The Magazine of SGL Carbon 01_19

think together

Collaborating for Successful Innovation

sgl carbon

Zoom

Due to their special material properties and futuristic aesthetics, carbon fibers are increasingly being used by interior designers. One example of the innovative use of carbon is the Pure Noir Table by Dutch manufacturer Studio Wynd. “This table series makes the incomparable lightness and porous surface structure of the carbon fibers visually and haptically perceptible,” designer Javid Jooshesh notes, describing his creation. The piece of furniture weighs only seven kilograms. It is wound from a single, 1.2-kilometer-long SIGRAFIL® carbon fiber braid—without any frames or additional components. In addition to its ultra-light weight, the table is distinguished by its innovative aesthetics and efficient material usage thanks to carbon fiber’s excellent properties. The designer has achieved a high degree of stability and beauty with minimal use of materials: pure carbon.

— www.studiowynd.com

Photo: Wynd

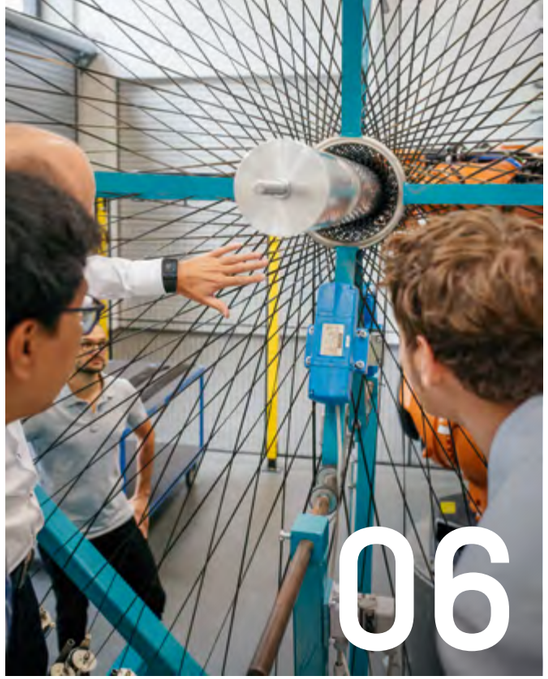
#sglthinc together

Curiosity, open-mindedness, respect: real partnerships grow from these ingredients. The type of partnerships that initiate innovation and deepen trust. Partnerships that bring together everyone involved and create joint solutions. In other words, partnerships that deserve to be called just that.

The new **#SGLCarbon** is advancing just these sorts of partnerships. It cooperates with customers and partners, with scientists and among internal experts. The results are sophisticated, smart solutions—implemented on the basis of composites and graphite, designed from the perspective of our customers and partners.

In this issue of the magazine, we are taking you along to some of the pioneers of this new approach. To Andreas Wöginger and his colleagues, who offer application-oriented lightweight expertise, to Calin Wurm, who is setting up SGL Carbon's new battery laboratory in Meitingen, Germany, or to Robert Hütter and Herwig Fischer, who serially produce finished composite components in Austria, for example leaf springs for Volvo.

It is a journey on which you will learn why intensive cooperation is particularly worthwhile for B2B companies, when it works and which everyday hurdles can arise. Come join us on this trip.



Think Together

Why cooperation produces particularly successful innovations—and how SGL Carbon is implementing this approach.

Runs Like Clockwork

In Austria, SGL Carbon mass-produces complex components from fiber-reinforced plastics for serial applications in automotive. An on-site visit.

Master of the Poles

Calin Wurm has been fascinated by batteries for a very long time. Now he is setting up a new research laboratory for SGL Carbon in Meitingen, Germany.

Short Breaks

Photos: Myrzik und Jarisch (Cover); Wynd (p. 02/03) Myrzik und Jarisch (p. 06); Julia Sellmann (p. 18); LEMRICH (p. 24)

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Think **Together**

SGL Carbon has been supplying its partners with high-tech materials for a long time. Now the company wants to bring its **cooperations** to the next level and involve customers even more systematically in the development of new innovations. Join us on an expedition to a few of today's and tomorrow's pioneers of this new strategic approach.

Photo: Myrik und Jansen

When Andreas Wöginger talks about his work, he speaks a long time about trust, openness and respect. About how important it is to listen to customers, to understand their problems from their point of view and then to find solutions by working together. "Customers are learning how to work with these relatively new composite materials," says the mechanical engineer. Behind him, a robotic arm is placing a carbon fiber mat into a machine press.

Wöginger is responsible for technology development within the business unit Composites – Fibers & Materials (CFM) at SGL Carbon. In his 2,000-square-meter lab, he and his colleagues are testing the newest production methods. SGL offers services along all steps of the value chain, from design services to development and implementation of the finished component.

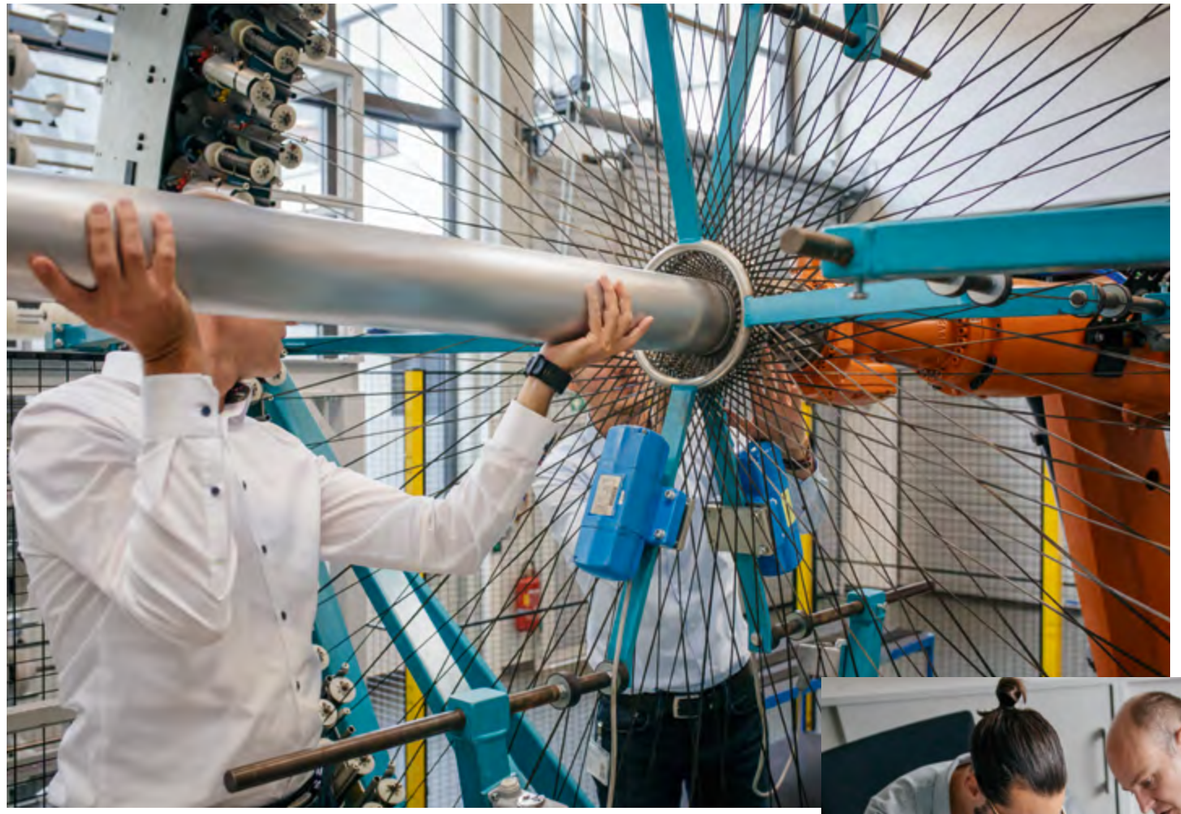
Sometimes customers come without any prior knowledge in the field of composites and they work together with the SGL team to develop a completely new component. Sometimes it is about supporting a more experienced customer to advance development of lightweight components for mass production. Yet regardless of whether it's a new design or an adaptation of a current one: "Cooperation between customers and SGL is becoming increasingly important," explains Christoph Ebel, who is a member of Wöginger's team and leads SGL's in-house Lightweight and Application Center (LAC).

Cooperation is Crucial

What is true for lightweight construction can also be applied to all industries of SGL Carbon. From the battery sector to the LED and semiconductor industries to the chemical industry: cooperation with customers is more important than ever before. SGL Carbon has made the credo of partnerships the focus of its new corporate strategy and corporate culture. "In addition to continue to manufacture high-quality and functional materials, we will also develop smart solutions together with our customers," says SGL Carbon CEO Jürgen Köhler.

There are good reasons for the strategic realignment. All over the world, manufacturers, customers and their suppliers are working even more closely together to develop new products, applications and solutions. The days when engineers and designers spent years tinkering in laboratories and studios and then presenting customers with a finished product are over. The package and mail logistics company DHL, for example, has been bringing its customers and partners together in innovation centers for some time now. This led, for example, to the idea of the Parcelcopter—an autonomous flying package-delivery drone. Software companies such as SAP and the food-products multinational Danone are using platforms to involve their customers in developing their products.

"Collaborating with external partners is crucial for the success of innovative projects," says Krsto Pandza, an innovation researcher at Leeds University Business School. He's been dealing with this topic for years (see the interview on p. 12). To date, B2C companies in particular have relied on close cooperation with customers and partners since the hurdles to cooperation are lower and the successes more quickly apparent. In the B2B sector, in contrast, many companies still remain in traditional contractual agreements, which have proved their worth but aren't terribly likely to promote innovation. Marie Taillard and Jerome Couturier of the ESCP Europe Business School consider this a mistake. The advantages can be just as tempting in the B2B sector, they argue in an analysis. „But they require the foresight to see beyond traditional corporate boundaries, and the audacity to share with those you naturally want to keep at a distance."



Sometimes SGL Carbon works with customers to develop a completely new component, sometimes it's about optimizing processes. The focus is always on a partnership of equals.

In the Lightweight and Application Center, Christoph Ebel supports his customers from the very start. True cooperation is becoming increasingly important.

Photos: Myrik und Jarisch (2x)

A Tradition of Close Collaboration

SGL Carbon has a tradition of cooperating with partners. For instance, the Graphite Materials & Systems (GMS) division has long relied on Technical Sales Managers. They remain in close contact with customers and develop customized solutions based on the customers' requirements. "This is how we combine our strengths with our customers' needs," says GMS Senior Vice President of Marketing and Sales Christoph Henseler. In this way, Henseler and his team have learned, for example, that a mixture of modular solutions and corresponding adaptations are optimal for their customers in the area of heat exchangers, while in the semiconductor industry or the battery segment almost every customer has individual requirements. Henseler's motto: "We have two ears and one mouth—and that's how we should behave."

For SGL's composites division, the topic of partnership is also nothing new. Cooperations have often even taken the form of joint ventures. SGL Carbon's long-standing joint venture with BMW has really left its mark in this respect. In joint pioneering work, the two partners realized the BMW i3—the first complete mass-producible car passenger compartment made of carbon fiber-reinforced plastics—and advanced the material's utilization for other BMW models. They also established the two facilities in Moses Lake, Washington (US) and Wackersdorf, Germany, being the world's most state-of-the-art carbon fiber production and a highly innovative fiber processing facility.

The collaborative approach has grown increasingly stronger throughout SGL Carbon. The result: numerous projects are already proving that cooperation is worthwhile wherever it occurs. An expedition in five chapters:

Erik Johansson works as a design engineer at Volvo Cars. Together with SGL Carbon, he has been involved in the development of the composite leaf spring from the very beginning.

Volvo Cars & SGL Carbon: From Scratch Together

Per year, 500,000 leaf springs made of glass fiber-reinforced composite come off the fully automated assembly lines in the SGL facility in Ort, Austria. They'll end up being installed in the rear axle of all Volvo 60 and 90 models. The serial production of this high-tech component demonstrates what can result when two partners work closely together: a part that is 65 percent lighter than conventional steel leaf springs.

Erik Johansson, Senior Design Engineer at Volvo Cars, is instrumental in the design, implementation and development of the Volvo Scalable Product Architecture (SPA) platform and its leaf spring project. He can vividly recall how the cooperation with SGL Carbon and Benteler, the joint venture partner at the time, started six years ago. "We always wanted to design the leaf spring for our new SPA platform based on composite material," Johansson explains, "and after the request for proposals, we quickly decided to go with SGL." Once the contract was signed, the joint cooperation started immediately: weekly telephone conferences, reciprocal visits between Gothenburg (Sweden), Ried (Austria) as well as at a test facility in the Netherlands, and always new meetings to plan the next steps.

SGL Carbon serially produces the leaf springs in Austria.

Photos: Ken Hermann (Volvo); Julia Selimnann (leaf spring); Myrik und Jarisch (Pierburg)

"The crucial point for such a development is that we must bring together all the capabilities, from component design, prototype development and validation to series process design. In this case, we were able to demonstrate this very well." says Robert Hütter, Director Sales and Program Management Automotive for SGL Carbon in Austria. At the same time, it wasn't easy to adapt Volvo Cars' original design to serial production processes. "There were long, always constructive, discussions about it," Hütter recalls. "But, in the end, together we found a way where we could fulfil all requirements from Volvo Cars and are able to produce in a stable high-volume process."

Johansson was also impressed by how the partners were able to pull together despite the project's many hurdles. "The lines of communication were open and clear from the very beginning, and everyone was open to ideas and solutions from the other side," he says. One of the major contributing factors to the success of this project was SGL Carbon's expertise in production processes, not to mention in research and development.

The new leaf spring is helping Volvo Cars build lighter and more compact rear axles. "Not only that," Johansson adds, "but the new leaf spring gives us a lot of flexibility because we can use the same variant in many models, meaning we don't have to redesign it every time." Johansson, Hütter and their teams are already working on the next generation of the leaf spring and the associated manufacturing facilities.

Nabil Al-Hasan from Pierburg (middle) is discussing the details of the new manufacturing facility at the SGL site in Bonn, Germany, with SGL Carbon employees Adi Woizenko (left) and Werner Müller.

Pierburg & SGL Carbon: Cleared All the Hurdles Together

A customer inquiry, two components and a couple of technical drawings—these marked the start of the cooperation between Pierburg, owned by Rheinmetall Automotive AG, and SGL Carbon. Eight years later it has resulted in a true partnership. Working continuously together, the two companies have advanced development of the EVP 40, a vacuum pump to increase braking power—and both companies have benefited from this long-term process.

Pierburg appreciates the robustness of SGL Carbon's graphite. Thanks to its good friction properties and temperature resistance, the pump no longer requires oil lubrication and lasts much longer. In turn, the SGL Carbon team used Pierburg's inquiry and demand for products to further expand its production of graphite components for the automotive industry.

Mutual Interest and Respect

Adi Woizenko has been monitoring the development work for SGL Carbon at the Bonn site for the past three years. This was the transition phase from the project to mass production and now the current ramp-up to full production. The key to the partnership's success has been mutual interest, respect and a shared fascination for technology. "In all these years it's like we've been hitting the Ping-Pong balls right back to each other," he recalls. Naturally it wasn't all smooth sailing, like when it came to converting production to a fully automatic grinding process. "In the end, though, it was precisely at these points that it became apparent that we stood together, even during difficult phases," Woizenko says.

Today all the effort continues to pay off. "The SGL components have always been a safe bet for us, although they are the two most complicated components in the pump," says Nabil Al-Hasan at Pierburg. "You can see how helpful it was that SGL Carbon had been working on mass production for such a very long time." For Al-Hasan, the good experiences are the foundation for further cooperation. "We are currently in the process of developing larger pumps—and we will continue to rely on SGL Carbon for them."

› No cooperation, no innovation ‹

Companies must cooperate for **innovation** to succeed; at least, that's what innovation researcher Krsto Pandza from Leeds University Business School believes. Why it depends on cultural instinct—and why technical hurdles are often the most minor problem.

Professor Pandza, what are the main challenges when it comes to innovation?
Companies are designed to be efficient. Innovation is thus sometimes perceived as an obstacle to well-established processes. Managers prefer to rely on past experience; they tend to shy away from uncertainty, ambiguity and complexity.

Is that a general attitude?
Yes, regardless of size or industry—innovation does not come naturally to any company. Manufacturing companies are generally really good at incremental improvements in products and processes, but they are often less well prepared for more radical changes. It's tough for them to break with their past experience. With innovations such as introducing service-based business models or leading a digital transformation, they are confronted with major challenges.

What would be the best approach for a successful innovation strategy?
This is clearly management's foremost job. They must decide what innovation means for the organization and it is their job to prevent it from becoming a hollow phrase. While it is necessary to protect the company's core business, management needs to explore radical technologies and unfamiliar markets. They are well advised to distinguish between innovations that exploit existing businesses and those that aim at exploring emerging opportunities.

Can you describe the role of cooperation in this innovation process?
Cooperation is the key. No single organization manages to combine all of the smart people, all the relevant knowledge and all the technologies under one roof. The more uncertain the technology and the less that is known about the new customers, the greater the importance of collaborating with external partners. The message is: don't innovate alone, share risks, pool resources. Collaboration with external partners is crucial for innovation and it is a major managerial challenge.

Photos: Krsto Pandza (interview): Myrzik und Jarisch (Brembo)

And it works just like that?
Of course it is enormously challenging. The more they collaborate, the more companies need to set up processes and structures for such collaborations, for instance dedicated innovation managers focusing exclusively on coordination.

Presumably each new partner is different?
Cultural differences between cooperation partners can be huge. Collaborating with a supplier is definitely not the same as collaborating with a university, a start-up or an industrial partner from a different sector.

Some companies use the Open Innovation approach to make innovation projects completely public. Is this just hype or is it a sensible approach?
It always depends. The notion of Open Innovation is understood differently by different companies. For some it's a synonym for any kind of collaboration, others use it for the exploration of emerging technologies. Sometimes it is used as a label for crowd-sourcing initiatives.

So it depends on the specific case?
Absolutely. The only certainty is that collaborative innovation is an imperative. All companies that work together with partners on innovation projects reap the benefits—as long as they use their own resources as well and have thought about strategy. What you end up calling this kind of cooperation doesn't really matter.

Finally, a personal question: You started your career with a Slovenian company producing safes, safe cabinets and vault rooms. What did you learn there regarding innovation management?
There are three major experiences I learned from in my career. First, innovation challenges are not the same as the challenges of running efficient operations. Second, innovation is not a single event triggered by a heroic inventor, but rather a collaborative process. And third, finding a technological solution is often the least problem with innovation.

Personalia

Krsto Pandza is Professor of Strategy and Innovation at Leeds University Business School. His research combines the domains of strategic and innovation management, manufacturing strategy and R&D policy. Pandza strives to achieve a more integrated understanding of the role of scientific and technological knowledge. When he's not exploring innovation management issues, he loves playing basketball with his sons.

Joint Venture Brembo & SGL Carbon: Setting Completely New Standards

Sometimes two partners find each other at just the right moment, and that was exactly the situation in which SGL Carbon and the Italian brake manufacturer Brembo found themselves in 2009. Both companies had been developing carbon ceramic brake discs—which are 50 percent lighter than traditional brake discs and almost as hard as diamonds—for more than ten years independently of one another. But then it was time to join forces, and the two companies founded the joint venture Brembo SGL Carbon Ceramic Brakes (BSCCB) in order to make the carbon ceramic discs a standard for the high-end automotive sector.

Roberto Vavassori, Head of the joint venture's Supervisory Board, regularly visits the brake disc production facility in Meitingen with his colleagues.

Mixed Teams from the Start

When Brembo Marketing Director and Chairman of the BSCCB Supervisory Board Roberto Vavassori thinks today about the factors behind the success of the joint venture, three things immediately come to his mind: "From the very start, we had very open and direct communication

culture. We put together a mix of people from both organizations for the teams. And we provided the joint venture colleagues access to both companies' research and development." This convinced the engineers on both sides. In addition, in recent years the joint venture became financially independent, as Markus Müller, SGL's representative in BSCCB's management team and as CFO responsible for the financials of the JV, states. "All of these factors shaped our most important resource, namely trust", explains Furio Rozza, who came from the outside seven years ago to join BSCCB's management as an independent general manager. Today, the brake discs are installed in the top models of almost all sports car manufacturers, from Bentley, Bugatti, Lamborghini, over to Audi, Porsche and Ferrari as well as McLaren. Production is running at full speed in the two BSCCB facilities in Meitingen, Germany, and Stezzano, Italy, and is being expanded step by step. As Vavassori, Rozza and Müller proudly report, "Our joint product has since matured and found its place on the market." The key to this has been and still is the successful partnership.

Science & SGL Carbon: Driving Lightweight Application Research

Before starting as the head of the LAC at SGL Carbon, Christoph Ebel spent almost eight years at the Technical University of Munich at the Chair of Carbon Composites, where he researched methods for processing carbon. The chair was co-founded by SGL and the company continues to support it to this day. Yet Ebel's move to SGL Carbon is not the only evidence of the close links between the sciences and SGL. Time and again the company enters into close cooperations with scientific institutes on a variety of topics. One example: the LAC-affiliated Fiber Placement Center (FPC), which SGL Carbon and the Fraunhofer Research Institute for Casting, Composite and Processing Technology (IGCV) operate in cooperation with other partners from industry and the sciences. The FPC headquarters are at the SGL facility in Meitingen, Germany.

Hannah Paulus heads the Fiber Placement Center—and works in close cooperation with the scientists at Fraunhofer IGCV and the center's other partners.

Rebecca Schuster from Central Innovation and Michael Mändle from the business unit CFM are inspecting the new Advanced Modulus (AM) carbon fiber.

Photos: Myrzik und Jarisch (3x)

The Fiber Placement production process refers to the automated and material-efficient laying and cutting of fibers. With the center, both partners aim to incorporate the it into more high-volume applications across industries. "In this way, we can offer the technology, which originated from the aerospace industry, to other sectors at an industrial level," explains Hannah Paulus, Head of the FPC, "while at the same time continuing to further develop the technology." Preparations are already underway at the new center for realizing projects for secondary and primary structural components for aircraft and automotive manufacturers worldwide. This allows scientists at the IGCV to test their research results directly in practice.

Florian Neumann put together an interdisciplinary team at SGL Carbon for the Digital Customer Experience project.

Inside SGL Carbon: Partnerships as an Example

Cooperation with external partners is important, but it is of little value if in-house cooperation isn't going well. "'Convince through performance', 'be open-minded' and 'create momentum' are the central values of our corporate culture," says SGL Carbon Group Vice President Human Resources Birgit Reiter. The new employer brand, which is currently in development, will also be aligned to these values. "In the past we suffered too much from a silo mentality," CEO Köhler says. "Only by thinking and acting beyond internal borders can we support our customers as a reliable partner."

Interdivisional Cooperation

The in-house Digital Customer Experience initiative illustrates how this interdivisional cooperation works. The project's goal is to exploit the potential of digitization in the sales division across the individual business units. An interdisciplinary team was formed to implement the project: three experts from CFM, three specialists from GMS and two IT specialists. Additional experts are added depending on the project status. The idea is working. "The spirit of cooperation is great," says Florian Neumann, who coordinated the project across the board in the first phase. In five months, the team identified four customer groups, each with different needs and a multitude of individual digitization measures.

Interdisciplinary cooperation is also particularly important in research and development. With this in mind, Kristina Klatt, Rebecca Schuster and a team from the Central Innovation (CI) division worked together with Michael Mändle and other colleagues from the CFM unit—together they developed a completely new carbon fiber for aerospace applications. What is called the Advanced Modulus (AM) fiber is somewhat thicker than conventional aerospace fibers, yet it is particularly strong and effective. "The development of the AM fiber is also a good example of how we understand the role of CI, namely as a seismograph for innovation trends and interactive driver of developments that ultimately enhance SGL Carbon's product portfolio," says Senior Vice President CI Tilo Hauke.

The AM fibers, the leaf springs for Volvo, the Brembo-SGL brake discs, the FPC and the cooperation with Pierburg: with its new aspiration for particularly intensive cooperation, the new SGL Carbon wants to make a difference—and is often making one already today. "Being open, listening, providing inspiration—that's what counts," Köhler says. "We want to take our partnerships seriously, because only genuine partnership can bring our customers and partners forward together with us."

In a Nutshell

News about the company, trends, products and partnerships

State-of-the-Art Logistics Center

For the new SGL, with its focus on customers in the innovative and fast-growing areas of mobility, energy and digitization, one of the success factors in a global world is state-of-the-art, efficient and effective logistics. Fast turnaround times—whether receiving or shipping goods—are crucial. This also holds true for targeted in-company distribution to various production facilities. Modern logistics nowadays includes up-to-date and comprehensive quality inspections for incoming goods, which is an aspect and standard that customers demand, particularly in the automotive industry. This is why SGL Carbon is investing 8 million euros in a central, state-of-the-art logistics center at its largest site in Meitingen, Germany.

A logistics warehouse with a footprint of 6,000 square meters with four adjustable dock levelers and the possibility of ground-level loading and unloading will be completed by July 2019. The transshipment of goods between the production facilities and the new logistics center is part of an ongoing follow-up project based on a digital transport control system. New scanning technologies are an important building block for this. Aside from SGL Carbon, Brembo SGL Carbon Ceramic Brakes (BSCCB) will be one of the main users.

Capital Markets Day

For the first time in ten years, SGL Carbon hosted a Capital Markets Day for analysts and investors with a focus on market trends and material solutions. At the all-day informational event held in Meitingen, Germany, SGL presented updates on the company's strategic realignment and drivers and trends in the individual market segments as well as exhibits demonstrating its high-level expertise in materials, solutions and applications across the entire value chain. A total of around 35 participants came from London, Frankfurt and other financial centers. "It's extremely important and valuable for SGL to present and explain its new focus on the megatrends mobility, energy and digitization, the topics that will determine the future, not to mention our complex world of materials," says Dr. Michael Majerus, Chief Financial Officer of SGL Carbon. "This is naturally best highlighted on site, where questions can be answered directly."

Photos: Myrzik und Jarisch (groundbreaking); SGL Carbon (4x)

20 years in China

China is today the second largest economy in the world and meanwhile has a pioneering role for many different industries. It is also an important market for SGL Carbon specifically in the automotive, LED, semiconductor and solar sectors. In China, SGL Carbon, which celebrated its twentieth anniversary in the country in October 2018, is now employing around 400 employees at the two locations in Yangquan and Shanghai. "We have started in 1998 in Shanghai with one manager, one assistant and one driver," says Nancy Chen, Head of the SGL activities in China. "Today we are steering our entire activities in Asia from here."

JEC World 2019

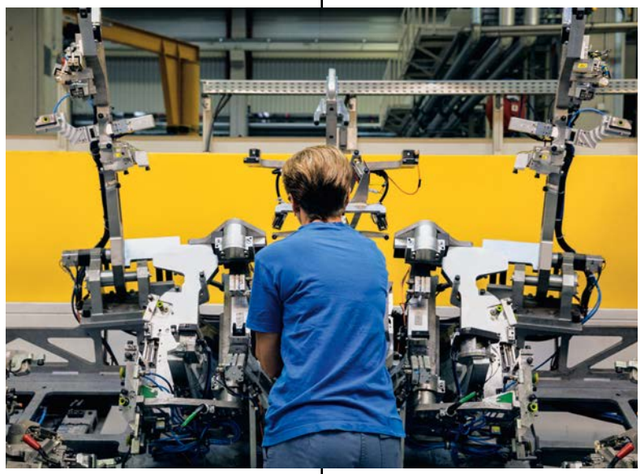
Collaboration is the be-all and end-all for developing successful innovations. Trade shows are also a good platform for this, which is why SGL Carbon will—like it does every year—will be represented at the world's largest trade show for composite materials, the JEC World, from March 12 to 14, 2019 in Paris. This year's trade-show appearance will focus on innovative composite solutions. Another important starting point for discussions will be the optimized use of fiber composite components.

SGL Carbon will also be presenting its entire value chain: following the integration of the former joint venture sites in Ried, Ort (Austria) and Wackersdorf (Germany), the company's value chain now ranges from the manufacture of carbon fibers and semi-finished products and on to serial production of finished components. In tandem with SGL's in-house Lightweight and Application Center (LAC), the company offers materials from a single source as well as comprehensive consulting and solutions around composite materials. This positioning will also be the focus of an evening get-together at the SGL stand. You will be able to find SGL Carbon at the JEC World in hall 6, stand 25.

Federal President of Germany visits SGL Carbon

SGL Carbon is one of Germany's best companies for apprenticeship. German Federal President Frank-Walter Steinmeier was also convinced of this during a visit to the SGL production site in Bonn. After an introduction to the company by Jürgen Köhler, Steinmeier took the time for some personal contact with employees and apprentices. "It was a very special situation, and the entire facility had prepared for the visit," said Andreas Heuser, an industrial management assistant who has completed his apprenticeship. "The president also asked personal questions," Heuser added, impressed by President Steinmeier's profound interest. Human Resources Manager Kiya Biazar said, "I was pleased that Mr. Steinmeier had wished to be informed about the topic of training." Following this, President Steinmeier, his wife and Bonn's Lord Mayor Ashok-Alexander Sridharan also met with representatives from the Works Council.

Runs Like Clockwork



Where skis were once handcrafted, SGL Carbon now works in cooperation with its customers to produce extremely lightweight components made of fiber-reinforced plastics for the **automotive industry**. At the Austrian facilities in Ried and Ort im Innkreis, everything is fast, efficient—and increasingly mass produced.

Photos: Julia Sellmann (6x)

Herwig Fischer stretches both hands into the air, like a conductor, pointing to the machines and employees—first with his left hand, then with his right. In the large hall in front of him, carbon fibers are stored on large spools, and huge press machines form automotive components from what are known as preforms. Although Fischer, head of the two sites, has often taken visitors on tours of SGL's Austrian sites in Ried and Ort im Innkreis before, you can still sense his enthusiasm. "What we are doing here with carbon and other fibers is a bit of the future for car bodywork—regardless of whether the vehicle is powered by an electric motor or a combustion engine," he says. Fischer has been hitting all the right notes with his orchestra, so to speak, for some time now.

The SGL facilities are located in an idyllic setting around sixty kilometers northeast of Salzburg. Here, SGL Carbon is advancing series production in lightweight construction with fiber-reinforced synthetics. The composite production facility in Ried arose from a manufacturing site belonging to the sporting goods producer Fischer—the company had already been working on lightweight components for the automotive industry for several years around the turn of the millennium and today still manufactures high-performance skis in the immediate vicinity.

In 2009, SGL Carbon and the automotive supplier Benteler purchased part of the ski manufacturer's facility in Ried im Innkreis district. In the Benteler-SGL joint venture, the companies subsequently established a center of excellence for lightweight applications. The unique facilities and projects became the cornerstone for today's high-volume production, which has helped make SGL one of the world's market leaders.

Ort and Ried im Innkreis are located near Salzburg in Austria.

From Small Batches to Large-Scale Production

Every day, the two plants under SGL management in Ried and Ort mass-produce a large number of components, including spoilers for the Porsche 911 GT3, rear panels for the Audi R8, component sets for the BMW i3 and leaf springs for various Volvo models. "These sorts of things really didn't exist until just a few years ago," Fischer says. "It's still a very young industry."

For SGL Carbon, the Austrian facilities are an important component in its new strategic alignment. About a year ago, the company acquired the shares from its joint venture partner Benteler, closing the final gap in the value chain for composite components. The precursor, the raw material for producing carbon fibers, is made in Portugal, while the fibers themselves are manufactured in the United States and in Scotland. Additional processing is carried out by employees at various locations in Germany and the finished components are produced in Austria.

Component production is part of SGL's core business. "Some customers are satisfied enough with the guidance they receive from the colleagues in the Lightweight and Application Center in Meitingen, Germany and also with the material," Fischer explains, "and decide to take on the final production steps themselves." Others, in contrast, would like the entire component from SGL Carbon. "That's where we come into play," he adds.

Depending on the specific needs, manual production is also still a very suitable method for production even today. The production site in Ried smells like a mélange of liquid synthetics. Many small batches are produced here and most of the steps are completed by hand. Every day brings more knowledge about production processes, knowledge that often forms the basis for mass production on the assembly line. "In manual production we can try out material combinations and geometries and use this experience to improve automation," says Team Leader Production Gerhard Traunwieser, who supervises part of the production in Ried. "A mixture of manual and mechanical production is a good idea, particularly for complex components."

This also holds true for the spoiler on the Porsche GT3. Production begins in Ried as soon as the fine fiber mats are delivered. A so-called cutter trims them to the desired size with an ultrasonic knife while the material is still dry before being impregnated with synthetic resin. The trimmed mat pieces are then molded. After these preforms have been produced, the component starts to take shape. Carbon fibers are perfect for producing geometrically complex components with an especially efficient use of materials. The fibers are placed in the component in exactly the quantity and orientation required for the GT3 spoiler to attain the curves of the design yet simultaneously remain as lightweight as possible.

Now an employee places the preform into the machine. The press closes and creates a vacuum in its interior, and then precise quantities of synthetic resin and hardener are injected inside. Finally, the part hardens. This method is used to produce the spoiler's outer shell, inner shell, inner shell cover, the two air scoops and the wings. During the process, a stable core of liquid wax is cast as a support for the specific composite components. This is later melted out, creating a hollow structure. "This makes the part even lighter," Traunwieser explains.

"In a last step, the individual components are pretreated, glued together to form the entire spoiler, and then undergo a detailed inspection," Traunwieser adds. He and Fischer point out a compartment that is lighted by 21 neon lights, which is where the final inspection takes place.

Fischer, a native to the region, has been managing operations in Ried and Ort since early 2018. He studied logistics management and served in various positions during the development of

Herwig Fischer (l) and Robert Hütter (r) during a tour through the production facilities in Ort and Ried im Innkreis.

Every day, SGL Carbon produces numerous leaf springs and other components in Austria.

The spoiler for the Porsche 911 GT3 is assembled from various preformed parts. The carbon components are delivered with different paintwork.

An employee applies an adhesive bead made of two-part adhesive epoxy to a component.

the locations, from the joint venture to the acquisition by SGL in 2009. He is driven about his work—as a well-organized, technophile businessman, he enjoys being the connective link between employees, specialist topics and mass production.

These character traits are important, given the continual transformation of the plants. While a lot of production work is still completed by hand in Ried, the manufacturing facility in Ort im Innkreis—with a footprint of ten thousand square meters, about as large as a Manhattan city block—is mostly fully automatic. The manufacturing systems were set up from scratch back in 2012 and include around one hundred different, often directly interlocking, individual automated processes.

In order to keep track of this complexity, Fischer and his most important employees meet in the control room every day at nine in the morning. Outside the room the machines are springing back and forth, humming and buzzing, while inside the walls are decorated with diagrams and evaluations from the previous shift. "We monitor and control the production in here," Fischer explains. How high was the previous shift's output? Were there any incidents? What about the quality of the components? "All this information comes together here and it is up to us to draw conclusions and decide what steps may need to be taken."

The Best Time is Just Beginning

In the factory, the robots work completely autonomously, grabbing, sorting and rotating components along the production line. This is how the leaf springs for Volvo are produced. The component demonstrates how SGL's focus and its facilities have evolved. "We're no longer just supplying customers with material, but are also offering solutions and project support from a single source," Robert Hütter says. He and his team are responsible for Volvo in the SGL Carbon sales team (see p. 10). He continues: "This approach has for instance enabled us to build half a million leaf springs a year for Volvo." Hütter, who was also born in Austria, has helped build and expand the production facilities here and the manufacturing for Volvo over the years. He often travels around the world to work with SGL customers to find exactly the solutions they want.

The Volvo leaf springs roll off the assembly line in two rows. Just like in Ried, the preforms are first trimmed, placed in the press molds, mixed with resin under pressure, hardened and then milled to completion. But everything happens automatically in Ort. "A finished leaf spring comes off the end of the assembly line every few moments," Hütter says. "Even quality control and the documentation via two-dimensional code labels is automated."

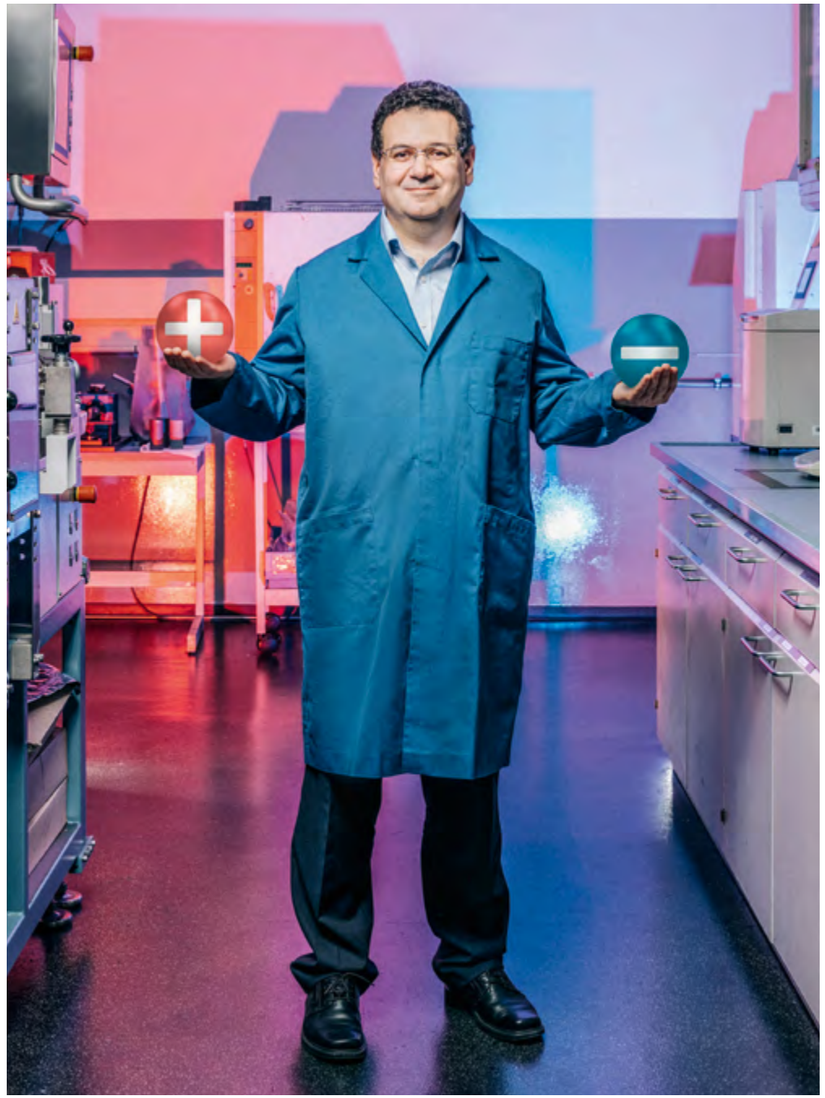
This high degree of automation is also winning over more and more customers. Additional development projects for machine-based serial production in the automotive sector have long been underway—including broadening the expertise in leaf springs to an alternative manufacturing technology and an additional mass-production project with another major automobile manufacturer. According to what Fischer says, they will soon be producing ultra-light and extremely sturdy components for use in other fields such as the aerospace industry.

The transformation from a ski manufactory to a high-tech production center and pioneer facility for mass-produced lightweight applications could still go much, much further. The best time is just beginning for Fischer, Hütter and the 250 employees in Ried and Ort.

> The type of production you find here didn't really exist until just a few years ago. It's still a very young industry.

Herwig Fischer
Head of the two Austrian SGL facilities in Ried and Ort im Innkreis.

Master of the Poles



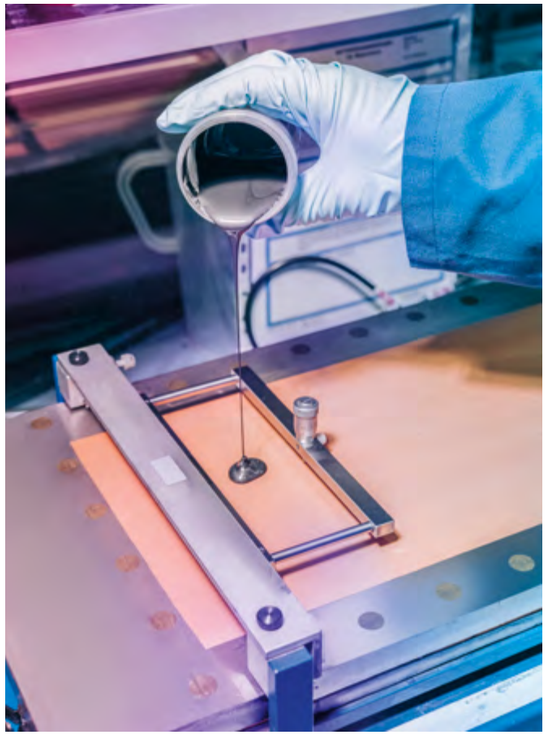
Varta, SGL, Bosch—and back to SGL: for years now, Calin Wurm's profession has been coaxing lithium-ion batteries into giving up their secrets. In Meitingen, Germany, he's now helping to set up the new SGL Carbon **battery application laboratory** with which the company plans to offer its battery customers even more comprehensive services.

The graphite mixture, viscous as honey, drips out of the beaker. "This is the slurry," Dr. Calin Wurm says. Pipettes, tongs and jars with chemical formulas surround him in the lab. Wurm, the director of the research laboratory, holds the beaker with the slurry in one hand. It's made of graphite powder and an ultrapure putty-like solution. He carefully pours the slurry into the coating equipment. The system spreads it out to wafer-thinness onto a copper foil, sends it all through the dryer, and at the end a finished anode foil emerges.

Wurm is pleased. What he just accomplished by hand is something that happens on a very large scale at battery manufacturers all around the world. "We want to work as closely as possible with our customers," Wurm explains. That's why he is currently reconstructing the individual work steps of industrial battery production in SGL's new and expanded battery laboratory in Meitingen, Germany. This isn't so he can produce the batteries himself, but rather to gather knowledge to support major manufacturers as a development partner, technology expert and materials specialist.

In the battery and energy-storage business, this combination is becoming more and more important. While raw materials, components and end products are standardized down to the last detail in many other industries, lithium-ion batteries and their components differ enormously from one another. Composition, further processing, size: almost everything varies depending on the field of application and the objective. At the same time, the demand for lithium-ion batteries is rapidly increasing. Highly efficient and safe batteries are required almost everywhere—whether in electric cars, e-bikes, smartphones or laptops. It is estimated that the demand for lithium-ion batteries will increase by up to 30 percent annually by 2025.

Power cells made of lithium metal oxides, electrolytes, separators and graphite are becoming increasingly indispensable, especially in electromobility. According to a study by the International Energy Agency (IEA), 130 million new electric cars could be registered in 2030—almost all of which will contain lithium-ion batteries. The rapid demand is already leading to shortages of raw materials, strengthening the market power of the source countries. The market is divided into about half natural graphite and half synthetic graphite. Natural graphite mainly comes from China and is less flexible, technically speaking. "You have much more freedom with synthetic graphite," Wurm says. Furthermore, it can be customized to the respective battery to a higher degree. This advantage is particularly important in battery manufacturing and is an advantage from which SGL Carbon, as one of the market leaders in the field of synthetic graphite, benefits.

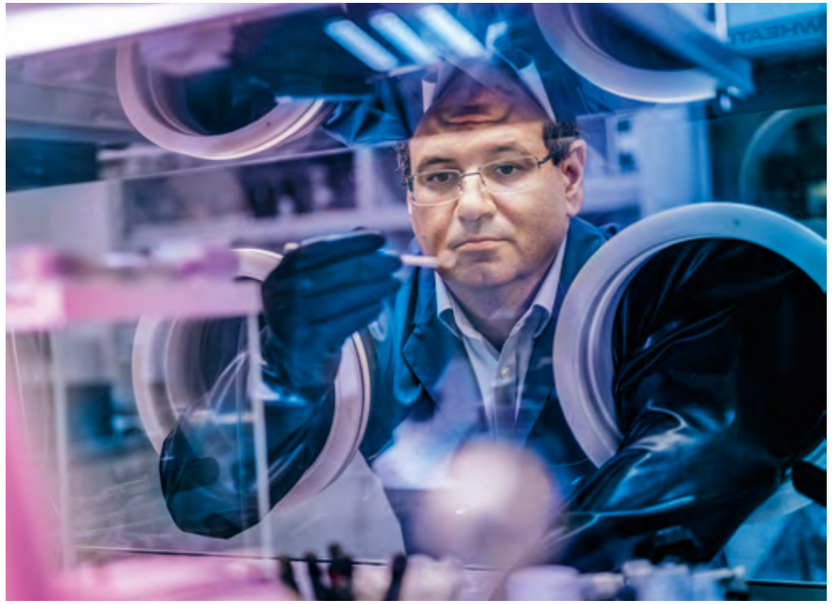


The graphite slurry is spread in a wafer-thin layer onto a copper foil.

"All of a battery's parts are interconnected," Wurm says in his lab. It's what makes them so complex. The company that wants to offer the best materials for the best battery must therefore understand precisely how these interconnections work. That's the goal that Wurm has set for himself in Meitingen—and why he returned to SGL Carbon to accomplish it. As he walks through the lab, he talks about how, as a young student in Bucharest, he discovered his fascination for batteries, then moved from his birthplace Romania to Paris to complete his doctoral thesis, then to Amiens, France, then in 2004 went to Ellwangen, Germany, to develop batteries for Varta, and finally joined SGL for the first time in 2008.

Even back then, Wurm was one of the leading experts on graphite anodes on the market. After completing his doctoral dissertation, he worked

Photos: LEMRICH (4x); Getty Images/rasslava (poles)



In what's known as a glove box button cells are assembled in an oxygen-free environment.

› My heart once again chose the battery. ‹

Calin Wurm
Head of the battery application laboratory at SGL Carbon in Meitingen and Director Technical Marketing Product Segment Battery Solutions.

for many years for cell manufacturers and purchased, tested and incorporated graphite anode materials for production.

At SGL, Wurm used this experience to advance research into graphite. In 2012, when Bosch offered him the position of cell development manager at the battery factory being planned in Eisenach, Germany, Wurm followed his passion for batteries and continued to expand his knowledge and expertise. He returned to Meitingen in August 2018 with even more experience and motivation. "When it became clear that Bosch would not become a cell manufacturer, I had a choice," Wurm recalls. Should he stay with Bosch and simply do something different or remain loyal to batteries? "My heart once again chose the battery—and SGL."

Fascinated by the Diversity of Batteries

When Wurm talks about a battery's assorted components, you can sense just how enthusiastic he is about them. The 47-year-old can talk about hexagonal graphite structures, discharge cycles and intercalation stages and, in the next sentence, quite clearly explain why the electrolytes in a lithium-ion battery take on the function of trucks. What fascinates him about batteries is their enormous diversity. "You never get bored and there's always room for improvement," he says.

In the coming years he wants to use his enthusiasm and experience to get the most out of lithium-ion batteries with SGL Carbon's various grades of special graphite. Wurm fishes something out of a drawer in the laboratory that looks like a folded survival blanket. "This is what the completed battery cell looks like," he explains. There's an anode consisting of a copper foil coated with graphite, binder and conductive additives; a cathode made of an aluminum foil coated with lithium metal oxide, binder and conductive additives; and a separator between them. The components are surrounded by a casing and impregnated with an electrolyte.

"It sounds simple, but it's incredibly complex," Wurm says. Depending on the application, the cells are either coiled or stacked. The casing may be a hard enclosure or a flexible composite material such as special foils for pouch cells. There are various electrolytes with differing conductive salts and solvents. Even the manufacturing method used for the copper foils affects the final product.

Wurm knows from his own experience that the countless interactions pose an enormous challenge for lithium-ion battery manufacturers. When he used to build batteries himself, using graphite, he repeatedly witnessed how the material in different battery types often had different performance parameters and lifetimes in practice. As he knows all too well: "Not all graphite is created equal. The art is knowing in advance which graphite is the best fit for the special cell design."

Investment in Graphite Research

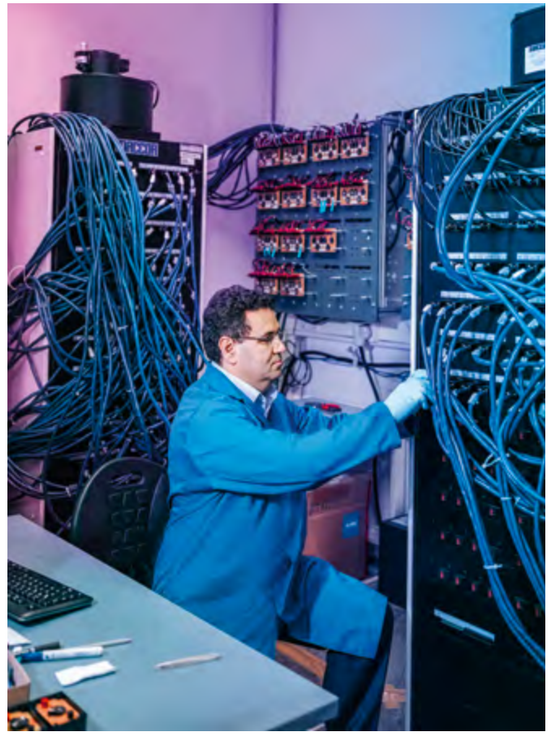
It is precisely for this reason that SGL intends to begin offering comprehensive services in the application laboratory. Instead of having one, two or three standard materials in its repertoire, SGL Carbon is starting to focus more on customized battery graphite products for the future. "We want to be able to sell our customers exactly what they need," Wurm says. "Our advantage is that we know exactly how to produce a particular type of graphite and what its properties are. Now the idea is to utilize this knowledge even more effectively for designing batteries."

This expertise has even more benefits. Battery manufacturers often test their suppliers' materials in their own laboratories, which is an expensive, complicated and time-consuming process. "We can carry out such tests much more effectively, accurately and quickly for the customer using our accumulated expertise and knowledge," Wurm says.

The strategy for the new battery laboratory perfectly implements the new SGL approach: "Customer orientation is even more important in our graphite anode business these days," says Vice President Product Segment Battery Solutions Dr. Peter Roschger. "We are continually evolving from a materials supplier to a solutions provider in this area, as well."

SGL Carbon has already made additional investments in order to successfully follow this path. Graphite production facilities in Poland and the United States have been upgraded, and the laboratory in Meitingen is being expanded, where Wurm will also be adding needed personnel for the new facility. Together with their colleagues in sales and production, everyone is now working on the common vision.

In one of the laboratory rooms that are crucial to making this vision a reality, hundreds of lights are blinking. Dozens of cables snake their way through the room, and a wide screen displays a rising curve. In what are known as battery testers, hundreds of prototypes are transferred from the laboratory to the test station. This is the only way to produce statistically valid results. Wurm enters the room and quickly closes the door behind him. "If the temperature changes in here, it distorts our findings," he explains. Lithium-ion batteries are sensitive components. A couple of degrees of warmth shouldn't disturb the battery revolution in Meitingen. ‹



Dozens of test series are used to verify the performance of each battery cell.

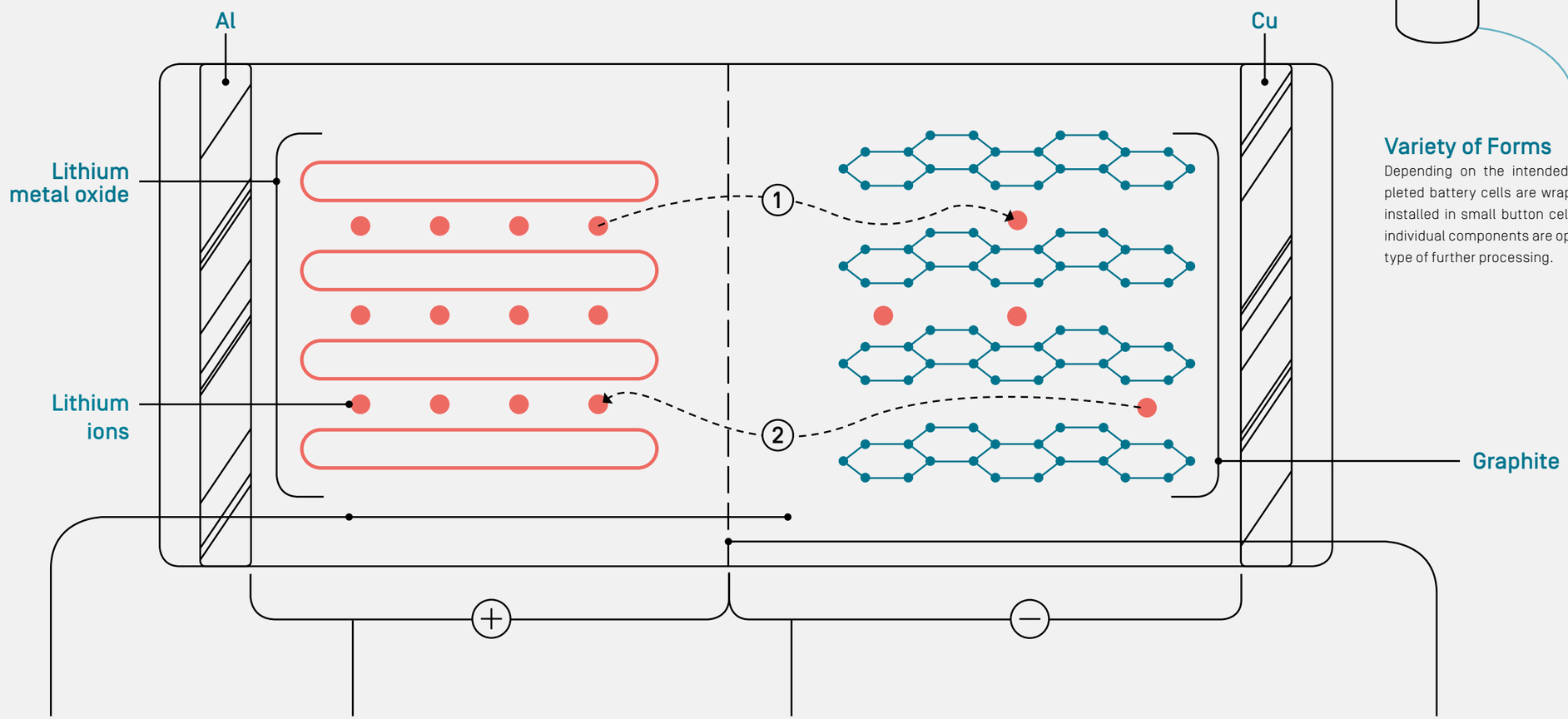
Layers that Power the World

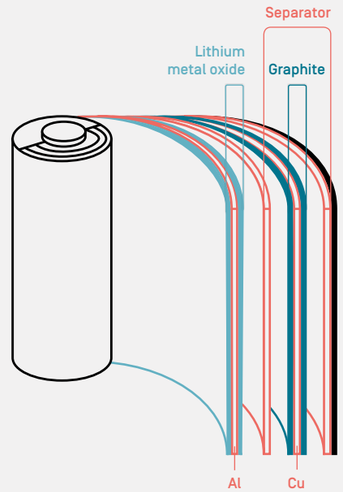
Whether an electric car, smartphone or laptop: **lithium-ion batteries** are usually what supplies us with power. In order to get the maximum performance out of every battery, SGL Carbon researches how all the components interact—and offers high-quality and precisely customized graphite anode materials for every field of application.

Lithium ion batteries function according to a simple principle: when charging, (1) lithium ions migrate from their "home," the lithium metal oxide-based cathode, to their "vacation home," the graphite-based anode. When the battery is discharged, (2) they move back again and release energy. The electrolyte is the "street" the ions are traveling on. But why do the ions migrate? The voltage applied creates an excess of electrons at the anode, which attracts the positively charged lithium ions. As soon as they arrive at the anode, they take up the excess electrons, thereby bringing about a new equilibrium. During discharge the anode releases electrons, which then flow to the cathode via the outer circuit. This releases the energy again.

Lithium is the material of choice for batteries because it's the lightest metal on the Periodic Table—weighing about half as much as water. Furthermore, because of its high electrode potential. This allows the cell voltage to be maximized while minimizing the battery's weight.

The individual components of the lithium ion battery have been continually improved over the years. These improvements include a significant increase to the batteries' capacity. While the first commercial column-shaped battery type (technically called "18650" due to its dimensions) had a capacity of 1,200 mAh at the beginning of the nineties, the same battery now has a capacity of 3,400 mAh. In the Tesla Model S 100, for example, a total of 8,256 such batteries enable a range of 450 to 500 km.





Variety of Forms

Depending on the intended use, the completed battery cells are wrapped, stacked or installed in small button cells. The battery's individual components are optimized for each type of further processing.

Electrolyte

The battery cell is filled with an electrolyte. It is made up of a conductive salt and various organic solvents. Any change in the electrolyte formulation affects all of the battery's other components. In addition, a high quality battery has as little water as possible remaining in the electrolyte.

Cathode

The cathode consists of a wafer-thin layer of lithium metal oxide with conductive additives and a binder (a type of adhesive), which is coated onto an aluminum foil. The more uniform and optimized chemical composition and mechanical properties of the electrode, the higher the quality of the battery.

Anode

Graphite is the perfect material for the anode. It is coated onto a copper foil together with binder and usually also with conductive additives, forcing the lithium atoms to find a fixed place in the material's lattice structure. This has the following advantages: higher cycle stability, better performance during rapid charging and higher quality consistency compared to other battery types (such as lead-acid batteries). The purer the graphite, the better this mechanism works. Synthetic graphite handles this task particularly well thanks to its optimized and customizable properties. SGL Carbon's many years of experience in production ensure the consistent quality of the graphite.

Separator

The cathode and anode are separated from one another by a separator, which prevents a short circuit. Yet is must also be as permeable as possible so that the tiny lithium ions can migrate between the anode and cathode when charging and discharging. The separator is usually made of a synthetic compound.

Idea Factory

Anything – but Ordinary

Carbon fibers are particularly well suited for making lightweight components. In the automotive and aerospace industries, they help to reduce weight and thus fuel consumption, meaning less CO_2 is produced. Dr. Oswin Öttinger and his team are convinced that much more can be accomplished with the fiber. It could sooner or later also help solve other pressing problems of our time.

To show a glimpse of what the future could bring Öttinger, Head of New Technologies in SGL Carbon's Central Innovation division, unfolds his laptop. First some gray-colored boxes pop up on the screen. "These are the traditional application areas for carbon fiber textiles," he explains. "Lightweight construction for automobiles and aerospace, charging racks for solar cell production, column internals for chemical apparatus engineering". Then Öttinger continues clicking and a number of new boxes emerge on the screen. "The future could look like this," he says as new applications flash into view every second. Aside from being lightweight and having a high tensile strength, carbon fiber is resistant to chemicals and to heat, and is also electrically conductive, making it especially versatile in various applications.

For example, carbon fibers can be used in the construction industry to help make walls thinner and assist in realizing more complex structures by replacing the steel in reinforced concrete. Its resistance to corrosion and its good electrical conductivity mean it plays an important role in energy storage and energy conversion. It could also help solve one of our era's most pressing issues: the looming scarcity of drinking water.

Not far from the port city of Denia, on the Costa Blanca in Spain, engineers are currently building the first drinking water treatment plant based on microbial-assisted desalination as part of the project Microbial Desalination for Low Energy Drinking Water (MIDES), an initiative being supported by the European Union as part of the Horizon 2020 program. The project's goal is to show that bacteria and carbon fiber can help treat seawater using significantly less energy than conventional desalination plants.

Science Fiction that Works

Up until now, seawater has generally been desalinated using a process known as reverse osmosis. Massive pressure forces the salty water through a membrane between two tanks. The membrane prevents the salty constituents in the water from passing through, meaning that the water collected in the tank on the other side is pure. The disadvantage: the pressure requires energy. Currently, about three kilowatt-hours of energy are needed to desalinate one thousand liters of seawater.

Droughts and climate change are threatening more and more countries. New technologies for seawater desalination could help alleviate the problem.

"With new desalination cells using carbon fibers, we are already starting one step earlier in the process," Öttinger says. Technically speaking, the new process uses the principle of electrodialysis. Two differently polarized electrodes extract the majority of the sodium and chloride ions from the seawater. These ions migrate through two membranes into two separate chambers and cannot go back to the original chamber. Largely salt-free water remains in the middle chamber, which is then desalinated through reverse osmosis, requiring considerably less energy.

However, these electrodes also require an external source of electricity. At least that used to be the case. Now bacteria are producing the energy required in the new desalination cell. What sounds like science fiction actually works. As the bacteria feed on wastewater, they produce electricity. Yet the bacteria don't like electrodes made of metal. "That's why we use carbon electrodes in the new desalination cell," Öttinger explains. The extremely thin carbon fibers provide a support structure for the bacteria, and the electricity they produce is conducted through the carbon fibers.

"This innovation completely changes desalination: the energy generated from the wastewater makes it possible to produce drinking water from seawater at a very low cost," says Frank Rogalla, project coordinator and head of research and innovation at FCC Aqualia SA, a partner company in the project. It's a fascinating solution that could help defuse looming conflicts over drinking water throughout the world and, what's more, help poorer countries in the process. Along the way, however, many aspects of this approach still need additional research. For example, it remains unclear which bacteria work best with which type of wastewater.

To keep the bacteria as comfortable as possible, the SGL team and other project partners are working on different approaches. Could it help the bacteria, for instance, to apply electrical voltage to the water during the colonization phase? Or do the tiny energy producers need a specific temperature? Öttinger and his team are mainly optimizing the carbon fibers to offer the bacteria the perfect surface to settle on. "But it may take some time before we have cleared the biggest hurdles," Öttinger says.

You Just Have to Keep at It

Yet even if it takes several years before the first industrial plants with carbon-fiber desalination cells go into operation, they prove to Öttinger something much more fundamental: the enormous potential of the fibers. "If someone had told me five years ago that we would be putting carbon fibers into seawater, I probably would have just shaken my head in disbelief," he says. "And today our research is a great success."

It's clear to Öttinger and his team that the potential of carbon fibers is far from being exhausted. "Time and again, basic research brings amazing opportunities to light," he says, and then brings up a bit of history. The carbon fiber of today was patented almost sixty years ago—and now the first commercial-scale applications are ready to go into production. When Öttinger looks at his current research in light of this time frame, one thing becomes clear: "Today we're definitely laying the foundation for some interesting new applications in the future. You just have to keep at it."

Photos: Myrzik und Jarisch (Faser); Getty Images/Westend61 (desalination)

Here to Stay

In-house training centers, a kick-off week, almost 100 percent hiring rate: **good training** is a tradition at SGL Carbon. It's no surprise that the firm is one of Germany's best companies for apprenticeships. Five apprentices tell us why.

Sometimes the numbers speak for themselves. For instance, when 88 percent of trainees report they have a very good apprenticeship position. When 89 percent of trainees approve of the pay they're receiving. Or if 86 percent of the young talent in your company feels welcome and well taken care of. These figures are the result of an employee survey, certified by the independent Great Place to Work® institute, which SGL successfully completed.

As part of the survey, the trainees were asked 27 questions to find out how they experience and rate their training. Afterwards, the respondents' data and the results of a "working culture" audit were compared with those of other companies with similar baseline conditions and in similar industries. The result: top marks for SGL. Not to mention a certification with the "Great Start" distinction. This officially makes SGL Carbon one of Germany's best companies for training.

As Head of the Vocational training department Uwe Moderer in Meitingen, Germany—home of SGL Carbon's largest facility—says, "Such a result makes me proud, of course. SGL trainees in Germany also frequently demonstrate above-average performance in vocational colleges as well."

Yet these top ratings don't just come out of nowhere. Moderer and his colleagues at the German sites in Bonn, Limburg and Willich work hard so that their protégés make progress and feel comfortable. It all starts in the first week at the company. Instead of throwing their trainees directly into work, those responsible for training offer factory tours and welcome rounds. "This way we make it easier for the trainees to make the transition into working life," Moderer explains. Later, training trips, project weeks and professional development seminars continue the approach. "Professional training and team-building always go hand in hand," Moderer adds.

At the two main training locations, Meitingen and Bonn, SGL Carbon trains apprentices in seven technical and two commercial occupations. There are also several dual courses of study. "We naturally want to offer our trainees the best opportunities in all areas and make them as fit as possible for working life," says Ralf Wolf, who coordinates the vocational training in Bonn together with Andreas Walter. "But we also expect commitment and performance in return."

This agreement almost always works for trainees and companies. In recent years, almost 100 percent of the trainees have been hired by the company. For Wolf, Walter and Moderer, however, this is no reason to rest on their laurels. Both are well aware of their responsibility to the next generation. "We are helping to build a piece of SGL's future here," they say. "There can hardly be any greater incentive."

Nicole Lindenmeier, 18, chemical laboratory apprentice in Meitingen

I actually wanted to become a vet, but I didn't like seeing sick animals every day. The Girl's Day Academy led me to SGL. After an internship, I applied online and was then invited for an interview after a recruitment test. Although I was pretty nervous during the interview, I felt like I was in good hands. That was also the deciding factor in my decision to join SGL. My coworkers are great and support me wherever they can. We also get enough time to prepare for vocational college and the exams there. After my training, I want to gain more professional experience at SGL and maybe later become a certified master or technician.

Daniel Delil Gül, 21, industrial technician apprentice in Bonn

I came to SGL through my cousin. He did his training here eleven years ago and is still with the company, so I knew that I would get a great education at SGL Carbon. Now I'm starting my third year of training and have never regretted my decision. We are just learning how to wire circuits. First it was simple things like electrical sockets or light bulbs. Meanwhile I can control an electric motor with what is known as a star-delta circuit. If you're interested and motivated, you can learn a lot at SGL. And you can always count on the instructors to support you. If something goes wrong, it's not the end of the world. You have to face up to your mistakes and then learn from them. It's the only way to move ahead.

Photos: LEMRICH (5x)

Markus Lang, 18, industrial technician in Meitingen

Right now I'm working four-to-five-week stints in different departments and learning a lot about the specific processes there. After that I hope to be hired by one of the departments. The variety was what I always liked best during my training. I was constantly learning new things and meeting new people. The coolest thing was our training trip and the socio-educational seminar in Grainau, where we learned presentation techniques. I also learned something from my instructors that will help me all my life: always keep a cool head, even if everything isn't working out.

Philipp Dohmen, 22, machine and plant operator apprentice in Bonn

I'm still at the beginning of my training and during the first year I learned the basic techniques such as filing, drilling, lathing and milling. That was exciting because we were given different tasks every day and were constantly learning new things. When things got more difficult, the instructors each supported us individually. This also taught me how to get a grip on my anxiety about exams and to plan my work processes better. I now want to fully focus on my training and hope to be hired afterwards. Even so, it isn't always about the work. On our training trip, for instance, we took a spontaneous detour to a go-kart racing track.

Rebecca Theresa Heimerl, 20, dual-track student in controlling and consulting in Meitingen

SGL is a global company—and that's exactly why I wanted to get a trainee position here. The idea of being part of such a large company fascinates me just as much as the untold number of applications for carbon and graphite. I'm lucky it worked out. After just a few days with the company, I already had the feeling that I fully belonged here. My coworkers were open about integrating me into the team and took a lot of time to familiarize me with the job. I then spent a few weeks gaining practical experience and then started studying at DHBW Villingen-Schwenningen (vocational college) at the same time. The mixture of on-the-job practice and classroom theory is ideal for me and will hopefully build a foundation for many more years at SGL Carbon.

True All-Rounder

The ancient alchemists treasured what they called spirits of salt—what we know today as hydrochloric acid—using it to search for the philosopher's stone. Today this all-rounder is an important basic chemical for modern chemistry. SGL Carbon has been building complete plants for manufacturing **hydrochloric acid** for more than fifty years and relies on the jack-of-all-trades graphite: it dissipates heat, doesn't corrode and is indispensible for hydrochloric acid production.

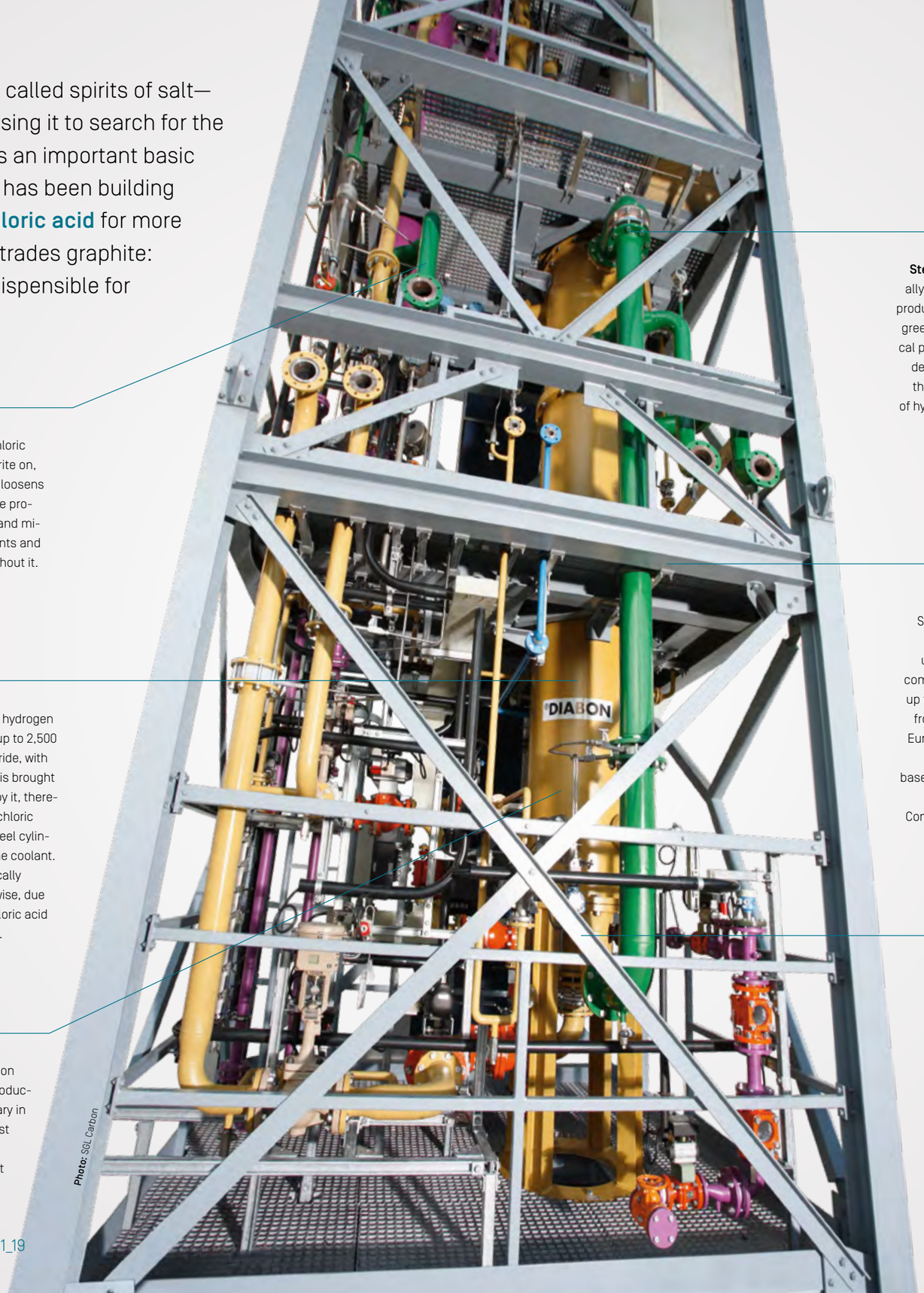


Photo: SGL Carbon

1

Basic Material for Chemistry: Hydrochloric acid helps bleach the paper that we write on, makes water purification possible and loosens layers of rock in mining. It is used in the production of silicon for solar cells, LEDs and microchips. Even the manufacture of paints and varnishes would hardly be possible without it.

2

Hot Stuff: In the combustion chamber, hydrogen and chlorine react at temperatures of up to 2,500 degrees Celsius to form hydrogen chloride, with the chemical formula HCl. The hot gas is brought into contact with water and absorbed by it, thereby transforming into the desired hydrochloric acid. The DIABON graphite inside the steel cylinder effectively dissipates the heat to the coolant. The material is also particularly chemically resistant, which is a good thing; otherwise, due to its corrosive properties, the hydrochloric acid would attack the materials in the plant.

3

Size Matters: The size of the combustion chamber determines the maximum production capacity. The graphite cylinders vary in diameter from 25 centimeters to almost 150 centimeters. This translates into enough for 5 to 160 tons of 100-percent hydrogen chloride per day.

4

Steam Generator: The HCl synthesis continually generates waste heat. This can be used to produce steam at temperatures of up to 160 degrees Celsius that can be used in many chemical plants at different places. Depending on the design of the chemical park, the utilization of this waste heat can be a positive side benefit of hydrochloric acid production, helping to save energy and thus reduces CO_2 emissions.

5

Tradition for Customers Worldwide: SGL Carbon can look back on more than fifty years of experience in designing and manufacturing HCl synthesis plants. To date the company has supplied more than 500 of these up to 25-meter-tall facilities all over the world, from North and South America, through all of Europe, Australia and Russia, and on to China, India, Japan and Indonesia. The customer base runs the gamut from plant manufacturers to chemistry giants such as Dow Chemical Company and BASF. The oldest plant has been in operation since 1968.

6

Global Market, Global Production: HCl synthesis plants are built in Meitingen, Germany, as well as in Strongsville, Ohio in the United States, in Pune, India, and in Shanghai, China. Thanks to completely factory-preassembled modules, the so-called skids, the systems can quickly be up and running all over the world.

A Journey by Pneumatic Tube

Carbon 360°

The Hyperloop could **revolutionize rail transport**. What was once an option for urgent mailings is now being developed to potentially transport people and goods in future at almost the speed of sound—capsules could be whizzed through vacuum tubes at speeds of around 1,200 kilometers per hour. The most successful prototype to date was developed with carbon fiber materials from SGL Carbon.

Riding a train at the speed of sound: the Hyperloop is an idea from Tesla founder Elon Musk. It's based on the concept of pneumatic tubes, like the old-style mailing system. High-speed trains will be transported at extreme speeds through a tube filled with a partial vacuum, an idea that has long since stopped being science fiction. Students at the Technical University of Munich (TUM) have already sent their test model of the so-called "pod"—that is to say, the prototype of the possible later cabin capsule—racing at 467 kilometers per hour through the experimental tube on the premises of SpaceX, Musk's space company, in Los Angeles.

The TUM team used carbon fibers from SGL Carbon for the prototypes. Along with supplying the carbon fiber materials, the company also provided the students of the Scientific Workgroup for Rocket Technology and Spaceflight (WARR) at TUM with the expertise, resources and equipment.

This newest speed record marks the third time in a row the WARR team has won the "Hyperloop Pod Competition" launched by Elon Musk; some thirty student workgroups from all over the world take part. While the first competition was about an overall working concept for a Hyperloop Pod, the main focus of the second competition was on the speed achieved, with the Munich team victorious at 324 kilometers per hour.

The third competition was once again about the maximum speed, but this time only pods with their own propulsion systems were allowed to compete. Only three teams made it into the finals, including the TUM team. Although the winning speed of 467 kilometers per hour is still a good way off from the speed of sound (1234.8 kilometers per hour), the dream of a train ride from Munich to Berlin within 35 minutes is coming nearer. The Hyperloop makes use of the pneumatic tube principle developed in the nineteenth century: once the train has initially accelerated, the vacuum inside the tube means that almost no more energy is required for it to reach its destination. If this innovative means of transport can be realized in an economically viable manner, it would be faster and more environmental-friendly than air travel and simultaneously cheaper than rail.

Head of Industrial Applications & Marketing for Composites – Fibers & Materials (CFM) at SGL Carbon Dennis Baumann, is excited about the development of the Hyperloop: "The Hyperloop pod is an up-and-coming project with global significance and great potential in the field of future-oriented mobility. That's why we are very happy to support the students with our expertise and our materials. Much like in our customer projects, the focus with the young university team is on working together as partners and developing integrated solutions." SGL also works closely with TUM on more than just the Hyperloop project. For more than eight years the company has been supporting the Carbon Composites endowed professorship (LCC), which is focused on the integrated study and advancement of fiber-reinforced composites and their applications.

467

kilometers per hour was the speed of the Hyperloop prototype pod.

35

minutes is how long the ride from Munich to Berlin could take in the future.

28

people are to fit into each Hyperloop passenger cabin.

Once the train has accelerated, the vacuum inside the tube means that almost no more energy is required, which is why the Hyperloop would be both fast and environmental-friendly.

Photo: WARR Hyperloop/TUM

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