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THE TECHNICAL SERVICE MAGAZINE FOR THE RUBBER INDUSTRY VOLUME 268, No. 5

Sustainable additives for the rubber industry

Mechanical and dynamic properties

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Sustainable additives
for the rubber industry

Mechanical and dynamic properties
of peroxide cured HNBR terpolymers

Towards the modern automotive industry:
Adhesive innovations with styrenic TPEs

Influence of functionalized terpolymer resin
on carbon black reinforced rubber compounds

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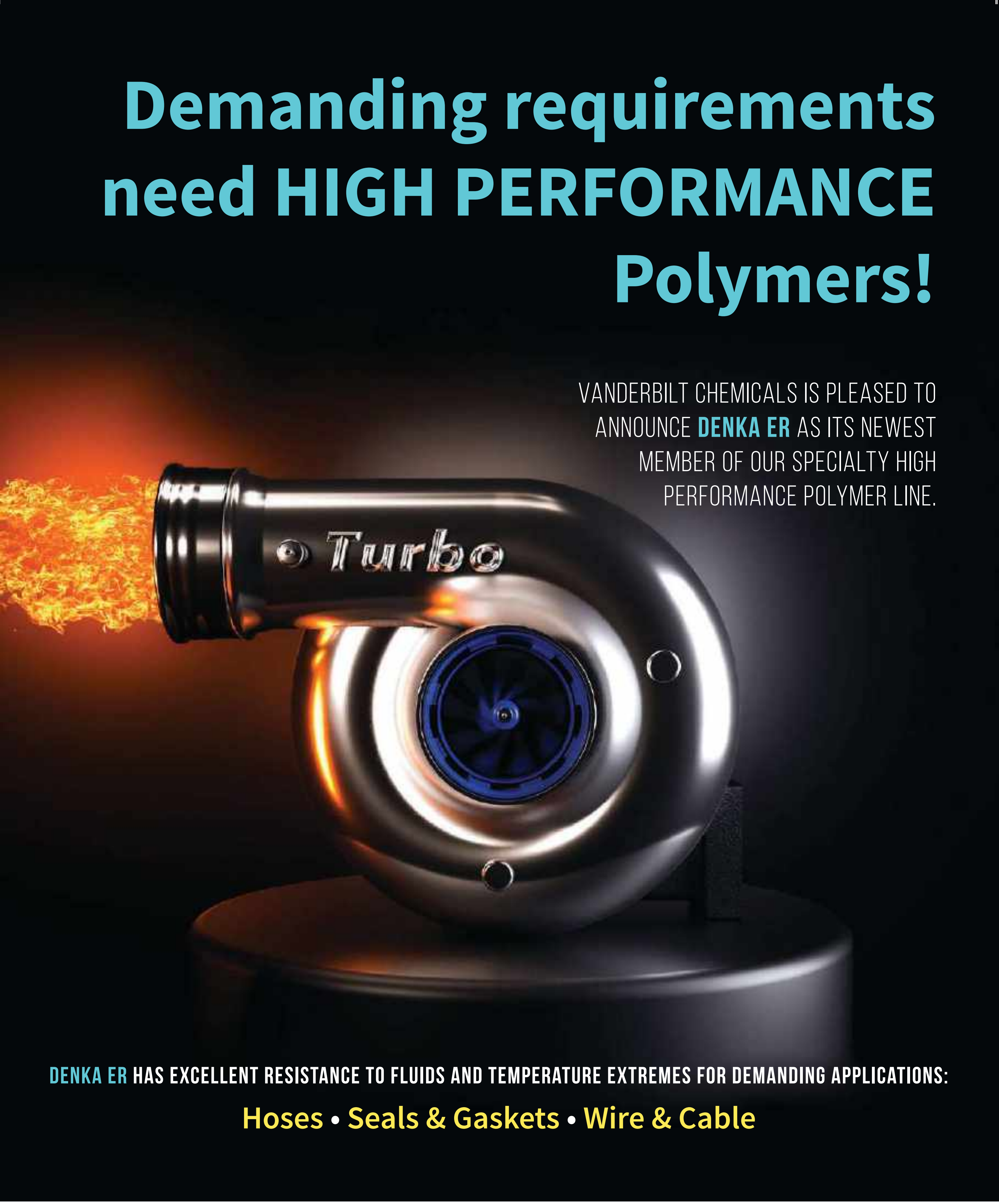
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Vol. 268, No. 5 August 2023

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Cover photo: Courtesy of NovationSi

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From the Editor

Jill Rohrer

USTMA explores 6PPD alternatives

The U.S. Tire Manufacturers Association (USTMA), which represents several of the world's largest global tire companies, has mobilized a consortium of 16 tire manufacturers to conduct an alternatives analysis for 6PPD in tires under California's Safer Consumer Product Regulations (SCPR). This comes after the decision by California Department of Toxic Substances Control (DTSC) to act on USTMA's recommendation to list 6PPD in tires as a Priority Product under the state's Safer Consumer Products (SCP) program.

Members include USTMA's full members: Bridgestone Americas; Continental Tire the Americas, LLC; Giti Tire (USA) Ltd.; Goodyear Tire & Rubber; Hankook Tire America; Kumho Tire U.S.A.; Michelin North America; Nokian Tyres; Pirelli Tire North America; Sumitomo Rubber Industries; Toyo Tire Holdings of America; and Yokohama Tire, and USTMA's statistical affiliate members: Double Coin North America (CMA) LLC; Maxxis International USA; Nexen Tire America; and Sailun Tire Americas.

"This consortium will power a collaborative approach to the alternatives analysis process, which will yield the most effective and exhaustive review possible of whether a safer alternative to 6PPD in tires currently exists," said USTMA President and CEO Anne Forristall Luke. "With the DTSC taking this action, we will continue our active and transparent work to complete the required alternatives analysis and collaborate with other stakeholders."

The SCPR provides a rigorous, transparent, scientific regulatory framework to analyze whether potential 6PPD alternatives exist. Any potential alternative to 6PPD identified through the SCPR process must provide equivalent tire safety and performance to 6PPD, while improving environmental metrics. The SCPR framework accounts for this, including the need for products to continue complying with Federal Motor Vehicle Safety Standards (FMVSS) and other consumer, vehicle and tire manufacturer requirements. USTMA has aligned with numerous federal and state regulatory bodies, material suppliers, academic and government research teams, industry associations and other partners to advance research into 6PPD-Quinone and identify effective mitigation strategies.

6PPD helps prevent degradation and cracking of tires in use. USTMA's primary focus will be on maintaining these critical tire and vehicle safety benefits in any potential replacement product to ensure tire safety.

Jill Rohrer

RubberWorld

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Alliance for Audited Media

Business Briefs

GRI acquires ATRA, expands in Europe

Global Rubber Industries (GRI) (www.gritires.com), Colombo, Sri Lanka, has acquired **ATRA Kecskemet** of Hungary, and will add it to its network of companies worldwide, strengthening its presence in Europe. With an operating presence of over 30 years, ATRA is said to be a versatile, dynamic and diversified company that services material handling and other industries and fitment services across Hungary and neighboring countries in Europe. GRI produces high grade specialty tires that are built sustainably using pure natural rubber in Sri Lanka.

Acquisitions, expansions

Semperit (www.semperitgroup.com), Vienna, Austria, has completed the acquisition of **RICO Group**, a global full range supplier of customized elastomer and plastics applications. RICO generated revenue of approximately €90 million in 2022, and employs more than 500 people in Austria, Switzerland and the USA. The acquisition is said to help Semperit achieve technology leadership in liquid silicone and high end mold production, and strengthens its industrial core business.

Nexen Tire (www.nexentire.com), Yangsan-si, South Korea, plans to expand production capacity by 40% within five years, including building a tire factory in the U.S. and expanding its existing factory in the Czech Republic. Nexen has invested approximately £732 million in the expansion of the factory in Zatec, Czech Republic, which will have an expected capacity of 11 million tires per year upon completion in 2025.

Quality registrations

Bridgestone Americas (www.bridgestoneamericas.com), Nashville, TN, announced that its Wilson, NC, passenger/light truck tire manufacturing facility has earned International Sustainability and Carbon Certification (ISCC) Plus recognition for its transparency and traceability of sustainable raw materials, including bio, bio-circular and circular based materials to replace synthetic rubber in its transition to a circular economy.

CJ Biomaterials (www.cjbiomaterials.com), Woburn, MA, a division of South Korea based **CJ CheilJedang** and a primary producer of polyhydroxyalkanoate (PHA) biopolymers, announced that **CJ Blossom Park** has received laboratory accreditation for Acceptance of Client Testing from **TÜV SUD**'s biodegradable certification for various biomaterial products, including PHA technology developed by CJ Biomaterials.

Stahl (www.stahl.com), Waalwijk, Netherlands, a provider of coating technologies, announced the successful recertification of two manufacturing sites, in Germany and the Netherlands, according to the ISCC Plus standard. The recertification of the sites by certifying body **TÜV Nord** means Stahl can continue to scale up its use of renewable feedstocks across its polyurethane portfolio and beyond. This will enable the company to offer customers more products containing attributed renewable raw materials.

Business Briefs

Continental partners with Bill Morgan Tire

Contracts, licenses

Continental (www.continental.com), Hanover, Germany, has partnered with **Bill Morgan Tire** to open the first retread facility in Lexington, KY, in 40 years. The facility boasts more than 25,000 square feet and is said to be one of the largest commercial truck tire facilities in Kentucky. With this facility, Bill Morgan Tire is expecting to do more than 15,000 retreads in the first year of offering the service.

Continental announced that, after five years of planning, **Atlas Energy Solutions** has contracted with Continental to supply the conveyor belt for the Dune Express in Kermit, TX, said to be a world renowned conveyor system accompanied by digital solution components. During the planning phase, the two companies worked closely together to solve various technical challenges that had arisen due to the size and complexity of the project.

The **Global Platform for Sustainable Natural Rubber** (GPSNR) (www.sustainablenaturalrubber.org), Singapore, announced the addition of **Sri Trang Agro-Industry Public Ltd.** as its newest member in the Producers, Processors and Traders category. The fully integrated natural rubber company was established in 1987, and is said to be committed to the industry's transition towards the sustainable and equitable production of natural rubber at scale.

Bolder Industries (www.bolderindustries.com), Boulder, CO, has signed a long term supply agreement with **Soucy Techno** for BolderBlack, a sustainable carbon black alternative. This is an extension of a previous agreement made between Bolder and Soucy, said to signal a major achievement in the recovered carbon black industry.

The United Steelworkers (www.usw.org), Pittsburgh, PA, announced that members voted to ratify a four-year first contract covering about 325 workers at Kumho Tire. USW District 9 Director Daniel Flippo said the contract provides yearly wage improvements and other pay increases. It also includes addition paid time off, a joint health and safety committee and other workplace protections, all while maintaining quality health care and other benefits.

Business Briefs

CORPORATE, FINANCIAL NEWS

Orion releases sustainability report

Orion S.A. (www.orioncarbons.com), Luxembourg, a global specialty chemicals company, released its 2022 Sustainability Report that highlights a variety of initiatives, including launching four sustainable products, conducting a Scope 3 greenhouse gas emissions inventory and nearing the completion of a massive air emissions control project. The report describes the magnitude, complexity and impact of the air emissions control initiative that started five years ago and is the biggest sustainability linked project in Orion's history.

The **Center for the Polyurethanes Industry of the American Chemistry Council** (www.americanchemistry.com), Washington, D.C., announced Sika's SikaForce-840 L07 and Wanhua's Wannate 9131FC as the finalists for this year's Polyurethane Innovation Award. The annual honor recognizes inventive new commercial technologies within the polyurethanes industry. The award will be presented to the winner during the 65th Polyurethanes Technical Conference, September 25-27 in San Antonio TX (see page 104).

UTH commits to sustainability and environmental protection

UTH GmbH (www.uth-gmbh.com), Fulda, Germany, announced that its management systems in the areas of quality and environment have now been certified according to the internationally recognized norms DIN EN ISO 9001 and DIN EN ISO 14001. The focus of the worldwide operating machine manufacturer was on the validation of their in-house environmental management. "We want to transparently show that social responsibility and our commitment to sustainability is anchored in UTH's corporate management," said Managing Director Peter J. Uth.

During the certification, the auditors examined all quality and environment management processes that have been implemented and continuously refined by UTH. Especially with regard to the environment, all information concerning relevant topics in the different departments were evaluated. These include, for example, ecological aspects in the product development and the production, the selection of suppliers, the handling of hazardous substances or in the waste separation and disposal. Additionally, the examiners inspected the risk management and the emergency plans.

"The auditors have confirmed that our environment management fulfills the required criteria for DIN EN ISO 14001:2015," said Uth. "This certification is a determined step for UTH GmbH because it is a decisive benchmark for our customers: environmental protection, sustainability in the supply chain, as well as transparency are continuously gaining importance in business relationships. The certification according to DIN EN ISO 9001 is also a highly gratifying result. It proves the high standard of our quality management system, which many of our customers from the rubber, tire and silicone industries worldwide rely on," Uth added.

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Global TPE market to grow at 9.5% CAGR

The global thermoplastic elastomers (TPE) market is slated to expand at an approximate 9.5% CAGR (compound annual growth rate) between 2023 and 2035, according to a report from Research Nester. The market is predicted to reach $76 billion by the end of 2035, up from $26 billion in 2022.

The rapidly increasing demand for consumer and industrial electronic and electrical products, along with the growing use of elastomers in everyday electrical and electronics products, will push demand. Due to their flexibility, electrical resistance, wear resistance, durability and UV stability, there is increased usage of TPEs in computing products, mobile telephone components, television, radio, cables, plugs and sockets. It is estimated that the total consumer electronic industry's revenue in 2023 will reach more than $700 billion, whereas the average annual growth rate of the industry will reach nearly 11% from 2023 to 2027, which is almost four times more than the previous year's average.

The study says the market in the Asia Pacific region is estimated to be the largest by the end of 2033. The region's growing population, rising urbanization and rapidly expanding construction industry, all of which are driving up demand for durable and flexible materials for extruded weather seals, are expected to drive up TPE market growth in the region over the forecasted period.

Europe's TPE market is estimated to have the highest CAGR by the end of 2033. The rapidly rising research and development investments in the region, along with the growing demand for nontoxic recyclable polymers that are highly eco-friendly and biodegradable, in addition to the increasing demand for biobased products with high strength, light weight and relatively low processing costs to adhere to the sustainable development goals in the region, are expected to boost the market growth in the region. Research and development investments in Europe hit 8.9% in 2021, compared to a 2.2% COVID-19 pandemic related dip in 2020. Furthermore, the adoption of climate neutral practices endorsing a green economy in the region is further expected to contribute to regional market growth in the upcoming years, the study says.

The growing adoption of environmentally friendly and easy-to-recycle materials worldwide is expected to propel segment growth over the predicted time frame. Furthermore, in the thermoplastic elastomer versus rubber comparison, TPEs offer better environmental advantages.

The thermoplastic vulcanizates (TPV) segment is anticipated to be the largest by the end of 2033. TPV's unique combination of properties, such as its flexibility, strength and resistance to abrasion, temperature and chemicals, makes it ideal for use in a wide variety of applications, including automotive, electrical/electronics, construction and consumer products. These benefits are expected to drive the demand for TPV in the coming years. Moreover, TPV is a thermoplasic elastomer made from a blend of polypropylene, EPDM rubber and other materials, making it strong, flexible and recyclable.

USTMA sees decline in tire shipments

The U.S. Tire Manufacturers Association (USTMA) projects total U.S. tire shipments of 325.4 million units in 2023, compared to 332 million units in 2022 and 332 million units in 2019.

Compared with 2022, original equipment (OE) shipments for passenger, light truck and truck tires are expected to change by 5.6%, -0.5% and 0.0%, respectively, with a total increase of 2.3 million units. Replacement passenger, light truck and truck tire shipments are also projected to change by -1.5%, -3.6% and -16.0%, respectively, with a total decrease of 8.9 million units.

The U.S. Tire Manufacturers Association is the national trade association for tire manufacturers that produce tires in the U.S. Its 12 member companies operate 58 tire related manufacturing facilities in 17 states. U.S. tire manufacturing has an annual economic footprint of $170.6 billion and is responsible for more than 291,000 U.S. jobs in manufacturing, distribution and retail. The industry supports more than 510,000 additional U.S. jobs in supplier and induced activities, totaling more than 801,000 jobs nationwide.

USTMA is said to advance a sustainable tire manufacturing industry through thought leadership and a commitment to science based public policy advocacy. Its member company tires are said to make mobility possible. USTMA members are committed to continuous improvement of the performance of their products, worker and consumer safety, and environmental stewardship. Further information is available at www.USTires.org.

USTMA 2023 projected tire shipments

	2023 forecast	2022	% change	Units +/-
Original equipment tires				
Passenger	43.9	41.6	5.6	2.3
Light truck	6.2	6.3	-0.5	0
Truck	6.5	6.5	0	0
Replacement tires				
Passenger	210.5	213.7	-1.5	-3.2
Light truck	35.9	37.2	-3.6	-1.3
Truck	22.4	26.6	-16	-4.3
Total	325.4	332.0	-2	-6.6

All shipments in millions. Figures are rounded.

Thermal interface material for electrical use

Freudenberg Sealing Technologies has developed a silicone based elastomer, calling it a thermal interface material, for a wide range of complex electrical applications. For the new material, silicone is mixed with inorganic fillers that make it thermally conductive. These fillers are special non-conductive metal compounds. It combines seemingly incompatible properties, since it is good at conducting heat, while also providing electrical insulation.

Universal applicability was the goal of Freudenberg Sealing Technologies in developing this new elastomer. What all the customer projects have in common is their enormous complexity; for example, the charging port of an electric car. One car manufacturer has already used this in high quantity series production. Behind the charging port cover, the vehicle displays a usual multi-pin connector for the charging cable, embedded in a plain plastic front. What remains invisible is the high tech area right behind it. Here are several components whose interaction is essential for the thermal management of the charging process: a circuit board with temperature sensors, measurement and control electronics for charging management, all secured inside a housing about the size of a hand.

At the same time, via the integrated and innovative thermal interface material (TIM), this ensures the best possible thermal conductivity between the housing and the sensors. It picks up the heat flow through the copper wires connected to the battery and passes it on to the temperature sensors, thus promoting the rapid buildup of charging control, including the continuous thermal management of the vehicle battery.

The two-component plastic housing has a complex three-dimensional geometry, since the charging plug's connection poles pass through it. It reliably keeps the easily bent board in place and facilitates the assembly. The electronics unit is clipped in with snap connections. The new elastomer supports precise contact while its electrical insulation capability shields the sensitive electronics from the charging voltage of up to 800 volts. Freudenberg Sealing Technologies manufactures the housing with injected elastomer, and provides it to an automotive supplier, which in turn produces the module ready for installation by the automaker.

"This project was right up our alley, because our material is predestined for a wide range of complex electrical applications. With its numerous qualities, it provides the right answers," said Armin Striefler, product and process developer at Freudenberg Sealing Technologies. "An important advantage for efficient series processes: The elastomer material can be processed through injection molding. This also makes its use very flexible, since nearly all three-dimensional geometries are possible and, thanks to the material properties, it always adheres optimally to the substrate, whether plastic or metal. It can be sprayed on directly, and does not need primer," Striefler added.

Thermal conductivity for the new material is 1.7 to 2 watts per meter and Kelvin. For comparison, the thermal conductivity of air is 0.026. The manufacturing process makes thin walled components possible. According to the heat equation from the Fourier equation, this is good for thermal conductivity. "We have had very good experiences with thicknesses between 0.8 and 3 millimeters," Striefler reported. "For physical reasons, heat transfer decreases when the walls are thicker."

The material achieves a CTI value of 600, placing it in the best possible protection class for tracking resistance. The dielectric strength is more than 10 kilovolts per millimeter. This means that the common test voltages of 2.4 to 4 kilovolts will not pose any particular challenges for the material. Its hardness is around 35 durometer A.

Being able to use an injection molding process is a definite plus. The specific production process prevents trapped air both in the elastomer and on the contact surfaces with other materials. This might otherwise lead to electrical problems, such as voltage breakdowns. The material is fire resistant in accordance with UL94 with classification V0, which puts it at the highest possible safety level.

Effective heat dissipation is a prerequisite for efficient processes in numerous electrical applications, wherever considerable computing power is required or high currents are flowing. At this time, typical applications are in the field of electromobility; not least because of the significant requirements when the charging voltage is 800 volts, which is increasingly common in electric vehicles. Cooled busbars in traction batteries are one example. Especially during fast charging or high power output, these heat up with relatively high intensity.

The range of applications is vast. This is evident in the example of an oil resistant TIM that is currently in pre-development at Freudenberg Sealing Technologies. A material like this goes even further in expanding the potential applications. "We welcome tricky challenges," Striefler concluded. "Because that is exactly where this material is in its element."

Masterbatches: A cost effective system for latex compounding raw materials

A wide variety of rubber products is produced from natural or synthetic latex. The latexes, while having some unique and interesting physical and chemical properties, are typically formulated with other chemical ingredients to improve, stabilize and protect these unique properties.

There are five distinct categories of materials often used in a latex formulation:

- Curatives: sulfur, zinc oxide
- Accelerators: dithiocarbamates, thiurams, etc.

Jim Finn is principal consultant for FinnTex LLC. Finn was formerly president of Akron Dispersions, a provider of dispersions and emulsions, and a processor of finely powdered chemicals, elastomers and formulations. Finn has authored technical papers on latex and has chaired many latex conferences.

- Antioxidants: phenolics and amines
- Fillers: clays, carbonates, etc.
- Modifiers: plasticizers, extenders. etc.

These materials are added to the latex as aqueous or water based dispersions. The addition of all of these materials as a single dispersion is called a masterbatch.

Dispersions

Aqueous dispersions are defined as water insoluble compounding ingredients added to the latex in the form of a stable, fine particle, heterogenous water based system. The first law of latex compounding is "Do no harm."

It is a key requirement that dispersions, when added to the latex, not cause instability or minimize the latex's unique properties. A preferable outcome would be an improvement in the stability of the latex.

It should be noted, however, that because a fine particle dispersion has a high surface area, it is capable of "robbing" the soap stabilizer present in the latex. The soap, already present in the raw latex, will be "shared" with the new particle addition. It is not untypical for an additional amount of stabilizer to be added to the latex to retain its stability.

The second law of latex compounding is "Gravity always wins." That is, when ingredients are added to the latex, they have a tendency over time to settle to the bottom of the container. This sedimentation is, in many ways, directly related to the particle size and its density.

Sulfur is twice as heavy as water, and zinc oxide is nearly six times heavier. It is logical. The Stokes Law demonstrates that a particle with a radius of 2 will settle in a viscous fluid four times faster than a particle with a radius of 1.

Particle size reduction is accomplished in a variety of ways. First, the dispersion recipe calls for a concentration of "active" ingredients to be in a range of 50% to 60%, at least. A dispersing agent is added during mixing to effectively minimize agglomerates of powdered chemicals. This is called the slurry stage. This stage will not reduce the particle size, but merely break up the agglomerates.

The next stage, milling or grinding, will actually reduce the size of the particle.

There has been a variety of machines designed over the years to accomplish this particle size reduction from ball mills, sand mills, attritors and horizontal mills. What all of these have in common is the employment of grinding media, motion (tumbling, churning, sliding and cascading), point of contact and grind time.

Grind time or residence time in the mill is determined by a number of factors, such as material being dispersed, dispersion recipe, type and density of media, material charge (weight or volume) and rotational speed of the mill. Optimizing these factors will enable the dispersion manufacturing to produce the finest particle size in the shortest amount of time.

Ideally, the particle size of a dispersion can be represented graphically using a laser particle size analyzer. It will show the particle size distribution of the dispersion.

Percent by volume is always a better way to characterize the dispersion, rather than percent by number. Using percent by number will show an artificially lower particle size than is actually the case. Comparing particle size graphs of a material dispersed in August with one produced in June will reveal the consistency of a process. Rechecking the particle size of the June product in August will show if the dispersion is still stable and has not reagglomerated. A six month shelf life, at least, is the goal.

Masterbatches

The addition of four or five compounding ingredients, as dispersions, to the latex represents a number of activities that qualify as opportunities for error that could contribute to variability in the final product. From the selection of the various raw materials

from inventory, determination of the required amount of each material in the formulation, weighing each material, dispensing each material, and the necessary cleanup to minimize cross contamination in preparation for the next batch, all present opportunities for error. Add the variability of additional shift work, along with the necessary training requirements, and one can see a need for streamlining the process.

A single dispersion containing the necessary four to five key ingredients for the latex compound will eliminate excess stock keeping units (SKUs). Purchasing and inventory control become easier. Staging these materials in preparation for compounding also becomes less complex, i.e., “Did I just add the sulfur, or didn’t I?”

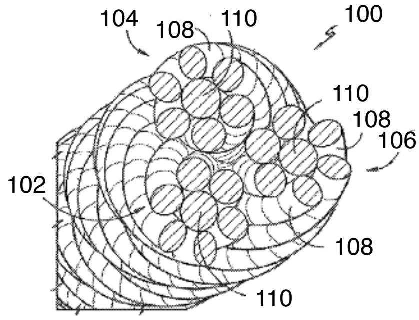
Anecdotal observations when comparing masterbatch results with single dispersions results on the latex film properties have shown a clear improvement of film quality. One particular reason offered for this phenomenon is the “juxtaposition” or “marinating” of the individual raw materials in a single dispersion.

Compounding and processing latex are not easy. Masterbatches may allow the manufacturer to simplify and stabilize their process to insure product consistency.

Patent News

Butyl rubber reactive bonding layer for pre-paving reactive-bonding waterproofing coiled material, preparation method thereof and pre-paving reactive-bonding waterproofing coiled material
U.S. patent: 11,655,401
Issued: May 23, 2023
Inventors: Yuqin Xiong, Ning Yang, Ning Tan and Yang Liu
Assigned: Beijing Oriental Yuhong Waterproof Technology
Key statement: A butyl rubber reactive bonding layer for a pre-applied reactive-bonding waterproofing coiled material, a preparation method thereof and a pre-applied reactive-bonding waterproofing coiled material, relating to the technical field of high molecular pre-applied materials, are disclosed. The butyl rubber reactive bonding layer is prepared mainly from the following raw materials: 100 parts of a raw rubber, 9.5-15.5 parts of a linear tackifier containing a terminal hydroxyl structure and 12.5-19.5 parts of an active filler. The active filler includes active silicon dioxide and aluminium oxide.

Cable for a tire
U.S. patent: 11,655,586
Issued: May 23, 2023
Inventors: Fanny Layec, Rèmi Pinaut, Marie Chassagne and Laurent Bucher
Assigned: Michelin
Key statement: A cable as may be used in a tire, including a pneumatic tire. The cable is constructed in a manner that can provide a desired stiffness to a tire, as well as a certain amount of structural elongation. The cable can be provided in a manner that does not necessarily result in an increase in the overall weight of the tire as would occur by, e.g., increasing the diameter of a conventional cable construction.



High performance rubber damping material and method for preparing the same
U.S. patent: 11,661,467
Issued: May 30, 2023
Inventors: Hongchao Liu, Heping Yu, Qifang Wang, Yongzhen Li and Zheng Peng

PTE
Competence in Compounding

Installing Solar Panels in PTE Compounding de Mexico

In an era of increasing environmental consciousness and the pursuit of sustainable energy sources, PTE Compounding de Mexico has driving by a strong commitment to sustainability and reducing our carbon footprint by installing solar panels. We successfully installed a state-of-the-art solar panel system on our factory's rooftop.

The installation process was a significant undertaking that involved careful considerations of our energy needs, available space, and local regulations. Our team worked closely with experienced engineers to design a customized system that maximizes energy generation and efficiency. The installation was executed seamlessly, and we are now reaping the rewards of clean, renewable energy.

Since the solar panels were installed, we have experienced a significant reduction in our electricity costs. The power generated from the panels has allowed us to rely less on traditional energy sources, resulting in substantial savings. Our solar panel installation has not only transformed our factory into a more environmentally friendly facility but has also set an example for other businesses in our industry. We are proud to be at the forefront of the renewable energy movement, and we hope to inspire others to follow suit.

Patent News

Assigned: Agricultural Products Processing Research Institute, Chinese Academy of Tropical Agricultural Sciences
Key statement: The present disclosure discloses a high performance rubber damping material and a method for preparing the same, relating to the technical field of damping materials. The method for preparing the high performance rubber damping material includes: grafting hydroxyethyl methacrylate and lignin to a rubber molecular chain of natural rubber latex through graft copolymerization reaction, so as to obtain a high performance rubber damping material. This method adopts natural rubber latex as a base material; the hydroxyethyl methacrylate and lignin are grafted to the rubber molecular chain of natural rubber latex through graft copolymerization reaction to form a semi-interpenetrating network structure.

Silica reinforced rubber composition containing a multi-functional group functionalized elastomer and tire with tread
U.S. patent: 11,661,500
Issued: May 30, 2023
Inventors: George Jim Papakonstantopoulos, Aaron Patrick Murray, Bruce Raymond Hahn and Teresa Diane Martter
Assigned: Goodyear Tire & Rubber
Key statement: This invention relates to a rubber composition containing filler reinforcement comprised of precipitated silica with silica coupling agent therefore and conjugated diene based elastomer which contains end chain functionalization with multi-functional groups. The groups functionalizing the elastomer are multi-functional in the sense of containing one group reactive with at least one of said precipitated silica and silica coupling agent and another different group reactive with diene based elastomers through sulfur cure of the rubber composition. A sulfur cured rubber composition containing said end chain functionalization is provided. A tire is provided having a component comprised of said rubber composition. Representative of said tire component is a tire tread.

Process for preparing compounds for tires and tires comprising them
U.S. patent: 11,661,498
Issued: May 30, 2023
Inventors: Antonio Susanna, Raffaella Donetti, Luca Giannini, Thomas Hanel, Roberto Scotti and Barbara Di Credico

International Elastomer Conference

October 16-19, 2023 • Cleveland, OH

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COLMEC Advanced RUBBER EXTRUSION and COMPOUNDING Solutions Booth # 631	ANCORA PRISM WORLDWIDE Booth # 1060	HF MIXING GROUP Booth # 401
R.E. Carroll, Inc. Specialty Chemicals • Petroleum Products Booth # 742	Vanderbilt Chemicals, LLC A Wholly Owned Subsidiary of R.T. Vanderbilt Holding Company, Inc. Booth # 453	LAWER® dosing & dispensing systems Booth # 495
RDAbbott. APPLIED CURIOSITY Booth # 353	Fulflex® Booth # 794	RENKERT Specialty Oils and Products Booth # 390
BRENNTAG Booth # 222	POLYMERICS Booth # 970	SOVEREIGN CHEMICAL Booth # 515

Patent News

Assigned: Pirelli Tyre S.p.A.
Key statement: The present invention relates to a process for preparing a vulcanizable elastomeric compound for tires, characterized by the use of a particular vulcanization-activating filler and by the methods of adding additives, in particular the compatibilizing agent (silane), which occurs only after completion of the reaction between the activating filler comprising zinc and the fatty acid (stearic acid). The present process, advantageous in itself due to the possible reduction of the times and of the energy required for vulcanization, allows preparing compounds which, with the same performances compared to the traditional ones, can have a reduced zinc content and consequently a lower release thereof from tires during use at an environmental level.

Fluoropolymer thermoplastic elastomer
U.S. patent: 11,661,508
Issued: May 30, 2023
Inventors: Ramin Amin-Sanayei, Samuel Devisme, Florent Abgrall, Jerome Chauveau, Anthony Bonnet and Gregory O'Brien
Assigned: Arkema
Key statement: The invention relates to an object or object part made from a composition comprising at least one fluoropolymer F, wherein: the at least one fluoropolymer F comprises vinylidene fluoride units and at least 30 wt.% of units derived from at least one monomer of formula (I): (I) $CX_1X_2{=}CX_3Y$, wherein each of X_1, X_2 and X_3 is independently selected from H, Cl, F, Br, I and alkyl groups comprising from 1 to 3 carbon atoms which are optionally partly or fully halogenated and Y is an alkyl group comprising from 1 to 3 carbon atoms which is optionally partly or fully halogenated; the proportion of the at least one fluoropolymer F in the composition is at least 80 wt.%; and the viscosity of the composition is at least 1,000 Pa·s at a temperature of 230°C and at a shear rate of 100 s^{-1}.

Resin modified vegetable oils in rubber compositions and tires
U.S. patent: 11,667,775
Issued: June 6, 2023
Inventors: Kelsey Elizabeth Cantwell, Stephan Rodewald, Joseph John Kulig and Paul Harry Sandstrom
Assigned: Goodyear Tire & Rubber
Key statement: The present invention is directed to the use of modified vegetable oils in rubber compositions and in tires.

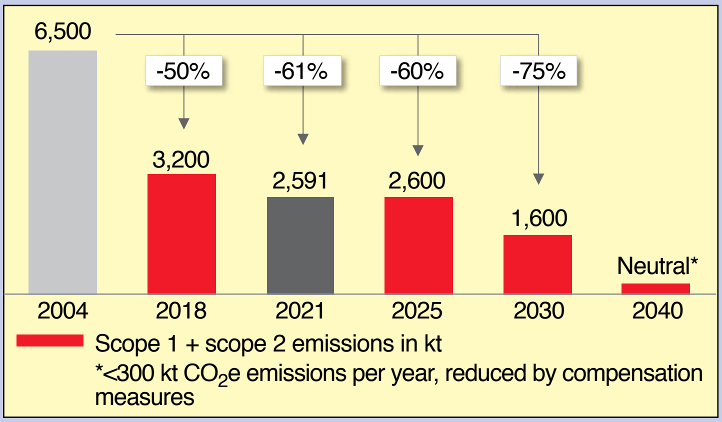
Sustainable additives for the rubber industry

by Joel Neilsen and Antonia Albers, Lanxess

Efforts to make rubber products more environmentally friendly (green) continue to increase (ref. 1). These efforts have become increasingly important to all rubber companies, large and small. Suppliers that produce rubber additives have increasingly focused efforts to provide products to the rubber industry that help meet the goal of increased sustainability. In this regard, Rhein Chemie (RCH), a business unit of Lanxess, currently has a sizeable portfolio of sustainable additives for rubber compounds, and also continues to explore the development of new products that meet the challenge of increased sustainability. This article will focus on currently available products and future products under development that will aid rubber companies in achieving the goal of more environmentally friendly products. Lanxess has two major commitments to the effort of increased sustainability: become climate neutral by 2040 (figure 1) and carbon neutral by 2050 (figure 2).

RCH additives can contribute to rubber product sustainability in a number of ways, as will be discussed. Figure 3 illustrates the sustainability cycle as it relates to Rhein Chemie additives: Certain additives are efficiently produced from renewable raw materials, which in turn are then shipped to RCH customers. Some RCH additives are not produced from renewable resources, but their use helps to extend the life of rubber products, which can allow for fewer products to be required. Other additives aid in the depolymerization of natural rubber, allowing it to be blended with virgin rubber, thus extending its post consumer useful life. Asterisks in figure 3 illustrate the areas of sustainability that will be discussed in this article: additives from renewable raw materials, additives

Figure 1 - Lanxess goal: climate neutral by 2040



Three-pillar strategy

Major impact projects
Promote coal phase-out in chemical parks
Nitrous oxide reduction at plant in Antwerp
Switch to renewable energies in India

Decouple emissions and growth
Climate targets for each business unit
CO_2e footprint as a criterion for growth and acquisitions

Technological innovations
Increase energy effciency in Verbund structure
Focus research on climate neutral processes and technological innovation

Figure 2 - climate protection is of utmost importance for Lanxess

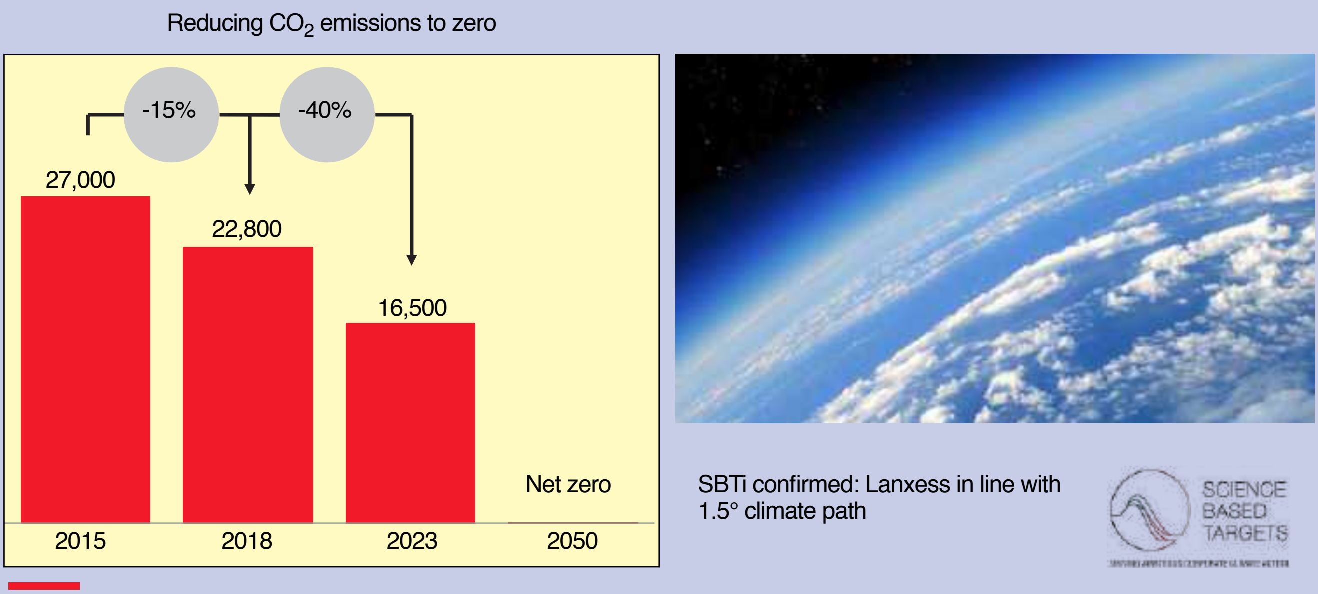


Figure 3 - contribution of rubber additives to sustainability along the product lifecycle

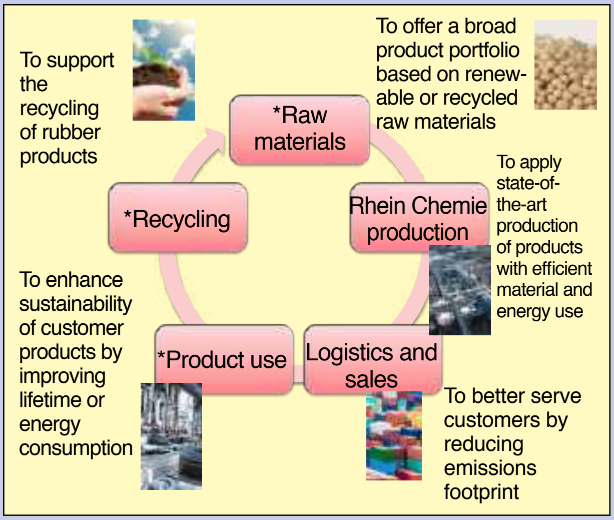
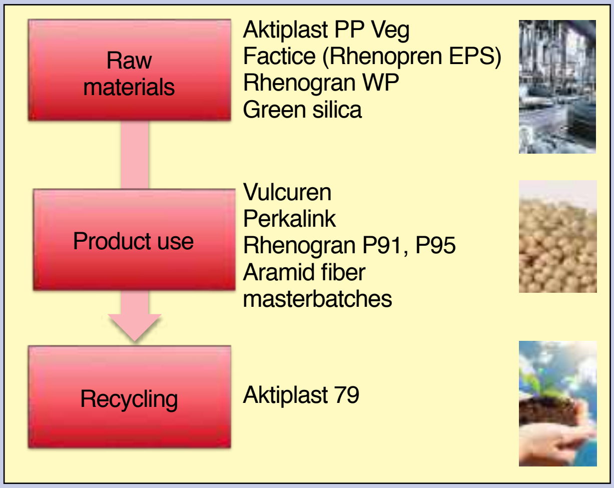


Figure 4 - products supporting sustainability



that extend the service life of rubber products and an additive that depolymerizes natural rubber. A final section will focus on new sustainable additives that are currently under development. Figure 4 lists the specific products that will be discussed in each category. The first section of this article will focus on those specific products that are produced from sustainable raw materials.

Figure 5 - Aktiplast PP Veg

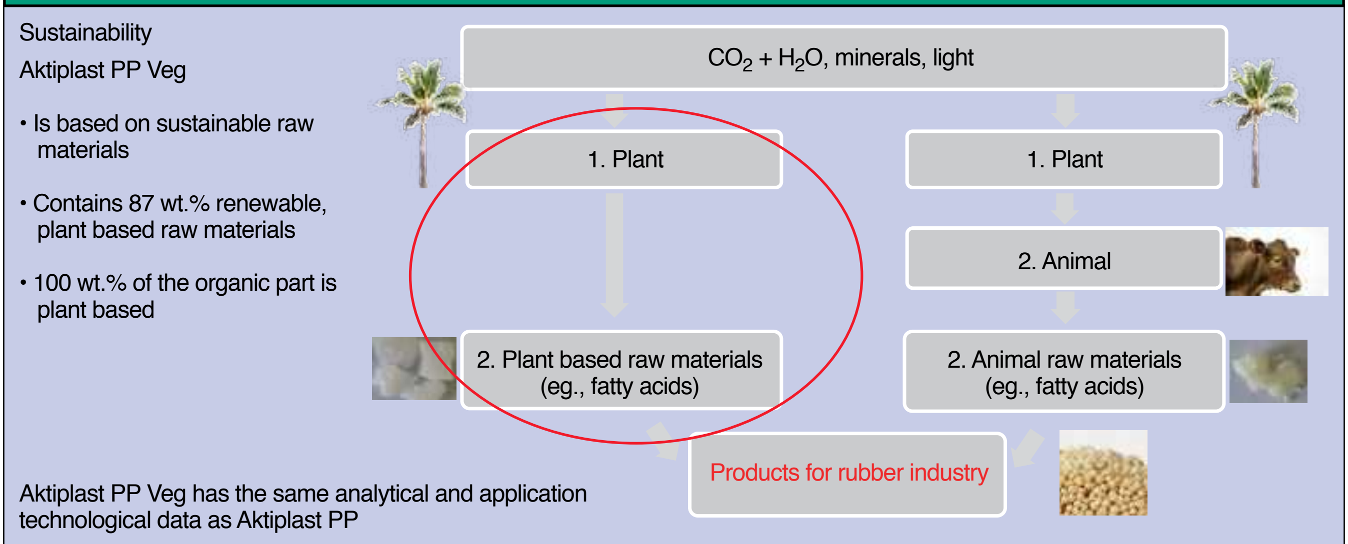


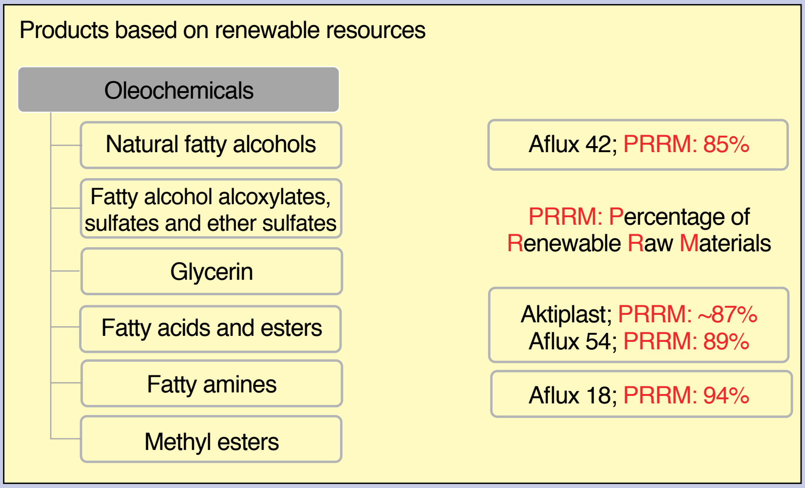
Table 1 - Aktiplast PP Veg

Performance and application

**Results of a carbon black containing sidewall compound based on NR/BR*

Property	*Testing*		*Reference (%)*	*Oil (%)*	*Aktiplast PP Veg (%)*
Rheology	Mooney	(MU)	100	89	94
	Rheo vulcameter	(mm^3)	100	121	146
	Extrusion m, p, edge	(g/minutes, bar)	100/100/6	97/91/8	101/91/9
	Scorch 120°C TS 5	(minutes)	100	100	82
Vulcanization	Curing times TC 95	(minutes)	100	105	113
Dynamics	De Mattia	(kcyc.)	100	250	500
	HBU (inner temperature)	(°C)	100	94	88

Figure 6 - raw materials and products



Aktiplast PP Veg

Oleochemistry is based on vegetable and animal oils as opposed to petroleum oil (ref. 2). Oleo chemicals include many components of RCH processing promotors, including: fatty acids, fatty acid methyl esters, fatty alcohols and fatty amines. Figure 5 illustrates the differences in composition between standard Aktiplast PP and Aktiplast PP Veg. Both are zinc salts of high molecular weight fatty acids, but PP Veg contains no animal based fatty acids. Table 1 illustrates the effectiveness of Aktiplast PP Veg in an NR/BR tire sidewall compound as compared to a non-aromatic processing oil. Both processing aids effectively reduce viscosity, but Aktiplast PP Veg is superior for extrusion rate (Rheo Vulcameter), edge appearance, DeMattia flex to fatigue and heat buildup. A number of other RCH processing promotors are based on renewable oleochemicals, as illustrated in figure 6. The processing promotors listed are effective in a variety of elastomers, and all contain a very high percentage of renewable components.

Rhenopren EPS factice

A unique processing aid is factice, which is primarily vulcanized unsaturated vegetable oil. Factice yields a rubbery material that improves the processing characteristics, surface appearance and ozone resistance of rubber compounds. Figure 7 lists a number of factice grades available from RCH. All are made from sustainable vegetable oils, and Rhenopren EPS is highlighted here because it can be used in compounds that are vulcanized with either sulfur or peroxide. Since factice is vulcanized, it adds to the overall crosslink density of a rubber compound. Factice grades are effective in maintaining complex extruded rubber profiles' shape stability prior to vulcanization. Figure 8 summarizes the benefits that factice bring to rubber compounds, including improved filler dispersion,

Figure 7 - Rhenopren factice

Sustainability

Crosslinked vegtable oils

Rhenopren EPS

Product portfolio

Product	*Description*
Rhenopren 14	Pure rapeseed oil crosslinked with sulfur
Rhenopren Asolvan	Castor oil crosslinked with sulfur
Rhenopren Asolvan T	Castor oil crosslinked with sulfur, blended with refined rapeseed oil
Rhenopren C	Refined rapeseed oil crosslinked without sulfur and hardened
Rhenopren EPS	Vegtable oil crosslinked without sulfur or chlorine
Rhenopren HF	Refined rapeseed oil crosslinked with sulfur
Rhenopren ZD	Refined rapeseed oil crosslinked with sulfur in mineral oil

Figure 8 - Rhenopren factice

Performance

- Promotes dispersion of fillers and absorption of plasticizers
- Enhances the form stability and green strength of unvulcanized extrudates
- Improves air release during extrusion (degassing)
- Reduces swelling
- Improves extrusion rates (acts as a lubricant, reduced stickiness)

Application

- Hoses, profiles, molded goods, roller sheets
- Standard dosage 10-30 phr

Rhenopren EPS in covering on roller shell

Figure 9 - Rhenogran WP

Sustainability

- Naturally occuring (non-regenerated) cellulose fiber (wood pulp)
- Biodegradable material
- Rhenogran form offers the opportunity for
  - Shorter mixing cycles
  - Better dispersion in rubber compounds
  - Better uniformity in products
  - Smaller amounts needed

Product portfolio

Product	*Active content*	*Polymer binder*	*Color*
Rhenogran WPD-70/SBR	70%	SBR	Black
Rhenogran WPDX-73/SBR	73%	SBR	Black
Rhenogran WPH-65/EPDM	65%	EPDM	Black
Rhenogran WPW-77/PVC	77%	PVC	Gray

plasticizer absorption (thus lower compound swell), improved unvulcanized shape retention and higher extrusion rates.

Rhenogran WP cellulose fibers for reinforcement

WP is short for wood pulp, which is obtained from the forestry industry. Figure 9 lists the features of wood pulp and the grades of predispersed wood pulp offered by RCH. Predispersion in an elastomeric binder is essential to successfully disperse wood pulp in rubber compounds. Rhenogran WPD-70/SBR and Rhenogran WPH-65/EPDM contain a resorcinol-formaldehyde resin, and with the addition of a methylene donor such as HMMM, will create a resinous bond between fiber and rubber. Rhenogran WPDX-73/SBR and Rhenogran WPW-77/PVC do not contain the resin and, therefore, will not form a chemical bond, but will provide strength and shape retention through physical dispersion in rubber compounds. All of the predispersed wood pulp grades are effective for cut chip resistance in off-road tires and other applications that experience severe service conditions. Figure 10 illustrates a unique aspect of wood pulp fibers dispersed in a rubber compound: anisotropy. When the fibers are initially mixed into the compound, they do not have a particular orientation. However, as the compound is processed, the majority of fibers (approximately 80%) align themselves lengthwise in the same direction as the process sequence, e.g., extrusion or calendering. Stiffness and reinforcement properties are greater in the compound in the direction of fiber alignment. Figure 11 shows the increase in compound tensile properties in the fiber aligned direction versus perpendicular to alignment, and also compared to no fiber reinforcement and the addition of reinforcing carbon black.

Figure 10 - Rhenogran WP

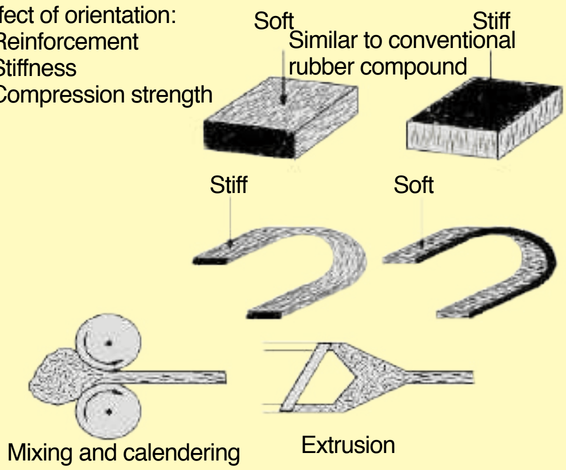
Performance

Using short fibers in rubber

- Modifies and improves mechanical properties of rubber compounds
- Leads to reinforcement of articles
- Leads to improved service life
- Reduces costs compared to textile reinforced articles
- Lowers the conductivity

Effect of anisotropy on physical properties

Effect of orientation:
- Reinforcement
- Stiffness
- Compression strength



Green silica produced from rice husks (developmental)

Precipitated silica is SiO_2 and can be produced from a variety of raw materials, with the primary one being sand (quartz) (ref. 3). However, renewable biomass materials are also a source of silica, and these are considered sustainable (ref. 4). Figure 12 focuses on rice husks, considered waste, as a green source of silica. Husks are first separated from the rice grains, combusted, and the silica is then purified from the residual ash. Husks contain a high concentration of high purity silica. RCH is exploring their use as an additive for dry liquid concentrates, and also as an effective partitioning agent.

Products to extend service life

The following products, Vulcuren, Perkalink and Rhenogran P95 and P91, are produced by RCH and extend the useful ser-

Figure 11 - Rhenopren WP

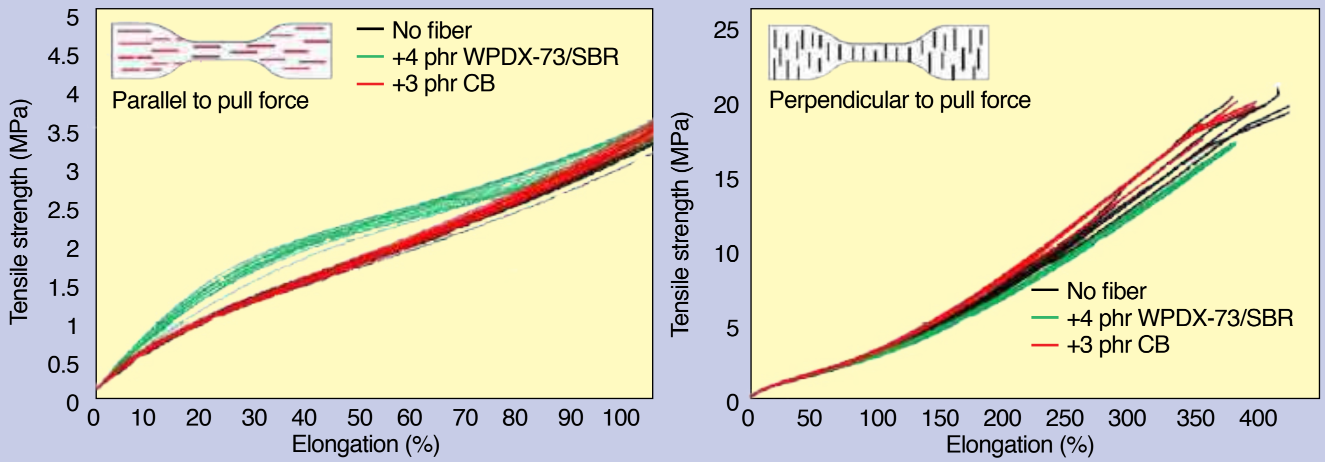


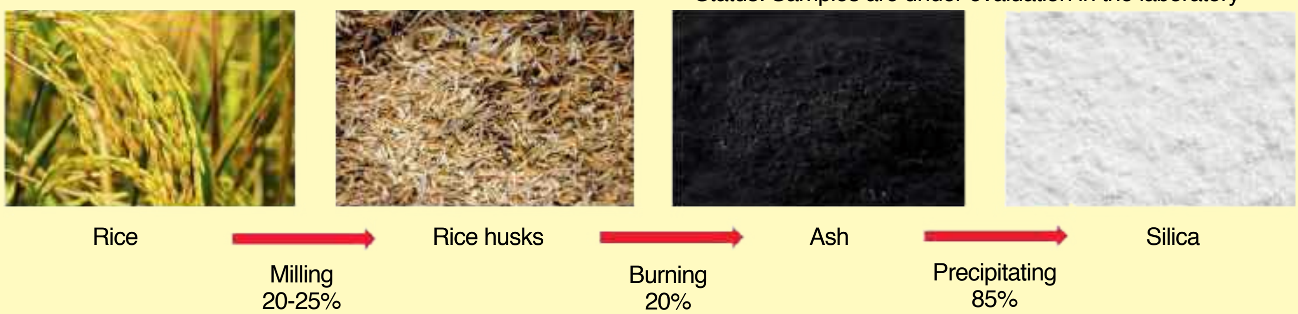
Figure 12 - green silica

Sustainability

- Silica made from rice husk
- 20-25% of the dry weight of paddy rice, considered waste
- Contains high silica content: 15-28 wt.%

Application

- Many silica grades are commercially available
- Rhein Chemie plans to integrate silica in products (e.g., dry liquids)
- Status: Samples are under evaluation in the laboratory



vice life of rubber products, and thus reduce the number of new products required for a particular application.

Vulcuren antireversion agent and crosslinker

Vulcuren forms a unique hybrid crosslink during vulcanization

Figure 13 - Vulcuren

Sustainability

- Bifunctional crosslinker with accelerating effect
- Retention of dynamic behavior during aging
  → Highly reversion resistant vulcanizates
- Lifetime of the product will be extended

Performance

- Thermodynamically stable and flexible hybrid crosslinks
- Good physical and viscoelastic properties of vulcanizates

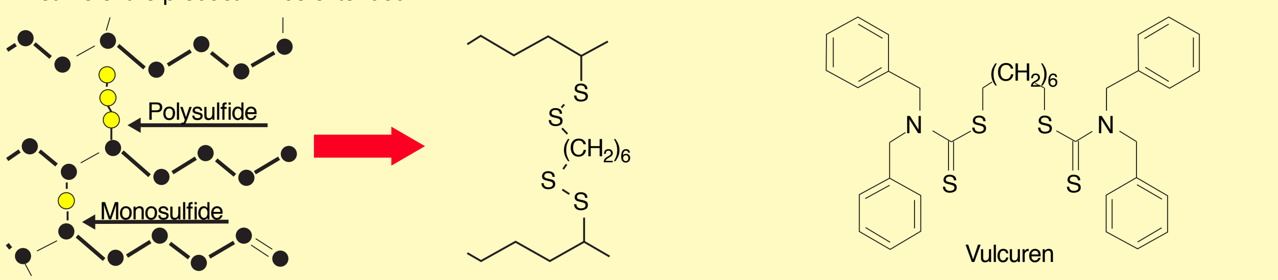


Figure 14 - Vulcuren

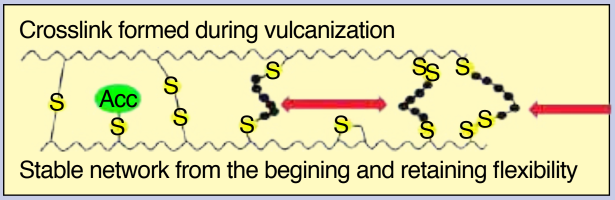


Figure 15 - Vulcuren

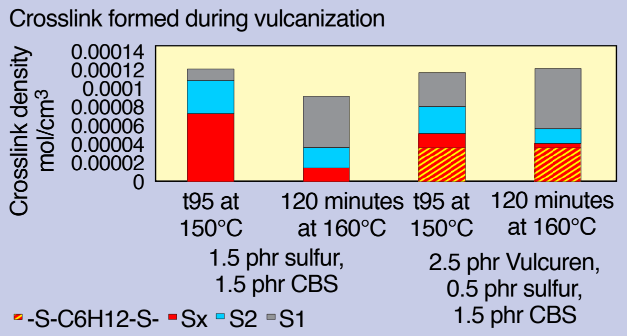
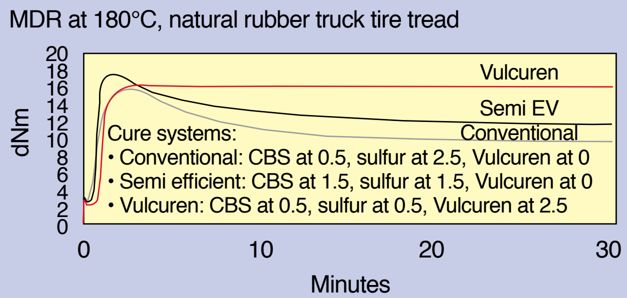


Figure 16 - Vulcuren



(figures 13 and 14). This crosslink is stronger and more flexible than typical polysulfidic crosslinks, which tend to break down to some extent during vulcanization and in service (e.g., large tires composed of high levels of natural rubber). Flexible hybrid crosslinks from Vulcuren help to stabilize the network, as seen in figure 15: Total crosslink density stays more constant with Vulcuren after overcure. Figure 16 clearly shows how Vulcuren virtually eliminates reversion as measured by rheometer maximum torque. The same natural rubber compound cured with a conventional and semi-efficient cure system shows typical reversion. Figure 17 summarizes Vulcuren's properties that help extend the service life of rubber products, such as heavy duty tires, conveyor belts, etc. Note that Vulcuren is also an effective replacement for secondary accelerator DPG (diphenyl guanidine) in green tire tread compounds (an environmental improvement, since DPG emits large amounts of the harmful VOC aniline during and post vulcanization).

Perkalink 900 antireversion agent and crosslink repair

In contrast to Vulcuren, Perkalink 900 is inert during vulcanization, unless significant overcure occurs. Figure 18 shows the structure of Perkalink 900 and how it repairs polysulfidic crosslinks that have degraded. Figure 19 illustrates the strong, flexible crosslink formed by Perkalink 900 via a Diels-Alder mechanism. Table 2 shows that under normal vulcanization conditions, Perkalink 900 does not affect cure properties, such as cure rate or torque development. However, under overcure conditions (figure 20), Perkalink 900 maintains the crosslink network much more effectively than the control compound. This stability of the network is evident when dynamic properties are measured. Table 3 shows that tangent delta of the compound containing Perkalink 900 does not increase, as does the control as overcure conditions are increased. Table 4 summarizes how Perkalink 900 contributes to rubber product sustainability: Aging resistance, reversion resistance and ply adhesion are all improved, which will lead to longer rubber product service life, and thus reduce the need for new replacement products.

Rhenogran P91 and P95 aramid short fiber dispersions

Additives that extend rubber product service life can contribute to sustainability, since their performance will allow for fewer new products required for a particular application. An example of this is chopped aramid fibers (ref. 5) that are predispersed in an elastic binder for easy dispersion in rubber. Aramid fibers can significantly increase compound reinforcement and improve resistance to heat, cut/chip and chemical exposure (figure 21). Also listed in figure 21 are the current predispersed aramid fiber products offered by Rhein Chemie (black text); products in red text are currently being developed. These developmental

Figure 17 - Vulcuren

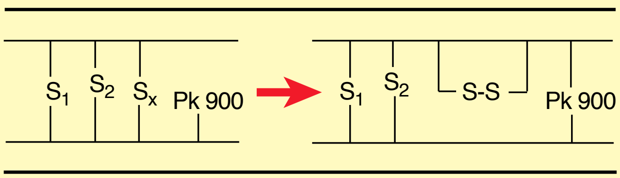
Application
- For all reversion sensitive rubbers
- Use in sulfur vulcanization (conventional/semi-efficient)
  - Combination with accelerators (e.g., MBTS, CBS)
- Passenger car tire treads based on SSBR/BR silica compounds
  - Reduced hardening of tread during service life
  - Fewer post-curing reactions and network alterations at high temperatures
  - Can replace DPG, which emits large quantities of aniline

Dosage recommendations

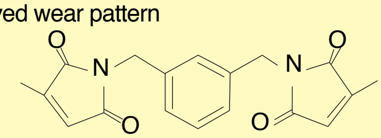
Application (NR, BR, SBR)	Dosage (phr)
Anti-reversion agent	2.0-4.0
Crosslinker/secondary accelerator	0.3-1.0

Figure 18 - Perkalink 900

Performance
- Compensates for the loss of sulfur bridges during curing or service life
- Not reactive during vulcanization or at low temperatures
- Increased rate of reversion → increased reactivity



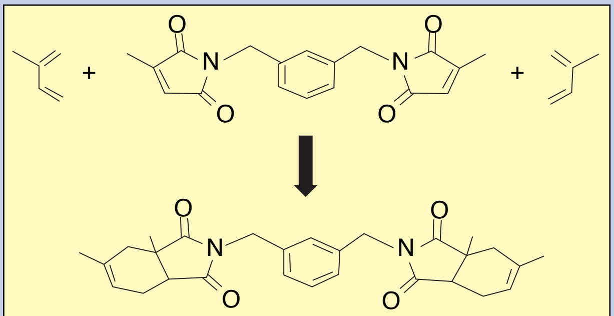
Sustainability
- Improved lifetime of vulcanizates
- In tire compounds
  - 10°C to 12°C reduction in heat buildup
  - 7-10% reduction in rolling resistance
  - 15% improvement in endurance mileage
  - Improved wear pattern



Perkalink 900

Figure 19 - Perkalink 900

Crosslink formation, Diels-Alder mechansim



products include fibers dispersed in silicone and fluoroelastomer binders. The Rhenogran P91 grades have their ends mechanically fibrillated to increase their reinforcing potential in rubber compounds. The P95 grades have ends that are simply chopped.

Figure 22 compares physical properties of various fibers that can be used in masterbatches, including chopped aramid. Only carbon fibers, which are significantly more expensive than aramid, offer higher modulus and tensile properties. Aramid fibers also offer exceptional heat resistance. Similar to wood pulp fibers, chopped aramid fibers exhibit anisotropy in rubber compounds, as seen in figures 23 and 24. Figure 23 shows the significant increase in tensile properties when samples containing aramid fibers are pulled in the same direction as fiber alignment, as compared to pulls that are perpendicular to alignment. Figure 24 shows the same significant increase in modulus when samples are pulled in the direction of fiber alignment.

As the performance of the products in this section has shown, increasing sustainability of rubber products can be obtained by more than focusing on rubber additives that are produced from renewable raw materials. Additives that extend rubber product service life can significantly contribute to the overall sustainability effort.

Recycling rubber with Aktiplast 79

Recycling or reusing rubber is an essential part of the overall sustainability effort. Since approximately 70% of the rubber produced in the world is used in tire manufacturing, tire recycling has become a major effort for many years. Currently in the United States, approximately 76% of used tires are recycled (ref. 6). There are a number of ways that tires that would otherwise end up in landfills are reused:

- Shredding and cyrogenic grinding can allow the reuse of tire rubber into products such as synthetic turf, playground flooring and road reinforcement.

Figure 20 - Perkalink

Cured properties, overcure study

	(Control)			Perkalink 900		
Cure temperature, °C	170	190	205	170	190	205
Cure time, minutes	20	15	10	20	15	10
Modulus 50, MPa	1	0.9	0.85	1	1	1
Modulus 300, MPa	6.7	6.1	5.8	6.7	6.6	7.1
Tensile strength, MPa	21.1	20	19.2	21.3	21.8	20.8
Elongation at break, %	675	715	690	670	675	660
Tear strength, kNm	45	40	-	50	55	-
Abrasion DIN, mm^3	105	120	130	90	100	100
Crosslink density	4.5	3.8	3.2	4.6	4.2	4.1

- Cures properties are stable and crosslink density is not affected in the presence of Perkalink
- Properties of the control are worse if high curing temperatures are applied
- Crosslink density is reduced by high temperature without Perkalink

Table 2 - Perkalink 900

Recipe and rheological properties

	1 (Control)	2 (Perkalink 900)
SBR 1712	82.5	82.5
BR CB29	55	55
N-220	70	70
Zinc oxide	3	3
Stearic acid	2	2
6PPD	1	1
TMQ	2	2
Microcrystalline wax	3	3
TBBS	1	1
Sulfur	2	2
Perkalink 900	-	**0.75**

Rheometer MDR 2000 E		1 (Control)	2 (Perkalink 900)
t90	Minutes	6.4	6.5
Delta S'	Nm	1.14	1.15

- Not reactive during vulcanization or at low temperatures

→Processing and cure properties (scorch delay, vulcanization rate, cure time) remain unaffected

- Chemical breakdown (reclamation) of rubber can allow low levels of addition to virgin rubber to produce compounds for new tires and other rubber products
- Devulcanization of vulcanized rubber can create a material that is capable of being crosslinked with sulfur or peroxide and added at a low level to virgin rubber compounds.

It is with the third option where Aktiplast 79 can be used as an effective devulcanizer. Figures 25 and 26 illustrate the significant progress that has been made in recycling tires. In the past, the primary disposal method of worn tires was landfills: These massive tire piles are unsightly and often are a breeding ground for insects (e.g., mosquitos). Additionally, arson or other causes can create large tire fires, which because of the oil based nature of tires are very difficult to extinguish. Shredding tires and separating out the metal and textile components allows for the use of the resulting material in a variety of ways (e.g., playground/sports surfaces). Beyond shredding, ambient and cryogenic grinding of tires produces crumb rubber with a particle size between 5-60 mesh. A depolymerizer such as Aktiplast 79 can be added to crumb rubber to chemically break down mono, di and polysulfidic crosslinks, and thus allow for limited revulcanization of the material.

Figure 27 illustrates the basic differences between depolymerization and reclamation. The former mainly causes scission of sulfur crosslinks and leaves the rubber chains essentially intact. Reclamation, on the other hand, breaks down carbon-carbon bonds, in addition to sulfur crosslinks, which render the resulting material less effective for reuse. The use of Aktiplast 79 as a devulcanizer produces a material that has significant

Table 3 - Perkalink 900

Eplexor and heat buildup, overcure study

	(Control)			Perkalink 900		
Cure temperature, °C	170	190	205	170	190	205
Cure time, minutes	20	15	10	20	15	10
Eplexor, temperature sweep, 15 Hz						
E' (60°C), MPa	5.0	4.3	4.2	5.0	4.8	4.7
E" (60°C), MPa	1.04	0.98	0.98	1.01	0.96	0.95
Tan delta (60°C)	0.207	0.226	0.231	0.201	0.200	0.202

- E' is decreasing in the control, but more stable in the sample with Perkalink 900
- Tangent delta is more stable in the sample with Perkalink 900

Table 4 - Perkalink 900

Application
- SSBR/BR compounds → improved aging resistance
- NR compounds → improved reversion resistance while maintaing tear and flex properties, improvement in HBU
- Skim compounds → improvement of adhesion systems
- Innerliner compounds → improved heat and reversion resistance
- Use in technical rubber articles → improved heat and reversion resistance

Dosage
- Number of compensating crosslinks directly related to the concentration
- Dosage depending on type of polymer and curing system

General dosage recommendation:

Polymer system	*Cure system*	*Perkalink 900 concentration (phr)*
100% NR, IR or	EV to SEV	0.25-0.40
blend with >50%	SEV to conventional	0.50-0.75
NR, IR	high sulfur	0.50-0.75
SBR/BR blends	SEV to conventional	0.25-0.40
Other saturated polymers e.g. NBR	SEV to conventional	0.25-0.50

Figure 21 - Rhenogran P91, Rhenogran P95

Performance and sustainability

- Pure fiber pulp (Twaron) predispersed in rubber matrix
- Effect
  - Excellent reinforcement, high flexibility
  - Extremely durable
  - Heat, cut and chemical resistant
- Non-conductive, high decomposition temperature, low flammability

Application and product portfolio

- Lightweight applications
- High performance applications

Product	*Active content*	*Polymer binder*	*Color*
Rhenogran P91-40/EPDM	40%	EPDM	Yellow
Rhenogran P91-40/NBR	40%	NBR	Yellow
Rhenogran P91-40/NR	40%	NR	Yellow
Rhenogran P91-40/Q	40%	Q	Yellow
Rhenogran P91-40/FKM	40%	FKM	Yellow
Rhenogran P95-50/EPDM	50%	EPDM	Yellow
Rhenogran P95-50/NBR	50%	NBR	Yellow

New

Figure 22 - Rhenogran P91, Rhenogran P95

Short fiber characteristics

Fiber	*Density (g/cm^3)*	*Young's modulus (GPa)*	*Tensile strength (GPa)*	*Elongation at break (%)*	*Decomposition temperature (°C)*
Carbon (PAN)	1.8-2.0	160-450	3.5-7.0	0.7-2.0	>3,700
E-glass	2.6	72	1.5-3.0	1.8-3.2	825 melting
Nylon	1.1	n.a.	0.9	18-25	260 melting
Polyester	1.4	n.a.	1.1	10-15	255 melting
Twaron aramid	1.4-1.5	60-120	2.4-3.6	2.2-4.4	>500

Selection of various fibers for masterbatches

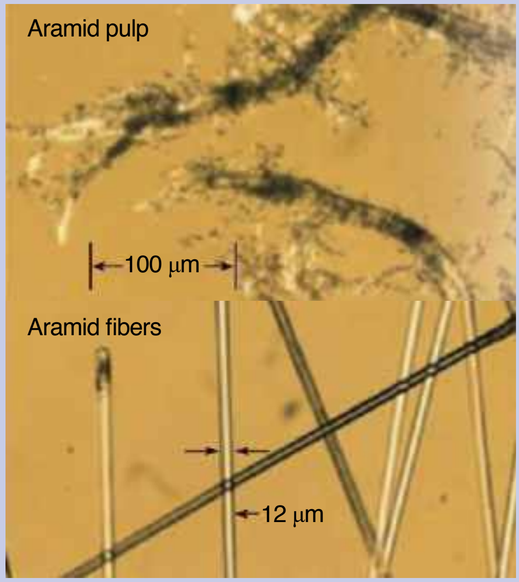


Figure 23 - Rhenogran P91, Rhenogran P95

Performance

Basic study of fiber masterbatches in OTR formulation, effect of anisotropy

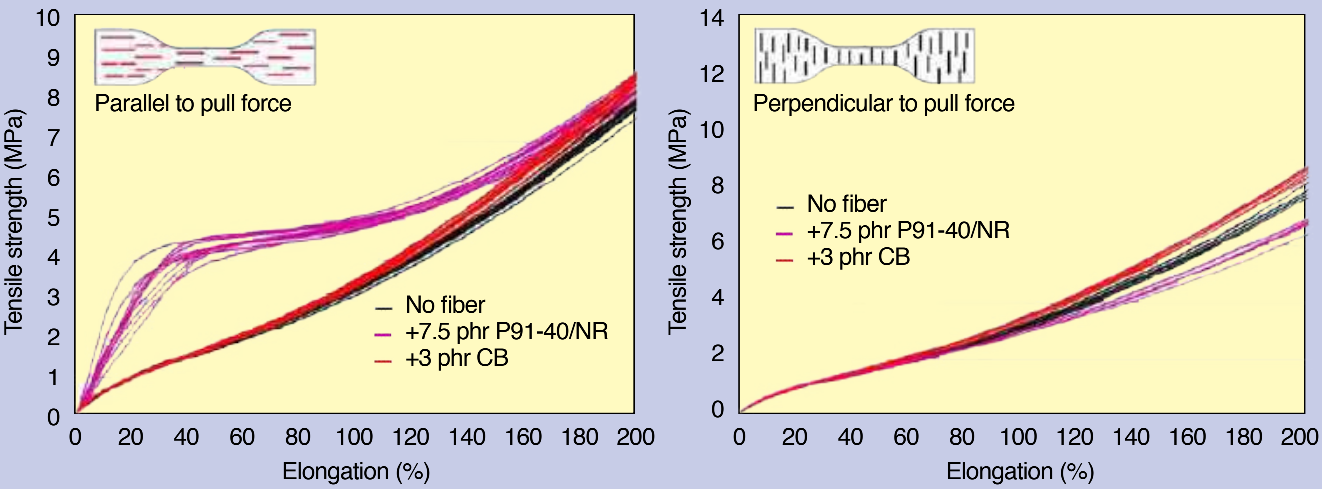
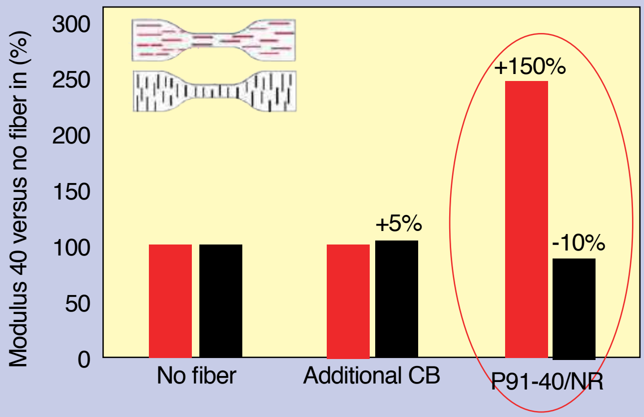


Figure 24 - Rhenogran P91, Rhenogran P95

Performance



- Rhenogran P91 leads to significant modulus increase (particularly at 40% elongation) in longitudinal direction of the fiber orientation compared to no filler or carbon black
- In transversal direction to the fiber orientation, the level of the 40% modulus remains almost unchanged

Figure 25 - Aktiplast 79

Non-sustainable disposal

Dangers of used tire piles

Figure 26 - Aktiplast 79

Roofing tiles produced from used tires

Playground covered with shredded tires

performance value, and thus contributes to the overall sustainability effort. Crosslinkable devulcanized rubber can partially replace virgin rubber without a detrimental effect on tire performance (ref. 7).

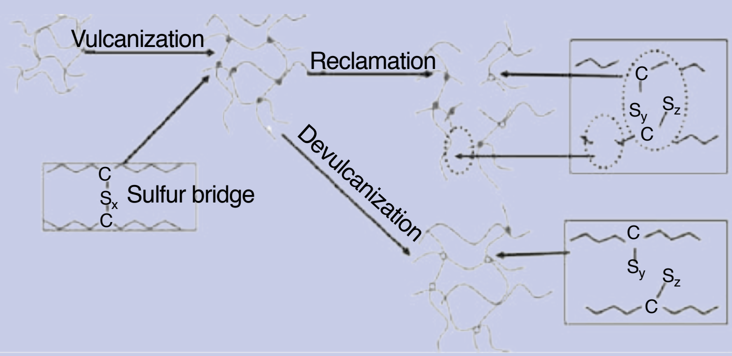
Development of sustainable rubber additives: What is next?
The effort to develop new rubber additives that are sustainable must continue. To that end, the Lanxess business unit, Rhein Chemie, is exploring additional additives beyond those presented in this article:

- Nanocellulose is a light solid substance obtained from plant matter (typically wood pulp) which comprises nanosized cellulose fibrils. Widths typically are between 5-20 nanometers, and lengths can be several microns. The fibrils are pseudo-plastic and possess the property of specific kinds of fluids or gels that are generally thick in normal conditions. The fibrils are effective stiffening additives which increase rubber compound mechanical properties. Similar to aramid, nanosized fibrils have higher tensile strength per unit weight versus steel.
- Lignin based materials add compressive strength and

Figure 27 - Aktiplast 79

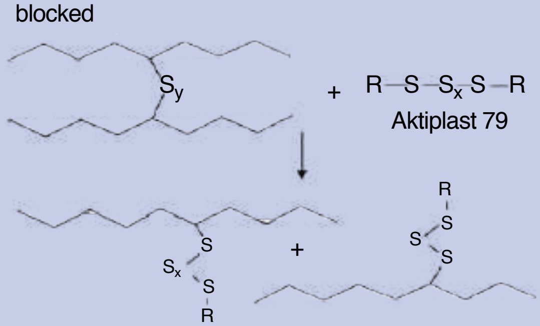
Reclamation versus devulcanization

Devulcanization actively cleaves sulfur bonds only
→ Mechanical properties are mostly maintained



Sustainability

- Aktiplast 79 (dioctylpentasulfid, DOPS) is used for devulcanization
- Sulfur bonds are cleaved and formed radicals are blocked



stiffness to the plant cell wall. Along with cellulose, lignin is one of the main components of wood; a stiffener that can be used to increase mechanical properties of rubber compounds. Chemically, lignin is polyphenolic and may find use in phenol-formaldehyde curing systems, as it is less toxic and renewable

Summary

The number of Rhein Chemie's additives for rubber compounds that contribute to the sustainability effort is extensive. As has been shown that rubber compound additives can be considered sustainable by either being produced from renewable raw materials, by extending the service life of rubber products, or by improving the recyclability of post consumer rubber compounds, which will reduce the need for virgin rubber. Rhein Chemie will continue to explore the development of new sustainable additives, since the need for new products of this type will only increase in the future.

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

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Mechanical and dynamic properties of peroxide cured HNBR compounds, part 2: HNBR terpolymers

by Victor Nasreddine and Pete Spanos, Arlanxeo USA LLC

This article is the second of a two-part study on hydrogenated nitrile rubber (HNBR) (refs. 1 and 2), a specialty elastomer used in demanding applications in the automotive, industrial, and oil and gas markets. Part 1 (ref. 3) focused on HNBR copolymers of acrylonitrile and butadiene, and demonstrated how mathematically derived models, via a statistical experimental design, could be used for polymer selection and better design of compounds to meet application requirements.

However, not all HNBR polymers are copolymers. Would the previously derived copolymer models apply to HNBR terpolymers? If not, could new terpolymer models be created? Indeed, the previously derived models were found to be good for all of the HNBR copolymers, but were not applicable to the terpolymer types. The terpolymer types evaluated here are specifically targeted for improved low temperature properties, and the ability to expand their elasticity to colder service temperatures. This article presents a new Design of Experiments (DOE) method on terpolymers to utilize these types of materials.

Experimental

HNBR LT terpolymers for improved low temperature properties, including the low Mooney viscosity HNBR AT LT grade, have the following respective properties: acrylonitrile (ACN) content of 17% to 31%, residual double bond (RDB) from less than 0.9% to 6%, and Mooney viscosity ML (1 + 4) at 100°C of 39-80 MU.

Testing was conducted on a standard HNBR formulation (table 1). The model is only applicable to this formulation, but the utility can be extended to other recipes by determining the optimum polymer desired characteristics and applying them. The HNBR polymer type is varied, and the peroxide level is adjusted for polymers of different RDB, as in the previous design of experiment study performed on HNBR copolymers (ref. 3). This peroxide adjustment, as was demonstrated, aligned the state of

Table 1 - HNBR compound formulation (phr)

HNBR terpolymer	100
N550 carbon black	40
Stearic acid	1
CDPA	1.1
Zinc-4- and 5-methyl-2-mercaptobenzimidazole (ZMMBI)	0.4
MgO	3
ZnO	5
Powdered dispersion of high vinyl butadiene	6
2,5-dimethyl-2,5-di(tertbutylperoxy) hexane	6.5/7/7.5
Total	163-173

Figure 1 - comparison of how the copolymer model predicts HNBR copolymer and terpolymer compound properties; R^2 is the correlation factor of tested (actual) versus model calculated properties

Good fit of copolymer derived model for copolymers, but poor fits for terpolymers

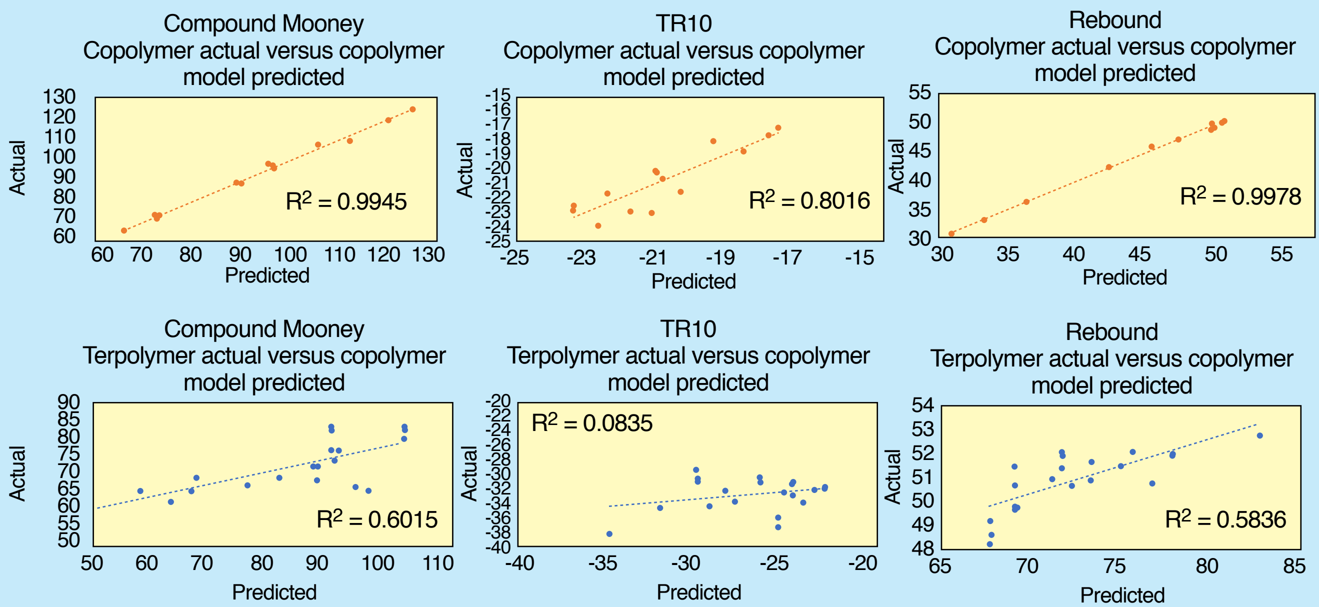
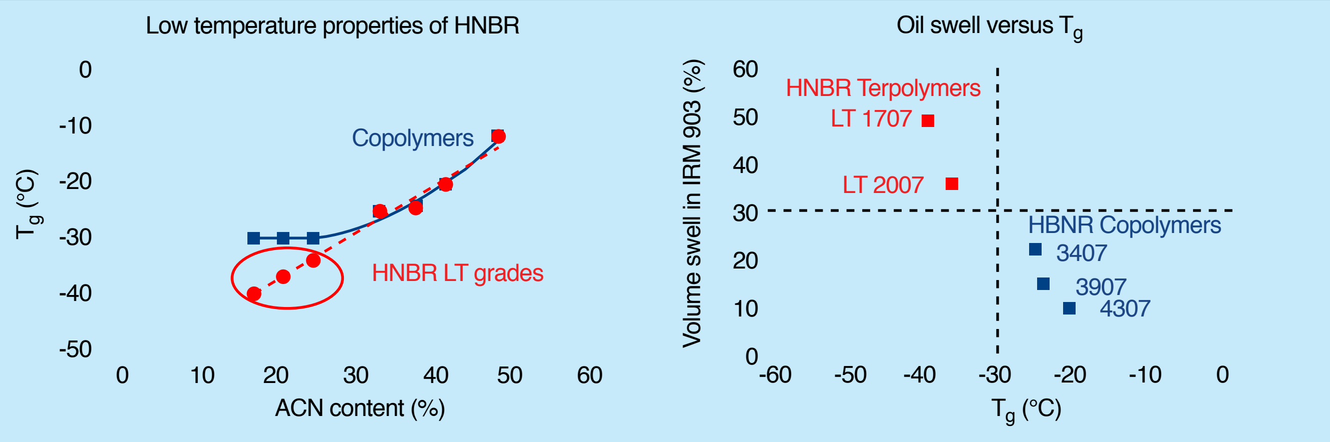


Figure 2 - dependence of T_g and volume swell in IRM903 test oil for HNBR copolymers and terpolymers



cure of the compounds so that data with a low state of cure are excluded from this analysis.

Carbon black filled compounds were mixed in a 1.5 liter Krupp GK 1.5E internal mixer, followed by final dispersion on a 25.4 x 50.8 cm two-roll mill. For mixing, a filling degree of 68%, a ram pressure of 200 kPa and a rotor speed of 60 rpm were used. The mixer temperature was set to 30°C. A standard mixing procedure was adopted, with polymer added first, followed by fillers and other additives. At 130°C, the compound was discharged. The curatives were added on the mill and tempered at 30°C. Finally, the compound was cut and rolled end-way-on six times, respectively.

The curing characteristics were obtained using an MDR 2000E rheometer (Alpha Technologies) at 180°C (ASTM D 5289). Test pieces were prepared by curing at 180°C using a curing time of t90 + 5 minutes at 180°C. Standard procedures and test conditions were used for Mooney viscosity and scorch (ASTM D 1646), hardness (ASTM D 2240), tensile strength (ASTM D 412), tear strength (ASTM D 624), abrasion (DIN 53516), compression set (ASTM D 395), rebound resilience (DIN 53512), Goodrich flexometer (DIN 53533), dynamic mechanical analysis (DIN 6721), low temperature retraction (ASTM D 1329), hot air aging (ASTM D 573) and fluid resistance (ASTM D 471).

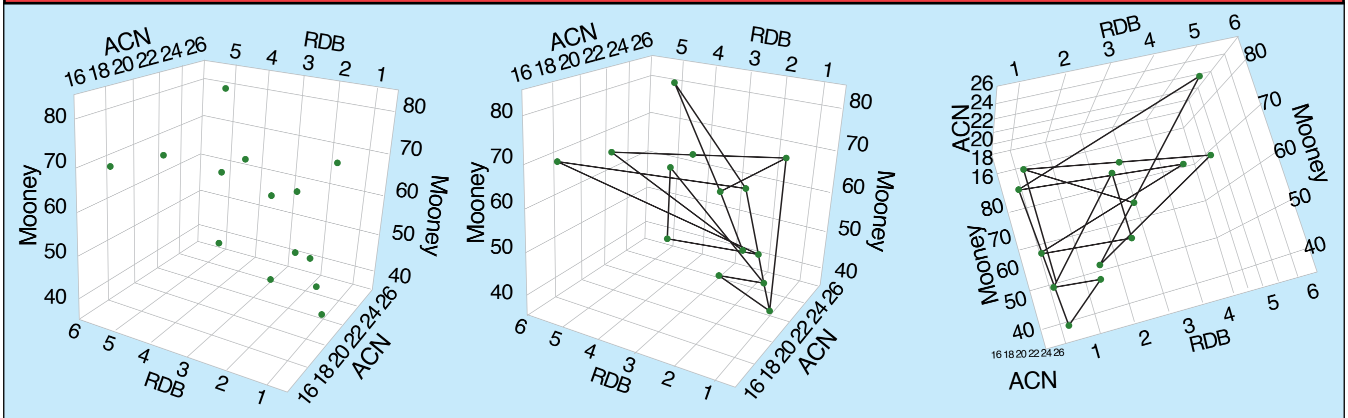
Results and discussion

In previously published work (ref. 3), part one of this two-part study, mathematical models were derived via a DOE to predict compound properties of HNBR copolymers based on ACN, RDB and Mooney viscosity values. Those models were derived with copolymers, and were expected to apply only to copolymers within the upper and lower ACN, RDB and Mooney levels, as described. Figure 1 shows a selection of the many properties that the copolymer models accurately predict for copolymers. How-

Table 2 - HNBR terpolymers and blends used for the terpolymer model

HNBR	*ACN (%)*	*RDB (%)*	*Mooney ML1+4 100°C*	*Peroxide (phr)*	
LT 1707 VP	17	0.9	74	7.5	1
LT 1757 VP	17	5.5	70	6.5	2
AT LT 2004 and LT 1707 50:50 blend	19	0.9	56.5	7.5	3
AT LT 2004 and LT 1757 50:50 blend	19	3.2	54.5	7	4
LT 2057 and LT 1707 50:50 blend	19	3.2	70.5	7	5
AT LT 2004 and 1707 75:25 blend	20	0.9	47.75	7.5	6
AT LT 2004 and 1757 75:25 blend	20	2.05	46.75	7.5	7
AT LT 2004	21	0.9	39	7.5	8
LT 2007	21	0.9	74	7.5	9
LT 2057 and LT 2007 50:50 blend	21	3.2	70.5	7	10
LT 2057	21	5.5	67	6.5	11
AT LT 2004 and 2568 75:25 blend	22	1.925	49.25	7.5	12
AT LT 2004 and 2568 50:50 blend	23	2.95	59.5	7	13
LT 2568 VP	25	5	80	6.5	14
LT 2568 VP	25	5	80	6.5	15
LT 1707 VP	17	0.9	74	7.5	16
AT LT 2004	21	0.9	39	7.5	17
LT 2007	21	0.9	74	7.5	18
LT 2007	21	0.9	74	7.5	19
AT LT 2004 and LT 2568 50:50 blend	23	2.95	59.5	7	20
LT 2568	25	5	80	6.5	21

Figure 3 - 3D graphical depiction of the experimental design; dots are the experimental points; several views shown for clarity



ever, they do not predict the properties of HNBR terpolymers well. New models are needed for terpolymers.

The terpolymers differ from copolymers (ref. 4), as they have a termonomer in the polymer backbone that disrupts the crystallinity of the ethylene segments in HNBR copolymers, and they also have lower acrylonitrile contents. The glass transition temperature (T_g) of HNBR copolymers decreases with ACN content until 34% ACN content is reached, below which the T_g does not decrease due to the presence of ethylene sequences. These ethylene sequences result from the hydrogenation of the butadiene found in nitrile rubber (NBR). Introducing a termonomer opens a window into lower temperature performance for HNBR, as shown in figure 2. Oil resistance correspondingly decreases with lower ACN content.

A statistically designed experiment (refs. 5-7) was conducted with ACN, RDB and Mooney viscosity varied. JMP software from SAS was used to analyze the results via a standard least squares fit. Current commercially available production grades of HNBR terpolymers and their blends were used and fit into the experimental design. The blends were prepared to create more input data to fill the space of the design to create a better model. Table 2 shows the polymers and corresponding ACN, RDB and Mooney levels, while table 3 shows the coded experimental levels. Twenty-one experiments were run, with several replicates which are colored by group in the tables. These conditions are depicted graphically in figure 3 via dots, connected dots and a rotated view.

The resulting statistically derived models for the terpolymers show good fits in predictions for the terpolymer properties. Figure 4 shows the same data that appears in figure 1, but the terpolymer model is applied. As expected, the new model is good for the terpolymers, but poor for the copolymers. Different models are necessary for HNBRs with the differing compositions.

Figure 4 - comparison of the copolymer and terpolymer models for predicting the properties of HNBR terpolymers

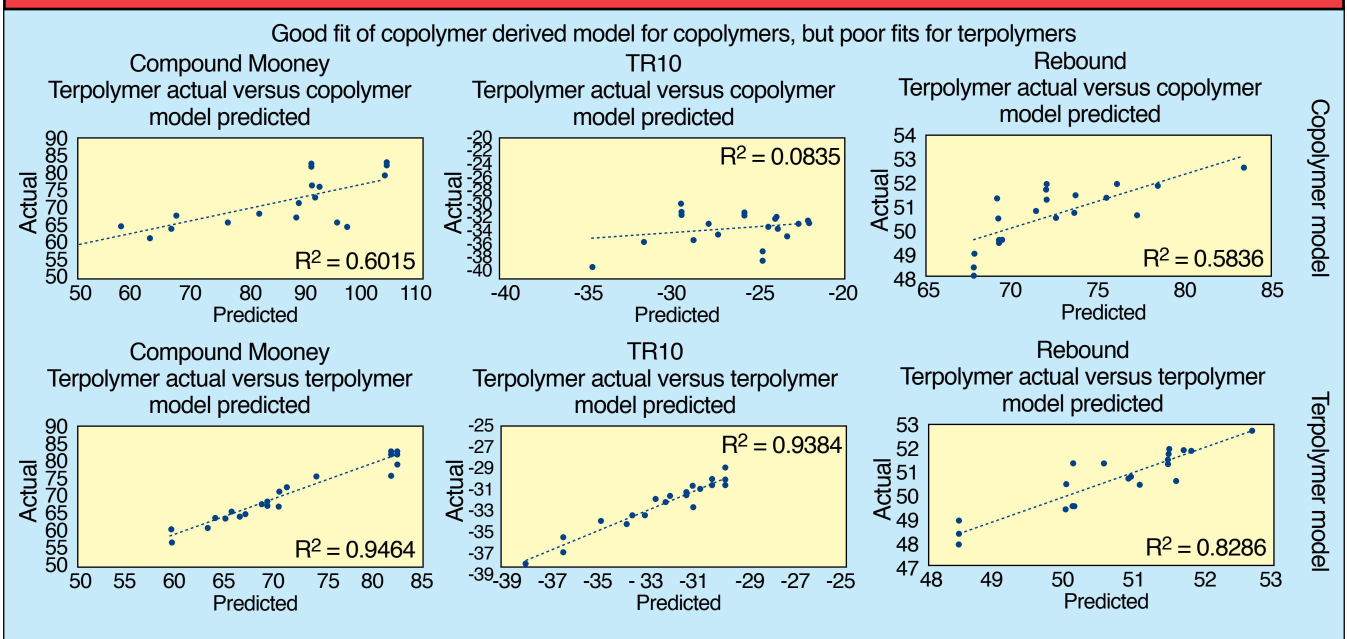


Table 3 - experimental coded levels

Experimental design	ACN	RDB	Mooney	
	Design used			
	-1.1	-0.5	0.4	1
	-1.1	1.7	0.2	2
	-0.6	-0.5	-0.5	3
	-0.6	0.6	-0.6	4
	-0.6	0.6	0.2	5
	-0.3	-0.5	-0.9	6
	-0.3	0.1	-1.0	7
	-0.1	-0.5	-1.4	8
	-0.1	-0.5	0.4	9
	-0.1	0.6	0.2	10
	-0.1	1.7	0.0	11
	0.2	0.0	-0.9	12
	0.4	0.5	-0.4	13
	0.9	1.5	0.6	14
	0.9	1.5	0.6	15
	-1.1	-0.5	0.4	16
	-0.1	-0.5	-1.4	17
	-0.1	-0.5	0.4	18
	-0.1	-0.5	0.4	19
	0.4	0.5	-0.4	20
	0.9	1.5	0.6	21

Prediction profilers, as shown in figure 5, provide the dependence of processing and vulcanizate properties as a function of terpolymer ACN, RDB and Mooney. The compound Mooney viscosity is most strongly influenced by the polymer Mooney viscosity, and the volume swell in IRM 903 fluid is mostly influenced by ACN content, as expected, and the models quantify this dependence. Overall, the influence of the parameters is generally similar to that of part 1 for copolymers.

Predicted properties, as generated by the constructed models, can be calculated and depicted graphically. Figure 6 is an example whereby predictions are shown graphically for various ACN and RDB levels for a given Mooney viscosity. Actual test data points are incorporated, and two different perspectives of the same model shown. The low temperature property, temperature of retraction to 10% (TR10), is highly dependent on ACN content, but also influenced by RDB.

The generated models show similar ACN dependence for both TR10 and TR70 (figure 7); but TR70 is more strongly influenced by RDB content. Here, the models can calculate the degree of dependence, and the result is as observed in a previous separate study (ref. 8).

The trade-off in desired properties is common practice, and becomes an engineering choice. Figure 8 shows how both low swell in IRM 903 fluid and low TR10 may be desired properties; but polymer ACN content dictates one versus the other.

In dynamic applications, the increase in temperature as a result of energy absorption can lead to premature failure. Complimentary conditions are shown for volume swell in IRM 903.The high ACN and tight crosslink density result in less swelling of the polymer network. Also, the tighter crosslink density results in a more resilient network with less heat generation (figure 9).

For a given set of polymer parameters, a complete set of predicted properties can be generated, as shown in table 4. For example, the previously shown graphical depictions and the calculated value shown in table 4 are as per the DOE generated equation:

TR10 = -50.2 + ACN - 0.51 * RDB + 0.05 (ACN-20.9) * (RDB - 2.6) - 0.03 * PMooney - 0.02 * (ACN - 20.9) * (PMooney - 63.8) - 0.02 * (RDB - 2.6) * (PMooney - 63.8) + 0.001 * (ACN - 30.9) * (RDB - 2.6) * (PMooney - 63.8)

Similar equations were generated for all properties.

As per the example in table 4, a polymer with 23% ACN, 2.95% RDB and 59.5 Mooney viscosity results in a compound with a TR10 value of -30.5°C.

Scenarios can be generated where trade-offs and impacts on other properties are calculated. Desirability functions could be applied. Table 5 is one such example, with a target of the lowest possible heat rise for a polymer resulting in a volume swell less than 32% in IRM 903. A number of approaches can be taken to solve for the optimum solution. The Microsoft Excel solver tool

Figure 5 - prediction profilers: selected graphical depictions of compound characteristics as a function of polymer ACN, RDB and Mooney viscosity

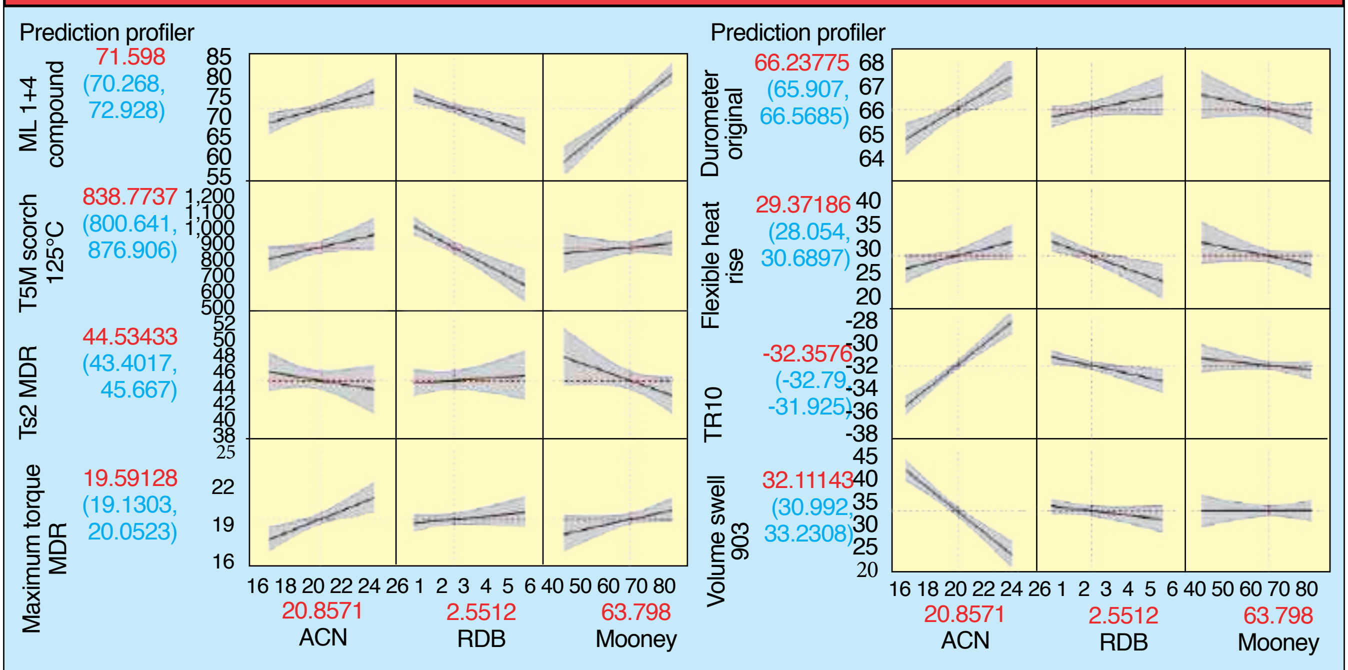
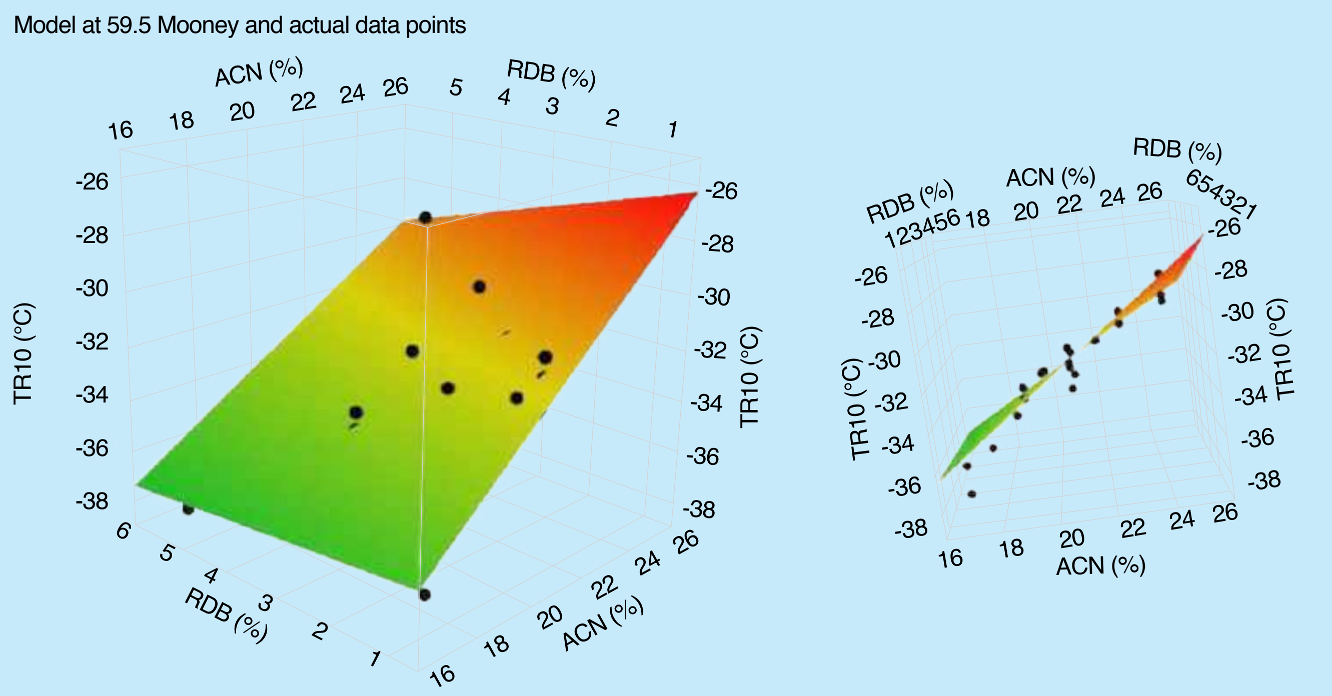


Figure 6 - graphical depiction of tested (actual) versus model calculated data points for TR10



was utilized through the "evolutionary" method through an iterative process to find the best match. The resulting solution of ACN/RDB/polymer Mooney = 21%/5.5%/47 MU with the predicted properties demonstrated in table 5. If, for example, the predicted tensile strength of 22 MPa is below acceptable levels, additional constraints could be placed on the model calculation to increase its value to 23 MPa. The resulting presented solution is then ACN/RDB/polymer Mooney = 22%/5.5%/49 MU. As a commercially available similar polymer is available with a 67 Mooney viscosity, predicted properties and the best available solution result in a 23.4 MPa polymer with 25°C flexible heat rise.

The dependence of IRM 903 oil swell, TR10 and G' (storage modulus) at -20°C is shown in figures 10 and 11. The HNBR copolymers and terpolymers cover different ranges of ACN content, and it is clear from these figures that physical properties are from distinct sets. The volume swell results of figure 10 are not

Figure 7 - dependence of TR10 and TR70 on ACN and RDB

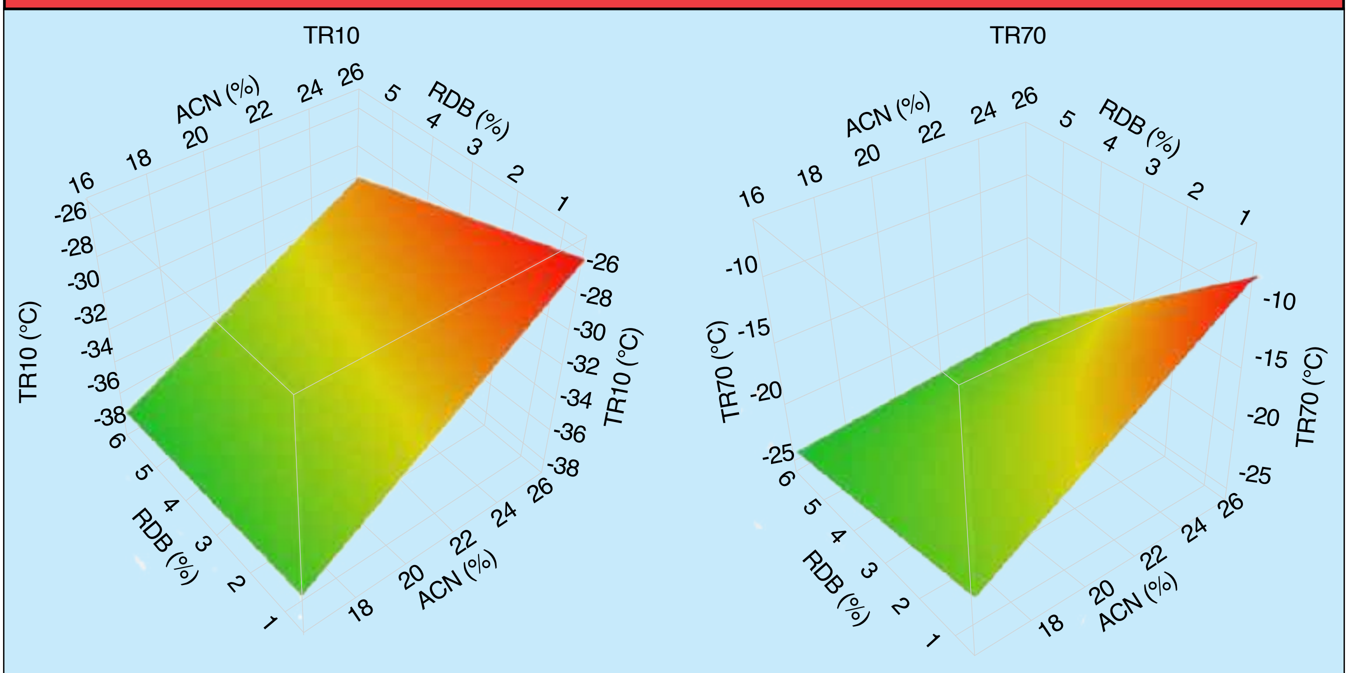


Figure 8 - dependence of TR10 on ACN and RDB and the trade-off versus oil swell

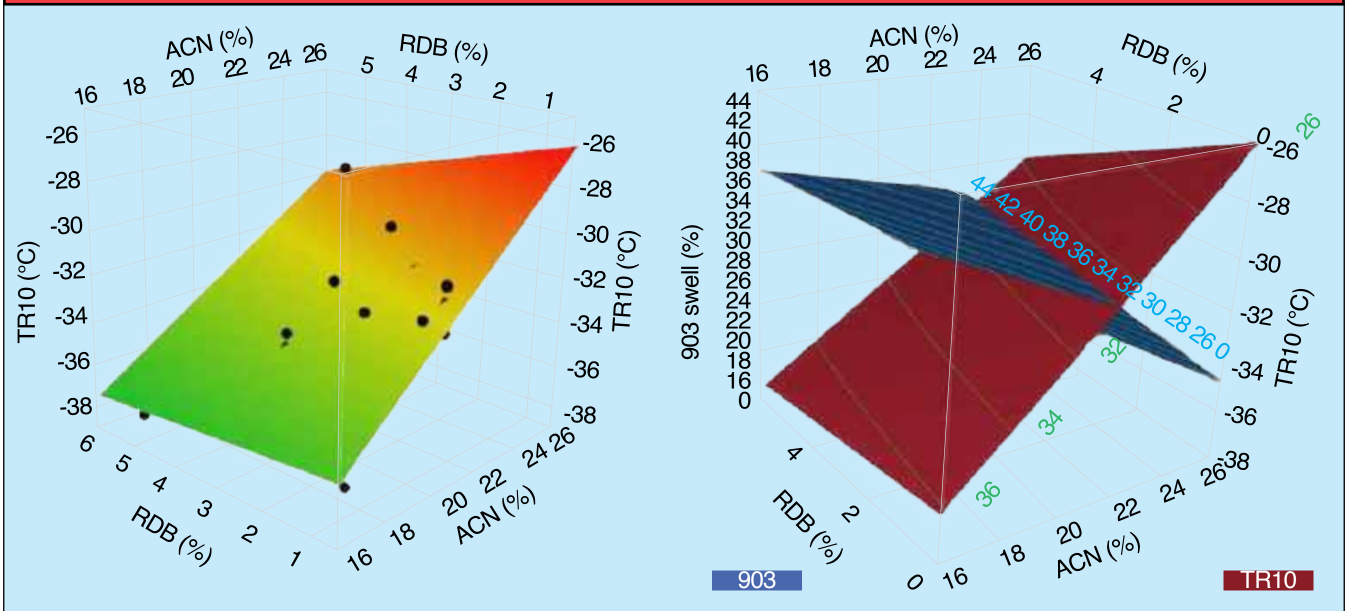
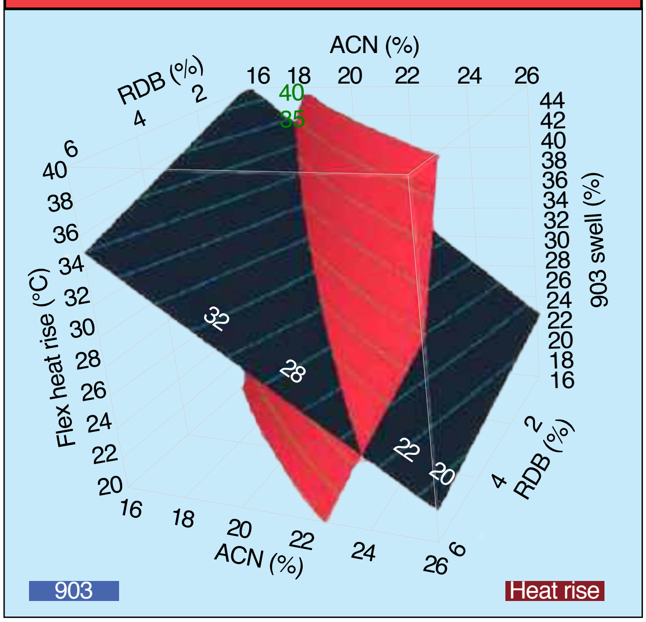


Table 4 - the model can be used to calculate compound and/or terpolymer properties

	Input values	Model lower boundary	Model upper boundary
ACN	23	17	25
RDB	2.95	0.9	5.5
Mooney	59.5	39	80
Property	*Model predicted*	*Property*	*Model predicted*
ML1+4 compound	69	Ares G' 0°C	7.5
Minimum torque MDR	1.26	Ares G' 23°C	5.8
	19.8	Ares G' 60°C	4.5
Maximum torque MDR			
Ts2 MDR	45	Ares tan δ 0°C	0.19
T90 MDR	351	Ares tan δ 23°C	0.17
		Ares tan δ 60°C	0.15
Durometer original	67	TR10	-30.5
Tensile original	25.1	TR70	-17.0
Elongation original	303	-	-
Compression set 168 hours at 150°C	45	Abrasion	82
Rebound	50.0	Volume swell 903 durometer	-12
Flex M temperature rise	30.9	Volume swell 903	27.3

Figure 9 - heat buildup and IRM 903 oil swell as a function of ACN and RDB



linear across the ACN range, due to the different compositions of copolymers and terpolymers. The alternate terpolymer corresponds to HNBR ST grades based on new terpolymer technology that combines improved oil resistance and better low temperature properties (refs. 9 and 10).

Low temperature properties are highlighted in figure 11, where the onset of polyethylene stiffening is apparent in TR10 for the copolymers with decreasing ACN content. The terpolymers extended the low temperature TR10 range. At -20°C, the polymers above 40% ACN approach their T_g, and the storage modulus increases rapidly.

Conclusions

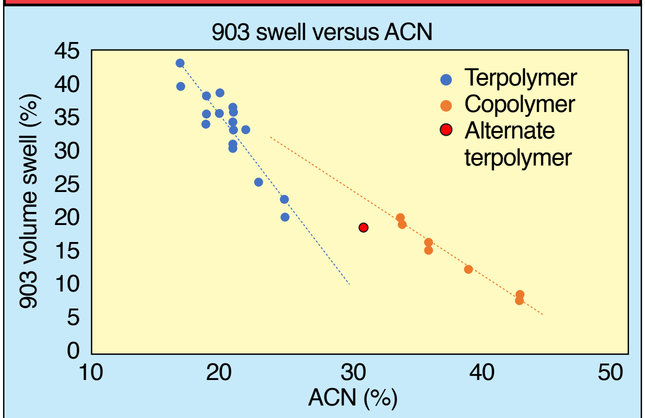
This article is the second part of an experimental design approach to quantify HNBR polymer parameters, ACN content, RDB % and Mooney viscosity, to quantify predicted properties and aid in polymer and blend selection. Part 1 focused on copolymers. This work extended the approach to terpolymers. The copolymer model in the first part was shown not to be applicable to terpolymers, as expected, due to their different compositions. So, a new model was generated, based upon an experimental design approach for the terpolymers. The experimental design space was limited to commercially available terpolymers so that the predicted outcomes can be practically realized industrially. Exam-

Table 5 - scenario with target properties, calculated outputs and closest matches

Original	*Scenerio* *Target 1*	*Solved from equations*		*Model predicted*	
C Mooney		ACN	21	C Mooney	56
Durometer		RDB	5.5	Durometer	67
Tensile		P Mooney	47	Tensile	22
Elongation				Elongation	224
Temperature rise	Lowest			Temperature rise	23
903 swell	<32			903 swell	26

	Scenerio *Rev target 1*	*Solved from equations*		*Model predicted*		*Commercially available HNBR 2057*		*Model predicted*	
C Mooney		ACN	22	C Mooney	56	ACN	21	C Mooney	67
Durometer		RDB	5.5	Durometer	66	RDB	5.5	Durometer	66
Tensile	>23	P Mooney	49	Tensile	23	P Mooney	67	Tensile	23.4
Elongation				Elongation	244			Elongation	225
Temperature rise	Lowest			Temperature rise	24			Temperature rise	25
903 swell	<32			903 swel	25			903 swel	31

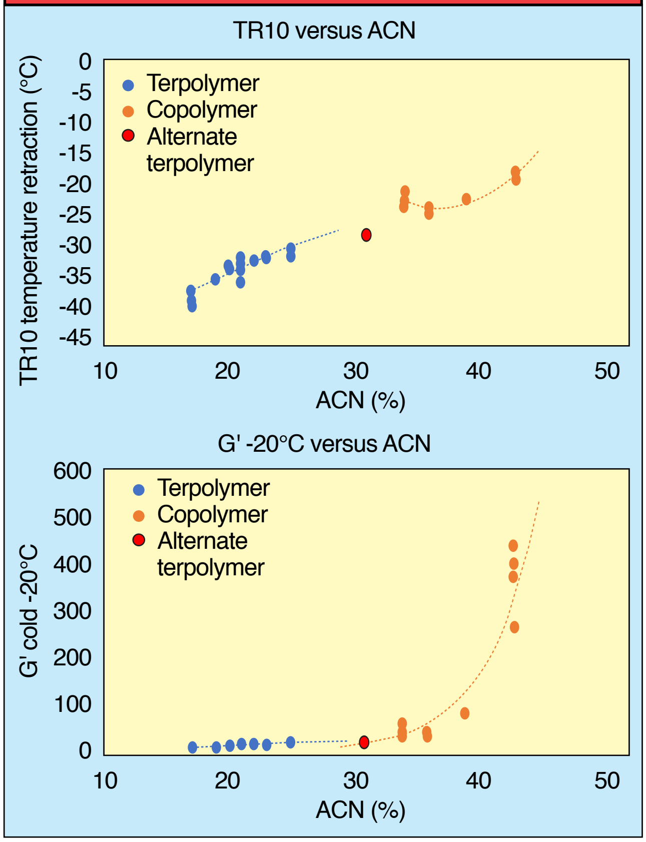
Figure 10 - volume swell in IRM 903 for different HNBR copolymers and terpolymers



ples were presented demonstrating property trade-offs, complimentary goals and the use of the generated models to solve for desired properties. A set of targets can be input; and if possible, best candidate solutions can be calculated.

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

Figure 11 - correlation of TR10 and G' (storage modulus at -20°C) with ACN content for HNBR copolymers and terpolymers



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Towards the modern automotive industry: Adhesive innovations with styrenic thermoplastic elastomers

by Alicia De San Luis González, Jessica Nolasco Santiago and Jesús Ibarra Rodriguez, Dynasol Group

In automobile manufacturing, hot melt adhesives have numerous purposes, such as applications in the trunk, roof linings, seat assembly, filter manufacturing, emblems, trim and assembly bonding. The trunks of modern cars, especially trucks with large storage space, are complex. Individual elements, such as the trunk floor, rear seat backs, rear covers, etc., have been produced for several years with dispersion based adhesive systems, with a growing trend of polyurethane reactive (PUR) systems. It is worth noting that to ensure the safety of the manufacturer/environment/end user, the adhesives must have low emission properties. The use of adhesives for textile materials, foam elements and lightweight components, and combinations of these materials, allows structurally simple solutions. However, adhesives and bonded elements must meet the requirements resulting from the demanding temperature changes in the trunk area (refs. 1-3).

In that sense, living anionic polymerization is a flexible technology that enables the synthesis of a wide variety of block copolymers, with tailored molecular weight distributions and controlled microstructures. Due to all these possibilities, the use of this technology is advantageous for an extensive variety of applications (refs. 4 and 5). Focusing on the synthesis of styrene butadiene copolymers and its application in the adhesive sector, the adjustment of the styrene content, the molecular weight distribution and the styrene butadiene diblock content allows an a la carte modification of the adhesive performance, temperature resistance and melt viscosity. For example, an increase in the styrene content of the copolymer improves the thermal resistance and the cohesive properties of the formulated adhesive, and provides a slight reduction in the melt viscosity. On the other hand, a low molecular weight polymer shows an increase in the adhesive properties of the adhesive, a decrease in its cohesive properties and a greater decrease of its melt viscosity. Finally, an SBS/SB mixture impacts the adhesive performance, with an increase in its adhesion properties; hence, a decrease in its cohesive properties and a decrease of both thermal resistance and melt viscosity. Additionally, the tuning of these parameters affects the compatibility of the block copolymer with the different components of the adhesive formulation. Therefore, the controlled combination of the block copolymer properties, together with a careful selection of a tackifier and oil, makes possible an infinite number of adhesive formulations with the desired properties and performance.

In this article, the use of a new styrenic block copolymer (Calprene 5375X) is described, which has a non-conventional structure, high styrene content, low molecular weight and high diblock content, in hot melt adhesives for a trunk assembly application. The adhesives formulated with the Calprene 5375X have very high temperature resistance, excellent cohesive properties and good adhesion to several materials, like carpet.

Experimental

Materials

Calprene 5375X is a styrenic thermoplastic elastomer with high styrene and high diblock content, presenting a low toluene solution viscosity (TSV) at 5.23 wt% measured at 25°C. Table 1 shows the properties of Calprene 5375X evaluated in four different adhesive formulations.

Foral 85 rosin ester resin from Synthomer was used as a tackifier resin in combination with Piccolyte A125 polyterpene alpha pinene resin from Pinova, and Endex 160 hydrocarbon resin from Synthomer. The first two tackifier resins affected the middle block of the block copolymer, whereas the last one was an end block resin affecting the styrene blocks of the copolymer. Additionally, the naphthenic oil Nyflex 223 from Nynas was used as a plasticizer; and to avoid degradation of the adhesive, the antioxidant Irganox-1010 from BASF was added to the adhesive mixture.

Preparation of hot melt adhesives

Table 2 presents the adhesive mixtures tested, in which the type and tackifier ratio have been changed. The preparation of the hot melt adhesives was done in an aluminum vessel using a three-blade mixer that measures 55 mm in diameter and 350 mm in length, and a heating mantle with controlled temperature. First, the tackifier, oil and antioxidant were melted into the vessel, stirring at 250 rpm and 140°C. When those were melted and mixed, the desired amount of Calprene 5375X was slowly

Table 1 - Calprene 5375X properties

	Structure	*Total styrene content (%)*	*Diblock content (%)*	*TSV at 5.25%, (cSt)*
C-5375X	Hybrid SBS/SB	37	75	5.2

Table 2 - hot melt adhesive developed formulations for trunk applications

	A01, phr	*A02, phr*	*A03, phr*	*A04, phr*
C-5375X	100	100	100	100
Foral 85	60	100	100	60
Piccolyte A125	80	40	40	60
Endex 160	0	0	0	20
Nyflex 223	30	40	60	60
Irganox-1010	3	3	3	3

added, increasing the agitator speed to 750 rpm and the temperature to 177°C. The mixture was held for 2 hours to ensure a complete incorporation of the rubber, and then poured into a suitable receptacle to cool down prior to its characterization.

Characterization

Properties and performance of the four developed hot melt adhesives were characterized. All the adhesives' evaluations were developed according to ASTM and PSTC procedures (specified in the description of each evaluation technique) in a special laboratory area capable of maintaining environmental conditions of 23°C and 50% relative humidity.

First of all, melt viscosity of the adhesives was measured at three different temperatures (150°C, 160°C and 177°C) using a digital Brookfield Model RV DV-II+ viscometer, equipped with a spindle #27, following the ASTM D4402 test method. Viscosity was measured at a constant rate of speed, different for each temperature, looking for the maximum torque until a constant viscosity value was achieved.

Once the viscosity of the adhesive was known, it was coated using a hot melt laboratory system from ChemInstruments set at 160°C and at a constant speed rate of 12 inches per minute. For this specific application, the coating weight was set at 18 ± 2 g/m^2. From the coated adhesive, probes for cohesion and adhesion tests were prepared based on the corresponding standard method.

A lap shear test based on the ASTM D1002 method was done to test the adhesion strength between different materials (carpet-carpet and carpet-PP) and at two different lengths of time (one hour and 24 hours). The adhesive was coated using a hot melt glue gun with a special flat nozzle.

On the other hand, conventional loop tack based on PSTC-16 Loop Tack, Method B from the 15th Edition of the Test Methods for Pressure Sensitive Adhesives Tape was measured for the developed adhesives. In this case, the evaluation was done utilizing stainless steel probe plates.

Cohesion of the prepared adhesives was measured using the static shear technique based on ASTM D3654/D3654M-06 Standard Test Methods for Shear Adhesion of Pressure Sensitive Tapes. Adhesive probes were adhered to the shear test clips, made of stainless steel material, which were held to 1 kg weight. To ensure a good lamination to the test substrate, a rolldown machine was used. The prepared samples were then placed on a bank shear tester which automatically controls the time until the samples fall down.

Thermal properties were measured using two different techniques, including shear adhesion failure temperature (SAFT) and softening point measurement. The first technique is based on the PSTC-107 method from the 15th Edition of Test Methods for Pressure Sensitive Adhesives. The same equipment was used for static shear; however, a 0.5 kg weight was held on the sample probes. Additionally, a temperature ramp was set, measuring the temperature and the time at which the sample failed.

On the other hand, softening point measurements were based on the ASTM D36-86 Standard Test Method for Softening Point of Bitumen, for which a ring-and-ball apparatus was used. Since softening points higher than 80°C were expected for all the prepared adhesives, glycerin was used for the measurements.

Finally, dynamic mechanical evaluation of the adhesives was carried out in the ARG-2 TA universal dynamic rheometer using parallel plates of 8 mm, frequency of 10 rad/s and a variable strain between 0.01% and 1%.

Results

The study of the performance of Calprene 5375X in trunk assembly applications was done in four different hot melt adhesive formulations (table 2), varying the nature and concentration of the tackifier resins to get the maximum capability of the block copolymer. On one hand, tackifier resins affecting the mid-block (polybutadiene segment) of the block copolymer produced an increase in the T_g of this mid-block, and decreased the viscosity of the hot melt adhesive. In this sense, Piccolyte A125, with a high softening point, was used in combination with Foral 85 resin in formulations A01, A02 and A03. Moving to higher and broader Hildebrand solubilities, rosin ester resins like Foral 85 affected both the mid-block and the end-block (polystyrene segment) of the block copolymer, which, apart from affecting the T_g and the viscosity, increased the cohesion performance of the final hot melt adhesive. Finally, terpenic resins like Endex 160, with a higher Hildebrand solubility, exclusively affected the copolymer end-block, increasing the thermal resistance and the cohesion of the final adhesive (ref. 6). It is worth noting that, in addition to the variation of the tackifier resin, the concentration of plasticizer had the greatest effect on the viscosity of the hot melt adhesive.

The combination of these resins led to a wide range of performance and property possibilities for the same application, all of them within the specification requirement for a trunk assembly.

Starting with the effect of the tackifier resins on the melt viscosity, figure 1 shows how the melt viscosity varies at three different temperatures for each hot melt adhesive formulation. As expected, the variation of the tackifiers and its ratio in the adhesive formulation had a great impact on the viscosity, in addition to the concentration of plasticizer. It was observed that formulation A01, containing a combination of terpenic and

Figure 1 - hot melt adhesive viscosity for each developed formulation at 150°C, 160°C and 177°C

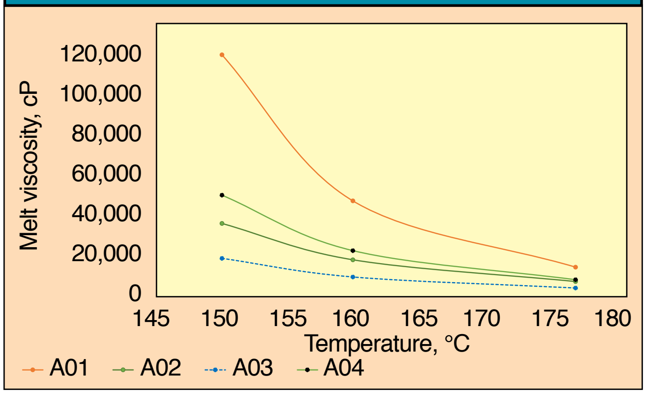


Figure 2 - lap shear and loop tack performance results

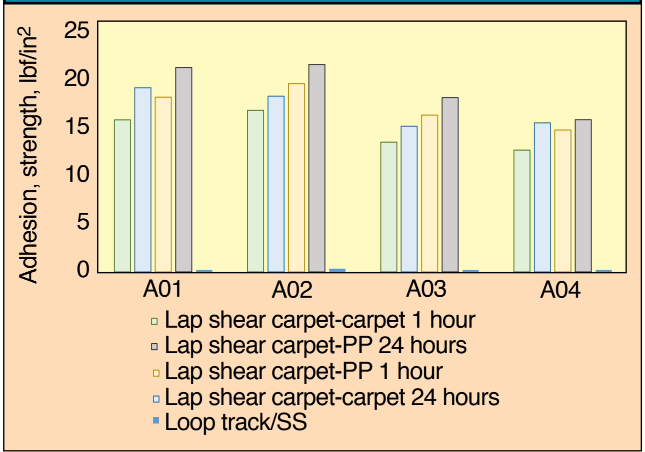
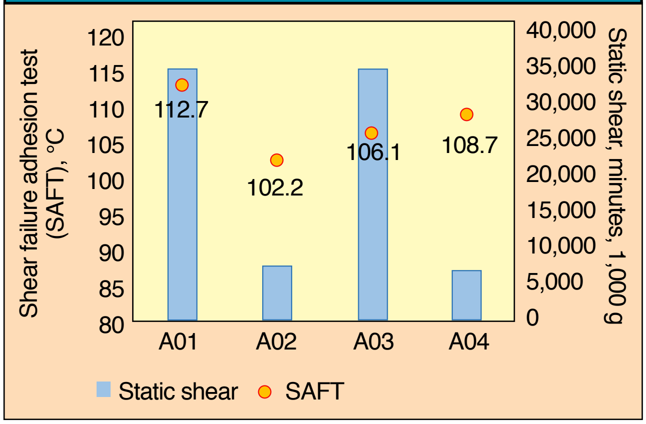


Figure 3 - static shear and shear adhesion failure temperature evaluation results



rosin ester resins at a concentration of 60/80, and the lowest plasticizer concentration, showed the highest viscosity. In contrast, while increasing the rosin ester tackifier ratio, which has a lower T_g than the terpenic one, the melt viscosity decreased. Furthermore, with the same tackifier resins ratio, the increase in the plasticizer concentration led to a further decrease in the melt viscosity. Finally, the incorporation of an end block resin (Endex 160), maintaining the highest oil concentration tested, produced a slight viscosity increase. In all cases, the melt viscosity was maintained within the processability range according to the specification requirement: 20,000-48,000 cP at 150°C. Therefore, the processability of the adhesives formulated with Calprene 5375X can be adjusted by controlling the proportions of the formulation raw materials.

Regarding the performance results, loop tack was very low in all the cases; it did not show differences independently from the tackifiers used. In contrast, lap shear showed an adhesion force superior to that of the target sought (15 lbf/in^2) for the four adhesives tested, independently from the tackifier resin used or the compression time. Further details regarding the material showed a good compatibility between carpet and both plastic (polypropylene, PP) and textile (carpet) substrates, with compatibility with PP being a bit higher. Focusing on the curing point, results were slightly higher for all cases after 24 hours, versus after 1 hour. This means that the adhesive needs some time under pressure to reach its maximum performance. These results are shown in figure 2.

A different type of shear measurement, static shear, was done to get information about the cohesion of the developed adhesives. In contrast to lap shear, these evaluations were done on stainless steel. Figure 3 shows an excellent cohesion development for all the tested formulations, but remarkable for A01 and A03 formulations, with failure times longer than 25 days. In the case of formulations A02 and A04, the failure time was 5 days, which is far superior to the requirements for this application (1.7 days). In terms of the effect of the raw materials, the increase in the rosin ester tackifier concentration (A02) makes shear decrease, unless the oil concentration is also increased (A03). On the other hand, the introduction of an end-block resin (A04) maintaining a high plasticizer concentration reduces cohesion of the resulting adhesive.

Focusing on the thermal properties of the developed adhesives, which are an important requirement for adhesive application, two different methods were studied, including shear adhesion failure temperature (SAFT) and softening point. SAFT results are shown in figure 4. In contrast to static shear at room temperature, when applying higher temperatures, there were no such differences between the formulated adhesives. All of them showed excellent resistance to adhesive-cohesive failure at high temperatures. On the other hand, the softening point of the adhesives was measured. Regarding the minimum softening point requirement for the application (80°C), all the developed adhesives showed superior softening points, hence a very good resistance to high temperatures. Including SAFT results, there were no large differences between the hot melt adhesive formulations. This means that, independently from the adhesive formulation, Calprene 5375X provides a very good thermal resistance itself to the hot melt adhesive thanks to its optimal balance of SBS/SB structures.

Finally, dynamic mechanical analysis was done to determine the temperature region in which the adhesives perform

Figure 4 - softening point results for each of the adhesive formulations tested

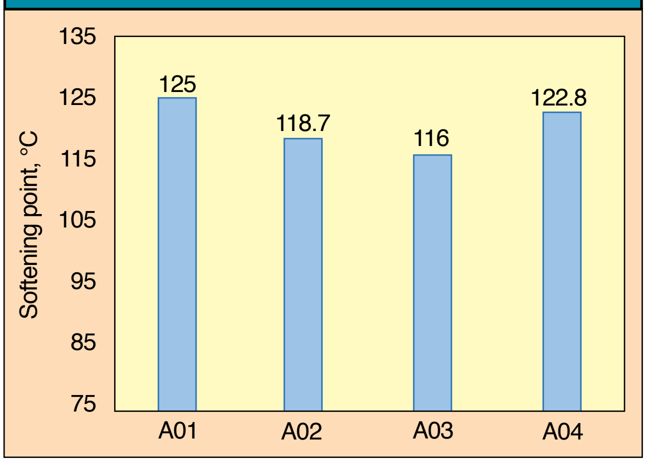


Figure 5 - dynamic mechanical analysis including the storage modulus and tan δ curves

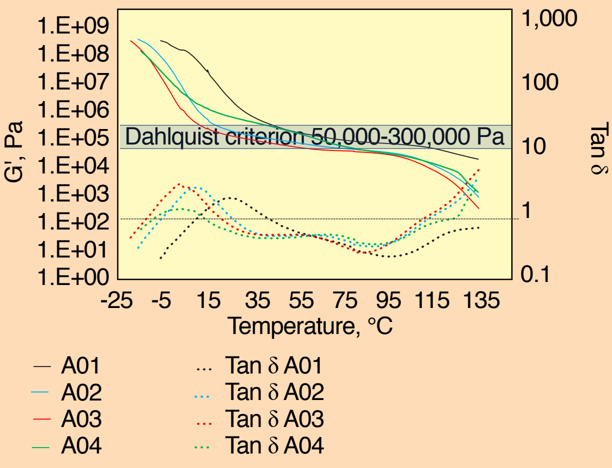


Table 3 - dynamic mechanical analysis results for each hot melt adhesive formulation

Adhesive	T_g, °C	T_x °C	G' at 35°C, Pa	Plateau zone, °C
A01	24.0	135.0	496,100	38.5-135.0
A02	10.6	116.0	109,400	23.9-116.0
A03	3.1	114.3	77,100	17.9-114.3
A04	3.2	127.8	328,500	10.4-127.8

well. Results are shown in figure 5. The data obtained in terms of glass transition temperature (T_g), crossover temperature (T_x) where G' = G" occurs, storage modulus at 35°C and temperature range of the storage modulus plateau are presented in table 3. Due to the nature of the tackifiers, and hence due to their combination in the adhesive formulation, the T_g of the adhesive shifts from lower to higher temperatures. It is interesting to highlight that the addition of a higher concentration of oil maintaining the tackifier resins' concentration (A03) had a similar effect as the inclusion of an endblock resin (A04), decreasing significantly the T_g of the adhesive. In contrast, formulation A04 showed a high crossover temperature, like that of the A01 formulation, and a high storage modulus value at 35°C. Similarly, formulation A04 showed the largest plateau zone, illustrating the other three similar results between them. Therefore, Calprene 5375X has a molecular structure that allows formulating adhesives either at low or high temperature, where the selection of tackifier resin will have a great impact on the adhesive use temperature window.

Conclusions

Calprene 5375X, a styrenic thermoplastic elastomer SBS/SB with high styrene and diblock content, has been tested in the formulation of hot melt adhesives for trunk assembly applications. This application requires high temperature resistance of the hot melt adhesive, as well as good processability with different application equipment (roller, spray nozzle or lot nozzle). The first advantage shown by Calprene 5375X in the formulation of hot melt adhesives is in terms of sustainability; it shows a good compatibility with tackifiers from a sustainable origin such as rosin ester and polyterpenes. Additionally, the developed adhesives are free from residual emissions; and hence, the adhesives are out of the scope of the European standard EU regulation 2020/1149.

A good combination of tackifiers, in addition to the adjustment of the oil concentration, drives a controlled and adjustable melt viscosity of the adhesive, depending on the application requirements. In terms of performance, the introduction of Calprene 5375X in a hot melt adhesive formulation provides excellent temperature resistance, good adhesion properties in different substrates, including polar, and excellent cohesion in stainless steel, without the need for chemical crosslinking. The adhesion-cohesion properties balance is maintained. Additionally, due to the molecular structure of the Calprene 5375X, the developed hot melt adhesives show a broader range of temperatures where they can be used.

In conclusion, Calprene 5375X is a good alternative to produce hot melt adhesives used in trunk assembly applications. Its processability is easily tunable, and it allows a wide range of excellent adhesion-cohesion performance temperatures.

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Influence of functionalized terpolymer resin on carbon black reinforced rubber compounds and co-relation with tire performance

by Anup Mondal, Elham Rezvanpanah, Mohamed Tharik and Daniele Lorenzetti, Apollo Tyres

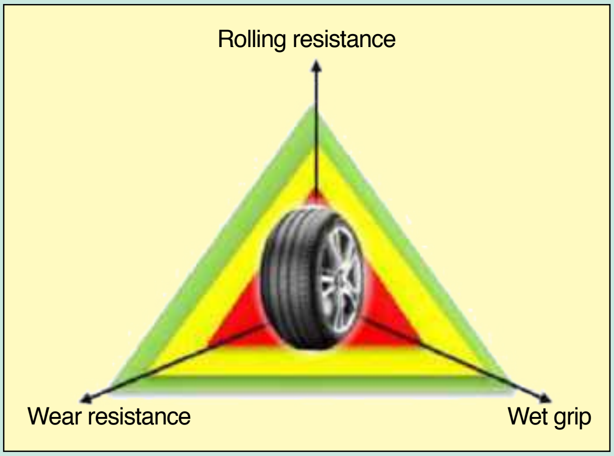
In recent years, the European Union (EU) has mandated reducing greenhouse gas emissions, especially carbon dioxide (CO_2). Passenger cars are responsible for roughly 13% of the total CO_2 emission in the E.U. From 2021, the CO_2 emissions of new passenger cars must be reduced by 27% compared to 2015 (ref. 1).

Improved technologies for tire applications are continuously sought to reduce the energy consumption of vehicles. Rolling resistance is one of the key performance parameters of a tire for passenger cars and heavy duty trucks. This tire performance parameter contributes approximately 20% to 30% to the total fuel consumption, depending on the type of vehicle, road conditions and driving habits (refs. 2 and 3).

For tire technology, there are three critical properties that tire engineers focus on, including rolling resistance, tread wear and wet grip, which form the “magic triangle” (figure 1).

The reason for calling it “magic” is that if one tire property is improved, the other properties are deteriorated. The main challenge for tire engineers is to improve one or two properties without deteriorating the other parameters negatively (ref. 3).

Figure 1 - tire “magic triangle”



Many factors influence this tire performance, e.g., the compound materials, including elastomer, filler, curative, oil, resin, silane and other additives, and processing of compounds, including mixing, silanization and curing (refs 3, 4 and 5).

Nowadays, researchers and businesses are focused on developing and testing novel raw materials and methods to improve the polymer-filler interaction, polymer compatibility and filler-filler interaction by introducing functionalized polymers, filler surface modification and a new generation of resins (refs. 4 and 5).

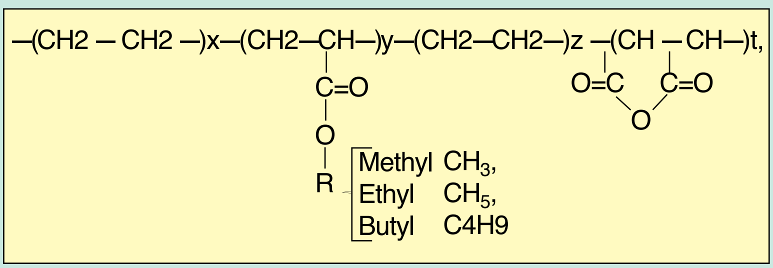
Resins for rubber are recognized as an oligomeric, amorphous material that can act as a processing aid, softener and homogenizing agent in rubber compounds. However, when they are in a cured rubber, they function like a plasticizer and/or reinforcing agent. The new generation of resins is becoming more noticeable, as they can effectively provide satisfying wet grip performance and rolling resistance (refs. 4 and 5).

Ethylene acrylic ester terpolymers are random copolymers of ethylene, acrylic ester and a third monomer which is a reactive monomer such as maleic anhydride (MAH) and glycidyl methacrylate (GMA). The high pressure polymerization process produces the reactive random terpolymer of ethylene, butyl acrylate and glycidyl methacrylate (epoxide function). Figure 2 demonstrates a typical structure of ethylene acrylic ester maleic anhydride (MAH) (refs. 4 and 6).

These copolymers are compatible with many polymer resins and additives, and possess sufficient thermal stability and fluidity to be blended and processed by extrusion. Due to the presence of glycidyl methacrylate (GMA) or maleic anhydride (MAH), the two terpolymers can form chemical bonds with amine (-NH2) or hydroxyl groups (-OH) such as ethylene vinyl alcohol (EVOH). The mentioned terpolymers are very flexible resins and well known modifiers, compatibilizers and adhesion promoters in thermoplastics (ref. 6).

In this article, the effect of a new generation of functionalized terpolymer resin (ethylene acrylic ester maleic anhydride terpolymer) is investigated in the three most common rubber blends (NR/BR, NR and halobutyl) used in the tire industry. In three model compounds, a portion of reinforcing carbon black is replaced by the functionalized terpolymer resin (FTR), and rheological, physical, hysteresis properties and their correlation with tire performance are investigated.

Figure 2 - typical structure of ethylene acrylic ester maleic anhydride (MAH)



Experimental

Compound formulations and mixing procedures

Based on the most common elastomer combina-

Table 1 - the test setup configuration

Ingredients	Test setup 1 Ref. 1	Test setup 1 EXP 1	Test setup 2 Ref. 2	Test setup 2 EXP 2	Test setup 3 Ref. 3	Test setup 3 EXP 3
Polymer (NR + BR)	100	100	-	-	-	-
Polymer (NR)	-	-	100	100	-	-
Polymer (NR + halobutyl)	-	-	-	-	100	100
Filler (CB)	70.0	60.0	70.0	60.0	80.0	70.0
Activators	5.5	5.5	6.0	6.0	4.0	4.0
FTR	-	10.0	-	10.0	-	10.0
Antioxidant	4.5	4.5	3.8	3.8	-	-
Others	7.0	7.0	10.0	10.0	14.0	14.0
Curative	6.45	6.45	5.4	5.4	2.5	2.5

tion used in different components of tires (NR/BR, NR, halobutyl), three model compounds were designed: NR/BR (setup 1) and NR (setup 2) compounds primarily used for tire body, truck bus radial/off the highway tread compounds. The halobutyl based compound (setup 3) is mainly used in tire inner liners to improve air retention properties.

Each test setup includes a reference compound and an experimental compound (EXP). Ethylene acrylic ester maleic anhydride terpolymer is applied as a functionalized terpolymer resin (FTR) in all three setups. For EXP compounds, 10 phr carbon black filler is substituted by 10 phr FTR, and other ingredients are the same as the reference compound (table 1).

Compounds were prepared by mixing primarily in a laboratory scale tangential internal mixer with a mixing chamber of 1.7 L. The fill factor was adjusted to 65% to 70%.

In stage 1, masterbatch was prepared at 140°C for 5 minutes in an internal mixer. Stage 1 includes rubber, fillers, process oil, zinc oxide and antioxidant.

Stage 2 is the final step, where curatives (sulfur and accelerator) were added to the resulting masterbatch at 110°C for 3 minutes in an internal mixer.

After stages 1 and 2, the compound was milled for 5 minutes on a two-roll mill and stored for 24 hours. The optimum cure time (t_c90) for the composites was determined by a rubber process analyzer (RPA) at 160°C. The mixing procedure is shown in table 2.

Testing and characterization

The technical properties of compounds were characterized and measured by following the procedures described in this section.

Rheological properties

Cure characteristics of the compounds were measured using a rubber process analyzer (RPA 2000, Alpha Technologies). The optimum curing time at 95% vulcanization degree (t95) was determined and used to prepare the samples for tensile and DMA measurements.

Mooney viscosity and scorch time measurements of the uncured compounds were carried out using a Mooney viscometer (MV 2000, Alpha Technologies) at 135°C.

Hysteresis properties

Dynamic mechanical analysis (DMA) of rubber compounds was performed for cured samples by a Metravib DMA+450 in double shear mode. DMA is performed by temperature sweep at constant frequency and strain.

Physical properties

Tensile strength analysis was performed for cured samples by a Zwick Z005 with a speed of 500 mm/minute. Standard tensile specimens were cut from the rubber sheet according to ISO 37:2011 standards. The reported values were averaged from the data of five tensile specimens.

The hardness test was performed according to DIN 53505 at room temperature using the Zwick 3150 durometer A hardness tester (ZwickRoell). The average value from five measurements is reported.

The air permeability measure was based on ISO 2393 by utilizing a measuring cell in a water bath. A circular sample of 13 cm diameter with a thickness between 0.5 mm and 0.9 mm was prepared and vulcanized at 160°C for 20 minutes.

Table 2 - mixing procedure

Stage 1:		
Rotor speed: 90 rpm		
Initial temperature: 50°C		
Fill factor: 70%		
Minutes: seconds		
00:00	Add polymers	
00:30	Ram down	Mix 45 seconds
01:15	Ram up; add all other ingredients	
01:45	Ram down	Mix 3 minutes
04:45	Dump at 140°C	
	Check weight; sheet out; storage 24 hours	
Stage 2:		
Rotor speed: 75 rpm		
Initial temperature: 50°C		
Fill factor: 65%		
Minutes: seconds		
00:00	Add batch stage 1 + vulcanization system	
01:00	Ram down	Mix 2 minutes
03:00	Dump at 110°C	
	Check weight; sheet out; storage 24 hours	

Results and discussion

The results are reported by index value compared to the corresponding reference compound. A higher index value means a higher value, and ±3% can be considered comparable.

Test setup 1: NR/BR model compound

As figure 3 illustrates, in test setup 1, substituting a part of filler with the FTR resulted in lower Mooney vis-

Figure 3 - rheological properties of test setup 1

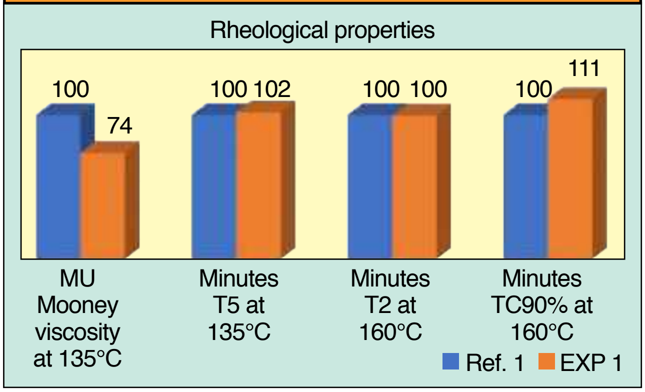


Figure 4 - physical properties of test setup 1

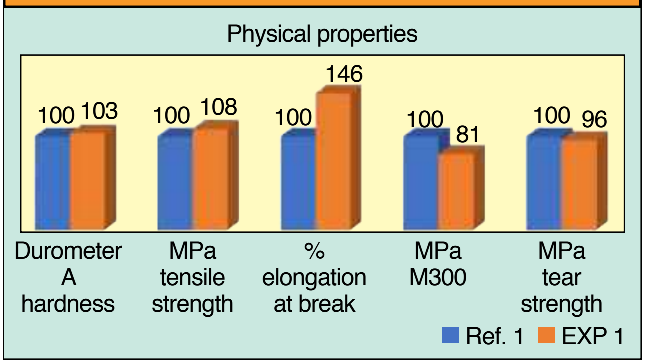


Figure 5 - hysteresis properties of test setup 1

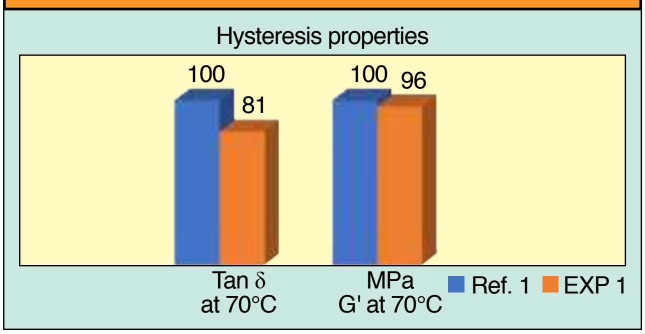


Figure 6 - rheological properties of test setup 2

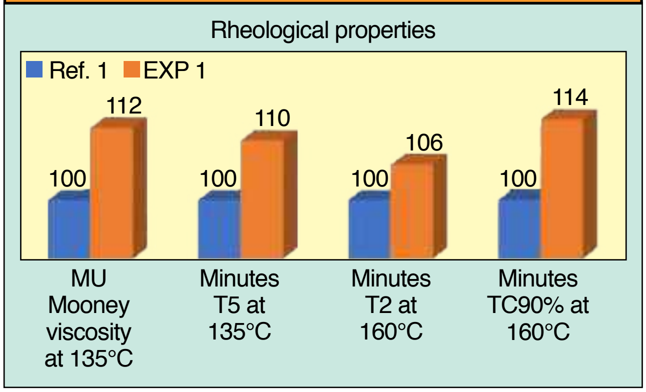


Figure 7 - physical properties of test setup 2

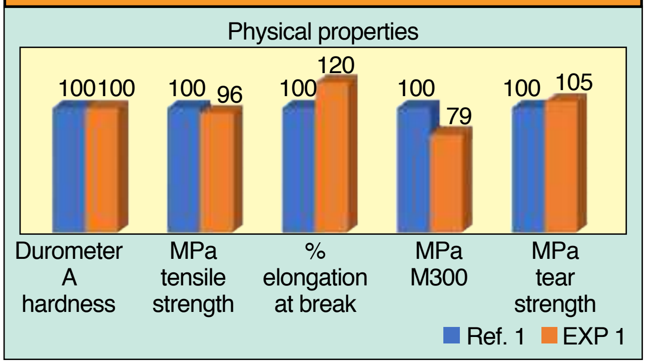
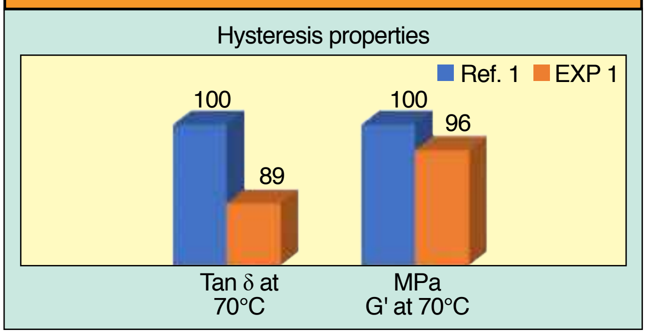


Figure 8 - hysteresis properties of test setup 2



cosity than the reference compound, which can affect the processability of compounds positively. Lower Mooney viscosity can be partly explained by reducing part of the filler amount, and further lower Mooney viscosity indicates that FTR has good compatibility with NR/BR compounds.

The cure time for a compound containing FTR is noticeably higher (figure 3). The functional groups in FTR can slow down the curing procedure. Lower viscosity, and as consequence lower shear rates, also can partly affect the curing rate.

The physical properties (hardness, tensile strength and elongation at break) of the experimental compound containing FTR show better results than the reference (figure 4). Generally, by reducing the filler part, hardness and tensile strength tend to the lower side. But in this experiment, despite the reduced filler parts, improved physical properties indicate a positive interaction of FTR with the NR/BR system, which can translate to improved durability of the tire.

The tan δ at different temperatures is highly predictive of most of the critical parameters of a tire. The tan δ value at the range between +30°C to +70°C represents the running condition of a tire. Under these temperature conditions, the tan δ value determines the degree of rolling resistance. It is desirable to have low tan δ at 70°C to ensure a lower hysteresis property of the compound, leading to lower rolling resistance (better fuel economy) (refs. 3-5). Also, G' at 70°C denotes the dynamic stiffness of the compound. The higher dynamic stiffness of the

Figure 9 - rheological properties of test setup 3

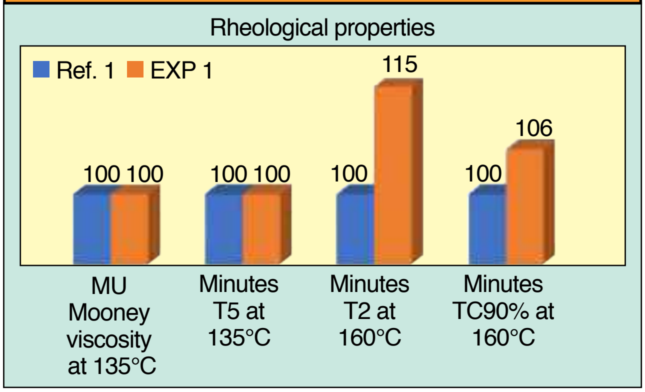
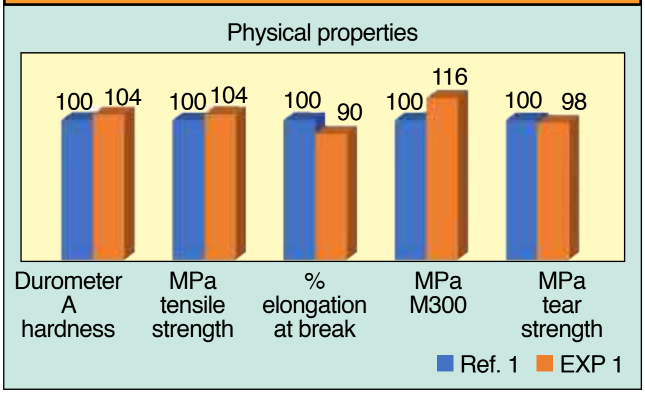


Figure 10 - physical peoperties of test setup 3



compound resists tire deformation and increases tire stiffness.

Figure 5 demonstrates that the hysteresis properties of setup 1 are significantly improved, without sacrificing dynamic stiffness (G').

Test setup 2: NR model compound

From the rheological properties of setup 2, it is observed that Mooney viscosity is increased and the cure rate is slower for the experimental compound (figure 6).

In the NR setup, the comparision of the reference and experimental compounds shows hardness is similar for both, and elongation at break is better in EXP with a slight tradeoff of tensile strength (figure 7).

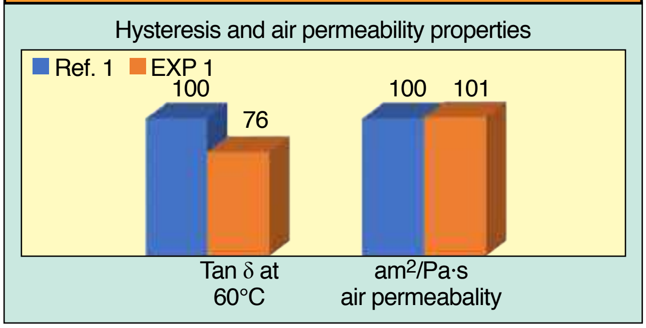
The unlikely behavior in the two model compounds (setups 1 and 2) indicates that FTR has different compatibility and interaction in the NR compound compared to the NR/BR compound.

The experimental results show better hysteresis properties, with no tradeoff of dynamic stiffness (figure 8). Both properties' trend is pretty similar for both setups 1 and 2.

Test setup 3: Halobutyl model compound

In test setup 3, Mooney viscosity is similar, and the cure rate is slower for the experimental compound compared to the reference compound (figure 9).

Figure 11 - hysteresis and air permeability properties of test setup 3



In test setup 3, hardness, tensile strength and modulus become better for an experimental compound containing FTR compared to the reference (figure 10).

The halobutyl model compound is mainly used in tire inner liners to improve air retention properties. Using FTR in the compound improved hysteresis properties compared to the reference. Generally, by applying less filler, the air retention decreases due to the lower volume fraction, which can lead to air loss during the tire's service life (figure 11).

Conclusion

In this article, it is observed that, despite reducing the filler portion in the experimental compound, which commonly leads to lower mechanical properties, in all experimental setups, the mechanical properties are improved or reach the same level as the reference. These results confirm that the functional groups in the functionalized terpolymer resin (ethylene acrylic ester maleic anhydride terpolymer) interact with polymers in the subjected compounds.

Utilizing terpolymer functional resin for test setup 1 and test setup 2 improves the hysteresis property of the compound, which is better for tire rolling resistance and fuel economy.

Using FTR improves mechanical properties, which can be translated to better tire durability.

In halobutyl model compounds, terpolymer functional resin improves hysteresis without compromising air retention properties. A lower hysteresis property is better for tire rolling resistance, and a suitable air retention property is better for less air loss during the tire service period, indicating better tire durability.

A common observation in all three experimental setups is the increased curing time (slower curing rate) using the FTR. The slower curing rates influence processing safety, and can be adjusted per requirements.

Different trends of effects for FTR were observed in all experimental setups due to further interaction and compatibility between the functional groups of resins and polymer systems.

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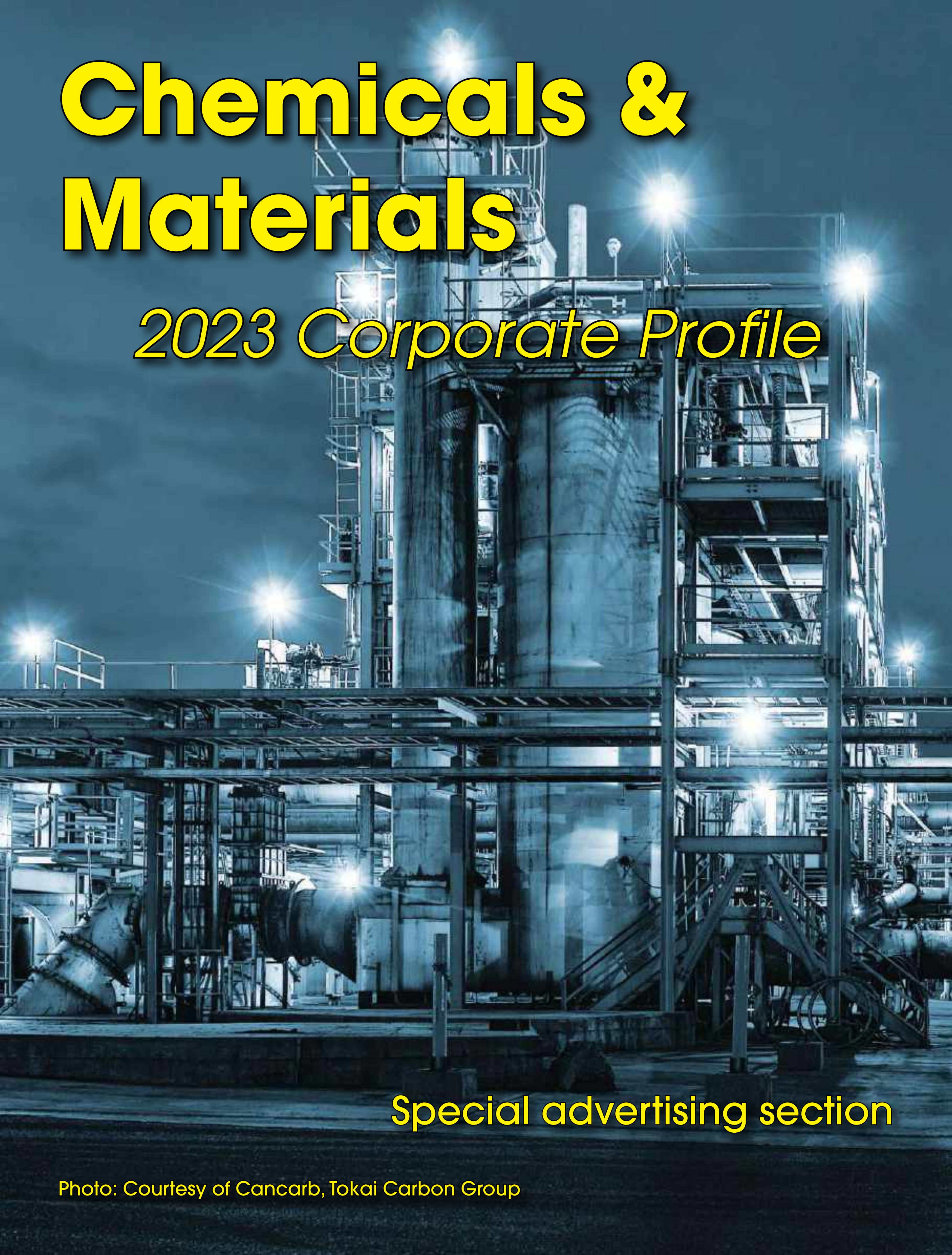

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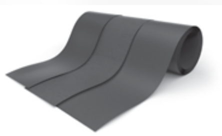

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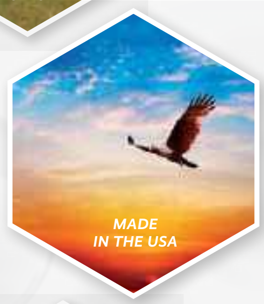

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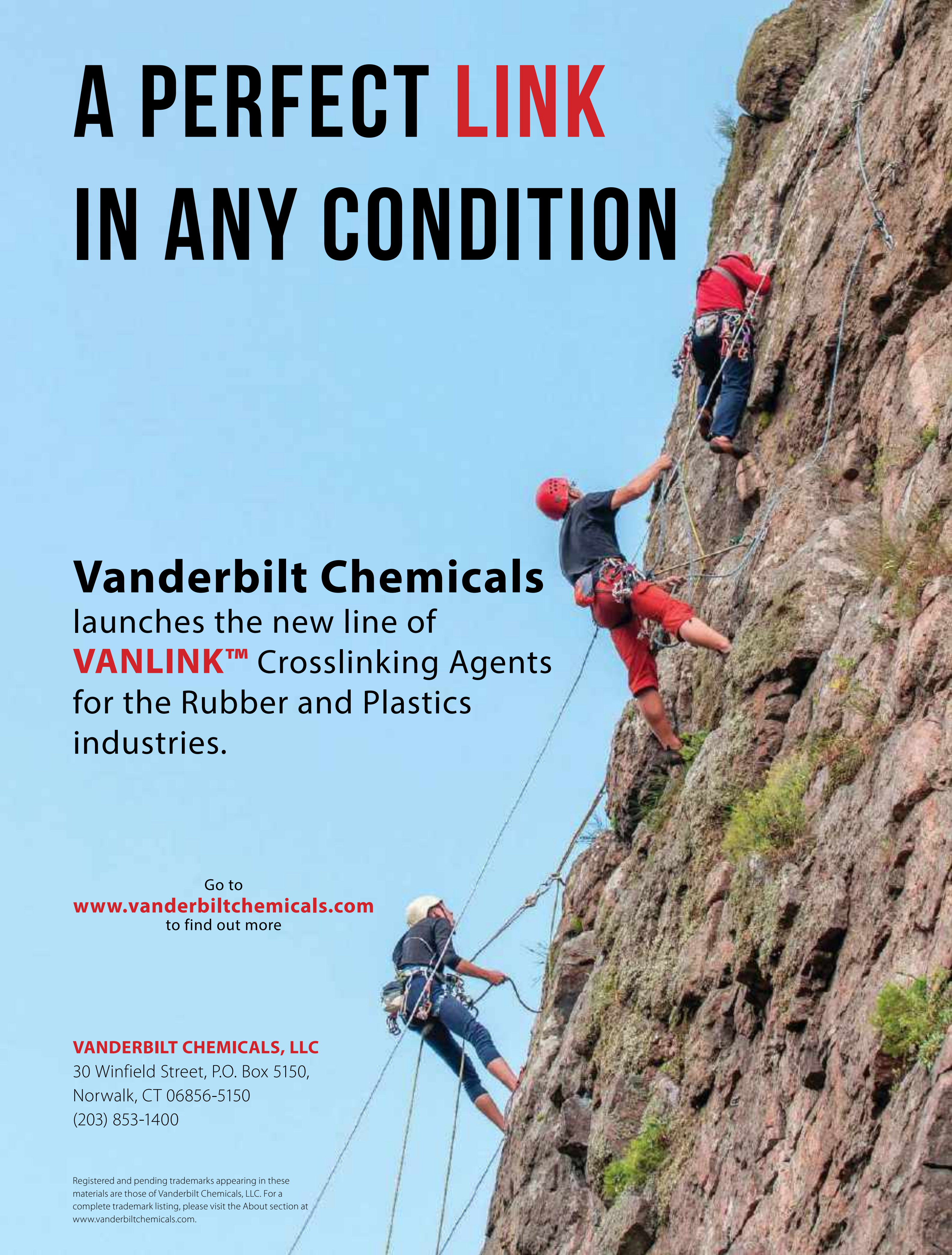
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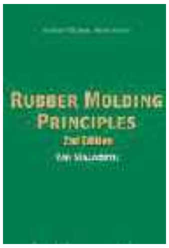

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Author: Van Walworth
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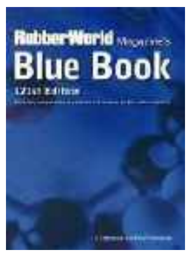

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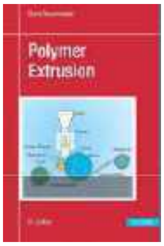

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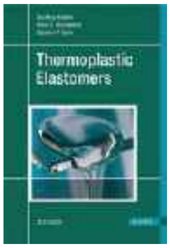

Thermoplastic Elastomers

Author: Holden, G., Kricheldorf, H., Quirk, R.
Copyright: 2004
ISBN: 9781569903643
Hardcover: 540 page

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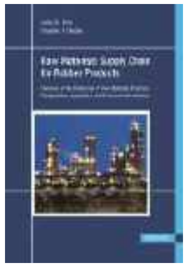

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Authors: John S. Dick & Charles P. Rader

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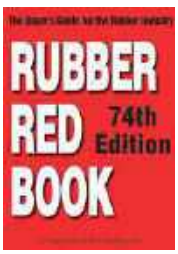

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How to Improve Rubber Compounds

1,800 Experimental Ideas for Problem Solving

Author: Dick, J.
Copyright: 2014 ISBN: 9781569905333
Hardcover: 407 pages

Rubber compounding is an art as well as a science. The art of rubber compounding is to achieve the best trade-offs in properties and to meet product performance requirements at acceptable production costs. The purpose of this book is to provide various experimental ideas for developing better compounds and solving technical problems. This second edition includes more than 1800 experimental ideas to improve specific rubber properties. Many of the additional ideas are a result of an extensive review of recent journal articles and conference presentations from rubber societies throughout the world.

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Vanderbilt Chemicals, LLC (www.vanderbiltchemicals.com), from its early beginnings in 1916, has grown to supply a wide range of products to many different industries, including rubber, plastics, petroleum, paint, CASE, pharmaceutical, agricultural, ceramic, personal care and household products. In addition to offering a variety of products from key suppliers, Vanderbilt Chemicals, LLC produces a number of ultra accelerators and antioxidants out of its large chemical manufacturing facility in Murray, KY.

The Vanderbilt companies offer products in the United States and in some 80 countries around the world. Vanderbilt Worldwide Limited, with an office in Nantwich, U.K., provides marketing, technical and sales support for Vanderbilt Chemicals in Europe, the Middle East and Africa, and Vanderbilt (Beijing) Trading, Ltd. has an office in Beijing, China. Vanderbilt's corporate headquarters, including its analytical and applications laboratories, are located in Norwalk, CT.

Vanderbilt products include EPDM, CR, FKM, CIIR, BIIR, POE, peroxides, coagents, accelerators, antioxidants, HALS, UVAs, process aids and mineral fillers.

Vanderbilt Chemicals, LLC has processing aids for rubber which reduce plasticity and improve mold flow and release, without adversely affecting physical properties. They also reduce compound plasticity, improve mold flow and release, and have little effect on optimum physical properties. Vanderbilt also offers an effective dry form plasticizer and processing aid for NR, SBR, IR and IIR. Vanderbilt's mold lubricants for rubber stock remove surface tack from freshly mixed stock and act as a corrosion inhibitor.

VAROX® organic peroxide accelerators can be used to crosslink elastomers, and are especially useful to maximize resistance to heat aging and compression set. These organic peroxides work by decomposing to form free radicals when heated. These radicals then couple to create carbon-carbon bonds across polymer chains.

VAROX® is a registered trademark of Vanderbilt Chemicals, LLC.

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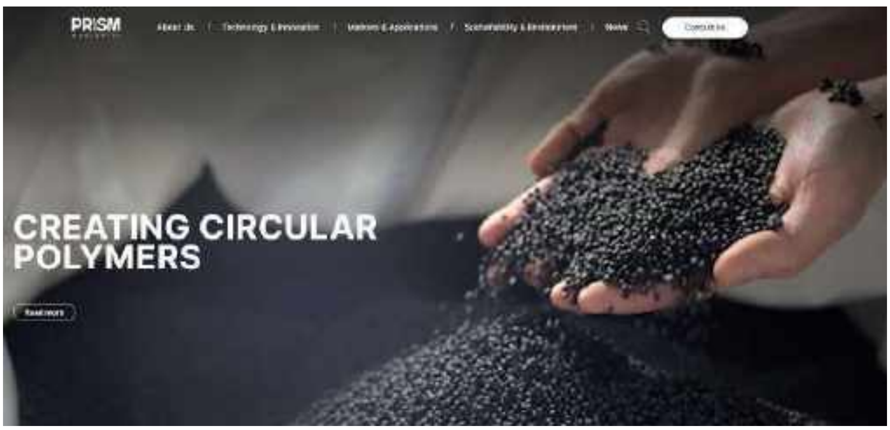
AGC Chemicals Americas, Inc. (www.agcchem.com) is a wholly owned subsidiary of AGC Inc., a $13.6 billion multinational corporation and one of the world's largest manufacturers of glass, electronic displays and chemical products. The company was formed in 2004 through the merging of sister companies Asahi Glass Fluoropolymers USA and AGA Chemicals. Headquartered in Exton, PA, including a state-of-the-art technology center, AGC Chemicals Americas maintains manufacturing operations in nearby Thorndale, PA, a satellite sales office in Sao Paulo, Brazil, and warehouses and distributors located throughout North America.

AGC Chemicals Americas manufactures, markets and sells fluoro products, including Fluon fluoropolymer resins, Fluon+ enhanced fluorinated materials and compounds, and AFLAS fluoroelastomers. AGC also markets and sells specialty chemicals, including AsahiKlin fluorinated solvents, Lumiflon PEVE resins, AsahiGuard E-Series water and oil repellents, Solesphere fine silica additives, polyols for polyurethanes, Cytop amorphous fluoropolymers and various fluoro intermediates for pharma and agro products. Specialty materials offered include FORBLUE ion exchange membranes, Fluon film and F-CLEAN greenhouse films.

AFLAS fluoroelastomers are the material of choice for parts and components that need to perform reliably in the world's harshest environments. AGC formulated AFLAS resins form alternating polymers of tetrafluoroethylene and propylene to achieve unique properties over a conventional FKM type fluoroelastomer. These properties include outstanding resistance to heat, chemicals, fuels, acids, bases, solvents, ozone and steam. Several AFLAS grades are approved for contact with food.

Fluon+ melt processable compounds are based on copolymer resins FEF, ETFE, ECA, PFA, PVDF, MFA and ECTFE. These compounds extend the fluoropolymer properties of chemical resistance, toughness and lubricity. All Fluon melt processable compound products are manufactured to precise specifications.



Prism Worldwide (www.prismww.com) has introduced a solution that reinvents the recycling process at a molecular level. Prism provides sustainable materials and solutions for polymeric and elastomeric applications for a broad range of industries. Prism Worldwide is a clean technology company that develops and manufactures performance oriented circular polymer materials from recycled tire rubber and scrap plastic to offset virgin materials. This creates a consistent product that offers value and sustainability to customers.

The PRISM™ process can in part reverse sulfidic bridges in crumb rubber. This creates a thermoplastic rubber intermediate that can be used as an additive to modify asphalt; as an ingredient in compounds to make thermoset rubber products; to produce thermoplastic elastomers (TPE); and as an additive to modify thermoplastics.

Prism Worldwide's ViaTec™ polymer modifier is used in asphalt applications. Asphalt is commonly modified with virgin synthetic rubber (especially SBS copolymer) to improve durability. ViaTec™ circular polymers offer a sustainable alternative to these materials. Whether used to improve asphalt binder for roads, or in roofing applications, ViaTec™ technology can help improve service life and performance.

Ancora™ thermoplastic elastomers are manufactured using Prism Worldwide's polymers. Ancora™ elastomers use a high percentage of recycled materials and can be used to create many different finished products. Since these elastomers are primarily created from waste streams, these materials offer sustainability options not previously available in virgin materials.

Ennova™ polymer modifier is added to thermoplastic compounds to improve impact resistance while using recycled content. A current project is replacing virgin olefinic materials with compounds using Ennova™ to improve durability and strength.

If you would like your web site featured here contact your sales rep
Dennis Kennelly, dennis@rubberworld.com, Mike Dies, mike@rubberworld.com or Pete McNeil, pete@rubberworld.com

Meetings

Detroit will host Silicone Expo 2023

Silicone Expo USA, an established global trade show and conference for the entire silicone industry, organized by Select Global Events Ltd., will be held October 4-5 at Huntington Place in Detroit, MI. Technical conferences, thought leadership, live product demonstrations and international networking will be included. This unique event is said to offer a vital networking opportunity for all verticals of the silicone supply chain (of elastomers, resins, fluids and gels),

Rubber Group News

The **Chicago Rubber Group** will hold its Wisconsin golf outing September 13 at the Hawk's View Golf Club in Lake Geneva, WI. Details are available at www.chicago-rubbergroup.org.

The **Detroit Rubber Group** will hold a golf outing August 22 at the Bay Point Country Club in West Bloomfield Township, MI. Details are available at www.rubber.org/detroit-rubber-group-inc.

The **Mexico Rubber Group** will hold the course, "Rubber Compounds, Part 1: Chemical Reactions Mechanism," instructed by Soul Leonides, on September 7 at the Rubber Chamber Auditorium in Mexico City, Mexico. The MRG will hold the course, "Design, Development and Production of Rubber Compounds," instructed by Luis Mayorga, at the Rubber Chamber Auditorium in Mexico City, Mexico. Further information is available at www.rubber.org/mexico-rubber-group.

The **MidAtlantic Rubber and Plastics Group** will hold a Lunch and Learn online event August 24 on Sustainability of Rubber and Plastics. Details are available at www.marpg.org.

The **Ohio Rubber Group** will hold a golf outing August 28 at Silver Lake Country Club in Stow, OH. The ORG will hold a technical meeting September 26 at the Hilton Garden Inn in Twinsburg, OH. Details are available at www.ohiorubber-group.org.

The **Ontario Rubber Group** will hold a golf tournament September 13 at the Royal Ontario Golf Club in Milton, Ontario, Canada. Further information is available at www.rubber.org/ontario-rubber-group.

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

providing a forum to do business face-to-face, both from within the industry and with diverse end user markets.

Attendees are said to represent the following groups: lifestyle products, electronics, consumer goods, construction, oil and gas, marine, HVAC, aviation, industrial products, mass transit, agriculture, energy, textiles, medical and automotive.

Technical presentations on Wednesday, October 4, will include the following: "Keynote address: Market analysis," Zoe Liu, Sublime China Information; "History of silicone," Jeff Hoffman, Paul O. Abbe; "Movements in metalized silicone and effect on silicone," Ken Baker, NewAge Industries, and Scott Kearns, ElastaPro; "Reducing the CO_2 footprint of silicone rubber, foams and adhesives," Richard Austin, Saint-Gobain; "Efficient removal of volatile substances with the planetary roller extruder," Michael W. Batton, ENTEX Rust & Mitschke GmbH; "Emerging silicone technologies in textiles and industrial applications," Ganesh Srinivasan, Resil Chemicals; "Can we make silicones more sustainable by incorporating natural materials," Michael Brook, McMaster University; "Life cycle assessment of recycled products and carbon savings," Chris Fu, Eco USA LLC; "Self-bonding platinum addition silicone potting materials," Michael Watson, Gelest; "Storage and media resistance of liquid silicone rubber: A comparative study of different test conditions," Svenja Marl, UNIpace; and "Devulcanization: A solution to scrap silicone," Ben Chouchaoui Windsor Industrial Development Laboratory.

Technical presentations on Thursday, October 5, will include the following: "Keynote address: Sustainability," Anna Felix, Dow; "Organic-silicone hybrid polymers: A review of commercially successful and emerging technologies," Pete LeBaron, CHT Group; "Solving LSR cold-deck tooling challenges using simulation," Alex Baker, Moldex3D; "Automation for AI laboratories," Khaled Boqalieh, LabsCubed; "Silicone based adjuvants in agrochemicals," Manju Mamparambath, Resil Chemicals; "Amulit silicone 3D printing: Additive manufacturing in ultra-low interfacial tension," Senthil Duraivel, University of Florida; "Panel discussion: Prosthetic application of silicone and the end users," Mariya Cameron, 14ELMT Fabrication, and Dan Hill, Baker Orthotics and Prosthetics, Hanger Clinic; "Big leap in silicones 3D printing," Thomas Batigne, Lynxter; "Engineered silicone solutions for energy storage," Andrei Szabo, Wevo-Chemie GmbH; "State-of-the-art automated silicone compounding and extrusion technology," Martin Yonnone, Colmec USA; and "Further steps to an efficient and automated production process for mixing, extrusion and straining of silicone rubber compounds," Julia Uth, Uth GmbH.

Registration information for Silicone Expo USA is available at www.silicone-expo.com.

Gerlach organizes vulcanization webinar

Gerlach Maschinenbau GmbH will hold the webinar, Hot Air Vulcanization, September 27-28. This online seminar focuses on the latest hot air vulcanization devices for rubber and silicone profiles with incredibly low power consumption.

An expert speaker will instruct attendees about the advanced features of these devices, including precise temperature control, improved product quality and increased productivity. Participants will discover how this technology can help their business reduce energy costs and meet sustainability goals.

Registration information is available at www.gerlach-machinery.com.

Polyurethanes event celebrates 65 years

The 2023 Polyurethanes Technical Conference, celebrating its 65th year, will be held September 25-27 at the Marriott Rivercenter in San Antonio, TX. This event is organized by The Center for the Polyurethanes Industry (CPI) of the American Chemistry Council.

Paper presentations and a poster session will describe the latest research and technical developments for all the important polyurethane industry sectors.

Debbie Mielewski, a sustainability expert, will deliver the keynote address.

Further information is available at: https://www.americanchemistry.com/industry-groups/center-for-the-polyurethanes-industry-cpi/polyurethanes-technical-conference.

Rubber Division
American Chemical Society
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NEVER STOP LEARNING!

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.

TRAINING PASS: You can purchase a training pass to attend all our virtual courses and webinars for ONE YEAR for ONE PRICE. Individual passes, as well as company level passes with tiers of up to 50 trainees are available.

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

UPCOMING LEARNING OPPORTUNITIES

- **August 17, 2023**
  Career Catalyst Webinar: *Beat the Bots! Get Your Resume Past the Applicant Tracking System*
- **August 18, 2023**
  Formulating Fridays Webinar: *Formulating Wrap Up*
- **August 21, 2023**
  Course: *Elastomers for Selective Gas Separation, including Carbon Capture*
- **August 24, 2023**
  Webinar: *Maintaining High Performance in Challenging Testing Laboratories*
- **August 30, 2023**
  Course: *An Introduction to Continuous Vulcanization*
- **September 6, 2023**
  FREE Webinar: *PFAS – The Situation & The Challenge*
- **September 15, 2023**
  Course: *Communications Workshop & Luncheon (In-person Only)*
- **September 20, 2023**
  Course: *Rubber Extrusion Technology*
- **September 21, 2023**
  Career Catalyst Webinar: *Virtual Interviewing – How is it Different From In-person Interviewing*
- **October 16-18, 2023**
  Educational Symposium at the International Elastomer Conference
- **October 30, 2023**
  Endurica Workshop: *Characterizing Elastomer Fatigue Behavior for Analysis and Engineering*
- **November 8, 2023**
  Course: *Sponge Rubber 101*
- **November 9, 2023**
  Career Catalyst Webinar: *Using LinkedIn to Increase Your Visibility in the Job Search*
- **November 14, 2023**
  Course: *Advanced Rubber Compounding & Testing*
- **December 4, 2023**
  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)!

Calendar

Rubber Division
American Chemical Society

Future Meetings/ Expos

2023
Cleveland October 16-19

2024
Pittsburgh September 9-12

www.rubber.org

R.D. Abbott, Manufacturing with Silicone Rubber workshop, Barberton, OH, www.rdabbott.com - August 15-18.

Rubber Division, ACS, Career Catalyst Webinar: Beat the Bots! Get Your Resume Past the Applicant Tracking System, www.rubber.org/training - August 17.

Rubber Division, ACS, Formulating Fridays Webinar: Formulating Wrap Up, www.rubber.org/training - August 18.

Rubber Division, ACS, Elastomers for Selective Gas Separation, Including Carbon Capture online course, www.rubber.org/training - August 21.

Detroit Rubber Group, golf outing, Bay Point Country Club, West Bloomfield Township, MI, www.rubber.org/detroit-rubber-group-inc - August 22.

MidAtlantic Rubber and Plastics Group, Lunch and Learn: Sustainability of Rubber and Plastics online event, www.marpg.org - August 24.

Rubber Division, ACS, Webinar: Maintaining High Performance in Challenging Testing Laboratories, www.rubber.org/training - August 24.

Ohio Rubber Group, golf outing, Silver Lake Country Club, Stow, OH, www.ohiorubbergroup.org - August 28.

Rubber Division, ACS, An introduction to Continuous Vulcanization course, www.rubber.org/training - August 30.

September

Rubber Division, ACS, PFAS: The Situation and the Challenge webinar, www.rubber.org/training - September 6.

Mexico Rubber Group, Rubber Compounds: Chemical Reactions Mechanism course, Rubber Chamber Auditorium, Mexico City, Mexico - www.rubber.org/mexico-rubber-group - September 7.

Sigmasoft, Tooling and Process Development for Injection Molding Thermoplastic Parts seminar, Renaissance Schaumburg Convention Center Hotel, Schaumburg, IL, www.sigmasoftvm.com - September 7.

University of Akron, Akron Polymer Training Services, Dynamic Viscoelastic Behavior of Rubber and its Products course, www.uakron.edu/apts/ - September 7-8.

Executive Conference Management, LSR 2023, Sonesta Hotel, Charlotte, NC, www.executive-conference.com/conference/lsr-2023 - September 11-14.

University of Akron, Akron Polymer Training Services, Rubber Molding Processes: Principles, Troubleshooting and Mold Design course, www.uakron.edu/apts/ - September 12-14.

Chicago Rubber Group, Wisconsin golf outing, Hawk's View Golf Club, Lake Geneva, WI, www.chicagorubbergroup.org - September 13.

Ontario Rubber Group, golf tournament, Royal Ontario Golf Club, Milton, Ontario, Canada, www.rubber.org/ontario-rubber-group - September 13.

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.

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.

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.

TPE material derived from end-of-life tires

Ancora C-1000 thermoplastic elastomer (TPE) contains 50% post-consumer recycled content derived from end-of-life tires. Based on the company's patented technology, Ancora C-1000 maintains the look, feel and processing of a typical petrochemically derived TPE.

Ancora TPEs are a new class of TPE compounds utilizing polymers derived from end-of-life tires manufactured with the firm's patented Prism process. This process uses tire rubber as the primary feedstock in the production of polymer intermediates called PTR. These intermediate polymers are then compounded into injection moldable TPE pellets at the company's Rochester, NY area facility.

The first compound in a series, Ancora C-1000, is suitable for use in a broad range of applications, such as automotive all-weather mats, weather stripping, footwear and more. This Ancora compound is available in black and has a durometer A hardness of 80.

Ancora C-1000 is 99% domestically sourced, meeting Infrastructure Investment Jobs Act (IIJA) Buy America requirements. Compared to virgin synthetic rubber compounds, the firm's base polymer has an approximately 86% lower carbon footprint. This product is said to fill a unique market demand for both sustainability and performance. The technology can be applied over a broad range of applications, and the company is said to look forward to working with the industry to grow this into a family of TPE compound products. (*Prism Worldwide*)

www.prismww.com

Rubber, tire mold cleaning

From core expertise in optics and rubber molding, this company introduces a UV optical material (DUV280) with over 90% transmittance of 280 nm UV-C light, and almost no performance loss after 15,000 hours of irradiation at $\Phi e = 70$ mW. This material is said to exhibit silicone's advantage at realizing complex shapes and fine details for expansive possibilities. Two standard lenses are initially available as well: the AL-10M-DUV280 with a ~10° distribution angle compatible with 3535 footprint LEDs, and the AL-20M-DUV280 with a ~20° distribution angle compatible with 6868 footprint LEDs. DUV280 optics can support wide ranging applications, including sterilization and dermal phototherapy, among others. (*Asahi Rubber*)

www.asahicrosslink.com

Fluoroelastomers

Aflas fluoroelastomers are said to be the material of choice for parts and components that need to perform reliably in the world's harshest environments. Aflas resins are formulated from alternating polymers of tetrafluoroethylene and propylene to achieve unique properties over a conventional FKM type fluoroelastomer, according to the company. These properties are said to include outstanding resistance to heat, chemicals, fuels, acids, bases, solvents, ozone and steam. Several Aflas grades are approved by the Food and Drug Administration (FDA) for contact with food, making them an ideal material for parts like seals that are used in food processing applications where heat and/or aggressive chemicals will quickly degrade other types of rubber. (*AGC Chemicals*)

www.agcchem.com

Mold release products

This global manufacturer of professional grade industrial cleaning, maintenance and manufacturing chemicals and parent of Franklynn DiamondKote and Franklynn Crystal mold release agents launched DKW-4185 water based semi-permanent mold release. Based in years of previous water based release development, DKW-4185 is said to be a premium release agent that carries universality for a variety of elastomers, including but not limited to natural rubber, sulfur cured EPDM, polyacrylate and a variety of fluoroelastomers. Designed for many molding applications, including anti-vibration parts, seals and gaskets, and general rubber molded parts, DKW-4185 is said to offer excellent cycle life, cleaner molds and reduced scrap rates compared to earlier products. It is available in pails, drums and totes. Product features are said to include: stable, non-transferring and excellent release properties; improved cosmetics and fewer defects; increased mold life and less frequent mold cleaning required; forms a tough, durable release film; water based formula avoids complications found in solvent based products; promotes good rubber flow; and does not need to be diluted prior to use. (*ITW Pro Brands*)

www.itwprobrands.com

Silicone rubber grades

The Silpuran product range comprises HTV solid and liquid silicone rubber (LSR), and room temperature vulcanizing grades (RTV-1 and RTV-2). These high end silicone rubber grades meet the stringent demands of the health care industry. All products have passed selected ISO 10993 and USP Class VI tests, and are said to meet the high safety standards imposed by the health care industry. The cleanliness needed for fulfilling the medical requirements of today and tomorrow are said to be ensured by the company's Clean Operation program. (*Wacker Chemie AG*)

www.wacker.com

Fluoroelastomer products

Fluonox fluoroelastomers (FKM) from GFL are exclusively distributed by this company in the U.S., Canada and Mexico. This FKM portfolio contains a wide range of bisphenol curable copolymers, bisphenol curable terpolymers and peroxide curable terpolymers with up to 70% fluorine content. The Fluonox product line encompasses a wide range of Mooney viscosities and cure rates for excellent processability and productivity in a wide array of processes, according to the company. These include compression molding, injection and transfer molding, extrusion and calendering. The Fluonox portfolio offers a full range of physical properties, heat and chemical resistance, and low temperature flexibility to provide superior performance in any environment, according to the firm. Fluonox fluoroelastomers are PFAS free, PFOA free and REACH compliant. Technical service and application development are available. With recent and continual expansions, Fluonox is said to be a stable FKM supply source. Servicing the rubber, thermoplastics and other polymer related industries for more than 85 years, this company is a management owned and operated sales, marketing and technical support organization. (*Harwick Standard Distribution*)

www.harwick.com

Functional black pigment

Microlen Black 0098 MP is a highly functional black pigment preparation with near infrared (NIR) reflectivity which can be used in several applications where carbon black based products have some limitations, such as: packaging materials that can still be sorted by polymer, enabling recycling; cool black materials with significantly lower heat buildup; and automotive applications supporting autonomous driving enablers via LiDAR detection. Microlen Black 0098 MP is delivered in a low dusting powder form and can be dosed in an efficient way. Microlen offers a comprehensive range of preparations for the coloration of rubber. The products are used in a variety of rubber applications, such as flooring, automotive, building and construction, sportswear, home and personal care, industrial and more. A few key benefits of Microlen preparations are said to include the excellent levels of dispersions and the wide range of chromatic colors. This allows for easy coloration of the rubber and avoids deviations from previous product runs. Several products out of Microlen's range can be used for sensitive applications, such as food contact applications or toys. Specific information for each dispersion and color can be provided by the company. (*Sun Chemical*)

www.sunchemical.com

Performance silica

Agilon silica provides nearly 50% energy savings and cuts manufacturing time by a third compared to conventional silica by eliminating one mixing step, according to the company. Agilon precipitated silica is chemically modified, enabling tire makers to eliminate a manufacturing step required in conventional technology, in which high density silica undergoes a reaction with silane. Because the company formulates Agilon performance silica by precipitating silica and silane together, this non-value-added processing step is not required, saving energy and reducing manufacturing complexity. Research also found added benefits for tire makers compared to non-treated silicas, including increased mixer fill factor (the ratio between the volume of material put in a mixer, and the total mixer volume), higher silica loadings, reduced mixer temperature and lower water consumption, according to the company. There are also said to be significant sustainability benefits for end users. When used in tire treads, Agilon silica is also said to improve fuel efficiency and traction. Agilon silica products are engineered to lower rolling resistance for improved fuel efficiency, increase traction for improved safety and handling, and extend the useful life of tires. (*PPG*)

www.ppg.com

Reflective coatings

UV-C and UV-A silicone based diffuse reflective coatings for performance and protection are available from the company. UV diffuse reflective coatings are based on a silicone matrix with high reflective efficacy and durability against discoloration. Excellent diffusion approaching that of an ideal diffuser helps avoid hotspots and effectively spreads light broadly, regardless of incidence angle, according to the company. Varieties are available in an assortment of hardnesses to support needs from flexibility to scratch resistance. All are multi-part with heat cure. Recommended application methods are spray or screen print with a thickness of 30-50 µm. Customers are said to increase their module efficiency or protect vulnerable substrates with a variety suitable for specific applications, at wavelengths of 200 nm to 405 nm. Visible light formulations are also available. (*Asahi Rubber*)

www.asahicrosslink.com

Vulcanized vegetable oil

Brown factice (vulcanized vegetable oil), manufactured by Caufit S.A. in Buenos Aires, Argentina, is now being supplied by this company to the North American market. Caufit manufactures its brown factice by the sulfur crosslinking of high quality soybean oil. Caufit is ISO 9001:2015 certified. This company invites inquiries from both end users and potential stocking distributors. (*Lobel Chemical*)

lobelusaat@gmail.com

Styrene butadiene rubber

Tufdene S-SBR (solution polymerized styrene butadiene rubber) and Asadene BR (butadiene rubber) are available from the company, said to be known for its high performance S-SBR grades. The S-SBR grades are said to be ideal for environmentally friendly tires, with characteristics such as excellent fuel efficiency and wear resistance. The synthetic rubber produced from raw materials such as biomass and plastic waste, as well as other raw materials, makes an important contribution to reducing CO_2 emissions, according to the company. Furthermore, relevant stakeholders are calling for a lower environmental impact, including decarbonization, in many other areas of application. For these products, the firm will also manufacture and sell butadiene rubber produced using the mass balance method. The company is currently expanding its range of more sustainable materials. By focusing on the use of renewable energies, as well as mass balanced and recycled raw materials, the company wants to make its contribution to a carbon neutral and more sustainable world. The mass balance method is a globally used method to calculate the proportion of sustainable raw materials for individual products in a mix of sustainable and petroleum derived raw materials. As an international certification system, the ISCC (International Sustainability and Carbon Certification) offers solutions for the implementation and certification of waste and residual raw materials. (*Asahi Kasei*)

www.asahi-kasei.com

Perfluoroelastomer

Chemraz G57 is a perfluoroelastomer specifically developed to meet the demands of aggressive dry plasma systems and other extremely demanding semiconductor fabrication sealing applications. Chemraz G57 perfluoroelastomer's unique formulation provides enhanced plasma resistance and minimal contamination, resulting in less downtime and higher wafer processing yields, according to the company. Recommended primarily for both static and dynamic oxide etch wafer processing applications, Chemraz G57 remains stable at service temperatures up to 572°F/300°C. With nearly universal chemical compatibility and the broadest chemical resistance of any elastomeric material, Chemraz G57 is ideal for use across a wide range of sealing applications, including endpoint windows, bell jar seals, valve seals, KF fitting seals, window seals, isolator valve seals, lid seals, gas inlet seals, slit valve seals, and chamber seals, according to the manufacturer. The firm is said to deliver highly customizable solutions guaranteed to provide excellent performance under extremely challenging operating conditions in the semiconductor industry. It provides a portfolio of advanced elastomer seals and thermoplastic components. (*Greene Tweed*)

www.gtweed.com

Precipitated silica powder

Mansil-190MP is a high dispersion, high purity precipitated micro-pearl silica powder. Mansil-190MP is a reinforcing filler for use in synthetic and natural rubber compounding. Advantages are said to include faster incorporation time and less viscosity buildup, while maintaining excellent dispersion and superior rubber compound properties, according to the company. Mansil-190MP precipitated silica is said to increase hardness, tensile strength, abrasion and tear resistance. For mechanical rubber goods, Mansil-190MP can be used as the primary filler or in combination with carbon black. In tire applications, these silicas are said to improve rolling resistance, flex fatigue and enhance traction. In adhesives compounding, silica provides an additional method of promoting improved adhesion, as well as providing reinforcement. Silicas are universally applied to provide increased abrasion resistance, green strength and translucence in the formulating of shoe sole compounds. Lightly loaded compounds are prepared using 5-20 phr, while highly loaded, oil extended compounds can use 75-100 phr. PEG-3350 is the most often used activator to improve cure rate and state of cure. (*Akrochem*)

www.akrochem.com

Equipment

Rubber grinding system

A granulation line is designed for use with EPDM rubber with higher capacity and lower granulate temperature rise, even with the small screen's diameter. The restyling of the plant involved the entire line, with the goal of lower energy consumption, higher efficiency, greater automation and full compatibility with Industry 4.0, according to the company. With this system, the bales can be positioned perpendicular to the length of the belt to allow for an increase in their number per meter of conveyor belt. Two sensors, at the entrance and exit, allow the system to count the bales and provide an alarm if their number in transit to the guillotine is less. The GT 600 A1 guillotine has been developed with an opposing wing feeding system to allow feeding from a choice of two different conveyors. The cutting design allows 10 bales to be quickly sliced at a rate of 10 cuts in 100 seconds for smooth batching at the mill. The MU 512 GT A1 flagship model has a capacity of 1,500 to 2,000 kg/hour of rubber, even with a ϕ10 mm screen, with energy savings of 20% to 25% compared to the previous generation of grinders. The result is that compounders are now able to meet two pressing needs: to have a single line suitable for grinding two types of rubber at the same time, while keeping them separate; and to save space and the purchase of an expensive intermediate buffer. (*Previero*)

www.previero.it

Mixing mill with strip cutter

Plus and Premium versions of Neo mixing mills can now be upgraded with a strip cutter and a sliding jaw with folding function. Optional features can be customized to further optimize production processes, always focusing on the safety of operators. The company is said to offer its users the greatest possible customization. This begins with the selection of the best mixing mill from a broad portfolio and ends with additional optional features. For example, it is now possible to equip Plus and Premium mixing mills with plastic or brass rotating circular blades. Premium mixing mills can also be upgraded with material stock guides that move to one side. Two to four pieces can be attached to Plus and Premium mixing mills. While the strip cutters are free standing as standard, the company can build retractable strip cutters on request. In rest mode, the knives are covered under the tray. Only when the operator adjusts the knives according to customer parameters do the flaps in the collection tray open automatically. The knives are pneumatically pressed against the material. Easy manual width adjustment is possible via two-hand control on the control panel. (*Deguma*)

www.deguma.com

Force measurement

The company's force and material test division offers a line of products that specializes in tensile and compression testing. The firm's test stands are highly customizable, with multiple load capacities and travel ranges, depending on the application requirements. The equipment is said to be easy to set up, operate and maintain. This and the accompanying software options guarantee a solution for virtually any application, according to the company. Test stands from the company come in a wide variety of options and configurations. From the entry level manual stands to the 50 KN capacity motorized dual column machines, the firm is said to have a solution to meet individual force and material test needs. Granite based test stands are said to offer exceptional stiffness, stability and water resistance. Paired with high accuracy encoders, they are able to support extensometers in conjunction with the material test software, allowing for testing material properties such as Young's modulus and ultimate tensile strength. Highly elastic materials which are capable of producing large amounts of elongation before reaching a point of structural failure can now be more accurately testing, according to the company. (*L.S. Starrett*)

www.starrettmetrology.com

Automation system

The tailor made MAP.autocell takes over the entire manufacturing process of products, from component feeding through production to further processing. This rubber injection molding specialist is said to offer a wide range of automation solutions for process optimization, increasing efficiency and reducing cycle times in the production process. Handling systems include heating plate and frame shifting, center plate changing, etc. Robotic solutions are offered, in addition to brushing and demolding systems. Individual automation technology can be developed together with the customer. Customers are said to benefit from this one-stop solution; visualization and control of machine and automation via a uniform control unit, the MAP.commander C6 control; a familiar user interface for all automation components with MAP.commander C6; first level support from the company for all components; a compact and optimized footprint; and a modular concept. Effective automation options for horizontal injection molding machines include the firm's robust brush systems for automatic demolding and cleaning. They enable the fully automatic production of all free-fall articles such as o-rings, sealing elements and molded articles. (*Maplan GmbH*)

www.maplan.at

Corporate Sponsor

Rubber World Industry Links

Eagle Elastomer (www.eagleelastomer.com) has manufactured fluoroelastomer products for a wide range of markets since 1983. Eagle Elastomer supplies fluoroelastomer (FKM) and perfluoroelastomer (FFKM) custom mixed compounds, as well as fully cured FKM extrusions and sheet products. The company's products offer excellent sealing properties for applications requiring high temperature and chemical resistance.

Eagle Elastomer delivers the highest quality fluoroelastomer products and offers the best customer service and technical suport in the elastomer industry. The firm's knowledgeable engineering staff and long term relationships with the FKM suppliers DuPont, 3M, Daiken, AGC Chemicals and Solvay ensure that Eagle Elastomer is constantly monitoring new developments and processes in the fluoroelastomers industry.

Conformance to product requirements is assured through Eagle Elastomer's world class manufacturing facility and quality system certified to AS9200 and ISO 9001.

Eagle Elastomer specializes in the production of high quality fluoroelastomer products. Only 100% virgin fluoroelastomers are used in the manufacture of the company's products. No regrind, off-spec or non-fluoroelastomer polymers are used in production. Short lead times are achieved by maintaining an inventory of standard items in most sizes.

Eagle Elastomer is committed to be the leader in supplying fluoroelastomer custom mixed compounds, and extruded and cured sheet products requiring high technology and special expertise. Fluoroelastomer compound mixing serves such industries as oil and gas, truck and rail, aerospace, automotive, mining, food and beverage, agriculture, semiconductor, chemical and pharmaceutical.

Custom fluoroelastomer mixing is offered for polymers (copolymers, terpolymers, peroxide curable polymers and specialty samples) to 500 pound lots of fluoroelastomer compound.

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ARP Materials (www.arpmaterials.com) is an ISO 9001:2015 certified distributor of raw materials to the rubber and plastics industries, focused on quality and consistency. By partnering with today's leading raw material producers from around the world, ARP Materials is committed to being a trusted partner to customer supply chains. ARP Materials is dedicated to providing unmatched customer service by delivering complete solutions to specific raw material needs. ARP's goal is to build on this foundation by staying close to its customers and responding to their changing needs. By utilizing a global strategy that combines vertical integration, lower costs and high quality raw materials, ARP Materials is confident customers cannot find a better supplier for their raw material needs.

With over 700 products distributed through several warehouses across the U.S., ARP Materials is dedicated to delivering products just in time, allowing for rapid response. ARP's team knows its materials inside and out, offering expert custom solutions to customer manufacturing needs and obstacles. Experts handle the logistics, focusing on efficiency and budget, so customers can focus on their business.

ARP Materials has always been a family run business committed to forging relationships with vendors and customers; to going above and beyond, and creating lasting, sustainable solutions. ARP Materials (formerly Alternative Rubber & Plastics Inc.) was founded in 1993 by Jerry Fasolino, Sr. He created a company with unwavering commitment to customer-first values centered around being a trustworthy and reliable partner that works hard to serve its customers.

ARP Materials supplies polymers, including chlorinated polyethylene, ethylene propylene rubber, polybutadiene, nitrile butadiene rubber, nitrile powder, nitrile/PVC, chlorosulfonated polyethylene, styrene butadiene rubber, high styrene resin, butyl rubber, butyl reclaim, whole tire reclaim, polychloroprene and natural rubber. Performance products and additives are also supplied.

Akrochem Corporation (www.akrochem.com) has the right ingredients, from simple fillers to unique rubber chemical blends and dispersions, because the company offers the broadest line of materials anywhere. An experienced technical staff always goes above and beyond the call of duty to help customers find the most intelligent solutions.

Improving customer productivity has been the Akrochem goal since the firm began serving the rubber and plastic industries in 1929. Akrochem provides a comprehensive assortment of compounding materials and color concentrates, from the basic to the most complex and customized, all supported by the industry's best technical expertise and service. Akrochem promotes professionalism through its ISO 9001:2015 and National Association of Chemical Distributors (NACD) accreditations.

Akrochem's product lines for rubber compounding include antifoams, carbon blacks, chemical dispersions, colors (powders), colors (paste dispersions), colors (polymer dispersions, masterbaches), colors (thermoplastic color concentrates), cure blends and chemical blends, elastomers, emulsions and fluids, fire retardants, flocks and wood flours, magnesia products, mineral fillers, plasticizers, processing aids, release agents, resins and tackifiers, rubber chemicals, silicone products, silicone rubber additives, stearates, sulfurs, vulcanized vegetable oils, waxes and zinc oxides.

Antioxidant BLS-25 is a reaction product of acetone and diphenylamine. BLS-25 offers protection against flex cracking, heat and oxidation to natural and synthetic elastomers such as NR, CR, NBR, SBR, BR and EPDM.

Mansil 190MP is a high dispersion, high purity precipitated micro-pearl silica powder. Mansil 190MP is a reinforcing filler for use in synthetic and natural rubber compounding. Advantages include faster incorporation time and less viscosity buildup, while maintaining excellent dispersion and superior rubber compound properties.

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People in the News

Ibáñez appointed at R.D. Abbott de México

Humberto Ibáñez
R.D. Abbott de México

Jiao Jian
Pirelli

Deborah Smalley
Precision Roll Grinders

Mario Navarro
Arburg

Humberto Ibáñez was hired by R.D. Abbott as senior account manager for R.D. Abbott de México. Ibáñez joined R.D. Abbott's subsidiary in June, and is responsible for developing business relationships, fostering sales growth and providing technical support to customers in Mexico. He is said to bring strong technical sales skills to his new role, and has many years of experience selling Cancarb Limited's Thermax brand medium thermal carbon blacks. R.D. Abbott de México is now the exclusive distributor of Thermax products in Mexico.

Management

Jiao Jian was named chairman of the board of directors for Pirelli. **Marco Tronchetti Provera** was appointed executive vice chair, and **Andrea Casaluci** was named chief executive officer of Pirelli.

Deborah S. Smalley was named chief financial officer and treasurer for Precision Roll Grinders. She succeeds **Tom Pecuch**, who retired after 35 years with the company.

Mario Rodriguez Navarro has taken over as managing director of the Arburg branch in Querétaro, Mexico. **Martin Baumann** was named president of Arburg USA, succeeding **Friedrich Kanz**, who is retiring after 23 years as president of the Arburg subsidiary.

Goodyear Tire & Rubber announced that **Joseph R. Hinrichs**, president and CEO of CSX; **Max H. Mitchell**, president and CEO of Crane; and **Roger J. Wood**, former co-CEO of Tenneco have joined its board of directors.

MaryAnn Peterson Kanary was appointed senior vice president, chief legal officer and secretary of Cooper Standard. Based at Cooper Standard's headquarters in Northville, MI, Kanary will lead the legal and compliance functions for the company and report directly to **Jeffrey Edwards,** chair and CEO of Cooper Standard.

Brenntag announced that its board of management will consist of four members, including: **Christian Kohlpaintner**, chief executive officer; **Kristin Neumann**, chief financial officer; **Ewout van Jarwaarde**, CEO of Brenntag Essentials; and **Michael Friede**, leader of the Specialties division.

Olaf Kreis was appointed plant manager of the Continental Tyre South Africa Gqeberha facility, Continental's only tire manufacturing plant in Africa.

Joe Rios was named chief financial officer of Tire Group International, and **Enrique Hernandez** was appointed chief operating officer of the company.

Thomas Aichberger was appointed chief executive officer of RICO Group GmbH.

Technical

Jeremy Kahrs was promoted by Yokohama Tire to vice president of research and development at the Yokohama Development Center America facility in Cornelius, NC.

Carl Williams was appointed as a customer engineering support team member in the U.K. and Ireland for Michelin Tyre plc. Williams succeeds **Rob Blurton**, who is retiring from Michelin after 44 years with the business.

Anders Nybäck was named vice president of the Technical Molding and Teletronics business unit of Engel.

Stephen Redfern was appointed head of engineering and product development for Pneumatic Components Limited.

Associations

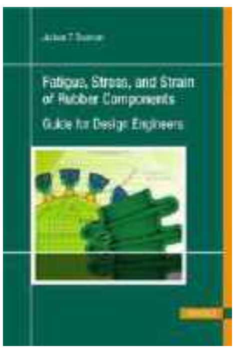
The Tire Industry Association (TIA) elected two current board members to its executive committee during its recent mid-year board meeing. **Russ Devens** of McCarthy Tire Service was voted in as secretary. **T.J. Trum** of Pomp's Tire Service was elected treasurer.

Obituary

James Albert (Jim) Jennett, who ran Rep from its beginning in 1970 until 1988, died on June 22 at the age of 78 after a long illness. Following his time at Rep, Jennett established ARC (Another Rubber Company), a molder of rubber products best known for its StarGrip golf grips, in Chandler, AZ.

Classifieds

Classifieds



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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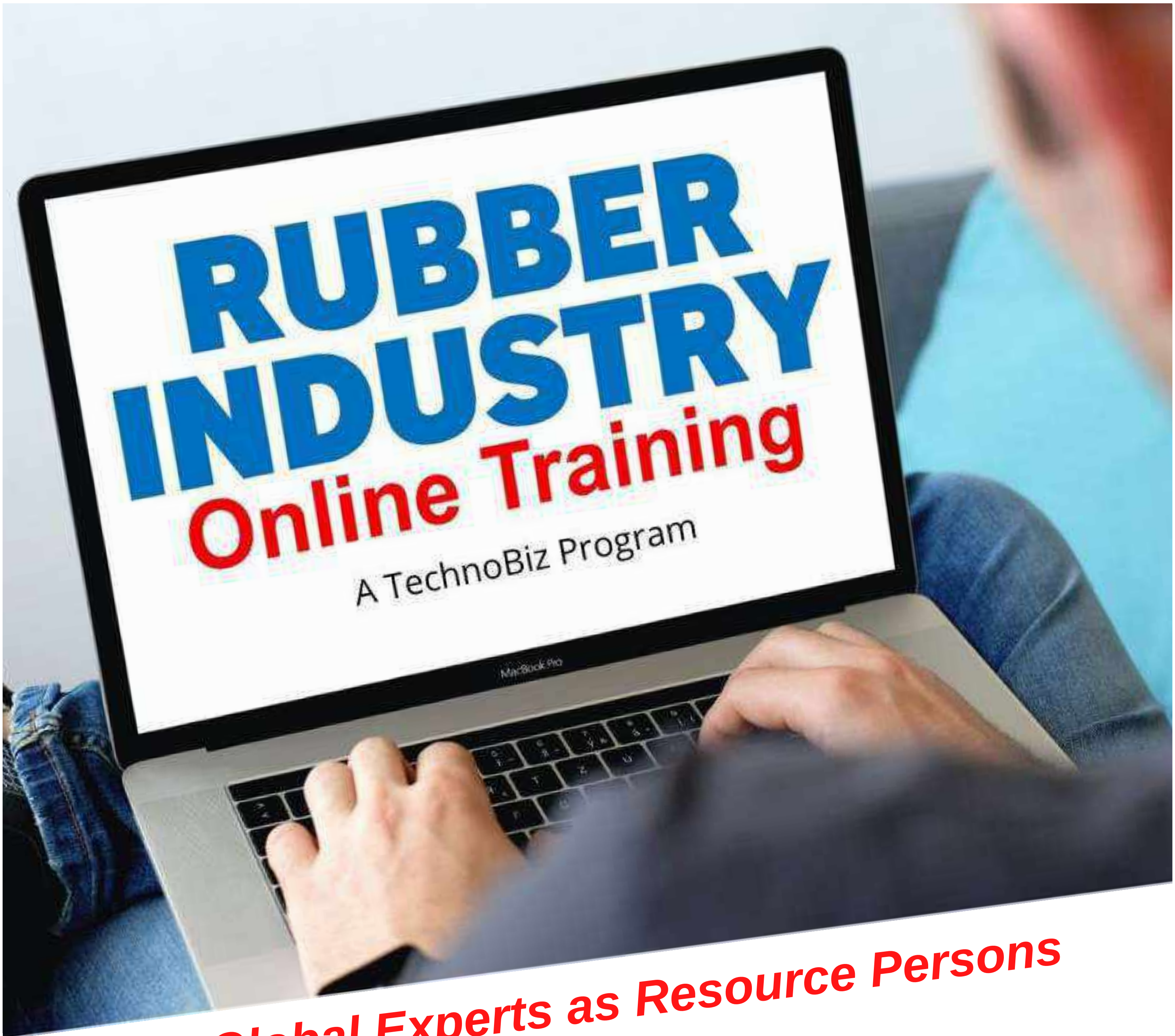

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