SEPTEMBER 2023

RubberWorld

134 years

THE TECHNICAL SERVICE MAGAZINE FOR THE RUBBER INDUSTRY VOLUME 268, NO. 6

High molecular weight functionalized batch SSBR for electric vehicle tires

EV tread development: Improving traction in high NR loaded compounds

Achieving manufacturing energy savings with treated silicas: A solution for the tire industry

The two-roll plasticizer (TRP)

Rubber Division
American Chemical Society
ACS Events, page 59

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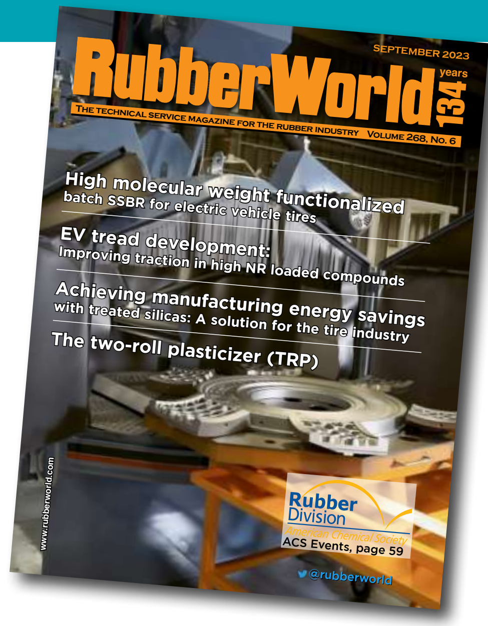

Cover photo: Courtesy of Guyson Corporation of U.S.A.

Departments

From the Editor

Jill Rohrer

Zeppelin, Siemens partner on tires

Under the umbrella of the Zeppelin Sustainable Tire Alliance, launched in March 2023, plant manufacturer Zeppelin Systems is pursuing the goal of making the tire industry more sustainable. Not only the production of tires, but also tire recycling in the sense of the circular economy are to be rethought in a more environmentally friendly way. In order to put this vision into practice at different points in the tire value chain, the Zeppelin Sustainable Tire Alliance unites international companies under one roof. Siemens AG has joined the alliance as a technological innovation driver for the field of automation and digitalization.

Along the value and process chain in tire production, each partner of the Zeppelin Sustainable Tire Alliance contributes its individual, innovative technical and technological knowhow. As an integrated solution provider for the tire industry, Zeppelin Systems combines these technological, technical and innovative competencies with high quality and proven plant engineering solutions. In addition to AI supported sorting systems from the French company Regom, Zeppelin Systems also offers, for example, the dismantling of used tires using high pressure water jet technology through the company RubberJet & Vertech. The Polish partner Recykl developed a solution to produce a valuable, functional additive from the fibrous content of the scrap tires. The German company Entex devulcanizes rubber with a planetary roller extruder. The Polish company ReOil uses continuous pyrolysis to break down used tires into raw materials, such as steel, oil and recovered carbon black (rCB). Nano Technologies refines raw recovered carbon black.

A new member of the technology network is Siemens AG, which, together with Zeppelin Systems, is joining forces in the field of tire recycling and sustainable tire production. Siemens also recognizes the challenge of further advancing sustainable tire production processes, such as decarbonization, paired with energy and resource efficiency.

Specifically, as part of the alliance, Siemens is providing the use of digital twins to develop and improve sustainable tire production. For example, seamless information flows between the real and digital worlds, holistic sustainability impacts along the value chain, or the optimization of process cycles can be simulated. Driving decarbonization through transparent and manageable CO_2 footprints of products (PCF) with SiGreen, an application for exchanging dynamic PCFs along Siemens' value chain, is also part of the alliance's partnership.

Jill Rohrer

RubberWorld

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Business Briefs

Zochem acquires 40% stake in IEQSA

Acquisitions, expansions

Zochem (www.zochem.com), Dickson, TN, a subsidiary of **Zinc Acquisition Holdings** with operations in Dickson, TN, and Brampton, Ontario, Canada, has acquired a 40% stake in **Industrias Electro-Quimicas** (IEQSA), based in Callao, Peru, a South American manufacturer of zinc products from **Umicore S.A.** The strategic partnership will allow both companies to continue operating independently under their current names.

Bridgestone Americas (www.bridgestoneamericas.com), Nashville, TN, celebrated the expansion of its Warren County, TN, truck and bus radial tire plant, located in Morrison, with an official groundbreaking. The $550 million investment will add 380 new jobs and expand the plant's existing footprint by 850,000 square feet to support increased capacity and to accelerate the use of advanced technologies that support cleaner, safer and more efficient commercial truck and bus fleets.

Linglong Tire (www.linglongtire.com), Zhaoyuan City, Shandong Province, China, announced the launch of its wholly owned subsidiary, **Longlong N.A. Sales**, based in Palm Beach Gardens, FL.

Quality registrations

R.E. Carroll (www.recarroll.com), Ewing, NJ, has successfully passed its **National Association of Chemical Distributors** (NACD) Responsible Distribution verification, reaffirming the company's commitment to the health, safety and security of its employees, communities and the environment. Responsible Distribution is NACD's verified environmental, health, safety, security and sustainability program, allowing members to demonstrate their commitment to continuous performance improvement in every phase of chemical storage, handling, transportation and disposal. R.E. Carroll is a 98 year old family owned specialty chemical and petroleum products distributor based in New Jersey, with stocking locations in Georgia, New Jersey, Ohio and Texas. Its primary market is ingredients for rubber compounding, as well as ingredients for the adhesives, sealants and coatings markets. The Responsible Distribution program requires verification of facilities against a set of guiding principles, including strict adherence to laws and regulations, and participation with interested entities in creating responsible laws, regulations and practices to help safeguard the community, workplace and environment. Participation in Responsible Distribution has significant benefits, including lower instances of safety and environmental incidents, better documentation of company policies, better communication with local communities, reduced audit time and costs, and increased credibility.

Continental (www.continental-tires.com), Hanover, Germany, announced that its tire plant in Lousado, Portugal, received the International Sustainability and Carbon Certification (ISCC) Plus.

Business Briefs

Safic-Alcan distributes Dow polyurethanes

Safic-Alcan (www.safic-alcan.com), Paris, France, a global distributor of specialty chemicals, announced a significant expansion of its collaboration with **Dow** across the central and eastern European region. The extended partnership now covers territories including the Czech Republic, Slovakia, Hungary, Romania, Bulgaria, Albania, Serbia, Slovenia, Bosnia and Herzegovina, Croatia, Macedonia and Montenegro, reinforcing the distribution of Dow's polyurethane range. Safic-Alcan also announced an agreement, effective immediately, with **Union Colours**, the European division of **Sincol**, to promote the full range of high quality organic pigments from Union Colours in France and the Benelux region.

CONTRACTS, LICENSES

Messe Düsseldorf Asia (www.mda.messe-dusseldorf.com), Singapore, and **Informa Markets**, said to be two of the region's leading international exhibition organizers, announced a partnership to consolidate their rubber and plastics trade shows in Southeast Asia. Starting in 2024, the new alliance of the two companies will jointly organize the rubber and plastics trade fair series, beginning with Plastics and Rubber Thailand, scheduled for May 15-18 at the Bitec exhibition center in Bangkok. In 2024, the partners will also jointly organize Plastics and Rubber Indonesia and Plastics and Rubber Vietnam.

Bridgestone Americas (www.bridgestoneamericas.com), Nashville, TN, will become the presenting sponsor of the Bridgestone Collegiate Development Program, as part of the **PGA Tour**'s Pathway to Progression. The program is designed to achieve greater diversity in the sport through increased focus on developing talent from diverse and historically underrepresented groups.

Bridgestone Retail Operations, a subsidiary of Bridgestone Americas, is celebrating 30 years of partnership with **Army & Air Force Exchange Service**. Bridgestone currently serves the nation's military and their families at more than 40 tire and automotive service centers located on military bases in collaboration with the Exchange, which provides quality, tax-free merchandise, goods and services that military communities need, regardless of location, risk or challenge.

Business Briefs

Enviro nominated for recycling awards

Corporate, financial news

Scandinavian Enviro Systems (www.envirosystems.se), Gothenburg, Sweden, has been nominated for an Industry Achievement Award in the Tire Recycling Sector at the 2023 edition of the Recircle Awards. The award recognizes particularly noteworthy technological achievements within tire recycling, and Enviro is nominated for the company's pioneering work within the tire pyrolysis sector.

Freudenberg-NOK Sealing Technologies (www.fst.com), Plymouth, MI, recently presented its SEAL (Supplier Excellence Achievement Level) Awards to vendors that provided outstanding service and support to the company during 2022. **Freudenberg-NOK** runs the business operations for Freudenberg Sealing Technologies in the Americas. 2022 SEAL Award winners in the Chemicals and Non-Metallic Components category include: **Chemours** (Gold winner); **Accudyn Products** (Silver winner); and **Wacker Chemical** (Bronze winner). The annual awards represent the highest recognition Freudenberg-NOK gives to suppliers.

Momentive Performance Materials (www.momentive.com), Niskayuna, NY, released its 2022 Sustainability Report, highlighting the company's innovative solutions contributing to a more sustainable future, and its progress toward achieving 2025 sustainability goals. The report provides an overview of the company and its sustainability journey, and highlights Momentive's recent commitment to the Science-Based Target Initiative and Carbon Disclosure Project. As a signatory to the United Nations Global Compact (UNGC) since 2021, this report is also said to demonstrate Momentive's commitment to upholding the UNGC's Ten Principles in the areas of human rights, labor standards, the environment and anti-corruption, working within its sphere of influence to encourage broader support.

Yokohama Tire (www.yokohamatruck.com), Santa Ana, CA, has notified the **National Highway Transportation Safety Administration** (NHTSA) it is voluntarily recalling one size of the 504C tire. A total of 6,992 of size 11R22.5 tires manufactured at Yokohama's plant in West Point, MS, between June 27, 2022 and December 4, 2022 are being recalled. The recall was issued because the tires may have been manufactured with an improperly manufactured belt cushion splice.

Huntsman (www.huntsman.com), The Woodlands, TX, announced that its automotive team has been given a Supplier Award by **Toyota Boshoku Europe**, the European headquarters of the Japanese automotive component manufacturer. The award recognizes the contribution that Huntsman's polyurethanes team makes in supporting Toyota Boshoku's sustainability improvement efforts.

Market Focus

Medical silicone market to grow at 6% rate

The global medical grade silicone rubber (MGSR) market size was $670.78 million in 2022, and is expected to reach $1.13 billion in 2032, registering a revenue compound annual growth rate (CAGR) of 6% during the forecast period, according to a report from Reports and Data. Rising demand for minimally invasive procedures, chronic diseases, age related health issues, and the expanding use of silicone rubber in medical applications due to their biocompatibility, flexibility and durability are major factors driving market revenue growth.

Growth is also being fueled by the creation of fresh and cutting edge silicone rubber products for use in medical applications, such as liquid silicone rubber (LSR) and high consistency rubber (HCR), according to the study. HCR is frequently used in medical tubing and catheters due to its great mechanical qualities and flexibility. LSR, a highly pure type of silicone rubber, is said to be perfect for use in medical implants and prostheses due to its outstanding biocompatibility and biostability.

Moreover, increased healthcare infrastructure investments and rising healthcare costs in emerging economies are expected to drive market revenue growth. An example cited in the report states that the Indian government has started several programs to encourage the use of medical equipment and devices in the nation, such as the Make in India program and the National Health Policy, which are expected to raise demand for products made of medical grade silicone rubber (MGSR) in the area. In addition, the healthcare industry's rising need for the rubber is expected to drive market revenue growth.

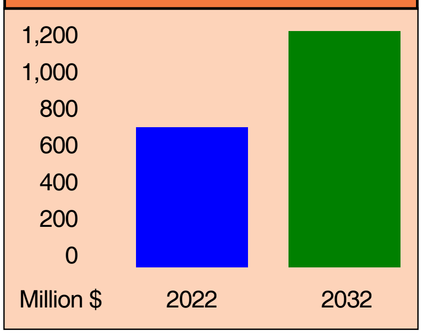
The demand for MGSR is rising as a result of some aging populations and the rising incidence of chronic diseases such as cancer and diabetes, increasing demand for medical devices and implants. Demand is also being fueled by increasing popularity of minimally invasive procedures and the growing attention being paid to the creation of cutting edge medical technologies.

Restraints on growth include high manufacturing costs and strict laws controlling the creation and use of medical devices and equipment. The cost of manufacturing medical grade silicone rubber products is expected to rise as a result of strict regulatory standards, such as ISO 13485 and U.S. Food and Drug Administration (FDA) regulations, which control the production of medical devices and equipment.

The global medical grade silicone rubber market is segmented into LSR and HCR. The LSR segment is expected to account for the largest revenue share during the forecast period due to its distinctive qualities, including biocompatibility, chemical resistance and high temperature stability, making it suited for a variety of medical applications. With its outstanding durability, flexibility and simplicity of processing, LSR is frequently employed in the production of medical devices, implants and drug delivery systems. LSR is a great option for complicated medical applications, since it also delivers higher performance and increased design freedom.

The HCR segment is expected to register a faster revenue growth rate over the forecast period. HCR is an ideal material for a variety of medical and healthcare applications, since it has outstanding mechanical qualities and is highly heat and chemical resistant. As it offers high biocompatibility and excellent mechanical strength, HCR is frequently utilized in the production of medical devices, such as catheters, surgical instruments and prostheses. With its capacity to produce precise imprints and ease of handling, HCR is frequently utilized in dental impressions and molds.

Medical grade silicone market size 2022-2032



Based on application, the medical devices and components segment is expected to account for the largest revenue share during the forecast period due to its distinctive qualities, including biocompatibility, chemical resistance and high temperature stability, according to the study.

The prosthetics and orthopedic devices segment is expected to register a significantly fast revenue growth rate during the forecast period. Manufacturing orthopedic and prosthetic devices, including artificial joints, heart valves and other implants, frequently uses medical grade silicone rubber because of its outstanding biocompatibility, flexibility and durability. The demand for prostheses and orthopedic devices is also raising the demand for medical grade silicone rubber, which in turn is driving the prevalence of musculoskeletal illnesses and injuries, as well as the growing elderly population.

The medical tapes segment is expected to account for a moderately large revenue share during the forecast period. These are frequently employed for securing medical equipment and treating wounds, offering high adhesion, flexibility and biocompatibility.

The implant segment is expected to register a steady revenue growth rate during the forecast period due to the rising trend of minimally invasive operations and rising need for implants. Breast implants, pacemakers and other medical devices are frequently made of medical grade silicone rubber due to biocompatibility, chemical resistance and durability.

Some of the prominent players include Dow Corning, Wacker Chemie AG, Shin-Etsu Chemical, Momentive Performance Materials, Bluestar Silicones International, Stockwell Elastomerics, Elkem Silicones, Saint-Gobain Performance Plastics, Quantum Silicones and KCC.

Henkel expands medical wearable portfolio

Henkel is expanding its portfolio for medical wearables in healthcare applications. From smart health patches to continuous glucose monitors to smart glasses, the use of medical wearables and consumer wearables for remote monitoring has increased dramatically. The shift from hospital care to remote home care has led to a demand for remote tracking and diagnostics. Devices are smaller, require better environmental protection and reliable diagnostics, while maintaining patient safety and comfort. These advancements in medical device design require innovative solutions to optimize devices and processes beyond today's level of care.

Henkel's adhesives and electronic materials facilitate the design and manufacture of leading edge medical devices; all engineered to streamline diagnostics and improve patient outcomes. The company's materials know-how and expertise enable the co-development and support of medical solutions for caregivers and patients to improve quality of care and life. Based on this experience, Henkel now has expanded its portfolio for wearables in healthcare applications. The company leverages its capabilities and broad portfolio for a variety of wearable application types alongside the entire value chain. The portfolio includes high impact solutions for low pressure molding technologies, skin bonding, assembly adhesives, and electronics and printed electronics.

Recently, the company adapted a molding technology, that was traditionally used in industrial electronics, for wearable medical applications. The new technology is medical grade and skin safe, and replaces the typical clamshell housing, which requires multiple components and assembly steps, with a single step overmold design. This is said to offer a significant process saving step that contributes to lower production cost, especially when there is a high volume of production.

"At Henkel, we believe that offering a comprehensive portfolio of products and solutions to our customers is the sustainable way to drive innovation and growth for businesses," explained Philipp Loosen, head of industrials, EIMEA, and global key accounts, medical, at Henkel. "We are proud to expand our product portfolio of medical wearables into the market to further support our customers and ecosystem partners with an efficient and reliable healthcare solution. With our products and technologies, we help to redefine the way people access and monitor their health."

Henkel's medical device adhesives are tested to the industry's most comprehensive ISO 10993 biocompatibility standards. In addition, the company employs strict manufacturing and quality controls to ensure continuity of compliance. Henkel's Adhesive Technologies business unit is said to be the global leader in the market for adhesives, sealants and functional coatings.

Thermally conductive electrically insulative epoxy for medical devices

Master Bond's EP40TCMed is a two-part, room temperature curing epoxy system that meets the requirements of ISO 10993-5 for non-cytotoxicity. It is thermally conductive, electrically non-conductive, and can be utilized as an adhesive or sealant in various medical and wearable device applications.

This toughened epoxy delivers an elongation of 60% to 70%. It has good strength properties with a tensile lap shear strength between 2,300 and 2,500 psi, a T-peel strength of 40 pli to 60 pli and a low tensile modulus of 5,000 to 15,000 psi at room temperature, making it ideal for applications where low stress is needed, according to the company. The system's small particle size filler allows for effective heat transfer when applied in thin layers, lowering its thermal resistance. It is also capable of withstanding exposure to EtO, radiation and several sterilants, as well as antimicrobial cleaning agents. Serviceable from -100°F to +300°F (-73°C to +149°C), EP40TCMed is said to feature reliable electrical insulation characteristics, with a dielectric constant of 4.4 at 60 Hz and a volume resistivity greater than 1,015 ohm-cm. Its thermal conductivity is 8-11 BTU•in/(ft^2•hr•°F) (1.16-1.60 W/[m•K]).

EP40TCMed offers convenient handling with a 1:1 mix ratio by weight, and has a relatively long working life of 2-3 hours for a 100 gram batch of mixed epoxy at 75°F. After mixing, the epoxy has a moderate viscosity of 80,000 to 100,000 cps, which is useful for applications where some, but not too much, flow is required. Upon cure, it has low shrinkage and a hardness of 70 to 80 durometer D. EP40TCMed comes in standard sized units of ounce jars, one half pint, pint, quart and gallon kits. It is also available in premixed and frozen syringes.

Master Bond's focus is said to have been on developing the best in epoxies, silicones, polyurethanes, polysulfides, UV cures and other specialty adhesive systems. Master Bond is said to employ true specialists in the field, and is said to be recognized by many as the preeminent adhesive formulation company in the world.

by Don Heelis,
Cimcorp North America

Bringing automation dreams to life in today's tire plants

Automation has become a necessity in modern manufacturing. And as robotic systems and software evolve, they are powering new efficiencies within production and distribution operations. Manufacturers in any industry can leverage these advancements to run better and faster than ever before, and tire makers are no exception.

Tire manufacturers are under high pressure to maximize output and meet rising customer demands. At the same time, they need to keep quality up and costs down. And on top of it all, they are dealing with external disruptions, like ongoing labor shortages and post-pandemic market shifts.

Given these challenges, tire plants can no longer rely on outdated and disconnected processes to achieve production goals. Now, tire manufacturers are exploring new ways to connect and streamline the flow of materials and data through each stage of production, leaving no room for errors or delays. Many industry leaders are finding success with end-to-end automated tire handling solutions.

Cimcorp Dream Factory automation

Finished tire automation

The tire factory of the future

Today, automated material handling systems are available that meet the unique needs of the tire industry. These solutions use a range of robotic technologies, like gantry robots, monorail transfers and mobile robots, to optimize the storage and movement of materials throughout all areas of the tire factory.

And the robots do not do it alone. Intelligent software controls everything in real time, from individual robot movements to overall material and data flow. The software seamlessly integrates with all machinery and factory systems, from the PLC to the ERP level. Millions of data points get organized into a single

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interface, enabling access to real-time data about production, inventory and orders. And all data get recorded, creating full traceability for each individual tire.

With these physical and digital technologies working together, production and distribution operations become fast, efficient and flexible. Tire manufacturers can maximize output and productivity, adapt to any demand changes or disruptions, and ultimately ensure customer satisfaction.

Fit for new builds and legacy factories

Greenfield and brownfield tire plants are both great candidates for automated tire handling. Each type of factory requires a unique approach:

Greenfields

When building a new plant from the ground up, it is important to plan the factory footprint with automation in mind from the start. It is the perfect opportunity to design the ideal layout and flow, based on current needs and growth plans. The result will be a totally new, end-to-end automated plant, where everything is optimized, from raw materials to the shipping dock.

Green tire automation

Monorail transfer

Tech Service

Award winning automation software in use

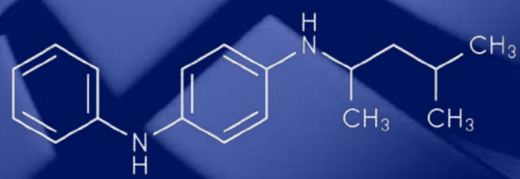
Brownfields
When automating a plant that has been running for years, manufacturers need to make sure they do not disrupt ongoing operations. The best approach is a phased implementation, made possible by innovative modular automation technology. Modular solutions can be used to automate individual production areas block by block, starting with areas that will generate the biggest return on investment. For example, a manufacturer could start by automating the finished tire area where they sort, stack and palletize finished products. Since this area typically takes up a lot of space and requires a lot of manual labor, automation means big savings. Next, the manufacturer could move on to automate green tire handling, storage, retrieval and delivery to the curing department. Over time, the manufacturer could gradually automate other areas as needed to boost capacity and gain new efficiencies.

A partner for the long haul
To make any automation project successful, tire manufacturers need an experienced automation provider that brings more than technology to the table. The right partner will spearhead collaborative efforts, starting with a discovery phase for high level concepts and solution development. Then comes detailed engineering, where the automation provider and tire manufacturer work through exactly what technology is needed, and what it will do.

Throughout implementation, the partner will train the manufacturer's technical team on the technology and software, and train factory personnel on proper equipment operation and maintenance. Once installation and training are complete, everyone in the plant will be well prepared to take over running the solution.

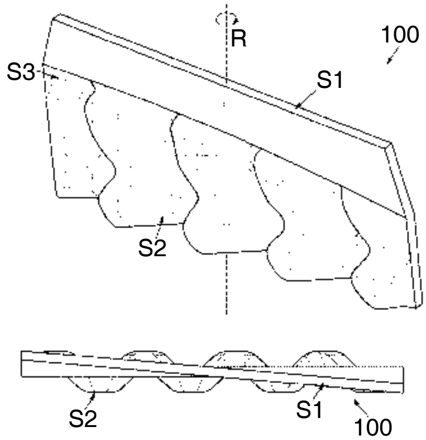
And the collaboration does not end there. The right automation partner will provide a lifetime of support services to maximize uptime. As new advancements in automation emerge, they will also pinpoint opportunities to introduce the latest promising technologies, like artificial intelligence (AI).

While the prospect of automating may seem daunting, it does not have to be a long and overly complicated undertaking. The right solution, strategy and partner can make automation dreams a reality for greenfield and brownfield tire plants alike.



Rubber vulcanization processes employing an eutectic mixture
U.S. patent: 11,667,774
Issued: June 6, 2023
Inventors: Erin Sheepwash, Julia A. Dart and Michael C. Davis
Assigned: Bridgestone
Key statement: A process for preparing a rubber vulcanizate, the process comprising (i) providing a vulcanizable composition of matter including a sulfur-based curative, zinc oxide and a eutectic solvent; and (ii) heating the vulcanizable composition to thereby effect vulcanization.

Tread for a pneumatic tire and a pneumatic tire
U.S. patent: 11,667,159
Issued: June 6, 2023
Inventors: Giuseppe Rodriquez and Beatrice Mellara
Assigned: Bridgestone Europe
Key statement: Tread for a pneumatic tire comprising a sipe having a sipe extension (L) and a sipe depth (P) along a direction of wear (U), wherein said sipe has at least two sections (S1, S2) along said direction of wear (U) having respective differentiated conformations, such that an intersection profile (P1, P2) between the sipe and a surface (T1, T2) parallel to the contact surface of the tread is different for each of said at least two sections (S1, S2), wherein at least one surface section (S1) of said at least two sections (S1, S2) has a depth (PS) that is variable along said sipe extension (L), said two sections (S1, S2) being connected by a transition section (S3) defining a transition line (TL) between the respective sections (S1, S2), said variable depth (PS) of said surface section, presenting a maximum depth (PSMAX) and a minimum depth (PSMIN) and wherein the surface section (SI) has a twisted configuration.



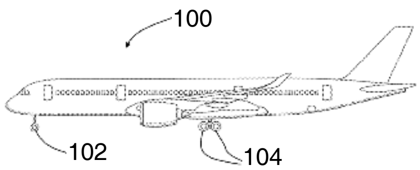
Thermoplastic elastomer compounds exhibiting improved stain

resistance
U.S. patent: 11,667,785
Issued: June 6, 2023
Inventors: Liang Xu and Christopher Engel
Assigned: Avient
Key statement: A thermoplastic elastomer compound includes acrylic block copolymer and functionalized polysiloxane. Polymeric articles formed from the thermoplastic elastomer compound can have improved stain resistance, while also achieving other desirable properties such as low tackiness (i.e., low coefficient of friction) and good clarity (i.e., low haze).

Styrene butadiene rubber latex compositions and methods for making and using same
U.S. patent: 11,674,059
Issued: June 13, 2023
Inventors: Lawrence Douglas Harris and Willie C. Burton
Assigned: Lion Copolymers
Key statement: Disclosed herein are styrene butadiene rubber latex compositions with high solids content and methods for making and using these compositions. The method for making the styrene butadiene rubber latex compositions can include mixing a seed, a styrene, an initiator, a base, a surfactant and a solvent; adding a first portion of 1,3-butadiene to make a first reaction mixture; heating the first reaction mixture for a first reaction time to make a first styrene butadiene rubber latex; mixing the first styrene butadiene rubber latex, a styrene, a base, an initiator, a surfactant and a solvent; adding a second portion of 1,3-butadiene to make a second reaction mixture; and heating the second reaction mixture for a second reaction time to make a second styrene butadiene rubber latex, where the second styrene butadiene rubber latex has a solids content higher than that of the first styrene butadiene rubber latex.

Apparatus and method for determining aircraft tire pressure
U.S. patent: 11,667,162
Issued: June 6, 2023
Inventor: Anand Puntambekar
Assigned: Airbus SAS
Key statement: An apparatus configured to determine the pressure of an aircraft tire at a reference temperature. The apparatus includes a processing system configured to: obtain a measured tire pressure and a measured temperature associated with the measured tire pressure; and determine a tire pressure at the reference tempera-

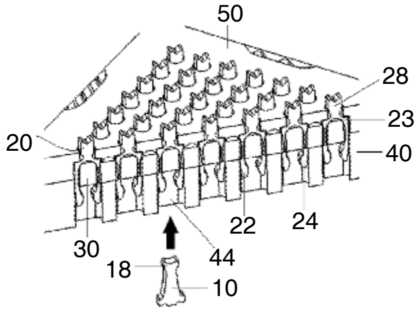
ture by adjusting the measured tire pressure using a predetermined temperature characteristic, a square root of the measured temperature and a square root of the reference temperature. The predetermined temperature characteristic is a gradient of the relationship between the square root of temperature and tire pressure.



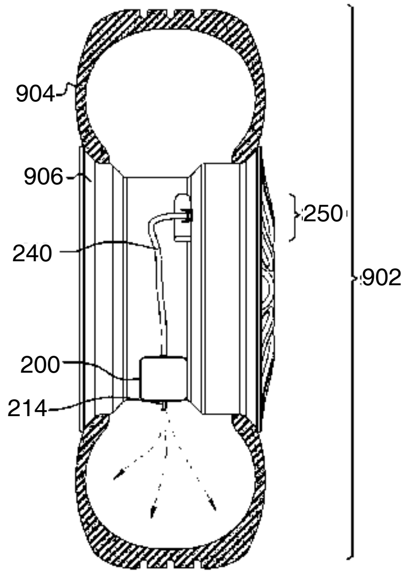
Dielectric elastomer precursor fluid, preparation method therefor and use thereof, dielectric elastomer composite material, flexible device and light emitting device
U.S. patent: 11,674,076
Issued: June 13, 2023
Inventors: Shiping Zhu, Changgeng Zhang, Lei Shi and Qi Zhang
Assigned: The Chinese University of Hong Kong, Shenzhen
Key statement: The present disclosure relates to the field of dielectric elastomers. In particular, provided are a dielectric elastomer precursor fluid, a preparation method therefor and the use thereof, a dielectric elastomer composite material, a flexible device and a light-emitting device. The dielectric elastomer precursor fluid comprises an elastomer matrix, an ionic liquid and a solvent, wherein the volume fraction of the ionic liquid and the solvent is 5-45%. The dielectric elastomer precursor fluid has the advantages of a high conductivity, a high transparency and a good fluidity, and is beneficial for preparing a dielectric elastomer composite material having a high dielectric constant, a low elastic modulus and a high optical transparency, thus fully solving the problem that a high dielectric constant cannot be balanced with a low elastic modulus and a high optical transparency in a dielectric elastomer.

Short interconnect assembly with strip elastomer
U.S. patent: 11,674,977
Issued: June 13, 2023
Inventors: Wei Kuong Foong, Kok Sing Goh, Shamal Mundiyath, Eng Kiat Lee and Grace Ann Nee Yee
Assigned: JF Microtechnology SDN, BHD
Key statement: An electrical contact assembly that uses an elastomer strip for each row of individual contacts. Each contact comprises a rigid bottom pin and a flexible top pin with a pair of arms

which extend over and slide along sloped concave surfaces of the bottom contact. The elastomer strip is located between rows of the bottom and top pins. A bottom socket housing is provided with grooves which receive each elastomer strip. A row of top pins is then placed over each elastomer strip and through ducts in the bottom socket housing. Bottom pins are then snapped into place in between the pair of arms.



Vehicle tire inflation system
U.S. patent: 11,673,433
Issued: June 13, 2023
Inventor: Jeff Choizi
Key statement: The vehicle tire inflation system comprises an air jacket and an air hose. The air jacket may reside within a wheel of a vehicle and may be mounted to the inside of a rim of the wheel. The air jacket may determine that a tire of the wheel has at least partially deflated by sensing that tire pressure within the wheel has dropped below a first pressure threshold. The air jacket may release compressed air within the wheel until the air jacket senses that the tire pressure has reached a second pressure threshold such that the tire may be reinflated. The air hose may be configured to couple the air jacket to a tire pressure monitoring system such that the air jacket has access to an external air supply located outside of the wheel via the tire pressure monitoring system.



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BRENNTAG Booth # 222	POLYMERICS Booth # 970	SOVEREIGN CHEMICAL Booth # 515

Patent News

Molding method for producing a stator for a screw drilling tool using elastomer material

U.S. patent: 11,673,297
Issued: June 13, 2023
Inventors: Dingyu Guo, Hongrui Zhang, Minghui Zhu, Yiran Liu, Zhuanrui Liu, Paul Kwong Shun Cheung and Xiaobo Liu
Assigned: Shanghai Pujia Drilling Technology
Key statement: A molding method for producing a screw drill stator using an elastomer material includes: S1. sequentially roughening, cleaning and drying an inner surface of the stator tube; mixing an adhesive and a diluent, coating the mixture obtained on the inner surface and heating it for later use; S2, uniformly coating a mold release agent on a surface of a mandrel mold and heating or drying it naturally for later use; S3. assembling the processed stator tube and the processed mandrel mold to obtain an assembled mold; S4. performing a vacuum defoaming under negative pressure on a mixture obtained by uniformly mixing a prepolymer of the elastomer material with a defoaming agent; S5. uniformly mixing the defoamed prepolymer of the elastomer material with a curing agent and pouring the obtained mixture into the assembled mold, sealing and curing the poured assembled mold by hierarchical heating to obtain the stator.

Tire provided with an outer sidewall comprising a liquid plasticizer having a low glass transition temperature

U.S. patent: 11,674,019
Issued: June 13, 2023
Inventor: Christophe Chouvel
Assigned: Michelin
Key statement: A tire is provided with an external sidewall, said external sidewall comprising a composition based on at least one elastomeric matrix comprising at least one diene elastomer selected from the group consisting of butadiene polymers having a glass transition temperature of less than or equal to -50°C and a thermoplastic elastomer comprising at least one elastomer block and at least one thermoplastic block, the thermoplastic elastomer not comprising a polyisobutylene block; a liquid plasticizer exhibiting a glass transition temperature of less than -70°C; a crosslinking system; and a reinforcing filler.

Piece of jewelry made of natural elastomer material

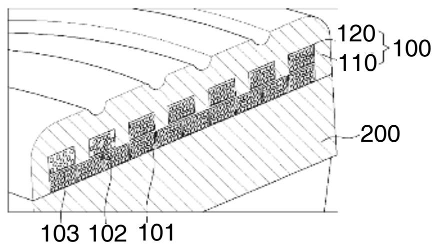
U.S. patent: 11,672,313
Issued: June 13, 2023
Inventors: Nicolas Francois, Julien Dahan and Gregory Kissling
Assigned: Swatch Group Research and Development
Key statement: A piece of jewelry made of a natural elastomer composite material, wherein the natural elastomer composite material includes a natural elastomer matrix wherein between 0% and 6% cellulose fibers, between 0 and 5% anti-odor agents and between 0 and 30% silica are dispersed.

Rubber composition

U.S. patent: 11,680,153
Issued: June 20, 2023
Inventors: Suk Youn Kang, Jin Sook Ryu, Kyoung Hwan Oh and Jeong Heon Ahn
Assigned: LG Chem
Key statement: The present invention relates to a rubber composition having excellent tensile properties and viscoelasticity properties and including a conjugated diene based polymer. The rubber composition may include a modified conjugated diene based polymer which is selected considering target tensile properties and viscoelasticity properties, by predicting in advance the correlation between the modification ratio of the modified conjugated diene based polymer and the dynamic viscoelasticity loss coefficient at 60°C of the rubber composition through Mathematical Formula 1 and Mathematical Formula 2. Therefore, excellent compounding properties may be shown.

Non-pneumatic tire having block type reinforcement

U.S. patent: 11,679,627
Issued: June 20, 2023
Inventors: Jeong Mu Heo, Chang Young Sohn and Seok Ju Choi
Assigned: Hankook Tire & Technology
Key statement: A non-pneumatic tire having a block type reinforcement configuration includes: a tread unit that forms an outer portion of the tire and comes in contact with a road surface; a wheel unit that is connected to an axle; a spoke unit that is formed between the tread unit and the wheel unit; and a block type reinforcement unit that includes a block formed inside the tread unit in the circumferential direction of the tread unit and a plurality of reinforcing members formed in the block to correspond to the shape of the block.



Rubber composition for a tire tread

U.S. patent: 11,685,821
Issued: June 27, 2023
Inventor: Tenko Hayashi
Assigned: Michelin
Key statement: A tire has a tread comprising a rubber composition based on at least an elastomer matrix, a reinforcing filler comprising between 65 and 115 phr of a reinforcing inorganic filler, more than 30 phr of a plasticizing agent and more than 5 phr of crumb rubber particles having a median particle size by volume, which is measured by laser diffraction methods in accordance with ISO standard 13320-1, which satisfy the following relations: 100 $\mu m < D_{50} < 1{,}000\ \mu m$, wherein D_{50} is the medium particle size by volume corresponding to 50% of a cumulative distribution obtained from the volume particle size distribution.

High molecular weight functionalized batch SSBR for electric vehicle tires

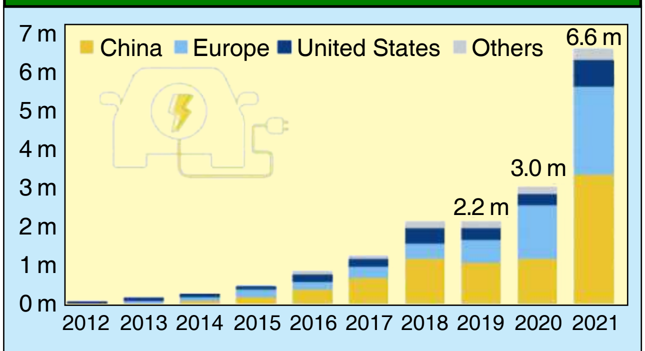
by Sven Thiele, Christian Doering, Michael Boomhoff, Daniel Heidenreich and Stefan Schulze, Synthos Schkopau GmbH

In December 2015, the United Nations Climate Change Conference was held in Paris. The conference negotiated the Paris Agreement, which is a global agreement on the reduction of climate change. At the follow-up climate change conference in Marrakech (COP22) in November 2016, the member states of the Kyoto Protocol agreed to set the goal of limiting global warming to a still acceptable level of less than 2°C compared to pre-industrial levels. This target requires that the zero emission of CO_2 is achieved soon. Unfortunately, global CO_2 emissions are still at a very high level and the worldwide CO_2 emissions growth has not been stopped yet. Accordingly, from 2015 to 2021, the world total CO_2 emissions rose by 2%, from 35.6×10^9 to 36.3×10^9 metric tons of CO_2 (ref. 1). The world total CO_2 emissions from road transportation accounts for 15% (total transportation 21%) of the global CO_2 emissions, and rose by almost 9% in only 10 years (2010-2020) (refs. 2 and 3). Furthermore, the International Energy Agency (IEA) expects global transport measured in passenger car kilometers will still double by 2070 (ref. 4).

Larger developed economies responded to these challenges with CO_2 emission standards for passenger cars and light and heavy trucks. As future CO_2 emission targets (e.g., 67 g [CO_2]/km in Europe in 2030 for passenger cars) can hardly be fulfilled with fossil fuel based automobiles, there is a need for a suitable energy efficient alternative (ref. 5). Electric vehicles (EVs) improve the overall CO_2 balance of passenger cars, but sales numbers are still comparatively low, particularly outside of Europe and China (figure 1) (ref. 6). The increasing car sales in Europe and China are the result of incentives for new electric car acquisitions, and investments into electric infrastructure or public transportation (ref. 7).

The European Commission wants to accelerate the transition process toward EVs, and very recently confirmed a ban on the sale of internal combustion engine based passenger cars by 2035 (ref. 8). This measure is accompanied by large automobile manufacturers, including Volvo, Mercedes Benz, Porsche, Peugeot and Opel, converting to 100% electric passenger car production earlier than this date (ref. 9).

Figure 1 - global electric car sales (electric vehicles, including plug-in hybrids)



The self-accelerating trend toward automobile electrification even impacts the construction of traditional vehicle components. Accordingly, EV tires need to comply with a relatively high engine turning moment, high vehicle weight and the corresponding increase in braking distance, limited driving range and low noise generation. All of this needs to be achieved without a negative impact on safety or driving comfort.

Altogether, tire manufacturers need to improve wear, rolling resistance, braking distance and low noise characteristics of electric passenger cars and light trucks (ref. 10).

Styrene butadiene copolymer made in solution (SSBR) is an important tire performance influencing component, and usually accounts for 30 to 60 phr of a tire formulation. SSBR interacts with selected fillers, carbon black or silica, and has a strong impact on the processing behavior of the rubber composition, as well as on the rolling resistance and wear performance of the final cured composition. Furthermore, SSBR can be provided with different glass transition (T_g) temperatures, which determine the rolling resistance/wet grip performance profile; whereas the polymer architecture and molecular weight determine the mechanical property profile and abrasion resistance of the cured rubber composite.

The priorities set by tire manufacturers for SSBR of supporting excellent mechanical and wear properties of low rolling resistance tires for EVs has triggered the development of new treated distilled aromatic extract (TDAE) extended, functionalized high molecular weight SSBR. New mineral oil extended (OE) polymers of different T_g are being introduced, and the corresponding rubber composition recipes and performance characteristics are described in more detail in the following article sections.

Enhanced functionalized polymers, particularly functionalized SSBR, are anticipated to remain an essential performance determining component in sustainable green EV tires.

Experimental

Polymer characteristics

Regarding Sprintan 918S (laboratory made sample SSBR 1 of a new polymer grade), the OE SSBR comprises 25 phr of TDAE and has a Mooney viscosity of 76 MU. The clear (oil-free) SSBR fraction of Sprintan 918S has a T_g of -33°C as determined by DSC, and it comprises 40 wt% of styrene and 26 mol% of 1,2-polybutadiene (also referred to as vinyl group content) in the polybutadiene fraction as determined by NMR.

Regarding Sprintan 718S (laboratory made sample SSBR 2 of an experimental grade), the OE SSBR comprises 37.5 phr of TDAE and has a Mooney viscosity of 55 MU. The clear SSBR fraction of Sprintan 718S has a T_g of -25°C as determined by DSC, and it comprises 28 wt% of styrene and 60 mol% of 1,2-polybutadiene in the polybutadiene fraction as determined by NMR.

Regarding SSBR 3 (laboratory made sample of a new experimental grade), the OE SSBR comprises 37.5 phr of TDAE and has a Mooney viscosity of 67 MU. The clear SSBR fraction of Sprintan 718S has a T_g of -29°C as determined by DSC, and it comprises 40 wt% of styrene and 60 mol% of 1,2-polybutadiene in the polybutadiene fraction as determined by NMR.

Regarding SSBR 4 (laboratory made comparative benchmark SSBR sample), the OE SSBR comprises 37.5 phr of TDAE and has a Mooney viscosity of 67 MU. The clear SSBR fraction of SSBR 4 has a T_g of -34°C as determined by DSC, and it comprises 40 wt% of styrene and 24 mol% of 1,2-polybutadiene in the polybutadiene fraction as determined by NMR.

Regarding SSBR 5 (laboratory made comparative benchmark SSBR sample), the OE SSBR comprises 37.5 phr of TDAE, and has a Mooney viscosity of 55 MU. The clear SSBR fraction of SSBR 5 has a T_g of -27°C as determined by DSC, and it comprises 25 wt% of styrene and 62 mol% of 1,2-polybutadiene in the polybutadiene fraction as determined by NMR.

The T_g was determined using a DSC Q2000 (TA Instruments) under the following conditions:

- Sample weight: ca. 10-12 mg
- Sample container: Alu/S
- Temperature range: -140°C to 80°C
- Heating rate: 20 K/minute, respectively, 5 K/minute
- Cooling rate: Free cooling
- Purge gas: 20 ml Ar/minute
- Cooling agent: Liquid nitrogen

Measurements were performed at least once on every sample, and each measurement comprised two heating runs. The second heating run was used to determine the T_g.

The ratio between the 1,4-cis-, 1,4-trans- and 1,2-polydiene content of the polybutadiene or of the styrene butadiene copolymer was determined by ^{1}H-NMR and ^{13}C-NMR spectroscopy (Avance 400 [^{1}H = 400 MHz; ^{13}C = 100 MHz] of Bruker Analytic GmbH). The 1,2-polybutadiene content in the conjugated diolefin part was additionally determined by IR absorption spectroscopy (Morello method, IFS 66 FT-IR spectrometer from Bruker Analytic GmbH). The IR samples were prepared using CS_2 as a swelling agent.

The Mooney viscosity of the polymers (and polymer compounds) was measured according to ASTM D 1646 (2004) with a preheating time of 1 minute and a rotor operation time of 4 minutes at a temperature of 100°C [ML1+4 (100°C)].

Compound and vulcanizate preparation

The new developmental grades of OE SSBR, as well as the grades of SSBR used for comparisons, also referred to as benchmark SSBR, were compounded with silica. The corresponding test formulations can be found in tables 1-3.

Rubber sheets were made using a Collin two-roll mill according to a Synthos Schkopau internal procedure.

Measurements of the rheological properties of raw (non-vulcanized) compound to characterize cure characteristics were made using a rotorless shear rheometer (MDR 2000 E, Alpha Technologies) in accordance with ASTM D 5289-95. Test pieces were vulcanized to t95 at 160°C, with the exception of test pieces for rebound resilience (RB) tests (ISO 4662), which were vulcanized to t_{95+5} at 160°C.

Tensile strength, elongation at break and modulus at 100% (modulus 100) and at 300% elongation (modulus 300) were measured according to ASTM D 412-98A (reapproved in 2002) on a Zwick Z010.

Durometer hardness at 0°C, 23°C and 60°C was measured according to ASTM D 2240.

Table 1 - three stage compounding recipe for OE SSBR grades Sprintan 918S and SSBR 4

First and second mixing stage	*918S, phr*	*Benchmark SSBR 4, phr*
SSBR	100	110
High-cis Ni-BR	20	20
Silica BET 160 m²/g	80	80
Silane TESPD	6.9	6.9
6 PPD	2	2
Wax	1.5	1.5
Zinc oxide	2.5	2.5
Stearic acid	1	1
TDAE	10	0
Third mixing stage		
Sulfur	1.4	1.4
TBBS	1.7	1.7
DPG	2	2

Table 2 - three-stage compounding recipe for OE SSBR grades SSBR 3 and SSBR 4

First and second mixing stage	*New SSBR 3, phr*	*Benchmark SSBR 4, phr*
SSBR	110	110
High-cis Ni-BR	20	20
Silica BET 160 m²/g	80	80
Silane TESPD	6.9	6.9
6 PPD	2	2
Wax	1.5	1.5
Zinc oxide	2.5	2.5
Stearic acid	1	1
Third mixing stage		
Sulfur	1.4	1.4
TBBS	1.7	1.7
DPG	2	2

Table 3 - three-stage compounding recipes for OE SSBR grades Sprintan 718S and SSBR 4

First and second mixing stage	*718S, phr*	*Benchmark SSBR 4, phr*
SSBR	110	110
High-cis Ni-BR	20	20
Silica BET 160 m²/g	80	80
Silane TESPD	6.9	6.9
6 PPD	2	2
Wax	1.5	1.5
Zinc oxide	2.5	2.5
Stearic acid	1	1
Third mixing stage		
Sulfur	1.4	1.4
TBBS	1.7	1.7
DPG	2	2

Heat buildup was measured according to ASTM D 623, method A, on a Doli Goodrich flexometer.

Rebound resilience was measured at 0°C, 23°C and 60°C according to ISO 4662.

Tan δ and storage modulus E' at 0°C and 60°C were measured using a dynamic spectrometer Eplexor 150N/500N manufactured by Netzsch Gabo Instruments GmbH (Germany) applying a static strain of 3% and a dynamic strain of 2% at a frequency of 2 Hz in strain measurement mode. Tan δ at 0°C and 60°C was measured using the same equipment and load conditions.

DIN abrasion was measured according to DIN 53516 (1987-06-01). Extrudates were produced at 125°C with the B50 drive unit (Brabender GmbH, Germany) equipped with a Garvey die.

Compounding investigations

Compounding investigations were performed in a 1.6 L HF intermesh mixer (HF Group, Germany) with a chamber volume of 1,600 cm^3, fill factor of 0.72, initial chamber temperature of 50°C and initial rotor speed of 60 rpm. All ingredients, with the exception of the sulfur/accelerator system, were added during the first mixing step (polymer, 2/3 silica + silane and 1/3 silica + chemicals). After closing the ram, the mixing time was 4 minutes. The compound from mixing step 1 was homogenized during the second mixing step (3.5 minutes). The sulfur/accelerator system was added in mixing step 3 using a mixing time of 70 seconds. The mass temperature in this stage was below 120°C. Fill factors were adjusted accordingly.

Results and discussion

Novel-functionalized OE-SSBR silica formulation characteristics

For use in electric passenger car tires, tire manufacturers request SSBR providing a combination of low rolling resistance, good abrasion resistance, excellent mechanical properties and high wet grip. These requirements can be addressed readily by using silica active functionalized SSBR of high molecular weight, and by selecting the correct microstructure and coupling architecture for the polymer.

One drawback of highly functionalized SSBR grades with high molecular weight is a significant deterioration in mixing and extrusion characteristics. Often, those disadvantages are recognized as a result of predictive laboratory tests. High SSBR-silica compound viscosities, increased Mooney slope, rough surfaces of milled rubber sheets or of extrudates of raw rubber compositions, and low green strength are typical indications of difficult processing behavior during tire manufacturing. Challenging tire compounding or extrusion processes can be countered by the addition of processing aids or tire performance influencing components of low molecular weight, such as resins, silanes or low viscosity polymers, which also provide a positive impact on the processability of the rubber formulation. Furthermore, processing of rubber compositions can be controlled better by adding additional compound mixing steps, reducing the run rate of the tire compound manufacturing process or through investment in an improved compound mixing technology. Unfortunately, the introduction of further processing improving components increases the mixing process complexity and may cause undesired reactions or performance characteristics, thus extending the development timeline of new high performance tire formulations. The addition of further mixing steps, the reduction of the tire compound manufacturing run rate or investment in enhanced mixing technology lead to fewer economic processes, which then often turn out not to be competitive for a commercial application.

Accordingly, SSBR needs to achieve both an enhancement of the above discussed target performance characteristics of the electric passenger car tire and to balance processing of the new functionalized SSBR compound. High molecular weight commercial TDAE oil-extended grades, Sprintan SLR 6430, Sprintan SLR 4630 and Sprintan 941S, are non-functionalized and address applications in different target T_g areas. As a high molecular weight SSBR has a comparatively low hysteretic energy loss compared with a clear (oil-free) SSBR of the same microstructure, the above mentioned OE-SSBRs already have a reasonably good balance of wear, rolling resistance and wet grip, without causing remarkable processing challenges in tire production.

The limited driving distance of EVs triggered the need for different T_g versions of SSBR functionalized to interact efficiently with silica, without negatively influencing the processing of the new functionalized SSBR-silica formulation, or the balance of rolling resistance to wet grip and abrasion resistance. Therefore, three new functionalized SSBRs, Sprintan 918S, Sprintan 718S and the new experimental grade SSBR 3, were developed, which correspond to the following OE-SSBR T_gs: -36°C, -25°C and -30°C.

Regarding Sprintan 918S performance characteristics, the surface of the raw compound rubber sheets is smooth (figure 2) and provides a balanced compound Mooney viscosity when compared with the corresponding non-functionalized benchmark SSBR 4. The selected polymer functionalization does not react strongly with silica in the compound; hence, still enabling a good control of the target Mooney viscosity.

The heavy battery pack of often large electric passenger cars increases requirements with respect to the mechanical stability of

Figure 2 - rubber sheets of Sprintan 918S and SSBR 4 compounds

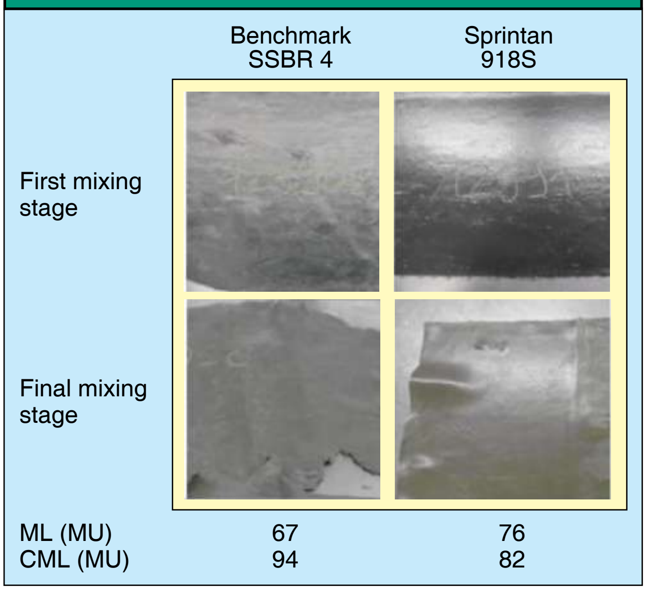


Figure 3 - tensile stress versus elongation curves of Sprintan 918S and SSBR 4 composites

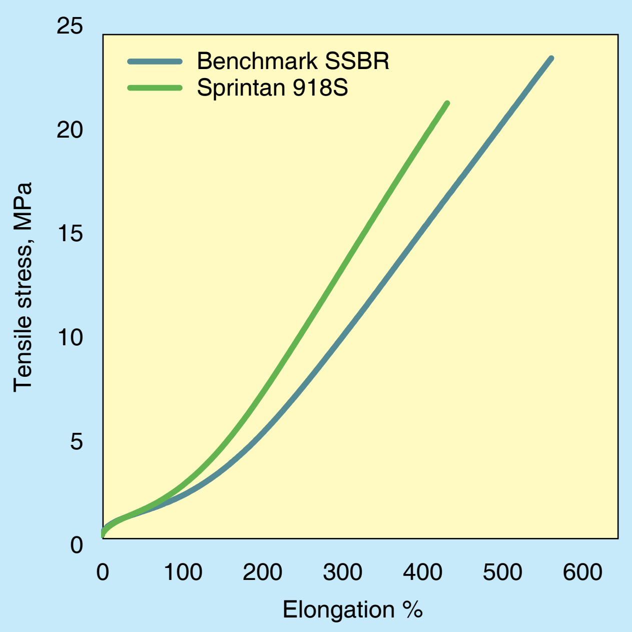
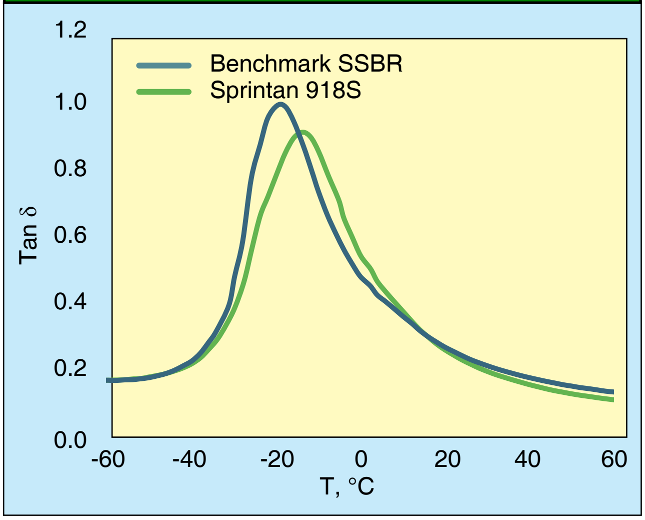


Figure 4 - DMA curves of Sprintan 918S and SSBR 4 composites

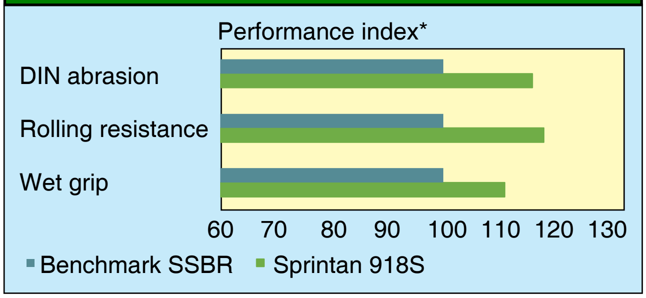


the tires. Cured specimens of the rubber compounds were subjected to tensile testing to break. Figure 3 indicates that the tensile strength of vulcanized compounds of Sprintan 918S and the non-functionalized benchmark SSBR 4 are close, while there is a moderate drop of elongation at break for the former. This is assumed to result from the increased elasticity of the new functionalized SSBR.

Rolling resistance and wet grip were assessed by performing both dynamic-mechanical and rebound experiments (table 4 and figures 4 and 5). The DMA curves indicate an 18% reduction in tan δ at 60°C and an 11% increase in tan δ at 0°C for Sprintan 918S. This improved rolling resistance/wet grip balance is supported by an increased rebound resilience at 60°C, and by an increased value of modulus 300, the latter which is often (but sometimes also controversially) discussed as indicating an increased silica-polymer interaction.

Sprintan 918S exhibited an 18% improvement in DIN abrasion of the sulfur crosslinked composition in comparison to the SSBR 4 formulation. Accordingly, use of Sprintan 918S in EV

Figure 5 - summary of key performance improvements of Sprintan 918S compared with SSBR 4 composites



tires may be a good measure, particularly as tires suffer increased abrasion as a result of the high torque of EVs.

Regarding the new experimental grade SSBR 3 performance characteristics, the surface of the sheets of raw compound rubber derived from SSBR 3, from both the first and the final (third) mixing stage, is smooth (figure 6), and the compound Mooney viscosity is close to that of the compound from the corresponding non-functionalized benchmark SSBR 4. The compound Mooney slope of SSBR 3 is similar compared with that of SSBR 4. These observations indicate that the selected polymer functionalization does not react strongly with silica in the compound, enabling good control of the target compound Mooney viscosity at the same slope values. This observation is further supported by the fairly similar appearance of Garvey extrudates, demonstrated in figure 7, of SSBR 3 and SSBR 4 composites obtained after applying different screw rates.

Figure 8 indicates that the tensile stress versus elongation curve of the new SSBR 3 vulcanizate is almost coincident with the curve for the non-functionalized benchmark SSBR 4 vulcanizate, although there is a moderate decrease in elongation at break. The latter is assumed to result from the increased elasticity of the functionalized new SSBR 3. The DIN abrasion presented in table 5 indicates the same abrasion resistance for both

Table 4 - mechanical performance characteristics of Sprintan 918S and SSBR 4 composites

	Benchmark SSBR 4	*Sprintan 918S*
Tensile strength, MPa	23.6	21.6
Elongation at break, %	559	432
Modulus 100, MPa	2.1	2.6
Modulus 300, MPa	9.9	13.3
Durometer A hardness at 23°C	63.3	61.9
Rebound resilience at 0°C, %	11.7	10.3
Rebound resilience at 60°C, %	56.5	59.7

Figure 6 - rubber sheets of new SSBR 3 and SSBR 4 compounds

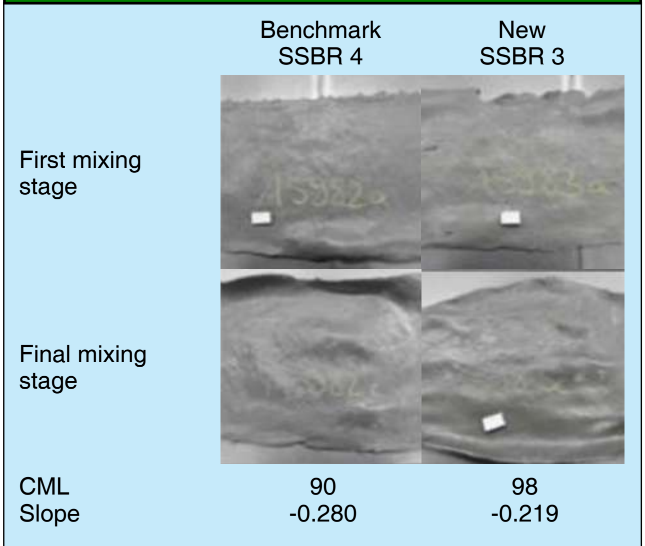


Figure 7 - Garvey extrudates of new SSBR 3 and SSBR 4 compounds at different screw rates

polymer grades, which is considered to be a good result.

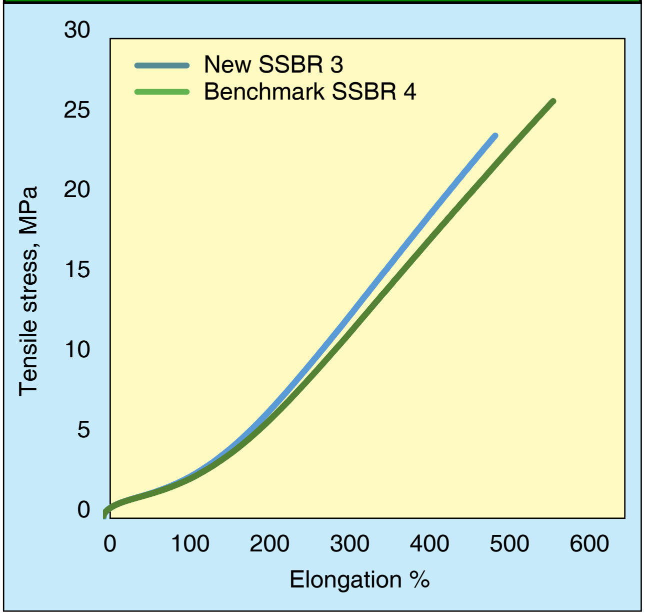
The DMA curve in figure 9 reveals a 25% increase in tan δ at 0°C; this being the result of both a difference in the T_g of the grades, visible as a shift in the temperature at which the maximum in tan δ is located (tan δ_{max}), and a broadened tan δ curve, as well as slightly improved tan δ at 60°C (10% lower). The measured increase in tan δ at 0°C correlates well with the observed rebound resilience presented in table 6. The rebound resilience of the SSBR 3 based vulcanizate at 60°C is of the same order as that of the benchmark SSBR 4, and thus does not follow the same trend.

Regarding Sprintan 718S performance characteristics, the surface of the rubber sheets of the raw compound based on

Table 5 - mechanical performance characteristics of new SSBR 3 and SSBR 4 composites

	Benchmark SSBR 4	*New SSBR 3*
Tensile strength, MPa	24.4	23.6
Elongation at break, %	533	493
Modulus 100, MPa	2.2	2.3
Modulus 300, MPa	11.1	11.8
DIN abrasion, mm^3	115	115

Figure 8 - tensile stress versus elongation curves of new SSBR 3 and SSBR 4 composites



Sprintan 718S is smooth (figure 10), and the compound Mooney viscosity is close to that of the compound based on the corresponding non-functionalized benchmark SSBR 5. This indicates that the selected polymer functionalization does not strongly react with silica in the compound, enabling good control of the target compound Mooney viscosity.

Tensile testing of the cured specimens of the polymer compounds was performed to break. Figure 11 demonstrates that the tensile strength of the Sprintan 718S vulcanizate is almost at the same level as that of the non-functionalized benchmark SSBR 5 vulcanizate. The elongation to break of the Sprintan 718S vulcanizate is also essentially the same as that of the benchmark SSBR 5 vulcanizate, which indicates a similar elas-

Figure 9 - DMA curves of new SSBR 3 and SSBR 4 composites

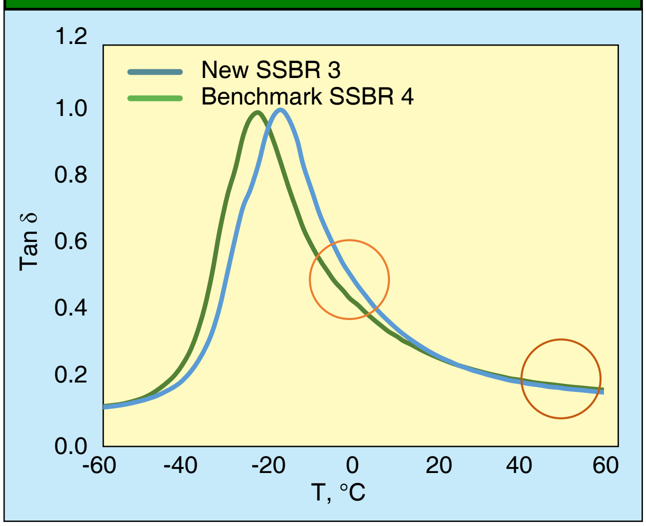


Table 6 - rebound resilience and tan δ values of new SSBR 3 and SSBR 4 composites

	Benchmark SSBR 4	*New SSBR 3*
Hardness durometer A at 23°C	57	61
Rebound resilience at 0°C, %	15	11
Rebound resilience at 23°C, %	33	29
Rebound resilience at 60°C, %	59	57
Tan δ at 0°C	0.441	0.549
Tan δ at 60°C	0.137	0.124
T at tan δ_{max}, °C	-20	-14

Table 7 - rebound resilience and tan δ values for Sprintan 718S and SSBR 5 composites

	Benchmark SSBR 5	*Sprintan 718S*
Rebound resilience at 0°C, %	13	11.9
Rebound resilience at 60°C, %	55.9	58.1
Tan δ at 0°C	0.483	0.495
Tan δ at 60°C	0.138	0.109
T at tan δ_{max}, °C	-18	-16
DIN abrasion, mm^3	118	111

ticity of the two SSBR samples.

An assessment of rolling resistance and wet grip was performed through dynamic mechanical and rebound experiments (table 7 and figures 12 and 13). The DMA curves indicate a 21% reduction in tan δ at 60°C and a 3% improvement (increase) in tan δ at 0°C for Sprintan 718S. This improved rolling resistance/wet grip balance is supported by an increased rebound resilience at 60°C and reduced rebound resilience at 0°C. The higher value of modulus 300 for the Sprintan 718S vulcanizate shown in table 8 is consistent with the aforementioned results, because it indicates an increased silica-polymer interaction.

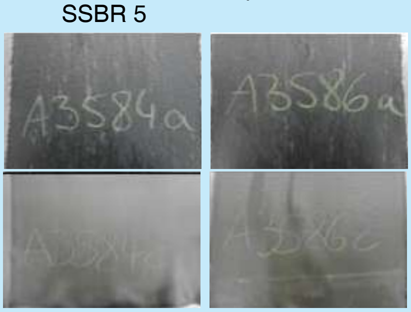
Conclusions

Intensive research activities at Synthos were triggered by customer demand on energy efficient tires for use in electric passenger cars. The study of EV tire requirements added the need to address wear and wet grip characteristics, as both properties are negatively impacted by the high weight of EVs.

Accordingly, a new Synthos proprietary functionalization technology was applied to SSBR to improve the rolling resistance/wet grip/abrasion resistance balance. As an increase in silica active groups in SSBR creates the risk for processing challenges during tire compound manufacturing, the need to process SSBR formulations at reasonable run rates was also considered

Figure 10 - rubber sheets of Sprintan 718S and SSBR 5 compounds

	Benchmark SSBR 5	Sprintan 718S
First mixing stage		
Final mixing stage		



ML	55	55
CML	82	77

Figure 11 - tensile stress versus elongation curves of Sprintan 718S and SSBR 5 composites

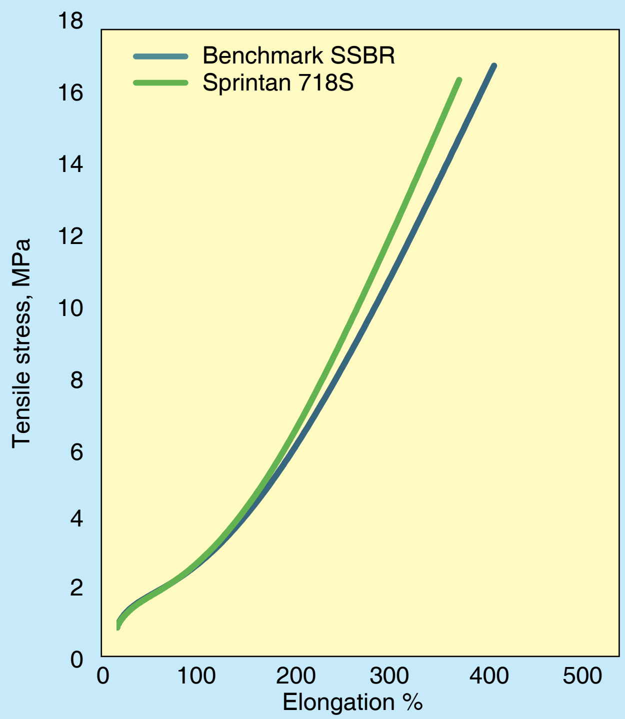


Figure 12 - DMA curves of Sprintan 718S and SSBR 5 composites

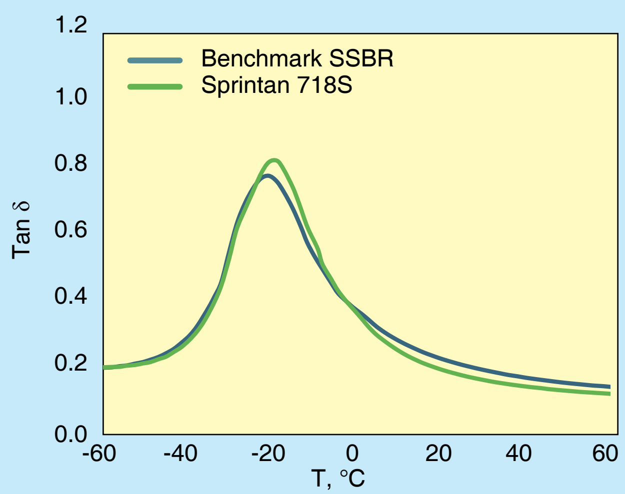
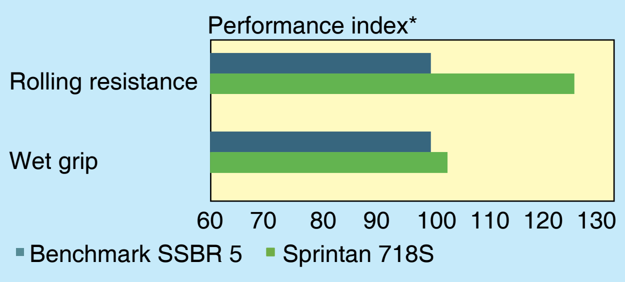


Figure 13 - summary of key performance improvement of Sprintan 718S and SSBR 5 composites



in the design process for new functionalized SSBR.

The development led to three TDAE-extended, functionalized SSBR solutions for EV tire compounds. Sprintan 918S improves rolling resistance by 18%, wet grip by 11% and abrasion resistance by 18% in predictive laboratory tests when compared with a market established, non-functionalized benchmark SSBR. This new grade with the comparatively lowest T_g is already manufactured at a larger volume scale and, therefore, the observed increasing customer demand can be quickly satisfied.

Sprintan 718S has the comparatively highest T_g and leads to a 21% rolling resistance reduction, along with improvements in wet grip and abrasion resistance.

Table 8 - mechanical performance characteristics of Sprintan 718S and SSBR 5 composites

	Benchmark SSBR 5	*Sprintan 718S*
Tensile strength, MPa	16.9	16.5
Elongation at break, %	406	372
Modulus 100, MPa	2.4	2.4
Modulus 300, MPa	10.9	12.2
Durometer A hardness at 23°C	61.7	58.3

A new experimental grade, SSBR 3, is intended to provide customers with the option of improving wet grip at an excellent rolling resistance performance level, and without negatively impacting tire abrasion. Improvements of 25% in wet grip and 10% in rolling resistance in predictive laboratory tests, compared to the selected non-functionalized benchmark SSBR, have proved to be attractive for new tire developments.

Sprintan 718S and SSBR 3 have been the subjects of several successful pilot plant campaigns, and further upscaling to a commercial production plant is scheduled.

All of the grades presented here, including the described benchmarks, have an excellent mechanical property profile, and could be compounded without experiencing any remarkable challenges.

Therefore, all three new grades, Sprintan 918S, Sprintan 718S and SSBR 3, fulfill the target of providing the tire industry with SSBR solutions which are easy to process and enable manufacturing of energy efficient, low wear and safe tires, capable of also resisting high loads.

This article is based on a paper presented at the 202nd Technical Meeting of the Rubber Division, ACS, October 2022.

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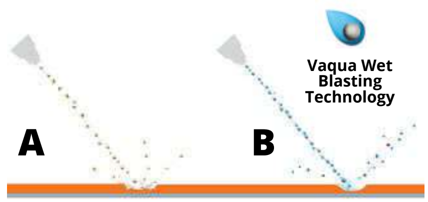

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EV tread development: Improving traction in high natural rubber loaded compounds using silane-terminated diene resins

by Steven K. Henning, TotalEnergies Cray Valley

Developing tire tread formulations for electric vehicles (EVs) presents a unique challenge. Instantaneous high torque and vehicle dynamics demand traction performance, while owner expectations for battery life and range highlight the need for very low rolling resistance compounds. In addition, vehicle weight and new environmental pressures increase the need for improved durability and abrasion resistance. Silane-terminated polybutadiene resins developed by Cray Valley are functional additives designed to help manage the new EV tire performance balance. Previous work has demonstrated the unique mechanism of interaction between the silica/silane filler system and silane-functional resins, and the impact on traction indicators (refs. 1 and 2), and identified the importance of functional group placement on achieving the best balance of compound properties (ref. 3). Increasing filler loading is one formulation strategy when attempting to manage the traction/rolling resistance/abrasion performance balance. More recent studies have explored how silane-terminated poly(diene) resins can reduce filler-filler networking, even at elevated silica filler volume fractions (ref. 4).

Natural rubber (NR) is becoming more widely used in passenger car tires for EV fitments, as its inclusion can provide solutions to a number of performance needs. It has been reported that blends of NR with synthetic elastomers can provide improved tensile properties and abrasion resistance, improving the durability of the tire (refs. 5-7). NR is not compatible with polybutadiene rubber (BR) or solution polystyrene-co-butadiene rubber (SSBR), resulting in the formation of a discrete phase of NR in the elastomer blend. This multi-phase structure is likely responsible for some improvement in the tear properties of the compound. Finally, the addition of NR to a compound is a relatively easy and inexpensive way to increase the sustainable content of the tire. However, the addition of NR is not a panacea. The low T_g of the elastomer negatively impacts the traction component of performance; and by introducing gross phase structure into the compound, rolling resistance may increase. In this study, NR is added to a model BR/SSBR silica filled tread formulation at elevated silica loading. Silane-terminated polybutadiene resin is also incorporated into these compounds in order to quantify the impact on traction, rolling resistance and mechanical properties at increasing NR loading.

Experimental

The synthetic route to produce near quantitative terminal silane functionality based on poly(diene) resins has been published (ref. 8). This high fidelity route is the most efficient way to produce functional additives with the highest performance. Ricon 603, a commercial silane-terminated polybutadiene resin developed by Cray Valley, is characterized in table 1. A model silica filled BR/SSBR compound formulation was modified by adding 25 and 50 phr NR in place of the BR/SSBR blend. A high silica filler loading (100 phr) was used. Resin was loaded at a base 20 phr. TDAE oil was used as a control. The oil removed from the compound as the oil-extended SSBR was replaced with NR, and is compensated for with free TDAE oil. Compound designations consist of the prefix indicating process oil (PO-) or silane-terminated polybutadiene (PB-), followed by a number representing the phr loading of NR (-0, -25, -50).

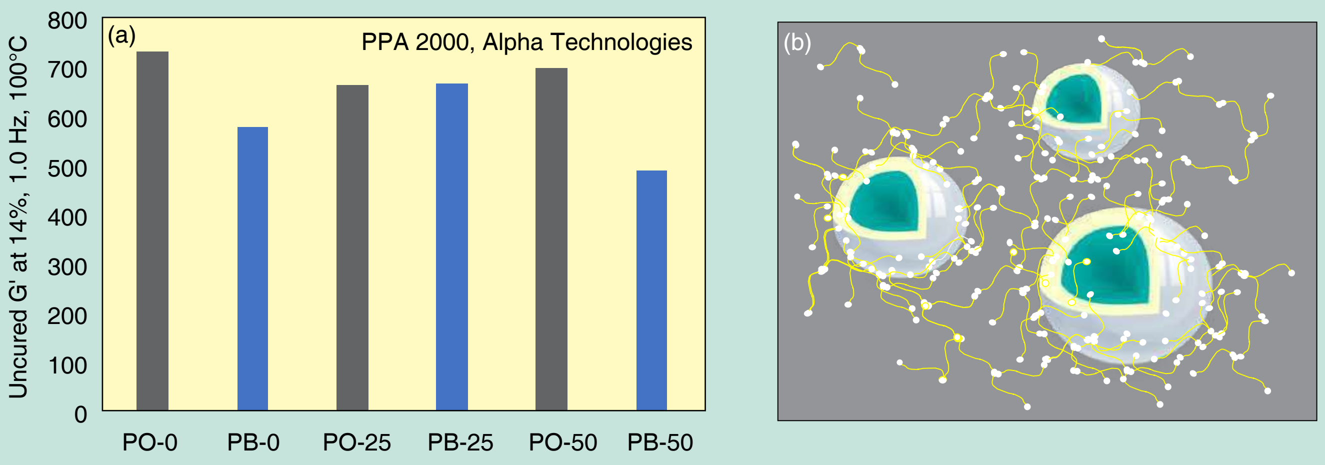
All compounds were prepared in three stages in an internal mixer (Brabender Prep-Mixer, 420 ml capacity, with Banbury blades and Intelli-Torque Plasti-Corder 7.5 hp drive). The compounds were calendered in between mixing stages using a laboratory scale two-roll mill (Reliable Rubber and Plastic Machinery, 6” x 13” variable speed drive, Model 5025). Compounds were removed and allowed to cool overnight prior to curing and analysis. All compounds were cured and molded in a heated

Table 1 - characterization of Ricon 603, a silane-terminated polybutadiene resin and model silica filled tread formulation with NR loading ladder

	Ricon 603 silane-terminated polybutadiene
Designation	PB
Grade	Ricon 603
Topology	Linear
Group	Triethoxysilane
Functionality	2
Location	Chain end
Mw (g/mol)	3,500
T_g (°C)	-35
Sustainability	ISCC+

	PO-0	*PB-0*	*PO-25*	*PB-25*	*PO-50*	*PB-50*
Buna CB24	25.00	25.00	18.75	18.75	12.50	12.50
Buna VSL 4526-2 HM	103.10	103.10	77.30	77.30	51.56	51.56
SIR20 NR	0.00	0.00	25.00	25.00	50.00	50.00
Zeosil 1165 MP	100.00	100.00	100.00	100.00	100.00	100.00
Xiameter OFS-6945	15.60	15.60	15.60	15.60	15.60	15.60
TDAE oil	22.20	-	29.20	7.00	36.20	14.40
ST PB	-	22.20	-	22.20	-	22.20
Stearic acid	2.30	2.30	2.30	2.30	2.30	2.30
6PPD	2.00	2.00	2.00	2.00	2.00	2.00
TBBS	1.70	1.70	1.70	1.70	1.70	1.70
Sulfur	1.30	1.30	1.30	1.30	1.30	1.30
DPG	2.00	2.00	2.00	2.00	2.00	2.00
Zinc oxide	2.30	2.30	2.30	2.30	2.30	2.30
TBzTD	0.50	0.50	0.50	0.50	0.50	0.50

Figure 1 - (a) uncured G' as a function of NR loading and silane-terminated resin addition, (b) schematic representation of the additional silane-terminated resin network linking filler particles (ref. 1)



press at 160°C for 20 minutes.

Uncured Mooney viscosity was approximated using low frequency, medium strain oscillatory testing (1 Hz, 14% strain, 100°C). Cure properties, such as delta torque (MH-ML), were measured using a moving die cure rheometer (PPA 2000, Alpha Technologies) at 160°C for 35 minutes at 1.667 Hz frequency and 6.675% deformation angle. Crosslink density (XLD) was calculated using Flory-Rehner methodology (ref. 9).

Durometer A hardness was measured according to ASTM D2240. A tensile tester (Instron 3366) was used to measure tensile modulus via ASTM D412 type C at a crosshead speed of 10 inches/minute. Die C tear properties were evaluated via ASTM D624.

Viscoelastic properties were measured via dynamic mechanical analysis (DMA, Q-800, TA Instruments) of the cured tread rubber compounds using a tension film clamp, oscillation amplitude of 6 microns, 14 Hz frequency and static force of 0.05N. Payne effect was measured in double button shear mode with storage shear moduli (G') of the cured compounds measured under increasing strains to determine the differences between the response at low and high deformation.

Results and discussion

Uncured shear moduli can be used as a measure of compound processability and viscosity, as well as an early indicator of filler-filler networking and silane-resin network formation. Figure 1a provides PPA uncured G' for the compounds. The PO series viscosity is fairly steady with increased NR loading. The results for the PB loaded compounds are likely a result of the opposing effects on uncured viscosity of decreasing filler-filler networking (lowering viscosity) and the development of the polycondensed interpenetrating network of silane-terminated chains and the filler system (increasing uncured viscosity), represented visually in figure 1b.

Diene resins typically display "sulfur stealing" behavior, which leads to the net reduction in overall crosslink density. Figures 2 and 3 show PPA delta torque (MH-ML) and measured XLD by swelling measurements. The PO containing compounds show a steady decrease in crosslinking as the NR level is increased. The XLD of PB series is higher and remains elevated over the whole NR loading series.

Here is where a discussion regarding material partitioning

Figure 2 - MDR delta torque values

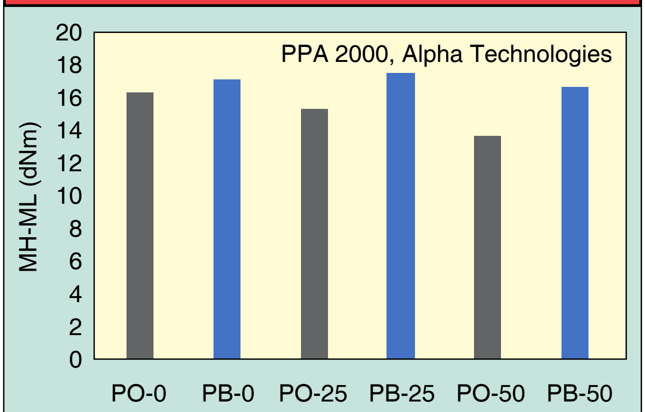


Figure 3 - crosslink density by swelling experiments

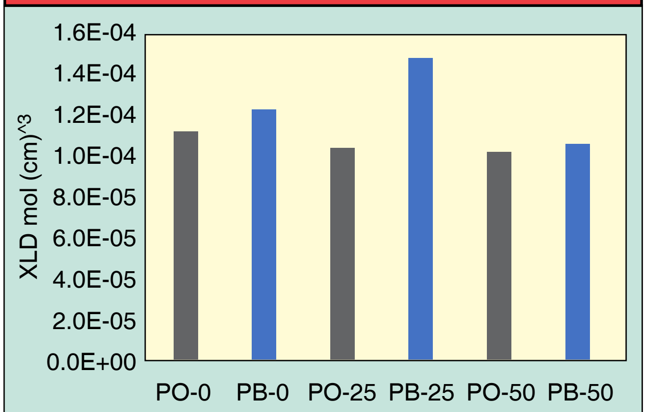
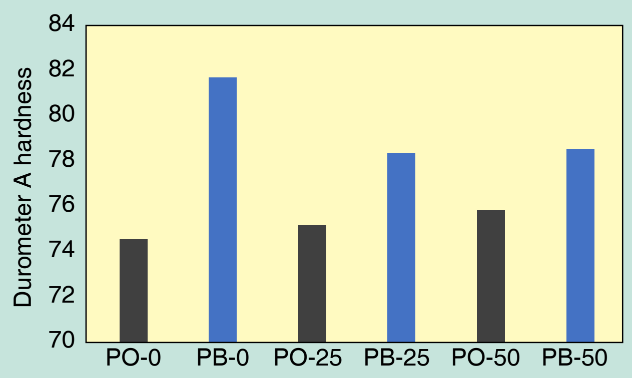


Figure 4 - durometer A hardness values



may be helpful in interpreting the results. It is well known that NR forms a discrete phase in the BR/SSBR continuous phase for this type of elastomer blend. It has also been documented that fillers, plasticizers, curatives and other additives will partition between these phases unequally based on the solubilities of these ingredients. It has been shown that the more polar additives (silica/silane, curatives) will partition into the more polar SSBR phase of the blend (ref. 10). Unequal phase partitioning leads to a heterogeneity of filler concentration and state of cure within the different phases of the compound, which will alter the viscoelastic profile and other physical properties of the compound overall (ref. 11). As NR increases, so does its phase volume. If the curatives are partitioning in the other phase, an overall decrease in XLD may be seen. It is also possible that the silane-terminated resins also partition, most likely with the filler/curative ingredients. The partitioning will lead to an increasing concentration of filler, silane and curatives in the BR/SSBR phase.

Durometer A hardness values are compared in figure 4. PO compounds increase hardness slightly with increased NR loading, while the PB containing compounds show much higher hardness at all NR loading levels.

Figure 5 provides 100% modulus data. For PO containing compounds, modulus decreases slightly with NR loading. This could be explained by curative partitioning effects. However, the PB containing compound series shows increased modulus over the other additives at all NR loadings. Both hardness and modulus increases for PB containing compounds can be directly attributed to the additional network formation, as well as entanglement and crosslinking with the surrounding elastomer matrix.

Figure 5 - 100% modulus values

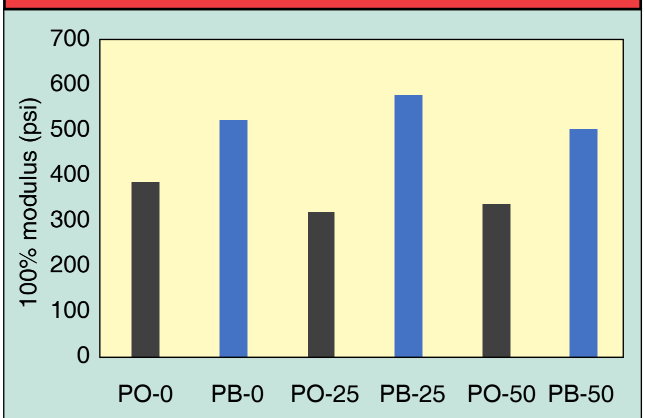


Figure 6 - tensile strength values

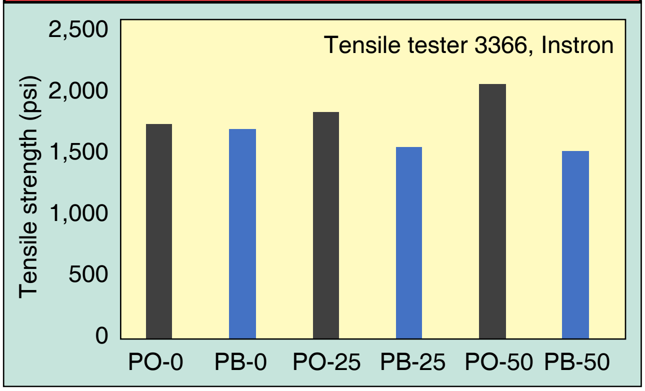
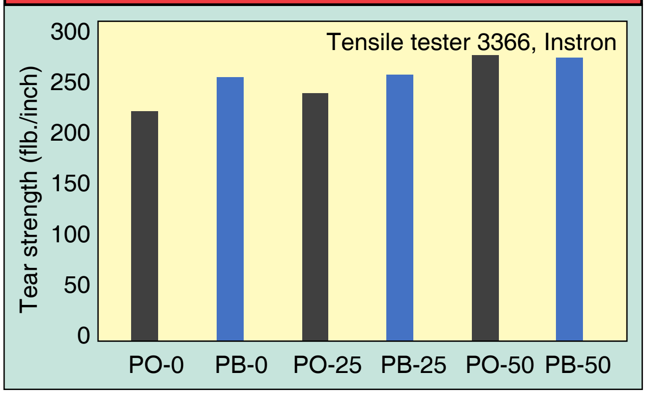


Figure 7 - tear strength values



Tensile strength and tear strength data are provided in figures 6 and 7, respectively. Looking at the PO containing compounds, the effects of including NR in the formulation are evident; both ultimate tensile strength and tear properties improve with NR loading. Tensile strength decreases slightly for the PB containing compounds when NR is introduced into the formulation. However, tear strength is higher overall for the PB containing compounds at all NR loadings.

A traditional traction indicator is tangent delta at 0°C. Higher energy loss at this temperature correlates with expected tire wet traction. Rolling resistance, having a major influence on the range of EVs, can be correlated to tangent delta at 60°C. Lower values in the higher temperature range correlate to improved rolling resistance. Figures 8 and 9 compare these indicators, respectively. As expected, for compounds not containing functional resins, the traction indicator decreases linearly with NR loading. While tangent delta at 0°C also decreases in step in the functional resin compounds, at each NR loading, the value is still well above that of the PO controls.

Interestingly, the rolling resistance indicators also decrease (improve) with NR loading, despite the introduction of the phase structure and new interfaces. NR is an extremely high molecular weight elastomer, unique compared to relatively low molecular weight synthetic elastomers. The reduction in chain ends may

Figure 8 - tangent delta at 0°C

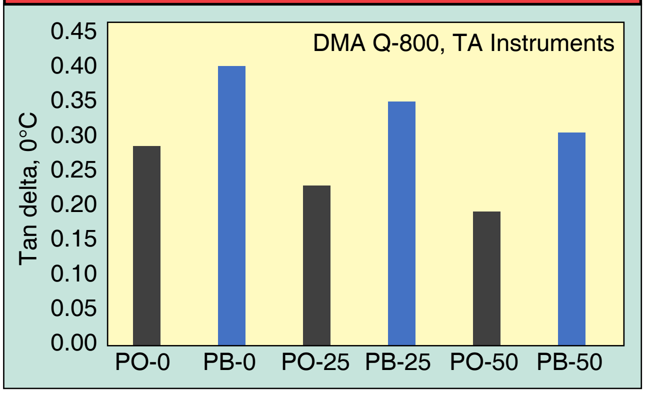
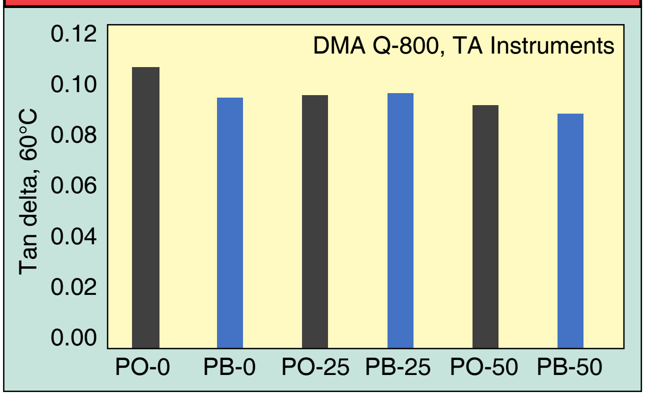


Figure 9 - tangent delta at 60°C



result in the improved hysteresis. It is also shown that in the compounds with no NR, the functional resin containing compound has lower tangent delta at 60°C; but as NR is introduced, the PB containing compounds are still equal to or better than the PO controls.

There are other ways to compare the viscoelastic data. Figure 10 plots the two main tire performance indicators on the same graph. The results are spatially grouped by additive. In general, PB containing compounds provide the best traction/rolling resistance tradeoff, regardless of NR loading. The PO results have the lowest traction indicators and a wider spread of rolling resistance values.

Figure 10 - tangent delta at 0°C as a function of tangent delta at 60°C

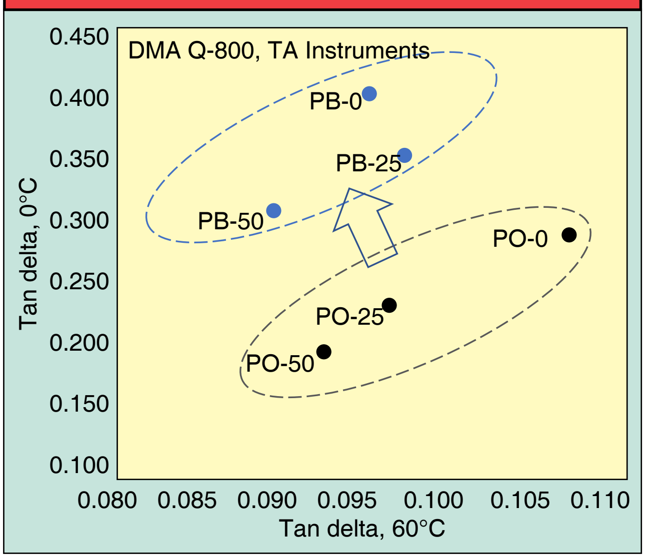
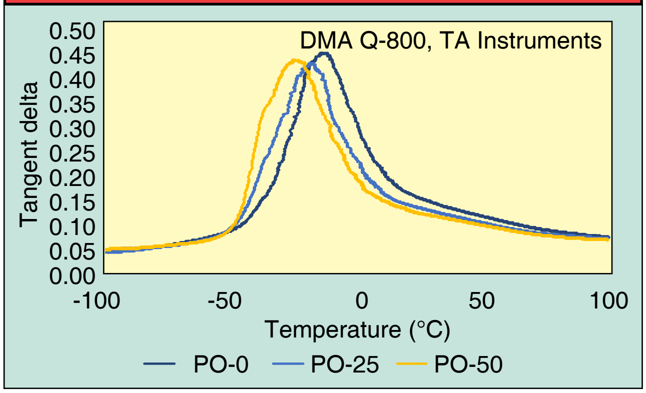


Figure 11 - tangent delta curves for PO containing compounds as a function of NR loading



Figures 11-13 provide the actual tangent delta curves representing different comparisons of data. Figure 11 overlays the

Figure 12 - tangent delta curves for the different compounds at zero phr NR

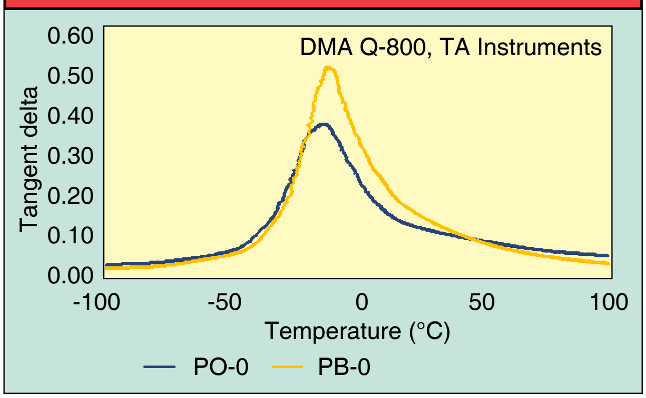


Figure 13 - tangent delta curves for the different compounds at 50 phr NR

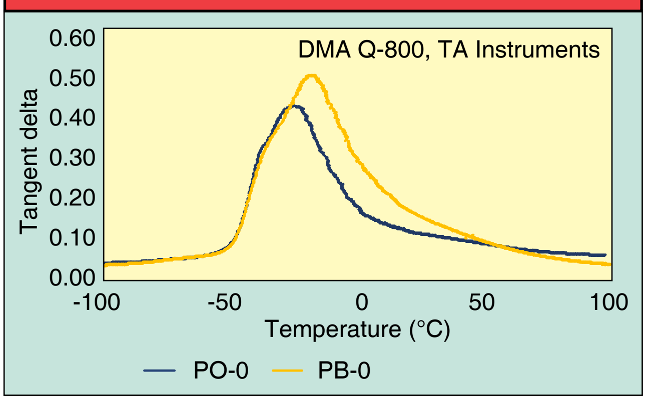


Figure 14 - cured G' as a function of log % strain for the compounds containing PO and increasing levels of NR

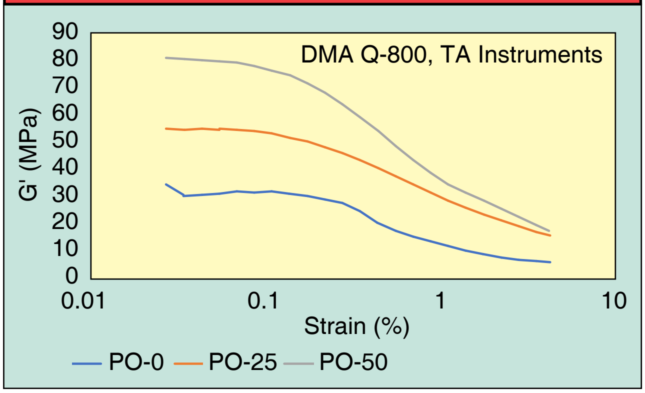
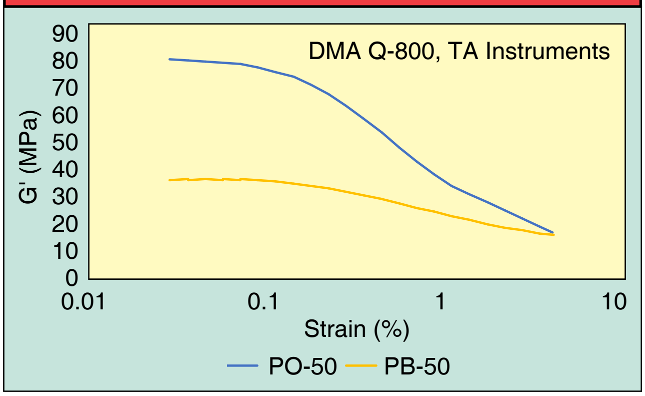


Figure 15 - cured G' as a function of % strain for the compounds containing 50 phr NR



tangent delta curves for the PO containing compounds as a function of NR loading level. As NR phr increases, the peak shifts to the left and a visible shoulder appears, consistent with the formation of a second NR phase. Figure 12 compares the curves of compounds containing oil or functionalized resin at zero phr NR. With the addition of high T_g silane-terminated resin, the tangent delta peak both increases in height and shifts to the right (high temperature), both contributing to the large increase in traction indicator. Finally, figure 13 compares the compounds at the highest NR loading (50 phr). Both compounds have the NR phase shoulder in the curves, but the compound containing the functionalized resins maintains a high peak height and increased breadth; again, both contributing to increased traction indicator. Notably, in both figures 12 and 13, the PB containing compound has lower tangent delta values than the control PO compounds at the high temperature region of the curves, indicating improved rolling resistance. This reduction in energy loss will also be demonstrated in comparisons of cured Payne effect measurements.

Payne effect

Finally, figures 14 and 15 show cured G' as a function of % strain for the compounds containing PO and increasing levels of NR, and for those containing 50 phr NR, respectively. In figure 14, the low strain initial modulus increases significantly with NR addition. The delta between low strain and high strain G' for a given NR loading increases, as well. It is possible that as NR loading increases, more filler is partitioned into the BR/SSBR phase, such that the local filler concentration there is significantly higher than for the overall formulation. Opportunities for filler networking and higher low strain moduli would then increase. Figure 15 demonstrates what effect an increase in polymer-filler interactions facilitated by silane-terminated functional resins can have on the Payne effect. Lower overall initial low strain G' is seen, as well as a flatter overall profile as strain increases.

Figure 16 - Payne effect, G' (0.3%) – G' (3.0%)

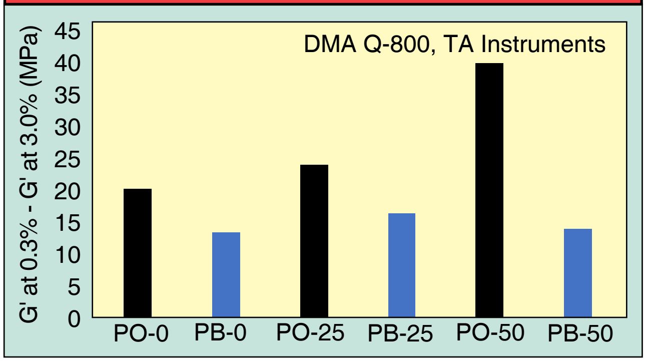


Figure 16 summarizes the strain sweep data by calculating the relative magnitude of the Payne effect. The presence of silane-terminated resin keeps the low strain/high strain differences to a minimum, regardless of NR loading level. Silane-terminated resins have been shown to act as linking agents between filler particles, reducing the amount and rate of filler-filler networking. An increase in polymer-filler interaction has been associated with not only lower hysteresis, but improved rolling resistance.

Conclusions

Including NR in an EV tread formulation based on synthetic elastomers and higher filler loadings can increase durability and abrasion resistance, and significantly contribute to the sustainable material content of the tire. However, key performance parameters such as traction and rolling resistance may be compromised. The application of silane-terminated polybutadiene resins has been shown to mitigate the performance tradeoff. Addition of silane-terminated polybutadiene with increasing natural rubber content showed an increase in traction and Payne effect, along with improving rolling resistance. Silane-terminated diene resins interact with silica/silane filler systems and can polycondense, forming a secondary network that can further entangle and co-vulcanize with the elastomer matrix. The result is improved polymer-filler interactions and reduced rolling energy loss in the tire tread. Silane-terminated polybutadiene resins can be sustainably sourced through mass balance certification of the butadiene monomer. Theses functional additives can both decrease the overall CO_2 footprint of the vehicle, as well as increase the sustainable content of the tire.

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(continued on page 45)

Achieving manufacturing energy savings with treated silicas: A solution for the tire industry

by Lucas Dos Santos Freire, PPG

Rising fuel costs, a wide range of environmental legislation and increased public consideration for energy usage and the environment continue to encourage the pursuit of fuel efficient and longer lasting automobile tires. These demands require the expansion of the tire industry's "magic triangle," comprising fuel efficiency, traction and treadwear. This article will explore the use of treated silica as a filler in passenger, truck and bus tires, and how using treated precipitated silicas can overcome manufacturing limitations associated with conventional high dispersible silica (HDS)/in situ silane technology.

Manufacturing industry and importance of suppliers

Manufacturers across the U.S. agree that sustainability is a critical priority. A recent survey by Ernst & Young of supply chain executives shows that eight in 10 firms are increasing their focus on supply chain sustainability (ref. 1). But the work manufacturers do inside their facilities is just one part of a successful sustainability strategy and the corresponding results. In fact, the role of suppliers, including original equipment manufacturers (OEMs) and their suppliers, is just as important. According to Principles for Responsible Investment (PRI), an independent proponent of responsible investment, supplier data are an integral component in measuring environmental, social and governance (ESG) results (ref. 2).

Now, pair the manufacturing sector's drive toward sustainable solutions with the clear need to accelerate the transition to cleaner, safer, more inclusive transportation systems, or "sustainable mobility." Opportunities lie not only with the manufacturers, but also with suppliers and OEMs to identify, innovate and bring new solutions to the market.

Automotive, tire and rubber industry trends

As the automotive industry experiences an uptick in future-forward innovation across the industry, the global megatrends of urbanization, surging demand for transportation and an urgent need for climate action will accelerate the transition to sustainable mobility. This includes cleaner, safer, more inclusive transportation systems. The tire and rubber industry plays a significant role in this transition.

The tire and rubber industry has been facing increasing pressure in recent years to reduce energy consumption and improve efficiency. Rising fuel costs, a wide range of environmental legislation and increased public consideration for energy usage and the environment continue to drive the pursuit of fuel efficient and longer lasting automobile tires. As a result, the tire industry is compelled to broaden its focus on the "magic" triangle of fuel efficiency, traction and treadwear to meet these demands.

A snapshot of silica history

The tire industry's history in developing sustainable tire formulations dates back decades to as early as the 1980s and 1990s. Silica emerged as a favored reinforcing filler in passenger tires in the 1990s due to its ability to impact fuel efficiency and traction compared to the conventional carbon black filler in tire rubber compounds. Although researchers were working with conventional silica compounds as early as the 1970s, Michelin was the first to patent the use of silica in the 1990s as an adoption of a sustainable tire option (ref. 3).

When PPG introduced treated silica in 2009, rolling resistance was reduced by 30%, enabling a nearly 6% increase in fuel efficiency. The introduction of treated silica maintained the traction delivered by conventional silica, and laboratory tests showed a 10% improvement in abrasion resistance leading to improved treadwear (ref. 4). In 2015, Goodyear introduced the first tire created with treated silica (ref. 5).

Traditional silica in tire manufacturing

Although silica reduces rolling resistance and offers fuel consumption savings throughout the tire's lifespan to reduce CO_2 emissions, it also has a significant impact on energy usage during the tire manufacturing process.

It is widely known in the tire industry that silica mixing in rubber compounds requires long mixing times and high temperatures to provide adequate silica dispersion and an efficient silanization reaction (refs. 6 and 7).

Amorphous precipitated silica is commonly used as a filler in rubber compounds due to its low cost and performance properties. However, untreated silica has certain limitations, such as poor dispersibility in rubber, which can make it difficult to incorporate into rubber compounds. Thus, the manufacturing disadvantages of rubber compounds filled with conventional silica can include reduced productivity due to longer mixing times, higher mixer energy consumption, higher mixer wear and volatile organic compound (VOC) emissions.

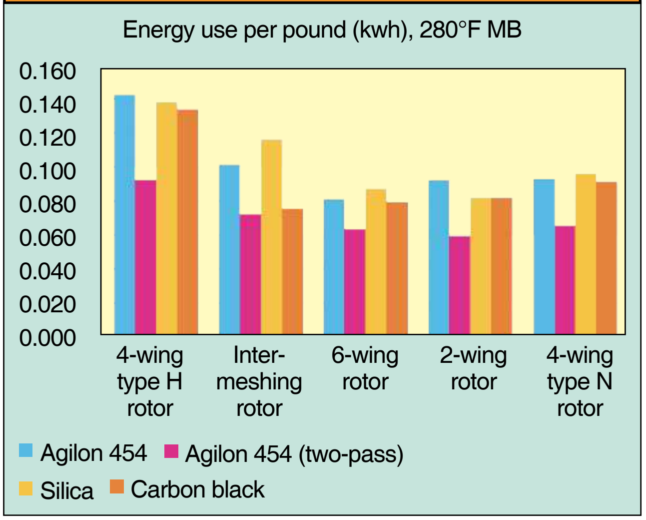
To overcome these limitations, silica can be treated with various surface coatings to modify its properties.

Treated silicas have been chemically modified to enhance their properties. They are engineered to have unique surface properties that can improve the performance of rubber compounds and reduce energy consumption during the tire manufacturing process. They can be used in various industrial applications, including coatings, adhesives, sealants, plastics and industrial rubber. The industry has historically turned its attention to tire performance to deliver sustainability improvements; and now, with products like PPG Agilon high performance silica products, they can focus on manufacturing efficiency to meet their sustainability goals.

Benefits of treated silicas

In the tire industry, treated precipitated silicas, such as PPG Agilon silica products, have emerged as a promising approach to achieving energy savings and improving the performance of

Figure 1 - energy use in natural rubber compounds (ref. 8)



rubber compounds, particularly in tire manufacturing (ref. 3).

By increasing their compatibility with the rubber and eliminating the need for the silanization reaction to take place in the mixer, treated silicas can help to reduce energy consumption during the mixing process, and offer improved tire performance, including reduced rolling resistance and fuel consumption savings during the tire's lifetime.

One of the main advantages of treated silicas is their ability to improve the reinforcing properties of rubber compounds. The surface coatings on treated silicas can enhance the interaction between the filler and the rubber matrix, resulting in improved mechanical properties such as tensile strength, heat buildup, tear resistance and abrasion resistance. This can lead to long lasting and durable rubber products compared to conventional silica.

Additionally, the use of treated silicas can help to reduce the amount of energy required during the mixing process. By being pre-silanized, treated silicas can help to reduce the amount of energy required to mix the compound and improve the overall efficiency of the mixing process. This can be particularly useful in applications such as tire manufacturing, where large amounts of rubber compounds are mixed and energy consumption is a significant concern.

Treated silicas and sustainability: A case study

Agilon performance silicas are pretreated with silane coupling agents, as well as other compatibilizers. These are pre-reacted onto the silica surface so that tire and industrial rubber manufacturers do not need to perform the silanization reaction during compounding. Since the silane is already covalently bound to the silica surface, in situ silanization during mixing is not necessary, and a less energy intensive mixing process is possible.

Several studies have demonstrated the effectiveness of Agilon products in achieving energy savings and improving the performance of rubber compounds. For example, Okel and Martin studied the energy savings from using Agilon silica in NR compounds, using a different type of rotors, when compared to untreated silica and carbon black.

Figure 1 shows the energy savings they were able to obtain by eliminating one mixing pass when using Agilon 454G silica. The study also found that the use of Agilon products can improve the mechanical properties of the rubber compound, resulting in longer lasting and more durable rubber products.

A recent PPG study of rubber mixing involved using two types of silica: Agilon 400G-D silica and PPG Hi-Sil EZ160G silica, along with other compound ingredients. The compounds were mixed in a Farrel IM1.5E mixer with intermeshing rotors, and mixing curves were analyzed with Advise ES 2.3 software. The mixing process involved three stages, each with different, carefully selected temperatures, rotor speeds and fill factors. The compounds were then milled for 60 seconds on a two-roll mill after every stage. Various tests were conducted on the mixed compounds, including durometer A hardness, stress/strain properties, dynamic properties, rebound, heat buildup, permanent set and tear strength, according to ASTM standards. The results of the study provide valuable insights into the use of silica in rubber mixing, and can help improve the quality of rubber products.

In the recent PPG study, the company demonstrated how treated silica products are engineered to have unique surface properties that can improve the reinforcing properties of rubber compounds and reduce the viscosity of the compound, resulting in energy savings and improved efficiency.

Figures 2 and 3, obtained during this study, show the ram position during mixing for the first mixing stage when using different fill factors. According to the mixer manufacturer recommendations, the fill factor for the first mixing pass should be such that the mixer ram bottoms towards the end of the mix time. Figure 2 shows that, for the compound with PPG Hi-Sil EZ160G silica, a 79% fill factor is too high and the ram does not sit, even after 6 minutes of mixing. A 76% fill factor seems to be ideal. Figure 3 shows that a 79% fill factor is possible when using Agilon 400G-D silica. Also, when using Agilon silica, the ram position does not fluctuate as much. It is hypothesized that this behavior is due to the better incorporation of the silica and the absence of VOCs trying to escape from the mixer.

Figure 2 - ram position during mixing of Hi-Sil EZ160G silica compound

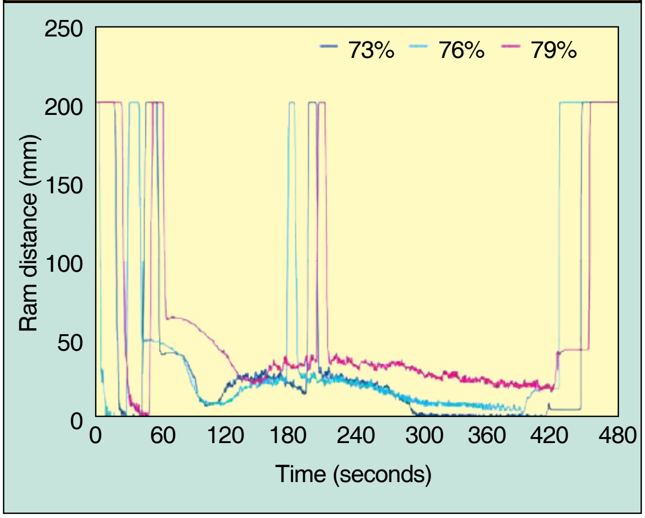
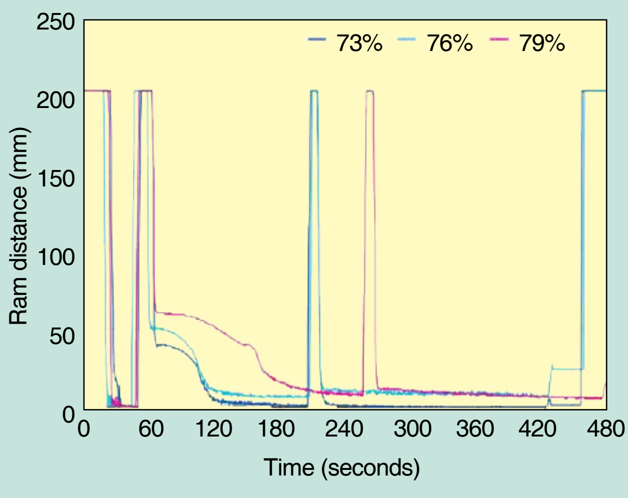


Figure 3 - ram position during mixing of Agilon 400G silica compound



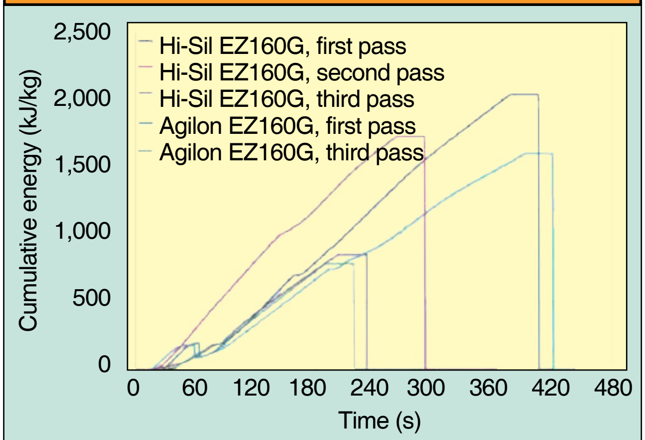
After determining the optimum fill factors, compounds were prepared using a standard mixing procedure used for untreated silicas with a silanization step, and with reduced mixing times, since silanization is not necessary for Agilon silicas. In the study, it was demonstrated that reducing mixing times has negative effects on the performance of the compounds with untreated silica. On the other hand, compound performance is enhanced when the Agilon compound is mixed with reduced mixing times, even eliminating one mixing pass, and temperatures. Energy consumption was monitored during mixing, and the cumulative energy consumption for each mixing stage is shown in figure 4. When adding the energy consumed in each stage, for each compound, it is observed than the Agilon compound is prepared using 48% less energy. This was achieved while still obtaining good compound performance.

Case study results

The effect of using different mixing strategies for synthetic rubber compounds filled with Hi-Sil EZ160G and Agilon 400G silicas was evaluated. First, the optimum mixer fill factor was determined for each type of silica. It was concluded that Agilon 400G silica should be mixed with a slightly higher fill factor than Hi-Sil EZ160G silica. It is hypothesized that this is due to the absence of VOCs generated during mixing, and the higher hydrophobicity of Agilon silica. Using the optimized mixer fill factors, compounds were mixed using standard mixing procedures generally used for untreated silica-silane mixing and a more sustainable mixing procedure. It was concluded that Agilon 400G can be mixed for significantly shorter times, while reducing mixer energy consumption by 48%. As a result of this, higher plant productivity and less mixer wear can also be obtained. These manufacturing benefits can be achieved without any loss of compound performance.

By reducing energy consumption during the manufacturing process, treated silicas can help to reduce greenhouse gas emissions and improve the overall sustainability of the industry. Additionally, the improved mechanical properties of rubber compounds can lead to longer lasting and more durable products, reducing the need for frequent replacements, and ultimately reducing waste. The full case study, including all figures, tables and results, is available from PPG (ref. 9).

Figure 4 - cumulative energy consumption curves



Future directions

Despite the challenges and limitations, the use of treated silicas represents a solution for achieving energy savings and improving the performance of rubber compounds in the rubber industry. Ongoing research and innovation in this field hold great promise for the future of the industry.

One area of potential research is the development of new types of treated silicas that can achieve even greater energy savings and improved performance. For example, researchers could explore the use of treated silicas in other types of rubber products, such as seals and gaskets, to achieve energy savings in these applications. In tires, new developments will continue to further extend the tire industry's "magic triangle" to lower rolling resistance, increase traction and improve wear resistance.

Another area of potential research is the development of new mixing and curing processes that are optimized for the use of treated silicas. For example, researchers could explore the use of new types of mixing equipment and techniques that are specifically designed to work with treated silicas. This could help to further reduce the energy consumption associated with the mixing of rubber compounds, and improve the overall efficiency of the manufacturing process.

As the demand for energy efficient and high performance rubber products continues to grow, the use of treated silicas is likely to become increasingly important in achieving these goals, while also promoting sustainability and reducing the environmental impact of the industry.

Conclusion

Manufacturers around the world are facing increased pressures to improve and accelerate their sustainability strategies and performance. Working closely with the value chain and utilizing the data from suppliers and OEMs is a critical component to achieving desired climate care results. Within the tire industry specifically, the use of treated silicas represents a promising solution to achieve energy savings and improve the performance of rubber compounds in the rubber industry. By improving the reinforcing properties of rubber compounds and reducing the viscosity of the rubber compound, treated silicas can help to reduce energy consumption during the mixing and curing process, and improve the overall efficiency of the end product. Several case studies have demonstrated the effectiveness of treated silicas, including Agilon products, in achieving these goals; and ongoing research and innovation in this field hold great promise for the future of the industry. As the demand for energy efficient and high performance rubber products continues to grow, the use of treated silicas is likely to become increasingly important in achieving these goals, while also promoting sustainability and reducing the environmental impact of the industry.

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Treated silicas

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The two-roll plasticizer (TRP)

by Julia Uth and Manuel Bessler, UTH GmbH

The TRP Reworker is a resource saving technology for the economical processing of rework materials based on the two-roll plasticizer (TRP) with integrated Roll Ex gear pump. In an automatic process, unvulcanized rubber compounds are processed particularly gently and continuously in order to return this rework material to the production process. In tire production, compound waste is unavoidable due to the process. This material should be reworked with regard to the issues of sustainability and the economical handling of valuable resources, and not least because of the high raw material costs. Based on the UTH TRP technology, the company has developed the TRP Reworker. This process technology combines the proven methods in rubber processing, such as cracking, homogenizing and discharging; thus, closing a gap in the processing of rework materials. The concept is based on TRP technology and comprises three zones along the length of the roll, resulting in a continuous, reproducible and fully automated process.

The tire is a complex, high tech product consisting of more than 10 different rubber compounds and more than 20 components. For this reason, tire production is a very complex and high precision process. During the individual process steps, a considerable amount of base material residue falls to waste. This so-called rework material consists of high quality raw materials. In terms of sustainability and the economical handling of valuable resources, and not least because of the high raw material costs, the rework material should not be considered as waste. Tire manufacturers are pursuing the worthwhile aim of processing this material with low sheer into a high quality intermediate product, so that it can be returned to the production process. A material friendly preparation process is crucial. The better the quality, the higher the return rate. With smaller and smaller batch sizes for a larger number of specialized tires, the absolute amount of rework material is increasing worldwide. This creates a need to collect this material in order to be able to return it to the production line by means of a reproducible and economical rework process.

State-of-the-art

During the rework process, the material is first plasticized, homogenized and then discharged, so that it can be blended with fresh compound. Today, the reprocessing steps often take place cyclically in the same production lines in which the preliminary products are also manufactured, e.g., internal mixer or open mill lines (figures 1 and 2).

The use of open mills has been proven to ensure stable temperature control, and is therefore particularly well suited for a material friendly reprocessing process. Due to the cyclical accumulation of rework material, the entire process must be carried out manually, which increases the risk potential for the operator. In addition, reproducible quality is difficult to ensure, as it depends on the operator's experience and skills in controlling the open mill process. The reprocessing of rubber compound in the internal mixer line is better to control than the open mill lines, and causes less risk for the operator. However, on the process technology side, the rework material experiences relatively high shear forces, and thus increased temperatures, which can further

Table 1 - process requirements

- Feeding of rubber compound or rework material with different specifications and shapes
- Sufficient plasticization and homogenization with gentle material treatment
- Good access to the processing area for cleaning and material change
- Reproducible and automated processing with minimum of operator workload

Figure 1 - internal mixer line

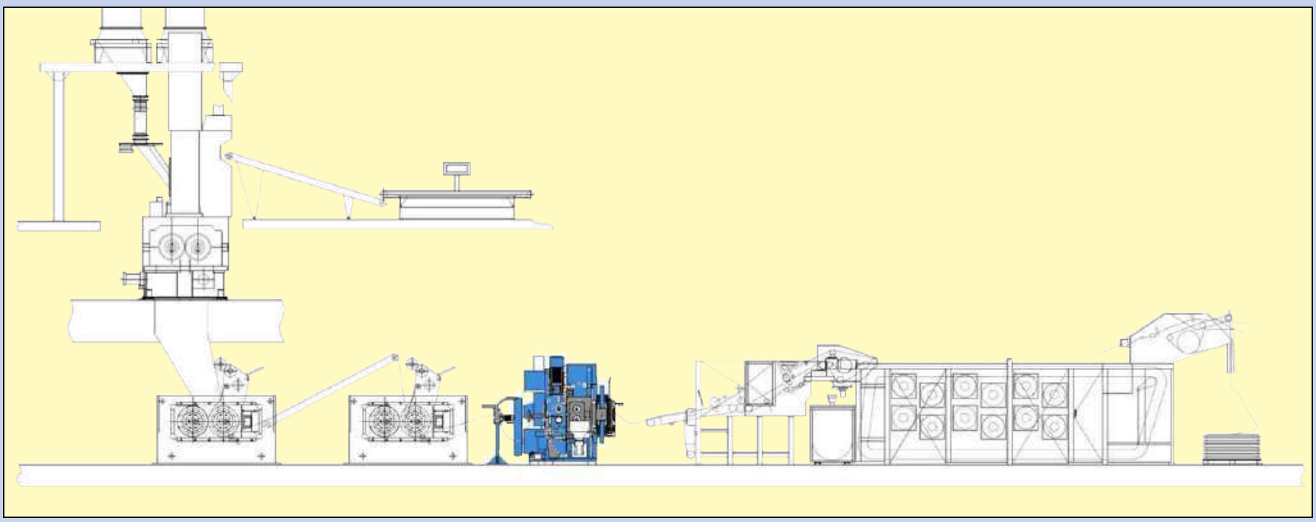
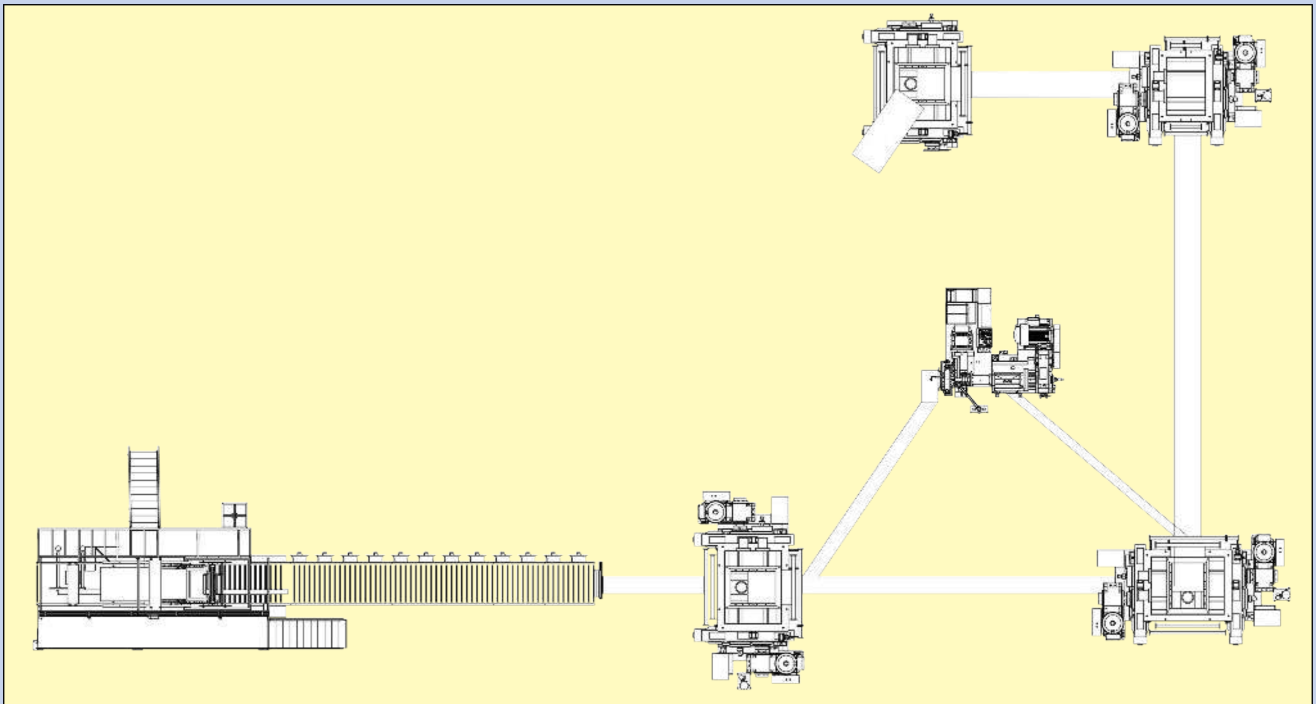


Figure 2 - open mill line



harm the material that is already under stress. To ensure a low sheer process, the internal mixer must be set at a slow rotor speed, which results in comparatively long mixing times. The cost efficiency of the cyclic reprocessing process is also lessened by high energy and space requirements, as well as the cost of machine minutes for the entire mixing line (table 1).

Basic principles of TRP technology

The two-roll plasticizer (TRP) with integrated gear pump from UTH has been established as a solution which meets these requirements. The automatic and continuous process combines proven technologies in rubber processing, such as cracking, homogenizing and discharging. The basic principle is based on an open roll system combined with the Roll-Ex gear pump technology.

The compact system consists of three zones located along the length of the roll (figure 3). In the feeding zone, materials of various types and shapes, such as slabs, sheets or shaped profiles, can be fed by a conveyor. During the process, a mechanically effected transformation takes place in the nip of the homogenization zone in which the material is plasticized and homogenized (figure 4). According to the Roll-Ex TRF principle, the material is then directly extruded in the discharging zone. The manual

Table 2 - advantages of the TRP Reworker

- During rework process, the material is processed under low sheer continuously with very good temperature control
- Automated processes for reproducible results
- System has a modular design: an integrated Roll-Ex gear pump with the option of fine mesh straining allows discharge of the material in different shapes
- Process area is completely enclosed and thus ensures a high level of work safety
- Due to the compact, space saving design, space costs can be reduced
- Good access to the system components for cleaning and compound changes
- Up to 50% energy savings compares to existing processes
- At least 5% of raw materials in tire production can be saved by using the TRP technology
- 98% of the process related waste can be returned to the tire manufacturing process

Figure 3 - basic principle of TRP technology

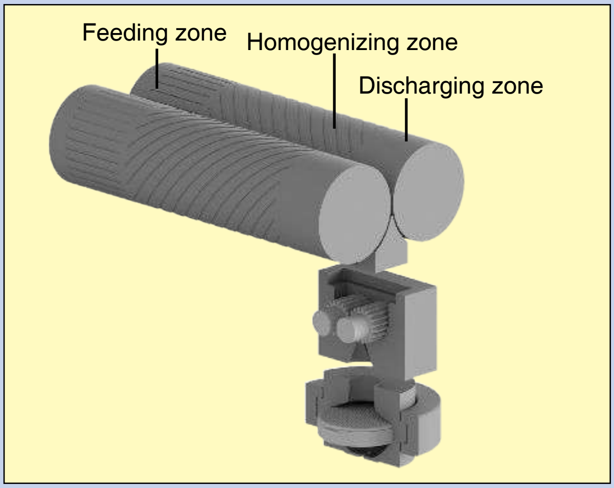
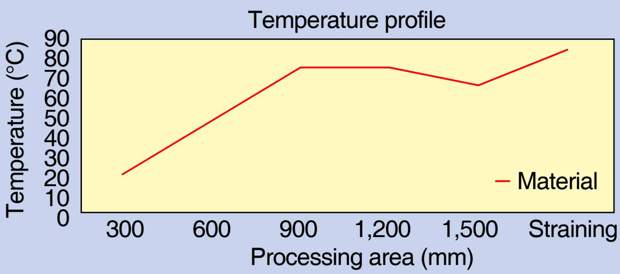


Figure 4 - homogenization of the compound on the nip of the open mill

Figure 5 - temperature profile along the rolls



intervention of an operator in the process area is, therefore, no longer required, and is also prevented by a full housing of the processing area. The final outcome is a safe, controlled and continuous homogenization process with reproducible results (table 2). Due to the modular concept, the TRP offers the option of an integrated gear pump extruder for the gentle fine mesh straining of the material (table 3).

The basis for a low sheer rework process is a controlled temperature development (figure 5). In TRP process technology, this is guaranteed by temperature zones that can be set differently across the entire length of the rolls. Good homogenization and plastification performance are achieved by mechanical transformation of the compound. The required friction, which increases the plasticizing performance, can be optimized for the respective process by means of different roller speeds and gap adjustments. A roll design, which is especially designed for the rework process, also enables an axial material transport from the feeding zone to the discharging zone.

Design of the TRP Reworker system

Based on the two-roll plasticizer, a system solution has been developed to meet the demands of the rework process in the tire industry (figure 6). In addition to the core component (the plasticizing unit), the modular concept consists of several system components, and thus enables application specific solutions.

Table 3 - what is fine mesh straining?

Fine mesh straining is the fine filtration of rubber or silicone compounds. Impurities are retained in a screen and removed from the material flow. Depending on the compound quality and mesh size, pressures of several hundred bar are required for this process.

The feeding unit

Rework materials such as treads, sidewalls or profiles usually vary in geometry and piece weight. A continuous homogenization process is, however, necessary for a controlled process and reproducible results. The discontinuous feeding is coupled with a continuous process by the feeding unit. The material is first transported to a weighing and cutting device via a horizontal belt conveyor before it passes through the metal detector, and is then fed to the plasticizing unit via an ascending conveyor. Alternatively, slabs can be fed directly from a pallet using a slab feeder and cutting device.

Plasticizing unit

The plasticizing unit of the TRP Reworker is based on the process technology of the two-roll plasticizer. A feeding zone, especially tailored to the rework process, enables the processing of materials with different rheological properties. Common rework materials in the tire industry are, for example, truck or car tread compounds with a hardness of 60-70 durometer A and a Mooney viscosity of 50-60 units; sidewall compound with a hardness of 40-55 durometer A and a Mooney viscosity of 50-60 units; or apex material with a hardness of 60 durometer A and a Mooney viscosity of 75 units. All the rework materials deriving from these components can be easily reworked in the plasticizing unit. The same also applies to ply or inner liner compound.

TRP discharging zone

The discharging zone of the plasticizing unit is based on the proven Roll-Ex TRF principle (two-roll feeding unit). The following gear extruder is actively fed by two temperature controlled rolls. When the material leaves the roll nip, the feed pressure is generated, which is necessary to completely fill the teeth of the gear pump. In the material discharge zone, the temperature of the material can be modified by means of a separate temperature controlled zone (figure 5), which provides additional temperature variations for subsequent processes.

Strainer gear pump unit

In the standard configuration, a Roll-Ex gear pump-strainer unit is positioned under the TRP discharging zone. The gear pump and the strainer head can be hydraulically swiveled away from the TRP for cleaning and screen changing purposes. Temperature sensors record the temperature in the discharging zone of the plasticizing unit (in front of the gear pump) and in the strainer head to allow monitoring of the temperature development.

The gear extruders work on the principle of positive displacement pumps. At the entering side of the pump, the material is retracted, transported in the space width of two intercombing gears, and then displaced from these spaces by the interlocking

Figure 6 - the complete solution: TRP Reworker

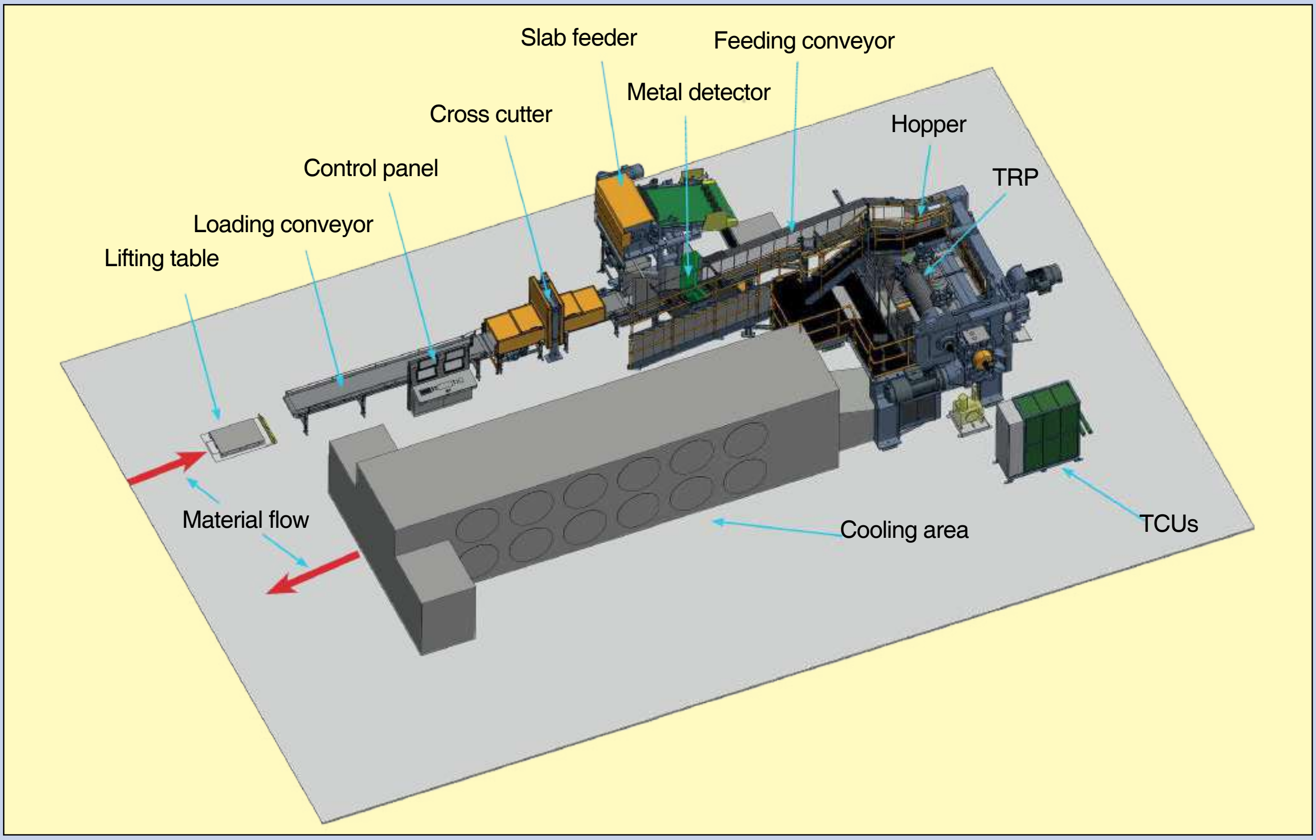


Figure 7 - gear pump extruder with two-roll feeder

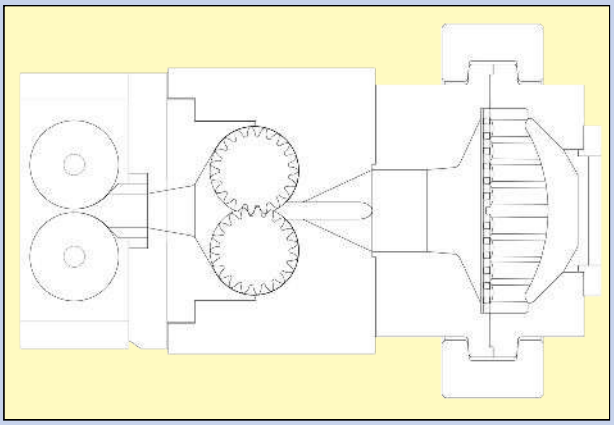


Figure 8 - TRP Reworker 2800 with integrated gear pump

of the gears. This displacement results in the building of pressure and further material transport (figure 7).

Cooling section

The rubber compound can be cooled in conventional cooling systems. Depending on the form of the discharged compound, cantilever cooling sections or classic batch-off systems are suitable for palletizing sheets. Since the temperatures of the batches are approximately 100°C and, due to the relatively slow speeds, e.g., between 5-9 m/minute in the case of a sheet extrusion, the cooling sections can be of relatively compact dimensions.

State of development and future outlook

The TRP technology has established itself in the tire industry as an alternative solution for the processing of rework materials. The TRP Reworker the size of the 2800 model has a throughput of 2,500 kg/hour, and thus meets the usual rework requirements in a tire factory (figure 8). Other sizes and designs can provide options for other processing tasks in rubber and silicone processing, such as preheating, mixing and discharging.

Rubber Division's IEC returns to Cleveland

The Rubber Division of the American Chemical Society will host this year's International Elastomer Conference (IEC), featuring the 204th Technical Meeting, Educational Symposium and Expo, October 16-19 at the Huntington Convention Center in Cleveland, OH.

Frank A. Davis, president and CEO of The Horizon Group of Companies, will present the keynote address, "Building order from chaos to jumpstart excellence," on Tuesday, October 17, at 9 a.m.

The IEC Expo will feature nearly 200 companies and organizations. Exhibitors will include a wide variety of companies, such as equipment manufacturers, injection molders, custom mixers, providers of extruders, processing equipment, hydraulic presses and vacuum molding, testing laboratories, distributors, suppliers, and more. Expo hours are 10:30 a.m. until 5 p.m. on Tuesday, October 17, 10 a.m. until 5 p.m. on Wednesday, October 18, and 10 a.m. until 1 p.m. on Thursday, October 19.

The WORD (Women of Rubber Division) program will take place on Monday, October 16, at 4 p.m. With a focus on cross-generational communications, this event will feature a panel of women representing multiple generations, as well as small group breakouts, concluding with a networking reception.

The 25-Year Club Luncheon will take place on Tuesday, October 17, at noon. The featured speaker is Dan Ruminski, The Cleveland Storyteller, who will share stories that illuminate what made Cleveland great. The Young Professionals Forum takes place on Tuesday at 4 p.m. The Welcome Reception will be held on Tuesday, October 17, at 5 p.m.

The annual 5K Walk/Run, sponsored by H.M. Royal, will be held on Wednesday, October 18, with check-in at 6:30 a.m.

The Business of Rubber will be held on Wednesday, October 18, at 9 a.m. This event will provide key industry insights and perspectives that are focused on the business/commercial side of the industry. The speaker will be Neill Mendes, CEO of Alpine Polytech, who will present, "Global energy transition: Market overview and demands on non-metallics."

The Young Professionals Reception will take place on Wednesday, October 18, from 5 p.m. until 7 p.m.

Career Catalysts will be held October 18 and 19, and will include half hour presentations in the Expo Theater designed to help attendees take their careers to the next level by providing the tools and guidance they need to succeed. William Hyde, vice president, Olefins and Elastomers, OPIS, A Dow Jones Company, will present, "Commodity petrochemical markets: Will over capacity in key markets ever be absorbed?"

The Awards Breakfast takes place at 8 a.m. on Thursday, October 19. Winners of the Student Symposium, Service Awards, Best Paper Awards, etc., will be announced.

The Experience Elastomers student outreach program will be held on Thursday, October 19, from 9 a.m. until 1 p.m. High school students will learn about the industry through hands-on workshops, Expo booth interaction activities and discussions regarding different career paths.

This year's Educational Symposium, sponsored by Parker Lord, will include the following courses:

Introduction to Testing and Understanding Your Data will be held on Monday, October 16, from 1 p.m. until 4 p.m. This course is designed for both non-technical and technical individuals who are new to the rubber industry. The course is centered around basic explanations of common tests and practical examples of how to apply the data collected. Kylie Knipp of ACE Laboratories is the course instructor.

Essentials of Silicone Rubber will be held on Tuesday, October 17, from 8:30 a.m. until 12:30 p.m. This course is designed to provide a thorough understanding of silicone's engineering characteristics. It will guide attendees from creation of silicone from sand through formulating the compound and the various methods by which silicone can be fabricated into useful service articles. The subject matter will deal with the differences between high consistency rubber, caulks and the various liquid silicone rubbers. The course instructor is Joseph Walker of Elastomer Technologies.

Rubber Explained will be held on Tuesday, October 17, from 8:30 a.m. until 12:30 p.m. This course is designed for sales and executives working in the rubber industry. Centered around practical explanations and basic fundamentals, this is said to be the perfect course for the non-technical individual. Kylie Knipp of ACE Laboratories is the course instructor.

Rheology 101 will be held on Tuesday, October 17 from 10 a.m. until 11 a.m., and again on Wednesday, October 18, from 12:30 p.m. until 1:30 p.m. This course is designed to provide attendees with the theory behind rheology testing. Attendees will be guided through hands-on instrument and sofware instruction from Alpha Technologies applications engineers. The course instructor is Unal Yilmazoglu of Alpha Technologies.

Predicting Tire Performance will be held on Tuesday, October 17, from 12:30 p.m. until 1:20 p.m. This course is designed to provide attendees with an understanding of how to predict tire performance using an experimental design and real world

Rubber Group News

The **Mexico Rubber Group** will hold the course, "Design, Development and Production of Rubber Compounds," instructed by Luis Mayorga, November 23 at the Rubber Chamber Auditorium in Mexico City, Mexico. Details are available at www.rubber.org/mexico-rubber-group.

The **Ohio Rubber Group** will hold a technical meeting September 26 at the Hilton Garden Inn in Twinsburg, OH. Details are available at www.ohiorubbergroup.org.

The **Twin Cities Rubber Group** will hold a technical meeting September 21 at Cowboy Jack's in Bloomington, MN. Visit www.twincitiesrubbergroup.org.

SDS-SYSTEMTECHNIK 25TH ANNIVERSARY

SDS Systemtechnik celebrates its 25-year anniversary. Founded in 1998 by Stefan Dengler, the company started with a handful employees in a back garage. Since then, SDS has grown to a 25-person company with over 2,500 square meters for production, assembly and administration.

With a wide range of equipment, the complete systems are manufactured and tested in house and delivered from SDS to clients all over the world. Almost all supplied systems can be repaired and updated, regardless of type and year of manufacturing.

With Central Marketing, SDS has a strong partner at its side since 2012. Central Marketing is the point of contact for all customers in North America. The company has been a servicing supplier to the new tire manufacturers and the retread tire industry for over 37 years. Currently, to support equipment in the field, Central Marketing carries a very large inventory of parts.

The SDS product catalog provides a wide range of equipment for the new tire and retreading industry:

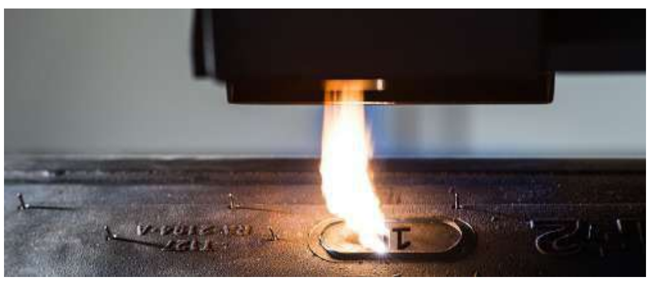
ITT – **I**nterferometric **T**ire **T**ester

LMS – **L**aser **M**arking **S**ystem

Gamma-X – cross section measuring

EMS – **E**ndurance **M**easuring **S**ystem

PTS – **P**ressure **T**esting **S**ystem



case studies with a rubber process analyzer. Rolling resistance, wet/dry traction, ice traction and handling/cornering will be covered. The course instructor is Richard Hanzlik of Alpha Technologies.

Dynamic Viscoelastic Properties will be held on Tuesday, October 17, from 1 p.m. until 5 p.m. This course starts with a very brief introduction to viscoelastic theories and models, and then shifts to explanation of the viscoelastic properties of elastomers and how those properties can be measured. Participants will learn about how tire performance can be produced using dynamic mechanical analysis, and how these testing methods can be applied to other non-tire applications, as well. The course instructors are Nicki Hershberger and Bonnie Stuck of Akron Rubber Development Laboratory.

Scientific Rubber Molding will be held on Tuesday, October 17, from 1 p.m. until 5 p.m. This course is designed to show how to establish a rubber molding process based on crosslink density. It is designed to show the influence of crosslink density on mechanical properties, as well as its influence on demolding. The overall focus is the design of a rubber molding process that yields the most consistent properties. The course instructor is Joseph Walker of Elastomer Technologies.

Process Engineering with an Alpha RPA Level 1 will be held on Tuesday, October 17, from 2 p.m. until 5 p.m. This course is designed to provide attendees with an understanding of the Alpha Technologies Premier RPA instrument. The entry level training is designed to help technicians, engineers and laboratory managers better understand how to utilize their RPA and interpret results in a meaningful way. The course instructor is Richard Hanzlik of Alpha Technologies.

Essentials of Rubber Technology will be held on Wednesday, October 18 from 8:30 a.m. until 12:30 p.m. Course content will cover rubber and its history; basic polymer chemistry and how to use it; differences between rubber and plastic; rubber use by engineers; types of rubber; selection of rubber for applications; rubber compound formulation; rubber mixing; rubber curing and its relationship to properties; rubber testing, bonding and molding; improving rubber part quality; and writing and interpreting rubber specifications. The course instructor is Joseph Walker of Elastomer Technologies.

Rubber Vulcanization and Curing Chemistry will be held on Wednesday, October 18, from 8:30 a.m. until 12:30 p.m. This course gives an overview of the chemistry behind rubber vulcanization, but focuses on how different types of curatives and accelerators affect rubber properties such as crosslink density, tensile, modulus, compression set, heat resistance, etc. The course instructor is Bonnie Stuck of Akron Rubber Development Laboratory.

Enterprise Software Training will be held on Wednesday, October 18, from 9 a.m. until 11 a.m. This course is designed to provide attendees with an understanding of the Alpha Technologies Enterprise Software program that is used with Premier series instruments. The course will cover the basics of enterprise software and how to set up custom tests, work orders, formulas and parameters. Sofware as an LIMS system and how to best integrate it into a laboratory will be examined. The course instructor is Joe Cronin of Alpha Technologies.

Compounding Fluoroelastomers will be held on Wednesday, October 18, from 1 p.m. until 5 p.m. Course content will cover what fluoroelastomers are; how they differ from other elastomers; different types of fluoroelastomers; compounding ingredients used in fluoroelastomers; properties of fluoroelastomers, both processing and physical properties; troubleshooting; and applications. The course instructor is William Stahl of WMS Technologies.

Mixing and Testing for Compound Consistency will be held on Wednesday, October 18, from 1 p.m. until 5 p.m. This course is designed to provide participants with an in depth understanding of the influence of the mixing process on the characteristics of the mixed compounds. The focus of the course is on reducing the batch-to-batch variation commonly associated with batch mixed rubber compounds. Detailed discussion will take place on storage and handling of raw materials and the influence of the storage environment on the properties of the rubber compounding using them. The course will cover the importance of sizing the rubber batch for the mixer and how to determine batch factors. Rubber test methods will be discussed in detail. The course instructor is Joseph Walker of Elastomer Technologies.

Process Engineering with an Alpha RPA Level 2 will be held on Wednesday, October 18, from 2 p.m. until 5 p.m. This course is designed to provide attendees with a more in-depth understanding of the Alpha Technologies Premier RPA instrument. This advanced level training will cover highly technical test methods such as harmonic analysis, Fourier transform rheology and how to create correlations between results. The course instructor is Richard Hanzlik of Alpha Technologies.

For more information on the Educational Symposium, including registration costs, visit www.rubber.org.

The 204th Technical Meeting, sponsored by Lianda, will include the following presentations:

Tuesday, October 17
Synthesis and Chemical Modification

Chemical modification of polymeric architecture for functional properties: An overview, Anil K. Bhowmick.

Modifications of acrylic rubber for improved performance, Mousumi DeSarkar.

Traceless crosslinking of polyisobutylene, Arsalaan N. Pathan.

Tuesday, October 17
Thermoplastic Elastomers

Using the RPA in four different rubber manufacturing systems, John Dick.

Elastic/viscoelastic polymer bilayers: A model based approach to intelligent stretchable constructs, Gary Wnek.

Optimizing the sensing performance of TPU/CNTs piezoresistive pressure, Sara Naderizadeh.

Tuesday, October 17
Advances in Tires

Understanding and improving the processing of silica/mercaptosilane filled tire tread compounds, Anke Blume.

Road to safer tires: Finding the right silica/silane combination, Fabian Grunert.

Use of vegetable oils in high polarity tire and rubber formulations to address current formulation requirements, Nick White.

Investigation of suitability of graphene as a potential partial replacement filler in natural rubber/butadiene rubber based tire compounds, Rajesh Theravalappil.

Next generation carbon black to improve performance properties in automobile tire tread compounds, Lashan M. Hendavitharanage De Silva.

Very high structure carbon blacks to address challenges in tread compound performance, Lewis Tunnicliffe.

Thermo-oxidative aging study of tire tread compound: Influence of silica and carbon black filler in SSBR based compound, Rajeshbabu R.

Tuesday, October 17
Healthcare and pharma

Some recent advances in elastomer based smart materials for energy harvesting, sensing and electromagnetic shielding, Changwoon Nah.

Consideration of thermoplastic elastomer gels as transdermal drug delivery media, Kenneth Mineart.

Antimicrobial and food grade EPDM compound, Ali Vahidifar.

Durability variation and composition of medical gloves, Ashley Herkins.

Multiscale thermo-kinetic aging model of complex systems: Application to polymeric materials and interfaces, Nestor Rodriguez.

Tuesday, October 17
Wear and Tribology

The influence of temperature on friction and wear performance of tire tread compounnds using a novel friction-wear rig, Eathan Plaschka.

Laboratory prediction of tire tread wear and associated high frequency vibrations, Hiroshi Mouri.

Tuesday, October 17
Sustainable Materials

UPM BioMotion renewable functional fillers for a lighter and more sustainable future, Barbara Gall.

Bio-sourced rubber curing ultra-accelerator for tires and TRG applications, John Kounavis.

From forest to formulations: Caltiox L as a green antioxidant for superior rubber performance, Germano Siqueria.

Upgrading rC for equivalent performance in existing carbon black applications, Constantine Khripin.

Circularity and performance attriutes of Continua sustainable carbonaceous material from Birla Carbon, Natalie K. Harris.

Properties of ultrasonically devulcanized and revulcanized used tire rubber and their blends with carbon black filled virgin natural rubber, Avraam I. Isayev.

Devulcanization of peroxide cured EPDM: Is it possible? Wilma K. Dierkes.

Wednesday, October 18
Contributed Papers

Rubber for Mars: Optimization of BR/VMQ compounds, Rafal P. Anyszka.

O-ring electrical resistance in wet conditions, Allan Zhong.

How to injection mold fast curing natural rubber, Connor Adams.

3D printing of fully compounded thermoset elastomers: Effects of compound formulation, Joey L. Mead.

Fiber-reinforced silicone pneumatic system with haptic feedback for teleoperation, Nathanlia Diaz Armas.

Proposed changes to established ASTM rubber processability methods to improve their effectiveness, John Dick.

Mechanistic investigation of LSR degradation of FR rated automotive electrical connectors, Noel Chang.

Wednesday, October 18
Advances in Tires

On the compound stiffness amplification by a reinforcing resin, Chenchy J. Lin.

Silane functionalized liquid rubber for electric vehicle tires, Yosuke Uehara.

Evaluation of farnesene/butadiene and farnesene/styrene/butadiene liquid rubbers in a silica tread, Edward R. Terrill.

Compatibility study of hydrocarbon resins with SSBR/BR rubber for tire applications, Howard Colvin.

Direct ink write of rubber formulations for automotive applications, Sarath Kamath.

Inferring the processability of high-cis-BR from molecular architecture, Fabio Bacchelli.

Beyond the Magic Triangle: Simultaneously optimizing abrasion and rolling resistance with advanced synthetic rubber solutions, Thomas Stratton.

Wednesday, October 18
PFAS Regulatory Environment

Fluoropolymer and fluoroelastomers amidst global PFAS regulations, Cy Genna.

Survey of PFAS analytical methodologies, Edward R. Terrill.

Fluorinated silicones, Alexandra Rinehart.

Regulations on PFAS (including PTFE), and what it could mean to the pumping and sealing industry, Phil Mahoney.

Potential impacts on global fluoropolymer supply due to PFAS legislation and litigation, Kurt Hayden.

Wednesday, October 18
Safeguarding Rubber Chemicals

Health and Environmental safety and Rhenogran predispersions, Joel G. Neilsen.

Carbon nanotube EH&S overview; Regulation, end-of-life, biotoxicity trends and Molecular Rebar, August Krupp.

Wednesday, October 18
Sustainable Materials

Sustainable options in non-tire markets, Nicki Hershberger.

A sustainable and cost effective TPV for a better future, Edgar Gonzalez.

Chain shuffling: A synthetic pathway to multiblock copolymers, Abhishek Banerjee.

Reducing carbon footprint by sustainable compounding, Ajithkumar Nair.

Investigation of filler interaction and degradation of disulfide elastomers made by reversible radical recombination polymerization (R3P), Aswathy S. Pillai.

Comparative chemical composition of U.S. and European tires VOC profile, potential environmental impact, including 6PPD, Nick Molden.

Wednesday, October 18
Characterization

Influence of silica and silane on the cure behavior of filled SSBR compounds, Anmol Aggarwal.

Understanding the crystallinity of carbon black and its effects on filled rubber compounds, Sadhan C. Jana.

Physical characterization of SuMo fly ash compounds, Eric Devney.

CO_2 solubility and diffusivity in fluoroelastomers and the challenges of API Spec 6A fixture test, Xuming Chen.

Enhanced thermal performance properties of EPDM carbon black composites via crossover curing ingredients, Arshad R.

Parathodika.

Characterization of dynamic mechanical and dielectric properties of rubber compounds by simultaneous high force DMA and DES, Yanxi Zhang.

Investigating the effects of thermal history on interlayer adhesion in thermoset 3D printing by atomic force microscopy (AFM), A.A. Mubasshir.

Wednesday, October 18
Advances in Tires

Fundamental studies of fatigue life of aramid tire cords, Tanvir Ahmmed.

Understanding the role of silica hybrid particles with styrene butadiene rubber shells on tread compound properties, Marcin Sek.

Wednesday, October 18
Adhesives

Advances in rubber to substrate bonding: An introduction and analysis of key principles and techniques, Roger A. Cassell.

Addressing sustainability within the rubber to substrate bonding market: A comparative study of the latest adhesive technology to convert typical solvent based bonding agents to earth friendly options, Roger A. Cassell.

Development and performance of water based adhesive system for the manufacture of rubber to substrate bonded products for sustainability and performance, Dennis Joseph.

Wednesday, October 18
Fatigue and Environmental Resistance

Using compression stress relaxation tools and DMA correlation to gain useful information on rubber compounds, Deidre Tucker.

Evaluating the combined effects of swelling and elevated temperatures in elastomer composites, Aaron M. Duncan.

Understanding the pitfalls of ASTM J2000/SAE J200 rubber specifications, Tom Hofer.

Wednesday, October 18
New Commercial Developments

Ultra-fine polyester staple fiber for rubber reinforcement, Mie Kamiyama.

Utilization of SureMix functional process aids in conjunction with low reactive silanes and high performance silanization to enhance performance, Gabriel Short.

Struktol performance liquids: A novel solution towards the performance-processability target conflict, Christian Geidel.

Functional low T_g SSBR for silica compounding, Hanjoung Cho.

Dynamic mechanical analysis of silicone rubber for cold temperature applications, Travis Parkman.

Unique silicone-organic synthetic leather first to combine genuine leather qualities with advanced sustainability, Craig Gross.

Technical results and processing performance of new Viton FWRD APA fluoroelastomers, Luca Cirillo.

Investigating the effects of graphene nanoplatelets (GNPs) and external water based crosslinker (eWCL) on the mechanical and thermal properties of water based elastomer (WBE) nanocomposites, Christian N. Nwosu.

Wednesday, October 18
Sustainable Processes

Closing the loop for silica filled passenger car tire rubber, Rounak Ghosh.

Thermo-mechanical deculcanization of ELT using a planetary roller extruder, Michael W. Batton.

Vulcanization of an IR/BR copolymer using a CO_2 laser as inline curing method for additive manufacturing of rubber based parts, Sebastian Leineweber.

Minimizing temperature deviations in rubber extrusion lines using artificial neural network based process control, Marco Lukas.

Sustainable EPDM rubber, expanding the use of bio-sourced feedstocks and certification, Pete G. Spanos.

Rubber dandelion: A source of natural rubber latex, Nathaniel King-Smith.

Energy savings obtained when using treated silicas, Lucas Santos Freire.

Application of a lean metric, overall eqipment effectiveness, in production processes in the rubber industry for sustainable performance, Tapan Das Gupta.

Asahi Kasei's new selectively hydrogenated SBR for 6PPD reduced usage, Daisuke Hayata.

Thursday, October 19
Characterization

Characterization of dielectric elastomer actuators based on functionalized liquid isoprene rubber for soft robotics applications, Jishnu N. Suresh.

Optimization of test parameters for time-temperature superposition testing and effect of heat history on time-temperature superposition results, Jonathan Martens.

Understanding the role of temperature dependent bound rubber on the viscoelastic properties of filled elastomer composites, Kirsty Rutherford.

Use of advanced microscopy to elucidate the structure and mechanism of crosslinking of rubber, Gina Butuc and Kees van Leerdam.

The crosslink density and its distribution by double quantum nuclear magnetic resonance, part 1: Heat and oil resistant elastomers, Richard J. Pazur.

Determination of the crosslink density of silica filled styrene butadiene rubber compounds by different analytical methods, Pilar B. Ortega.

Recyclable elastomers with dynamic covalent bonds: How to characterize reversible crosslinked networks, Anureet Kaur.

Thursday, October 19
Fatigue and Environmental Resistance

Interaction of hydrogen with fluoroelastomers: Sorption and degradation, Anil K. Bhowmick.

Effects of supercritical CO_2 on oilfield elastomers for energy transition: Chemical compatibility and rapid gas decompression, Jay Yun.

Study of rapid gas decompression using coupled diffusion-structure analysis, Goang-Ding Shyu.

Investigating origin of temperature dependence of rubber rupture, Zehao Fan.

Development of silica filled military track pads, Chris Tolliver.

Effect of pre-irradiation of gamma ray on the thermal degradation of tetrafluoroethylene-propylene elastomer evaluated using weight change, Masayuki Ito.

A review of thermal effects on elastomer durability, Will V. Mars.

Thursday, October 19
New Commercial Developments

Upgrading recovered carbon: Performance characteristics of Sterling SO RC110 circular reinforcing carbon in sidewall and weatherstrip applications, Mark J. Pender.

Sustainable carbon black production, Lin F. Bradley, Jr.

Moldex3D rubber molding simulation and validation, Harshal Bhogesra.

VMI's continuous mixing and blending approach seeks to improve operational efficiency and product quality, Bill Bisson.

3D printing of articles from fluoroelastomer (FKM) and perfluoroelastomer (FFKM) and printer used for them, Mookkan Periyasamy.

3D printing of industrial elastomers: Reactive extrusion additive manufacturing at scale, Cora Leibig.

Small chemicals weighing innovation, Guido Fona.

Thursday, October 19
Custom Mixing

Increasing throughput and energy efficiency utilizing new PES7 intermeshing rotor technology, Georgia Sharp.

The influence of fine mesh straining in the mixing line upon the rheological and physical properties of rubber compounds, Julia Uth.

Mix time and energy savings with green compound stability with Pepton DBD based chemical peptizers, Dave Abdallah, Jr.

Thursday, October 19
PFAS Regulatory Environment

Possible effects of regulations on the aerospace and defense industries, Jessica Mattison

Thursday, October 19
Contributed Papers

FDA compliant Zetpol HNBR nonblack compounds, Adeyemi Adepetun.

Federal international trade policies and predictions, Daniel Pickard.

Design and development of an indigenous air spring system for Indian railway model simulation and evaluation, Tapan Das Gupta.

Further information on the 2023 International Elastomer Conference, including registration details, is available from the Rubber Division (330) 595-5531; www.rubber.org.

Calendar

Messe Düsseldorf North America, T-PLAS, International Trade Fair for the Plastics and Rubber Industries, Bangkok Trade & Exhibition Center (BITEC), Bangkok, Thailand, www.mdna.com - September 20-23.
Rubber Division, ACS, Career Catalyst Webinar: Virtual Interviewing, How is it Different from In-Person Interviewing, www.rubber.org/training - September 21.
Twin Cities Rubber Group, technical meeting, Cowboy Jack's, Bloomington, MN, www.twincitiesrubbergroup.org - September 21.
Center for the Polyurethanes Industry, 65th Polyurethanes Technical Conference, Marriott Rivercenter, San Antonio, TX, https://www.americanchemistry.com/industry-groups/center-for-the-polyurethanes-industry-cpi/polyurethanes-technical-conference - September 25-27.
Ohio Rubber Group, technical meeting, Hilton Garden Inn, Twinsburg, OH, www.ohiorubbergroup.org - September 26.
Interplas Events Limited/Rapid News Group, Interplas Insights Conference 2023, National Exhibition Center (NEC), Birmingham, U.K., www.interplasuk.com - September 26-28.
Gerlach, Hot Air Vulcanization online seminar, www.gerlach-machinery.com - September 27-28.
Messe Düsseldorf, Central Asia Plast World, Atakent Exhibition Center, Almaty, Kazakhstan, www.mdna.com/shows - September 28-30.

October

University of Akron, Akron Polymer Training Services, Rubber and Plastics Failure Analysis: Physical and Chemical Analysis Techniques course, www.uakron.edu/apts/ - October 2.
University of Akron, Akron Polymer Training Services, Introduction to Continuous Vulcanization and CV Processes course, www.uakron.edu/apts/ - October 3.
Select Global Events, Silicone Expo USA, Huntington Place, Detroit, MI, www.silicone-expo.com - October 4-5.
University of Akron, Akron Polymer Training Services, Rubber Technician Training, www.uakron.edu/apts/ - October 9-11.
University of Akron, Akron Polymer Training Services, Aircraft Tire Technology course, www.uakron.edu/apts/ - October 12.
University of Akron, Akron Polymer Training Services, RPA Testing of Rubber Processability and Dynamic Properties course, www.uakron.edu/apts/ - October 12-13.
Rubber Division, ACS, International Elastomer Conference, Huntington Convention Center, Cleveland, OH, www.rubber.org - October 16-19.
Association of Modified Asphalt Producers, 2023 Annual Conference and Workshop, Hyatt Regency Riverfront, Jacksonville, FL, info@modifiedasphalt.org - October 17-19.
Mexico Rubber Group, How to Improve Rubber Compounds, Part III course, Rubber Chamber Auditorium, Mexico City, Mexico - www.rubber.org/mexico-rubber-group - October 19.
JEC Group, JEC Forum DAH, Salzburg, Austria, www.jeccomposites.com - October 24-25.
University of Akron, Akron Polymer Training Services, Sponge Rubber 101, www.uakron.edu/apts/ - October 25.

November

University of Akron, Akron Polymer Training Services, Rubber Compounding and Process Troubleshooting course, www.uakron.edu/apts/ - November 3.
Endurica, Characterizing Elastomer Fatigue Behavior for Analysis and Engineering workshop, www.endurica.com - November 6-10.
University of Akron, Akron Polymer Training Services, Understanding Raw Materials, the Building Blocks of Rubber Compounding course, www.uakron.edu/apts/ - November 7.
University of Akron, Akron Polymer Training Services, Structure/Property Relationships in Polyurethanes course, www.uakron.edu/apts/ - November 7-8.
Detroit Rubber Group, Fall Technical Meeting, Freudenberg-NOK Sealing Technologies, Plymouth, MI, www.rubber.org/detroit-rubber-group-inc - November 8.
University of Akron, Akron Polymer Training Services, Rubber Compounding for Performance course, www.uakron.edu/apts/ - November 8-9.
University of Akron, Akron Polymer Training Services, Elastomer Molding Technology course, www.uakron.edu/apts/ - November 8-10.
Rubber Division, ACS, Career Catalyst Webinar: Using LinkedIn to Increase Your Visibility in the Job Search, www.rubber.org/training - November 9.
University of Akron, Akron Polymer Training Services, Solving Problems in Rubber Compounding and Processing course, www.uakron.edu/apts/ - November 10.
University of Akron, Akron Polymer Training Services, Polymer Compounding, Formulating and Testing of Plastics, Rubber, Adhesives and Coatings course, www.uakron.edu/apts/ - November 14-16.
Rubber Division, ACS, Advanced Rubber Compounding and Testing course, Akron Rubber Development Laboratory, Barberton, OH, www.rubber.org/training/ - November 14-17.
University of Houston, Elastomers: Behavior and Failure in Critical Environments online course, https://uh.edu/uh-energy/elastomers-behavior-failure-critical-environments/ - November 15-16, 29-30.
TechnoBiz, Middle East Rubber & Tire Expo 2023, Sharjah Expo Center, Sharjah, United Arab Emirates, https://expo.technobiz.org - November 21-22.
Mexico Rubber Group, Design, Development and Production of Rubber Compounds course, Rubber Chamber Auditorium, Mexico City, Mexico - www.rubber.org/mexico-rubber-group - November 23.
University of Akron, Akron Polymer Training Services, Essentials of Rubber Science and Technology course, www.uakron.edu/apts/ - November 28.
Offshore Energy, Offshore Energy Exhibition & Conference 2023, Amsterdam, The Netherlands, www.offshore-energy.biz - November 28-29.
Smithers, Silicone Elastomers World Summit, Amsterdam, Netherlands, www.smithers.com - November 28-29.
Smithers, Thermoplastic Elastomers World Summit, Amsterdam, Netherlands, www.smithers.com - November 28-29.
International Plastic Fair Association, IPF (International Plastic Fair) Japan 2023, Makuhari Messe, Tokyo, Japan, www.ipfjapan.jp - November 28 - December 2.
Leistritz Extrusion Technology, Twin Screw Workshop, Hyatt House Hotel, Branchburg, NJ, May Zaw (mzaw@leistritz-extrusion.com) - November 29-30.

December

Endurica, Application of Rubber Fatigue Analysis with Endurica Software workshop, www.endurica.com - December 4-7.

Machines for production of tire bladders

Machines that produce tire bladders to manufacture automotive tires are offered by this company. The firm's equipment is said to offer refined engineering features for this industry segment. The company furnishes extremely long (or extended) tie rods for the tire bladder molds themselves; daylight is needed not only for mold opening and closing, but also to access the molded bladder when all mold cores are fully extended. A mold opening stroke of up to (or daylight) 1,750 mm is available (~69 inches).

The company's hydraulic systems are said to provide increased flexibility. The firm's equipment opens and closes with a movable bolster with .01 mm accuracy. This hydraulic system can energize circuits to allow the mold core to assist in mold opening for ultimate process control, especially during the demolding process, according to the company. Furthermore, the DRC 2030 TMB control incorporates demolding of the bladder for process optimization. The company can also integrate steam control into the DRC 2030 TBM and the machine's internal safety systems, allowing for a uniform heating bladder mold's retractable core. Pictured is a recently commissioned and built bladder machine for the automotive sector.

This company is said to be the only complete systems provider in North America for rubber injection molding solutions. Quality German engineered rubber injection molding machines and domestically designed molds are supplied by its North American Manufacturing Center. Typical industries served are: electrical, pharmaceutical, automotive, oil, gas, military and industrial products. The company has experience with various elastomers such as EPDM, silicone, NBR, SBR and fluoroelastomers. (*Desma*)

www.desma-usa.com

Hot stamp marking system

A compact robotic hot stamping coding solution is provided by the company. The machines cover all manufacturing processes, from feeding in the raw material mixing zone to final inspection and palletizing of the tire. The firm has several patents within the tire sector that allow it to fully automate tire manufacturing processes. The robot marking system is said to be a solution designed to mark all types and sizes of tires. The point could be in any color, and the company can adapt the machine to the needs of the client. The system is said to be easy to configure and designed to be flexible and simplify the tire marking. The robot solution processes finished tires using an automatic marking system based on an anthropomorphic robot and a double clamp system with tape marker. It can be integrated into any production line. (*Desmasa*)

www.desmasa.com

Enhancing graphene

Graphene on its own is said to be a highly effective nanomaterial with extraordinary properties. It is commony used as a nano-additive to improve the properties of a host material, even when added at very low load factors. It is said to be critical that the graphene is evenly dispersed throughout the host matrix to maximize its effectiveness. One approach is to functionalize the graphene to enhance exfoliation, avoid agglomeration and ensure even dispersion. The carbon surface can be treated with coupling agents such as titanates and zirconates. If graphene is to succeed in tires, it must be exfoliated and functionalized, and coupling agents such as titanates and zirconates are said to be the solution. (*Kenrich Petrochemicals*)

www.4kenrich.com

Steel belt production

The UNIXX belt maker is said to produce high quality endless steel belts by means of an innovative and accurately controlled extrusion process that can handle a wide range of compounds. The system is said to be optimally suited for hands-off, eyes-off production. Scrap and waste from angle and compound changes are reduced because of the limited width of the extruded strip. Next to this, the automated and accurately controlled process is said to produce a consistent high quality belt. The highly efficient extrusion and cutting process, reduced waste and scrap, lower energy consumption and minimum operator involvement are said to result in a lower overall cost per produced square meter steel belt compared to the conventional belt making process. The UNIXX belt maker allows for the production of thinner belts to reduce tire weight and rolling resistance without compromising tire performance, contributing to a lower fuel consumption and CO_2 emission levels, according to the manufacturer. (*VMI Group*)

www.vmi-group.com

Patented pyrolysis system

A patented polyrolysis system recycles end-of-life tires. The system incporates a Farrel continuous mixer in its process. The firm is said to leverage the strength of Farrel continuous mixing technology, as well as Farrel Pomini's engineering and manufacturing capabilities to create a solid platform within the pyrolysis sector. This is said to close the recycling loop with a reliable system for producing viable recovered materials. (*WF Recycle-Tech*)

www.wfrecycle-tech.com

Elastomer composite

E2C DX9660 is designed to deliver significantly increased rubber durability through high abrasion resistance. The product is said to provide a 30% increase in abrasion resistance compared to a conventional compound, and further expands the portfolio of E2C solutions for use in a wide range of on-road commercial tire applications and industrial rubber products. The company has completed its first ever life cycle assessment of an E2C solution used in an on-road truck tire application. The DX9660 solution is said to deliver high abrasion resistance and increased durability performance in on-road commercial vehicle tire treads and protective rubber liners. This solution is said to expand the company's current E2C product line for use in on-road commercial tire applications, including long haul, regional and intercity trucks and buses, commercial tire retreads, as well as protective rubber liners. The DX9660 solution is said to offer high levels of tread wear resistance without sacrificing rolling resistance. As such, this increased tread life leads to a reduction in end-of-life tire (EOLT) waste, as well as a decrease in the net emissions from the tire manufacturing process, according to the company. (*Cabot*)

www.cabotcorp.com

Rubber processing system

Roll-Ex fine mesh straining solutions and Roll-Ex gear pump technologies are said to enable rubber and tire manufacturers to meet the challenges of rubber processing. The demands are said to be products of the highest quality, as well as greater cost-effectiveness. New requirements in the tire industry, the demand for sustainable and reliable processes, the consistent reduction of the scrap rate and new specifications are said to be covered by the new generation of Roll-Ex machines. These machines are used in the different areas of tire manufacturing; for example, in the rework area (based on the TRP technology for the economical reworking of material in rubber processing), in the mixing line for the final compound and masterbatch, complete offline straining cells and in the extrusion line. The Roll-Ex extrusion system is said to have become the benchmark on the international market for fine mesh straining solutions. The Roll-Ex gear pump is said to ensure particularly gentle processing of the material and fast compound changes. (*UTH GmbH*)

www.uth-gmbh.com

Tire uniformity sensors

The SL4 high speed line laser sensors are said to offer the highest resolution and speed for TGIS radial run-out (RRO), lateral run-out (LRO) and bulge measurement to date. The SL4 sensors are optimized for cured tire runout and bulge measurement by combining the world's leading high speed CMOS camera with precision optics and laser diode, according to the company. A complete redesign of its predecessors, the new sensors are said to achieve triple the resolution at 2,500 (H) x 13,312 (V) and double the speed with a scan rate of 6 kHz. SL4 sensors are a direct replacement and can be used in combination with older SL3 and Akroscan sensors in the same system, allowing customers to continue to replace single sensors. Line laser sensors acquire 850 tracks of measurement over a wide area to assure that each tire is inspected over the largest possible area, according to the firm. The SL4 sensors are available in three configurations, all optimized for integration into tire uniformity machines, balance machines and dedicated tire geometry test machines. (*Starrett-Bytewise*)

www.starrett.com

Biobased tire oils

Produced with renewable feedstock, Nytex BIO 6200 biobased tire oil is said to have been ranked as one of the most important sustainability projects. Extensive studies of the company's rubber compounding laboratory are said to have provided promising results for the performance of key properties, confirming that the biobased oil will perform at least as well as conventional mineral tire oils, while adding significant value with regard to raw material sustainability. With performance targets for the biobased oil equalling those of conventional tire oils in various laboratory studies, the natural next step was to test the oil in real tires, according to the company. Tires were produced with a European winter tire tread compound formulated with either Nytex BIO 6200 or TDAE, which was used as a reference. The performance of the tires was then tested in accordance with standard test methods. In addition, the test results were also compared with the results of similar real tire tests carried out in 2016 on a tire tread compound based on Nytex 4700, using TDAE as a baseline reference. Tests of the real tires showed that Nytex BIO 6200 had the same wet traction properties as TDAE, but displayed advantages for rolling resistance, and ice and snow traction. (*Nynas*)

www.nynas.com

Mixing room technology

Material handling technology for mixing rooms is provided by the company, along with new concepts for sustainable remanufacturing. This solution provider focuses on specialist handling of conventional materials, as well as high quality recyclates and new sustainable materials, contributing to a circular economy. The firm is said to be well known for its process know-how and supply of solutions for silo storage, pneumatic conveying, weighing and feeding of powders, chemicals, solids and liquids, all carefully managed by its automation packages. Tire recycling is now an essential and expanding part of the firm's plant engineering business. Modern tire production needs to embrace new targets in sustainability, accuracy, reliability and quality through precision materials handling, according to the firm. Additionally, new sustainable materials and return of recovered raw materials to the production cycle are said to be key. The company is said to meet these needs by supplying solutions for the tire mixing room, recycling technology and recovery plants for end-of-life tires. Comprehensive expertise is said to be offered in both conventional materials handling, along with reprocessing solutions. (*Zeppelin Systems*)

www.zeppelin-systems.com

Tread pattern simulation

Innovative tire tread computer simulation processes aimed at accelerating the use of simulation in the tire industry is the mission of an exploratory grant awarded to Coreform by the United States Department of Energy (DOE). This firm will apply Coreform's isogeometric analysis (IGA) technology, which replaces difficult and time-consuming portions of computer simulation work while providing greater design clarity and detail, to the simulation of the advanced tire tread patterns required by emerging vehicles. To fully implement the grant's scope, this company has been selected as a technology partner to provide key tire industry endurance evaluations, including rolling resistance, heat buildup and wear behavior. Traditional finite element analysis (FEA) first requires geometry to be defeatured and meshed, which can be both time-consuming and relationally inaccurate. IGA was introduced in 2005 to run simulation directly on the design model, leveraging the power of splines. Coreform IGA is said to provide a full spectrum of input options and flexible modeling, allowing engineers to minimize manual effort for a desired solution solve time. (*Endurica*)

www.endurica.com

Hydraulic drive motors

The Quantum range of hydraulic motors does away with established barriers, combining torque and speed with previously unthinkable efficiency, according to the manufacturer. For direct drives in heavy duty applications, it is said to create a powerful new reality. Bending the laws of size, strength and speed, the Quantum range is said to shape proven strengths into an extraordinary new performance curve. It offers a top speed of over 150 rpm, yet it provides a sustainable maximum torque of more than 350 kNm, according to the firm. At corner power, where the two extremes meet, users can achieve a 3 MW without sacrificing compactness or efficiency, according to the firm. By stretching the limits so far beyond previous solutions, the Quantum range is said to introduce possibilities for greener operation, mobile applications, and more. Within the Quantum range are two motors with shared DNA. Quantum is the new name for the CB, which has evolved so significantly over time that it can no longer be considered the same motor. Tweaks in design and materials have increased its efficiency and tripled its life expectancy, according to the company. Quantum Power merges a slim new connection block with this reliable foundation. Through additional ports and innovative internal design, the block enables far higher speeds, while retaining full torque capacity at high efficiency, according to the firm. Consequently, the Quantum Power is said to deliver high power with greater economy and sustainability than any previous solution. (*Hägglunds*)

www.hagglunds.com

High speed dispersers

High speed dispersers from the company are said to be economical mixers widely used in various industries such as chemicals, polymers, composites, inks, paints, adhesives, and more. Designed to mix powders into liquids and break down particle agglomerates to generate fine stable dispersions, these mixers make a wide variety of thin pastes and slurries. The pictured floor mounted model HSD-15 high speed disperser features an air/oil hydraulic lift with telescoping cover which allows the end user to mix different batch sizes and prevent stratification, while keeping the vessel covered all throughout the mixing cycle. This helps to contain dusts and vapors for improved operator safety and cleanliness, according to the company. The 12” disperser blade operates up to 1,590 rpm to induce vigorous turbulent flow within a low viscosity batch, creating a vortex into which dry ingredients can be poured for fast wetting. The blade speed may be changed as the batch thickens or increases in volume to maintain the vortex and rate of material turnover. The cover has a 1/3 hinged port for the easy addition of powders. (*Charles Ross & Son*)

www.mixers.com

Rubber-to-metal bonding

Cilbond 24 is a one-coat rubber-to-metal bonding agent used in noise, vibration and harshness (NVH) components that isolates vibration, reduces shock and improves dynamic fatigue performance in a wide variety of industrial bonding applications for excellent long term performance, according to the manufacturer. With the Cilbond range, it is said to be possible to achieve an engineering bond capable of surviving extreme environmental attack from chemicals, temperature variations, dynamic stresses and fatigue. With a product for every compound type and every molding technique, including injection, compression, transfer and even post-vulcanization, the Cilbond 24 one-coat bonding agent provides the rubber industry with the ultimate combination of performance and versatility, according to the company. Benefits are said to include reduced process cost and improved productivity; bonds a wide range of elastomers; outstanding performance in demanding dynamic applications; expanded pre-bake process window; enhanced corrosion protection and chemical resistance; and improved performance in high temperature applications. Applications include engine mounts, seals and gaskets, rollers, belts, and more. (*H.B. Fuller*)

www.hbfuller.com

Fluorochemical solutions

Fluon+ enhanced materials and compounds are said to improve performance properties of wire and cable, such as durability, flexibility and heat resistance, in demanding applications. Fluon+ materials use advanced fillers, pigment systems and additives to enhance the performance of the company's Fluon fluoropolymer resins. These materials are said to add performance characteristics such as toughness; lubricity; creep, wear and chemical resistance; and thermal and electrical conductivity. Products like wire and cable jackets, insulated coatings, fuel hoses and multilayer film made with Fluon+ materials are used in a wide range of applications in the automotive, aerospace, chemical processing, resource recovery, electronics and semiconductor markets. Fluon+ modified PEEK uses specialty fluoropolymers to improve its impact strength, wear resistance, flexibility and electrical insulating properties. Fluon+ modified PEEK retains mechanical properties at high temperatures up to 200°C. It is said to be ideal for wireline and cable insulations to better withstand repetitive use in harsh environments. Fluon+ flexible AR compounds are melt processable materials based on ETFE and a fluoropolymer. (*AGC Chemicals Americas*)

www.agcchem.com

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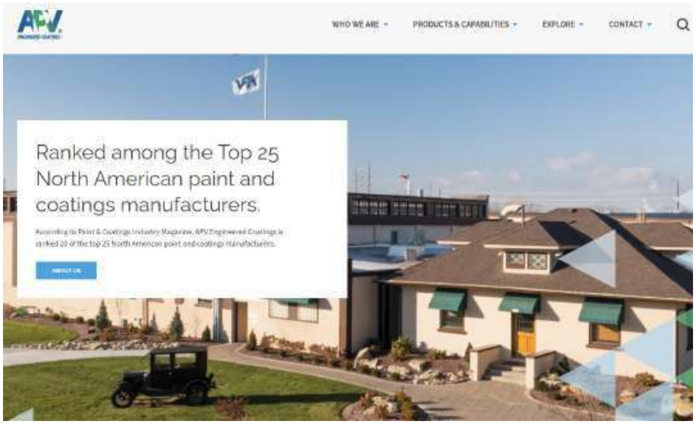

APV Engineered Coatings (www.apvcoatings.com) custom engineers and manufactures industrial coatings and advanced chemical products out of its state-of-the-art facility in Akron, OH. APV is a partner to some of the world's top producing manufacturers due to its expertise in chemical composition, the commercialization of advanced materials and large scale production with acute quality control. APV's product line includes adhesives, binders, concentrates and slurries, crayons, decals, dyes, forging lubricants, inks, inspection markers, maskant materials, paints and coatings, primers, tire and rubber lubricants, and custom formulations and specialty applications.

APV has grown alongside the tire industry in Akron, OH. Today, APV provides a comprehensive product line for every step of the tire making and rubber manufacturing process. This includes rubber cements, marking inks (for striping, alphanumeric coding via inkjet or offset printing), outside tire or precure paints, lubricants, repair paints, rubber marking crayons, dot markers, and much more. APV also has a full line of water based products that address the VOC and emissions regulations for production facilities.

In addition to superior coating products, APV offers product development and manufacturing services. APV's team of experts can help customers bring their product to market quickly and cost-effectively. When outsourcing to APV's manufacturing facility, customers reduce production expenses and capital investments. APV's chemical engineers and technical experts offer the latest technologies in formulation and product development services to provide innovative coating solutions for customer needs. APV's manufacturing resources provide a cost-effective means for production and distribution. APV also offers the value-added service of custom packaging and shipping.

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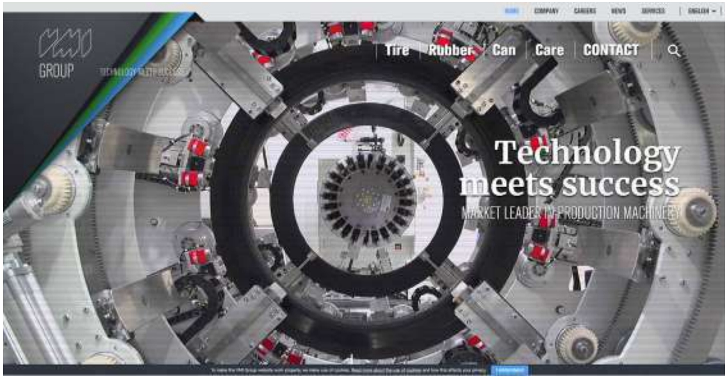

VMI (www.vmi-group.com) is the world's leading supplier of machinery and services to the manufacturers of radial passenger tires, light truck tires, all steel radial truck tires, bus tires and off-the-road tires. Main product groups include the technical rubber industry, the tire industry and tire retreaders.

VMI supplies millroom equipment and a complete line of tire manufacturing, tire curing and testing systems for bias and radial tires for cars, trucks, utility and off-the-road vehicles. VMI's services range from financing through engineering and contracting projects. The firm also offers maintenance contracts and upgrades of existing rubber and tire equipment.

VMI is known as the leader in millroom equipment and single stage machines for radial car and truck tires. VMI's network of agents is constantly monitoring developments in local markets on all continents. The firm's research and development department collaborates with the leading international rubber research institutes and with key suppliers of commercial components.

Service departments are on call 24 hours a day to provide rapid on-site service. VMI's global organization includes spare parts supply and servicing from plants in the Netherlands, the U.S. and China.

VMI's product portfolio for the tire industry includes millroom equipment, tire component systems, bead making and apexing machines, tire assembly systems for passenger and light truck tires, truck and OTR tire assembly systems, flexible tire building cells, tire building drums, tire testing machines, compound testing systems, tire curing presses and extruders.

For the technical rubber industry, VMI provides millroom equipment, molded products and rubber-to-metal processing systems, extrusion heads, preformers, straining equipment and airspring building systems.

VMI also provides retread tire curing systems.

SDS Systemtechnik (www.sds-systemtechnik.de) develops and sells patented tire testing systems. Today's industry demands faster and simpler systems for manufacturing. An important step in this direction is the three-head technology patented by SDS, which significantly and efficiently minimizes the cycle time compared to single-head or other multi-head systems. In the bead-to-bead inspection, the entire tire is tested in the patented SDS process and test cycles are recorded. This enables a test capacity that would otherwise require significantly more complex systems with more measuring heads.

Each SDS test system can be equipped with an individual conveyor system. The conveyor modules can be used for a wide variety of tasks (for example, for loading and unloading, transporting and sorting), providing an automatic process without operating personnel, and even more economy, productivity and flexibility in tire testing.

The automatic pressure test system replaces the classic pressure test with a modern procedure using different pressure levels. It is used as soon as structural damage and sidewall anomalies are to be detected, displayed and archived. In addition, the geometry data of a tire can be measured.

All SDS systems and conveyor lines can be flexibly combined for highly economical, full service tire testing. The SDS systems can also be easily integrated into customer conveyor systems with individual interfaces.

An endurance test monitoring system innovation is available from SDS for non-stop online monitoring on chassis dynamometers. The system shows and logs the formation and change of defects over a recording period of almost any length. In addition, it offers automatic switch-off criteria for the test, depending on the defect size, position, etc.

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CONVENIENCE: Most all our learning opportunities are virtual only with some in-person courses at our partner's locations.

CEUs: We have partnered with The University of Akron to offer CEUs for many of the courses we offer, as well as for our Basic, Intermediate and Advanced Rubber Technology Self-paced Learning opportunities.

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Visit rubber.org/training for details about these courses, including full descriptions and pricing.

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  Course: *Rubber Extrusion Technology*
- **September 21, 2023**
  Career Catalyst Webinar: *Virtual Interviewing – How is it Different From In-person Interviewing*
- **October 16-18, 2023**
  15 Courses at the International Elastomer Conference Educational Symposium
- **October 18 & 19, 2023**
  4 Career Catalysts at the International Elastomer Conference
- **October 30, 2023**
  Endurica Workshop: *Characterizing Elastomer Fatigue Behavior for Analysis and Engineering*
- **November 1, 2023**
  Webinar: *Elastomers for Selective Gas Separation, including Carbon Capture*
- **November 2, 2023**
  Course: *An Introduction to Continuous Vulcanization*
- **November 8, 2023**
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  Career Catalyst Webinar: *Using LinkedIn to Increase Your Visibility in the Job Search*
- **November 14, 2023**
  Course: *Advanced Rubber Compounding & Testing*
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  Endurica Workshop: *Application of Rubber Analysis with Endurica Software*
- **December 14, 2023**
  Career Catalyst Webinar: *Know Your Worth! Negotiating Salary & Benefits in a New Job*

All webinars are FREE for Rubber Division, ACS Members and all Rubber Division, ACS courses are FREE for undergraduate Student Members (discount for masters & graduate Student Members)!

People in the News

Vanderbilt promotes Murphy and Gauquier

Dan Murphy was promoted to the newly created position of technical service manager for the Rubber and Plastics department of Vanderbilt Chemicals LLC. **Brian Gauquier** was promoted to the newly created position of global stabilization product manager for the Rubber and Plastics department of Vanderbilt Chemicals LLC.

Dan Murphy
Vanderbilt Chemicals

Brian Gauquier
Vanderbilt Chemicals

Matt Kent
Smithers

Manja Greimeier
Continental

Management

Matt Kent was promoted to the role of general manager of the Smithers Tire & Wheel Test Center. In his new role as general manager, Kent will lead the team at the Smithers Tire & Wheel Test Center to ensure the delivery of accurate data, on time, and the development and care of customer relationships. His duties will include researching and developing new capabilities that align with the changing needs of Smithers' clients in the tire and wheel industry.

Niko Haavisto was named chief financial officer of Nokian Tyres, and a member of the company's management team. Haavisto will report to **Jukka Moisio**, president and chief executive officer. **Jari Huuhtanen**, vice president, group business control, will continue in the interim position of senior vice president, finance and treasury, until the end of February 2024.

Manja Greimeier was appointed by Continental as head of its Tires Original Equipment business area. In this role, Greimeier is responsible for the tire manufacturer's global original equipment business for passenger and commercial vehicles. Her predecessor, **David O'Donnell**, recently took over responsibility for the global research and development activities for Continental's passenger car tire replacement business.

Geoff Doster was appointed president of Linglong N.A. Sales, based in Palm Beach Gardens, FL, a wholly owned subsidiary of Linglong Tire, said to be a top global leader in tire manufacturing, headquartered in Zhaoyuan City, Shandong Province, China.

Minoo Mehta will assume the position of managing director, BKT USA and BKT Tires, with immediate effect. Mehta is said to have played a crucial role in establishing BKT's leading position in the USA market. Mehta's team has led to BKT expanding its USA market share in both the agriculture, and medium and large OTR sectors. **Alan Eskow**, vice president, will continue to manage the agricultural vertical, and **Chris Rhoades**, vice president, will continue to look after the medium and large OTR vertical.

Scandinavian Enviro Systems has contracted **Mårten Wikforss** as responsible for the company's communications and investor relations. Scandinavian Enviro Systems is said to contribute to enhanced environmental and economic sustainability using a patented technology for the recovery of valuable raw materials from scrapped and end-of-life products, including tires.

Sales

ITW Pro Brands, a global manufacturer of professional grade industrial cleaning, maintenance and manufacturing chemicals, and parent of Franklynn Diamond-Kote and Crystal brand rubber mold release agents, hired **Katherine Del Valle Carrasquel** as regional sales manager for mold release products in the Mexico and Latin America regions. She will be based in Queretaro, Mexico. **Richard Lucal** was rehired by ITW Pro Brands as a regional sales representative for mold release products in the western USA region.

Hiroaki Takizawa was appointed general manager of the Toyo Tire Europe, Africa and Middle East sales department and sales division. Takizawa succeeds **Masaomi Kono** in these roles.

Mike Braucher was appointed chief commercial officer of Echelon Supply and Service, a supply chain management and logistics service provider of industrial hose, fluid power products and hose assembly solutions. Braucher will lead sales and marketing operations, while assuming responsibility for branch operations in the U.S. and Canada.

Associations

Sumitomo Rubber North America (SRNA) announced that **Richard Smallwood**, former president and CEO of SRNA, will be inducted into the prestigious Tire Industry Association Hall of Fame. This recognition is said to come as a testament to Smallwood's outstanding contributions and leadership within the tire industry. Smallwood is currently chair of SRNA, serves on the board of Sumitomo Rubber USA, and is an advisor of Sumitomo Rubber Industries, Ltd. of Japan.

Obituary

Lucille Gerard, who for over 30 years served as Interbusiness USA's vice president and general manager, died in early August.

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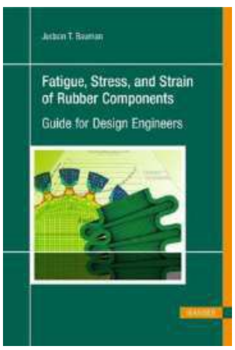

Fatigue, Stress, and Strain of Rubber Components

This book covers the fatigue testing of specimens, curve fi tting of equations to the test data, and theuse of such equations in life prediction. Earlier chapters are background in the nature of rubber, historyof its usage, brief mention of types of rubber and manufacturing methods. Stress-strain testing andbehavior is covered to the extent relevant to fatigue analysis. Also, the text covers the application offi nite element analysis to components to determine high stress points that are vulnerable to fatigue-failure. It is a very useful reference for practicing engineers charged with the responsibility to designstructural rubber components where fatigue life is a concern.

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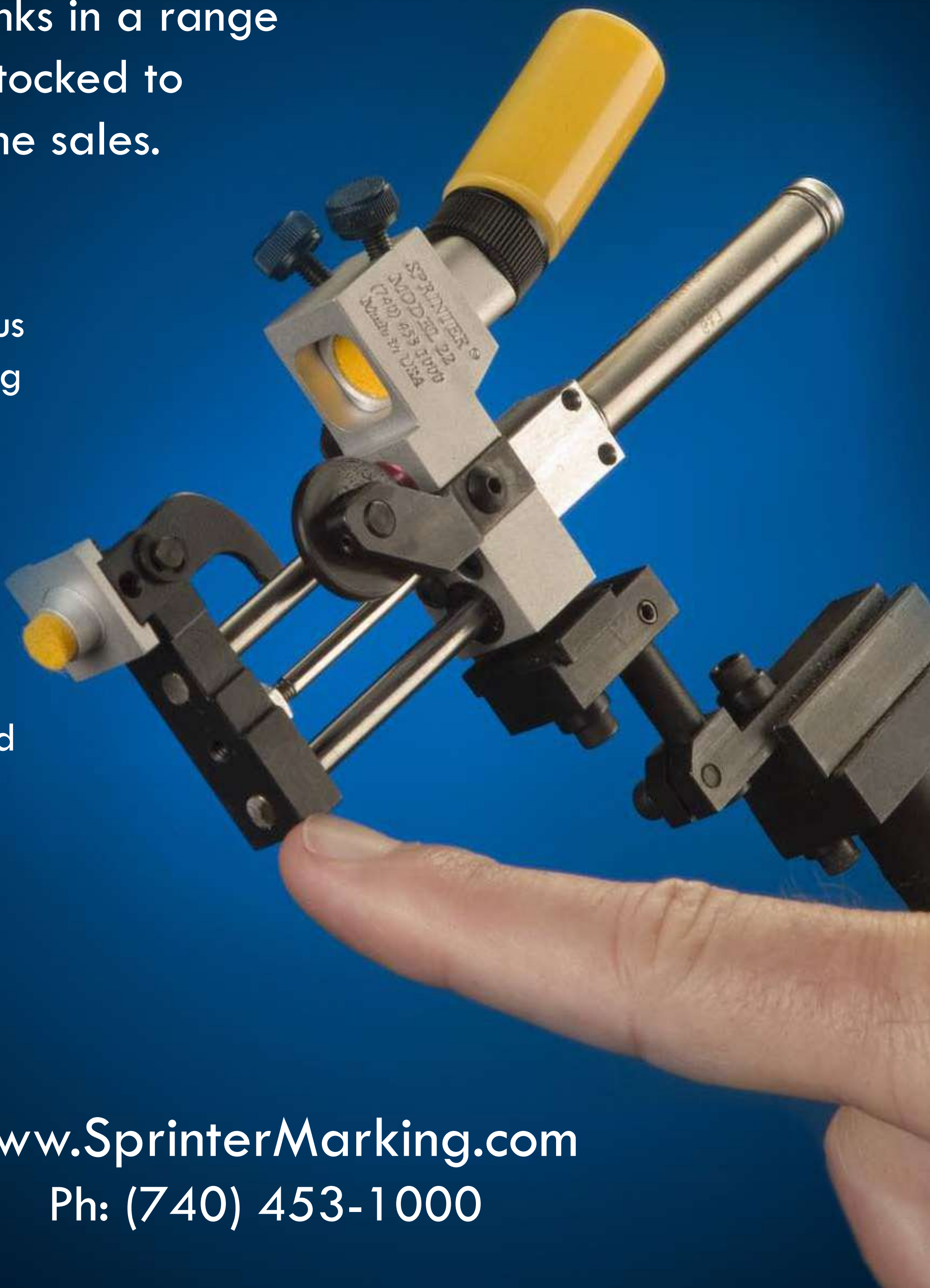

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