The SGL Carbon Magazine 01_18

thinc Brand New

sgl carbon

Braking Art

Zoom

Whether for example, a Porsche, a Ferrari, a Bentley, a Bugatti, a Lamborghini, or an Aston Martin, Audi, BMW M or Mercedes AMG—without a doubt, all of these cars are beauties. Yet what is exceptional about them is not just in the elegant car body, the breathtaking engines or the exquisite interiors—it is also in the braking systems.

The carbon-ceramic brake discs from the joint venture between the Italian brake system manufacturer Brembo and SGL Carbon combine aesthetics and sheer efficiency. The secret of these brake discs is the ceramic composite material. Both the body and the friction layers applied to both sides of the brake discs consist of carbon fiber-reinforced silicon carbide—the hardest material except for the diamond.

Compared to the usual gray cast-iron brake systems the carbon-ceramic brake discs are 50 percent lighter, offer higher temperature resistance, and have a significantly longer service life.

Moreover, the partners won the "Compasso d'oro", the Golden Compass international design prize with their brake disc. As the jury explained: "If it was not a brake it would be a sculpture worthy of any modern art museum."

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What is #newsgl? What makes it special? What does it represent? These were just a few of the questions we have been dealing with over the past several months. What is come out of it is SGL Carbon's new brand promise: we have moved even closer to our customers. We consider ourselves a partner and source of inspiration, finding answers to the questions of tomorrow and seeking solutions. The future of the world and of SGL Carbon revolves around **#smartsolutions**.

Our world is fast-paced, versatile, complex and at the same time full of opportunties. From this point forward, **#sglthinc** will be offering trendsetting stories from the SGL Carbon cosmos twice a year: we'll shine a light on special partnerships and take a detailed look at the great social challenges of our time. Read about brands and their strategic importance in our cover story, or wend your way through the "[R]Evolution on the Streets" and the opportunities offered by sustainable mobility.

At SGL Carbon, we are thinking a step ahead to anticipate future developments. Follow us with our new magazine. We hope you enjoy reading the first issue! **#petrolisthenewblue**

Images: Cover: Ulrike Myrzik; Ulrike Myrzik (Flyer), SGL (Carrier), Ricky Rhodes (Magnifying Glass)

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Brand New

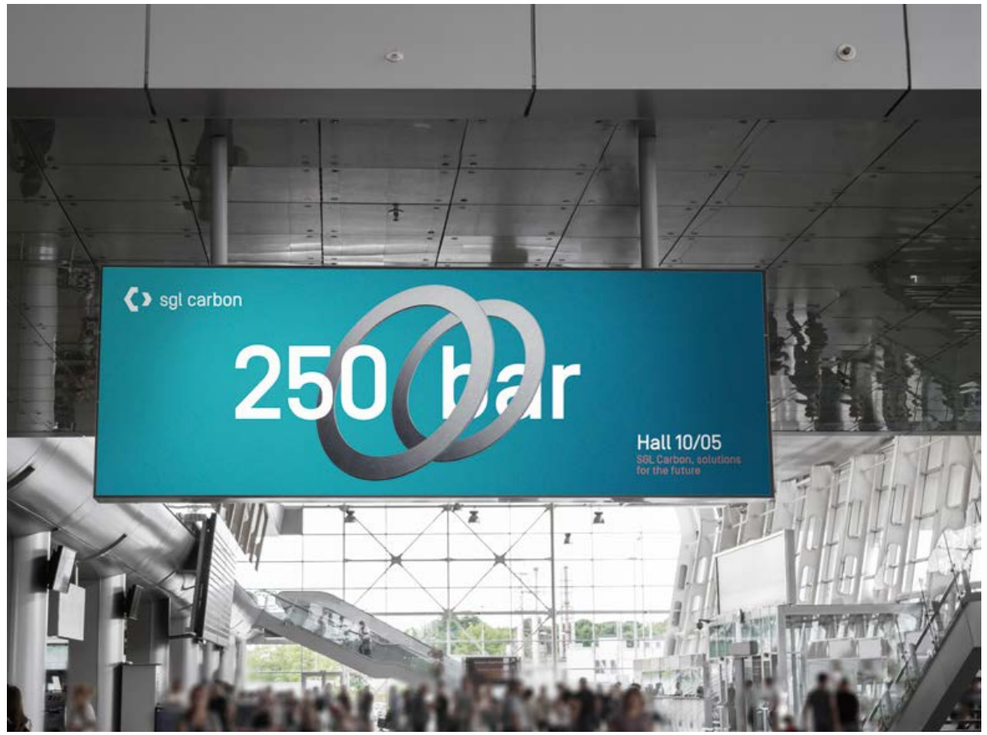
› As the new SGL, we focus our thoughts and actions on our customers. ‹

Andreas Pütz
Head of Corporate Communications and Marketing

Brand management for many B2B companies has developed from being “nice to have” to being a “must have.” A differentiated brand image can make a difference in a competitive market. Companies that focus on strong branding increase their chances for success and boost trust among customers.

A word can change the world. That was the approach that the American technology company Intel pursued in the 1990s. Intel produced processors that made computers faster, but almost nobody knew that these parts were installed deep within the hardware. As PCs became increasingly popular, and speed the most important purchasing decision, Intel saw its time had come. The company added just one little word to its name and created a brand: “Intel inside.” Which meant: if Intel is in your computer, it will be fast. Almost immediately, Intel’s processors became the global leaders because buyers identified them as a mark of quality. In retrospect, Intel’s targeted brand campaign turned out to be a historic marketing success.

Within the world of B2B companies, this story is considered a blueprint for good brand communication—today more than ever. Because of increasing standardization and growing competition from Asia, the B2B market is dominated by offerings that are frequently of the same high quality, with differences measured in nuances. Customers are all too often spoiled for choice. Companies that proactively position their brands increase the chances for success. “A strong B2B brand describes what a company stands for and what makes it special,” says Karsten Kilian, professor for brands and media at the University of Applied Sciences Würzburg and one of Germany’s leading brand strategists. “Every company has personality, a brand. But it is about consistently bringing it to life.”



The company’s visual presentations will be featuring the new brand image starting in June 2018, whether on the internet, for print materials or at trade shows

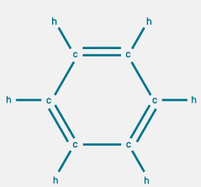
For the in-house brand launch, employees received a number of items, including a notebook, on the first page of which the essence of the new brand was explained in detail.

Images: Ulrike Myrzik (Buch); SGL (Airport)

Numerous studies demonstrate the increased importance of brand strategies, including a survey by the management and consulting firm McKinsey of 1,000 purchasing decision-makers from Germany, the United States and India. Among the respondents, 27 percent from Germany stated that they had been influenced by a company’s brand strength when making purchasing decisions. Asked about the reasons for the strong relevance of the brand, 42 percent said that trusted brands are associated with a minimized risk. “The brand is frequently described as a repository of knowledge,” Kilian says. “We associate that with impressions and experiences. If a company delivers high performance for years and years, this experience gets deposited in the brand’s knowledge repository, which becomes a factor of added value.” Which means that the famous words of American businessman Steve Forbes remain true to this day: “Your brand is the single most important investment you can make in your business.”

This is why SGL Carbon has been very intensely involved with the topic of branding for the past two years. “As part of our strategic realignment and the sale of the former core business, which had shaped the company’s identity for years, we asked ourselves the question of who we are and what the company should principally stand for,” says Head of Corporate Communications and Marketing Andreas Pütz. To help answer this question, the company surveyed more than one hundred people around the world—starting with employees, then moving on to customers, analysts and journalists, too.

Through the close interconnection with the business strategy, the new brand core “smart solutions,” including vision, mission and new brand



sgl carbon

The hexagonal shape of graphite‘s chemical structure provides the formal basis of the new logo‘s appearance. The „C“ represents the chemical symbol for carbon. The arrow-like element symbolizes dynamics and therefore the brand value „providing impetus“.

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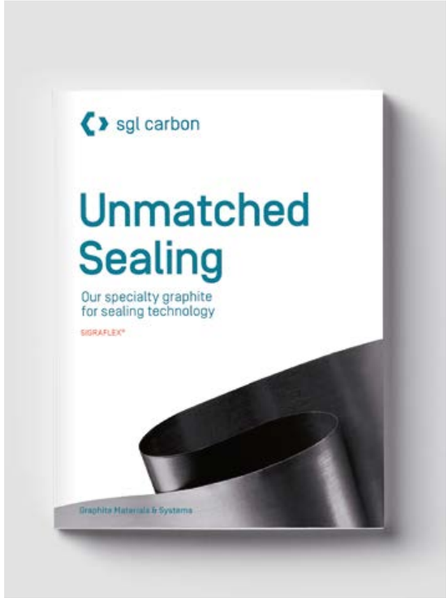

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1 The brand was introduced in the company at the global management event in early 2018.

2 The color choice for the brand is also an important factor of differentiation.

3 Susanne Mändle and Andreas Pütz from the communications and marketing team discussing a brand project.

4/5 Potential digital applications for the brand design were considered from the start on. The launch of a new website followed.

6 The future product brochures also follow the brand's goal of presenting things in a straightforward and easy-to-understand manner.

7 A wide variety of materials are now being progressively adapted. The rebranding will be completed by the end of 2019.

Images: Ulrike Myrzik (5x), SGL (presentation, books)

A leaflet about the new brand serves as a compact explanation and eye-catcher for the in-house rollout.

values emerged. "SGL Carbon was and is a technology-based company," Pütz continues. "But today, we are so much more than just a materials supplier. Working together with our customers, we develop smart solutions for the key future fields of mobility, energy and digitization. We are thus a manufacturer, supplier and development partner. As the new SGL, we focus our thinking and actions on our customers."

It is an approach that illustrates how greatly the requirements for a brand strategy have changed in the past years. Brand strategies back in the 1980s and 1990s for the pioneers of Silicon Valley, such as Intel and IBM, focused principally on the companies' first-rate products. Nowadays, however, it is customers who are the main focus. As the journalist Cartin Bialek puts it, "Brands mean margins. They are the glue between a company and its customers."

> Together with the management team, the CEO is the linchpin of brand success.

Karsten Kilian
professor of brands and media

Employees, as well, are always central to successful brand communication. As compared to the B2C market, they are the ones who are mainly responsible for selling products in the B2B market and whose expertise and personal presence stand for trust, quality and innovations. The people make the brand. The brand drives the strategy. And the strategy and therefore the people in turn drive the brand. So that the brand can be successful, this cycle must work—up through to the executive level. "Together with the management team, the CEO is the linchpin of brand success." Kilian explains. Nonetheless, the brand has to be brought to life by everybody.

Thus, employees also make a huge contribution to how quickly a new brand becomes established. At the same time, the company cannot relax its efforts to anchor the company's new image in the minds of its customers. "We are taking the brand as the benchmark, leaving no stone unturned in living up to our commitment to be a smart company," Pütz says. "The brand is a central tool for us within the company, helping to drive change."

The brand's commitment is visually transported by the new corporate design, developed by the Munich-based branding agency KMS Team. "The strategic realignment marks a new era for SGL Carbon, a change that we wanted to visualize both inbound and outbound," says KMS Team Managing Partner Knut Maierhofer. "The new visual appearance, including the new logo, illustrates the corporate strategy, the expertise and the innovative power of SGL Carbon."

This is moving in the right direction, in the opinion of brand expert Kilian. Asked about the key characteristics of successful B2B companies, he says: "Innovations and again innovations. And please do not forget the branding."

A Brand for the Future

Interview

Dr. Jürgen Köhler, CEO of SGL Carbon, explains why now is the right time for an SGL brand relaunch and how employees play a key role.

Mr. Köhler, with a new name, new positioning and a new appearance, how new is the new SGL Carbon?

The world is changing and our markets are changing. And we have faced up to these changes in the past three years. The strategic realignment means the start of a new era for our company, with a focus on the key topics of the future: mobility, energy and digitization.

How does this effect your way of doing business?

We are evolving from a production-oriented company to a customer-focused one. What this means in practice is that we consider ourselves a partner to our customers. For the new SGL, our clients' needs are always the starting point for all of our actions and thinking.

How exactly will this objective be achieved?

The key topics for the future call for more intelligent, networked solutions that are more efficient and sustainable over the long term—in brief, "smart solutions." Developing and delivering these solutions is our aspiration and is our central value proposition.

The company has just completed a phase of consolidation. Why is investing in a new brand still important?

With the completion of the strategic realignment, a new era begins for SGL. A new beginning is the right time to consider and sharpen our profile. With the revised brand, we clearly show our commitment to our customers and what we demand from ourselves. The investment in the new brand is therefore an investment in the future.

But then why keep the old SGL Carbon name? How does that work?

We know from customer surveys that the names SGL and Carbon are inseparably linked. The wordmark "SGL Carbon" expresses the company's core expertise and origin—its DNA, so to speak. The newly developed word and figurative mark along with the modern appearance bridges our origin and the future.

How do your employees contribute to the success of the SGL brand?

They are the key to our success. Our employees help customers truly experience the brand. How we conduct ourselves on a day-to-day basis—both internally and externally—is a testimony to the quality of our company and the strength of our brand.

Jürgen Köhler in discussion with managers about the significance of the new brand.

Images: Ulrike Myrzik; SGL (Interview)

In a Nutshell

News about the company, trends, products and partnerships.

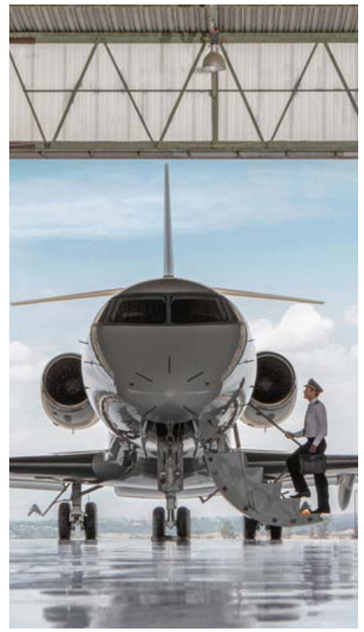
Debut at the ACHEMA

The new SGL Carbon brand can now be experienced at trade shows. The company will be introducing its new appearance for the first time at ACHEMA, the leading international trade fair for the chemical industry, process technology and biotech, from June 11 to 15, 2018 in Frankfurt. The contents of the trade fair presentation also reflect the essence of the realigned company. In addition to innovative products such as a new tube sheet system for silicon carbide heat exchangers [SICABON®], high-strength press-to-size specialty graphite [SIGRAFINE® EK29], oxidation-resistant textile yarns [SIGRAFLEX® OXR yarn] for high-temperature applications and Best-in-Class sealing materials made of expanded graphite, SGL Carbon will also be demonstrating how complex components made of carbon and silicon carbide can now be produced using 3D-printing. Examples of partnerships include the cooperation with GEA in the field of vacuum systems/jet pumps and the cooperation with SULZER Chemtech on the joint development and marketing of column internals made of carbon fiber-reinforced carbon [SIGRABOND®]. Furthermore, visitors can get a glimpse of current projects on digitization of the chemical process technology.

You can find SGL Carbon at ACHEMA at booth F26 (process technology) in Hall 4.0 and also at booth L81 (solutions made of expanded graphite, carbon and graphite materials) in Hall 8.0.

Perfect Placement

For the further development of lightweight construction with composite materials, the type of processing is paramount. An especially future oriented procedure is the automated and particularly material-efficient placing and cutting of the fibers, a process known as fiber placement. In early 2018, to increase the use of this manufacturing technique in mass-production applications across industries, SGL Carbon founded a joint Fiber Placement Center at the SGL facility in Meitingen, Germany, together with the Fraunhofer Research Institution for Casting, Composite and Processing Technology (IGCV) and additional partners. This new development and production center, with more than 500 square meters of space and a wide variety of high-tech equipment, offers its customers the opportunity to develop manufacturing concepts involving fiber placement and to test them with prototyping. Subsequently, large scale production can be accomplished at SGL Carbon.



Super Fiber

It is designed for aerospace, but can also be used in applications for pressurized vessels, drive shafts and many other applications: SGL Carbon's new, high-performance carbon fiber, the SIGRAFIL® C T50-4.8/280. It complements the company's broad fiber product portfolio and combines high tensile strength and rigidity with suitability for serial production. The uniqueness lies in the fact that this is fiber with many filaments (50,000 pieces) and exhibits properties no other large tow carbon fiber does. The SGL Carbon development teams have thus transferred their experiences in serial production for the automotive industry to other industrial sectors.

One-Stop Shop

To date, many automotive companies and manufacturers from other industries still rely on cooperations with various experts for lightweight construction projects with composites. However, support from a single partner is increasingly in demand. SGL Carbon is one of the few solution providers that can successfully deliver this. The company further strengthened this position at the end of last year with the purchase of Benteler's 50-percent stake in the former Benteler-SGL joint venture and the incremental acquisition of BMW Group holdings in the former SGL Automotive Carbon Fibers joint venture. Over the years, comprehensive development work occured in both of these joint ventures to establish the use of carbon as a lightweight construction material in the automotive industry and to bring it into serial production. The state-of-the-art facilities in Ried and Ort in Austria, plus Wackersdorf, Germany, and Moses Lake in the United States, are now being fully integrated into the SGL Carbon production network.

Home of Speciality Graphite

Bonn, Germany, is many things: former German capital, city of science, home to a United Nations Campus, or headquarters for Deutsche Telekom and DHL. But it is also the home of specialty graphite. The SGL Carbon facility here, with around eight hundred employees, produces a variety of very specific graphite materials and solutions, particularly for the solar, LED and semiconductor industries, but also for the automotive sector. For the latter, among other things the company won a major contract from Rheinmetall Automotive Pierburg. In order to meet the increasing demand for special graphite components for automotive pumps and gaskets, SGL will be investing around €25 million over the next four years to expand its manufacturing capacities at its Bonn facility. Along with new production lines, a new building is also being set up.

Images: Echo (Flugzeug), Getty Images/Westend61 (Bonn)

[R]Evolution on the Streets

The long period of evolutionary development in the automotive industry is rapidly being replaced by disruptive innovations. New competitors are expanding the range of possibilities and increasing the speed of innovation. **Lightweight construction with composites**, as well as **graphite-based solutions** for alternative drivetrain systems, are playing a central role.

Lightweight Construction

They have a lot in common, yet are so different. A passing glance at the Tesla Model S and the BMW i3 shows two electric cars that have helped shape the future of mobility—but a second look reveals that the two are taking very different approaches. On one side you have Tesla, a disruptive tech company, that in typical American fashion is betting on cars built from steel and aluminum that can travel long distances. And then there is the BMW i3, better suited to urban spaces, a lightweight construction with a passenger compartment made of 100 percent carbon fiber-reinforced plastics. These differing concepts beg the question: Which is the most promising approach? Or will we need other approaches?

It is hardly surprising that a wide variety of different scenarios are currently being considered. The automotive industry finds itself in the midst of a revolutionary transformation, with increasing numbers of tech companies beginning to compete with traditional carmakers. Both want the same thing: to create the mobility of tomorrow. This mobility must be capable of fulfilling

The future is in the mix: both the new BMW i8 Roadster and the new BMW i8 Coupé are based on the LifeDrive vehicle architecture with an aluminum chassis and a passenger compartment made of carbon fiber-reinforced polymer

Image: BMW Group

Two Drivetrain Technologies for the Future

Alongside lightweight construction, emissions-free drives rank among the important elements of future mobility. The continued development of these systems, whether using lithium-ion batteries (LIB) or hydrogen-based fuel cells, requires the interplay of a variety of components as well as new, particularly high-performance and long-lasting materials.

In the long run, lithium-ion batteries, which have become the accepted standard, will play a crucial role for energy storage in electric vehicles. SGL Carbon has been a partner in this area from the very start and is the leading manufacturer of synthetic graphite for anode materials in this market. One of the company's main strength is its close collaboration with its customers. Decades of development work have resulted in the continual optimization of the technology for the material used in the anodes, which is based on synthetic graphite. At the same time SGL Carbon participates in various research and development cooperations with leading automobile and cell manufacturers.

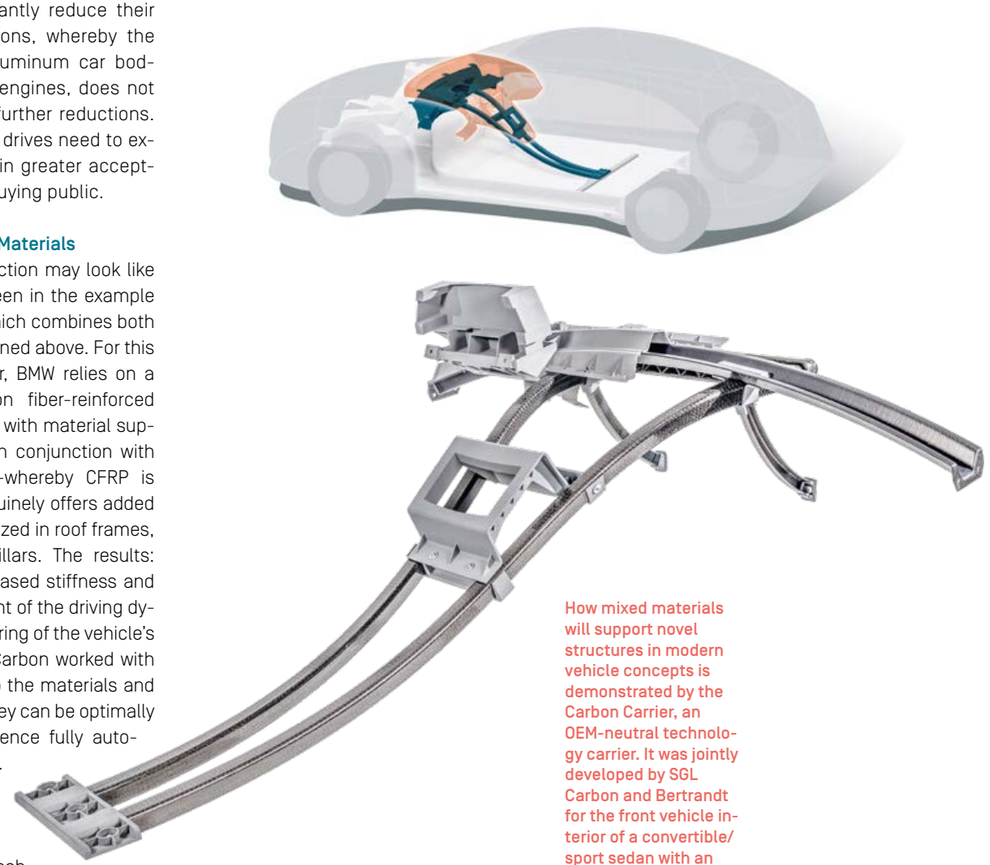
customer needs while also helping the environment with reduced carbon-dioxide emissions. At the same time it has to be perfectly safe and still be seen as economical by society and businesses. The new mobility—it is complex and multifaceted.

So a lot of options are being tested, as the examples of Tesla and BMW show. But the ideas are not limited only to electric cars in this process. The era of the combustion engine is far from over. Yet the two drivetrain systems have different challenges: For this combustion car engines must significantly reduce their carbon-dioxide emissions, whereby the weight of the steel/aluminum car bodies, as well as of the engines, does not leave much room for further reductions. In turn, the alternative drives need to extend their range to gain greater acceptance among the car-buying public.

The New Trend: Mixed Materials

What car body construction may look like in the future can be seen in the example of the BMW 7 Series, which combines both of the materials mentioned above. For this combustion engine car, BMW relies on a combination of carbon fiber-reinforced polymer (CFRP), largely with material supplied by SGL Carbon, in conjunction with steel and aluminum—whereby CFRP is used only where it genuinely offers added value. It is primarily utilized in roof frames, side skirts and the pillars. The results: weight reduction, increased stiffness and safety, and improvement of the driving dynamics due to the lowering of the vehicle's center of gravity. SGL Carbon worked with BMW to further develop the materials and carbon fibers so that they can be optimally used in large-scale, hence fully automatic mass production.

Further examples also indicate that hybrid construction techniques are the future. Audi, for instance, utilizes a similar solution in the A8; CFRP is used primarily in the rear panel and ensures better vehicle stability with concurrent weight reduction for the component. Volvo in turn uses a leaf spring made of SGL Carbon glass fiber-reinforced composite, which weighs 65 percent less than conventional heavy steel springs (see the



How mixed materials will support novel structures in modern vehicle concepts is demonstrated by the Carbon Carrier, an OEM-neutral technology carrier. It was jointly developed by SGL Carbon and Bertrandt for the front vehicle interior of a convertible/sport sedan with an electric drive and contains all the important functional parts and trim of a traditional instrument panel.

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1 Filling up for tomorrow: electric vehicles are an elementary part of the (r)evolution on the streets.

2 There is more graphite than lithium in lithium-ion batteries. A vehicle like the Tesla S 90 contains around 90 kilograms of graphite powder.

3 There is also carbon in the fuel cell, namely in the form of gas diffusion layers based on carbon fibers. These interlayers ensure an even distribution of gas to the catalyst.

Images: Tesla

For instance, the Fab4Lib project is advancing the potential German mass production of LIB cells.

Graphite is a irreplacable component of anodes in these battery cells. In fact, there is more graphite than lithium in these batteries, despite the LIB name: about one kilogram per kilowatt-hour of battery capacity in the car. By way of example, a car like the Tesla S 90 contains almost 90 kilograms of graphite.

Synthetic graphite has proven to be more advantageous for LIBs than natural graphite. As SGL Carbon's Head of Battery Solutions Dr. Peter Roschger explains: "Firstly, its performance profile can be systematically controlled through its synthetic production. Secondly, the reproducible production process means consistent quality."

And development continues apace: to increase the capacity of both the anode and the LIB, SGL Carbon is working on improving the formulas and processes. Such as a compound of carbon and silicon, known as a carbon-silicon composite. The market has very high expectations for silicon with respect to improved energy density. Even though silicon combined with graphite will be adopted as a complementary technology in special fields of application, it is expected that graphite will continue to be the dominant feature in LIB anodes also in the future due to its outstanding price/performance profile.

Fuel Cells Ascendant Again

Yet batteries are by no means the sole focus for alternative engines. Fuel cells where cars are powered with hydrogen, rather than with gas or diesel, are looking promising again. Vehicles with this technology run very efficiently, and like electric cars are extremely quiet when in operation and above all have no harmful emissions.

People had high hopes for fuel cells back at the end of the 1990s. Experts predicted they would quickly be enormously successful. However due to a lack of infrastructure—filling stations were few and far between—and concerns over safety, the predictions never came to fruition. By now, however, fuel cells are absolute-

article on page 28). Among experts, the secret to success has long been known: for the mobility of the future it is all about using the right material in the right location.

Mixed materials will also allow novel structures in the modern vehicle concepts of the future, as demonstrated by the Carbon Carrier, which SGL Carbon developed in cooperation with the development solutions specialist Bertrandt. The flexible, OEM-neutral technology carrier was developed for the front vehicle interior of a convertible/sport sedan with an electric drive. The model contains all the important functional parts and trim of a traditional instrument panel. Even the structural components were redesigned. Taken together it gives the interior an airy, light and free-floating feeling.

"While designing the Carbon Carrier, we made sure that the components, technologies and assembly concepts used, were ready for large-scale production either today or in the near future," says Bertrandt's Head of Body Development/CAE, Michael Hage. This was deliberate: real solutions for the future are needed in large quantities—and they must be easy to integrate into existing vehicle production lines.

ly safe and the technology has improved tremendously.

This is why for the past several years car manufacturers and their partners, including SGL Carbon, having been putting a lot of work into fuel cell development. The so-called gas-diffusion layer (GDL) based on carbon fiber paper is one of the fuel cell's key components. These interlayers ensure an even distribution of gas to the catalyst, which is applied to both sides of the ion-exchange membrane that converts hydrogen and atmospheric oxygen into electricity and water. One of SGL Carbon's activities to further promote the use of this material is its participation since 2016 in the EU-sponsored INSPIRE project, which aims to develop a new generation of long-lasting high-performance fuel cells. Moreover, the company is also working on a number of customer projects dealing with fuel cells. The SGL team recently finalized an expanded cooperation with Hyundai. Specifically, SGL Carbon delivers the gas-diffusion layers for the fuel-cell car NEXO, which has been on the market as a production model since March of this year.

But which approaches will prevail? At the moment, work is proceeding on many solutions without anyone being able to say for certain what the future of mobility will look like exactly. Yet it is these very processes—tinkering and developing with current concepts—that are so important, allowing innovations to move from mere ideas to tangible benefits for society. This is not a new concept, but is actually something the well-known computer scientist Alan Kay said back in the 1970s: "The best way to predict the future is to create it."

Idea Factory

Since 2014, Dr. Tilo Hauke is in charge of the Central Innovation research department at SGL Carbon. He's been with the company for seventeen years.

So Tell Me, Mr. Hauke...

What was the most recent idea campaign for hybrid multilayered composites all about?

The idea campaign for hybrid multilayered composites is just one of several worldwide campaigns that we have carried out over the past two years. We've used this tool to inform all SGL employees about what the company is researching, and at the same time it creates a company-wide innovation network: every employee can weigh in and participate. It opens everyone's eyes to what's going on and accelerates the implementation of innovations.

How so?

Today we are primarily a "carbon" company. But when we look at the topic of hybridization, it becomes clear how valuable it can be to combine our materials with other materials as well. It opens up entirely new perspectives, new potential solutions, new applications—a very good foundation for material innovations. Every member of the innovation network naturally brings along their own contacts, and in this way we can quickly find interested external partners for innovative projects. It also allows us to get a very differentiated view of the current challenges.

Could you describe some specific types of hybrid composite materials?

Let us take a direct example from our idea campaign. For e-mobility, we need battery casings for lithium-ion batteries, which must be well protected against physical damage: carbon fiber reinforced polymer (CFRP) is ideal for this. The disadvantage is the low thermal conductivity. A possible solution: graphite foil has very good thermal conductivity. A hybrid laminate made of both materials makes a lot of sense here.

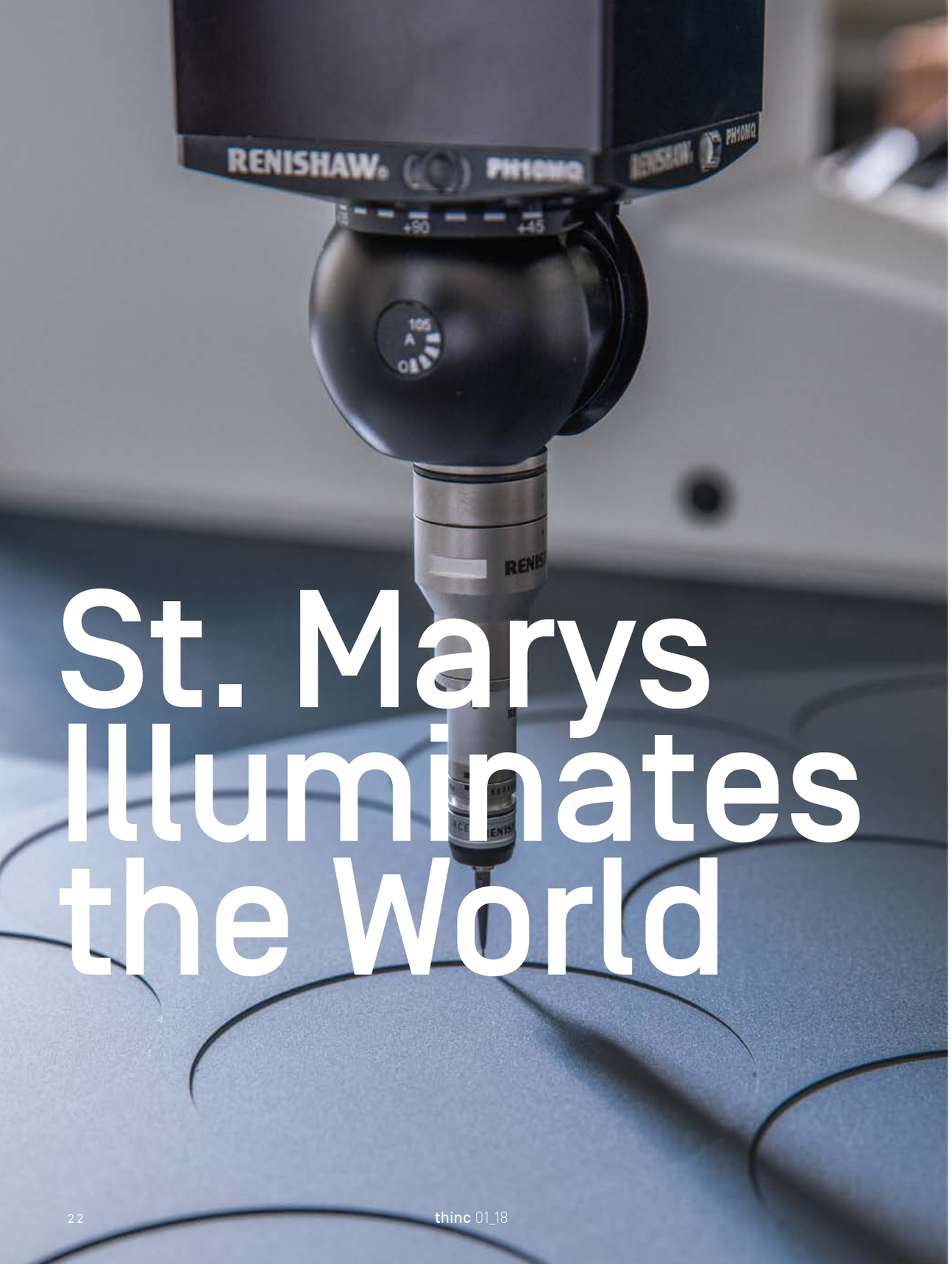
What other ideas are there for these innovative composite materials?

Right now, we are focusing on five specific proposals. Along with the e-mobility example, these also include multilayer composites of CFRP and wood for construction applications. This is not necessary a logical choice—but that is what makes it so interesting: the use of fiber-reinforced polymer layers can, for instance, increase the load-bearing capacity of wood or help reduce potential resonance effects and vibration problems in buildings. The electrical properties of carbon fibers could also enable the integration of electronic functions in the wood.

How is the company currently following up with the innovative ideas for hybrid composites?

We are looking for partners for each idea. For the battery casings, the partner is within the company, which makes it easier. For the combination carbon/wood composite, we need wood experts, for instance, whom we can find in our extensive network. We will know for certain in the next couple of months whether our ideas actually receive a positive response from the users we've targeted and how quickly we can work out innovative solutions for current challenges with the respective interested stakeholders.

Images: Dominik Gigler



St. Marys Illuminates the World

Semiconductors are one of the most significant technologies for the future. Increasingly powerful, they form the basis for LEDs and computer chips. With a multi-million dollar investment in its US facility in St. Marys, SGL Carbon further strengthens its position to support its customers in the industry with optimal solutions.

Wafer carriers for the production of LEDs and semiconductors require high standards in terms of dimensions, tolerances and purity. SGL colleague Keith Gore loads a LED carrier onto a measuring machine for final inspection.

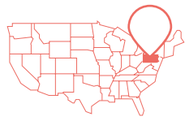
If you want to pinpoint the home of digitization, especially in the United States, it does not take long. Silicon Valley, with its many tech companies, is considered the hub of digital innovation par excellence. Companies such as Apple, HP, Facebook and Google are synonyms for creativity. In contrast to this, there is a small town named St. Marys located in the state of Pennsylvania, midway between New York City and Cleveland, Ohio. You would never guess that it plays a huge role in digitization as well. Yet here on the outskirts of the idyllic Allegheny National Forest essential materials and components are developed and produced, without which the digital transformation would never be possible. As an SGL advertisement from 1995 succinctly put it: Without graphite, you could only raise sheep in Silicon Valley.

Driving to the town, with its population of just around 13,000 residents, you pass signs warning of wild bears. Other signs, in turn, herald the many carbon and graphite companies that have set up shop in peaceful St. Marys. The lineage of SGL Carbon's St. Marys facility dates back to 1899, carrying digitization from St. Marys out into the world. The production capabilities in the largest town of Elk County, as the region is called, is a central location of SGL Carbon's production chain that enables and advances global digitization, especially of LED and semiconductor technology as the basis for computer chips.

Many manufacturers of LED and semiconductors rely on system components from St. Marys for their manufacturing processes—namely in the form of SGL Carbon graphite-based carriers coated with silicon carbide (SiC), known as wafer carriers. During the manufacture of LEDs or semiconductors, the chip blanks are deposited into prepared indentations on the round rotating carriers and are then coated with various semiconductor materials. This process also largely determines the properties of the LEDs, for instance their color or brightness.

Agriculture with LEDs

"LEDs and semiconductors will influence our lives even more than they have before," says SGL Carbon Global Product Manager Barry Hancox. LEDs in particular are becoming increasingly prevalent in our everyday lives. They are used not just in smartphone and television screens, but



St. Marys is located between New York City and Cleveland, Ohio in the US state of Pennsylvania.

Images: Ricky Rhodes

also in the automotive industry in headlights, daytime running lights, taillights, turn signals and interior lighting. More and more signage systems can't be made without LEDs. In vertical farming, special LED color combinations replace sunlight and thus make it possible to grow tomatoes and other vegetables all year long regardless of location.

"Light emitting diodes transform electricity into light with up to ten times more efficiency and therefore require only a fraction of the energy an incandescent light bulb uses," says SGL Carbon Technical Marketing Manager for Coating Technology Yad Singh. Nowadays many more properties of LEDs are coming into play. With digital controls, LEDs can rapidly switch on and off an enormous spectrum of colors, while being freely scalable and combinable in their size.

And the market for semiconductors, computer chips and other applications is also dynamic. Among industry experts, power semiconductors of silicon carbide (SiC) are considered a disruptive market force. Compared to semiconductors of regular silicon, they are faster, more robust and more efficient. Studies show that the worldwide demand in the SiC technology sector may rise to more than three billion euros by the year 2025, with double-digit growth rates. The figures for LEDs are even more impressive: studies show that sales volumes could rise to 45.5 billion euros by the year 2022 (from 16 billion euros in 2014)—helped by the fact that since 2012, with only a few exceptions, incandescent lamps are no longer being sold.

The strong growth is also fueling the demand for SiC-coated wafer carriers from SGL Carbon. In order to fulfill the increasing demand, the company is investing in the expansion of the SiC coating systems and the further development of its systems, solutions and expertise in St. Marys—a total of 25 million euros by mid-2018. The focus is on increasing capacities but also on the extreme cleanliness in production and process innovations. "Our customers work in sterile environments and we must continually adapt to this standard to remain

Modern gas control equipment helps to control the high temperature processes required to coat the graphite-based wafer carriers.

In addition to the robotic inspection of the carriers, a manual inspection process step is being performed by SGL CVD Technicians under clean room conditions.

Prior to entering the clean room, all employees dress in protective clothing and pass through the air shower to remove containments. SGL colleague Karen Hammonds is properly dressed and awaits entry into the air shower.

the preferred choice," says St. Marys Site Operations Manager Tom Detsch, who is also coordinating the expansion. Among other things it includes an expanded surface inspection designed to detect surface abnormalities in the carrier trays. "We are speaking of discovering deviations in the micrometer range," explains St. Marys Quality Manager Tom Chiodo. "The purity of the carriers ultimately determines the purity and thus the performance of the chips."

Clean Room—No Dust

There really is no trace of graphite dust in the facilities at St. Marys. Instead of regular lab coats, employees wear clean-room apparel. The final products are touched only by employees wearing white gloves and the products' surfaces are analyzed with high-powered microscopes. Cleanliness and continual quality improvement have the highest priority.

In turn, new thermal simulations help to analyze in advance how high the stresses and strains are for the wafer carriers during the production processes and determine where optimizations are needed. "This is about avoiding material defects early on and thereby minimizing costs," notes Detsch. "At the same time, it is increasingly important to give customers our own impulses for further developments, for instance in the form of new models for controlling production processes or for new designs." To meet this goal, the expansion is not just an enlargement and modernization of the facilities. It also includes building up new research and development expertise.

Customer interaction is of particular importance. Customer representatives regularly meet with interdisciplinary SGL teams at the site to develop new solutions together. The St. Marys facility is thus already a prime example of the general development of SGL Carbon—from a materials supplier to a technology driver working to find trendsetting solutions with its partners.

The future has already begun—and in St. Marys, too. Micro LEDs, for example, are a next-generation trend. They are smaller than 100 micrometers in length and tinier than the width of a human hair. Their biggest fields of application will be in smartphones, smart watches, televisions and for virtual reality applications. These types of displays offer an even more luminous image and are simultaneously thinner and much more energy efficient. Whether small or large LEDs, one thing is clear: without the materials and solutions from the SGL production facility in Elk County, the world would be a much darker place.

> LEDs and semiconductors will influence our lives even more than they have before <

Barry Hancox
Global Product Manager at SGL Carbon

Leaf springs made of composite materials for the rear axle of cars have been around for a while—but not in mass production! SGL Carbon shows how it is done with fully automated and scalable serial production of glass fiber-reinforced leaf springs for a variety of models.

Light and Easy

Innovative potential: The targeted annual volume of 500,000 parts for 2019 makes SGL Carbon's mass production of leaf springs the largest capacity program for continuous fiber components in the automobile industry thus far.

3

Huge growth potential: In the future, lighter utility vehicles such as pickups could also be equipped with the GFRP leaf springs.

6

1

Not heavy at all: Compared to steel leaf springs, which can weigh up to 15 kilograms, the weight of comparable leaf springs made with glass fiber-reinforced plastic (GFRP) is 6 kilos, making them 65 percent lighter.

2

Other benefits: As compared to a coil spring concept, the leaf spring also takes up less space and provides better handling during driving. Furthermore, the composite construction allows the spring to be adapted to various models without the use of expensive new tools.

4

The future: Fiber-reinforced plastic will find its way, piece by piece, into the material mix of the future. The example of Volvo already shows the way: the leaf spring has been integrated into the S60, S90, V60, V90 and XC60 models. Mercedes is also using the leaf spring in its Sprinter.

5

Fully automated production: In the manufacturing process at the SGL facility in Ort/Innkreis in Austria, two lines are served in parallel by a dosing system. There are nine production steps in total.

7

Targeted research: This sort of mass production is the result of many years of research and development. After five years of basic development and process maturation, the company has now also five years of experience in serial production. SGL employees are also currently working on the next generation of mass production systems, which should become operational in 2019.

Future Giants

Energy storage is one of the key topics of the future—whether for mobile communication devices, electric vehicles or supplying homes. An ongoing research project in Pfinztal, Germany, where researchers are installing what is currently Germany's largest battery, is demonstrating how batteries can also be used for very large amounts of electricity.

Smaller is better. At least that is the maxim for the batteries that assist us in our everyday lives: in smartphones, laptops and—if you wish to go a bit larger—electric cars. We rely on energy storage systems, which is why they continue to evolve, mostly by increasing capacity, thereby reducing size. But a few are also getting larger, even much, much larger.

There is still a lot of research and development work that needs to be done for storing very large amounts of energy. While numerous solutions already exist for smaller amounts of energy and for mobile applications, there is currently a lack of large, stationary energy storage systems that can be flexibly installed in any location and that are scalable as needed to actual energy demands. Hydropower, the current standard technology for stationary storage, cannot accomplish this. More responsive storage systems and flexibility are needed: whether to store energy from traditional energy production to ensure coverage during peak demand or for network stabilization—but also, especially, because of the continual increase in renewable energy sources.

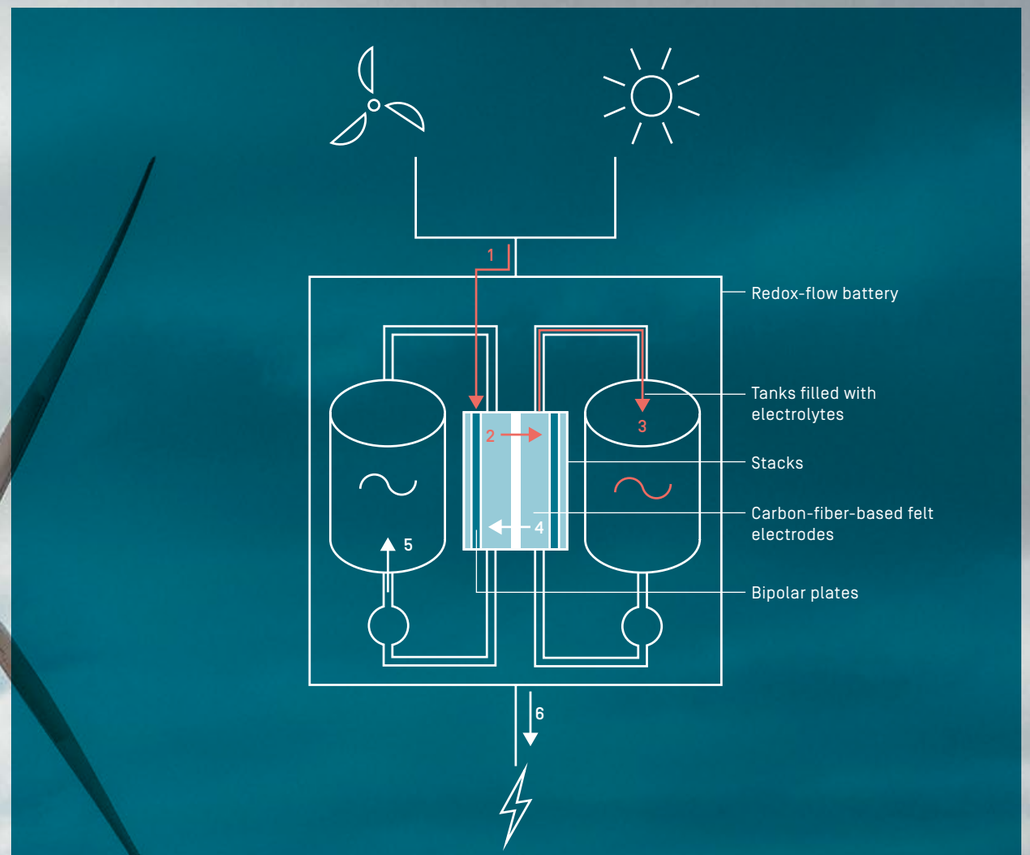
A forty-fold increase in stationary energy storage capacities in developing nations by 2025 is predicted.

There is little debate about the important role that stationary energy storage will play in the supply of electricity. The topic has a global scope, as well, which is underscored by numerous studies, for instance one from Navigant Research on behalf of the World Bank: in industrialized nations, the use of large stationary energy storage solutions will be crucial for the successful expansion of renewable energies. The report also predicts a forty-fold increase in stationary energy storage capacities in developing nations by 2025. However, the report goes on to state that these countries will have to double their electricity generation by 2020 to meet rising demand. The largest energy storage markets in the coming decades will be large and heavily-populated nations such as China and India. Latin America and South Africa are also considered to be attractive markets.

It is no wonder that a lot of hopes are resting on the further development and broad availability of stationary energy storage. Especially in comparison with fossil fuels or nuclear energy, energy obtained from the sun and wind has a serious drawback: it is only produced when the sun shines or the wind blows. And this isn't necessarily when the demand is greatest. The solution for the future is thus an energy storage system that can supply energy at all times.

Battery of Unprecedented Dimensions

Near Karlsruhe, in southwest Germany, just such an energy storage system is being created. It takes up the space of a mid-sized gym and stores enough energy to supply thousands of households with electricity for twenty-four hours. The Fraunhofer Institute for Chemical Technology (ICT) has based this battery on what is known as redox-flow technology and began operating it last year in Pfinztal, just outside of Karlsruhe. Developed by ICT scientists, the battery is part of the RedoxWind project, which is being supported by the German federal state of Baden-Wurttemberg, the Federal Ministry of Education and Research as well as the Fraunhofer Institute to the tune of €19 million. The project includes a 2-megawatt wind power system that delivers electrical energy, which can be temporarily stored in the battery. The battery's storage capacity will be a total of 20 megawatt-hours. In theory, this means that the complete output of the wind power system can be stored for up to ten hours.



1 The power from renewable energies runs through current collectors, the so-called bipolar plates, into the battery cell. The carbon-based battery felts, the electrodes, are flooded by electrolytes and provide the surface space for the electrochemical reactions.

2 When charging the battery, the electrolyte on the left oxidizes on the electrode and electrons are emitted.

3 The electrolyte on the right is being electrochemically reduced at the same time by absorbing these electrons, thus storing the energy in the electrolyte solution.

The reduction (RED) and oxidation (OX) gives the redox-flow battery its name. A membrane keeps the two electrolyte solutions from mixing with one another.

4–6 When being discharged this process runs in reverse and energy is being generated by the electrochemical process.

Images: unsplash/Drew Hays

Electroconductive carbon felts are used in battery cells as electrode material since they offer a large surface area for the electrochemical reactions.

In technical terms, a redox-flow battery consists of electrochemical cells, so-called stacks, in which the energy conversion takes place and which determine the installation's power output, and the electrolyte tanks, in which the energy is absorbed and thus define the energy storage capacity. Consequently, the power and the capacity can be adjusted independently from one another and adapted to the respective individual requirements—an advantage that no other energy storage technology offers. Furthermore, the storage tanks that contain the electrolyte solutions can be of any size. In Pfinztal, there is a whole series of tanks, each holding 45,000 liters.

The redox-flow battery can store enough energy to run the entire Fraunhofer ICT campus for more than ten hours.

Essential Components made of Carbon

The stacks then are composed of a multitude of galvanic cells. Each cell consists of two half cells which are separated by an ion-exchange membrane. The half cells are flooded by the electrolyte solution which contain different metal ions. "All the conductive parts of the cells are made from carbon, for instance the current collectors and the bipolar plates," says Dr. Peter Fischer from the Fraunhofer Institute in Pfinztal. Since the electrochemical reactions within the stacks must take place on the surface of a suitable material, carbon felts are typically used for the electrodes between the bipolar plates and membrane. Besides a large surface area, the carbon felt for redox-flow batteries must additionally offer as little resistance as possible. The felts are therefore additionally activated by a special surface treatment.

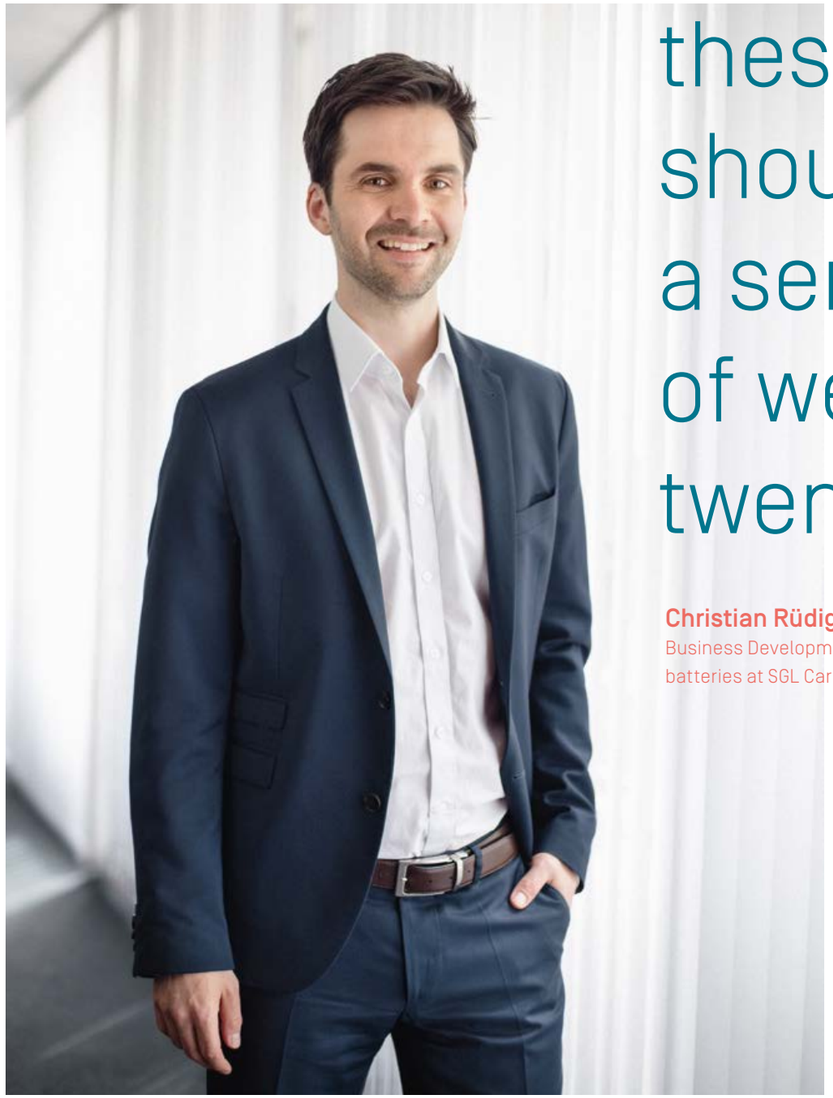
SGL Carbon is a project supplier for this key cell component. All in all, the company has already delivered to ICT a total of 3,500 square meters of these SIGRACELL® felt electrodes for the redox-flow batteries—which could cover half of a soccer field—plus 1,750 square meters of bipolar plates. The project scientists further rely on SGL Carbon's expertise for optimizing the battery cells. One reason for this is experience, as Christian Rüdiger, SGL Carbon's Business Development Manager for Redox-Flow Batteries, explains: "We started developing felt electrodes back in 1999, continually refining them and increasingly customizing them for the application. We also chalk it up as a success that we currently supply both the world's leading manufacturers of redox-flow batteries as well as creative startups with their new ideas."

The long ongoing RedoxWind project in Pfinztal is also being used to research whether this technology can be used for transforming a regenerative energy source into a predictable energy supplier. In the future the facility will supply the Fraunhofer Institute in Pfinztal with electricity, thereby demonstrating its reliability. These systems should have a service life of well over twenty years.

Yet redox-flow batteries, as large stationary storage units, are conceived not only as a means for modifying the energy supply system to use renewable energy sources. The combination of wind power systems and batteries also offers the possibility of creating a self-sufficient energy supply. One conceivable application is electrification in remote or poorly served locations using isolated solutions, as well as the temporary provision of electricity, for instance at large construction sites or in times of crisis after natural disasters.

But no matter which application or which target market is to be served—what's certain is that the demand for temporarily stored energy will increase in most countries around the world. Conventional solutions alone won't be enough. And so, in the future, along with a progressive and flexible technology, apparently size really does matter.

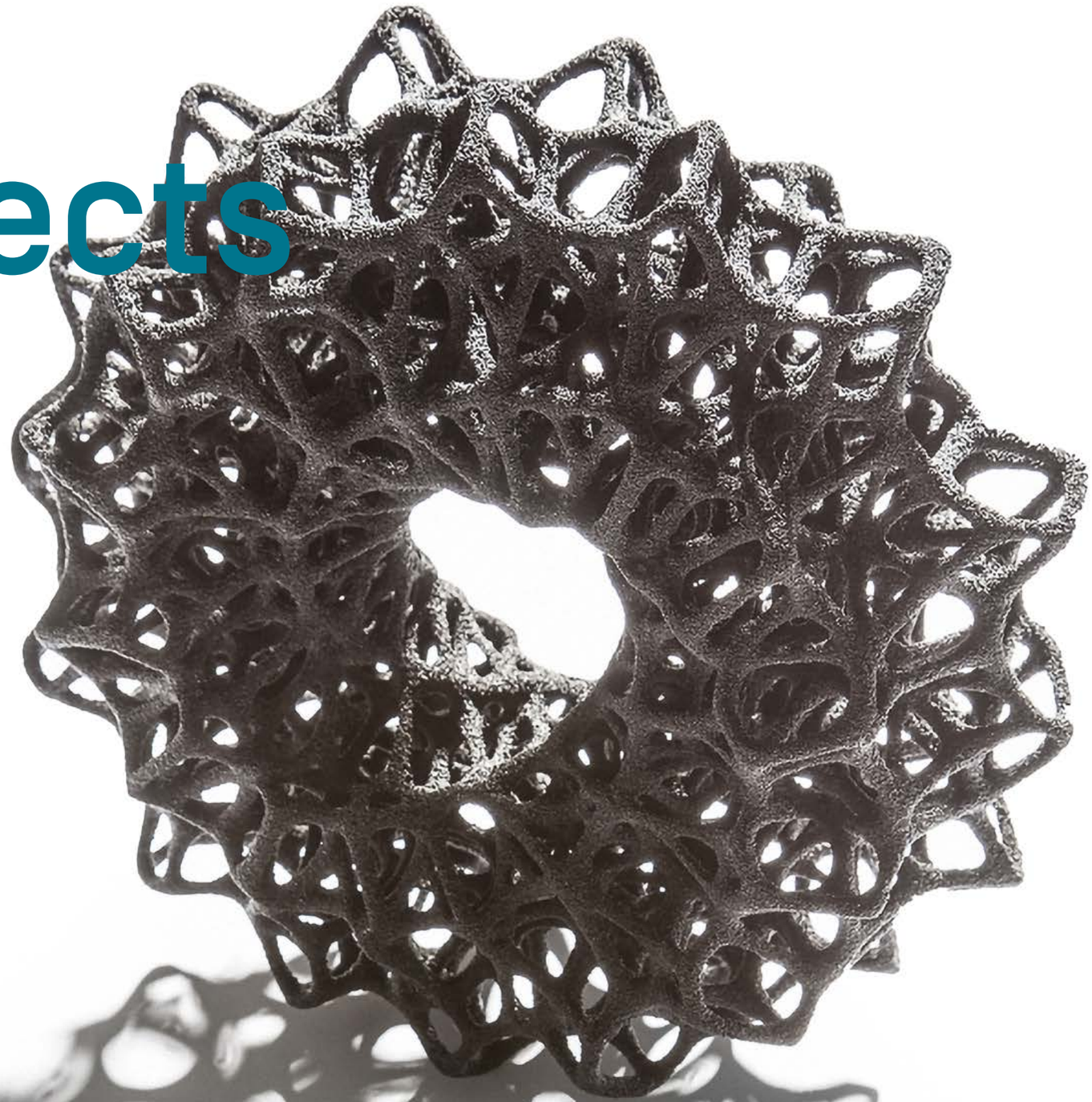
Images: Dominik Obertreis, Marina Weigl (Portrait)



› In the future these systems should have a service life of well over twenty years. ‹

Christian Rüdiger
Business Development Manager for redox-flow batteries at SGL Carbon

Bright Prospects



Extremely complex geometries made of carbon and graphite are now possible through the use of 3D printing. The pictured graphite-based demonstration component illustrates this freedom in design.

The technique of 3D printing offers a variety of possibilities, particularly for prototypes and small batch production. Its use in the manufacture of components based on carbon and graphite is also developing rapidly. Three benefits, highlighted below, provide insights into why 3D printing is a very useful complementary technology. The days when 3D printing technology was only for little plastic doodads are long past. The experts at Wohlers Associates, the leading consulting firm in the area of additive manufacturing, estimate that worldwide market for all 3D printing sectors was about $6.1 billion USD in 2016. The current average annual growth rate is 20 percent. This growth is hardly surprising. Almost every conceivable form or geometry that can be constructed with a 3D CAD program can be additively manufactured—as opposed to the subtractive process of cutting out or milling a component from a block of material. The advantages of 3D printing are numerous. ›

3D Printing Is...

› Fast

Compared to traditional construction methods, 3D printing is unbelievably fast. Because of this, additive manufacturing has the greatest added value for developing new products and in small batch production. Using agile rapid prototyping, the process of building a prototype takes a mere fraction of the time needed for subtractive manufacturing, which can often take several weeks or months. Subtractive techniques will most likely continue to be relied upon for large-scale production in the future. Experts from the automotive industry say there probably won't be a 3D printed car for another twenty years, but even today a good 3,000 parts in a prototype may originate from a 3D printer.

Dr. Oswin Öttinger, in partnership with his team, develops 3D printing at SGL Carbon.

"Fast innovation is becoming increasingly important," says Oswin Öttinger, who runs the pioneering field of 3D printing in the Research and Development department at SGL Carbon. "This is also the case in established industries and for applications such as carbon-based parts for distillation equipment in the chemical sector. 3D printing helps us continually accelerate the development of new solutions, together with our customers."

› Efficient

At the same time, additive manufacturing is also a particularly efficient process. Only as much material as is needed for the final product is actually used to print it. Large quantities of leftover shavings or chips, such as the byproducts of grinding, drilling and milling in subtractive manufacturing, are virtually eliminated. In addition to conserving resources, over the long term this also results in more cost-efficient operations.

Heat exchangers made of special graphite materials or ceramics are a great example of how 3D printing can make production more efficient. Heat exchangers are indispensible for energy-efficient processes of heat recovery, for example in power engineering or combustion and heating technology, not to mention in chemical industry processes. They ensure that the thermal energy of flowing substances such as water, air, gases or working materials can be transferred to other material flows. In detail, such a heat exchanger is often made up of a plethora of individual plates or pipes with a corresponding sealing design. This multipartite structure takes more time to manufacture, increasing costs. With 3D printing, various components in an assembly can be combined and thus be manufactured in a single operation. This makes the production considerably more efficient and simultaneously simplifies the sealing system.

› Innovative

Geometries can be created with 3D printing that are either impossible or much more difficult to produce with subtractive manufacturing. One example is so-called pump impellers, specially shaped pump rotors made of ceramic that are used in the chemical industry to pump particular, often aggressive substances. They increase the pumping capacity and ensure durability because of their special shape. Additional examples from SGL Carbon currently in testing include specially shaped column internals, static mixer components and complex catalyst supports with large surface areas.

What is more, 3D printing also offers the opportunity to very easily combine several materials in the form of mixtures, thereby creating entirely new property profiles. It is an approach that SGL Carbon is taking with its partner ExOne, using binder jetting techniques. Following the actual printing, components can be further enhanced using impregnation and infiltration processes as well as coating techniques. Consequently, component properties can be further optimized specific to their application, and all of this starting at batch size 1.

These are all reasons why additive manufacturing can often be an excellent solution, also for specific industrial sectors. 3D printing can also provide an important impetus in matters of cooperation, particularly by facilitating increased flexibility. One example is design programs that customers can use to design their own components, something employees at SGL Carbon are already experimenting with—further evidence of our focus on customers and orientation towards the future.

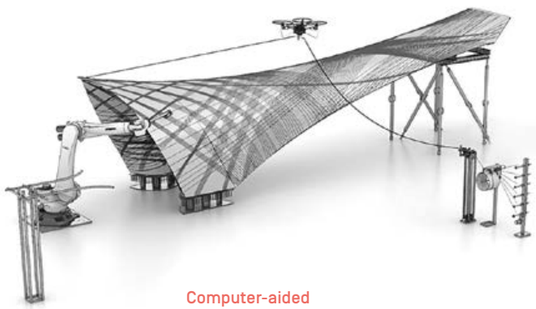
Learning From the Apple Leaf Skeletonizer

Carbon 360°

Researchers are inspired by nature time and again when developing new technologies and applications. This approach can prove helpful even when conceiving of novel architectures using composite materials. Take the larvae of the apple leaf skeletonizer for instance, which use long threads to spin cocoons on the leaves of apple or cherry trees.

Researchers from the Institute for Computational Design and the Institute for Structures and Structural Design—both at the University of Stuttgart—worked with SGL Carbon to utilize the larvae's special technique to build architectural structures made of carbon and glass fiber-reinforced composites.

Carbon fibers currently form the basis for many lightweight construction applications in the fields of mobility and energy—from automobiles to aeronautics to wind power. But some day they could also be used on a larger scale in the construction industry to help renovate buildings or to create unconventional architectural structures.



Computer-aided construction offers numerous advantages: here, cooperating robotic systems are manufacturing a self-supporting structure that has a span of about 12 meters and is 3 meters wide.

Images: Dominik Gigler (Portrait), Roland Halbe (Motte), Uni Stuttgart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