NOVEMBER 2024

RubberWorld

136 years

THE TECHNICAL SERVICE MAGAZINE FOR THE RUBBER INDUSTRY VOLUME 271, NO. 2

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Quality requires responsible manufacturing and testing

Tire intracarcass pressure
and tire durability

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Vol. 271, No. 2 November 2024

Features

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Departments

From the Editor

Jill Rohrer

GPSNR assesses NR companies

The Global Platform for Sustainable Natural Rubber (GPSNR) recently completed five pilot assessments involving three processors and producers (PPTs), one manufacturer and one end user. These assessments, conducted by four independent assessors, provided valuable insights into companies' readiness to meet GPSNR requirements in key areas like supply chain mapping, due diligence, risk assessment and shared investment.

The results showed that companies are more advanced in supply chain mapping with 60% conformity, likely driven by preparations for the European Union Deforestation Regulation (EUDR). However, gaps remain in due diligence (29% conformity) and risk assessment (31% conformity), particularly regarding documentation and the need for comprehensive systems that cover entire supply chains. The shared investment theme saw full conformity.

These pilots highlighted the need for more extensive training to ensure all companies are equipped to meet GPSNR's expectations. They also revealed that smaller organizations may require additional support to build effective due diligence systems. The GPSNR secretariat plans to address these challenges through further training and refining the assessment criteria to ensure clarity and consistency.

IRGMA welcomes glove guidelines

The Indian Rubber Gloves Manufacturers Association (IRGMA) welcomed new guidelines detailing the functions and responsibilities of the Central Drugs Standard Control Organization (CDSCO). The association urged the government to take stringent measures to implement the order effectively to stop the import of substandard gloves in the country.

Guidelines were last released in 2011, and the recent changes, including new rules and regulations and an online system, necessitated the revised order in line with the procedures followed in CDSCO offices. IRGMA General Secretary Man Mohan Singh Gulati said, "The new guidelines issued by CDSCO are a welcome step. However, the implementing authorities, including ADCs posted at ports, must be made aware of the document to effectively control the import of substandard bulk-packed gloves."

Jill Rohrer

The association has long been demanding the quality control order for gloves to keep substandard imports at bay and urged the government to expedite its process. The IRGMA says the guidance document will bring uniformity, transparency, predictability and accountability to all offices.

RubberWorld

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1. Outside county nonrequested copies stated on PS form 3541 (include sample copies, requests over 3 years old, requests induced by a premium, bulk sales and requests including association requests, names obtained from business directories, lists, and other sources)	3,439	3,318
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I. Percent paid and/or requested circulation	43.2%	43.6%
Electronic copy circulation		
A. Requested and paid electronic copies	2,349	2,229
B. Total requested and paid print copies+ requested/paid electronic copies	5,008	4,854
C. Total requested copy distribution + requested/ paid electronic copies	8,497	8,251
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I certify that the statements made by me above are correct and complete.

Job. H. Lippincott
Publisher

Business Briefs

Bridgestone receives DOE grant for SR

Bridgestone Americas (www.bridgestoneamericas.com), Nashville, TN, received a grant from the **U.S. Department of Energy (DOE) Industrial Efficiency and Decarbonization Office**. Bridgestone will design, build and operate a pilot plant that will advance an innovative, potentially more sustainable and cost effective approach to obtaining butadiene from ethanol. The project will evaluate the economic and commercial viability, as well as the carbon footprint, of converting ethanol to butadiene. The company plans to utilize the butadiene produced to further study and confirm the potential use as a feedstock for raw materials in Bridgestone tires.

ACQUISITIONS, EXPANSIONS

Guill Tool & Engineering (www.guill.com), West Warwick, RI, a provider of extrusion tooling, announced its expansion in the European market with the creation of **Guill Tool Europe**. Guill will offer a full line of products, as well as sales and engineering support throughout Europe.

Zeppelin Systems GmbH (www.zeppelin-systems.com), Friedrichshafen, Germany, is opening a modern facility at the competence center in Reggio Emilia, Italy, covering an area of over 5,000 square meters. In addition to expanding its production capacities, the company is also pooling its expertise for the tire and rubber industry, and the plastic and polyolefin industry.

Toyoda Gosei (www.toyoda-gosei.com), Aichi, Japan, is doubling its rubber recycling capacity at the Morimachi Plant in central Japan to accelerate the recycling of rubber used in

Diamond America moves office

Diamond America (www.daextrusion.com), Mogadore, OH, a U.S. based extruder and die manufacturer, has officially migrated operations from Akron to Mogadore, OH. The company held a public open house to celebrate the grand office opening. Attendees watched the inaugural ribbon cutting ceremony, networked and toured the new manufacturing facility.

Mike Magee, Diamond America president, thanked key vendors, suppliers and employees for the pivotal role they have collectively played during the office relocation. "Additionally, thank you to the community for their ongoing support during this transition period and for the warm welcome to the Mogadore community and Portage County. This would not be possible without all of you," Magee stated. "We are grateful for all who stopped by to share in this momentous milestone. This expanded facility enables Diamond America to better serve customers, and positions us for continued growth experienced over the last 20 years. We are excited to make a positive impact," Magee added.

Business Briefs

automobiles. Toyoda Gosei began operations of its first recycling line in 2021, using its proprietary devulcanization technology that can recycle rubber products into high quality raw materials. The company has been reusing the waste material generated in the production of products.

Lanxess (www.lanxess.com), Cologne, Germany, signed a contract to sell its **Urethane Systems** business to **Ube** of Japan, with expected proceeds of around €500 million.

UTH expands with U.S. subsidiary

UTH GmbH (www.uth-gmbh.com), Fulda, Germany, with sub-sidiaries in China and Japan, is deepening its global commitment by establishing a new location in the U.S. "This strategic decision is driven by our deep understanding of our customers' growing needs and specific requirements, as well as our ongoing commitment to providing the best possible support as a reliable partner to the rubber and silicone processing industry," said Julia Uth, who, along with Manuel Bessler, is overseeing the U.S. project.

As a specialist in fine mesh straining, precise extrusion and mixing, the family owned company, with nearly 40 years of industry expertise, offers innovative solutions and intelligent technologies worldwide for the rubber, tire, silicone, sealant and adhesive industry. The product range includes high quality serialized machines, customized system solutions and specialized machinery. UTH's modular roll-ex extrusion system sets international standards for the particularly gentle and clean processing of rubber and silicone, "with a clear focus on sustainability and cost efficiency," emphasizes Julia Uth. She added, "A concrete example of this is our involvement with a leading tire manufacturer in the U.S. Through the use of our innovative and resource saving TRP (two-roll plasticizer) solution, based on the patented roll-ex gear pump technology, our customer was able to reduce energy consumption in reprocessing by up to 50%." Additionally, approximately 98% of the process related waste is returned to the tire manufacturing process.

Quality registrations

Covestro (www.covestro.com), Pittsburgh, PA, has secured the ISCC (International Sustainability and Carbon Certification) Plus certification for its site in South Deerfield, MA.

Henkel (www.henkel.com), Düsseldorf, Germany, announced that the **Henkel Adhesive Technologies** polyurethane production site in Düsseldorf received International Sustainability and Carbon Certification (ISCC) Plus certification.

Maxam Tire (www.maxamtire.com), Danvers, MA, announced that its AgriXtra XL VF and standard radial R-1W agricultural tires have been awarded the DLG Approved quality seal by the **German Agricultural Society**'s (DLG) independent testing institute.

Nynas (www.nynas.com), Stockholm, Sweden, has received the **EcoVadis** Gold sustainability rating for 2024, securing a position in the top 5% among all rated companies for sustainability performance.

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Business Briefs

Vanderbilt partners with Prisma Colour

Vanderbilt Chemicals (www.vanderbiltchemicals.com), Norwalk, CT, a privately held manufacturer and distributor, announced an exclusive distribution partnership with **Prisma Colour, Ltd.** to represent its line of rubber color masterbatches in the NAFTA region. Founded in 1991, Prisma Colour is a global supplier of color and additive masterbatches with an annualized capacity in excess of 48,000 tons. Vanderbilt, founded in 1916, is a U.S. producer of a variety of chemicals, along with a strong distribution portfolio, for servicing the rubber and plastics industries.

Contracts, licenses

Lanxess (www.lanxess.com), Cologne, Germany, announced that its **Polymer Additives** business unit received a 2024 Supplier of the Year award from **Avient**, a provider of specialized and sustainable materials solutions.

Biesterfeld Performance Rubber GmbH (www.biesterfeld.com), Hamburg, Germany, an international distributor of rubber products, is entering a partnership with **Polytek Development**, a manufacturer of specialty polymers for mold making and casting applications across industrial and consumer sectors.

Continental (www.continental.com), Hanover, Germany, announced that **Porsche** approved three Continental tire lines as original equipment for the Panamera sports sedan.

Siempelkamp Group (www.siempelkamp.com), Krefeld, Germany, concluded its first syndicated financing agreement for €250 million. The company and its banking partners are thus switching from bilateral to syndicated financing.

Kraiburg TPE Americas (www.kraiburg-tpe.com), Buford, GA, is partnering with **Anders**, based in Lima, Peru, for representation in the Andean region.

U.S. Medical Glove (www.usmg.us), Harvard, IL, said to be the only American manufacturer of the machines, components and chemicals necessary to make nitrile and polyisoprene exam gloves in the United States, announced a contract worth $80 million. The agreement is a joint venture partnership with **Medeco Protective Safety Equipment Manufacturing**, a division of **Abu Dhabi Medical Devices** in the United Arab Emirates, and contracts USMGC to manufacture 12 of its proprietary medical exam glove making machines.

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Business Briefs

Evonik process should advance tire recycling

Evonik Industries AG (www.evonik.com), Essen, Germany, wants to help make rubber materials from scrap tires easier to reuse in the manufacture of new automobile tires. So far, the suitability of recycled rubber is said to have been very limited because its chemical structure hampers interaction with new tire materials. A team of researchers at Evonik has now made a key step forward with a process that could make it possible to use up to four times as much recycled rubber in new tires as in the past. The team of Evonik researchers has now succeeded in reversing the vulcanization of rubber to a large extent. The research team has already used these vinyl silanes successfully for devulcanization.

CORPORATE, FINANCIAL NEWS

Prism Worldwide (www.prismww.com), Kirkland, WA, a provider of innovative material solutions, dedicated to advancing end-of-life tire recycling technology, has raised $40 million in Series A and Series A1 funds. Prism is using the funds to consolidate operations, make capital investments in technology and equipment, and expand its team. To date, the funding has provided a foundation from which Prism has reached commercial viability, demonstrated by an initial round of sales and sales commitments for its thermoelastic polymers (TPEs). The development of these TPEs is said to mark the first time a company has successfully created a sustainable, high performance polymer derived from end-of-life tires. The funding rounds were co-led by return investors **Columbia Pacific Advisors**, a Seattle alternative investment firm, and Jim Sinegal, co-founder and former CEO of **Costco**.

The **U.S. Tire Manufacturers Association** (USTMA) (www.ustires.org), Washington, D.C., announced that members of its 6PPD Alternatives Analysis Consortium have received notice of compliance from the **California Department of Toxic Substances Control** for its revised Preliminary (Stage 1) Alternatives Analysis report.

Wacker Chemie AG (www.wacker.com), Munich, Germany, has successfully captured carbon dioxide (CO_2) generated from silicon production. The project, which was enabled by the technology and expertise of the **SLB** and **Aker Carbon Capture Joint Venture (SLB-ACC JV)**, involved a pilot test of the capture process at Wacker's production site in Holla, Norway, where quartz and carbon are combined to produce silicon for use in its silicone products. This reaction generates a considerable share of the CO_2 emissions relevant to Wacker and its products. The newly tested capture process makes it possible to reuse or store this greenhouse gas and prevent its release into the atmosphere, said to be a critical step on the road to net-zero chemicals production.

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EU replacement tire sales still struggling

The European Tyre and Rubber Manufacturers' Association (ETRMA) replacement tire sales figures for the third quarter of 2024 show an industry struggling to get back to pre-pandemic levels.

Adam McCarthy, ETRMA's secretary general, said, "Starting from a low base, the evolution of volumes in the first three quarters of 2024 is improving in the consumer segment, mainly thanks to all season tires, but is still negative in the truck segment. In the same period of 2023 (versus 2022), volumes fell by 8% for consumer tires, and by 17% for truck tires. In both the consumer and truck segments, we are still far from pre-pandemic volumes: respectively down 6% and 11% versus year to date September 2019. The third quarter 2024 evolution is positive versus the third quarter of 2023 in all product lines, mainly due to weak performance in the third quarter of 2023."

ETRMA also reported imports of passenger car and light truck (PCLT) tires into Europe (EU27 plus U.K.) have increased by 10% in the first eight months of 2024. They are now 18% higher than during the same period in 2019, prior to the impact of the pandemic: an additional volume of almost 16 million units.

Imports of PCLT tires from China have risen at a faster pace, up 11% year on year, but up over 40% on 2019 (more than 20 million extra units). In part, these tires replace imports from Russia (6 million units in January to August 2019). Imports from Korea are up 25% from 2023. Imports from India, from a low base, have more than tripled since 2019, and are up a further 22% in 2024. Japan and Thailand have, meanwhile, seen a further decline in their share of PCLT tire imports.

In the first eight months of 2024, truck and bus tire imports from outside Europe fell by 5%; however, they are still 11% higher than in the same period of 2019.

ETRMA reported volumes from Viet-nam have increased by almost 20% this year, and it is now the second largest source, moving ahead of China. For reference, China's share was over 70% in 2017, before falling sharply following the imposition of tariffs by the EU; it regained some share in 2024. Thailand remains the leading importer, although it has lost share in 2024 alongside Korea and Japan.

ETRMA said although the number of electric cars in Europe rose almost tenfold between 2018 and 2023, the 6 million pure battery electric vehicles (BEVs) still represented just over 2% of all EU cars.

Significant national and regional variations exist. Norway is the clear outlier, with BEVs accounting for 24% of cars at the end of 2023 (and by September 2024, more than a quarter share). Sales of new petrol and diesel cars will be banned in the country from the start of 2025.

The number of BEVs has risen sharply in the rest of the Nordic region, now exceeding 5%. This is double the share in the rest of western Europe. Here again, there is a significant difference between the northwest region (just under 3%) and the southern markets (0.6%). In southern Europe, as in central Europe (0.4% of cars), the limited share reflects the low penetration in new car sales and the age of the car inventory, according to the report.

European replacement tire sales

	Q3 2023	*Q4 2024*	*% change*
Replacement consumer tires	55,345	57,854	5%
Summer tires			2%
All season tires			13%
Winter tires			0%
Replacement truck and bus tires	3,043	3,112	2%
Replacement agricultural tires	153	161	5%
Replacement moto and scooter tires	1,640	1,849	13%

'000 units
Consumer = passenger car, SUVs and light commercial vehicles

USTMA reports 79% of EOL tires recycled

The U.S. Tire Manufacturers Association's (USTMA) recently released End-of-Life Tire Management Report reveals positive momentum in tire recycling, with 79% of end-of-life (EOL) tires being consumed by end-use markets. This reflects a 10.5% increase in overall utilization, reinforcing that end-of-life tires remain one of the most recycled and reclaimed consumer products, outpacing materials like metal, glass, aluminum, plastic and paper.

"This over 95% reduction in stockpiles is the result of decades of progress developing the tire recycling industry, remediating stockpile sites and driving innovation," said Anne Forristall Luke, president and CEO of USTMA.

Ground rubber has become the second largest market for end-of-life tires, increasing 29% since 2019, and consuming about 28% of end-of-life tires in 2023. Ground rubber is used in a range of applications, including rubberized asphalt for roads.

Rubber modified asphalt (RMA), a key use of ground rubber, is showing significant growth. Since 2021, RMA has consumed 165,000 tons of ELTs, representing a 17% increase.

Despite the significant achievements made, approximately 48 million end-of-life tires remain in stockpiles. USTMA is engaging all stakeholders in the value chain to drive sustainable practices and eliminate these stockpiles. The Tire Recycling Foundation (TRF), a joint initiative of USTMA and the Tire Industry Association, aims to provide critical support by educating, networking and collaborating with key players in the recycling ecosystem.

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Additive manufacturing silicone solutions

Elkem has enlarged its portfolio of silicone solutions for additive manufacturing/3D printing. In addition to the existing AMSil 20501/AMSil Silbione 24501 and AMSil 20502 (special for food grade) range, Elkem has developed the AMSil 20503 and AMSil Silbione 24503 range. Besides a longer shelf life for easier handling, these formulations are laying the base and open perspectives for an enlarged use in restricted and unrestricted medical application in the future. The new developments are available with durometer A hardness from durometer 10A to durometer 70A, with all well known properties of 100% silicones for LDM (liquid deposit molding) based systems.

Elkem also added a reference AMSil 92102 in the support material series. This paste-like water soluble material has improved printability and surface aspects, and is suitable for use in common with the AMSil and AMSil Silbione range, allowing it to taking advantage of features and structures associated with the freedom of design approach inherent to additive manufacturing/3D printing.

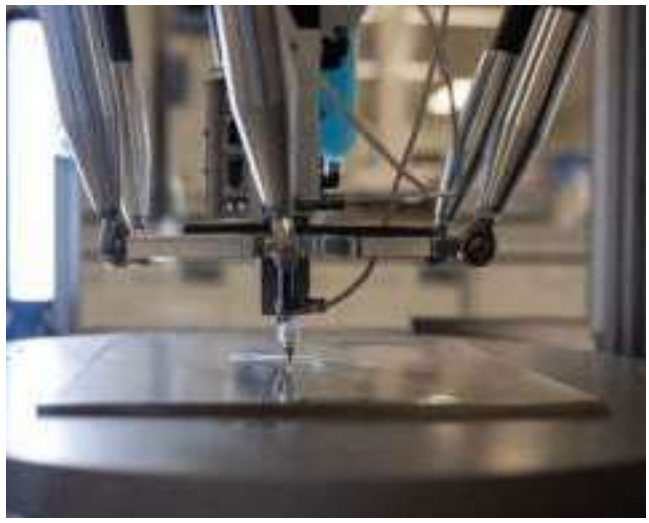
These latest developments show the commitment from Elkem to additive manufacturing/3D printing and its potential of being part of a more sustainable economy in the future.

Scaling additive manufacturing/3D printing to industrial levels through digital manufacturing will create innovative, profitable and sustainable solutions, reducing waste, transportation and storage costs, thereby lowering the carbon footprint of end products.

Elkem Silicones has developed a production process based on extrusion principles called liquid deposition modeling. This process allows for the use of a new series of customized silicone materials, the AMSiL series, which can be used for additive manufacturing/3D printing. High performance parts with 100% silicones with complex geometries, overhangs that are impossible to achieve using traditional dies, molds and machining in order to create elastomeric parts/objects by direct printing, can be designed.

This process works at room temperature and as an initial step before the finishing by a post-curing cycle. If required, more advanced post-processing procedures have been established, giving the final touch to the parts/objects and ensuring that they meet the required specifications.

The liquid deposit molding process allows for taking advantage of the unique properties of silicone elastomers in an almost unlimited number of existing and new applications, with final



part properties comparable to traditional processed silicone elastomers combined with the advantages of additive manufacturing/3D printing, enhancing a competitive edge, according to the company.

Medical grade TPEs for biopharmaceutical tubing

Teknor Apex expanded its medical grade thermoplastic elastomer (TPE) portfolio with new grades specifically designed for biopharmaceutical tubing applications. Medical device manufacturers choose TPEs for applications that require flexibility or rubber-like elasticity. The Medalist series is tailored to address the unique challenges associated with the continuous processing of biopharmaceuticals through roller pumps.

These Medalist grades offer a combination of performance benefits, including: enhanced clarity, improved transparency for visual inspection of fluid flow and potential particle contamination; reduced spallation, minimized material loss and contamination risks during extended pump operation; and extended pump life, increased durability and longevity of tubing, reducing maintenance requirements and downtime.

These advanced materials are said to be ideal for a wide range of biopharmaceutical applications, including single-use systems, bioreactors, filtration systems and fluid transfer lines.

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by Zshelyz Lee,
Dow, Packaging & Specialty Plastics

Ready, set, decarbonize: Material science's role in achieving carbon neutrality

No matter where you and your company are in your decarbonization journey, there are steps to get you started or to accelerate your initiatives towards carbon neutrality. The challenge, in its depth and complexity, seems daunting; but practical options exist today that can help provide tangible change that we as design, engineering and business teams can use as a start.

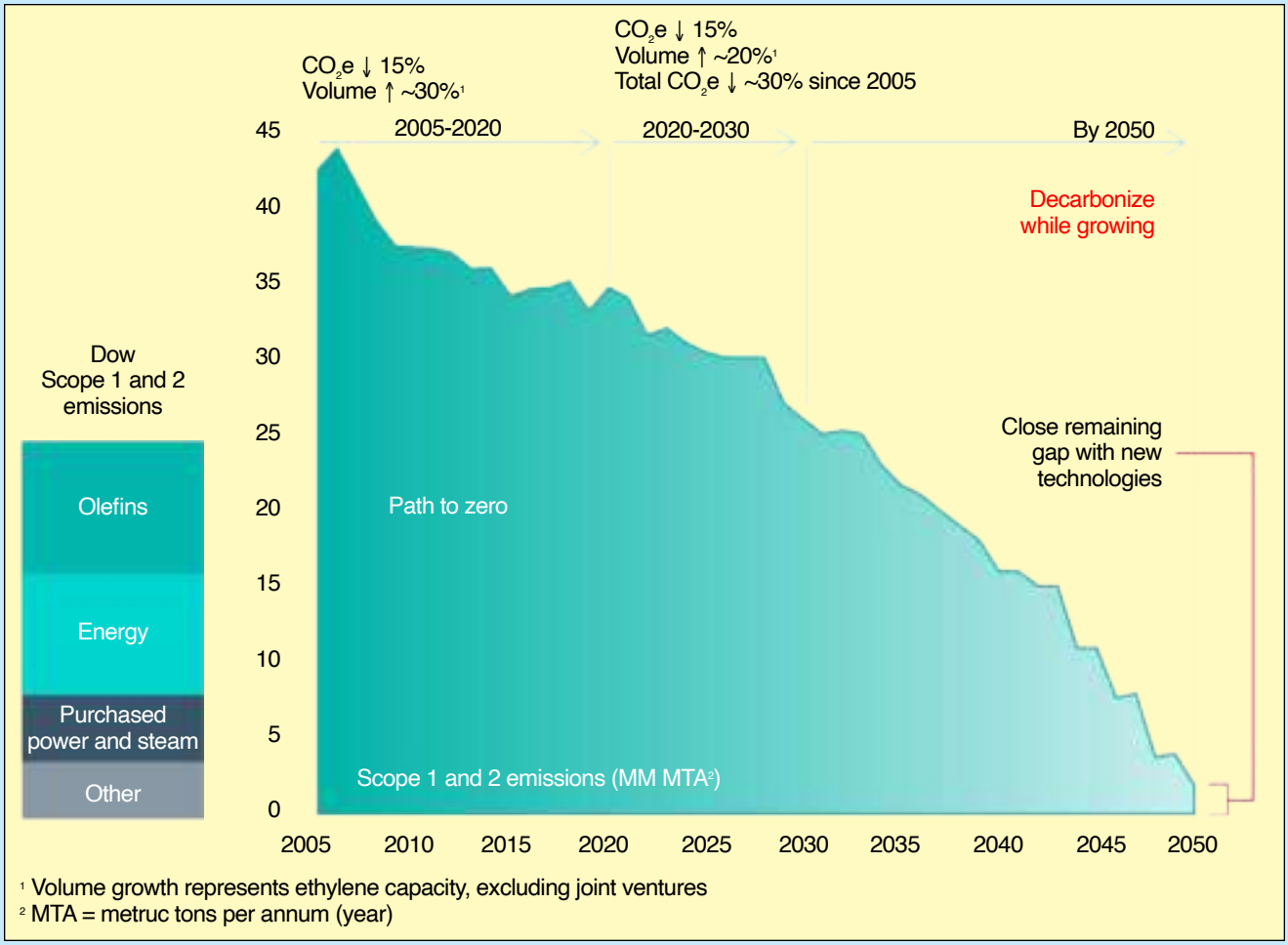
How we do business, how we operate as nations and how we live as individuals are all under threat of the impact of climate change. It is a crisis. Extreme weather conditions have already increased in frequency and intensity, affecting operations, trade and, most importantly, households. The surge in costs from these disruptions is just one dimension of the overall burden of going beyond the 1.5°C above pre-industrial levels.

Missing the target also means the rise of health issues globally, as changing temperatures mean the proliferation of diseases and increased risk of heat exposure and vulnerability (Europe's temperatures are rising faster than the global average). It also prescribes the displacement of communities from areas made unsuitable for human habitation, signifying further escalation in mass migrations. Furthermore, loss in agricultural yields can only aggravate food insecurity; an effect that will not just be felt by the global south, but also high income economies, as inflation driven by both basic commodities and healthcare will advance income inequality and endanger overall economic and, in turn, geopolitical stability.

Addressing the climate problem

Worldwide recognition of the issue at hand and the consequent

Figure 1



[1] Volume growth represents ethylene capacity, excluding joint ventures
[2] MTA = metruc tons per annum (year)

global climate action have in their way born some fruit. From 1990 to 2020, both the EU and the U.S. have decreased overall greenhouse gas (GHG) emissions. Nonetheless, in 2023, the planet reached the 1.5°C levels. Without the initiatives already undertaken, the situation would surely have been much worse, but it does not erase the fact that we need to do more: much more.

The top three contributors to the GHG emissions of the EU, the U.S. and China outside of households are industry, transportation (particularly road transport via passenger cars) and energy use. They come in varying degrees, depending on the geography, but the picture remains the same: What we do in the industry can have a material impact on overall global emissions. The production of materials, along with the automotive industry, has a key role to play in achieving global goals in climate protection.

Yet, it is not so easy. From a rubber and overall raw material perspective, parts have been designed for specific parameters over decades: Technologies were developed for high performance, comfort, aesthetics (all attributes demanded by consumers) and, vitally, safety. Safety remains paramount. The resulting durability of components arising from designing parts to withstand varying conditions to still provide safety, moreover, brings the added property of longer lifetimes and, thus, less waste. Evolving materials for decarbonization and circularity must thus factor in all of these, and accomplishing all diverging targets is not so straightforward.

This is where material science comes in. Understanding tradeoffs and generating new approaches to solve multidimensional challenges require application and technology knowhow alike. This industry is comprised of scientists, engineers, designers and strategists, and we have the tools to crack this nut.

With such a complex issue, though, how do we get started? Step 1 is analyzing one's footprint. From where are the emissions coming? Which activities contribute the most? Determining the primary sources of one's greenhouse gas emissions as carbon equivalents is an arduous task, but a necessary one. To tackle a problem, we need to know its root causes. To sketch out a clear path to zero, we need to know from where we are coming.

At Dow, for example, we have mapped out our biggest emission sources as a global enterprise. Given our technologies, the majority of our Scopes 1 and 2 footprint comes from olefin production and energy use (figure 1).

Step 2 is to map out your journey and get started on your biggest Scopes 1 and 2 contributors one by one. At Dow, for example, we have taken a site-by-site approach. We are replacing end-of-life and less efficient assets with technologies such as circular hydrogen, carbon capture and storage, among others. This also includes increasing use of clean energy and steam, investing in transformative manufacturing technology, and developing low-GHG emissions products and services.

One of those technologies that we have brought to market and that reduces environmental impact is behind the production

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of one of Dow's rubber materials, Nordel EPDM, that goes into automotive, infrastructure and consumer applications. Using the Advanced Molecular Catalyst (AMC) technology, these ethylene propylene diene terpolymers (EPDM) are produced through a highly efficient process that uses 24% less energy than the conventional Ziegler-Natta (ZN) process.

This translates to a 39% lower carbon footprint for the standard Nordel EPDM grades versus ZN alternatives, and these values have been validated by a third party life cycle analysis (LCA). Additionally, the assessment also demonstrates reduction of other environmental impacts: 45% less smog, 69% less ozone depletion, 55% less eutrophication, and 37% less acidification compared to ZN EPDMs.

This is only one aspect of Dow's continuous innovation for decarbonization. Overall as a company, Dow has thus decreased its footprint by 15% from 2005 to 2020. Dow is now in the second phase of its Path to Zero and is on its way to lower it further to reach -30% by 2030 vis-à-vis 2005; and in practical terms, by 2025, Dow intends to reduce its net annual emissions by 2 million metric tons versus its 2020 baseline.

To further accelerate Dow's decarbonization journey, the board of directors approved in November 2023 the final investment decision for its Fort Saskatchewan Path2Zero project to build the world's first net zero Scope 1 and 2 emissions integrated ethylene cracker and derivatives facility in Alberta, Canada. The project includes building a new ethylene cracker and increasing polyethylene capacity by 2 million metric tons per year, as well as retrofitting the site's existing cracker to net zero Scope 1 and 2 emissions.

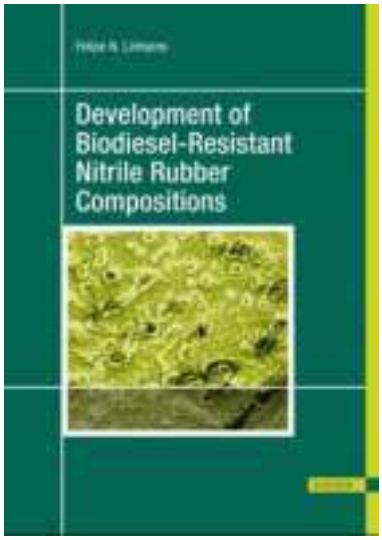
The end goal to be carbon neutral by 2050 for all Scopes, however, calls for a focus on Scope 3 also. Accordingly, Dow has investigated the contribution of its upstream and downstream Scope 3 emissions. From this, we have learned that approximately 70% of our footprint falls into Scope 3 categories. More than half of those emissions derive from the raw materials, transportation and other services we purchase as a company. We continue to validate and develop Scope 3 emissions reduction and mitigation efforts.

Step 3, then, is addressing Scope 3. At Dow, this means not just working with suppliers on upstream decarbonization opportunities, aligned with our Supplier Code of Conduct, but also helping enable customers to reduce emissions, amplifying our impact through design for recyclability, lightweighting, downgauging and lowering carbon footprint delivery.

In the transportation sector and rubber industry, specifically, seeing the bigger picture of total emissions beyond one's Scopes 1 and 2 means analyzing the carbon footprint of not just the material we produce, but also the overall automotive part in which Nordel EPDM is used. We have thus mapped out the carbon footprint of the weatherstrip, from the EPDM component to the other raw materials in the formulation, to the production process of manufacturing the seal.

We have built a model using existing frameworks and databases to assess the carbon footprint of diverse types of weatherseals, like dense and sponge. The resulting calculations show that the majority of a weatherstrip's product carbon footprint comes from the raw materials themselves, particularly from the recipe's main ingredients: EPDM, fillers and oil. Designing a lower emission version of the weatherseal ought to be anchored on replacing these elements with more sustainable options.

And so Dow has developed Nordel REN EPDM to offer the rubber industry, along with the automotive, building and construction, wire and cable, and consumer sectors, a new option to help reduce its Scope 3 carbon emissions. Nordel REN EPDM is manufactured using bio residues from other industries as raw material. As only waste residues or by-products from an alterna



Development of Biodiesel-Resistant Nitrile Rubber Compositions

Biodiesel is an excellent potential replacement for petroleum diesel fuels because of its comparable physical properties in addition to its improved environmental benefits, such as low pollutant gas emissions, nontoxicity, renewability, and biodegradability. However, biodiesel and petroleum diesel differ greatly with respect to their chemical properties. Therefore, the compatibility of the materials that are commonly employed in contact with diesel must also be assured for biodiesel that has been obtained from different sources.

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tive production process are utilized, these raw feedstock materials will not consume extra land resources, nor compete with the food chain.

The plant based EPDM will be made through an ISCC PLUS certified mass balance system which traces the flow of bio-based raw material through the complex rubber value chain and attributes it through verifiable bookkeeping.

What is key here is that the mass balance accounting approach presents the possibility to start today. The resulting product offers identical performance to virgin material with no requalification required, helping customers accelerate their transition to more sustainable options.

This also bypasses the need to wait, not just for investment decisions to be made in building a completely new production line for a separate parallel process, but also for its construction. The mass balance system thus brings the carbon reduction timeline forward to 2024, and offers flexibility to the potential purchasers of this technology with broader grade options. On top of that, this avoids the additional carbon emissions that would result from building and maintaining a concurrent production stream.

The path to net zero has material science options ready today

With the urgency of the climate crisis, it is crucial to focus on action; and immediate action. The steps described above are not exclusively sequential: Imperfect information in Step 1 (analyzing one's footprint) should not stop the industry from acting immediately on Step 2 (addressing one's Scopes 1 and 2); nor should an incomplete program in Step 2 hinder us from working on Scope 3 today.

Moreover, collaboration is key. One organization's Scopes 1 and 2 are another's Scope 3. Likewise, all players in the value chain would be needed to chip in if the downstream Scope 3 emissions coming from the product's use phase are to be mitigated: Designing materials for lightweighting and electrification to lower tailpipe emissions, and also for end-of-life or second life, is a multi-company or even multi-sector endeavor. Decarbonization takes forming new alliances and shaping new ecosystems.

Underpinning all the steps described above is change management of entire organizations. To significantly reduce or even eliminate one's carbon footprint means change in not just how we operate, but also how we strategize. The key performance indicators of yesterday for the different departments of the industry and the defined roles of the different parties in the value chain must be reshaped to allow for important decisions needed for decarbonization. It takes investment. It takes innovation. And, foremost, it takes leadership.

It is not an overnight exercise, but actions can already be taken now. Speed is necessary. We are already experiencing in our day-to-day business and home lives the impact of unchecked climate change. But there are options available today, and we can get started.

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Patent News

Adhesion of silicone rubber to thermoplastics
U.S. patent: 11,945,981
Issued: April 2, 2024
Inventors: Florian Geyer and Michael Backer
Assigned: Dow Silicones
Key statement: There is provided an adhesion mediator composition for use in the adhesion of silicone elastomers made from hydrosilylation curable silicone rubber compositions to thermoplastic substrates, especially polyolefin substrates. There is also provided a process for adhering silicone elastomers to thermoplastic substrates using the adhesion mediator composition. The adhesion mediator composition comprises: (i) a trialkoxysilane; (ii) a platinum group metal based hydrosilylation reaction catalyst; (iii) an alkoxy titanium compound; (iv) a tetraalkoxysilane; and (v) either (a′) a polyorganosiloxane containing at least two unsaturated groups; or (b′) a mixture of two or more polyorganosiloxanes containing at least two unsaturated groups. The method comprises the steps of: (a) optionally activating a thermoplastic substrate surface; (b) treating the optionally activated thermoplastic substrate surface with the adhesion mediator composition; (c) applying a hydrosilylation curable silicone rubber composition on to the treated surface resulting from step (b); and (d) curing the hydrosilylation curable silicone rubber composition.

Rubber composition comprising esters from renewable sources as plasticizers
U.S. patent: 11,945,952
Issued: April 2, 2024
Inventors: Franco Cataldo, Louis Plancq, Francine Genin and Zubin Arora
Assigned: Total Marketing Services
Key statement: The present invention relates to a rubber composition for tire applications comprising: rubber polymer(s) comprising at least optionally functionalized styrene butadiene rubber (SBR) and at least one rubber selected from polybutadiene rubber (BR), natural rubber (NR), polyisoprene rubber (IR) and mixtures thereof, and at least one ester derived from renewable sources resulting from the esterification of trimer and/or dimer acids having the formula A-(COOH)q, with q being 2 or 3 and A being an acyclic, cyclic or polycyclic, saturated or unsaturated, linear or branched hydrocarbon group having from 3 to 69 carbon atoms, with acyclic or

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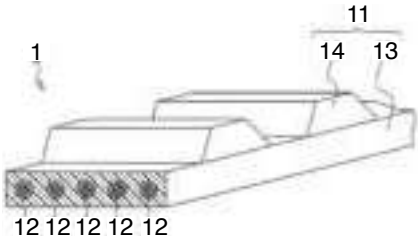
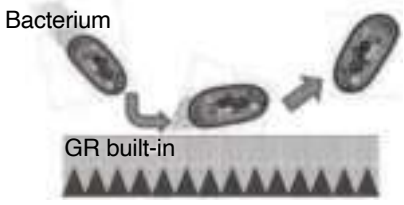
Patent News

cyclic, saturated or unsaturated, linear or branched alcohols.

Rubber reinforcing cord and rubber product including same
U.S. patent: 11,945,948
Issued: April 2, 2024
Inventor: Shinya Katagiri
Assigned: Nippon Sheet Glass
Key statement: A rubber reinforcing cord (12) of the present invention includes at least one strand. The strand includes at least one filament bundle and a coating provided to cover at least a portion of the surface of the filament bundle. The coating contains a polymer and cellulose nanofibers and does not contain a resorcinol-formaldehyde condensate. The polymer contains at least one selected from a polyurethane and a rubber component. In the coating, the content of the cellulose nanofibers is 0.1 to 10 parts by mass with respect to 100 parts by mass of the polymer. The proportion of the coating in the rubber reinforcing cord is 18 volume % or more.



Germ repellent silicone rubber and preparation method and application thereof
U.S. patent: 11,945,950
Issued: April 2, 2024
Inventors: Xiaonan Huang, Xianqiao Liu and Chun Kit Choi
Assigned: Hongrita Plastics
Key statement: The present invention provides a germ repellent silicone rubber comprising: a silicone rubber substrate and a germ repellent active ingredient incorporated therein; wherein, the silicone rubber substrate includes polydimethylsiloxane; the germ repellent active ingredients include poly(ethylene oxide) and silicone oil or their derivatives. The disclosed germ repellent silicone rubber reduces the bacterial growth by inhibiting their adherence to the surface instead of killing them, does not contribute to super bacteria formation nor cause skin irritation.



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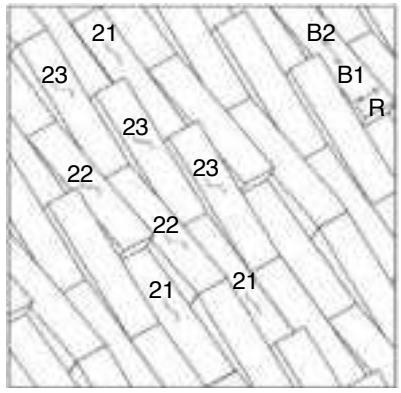
Patent News

Processing method of natural rubber latex using creaming
U.S. patent: 11,952,437
Issued: April 9, 2024
Inventors: Xiaohui Tian and Dongqi Wang
Key statement: A processing method of natural rubber latex using creaming includes the following steps: adding a surfactant, a pH adjuster and deionized water to natural rubber latex, adding a preservative and a creaming agent, mixing and standing a resulting mixture until phase separation occurs and collecting an upper rubber latex phase and a lower skim latex phase, separately; diluting the upper rubber latex phase with deionized water, adding a preservative, a pH adjuster, a surfactant and a creaming agent, mixing and standing a resulting mixture until phase separation occurs and collecting an obtained upper rubber latex phase; and adding a preservative, a pH adjuster, a surfactant and a creaming agent to an obtained lower skim latex phase, mixing and standing a resulting mixture until phase separation occurs and collecting an obtained upper rubber latex phase.

Pneumatic tire
U.S. patent: 11,951,775
Issued: April 9, 2024
Inventor: Hikaru Kuriyama
Assigned: Toyo Tire
Key statement: A pneumatic tire includes a decorative area (11) provided on a sidewall surface (10), in which three kinds of planes (21), (22) and (23) with different inclinations with respect to a profile surface (20) are tightly arranged in the decorative area (11), two kinds of planes (21), (22) or (23) from the three kinds of planes (21), (22) and (23) are aligned in a first direction to make a pair, plural kinds of pairs with different combinations are aligned in a second direction and boundaries (24) between each two planes (21), (22) or (23) aligned in the first direction are shifted in the first direction between the pairs adjacent in the second direction.



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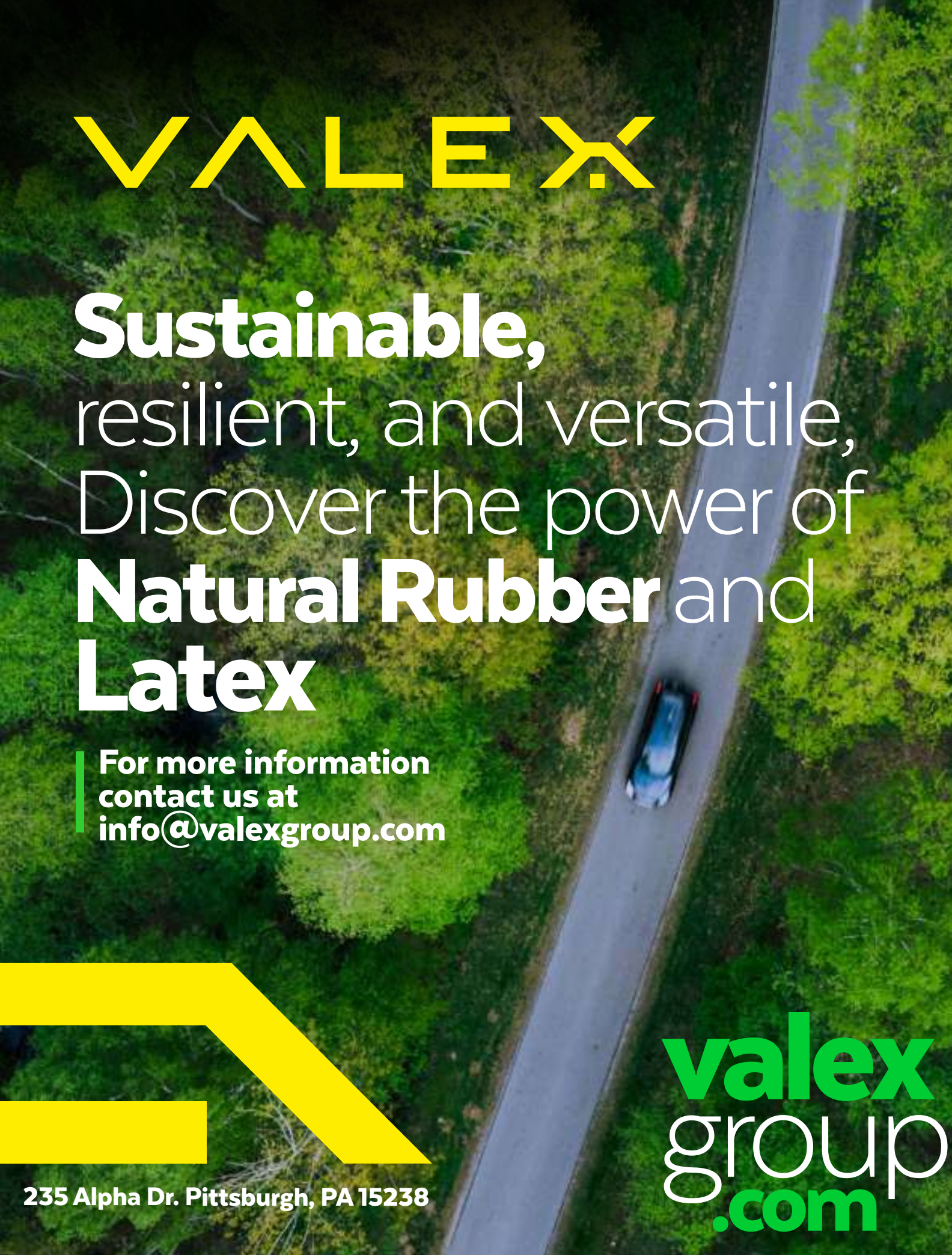
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Patent News

Thermoplastic elastomer compounds exhibiting retained clarity and improved surface structure
U.S. patent: 11,952,486
Issued: April 9, 2024
Inventors: Liang Xu and Christopher Engel
Assigned: Avient
Key statement: Surface structure modification is achieved for an acrylate block copolymer thermoplastic elastomer by the addition of an organo-functional polydimethyl siloxane, but also without loss of clarity.

Modified conjugated diene based polymer and rubber composition comprising same
U.S. patent: 11,970,616
Issued: April 30, 2024
Inventors: Kyoung Hwan Oh, Hyo Jin Bae, Hyun Woong Park, Jeong Heon Ahn and Jae Hyeong Park
Assigned: LG Chem
Key statement: A modified conjugated diene based polymer having high linearity and improved compounding properties is provided. The modified conjugated diene based polymer includes phosphor, sulfur and chlorine in specific amount ranges and the degree of branching is controlled and accordingly, if applied to a rubber composition, tensile strength and viscoelasticity may be excellent and processability may be markedly improved.

Tire rubber composition using pyrazalone based compound
U.S. patent: 11,970,610
Issued: April 30, 2024
Inventors: Jeffery Hakim Hayat and Robert Vincent Dennis-Pelcher
Assigned: Goodyear Tire & Rubber
Key statement: The present invention is directed to a tire layer (e.g., tire tread or carcass layer) having a rubber composition including a pyrazolone based compound in combination with reinforcing filler material and optionally a processing aid and tires using the same, that provides desirable tire performance properties, such as improvements in tear strength without negatively impacting stiffness or hysteresis. In one embodiment, the tire layer includes a rubber composition having an elastomer (e.g., natural or isoprene rubber), a pyrazolone based compound, reinforcing filler selected from carbon black only, carbon black/silica blends only, or graphene, functionalized graphene, carbon nanotubes, functionalized carbon nanotubes or mixtures thereof further optionally with carbon black and an optional processing aid, such as a metal glycerolate, in desirable amounts to provide enhanced tear strength without negatively impacting stiffness or hysteresis.

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  Course: *Essentials of Rubber Technology*
- **January 22, 2025**
  Course: *Essentials of Silicone Rubber*
- **January 28, 2025**
  Webinar: *Basics of Polymer Testing & Processing*
- **February 4, 2025**
  Course: *Sponge Rubber 101*
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Condoms in sub-Saharan Africa: Quality requires responsible manufacturing with required independent testing

by Katrina Cornish, United States Department of Agriculture

The Republic of South Africa (RSA) still has the greatest rate of HIV infection and AIDS deaths in the world. The societal cost is enormous and heartbreaking, especially among rural communities with limited access to professional medical care. Condoms are the best way to prevent sexually transmitted infection (STDs), including HIV. The World Health Organization supports the distribution of free condoms across sub-Saharan Africa. In the past, high quality, properly leached condoms were manufactured by Alatech (Eufala, AL) under a contract with the U.S. government for distribution in Africa. Alatech lost the contract in 2009 when it was awarded to a Chinese condom manufacturer, presumably because of a lower bid on the contract. The Chinese company went on to produce Choice brand condoms, distributed by the RSA government for free use.

However, Alatech's closure was not the only negative consequence of the change in manufacture, because the contract may have only specified the mechanical properties that must be met by the condom manufacturer, but not other extremely important health related parameters: most notably, extractable protein and residual chemical content. However, this seems unlikely because the current WHO specification (ref. 1), which follows ISO 4047, requires that: "The condoms shall not liberate toxic or otherwise harmful substances in amounts that can be irritating, sensitizing or otherwise harmful to the user of the condom under normal conditions of use," and that, "the WHO specification requires manufacturers to minimize the level of water extractable proteins in the condoms," (WHO 2019).

Reputable manufacturers of products made from tropical Hevea natural rubber latex always include a leaching step of the product at the gel stage of manufacturing, as did Alatech when they were making the condoms. This step washes soluble proteins and residual chemicals, such as antioxidants and accelerators, from the products. Once the product is fully cured, simple washing no longer effectively removes these contaminants, but human saliva and bodily fluids still can. As reviewed (ref. 2), in the early 1990s, high levels of protein left in powdered medical gloves sensitized huge numbers of healthcare workers and multiple surgery patients to life threatening Type I latex (protein) allergy. Sensitized healthcare workers were forced to abandon their careers and the U.S. alone lost 10% to 15% of these trained professionals from the workforce. Although not directly life-threatening, many chemicals used in compounding cause irritant dermatitis or Type IV allergenic contact reactions (ref. 3). Cracking and rashes of the skin weaken its barrier properties to the extent that allergenic proteins can then directly pass through the skin, in addition to passing through mucosal membranes and into bodily fluids contacted during surgery. It has been estimated that 50% of patients suffering from rubber chemical induced rashes go on to develop Type I latex allergy, as well, if high protein products are being used (ref. 4).

This author visited the Republic of South Africa several times in the early 2010s to attempt to establish a guayule crop in this country's ideal guayule growing environment, particularly as a source of allergy-safe latex for condoms (ref. 2). It is well established that guayule latex meets the requirements of ASTM D1076, Category 4, and that it contains no proteins that cross-react with antibodies raised against Hevea latex proteins in humans or animals. After discussing the condom situation in RSA with collaborators there, it became clear that quality issues surrounding the Choice condom were prevalent. Apparently, users of the free Choice brand condoms distributed by the RSA government reported significant rashes and irritation of their reproductive areas, and some interpreted this to mean that they had contracted an STD from the condom itself. This is absolutely counter to the intended outcome, and certainly does not encourage condom use. Samples of the free Choice condoms were taken back to the laboratory at The Ohio State University to test, because these reports suggested to the author that the condoms had not been properly leached during manufacture.

Methods

A classic formulation (table1) indicates the additives which may cause irritant and allergic contact reactions, and the method for condom manufacture follows. Although this formulation was optimized for guayule latex, these additives are likely similar to those used by the manufacturer of the Hevea latex Choice condoms.

Condoms are made using a straight (not coagulate-assisting) dipping protocol using heated formers.

The key steps for guayule condoms on a laboratory scale follow (leaching step is indicated in bold text). Although Hevea latex time and temperatures will differ from this protocol, the

Table 1 - formulation of guayule latex condoms using a conventional curing package

Formulation	*phr*
Guayule latex	100
Ammonium hydroxide	1.0
Wingstay L antioxidant dispersion	2.0
Zinc oxide dispersion	1.0
TBBS (t-butylbenzothiazole sulfonamide)	0.6
ZDEC (zinc diethyldithiocarbamate)	0.5
DPG (diphenyl guanidine)	0.4
Sulfur dispersion	2.0
H_2O top up to 36% to 53% total solid contents (depending on dipping desire TSC)	
Swell % requirement prior to dip	120-170

Table 2 - mechanical properties

Condom #	*Load at peak (N)*	*Load at break (N)*	*Elongation at break (%)*
1	3.12	0.115	930
2	3.04	0.034	674
3	2.99	0.137	1,048
4	4.91	0.115	1,056
5	7.48	0.126	1,200
Mean	4.31	0.105	982
± s.d	1.95	0.041	197

step sequence will be very similar:

- Preheat former at 60°C to 70°C for 10-20 minutes
- Dip hot former into latex (36% to 53% dry rubber solids content) for 3-15 seconds; latex temperature from 15°C to 30°C.
- Dry coated former at 70°C for 5-10 minutes
- Re-dip coated former for another 5-15 seconds
- Dry double coated former at 60°C to 70°C for 5-10 minutes
- Roll bead
- **Leach in hot water (40°C to 80 °C) for 2-3 minutes**
- Dry at 70°C for 30-45 seconds
- Dip in polymer coating donning agent
- Cure at 100°C to 120°C for 10-60 seconds
- Cool and strip condoms (lubricant can be added here)
- Tumble dry at 70°C for 40-60 minutes.

Five condoms were randomly chosen from three separate packs of 20 condoms each. These condoms were then tested according to ASTM D412 for mechanical properties (table 2), and for extractable antigenic protein content according to ASTM D6499 in triplicate. Also, three samples of different condom brands were purchased from a pharmacy in Wooster, OH, and tested for total extractable protein according to ASTM D5712.

Results

The mechanical properties of the condoms (table 2) confirm that the condoms met the requirements of the standard: ISO 4074:2015. However, the protein tests (table 3) revealed that large amounts of extractable proteins remained in the Choice condoms. In comparison, average total extractable protein of condoms purchased in Wooster, OH, was 29.3 + 12.3 µg/g, with the lowest value being 19.6 µg/g. All values were much lower than for the Choice condoms.

Furthermore, ASTM D6499 measures antigenic protein, a subset of total extractable protein. The correlation of these two tests using published data with quantified protein levels, in which both methods were used on identical samples across many different latex products (ref. 5), was $r^2 = 0.853$, d.f. = 11. The ratio of total extractable protein to antigenic extractable protein was 16.0 + 14.2 (n = 12), which means that the predicted total extractable protein in the Choice condoms is 1,283 µg/g. Individual ratio values ranged from 2 to 57. Thus, the total extractable protein in the Choice condoms could be as low as 161 µg/g to as high as 4,900 µg/g.

Table 3 - extractable antigenic protein content by D 6499 of Choice condoms

Choice condom #	*Extractable antigenic protein content (mg/g) ± s.d*
1	71.6 ± 7.0
2	81.5 ± 0.3
3	84.2 ± 7.4
4	76.2 ± 5.6
5	93.4 ± 10.5
Mean	80.6 ± 8.6

The actual extractable antigenic protein and the predicted total extractable protein data clearly demonstrate that the Choice condoms were not leached during manufacturing to remove soluble latex proteins and, concomitantly, residual chemicals. Unleached latex products pose a significant risk of sensitization with life threatening Type I latex allergy and to residual sensitizing chemicals. Required independent testing to ensure compliance with ISO 4047 would eliminate the failure of the Choice condom manufacturer to follow the WHO specifications if they are still failing to leach during production.

Over the years, there have been many cases of harm to humans caused by shortcuts in manufacturing standards or material replacements in order for manufacturers to make slightly more profit. Some of the most well known were manufactured by Asian companies. The melamine-contaminated baby milk powder comes to mind, as do the Australian toddlers who accidentally ate a supposedly safer fuse bead product in which the contracted formulation had been changed to include a cheaper ingredient which metabolized to a date rape drug. Similarly, some "lead-free" childrens' Disneyland jewelry was found to be made of the even more toxic cadmium.

In conclusion, the actual extractable antigenic protein and the predicted total extractable protein data clearly demonstrate that the Choice condoms tested in this study were not leached during manufacturing to remove soluble latex proteins and, concomitantly, residual chemicals. This explains why some users of the free Choice brand condoms distributed by the RSA government reported significant rashes and irritation of their reproductive areas. Unleached latex products pose a significant risk of sensitization with life threatening Type I latex allergy and to residual sensitizing chemicals. A requirement for independent inspection and testing should resolve such manufacturing problems.

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(continued on page 40)

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- Fully committed to sustainability & circularity through ISCC (PLUS), to support our customers and foster a sustainable future.
- Support of hygiene Mega-trends globally

Key Strengths

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- On the ground Commercial and Technical Teams providing hands-on domestic support for the American glove industry
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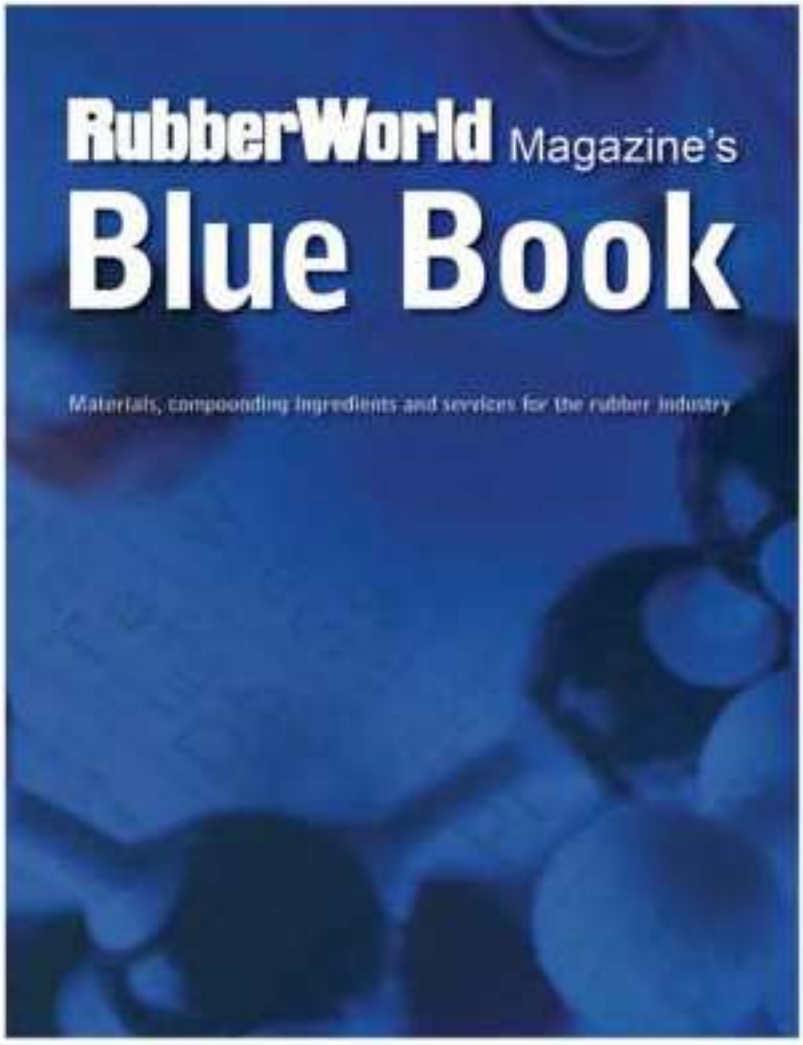

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Tire intracarcass pressure and tire durability

by Brendan Rodgers, ELL Technologies LLC

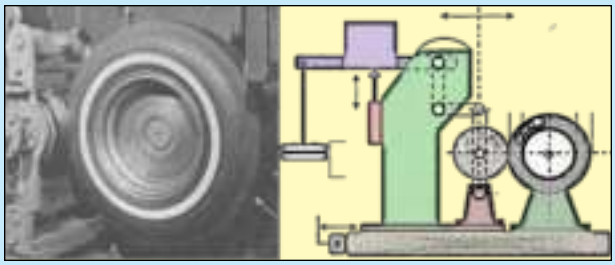
Since the mid 1960s, it has been generally accepted that excessive gas pressure buildup in the cord area of a tubeless tire causes or accelerates separations between components, and hence reduces durability and consequently results in tire failure. The phenomenon has been described as intracarcass pressure (ICP), and though difficult to measure, methods have since been developed to obtain the pressures using pressure gauges inserted into the mid sidewall (ref. 1). Small diameter test wheels had also been developed that were very effective in discriminating between tires displaying different intracarcass pressure values (figure 1). The diameter of such wheels ranged from 11 inches to 28 inches, the size increasing following the trend in tire sizes; and they were also much smaller than the now standard 67 inch or 1.701 meter diameter tire test wheel used for tire durability, high speed and rolling resistance measurements. Though now almost universally replaced by larger diameter machines, the test equipment had proven to be most effective in evaluating radial tire innerliner performance.

Early results from tests using this equipment showed the effectiveness of butyl based rubber innerliners for tubeless tires (table 1). The results consistently demonstrated that chlorobutyl and bromobutyl based innerliner compounds with lower permeability were effective at extending the life of a tire.

A set of definitions and terms pertaining to innerliner performance includes:

- CIIR (chlorobutyl rubber)
- BIIR (bromobutyl rubber)
- IPR (inflation pressure retention)
- IPLR (inflation pressure loss rate)
- ICP (intracarcass pressure)
- IGA (innerliner gauge analysis)
- Endurance (measured in tire test hours with incremental increases in load on a 67" (1.701 meter) diameter road wheel test machine)
- Durability (measure of the duration or life cycle of a tire)
- High speed (measure of tire test hours with incremental increases in speed on a 67" (1.701 meter) diameter road wheel test machine)
- Heat rise (measurement of tire temperature increase during the tire endurance test)

Figure 1 - small diameter test wheels for tire durability (ref. 1); diameters ranged from 11" to 28"



Causes of intracarcass pressure (ICP)

There are a number of conditions which can cause an increase in tire intracarcass pressure. These include:

- Thin innerliner gauge: Innerliner gauge below 1.00 mm for automobile tires and below 2.00 mm for commercial radial medium truck tires will result in greater transmission of high pressure gases from the tire cavity into the tire body, resulting in increased intracarcass pressure.
- Gas transmission rates will increase with increasing tire operating temperature.
- Innerliner compound formulation containing natural rubber, or high process oil levels will increase liner permeability and thus allow more gas to permeate into the tire casing.
- High innerliner component endings above the toe thus allow gas to permeate through the bead area and then up the ply cords to the belt endings with consequent oxidation and belt area component degradation.
- High frequency strain related compound fatigue creates innerliner cracks; liner cracks which could be due to fatigue, and in most instances are due to the low fatigue life of the innerliner compound formulation.
- Liner splits or cracks due to impact or other road hazards. Many times the site of a liner split would correspond to the location of tire exterior damage, such as tread cuts or other damage.
- Mounting and dismounting of the tire from the rim, resulting in innerliner tears.
- Punctures and improper repairs.

To ensure low ICP, a well formulated innerliner compound is needed, and will have features such as 100 phr halobutyl rubber, and preferably bromobutyl rubber, low oil content, use of a ho

Table 1 - effect of chlorobutyl liner on tire durability (ref. 1)

Tire construction	*Compound type*	*Innerliner gauge (inches)*	*Relative durability (higher is better)*
1 (at 28 psi)	SBR (manufacturer A)	0.0545	100
	Chlorobutyl (CIIR)	0.0525	141
2 (at 28 psi)	SBR (manufacturer B)	0.0547	100
	Chlorobutyl (CIIR)	0.0460	166
3 (at 30 psi)	SBR	0.0540	100
	CIIR	0.0460	247

Figure 2 - inflation pressure loss rate versus innerliner gauge for a passenger tire, 195/65VR14 (ref. 2); the GM specification is 2.5%/month

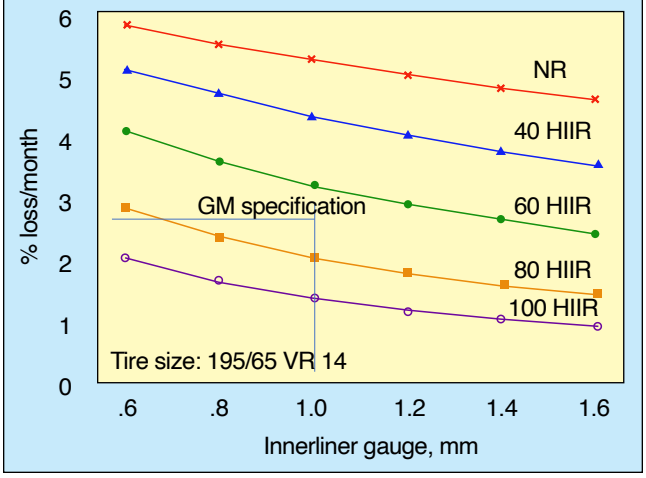
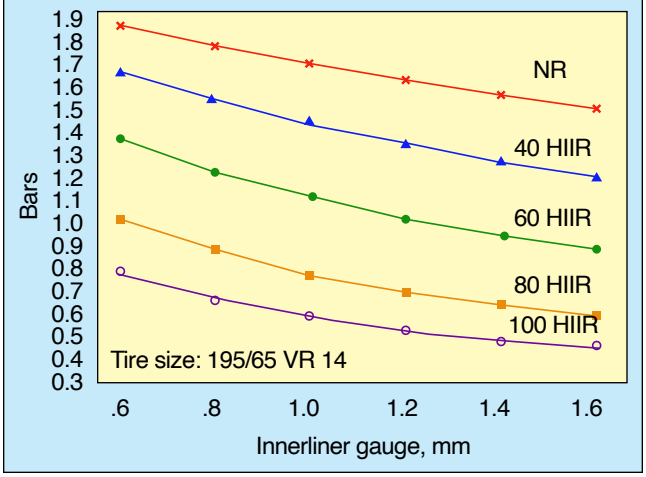


Figure 3 - intracarcass pressure in bar versus innerliner gauge for a passenger tire, 195/65VR14 (ref. 2)



mogenization agent and absence of inorganic filler which may initiate fatigue related cracking. The compound used to produce an innerliner will also have sufficient gauge and will show uniform gauge bead-to-bead, low permeability, Mooney viscosity values specified to allow efficient processing in tire manufacturing operations, sufficient green strength to prevent distortion during processing in manufacturing, high adhesion to any adjacent barrier, squeegee or gum strips in the tire, high resistance to fatigue and a low brittle point.

Bromobutyl rubber is proven to be the best polymer for this set of requirements, and compounds typically use carbon black, and specifically the grade N660 or a close equivalent, low levels of naphthenic process oil, a homogenization agent and a semi-EV vulcanization system using the accelerator MBTS. Companies such as Saudi Aramco and its predecessors, Lanxess, Bayer and Polysar, and also ExxonMobil have published many technical papers, text book chapters and reviews giving guidelines on development of innerliner compounds, formulations and associated compound technologies.

Halobutyl tire innerliners

Chlorobutyl rubber, which was the first of the commercially available halobutyl polymers, consists of around 98% isobutylene monomer and 2% isoprene. It is a highly saturated polymer, with the only chemical functionality available for participation in vulcanization being the isoprenoid carbon-carbon double bonds and chlorine, which is located on the isoprene units. Surprisingly, compound development took a considerable time, primarily because of the highly saturated nature of the halobutyl polymer chain. Today, companies such as ExxonMobil provide formularies to assist tire manufacturers. Difficulties in the case of chlorobutyl rubber compounds further centered on achieving adequate fatigue resistance, cut growth resistance and tear strength, and most significantly, adhesions to adjacent components in the tire. This was largely addressed with the invention and implementation of bromobutyl rubber, which is now by far the dominant halobutyl type in terms of usage, the optimization of compound process aids such as use of homogenization agents and a vulcanization system using only the accelerator, MBTS, optimum zinc oxide and stearic acid levels, and sulfur.

Inflation pressure losses and intracarcass pressure

With the introduction of bromobutyl rubber in the 1980s, much research has been conducted to quantify the effect on tire inflation pressure retention (IPR), inflation pressure loss rate (IPLR) and intracarcass pressure (ICP). Costemalle (ref. 2) benchmarked a set of commercial passenger tires for IPLR and ICP (table 2). The author attempted to model both IPLR and ICP, and showed:

- As the tire air to volume (A/V) ratio increased, IPLR increased.
- As halobutyl content increased, IPLR decreased.
- As liner gauge increased, IPLR decreased.

The author reported that when air permeates into the body of a tire, it can migrate along reinforcements. The rate of air transmission along the longitudinal direction of a tire cord can be up to 300 times that of rubber. In that regard, both fabric and steel cord manufacturers have developed cord constructions which allow greater rubber penetration; and though still measurable, it does reduce gas migration along cords to the tire crown area. Therefore, coupled with the use of an optimized bromobutyl innerliner compound and adequate gauge, the buildup of intracarcass pressure can thus be controlled.

From Costemalle's work, two definitive graphs evolved (figures 2 and 3), governing tire inflation pressure loss (IPLR)in %/month and ICP in bar. This proved highly effective in optimizing a tire for durability. The data were obtained by testing at 21°C, similar to today's ASTM F1112 titled Standard Test Method for Static Testing of Tubeless Pneumatic Tires for Rate of Loss of Inflation Pressure. The temperature of 21°C was selected for the ASTM specification, as it represented an ambient condition which, in turn, better reflected conditions when vehicles were mostly parked. In the case of commercial tires, that

Table 2 - intracarcass pressure and tire durability (ref. 3)

Innerliner butyl content phr	*Volume halobutyl %*	*Liner permeability rating at 65°C*	*Intracarcass pressure, ICP psi*	*Endurance under method: FMVSS 109, hours to removal*
BIIR 100 phr	65.2	3.0	5.3	61.5
BIIR 75/NR 25	48.3	4.2	9.1	56.9
BIIR 65/IIR 10/ NR 25	42.2	5.9	9.1	40.2
SBR 54/IIR 10/ NR 36	16.1	8.9	13.0	31.6

would not be the case, since a significantly greater amount of time is in operations.

Niziolek and coworkers further studied the effect of compounding materials on tire durability. Tire casing durability is the most important factor in determining the service life of a radial medium truck tire (RMT), aircraft tire and off-road or OTR tire (ref. 3). In the case of commercial truck tires, when operating at 50 miles per hour or 80 km per hour, they undergo 10 to 11 revolutions every second (nominally 11 Hz) and operate at temperatures up to 75°C. As the tire goes through its service life, both aerobic and anaerobic oxidation will occur to both external and internal components. When underinflated, excessive deflection will further generate additional heat due to compound hysteresis, thus increasing the rate of compound oxidation.

The innerliner thus becomes one of the most important components in the radial medium truck tire. In fact, together with the flat belt system allowing a uniform tire footprint, these two components (the halobutyl rubber innerliner and brass coated steel wire belt system) have been two key enabling technologies for the modern radial tire. The purpose of the innerliner is to provide a barrier to oxygen, nitrogen and moisture in the tire chamber permeating through the tire casing. Thus, the liner helps maintain inflation pressure and reduces or prevents the buildup of intracarcass pressure. Niziolek et al. noted water vapor and gas penetrating into the body of a tire will cause internal component separations, compound degradation and loss of adhesion. These durability parameters are dependent on an effective barrier or innerliner. The quality and effectiveness of the innerliner thus becomes a function of:

- Bromobutyl content, i.e., maximum bromobutyl level in phr, minimization of process oil and the selection of compound component materials
- Liner gauge: For trouble-free operation of a passenger tire, the optimum is on the order of 1.00 mm, and for a commercial truck tire, 2.00 mm
- Location of the innerliner ending, i.e., under the toe of the tire, and thus having full bead to bead coverage

The impact on tire innerliner quality and durability can be seen in table 2. The authors noted that there was a relationship between butyl and halobutyl content and permeability. Replacing a compound with 100 phr of bromobutyl with SBR and natural rubber resulted in tire endurance falling by up to 50%.

As seen in table 2, the authors reported that:

- As bromobutyl content increased, the liner permeability decreased (better).
- As inner liner permeability decreased, intracarcass pressure decreased.
- As ICP decreased, tire durability (miles to removal on the dynamometer) improved (figure 4).

Similar work has been reported in other Rubber Division, American Chemical Society (ACS) publications. In 2009, tire durability results with tires showing various levels of intracarcass pressure showed similar trends (table 3). There was a near linear relationship between an increase in tire ICP and a drop in tire durability or distance traveled before removal (ref. 4).

Yin and coworkers (ref. 5) conducted modeling work in attempting to qualify the relationship between truck tire operating temperature and thermal degradation of the shoulder wedge and cushion. They modeled an 11.00R20 tube type tire and noted:

- Strain fatigue induced a decrease in storage modulus.
- Thermo-oxidative aging caused an increase in modulus (the compound would be more brittle).
- Thermal reversion and anaerobic aging caused a decrease in storage modulus and an increase in tan δ.

The authors then concluded that the shoulder component failure mechanisms were due to strain fatigue and thermal oxidative aging. The tread cushion in the central belt region would fail due to anaerobic degradation, diffusion limited oxidation (DLO) and strain fatigue.

Figure 4 - effect of halobutyl and intracarcass pressure on tire durability

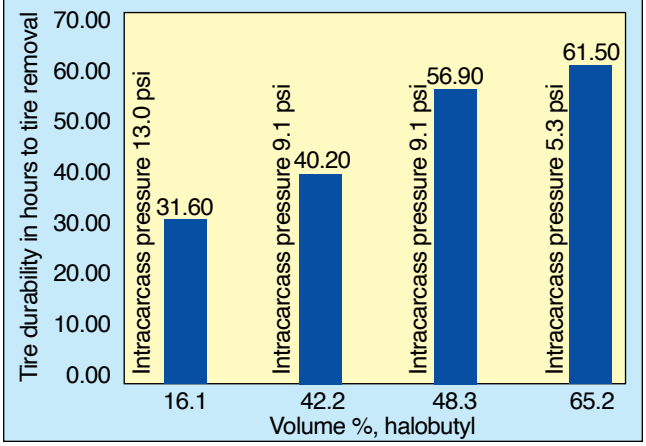


Table 3 - tire intracarcass pressure and tire durability, km to failure (ref. 4)

Innerliner polymers	*ICP kPa*	*Kilometers to failure*	*Hours to failure*
CIIR: 100 phr	40	33,270	415.9
CIIR/NR: 75/25	55	23,310	291.4
CIIR/NR: 50/50	95	21,922	274.0
NR: 100 phr	115	12,650	158.1

Table 4 - effect of flat track speed on tire surface temperature (ref. 6)

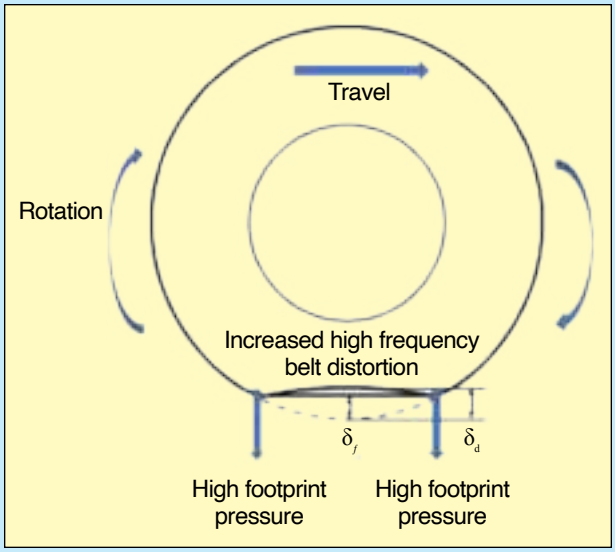
Load (Newtons)	*Pressure kPa*	*Speed Kph*	*Flat surface temperature °C*
18,640	790	30	43.2
18,640	790	60	53.1
18,640	790	90	64.3
18,640	790	120	76.2

LaClair and Zarak from Michelin conducted work to better understand tire operating temperatures on surface types (ref. 6). Low operating temperature is very important to the endurance of a tire. Temperature increases as tire speed increases, and for truck tires, significantly high operating temperatures can occur when the tire is in normal use. Low inflation pressure can further increase tire operating temperatures. At very high elevated temperatures, rubber compound reversion can occur, with the authors noting that an increased shoulder temperature above normal conditions can reduce tire life up to a factor of three. The authors, using truck tires size 275/80R22.5 drive axle designs tested on a flat surface dynamometer, showed the effect of speed on temperature (table 4).

Heat buildup in a tire is generated primarily through compound hysteresis when the component compounds of a tire are cyclically deformed as the tire passes through its footprint, i.e., high frequency deformation. The heat generation is thus a function of energy dissipation per deformation and frequency of rotation, in cycles per second or hertz. Furthermore, the deflection of the tire as it enters its footprint then increases over the footprint length, which then adds increased shear stress in the belts, and particularly at the belt endings (figure 5).

It was concluded that cyclic deformation in a truck tire belt region can lead to compound strain fatigue and degradation. High frequency deformations will also generate heat, and coupled with the presence of oxygen, thermal oxidative degradation will follow. However, in the central belt region, i.e., in the centerline of the tire, there would be inadequate oxygen, and then diffusion limited oxidation or anaerobic thermal degradation might proceed.

Figure 5 - tire footprint pressure (ref. 6)



This was explored by Nasdala et al. in a modeled passenger tire (ref. 7). Oxygen in the center of the belts will react faster at elevated operating temperatures than the rate of oxygen diffusion, and thus predicted tire life cycles would also be affected by the diffusion limited oxidation processes. They then described an increase in tire operating temperature being related to a reduction in aging time by a shift factor, α_T. As the operating temperature is increased, the rate of oxygen consumption increases faster than the oxygen diffusion rate, and thus the modulus profile is heterogenous at the highest service temperatures. In any case, it is essential that oxygen diffusion into the shoulder components is minimized. The models developed by the authors indicated the innerliner performance and lower permeability were critical.

Gas buildup in the body of the tire, or intracarcass pressure, was analyzed by Giapponi, who described it as a time driven event almost exclusively associated with the liner, and that resulted in hardening of the belt compound and belt wedges, and then in a separation of the upper sidewall and belts from the tire casing ply (ref. 8). The root cause of such separations can be:

- Inadequate liner gauge and high liner ending
- Innerliner compound composition
- Poor belt and tread gauge, and placement control (i.e., off center)

The acceleration of tire component degradation in the crown area results from an increase in air pressure and oxygen; and then oxidation of the internal compounds, reducing compound physical properties with consequent crack formation. Hardening, sometimes described as crystallization of the 2/3 wedge and belt compound, is indicative of ICP. In addition, separation of sidewalls can also be attributed to ICP occurring at the upper sidewall and shoulder region, and can extend around the full circumference (figure 6).

Figure 6 - intracarcass pressure contributing to upper shoulder wedge separation (ref. 9)

Tire aging and intracarcass pressure

As already described, intracarcass pressure is the gas pressure in the body plies and interior tire layers that is part of the pressure gradient from the innerliner to the outboard side, and is due to natural and accelerated diffusion from the inflated tire cavity, i.e., the total pressure of the gas mixture in the mounted tire cavity minus the outside atmospheric pressure. Kerchman at Kumho Tire modeled this using a light truck load range E tire, LT 245/75R16 (ref. 9). He noted that most O_2 was being consumed by oxidation reactions, and after five weeks, absorbed oxygen was adding over 1% weight to the mid and upper sidewall and casing plies. As a consequence, peel adhesion was expected to drop appreciably.

High halobutyl content in the innerliner compound and thick liner gauge help mitigate or reduce intracarcass pressure. In the Kerchman study, ICP levels below 0.6 bar were considered acceptable. However, when ICP reached 0.8 bar, then tire durability testing for hours-to-failure dropped due to belt separations. In addition, excessive degradation was also found with air-oven aged tires produced with thin innerliners. Similarly, when the liner ending exceeded 30 mm above the toe, durability dropped. The author noted that with high innerliner ending there was accelerated permeation through the exposed chafer, then into the ply and along the ply cords to the shoulder. There was also excessive ICP and oxidation in the apex and sidewall regions, which were reduced when the innerliner ending was dropped to 12 mm above the toe, and lower. By having sufficient gauges, the degradation was mitigated. The author then concluded:

- Higher ICP values occurred when the liner gauge was reduced.
- Increasing the liner ending distance above the toe caused an increase in ICP.
- High ICP and oxidation induced a degradation in compound strength, which can also cause sidewall-to-ply component interface degradation and separation.

Measurement of intracarcass pressure (ICP)

Measurements of ICP cannot be performed directly inside the oven due to equipment limitations. Therefore, to measure ICP experimentally, tires are first conditioned at the test temperature, preferably 21°C, according to ASTM F1112 used for measurement of inflation pressure loss rate. Hypodermal needles with pressure gauges are inserted into the central sidewall, as shown in figure 7, and pressure measurements taken with time. Test durations are described in ASTM F1112. Passenger and light truck tires require a minimum of four pressure gauges. Truck tires require a minimum of eight gauges to compensate for losses due to plugged needles and operators missing placement of the needle tip next to a ply cord. In addition, many new tire wire constructions are closed, i.e., no channel through the center, so extra test transducers are required in order to collect enough data for which additional test gauges help compensate.

Figure 7 - measurement of intracarcass pressure, ICP

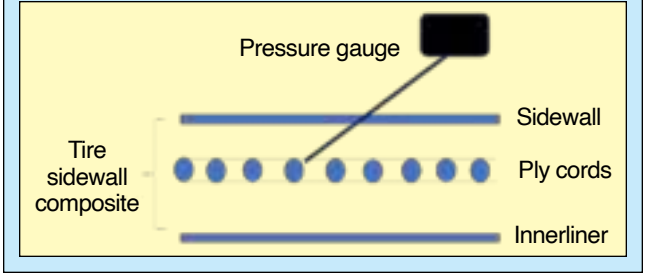
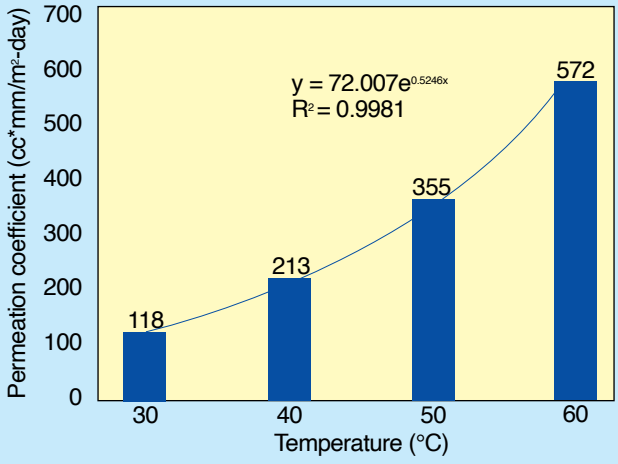


Figure 8 - effect of temperature on innerliner permeability coefficient (ref. 10)



Recent modeling work on inflation pressure loss rate (IPLR)

Following an Arrhenius type of relationship (figure 8), tire innerliner permeability increases with temperature; the temperature coefficient being on the order 1.8 (ref. 10). The inflation pressure loss rate for a truck tire has been described in the document IP.com IPCOM000253952D (ref. 11). IPLR results were on the order of 0.714% to 0.720% per month at ambient temperature (21°C). In this case, the liner ending extended to the toe of the tire. Furthermore, when the liner ending extends below the bead bundle due to its steel construction permeability, diffusion is greatly reduced. When the liner ending is above the bead bundle, then there is an opening to the chafer, and IPLR increases (figures 9 and 10).

Figure 9 - IPLR results for truck tire (ref. 11)

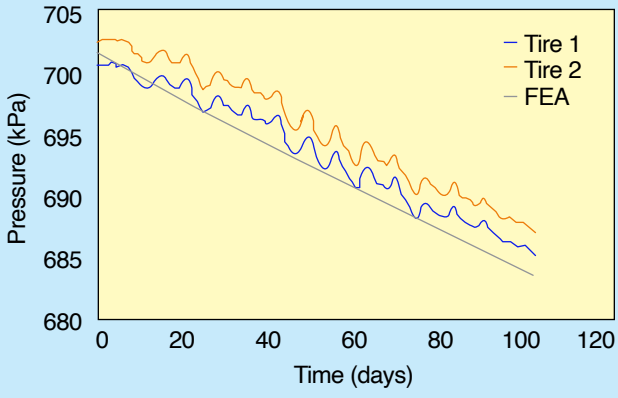
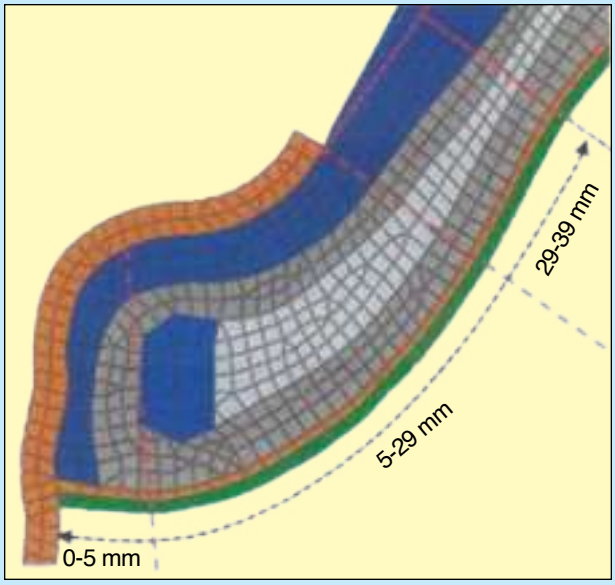


Figure 10 - liner ending in a truck tire (ref. 11)



Liang et al. undertook a modeling analysis of passenger and truck tires which further validated the data reviewed above (ref. 12). The authors note that failure modes attributable to high IPLR are belt separation failures. A higher IPLR leads to an underinflated tire at an earlier stage, causing a larger footprint for rolling tires, and increases the temperature of the belt region due to high frequency deformations. The high temperature causes increased stress concentration, thus accelerating the oxidation in the belt region, which in turn increases the susceptibility of this region to separation failures. The driving force for gas diffusion is considered to be the concentration gradient, which for truck tires and inflation pressures up to 100 psi (6.8 bar) is much greater than for automobile tires (32 psi or 2.2 bar).

As temperature increases, the permeability of a compound, such as the liner, increases in an exponential manner. It would typically follow an Arrhenius type relationship, nearly doubling with every 10°C increase in temperature. In the case of gas transmission through the liner, the temperature coefficient is on the order of 1.8. The terms used to describe gas flow through a rubber sheet, such as a tire innerliner, are shown in table 5.

The transmission rate is of particular significance, since it relates to gas flow through a rubber liner in a specific tire when the specified gauge shows a high degree of variability. Regardless what the permeation or permeability coefficient are, if the innerliner gauge is reduced, transmission rate will increase and intracarcass pressure will also then increase, more so with increasing tire operating temperature, and with a corresponding detrimental impact on tire durability.

Innerliner gauge is, therefore, of importance. All else being equal (i.e., compound formulation and tire construction), then the higher the gauge, the better the tire performance.

As a guide, passenger tire inflation pressure loss rates should not exceed 2.5% per month, which would also be in alignment with the General Motors guidelines; and heavy duty truck tires

Table 5 - important terms defining tire innerliner permeability

Term	*Units*
Transmission rate	(cc/m^2-day)
Permeation coefficient	(cc*mm/m^2-day)
Permeability coefficient	(cc*mm/m^2-day-mmHg)
Permeance	(cc/m^2-day-mmHg)

Table 6 - tire compound oxygen diffusivity (ref. 12)

Tire component	*Oxygen diffusivity coefficient (10^{-11}m^2/seconds)*
Tread	4.570
Belts	5.790
Sidewall	20.490
Ply	8.800
Innerliner	1.430

should have an inflation pressure loss rate of less than 0.7% per month, which would be in alignment with guidelines from ExxonMobil Chemical (ref. 13). Most important, such IPLR targets will thus allow trouble-free tire operations.

Butyl polymers, and specifically bromobutyl rubber, have emerged as the preferred polymer for innerliners. The fundamental reason for the use of these polymers is efficient intermolecular packing resulting in very low specific free volume and higher specific gravity compared to other elastomers. Furthermore, gas diffusion is very sensitive to small changes in specific free volume and polymer specific gravity (ref. 14). This is also demonstrated by the use of polyoxymethylene, with a specific gravity of 1.41 being selected for use in hydrogen refueling hose tubes (ref. 15).

Elaborating further, the solubility of the diffusing gas phase is different for various base materials, so the concentration of the diffusing phase is usually discontinuous. Diffusion through natural rubber based compounds is much faster than for bromobutyl based innerliner compounds. The function of the innerliner is thus to prevent air permeation into other tire components (table 6).

For air inside the tire, in the bead region air will flow faster through the rubber where the toe or chafer area is not covered by the innerliner, i.e., the result of high innerliner endings. This air will diffuse into the ply cords and up the sidewall. Liang et al. (ref. 12) showed tire pressure retention performance can be improved by increasing the innerliner gauge, decreasing the innerliner permeability and lowering the liner ending to the bottom of the toe (figure 11).

The authors then noted:

- For air inflated tires, oxygen and nitrogen have nearly equal contribution to total inflation pressure loss. This may be explained by the fact that most rubber is over three times more permeable to oxygen than nitrogen, but the initial partial pressure of the nitrogen is over three times higher than the initial partial pressure of the oxygen.
- Compared with increasing the innerliner gauge, decreasing

Figure 11 - effect of innerliner gauge on IPLR; increasing innerliner gauge will improve inflation pressure retention (ref. 12)

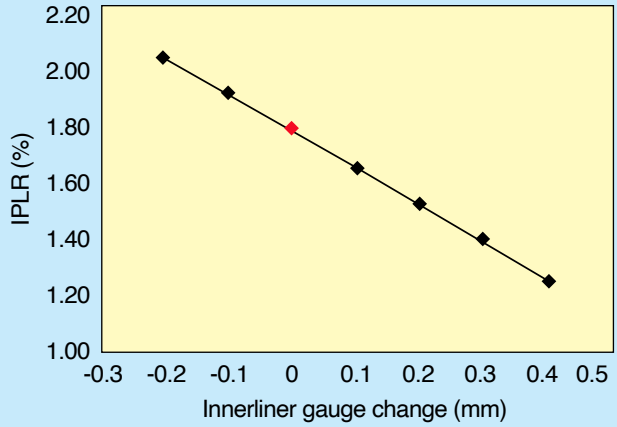
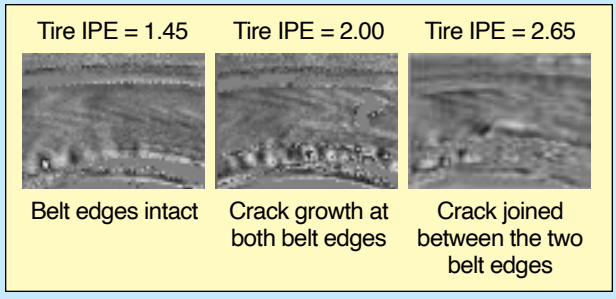


Figure 12 - IPLR and shearography anomalies (ref. 16)



liner ending length provides a more cost efficient solution to reduce IPLR.

- IPLR changes linearly with innerliner permeability. Increasing halobutyl content above 80 phr will have a greater effect on reducing IPLR.
- The inflation pressure retention performance and intracarcass pressure in a tire can be improved by:

Table 7 - innerliner composition, IPLR and durability (ref. 16)

Innerliner polymer composition (phr)	*Inflation pressure loss rate (%/month)*	*Tire removal (hours)*
100 phr bromobutyl rubber	1.45	55.8
80 bromobutyl rubber, 20 natural rubber	2.00	49.0
60 bromobutyl, 40 natural rubber	2.65	39.7

a. increasing the innerliner gauge,
b. decreasing innerliner permeability, and
c. lowering the innerliner ending.

Early deterioration of the belt edges due to oxidation can be observed using shearography. Though there is little work in the public domain for large truck tires, work on passenger tires is available. Three sets of tires were built with different innerliners allowing different tire inflation pressure loss rates (table 7), and then tested for endurance using a 1.7 meter road wheel, following the test method in FMVSS 139 (refs. 16 and 17).

Figure 12 shows the effect of tire intracarcass pressure on tire internal anomalies visible using shearography, and then durability. Based on this graphical representation of ICP data, it is nearly a linear relationship with durability (figure 13). Tires undergoing endurance testing subsequently failed by belt edge separation, as illustrated in figure 14. The root cause is the thermal oxidation and degradation of compounds in the crown region, and specifically at the belt endings. Unsaturated polymers, such as natural rubber, are attacked by oxygen when energy has especially been applied, such as when under high frequency deformations. The application of thermal energy will come from hysteresis and dynamic shear promoting faster oxidation.

Compound oxidation

Oxidative degradation of the polymers is a free radical process. This oxidation process, also known as auto-oxidation, consists of three steps: initiation, propagation and termination, as illustrated in figure 15. Polymer chain scission coupled with chang

Figure 13 - tire ICP and durability (ref. 17)

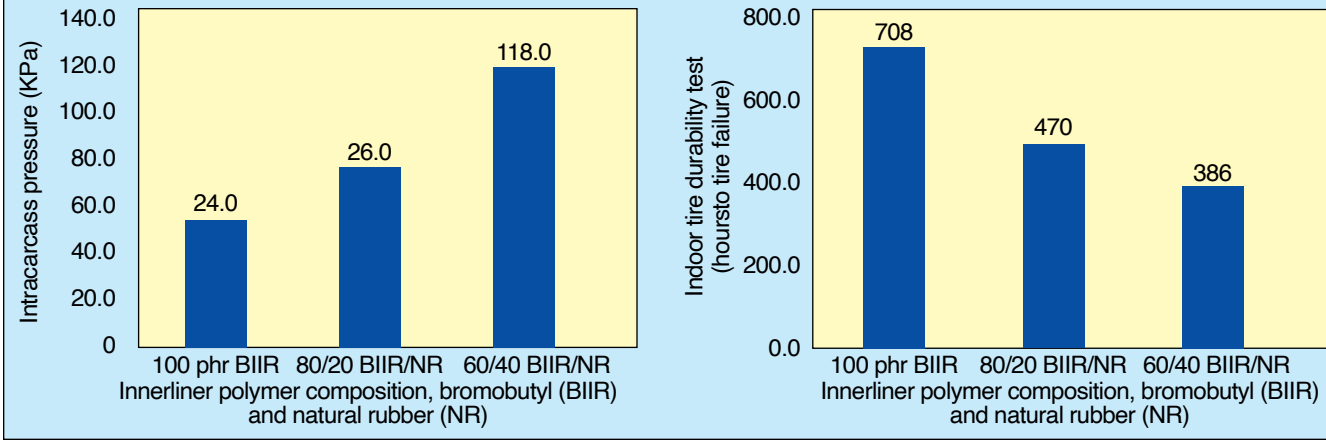


Figure 14 - belt edge separations in an automobile tire and truck tire

Automobile tire | Truck tire

es in the crosslink network, such as reduction in polysulfidic crosslinks and increase in mono- and disulfide crosslinks, cause a loss of mechanical properties, eventually leading to component failure (ref. 18).

The best method to reduce a compound's susceptibility to thermal oxidation is use of antioxidants, including antiozonants such as polymerized trimethyl-1,2-dihydroquinoline (TMQ) and N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD) (figure 16). However, the best solution is to prevent oxygen migrating into the internal tire components. Protectant systems will certainly help, but preventing buildup of intracarcass pressure will allow longer product life cycles.

The oxidation of rubber compounds leads to the deterioration of the compound, and in turn can result in end product failure (refs. 19 and 20). Figures 17 and 18 illustrate two samples of rubber: one which has been protected from oxidation and the second that has only minimal levels of conventional antioxidants and antiozonants, which could be the case for internal compounds in a tire crown region. It is clearly evident that such deterioration in a compound due to oxidation, and especially oxidation at an elevated temperature, such as at tire operating temperatures on the order of 60°C, will cause a drop in performance.

Truck tire failure mode

In most cases, the failure mode for a truck tire with high intracarcass pressure is 2/3 belt separation. Figure 19 illustrates the process. Aerobic compound oxidation is induced by oxygen buildup

Figure 15 - oxidation and degradation mechanism (ref. 18)

Initiation

	Energy		
RH	→	R	(Reaction 1)
$2RH + O_2$	→	$(RH...O_2) + RH \rightarrow 2\,R + H_2O_2$	(Reaction 2)
ROOH	→	RO + OH	(Reaction 3)
2 ROOH	→	$RO + ROO + H_2O$	(Reaction 4)

Propagation

$R + O_2$	→	ROO	(Reaction 5)
ROO + RH	→	ROOH + R	(Reaction 6)

Termination

2R	→	Non-radical products	(Reaction 7)
R + ROO	→	Non-radical products	(Reaction 8)
2ROO	→	Non-radical products	(Reaction 9)

Figure 16 - primary antioxident (TMQ) and antiozonant (6PPD) used to prevent aging (ref. 18)

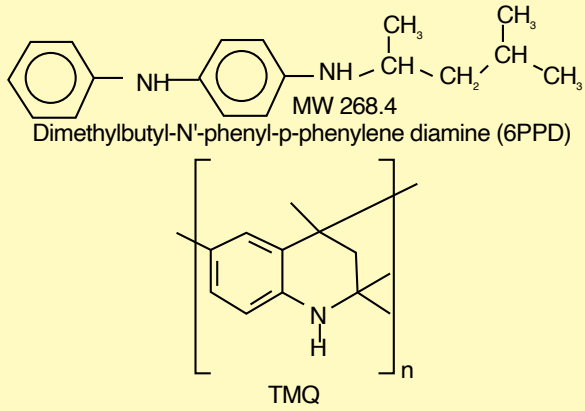


Figure 17 - compound deterioration due to oxidation; one with an effective AO system versus one without (ref. 19)

or intracarcass pressure. Then, degradation (figures 17 and 18) will initiate at the belt endings due to heat generated by high frequency belt ending deformation and compound hysteresis, and typically starts at the 2/3 wedge, or second or third belt ending. The higher the temperature and the higher the ICP, the sooner cracks, tearing and separation will initiate and then propagate along the second and third belt interface.

Separation will be accelerated when there is:

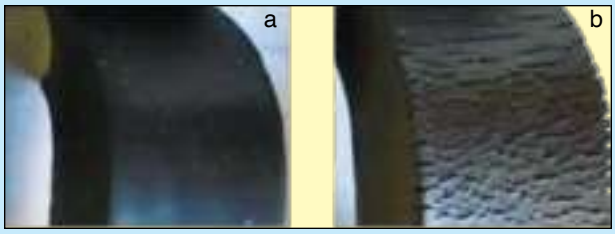
- Inadequate skim coat gauge and close proximity of adjacent belt wires, allowing tearing to rapidly progress through the belts
- Low wire coat compound to wire coat compound adhesion
- Low rubber to wire adhesion

This mechanism is also representative of passenger tires; though because of the use of nylon overlays, catastrophic belt separation is seldom seen.

Tire inspection for potential intracarcass pressure failure modes

Figure 20 is an examples of a tire where the fundamental failure mode of the tire can be due to high in

Figure 18 - presence (a) and absence (b) of antioxidant systems and compound deterioration due to oxidation aged under identical conditions (ref. 20)



tracarcass pressure. In such cases, the root cause of the intracarcass pressure would be higher tire innerliner component permeability, inadequate liner gauge or high liner ending locations. In a tire inspection, observations consistent with a buildup of intracarcass pressure would include:

- Shiny black-blue surfaces at the failure location
- For truck tires, the 2/3 wedge showing a burnt shiny surface
- Dark bluish interfaces at adjacent component separation locations
- Internal components showing burnt appearance

The shiny colored appearance has been described by Giapponi (ref. 8), who noted the burnt black-bluish appearance at a failure location is consistent with degradation induced by high intracarcass pressure. Such failure modes would be different from separations due to high speed centrifugal forces, chip/chunk/cutting, excessive deflection underinflation or excessive heat. In such instances, the separation could be rough, or is sometimes described as a knotty tear; or a smooth separation which would be due to initial inadequate adhesion, such as between compounds containing non-compatible polymers. In those instances, the surfaces might be black or degraded, and no black-bluish surface is evident.

Summary and conclusions

Intracarcass pressure, or ICP, is the gas pressure in the body plies and interior tire layers that is part of the pressure gradient from the innerliner to the outboard side, and is due to natural and accelerated gas diffusion from the inflated tire cavity: i.e., the total pressure of the gas mixture in the mounted tire cavity minus the outside atmospheric pressure. There is a large body of literature describing the term tire intracarcass pressure, or ICP, and the effect of high ICP on tire durability. A significant difficulty regarding the concept of ICP is the measurement of intracarcass pressure, including:

- It requires considerable skill on behalf of the laboratory technicians.
- Many times needles inserted into the sidewall become plugged, thus causing misleading results.
- A minimum of eight transducers are needed for medium truck tires; and of these eight, up to four could fail due to needle insertion, not contacting with a ply cord or other plugging causes.
- Passenger tires require a minimum of four transducers for similar reasons.

Figure 19 - example of 2/3 belt separation (ref. 12)

Figure 20 - burnt, blue areas at failure locations

- Test temperatures are frequently too low. For example, a test temperature of 21°C, described in ASTM F1112 for commercial truck tires, is not representative of tire service conditions.

Having recognized the challenges for laboratory technicians conducting the test, several conclusions are still evident:

- Lower quality innerliners lead to an increase in inflation pressure loss rates (IPLR).
- The higher the gas transmission rate through the innerliner, the higher would be the intracarcass pressure.
- Tire operation under low inflation pressures causes an increase in heat buildup due to increased high frequency cyclic deformations, higher IPLR and higher ICP.
- As IPLR increases, the internal gas pressure within the tire body increases due to gas permeation through the casing (ICP).
- Oxygen in the tire body operating at elevated temperatures, e.g., 60°C, facilitates compound thermo-oxidative degradation, and then component separation and failure.
- Diffusion limited oxidation also occurs. And with nitrogen, anaerobic degradation will also occur.
- Increase in ICP has a direct impact on tire endurance. To minimize the effect, a passenger tire should have an IPLR rate of 2.5 % per month or lower. High quality tires have an IPLR as low as 1.25% per month.
- A commercial truck tire should have an IPLR rate of 0.70% per month or lower. High quality truck tires have IPLR as low as 0.35% per month, thus enabling intracarcass pressures below 0.5 KPa.

Further references are also recommended, and specifically Giapponi (ref. 8) and ExxonMobil Chemical Company publications for innerliner compound formulations (refs. 21, 22 and 23).

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Condoms in sub-Saharan Africa

(continued from page 28)

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There are four grades of DPR available, all the same chemical but with different viscosities. They range from the most viscous, DPR-400, to the least, DPR-35. Molecular weight of the most viscous grade is about double that of the least viscous.

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Rewritable, recyclable smart skin monitors biological signals on demand

by Ashley WennersHerron, Penn State

Skin can send certain health related signals, such as dry skin feeling tighter, to indicate the need for moisture. But what if skin could be smarter; capable of monitoring and sharing specific health information, such as the concentration of glucose in sweat or heart rate? That was the question driving a team led by Penn State researchers that recently developed an adhesive sensing device that seamlessly attaches to human skin to detect and monitor the wearer's health.

The details of the smart skin, including how it can be efficiently reprogrammed to detect various signals and even recycled, were published in *Advanced Materials*, and featured on the cover of the journal's August issue. The paper was included in the "Rising Stars" series, which is coordinated by multiple journals to highlight work by early career researchers around the world. The researchers also filed a provisional patent application on the work.

"Despite significant efforts on wearable sensors for health monitoring, there have not been multifunctional skin-interfaced electronics with intrinsic adhesion on a single material platform prepared by low-cost, efficient fabrication methods," said co-corresponding author Huanyu Cheng, the James L. Henderson, Jr., memorial associate professor of Engineering Science and Mechanics in the Penn State College of Engineering. "This work, however, introduces a skin-attachable, reprogrammable, multifunctional adhesive device patch fabricated by simple and low-cost laser scribing."

Cheng explained that conventional fabrication techniques for flexible electronics can be complicated and costly, especially as sensors built on flexible substrates, or foundational layers, are not necessarily flexible themselves. The sensor's rigidity can limit the flexibility of the entire device. Cheng's team previously developed biomarker sensors using laser-induced graphene (LIG), which involves using a laser to pattern 3D networks on a porous, flexible substrate. The interactions between the laser and the materials contained in the substrate produce conductive graphene.

Figure 1 - adhesive sensing device that seamlessly attaches to human skin to detect and monitor the wearer's health

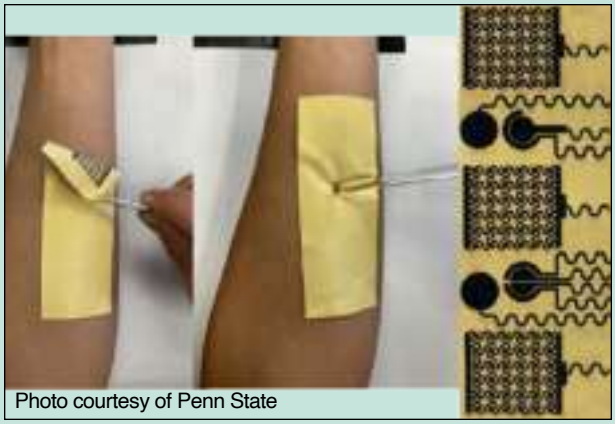


Photo courtesy of Penn State

"However, the LIG based sensors and devices on flexible substrates are not intrinsically stretchable and cannot conform to interface with human skin for bio-sensing," Cheng said, noting that human skin is changeable in shape, temperature and moisture levels, especially during physical exertion when monitoring heart rate, nerve performance or sweat glucose levels might be necessary. "Although LIG can be transferred to stretchable elastomers, the process can greatly reduce its quality."

As a result, Cheng said, it is more difficult to program a sensor device to monitor specific biological or electrophysical signals. Even when the device can be appropriately programmed, its sensing performance is often degraded.

"To address these challenges, it is highly desirable to prepare porous 3D LIG directly on the stretchable substrate," said co-author Jia Zhu, who graduated with a doctorate in engineering science and mechanics from Penn State in 2020, and is now an associate professor at the University of Electronic Science and Technology of China.

The researchers achieved this goal by making an adhesive composite with molecules, called polyimide powders, that add strength and heat resistance and amine based ethoxylated polyethylenimine, a type of polymer that can modify conductive materials, dispersed in a silicone elastomer, or rubber. The stretchable composite not only accommodates direct 3D LIG preparation, but also its adhesive nature means it can conform and stick to non-uniform, changeable shapes, like humans.

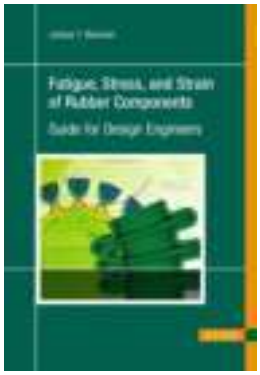
The researchers experimentally confirmed that the device can monitor the pH value, glucose and lactate concentrations in sweat as well as can be detected via finger prick blood draws. It can also be reprogrammed to monitor heart rate, nerve performance and sweat glucose concentrations in real time. Reprogramming is as simple as applying clear tape over the LIG networks and peeling them off. The substrate can then be re-lasered to new specifications, up to four times before it becomes too thin. Once it becomes too thin, the entire device can be recycled.

Critically, according to Cheng, the device remains adhesive and capable of monitoring, even when the skin is made slick with sweat or water. Currently powered by batteries or near-field communication nodules, like a wireless charger, the device could potentially harvest energy and communicate over radio frequencies, which researchers said would result in a standalone, stretchable adhesive platform capable of sensing desired biomarkers and monitoring electrophysical signals. The team said they plan to work toward this goal, in collaboration with physicians, to eventually apply the platform to manage various diseases such as diabetes, and monitor acute issues like infections or wounds.

"We would like to create the next generation of smart skin with integrated sensors for health monitoring, along with evaluating how various treatments impact health, and drug delivery modules for in-time treatment," Cheng said.

Cheng is also affiliated with the departments of Biomedical Engineering, Mechanical Engineering, Architectural Engineering and Industrial and Manufacturing Engineering, as well as the Materials Research Institute and the Institute for Computational and Data Sciences. Other collaborators affiliated with the Department of Engineering Science and Mechanics at Penn State include Xianzhe Zhang, Chenghao Xing and Shangbin Liu, all graduate students; and Farnaz Lorestani, associate research fellow. Co-authors from outside of Penn State include Yang Xiao, Jiaying Li, Ke Meng, Min Gao, Taisong Pan and Yuan Lin, all with the University of Electronic Science and Technology of China; and Yao Tong, Yingying Zhang, Senhao Zhang, Benkun Bao and Hongbo Yang with the Suzhou Institute of Biomedical Engineering and Technology, Chinese Academy of Sciences. Li is also affiliated with the institute.

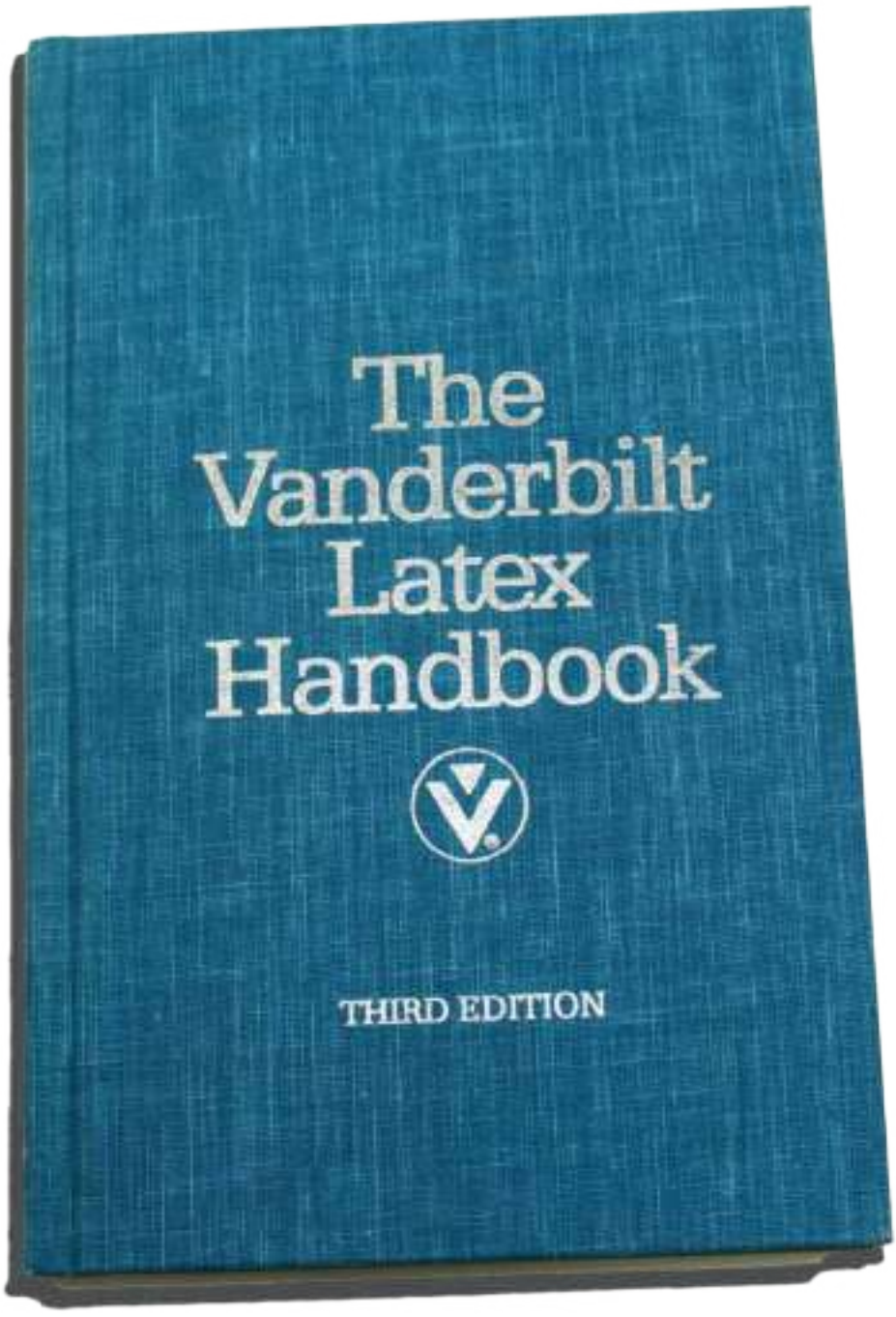
The U.S. National Institutes of Health, the U.S. National Science Foundation, Penn State, the University of Electronics Science and Technology China and the National Natural Science Foundation of China funded this research. This article was originally published by Penn State College of Engineering.



Fatigue, Stress, and Strain of Rubber Components

This book covers the fatigue testing of specimens, curve fitting of equations to the test data, and the use of such equations in life prediction. Earlier chapters are background in the nature of rubber, history of its usage, brief mention of types of rubber and manufacturing methods. Stress-strain testing and behavior is covered to the extent relevant to fatigue analysis. Also, the text covers the application of finite element analysis to components to determine high stress points that are vulnerable to fatigue failure. It is a very useful reference for practicing engineers charged with the responsibility to design structural rubber components where fatigue life is a concern. It also serves as a text for short courses, or as a supplementary text for a university course in rubber engineering.

www.rubberworld.com/book-store



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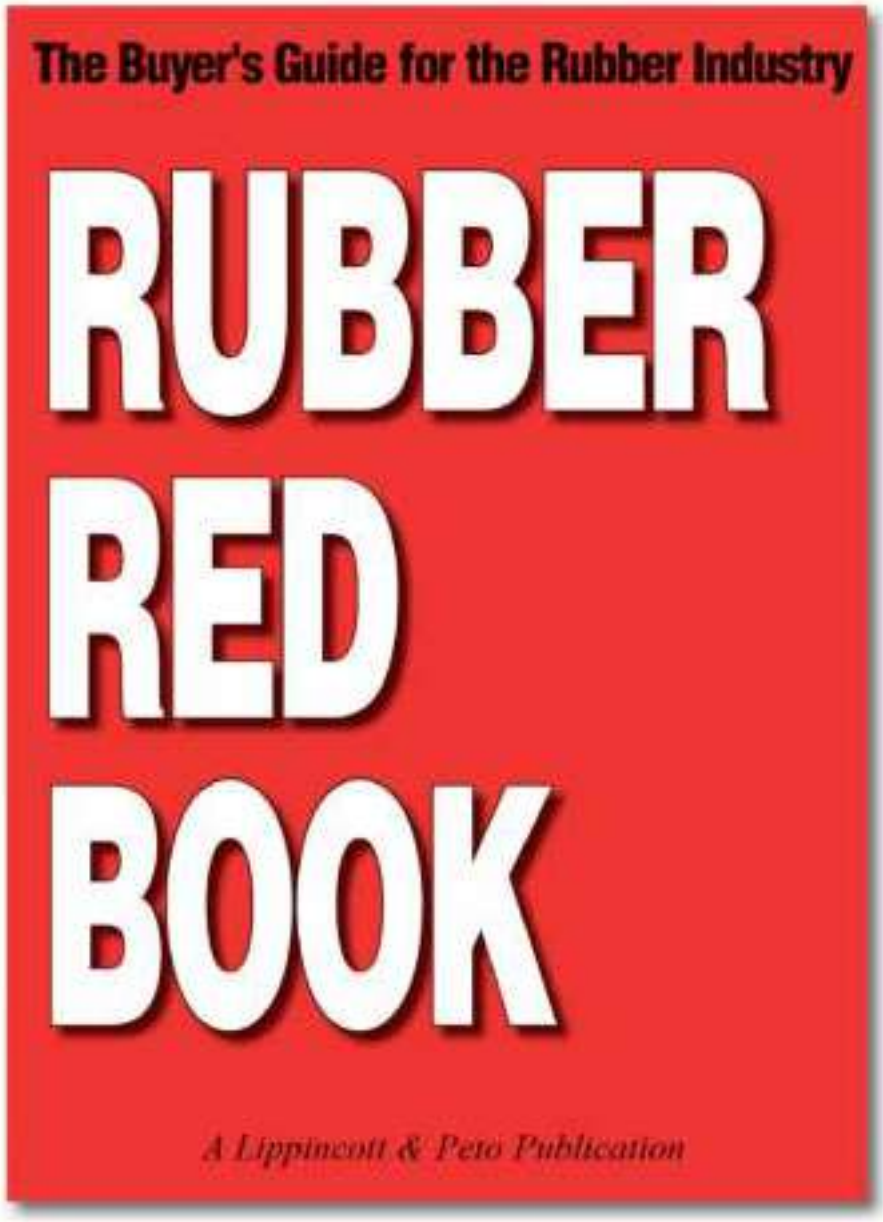

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Rubber Division S&T Award winners named

The Rubber Division of the American Chemical Society annually honors the best of the best with the most prestigious awards in the industry: the Science & Technology Awards. The 2025 winners will be celebrated at a banquet sponsored by Alpha Technologies on March 5 during the Rubber Division, ACS Spring Technical Meeting in Lake Buena Vista, FL. Each S&T Award winner will also give a presentation following the banquet.

Dr. Gert Heinrich was named the 2025 Charles Goodyear Medalist. The most prestigious award given by Rubber Division, ACS is sponsored by HF Group and was established in 1941 to perpetuate the memory of Charles Goodyear as the discoverer of the vulcanization of rubber. It honors individuals for outstanding invention, innovation or development which has resulted in a significant change or contribution to the nature of the rubber industry. Heinrich served as a

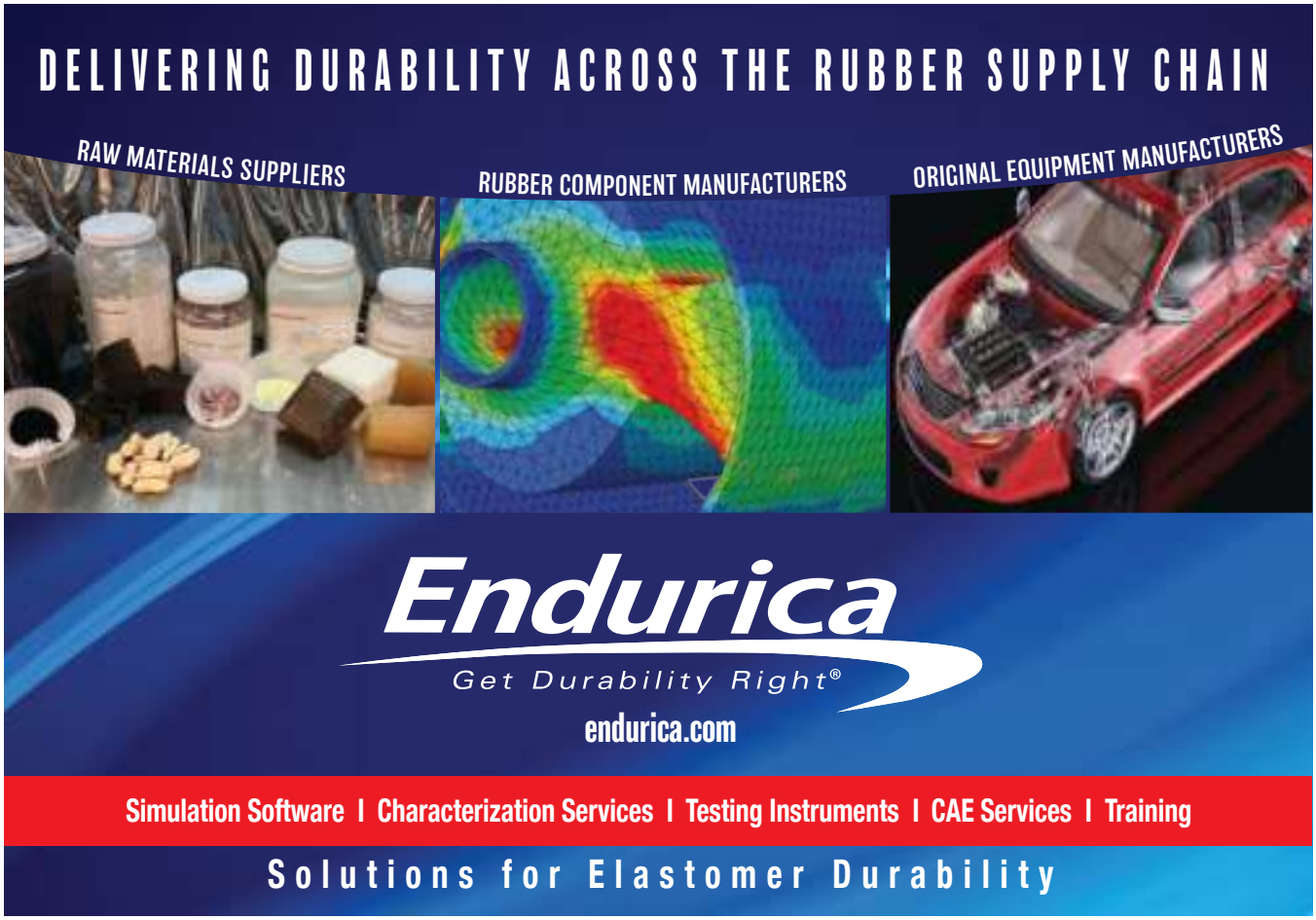
senior research professor at the Technical University of Dresden in Germany until April 2017. He is a prolific academician and has authored more than 850 scientific articles, several patents and book chapters, and founded the research field "rubberiomics" as a concept for holistic research approaches to elastomers.

Rubber Group News

The **Chemical Institute of Canada, Rubber Chemistry and Technology Division**, will hold a virtual rubber seminar December 5. Further information is available at www.cheminst.ca/cic-virtual/seminar-series/rubber-virtual-seminar/.

The **Mexico Rubber Group** will hold the Design, Development and Production of Rubber Compounds course, instructed by Luis Mayorga, November 28 at the Rubber Chamber Auditorium in Mexico City, Mexico. Further information is available at www.rubber.org/mexico-rubber-group.

The **MidAtlantic Rubber and Plastics Group** will hold its fall technical meeting November 20 at The Inn at Villanova University in Wayne, PA. Several speakers are scheduled for the event, along with time to network. Further information is available at www.marpg.org.



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Meetings

Dr. Sunny Jacob was selected for the 2025 Melvin Mooney Distinguished Technology Award, sponsored by Lion Elastomers. This award perpetuates the memory of Melvin Mooney, the developer of the Mooney viscometer and other testing equipment, and honors individuals who have exhibited exceptional technical competency by making significant and repeated contributions to rubber science and technology. Jacob joined ExxonMobil Chemical in 1998 after graduating with a Ph.D. from the Department of Polymer Science and Engineering at the University of Akron. He is a technical advisor for Proxxima polyolefin thermosets, and designed and managed programs for TPV products, Vistamaxx, Exact, Vistalon and butyl elastomers. He is the author of more than 25 publications and has more than 200 patents.

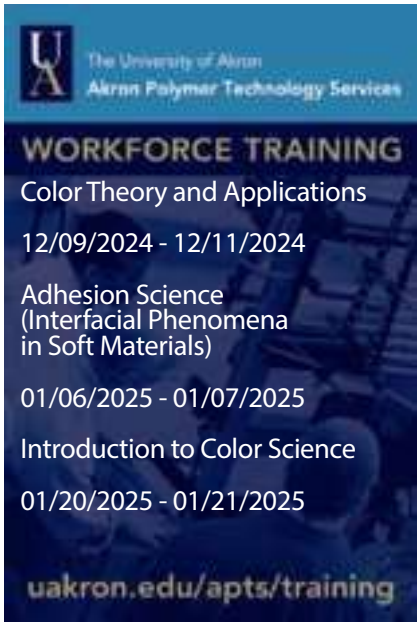
Dr. Robert Weiss was named the winner of the 2025 George Stafford Whitby Award for Distinguished Teaching and Research, sponsored by Cabot. This award honors teachers and academic scientists for distinguished, innovative and inspirational teaching and research in chemistry and polymer science. The award perpetuates the memory of George S. Whitby, head of the rubber laboratory at the University of Akron, and for years the only one who taught rubber chemistry in the USA. It honors outstanding international teachers of chemistry and polymer science. Weiss retired in 2016 from the University of Akron as the Hezzleton E. Simmons Professor of Polymer Engineering and associate dean for research in the College of Polymer Science and Polymer Engineering.

Dr. Titash Mondal was chosen for the 2025 Sparks-Thomas Award, sponsored by Endurica, LLC. This award perpetuates the memory of William J. Sparks and Robert M. Thomas, chemists who developed butyl rubber. It recognizes and encourages outstanding scientific contributions and innovations in the field of elastomers by younger scientists, technologists and engineers. Mondal is an assistant professor at the Indian Institute of Technology Kharagpur, and holds degrees in chemistry from the University of Calcutta and rubber technology from IIT Kharagpur. He has specialized in carbon nanomaterials (graphene) and elastomers, and silicone rubber composite applications in autonomous and electric vehicles, as well as elastomer composite based flexible/wearable sensors and triboelectric nanogenerators.

Dr. Takeji Hashimoto was selected for the 2025 Chemistry of Thermoplastic Elastomers Award, sponsored by Renkert Oil, LLC. This award recognizes the contributions of scientists in the field of thermoplastic elastomers. Particular emphasis is placed on innovations that have yielded significant new commercial or patentable materials. Hashimoto is broadly recognized as a leading researcher in the field of block copolymers. His research has provided the scientific foundation for a wide range of rubber and thermoplastic elastomer products, including styrenic and acrylic block copolymers, PSAs, TPVs and urethane elastomers.

Dr. Ed Terrill is the winner of the 2025 Fernley H. Banbury Award, sponsored by HF Group. It perpetuates the memory of the inventor and developer of the internal mixer that bears his name, and honors innovations in production equipment, instrumentation, control systems or improved processing technologies widely used in the manufacture of rubber or rubber-like articles. Terrill□s accomplishments are in the development of instrumentation, including modulus profiling, oxidation models, oxygen consumption, angle abraders, coefficient of friction, fatigue, DMA techniques and crosslink measurement.

Further information is available from the Rubber Division at www.rubber.org.



Rubber Division, ACS Overview

Upcoming Events

Education & Training

Rubber Chemistry & Technology Journal

Membership

Student Resources

Stay Informed

Rubber Division

American Chemical Society

Educating, connecting and growing the evolving elastomer community. **Visit rubber.org** to learn all about Rubber Division, ACS (American Chemical Society) and how we can be a valuable resource for you.

Check us out on social:

Calendar

Rubber Division
American Chemical Society

Future Meetings/ Expos

2025

Orlando — **March 4-6**
Cleveland — **September 8-11**

2026

Louisville — **Sept. 28 - Oct. 1**

www.rubber.org

Smithers, Thermoplastic Elastomers and Silicone Elastomers World Summits, Vienna, Austria, www.smithers.com - November 19-20.
Rubber Division, ACS, Endurica Workshop: Application of Rubber Fatigue Analysis with Endurica Software (online), www.rubber.org - November 19-22.
MidAtlantic Rubber and Plastics Group, fall technical meeting, The Inn at Villanova University, Wayne, PA, www.margp.org - November 20.
Messe Dusseldorf Asia, 35th International Plastics & Rubber Indonesia, JIEXPO, Kemayoran, Indonesia, www.plasticsandrubberindonesia.com - November 20-23.
University of Akron, Akron Polymer Training Services, Essentials of Rubber Science and Technology online course, www.uakron.edu/apts/ - November 26 - December 16.
Mexico Rubber Group, Course: Design, Development and Production of Rubber Compounds, Rubber Chamber Auditorium, Mexico City, Mexico, www.rubber.org/mexico-rubber-group - November 28.

December

University of Akron, Akron Polymer Training Services, Polymers in Packaging online course, www.uakron.edu/apts/ - December 2-3.
Leistritz Extrusion, Twin Screw Workshop, Branchburg, NJ, www.extruders.leistritz.com - December 4-5.
University of Akron, Akron Polymer Training Services, Applications of FTIR and NMR Spectroscopy in Polymer Product Development (Problem Solving, Development, IP Creation) online course, www.uakron.edu/apts/ - December 4-5.
Chemical Institute of Canada, Rubber Chemistry and Technology Division, virtual rubber seminar, www.cheminst.ca/cic-virtual/seminar-series/rubber-virtual-seminar/ - December 5.
Mexico Rubber Group, end of the year luncheon, Concamin Ballroom, Mexico City, Mexico, www.rubber.org/mexico-rubber-group; or Jose Gazano (antogua@prodigy.net.mx) - December 6.
University of Akron, Akron Polymer Training Services, Color Theory and Applications online course, www.uakron.edu/apts/ - December 9-11.
Rubber Division, ACS, Gear Pump Technology in Rubber Application webinar, www.rubber.org - December 10.
Leistritz Extrusion, Twin Screw Workshop, Branchburg, NJ, www.extruders.leistritz.com - December 11-12.

January

University of Akron, Akron Polymer Training Services, Adhesion Science (Interfacial Phenomena in Soft Materials) online course, www.uakron.edu/apts/ - January 6-7.
Al Fajer Information and Services, ArabPlast 17th International Trade Show for Plastics, Recycling, Petrochemicals, Packaging and Rubber Industry, Dubai World Trade Center, United Arab Emirates, www.arabplast.info - January 7-9.
University of Akron, Akron Polymer Training Services, Color Theory and Applications online course, www.uakron.edu/apts/ - January 13-15.
Rubber Division, ACS, Utilizing Lab Equipment for Efficient Development and Problem Solving webinar, www.rubber.org - January 14.
Rubber Division, ACS, Managing Scientists and Engineers webinar, www.rubber.org - January 16.
University of Akron, Akron Polymer Training Services, Introduction to Color Science course, APTS, Akron, OH, www.uakron.edu/apts/ - January 20-21.
Rubber Division, ACS, Essentials of Rubber Technology online course, www.rubber.org - January 21.
Rubber Division, ACS, Essentials of Silicone Rubber online course, www.rubber.org - January 22.
Rubber Division, ACS, Basics of Polymer Testing and Processing webinar, www.rubber.org - January 28.
M.R. Toub, Silicone Elastomers Technology and Fabrication course, Kellogg West Conference Center, Pomona, CA, www.mrtoubtraining.com - January 28-31.

February

Rubber Division, ACS, Sponge Rubber 101 online course, www.rubber.org - February 4.
Rubber Division, ACS, Carbon Black Manufacturing, Properties and Applications in Rubber Compounds online course, www.rubber.org - February 6.
University of Akron, Akron Polymer Training Services, Polymers in Packaging online course, www.uakron.edu/apts/ - February 6-7.
University of Akron, Akron Polymer Training Services, RPA Testing of Rubber Processability and Dynamic Properties online course, www.uakron.edu/apts/ - February 10-11.
Rubber Division, ACS, Optimizing Rubber Molding Process Through Advanced Simulations webinar, www.rubber.org - February 11.
University of Akron, Akron Polymer Training Services, Polymer Compounding, Formulating and Testing of Plastics, Rubber, Adhesives and Coatings online course, www.uakron.edu/apts/ - February 12-14.
Rubber Division, ACS, Understanding Your Data online course, www.rubber.org - February 13.
University of Akron, Akron Polymer Training Services, Structure/Property Relationships in Polyurethanes online course, www.uakron.edu/apts/ - February 13-14.
University of Akron, Akron Polymer Training Services, Rubber Technician Training course, APTS, Akron, OH, www.uakron.edu/apts/ - February 17-19.
University of Akron, Akron Polymer Training Services, Introduction to Color Science online course, www.uakron.edu/apts/ - February 18-19.
Rubber Division, ACS, Global Regulatory Compliance in the Rubber Industry online course, www.rubber.org - February 19.
University of Akron, Akron Polymer Training Services, Rubber Molding Processes: Principles, Troubleshooting and Mold Design online course, www.uakron.edu/apts/ - February 19-21.
Rubber Division, ACS, Dynamic Viscoelastic Properties online course, www.rubber.org - February 20.
Rubber Division, ACS, Elastomers for Selective Gas Separation, including Carbon Capture webinar, www.rubber.org - February 25.

March

University of Akron, Akron Polymer Training Services, Sponge Rubber 101 online course, www.uakron.edu/apts/ - March 7.
TechnoBiz, GRTE 6th Global Rubber Latex & Tire Expo, Bangkok International Trade & Exhibition Center, Bangkok, Thailand, www.grte-expo.com - March 12-14.
University of Akron, Akron Polymer Training Services, Rubber Compounding for Performance online course, www.uakron.edu/apts/ - March 13-14.

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Heat sensitive, high molecular weight, high boiling point or viscous materials are readily and gently separated in the company's Wiped-Film Still systems. Laboratory, pilot plant and production scale units are offered, all utilizing the same design, simplifying process coordination between scales, according to the firm. Single or multiple stage systems in various configurations are optimized for molecular distillation, evaporation, concentration, plus hybrid column fractionation. Key features include high vacuum capability, short (seconds) residence time and optimized thin film mixing, transport and thickness control, said to result in the highest quality and yield of product and minimized degradation.

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For optimal purification of polymers, wiped-film molecular distillation is said to play an important role as a final or near final process step. In the manufacturing of polymers, reactions are run where monomer building blocks in a solvent base are joined together to create polymer chains of desired lengths. In many of these reactions, an excess of monomer is maintained to keep the polymerization process going in a controlled, predictable manner. After these reactions, the polymer product will contain shorter chains, monomers, solvent and other lower boiling point contaminants which must all be removed. In some applications, such as biopolymer implants and injections into patients, it is absolutely critical that not only solvents be removed, but monomers and short chains as well. (*Pope Scientific*)

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www.sunchemical.com

Rubber tree rain guard

This rubber tree rain guard seal assembly is said to improve the efficiency and service life of a rubber tree rain guard seal. The performance of existing rubber tree rain guard seals depends on a fixed mechanical and/or chemical attachment of the seal to the tree. These methods of attachment prevent the seal from expanding with the circumferential growth of the tree resulting in premature seal failure and damage to the tree within a year of operation. In this invention, the seal is comprised of five components that are not fixed to the tree, allowing the seal to expand along with tree growth. An adjustable outer seal connector regulates the pressure required to establish consistent sealing contact against the tree, thus providing extended service life of the seal assembly. The seal assembly comes apart for easy maintenance. (*Dynamic Tapping Shield LLC*)

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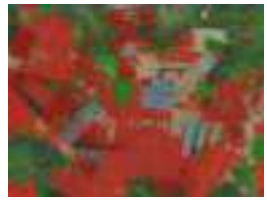
Natural rubber solution

In the past, the company's primary focus was on production of the conventional limestone polychloroprene material, which possessed the universal presence of a particular harmful ingredient. Yulex natural rubber has since presented alternative production methods as a less detrimental substitute for polychloroprene, showcasing the company's commitment towards less harmful practices. The firm recognized the need to produce Yulex wetsuit alternatives that are harmless for its clientele. The company can now produce its own G5 series natural rubber sheet (85% natural rubber from rubber trees/15% synthetic rubber by polymer content) which has the equivalent flexibility and durability as the limestone polychloroprene, but is a more sustainable material, and without compromising output or increasing costs. The company also specializes in producing the water based glue that is utilized when lamining the fabric with the natural rubber sheets. Compared with the traditional oil based glue, the product is said to be toluene-free, non-toxic and odorless, illustrating the company's care for the health of its customers who enjoy water sports. (*Dongguan Jinye Sports Apparatus*)

www.jinyesport.com

Geospatial monitoring

This provider of GeoAI solutions has launched an all-in-one product for plot monitoring, reporting and verification to enable companies involved in the supply chain of soft commodities and forestry, including natural rubber production, to meet compliance and sustainability goals. Picterra Tracer is designed to simplify and enhance the process of creating, validating, analyzing and monitoring land plots and boundaries. By utilizing satellite, drone and aerial imagery, along with global and regional open source layers and a visually intuitive geographic interface, Picterra Tracer is said to enable precise and reliable plot analysis. Developed with flexibility and efficiency in mind, it enables producers, operators and traders involved in the supply chain of soft commodities and forestry to comply with critical environmental regulations and sustainability reporting, such as the European Union Deforestation Regulation (EUDR), according to the company. (*Picterra*)



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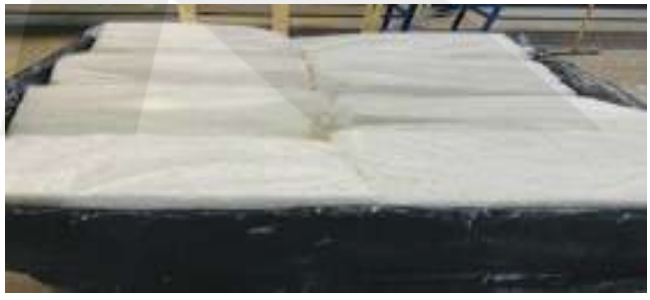

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Infrared preheat systems

SRG infrared modular clamshell preheat systems are designed for customers to preheat a wide range of extruded rubber and silicone flat and profile products processed horizontally. The system features a ceran glass face, uniform temperature, electric infrared heaters with excellent product coverage and complete controls with manual or pneumatic open and close mechanism, and with and without weighted open assist, according to the company. The system can be used as a standalone or in line with a complete horizontal conveyorized cure oven system, or in conjunction with extrusion equipment and/or incoming and outgoing conveyors. The company designs and manufactures gas and electric infrared heater/control packages, and infrared, hot air/convection and combination ovens. Small to medium sized conveyorized ovens are available, as well as turnkey systems for automated or batch processes. (*David Weisman, LLC*)

www.daveweisman.com

Extruders, dies, cutters

Custom extruders, dies, cutters and related components are manufactured by the company. The firm's tabletop extruders are said to be ideal for testing small and large batches. Standard 1" and 2" models are available. Customized features and options for dies, feeders and cutters are built to customer specifications. Available in 2", 4" or 6" base models, the company's twin feed extruders are built to handle products such as petrochemical catalysts, DeNOx catalysts, carbon, rubber (EPDM and recyclable), silicone, clay and ceramics. Cutters manufactured by the firm are said to be ergonomically designed, hygienic and easily fitted for maximum uptime. From rotary to fly knife cutters, a robust lineup and customization options ensure the optimal cutter is assembled, according to the manufacturer. From forming to sheet and flow control dies, the company's smart, modular designs are said to provide rapid fitting and removal. All dies are designed and manufactured in-house. Services provided by the company include laboratory testing and proof of concept, machine refurbishments, equipment design and remanufacturing (extruders, screws, barrels, and more) and consultations. (*Diamond America*)

www.daextrusion.com

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Brittleness point tester

The QualiBrittle BPT-NDAH brittleness point temperature tester is said to provide highly accurate and reliable testing of rubber and elastomer materials, ensuring their durability in extreme environmental conditions, including low temperatures. As industries increasingly rely on high performance materials that can withstand a wide range of environmental stressors, ensuring the quality and durability of these materials has become essential, according to the company. The QualiBrittle BPT-NDAH is said to address this demand by accurately determining the temperature at which materials become brittle, helping manufacturers improve product performance and extend material life in critical applications. Materials used in industries such as automotive, aerospace and consumer goods must endure extreme conditions, from sub-zero temperatures to constant mechanical stress. Rubber and elastomer components, in particular, are prone to cracking or failure when exposed to cold temperatures. The QualiBrittle BPT-NDAH is said to offer precise measurement of the brittleness point, compliant with international standards such as ASTM D74, ASTM D2137, ISO 812, ISO 974, JIS K 6261 and BS 903 A25. (*Qualitest North America*)

www.worldoftest.com

Hardness testing system

The company's hardness tester features interchangeable units, a laser centering device, a rotating sample holder and software. The instrument performs automatic serial measurement of o-rings, technical articles and standard samples. The instrument automatically performs multi-point hardness testing on each sample placed across the test line of the sample holder. The position of the sample is automatically detected by the laser system, and operators can set the number of tests to be performed on each sample. The instrument automatically detects the ideal position for measuring micro-IRHD (or micro-Shore) hardness of small parts. The instrument can also scan the parts to be tested to set the test procedure for non-symmetrical parts. The software hardness check permits users to prepare the sequence of parts to be measured; automatically use the test setups for each product; compare the results with the tolerance limits; save all test results in the SQL database; and produce multi-language test reports. (*Gibitre Instruments*)

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EXR199 – 3 1/2" Davis Standard Rubber Extruder, 15: 1 L/D, Thermatic II
EXR190 – 75mm Davis Standard Rubber Extruder Model 75mm 25H

MIXERS:
PLA668 – Farrel Banbury Mixer, #11D, 1000 HP DC Drive
PLA628 – Farrel Banbury Mixer, #9 w/Ram, Hydraulics and Heat Exchanger
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ChemPacific offers a number of Eco-Friendly Latex Rubber Emulsion products for a variety of industrial manufacturing applications. Currently, these products are widely used in the production of latex gloves. These emulsions provide improvements to process & performance of finished products such as enhanced barrier properties, improved fabric strength, increased handling features, and elasticity & viscosity of many anionic emulsions.

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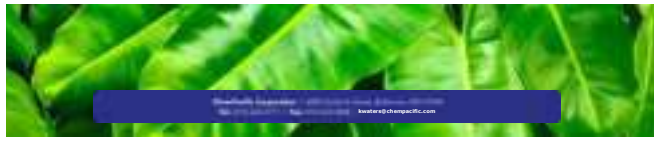

Predispersed additives

A global supplier of predispersed chemicals and additives, has revised its product brochure for the rubber and thermoplastic industries. Highlights include a section about the company's Premix specialties and new pages about its Veaflame flame suppressors, and films and bags for chemical predosing. Premix Specialties are predispersed specialty chemicals. The brochure compares Premix to Premix/S, which is based on a special elastomeric matrix that provides lower viscosity and hardness. Premix products are divided into accelerators, sulfur and sulfur donors, retarders, inorganic metal salts, antioxidants and other products. Premix N products are predispersed chemicals with a nitrile rubber polymeric matrix. Premix FA products are predispersed chemicals with a food approved polymeric matrix according to FDA 177.2600. In addition to standard products, the company can produce custom predispersed materials in response to customer demand. For example, the firm can produce Premix products with different active part concentrations. The company's research and development team is said to work closely with its technical department, and there may be new products in stock that are not included in the brochure. Veaflame is a new class of highly active flame suppressors for polymeric composites. Standard grades include Veaflame 13 for solid and sponge rubber, and Veaflame 20 for when a delayed ignition is required. Both products are said to boost existing flame retardant systems. The updated brochure contains a section for Veafilm and Veabag products. These low melting point plastic films and bags are designed for predosing operations in rubber and plastics mixing operations. (*R.D. Abbott/Rubber Dispersion Chemical*)

www.rdabbott.com

Sustainable colorants

This provider of specialized and sustainable materials solutions and services offers OnColor REC polymer colorants, formulated with pigments derived from recycled content, including end-of-life tires. They are said to offer an alternative to traditional carbon black formulations and can help manufacturers reduce their product carbon footprint (PCF). OnColor REC polymer colorants can perform comparably to traditional carbon black in plastics. They are versatile, can be used in multiple resins, and are available in standard and custom color formulations. Additionally, they are said to meet strict regulatory requirements, passing Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) and Restriction of Hazardous Substances (RoHS) standards and certification by TÜV Rheinland. Proposition 65 letters are also available. OnColor REC polymer colorants are available in the United States and Canada for use in a wide range of industries and applications, including automotive, wire and cable, building and construction, appliances, electrical and electronics, industrial molding applications, textiles and fabrics, and office furniture. A PCF calculation for using them is available from the company upon request. (*Avient*)

www.avient.com

Phosphazene polymers

PNF (polyfluoroalkoxyphosphazene) performance polymers are said to have a wide temperature range and have no extractable plasticizers. PNF meets service requirements for dynamic and static applications between -85°F and 350°F, and will withstand 400°F+ temperatures, according to the company. The exceptional low temperature flexibility of PNF is said to be inherent in the polymer, and this avoids the problems associated with plasticized low temperature rubbers, according to the firm. Most low temperature elastomers are said to require plasticizers, which can leach out in service fluids or vaporize during high temperature cycles to degrade performance. PNF is said to have demonstrated exceptional resistance to most fluids encountered in industries such as oil and gas exploration, transportation and processing; construction equipment; aerospace; and automotive. This includes fluids such as unleaded and high peroxide content gasoline, Arctic diesel fuel, conventional and synthetic jet fuels, and diester synthetic and E.P. gear lubricants which are not compatible with many conventional elastomers, according to the company. PNF is also said to solve problems caused by conversions to fire resistant fluids. (*PNeuzene Polymers*)

www.pneuzene.com

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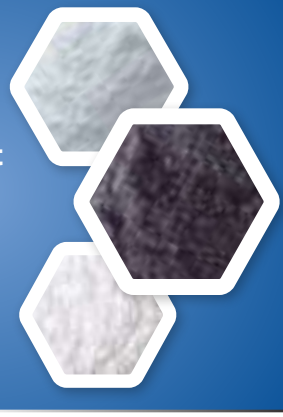

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Çinar Kauçuk Madeni Yağ Kimya ve Ticaret Limited Şirketi (www.cinarkaucuk.com), with a manufacturing plant in Denizli, Turkey, meets the raw material needs of manufacturers in the rubber industry with the highest quality at the most affordable price. Cinar Kaucuk is an indispensable partner of companies that manufacture products from different types of rubber. Cinar Kaucuk focuses on recycling synthetic rubber. The company's chemist team matches its materials to customer needs.

Cinar Kaucuk recycles 98% of the material that it receives from scrap synthetic rubber plants, including cartons, plastic, wood, paper, etc. The company recycles synthetic rubber in its plants. The rest of the material is outsourced to recycling companies to ensure that 98% of the material is recycled.

Reprocessed synthetic rubber available from Cinar Kaucuk includes SBR 1502, 1500, 1723 and 1712; S-SBR dry (non-oil); S-SBR 1205 grade; S-SBR oil extended; high cis BR; low cis BR; and EPDM. Off-grade synthetic rubber available from Cinar Kaucuk includes SBR 1502, 1500, 1723 and 1712; S-SBR dry (non-oil); S-SBR oil extended; and high cis BR.

Off-spec and/or surplus NR-SBR rubber compounds come from the largest tire manufacturing companies. Cinar Kaucuk offers three different grades, depending on the vulcanization level and quality of the compound. NR cleanout is the output material of the internal mixer cleaning operation, and the majority of this material is natural rubber. Masterbatch rubber compound from tire plants and custom rubber mixing plants does not contain cure pack and accelerator. SBR, NR and EPDM masterbatch rubber compounds are offered. Off-spec and/or surplus EPDM rubber compounds from automotive OEM and custom rubber mixing plants are offered. All EPDM compounds have the same specification since it comes from one manufacturer.

Near prime, off-spec, PCU and reprocessed synthetic rubber is also provided by Cinar Kaucuk. Rubber accelerators and rubber grade prime silica are also supplied.

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Valex (www.valexgroup.com) is a leading distributor of raw materials for the rubber industry. Valex is dedicated to providing high quality natural rubber and latex products to customers worldwide. With a focus on innovation and sustainability, Valex strives to exceed its customers' expectations and deliver exceptional value.

The Valex team of experienced professionals is committed to delivering outstanding customer service and support. Valex works closely with its customers to understand their unique needs and provide customized solutions that meet their specific requirements. Valex's extensive industry knowledge and expertise enable it to deliver the highest quality products and services, helping customers to optimize their operations and achieve greater success.

Valex is passionate about its products, customers and the environment. The company is committed to sustainability and ethical business practices, and works tirelessly to minimize its environmental impact and promote social responsibility. Valex's dedication to excellence, innovation and sustainability sets it apart and makes it the partner of choice for customers around the world.

Featured products available from Valex include low ammonia solutions, nitrile latex NBR, nitrile latex XNBR 525, nitrile latex XNBR 571, Pirosil PS 200, prevulcanized natural latex, Rubbersil RS 200, skim, and styrene butadiene latex SBR 380.

Markets served by Valex include adhesives, automotive/transportation, building construction, consumer goods, food additives, gloves, healthcare, industrial, personal care, rubber and tires.

Valex product groups include carbon black pyrolytic, natural latex, natural rubber, nitrile latex and precipitated silica.

Deproteinized natural rubber (DPNR) from Valex possesses excellent mechanical properties, is impermeable to liquids and gases, offers ease in forming films, and possesses a nonallergic nature to humans, even after direct contact during testing compared to other rubbers.

Wacker (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 to 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 silicone-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 resistance 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.

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People in the News

Hexpol announces leadership change

Hexpol Compounding Americas (HCA), under the direction of President and Chief Executive Officer **Gary Moore**, announced a change to its commercial team leadership. **Matt Angell** was named commercial director for the industrial market segment. He will report directly to **Bruce Wynd**, chief commercial officer of HCA.

Matt Angell
Hexpol

Ken Hsu
Sumitomo Rubber

A. Vedanayagam
Continental Tire

Natalia Scherbakoff
Orion S.A.

Management

Teresa J. Rasmussen was named chair of the H.B. Fuller board of directors following the retirement of **Lee R. Mitau**.

Pekka Natri was appointed to head the North America region for Cimcorp, a provider of logistics automation. Cimcorp named **Anne Happonen** as the company's vice president of operations.

Sales

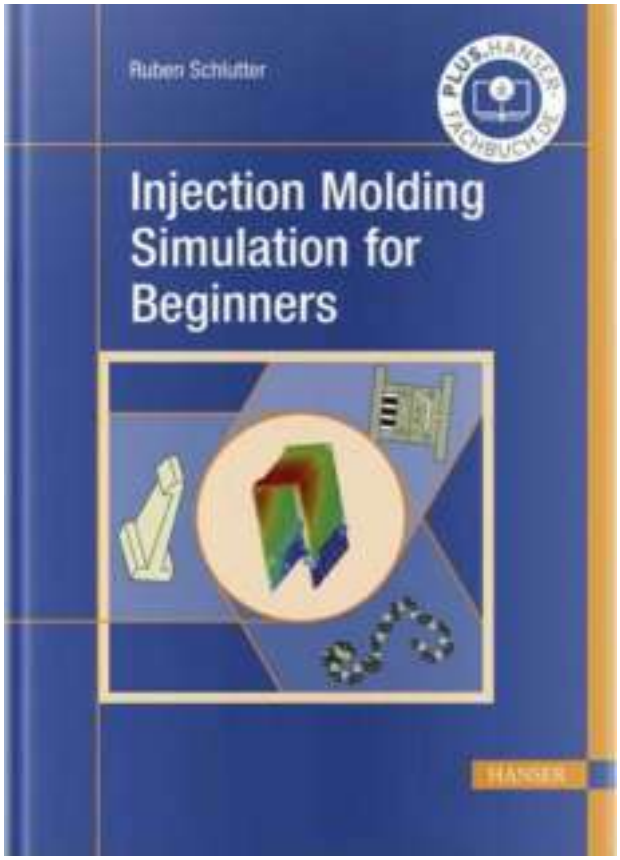
Ken Hsu was named marketing vice president for Sumitomo Rubber North America.

Ashok Vedanayagam was appointed head of marketing for passenger and truck tires for Continental Tire the Americas.

Technical

Natalia Scherbakoff was appointed chief technology officer for Orion S.A., a global specialty chemicals manufacturer.

Alan Franc has joined the technical consulting team at Smithers.



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