100 years of synthetic rubber

This year synthetic rubber celebrates its 100th birthday. Patent No. 250690 for the first “process for manufacturing artificial rubber” was granted on September 12, 1909. The inventor Fritz Hofmann was at that time employed at Elberfelder Farbenfabriken Friedr. Bayer & Co., a company whose legacy is continued today by LANXESS.

This innovation was much hmore inportant than is generally known. Rubber products make our life more and more comfortable through their use in vehicles and packaging, in medicine and domestic appliances, in sports and for the modification of plastics. Until Hofmann’s discovery, industry was forced to rely on plantation rubber. But the natural resource is limited and not appropriate for every application. Such a broad and varied use, as it is practised nowadays, would have not been possible without the pioneer work of Fritz Hofmann.

For Hofmann’s successors the synthetic rubber inventor’s reputation has always been both an incentive and a benchmark that the rubber chemists strive to live up to. From the outset, they have been heavily involved in the further development of the material. LANXESS rubber innovations continue to ensure that rubber remains successful in challenging technical applications amid ever greater demands on elastic materials.

Good to know

Rubber has become an indispensable part of the modern world. Wherever machines or engines have to be provided with bearings, forces transferred, liquids transported, rotating shafts or containers sealed, there’s no getting around this material. However, today’s high-performance elastomers have little in common with the materials obtained from natural rubber.

The technology and the requirements that rubber has to satisfy have been revolutionized since the early days when the first coats, boots, inkpots and even combs were made on a basis of natural rubber. Higher application temperatures, faster machines and ever more stringent demands on energy efficiency and cost-effectiveness are compelling engineers to opt increasingly for special grades.

In 2007, some 13.6 million metric tons of synthetic rubber were used worldwide, compared to around “only” 9.7 million metric tons of natural rubber. Experts expect that the share of synthetic rubbers will continue to grow faster than natural rubber as a result of its properties. Synthetic rubber is used today as the basis for a wide range of high-performance rubber products and it will continue to be used to unlock the potential of new opportunities and applications in the future.

Market volume

The diversity of rubber’s properties and varieties and its still far from exhausted application potential have ensured sustained growth in sales on international markets for many years. In particular, economically dynamic markets and countries in Asia such as China and India along with Russia, Eastern Europe and Latin America are developing into strong customers in the rubber industry and strong production locations.

Including rubbers for the tire industry, manufacturers produced 13,596,000 metric tons of synthetic rubbers across the world in 2007, according to estimates by the International Rubber Study Group; consumption amounted to 13,197,000 metric tons. The largest consumer was Asia/Oceania with 6,369,000 metric tons (production: 5,994,000 metric tons), followed by North America (consumption: 2,140,000 metric tons, production: 2,790,000 metric tons) and the EU (consumption: 2,711,000 metric tons, production: 2,774,000 metric tons).

Characterstics of Rubber

Material (Abbr.)	LANXESS Products	Properties	Applications
Chloroprene rubber (CR)	Baypren®	Temperature range: -45° to 110° C; good mechanical properties; good ozone, weathering, chemical and aging resistance; medium oil and fuel resistance; high fire retardance	Cable sheathings, hoses, seals, window and construction profiles, drive belts, diving suits
Polybutadiene (BR)	Taktene®, Buna™ CB	Temperature range: -80° to 90° C; excellent strength; outstanding abrasion resistance; crack resistance	Car tires, conveyor belts, crash protection pads
Ethylene-propylenediene rubber (EPDM)	Buna® EP	Temperature range: -50° to 150° C; very good aging resistance, including for UV and ozone; resistant to dilute acids and non-mineral-oil-based brake fluids; not resistant to mineral oil products	Body seals in automotive engineering, roof and pond sheeting, membranes, seals, construction profiles, hoses, floor tiles, belts, conveyor belts, roll covers
Ethylene-vinyl acetate rubber (EVM/EVA)	Levapren®/ Levamelt®, Baymod® L	Temperature range: -30° to 170° C; excellent heat resistance; good electrical properties	Hot product conveyor belts, flame-retardant, halogen-free cable insulating materials, films, technical products of all kinds, sports shoe midsoles
Hydrogenated nitrile rubber (HNBR)	Therban®	Temperature range: -40° to 150° C; excellent physical properties, very good abrasion resistance; high resistance to ozone and hot air; good resistance to chemically aggressive oils	Heavy-duty rubber products, e.g. for the oil industry and mechanical engineering such as seals, hoses, stators, belts for the automotive industry, cable insulation, special couplings
Butyl rubber (IIR)	Regular Butyl, Bromobutyl, and Chlorobutyl	Temperature range: -40° to 140° C; good resistance to acids, hot water, glycol, high gas impermeability; high buffering capacity; ozone-resistant; moderate mechanical properties	Inner plies for tubeless tires, bladders for tire manufacture, roof sheeting, tunnel insulation, hot water hoses, bearing elements with excellent shock absorption, inner tubes for tires
Nitrile-butadiene rubber, acrylonitrile-butadiene rubber (NBR)	Perbunan®/ Krynac®, Baymod® N:	Temperature range: -40° to 20° C; moderate ozone and weathering resistance; high resistance to oils, grease and hydrocarbons; favorable aging behavior; low abrasion	Seals, hoses for hydraulics and pneumatics; rubber gloves, elastic threads, blankets for print cylinders and rolls
Styrene-butadiene rubber (SBR)	Buna™ VSL, Krynol, Krylene®	Temperature range: 50° to 100° C; moderate abrasion resistance; good mechanical properties	Tread in car tires, technical rubber products (conveyor belts, seals, profiles); floorings; shoe soles and heels

Invention of a material

The fascinating history of synthetic rubber started with an idea patented 100 years ago – and is far from over yet. In 1909, the chemist Fritz Hofmann succeeded in producing the elastic substance methyl-isoprene, and thus paved the way for the development of synthetic rubber. Hofmann conducted his research at the laboratories of "Elberfelder Farbenfabriken vorm. Friedr. Bayer & Co." – a company whose tradition is continued today by the specialty chemicals group LANXESS.

Not a lot was known about rubber back then. For example, it was not until 1905 that it was discovered that the chain molecules of this elastic material comprised countless strings of isoprene molecules, but no one knew how to crosslink them. Nevertheless, Hofmann decided to give it a try. As it was difficult to produce the "natural rubber module" isoprene, Hofmann quickly decided to use methyl-isoprene, which had a very similar chemical structure and was easier to manufacture. He placed the material in tins, heated them, and waited – sometimes even for months. Depending on the temperature, the substance that formed in the tins was sometimes softer, sometimes harder, but it was always elastic. As it turned out, Hofmann had invented methyl rubber. The patent for the world's first synthetic rubber was awarded a hundred years ago on September 12, 1909.

Continental – a leading rubber company even then – started to produce the first car tires from this new material as early as 1910. Hofmann's boss Carl Duisberg traveled 4,000 km on the tires "without a puncture". Even the German Kaiser had his car fitted with the tires and was "extremely pleased" with the results.

Pioneer of synthetic rubber: Fritz Hofmann

Hofmann, who was born in Kölleda near Weimar on November 2, 1866, attended school in Klosterdonndorf and Schulpforta before taking up practical training as a pharmacist in an apothecary in Göttingen. After this, he studied pharmacy in Berlin and then chemistry in Rostock. There, he obtained a doctorate "magna cum laude" in philosophy.

Prior to joining Bayer in 1897, he taught for two years at the Technical University of Aachen. At the age of 85 Hofmann gave a talk to his old school about his life and work researching rubber. Here are a few short extracts from the lecture: "As the head of various research laboratories I was constantly on the lookout for promising areas of work for my staff. Here [in the manufacture of synthetic rubber] I saw the opportunity to create something that was lacking in my own country and, at the same time, would free it from having to import an expensive product from foreign countries that were naturally blessed with it… In response to my written proposals… the Farbenfabriken company in Elberfeld granted me the initial sum of one million marks to be paid in 10 annual installments of 100,000 marks each. Well, if only it had remained at that figure of one million. Instead, the insatiable needs of research swallowed up that amount several times over... So I dared it and could see the first results after two years. Already in the summer and autumn of 1909 we could file an application for the basic patent. The experts had to admit that Fritz Hofmann had really produced rubber."

Hofmann was to receive a number of awards and distinctions for his scientific work: among them the Fischer Medal in Gold from the Society of German Chemists, an Honorary Plaque from the German Rubber Society and the gilded Buna medal at the World Exhibition in Paris. He died in Hanover in 1956 at the age of 90. He lived to see much of the continuing rapid development made possible by his invention.

Hofmann's successors

Synthetic rubber became even more important as it was discovered how to form chain molecules from rubber modules, such as Hofmann's methyl-isoprene, more quickly and successfully than before. It was the addition of sodium that made this possible. In the 1920s, Hofmann's successors succeeded in using this metal and many process tricks to create another synthetic rubber from butadiene, a "simpler" chemical relation of the natural rubber module isoprene. This product went down in history as "Buna" – a term coined from its constituents butadiene and sodium (Na).

The next step was taken a short time later by the chemists Walter Bock and Eduard Tschunkur. Bock in particular was responsible for combining butadiene with another highly promising module – styrene. This gave rise to the "styrene rubber" Buna S, which – in a much evolved form – remains a key component in car tires today. The patent for the copolymerization of butadiene and styrene was awarded on June 21, 1929.

This period also saw the invention of a further rubber from Leverkusen that became popular – the nitrile rubber Buna N invented by the chemists Eduard Tschunkur, Helmut Kleiner and Erich Konrad. A patent for the new oil-repellent rubber was awarded on April 26, 1930. From 1938 this remarkable elastomer was marketed under the name Perbunan to distinguish it more clearly from Buna S.

Gradually, the chemical industry launched more and more rubbers onto the market that all exhibited new technical properties. Along with these came countless innovations in the field of rubber chemicals that are essential for manufacturing rubber, for example antioxidants (antidegradants) and vulcanization accelerators such as Vulkanox and Vulkacit. Chemists and technicians from LANXESS have played a key role in many of these developments.

Products & applications

LANXESS is one of the world's biggest producers of synthetic rubber. The company produces hundreds of different grades of synthetic rubber designed for a diverse range of applications, making it the manufacturer with the broadest product range. With 100 years of experience in synthetic elastomers the company is also regarded as a technology leader and a driving force in the industry.

The different grades of synthetic rubber are produced by the _Technical Rubber Products (TRP), _Butyl Rubber (BTR) und _Performance Butadiene Rubbers (PBR) business units. Additionally, the Latin-American company Petroflex that belongs to the LANXESS group since April 1st 2008 has its focus on synthetic rubber. Furthermore the Rubber Chemicals business unit produces chemicals for the rubber industry.

Many of the grades of synthetic rubber which are made by LANXESS are geared to particular areas of application and adapted to the specific needs of each customer. With these products and rubber chemicals, LANXESS achieves sales of more than EUR 500 million each year (basis 2008) and serves over 600 customers. Although the automotive industry is the largest consumer of rubber products from LANXESS, it accounts for somewhat less than half of LANXESS revenues.

Butyl Rubber, BTR

One of butyls major properties is it is impermeable to air. This characteristic is the basis for our activities. BU BTR manufactures its butyl rubber products, Regular Butyl, Bromobutyl, and Chlorobutyl. All of these have a remarkable range of properties including low air permeability, excellent absorption and other mechanical properties.

The main market is the tire industry, where Halobutyl (Bromobutyl and Chlorobutyl) is used for the innerliners of tires for cars, trucks, buses, coaches, and aircraft. Regular Butyl can be found in inner tubes for tires, bicycles and sports balls. Special applications are protective clothing, stoppers for the pharmaceutical industry, and the chewing gum market.

Locations: Zwijndrecht (Belgium), Sarnia (Canada), as of 2012 Singapore, too

Performance Butadiene Rubbers, PBR

Performance Butadiene Rubbers is a major manufacturer of solvent styrene butadiene rubber (SBR) and polybutadiene, an all-purpose caoutchouc. The bulk of approximately 70 percent of the production volume goes into tire materials and another 20 percent into modified plastics. The business unit offers polybutadiene products catalyzed with neodymium, cobalt and lithium.

The BU's customers work in a wide variety of industries, in particular tire and plastics manufacturing, but also in the sports industry. Typical applications include car tires, polystyrene for injection molding applications, golf balls and shoe soles.

Most important brands & products
PBR (polybutadiene rubber): Taktene®, Buna™ CB;
SSBR (solution styrene butadiene rubber): Buna™ VSL

Locations: Dormagen (Germany), Orange (USA) and Port Jérôme (France).

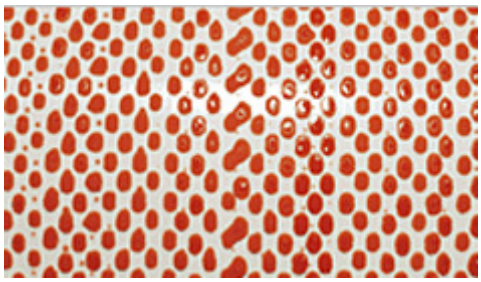
Petroflex

LANXESS acquired the majority share of the Brazlian company Petroflex in 2008. It now organizationally belongs to the Performance Butadiene Rubbers business unit. Petroflex is not only one of the leading manufacturers of synthetic rubber products in Latin America, but also one of the world's largest suppliers in this field. Its broad product portfolio ranges from basic rubber to specialties.

Locations: Duque de Caxias, Cabo de Santo Agostinho and Triunfo (all Brazil)

Rubber Chemicals, RUC

LANXESS is a global leader in the manufacturing and distribution of rubber chemicals. We offer high-quality products with excellent processing characteristics.



The customers include leading manufacturers of tires and rubber products for technical applications. The products are also used in the cosmetics and pharmaceutical industries, but also in mining.

Most important brands & products

Vulkanox® as an age-inhibitor, Vulkacit® as an accelerator, special Chemicals (e.g. Vulkanol ®, Vulkalent ®, Cohedur ®, Vulkasil ®, Renacit ®).

Locations: Leverkusen, Dormagen, Brunsbüttel, Krefeld-Uerdingen (Germany), Antwerp (Belgium), Bushy Park (USA), Thane (India), Isithebe (South Africa).

In addition, BU RUC operates sales offices and customer and technical services units at other overseas locations in Asia and South America.

Technical Rubber Products, TRP

Products from Technical Rubber Products are particularly versatile and in many cases very hardwearing. The TRP business unit is one of the main global suppliers of synthetic rubber for the rubber processing industry. The products are used to produce functional components for the automotive, gas/oil exploration and production and mechanical, construction and cable engineering industries. They are also used as modifiers for plastics and as raw materials for adhesives.

Many individual products of a portfolio comprising more than 200 items are customized for special applications. Building K10 at Leverkusen is the corporate headquarters and also houses the test center operated by BU TRP, making it an address well-known throughout the global rubber market.

Most important brands & products
Therban®: hydrogenated nitrile rubber (HNBR),
Levapren®/Levamelt®, Baymod® L: ethylene-vinyl acetate rubber (EVM),
Baypren®: polychloroprene solid rubber (CR),
Buna® EP: ethylene-propylene[-diene] rubber (EP[D]M)
Perbunan®/ Krynac®, Baymod® N: nitrile rubber (NBR),

Production Locations: Leverkusen, Dormagen, Marl (Germany), La Wantzenau (France), Orange (USA)

In addition, BU TRP operates technical customer support, research and application technology centers at other overseas locations in Asia, Europe and North America.