tire technology EXPO 2019

5, 6, 7 MARCH 2019

DEUTSCHE MESSE, HANNOVER, GERMANY

CONFERENCE PROGRAMME

13 STREAMS

INCLUDING **SCIENTIFIC, TECHNICAL**
AND **BUSINESS STRATEGY** SESSIONS
PLUS 7 SPECIALIST COURSES

160-180
PRESENTATIONS

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Welcome to the Tire Technology Expo Conference

The ***Tire Technology Expo Conference 2019*** is our biggest and most all-embracing ever, with 160+ speakers already announced in this preliminary programme. Each day, the streams and sessions announced here will remain as detailed; some additions may be incorporated as there are a few speakers with whom final arrangements are being made as this programme goes to press. As always, one-, two- and three-day conference passes are available and there are options to combine these with seven specialist courses as well. Note that the courses all commence on the Monday and the Akron Short Course spans four full days – see page 22 for details. Speaker additions will be announced on our website as they occur – www.tiretechnology-expo.com.

Tony Robinson, founder & CEO, UKi Media & Events

CONFERENCE STREAMS AT A GLANCE

1 **The Role of the Tire in Future Vehicle Transport –** Day 1

2 **Improving the Accuracy of Tire Testing –** Days 1 & 2

3 **Developments Within Steel and Non-Steel Cord Reinforcement –** Day 1

4 **Tire Manufacturing – Improving the Efficiency of Current Technology –** Day 1

5 **Modelling Tires and Tire/Vehicle/ Road Performance –** Day 2

6 **Improvements in the Science of Rubber Compounding –** Day 2

7 **Sustainability Developments Within Tire Material Science –** Days 2 & 3

8 **Improving the Accuracy of Tire and Material Test Data –** Day 2

9 **Recycling Tire Materials and their Potential Use in New Tire Manufacture –** Day 2

10 **The Changing Role of Polymer Science in Tire Performance Improvements –** Days 2 & 3

11 **Business Strategy –** Day 2

12 **New Advances in Pneumatic Tire Performance –** Day 3

13 **Non-Contact Tire Identification Systems –** Day 3

Tire Expo Conference rates Price + 19% German VAT	
Tire Expo Conference 1-day pass	**€695**
Tire Expo Conference 2-day pass	**€1,075**
Tire Expo Conference 3-day pass	**€1,425**

Main conference is 5, 6 & 7 March. You can book one- or two-day courses PLUS two days of main conference as a package for €1,695; or three days of main conference PLUS an optional one-day course at €1,695.
For other options please email mark.fenner@ukimediaevents.com.

PLEASE NOTE: Conference and Short Course passes are valid for FREE ENTRY into the exhibition on ALL DAYS

SPECIALIST SHORT COURSES	Price + 19% German VAT	Dates
Akron Tire Mechanics Short Course - 4 days	**€1,875**	**4/5/6/7 March**
Tire Mathematical Modelling Short Course - 3 days	**€1,425**	**4/5/6 March**
Intelligent Tires-and-Vehicle Systems in Automotive Transportation Short Course	**€1,425**	**4/5/6 March**
Basic Rubber Compounding Short Course - 2 days	**€1,075**	**4/5 March**
Tire Regulations Short Course - 1 day	**€695**	**4 March**
The Effect of Road Surface Variation on Tire Performance Short Course - 1 day	**€695**	**4 March**
Tire Reinforcing Materials Applications and Fatigue Testing Short Course - 1 day	**€695**	**4 March**

Starting on Tuesday 5 March, the conference features three days packed with the latest developments in tire design, materials and manufacturing. Extra presentations to be added!

DAY 1 TUESDAY 5 MARCH

1

Robert William Thomson Lecture

Stream 1 The Role of the Tire in Future Vehicle Transport

Achieving resource savings and driving safety – the future challenge

Pierre Fraisse, vice president technical operations - passenger car and light truck tires, Michelin, France

One of the biggest challenges for the tire industry to overcome is simultaneously enabling a better safety level and increased environmental and natural resources protection. The success in these areas can be achieved through exploitation of the full potential of the tires – which is not totally used today – and a performance evaluation based on relevant usage conditions. The use of those two ingredients will drive the tire industry on a virtuous circle.

Innovative tough rubber compound for environmentally friendly tires

Dr Katsuhiko Tsunoda, fellow, Bridgestone Corporation, Japan

Bridgestone Corporation took part in the ImPACT (Impulsing Paradigm Change through disruptive Technologies) research programme, which is a large, nationally funded five-year R&D activity operated by the Cabinet Office, Government of Japan. In the ImPACT programme, Bridgestone worked to realise resource-saving, lightweight tires through innovative tough rubber compound while maintaining energy efficiency. Comprehensive, multi-faceted analyses for fracture mechanisms of rubber were carried out. The overall research framework, derived innovative material design concept and practical realisation methodology with double network concept will be presented.

How the electric vehicle revolution will impact the tire industry

Bruce Lambillotte, vice president, technical consulting, Smithers Rapra, USA

What impact will the revolution in electric vehicles have on the tire industry? This presentation looks at how the move to electric vehicles will influence tire market requirements and demand to 2028 – from changing mobility trends and car sharing, to new technology and performance requirements, and more. Electric drivetrains will require adjustments in tire design to balance performance, safety and vehicle range. A review of tire development considerations will cover areas such as material choices and tire engineering. In addition, key insights will be provided based on Smithers Rapra's in-depth research for a new report, The Impact of Electric Vehicles on Tires to 2028.

New regulatory advances regarding tire labelling and CO_2 emissions

Ricard Anadón, senior product manager, Idiada Automotive Technology SA, Spain

This presentation summarises the forthcoming regulatory advances regarding the new proposal for a European regulation on the labelling of tires with respect to fuel efficiency and other essential parameters, published in May 2018. This new regulation, when approved in 2019, will repeal the current R(EC)No 1222/2009. In addition, a revision of the new EU type-approval legislative framework in application of the R(EU) 2017/2400 will be presented. After 1 January 2019, truck manufacturers will have to calculate the CO_2 emissions and fuel consumption of new vehicles they produce for the EU market using the new Vehicle Energy Consumption Calculation Tool (VECTO).

Digital roads for digital tires? A vision on future mobility

Michael Kaliske, professor, Institut für Statik und Dynamik der Tragwerke, Germany

Autonomous cars and smart vehicles are gaining increasing attention and form a new mobility technology that will change the industrial ecosystem and the paradigm of transport in human life. The appearance of smart tire systems will give rise to better tire performance, better vehicle control and the enhancement of intelligent systems for autonomous vehicles. In combination with real-time monitoring, e.g. by sensor-equipped tires, data exploration and underlying holistic simulation models for the road-tire-vehicle system, lifecycle predictions become feasible and allow the tracking and predicting of the behaviour of single components from manufacturing, through service, until failure state.

The changing global tire industry

Robert Simmons, director, LMC Tyre & Rubber, UK

With more countries introducing tariffs to protect their tire industries, the direction of global trade and the tire market is changing. Most duties are against China. The paper will assess the impact of duties in the USA, EU, India and Brazil. In addition, tire capacity in the USA is increasing, with some 50 million units of capacity due to come on stream in the coming years. The paper will assess the winners and losers from this investment.

Review of the Indian automotive and tire market

Lionel Tomas Rodriguez Perez, senior manager rubber compound and materials, CEAT Tire, Germany

The Indian market has grown to produce over four million cars/year, putting it behind only China, Japan and Germany. In addition, it has a growing economy and expenditure in research and development in the areas of chemistry, IT and automotive. In this presentation CEAT reviews the market trends in the Indian tire and automotive industries, with a focus on the performance of tires and the trends in connectivity, autonomous driving, car sharing and alternative fuels. The second part of the presentation shows how the level of technology in products for Indian customers is increasing.

The distributor as a driver for innovation trends

Mauro Pessi, CEO, EFTD - European Fintyre Distribution Group, Italy

How is innovation perceived by tire users? Thanks to the proximity to the consumer, the tire distributor is a fundamental link in the tire industry's value chain because it can very closely observe consumers' habits and expectations in terms of innovation. EFTD is one of the leading European tire distributors and, based on extensive market research, will explain how the global distributor of the future will increasingly support tire manufacturers by providing direct feedback from the market, and will therefore have a decisive influence on market trends.

Panel Discussion: Can there be an EV tire that is low rolling resistance, failsafe, high grip, ultra light and long life?

2 *Stream 2 Improving the Accuracy of Tire Testing*

Analysis of rolling tire vibrations by a deconvolution method

Dr Naoshi Miyashita, general manager, The Yokohama Rubber Co Ltd, Japan

Tire harshness is usually discussed on the basis of the results of dynamic cleat test. By applying a blind deconvolution method, we decomposed the response waveform measured at tire rotation axis into (a) the impact waveform that the cleat had on the tire outer surface (tread/belt ring); (b) the vibration transfer function of tire-side part. Although both (a) and (b) are approximate, they are very informative for tire design, and enable the estimation of some tire vibrations and ride comfort under various conditions.

Development of an indoor tire wear test method

Dominique Cettour-Janet, senior fellow for tire performance evaluation and tire physics, Michelin, France

Measuring the wear of tires and ranking their mileage capabilities is a challenge that the tire industry has been facing for decades. The current reference method consists of comparing tires through a so-called 'convoy' method: vehicles are driven simultaneously on a defined route at the same speed and acceleration. Despite the strong advantage of a true representation of use and method accuracy, such testing procedures are quite complex to monitor. Performing these comparisons by driving tires on an indoor drum machine will be discussed. Results from indoor and convoy test methods are compared. Perspectives on such testing are also given.

Wet grip of worn tire: mechanisms analysis, test method relevance

Frederic Biesse, tire performance analysis expert, Michelin, France

Experts know that on wet roads a worn tire has lower grip than a new one. Here, we propose an original approach (based on the calculation of the grip coefficient μ at each speed of the braking test) to highlight mechanisms involved during the regulatory wet braking tests for new and worn tires. This analysis shows that the regulatory test applied on new tires focuses mainly on rubber friction, while on worn tires hydroplaning mechanisms also have high importance. We conclude that the regulatory wet traction test is relevant to reveal grip and aquaplaning performance of worn tires.

Characteristics of a tire testing machine and the practicality of tire data

Dr Shunichi Yamazaki, president, Intelligent Vehicle Research Institute, Japan

There are many types of dynamic tire testing machines, such as drums, flatbelts and crawlers. In this presentation, characteristics of various tire testing machines will be organised and differences of test data will be discussed. Differences in road surface curvature affect tire test results. When the vehicle is going straight ahead, the slip angle is not 0°. However, in all test methods, the slip angle of straight running is set to 0°. The presentation will consider whether tire test methods such as ISO simulate a real running tire and whether the test method is effective.

Testing of rubber and tire friction

Alexander O'Neill, research engineer, Jaguar Land Rover/University of Surrey, UK

Compared with outdoor testing, indoor flat-track testing has considerable advantages in terms of repeatability and consistency. However, the tire is tested on an unrealistic surface (sandpaper), which raises concerns about the accuracy of the obtained data. To remedy the situation, Jaguar Land Rover and the University of Surrey are working together to enhance understanding on how to transfer tire force and moment characteristics from one surface to another. The long-term goal is to establish procedures to scale high-quality data from indoor testing to allow accurate prediction of tire behaviour on real surfaces.

Rolling resistance – is one label figure sufficient information?

Dr Christian Bachmann, senior manager tire technology, FKA Forschungsgesellschaft Kraftfahrwesen mbH Aachen, Germany

The current standardised test procedures to determine tire rolling resistance allow a very accurate and comparable achievement of results under laboratory conditions. However, similar to fuel consumption tests of vehicles in the lab and on real roads (WLTP, RDE, etc.) the tire test results differ from real usage on a road. This presentation will compile some known issues and try to suggest adjustments to the actual test procedures to increase the information content and eventually achieve more realistic conclusions.

Investigation of damage in rubber materials by x-ray diffraction

Dr Konrad Schneider, head of department, IPF Dresden, Germany

Under real conditions, rubber material is loaded with constraint boundary conditions. Due to mainly hydrostatic load, cavitation will appear in the bulk ahead of any crack tip. Synchrotron x-ray diffraction enables the online investigation of early stages of damage. Investigations of crack propagation with simultaneous x-ray diffraction will be presented and discussed.

Effect of road surface macrotexture and microtexture on skid resistance

Dr Malal Kane, researcher director, Ifsttar, France

The influence of road macrotexture and microtexture is investigated. Original surface profiles are decomposed using an empirical decomposition method into constituent profiles (IMF). The first IMF profiles are differentiated from the original and each other to derive a smoother profile. The DFM is then applied to these new profiles to highlight the role of the respective two roughness scales. The results show that the higher the microtexture can be maintained, the better the skid resistance will be. Furthermore, for two wet road surfaces with the same microtexture, the higher the macrotexture is, the later hydroplaning will occur.

3

Stream 3

Developments Within Steel and Non-Steel Cord Reinforcement

New TCF dipping – a unique offer

Dr Thomas Kramer, head of expert reinforcements and skim compounds, Continental Reifen Deutschland GmbH, Germany
Dr Mustafa Yasin Sen, project leader, Kordsa Global, Turkey

Kordsa and Continental are co-developing a new resorcinol-formaldehyde-free adhesion system for bonding textile reinforcement materials to rubber-based compounds. The development is motivated by the companies' commitment to sustainability and to defining a new standard for the tire industry. The technology being developing will be provided free of charge to lay the foundation for a new eco-friendly adhesion system standard. This joint presentation will cover the free licensing and sampling concept along with the latest technical results.

Online tire ply thickness fabric cord balance measurements using THz

Steven Jenkins, senior process engineer, Bridgestone, USA

Online measurements of tire ply critical features (total ply thickness and cord balance) allow for better control and thus provide a clear advantage to tire manufacturers with higher quality and lower costs. For products with fabric cords, the ability to measure balance was not previously available. This presentation will concentrate on the use of a single THz sensor to provide safe, fast, accurate thickness and simultaneous balance measurements of ply constructions, particularly on products with fabric cords. A THz sensor uses reflections of an emitted energy pulse to make layer thickness measurements. Results from multiple product configurations will be presented.

Industrialisation of formaldehyde-free dip system for textile cords

Delphine Fleury, material designer, Michelin, France

Michelin has been investing in research for some years to limit the use of formaldehyde- and resorcinol-based resins commonly used for bonding textile cords to rubber. This new technology based on polyphenols and aldehydes chemistry can be used on various type of fibres (nylon, polyester, aramid, rayon) with adhesion levels equivalent to RFL. Results from the lab, tire testing and industrialisation phase will be shown and compared with RFL performances. For resin production as well as its commercialisation for tires and other applications, Michelin created ResiCare.

Steel tire reinforcement solutions – better together for a sustainable future

Ann Lambrechts, vice president technology rubber reinforcement, Bekaert, Belgium

In the past 70 years, Bekaert has developed the most innovative and sustainable steel tire reinforcement solutions. The ever-increasing strength of steel cord leads to lower rolling resistance and CO_2 emissions. Bekaert's coating technologies enable tire makers to produce more eco-friendly tires. The firm's global footprint and focus on greener production processes help to achieve the ever-increasing sustainability ambitions of the tire manufacturers and therefore reduce the carbon footprint in the automotive supply chain. One out of three tires in the world contains Bekaert steel cord reinforcement. A strong focus on innovation, global manufacturing and a customised product portfolio has made Bekaert a preferred supplier of steel cord and bead wire reinforcement solutions worldwide.

Plasma deposition as an alternative to RFL treatment

Dr Wilma Dierkes, associate professor, University of Twente, Netherlands

The tire industry is focusing more and more on sustainable processes and materials, with special attention on a replacement for RFL treatment for cord-rubber adhesion. One of the alternatives is atmospheric plasma treatment, in which the fibre surface is activated and a reactive coating is applied. Precursors with different types of anchoring groups for coupling to the cord and the polymer will be compared. They are applied to two different types of cords – rayon and polyester – of which the intrinsic properties determine the processing window and thus the activation efficiency. The chances and limitations of this technology will be discussed.

Shrinkage – shrink force of reinforcing textile simulating tire curing process

Dr Barun Samui, scientist, Hasetri, India

The conventional 'free shrinkage' values have little significance in rubber-cord composites like tires. In the present work, more focus has been put on shrink force, which is actually linked with the morphological structure of the polymeric fibre. Thermal shrinkage, more of a physical phenomenon, is a manifestation of the shrink force developed in the microstructure. The uniqueness of the present work lies in the approach of programming the shrink force and shrinkage study in 'dynamic mode', simulating time-temperature cycle close to the actual curing process of a PCR tire. Reinforcing textiles such as polyester, Polyamide6, Polyamide66 and rayon have been studied.

Quality monitoring of tire cord on high-performance Dornier weaving machines

Oguz Karcier, head of product management, Lindauer Dornier GmbH, Germany

Industry's main focus lies in the efficient production of a high-quality product. The weaving process is part of the complete process chain in tire cord production. Lindauer Dornier GmbH has set numerous milestones in order to optimise this process, reduce the costs for customers and offer a machine to produce premium

tire cord. The presentation examines the weaving process and gives details about the production of high-quality tire cord.

Innovative steel cord inspection for monitoring, analysis and preventive action

Christian Schäfer, export manager, Roland Electronic GmbH, Germany

For reduction of scrap it is mandatory to control the steel cord cutting and splicing process by the Steel Cord Inspection System SIS. This system, based on a magnetic technologies, is highly developed and can be operated nearly without any user intervention. Thanks the newly developed ProcessAnalyser tool, product defects in steel cord are automatically monitored and synchronised with defect types. The process responsible and the quality management are now enabled to analyse past defects of a preferred time, in order to take preventive action.

Online tire ply thickness fabric cord balance measurements using terahertz

Dr Jeffrey White, senior research scientist, TeraMetrix, USA

Online measurements of tire ply critical features (total ply thickness and cord balance) allow for better control and thus provide a clear advantage to tire manufacturers with higher quality and lower costs. For products with fabric cords, the ability to measure balance was not previously available. This presentation will concentrate on the use of a single THz sensor to provide safe, fast, accurate thickness and simultaneous balance measurements of ply constructions, particularly on products with fabric cords. A THz sensor uses reflections of an emitted energy pulse to make layer thickness measurements. Results from multiple product configurations will be presented.

Creep characterisation of tire cord using time temperature superposition technique

Prof Mohammad Karimi, faculty member, Amirkabir University of Technology, Iran

A temperature-accelerated creep test programme was conducted in this work to present long-term creep deformation response. Nylon and polyester basic yarn as well as their hybrid cords were tested using dynamic mechanical analysis to form the master creep curves by superimposing the creep strain responses measured at different temperatures. Design criteria in the current work establish a critical total tire cord strain that should not be exceeded during a structure lifetime. In our new perspective, some tire performance characteristics affecting grove crack defect and durability of tire cord will be studied based on time-temperature superposition technique.

4 *Stream 4 Tire Manufacturing – Improving the Efficiency of Current Technology*

Condition-based maintenance: actively manage the health condition of equipment

Paolo Gamarino, European industry manager - automotive parts, SMC Corporation, Italy

The presentation will show innovative automated systems and simple cost-effective manual systems that facilitate predictive maintenance. These systems can be performed at predetermined or random intervals during the tire manufacturing process. Predictive maintenance requires data collection and non-invasive measurement of one or more conditions within the equipment, such as temperature, pressure, flow, etc. Application examples and case histories of existing and future automation systems will be explained.

Tire construction flexibility with MAXX technology

Erwin Zweers, R&D manager, VMI Group, Netherlands

The VMI MAXX has been on the market for almost 10 years and is still ready for the future. During the last 10 years, VMI has continuously invested in new developments on the MAXX platform. The VMI MAXX is designed to maximise productivity with a high level of uniformity and quality. Current and future demands of the car and tire industry require more flexibility in production. The smart factory will be flexible and produce individualised products in high volumes – the VMI MAXX is doing exactly that. Combined with state-of-the-art automation and VMI Pixxel vision systems, the MAXX is ready for the future.

New insulation possibilities for energy-efficient tire presses

Tomasz Janiszewski, product manager, Continental - ContiTech, Germany

Generating energy savings at tire presses can be challenging. While the presses are built as compactly as possible there is little space for insulation material to cover pipes, valves and hoses. Also, flexible hoses are a challenge for insulation materials. The harsh environment also demands a durable solution to keep maintenance at a minimum. We are looking at a new insulation solution that has already been applied at Continental plants. It shows new possibilities to save energy and thus reduce steam consumption at places that are usually left uninsulated.

Advanced technologies for the mixing room

Guido Veit, business unit manager, Zeppelin Systems GmbH, Germany

The liquid dosing system (LDS) is a closed-loop, robust, modular system offering precise injection of liquids at high injection velocities, irrespective of the viscosity. Suitable for silanes, liquid rubbers and all other liquids, the latest systems can inject up to 36 different liquids at each mixer per batch, offering breakthrough results in speed and accuracy. This can be a game-changer in the mixing room, opening possibilities that no-one found necessary a few years ago.

Mould, bladder, tooling and press management in Smart Manufacturing Industry 4.0

Jos Uijlenbroek, vice president, FineLine Technologies, Data2, Netherlands

35% of the overall tire quality is directly related to tool management and yet it is one of the most difficult processes to master within the tire industry. Using solutions based on RFID technology achieves connectivity of tools through nearly all processes. This connectivity provides total transparency and traceability, directly associating individual manufactured tires with the press, mould, mould segment, bladder and even other tools used in the tire manufacturing process, such as dies (extruder).

The impact of aerospace technology pressure switches on curing press up-time

Paul Konrath, VP - marketing and sales, Custom Control Sensors, USA

CCS developed the dual-snap disc spring to provide precise, highly reliable pressure switch technology for aerospace applications. Due to the reliability of this technology, it has been used for industrial purposes. Most recently, working with tire manufacturers in several countries, CCS has developed a pressure switch specifically for the safety interlock on curing presses. Unique features on the switch increase press productivity through reduced downtime, and improve safety of the workers while providing lower cost of ownership.

SITOP power supplies – power for the tire industry

Thomas Senft, business development manager, Siemens, Germany

Due to the harsh environment, the requirements for power supplies are very special. Each production step has different requirements. SITOP provides for each production step regarding power supply.

Laser cleaning of innerliner – enabling advanced tire concepts

Florian Schreiber, vice president sales, 4Jet Technologies GmbH, Germany

Technology demands from OEMs are increasing the requirements for tire capabilities. The growing market for high-performance automobiles demands additional capabilities for tires, such as noise reduction and being puncture-proof. Such technology is applied in a post-curing process that requires a clean surface on the inside of tires. The presentation shows how laser technology overcomes issues arising from traditional cleaning methods on the innerliner of tires. It demonstrates how laser cleaning combines all the advantages of laser applications to the benefit of tire manufacturers. The technology sets benchmarks in cost, quality, automation, footprint and overall performance.

Microwaves in the tire industry – benefits, advancements, breakthroughs

Daniel Kettner, sales director, Romill Microwave s.r.o., Czech Republic

Everyone who attended the previous conferences is already familiar with the possibility of applying microwaves in the tire industry. The principle of microwave heating doesn't change much over time, but the applications do. Find out about the newest advancements and findings related to how microwaves can enhance your tire production process. The speaker will talk about different approaches, their pros and cons and how they affect the process. He will also present some other applications from the general rubber industry as these can also act as an inspiration for new technological advancements.

State-of-the-art uni-stage passenger tire building machine

Santhanam Kumar, state-of-the-art passenger tire building machine, Larsen & Toubro Limited, India

The presentation discusses a new tire building machine for passenger car tires, with in-built accuracy monitoring and state-of-the-art onboard and mobile device controllable diagnostic systems. The machine uses a unique collapsible pusher can for bladder drums, ensuring the best bead-wrap and geometrical accuracies. The safety systems ensure best operational safety with onboard diagnostics and remote connectivity to the tire plant. The machine is IIoT enabled, connecting to the customer's servers. Diagnostics and testing and setting machine parameters can be achieved via remote setting pads and HMI. An in-built energy loss detection system detects the precise location of any leak.

Use of IIoT for smarter extrusion machinery – an edge computing approach

Rajkumar RB, senior executive - machine development, MRF Limited, India

With effective use of disruptive technology such as the Industrial Internet of Things, rubber extrusion machinery can be made intelligent, reliable and self-diagnostic. Appropriate use of smart sensors networked to local servers through a traditional OT infrastructure can be used to build data silos for predictive maintenance, scheduling, track and trace, and visibility of insights across the board to boost productivity, availability and reliability. This enables a move from a traditional decision-making process to a way to make the best decisions aided by robust data analytics from shop floors to boardrooms.

ROLLMILLMATIC: high-productivity single-stage automatic mixing process SSM

Mario Sacchi, R&D chief technology officer, Comerio Ercole SpA, Italy

The presentation will discuss a technological innovation based on the production of masterbatch and final compounds in a single stage, enabling low-temperature processing based on Comerio Ercole's special ROLLMILLMATIC automatic mixing mills to improve the quality of the compound utilised for high-performance tires. The SSM batch temperature is quickly lowered during the ROLLMILLMATIC cycle with reliable process benefit to the downstream blending stage. Engineering support for a turnkey mixing plant is provided based on the Industry 4.0 concept.

Tire manufacturing – improving safety levels without compromising productivity

Enrico De Carolis, vice president global technology, Emerson, USA

Tire manufacturers must prevent workplace accidents by guarding against safety risks. Reaching the desired safety level can be challenging as it can add complexity and reduce productivity. This presentation will introduce a unique approach known as zoned safety, which enables reduced complexity in the design of redundant pneumatic safety circuits and improved tire manufacturing machine productivity. It explains the advantages of the concept over the traditional method of pneumatic safety circuit design using dump valves, and lists the benefits for equipment manufacturers (OEMs) and end users that are active within the tire industry.

Automated tire mould cleaning system

Ahmet Erdogan, global key account manager tire, Cold Jet BVBA, Belgium
Dietmar Juchmes, senior VP Europe & Africa, Cold Jet BVBA, Belgium

Cold Jet, a leader in dry-ice cleaning and surface preparation systems, presents how its Automated Environmental Dry Ice MicroParticle Cleaning Solution can fulfil the requirements of the tire industry. The paper explains how to efficiently improve the cleaning process while consuming less dry ice/air, while achieving a consistent cleaning result, and a better and more environmentally friendly workplace by using automated robotic cleaning. The most important step for effective tire

manufacturing is the selection of the right cleaning solution, which ensures process control and enhanced mould cleaning that is faster, produces less noise and uses less medium.

Anti-tack and toilet paper – the saga rolls on

Howard Kennedy, VP marketing, HL Blachford Ltd, Canada

This presentation is a follow-up to the one made in 2017 titled 'Anti-tack – the toilet paper of the tire industry', and will present solutions and strategies to reduce costs and improve the efficiency of the anti-tack/anti-adherent operations in the mixing area of the tire manufacturing facility. The paper will cover anti-tack chemistries, dispersion technology and automation strategies that lead to lower solids usage, less stuck rubber and, in the end, lower overall total cost.

A new beadwrap method for tire building

Santhanam Kumar, state-of-the-art passenger tire building machine, Larsen & Toubro Limited, India

Beadwrap is a process that makes the innerliner/ply to wrap around the bead bundle not only without any gap but also ensuring that the bead bundle is locked in tightly. The shape of the bead apex is key, and is influenced by the composition of the tire components. The use of bladder turnup ensures all-round contact pressure on the bead bundle. Later trends such as the use of mechanical fingers with rollers have the advantage of compact, sturdy machine construction. This paper analyses various approaches and suggests what the future might be.

Evaluation of the effect of thermal conductivity of bladder failure

Dr Ali Abbasian, professor, SRBIAU, Iran

Heat generation in rubber compound is the most important reason for material failure during operation. The idea of utilising a thermally conductive carbon black ENSACO 250G in rubber compound was examined and heat generation was studied via Bhowmik's empirical relationship. It was understood that by incorporating ENSACO 250G featuring relatively low specific surface area, heat generation in compound would be much lower compared with conventional N220 and N330. The main reason for this behaviour was attributed to significant impact of ENSACO 250G on various parameters affecting heat generation, namely thermal conductivity, modulus and hysteresis.

DAY 2 WEDNESDAY 6 MARCH

2

Stream 2 Improving the Accuracy of Tire Testing (continued)

Accurate measurement of parking forces

Dr James Cuttino, director, tire research and development, Link Engineering Company, USA

Power margins for electric steering systems are much smaller than classic hydraulic systems, so sizing them has huge implications for performance and costs. Predicting steering loads from classic F&M measurements is difficult due to the complex motion of the tire during braked steering, which combines rotation, sliding, cambering and shifting loads of the tire due to kingpin angles. This paper describes tests conducted on a system designed to measure forces and moments generated when turning a braked wheel about its kingpin axis. Experimental results will be presented comparing results with and without scrub radius, kingpin inclination, and other pertinent parameters.

Identification of the lateral relaxation length

Dr Yi Li, simulation engineer, GCAPS, USA

The lateral transient impact of tires on vehicle dynamics and the need to accurately simulate this has been increasing over the years. GCAPS' high dynamic equipment enables unique research in this area. The research will review testing methods and current processing methods and introduce a new processing method to identify the lateral relaxation length. These methods are applied to different tire types. Different conditions such as speed, inflation pressure, application rate, test waveform and endpoints all change the relaxation length. A suggested method of implementing a non-linear transient model will be included.

Passenger car tire-road contact stress distributions at low speed

Prof Gabriel Anghelache, professor, University Politehnica of Bucharest, Romania

The presentation shows some experimental results regarding tire-road contact stress distributions, measured simultaneously on each square unit area of contact patch in three orthogonal directions. Some functional conditions refer to: slick passenger car tire, free rolling at low speed, and different parameter values such as internal pressure, vertical load and toe angle. Conclusions extracted from the experimental results are discussed.

Measuring contact patch shapes and their effect on tire performance

Henning Olsson, director, R&D, Calspan Corporation, USA

All of a tire's cornering, braking and driving forces are generated within the contact patch. A new method has been developed to measure the shape of the contact patch in various rolling and loaded operating conditions on a flatbelt tire test machine. Using this method, contact patch shape attributes have been compared with important tire performance attributes such as stiffness and grip. Initial results are discussed and an approach to modelling contact patch attributes for use in intelligent tires' real-time force estimation is presented.

An evaluation of severe impacts encountered by highway truck tires

William Woehrle, owner, Tire Forensics Investigations, USA

Truck tire durability issues continue to attract considerable attention in the USA. Recent increases in posted speeds on USA expressways, together with further, widespread deterioration of pavement surfaces, have seemingly combined to at least partially suggest the cause of the damage as well as ultimate failures in truck tires. This presentation will include impact, x-ray and fatigue endurance test results for highway truck tires in the 22.5 and 24.5 sizes, new and reduced tread depth, and conventional and super single tires.

Capturing tire behaviour and performance at high speeds

Camilo Aladro, pressure mapping product manager, Tekscan, USA

The High Speed TireScan system captures the impact of speed, motion and inertial forces on a tire at speeds up to 265km/h (165mph). The robust array of pressure-sensing elements scans at 20kHz as the tire rolls across the system. This system allows engineers to evaluate tire performance at high speeds, identify failure modes and measure tire distortion from inertial force.

Investigations of structure-borne noise and airborne noise of rotating tires

Hendrik Alteepping, engineer, Amitronics GmbH, Germany

The presentation will discuss measuring the structure-borne noise of stationary and rotating tires using a newly developed measuring wheel in combination with a laser Doppler vibrometer. This will include recording the airborne noise inside and outside the tire to understand the connection between structural dynamics and sound emissions of rotating tires.

Dynamic tire footprint measurements to enhance and validate tire simulation

Jan Friederichs, research assistant and PhD student, Institute for Automotive Engineering (IKA), RWTH Aachen University, Germany

Today's vehicle development is impossible to imagine without computer-aided engineering in the form of multi-body simulations. Therefore, accurate tire models are needed for reliable component and full car simulation results. Standard parameterisation of tread and footprint characteristics is done on the basis of static data. In this investigation, IKA's mobile tire test rig and A&D's Force Matrix Sensor are used to measure dynamic tire footprints for the improvement of physical tire models such as FTire. By these measures it is possible to quantify shear stresses and pressure distribution in the contact patch in simulations on digitised asphalt surfaces.

Efficient method of estimating tire durability

Dr Radek Stocek, head of R&D, PRL Polymer Research Lab, Czech Republic

There are always questions about the endurance limit of rubber articles, especially tires. The crack growth rate is a lifetime-limiting parameter, but what is the lowest load at which no crack growth happens? A methodology of laboratory testing will be introduced, which is capable of estimating this threshold tearing energy (intrinsic strength). Although a classical crack growth experiment with such a low tearing energy is practically impossible because it would need months of testing time to find the energy limit between crack propagates or not, the introduced methodology needs only few hours to be performed with reliable results.

The SPC: a revolution in tire testing worldwide

Arnaud Dufournier, president, Dufournier SAS, France

The SPC is set for self-propelled carriage. After an overview of the current situation, three topics will be discussed: Dufournier's unrivalled experience in this area; quality of measurement with no equivalent to date; unique industrial test capability.

On-the-road rolling resistance derived from tire temperature profiles gathered while driving

Alan Bennetts, director, Bay Systems Ltd, UK

Rolling resistance ends up as heat in the tire – this is universally true. Tire temperature profiling in the laboratory provides very interesting comparisons and correlates very closely with the RR score. When we start to measure tire temperature profiles when driving on the road network, the profiles are dramatically different to those measured in the laboratory. Is the laboratory measurement correct or good for customers to compare tire RR performance or is it a little or totally misleading, just like the engine efficiency numbers?

Stream 5 Modelling Tires and Tire/Vehicle/Road Performance

5

Improving the CAE vehicle development by using physical tire models

Luca Dusini, responsible for vehicle dynamics and simulation, Maserati SpA, Germany

Maserati aims to reduce the development time from three years to one. The quality of the final product is extremely important for the customer. It can only be guaranteed by testing the cars in combination with different tires on track and analysing performances in depth. Maserati has improved the CAE process by using CDTire/3D. The whole procedure has been validated. The key questions related to the tire during the early design phase include: which tire/rim size to choose; how closely it is possible to predict the key performance indicator variations; how to improve the driving experience by using driving simulators.

Role of simulations in OEM and trade tire development

Mario De Martino, product development engineer, Prometeon - Pirelli Industrial, Italy

The presentation will explain how Prometeon, in a 100% open innovation environment, is working with external companies to improve the synergy with OEMs and satisfy the coming market requirements. It will also show some preliminary results from the collaboration between Prometeon and Megaride, and thanks to the research activity done at the University of Naples Federico II.

Tire-based algorithms for onboard evaluation of performance and smart mobility perspectives

Dr Flavio Farroni, assistant professor / CEO and co-founder, UniNa / MegaRide, Italy

Advances in vehicle onboard hardware performance and in increasingly connected mobility pushed the research activities of UniNaVehicleDynamics group towards the implementation of modelling and data-processing technologies developed for automotive partners, for real-time simulation platforms and vehicle control logics. The availability of an onboard tool for the evaluation of tire forces, of machine-learning-based virtual sensors and of a procedure for the identification of reference tire models allowed the group to develop an HMI concept that can teach the driver to 'feel the limit' and to get progressively closer to it. Such technology is now the subject of further improvements orientated to smart mobility scenarios.

Simulation of tire variation

Francesco Calabrese, research fellow, Fraunhofer ITWM, Germany

Vehicle R&D teams aim at reducing development cycles to produce a car. The best way to reduce the development time span is to speed up the concept phase. Using simulation tools, it is possible to modify the gradient of increasing maturity of

the project without losing quality. Fraunhofer developed a methodology to use CDTire to predict the effect of the tire/rim sizes and tire inflation pressure on the tire characteristics. New 'virtual tires' together with the 'virtual vehicle' are used to estimate the effect of the tire variations on the vehicle performances (KPIs). The process has been validated by Maserati SpA against vehicle/tires measurements.

Stress investigation of a radial tire using 3D non-linear FEA

Dr Abdul Waheed Awan, senior lecturer - mechanical and automotive engineering, Staffordshire University, UK

In this study, a 3D non-linear tire model was developed using rubber hyperplastic and viscoelastic properties along with all the reinforcement plies' geometrical and material properties. Stress field is investigated under inflation pressure only, inflation pressure along with tire vertical load, and steady-state rolling and cornering conditions. A radial tire of 225/55 R17 is cross-sectioned and modelled in this research, and analysis is conducted using different speed, pressure and vertical loads. Finally, the tire design parameters effect is also studied on the stress field under different operating conditions.

Vehicle dynamics hybrid simulation study

Ki Hyun Kim, senior research engineer, Nexentire, Korea

This study evaluates the feasibility of using hybrid simulation to quantify vehicle-level behaviour with physical tires. The hybrid simulation system consists of a vehicle dynamic model (MSC CarSim) combined with a tire specimen in a loading rig (MTS Flat-Trac CT+). Hybrid simulation provides a quick way to evaluate tires on vehicle handling performance without the need to parameterise and validate a tire model and with higher fidelity than pure simulation.

Analysis of tire-soil interaction models for real-time off-road simulation

Brandon Ballard, PhD student, Coventry University, UK

Tire-soil interaction models define the forces, stresses and movement at the boundary between tire and soil. This work assessed the real-time capabilities of these models. Material and method: i) Code the models using MATLAB/Simulink; ii) Combine a full car with each tire-soil interaction model for a horizontal track; iii) Deploy and evaluate models on different hardware platforms. Results: Given in terms of computational performance (FLOPS, execution time, hardware) and capabilities (tire and soil parameter combinations, longitudinal relaxation length, bulldozing effects). Conclusions: There is a trade-off between model accuracy, tuning complexity and computational resources required.

Tires on the driving simulator

Diego Minen, CTO, VI-grade, Italy

The presence of a tire model is vital in the context of vehicle development based on virtual tools. As vehicle development increasingly relies on driving simulators, it becomes necessary to enable the support of different mathematical tire models, suitable for different application areas. Through a selection of discipline-specific use cases, the paper illustrates how the tire models developed and supported by the main tire manufacturers and research centres can be implemented in the detailed real-time vehicle model used in a driving simulator environment, correlating the results of the simulation with experimental testing.

An efficient approach for the simulation of tires with detailed tread pattern

Thirumal Alagu Palanichamy, doctoral researcher, IBNM, Germany

The Arbitrary Lagrangian Eulerian (ALE) kinematics framework is used widely in rolling contact analysis due to its main advantages in implementing the detailed contact analysis with local mesh refinement and time-independent formulation of elastic stationary rolling. Tires with circumferential grooves satisfy the axisymmetric constraint, whereas tires with detailed tread pattern do not comply with axisymmetric constraint of the ALE formulation. The goal of this research is to develop the coupling of tread pattern (transient dynamic Lagrangian) with tire base structure (steady-state ALE) using kinematic constraints. The advantage of such coupling will complete the whole picture of treaded tires simulation in ALE framework.

A new multiphysics technology for tire hydroplaning simulations

Biswanath Nandi, senior industry solutions manager, Dassault Systèmes, USA

Predicting the hydroplaning velocity of a particular tire is an important safety criterion for tire manufacturers. This presentation investigates a new co-simulation technique between Abaqus/Explicit and XFlow – a Lattice-Boltzmann Method (LBM) CFD code to solve this challenging problem. The tire is modelled in Abaqus/Explicit, and the water is modelled in XFlow. In the co-simulation, information exchanges occur though the contact surface between the tire and the water. The presentation focuses on guidelines for setting up the co-simulation for obtaining meaningful results in hydroplaning simulations.

adheRIDE: real-time advanced MF tire modelling for vehicle performance optimisation

Dr Aleksandr Sakhnevych, CTO - vehicle dynamics researcher, MegaRide / UniNa, Italy

The physical modelling of tire-road interaction phenomena, approached in a multi-physics MF-based simulation platform, allows the prediction and reproduction of local distribution of tire temperature, tread wear and adherence within the contact patch, also accounting for road texture roughness and tread compound characteristics. Such a tool, comprising thermoRIDE/adheRIDE models, was awarded Tire Technology of the Year at the 2018 TTI Awards. It can be employed, as in the proposed case study, from the beginning of the vehicle manufacturing design phase, to understand how to exploit the tire to maximise performance and safety, and also to take dynamically into account the physical phenomena exhibited at the tire/road interface, with the aim of reaching a higher level of predictivity in tire development and in motorsport real-time simulations.

A novel approach to tire uniformity through simulation

Vinay Kumar Bedi, senior engineer, Hasetri, India

Tire non-uniformity, characterised by force variation at the axle of a rotating tire, is singularly responsible for vibration, ride comfort and irregular wear. The present work attempts to determine the effects of various influencing parameters, from both manufacturing and design, individually and in combination, on tire uniformity through simulation. Pitch sequencing, component spotting, splicing and run-out have been included in the finite-element model. A mesh optimisation study for choice of element, refinement and other controls was undertaken initially to minimise numerical variations while simulating low-speed run on a uniformity drum. Finally, an optimised combination of the said influencing parameters has been proposed and verified.

Cure status prediction of TBR tires using finite element method

Mohammadreza Hosseinkhani, tire engineer, Barez Tire, Iran

In this research work, a simulator for the radial truck tire curing processes is developed based on the finite element code in conjunction with an in-house written subroutine to solve the heat conduction equation and the rubber cure kinetics. The anisotropy of heat transfer properties of rubber composites, the dependence of properties of rubber compounds on the temperature and the extent of cure, and the time-varying boundary conditions including the post-cure of the tire are also taken into account. The results showed good correlation with experimentally measured data, which confirmed the accuracy and applicability of the method.

Stream 6 *Improvements in the Science of Rubber Compounding*

6

Using RPA to study scorch behaviour of silica-filled compound

Dr Danling Wang, research department manager, Zhongce Rubber Group Company Limited, China

The effect of bis(triethoxysilylpropyl) tetrasulphide (TESPT) on the vulcanisation process of silica-filled solution styrene butadiene rubber was investigated. It was found that the scorch time T5 in ASTM D1646-2015 did not accurately reflect the pre-scorch behaviour in silica-filled compounds. To solve this problem, the rubber processing analyser (RPA) was applied to investigate the silica flocculation and matrix vulcanisation separately by using the time sweep under different strains. Moreover, the silica flocculation rate and matrix vulcanisation rate were also calculated separately.

A new concept for an alternative silica/polymer coupling

Anke Blume, university professor, University of Twente, Netherlands

The silica/silane system is widely used in the rubber industry. A disadvantage of the current system is that once the relatively stiff covalent sulphur bridge of the silica/silane/polymer connection is broken, there is no possibility to reconnect. As a consequence, a completely different coupling concept was considered, mimicking the Velcro-like system known in nature. Following this concept, an alternative type of rubber/silica coupling based on physical entanglements and steric hindrance was developed. The tangled rubber macromolecules act as molecular loops, and relatively long elastomer brushes grafted on the silica surface act as molecular hooks.

Impact of compound formulation on tire performance

Zuzanna Andrzejewska, PDEng, University of Twente, Netherlands

Tire manufacturers continuously improve tire performance towards better fuel economy, tire durability and driving safety of a vehicle. This presentation gives an overview of the key factors that affect tire performance, with an emphasis on the influence of the compound formulation on the properties of silica-filled tread compounds. The dependence of the magic triangle – rolling resistance, wet skid and abrasion resistance – on the compound formulation of a tire is discussed.

S-SBR/Li-BR for eco tire with ZSE's outstanding technologies

Dr Satoshi Anezaki, chief researcher, ZS Elastomers Co Ltd, Japan

ZS Elastomers (ZSE) has many outstanding technologies that can provide a wide variety of S-SBR/LiBR. These technologies contribute to improvement of rolling resistance, wet grip, abrasion resistance and processability. Thus, the company's polymers cover a wide range of tire design, such as winter, all-season, summer, HPT and race tires. This presentation will introduce the effects and mechanisms of ZSE's technologies, and the products to which those technologies are applied.

Combined DMA and DEA investigations on elastomeric materials

Dr Sahbi Aloui, application engineer, Netzsch Gerätebau GmbH, Germany

The realisation of the required mechanical properties profile of tire compounds is based on a molecular understanding of the interaction between rubbers and fillers. Information about the dynamic of the polymer chains and the filler network under load can be characterised with DMA and dielectric analysis (DEA). DEA offers the advantage over DMA that a very large frequency range can be investigated. For rubber formulators and finished parts manufacturers, only simultaneous operando DMA/DEA (diplexer) allows a better understanding of damage effects caused by large strains, long-term dynamic loads and high temperatures, since the relaxation processes are not yet started.

Effect of flocculation on physical properties of natural-rubber-based silica compounds

Meisam Askarpour Kabir, mixing process engineering manager, Barez Industrial Group, Iran

Curing is one of the most important procedures in tire production, and affects the mechanical properties of tires. Rheological graphs determine curing status. Nowadays silica compounds are widely used in tires. In rheological tests of natural-rubber-based silica compounds, a peak appears in the first minutes, known as flocculation. In this paper we try to predict the mechanical properties of compounds by using rheological data. We then want to find out the effect of flocculation phenomena on mechanical properties by using simulated data.

Performance resins in tread formulations – optimising wet, winter, wear

Dr Mark Arigo, associate scientist, Eastman Chemical Company, USA

Hydrocarbon and natural resins are low molecular weight polymers with high glass transition temperatures that are used in tire tread formulations to modify viscoelastic properties. In this presentation we investigate the impact of resins on tread performance and examine why resins provide unique solutions to balancing wet grip, wear and winter performance. Combined with low Tg polymers, resins enable significant improvements in abrasion without sacrificing wet grip. Additionally, resins are shown as an essential component in compounding strategies to improve the wet/winter performance balance in all-season tires. Overall, performance resins provide essential tools for compounders to optimise high-performance compounds.

The effect of non-tread rubber properties on tire rolling resistance

Minkyeong Oh, research engineer, Hyundai Motors, Korea

As requirements for fuel efficiency of vehicles increase, non-tread rubber parts are being developed for tire rolling resistance as well as safety and durability, which are the main requirements of non-tread rubber in general. It needs to be known how each non-tread part affects RR quantitatively. This work describes the correlation of viscoelastic properties with tire RR for three main non-tread rubber parts (under-tread, sidewall and rim cushion). It will be useful to predict the effect of non-tread rubber on RR without indoor or vehicle test.

Sustainable performance in agricultural tires

Dr Fabio Bacchelli, technical manager, Versalis, Italy

Statistically designed studies were used in the past to identify materials for improved farm tire tread performance, showing that the use of precipitated silica in NR and SBR agricultural tread compounds is beneficial to many properties, including resistance to chipping and chunking. Modern trends require enhanced carbon footprint through the reduction of fuel consumption at reduced inflation pressure and the introduction of materials from renewable resources. Blends of specially designed sSBR are investigated, for targeting low hysteresis (rolling resistance, HBU), processability and tear. Sustainability is also significantly improved by replacing fossil process oil with a highly sustainable bio-refinery plasticiser.

Manufacturing green silica from rice husk ash

Paulo Garbelotto, director of sales and marketing, Oryzasil, Brazil

Oryzasil is producing functional silicas (SiO_2) from rice husk ash. The products are equivalent to or better than those from competitors producing precipitated silica in the common – energy-intensive – way. Oryzasil is able to work with temperatures lower than 300°C. Due to the phenomenon known as phytomining there are no impurities in the silicas produced through the process applied by Oryzasil.

Optimisation of chemical curative using design of experiment method

Dr Farhan Saeed, assistant professor, University of Engineering and Technology, Lahore, Pakistan

A number of chemical ingredients such as curing agents, accelerators, activators, fillers, processing aids and antidegradants are used to compound the rubber for a particular application. The design of experiment technique was used in this study to optimise the compounding ingredients based on the ANOVA analysis. Furthermore, the contribution of each chemical curative towards the cure properties was determined considering the synergic effect of each chemical. The amount of filler was fixed to 60 phr and optimised quantities of the primary and secondary accelerators and activator were determined based on the S/N curves obtained from ANOVA analysis.

Compounds from latex mixing with anisotropic fillers for improved properties

Prof Ulrich Giese, managing director, German Institute of Rubber Technology, Germany

Modern tire compounds have to fulfil different properties at very high levels. Concerning innerliner materials, low permeation rates are desired without any loss of strength and with low weight. Desired properties of tread compounds are low abrasion and optimum traction and rolling resistance. Such highly sophisticated properties can be achieved using anisotropic fillers like layered silicates, nano-filibrated cellulose (NFC), CNT or graphene platelets in combination with optimised mixing strategies for high dispersion. As a promising methodology, a very efficient latex mixing process is used. The compounds are characterised for permeation, swelling behaviour and reinforcement.

Modified compound characteristics with liquid rubber

Marcel Gruendken, technical manager, Kuraray Europe GmbH, Germany

Kuraray has developed a series of liquid rubber products with molecular weights ranging from a few thousand to a hundred thousand. These polymers, which consist of isoprene, butadiene, styrene and a new, bio-based monomer called Farnesene, can be used by tire manufacturers to achieve improvements in processing and tire performances. Liquid Farnesene rubber contributes to vehicle fuel economy through reduction in tire rolling resistance. Moreover, we found that liquid Farnesene rubber offers ice grip performance improvement compared with oil and other liquid rubbers.

Analytic study on antidegradant volatility and tire compound odour

Yang Gao, senior application manager, Sennics Co Ltd, China

By simulating the different conditions of tire processing, the volatilisation characteristics and volatile components of different antidegradants were determined. Based on the mixing and analysis of tire surface compound with different antidegradant combinations, the volatile substances of tire mixing were determined as well as the relationship with the storage condition (temperature and time). The main factors affecting the tire compounds' odour were analysed, and suggestions for improvement were put forward as well.

Stream 7

Sustainability Developments Within Tire Material Science

7

A pragmatic approach to sustainable tire tread oil development

Dr Mika Lahtinen, global technical manager, Nynas Naphthenics, Sweden

Sustainability has become an important driver in the tire industry. The fuel efficiency of tires has been improved, noise reduction work is ongoing and raw materials produced from renewable sources are being developed. Yet implementing these materials takes time, and global capacity build-up without significant cost implications for tire companies won't happen quickly. Instead, smaller steps must be taken. In this paper we discuss the use of naphthenic tire oils with moderate aromatic content, taking a pragmatic approach to affordable sustainability: achieving on-par tread compound performance compared to any existing tire oil but with 30-50% lower aromaticity.

Novel alkylphenol tackifier resins made using alternatives to alkylphenol monomers

Dr Ashok Reddy, group leader - phenolic specialities, Hexion Inc, USA

A new class of alkylphenol tackifier resins has been developed, where the use of environmentally regulated monomers such as PTOP, PTBP, PNP, and in some cases formaldehyde, has been eliminated from the manufacturing process of alternative alkyphenol tackifier resins. The new synthetic process has the capability to make tackifier resins with a wide range of softening points and molecular weights. The performance of new phenolic tackifier resins has been evaluated using standard sidewall compounding formulation. The overall performance of new phenolic tackifier resins was comparable to industry-leading PTOP-formaldehyde-based tackifier resin, but in the case of tack and peel adhesion, new resins showed improvement.

Silica benefits for internal tire parts

Guilherme Brunetto, global application engineer, Solvay, France

The use of highly dispersible silica (HDS) in tread is already a key contributor to the production of fuel-efficient tires. Let's go beyond by adding highly dispersible silica in non-tread parts like sidewall, belt and bead to improve tire performance. This presentation underlines how Solvay's silica speciality portfolio in tire non-tread parts is meeting the increasingly demanding performance requirements in terms of rolling resistance.

Innovative carbon blacks for new-generation automotive tires

Chi Ta Tsai, R&D manager, Continental Carbon, Taiwan

New-generation tires are required to reach a superb performance of wear resistance and rolling resistance. Because of a wide range of microstructure and chemical group, carbon black is the superior material for reinforcing various polymers in the tire. This presentation will focus on the performance improvement of innovative carbon black grades with surface modified structure. Experiments show that wear performance and rolling resistance can be improved in tires.

Innovative design of SSBRs for winter tires

Dr Luis Rodriguez-Guadarrama, tire research leader, Dynasol Group, Spain

The design of low-rolling-resistance tires is an important issue for current and future mobility. The next generation of tires will meet greenhouse gas legislation targets established in the European Union. Functionalised SSBRs contribute to improve rolling resistance, wet grip and abrasion of tires. This presentation describes the functionalisation strategy followed by Dynasol Group to design SSBRs for winter tires. A molecular simulation model was developed to determine the characteristics of the functional groups in the SSBRs

Tire test results with new functionalised S-SBRs

David Hardy, technical service and development manager, Arlanxeo Deutschland GmbH, Germany

Functionalising butadiene rubbers is a proven method employed to improve their interaction with silica fillers. This results in the enhancement of dynamic performance in passenger tire tread compounds. Tire testing data will show that this results in reduced rolling resistance but can also lead to a deterioration in other important tire properties such as handling/cornering (among others), which are not covered by the tire label.

Replacing cobalt salts in steel skim formulation

Dr Leandro Forciniti, senior application research scientist, Eastman Chemical Company, USA

The tire industry wants to reduce or replace cobalt fatty acid salts (CS) due to an increase in cost, a problematic supply chain and regulatory issues. We have shown that hexamethylene thiosulphate bunte salts used in lab-scale tire steel cord formulations may provide superior properties to CS. We show how these bunte salts mechanistically interact with other additives in rubber formulations to give the desired performance. We show how they interact at the interface between the rubber and brass phase to provide excellent original and corrosively aged steel cord adhesion versus CS.

Next-generation insoluble sulphur: setting a new standard for productivity

Dr Dominica H C Wong, senior chemist, Eastman Chemical Company, USA

Eastman Crystex Cure Pro insoluble sulphur is a highly optimised polymeric sulphur specifically engineered for maximum performance characteristics. It is a unique performer because it has the important features that tire manufacturers want in insoluble sulphur: enhanced flow, superior dispersion characteristics and improved thermal stability. Enhanced flow means easier handling and faster fill rates. Superior dispersion facilitates uniform mixing in less time. High thermal stability allows higher mixing temperatures, faster calender speeds and avoidance of bloom. With these distinct properties, Cure Pro enables tire manufacturers to improve productivity and achieve critical operational cost and energy savings.

Compounding of silica/silane systems in natural rubber

André Wehmeier, head of Rubber Technology Group / senior manager rubber silica, Evonik Resource Efficiency GmbH, Germany

Silica/silane as a highly effective reinforcing system in synthetic rubber compounds is well established, and the performance has been demonstrated especially in passenger car tire tread compounds for decades. The use of this system in natural rubber compounds, more precisely in truck tire tread compounds, is still limited even though the advantages of rolling resistance and wet grip are accomplished there, too. This is due to the fact that it is easier to achieve excellent abrasion resistance by carbon black. The presentation covers compound optimisation strategies based on different silica/silane systems to close the gap to carbon black.

The influence of tread enhancement additives on the performance of filled tread compounds – an insight into the effect of SYLVATRAXX

Jochem Vervelde, senior technician, Kraton Chemical, Netherlands

Using fundamental expertise in the interaction between elastomers and resins, Kraton has developed a TEA showing performance in compound similar to a limonene-based TEA. The compatibility of this new TEA with different elastomers used in PCR tire tread compounds will be shown. Furthermore, the insights gained with the model elastomer/TEA allow us to predict resin performance in real compounds. We will show this correlation by presenting the performance of this TEA in a PCR tread compound formulation, which will demonstrate the benefit of the new TEA grades.

Improved measure of Crystex insoluble sulphur dispersion in tire formulations

Dr Thomas Floyd, group leader, Tire Additives Rubber and Analytical Laboratory, Eastman Chemical Co, USA

Insoluble sulphur dispersibility is critical to formulating rubber for tire manufacturing, impacting plant mixing choices, calendering operations and compound performance. Eastman's Crystex Cure Pro insoluble sulphur provides superior dispersion when evaluated in commercial-scale mixing processes. Conventional approaches to measuring sulphur dispersion involve mechanical testing and assessment of critical flaws. Image-based methodologies have recently been adopted as a timely and information-rich approach to quantifying mixing efficiency. This paper will highlight methodology validation and provide insight on the dispersibility of Crystex in typical rubber formulations. This straightforward approach will illustrate opportunities for higher productivity in product evaluation and tire plant operations.

Sustainability and performance: non-mineral-oil-based tire and rubber plasticisers

Dr Kamyar Alavi, senior technical advisor, Nynas, Sweden

Our collective environmental footprint and how to increase the sustainability of the products we manufacture and use are issues that can no longer be postponed. For the tire, this has meant the introduction of new raw materials made from non-mineral oil sources. Important as the improved sustainability profile is, no compromise on the technical performance of the final product – the tire – is accepted. This paper will present and discuss the results achieved in tire rubber compounds prepared from non-mineral-oils plasticisers, showing similar or improved performance compared with those made with traditional mineral oils.

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Stream 8

Improving the Accuracy of Tire and Material Test Data

The role of viscoelasticity in steady and dynamic crack growth

Prof Manfred Klüppel, head of department, Deutsches Institut fuer Kautschuktechnologie eV, Germany

Based on the previous work of Gent and co-workers, the viscoelastic response during steady and dynamic crack growth of unfilled and filled SBR is investigated by tensile tests at trousers samples and tear fatigue measurements at SENT samples, respectively. For unfilled SBR, both types of measurements indicate that the tearing energy is dominated by the viscoelastic properties of the polymer. For filled SBR, only dynamic tearing is found to be dominated by viscoelasticity. For steady tearing, filler networking seems to alter crack propagation rates and the viscoelastic fingerprint is no longer visible.

Lab evaluation of extrusion behaviour of highly filled compounds using the Garvey die

Dr Endres Borchardt, test method developer, Continental Reifen Deutschland GmbH, Germany

It can be challenging to describe the extrudability behaviour of highly filled rubber compounds on a lab scale. The lab-extrusion test using the 'Garvey die' is a common technique to describe the extrudability properties of elastomers. It was carried out in a systematic study for highly filled SBR compounds based on the 'green tire recipe'. Compound variations were realised by changing the polymer base (linear and branched) as well as the filler system (carbon black, silica including silane). Evaluating the results, it was possible to elucidate influences of the different ingredients on the extrudability behaviour.

Observations of contact behaviour between rolling-sliding rubber wheel and water

Ryutaro Nakagawa, staff, Yokohama Rubber Co, Japan

Rotating cylindrical rubber specimens were rubbed against a water-lubricated smooth acrylic surface. The light from an LED light source irradiated the contact region from the back of the acrylic surface, and the total reflected light was observed by a high-speed camera. We investigate the distribution of the slip amount of the real contact regions. It is found that high-frequency stick-slip behaviour is generated in each contact region.

The study of NVH improvement for worn tires

Dr Sungwook Hwang, senior researcher, Nexen Tire, Korea

In this study, we investigated a method to improve the noise component of a tire when the pattern shape of the tread is worn out. Since the noise deteriorates due to the reduction in tread weight and the increase in stiffness at the time of tire wear, it is necessary to find the cause of the NVH of deterioration through tire characteristic test analysis between the new tire before wear and the worn tire. New tires and worn tires running at a certain distance in the general market were collected and tested in anechoic chambers.

High-frequency testing for predicting WSR of tire tread compounds

Akansha Rathi, PhD researcher, University of Twente, Netherlands

Wet skid resistance (WSR) requires high energy dissipation at high frequencies by the tread compound and a strain-induced, reversible phase change. For this, the compound should respond within the glass-to-rubber transition zone where it shows maximum mechanical hysteresis. For prediction of WSR, a dynamic mechanical analysis (DMA) based method is most commonly used, which utilises the value of tan at 0°C at low frequency as the indicator. However, these measurements are not always in agreement with the real tire test results. In this work, an alternative approach based on broadband dielectric spectroscopy is discussed.

Rubber friction and wear investigations of aircraft tires

Stephanie Kahms, research assistant, Leibniz University Hannover, Institute of Dynamics and Vibration Research, Germany

The friction and abrasion behaviour are of great importance not only in the automotive sector but also in the aircraft industry. The aircraft tires should withstand as many take-off and landing cycles as possible until the maximum level of wear is reached. At the Institute of Dynamics and Vibration Research, the friction and abrasion behaviour is investigated experimentally at profile block level for varying operational conditions. From these measurements, phenomenological friction and abrasion equations are derived. Subsequently, the

results are implemented in an overall tire model and the tire wear is simulated under a wide range of operating conditions.

Quantitative measurement of chip and cut impact to estimate tire lifetime

Dr Radek Stocek, head of R&D, PRL Polymer Research Lab, Czech Republic

While travelling off-road, gravel, stone, soil, sand and stubble will cause very strong impacts on tires. In those driving conditions, serious erosion influences the lifetime of tires. This effect is is well known as chipping and cutting (CC). The experimental determination of the CC resistance of tire rubber by using fully instrumented lab testing equipment will be described. The test conditions are parameterised, all acting forces and energies are recorded over time, and the CC wear is quantitatively determined. The presentation will also show how the results correlate with crack propagation measurements on the same materials.

Optical system for improving tire simulation and research

Oliver Sipply, manager testing tire, FKA mbH Aachen, Germany

Tire characteristics depend on a huge variety of parameters. A precise simulation of any possible behaviour isn't possible without exact knowledge of the interaction between tire and road. Therefore, numerous test benches have been developed and improved continuously. Fka has recently introduced a 3D contour scanner for digitisation of tire and tread geometries. This tool enables not only the measurement of exact geometric values like curvature radius, shoulder profile and cross-section but also the determination of tread wear after handling measurements. In this investigation, this information is used for predicting and simulating the shear stress in the contact patch during handling manoeuvres.

Fatigue crack growth behaviour of SBR compounds

Dr Nathan Selles, research engineer, LRCCP, France

Many rubber products (tires, anti-vibration components, etc.) are dynamically loaded and their fatigue behaviours have to be studied to assess and improve their service lifetimes. The purpose here is to characterise the fatigue crack growth behaviour of a filled SBR compound, representative of tire treads of cars. The influence of the cyclic waveform and of the temperature (isothermal tests) on the cracking behaviour of this SBR material will be evaluated. More innovative experimental methods have also been considered to study the influence of a mechanical overload that could potentially reproduce daily impacts undergone by tires and temperature variations (anisothermal tests).

Tire testing road tires on rails: why and how?

Stefan Müller, co-CEO, Müller Frauenfeld AG, Switzerland

Road-rail vehicles (RRVs) are the new shunting engines. Their pulling power relies on road tires rolling on rails with transferable traction forces three times higher than on conventional steel wheels. This research is to accurately predict the pulling power of RRVs by means of multibody systems (MBS). Key to an accurate prediction is a valid tire model for use on rails. This in turn requires tire-on-rail testing equipment, which will be described in this presentation.

Halogenated butyl rubbers with a narrow polydispersity: the influence on the processing properties of rubber compounds, the physical and mechanical properties and gas permeability of vulcanisates

Vladimir Borisenko, head of the laboratory, Nizhnekamskneftekhim, Russia

The purpose of the research was to study the influence of the properties of halogenated butyl rubbers on the processing properties of rubber compounds, the physical and mechanical properties and gas permeability of vulcanisates. The presentation delivers the analysis of the narrow dispersed samples produced by PJSC Nizhnekamskneftekhim in comparison with equivalents. This paper presents information on the influence of rubber Mooney viscosity and the halogen content on the properties of the carbon black vulcanisates.

Study on elasto-hydro dynamic lubrication and its effect on dynamic strain for better wet skid resistance

Dr Reza Limoochi, head of tire improvement technology, Iran Tire Co, Iran

Rubbers act as Hukian solids under 5% of strain. Tire reflection and deflection as a semi-solid is iso-energetic behaviour, and some of the conformation is not accessible due to anthropy, which is the main reason for loss and heat buildup in rubbery solids. Tie-points is a very effective influence on rubber chain behaviour, and this presentation discusses the best ways to decrease tie-point losses with new lubricants.

Stress relaxation vs. physical properties of different compounds

Alireza Baniasad, compounding and material research chief officer, Barez Industrial Group, Iran

Stress relaxation testing provides a methodology for investigating the viscoelasticity of rubber or rubber-like materials. Although compound processability could be evaluated in this way, this paper tries to find if there is any correlation between stress relaxation factors and some physical characteristics such as tensile strength, reinforcing index, resilience, heat buildup, HD and energy dissipation. To do this, 16 different truck compounds were produced and tested. Finally the results were analysed.

9 Stream 9 *Recycling Tire Materials and their Potential Use in New Tire Manufacture*

Achieving a circular economy with the 4R strategy

Alan Barton, CEO, Lehigh Technologies, USA
François Masson, programme manager, Michelin, France

The tire industry serves as a champion for the circular economy. Manufacturers like Michelin look to incorporate sustainable solutions to reduce a reliance on natural resources and improve the performance of market-ready products. In 2017, Michelin acquired the speciality chemicals group Lehigh Technologies to enhance its 4R strategy to reduce, reuse, recycle and renew materials. Lehigh enables Michelin's commitment to sustainability by transforming end-of-life tires (ELTs) into high-value raw materials called micronised rubber powder (MRP).

MRP replaces oil- and rubber-based feedstocks in applications like high-performance tires – Michelin's core market. Michelin programme manager François Masson and Lehigh CEO Alan Barton will explore the benefits of the recycling economy.

Micronised rubber powder – a high-value sustainable solution

Dr Damien Thomasson, senior principal materials development engineer, Michelin, France

Looking towards 2030, the circular economy and reusing a valuable resource, tire rubber will continue to play a pivotal role in the future of the industry. We expect more key players will embrace the use of recycled materials and drive them to become mainstream. However, there are challenges in reusing tire rubber in a traditionally conservative industry. There is now consensus that business as usual is no longer enough. Thanks to new manufacturing technology developed by Lehigh Technologies, new recycled rubber materials and compounding technologies have been developed that are enabling the ever-increasing use of renewable materials in new tires.

Sustainability and optimisation of crumb rubber in tire applications

Dr Partheban Manoharan, manager R&D, Alliance Tire Group - a group company of Yokohama, India

The recycling of tires after their intended use continues to be an important subject from an ecological perspective. Rubber crumb is of prime interest in sustainability materials, and reduces the problem of tire disposal. This study explores the Taguchi experiment method to identify the optimum dosage of crumb rubber according to different mesh sizes. This research confirms the efficacy of rubber crumb in typical tire applications.

Tire-to-tire recycling – new opportunities with an old technology

Martin von Wolfersdorff, principal advisor, Wolfersdorff Consulting, Germany

Tire recycling in 2019 is still largely dominated by thermal valorisation but it is changing towards material valorisation. To recycle carbon blacks from tire to tire requires an understanding of tire feedstocks, the heat history of the recovery process and carbon black requirements in tire tread. Practical data will be given as well as a global industry overview.

Characterisation of pyrolytic carbon black and its application in NR

Maria Pina, general manager, Silkymia, Colombia

Pyrolytic carbon black was produced using a rotary kiln oven with a daily batch capacity of 5 MT. Its application as a reinforcing filler in natural rubber was evaluated. The pyrolysis was performed in an inert atmosphere at a temperature range from 400-500°C for approximately eight hours. Inorganic content was approximately 12% (primarily zinc oxide) and sulphur content was approximately 3%. Secondary treatments achieved an increase of approximately 10% in oil absorption capacity and an increase in mechanical properties in NR compounds, very close to those of commercial carbon black grades.

Use of recycled worn tire materials in tire manufacturing

Dr Arup Saha Deuri, head of R&D, Balkrishna Industries Ltd (BKT), India

Use of recycled materials derived from worn tires is gaining importance mainly due to issues related to sustainability, cost reduction and saving virgin materials in tire manufacturing. This presentation discusses current recycling processes including their effectiveness in potentially replacing virgin materials in tire manufacturing.

Practical experience from recycling tires to petrochemicals and carbon

Lars Boysen, general manager, CEO, T2O Egebjerg AS, Denmark

The presentation will discuss the potential of the new form of upcycling based on the speaker's own experience in building and processing tires in a pyrolysis plant. It will, among other things, highlight the differences between tire types and the result of tire processing, and will discuss the possibilities for recycling products in the tire industry.

Advantages of using micro-fine tread rubber crumb (generated from ELTs - TBR) in manufacturing of new tires

Arun Kapoor, technical director and advisor, Tinna Rubber & Infrastructure Limited, India

High-structure micro-fine tread rubber crumb is developed using an ambient grinding process and is being produced from used TBRs. This is a cost-effective and technically strong solution for manufacturing new radial and bias tires. Its greatest advantage is safe disposal of an environmental hazard (used tires) in environmentally friendly way. The process has been successful in India and the product is being used by leading Indian tire majors.

Innovative technology for reworking material in the tire production process

Manuel Bessler, sales engineer rubber extrusion systems, UTH GmbH, Germany

In tire production, increasing amounts of unvulcanised rubber are being produced. The reasons for this include the frequent changeovers resulting from an increasing product variety and rubber mixing batches that are out of specification. For financial and environmental reasons it is desirable to return these valuable raw materials to the production process. This process must be cost-effective and, in order to meet quality demands, the material must be treated gently. The TRP Reworker System, which is based on the UTH Two-Roll Plasticiser, incorporates new technology that combines several proven processes. This continuously operating Reworker System offers new possibilities.

Tire wastage recycling in Bangladesh

Mohammed Abul Hossain, CEO, Nitol Marketing Company, Bangladesh

There are number of tire recycling plants in Bangladesh operating on a small scale as small and medium enterprises (SME). As a small country with a huge population density, Bangladesh needs to pay more attention to this sector to protect the environment, recycle the product to produce raw material for tires, and make roads or pavements with tire waste products.

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Stream 10 The Changing Role of Polymer Science in Tire Performance Improvements

Wet mixing of silica and S-SBR – what we know

David Shaw, CEO, Tire Industry Research, UK

The presentation offers an overview of the state of the art in liquid-phase mixing of S-SBR and silica, including history, the current situation and implications for the tire industry at large. The paper is an 'insider's guide' to the current state of the art of wet mixing, and focuses especially on how this technology could change the status quo in the tire industry to the same or even greater extent that the introduction of the radial did 60 years ago.

Mechanical properties of styrene-butadiene rubber composite reinforced with cellulose nanofibres

Dr Masayuki Kawazoe, senior engineer, The Yokohama Rubber Co Ltd, Japan

Various physical properties obtained by incorporating CNF into SBR have been measured in this study and will be discussed. The features will be compared with the results of other researchers previously reported. The main topic of this presentation is how to overcome the mismatching relationship between the hydrophilic cellulose and hydrophobic rubber.

Surface-modified silica particles as filler for self-healing elastomer

Aladdin Sallat, PhD candidate, Leibniz Institut für Polymerforschung Dresden eV, Germany

Silica-rubber composites have been prepared, the properties of which were adjusted through the matrix-filler interactions. An ionically modified self-healable bromobutyl rubber served as the rubber matrix. The aim of the present work was to figure out to what extent the properties of BIIR can be improved further by the addition of silica without sacrificing self-healing. In order to adjust the interactions between the rubber matrix and the filler, the filler surface was modified by silanisation with three alkylsilanes. The influence of the different alkylsilanes and the mixing procedures on the material properties is discussed.

Conductive elastomers: parameters affecting their properties and conductivity

Carmela Mangone, PDEng, University of Twente, Netherlands

Considerable improvement in mechanical properties and electrical conductivity of elastomers can be achieved by use of carbon nanofillers, since they possess a high aspect ratio and generate strong polymer-filler interactions. In the present study the orientating capability of anisotropic fillers under strain as

AWARDS FOR INNOVATION AND EXCELLENCE

On the second evening of the conference and exhibition (6 March 2019) there will be an entertainment-packed evening where we will present the Awards for Innovation and Excellence. Delegates, exhibitors and their guests will have free access to this event.

well as the formation of a filler network are taken into account to explain the performance of this material. Processing parameters and compound formulation have a strong impact on filler dispersion, which in turn influences the properties of conductive elastomers. A review of these relevant key aspects is presented.

The physics of tire compound processing: considerations for the 21st century

Dr Saeid Kheirandish, project manager, polymer testing, Arlanxeo Deutschland GmbH, Germany

The demands of green mobility have forced chemical companies to introduce highly specialised material structures into the market to meet these demands. However, the know-how in terms of understanding the flow behaviour of compounds made of these materials is still lagging behind. Using examples of the recently marketed EZ group of NdBR products, the presentation will provide the results of some case studies where targeted testing has shown to improve understanding of what exactly the proper processing parameters in each case are.

Factors influencing heat generation of aircraft tire tread compounds

Indriasari I, PhD candidate, University of Twente, Netherlands

Energy dissipation is a major factor in tire development. For aircraft tires, a high slip ratio upon landing as well as take-off causes a rapid temperature increase. In general, treads of aircraft tires contain natural rubber, which is prone to thermal degradation and thus affects the performance. Therefore, a development of treads showing a low hysteresis at the critical temperature is essential. The influence of processing and compound composition was studied. For hybrid carbon black-silica NR/BR compounds, the addition sequence of ZnO and DPG was optimised, and four types of butadiene rubber differing in linearity as well as cis and final content were compared.

Better network for better vulcanisate performance

Dr Hermann-Josef Weidenhaupt, senior specialist rubber additives business, Lanxess Deutschland GmbH, Germany

The network of a vulcanisate has a significant influence on the performance of the rubber part during service life. Rubber articles are often exposed to high temperatures or severe mechanical stress, which causes major changes in the properties and may lead to destruction of the articles. Short sulphur crosslinks offer high temperature stability, but the tear and dynamic behaviour are insufficient for tire applications. Therefore, the temperature-sensitive polysulphidic crosslinks are used. For conventional or semi-efficient crosslinking systems, Perkalink900 can improve the stability of rubber articles. Vulcuren as a hybrid crosslinker forms very flexible and stable crosslinks directly during vulcanisation for excellent performance.

Influence of functionalised S-SBRs on silica-filled rubber compound properties

Chigusa Yamada, manager, Asahi Kasei Europe GmbH & University of Twente, Germany

Asahi Kasei solution SBRs (S-SBRs), developed with unique functionalisation and high molecular weight, bring significant improvement to the balance between fuel efficiency, wet grip and wear resistance of high-performance eco-tire treads. In this study, different types of functionalised SBRs are synthesised by anionic polymerisation, to investigate the influence of each functional group on the properties of silica-filled compounds. A special emphasis will be laid on the relationship between polymer structure and performance in vulcanised compounds.

Increased hydrocarbon solvent resistance for EPM/EPDM-containing elastomer blends

Gina Butuc, PhD candidate, University of Twente, Netherlands

This paper proposes a novel approach to increasing EPDM and EPM resistance to non-polar solvents by creating polymer blends. These are either an interpenetrating polymer network (IPN) or thermoplastic vulcanised blends of EPDM or EPM with low-molecular-weight polymeric material. This oligomer is a cyclic oligosulphide containing at least one tetrasulphide group in the molecule. The focus of this paper is on a proposed mechanism of crosslinking facilitated by both organic peroxide and sulphur, with the oligomer becoming a sulphur donor and participating in the crosslinking process. This is a potential platform mechanism for creating unique elastomer materials

Presentation title to be confirmed

Alexander Bleider, project engineer - tire application, UTH GmbH, Germany

The effect of rubber modified silanes on tire tread compounds

Munenao Hirokami, R&D engineer, Shin-Etsu Chemical Co Ltd, Japan

Shin-Etsu has developed rubber modified silanes that can provide a strong interaction between silica and the SBR/BR polymers, and has also continued to optimise the formulations, conditions and structure of molecule. The company will present the evaluation test results in those studies.

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Stream 11 Business Strategy

Tire machinery innovation walk-through, with particular focus on fast-line first-stage tire building machines

Massimo Lenti, technical director, Marangoni Tyre Machinery, Italy

The presentation provides an updated overview of the latest innovations made by Marangoni in 2017-2018 and introduced into the latest tire building machines. This includes the 'digital twin' approach for design, and automation features to enhance productivity and tire quality outcome.

Green economy – challenges and opportunities for the tire industry

Dr Rabindra Mukhopadhyay, director and CE - Hasetri / chairman - Indian Rubber Institute, Hasetri, India

Over the last few years, the concept of a 'green economy' has moved into the mainstream of policy discourse across the world. The green economy is a development strategy that harmonises both economic development and ecological sustainability. The general public's perception of the rubber industry is that it is not environmentally friendly or energy efficient, uses non-renewable resources, and produces non-biodegradable waste, etc. To change this perception,

the rubber industry has to work towards the green economy through development of green technology. The challenges and opportunities for the Indian automotive and tire industries working towards the green economy will be discussed.

The digital twin for tire manufacturing

Bill Henderson, manager OEM team, Siemens Industry Inc, USA

Making tires can be challenging. Demand increases every year for tires that last longer and can handle all types of surfaces while being produced with a high level of quality and flexibility. We will discuss the manufacturing advantages of enabling a digital twin of a curing press and other machinery so that engineering enhancements can be made virtually, without the need for a physical machine. In addition, the advantages of simulating the entire process can enable bottleneck analysis and detailed planning. We will show real examples of the tire digital thread and discuss how these tools can provide significant benefits.

How to meet the future requirements of the automotive industry?

Fabian Grunert, postdoc, University of Twente, Netherlands

The automotive industry is one of the main driving forces for the European economy, providing employment to 12 million workers. But the sector is facing many structural changes, including stricter emission standards and decarbonisation as part of new mobility concepts. A high quality of education, skills and training is the basis to ensure the strong position of the automotive industry in the future: knowledge, innovation, R&D and competence development are mainly important. The future jobs will have a different mix of skills and will require permanent upgrading of skill levels and competencies. The European DRIVES project is dealing with this challenge.

Change in the global tire industry – how to adapt

David Shaw, CEO, Tire Industry Research, UK

The tire industry goes through cycles of change every few decades and we are currently undergoing one of these generational changes. The paper attempts to identify the key changes in the industry in terms of technology, geography, customer expectations, business models and other dimensions. It also offers a personal view on which companies are winning and which are losing the race to adapt to the fast-changing environment.

CytroBox – a smart hydraulic power control in tire curing

Nicolas Cano, senior product manager, Bosch Rexroth, Germany

Through more extensive networking integration of the machines in the tire industry, a big potential is emerging, which is shaping current and future needs in a more cost-effective and intuitive way. The CytroBox of Bosch Rexroth, one of the biggest electrohydraulic suppliers, is matching expectations with a smart HPU design from 7.5 to 100kW. The benefits include up to 60% energy saving, a 70% more compact design with 80% less oil and low noise. Furthermore, the integration of the IoT concept is redefining the operative frame to a full Industry 4.0 factory.

Innovations in materials, processes and business models for sustainable mobility

Dr Michael Beaulieu, application development lead - tire, Cabot Corporation, USA

Global demand for sustainable mobility is driving the tire industry to rethink the way we develop new products and technologies. The desire to improve the performance, safety and lifespan of tires while reducing the cost and environmental impact of production is driving tire companies to explore innovative solutions that have the potential to transform tire manufacturing as we know it. Those companies that harness the power of innovative materials, processes and business models will be best placed to meet these challenges. In this presentation, we share one example of how innovative thinking can transform tire performance and production.

Market growth of laser-engraved 2D matrix codes

Dr Armin Kraus, managing director, 4JET Technologies GmbH, Germany

The worldwide annual capacity for laser engraving of 2D matrix codes on tires exceeds 30 million codes per year in more than 20 tire plants. Driven by convincing use cases for passenger car OEMs, tire management solutions for commercial tires as well as regulatory requirements, the capacity is expected to grow to 150 million per year until 2028. The presentation provides a quick overview of the SCANNECT technology, gives an insight into the details of the existing use cases, and summarises trends and developments for the foreseeable future.

A practical 'smart factory' approach to final finish management

Dr Shaun Immel, division vice president and CTO, Micro-Poise Measurement Systems - Ametek, USA

There is a digital and data revolution happening in the tire industry today. It is difficult for many tire manufacturers to make sense of all the new emerging technologies and associated buzzwords. Discovering what is important and which technologies can provide true return can be very challenging at best. These new and emerging developments are also difficult to prioritise and then integrate into a vast base of installed equipment. This presentation will help to clarify and sort through these questions across the whole enterprise, with a focus on the data-rich final finish area of the manufacturing plant.

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DAY 3 THURSDAY 7 MARCH

Stream 7 Sustainability Developments Within Tire Material Science (continued)

The role of BR in new-generation tires

Ting-Hisang Chang, senior chemist, TSRC, Taiwan

In the tire industry, energy efficiency, safety and eco-friendly materials have attracted increasing attention. TSRC has recently modified and upgraded its manufacturing process for co-BR. As a result, a harmful solvent was eliminated. Also, the cis content increased dramatically (to 98.5%) so that Taipol 0150L could possibly compete with certain kinds of Nd-BR on tensile strength, abrasion and rebound. Furthermore, to better balance the processability and physical properties, Taipol 0150L was optimised on molecular weight distribution, which brings more value to the application of tire compounds.

New polymer with LRR/wet and wear properties

Ken-ichi Itoh, research and development specialist, JSR Corporation, Japan

Recent demands for the tread of tires include improved fuel efficiency to reduce CO_2 emission, and improved wear resistance to increase lifetime. The introduction of functional groups into the end of the polymer is a novel solution to improve fuel efficiency. Strong interaction between functional groups and silica surface can reduce the hysteresis loss of rubber compound. To improve wear resistance, an effective approach is to increase polymer molecular weight, which provides a well-entangled polymer network. However, functionalised SSBR with high molecular weight increases compound viscosity. JSR suggests a solution.

Influence of NR mastication on rheological and dynamic mechanical properties

Thomas Rauschmann, business development manager, rubber testing, TA Instruments, Germany

NR mastication is a very important process to bring NR to a constant level of viscosity. The level of viscosity is normally evaluated by Mooney values. But with RPA technology it is possible to describe the mastication process in much more detail. In this presentation, different types of NR mastication with and without peptisers are prepared and tested with RPA to characterise molecular weight, molecular weight distribution and long chain branching. Furthermore, different compounds with this different level of NR mastication are produced to evaluate the influence on the dynamic properties of the cured compounds.

High-performance carbon blacks for improved rolling resistance and wear

Dr Florian Diehl, technical market manager, Orion Engineered Carbons, Germany

Mobility in general is facing its biggest revolution since the invention of the first internal combustion engines back in the late 19th century. Autonomous and electric battery-driven passenger cars and trucks will require further expansions of today's existing tire technologies with respect to rolling resistance and wear performance. To manage this conflict, Orion Engineered Carbons has a new series of carbon blacks with tailor-made morphology. This presentation will highlight the performance enhancements that can be achieved.

Performance resins for enhancement of tire tread traction

Mridul Das Gupta, senior scientist, Hasetri, India

Tire manufacturers are facing stiff challenges to meet today's requirements for different performance properties of passenger car tires. One of these requirements is a high level of traction – wet and/or dry – as the service condition of a specific tire demands. The major obstacle to attaining these requirements by modulating the tread compound formulation comes from the fact that conventional avenues of increasing traction may lead to a significant increase in the rolling resistance of the tires, which is not desirable. This presentation deals with a study of some performance resins to examine the improvement in traction characteristics.

Coupling agents – effect on processing and performance

Dr Saikat Das Gupta, chief scientist - vice president, Hasetri, India

For years, silane coupling agents have been the most effective enabler for the adoption of silica technology for the development of rubber compounds for tire application. Different new silanes have been brought to market during the last few years, not only to improve the processability and performance properties of silica-based tire compounds but also to cater to the requirement to restrict environmental pollution, which will lead to more 'green technology'. A comparative study of different silane coupling agents is presented here to explain the comparative advantages and disadvantages of these in silica-based passenger tire tread compounds.

Breakthrough in epoxidised NR (ENR) tread compounding by use of surface-modified fillers

Dr Joachim Bertrand, director, Behn Meyer Europe GmbH, Germany

For more than 25 years, tire companies have been interested in using epoxidised natural rubber (ENR) as a sustainable alternative to synthetic rubbers. Furthermore, ENR has the potential to directly link to silica as a filler, reducing the costly coupling agents. However, these concepts have mostly failed because physical and tire properties could not yet meet the performance of NR or synthetic rubber compounds. Behn Meyer introduces surface-modified fillers that show the potential to dramatically improve ENR compound performance and offer a new set of tools to change properties in the desired direction.

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Stream 10 The Changing Role of Polymer Science in Tire Performance Improvements (continued)

NXT Z 45 silane: new insights into silane processing when manufacturing high-performance tire compounds

Dr Daria Sitnikova, application development engineer, Momentive Performance Materials, Germany

Momentive's NXT Z 45 silane, an oligomeric mercapto silane coupling agent, incorporated into a model passenger tread compound, can enable improved rolling resistance, wet traction and wear performance as compared with standard sulphur silanes. This presentation provides insights into making NXT Z 45 silane-based rubber compounds easier to process. These methods are based on model chemistry, computational modelling and rheology studies. Using these approaches, superior performance and enhanced processability of rubber compounds containing NXT Z 45 silane were achieved.

Impact of reduced graphene oxide on tire tread compound

Dr Arup Saha Deuri, head of R&D, Balkrishna Industries Ltd (BKT), India

Graphite-based nanomaterials are receiving attention as reinforcing materials in tire compounds. Graphene oxide, and subsequently the reduced graphene oxide, are synthesised and characterised and reported in this paper. This is mixed with SBR-based black filled tread compound and tested for related mechanical and failure properties and reported here. The impact of this material is assessed by optimising all the properties measured.

Effects of alumina-silicate-based inorganic filler in SBR composites

Nese Kaynak, PhD student/R&D engineer, Yalova University Department of Polymer Engineering/Brisa Bridgestone Sabanci Lastik Sanayi VE Ticaret AS, Turkey

Styrene-butadiene rubber (SBR) has been widely used in automobile tire treads and compounded with different inorganic fillers to achieve cost reduction and reinforcement. In this study, we report a novel binary filler system based on carbon black and an alumina silicate inorganic one. Surface modification of the inorganic filler was done with a sulphur-containing silane coupling agent. Mechanical properties of the resultant composites including both fillers will be compared with those of the SBR containing only carbon black. Moreover, their wet grip and rolling resistance properties for tire applications will be discussed.

Micro- and macro-dispersion of silica-filled tire tread compounds

Dr Wisut Kaewsakul, assistant professor, University of Twente, Netherlands

The quality of filled rubber compounds is highly dependent on the uniform dispersion of fillers throughout the rubber matrix. Poor filler dispersion results in deterioration of processing and end-use properties of compounds and vulcanisates. Basically, the dispersion of fillers in rubber compounds is classified into two different levels: micro- and macro-dispersion. This work presents the impact of these two dispersion levels on the properties of silica-filled tire tread compounds. The key parameters influencing silica dispersion in the compounds will be discussed.

Manipulating SSBR microstructures for superior material properties and tire performance

Dr Chun-Lin Chen, principal chemist, TSRC, Taiwan

Over the past several years, we have developed certain unique technologies to improve the dynamic and physical properties by increasing the functionality and controlling the microstructure of SSBR. In this work, we will elucidate our state-of-the-art technologies on (a) how to tailor SSBR microstructures for homogenous, tapered or partial block polymers; (b) how to modify SSBR with various novel functional groups; and (c) how to build a solid foundation of structure-property relationships. These technology breakthroughs are being applied to new product developments, including next-gen dry and oil extended grades.

Neodymium-based catalyst system for stereospecific polybutadiene with narrow polydispersity

Dilyara Fazilova, head of laboratory, R&D, Nizhnekamskneftekhim, Russia

Key behaviour of the neodymium-based catalyst system for stereospecific polybutadiene with narrow polydispersity is depicted in the presentation. It presents all kinetic parameters calculated at optimal polymerisation. The results of polymer modifications with various compounds are also discussed in this study. Finally, the report compares physical and mechanical properties of obtained cis-1,4-polybutadiene linear and branched samples.

Incremental effect of DPG/silica/silane on reducing rolling resistance

Mahdi Kafrashi, technical expert, Yazd Rubber Industrial Complex, Iran

In this study, the effect of DPG accelerating enhancement and silica in the presence of silane with a decrease in carbon black consumption was investigated. TESPT contains a polysulphide field that can react with the polymer and the silica ethoxysilyl group. Of course, the velocity of the silanisation silica reaction flows with the presence of DPG. By changing the value of DPG, silane and silica, the physical properties and then using the NMR (nuclear magnetic resonance), DMTA (dynamic mechanical thermal analysis) and SEM (scanning electron microscopy) testing methods, the chemical and mechanical ones of the mixture were investigated.

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Stream 12 New Advances in Pneumatic Tire Performance

Development of mechano-adaptive elastomer composites for future tires

Tamil Selvan Natarajan, PhD student, Leibniz Institut Für Polymerforschung Dresden, Germany

Autonomous vehicles pose several challenges to vehicle and tire manufacturers. One such challenge is the ability of tires to flex/adapt to varying road conditions. Several solutions are discussed here. However, innovative rubber compounding is a new route that is still in its infancy. We show how bio-inspired mechano-adaptive composites could pave the way for designing adaptive tires. We present two different strategies based on the concepts of solid-liquid and polymorphic phase transitions of dispersed filler in an elastomer composite. We show the adaptability behaviour of these new kinds of rubbers and discuss future challenges.

Effect of air retention on electric vehicle performance

Jeff Valentage, global tire market development manager, specialty elastomers and butyl, ExxonMobil Chemical, USA

The presentation discusses the evolving mobility market, electric vehicle outlook, overview of current electric vehicle tires, in-use 'real-world' efficiency testing results and the opportunities to improve tire regulations and specifications.

Flexible section – the new role of pneumatic pressure in tires

Elan Amirav, CEO, D&A Design and Architecture, Israel

"Every tiny improvement in tire technology may yield huge benefits for our environment. Pneumatic pressure, as a way to carry travelling loads, is being reconsidered lately. I think that vehicles will continue to travel airborne in the future." Elan's research is about exploring pneumatic pressure not only as a carrier but as a shaping force. He will present methods of applying mass reductions in the inner layers to produce flexible tire structures that respond to different pressure values and display various road behaviours. Elan's patented proposal introduces tires with multiple designed pneumatic values that may substantially reduce environmental damage.

Road surface classification using intelligent tires

Chidambaram Subramanian, graduate research assistant, Virginia Tech, USA

Adverse weather conditions and their effect on the safety of autonomous vehicles has hindered the growth of autonomous vehicle technology. Estimating the road surface friction using intelligent tires will open the potential for advanced new control systems. In this work, an advanced signal processing algorithm was developed to classify the road surface based on a comprehensive study into four major categories. Based on extensive test data collected, the algorithm has shown an accuracy of more than 80% in all road categories. Additionally, the algorithms have been implemented in real time and have shown promising results.

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Stream 13 Non-Contact Tire Identification Systems

Intelligent tread wear sensor technology

Dr Aaron Franklin, chief technology officer, Tyrata Inc, USA

Every year, tire-related accidents claim the lives of thousands. The industry is in desperate need of a mechanism for monitoring the thickness of a tire's tread, in real time. Tyrata Inc is a sensor development and data management company offering patent-pending IntelliTread wireless sensing technology that monitors, tracks and predicts tread wear over the life of any tire. The presentation will describe how the new technology works, present results from recent testing, describe the roadmap towards commercialisation, and discuss the potential impact the technology could have on safety, efficiency and vehicle autonomy.

Towards the development of self-sensing tires

Eshwaran Subramani Bhagavatheswaran, scientific researcher, Leibniz Institute of Polymer Research Dresden eV, Germany

Tire manufacturers are convinced that we are running to a point where deep innovation is needed in rubber compound and complete tire design for the next generation. Self-sensing tires are one such innovative outcome. Rubber-based strain sensing utilises the concept of piezoresistivity; unfortunately, no works on dynamic piezoresistive performance of rubber composites are available. Inspired by the aforementioned challenges, the dynamic piezoresistivity behaviour is studied on composites prepared from commercial rubbers. This basic scientific study will be the stepping stone for developing rubber-based dynamic strain sensors for the future.

Study on observation of the dynamic tire contact patch

Kazuki Okamoto, data analysis expert, A&D Company Limited, Japan
Akira Inoue, deputy general manager, A&D Company Limited, Japan

While electrification and auto-pilot technologies are evolving vehicles, requirements for tire are increasing. Understanding dynamic tire behaviour in the road-contacting area is becoming more important for tire and vehicle chassis development. A&D has introduced placing a force matrix sensor (FMS) at the road surface to observe dynamic tire contact patch behaviours when the vehicle runs over the sensor. Now FMS is installed in a drum tire testing rig to scan the tire contact force in lateral direction simultaneously. This enables the dynamic contact patch behaviour to be analysed more precisely only with tire. This paper describes the outline and basic measurement results of the FMS drum tire testing rig.

*This programme may be subject to change

SPECIALIST SHORT COURSES

48TH TIRE MECHANICS SHORT COURSE

4 - 7 MARCH 2019

€1,875 PLUS GERMAN VAT

This four-day educational and developmental course will provide engineers and scientists with an in-depth, intense study of the latest developments surrounding tire engineering. The course is designed for practising engineers, chemists and scientists who are concerned with tires and vehicles and who have an engineering or science background at the Bachelor of Science level. The basic and practical aspects of the mechanics of pneumatic tires will be introduced by internationally renowned experts in tire mechanics. Extensive, detailed course notes prepared by each instructor will be provided for all participants, along with a 700-page e-book, 'The Pneumatic Tire' edited by Professors Gent and Walter. Those who complete this course will receive a certificate from the University of Akron.

BASIC RUBBER COMPOUNDING SHORT COURSE

4 - 5 MARCH 2019

€1,075 PLUS GERMAN VAT

Presented by Bob Kind MIMMM, GPRI, technical director of Polymer Recyclers UK; and John Bowen MIMMM, BSc, consultant formerly of Robinson Bros Chemicals UK. This basic course is designed for all those working in the associated tire industry who wish to know more about the compounding of rubber. It will try to define the concepts in simple terms, but at the same time relate them to actual manufacturing and product circumstances.

TIRE REGULATIONS SHORT COURSE

4 MARCH 2019

€695 PLUS GERMAN VAT

The course will be delivered by Lars Netsch of TÜV Süd, who has considerable knowledge of the current tire regulations in Europe and beyond. These are particularly critical as tire labelling and new type approval regulations are introduced. Some indication of the future in terms of tire regulations will be discussed and a brief outlook on the impact on tires of the EU's chemical regulation, REACH, will also be given.

TIRE MATHEMATICAL MODELLING SHORT COURSE

4 - 6 MARCH 2019

€1,425 PLUS GERMAN VAT

This year we are extending the course to three days with additional speakers joining our experienced team of presenters from both academia and industry. The course covers the computer modelling of tires within a full vehicle system and explains the use of models in a simulation environment. It is aimed at engineers and researchers working in industry and academia. The subject matter will be of primary interest to vehicle dynamicists, for whom the tire is the primary force and moment generation element on the vehicle. Tires are not particularly complex but are deeply counterintuitive; practitioners require an understanding of tire behaviour and the range and capability of existing models in order to generate full system models to predict the dynamic performance of a vehicle – both for comfort and for active safety.

TIRE REINFORCING MATERIALS APPLICATIONS AND FATIGUE TESTING SHORT COURSE

4 MARCH 2019

€695 PLUS GERMAN VAT

Experts from Cordenka, Kordsa and Bogimac will be course chairs

The course schedule will include the following:

- Tire function, specification and design challenges, rubber reinforcement need different tire application field
- Tire bias/radial construction and their components, trend to radialisation
- Global reinforcement materials usage overview
- Steel cord and textile construction and generic material data
- Load types on the cord (tension/compression, single/reverse bend, adhesion, corrosion, ageing), explaining thereby the specific differences between steel and textile cord
- Type of cord stresses and strain in each tire component (bead, 'carcass' region is looked at differently in apex/sidewall/corner region because of their specific loads, belt, cap ply)
- Overview material-tire component usage matrix

INTELLIGENT TIRES-AND-VEHICLE SYSTEMS IN AUTOMOTIVE TRANSPORTATION

4 - 6 MARCH 2019

€1,425 PLUS GERMAN VAT

Development of intelligent tires-and-vehicle is an area of high interest in automotive transportation, and such interest is likely to grow further, both for conventional vehicles as well as for those with some level of autonomous driving. This course will discuss the multiple aspects of automobile dynamics that are driving the development of intelligent tires. It will also discuss the technologies and engineering principles required for the integration of intelligent tires and vehicles to meet various goals. Current status, ongoing developments and future applications of these technologies will be presented.

The course will be run by Professors Mukul K Verma and Vladimir Vantsevich from The University of Alabama at Birmingham

THE EFFECT OF ROAD SURFACE VARIATION ON TIRE PERFORMANCE SHORT COURSE

4 MARCH 2019

€695 PLUS GERMAN VAT

This course will investigate the effect of the road surface on the rolling properties of tires: noise, rolling resistance and braking.

The objective is to improve tire engineers' understanding of the variation in road surface properties found in the real world, and how such variations upset the carefully designed properties of the tires when run on these surfaces.

The course will be run by Bert Peters, M+P Consulting Engineers and Jacob Groenendijk, KOAK-NPC

tire technology EXPO 2019

25,000 SQUARE METRES OF EXHIBITS

CONFIRMED EXHIBITORS TO DATE INCLUDE: 4JET Technologies • A-tekniikka • A&D Europe • AB Svenskt Konstsilke • Aerox • AirTec Controls • Akron Special Machinery • Akron Steel Fabricators • Albeniz • Alfamation • All India Rubber Industries Association • Alligator Ventilfabrik • Allnex • Alpha Technologies • Altracon • Amino-Chem • Ammeraal Beltech • AP2 – Automazione Processi Produttivi • Applus Idiada • Arlanxeo • Asahi Kasei Europe • ASM-Hasbach • Barbe • Bartell Machinery • Bastian Solutions • BD Testing • Beckhoff Automation • Behn Meyer Europe • Benninger Zell • Berrmak • Beumer Group • Birla Carbon • Bizerba Tekno Label • Black Donuts Engineering • Bogimac • Bosch Rexroth • BST Eltromat International • Buss • Buzuluk Komarov • C&D Robotics • Cabot Corporation • Calemard • Carl Zeiss Optotechnik • Cassioli • Center for Tire Research (CenTiRe) • Chem Trend (Deutschland) • China United Rubber Corporation (CURC) • Cimcorp • CMV Hoven • Cold Jet Europe • Color Service • Comerio Ercole • 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Machinery • Rado Engineering • REA Elektronik • Rekor • Rhein Chemie Rheinau • RJS Corporation • Robotics & Vision Technologies • Rockwell Automation • Rodolfo Comerio • Roland Electronic • Romill • Rubber Consultants • Rütgers Germany • Saehwa IMC EU/EMT Puchov • Safe-Run Machinery (Suzhon) • SAR Elektronic • Saurer Technologies • Schill + Seilacher "Struktol" • Schubert & Salzer • SDS Systemtechnik • Seichter • Sennics • Sensit • SEW-Eurodrive • Shandong Yanggu Huatai Chemical • Shanghai Amino-chem • Shin-Etsu Silicones Europe • Sibur Holding • Sick Vertriebs • Siemens • Simaform • SinoArp Tires Equipment Technology (Suzhou) • SLM Solutions Group • SMC Deutschland • Smithers Rapra • Solvay • Spoolex • Starrett-Bytewise Europe • Steelastic • STL Standard Testing Labs • Świat Opon • SWS Translation Agency • Synthos • TAG Chemicals • TARRC • Tauform Tyre Moulds • Teijin Aramid • Tekna Automazione e Controllo • Tekscan • Test World • The Poling Group • TianJin Reager Technology • Tianjin 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*see website for the latest exhibitor list

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