tire technology EXPO 2018

20, 21, 22 FEBRUARY 2018

DEUTSCHE MESSE, HANNOVER, GERMANY

CONFERENCE PROGRAMME

15 STREAMS

INCLUDING **SCIENTIFIC** AND **TECHNICAL** SESSIONS

PLUS BUSINESS STRATEGY CONFERENCE SESSIONS

180+
PRESENTATIONS

6
SPECIALIST COURSES

SPONSORS

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Welcome to the Tire Technology Expo Conference

The ***Tire Technology 2018 Conference*** is our biggest and most all-embracing ever, with 180+ 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. New for 2018, the **Business Strategy Conference** is incorporated within this all-embracing programme, which we believe will make it easier to follow the entire content and enable you to best plan your participation. As always, one-, two- and three-day conference passes are available and there are options to combine these with six 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 **Keynote + Next-Generation Tire Technology –** Day 1

2 **Business Strategy –** Days 1 & 2

3 **Development in Cord, Steel, Wire and Reinforcement –** Day 1

4 **Polymer Science –** Day 1

5 **Tire Testing – Lab and Track –** Days 1, 2 & 3

6 **Tire Manufacturing and Production Developments –** Day 2

7 **Research for Sustainable and Reclaimed Materials –** Day 2

8 **Polymer to Filler Interactions –** Day 2

9 **New Rubber Compound Additives –** Day 2

10 **Simulation Modelling and Testing + Conclusions –** Day 2

11 **Tire Material Research – University of Twente –** Day 2

12 **Young Scientist Developments –** Day 2

13 **Natural Rubber and the Science of Sustainable Materials –** Day 3

14 **Innovative and Experimental Tire Concepts –** Day 3

15 **Tire as an Information Source –** 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 20, 21, 22 February. 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**	**19-22 February**
Tire Mathematical Modelling Course - 2 days	**€1,075**	**19-20 February**
Basic Rubber Compounding Course - 2 days	**€1,075**	**19-20 February**
Tire Regulations Short Course - 1 day	**€695**	**19 February**
The Effect of Road Surface Variation on Tire Performance - 1 day	**€695**	**19 February**
Tire Reinforcing Materials Applications and Fatigue Testing - 1 day	**€695**	**19 February**

Starting on Tuesday 20 February, three days packed with the latest developments in tire design, materials and manufacturing. Extra presentations to be added!

DAY 1 TUESDAY 20 FEBRUARY

1

Stream 1 Keynotes + Next-Generation Tire Technology

RFID for tires – an enabler for new services

Pierre Loiret, industrial standards government regulations, Michelin, France

This presentation will focus on the universal ISO TC31 WG10 RFID tire tags standard, which will be forthcoming as an industry-wide adoption. We will discuss the advantages of having the ability to identify each tire during its entire lifecycle, reasons for implementing a unique tire identifier, and the consequences in terms of new services availability, especially from the perspective of connected and autonomous vehicles.

From a tire manufacturer to a solutions provider for off-road operations

Enno Straten, head of commercial speciality tires, Continental Reifen Deutschland GmbH, Germany

The key characteristic of the commercial speciality tires business lies within its high complexity of products and tough applications. It includes solid tires in material handling, agricultural tires for the farming segment and the big OTR tires in earthmoving. Enno Straten reveals how the commercial speciality tire market has changed over the years into a market with more and more dedicated products, integrated solutions and new service concepts that answer complex customer needs in demanding environments.

Tire sensing technology – SENSING CORE

Hiroaki Kawasaki, technical manager, Sumitomo Rubber Industries Ltd, Japan

Sumitomo Rubber Industries Ltd has developed a new tire sensing technology called SENSING CORE, which is able to detect road conditions, tire load and tire-vehicle-related performance information. SENSING CORE software analyses existing wheel speed signals without additional dedicated sensors in the tires. The SENSING CORE information can be communicated to the driver and integrated into other vehicle systems, resulting in increased vehicle safety with an environmentally friendly, maintenance-free technology. We believe that SENSING CORE is one of the key technologies that will contribute to the realisation of autonomous transportation and a safer mobile society.

Realising resource-saving tires through innovative tough rubber compound

Dr Katsuhiko Tsunoda, fellow, Bridgestone Corporation, Japan

Bridgestone Corporation is taking 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. Bridgestone is challenging on realising resource-saving tires through developing an innovative tough rubber compound in this programme. Focusing on unique and not well-known discontinuous crack growth phenomena, comprehensive and multi-faceted analyses are being carried out, aiming to elucidate brand-new tough rubber compound design concepts. The overall research framework and interim research progress will be reported in this presentation.

Objective truck tire performance design helping OEM developments

Mario De Martino, R&D engineer, Prometeon Tyre Group, Italy

The presentation will explain how Prometeon Tyre Group, exploiting external know-how and virtual prototype development in a real open-innovation environment, is approaching the business of tire design for OEMs in truck, bus, OTR and agro businesses, thanks to collaborations with vehicle manufacturers and universities. The aim is to enhance the tire and vehicle integration. The presentation will also look to the future: driving assistance systems, autonomous vehicles, sustainable mobility and connected tires.

Automotive megatrends and the importance of tire air retention

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

Today's economies are changing dramatically, triggered by rapid developments in emerging markets, the accelerated rise of new technologies, and changing consumer preferences. From these changes, certain megatrends have arisen: sustainability, diverse mobility, electrification and autonomous driving. For the automotive industry to succeed, we must master the trends, lead in innovation and drive these changes. The presentation will cover: electric and autonomous vehicle growth; the importance of air retention in electric and autonomous vehicles; air retention of tires used on commercially sold electric vehicles; in-use real-world efficiency results; opportunity to improve the current EU tire labelling scheme.

Panel discussion - Next-generation tire technology

Christophe de Valroger, vice president original equipment, Bridgestone EMEA, BELGIUM

Jan Prins, tire specialist, Jaguar Land Rover, UK

Mauro Martino, R&D tire specialist - FCA Italy, ITALY

Jörg Sturmhoebel, marketing and sales, NIRA Dynamics AB, SWEDEN

Sebastian Franke, development of tire pressure monitoring systems, Audi AG, GERMANY

Pierre Loiret, industrial standards government regulations, Michelin, FRANCE

More panellists to be confirmed soon. Please see website for updates!

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Stream 2 - Business Strategy

Business Strategy Conference Sessions

Disruptive change in the global tire industry

David Shaw, CEO, Tire Industry Research, UK

The tire industry globally is facing unprecedented change in technology, business models and approach to business, as well as geographic disruption. This is combined with radical changes in mobility coming from the vehicle sector. This paper attempts to give some views on possible futures for the tire industry and suggests some strategic directions for the future.

The importance of the emerging markets to the tire industry

Robert Simmons, head of rubber and tire research, LMC International, UK

The presentation will discuss trends in new vehicle sales in emerging markets and how these increase the number of vehicles on the road. This then leads to higher replacement tire sales although miles driven are falling in many emerging markets. Finally, the presentation will discuss the importance of trade to emerging market tire production and the impact of the use of tariff barriers.

Opportunities and challenges for the Indian tire industry responding to the global situation

Vijay Kumar Misra, technical director, JK Tyre & Industries Ltd, India

Multiplying population, economic growth and increased mobility are accelerating changes in the automobile and tire industry in the Asia-Pacific region. Over the next decade, global demand for vehicles and components, including tires, will be driven by emerging markets like India and China. India is expected to witness strong growth in vehicle production until 2025 across all segments. The opportunities and challenges posed by recent developments in the Indian automobile industry will be discussed, with special reference to radialisation of commercial vehicles and factors affecting the rate of change. The preparedness of the Indian tire industry to respond to the global situation will also be discussed.

Green mobility challenges and opportunities for the rubber and automotive industries

Dr Rabindra Mukhopadhyay, director & CE, Hari Shankar Singhania Elastomer & Tyre Research Institute (HASETRI), India

Road congestion, urban sprawl and air pollution are among the most important challenges being faced by cities today; indeed, green objectives have been introduced in the majority of cities. Green mobility is a key sector for green economic growth. This paper will provide an overview of challenges and opportunities for the rubber, automotive and related industries, working towards green mobility through a focus on: green economy, decoupling natural resources used and environmental impact from economic growth, usage of advanced material, design for environment (DFE), resource optimisation with 4R strategy (reduce, reuse, recycle and renewable), smart manufacturing and cleaner production.

Presentation TBC

Harm Voortman, president & CEO, VMI Group, Netherlands

Intelligent solutions with customer focus by Bosch Rexroth

Mattias Ljungdahl, application manager, Bosch Rexroth, Sweden

Uptime and productivity are already facts with condition monitoring and predictive maintenance. The challenge is to deliver the information to the customer in a useful and understandable way. Sensor signals and logging are easy, but to pinpoint the failure and understand the readings you must have expert knowledge. This is our advantage compared with many other digital solutions. Hägglunds inside intelligence is not just about delivering data; it's a complete concept with service contract, expert evaluations, weekly reports and instant alarms from your system to the designated service station. It's about understanding the needs of the customer.

Virtual tire plants – experiences and results in reality

Dr Gert Nomden, senior consultant, Cards PLM Solutions BV, Netherlands

Material flow simulations of tire manufacturing operations are gaining traction. These virtual tire plants offer important benefits to tire producers: increased productivity of existing facilities, reduced investment in the planning of new facilities, and reductions in inventory and throughput times. These benefits are realisable throughout the entire chain of production and logistics, both in brownfield and greenfield sites. Material flow simulation is versatile at a low implementation cost, offering a valuable, cost-efficient and risk-free testbed to achieve world-class operations. It is becoming an indispensable aid for tire manufacturers during the design, commissioning and streamlining of their plants and processes.

tire TECHNOLOGY INTERNATIONAL 2018 AWARDS FOR INNOVATION AND EXCELLENCE

AWARDS FOR INNOVATION AND EXCELLENCE

On the second evening of the conference and exhibition (21 February 2018) 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.

3 Stream 3 - Development in Cord, Steel, Wire and Reinforcement

An alternative approach to RF-free dipping standardisation

Dr Mustafa Yasin Sen, project leader, Kordsa, Turkey
Dr Thomas Kramer, head of expert field reinforcement and skim compounds, Continental Reifen Deutschland, Germany
Kordsa and Continental are working together on a new, sustainable adhesion system standard for bonding textile reinforcing materials to rubber-based compounds. Within this joint presentation, first results will be shown. The formulation is an eco-friendly alternative to resorcinol- and formaldehyde-based adhesives widely applied for more than 80 years. In view of the critical fields of application, exchanging the adhesion technology represents a major challenge to the tire industry. Via offering a free licensing concept for the newly developed adhesion technology, both companies agreed to try an alternative approach to deal with that challenge.

A review of steel cord and wire-rubber adhesion

Dr Guy Buytaert, senior R&D project manager and team leader, Bekaert, Belgium
Although brass-coated steel cords are extensively used as reinforcement material in radial tires, bronze-coated wires are the foundation reinforcement of tire beads. It is crucial for the performance and lifespan of passenger and truck tires to achieve optimal adhesion between rubber and steel. This presentation will review the adhesion build-up and degradation mechanisms of the CuxS adhesion interphase layer, which bonds brass-coated steel cords and bronze-coated steel wires with rubber. Other topics include standard adhesion tests, advanced interphase studies, current state-of-the-art technology and what the future holds for improving rubber adhesion.

Angular fabrics: process optimisation for reinforcement of rubber products

Katharina Bibbig, product and process manager, Mehler Engineered Products GmbH, Germany
MEP developed its angular fabric (Spidercord) for the optimisation of production processes with rubber products. Angular fabric allows for the elimination of several processing steps after calendering.

Ready-to-use cap-ply – value beyond cost savings

Peter Eeckhout, development manager, Milliken Textiles BVBA, Belgium
TBC

Finite element modelling of tire cord properties

Dr Andreas Renken, global segment technology leader, DuPont, Switzerland
The DuPont Kevlar technology segment developed an explicit cord model to predict tire cord performance, starting from the individual filament properties and cord manufacturing parameters. The calculated properties can then be used to explicitly represent the composite performance based on cord performance, and the compound surrounding it. This unique cord model can be used to design textile hybrid cords and facilitate the design of optimum cord constructions to meet the desired tire performance requirements, thereby significantly decreasing new tire development cycle time. This becomes even more important since hybrid cords allow for an infinite combination of materials and properties.

4 Stream 4 - Polymer Science

Advanced manufacturing: the 21st century opportunity

Eric Amis, dean, College of Polymer Science and Polymer Engineering, University of Akron, USA
Even the most exciting new materials must buy their way into real applications, especially in demanding industries. Performance, cost, reliability, sustainability and time to market must all converge to make a successful transition from the laboratory to successful application. Going from invention and design through scale up and production demands the optimisation of multiple – often competing – factors. For new manufacturing technologies, there is an opportunity to integrate scientifically based approaches, focused on the challenges of manufacturing. We will discuss the application of agile measurement methods, integrated modelling and virtual design optimisation, and their prospects for polymeric materials.

Bio liquid polymer for winter tires

Keiji Ikeda, manager, Sumitomo Rubber Industries Ltd, Japan
Sumitomo Rubber Industries Ltd has adopted bio liquid polymer (BLP) in tread compounds for winter tires. BLP enhances ice grip because it improves softness of the tread rubber compound. In addition, BLP has the unique characteristic that it can stay in rubber compound longer term and keep softness longer than conventional oil. This means ice grip is maintained for the long term. Also in this presentation, Sumitomo's activities on biomass material and simulation technologies will be reported.

Current developments in rubber rheology

Prof. Jorge Lacayo-Pineda, head of materials evaluation expert field, Continental Reifen Deutschland GmbH, Germany
Some of the latest innovative developments in the assessment of rubber rheology, including temperature scanning stress relaxation and Fourier transform rheology, are described and their potential to contribute to the understanding of basic rubber behaviour is discussed. Examples of applications on natural and synthetic rubbers are presented to illustrate these new techniques.

Functionalised polymers and their effect on tire performance

David Hardy, technical service and development, 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.

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SSBR for energy-efficient and safe tires

Dr Sven Thiele, R&D leader process and product development anionic, Trinseo Deutschland GmbH, Germany

Energy efficiency and safety standards are at the centre of any tire approval process, and durability is often key to consumers' purchasing decisions. Furthermore, good rubber formulation process conditions are a key characteristic of an economical tire plant. The diverse market needs for high-performance passenger car tires are addressed by Trinseo SSBR products and developments. Therefore, a new Trinseo grade improves tire grip properties, and another new Trinseo functionalised SSBR grade enables a substantial rolling resistance/grip balance improvement with good rubber formulation processing characteristics. SSBR capacity expansion at Trinseo is going to enable the market availability of the new grades.

Quality improvement of tire compounds by fine mesh straining

Winfried Trost, business area manager rubber extrusion systems, UTH GmbH, Germany

The presentation will discuss quality improvement of tire compounds by fine mesh straining.

How long-term commitment to fundamental understanding pays off

Ronald Korstanje, programme manager, DPI, Netherlands

Because of the complexity and variability of their structure, natural as well as synthetic rubbers have mostly been researched by trial and error. A programme approach focused on fundamental understanding of various rubber types and development of relevant analytical techniques has resulted in a better understanding of various rubber types as well as their interaction with fillers and fibres. The programme setup as well as the results from the various research projects will be discussed for isotactic PP and EPDM.

Advantages of NKNK new rubbers for tires production

Dr Aidar Vagizov, head of R&D lab, NKNK, Russia

The presentation shows the results of the company development of new commercial and prospective grades of rubber. For today, three new grades of anionic and stereoregular rubbers have been developed at NKNK to produce high-performance tires with low rolling resistance, improved wet grip and wear resistance. Further prospective fields of BR and SSBR development will be presented.

Easy processing SSBR for UHP tread and high silica load

Dr Fabio Bacchelli, technical manager, tire, Versalis, Italy

Manufacturers of UHP tires can now overcome the difficult processing of traditional high-performance batch SSBR. A high molecular weight continuous grade containing a controlled amount of long chain branching was specially designed to optimise processing and performance at the same time. The molecular architecture able to conjugate those extremely different aspects was determined on the basis of relaxation time spectrum and non-linear viscoelasticity. By considering high-severity recipes with more than 100 phr of silica, the processability results are comparable with those of emulsion SBR, while keeping the traction properties at the same level as traditional batch grades.

Liquid rubber for safer and faster tires

Marcel Gruendken, technical manager, elastomers, Kuraray Group & University of Twente, Germany

Kuraray Liquid Rubber (KLR) acts as a co-vulcanisable plasticiser and provides rubber modification that exceeds the pure plasticising effect. This presentation introduces the different liquid diene rubbers. Depending on the backbone and microstructure, liquid rubber can modify tire performances such as abrasion resistance, rolling resistance and wet grip as well as snow and ice grip. In particular, the latter can be significantly improved by liquid polybutadiene (LBR). This will be discussed via DMA characteristics and ice grip test results.

New functionalised SSBR types for overall improved tire performance

Chigusa Yamada, synthetic rubber development, Asahi Kasei Corporation, Japan

Asahi-Kasei Solution-SBR (S-SBR), developed with proprietary functionalisation, brings significant improvement to the balance between fuel efficiency, wet grip and wear resistance of high-performance eco-tire treads. New S-SBR grades will be introduced and a new strategy for eco tires will be presented. A special emphasis will be laid on the relationship between polymer structure and performance in vulcanised compounds.

The use of EPDM for improved tire sidewall performance

Philip Hough, senior technical manager, Arlanxeo Performance Elastomers, Netherlands

Attention is given to the use of EPDM in tire sidewall compounds to replace PPDs for non-staining ozone protection. EPDM has a fully saturated polymer backbone, giving it excellent resistance to ozone and oxidative ageing, unlike polydienes that are susceptible to main chain scission. Blending of EPDM with natural and polybutadiene rubbers presents challenges due to differences in solubility and cure rates. However, it is shown that combining best practice for compound design, mixing methodology and the type of EPDM gives sidewall compounds closely matching typical sidewall properties, but with improved heat ageing, ozone resistance and dynamic behaviour.

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Stream 5 - Tire Testing – Lab and Track *(continues on days 2 & 3)*

Effect of non-linear elasticity to crack growth of tough rubber compound

Dr Yoshihiro Morishita, material scientist, Bridgestone Corporation, Japan

The understanding of the crack-growth phenomena in rubbers is an important issue in industrial applications because the crack growth plays an essential role in the life of the tire. Our home-built experimental setup enables us to measure simultaneously the velocity of crack growth and the crack-tip profile as a function of input tearing energy. We found that filled rubbers show an abrupt and dramatic change in the velocity of crack growth in a narrow range of the tearing energy. We reveal the contribution of non-linear elasticity to the velocity transition on the basis of detailed analysis for kinetics of crack growth and crack-tip shapes.

Road hazard impacts – influence and forensic signs on radial tires

Vandy Price, senior technical advisor, Michelin North America, USA

This presentation summarises existing literature on the topic of road hazard impacts and their potential to cause tread belt detachments. It also brings to light a cache of impact studies never published before, which support the premise that road hazard impacts can lead to tread belt detachments and highlight the forensic evidence these events leave behind. Specifically, the study contains 24 examples of passenger, light truck and commercial truck tires, both new and used, that were tested for endurance, impacted and tested to failure on a road wheel and subsequently inspected. All failed with tread belt detachment at impact point.

Morphology and nanomechanical characteristics of NR/SBR blends

Darja Klat, special lab scientist, Continental Reifen Deutschland GmbH, Germany

Tire tread materials are complex rubber compounds generally made of blends of at least two rubbers, fillers and other materials, resulting in multiphase morphology. The properties of these rubber blends are influenced by morphology and microphase characteristics. Experimental techniques are required that can both discriminate between phases in a blend and provide quantitative information about their physical properties. Atomic force microscopy (AFM) has been used to investigate the effect of polymer ratio and microstructure of SBR on blend morphology and nanomechanical properties of unfilled NR/SBR blends. Nanomechanical properties were determined and compared with macroscopic values obtained by DMA.

Pot-Hole: integrity index evaluation

Daniel Pugliese, R&D engineer, Pirelli, Italy

Pot-Hole is an important performance, especially for critical markets such as APAC and LATAM. In this paper we will evaluate an integrity index that states the probability of a tire failing the pot-hole test.

The effects of tire parameters on shimmy stability in motorcycles

Heron Dionísio, research and development engineer, Pirelli Pneus Ltda, Brazil

Shimmy can be described as a self-excited oscillation motion of a wheel around its steering axis, and is caused by the interaction between the dynamic behaviour of the tire and the supporting structure. The oscillation can increase to considerable amplitude, causing loss of control and a reduction of the durability of mechanical components. The phenomenon can be stable or unstable depending on the system characteristics. Using a motorcycle mathematical model of four degrees of freedom, a sensitivity analysis is developed to evaluate the influence of tire parameters on shimmy stability.

Test World – meeting the increasing demand for year-round winter testing

Janne Seurujärvi, managing director, Test World OY, Finland

In 2012 Test World opened the world's first indoor winter test facilities, allowing vehicle and tire developers to test on natural snow 12 months of the year. Today these facilities are still unique, and vehicle and tire manufacturers alike are demanding more. Test World continues to innovate to offer new indoor facilities providing winter and summer testing capability all year round. Janne Seurujärvi will discuss how these new facilities have evolved, how Test World is making significant investment to develop its facilities to meet the many different requirements, and how technical challenges have been overcome.

A non-contacting technique to measure deformations of rolling tires

Dr Mohammad Behroozi, research fellow, University of Birmingham, USA

The deformations of tires can indicate the magnitude of vertical, lateral and longitudinal loads that are applied to a vehicle. However, measuring these deformations has always been a challenge. Strain gauges usually fail to measure these deformations after a few cycles because of high variations of strain in a rolling tire. Furthermore, these sensors can only provide strain at discrete locations. In the current work, we use Three-Dimensional Digital Image Correlation (3D DIC), a non-contacting technique, to measure the deformation of a tire. A test rig was designed and manufactured to mount a pair of cameras on a car wheel. The following authors have contributed to the presentation: Mr Aakash Mange, Dr Javad Baqersad.

Complex characterisation of rubber's resistance against chip and cut behaviour

Sergio Cavaglieri, student, Politecnico di Milano, Italy

This work describes analytical methods to characterise the failure during lab-simulated operation of tires in rough terrain, that show a behaviour known as chip and cut effect. Methodology: experimental observation of damage occurring under realistic tire loading conditions with a new lab instrument that controls/records applied load displacements. Natural rubber (NR), butadiene rubber (BR), styrene butadiene rubber (SBR) and binary rubber blends suitable for tire tread applications are examined. The mechanisms that affect tire tread in service (e.g. dynamic impacts, frictional sliding, abrasion by hard asperities) are discussed. Finally, heat build-up during the chip and cut process has been measured and quantified for given varied rubbers.

Comparison between four different force and moment testing methods

Anton Albinsson, PhD candidate, Chalmers University of Technology, Sweden

Increasing accuracy requirements for handling simulations implies a need for more accurate tire models. Hence, new force and moment testing methods are being investigated to more accurately represent the real-world road surfaces on which the physical vehicle will be tested. This contribution compares force and moment testing results from four different sources: traditional flat-trac measurements, a mobile tire testing rig, vehicle-based tire testing, and measurements from the new Camber Ridge tire testing facility. The contribution mainly focuses on the differences in lateral tire force characteristics, its causes and implications for full-vehicle simulations.

Force and moment testing on asphalt

Dr James Cuttino, chairman, Camber Ridge LLC, USA

The primary method for assessing tire force and moment performance has traditionally been flat-belt systems utilising sandpaper to replicate asphalt. However, the abrasiveness of sandpaper has a non-linear effect on tire performance, particularly in limit braking and cornering. This paper introduces a new machine that tests tires on an asphalt track in an environmentally controlled facility. Significant improvements are seen in measurements of braking and cornering events. Tire wear is similar to that of a vehicle, so fewer tires are required and wear-related tire changes are minimised, resulting in improved turnaround times and shortened vehicle development cycles.

Accurate prediction of measuring parking forces

James McIntyre, vice president of technology, Camber Ridge LLC, USA

Power margins for electric power-assisted steering systems are much smaller than hydraulic systems, so sizing them has huge implications on performance and costs. Predicting steering loads from classic F&M measurements is difficult due to the convoluted motion of the tire during braked steering, which combines rotation, sliding and cambering of the tire due to kingpin angles. Camber Ridge's system replicates the complex motions of the tire during parking, providing accurate F&M data for sizing steering systems early in the design cycle. This presentation will discuss steering motions and compare classical unidirectional stiffness tests with multi-directional measurements.

DAY 2 WEDNESDAY 21 FEBRUARY

6

Stream 6 - Tire Manufacturing and Production Developments

Advances in tire manufacturing for the agro and OTR industry

Massimo Lenti, technical director, Marangoni Tyre Machinery, Italy

The paper aims to introduce the new advances in tire manufacturing for the agro and OTR industry; particularly green-tire building machine setup, quality improvement and productivity enhancements. The overview provides solutions to high productivity and quality targets.

MINDUPLEX: smart calender line 4.0 for a flexible fabric/steel cord rubberising process

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

Industry 4.0 is replacing the traditional working paradigm by providing more intelligent manufacturing equipment and environments; it is the trend of the future smart factory. Comerio Ercole is ready to develop special and reliable 4.0 solutions based on different available packages already implemented for innovative tire fabric and steel cord calendering processes. One of the most recent innovations is the MINIDUPLEX, which introduces a flexible mini calender line based on standard modules, enabling high performance for experimental new technologies, short production campaigns, flexibility and reduced layout configuration with space and cost savings.

Microwaves in the tire industry – benefits, advancements, breakthroughs

Daniel Kettner, sales director, Romill, Czech Republic

The principle of microwave heating doesn't change much over time, but the applications do. Find out about the newest advancements and discover how microwaves can enhance your tire production process. The presentation will cover different approaches, their pros/cons and how they affect the process.

Future trends in gearbox technology for the rubber industry

Jan Vosatka, group technical director, Wikov Industry AS, Czech Republic

Various driven machines used in the rubber industry represent very demanding applications for the whole powertrain. The gearbox in particular needs to be robust, shock-load resistant, durable, efficient, low maintenance, with good NVH behaviour, and in general work well in terms of CAPEX and OPEX. Power density increase is the key to achieving such requirements. Going from parallel shaft to planetary gearbox design is a logical step in power density increase; Wikov's patented flexible pin technology in Orbi-fleX planetary gear range goes several steps further, and sets a new benchmark for modern planetary gearboxes.

Anti-tack – the toilet paper of the rubber industry

Howard Kennedy, vice president, H.L. Blachford Ltd, Canada

Anti-tack (aka 'anti-adherent', 'slab dip', 'soap') is a key but often neglected corner of tire manufacturing. This presentation will cover the key problems with anti-tack that steal profits in almost every tire plant, and will detail the ways to prevent/fix these problems and improve the bottom line. Key areas covered will include: slurry vs. powder, sticking, housekeeping, foaming, sludging, particle size and crystalline silica. The presentation will also cover how to incorporate anti-tack systems into Industry 4.0 and smart factory automation.

Automatic steel cord inspection system with the new Signal Interpreter

Joachim Manz, managing director, Roland Electronic GmbH, Germany

For reduction of scrap it is mandatory to control the steel cord cutting and splicing process using the Steel Cord Inspection System (SIS). This system, based on a magnetic method, is highly developed and can be operated without almost any user intervention. Assisted by the new Signal Interpreter, the operator will get a more detailed indication, e.g. about the type of fault. So the repair time can be reduced and uptime of the splicing process will increase.

Actual trends in extrusion of tire components

Harald Hepke, VP engineering rubber processing machinery, KraussMaffei Berstorff GmbH, Germany

The presentation will discuss state-of-the-art extrusion lines for the production of tire components, plus future trends.

New tire mould generation made by metal 3D printing process

Ralf Frohwerk, global head of business development, SLM Solutions Group AG, Germany

SLM Solutions is leading the evolution of metal-based selective laser melting (SLM) manufacturing from prototyping to production in the automotive and tire markets. The new metal 3D printer helps to create components in a quicker, more cost-effective and precise way than traditional machining. SLM Solutions continuously improves the productivity of the SLM process to improve the commercial breakeven point vs. conventional production. The tire industry uses SLM's metal 3D printing technology to create innovative new tire tread designs for prototyping, series mass production and the tire retreading process.

Performance improvement leaps in tire x-ray automatic defect recognition (ADR)

Dr Shaun Immel, division VP & CTO, Micro-Poise Measurement Systems, USA

Defect detection automation that provides greater consistency in measurement and detection, and enables labour resources to be freed from non-value-added activities and redirected towards providing higher value to the tire company, has existed for several years. This presentation outlines several brand-new defect detection methodologies that take performance to an unprecedented level, enabling companies to remain competitive and increase profitability through efficient final finish processes and improved production quality. Very low alpha and beta detection error rates have been achieved based on in-plant production data. New classes of defects have also been added to this automated x-ray image detection capability.

Future mill-room systems – technology and features for increasing requirements

Alexander Quast, manager technical center, HF Mixing Group, Germany

The presentation will discuss: the importance of thoughtful engineering of pneumatic material transportation and mixer feeding (silo, day bin, scale, mixer, aspiration); ideas and features for increased mixing line performance with regard to throughput and quality; minimising of environmental pollution, friction losses and downtime by using controlled and monitored dust stop technology; positive effects of thoughtful mill-room component selection (reduction of noise level, odour emissions, ideas and features for an increased mill-room performance, etc.).

Track and trace for tire and rubber production

Lutz Dittmann, manager business development, Rea Jet, Germany

Product identification through the entire production process provides significant quality improvement. Machine-readable identification codes such as data matrix codes enable end-to-end tracking. Production issues will be detected and eliminated at an early stage and prevent costly scrap production. The presentation provides a detailed view of various product marking processes and how they tie into a track-and-trace solution throughout the entire production chain.

New features for tire identification in production, warehouse and distribution

Bernhard Lenk, DACH sales manager transportation and logistics, Datalogic Srl, Germany

Datalogic has developed a concept based on vision technology called Matrix 410 ATS and STS400 to identify tires in each step of the process from first stage and second stage, to curing, sorting and test machines in production. Furthermore, warehouse management and e-commerce solutions for tire distribution are also using this high-performing reading technology with outstanding read rates to grant very high throughput of thousands of tires a day. Matrix 410 ATS and STS400 grant full transparency of the tracking and tracing of each individual tire from the green tire to the mounted tire on the end-user's car.

Because you have no time for downtime!

Ahmet Erdogan, Cold Jet global key account manager tire, Cold Jet BVBA, Belgium

A major problem faced by tire manufacturers is mould fouling. Build-up of cured material and mould release agents causes sticking moulds, blemishes and unwanted flash on final parts, making them unusable and requiring press shutdown for cleaning. Traditional cleaning methods can be time consuming and ineffective, damaging moulds and resulting in high labour and material costs. Cold Jet Dry Ice MicroParticle cleaning offers an online or offline, quick and effective way to clean moulds without any damage. Cold Jet's shaved ice MicroParticles can also safely clean the tire mould spring and micro vents, which require a soft but effective cleaning method.

Digitalisation and standardisation for tire production

Peter Haan, head of VMM Tire, Siemens AG, Germany

Digitalisation and Industry 4.0 require tighter integration of tire production machines in terms of both horizontal and vertical integration. Both types of integration generate many benefits for tire manufacturers, but add effort for the machine builders and the tire manufacturers' maintenance teams. The presentation will show how this effort can be limited by standardisation of hardware and the use of preconfigured standard software blocks.

Integrated data management through label automation for Industry 4.0

Simon Boddy, global product manager - industrial markets, Computype, UK

Both the Industrial IoT and Industry 4.0 rely on capturing data at multiple stages of the manufacturing process. Driving this is the need for a secure and efficient product branding and identification network capable of facilitating the increased demand for data interrogation and communication. The speaker will provide an overview of the means by which the integration of automated labelling and barcoding systems support improved data management and communication to support the shift to Industry 4.0.

Manufacturing operations management for the tire industry

Gian Paolo Di Salvo, engineer, Siemens, Italy

The presentation will discuss how Siemens' digital enterprise strategy can support tire manufacturers to optimise their production, increasing efficiency and quality.

Interoperable sensor communication for digital supported production processes

Andreas Hoell, technical industry manager, SICK AG, Germany

To use the potential of the digitally networked economy, Industry 4.0, the linked sensors, machines and systems must interoperably communicate with each other. The main task is going to be the introduction of the new Industry 4.0 Maturity Index, by examples of quality control and traceability in tire production. Based on today's typical development levels achieved in the maturity index model, the necessary next steps towards the Industry 4.0 Smart Factory will be shown. The presentation will end with an outlook on networking beyond the classic supply chain, using new communication and data standards.

Innovative automation solutions to enhance tire productivity

Paolo Gamarino, European industry manager automotive parts, SMC Deutschland GmbH, Germany

The new generation of automation systems is digitally integrated, highly energy efficient and fully optimised in weight, size and performances. The presentation will explain the background and technical features of the latest innovations. Application examples with technical data will show the extent of the improvement over traditional systems that are still in use in some manufacturing processes. These innovations

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will inspire customers' engineering, R&D and manufacturing in reaching their objectives of better production efficiency.

Transformative opportunities in production system and machinery design

Paul Gatley, vice president engineering, Bartell, USA
The impact of technologies such as the Internet of Things (IoT), advanced robotics and additive manufacturing in industrial environments is influencing the future of industrial machine design. The ability to engineer innovative new production machinery systems that can apply machine data, leverage advanced materials and further integrate robotics can allow for new levels of competitive manufacturing to be realised. Through design, integration and implementation of these technologies into modern production machinery and process design, production quality, efficiency and safety will experience a positive transformation.

Digitised pneumatics is revolutionising tire manufacturing

Anja Schönfeld, marketing industry segments and processes, Festo AG & Co KG, Germany
Increased productivity is combined with a high level of standardisation. The presentation shows how the new app-controlled technology is generating savings opportunities. Industry 4.0-capable components like the Festo Motion Terminal VTEM offer the following advantages for the loading and unloading process for tire presses: shorter cycles, i.e. more tires per year, lower energy costs, reduced unplanned downtime, fewer spare parts to keep in stock.

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Stream 7 - Research for Sustainable and Reclaimed Materials

Model vulcanisation as a tool for investigation of devulcanisation processes

Prof. Ulrich Giese, managing director, German Institute of Rubber Technology, Germany
Concerning sustainability and limited raw material resources, effective devulcanisation processes are of high interest for the recycling of used sulphur crosslinked rubbers. Existing methods are not very effective and cannot be improved, because of a gap in knowledge about the chemical reactions in detail. One problem is that vulcanised rubbers cannot be analysed in detail concerning the chemical reactions at crosslinks, because of their insolubility. So low molecular model vulcanisates are prepared on the base of dimethylbutene with systematic variation of crosslink density and structure. The reaction and efficiency of devulcanising agents are investigated using GC-MS and HPLC-MS.

Bio-based combustion energy and CO_2 emission by ISO evaluation methods

Dr Masao Kunioka, project leader, ISO/TC45 Japan National Committee in the Japan Rubber Manufacturers Association (JRMA), Japan
We submitted determination methods (ISO/DIS 20463) of bio-based combustion energy and CO_2 emission from rubber products using ISO 19984-2 related to 'bio-based carbon content'. These methods use a bomb calorimeter based on real combustion of rubber products in a bomb filled with oxygen gas, and measure combustion energy (gross calorific value) and emitted CO_2 amount directly. The bio-based combustion energy and CO_2 emission can be calculated by total amounts and bio-based carbon content of measured rubber product. The rubber products with higher bio-based carbon content are suitable for energy recovery because of higher combustion energy and lower CO_2 emission from fossil fuels.

Sustainable new materials for the tire industry

Glenn Denstaedt, director, tire and rubber, Lehigh Technologies, USA
A sustainable new generation of materials has been developed for the rubber industry. Recovered tire materials have been successfully functionalised while preserving the polymer backbone. This presentation will provide evidence of functionality on the polymer backbone and demonstrate the breaking of sulphur-sulphur bonds while maintaining high polymer molecular weight. This functional compound may be used at up to 20% over the original formula base in several different rubber compound applications, to generate improvements in key physical and dynamic properties without significant changes in compound viscosity.

Bringing the circular economy to tires

Serge Klunder, sales manager, Black Bear Carbon, Netherlands
Black Bear has developed breakthrough technology to create high-quality 'green' carbon black that is a highly attractive technical substitute for several conventional furnace and gas carbon blacks used in tires. In addition to providing technical performance benefits, it offers huge positive environmental impact with regard to CO_2 emission as well as reduced air pollution and extremely low PAH content. In close cooperation with major tire manufacturers, its technical and commercial feasibility has been validated. Main observations and results from these assessments will be shared in this presentation to show how the industry can move to a more sustainable future.

Tire recycling with pyrolysis – changing technologies and interests

Martin von Wolfersdorff, principal advisor, Wolfersdorff Consulting, Germany
Tire pyrolysis technologies and the tire industry's interest in pyrolysis are evolving. The presentation will give an overview of evolving technologies such as several microwave pyrolysis processes and upgrading processes including reactivation. It will also analyse the tire industry's involvement in tire pyrolysis. Microwave pyrolysis processes appear to have an advantage over traditional pyrolysis processes through a more balanced quality of pyrolysis oil and carbon. Although the tire industry is still reserved about the use of pyrolysis carbon products in PCR tires, its interest in integrating this into industry will be analysed.

A devulcanisation process to regenerate rubber and revolutionise mould cleaning

Dr Brian Harrison, chief technology officer, Rubreco, Canada
Rubreco is a Canadian company that has successfully developed a technology that allows for the devulcanisation of rubber. This is achieved by the opening of the sulphur bonds that provide the integrity necessary for rubber products. This is the only process in the world capable of true devulcanisation, and makes possible the regeneration of devulcanised waste rubber for tire production and other industrial applications. By altering of some of the devulcanisation conditions, this

process makes possible the removal of rubber contaminating virtually all surfaces, particularly tire moulds, at a fraction of the price of current mould cleaning methods.

Sustainability is indispensable in the mixing room

Guido Veit, business unit manager plastics and rubber plants, Zeppelin System GmbH, Germany

Sustainability has reached the mixing rooms. Companies that operate according to the principle of corporate social responsibility (CSR) have been proved to be more economical and secure in the future. Examples will show how the demand for sustainability can already be implemented in practice. The examples will not be limited to the mixing room, but the complete lifecycle of the tire and the regeneration of the recycling materials will be shown as an outlook.

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Stream 8 - Polymer to Filler Interactions

Mechanical properties of SBR composite reinforced by cellulose nanofibres

Tomoyuki Sakai, assistant manager, The Yokohama Rubber Co Ltd, Japan

SBR compounds reinforced by TEMPO oxidised cellulose nanofibres, derived from paper pulp instead of petroleum-like traditional carbon black, have been studied. Their 100% tensile stress was two to three times greater than that of those reinforced by the same amount of carbon black. We will discuss how to improve their mechanical properties by examining the bound rubber of the interface between the rubber and cellulose nanofibres.

Tailoring new fillers by control of particle shape and surface

Dr Luca Giannini, senior researcher, Pirelli Tyre, Italy

The challenge in the development of new rubber compounds for high-performance tires is to widen the range of achievable compound thermomechanical properties, surpassing the known trade-offs, e.g. between wet performance and rolling resistance. The invention of new materials offers the chance to achieve such progress. Thanks to research programmes run in cooperation with Politecnico of Milano and CORIMAV consortium with Milano Bicocca University, Pirelli has developed a new family of silica fillers, featuring unique particle shape and tailored surface chemistry, leading to unprecedented rubber compound properties.

Advanced SSBR and BR: addressing the tire industry challenges?

Dr Sandra Hofmann, director technology and innovation synthetic rubber, Trinseo Germany GmbH, Germany

The ever-higher performance demands of the tire industry require innovative solutions. Advanced SSBR and Nd-BR enable the setting of new benchmarks that meet fuel-efficiency performance requirements while addressing safety standards and CO_2 legislation targets. Critical is the understanding of the rubber-filler interaction fundamentals at the molecular, meso and macroscopic scales. By combining understanding of customer challenges with materials science, fast prototyping and focused product development, timely solutions are offered for immediate implementation.

Nanoparticles in tire application

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

Use of nanoparticles is well known in polymer and also in other industries. However, extensive use of nanoparticles is not evident so far in the tire industry. In this paper, extensive work has been carried out to evaluate several nanomaterials in use in several tire components and reported here. It has been observed that certain nanoparticles are useful to enhance the performance properties of tires. However, the cost-effectiveness of these materials is yet to be established.

Silica-filled ENR compounds for 'green' tire tread compound

Teku Zakwan Zaeimoedin, PhD student, Loughborough University, UK

A previous study has shown that high silica loading in ENR without any coupling agent results in low rubber-filler interaction and lack of adhesion to the rubber matrix, which in turn affects the processability and physical properties of the rubber compound. In this work, with the aim of improving silica-filled ENR compound properties, the effect of X50S silane coupling agent concentration during mixing a silica-filled ENR compound was studied. Silica-filled ENR compounds with 0 to 8phr X50S silane coupling agent were prepared and the rheological and physical properties of the compounds were measured and evaluated.

Nuvolve engineered polysaccharides application as reinforcing filler in rubber composites

Dr Christian Lenges, business development biomaterials, DuPont Industrial BioSciences, USA

Rubber compounds are frequently reinforced with fillers to modify static and dynamic as well as mechanical properties, and also physical and thermal properties to improve the performance of rubber products. DuPont is developing enzymatic polymerisation as platform technology to engineer new polysaccharide materials. This process allows for the targeted control of polymer linkage and chain branching as well as polymer morphology through selective choice of process conditions. A first material to be introduced by DuPont based on this technology platform is an alpha-1,3 linked polysaccharide. The application of this material as reinforcing filler in rubber composites will be described in this presentation.

Dissipation and reinforcement in rubber composites

Prof. Mario Beiner, scientific director, Fraunhofer IMWS, Germany

A physical picture that explains different contributions to dissipation and reinforcement consistently in rubber composites based on a filler network incorporating glassy rubber bridges is presented. Data from strain sweeps is analysed using the Kraus model for storage modulus and a modified Kraus equation for loss modulus. The results show that properties of glassy rubber bridges determine the mechanical strength of the filler network. Further, it is demonstrated that these glassy bridges are also of major importance for the dissipation of composites. This is an important finding with relevance for the optimisation of rubber composites for applications like tire treads.

Low RR TBR compounds using ENR and surface-modified carbon black

Dr Zachary Combs, lead scientist, Birla Carbon, USA

Low rolling resistance tires continue to be important for current and future mobility and as a way of meeting government regulations and driving sustainability. This work covers the development of low rolling resistance tread compounds primarily with a combination of a surface-modified carbon black and epoxidised natural rubber. In addition, strategies for manipulating and controlling the carbon black phase distribution in ENR/NR blends is discussed as a method for improving and optimising the viscoelastic performance.

New S-SBR/Li-BR for eco tire with brand-new technologies

Hiroaki Shindo, chief researcher, ZS Elastomers, Japan

ZS Elastomers has many outstanding technologies associated with S-SBR/Li-BR. These technologies contribute to improvement of rolling resistance, wet grip, abrasion resistance and processability. In this presentation, we will introduce the effect and mechanism of ZSE's technologies, and the products to which those technologies are applied. Typical development levels achieved in the maturity index model, and the necessary next steps towards the Industry 4.0 Smart Factory will be shown. The presentation will end with an outlook on networking beyond the classic supply chain, using new communication and data standards.

Approaches for anti-static behaviour with low hysteresis in casing compounds

Maurizio Lucchi, European technical service director, Cabot Corporation, Italy

Tire manufacturers continue to optimise tread and casing compounds to reduce tire rolling resistance. Typical compounding approaches are to use a lower surface area carbon black, reduce carbon black loading, or increase adoption of silica as a reinforcing agent. These methods lead to significantly lower electrical conductivity, which can impair electrostatic charge dissipation, requiring more complex tire designs and construction. This presentation describes how conventional carbon black can strongly impact electrical conductivity and hysteresis, and explores limitations and tradeoffs. Furthermore, it will focus on new ideas and product concepts for improving electrical conductivity while minimising the impact on hysteresis.

Conducting polymer

Dinanath Sayaji Chavhan, production assistant manager, Ceat Tyres, India

The presentation will discuss the preparation of conducting polymer by incorporating HDPE in carbon black.

A new rubber silica for a new market

Dr Jens Kiesewetter, director applied technology tire and rubber, Evonik Resource Efficiency GmbH, Germany

A novel rubber silica grade was developed and is now being introduced to the tire market. Evonik's ULTRASIL 7800 GR is tailor-made for large SUV and all-season tires. ULTRASIL 7800 GR ideally balances high compound extrusion throughput due to its favourable processing and high dynamic stiffness on the other side. ULTRASIL 7800 GR mainly targets the US market with its special tire requirements. Consequently, it will be produced in Evonik's American plants, the capacity of which will be considerably increased by the launch of a new world-scale rubber silica plant in 2018.

Effect of carbon black properties on passenger tire tread performance

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

Passenger tire tread plays an important role in fine-tuning the 'Magic Triangle', with an extension in RR arm, reduction in wet grip arm and keeping the same length of durability arm. Besides wet grip, in tropical countries dry grip and dry handling also play a crucial role in tire performance. Silica technology has supported tire makers to achieve rolling resistance and wet grip with a limitation in dry grip/handling and durability. With new types of carbon black, one may achieve optimisation of all performance requirements, which will be outlined in this paper.

The effect of rubber modified silanes on tire tread compounds

Munenao Hirokami, researcher, Shin-Etsu Chemical Co Ltd, Japan

An enhancement of the interaction between silica and SBR/BR is one of the important factors of tire tread compounds. Recently, Shin-Etsu has developed rubber modified silanes that can provide a strong interaction between the silica and the SBR/BR polymers. This interaction is caused by the backbone and the triethoxysilyl groups on the side chain of the polymer silane. As a result, an improvement in fuel efficiency and wet grip is observed. Shin-Etsu will present the evaluation test results, which prove that rubber modified silanes are valuable additives in tire tread compound formulations.

Challenges in understanding physics and processing of modern tire compounds

Dr Saeid Kheirandish, processing expert, Arlanxeo Deutschland GmbH, Germany

The introduction of highly linear NdBR and functionalised SSBR with varying microstructures has confronted the processing side of tire manufacturing with new challenges. Scientific effort on rheological testing and simulation of tire compound processing evolved and peaked mainly during the second half of the previous century. However, compounds that comprise energy-efficient tires often show puzzling viscoelastic, temperature-dependent behaviour and contradict the general wisdom in this regard. The current paper gives an overview of the highlights of the previous century and the road ahead with regard to physical testing and non-linear rheological modelling of modern tire compounds.

Solvay high surface silica attributes in tread and non tread

Dr Thomas Chaussée, global R&I tire manager, Solvay, France

The use of highly dispersible silica (HDS) in tire treads is a key contribution to the production of fuel-efficient tires, complying with global regulation on tires and vehicle fleets, and minimising the environmental impact of road transportation. This paper focuses on specific attributes of the Solvay HDS high surface area silica portfolio in: severe wear for passenger car and truck, and further RRC improvement via silica introduction in non-tread parts, mainly sidewall.

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Stream 9 - New Rubber Compound Additives

The way to improve wet and ice traction of tires

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

Wet and ice traction of tires is very important within the tire industry. The introduction of silica technology for tread compounds of passenger cars has resulted in a significant step forward for these properties. Another way to improve wet and ice traction – and also rolling resistance – is the use of Vulkanol TOF (a phosphorous ester compound) in silica tread formulations. Low dosage of this chemical as an additive or partial replacement of mineral oils has resulted in additional improvements in these tire properties.

Revisiting the sulphur vulcanisation of rubber

Dr Ali Ansarifar, senior lecturer, Loughborough University, UK

Sulphenamide accelerators and zinc oxide activator are used in the sulphur cure systems of tires. The use of these chemicals has raised concerns regarding their adverse effect on marine life, human health and the environment. Zinc oxide was functionalised with a sulphenamide accelerator to provide a single material to use as an additive. The effect of the additive on the cure properties of natural rubber was measured. When the cure properties were compared with those of an NR-based tire compound, the optimum cure time was shorter and the rate of cure faster, despite reducing the use of these two curatives.

Functional additives offer benefit towards advanced tire compounding and processing

Colin Clarke, director technical sales, Schill + Seilacher, Germany

Tire component formulations and associated processing are becoming increasingly complex, with strong emphasis on improved tire performance. The need for additives to maximise efficiency is significant. The trade-off in vulcanised properties for the benefit of easier processing is unacceptable in most cases. Process additives must therefore contribute towards property enhancement alongside process improvement. To achieve this, new classes of additives are being developed. This presentation will explore several applications, such as high dynamic stability tread compound and high-speed extrusion processing, where the use of new additives benefits the processing and contributes towards better tire performance.

Synthesis and application of calixarene derivatives as tackifier resin in tire applications

Henrik Margharian Pekachaki, R&D compounding engineer, Iran Rubber Industries Research Center and Iran Yasa Tire and Rubber, Iran

Dr Saeed Taghvaei Ganjali, CEO, Iran Rubber Industries Research Center, Iran

Regarding the tire industry's need for modern resins, we have developed a new speciality resin with significant properties for various tire applications. The aim of this study was to increase tack and adhesion of rubber to rubber, metal and fabric by means of substitution of calixarene derivatives with Novolak phenolic tackifier resin. The effects of both 'in situ' and 'offline' calixarene polymerisation have also been investigated. Calixarenes are cyclic tetramers with a three-dimensional network, made up of p-tert-butylphenol and formaldehyde units.

Study on the performance of novel long-acting antioxidant

Dr Meng Zhao, R&D engineer, Sennics Co Ltd, China

A novel, environmentally friendly antioxidant with adjustable components was prepared through technical innovation. The new antioxidant, named N3100, is an ideal substitute for DTPD (traditional 3100). As one of its components is different from DTPD and the ratio of its components can be adjusted freely, tire manufacturers could achieve a better long-term anti-ageing effect by adjusting the formulation, and the risk from REACH could also be avoided. When applied to rubber and tires, its ozone ageing, thermal oxidative ageing and mechanical ageing properties are comparable to those of the DTPD.

Effects of curing systems on layer adhesion strength for silica compounds

Reza Limoochi, technology director, Khuzestan Tire Company, Iran

Tests and examinations have shown that the compatibility and harmony between silica and cure systems and adhesion strength between tire layers and particles depend on the best cure systems for each particle with temperature gradient and curing rate index(CRI). These items have powerful effects on tire durability, service and quality and conjunction adhesion strength by interfering with silica in curing reaction.

Improvement of dynamic fatigue in tire compounds by graphene

Mina Saghaei, research assistant, RIERCO, Iran

Tire blister and circumferential fatigue rupture are the major problems that have been reported in the tire industry. A wide variety of efforts have been made to design compounds with less failure. The introduction of graphene in recent decades has attracted the attention of researchers to apply this superior material to the tire compound. This study investigates the potential application of graphene to reduce heat buildup and improve dynamic fatigue to restrict blistering and rupturing in tires.

Science of performance process aid for highly loaded silica compounds

Dr Rikki Lamba, managing director, additives, Polymer Solutions Group, USA

Tire manufacturers are continuously seeking new material technologies that can be leveraged to meet ever-increasing performance requirements for improved fuel economy and wet braking demanded by vehicle manufacturers and tire-buying consumers. Material designers are using very high levels of silica (>90phr) to achieve these objectives, but at a substantial cost to processability. Most process aids also retard cure and degrade performance properties. Focusing on the needs of tire and rubber materials developers and their customers, Flow Polymers has developed SureMix CO_2. When used in highly loaded silica tread formulations, it can improve processability while enhancing wet traction and fuel economy.

NXT silane: broad formulation latitude with ease of processing for high-performance tires

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

Momentive's NXT silane, a thiocarboxylate functional silane coupling agent, incorporated into a model passenger tread

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compound can enable broad formulation latitude with good processability and improved dynamic properties compared with standard sulphur silanes, namely, bis-(3-triethoxysilylpropyl)-tetrasulphide (TESPT) and bis-(3-triethoxysilylpropyl)-disulphide (TESPD). A comprehensive set of data will be presented for a range of polymer and silica combinations of high-performance tire compounds. This data set will include lab indicators of improved processability and performance and demonstrate the benefits that can be achieved by incorporating NXT silane.

Synthesis of cobalt adhesion promoters, analysis and effect of cobalt

Mehdi Kafrashi, technical expert, Yazd Tire Production Company, Iran

In this study, the compound synthesis of belt tire radial was characterised by laboratory tests such as MDR, hardness and physical-mechanical properties. Three compound samples with amount of cobalt (0, 1, and 2 phr) were constructed and its effect on intra-surface morphological structure was evaluated by means of photoelectron spectroscopy, radiation of x-ray diffraction and transmission electron microscopy (TEM). Meanwhile, these levels show different amounts of adhesion promoters affecting the amount and distribution of cobalt ions (XRD). The effect of cobalt on intra-surface structure and crystallisation and also its correlation showed better adhesion performance.

Cyclododecasulphur – a novel vulcanising agent

Dr Frederick Ignatz-Hoover, technology fellow, Eastman Chemical Co, USA

The rubber industry depends heavily on insoluble sulphur (IS) for effective manufacturing of complex composite rubber articles such as hoses, belts and tires. Commercially available insoluble sulphur (otherwise known as polymeric sulphur) is a metastable material, i.e. it is thermodynamically unstable at room temperature and at typical rubber processing temperatures. Consequently, great care is required in processing compounds containing insoluble sulphur such that the polymeric sulphur does not convert to rhombic or conventional sulphur. Cyclododecasulphur, S12, can be recrystallised and isolated in high purity.

Crystex Cure Pro insoluble sulphur – the next generation of insoluble sulphur

Dr Frederick Ignatz-Hoover, technology fellow, Eastman Chemical Co, USA

Eastman Crystex Cure Pro insoluble sulphur is a highly optimised polymeric sulphur specifically engineered for maximum performance characteristics. Crystex Cure Pro demonstrates a combination of superior critical characteristics for polymeric insoluble sulphur. Enhanced flow, easier handling and superior dispersion characteristics along with improved thermal stability make Crystex Cure Pro a unique performer because it has the important features that tire manufacturers want in insoluble sulphur. Better flow and handling provide considerable convenience and accurate dosing in plant operations, while the improvements in dispersion and thermal stability provide users of Crystex Cure Pro with operational savings opportunities.

Tire oils with low aromatic content and high solvency

Dr Mika Lahtinen, global technical manager, Nynas AB, Finland

Aromatic oils have been replaced with safe oils in tire compounding in most regions. The next region to introduce legislation will be India or China. Replacement of aromatic oils in non-tread compounds has been fast. Oil content is lower and polymers less polar than in passenger car tires (PCR). The PCR tread compounds contain SBR, and require more polar plasticisers. Furthermore, high glass transition temperature is required to ensure traction. Oils with medium aromatic content (23-35%) are thus favoured. In this paper we discuss the use of tread compound oil with low aromatic content. It is also beneficial for future supply.

Performance hydrocarbon resins in tread formulations – why use resin?

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

Hydrocarbon resins are low molecular weight polymers with high glass transition temperatures that are used in tire tread formulations to modify the 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. It is observed that resins modify the compound Tg, producing a significant difference between polymer glass transition (E" peak) and compound glass transition (tanδ peak). Resins also increase the breadth of the tanδ peak and thus the range of performance possible for the compound, be it WG, RR, wear or snow properties.

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Stream 5 - Tire Testing – Lab and Track *(continued from day 1)*

Tire testing procedures: is it time for a new standard?

Christian Bachmann, division manager tire technology, fka Forschungsgesellschaftkraftfahrwesen mbH Aachen, Germany

Currently all tire and vehicle manufacturers test tires for various purposes. However, many of these test procedures seem based on former technical capabilities that have been overcome today. Standardised procedures like TIME are no longer used as a standard by the data requesters – especially with respect to tire characterisation and tire model parameter identification. The presentation will discuss the question: what are the common requirements for a new test procedure that covers all demands?

Taking a closer look at wear and abrasion testing

Dr Pamela Martin, research scientist, TARRC (Tun Abdul Razak Research Centre), UK

Tire tread wear is a complex phenomenon and notoriously difficult to predict by laboratory tests such as Akron abrasion. Previous work at TARRC has shown that such laboratory tests are unable to replicate well the mechanism of tire wear on the road. This paper will discuss the wear behaviour of rubber compounds subjected to other laboratory abrasion test methods, including the blade abrader and LAT-100. Surface wear characteristics of laboratory-generated test pieces have been examined microscopically to establish how well they resemble on-the-road wear of tires.

EMSlight – defined shutdown of test wheels

Bernward Maehner, software engineer, SDS Systemtechnik GmbH, Germany

With the Endurance Test Monitoring System EMS, a new application for the Sheet of Light measuring technique was introduced by SDS. The online analysis of starting and growth of separations, cracks, etc. while a tire is running on a test wheel without stopping is an outstanding possibility for R&D. For regular operation, the new EMSlight offers an automated analysis of the tire surface specifically to stop a test run with predefined criteria and thresholds. This solution offers a much better defined and safer stop of a running test compared with actual methods with capacitive sensors or bent wires.

Effects of inflation pressure internal variations on the tire rolling and cornering characteristics

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

Tire lateral forces, moments and rolling resistance are important aspects of tire characteristics. They are influenced by tire type and size, vertical load and speed, inflation pressure, road condition and tire design parameters. In this particular research study, the effect of tire inflation pressure's internal variation within the tire chamber on different tire characteristics is considered. 3D finite-element-based parametric analysis is conducted by taking a 17 inch (225/55/R17) radial car tire for different operating conditions.

Dissipation-equivalent load control in dynamic fatigue test

Hamid El Maanaoui, research associate, Deutsches Institut für Kautschuktechnologie eV, Germany

Under dynamic loads, technical elastomers display hysteresis-induced heating, altering the effective test temperature. To achieve a Wöhler curve based on tests at similar effective temperature, a procedure is presented that adjusts the actual frequency at each load level by taking into account the dissipated energy density from the hysteresis area. We measured the lifetime performance of rubber materials reinforced with 50phr of CB N347. For verification of the concept, infrared measurement was done. With the resulting thermally adjusted Wöhler curves, significant corrections for cycles number were found.

Mechanical testing with new automated dynamic mechanical analysis method

Hugues Baurier, international sales manager, Metravib, France

In 2017, Metravib introduced a brand-new concept of mechanical dynamic testing designed to meet the expectations of the tire industry in terms of productivity and data accuracy. The automated DMA brings advanced capabilities to clearly distinguish the mechanical behaviour of various rubber compounds and achieve an impressive testing throughput. This presentation will discuss the capabilities and limitations depending on the various possible test modes: tension, compression and shear, in referring to a significant database analysis.

Development of an endurance testing method for high-performance tires

Joan Puig, tire technology product manager, Applus IDIADA Group, Spain

Katech and IDIADA have developed an endurance test method for high-speed tires in laboratory. The main target has been to reproduce in laboratory the same damage suffered by tires that are rolled in circuit driving conditions. An Audi R8 has been driven in racing conditions until the tires showed a drop in their performance. Thanks to chassis calculation tools, the vehicle data acquired enabled evaluation of the loads suffered. Eventually, tire loads observed in circuit driving conditions were converted to tire test rig inputs. Based on this particular exercise, the general tire endurance test method is defined.

Road hazard impacts – influence and forensic signs on radial tires

Glenn Follen, tire analyst and consultant, Follen Consulting LLC, USA

This presentation summarises existing literature on the topic of road hazard impacts and their potential to cause tread belt detachments. It also brings to light a cache of impact studies never published before, which support the premise that road hazard impacts can lead to tread belt detachments and highlight the forensic evidence these events leave behind. Specifically, the study contains 24 examples of passenger, light truck and commercial truck tires, both new and used, that were tested for endurance, impacted and tested to failure on a road wheel and subsequently inspected. All failed with tread belt detachment at impact point.

Chemical structure of crosslinks formed during tire ageing

Dr Ed Terrill, applied research fellow, Akron Rubber Development Laboratory, USA

Aerobic ageing of tire belt-coat compound (during tire oven ageing or normal 'field' service) was found to increase crosslink density. Through a combination of analytical techniques, the linkages formed during aerobic ageing appear to be oxygenated species (sulphoxide, ether, epoxide or peroxide). The extractable sulphur results suggest that the original sulphur network stays intact during ageing (not thermally reverted). However, the sulphur linkages are probably participating in the formation of crosslinks in the form of sulphoxide linkages. At higher temperatures (e.g. oven ageing), the oxygenated linkages rearrange to carbon-carbon linkages with the evolution of CO_2, CO and SO_2.

Linear and non-linear rheological measurements on rubber polymers and compounds

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

The scope of the talk is to evaluate differences in polymer and rubber compounds based on molecular weight, molecular weight distribution and long chain branching using a rubber process analyser (RPA). In the first step, the comparison is done based on a standard frequency sweep using different polymer samples and how differences show up compared with standard tests, namely the Mooney Viscosity and the MDR Cure Curve. In the second step, the linear and non-linear responses from a standard strain sweep experiment are evaluated for a series of polymer grades such as BR with different branching.

Fatigue modelling of a cord-reinforced system

Niraj Kumar Jha, PhD student, Continental Teves / Leibniz University of Hannover, Germany

The computational methods to assess the durability of a cord-reinforced structure will be explained. A mainly damage mechanics approach will be used to explain the various failure modes, such as debonding, matrix damage, etc.

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Stream 10 - Simulation Modelling and Testing + Conclusions

Numerical simulation of the fluid-structure interactions inside the aquaplaning problem

Dr Corentin Hermange, research and development engineer, Michelin, France

A new coupling strategy between smoothed particle hydrodynamics (SPH) and finite element (FE) methods is developed and applied to the tire aquaplaning problem. Improvements in the SPH-FE coupling are proposed to achieve efficient simulations of such a complex phenomenon. On the fluid side, the SPH method seems perfectly suited to handle the three complex interfaces of the aquaplaning phenomenon: free-surface, ground/fluid and fluid/tire interfaces. The present 3D SPH-FE model is first validated on various academic test cases before considering the complex problem of the 3D aquaplaning simulations for new and worn tires.

Need of thermal tire modelling for handling simulation: practical verification

Lorenzo Tonelli, junior applied research engineer, Pirelli Tyre SpA, Italy

Many different technical papers take into account the effect of temperature variation on tire cornering and braking properties. It has been proved that the tire forces and moments depend on thermal effects, which in turn depend on lateral and longitudinal slip and on the forces themselves. In this presentation, the typical vehicle handling manoeuvres are analysed to assess how much every manoeuvre is affected by a thermal tire model.

The latest tire modelling and testing developments at Jaguar Land Rover

Jan Prins, technical specialist, Jaguar Land Rover, UK

The presentation will provide an overview of the latest tire modelling and testing developments at Jaguar Land Rover.

Advanced methods for tire handling analysis, characterisation and parameterisation with CDTire

Francesco Calabrese, tire and vehicle dynamics simulation engineer, Fraunhofer-Institut für Techno- und Wirtschaftsmathematik, Germany

CDTire/3D is a physical 3D mechanical tire model. In the model each functional part of the tire structure – sidewall, belt layers, carcass, cap ply – is described by means of shell formulation. The thread is described with an advanced brush model. This presentation will show how to analyse typical tire handling behaviour by using simulation; how to explain the connection between handling property and the tire structure; how it is possible to parameterise CDTire/3D for handling; what is the minimum requirement of measurements needed for complete characterisation.

Presentation TBC

Jan Grashuis, vice president global R&D, VMI Group, Netherlands

Tire rubber extrusion experiment and simulations with wall slip

Tijmen Mateboer, researcher, Professorship for Polymer Engineering of Windesheim University of Applied Sciences, Netherlands

Extrudate swell of filled rubbers is common in the tire industry. Extrudate swell is a complicating factor in the die design. Numerical simulation of extrudate swell may benefit the die design process. Wall slip of rubber along the die wall is a relevant parameter for the flow behaviour and the extrusion simulation. Extrudate swell simulations and experiments have been performed with a viscoelastic tire rubber compound through a circular die. A viscoelastic PTT model was fitted onto rheological data of the rubber. Wall slip was determined with rheological measurements.

NVH technology as a diagnostic tool in OE development programmes

Subramaniam Loganathan, senior manager - vehicle dynamics, CEAT Limited, India

Tire development for the Indian automotive market is a challenge, with comfort and fuel efficiency the top priorities. Today, product validation through physical testing is still indispensable, despite the advancement in virtual simulation. Well-developed NVH technology in outdoor vehicle measurement gives more freedom in optimising tire tuning with pattern and construction to meet stringent customer requirements including OEMs. This study probes the impact of pattern, cavity and construction on tire NVH by virtual simulation and validation at vehicle level. It also covers source level noise measurement and unique analysis techniques to quantify tire NVH performance at vehicle level.

Modelling and replicating real-world surfaces for indoor laboratory testing

Matthew Della Pia, simulation engineer, Global Center for Automotive Performance Simulation, USA

Historically, the precisely controlled environments at indoor tire testing facilities have produced repeatable tire force and moment data with the understanding that the testing surface was not asphalt. Indoor surfaces that are more characteristic of asphalt allow for repeatable test data that is more representative of outdoor testing results. This presentation will demonstrate an analytical approach for transforming outdoor surface roughness scan data into viable surfaces for indoor high-speed flat-belt testing.

Understanding the surface contribution to indoor/outdoor tire test data

Dr Kevin Kefauver, technical director, Global Center for Automotive Performance Simulation, USA

Surface properties are a major factor in the force and moment generation process of the tire/roadway system. Typically, indoor tire testing is performed on sandpaper, and understanding the differences between sandpaper and asphalt tire test data is critical for translating indoor to outdoor. This presentation will compare the results of indoor testing on various flat-belt surfaces with the results of outdoor roadway testing in dry and wet conditions. Included in the presentation will be results from non-standard indoor tire testing surfaces.

Simulation of rolling disc with lateral tread pattern

Thirumal Alagu Palanichamy, doctoral student, Leibniz University, Germany

The present methods for the simulation of rolling tires with lateral tread pattern take a lot of computational effort. Arbitrary Lagrangian Eulerian (ALE) relative kinematic framework is widely used for rolling tires due to less computational effort. But the disadvantage is that it can only be applied to axi-symmetric tire models. In this work, a coupled ALE - Lagrangian framework is proposed for the simulation of tire model with lateral tread

pattern. The tread cap is defined in the Lagrangian manner and the tread base is defined in an ALE relative kinematic framework.

Finite element modelling of tires for dynamic test

Abubaker Al-Tayawe, PhD researcher, Cranfield University, UK

The presentation discusses the procedures to implement a proper dynamic rubber material card on a finite element model of a tire. Current state-of-the-art models implement an improper representation of rubber behaviour in dynamic scenarios. This presentation looks at the implementation of an equation-based material card, which best defines the viscoelastic dynamic behaviour of rubber at varying strain rates. The material model is supported by material test data, where validations were carried out on the material card. Several static and dynamic scenarios of a tire are modelled using LS-DYNA software: quasi-static compression, dynamic rolling tire, rolling tire over a wedge.

Contribution to tire/road friction modelling: introduction to the wetting effect

Dr Malal Kane, senior researcher, IFSTTAR (France), France

This work presents a tire/road friction model considering the viscoelasticity of the tire rubber, the texture of the road surface and the water at the tire/road interface by introducing explicitly the wetting in the calculation process of the hysteretic friction. The geometry of the wet part of the contact is simplified by transforming it into an equivalent hydrodynamic bearing. By means of the Reynolds equation, the bearing load capacity is calculated and subtracted from the contact load when calculating the friction.

Three-dimensional characterisation of dynamic tire deflections

Henning Olsson, director, research and development, Calspan, USA

The external shape of a tire changes significantly with operating conditions such as speed, load and inflation pressure. Using dynamic measurements of tire surfaces, a method has been developed to correlate operating conditions with external tire surface deflection. The deflection correlation is used to generate a tire surface model. Analysis of how operating conditions influence the overall tire geometry is presented. Finally, the use of this in full vehicle aerodynamics simulation and its impact on vehicle energy efficiency is discussed.

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Stream 11 - Tire Material Research – University of Twente

Influence of resins on in-rubber properties of an elastomeric compound

Neven Markovic, PDEng, University of Twente, Netherlands

Resins are widely used in adhesives due to their ability to improve tack. For the same reason they are applied in rubber compounds. These resins are low-molecular-weight oligomers produced from a natural or synthetic source of monomers. When applied in a rubber formulation they can replace the oil and act as a processing aid. The solubility of both a rubber and a resin are major factors that determine the behaviour of a rubber-resin blend. Besides solubility, the structure molecular-weight and concentration of the resin have the highest influence on a rubber. These influences will be covered during the presentation.

Dispersion control during mixing of silica-filled tread compounds

Ayush Kharel, PDEng, University of Twente, Netherlands

Rheology of silica-reinforced compounds is affected by the filler interaction with the elastomer. The process of mixing silica into the elastomer determines the interaction between them and influences their extrudability and rheological properties. A mechanical breakdown of silica agglomerates as well as a chemical reaction between silica and silane have to occur during mixing. Therefore, it is a challenge to maintain a consistent level of interaction in every batch. The Payne effect is an indicator of inter-particle interaction. This project aims to design a predictive mixing control method by mapping the evolution of Payne effect with mixing parameters.

Prediction of in-rubber dispersibility of silica by analytical methods

Fabian Grunert, PhD student, University of Twente, Netherlands

Precipitated silica in combination with bi-functional organosilanes are among the most important fillers for passenger car tire tread compounds. Still, the challenge is to reach a good dispersion and distribution of the silica inside the rubber matrix. It is known that the compound formulation and mixing process influence the processing and dispersion behaviour. Moreover, silica itself has a great impact on the in-rubber dispersion quality and it is crucial to be aware of the typical analytical parameters and their impact on the dispersibility. Therefore, different approaches were investigated to predict the in-rubber dispersibility of silica by new analytical methods.

Alternative to diphenylguanidine in silica-reinforced natural rubber tire tread compounds

Chesidi Hayichelaeh, PhD student, University of Twente (Netherlands), Thailand

Diphenylguanidine (DPG) is widely used in silica-reinforced rubber compounds to enhance the silanisation and vulcanisation reactions. Due to toxic aniline liberated by DPG under high processing temperature, safe alternatives are required. This work investigates octadecylamine (OCT) as a DPG alternative in silica-filled natural rubber compounds. The compound properties are comparatively assessed by taking the ones with DPG and without amine as references. Kinetics of the silanisation reaction between silica and silane in the presence of amines are studied based on model compounds. The use of OCT promotes interfacial compatibility combining chemical and physical interactions, resulting in good performance.

Influence of network structure on elastomer properties

Anke Blume, university professor, University of Twente, Netherlands

Considerable attention is paid to the influence of crosslink density and crosslink structures on the behaviour of elastomers. A very important parameter seems to be underestimated: the modifications to the polymer chains by curatives, formed by sulphur and fragments of accelerators. The present paper intends to draw attention to this important contribution to performance of spatial networks. The emulsion styrene-butadiene rubber (E-SBR) samples, cured with tetramethylthiuram disulphide and sulphur (TMTD/S8), and zinc dialkyl dithiophosphate with sulphur (ZDT/S8), were studied.

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Silica-NR masterbatch as an alternative for tire raw materials

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

In the conventional mixing of silica-filled rubber compounds, the silica and silane coupling agent are added separately into the mixer during the second sequence, which is the most crucial step in achieving adequate hydrophobation on silica surface. However, there are drawbacks including difficult mixing control, long cycle time as well as high energy input and cost. In this study, alternative approaches are made by utilising pre-silanised silica and silica-NR masterbatch. Positive results are found in the latter case as it essentially overcomes the hassles encountered in conventional mixing, while slightly improving reinforcement efficiency.

Reactivity study of mercapto-silane and sulphide-silane with polymer

Masaki Sato, PhD student, University of Twente, Netherlands

Mercapto-silanes enable an improved silica dispersion state compared with sulphide-silanes in tire tread compounds. However, they also have a tendency to cause processing difficulties. Therefore, as a possible influencing factor for the above-described phenomena, the silane/rubber reactions were investigated in a model system using alkenes instead of polymers together with silanes. The results reveal that mercapto-silanes and sulphide-silanes react in different ways depending on the type of double bond. Based on the findings, the reason for the different properties in silica-filled compounds with various polymer/silane combinations will be explained.

Business Strategy Conference Sessions

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Stream 2 - Business Strategy *(continued from day 1)*

Greening carbon black for green tires

Francois Terrade, president, Pro2ACT Management SAS, France

Carbon black is not considered to be a green industry. What are the challenges? The industry has considerably supported the effort to reduce tire rolling resistance, which is a great step towards minimising vehicles gas consumption. But can this industry evolve towards a greener process, and how? Working on raw materials, the manufacturing process itself and the circular economy will definitely allow the production of greener tires.

Presentation TBC

Christoph Stürmer, autofacts global lead analyst, PwC, Germany

Data collection as the core of modernisation when creating better factories

Aki Nurminen, material and information flow manager, Black Donuts Engineering, Finland

The presentation will discuss: what is data and why it is needed in tire factories; what and who are needed in automation and modernisation projects from different participants; how data can be used in future projects when creating new processes or factories; data and simulation of core processes – impact on material flow and optimisation.

Low NR prices and a big surplus: what will happen?

Dr Hidde Smit, consultant, Rubber Forecasts, Netherlands

The presentation will cover: 1) The outlook for total rubber consumption; 2) Price sensitivity of consumers; 3) The outlook for natural rubber (NR) consumption; 4) Boom in planting of NR and the effect on production potential; 5) Price sensitivity of NR producers: the extent to which farmers reduce production intensity; 6) Future planting and the surplus in production potential: when is the peak, when is it finished?; 7) Driving forces for the developments in prices of NR, BD and SBR; 8) The outlook for NR production and for NR, BD and SBR prices.

Presentation TBC

Harjeev Khandari, CEO, Zenises, United Arab Emirates

Regulation paves a one-way street to a dead end

Stephan Rau, technical director (CTO), WDK - German Rubber Manufacturers Association, Germany

Tires are among the most regulated products in Germany, Europe and the world. Regulations start with the raw materials, continue over use time and do not stop at the end of life of the product. Tires are essential in our world of transport, be it personal or professional, but regulation increasingly restricts production, use, recycling and scrapping of tires. WDK's goal is to create political awareness related to some counterproductive legislative measures, by trying to bring the topics back to a more factual basis.

Indian Automotive Mission Plan 2026 – challenges and opportunities

Dr Shobha Dhawan, chairperson, Dawnsun Exim Corp, India

The Indian Automotive Mission Plan 2026 (AMP 26) showcases the high growth potential of the Indian automotive industry and the tire industry. The presentation will discuss the opportunities and challenges for suppliers and ancillary industry caused by this phenomenally high growth in the Indian industry.

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Stream 12 - Young Scientist Developments

Fatigue modelling of cord-rubber composites

Niraj Kumar Jha, PhD student, Leibniz University, Germany

Modelling of damage in elastomeric composite structures nowadays is a subject of growing interest mainly because of the high demand in automotive industries. Such structures are, for example, tires, hoses and air springs. This presentation will focus on accurate fatigue damage modelling for a cord-reinforced rubber structure. The potential failure modes e.g. cord-rubber interface debonding, delamination, matrix damage or interacting damage mechanisms will be explained. Also, numerical methods to assess durability will be explained with regard to the implementation in commercial finite element code ABAQUS.

Cavitation damage in tire rubber materials investigated by computed tomography

Eric Euchler, PhD student, Leibniz-Institut fuer Polymerforschung Dresden eV, Germany

Under constraint conditions, multi-axial stress states arise in rubber materials under tensile loading. They are responsible for cavitation phenomena as first steps in the failure process of the whole material. Micro computed tomography (µCT) enables the characterisation of the formation of reversible as well as irreversible cavities and their merging in the case of failure. By synchrotron small-angle x-ray scattering it is possible to investigate initial stages of the damage process. The results of these investigations can be compared and discussed, considering results achieved by dilatometry tests.

Temperature, roughness and wear in real-time advanced MF modelling

Dr Flavio Farroni, research fellow - CEO and co-founder, University of Naples - MegaRide, Italy

The physical modelling of tire-road interaction phenomena and the employment of advanced simulation tools developed by UniNa Vehicle Dynamics research group and engineered by its spin-off, MegaRide, allow the prediction and simulation of tire temperature local distribution, tread wear and the adhesive and hysteretic components of friction arising at the road interface. The cooperation among such physical models allows the level of realism and reliability provided by a simulation system to be increased, predicting, in the proposed case study, the modifications that the effects of the cited phenomena will cause to the parameters of an innovative methodology to implement Pacejka's MF formulation.

Multi-physical approach for tire contact and wear mechanisms modelling

Aleksandr Sakhnevych, PhD student, Università degli Studi di Napoli Federico II, Italy

The experience gained through the development of physical models and continuous research into advanced and innovative testing procedures could finally lead to full characterisation and understanding of the tire thermodynamic behaviour. Taking into account the temperature and wear influence on both the tire structural and compound viscoelastic characteristics, expressed respectively in terms of interaction stiffness and performance level, as a function of tread temperature, sliding speed, road granularity and load history, the approach to a tire complete dynamic analysis and modelling can therefore be necessarily multi-physical.

Model-based sensitivity analysis of tire transient handling performance

Pavel Sarkisov, PhD candidate (former), TU Dresden (former), Germany

The paper represents an analysis of the effect chain between tire structural parameters and its transient handling performance. Eight tire parameters were considered (e.g. carcass lateral stiffness, tire dimension) and five model properties (e.g. number of brush elements). Handling performance was analysed with the help of seven criteria of tire performance (e.g. cornering stiffness, bore stiffness) and seven criteria of tire state (e.g. carcass deflection). This approach may be helpful for estimation of tire properties in the early phase of the vehicle development process as well as for tire model development.

DAY 3 THURSDAY 22 FEBRUARY

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Stream 13 - Natural Rubber and the Science of Sustainable Materials

Method for resin selection in natural rubber tread compounds

Zachary Walters, research engineer, Cooper Tire, USA

Natural rubber is typically not used as a major component in passenger tire tread formulations due to wet grip considerations. We have demonstrated that passenger tread compounds containing as much as 100% natural rubber can be developed, which have excellent overall properties, including wet grip. This is accomplished by a careful selection of high Tg hydrocarbon resins, which are compatible with natural rubber. The presentation will discuss a method for selecting resins applicable for use in tread compounds containing high levels of natural rubber.

Thermo-mechanical evaluation of strain-induced crystallisation of natural rubber composites

Prof. Manfred Klüppel, head of department, Deutsches Institut für Kautschuktechnologie, Germany

Strain-induced crystallisation (SIC) of unfilled and filled natural rubber is investigated by mechanical multi-hysteresis cycles and a thermal analysis during stretching and retraction. The expected heating of the sample due to mechanical work done at the samples is compared with on-line measurements of the surface temperature by IR camera. SIC is quantified by taking into account that crystallisation is an exothermal process leading to additional heating besides entropy-caused reversible heating and dissipative heat losses. From the measured excess temperature and the known crystallisation enthalpy, the degree of crystallinity in the stretched rubber sample is estimated.

Road condition monitoring for autonomous vehicles using rigid-ring tire model

Dr Mohammad Behroozi, research fellow, University of Birmingham, USA

Drivers have an anticipation of the road condition based on background knowledge, and react accordingly if needed; e.g. lowering vehicle speed in snow. All the steps of a driver's reaction – which is a complex combination of sensing, reasoning, planning and reaction – are not fully comprehended in driverless vehicles. Using technologies such as lasers and cameras is useful in the meantime but not robust enough in the longer term to be fully trusted to replace human perception. In this work, a rigid ring tire model is considered as a sensor to identify the road condition and provide assistance to other detection algorithms. The following authors have contributed to the presentation: Mr Vikas Birajdar, Dr Javad Baqersad.

Improving the fuel efficiency of truck tires with treated silica

Dr Lucas Dos Santos, senior R&D engineer, PPG, USA

In-situ silanisation technology has allowed the introduction of low rolling resistance silica-filled passenger treads. When treads are predominantly comprised of natural rubber, silicas no longer provide the same benefits over carbon black due to the inability to efficiently perform the in-situ silanisation reaction. Pretreated silicas allow this barrier to be overcome, and silica-filled NR compounds to be produced. A pretreated silica-NR truck tire tread was developed under a United States DOE-sponsored project. A truck tire manufactured with this tread showed 16% improved RRC, while maintaining other performance parameters, over the carbon black-filled control tire. The development work will be presented here.

Influence of filler dispersion and residue on fatigue of sidewalls

Dr Lewis Tunnicliffe, scientist, Birla Carbon, USA

The role of carbon black dispersion state and residue level on the static, dynamic and fatigue properties of model sidewalls was investigated. A controlled series of compounds was prepared, varying in carbon black residue (grit) level and dispersion state. Micrometer length scale residue particles and undispersed carbon black act as potential flaws in the material, leading to changes in fatigue life and fatigue crack growth rate. Fracture mechanics experiments are coupled with microscopy of the evolution of cracks from residue precursors to highlight the role that carbon black cleanliness and quality of dispersion can play in sidewall performance.

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Stream 14 - Innovative and Experimental Tire Concepts

Trends and techniques for lightweighting in truck tires

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

The issue of lightweighting in tires has been of historical interest for materials cost control. However, with fuel costs being a major driver in the trucking industry, OEMs and fleets continue to search for ways to optimise fuel efficiency past rolling resistance. This study will employ a tire analysis database to study lightweighting in truck tires with the objectives of identifying: whole tire vs. individual component perspectives; target tire components for weight reduction; component volume vs. density trade-offs; weight reductions – rubber components vs. reinforcements.

Smart rubber innovations for next tire generations

Dr Gert Heinrich, professor, Leibniz Institute of Polymer Research Dresden, Germany

We present concepts of how autonomic self-healing can be implemented into commercial tire rubbers, i.e. the material repairs by itself, leading to slowing down of crack propagation and increase of tearing resistance. The self-healing rubber concept would also lead to a very positive impact on solving the scrap tire problem. Another example of functional rubber design is rubbers with strain-dependent electrical conductivity. The change of relative resistance, ΔR/R, was found to be as much as _1,300 at around 120% elongation. This type of rubber could be used in structural health monitoring and for stretchable sensors in tires.

Tire design trade-off between rolling resistance and NVH performance

Mauro Martino, wheels and tires - designer responsible, Fiat Chrysler Automobiles, Italy; Andrea Carzana, R&D tire specialist, FCA Italy, Italy

In the last decades, acoustic comfort has gained increasing importance for customers. Improving tire NVH performance without significant drawbacks in handling/safety, and following a trade-off with rolling resistance coefficient, has become a major design challenge for tire makers. This study focuses on the bead apex height and sidewall compound stiffness as design parameters that strongly influence the NVH performance on a broad frequency range. An experimental campaign that includes on-vehicle subjective and objective testing was carried out. This study provides useful information to deal with future NVH issues, enhancing the final customer experience.

Tire parameters affect trade-off between vehicle pulling and driving dynamics

Mauro Martino, wheels and tires - designer responsible, Fiat Chrysler Automobiles, Italy

Alberto Veneziano, tire specialist, Fiat Chrysler Automobiles, Italy

Together with suspension, tires are the main components that affect drift and pull. This study focused on analysis of tire plysteer residual aligning torque. Among the hundreds of design parameters that might have an influence on the tire PRAT, the analysis focused on tread design. An experimental campaign was defined, including on-vehicle subjective and objective testing. This study might provide useful information for improved understanding and approach to future tire design, and validate the mathematical model of the vehicle to predict the real vehicle behaviour.

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Stream 15 - Tire as an Information Source

Measuring real-life rolling resistance using tire liner temperature sensing

Alan Bennetts, director, Bay Systems, UK

The presentation will discuss using a 65-channel IR pyrometer sensing system to measure bead-to-bead temperature distribution for a variety of tires. The weighted temperature distributions correlate well with standard rolling road laboratory test data. Using this instrumentation on the road allows real-life rolling resistance data to be gathered. The effect of vehicle loading and driving styles can now be used to help improve tire design to improve rolling resistance in use.

RFID tire labelling: enhancing functionality, efficiency and environmental ambitions

Marc Flederus, CEO, Ferm RFID Solutions, Netherlands

The presentation will examine the current status and ambitions regarding the use of RFID within the worldwide tire market. There is increasing interest from regulators regarding the production, maintenance and use of tires, from environmental as well as safety points of view. There are two approaches regarding unique identification of individual tires with RFID: 1) Improved traceability of tires; 2) Improved maintenance of the tire. All over world, initiatives to adopt RFID are under way, not only at the tire producers themselves but also among suppliers of this industry. During this presentation you will learn why.

Tracking of commercial tires with SCANNECT laser-etched 2D matrix codes

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

Laser engraving is a cost-efficient and robust process to individualise tires with smartphone-readable 2D matrix codes. For new tires, conveyor-based reading rates of >99.8% are achievable. However, for tracking the tire over its lifetime, codes and reading technology have to cope with wear, dirt and contamination of all kinds. The SCANNECT QR code marking solution and the corresponding SCANNECT app for Android and IOS use optimise light-trapping surface structures and tailor-made image processing algorithms, and achieve astonishing all-lifetime reading rates of >>96%. The SCANNECT app can easily be integrated into proprietary tire management applications and strongly facilitates tire-as-a-service business models.

Non-contact monitoring systems for in-service tire identification and condition analysis

Roger Tracy, founder and CEO, Tire Profiles LLC, USA

Recent product developments in North America and Europe over the past several years using high-tech hardware and state-of-the-art technology solutions have produced a choice of equipment and methods to monitor tire condition and tire identification. Several different technical techniques for the vehicle aftermarket are now available. Solutions for large commercial fleets, large and small car dealerships, tire replacement chains, small replacement tire and automotive repair shops at various price and performance levels will be explained and discussed. The world can now know the condition and age of the world's tire population as never before. Big data now.

A smart tire concept based on multi-sensors

Yintao Wei, professor, Tsinghua University, China

A smart tire concept based on TPMS sensors and accelerometer has been developed for monitoring load, force and moment, as well as road friction coefficients identification. The tire inverse dynamics have to be properly modelled to link the signals of the sensors and the tire performance. Therefore, this smart tire concept actually is the smart combination of the tire mechanics and tire sensors.

Intelligent Tire: real-time estimation of available and potential friction coefficient

Giuseppe Callea, Head of BhaiTech Technology, BhaiTech, Italy

BhaiTech Intelligent Tire is a technology designed for real-time estimation of a number of tire mechanical properties along with tire forces, and available and potential road-tire friction coefficient. The technology allows this information to be fed back to the vehicle, and it can be used to improve all ADAS efficiency affecting the vehicle dynamics, from ABS to more complex control and stability systems, determining the manoeuvring limits of the vehicle in the actual operating conditions. This is key to the autonomous driving application in the ultimate level of automation. Information acquired about the tire can also be used to detect possible failures.

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Stream 5 Tire Testing – Lab and Track *(continued from day 2)*

Physical wear model on wear progress of irregular wear

Prof. Yukio Nakajima, professor, Kogakuin university, Japan

Studies of tire wear have rarely been conducted on wear progress but just wear of tires. The physical wear model has been developed to clarify the mechanism of wear progress and showed qualitative agreement with the observation where the kernel of irregular wear is initiated due to lateral stress, and then the wear is accelerated due to longitudinal stress in tires. To improve irregular wear, both maximum wear energy and step of irregular wear should be decreased. For example, ways to improve irregular wear are to increase the Young's modulus of tread rubber or increase the crown radius.

Novel method to quantitatively characterise the heat build-up in rubber

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

A novel methodology and laboratory instrument are introduced. With this appliance there is an easy and reliable way to undertake the characterisation of the heat build-up process and the description of the viscoelastic properties of rubber at the same time. A novel approach is discussed and the specification of the measuring setup is given. The measuring process serves values like internal temperature, energy absorption, complex modulus, elastic energy and dissipated energy, which are recorded simultaneously over time. Furthermore, the novel loading kinematic of the sample accurately simulates the loading condition for tire rubbers in different applications.

Analysing rubber mechanical and rheological properties with compatibility concept

Dr Ali Abbasian, university lecturer, Science & Research Branch, Islamic Azad University (SRBIAU), Iran
Shabnam Ezzoddin, technical forecast researcher, Barez Industrial Group, Iran

Process oil is one of the most important ingredients in rubber compound compatibility, which affects rubber properties. Compatibility is estimated by several methods such as VGC, aniline point and swelling, none of which can give a thorough estimation of the concept. This study introduces the Hansen solubility parameter as a new method for evaluating compatibility. Low aromatic process oils as well as tire tread elastomers were subjected to inverse gas chromatography testing to calculate their solubility parameters. Results showed that rubber mechanical and rheological properties, such as tensile properties and slip velocity, could be analysed using the compatibility concept.

Characterisation of elastomers by nuclear spin relaxation

Dr Winfried Kuhn, managing director, IIC Dr. Kuhn GmbH & Co KG, Germany

Elastomer and polymer properties are usually characterised by means of well-established mechanical, thermal and chemical methods, revealing macroscopic material properties. To gain a better understanding of properties such as cross-linking structure, polymer/filler interaction and ageing processes on the molecular scale, more sophisticated techniques such as e.g. nuclear spin relaxation, dielectric relaxation and others are required. We will report on studies of elastomer properties on the molecular level using nuclear spin relaxation as a tool to explore molecular dynamics as a function of curing, ageing, filler type and filler concentration.

The impact of strain history on crack growth of rubber

Dr Jean-Louis Poisson, research engineer, Tun Abdul Razak Research Centre, UK

An automatic method has been developed at TARRC to characterise the crack growth of rubber. This method consists of cyclic testing of a flat and pre-cracked specimen with a servohydraulic testing machine, and recording simultaneously the evolution of the crack with a camera. Experimental work on the impact of strain history on crack growth of rubber illustrates the technique. Blocks of fully relaxing cycles at different strain levels are imposed on a pure shear test piece, and the crack growth rates are determined. An attempt to correlate the crack growth behaviour with the roughness of the cracked surfaces is also presented.

SMMB tire on rail testing equipment

Stefan Olivier Mueller, PhD student, Coventry University, 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 multi-body 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.

Experimental analysis of structural behaviour of repaired tires with thermography

Prof. Umberto Galietti, Prof. PhD, DMMM - Politecnico di Bari, Italy

Tire repair is an extremely delicate and accurate process that needs careful analysis. With this work, the behaviour of some tire patches, which have the task of compensating for the lack of structural integrity, has been analysed. The possibility to follow the tire's deformations, due to everyday working on the road stresses, of different patches has been evaluated. In particular, the thermo-mechanical behaviour has been highlighted by means of an IR camera, which revealed extreme sensitivity to the thermal superficial gradient induced by hysteresis phenomena. A comparison with numerical results will also be presented.

Tire testing innovation: tire dynamic footprint (DFPM)

Dr Mohamed Hassan, president, TMSI LLC, USA

Size, shape and pressure distribution within a tire contact patch are important for the ride qualities and handling characteristics of a vehicle. Tire companies have utilised static load deflection for tire footprint measurements. DFPM enables identification of how the lugs travel into and out of the footprint, pressure distribution across the footprint, and lug stiffness. DFPM performs rolling tests on tires through three measurement devices: multi-axis load cell, glass plate method and Pottinger type probes. The machine is capable of producing data in a plethora of slip, camber, load and inflation conditions over the entirety of the tire's circumference.

*programme subject to change

SPECIALIST SHORT COURSES

46TH TIRE MECHANICS SHORT COURSE

19 - 22 FEBRUARY 2018

€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. Over 1,000 pages of course notes prepared by the instructors will be provided for all participants. Those who complete this course will receive a certificate from the University of Akron.

TIRE REGULATIONS SHORT COURSE

19 FEBRUARY 2018

€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.

Full course notes will be given to delegates on CD or memory stick.

TIRE MATHEMATICAL MODELLING SHORT COURSE

19 - 20 FEBRUARY 2018

€1,075 PLUS GERMAN VAT

This course covers the computer modelling of tyres within a full vehicle system. 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 especially complex but are deeply counter-intuitive; 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.

THE EFFECT OF ROAD SURFACE VARIATION ON TIRE PERFORMANCE SHORT COURSE

19 FEBRUARY 2018

€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 Gijsjan Van Blokland, M+P consulting engineers and Jacob Groenendijk, KOAK-NPC

BASIC RUBBER COMPOUNDING SHORT COURSE

19 - 20 FEBRUARY 2018

€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 REINFORCING MATERIALS APPLICATIONS AND FATIGUE TESTING SHORT COURSE

19 FEBRUARY 2018

€695 PLUS GERMAN VAT

This new course will provide engineers with a thorough grounding in all aspects of cords and steel wire. It will explain how they influence the design and manufacture of the tire. The course will be run by experts who have many years of experience and influence within tire manufacturing.

Experts from Bogimac, Cordenka and Kordsa will be course chairs.

Full course notes will be given to delegates on CD or memory stick.

tire technology EXPO 2018

2018 EXHIBITOR LIST

CONFIRMED EXHIBITORS TO DATE INCLUDE: JET Technologies GmbH • A & D Europe GmbH • AB Svenskt Konstsilke • AFACHE • AIRTEC Controls GmbH • Akron Special Machinery • Akron Steel Fabricators • Albeniz • Alfamation SpA • ALLIGATOR Ventilfabrik GmbH • Allma Volkmann Zweigniederlassung der Saurer Germany GmbH & Co KG • Alpha Technologies • Altracon SA • Ammeraal Beltech Nederland Beheer BV • AP2 - Automazione Processi Produttivi Srl • Applus IDIADA • Aradhya Steel Pvt Ltd • ARLANXEO Deutschland GmbH • Asahi Kasei Europe GmbH • ASM-Hasbach • Bainite Machines Pvt Ltd • Barbe GmbH • Bartell Machinery Ltd • Bartell Machinery Systems LLC • Bastian Solutions • Beckhoff Automation GmbH & Co KG • Benninger Zell GmbH • Berrmak Makina • BEUMER Group • Birla Carbon • Bizerba Tekno Label • Blachford • Black Donuts Engineering Inc • Bluestar Silicones France SAS • Bogimac NV SA • Bosch Rexroth AG • BST eltromat International GmbH • Budde Systems GmbH • Buzuluk Komarov AS • Cabot Corporation • Camber Ridge LLC • Carl Zeiss Optotechnik GmbH • CASSIOLI Srl • Center for Tire Research (CenTiRe) • Chem Trend (Deutschland) GmbH • CHIRON Werke GmbH & Co KG • Cimcorp Oy • CMV Hoven GmbH • Cold Jet Europe bvba • Color Service Srl • COMERIO ERCOLE SPA • Commercial Timesharing Inc • Computype • Continental Reifen Deutschland GmbH • ContiTech Elastomer-Beschichtungen GmbH • Cordenka GmbH & Co KG • Cray Valley (Total) • CyXplus • D-Company Ltd • Daehwa Engineering & Machinery Co Ltd • Dahmen GmbH • Dalian Baofeng Machinery Manufaturing Co Ltd • Dalian Glospect Machinery Equipment Manufacturing Co Ltd • Data2 Corporation • Datalogic Automation Srl • Dawnsun Exim Corporation • DEC Chemicals Co ltd / Cremone Chemicals Co Ltd • Deshors Moulage • DRT • Dufournier SAS • Duplomatic Oleodinamica • DuPont International Operations • Eastman Chemical BV • EGE Kimya Sanayi ve Ticaret AS • Ektron Tek Co Ltd • Electronic Systems SpA • Elisto GmbH • EMS-CHEMIE AG • EOS GmbH • Erhardt & Leimer GmbH • Euroimpianti SpA • Europa Systems Sp. z o.o. • European Rubber Journal • Evonik Resource Efficiency GmbH • EZ Metrology • FACTS Inc USA • Ferm RFID Solutions • Festo AG & Co KG • Forbo Siegling GmbH • Fraunhofer EZRT • Gama Consulting doo • GCAPS-NTRC/SoVaMotion/VDIL • Genan A/S • General Equipment Technology Development Ltd (GETD) • Getriebebau NORD GmbH & Co KG • GF Machining Solutions Management SA • GfA De Pryck & Co mbH • Gislotica Mechanical Solutions • GL Messtechnik GmbH • Glanzstoff Industries • Glebus Alloys Europe Sro • Gottschol Alcuilux CZ • GSM - Gesellschaft für Systemtechnik und Maschinen mbH • Guangzhou Ecopower Chemical Co Ltd • Gudel AG • Guilin Rubber Machinery Co Ltd • GVD Corporation • Habasit AG • Hangzhou Fuyang Hengshan Composite Materials Co Ltd • Harburg Freudenberger Maschinenbau GmbH • Hennecke Systems GmbH • HERBERT Maschinenbau GmbH & Co KG • Himile Mechanical Science and Technology Co Ltd • HOFMANN Maschinen-und Anlagenbau GmbH • IBA Industrial • Ichimaru Giken • IGTT AS • IHI Logistics & Machinery Corporation • Ilmberger Maschinen- und Zahnradfabrik GmbH • INABATA Europe GmbH • Indian/International Rubber Journal • Industriefabrik Schneider GmbH • inmess GmbH • INTEREUROPEAN Srl • INTERROLL (Schweiz) AG • Intralox LLC Europe • Jinan Ever Growing Rubber Additive Co Ltd • Kara Gostar • Karl Eugen Fischer GmbH • KBA-Metronic GmbH • Kelviplast GmbH & Co KG • Kistler Instrumente GmbH • Kobelco Stewart Bolling Inc • Konstrukta - Industry AS • KORDÁRNA Plus AS • Kordsa Global • Kraton Chemical • Kraussmaffei Berstorff GmbH • Kuraray Europe GmbH • Kurschat GmbH • Lang GmbH & Co KG • LANXESS Deutschland GmbH • LAP GmbH Laser Applikationen • Larsen & Toubro Limited • Lawer SpA • Lianyungang Rebo Chemical Co Ltd • LMI Technologies • LS Cable & System Ltd • LY-Holding GmbH • Madura Industrial Textiles • MAKROchem SA • Marangoni Meccanica SpA • Matteuzzi Srl • Matthews Kodiersysteme GmbH • McNeil + NRM Inc • Meerut Microsystems Private Limited • Mehler Engineered Products GmbH • MESNAC • Metravib • Micro Epsilon Messtechnik GmbH & Co KG • Micro-Poise Measurement Systems LLC • Milliken Textiles BVBA • Mitsubishi Heavy Industries Ltd • Mitsubishi International GmbH • Momentive Performance Materials GmbH • Mondon SAS • MonTech Werkstoffpr • MTS Systems Corporation • MTV CUTTING-EDGE GmbH & Co KG • Muench Chemie International GmbH • Mycronex AG • Nakata Engineering Co Ltd • NDC Technologies Ltd • NHV Corporation • NOL-TEC EUROPE SRL • Numetrix Technologies Inc • NV Bekaert SA • Nynas AB • OCSiAl Europe • OPEN MIND Technologies AG • ORGKHIM • OZMETAL Makina Imalati ve Kalip Sanayi Tic Ltd Sti • Parker Hannifin GmbH • Pelmar Engineering Germany GmbH • Performance Fibers • Pesmel Oy • PFAFF Industriesysteme und Maschinen AG • PHP Fibers GmbH • Pioneer Industrial Systems LLC • PNEUFORM Hulin AS • Polymer Solutions Group • PPG Silica Products • PRL Polymer Research Lab • Prodicon International Srl • PROZAX s.r.o. • Qingdao Doublestar Rubber & Plastic Machinery Co Ltd • Qingdao Yellowsea Rubber Bladder Co Ltd • REA Elektronik GmbH • RIX Corporation • RJS Corporation • RMS Equipment LLC • Rockwell Automation BV • RODOLFO COMERIO SRL • Roland Electronic GmbH • Rostan Tiremolds • RÜTGERS Novares GmbH • Safe-Run Machinery (Suzhon) Co Ltd • SAR Elektronic GmbH • Schill + Seilacher "Struktol" GmbH • SDS Systemtechnik • Seichter GmbH • SENSIT s.r.o. • Shanghai Amino-chem Co Ltd • Shin-Etsu Silicones Europe BV • SIBUR Holding, PJSC • SICK Vertriebs-GmbH • Siemens AG • Simaform SA • Sino-Arp Tires Equipment Technology (Suzhou) Co Ltd • Sinorgchem Europe BV • SLM Solutions Group AG • SMC Pneumatik GmbH • Smithers Rapra • Solvay • Spoolex SAS • Starrett-Bytewise Europe • Steelastic • STL Standard Testing Labs Inc • Swiat Opon • SWS Translation Agency GmbH • Synthos SA • Systraplan GmbH & Co KG • TARRC • TAUFORM Tyre Moulds Co Ltd • Teijin Aramid GmbH • Tekna Automazione e Controllo Srl • Test World Oy • The Poling Group • TianJin Reager Technology Co Ltd • Tianjin Saixiang Technology Co Ltd • TKM GmbH • TRANSFER GOMMA Srl • TRANSSYSTEM Spolka Akcyjna sp.k • Trinseo Europe GmbH • Troester GmbH & Co KG • Trustwell Co Ltd • TS TestingService GmbH • TÜV SÜD Product Service GmbH • Uteco Contec • UTH GmbH • Uzer Makina ve Kalip Sanayii AS • versalis SpA • Vipo AS • VMI Group • Vredestein Consulting BV • WD Racing Ltd • Werba-Chem GmbH • Wikov MGI AS • Willo • Yxlon International GmbH • Z-Laser Optoelektronik GmbH • Zeon Europe GmbH • Zeppelin Systems GmbH • ZF Friedrichshafen AG

*see website for the latest exhibitor list

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