber to stick to itself - and then discusses the reasons for tack, enhancement of tack, tackifier resins, petroleum resins manufacturing, change in physical properties with resins, selection of resins, and finally the measurement of tack. 5 refs.

INDIA

Accession no.639497

Item 399

**Tire Technology International**

1997, p.131/40

**PHENOL FORMALDEHYDE REINFORCING RESINS IN TYRE COMPOUNDS**

Stuck B L; Souchet J-C; Fourrier C M

Sovereign Chemical Co.; CECA

This comprehensive article supplies a detailed assessment of the chemistry and applications of phenol formaldehyde reinforcing resins in the tyre industry. The differences between resol and novolak phenol formaldehyde resins are explained and a variety of chemically modified phenol formaldehyde reinforcing resins are evaluated in several different tyre compounds. The article also reviews laboratory studies that show that phenol formaldehyde reinforcing resins can be used to create improved tyre compounds.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.636141

Item 400

**Tire Technology International**

1997, p.87/90

**RUBBERS FOR LOW ROLLING RESISTANCE**

Suzuki F

Nippon Zeon Co.Ltd.

Low rolling resistance has become an important requirement for vehicle manufacturers facing environmental pressures. This comprehensive article

supplies details of the properties and characteristics of a chemically modified polybutadiene with a high vinyl content, that exhibits an excellent balance of rebound resilience at high temperature and wet skid resistance.

JAPAN

Accession no.636132

Item 401

**Tire Technology International**

1997, p.76-8

**IMPROVING RUBBER PENETRATION INTO STEELCORD**

Doujak S

Pirelli

This comprehensive article describes the latest developments in improving rubber penetration into steelcord. The article focuses on a new approach with aims which include: obtaining full compound penetration of the steelcord during calendaring, providing the necessary adhesion and corrosion resistance; obtaining appropriate cross-section geometry during calendaring and curing; and obtaining a steelcord free from residual torsion in order to produce the desired quality of rubberised fabric.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.636130

Item 402

151st ACS Rubber Division Meeting, Spring 1997, Conference Preprints.

Anaheim, Ca., 6th-9th May 1997, Paper 40, pp.37. 012

**EFFECT OF SILICA ON THE VISCOELASTIC PROPERTIES OF A MODEL TREAD COMPOUND**

Patkar S D; Bice J A E; Okel T A

PPG Industries Inc.

(ACS,Rubber Div.)

A study was made of the effects of silica/carbon black content, bistrithoxysilylpropyl tetrasulphane coupling agent content and silica surface area on the dynamic viscoelastic properties of a model SBR/polybutadiene tyre tread compound. While silica nitrogen-BET surface area did not correlate with tan delta, the CTAB and micropore surface areas correlated with both tan delta at 60C and the difference between tan delta at 0 and 60C. Coupling agent and silica content and silica micropore surface area were inversely correlated with tan delta at 60C. Silica CTAB surface area directly correlated with tan delta at 60C. The silica filled compounds had a greater impact in reducing tan delta at 60C than tan delta at 0C compared to a low hysteresis carbon black filled control. 24 refs.

USA

Accession no.636048

*Item 403*

151st ACS Rubber Division Meeting, Spring 1997, Conference Preprints. Anaheim, Ca., 6th-9th May 1997, Paper 38, pp.24. 012  
**INVESTIGATION INTO THE CHEMISTRY OF THE TESPT SULFUR CHAIN**  
Goerl U; Muenzenberg J  
Degussa AG  
(ACS,Rubber Div.)

A study was made of the reaction behaviour of the sulphur chain of bistriethoxysilylpropyl tetrasulphane (TESPT) coupling agent during vulcanisation. Model rubber systems were used to experimentally prove the existence of the rubber/filler bond, and experiments with a tyre tread compound based on a blend of solution SBR and polybutadiene were also carried out. The reactivity of the TESPT sulphur chain was studied in the absence of a material containing double bonds, and the behaviour of the polysulphide chain under thermal influence, addition of sulphur and addition of accelerator with and without sulphur was investigated by HPLC. Possible mechanisms of known reaction phenomena and effects arising due to the use of polysulphidic silanes were examined. The conclusions drawn from these investigations were applied in the development of bistriethoxysilylpropyl disulphane, a new silane for use in highly silica filled tread compounds. 26 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE  
*Accession no.636046*

*Item 404*

151st ACS Rubber Division Meeting, Spring 1997, Conference Preprints. Anaheim, Ca., 6th-9th May 1997, Paper 25, pp.63. 012  
**CARBON-SILICA DUAL PHASE FILLER: A NEW GENERATION REINFORCING AGENT FOR RUBBER. II. APPLICATION OF CARBON-SILICA DUAL PHASE FILLER TO TIRE TREAD COMPOUNDS**  
Wang M J; Patterson W J; Brown T A; Money Penny H G  
Cabot Corp.; Cabot Leiden Technical Centre  
(ACS,Rubber Div.)

Carbon-silica dual phase fillers, consisting of a carbon phase with a finely divided silica phase dispersed therein, were evaluated in NR, SBR and polybutadiene tyre tread compounds. Studies of mixing techniques and compounding design showed that, with proper mixing and compound formulation, the new fillers could give a much improved balance of hysteresis in terms of higher or comparable tan delta at low temperature and lower tan delta at higher temperature, as well as increased abrasion resistance, compared to carbon black and silica filled compounds. The use of the dual phase fillers made it possible to significantly reduce rolling resistance while also giving advantages in treadwear resistance and traction. 31 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; USA; WESTERN EUROPE  
*Accession no.636036*

*Item 405*

151st ACS Rubber Division Meeting, Spring 1997, Conference Preprints. Anaheim, Ca., 6th-9th May 1997, Paper 24, pp.62. 012  
**CARBON-SILICA DUAL PHASE FILLER: A NEW GENERATION REINFORCING AGENT FOR RUBBER. I. CHARACTERISATION OF CARBON-SILICA DUAL PHASE FILLER**  
Wang M J; Mahmud K; Murphy L; Patterson W J  
Cabot Corp.  
(ACS,Rubber Div.)

Carbon-silica dual phase fillers were characterised by a number of analytical techniques and evaluated in SBR, polybutadiene and NR compounds. The fillers consisted of a carbon phase with a finely divided silica phase (domains) dispersed therein. When incorporated into rubbers, the fillers were characterised by higher filler-polymer interaction compared to a physical blend of carbon black and silica, and lower filler-filler interaction in comparison with either conventional carbon black or silica with comparable surface area. Combined with a silane coupling agent, the fillers gave abrasion resistance comparable to that obtained with conventional carbon black, and viscoelastic properties were improved. Hysteresis at higher temperatures was drastically depressed, and at low temperatures was increased. In tyre tread applications the fillers gave lower rolling resistance, better traction and comparable wear resistance compared to compounds filled with conventional carbon black. 33 refs.  
USA

*Accession no.636035*

*Item 406*

151st ACS Rubber Division Meeting, Spring 1997, Conference Preprints. Anaheim, Ca., 6th-9th May 1997, Paper 23, pp.16. 012  
**WET SKID PROPERTIES OF FILLED RUBBERS AND THE RUBBER-GLASS TRANSITION**  
Heinrich G; Dumler H B  
Continental AG  
(ACS,Rubber Div.)

The physical relationships between the wet skid resistance of filled tyre tread compounds and the dynamics of the corresponding bulk polymers in the rubber-glass transition zone were investigated. Wet grip data and their ratings were shown to correlate with dynamic glass transition temperatures in the NMR time scale for the spin-spin relaxation time characterising the relaxation of transverse magnetisation. The corresponding frequency was independent of the Larmor frequency of the NMR experiment, the value of which was located in the frequency region of the glass-rubber transition and was a

function of polymer microstructure. Some molecular aspects of the network dynamics in the transition zone were considered. Damping curves could be predicted using the Kloczkowski-Mark-Frisch bead-spring model considered as an extended Rouse model of an entanglement network with tree-like connectivity and a certain number of sub-chains. 24 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.636034

*Item 407*

151st ACS Rubber Division Meeting, Spring 1997, Conference Preprints. Anaheim, Ca., 6th-9th May 1997, Paper 16, pp.21. 012  
**DEVELOPMENTS IN IMPROVED PERFORMANCE BROMOBUTYL RUBBERS**  
Sumner A J M; Kelbch S A; Verbiest A  
Bayer AG  
(ACS,Rubber Div.)

The processing and properties of tyre inner liner compounds based on bromobutyl rubbers with different levels of modification (of unidentified nature) were studied in comparison with a standard inner liner compound. Tests undertaken with the Bayer Tear Analyser showed a strong reduction in crack growth rate with increased modification, especially after ageing. Modulus was reduced with increasing modification, and scorch time increased without seriously affecting cure rate. Cured adhesion to an NR carcass remained at a high level over much of the range, and permeability was not affected. The low temperature properties of the more modified polymers showed a small improvement. The effects of using TMTD as a secondary accelerator on cut growth and modulus were also investigated. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.636030

*Item 408*

**Tire Business**

14, No.25, 31st March 1997, p.16

**WINTER WONDERLAND**

Zielasko D

The ability to start or stop a vehicle on snowy or icy roads is only one of the most important characteristics of a winter tyre, according to Nokian Tyres. Safe winter tyres, it claims, exhibit not only good braking and acceleration in snow, slush, ice and on rutted roads, but just as importantly, lateral grip. And these characteristics need to remain constant throughout the life of the tyre - a philosophy the company calls 'durable safety'. Achieving that type of winter driving control is the premise behind Nokian Tyres' latest product - the Hakkapeliitta 1, a studded winter tyre featuring new, environmentally friendly studs, a redesigned tread pattern and a new rubber

compound. Nokian, headquartered in Nokia, Finland, recently demonstrated the handling characteristics of its newest snow tyre; details are given.

NOKIAN TYRES LTD.

FINLAND; SCANDINAVIA; WESTERN EUROPE

Accession no.635725

*Item 409*

**Rubber Chemistry and Technology**

69, No.5, Nov-Dec.1996, p.858-73

**TIRE WET TRACTION - EXPLAINING PERFORMANCE VARIATION USING THE 'CRITICALITY' CONCEPT**

Veith A G

Technical Development Associates

The results of four different wet traction evaluation techniques show that the relative performance for individual tyres is a function of the test conditions as well as tyre design features. Two sets of candidate tyres were evaluated. Set 1 comprised six different commercial replacement tyres for regular passenger vehicles. Set 2 consisted of two groups of three experimental tyres: (1) three groove depth variations with equal tread pattern and compound properties, and (2) three compound hysteresis variations with equal tread pattern and groove depth. For a given tyre, test conditions such as test speed, road texture and water depth determine the relative magnitude of two basic footprint lubrication modes; (1) boundary layer, with intimate contact and good grip which predominates at low speeds, high texture and minimal water depth; and (2) elasto-hydrodynamic, with minimal contact and poor grip which predominates at high speeds, low texture and deeper water. A concept called 'criticality' is defined as the fraction of the footprint contact area in the elasto-hydrodynamic mode. Knowledge of the test conditions permits an estimate of the relative criticality information since tests at low criticality frequently show minimal differences (among candidate tyres) while tests at high criticality usually show a wide range of performance. 12 refs.

USA

Accession no.633323

*Item 410*

**Rubber Chemistry and Technology**

69, No.5, Nov-Dec. 1996, p.786-800

**HIGH FREQUENCY VISCOELASTICITY OF CARBON BLACK FILLED COMPOUNDS**

Gerspacher M; O'Farrell C P; Nikiel L; Yang H H; Le Mehaute F

Richardson S.,Carbon Co.; Le Mans,Institut Superieur des Materiaux

A high frequency viscoelasticity spectrometer, using the state-of-the-art ultrasonic technology, was constructed. The longitudinal and shear waves characteristics were measured in rubber compounds to obtain the attenuation

coefficient and the sound velocity. Preliminary results were obtained for a number of filled and unfilled polymers. The grade of carbon black used, filler loading, crosslinking density and filler dispersion were varied during the study. Temperature sweeps from -100 deg. C to + 60 deg. C were also studied. Results are discussed, and, in particular, it is shown that above  $T_g$ , the longitudinal wave measurements could be sufficient to determine the high frequency dynamic properties of filled and unfilled polymers; it is proposed, therefore, that the described method could be used as a tool for potential tyre traction prediction. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
USA; WESTERN EUROPE

Accession no.633317

Item 411

**International Polymer Science and Technology**

23, No.11, 1996, p.T/54-7

**DEVELOPMENT OF A METHOD FOR ASSESSING THE REAL DURABILITY OF VULCANISATES UNDER THE ACTION OF EXTERNAL FACTORS**

Prokopchuk N R; Kudinova G D; Aslovskaya O A;  
Gugovich S A

The influence of ozone and UV irradiation, with their separate action and successive application, on the activation energy of thermomechanical degradation and durability of vulcanisates was investigated. Studies were carried out on tyre tread and sidewall vulcanisates based on NR, a butadiene-methylstyrene copolymer and a blend of polybutadiene and polyisoprene. The results confirmed the correctness of using the principle of additivity of failure caused by the action of a combination of service factors in the calculation of the durability of vulcanisates. 10 refs. (Translation of *Kauchuk i Rezina*, No.4, 1996, p.25).

RUSSIA

Accession no.629924

Item 412

Patent Number: EP 747243 A1 19961211

**VEHICLE TYRE WITH DISSIPATION OF ELECTROSTATIC CHARGES**

Gerresheim M; Schomburg J; Leinweber H; Ditzel E;  
Endres W  
SP Reifenwerke GmbH

This has a tread strip of electrically insulating or poorly conductive material forming the tyre running surface and a conducting layer of good electrical conductivity arranged beneath the tread strip. A layer of material, which conducts electricity well, is provided between the two mutually abutting end faces of the tread band, which is bent into the ring-shaped tread strip. This latter layer extends radially outwardly to the ground contacting surface of the tread strip and is electrically connected to

the conducting layer beneath the tread strip, which is connected to the tyre bead region in a manner, which conducts electricity well.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.617788

Item 413

**Rubber Chemistry and Technology**

69, No.3, July-Aug.1996, p.495-568

**ROLLING RESISTANCE, WEAR AND TRACTION PROPERTIES OF TREAD COMPOUNDS**

Grosch K A

A review of the literature on the above is presented, covering tyre traction (including rubber friction, influence of the friction coefficient on braking-, traction- and cornering-forces of partially slipping wheels, and tyre forces and their relation to the tread component friction coefficient), tyre wear, rolling resistance, and interaction between rolling resistance and traction properties of tread compounds. 87 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.610696

Item 414

IRC '96. International Rubber Conference. Conference proceedings.

Manchester, 17th-21st June 1996, paper 25. 012

**DEVELOPMENT AND USE OF A LABORATORY TREAD COMPOUND WEAR EVALUATION FACILITY**

Grosch K A

(Institute of Materials)

The influence of tyre forces and speeds on the abrasion of tread compounds is described. Load and slip conditions are combined into one variable, the energy dissipated in the contact area. Experiments show that the abrasion loss is a power function of the energy dissipation in the contact area and requires two parameters, the abrasion loss  $g$ , unit energy dissipation  $A_0$  and a power index  $n$ , to describe this behaviour over a wide range of energies. These parameters are a function of the abrasive surface on which the experiments are carried out, of the compound under test and of the forward speed of the track. Energy dissipation and speed dependence can be combined into one equation in which log abrasion is related to log energy dissipation, log speed and an interaction term of log energy and log speed. With this relation the driving influences on wear on a particular surface can be described. The data are best presented as tables of ratings in relation to a known control as function of log energy dissipation and log speed. Such tables give a more comprehensive information as to the capabilities of the experimental compounds under test than a single number

and may well be useful to direct further development. At least four testing conditions are necessary for the construction of such a table. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.610041

Item 415

*European Rubber Journal*

178, No.10, Nov.1996, p.26-32

**PRESSURE LOWER AS INDUSTRY ACTS**

White L

Activity in tyre recycling across Europe is high, but the legislative future is uncertain and there are concerns about the validity of the data now available. This article examines the state of scrap tyre recycling in Europe, including the growing interest in tyres as a cement kiln fuel and numerous pyrolysis projects. Applications for scrap rubber, in particular castors and wheels, are examined.

WESTERN EUROPE-GENERAL; WESTERN EUROPE

Accession no.608928

Item 416

*International Polymer Science and Technology*

23, No.5, 1996, p.T/101-6

**TEMPERATURE DEPENDENCE OF LAMBOURN ABRASION. I. RELATION BETWEEN WEAR MECHANISM AND PROPERTIES IN LOW TEMPERATURE AND HIGH TEMPERATURE REGIONS**

Mitsuhashi K; Kaido H; Kabe K; Fujimoto K; Shinohara A

The temp. dependence of abrasion from SBR vulcanisates of varying carbon black and process oil contents was analysed at temps. of -5 to 70C using the Lambourn abrasion test. The temp. dependence curve of wear rate could be divided into a high temp. and a low temp. region, respectively above and below a temp. of about 30C, and was governed by the carbon black and oil contents. Furthermore, structural and physical parameters and the mode of abrasive wear and volume abraded exhibited a single point at the same temp., indicating transition. Although the temp. dependence of normalised applied energy, defined as the ratio of applied energy to rupture energy, obeyed a relation to some extent consistent with the temp. dependence of wear, terms quantifying the mode of abrasive failure and volume abraded should be introduced to express wear rate adequately. 11 refs. (Full translation of Nippon Gomu Kyokaishi, No.8, 1995, p.567)

JAPAN

Accession no.608113

Item 417

*Angewandte Makromolekulare Chemie*

Vol.240, Aug.1996, p.137-49

**DESIGNING ELASTOMER NETWORK FOR DESIRED TYRE PERFORMANCE CHARACTERISTICS**

Futamura S

Goodyear Tire & Rubber Co.

A series of SBR polymers was synthesised to study the effect of micro- and macro-structure of the polymer on the viscoelastic properties of tread compounds and their tyre performance properties. Correlations of wet traction of the tyre to the segmental motion of the chains are discussed. 7 refs.

USA

Accession no.603254

Item 418

RadTech '92 North America. Volume 2. Conference proceedings.

Boston, Ma., 26th-30th April 1992, p.765-9. 895

**MEDIUM ENERGY APPLICATIONS OF EB PROCESSING**

Cleland M R

Radiation Dynamics Inc.

(RadTech International)

Electron beam processing is used to modify and improve a variety of materials and products on an industrial scale. It is well established and its use is continually expanding. The main applications are the treatment of polymeric and elastomeric materials and the sterilisation of medical devices. Other environmental applications may be implemented in future. Several types of electron accelerators are available with a wide range of electron energies suitable for these purposes. An overview of this promising field is presented. 12 refs.

USA

Accession no.592819

Item 419

149th ACS Rubber Division Meeting, Spring 1996. Conference preprints.

Montreal, 5th-8th May 1996, paper 34, pp.37. 012

**APPLICATION OF THE RUBBER PROCESS ANALYSER IN CHARACTERISING THE EFFECTS OF SILICA ON UNCURED AND CURED COMPOUND PROPERTIES**

Dick J S; Pawlowski H

(ACS,Rubber Div.)

There is an increased interest in the use of precipitated hydrated silica because of the special properties it imparts to cured tyre tread compounds. The RPA 2000 Rubber Process Analyser RPA is used to study the special effects of silica. The compound effects from different types of silica are studied in the uncured state, while curing, and in the cured state. In the uncured state, the effects of variations in silica loading, particle size and structure on the formation of networks are studied with the Rubber

Process Analyser. Comparisons are made with the formation of carbon black networks. Silica loading effects on the critical strain are also studied. The non-Newtonian and thixotropic nature of silica loaded compounds are also investigated. The RPA is used to study the effects of heat treatment and the addition of an organosilane coupling agent on the mixing process for silica loaded compounds and their resulting processing and scorch properties as well as effects on cured dynamic properties at lower temperatures. Finally, the effects of silica on thermal conductivity and its implications for variable temperature cure are reviewed. 49 refs.

FLEXSYS AMERICA LP  
USA

Accession no.591675

Item 420

149th ACS Rubber Division Meeting, Spring 1996.  
Conference preprints.

Montreal, 5th-8th May 1996, paper 5, pp.36. 012

**CORRELATION OF WET TRACTION WITH  
VISCOELASTIC PROPERTIES OF PASSENGER  
TREAD COMPOUNDS**

Nahmias M; Serra A

Pirelli Coordinamento Pneumatici SpA  
(ACS,Rubber Div.)

Braking tests on wet surfaces are performed with different compounds covering a wide range of passenger tyres from low rolling resistance S rated to V and Z rated tyres. Two different roughness surfaces are used to evaluate tyre peak and slide behaviour. Viscoelastic properties of compounds are measured using temperature and strain sweeps. Tyre peak behaviour is very well predicted by G (constant strain energy loss) varying the strain level for different surface roughness. Sample curing conditions are critical for a good wet traction prediction. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;  
WESTERN EUROPE

Accession no.591646

Item 421

**European Rubber Journal**

178, No.6, June 1996, p.22

**MICHELIN CONFIRMS C3M PLANTS**

Groupe Michelin has confirmed that it is building C3M plants North America. The company is also building earthmover tyre operations there and truck tyre operations. Michelin is currently working on four new lines for solution polymers. Each line would have capacity for about 45kt/year of polymer, depending on the type and grades involved. The lines will be used for S-SBR and BR. The company is adding additional lines at its Bassens, France facility and its Louisville, Kentucky unit. In addition, Michelin is planning a new polymer facility in Thailand with its partner Siam Cement group.

MICHELIN GROUP

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;  
WESTERN EUROPE

Accession no.590444

Item 422

London, Chapman & Hall, 1996, pp.ix, 342. 69.00.  
10ins. 31/1/96. 9T

**PHYSICAL TESTING OF RUBBER. THIRD  
EDITION**

Brown R

Rapra Technology Ltd.

This book presents a comprehensive coverage of physical test methods for rubbers. It includes a discussion of reasons for testing, trends in test development and quality control in laboratories. A number of subjects common to all areas of physical testing are addressed, including stress and strain, friction and wear, creep, relaxation, set and fatigue. The book also describes all relevant ISO, BSI and ASTM standards. Appendices provide information on the national standards bodies, and thermal equilibrium times for non-ambient testing.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK;  
WESTERN EUROPE

Accession no.588279

Item 423

**European Rubber Journal**

178, No.5, May 1996, p.23

**NEURAL NET SHOWS GREAT PROMISE**

Shaw D

Neural networks in general and CAD/Chem from AI Ware in particular, help reduce recipe development time, according to rubber processors who use the system. Cooper Tire & Rubber says it puts the system to good use as a compounding simulator for new recruits, enabling them to experiment without using up lab time. Cooper and Standard Products both said it was the trigger which made them finally set up a proper database of ingredients and compound properties. While DSM has only used the programme on a very small sub-set of recipes, it expects to see "stunning results" when the software is used on the full set of 20,000 recipes.

AI WARE INC.

WORLD

Accession no.587260

Item 424

148th ACS Rubber Division Meeting, Fall 1995.  
Conference Preprints.

Cleveland, Oh., 17th-20th Oct.1995, Paper 65, pp.26.  
012

**MECHANISM BY WHICH PRECIPITATED  
SILICA IMPROVES BRASS COATED WIRE-TO-  
NATURAL RUBBER ADHESION**

Waddell W H; Evans L R; Goralski E G; Snodgrass L J  
PPG Industries Inc.

(ACS,Rubber Div.)

The effects of precipitated silica on adhesion between brass coated steel tyre cords and an NR/polyisoprene wire coat formulation were investigated by the quantitative determination of elements in the interfacial growth layer formed on cords treated in model systems consisting of squalene suspensions containing carbon black and curing ingredients, with and without silica and organocobalt. The surface characterisation techniques used included SEM with energy dispersive X-ray analysis, Auger electron spectroscopy, X-ray photoelectron spectroscopy and proton induced X-ray emission spectroscopy. The effects of using silica and cobalt neodecanoate in the suspensions were statistically analysed. The mechanism for adhesion improvement by silica was shown not to be a simple effect of improving the rubber physical properties. A chemical mechanism in which silica moderates the thickness and relative elemental composition of the interfacial growth layer was proposed. 44 refs.

USA

Accession no.580248

*Item 425*

148th ACS Rubber Division Meeting. Fall 1995.  
Conference Preprints.  
Cleveland, Oh., 17th-20th Oct.1995, Paper 30, pp.47.  
012

**TYRE TRACTION VERSUS TREAD  
COMPOUND PROPERTIES: HOW PAVEMENT  
TEXTURE AND TEST CONDITIONS  
INFLUENCE THE RELATIONSHIP**

Veith A G

Technical Development Associates  
(ACS,Rubber Div.)

A review is presented of the basic mechanisms of rubber friction and the technology for evaluating the skid resistance of tyres. Results are given of a study undertaken to assess the influence of the viscoelastic properties of tread compounds with varying T<sub>g</sub> and carbon black and oil contents on wet traction over a range of test conditions and on surfaces with different textures. Some limitations of current tyre traction evaluation protocols are discussed, and recommendations are made for techniques which directly relate to motoring situations most likely to cause skidding. 30 refs.

USA

Accession no.580217

*Item 426*

148th ACS Rubber Division Meeting. Fall 1995.  
Conference Preprints.  
Cleveland, Oh., 17th-20th Oct.1995, Paper 29, pp.25.  
012

**REVIEW OF GLOBAL HEAVY-DUTY TRUCK  
TYRE TESTING**

Carmickle S P; Mezynski S

Goodyear Tire & Rubber Co.  
(ACS,Rubber Div.)

An examination is made of factors affecting tyre performance, and testing methodology involved in the development of heavy-duty truck tyres is reviewed. 10 refs. (The published paper is incomplete).

USA

Accession no.580216

*Item 427*

**European Rubber Journal**

177, No.12, Dec.1995, p.22

**NOISE IS TOP OF TYRE AGENDA**

Shaw D

Noise and rolling resistance were the twin themes of TyreTech '95 in Turin. Leading tyre companies are now talking about "low hysteresis compounding" for all the rubber compounds used in a tyre. An example of FEA analysis of tyre elements to improve rolling resistance was given by Bridgestone. Presenting an alternative view on tyre development, especially from the noise point of view, Belgium's Road Research Institute highlighted the importance of road "megatexture" on noise and wear. Megatexture refers to surface irregularities in the road which are of the same order as the circumference of a tyre.

WORLD

Accession no.569070

*Item 428*

**Rubber and Plastics News**

24, No.19, 10th April 1995, p.6

**OPEL ASTRA FIRES LEAD TO STUDY OF  
MICHELIN'S SILICA-BASED TIRES**

Davis B

This article reports that insufficient conductivity of Michelin's "green" tyres is being investigated as a possible cause of an electrostatic build-up on Opel Astra compacts, that has led to flash fires during fuelling, all of which have occurred in Germany. Details of the situation are provided.

MICHELIN; MICHELIN NORTH AMERICA; OPEL  
AG

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;  
WESTERN EUROPE

Accession no.561248

*Item 429*

**Kautchuk und Gummi Kunststoffe**

48, No.7-8, July/Aug.1995, p.515/20

**REDUCTION OF ROLLING RESISTANCE  
UNDER HIGH INFLATION PRESSURE -  
ELECTRIC VEHICLE TYRE**

Uemura Y; Saito Y

Sumitomo Rubber Co.Ltd.

For the reduction of rolling resistance, adoption of high inflation pressure is significantly effective, but under this condition, effects of energy loss in the tyre tread region becomes larger than those of other parts. Therefore, aiming at the improvement of energy loss in tyre tread region, many tyres were made incorporating combinations of different tread compounds and patterns to investigate the effects of these factors on tyre rolling resistance.

JAPAN

Accession no.559848

*Item 430*

147th Meeting, Spring 1995, Conference Preprints. Philadelphia, Pa., 2nd-5th May 1995, Paper 27, pp.14. 012

**PROPERTIES AND APPLICATIONS OF PEN FIBRES**

Rim P B  
AlliedSignal Inc.  
(ACS,Rubber Div.)

Studies of the mechanical properties of tyre cords made of polyethylene naphthalate (PEN) fibres are reported and comparisons made with rayon, nylon 66, aramid, PETP and steel cords. Potential applications of PEN cords in high performance passenger tyres, truck tyres and passenger tyre cap plies are examined. 4 refs.

USA

Accession no.552363

*Item 431*

146th Meeting, Fall 1994, Conference Proceedings. Pittsburgh, Pa., 11th-14th Oct.1994, Paper 83, pp.23. 012

**TECHNIQUES FOR ELECTRON VULCANISATION OF RUBBER**

Nablo S V; Makuuchi K

Energy Sciences Inc.; Japan,Atomic Energy Research Institute  
(ACS,Rubber Div.)

The use of electron beam and gamma irradiation for the crosslinking of elastomers is reviewed, with emphasis on the production of NR latices suitable for the manufacture of dipped products having reduced cytotoxicity, modulus and ash/gas formation on incineration compared with sulphur vulcanised materials. The beneficial effects of radiation in extracting water soluble proteins responsible for allergic reactions are examined, and results are presented of tests showing the negligible nitrosamine content resulting from the absence of dithiocarbamate accelerators. 16 refs.

JAPAN; USA

Accession no.535557

*Item 432*

Shawbury, Rapra Technology Ltd., 1993, pp.122. 12ins. 22/11/93. Rapra Review Rept.No.68. Vol.6, No.8, 1993. 9111T

**CURE ASSESSMENT BY PHYSICAL AND CHEMICAL TECHNIQUES**

Willoughby B G  
Rapra Technology Ltd.  
Edited by: Dolbey R  
Rapra Review Report No.68

Physical and chemical monitoring methods used to evaluate the state of curing are described and critically evaluated. Comments on both practical and theoretical aspects of cure monitoring are included and the process of cure itself is considered. 510 refs. This item is available only by purchase from Rapra Technology Ltd.

EUROPEAN COMMUNITY; UK; WESTERN EUROPE

Accession no.501040

# Subject Index

## A

ABRASION, 4 5 24 83 84 184 203  
257 296 297 300 333 379 388  
416 425

ABRASION RESISTANCE, 7 8 10  
11 19 25 28 34 41 51 71 74 80  
87 88 89 98 99 105 108 113 133  
148 149 157 160 161 172 180  
199 201 203 210 212 219 225  
238 239 240 244 245 249 250  
259 261 275 281 299 305 306  
313 314 316 318 333 337 341  
344 346 349 351 362 366 373  
375 389 393 404 405 414 426

ABS, 137

ABSORPTION, 332 375 402 404  
405

ACCELERATED TEST, 5 21 113  
203 250 426

ACCELERATION, 218

ACCELERATOR, 18 30 36 68 106  
139 157 169 185 226 234 241  
248 252 253 254 259 284 290  
295 299 317 331 383 403 404  
407 418 431

ACCELEROMETRY, 388

ACCIDENT, 59

ACOUSTIC SPECTROSCOPY, 78

ACTIVATOR, 139 246

ADHESION, 4 13 16 24 36 49 50  
52 54 58 59 60 64 72 74 76 90  
91 101 121 123 131 139 140  
144 158 195 211 220 224 239  
249 251 253 254 255 256 257  
263 264 287 294 296 297 301  
307 317 325 336 353 390 391  
397 398 401 407 422 424 425  
430

ADHESION PROMOTER, 16 49  
50 52 54 55 56 58 72 76 127  
132 220 253 255 292 294 298  
301 317 353 424 430

ADHESIVE, 58 60 90 93 221 255  
302 430

ADHESIVE FAILURE, 257

ADSORPTION, 133 248 249 316  
364 404 405

AGEING, 4 5 16 18 19 50 52 57 76  
106 109 114 171 177 204 217  
234 239 245 250 251 253 254  
279 298 307 315 346 357 364  
377 391 394 407 424 426 431

AGEING RESISTANCE, 40 64 71  
123 264 287

AGGLOMERATE, 239 248 316  
389

AGGREGATE, 8 118 249 270 282  
345 372 404 405

AGRICULTURAL TYRE, 232

AIR PERMEABILITY, 64 173 239  
254 263 407

AIR PRESSURE, 257 388

AIRCRAFT TYRE, 232 254 258  
291 339

ALKYLRESORCINOL  
POLYMER, 55

ALL-WEATHER TYRE, 88 165

ALPHA-METHYLSTYRENE  
TERPOLYMER, 263

ALUMINA, 388

ALUMINIUM TRIHYDRATE, 38  
125

AMBIENT GRINDING, 128 415

AMINE, 13 18 226 290 295 342

AMINOPROPYLTRIETHOXY-SILANE,  
259

ANALYSIS, 15 24 32 33 45 47 52  
82 86 115 122 134 176 178 227  
234 243 248 249 252 256 257  
259 260 261 262 271 274 301  
329 330 345 367 368 388 389  
390 391 402 403 404 405 406  
407 424 425 426 431 432

ANGLE-PLY, 258

ANISOTROPY, 33 315

ANNEALING, 119 120

ANTIDEGRADANT, 215 216 239  
241 253 254 342

ANTIFERROMAGNETIC  
PROPERTIES, 61

ANTIFREEZE, 388

ANTIOXIDANT, 59 68 81 124 216  
234 239 251 253 254 273 342  
426 431

ANTIOZONANT, 6 20 43 113 124  
139 170 191 216 226 234 239  
250 251 253 254 273 287 309  
329 339 349 391

ANTI-REVERSION AGENT, 6 20  
191 253 287 339 349

ANTI-SCORCH AGENT, 234

ANTITACK AGENT, 63 321 431

APPEARANCE, 390 391

AQUAPLANING, 45 84 115 167  
176 425

AQUAPLANING RESISTANCE,  
1 3

AQUEOUS ADHESIVE, 255

ARAMID FIBRE, 164 195 312 430

ARAMID FIBRE-REINFORCED  
RUBBER, 37 255 334

ARGON, 56 96

AROMATIC, 14 80 183 360 361

ARTIFICIAL NEURAL  
NETWORK, 262

ASPECT RATIO, 27 38 426

ASPERITY, 256

ASPHALT, 256

ASSEMBLY, 48 61 95 137 292

ATOMIC FORCE MICROSCOPY,  
107 259 310 337

AUTOMATION, 95 240 280 331  
332 355 366 388

## B

BALE, 284

BANBURY MIXER, 36 239 268  
286 299

BARIUM SULPHATE, 7 38

BATCH CONTROL, 185

BATCH MIXING, 45 47 110 115  
134 176 299

BATCH TESTING, 47

BEAD, 399

BEAD-SPRING MODEL, 406

BELT, 4 37 59 68 74 86 117 139  
255 284

BENZENE, 234 270

BENZOQUINONE, 13

BENZOTHAZOLE, 290

BENZOTHAZOLE  
SULPHENAMIDE, 252

BETAINE, 13

BIAS PLY TYRE, 144 232 258

BICYCLE TYRE, 71 382

BINDER, 46 197

BIOLOGICAL ATTACK, 5

BIOPOLYMER, 3 236 314 328 356

BISCITRACONIMIDO-  
METHYLBENZENE, 6 191  
289 349 393

BISMALEIMIDE, 132

BISPHENOL, 391

BISTETRAHYDROBENZALDEHYDE  
PENTAERYTHRITYL  
ACETAL, 391

BISTRIETHOXY-SILYLPROPYL  
DISULPHANE, 403

BISTRIETHOXY-SILYLPROPYL  
DISULPHIDE, 9

BISTRIETHOXY-SILYLPROPYL  
TETRASULPHANE, 175 243  
402 403 405

- BISTRIETHOXSILYLPROPYL  
 TETRASULPHIDE, 6 9 76 259  
 BISTRIMETHOXSILYLPROPYL  
 AMINE, 76  
 BITUMEN, 364  
 BLACK INCORPORATION  
 TIME, 407  
 BLADDER, 57 217  
 BLEND, 12 14 18 19 28 42 44 54  
 66 71 78 81 87 88 103 104 124  
 126 145 146 157 168 177 182  
 185 191 204 205 206 208 234  
 239 250 251 252 253 254 255  
 259 260 261 262 273 275 281  
 299 300 322 323 338 343 347  
 356 363 376 388 389 390 391  
 402 403 411 414 424 425 426  
 431  
 BLOOM, 113 391  
 BLOOMING, 4 250 377  
 BLOW-OUT, 6 252 253  
 BOND STRENGTH, 13 36 52 54  
 93 123 132 238 253 255 317  
 BONDING, 4 16 50 52 54 55 59 60  
 61 72 76 90 91 220 221 238  
 253 254 255 287 291 292 298  
 317 397 403 421 430  
 BONDING AGENT, 4 46 49 58 90  
 93 253 255 287 292 302 339  
 430  
 BOUND ANTIOXIDANT, 234 253  
 BOUND RUBBER, 37 119 120  
 404 405  
 BRABENDER PLASTICORDER,  
 405  
 BRAKING, 1 3 67 78 84 85 165  
 218 256 300 388 413 425  
 BRASS, 4 16 76 254 307 325 353  
 424  
 BREAKING STRENGTH, 12 82  
 BROMINATED, 88 157 251 259  
 260 336 390 391  
 BROMINE, 88 204 254 336  
 BROMOBUTYL RUBBER, 19 44  
 121 139 254 286 352 391 407  
 BROMOMETHYLSTYRENE  
 COPOLYMER, 251 260  
 BUS TYRE, 45 115 176 286 300  
 BUTADIENE-ACRYLONITRILE  
 COPOLYMER, 4 30 42 58 66  
 74 113 114 185 199 206 255  
 256 278 308 363 371 395 425  
 BUTADIENE COPOLYMER, 13  
 BUTADIENE-  
 METHYLSTYRENE  
 COPOLYMER, 13 411  
 BUTADIENE RUBBER, 66 311  
 BUTADIENE-STYRENE  
 COPOLYMER, 12 15 18 19 27  
 28 29 30 36 39 42 44 47 70 73  
 75 78 80 82 83 88 106 134 143  
 151 154 161 182 186 191 193  
 198 199 206 207 208 209 211  
 216 229 232 239 249 250 252  
 253 255 259 261 262 263 275  
 277 278 279 283 293 300 308  
 315 326 329 331 338 340 345  
 346 347 351 372 379 388 398  
 400 402 403 404 405 406 410  
 411 414 416 417 421 423 425  
 426 431  
 BUTADIENE-STYRENE  
 RUBBER, 119 120 141 279 303  
 311 333 400 410  
 BUTADIENE TERPOLYMER,  
 263  
 BUTYL BENZOTHAZOLYL  
 SULPHENIMIDE, 18  
 BUTYL BENZOTHAZYL  
 SULPHENAMIDE, 252  
 BUTYL RUBBER, 12 19 44 64  
 121 126 139 142 144 160 168  
 199 204 208 216 217 239 247  
 254 278 283 286 309 338 344  
 352 376 391 395 406 407  
 BY-PRODUCT, 316
- C**
- CALCIUM CARBONATE, 38  
 CALCIUM HYDROXIDE, 38  
 CALCIUM SILICATE, 50  
 CALENDER, 48 198  
 CALENDERING, 285 294 401  
 CAMELBACK, 300  
 CAP PLY, 37 430  
 CAPILLARY RHEOMETRY, 306  
 CAPILLARY VISCOMETER, 47  
 CAR TYRE, 26 27 41 48 65 77 81  
 84 105 106 149 155 165 167  
 188 200 201 205 226 227 235  
 240 245 248 254 259 264 279  
 288 293 301 322 335 336 348  
 352 375 376 381 402 403 404  
 407 420 430  
 CARBON BLACK, 7 8 12 13 15  
 17 22 23 24 30 35 39 42 44 47  
 49 51 52 65 70 78 81 82 83 87  
 88 99 101 103 107 108 118 119  
 120 126 139 140 141 143 145  
 148 149 156 160 161 172 173  
 177 180 181 182 183 185 186  
 189 202 204 208 210 211 224  
 225 232 233 234 237 239 240  
 244 246 249 250 251 253 254  
 255 257 258 259 260 262 269  
 271 275 280 281 282 283 284  
 296 297 299 303 309 310 313  
 314 315 316 318 319 323 324  
 332 333 337 340 343 345 346  
 347 362 364 367 368 371 372  
 373 375 378 380 388 389 390  
 391 392 396 398 400 402 404  
 405 407 410 414 416 424 425  
 428  
 CARBON DIOXIDE, 40  
 CARCASS, 36 180 239 291 430  
 CARCINOGEN, 274 276 295 360  
 361  
 CASE HISTORY, 43 115 176  
 CAST, 179  
 CASTOR OIL, 57  
 CATALYST, 29 121 151 254 255  
 300 305  
 CELLULOSE, 253 314  
 CELLULOSE FIBRE, 253  
 CETYLTRIMETHYLAMMONIUM  
 BROMIDE, 402  
 CHAIN BRANCHING, 261 331  
 CHAIN LENGTH, 251 390 403  
 406  
 CHAIN SCISSION, 257 391 404  
 406  
 CHANNEL BLACK, 13  
 CHARACTERISATION, 8 24 25  
 35 47 76 107 172 278 333 368  
 373 378 401  
 CHEMICAL BONDING, 238 243  
 254 255 292  
 CHEMICAL MODIFICATION, 11  
 50 55 104 129 147 151 174 181  
 189 240 250 255 259 260 280  
 281 341 344 390 391 399 400  
 403 407  
 CHEMICAL RECYCLING, 31  
 CHEMICAL RESISTANCE, 87  
 113 139 146 234 239 250 251  
 253 254 257 279 390 391 394  
 411  
 CHEMICAL STRUCTURE, 28 35  
 37 61 73 74 87 113 126 163 247  
 251 260 261 263 264 300 325  
 390 403 406 411  
 CHINA CLAY, 38  
 CHIP RESISTANCE, 253 426  
 CHLORINATED PARAFFIN, 57  
 CHLORINATED PE, 139  
 CHLOROBUTYL RUBBER, 44  
 286 344 379 391 425 426  
 CHLOROFORM, 234  
 CHLOROSULPHONATED  
 POLYETHYLENE, 139 299  
 CHROMATOGRAPHY, 47 194  
 329 391 403

- CIS-1,4-POLYBUTADIENE, 252  
 CIS-POLYBUTADIENE, 250 259  
 263 300  
 COAGULATION, 261 431  
 COATED FILLER, 23 249  
 COATING, 31 59 63 123 301 392  
 401  
 COBALT, 300 353 424  
 COBALT SALT, 52 220 239 253  
 254 298 424  
 COEFFICIENT OF FRICTION, 24  
 67 140 158 256 306 388 406  
 409 425  
 COEXTRUSION, 240  
 COLD FEED, 116 117 284  
 COLD-FEED EXTRUDER, 48  
 COLLAPSIBLE, 95  
 COLLOIDAL SILICA, 140  
 COLOUR, 390 391 395  
 COMFORT, 95 167  
 COMPATIBILISER, 46 128 185  
 311  
 COMPATIBILITY, 14 61 174 228  
 281 343 360 383 390  
 COMPLEX MODULUS, 86 248  
 256 425  
 COMPOSITE, 4 35 37 52 54 61 70  
 73 74 137 177 182 185 189 195  
 239 241 253 254 255 258 302  
 303 311 312 334 382 399 401  
 424 426 430  
 COMPOUND, 42 45 46 52 61 80  
 95 152 155 158 177 180 185  
 239 248 249 250 252 254 255  
 256 259 260 261 262 283 284  
 291 299 314 316 365 366 367  
 382 388 389 390 398 399 400  
 401 402 403 404 406 407 420  
 425 428  
 COMPOUNDING, 8 12 23 25 35  
 37 39 52 71 73 94 102 103 107  
 110 111 121 138 148 152 168  
 174 193 196 198 200 234 239  
 245 247 248 249 252 253 259  
 260 262 268 269 271 281 284  
 286 299 308 324 328 332 343  
 347 355 356 369 371 375 377  
 389 390 392 402 403 404 405  
 407 414 423 424 427  
 COMPOUNDING INGREDIENT,  
 121 281 283 346  
 COMPRESSIBILITY, 86  
 COMPRESSION, 249 263 306  
 COMPRESSION MODULUS, 430  
 COMPRESSION PROPERTIES,  
 100 300  
 COMPRESSION SET, 18 28 30 79  
 86 89 114 139 290 346  
 COMPUTER AIDED ANALYSIS,  
 115 176 259 262 389 402  
 COMPUTER AIDED DESIGN, 41  
 45 115 167 176 179 365 423  
 COMPUTER AIDED  
 FORMULATION, 423  
 COMPUTER AIDED TESTING,  
 388 407 426  
 COMPUTER CONTROL, 95 355  
 388  
 COMPUTER MODEL, 45 115 179  
 427  
 COMPUTER SIMULATION, 115  
 332 355 365  
 CONTACT AREA, 165 256 388  
 425  
 CONTACT PRESSURE, 24 425  
 CONTAMINATION, 134 137  
 CONTROL EQUIPMENT, 110 117  
 240 269 365  
 CONTROL SYSTEM, 95 280 355  
 388  
 COOLING, 11 95 117 159 196 239  
 240 262 284 299  
 COPPER, 16 52 424  
 COPPER SULPHIDE, 239  
 CORD, 58 255 258 317  
 CORN STARCH, 314  
 CORNERING, 218 259 388 413  
 425 426  
 CORRELATION COEFFICIENT,  
 359 388 425  
 CORRELATION FUNCTION, 256  
 406  
 CORROSION, 4 422  
 CORROSION RESISTANCE, 76  
 301 401  
 COST, 2 7 9 29 55 64 95 125 133  
 137 188 198 213 277 280 281  
 284 285 301 312 321 356 383  
 COUNTER-PRESSURE, 299  
 COUPLING, 9 356  
 COUPLING AGENT, 6 7 9 11 12  
 40 42 61 73 74 76 88 89 91 97  
 102 104 112 129 133 147 148  
 157 162 175 186 209 236 238  
 239 240 248 259 280 281 303  
 316 331 341 344 345 353 354  
 373 397 402 403 404 405  
 CRACK GROWTH, 15 33 42 79  
 82 108 145 173 204 205 210  
 251 254 257 300 332 357 359  
 390 407  
 CRACK INITIATION, 257  
 CRACK RESISTANCE, 14 113  
 128 250 390  
 CRACKING, 81 108 180 205 250  
 251 254 257 258 305 376 390  
 391 407 426  
 CREEP, 5 79 81 86 202 258 312  
 422 426  
 CROSS PLY TYRE, 144 232 258  
 CROSSLINK, 29 30 135 395 431  
 CROSSLINK DENSITY, 18 30 73  
 114 126 194 209 210 215 248  
 251 252 263 289 406 426 432  
 CROSSLINKING, 6 28 44 61 106  
 123 135 147 169 185 194 206  
 209 214 240 243 248 251 252  
 253 346 349 358 377 390 398  
 399 403 404 406 410  
 CROSSLINKING AGENT, 123  
 128 311  
 CRUMB RUBBER, 31 53 75 136  
 192 193 194 198 199 278 285  
 308 415  
 CRYSTALLINITY, 61 190 398 430  
 CURE METER, 47 86 226  
 CURE RATE, 10 18 42 52 57 89  
 112 122 139 163 169 175 209  
 234 248 252 253 254 290 331  
 332 404 405 407 432  
 CURE TIME, 36 50 52 91 168 191  
 248 250 252 253 259 260 261  
 389 395 399 402 407 424  
 CURING, 4 20 30 36 44 45 46 57  
 87 88 93 112 115 162 168 169  
 171 175 176 178 185 209 215  
 217 224 241 271 286 306 307  
 324 331 332 336 339 353 354  
 373 376 381 382 398 401 410  
 418 419 431 432  
 CURING AGENT, 10 106 121 123  
 127 128 139 157 163 205 214  
 229 234 239 252 253 254 255  
 259 260 284 286 289 299 311  
 327 339 370 376 377 379 385  
 389 391 393 395 399 403 411  
 424 431  
 CURING BLADDER, 217 370  
 CURING SYSTEM, 30 251 252  
 253 403 404 407  
 CURING TEMPERATURE, 52 72  
 168 191 250 252 255 259 260  
 302 341 389 390 395 405  
 CURVE FITTING, 388  
 CUSHION GUM, 36  
 CUSTOM COMPOUNDING, 94  
 138  
 CUT GROWTH, 87 205 250 254  
 300 346 354 390 407  
 CUT RESISTANCE, 390 426  
 CYCLE TIME, 11 159 299  
 CYCLIC LOADING, 33 258  
 CYCLOHEXYL  
 BENZOTHAZYL

SULPHENAMIDE, 252  
CYCLOHEXYL  
THIOPHTHALIMIDE, 234

**D**

DAMAGE, 154 258 426  
DAMPING, 86 167 406  
DATABASE, 332 355 423  
DEAGGLOMERATION, 89 248  
DEBONDING, 257 258  
DEFECT, 257 316 389  
DEFLECTION, 32 257 390 407  
426  
DEFORMATION, 12 15 22 27 78  
83 86 118 143 218 227 242 255  
256 258 263 282 316 359 387  
406 411 425 430  
DEGRADATION, 4 5 16 18 19 29  
50 52 57 73 76 81 106 109 114  
120 171 177 200 204 217 234  
239 245 250 251 253 254 279  
298 307 315 327 357 364 377  
391 394 395 407 411 418 426  
DEGREASING, 4  
DEGREE OF DISPERSION, 7 51  
73 122 182 284 347  
DEGREE OF SWELLING, 13 14  
DEGREE OF UNSATURATION,  
35 87 247  
DELAMINATION, 258  
DENSITY, 7 35 61 71 122 248 260  
356 360 410 422  
DEPTH PROFILING, 16 424  
DESIGN, 11 26 31 32 34 45 59 85  
115 130 131 137 152 153 158  
159 176 179 193 196 207 227  
235 262 264 266 267 293 365  
DESIGN FOR DISASSEMBLY,  
137  
DEVELOPMENT, 41 47 136 138  
166 188 245 278 291 312 335  
368 374  
DEVULCANISATION, 29 31 75  
193 285 395  
DIALKYL  
PARAPHENYLENEDIAMINE,  
113 250  
DIBENZYLTHIOCARBAMOYL  
DITHIOHEXANE, 106  
DIBUTYL PEROXIDE, 122  
DIBUTYL PHTHALATE, 248 249  
402 405  
DIE SWELL, 119 120 180 331  
DIELECTRIC PROPERTIES, 432  
DIENE POLYMER, 36 51 304 305  
306  
DIENE RUBBER, 146 163 214

251  
DIFFERENTIAL SCANNING  
CALORIMETRY, 329 432  
DIFFERENTIAL THERMAL  
ANALYSIS, 283 329 384 410  
DIFFUSION, 247 250 253 391 404  
DIISOBUTYLAMINE, 252  
DIMENSIONAL STABILITY, 131  
254 374 383 430  
DIMETHYLBUTYL PHENYL  
PHENYLENEDIAMINE, 234  
250  
DIMETHYLPENTYL  
PHENYLENEDIAMINE, 250  
DIPPING, 255 430 431  
DIRECTIONAL TREAD, 1  
DIRECTIVE, 137 361 415  
DISASSEMBLY, 137  
DISCOLOURATION, 309 390 391  
DISPERSANT, 40 46 128 135 162  
311  
DISPERSE PHASE, 390  
DISPERSIBILITY, 37 74 89 111  
114 133 161 174 246 316 341  
DISPERSING AGENT, 40 46 128  
135 162 311  
DISPERSION, 9 35 42 47 63 89  
135 138 139 150 177 200 201  
223 239 240 248 249 251 255  
261 269 280 284 299 316 321  
331 356 369 371 372 382 389  
403 404 424  
DISPERSIVE MIXING, 73 239  
DISPERSIVITY, 7 51 73 122 182  
284 347  
DISPLACEMENT, 249 257 258  
DITHIOCARBAMATE, 391 431  
DOPING, 405  
DRYING, 89 240 316  
DURABILITY, 19 20 82 121 128  
144 146 247 251 252 253 254  
263 342 382 383 411 426  
DUROMETER, 46  
DYNAMIC, 10 50 242 250 422  
DYNAMIC LOSS MODULUS,  
182  
DYNAMIC MECHANICAL  
ANALYSIS, 78 118 259 288  
320 331 332 402  
DYNAMIC MECHANICAL  
PROPERTIES, 20 52 86 118  
122 130 180 182 206 210 215  
239 242 248 249 256 259 261  
262 263 290 326 357 363 384  
390 402 403 404 405 406 425  
430  
DYNAMIC MECHANICAL  
SPECTROSCOPY, 21 405

DYNAMIC MECHANICAL  
THERMAL ANALYSIS, 21  
390  
DYNAMIC MODULUS, 86 140  
143 156 239 248 402 430  
DYNAMIC PROPERTIES, 5 20 30  
52 86 88 100 102 106 118 122  
130 143 148 150 156 162 180  
182 200 206 210 214 215 239  
242 248 249 256 259 261 262  
263 282 288 290 324 326 336  
341 344 345 357 362 363 381  
384 390 402 403 404 405 406  
410  
DYNAMIC STORAGE  
MODULUS, 78  
DYNAMIC VISCOELASTIC  
PROPERTIES, 402  
DYNAMIC VISCOSITY, 86

**E**

E-MODULUS, 86  
EARTHMOVER TYRE, 74 421  
ELASTIC MODULUS, 33 86 257  
262 338 381 404 420 425  
ELASTIC PROPERTIES, 12 20 22  
24 47 52 78 83 86 100 104 108  
118 144 153 158 171 173 200  
206 208 210 215 224 234 246  
249 256 262 263 271 275 281  
297 307 324 326 330 331 338  
347 354 356 359 373 379 396  
402 404 405 406 410  
ELASTICITY, 61 180 242 257 313  
331 345 432  
ELECTRICAL CONDUCTIVITY,  
180 412 428  
ELECTRICAL INSULATION, 92  
137  
ELECTRICAL PROPERTIES, 61  
92 137 150 180 249 271 284  
404  
ELECTRICAL RESISTANCE, 12  
156 181 246 249 422  
ELECTRICAL RESISTIVITY, 150  
249 284 375 381 404  
ELECTROCHEMICAL  
DEPOSITION, 301  
ELECTRON BEAM CURING,  
418 431  
ELECTROSTATIC DISCHARGE,  
162  
ELECTROSTATIC DISSIPATION,  
233 412  
ELONGATION, 10 46 47 52 132  
162 217 250 251 253 261 286  
383 402 405 411 430

- ELONGATION AT BREAK, 2 64  
82 88 114 170 180 198 259 316  
390 405 431
- EMISSION, 4 137 183
- ENERGY CONSERVATION, 1 19  
105 133 151 166 181 223 230  
237 244 263 281 368 376
- ENERGY CONSUMPTION, 3 12  
23 40 52 95 110 116 137 138  
284 299 314 368 383 407
- ENERGY DISPERSIVE X-RAY  
ANALYSIS, 249 405 424
- ENERGY DISSIPATION, 61 86  
158 256 281 282 316 330 388  
406 407 414 427
- ENERGY EFFICIENCY, 11
- ENERGY LOSS, 22 67 256 263  
281 425 429
- ENERGY RECOVERY, 31 137  
386 415
- ENERGY RELEASE RATE, 258
- ENERGY STORAGE, 257 282
- ENVIRONMENT, 5 68 95 137 183  
230 237 328 386 418
- ENVIRONMENTAL HAZARD,  
68 360 361
- ENVIRONMENTAL IMPACT, 4  
40 68 95 137
- ENVIRONMENTAL  
LEGISLATION, 137
- ENVIRONMENTAL  
PROTECTION, 12 40 46
- ENVIRONMENTAL  
RESISTANCE, 79 253 422
- ENVIRONMENTALLY  
FRIENDLY, 3 46 314 335
- EPICHLOROHYDRIN RUBBER,  
139
- EPOXIDISED NR, 127
- EPOXY RESIN, 69
- ETHYLENE-PROPYLENE  
COPOLYMER, 299
- ETHYLENE-PROPYLENE-  
DIENE TERPOLYMER, 4 30  
61 74 87 92 124 126 134 139  
180 195 196 199 255 278 284  
299 309 326 371 376 379 389  
391 395 398 423
- EXPOSURE TIME, 52 250 257  
411
- EXTENDER, 38 80 98 180 239  
250 252 254 259 274 275 276  
284 299 390 391 404 407 425
- EXTENSIONAL VISCOSITY, 86
- EXTRACTION, 14 234 360 405  
431
- EXTRUDATE, 119 120 261 389
- EXTRUDER, 45 48 95 115 116  
117 138 240 266 267 280 284  
285 294 299
- EXTRUDER HEAD, 116 117 240  
284
- EXTRUSION, 45 52 95 115 129  
134 152 171 176 180 187 198  
212 240 246 261 266 267 271  
280 284 286 299 371 389 404
- EXTRUSION FAULT, 261 389
- EXTRUSION MIXING, 266 267  
284
- F**
- FABRIC, 4 245 401
- FAILURE, 4 15 59 82 210 250 251  
253 254 257 258 291 318 390  
407 411 416 430
- FAILURE ANALYSIS, 33 43 132
- FATIGUE, 5 15 33 64 79 82 205  
210 216 239 251 253 254 257  
258 263 287 305 306 307 336  
352 357 359 362 390 407 422  
430
- FATIGUE RESISTANCE, 87 121  
342 374 426
- FAULT, 222
- FERRIMAGNETIC, 61
- FIBRE, 37 58 131 253 255 312 314  
382 383 427 430
- FIBRE-REINFORCED RUBBER,  
52 195 239 253 254 255 258  
334
- FILLED, 143 153 154 156 157 206  
208 209 315 326 338 406 410
- FILLER, 1 2 3 4 6 7 8 9 11 12 13  
15 17 19 23 24 27 30 34 35 38  
39 41 44 52 53 61 65 71 74 77  
78 82 83 84 85 86 101 102 103  
105 107 108 111 112 118 119  
120 122 125 128 129 133 134  
135 139 140 141 142 143 145  
147 148 149 150 151 153 155  
156 157 159 160 161 162 164  
165 166 167 171 172 173 174  
175 177 180 181 182 185 186  
188 190 192 196 198 200 201  
202 204 208 209 210 211 218  
223 224 225 230 232 234 236  
237 238 239 240 241 242 243  
244 245 246 247 248 249 250  
251 253 254 255 257 258 259  
260 261 262 263 264 269 270  
271 272 275 280 281 283 284  
288 296 297 299 303 307 308  
310 314 315 316 318 319 320  
323 326 328 331 332 337 341  
343 345 347 354 356 359 362  
367 368 371 372 373 375 378  
380 381 385 388 389 390 391  
396 399 400 402 403 404 405  
406 407 414 415 416 419 421  
423 424 425 427
- FILLER CONTENT, 38 78 116  
133 248 249 250 253 257 258  
259 260 345 402 405 407 410  
424 425
- FILLER DISTRIBUTION, 35 78  
87 129 259 260 294 389 410
- FILM, 76 255 260 431
- FILTRATION, 89 299 316
- FINITE ELEMENT ANALYSIS,  
15 24 32 33 115 176 227 257  
330 426 427
- FLEX CRACK, 42 251 390
- FLEXURAL FATIGUE, 64 254  
263 287 426 430
- FLEXURAL PROPERTIES, 42 79  
86 122 248 250 251 253 254  
257 258 261 305 388 390 392  
425 430 432
- FLOW, 86 180 254
- FLOW PROPERTIES, 115 116 347
- FLUOROCARBON RUBBER, 30  
177 185
- FORCE, 21 77 127 134 256 257  
388 407 411 426 430
- FORCE ANALYSIS, 32 332
- FORMULATION, 20 30 46 71 73  
75 87 88 89 90 99 105 109 112  
126 128 129 139 142 143 147  
149 153 156 157 171 174 175  
178 193 197 198 199 200 202  
205 206 209 223 226 229 240  
244 246 273 274 280 286 288  
289 299 308 314 320 322 323  
328 329 330 331 341 343 344  
345 346 347 349 354 355 362  
365 367 373 375 376 378 381  
393 397 408
- FOURIER TRANSFORM  
INFRARED SPECTROSCOPY,  
96 194 373
- FRACTAL DIMENSION, 74 256
- FRACTURE, 136 173 205 224 257
- FRACTURE MECHANICS, 108  
257
- FRACTURE MORPHOLOGY, 44  
74 119 120 126 154 177 195  
236 356 371 375
- FREQUENCY, 52 78 83 86 234  
248 256 258 259 263 332 402  
406 407 425
- FRICTION, 67 177 181 219 256  
297 379 388 409 413 422
- FRICTION COEFFICIENT, 24 67

140 158 256 306 388 406 409  
 FRICTION PROPERTIES, 12 28  
 83 154 155 181 256 380 387  
 406 409 425  
 FUEL CONSERVATION, 166  
 FUEL CONSUMPTION, 3 12 40  
 52 137 368 383 407 427  
 FUEL ECONOMY, 1 19 105 133  
 151 181 230 237 244 263 281  
 376  
 FUNCTIONALITY, 61 112 160  
 174 175 402 432  
 FUNGICIDE, 123  
 FURFURAL, 14  
 FURNACE BLACK, 282 310

## G

GAS DIFFUSION, 247  
 GAS PERMEABILITY, 44 204  
 GEL, 177 194 431  
 GLASS TRANSITION  
 TEMPERATURE, 28 78 80 98  
 128 194 211 228 261 263 274  
 384 400 406 410 417 425 430  
 GREEN STRENGTH, 64 74 263  
 407 418 431  
 GREEN TYRE, 6 73 139 161 171  
 239 246 248 275 281 316  
 GRINDING, 65 128 136 137 193  
 395  
 GRIP, 80 140 409  
 GROUND PRESSURE, 388  
 GROUND RUBBER, 46 69 128  
 135 385  
 GUM, 74

## H

HALOBUTYL RUBBER, 64 139  
 239 309 344 391  
 HANDLING, 9 23 41 190 264 331  
 332 374  
 HARDNESS, 2 5 38 47 52 57 79  
 80 86 87 89 122 168 180 248  
 250 255 259 261 307 313 322  
 343 346 380 402 405 407 425  
 432  
 HEALTH HAZARD, 4 23 54 68 80  
 137 139 190 228 276 295 360  
 361 386  
 HEAT AGEING, 52 93 123 139 216  
 250 253 254 287 327 391 424  
 HEAT BUILD-UP, 2 6 18 20 42 51  
 52 71 105 107 114 169 180 225  
 226 229 246 247 253 287 290  
 306 349 352 354 362 392 393  
 426

HEAT DEGRADATION, 73 251  
 258 327  
 HEAT DISSIPATION, 86  
 HEAT GENERATION, 52 79 86  
 180 258 287  
 HEAT RESISTANCE, 6 71 73 123  
 139 214 245 251 253 254 255  
 286 312 327 346 403  
 HEAT TRANSFER, 45 115 176  
 388  
 HEAT TREATMENT, 75 345 404  
 419  
 HEATED, 45 86 119 299 403 411  
 HEAVY DUTY TYRE, 426  
 HEAVY-VEHICLE TYRE, 19 20  
 26 33 45 48 52 74 105 107 108  
 115 144 145 146 148 149 172  
 176 177 180 185 214 224 225  
 229 232 244 245 253 254 279  
 285 286 288 301 337 352 353  
 359 368 404 407  
 HEXACHLOROPARAXYLENE,  
 123  
 HEXAMETHOXYMETHYL  
 MELAMINE, 287  
 HEXAMETHYLDISILAZANE,  
 249  
 HIGH DENSITY  
 POLYETHYLENE, 177  
 HIGH FREQUENCY, 78 406 410  
 HIGH MODULUS, 383 430  
 HIGH PERFORMANCE TYRE,  
 34 95 231 374 430  
 HIGH PRESSURE, 47 429  
 HIGH-SPEED, 388  
 HIGH TEMPERATURE, 30 217  
 346 404 405 416  
 HIGHLY-FILLED, 239 403  
 HINDERED PHENOL, 342 391  
 HOMOGENEITY, 103 115 389  
 HOMOGENISATION, 116 299  
 HOPPER, 134 159 299  
 HOT AIR AGEING, 253 305  
 HUMIDITY, 16 294 424  
 HYDRODYNAMIC  
 PROPERTIES, 425  
 HYDROFLUORIC ACID, 249 405  
 HYDROGEN BONDING, 13 61  
 46 404 431  
 HYDROLYSIS, 249 431  
 HYDROPHILICITY, 140 249  
 HYDROPHOBICITY, 248 249 281  
 HYDROPLANING, 45 84 115 167  
 176 425  
 HYDROQUINONE, 391  
 HYDROSTATIC STRESS, 33  
 HYSTERESIS, 12 24 27 28 41 52  
 61 67 107 121 140 172 180 181

182 189 206 207 223 225 234  
 239 244 249 253 254 256 258  
 261 263 281 288 296 297 318  
 328 330 337 356 360 373 396  
 402 404 405 407 409 420 425  
 426 427

## I

ICE, 140  
 IMPERMEABLE, 352 407  
 INDUSTRIAL HAZARD, 190 228  
 INFLATION PRESSURE, 27 95  
 247 254 281 388 407 425 426  
 430  
 INHIBITOR, 72 213  
 INJECTION MOULDING, 47 71  
 177 187 198 292 389  
 INNER LINER, 1 64 88 121 343  
 INNER TUBE, 142 144 173 204  
 247 277 286 294 304 352  
 INSULATION, 43 92 137 428  
 INTERFACIAL ADHESION, 13  
 16 96 249 251 257  
 INTERFACIAL INTERACTION,  
 72 118 182  
 INTERFACIAL PROPERTIES, 61  
 72 76 96 118 158 182 211 219  
 INTERMESHING ROTOR, 11 134  
 159 299 389  
 INTERNAL MIXER, 11 78 115  
 147 159 174 196 239 262 284  
 299 332 389 423  
 INTERNAL MIXING, 129 239  
 259 262 284 299 389 390  
 INVERSION BLACK, 368  
 IRON, 424  
 IRRADIATION, 81 116 285 431  
 ISOBUTYLENE COPOLYMER,  
 88 104 146 157 251 259 260  
 309 336 390 391  
 ISOTHERMAL AGEING, 30

## K

KAOLIN, 38  
 KINETICS, 5 44 81 119 120 331  
 397  
 KNEADING, 284

## L

LABORATORY EQUIPMENT, 99  
 366  
 LANDFILL, 31 415  
 LATEX, 13 93 101 103 239 255  
 261 302 335 430 431  
 LAW, 31 46 137 228

- LEACHING, 68  
 LEAKAGE, 428  
 LEGISLATION, 31 46 137 228  
     415  
 LEVY, 415  
 LICENCE, 138 285 415  
 LIFE CYCLE ANALYSIS, 12 40  
 LIFETIME PREDICTION, 411  
 LIGHTWEIGHT, 374  
 LINEAR ELASTIC FRACTURE  
     MECHANICS, 257  
 LINEAR REGRESSION  
     ANALYSIS, 262 388 425  
 LINING, 44 144 352  
 LITHIUM ALUMINIUM  
     HYDRIDE, 248  
 LITHOGRAPHY, 179  
 LITIGATION, 136 415  
 LOAD BEARING, 392  
 LOAD CAPACITY, 426  
 LOAD CELL, 407  
 LOAD DEFLECTION, 426  
 LOADBEARING, 392  
 LOADING, 38 59 112 251 257 258  
     372 407 430  
 LORRY TYRE, 52 279  
 LOSS MODULUS, 30 47 78 182  
     256 262 263 381 402 404 425  
     426  
 LOSS TANGENT, 22 30 47 78 83  
     256 262 263 381 402 404 406  
 LOW DENSITY  
     POLYETHYLENE, 43  
 LOW FRICTION, 392  
 LOW MODULUS, 407  
 LOW-PROFILE TYRE, 232  
 LOW SHRINKAGE, 383  
 LOW SPEED, 388  
 LOW TEMPERATURE, 30 138  
     404 405  
 LOW TEMPERATURE  
     PROPERTIES, 77 254 261 407  
     416  
 LOW VISCOSITY, 248 280 299  
     343  
 LUBRICANT, 46 59 228 301 311  
     388 409 425
- M**
- M-PHENYLENE-  
     BIS(MALEIMIDE), 132  
 MACHINERY, 95 117 136 137 138  
     152 153 159 179 187 196 239  
     262 266 267 268 284 285 294  
     299 389 405  
 MAGNESIUM OXIDE, 388  
 MAGNETIC PROPERTIES, 61  
     218 235  
 MAGNETISATION, 315 406  
 MALEIC ANHYDRIDE, 255  
 MALEINISED, 255  
 MANUFACTURE, 25 300  
 MANUFACTURING, 45 59 179  
     398  
 MASTERBATCH, 23 39 73 87 138  
     195 202 205 240 252 255 259  
     338 354 395  
 MATERIAL REPLACEMENT, 51  
     73 75 80 113 125 137 161 204  
     228 236 237 250 252 265 276  
     281 295 306 312 319 356 360  
     361 383 391 419  
 MATERIALS HANDLING, 110  
     134  
 MATERIALS SELECTION, 12 63  
 MATHEMATICAL MODEL, 47 70  
     82 115 207 262  
 MEASUREMENT, 22 33 47 173  
     222 235 240 358 372 432  
 MECHANICAL DEGRADATION,  
     411  
 MECHANICAL RECYCLING,  
     137 395  
 MECHANISM, 46 125 296 297  
     310 416 424  
 MECHANOCHEMICAL  
     DEGRADATION, 404  
 MELAMINE FORMALDEHYDE  
     RESIN, 50  
 MELT FRACTURE, 119 120  
 MERCAPTOBENZTHIAZOLE,  
     234 403  
 METAL, 4 52 59 91 253 424  
 METAL ADHESION, 52 239 424  
 METAL CORD, 54 55 95  
 METAL DEACTIVATOR, 43  
 METAL FIBRE-REINFORCED  
     RUBBER, 253 254 258 292  
 METAL FILLER, 218  
 METAL ION, 61 431  
 METALLOCENE, 255  
 METHODOLOGY, 73 262 365 366  
 METHYL STYRENE  
     COPOLYMER, 88 104 146 157  
     251 259 260 309 336 390 391  
 METHYLSTYRENE  
     COPOLYMER, 88 104 146 157  
     251 259 260 309 336 390 391  
 MICROGRAPHY, 42 184  
 MICROPORE, 402 405  
 MICROPOROSITY, 180 282  
 MICROSCOPY, 81 107 248 260  
     310 337 364 372  
 MICROSTRUCTURE, 12 37 151  
     236 263 275 300 340 356 404  
     405 406 430
- MICROTEXTURE, 427  
 MIGRATION, 113 170 234 250  
     253 315 370 391  
 MILLING, 198 268  
 MINER'S RULE, 82  
 MINERAL FILLER, 38 71 125 141  
     299  
 MISCIBILITY, 78 208 390  
 MIXER, 11 36 94 134 138 159 196  
     239 262 268 286 299 389 405  
 MIXING, 9 11 12 23 37 45 46 47  
     51 52 73 78 97 102 103 104 110  
     114 115 116 119 120 126 128  
     129 134 138 139 147 149 153  
     168 169 171 173 174 175 176  
     200 202 224 234 239 240 246  
     248 249 252 259 260 262 266  
     267 268 269 271 273 280 281  
     284 286 289 299 320 322 331  
     338 341 343 345 356 371 376  
     377 381 389 390 395 402 403  
     404 405 407 410  
 MIXING TIME, 234 262 299 372  
     389 404  
 MODEL, 86 119 120 206 209 242  
     251 256 257 262 315 316 318  
     365 388 406 425  
 MODEL COMPOUND, 29 234  
     403 424  
 MODIFICATION, 54 55 123 129  
     132 151 181 255 259 260 291  
     390 391 399 400 403 407  
 MODIFIER, 54 55 66 112 127 175  
     197 234 363  
 MODULUS, 2 10 27 37 38 46 64  
     79 89 102 162 170 180 206 239  
     248 250 252 253 254 255 257  
     258 259 261 265 286 287 306  
     312 316 341 344 345 346 402  
     403 407 430 431 432  
 MOISTURE, 119 129 161 174 202  
     294  
 MOISTURE RESISTANCE, 9  
 MOLECULAR STRUCTURE, 28  
     35 37 61 73 74 87 113 126 161  
     163 247 251 260 261 263 264  
     278 300 325 390 403 406 411  
     417 431  
 MOLECULAR WEIGHT, 12 19 39  
     87 103 113 194 199 239 250  
     252 255 261 263 305 331 336  
     391 398 403 404 406 417  
 MONITORING, 47 218 235 372  
 MOONEY RELAXATION, 47  
 MOONEY SCORCH, 180 250 252  
     253  
 MOONEY VISCOMETER, 47

119 120  
 MOONEY VISCOSITY, 2 23 28  
 36 38 42 46 47 74 87 104 105  
 112 114 122 128 129 147 149  
 174 175 180 196 199 212 226  
 234 246 248 250 254 261 262  
 299 332 340 341 346 390 397  
 402 404 405  
 MORPHOLOGICAL  
 PROPERTIES, 44 61 74 119  
 120 126 154 177 195 236 248  
 249 251 256 259 260 261 356  
 371 375 390 405  
 MOTOR CYCLE TYRE, 28 164  
 382  
 MOULD, 95 198  
 MOULD CLEANING, 62 187 213  
 MOULD FOULING, 213  
 MOULD RELEASE AGENT, 213  
 369  
 MOULDING, 4 95 180 199 292  
 371  
 MOULDING COMPOUND, 52  
 136 262 389 429  
 MOVING-DIE RHEOMETER, 86  
 MULTI-CAVITY MOULD, 198

## N

NANOSTRUCTURE, 61 107 172  
 225 244  
 NAPHTHENIC OIL, 183 391  
 NATURAL FIBRE-REINFORCED  
 RUBBER, 253  
 NATURAL RUBBER, 4 15 18 19 28  
 30 36 39 40 44 47 52 66 70 78 81  
 82 87 93 103 112 113 116 124  
 126 127 134 138 157 168 175  
 180 193 196 199 201 204 205  
 206 208 214 215 216 224 229  
 230 234 239 244 245 250 251  
 252 253 254 255 262 263 273  
 278 283 291 293 298 300 302  
 307 308 311 315 317 319 329  
 331 343 363 372 376 379 380  
 388 389 390 391 393 395 398  
 403 404 405 406 407 410 411  
 414 415 423 424 425 426 431  
 NEODYMIUM, 51 254 300  
 NEODYMIUM COMPOUND, 121  
 305  
 NEOPRENE, 4 57 74 199 260 278  
 299 395  
 NETWORK, 6 242 315 406 411  
 432  
 NEURAL NETWORK, 262 355  
 423  
 NITRILE RUBBER, 4 30 74 185 199

255 256 308 363 371 395 425  
 NITROGEN, 315 402 431  
 NITROGEN DIOXIDE, 189  
 NITROGEN OXIDE, 189  
 NITROSAMINE, 169 252 295 431  
 NMR SPECTROSCOPY, 194 315  
 337 380 384 397 403 406  
 NOISE REDUCTION, 3 117 264  
 281 427  
 NON-BLACK, 38 177  
 NON-DESTRUCTIVE TESTING,  
 257  
 NON-STAINING, 124 309 390 391  
 NORMALISING, 258 259 402 405  
 NYLON, 58 69 84 127 137 165  
 255 258 265 302 312 383 430

## O

OFF-THE-ROAD TYRE, 6 20 254  
 OIL, 80 180 239 247 250 252 254  
 259 284 296 299 333 388 390  
 391 404 407 416 425  
 OIL ADDITIVE, 134  
 OIL CONTENT, 180 250 254 259  
 407 425  
 OIL EXTENDED, 261 388  
 OIL EXTENSION, 180 239 250  
 252 254 259 284 299 390 391  
 404 407  
 OILS, 80 180 239 247 250 252 254  
 259 284 296 299 333 388 390  
 391 404 407  
 OPTICAL PROPERTIES, 38 372  
 390 391 395  
 OPTIMISATION, 7 36 73 175 198  
 204 278 311 341 365 376 389  
 ORGANOSILANE, 91 97 102 112  
 129 174 175 243 345 397  
 ORIGINAL EQUIPMENT, 95 149  
 237 291 392 428  
 OSCILLATING-DISC  
 RHEOMETER, 331  
 OVERCURE, 18 178 252 253  
 OXIDATIVE DEGRADATION, 43  
 180 234 247 251 253 411  
 OZONE, 5 250  
 OZONE CRACKING, 113 250 251  
 257 390 426  
 OZONE DEGRADATION, 251  
 279 309 342 391 411  
 OZONE RESISTANCE, 87 113  
 146 234 239 250 251 253 254  
 279 390 391 394 411

## P

PACKING DENSITY, 411

PARAFFIN, 57  
 PARAFFIN OIL, 140 180  
 PARAMETHYLSTYRENE  
 COPOLYMER, 259 390 391  
 PARTICLE SHAPE, 3 38 257  
 PARTICLE SIZE, 38 107 128 136  
 180 190 239 248 257 316 345  
 371 389 395 405  
 PARTICLE SIZE  
 DISTRIBUTION, 65 180 244  
 248 389  
 PASSENGER TYRE, 8 19 34 73  
 74 75 254 259 280 300 341 342  
 344 367 368 382 402 403 404  
 407 409 428 430  
 PATENT, 95 138 223 229 235 238  
 291 301 319 356 374 382  
 PEEL STRENGTH, 36 60 76 255  
 PENETRATION, 401 426  
 PERFORMANCE, 45 313 382 383  
 PERMANENT SET, 86 341 431  
 PERMEABILITY, 44 64 121 144  
 173 204 239 247 254 263 286  
 319 407 422  
 PEROXIDE, 255 389  
 PEROXIDE VULCANISATION,  
 255 346 389  
 PETROLEUM, 14 398  
 PH, 249 255  
 PHASE BOUNDARY, 54  
 PHASE DISTRIBUTION, 390  
 PHASE INVERSION, 260  
 PHASE MIXING, 259  
 PHASE MORPHOLOGY, 259 260  
 390  
 PHENOL-FORMALDEHYDE  
 RESIN, 54 217 322 399  
 PHENOLIC RESIN, 322  
 PHENYLENE DIAMINE, 58 170  
 250 342 391  
 PHOSPHITE, 391 431  
 PHOTODEGRADATION, 81  
 PHYSICAL PROPERTIES, 9 16  
 18 46 51 64 66 75 87 91 111  
 114 122 128 135 168 191 195  
 226 275 288 289 291 306 307  
 334 341 342 343 359 368 375  
 398 400  
 PHYSICOCHEMICAL  
 PROPERTIES, 123 194 300  
 PIN EXTRUDER, 240  
 PLASMA TREATMENT, 96 211  
 PLASTICISER, 4 14 57 61 116  
 135 139 234 284 297 299 356  
 402  
 PLY SEPARATION, 33  
 PNEUMATIC, 232  
 PNEUMATIC TYRE, 233

- POLLUTION CONTROL, 23  
 POLYACRYLATE, 139  
 POLYALKENE, 137 279  
 POLYAMIDE, 58 69 84 127 137  
 165 255 258 302 312 383 426  
 430  
 POLYBROMOISOBUTYLENE  
 METHYLSTYRENE, 344  
 POLYBUTADIENE, 13 14 19 36  
 51 73 78 81 87 88 121 134 140  
 157 191 205 239 250 251 252  
 253 254 255 259 260 262 263  
 279 283 293 300 304 305 307  
 331 343 345 347 379 380 388  
 390 391 400 402 403 404 405  
 406 411 421 425 426 431  
 POLYBUTYLENE, 139 247 260  
 344  
 POLYCHLOROPRENE, 4 30 47  
 57 74 139 199 260 278 299 395  
 POLYDIENE, 36 51 146 163 214  
 251 304 305 306  
 POLYEPOXIDE, 69  
 POLYETHYLENE, 43 137 139  
 177 299  
 POLYETHYLENE  
 TEREPHTHALATE, 383 430  
 POLYISOBUTYLENE, 139 247  
 260 344  
 POLYISOCYANATE, 132  
 POLYISOPRENE, 14 140 234 239  
 263 279 306 351 379 388 389  
 411 424  
 POLYMERIC COUPLING  
 AGENT, 9  
 POLYMERIC MODIFIER, 54 55  
 POLYMERISATION, 56 69 96 98  
 156 186 207 238 254 263 303  
 315 398 432  
 POLYMERISATION CATALYST,  
 121 151 254 255 300 305  
 POLYOCTENAMER, 128 135 197  
 343  
 POLYOLEFIN ELASTOMER, 139  
 POLYPHENYLENE  
 TEREPHTHALAMIDE, 195  
 POLYPROPYLENE, 43 137  
 POLYSACCHARIDE, 230 314  
 POLYSULPHANE, 129 243  
 POLYSULPHIDE, 97 215 243  
 POLYURETHANE, 4 69 71  
 POLYVINYL ALCOHOL, 356  
 POLYVINYL CHLORIDE, 43 137  
 431  
 POLYVINYL PYRIDINE, 302  
 PORE SIZE DISTRIBUTION, 341  
 405  
 POROSITY, 180 253 282 294 341  
 405  
 POST-CURE, 4 292  
 POTASSIUM HYDROXIDE, 431  
 POWDERED RUBBER, 137 284  
 299  
 PRECIPITATED SILICA, 111 112  
 161 175 239 248 249 259 272  
 288 316 341 345 402 424  
 PRESSURE, 59 86 95 134 235 239  
 247 256 262 284 299 313 388  
 407 425  
 PRESSURE SENSOR, 95  
 PREVULCANISATION, 403 431  
 PRICE, 46 231 278 332  
 PRIMER, 255  
 PROCESS CONTROL, 11 47 95  
 110 115 134 331 355  
 PROCESSIBILITY, 12 37 47 51 64  
 73 112 119 120 133 139 144  
 162 175 180 201 202 212 239  
 246 248 261 305 306 338 343  
 345 347 404 407  
 PROCESSING, 4 9 18 29 36 39 47  
 50 59 103 125 174 177 278 311  
 312 364 377 398  
 PROCESSING AID, 63 128 171  
 183 239 246 311 320 323 343  
 347 370 395  
 PROCESSING OIL, 183 297 360  
 361 372 390  
 PRODUCT ANNOUNCEMENT, 1  
 15 23 26 34 63 73 75 92 106  
 111 124 161 162 163 174 186  
 219 230 231 235 244 246 267  
 269 272 276 279 314 335 341  
 347 348 355 366 367 374 382  
 392 394 408  
 PRODUCT DEVELOPMENT, 41  
 47 136 138 166 245 421 427  
 PRODUCT RECALL, 59  
 PRODUCTION COST, 55 64 281  
 284 383  
 PROPERTY RETENTION, 52 250  
 252 253  
 PROTOTYPE, 95 138 179 218 285  
 PULL-OUT, 253 255 257 424  
 PULL-OUT TEST, 302  
 PULVERISATION, 395  
 PUNCTURE RESISTANCE, 254  
 348  
 PYROLYSIS, 31 65 270 350 364  
 415
- Q**
- QUALITY, 47 95 163 278 284  
 QUALITY CONTROL, 47 89 128  
 134 149 159 222 223 262 289  
 331 355  
 QUINONE, 13  
 QUINONE DIIMINE, 215 234 273
- R**
- RACING TYRE, 34 84 231 281  
 RADIAL PLY TYRE, 27 54 131  
 144 146 164 201 226 232 253  
 254 342 353 425 426  
 RADIAL STRESS, 32  
 RAPID MANUFACTURING, 179  
 RAW MATERIAL, 110 134 278  
 314  
 RAYON, 383 430  
 REACTIVITY, 61 133 250 385 395  
 403 411  
 REBOUND, 89 180 261 402  
 REBOUND RESILIENCE, 28 87  
 400  
 RECLAIM, 31 93 109 135 137 192  
 193 197 198 278 308 350 386  
 RECLAIMED RUBBER, 64 75  
 RECLAIMING, 31 53 135 137  
 RECYCLATE, 53 278 285  
 RECYCLED CONTENT, 64 75  
 137 415  
 RECYCLING, 29 31 46 53 65 75  
 128 136 137 142 192 193 194  
 197 199 241 278 285 308 350  
 364 385 386 395 415  
 RECYCLING RATE, 46 415  
 REGRESSION ANALYSIS, 21 73  
 140 262 388 425  
 REGULATION, 31 46 228 360  
 REINFORCED RUBBER, 35 38  
 52 61 72 74 129 195 233 238  
 239 253 254 255 258 382 430  
 REINFORCEMENT, 6 55 61 133  
 148 156 161 238 248 272 293  
 312 316 322 343 373 375 399  
 401 403 426 430  
 REINFORCING AGENT, 38 180  
 367 368 404 405  
 REINFORCING FILLER, 17 38 52  
 111 122 180 238 239 248 249  
 259 316  
 RELAXATION MODULUS, 406  
 RELAXATION TIME, 86 263 406  
 RELEASE AGENT, 213 369  
 RENEWABLE RESOURCE, 3 236  
 356  
 REPLACEMENT TYRE, 188 237  
 313 335 392  
 RESEARCH, 61 65 245 285 301  
 313 356 374 399 421  
 RESIDUAL STRENGTH, 82 258  
 RESIDUAL STRESS, 401

- RESILIENCE, 13 28 42 87 98 300  
400 425
- RESISTIVITY, 150 284 375 381  
404
- RESORCINOL, 253 287
- RESORCINOL-  
FORMALDEHYDE RESIN, 55  
255 302 430
- RESORCINOL  
HEXAMETHYLENE  
TETRAMINE, 131
- RESORCINOL RESIN, 55 255 302
- RETARDER, 234
- RETREAD, 193 241 430
- RETREADING, 31 36 93 116 221  
232 253 254 285 286 300 415
- RETROFIT, 428
- REVERSION, 20 114 252 253 291  
327 346
- REVERSION INHIBITOR, 163
- REVERSION RESISTANCE, 6  
191 214 215 252 253 327 339  
377 393 403
- REVIEW, 4 5 11 19 31 35 43 53  
110 123 179 185 186 232 238  
242 292 309 310 334 345 366  
391 399 400 413 422
- RHEOGRAPH, 217
- RHEOLOGICAL PROPERTIES,  
14 23 39 42 44 46 47 61 75 86  
89 103 112 116 119 120 134  
147 148 162 168 171 180 191  
193 196 199 200 202 206 207  
209 212 217 226 234 239 240  
248 250 254 255 261 262 271  
273 274 280 284 286 299 306  
320 326 330 331 338 360 389  
390 399 400 402 403 404 405  
417 423 431
- RHEOMETER, 47 86 119 120 128  
168 178 199 200 213 226 229  
252 259 261 290 331 332 338  
339 376 403 404 405
- ROAD, 256 364
- ROAD SURFACE, 24 31 128 137  
203 409 427
- ROAD WEAR, 388 426
- ROADHOLDING, 77 84 281 409
- ROLLING RESISTANCE, 1 3 7 8  
12 19 20 21 22 27 35 40 42 52  
66 71 74 80 87 88 98 100 105  
107 111 125 130 133 141 149  
150 153 156 161 165 166 167  
172 180 181 182 183 188 199  
201 210 212 225 230 234 237  
239 240 242 244 246 248 249  
254 259 261 263 280 281 293  
306 314 316 322 324 330 340  
341 347 349 352 354 356 359  
363 366 367 368 373 378 381  
388 392 396 397 399 400 402  
403 404 405 407 413 417 420  
426 427 428 429
- ROTOR, 11 134 138 159 262 299  
389
- ROTOR SPEED, 11 134 262 389
- ROUGHNESS, 24 52 119 120 244  
256 388 405
- RUBBER BAND, 30
- RUBBER TO METAL BONDING,  
4 16 50 52 54 55 76 90 91 220  
221 254 287 292 298
- RUBBERISED ASPHALT, 53 128  
135 192 197
- RUBBERISED CARBON  
BLACK, 23
- RUBBERISED FABRIC, 401
- RUN-FLAT TYRE, 95 227 235 241  
245 263 293 313 348 374 392
- RUN-OUT, 222 426
- RUPTURE, 416 426
- RUTTING RESISTANCE, 364
- S**
- SAFETY, 1 31 59 228 346 368 382  
392
- SALT BATH, 52
- SATURATED POLYESTER, 127  
131 255 265 383
- SCANNING ELECTRON  
MICROSCOPY, 44 249 259  
282 405 424
- SCISSION, 257 391 404 406
- SCORCH, 42 44 46 73 180 234  
250 252 253 254 261 290 345  
377 403 404 407
- SCORCH RESISTANCE, 10 18  
132 234
- SCORCH TIME, 2 75 175 234 252  
254 261 306 346 347 404 405  
407
- SCRAP, 31 53 65 95 128 135 136  
137 285 331 395
- SCRAP RUBBER, 53 135 415
- SCRAP TYRES, 31 53 65 75 128  
136 137 192 197 198 285 308  
350 364 385 386 395 415
- SCREW, 138 187 240 284
- SEAL, 30 43 177 334
- SEALANT, 335 348
- SECONDARY ACCELERATOR,  
252 407
- SEMI-EFFICIENT  
VULCANISATION, 20 30 253
- SEMI-REINFORCING AGENT,  
38 180
- SENSOR, 95 218 235
- SERVICE LIFE, 40 51 105 248  
254 286 293 357 359 376 407  
411 415
- SHARKSKIN, 261
- SHEAR, 15 33 116 177 249 257  
263 356 359 425
- SHEAR DEFORMATION, 86 143  
258
- SHEAR MODULUS, 33 47 86 147  
156 262 406 407 432
- SHEAR PROPERTIES, 86 119 120  
143 145 180 206 212 249 258  
356
- SHEAR RATE, 119 120 196 202  
331
- SHEAR STRAIN, 258
- SHEAR STRESS, 119 120 180 206  
212 249
- SHEAR VISCOSITY, 86
- SHORE HARDNESS, 2 47
- SHREDDING, 31 65 137 415
- SHRINKAGE, 240 251 265 280  
343 383 430
- SIDEWALL, 88 121 205 218 222  
239 241 245 250 251 253 254  
257 263 279 300 306 309 342  
346 376 383 390 391 411 426  
430
- SIGNAL PROCESSING, 258
- SILANE, 6 7 9 49 61 73 74 91 97  
104 105 112 119 120 129 156  
157 159 161 175 209 239 248  
259 280 316 344 354 402 403  
405
- SILANISATION, 11 104 129 147  
174 240 280 341 403
- SILANOL GROUP, 8 122 248 249  
403
- SILICA, 1 6 7 8 9 11 12 13 17 24  
27 34 38 40 42 52 58 61 73 74  
83 85 88 89 99 102 105 111 112  
119 120 122 129 131 133 139  
141 143 147 148 149 151 153  
156 157 159 161 162 174 175  
177 181 182 183 185 186 188  
190 196 200 201 202 209 223  
224 237 238 239 240 243 246  
248 249 253 255 257 259 260  
261 264 269 271 272 275 280  
281 288 292 299 303 307 310  
314 315 316 320 323 340 341  
343 344 345 346 347 354 367  
373 375 378 381 388 389 391  
397 400 402 403 404 405 414  
419 421 424 428
- SILICATE, 38

- SILICON CARBIDE, 83  
SILICONE ELASTOMER, 4 30  
179 195 370  
SILICONE OIL, 431  
SIMULATION, 21 33 45 137 207  
270 318 330 351  
SKID RESISTANCE, 24 83 160  
172 263 280 347 366 384 406  
409 425 426  
SKIM RUBBER, 121 253 254 287  
SLIDING, 24 83 256 388 406 425  
SLIDING PROPERTIES, 409  
SLIDING TRACK, 256  
SLIP, 219 388  
SLIP ANGLE, 388 426  
SLIP PROPERTIES, 154  
SLIP RESISTANCE, 140  
SLIP VELOCITY, 155 425  
SMART MATERIAL, 235  
SNOW TYRE, 133  
SODIUM TRIAZINE TRITHIOL,  
317  
SOFTENING POINT, 71 356  
SOFTWARE, 80 95 115 219 262  
332 366 389 423  
SOLID GROUND CURING, 179  
SOLID TYRE, 232 300 415  
SOLUTION POLYMER, 239 259  
261 402 403 404 405 421  
SOLUTION POLYMERISATION,  
98 156 186 207 303  
SPARE TYRE, 335 407  
SPECIFIC ENERGY  
CONSUMPTION, 284  
SPECIFICATION, 31 33 60 134  
428  
SPECTROSCOPY, 78 100 189 234  
260 315 325 364 391 410 432  
SPEED, 24 221 388 425  
SPEED RATING, 3 77 84 85 264  
SPLICING, 286  
SQUALENE, 403 424  
STABILISER, 43 121 215 216 226  
251 253 273 287 431  
STABILITY, 73 84 123 215 251  
312 398 403  
STAINING, 390 391 422  
STANDARD, 31 33 60 134 137  
272 291 372 394 422  
STANDARD MALAYSIAN  
RUBBER, 315  
STARCH, 3 41 236 356  
STATIC, 50 242 250  
STATIC DISSIPATION, 233 412  
STATIC LOADING, 258  
STATIC PROPERTIES, 30 214  
STEARIC ACID, 239 338 403  
STEEL, 16 50 52 59 72 76 188 253  
254 292 307 374 424  
STEEL BELTED, 33 84 164 232  
239 424  
STEEL CORD, 52 60 72 76 220  
239 241 253 254 287 292 294  
301 317 359 374 401 424 426  
430  
STEEL FIBRE-REINFORCED  
RUBBER, 52 239 253 254 258  
424 426  
STIFFNESS, 79 86 122 248 254  
257 258 261 388 392 425 430  
STORAGE, 95 119 120 377 411  
STORAGE MODULUS, 30 83 256  
340 402 426  
STORAGE STABILITY, 139 286  
364 411  
STRAIN, 12 22 30 78 82 118 248  
249 251 257 258 259 261 324  
345 396 402 405 407 422 425  
STRAIN ENERGY, 118 210 257  
282 420  
STRAIN RATE, 202 402 430  
STRAIN-SOFTENING, 30  
STRENGTH, 13 38 79 238 257  
312 317 374 383 430  
STRESS, 43 47 86 119 120 180  
242 249 250 251 256 257 258  
359 401 405 407 411 425 426  
STRESS RELAXATION, 5 74 79  
86 182 206 331 422  
STRESS-STRAIN PROPERTIES,  
5 24 32 33 79 180 217 257 258  
259 390 402 404 417 425  
STRIP, 95 284  
STYRENE-BUTADIENE  
COPOLYMER, 70 398 400 410  
STYRENE-BUTADIENE  
RUBBER, 12 13 15 18 19 27 28  
29 30 36 39 42 44 47 73 75 78  
80 82 83 88 106 119 120 134  
141 143 151 154 161 182 186  
191 193 198 199 206 207 208  
209 211 216 229 232 239 249  
250 252 253 255 259 261 262  
263 275 277 278 279 283 293  
300 303 308 311 315 326 329  
331 333 338 340 345 346 347  
351 372 379 388 400 402 403  
404 405 406 410 411 414 416  
417 421 423 425 426 431  
STYRENE-ISOPRENE-  
BUTADIENE TERPOLYMER,  
263  
SULPHENAMIDE, 169 226 234  
254  
SULPHUR, 16 29 59 73 93 97 131  
157 217 234 239 243 252 253  
255 260 313 377 379 385 389  
391 395 403 411 424 431  
SULPHUR CONTENT, 360 403  
411  
SULPHUR VULCANISATION, 30  
76 112 175 234 239 252 253  
255 260 346 389 391 395 403  
424 431  
SULPHURIC ACID, 248 249 316  
SUMMER TYRE, 188 231 264  
SURFACE ACTIVE AGENT, 40  
46 63 128 135 162 255 311  
SURFACE ACTIVITY, 7 248 278  
280 281 404  
SURFACE ANALYSIS, 248 249  
301 389 391 405 424  
SURFACE AREA, 7 52 74 105 122  
133 180 244 248 249 256 402  
404 405 407 424  
SURFACE CHEMISTRY, 248 316  
405  
SURFACE DEGRADATION, 391  
SURFACE ENERGY, 256 316 404  
405  
SURFACE MODIFICATION, 4  
135 161 211 244 317  
SURFACE PREPARATION, 292  
SURFACE PROPERTIES, 35 67  
101 122 156 172 248 256 364  
385 389 405 420  
SURFACE STRUCTURE, 52 249  
282 388  
SURFACE TEMPERATURE, 388  
SURFACE TREATMENT, 4 36 56  
96 135 161 187 197 199 211  
244 249 298 317  
SURFACE WETTING, 24  
SUSPENSION, 316 424  
SWELLING, 13 14 31 101 180 194  
240 252 280 432  
SYNTHETIC FIBRE-  
REINFORCED RUBBER, 37  
195 255 258 334 430  
SYNTHETIC RUBBER, 5 19 36  
59 66 80 124 138 177 181 182  
184 186 232 245 398 421
- T**  
T-PEEL, 36  
TACK, 87 221 239 250 398 407  
431  
TACKIFIER, 4 46 398 399  
TACKINESS, 14  
TALC, 38 284  
TAN DELTA, 21 30 42 47 52 66 86  
107 122 180 182 234 248 249  
256 259 261 263 288 297 340

- 341 363 375 378 379 390 402  
404 406 425 426
- TANGENTIAL ROTOR, 11 134  
159 299
- TEAR ENERGY, 180 257
- TEAR RESISTANCE, 14 107 145  
339 357 362
- TEAR STRENGTH, 2 14 18 28 47  
52 64 71 87 89 107 145 148  
180 239 250 252 253 255 261  
287 290 339 346 357 362 389  
390 424 426
- TEARING, 257 425
- TECHNICALLY SPECIFIED  
RUBBER, 239 300
- TEMPERATURE, 5 24 52 70 78  
86 119 120 129 134 219 221  
234 239 249 250 252 256 259  
262 263 283 284 286 291 299  
331 363 379 388 395 402 403  
404 405 406 407 411 422 425  
426 430
- TEMPERATURE CONTROL, 48  
117 155 174 239 240 299
- TEMPERATURE DEPENDENCE,  
22 55 73 157 247 249 333 373  
410 411 416
- TENACITY, 383 430
- TENSILE FAILURE, 257
- TENSILE MODULUS, 383
- TENSILE PROPERTIES, 2 5 28 42  
46 47 52 57 64 71 74 75 79 81  
82 89 100 102 131 162 170 180  
195 196 198 205 211 217 249  
250 251 252 253 257 258 259  
261 275 286 307 336 350 383  
389 402 405 411
- TENSILE STRAIN, 249
- TENSILE STRENGTH, 2 47 64 71  
74 89 131 162 170 180 195 196  
205 217 250 253 258 259 261  
286 389 402 405 426 431
- TENSILE STRESS, 81 257 411  
422
- TENSION, 258 401 427
- TENSION LOADING, 258
- TENSION SET, 407
- TEST EQUIPMENT, 25 86 99 100  
108 155 156 208 219 331 332  
345 357 359 366 372 388 389  
394 407 414
- TEST METHOD, 4 5 20 21 22 24  
25 33 41 46 47 60 64 65 71 73  
76 78 79 80 89 99 113 127 140  
177 203 221 243 246 290 291  
312 329 332 333 338 341 344  
345 347 353 355 357 359 366  
367 368 370 373 378 383 389  
396 399 409 426
- TEST SPECIMEN, 25 86 372 411
- TESTING, 4 5 20 21 22 24 25 33  
41 46 47 52 60 64 65 71 73 76  
78 79 80 86 89 99 100 108 113  
127 140 155 156 177 203 208  
219 221 243 246 290 291 312  
329 331 332 333 338 341 344  
345 347 353 355 357 359 366  
367 368 370 372 373 378 383  
388 389 394 396 399 407 409  
414 422 423 426
- TETRABENZYLTHIURAM  
DISULPHIDE, 10 169 252
- TETRABUTYL THIURAM  
DISULPHIDE, 252
- TETRAETHYLTHIURAM  
DISULPHIDE, 252
- TETRAMETHYLTHIURAM  
DISULPHIDE, 10 252 407 431
- THERMAL BLACK, 180
- THERMAL CONDUCTIVITY, 86  
345 388
- THERMAL DEGRADATION, 5  
52 73 93 123 139 216 250 251  
253 254 258 287 327 391
- THERMAL PROPERTIES, 24 51  
86 261 263 283 299 304 364  
382 384 388 406 422 425 430
- THERMAL SHRINKAGE, 383
- THERMAL STABILITY, 6 71 73  
123 245 251 253 254 255 286  
312 327 346 403 426
- THERMOLABILE, 403
- THERMOMECHANICAL  
DEGRADATION, 411
- THERMOMETRY, 388
- THERMOOXIDATIVE  
DEGRADATION, 43 253 411
- THERMOOXIDATIVE  
STABILITY, 305
- THERMOPLASTIC  
ELASTOMER, 71 292
- THERMOSET, 1 42 50 66 69 70  
73 137 163 177 179 185 187  
192 217 233 243 247 255 265  
280 282 292 312 314 322 399  
401 418 430 432
- THICKNESS, 86 128 222 260 407  
424
- THIN-WALL, 431
- THIURAM DISULPHIDE, 10 252
- THIXOTROPY, 206 345
- TIME TEMPERATURE  
SUPERPOSITION  
PRINCIPLE, 78 326 340
- TIN COMPOUND, 186 303
- TITANIUM, 300
- TITANIUM DIOXIDE, 38
- TOOLING, 179
- TORQUE, 44 46 162 219 252 253  
261 300 331 332 403 426
- TORSION, 15 86 218 257 401
- TOUGHNESS, 222 257 383
- TOXICITY, 54 68 80 137 295 360  
431
- TRACTION, 7 22 24 26 35 41 71  
74 78 83 84 85 88 99 108 125  
133 149 156 157 158 160 161  
165 177 219 234 239 240 248  
249 256 259 261 263 264 281  
296 324 341 344 347 351 356  
367 378 381 387 388 402 404  
405 406 409 410 413 420 425  
426
- TRANS-1,4-POLYISOPRENE,  
306
- TRANS-POLYOCTENAMER, 128  
135 197 343
- TREAD, 1 7 8 9 12 14 19 20 22 23  
24 27 28 45 49 52 59 66 67 73  
74 86 88 89 95 99 106 108 111  
115 116 122 133 143 147 148  
150 156 157 158 159 161 162  
168 171 172 176 180 182 184  
191 199 200 201 206 210 212  
215 219 222 225 226 229 231  
233 234 238 239 240 243 244  
245 246 248 249 250 253 254  
256 257 259 261 262 263 264  
274 280 288 294 296 299 300  
301 305 306 311 313 314 316  
318 324 328 337 338 340 341  
342 343 344 345 347 351 354  
356 362 363 367 368 372 374  
375 378 381 384 387 388 389  
393 399 402 403 404 405 406  
407 408 409 411 412 413 414  
425 426 427 428
- TREAD DEPTH, 409 426
- TREAD PATTERN, 34 41 77 84  
165 167 188 264 281 408 409  
426
- TREAD RUBBER, 12 55 77 78  
140 162 182 203 219 246 263  
264 311 359
- TREADWEAR, 52 74 89 180 219  
244 253 254 259 261 263 316  
341 367 368 374 381 388 404  
405 407 426
- TRIETHOXY-SILYL-PROPYL  
TETRASULPHIDE, 112 316  
404
- TROUSER TEAR TEST, 253 257  
261
- TRUCK TYRE, 19 20 26 33 45 48

- 52 74 105 107 108 115 144 145  
 146 148 149 172 176 177 180  
 185 214 224 225 229 232 244  
 245 253 254 279 285 286 288  
 301 337 352 353 359 368 404  
 407 415 421 426 430  
 TUBE, 277 284  
 TUBELESS TYRE, 239 254  
 TWIN-SCREW EXTRUDER, 45  
 115 266 284  
 TWO-ROLL MILL, 286 332  
 TYRE BALANCING, 426  
 TYRE BEAD, 133 216 227 245  
 264 301 342 427  
 TYRE BELT, 27 77 95 133 164  
 165 245 253 254 257 263 300  
 301 342 426 430  
 TYRE BUILDING, 3 48 57 95 115  
 138 245 421  
 TYRE CARCASS, 27 48 52 95  
 132 133 247 253 254 258 300  
 312 342 346 383 407 430  
 TYRE CASING, 254 426  
 TYRE CONSTRUCTION, 188  
 TYRE CORD, 4 13 16 50 52 54 55  
 56 58 60 76 90 91 95 96 101  
 127 131 132 232 239 245 254  
 255 257 265 292 293 294 298  
 302 307 312 317 325 353 374  
 383 424 426 430  
 TYRE DERIVED FUEL, 137 415  
 TYRE FOOTPRINT, 257 426  
 TYRE INDUSTRY, 40 222 232  
 241 355  
 TYRE INFLATION, 254 388 407  
 425 426 429 430  
 TYRE INNER LINER, 19 109 133  
 239 254 342 407 426  
 TYRE NOISE, 165 167 281 426  
 TYRE PRESS, 62  
 TYRE PRESSURE, 95 254 407  
 430  
 TYRE PRESSURE SENSOR, 95  
 TYRE REPAIR, 335  
 TYRE RIM, 342 343  
 TYRE SHOULDER, 253  
 TYRE SIDEWALL, 81 87 104 113  
 126 133 146 149 215 216 226  
 240 336  
 TYRE TREAD, 7 8 9 12 14 19 20  
 22 23 24 27 28 45 49 66 67 73  
 74 88 89 99 106 108 111 115  
 116 122 133 143 147 148 150  
 156 157 158 159 161 162 168  
 171 172 176 182 184 191 199  
 200 201 206 210 212 215 222  
 225 226 229 233 238 240 243  
 246 264 274 280 288 294 296  
 300 301 305 306 311 318 324  
 328 337 338 340 341 342 343  
 344 345 347 351 354 356 362  
 363 368 372 375 378 384 387  
 393 399 408 409 412 413 414  
 417 420 429  
 TYRE VALVE, 286  
 TYRE WALL, 301
- U**  
 UNFILLED, 208 256 410  
 UNVULCANISED, 345 372 389  
 422  
 UV DEGRADATION, 411  
 UV IRRADIATION, 5 81 411
- V**  
 VAPOUR PERMEABILITY, 254  
 VELOCITY, 256 410 425  
 VIBRATION, 84 248  
 VIBRATION DAMPER, 86 196  
 VINYL TOLUENE  
 COPOLYMER, 104 259 260  
 336  
 VISCOELASTIC, 12 20 22 24 47  
 52 78 83 86 100 104 108 118  
 144 153 158 171 173 177 200  
 206 208 210 215 224 234 242  
 246 249 256 262 263 271 275  
 281 282 297 307 324 326 330  
 331 338 347 354 356 359 373  
 379 396 402 404 405 406 410  
 417 420 425  
 VISCOSITY, 14 23 39 42 44 61 75  
 86 89 103 112 116 134 147 148  
 180 191 193 200 207 234 239  
 240 248 250 254 255 261 262  
 273 280 284 286 299 331 345  
 360 390 399 400 402 403 404  
 405 431  
 VISCOSITY GRAVITY  
 CONSTANT, 360  
 VISCOSITY MODIFIER, 112 175  
 234  
 VULCANISATE, 2 18 52 61 71 80  
 86 123 177 183 194 234 248  
 252 284 305 316 327 340 349  
 362 389 395 404 405 410 411  
 416  
 VULCANISATION, 14 16 18 20  
 30 50 52 59 72 76 86 91 95 97  
 112 114 123 126 132 157 168  
 169 170 175 178 180 185 191  
 209 213 215 217 229 234 239  
 243 248 250 252 253 254 255  
 259 260 261 283 284 295 313  
 331 342 346 349 369 370 377  
 389 390 391 395 402 403 404  
 405 406 407 419 424 426 431  
 VULCANISATION TIME, 36 50  
 52 91 168 191 248 250 252 253  
 259 260 261 389 395 399 402  
 407  
 VULCANISING AGENT, 385
- W**  
 WATER REPELLENT, 128  
 WATER RESISTANCE, 364  
 WATER VAPOUR  
 PERMEABILITY, 254  
 WATER-BORNE, 4 255 292  
 WAX, 43 113 279 329  
 WEAR, 25 52 99 108 125 150 154  
 155 177 180 184 203 219 222  
 253 254 259 261 263 330 337  
 349 362 378 388 404 405 407  
 413 416 422 426  
 WEAR RESISTANCE, 7 8 10 11  
 19 25 28 34 41 51 71 74 80 87  
 89 98 99 105 108 113 133 148  
 149 157 160 161 172 180 199  
 201 203 210 212 219 225 238  
 239 240 244 245 249 250 259  
 261 275 281 299 305 306 313  
 314 316 318 333 337 341 344  
 346 349 351 362 366 373 375  
 389 393 404 405 414  
 WEATHER RESISTANCE, 5 71  
 121 254  
 WEATHERING, 5 121 254  
 WEIGHT REDUCTION, 3 19 40  
 64 137 314 356 383 407 430  
 WET FRICTION, 181 388  
 WET GRIP, 28 34 42 66 80 98 140  
 153 172 181 183 234 239 242  
 248 249 259 263 363 368 388  
 402 406 425 426  
 WET SKID RESISTANCE, 8 12  
 34 148 172 181 238 263 296  
 297 379 406 425 426  
 WET TRACTION, 7 22 71 74 78  
 83 88 125 133 161 165 234 239  
 240 248 249 259 263 264 281  
 341 344 356 378 388 402 406  
 409 425 426  
 WET WEATHER TYRE, 66  
 WETTING, 24 63  
 WETTING AGENT, 46 388  
 WHEEL, 235 415  
 WHEEL RIM, 342 343  
 WHITE FILLER, 239 310  
 WINTER TYRE, 26 77 85 105 133  
 140 149 157 188 201 237 408

WLF EQUATION, 125 263 388  
WORK OF FRACTURE, 257

## **X**

X-RAY ANALYSIS, 249 405

## **Y**

YIELD, 212 240  
YIELD POINT, 426  
YIELD STRESS, 47 119 120  
YOUNG'S MODULUS, 33 86 257  
262 338 381 404 420 425

## **Z**

ZINC, 16 291 292 301 338 424  
ZINC OXIDE, 2 97 114 239 260  
284 341 403 424 431  
ZINC SULPHIDE, 424



