WACKER is a highly research-intensive, international chemical company. In 2011, we spent over €170 million on research and development. WACKER sees innovation as an important lever for profitable growth. We concentrate on two essential pillars: innovations in processes and innovations in products.

But it is not enough just to develop new ideas; they have to yield a benefit. That is why we place greatest priority on applications for our customers. Before we start a new project, we assess it for customer benefit, sales potential, profitability and technological positioning.

Process innovations are just as important to us. We are convinced that a company can only remain at the top of its game if it reduces costs and continually improves the efficiency of its processes.

This annual report shows how we manage innovations and successfully put them into practice. And it gives a glimpse of the future of electromobility, which is also one of WACKER's fields of work.

Paths to Innovation

Innovation Management

It’s One Thing to Have a Lot of Ideas. But Backing the Right One Is Something Else Entirely.

Process Innovation

Being Able to Think in Detail. And Act on a Big Scale.

Product Innovation

Combining the Advantages of Silicones and Organic Polymers.

Focus Innovation

Creating More Energy for Tomorrow’s Mobility.

It's One Thing to Have a Lot of Ideas. But Backing the Right One Is Something Else Entirely.

Innovation Management Means Backing the Right Idea.

1

1
Dr. Fridolin Stary is head of Corporate Research & Development. A chemist, he is responsible for implementing R&D strategy. He is proud of the creativity and high levels of expertise shown by his staff – many of their developments become success stories within a short time.

2
The new Consortium building in the south of Munich offers its researchers state-of-the-art labs and workplaces.

2

3

4

24%
New-Product Rate

5

3
Researchers not only examine details under the microscope, but also scrutinize economic aspects carefully.

4
A new development only stays in focus if it is found to be marketable.

5
A meeting at the Consortium. The research team is objective and transparent in its decision making.

Creativity can very easily be steered in the right direction. Systematically conducted R&D is an important source of growth for WACKER.

Dr. Stary, can you control creativity?
If you are referring to the creativity of individual researchers – no, you can't control it or steer it. That said, we can certainly direct the collective creativity of our 1,000 researchers. But it's not as if we go around asking: who's got the best idea today? Our employees work on clearly defined projects and, here, creativity can definitely be nudged in the right direction. Systematically conducted R&D is a steady source of growth for WACKER.

Who determines what the researchers in your laboratories work on?
Our everyday work stems from the project portfolio which our innovation strategy has identified. Before we start a new project, we evaluate it in terms of technology position, potential sales and profitability. That also means that all our projects are in competition with each other.

What is your role in all this?
The most important decision is to tackle the right projects with the right resources at the right time. Our innovation budget may be relatively high for a chemical company at 3.5 percent of sales, but it can't be extended indefinitely. We can't do everything. So, if our budget is fixed and we want to translate more of our ideas into market successes, we need to choose well and provide targeted funding.

Does that mean spending plenty of money on just a few projects?
I wouldn't put it like that. But focus certainly takes precedence over diversification. This means that we are concentrating even more on our key strategic projects. The chief goals here are to further improve our existing product platforms and production processes. These key projects consume around one-fourth of our R&D budget. However, we also look to important future trends that we can target with our technological expertise, such as photovoltaics and electricity storage. Focusing also entails drawing a line under old projects that have no prospect of economic success. That's not as easy as it seems. Employees are passionate about their own projects, after all. So, we must exercise maximum objectivity and transparency when making our decisions.

Does that mean frustration is part of being a researcher?
I'd be more inclined to say that we are all at risk of having our projects shelved. It's not a question of failure, it's just life. In fact, for me it's more a sign of strength when someone has the courage to say: I can't go any further with this.

Especially since the speed of research has picked up, too…
That's right. Up until a few years ago, developers were not under as much pressure. But they are now, because when the market sees really good solutions it wants them immediately. What's more, we have to be constantly in tune with the demands both of technologies and customers. Such a situation arises for instance when a leading chip manufacturer dictates when and in what quality a new generation of wafers must be ready. The same goes for electromobility, where we're helping to develop third-generation batteries. An industrially feasible solution must be ready by 2014. If we're not ready by then, no-one will wait for us. There's no point producing the ultimate solution a year later. See Focus Innovation

WACKER has now appointed technology managers to monitor areas that will be crucial in the future, such as electromobility. What is their task?
The technology managers monitor the technologies and markets of the future. They must become thoroughly conversant with all the technical and economic aspects of these technologies and be able to evaluate them. They identify users' requirements and match them with our specific capacity to deliver a solution. They build up partnerships, form networks and also have an overview of all internal projects related to that area. A technology manager is a kind of marketing manager for new technologies. So, even before we invest a single euro in research, we know fairly exactly what our solution must look like and what its potential is.

What are the future technologies that the technology managers oversee?
Aside from electricity storage and electromobility, we are currently focusing on concentrated solar power plants,

or CSP for short. These use, for example, parabolic mirrors to concentrate the rays of the sun. This concentrated heat energy is transferred to a steam circuit to generate electricity, as in conventional power plants. The heat-transfer fluid employed here must remain stable at very high temperatures. Within the last few months, we have developed and are currently testing a silicone-based prototype of one such fluid. The potential is huge. A power plant requires up to 8,000 metric tons of heat-transfer fluid. Without the technology manager, we would never have been so focused and progressed so quickly.

What would have happened in the past?

In the past, we used to develop properties and then search for a market. And then we were sometimes disappointed that customers failed to appreciate our innovation. This was because we ignored the fact that our customers always expect new solutions to benefit them economically.

So should developers preferably also have studied business administration?

Technical or scientific training clearly takes priority, but we want developers to deal with the economic aspects from the start. We need researchers who are creative in searching for new molecules but their objective must always be to devise a solution that is technically and economically superior and can be sold on the market. Except for the area of basic research, we don't draw up plans today for things that we can't sell tomorrow.
See Product Innovation

But that doesn't apply just to new products…

That's right. It's true that one-fourth of our sales come from new products. But we must further expand our existing business. Our goal here is to make processes better and cheaper. And this is an area of collaboration between Corporate R&D, the business divisions and technical service managers.

Can you give a specific example?

Take polysilicon for the solar industry. Every day you read how tough the competition is. We, too, can only do good business if our cost position is better than that of our competitors. How can we achieve that? By having a fully closed loop in the case of silicon, for example. There is still scope for optimizing the yield of material. The goal is zero waste. And we are working on boosting the energy efficiency of silicon deposition. Innovations of this kind can help us to thrive even in this fiercely competitive market.

WACKER operates in global markets. How international does research and development have to be here?

Some 800 of our roughly 1,000 R&D employees work in Germany. Nevertheless, research is swiftly becoming internationalized. In our local technical centers in China, India and Brazil, products are being adapted to the local market. This generates ideas for basic research. In other countries, creativity manifests itself differently. Other nationalities often have a more pragmatic approach, and that is good. In India, for example, a researcher at one of our joint ventures used raw materials from Germany to create a silicone emulsion for hair rinses, which will now be used around the world. This shows that the German solution is not always the best.
See Process Innovation

Is this also a step toward global recruiting?

Naturally, local networks spring up on account of our technical centers. We get to know the local scene and that enables us to be selective in our recruiting. In Germany, our reputation still enables us to choose the very best – experts who know that we live for innovation.

A strong claim. Can you back it up?

Last June, for example, WACKER received the Best-Innovator-Award. The jury highlighted the fact that thinking and acting innovatively are firmly embedded across the company. At WACKER, everyone from the Executive Board right down through all management levels has an understanding of the matter. And that makes a difference, you know, when you not only have a strategy for innovation, but also want to implement it.

Innovation Management

3.5%

of our sales revenue is invested in R&D.

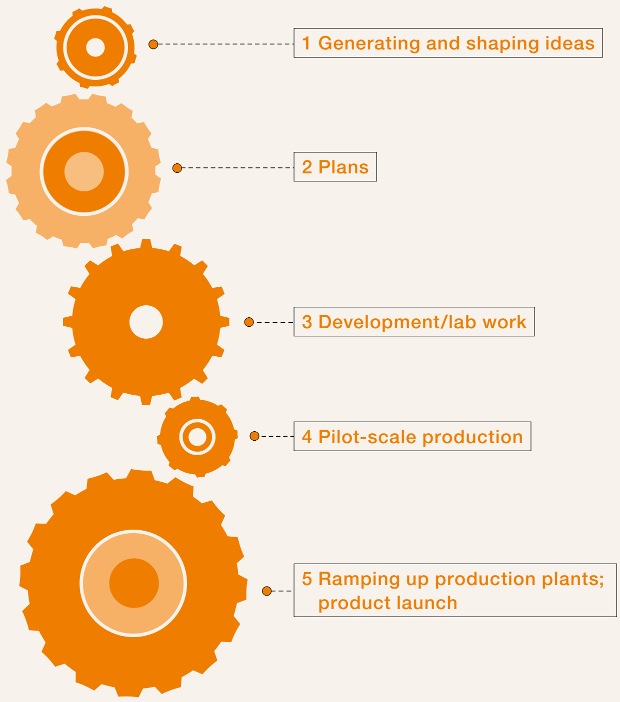
24%

of our sales revenue was achieved with new products in 2011.

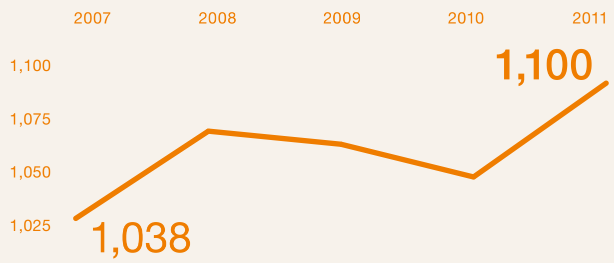
Outstanding Research

- The "Thomson Reuters 2011 Top 100 Global Innovator Award" distinguished WACKER as one of the most innovative companies in the world. WACKER received the award for its outstanding innovation and patents.
- WACKER received Germany's 2011 Best Innovator Award in the Chemical category for its sustainable innovation management. A.T. Kearney and German business weekly "WirtschaftsWoche" organized the competition, in which more than 100 companies participated.

Stages in the Innovation Process



5-Year Comparison of Employees in R&D



179

researchers have entered for the Alexander Wacker Innovation Award since 2006.

In 2011, WACKER worked with more than 25 international research institutes on around 64 research projects. In 2011, we enlisted around 66 students from 33 international universities to write theses. In the 5 years since the Institute of Silicon Chemistry was established at the Technical University of Munich, we have funded a total of 44 scholarships, including 5 post-docs. So far, 25 of our scholarship holders have completed their doctorates. 14 scholarship holders are currently working on their theses.

Being Able to Think in Detail. And Act on a Big Scale.

An innovative analytical method improves production processes.

1

1
Specialists in process optimization: Dr. Thomas Frey (left), head of Process Development and Productivity at Corporate Engineering, and Jochen Groß, silane production manager in Burghausen.

2
The model fluidized-bed gives the engineers an insight into how the reactor works. This is where analyses are performed.

A radically new insight into two key processes used in the chemical industry will boost the efficiency of silicone and hyperpure silicon production while reducing raw material consumption.

Jochen Groß knows "his" plant on the WACKER site in Burghausen like the back of his hand. The 3,000-square-meter complex has been the focus of his working life for over 15 years. "Up there," says the production manager pointing to the walkways at a dizzying height, "you can feel the eddies inside the reactors. Standing there, I can sense whether the reactor is running properly." Each year, the facility produces several hundred kilotons of methyl chlorosilanes. These serve as feedstock for producing silicones – fluids, rubbers and resins with applications in such industries as construction, automotive, plastics, electrical and textiles.

A Fluid Contact Mass

The principle behind the process is anything but new. It was discovered back in 1940 by Eugene Rochow, an American, and Richard Müller, a German. It starts from solid silicon and gaseous methyl chloride. Copper is also required as a catalyst, to increase the reaction rate and make the process economical.

The silicon and copper, along with co-catalysts, are finely ground and then mixed to make the contact mass. In the Müller-Rochow reactors at WACKER, the methyl chloride flows up through a bed of contact mass particles at high speed. "This causes the particles in the contact mass to behave like a boiling liquid. In this fluidized bed, bubbles are created and the particles constantly rise and sink," explains Groß.

There is another key production process, well-established at WACKER, that is performed in fluidized-bed reactors, namely the industrial-scale production of trichlorosilane – the precursor of hyperpure silicon in solar cells and semiconductors. Trichlorosilane (TCS) synthesis, too, is the first stage of a value-creation chain but distinct from that of the Müller-Rochow process. TCS synthesis is therefore the responsibility of a different WACKER business division. Yet the two processes are in fact very similar. In TCS synthesis, too, a gas is forced through solid metallurgical grade silicon, where it reacts to form the product.

WACKER performs both of these processes in fluidized-bed reactors because these systems offer optimum thermal and mass transfer. The yield is higher, i.e. more product. And local hotspots are avoided, which could otherwise compromise the product's composition.

"Up until now, Müller-Rochow and TCS synthesis have been studied empirically," says Dr. Thomas Frey, WACKER's head of Process Development and Productivity at Corporate Engineering. This means that records are kept of how changes in the conditions within the reactor affect the quantity and composition of the product. The information and experience accumulated over the years have helped WACKER to make continuous improvements to its processes. "However, there's limited scope left for making further empirical optimizations ," admits Frey.

The problem is that there are too many variables. Hundreds of them, he says: starting with desirable and undesirable impurities in the silicon and catalytic additives, then the crystal structures of the solids, and their particle sizes, and finally process engineering variables such as pressure, temperature and flow rate. "Looked at on this scale, the Müller-Rochow and TCS syntheses constitute a black box – very complex systems that can only be examined in terms of their external behavior," explains Frey. Consequently, attempts to elucidate the process in recent years were limited to the use of computers and ingenious algorithms to explain the interplay of the various factors.

The Reactor Is No Longer a Black Box

"Now, though, a new and highly promising approach has been developed that enables us to simulate the processes inside the reactor realistically using a computer," adds Frey. Meanwhile, in production, Jochen Groß is also testing the new findings, which could prove to be a milestone in making production more versatile, cheaper and more economical on resources. What has made the two so optimistic is the outcome of some truly cutting edge research. A team led by Dr. Anne Alber from Corporate R&D has refined a special analytical technique to the point

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Getting to Grips with a 3,000 m² Plant

3
The control room of a metallurgical-grade silicon production plant in Burghausen. Every detail of the plant is documented in plans and computers.

4
Skyline view with the fluidized-bed reactors and distillation columns at WACKER's Burghausen. site.

5
The process engineers have carefully planned the chemical production facilities down to the minutest detail.

where it can now be used to view individual, fundamental processes occurring on the surface of the solid particles. The graduate chemist was honored with the Alexander Wacker Innovation Prize 2011 for her work.

The Particles Can Now Remain in the Reactor for Analysis

"What makes the technique so special is that we can use it to analyze the solids at the molecular level minute by minute in realistic conditions as the reaction is happening," explains Alber. In the past, analysis entailed removing solid particles from the reactor for examination. The time delay allowed the particles to cool down and also to react with oxygen in the air. As a result, this analysis gave little information about what was really happening inside the reactor. Thanks to this new, innovative technique, WACKER researchers have already gained a very detailed idea of what Alber calls the reaction network of the Müller-Rochow process. The formation of methylchlorosilanes on the surface of the contact mass particles actually proceeds via a complicated process involving scores of intricately interlinked intermediate steps. The catalyst, too, plays a number of active roles, even though it ultimately emerges from the process virtually unchanged.

As Anne Alber has only recently begun to apply her special analytical technique to trichlorosilane synthesis as well, concrete results are not yet available. "Much of what we learned from our pioneering work on the Müller-Rochow process is transferable to the trichlorosilane synthesis. So, progress will be swift," assures Alber.

Armed with the fresh knowledge of the fundamental processes occurring in the Müller-Rochow direct synthesis, the WACKER process engineers have identified ways to further improve it. They are now assessing which of the possible recipes will be particularly effective at lowering silicon consumption in practice and at boosting productivity. For now, they are conducting model trials in fluidized-bed reactors the size of a glass beaker. Then, they will scale this up to reactors capable of converting several kilograms of raw materials. "Many of the new optimization methods have already gone to factory trials at the ton scale and will be phased into regular production," adds Frey, visibly pleased.

6
At the Munich-based Consortium, Dr. Anne Alber researches into the processes taking place in the Burghausen reactors.

7
When an innovation succeeds in this model, it is gradually introduced into production.

6


7

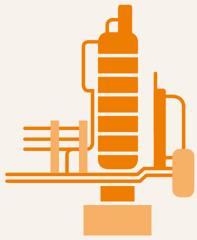

Process Innovation for Silane Production

80%

WACKER's group sales are mainly derived from products whose precursors are produced in fluidized-bed reactors. Here, the fluidized bed of solid particles comes into intimate contact with the fluidizing material (gas or liquid), resulting in a dynamic exchange in all directions. This leads to good thermal transfer within the reactor, which is ideal for an efficient, energetically favorable process.

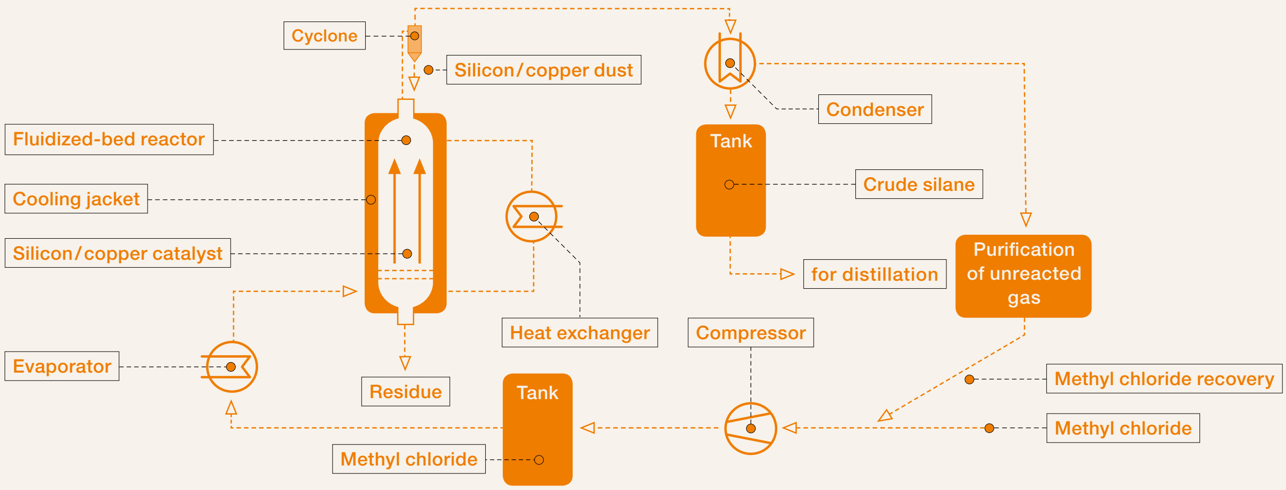
85 m

is the height of the distillation columns used to synthesize chlorosilanes at WACKER. Such columns are in use at the Burghausen and Nünchritz sites.



Müller-Rochow Direct Synthesis

The U.S. American Eugene Rochow and the German Richard Müller independently discovered the basic principle for manufacturing silanes – Mülller-Rochow direct synthesis – in 1940. It starts from solid silicon and gaseous methyl chloride. Copper, as a catalyst, speeds up the reaction. In the Müller-Rochow reactors at WACKER, the methyl chloride flows up through a bed of contact mass particles. Then the methylchlorosilanes that are produced are separated from unspent methyl chloride in a condenser.



2,500 Silicone Products

WACKER manufactures silicone products using Müller-Rochow direct synthesis. As feedstocks for producing silicones, methylchlorosilanes make possible many products that are essential to modern life. They can be found, for example, in cars, electrical equipment, plastic products, textiles and buildings.

Process Innovation for Polysilicon Production

1839 was the year that Alexandre Becquerel discovered the photovoltaic effect. The French physicist immersed two platinum electrodes in an acid bath to create a battery. Then he separated the electrodes optically and exposed one to light while shading the other. He found that more current can be obtained from the battery when the electrode is exposed to sunlight.

1904 was when the German physicist Phillipp Lenard discovered that certain metals release electrons from their surface when irradiated with light. He thereby gave the first explanation of the photoelectric effect, obtaining the 1905 Nobel Prize for Physics for his work.

1905 was the year that Albert Einstein, using quantum theory, explained that light can exist either as a wave or a particle. He realized that the energy of a light particle (photon) depends on the wavelength. He, too, proved that bombarding a metal with light beams releases electrons. Using two electrodes, he was able to utilize the electrons as electric current. Einstein was awarded the 1921 Nobel Prize for Physics for these discoveries.

200 megatons

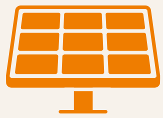
of carbon dioxide can be prevented by the amount of silicon that WACKER produced in 2011 for use in photovoltaic modules. In 2014, the potential saving is estimated at 380 million metric tons.

6 months

is the energy payback time for a photovoltaic cell in the Sahara. This is how long it must operate in order to generate the amount of energy used in its manufacture. In Northern Germany, the energy payback time is 18 months.

30 years

is the lifetime of crystalline solar cells. After 25 years, manufacturers still offer a performance warranty of 80 percent.



Combining the Advantages of Silicones and Organic Polymers

GENIOSIL® Hybrid Polymers Are the Basis of Completely New Product Innovations.

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1
Dr. Rudolf Hager heads the alpha-silane project at WACKER SILICONES. After training as a chemist, he has worked for WACKER ever since gaining his doctorate in 1990. Silanes have occupied him for ten years. The 51-year-old also shows his stamina and determination in his hobbies – swimming, cycling and jogging.

2
This instrument is used by the researchers in Burghausen to measure the tensile strength of innovative adhesives.

5

3

4

10 Years
of Intensive Research

3
A Burghausen staff member tests various adhesives for tensile strength.

4
A close up of the tensile testing instrument used for hybrid polymers.

5
Preparing batches of innovative adhesives to test according to customers' demands.

WACKER is a leading producer of silicones and polymers. Drawing on their expertise in these two areas, its researchers have now created a totally new product class.

Karl Kiermaier, facility manager at the WACKER site in Burghausen, has never bothered to count the many first-aid kits and safety glasses distributed around the site. They probably number in their thousands. As the company's main production site grows, he and his colleagues have to continually anchor more and more plastic boxes to the wall – to hold safety glasses or gauze bandages. This can be troublesome – especially where a wall forms part of an explosion zone harboring, say, flammable solvents. Clearly, an electric drill is out of the question for safety reasons. Now, though, Kiermaier's job has been made quite a bit easier thanks to a recent invention by Corporate R&D. Whenever he leaves his workshop these days, instead of his drill, he simply takes a tube of adhesive along: GENIOSIL® N70-HT. The HT stands for high tack. For Kiermaier that means "just press firmly in place for an instant bond."

Innovation Award for a High Performance Adhesive

Banal though that might sound, it represents a crucial leap forward for modern industries and applications. Adhesives are a great way of joining things together. They eliminate the need for drilling holes, or inserting screws and rivets. Nor must the material be heated, as in the case of welding. Adhesives are unobtrusive and easy to use. Modern automobiles contain the equivalent of a 100-meters of adhesive seams, and shipbuilders and aircraft makers, too, are employing them more and more. Whatever the application, the adhesives and sealants must be easy to use, fast curing and ecologically sound.

GENIOSIL® high-performance adhesives fit the bill exactly, which is why, last September in London, WACKER chemist Dr. Rudolf Hager was presented with the New Product Innovation Award by the management consultant Frost & Sullivan. Hager heads the key Group project which forms the basis for the new product range and goes by the somewhat cumbersome name of "Silane-Curing Organic Polymers." For him, the award is a milestone, "because it shows that market experts and analysts, too, are excited about our technology."

Market experts? Analysts? Surely a chemist should be more interested in garnering praise from his peers and boosting his scientific status. Hager, though, prefers to seek out new solutions for new markets. Take adhesives, for example. Two thirds of the 1.7 million metric tons of adhesives consumed annually contain either silicone or polyurethane. The new hybrid adhesives combine the advantages of both. "We're not re-inventing adhesive bonding, but making it easier to find new solutions," explains Hager. And floorers could hardly fail to be delighted with a wood floor adhesive that does not take days to cure, is elastic, does not present a health or environmental risk and is still easy to use. In these new GENIOSIL® hybrid polymers, WACKER is supplying adhesives manufacturers with the component for an adhesive that is both technically and ecologically optimum.

2,000 metric tons of hybrid polymers are currently in production in Burghausen. It may still be a niche business for WACKER, but it is growing fast. The new polymers will not just wind up as binders in wood floor adhesives. They make prime candidates for all bonding, sealing, coating and foaming tasks. They can be used to customize a wide variety of products to specific tasks: such as all-round assembly adhesives, isocyanate-free construction foams, flexible sealing membranes and scratchproof top coats for the automotive industry.

Developing the hybrid polymers took ten years of intensive research. Yet, it was clear to the basic research scientists in the Consortium from the outset that they had to focus on the intended application. The objective was ambitious: the researchers wanted to create a wholly new class of product combining the advantages of organic polymers with those of silicones. The small team was left alone to focus exclusively on this topic.

Methodically Improving the Success of Innovations

So, it is no coincidence that a successful product is now on the market. WACKER's strategy of innovation ensures that research is focused on market needs. To appreciate how revolutionary this approach is, it is necessary to delve a little into the history of the German chemical industry. It has always involved a lot of experimentation. But all too often, after years in the laboratory, the basic researchers came up with some wondrous inventions that were not really needed in the outside world. In recent years, WACKER has managed to systematically increase the success of its innovations. With global competition intensifying and production cycles becoming ever shorter, there is no such thing now as a business that is not innovation driven. Hybrid polymers are evidence that a Group like WACKER is not an immovable colossus. WACKER is the only company in the world with industrial-scale production capability for highly reactive alpha-silanes, the precursors for the new polymers.

Back in 2001, the laboratory researchers expended tremendous time and effort on synthesizing the first few milliliters of these specialty silanes. “The amount we made wouldn’t have filled my coffee mug,” recalls Hager. At that time, nobody had a clue about how to set about producing large quantities. Alpha-silanes posed a challenge to all, because they are roughly one-hundred times as reactive as conventional silanes. “This reactivity is a huge advantage, but you must be able to control it,” explains Hager. The technical service managers and engineers had to draw on their experience and creativity to develop the production facilities in Burghausen; as a result, many processes in the complex production method are unique.

Versatile Hybrid Polymers

The first batches of the hybrid polymers to emerge from the pilot plant in 2005 were destined for established markets, primarily the construction industry. However, because the hybrid polymers are so versatile, new solutions are continually being devised in the laboratories in Burghausen. Trials are underway, for example, to seal damp walls with a membrane of hybrid polymers. The chemists are also working on a waterproof wood glue that meets the most stringent of the relevant standards, DIN D4. So far, only adhesives made from polyurethanes meet this standard, “but we’re close to achieving it without polyurethane,” says Hager.

Soon, innovative solutions for new, lucrative application areas will become available. WACKER sees itself as a provider of products for innovative solutions, which it creates by working closely together with customers . The rotor blades of wind turbines, for example, are growing larger and larger and must withstand enormous forces. Here, WACKER is developing the optimum adhesive for this purpose. For the automotive industry, WACKER is formulating new adhesives that will increase the economics of carbon fiber processing. And facility manager Karl Kiermaier might never need to use anchors and screws ever again.

6

7

6
The yellow fluid in the glass is one of Dr. Rudolf Hager’s closely guarded secrets.

7
WACKER produces hybrid polymers at this Burghausen plant.

Product Innovation

2011

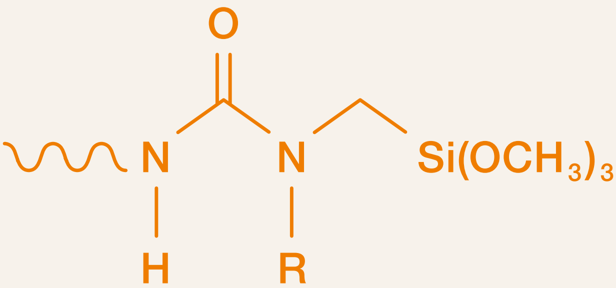
New Product Innovation Award

WACKER was awarded the New Product Innovation Award in 2011 by the management consultant Frost & Sullivan for its GENIOSIL® product class in the construction field.

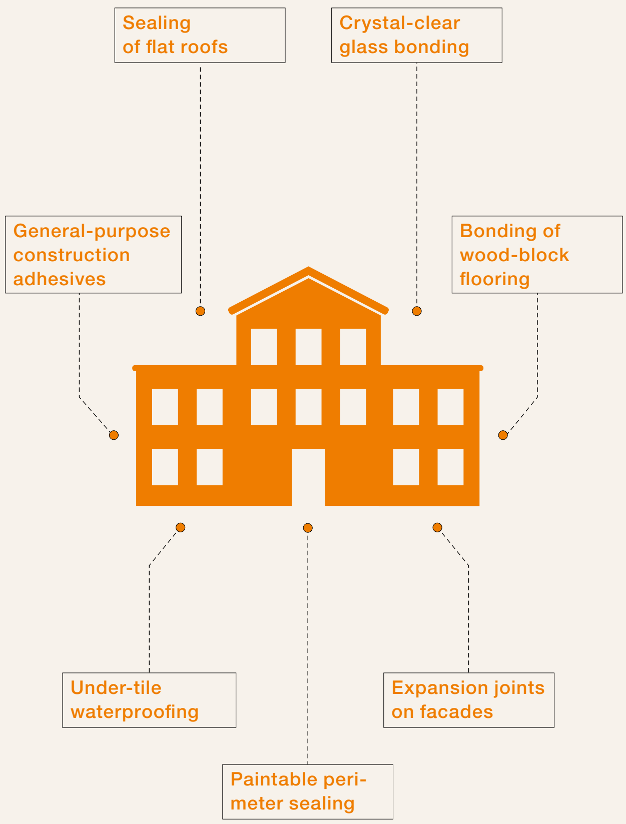
1.7m Tons

of sealants and elastic adhesives are consumed per year. Two thirds of these are based on silicone or polyurethane. The new hybrid adhesives combine the advantages of both.

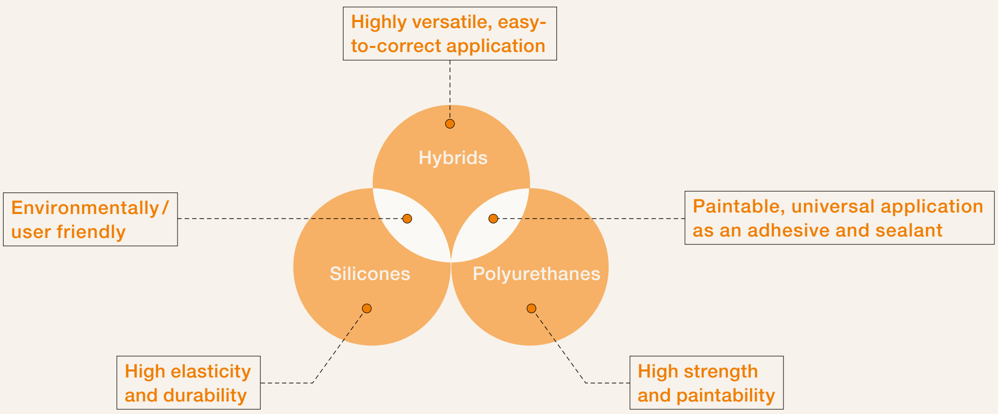
Chemical formula for an alpha-silane



Everyday Applications of Silane-Crosslinking Hybrids



Reactive, moisture-curing adhesives and sealants have been an integral part of construction for decades. Silicones and polyurethanes are the best known, with hybrids increasing in popularity, too.



Creating More Energy for Tomorrow's Mobility.

Silicon Greatly Enhances Battery Efficiency.

1

1
Dr. Jürgen Pfeiffer sees energy storage as one of tomorrow's key technical and economic challenges.

2
A look into the scanning electron microscope used to prepare SEM micrographs for analyses.

Silicon is the key to improving the energy density of lithium-ion batteries. WACKER researchers are investigating ways of increasing the range of future electric vehicles up to fourfold.

Mumbai never stands still. Especially not at noon, when the “dabbawalas” in their pristine white caps are swarming around the center of the 35-million metropolis. They deliver lunch in small boxes direct to the offices that make up the Indian commercial center. Barely 20 years ago, this would have been a hazardous undertaking, sprinting in sandals between honking taxis, overcrowded buses and clattering mopeds. Back then, in 2011, the city had a population of 20 million, and was permanently shrouded in a grimy, acrid smog. But now, in 2030, the noise and stench have disappeared. Electromobility dominates the city center as exhaust-free urban vehicles guided by smart vehicle telematics drive silently around the congestion-free city. Hopelessly utopian, perhaps?

In 2011, chemists, solid state chemists and physicists based in WACKER’s Corporate R&D facility in Munich were all working intensively on energy-storage technologies that will pave the way for viable, sustainable electromobility. For a year now, Dr. Jürgen Pfeiffer, a chemist, has been in charge of Technology Management in the Energy Storage and Conversion section. He is consolidating the company’s expertise in silicon, silicone, silane and polymer chemistry and channeling it into lithium-ion cell research. “You won’t find this combination anywhere else in the world,” he says, proudly. “That holds big opportunities for WACKER.”

Unity amongst Different Industries

Back in 2010, the German government launched the “National Platform for Electromobility” (NPE) aimed at bringing a million electric vehicles onto the streets by 2020 and at making Germany the lead market for electromobility. “WACKER is positioning itself here as an expert manufacturer of active materials,” says Pfeiffer, who, along with his colleagues, represents WACKER on the NPE working groups. “Never before have companies and industrial sectors shown such solidarity. From raw-material suppliers to automotive companies, the response has been fantastic, with representatives even getting involved in laying down definitions of requirements and specifications. That has accelerated the pace and efficiency of developments.”

The energy storage systems currently employed in electric vehicles cannot match the 600-km range of combustion engines. The average battery pack is only good for 60 to 100 kilometers at the moment. That may not sound like a lot, but “in Europe, more than 70 percent of car trips are shorter than 40 kilometers a day,” says Pfeiffer. “If these were made on purely regenerative electric power alone, the bulk of the carbon dioxide emitted by private transport today could be avoided.”

It is an opportune moment for WACKER to become involved in car-battery development. “Electricity storage technology is set to become the technology carrier in the electrification of powertrains,” says Prof. Ferdinand Dudenhöffer, Director of CAR (the Center for Automotive Research) at the University of Duisburg-Essen. Dudenhöffer expects sales of high-performance vehicle batteries to hit €130 billion by 2025.

Asia has set a blistering pace on the path to realizing these “turbo” batteries. At the forefront are Japan, Korea and China, the most important makers of small electronic devices, who have played a central role in advancing lithium-ion battery technology. The principle is simple: during charging, positively charged lithium ions migrate from the cathode to the anode. During discharging, the process is reversed. The more lithium ions that the anode and cathode can store, the greater is a battery’s capacity.

While the cathode usually comprises transition metal oxides, e.g. of cobalt or manganese, or iron phosphate, the anode nowadays is predominantly graphite. The researchers aim to progressively replace it with silicon. This is because silicon can theoretically absorb up to 10 times as many lithium ions as can carbon. The problem is graphite swells by roughly 10 percent when it absorbs lithium ions, compared with up to 300 percent for silicon. “Our work here is focused on designing silicon-based active materials that are firmly attached to the anode, but are still inherently flexible. The goal is to substantially reduce the absolute volume swell accompanying lithium-ion absorption and so significantly extend the lifetime of such materials,” explains Pfeiffer.

3

1 Million
Electric Cars by 2020

4

5

3
The Consortium in Munich performs tests for coating the battery electrodes.

4 and 5
When testing silicon for use in battery cells, WACKER researchers work in a cleanroom environment.

But irrespective of what optimization work is performed, the weight must be right: automakers nowadays factor 200 kg for the battery into every 1,000 kg that a vehicle weighs. "Consequently, we have to pack much more energy into those 200 kg." The electrolytes employed at the moment consist of low-boiling organic compounds that are highly flammable. This means that the casings for protecting the system must be made of a substantial material. "The use of silicon-containing electrolytes, which are more flame resistant, or even form a harmless ash, could make a sizable contribution toward increasing the safety of lithium-ion batteries. They could help reduce weight by eliminating the safety measures that would otherwise be necessary.

Innovations Shift Focus onto What Is Feasible

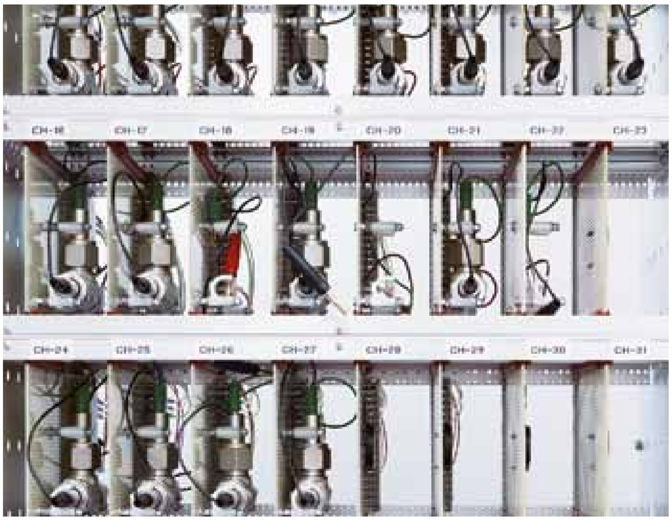
To help them resolve such complex chemical and physical issues, the developers at WACKER have devised a clearly structured innovation schedule called the Stage Gate Process, which spans the range from initial idea to market launch. "Stage Gate requires a strict focus on what is feasible," stresses Pfeiffer. But there must also be scope left for independent research. The 44-year-old has only praise for the many creative spirits within the various participating teams. "Being innovative requires not only outstanding expertise, but also enthusiasm, targeted action and the ability to think outside the box." To this end, information exchanges are held at all working group levels. They ensure that communication lines remain open across product and process innovations. These are backed up by a constant exchange of ideas with companies, universities and scientific institutes.

"Step by step gets you to the top," says Pfeiffer, who is an avid rock climber in his leisure time. He thinks that it will be 2025 or 2030 before the post-lithium-ion technologies of the future, based on lithium-sulfur or lithium-air, come onto the market.

These technologies could possibly quadruple the range of today's electric vehicles. He is convinced that, here too, WACKER will still be in the vanguard of developments, thanks to its expertise in active materials.

If high-performance energy-storage devices help electromobility to make further inroads around the world, then, during rush hour in 2030, it might well be the dabbawalas who enchant downtown Mumbai with the aroma of steaming curry.

6



7

6
Battery test rig at the Consortium.

7
The researchers use the scanning electron microscope to analyze anode structures.

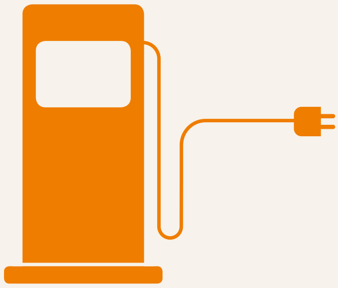
Focus Innovation

66%

of 14 to 29-year-olds in Germany believe that electric vehicles will supersede conventional combustion engines. Younger people are even more certain. Among the over fifties, 55 percent believe that the future lies with the electric car.

Charging Stations

for car batteries have been available in all German cities since 2011.

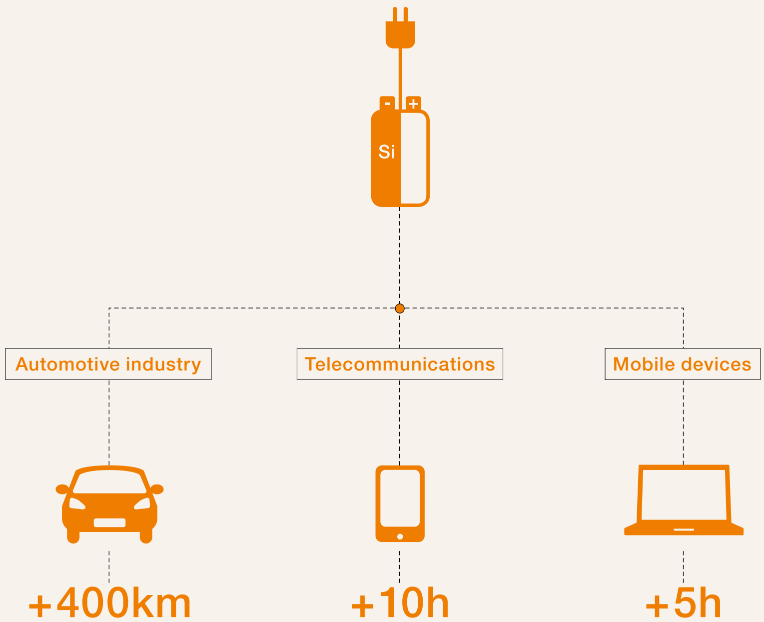


Li

Lithium

named from the Ancient Greek “lithos” (stone) is a chemical element with the symbol Li and the atomic number 3. The element was called “lithium” because, unlike sodium and potassium, it was discovered in stone. It is the alkali metal in the second period of the periodic table of elements. Lithium is a light metal with the lowest density of all solid elements under standard conditions.

Goals for the application of silicon-based lithium-ion batteries and the potential for increasing their power.

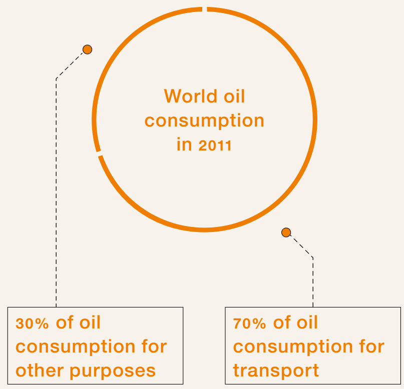


1 Million

electric vehicles, at least, should be running on Germany’s roads by 2020. That is the goal of the National Platform for Electromobility. It is estimated there will be 5 million electric vehicles on China’s roads by 2020.

70%

was the share of world oil reserves consumed by transport in 2011. At the current consumption rate, oil reserves would only last another 40 years.



60–160km

is the current range of battery powered cars. Over 70 percent of all journeys in Europe are less than 40 kilometers.

1899

was the year that, on April 29, the Belgian racing driver Camille Jenatzy became the first person to drive a car at over 100 kilometers per hour. His vehicle was called “La Jamais Contente” (The never satisfied), and was electrically driven.

How is something new created? Through a mix of knowledge, creativity and perse-verance. And the will to make things better. We work at this day in, day out, constantly developing ourselves as well as innovative products.