

AUGUST 2021

# RubberWorld

years  
**132**

THE TECHNICAL SERVICE MAGAZINE FOR THE RUBBER INDUSTRY VOLUME 264, No. 5

## **Processing promoters:**

**Rubber additives improve mixing and processing**

## **FKM and FFKM crosslinking methods**

**and their effect on upper use temperature of seals**

**Developing ecological thermal insulation  
using multi-surface chlorinated rubber paint**

## **Testing of silicone elastomers**


**using the Dynamic Mechanical Yerzley Oscillograph**

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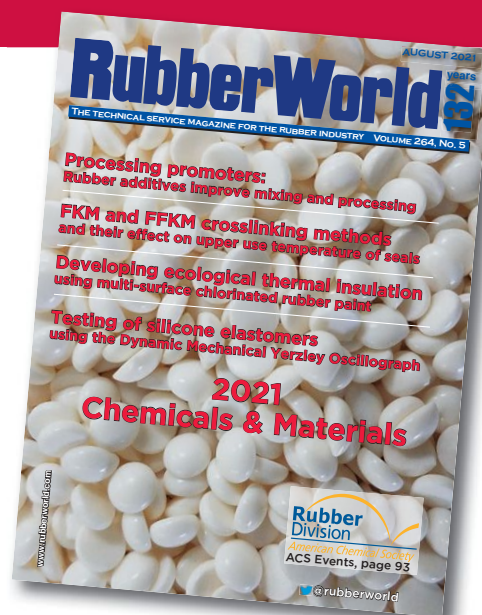
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Cover photo: Courtesy of Polymer Solutions Group

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## Infrastructure plan praised by USTMA

The U.S. Tire Manufacturers Association (USTMA) praised a deal reached by the White House and Senate on a bipartisan infrastructure package. The agreement comes after several weeks of negotiations between the Biden administration and a bipartisan group of senators, and includes several provisions that will help advance research and integration of technologies derived from scrap tire rubber into future infrastructure projects.

"I applaud the important work produced by senators on both sides of the aisle that will allow us to make the necessary investments in our infrastructure and advance technologies in pavement design and stormwater control," said Anne Forristall Luke, USTMA president and CEO. "This truly is a much-needed victory for our nation, proving that there are still willing partners who can come together when it matters and deliver solutions that affect every person in this nation."

USTMA has been engaged in the infrastructure discussions since May when the association first issued a letter to congressional leadership to outline its priorities in an infrastructure package, and has offered additional support for provisions in both the bipartisan Surface Transportation Reauthorization Act of 2021 in the Senate, and the INVEST in America Act in the House.

## Rubber Division's IEC draws near

Pittsburgh is hosting this year's International Elastomer Conference from October 4-7, including the Rubber Division's 200th Technical Meeting, Expo, Educational Symposium, and more. More than 150 companies and organizations are exhibiting at the Expo. Housing closes September 2, so be sure to book your hotel soon. To register for the International Elastomer Conference, visit [www.rubberiec.org/register\\_now.cfm](http://www.rubberiec.org/register_now.cfm).

*Rubber World* publishes the *IEC Daily* tabloid publication, distributed to attendees every day of the conference. News from the show, event schedules, announcement of next year's Science and Technology Award winners, special features and photos from the Expo floor fill the pages of the *IEC Daily*.

*Rubber World's Pocket Spotlight* lists all IEC exhibitors with their company contact details, booth personnel and details on what they will be exhibiting during the Expo.

There is still time to advertise and have your company featured in these important IEC publications. Contact Dennis Kennelly ([dennis@rubberworld.com](mailto:dennis@rubberworld.com)); Mike Dies ([mike@rubberworld.com](mailto:mike@rubberworld.com)); or Pete McNeil ([pete@rubberworld.com](mailto:pete@rubberworld.com)) for details.



Jill Rohrer

# RubberWorld

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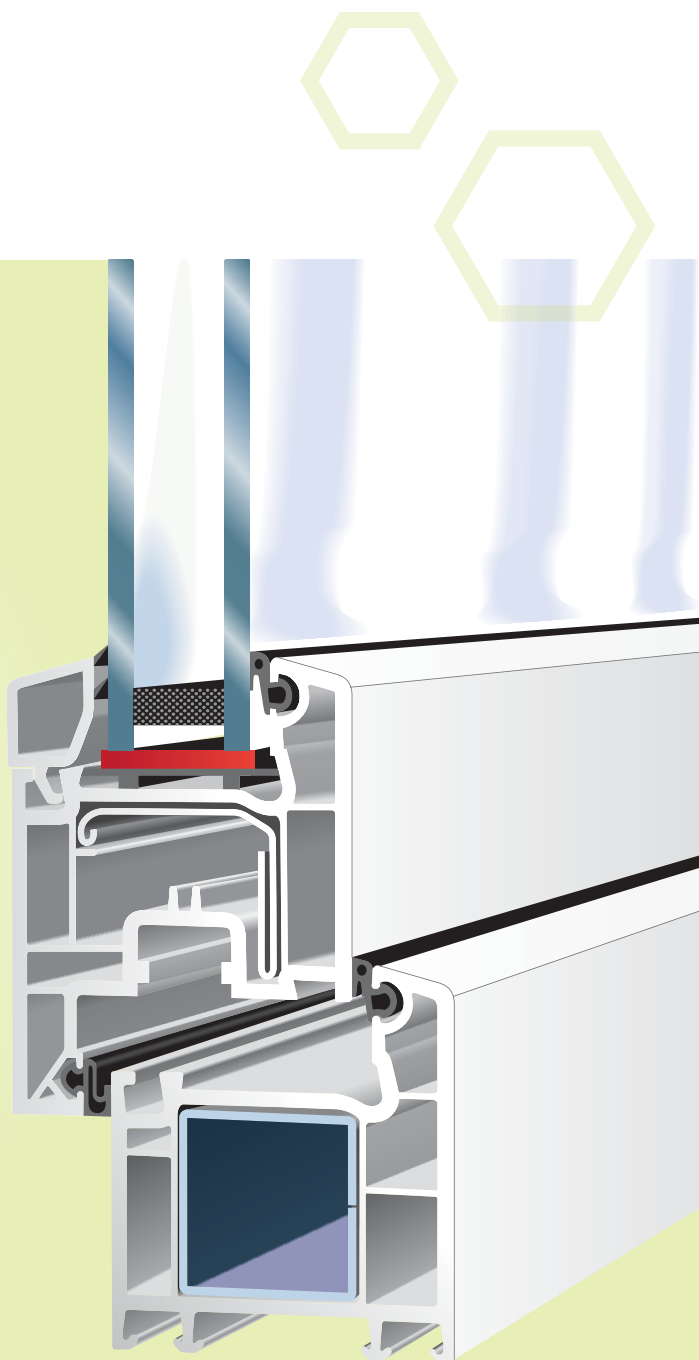
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## Business Briefs

### Minnesota R&P adds innovation center

**Minnesota Rubber and Plastics** ([www.mnrubber.com](http://www.mnrubber.com)), Plymouth, MN, a provider of highly engineered elastomer and thermoplastic solutions, is building a state-of-the-art innovation center adjacent to its corporate headquarters in Plymouth, MN. The 9,000 square foot innovation center is said to provide customers with direct access to some of the industry's foremost materials scientists and engineers in an immersive design-prototype-build-test process.

**Lanxess** ([www.lanxess.com](http://www.lanxess.com)), Cologne, Germany, has completed the acquisition of **Emerald Kalama Chemical**. Lanxess signed a purchase agreement in February. All required regulatory approvals have been received. Lanxess financed the purchase price of approximately \$1.04 billion from liquid funds.

**Rain Carbon** ([www.raincarbon.com](http://www.raincarbon.com)), Stamford, CT, a global producer of carbon-based products and advanced materials, has opened a state-of-the-art rubber laboratory at its production facility in Duisburg, Germany. The \$1.3 million laboratory comprises a complete processing line, starting with a rubber bale cutter, continuing with an advanced laboratory station for internal mixing, and concluding with complete analysis employing rubber process and dynamic mechanical analyzers.

### Harwick related company acquires Western Reserve Chemical

**Harwick Standard Distribution** ([www.harwick.com](http://www.harwick.com)), Akron, OH, announced that a related entity has completed the acquisition of **Western Reserve Chemical**. At this point, the Western Reserve Chemical business will operate in parallel with Harwick Standard. The integration process will be mapped out over the coming months. Ron Anderson (pictured on the left with Harwick President Ernie Pouttu on the right), president of Western Reserve, will continue to be involved in the business. Financial details of the transaction were not disclosed.

Pouttu commented, "Ron Anderson has built a very strong business that will be complementary to Harwick Standard and our brand. This was a great opportunity to pair up two key suppliers in the rubber and plastics industries. Western Reserve Chemicals' customer focused culture makes it a natural fit."

Anderson commented, "This was a great opportunity to work alongside a great company. Now with over 130 years of combined experience in chemical distribution between our two companies, we look forward to continuing great service to our customers."



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## Business Briefs

### R.D. Abbott expands distribution for 3M

**R.D. Abbott** ([www.rdabbott.com](http://www.rdabbott.com)), Cerritos, CA, has signed a distribution agreement with **3M** to expand its distribution of 3M advanced materials to Canada. This agreement will be

#### CONTRACTS, LICENSES

facilitated and managed locally by R.D. Abbott's Canadian division, **RDAbbott Canada, Ltd.**, based out of Burlington, Ontario. The agreement became effective on July 1, and covers fluoroelastomers, perfluoroelastomers, and FKM curatives and process aids.

**Orion Engineered Carbons S.A.** ([www.orioncarbons.com](http://www.orioncarbons.com)), Luxembourg, a global supplier of specialty and high performance carbon black, has partnered with the **Rise Research Institute** of Sweden on a project to develop and produce renewable carbon black. This collaboration is said to represent an important step towards more climate-neutral carbon black production by replacing traditional carbon black feedstock with pyrolysis oil from biomass oil. Orion plans to convert the

biomass into carbon black using its small scale furnace reactor in Kalscheuren, Germany. Additionally, using a pilot scale reactor at its site in Pitea, Sweden, Rise will evaluate the use of electrofuels, such as plasma or hydrogen from electrolysis, as sustainable heat sources for the carbon black process.

**Tireco** ([www.tireco.com](http://www.tireco.com)), Gardena, CA, announced that **Milestar**, a provider of performance tires, is joining **Tread Lightly!** as an official partner. Tread Lightly! is a U.S. based nonprofit dedicated to promoting responsible outdoor recreation through stewardship and educational programs.

**Bridgestone Americas** ([www.bridgestoneamericas.com](http://www.bridgestoneamericas.com)), Nashville, TN, has been selected by **Fisker**, a creator of electric vehicles and advanced mobility solutions, as the exclusive tire partner for the Fisker Ocean all-electric SUV. The Fisker Ocean will sit on custom developed Bridgestone Potenza Sport tires for vehicles sold in Europe and select models sold in North America.

**Prism Worldwide, LLC** ([www.prismww.com](http://www.prismww.com)), Kirkland, WA, a recycled tire rubber and plastics innovation company, closed a \$10.5 million capital funding round, bringing the total capital raised to \$23.5 million. The latest round of investment comes from **Columbia Pacific Advisors** and the **Baty Family**.

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## Business Briefs

### AirBoss reports strong second quarter results

**AirBoss of America** ([www.airboss.com](http://www.airboss.com)), Newmarket, Ontario, Canada, announced strong second quarter financial performance as it enters the second half of 2021 with continued momentum. AirBoss

#### CORPORATE, FINANCIAL NEWS

reported the highest quarterly earnings per share in the company's history, growing diluted earnings per share by 141% to \$0.65 for the quarter ended June 30. AirBoss completed the acquisition of **Blackbox Biometrics**, the developer of the Blast Gauge system for lightweight wearable blast overpressure sensors.

AirBoss of America's management presented at **Canaccord Genuity's** 41st Annual Growth Conference earlier this month.

**Corrie MacColl** ([www.corrie-maccoll.com](http://www.corrie-maccoll.com)), a subsidiary of global natural rubber supply chain manager **Halcyon Agri**, Singapore, launched its Cameroon Outgrower Program which will equip 13,000 smallholder farmers in Cameroon with education and \$28 million in financing to develop 27,000 hectares of multi-crop farms around a core crop of 100% traceable rubber.

**Cabot** ([www.cabotcorp.com](http://www.cabotcorp.com)), Boston, MA, has executed a \$1 billion unsecured revolving credit facility. With this transaction, Cabot has replaced its existing \$1 billion unsecured credit agreement that was scheduled to mature in October of 2022, while adding a sustainability linked pricing mechanism to the new agreement.



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## IRSG predicts process chemicals growth

Global rubber demand declined by 6% in 2020, reaching 27.07 million metric tons, according to the International Rubber Study Group (IRSG). The contraction in 2020 was 1.1% smaller than the IRSG's earlier projection because of strong recovery in the second half of 2020 in the advanced economies and China.

The IRSG forecast comprises two economic scenarios, including a base case scenario rooted from the IMF's baseline GDP forecast, and a downside scenario which assumes bottlenecks in reaching effective vaccine protection and high infection rates of COVID-19 variants causing a drag on the normalization in mobility and recovery in contact intensive sectors in 2021 and 2022.

The vaccine powered recovery in a few advanced economies amid high infection rates of the virus variant, low vaccination rates and more sluggish growth in developing countries are leading to a lopsided

global recovery, which explains much of the upward revision in the global outlook in 2021 under the base case scenario. Global rubber demand in the tire sector is expected to recover by 7.2% in 2021 from a deeper contraction (-7.3%) experienced in 2020. A stronger recovery projected for the non-tire sector (7.6%) is driven by a continuing surge in the demand for rubber products in the global healthcare industry and stronger recovery of rubber products in the supply chain of mobility. The total rubber demand is forecast to rebound by 7.4% in 2021, and moderate to 4.7% in 2022 under the IMF scenario.

Global NR demand contracted by 6.8% in 2020, reaching 12.71 million metric tons, and is projected to rebound by 7.1% in 2021 owing to a sharp recovery expected in the CV segment in the mature and emerging markets. World SR demand declined by 5.3%, reaching 14.36 million metric tons in 2020, and is

forecast to recover by 7.6% in 2021, supported by stronger growth in the U.S., Europe and emerging Asia.

World NR production declined by 5.1% in 2020, reaching 13 million metric tons. Tapping days lost due to risks associated with extreme weather, spread of leaf fall disease and labor shortages during the pandemic crisis disrupted production in major producing countries in Southeast Asia. As many natural rubber producing countries are badly affected by the virus variants, a lower rate of total planting likely will impact the medium and longer term supply. Total NR production is forecast to rebound by 6.5%, reaching 13.86 million metric tons and exceeding the pre-pandemic 2019 level. NR production growth will moderate to 3.5% in 2022, according to the IRSG.

### PU growth to reach 6.3%

According to a report by Markets and Markets, the market for industrial polyurethane (PU) elastomers is projected to reach \$10.5 billion by 2026 from \$7.7 billion in 2021 at a CAGR of 6.3% during the forecast period.

Increasing demand for highly efficient and lightweight materials in the transportation industry and stringent emission regulations implemented by the governments of various countries will spur growth. Moreover, automobile manufacturers worldwide prefer elastomers over conventional metals, as they increase automobile efficiency by reducing fuel consumption, carbon emissions and engine size.

The industrial PU elastomers market is also expected to benefit from the growing demand for replacement of metal and conventional materials in end use industries such as material handling, manufacturing, mining equipment, medical, building, construction, automotive, electronics, military and defense.

The growth of this segment can be attributed to the global low cost and easy availability of thermoset PU elastomers, especially in the Asia Pacific region.

## USTMA sees 11% gain in tire shipments

The U.S. Tire Manufacturers Association (USTMA) projects total U.S. tire shipments of 336.1 million units in 2021, compared to 303.2 million units in 2020 and 332.7 million units in 2019. In comparison with 2020, original equipment (OE) shipments for passenger, light truck and truck tires are expected to increase by 9.9%, 6.2% and 25.3%, respectively, with a total increase of 5.2 million units. Replacement shipments for passenger, light truck and truck tires are also projected to increase by 10.1%, 13.2% and 14.6%, respectively, with a total increase of 27.7 million units.

### USTMA 2021 projected tire shipments (July forecast)

	2021 forecast	2020	% versus 2020	Units versus 2020	2019	% versus 2019	Units versus 2019
<i>Original equipment tires</i>							
Passenger	40.9	37.2	9.9	3.7	46.3	-11.6	-5.4
Light truck	5.7	5.4	6.2	0.3	5.9	-2.8	-0.2
Truck	5.9	4.7	25.3	1.2	6.5	-9.1	-0.6
<i>Replacement tires</i>							
Passenger	224	203.8	10.1	20.6	222.6	0.8	1.8
Light truck	37.3	32.9	13.2	4.3	32.5	14.5	4.7
Truck	21.9	19.2	14.6	2.8	18.9	15.9	3.0
<b>Total</b>	<b>336.1</b>	<b>303.2</b>	<b>10.9</b>	<b>32.9</b>	<b>332.7</b>	<b>1.0%</b>	<b>3.4</b>

*All shipments in millions. Figures are rounded.*



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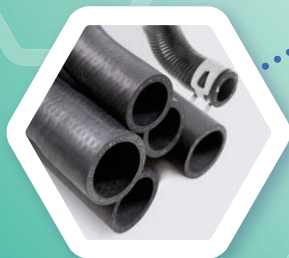
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## Seals for hydrogen production via electrolysis

By providing seals for electrolyzers, Freudenberg Sealing Technologies is contributing to sustainable hydrogen production based on solar and wind power. The seals are designed for automated production, enabling a rapid buildup of high manufacturing capacities.

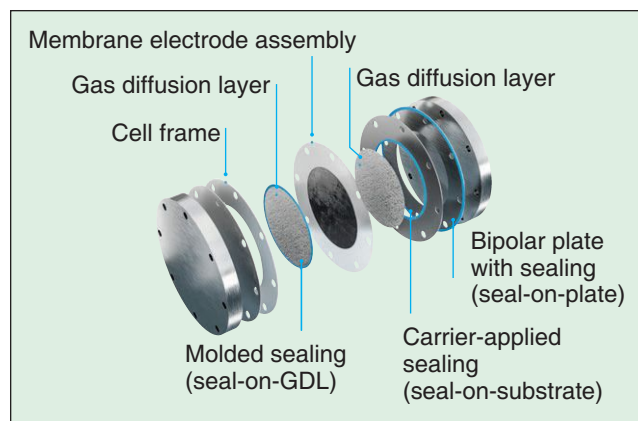
Global production capacity for green hydrogen could increase to more than 250 gigawatts by 2030, according to a study by the International Renewable Energy Agency (IRENA). The technologies needed to split water by using green power (electrolysis) are already well advanced. Experts believe that membrane electrolysis, which in principle works like a fuel cell in reverse, is particularly suitable for intermittent production with a highly fluctuating power supply. However, like the established process of alkaline electrolysis, systems for polymer membrane electrolysis so far have only been built in small quantities. Series production has only become attractive with the increased climate protection plans in China, Europe and the U.S. By now, the first manufacturers are planning gigafactories where electrolyzers with a high degree of automation can be built at significantly lower costs.

This kind of production concept, however, requires components that are designed for mostly automated assemblies from the start. This applies especially to seals, which provide reliable media separation during the electrolysis. The component size itself is one of the challenges: In some cases, seals with a diameter of up to one meter are used, making the seals more difficult to handle. It also places high demands on the installation quality to ensure that the surface pressure is uniform and the tightness is guaranteed for the entire service life.

One of the solutions pursued by FST is based on molding the sealing material directly onto the functional part. The company is already using a similar process to produce gas diffusion layers in fuel cells. Alternatively, the seal can be applied to or inserted into specialized carriers, which in turn are easy to transport and install.

"In principle, we face similar challenges as when we seal large battery housings in electric vehicles," explains Robert Lidster, technical director, gaskets. "That's why we can transfer our expertise to the electrolyzer market." Through its work on fuel cell components, Freudenberg has also gained more than 20 years of experience in handling hydrogen.

Freudenberg has developed materials with very low permeability for hydrogen. These include special rubbers based on EPDM or fluoroelastomers (FKM). Extensive testing of the materials against aggressive media combinations in electrolysis is



underway. For polymer membrane electrolysis, materials that promise a long service life of over 50,000 operating hours are already available. Once a customer specific solution has been found, Freudenberg Sealing Technologies' plants can produce it in high quantities according to globalized standards.

## Production of large o-ring seals

Greene Tweed offers manufacturing solutions for large diameter o-ring seals that exceed the size limitations of conventional compression molding presses. These seals are produced using either the Extensis molded o-ring or horseshoe molding methods. Both techniques are said to be ideal for manufacturing elastomeric seals.

The Extensis method provides a superior joint by bonding partially cured extrudate segments with a proprietary curing agent that is compositionally similar to the base material. The o-ring is then post-cured, deflashed and buffed, as required; similar to the traditional compression molding process. The Extensis method can be used for o-rings with a minimum inner diameter limit of 42 inches; there is no limit to the maximum inner diameter.

Greene Tweed's horseshoe molding process is said to be ideal for critical equipment where asset integrity is paramount, such as compressors used in the oil and gas industry. The process is consistent with that of typical compression molded o-rings and produces a truly homogenous joint with the highest performance.

The company performs extensive dimensional and visual inspection for large o-rings using standard measurement tools, best-in-class optical non-contact measurement systems and ISO 3601-3 criteria.

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## India Rubber Board owned research farm develops genetically modified rubber

A research farm owned by India's Rubber Board, located in Satori on the outskirts of Guwahati, the capital of the north-eastern state of Assam, now boasts the world's first genetically modified (GM) rubber plant, which has been tailored for the climatic conditions of the region. According to the Rubber Board, the GM rubber plant contains additional copies of the gene MnSOD, or manganese containing superoxide dismutase, inserted in the plant, which is expected to help the plant endure the severe cold conditions during winter in the northeast region of India (a major factor affecting the growth of young rubber plants in the region). This unique rubber plant, which is predicted to be a game changer for the rubber growing sector, was developed at the Rubber Research Institute of India (RRII), based in Kottayam, Kerala.

A ceremony was held on June 22 to plant the GM rubber at the research farm, which was conducted strictly adhering to the pandemic protocols. The planting ceremony was held in the presence of a small group of Rubber Board officials, soil conservation department officials and local rubber growers. Speaking during the occasion, Dr. K.N. Raghavan, chairman and executive director of the Rubber Board, explained that following years of painstaking research, the RRII has developed two high yielding hybrid clones of rubber in its biotechnology laboratory, which are adapted to the climatic conditions of northeast India.



K.N. Raghavan

The MnSOD gene has the ability to protect plants from the adverse effects of severe environmental stresses such as cold and drought. Laboratory studies conducted at the RRII revealed that the GM rubber plants over expressed the MnSOD gene as expected, offering protection to the cells. Based on this research, the Rubber Board expects the GM plant to successfully establish and thrive in the region. Addressing common concerns about GM plants, Raghavan pointed out that the planting had been done at an experimental level, following all the mandatory bio-safety measures applicable to field trials involving GM crops. The Rubber Board especially provided assurances that there was no risk of genes flowing from the GM rubber into any other native species.

### India's tire sector seeks effective collaboration on raw materials

India's tire sector is seeking effective collaboration with raw material partners to harness its potential, according to the Automotive Tyre Manufacturers Association (ATMA). According to ATMA Chairman Anshuman Singhania, managing director of

J.K. Tyre and Industries, India's tire industry has immense growth potential in the emerging new world order. However, an effective collaboration between the industry and raw material partners is imperative to harness this potential, Singhania commented at the recently held ATMA Partners' Summit. "As a key sector of the economy, the tire industry has displayed resilience to bounce back after every challenging phase," he was quoted as saying in a statement.

"Last year, the growth plummeted in the first quarter in view of the lockdown. However, the industry staged a strong recovery in the subsequent quarters and the supply side was under stress to meet the demand. This year again, we have witnessed a slowdown in the months of May and June. But I am hopeful of recovery soon as the process of unlocking has begun in earnest and the vaccination drive is gathering momentum," he added. He encouraged the supply chain partners to keep pace and support the recovery to meet demand projected for tires in the coming quarters. According to the statement, a key highlight of the event was the high profile industry presentations made by Indian Synthetic Rubber (ISRPL), the Synthetic Rubber business of Reliance Industries (RIL) and ExxonMobil on such segments as SBR, PBR and butyl rubber, respectively.

### Rubber Research Institute of India delineates rubber plantations

The Rubber Research Institute of India has successfully delineated rubber plantations into low, medium and high landslide risk categories using satellite-derived maps of the distribution of rubber plantations and the district-wise landslide susceptibility zones developed by the Kerala State Disaster Management Authority. These landslide susceptible zones were prepared by integrating multiple databases like topographical maps, remote sensing data, and ground truth and geo-technical investigations. The landslide zones were analyzed geo-spatially with satellite-derived rubber plantation maps.

"We can recommend growers to adopt good agricultural practices at a location according to its vulnerability to landslides, as well as cultural operations that should not be undertaken to minimize the impact of landslides," the officials said. Kerala is characterized by hilly and undulating terrain with a tropical monsoon climate. Triggered by heavy rainfall, the hilly regions of the state witnessed two massive landslides causing many human casualties and serious damage to the environment and properties in the past couple years.

Extremely intense rainfall can destabilize hilly terrain where natural rubber is a popular crop, among others. Occupying more than 22% of the gross cropped area of the state, natural rubber plantations are mostly grown on the undulating and

# India Update

sloping terrain along the foothills of the western Ghats, which are increasingly becoming vulnerable to landslides. A landslide is a natural disaster that cannot be predicted with any degree of absolute certainty. But science based precautions can empower local communities to remain vigilant, reducing the risk of occurrence of a landslide and its impact on people and property if it happens, the officials said.

## Corporate social responsibility webinar offers skill development

The webinar, Transforming the Skill Ecosystem with the Industry CSR, was held July 23 by India's Rubber, Chemical and Petrochemical Skill Development Council, a sector skill council working under the guidance of the Ministry of Skill Development and Entrepreneurship (MSDE). The aim of the webinar was to develop an understanding of the skill requirements in the industry and how the industry can contribute its corporate so-

cial responsibility (CSR) to help make India "the skill capital of the world." The webinar cast light on the perspectives of industry CSR leaders about the role of CSR organizations in transforming the skill ecosystem of the country.

The webinar featured distinguished industry speakers who shared their insights, including Ranu Kulshrestha, head of Bridgestone India Ltd., and Ravi Nayse, vice president (skill development) of the Ambuja Cement Foundation. The webinar was moderated by Anupam Bajpai, chief manager of J.K. Tyre. The speakers felt that companies in both the private and public sectors have adequate scope to contribute and make an impact through their CSR programs. This investment creates a win-win situation for industries by developing a skilled and efficient labor market, while serving their social responsibility purposes. By upskilling and reskilling the youth, companies are facilitating future-ready skilled manpower for society, according to the webinar speakers.

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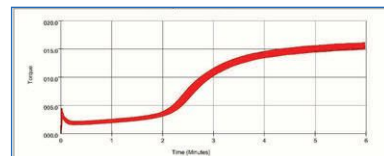
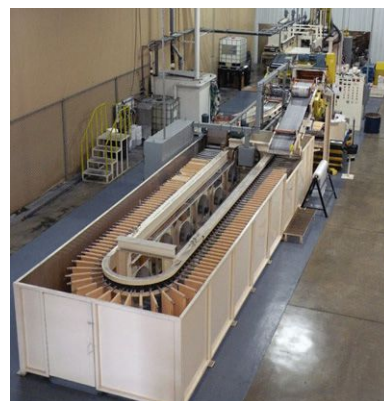


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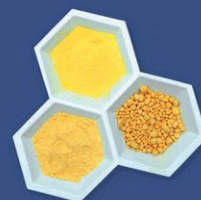
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## Rubber composition comprising a specific crumb rubber

U.S. patent: 11,041,065

Issued: June 22, 2021

Inventors: Damien Thomasson and Olivia Cuscito

Assigned: Michelin

**Key statement:** A rubber composition is based on at least an elastomer, a reinforcing filler, a crosslinking system and a crumb rubber, in which the crumb exhibits a content of sulfur and a content of accelerator such that their sum is less than or equal to 5 parts by weight per 100 parts by weight of elastomer (phr), the said crumb exhibiting a total sulfur content of less than or equal to 4 parts by weight per 100 parts by weight of elastomer (phr) in the composition of the crumb.

## Rubber composition for tire tread

U.S. patent: 11,041,066

Issued: June 22, 2021

Inventor: Miyuki Nakajima

Assigned: Yokohama Rubber

**Key statement:** A rubber composition for a tire tread is a rubber composition containing from 66 to 110 parts by weight of a filler containing not less than 50 wt. % of a silica per 100 parts by weight of a diene rubber containing not less than 40 wt. % of a terminal-modified styrene-butadiene rubber, from 8 to 35 wt. % of a natural rubber and from 15 to 40 wt. % of a butadiene rubber; the terminal-modified styrene-butadiene rubber having a terminal functional group derived from a compound reacting with silanol groups; a styrene unit content thereof being from 38 to 48 wt. %; an oil-extended oil content thereof being less than 30 wt. %; a ratio (BR/NR) of a compounded amount of the butadiene rubber (BR) to the natural rubber (NR) being more than 1.0 and

not more than 2.5; and an embrittlement temperature of the rubber composition being not more than -45°C.

## Tire containing an RFID tag

U.S. patent: 11,046,125

Issued: June 29, 2021

Inventors: Guilherme Petry Breier, Ismael Trindade Fraga, Eric Ericson Fabris, Marcos Tadeu de Lorenzi, Guilherme Berzagui, Roberto Falkenstein, Roberto Tadayuki Yamada, Adiel Moura Nunes Bittencourt, Davi Menezes Lopes and Mendes Paulo de Tarso Luna

Assigned: Ceitec

**Key statement:** The present invention describes a tire, which shows the insertion of a passive UHF RFID tag at its moment of manufacture, in which said tag is affixed on top of the metallic part of the referred tire, more specifically on the bead rim, with the purpose of reducing the mechanical

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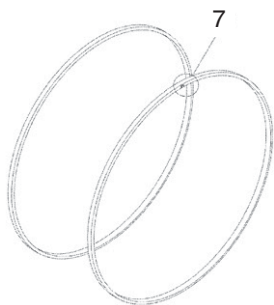
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# Patent News

stress of the tire in question and allowing its tracking in the manufacturing chain since its first manufacturing stages.



## Method for reclaiming rubber and renewed rubber compositions obtainable thereby

*U.S. patent:* 11,041,059

*Issued:* June 22, 2021

*Inventors:* Francesco Picchioni and Antonius Augustinus Broekhuis

*Assigned:* Rijksuniversiteit Groningen

**Key statement:** A method for reclaiming rubber comprises the steps of: (i) providing a starting material comprising a vulcanized rubber polymer; (ii) subjecting the starting material to mechanical stress and at a temperature of at least 200°C to achieve at least a partial destruction of the crosslinks and the backbone structure of the rubber polymer into fragments; and (iii) reconstituting at least part of the fragments in the presence of a branching/grafting agent to obtain a renewed rubber composition.

## Method for preparing conjugated diene-based copolymer, conjugated diene-based copolymer prepared therefrom, rubber composition comprising the same

*U.S. patent:* 11,041,032

*Issued:* June 22, 2021

*Inventors:* In Sung Jo, Byoung Yun

Kim, Hyung Woon Yoon, Jae Min Lee and Woo Seok Choi

*Assigned:* LG Chem

**Key statement:** Provided is a method for preparing a conjugated diene-based copolymer, a conjugated diene-based copolymer prepared therefrom and a rubber composition including the same.

## Rubber composition and pneumatic tire

*U.S. patent:* 11,041,062

*Issued:* June 22, 2021

*Inventors:* Hirokazu Kageyama and Kazushi Kimura

*Assigned:* Yokohama Rubber

**Key statement:** A rubber composition of the present technology includes: a diene rubber; silica; and a heterocyclic compound (the heterocyclic compound does not have a silicon atom) which includes a hydrocarbon group having

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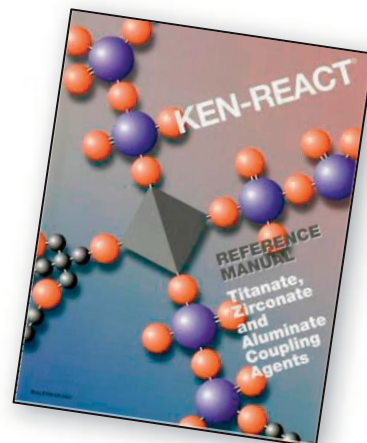
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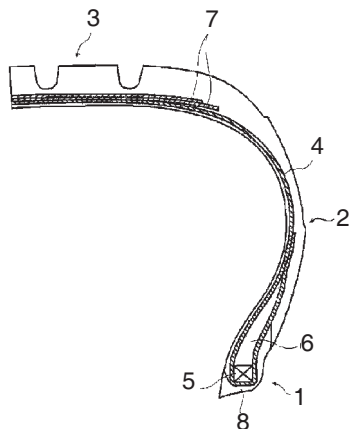


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from 3 to 30 carbons and at least one type of heterocycle selected from the group consisting of a piperazine ring, a morpholine ring and a thiomorpholine ring and a content of the silica being from 50 to 200 parts by mass per 100 parts by mass of the diene rubber and a content of the heterocyclic compound being from 0.5 to 20% by mass with respect to the content of the silica.



## Rubber composition for tire and pneumatic tire

*U.S. patent:* 11,040,572

*Issued:* June 22, 2021

*Inventors:* Kazushi Kimura, Hirokazu Kageyama and Satoshi Mihara

*Assigned:* Yokohama Rubber

*Key statement:* A rubber composition for a tire contains 100 parts by mass of a diene rubber (A) and from 1 to 60 parts by mass of an organic microparticle (B); an average particle size of the organic microparticle (B) being from 0.001 to 100  $\mu\text{m}$ , the organic microparticle (B) having a complex structure composed of a compatible component that is compatible with the diene rubber (A) and an incompatible component that is not compatible with the diene rubber (A), the complex structure having an inner part in which an amount of the incompatible component is greater than an amount of compatible component and an outer part which covers at least a part of the inner part and in which the amount of the compatible component is greater than an amount of the incompatible component. A pneu-

matic tire including such rubber composition has a desirable elongation, rigidity, durability and wear resistance.

## Method for producing recycled thermoplastic rubber masterbatch with improved green strength and tack

*U.S. patent:* 11,034,822

*Issued:* June 15, 2021

*Inventor:* Moshe Rakhman

*Assigned:* Tyrec

*Key statement:* The embodiments of the invention relate to recycled rubber masterbatch which exhibits a sufficient level of green strength and tack. The devulcanization of thermoset rubber is provided by reactive mixing of pulverized rubber, thermoplastic matrix, main-chain backbone antidegradant and green strength enhancer in the presence of a devulcanizing promoter. The embodiments of the invention also provide a thermoplastic dynamically post-vulcanized rubber which comprises at least one devulcanized rubber masterbatch and a polymer, wherein the rubber component is dispersed as a domain in a continuous resin phase and is selectively crosslinked during melt mixing with a molten thermoplastic.

## Rubber compositions containing carbon black and whey protein

*U.S. patent:* 11,046,824

*Issued:* June 29, 2021

*Inventors:* Benjamin C. Galizio, Amy M. Randall and Melissa M. Clark

*Assigned:* Bridgestone Americas Tire

*Key statement:* The present disclosure is directed to rubber compositions comprising at least one rubber, at least one reinforcing carbon black filler and a whey protein component. The whey protein component is in an amount sufficient to provide about 0.1 to about 5 phr whey protein. The present disclosure is also directed to methods of preparing such rubber compositions and to tire components containing the rubber compositions disclosed herein.

## Rubber composition comprising a specific crumb rubber

*U.S. patent:* 11,046,838

*Issued:* June 29, 2021

*Inventors:* Damien Thomasson and Olivia Cuscito

*Assigned:* Michelin

*Key statement:* A rubber composition is based on at least an elastomer, a reinforcing filler, a crosslinking system and a crumb rubber, the said crumb exhibiting a content of isoprene elastomer of greater than 80 phr in the composition of the crumb and the crumb rubber exhibiting a fraction by weight of carbon black ranging from 31% to 35%.

## Methods of making an elastomer composite reinforced with silica and carbon black and products containing same

*U.S. patent:* 11,053,360

*Issued:* July 6, 2021

*Inventors:* Jincheng Xiong, Martin C. Green, William R. Williams, Dmitry Fomitchev, Gerald D. Adler, Duane G. McDonald, Ron Grosz and Michael D. Morris

*Assigned:* Cabot

*Key statement:* Methods to make a silica and carbon black elastomer composite with a destabilized dispersion that includes silica are described, along with particle reinforced elastomer composites made from the methods. The advantages achieved with the methods are further described.

## Rubber compositions

*U.S. patent:* 11,034,821

*Issued:* June 15, 2021

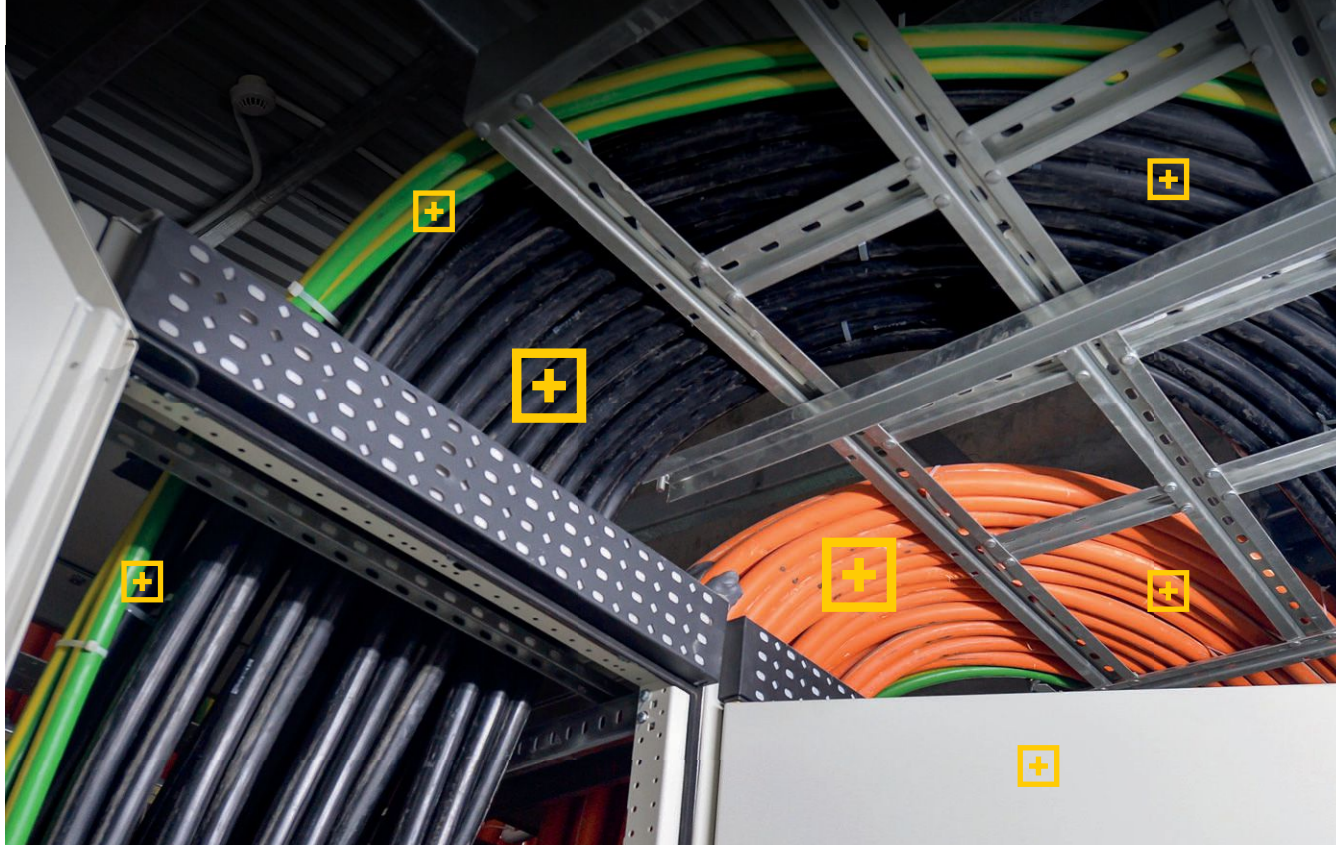
*Inventors:* Hiromi Maeda, Daisuke Koda, Hiroshi Kanbara and Satomi Ohta

*Assigned:* Kuraray

*Key statement:* A rubber composition includes 100 parts by mass of a solid rubber (A), 0.1 to 50 parts by mass of a modified liquid diene rubber (B) having a functional group derived from a silane compound represented by the formula (1) and 20 to 200 parts by mass of a filler (C), the modified liquid diene rubber (B) satisfying (i) to (iii) below: (i) the weight average molecular weight (Mw) is 15,000 to 120,000; (ii) the vinyl content is not more than 70 mol. %; (iii) the average number of functional groups per molecule of the modified liquid diene rubber (B) is 1 to 30.

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# Processing promoters: Additives for rubber compounds improve mixing and processing

by Joel Neilsen and Torsten Ziser, Lanxess

The efficient mixing of rubber compounds comes with many challenges. These include effectively blending the individual raw materials, which involves breaking down and blending different types of elastomers, adequately dispersing large fractions of fillers, oils and small weightings of chemicals in a relatively short time in the internal mixer. Once mixed, the compound then must be processed, e.g., extruded, calendered or molded to form the desired shape which is then vulcanized to produce the final product. The choice of the correct processing promoter will assist in these efforts. Certain promoters function primarily as dispersing agents, whereas others act more as lubricants to speed the mixed compound through the production process. Both types improve overall compound quality and production efficiency. Compound viscosity typically is also reduced. This article will focus on a number of processing promoters offered by Rhein Chemie and their effects on rubber compound quality and processability.

Aktioplast promoters are usually metal salts of unsaturated fatty acids which influence compound cure behavior. They can also contain metal complexes that effectively depolymerize natural rubber. Aflux promoters consist, for example, of fatty esters, amides and alcohols which do not influence vulcanization. Rhenopren products are factices (vulcanized vegetable oils) that provide various improvements, for example in uncured shape retention, surface appearance and some level of reinforcement. Rhenosin products are blends of hydrocarbon resins that aid in dispersion, compatibility and viscosity reduction. Properties of rubber compounds with and without each of these types of processing promoters will be presented and discussed.

## Introduction and background

The rubber industry of today faces the ongoing challenges of producing rubber products that meet or exceed consumer performance expectations and also achieve significant economic realities of production time and costs. A very significant aspect of rubber production for both cost and performance is the mixing and processing of the compound prior to vulcanization. Improving efficiencies in this area has been a major focus since the very beginning of the rubber industry. A tremendous increase in rubber compound production volume capacity occurred early in the 20th century, when Fernley H. Banbury significantly improved the design of the internal mixer, which allowed the gradual replacement of mill mixing and other less efficient mixing technologies to a great extent (ref. 1). The resulting shorter mixing times and higher batch volumes made the challenge of producing uniform, homogeneous compounds even greater. Accordingly, developing additives that improve rubber mixing and processing increasingly became an area of major focus. Rhein Chemie, a business unit of Lanxess, has developed a wide range of processing promoters that have positive effects on the mixing and processing of rubber compounds.

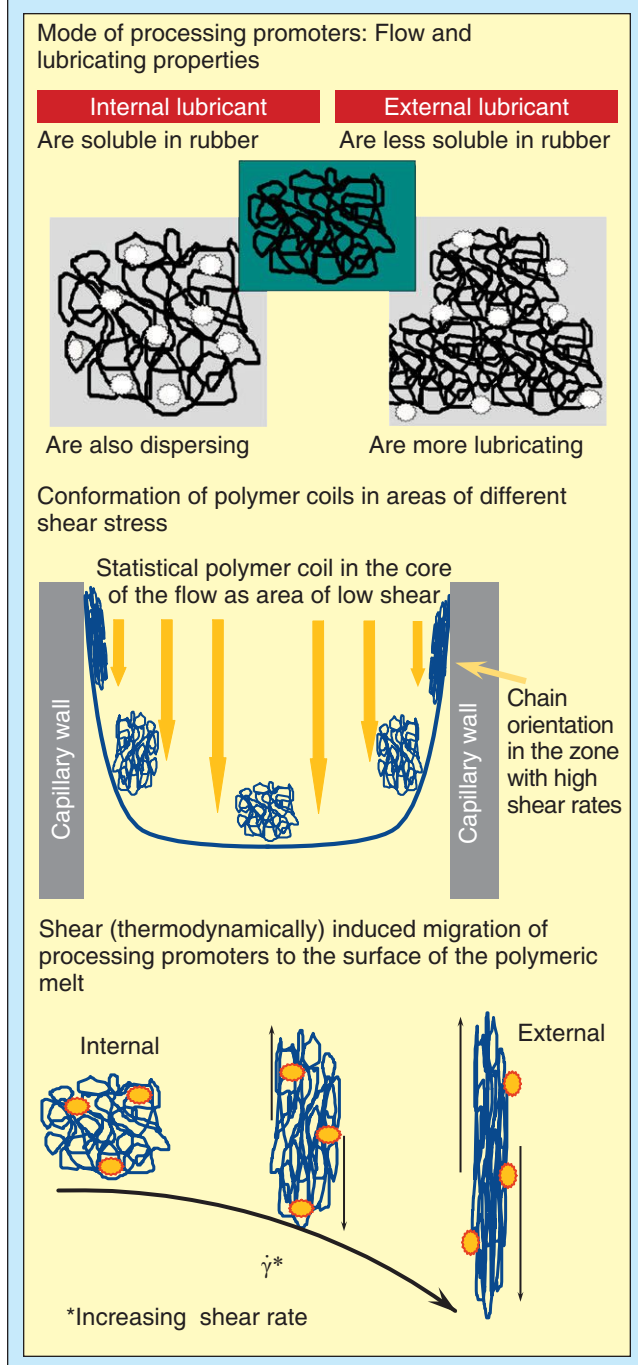
This article will illustrate the performance of five processing promoters from Rhein Chemie by comparing them in rubber compounds with and without the promoter. These promoters represent multiple product lines that Rhein Chemie offers, each bringing unique properties to the compound. Key product lines that will be discussed in this article, including Aktioplast, Aflux, Rhenopren and Rheosin, are all registered trademarks of Lanxess, along with the products utilized in the test compounds, including Antilux, Renacit, Rhenofit, Rhenocure, Rhenogran, Vulkanox and Vulcasil. Each product line contains many other promoters that may be more suitable for a specific application, depending on the particular mixing and processing needs.

Before presenting and discussing results of specific processing promoters, a general description of how they work is in order. The majority of promoters typically fall into three categories, including internal lubricants/dispersants, external lubricants and peptizers, which break down the polymer chains of natural rubber during the mixing process.

Internal dispersants tend to be quite soluble in the rubber matrix and lubricate between the polymer chains, allowing additional movement of the matrix. They are effective in wetting the fillers, and thus improving dispersion. External lubricants are processing promoters that are less soluble in the polymer matrix and tend to migrate to the surface of the compound and lubricate between the compound surface and the process equipment, e.g., extruder, calender, mold, etc. An illustration of these different behaviors is found in figure 1. It should be noted that all processing promoters possess both types of behavior to some degree. The more significant type of performance of a particular processing promoter depends on its composition and its solubility in the compound of interest. The relative polarity of compounding materials will have a significant effect on their compatibility in the compound (ref. 2). Polar processing promoters added to polar elastomers such as polychloroprene are relatively compatible and become primarily internal lubricants.

The opposite is true when a polar promoter is added to a non-polar elastomer such as EPDM. Then, the effect is primarily external lubrication. It should be noted that the filler type (e.g., carbon black or silica) will affect the compound polarity. Increasing temperatures of the compound in the processing operation tend to increase the external lubricating effect of processing promoters. The level of addition will also influence the promoter's behavior; if the loading exceeds the solubility limit, then the promoter will not only internally lubricate the matrix, but will become an external lubricant, as well. Solubility is not the only factor that influences the external lubricating properties of processing promoters. The phenomenon of shear thinning is also an influence. As illustrated in figure 1, the non-Newtonian shear thinning behavior of rubber compounds (ref. 3) near the walls of the processing unit causes the random, entangled nature of polymer chains in the matrix to become more aligned, or thinner, with increasing shear stress, so the viscosity is lowered. This

**Figure 1 - modes and influences of processing promoters**

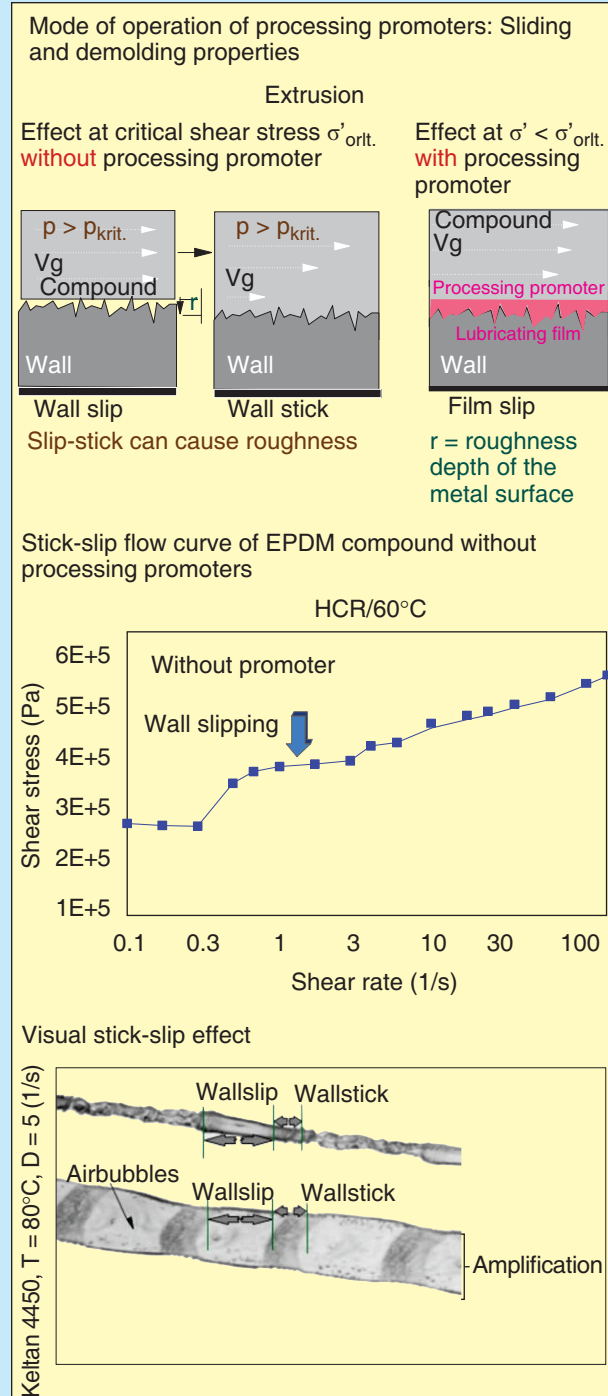


change in the polymer matrix causes some movement of the processing promotor from inside to outside of the matrix, where they then come in contact with the metal surface and increase external lubrication (figure 1). Figure 2 illustrates the importance of adequate lubrication of a rubber compound during processing; in this case extrusion. Figure 2 shows that without the use of a processing promotor, the issues of wall slip or wall stick can occur. Slippage and stick can cause surface imperfections and non-uniformity in compound flow (velocity), which will reduce throughput. The addition of the proper processing

promotor will overcome both of these issues.

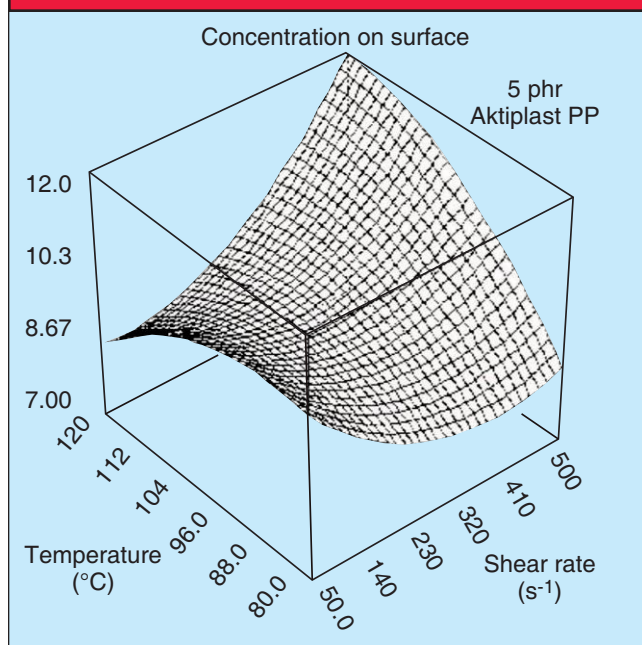
Figure 2 shows the effect of wall slip on the shear stress in a high pressure capillary (HCR) viscometer for a compound that does not contain a processing promotor. The figure gives visual examples of wall slip and wall stick in an extruded ribbon. As mentioned above, certain processing promoters feature peptizing properties which accelerate the mastication process where the polymer chains of the rubber are split into free radicals in the pres-

**Figure 2 - issues that can occur without adequate lubrication**





**Figure 3 - concentration of Aktiplast PP on surface for different temperatures and shear rates**



ence of atmospheric oxygen. The peptizing components of certain processing promoters act as free radical acceptors, which prevent recombining of the polymer chains, thus lowering viscosity.

Now that the ways processing promoters function in rubber compounds have been discussed, the performance of five promoters having different compositions will be presented.

#### Aktioplast PP: Zinc salts of high molecular weight fatty acids

In general, Aktiplast PP is primarily an internal lubricant at low concentrations, and provides good dispersion performance, as well, with a reduction in viscosity. The effect as an internal or external lubricant depends on concentration, temperature and shear rate. Figure 3 illustrates how the concentration on the surface increases with both increasing temperature and shear rate. The soluble zinc salts cause a delay in scorch, and then increase cure rates during vulcanization. This cure activating effect of Aktiplast PP is particularly useful for compounds containing low unsaturated elastomers, such as EPDM. A comparison of compound performance with and without the addition of Aktiplast PP is illustrated. Table 1 lists the EPDM compound recipe. Figure 4 shows the effectiveness of Aktiplast PP as an external lubricant. In figure 4, Mooney viscosity is reduced, and as

**Table 1 - compound study: Improvements in processability using Aktiplast PP (recipe)**

EPDM compound		
Ingredient	Aktioplast PP	Control
Keltan 4450	100	100
CB N550	30	30
Rhenogran S-80	1	1
Rhenogran TMTD-80	2	2
Rhenogran ZnO-80	3	3
Stearic acid	1	1
Aktioplast PP	4	0

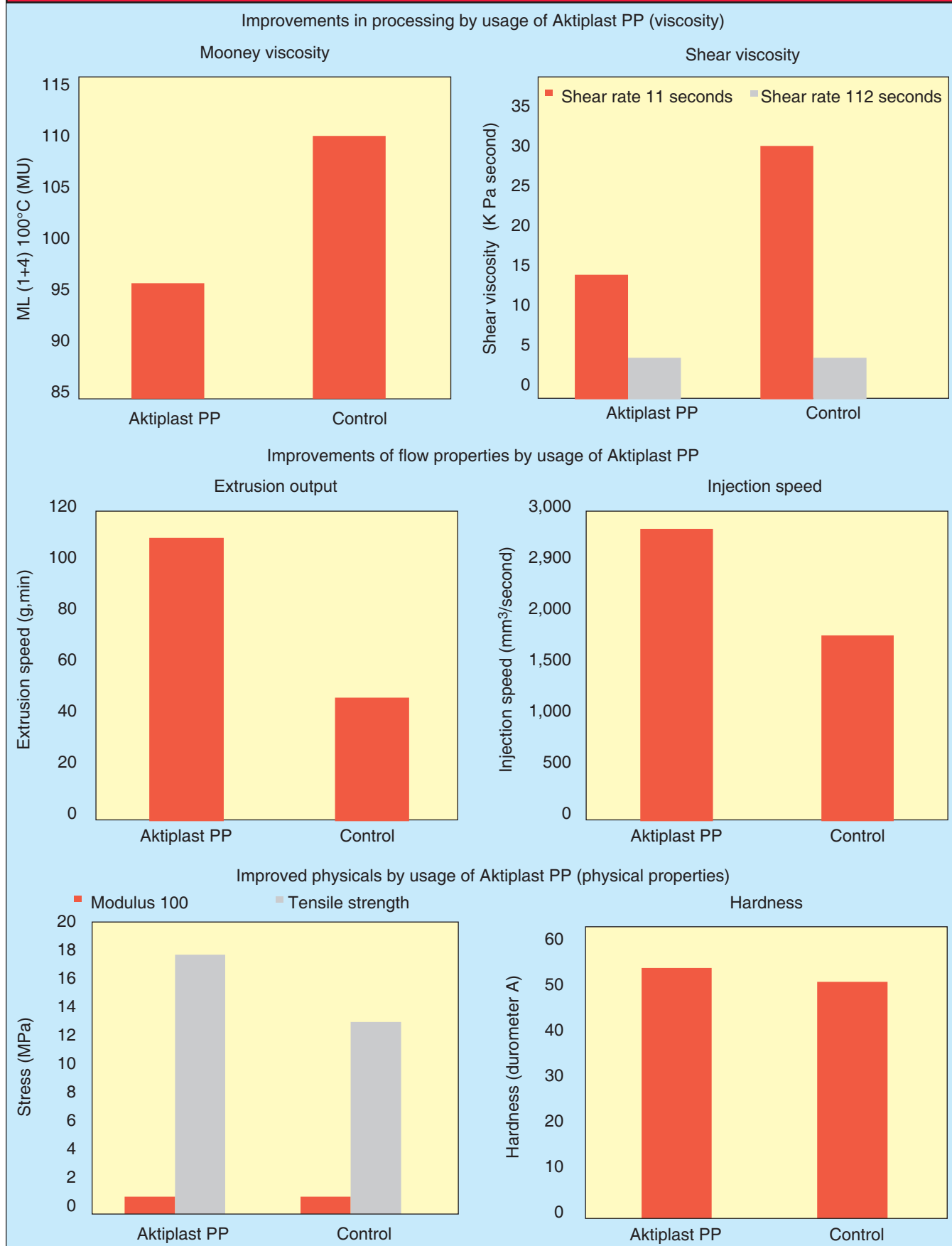
measured in a high pressure capillary viscometer, shear viscosity is also reduced at low shear rates. Shear viscosity is considered a good measure of compound performance under real world processing conditions, since it measures resistance to flow (ref. 4). Figure 4 measures compound flow through the Rheovulkameter and the Garvey die extruder. Both output (mass, extrusion) and injection speed (Rheovulkameter) are increased with the use of Aktiplast PP, indicating increased productivity.

The positive effect of Aktiplast PP on compound physical properties is observed in figure 4. Higher values for tensile and hardness indicate a higher crosslink density achieved with Aktiplast PP. These increases should allow a reduction in the use of zinc oxide, since the zinc salts in Aktiplast PP provide additional activation. The reduction of free zinc oxide is desired because it is well known that leaching of zinc from rubber products has a detrimental effect on the environment, especially

**Table 2 - comparing various cure systems using Aktiplast PP as a process promoter**

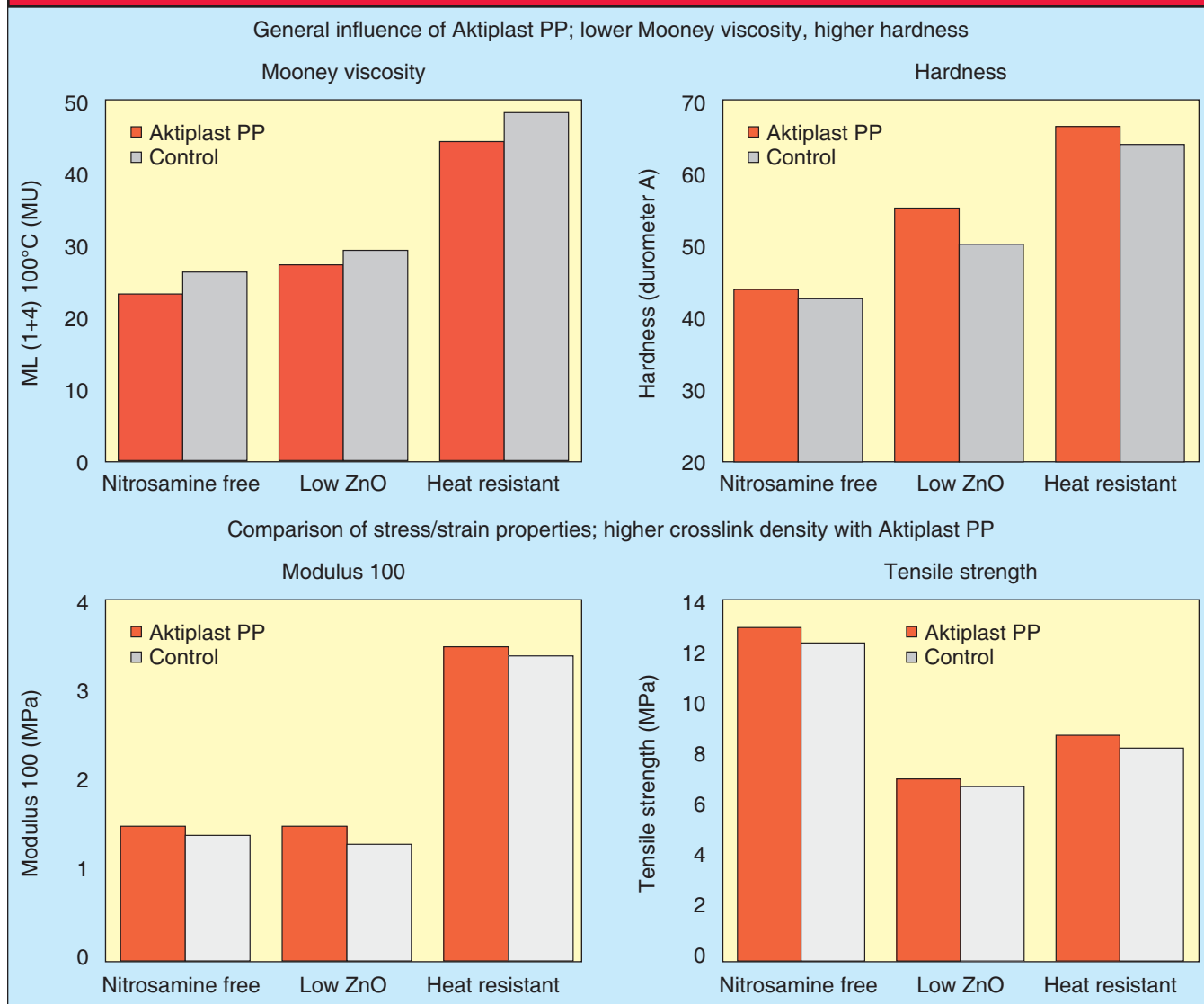
EPDM compounds: Construction and automotive profile applications					
Ingredient	Hardness 45-50 durometer A, nitrosamine free		Hardness 55-60 durometer A, low ZnO		Hardness 65-70 durometer A, nitrosamine reduced, heat resistant
Keltan 9650Q	50.0	50.0	-	-	-
Keltan 6469	100.0	100.0	-	-	-
Keltan 4450	-	-	100.0	100.0	100.0
CB N-550	90.0	90.0	90.0	90.0	60.0
Paraffin oil	25.0	25.0	70.0	70.0	20.0
Silica silitin N85	50.0	60.0	50.0	50.0	0.0
Stearic acid	1.0	1.0	1.0	1.0	1.0
PEG 4000	2.0	2.0	0.0	0.0	0.0
Rhenogran ZnO-80	5.0	5.0	1.5	1.5	5.0
Rhenogran CaO-80	3.0	3.0	10.0	10.0	0.0
Rhenogran S-80	1.6	1.6	1.2	1.2	2.0
Rhenogran CBS-80	2.3	2.3	-	-	-
Rhenocure ZDT/S	1.0	1.0	-	-	-
Rhenogran ZAT-70	2.4	2.4	1.5	1.5	-
Rhenogran MBT-80	-	-	0.8	0.8	-
Rhenogran ZBEC-80	-	-	1.0	1.0	1.2
Rhenogran ZDBC-80	-	-	1.2	1.2	-
Rhenogran TDEC-80	-	-	0.4	0.4	-
Rhenogran DPTT-70	-	-	1.0	1.0	1.0
Rhenogran ZDT-50	-	-	-	-	2.5
Aktioplast PP	0.0	3.0	0.0	2.5	0.0

**Figure 4 - results of using Aktiplast PP as an external lubricant**





**Figure 5 - general influences on EPDM compounds using Aktiplast PP**



aquatic life (ref. 5). Zinc salts from Aktiplast PP are more solubilized, thus requiring lower zinc levels for cure activation. The opportunity for free zinc oxide reduction is seen in table 2 in one of three EPDM based compounds with varying hardness levels (recipes). Figure 5 again shows the reduction in Mooney viscosity, and also higher crosslink density which produced higher values of hardness, modulus and tensile strength, even in the compound where 80% active zinc oxide was reduced from 5 phr to 1.5 phr.

#### **Aflux 42: Blend of fatty alcohols and fatty acid esters**

Aflux 42 is a general purpose, slightly polar processing promoter that does not influence scorch or cure characteristics of rubber compounds. In EPDM compounds, the slight polarity of Aflux 42 causes it to be less soluble than other processing promoters, thus designating it primarily as an external lubricant. Aflux 42 does, however, reduce viscosity, and aids in dispersion, as well. In a generic EPDM based compound, Aflux 42 was evaluated, as seen in table 3 (recipe). Rheometry values and

physical properties in table 3 show that Aflux 42 does not influence the vulcanization or final physical properties of the cured compound. The positive performance of Aflux 42 is clearly seen in table 3, which shows the influence on injection molding characteristics as measured by the Rheovulcameter. Aflux 42 increases both the amount (mass) and speed of compound being injected, and the visual evidence of increased mold fill is clear. Aflux 42 is particularly useful for continuous vulcanization processes for EPDM compounds such as LCM (salt bath) and UHF (microwave).

#### **Rhenopren EPS: Vegetable oil crosslinked without sulfur or chlorine**

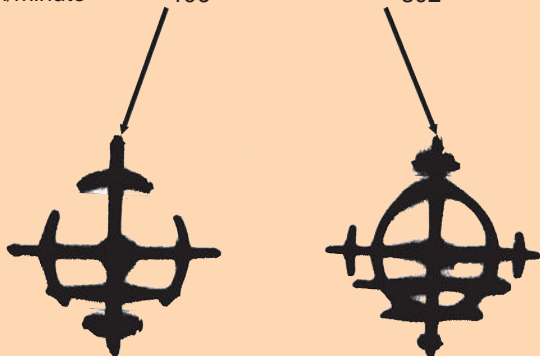
Rhenopren EPS is one of a number of factice products offered by Rhein Chemie. In general, factices are vulcanized vegetable or animal oils that improve processability and dimensional stability of rubber compounds prior to vulcanization. Rhenopren EPS has little effect on vulcanization, and therefore it can be used for either sulfur or peroxide cured compounds. The perfor-

**Table 3 - results of using Aflux 42 as an external lubricant (EPDM recipe)**

Aflux 42 in EPDM compound recipe		
	A	B
Keltan 6750	100	100
N330	30	30
Stearic acid	1	1
Rhenogran ZnO-80	5	5
Rhenogran TMTD-80	1.5	1.5
Rhenogran S-80	1.5	1.5
Aflux 42	0.0	3.5

Vulcanizate properties		
	Control	Aflux 42
ML 1+4 at 100°C	123	108
Rheometer at 160°C		
t10 (minutes)	1.7	1.8
t50 (minutes)	2.9	3.3
t90 (minutes)	11.2	11
Maximum-minimum (Nm)	0.99	0.83
tv <sub>max</sub> (minutes)	2.2	2.6
V <sub>max</sub> (Nm/minute)	0.33	0.25
Stress/strain		
Modulus 100% (MPa)	2.9	2.8
Tensile strength (MPa)	7.6	6.8
Elongation at break (%)	199	192
Hardness (durometer A)	67	66
Density (g/cm <sup>3</sup> )	1.013	1.011

Injection molding properties: Rheovulcameter		
	Control	Aflux 42
g/minute	18.1	29.5
cm/minute	196	302



Aflux 42 helps the flowing process in injection molding, demonstrated by better filling of the mold.

mance of Rhenopren EPS in a peroxide cured EPDM compound is illustrated. Table 4 lists the compound recipe and vulcanized physical properties. Other than a notable increase in Mooney viscosity and lower compression set, no differences are seen between the control and the compound containing Rhenopren EPS. The increase in viscosity illustrates an important difference between factice and other processing promoters, which mainly tend to lower viscosity. The increase in viscosity contributes to improved shape retention of the rubber part prior to vulcanization. The benefits of Rhenopren EPS for the finished

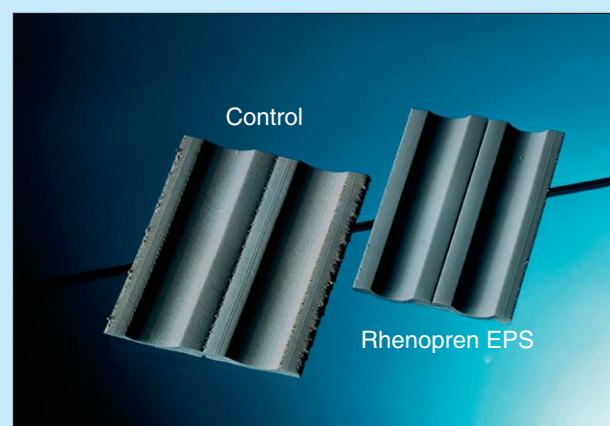
**Table 4 - recipe and properties using Rhenopren EPS in an EPDM profile (peroxide)**

EPDM profile compound with Rhenopren EPS: Recipe		
	Control	EPS
Keltan 3973	130.0	130.0
ZnO	5.0	5.0
Vulkanox MB	1.0	1.0
Vulkanox HS	1.0	1.0
Whiting	60.0	60.0
China clay	135.0	135.0
Paraffinic oil	15.0	15.0
Silane A172	1.5	1.5
Aflux 42	3.0	3.0
Aflux 25	3.0	3.0
Peroxide	7.5	7.5
Rhenofit TRIM/S	1.0	1.0
Rhenopren EPS	0.0	8.0

EPDM profile compound with Rhenopren EPS: Vulcanizate properties		
	Control	EPS
ML (1+4) 100°C	47.0	55.0
Rheometer 180°C		
t10 (minutes)	1.0	0.9
t90 (minutes)	5.8	5.5
Vulcanization 6 minutes, 180°C		
Hardness (durometer A)	62	63
Modulus 100 (MPa)	2.5	2.7
Tensile strength (MPa)	8.4	8.8
Elongation (%)	385	405
Aging 7 days at 100°C		
Hardness (durometer A)	66.0	66.0
Tensile strength (MPa)	9.4	9.8
Elongation (%)	325	370
Compression set (DIN 53517)		
24 hours at 100°C (%)	17	14

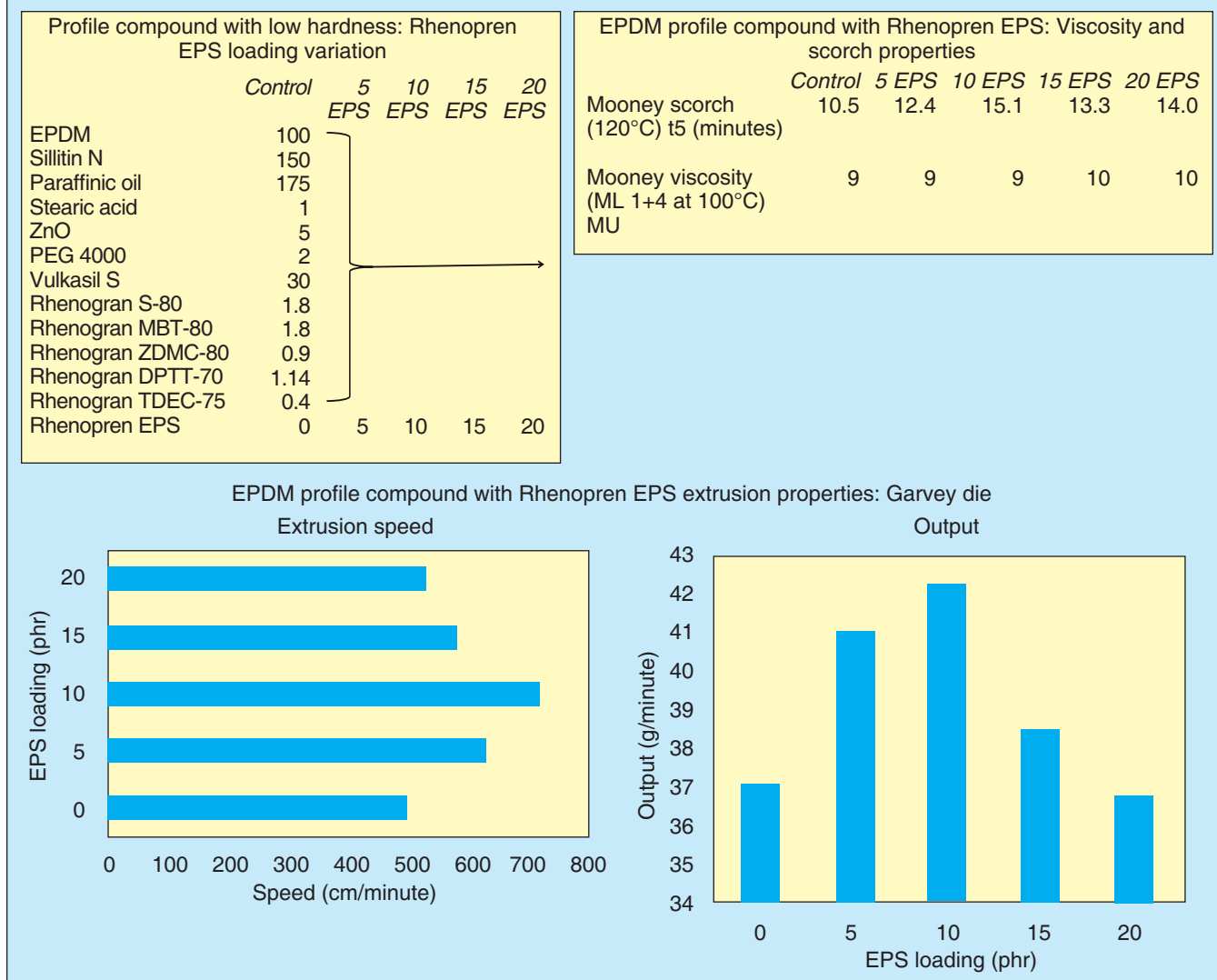
product are seen in figure 6: Much smoother surface appearance characteristics, sharp edges, shape retention and no air bubbles are noted. In another comparison, a loading variation study was

**Figure 6 - EPDM profile compound with Rhenopren EPS: Surface improvement**





**Figure 7 - recipe and resulting properties using Rhenopren EPS in an EPDM profile (sulfur)**



conducted on a very low hardness EPDM compound for profile or roll covering applications (figure 7) (recipe). Figure 7 shows increased scorch delay with increasing Rhenopren EPS; but unlike the higher hardness compound in the previous study, just a slight increase in Mooney viscosity is noted at higher loading levels. In figure 7, Garvey die behavior shows an improvement in extrusion speed and mass output up to 10 phr loading, after which these advantages decline. With higher loading levels of Rhenopren, its solidifying characteristics get more dominant, which reduces flow behavior. Results of this study are a good example of the importance of determining the optimum loading level of a processing promotor based on desired processing requirements, as well as final compound physical properties.

#### Rhenosin 145A: Blend of paraffinic, naphthenic and aromatic hydrocarbons

Rhenosin 145A is an unsaponifiable resin, which allows it to maintain its chemical composition after exposure to alkaline or acidic chemicals (metal salts are not formed). Rhenosin 145A is primarily used as a dispersant of fillers, and as an improver of

homogeneity of elastomeric blends. As with other promotors, it does reduce viscosity and improves processing characteristics (extrudability, calendaring and mold flow). Table 5 illustrates the benefits of this processing promotor in dissimilar rubber compounds.

Rhenosin 145A at 6 phr was evaluated in a generic compound for truck/bus application. Rheological properties show a reduction in Mooney viscosity, and also some delay in Mooney scorch and cure rates. In table 5, physical properties show some reduction in hardness and modulus development, but also a significant increase in tear resistance with the use of Rhenosin 145A. This increase in tear resistance is evidence of the increase in homogenization and dispersion of the compound ingredients.

Rhenosin 145A at a lower level (2 phr) was evaluated in a generic butyl compound for tire curing bladder applications (recipe) (table 6). The low level of processing promotor has no effect on Mooney viscosity or scorch; and unlike the performance in the truck tread compound, where Rhenosin 145A was evaluated at 6 phr, both unaged and aged physical properties

**Table 5 - recipe and resulting use of homogenizing agent; Rhenosin 145A in NR/BR compound**

Rhenosin 145A in NR/BR truck tread compound (recipe)		
Recipe	Control	Rhenosin 145A
SMR-5	80	80
Buna CB10	20	20
Aktioplast F 2635	1.5	1.5
Carbon black N330	60	60
Naftolen ZD	5	5
Vulkanox 4010 NA	2.5	2.5
Antilux wax	2	2
Vulkanox HS	1	1
Zinc oxide	5	5
Stearic acid	1.5	1.5
Sulfur	3.0	3.0
Rhenogran TBBS-80	0.9	0.9
Rhenosin 145A	0	6

**Rhenosin 145A in NR/BR truck tread compound: Rheological properties**

	Control	Rhenosin 145A
ML (1+4) 100°C	67	54
Rheometer data at 160°C		
t10 (minutes)	1.36	1.00
t50 (minutes)	3.52	4.40
t90 (minutes)	4.52	5.68
Mooney scorch at 120°C		
t5 (minutes)	22.26	32.48
t35 (minutes)	26.10	39.42

**Rhenosin 145A in NR/BR truck tread compound: Physical properties (cured 15 minutes at 150°C)**

	Control	Rhenosin 145A
Hardness (durometer A)	65	61
Elasticity (%)	43	38
Modulus 100% (MPa)	3.5	2.7
Modulus 300% (MPa)	14.3	9.3
Tear strength (N/mm)	39	79
Tensile strength (MPa)	17.1	16
Elongation at break (%)	350	360

were not affected, with the exception of improved tear resistance. The evidence is clear that Rhenosin 145A positively af-

**Table 6 - recipe and resulting use of homogenizing agent Rhenosin 145A in IIR compound**

**Rhenosin 145A in a butyl rubber tire curing bladder compound (recipe)**

Ingredients (phr)	Control	Rhenosin 145A
Butyl 301	95	95
Baypren 210	5	5
N330 black	55	55
Castor oil	5	5
Rhenogran WBC-41/IIR resin	19	19
Rhenosin 145A	0	2

**Rhenosin 145A in a butyl rubber tire curing bladder compound: Viscosity and scorch properties**

	Control	Rhenosin 145A
Mooney viscosity (1+4) 100°C	78	82
Mooney scorch at 140°C		
t5 (minutes)	32.3	31.1
t35 (minutes)	56.3	54.5

**Rhenosin 145A in a butyl rubber tire curing bladder compound: Physical properties (unaged)**

	Control	Rhenosin 145A
100% modulus (MPa)	2.0	2.0
300% modulus (MPa)	6.3	6.3
Tensile (MPa)	14.9	16.2
% elongation	560	565
Die C tear (N/mm)	38.6	42.4
Hardness (durometer A)	60	61

**Rhenosin 145A in a butyl rubber tire curing bladder compound: Physical properties (aged 7 days at 150°C)**

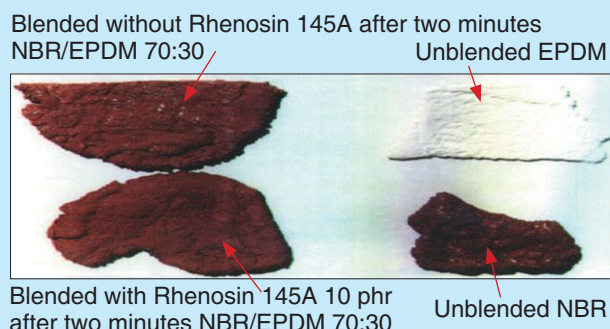
	Control	Rhenosin 145A
100% modulus (MPa)	4.3	4.3
300% modulus (MPa)	9.4	9.4
Tensile (MPa)		
	11.7	11.5
% elongation	370	395
Die C tear (N/mm)	23.6	27.2
Hardness (durometer A)	83	85

fects tear resistance, even at a low level of addition.

The results from the evaluations of Rhenosin 145A in the previous compounding studies show positive performance at different levels of addition (6 phr and 2 phr). It is possible that the levels could be further adjusted by the use of statistical methods such as Design of Experiments (ref. 6) to optimize the level of a particular promoter or any raw material to achieve the desired outcome; in this case, processing and final compound properties.

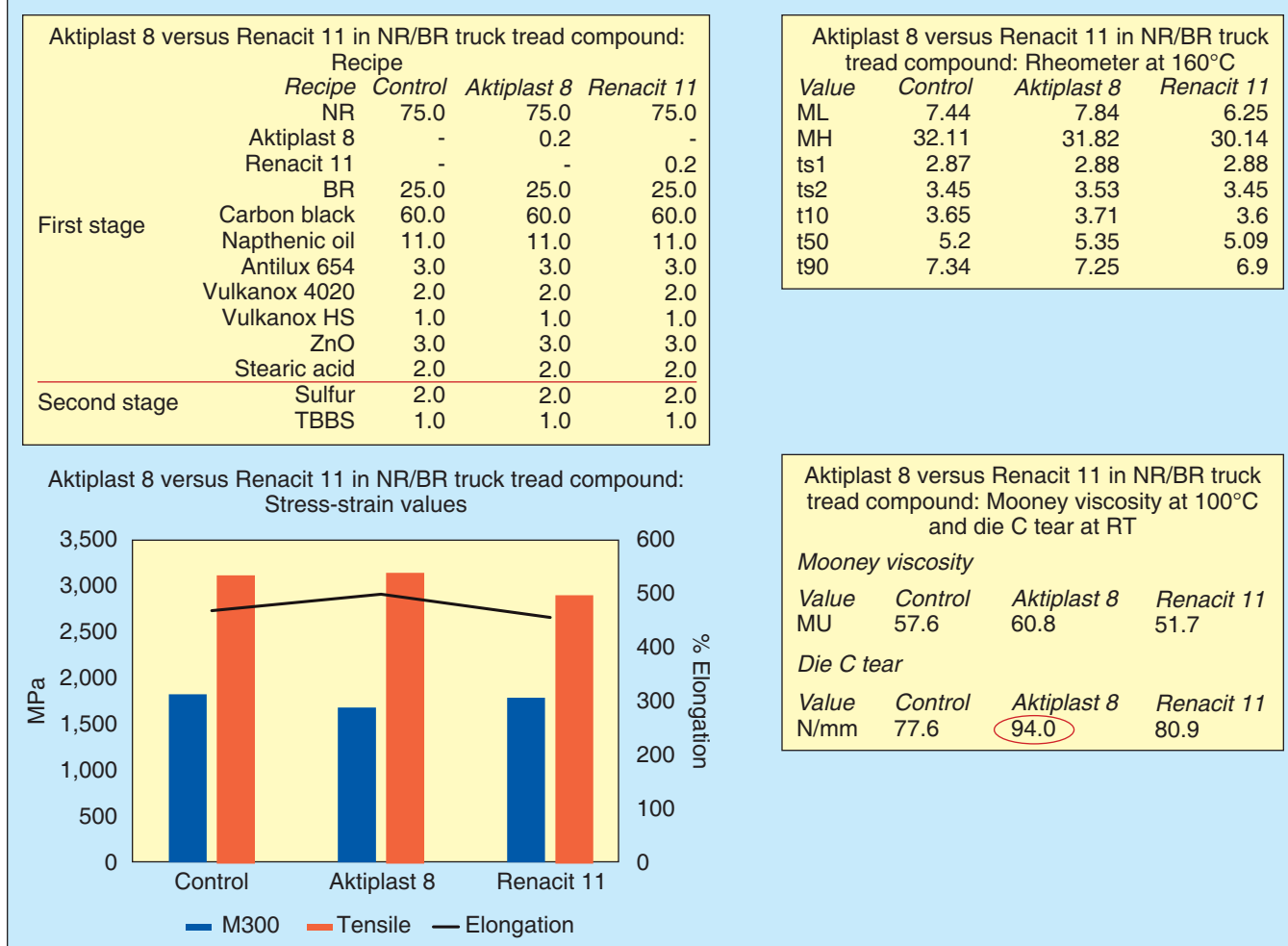
Results of a third evaluation of Rhenosin 145A as an effective elastomer blend homogenizer are shown in figure 8. Two distinctly different elastomers, pale colored EPDM (nonpolar, low unsaturation) and a pigmented nitrile rubber (polar, higher unsaturation) with and without Rhenosin 145A, were mixed for two minutes in an internal mixer. The color of the final blend containing Rhenosin 145A is uniform, whereas light areas of the

**Figure 8 - homogenization of EPDM and NBR blend using Rhenosin 145A**





**Figure 9 - recipe and resulting use of peptizer Aktiplast 8 versus Renacit 11 in NR/BR compound**



blend without the promotor show a reduction in homogeneity.

#### Aktioplast 8: Metal complex with blend of fatty alcohols and fatty acid esters

Past work has determined that metal complexes based on iron, for example, are effective peptizers for natural and synthetic elastomers (refs. 7 and 8). Specifically for Aktiplast 8, the metal (Fe) complex along with the blend of petroleum based fatty components allow it to be both an effective peptizer and processing aid for rubber compounds, particularly those based on natural rubber. Figure 9 shows a comparison of Aktiplast 8 to a well known peptizer, Renacit 11 (2,2'-dibenzamidodiphenyldisulfide, or DBD) in a rubber compound containing a high level of natural rubber (recipe). Rheometry values listed in figure 9 show no significant differences for rate of cure development or final state of cure for compounds containing the peptizers versus the control. Physical properties (modulus, tensile, percent elongation) shown in figure 9 also show equivalence. Figure 9 shows both Mooney viscosity and die C tear resistance. It is evident from viscosity values that Renacit 11 was more effective in breaking down the natural rubber than Aktiplast 8. Two probable reasons for this are due to the low level added (0.2 phr), and

also that the carbon black filler can reduce the effectiveness of Aktiplast 8. Slightly increasing the level of addition, and a mastication step involving Aktiplast 8 without carbon black should overcome this limitation. A significant positive for using Aktiplast 8 is seen in the tear results. The plasticizing components of Aktiplast 8 significantly improve the homogeneity of the natural rubber/polybutadiene blend, which leads to better tear resistance. This is a very desirable property, since natural rubber in blends with synthetic rubber are often used in severe off-road service conditions, such as heavy tires and belting in the mining and logging industries.

#### Conclusions

Processing promotors are essential to produce homogenous rubber compounds that mix and process efficiently. The evaluations of the five processing promotors presented in this article illustrate the wide range of promotors that are currently available, and also how selecting the optimal promotor involves having clear knowledge of what is required for successful compound processing and final cured physical properties. In addition to promotor type, it has been shown that the level of addition is quite important to determine the best overall performance. The



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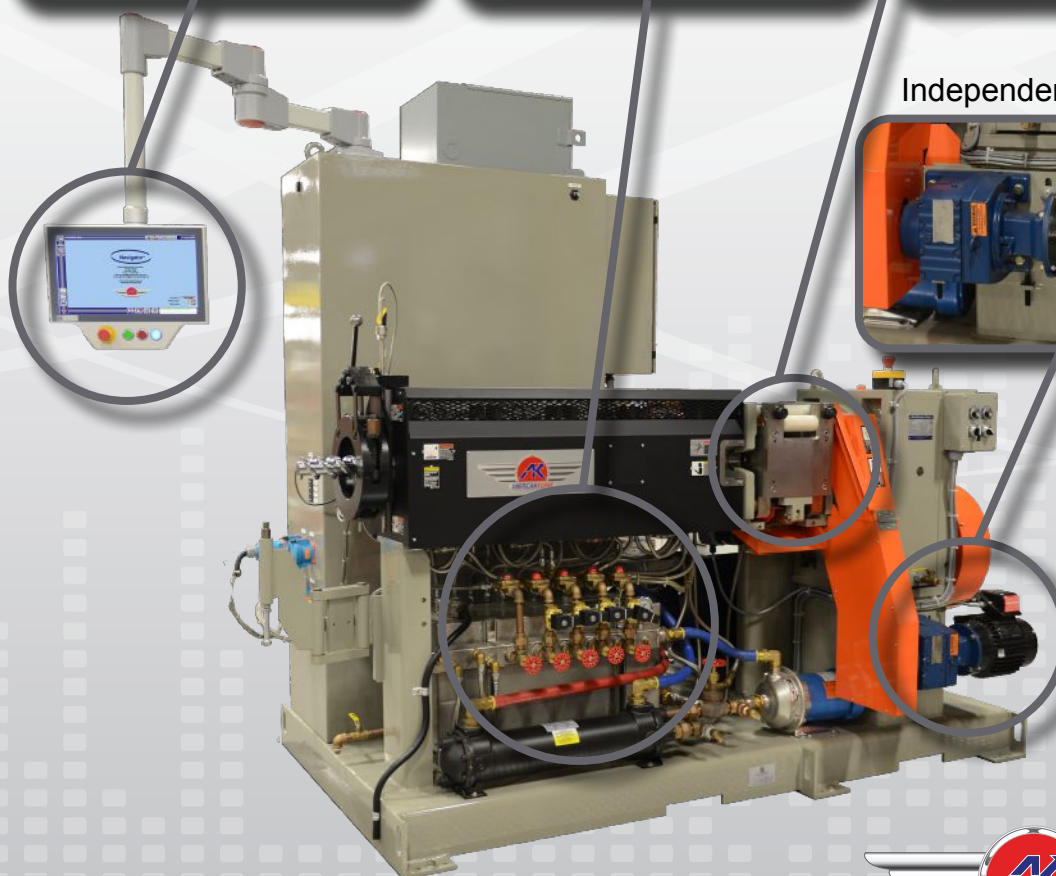
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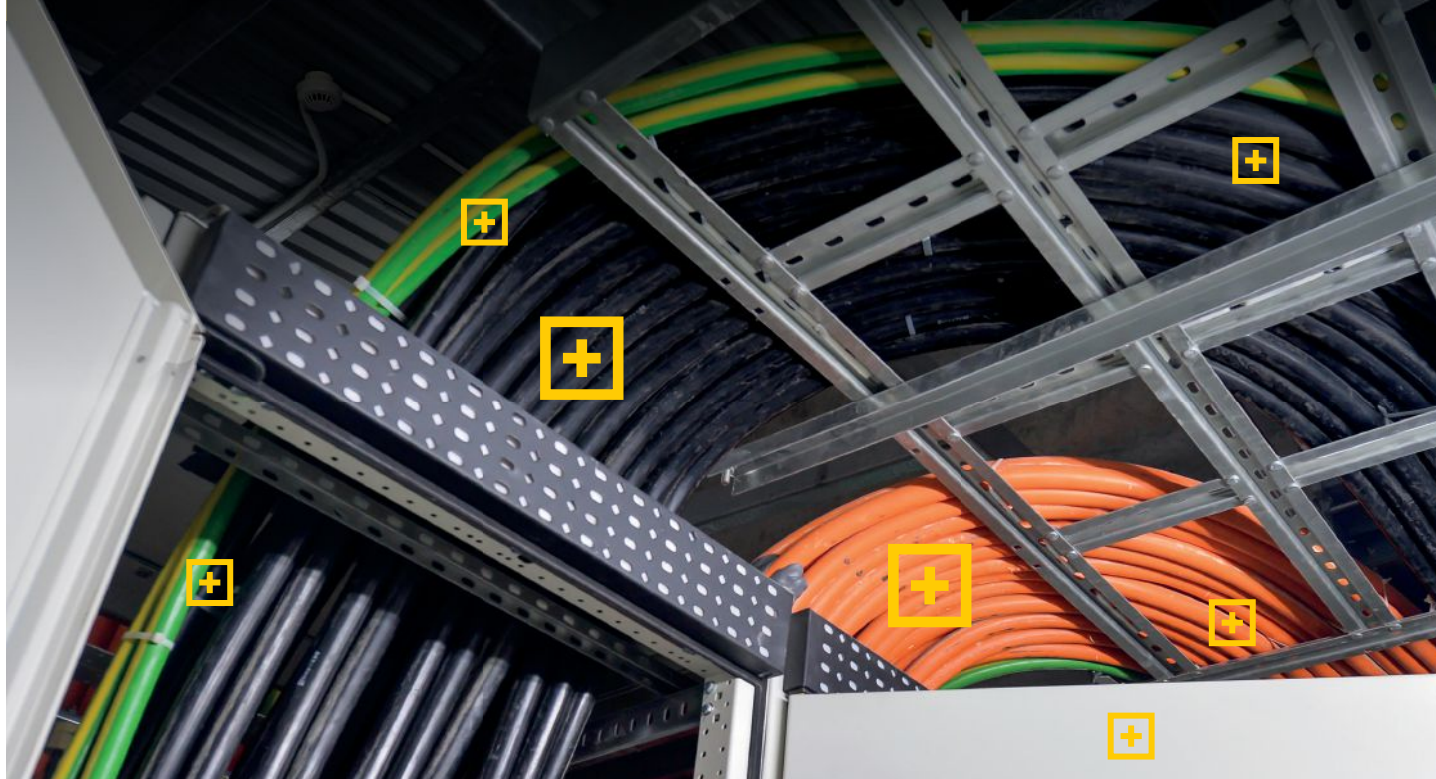


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evaluation of multiple promoters and a range of addition levels should involve statistical methods to most effectively select and optimize the use of a particular processing promoter in the compound or compounds of interest.

This article is based on a paper presented at the 198th Technical Meeting of the Rubber Division, ACS, October 2020.

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# FKM and FFKM crosslinking methods and their effect on upper use temperature of seals

by Ronald R. Campbell and Thomas S. Reger, Greene, Tweed & Company LLC

Fluoroelastomers (FKMs) were first introduced to market more than 50 years ago in response to performance needs in the aerospace industry. Their increased thermal stability and chemical resistance, and comparable mechanical properties relative to hydrocarbon rubber materials provided significant performance benefits. Not surprisingly, FKM compounds soon became widely adopted in seals and gaskets for many other applications across the automotive, oil and gas, semiconductor and pharmaceutical/food processing industries, where long term durability and reliability in challenging environments was critical (ref. 1).

Perfluoroelastomers (FFKM) (ref. 2) offered the next evolution in high temperature materials. The discovery of polytetrafluoroethylene (PTFE), a heat resistant and chemically inert fluoroplastic, followed by perfluoroalkoxy (PFA) copolymers having improved melt processability, led to the availability of perfluorinated tubing, piping, fittings and films for specialized applications (ref. 3). The incorporation of a cure site monomer into the polymer backbone allowed for crosslinking and elastomeric properties.

FFKM elastomer compounds provide the highest temperature capability and broadest chemical resistance of any rubber material. They are used for sealing in the most aggressive environments, including gas turbines in aircraft engines, processing pumps in chemical plants, downhole drilling equipment for oil and gas exploration, and chamber seals in semiconductor processing equipment (ref. 4). Despite their higher cost, the value of FFKMs is realized by minimizing equipment downtime and enabling new technology development.

The use of electrical submersible pumps (ESPs) in steam-assisted gravity drainage (SAG-D) in oil sands is a good example of how the high temperature capability of FFKM can provide value to the customer by decreasing the meantime between failure. ESPs operate between 135°C and 220°C in this application, with maximum operating temperatures around 250°C. Internal analysis based on publicly reported data showed that upgrading critical components within the ESP, such as the seals, to high temperature materials such as FFKM could double the meantime before failure (ref. 5). By extending the lifetime of the ESP, operators avoid non-productive downtime and the expense

of pulling an ESP out of a well ahead for scheduled maintenance. However, a key step in determining whether a material will perform reliably in this application is to establish the appropriate high temperature range.

In this article, we examine the upper use temperature of a set of FKM and FFKM elastomer compounds as a function of their crosslink chemistry (peroxide or nitrile) and curative type.

## Experimental

The exact formulations for the compounds described herein are proprietary; however, they all contain a minimum of 20 phr of carbon black and use base polymers available from major fluoropolymer suppliers, such as 3M, Daikin and Solvay. Tri-allyl-isocyanurate (TAIC) was purchased from Chemours, and BOAP was purchased from TCI America. The 2,5-dimethyl-2,5-di-(tert-butyl peroxy) hexane was purchased from either Arkema (Luperox 101) or Vanderbilt (Varox DBPH-50). All compounds were mixed on either a two-roll mill or in an internal mixer prior to molding and post-cure. Physical property values were measured on AS568A-214 o-rings in accordance with ASTM D1414. Durometer A hardness was measured on buttons according to ASTM D2240. Compression set tests were performed on AS568A -214 o-rings (ASTM D1414) in accordance with ASTM D395 Method B, Compression Set Under Constant Deflection in Air.

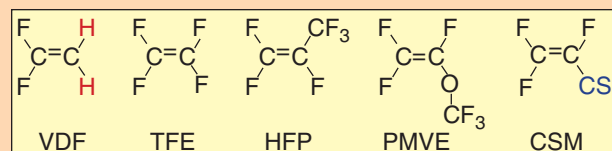
## Background

Examination of the polymer composition and crosslink structure of fluoroelastomers and perfluoroelastomers aids in understanding the properties and performance of these materials. All FKM elastomers contain vinylidene fluoride (VDF) and at least one additional monomer type. These monomers include tetrafluoroethylene (TFE), hexafluoropropylene (HFP), perfluoromethylvinylether (PMVE) and, optionally, a cure site monomer (CSM) (ref. 6). The structures of these monomers are shown in figure 1.

Crosslinking of FKMs is typically accomplished through either a bisphenol or a peroxide mechanism (ref. 7). Bisphenol crosslinking does not require the presence of a cure site monomer, while the peroxide method does. Peroxide cured FKM materials have higher chemical resistance, but lower thermal capability than their bisphenol counterparts.

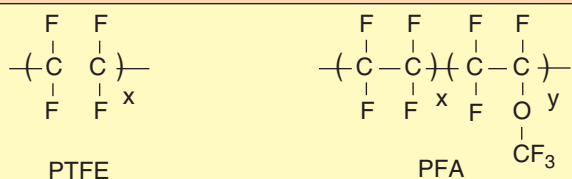
FFKM elastomers are primarily composed of TFE and PMVE, along with a small amount of a CSM to allow for crosslinking. The fully fluorinated carbon backbone of FFKM elastomers is the principal reason for their excellent chemical resistance and high thermal stability. The high strength of the carbon-fluorine bond (~116 kcal/mol compared to ~100 kcal/mol for a comparable carbon-hydrogen bond) underlies these characteristics (ref. 4). In addition, the carbon-carbon bonds in the backbone of a perfluorinated polymer are significantly stronger than those from an equivalent hydrocarbon (ref. 3).

**Figure 1 - monomers for FKM and FFKM polymers**

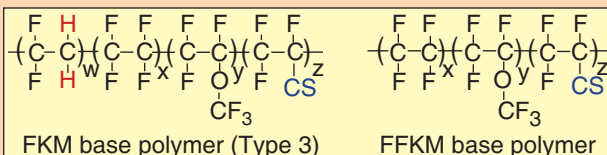




**Figure 2 - structures of common fluoroplastics**



**Figure 3 - general structures of FKM and FFKM elastomers**

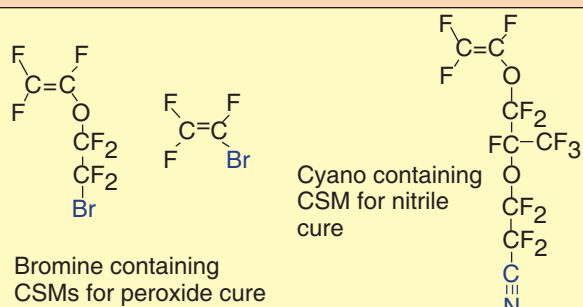


As previously mentioned, PTFE and PFA are perfluoroplastics with excellent thermal properties, and their general structures are shown in figure 2. Due to their lack of crosslinking, both PTFE and PFA are not elastic and will soften substantially above 250°C. In fact, both materials will melt at temperatures just beyond 300°C. Incorporation of a cure site monomer and subsequent crosslinking (or curing) of perfluoropolymer chains confers elasticity and allows the material to return to near its original shape after being under compression. This stands in sharp contrast to the aforementioned plastics that would undergo permanent deformation under similar conditions.

Figure 3 illustrates representative FKM and FFKM base polymer structures that contain a cure site monomer. Note that these general structures present many opportunities for suppliers to customize their material offerings. The monomer ratio and choice of cure site monomer both contribute greatly to compound properties. Development of novel monomers in the vinyl ether class (structures not shown), for example, has provided access to new low temperature compounds (ref. 8).

There are two general classes for curing of FFKMs, including peroxide and nitrile (ref. 9). FFKMs may also be peroxide

**Figure 4 - representative structures of cure site monomers**



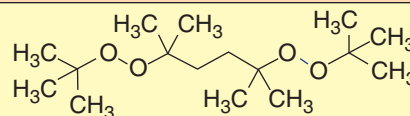
cured if an appropriate cure site monomer has been included in the base polymer. As mentioned earlier, FFKMs may also be cured by a bisphenol or diamine mechanism that does not require a cure site monomer, although these methods will not be discussed further in this report (ref. 7).

The cure site monomer for the peroxide cure class contains either a reactive bromine or iodine group (ref. 9). The carbon-bromine or carbon-iodine bond provides a site for bond scission and radical formation that begins the crosslinking process. Nitrile curing is currently limited to FFKMs and, appropriately, the cure site monomer contains a terminal nitrile group. Representative structures of cure site monomers for peroxide cure and nitrile cure are shown in figure 4. The cure process of both the peroxide and nitrile cure class connects individual polymer chains through reactions taking place between the cure site monomer and a curative and/or catalyst. The curative is a separate component that is usually incorporated during the compounding process. Curative selection, in addition to base polymer choice, is also critical for achieving optimal material performance.

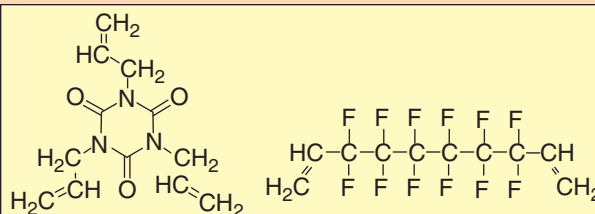
The crosslinking mechanism for peroxide cure compounds is the same for FKM and FFKM elastomers. A peroxide initiator such as 2,5-dimethyl-2,5-di(t-butylperoxy)hexane is necessary to generate radicals that begin the crosslinking process (figure 5). This occurs through homolytic cleavage of the labile oxygen-oxygen bond of the peroxide to give oxygen centered radicals. These can undergo addition or abstraction reactions, as well as further decompose to carbon centered methyl radicals.

Ultimately, a radical is produced at the site of the carbon-bromine bond on the cure site monomer, as previously described. This radical can then react with pendant double bond groups on the curative. Triallyl isocyanurate (TAIC) (figure 6) is a very common curative for both FKM and FFKM peroxide cure polymers. Its low cost and ease of handling make it an attractive curative for large scale production processes. Further, the presence of three reactive double bonds offers potential to form a robust crosslink network.

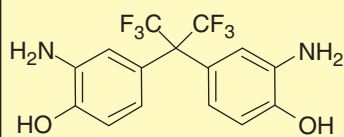
**Figure 5 - peroxide initiator (2,5-dimethyl-2,5-di(t-butylperoxy)hexane)**



**Figure 6 - peroxide curatives triallyl isocyanurate/TAIC (left) and bis-olefin (right)**



**Figure 7 - BOAP curative for nitrile cure FFKM elastomers**



carbon-fluorine bonds on the main polymer chain. Second, the cyclic urea core structure of TAIC is also more vulnerable to thermal degradation than the polymer backbone. Finally, due to its lack of fluorination, TAIC does not readily blend with the base polymer and may agglomerate prior to the cure process, which can lead to homopolymerization during curing and formation of concentrated weak points in the elastomer network.

To overcome some of these deficiencies, the bis-olefin curative shown in figure 6 was developed (ref. 10). In most cases, the bis-olefin is pre-incorporated into the polymer backbone with one of the double bonds remaining available for crosslinking. This precludes the need for a halogenated (bromine or iodine) cure site monomer, and crosslinking can occur with only the addition of a peroxide initiator. While the double bonds in the bis-olefin do contain carbon-hydrogen bonds that become part of the crosslink structure, there are significantly fewer than there are in TAIC. In addition, the perfluoroalkyl linker between the double bonds is very robust and much more thermally and chemically stable than the heterocycle linker in TAIC.

Nitrile cure FFKMs are crosslinked by the reaction of a curative with the nitrile groups on the cure site monomer. One such curative, diaminobisphenol AF (BOAP), is illustrated in figure 7. During the cure process, the amino phenol groups at each end of the molecule both react with a nitrile group on the cure site monomer to form separate benzoxazole aromatic rings. Thus, the crosslink structure is a bis-benzoxazole that does not contain any alkyl carbon-hydrogen bonds. An alternative method for crosslinking of nitrile cure site monomers is to use a catalyst that promotes cyclotrimerization of the nitrile to generate a triazine structure (refs. 11 and 12). In this case, the catalyst itself does not become part of the crosslink, but is regenerated after each cure reaction. Typical catalysts include ammonia generating molecules

(ref. 11) and phosphonium salts (ref. 12) (structures not shown).

The goal of this article is to examine the upper use temperature of a set of FKM and FFKM elastomer compounds as a function of their crosslink chemistry (peroxide or nitrile) and curative type. Four compounds were evaluated, and the general characteristics and original physical properties are shown in table 1. All of the compounds were prepared from commercially available base polymers and contain carbon black filler. A single peroxide cure FKM was prepared, along with three FFKM compounds with unique crosslink chemistries. Two of these are peroxide cured with either TAIC or the bis-olefin as the curative, while the third FFKM compound is based on nitrile cure with BOAP as the curative. Examination of the upper use temperature of each of these compounds will provide valuable insight on the effect of crosslink structure on thermal stability.

Long term compression set testing is one method for establishing the upper use temperature of a material. Compression set represents the tendency of an elastomer to undergo permanent deformation when subjected to a compressive load at temperature. A material that resists compression set, therefore, is able to recover to close to its original cross-section after the compressive load is removed. This is an important property for an elastomer compound with the goal to maintain sealing force through its service history.

Temperature is the most significant contributor to compression set increase of an elastomer in application. Over time, the chemical bonds in the compound can degrade and the material will begin to lose elasticity. This process is accelerated as the temperature is increased. By measuring the compression set of an elastomer at various temperatures across multiple time points, an estimation of the upper use temperature can be made. The upper use has been defined as the temperature at which a seal will have 80% compression set after 1,000 hours.

Additional methods for estimating elastomer upper use temperature include isothermal thermogravimetric analysis (TGA), compression stress relaxation (CSR) and retention of properties at temperature. Isothermal TGA is strictly a measure of the thermo-oxidative stability of a material, while CSR provides information on sealing force retention as a function of temperature and time. Finally, a method based on specification SAE J2236 describes retention of 50% of original elongation and tensile strength after 1,000 hours of heat aging as a measure of upper use temperature.

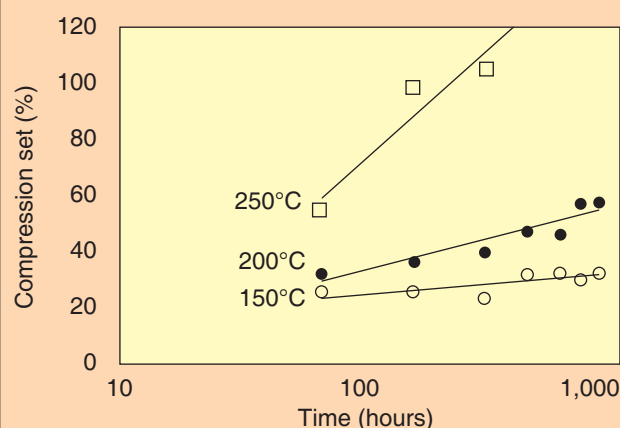
**Table 1 - compound characteristics and original physical properties**

Compound	Description	Hardness (durometer A)	Tensile strength (psi)	Elongation (%)	100% modulus (psi)
FKM X3231	Peroxide cure FKM TAIC	82	2,280	139	1,479
FFKM 678	Peroxide cure FFKM TAIC	90	1,940	120	1,590
FFKM 562	Peroxide cure FFKM bis-olefin	80	3,175	165	1,565
FFKM 676	Nitrile cure FFKM BOAP	74	2,667	148	1,443

## Results and discussion

Long term compression set testing was performed for each of the four compounds previously described. This process is illustrated with FFKM 678, which is a peroxide cured FFKM with a TAIC curative. Compression set measurement was performed based on ASTM D395 (Method B) on AS568A-214 o-ring samples at 25% deflection. Figure 8 shows a plot of the compression set results for FFKM 678 at 150°C, 200°C and 250°C at

**Figure 8 - plot of raw data from compression set testing of FFKM 678 at three temperatures**

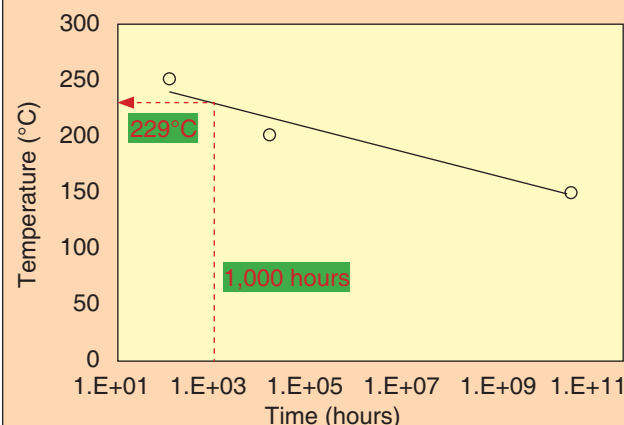


multiple time points from 70 to 1,000 hours. Each data point represents a median of three compression set determinations. The time to reach 80% compression set at each of the three temperatures was then calculated, and a separate plot based on this result was generated (figure 9).

A log regression model was used to determine the best fit line after which the temperature at which 80% compression will be reached after 1,000 hours can be calculated. Based on this methodology, the upper use temperature for FFKM 678 is 229°C. It is important that the temperatures selected for compression set testing bracket the eventual upper use temperature calculation. Polymer suppliers will typically provide some guidance on the temperature capabilities of their raw materials, and this information can then be used to select the appropriate temperatures for compression set testing of elastomer compounds of interest.

The process described for FFKM 678 was repeated for the three additional compounds introduced in table 1. Table 2 summarizes the upper use temperature results for all four compounds, along with the elastomer type and cure characteristics of each. There is a clear dependence of the upper use temperature on the elastomer class, cure system and curative selection. As expected, the FKM compound gave the lowest result, while the nitrile cure FFKM compound had the highest upper use

**Figure 9 - plot of temperature versus time to reach 80% compression set for FFKM 678**



temperature of 304°C. Within the peroxide cure FFKM class, the bis-olefin curative proved superior to TAIC, as the upper use temperature of 269°C for FFKM 562 is 40°C higher than that of FFKM 678.

**Figure 10 - arrhenius equation**

$$\ln(\text{rate}) = -E_a/RT + \ln(A)$$

The results in table 2 can be rationalized based on the chemical structures of each of the materials. The materials containing the most carbon-hydrogen bonds (already described as being weaker than the carbon-fluorine bond) will have the lowest upper use temperature. The peroxide cured FKM X3231 with TAIC curative contains carbon-hydrogen bonds not only in the crosslink structure, but also at regular intervals in the polymer backbone due to the presence of VDF monomer.

At the upper end of the temperature scale, nitrile cure FFKM 676 with BOAP curative does not contain any alkyl carbon-hydrogen bonds, and the aromatic nature of the benzoxazole crosslink provides additional thermal stability. The peroxide cured FFKM 678 with TAIC curative has more carbon-hydrogen content than the peroxide cured FFKM 562 with the bis-olefin curative, which explains its lower upper use temperature. It should be noted that the structural features of an elastomer compound are not the only characteristics that will impact the compression set values, and thus the upper use temperature calculation. Variables such as filler type and filler loading, for example, will also influence compression set. The compounds described herein all contain the same filler (carbon black) with similar loadings (minimum 20 phr), so comparison of the long term compression set results should provide a meaningful way to rank order their thermal capabilities.

A drawback of the long term compression set methodology is that it is time consuming (1,000 hours of testing takes six weeks) and requires a significant amount of AS568A-214 o-ring samples to complete. Therefore, isothermal TGA of FFKM 678 was investigated as a complementary method for upper use temperature determination. This technique mea-

**Table 2 - summary of upper use temperatures based on long term compression set testing**




Compound	Upper use temperature*	Elastomer class	Cure system	Curative
FKM X3231	203°C	FKM	Peroxide	TAIC
FFKM 678	229°C	FFKM	Peroxide	TAIC
FFKM 562	269°C	FFKM	Peroxide	Bis-olefin
FFKM 676	304°C	FFKM	Nitrile	BOAP

\*Based on calculated temperature to reach 80% compression set after 1,000 hours



**Table 3 - isothermal TGA: Time to reach 5% weight loss for FFKM 678 at four temperatures**

Time (minutes)	Rate (%/minute)	ln(rate)	Temperature (°C)	Temperature (°K)	1/temperature (°K <sup>-1</sup> )
196	0.026	-3.669	350	623	0.00161
38.1	0.131	-2.029	380	653	0.00153
7.5	0.668	-0.403	410	683	0.00146
2.1	2.392	0.872	440	713	0.0014

 Measure
  Plot
  Plot

**Table 4 - FFKM 678 calculated temperature for selected decomposition rates**

Weight loss (%)	Time (hours)	Temperature (°C)
0.5	1,000	237
1	1,000	245
5	1,000	265

asures weight loss as a function of time and temperature, and reflects the thermo-oxidative stability of a material. Attractive features of this method are the shorter duration of testing and the smaller sample quantity required. The Arrhenius equation (figure 10) was used to represent the relationship between degradation rate and temperature.

Isothermal TGA testing of FFKM 678 was conducted in air and measured the time to reach 5% weight loss at four different temperatures (table 3). A plot of ln(rate) versus 1/T according to the Arrhenius equation represents the relationship between degradation rate (% weight loss per minute) and temperature (figure 11). The rate equation representing the best fit line of the plot was then used to calculate the temperature that would produce a particular decomposition rate of interest (representative of upper use temperature) (table 4). The calculated temperature of 237°C that would generate 0.5% weight loss over a 1,000 hour time period aligned most closely with the upper use temperature of 229°C determined through long term compression set testing. Efforts to extend this testing to additional compounds described in this report are in progress.

Compression stress relaxation (CSR) was introduced earlier as a technique that measures sealing force retention of a material under constant deformation at a temperature profile of interest (ref. 13). This is a direct measure of sealing force of material under stress, and the potential for temperature cycling and/or fluid exposure make CSR a potentially valuable tool for simulating actual application conditions. The power of CSR lies in the real time sealing force response during testing. In contrast, compression set testing measures elastic recovery only after completion of the test protocol. Compression set is certainly the more routine test for elastomer compound development laboratories, as it does not require any specialized equipment; but CSR results may ultimately translate better in real world conditions. Greene, Tweed is currently working with a partner to develop a CSR based method not only for upper use temperature determination, but also for seal lifetime prediction.

An example of combining the outstanding chemical resistance and thermal resistance for harsh sealing needs is captured in the development of Greene, Tweed's FFKM compound 694 for enhanced oil recovery (ref. 14). A customer's needs were not being met by EPDM, FEP, FKM or even existing FFKM seals that included broad chemical resistance plus better physical property retention after steam aging. With customers, Greene, Tweed established acceptable property changes for a new compound after an aggressive steam aged test of one week at

260°C, which included tensile, elongation and modulus on 30% maximum loss and low hardness and volume change. Greene, Tweed's best steam resistant and high temperature peroxide cured FFKM compound at the time was FFKM 562, and that compound lost over 50% tensile and modulus after the one week steam aging test using AS568-214 o-rings, even with its low hardness and volume change after the steam aging test.

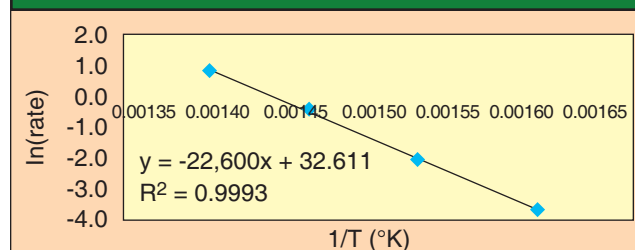
The development process involved evaluating FFKM based polymers from four different suppliers and vetting available FFKM cure systems, then evaluating over 20 different filler packages to obtain consistently passing scores on the steam aging test. The long term (1,000 hours) compression set tests were then conducted as outlined above, and calculated the temperature at which AS568A-214 o-rings would reach 80% set in air after 1,000 hours as 258°C.

FFKM 694 with the vetted cure system and the selected filler package was then commercialized for use in equipment such as ESPs operating in high temperature steam applications, including SAG-D, cyclic steam simulation, geothermal and heavy oil completions. FFKM 562, 676, 678 and 694, cited in this article, are commercialized under the Chemraz brand name and are available from Greene, Tweed. Technical data sheets are available at [www.gtweed.com](http://www.gtweed.com).

## Conclusions

Four compounds from different elastomer classes and with different cure systems and curatives were evaluated in long term compression set testing to estimate an upper use temperature. Consistent with known service performance, the nitrile cure FFKM material exhibited the highest temperature capability, and the peroxide cure FKM showed the lowest. Within the peroxide cure FFKM class, the bis-olefin curative proved superior

**Figure 11 - arrhenius plot based on isothermal TGA data**



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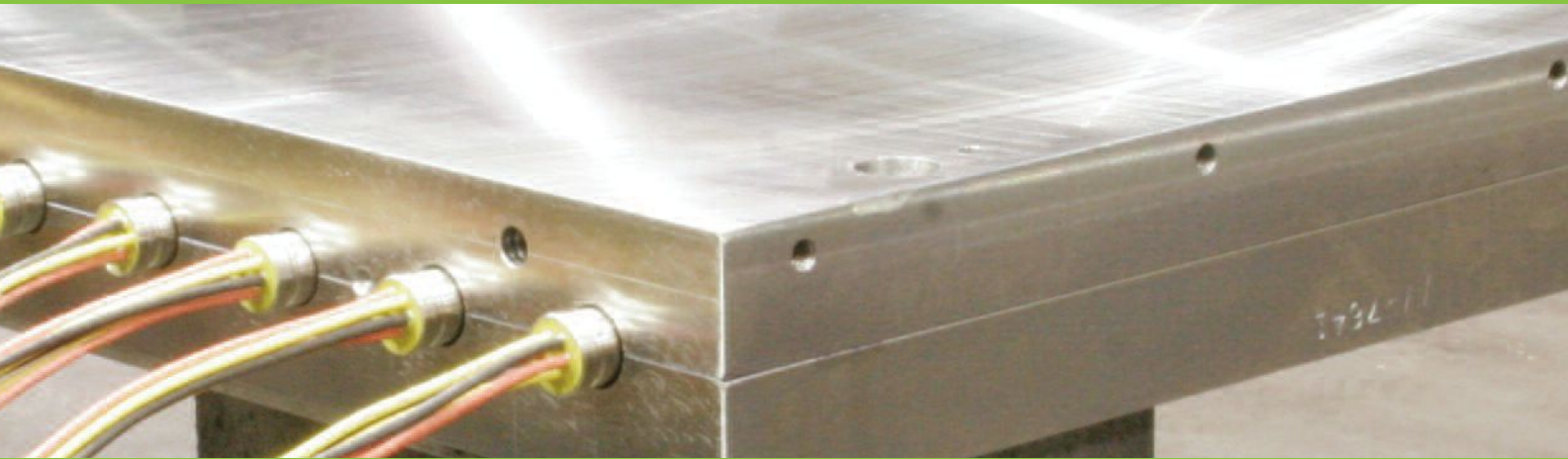
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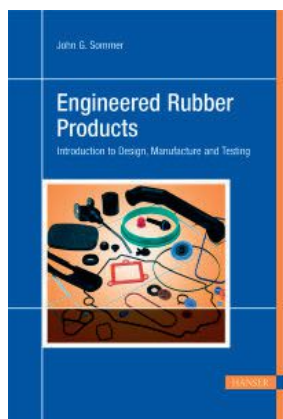


to TAIC, which may be due to the high number of alkyl carbon-hydrogen bonds that are incorporated in the crosslink structure with TAIC. Results with isothermal TGA demonstrate its potential as an accelerated test for upper use temperature determination, and compression stress relaxation is also being explored in this regard.

This article is based on a paper presented at the 194th Technical Meeting of the Rubber Division, ACS, October 2018.

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# Development of an ecological thermal insulation by using multi-surface chlorinated rubber paint

by Priyanka N. Chavda, L.D. College of Engineering, India

Thermal insulation is the process of reducing the heat transfer between surfaces using special materials in order to prevent the cold air in the exterior environment from causing temperature loss in the interior environments in winter months, and hot air in the exterior environment from causing a temperature increase in the interior environments in summer months (figure1).

In order to balance the temperature in houses, owners try to increase the temperature using fuels like natural gas and coal in winter, and decrease the temperature using air conditioners or similar cooling appliances in summer. Homeowners consume a certain amount of energy during all these heating and cooling processes. Unfortunately, more than half of the energy which is used for heating purposes in buildings is lost when there is no thermal insulation (ref. 1).

Thermal insulating paint is a green option that can be used on both the interior and exterior of a home (figure 1). When used as an exterior paint, insulating paint reflects heat that would normally be absorbed by exterior walls in the warmer months, and also adds an extra barrier on the outside of the house to help hold heat in when the colder, winter months arrive. One of the breakthroughs of this innovation is that a thin layer of paint applied by a brush, or a paint spray competes with inches of insulation material. This opens up many opportunities for energy savings in sectors where space has been a limiting factor.

Used on interior walls, the paint works the same way. It provides an extra barrier that helps to maintain the temperature of a home and works great in addition to traditional insulation. Ceilings painted with insulating paint are especially effective in reducing winter heating and summer cooling bills by controlling the flow of heat in a home; heat rises, and keeping it from traveling between floors of a home will help to keep utility bills under control.

While many other forms of insulation, including fiberglass and cellulose, are not as effective in protecting against radiant heat, most insulating paints offer this protection. Traditional insulations absorb and slow down the travel of heat, but insulating paint actually reflects it. Radiant heat is responsible for about 93% of summer heat gain and 75% of winter heat loss in most traditionally built structures, so the reflective abilities of insulating paint give homes a degree of insulation that no other product can match. Using insulating paint in addition to other, more traditional insulating methods can save money over time, making it well worth the time, effort and investment (refs. 1 and 2).

## Reflective insulation

For reflective insulation types, the important physical property is low surface emittance. Surfaces with low emittance have high reflectance. The greater the refractive index difference between particles and the medium, the greater the light reflected by the surface. Reflective insulations have emittance values in the range of 0.04 to 0.1.

The speed of electromagnetic waves in vacuum,  $c = 2.99792458 \times 10^8$  m/s, is one of the most important constants in physics. A human eye is able to detect electromagnetic waves in a range from 360 nm (violet color) to 750 nm (red color). It is called a visible range of light.

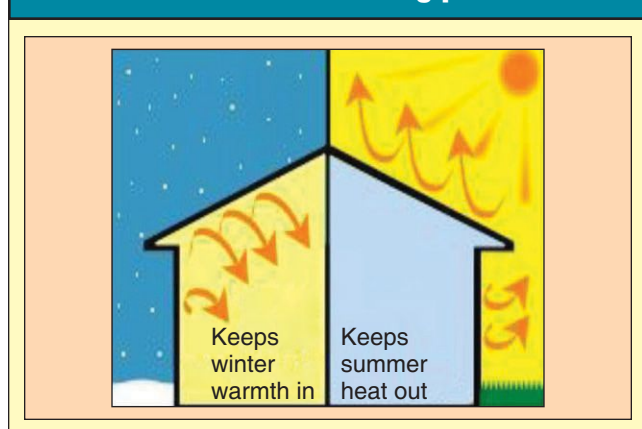
When light waves travel through a medium (optical medium), its electric part interacts with the electrons of that medium, causing them to vibrate. The electrons of the medium thus become radiating light waves as the secondary sources. However, the speed of new waves,  $v$ , changes according to the optical properties of the particular medium. It is always smaller than the speed of light in vacuum,  $v < c$ . All materials are characterized by their ability to slow down the light waves, known as optical refractive index,  $n$ :

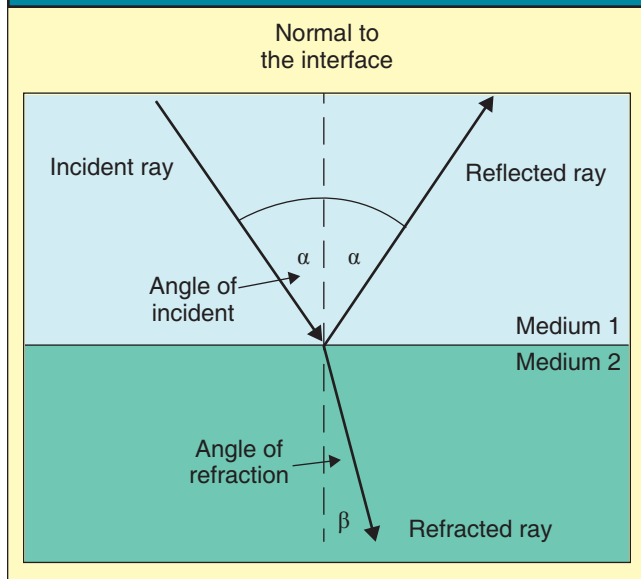
$$n = c/v$$

The refractive index is a unitless parameter, equal to 1 for a vacuum and larger than 1 for any other material (e.g.,  $n = 1.33$  for water). The speed of light in air is only slightly less than  $c$ , resulting into the refractive index of 1.0003. Typically, it is truncated to 1 (ref. 3).

The difference between light speed in different media results into the change of direction along which the light propagates, refraction (figure 2). Refraction occurs when the light passes from one medium to a medium with a different index of refraction, except for the light that approaches the boundary between the two media perpendicularly (ref. 4). According to the properties of an optical medium, some portion of light approaching the interface at an incident angle,  $\alpha$ , is reflected back to the first medium, while the rest propagates into the other medium at an angle of refraction,  $\beta$ . The angles of incident, reflection and refraction are defined as angles between the particular ray and the

**Figure 1 - schematic diagram showing role of thermal insulating paint**



**Figure 2 - refraction of light**

normal interface (figure 2).

The reflection angle is always equal to the incident angle. On the other hand, the refractive angle is determined by the Snell's law:  $n_1 \sin \alpha = n_2 \sin \beta$ , where  $n_1$  is the refractive index of medium 1 and  $n_2$  is the refractive index of medium 2.

It is possible to define an optical density for the media of different refractive indices.

Medium A has a higher optical density than medium B if its refractive index is higher than that of medium B. According to the Snell's law, the light ray is "bending towards the normal" ( $\beta < \alpha$ ), if it enters the medium with a higher optical density (figure 2). When it enters the medium with a lower optical density, it is "bending away from the normal" ( $\beta > \alpha$ ).

For light incident at right angles to a transparent medium, the fraction reflected at the interface is equal to  $(n - 1)^2 / (n + 1)^2$ . This law was first enunciated by Fresnel, and simply implies that "the greater the refractive index difference between particles and the medium, the greater the light reflected by the surface."

For polished glass of refractive index 1.5, for example, the percentage of light reflected would be 4% (ref. 4).

### Reflection mechanism of infrared radiation

The infrared reflective pigments do not absorb in the near infrared region. They either reflect it or transmit it. Their refractive index is different from that of the binder in the infrared region. This causes diffused reflection in the IR region. If the refractive index of the pigments in the IR region is similar to that of the binder's refractive index in the IR region, the pigment would be transparent to near infrared light (NIR). In such a case, any reflection in the near infrared region would be due to the undercoat.

Absorption of light occurs when light energy promotes electrons from one bonding state to another. If light of a different wavelength is used to cause this energy transition, it will not be absorbed; e.g., iron chrome blacks absorb light through the visible region. This means there are electronic transitions respon-

**Table 1 - refractive indices of different extenders**

Extenders	Refractive index
Talc	1.490
Silica	1.550
Magnesium carbonate	1.550
Whiting	1.580
Zinc oxide	2.000
Titanium dioxide	2.580

sible for absorbing light with wavelengths of energy from 400-700 nm. Light of lower energy ( $>700$  nm) is not absorbed. In this case, a beam of light with a wavelength of 1,500 nm is too low in energy to cause any electronic transitions in the material. Thus, it will not be absorbed. Instead, the 1,500 nm light beam is refracted, reflected and scattered (depending on the refractive index), leading to diffuse reflection of NIR light.

There is no method to predict the IR reflectivity of an inorganic or organic compound.

The optical properties of a pigment are resolved into two components: the color strength and the opacifying (hiding) power. These depend on the basic pigment properties: namely, particle size, light scattering coefficient (S), light absorption coefficient (K) and refractive index (n). For white pigments in rubber, a mean particle size of 150 nm is found far superior to one with a mean size of 220 nm or more, and is found most suitable for oleo resinous paints. For white pigments, K can be neglected; while for black, S is small.

This property appears to be an inherent characteristic property, just like density, thermal conductivity, color, refractive index, etc. (refs. 5-7).

Refractive indices of different extenders are shown in table 1. Formulations and a comparison chart are shown in table 2. The refractive index of chloroprene rubber is 1.45. The refractive index of titanium dioxide is 2.58.

### Properties and performance

Physical properties include the following:

- Form: Liquid
- Color: As desired (depends on pigment)
- Odor characteristic: Solvent
- pH: Neutral
- Specific gravity: 0.90 ( $\pm 0.02$ ) at 32°C
- Viscosity can be varied by end users
- Solid content
  - Brush technique 45-50% (wt.%)
  - Spray technique 25-35% (wt.%)

**Table 2 - formulation of paint**

Raw materials	% weight	Weight (grams)
Chloroprene rubber	100	1,000
Zinc oxide	10	100
Cl resins	5	50
Silica	8	80
2,2,4-trimethyl-1, 2-dihydroquinoline (TDQ)	2	20
Titanium dioxide ( $\text{TiO}_2$ )	4	40
Toluene	200	1,732
Methyl ethyl ketone (MEK)	100	810



**Figure 3 - wooden slab**



**Figure 4 - metal sheet**



Application properties include the following:

- Touch dry: 15 minutes
- Recoatable: 20 minutes
- Hard dry: 24 hours
- Application method: Conventional spray/brush technique
- Surface requirement: Free from dust, rust, oil, grease and any other foreign deposits

Testing on different substrates, including a wooden slab, metal sheet and cement paver, is illustrated in figures 3, 4 and 5. Results, including temperature measurement data, are shown in figures 6, 7, 8 and 9.

### Conclusion

Anti-corrosion and other functional coatings have emerged to

**Figure 5 - cement paver**

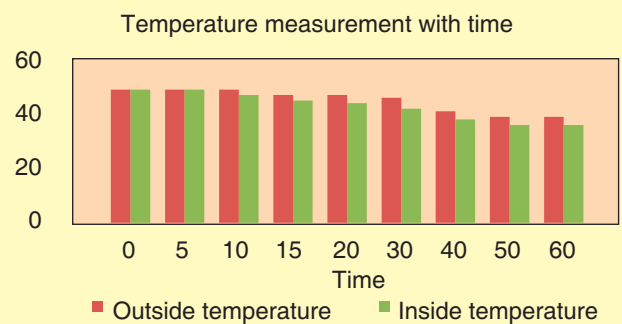


**Figure 6 - temperature measurement data taken by testing on a cardboard box**



reduce the sun's heat radiation by increasing the reflection of sunlight to reduce heat absorption, therefore adding insulation and reflective cooling. These coatings in large part reduce solar heat radiation hazards and are said to have excellent market prospects. The method of increasing the reflection of light from the coated surface can be useful in increasing the

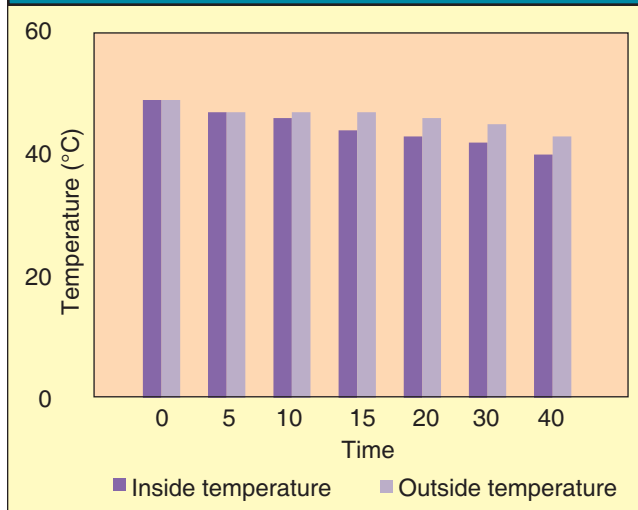
**Figure 7 - graphical representation of temperature measurement (°C) taken inside and outside of a cardboard box with respect to time (minutes)**



**Figure 8 - temperature measurement data taken by testing on a wooden box**



**Figure 9 - graphical representation of temperature measurement (°C) taken inside and outside of a wooden box with respect to time (minutes)**



heat insulating property of rubber paint. The white pigments have a negligible light absorption coefficient (K); thus, it is preferable to use this in paints where heat insulation is the main purpose.

One of the breakthroughs of this innovation is that a thin layer of paint applied by a brush or a spray competes with inches of insulation material. This opens up many opportunities for energy savings in sectors where space has been a limiting factor. While many other forms of insulation, including fiberglass and cellulose, are not as effective in protecting against ra-

diant heat, most insulating paints offer this protection. Traditional insulations absorb and slow down the travel of heat, but insulating paint actually reflects it. Radiant heat is responsible for about 93% of summer heat gain and 75% of winter heat loss in most traditionally built structures, so the reflective abilities of insulating paint give homes a degree of insulation that no other product can match. By using higher refractive index pigment, i.e., titanium dioxide having a refractive index value of 2.58, a higher heat insulation property can be gained. By means of chloroprene rubber paint, up to a 3°C temperature difference can be gained from the outer atmospheric temperature. Using insulating paint in addition to other, more traditional insulating methods can save significant money over time, making it well worth the time, effort and investment.

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# Dynamic mechanical properties and crosslink density testing of silicone elastomers using the Dynamic Mechanical Yertzley Oscillograph

by Murat Sen and Davut Aksit, Hacettepe University; and Nuri Akgerman and Ismail Saltuk, Tavdi

Material evaluation tests for this article were performed using the recently developed Dynamic Mechanical Yertzley Oscillograph (DMYO) (figure 1). Just like the Yertzley Oscillograph (YO) (refs. 1 and 2), the DMYO supports the ASTM D945 standard. Its design is an evolution of the YO with additional sensors, electronic data acquisition and computer control, including automated data evaluation.

Microcomputer aided Yertzley oscillography, AYO-IV, was developed in the mid-1980s (ref. 3). A striking characteristic of AYO-IV is that it can yield the natural frequency of a viscoelastic sample within three seconds (ref. 4). AYO-IV can improve rubber compounding and molding operations with tests conducted according to the ASTM D945-16 test method (ref. 5). This test machine can also predict the dynamic properties of rubber components and their behavior under dynamic stresses (ref. 6). Elastomer technicians and design engineers would like to know how a component's dynamic modulus will relate to its static modulus (ref. 7). The latest model DMYO combines a load cell with a displacement transducer to yield a wide range of dynamic, static hysteresis and creep parameters (ref. 8).

Organizations such as the U.S. Navy, NASA, General Dynamics, McDonnell Douglas Astronautics, Goodyear Tire & Rubber, BFGoodrich, Edgewood Arsenal and the Department of National Defense have been users of this rugged, functional, accurate and precision dynamic testing machine for rubber.

The DMYO can perform dynamic compression and shear tests at their natural frequency, as well as static hysteresis and

creep tests. Dynamic testing capability has been examined in this article. Figure 2 illustrates typical output. Just like the YO, the DMYO also supports the ASTM D945 standard (ref. 7), and can determine the following parameters:

- Yertzley resilience
- Yertzley hysteresis
- Point modulus
- Dynamic modulus
- Natural frequency
- Moment of inertia
- Energy absorbed

Besides a displacement transducer, the DMYO also includes a load cell. Thus, it can determine additional parameters such as:

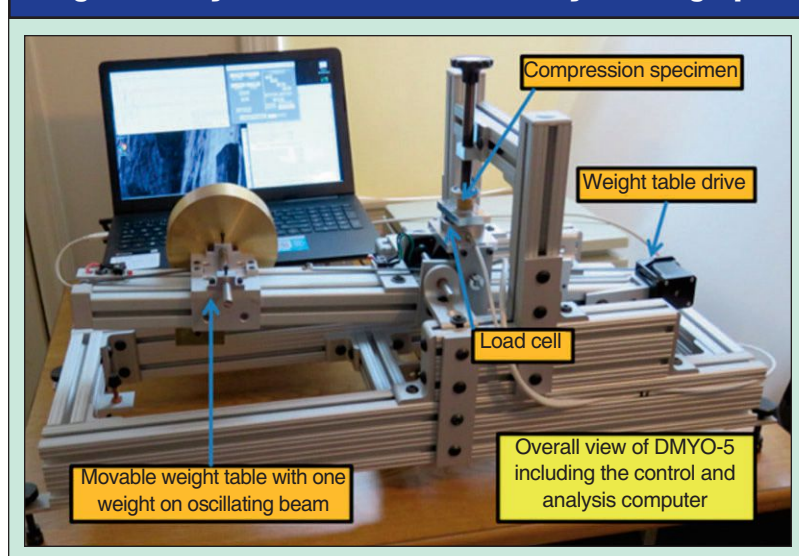
- Tangent of delta, loss angle
- Measured phase angle
- $E'$  and  $E''$ , storage and loss moduli in compression
- $G'$  and  $G''$ , storage and loss moduli in shear
- Elastic region modulus based on the Lambda strain
- Damping coefficient
- Power density

The principle of operation of the DMYO is that of simple harmonic motion: Properties of the material under test are derived from the analysis of the vibrational frequency and the damping rate of the free oscillations, which follow the initial known potential energy applied to the test sample, as described by Menough (ref. 9). The natural frequency of a given specimen, compounded and vulcanized to the final service conditions, is determined by the DMYO under compression or shear mode. This kind of specimen may represent a typical vibration isolating component, which may be used in the following fields

of application: floating track slab isolation for railroads; oil and gas exploration rig vibration isolators; highway bridge vibration isolators; skyscraper and high rise seismic isolators; heavy machinery vibration isolators; high precision instrumentation vibration isolators from ground noise; military equipment vibration isolators; marine ship dock and offshore rig fender and bumper response characterization; rolling resistance predictions of vehicle tires; low frequency characterization of rubber and polymeric components; and o-ring and seal characterization in the nuclear waste disposal industry. These are some of the application areas where DMYO can offer highly efficient assistance to designers, as well as mold, extruder, polymer, mechanical and civil engineers, etc. (ref. 10).

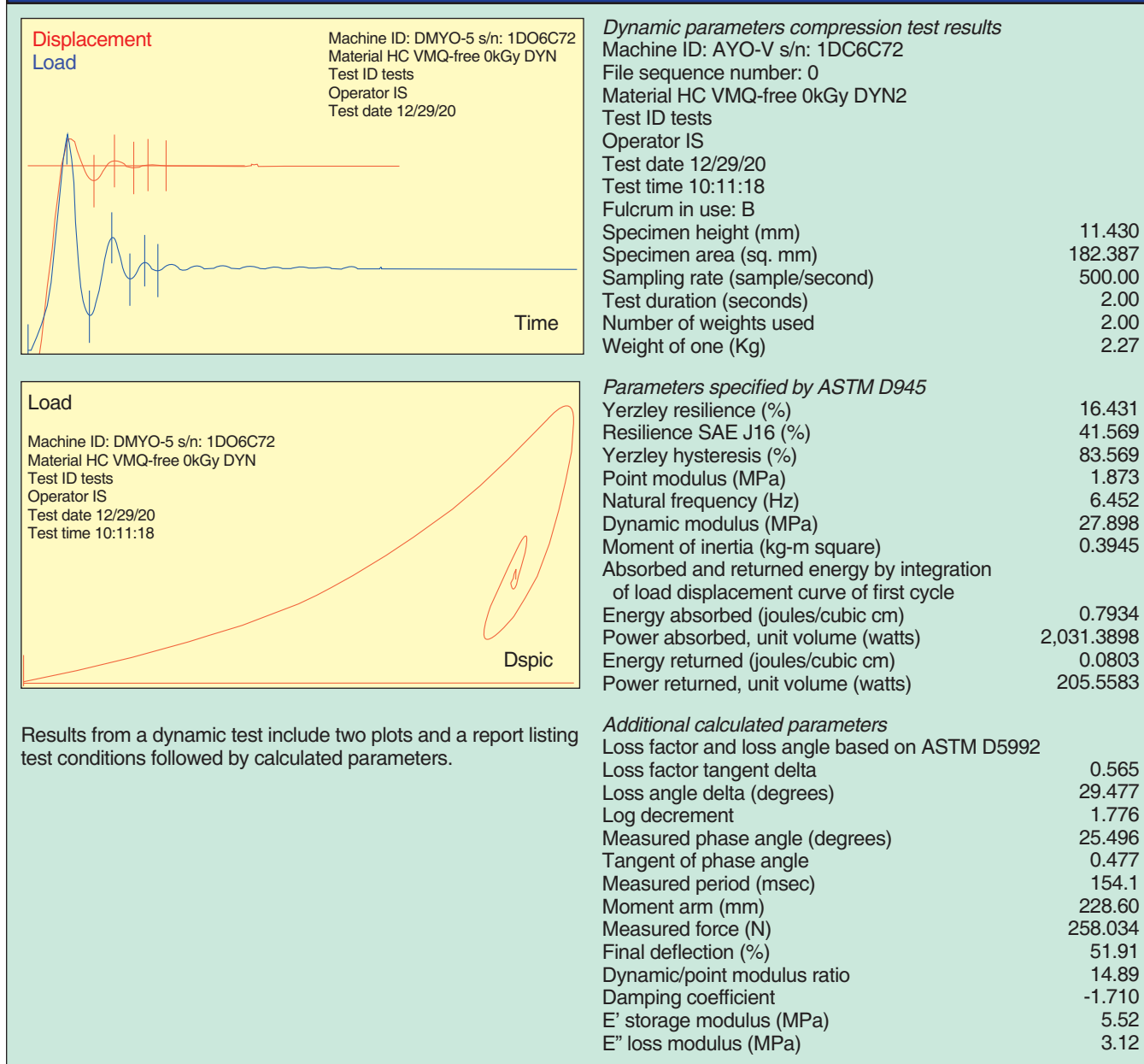
Besides the dynamic test protocol, the DMYO can also perform static hysteresis and creep tests. The static hysteresis test is user programmable. The step size, duration and test limits can be specified.

**Figure 1 - Dynamic Mechanical Yertzley Oscillograph**





**Figure 2 - typical output from the DMYO for dynamic testing of elastomers includes a detailed test report and two plots**



Once started, it will run to completion unattended. Figure 3 shows a typical hysteresis test result for a PVMQ elastomer. Figure 4, on the other hand, is a typical creep test result for a foam material, as specified in ASTM D945 (ref. 11). The creep test starts with the same impact sequence as the dynamic test; then it transfers into creep mode. Once started, this test also runs unattended.

Silicone oligomers and polymers, as well as materials based on them, are increasingly being used in almost all industries owing to their unique properties. They are often implemented where other materials cannot be. This wide range of applications is accounted for by the fact that silicone elastomers greatly improve the quality of materials, giving them long life, and providing noticeable technical and economic benefits.

Depending on their chemical composition, molecular structure and molecular weight, silicone compounds can be used as liquids, oils and lubricants of various consistencies, as elastomers (for sealants, compounds and rubbers), and polymers for varnishes, plastic laminates and films (ref. 11). The most important reason for the increasing use of silicone elastomers in recent years is the development of elastomer systems containing new and different functional groups.

Addition of a polyfunctional monomer (PFM) containing more than two polymerizable carbon-carbon double bonds is the most popular method of enhancing the thermal curing of silicone elastomers (ref. 12). The PFM is called a crosslinking promoter, crosslinking sensitizer or coagent.

In previous studies (refs. 13 and 14), the effect of PFMs like

**Figure 3 - typical output of static hysteresis test from the DMYO for an elastomer**

*Hysteresis compression test results*

Machine ID: DMYO-5 s/n: 1DC6C72

File sequence number: 0

Material HC VMQ TAIC OKGY HY10

Test ID tests

Operator IS

Test date 02/20/21

Test time 12:42:13

Fulcrum in use B

Specimen height (mm) 5.329

Specimen area (sq. mm) 191.161

Pause time (seconds) 2.00

Step size (mm) 12.700

Weights used 2.00

Weight of one (Kg) 2.27

Maximum moment arm (mm) 228.600

Repeat count 2

Static modulus at 32.7%, loading (MPa) 4.92

Static modulus at 32.7%, unloading (MPa) 11.86

Energy loss/unit volume due to hysteresis (joules/cubic.cm) 0.07

*Mullins effect data*

	Stress	Strain	Time
Peak #1, Maximum stress	1.340	0.327	59,297
Maximum strain	1.274	0.333	71,156
Peak #2, Maximum stress	1.341	0.338	177,860
Maximum strain	1.325	0.340	183,844
Peak #3, Maximum stress	1.340	0.343	296,438
Maximum strain	1.325	0.345	302,360

Stress

Machine ID: DMYO-5 s/n: 1DO6C72

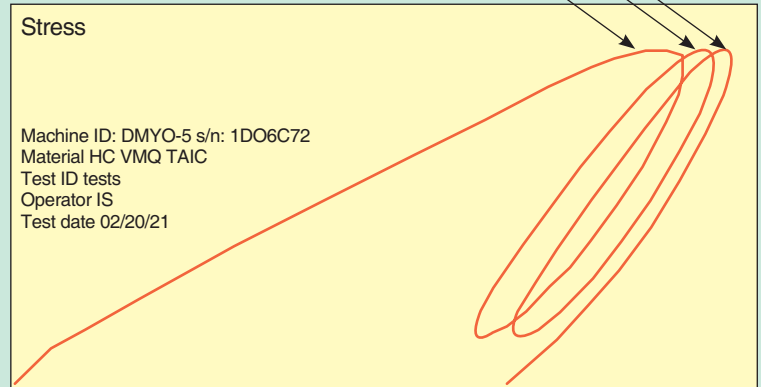
Material HC VMQ TAIC

Test ID tests

Operator IS

Test date 02/20/21

Mullins effect



Hysteresis test plot and report illustrating Mullins effect

TAC, TAIC, ZDA and ZDMA, and radiation modification on the stress relaxation properties and dynamic mechanical properties of VMQ and PVMQ elastomers at forced deformations were investigated in detail. However, there are no reports in the

literature on the identification of dynamic mechanical properties of these silicone elastomers at natural frequencies.

In this article, the effects of coagents on the dynamic mechanical and damping properties of vinyl-methyl-polysiloxane

**Figure 4 - typical output of creep test from the DMYO for an elastomer**

Displacement  
Load

*Creep and set compression test results*

Machine ID: DMYO-5 s/n: 1DC6C72

File sequence number 0

Material VO Foam124125BK CRP 01

Test ID tests

Operator IS

Test date 12/12/20

Test time 14:26:06

Specimen height 0.650

Specimen area (square inches) 0.785

Creep time (seconds) 180

Creep load (lbf) 23.66

Creep stress (psi) 30.14

Creep (%) 4.32

Set (%) 3.85

Number of creep samples 180

Machine ID: DMYO-5 s/n: 1DO6C72

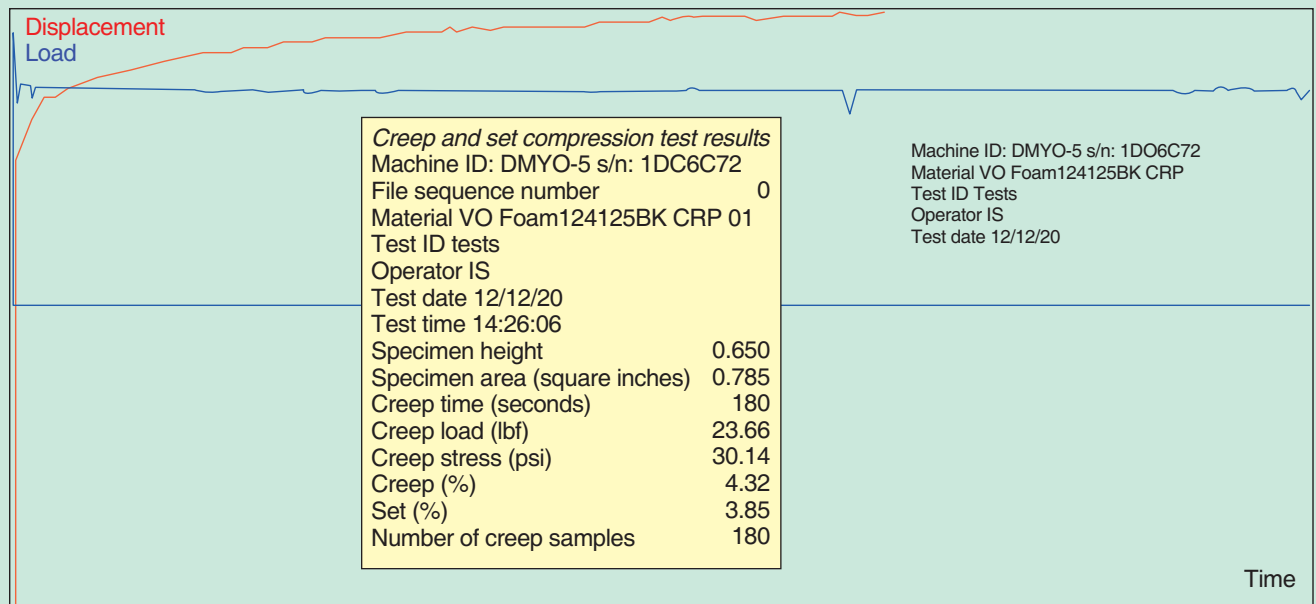
Material VO Foam124125BK CRP

Test ID Tests

Operator IS

Test date 12/12/20

Time



Creep test plot and report. Note the displacement trace trending up while load stays constant

**Table 1 - dynamic compression test parameters**

<i>Machine ID: DMYO-5 s/n: 1DC6C72</i>	
Material	VMQ
Test ID	Tests
Operator	IS
Test date	12/29/20
Test time	10:07:34
Specimen height (mm)	11.430
Specimen area (sq. mm)	182.387
Sampling rate (sample/second)	500.00
Test duration (seconds)	2.00
Number of weights used	2.00
Moment arm (mm)	228.6

(VMQ) elastomers at natural frequencies cured thermally with peroxide are identified. The capacities of the DMYO-5 instrument for the characterization of viscoelastic properties and network structure characteristics, and crosslink density are also demonstrated.

In order to achieve this goal, in the first step, VMQ elastomers were prepared in the presence and absence of the Type I and Type II coagents ZDMA and TAIC, respectively, by using 2,5-bis(tert-butylperoxy)-2,5-dimethylhexane as the peroxide.

In order to investigate the effect of the coagent on the mechanical properties of samples, the dynamic compressibility behavior at natural vibration frequency was assessed by DMYO oscillation curves; and tan delta, absorbed energy at loading and unloading, damping energy, point modulus, elastic modulus, resilience and crosslink density values were determined.

Owing to higher levels of vinyl functionality, it has been found that the mechanical properties of systems prepared using TAIC can be increased at higher rates than those prepared in the presence of ZDMA and coagent-free VMQ elastomer.

As a result of the studies, it has been proven that when the VMQ elastomer is thermally cured with peroxide in the presence of Type I or Type II coagents, i.e., ZDMA and TAIC, all the dynamic mechanical properties (elasticity or damping properties) can be significantly altered. The elastomeric materials designed in this study were intended to have high elastic properties. At the end of the dynamic compression analyses, it was found that the elasticity of VMQ elastomers follows the order of VMQ-TAIC > VMQ-ZDMA > VMQ-free, and energy absorption capacity or damping properties were opposite. Taken together, the results reported in this article demonstrate that the presence of coagent in a compound is one of the important parameters for controlling the crosslink density, and consequently dynamic mechanical and elastic properties, of VMQ elastomers at natural vibration frequencies.

## Experimental

Uncured vinyl-methyl-polysiloxane (VMQ) was purchased from Wacker (Germany). Curing was performed by thermal activation of 2,5-bis(tert-butylperoxy)-2,5-dimethylhexane (DBPH) (Trigonox 101-45S, peroxide content: 44-46%, obtained from Akzo Nobel) at 180°C. The coagents (crosslinking agents), triallyl isocyanurate (TAIC) and zinc methacrylate

**Table 2 - cure characteristics of coagent-free and coagent containing VMQ**

Parameter	VMQ-free	VMQ-TAIC	VMQ-ZDMA
ML (dNm)	1.22	1.19	1.35
MH (dNm)	8.54	14.92	11.49
ts2 (minutes)	0.49	0.44	0.32
t5 (minutes)	0.34	0.36	0.24
t90 (minutes)	2.54	1.55	0.90
t95 (minutes)	4.65	2.07	1.13
$\Delta$ torque = MH-ML	7.32	13.57	10.14
CRI = 100/(t90 - ts2)	48.78	90.09	172.41

(ZDMA) were obtained from Sigma-Aldrich.

Three different combinations of VMQ compounds (VMQ, VMQ-ZDMA and VMQ-TAIC) were prepared using a Thermo-Haake torque rheometer mixing system and internal mixer type rollers. The rubber content in the blends is 100 phr, the DPBH content is 0.8 phr and the coagent content is 0.5 phr. The curing characteristics were determined using an RPA-Elite rubber process analyzer (RPA) rheometer from TA Instruments.

The blends were cured at 180°C using a TA-Elite RPA according to ASTM standard D5289 in order to obtain the curing characteristics. Then the blends were cured at 180°C using a Brabender Polystat 200 T hydraulic hot press at a pressure of 300 bar for 11 minutes. The selected time of 11 minutes is sufficient to decompose 90% of the DBPH present in the compound (refs. 6-8). The dynamic mechanical properties of the elastomers at the natural frequency were determined using a Tavid DMYO in compression mode according to ASTM standard D 945-16. Tests were performed using 13 x 11.43 mm cylindrical samples. The other setup parameters of the machine are shown in table 1, and examples of the DMYO-5 output are given in figure 2.

## Results and discussion

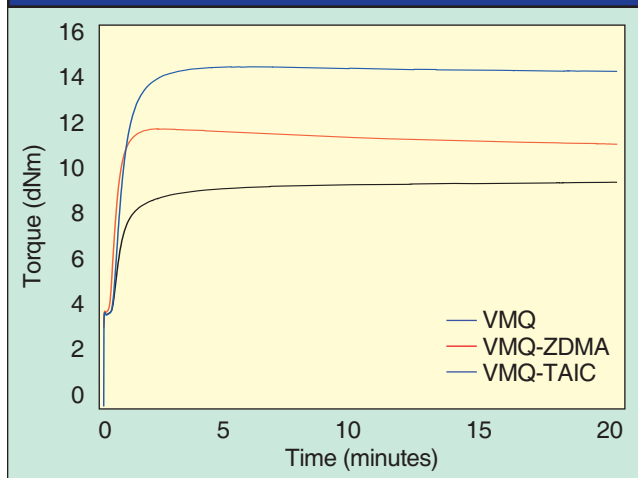
### Cure characteristics of VMQ compounds

In order to investigate the curing behavior and to elucidate the effects of the coagents on the degree of curing, the rheological properties of the compounds were analyzed by an RPA. The rheograms of the coagent-free compound and those containing 0.5 phr TAIC, or ZDMA, are presented in figure 5. Important cure characteristics obtained from evaluation of the cure curves are summarized in table 2. As can be seen in figure 5 and table 2, using a coagent for curing of the vinyl-methyl-polysiloxane elastomers increased the cure degree up to twofold. Mixtures prepared using the Type I coagent ZDMA were found to have a higher cure rate than those prepared using the Type II coagent TAIC.

The degree of cure ( $\Delta$  torque) is directly proportional to the crosslink density of the system. The higher  $\Delta$  torque (MH-ML) values of the systems using TAIC indicate that these systems have higher crosslink density (refs. 15 and 16). The main reason for the higher crosslink density of the TAIC containing elastomers is probably that these molecules have three vinyl functional groups per molecule, while ZDMA contains two vinyl groups per molecule (refs. 17-19). The effects of the coagent system on the crosslink density are discussed here in more detail.



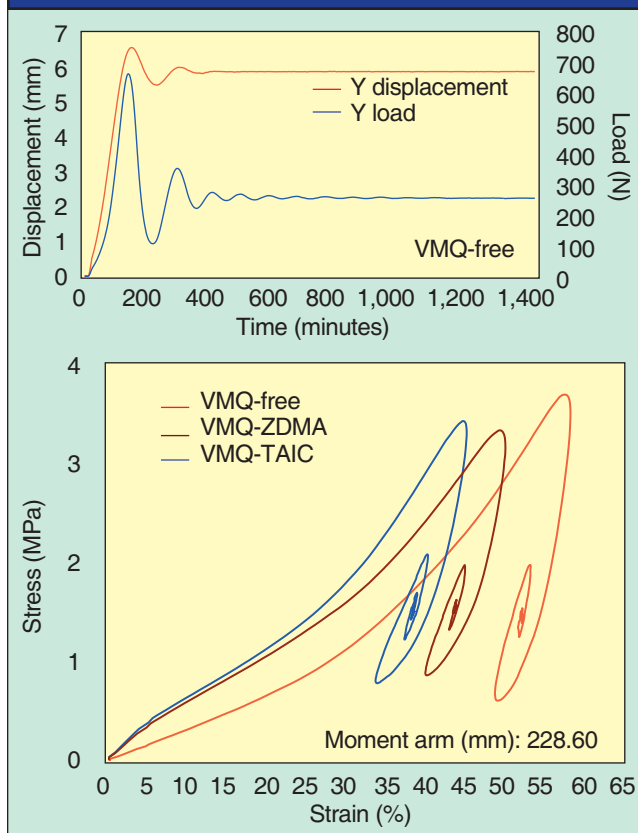
**Figure 5 - cure curves for coagent-free and coagent containing VMQ compounds**



*Effect of coagent on the dynamic compressibility of VMQ elastomers*

The principle of operation of the DMYO is that of simple harmonic motion. Properties of the material under test are derived from the analysis of the vibrational frequency and the damping

**Figure 6 - time versus displacement and load oscillation curves of VMQ-free (top); and strain versus stress curves of VMQ-free, VMQ-ZDMA and VMQ-TAIC elastomers (bottom)**



rate of the free oscillations, which follow the initial known potential energy applied to the test sample, as described by Me-nough (ref. 9).

The free oscillation curves obtained in dynamic compression mode for the VMQ elastomers which were prepared in the presence of the coagents TAIC and ZMDA, and without coagent, are given in figure 6. As can be seen from the figure, with the addition of coagents TAIC and ZDMA to the elastomer structure, both the values of percent deformation and compressibility, and stress value decreased significantly.

The maximum compressibility value of TAIC-free VMQ (VMQ-free) is 57.3%, while for the elastomer prepared in the presence of ZDMA, the compressibility value is 49.2%, and in the presence of TAIC (VMQ-TAIC), it is 44.6 %. The reason for this decrease was attributed to the higher crosslink density of the TAIC containing elastomer compared to the ZDMA and coagent-free system.

The point modulus value obtained from oscillation curves is another parameter that provides an idea of the hardness and also compressibility degree or elasticity of an elastomer. As defined in ASTM D945-16, point modulus can be determined by dividing the applied stress at steady state to the strain at steady state. It is also a measure of expected service performance of an elastomer.

The point modulus value of the VMQ-free system is 1.873 MPa, while the point modulus of the VMQ-ZDMA elastomer is 2.229 MPa; and it is 2.530 MPa for the VMQ-TAIC system. The increase of this value approximately 1.35 fold has shown that the hardness of the VMQ elastomer can also be controlled by adding a small amount of coagent in the compound.

*Effect of coagent on the loss factor tan delta of VMQ elastomers*

As can be seen from figure 6, the DMYO measures both load and displacement against time. The phase angle between these signals is a measure of the energy loss due to the viscous component of the damping in the material. The term loss angle is also used, as well as tan delta. These terms are well defined in the ASTM standard D5992 (ref. 20).

The DMYO-5 instrument used in this study employs free resonant vibration. Referring to ASTM D5992, section X5.1, log decrement  $\Delta$  is defined as the natural logarithm of the ratio of two successive peaks. It is difficult to establish a zero amplitude line, so peak-to-peak amplitudes are used. The value  $\Delta$  is defined in equation (1), and tan delta in equation (2):

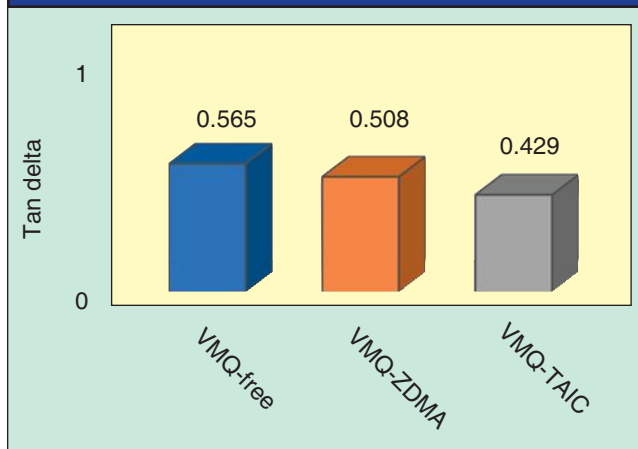
$$\Delta = \ln(a_1/a_2) \quad (1)$$

where  $a_1$  and  $a_2$  are successive peak-to-peak amplitudes,  $a_1 > a_2$ .

$$\tan \delta = \Delta/\pi \quad (2)$$

Since it is difficult to establish a zero amplitude line, the phase angle is measured by comparing the peak to adjacent peak time values. It becomes imperative to locate the actual maxima and minima reliably. It is necessary to be able to resolve oscillations well enough to determine the time values. The selected method fits a parabola to the maxima or minima. The resulting equation's derivative is solved at zero to obtain the peak. The maxi-

**Figure 7 - loss factor, tan delta values of prepared VMQ elastomers**



ma and minima of both the load and the displacement curves are derived by this method; then, four successive extrema are compared, and the result is averaged to arrive at a measured phase angle.

As can be seen from figure 7, the tan delta value of the VMQ elastomers follows the order of VMQ-free > VMQ-ZDMA > VMQ-TAIC.

The results obtained demonstrate that the coagent types are important parameters for controlling the tan delta of VMQ elastomers. The tan delta value for the TAIC containing systems is relatively lower than for the ZDMA containing elastomer, and the tan delta ZDMA containing elastomer value is lower than for the coagent-free VMQ system. The main reason for this decrease was attributed to increased crosslink reactions with the help of the three- and two-vinyl functional groups per molecule in the chemical structure of TAIC and ZDMA, respectively. The decrease of this value, approximately 32%, has shown that the elasticity of the VMQ elastomer can also be controlled by adding a small amount of coagent in the compound.

Damping is an influence within or upon an oscillatory system that has the effect of reducing or preventing its oscillation. In physical systems, damping is produced by processes that dissipate the energy stored in the oscillation (ref. 21). It is well known that the tan delta quantifies the way in which a material absorbs and disperses energy. It expresses the out-of-phase time relationship between an impact force and the resultant force that is transmitted to the supporting body. The elastomer that affects the greatest phase shifts, approaching 90°, has the highest tan delta values. These materials demonstrate the greatest capability to dissipate energy in a safe form, such as heat at as close to 90° (perpendicular) to the impact surface as possible. Tan delta is also known as the loss factor due to this loss of energy from the impact force via conversion to, and dispersal of, a safer form of energy. Thus, the tan delta is ultimately an indication of the effectiveness of a material's damping or elastic capabilities. The higher the tan delta and the greater the damping coefficient, the more efficient the material will be in effectively accomplishing energy absorption and dispersal, and vice versa; the lower the tan delta and the greater the elasticity, the more efficient the

material will be in effectively accomplishing energy recovery and rebound. The results clearly indicate that the elasticity of the VMQ elastomers follows the order of VMQ-TAIC > VMQ-ZDMA > VMQ-free.

#### *Determination of crosslink density of VMQ elastomers by the DMYO*

The results reported here demonstrate that the presence of coagent in a compound is an important parameter for controlling the dynamic mechanical and damping properties of VMQ elastomers at natural vibration frequencies. It has previously been emphasized that the main reason for this change may be due to the change of the crosslink density (XLD) of elastomers. In order to prove this assumption, the crosslink densities of the prepared elastomers were calculated by using the displacement force curves obtained at the end of dynamic compression studies with the DMYO and equations developed using the rubber-like elasticity theory.

Rubber-like elasticity and uniaxial deformation experiments have been used for the characterization of various types of cross-linked polymeric systems. For uniaxial deformation, the statistical theories of rubber elasticity yield equation 3, given below for Gaussian chains (ref. 22):

$$f = G_m v(\lambda - \lambda^{-2}) \quad (3)$$

Where  $f$  is the force acting per unit cross-sectional area of the undeformed gel specimen,  $G_m$  is the elastic modulus of the sample, and  $\lambda$  is the deformation ratio (deformed length/initial length). For a homogenous network of Gaussian chains, the elastic modulus of gel swollen to equilibrium,  $G_m$ , is related to the network crosslink density by equation (4) (refs. 23-25):

$$G_m = A \rho / M_c RT [v_{2r}^{2/3} v_{2m}^{1/3}] \quad (4)$$

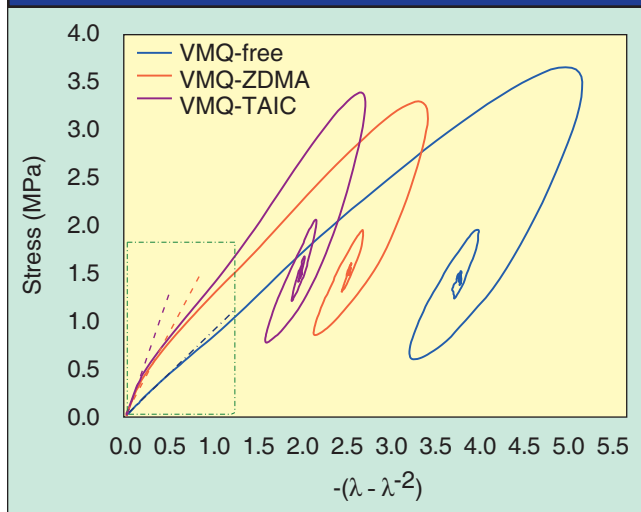
Where  $\rho$  is the polymer density and  $M_c$  is the molecular weight between crosslinks. The prefactor  $A$  equals 1 for an affine network and  $(1-2/\phi)$  for a phantom network.  $v_{2r}$  is the polymer volume fraction in the relaxed state, i.e., after crosslinking, but before swelling, and  $v_{2m}$  is the polymer volume fraction in the swelled state. If the crosslinked structure is prepared in the dry stage and not swelled in a solvent,  $v_{2r} = v_{2m}$ , and it is equal to 1. In this case, equation 4 can be written as:

$$G_m = A \rho / M_c RT = A v RT \quad (5)$$

Where  $v = \rho / M_c$ . The initial stages of the deformation plots in the dotted region of figure 8 of  $f$  versus  $(\lambda - \lambda^{-2})$  yield straight lines (refs. 26-28). The value of  $G_m$  can be determined from the data as the slope of this linear portion of the curve. Then, the remaining equations can be used to estimate the crosslink density. Thus, the DMYO can provide the parameters needed to determine crosslink density in a few seconds.

$\lambda$  is the deformation ratio and equal to  $L/L_0$ .  $L_0$  and  $L$  are the lengths of the undeformed and deformed elastomer during compression, respectively. The  $G_m$  value was calculated from the slope of lines, and by using  $G_m$  values and other relevant ex-

**Figure 8 -  $-(\lambda - \lambda^{-2})$  versus stress curves of VMQ elastomers**



perimental parameters,  $\nu$  values for an affine network were calculated by using equation 5.

The variations in the calculated XLD values, depending on the coagent type, are presented in figure 9. As seen from the figure, the XLD value has increased approximately twofold and by a factor of 2.3 with the additions of ZDMA and TAIC to the compound, respectively.

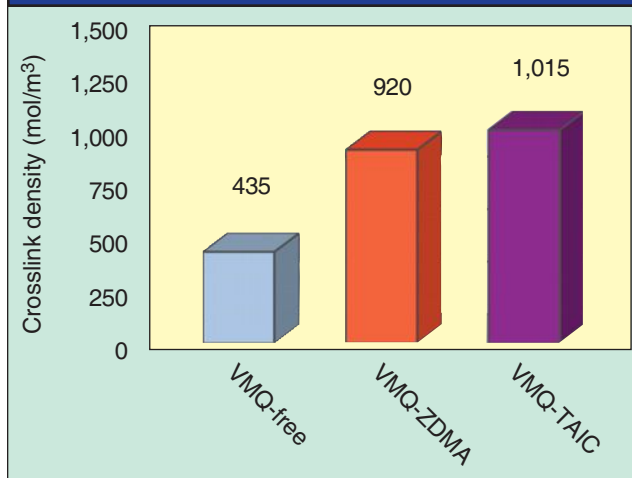
As explained before, the main reason for the higher crosslink density for TAIC containing elastomers is probably that TAIC molecules have three vinyl functional groups per molecule, while ZDMA molecules contain two vinyl groups.

## Conclusions

The DMYO and its data evaluation software can be used to determine the crosslink density of VMQ elastomers.

Moreover, the DMYO can quantify the Mullins Effect, as shown in figure 3. This is a whole new approach to analyze the Mullins Effect during static hysteresis tests on elastomers. It is a

**Figure 9 - variation of crosslink density of VMQ elastomers**



promising analysis tool for elastomer design engineers who design pre-stressed vibration isolation components for the automotive industry.

The DMYO can also be used to compare the mechanical properties of elastomers quickly, as data analysis is automated.

The presence of coagent in a compound is an important parameter for controlling the dynamic mechanical and damping properties of VMQ elastomers at natural frequencies.

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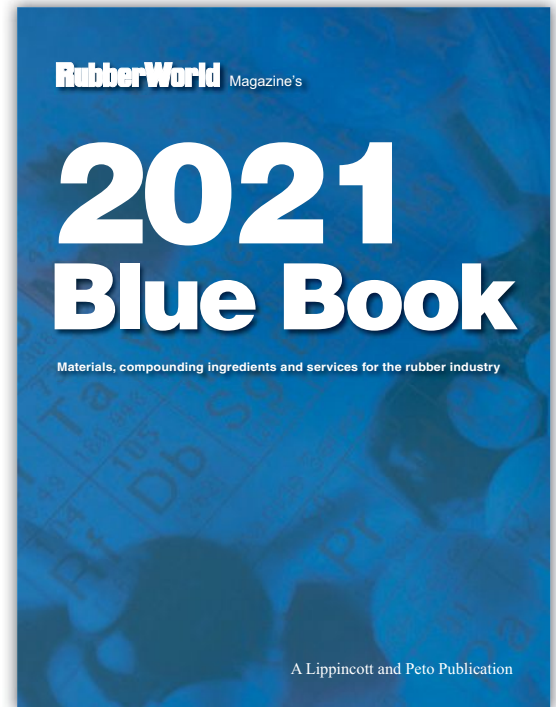
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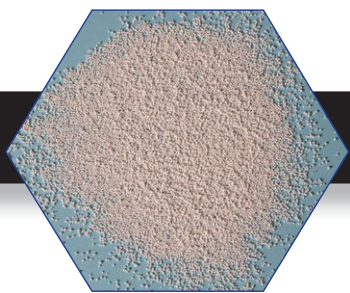
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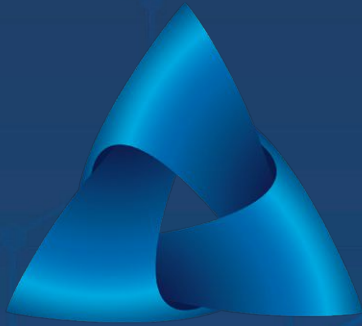
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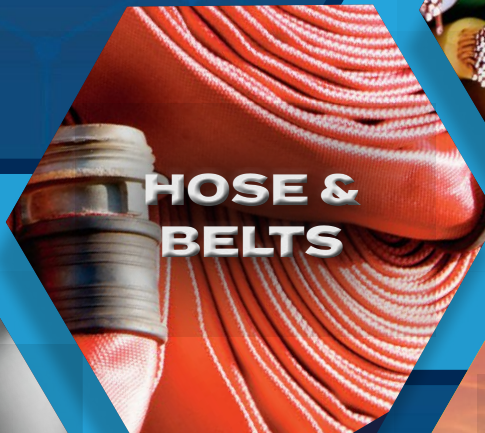
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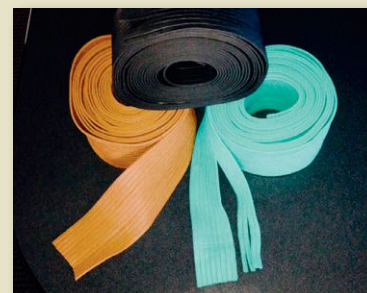
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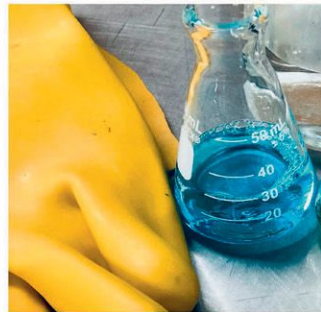
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AGGIORNAMENTI CONTINUI  
PER IL PERSONALE.  
*CONTINUING  
OPERATOR TRAINING.*



RISPETTO  
AMBIENTALE.  
*RESPECT FOR  
THE ENVIRONMENT.*



# REACH

Tutti gli INTERCURE® soggetti alla registrazione REACH sono stati registrati da IB Chem S.r.l. (Interbusiness Group) in qualità di Lead Registrant. I nostri Clienti possono quindi continuare ad acquistare tutti i prodotti della nostra gamma.

*All INTERCURE® products requiring REACH registration have already been registered, and IB Chem S.r.l. (Interbusiness Group) is the Lead Registrant for all of them. Therefore, customers worldwide can confidently continue enjoying easy access to our full range supply.*



## OUR INTERCURE®

Dal 1991, IB Chem S.r.l. (Interbusiness Chemicals), unità operativa di INTERBUSINESS S.r.l., si dedica alla produzione della gamma INTERCURE® impiegando le più moderne tecnologie.

*Since 1991, IB Chem S.r.l. (Interbusiness Chemicals), operational center of INTERBUSINESS S.r.l., has been dedicated to INTERCURE® production, utilizing the most advanced technologies.*

### INTERCURE® 1

Hexamethylenediamine carbamate (HMDC)

### INTERCURE® 1-DF

HMDC - dust free  
(2% Paraffinic White oil)

### INTERCURE® 1-DF10

HMDC - dust free  
(10% ester plasticizer)

### INTERCURE® 2

Tetraphenylphosphonium bromide (TPPB)

### INTERCURE® 2-DF4

TPPB - dust free  
(4% Paraffinic White oil)

### INTERCURE® 3

N,N'-dicinnamylidene-1,6 hexanediamine

### INTERCURE® 4

4,4'-methylene-bis  
(cyclohexylamine)  
carbamate

### INTERCURE® 18

Octadecyltrimethylammonium bromide (OTAB)



# DiamondKote™

## CRYSTAL



## A FOCUS ON NEW PRODUCT DEVELOPMENT.

The deep capabilities and creativity of our people is evidenced by the ITW portfolio of approximately 18,000 granted and pending patents, including more than 1,700 new patent applications filed in 2018.

The ability to invent, envision and create is central to ITW Pro Brands'. Our innovation is driven by your growth and success. Key customer relationships are the cornerstone of our chemical developments. Your operational difficulties create the roadmap for our new products that are designed to improve your business' performance.

### **This commitment is represented in every product we manufacture.**

Our mold release agents provide much more than just release of a molded part from the mold surface. DiamondKote™ and Crystal are comprehensive lines of water-based mold release agents. Featuring best in class semi-permanent release agents, ITW Pro Brands (formerly Franklynn) has special formulations for performance in all types of rubber elastomers, urethanes, fiberglass and other resins. Our innovative technologies allow us to provide you the release agent that will optimize your production process.



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Scrap Rates



Increased Cycles  
Per Application



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Appearance



Reduced  
Transfer



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Reduce Downtime



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Construction

Power / Oil & Gas

Sporting Goods & Apparel

General Rubber Goods

And more...

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#### Key Contacts

##### **Frank Thompson**

Industry Segment Leader - Rubber

##### **Jose Murillo**

Regional Sales Director

##### **Brian Garrett**

Product Manager - Mold Release Agents

##### **Carlos Gonzalez**

Technical Applications Engineer



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**Quality products and unsurpassed service to our customers**

# **LIANDA** *More than a Distributor*

## **Celebrating 26 Years!**

### **COMPANY HISTORY:**

Founded in 1995, Lianda Corporation is a privately held company with its corporate offices located in Twinsburg, OH, USA. The company focuses on high performance polymers and specialty additives. Since 1995, Lianda has successfully supplied chlorinated Polyethylene (CPE) elastomer to the NA market. The company also distributes Silicone, FKM and HNBR, high performance elastomers for the oil & gas, automotive and other demanding applications. To effectively support its customers Lianda has a 4 full time technical staff and operate a 3000ft<sup>2</sup> fully equipped lab. Its technical capability includes formulation development, raw material evaluation, trouble shooting, QC spot check, etc.

### **PRODUCT LINES:**

Lianda's performance elastomer line includes: CPE, HNBR, FKM, CR, ECO, CSM, Silicone. Lianda's specialty chemical line includes: Peroxides, Curatives, Zeolites, Silanes, Co-agents, Silica, Blowing Agents, Flame Retardants, Colorants, Metallic Co-Agents, Tin Stabilizers, and Composite & Active Zinc Oxide.

### **PRODUCT SOURCING:**

Lianda has established strong relationships and strategic partnerships with their manufacturers around the world. These arrangements ensure Lianda maintains attention from supplier's top management and continuous supply of products.

### **LAB CAPABILITY:**

- Banbury, Brabender
- Hot/Cold Presses
- Long Term Aging Oven
- MDR 2000, MV 2000, Brookfield
- Capillary Rheometer
- FTIR
- DSC/TGA/DMA
- Tensometer
- Gardner Impact
- Vertical Rebound

### **TECHNICAL SUPPORT:**

Technical know-how is core capability of Lianda. The company takes great pride in positioning itself apart from the rest of the industry by having highly experienced TS&D staff to provide technical support to customers and a well-equipped lab that can perform tests such as cure and flow rheology, physical properties, heat and oil aging, thermal analysis, etc.

### **QUALITY COMMITMENT:**

Since 2003, Lianda has been an ISO 9001 certified Company. Every employee is rigorously trained on quality processes before and throughout their employment at Lianda Corporation.

### **WAREHOUSES:**

To serve our valued customers, Lianda has warehouses located throughout the country. As the business expands and needs arise we continue to add other warehouses in order to serve our customers in the shortest possible lead time. Some of our major warehouses are located in:

- Akron, OH
- North Kingstown, RI
- Savannah, GA
- Jacksonville, FL
- Sparks, NV

### **CONTACT INFORMATION:**

#### **Sales & Tech Service:**

+1-330-653-8341  
[inquiry@liandacorp.com](mailto:inquiry@liandacorp.com)

#### **Customer Service:**

[orders@liandacorp.com](mailto:orders@liandacorp.com)  
+1-330-653-8341

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*Silane Treated, Waterwashed, Calcined, Exfoliated,  
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***Excellence in Service,  
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# Vanderbilt Chemicals, LLC

A Wholly Owned Subsidiary of R.T. Vanderbilt Holding Company, Inc.

## Our Company

From its early beginnings in 1916, Vanderbilt Chemicals, LLC has grown to supply a wide range of products to many different industries, including rubber, plastics, petroleum, paint, CASE, pharmaceutical, agricultural, ceramic, personal care, and household products.

In addition to offering a variety of products from key suppliers, Vanderbilt Chemicals, LLC produces a number of ultra accelerators and antioxidants out of its large chemical manufacturing facility in Murray, Kentucky.

The Vanderbilt companies offer products in the United States and in some 80 countries around the world. Vanderbilt Worldwide Limited, with an office in Nantwich, UK, provides marketing, technical, and sales support for Vanderbilt Chemicals in Europe, Middle East, and Africa and Vanderbilt (Beijing) Trading, Ltd. has an office in Beijing, China. Our corporate headquarters, including our analytical and application labs, is located in Norwalk, CT.

## Headquarters

30 Winfield Street, Norwalk, CT 06855 USA

Toll Free: +1 800-243-6064

Tel: +1 203-853-1400

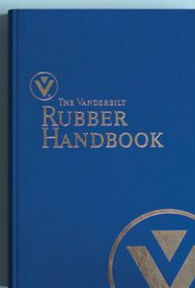
Fax: +1 203-838-6368

## Our Products

- |             |                   |
|-------------|-------------------|
| ■ EPDM      | ■ ACCELERATORS    |
| ■ CR        | ■ ANTIOXIDANTS    |
| ■ FKM       | ■ HALS            |
| ■ CIIR      | ■ UVA'S           |
| ■ BIIR      | ■ PROCESS AIDS    |
| ■ POE       | ■ MINERAL FILLERS |
| ■ PEROXIDES |                   |
| ■ COAGENTS  |                   |

## Our Mission

Building relationships to achieve sustainable and ethical growth through a culture of quality and innovation.



Vanderbilt's chemical plant in Murray, Kentucky



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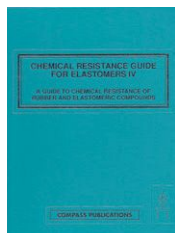
**VANDERBILT CHEMICALS, LLC**

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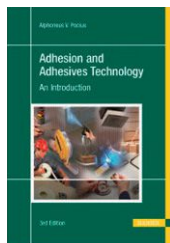
# Indispensable R



## Chemical Resistance Guide for Elastomers IV

Compass Publications  
Hardcover: 780 pages  
ISBN-10: 188971206X

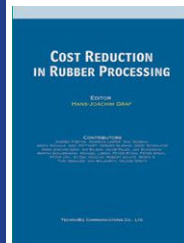
Data for more than 100,000 combinations of corrosents vs. rubber and other elastomeric compounds and representing 60% new updates. This updated edition is a concise guide to chemical and environmental resistance of rubber and elastomeric compounds, when exposed to hostile media. Now 50 rubber and elastomeric compounds are examined in more than 100,000 combinations with corrosents, including 3,000 liquid or dry chemicals, gases, lubricants, household fluids, foods and other environments. In addition, mechanical and physical properties of the materials are covered, including specific rates of deterioration, time and temperature, for selected compounds.



## Adhesion and Adhesives Technology

Author: Pocius, A.  
Copyright: 2012  
ISBN: 978-1-56990-511-1  
Hardcover: 370 pages

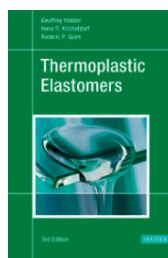
This book describes, in clear understandable language, the three main disciplines of adhesion technology: mechanics of the adhesive bond, chemistry of adhesives, and surface science. Some knowledge of physical and organic chemistry is assumed, but no familiarity with the science of adhesion is required. The emphasis is on understanding adhesion, how surfaces can be prepared and modified, and how adhesives can be formulated to perform a given task. Throughout the book, the author provides a broad view of the field, with a consistent style that leads the reader from one step to the next in gaining an understanding of the science.



## Cost Reduction In Rubber Processing

Editor Hans-Joachim Graf  
Pages: 286 Hardbound  
Publisher: TechnoBiz Communications Co., Ltd.  
ISBN: 978-616-90836-9-6  
Year: March 2014

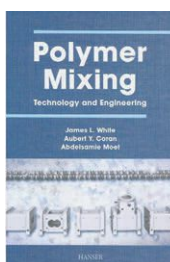
SECTION 1: GENERAL CONSIDERATIONS  
SECTION 2: RAW MATERIALS  
SECTION 3: MACHINERY & MOLDS  
SECTION 4: PROCESSING & PARTS  
SECTION 5: AUTOMATION & SIMULATION  
SECTION 6: LATEX PROCESSING



## Thermoplastic Elastomers

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

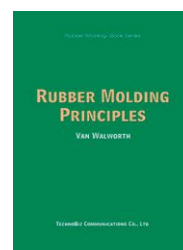
Thermoplastic elastomers are one of the fastest growing material groups. They can be processed like thermoplastics but their properties are close to those of vulcanized elastomers. New products, new processing techniques, new properties, and new applications have developed since the publication of the second edition. All these developments are reflected in the new edition of this well-established standard work. A unique and comprehensive, up-to-date guide to all scientific and technical aspects of thermoplastic elastomers—indispensable for everyone working in this field.



## Polymer Mixing: Technology and Engineering

By James White, Aubert Coran, and Abdelsamie Moet  
ISBN 1569902372  
copyright 2001  
Hardcover: 241 pages, 164

During the past 25 years, there has been an accelerating increase in the development and production of new polymer blends and in the preparation of compounds of polymers with carbon black, various fibers, and inorganic particles. These developments have led to a blending/compounding industry, which sits between the polymer producers and the manufacturers of shaped products such as injection molders. This book provides a broad based examination of the characteristics of polymer blends and compounds, and the methods of preparing them in batch and continuous mixing equipment.



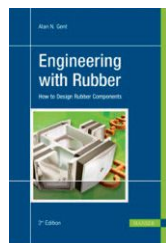
## Rubber Molding Principles

Author: Van Walworth  
Book Release: August 2013  
ISBN: 978-616-90836-8-9  
Hardbound, 150 Pages  
Publisher: TechnoBiz Communications Co., Ltd

Rubber Molding Principles is the first in a series of technical books written to highlight the fundamentals of various aspects of rubber molding technology and how they relate to each other. The more one understands the interactions and relationships of these fundamental principles, the better one is able to exploit the fundamentals to their fullest advantage. Rubber Molding Principles is not intended to be an exhaustive attempt to cover every aspect of rubber molding technology.

# RubberWorld

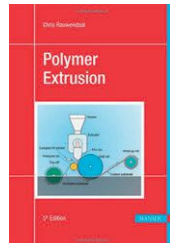
# Reference Tools



## Engineering with Rubber

Author: Gent, A.  
Copyright: 2012  
ISBN: 9781569905081  
Hardcover: 433 pages

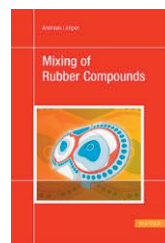
This book provides the principles of rubber science and technology: what rubber is, how it behaves, and how to design engineering components with rubber. It introduces the principles on which successful use of rubber depends and offers solutions to the questions engineers in rubber processing face every day. How is an elastomer chosen and a formula-tion developed? Why is rubber highly elastic and relatively strong? How is the stiffness and strength of a product estimated? How is high quality and durability guaranteed? The authors describe current practices in rubber engineering.



## Polymer Extrusion

Author: Rauwendaal, C.  
Copyright: 2014  
ISBN: 9781569905166  
Hardcover: 934 pages

Bridging the gap between theory and practice, the fifth edition of Polymer Extrusion continues to serve the practicing polymer engineer and chemist, providing the theoretical and practical tools for successful extrusion operations. In its revised and expanded form, this book incorporates many new developments in extrusion theory and machinery.

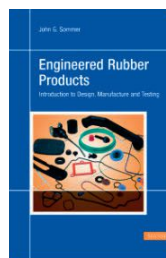


## Mixing of Rubber Compounds

Author: Limper, A.  
Copyright: 2012  
ISBN: 9781569904589  
Hardcover: 239 pages

It is a characteristic of the rubber industry that compounds are usually not bought from a supplier but compounded in an in-house mixing facility. The different mixing technologies add yet another degree of freedom to the tailoring of compound properties.

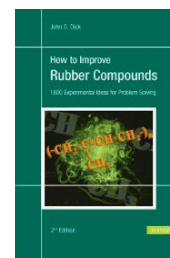
This book covers the major aspects of rubber compounding. For the first time, the reader finds all relevant issues—whether it is machine design, process technology, or material parameters—covered in one comprehensive volume.



## Engineered Rubber Products Introduction to Design, Manufacture and Testing

Author: Sommer, J.  
Copyright: 2009  
ISBN: 9781569904336  
Hardcover: 181 pages

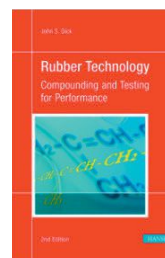
The successful manufacture of engineered rubber products is complicated. It involves different disciplines, materials, and types and designs of equipment. Problems sometimes occur because of less-than-desirable communication among personnel involved in the development and manufacture of rubber products. This book's intent is to improve communication among different disciplines. Using a systems approach, it is further intended to introduce chemists and engineers to the unique capabilities of rubber in a wide range of tire and non-tire products.



## How to Improve Rubber Compounds 1,800 Experimental Ideas for Problem Solving

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

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



## Rubber Technology Compounding and Testing for Performance

Author: Dick, J. Copyright:  
2009  
ISBN: 9781569904657  
Hardcover: 567 pages

This book is a practical guide to cost-effective formulating of rubber compounds to achieve optimal processing and performance. It provides a thorough discussion of the principles of rubber compounding, rubber testing, and how various compound changes will affect different properties and test measurements. Rubber compounding is discussed as a series of interdependent systems such as the elastomer system, the filler-oil system, and the cure system. A holistic approach is used to show how changes in these different systems will affect specific compound properties. Much attention is given to trade-offs in properties and emphasis is placed on finding the best balance for compound cost, processing properties, and product

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## UPCOMING LEARNING OPPORTUNITIES:

- **August 18, 2021**  
*Course: Compound Development Series - Vulcanization*
- **August 18, 2021**  
*Course: Compound Development Series - Processing & Testing of Rubber*
- **August 19, 2021**  
*Course: An Introduction to Continuous Vulcanization*
- **August 25, 2021**  
*Course: How to Extend Lifetime of Elastomers and Rubber Products*
- **August 26, 2021**  
*Course: Soft Skills for Scientific Success*
- **September 1 & 2, 2021**  
*Course: Rubber Formulating 1.0*
- **September 8, 2021**  
*Course: Hazardous Communication*
- **September 17, 2021**  
*Course: Preincident Planning*
- **September 21, 2021**  
*Webinar: The Ins and Outs of Cybersecurity Risk Management*
- **September 23, 2021**  
*Webinar: Essentials of PPE Selection*
- **September 28, 2021**  
*Course: Rubber Explained*
- **September 28-30, 2021**  
*Endurica Workshop: Rubber Compounding for Durability*
- **October 4-6, 2021**  
*Educational Symposium at the International Elastomer Conference*
- **October 19-20, 2021**  
*Endurica Workshop: Viscoelastic Effects in Elastomers and Impact on Durability*
- **November 1-5, 2021**  
*Endurica Workshop: Characterizing Elastomer Fatigue Behavior for Analysis and Engineering*
- **November 16, 2021**  
*Course: Compounding Fluoroelastomers*
- **November 22 & 29 and December 6 & 13, 2021 (four-part course)**  
*Course: Final Safety Program*
- **December 7-10, 2021**  
*Endurica Workshop: Application of Rubber Fatigue Analysis with Endurica Software*

All webinars are **FREE** for Rubber Division, ACS Members and all Rubber Division, ACS courses are **FREE** for Student Members! Visit [rubber.org](https://rubber.org) to learn about the benefits of membership.



# Meetings

## R.D. Abbott organizes LSR 2021 conference

R.D. Abbott is an organizer, sponsor and exhibitor for LSR 2021. This year's liquid silicone rubber focused event is scheduled for September 13-16 in Schaumburg, IL, and will include technical presentations by R.D. Abbott and three of its supplier partners: Dow, Parker Lord and DuPont.

LSR 2021 will include two days of technical presentations, an expert panel discussion titled Machine Technology to Support LSR Processing, and a workshop on silicone characterization and processing simulation. Sodick Co. Ltd., a precision injection mold machine manufacturer, and Plustech, a joint venture between Sodick and Yamazen, will provide a tour of their nearby Sodick-Plustech facility so LSR 2021 participants can observe the injection molding of silicone parts.

Jake Steinbrecher, technical service and development engineer for Dow, will deliver LSR 2021's keynote address, "Innovation in LSR: Using sound materials science to solve performance and manufacturing issues," on Tuesday, September 14, at 9:15 a.m. (ET).

Rick Ziebell, R.D. Abbott's vice president of technology, will present, "LSR third-stream modifiers that change surface properties," on September 14 at 10:00 a.m. (ET). Ziebell will explain how R.D. Abbott and NovationSi, maker of NovaSpere silicone dispersion products, are exploring collaborative technologies for surface, antimicrobial and nanotechnology modifications.

Paul Wheeler, staff scientist for Parker Lord, will present, "Novel adhesion

additive for liquid silicone rubber," on September 14 at 11:00 a.m. (ET).

William Inman, technical representative for DuPont, will present, "Working together: A team approach for determining biocompatibility of medical devices," on September 14 at 12:00 p.m. (ET).

For further information on LSR 2021, visit [www.executive-conference.com](http://www.executive-conference.com).

## Rubber Division offers learning opportunities

Online courses and webinars are offered in September by the Rubber Division, ACS, and will include the following:

Rubber Formulating 1.0 will be held September 1-2 at ACE Products & Consulting in Ravenna, OH. The course

### Rubber Group News

The **Bourbon Trail Elastomer Group** will hold a technical meeting August 19 in Lexington, KY. The BTEG will hold a technical meeting December 7 in Louisville, KY. Further information is available at [www.bourbontrailelastomer-group.org](http://www.bourbontrailelastomer-group.org).

The **Detroit Rubber Group** will hold a golf outing August 25 at the Bay Pointe Golf Club in West Bloomfield Township, MI. Details are available at [www.rubber.org/detroit-rubber-group-inc](http://www.rubber.org/detroit-rubber-group-inc).

The **Mexico Rubber Group** will hold the Rubber Compounding Part 2 course on August 26 at the Rubber Chamber Auditorium in Mexico City, Mexico. The MRG will hold the Vulcanization of Rubber Compounds: Curing Systems course on October 7 at the same location. Further information is available at [www.rubber.org/mexico-rubber-group](http://www.rubber.org/mexico-rubber-group).

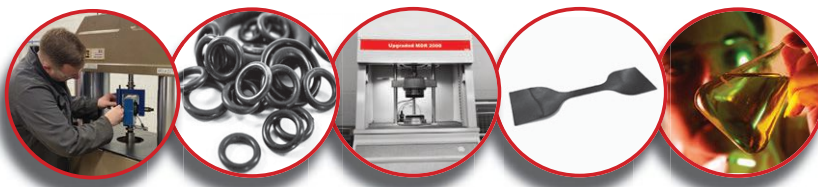
The **Ohio Rubber Group** will hold a golf outing August 30 at Silver Lake Country Club in Silver Lake, OH. The ORG will hold a technical meeting September 28 at the Hilton Garden Inn in Twinsburg, OH. Details are available at [www.ohiorubbergroup.org](http://www.ohiorubbergroup.org).

The **Ontario Rubber Group** will hold a golf tournament September 14 at the Royal Golf Club in Milton, Ontario, Canada. Further information is available at [www.rubber.org/ontario-rubber-group](http://www.rubber.org/ontario-rubber-group).

### Akron Rubber Development Laboratory, Inc.



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# Meetings

will cover training needed to be able to develop a simple compound and mix procedure. ACE will then mix and test each formulation submitted to see how close they got to meeting the specification.

Hazardous Communication (online course) will be held September 8. This course will give participants an understanding of the current HazCom globally harmonized system.

Preincident Planning (online course) will be held September 17. This course will review several OSHA standards, as well as other guidelines.

Essentials of PPE Selection (webinar) will be held September 23.

Rubber Explained (online course) will be held September 28. Centered around practical explanations and basic fundamentals, this course is for the non-technical individual.

Endurica Workshop: Rubber Com-

pounding for Durability will be held September 28-30.

Course details are available at [www.rubber.org/training](http://www.rubber.org/training).

## R.D. Abbott holds free LSR webinar

R.D. Abbott will hold a free webinar, Optically Clear LSRs: A How-To Guide, on August 24, providing an in-depth look at how optically clear liquid silicone rubbers from Dow are molded into functional parts with unique properties. During this live webinar, Jake Steinbrecher, a technical service and development specialist with Dow, will examine how optical silicones are processed differently than standard LSRs, along with technical details, optical terms and how uncured materials become functioning parts. Visit [www.rdabbott.com/news/2021webinars](http://www.rdabbott.com/news/2021webinars) for details.

## Paper call

**Rubber Division, American Chemical Society.** A call for abstracts has been issued by the Rubber Division, ACS, for its 201st Technical Meeting, to be held April 26-28 at the Marriott Cleveland East (Beachwood area) in Warrensville Heights, OH.

Featured topics for this meeting will include nanoscale characterization of rubber materials and composites; computational chemistry and multiscale modeling; structure and physics of elastomers; friction of rubber at interfaces; winter performance in passenger tires; recycling and reprocessing of rubber; and seals and dynamic sealing.

The deadline for receipt of abstracts is November 6. Further information is available from Chuck Brady (330) 595-5543; or at [www.rubber.org](http://www.rubber.org).

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# International **Elastomer** Conference

**WE'RE BRINGING THE INDUSTRY BACK TOGETHER!**

**October 4-7, 2021**

**David L. Lawrence Convention Center • Pittsburgh, PA USA**

The International Elastomer Conference is the premier place where educators, customers, manufacturers and suppliers of materials, equipment, tools and services come together. This event is the one place, one time a year, where you find the best of our industry all under one roof. It is an event where connections are made, knowledge is shared, new products, new technology and new ideas are introduced, business is conducted, developed and gained, fun is had, encouragement and empowerment happen, and the future is embraced.

## **The Expo**

The best of our industry will be exhibiting! A wide variety of companies will be represented, such as equipment manufacturers, injection molders, extruders, custom mixers, processing equipment, hydraulic presses, vacuum molding, testing labs, testing equipment, distributors, suppliers and many more in the industry.

**Visit [rubberiec.org](http://rubberiec.org) to view the floor plan/exhibitor list and learn about exhibiting!**

**Other Events • Student Symposium • Women's Workshop • Career Fair • Experience Elastomers Student Outreach Program • Special Events, including a 5K Walk/Run, Young Professionals Forum, 25-Year Club Luncheon and Awards Ceremony • Networking Opportunities and Events • Welcome Reception**

Brought to you by:



## **200<sup>th</sup> Technical Meeting**

To celebrate our 200<sup>th</sup> Technical Meeting we are featuring a special 'Frontiers' symposia to address the past, present and future of key areas in rubber science – Rubber Synthesis, Reinforcement of Rubber and Additives & Applications. Technical Meeting presentations will also share knowledge on these topics:

- **Characterization of Elastomers & Raw Materials**
- **Sustainability & Renewable Materials**
- **Advances in Materials & Processes for Tires**
- **Modelling & Simulation**
- **Connectivity, Robotics & AI in the Rubber Industry**
- **New Commercial Developments**
- **Science & Technology Award Winner Presentations**

## **Educational Symposium**

We have developed a great educational symposium featuring these courses:

- **Introduction to Compounding**
- **Compounding Fluorelastomers**
- **Dynamic Viscoelastic Properties**
- **Essentials of Rubber Technology**
- **Essentials of Silicone Rubber**
- **Mixing & Testing for Compound Consistency**
- **Scientific Rubber Molding**
- **Using Augmented Reality in the Rubber Industry**
- **Interactive Compound Development & Problem Solving**
- **Rubber Explained**
- **Critical Elements of Science – Communication & Other Soft Skills**

***Interested in attending or exhibiting? Visit [rubberiec.org](http://rubberiec.org).***





## Future Meetings/Expos

**2021**  
**Pittsburgh** **October 4-7**

**2022**  
**Knoxville** **October 10-13**  
**www.rubber.org**

**Rubber Division, ACS**, Compound Development Series: Processing and Testing of Rubber online course, [www.rubber.org](http://www.rubber.org) - August 18.

**Rubber Division, ACS**, Compound Development Series: Vulcanization online course, [www.rubber.org](http://www.rubber.org) - August 18.

**Bourbon Trail Elastomer Group**, technical meeting, Lexington, KY, [www.bourbontrailelastomergroup.org](http://www.bourbontrailelastomergroup.org) - August 19.

**Rubber Division, ACS**, An Introduction to Continuous Vulcanization online course, [www.rubber.org](http://www.rubber.org) - August 19.

**Messe Frankfurt**, Techtextil North America, Raleigh Convention Center, Raleigh, NC, <https://techtextil-north-america.us.messefrankfurt.com/> - August 23-25.

**University of Akron, Akron Polymer Training Services**, Polymer Science for Engineers online course, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - August 23-25.

**R.D. Abbott**, Optically Clear LSRs: A How-To Guide webinar, [www.rdabbott.com/news/2021](http://www.rdabbott.com/news/2021) webinars - August 24.

**Detroit Rubber Group**, golf outing, Bay Pointe Golf Club, West Bloomfield Township, MI, [www.rubber.org/detroit-rubber-group-inc](http://www.rubber.org/detroit-rubber-group-inc) - August 25.

**Rubber Division, ACS**, How to Extend the Lifetime of Elastomers and Rubber Products, [www.rubber.org](http://www.rubber.org) - August 25.

**Mexico Rubber Group**, Rubber Compounding Part 2 course, Rubber Chamber Auditorium, Mexico City, Mexico, [www.rubber.org/mexico-city-rubber-group](http://www.rubber.org/mexico-city-rubber-group) - August 26.

**Rubber Division, ACS**, Soft Skills for Scientific Success online course, [www.rubber.org](http://www.rubber.org) - August 26.

**TechnoBiz**, KnowHow Webinar: Rubber Extrusion Theory and Practice, [www.knowhow-webinars.com](http://www.knowhow-webinars.com) - August 26.

**Ohio Rubber Group**, golf outing, Silver Lake Country Club, Silver Lake, OH, [www.ohiorubbergroup.org](http://www.ohiorubbergroup.org) - August 30.

**University of Akron, Akron Polymer Training Services**, Organosilanes: The Link Between Polymers and Surfaces online course, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - August 30-31.

**The Tire Society**, 40th Annual Conference on Tire Science and Technology, [www.tiresociety.org](http://www.tiresociety.org) - August 30 - September 3.

## September

**Rubber Division, ACS**, Rubber Formulating 1.0 course, ACE Products & Consulting, Ravenna, OH, [www.rubber.org/training](http://www.rubber.org/training) - September 1-2.

**Rubber Division, ACS**, Hazardous Communication online course, [www.rubber.org/training](http://www.rubber.org/training) - September 8.

**University of Akron, Akron Polymer Training Services**, Understanding Dynamic Properties of Rubber and Rubber Products online course, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - September 8-9.

**University of Akron, Akron Polymer Training Services**, Color Theory and Applications online course, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - September 8-10.

**Guangzhou Guangya Messe Frankfurt**, Formnext + PM China, Shenzhen Convention Center, Shenzhen, China, [www.formnext-pm.com](http://www.formnext-pm.com) - September 9-11.

**Executive Conference Management**, LSR 2020, Marriott Schaumburg Hotel, Schaumburg, IL, [www.executive-conference.com](http://www.executive-conference.com) - September 13-16.

**TechnoBiz**, KnowHow Webinar: Rubber Compounding for Non-Tire Products, [www.knowhow-webinars.com](http://www.knowhow-webinars.com) - September 13-17.

**Ontario Rubber Group**, golf tournament, Royal Ontario Golf Club, Milton, Ontario, Canada, [www.rubber.org/ontario-rubber-group](http://www.rubber.org/ontario-rubber-group) - September 14.

**University of Akron, Akron Polymer Training Services**, Structure/Property Relationships in Polyurethanes course, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - September 14-15.

**U.K. Industry Events Ltd.**, Chemluk2021 U.K. Chemical Industries Supply Chain Expo, National Exposition Center, Birmingham, U.K., [www.chemicalukexpo.com](http://www.chemicalukexpo.com) - September 15-16.

**University of Akron, Akron Polymer Training Services**, Applications of FTIR and NMR Spectroscopy in Polymer Product Development (Problem Solving, Development and IP Creation) online course, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - September 15-16.

**University of Akron, Akron Polymer Training Services**, ASTM Rubber Testing: Selecting, Performing and Interpreting ASTM Rubber Test Methods course, Akron, OH, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - September 15-16.

**Rubber Division, ACS**, Preincident Planning online course, [www.rubber.org/training](http://www.rubber.org/training) - September 17.

**MidAtlantic Rubber and Plastics Group**, technical meeting, Evonik, Parsippany, NJ, [www.marpg.org](http://www.marpg.org) - September 23.

**Rubber Division, ACS**, Webinar: Essentials of PPE Selection, [www.rubber.org/training](http://www.rubber.org/training) - September 23.

**TechnoBiz**, KnowHow Webinar: Compression Rubber Molding, [www.knowhow-webinars.com](http://www.knowhow-webinars.com) - September 23.

**University of Akron, Akron Polymer Training Services**, Rubber Technician Training course, Akron Polymer Training Center, Akron, OH, <https://www.uakron.edu/apts/training/courses/> - September 27-30.

**Ohio Rubber Group**, technical meeting, Hilton Garden Inn, Twinsburg, OH, [www.ohiorubbergroup.org](http://www.ohiorubbergroup.org) - September 28.

**Rubber Division, ACS**, Rubber Explained online course, [www.rubber.org/training](http://www.rubber.org/training) - September 28.

**Rapid Plastics Media Ltd.**, Interplas, National Exhibition Center (NEC), Birmingham, U.K., [www.interplasuk.com](http://www.interplasuk.com) - September 28-30.

**Rubber Division, ACS**, Endurica Workshop: Rubber Compounding for Durability (online), [www.rubber.org/training](http://www.rubber.org/training) - September 28-30.

**Mettler Toledo**, Thermal Analysis of Biopolymers webinar, [www.mt.com/nalab-webinars](http://www.mt.com/nalab-webinars) - September 30.

## October

**ASTM International**, Fall Committee Week, Atlanta, GA, [www.astm.org/meetings](http://www.astm.org/meetings) - October 3-8.

**Rubber Division, ACS**, International Elastomer Conference, 200th Technical Meeting, Educational Symposium and Expo, David L. Lawrence Convention Center, Pittsburgh, PA, [www.rubberiec.org](http://www.rubberiec.org) - October 4-7.

**Center for the Polyurethanes Industry**, 63rd Polyurethanes Technical Conference, Gaylord Rockies Resort & Convention Center, Denver, CO, [www.polyurethane.americanchemistry.com](http://www.polyurethane.americanchemistry.com) - October 5-7.

**University of Akron, Akron Polymer Training Services**, Complete Injection Molding course, Akron, OH, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - October 6-8.

**Latin Expo Group, LLC**, Latin Tyre Expo & Latin Auto Parts Expo, Panama Convention Center, Panama, Republic of Panama, [www.latintyreexpo.com](http://www.latintyreexpo.com) - October 6-8.

**Mexico Rubber Group**, Vulcanization of Rubber Compounds: Curing Systems course, Rubber Chamber Auditorium, Mexico City, Mexico, [www.rubber.org/mexico-city-rubber-group](http://www.rubber.org/mexico-city-rubber-group) - October 7.

**Messe Dusseldorf Asia**, Indoplas, Indopack and Indoprint Exhibition, Jakarta International Expo, Jakarta, Indonesia, [www.mdna.com](http://www.mdna.com) - October 13-16.

**University of Akron, Akron Polymer Training Services**, Automotive OEM Coatings Chemistry and Applications online course, [www.uakron.edu/apts/](http://www.uakron.edu/apts/) - October 14-15.

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## Process aids for rubber compounds

Patented SureMix functional process aids are available from this specialty polymer additives, dispersions and performance chemicals manufacturer. SureMix functional process aids have proven effective in resolving today's silica challenges in rubber compound processing and tire performance. They were developed for tire and industrial rubber component manufacturers to reduce mixing time/passes, increase throughput, increase shelf life, lower rolling resistance, increase wet traction and improve handling.

SureMix CO<sup>2</sup> is a performance optimizing process aid that enables next level hysteresis reduction with functional, solution SBR, and provides a route to more efficient, complete silanization, according to the company. Formulators can utilize SureMix to optimize mixing and processing without sacrificing performance or the need for higher silane loadings. Tire companies can solve today's challenges resulting from new raw materials (especially



functional, solution SBR [FsSBR] and silica). SureMix is said to cost-effectively meet the performance and environmental challenges faced by the tire industry.

SureMix CO<sup>2</sup> not only provides a route to more efficient, complete silanization, it also enables the next level in hysteresis reduction when used in conjunction with functional, solution SBR, without sacrificing processability, according to the firm. With SureMix, compounders are said to formulate without compromise.

The manufacturer of SureMix is said to be an innovative producer of proprietary and custom polymers, additives and performance chemicals for the rubber, wood, consumer, construction and medical industries. The firm offers a variety of customer-centric solutions that improve polymer processing, increase surface protection and enhance product performance. (*Polymer Solutions Group*)

[www.polymersolutionsgroup.com](http://www.polymersolutionsgroup.com)

## Compounding solutions

An experienced and innovative technical staff collaborates with companies across the globe to find the most beneficial rubber compounding solutions. From simple fillers to unique rubber chemical blends, this company is said to have the right ingredients. An extensive catalog of quality rubber compounding products is supplied, such as accelerators, activators, antifoams, antioxidants and antiozonants, co-agents, colors (including polymer masterbatch dispersions, paste, powder and thermoplastic color concentrates), mineral fillers, carbon blacks, elastomers, fire retardants, cure blends and chemical blends, silicone fluids, flocks and wood flours, magnesium and calcium products, peptizers, resins and tackifiers, stearates, sulfurs, process aids, vulcanized vegetable oils, waxes and zinc oxides. The firm works alongside customers to optimize cure systems, improve chemical dispersion and yield better results in batch uniformity. The company has ISO 9001-2015 and National Association of Chemical Distributors (NACD) accreditations. (*Akrochem*)

[www.akrochem.com](http://www.akrochem.com)

## Fluoroelastomer products

Aflas fluoroelastomers are offered for lamination to other elastomers in automotive hose applications. Aflas FEPM grades are designed for lamination technology for multi-layer hose constructions. This multi-layer technology using Aflas grades 400E and 600X is said to be ideal for use in high pressure, high temperature areas around the engine where hoses are exposed to NO<sub>x</sub>, SO<sub>x</sub>, engine oils and other aggressive automotive fluids. Trends including engine and turbo efficiency improvement, fuel consumption improvement and environmental regulation changes require such technology. (*AGC Chemicals Americas*)

[www.agcchem.com](http://www.agcchem.com)

## Sustainable carbon black

Continua sustainable carbonaceous materials are said to represent a step forward in the availability and know-how of sustainable solutions in the carbon black industry. Continua products, by their circular nature, will enable large and quantifiable carbon footprint reductions, paving the way for greener, cleaner and more sustainable industry value chains, according to the company. Over the next five years, 73,000 metric tons of Continua will be available annually for use in a wide range of applications, including tires, mechanical rubber goods, plastics, and more. A life cycle assessment conducted according to ISO 14040 and ISO 14044 demonstrates that, at full capacity, 228,000 metric tons of direct and indirect CO<sub>2</sub> emissions will be eliminated on an annual basis when compared to the conventional carbon black process, according to the company. (*Birla Carbon*)

[www.birlacarbon.com](http://www.birlacarbon.com)

## Pigment preparations

In February, the EU classified titanium dioxide as a suspected carcinogen (carcinogenic Category 2) by inhalation per the CLP regulation. This classification will be broadly applied throughout the European supply chain no later than October 1. To address ever-evolving regulations, the company's product safety and regulatory team has assessed its colorant portfolio and found that none of its products are subject to the new classification. Across various industries, including coatings, agriculture and plastics, the company's brand offers compliant, low dusting solutions. These TiO<sub>2</sub> containing products range from pigment preparations, such as Xfast, Micranyl and Microlith, to effect pigments products in powder, low dusting and dust free preparation form. (*BASF Colors & Effects*)

[www.colors-effects.com](http://www.colors-effects.com)



### Cure activation chemicals

With the rubber and plastics industries recently suffering from a critical shortage in cure activation chemicals due to unexpected supply chain delays, the company credits its own integrated supply chain for its recent success. Cure activation chemicals are required for curing, a process which hardens and toughens a liquid compound into a more solid state; a necessary part of the process to manufacture rubber or plastic. However, recent supply chain delays have left many compound manufacturers without access to the necessary cure activators needed to maintain productivity levels. Thanks to its integrated supply chain, the firm has been unaffected by global shortages and continues to offer its own calcium hydroxide cure activator, Innovoh, for immediate dispatch worldwide. Said to be relied upon by many FKM fluoroelastomer producers, Innovoh is just one of the many products in the company's range, which also features the Innovox calcium oxide desiccant range. (*Birch Chemicals*)

[www.birchchemicals.co.uk](http://www.birchchemicals.co.uk)

### Mold purging compounds

A proper shutdown of thermoplastics injection molding equipment will make the subsequent start-up much quicker and more effective. Using efficient purging compounds and mold maintenance solutions will help manufacturers increase their efficiency after a return. Ultra Purge compounds continually evolve to address the challenges faced as a thermoplastics processor and are designed to add significant value to an operation. The firm's portfolio covers a wide array of process applications, polymers, operating temperatures and equipment types, allowing for the best match for a specific situation. (*Chem-Trend*)

[www.chemtrend.com](http://www.chemtrend.com)

### EPDM material for seals

Seals are being manufactured from a new ethylene propylene diene monomer (EPDM) material that successfully addresses a significant challenge in the aerospace industry: hydraulic seal leakage at high altitudes and low temperatures. The 80 EPDM 426288 material is said to successfully seal hydraulic systems operating at temperatures as low as -85°F (-65°C), which is said to be a breakthrough in EPDM formulations. Company scientists have used a unique polymer, rather than adding large amounts of plasticizers, to produce 80 EPDM 426288. The material meets the rigorous requirements of the new AMS7361 specification for improved low temperature behavior in commercial aircraft hydraulic systems. In both laboratory testing and application, 80 EPDM 426288 is said to demonstrate superior, low temperature sealing behavior after extensive exposure to fluids, pressures and temperature extremes. EPDM can be crafted to resist sunlight, ozone and chemical degradation, effectively seal phosphate-ester hydraulic fluids and other fluids, and performs well at temperatures of up to 302°F (150°C), according to the company. (*Freudenberg Sealing Technologies*)

[www.fst.com](http://www.fst.com)

### Zinc oxide powder, pellets

A wide variety of zinc oxide powders and pellets with purities of 99.9% and beyond, manufactured to specific customer applications, are provided by the company. A development laboratory offers blending of zinc oxide with other powders, density and hardness studies of powders and pellets, new applications for zinc oxide, optimized particle size for best performance, surface coating of powders with liquids, and more. (*Zochem*)

[www.zochem.com](http://www.zochem.com)

## Environmentally-friendly blowing agent

A blowing agent is a substance which is capable of producing a cellular structure by means of a foaming process in a variety of materials that undergo a hardening or phase transition, such as polymers, plastics and rubbers. They usually contain some gaseous and solid components which are harmful to the environment. The issue is that gases such as ammonia and formamide result in an unpleasant odor, respiratory diseases, or local skin and mucous membrane irritation.

These substances are an integral part of mats for sports and children's products, shoe soles and various foams which can be used in everyday, industrial and medical applications.

To protect health and meet ecological requirements, the company has developed the KY-ECO blowing agent which is said to be the world's first blowing agent that is naturally environmentally-friendly after the foaming process. Cellcom KY-ECO is an eco-friendly blowing agent which is free from

hazardous gases such as ammonia, formamide and sulfur dioxide. Results of an analysis for hazardous gases of the KY-ECO in comparison with two representative blowing agents, ADCA and OBSH, showed positive results.

Cellcom KY-ECO is supplied in pellet form, the carrier resin of which is EVA, and the content of active blowing agent is 50%. KY-ECO makes no powder dust during use and is evenly dispersible in the polymers using most conventional mixing equipment. It is also able to reduce the loss of chemicals during processing. As KY-ECO only generates nitrogen gas, this can be useful for the manufacture of such eco-friendly foams as EVA shoe soles, mats made of EVA and rubbers using conventional methods.

Cellcom KY-ECO has recently been used for EVA puzzle mats and polychloroprene sports and yoga mats free from ammonia and formamide gases. (*Kumyang*)

[www.kyc.co.kr](http://www.kyc.co.kr)



## Keeping Service in the Mix

Experience, Technology, & Personal Response

- Custom Mixing
- Dispersions
- Chemical Blending



## Custom Rubber Mixing

- Black Mixing
- Color Mixing
- Straining Capabilities
- Slab, Strip, or Pellet Forms Available

## Dispersions

- Combination-type Dispersions
- Slab or Pellet Form
- Custom Dispersions Available

## Chemical Blending

### Benefits

- Increased Control
- Tighter Consistency
  - Modulus
  - Tensile
  - Cure Rates
- Safe Material Handling



[www.polymericsync.com](http://www.polymericsync.com)

Ph: 330.928.2210 • [sales@polymericsync.com](mailto:sales@polymericsync.com)

## Chemicals/Materials

## Liquid silicone foam

The company's expanding silicone product line includes NS-120, a direct equivalent to Rogers HT-800 that is best known for its extreme smoke and flame rating, FDA approved ingredients, shock absorption and vibration isolation in a lighter density, smooth skinned, closed cell foam. NS-120 has a UL-94-V0 smoke and flame rating perfect for applications in electric vehicles (EVs), EV charging stations, aerospace and railcar, to name a few. This material also meets 21 CFR 177.2600 for repeated contact with food. Low compression set, UV/ozone resistance, an extreme temperature range and superior sealing capabilities make NS-120 perfect for many outdoor sealing and enclosure applications, according to the company. Independent laboratory testing has fully qualified this material to meet UL 94 V-0, AMS 3195, FDA 21-CFR 177.2600 and the ASTM D1056 2D2 standard for compression deflection at high temperatures. This gray, smooth skinned, closed cell, light density foam is available in thicknesses ranging from 1/32" to 1/2". (*National Silicone*)

[www.nationalsilicone.com](http://www.nationalsilicone.com)

## Functional black pigment

Spectrasense Black EH 8082 is a functional black pigment said to provide improved jetness in solid and neutral color travel in effect shades. Said to be a breakthrough in hue control for white and metallic reductions, the Spectrasense Black EH 8082 product is said to benefit designers and technologists alike by providing design freedom, while not compromising on technical benefits. With low near infrared (NIR) absorption, Spectrasense Black EH 8082 enables the creation of neutral gray and dark shades in solar heat management and light detection and ranging (LiDAR) applications, according to the company. (*BASF Colors & Effects*)

[www.colors-effects.com](http://www.colors-effects.com)



## INTERCURE® - ISO CERTIFIED FACILITY

INTERBUSINESS GROUP is a leader in the manufacture and distribution of a complex range of specialty chemicals for the rubber industry.

**INTERCURE®** accelerators, vulcanizing agents, and curing agents for special elastomers are produced through IB Chem. S.r.l., its European ISO 9001:2015 certified, state-of-the-art production facility.

The Group has locations in Italy (Milan and Brindisi) and in the USA (New York and New Jersey), as well as a global network of independent distributors.

[www.interbusinessgroup.com](http://www.interbusinessgroup.com)

### Calcium oxide, hydroxide

Sustainably produced solutions and products are available from this supplier of specialty chemicals to the rubber industry. With a sustainability plan that includes targets for carbon reduction and environmentally friendly alternatives to necessary business processes, the firm is said to have gone the extra mile for sustainability. The company recycles 80 to 100 metric tons of waste metals annually, along with 95% of all of its waste oils. It also operates four parallel flow regenerative shaft kilns, said to be the most fuel efficient kilns available. Recently, the business announced plans to replace all petroleum oil additives in its product range, including moisture control solutions Innovoh and Innovox, with plant-derived alternatives. The company manufactures and supplies high quality calcium oxide and calcium hydroxide solutions for rubber and plastics, including Innovox, Innovoh and the powerful Birchset CR cure stabilizer. Accredited to the ISO 14001:2004 standard since 2001, the firm boasts an integrated supply chain that allows it to control each step of its manufacturing process for higher quality and best sustainability practice. (*Birch Chemicals*)

[www.birchchemicals.co.uk](http://www.birchchemicals.co.uk)

### Low free prepolymers

A low free TDI polycarbonate prepolymer for high temperature applications and low free 1K blocked prepolymers for easier processing and enhanced performance are provided by the company. The two new prepolymers in the Adiprene range are produced using low free (LF) technology so they contain very low diisocyanate content. One of the most challenging applications for polyurethane casting systems is said to be high temperature applications. As polyurethane chemistries have advanced over the years, casting systems are being used more frequently in this high performance segment. The novel Adiprene LF TR400 high temperature prepolymer is based on polycarbonate. This low free TDI prepolymer is cured with MCDEA (4,4'-methylenebis(3-chloro-2,6-diethyl-aniline)). It is said to be much easier to process than comparable prepolymer systems for high temperature applications. It offers a manageable processing/pour life. The resulting cast elastomers are said to demonstrate improved high performance properties. (*Lanxess*)



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### Grinding, homogenizing

Grinding and homogenizing lines are offered for natural and synthetic rubber to feed internal mixers, extruders or solvent units. The company's technologies are said to be widely used in the tire industry, rubber polymerization factories, in production of rubber compounds, polymeric alloys (TPV, TPU) and adhesives. The company works side by side with its customers in the field of rubber grinding in order to develop its machines according to their needs, aiming to always achieve the mandatory high standard worldwide requested by the chemistry and tire production industries. The company's grinders are able to keep to a minimum the temperature increase between the inlet and the outlet of ground material, at the same time optimizing the energy consumption. They are also said to be excellent at processing sticky and soft rubber with a minimum demand for anti-sticking liquid and powder. Grinder output is 150 to 20,000 kg per hour. Rubber bale guillotines, dicers and choppers are offered. (*Previero N.*)

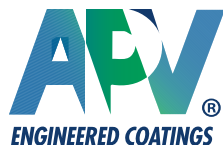
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### Rotary extrusion dies

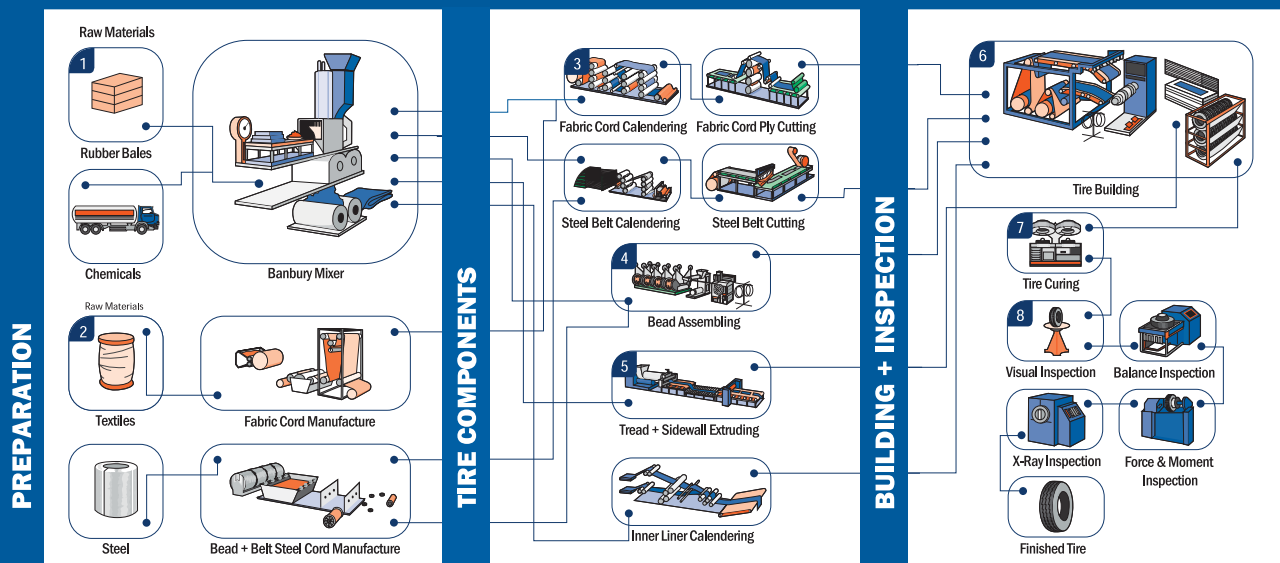
High production rotary models, both inline and crosshead style, have been redesigned. A two-fold increase in speed, with models running to 1,000 rpm, depending on the application, are now available in these patented rotating tip and die designs. By rotating the tooling in relation to the material flow, a rotary head increases the wall strength of an extrusion, thereby allowing a thinner wall with less material and the corresponding cost savings for the user. Typical applications for rotary heads include medical and multi-lumen tubing, plus various high end extrusions with interlocking layer or multiple striping requirements. Features offered on these rotating extrusion dies include counter-rotating tip and die, co-rotating tip and die, rotating die with conventional tip, rotating tip with conventional die, crosshead or inline designs, multi-layer and striping capability, and optional quick change cartridges that are said to minimize cleaning downtime. By using rotary dies, extruders can realize a cost savings due to the elimination of secondary processes. (*Guill Tool & Engineering*)

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### Inspection system using AI

Automatic vision inspection equipment is designed, manufactured and marketed by the company for quality control of rubber and plastic parts, from statistical sampling to full volume production. Combining real time monitoring with advanced image processing tools, the company's systems are said to deliver high performance and consistent results throughout the entire quality inspection process. The integration of artificial intelligence (AI) is said to revolutionize the traditional image processing methods based on manually set thresholds. The company's AI software is able to easily identify objects (with defined shapes) and surface defects (with undefined shapes). The operator simply needs to collect a set of sample images that well represent the range of defects. Thanks to SuperVised Learning (SVL), the machine can be quickly trained to classify objects and detect defects according to the user's needs. This approach is independent of the variables that require frequent manual adjustments, resulting in less downtime and reduced inspection errors. Another cutting-edge technology is the patented color illumination, consisting of four wavelengths (green, blue, red, yellow) with independent brightness control. (UTPVision)

[www.usa.utpvision.com](http://www.usa.utpvision.com)

### Fatigue testing software

An added feature in the Endurica CL fatigue solver is automatic block cycle generation which enables users to extract a simplified durability testing schedule (known as a block cycle test) from multi-channel road loads recorded at the testing track. The simplified testing schedule preserves the most essential features of the original road load history, while maintaining the original failure mode and discarding non-critical load history. The capability enables rubber part suppliers to design fatigue tests that execute quickly and that develop realistic damage. It enables car makers to ensure durability under actual driving conditions, according to the company. Some suppliers try to use fatigue codes written for metals to generate their block cycle schedules, according to the firm. It is said to be a questionable approach that fails to account for the significant differences between metallic and rubbery behavior. Block cycle tests that were generated this way can too often change the failure mode of the part so that the laboratory test fails to match the field test. The company's method uses critical plane analysis. It takes into account rubber's nonlinear material properties. It calculates a block cycle schedule that preserves the failure mode of the original. (Endurica)

[www.endurica.com](http://www.endurica.com)



### Ueshima Fully AUTOMATIC Dynamic Mechanical Analyzer (DMA) Model VR-7130

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This tool offers the ability to greatly reduce the time and effort it takes for detailed characterization of viscoelastic materials including polymers. Even if you only possess a small amount of material yet you want to understand its properties such as glass transition temp (T<sub>g</sub>), it's quite simple with the VR-7130. The required specimen size is very small which minimizes variables that may influence the outcome. Perhaps the greatest feature is not needing liquid nitrogen.

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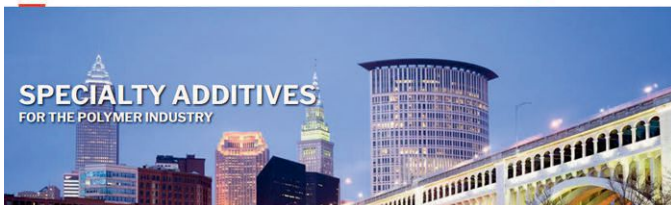
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STRUKTOL ADDITIVE SOLUTIONS

**Struktol Company of America, LLC** ([www.struktol.com](http://www.struktol.com)) is a member of the Schill+Seilacher group, with global representation in over 100 countries. Struktol's approach to the rubber and plastic additives business is by no means typical or ordinary. Chemistry is at the heart of everything Struktol does. Providing intelligent additive solutions, Struktol products are designed to meet the challenges and exacting demands of its customers. Struktol's technical specialists, research and development chemists and compound laboratory are dedicated to creating innovative solutions for the ever-changing polymer industry; solutions that keep customers ahead of their competition with increased productivity, better qual-

ity parts and lower overall cost. In addition to premium product performance, Struktol's customer service initiatives have become the industry benchmark.

Struktol manufactures a complete line of additives that function individually or in combination in both natural and synthetic rubber. By providing a full range of material enhancing products, i.e., dispersants, homogenizers, lubricants, peptizers, plasticizers and tackifiers, the incorporation of Struktol additives can significantly improve processability for all stages of rubber production. Struktol is a flexible innovation partner, producing its additives in accordance with the demanding specifications of all its customers and reacting swiftly to market needs, adapting new technologies quickly to ensure customer satisfaction and loyalty.

Customers depend on Struktol's intelligent additive solutions for superior viscosity control, improved mold release, improved mixing and uniform filler dispersion, decreased mixing times and energy, and improved ease of manufacturing.

Struktol silica dispersants provide faster processing of high performance silica compounds. The use of processing additives in compounds containing high dispersity silica/silane coupler and high levels of natural rubber can provide a variety of processing and physical property benefits, including reduced viscosity for improved processing, increased cure state, improved scorch safety, better modulus and tensile, significant decrease in Payne effect, reduced abrasion loss, and more.

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## CUSTOM CALENDERING

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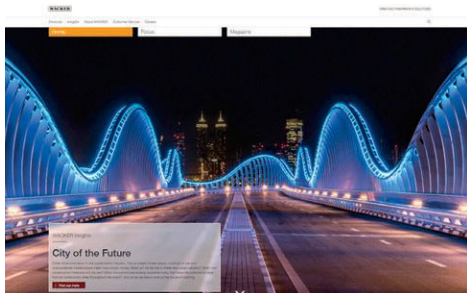
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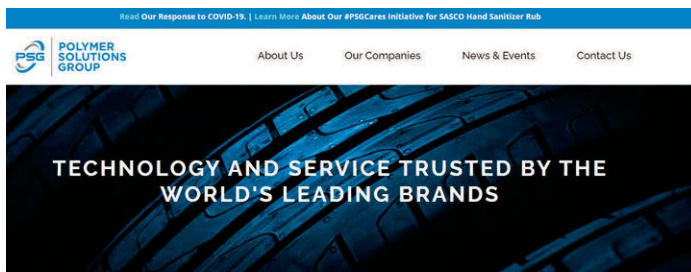


**Wacker** ([www.wacker.com](http://www.wacker.com)) is a technological leader in the chemical industry and manufactures products for all key global industries. It is active in the silicone, polymer, life sciences and polysilicon markets. With a range of more than 2,800 silicone products, Wacker ranks among the world's largest manufacturers of silanes and silicones. Wacker is also the market leader in key subsegments, with a product portfolio ranging from silanes through silicone fluids, emulsions, elastomers, sealants and resins to pyrogenic silicas. Thanks to their highly diverse properties, silicones offer virtually unlimited potential for intelligent, customizable solutions in numerous sectors. Key application areas include engineering, electronics, chemicals, cosmetics, textiles and paper.

Wacker's wealth of products, experience and expertise enables the firm to offer complete, customized solutions. Cooperating closely with customers, Wacker develops new products and innovative production processes to help customers cut costs and optimize their business. To this end, Wacker provides laboratory support for product formulation and approval, and for scale-up to full production. Wacker also assists customers with the development of supply chain and packaging strategies.

Non-vulcanized silicone rubber consists of polymers of different chain lengths. These so-called polysiloxane chains always contain a silicon-oxygen backbone, with two organic side groups, usually methyl groups, bound to each silicon atom. These polysiloxane chains determine the key material properties common to all silicone rubbers, such as heat resistant and electrical characteristics. The choice of additive determines the particular processing and material properties of Wacker's silicone rubber portfolio, extending the approximately 1,000 products. Crosslinkers, fillers and catalysts are among the most important additives. Wacker offers a wide range of different silicone rubber grades marketed under the trade names Elastosil, Geniosil, Powersil, Semicosil, Silmix, Silpuran and Wacker.

Wacker's integrated management systems represent the company's most comprehensive management tool to maintain sustainable business practices.



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**Polymer Solutions Group** ([www.polymersolutionsgroup.com](http://www.polymersolutionsgroup.com)) strives to make its customers' products the best they can be. Within the walls of each PSG company, including Flow Polymers and SASCO Chemical Group, the firm nurtures a commitment to customer-centric innovation that demands deep knowledge of the markets served. By cultivating strong customer relationships, Polymer Solutions Group maintains insights into the chemistries, processes and market forces that drive its customers' success. Functioning as a team of teams, PSG innovates with an entrepreneurial edge that satisfies customers and fuels growth.

Flow Polymers provides performance additives and dispersions for 85% of the world's tires. With 30 years of experience formulating performance additives and hundreds of dispersions for all types of processes, Flow Polymers is a leading supplier to the global tire industry. Flow Polymers' deep knowledge of its customers' businesses is founded in its devotion to customer-centric service, innovation and quality. Additives are materials used in relatively low dosage in rubber compounds to improve compatibility of dissimilar elastomers, improve mixing, processing and surface tack, and improve extrusion rates and appearance. Additive categories offered by Flow Polymers include homogenizing agents, process aids and special products. Flow Polymers also provides a complete line of single and multiple ingredient value added dispersions to improve processing and insure safe handling of rubber and plastic additives.

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## People in the News

# Goodyear and Cooper associates honored

The Manufacturing Institute will honor three Goodyear Tire & Rubber and Cooper Tire & Rubber associates at the 2021 Science, Technology, Engineering and Production (STEP) Ahead Awards. **Shawn Donaldson**, research and development manager for Cooper, and **Ronda Williams**, regional quality manager for Goodyear, are both recognized as STEP Ahead honorees. **Ann Myers**, an engineering associate at Goodyear, will receive the STEP Ahead Emerging Leader Award. The awards celebrate women in science, technology, engineering and production careers who have made outstanding achievements in their companies and communities.



**Shawn Donaldson**  
*Cooper Tire*



**Ronda Williams**  
*Goodyear*



**Ann Myers**  
*Goodyear*



**Huned Contractor**  
*Rubber World*

Deutschland, based in Germany.

**Craig Allshouse** has joined Fluence Analytics as an executive advisor.

**Alan Aspuru-Guzik** has joined the P2 Science scientific advisory board.

ber industry journalist in India, was appointed *Rubber World's* advertising sales representative in India.

**James Chura** was named an aftermarket sales engineer for Davis-Standard.

**Gareth Meese** was promoted to regional sales director, EMEA, for Eriez.

Hankook Tire U.K. named **Andy Hodkin** regional sales manager and **James Young** national accounts manager.

## MANAGEMENT

**Eric Adams** was appointed managing director for the newly established Eriez

## SALES

**Huned Contractor**, a consultant with more than 30 years of experience as a rub-

# Technical Sales Representative

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- Monitor and report on industry activities that contribute to increased sales growth by specific markets served.

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- 5-7 years Experience /Technical Knowledge in Specialty Chemicals is required.
- Outside Sales Experience 3-5 years is required.
- 4 year Technical and/or Business Degree

### Preferred Skills

- Strong Interpersonal Skills, Self Driven, Exceptional Organizational Skills required.
- Excellent Communications Skills in English both written and verbal is required.
- Proficient in Microsoft Office and CRM Software.

**Only Candidates with Specialty Chemical Sales experience in Rubber, Paint & Coatings, and other related industries will be considered.**

Competitive Base Salary (based on experience and skills), along with Sales Commission, Profit Sharing Plan, and Health Care Plan. Company provided Vehicle, Cell Phone and Laptop.

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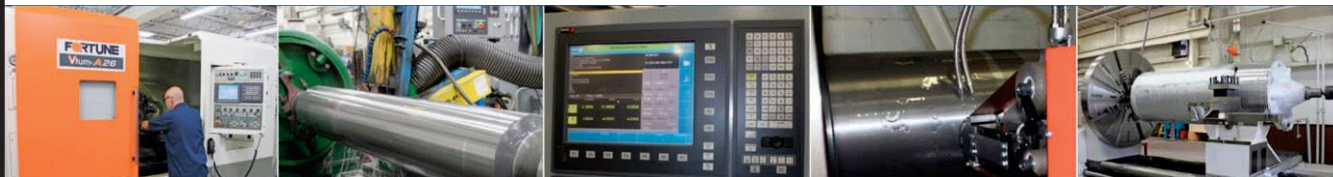
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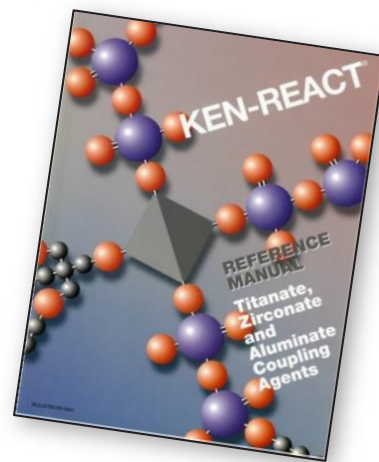
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