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WACKER



INSIDE THE LASCAUX CAVE

WACKER silicones and cutting-edge 3D computer technology recreate this World Heritage Site.

ECS SPECIAL
WACKER INNOVATIONS AT THE
EUROPEAN COATINGS SHOW

WACKER DIGITAL

WACKER offers a wide range of print and digital media that provide you with information about the company, its innovative products and the exciting application possibilities. Take advantage of these offerings at the Group website www.wacker.com and the mobile edition of WWW magazine, also easily accessible by scanning the QR code shown further down this page.

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The WACKER website's "Innovations Magazine" provides you with information on the company's intelligent solutions and pioneering technologies.
www.wacker.com/innovations

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The Information Edge

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Simply click on the icon to call up the additional elements and information.

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SMALL BEGINNINGS, GROUNDBREAKING RESEARCH AND EXPONENTIAL GROWTH

Dear Reader,

The European Coatings Show (ECS) in Nuremberg gives WACKER a central platform for presenting new solutions for paints, adhesives and coatings. A look at WACKER's new offerings at this leading international tradeshow reveals the range of solutions we supply for a variety of sectors and applications.

Easy-to-clean coatings feature strongly among our new products – such as the newly developed anti-graffiti coating and impregnations for concrete floors and other mineral-based surfaces.

Not only our production processes, but our products, too, are constantly being optimized. This applies equally to our established products, which we have made even better. Our polymer binders for cementitious waterproofing membranes are one such example.

Sustainability is another key ECS topic: we are working on making our products more environmentally friendly for users by reducing the amount of organic solvents found in a formulation.

Sustainability has a lot to do with innovation: it requires not only corresponding investment in research and in product development, but also a corporate culture driven by continuous improvement. From the beginning, over a century ago, WACKER has been at the vanguard of new discoveries.

In 1947, Wacker Chemie was the first European company to begin research into silicones. Even back then, innovation was a driving force. What began as a modest new venture 70 years ago has now grown into our largest business division. WACKER is currently the world's second biggest silicone manufacturer and is recognized and respected as a leader in silicon-chemistry expertise and technology. In the current issue of WWW, we will be revisiting this chapter in our history.

I hope reading this magazine will inspire you.

Dr. Rudolf Staudigl
 President and CEO of Wacker Chemie AG



Dr. Rudolf Staudigl, President and CEO of Wacker Chemie AG

“Sustainability has a lot to do with innovation and requires a corporate culture driven by continuous improvement.”

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ECS SPECIAL

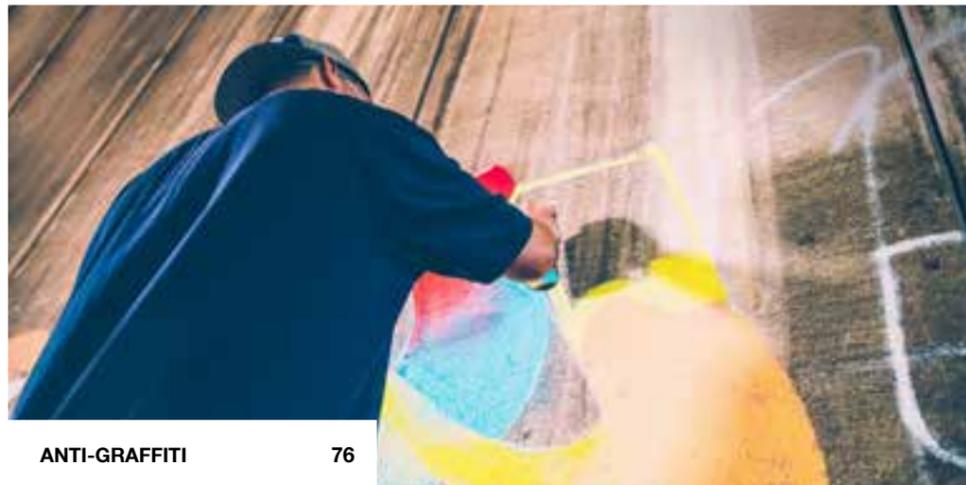
EUROPEAN COATINGS SHOW

At ECS 2017 in Nuremberg, WACKER is launching its new PRIMIS® SAF 9000 dispersion series for dirt-repellent floor and wall surfaces. Other innovations being showcased are SILRES® BS 6920 silicone binders for stain-resistant concrete surfaces and SILRES® BS 710, a silicone rubber for anti-graffiti coatings. The new VINNAPAS® 760 ED polymer dispersion is ideal as a binder in water-repellent construction coatings, while the silane-terminated GENIOSIL® XM 20 and GENIOSIL® XM 25 polymers improve the bonding properties of plasticizer-free adhesives.

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To preserve the stone-age paintings of Lascaux for posterity, a French team created a replica of the cave using 3D computer technology and WACKER silicones.

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Energy losses caused by leaks in heating and air conditioning pipes cost money. As a result, sealants based on VINNAPAS® dispersions from WACKER are trending.

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Specially modified silicone rubbers retain their properties across an extensive temperature range, making them suitable for extreme applications such as space travel.

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WACKER is launching CANDY2GUM® onto the market. This is a brand new technology for manufacturing soft candy that turns into gum while you chew.

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> 70 YEARS OF SILICONES

1947 was the year WACKER started researching silicones in Burghausen – the first-ever European company to do so: a modest start to what is now the Group's largest business division.

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WACKERWORLDWIDE

WACKER has production sites, application technology centers, subsidiaries and sales offices on every continent. Here is a selection of news and interesting topics from the Group's five business divisions.



① MICHIGAN

Until now, the relatively limited range of electric cars has often deterred potential buyers. However, the industry has been relentlessly working on improving their performance. For example, the American car manufacturer General Motors recently presented its new model, the Chevrolet Bolt, whose European equivalent is the Opel Ampera-e. Besides its impressive range of up to 500 kilometers, an integrated fast charging function means that this electric car only needs 30 minutes at a charging station to charge up enough power for a journey of 145 kilometers. WACKER is working closely with cell producers to replace carbon – the standard anode material in lithium-ion batteries – with silicon, in order to boost the performance of this kind of storage media.



② OUARZAZATE

Morocco has also ushered in the energy transition. To date, the kingdom has met its energy demand predominantly through fossil fuels. Their objective is to increase the usage of renewable energies to meet 52% of this demand by 2030. To achieve this, the largest solar installation in the world called Noor – Arabic for light – is currently under construction in the Atlas Mountains. The first of four power stations joined the grid at the beginning of 2016. Noor II and III are under construction, and Noor IV is in planning. While Noor I and II focus on solar thermal energy, Noor III is a solar tower power station constructed with parabolic mirrors that concentrate the rays of the sun onto a 240-meter-high tower, where the energy is collected by an absorber and transformed into heat. This is then used to generate steam, which drives a conventional generator. Noor IV will provide energy using a photovoltaic system. WACKER is one of the world's biggest manufacturers of hyperpure polysilicon for the photovoltaic industry.



③ BURGHAUSEN

Former WACKER student employee Cordula Weiss was awarded the 2016 Promotion Prize for her Master's thesis by Deutsche Bauchemie e. V., the German construction chemicals manufacturers' association. The knowledge she

acquired in 2014 during experiments carried out at Corporate Analytics in Burghausen enabled her to expand the analytical basis underpinning polymer-modified mortars. Weiss, a chemistry and business administration student, used AFM (atomic force microscopy) to develop new force-scanning and imaging methods for measuring the adhesive forces between the polymeric and mineral phases of cements. Polymer-modified dry-mix mortars are a key business for WACKER POLYMERS.



⑤ BEIJING

WACKER Chemicals (China) Co. Ltd. received a "Most Socially Responsible Company" award from the China Petroleum and Chemical Industry Federation (CPCIF) in early 2017. The CPCIF is a non-governmental organization with no commercial interests whose membership totals over 300 companies and institutions. Issues the organization assesses include corporate management, workers' rights, social benefits, environmental protection, production process safety and technological innovation, as well as tax contributions to public communication and public welfare. WACKER is part of the global Responsible Care® initiative, and was one of the first 24 international chemical companies in China to sign the Beijing Manifesto for protecting the environment, employees and society.



④ KOSGODA

A violent tsunami laid waste the coasts of Asia in December 2004, with hundreds of thousands losing their lives or livelihoods. Sri Lanka was particularly hard hit. At the time, WACKER made a donation at short notice for aid projects, and founded WACKER HILFSFONDS in 2005. Through this relief fund, the Group has supported projects helping victims of natural disasters ever since. This includes the school in Kosgoda. Inaugurated in 2006, it has celebrated ten productive years. The principal Sadu Wimaladhamma Tissa is delighted that the first three students will be taking their school-leaving certificate next year.

GROUP UPDATE



The setting speed of paper and packaging adhesives is measured in the lab by WACKER Technical Service staff.

POWERFUL AND ENVIRONMENTALLY COMPATIBLE: VINNAPAS® EP 400 E

New Dispersions for Formulating Paper and Packaging Adhesives

Like many sectors, the paper and packaging industry is making stricter demands on the environmental compatibility of the raw materials it uses. WACKER developed VINNAPAS® EP 400 E dispersions specifically to address these requirements. This product's formaldehyde content is exceptionally low (< 20 ppm).

Its performance profile is impressive, though. Based on vinyl acetate-ethylene copolymers, the binder features a high setting speed and finely balanced adhesion and cohesion. The dispersion is suitable for high-speed nozzle applications while demonstrating good machine running properties during

roll coating, thereby catering to increasingly sophisticated productivity demands in paper processing. The VINNAPAS® EP 400 E dispersion is ideal for formulating paper and packaging adhesives that combine top performance and improved environmental compatibility.



Hoisting the premix tank into the production building: WACKER is constructing a new 60,000-metric-ton dispersion reactor in Burghausen.

NEW DISPERSIONS FACILITY WITH AN ANNUAL CAPACITY OF 60,000 METRIC TONS

WACKER POLYMERS is investing €25 million in VAE production in Burghausen

The Group is constructing an additional dispersion reactor for polymer binders with an annual capacity of 60,000 metric tons at its site in Burghausen. Some €25 million have been earmarked for expanding production and local infrastructure. The plant is scheduled for completion before the end of the year.

WACKER's dispersions are commonly used to formulate low-odor and low-emission indoor paints, but can also be found in plasters, adhesives, carpet applications and technical textiles. Moreover, they are the key raw material for the production of dispersible polymer powders for construction applications. WACKER manufactures these powders by spray drying at its Burghausen site. "The enlargement of our

dispersion production in Burghausen is part of our strategy to achieve further profitable growth through expansions at existing production plants," said Rudolf Staudigl, president & CEO of Wacker Chemie AG, explaining the investment measure. "The additional capacity will strengthen our market position as one of the world's leading manufacturers of dispersions and dispersible polymer powders, and will help us meet our customers' continuously increasing demand over the long term," emphasized the Group CEO.

In this way, WACKER is taking account of the global rising demand for high-quality polymer binders, which is driven by worldwide trends such as urbanization, renovation and energy

efficiency. Alongside the new reactor, the Group is also investing in the expansion and modernization of local infrastructure. "We are not only making a key contribution to supply security in the years to come, but also to the cost-efficient production of our dispersions and dispersible polymer powders," explained Peter Summo, head of the WACKER POLYMERS business division.

WACKER copolymers and terpolymers are used as binders in sectors such as construction, paints, coatings and adhesives for formulating high-quality tile adhesives, cementitious waterproofing membranes, energy-saving external thermal insulation composite systems, and low-odor, low-emission interior paints.

SHOWROOM FOR CONSTRUCTION APPLICATIONS OPENED IN HO CHI MINH CITY

“Application House” familiarizes Vietnamese customers with the advantages of modern construction chemicals



A technician demonstrates the performance of polymer-modified tile adhesives in the showroom.

WACKER has opened a showroom for construction applications in Ho Chi Minh City. The aim of Application House is to raise awareness of the advantages of construction chemicals among Vietnamese customers. Considered one of the growth power houses in Southeast Asia, burgeoning building activity in Vietnam has focused attention on quality in construction. “Vietnamese construction companies are finding it difficult to deliver good quality while keeping prices down,” explains Long Nguyen, an applications engineer at WACKER Vietnam. The Group has responded by prioritizing sharing knowledge about the advantages of polymeric additives in mortars with the Vietnamese construction industry. Operated in collaboration with COSIC (Ho Chi Minh City Construction Service and Information Center), the showroom provides an opportunity to try out interior and exterior applications with dispersible polymer powders and dispersions, as well as construction silicones. WACKER’s construction polymers are used in finishing plasters, tile adhesives, self-leveling flooring compounds and waterproofing membranes. Silicones are used in sealants and adhesives.

WACKER EXPANDS SILICON-METAL CAPACITY AT HOLLA PLANT

Group invests €85 Million in Norway site

Wacker Chemie AG is expanding the capacity of its silicon-metal site at Holla in Norway. The Group is constructing an additional plant there, with world-scale annual capacity. Capital expenditures of around €85 million are budgeted for the capacity increase and for expanding local infrastructure. Completion of the plant is expected during the first half of 2019. “Expanding our silicon-metal capacity at this site is a key strategic step in our sourcing of raw materials” said Wacker Chemie AG’s CEO, Dr. Rudolf Staudigl, as he explained the reasons behind the investment decision. “At present, Holla covers around a quarter of our silicon-metal requirements. Capacity expansion there is necessary to maintain this scale of coverage in the future. The fact that we produce silicon metal ourselves makes us more independent of price fluctuations on raw-material markets and, at the same time, boosts the reliability of our supplies during peak-demand periods,” the Group’s CEO pointed out. Silicon metal is one of WACKER’s most important raw materials. It is needed for producing silicones and hyperpure polysilicon.



Production of metallurgical-grade silicon in Holla: quartz gravel is melted down with carbon. The liquid silicon metal then flows out of huge boilers to reach a bed of silicon sand, where it can cool down and solidify.



FOOD LABORATORY IN SINGAPORE GOES INTO OPERATION

WACKER expands technical competence center in Southeast Asia

Wacker Chemie AG has opened a new food laboratory at its technical center in Singapore. The regional competence center now has a new laboratory dedicated to innovative food ingredients, dietary supplements and chewing gum applications, e.g., for fat-free desserts, egg-free baked goods, caseinate-free coconut milk powder, vegan meat flavors or highly bioavailable curcumin. The new laboratory enables WACKER to provide its customers in Greater Asia with even better service as well as support in developing novel, customized products in the fast-growing market for food solutions.

“Asia is a focus market for the food industry and also for our innovative food ingredients and dietary supplements,” said Dr. Gerhard Schmid, president of WACKER BIOSOLUTIONS at the official opening ceremony at the beginning of November. “We are meeting our customers’ growing demand by enhancing our local services. With this facility, which is unique in the region, we can further augment our position as an innovative partner to the food industry.”

The chief focus of food activities at WACKER BIOSOLUTIONS, the life sciences and biotechnology division within the WACKER Group, is food ingredients and dietary supplements. The company already operates dedicated food laboratories in the USA and Germany to provide its customers with optimum service. The new laboratory in Singapore will focus on applications involving cyclodextrins, cysteine and hydroxytyrosol intended for the special demands and needs of Greater Asia.

The Singapore technical center has also been supporting customers from the electronics, polishes, textiles, automotive, coatings, construction and health industries since 2007. All labs are equipped with cutting-edge instrumentation meeting international standards. Spanning an area of more than 1,500 square meters, the regional competence center now houses customer development, applications technology, sales, and basic and advanced training under a single roof.



Heiko Zipp, head of the Nutrition business team, Dr. Gerhard Schmid, president of WACKER BIOSOLUTIONS, and Patrick de Wolf, managing director, Southeast Asia, at the opening of the food lab.



Silane distillation columns in Charleston: the new HDK® facility at the US site is the next step toward integrated production.

NEW HDK® FACILITY TO BE ERECTED IN CHARLESTON

WACKER is investing US\$150 million at the US site and expanding capacity in Burghausen

WACKER is erecting a new production plant for HDK® pyrogenic silica at its Charleston site in Tennessee, USA. With an annual capacity of about 13,000 metric tons, investment in the facility is expected to be around US\$150 million. Some fifty new jobs will be created when the plant is completed in the first half of 2019. The Charleston site with its roughly 650-strong workforce is where WACKER already produces hyperpure polysilicon for the solar and semiconductor industries.

“The new facility is the next logical step in making Charleston a fully integrated silicon site in the second largest chemical market in the world,” emphasized CEO Dr. Rudolf Staudigl, explaining the strategy behind the investment. It constitutes an important addition to the supply chain at the Charleston site. The most important byproduct of polysilicon production is tetrachlorosilane, which either has to be converted and fed back into the production loop or it can create added value by

being further processed into HDK®. An integrated system from polysilicon and HDK® production permits maximum flexibility in the processing of tetrachlorosilane, obviates the disposal of waste products, while enhancing the viability of integrated production as a whole.

WACKER is increasing its production capacities for pyrogenic silica by some 40 percent in Burghausen. Investment there stands at around €1.4 million. Expansion is scheduled for completion in the third quarter of 2017. “The expansion enables us to meet rising customer demand for high-quality specialties and tailored solutions from WACKER,” said Auguste Willems, WACKER Executive Board member. “This project is part of our strategy to grow our profitability through cost-effective expansions of existing plants and also to raise the proportion of specialties in our business as a whole.”

WACKER AT TRADESHOWS

 **European Coatings Show**
Nuremberg, Germany
April 4-6, 2017
www.european-coatings-show.com

 **JEC**
Paris, France
March 14-16, 2017
www.jeccomposites.com

 **In-Cosmetics Global**
London, UK
April 4-6, 2017
www.in-cosmetics.com

 **EWMA**
Amsterdam, Netherlands
May 3-5, 2017
ewma.org/ewma-conference/2017

 **Techtextil**
Frankfurt, Germany
May 9-12, 2017
techtextil.messefrankfurt.com

 **BIO USA**
San Diego, California, USA
June 19-22, 2017
convention.bio.org

 **FI Asia**
Bangkok, Thailand
September 13-15, 2017
www.figlobal.com/asia-thailand

 **Fakuma**
Friedrichshafen, Germany
October 17-21, 2017
www.fakuma-messe.de



The new pilot reactor in Nanjing is a research and test facility for custom-made VAE dispersions.

NEW PILOT REACTOR FOR VAE DISPERSIONS IN NANJING

Pilot reactor for developing customized VINNAPAS® products for the Chinese market in operation

WACKER started up a new pilot reactor for vinyl acetate-ethylene copolymer (VAE) dispersions at its Nanjing site in China. Investment costs for the pilot reactor amount to around €2.4 million. “Our objective is to work with our customers to develop first-class solutions adapted to local needs and, in that way, to contribute to WACKER’s future growth,” explains Peter Summo, president of WACKER POLYMERS. “WACKER is now one of the world’s few VAE manufacturers able to support customers in China from the development lab all the way through to large-scale production. “This strengthens our role as a leading technology partner for numerous key sectors and underscores our long-term commitment in China,” noted Paul Lindblad, president of WACKER Greater China. The pilot reactor serves as a research and test facility for custom-made VAE dispersions and dispersible polymer powders, which go on to be used in the construction, coatings and adhesives industries, among others. With its experienced technical team on site and its well equipped technical center in Shanghai, WACKER can now cooperate even more closely with customers in developing first-class products, optimizing production processes and shortening development times. The ultramodern plant has a fully automated control and monitoring system. WACKER already manufactures its VINNAPAS® VAE dispersions and dispersible polymer powders in Nanjing – products used, for example, for formulating high-quality adhesives, low-odor, environmentally friendly interior paints, tile and carpet adhesives, and for energy-saving building solutions such as external thermal insulation composite systems.



50

to 70 percent lower coefficient of dynamic friction than standard liquid silicones of the same hardness.

Tube made with SILPURAN® 6760/50: this self-adhesive silicone rubber is ideally suited to applications with both hard and soft components.

SELF-ADHESIVE SILICONE RUBBER WITH MINIMAL SURFACE FRICTION

SILPURAN® 6760/50 makes injection molding possible with hard-soft components

WACKER has introduced a new self-adhesive liquid silicone rubber with low coefficients of friction. The new SILPURAN® 6760/50 grade cures to form an elastomer with a smooth, low-friction surface: this property opens up new avenues for self-adhesive liquid silicone rubber applications. The silicone adheres readily to certain polyesters such as polybutylene terephthalate (PBT).

SILPURAN® 6760/50 is an addition-curing liquid silicone rubber. It has two components and, once mixed, cures to form a transparent, mechanically robust elastomer with a 50 Shore A hardness. Since the cured product's coefficient of dynamic friction is 50 to 70 percent lower

than that of standard liquid silicones of the same hardness, new applications for moving sealing components are now possible. And, thanks to reduced dynamic friction, installing components in medical devices is easier and takes less time.

SILPURAN® 6760/50 was specifically designed for manufacturing parts comprising hard/soft combinations such as those used in the pharmaceutical and medical-technology sectors. They are often made from a shaping thermoplastic encased in a soft plastic layer. SILPURAN® 6760/5 enables cost-effective, large-scale manufacturing of such parts with injection molding.

As a self-adhesive grade, SILPURAN® 6760/50 does not need an adhesion promoter. It adheres readily to certain polyesters, such as polybutylene terephthalate (PBT), a thermoplastic often used in injection molding.

SILPURAN® 6760/50 fulfills a variety of test specifications as per ISO 10993 and United States Pharmacopeia (USP) Class VI. Post-cured parts are suitable for food-contact applications and can be used in line with the recommendations of the German Federal Institute for Risk Assessment (BfR) and the US Food and Drug Administration (FDA).



These days, balancing family and a career is an important factor – not only for young women.

ONE OF THE MOST FAMILY-ORIENTED EMPLOYERS IN GERMANY

German-language Eltern magazine honors WACKER: 274 companies awarded seal of approval

WACKER is one of Germany's most family-friendly companies with more than 500 employees: these are the findings of a survey conducted by Eltern magazine and the Statista statistics website. Last summer, the magazine and the market research firm joined forces to ask roughly 19,000 employees all over Germany what mothers and fathers expect from their employers. WACKER received three of a possible four points in each of the following categories: "Work-life balance," "Flexible working hours" and "Would you recommend your employer?" Those results make the Group one of 274 companies in Germany to receive the "Best Companies for Families" seal of approval.

"It simply goes without saying today that being able to reconcile career and family demands to the greatest possible extent is important to applicants of both genders when deciding on an employer," explained Angela Wörl, the head of Corporate Human Resources. Because a modern, global company like WACKER has to compete for qualified technical and managerial personnel, and because it is confronted with demographic changes – especially at its sites in Germany – it must take an interest in offering its employees the work environment they need to find that balance, Wörl went on to say.

Eltern magazine and Statista found out what young adults really mean by a "family-friendly employer." The survey showed that the most important criteria include flexible work hours, working time accounts, flexible part-time models, practical solutions for emergencies (sick children or other family-care situations), and equal pay for women and men doing comparable work.

"Flexible work hours is one way that we at WACKER aim to make good on our claim to be a family-friendly organization," emphasized Christian Stadler, director of HR policies for Corporate HR. In addition to a large number of part-time models, independent working hours and/or flextime accounts, employees also have the option of taking relatively long periods of time off for purposes such as sabbaticals. In addition, WACKER Germany has a company agreement addressing career and family care, and uses this as a basis for offering both a variety of part-time models as well as the option of taking up to 24 months off to employees with family members requiring long-term care.

The WACKER ACADEMY
in Jandira, Brazil



“OUR CUSTOMERS’ NEEDS DEFINE OUR PORTFOLIO”

Dr. Alexander Daboul on the new approach of WACKER ACADEMY, the Group’s training and skills-development facility

The VINNAPAS® ACADEMY in Burghausen was launched in 2007 with training courses on the use of polymer chemistry in construction applications. Renamed WACKER ACADEMY, the Group’s in-house training and skills-development facility currently operates at twelve sites on four continents, and offers a portfolio encompassing topics from the following three business divisions: WACKER SILICONES, POLYMERS and BIOSOLUTIONS. Under the leadership of

Dr. Alexander Daboul, the ACADEMY is now moving in a new direction that places even greater emphasis on customer needs.

Dr. Daboul, you direct the WACKER ACADEMY program. Could you explain what WACKER ACADEMY stands for today?

Dr. Alexander Daboul: First and foremost, WACKER ACADEMY is a sales and marketing

tool that supports the business divisions in various ways. These include winning customers, diversifying existing customer bases, tapping into new markets, introducing technologies and strengthening customer relationships.

Which aspects of this new direction are especially important to you?

I want to see the needs of the customer play an even bigger role in defining the portfolio. The

question we ask ourselves shouldn’t be, We have training programs, which ones do people need? Instead of offering training based on what we have, we should be offering training customized to meet customer needs. In keeping with that idea, we often work with customers to define their needs and we develop new support services, training content and formats – like the initial training video – as a collaborative effort. Special laboratory and product training can be part of that portfolio, and so can events or public-private partnerships with government or educational institutions, like what we’re doing in Brazil.

What roles does WACKER ACADEMY take on?

Our primary, though by no means only, role is concrete sales support. Products that require explanation simply sell better if you explain them in detail. Examples here would be seminars on basic polymer chemistry for construction applications or on the use of silicone elastomers in industry. That way participants can experience the advantages of our technology through our products – it’s a powerful marketing tool.

How do WACKER and its customers benefit from WACKER ACADEMY, above and beyond pure sales support?

In established, saturated markets, WACKER ACADEMY serves as a powerful customer relationship tool. By offering innovation workshops, training new employees, and supplying guest speakers and experts for customer events, the ACADEMY helps ensure that WACKER will remain our customers’ preferred partner going forward. Alongside joint workshops on product development, we provide processing and marketing training as well. The breadth of our portfolio ensures that WACKER ACADEMY keeps

our fingers on the pulse of the market and our customers. WACKER ACADEMY events serve two functions: on the one hand they allow us to explain our products, thus ensuring knowledge transfer, while establishing ourselves as a leading source of information that benefits from its customers’ expertise.

Are there comparable facilities that WACKER ACADEMY competes with on the market?

WACKER ACADEMY makes us stand out by offering customers a clear and tangible benefit. None of our competitors offers anything like this. The ACADEMY sets us apart and underscores how unique many of our products are.

How do you intend to establish WACKER ACADEMY in emerging markets?

In emerging markets where WACKER and

“Our training facility reflects the market and our customers’ needs.”

Alexander Daboul, head of WACKER ACADEMY

its technologies are not as well known, the ACADEMY serves first and foremost as a way of opening doors so that we can familiarize distributors, market partners (such as machine manufacturers that could process our products), potential customers, stakeholders, professional associations, etc. with the advantages of our technologies and products.

The construction industry, in particular, is concerned with meeting standards and codes. What kinds of services can WACKER ACADEMY provide in this regard?

Our ACADEMY experts also provide consultation services for introducing new standards for products, testing or technology, as is the case right now in South Korea. The ACADEMY can



Dr. Alexander Daboul is WACKER ACADEMY’s program manager.

also offer events in collaboration with chambers of commerce and professional associations, give presentations at universities, and pursue other activities that aim to influence which standards are to be developed in the future. WACKER ACADEMY raises awareness in the sense that it acts as an awareness engine. We shape opinion and serve as a mouthpiece – not only for our own company, but also for the entire industry.

Can the benefits of this training center be quantified?

In 2016, we started defining key performance indicators (KPIs) that would allow us to gauge our success. The most important KPI is the rate at which non-customers are converted to customers. To determine this, we base our definition of a customer on the purchase of a product – regardless of the quantity – within six months of the corresponding WACKER ACADEMY event. In regions where we’re already collecting this conversion rate data, we’ve seen that the ACADEMY does indeed contribute to the company’s success. And attending an ACADEMY event naturally has a positive impact on sales development with existing customers too.



As a free-flowing powder, CAVACURMIN® is ideal for use in tablets, capsules, energy bars and beverages.

GAMMADEXTRIN COMPLEX INCREASES CURCUMIN'S BIOAVAILABILITY

A study in the "European Journal of Nutrition" shows the positive effects of food supplements

A clinical study recently published in the European Journal of Nutrition shows that the bioavailability of curcumin, the active compound in turmeric, can be increased significantly with the help of gammadextrin – by a factor of 40 compared to conventional curcumin extract. Curcumin is a powerful antioxidant with antibacterial, anti-inflammatory and hypoallergenic properties that is not readily absorbed in the human bloodstream because it is not water-soluble.

An independent double-blind crossover clinical study performed in the USA compared the relative absorption of CAVACURMIN® (gammadextrin-curcumin formulation) with pure curcumin extract (95%) and two commercially available curcumin preparations designed to increase bioavailability. After oral ingestion of the substance, the blood of the study participants was analyzed at regular intervals over the course of 12 hours. It was shown that CAVACURMIN® was absorbed approximately 40 times more efficiently than the standard extract, and at least 4.6 times better than the next best comparable commercial product.

The cyclic oligosaccharide gammadextrin increases the bioavailability of curcumin because it is hydrophilic on the outside with a hydrophobic cavity on the inside, which allows it to accommodate other hydrophobic substances. In this way, cyclodextrins can bind ingredients, release active agents or stabilize sensitive substances and interfaces.

To increase bioavailability, the water-soluble gammadextrin can encapsulate fat-soluble curcumin, for example. Hydrophobic curcumin thus gets a hydrophilic shell and forms a molecular dispersion that is absorbed much more readily by the human body.

As a free-flowing, dispersible powder, CAVACURMIN® is suitable not only for dry or powdered food supplements, such as tablets, capsules and energy bars, but also for functional beverages. The alternative that cyclodextrins offer for many food-supplement formulations is not only cholesterol-free and non-allergenic, but also plant-based: WACKER manufactures its cyclodextrins – produced enzymatically from starch – entirely from renewable raw materials.

"We are very pleased with the positive results of the clinical study on the enhanced bioavailability of curcumin with the aid of gammadextrin," said Helmut Reuscher, sales and technical director for Nutrition at WACKER BIOSOLUTIONS. "The importance of high bioavailability in food supplements is on the rise among our customers. We are very proud that our innovative cyclodextrin platform is finding more widespread use and allows our customers to make a contribution to the development of enhanced food supplements."

WACKER EXPANDS CYSTEINE PRODUCTION

Group acquires fermentation plant in Spain

WACKER BIOSOLUTIONS has purchased a large-scale fermentation plant in Spain with a capacity of 800 m³ from Antibióticos de León SLU (ADL). The two companies announced the signing of the contract of sale at the end of last year. At the León plant, WACKER will produce cysteine by fermentation for use in food and pharmaceutical products. WACKER intends to invest some €30 million in modernizing the existing facility as well as additional production equipment over the next few years. Around 35 new jobs are planned at the site.

"The expansion is part of our strategy of raising the proportion of specialties in our business as a whole to boost growth and profitability. The acquisition places us in an ideal position to securely meet our customers' growing demand for cysteine and to commercialize new fermenter products in the future," said WACKER Executive Board member Auguste Willems. Juan Molins, managing director of Antibióticos de León, said: "We are happy that the WACKER Group is investing in León and are sure we have found the right partner to continue developing this site for a successful future." Cysteine is a natural amino acid that is widely used in the pharmaceutical, cosmetics and food sectors not only to produce flavorings, but also as a processing auxiliary for breaking down gluten in bakery goods, as a radical scavenger in cosmetics and as an expectorant in cough medicines.

PRODUCTION BY FERMENTATION

Unlike many conventional manufacturers who extract the amino acid cysteine from human or animal sources, such as hair, feathers or pig bristles with the aid of hydrochloric acid, WACKER produces cysteine by fermentation in a patented biotech process – the first company in the world to do so. Since it is manufactured from purely plant-based and inorganic starting materials, WACKER's cysteine is entirely vegetarian. This eliminates any risk of contamination by animal or human pathogens, making it ideal for foodstuffs and pharmaceutical products.



A technician applies interior paint formulated with VINNAPAS® EZ 3011 as a binder.

VINNAPAS® EZ 3011 FOR LOW-EMISSION INDOOR PAINTS

Waterborne polymer dispersion is especially kind to the environment

Another novelty at ECS 2017 is VINNAPAS® EZ 3011, a waterborne polymer dispersion based on vinyl acetate and ethylene that has a very low environmental impact. The product is manufactured without the use of alkylphenol ethoxylates (APEOs), plasticizers, film-forming agents or solvents, is low-odor and boasts a low formaldehyde content (< 20 ppm). It also lends itself to paint formulations that have a low volatile-organic-compound content (VOC < 1 g/L). Furthermore, VINNAPAS® EZ 3011 offers excellent pigment-binding capacity and high color consistency. The new dispersion is thus ideal as a binder for formulating high-performance, yet low-odor and low-emission interior paints.

A view inside the copy of the Lascaux cave: modern reproduction techniques create new ways of exhibiting cultural heritage.

FROM STONE AGE TO HIGH TECH

The Lascaux cave, with its 17,000-year-old paintings is a World Heritage Site, but the sheer number of visitors has taken its toll.

To preserve the original paintings for future generations, the French company AFSP has produced detailed replicas of the cave walls using ELASTOSIL® M silicone rubber from WACKER.



Specialists from AFSP correct the final reproduction of a cave panel using a coarse-grained stone paste.

Dating back around 17,000 years, these art works have survived the end of the last Ice Age, the Bronze Age, and the Greco-Roman era. It was only in the Modern Age - 1940 to be specific - that the Stone Age paintings of Lascaux were rediscovered. The cave complex is situated in southwest France, about 150 kilometers north

of Toulouse, in the commune of Montignac. Concealed in the rock are some 2,000 wall paintings, covering several hundred square meters, chiefly showing animals. The skillful rendition of bulls, reindeer and horses soon became known as the “Stone Age Sistine Chapel.”

This cultural jewel, which had endured for millennia since prehistoric times, now found

itself threatened by hordes of visitors streaming through after the original Lascaux cave was opened to the public in 1948. Particularly the moisture exhaled by the many visitors – up to 1,200 per day – affected the highly sensitive cave climate. The delicate biological equilibrium was thrown out of kilter – a veil of algae, mineral deposits and microorganisms began to spread over the wall paintings (see box). Consequently, after only 15 years, the cave complex was closed to visitors in 1963, and an elaborate ventilation system was installed. But pressure remained high to make the Stone Age masterpieces accessible to the public once again.

DETAILED COPY

Eventually, the French state opted to have a copy made of the entire cave complex. The detailed replicas measuring about 900 square meters are housed in a modern exhibition at the foot of the Lascaux hills. At the 6,000-square-meter International Center for Cave Painting in Montignac-Lascaux, visitors can experience all the original cave paintings.



The elastic silicone mold is released from the final reproduction by members of the international AFSP team.



The silicone elastomer is applied to the polystyrene model to produce a negative mold.

DANGER FROM MICROORGANISMS

Before the Lascaux cave was discovered in the 1940s, it had not been exposed to humans for a long time. Such self-contained biotopes are often a paradise for specially adapted microorganisms, which form a sophisticated ecosystem that leaves the paintings undamaged. If conditions change, different microorganisms that can damage the art works reproduce.

As early as 1960 – only twelve years after the cultural monument had been opened to visitors – green algae could be seen on the walls. The delicate equilibrium previously maintained by the system became unbalanced. Only three years later, the conservators saw themselves forced to start combating the green biofilm growing there. They used a number of agents for this, including various antibiotics and chemicals.

At the turn of the millennium, another threat emerged, this time not green but white. *Fusarium* fungi colonized the cave, covering the walls with a white fuzz. Since 2006, black patches have also been weaving their way from ceiling to floor. To combat all these fungi, the conservators again resorted to a cocktail of antibiotics and chemicals, together with elaborate physical cleaning and improved ventilation. Another partial victory in the battle to preserve the 17,000-year-old Lascaux Stone Age masterpieces for future generations.

Formally opened in December 2016 by President François Hollande, this permanent exhibition is known as Lascaux 4. It is the third replica of the original cave of Lascaux 1, which was closed to the public in 1963. UNESCO has since declared this and other caves in the Vézère valley a World Heritage Site.

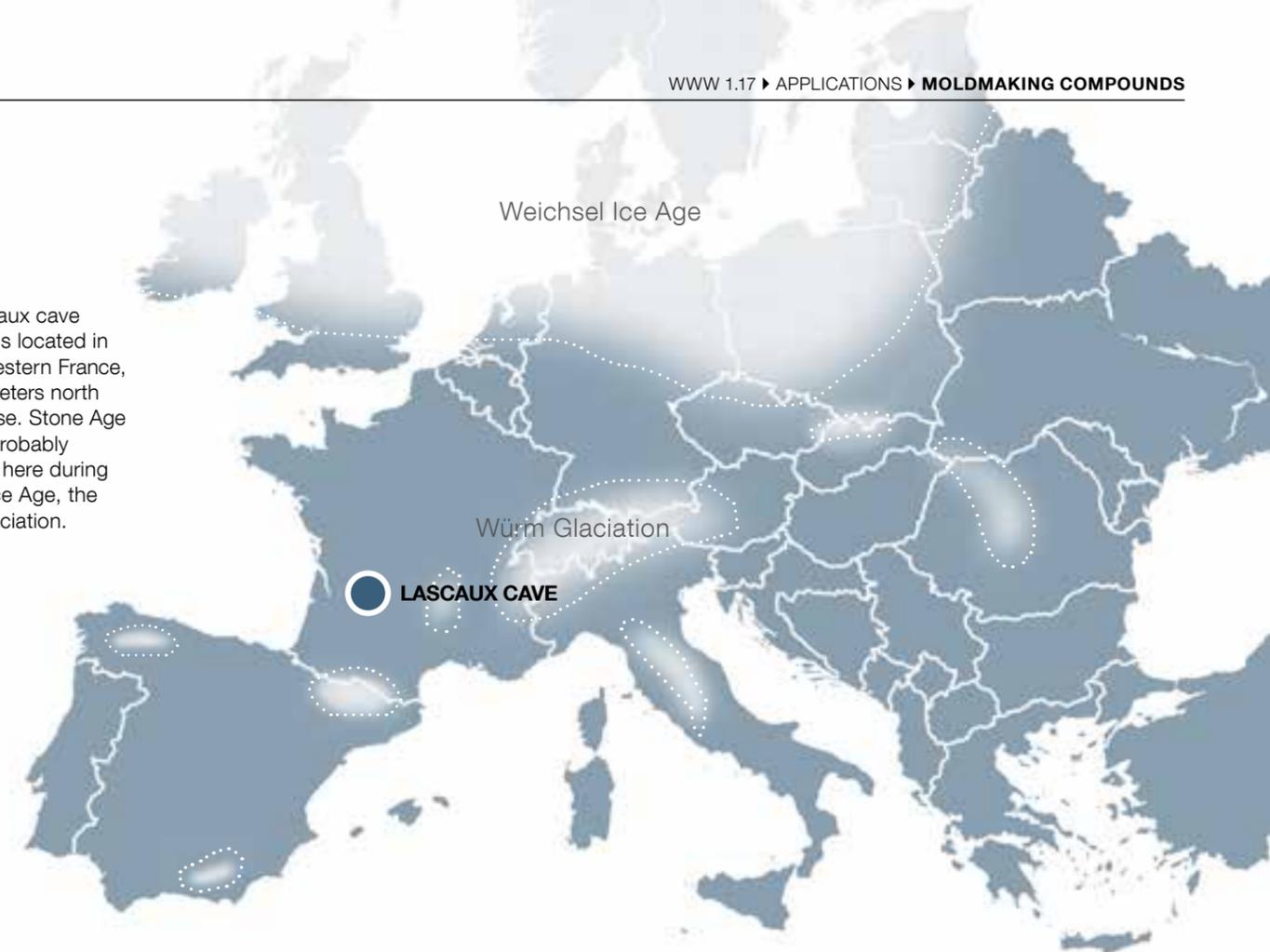
In 1983, the first visitors walked through the facsimile caverns of Lascaux 2, containing some 90 percent of the wall paintings. This mecca for Stone Age enthusiasts has since been viewed by ten million people. "Such a stream of visitors is bound to cause damage. Three decades after Lascaux 2 first opened, we were involved in carrying out the urgent repair work," explains Francis Ringenbach, artistic director and head of production at the

Atelier des Fac-Similés du Périgord – AFSP. The company developed a process for scanning a cave in three dimensions and using the data to produce a millimeter-accurate reproduction from an artificial stone. The choice of silicone for moldmaking was the result of close technical cooperation between Group

Gazechim (a WACKER partner in France) and AFSP.

For both Lascaux 3, a mobile exhibition on show across the world since 2012, and now Lascaux 4, the AFSP experts have reproduced the cave complex in panels corresponding to the original Lascaux 1. They invoke in visitors the

The Lascaux cave complex is located in South-Western France, 150 kilometers north of Toulouse. Stone Age hunters probably sheltered here during the last Ice Age, the Würm glaciation.



“ELASTOSIL® allows every detail of the polystyrene master mold to be transferred to the imitation stone panels.”

Hans-Rudolf Pfeffer, head of Technical Marketing, Industrial Solutions



From the 3D Scan to the Replica

The deceptively realistic imitation of the Lascaux cave is the result of state-of-the-art computer technology, years of experience with the materials, and a sensitive artistic touch.

1.

Preparing a Master Mold

Foam polystyrene blocks are cut to size based on the 3D scan. The technicians smooth over unevenness with a mineral coat. They mark the outlines of the paintings with reference points.

2.

Copying the Master Mold

A layer of ELASTOSIL® M Silicone (yellow) is transferred to the master, copying all the details. It is part of the negative mold.

3.

Preparing the Negative Mold

The negative mold is stabilized with casting resin and a metal scaffold. Then the polystyrene master mold is removed.

4.

The Replica Is Created

The specialists transfer the veil of stone onto the negative mold.

5.

The Negative Mold Is No Longer Needed

It is supported by another casting resin coat, while stability is provided by a metal scaffold. The stabilizing casting resin coat and the silicone of the negative mold are removed.

6.

Finalizing the Panels

After the ELASTOSIL® M coat has been removed, the experts apply patina to the imitation stone that remains. Finally, they add the original wall paintings using the reference points duplicated in the silicone as a guideline.



From a 3D scan, foam polystyrene blocks are cut to size (below), and – via the silicone negative mold – an imitation stone positive mold is then made (top).

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same feeling that stirred four teenagers, who, on September 12, 1940, became the first people in thousands of years to walk through the caverns of Lascaux and see the uniqueness of this Stone Age monument with their own eyes.

In the process developed by AFSP, the scientists map out the original Lascaux 1 cave with great precision using a 3D scanner, and take photos of all the walls. This data enables them to make accurate copies of the wall contours using 50 polystyrene panels, into which the shapes taken from the 3D scans are cut. On average, they correspond to about 20 square meters of the original wall surface. The conservators apply a molding compound to the

foam polystyrene panels by hand to complete a faithful copy of the original: the master mold. They also manually transfer the colored reference points of the wall paintings

EASY SEPARATION

Then, to ensure that the positive and negative molds can separate easily, a modern material comes into play: the two-component silicone rubber ELASTOSIL® M from WACKER. “It allows us to transfer every detail of the foam polystyrene master mold, including the mineral molding compound and color to the synthetic stone panels,” explains Hans-Rudolf Pfeffer, who is responsible for technical sup-

port for silicone moldmaking compounds. “Reproduction with ELASTOSIL® M is so accurate that it can even be used to copy a vinyl record,” notes Pfeffer. He actually didn’t believe it until he had tried it himself.

ELASTOSIL® M is the ideal material for copying the cave walls, not just because of its fidelity. The silicone can be easily processed and, with the right formulation and curing agent, it vulcanizes rapidly even at room temperature, so it can be processed without expensive equipment. In addition, the material retains its shape: shrinkage on vulcanization either does not occur or is only marginal. “The resulting polymer is robust





The experts took about three months to make each panel.

and durable, and the molds can be used to make hundreds of reproductions,” says Hans-Rudolf Pfeffer. The raised reference points of the wall paintings are transferred to the vulcanized silicone rubber.

To allow the silicone layer to serve as a negative mold for the artificial stone, it is stabilized with a layer of resin - the support mold. The two parts are not permanently bonded, so that the high flexibility of the silicone rubber can be utilized for handling. The AFSP staff support the shell with a metal scaffold and remove the foam polystyrene master. The material the experts finally apply to the silicone layer cures to give the look and feel of a stone wall. This artificial stone is extremely

durable and resistant, and is based on a mixture developed and patented by AFSP.

RESIN SUPPORT MOLD

Once the technicians have also applied resin to the stone layer and the dried panels have been stabilized with a metal scaffold, they remove the support mold from the resin. At this stage, ELASTOSIL® M remains on the artificial stone. The reference points of the cave paintings from the master mold have now been transferred to the artificial stone. The silicone layer can then be peeled off the copy. In the last step, the artists manually apply patina to the artificial stone and add the reference points to the original cave paintings. 70 international specialists

“With our silicone rubber, you can even faithfully copy a vinyl record.”

Hans-Rudolf Pfeffer, WACKER
Applications Technology

were involved in the project, working, on average, for about three months on each panel. The AFSP team thus contributed to the continued conservation of the Lascaux 1 World Heritage Site, while making the 17,000-year-old masterpiece publicly accessible. Lascaux 4 provides a

framework in which the visitor can experience the cultural treasure in a historical context in one of the most modern exhibition galleries in the world – thanks to intricate craftsmanship, the latest 3D computer technology and the multifaceted talents of silicone. ■

The new state-of-the-art visitor center featuring the replica Lascaux cave is nestled in the hills of southwest France.



PODCAST



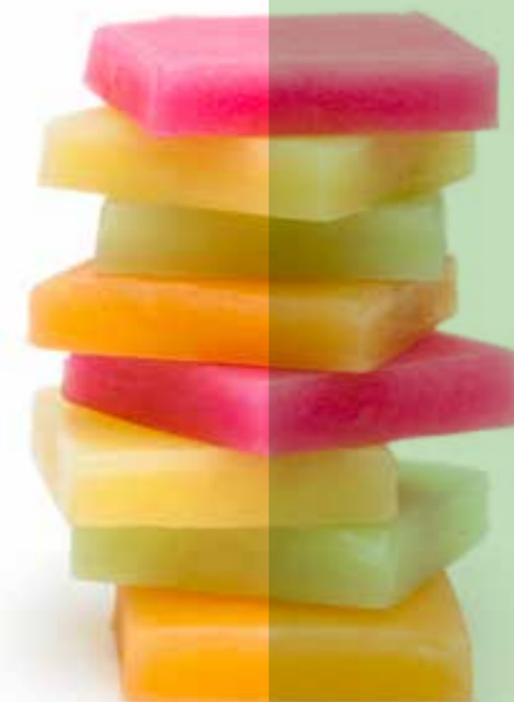
Our podcast called “Nuremberg’s New Imperial Busts” tells you more about the advantages of silicone moldmaking compounds: www.wacker.com/podcast



MOUTHWATERINGLY TASTY

WACKER is launching CANDY2GUM® – a completely new confectionery manufacturing technology – onto the market. This makes it possible to produce chewy candy that turns into chewing gum in the mouth, opening up entirely new prospects for the sugar confectionery industry.

The CANDY2GUM® technology opens up the possibility of adding natural ingredients to the boiling process.



The chewing of gum-like substances appears to always have been a basic human need. Archeologists found the oldest specimen to date of a precursor to chewing gum when they excavated a 9,000-year-old settlement in southern Sweden. The ancient Greeks were also fond of similar substances. Some 2,000 years ago, they chewed on the resin of the mastic tree, which is still harvested on the Greek island of Chios. Nowadays, chewing gum is generally based on synthetically produced solid resins that serve as carriers for sugar, sweeteners and flavorings.

60 YEARS OF EXPERIENCE

The production of raw materials for the chewing gum industry is also a WACKER tradition. For over 60 years now, the company has been a leading supplier of food-grade polyvinyl acetate solid resins, which industry uses to make gum base. Together with finely ground sugar and concentrated flavorings, the gum base is kneaded into chewing gum at around 60 degrees Celsius. This gives the mixture a tough and tacky consistency,



Dr. Martin Seizl and Dr. Thomas Wimmer pull the candy mass based on CAPIVA® C03 for a couple of minutes to fine-tune the mouth-feel. Afterwards, this mass can be flattened manually or run through a batch roller, rope sizer or extruder.

“The CANDY2GUM® technology can be used to formulate unprecedented confectionery.”

Dr. Martin Seizl, head of the Gum business team at WACKER BIOSOLUTIONS

which is why it must be processed by powerful specialty machines. The choice of ingredients is limited. Water-based additives are not suitable, because they would dissolve the sugar out of the gum mixture. The disadvantage of fat-based ingredients is that they make the gum base extremely soft. This would cause the chewing gum to simply disintegrate in the mouth while being chewed instead of forming a homogeneous mass.

According to the Euromonitor market database, roughly 1,000 kilotons of chewing gum

were sold worldwide in 2015 alone. The same period saw sales of gumdrops, jelly and chewy candy that were more than double that quantity. This also includes soft candy, as flexible sugar bars are known in the industry, which is available in every flavor variation – from all kinds of fruit to milk and even soft chocolate centers. These are based on a melted sugar solution, which is boiled with glucose syrup at approximately 100 to 130 degrees Celsius. Water- and fat-based ingredients such as milk, cream, honey, cocoa, nuts, vitamins

and other flavorings, as well as colorings, can easily be added to the boiled sugar mixture. Chewy candy is produced in a continuous boiling process. Since sugar dissolves in water, it is also very easy to clean the equipment. Chewy candy thus has decisive advantages over chewing gum. However, it has a weak point: due to its sugar base, the calorie content is high.

Chewing gum, on the other hand, provides a long-lasting chewing experience without giving you a guilty conscience – the calorie intake





is considerably lower. In addition, the chewing of gum stimulates the formation of saliva, which increases the pH value in the mouth, neutralizing the acids that attack tooth enamel. Alkaline saliva can also remineralize teeth. To prevent tooth decay, only sugar-free gum should be chewed, of course.

THE BEST OF BOTH WORLDS

WACKER's new CANDY2GUM® technology combines the best of both worlds: the texture of chewing gum with the boiling options of chewy candy. "This opens up entirely new possibilities for integrating ingredients. The CANDY2GUM® technology can be used to formulate unprecedented confectionery," says Dr. Martin Seizl, head of the Gum business team at WACKER BIOSOLUTIONS. Plus, CANDY2GUM® makes for an entirely new mouthfeel. It starts as a chewy candy and then turns into chewing gum after a short time in the mouth.

The secret of CANDY2GUM® lies in its basic ingredient. WACKER's preformulated CAPIVA® C03 mixture serves as the base. It is insoluble in water and melts completely, which means it can be blended uniformly. CAPIVA® C03 is suitable for blending with both sugary and sugar-free candy mixtures, which opens up numerous opportunities for novel confectionery products.

Since CAPIVA® C03 melts completely, manufacturers can make these products using conventional candy boiling processes. "We are thus producing the first raw material worldwide that makes it possible to boil chewing-gum-like candy and shape it as required instead of kneading it elaborately," explains Dr. Thomas Wimmer, head of the chewing gum lab run by the WACKER BIOSOLUTIONS division.

A chewing gum was successfully boiled for the first time in December 2013 at a WACKER food-technology laboratory in Burghausen. "We wanted to find out whether what we did in a cooking pot would also work on an indus-

trial scale," says Wimmer. That's why the team got in contact with the confectionery machinery maker Chocotech in Wernigerode, Germany, in early 2014. "We were excited about the CANDY2GUM® technology from the start, because it can be used to make a completely new type of candy. We wanted to find out whether the technology would work with conventional equipment," says Volker Günnel, a qualified engineer and area sales manager at Chocotech.

Chocotech equips well-known German and international confectionery manufacturers with machinery for producing hard and soft candy, fruit-flavored jelly candy, caramel and whipped sugar mixtures. In industrial-scale production, candy manufacturers normally use continuous cookers that produce confectionery in a non-stop chain process. While the ingredients are weighed into the first pot in batches in accordance with the recipe, finished candy comes out at the end of the process in a continuous loop.

Chocotech tests showed that the CANDY2GUM® technology can be used in a continuous boiling process, but some adjustments were required. For two years, WACKER food technicians refined the preformulated CAPIVA® C03 mixture so that it could be used in industrial production. In addition, Chocotech engineers worked on adapting conventional production machinery and processes for the new CANDY2GUM® technology. Ultimately, the engineers equipped a machine that usually produces hard candy with an additional melting container for CAPIVA® C03, including pump and flow meter. "The ready-to-use pre-mix is melted in separate containers and only mixed with the sugar mixture and flavorings in one of the final production steps to minimize cleaning," explains Günnel. At the end, the cooled mixture runs through a cut-and-wrap machine that cuts the candy into bite-sized pieces and packages them.



Since the basic ingredient of CANDY2GUM® melts completely, manufacturers can make novel confectionery products using conventional candy boiling processes.



“Hard-candy production facilities are perfectly equipped for handling the CANDY2GUM® technology.”

Volker Günnel, engineer and area sales manager at Chocotech

Volker Günnel, an engineer at Chocotech, is convinced that candy producers will appreciate the great amount of flexibility offered by the CANDY2GUM® technology.

“Generally speaking, hard-candy production facilities are perfectly equipped for handling the CANDY2GUM® technology. Traditional hard-candy manufacturers can considerably expand their product portfolio with little investment spending,” explains Günnel. His customers can thus gain a great amount of flexibility.

A LITTLE INVESTMENT PAYS OFF

WACKER started to present the new CANDY2GUM® technology to various customers and partners in 2015. A market study that was commissioned by WACKER and involved 4,000 participants worldwide shows that CANDY2GUM® is also received well by end consumers. Regardless of where they were from, those surveyed found the integration of natural ingredients such as real fruit juice and vitamins particularly interesting. In the USA, consumers are especially looking forward to chewing-gum-like candy with real caramel. In China, the underlying idea got an impressive

70-percent approval rating, particularly because real milk or coconut milk could be added to the confectionery.

It is also remarkable that all age groups in China rate CANDY2GUM® as highly promising. Seizl believes that this is due to growing health awareness: “CANDY2GUM® offers an opportunity of adding fresh, natural flavoring ingredients such as milk or fruit juice to chewing gum. This is very popular with Chinese people of all ages.” A study by the German Federal Ministry of Food and Agriculture on the topic of “potential of German confectionery in China” shows that, when it comes to the consumption of sugar confectionery, the Chinese place particular importance not only on taste, but also on product innovations. In other words, Chinese consumers have a fondness for new, unusual food.

With retail sales of over \$15 billion, China is the second-biggest confectionery market in the world after the USA. The chewing-gum



market, in particular, has been registering above-average growth for years. The focus is primarily on sugar-free products. Health is a key sales argument here. Natural ingredients obtained from fruit or plants are very popular with consumers, too. “Nowadays, one in three people will give the list of ingredients a critical glance before putting confectionery in their shopping cart,” explains Seizl. CANDY2GUM® can furthermore be used to produce functional candy with health-promoting ingredients. The technology makes alternative product forms for active ingredients such as vitamin C possible.

“The new CANDY2GUM® technology rounds out both our successful food-grade VINNAPAS® solid resins for gum base and our innovative CAPIVA® products, expanding the multifaceted WACKER portfolio for the chewing gum and confectionery industry,” says Seizl. From January 29 to February 1, WACKER BIOSOLUTIONS showcased the technology at the ProSweets confectionery supplier trade-show in Cologne, Germany, for the first time. The first products made with CANDY2GUM® technology are expected to be launched on the market during 2017, offering consumers worldwide an entirely new chewing experience. ■

Continuously produced CANDY2GUM® mass cools down on a SUCROMASTER® hard-candy tempering belt.



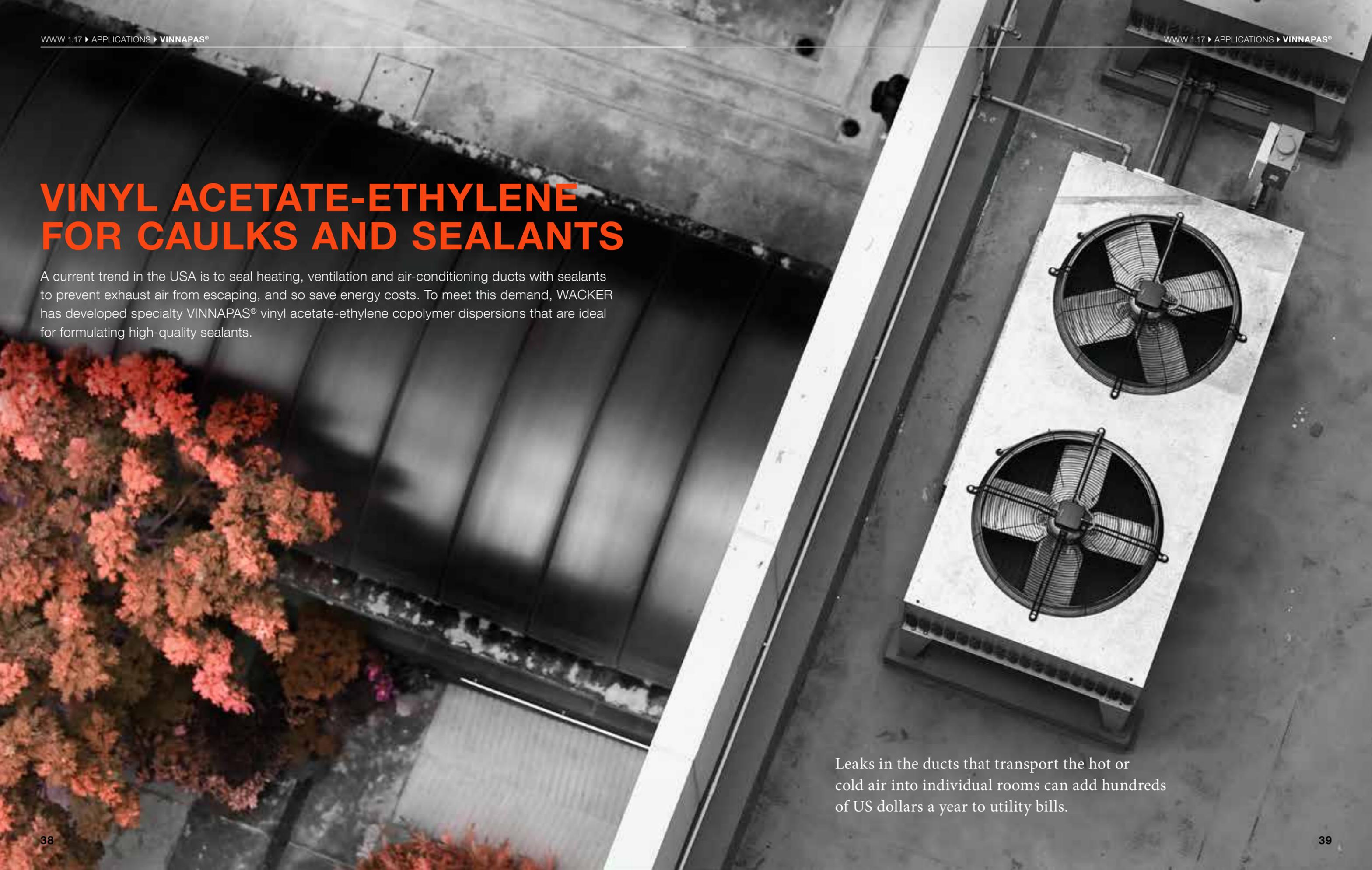
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VINYL ACETATE-ETHYLENE FOR CAULKS AND SEALANTS

A current trend in the USA is to seal heating, ventilation and air-conditioning ducts with sealants to prevent exhaust air from escaping, and so save energy costs. To meet this demand, WACKER has developed specialty VINNAPAS® vinyl acetate-ethylene copolymer dispersions that are ideal for formulating high-quality sealants.



Leaks in the ducts that transport the hot or cold air into individual rooms can add hundreds of US dollars a year to utility bills.



Essentially, the sealants have to be provided with the necessary adhesion, stability, flexibility and heat resistance. Thanks to VAE, all that is possible.

Heating, ventilation and air-conditioning (HVAC) systems are popular in the USA. Electric blowers deliver hot or cold air, as appropriate, through an extensive duct network to individual rooms to bring them to the required temperature. According to the US Energy Information Administration, air-conditioning costs – at around 47 percent – are the largest item on a household’s energy bill in the United States. Poorly sealed HVAC air ducts contribute significantly to high energy consumption. Leaks in the ducts that transport the hot or cold air

into individual rooms can add hundreds of dollars a year to utility bills.

Sealing of the metal ductwork is easy with the aid of flexible sealing compounds. Polymer-based systems, for which WACKER has been supplying VAE dispersions as binders since 2009, are particularly suitable for this. They provide the water-based sealants with the necessary adhesion, stability and flexibility. In addition, WACKER’s VAE dispersions are heat-resistant and retain their outstanding adhesive properties even when exposed to high temperatures.

“The market for polymer-modified sealing and caulking compounds is promising.”

Dr. Martin Schierhorn, marketing manager for VAE dispersions for sealing and construction applications.

TAILOR-MADE SOLUTIONS

Depending on applications and requirements, WACKER offers different VINNAPAS® grades that are suitable for the formulation of sealants. With the right grade, the finished formulations show excellent bonding, even to difficult substrates such as PVC and metal. The various VINNAPAS® grades furthermore possess high filler acceptance. Compared to alternative binders, WACKER’s VAE dispersions have a clear advantage. “Our VAE can be produced from a range of different raw materials. One possible starting material is natural gas, the price of which is virtually constant compared to that of crude oil. This allows us to offer our customers price stability,” says Dr. Martin Schierhorn,



Over recent years, the demand for WACKER’s VAE dispersions as binders for sealing and caulking applications has risen by an average of 16 percent per year.



Saving energy and costs: flexible sealing compounds based on WACKER’s VAE technology are an easy and reliable way to seal the metal ductwork in HVAC systems.

strategic marketing manager for VAE dispersions for sealing and construction applications.

Over recent years, the demand for these VAE dispersions from WACKER as binders for sealing and caulking applications has risen by an average of 16 percent per year. The VINNAPAS® binders for caulks and sealants have grown into a key component

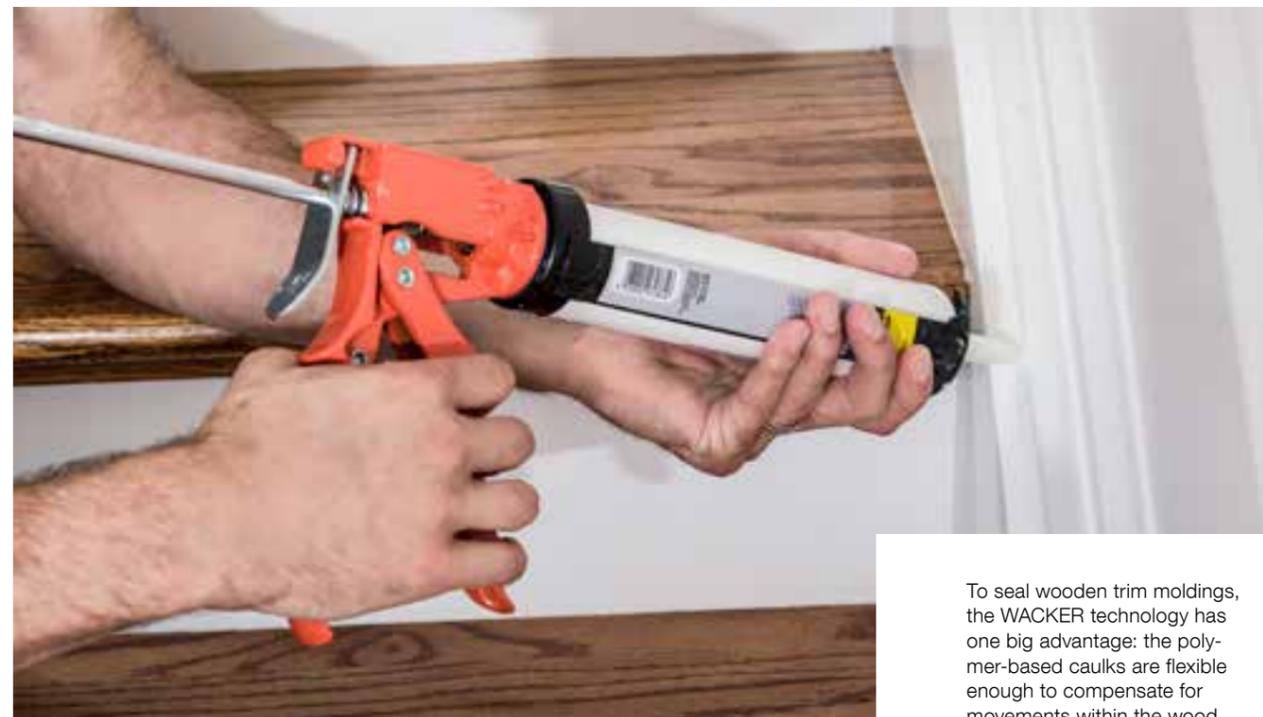
of WACKER's product portfolio. "One of the reasons for this is a growing awareness among Americans that a lot of energy, and thus money, can be saved through simple measures such as sealing ventilation ducts," reports Robert Cuscino, marketing manager for VAE dispersions for sealing and caulking compounds at WACKER's US site in Allentown.

"Through simple measures such as sealing ventilation ducts, a lot of money can be saved."

Robert Cuscino, marketing manager for VAE dispersions for sealing and caulking compounds at WACKER's site in Allentown (USA).



Unlike other systems, the VAE-modified caulks can create a stable bond between two different surfaces, for instance between a mineral surface and wood. What's more, crown molding seams that are sealed with polymer-based caulks can be painted.



To seal wooden trim moldings, the WACKER technology has one big advantage: the polymer-based caulks are flexible enough to compensate for movements within the wood.

GREAT MARKET POTENTIAL

WACKER's VAE dispersions are also ideal for formulating caulking compounds based on calcium carbonate or similar fillers. The dispersions lend the compound the necessary flexibility and ensure that the sealant retains its adhesion and provides reliably tight joints, even under heavy loading. Unlike other systems, the VAE-modified version can create a stable bond between two different surfaces, e.g. sealing the seam between a wooden baseboard and gypsum-based drywall. The same applies to wooden trim work like chair rails and crown moldings. "Another big advantage is that VAE can also be painted," explains Cuscino.

"The market for polymer-modified sealing and caulking compounds is promising," emphasizes Schierhorn. There is growing demand for the implementation of simple energy-saving measures, such as sealing ventilation ducts, in Asia, too. In the long term, however, WACKER wants to try and open up further applications as well. The team is currently testing formulations with VAE dispersions for assembly adhesives that are suitable for installing drywall, for example. WACKER's binders serve as ideal bonding agents between gypsum plasterboards and timber frames. ■

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BACK TO THE BEGINNING

In 1950, WACKER was the first European company to start producing silicones. The foundations were laid by Dr. Siegfried Nitzsche who began his research in Burghausen in 1947, under very modest conditions at first, with only one apprentice and a small laboratory in the basement.

WACKER's silicone fluids – as pictured – are characterized by their thermal and thermooxidative resistance and very low order of toxicity. Their versatile uses include cosmetics, shampoos, lubricants and transformer fluids.

Silicone research got off to an unfortunate start at WACKER – with a refusal. Early in 1947, a Doctor of Chemistry from Jena, Siegfried Nitzsche, applied for a job at the Burghausen site suggesting that a meeting could be of interest to both parties. These were the lean years just after the war, however, and WACKER was still controlled by the US military government – and remained so until 1953. The German economic miracle of the 1950s was still a long way off. So, Burghausen's reply was conceiv-

ably curt: "With regard to your letter, we are not interested in a meeting."

Some weeks later, production manager Eduard Kalb and chief chemist Dr. Wolfgang Gruber traveled from Burghausen to Heidelberg to take part in the first post-war conference held by the German Chemical Society from April 15 to 17, 1947. There, they attended a plenary talk by the same Dr. Siegfried Nitzsche on "silicon-containing plastics" – the subject he had chosen for his postdoctoral studies.

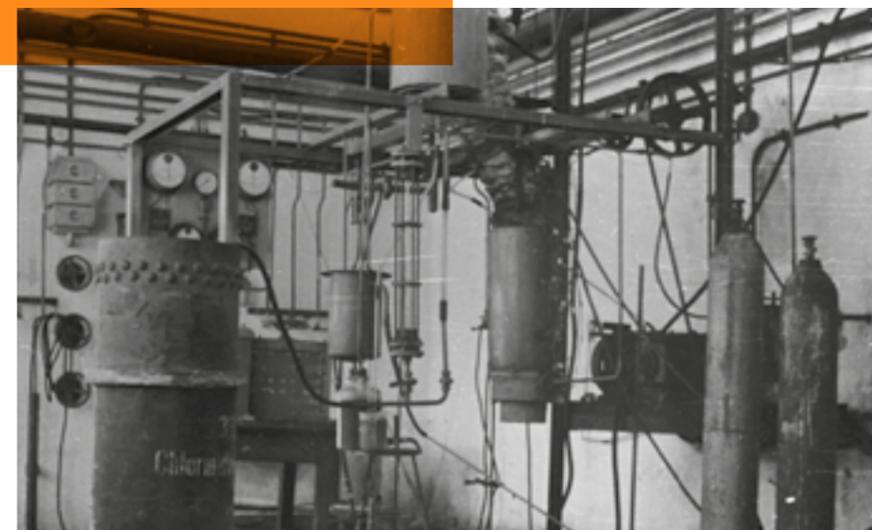


Dr. Siegfried Nitzsche

The Salettl building where silicones pioneer Dr. Nitzsche did his research.



In 1949, Dr. Nitzsche and his team achieved their own silane synthesis and the first silane furnace began operation in one of the Burghausen buildings, the Salettl.



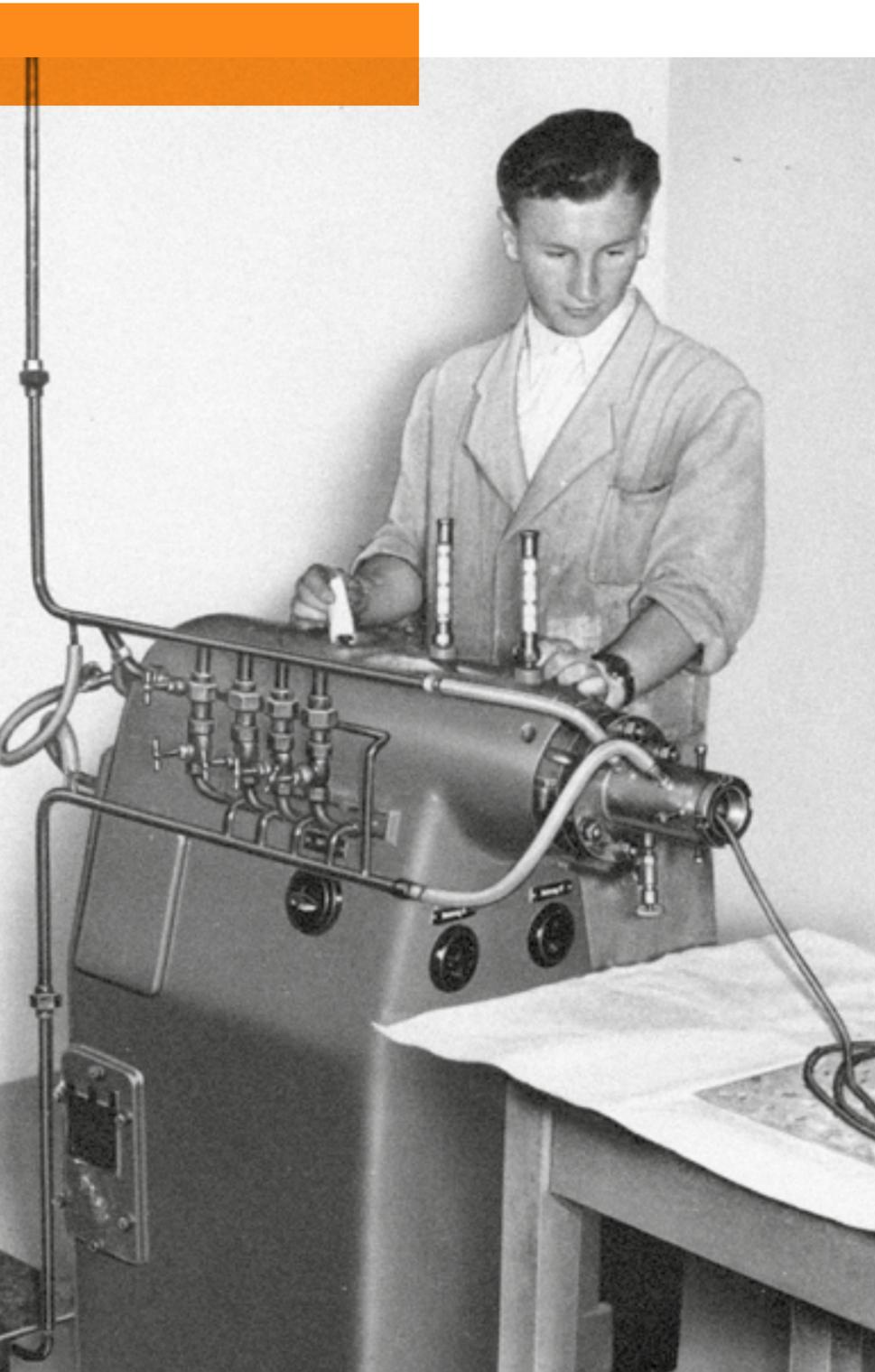
A look inside the first production facility for silanes – a starting product for silicones – in Burghausen in 1950.

The speaker proved to be one of the first German specialists on organosilicon compounds, which were still largely unknown in Europe, whose heat stability and water-repellent properties amazed experts. The WACKER representatives hired Dr. Nitzsche on the spot. The young research chemist from Jena began work in Burghausen on August 2, 1947 – a date that marked the starting point for WACKER's ascendancy into the top international group of silicone suppliers.

British scientist Frederick S. Kipping synthesized the first silicone in 1898, without actually recognizing the potential of this novel substance. In 1940, German Richard Müller from Chemische Fabrik v. Heyden in Radebeul, Saxony, and US Eugene G. Rochow of General Electric independently discovered a groundbreaking process for the large-scale production of silanes – the most important precursors of silicones. This process is known as the Müller-Rochow synthesis and remains the basis of silicone production to this day, not just at WACKER. It involves the synthesis of methylchlorosilanes from silicon,



Silicone rubber – a new class of polymer with versatile applications: technical service engineer Norman Dorsch demonstrating the use of WACKER's silicone joint sealants in 1965.



An extruder being used to process silicone rubber in 1955.

hydrogen chloride and methanol. WACKER uses these silanes to make silicones, whereby the hydrogen chloride – a mere auxiliary in the production – is released again and returned to the process.

The very first commercial silicone product appeared in 1944: a paste from Dow Corning for protecting the electric ignition systems of aircraft engines.

BASEMENT LABORATORY

In Burghausen, Dr. Nitzsche also took the Müller-Rochow synthesis as his starting point in 1947, but he had to research and develop subsequent areas of chemical and process-technology expertise himself – and with only very modest facilities available at first. Dr. Nitzsche's notes on his early days read: "On August 5, I was shown my 'laboratory': a basement room labeled 'Laboratory S'; its condition was far from attractive. I was also allocated a trainee laboratory technician – my first assistant!"

Before long, new colleagues joined Dr. Nitzsche in determining the chemical potential of the new substance class and developing techniques for the industrial-scale reproducibility of each new silicone grade. In 1949, Dr. Nitzsche and his team achieved their own silane synthesis and the first silane furnace began operation in one of the Burghausen buildings, the "Salettl," supervised by engineer

Sebastian Fellermeier. It ran day and night, using the company's own raw materials.

ADDITIVE FOR PVC AND SHELLAC

At first, research was concentrated on silicone fluids and resins. Silicone rubber compounds later joined the portfolio. Gel formation was a frequent problem at first, but, one by one, the difficulties were overcome. The research chemists tested the potential benefits of silicones by optimizing their own products and processes. For instance, by adding silicones, Shellac was made less sensitive to water, and PVC no longer adhered to rollers and spraying machines.

As early as 1949, the first small quantities of silicone fluids had been supplied as release agents to the tire industry. In the following year, the US military government – WACKER was still under the control of the occupation authority – officially permitted the company to start producing silicones. In 1951, WACKER expanded its silicone operations and published its first "provisional information" on silicone resins, effectively an instruction leaflet for customers: "Woven fiberglass impregnated with the solution is exceptionally resistant to heat. Once the solvent has fully evaporated at room temperature, leaving only a virtually tack-free film, the dried-on resin is baked for 10 hours at 180 °C."

VISITING THE SILANE FURNACE

In late 1950, Johannes Hess, then 74, who had been a managing director of WACKER from 1917 to 1945, paid a visit to the plant. He listened in silence as the silane furnace was explained to him. On this occasion, the employee newspaper reported: "In this furnace, we are currently producing at least 1,000 kilograms a month, and soon, when we have a further reactor, it will be two to three metric tons. Hess merely said 'Make two to three hundred tons as soon as you can' and walked away."

That was a farsighted piece of advice. Before long, silicones had arrived in a big way. The new,



Nowadays, medical applications would be unthinkable without ultrapure SILPURAN® silicone gels.



Thermal stability makes silicone resin seals ideal for use in engine compartments.

“Make 200 to 300 tons as soon as you can”

Johannes Hess, former managing director of Wacker Chemie, during a visit to a silane furnace in 1950.

environmentally sound product – the only big class of plastics to be derived from methanol (obtained from natural gas) rather than from crude oil – offered benefits to an increasing number of industrial sectors. 1949 and 1950 saw the introduction of silicone fluids as release agents in the rubber and tire industries. From 1951, silicone resins became available as

electrical insulation and silicones themselves were employed to insulate motors and transformers and for impregnating textiles; there were silicone antifoam agents for paints and lubricants and silicone pastes were used as anti-friction and damping agents. In 1953, silicone emulsions were introduced to optimize building materials, and silicone rubber for molding and casting.

A great future opened up for these “S Class” chemicals. On January 1, 1953, WACKER established its first silicone department – “N.” At that year’s Hannover trade fair, a customer – the building-protection company Drengwitz from Opladen, Germany – advertised a WACKER silicone product for the first time. In 1953, WACKER’s silicone output was 78 metric tons; by 1964, it was already 2,800 tons.

Today, WACKER produces thousands of regular silicone products and even more specialty products on customer request. The portfolio

ranges from silanes and silicone fluids, emulsions and elastomers, to sealants and resins. Every car contains several kilograms of silicone rubber grades that serve damping and sealing purposes. Silicone fluids and their emulsions find use in cosmetics and shampoos and serve as joint fillers in construction, especially in wet locations. In high-voltage cables, silicone insulators have replaced porcelain ones. Furthermore, to withstand weathering for prolonged periods, facades get a coat of silicone resin emulsion paint and silicone impregnations render textiles water repellent.

GLOBAL SUCCESS

What began shortly after the war under modest conditions in a basement laboratory in Burghausen has long achieved global success. Silicones’ unique set of properties that can be adapted to suit individual needs make them indispensable to most industrial sectors. ■

78
METRIC TONS of
SILICONE

2,800
METRIC TONS of
SILICONE



SILICONE RESEARCH AT WACKER

Research into silicones has a long tradition at WACKER: in 1947, Wacker Chemie became the first company in Europe to start conducting research on organosilicon plastics. Today, the WACKER SILICONES division has over 400 employees working on tomorrow’s products – which means that 10 percent of the division’s workforce is involved in R&D. Currently, over 100 research projects are in progress at WACKER SILICONES. The strong focus the division has traditionally placed on innovation is paying off – for customers and the WACKER Group: The new-product rate, i. e., sales of products less than five years old, is growing three times faster than business with our long-standing silicone grades.

Another success factor here is the increasing internationalization of R&D work. Products are increasingly being developed in regions where WACKER SILICONES’ markets are located. To meet this goal, the Group operates a global network of 22 state-of-the-art technical centers that focus on applications technology. The specialist staff at these centers are native speakers who work on customized solutions to meet local customer needs. They also take region-specific climate conditions, building standards and codes of practice into consideration.

For example, WACKER runs a Center of Electronics Excellence in Seoul, South Korea, that develops silicones for the local electronics and, in particular, LED sectors. In early 2016, WACKER expanded its technical center in Singapore to include a development and test laboratory for silicone elastomers. Opened in 2003, the technical center in Jandira, Brazil, focuses its expertise on silicone fluids and emulsions for cosmetics and hair-care products. The fact that technical centers and sales organizations usually share premises makes close collaboration possible between the sales and development teams – an ideal environment for customer support. What is more, the

technical centers cooperate closely with WACKER ACADEMY, the Group’s own training facility.

The latest addition to the Group’s global R&D network is the new lab complex – 28,000 square meters in size – in Ann Arbor, close to the University of Michigan, one of the foremost research universities in the USA. Offering a unique blend of science, start-up and well-established companies, Ann Arbor is the perfect location for developing silicone-related innovations designed to expand WACKER’s presence in the world’s second largest chemicals market.

Founded by WACKER in 2006, the Institute of Silicon Chemistry at the Technical University of Munich (TUM), one of Germany’s elite universities, likewise acts as an interface between academic and industrial research. The collaboration aims at combining the latest research findings

with WACKER’s 70 years’ experience in the field of silicon chemistry. The partnership between science and industry has so far produced over 30 research projects, ten new patents and 35 scientific publications.

Research at the Institute of Silicon Chemistry is currently being conducted into the heterogeneous polymerization of olefins on silica gels, the synthesis of innovative, siloxane-based hybrid materials, and the development of energy materials for electromobility and photovoltaics.

The WACKER Silicone Award plays a role in knowledge and technology transfer in that, for almost 30 years, it has been presented by the Group in recognition of outstanding scientific achievements in the field of organosilicon chemistry. The prize stands alongside the Kipping Award as silicon chemistry’s most important international accolade.



Prof. Bernhard Rieger (center) with staff members in front of a high-temperature chromatograph at the WACKER Institute of Silicon Chemistry. The equipment is used for determining macromolecular structures and analyzing the structure-property relationships of polymer materials.

“ADDING VALUE FOR CUSTOMERS”

Dr. Robert Gnann, president of WACKER SILICONES, on the division’s growth prospects

WACKER is currently the world’s number two silicones producer. What is your strategy for further growth?

Dr. Robert Gnann: We have a clear goal. We want to continue growing at over 4 percent per year – significantly faster than the global chemical industry. We have created the best conditions for this with our full-scale production plants for upstream products. Now, we are selectively expanding our capacities for downstream products. In the USA, we are currently building a new pyrogenic silica plant in order to become the No. 2 producer in this business. At the same time, we are continuing to expand our consultancy and service portfolio – particularly in growth regions such as Asia and South America, where we have a policy of using strong, locally based teams that work closely with customers. As far as our products are concerned, we want to offer more high-quality specialties, while also continually optimizing our technologies and processes – thus further improving our cost position.

How do you hold your own against the competition? In other words, what makes WACKER SILICONES better than its rivals?

One of our biggest strengths is our comprehensive customer service provided all around the world by first-rate specialists. We operate over a dozen technical competence centers across five continents. This proximity to our customers, understanding their requirements and developing solutions with them is what distinguishes us from many of our competitors. A good example of our extensive customer policy can be seen in South Korea. We have our Center of Excellence for Electronics Applications there, and work hand in hand with world-leading electronics companies on developing new solutions. In the USA, we are currently building a new research center at Ann Arbor. Customers get far more from us than just silicone: they gain a highly experienced advisor and reliable development partner, who has a detailed understanding of their needs, and helps them reach their goals.

So the main aim is to keep on improving silicones and modifying their properties for new applications?

Yes, but not only that. We are heavily reliant on fundamental innovations. Take 3D printing of silicone parts, for example. Until recently, there was no

mature industrial 3D printing technology available for silicones. We developed everything from scratch – starting with the technology, through specialty silicone, to control software for the printer.

That doesn’t sound like a business that will consume thousands of tons of silicone per year. Do you see WACKER SILICONES’ future in such specialty applications?

I don’t think it’s at all justified to assume that 3D printing will remain a niche application. The technology may still be young, but it has enormous potential. However, it’s true that global-scale plants like the ones we operate will never be utilized to capacity just by producing specialty products. We also need commodity silicones, which are in huge demand. The main issue here is to produce materials of uniformly high quality at the lowest possible cost. We are pursuing an optimum-mix strategy, not only offering high-efficiency production of commodity silicones, but also a growing share of tailored specialties that add value for customers.

WACKER already manufactures over 3,000 different silicone grades, which are used in almost every area of industry, from construction to electronics. Won’t the range of new applications be exhausted sooner or later?

I’ve got no worries on that score. Firstly, new technologies and applications that use silicones are emerging all the time. Just think of electromobility. Secondly, existing applications are continually being enhanced. The traditional self-adhesive plaster complete with wound dressing is almost 100 years old, but wound dressings with silicones set entirely new benchmarks. They are soft and flexible, breathable, adhere reliably and can be peeled off much less painfully. And we can even modify established products such as silicone fluids so that they can be used as heat-transfer media in solar thermal power generators, where they significantly improve efficiency. These are just two examples of many. I’m convinced silicones will demonstrate their superior properties in many applications that we haven’t even thought of yet. There are no limits to the creativity of our outstanding teams around the world.



Dr. Robert Gnann (52) has headed the WACKER SILICONES division since April 1, 2016. A chemist by training (University of Cologne), he previously worked at GE Silicones, Bayer, Lanxess and Momentive in the USA, Canada and Germany.



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EXTERIOR WALL PAINTS

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WACKER will introduce numerous innovations for paints and surface coatings, as well as for the construction, packaging and adhesives industries, at the European Coatings Show (ECS) from April 4 to 6, 2017, in Nuremberg, Germany.

JUST WIPE AND THE STAINS ARE GONE!

Whether on walls, floors or terraces – no one likes to see stains. But coffee, sauces or oil marks can be difficult to remove, especially from mineral surfaces. Thanks to WACKER's new PRIMIS® SAF 9000 series of dispersions, dirt now no longer penetrates flooring or wall paints.





The dispersion can be applied to mineral surfaces in diluted or undiluted form, in line with the specific requirements.

Decorative mineral flooring in business premises and homes, or concrete flooring in railway stations and on terraces have to put up with a great deal of wear and tear. They are a magnet for stubborn stains, such as coffee, greasy food residues, red wine or ketchup. And however much you try to clean off the dirt, there is always a residue. To prevent this, mineral surfaces are given protective treatment.

To meet this need, WACKER developed its PRIMIS® SAF 9000 series of dispersions. Concrete flooring and decorative self-leveling floor screeds are easy to protect against stains with the aid of these specialty acrylic-based aqueous dispersions. They contain high-molecular-weight

polymer particles that are less than 0.1 micrometers in size on average. Being so small, the polymer particles penetrate the fine micropores in the surface, instead of covering them. On drying, the particles form a film inside the pores, preventing the ingress of dirt. It can simply be wiped off. The advantage is that the surface's mineral appearance is hardly changed and the floor retains its familiar feel.

The high molecular weight of the polymer provides another benefit – after drying, the film deposited in the pores mechanically reinforces the surface and protects it against abrasion – an important advantage for flooring subject to heavy traffic in stores, warehouses or industrial buildings.

Another advantage is that the dispersions quickly soak into the floor, and can therefore be walked on after only about an hour.

ALL-ROUNDER

WACKER's developers did a lot of testing in the lab - coffee, balsamic vinegar, blackcurrant juice, cola, salad oil, ketchup and mustard – all these substances left stains on untreated mineral surfaces that even thorough cleaning couldn't shift. If, on the other hand, the surface was treated with a dispersion of the PRIMIS® SAF 9000 series, the dirt could be easily removed almost completely.

In the special dispersions series, there are currently two products: PRIMIS® SAF 9000 and

PRIMIS® SAF 9001. The latter shows improved performance with regards to abrasion resistance and dirt pick-up resistance. Both have a solids content of 42 percent and, in principle, the user only needs to dilute them with water.

The treatment of mineral surfaces is very simple, "The dispersion can be distributed on the surface using a sponge or mop," says Dr. Martin Schierhorn, Marketing Manager for Construction Dispersions at WACKER, "and you can walk on it as soon as it is dry." If necessary, several coats can be applied. The first will be more dilute to ensure that the polymer particles penetrate all the tiny pores and do not get in one another's way. "Both dispersions are very effective at treating absorbent surfaces. They can be readily diluted with water and easily applied, so that they are also of interest to DIY fans," says Schierhorn.

In the past, mineral floors were often sealed with resins of the two components epoxy and polyurethane, however they cause an allergic reaction in some people. By contrast, the PRIMIS® SAF 9000 series dispersions can be freely used. Because no organic solvents or harmful substances such as formaldehyde or isocyanate, or skin sensitizers such as epoxide are added during production, they are much more environmentally friendly and biocompatible than conventional products.

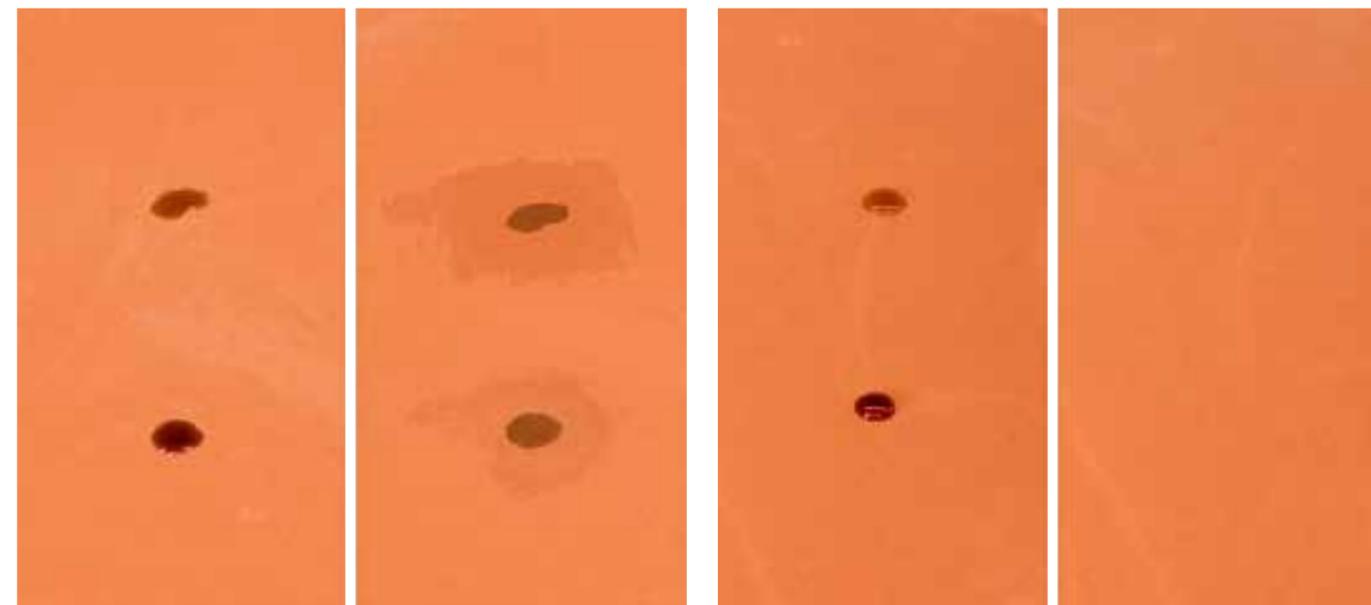
PROTECTION AGAINST BBQ GREASE

The polymer dispersions are also suitable for treating outdoor mineral flooring (such as terraces). Fresh-air lovers will know why – rust from gardening equipment or fat dripping from grilled meat form ugly stains on the terrace, and, even if this soiling is carefully avoided, the sur-

face still becomes dirty over time, for example from airborne pollen and dust. PRIMIS® SAF 9000 series dispersions are ideal for protecting such flooring. The amount to be applied, and its concentration, will be adjusted according to the absorbency of the mineral surface. The treated surfaces can even be high-pressure cleaned. Even chewing gum or dirty machine oil can be completely removed.

PRIMIS® SAF 9000 can also be used in wall paints to achieve an easy-to-clean effect. Specially formulated easy-to-clean paints prevent foreign matter from penetrating into the surface. PRIMIS® SAF 9000 increases the wet-scrub resistance. That means the wall can be repeatedly cleaned with a wet sponge without damaging the paint.

In the WACKER test lab, technician Manuela Mühlthaler demonstrates how



Coffee and blackcurrant juice leave clear stains on untreated decorative mineral flooring.

On the treated flooring, both substances can easily be completely removed by moist wiping.

effective the new dispersion is. Her colleagues have disfigured a test wall with marker pen, lipstick and pencil. This colorful mess is given a finishing touch with coffee stains, ketchup and mustard. When Manuela Mühlthaler wipes the wall with a microfiber cloth and some detergent, the contamination on the one half of the wall painted with conventional wall paint is only partly removed. The scrawl is smeared and the pigment particles are partially detached from the paint coat; material still adheres in some places. Meanwhile, on the other half, the paint is based on PRIMIS® SAF 9000. Here the lab technician can wipe away all the stains completely, returning the surface to an immaculate matt white – as though nothing had ever happened.

HARD SURFACE

The remarkable resistance of the new WACKER co-binder is impressively demonstrated by the pencil marks. With a conventional paint coat, the pencil lead leaves a small groove. If the wall paint contains PRIMIS® SAF 9000, on the other hand, the pencil has difficulty penetrating into the wall paint, since the new dispersion is a hard and very resistant polymer.

“I would have liked a wall paint like this when my children were small”, says Dr. Abdulmajid Hashemzadeh, one of the chemists at WACKER who developed PRIMIS® SAF 9000. The composition of the dispersion is chosen so that the film is not easily penetrated by either hydrophilic or oleophilic substances – not by coffee and not by lipstick. “This property profile is very attractive to the market,” adds Martin Schierhorn, since water-based dirt is easier to remove from hydrophobic substrates, while grease-based stains are easier to remove from hydrophilic surfaces. Reconciling these two

properties posed major challenges to the WACKER chemists. “Years of research were needed to combine all these properties in one product,” says Abdulmajid Hashemzadeh.

As marketing manager, Martin Schierhorn knows that the paint manufacturers, first and foremost, demand additives that allow easy surface cleaning and can be additionally processed into environmentally friendly, odorless paints and, not least, are easy to apply. In numerous lab tests, it was possible to show that the dispersion not only makes it possible to formulate easy-to-clean interior wall paints, but also offers

advantages for exterior paints by eliminating “snail trails.” They occur when it rains shortly after the paint has been applied to the plaster, leaching out the emulsifier. Adding the new WACKER dispersion prevents the water-soluble salts in the paint migrating to the surface and drying.

PRIMIS® SAF 9000 can also be used as a sole binder, e.g. for marble chip plasters. The polymer envelops the small, often multicolored quartz sand grains and protects them. From a distance, such a wall looks like marble because the eye cannot distinguish the individual chips. Here, too, the new dispersion has

“I would have liked a wall paint like this when my children were small.”

Dr. Abdulmajid Hashemzadeh, R&D Laboratory Manager at WACKER POLYMERS



Measurements taken in the lab show that wall paints modified with PRIMIS® SAF 9000 make it possible to remove stains completely.



“The protection of mineral surfaces against dirt pick-up is definitely a global trend in the construction and paint industry.”

Dr. Martin Schierhorn, Marketing Manager at WACKER POLYMERS

a decisive advantage. It remains transparent when moist – as has been demonstrated in the WACKER lab by the developers.

Conventional binders, on the other hand, turn white, as water penetrates into the polymer matrix over time. PRIMIS® SAF 9000 contains only a small amount of water-soluble component, and therefore “water whitening” is avoided. Consequently the colors retain their full brilliance, even when walls are subject to rain for relatively long periods. And the protective coating adheres reliably, even when wet. PRIMIS® SAF 9000 is thus also suitable for surface treatment for “Stucco Veneziano”, based on brightly colored lime paints. The addition of dispersion ensures

that this high-quality finish is effectively protected against dirt pick-up and moisture.

EASY-TO-CLEAN TREND

“The protection of mineral surfaces against dirt pick-up is definitely a global trend in the construction and paint industry,” Dr. Martin Schierhorn is convinced. Less work and lower costs for maintenance and cleaning of mineral surfaces, as well as permanent improvements in optical appearance mean that the costs for the treatment quickly pay off. Whether for flooring or nursery walls: once a user has treated the surface with dispersions of the PRIMIS® SAF 9000 series, they will only need to wipe it with a damp cloth from then on. ■

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PARTICULARLY HARDWEARING

Concrete floors are generally treated with an impregnating agent before they are used. Developed by WACKER, SILRES® BS 6920 is a novel binder for the construction industry that offers particularly effective stain protection and gives the surface an attractive finish.

Flooring with a visible concrete surface was used up until the 1980s only in areas that placed less value on aesthetics and more on robustness, durability and reasonable price. Once architects began to convert empty industrial buildings into stylish loft apartments, they discovered the design potential of concrete as a floor covering. High-quality processed concrete and cement-bound flowing-screed floors, which are ground and polished, are now considered part of contemporary interior architecture. Concrete floors are no longer just found in factory halls, garages and warehouses, they can now also be found in showrooms, shopping malls, restaurants and museums. Even developers of exclusive residential areas have been won over by the unadorned elegance of a concrete floor in kitchens and living rooms.

A look inside WACKER's distribution and logistics center in Burghausen: floors used by forklifts experience particularly severe strain.

However, concrete floors and cement-bound screeds have a porous surface and are less wear-resistant than they appear at first sight. Heavy foot traffic on concrete floors, or vehicles such as fork lift trucks, lead to wear, releasing material that settles as dust on nearby objects. Greater stress over longer periods causes the flooring to eventually crumble. As a result of its porosity, the unprotected surface also absorbs spilled drinks, engine oil or other fluids. This causes soiling that cannot be entirely removed – leaving unsightly stains.

Concrete and screed flooring is generally protected against soiling and abrasion before it is installed. The chemical industry has developed a range of impregnation agents for this purpose. Water-based systems based on silicates – so-called water glasses – and solvent-based impregnating agents based on silanes are widely used.

ALPHA-SILANE PROVIDES PROTECTION

At this year's European Coatings Show, WACKER will be presenting SILRES® BS 6920, a novel binder for concrete impregnation. The

binder is based on the Group's alpha-silane technology and is distinguished by excellent stain protection (anti-staining properties) and exceptionally high load-bearing capacity.

Which of these different systems the developer selects depends on the specific requirements of the individual case: petrol and oil might drip on to the floor of a vehicle garage. In a shopping mall, you can expect food remnants and spilled drinks on the floor. In turn, traffic on a warehouse floor includes fork lifts and sometimes trucks. Developers of single-family homes focus on aesthetic requirements and protective aspects – should the flooring have a natural or semi-matt appearance, perhaps even a high gloss?

During impregnation, liquid preparations penetrate deep into the open pores and fill them partially or entirely. Once the agent has solidified, liquid substances cannot enter the treated surface.

The level of soiling protection that impregnation agents offer should be as high and extensive as possible. When substances fall on the floor, it should be possible to simply wipe them away with paper towels, leaving no visible trace on the flooring.



“SILRES® BS 6920 enables the construction industry to easily produce one-component impregnating agents with high scrub resistance for concrete and screed floors.”

Dr. Udo Anders, Applications Engineer, Construction Silicones



A brush is used to coat a concrete test piece with SILRES® BS 6920 in the applications lab. The lab assistant then applies a drop of oil to test whether the impurity leaves stains.

EVERYDAY SOILING

“We tested the effectiveness of several conventional concrete-floor impregnating agents in our applications lab and noticed that silicate-based agents especially, as well as silane-based products, offer only very limited protection for many applications – even for everyday soiling,” says WACKER chemist Dr. Udo Anders, who developed SILRES® BS 6920 for the Group’s Construction Chemicals business team.

Marketing Manager Udo Goedecke, who is responsible at WACKER for launching SILRES® BS 6920 saw this result as an opportunity: “What use is an impregnation that doesn’t work against ketchup, mustard, red wine or cola?” Despite impregnation, it is difficult to remove such stains and keep the floor looking like new.

What is more, for toxicological and environmental-protection reasons, the construction industry is striving to avoid solvent-based systems. Goedecke sums up the requirements of the market: “The industry is seeking solvent-free impregnations that provide highly effective stain protection.”

In terms of its chemical structure, WACKER’s new SILRES® BS 6920 binder belongs to the group of alpha-silane-terminated polyethers that have attracted increasing attention in the adhesives and sealants sector in recent years. As with all silane-terminated polymers, SILRES® BS 6920 is crosslinkable: exposure to moisture sets in motion the formation of a siloxane network. Due to WACKER’s own alpha-silane technology, all that is needed is the presence of an aminosilane catalyst to ensure that crosslinking proceeds fast enough. Dr. Anders recommends that manufacturers of con-

crete impregnating agents use the aminofunctional silane GENIOSIL® GF 9 for preparations based on the new polymer. This silane grade has the added bonus of ensuring that the impregnation adheres exceptionally well to cement-bound substrates.

CLOSE-MESHED NETWORK

WACKER developers have custom-designed the new polymer for use in concrete impregnating agents. Adjustments were made to both the polyether backbone and the silane components, as Anders explains: “Initially we modified the silane components in such a way that SILRES® BS 6920 formed a particularly close-meshed network of quartz-like structural units upon curing. Then we adjusted the length of the polyether chains.” These optimization measures mean that the viscosity of the new binder is as low as olive oil. The binder penetrates deep into the pores of the concrete floor, fills these and cures to form a hard material.

“Consequently, liquids used on a daily basis containing water or oil cannot penetrate the treated flooring or cause any lasting color change if they are wiped off later the same day,” he says. The substrate is also mechanically

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Treatment of Floor Surfaces



Impregnation

Solid, porous materials are saturated with dissolved, emulsified or dispersed substances. The pores are filled either partially or completely.

Source: Wacker Chemie AG



Coating

A thin coating is applied to materials to prevent substances from entering or escaping. Pores are not filled, even if there are several layers.

“The industry is seeking solvent-free impregnations that provide highly effective stain protection.”

Udo Goedecke, Marketing Manager, Construction Silicones

CONCRETE IMPREGNATION

According to the DIN EN 1504-2 standard, concrete impregnation is a treatment that partially or entirely fills the pores of the concrete. Depending on the absorbency of the concrete and the quantity of the preparation used for the treatment applied, an ultrathin, non-uniform film also forms on the concrete surface. In comparison, the term coating applies if the treatment agent does not penetrate the pores and – instead of filling the pores – lies on the surface, bonds strongly and forms a sealed, thick film that also covers the pores. The film thickness of coatings is normally between 0.1 and 5.0 millimeters. No-solids formulations based on SILRES® BS 6920 usually produce impregnations. Adding solids stops the formulation from penetrating deeply into the pores, producing a thin coating.

reinforced, which increases scrub resistance. If the surface is exposed to high levels of UV radiation, the chemists recommend using the SILRES® BS 6920-based impregnating agent with UV stabilizers.

“SILRES® BS 6920 makes it possible for the construction industry to easily produce one-component impregnating agents that exhibit high scrub resistance for concrete and

screed floors,” says Dr. Udo Anders. The binder itself is solvent-free and can also be further processed without additives due to its low viscosity. But it can be diluted with solvents if needed. It is now possible to produce transparent impregnating agents that give concrete floors a glossy and polishable surface finish, even on rough surfaces. However, formulators can also mix in matting agents, pigments or reinforcing fillers

and then reduce the viscosity by adding a solvent. In this way, the preparation produces a thin coating with a matt surface.

Goedecke points out how very easy it is to use: “The impregnating agents are one-component additives, and processors can apply them using a mop, short-haired roller, or airless spray gun.” Two coats are often recommended, especially for highly porous and absorbent

flooring. “When the first coat is applied, the agent soaks into the floor by filling the pores,” explains Dr. Anders, “the second coat then reduces the surface roughness as a result of film formation, with the thickness of the film depending on the coating weight. Typically, this is approximately 50 to 150 g pro m². You can walk on the floor after twenty-four hours and – if required – polish it.

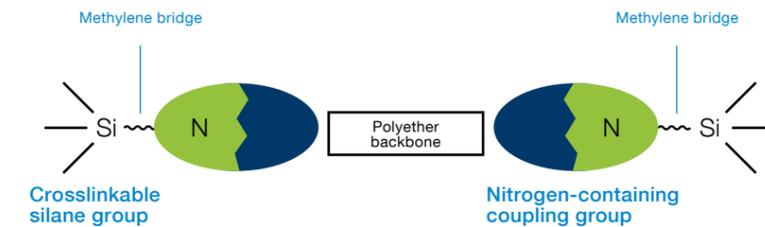
ALPHA-SILANE TECHNOLOGY

In the early 2000s, WACKER developed organofunctional alkoxy-silanes that could couple to organic polymers and were also characterized by an exceptionally high reactivity to moisture. The reason for the reactivity lies in the structure of these silanes: one of the four binding partners of the silicon atom is a nitrogen-containing organic group, whose nitrogen atom is bound to the silicon atom via a methylene bridge. This short bridge creates precisely the distance needed between the two atoms for the nitrogen atom to facilitate release of the alkoxy groups from the silicon atom, thereby accelerating the reaction with water molecules. Silanes of this type are called alpha-silanes – in contrast to those containing the significantly longer propylene bridge, the so-called gamma-silanes. The reaction-accelerating effect is so great in the alpha-silanes that they react about 100 to 1,000 times faster than the corresponding gamma-silanes.

This high reactivity is not even affected when the alpha-silane is coupled to an organic polymer. For the alpha-silane-terminated polyethers WACKER has already performed the coupling, rendering the polymer crosslinkable: the reaction with moisture produces a siloxane network. However, WACKER also offers alpha-silanes that are not bound to a polymer. At WACKER, “alpha-silane technology” refers to the company’s entire product portfolio of alpha-silanes and alpha-silane-terminated polymers as well as its extensive chemical-technical expertise concerning these compounds.

SILRES® BS 6920 enables the construction industry to easily produce one-component impregnating agents for concrete and screed floors.

Many architects now like to use concrete floor coverings to create loft-style living rooms. These floors are ground, polished and impregnated.



EFFECTIVE STAIN PROTECTION

This treatment significantly enhances the color – the flooring takes on a vibrant hue and the grain of the stone is accentuated. Yet the most impressive feature relates to the anti-staining properties achieved by impregnation with SILRES® BS 6920. In his Burghausen lab, Dr. Anders has compared the stain protection of SILRES® BS 6920 on cement-bound test plates with the effect of

impregnating agents based on silicates or silanes. The clear-cut result even surprised the WACKER expert: “Fourteen out of twenty test substances left stains after silicate impregnation, and seven stains were left after silane impregnation. But there were just three stains in the case of SILRES® BS 6920.”

“SILRES® BS 6920 is therefore the binder of choice where heavy stress from food, tire marks, foot traffic or vehicle traffic occurs

and ease of cleaning is important,” adds Goedecke. The application possibilities of impregnation agents produced with this silane-terminated binder range from parking garages, car repair shops, train stations and logistics centers, through showrooms, catering facilities, event and convention centers to museums and residential buildings. The treated floor is easy to maintain and keep clean. ■

VINNOL® PRODUCES BRILLIANT COLORS

Wide-format advertising banners and vehicle wraps are genuine eye-catchers. Their colored surfaces are created with professional inkjet printers that mostly employ solvent-borne digital printing inks. WACKER has developed the polymeric VINNOL® E 18/38 binder specifically for such inks.



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Everywhere we look in our cities, wide-format advertisements compete for our attention: giant banners hanging from building fronts, scaffolding and construction site hoardings push their way into our field of vision while standing signs entice us to enter hotels, museums and shops. Meanwhile, buses, trams and delivery trucks are adorned with visually impactful vehicle wraps – which cling like a second skin.

However different these advertisements may appear at first glance, they all have one thing in common: they are made of plastic films which are custom-printed and processed in relatively small numbers. These films mostly consist of plasticized PVC and are printed using wide-format inkjet printers. Advertising banners, standing signs and vehicle wraps are exposed to the elements and are also cleaned from time to time. Water-borne printing inks like those found in many domestic inkjet printers are generally not durable enough for this application. Nor do they adhere sufficiently to plasticized PVC. So instead, makers of advertising resort to either UV-curable or solvent-borne digital printing inks, whose binder systems provide not only the high quality print image, but also the necessary durability.

DEMAND FOR HIGH STANDARDS

The printing industry expects inkjet printing to deliver even better results in the future and that the inks will no longer be a noticeable odor nuisance. VINNOL® E 18/38 is a polymeric binder from WACKER that will help ink makers to meet these requirements.



“Use by Dates” are printed on the packaging of different consumer goods. Thanks to VINNOL® E 18/38, the printing ink adheres to a wide variety of substrates.

Samples have already been provided to all major customers. “The feedback is extremely encouraging. VINNOL® E 18/38 not only is a binder of the highest quality, but it also enables us to respond to customers’ needs and provide them with tailored technical service support,” says Feike van der Heide, who heads WACKER POLYMERS’ global Resins business. “Our goal is to continually develop new business fields and promote continued growth in existing markets through our innovative products.” One of the first customers to formulate its products with VINNOL® E 18/38 was Chinese ink maker Beijing KinColor Digital Technology. “We have noticed a vast improvement in

printing performance since then. One of the reasons for this is that the pigments are more evenly distributed in the printing ink thanks to the new VINNOL® E product,” explains Rong Jin, head of Beijing KinColor Digital Technology. This company has been using WACKER binders for many years because they offer a consistently high level of quality and performance. It collaborated with WACKER application technologists on the development of a suitable formulation for a printing ink containing VINNOL® E 18/38 that would be very well received on the market. “Thanks to WACKER, our new ink has strengthened our market position,” says Rong Jin.

“These requirements – low viscosity and no settling – pose a dilemma for ink makers.”

Dr. Ulrich Lauter, Head of the applications laboratory for VINNOL® resins, WACKER POLYMERS

Inkjet printing is a non-impact process. The ink is deposited as very fine droplets on the substrate, without the need for an image carrier or “printing plate” as it is called in the industry. Instead, the digital print data determine which areas receive the ink droplets and which do not. This eliminates the costs of producing a printing plate and reduces the turnaround times for the printing press, enabling smaller print-runs of very few or just one single article to be economically viable.

There are two types of inkjet printing - drop on demand (DOD) and continuous inkjet (CIJ). DOD is used for printing paper and films, even in large formats. CIJ, in contrast, is mainly used in printers that are integrated into industrial production lines because it is capable of printing on uneven surfaces. This affords a way of providing the produced articles with a serial number, a brand name, a QR code or a shelf-life date.

LONG-LASTING PRINT HEAD

“At the heart of the inkjet printer is the print head – it determines whether printing is a success or a failure. Keeping it working for as long

as possible is the topmost priority,” explains Dr. Ulrich Lauter, co-developer of the new polymeric binder VINNOL® E 18/38 and a technical service manager at WACKER. The print head, together with the printing ink, determines the quality of the print.

For the highest resolution, the print head must be designed in such a way that the smallest-possible ink droplets form and strike the printing surface. However, the smaller the droplets, the lower the viscosity of the ink has to be. The ink also determines the degree of color saturation. Particularly brilliant color prints are obtained with pigments that are

dispersed very finely and homogeneously in the liquid printing ink – the tiny pigment particles must not form large agglomerates and should remain in suspension for long periods of time.

“These requirements – low viscosity and no settling – pose a dilemma for ink makers,” says Dr. Lauter. “The thinner the fluid ink, the more readily the pigment particles will settle.” Settling not only impairs color brilliance, but also shortens the service life of the print head. If individual nozzles in the print head become clogged with pigment particles, the inkjet printer will stop working. A key

role regarding viscosity and dispersibility is played by the polymeric binder employed. “As inkjet printing technology advances, it is essential that the binders in particular be optimized,” stresses Dr. Lauter. The binder is the film-forming component of a printing ink – it envelops the pigment particles, binding them together and fixing them on the substrate.

WACKER has been offering binders under the brand name VINNOL® E for many years. These enable ink makers to keep settling to a minimum, explains the WACKER expert: “The binders are vinyl chloride–vinyl acetate copolymers, which we produce by



Inks based on the innovative VINNOL® binder can be used to print barcodes on various kinds of plastics.

VINNOL® – BINDERS FOR INDUSTRIAL APPLICATIONS

The surface coating resins that WACKER sells under the VINNOL® brand are polymers that can be used as coatings in many industrial applications, including industrial coatings and adhesives, paints and printing inks, and heat-sealable coatings used in food packaging. VINNOL® surface coating resins are vinyl-chloride-based copolymers and terpolymers. Each grade differs from the others in terms of its composition and degree of polymerization, resulting in differences in their physical and chemical properties. The line-up also includes grades containing carboxyl groups for strong adhesion to metal surfaces, and grades containing hydroxyl groups that can be used, for example, in coatings that cure via chemical reaction.

Overall, the VINNOL® range encompasses an diverse array of product grades, all of which can be used together in any combination and are compatible with many other common binders. For the production of VINNOL®, WACKER uses two different polymerization processes: suspension and emulsion. Grades intended for use in digital printing inks are predominately made by the emulsion process.

The low-viscosity VINNOL® E 18/38 binder can also be used to print high-resolution images on wide-format advertising banners.



An example of an application for CIJ inks based on VINNOL® E 18/38: cable encoding.



emulsion polymerization. These polymers are recognized for their ability to interact with the pigment surface, stabilizing the finely ground particles and keeping them in suspension.” That is why VINNOL® E represents a good compromise between the two conflicting goals of low viscosity and little or no settling.

SUITABILITY FOR MILD SOLVENTS

In the last few years, a further requirement has come to the fore: to reduce employees’ exposure to smelly solvent fumes, the printing sector is looking for inks that are formulated with the mildest-possible solvents. The fumes of mild or “eco” solvents are neither harmful to health nor noticeably malodorous. Examples are certain

glycol ethers and glycol esters. Such “eco-solvent printing inks” are intended for print shops or advertising agencies that use DOD printers. In the case of inks for CIJ printers, the odor is a minor problem as these printers are used exclusively in an industrial production environment where solvent vapors are extracted as necessary.

Mild solvents have their downsides too: a great many binders are not very soluble in them. In addition, inkjet inks formulated with mild solvents are less likely to adhere to plasticized PVC and other polymeric substrates, with the result that the print image is less resistant to abrasion. This is also true of the VINNOL® E grade, which has been available for use in digital printing inks for some considerable time. Dr. Lauter and his team therefore set out to fashion a new vinyl chloride-vinyl acetate copolymer from this product which would offer the best compromise between the somewhat contradictory requirements. Their efforts resulted in the new VINNOL® E 18/38.

This new grade not only improves solubility in mild solvents, but also yields a polymer solution that has particularly low viscosity. In addition, VINNOL® E 18/38 is resistant to water, alcohol and weakly basic cleaning agents.

VINNOL® E 18/38 is a binder which – as requested by the printing sector – supports further technological progress in solvent-borne inkjet printing. ■

INKJET PRINTING

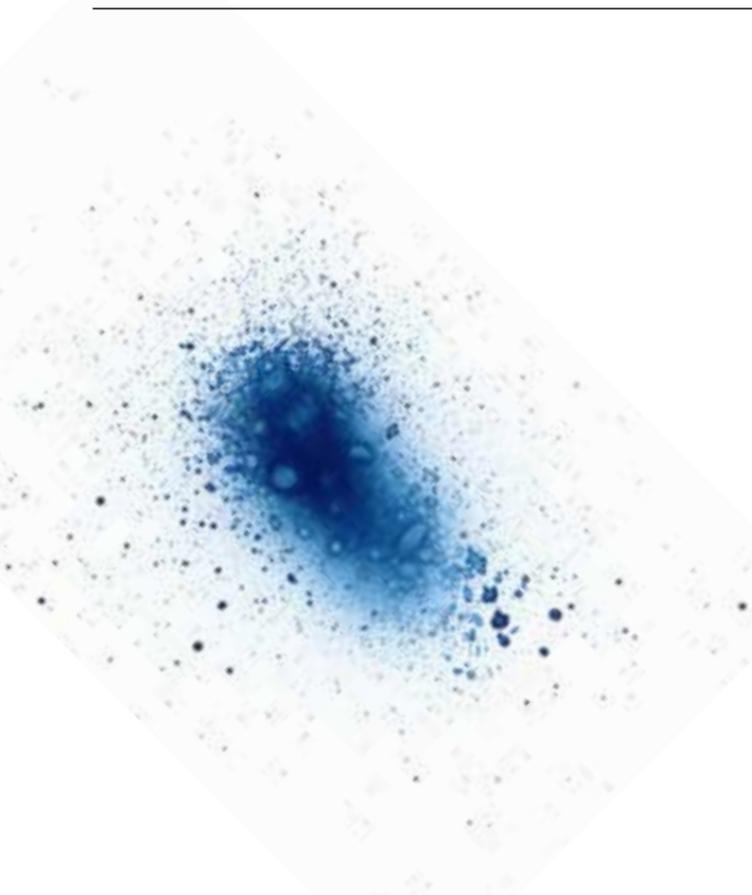
There are two types of inkjet printing process: discontinuous (drop on demand or DOD) and continuous inkjet (CIJ)

DoD – Drop-on-Demand: In this technology, the ink droplets are generated and then ejected from the print-head nozzles as required, i.e. only if they are needed to produce a dot. The print heads found in professional DOD printers typically have 256 nozzles of 20 to 50 micrometers in diameter per color. The droplet volume varies from 2 to 40 picoliters in accordance with the print-head technology. The pigment particles of the ink must not be larger than 5 to 8 micrometers. A filter is installed in front of each nozzle, blocking the passage of large particles. 2-Butoxyethyl acetate is currently the principal solvent used for DOD printers.

CIJ – Continuous Inkjet: This process ejects a continuous jet of electrically conducting ink from a nozzle located in the print head. The flow of inkjet disintegrates into individual microscopic droplets with a volume of between 10 picoliters and 1 nanoliter. From 60,000 to 100,000 such droplets are formed every second. The droplets move through two electric fields. The first provides them with an electrostatic charge. The second determines the trajectory of the droplets and is itself controlled by the digital print data: depending on whether the field is switched on or off, the droplets are either deflected toward the substrate with varying degrees of force to produce a colored dot or they are allowed to pass by the substrate without deflection. The non-deflected droplets are collected and returned to the printer’s ink reservoir. Methyl ethyl ketone is a common solvent for CIJ printer inks.

GRAFFITI DEFENSE

Graffiti and wild posting can make property look dilapidated and cause a great deal of economic damage. A specially developed silicone coating from WACKER can help keep cleaning costs low.



Graffiti artists usually work at night, spraying their often enormous creations – which they refer to as pieces – and their signature emblems – known as tags – on walls, fences and rail cars. They almost always do this without the consent of the property owner, whose only recourse is buffing – the term used within the graffiti scene for removing illegal pieces.

Egg-shell stickers are especially difficult to remove. They are the stickers and posters that often advertise events, and are usually found on relatively small objects like utility boxes and traffic signs.

The Association of German Cities estimates that the damage caused by illegal graffiti and wild posters costs the Federal Republic at least €200 million annually. In the United States, data provided by the Department of Justice indicate the cost of graffiti removal to be some



1



2

SILRES® BS 710 IN TESTS ON A VARIETY OF SUBSTRATES

1. SILRES® BS 710 is applied to test pieces made of various materials – including concrete and brick, both with and without plaster – at the Applications Technology laboratory in Burghausen.

2. Once the piece has dried, a laboratory assistant tests the coating by applying various sample paints.

3. She then tries to remove the test swatches using a pressure washer.



3

GRAFFITI PREVENTION: TEMPORARY, PERMANENT OR SEMI-PERMANENT

The protective film produced by temporary systems consists of waxes, biopolymers or acrylates. These materials do not prevent water vapor from migrating out of the substrate and into the ambient air and they are invisible, which is why they can be used on registered historic landmarks. The disadvantage of these systems is that the protective film has to be completely reapplied after cleaning off the graffiti; even without graffiti attacks, these coatings only last a few years.

The major advantage of permanent anti-graffiti systems is that they remain intact when the graffiti is cleaned off and can last many years without losing their ability to protect the surface. The downside, however, is that they usually affect the appearance of the substrate. In addition, the coatings of many traditional permanent systems are so dense that water vapor cannot penetrate them. If a coating that inhibits diffusion in this way is applied on a damp substrate, the moisture inside will not be able to escape. The protective film then comes off in some places as a result, potentially causing blisters to form or the paint to flake off; moisture damage to the building fabric is a possibility as well – a problem that does not arise with SILRES® BS 710. Traditional permanent coatings are based on substances such as polyurethanes, epoxy resins and fluoropolymers.

In semi-permanent coatings, only one component of the film is lost during cleaning rather than the entire film itself. The substrate has to be treated again every time graffiti is removed and at intervals of three to five years. The advantage of semi-permanent coatings is that they are virtually undetectable to the eye and are permeable to water vapor. These products often consist of blends of organic waxes, silanes and siloxanes.



4

4. The result is impressive: graffiti can be washed off with water using a commercially available pressure washer.



A technician sprays an unplastered test wall at the WACKER site in Burghausen using commercially available paint like those used by graffiti artists.

twelve billion dollars per year. One of the most costly practices is known as bombing – when the perpetrator tries to spray as many simple characters as possible in a short period of time, emphasizing quantity over quality.

It follows that public and private property owners are looking for ways of keeping removal costs low. One option for them is a preventive treatment with a protective anti-graffiti system. Developed by Wacker Chemie AG, SILRES® BS 710 is a concentrated active agent for long-term graffiti prevention. At the 2017 European Coatings Show, the Group will be unveiling the product to a wide audience of professionals.

Most anti-graffiti systems form an unbroken film over the substrate to be protected. This film seals all of the surface pores and acts as a barrier between the substrate and the paint sprayed onto it.

This barrier layer keeps the spray paint from entering the pores of the substrate, thus preventing the graffiti from adhering well to the surface and making it easier to remove – the graffiti can then be washed off using a suitable cleaning agent, though both the cleaning

method and the cleanser need to be appropriate to the coating in question.

Anti-graffiti treatments can be broken down into three categories in terms of their durability: temporary, semi-permanent and permanent systems, which differ according to the behavior of the barrier layer when the graffiti is washed off. If the barrier remains fully intact and withstands at least 20 graffiti attacks, including the subsequent cleaning processes, the system is considered to be permanent. If, on the other hand, it washes off along with the graffiti, we speak of a temporary system or sacrificial coating. The longevity of semi-permanent systems lies between the two extremes.

The three classes of product each have their advantages and disadvantages (see Graffiti Prevention section on page 79). “Temporary systems work to your advantage in cases where the building exterior needs to remain unchanged or if you don’t want to impede the exchange of moisture or permeability,” says Marianne Kreuzpointner, who is responsible for marketing the anti-graffiti coating at WACKER. “Both of those properties play an important role in preserving historic monuments.” The advantage of permanent systems, by contrast, is that they do not need to be reapplied for long periods of time, while still providing full protection against graffiti. “That’s a powerful financial argument,” Kreuzpointner underscores, “espe-

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Attempting to clean the wall with a household sponge.

Brick walls treated with SILRES® BS 710 can be readily cleaned after a graffiti attack.



cially in areas where graffiti attacks are likely to occur over and over again.”

The new concentrated anti-graffiti agent from WACKER produces a permanent silicone coating. SILRES® BS 710 is a condensation-curing, RTV 1 silicone rubber compound – a one-component silicone rubber grade that undergoes a chemical condensation reaction at room temperature and upon exposure to atmospheric humidity to form a silicone elastomer. With a Shore A hardness of 37, SILRES® BS 710 is soft when cured, achieving an elastic elongation value of 130 percent.

RTV-1 coating materials typically contain an oxime curing agent and a tin catalyst. During the development of SILRES® BS 710, however, WACKER chemists led by Dr. Hartmut Ackermann worked out a new formulation concept: “We reverted to a silane crosslinker and a silane adhesion promoter that simultaneously functions as a catalyst for the crosslinking reaction,” Ackermann explains. “That meant we could dispense with the use of traditional components, which are harmful to human health. That’s a benefit to anyone who formulates the concentrate or applies a liquid coating material made from the concentrate.”

With a viscosity of 5,000 mPa s, the concentrate is viscous, although it does thin when subjected to shear forces. The viscosity can also be reduced through the addition of an ali-

“Thanks to SILRES® BS 710, the building protection industry now has a highly effective concentrate at its disposal for use in permanent anti-graffiti coating agents.”

Dr. Rudolf Hager, head of the Construction Silicones business team

phatic solvent. Customers also have the option of adding pigments in order to color the compound. Manufacturers of building protection agents can easily incorporate SILRES® BS 710 into ready-to-use products and have the freedom to adjust the active content, the viscosity and, if necessary, the hue to meet the needs of the application at hand. An important point to keep in mind when using SILRES® BS 710 as a transparent coating is that the product intensifies the color of the substrate and produces glossy surfaces.

This value is below the s_d value of traditional polyurethane or coatings of equal thickness. Formulations based on SILRES® BS 710 are open to diffusion and do not block the exchange of moisture along building exteriors.

GOOD ADHESION ON CONCRETE AND BRICK

Not only is the concentrate easy to process – it is also quite simple to apply coating compounds made from SILRES® BS 710 as well: they can either be sprayed onto the substrate or spread on with a roller or brush.

The coating starts out as a liquid, but when exposed to atmospheric humidity, it cures from the outside in. The surface is no longer sticky after about four hours. A curing time of a day or more produces a strong silicone film that permanently bonds not only to many porous mineral substrates, but also to wood

and epoxy resins – no need to treat the substrate with a primer ahead of time.

Adhesion tests have shown that the most suitable of these substrates are concrete, brick, plaster, sandstone, sand-lime brick and natural stone. The tensile adhesive strength of unprimed sand-lime brick, for instance, has been measured as 1.30 N/mm² – a value frequently encountered in the construction materials industry for floor coatings on mineral-based substrates. Tests also showed that glass or painted metals need to be treated with a suitable primer in order to achieve the adhesion necessary.

VAPOR PERMEABLE WITH AN ABHESIVE SURFACE

A key property of silicone films made from SILRES® BS 710 is their exceptionally adhesive surface – a surface, in other words, to which other substances do not adhere well at all. As a result, graffiti can be washed off with cold water using a sponge or commercially available pressure washer – no special cleanser required – while posters and signs either fall off under their own weight or can be peeled off effortlessly.

Its adhesive properties are the result of the extraordinarily low surface energy of the silicone film. There are very few substances with lower surface tension, and, generally speaking, liquids are only able to wet and develop a strong bond to surfaces if the surface tension



WACKER anti-graffiti protection is particularly suitable for infrastructure such as bridges, underpasses and subway stations.

20

cleaning cycles can be withstood by this anti-graffiti agent.

of the liquid is lower than that of the surface. This same principle applies to spray paints and to the adhesives used on stickers – the surface tension in each of these cases, however, is significantly higher than that of silicone and, as a consequence, they do not adhere well to the silicone surface.

The application technology specialists at WACKER found that application of 200 to 250 grams of SILRES® BS 710 per square meter is enough to provide reliable protection against graffiti. If the material is prepared correctly, the surface only needs to be treated once – the cured silicone film will then completely cover the pores in the substrate. The coating nevertheless remains permeable to water vapor. This has been confirmed by the

s_d value determined for layers of the cured material (see s_d section on page 85).

The s_d value for samples roughly 200 micrometers thick – which corresponds to the recommended coating weight of 250 grams of SILRES® BS 710 per square meter – was measured as 0.3 meters (class II, mid-range), which is below the s_d value of traditional polyurethane or coatings of equal thickness.

LASTING PROTECTION

Coatings made from SILRES® BS 710 exhibit the typical durability of silicones: they are resistant to heat stress, remain flexible even in exceptionally cold conditions, and can withstand freeze-thaw cycles and rain simulations. Not even constant exposure to light and

UV radiation can damage the silicone film, which remains elastic, does not yellow – even under prolonged UV radiation – and retains its adhesive properties.

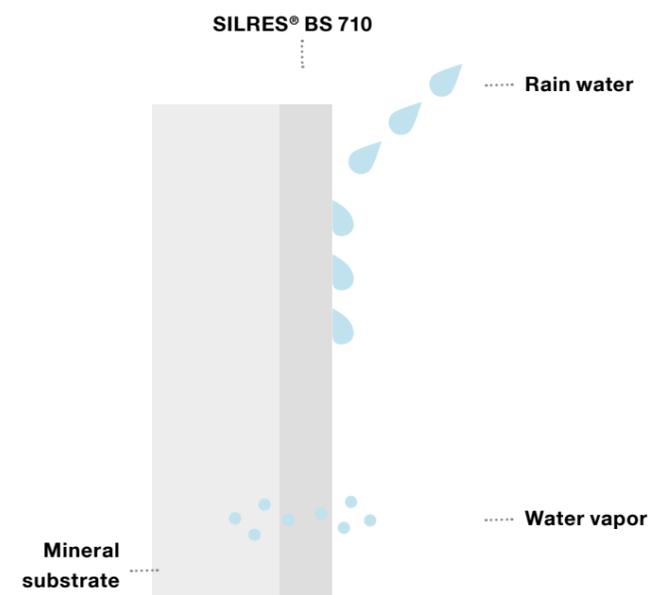
All of this has been tested and confirmed under outdoor weathering conditions, in graffiti removal studies and in accelerated aging experiments conducted in the laboratory. Coatings continued to provide full protection against graffiti, even after 20 cleaning cycles, demonstrating that SILRES® BS 710 offers permanent protec-

tion. Cleaning studies showed that if a pressure washer is used, the pump pressure should not exceed 100 bar.

“Thanks to SILRES® BS 710, the building protection industry now has a highly effective concentrate at its disposal for use in permanent anti-graffiti coating agents that can be customized for a variety of application processes,” notes Dr. Rudi Hager, who heads up the Construction Silicones business team at WACKER. “Also, coating agents made of SILRES® BS 710

only contain a single component, which eliminates the risk of blending errors during the application process.”

SILRES® BS 710 treatment makes tags, pieces, throw-ups, one-liners and rooftops easy to remove; even stickers can be effortlessly peeled off of treated surfaces. This WACKER active, in other words, is doing its part to limit the financial and social consequences of graffiti and to stem the flood of unwanted stickers. ■



Source: Wacker Chemie AG

s_d VALUE

The s_d value – the diffusion-equivalent air layer thickness – describes the resistance of a material sample to the diffusion of water vapor. This value indicates how thick a resting layer of air must be to produce the same level of resistance to water-vapor diffusion as the material sample, given the temperature is the same. The s_d value is given in meters.

A low s_d value indicates a high level of permeability to water vapor. According to DIN 7783, a layer of SILRES® BS 710 that is 200 micrometers thick exhibits class II permeability characteristics (average: ≥ 0.14 to < 1.4 m). An s_d value of < 0.14 m describes a high degree of permeability to water vapor. If the s_d value is ≥ 1.4 m, the material is categorized as being extremely impermeable to water vapor.



FLEXIBLE WATER BARRIER

In wet or damp interiors, cementitious waterproofing membranes protect building fabric against water that can seep in through tiny cracks in floor or wall coverings. WACKER is now launching a new hydrophobic binder onto the market, which makes under-tile waterproofing even more elastic and thus more durable.



Waterproofing membranes are applied directly to the plaster or screed. The coating protects the building fabric against penetrating water.

Children splashing around in the bath tub or water splashes from the shower landing on a tiled floor shouldn't really be a problem. After all, the tiles themselves and the tile grouts are water-repellent. However, fine cracks in the tiles or grouts have a capillary effect and actually draw in the shower water that would normally just run over the surface. The water spreads out in the masonry or under the shower or bath tub, initially unno-

ticed. There, it can cause great damage to the building fabric if it is not stopped by a waterproofing system, such as a membrane.

DIRECTLY UNDER THE TILE

The German Construction Industry Association (ZDB) information sheet on under-tile waterproofing has become the standard guideline for building waterproofing. The information sheet specifies that the surfaces

underneath and behind a shower or bath tub should generally be waterproofed. Under-tile waterproofing is applied between the mineral substrate and the ceramic covering – in the case of wall surfaces, the waterproofing system is applied to the finished plaster, while for floor surfaces, it is applied to the screed. The tile adhesive or shower base is placed directly onto the waterproofing. This design prevents the substrates from becoming saturated with water. Several different under-tile waterproofing systems have become established in the market – ones that can be brushed on or applied by trowel, as well as impermeable sheets or panels.

“Over recent years, polymer-modified mineral waterproofing membranes have proven their effectiveness in keeping floor and wall surfaces that are exposed to water permanently leak-proof,” says Dr. Tobias Halbach, who manages WACKER's marketing for polymer-based construction applications. Compared to impermeable sheets or panels, cementitious waterproofing membranes have the great advantage

“Watertightness is naturally the most important property of a waterproofing membrane. That's why we focused on the hydrophobic effect of the dispersion.”

Dr. Harald Zeh, Technical Manager at WACKER

ONE- AND TWO-COMPONENT SYSTEMS

Waterproofing membranes can be subdivided into one- and two-component systems. One-component systems are drymix mortars that are enhanced with dispersible polymer powders and only need to be mixed with the necessary amount of water directly at the building site. This reduces the risk of user errors.

Two-component systems, on the other hand, consist of a dry component – often cement and fillers – and a liquid component, for example a polymer dispersion. The two components are mixed at the construction site in accordance with manufacturer specifications.



PODCAST

Find out more about waterproofing membranes in our podcast on this topic:

www.wacker.com/podcast



The polymer-modified waterproofing systems can withstand water even under high pressure and permanent exposure.



Waterproofing membranes with VINNAPAS® 760 ED comply with the top crack-bridging class on the market. For this, they must be able to stretch by up to 0.75 cm – at temperatures between -20 and +23 °C

that they are easy to apply around fitting connections and to drains and awkward corners. Moreover, unlike conventional systems, polymer-modified mineral waterproofing membranes do not seal the walls, but allow water vapor to diffuse.

RESILIENT WATERPROOFING

WACKER has now developed an even more elastic polymer binder for mineral waterproofing membranes. VINNAPAS® 760 ED is ideal for formulating resilient two-component water-

proofing membranes. The dispersion is based on vinyl acetate, ethylene and vinyl ester and serves as a hydrophobic binder. "Watertightness is naturally the most important property of a waterproofing membrane. That's why we primarily focused our development on the hydrophobic effect of the dispersion," explains Dr. Harald Zeh, who is in charge of the technical management of liquid binders for hydrophobic construction applications at WACKER.

In Germany, the waterproofing of bathroom floors is regulated by standards. The con-

struction regulations of the federal states, for example, specify that buildings must be planned so that no damage or unacceptable disruption arises from water or moisture. Cementitious waterproofing membranes require the addition of polymers to achieve adequate water repellency. The vinyl ester contained in VINNAPAS® 760 ED is a particularly water-repellent monomer that copolymerizes readily with vinyl acetate. Laboratory tests show that, in water-

proofing membranes, the binder can withstand hydrostatic pressure of up to 1.5 bar for more than seven days. This means that the membrane does not allow a single drop of water to penetrate, even in a pool that is 15 meters deep.

ELASTIC PROTECTIVE LAYER

The vinyl ester in VINNAPAS® 760 ED has another advantage: in combination with ethylene, it provides the waterproofing

membrane with a high degree of elasticity. This allows the membrane to accommodate stresses that the building fabric is exposed to, for example due to temperature fluctuations. "If cracks develop in masonry due to shrinkage or settling, the waterproofing membrane must not lose its protective function. That's when the quality of the binder truly comes to the fore," says Dr. Zeh. This is also tested in the applications laboratory in Burghausen.

Laboratory assistant Peter Asbeck uses pressure and tensile tests to determine whether waterproofing membranes would tear under realistic loads. To do this, he applies a cementitious waterproofing membrane that has been enhanced with VINNAPAS® 760 ED to various substrates and then generates a controlled crack in the substrate. He then observes whether the membrane is able to permanently bridge the crack. In order to comply with the top crack-bridging class as per European Standard 14891 CM O2, waterproofing membranes must be able to stretch by at least 0.75 millimeters – at temperatures between -20 and +23 °C. "Our tests have shown that VINNAPAS® 760 ED has excellent crack-bridging characteristics. It's the dispersion that makes the coating really flexible," explains Asbeck.

Alongside watertightness and good crack-bridging properties, tensile adhesion strength also plays a big role in waterproofing



Crack-bridging tests at the WACKER lab in Burghausen show whether waterproofing membranes are flexible enough to accommodate stresses in the masonry.

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“Our tests have shown that VINNAPAS® 760 ED has excellent crack-bridging characteristics. It’s the dispersion that makes the coating really flexible.”

Peter Asbeck, laboratory assistant at WACKER POLYMERS

membranes. If there is no stable bond between the tile, waterproofing and substrate, water can find its way to the building fabric, despite the protective coating. That’s why waterproofing membranes consist predominantly of cement, water-resistant fillers such as sand, and up to 40 percent of polymer binders such as VINNAPAS®

760 ED. In this mix, the dispersion’s job includes ensuring strong and flexible adhesion between different substrates, as well as strong and elastic cohesion. “Our new dispersion forms strong polymer bridges that adhere reliably and permanently, even to difficult substrates,” says Dr. Zeh, explaining the mode of action.

In bathrooms, these cementitious waterproofing membranes are applied as a millimeter-thin layer to the walls and the screed. A coating of two to three millimeters is enough to effectively protect floors and walls against moisture. The dispersion can be blended in accordance with individual needs, because its high solids content of almost 60 percent allows users to tailor the polymer/cement ratio to the respective requirements, without increasing the viscosity. “Depending on the region and processor preferences, flexible waterproofing membranes are evenly applied in a thin layer by trowel or roller. The users naturally have different expectations of the waterproofing compound’s consistency – from thin for painting to thixotropic for trow-



Liquid waterproofing systems are becoming increasingly important, because they can optimally adapt to the surface structure.

WACKER SOLUTIONS FOR WATERTIGHT COATINGS

WACKER produces a range of solutions for watertight construction coatings. Alongside the VINNAPAS® 760 ED polymer dispersion for two-component cementitious waterproofing membranes, various VINNAPAS® dispersible polymer powders lend themselves to the formulation of one-component cementitious systems. GENIOSIL® WP, on the other hand, is ideal for particularly durable, UV- and chemical-resistant waterproofing systems that require high mechanical strength. The binder is based on special α -silane-terminated hybrid polymers. The silane-crosslinking product forms a firm, tack-free waterproofing membrane on the surface, which is watertight yet vapor-permeable. Hence, moisture can still escape from the substrate after waterproofing. GENIOSIL® WP is especially suitable for permanently waterproofing large surfaces such as flat roofs, balconies, patios and basement walls. The product has no labeling requirements under German hazardous substances legislation and allows the formulation of one-component, solvent- and plasticizer-free membranes.

Cementitious waterproofing membranes that contain VINNAPAS® 760 ED are used in many areas, including canals and sewers.

eling,” explains Dr. Zeh. For fast-setting systems, the next layer can be applied after only a few hours. Once the waterproofing membrane has set fully, tiles can be installed on the watertight protective layer.

Binders in waterproofing membranes must be easy to process with commercially available cement grades. WACKER’s new dispersion outperforms competitor products in this regard as well. The auxiliaries used in VINNAPAS® 760 ED have a positive effect on the processing properties. “This allows the cement to hydrate without restriction and

contribute to adhesion and cohesion,” says Asbeck. Furthermore, the dispersion does not require any additional solvents, plasticizers or film-forming aids, and is manufactured without the use of alkylphenol ethoxylates (APEOs).

GROWING DEMAND

VINNAPAS® 760 ED has good market prospects. WACKER anticipates that the demand for functional additives for water-repellent building materials and impregnations will rise worldwide over the coming years. According

to MarketsandMarkets estimates, the global market for waterproofing systems in the construction sector will grow by an average 9 percent to around \$36 billion by 2021. Waterproofing membranes provide an opportunity to protect buildings long term. According to MarketsandMarkets, property developers in the Asia-Pacific region, in particular, are increasingly deciding to use under-tile waterproofing. Across the globe, people don’t want to take the risk of children splashing around in bath tubs or shower water splashes and causing irreparable damage to building fabric. ■

VIBRATION DAMPERS TAKE OFF

French company SMAC develops vibration dampers for use in extreme conditions, such as those found in racing cars, aircraft and spacecraft. The developers need a silicone rubber which retains its properties over a very wide temperature range.

“For space exploration, you need a material that can be used over a wide temperature range.”

Dr. Franck Sosson, project engineer, SMAC

A hush of concentration prevails in the control room of the European Space Center in French Guiana. The only voice echoing through the room is that of Raymond Boyce as he does the countdown in French: “dix, neuf, huit...” It is December 21, 2016, and the launch team is working feverishly on the last launch of the year: “...sept, six.” The rocket, an Ariane V, is motionless, but not for much longer. Another five seconds to go: “cinq.” The cryo arms, which pump liquid oxygen and hydrogen into the huge tanks, pull away from the rocket. Then the powerful engine of the Ariane V ignites, burning up to five metric tons of fuel a second.

To this day, launching a rocket into space is still a technological marvel. The slightest of error or irregularity can cause the mission to fail. The stakes are high and mistakes could prove expensive: it costs between 150 and 200 million euros to launch an Ariane V. Not to mention the cost of the satellites that they transport into space. On this particular day, December 21, the payload consists of two telecommunications satellites: Star One D1 and JCSAT-15.

In order to reliably launch the rocket and its payload into space, the engineers scrutinize

every last detail. Such as how to damp troublesome vibrations in the design, for example. This is where French company SMAC comes in. For 70 years in the coastal resort of Toulon in the south of France, it has been developing vibration dampers for a wide range of applications. SMAC’s engineers have earned an outstanding reputation, and supply their products to racing-car and aerospace manufacturers. These vehicles are exposed to extreme conditions and special designs are called for. The French team uses silicone rubber from WACKER for some of these applications.

A HARDLY EXPLORED PHENOMENON

SMAC’s general manager is Philippe Robert. He explains why designers are so concerned about vibrations: “The damping of vibrations is a phenomenon that has been hardly explored at all up to now.” The vibration power, which is perceived as sound or vibration, can be low, in the order of milliwatts, up to very high, in the order of kilowatts. “This makes it hard to pinpoint the vibration with any accuracy and to study what causes it and how it is transmitted,” says Robert.

In the control room of the European Spaceport, every tiny detail is assiduously recorded. Enthralled, the engineers and com-

REBOUND RESILIENCE

Rebound resilience (or elastic recovery) is measured to determine the elasticity of elastomers during shock loading. At WACKER, this value is measured according to the international standard ISO 4662.

It indicates the percentage of kinetic energy returned by an elastomer after an impact test. This percentage helps applications engineers, because a high percentage is desirable for elastic applications, whereas a low percentage indicates suitability for use in areas that involve a considerable degree of vibration absorption.

WACKER uses the ISO 4662 measurement as follows:

a defined swing hammer, known as a peen, hits a twelve-millimeter-thick silicone rubber test piece.

The rebound resilience corresponds to the ratio of the original height of the pendulum and the maximum height reached by the pendulum after it has hit the elastomer.

The value usually lies between 30 and 70 percent. Low deformation of the test piece also indicates a high rebound resilience.

puter scientists stare fixedly at their screens: “deux, un...” And finally the moment they have all been waiting for comes: “zéro.” The rocket engine ignites. The mixture of oxygen and hydrogen burns with a bright flame. After seven seconds, the Ariane V develops enough thrust to lift off the ground with a force of 13,000 kilonewtons.

Everything has gone smoothly and the faces in the control room relax. The 780-ton vehicle is on its way to the stars. On board are parts from Toulon: the damping members in the rocket engine and around the instruments were supplied by SMAC. Robert talks about the challenges which space travel poses for the

engineers. “Deployment in a vacuum makes additional demands on elastomeric materials. These include outgassing, cleaning, resistance to gamma-radiation and heat/cold,” he says, listing them. His company pioneered developments in this field, he proudly adds. “There was very little history of using silicone materials in space travel before then.”

CONTROLLED DISINTEGRATION

2:22 minutes have elapsed since the launch of the Ariane V. By now, it has reached an altitude of 70 kilometers and is barely visible to the naked eye. Suddenly, the rocket comes apart. Deliberately, of course, as the EAP boosters, the

two engines on the sides, are jettisoned from the main stage. They, too, look like rockets, are 31 meters long and three meters in diameter. At the launch, they each weighed 277 tons, the bulk of which – 240 tons – was solid fuel. Since this is now exhausted, the empty boosters would only act as ballast. Which is why, high above the Atlantic Ocean, they are now plunging back down into the atmosphere.

The rest of the Ariane V continues to shoot its way into the heavens. Soon it is crossing the mesopause, the boundary layer between the mesosphere and the atmosphere. The temperature there is about minus 90 degrees Celsius, but varies according to the season. Higher up, it actually rises again, but this is barely perceptible because in space the particle density is low. This puts tough demands on materials.

“Space travel requires materials that can be used over a wide temperature range without loss of mechanical and damping properties,” says Dr. Franck Sosson. He is a project engineer at SMAC, responsible for formulating the silicones. For each application, he has to adopt a different approach. One of the SMACSIL® ranges for example, is based on WACKER’s ELASTOSIL® R 101 and R 752 silicone rubbers.

These series mark the two extremes of WACKER’s product range for damping applications. ELASTOSIL® R 101 has a high rebound resilience and is perfect for damping vibrations that occur over a narrow frequency



Photo: SMAC

Production of silicone rubber vibration dampers at SMAC, a French processor based in Toulouse.

“By making proper use of silicone rubber, we can target vibrations and minimize noise.”

Dr. Christof Wörner, Head of Application Technology for Rubber Solutions



WACKER’s applications lab uses this equipment to test the ability of a silicone test piece (red) to absorb vibrations: the lower plunger vibrates and the extent to which the test piece transfers the vibrations to the upper plunger is then measured.

“A vibration damper should work just as well at minus 30 degrees in Siberia as in the searing heat of the desert.”

Dr. Christof Wörner, Head of Technical Marketing, Rubber Solutions

band. These types of vibration occur, for example, inside vehicles.

“All parts, such as the dashboard and the steering wheel, have a natural frequency,” explains Dr. Christof Wörner, head of an application laboratory for silicone rubber at WACKER in Burghausen. “When this frequency is reached inside the vehicle, vibrations and rattling start to occur. By making proper use of silicone rubber, we can target these vibrations and minimize the noise.”

ELASTOSIL® R 752, by contrast, swallows up a much wider range of vibrations. In vehicles, it is deployed, among other things, in internal tube vibration dampers and tuned mass dampers for car transmissions. “Up to now, designers often specified other rubbers, such as acrylate elastomers,” says WACKER’s Wörner, who trained as a chemist. However, these fail at elevated temperatures. Because modern engines are hotter than their predecessors – the trend is leaning in favor of greater power with less displacement – the materials employed have to be more heat-resistant. “A vibration damper should work just as well at minus 30 degrees in Siberia as in the searing heat of the desert,” says Wörner, before citing a further advantage of the two product series: “During development, we have managed to keep the damping properties constant across a wide range of Shore hardness values.”



Silicone rubber grades can be used over a very wide temperature range, from -50 °C to +250 °C, and, in the case of specialty grades, even from -110 °C to +300 °C.



Motor racing is another sport that expects the materials it uses to meet high loads. SMAC vibration dampers minimize vibrations in racing cars as well.

Vibration dampers used in passenger planes enhance in-flight experience by minimizing annoying noises.

MINUS 90 DEGREES IN SPACE

Ordinary temperatures on Earth are not detrimental to silicone rubbers. In space, though, far more extreme conditions prevail: minus 90 degrees Celsius. To ensure that the materials will not fail, Dr. Sosson and his SMAC colleagues need to identify the right composition of silicone rubber and formulate it with specific additives. Even if the parts are not used on the outsides of the vehicles and are not exposed to the lowest temperatures, their properties must nonetheless remain unchanged down to minus 50 degrees.

The same applies to aviation. SMAC also provides aircraft makers with parts for damping applications. These, too, contain ELASTOSIL®-based SMACSIL®. Larger aircraft, especially, such as the Airbus 380 and the Boeing 787, experience in-flight vibrations which are perceived as noise inside the cabin. “We can specifically damp the troublesome frequencies to make the flight much more pleasant for passengers and crew,” says Dr. Sosson.

His company’s vibration dampers are also used to minimize vibrations in motor racing. For each application, SMAC develops new products, blends the base material with additives and tailors them perfectly to the custom-



“The materials used in a satellite worth millions of euros have to be of the highest quality and be absolutely reliable.”

Philippe Robert, General Manager, SMAC

er’s requirements. As these are usually small runs or even one-time products, the French company only needs small amounts of silicone rubber. WACKER France has therefore commissioned SILCOMP, a compounder, to handle distribution.

HIGH-PERFORMANCE MATERIALS

Nevertheless, SMAC general manager Philippe Robert appreciates having direct contact with WACKER. The German chemicals Group, which has been supplying the base material for several SMAC products for more than a year delivers “not only interesting high-performance

materials, but also very good service. We are very satisfied and would like to take the collaboration between us to the next level.”

The Ariane V has been traveling now for almost three-quarters of an hour and has shrunk to just a few meters in length, having jettisoned its fuel tanks and most of its rocket engines. The engineers at the European Spaceport are still keenly monitoring the stream of data sent back to Earth by the rest of the Ariane V. After 43:10 minutes, the last vestiges of tension finally evaporate in mission control. The second satellite, JCSAT-15, has reached its target altitude of 4,600 kilometers and decouples successfully from the carrier rocket. “Once the objects are in space, they are hard to repair,” says Robert. “And as one satellite costs tens of millions of euros, we need to use the highest-quality and most reliable materials.”

On their first orbit around the Earth, telecommunications satellites take up a position at a distance of 35,905 kilometers. In this geostationary orbit, they follow the direction of the Earth’s rotation. They appear so immeasurably far away in space. And floating up there with them are a few grams of silicone rubber from WACKER. ■

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ELASTIC COMPOUND, STRONG ADHESION

To provide joints with elastic seals or give building components flexible bonds, skilled manual workers need particularly elastic sealing compounds. WACKER's new GENIOSIL® XM line is the first to offer silane-terminated polymers that can yield such sealants and adhesives in top quality – even without solvents or plasticizers.



“The two grades open up applications in the adhesives and sealants sector that had previously been inaccessible to silane-crosslinking polymers.”

Lidia Miszke, marketing manager, Construction Sealants & Adhesives, WACKER SILICONES

When building components meet, they inevitably form a joint. The spaces are generally sealed to keep water, air, dust or other media out. Here, the difficulty lies in the detail. When components are exposed to heat or cold, they expand or contract, and the gap between them can increase or decrease. So, for the joint to remain permanently sealed, the sealant must be able to accommodate the changes in joint dimensions again and again without tearing or detaching from the surface.

REDUCING STRAIN ON JOINT EDGES

In construction engineering, in particular, joints are often located between components with sensitive substrates that are prone to crumbling. Typical examples include plasters, aerated concrete and external thermal insulation

composite systems. A sealant with high tear strength that lacks elasticity poses a problem for sensitive substrates – if the joint expands, this kind of sealant cannot accommodate the movement adequately. In the worst-case scenario, the joint edges are damaged by the excessive force exerted during adhesion.

That’s why such cases call for low-modulus, elastic sealants that require only a little force to stretch or compress. When the strain is removed, they largely return to their original form. These kinds of sealants absorb the components’ movements and lessen the strain on the joint edges.

In practice, a sealant may also be required to bond the two substrates together. Experts refer to this as an adhesive sealant or elastic adhesive. While such an all-rounder should be capable of transferring forces, it should also be elastic,

so that it can accommodate the component’s movement. This applies to assembly adhesives, for example, which should be strong yet elastic.

At this year’s European Coatings Show, WACKER is showcasing GENIOSIL® XM 20 and GENIOSIL® XM 25, the first two silane-terminated polymers of the new GENIOSIL® XM range. Both grades can be processed into sealants and adhesives. GENIOSIL® XM 25 is ideal for formulating sealants, while GENIOSIL® XM 20 is ideal for adhesives. “The two grades open up applications in the adhesives and sealants sector that had previously been inaccessible to silane-crosslinking polymers,” says Lidia Miszke, responsible at WACKER SILICONES for marketing the GENIOSIL® XM line.

In construction engineering, skilled manual workers so far usually resort to polyurethane or silicone products when they need

GENIOSIL® XM 25

GENIOSIL® XM 25, a gamma-silane-terminated polyether, is the binder component of choice for formulating low-modulus sealants with exceptionally high elastic recovery. If GENIOSIL® XM 25 is used as a co-binder, the sealants can exceed ISO 11600 specifications for low-modulus sealants. In the laboratory, test formulations achieved a modulus of less than 0.3 newton per square millimeter and a recovery of 80 to 90 percent, determined as per ISO 7389 (method B).

Possible applications for GENIOSIL® XM 25 include sealants for thermally stressed expansion and connection joints, especially where vulnerable joint edges need to be protected. A typical application is expansion joints in buildings made of industrially prefabricated concrete parts, which are built in large numbers all over the world. Low-modulus sealants are also needed for connection joints – the joints between window frames and walls. The required sealants can be tailor-made with GENIOSIL® XM 25.

GENIOSIL® XM 20

GENIOSIL® XM 20 is an alpha-silane-terminated polyether. This grade opens the door to plasticizer-free adhesives with extremely high elasticity. In the laboratory, elongation at break values of over 700 percent were measured, the actual value being determined by the specific formulation. The tested adhesive formulations achieved tensile strengths of up to 4 newtons per square millimeter. Furthermore, GENIOSIL® XM 20 can extend skin-over time, which is particularly beneficial for large-scale applications. This provides the user with sufficient tooling time.

GENIOSIL® XM 20 is thus ideal as a binder component in wood-flooring and assembly adhesives. This grade makes solvent- and plasticizer-free wood-flooring adhesives possible that do not require classification as a hazardous substance. What is more, GENIOSIL® XM 20 allows the formulation of adhesives that feature a virtually universal bonding profile. With this kind of universal solution, construction workers are well-prepared for any adhesive sealant tasks that may arise on the building site.



Low-modulus sealants such as GENIOSIL® XM 25 can produce a good seal for thermally stressed expansion and connection joints, for example in buildings made of industrially prefabricated concrete parts.

MODULUS

The modulus provides information on the stress-strain behavior of a material. To say that a material has a high modulus, basically means that it is rigid. A large amount of force would be needed to deform it. This would involve a high build-up of mechanical stress. The modulus is determined by means of a tensile tester with the aid of precisely defined, dumbbell-shaped test pieces of the material under examination. In the sealants sector, the modulus is defined as the mechanical stress that builds up in a test piece when it is stretched to twice its length, i.e. by 100 percent. The terms tensile stress value, modulus 100 or just M100 are synonyms. The modulus is measured in newtons per square millimeter.

low-modulus sealants. Both substance classes have proven their merit in countless applications over decades. Polyurethane sealants can be painted over and have good mechanical properties. As for silicone sealants, they are known for their excellent aging, weathering and heat resistance, their high elasticity and low-temperature flexibility.

REPAINTING NOW AN OPTION

Unfortunately, polyurethane sealants often contain solvents to allow them to be squeezed out of the cartridge easily at relatively cool temperatures. On the other hand, it is not possible to paint over silicones. Inexpensive standard formulations can additionally cause unsightly staining on absorbent substrates.

“These problems do not arise when silane-terminated polymers are used as binders for such sealants,” explains Lidia Miszke, “which is why this substance class is particularly interesting for compounders.” However, with conventional silane-terminated polymers, it is not easy to produce sealants with a modulus of less than 0.4 newtons per square millimeter and elastic recovery of over 70 percent. The introduction of CE marking requires construction sealants to comply with ISO 11600 – a specification that must be certified by an external institute. The addition of GENIOSIL® XM 25 to a sealant formulation ensures that this specification is easily met. Only construction sealants that conform to

this standard may bear the CE mark, which is important for marketing in Europe.

The new polymers GENIOSIL® XM 20 and GENIOSIL® XM 25 are suitable as binders for one-component adhesives and sealants and offer many different formulation options. “This versatility stems not only from their low viscosity, but also, because they are compatible with all other silane-modified polymers from WACKER, they can be blended to the desired ratio,” adds Dr. Lars Zander, who is in charge of an applications laboratory in Burghausen and for developing the XM range. Such blends offer scope for tailoring the properties of the binder system to the application. The two new polymers can serve either as the main binder or

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as a co-binder. On curing, they are chemically incorporated into the resulting network.

LOW VISCOSITY

Thanks to their low viscosity, GENIOSIL® XM 20 and GENIOSIL® XM 25 can be processed into sealants and adhesives that can be squeezed out of cartridges easily without the need for additional solvent. Compared to many conventional binders, such as polyurethanes, the low viscosity is an advantage. Like all silane-terminated polymers that WACKER markets under the GENIOSIL® brand, the GENIOSIL® XM grades are silane-terminated polyethers. As is typical of silanes, they cure under the influence of atmospheric humidity. Their molecules,

“GENIOSIL® XM thus ensures high elasticity and low modulus in the cured end products.”

Dr. Lars Zander, head of the applications technology laboratory, Construction Sealants & Adhesives

GENIOSIL® STP-E

WACKER offers various silane-terminated polyethers that have been designed as binders for adhesive and sealant manufacture. They can be blended with each other, acting either as the main binder or as a co-binder. This allows formulators to use the product portfolio like a toolbox to adjust the desired final properties of a given product. Both gamma- and alpha-silane-terminated polyethers are available.

Within this portfolio, the hybrid polymers of the GENIOSIL® STP-E product line constitute the standard. They cover a wide range of demanding adhesive and sealant applications. GENIOSIL® XB is ideal for the manufacture of powerful and tough adhesives that make structurally strong bonds possible. If, on the other hand, exceptionally strong yet elastic adhesives need to be formulated, polymers of the GENIOSIL® XT range are the binders of choice. GENIOSIL® XM is suitable for low-modulus sealants or flexible, highly elastic adhesive sealants with virtually universal adhesion.



PODCAST



Our “Tolerant Silicones” podcast tells you more about joint sealants:
www.wacker.com/podcast

COMPARISON OF THE TECHNICAL PROPERTIES OF VARIOUS SEALANTS

Polymer	Sealant based on GENIOSIL® STP-E35	Sealant based on a blend of GENIOSIL® STP-E35 and GENIOSIL® XM 25	Sealant based on a rival product
Skin-over time (in minutes)	15	60	180
Tensile strain (in percent)	700	750	860
M100* (in newtons per square millimeter)	0.7	0.4	0.6
Elongation at break (in newtons per square millimeter)	1.5	1.2	1.2
Shore A hardness	31	22	27
Elastic recovery (in percent) (ISO 7389 A – concrete)	75	85	42
M100* (in newtons per square millimeter) (ISO 7389 A – concrete)	0.68	0.4	0.43
Elastic recovery (in percent) (ISO 7389 B – concrete)	80	90	75
M100* (in newtons per square millimeter) (ISO 7389 B – concrete)	0.52	0.31	0.44

* Describes the modulus: the force required to elongate the test piece by 100 percent.

Tests show that sealants formulated with a blend of GENIOSIL® STP 35 and GENIOSIL® XM 25 have a lower modulus than comparable products. This provides better protection for vulnerable joint edges, such as prefabricated concrete parts or window frames.

unlike those of conventional silane-terminated polymers, only have a silane group at one of the two chain ends. The other end is inert to the crosslinking reaction. As a result, a wide-meshed network with long polymer chain segments develops. It takes only a little force to deform this. “GENIOSIL® XM thus ensures high elasticity and a low modulus in the cured end products,” says Dr. Lars Zander, a WACKER chemist.

Until now, sealant and adhesive formulators had to use plasticizers to achieve a comparable effect. With GENIOSIL® XM 20 and GENIOSIL® XM 25, this is no longer necessary. The new polymers achieve the same effect, but have the distinct advantage that they cannot

migrate out of the material, because they are polymerized into the network. Therefore, the two new grades can also be described as reactive plasticizers. Formulators now have a choice: they can either formulate plasticizer-free or plasticizer-containing sealants and adhesives.

GENIOSIL® XM 20 and GENIOSIL® XM 25 are slightly less polar than traditional silane-terminated polymers and consequently feature a broad adhesion spectrum. Furthermore, the absence, or reduction of conventional plasticizers has a positive effect on the bonding properties. Formulations always contain adhesion promoters that compete with plasticizers for free bonding spaces on the substrate surfaces.

Using GENIOSIL® XM as a reactive plasticizer and reducing the use of traditional plasticizers can improve adhesion considerably.

UNIVERSAL BONDING

WACKER applications engineers tested the adhesion profile on various substrates. They found that formulations containing GENIOSIL® XM 20 and GENIOSIL® XM 25 adhere well not only to concrete, wood, aluminum and glass, but also to difficult substrates such as polyvinyl chloride (PVC), polystyrene (PS) and cured ethylene propylene diene monomer (EPDM) rubber, without pretreating these substrates with a primer. ■

SILICONE RESINS FOR WEATHER- AND HEAT-RESISTANT COATINGS

At the European Coatings Show 2017, WACKER will be showcasing the new binder SILRES® REN70-M for heat-resistant coatings.

Combined with suitable pigments and fillers, the new phenyl methyl silicone resin offers extreme thermal stability of up to 600 °C in coatings that are stable at high temperatures, making the product especially suitable for formulating coatings used in industrial plants, engine parts, stoves and incinerators. Virtually free of aromatic solvents (< 0.1%), SILRES® REN70-M provides an alternative to conventional binders for extremely heat- and weather-resistant industrial coatings. These types of silicone resin binders are usually supplied as a solution in aromatic solvents such as xylene. Instead, SILRES® REN70-M uses biodegradable 1-methoxy-2-propyl acetate as a solvent.

SILRES® REN70-M offers the ideal combination of hardness and flexibility. As a binder in heat-resistant coatings, it effectively pro-

TECTS metal surfaces from corrosion, even at high operating temperatures or when rapid temperature fluctuations occur. The binder dries tack-free even at room temperature.

SILRES® REN70-M can also be fully chemically cured, which takes place via reactive silanol groups. With the aid of a catalyst, complete chemical cure can be achieved in just 20 minutes at 180 °C, i.e. faster than comparable products. SILRES® REN70-M easily passes solvent rub tests and so is ideal as a binder in coatings for industrial plants, piping or engine parts. SILRES® REN70-M also provides the resistance needed for coatings on barbecues, chimneys, wood-burning stoves or gas-fired incinerators. ■



SILRES® IC 235 AS AN INTERMEDIATE

Industrial coatings essentially consist of a binder, pigments, fillers, additives and solvents. Each and every ingredient plays a key role in a coating's performance. The chemical and physical properties of the binder can be improved by adding fully crosslinked polysiloxanes.

WACKER is now showcasing a new polysiloxane-based intermediate for optimizing organic binders: SILRES® IC 235, a methoxy-functional phenyl methyl polysiloxane that has a low molecular weight distribution and contains no aromatic compounds.

A 15-percent addition of the new silicone resin improves the UV and weathering resistance of the organic binder in a coating system without detracting from its mechanical properties. Weathering and lab tests have shown that SILRES® IC 235 substantially improves gloss retention, enhances protection against weathering and extends useful life. Additionally, a higher percentage of silicone in the binder improves the heat resistance of the coating system up to 300 °C. SILRES® IC 235 is used, for example, in coatings for static metal structures such as bridges or railings and in industrial plants.

SILRES® REN70-M is a highly heat-resistant binder suitable for coating mufflers, engine parts, stoves and incinerators.

HDK® storage silos at
WACKER's Nünchritz plant

FOUR STRONG CONTENDERS

At the European Coatings Show, the Group is presenting four hydrophobic specialty grades of HDK® which are used to control the flow properties of coatings and adhesives.

By selectively modifying their surface, WACKER has succeeded in making hydrophilic silicas water-repellent.

Coating systems with optimum anti-sag properties, clear coats with maximum transparency and excellent corrosion resistance, innovative adhesives for wind turbines or chemical dowels with extremely high mechanical strength: these customer demands may sound like an impossible wish list. However, they are entirely feasible if the products are selectively modified by the addition of pyrogenic silica.

WACKER has been producing ultrapure pyrogenic silica under its HDK® brand since the 1970s. The feedstock is tetrachlorosilane (SiCl_4), which is generated in large quantities as a byproduct in the manufacture of silicones and polycrystalline silicon. This byproduct can either be returned to the production process or be converted into pyrogenic silica. For this purpose, tetrachlorosilane is hydrolyzed at over 1,000 °C in an oxyhydrogen flame. This generates ultrapure amorphous silicon dioxide and hydrogen chloride (HCl). Due to its high reactivity, this hydrochloric acid gas is an essential auxiliary in WACKER's silicone and polysilicon production and is completely returned to the process.

During production, HDK® is generated as a white, amorphous powder with a very large specific surface area. This high surface-area-to-mass ratio is responsible for the outstanding effectiveness of HDK® as a rheology modifier. The silica formed in the oxyhydrogen flame is characterized by a hydrophilic, i.e. water-compatible, surface. By selectively modifying the surface chemistry using a silane or siloxane in a second reaction step, WACKER also produces a range of hydrophobic HDK® grades.

This creates a large portfolio of HDK® products, making it possible for the most diverse coating and adhesive formulations to consistently achieve optimum rheology performance. Introducing WACKER's four hydrophobic HDK® grades developed for different applications:

HDK® H30RM AND HDK® H30LM

Even better rheology control. These hydrophobic grades feature high specific surface areas and silane modification with pronounced water repellency. This is more pronounced in H30RM than for the H30LM grade. The two grades are particularly suitable for highly polar binder systems, while more pronounced rheology effects can be achieved with HDK® H30RM.

HDK® H30RM and HDK® H30LM feature outstanding transparency in clear coats. Furthermore, they contain no PDMS and make it possible to achieve crater-free surfaces during coating application. Accordingly, their main applications are in surface coatings for the automotive industry and high-quality industrial paints.

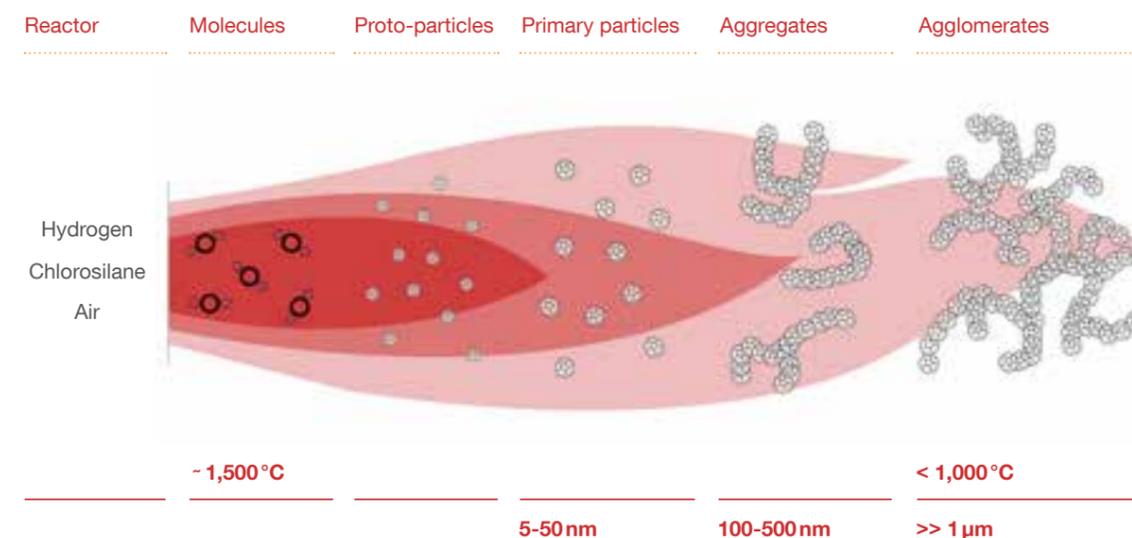
HDK® H20RH

Excellent storage stability in basic systems. HDK® H20RH is a hydrophobic silica that has been treated with alkylsilane. The silicone-fluid-free additive features exceptional rheological activity in polar systems and prolongs the shelf life, even at high pH values. HDK® H20RH is thus also suitable for use in amine hardeners for two-part adhesives. The product has proven its merit in the field of automotive adhesives, chemical dowels and bonding the half-shells of wind turbines.

HDK® H20RH can also give jointing compounds favorable pull-off characteristics and features good wettability. Products formulated with this silica can thus generally be readily painted over after curing.

HDK® H30RY

Additive with methacrylic functionality. HDK® H30RY is a hydrophobic, methacrylic-functional silica which is reactive and can be chemically incorporated in resin networks. It thus improves the mechanical properties of vinyl ester, polyester and acrylate-based systems. This yields a broad range of applications – from coatings and adhesives to sealants. Moreover, the properties of dental fillings and nail gels can be optimized with HDK® H30RY. ■



Pyrogenic silica is obtained by combusting chlorosilanes with hydrogen and oxygen in an oxyhydrogen flame at over 1,000 degrees Celsius. The reaction produces silica and hydrogen chloride. The latter is fed back into the production loop as an auxiliary. The particles formed in the flame are initially just a few nanometers in size. On cooling, they fuse to form larger, highly branched, flaky aggregates, which ultimately become several micrometers in size – resulting in the large surface of HDK®.



A WINTER SWEATER FOR HOUSE WALLS

In cold and wet weather, painters must interrupt their work, because the applied plaster and paint don't dry sufficiently. WACKER experts have now developed a new additive that forms a gelatinous protective film, allowing outdoor work to be performed for a greater part of the year.

Very few people welcome cold, wet weather. Facades, too, are sensitive to changes in the weather – especially when they have just been freshly painted or plastered. Water-based paint or plaster on exterior walls ideally dries at temperatures of greater than five degrees Celsius. If it is too cold, the various components freeze and the paint doesn't set fully. On thawing, the plaster cracks, so that the facade no longer serves its protective function. The plaster must then be applied again, which costs time and money.

As a rule of thumb, paints and plasters only set adequately when the temperature stays above five degrees Celsius for at least three consecutive days. Then, the water evaporates slowly enough for the polymer chains of the dispersion to diffuse and form a stable film. "In colder regions of the world, such as Northern or Central Europe, this is not usually the case in late fall or early spring. It is then simply too cold for outdoor painting work," explains Dr. Markus Busold, global marketing manager at WACKER POLYMERS for dispersions in the architectural coatings sector. "That's why manufacturers of paints and plasters are interested in solutions that extend the time frame for outdoor work."

Paints and plasters generally only set adequately if the temperature remains above 5°C for several days. Otherwise the waterborne systems will freeze. PRIMIS® KT 3000 shortens the setting time substantially.



Direct comparison in the laboratory: after six hours' drying time, the test surfaces are irrigated. While the commercial plaster (left) does not withstand the moisture, the plaster modified with PRIMIS® KT 3000 (right) has formed a stable polymer network after only a few hours.

STABLE NETWORK

This is exactly where WACKER's new additive comes in: PRIMIS® KT 3000 forms a gelatinous structure, which allows paints and plasters to dry at lower temperatures. "Laboratory tests have proven that, with our additive, the specified five degrees Celsius are only needed for six hours, even when atmospheric humidity is high. The polymer network is then stable," explains Lenine De Sousa Gomes, technical manager at WACKER. "This also protects the paint or plaster layer, allowing it to dry without interruption."

It even works when there is heavy rain, as De Sousa has demonstrated in the lab. He had a layer of plaster applied to a simple glass plate and allowed it to dry in a climatic chamber for six hours at 5 degrees Celsius and 85 percent atmospheric humidity. Then, a 20-minute shower – created with a shower head – rained down on the coated glass plate. "The test showed that one to three percent PRIMIS® KT 3000 is enough to significantly improve the adhesion. The surface of the coating was hardly damaged at all," says De Sousa. "This is a great advantage over products that are currently available on the market, which only feature very slight resistance to early rain."

GELATINOUS SHIELD

So, WACKER's additive ensures that a gelatinous structure can form. This is due to its chemical composition. The product contains zinc acetate, which forms complexes with water molecules, i.e. binds them to it. Poly-

ethyleneimine is another constituent. "This molecule can form bonds with components in the paint or plaster," explains the WACKER expert. "That creates a kind of gel, which distributes homogeneously in the coating, and is particularly resistant to rain." At the same time, water molecules can evaporate from the paint or plaster. This is important to allow the coating itself to dry. The chemist is currently performing further tests on drying times, storage stability and pH changes.

A big advantage is that the additive can easily be mixed with WACKER's vinyl acetate-ethylene-based VINNAPAS® dispersions. "In this way, we are expanding the application and service range of our own products and offer our customers – manufacturers of paints and plasters – a valuable additional benefit," says marketing expert Busold. The WACKER team is already testing whether the additive can also be used for other construction applications to make outdoor work less dependent on the weather. ■

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WACKER IN FIGURES

Voluntary commitments form the basis for sustainable corporate management at WACKER: for instance, Responsible Care® (the chemical-industry initiative), the UN's Global Compact initiative, and the Together for Sustainability (TfS) supply-chain program.

1991



was the year in which the chemical industry's Responsible Care® initiative was launched in Germany. WACKER signed on from the outset and is committed to showing its responsibility regarding environmental protection; occupational, product, transport and plant safety; emergency response procedures, and communications.



24

compliance officers are available to answer any questions WACKER employees groupwide might have about issues relating to responsible and legally compliant corporate management.



2006

was the year WACKER joined Global Compact. A key goal of this United Nations initiative is to shape globalization so that it improves the quality of peoples' lives all around the world.

82%

was the production-specific waste-recycling rate at Burghausen, the Group's largest site, in 2015.

1,600



pieces of machinery had undergone safety checks by late 2015. The Group had experts conduct these inspections at every WACKER site worldwide.



2015

Two years ago, WACKER joined the Together for Sustainability (TfS) procurement initiative to heighten awareness of sustainability in the supply chain.



TAKE A DEEP BREATH!

According to a popular German saying, a cold lasts just 14 days if you go to the doctor, but takes two weeks if you don't. The bottom line is that there is one solution when you have a cold: get some rest. However, with the right medication, some symptoms can be alleviated. Expectorants, for example, help you clear your respiratory tract by coughing. N-Acetylcysteine or carboxy cysteine is often used. These amino acids liquefy thick bronchial mucous by destroying the disulfide bridges in its proteins. The raw material is cysteine, which, for a long time, was mainly isolated from feathers and hair.

WACKER

WACKER is the world's first company to bioengineer cysteine in a patented, fermentation-based process – i.e. without using raw materials derived from humans or animals. WACKER's cysteine products satisfy vegetarian, kosher and halal requirements and conform to all important food and pharmaceutical quality standards.