

Freudenberg Sealing Technologies GmbH & Co. KG
Höhnerweg 2–4
69469 Weinheim, Germany
Phone: + 49 6201 8066-66
automotive@fst.com

www.fst.com

August 2016



LOW EMISSION SEALING SOLUTIONS

LESS IS MORE. MORE RESPONSIBILITY.

FREUDENBERG
SEALING TECHNOLOGIES

 **FREUDENBERG**
INNOVATING TOGETHER

WHAT MOVES US— AND WHAT WE CAN MOVE



Sealing technology opens up enormous potential for making sustainable contributions to the mobility of today and tomorrow. In our **LESS Initiative** (Low Emission Sealing Solutions), we combine product innovations focused on **reducing friction, emissions, installation spaces, and weights**. Sealing solutions for engines, transmissions, and alternative powertrains benefit from our unique material expertise. This expertise allows us to provide our customers with comprehensive solutions to actively help to achieve development goals for all vehicle components that **influence energy consumption and emissions**.

“Downsizing” and intelligent engine management systems raise internal combustion engines to a new level of efficiency, but they also create new challenges in terms of low friction, heat and pressure resistance, and material compatibility. When striving to achieve emissions goals the smallest of improvements can make all the difference. With the LESS Initiative, we apply our material expertise to this idea, because a reduction in friction can have enormous potential. The gas-lubricated Levitex Seal can lower **CO₂ emissions** by up to one gram of CO₂ per kilometer.

Massive rethinking is required: If a compact passenger vehicle weighed less than 800 kilograms 30 years ago, increasing comfort and safety needs has caused this weight to climb to 1.200 kilograms. Standing at the top of the **measures for reducing emissions** is lightweight construction. With an O-Ring configurator or a simulation tool for calculating the necessary lubrication film, we enable designers to **optimize material usage** and avoid sacrificing a single gram or millimeter of any installation space.

As a family company with over 165 years of tradition, we feel compelled by the demands of sustainability and for decades this has been an essential part of our company values. Sustainability guides our actions and in recent years we have received a variety of prominent national and international awards in the area of **innovation in the fields of climate and environmental conservation**.

Acting responsibly means developing solutions in preparation for the **post-oil era today** and until then managing consumption of our natural reserves as efficiently as possible. We'll only achieve **sustainable growth** if we **concentrate on “less”**.

WE'LL ONLY ACHIEVE SUSTAINABLE GROWTH IF WE CONCENTRATE ON "LESS".



ENGINE	Friction reduction	Weight reduction	Downsizing	Emission reduction
PAGE: 04-11	LEVITEX® TURBOCHARGER SEAL POP® SEAL CASCO® BLUESEAL	SEALING MODULES (RWDS®, CSWS PLASTIC, CS PLASTIC) 2K PUMP HOUSING CURVE GASKET	SEALING SOLUTIONS FOR DIRECT INJECTION VALVE STEM SEAL WITH BACK-PRESSURE LIP	EXHAUST-GAS AFTER TREATMENT: (SCR) ALTERNATIVE FUELS FLUOROPRENE® MAGNET-ANCHOR SOLUTIONS
TRANSMISSIONS	Friction reduction	Weight reduction	Downsizing	Emission reduction
PAGE: 12-15	THRUST WASHER LOW FRICTION SIMMERRING® ESS®: ENERGY SAVING SEAL LEVITAS	TRANSMISSION COVER GASKET	ENCODER PISTON ACCUMULATOR	
E-MOBILITY	Friction reduction	Weight reduction	Downsizing	Emission reduction
PAGE: 18-23		2K HOUSING	PROFILE TO GASKET (P2G) PLUG & SEAL	POUCH CELL FRAME SEAL FUEL CELL GASKET SIMMERRING® WITH ELECTRICALLY CONDUCTIVE NONWOVEN GASKETS FOR BATTERIES

You will find the entire LESS product line with relevant product features as well as the additional segment "Vehicle Systems" in the detailed over-view at the end of the brochure.



Freudenberg Sealing Technologies supports the automotive industry in its quest for greater efficiency and lower emissions. You can find further product fliers, 3D visualizations, and extensive information about our product portfolio on our microsite: <http://less.fst.com>

**LESS® IS MORE.
MORE RESPONSIBILITY**



Climate change and the finite supply of natural resources challenge the automotive industry to further reduce emissions and fuel economy. Global decisions dictate the direction in which we develop our products. With innovative sealing solutions, LESS helps to minimize friction losses, implement downsizing concepts, advance electrical-drive designs, and enable compliance with future exhaust emission standards.





INTERNAL COMBUSTION ENGINE: PERMANENT OPTIMIZATION

It had to do the job practically alone until now: for more than a century, the internal combustion engine—gasoline or diesel—took care of most of our mobility needs. While it will still play the central role for a long time to come in cars and utility vehicles, it is now being accompanied with new transmission technologies. Our 165 years of materials expertise enables the introduction of new technologies and thus helps to realize the internal combustion engine's full efficiency potential. These innovations will allow it to do the job with the same perfection in the future as it does today.

Downsizing is the magic word for engine developers. Today, highly efficient, supercharged engines with fewer cylinders, smaller displacements, and more intelligent management systems are replacing those of traditional large-volume engines. They have ultimately rendered absurd the saying that there's no replacement for displacement—except even more displacement. However, downsizing and lightweight construction technologies also create new

challenges. Although variable valve trains, integrated turbochargers, or minimized installation space can increase efficiency, they also change the requirement of the task and we are well equipped to handle these changes.

Weight savings is increasingly becoming the focus for engine developers. By substituting plastic for metal a weight savings of up to 50 percent can be achieved. Plastic components also offer greater potential for the integration of additional functions or assemblies and allow engineers considerably more design freedom than traditional metal components. We utilize two- or multi-component injection molding with products made of thermoplastics to take maximum advantage of this weight savings. Assembly or installation steps are integrated into the highly automated production process that offers the possibility of an automatic inspection of quality and function features on 100 percent of our components. Production and quality inspections are thus combined into a single process without cycle loss.

90 %

LESS FRICTION + LONGER SERVICE LIFE
LEVITEX®



LEVITEX®

The gas-lubricated **LEVITEX®** mechanical seal approaches the vision of a frictionless seal. The slide ring runs in conjunction with its counter ring on a cushion of air, thus creating 90 percent fewer friction losses than a conventional crankshaft seal. As a result, the CO₂ emissions in vehicle operation reduces by up to one gram of CO₂ per kilometer. Due to less wear, it creates a longer service life. LEVITEX also blazes a completely new trail in engine development due to its great pressure stability.

TURBOCHARGER SEAL

Following the same principle as the LEVITEX, our **turbocharger seal** works on the compression side of the turbocharger. It reduces oil losses, as well as the blow-by effect, even with negative pressure differences. No oil film forms on the intercooler due to the low leakage rates, which leads to considerably better heat dissipation. That in turn leads to a CO₂ reduction and therefore fewer emissions.



POP® SEAL

The **POP® Seal** (Power Optimized PTFE) demonstrates its robustness as a PTFE seal by adjustment of the material and the geometrical characteristics with minimal friction. Thus, at least 40 watts of energy can be saved at 6000 rpm when compared to the first-generation PTFE shaft seal.



CASCO®

The **CASCO®** cassette-type seal for utility vehicles goes a step farther. The axially fitted sealing lip on the output end of the crankshaft protects against more than just contamination and extreme environmental influences. When tested over 1,6 million kilometers, the seal can minimize friction by around 60 percent, thus reducing fuel consumption. The CASCO cassette-type seal's durability also contributes to a decrease in oil-carbon formation and an increased product life.



BLUESEAL

Downsizing engines is all about reducing weight and installation space. The **BlueSeal** is characterized by a 40 percent weight reduction compared to a conventional seal and needs only half as much axial installation space. Every millimeter saved with a Simmerring can lead to advantages for the weight of the entire engine block. The BlueSeal is extremely stable at high pressures and the PTFE material used in its friction-optimized sealing lip can withstand aggressive media, while friction losses are reduced by 30 percent.



30 %

LESS FRICTION
WITH THE BLUESEAL

up to

2/3

WEIGHT SAVINGS
WITH SEALING MODULES





SEALING MODULES (RWDS®, CSWS PLASTIC, CS PLASTIC)

Robust housing covers made of plastic for the crankshaft are integrated with static sealing with friction-reducing PTFE or POP® for dynamic sealing have many advantages. The functional integration of several assemblies in one reduces the weight up to two-thirds, saves space, and enables fully automatic installation. Freudenberg Sealing Technologies offers a series of innovative ideas for functional integration within light compact modules made of various supporting materials.



2K PUMP HOUSINGS

2K pump housings made of plastic for oil or water circuits, in addition to their weight advantage, offer the potential for optimally molded flow channels. This is a design that can only be achieved in metal housings through elaborate machine operations. The seal is created through an injection-molding machine that also saves installation processes and provides additional reliability.



CURVE GASKET

With greater stability, lower reaction forces, and broader compression areas, the **Curve Gasket** helps to reduce the amount of shape-stabilizing plastic required in engine covers. To do so, the seal has a combination of straight and wave-shaped cross-sections, which reduce the load. The Curve Gasket offers greater stability in smaller grooves, which is ideal for the thermoplastic covers of many new engine designs and thus makes an important contribution to the reduction of components.



SEALING SOLUTIONS FOR DIRECT INJECTION

Direct injection systems for gasoline or diesel engines are particularly efficient due to the use of modern, high-pressure injection nozzles and pumps. The **Duo-Forseal** makes more than just an indirect contribution to reducing emissions and greenhouse gases by securely sealing pumps under high loads. With diminished leakage rates due to patented FST technology, it also contributes directly to emissions reduction. Exceptional chemical resistance makes it the perfect choice for use with alternative fuels. Injector seals for sealing the injection nozzles to the combustion chamber and the compact Rail Seal complete the product range for direct-injection engines.



VALVE STEM SEAL WITH BACK-PRESSURE LIP

The **valve stem seal with back-pressure lip** enables low, long-term emissions values and the highest functional reliability for turbocharged engines with particle filters. Turbocharged engines build up great exhaust back-pressure, which can lead to lifting of the valve stem seal. Exhaust gases (blow-by) can thus negatively affect lubrication in the valve-stem guides causing leaks with the effect of elevating oil consumption, increasing emissions values, and particle-filter compromise. The new generation of valve stem seal with back-pressure lip has a unique secondary lip and an additional counterpressure lip, which reliably prevents a seal failure up into a differential pressure range far exceeding 6 bar.

EXHAUST-GAS AFTER TREATMENT: FOR ALL REQUIREMENTS (SCR)

Ever stricter emission standards can't be met with just engine-related measures, exhaust-gas after treatment also remaining a main topic. With **selective catalytic reduction (SCR)**, trucks meet the Euro-5 standard and passenger vehicles Euro-6. The injection of **AdBlue®** diminishes critical nitrogen oxides in the exhaust-gas. However, when the liquid urea solution can't be sealed with conventional materials. It's no problem for our material specialists.

ALTERNATIVE FUELS

Alternative fuels require different answers in the development of suitable elastomer mixtures. They differ from conventional fuels in their aggressiveness relative to elastomers as well as a high water and acid content in the blow-by gas. Special compounds with large fluorine fractions are ideally suited for these requirements. With a temperature range of -40°C to 140°C as well as their strong ability to bind to the supporting material, they are a perfect solution for alternative fuels.

FluoroXprene®

Emissions don't originate in the exhaust alone. Gasoline permeation out of fuel hoses is a frequently underestimated topic. With **FluoroXprene®**, we have a fluorinated thermoplastic elastomer that is used for the fuel hose's middle shell and is characterized by more than just flexibility and flexural strength. It also effectively prevents gasoline fumes from escaping into the atmosphere.



MAGNET-ANCHOR SOLUTIONS

Tank ventilation systems offer many application possibilities for our customer-specific **magnet-anchor solutions**, such as tank cutoff valves, air isolation valves, or regeneration valves. They're designed for a temperature range from -40°C to 120°C and are characterized by a high degree of media stability relative to fuel and aggressive blow-by gases.



Freudenberg Sealing Technologies supports the automotive industry in its quest for greater efficiency and lower emissions. You can find more information about our product portfolio for modern, environmentally friendly engines on our microsite: <https://less.fst.com/engine>

ADBLUE MATERIAL PORTFOLIO
IS COLD-RESISTANT TO

–52 °C





VARIOUS MODELS—ONE GOAL

In modern vehicles, transmissions must do more than just contribute to the vehicle's overall efficiency through an optimal gear ratio providing peak shifting. Like all of the other systems, it must also contribute through light weight construction and lowering internal friction.

Freudenberg provides reliable reduced-friction gaskets for shaft seals that are in a position to significantly reduced friction losses when compared to traditional sealing systems. In this connection, special materials resist the chemical attack of oils with aggressive additives.

275 °C

STABLE AT THE HIGHEST TEMPERATURES
THRUST WASHER



THRUST WASHER

Our **Thrust Washers** utilize the new polymer thrust and are a testament to the success of our advanced materials prowess. It combines outstanding friction and wear properties at elevated pressures and sliding speeds. The plastic used exhibits the highest stability and rigidity values up to a temperature of 275 °C and offers outstanding wear values as well as excellent resistance to chemicals.



Lower internal friction, weight reduction through light-weight construction, and the optimal exploitation of installation spaces. Our product solutions offer potential for enhancing the transmission's efficiency. You can find further information about our product portfolio for transmission application on our microsite: <https://less.fst.com/transmission>

LOW FRICTION SIMMERRING®

With the ACM 380 material innovation, the **Low Friction Simmerring** has better elasticity and can cover a broader temperature range. They significantly reduce friction up to 20 percent relative to a standard shaft seal in a wide range of temperatures from $-40\text{ }^{\circ}\text{C}$ to $175\text{ }^{\circ}\text{C}$.



TRANSMISSION COVER GASKET

An approach similar to that taken with the sealing modules in the engine area is also possible in transmission applications. With the **Transmission Cover Gasket**, an example of the integration of various components, it involved a static seal and the possibility of installing a dynamic seal. A molded frame seal on a plastic support offers a weight reduction by replacing that of traditional metal.



ESS®: ENERGY SAVING SEAL

Transmission oils with aggressive additives are a challenge for elastomer materials. All the more so for a shaft seal with no spring to press the sealing lip onto the shaft. The **Energy Saving Seal** guarantees reliable sealing function with significantly reduced friction.



ENCODER

Seals can assume additional tasks with an **encoder**. Our encoders can have a magnetized elastomeric exterior consisting of alternating north and south poles. This allows for positions detection of the shaft's angle of rotation speed, rotational-speed deformity, and the angle-of-rotation.



LEVITAS

Emission reduction and fuel efficiency are both in focus for transmission development. Transmissions with eight or more gears enhance the drive train's degree of effectiveness but also create new challenges. Our seal rings made of polyetheretherketone (**PEEK**) or polyamide-imide (**PAI**), in combination with our low-torque design (Levitas), we are well-equipped to handle greater loads. LESS offers closed or slotted sealing rings made from our Quantum®-PTFE materials for rotary feedthrough. Leakage rates are significantly reduced with the closed version.



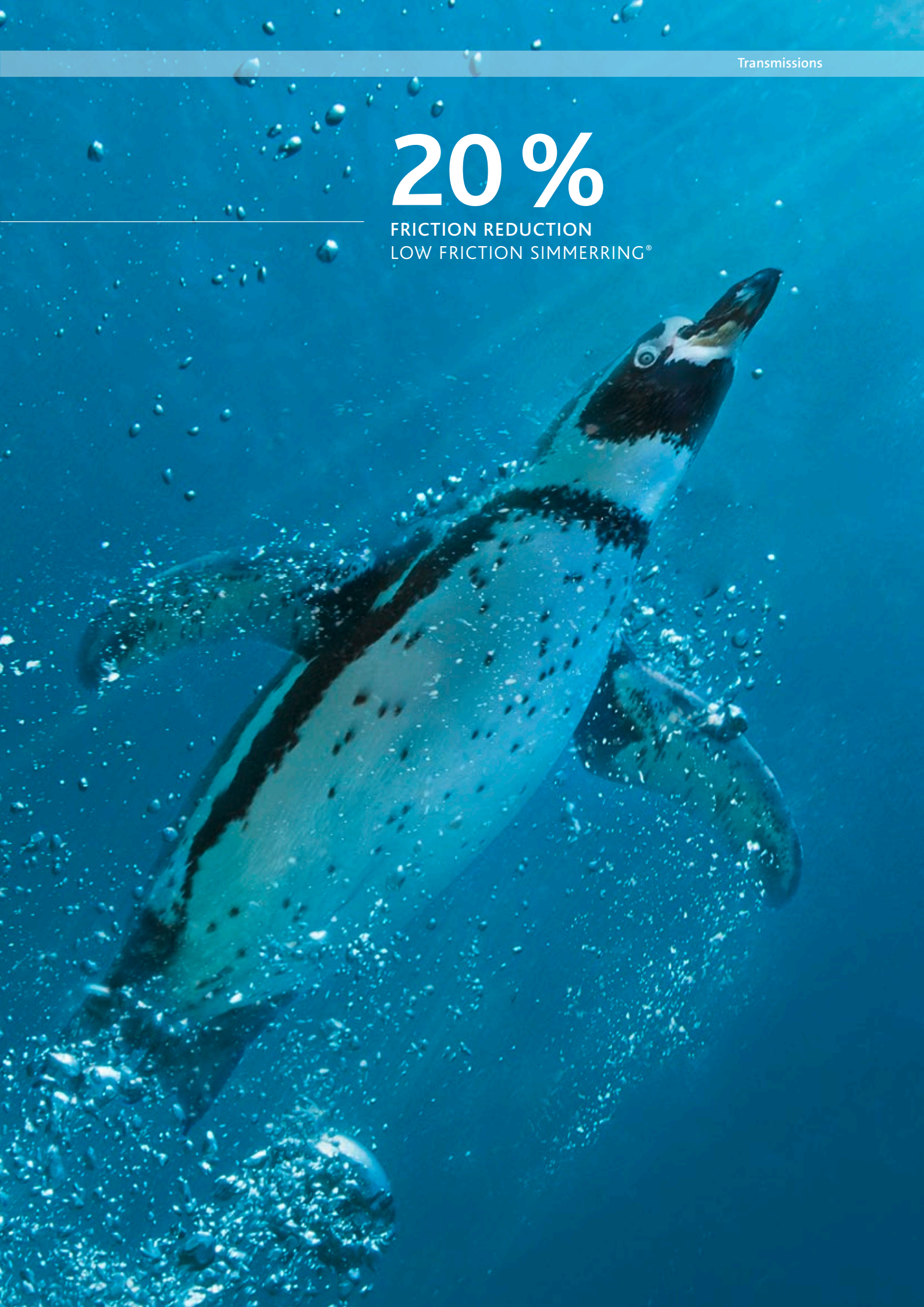
PISTON ACCUMULATORS

Piston accumulators save energy and reduce weight. Efficient new technologies such as direct-shift or automatic start-stop transmissions impose enormous loads on hydraulic systems. Start or shift procedures require large volume flows. While systems designed for maximum loads would be oversized, hydraulic accumulators consistently designed for light-weight construction can handle brief pressure spikes. Therefore, the hydraulic system only needs to be designed for average energy needs.




20 %

FRICION REDUCTION
LOW FRICTION SIMMERRING®



MORE THAN ONE WAY





Long live diversity

There is no simple path to a sustainable solution for future mobility requirements. The future is diversity, including different drive technologies, energy sources, and energy carriers. The range includes alternative fuels through purely electric vehicles, to fuel cells depending on customer requirements, intended use, or market conditions.



THE FUTURE IS ELECTRIC

For over 100 years, mobility has always been powered by fossil fuels such as petroleum or coal. However, the carbon released by burning these sources heats the atmosphere by releasing CO₂. Moreover, the supply of these natural resources are diminishing while global demand for energy continues to rapidly increase. To give mobility a sustainable future, we are working on seals for new, regenerative drive concepts, which produce fewer noise and exhaust emissions.

The future of mobility lies with electric components, and electric drive trains will have an increasingly vital role. However, different energy carriers do not just require the development of new drive solutions, but also that of surrounding technologies. Whether it's seals for battery systems, materials that exhibit resistance to biogenic and gaseous fuels, or frame seals for lithium pouch cells, LESS provides innovative solutions to meet these new challenges. The future is electric and we are looking forward to it.

SAFER

PROTECTION

OF LITHIUM-ION BATTERY SYSTEMS



POUCH CELL FRAME SEAL

Large-scale lithium battery systems are already present in a variety of applications. Among these are automobiles with micro, full, and plug-in hybrids, as well as purely electrical vehicles. Fastening elements enable pouch cells to be reliably embedded in lithium-ion battery systems. These battery systems are used in a variety of applications, both stationary and mobile. The cell frame ensures reliable embedding of the cell into the battery system and protects the pouch cell.

SIMMERRING® WITH ELECTRICALLY CONDUCTIVE NONWOVEN

Electric motors in plug-in hybrid vehicles with an operating voltage of 400 volts are mostly found on the automatic transmission's input shaft instead of a hydrodynamic converter. An electrical potential energy can build up between the housing and the shaft, which in extreme cases can lead to uncontrolled current flow and damage, particularly in the bearing area. A standard Simmerring can't discharge electric potential energy. However, in the shaft seal with electrically conducting nonwoven, a charge is directed specifically through the conductive transmission seal from housing to the shaft. This does not allow electrostatic charges to arise.



GASKETS FOR BATTERIES

With the development of electric mobility, new applications are created for elastomer seals in batteries. Flat flange seals can be securely seal battery covers. These seals are available in large dimensions to protect the entire battery unit from harmful environmental influences. Smaller "press-in-place" seals can be used in battery systems and seal components such as temperature control systems that optimize the battery's performance.



FUEL CELL GASKETS

The fuel-cell car is the alternative to the battery-powered car for zero-emission vehicles. To generate energy safely and efficiently, precise sealing solutions are needed in the fuel-cell stacks. The increasing selection of vehicle applications demands robust materials, perfect design, and quality-assured manufacturing to meet the requirements of daily use. Freudenberg has access to a global network and are experienced in the manufacturing of effective sealing components for fuel-cell stacks.



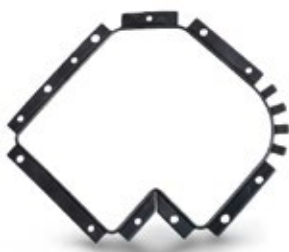
400 V

WITHOUT ELECTROSTATIC
CHARGING

RELIABLE

LEAKPROOF SOLUTIONS

FOR LONG SERVICE LIFE



PROFILE TO GASKET (P2G)

The sealing of housings in transmissions, engines, batteries and transformers is important for ensuring their functional reliability. The newly developed **profile to gasket (P2G)** is an extremely economical and technically efficient solution. The gasket profile which is manufactured as linear extrusion and is fabricated via water-jet cutting, can be tailored to each installation space. The assembly of the complete profile in one piece avoids unnecessary joints even in very large, complex housings. P2G solutions can be implemented with suitable materials and in low piece counts.



2K HOUSING

Electrical components are exposed to enormous stress from weathering and vibrations in automobiles and must be protected accordingly. **Housings with seals integrated in the cover in a 2K design** serve a greater purpose than just static sealing. They also reduce dynamic stresses and are situated to provide tolerance compensation, even during large temperature fluctuations. A component with a permanent injection-molded seal is more suitable for automatic final assembly, therefore yielding additional efficiency potential.



PLUG & SEAL

Plug & Seal connectors ensure that liquids and gases can be transported without leakage in automobile and utility-vehicle engines. Plug & Seals are also the best option for electrical mobility and hybrids, as they provide high-performance thermal management of battery technology.



E-mobility is on the fast track worldwide. Increasing costs for raw materials and increasingly strict emission regulations are accelerating this trend. You can find further information about our product portfolio for alternative drives on our microsite: <https://less.fst.com/emobility>



“EVOLUTION OF MOBILITY”

The world is faced with ever increasing population that is becoming both more urbanized and virtual, however these will not eliminate the need to transport people. With projections that nine billion people will be living on the earth by 2050 and two thirds of them will be in urban areas.

Global emissions—local problems

Local emissions difficulties compound to create the larger global problem of greenhouse gas emissions. In particular, the heavily stressed megacities in South America and Southeast Asia urgently need solutions to avoid suffocating in smog and air pollution. In the future, individuals may no longer have free access to inner cities with other alternatives being that free access would be strictly limited or access would come with considerable costs. The role models for these types of measures are London, Singapore, and Oslo beginning in 2020.

However, individual mobility will continue to remain important. Automotive societies predict that new passenger-car registrations will reach 89 million vehicles worldwide by 2020. The passenger car must reinvent itself in many ways to be fit for the demands of the future. Emissions-free driving will become the standard or at least heavily stressed with general technological

conditions determining the way. Reasonable costs, satisfactory cruising ranges, and a generous charging infrastructure for electrical cars have a chance to prevail on a broader front. If superchargers or induction charging can prove evidence of arbitrary scalability this offers promising perspectives.

Hybrid vehicles can off both emission-free driving in the inner cities and realize large cruising ranges on expressways. However, two drive systems in one vehicle generate high costs and additional weight, both are significant drawbacks that are in contrast to what automobile developers' demand. A capable infrastructure is needed to be able to max out their technological potential even for plug-in hybrids.

Is hydrogen the solution?

The fuel cell follows a different route. In the late 1990's, cold combustion, which creates renewable hydrogen, was celebrated as the simple path and was viewed as the response to local and global emission problems. The first mass produced vehicle with fuel-cell technology appeared in 2015 with a cruising range over 500 kilometers. The fueling procedure for this vehicle is completed in five minutes and proved the concept's capability. The technology can prove its potential in Japan and



California, where a hydrogen infrastructure exists. The internal combustion engine, whether diesel or gasoline, has yet to reach its maximum efficiency. The reduction of internal friction offers enormous potential and all of the possibilities in material selection and dimensioning are not yet exhausted. Even in the field of engines, improvements can be made to increase the efficiency of the century-old technology to a new level. Whether it is cylinder cutoff, turbocharger integration in the exhaust manifold, E-charger boosting, or the functional integration of inverters and chargers, the internal combustion engine still has an exciting future ahead of it.

Still indispensable

In the long run, the diesel engine will stay in the utility-vehicle area with-out alternatives. Other technologies struggle to offer maximum payload and transport space, as well as the requirement for extreme cruising ranges. But ultimately the “total cost of ownership” is the principle in which the utility-vehicle market must be measured.

The same concept applies to the area of inter-city buses. In many countries, this is still the only possibility for many people to overcome large distances. The rapidly growing world population illustrates the need for more efficient transport systems. Serious improvements are

also possible in this area. Enhancing efficiency by diminishing driving resistances has not come to an end, and fuel expenses are still the greatest cost pools for operators of truck and bus fleets.

For areas with inner-city buses, the argument for electric drives such as hybrid or battery-driven electric vehicles is becoming ever more interesting. Infrastructure and charging cycles fit perfectly into the usage profile and inner-city air quality could be significantly improved in many cities with the complete electrification of public transportation.

Whichever technology is favored for each use, the necessary materials expertise for the sealing of power units, shafts, or fuel systems is always a basic prerequisite for a technical solution or improvement. The evidence that we possess this ability is the fact that we have been a technology leader in the area of sealing for more than 80 years.

But that’s not enough for us. We are also working on solutions to make our products fit for a sustainable future. We are doing intensive research for opportunities to substitute renewable raw materials for petrochemical products in the manufacturing of elastomers. Because securing sustainable mobility is our common goal.

CLEAR ADVANTAGE

- fewer emissions
 - + more performance
 - + more cost-effectiveness
-

LESS

Sustainable sealing solutions for truck and passenger car





Product table

	ENGINE	TRANSMISSIONS	E-MOBILITY	VEHICLE SYSTEMS	FRICTION REDUCTION	WEIGHT REDUCTION	EMISSION REDUCTION	DOWN SIZING
ROTATION APPLICATIONS								
Levitex®	+				+		+	
ESS®: Energy saving seal	+	+	+		+		+	
BlueSeal	+				+	+	+	+
CASCO®	+	+	+		+		+	
Turbocharger seal	+				+		+	+
POP® Seal (power optimized PTFE)	+				+		+	
Low Friction Simmerring® (LFS)		+	+		+		+	
Encoder	+	+	+				+	+
Levitas	+	+			+		+	
Thrust washer	+	+	+	+	+	+	+	+
Simmerring® with electrically conductive nonwoven			+				+	+
Sealing modules (RWDS®, CSWS PLASTIC, CS PLASTIC)	+				+	+	+	+
AXIAL-SEALING APPLICATIONS								
Valve stem seal with back-pressure lip	+						+	+
Magnet-anchor solutions	+		+				+	
Sealing solutions for direct injection	+						+	+
Piston accumulators		+					+	+
STATIC APPLICATIONS								
Transmission Cover Gasket	+	+	+	+		+		+
Curve Gasket	+	+	+	+		+		+
2K pump housing	+	+	+	+		+		+
Exhaust-gas after treatment (SCR)	+						+	
Alternative fuels	+						+	
FluoroXprene®	+	+					+	
Gaskets for batteries			+				+	
Fuel cell gaskets			+				+	
2K housing	+	+	+	+		+		+
Plug & Seal	+	+	+	+		+	+	+
Profile to Gasket (P2G)	+	+	+	+			+	+
Pouch Cell Frame Seal			+				+	

LESS PRODUCT PORTFOLIO

<http://less.fst.com>



ENGINE

<https://less.fst.com/engine>



TRANSMISSIONS

<https://less.fst.com/transmission>



E-MOBILITY

<https://less.fst.com/emobility>

