

pulse

The ElringKlinger AG Magazine | Issue 2020

Electrified

Dr. Stefan Wolf talks to EnBW CEO Dr. Frank Mastiaux about the energy of change.

Cell growth

The future belongs to fuel cells. ElringKlinger is primed and ready.

ElringKlinger – Facts & Figures

EXPERIENCE MOBILITY – DRIVE THE FUTURE.

As an automotive supplier, ElringKlinger develops high-tech solutions for all drive systems in order to actively shape the world of mobility today and in the future.

SALES REVENUE

1,727 EUR million

were generated by ElringKlinger in fiscal year 2019.

HUMAN RESOURCES

10,393

people were employed by ElringKlinger worldwide as of December 31, 2019.

INNOVATIONS

64 % of the patents registered in the year under review were developed for vehicles with alternative drive technologies.

GROUP HEADQUARTERS

48°30'43"N, 9°21'45"E

ElringKlinger's corporate headquarters are located in Dettingen/Erms, approx. 40 kilometers south of Stuttgart.

GLOBAL PRESENCE

45 sites

ElringKlinger is represented globally: in all the major automotive markets and always in close proximity to its customers.

HISTORY

140 years

In establishing a trading company for technical products and seals in Stuttgart at the end of 1879, Paul Lechler laid the foundation stone for today's global Group.

SOCIAL MEDIA

ElringKlinger

Follow ElringKlinger on the social media networks of Facebook, Twitter, Xing, and YouTube (Elring – Das Original).

As an independent and globally positioned supplier, ElringKlinger is a powerful and reliable partner to the automotive industry. Be it passenger car or commercial vehicle, equipped with an optimized combustion engine, with hybrid technology, or with an all-electric motor – we offer innovative solutions for all types of drive system. In doing so, we are making a committed contribution to sustainable mobility.

Our lightweighting concepts help to reduce the overall weight of vehicles. As a result, vehicles powered by combustion engines consume less fuel and emit less CO₂, while those equipped with alternative propulsion systems benefit from an extended range. Developing cutting-edge battery and fuel cell technology as well as electric drive units, we were among the front-runners when it came to positioning ourselves as a specialist in the field of e-mobility.

At the same time, we are committed to evolving our sealing technology for a wide range of applications. Our shielding systems are designed to ensure high-end temperature and acoustics management throughout the vehicle. Dynamic precision parts developed by ElringKlinger can be used in all types of drive system.

Additionally, the Group's portfolio includes engineering services, tooling technology, and products made of high-performance plastics, which are also marketed to industries beyond the automotive sector. These efforts are supported by a dedicated workforce of more than 10,000 people at 45 ElringKlinger Group locations around the globe.

Dear Readers,

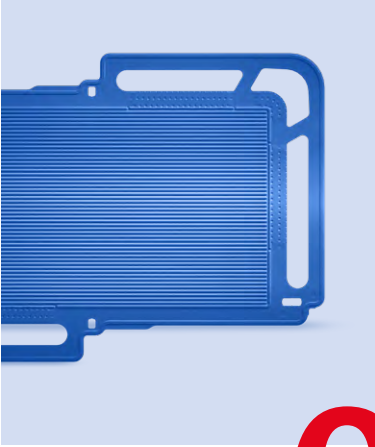
As the current debate suggests, a transformation that is as far-reaching as that taking place in the area of mobility requires a joint effort by the automotive industry and society as a whole. Besides smart traffic concepts for city centers and genuine alternatives for long-distance travel, one thing above all is needed: manufacturing capabilities that allow for the cost-effective series production of climate-friendly drive systems. This is precisely where ElringKlinger's strength lies.

On the following pages, we will show you that our fuel cells are ready and primed for action. And that battery technology can also be "made in Germany." Despite all the enthusiasm for new drive systems, however, we are not losing sight of the strong foothold we have established in the field of combustion engine technology. Indeed, our mindset embraces all types of drive technology.

We invite you to discover this for yourself on the following pages.

Dr. Stefan Wolf,
CEO of ElringKlinger AG





THE BEST OF BOTH WORLDS

What do the products of today's and tomorrow's world of mobility look like? A closer look at the individual divisions reveals common features and areas of advancement.

06

CELL GROWTH

Hydrogen-based drive systems that use fuel cells offer enormous market potential, particularly when it comes to environmental compatibility.



32



THE POWER OF A LIGHT TOUCH

Lightweighting offers many advantages for electric vehicles. The key technology is more advanced than ever before.

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DID YOU KNOW THAT ... the Aftermarket and Engineered Plastics segments are actually full of surprises?

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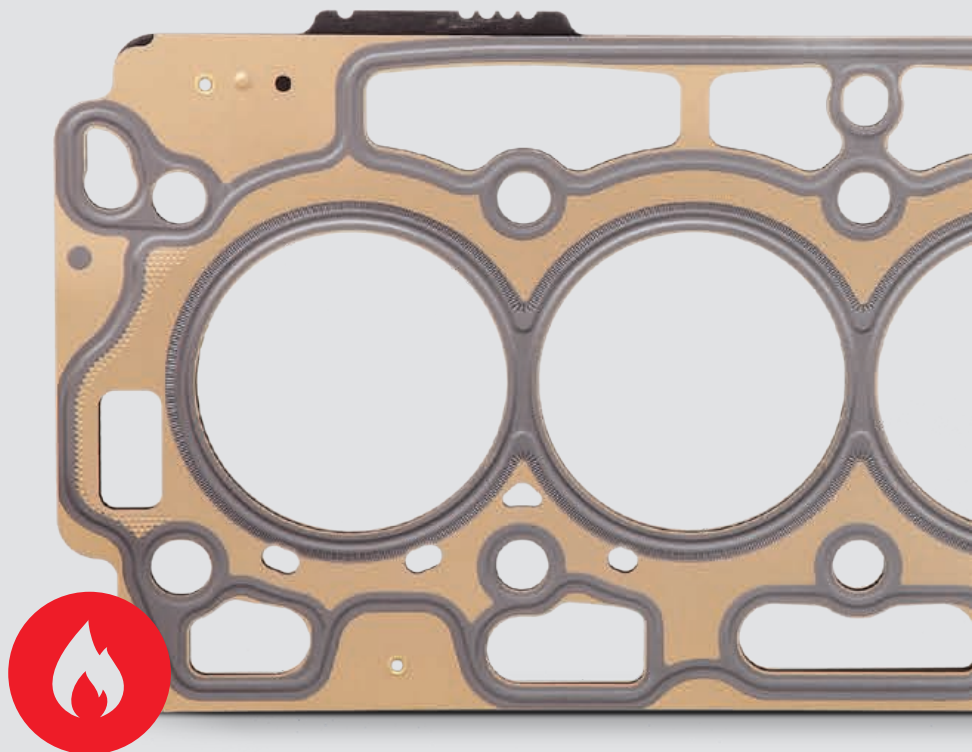
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THE BEST OF BOTH WORLDS

ElringKlinger geared up to the transformation that is sweeping through the automotive industry early on and has oriented its product portfolio to the technologies of the future in all of its business units. Throughout its core competencies of stamping, punching, forming, coating, and plastic injection molding, the Group offers high-tech solutions for both worlds: for vehicles powered by combustion engines as well as for alternative drive systems.

Cylinder- head gasket

No vehicle with a combustion engine would be drivable without a cylinder-head gasket. While such gaskets do not appear to be particularly complex at first glance, they involve an astonishing amount of know-how. The reason being that the much more extensive pressures and significantly higher temperatures in modern engine generations necessitate high-precision stamping, forming, and embossing in the micrometer range so that the gaskets are fully functional and seal the engine reliably and permanently.

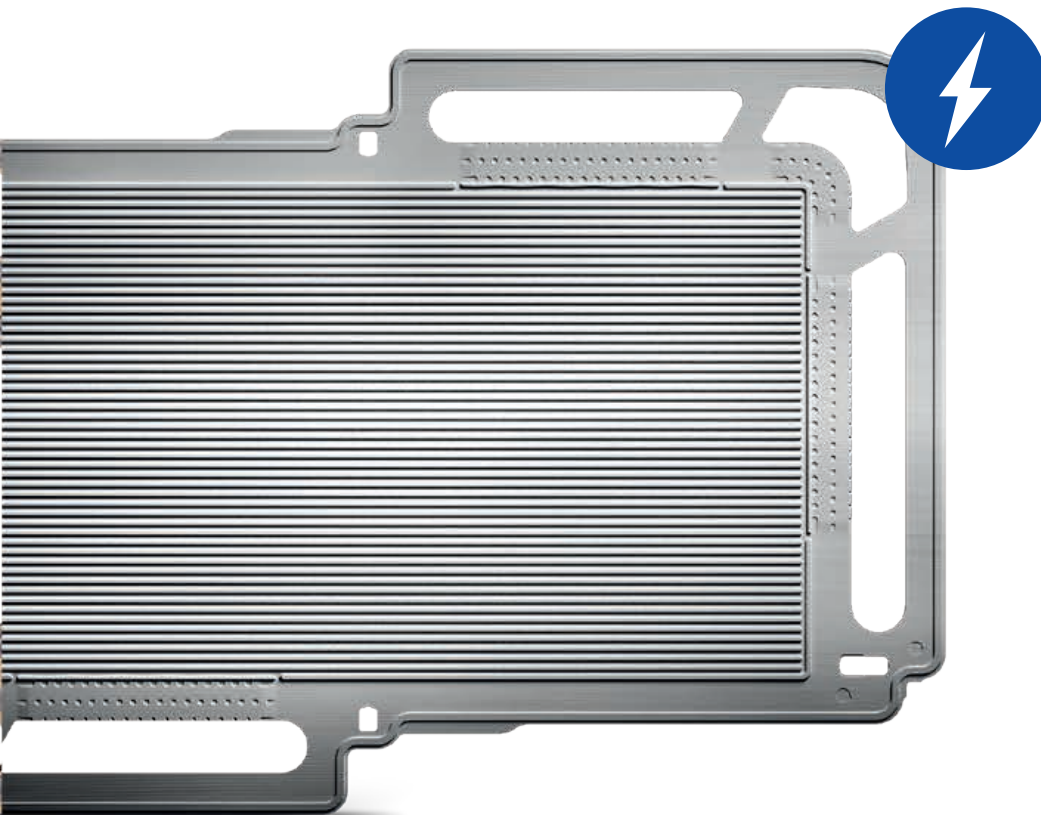


 Classic drives

 New drives

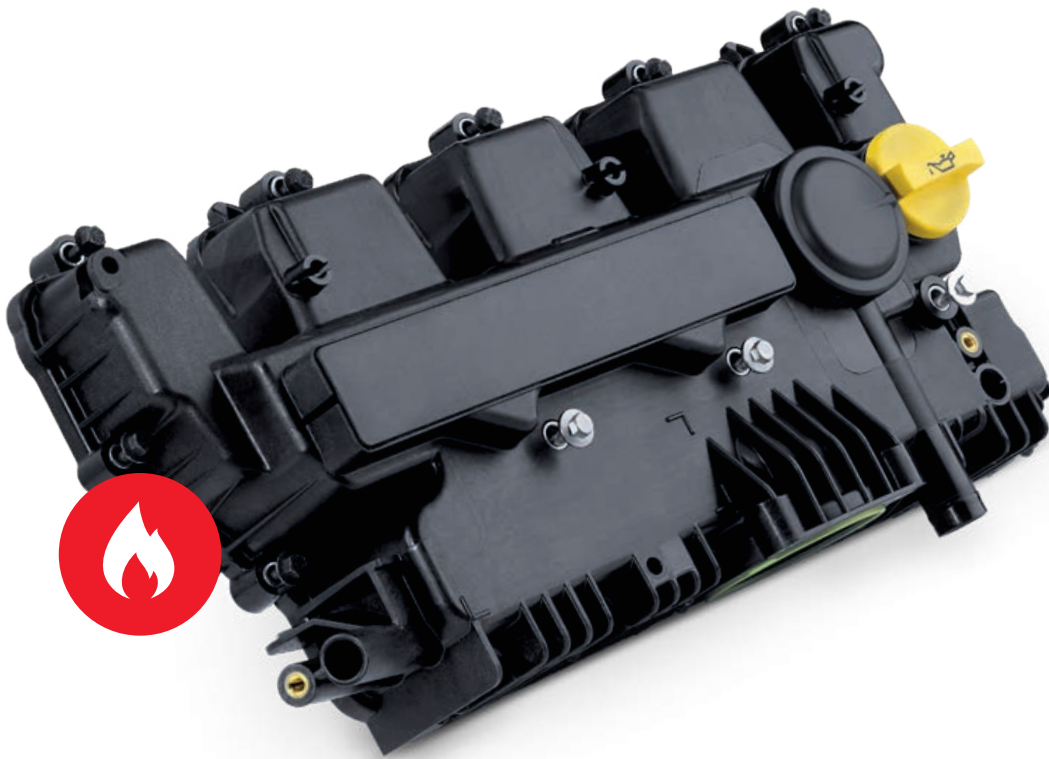
Bipolar plate

Alongside the membrane electrode assembly (MEA), two-layer metal bipolar plates are the core element of fuel cell stacks. In stacks of up to 450 cells, they form the heart of a fuel cell system. Each bipolar plate contains high-precision embossed flow profiles, through which hydrogen is supplied on one side and oxygen on the other. Acquired over a number of decades in the field of precision stamping and punching technology, the Group brings its gasket know-how to bear in order to produce these micro-channels.



Cylinder-head cover

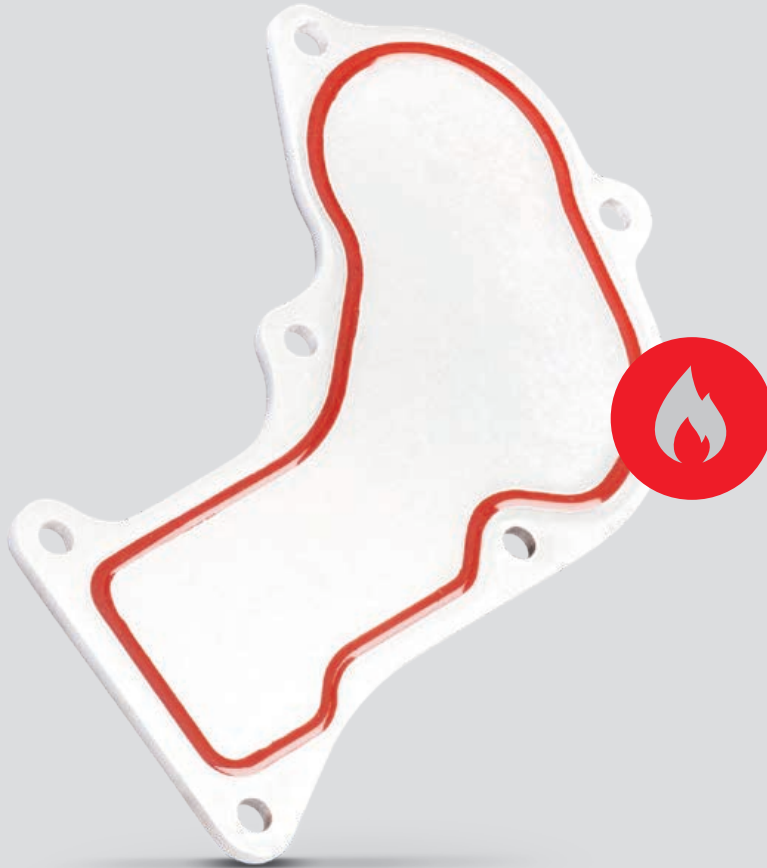
The requirements in terms of functionality, safety, and stability are demanding, particularly when components mounted close to the engine are involved. High temperatures and high pressures therefore necessitate the use of high-performance plastics, which offer crucial advantages in comparison with conventional solutions: besides their considerably lower weight, higher thermal insulation and better function integration options are points in favor of the lightweight design variant. ElringKlinger has perfected the requisite competence in injection molding tools over a number of years.





Media module

The unit responsible for fuel cell technology also benefits from ElringKlinger's proven material and tool expertise for underhood parts. Like the cylinder-head cover, the newly developed media module also simplifies the integration of the fuel cell's complete media supply system into a complex plastic assembly. The high-performance plastic component is mechanically stable, chemically resistant, and additionally weight-optimized. A range of system components such as pressure and temperature sensors are also integrated directly into the module and facilitate management of the overall system.

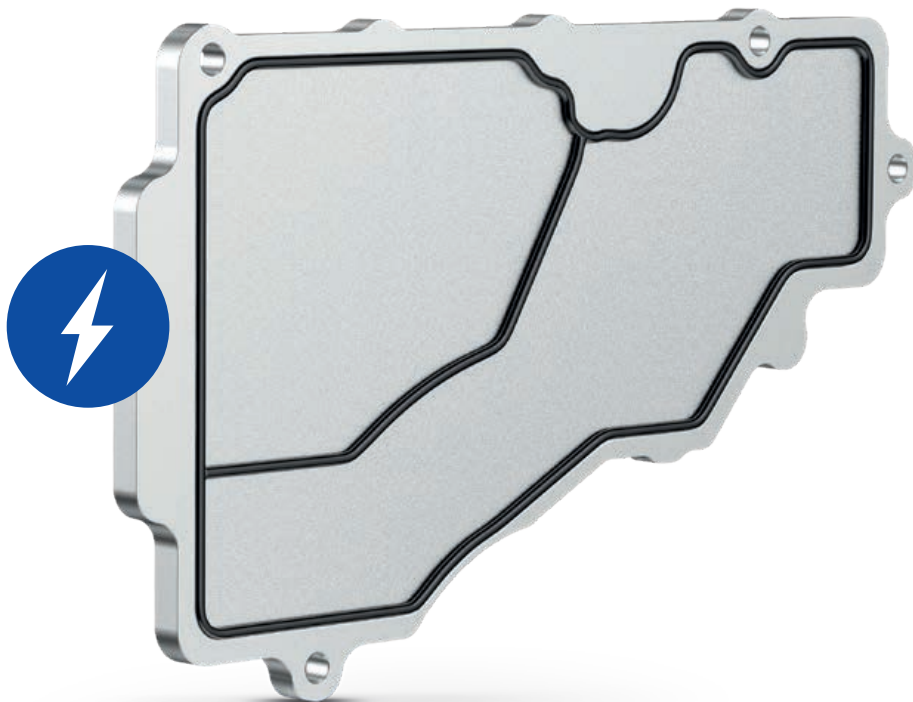


End cover

Specialty gaskets are used in the vehicle wherever components are connected or adjacent to one another. The different sealing systems are as diverse as the possible locations in which they are used. The end cover, for example, is fitted both on the combustion engine and on the transmission to securely seal the oil circuit. The material and the design are tailored precisely to customers' specific requirements. An embossed groove and the elastomer sealing compound additionally offer protection against excessive pressure and external influences.

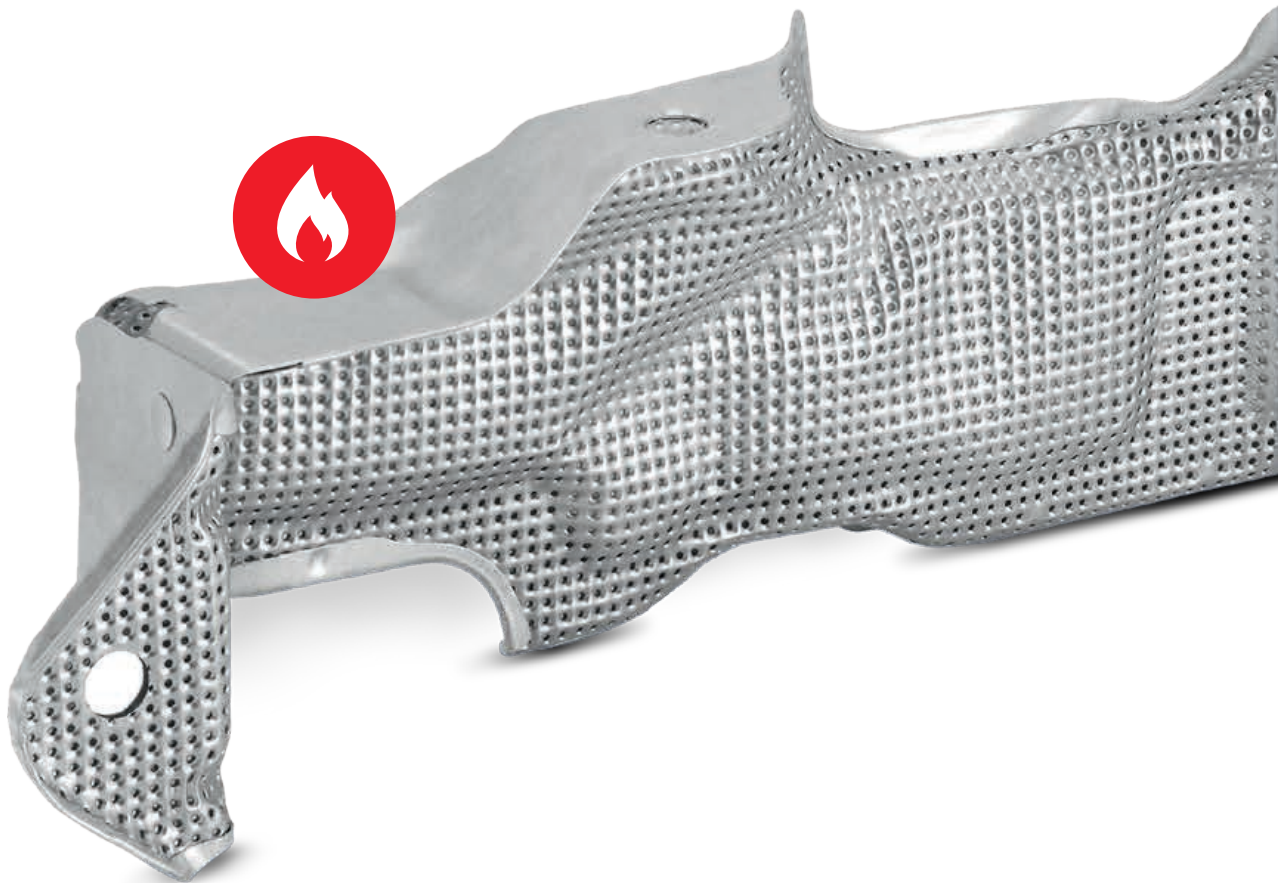
Service cover

Whether in the form of a service cover for the electric drive unit, as a housing cover in the drive electronics, or as covers on battery systems – specialized gasket technology from ElringKlinger is also used in the world of e-mobility. The company uses its profound engineering knowledge and extensive experience of materials to meet the requirements of sealing and electromagnetic shielding. An elastomer sealing compound, embossed protective strips, and molded-on spacers ensure that the components are reliably sealed.



Exhaust tract shielding

High temperatures in vehicles increase the number of shielding systems that are required. Consisting of metal and an insulation material that serves as an intermediate layer, the complexly shaped and custom-fit, multilayer shielding systems protect surrounding components from excessive thermal stress while simultaneously ensuring that the temperatures at which the catalytic converter operates optimally are reached as quickly as possible in the exhaust system.





Battery shield

Intelligent temperature management also plays an important role in e-mobility because lithium-ion batteries necessitate extensive safety precautions to minimize potential hazards. By developing the new stainless-steel battery cover, the developers have transferred their know-how in handling extreme temperatures to the world of alternative drive systems. The integration of this battery shield thus protects surrounding components from a thermal chain reaction caused by a thermal runaway.

ELEC- TRIFIED

CO₂ emissions generated within the transport sector are to be reduced by around 40 percent by the year 2030. For sustainable mobility to succeed, close cooperation between the energy and automotive industries is essential. Dr. Frank Mastiaux, CEO of energy supplier EnBW, and Dr. Stefan Wolf, CEO of ElringKlinger, discuss similarities and differences on the path to a climate-neutral future.





WHAT DO THE ENERGY TRANSITION AND THE TRANSFORMATION OF THE AUTOMOTIVE INDUSTRY HAVE IN COMMON?

MASTIAUX — We as EnBW can only stress the need for strategic alliances. We are facing a challenge, particularly in the field of e-mobility, which can only be met if we work together. Only if we consider the energy and transport sectors as a single entity will each be able to make its contribution to achieving its own objectives.

WOLF — In my opinion, change in our industry can only work in close cooperation with the energy sector. There is no point at all in the automotive industry simply rolling out vehicles with alternative drive systems. People actually have to buy such vehicles. And they will only do so if the cars meet their lifestyle and mobility requirements, which includes an adequate charging infrastructure.

MASTIAUX — Improved traffic management is also a key prerequisite for change in the area of mobility. Here we can contribute our experience in the operation of large infrastructures. Simply focusing on recharging points would be a short-sighted approach.

WOLF — Exactly, traffic management will also be a key factor. In addition, however, being able to charge enough electricity at the right time is essential for the success of e-mobility. And this brings us to the issue of grid capacity and the question of who pays for the expansion.

MASTIAUX — Yes, we in the energy sector see it the same way. Fundamentally, the customer must be able to have confidence not only in the vehicle technology but also in the infrastructure. However, setting up a charging infrastructure requires substantial investment in advance and such capital expenditure simply isn't worthwhile at present.

WOLF — The automotive industry is investing considerable amounts. Electric mobility is first and foremost about actually getting fully electric vehicles on the road. The focus is on completely new vehicle concepts.

IS IT SIMILAR FOR FUEL CELL VEHICLES AND HYDROGEN INFRASTRUCTURE?

MASTIAUX — I am convinced that other energy carriers such as hydrogen will play a major role when it comes to future road transport – alongside electricity. But if I understand my colleagues in the car industry correctly, we have not yet reached a point where a fuel cell vehicle would be competitive compared to an electric car.

WOLF — The main advantage of fuel cell technology is that the refueling process can be completed relatively quickly, as was previously the case with fossil fuels. Furthermore, hydrogen filling pumps can be integrated into the existing filling station infrastructure.

MASTIAUX — When I think of fuel cells, the first thing I can imagine is their use in the field of heavy-duty transport, because this segment requires higher energy densities and ranges.

WOLF — From a regional perspective, Asian countries such as Korea and Japan are more advanced. They are relying consistently on fuel cell technology and are looking to have larger fleets – including passenger cars, by the way – on the road by as early as 2030. And in China, our company is already working on more than 20 development projects for fuel cell drives. This is also of benefit to us in Europe when it comes to reaching series production readiness more quickly.

HOW DO YOU CHANNEL YOUR INVESTMENTS IN THIS SITUATION?

WOLF — We invest in technologies for new drive systems, while at the same time drawing on expertise gained from our long-standing business. For example, we produce our bipolar plates for fuel cells on the same machines as our cylinder-head gaskets. And our cell connectors for batteries fitted to electric vehicles are also manufactured with the help of established metal processing methods.

MASTIAUX — Essentially, we must all abandon the idea that a specific business model is future-proof in any way. This poses quite a challenge for the energy industry due to the substantial investments involved. Building a marine wind farm can quickly add up to two billion euros. We're therefore trying to pursue the right trend and spread the portfolio risk, for example, by investing in renewable energies, in the grid, and in new infrastructure projects that match our expertise.

HAS THE MORE EXTENSIVE DEBATE ON CLIMATE CHANGE DRIVEN CHANGE IN YOUR RESPECTIVE SECTORS?

MASTIAUX — We conduct surveys on a regular basis. According to these, a clear majority says that the changeover to renewable energies is the right choice. The issue becomes more problematic when wind farms or power lines are installed in close proximity to people. There is greater resistance in such cases. But in principle, acceptance is still high.

» **If we do not succeed in communicating to people that transformation really means change, major social projects such as energy transition and climate-neutral mobility are doomed to fail.** «

Dr. Stefan Wolf, CEO of ElringKlinger AG





WOLF — It is similar in our industry. Against the backdrop of climate change, almost everyone is in favor of electric mobility. But at a personal level, people compare the cost of an electric car with that of a vehicle powered by a combustion engine.

MASTIAUX — Ultimately, we are at a point where politics should actually draw up a kind of project plan. Indeed, the year 2050 seems so far away. But if we fail today to present a clear plan that focuses on the ultimate objective and if we do not implement such a plan consistently, we will never achieve our climate targets in this country. Cooperation between the energy and automotive sectors also needs to be much more intensive and systematic.

WOLF — I agree entirely. We are undergoing a process of deep transformation. If we do not succeed in communicating to people that transformation really means change, major social projects such as energy transition and climate-neutral mobility are doomed to fail.

WHAT DOES THIS TRANSFORMATION MEAN FOR YOU PERSONALLY AS A MANAGER?

MASTIAUX — Business models are changing more rapidly than ever before. Therefore, the ability to change becomes a strategic skill. A manager today can no longer say: “I know what the world will look like in ten years’ time.” Instead, managers must champion the idea of adaptability and encourage constant observation. Because your own employees are the ideal scouts for change.

WOLF — In my experience, you can get very far if you not only describe the instance of change to employees but also convey to them that there is the prospect of new responsibilities and secure jobs. Employees who respond positively to this often develop very innovative ideas.

THE INTERVIEW WAS CONDUCTED BY JOHANNES WINTERHAGEN.

» I am convinced that other energy carriers such as hydrogen will play a major role when it comes to future road transport – alongside electricity. «

Dr. Frank Mastiaux, CEO of EnBW Energie Baden-Württemberg AG

DR. FRANK MASTIAUX

Dr. Frank Mastiaux was born in Essen in 1964. After completing his doctoral thesis in chemistry, he began his professional career at Veba Oel AG in 1993. On an overseas posting, he worked at CITGO Petroleum Corp in the U.S. Following the merger of Veba Oel AG and ARAL AG, he became Managing Director of ARAL Mineralöl-Vertrieb GmbH. He was then employed in various management positions in the BP Group in London after the Veba Oel/Aral Group was acquired by BP p.l.c. Before joining EnBW Energie Baden-Württemberg AG, he held a number of positions on the Board of Management of the E.ON Group. On October 1, 2012, Dr. Frank Mastiaux was appointed the Chairman of the Board of Management of EnBW Energie Baden-Württemberg AG.



T R A I N

On non-electrified lines, in particular, rail transport can be decarbonized with the help of fuel cells, thus dispensing with fossil fuels. At the same time, such routes no longer have to be equipped with expensive overhead lines.

40%

Around 40% of Germany's rail network has not yet been electrified.



Cell growth

The future belongs to hydrogen drive systems based on fuel cell technology. Both powerful and environmentally friendly, fuel cells can be used in a wide range of applications. Be it cars, buses, trains, ships, or airplanes: fuel cells can be deployed in all modes of transport and offer tremendous opportunities for growth. ElringKlinger has been active in this field for nearly 20 years, supplying components such as bipolar plates and media modules as well as stacks and complete systems.

Those who have read books by Jules Verne will be acquainted with the tremendous vision displayed by the French novelist as far back as the end of the 19 century. He predicted a technically mature submarine in "Twenty Thousand Leagues Under the Sea", conjured up images of global travel in "Around the World in Eighty Days", and wrote about the as yet unrealized "Journey to the Center of the Earth". In espousing such ideas through his novels, he proved to be well ahead of the times. This is also evident elsewhere, when he described the energy of the future in 1874: "Water is the coal of the future. The energy of tomorrow is water decomposed into its primitive elements by electricity. Hydrogen and oxygen, which constitute it, will furnish an inexhaustible source of heat and light for planet Earth."

What Jules Verne was describing 145 years ago – five years before the establishment of the company that was later to become ElringKlinger – is essentially a fuel cell. In a fuel cell, hydrogen and oxygen are brought to a chemical reaction, which then releases electricity. Those who paid attention in chemistry lessons will be well aware of the power of this reaction. The specific advantage here is that the conversion of energy during the chemical reaction in the fuel cell occurs with a higher efficiency than in the combustion process.

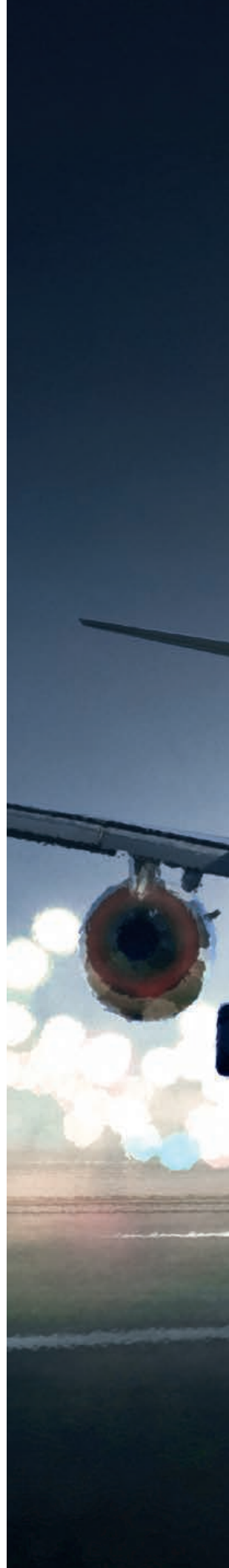
ElringKlinger recognized this potential when, around 20 years ago, the Group was asked to develop bipolar plates based on its expertise in the area of metalworking. Even when its development partner discontinued research into the fuel cell, ElringKlinger itself remained committed to the project. After all, it was evident that the fuel cell was a highly suitable drive system, particularly from an environmental perspective. If the hydrogen is produced from renewable energy, this technology even offers the benefit of being CO₂ neutral. The only exhaust gas produced is water vapor. This undoubtedly makes the fuel cell an energy solution tailored to the next generation of mobility.

Mobility has many dimensions. On the ground, the fuel cell offers enormous possibilities for the car. It is also suitable for deployment in trains. Fuel cells are the perfect solution for non-electrified routes that require locomotives with on-board electrical power supply. The same applies to the shipping industry, where energy is also provided on board.

However, this potential can be exploited not only on the ground but also in the air. Aircraft engines burn kerosene – often in large quantities, depending on the year of manufacture of the aircraft. The mere fact that emissions at high altitudes are more harmful to the climate than on the ground shows the great potential for savings when it comes to the environmental footprint of air transport. Fuel cells operate without such emissions – while still providing the power required for such areas of application. ElringKlinger's stacks are particularly well suited for this because they offer high power density.

Performance, however, is not the only argument in favor of the fuel cell. With hydrogen as an energy carrier, energy production and energy use can be separated from each other physically and in terms of timing. For example, it is possible to produce hydrogen today with wind energy along the coast of the North Sea and use it three months as fuel for a truck in southern Germany. Particularly in the case of commercial vehicles or regularly recurring, cyclical traffic, such as that attributable to bus transportation, purely battery-powered vehicles reach their limits relatively quickly and have to be recharged rapidly. However, stoppages due to recharging increase the vehicle's operating costs. This is where the fuel cell can demonstrate its true strengths and offer unparalleled advantages with much longer ranges and fast refueling times that are almost comparable with today's diesel vehicles.

Environmental compatibility is, of course, a major factor. After all, there are clear signs of climate change and a reduction in CO₂ emissions is inevitable. By issuing ever stricter regulations, policymakers have already set a framework for action. Now the aim is to implement it in order to be able to meet the various requirements and regulations. Hydrogen is a crucial component in this process. In this context, for example, CO₂-neutral mobility can be achieved if we switch to a hydrogen economy and combine it with renewable energies. The direction to be taken is known. After all, as Minister of Education and Research Anja Karliczek put it recently: "Hydrogen is the new oil." This clearly embraces the vision that Jules Verne formulated 145 years ago.



AIRPLANE

Aircraft have a substantial energy requirement. At the same time, however, they are faced with weight and volume restrictions for reasons of physics. Fuel cells can cover the energy needs of aircraft; they are comparatively compact and have a high power density. Batteries, by contrast, have a lower energy density and thus offer a shorter range.



230 g/Pkm

A domestic flight in Germany produces 230 g/Pkm in greenhouse gas emissions according to the Federal Environment Agency. A car emits 147 g/Pkm, while long-distance rail transport is responsible for 32 g/Pkm. (g/Pkm = grams per passenger kilometer).



87

There were around 87 hydrogen filling stations in Germany at the beginning of 2020. The existing fuel filling station infrastructure can be converted for use with hydrogen.

COMMERCIAL VEHICLES

The area of cyclical transport is particularly well suited for fuel cells. Prime example: buses that return to the depot on a regular basis. If this form of transport is to become environmentally friendly and, in a best-case scenario, CO₂ neutral, only the fuel cell is to be seen as a viable solution in economic terms. The same applies to trucks: frequent stoppages for recharging in the case of all-electric drives result in unfavorable costs.

FUND E D P R O J E C T S

ElringKlinger is involved in a number of funded projects aimed at advancing fuel cell technology for industrialization in various markets over the course of the 2020s.

VOLUMETRIQ

ElringKlinger successfully developed a fuel cell stack with very high power density as part of a project sponsored by the EU Commission and the Fuel Cell and Hydrogen Joint Undertaking (FCH JU). Together with its partners Johnson Matthey Fuel Cells, Solvay Specialty Polymers, and CNRS Montpellier, the Group was thus able to set new standards at an international level. The stacks are suitable for use in both passenger cars and commercial vehicles.

The project centered around the ElringKlinger fuel cell stack won the accolade of “Best Success Story” at the FCH JU Awards 2019. The honor is bestowed to recognize particularly successful and innovative projects in the field of fuel cell and hydrogen technology.

www.volumetriq.eu

H2HAUL

Together with the Dutch VDL Groep, three VDL vehicles will be equipped with fuel cell systems from ElringKlinger and tested in real-life operation by the Belgian retail group Colruyt Group as part of this FCH JU-sponsored project.

www.h2haul.eu

GIANTLEAP

In the multi-year EU-funded project, fuel-cell-powered range extenders for an electric bus from the Dutch manufacturer VDL Bus & Coach were developed and tested under real conditions. The final report concluded that ElringKlinger’s fuel cell stacks were convincing: “The overall performance of the system exceeded expectations.”

www.giantleap.eu

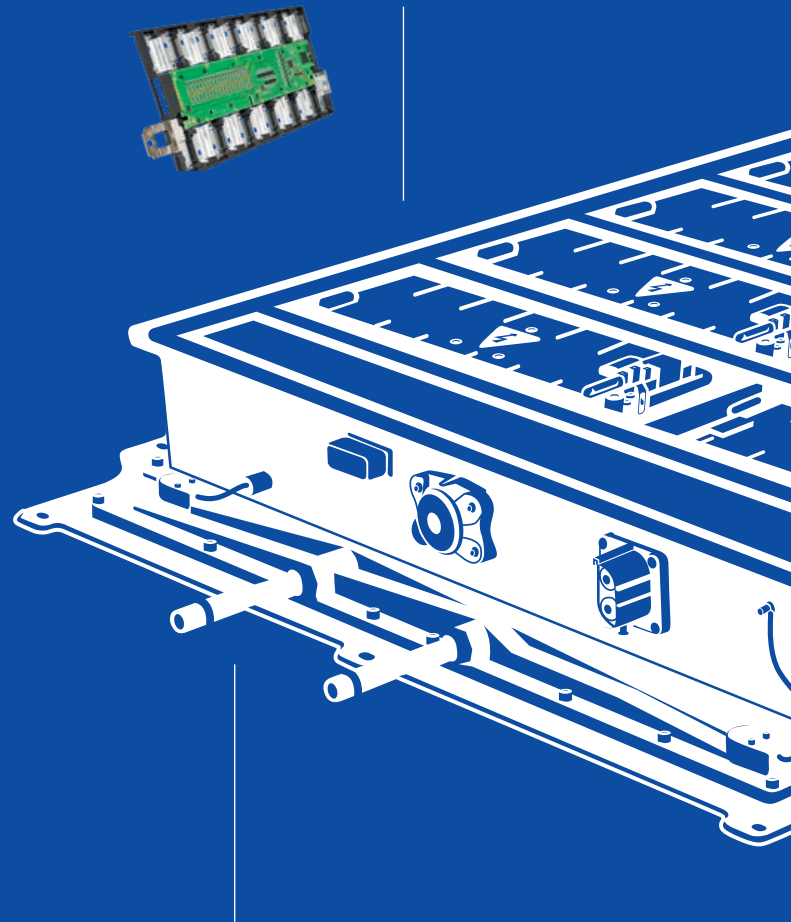
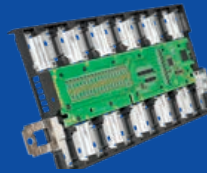


GOOD TO GO

The new era of mobility has begun and ElringKlinger is without a doubt good to go, quite simply because the company has already been mass-producing individual components for lithium-ion batteries since 2011. By establishing its first series production facility for battery systems, the Group is now taking a crucial step forward and is no longer merely a pure component supplier but also a supplier of complete battery units.

CELL CONTACT SYSTEMS

ensure the electrical connection of the cells within a battery module. They consist of a plastic carrier frame that holds the individual cell connectors together. The integrated sensor system monitors the voltage and temperature.



MODULE CONNECTORS

form the interface between the individual modules and the cell contact systems. They connect the modules both to each other and to the power electronics.





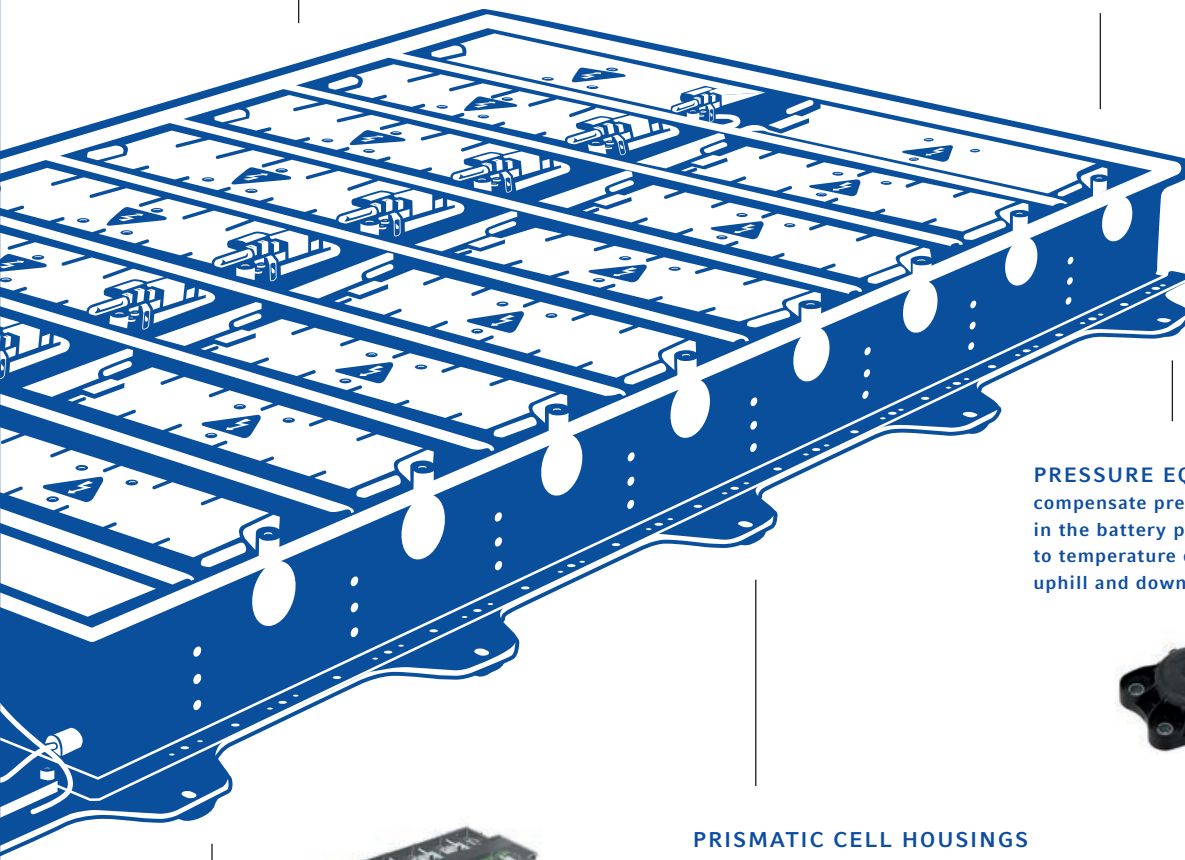
CELL CONNECTORS

carry current between the individual cells of the module. The aluminum connectors have the appropriate cross-section for optimal current carrying capacity.



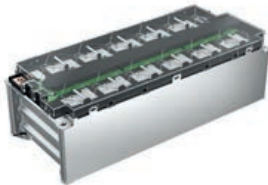
METAL-ELASTOMER GASKETS

in a puzzle design are an effective solution for large flanges such as those of battery pack housings. Joining the individual gaskets together reduces the space required during storage and shipping in comparison with their size in installed condition.



PRESSURE EQUALIZING ELEMENTS

compensate pressure differences that occur in the battery pack housing with regard to temperature differences or when driving uphill and downhill, for instance.



BATTERY MODULES

from ElringKlinger can be joined together to form overall systems with a voltage level of up to 800 V and can be used in numerous configurations in battery pack sizes from 2.2 to 60 kWh.

PRISMATIC CELL HOUSINGS

and cell cover modules make a significant contribution to the high power density and safety of prismatic lithium-ion cells. They have integrated safety devices for overpressure, overcurrent, and excessive temperatures.



When the heart of a vehicle no longer beats in the location in which it has functioned perfectly for over 100 years, this is obviously due to a major change that effects vehicle technology as a whole. It is a change that ElringKlinger recognized two decades ago. Since then, the company has been undertaking development work in the field of alternative drive systems, irrespective of technology. With a small organizational unit that acts like a start-up within the company, the Group commenced fully automated series production of the cell contact system for lithium-ion batteries – the first product for battery-powered electric vehicles – back in 2011 and gathered valuable experience in what was then a completely new drive area for ElringKlinger.

Over the next few years, the company dedicated large parts of its development know-how to battery technology, with a clear objective: demonstrating not only component but also system expertise – because the individual components can only be technologically perfected if the systems are understood in full. Extensive market research work that was undertaken in advance delivered the necessary framework data concerning flexibility, performance, size, and costs. One thing is certain: an efficient energy storage concept that is durable and optimized with regard to both installation space and costs is crucial to the universal acceptance of battery-powered vehicles. A battery concept tailored to the respective vehicle also directly affects the characteristics of an electric vehicle and therefore the benefit to the consumer.



ElringKlinger is good to go in helping to structure this technological revolution with its high-performance product solutions. The newly developed ElringKlinger standard module forms the basis of ElringKlinger battery packs. With a voltage level of up to 800 V, individual modules can be connected as required in the vehicle and be used in various configurations in battery pack sizes from 2.2 to 60 kWh – an innovation that is triggering profound structural changes in the ElringKlinger Group. For instance, the high demands on cost-effectiveness but also on the sustainability of the overall system necessitate holistic thinking and close cooperation between various areas of the company. While projects used to be initiated by Development, Sales, and Logistics employees, project managers, Purchasing, the production plants, Industrial Engineering, Supplier Management, and Testing are now also involved in e-mobility projects from the word go. After all, complex large-scale projects can only be realized in the shortest space of time through close interaction. In terms of system procurement, a variety of special machines, joined end-to-end to form a large assembly line, are also required to manufacture the systems.



The industrialization experts at ElringKlinger are responsible for setting up the first production system for battery systems.



Special machines tailored precisely to the manufacturing processes developed by ElringKlinger are used almost exclusively to produce the battery systems.

As early as the development phase, ElringKlinger's industrialization experts supported the Development department in implementing manufacturing-friendly designs that directly affect the choice of processes and accompanying manufacturing methods. ElringKlinger is treading new ground in a number of areas with this project. While the company can benefit from its core competencies in the fields of stamping, forming, laser welding, coating, and injection molding, it requires further manufacturing technologies, some of which are completely new, for the different production processes. Extensive safety measures, which have never existed at ElringKlinger before in this form, are also needed for testing and validation facilities in some process steps – cell testing, module testing, or component validation, for instance.

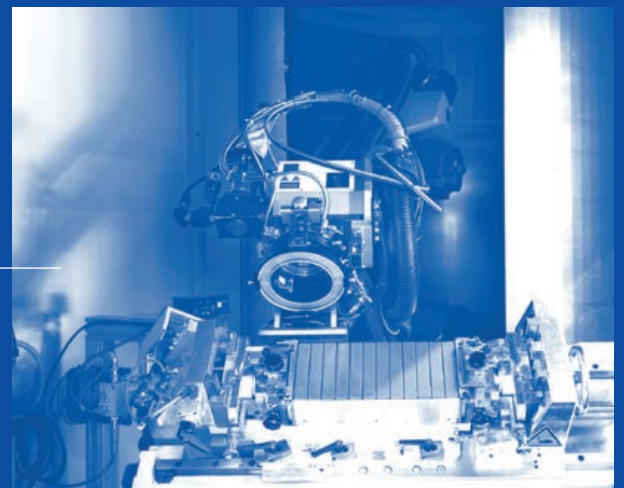
The complexity of the ElringKlinger standard module in terms of modularity and package dimensions also increased the requirements made on special machine manufacturers that design custom production, assembly, and transport systems on the basis of numerous requirement specifications. It is precisely this system flexibility that ultimately enables ElringKlinger to work on different customer projects on the same assembly line. This is a clear competitive advantage when future customer projects have to be realized quickly.

Initial highly automated series production of the powerful 800 V overall battery system is now being set up in an area covering 5,000 square meters at ElringKlinger's plant in Thale, Saxony-Anhalt. The Group is setting new standards here, since this will be its largest interconnected assembly line. It extends over a length of 70 meters and offers a maximum production capacity of 300,000 battery modules per year. The first battery systems are literally due to come off the line in 2020.

Sometimes, the past and the future lie virtually side by side. Here, the future is a new building that is scheduled for completion very soon and is located directly adjacent to the traditional cylinder-head and specialty gasket production facility at the company's headquarters in Dettingen an der Erms. This is the new development center, in which prototypes and preproduction series for alternative drive technologies will be produced in the future in an area measuring around 5,000 square meters. This newly created space will enable the Group to test theoretical process developments under practical conditions at a very early stage. To do this, resources are available for all manufacturing processes, albeit with a considerably lower level of automation than during subsequent series production. The new possibilities that are now readily available will enable ElringKlinger firstly to run through sample phases faster with customers and secondly to optimize its own manufacturing processes, quality checks, and throughput times prior to the start of series production in order to ensure a smooth and cost-optimized start of production for other projects as well.

ElringKlinger is ready to serve the e-mobility market with efficient and flexibly configurable battery systems, because the key to future mobility ultimately lies in the battery technology. It is crucial to the success of hybrid, electric, and fuel cell vehicles.

Prototype construction at the new development center in Dettingen an der Erms.



EFFECTIVE SHIELDING



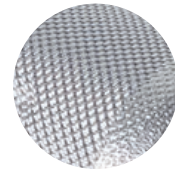
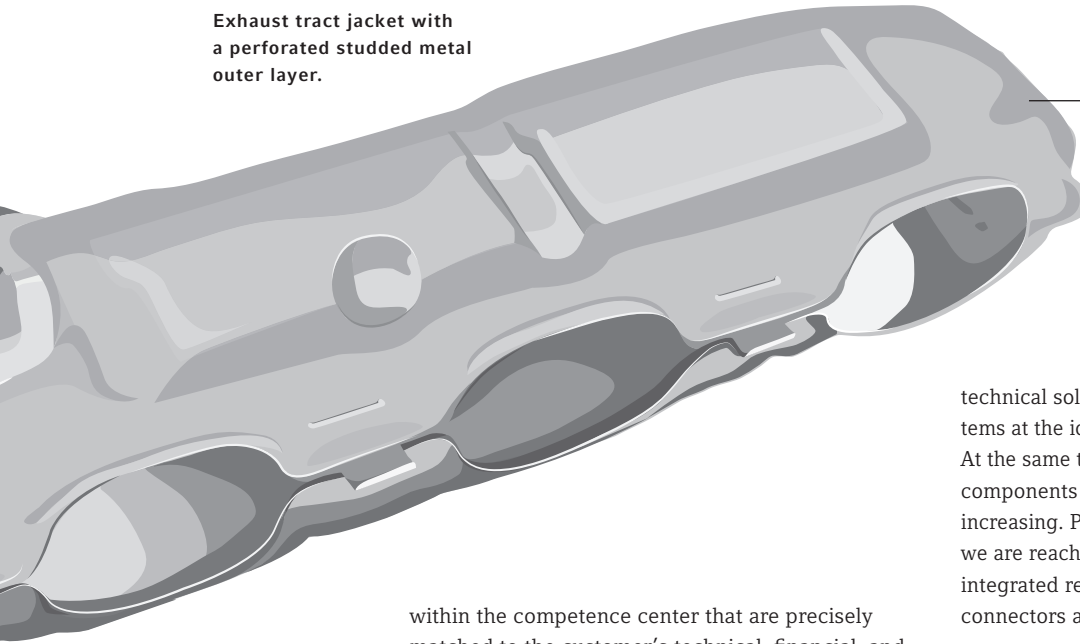
If you want to control heat and noise effectively in a vehicle, you have to understand the whole “car system.”
Peter Walker, Head of the Shielding Technology division, explains how effective shielding works and what challenges ElringKlinger is solving for current vehicle generations.

It hasn't really been that long since automobiles consisted almost entirely of mechanical components, the exhaust tract was just a simple pipe, and you could usually repair a vehicle using a few basic hand tools. Take a closer look at a modern vehicle, however, and you'll see that it now contains a large number of electronic components and lightweight materials. The exhaust tract resembles a small chemical factory, and the mechanic will often need to perform a series of checks with a diagnostic tool before undertaking any repairs. It is obvious that technological progress is greatly increasing the complexity of modern vehicles and that previously dispensable components are now essential. That includes, for example, many of ElringKlinger's shielding systems, which insulate heat-sensitive components and absorb sound in different areas of the vehicle.

Customized design

Development cycles are getting shorter and shorter, and the pace of innovation is rapid. What's more, there is simply less and less time for the industrialization of new developments. The development team in the Shielding Technology division is fully aware that increasingly complex relationships demand holistic thinking and a thorough understanding of the underlying systems, especially when you are dealing with mature technologies, such as combustion engines, and are tasked, for example, with important issues like the reduction of emissions. With this in mind, they bring together all the available experience of thermal and acoustic shielding and benefit from the wide-ranging expertise built up within the ElringKlinger Group. This makes it possible – in record time – to devise integrated system solutions

Exhaust tract jacket with a perforated studded metal outer layer.



The surface structure is designed to absorb noise.

within the competence center that are precisely matched to the customer's technical, financial, and environmental specifications. "We feel perfectly at home in places where it's either too hot or too noisy for others," explains Peter Walker, pointing to a table full of system variants, in many different shapes and sizes, all of which have one thing in common: they offer maximum insulation against extreme temperatures and noises, and can even reduce vehicle emissions, depending on where they are located.

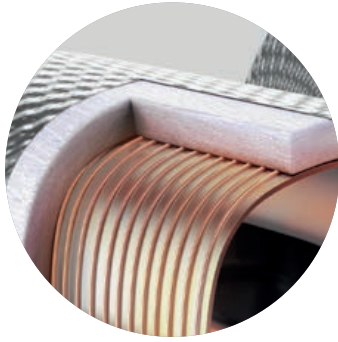
Protective shield against heat and sound

Demand for shielding systems has been growing continuously for many years. The need is great, and the explanation is simple. Tightly packed power units, more compact engines, ever-increasing levels of turbocharging, minimal cooling air flows, and new operating strategies, such as automated start-stop systems, keep pushing up temperatures in the engine compartment, underbody area, and exhaust tract, thus creating a demand for customized

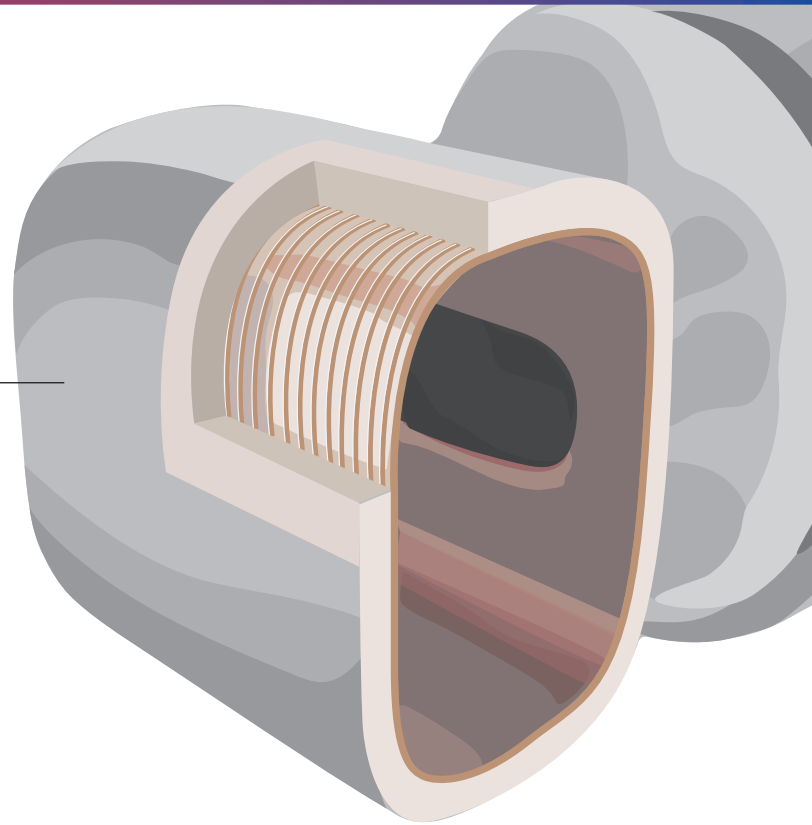
technical solutions, to maintain components and systems at the ideal operating temperature, for example. At the same time, the number of temperature-sensitive components that need to be protected from heat is increasing. Power units are now so tightly packed that we are reaching a limit in many vehicle models, and integrated retainers, seals, cable clips, fasteners, and connectors are already standard.

In order to be able to withstand operating temperatures of up to 1,000°C, the development team uses different material compositions, usually consisting of several layers. To illustrate the point, Peter Walker holds up an ElroShield D. The components made of one layer of stainless steel and a second layer of fiber material are assembled around various heat-conducting components, from the exhaust manifold and the turbocharger through to the catalytic converter. Besides insulating components from high temperatures along the exhaust tract, the technology has other advantages. For one, it reduces exhaust emissions because the cold start phase can be significantly shortened so that the catalyst reaches its optimal operating temperature more quickly. At the same time, ElroShield D also reduces noise from the exhaust system by a considerable margin.



**ELROACTIVE™**

ElroActive™ – a multi-layer shielding component with integrated heating elements for active thermal conditioning of exhaust systems.

**Overcoming technological boundaries**

It's perfectly clear that the automotive industry is currently under pressure from all sides. Although policymakers and industry are working together to drive change, demand for electric vehicles is stalling in many countries. Peter Walker stresses the huge challenges involved in meeting the average fleet emission levels prescribed in legislation within the specified time frame. He also notes that driving bans in urban areas are becoming increasingly problematic for many motorists. That makes it essential to further optimize existing technologies in combustion engine vehicles in order to deliver short- to medium-term solutions.

For Peter Walker, one solution that could be deployed relatively quickly involves actively controlling operating temperatures in the exhaust tract in order to minimize emissions of unburned hydrocarbons and nitrogen oxides during cold starts. Conventional catalysts are most efficient with a starting temperature of approx. 200°C. It can take some time before this temperature is reached. Meanwhile, exhaust gases enter the environment untreated. The goal is to keep this time to a minimum. Active electrical heating of the exhaust

tract shortens the time needed for the vehicle's exhaust gas purification systems to start cleaning and filtering out harmful emissions. The new system also promises to deliver major benefits in the commercial vehicle sector, where diesel engines tend to produce higher emissions, especially in slow-moving traffic. Here, an integrated electric heating system ensures that urea injection can start much earlier, converting nitrogen oxides into harmless nitrogen and water more quickly. And that's not all: the system can also be used to great advantage in hybrid vehicles. Whenever the internal combustion engine switches off, the electric heating wire ensures that the catalyst does not cool down and can therefore spring back into purification mode immediately if the driver suddenly accelerates.

In technological terms, the newly developed solution consists of a one-sided insulating material with heating elements on the exhaust gas component side; they are operated in output classes between one kilowatt and five kilowatts. A metal layer is attached on the outside to protect the material from mechanical or environmental damage.

900 °C

ElroActive™ can operate in temperatures up to 900° Celsius.

Depending on the vehicle model, the shielding system can be adapted to fit almost any location on the exhaust tract. It can even be retrofitted to existing exhaust tracts to achieve better emission ratings. This solution is particularly cost-effective if it puts the vehicle in a lower emissions category so that it can be driven, for example, in city centers that have introduced a ban on those vehicles that do not meet certain Euro standards.

The many advantages of this newly developed system have been confirmed in recent bench tests performed in collaboration with universities and car manufacturers. According to measurements recorded during these tests, installing the system can reduce nitrogen oxide emissions by more than 50%.

Peter Walker is absolutely convinced of the system's potential – so much so, he says, that he and his team are now doing everything possible to ensure that this innovation can further reduce emissions from existing and future generations of vehicles.

A clear focus on the future

When asked how he sees the future of his division, Peter Walker responds without a moment's hesitation. He is aware of the scale of the changes needed and has already analyzed potential new applications together with his team. That includes many areas of research related to battery technology, shedding more light, for example, on the impact behavior of battery housings.

He is certain that technologically sophisticated shielding systems will also be needed in electric vehicles, perhaps more in order to deal with electromagnetic radiation rather than extreme temperatures. Magnetic fields are created wherever electricity flows in large quantities, and this can affect radio signals and mobile phone communications. The first prototypes for electric vehicles have already been developed.

» The shift towards electromobility opens up completely new applications for us. Above all, we see a lot of potential in combining different functions, such as thermal and electromagnetic shielding. «

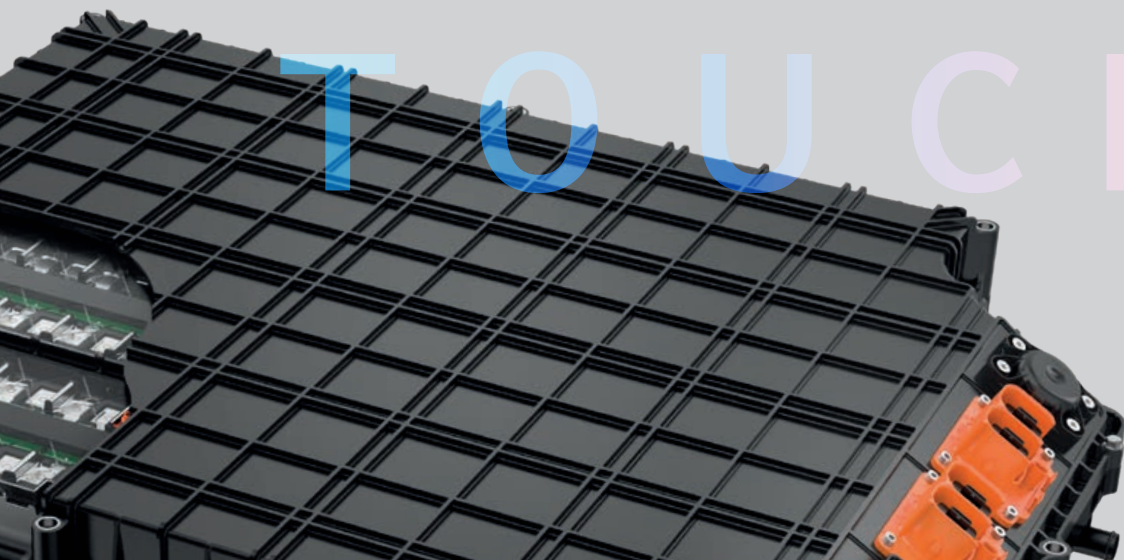
Peter Walker, Vice President Shielding Technology, ElringKlinger AG



Made of LWRT (Low Weight Reinforced Thermoplastic) and glass-fiber-reinforced thermoplastic, this underbody protection is ultralight and suitable for extreme stresses at the same time – properties that make it particularly interesting for electric vehicles. The LWRT weighs just 1,400 g/m².



THE POWER OF A LIGHT TOUCH



Increased safety, comfort, and vehicle dynamics combined with lower energy requirements and emissions – modern mobility is intended to be climate-friendly and efficient. This is an overarching societal aspiration that the automotive industry is meeting head on with innovations and new key technologies. Core issues such as lightweight design, which also encompasses function integration and resource efficiency, are more relevant than ever before in an age of increasing electrification.

For fossil fuel drive systems the simple formula of “lower weight = reduced fuel consumption = lower CO₂ emissions” summed up the crucial environmental benefit in a nutshell. The equivalent for electric vehicles – “lower weight = less energy requirement = longer range” – also sounds good but appears to be less convincing due to energy recovery in the case of battery-powered vehicles. There is no doubt that part of the kinetic and potential energy is returned to the battery pack system during the braking process thanks to recuperation. However, the extent to which this actually takes place has been investigated by the KIT (Karlsruhe Institute of Technology) and the Fraunhofer ICT (Institute for Chemical Technology) in a joint study using the example of a fully electric vehicle. It was discovered that a lower vehicle weight not only led to slightly lower energy requirements but above all that rolling, acceleration, and gradient resistance declined significantly. At the same time, not all of the energy was able to be recovered through recuperation.

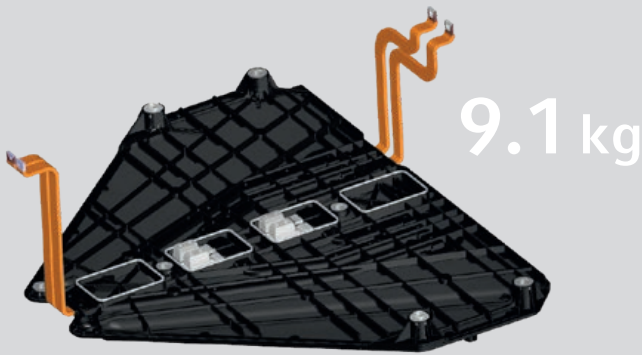
Our efforts to achieve greater quality of life in urban centers is also shifting focus to another aspect: the German Environmental Agency investigated the causes of particulate emissions in Germany and arrived at the result that around 20% are attributable to the transport sector, over half of this being caused by the abrasion of tires and other components. Significant parameters include the driving style, tire quality, road surface, and the weight of the vehicle. The KIT and the Fraunhofer ICT have calculated that a 20% increase in tire load also leads to 20% higher abrasion. This could be expressed simply as “lower vehicle weight = reduced tire abrasion = fewer particulate emissions.”

ElringKlinger is of the opinion that lightweight design offers far more advantages than merely saving weight, because the lightweight components that can now be implemented in almost every area in vehicles are far superior to conventional variants, particularly due to their increased function integration and the related cost savings. In combination with modern, precisely coordinated manufacturing processes, the wealth of “light” materials that are available enables products with complex geometries to be produced in short

1.5 kg



Hybrid lightweight design concepts combine the best respective properties of the different materials. The image shows a rocker panel for the framework of a battery-powered electric vehicle. Thanks to the combination of aluminum and plastic, it weighs just 1.5 kilograms.



Highly integrative: weighing 9.1 kg, this intermediate plate for battery modules consists of a crash-relevant basic composite fiber structure and includes bus bars and sealing elements. It is manufactured in what is called the one-shot process, meaning that all insert parts are positioned directly in the injection molding tool. This enables maximum possible form accuracy and leads to assembly cost savings at the same time.

cycle times. Added to this is a range of additional advantages that Klaus Bendl, Head of the Lightweighting/Elastomer Technology unit at ElringKlinger, sees as further reason to continue pushing the technology forward: "From the perspective of a manufacturer, I am delighted about the high dimensional stability, i. e., the highly precise and stable dimensional accuracy, that we can achieve with lightweight design technology in large-scale production. This may not be directly perceptible to end customers, but they get to experience something completely different, in a positive sense, namely improved vehicle dynamics with maximum possible safety."

Plastic-based composite materials such as continuous-fiber-reinforced thermoplastics, for example, are being used with increasing frequency to save weight in structural and energy-absorbing components. They are as solid and resilient as metal but can be processed faster and more easily. This includes organo

sheets and unidirectional tapes (UD), which are reinforced with carbon, glass, or aramid fibers, for instance. Thanks to their very good mechanical properties, these ultralight material compositions are interesting for crash-sensitive structural areas such as the underbody, battery environment, and front or rear end, which are vulnerable in the event of crashes. They are highly flexible in terms of their formability and surface impact, thus allowing aerodynamically optimized designs, including designs with high noise absorption, depending on application area. For instance, ElringKlinger processes a glass-fiber-reinforced, unidirectional continuous fiber tape to shield the underbody of battery packs. It is lighter in comparison with metal, aluminum, and titanium variants, and offers higher thermal insulation and, above all, considerably better impact energy absorption. Particularly in the case of battery-powered electric vehicles, the latter is of enormous importance for occupant safety in the event of a crash.

For such vehicle components, the product developers work out the precise form and combination of the materials to be used until the optimum is achieved. Biometric structures are often used to make components stiffer, more stable, and lighter. The engineers use software and topology optimization to calculate the points at which material is superfluous and where areas have to be reinforced to counteract excessively high stresses. This is how ElringKlinger R&D engineer Matthias Biegerl designed a so-called hybrid rocker panel as a load-bearing element for the framework of an electric vehicle together with project partners as part of a research project. The component is character-

» **F**or us, lightweight design means function integration, weight reduction, and production efficiency in one. «

Klaus Bendl, Vice President Lightweighting/Elastomer Technology, ElringKlinger AG

4.2 kg



As a body component, the 4.2 kg cockpit cross-car beam performs a stability function and supports the cockpit elements, including the steering column, airbags, air conditioning system, and instrument panel.

ized by an innovative tool concept: it was specifically reinforced by means of plastic injection molding. This improved what is referred to as its buckling resistance, which is important for high impact energy absorption in the event of a crash. Biegerl combined the best properties of both metal as well as short and continuous fiber-reinforced thermoplastics: the higher stiffness of the metal and the greater strength of the organo sheet. The cockpit cross-car beams and front-end carriers supplied by ElringKlinger as series-production components are also hybrid parts consisting of metal and plastic as base materials. Although they are up to 40% lighter than conventional, pure metal variants, these body components are characterized by high crash safety and increased function integration. This is supported by a special

manufacturing process that combines hydroforming with plastic injection molding in a single process step: as the basic material, an aluminum tube is brought to the required shape and plastic elements are molded on in the same tool sequence.

“In lightweight design, we combine function integration, weight reduction, and production efficiency. This succeeds because material and process know-how are intermeshed throughout the entire development phase of our products,” sums up Bendl, and concludes by pointing to another of the technology’s advantages: “The thermoplastic materials can be regranulated, meaning that they can be recycled at the end of a vehicle’s life and reused as raw material in a completely new product cycle somewhere on our planet.”

LIGHTWEIGHT E-MOBILITY

Comfort, safety, and a protected environment are required to make driving in an electric vehicle a positive experience. The key technology of lightweight design, which involves far more than mere weight reduction, makes an important contribution to this.

Cockpit cross-car beam,
front-end carrier, front-end adapter,
door module, roof support

Battery housing,
seat structure, seat shell



Front-end underbody,
major assembly carrier

Rear-end underbody,
battery base, wheel arch shell,
rocker panel

For ElringKlinger, a number of possible applications for lightweight design solutions are conceivable in electric vehicles – the figure shows some of them.

AFTERMARKET



... in 2019 over 5,000 people in 28 countries attended our technical product training courses?

... our online spare parts catalog is available in 27 languages and contains more than 12,000 different gaskets, gasket sets, and service parts?



Did you

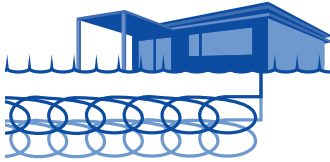
... ElringKlinger supplies cylinder-head gaskets for more than 2,000 different vehicle models?



... ElringKlinger can make customized cylinder-head gaskets for vehicles of all ages?

ENGINEERED PLASTICS

In the past 70 m²



With ThermoGenius™ 1.5 m²



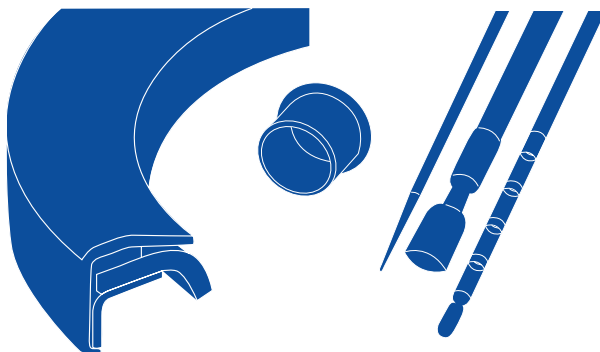
... the ThermoGenius™ geothermal water heat exchanger from ElringKlinger Kunststofftechnik requires a water surface area of just 1.5 m² to heat or cool a building in an environmentally friendly manner?

... ElringKlinger Kunststofftechnik supplies radial shaft seals specifically for high-speed e-mobility applications involving speeds of up to 20,000 rpm, and even as high as 150,000 rpm in other applications?



know that

... over 100 highly specialized, tailor-made material compounds from ElringKlinger Kunststofftechnik are used in a broad array of customer-specific applications?



... ElringKlinger Kunststofftechnik has sites on three continents and supplies some 4,000 customers in a vast range of industries worldwide – alone in Asia in 25 countries?

Global presence

45 sites



NORTH AMERICA

26%

SHARE OF SALES

2,069
EMPLOYEES

7
SITES

SOUTH AMERICA AND REST OF THE WORLD

4%

SHARE OF SALES

427
EMPLOYEES

2
SITES

EUROPE (excluding Germany)

29%

SHARE OF SALES

2,028
EMPLOYEES

12
SITES

ASIA-PACIFIC

18%

SHARE OF SALES

1,545
EMPLOYEES

11
SITES



GERMANY

23 %

SHARE OF SALES

4,324

EMPLOYEES

13

SITES

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