FEBRUARY 2025

# Rubber World

136 years

THE TECHNICAL SERVICE MAGAZINE FOR THE RUBBER INDUSTRY VOLUME 271, No. 5

## Truck tire tread compound development using low hysteresis carbon black

## Sustainable carbon black

## Novel additives for improving natural rubber compounds with surface modified carbon black

## Tech Service: A new low $CO_2$ reinforcing filler

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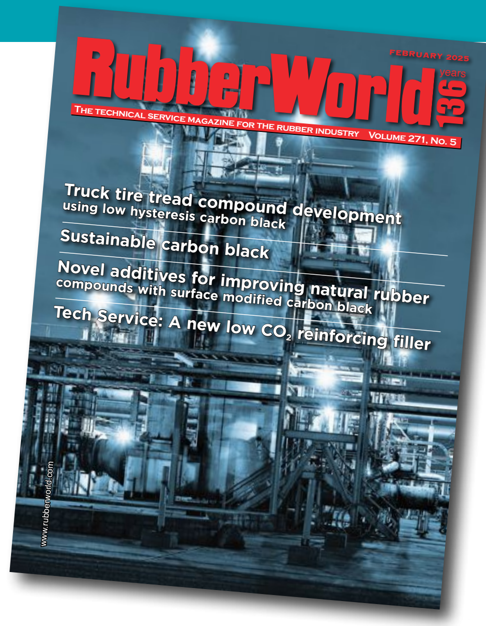
Vol. 271, No. 5 February 2025

## Features






Cover photo: Courtesy of Cancarb Ltd.



## Departments

# From the Editor

Jill Rohrer

## Rubber Division meets in Florida

Rubber Division, ACS will hold its Spring Technical Meeting March 4-6 at the Hilton Orlando Lake Buena Vista in Lake Buena Vista, FL. The event honors the 2025 Science & Technology Award winners, including Charles Goodyear Medalist Gert Heinrich of Leibniz Institute of Polymer Research, who will be honored at a special symposium on Combining Physics, Chemistry and Engineering of Rubber.

Rose Hernandez, International Space Station National Laboratory science program director for In Space Production of Advanced Materials and Manufacturing, will present the keynote address: The Science and Engineering of Advanced Materials and Manufacturing in the International Space Station (ISS) National Laboratory.

In addition to Charles Goodyear Medalist Gert Heinrich, other Science & Technology Award winners honored at the spring meeting will include Melvin Mooney Distinguished Technology Award winner Sunny Jacob of ExxonMobil Chemical; George Stafford Whitby Award for Distinguished Teaching and Research winner Robert Weiss of the University of Connecticut; Sparks Thomas Award winner Titash Mondal of the Indian Institute of Technology-Kharagpur; Chemistry of Thermoplastic Elastomers Award winner Takeji Hashimoto of Kyoto University; and the Fernley H. Banbury Award winner Edward R. Terrill of Akron Rubber Development Laboratory. See page 44 for complete coverage of the Spring Technical Meeting, including course descriptions and the technical presentations schedule.

Rubber Division, ACS has issued a Call for Abstracts for the 2025 Global Polymer Summit Technical Meeting and Student Symposium (see page 47). The submission deadline for abstracts is May 16. Papers are due August 24.

Technical training and scholarship opportunities are offered by Rubber Division, ACS, and the deadline for applications is March 1. The Rubber Technology Training Award is offered to an individual already in the rubber industry seeking additional education and opportunities for advancement. The award provides a $1,250 stipend to rubber industry employees to attend the events at a spring or fall Rubber Division, ACS meeting. In addition, two $5,000 undergraduate scholarships are available, as well as the $5,000 Russell Mazzeo Memorial Undergraduate Scholarship. Further information on these training and scholarship opportunities is available at www.rubber.org.

*Jill Rohrer*


# RubberWorld

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# VMI'S ICOM FINAL MIXING PROCESS

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# Business Briefs

## Wacker expands Asia silicones capacity

**Wacker Chemie AG** (www.wacker.com), started up two new production facilities for specialty silicones in Japan and South Korea. The expansion strengthens the company's activities in the Asian growth market. The plants, located in Tsukuba, Japan and in Jincheon, South Korea, will serve the growing demand from the automotive and construction industries for these products. In total, Wacker has invested an amount in the double digit million Euro range in the capacity expansions.

### Acquisitions, expansions

**Continental** (www.continental-industry.com), Hanover, Germany, announced the construction of a $90 million manufacturing plant focused on the production of hydraulic hoses in Aguascalientes, Mexico. The plant will enable the company to double its hydraulic hose manufacturing capacity and is designed to help meet demand from current and new customers in multiple industries across North and South America.

**PPG** (www.ppg.com), Pittsburgh, PA, has completed the sale of its silicas products business for approximately $310 million in pre-tax proceeds to **Qemetica**, a Warsaw, Poland based, privately held manufacturer of soda ash, silicates and other specialty chemicals. PPG's silicas products business manufactures and supplies precipitated silica products to major companies around the world as performance enhancing additives.

**Motion Industries** (www.motion.com), Birmingham, AL, a distributor of maintenance, repair and operation replacement parts, and a provider of industrial technology solutions, signed a definitive purchase agreement to acquire the net operating assets of **Maguire Bearing**, an industrial distributor based in Hawaii. Motion Industries has also signed a definitive purchase agreement to acquire the net operating assets of **Thompson Industrial Supply**, headquartered in Rancho Cucamonga, CA.

### Quality registrations

**Benvic Group** (www.benvic.com), Bourgogne, France, an international manufacturer of customized thermoplastic solutions, received the Gold Medal in the **EcoVadis** Sustainability Rating.

**Continental Tires** (www.continental-tires.com), Hanover, Germany, announced that its tire plant in Korbach, Germany, recently became the company's fourth plant to receive the International Sustainability and Carbon Certification (ISCC) Plus sustainability certification.

**Davis-Standard, LLC** (www.davis-standard.com), Chicago, IL, announced that its **Davis-Standard Global Services U.K.** facility has renewed its ISO 14001 certification. This international standard recognizes organizations for their commitment to environmental management.

# Business Briefs

## Orion partners with Contec on tire oil

### Contracts, licenses

**Orion S.A.** (www.orioncarbons.com), Houston, TX, a global specialty chemicals company, has signed a long term supply agreement with **Contec S.A.**, which will provide Orion tire pyrolysis oil to produce circular carbon black for tire and rubber goods customers. The agreement with Warsaw, Poland based Contec further enables Orion to diversify its sources of tire pyrolysis oil, commonly known as TPO.

**Prism Worldwide** (www.prismww.com), Kirkland, WA, a provider of material solutions dedicated to advancing end-of-life tire recycling technology, and **Sherwood Industries**, a family owned sheet extruder of thermoplastics, announced a partnership to introduce Prism's sustainable thermoplastic elastomers (TPEs) into extruded TPE sheets.

**Tiger Infrastructure Partners** (www.tigerinfrastructure.com), New York, NY, announced a transformational growth investment in **Bolder Industries**, a circular economy infrastructure platform said to meet a critical market need for sustainable materials for the rubber, plastic and petrochemical industries. Tiger Infrastructure is partnering with Bolder to provide growth capital to enable the buildout of new facilities. Bolder's existing operating facility in Maryville, MO, has commercialized its proprietary process for transforming end-of-life tires into recovered carbon black, an essential raw material in tires, rubber and plastics for which demand is growing globally. Bolder is currently constructing a second facility in Terre Haute, IN, to scale production, and has a third facility under development in Antwerp, Belgium.

The **Huber Advanced Materials** business unit of **Huber Engineered Materials**, a business that is part of **J.M. Huber** (www.huberadvancedmaterials.com), Atlanta, GA, announced an expansion of its distribution network for elastomer and rubber applications in several European countries. The two new distributors are **Nordmann** and **Safic-Alcan**.

**Kurita America**, part of the **Kurita Group** (www.kurita-america.com), Minneapolis, MN, a global provider of water treatment solutions, announced its pending merger with sister company **Avista Technologies**.

# Business Briefs

## Bridgestone to close LaVergne, TN, plant

### Corporate, financial news

**Bridgestone Americas** (www.bridgestoneamericas.com), Nashville, TN, will close its LaVergne, TN, truck and bus radial tire plant effective July 31. This decision is part of the company's strategic initiatives to optimize its business footprint, strengthen its competitiveness and enhance the quality of the company's U.S. operations. Bridgestone will also implement business footprint and cost optimization measures in other areas, as part of its strategic initiatives. These include plant capacity and workforce reductions at the Des Moines, IA, agriculture tire plant, as well as workforce reductions in the company's U.S. corporate, sales and operations. Bridgestone will work with all appropriate regulatory agencies and unions. Additionally, the company is undertaking business rebuilding activities in its Latin America operations, which include cost optimization efforts, along with reductions in workforce and production capacity at its facilities and business operations in Argentina and Brazil.

**Valex Group** (www.valexgroup.com), Pittsburgh, PA, has received Women's Business Enterprise certification from the **Women's Business Enterprise National Council**. The milestone is said to open new doors for Valex Group, allowing it to collaborate with organizations that prioritize supplier diversity and support women-owned businesses.

**R.D. Abbott** (www.rdabbott.com), Garden Grove, CA, marked its 75th anniversary in 2024 by giving back to its community through more than 90 acts of kindness. Over the past year, R.D. Abbott employees across North America partnered with more than 55 organizations, including food banks, shelters, senior centers and schools, volunteering, donating essentials, mentoring students, and honoring first responders and veterans,

**Ecore International** (www.ecoreintl.com), Lancaster, PA, a North American producer of recycled scrap tire derived rubber products, has earned the SEAL Business Sustainability Award in the Environmental Initiatives category. **Sustainability, Environmental, Achievement and Leadership (SEAL)** is an environmental advocacy organization that honors leadership through business sustainability and environmental journalism awards, while funding research and pursuing its own environmental impact campaigns.

**Lanxess** (www.lanxess.com), Cologne, Germany, has achieved top positions in several sustainability ratings. In the **Dow Jones Sustainability Index** (DJSI) Europe, the specialty chemicals company ranked first in the Chemicals category. In the DJSI World, Lanxess achieved 4th place. **MSCI ESG** confirmed Lanxess' AA rating for the fourth time. And Lanxess achieved **EcoVadis** Gold status for sustainability.

## Market Focus

# Chloroprene rubber market to grow 4.2%

The global chloroprene rubber (CR) market was valued at $1.16 billion in 2024, and is estimated to reach from $1.21 billion in 2025 to $1.68 billion by 2033, growing at a compound annual growth rate (CAGR) of 4.2% during the forecast period (2025–2033), according to a study from Straits Research.

Since it is flexible and pliable, CR is commonly used in outdoor and interior products. Insulation, gaskets, hoses, springs, belts, flexible mounts, shoe bottoms and adhesives are a few of its applications. CR resists ozone, weathering, acids, oils, water, greases and inorganic salts, making it ideal for outdoor applications like corrosion resistant coatings or landfill linings. CR sheets are utilized as transformer noise insulation and adhesive bases. Its fire resistance makes it useful for fire door weatherstripping. CR protects machinery, computer pads and car hoods.

Increased demand for latex and high quality rubber sheets is creating growth opportunities in the market, according to the report. CR has strong chemical stability and thermal flexibility, allowing for product-specific compounding. Increasing investments in research and development have resulted in high quality CR compounds that can be used in dip-molded products for dental, medical, sports, leisure, automotive and other industries. Medical and automotive industries use CR for its elastic metal bonding ability. Synthetic CR is latex-free, making it appropriate for medical products. Due to latex sensitivity, there is a growing need for CR sport shoe soles, generating new prospects for manufacturers.

CR is commonly used in binders, coatings, electric wire, hoses, belts and architectural rubber goods, in addition to typical industrial materials, construction and window seals. The adhesives application segment of the CR market is anticipated to account for a sizeable portion of overall demand during the forecast period.

Due to increased demand for synthetic rubber sheets and latex, several countries are spending extensively on CR production and development. Recently, CR has been used to make face masks because it can filter out particles smaller than COVID-19, creating manufacturing potential for market leaders.

Asia-Pacific dominated the market share for CR, a result of China's expanding demand for various industrial and automotive components. North America and Europe are anticipated to have considerable growth following Asia-Pacific.

Increased vehicle production, economic growth and tire manufacturing facilities in Latin America and Asia are all expected to increase the demand for rubber.

The study period is projected to see a decline in the use of synthetic rubber as thermoplastic elastomers (TPEs) become more popular due to low production costs and novel applications, according to the report.

# European replacement tire sales increase over weak 2023

Despite a decline in the summer tire segment, European replacement tire sales increased in 2024. Speaking of the results, Adam McCarthy, secretary general of the European Tire & Rubber Manufacturers' Association (ETRMA), commented, "The 4th quarter 2024 evolution is positive versus the 4th quarter 2023 in all product lines, mainly due to a weak performance in the 4th quarter of 2023. After a negative evolution in 2023 (versus 2022), with -8% in the consumer segment and -17% in the truck segment, the evolution of volumes in 2024 is getting better for consumer tires, mainly thanks to the all seasons segment, but still slightly negative for truck tires. In both segments, we are still far from the pre-pandemic volumes, respectively, at -3.5% and -10.3% versus 2019. Volumes in the agricultural tire segment have been supported by rainy weather conditions."

**European replacement tire sales**

| | 2023 Q4 | 2024 Q4 | Q4 change | 2023 year | 2024 year | Full year change |
|---|---|---|---|---|---|---|
| Replacement consumer tires | 50,683 | 56,516 | 12 | 212,265 | 223,267 | 5 |
| Summer tires | | | 1 | | | -2 |
| All season tires | | | 18 | | | 16 |
| Winter tires | | | 15 | | | 7 |
| Replacement truck and bus tires | 2,763 | 2,882 | 4 | 11,390 | 11,295 | -1 |
| Replacement agricultural tires | 136 | 152 | 12 | 682 | 716 | 5 |
| Replacement moto and scooter tires | 978 | 1,150 | 18 | 8,658 | 9,026 | 4 |

'000 units

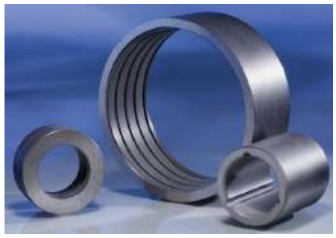
Consumer = passenger car, SUV and light commercial vehicles

Discrepancies with data previously published could happen because of periodic data corrections

# PFA composite for stationary wear rings

Greene Tweed's WR600, a carbon fiber reinforced, PFA based composite said to feature outstanding chemical, impact and thermal shock resistance, can withstand continuous service temperatures up to 500°F (260°C), and is said to be ideal for stationary wear rings for static applications; pump applications in refineries, chemical plants, power plants and water treatment plants; and all types of centrifugal pumps.

WR600 is said to withstand the strongest acids, bases, halogens and solvents. Its non-galling properties facilitate extended periods of dry running during upset conditions. Featuring excellent impact and thermal shock resistance, WR600 tolerates rapid startup or shutdown without the risk of fracture or pump failure. Components made of WR600 run tighter clearances than traditional metallic materials, reducing recirculation and improving efficiency, according to the company. This is said to result in substantial energy savings, extended service life and improved mean time between repairs.



Components made of WR600 will have improved dry run properties compared to standard materials, which is said to extend pump reliability and lifetime. Quick and easy machining to exact finish dimensions reduces pump repair turnaround time and increases equipment availability. In addition, WR600 improves vibration damping for increased pump life.

With comprehensive in-house machining centers, Greene Tweed offers finished WR600 parts, along with stock shapes in many sizes. Greene Tweed's engineers are said to provide expert assistance in determining the best material and design for each application.

# Low retention additives enhance hydrophobicity

Avient added to its growing portfolio of technologies tailored to meet the distinct needs and regulatory challenges of healthcare manufacturers. The company has introduced Cesa non-PFAS low retention additives and launched an expanded NEUSoft thermoplastic polyurethanes portfolio with an express color palette.

Cesa non-PFAS low retention additives are manufactured without intentionally added per- and polyfluoroalkyl substances (PFAS) based or fluorinated raw materials. They are said to offer a more sustainable solution developed with evolving regulatory requirements in mind. These additive concentrates and pre-compounds are said to enhance hydrophobicity in injection molded polypropylene components, delivering high performance water, solvent and laboratory solution repellency. Useful for labware and pipette tips, they are said to eliminate the need for secondary low retention coatings, enabling precise fluid dispensing with virtually no residual liquid left behind, according to the company.

The firm's NEUSoft TPUs are now available in 14 standard colors in the U.S. with a planned 14-day lead time for time sensitive development projects. The NEUSoft express colors are said to offer high performance TPUs in neat or 20% barium sulfate filled formulations. As with other NEUSoft products, which recently extended manufacturing to China, they are said to provide excellent flexibility, clarity and durability for a wide range of catheters and in-vivo applications.

Avient's portfolio also includes 3D molding and design services to accelerate product development with advanced design simulation and 3D printing technologies to provide accurate predictions of performance, as well as cost-effective and functional prototypes to help optimize part design. The company's high temperature formulations are engineered to provide vivid, biocompatible colors for medical devices. Based in polysulfone resins, these options are said to be well suited for demanding and reusable applications subject to multiple sterilization cycles and harsh cleaning agents.

The company's Mevopur healthcare colorants, functional additives and bio-based formulations are manufactured across a global network of ISO 13485 registered facilities. This broad portfolio is pre-tested to U.S. Pharmacopeia (USP) Class VI, ISO 10993, USP 661, European Pharmacopeia 3.1 and International Conference on Harmonization (ICH) Q3D protocols. Mevopur colorants can be used for various applications, such as brand recognition and differentiation, drug identification and visual appeal. Likewise, Mevopur functional additives can help to protect or enhance the performance of polymers used in medical devices, diagnostics or pharmaceutical packaging, according to the company.

by Nicholas Bridgen, CEO, Ferro-Alloy Resources Ltd.

# A new low $CO_2$ reinforcing filler

Ferro-Alloy Resources (FAR), a London, U.K. listed mining company with operations in Kazakhstan, recently announced plans to produce a new type of reinforcing filler as a carbon black substitute (CBS). When partially substituted for carbon black in a typical rubber formulation for passenger tire sidewalls, there was no significant deterioration of performance in a battery of tests that were conducted, and there were several advantages. Moreover, there is a very significant reduction in $CO_2e$ emissions in the production of this material compared with the production of carbon black. The company plans to

**Table 1**

| *Test* | *Result* | *Likely effect on tire manufacturing/ performance* |
|---|---|---|
| Compound mixing | No mixing issues reported | Processing of CBS would be practical for a tire manufacturer, no different to carbon black |
| Rheometer properties, extent of cure | Minimal effect | Minimal changes to tire curing conditions required |
| Scorch Time (TS2) | Slight increase | Slight increase in scorch safety |
| T90 | T90 increases with Ferro-Alloy Resources loading | Possible increase in tire curing time required at higher substitution levels |
| Microhardness | Reduction in hardness | Possible change in the on-vehicle handling performance of the tire at higher levels of substitution |
| Tensile strength | No effect | Unchanged |
| Elongation at break | Increase | Possible change in the on-vehicle handling performance of the tire at higher substitution levels |
| Tensile modulus | Decrease | Possible change in the vehicle handling performance of the tire |
| DMA-$T_g$ | No effect | Unchanged |
| DMA, tangent delta | Most variants offer lower tan $\delta$ at 60°C/70°C | Reduction in tire rolling resistance |
| DMA, complex (dynamic) modulus | Most variants have similar dynamic modulus to control, though some showed lower | Unchanged for most substitution levels indicating equivalent vehicle handling performance |
| DIN abrasion | Decrease in abrasion resistance | Sidewall compound could abrade more readily in service at higher substitution levels |
| Tear strength | Reduction in tear strength | Sidewall compound could be less resistant to physical damage |
| DeMattia flex crack initiation | Possible improvement | Sidewall compound more resistant to cracking |
| DeMattia flex crack growth | Possible improvement | Sidewall compound more resistant to physical damage |

market this material at a significant discount to the price of carbon black, giving users of the material not only a high quality product, but a significant cost and environmental benefit.

**Background**

Ferro-Alloy Resources is developing a very large vanadium deposit in Kazakhstan which contains some 8% carbon in the ore, in a form very similar to carbon black. This carbon remains intact in the process tailings, following the extraction of the vanadium and other metals, and would normally be dumped as waste in similar metal extraction operations. However, Ferro-Alloy Resources has carried out test work which shows that the carbon content in these tailings can be concentrated to 40% to produce the CBS, with the remaining material being predominantly silica. After concentration, the product is milled to around 10 microns and dried. At the planned level of ore treatment, some 220,000 metric tons of this material will be available per year, with plans to raise this level to over 600,000 metric tons in the future.

**Technical studies**

After initial test work was carried out at various universities, a test program was conducted in the U.K. by a market leading materials science and engineering company. The study demonstrated that the CBS can be successfully used as a partial substitute for conventional carbon black filler in a passenger car tire sidewall compound formulation. The results show that with up to a loading of 10% substitution, it is possible to produce compounds with similar physical properties to that of the carbon black control. In particular, a compound made with 90% N660 grade carbon black and 10% CBS yielded properties similar to those of the control compound, and would therefore be expected to deliver similar performance in a tire.

While the data did show that the CBS, when substituted at levels greater than 10%, produced slightly less of a reinforcing effect in the rubber compound than conventional carbon black, there were also some potential advantages. The desirable level of substitution will depend on the properties required.

The performance standards required for the production of passenger car tire sidewalls are high. The test results indicated that the CBS may be suitable for a number of uses for carbon black based rubber compounds that do not require such exacting standards, including agricultural and commercial vehicle tires, as well as non-tire uses. It is possible that high substitution levels may be possible in these other applications.

Various formulations were tested (table 1), using different substitution levels of CBS for carbon black, and reached the following general conclusions on the rubber performance compared with the control sample:

*Marketing*

A marketing study was carried out by a well known market reports agency to estimate a market price for the product in both tire and non-tire markets.

The marketing study took into account the successful test work conducted by the materials science and engineering company noted above, the price being determined in relation to other, similarly performing reinforcing fillers available in the market. It did not factor in any value for the expected vastly reduced Scope 1 and Scope 2 $CO_2$e emissions (direct and indirect emissions generated by a company's own operating activities) resulting from the production of the CBS product, in comparison with the manufacture of standard carbon black.

On this basis, the market reports agency advised that a price of $500 per metric ton would be appropriate in the tire market, and slightly higher for the non-tire market. These figures may be increased to take account of the environmental advantages of the CBS, especially if future tariffs are to be imposed on high $CO_2$e emission products.

Based on current available global logistics rates, the company estimates that the CBS can be economically shipped to both Western Europe and China.

The company is currently assembling a pilot plant at its production site in Shieli, Kazakhstan, to produce limited quantities of the CBS for research and development, and marketing purposes.

*Sustainability*

The production of standard carbon black is usually made by the incomplete combustion of oil or gas in an oxygen depleted atmosphere where, typically, the resulting product amounts to only 40% of the original carbon input. The production of standard carbon black is, therefore, both expensive and high in $CO_2$ emissions.

The company's CBS product is made by the concentration of naturally occurring carbon from the waste resulting from the treatment of the vanadium deposit ore, and not from the combustion of hydrocarbons, resulting in much lower production costs and significantly fewer emissions; an important consideration for tire and other rubber producers.

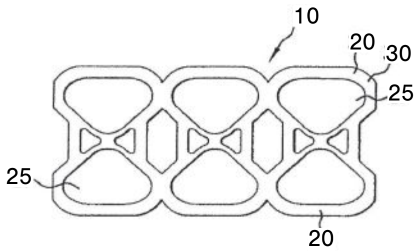
Based on preliminary desktop research, the company currently estimates that the combined Scope 1 and Scope 2 emissions per metric ton of CBS produced will be between 0.36 metric tons and 0.6 metric tons of $CO_2$e. By way of comparison, the production of a metric ton of standard carbon black ranges from around two to five metric tons of $CO_2$e (ref. 1).

In the European Union (EU), amendments to the Carbon Border Adjustment Mechanism (CBAM), approved in 2022, indicate the potential inclusion of organic chemicals, including carbon black, as part of a broader effort to integrate the chemical sector into CBAM, with a final decision due by the end of 2025 or early 2026. If adopted, importers of carbon black into the EU will have to buy carbon credits, currently costing around $72 per metric ton of $CO_2$e, for the emissions embedded in their imports of carbon black. This would lead to CBAM costs of between $144 per metric ton and $360 per metric ton for importers of standard carbon black, depending on the emissions of the actual producer. The far lower emissions generated from the production of the company's CBS would attract much lower CBAM costs, not accounted for in the marketing study.

Many tire manufacturers have stated their aims of reducing the $CO_2$e emissions associated with their products, and some are experimenting with the use of recovered carbon black, produced by pyrolysis from used tires which is energy intensive. The sourcing of lower carbon substitutes for carbon black is an ongoing issue for tire manufacturers.

# Patent News

**Polyolefin elastomer in multi-packaging carrier**
*U.S. patent:* 12,031,018
*Issued:* July 9, 2024
*Inventors:* Christopher J. Samaras, Rachell L. Slovik and Patrick R. Van Tholen
*Assigned:* Illinois Tool Works
*Key statement:* A flexible carrier for carrying a plurality of containers, such as soft drink and other beverage containers, is formed from a polymer composition which provides the carrier with improved elastic recovery following installation of the containers, along with tensile strength and tear resistance. The polymer composition includes about 10% to about 95% by weight of a post-consumer recycled plastic that includes recycled branched low density polyethylene and recycled linear low density polyethylene polymers, zero to about 90% by weight of a branched low density polyethylene polymer having a density of about 0.910 to about 0.950 grams/cm$^3$ and greater than zero to about 65% by weight of an elastomeric ethylene copolymer that includes about 60% by weight to less than 100% by weight ethylene and greater than zero to about 40% by weight of a vinyl acetate comonomer.

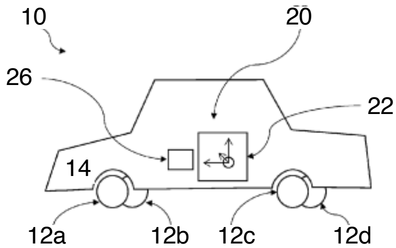



**Rubber protective wax, preparation method and application thereof**
*U.S. patent:* 12,031,037
*Issued:* July 9, 2024
*Inventors:* Hao Wang, Yang Gao and Yousheng He
*Assigned:* Sennics
*Key statement:* A rubber protective wax, comprising hydrocarbon compounds, a polyethylene wax and an antidegradant. The rubber protective wax of the present invention can render rubber good thermal oxidative aging resistance, static ozone aging resistance, dynamic ozone aging resistance, flex cracking resistance and tensile fatigue resistance and has good protection effects in both static environment and dynamic load environment.

**Tread rubber composition and pneumatic tire**
*U.S. patent:* 12,031,039
*Issued:* July 9, 2024
*Inventor:* Masako Nakatani
*Assigned:* Sumitomo Rubber
*Key statement:* Provided are tread rubber compositions and pneumatic tires which

are excellent in fuel economy, handling stability and abrasion resistance. Included are tread rubber compositions having a M200 at 25°C, a E* at 30°C and a tan δ at 30°C which satisfy the following relationship: M200 × E*/tan δ ≥ 400.

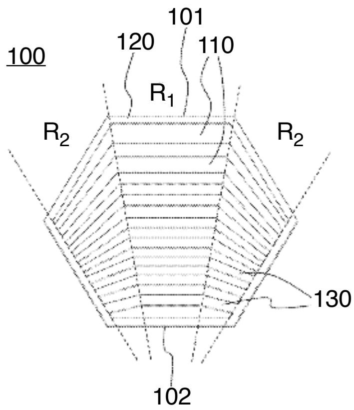
**Systems, methods and computer program products for detecting reduced tire pressure**
*U.S. patent:* 12,030,348
*Issued:* July 9, 2024
*Inventor:* Mats Widmark
*Assigned:* Nira Dynamics AB
*Key statement:* The disclosure relates to systems, methods and computer program products for detecting tire pressure loss in tires of a vehicle. The system comprises a sensor, which is arranged at the vehicle remotely from the tires, mechanically coupled at least indirectly to a chassis of the vehicle and configured to detect a property indicative of tilting spatial movement of the chassis. The system further comprises a processing unit, which is communicatively coupled with the sensor, configured to receive sensor signals from the sensor, the sensor signals being indicative of tilting spatial movement of the chassis and configured to detect a tire pressure based on the sensor signals. The processing unit is configured to detect a tire pressure loss responsive to the sensor signals indicating a tilting spatial movement of the chassis towards the at least one tire.




**Rubber composition with reduced odor and good thermal oxidative aging resistant and anti-fatigue properties**
*U.S. patent:* 12,031,036
*Issued:* July 9, 2024
*Inventors:* Yang Gao, Jin Zhang and Zhimin Tang
*Assigned:* Sennics
*Key statement:* A formulation for rubber composition with reduced odor and good thermal oxidative aging resistance and tension fatigue resistance comprising 100 parts by weight of a diene elastomer, 30 to 70 parts by weight of a reinforcing filler, 0.1 to 8 parts by weight of an antidegradant composition and 0.5 to 3 parts by weight of a crosslinker, wherein the antidegradant composition includes a 6PPD antidegradant with a purity of equal to or greater than about 98% and an S-TMQ. The rubber composition has no added odor inhibitor/adsorbent or deodorizing

additive, while by using combination of 6PPD with purity of equal to or greater than about 98% and an S-TMQ instead of traditional combination of 6PPD and a TMQ, the VOC emission of the rubber composition is effectively reduced, the odor grade is reduced and the thermal oxidative aging resistance and tension fatigue resistance is improved.

**Tire including a pattern forming area with a unit pattern**
*U.S. patent:* 12,036,822
*Issued:* July 16, 2024
*Inventor:* Hee Sung Jang
*Assigned:* Hankook Tire & Technology
*Key statement:* Proposed is a tire including a pattern forming area provided on a sidewall to display a pattern of predetermined shape, wherein the pattern forming area is formed by continuously arranging a plurality of hexagon-shaped unit patterns and the unit patterns existing on the edges of the pattern forming area are cut off in shapes to correspond to the shape of the pattern forming area.




**Tread rubber composition and pneumatic tire**
*U.S. patent:* 12,031,038
*Issued:* July 9, 2024
*Inventor:* Hiroshi Ito
*Assigned:* Sumitomo Rubber Industries
*Key statement:* Provided are a tread rubber composition and a pneumatic tire, which exhibit excellent wet grip performance when thermally damaged. A tread rubber composition having acetone extractable contents before and after heat aging (denoted by "AEf" and "AEo," respectively) that satisfy the following relationships 1) and 2):
1) AEf $\geq$ 16.0%;
2) AEo/AEf $\times$ 100 $\geq$ 95%.

**Rubber composition comprising a block copolymer**
*U.S. patent:* 12,037,437
*Issued:* July 16, 2024
*Inventors:* Marc Weydert, Alexander Shaplov, Abdullah Gunaydin and Clément Mugemana
*Assigned:* Goodyear Tire & Rubber

and Luxembourg Institute of Science and Technology
*Key statement:* The present invention is directed to a rubber composition comprising an elastomer, a filler and a block copolymer. According to the invention, the block copolymer comprises (i) an elastomer block and (ii) a thermoplastic block comprising a poly alkylacrylate, wherein the alkylacrylate comprises a polycyclic substituent at its single bonded oxygen atom. Moreover, the present invention is directed to a block copolymer.

**Process for forming rubber latex from branched polymers**
*U.S. patent:* 12,037,485
*Issued:* July 16, 2024
*Inventors:* Adrie Van Der Huizen, Henk Van De Weg, Wouter De Jong and Maarten Tromp
*Assigned:* Cariflex PTE
*Key statement:* The disclosure relates to rubber latex formed from any of: branched block copolymers derived from alkenyl aromatic hydrocarbon—1,3-diene monomer system and branched polyisoprene homopolymers derived from isoprene. The polymers in embodiments are obtained by polymerization in the presence of an anionic initiator; at a temperature from 0°C to 100°C; followed by coupling with a multifunctional coupling agent of formula $(R^1O)_3Si—Y—Si(OR^2)_3$, wherein $R_1$ and $R_2$ are independently $C_1$-$C_6$ alkyl groups; and Y is a $C_2$-$C_8$ alkylene group. The polymers are obtained as rubber cements having high solids content and low zero shear viscosities. The rubber cements are valuable for making latices for further applications.

**Propylene based polymer additives for improved tire tread performance**
*U.S. patent:* 12,037,425
*Issued:* July 16, 2024
*Inventors:* Edward J. Blok, Anthony J. Dias, Gabor Kiss and Paul T.Q. Nguyen
*Assigned:* ExxonMobil Engineering & Technology
*Key statement:* An elastomeric composition is disclosed. The elastomeric composition includes, per 100 parts by weight of rubber (phr): about 0 to about 25 phr of polybutadiene having a cis-1,4 linkage content of at least 95%; about 75 to 100 phr of a styrene/butadiene copolymer; about 10 to about 30 phr of a processing oil; about 50 to about 70 phr of a filler; a curative agent; an antioxidant; a silane coupling agent; and about 5 to about 30 phr of a propylene-ethylene-diene terpolymer.

# Truck tire tread compound development using low hysteresis carbon black

*by Lashan M.H. De Silva, Raymond Soufiani, Angel J. Marcucci, Brendan Rodgers and Ed Vega, Continental Carbon*

Fuel expenses are one of the major costs encountered by the trucking industry. In recent years, many modifications have been implemented which make commercial trucks and tractor-trailer combinations more energy efficient. Examples are improved aerodynamics, new drive train and engine configurations, and new emissions standards. The elements contributing to energy loss of a truck or tractor-trailer combination (figure 1) traveling at 80 kph (50 mph) under steady state conditions are on the order of: nominally 42% of the horsepower requirements required to overcome aerodynamic drag, 15% due to drive train losses, 9% due to accessories such as the compressor and electrical systems, and 34% attributable to tire rolling resistance. After aerodynamic drag, tire rolling resistance has the largest impact on steady state energy consumption of a vehicle and fuel consumption. In addition to engine particulate matter and nitrogen oxide (NOx) emissions, this is why much of the new regulatory attention has encompassed the tire industry.

With the ratio of losses changing with variable vehicle speed and load, tires can become the major contributor to the energy consumption of a highway truck. In consequence, reductions in tire rolling resistance can have direct effects on truck fuel consumption. In the case of line haul trucks, a ratio of 2.5% to 3.5% reduction in steady state tire rolling resistance can generate 1% fuel savings. In automobile tires, the improvement is not as large, with ratios closer to 7:1. Hence, truck tire rolling resistance reduction has greater benefits, particularly for commercial truck fleet operators, both in terms of cost and positive environmental impact (ref. 1).

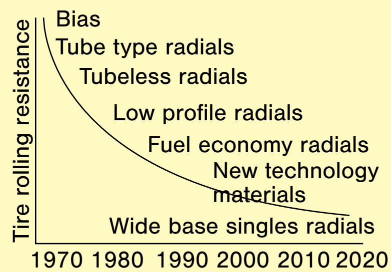
Improved tractor-trailer fuel efficiency can be achieved by designing tires which display lower rolling resistance. Over the last 50 years, the shifts from bias to tube type radial tires, and then to low profile tire constructions with new materials technologies, have allowed large reductions in tire rolling resistance and improved fuel efficiency (figure 2).

Another factor in truck and truck tire rolling resistance is the vehicle axle position. In terms of whole vehicle tire rolling resistance distribution, 12% to 14% is attributable to the steer axle tires, 40% to 42% to the drive axle tires, and on an 18-wheeler tractor-trailer combination, the balance of 38% to 40% is attributable to the trailer axle units (figure 3). That distribution will change, depending on the vehicle configuration, such as double trailer combinations or the "turnpike triples" operating on some interstate highways, with tractors hauling three trailers.

Modern commercial highway truck tires are designed for the wheel position, i.e., the steer axle tire, drive axle tire and trailer axle tire. In addition, designs may vary, depending on the tire mission profile, e.g., short haul pickup and delivery, bus and coach, and off road. Similarly, tire retreads can also be designed for specific wheel positions. Like new tires, retread material variables such as the compound hysteretic properties, tread

**Figure 1 - tractor-trailer combination for line haul trucking**

**Figure 2 - trends in improving tire rolling resistance (ref. 1)**




| Year | Rolling resistance index |
|---|---|
| 1974 | 100 |
| 1978 | 80 |
| 1982 | 62 |
| 1986 | 58 |
| 1990 | 50 |
| 1994 | 40 |
| 2010 | 35 |
| 2020 | 32 |

**Figure 3 - whole vehicle tire rolling resistance by wheel position (ref. 1)**

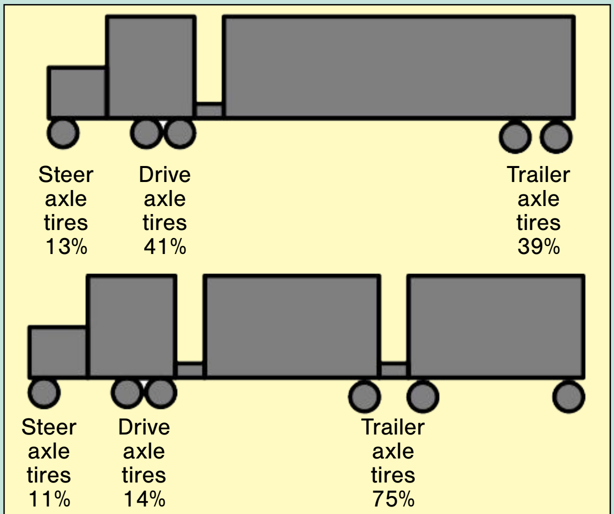
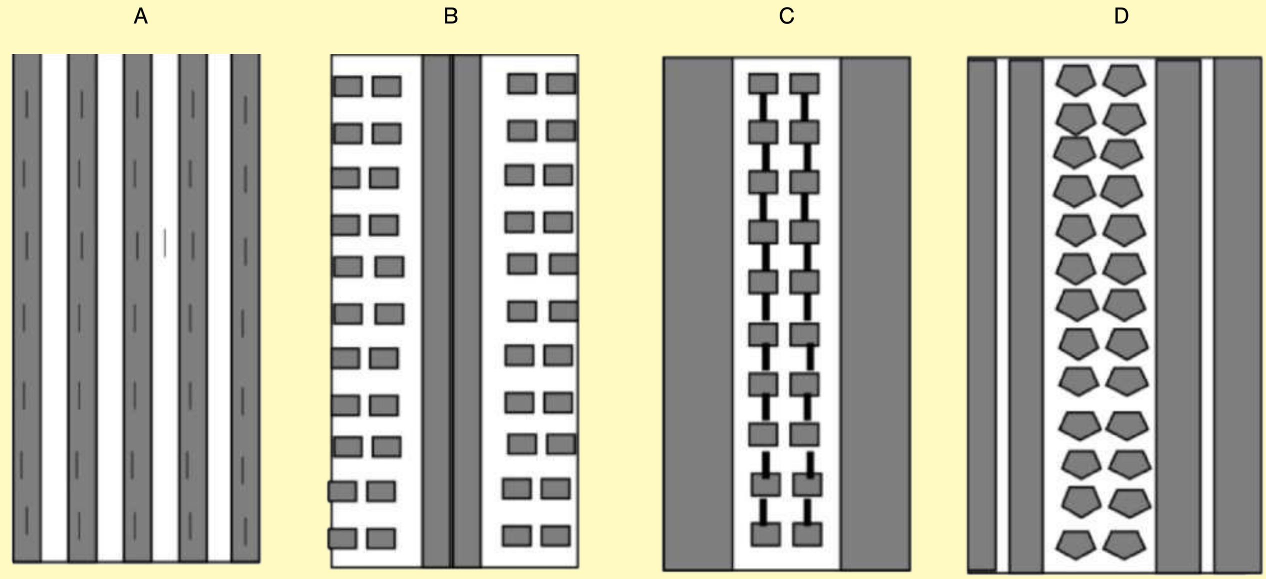


**Figure 4 - generic truck tire tread patterns**




Rib tire tread design
- 5 straight ribs,
- 4 grooves
- Sipes in ribs for traction

Rib-lug design
- Outboard lugs for traction
- Inboard ribs for good tread wear

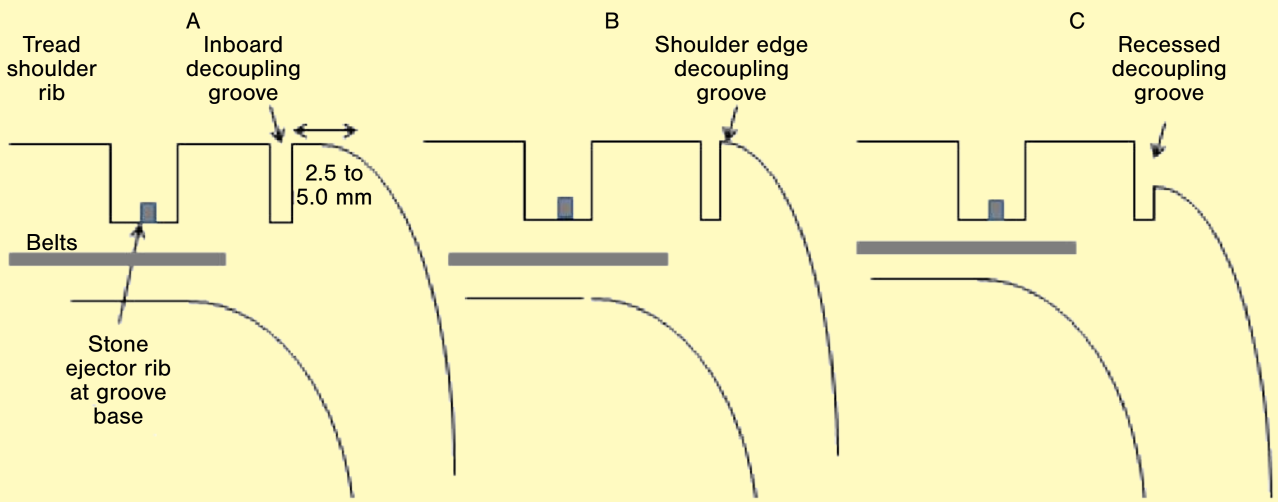
Rib-lug design
- Outboard ribs for fuel economy
- Inboard lugs for traction
- Tie bars connecting lugs circumferetially to improve lug stability

Trailer tire rib tread design
- Multiple straight ribs
- Shallow grooves
- High net to gross foot-print for lateral stability
- Central groove for water dispersion

depth or non-skid, and tread pattern are designed to maximize the whole tire performance and efficiency.

Steer axle, all-position and trailer axle tires tend to have rib-tread patterns (figures 4a and 4d). Such designs readily facilitate

**Figure 5 - truck tire tread decoupling groove configurations**




1. Inboard and shoulder edge grooves (A, B) for duplex tread and base configurations due to high tear strength of a typical natural rubber based tread compound
2 Recessed groove (C) for triplex tread base sidewall extrusions due to lower tear strength of natural rubber polybutadiene sidewall compound blend

natural rubber tread compounds. The trend in highway drive axle truck tire tread design is similarly to have solid shoulders (figure 4c) rather than outboard lugs (figure 4b). Even though outboard lug tread designs display greater traction performance, such tread designs require compounds consisting of both natural rubber and synthetic rubber, such as polybutadiene and solution SBR; and in consequence, high levels of carbon black to achieve the required tensile strength and, more important, fatigue resistance. Such compounds thus tend to display higher hysteresis (higher tangent δ), resulting in higher rolling resistance and the respective impact on vehicle fuel consumption. In the case of tread patterns with closed shoulders and tie-bars between the rows of lugs (figure 4c), natural rubber based compounds can be used with much lower hysteresis, and consequently better (lower) tire rolling resistance. Traction is then optimized by adjusting the dimensions of the central rows of lugs and the net footprint contact area. In consequence, the same fuel efficient, all natural rubber tread compound formulation may be used in all three tire designs, i.e., steer, drive and trailer tire tread compounds.

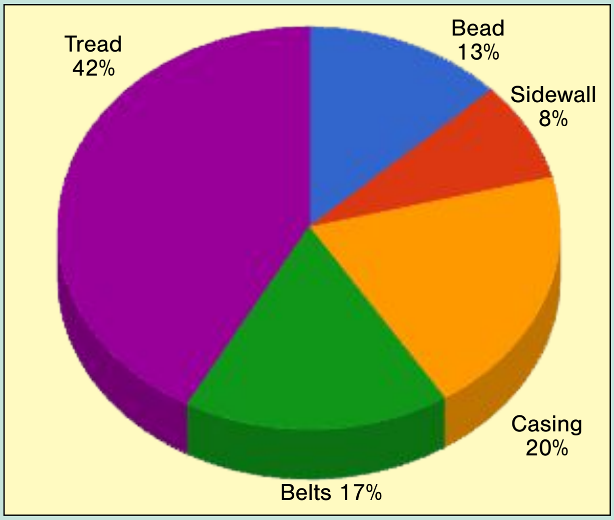
Steer axle and trailer axle truck and bus tires frequently have a modification in the shoulder, sometimes referred to as a decoupling or protection groove (figure 5). The purpose is to prevent or arrest fast wear, irregular wear or other abnormal wear patterns which in many instances start in the shoulder. Such wear conditions can start at the shoulder because of lack of belt support under this part of the tread. The groove can have one of three possible configurations: i) approximately 5 mm inboard from the shoulder edge, ii) at the shoulder edge or iii) recessed below the shoulder edge. The groove depth can vary from 50% to 100% of the primary tire tread grooves, depending on the tire tread compound tear strength. Low tear strength can result in cutting, tearing and chunking of the groove, resulting in a loss in performance and potential warranty claims. In the case of a sidewall over tread construction, where the sidewall extends up to the tread, then a recessed decoupling groove may help mitigate any tear damage due to the lower tear strength of the sidewall compound. In all cases, a high tear strength tread compound is essential. Compounding additives that have an adverse effect on tear strength will reduce the tire performance, thus further defining the need for natural rubber based compounds with low hysteresis carbon black filler or reinforcing systems.

A range of other tire variables such as axle alignment, inflation pressure and tire type also have a large effect on whole vehicle fuel consumption, and all of which are more related to operational considerations and maintenance.

**Tire rolling resistance**

Truck tires for all three wheel positions have evolved to require high tear strength compounds with low hysteresis and for which natural rubber is best suited. With regard to the tire construction, whole tire rolling resistance is a summation of the contribution of each of the individual components in the tire. This can be illustrated in a simple format as in figure 6, which shows the major contributions tire components make to whole tire rolling resistance (ref. 2). For heavy duty line haul truck tires, the crown or tread region is the most significant.

**Figure 6 - contributors to whole truck tire rolling resistance (ref. 2)**




The tread compounds of a tire suitable for use on a heavy duty commercial truck tire must show high tensile strength, a high level of adhesion to the adjacent components underneath the tread and excellent compound tear strength, further emphasizing the need for a rubber compound such as that based on natural rubber. In addition, the primary material property affecting the tire compound's contribution to tire rolling resistance is hysteresis or energy dissipation as heat. Hysteresis parameters in turn can be measured as the loss modulus, in shear (G") or in tension (E"), or more often simply using the rebound test due to its bulk or greater sample size (refs. 3 and 4). In many instances, natural rubber is the preferred polymer for low hysteresis and high tensile strength (refs. 5 and 6). The compounding variables which can then be used to improve the hysteresis of a natural rubber based truck tire tread compound are thus limited to the filler system, such as carbon black and silica, and to a much lesser degree, the vulcanization system.

Passenger tire tread compounds containing high levels of highly dispersible silica, abbreviated as HDS, containing a silane coupling agent and solution SBR, as described in U.S. Patent 5,227,425, have proven to be very effective at improving tire-vehicle fuel economy and wet traction with minimal loss in wear performance (ref. 7). However, for commercial heavy duty truck tires, the loss in tread wear performance by use of silica and highly dispersible silicas (HDS) has in many instances negated improvement in lowering whole tire rolling resistance. And for truck tires, the need for high tear strength, natural rubber based compounds is essential in ensuring the tire has adequate damage resistance.

Compared to corresponding ASTM grade carbon black, low hysteresis carbon black has a wider aggregate size distribution, with a higher percentage of larger aggregates. When the carbon black aggregate size distribution is narrow, it has a greater tendency to form stronger filler-filler networking in the rubber compound. Therefore, using carbon black with widened aggregate size distribution generally decreases the filler-filler net-

**Figure 7 - commercial truck tire performance parameters**

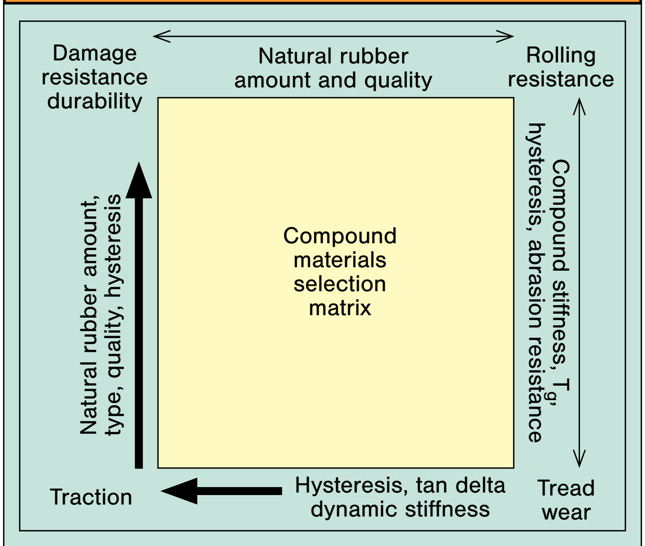
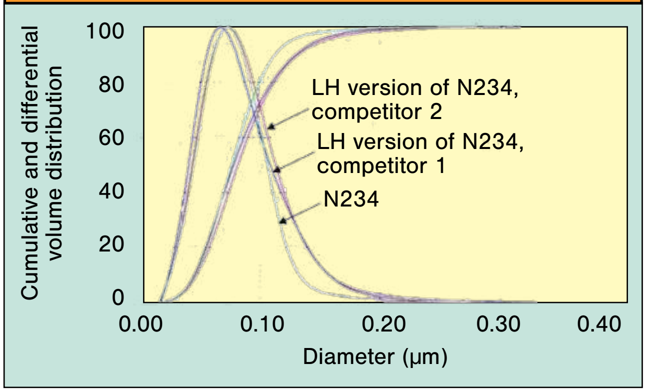



**Figure 8 - aggregate size distribution of N234 and LH version of N234 carbon blacks**




working strength, while maintaining the same average strength of polymer-filler interactions. However, low hysteresis carbon black is not adequate for increasing polymer-filler interactions to result in improvement of rubber properties other than rolling resistance.

For passenger tires, the performance parameters can be described by a simple triangle of wear, traction and rolling resistance. Truck tire performance parameters are said to be more complex. The major performance elements of a commercial truck tire tread compound can be defined by tire rolling resistance (RR), abrasion resistance (TW), traction (WT), and damage and durability resistance (DR) (figure 7). To improve these performance properties without a loss in wear, Continental Carbon has developed a new low hysteresis carbon black which has been shown to solely improve the tire rolling resistance with no trade-off in other properties (ref. 8). The carbon black has been described as a surface modified low hysteresis carbon black (SMLHCB), and has been compounded with other compounding materials typically found in a truck tire tread compound. The combination of natural rubber, carbon black and typical antioxidants, process aids and vulcanization system of the cured truck tire tread has demonstrated attainment of the performance better rolling resistance requirements for a truck tire with maintenance of traction, tear strength and resistance to abrasion.

**New carbon black technology**

With standard furnace type carbon blacks under the ASTM series N100, N200 and N300, simultaneous improvement of the performance properties described in figure 7 were difficult to achieve. After new technology silica was introduced to the tire industry, researchers investigated two approaches (refs. 9, 10 and 11):

- The development of new specialty carbon black grades
- Modifying ASTM grade carbon blacks to develop compounds with similar properties to silica compound formulations; these strategies were mainly focused on reducing filler-filler interactions and increasing filler-polymer interactions by modifying compound materials (e.g., carbon black, polymer) and mixing procedures

To reduce filler-filler interaction, carbon black manufacturers introduced low hysteresis carbon blacks (LH) which had a wider aggregate size distribution (ASD) with a higher percentage of larger aggregates compared to the equivalent standard ASTM carbon black materials (figure 8). Low hysteresis carbon blacks have been very effective in improving tire rolling resistance performance. Such carbon blacks reduce filler-filler network strength by increasing the average interaggregate spacing, while maintaining the same average strength of polymer-filler interactions, which in turn improves the rolling resistance performance. However, low hysteresis carbon blacks are not adequate for increasing polymer-filler interactions to improve compound properties other than rolling resistance. This manifested itself in loss of tire wear performance.

To increase filler-polymer interaction, researchers attempted chemical modification of carbon black. Numerous studies on surface treatment of carbon blacks have been conducted on this approach, and concepts such as the equilibrium cure have emerged with much success (refs. 12 and 13). Although improvement in rolling resistance performance or other properties was achieved, such compounds were difficult to process due to increases in bound rubber and consequent factory processing challenges. The efforts were further unsuccessful in simultaneous improvement of all three properties of the automobile tire performance matrix. Although filler-polymer interactions were improved, filler-filler network strength was still predominant.

The research team at Continental Carbon has combined the two main strategies, i) filler-filler interactions and ii) polymer-filler networks, by chemical modification of low hysteresis carbon black to develop a next generation carbon black named Continext-LH. In this case, filler-filler network strength is advantageously decreased, while filler-polymer interactions are increased, resulting in improvement of rolling resistance and damage resistance without negatively affecting wet traction and wear resistance. The chemical modification of low hysteresis carbon black was carried out by treatment of chemical compounds containing at least one amine group and at least one thiol group or di- or poly-sulfidic linkage. The improvement of the above properties using Continext-LH as a filler was better than the improvement reached by conventional CB as a filler in a model natural rubber tire tread formulation.

This approach has considerable commercial potential. The transportation sector is reported to be one of the largest industrial greenhouse gases (GHG) emission sources contributing to global temperature shifts. Continext-LH is a carbon based sustainability solution for all tires, including those for passenger vehicles, light trucks, heavy duty commercial trucks, farm tires, off-road (OTR) and aircraft. Extensive improvement in compound hysteresis, and thus tire rolling resistance performance, with Continext-LH will result in improved vehicle fuel economy. Therefore, a significant reduction of carbon dioxide emissions to the environment by commercial vehicles can be realized. Furthermore, the improvement of damage resistance with Continext-LH suggested better durability. In general, durability is a critical performance parameter for commercial truck tires operating in line haul service, short haul and stop-start conditions, and on-off road service. These factors thus made Continext-LH a green technology tool for the truck tire industry.

**Experimental in-compound studies**

The compounds were prepared using the model truck tire tread compound formulation shown in table 1. Compound A contains conventional N234 carbon black, which was used as the reference for this study. Compound 2 comprises LH11, which is Continental Carbon's low hysteresis version of N234, and compound C contains Continext-LH-T, which is a chemically modified LH11.

The compounds were mixed on a one-half liter DS0.5-5MHB-S Moriyama internal mixer following a two-step mixing process to optimize dispersion and compound homogeneity. The first non-productive step was comprised of adding the polymer and the other ingredients, and mixing them for 0.8 minutes. Then, the ram was raised and cleaned, and the compound was blended for another 5.0 minutes. It was assured that the mixing temperature did not exceed 160°C.

**Table 1 - formulations of the experimental compounds**

| *Compound #* | | *A* | *B* | *C* |
|---|---|---|---|---|
| *Filler* | | *N234* | *LH11* | *Continext-LH-T* |
| *Ingredient* | *Mixing step* | | *phr* | |
| Natural rubber (TSR10) | 1 | 100 | 100 | 100 |
| Carbon black | 1 | 50 | 50 | 50 |
| Renacit 11 | 1 | 0.15 | 0.15 | 0.15 |
| Aromatic oil (TDAE) | 1 | 3 | 3 | 3 |
| Paraffin wax | 1 | 1 | 1 | 1 |
| Microcrystalline wax | 1 | 0.5 | 0.5 | 0.5 |
| Antioxidant (TMQ) | 1 | 1 | 1 | 1 |
| Antiozonant (6PPD) | 1 | 2.5 | 2.5 | 2.5 |
| Zinc oxide | 1 | 4 | 4 | 4 |
| Stearic acid | 1 | 2 | 2 | 2 |
| Sulfur | 2 | 1 | 1 | 1 |
| TBBS | 2 | 1 | 1 | 1 |
| Retarder CTP | 2 | 0.2 | 0.2 | 0.2 |

During the second step, 50% of the non-productive masterbatch from step 1 was added, followed by the other ingredients, and the rest of the 50% of the masterbatch from step 1 was then added. The mixing continued for another 0.5 minutes. Next, the ram was raised and cleaned, lowered, and the compound was mixed for a further 1.0 minutes. The mixing temperature of the second stage was also controlled not to exceed 105°C. Each mixing step was followed by additional homogenizing and sheeting on an open two-roll mill. The test specimens were press cured (phi 50 ton press) for 25-35 minutes, depending on the specimen size, at 145°C.

Mooney viscosity (ML 1+4 @ 100°C) was measured on a Premier MV viscometer (Alpha Technologies) according to ASTM D1646. A rubber process analyzer (Premier RPA Enhanced) from Alpha Technologies was used for determination of compound cure kinetics (ASTM D5289).

For insight on the vulcanization kinetics, a simple cure rate index (CRI) was calculated using equation (1), where: tC90 and tC10 are times required to reach 90% and 10% of maximum torque, respectively (ref. 14).

$$CRI = 100/(tC90 - tC10) \quad (1)$$

Hardness measurement was carried out using a durometer (A)according to ASTM D2240. Tensile strength was measured using test samples described in ASTM D412 and D624, respectively, using an AT10 tensiometer from Alpha Technologies. In addition, from the tensile strength data, the modulus ratio, or the 300% modulus divided by the 100% modulus, was used as a subjective quality assurance indicator, with the ratio required to be above 3. Abrasion resistance, sometimes referred to as DIN abrasion, was reported in terms of volume loss, and was determined according to ASTM D5963. The percent rebound was measured as per ASTM D7121 using a Zwick rebound tester.

The magnitude of filler-filler interaction (known as Payne effect) was evaluated using the same rubber process analyzer from Alpha Technologies according to ASTM D8059. Storage modulus (*G*') of the unvulcanized rubber compound was measured, and the difference in *G*' at low (0.1%) and high (10%) strains was used to represent the magnitude of filler-filler interactions. Dynamic properties of the vulcanizates were measured in compression mode using a dynamic mechanical analyzer (DMA 850 from TA Instruments). The temperature sweep test was performed in a -30°C to 80°C range at 3°C/minute temperature rise under 1.0% of dynamic strain and 10 Hz frequency.

**Results and discussion**

The colloidal or analytical properties of N234, LH11 and Continext-LH-T carbon blacks are shown in table 2. Surface treatment had reduced the iodine absorption number, nitrogen surface area and STSA, all of which are typically preferred for shifts in compound hysteresis and lower rolling resistance. Structure (OAN and COAN) was not affected significantly, which may be preferred for abrasion resistance, fatigue resistance and tread wear performance.

## Table 2 - analytical properties of carbon blacks used for compounding

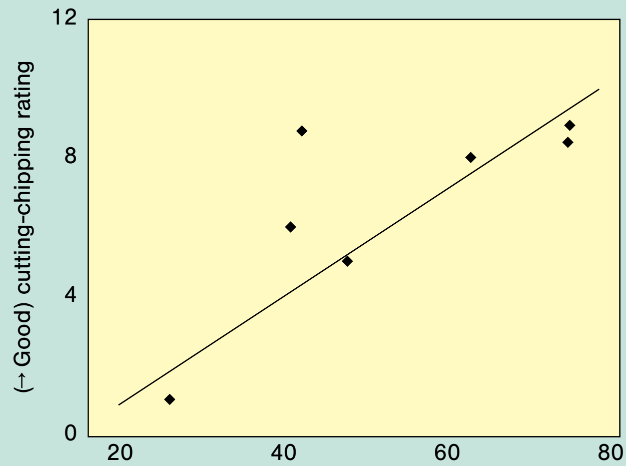
| *Property* | *Unit* | *N234* | *LH-11* | *Continext-LH-T* |
|---|---|---|---|---|
| Iodine absorption number (IAN) | mg/g | 119.2 | 117.0 | 79.8 |
| Nitrogen surface area (NSA) | $m^2/g$ | 116.5 | 116.9 | 101.5 |
| Statistical thickness surface area (STSA) | $m^2/g$ | 111.2 | 109.7 | 97.6 |
| Oil absorption number (OAN) | ml/100 g | 127.4 | 139.2 | 137.5 |
| Compressed oil absorption number (COAN) | ml/100 g | 99.5 | 110.0 | 108.3 |

The mechanical, dynamic and rheological properties of rubber compounds are shown in table 3. Most of the properties of compounds A and B were comparable. Compound C has the highest Mooney viscosity of 57 MU. It is approximately 30% higher than the reference compound. The curing kinetics data revealed that the Continext-LH-T compound had the highest vulcanization rate or cure rate index (CRI). It is 15% higher than reference compound A; consequently, the shorter processing time of compound C may be beneficial in manufacturing applications. Pre-vulcanization inhibitors or retarders (PVI) such as N-(cyclohexyl thio) phthalimide can also be used for optimizing the cure rate.

## Table 3 - properties of experimental compounds

| *Compound # (filler)* | | A (N234) | B (LH11) | C (Continext-LH-T) |
|---|---|---|---|---|
| *Property* | *Unit* | | | |
| Mooney viscosity ML (1+4) at 100°C | MU | 44 | 49 | 57 |
| | *Vulcanization kinetics* | | | |
| MH | Nm | 1.29 | 1.32 | 1.46 |
| ML | Nm | 0.15 | 0.19 | 0.23 |
| ΔT | Nm | 1.14 | 1.13 | 1.23 |
| Tx10 | Minutes | 2.47 | 2.90 | 2.02 |
| Tc90 | Minutes | 6.62 | 6.90 | 5.63 |
| Ts2 | Minutes | 3.36 | 3.65 | 2.43 |
| CRI | $Minutes^{-1}$ | 24.1 | 25.0 | 27.7 |
| | *Mechanical properties* | | | |
| Tensile strength | MPa | 28.3 | 27.2 | 28.1 |
| Elongation | % | 625 | 590 | 627 |
| Modulus 300 | MPa | 10.6 | 10.7 | 10.1 |
| Tear strength | $kNm^{-1}$ | 146.4 | 153.1 | 158.9 |
| Hardness | Durometer A | 63 | 62 | 62 |
| Payne effect | kPa | 1,240 | 995 | 500 |
| Zwick rebound at 60°C | % | 55.2 | 56.8 | 63.2 |
| DIN abrasion | $mm^3$ | 180.6 | 166.8 | 176.9 |
| | *Viscoelastic properties* | | | |
| Tan δ at 0°C | - | 0.293 | 0.304 | 0.295 |
| Tan δ at 60°C | - | 0.222 | 0.210 | 0.172 |
| E* at 60°C | MPa | 45.2 | 44.2 | 42.4 |

## Figure 9 - relationship between compound tear strength and cutting and chipping ratings



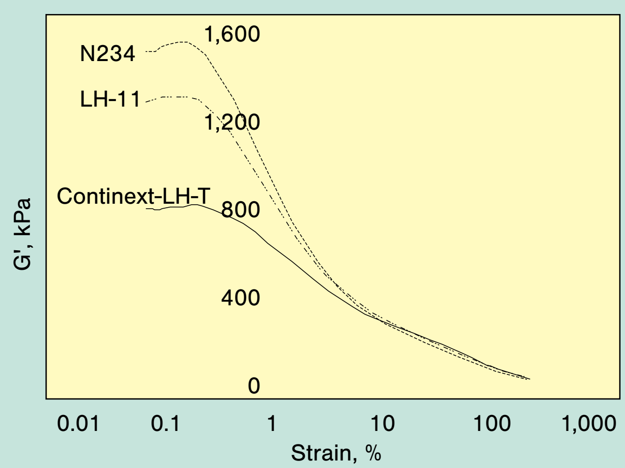
Tear strength (CP test piece) Tc versus cutting-chipping performance (ref. 1)

All three compounds had comparable mechanical properties such as tensile strength. The hardness of all the compounds was equally similar.

*Tread damage resistance*

The ASTM standard ASTM D624 describes the relationship between tear strength and specifically compound chip/chunk/cut resistance (i.e., damage resistance). The higher the tear strength, the greater the resistance to tire compound tread damage in service, as illustrated in figure 9 (refs. 15 and 16). As a damage resistance indicator, tear strength of the Continext-LH-T compound measured using die B described in the ASTM standard D624 was the highest among the compounds, which is very favorable for the truck tire tread compounds. Dynamic stiffness of compound C is comparable to the reference com-

## Figure 10 - reduction in Payne effect with carbon black modification



pound, thus suggesting there is no adverse effect on the compound conformity and vehicle handling.

*Compound hysteresis and rolling resistance*

The Payne effect, which is a substantial decrease in the storage modulus of a particle reinforced elastomer with an increase in the amplitude of mechanical oscillation, is indicative of potential rolling resistance improvements. Essentially, the lower the Payne effect, the better the hysteresis or lower rolling resistance. According to the Payne effect data, the Continext-LH-T compound had the lowest $\Delta G'_{0.1-10}$ among the compounds, thus indicating a high quality of dispersion (figure 10). The larger reduction of the Payne effect indicated the improved dispersion and filler-polymer interaction in place of filler-filler interaction (refs. 3-5).

According to the Zwick rebound test results at 60°C, the Continext-LH-T compound had the highest percent rebound with lowest energy loss, and Compound A had the lowest percent rebound. Therefore, from rebound data, it was expected that the Continext-LH-T compound will have better rolling resistance performance compared with N234. Because of the greater sample volume or bulk, the rebound result can in many instances be more representative of potential rolling resistance improvements than other viscoelastic tests. Regardless, the improvement was further confirmed by tan δ values at 60°C from a DMTA temperature sweep test.

*Abrasion and tread wear performance*

Compound tread wear performance is very difficult to predict. Fundamentally, tire wear is a function of either thermo-oxidative degradation (slow wear) or a tensile tearing process seen as Schallamach waves and indicative of fast wear conditions. The DIN abrasion test can still be of considerable predictive value, particularly for faster wear conditions. In this study, results indicated that all three compounds had comparable abrasion resistance. In the DMTA experiment, tan δ at 60°C and tan δ at 0°C were accepted as indicators for rolling resistance and wet traction performance, respectively (refs. 8, 9 and 10). Based on the DMTA experiment data, all the compounds had similar wet traction performance (tan δ at 0°C), but the Continext-LH-T compound had the highest improvement of rolling resistance performance (tan δ at 60°C). The indices of four performance properties for truck tire tread compounds are tabulated in table 4, in which the N234 compound has been used as the reference compound.

Thus, in summary, from tables 3 and 4, several points are evident:

- The abrasion resistance and indirectly tread wear resistance of the Continext-LH-T compound were similar to the reference N234 compound, i.e., equivalent tread wear
- Tan δ values at 0°C (wet traction indicator) illustrated that both the Continext-LH-T compound and the reference N234 compound have similar wet traction performance
- Tan δ values at 60°C (as a rolling resistance indicator) data indicated that the Continext-LH-T compound had 29% better predicted compound rolling resistance performance than the reference compound, thus suggesting the Continext LH-T carbon blacks will show potentially 3% to 10% tire fuel savings, depending on the predictive models; this is further validated by improvement in the Payne effect and eight point improvement in rebound
- The tear strength and by inference damage resistance of the Continext-LH-T compound was 9% better than that of the reference N234 compound

**Table 4 - performance properties of compounds**

| Compound # (filler) Performance index | A (N234) | B (LH11) | C (Continext-LH-T) |
|---|---|---|---|
| Wear resistance | 100 | 108 | 102 |
| Wet traction | 100 | 104 | 101 |
| Rolling resistance | 100 | 106 | 129 |
| Damage resistance | 100 | 105 | 109 |

Tables 3 and 4 indicate that the new technology carbon blacks compared with conventional N234 carbon black compound had similar wear resistance, equal wet traction and much better rolling resistance performance, as well as better damage resistance (figure 11), without negative effects on other compound mechanical properties.

In addition, in figure 12, a more detailed performance diagram including dynamic stiffness suggests that there will be no detrimental impact on irregular wear, which is a performance parameter dependent of storage modulus, E' and G' (ref. 17). The dynamic stiffness, comparable to that for N234 compound is at an optimum.

When the storage modulus is too high, the tread compound will become brittle, and in service show chipping, cutting and chunking. When too low, the compound will be too soft and thus more susceptible to scrubbing and abnormal wear patterns. In the case for this new technology carbon black, the compound stiffness is at an optimum, and thus would minimize susceptibility to either chipping or scrubbing, therefore offering a further unique performance advantage.

## Summary and conclusions

Heavy duty commercial truck tire tread compounds necessarily

**Figure 11 - performance rating diagram (indexed data, higher is better**

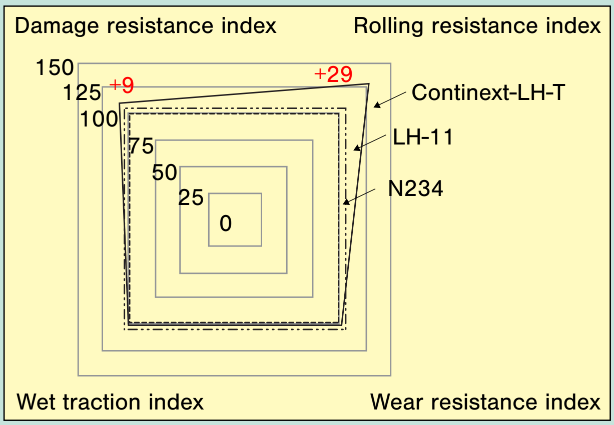
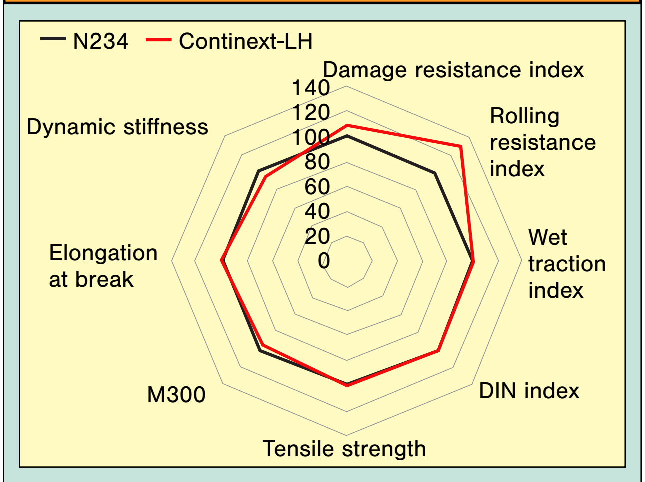


Figure 12 - multi-parameter performance diagram




must show both high tear strength properties and low hysteresis. Natural rubber is by far the best suited polymer to meet these needs. Given the importance of fuel economy, low rolling resistance, the role of the tread compound formulation and maintenance of tread wear, the use of the appropriate grade of carbon black can be an important differentiator in final tire performance.

In this study, a newly developed next generation surface treated low hysteresis carbon black (Continext-LH-T) compound's performance properties in an NR tire tread formulation was compared with a conventional N234, low hysteresis version of N234 (LH11). Predictive testing showed the new material had significantly improved rolling resistance and directional improvement in damage resistance without negative effects or trade-offs in wet traction and wear resistance. Those improved performance properties suggested that Continext-LH-T carbon black has the potential to be used as a reinforcing filler in truck tire tread compounds.

As fuel expenses are one of the major costs encountered by the trucking industry, approximately 30% improvement of rolling resistance with Continext-LH-T carbon black may result in up to a 10% reduction in whole tire rolling resistance, and an over 3% improvement in net fuel savings. It is also concluded there would be loss in manufacturing efficiencies compared to conventional carbon black compounds.

Since it provides noticeably improved rolling resistance and no negative effect on tread wear, Continext-LH-T is a better alternative to replace any silica grade used in truck tire tread formulations.

The significant improvement of rolling resistance with Continext-LH has the potential to improve manufacturing of low rolling resistance tires, with a significant reduction of carbon dioxide vehicle emissions to the environment.



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# Sustainable carbon black

*by Abegayl Thomas-McMillan, Wesley Wampler, Michael Widmor and Peter Cameron, Tokai Carbon CB*

The responsibility of protecting the environment has become ever more relevant in the last two decades due to the rising needs for resource conservation (sustainability) and effects of global warming (climate change). Climate change and sustainability are both interconnected issues that pose various challenges to our environment. Sustainability is about conserving our finite resources such that these valuable resources will be around for generations to come. Thus, when a resource can be shifted from a finite resource to renewable or circular resources, then this serves to protect the environment long term by not using the material until it is gone. In this article, a method for producing a more sustainable carbon black (sCB) by producing it from a circular raw material instead of a finite raw material will be presented.

The typical carbon black process, commonly known as the furnace black process, utilizes high aromatic oils refined from the fossil fuels buried in the earth as its carbon black feedstock. In this process, the carbon black feedstock is introduced into a hot gas stream which is produced by burning other raw materials, such as natural gas or oil. The hot gas stream reaches approximately 3,000°F before coming in contact with the feedstock oil within the reactors. Carbon black feedstock oil is thermally cracked in the reactors, forming an aerosol comprised of very fine solid carbon particles and gaseous products of incomplete combustion. This reaction time is between 0.3 and 1.0 seconds. Once desired properties are met, the process is arrested by quenching using water. The resulting solid carbon is conveyed through the process air preheater to further cool, and is then collected in a bag filter, where it is separated from the gaseous reaction products (tail gas) (ref. 1). The tail gas consists of significant amounts of hydrogen and carbon monoxide which are combusted to produce energy for heating purposes or steam production which is often employed in cogeneration of electricity for internal purposes and export to market. The cogeneration of electricity can reduce the $CO_2$ footprint of a carbon black plant by not having to purchase electricity from plants that burn natural gas or coal to produce electricity. Tokai Carbon CB (TCCB) utilizes cogeneration at all three facilities to reduce its $CO_2$ footprint, displacing over 250,000 tons of $CO_2$ per year, positively affecting climate change.

Most of the carbon black produced is used in rubber applications. The tire sector is the largest consumer of carbon black, where it serves as a reinforcing filler. Other industries utilizing carbon black include plastics, inks, coatings, electronics and other rubber goods. According to Precedence Research, in 2023, the global carbon black market size was $19.45 billion, and was $20.62 billion in 2024, with expectations to reach around $34.83 billion by 2033 (ref. 2). This equates to an annual production of approximately 15 million metric tons of carbon black yielding 29-79 million metric tons of carbon dioxide emissions (ref. 3); thus, leaving the carbon black sector with a great responsibility to produce a more sustainable product and seek alternative ways to reduce its global carbon footprint.

To combat the factors destabilizing the environment, sustainable efforts have been introduced within the industry. Over the last decade, the industry has been slowly adjusting to the idea of utilizing alternative feedstocks, whether solely in the process or partially with the traditional fossil fuel based feedstock. However, as sustainability targets loom, the transition from complete use of traditional carbon black feedstocks to alternative fuel sources is becoming a priority. The use of carbon black feedstocks that are renewable (such as vegetable oils) or circular (for example tire pyrolysis oil) are viable alternatives.

Tokai Carbon CB is committed to safeguarding the environment, and is invested in the goal of reducing its global carbon footprint. Long term sustainability efforts have already been taken by the company by reducing waste through circular economy practices. Under these efforts, TCCB serves to minimize waste and resource depletion, thus promoting sustainability and resource efficiency. Through circular economy, a circular feedstock, notably tire pyrolysis oil (TPO), is employed in the carbon black production process. Tire pyrolysis oil is an attractive alternative feedstock source from traditional petroleum products, produced from end-of-life (ELT) tires. In this process, ground tires are heated at temperatures ranging from approximately 800°F to 1,100°F under inert conditions. The resulting components are approximately 50% oil and derived products, 40% recovered carbon black (rCB) and 10% gas (figure 1).

When compared to methods such as open burning and landfilling, tire pyrolysis is deemed a tire disposal method that is environmentally friendly and safe with a low carbon footprint. Compared to traditional carbon black feedstock, TPO is a viable alternative, as it contains a high percentage of carbon, very close to the percentage of carbon content in the traditional fossil fuel feedstock. The primary limitation of TPO is the amount currently available on the market, as there are only a few commercial tire pyrolysis plants in operation. However, each of these companies has plans to grow, and others hope to enter the market.

**Figure 1 - sustainable circular carbon black**

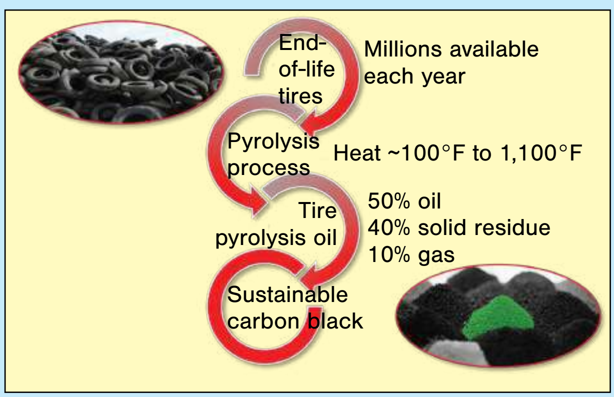


**Table 1 - rubber performance study in formulations ASTM D3191 and ASTM D3192**

| *D3191 (SBR)* | *phr* | *D3192 (NR)* | *phr* |
|---|---|---|---|
| SBR 1500 | 100.00 | Natural rubber | 100.00 |
| Zinc oxide | 3.00 | Zinc oxide | 5.00 |
| Sulfur | 1.75 | Sulfur | 2.50 |
| Stearic acid | 1.00 | Stearic acid | 3.00 |
| Carbon black | 50.00 | Carbon black | 50.00 |
| TBBS | 1.00 | Benzothiazyl disulfide | 1.00 |

In maintaining sustainable circularity for the tire and carbon black industry, tire pyrolysis oil is critical in the carbon black making process. By using TPO, Tokai Carbon CB satisfies the certification commitment to a circular economy under the International Sustainability and Carbon Certification Plus (ISCC Plus) scheme (ref. 4). In this manner, TCCB can utilize the mass balance approach to certify circularity and sustainability for carbon black. This means that the mass of the sustainable circular feedstock going in the process can be balanced with the mass of the sustainable product produced from the process. This process is transparent and traceable. It allows for the step by step process to identify and trace the origin, processing history, distribution and location of sustainable products through the supply chain. This is critical to ensuring that sustainability is maintained through the process for all involved parties.

TCCB was the first carbon black manufacturer in the world to be ISCC Plus certified. Now, all TCCB plants are ISCC Plus certified under circular economy; undoubtedly giving each plant the opportunity to produce sustainable circular products and allowing customers to meet some of their sustainability goals. All TCCB produced carbon black grades can be sourced as ISCC Plus certified.

**Sustainable carbon black performance in ASTM D3191 and ASTM D3192**

To ensure that rubber performance was not changed, a study was conducted in both ASTM D3191 (SBR) and ASTM D3192 (NR) using carbon black produced with no TPO (control) and the corresponding sustainable grade (made with TPO that uses

**Figure 2 - sCB versus grade specific control in SBR formulation ASTM D3191**

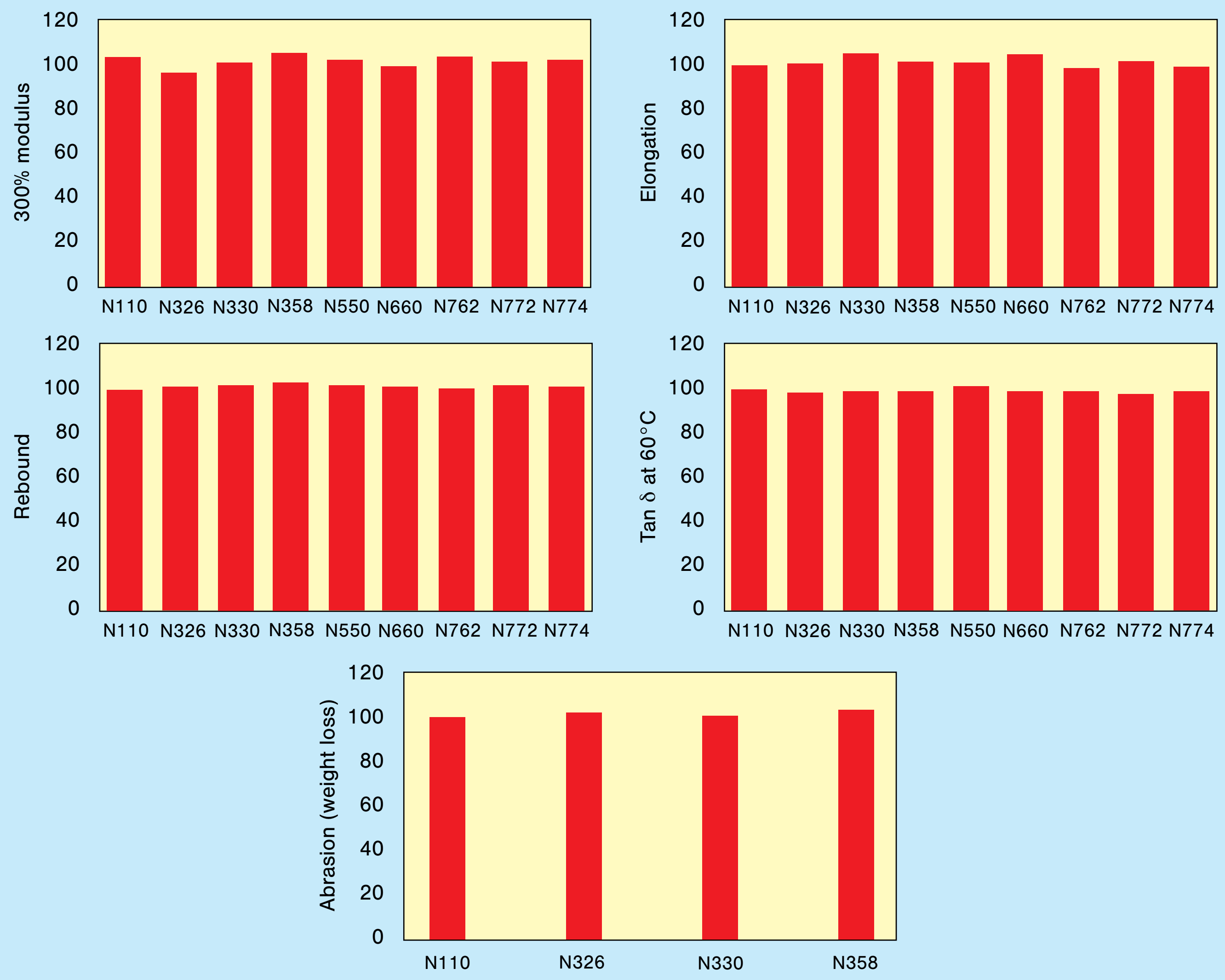
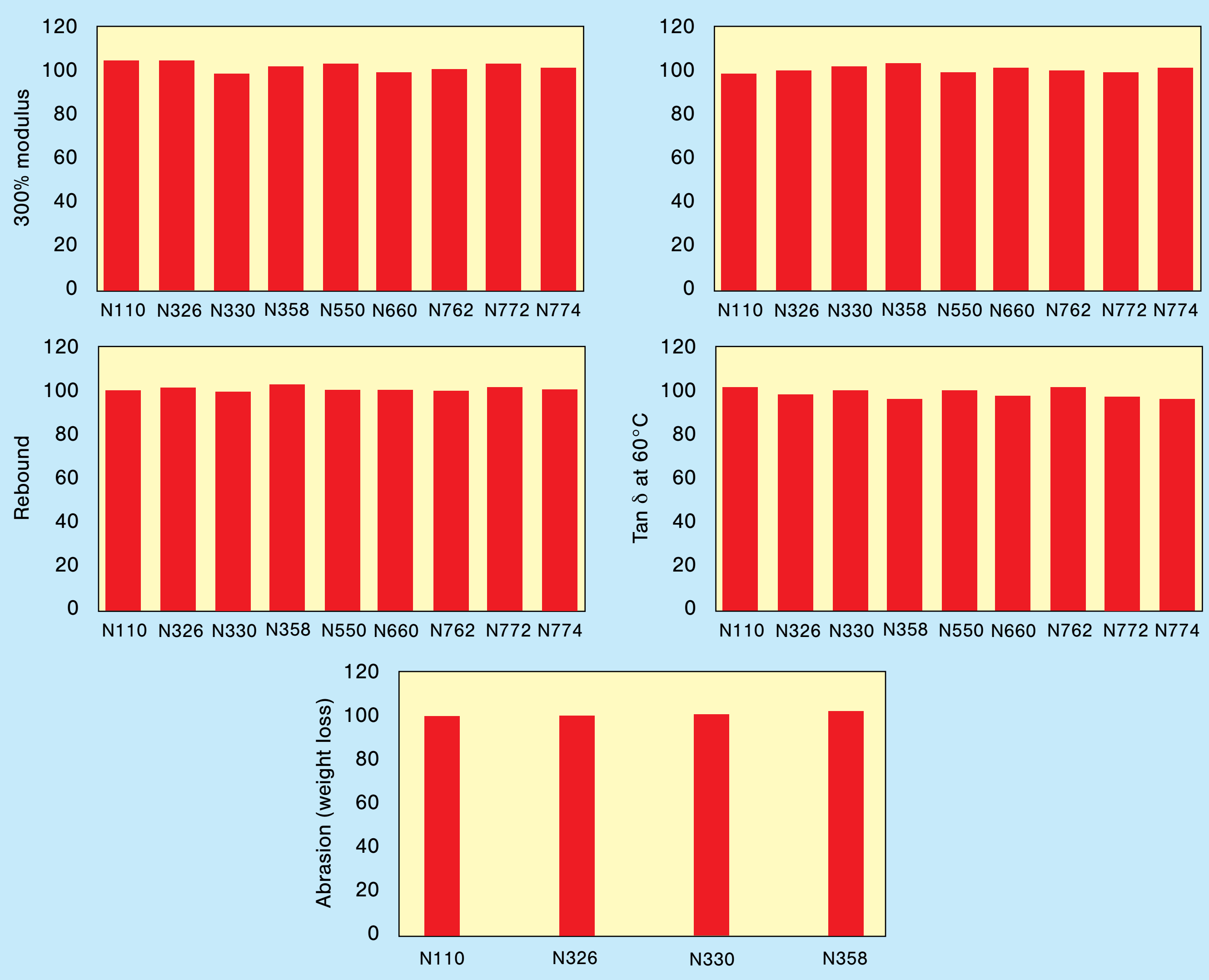


**Figure 3 - sCB versus grade specific control in NR formulation ASTM D3192**




mass balance to be certified as fully sustainable) (refs. 5 and 6) (table 1).

In both SBR and natural rubber utilizing various carbon black grades, no significant differences were observed for rubber properties, including modulus, elongation, rebound, abrasion resistance or hysteresis, versus their control (figures 2 and 3, respectively). This assures that TPO is a suitable sustainable alternative. Suitable production of sustainable carbon blacks will give rubber manufacturers the ability to significantly improve their products' environmental footprint; in turn, helping manufacturers of tires and rubber products meet their company's established goals in a timely fashion.



## Conclusion

Tokai Carbon CB offers ISCC Plus certified sustainable carbon black from all three manufacturing plants in the USA for any grade produced at these facilities. This is a good step in moving towards a more sustainable future for carbon black. However, there is currently a limited supply of TPO commercially available. There are efforts by Tokai Carbon CB to look for other renewable or circular feedstocks to expand on this concept and make the industry more sustainable.

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# APDS: Novel additives for improving natural rubber compounds with surface modified carbon black

*by Hauke Westenberg, Orion S.A.*

The reduction of greenhouse gas (GHG) emissions is required by the Paris Agreement on climate change. According to the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) (ref. 1), the transport sector has the third largest impact to global warming based on the GWP20 metric, and the third largest based on the GWP100 metric. GWP abbreviates global warming potential, which is also known as $CO_2$ equivalent, and measures how much heat a GHG creates in a certain time span relative to carbon dioxide. Twenty years and 100 years are frequently applied time horizons. Obviously, the reduction of the $CO_2$ emissions caused by transportation of goods and passengers is a valuable approach to meet the Paris Agreement. Among other measures, like higher efficiency of engines, lower vehicle weight and better aerodynamics, it is important to lower the rolling resistance of tires. This can be achieved by improved tire design in terms of tire construction, adjusted textile reinforcement and by the development of durable elastomeric compounds having lowered hysteresis. Commonly applied indicators for lower energy losses in the rubber compound are a low tan $\delta$ (ref. 2), a low heat buildup (ref. 3), a low Payne effect (refs. 4 and 5) and a high rebound (ref. 6). Test parameters such as temperature, dynamic strains, frequencies and others have to be chosen carefully in order to predict effects on the rolling resistance of the tire.

It is necessary to use reinforcing fillers to make the rubber compound durable and tough, because the tire is subjected to high dynamic load, stress, abrasion and tearing. The Payne effect is directly correlated to the usage of filler in the compound, and the reinforcing filler plays an important role in the rolling resistance of the tire. In general, it is difficult to improve the hysteresis of a compound without compromising the durability. Carbon black (CB) is the most important and versatile filler in the rubber industry. Modern process engineering enables the adjustment of the surface area per mass unit, the structure level, the surface morphology and the aggregate size distribution. Furthermore, the surface of the carbon black can be chemically modified. Orion possesses oxidation technologies which allow for increasing the amount of oxygen containing organic functional groups on the surface of carbon black. The resulting filler can be described as surface modified carbon black (SMCB). If the surface modification is performed correctly, it may lead to higher bound rubber, as described by Léopoldès et al. (ref. 7). Detrano et al. observed that the combination of SMCB with terminally functionalized SSBR resulted in a declined compound hysteresis (ref. 8). This approach was further exploited by Herd et al, using an in-chain functionalized SSBR (ref. 9).

Other research programs focused on testing of a crosslinker in combination with unfunctionalized polymers like the silica-silane system (refs. 10-12). The validation of the ammonium chloride cystamine*2HCl in combination with surface modified carbon blacks was promising (refs. 11 and 12), but the dispersion of the ionic crosslinker was difficult, and the addition of magnesium oxide and calcium hydroxide as hydrogen chloride scavengers may be detrimental to the abrasion resistance of the elastomers. Unfortunately, cystamine is not commercially available as a non-ionic free molecule due to its low stability at ambient temperatures.

Aminophenyl disulfides, which are commercially available as stable amines, could be a potential alternative to cystamines. While the sulfur and nitrogen atoms in the case of cystamine are ethylene bridged, the aminophenol disulfides are characterized by a benzene spacer which stabilizes the sulfur-sulfur bond. Bis-(2-aminophenyl)-disulfide (2-APDS) and bis-(4-aminophenyl)-disulfide (4-APDS) can be synthesized by the reaction of 2-aminothiophenol or 4-aminothiophenol with elemental sulfur. The yields are up to 100% (ref. 13) (figure 1).

Bis-(2-aminophenyl)-disulfide melts at 93°C, which makes it a very suitable rubber chemical because most rubber mixing processes have higher mixing temperatures. One could expect that the amine functional group may interact with the carboxylic groups on the surface of the carbon black, and the sulfur moiety could on the other hand interact with the unsaturated carbon-

**Figure 1 - cystamine (CA) and aminophenyl disulfides: bis-(2-aminophenyl)-disulfide (2-APDS) and bis(4-aminophenyl)-disulfide (4-APDS)**

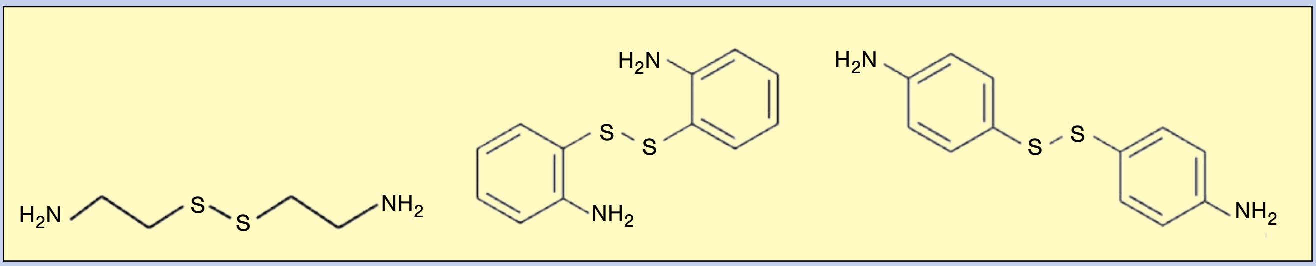


**Table 1 - test formulations for the remill study**

| | *phr* | *Stage of addition* |
|---|---|---|
| SSBR SOL R C2525 | 100 | 1 |
| SMCB EB 299 | 57 | 1 |
| TDAE | 10 | 1 |
| ZnO | 2 | 1 |
| Stearic acid | 1 | 1 |
| TBBS-80 | 1.7 | 3 |
| DPG-80 | 1.7 | 3 |
| Sulfur | 1.5 | 3 |

carbon bonds of diene based polymers like natural rubber. Both interactions could lead to improved compound properties.

**Experimental**

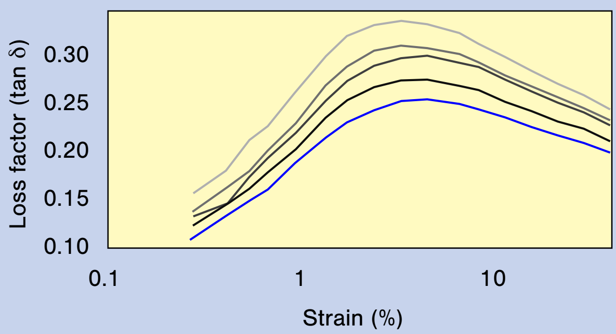
*Remill time*

Because bound rubber is forming more rapidly under agitation, it was intended to apply a three-stage mixing procedure. The first stage is intended to incorporate all fillers and chemicals, except for sulfur and accelerators, into the polymer. The curatives will be incorporated in the third and final stage. The second stage aims to improve filler dispersion and increase bound rubber. To estimate the optimal mixing time during this remill stage, the mixing times of the second stage have been altered. Five compounds, M0, M1, M3, M6 and M9, were prepared by using 0, 1, 3, 6 or 9 minutes of additional mixing. Each mixing step consisted of mixing in a GK1.5E internal mixer with intermeshing rotor geometry, followed by mixing on an open two-roll mill. The detailed formulations can be found in table 1. After the final stage, all compounds were press cured for 12 minutes at 160°C.

**Table 2 - analytical properties of EB 299**

| *Property* | *Unit* | *Value* |
|---|---|---|
| STSA | $m^2/g$ | 110 |
| COAN | ml/100 g | 100 |
| pH | - | <3 |
| Volatiles 950°C | wt% | >5 |

**Figure 2 - RPA strain sweep, 60°C, 1.6 Hz (light gray 0 minutes, blue 9 minutes)**



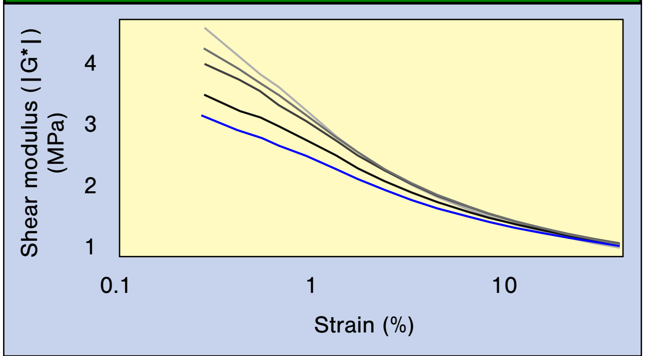

Europrene Sol R C2525 is a solution styrene butadiene rubber (SSBR) with a viscosity of 54 MU (ML (1+4) at 100°C), a styrene content of 24%, and a vinyl content of 26%. EB 299 is a surface modified carbon black with a surface area and structure very similar to the frequently used ASTM-black N234 (table 2). The most important application for N234 is tire treads; especially for radial truck and bus tires.

After three minutes, the drop temperature of the remilled compounds was approaching the maximum, which was at about 160°C (table 3). The measured temperature was 161°C for M6 and M9. The energy consumed during stage 2 was 47% higher for M9 compared to M6. For comparison, energy inputs during the first stage and final stage were negligible (table 3). If the remill stage was omitted, the bound rubber was only 32.6% and the optimum value was higher than 40%; i.e., 40.2% (M6) and 40.3% (M9), respectively. Additional mixing time caused lower hardness and viscosity, and significantly lower hysteresis. For instance, the maximal tan δ measure during an RPA strain sweep was reduced by 25%, while E* at low strains was decreased by longer agitation (figures 2 and 3). All graphs merged at larger dynamic deformations, leading to lower Payne effect for the longer mixed elastomers. This could be explained by lower

**Table 3 - properties of the compounds mixed with different remill times**

| *Property* | *Unit* | *M0* | *M1* | *M3* | *M6* | *M9* |
|---|---|---|---|---|---|---|
| Remill time | Minutes | 0 | 1 | 3 | 6 | 9 |
| Drop temperature, remill stage | °C | n/a | 143 | 155 | 161 | 161 |
| Relative energy, first stage | kWh/kg | 0.58 | 0.58 | 0.57 | 0.57 | 0.57 |
| Relative energy, remill stage | kWh/kg | n/a | 0.20 | 0.56 | 1.02 | 1.47 |
| Relative energy, final stage | kWh/kg | 0.27 | 0.27 | 0.27 | 0.27 | 0.26 |
| ML(1+4) 100°C (ref. 14) | MU | 88 | 82 | 80 | 77 | 73 |
| Bound rubber (ref. 15) | % | 32.6 | 37.0 | 38.3 | 40.2 | 40.3 |
| Hardness (ref. 16) | Durometer A | 68 | 66 | 67 | 64 | 63 |
| Tensile strength S2 (ref. 17) | MPa | 23.8 | 23.4 | 23.4 | 22.4 | 24.2 |
| Elongation at break S2 (ref. 17) | % | 550 | 520 | 520 | 480 | 490 |
| Modulus 300 S2 (ref. 17) | MPa | 10.5 | 10.9 | 11.3 | 11.6 | 12.5 |
| E* MTS (1 ± 0.5 mm, 60°C, 16 Hz) (ref. 2) | MPa | 10.1 | 9.8 | 9.6 | 9.3 | 8.8 |
| Tan δ MTS (1 ± 0.5 mm, 60°C, 16 Hz) (ref. 2) | - | 0.228 | 0.216 | 0.218 | 0.198 | 0.183 |
| Tan δ maximum, RPA (60°C, 1.6 Hz) | - | 0.335 | 0.309 | 0.298 | 0.273 | 0.252 |
| Heat buildup (55°C, 4.45 mm) (ref. 3) | °C | 121 | 116 | 112 | 104 | 96 |
| Ball rebound, 60°C (ref. 4) | % | 53.8 | 55.7 | 56.5 | 58.5 | 59.9 |
| DIN abrasion (ref. 18) | $mm^3$ | 108 | 107 | 103 | 96 | 94 |
| LAT100, performance rating (ref. 19) | % | 100 | 102 | 105 | 111 | 110 |

**Figure 3 - RPA strain sweep, 60°C, 1.6 Hz, (light gray 0 minutes, blue 9 minutes)**




filler-filler networking, which was inhibited by larger bound rubber layers formed during prolonged mixing.

The same trend was indicated by lower heat buildup and higher rebound. Likewise, the abrasion resistance was improved by 10%. Of course, adding a second mixing stage will generate higher manufacturing costs and lower throughput, but it may be worthwhile considering the remarkably enhanced compound properties.

*Compounds comprising aminophenyl disulfides (APDS)*

The following compositions are based on sulfur cured natural rubber and were made in a three-step mixing process. The fill factor was 0.68.

In the first step, natural rubber was milled in the internal mixer for 60 seconds. Then half of the CB and all the APDS materials were added and mixed for 1:15 minutes, before the other half of the carbon black was added and mixed for 45 seconds. The ram was lifted and cleaned, and the compound was further milled for 1:30 minutes. After a total time of 4:30 minutes of mixing, the compound was transferred on the open mill. The chamber temperature was 60°C and the rotor speed was set to 45 rpm during the whole first mixing step. It was determined that the batch temperature did not exceed 160°C.

After the compound was stored for more than 16 hours, the compound was mixed without addition of chemicals for 6 minutes in which the mixing chamber had a temperature of 60°C and the initial rotor speed was 55 rpm. But the rotor speed was later adjusted to make sure that the compound temperature was kept between 140°C and 160°C. Subsequently, the compound was transferred to the open mill.

After another storage time of a minimum of 16 hours, sulfur, stearic acid, ZnO, 6PPD, TBBS-80 and DPG-80 were added to

**Table 4 - test formulations for the initial validation of 4-APDS**

| | *Stage* | *R1 N234* | *R2 N234 3APDS* | *A1 EB299* | *A2 EB299 1.5 APDS* | *A3 EB299 3APDS* | *A4 EB299 6APDS* | *A5 EB299 +10 APDS* |
|---|---|---|---|---|---|---|---|---|
| Natural rubber | 1 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| N234 | 1 | 55 | 55 | - | - | - | - | - |
| SMCB EB 299 | 1 | - | - | 55 | 55 | 55 | 55 | 65 |
| 4-APDS | 1 | - | 3 | - | 1.5 | 3 | 6 | 3.5 |
| ZnO | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Stearic acid | 3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| TBBS-80 | 3 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| DPG-80 | 3 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 |
| Sulfur | 3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |

**Table 5 - compound properties of the initial APDS testing**

| *Property* | *Unit* | *R1* | *R2* | *A1* | *A2* | *A3* | *A4* | *A5* |
|---|---|---|---|---|---|---|---|---|
| N234 | phr | 55 | 55 | - | - | - | - | - |
| EB 299 | phr | - | - | 55 | 55 | 55 | 55 | 65 |
| 4-APDS | phr | - | 3 | - | 1.5 | 3 | 6 | 3.5 |
| Cure temperature | °C | 145 | 145 | 145 | 145 | 145 | 145 | 145 |
| Cure time | Minutes | 15 | 15 | 40 | 12 | 10 | 15 | 30 |
| ML(1+4) 100°C (ref. 14) | MU | 58 | 56 | 75 | 78 | 80 | 85 | n.m. |
| Bound rubber (ref. 15) | % | 52.6 | 55.5 | 69.8 | 77.9 | 80.1 | 72.3 | 87.6 |
| Hardness (ref. 16) | Durometer A | 71 | 71 | 66 | 63 | 64 | 70 | 70 |
| Tensile strength S2 (ref. 17) | MPa | 24.0 | 23.8 | 22.6 | 18.7 | 21.2 | 24.2 | 14.9 |
| Elongation at break S2 (ref. 17) | % | 350 | 410 | 330 | 260 | 280 | 400 | 190 |
| Modulus 100 S2 (ref. 17) | MPa | 4 | 3.1 | 3.2 | 3.5 | 3.8 | 3.4 | 5.2 |
| Modulus 300 S2 (ref. 17) | MPa | 20.3 | 16.5 | 19.9 | - | 21.6 | 17.8 | - |
| Tan $\delta$ MTS (0.2 ± 0.1 mm, 60°C, 16 Hz) (ref. 2) | - | 0.181 | 0.232 | 0.082 | 0.064 | 0.069 | 0.145 | 0.100 |
| Heat buildup (55°C, 4.45 mm) (ref. 3) | °C | 69 | 80 | 61 | 51 | 49 | 74 | 64 |
| Ball rebound, 60°C (ref. 4) | % | 62.5 | 55.0 | 71.3 | 74.2 | 75.4 | 63.3 | 69.5 |
| DIN abrasion (ref. 18) | $mm^3$ | 104 | 121 | 107 | 105 | 105 | 123 | 101 |
| LAT100, performance rating (ref. 19) | % | 100 | 101 | 92 | 102 | 117 | 106 | 114 |

**Table 6 - test formulations for the influence of DPG and 6PPD**

| | Stage | R3 N234 No DPG | A6 EB299 4-APDS DPG | A7 EB299 4-APDS No DPG |
|---|---|---|---|---|
| Natural rubber | 1 | 100 | 100 | 100 |
| N234 | 1 | 55 | - | - |
| SMCB EB 299 | 1 | - | 55 | 55 |
| 4-APDS | 1 | - | 3 | 3 |
| ZnO | 3 | 3 | 3 | 3 |
| Stearic acid | 3 | 1.5 | 1.5 | 1.5 |
| 6PPD | 3 | 1 | 1 | 1 |
| TBBS-80 | 3 | 1.7 | 1.7 | 1.7 |
| DPG-80 | 3 | - | 1.25 | - |
| Sulfur | 3 | 1.5 | 1.5 | 1.5 |

the composition, while the internal mixer was operated with a chamber temperature of 40°C and a rotor speed of 34 rpm. The drop temperature was between 85°C and 105°C. Again, the mixing stage was finalized by mixing on the open mill where sheets for further processing like molding and vulcanization were formed. The cure temperature was set to 145°C. The optimum cure time was determined by the analysis of moving die rheometer isotherms measured at 145°C. Changes in the formulation like the variation of diphenyl guanidine and APDS concentrations, as well as surface modification of carbon black, have an influence on the optimal vulcanization length.

*Optimum dosage of APDS*

The influence of the aminophenyl disulfide 4-APDS was investigated for compounds comprising surface modified carbon black EB 299 (A1 versus A2) and standard tread black N234 (R1 versus R2). The optimum dosage was also determined by assessing 1.5 phr (A2), 3 phr (A3) and 6 phr (A4) of 4-APDS.

In addition, a compound having 3 phr 4-APDS and an increased filler loading from 55 phr to 65 phr of EB 299 was prepared (A5) (table 4).

When comparing the standard compound A1, which comprises N234 and no APDS, to the compound A2 with the combination of N234 with 4-APDS, it can be concluded that the addition of 4-APDS to standard furnace blacks has a negative impact. The addition of 3 phr of 4-APDS (R2) led to a more hysteretic and less durable compound, which can be predicted by considering the lower rebound, higher tan δ and heat buildup, and more abraded material found in the DIN abrasion test compared to the APDS-free reference R1. However, addition of 4-APDS to a compound comprising surface modified EB 299 improved these test results substantially. An optimum loading at around 3 phr yielded the lowest hysteresis with a 62% lower tan δ at low strains in comparison to the reference R1. Moreover, the abrasion resistance was determined as the highest. An upgrade of 17% compared to the reference compound R1 could be observed. The increase of the filler loading to 65 phr of EP299 did not improve the abrasion resistance. On the other hand, tan δ and viscosity were increased, while ultimate tensile properties were decreased significantly. The elongation at break was below 200%, which is considered too low for a tire compound. Consequently, the initial loading of 55 phr of carbon black was kept constant in the subsequent experiments (table 5).

*Effect of DPG and 6PPD on the rubber properties*

N-(1,3-dimethylbutyl)-N′-phenyl-p-phenylenediamine 6PPD or its derivatives are currently an indispensable substance in the tire industry due to their excellent antioxidant effect to diene rubbers. Previous unpublished studies have shown that usage of 6PPD is suppressing the effect of surface modified carbon blacks like EB 299. The next study should examine whether this is also the case when EB 299 is combined with APDS (table 6).

N,N′-diphenylguanidine (DPG) is used, for instance, when acidic fillers prevent adequate rubber vulcanization. Keeping this in mind, the addition of DPG appeared useful in the first study, since the pH value of EB 299 is below 3. Normal furnace blacks, on the other hand, have a pH between 6 and 10, making them rather basic fillers in most cases. Therefore, the addition of DPG is not necessary in this case, which is the reason why a compound with N234 and without DPG was prepared as a reference. Furthermore, and two additional compounds with EB 299, but with 1 phr of DPG and without DPG, were compared. The mixing process was unchanged compared to the initial study (table 7).

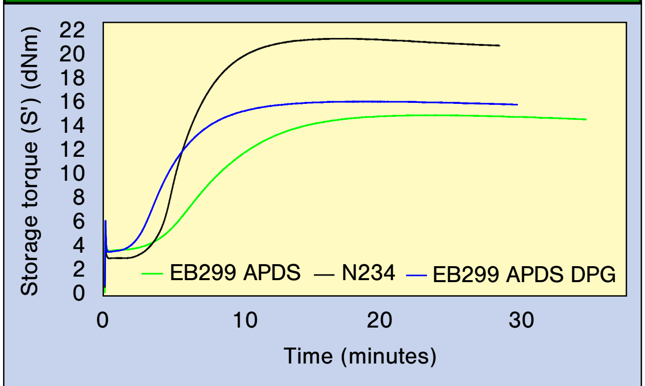
**Table 7 - compound properties influence of DPG and 6PPD**

| Property | Unit | R3 | A6 | A7 |
|---|---|---|---|---|
| N234 | phr | 55 | - | - |
| EB 299 | phr | - | 55 | 55 |
| 4-APDS | phr | - | 3 | 3 |
| 6PPD | phr | 1 | 1 | 1 |
| DPG-80 | phr | - | 1.25 | - |
| Cure temperature | °C | 145 | 145 | 145 |
| Cure time | Minutes | 13 | 13 | 19 |
| Bound rubber (ref. 15) | % | 56.0 | 81.6 | 76.1 |
| Hardness (ref. 16) | Durometer A | 68 | 63 | 63 |
| Tensile strength S2 (ref. 17) | MPa | 25.8 | 23.7 | 17.5 |
| Elongation at break S2 (ref. 17) | % | 390 | 320 | 270 |
| Modulus 100 S2 (ref. 17) | MPa | 3.8 | 3.4 | 3.2 |
| Modulus 300 S2 (ref. 17) | MPa | 19.2 | 22.2 | - |
| Tan δ MTS (0.2 ± 0.1 mm, 60°C, 16 Hz) (ref. 2) | - | 0.154 | 0.071 | 0.083 |
| Heat buildup (55°C, 4.45 mm) (ref. 3) | °C | 64 | 53 | 55 |
| Ball rebound, 60°C (ref. 4) | % | 64.8 | 74.0 | 70.5 |
| DIN abrasion (ref. 18) | $mm^3$ | 80 | 83 | 88 |
| LAT100, performance rating (ref. 19) | % | 100 | 132 | 118 |

The moving die rheometer revealed that the addition of DPG (A6) is useful to reduce cure times, showing a value 46% higher for A7, which did not contain DPG (figure 4).

DPG enabled keeping the same cure time compared to the compound containing the standard black N234 (R3). DIN abrasion was similar for all three compounds, but the LAT100 evaluation con-

**Figure 4 - MDR test at 145°C, R3 in black, A6 in blue, A7 in green**




firmed a significant improvement for compound A6, which comprised EB 299, 4-APDS and DPG. A6 was also the least hysteretic compound. The low strain hysteresis was significantly reduced compared to the reference. It can be concluded from this

**Table 8 - test formulations including 4-APDS and 2-APDS**

| | *Stage* | *A8* *4-APDS* | *A9* *2-APDS* |
|---|---|---|---|
| Natural rubber | 1 | 100 | 100 |
| SMCB EB 299 | 1 | 55 | 55 |
| 4-APDS | 1 | 3 | - |
| 2-APDS | 1 | - | 3 |
| ZnO | 3 | 3 | 3 |
| Stearic acid | 3 | 1.5 | 1.5 |
| 6PPD | 3 | 1 | 1 |
| TBBS-80 | 3 | 1.7 | 1.7 |
| DPG-80 | 3 | 1.25 | 1.25 |
| Sulfur | 3 | 1.5 | 1.5 |

**Table 9 - compound properties for natural rubber with 4-APDS and 2-APDS**

| *Property* | *Unit* | *A8* | *A9* |
|---|---|---|---|
| EB 299 | phr | 55 | 55 |
| 4-APDS | phr | 3 | - |
| 2-APDS | phr | - | 3 |
| Cure temperature | °C | 145 | 145 |
| Cure time | Minutes | 12 | 12 |
| Bound rubber (ref. 15) | % | 79.1 | 85.6 |
| Hardness (ref. 16) | Durometer A | 64 | 64 |
| Tensile strength S2 (ref. 17) | MPa | 22.7 | 22.7 |
| Elongation at break S2 (ref. 17) | % | 300 | 290 |
| Modulus 100 S2 (ref. 17) | MPa | 4.0 | 4.0 |
| Modulus 300 S2 (ref. 17) | MPa | 23.0 | 23.3 |
| Tan δ MTS (0.2 ± 0.1 mm, 60°C, 16 Hz) (ref. 2) | - | 0.065 | 0.066 |
| Heat buildup (55°C, 4.45 mm) (ref. 3) | °C | 48 | 48 |
| Ball rebound, 60°C (ref. 4) | % | 75.1 | 75.0 |
| DIN abrasion (ref. 18) | $mm^3$ | 79 | 76 |
| LAT100, performance rating (ref. 19) | % | 132 | 133 |

**Figure 5 - performance comparison of M0 (second stage omitted) versus M9 (second stage was 9 minutes); higher means better**

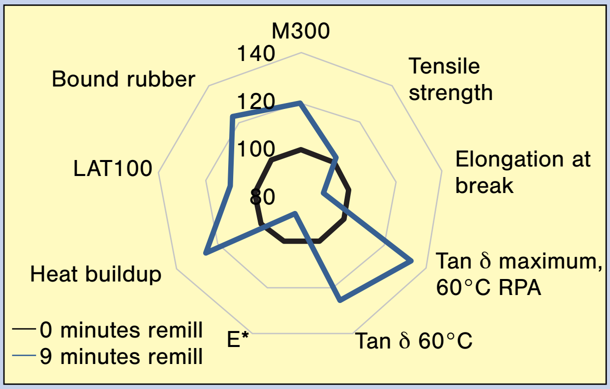
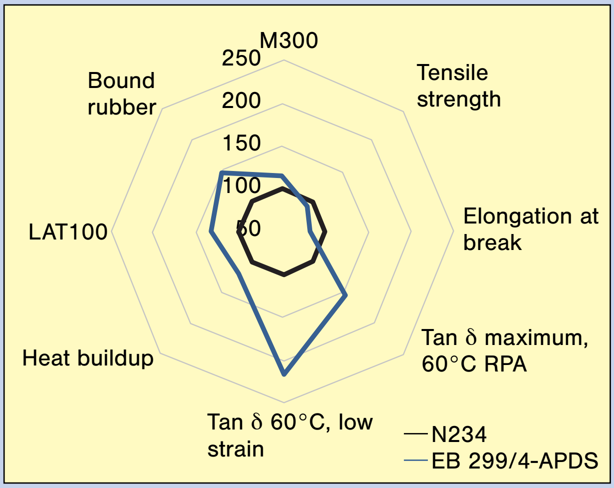



**Figure 6 - performance comparison of an R3 (N234) versus A6 (EB 299/4-APDS); higher means better**




study that the addition of 6PPD did not adversely affect the performance of the EB 299/4-APDS filler system.

*Comparison of 2-APDS with 4-APDS*

Two aminophenyl disulfide derivatives could be procured: bis-(2-aminophenyl)-disulfide (2-APDS), in which amine group and sulfur moiety are in ortho position to each other; and bis-(4-aminophenyl)-disulfide (4-APDS), in which the functional groups are para to each other (table 8). The following experimental work should evaluate if the ortho or para linkage has an influence on the in-rubber properties.

Surprisingly, the comparative experiments did not exhibit any significant differences addressed to the different linkage, para A8 or ortho A9, in the molecular structure of the different aminophenyl disulfides, 2-APDS and 4-APDS (table 9).

**Summary**

Preliminary mixing experiments revealed that increasing the mixing time of compounds containing surface modified carbon blacks, such as EB 299, is beneficial for the compound properties (figure 5). This could be realized by increasing the number of mixing stages from two to three. The masterbatch produced in stage one was just remilled in stage two, leading to significantly reduced hysteresis and to an increase in abrasion resistance of 10%.

The addition of aminophenyl disulfides further improved natural rubber formulations, which have surface modified carbon black like EB 299 as the main filler.

A compound with 55 phr EB 299 seems to require an optimized dosage of roughly 3 phr APDS to achieve outstanding abrasion resistance in combination with extremely low hysteresis. The addition of APDS to the reference elastomer which was filled with unmodified N234 yielded a low performing rubber. On the other hand, the addition of APDS to an unmodified furnace black N234 led to deteriorated elastomer properties (figure 6).

Currently, the usage of co-accelerators such as DPG in compounds containing SMCBs seems to be required to match the cure speed of standard natural rubber formulations. These promising results encourage further research because such a combination of surface modified carbon black with aminophenyl disulfides can, for example, lead to improved truck tires having better fuel economy and mileage.

This article is based on a paper presented at the 206th Technical Meeting of the Rubber Division, ACS, September 2024.

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# Rubber Division, ACS Spring Meeting held

The Rubber Division of the American Chemical Society will hold its 107th Technical Meeting March 4-6 in Lake Buena Vista (Orlando), FL. Featured technical presentation topics will include: Advances in Rubber Ingredients and Additives; Sustainable Raw Materials and Processes; Advances in Tires; Rubber Characterization and Analysis; Green Energy and Alternative Energy Technology; Urethanes; Science & Technology Awards Symposum; and Combining Physics, Chemistry and Engineering of Rubber: A Symposium in Honor of Charles Goodyear Medalist Gert Heinrich.

The course, Introduction to Elastomer Durability, from the Fatigue Limit to Tear Strength and Fatigue, instructed by Will V. Mars of Endurica, will take place on Monday, March 3. This class covers the basics of elastomer durability. Part I gives an overview of crack behavior, an introduction to the concept of fatigue threshold in elastomers and practical guidance on how to use this material parameter to develop highly durable rubber products. Part II reviews the physical principles that govern rubber's strength and durability, and provides an "on-ramp" to navigating the many aspects of durability in elastomeric materials development and product design. The course costs $395 for Rubber Division members; $495 for nonmembers; and is free for undergraduate student members.

The keynote address, "The science and engineering of advanced materials and manufacturing in the International Space Station National Laboratory," will be presented at 9 a.m. on Tuesday, March 4, by Rose Hernandez, International Space Station (ISS) National Laboratory science program director. The ISS National Laboratory serves as a unique platform for advancing the science and engineering of materials and manufacturing. In the microgravity environment of the ISS, researchers can explore the fundamental properties of materials without the interference of Earth's gravity. This allows for the development of unique atomic and molecular arrangements that lead to advanced materials with enhanced properties, such as improved strength, durability and thermal resistance. Experiments conducted in the ISS National Laboratory have led to breakthroughs in various fields, including metallurgy, polymer science and nanotechnology, paving the way for innovative applications in industries ranging from aerospace to healthcare. Moreover, the ISS National Laboratory provides an unparalleled opportunity for manufacturing research. The absence of gravity enables the study of fluid dynamics, combustion and other processes in ways that are not possible on Earth. This has significant implications for the production of high quality materials and the development of new manufacturing techniques. By leveraging the unique conditions of the ISS, researchers are driving technological advancements to benefit humanity as a whole.

Tabletop exhibits are included at the spring meeting, and attendees may visit them on Tuesday, March 4, from 10 a.m. until 6 p.m., and on Wednesday, March 5, from 10 a.m. until 2:30 p.m. Exhibitors will include ACE Laboratories, Akron Rubber Development Laboratory, Endurica LLC, HF Group, Kobelco Stewart Bolling, Kuraray America, Lion Elastomers, MonTech USA; Neville Chemical, Renkert Oil LLC, Smithers, Uth GmbH and VMI Group.

The Rubber Legend Luncheon will take place on Tuesday, March 4, at noon.



## Rubber Group News

**The Chemical Institute of Canada, Rubber Chemistry and Technology Division**, will hold a virtual rubber seminar on March 20. Further information is available at www.cheminst.ca/about/cic.

The **Detroit Rubber Group** will hold its spring technical meeting April 15 in Ann Arbor, MI. Further information is available at www.rubber.org/detroit-rubber-group-inc.

The **Energy Polymer Group** will hold its winter technical meeting March 19-20 at the Marriott Sugar Land in Houston, TX. Further information is available at www.energypolymergroup.org.

The **Mexico Rubber Group** will hold a Rubber Recycling course, instructed by Jose Gazano, February 20 at the Rubber Chamber facilities in Mexico City, Mexico. The MRG will hold the course, Introduction to Raw Materials, Quality Testing and Processing of Rubber, instructed by Soul Leonides, on April 10 at the same location. Details are available at www.rubber.org/mexico-rubber-group.

The **Ohio Rubber Group** will hold its spring technical meeting on April 29 at the University of Akron in Akron, OH. Further information is available at www.ohiorubbergroup.org.

The **Southern Rubber Group** will hold its winter technical meeting March 9-11 at the Embassy Suites in Greenville, SC. Details are available at www.southernrubbergroup.com.

The **Twin Cities Rubber Group** will hold its spring technical meeting March 13 at Cowboy Jack's in Bloomington, MN. Further information is available at www.twincitiesrubbergroup.org.

# Meetings

The Welcome Reception takes place from 4 p.m. until 6 p.m. on Tuesday.

The 5K Walk/Run, presented by H.M. Royal, will be held at 6:30 a.m. on Wednesday, March 5. The Science & Technology Awards Breakfast, sponsored by Alpha Technologies, takes place at 8 a.m. on Wednesday.

The following technical presentations will be held during the Rubber Division, ACS 2025 Spring Technical Meeting:

**Tuesday, March 4, Session 1: Advances in Rubber Ingredients and Additives**
"EPDM based smart elastomers: All-in-one approach to triboelectric current generation, piezoresistive strain sensing and solvent vapor identification," Arpita Kundu, Leibniz Institute of Polymer Research; and "Sulfur-like flexible but strong ionic network in ENR," Amit Das, Leibniz Institute of Polymer Research.

**Tuesday, March 4, Session 2: Advances in Tire Materials and Processes**
"Silane functionalized liquid rubber for electric vehicle tires," Erich Klein, Kuraray America.

**Tuesday, March 4, Session 3: Sustainable Raw Materials and Processes**
"Sustainable advancements in rubber processing: The role of gear pump extruder technology in enhancing efficiency and product quality," Julia Uth, Uth GmbH; "Milestones in energy and cost reduction in the continuous vulcanization process of rubber," Michael Drach, Gerlach Maschinenbau GmbH; "Smart devulcanization of end-of-life tire enhanced interface along with mechanical properties in NR/SBR compounds," Marzieh Shabani, University of Akron; "Recovery of polymerous material following devulcanization of sulfur crosslinked tire rubber," Michael LaRoche, Arduro; and "Environmentally friendly rubber process aid," Marymol P. Johnson, Apollo Tyres Global Research and Development.

**Wednesday, March 5, Session 4: Award Symposium**
"Charles Goodyear Medal address: Rubberiomics, a holistic approach to elastomers and elastomer products," Gert Heinrich, Leibniz Institute of Polymer Research; "Melvin Mooney Award address: Innovations in polyolefin based elastomers and thermosets," Sunny Jacob, ExxonMobil Chemical; "George Stafford Whitby Award address: High performance nano-structured polymer networks," Robert Weiss, University of Connecticut; "Sparks Thomas Award address: Elastomer composite based wearable and self-powered sensor for


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# Meetings

extreme point of care applications," Titash Mondal, Indian Institute of Technology-Kharagpur; "Chemistry of Thermoplastic Elastomers Award address: Hierarchically self-organized carbon black nano-particles in rubber matrices under externally applied energy flow," Takeji Hashimoto, Kyoto University; and "Fernley H. Banbury Award address: Studies on the mechanism of abrasion," Edward R. Terrill, Akron Rubber Development Laboratory.

**Wednesday, March 5, Session 5: Green Energy and Alternative Energy Technology**
"Evaluation of fluorine-containing elastomer seals in several sustainable aviation fuels," Ronald Campbell, Greene, Tweed.

**Wednesday March 5, Session 6: Urethanes**
"Innovative self-bonding rubber: A sustainable alternative to Neoprene and other rubbers in industrial applications," Hanin Issa, AMS.

**Wednesday, March 5, Session 2: Advances in Tire Materials and Processes**
"Understanding the mechanism of void formation and fracture in elastomeric nanocomposites at large strains," Harshad Bhapkar, University of South Florida; and "Tuning polymer-filler interactions to modulate elastomeric reinforcement," Pierre Kawak, University of South Florida.

**Thursday, March 6, Session 7: Combining Physics, Chemistry and Engineering of Rubber**
"Elucidation of wear phenomena and crack propagation in rubber by advanced in-situ x-ray scattering at the Synchrotron," Gert Heinrich, Leibniz Institute of Polymer Research; "Influence of strain constraint on stress distribution at crack tips of rubber vulcanizates," Toshio Tada, Sri Research & Development Ltd.; "Dispersion kinetics of carbonaceous particulates in elastomer mixing," Lewis Tunnicliffe, Birla Carbon; "Research and development applications of dynamic mechanical analysis in the rubber industry," Chris Robertson, Polymer Technology Services LLC; and "Integration of smart functionality to commercial rubbers," Amit Das, Leibniz Institute of Polymer Research

**Thursday, March 6, Session 8: Rubber Characterization and Analysis**
"Vulcanization, mechanical properties and strain induced crystallization of natural rubber," Seiichi Kawahara, Nagaoka University Of Technology; "Quantification of 6PPD and its transformation product (6PPD-quinone), concentration under the influence of ozone and migration kinetics analysis using an ultraviolet-visible-near-infrared spectrophotometer," Samara I. Nishi, University of Akron; "Rubbery rings: Rheological response of large macrocyclic polymers," Gregory B. McKenna, North Carolina State University; and "Time temperature superposition of rubber crack growth experiments," Aaron M. Duncan, Queen Mary University of London.

Further information on the Rubber Division, ACS, 2025 Spring Technical Meeting, including registration information and details on the costs for the educational course and special events, is available at www.rubber.org.

## 2025 Tire Technology Expo held in Hannover

Tire Technology Expo 2025, organized by *Tire Technology International*, will be held March 4-6 at Deutsche Messe in Hannover, Germany.

This event will feature exhibits from 240 specialist suppliers; the Tire Technology Expo Conference with 150+ speakers; the University of Akron Tire Mechanics course; the Tire Modeling and its Application in Tire and Vehicle Development course; The Tire Reinforcement Materials Applications and Fatigue Testing course and the Tire Technology International Awards for Innovation and Excellence. Further information is available at www.tiretechnology-expo.com.

## Paper call

**2025 Global Polymer Summit**. The Rubber Division of the American Chemical Society invites submissions for inclusion in the Global Polymer Summit Technical Meeting and Student Symposium, to be held September 9-11 in Cleveland, OH.

Key topics will include: Advanced Applications; Artificial Intelligence for the Rubber and Tire Industries; Elastomers in Energy Markets; Environmental Risk; Material Characterization, Testing and Modeling; Mixing Technology and Downstream Equipment; New Commercial Developments; New Tire Technologies; Polymer Degradation and Stability; Resins for Grip; Silicone Elastomers and Compounds; Sustainability in Rubber and Tires; Tire Manufacturing; and Vibration, Fatigue and Abrasion.

Undergraduate and graduate students in rubber/polymer chemistry and engineering programs are welcome to submit entries for the Student Symposium. Financial prizes will be awarded.

The deadline for receipt of abstracts is May 16. Papers are due August 24. Further information is available at www.rubber.org.

# Calendar

Rubber Division
American Chemical Society

**Future Meetings/ Expos**

**2025**

| | |
|---|---|
| Orlando | March 4-6 |
| Cleveland | September 8-11 |

**2026**

| | |
|---|---|
| Louisville | Sept. 28 - Oct. 1 |

www.rubber.org

**University of Akron, Akron Polymer Training Services**, Rubber Molding Processes: Principles, Troubleshooting and Mold Design online course, www.uakron.edu/apts/ - February 19-21.

**Mexico Rubber Group**, Course: Rubber Recycling, Rubber Chamber Facilities, Mexico City, Mexico, www.rubber.org/mexico-rubber-group - February 20.

**Rubber Division, ACS**, Dynamic Viscoelastic Properties online course, www.rubber.org - February 20.

**Rubber Division, ACS**, Elastomers for Selective Gas Separation, including Carbon Capture webinar, www.rubber.org - February 25.

## March

**Association for Rubber Products Manufacturers**, Advanced Rubber Manufacturing Technologies Training, Chicago, IL, www.arpminc.org - March 3-5.

**University of Akron, Akron Polymer Technology Services**, Thermoplastic Materials Engineering Synthesis, Structure Properties and End Use Performance course, www.uakron.edu/apts/ - March 3-5.

**University of Akron, Akron Polymer Technology Services**, Automotive OEM Coatings Chemistry and Applications course, www.uakron.edu/apts/ - March 4-5.

**Association of Modified Asphalt Producers**, 2025 AMAP March Educational Workshop, Embassy Suites by Hilton Dallas DFW Airport South, Irving, TX, www.modifiedasphalt.org - March 4-6.

**JEC Group**, JEC World 2025 International Composites Show, Paris-Nord Villepinte, Paris, France, www.jec-world.events - March 4-6.

**Rubber Division, ACS**, Spring Technical Meeting, Hilton Orlando Lake Buena Vista, Lake Buena Vista (Orlando), FL, www.rubber.org - March 4-6.

**UKi Media & Events**, Tire Technology Expo/Conference 2025, Hannover, Germany, www.tiretechnology-expo.com - March 4-6.

**University of Akron, Akron Polymer Technology Services**, Rheological Theories and their Direct Applications in the Polymer Industry course, www.uakron.edu/apts/ - March 5-7.

**Association for Rubber Products Manufacturers**, Product Liability Training, Indianapolis, IN, www.arpminc.org - March 6-8.

**University of Akron, APTS**, Sponge Rubber 101 online course, www.uakron.edu/apts/ - March 7.

**Southern Rubber Group**, 2025 Winter Technical Meeting, Embassy Suites, Greenville, SC, www.southernrubbergroup.org - March 9-11.

**TechnoBiz**, Asian Tyre Tech Conference, Bangkok, Thailand, www.technobiz.org - March 12-13.

**TechnoBiz**, GRTE 6th Global Rubber Latex & Tire Expo, Bangkok International Trade & Exhibition Center, Bangkok, Thailand, www.grte-expo.com - March 12-14.

**TechnoBiz**, Rubber Research Fair, Bangkok International Trade & Exhibition Center, Bangkok, Thailand, www.technobiz.org - March 12-14.

**Twin Cities Rubber Group**, spring technical meeting, Cowboy Jack's, Bloomington, MN, www.twincitiesrubbergroup.org - March 13.

**University of Akron, Akron Polymer Technology Services**, Aircraft Tire Technology course, www.uakron.edu/apts/ - March 13.

**University of Akron, Akron Polymer Technology Services**, Applications of FTIR in Polymer Processing and Product Development course, www.uakron.edu/apts/ - March 13.

**University of Akron, Akron Polymer Technology Services**, Applications of FTIR and NMR Spectroscopy in Polymer Product Development (Problem Solving, Development and IP Creation) course, www.uakron.edu/apts/ - March 13-14.

**University of Akron, Akron Polymer Training Services**, Rubber Compounding for Performance online course, www.uakron.edu/apts/ - March 13-14.

**University of Akron, Akron Polymer Training Services**, Understanding Raw Materials, the Building Blocks of Rubber Compounding online course, www.uakron.edu/apts/ - March 17.

**University of Akron, Akron Polymer Technology Services**, Silicone Elastomer Technology course, www.uakron.edu/apts/ - March 17-19.

**Rubber Division, ACS**, How to Create and Deliver Scientific Presentations webinar, www.rubber.org - March 18.

**University of Akron, Akron Polymer Training Services**, Solving Problems in Rubber Compounding and Processing course, www.uakron.edu/apts/ - March 18.

**Informa Markets**, Plastics and Rubber Vietnam 2025, Saigon Exhibition and Convention Center, Ho Chi Minh City, Vietnam, www.plasticsvietnam.com - March 18-20.

**Rubber Division, ACS**, Rubber Explained online course, www.rubber.org - March 19.

**Energy Polymer Group**, winter technical meeting, Marriott Sugar Land, Houston, TX, www.energypolymergroup.org - March 19-20.

**Chemical Institute of Canada, Rubber Chemistry and Technology Division**, virtual rubber seminar, www.cheminst.ca/about/cic - March 20.

**University of Akron, Akron Polymer Training Services**, Injection Molding Certificate Program online course, www.uakron.edu/apts/ - March 24-28.

**University of Akron, Akron Polymer Training Services**, Elastomer Molding Technology online course, www.uakron.edu/apts/ - March 26-28.

**Rubber Division, American Chemical Society**, Green Tire Chemistry: Optimizing the Tire Magic Triangle through Tread Chemistry webinar, www.rubber.org - March 27.

## April

**University of Akron, Akron Polymer Training Services**, Polymer Science for Engineers online course, www.uakron.edu/apts/ - April 1-3.

**International Institute of Synthetic Rubber Producers (IISRP)**, 65th Annual General Meeting, Hyatt Centric The Liberties, Dublin, Ireland, www.iisrp.com - April 7-10.

**Rubber Division, ACS**, Mixing and Testing for Compound Consistency online course, www.rubber.org - April 8.

**Akron Section of the Society of Plastics Engineers (SPE) and the Thermoplastic Elastomers Technical Interest Group of the SPE**, Thermoplastic Elastomer Conference on Compound Interest: TPEs in a Circular Economy, Hilton Garden Inn, Akron, OH, http://www.4spe.org/tpe25 - April 8-10.

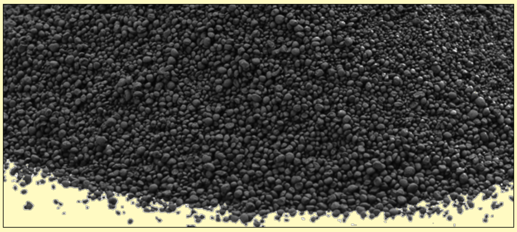
**Rubber Division, American Chemical Society**, Setting Up a Rubber Molding Process online course, www.rubber.org - April 9.

**Mexico Rubber Group**, Course: Introduction to Raw Materials, Quality Testing and Processing of Rubber, Rubber Chamber Facilities, Mexico City, Mexico, www.rubber.org/mexico-rubber-group - April 10.

**Detroit Rubber Group**, spring technical meeting, Ann Arbor, MI, www.rubber.org/detroit-rubber-group-inc - April 15.

# Thermal carbon black solutions

Thermal carbon black, often referred to as medium thermal black, is derived from thermal decomposition of natural gas. It is said to be one of the purest forms of carbon available on an industrial scale. All grades of the company's Thermax products are manufactured under strictly controlled conditions from high quality, commercial grade natural gas. As a result, manufacturers using Thermax are said to be assured of the overall consistency of the product. Easy mixing and good dispersion, excellent processing, smooth extrusion, excellent dynamic properties, low grit compounds, reduced compression set and low electrical conductivity are all part of the Thermax advantage, according to the company.



Thermax N990 consists of uniform soft pellets which are easy to disperse in most applications, yet can withstand the rigors of transportation. Thermax N990CG purposefully reduces PAH content for use in sensitive applications, without sacrificing quality and performance, according to the company. Thermax N990 can be added to an EPDM compound to evaluate compound dispersion and processing properties, and has been added to an NBR compound to evaluate the influence on dispersion and tensile failure distribution properties. Thermax N990CG was added to a CR wiper blade formulation leading to improvements in dispersion and viscosity. Thermax N990 has replaced furnace blacks in EPDM compounds, leading to improvements in dispersion and maintenance of physical properties, and it has replaced N330 in butyl tire curing bladder compounds. (*Cancarb*)

www.cancarb.com

## CB embedded powders

PA12 based Infinam 6013 P and Infinam 6014 P 3D printable powders possess a relatively substantial amount of carbon black in the core of each particle. Produced through the precipitation process, these carbon black powders are specially designed for powder bed fusion techniques like SLS (selective laser sintering), and offer high flowability and homogenous sintering, according to the company. Additionally, the high core-shell carbon black content is said to allow for true pigmentation uniformity, minimize visibility of surface abrasion and wear, and provide elevated resistance to ultraviolet rays and greater isotropic performance. These properties are said to make the carbon black powder an ideal material for producing 3D printed items destined for use outdoors. (*Evonik Industries*)

www.evonik.com

## Sustainable carbon black

The global tire industry is said to be the largest consumer of carbon black, which makes up about 30% of a typical tire by weight. The material reinforces rubber and makes tire treads more resistant to tearing, cutting, abrasion and other wear. Carbon black plays a key role in decreasing rolling resistance, leading to increased fuel efficiency. The material also enables engineers to fine tune performance and protects tires from the damaging effects of UV light, according to the company. This firm has developed and commercialized carbon black made from renewable feedstocks, such as industrial grade vegetable oils or other oils derived from waste and residues of biological origin from agriculture or forestry. The company also develops and manufactures carbon black with pyrolysis oils from end-of-life tires (ELT), enabling a tire circular economy. (*Orion*)

www.orioncarbons.com

## Carbonacious materials

Continua 8030 SCM is a circular material designed to address the growing sustainability needs of customers across the Indian subcontinent and Asia. After the launch of the Continua brand, the company is expanding its circular product offering. Continua 8030 SCM reinforces the firm's commitment to innovation through sustainability. Continua 8030 SCM is said to enhances the content of circular products, aiding customers in their environmental stewardship efforts. Stringent control over feedstock and highest operational standards are said to ensure consistent delivery, lot to lot. The company is said to provide robust technical service to facilitate smooth product integration, thus optimizing performance across different applications. Supported by state-of-the-art laboratories and quality control measures, Continua 8030 SCM is said to guarantee quality and reliability. Blended solutions are tailored to meet both operational and sustainability needs. (*Birla Carbon*)

www.birlacarbon.com

## Recovered carbon black

A chemical recycling process developed by the company is said to redefine the recovery of carbon black, rubber and silica from end-of-life tires and other rubber waste, establishing a new industry benchmark for sustainable, cost-effective and scalable material solutions, according to the company. The firm's flagship product is Eldarix r1000 recovered carbon black (rCB), a sustainable alternative to fossil fuel derived virgin carbon black grades. This patented, proprietary recovery process employs ambient temperatures and pressures to preserve the performance of the carbon black, which is said to make it a perfect fit for diverse industrial applications. (*Arduro*)

www.arduro.com

## N990 carbon black

This company's manufacturing plant is said to be the largest producer of carbon black in Turkmenistan and Central Asia. The company currently has an annual production capacity of 3,000 tons of N990 carbon black. The high quality N990 carbon black has been well received by manufacturers seeking a reliable source for this key material, according to the company. The firm's core mission is to supply industries worldwide with a sustainable source of high performance, eco-friendly carbon black at competitive prices. In addition to its focus on technology and innovation, the company is said to place a strong emphasis on quality control. The plant has stringent quality control measures in place at every stage of the production process to ensure that its products meet the highest standards. The company invests in training and development for its employees, pursuing certifications and accreditations, and staying up to date on the latest industry trends and technologies. (*Elastocon*)

www.elastocon.com

## Reinforcing carbon black

Propel E8 engineered reinforcing carbon black is designed to provide superior tread durability at low rolling resistance for high performance tire tread applications, according to the manufacturer. It is said to address the unique challenges posed by the heavier weight and higher torque of electric vehicles (EVs) compared to traditional internal combustion engine (ICE) vehicles. The Propel E8 grade complements the firm's existing solutions within the Propel E series, which are also suitable for use in high performance tires. As the global mobility landscape shifts to electric, the demand for more robust and efficient tires is said to have become evident. Automotive tire manufacturers are seeking to improve the efficiency of EV tires and enable a longer lifespan. The increased weight and higher torque of EVs have shown to increase tire wear by up to 30% in comparison to its ICE counterparts, according to the company. As such, this is generating a rise in end-of-life tires (EOLTs) over the lifespan of an EV, as well as higher total cost of ownership. Propel E8 is said to address such challenges by delivering low rolling resistance with increased tread durability to improve the tire lifespan, maximize range and reduce overall tire waste. (*Cabot*)

www.cabotcorp.com

## Two-roll plasticizer system

Two-roll plasticizer (TRP) technology is said to ensure consistent, high quality results, while saving resources and energy, critical factors in tire production where even minor material

inconsistencies can impact product performance and precision. TRP technology is suitable for the plastization and homogenization of masterbatch and final batch compounds, delivering reproducible material properties. Thanks to its advanced temperature control based on the roll design, the TRP is said to enable a particularly gentle and steady processing. Additionally, the system incorporates modern safety features and automation, boosting both operational safety and productivity, according to the firm. The TRP's lower installed drive power, compared to conventional batch kneaders, is said to increase economic efficiency in the mixing and extrusion area, and facilitates the efficient reprocessing of rework into homogeneous slab material, avoiding losses compared to the remilling of rework material within batch mixers. (*Uth GmbH*)

www.uth-gmbh.com

## Custom rubber molding

This specialist manufactures custom rubber molded products, and offers rubber-to-metal bonding and custom rubber gaskets for a wide range of industries, including transportation, medical, electrical, plumbing, healthcare, appliance, industrial, defense and aerospace. Their products, such as bumpers, tires, guards, gaskets and housings, are designed to provide impact absorption, vibration and noise control, resistance and protection across demanding applications. The company's recently acquired 350 ton vacuum press is said to enhance product quality by eliminating trapped air and gases during the molding process. This innovation significantly reduces defects, improves efficiency and allows for the processing of softer durometer materials previously challenging due to air entrapment, according to the company. Additionally, the vacuum press is said to open doors to new market opportunities, further expanding the company's capabilities. The firm's expertise spans various applications, from automotive and aerospace to industrial and consumer goods, and is said to make them a trusted partner for businesses seeking durable and reliable rubber components. (*Qualiform Rubber Molding*)

www.qualiformrubbermolding.com







## Valve selection program

This manufacturer of control valves and specialty fluid handling products announced updates to its ValveWorks program aimed at improving the sizing and selection process for globe and rotary control valves in accordance with the ISA 75.01 international standard. The latest revision introduces an interface that aligns with the ARI brand identity and includes several functional improvements. Users can now assign a quote number on the project edit page utilizing an alphanumeric text field that supports special characters. Enhancements to the input filters have been implemented for improved robustness and security, addressing previous limitations. A new checkbox on the fluid data page allows users to bypass trim limit filters when necessary. Additionally, a button has been added to the valve data page for removing blankets, which was not previously possible. A bug that occasionally prevented blanket information from being saved has also been fixed, ensuring consistent data retention, according to the company. These updates are said to enhance the existing capabilities of ValveWorks, which provides users with access to over 100,000 combinations of construction attributes. (*Warren Controls*)

www.warrencontrols.com

## Medical tubing capabilities

In-house medical tubing capabilities are being showcased. Machinery includes a static silicone tubing line and a running four-lumen Pebax line, while a running three-lumen TPE bump tubing line and a static 2.5″ 24:1 extruder from the company are being demonstrated. This machinery range is said to promote innovation that addresses market demand for tubing used in minimally invasive procedures, home healthcare applications and wearable medical devices. The four-lumen Pebax tubing line is said to merge the company's robust in-house medical tubing technologies. The lightweight and elastomeric properties of Pebax have made it a prevalent material choice for medical applications involving fluid transfer, catheters and balloon tubing, according to the company. This running line includes the firm's widely used HPE extruder along with a Maillefer die, vacuum tank, puller/cutter and conveyor. A Zumbach gauge system and servo air controllers, along with a Conair chiller and drying system, complete the line. Advantages include a conical helically grooved die with flow divider for uniform distribution; precision vacuum tank control (below 0.5 mbar); a closed loop water system; and more. (*Davis-Standard*)

www.davis-standard.com

## Laboratory cutting/splitting

Two laboratory machines offered by the company include the laboratory cutting/splitting machine for finished rubber samples and the high capacity rubber splitting machine for polyurethane, rubber, plastics, elastomers and thermoplastic materials. With advanced features and robust construction, they are said to redefine standards in efficiency and accuracy for industrial and laboratory applications. The machines are designed to meet the demands of precision cutting and splitting, according to the company. The high capacity rubber splitting machine is designed for industrial scale applications where high volume material processing is essential. Its robust construction and automation capabilities make it a reliable asset for production lines, ensuring consistent results with exceptional accuracy, according to the firm. The laboratory cutting/splitting machine focuses on detailed sample preparation, offering unparalleled precision for finished rubber and thermoplastic products, according to the company. (*Qualitest*)

www.worldoftest.com

## Stress relaxation testing

The company's continuous stress relaxation test system is upgraded both in hardware and software used for these tests. Stress relaxation tests are offered in the temperature range between -70 °C to +350 °C, depending on the chosen configuration. Some of the system configurations can cycle the temperature, and there are also options with individual temperature control in each cell. This means that in an oven with six cells, it is theoretically possible to test up to six different materials and/or in up to six different temperatures at the same time. The tests can be done in air or liquid, in both compression and tension. The company's software for stress relaxation testing, EC 05, is upgraded with over 100 improvements and features. Some examples are evaluation by F/F0, R(t) or ISO 3384 method B directly in the software. Another improvement is the reworked log point viewer, which easily can find, for example, the time points necessary for an Arrhenius plot and a lifetime estimation of rubber materials, according to the company. Additionally, the company provides its EC 15 software for Arrhenius plot, a user-friendly software which is said to make lifetime estimation easier than ever. (*Elastocon*)

www.elastocon.com

## Silicone resin hardener

Epoxy-polysiloxane topcoats are said to produce glossy metal surfaces and provide lasting protection against weathering. However, it is said to be essential that the formulations contain the right hardener. In Silres HP 2000 LV, the company is said to offer an improved version of its successful hardener system for such coatings. The product contains significantly less volatile compounds, as indicated by the suffix LV (for low volatiles). Consequently, it is now said to be possible to formulate metal coatings that are safer to process and to apply. Silres HP 2000 LV possesses the same high quality properties as its predecessor product, and can therefore also be used in existing formulations, according to the company. The silicone resin hardener is said to enable the formulation of isocyanate-free metal coatings that retain their luster, even after years of exposure to sunlight and weathering. The coatings are said to confer excellent corrosion protection, especially when combined with suitable primers, and are thus said to be an ideal solution for protecting ships, bridges and industrial plants. Topcoats containing Silres HP 2000 LV also lend themselves to two-coat systems, resulting in cost savings over three-coat systems, according to the company. With this hardener, the company is said to be assisting customers in the coatings industry who are increasingly prioritizing sustainability. Silres HP 2000 LV can be used to formulate high-solids coatings, for example. Such polysiloxane coatings have a much lower solvent demand and need less frequent renovation, due to their durability, according to the company. Furthermore, the fact that Silres HP 2000 LV allows for the formulation of two-coat systems is said to conserve resources and improve the sustainability of the coatings. (*Wacker Chemie AG*)

www.wacker.com

## Thermoplastic elastomers

Thermoplastic elastomer (TPE) materials, which have long been used in food contact, but also in many other areas such as consumer goods, medicine, pharmaceuticals and a number of other industries, are once again said to be of great importance because they are naturally free of plasticizers, and therefore also BPA-free. TPEs are food compliant and, thanks to their processing technology, conserve resources and save energy, according to the company. This company started in the early 1980s with PVC- and plasticizer-free sealants for crown caps and aluminum closures. Today, a broad portfolio of TPE materials is offered that can be used for closures and packaging, for the medical and pharmaceutical sectors, for all types of consumer goods, and for kitchen utensils for preparing, storing, cooking and baking. For example, ProvaMould 1190 NC is a TPE material that is suitable for reusable coffee cups. The natural colored TPE, optimized for injection molding, offers individual colorability. It is also dishwasher safe. (*Actega*)

www.actega.com

## Recycled rubber solutions

Thanks to its proprietary low temperature devulcanization technology, this company has developed the Sustainable Rubber Compounds (SRC) line, which allows the recycling of rubber from the end-of-life tires (ELT) stream and the production of high-concentration compounds (>20 phr), already adopted by major tire manufacturers. These compounds are said to reduce $CO_2$ emissions without affecting performance, making them ideal for all types of tires (PCR, TBR, AGRI, OTR), with no impact on tire labeling, according to the company. With its ability to significantly reduce the use of virgin raw materials and optimize the recycling of waste materials in the production of new compounds, the firm is said to be paving the way for global expansion, with development plans in India, the USA and Japan. The company is said to be rapidly establishing itself as a global supplier of high quality sustainable devulcanized rubber for the automotive, tire, footwear and rubber goods sectors. It offers devulcanized rubber grades derived from end-of-life tires and provides a circular service for the recycling of production and post-consumer waste, with technical support for compound formulation. (*Rubber Conversion SRL*)

www.rubberconversion.com


## Tire and rubber oils

Secure supply, improved fuel efficiency and a smaller carbon footprint are said to make Nytex 4700 an attractive alternative for tire manufacturers struggling to find formulation solutions for replacing treated distillate aromatic extract (TDAE) oil in their high performance rubber compounds. A complete and readily accessible alternative to TDAE in rubber production, Nytex 4700 requires no reformulation and is said to offer impressive performance in all types of tires. Nytex 4700 is a high viscosity naphthenic black oil which is said to exhibit a valuable combination of high solvency and low volatility. High solvency ensures good compatibility with a wide range of synthetic and natural rubber polymers; and low volatility makes the oil suitable for most polymer compounding and processing operations, according to the firm. Providing a glass transition temperature ($T_g$) similar to that of TDAE, Nytex 4700 is suitable for different parts of tires, both sidewalls and treads, and is said to contribute to an excellent year-round performance. Field tests on real tires made with Nytex 4700 that were carried out by an external laboratory produced results indicating improvements to both traction and rolling resistance, according to the company. Better traction performance on wet surfaces is said to ensure safer driving conditions, and a lower rolling resistance leads to reduced fuel consumption and carbon footprint, according to the firm. (*Nynas*)

www.nynas.com

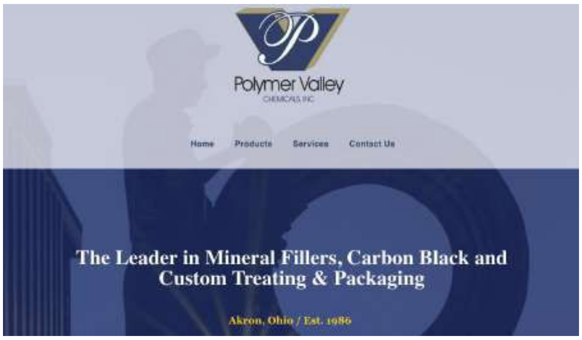
## Light cure adhesives

The medical device industry is said to be facing increasing regulatory scrutiny regarding the use of PVC materials containing Di(2-ethylhexyl) phthalate (DEHP), a known endocrine disruptor. Both the FDA's Center for Devices and Radiological Health and the EU Medical Device Regulation (MDR) 2017 have emphasized minimizing DEHP exposure, prompting manufacturers to explore alternative flexible substrates like thermoplastic elastomers (TPEs), according to the company. However, TPEs are said to present unique challenges in assembly, as traditional methods such as solvent welding and existing adhesives are often ineffective. The shift away from PVC materials is said to have created a pressing need for adhesives capable of bonding effectively with TPE substrates. Many existing adhesives fail to achieve required strength or to maintain performance under heat and humidity aging, critical for medical device reliability, according to the company. In addition, adhering to EU MDR regulations on CMR (carcinogenic, mutagenic or toxic for reproduction) and endocrine substances is said to be essential, further limiting material options. This company is said to address these challenges with the launch of two innovative light cure adhesives: Loctite AA 3952 and Loctite SI 5057. These adhesives are specifically designed to bond TPE substrates and overcome the limitations of traditional assembly methods. The key benefits of the products are said to include enhanced bonding performance; resistance to environmental factors; and regulatory compliance. (*Henkel*)

www.henkel.com

Corporate Sponsor

# Rubber World Industry Links




**Polymer Valley Chemicals** (www.polymervalleychemicals.com) has been a leader in mineral fillers, carbon black and custom treating and packaging for nearly four decades. Founded in Akron, Ohio in 1986 and privately held, Polymer Valley is dedicated to serving the rubber and plastics compounding and mixing markets with innovative products and services.

Specialists in reinforcing fillers, Polymer Valley offers an extensive line of carbon blacks and treated and untreated mineral fillers. Additionally, Polymer Valley provides expert toll conversion, pre-weigh and custom packaging services. Polymer Valley works with customers to create a treated product to fit their needs, and ships throughout North America and internationally.

Polymer Valley Chemicals maintains corporate offices, sales and warehousing in Akron, Ohio, and owns and operates two production and warehousing facilities in Macon, Georgia. Over the years, Polymer Valley Chemicals has expanded rapidly to meet the needs of its customers. Polymer Valley has been and is a pioneer in "green" business practices, and is ISO 9001:2015 certified and Ecovadis rated (Platinum 2024).

Polymer Valley Chemicals serves the rubber and plastics industries with a complete range of carbon blacks, including furnace black (all ASTM grades); thermal black (N990); and mixed grades (50:50 carbon black/silane, PV-Black 071 rCB, bulk transfer from super sacks to bulk trucks). Carbon blacks can be shipped as partial or split loads, or as full truck loads.

Treated hydrous clays, silane treated clays, calcined clays and precipitated silica are offered by Polymer Valley Chemicals. Kaolin clays include PV-Bond, PV-Bright and PV-Float; and silane treated, waterwashed, calcined, exfoliated, airfloated and custom blends. Silica products include PV-Sil, HDS, silane treated, precipitated and silica fume. Preteated silica can eliminate VOC emissions, improve coupling efficiency, reduce mixing cycle time, reduce the number of passes in multi-stage mixing and reduce energy consumption.

**CHEMICALS AND MATERIALS**
R.D. Abbott
AGC Chemicals Americas
AirBoss Rubber Solutions
Akrochem Corporation
APV Engineered Coatings
Arduro
ARP Materials
Brenntag Specialities
Cabot Corporation
Cancarb Limited
R.E. Carroll
Chardon Custom Polymers
Chemours
Çınar Kauçuk
Cri-Sil Silicones
Davis-Standard
DRP Industries
Eagle Elastomers
ECO USA
Emsodur
Harwick Standard
Kayton Industry Co., Ltd.
Kenrich Pertochemicals
Polymer Solutions Group
Polymer Valley Chemicals, Inc.
Prism Worldwide
Pyropel, Inc.
Renkert Oil
Struktol Company of America
Tokai Carbon Cancarb Limited
Valex
Vanderbilt Chemicals
Wacker
Wynca USA
Zochem LLC

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Samson Machinery
Seika Machinery
Sprinter Marking
Troester Machinery Ltd.
Tung Yu Hydraulic Machinery Co.
United Feed Screws
UTPVision
VMI Americas Inc.
Wabash MPI/Carver

**CUSTOM CALENDERING**
Hoosier Racing Tire

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Facts, Inc.
Future Foundation
Gibitre Instruments
Hoto Instruments
Rex Gauge
Seika
The L.S. Starrett Co.
SDS Systemtechnik
Starrett Bytewise
TA Instruments
Ueshima Seisakusho
Uncountable
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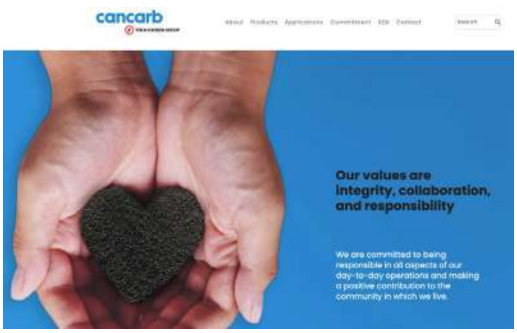


**Cancarb** (www.cancarb.com) is a leader in the development, manufacturing and global distribution of medium thermal carbon black. A proud member of the Tokai Carbon Group, Cancarb is focused on innovation. Cancarb's product portfolio currently has eight different carbon black grades, all manufactured at the world's largest thermal carbon black production facility, located in Medicine Hat, Alberta, Canada. Cancarb received a Platinum Sustainability Rating from EcoVadis in 2024.

Thermax brand carbon blacks are available globally and offer solutions to the rubber industry and more. Thermal carbon black, often referred to as medium thermal black, is derived from thermal decomposition of natural gas. It is one of the purest forms of carbon available on an industrial scale. Easy mixing and good dispersion, excellent processing, smooth extrusion, excellent dynamic properties, low grit compounds, reduced compression set and low electrical conductivity are all part of the Thermax advantage.

Thermax N990 was used to replace furnace black N550 in an EPDM coolant hose formulation. The benefits of Thermax N990 displacing up to 45 phr of N550 included up to a 20% reduction in mixing power consumption, significant improvement in dispersion; up to a 15% reduction in compound Mooney viscosity, allowing for lower energy usage and/or increased throughput in processing; excellent heat and fluid resistance; and maintenance of physical properties.

Thermax N990 was also used to replace furnace black N660 in a bromobutyl (BIIR) model tire inner liner formulation. The benefits of Thermax N990 confirmed in a study included a 12% to 22% reduction in mixing power consumption and improvement in dispersion; a significant decrease in compound viscosity; a slight increase in tack, which is an important property for the tire building process; improvement in fatigue resistance as measured by extension cycles to failure; an 8% to 15% reduction in compound permeability; improvement in adhesion to ply skim; decreased hysteresis at low strains above room temperature for both uncured and cured compounds; and significant compound cost reduction due to higher total filler loadings.


**Tokai Carbon CB** (www.tokaicarboncb.com) is a proud member of the Tokai Carbon Group. Tokai Carbon CB has been producing high quality, furnace grade carbon blacks in the United States since 1961. Tokai's product portfolio consists of more than 40 grades of carbon black produced at its three manufacturing locations. Tokai Carbon CB maintains its corporate headquarters, as well as a state-of-the-art research and development facility, in Fort Worth, TX. Tokai Carbon CB's products are utilized in tires, manufactured rubber goods, plastics, coatings, inks and toners.

ASTM blacks provided by Tokai Carbon CB include: N110, which gives maximum abrasion resistance, highest reinforcement and tensile, and is used in off-the-road tire treads, tread rubber, bridge pads and conveyor belts; N220, which provides excellent abrasion resistance, high tensile, good tear properties and moderate electrical conductivity, and is used in truck and passenger tires, and mechanical goods; N234, which provides superior abrasion resistance versus N220, and excellent wear and extrusion properties typical of improved process high structure blacks, and is used in all elastomers, especially SBR/BR blends for treads and tread rubber; N330, which provides good abrasion resistance with high resilience, easy processing, and good tensile and tear properties, and has a wide range of applications in natural rubber and synthetic rubber compounds for both tires and mechanical goods; and many others.

Specialty blacks provided by Tokai Carbon CB include: SC159, developed as a highly conductive carbon black, which imparts electrical conductivity to rubber and plastic products at low loading levels; SC119, developed as a cost effective conductive carbon black, which imparts electrical conductivity to rubber and plastic products while also offering improved processability; SR155, a high surface area, abrasion resistant N100 series carbon black developed for tire tread compounds requiring a high degree of reinforcement, which is particularly suited for high performance applications where excellent tread wear, handling and traction characteristics are desired; and many others.

**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**

Rubber Division

American Chemical Society

rubber.org

## NEVER STOP LEARNING!

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

**CEUs:** We partner 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

- **February 18, 2025**
  ***Webinar***: *The Fatigue Limit of Rubber*
- **February 19, 2025**
  ***Course***: *Global Regulatory Compliance in the Rubber Industry*
- **February 20, 2025**
  ***Course***: *Dynamic Viscoelastic Properties*
- **February 25, 2025**
  ***Webinar***: *Elastomers for Selective Gas Separation, including Carbon Capture*
- **March 13, 2025**
  ***Webinar***: *Storytelling in Communication – How to Use Stories to Engage your Audience*
- **March 17-21, 2025**
  ***Endurica Workshop***: *Characterizing Elastomer Fatigue Behavior for Analysis and Engineering*
- **March 19, 2025**
  ***Course***: *Rubber Explained*
- **March 25-28, 2025**
  ***Endurica Workshop***: *Application of Rubber Fatigue Analysis with Endurica Software*
- **March 27, 2025**
  ***Webinar***: *Green Tire Chemistry – Optimizing the Tire Magic Triangle through Tread Chemistry*
- **April 1, 2025**
  ***Course***: *Sponge Rubber 101*
- **April 2, 2025**
  ***Webinar***: *How to Create & Deliver Scientific Presentations*
- **April 2, 2025**
  ***Webinar***: *How to Create & Deliver Scientific Presentations*
- **April 9, 2025**
  ***Course***: *Setting Up a Rubber Molding Process*
- **April 15, 2025**
  ***Webinar***: *Communicate & Captivate – Your Guide to Engaging Connections*
- **April 15-17, 2025**
  ***Webinar***: *The Function & Selection of Ester Plasticizers*
- **April 24, 2025**
  ***Course***: *Processing & Testing of Rubber*
- **April 30, 2025**
  ***Webinar***: *U.S. Regulatory Compliance in the Rubber Industry*

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

# People in the News

## Zeon Specialty Materials promotes Cail

Zeon Chemicals L.P., a U.S. based subsidiary of Zeon (Tokyo, Japan), has appointed **Brian Cail** president and chief executive officer of Zeon Specialty Materials. **Darrin Roe** will succeed Cail as vice president of sales and marketing for Zeon Chemicals.

**Brian Cail**
*Zeon Chemicals*

**Darrin Roe**
*Zeon Chemicals*

**Mark Cox**
*Davis-Standard*

**Taylor Murray**
*Gehring-Montgomery*

### Management

Freudenberg Sealing Technologies announced that as of January 1, the company's management team consists of **Matthias Sckuhr**, chief executive officer; **Kerstin Borrs**, chief financial officer; and **Gary VanWambeke**, chief technology officer.

**Mark Cox** was appointed managing director, U.K., for the Davis-Standard Global Services team.

**Phil Littlefield** was named director of operations for Beacon MedTech Solutions.

**Tommi Alhola** joined Nokian Tyres as senior vice president, Central Europe. **Lauri Halme** was appointed senior vice president, North America, for Nokian.

### Sales

**Taylor Murray** has joined the team at Gehring-Montgomery, a distributor of fine and specialty chemicals serving commercial and industrial manufacturers in the automotive, coatings, adhesives and other industries across North America.

### Technical

**Nino Romano** was appointed chief technology officer of the Continental Automotive group sector.

**Aran Kumar** joined the management team at JK Tyre & Industries as chief technology officer.

**Samantha Chastain** joined Teledyne Labs as an instrument support technician for the company's Tekmar brand.

### Associations

**Arthur Dodge**, chair and CEO of Ecore International, has joined the inaugural board of directors for the newly established Tire Recycling Foundation, formed by the U.S. Tire Manufacturers Association and the Tire Industry Association.

## Lars Larsen passes at age 80

**Lars Christian Larsen** died January 24 at the age of 80. Larsen was born in Cleveland, OH and graduated from Brecksville High School in 1962. He was a Vietnam era United States Air Force veteran, and later graduated from Baldwin-Wallace College.

Larsen built a distinguished career in international technical sales in the rubber industry. He served in several key management positions during his 31-year tenure at Struktol Company of America, including as international business manager.

Larsen was the president and owner of Know Polymers, a rubber industry consulting company. He also served as international sales director for APV Engineered Coatings. Larsen was a member of the American Chemical

Society, and authored numerous technical papers. He served as a guest lecturer on industry topics at The University of Akron, and was an accomplished speaker and presenter.

## Classified

# Classifieds

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