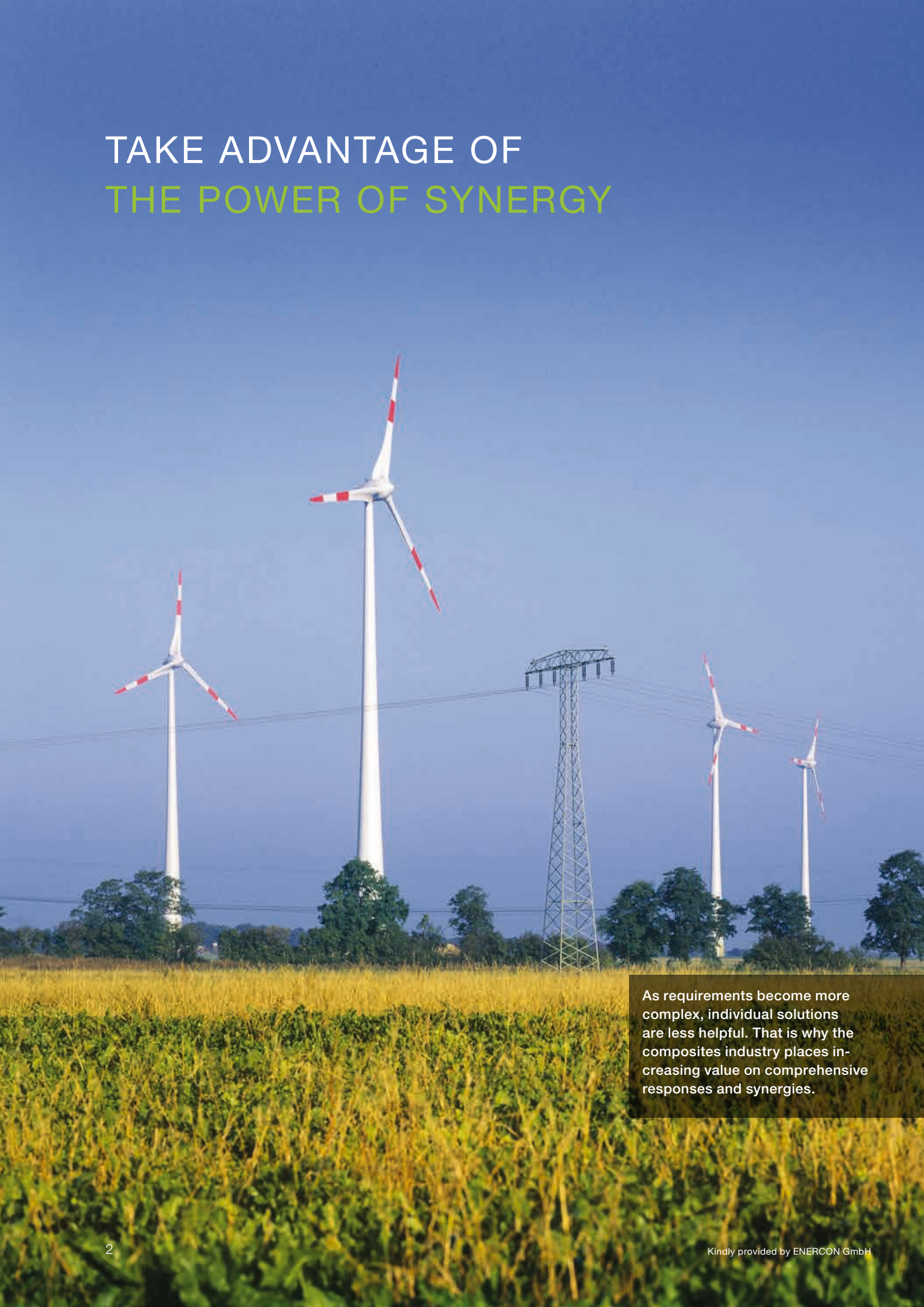
WACKER

CREATING TOMORROW'S SOLUTIONS

ELASTOSIL®, GENIOPERL®, GENIOSIL®, HDK®, VENTOTEC®, VINNAPAS®

FOCUS ON COMPOSITES EXPERTISE

TAKE ADVANTAGE OF
THE POWER OF SYNERGY



As requirements become more complex, individual solutions are less helpful. That is why the composites industry places increasing value on comprehensive responses and synergies.

Kindly provided by ENERCON GmbH

Contents

WACKER offers composites manufacturers an overarching solution – with highly specialized products and focused expertise.

Composites are special materials in which thermoset resins, such as unsaturated polyesters, epoxies, melamine or vinyl esters, are combined with carbon, glass or mineral reinforcing fibers.

The resulting materials have a wide range of superior properties:
- Light weight
- High mechanical strength
- High fatigue resistance
- Very high corrosion resistance
- Excellent impact properties
- High design flexibility
- Excellent acoustic properties combined with high stiffness
- Properties can be individually tailored to customers' requirements

As a leader in composites ingredients, WACKER helps to ensure that these materials can be produced in better quality than ever. WACKER as a partner will allow you to access all these products from a single source.

Performance Additives and System Components with One Goal: High-Quality Composites

- VINNAPAS® (polyvinyl acetate) solid resins are low-profile additives, which prevent shrinkage and thus guarantee an optimum surface of the molded part
- GENIOPERL® and VENTOTEC® organosilicone copolymers increase the toughness of epoxy resins without altering their property profile, even when added in very small amounts
- GENIOSIL® silanes improve the strength of composites by bonding together organic and inorganic materials
- HDK® pyrogenic silica controls flow behavior. The thixotropic effect makes systems stable and easy to handle.
- ELASTOSIL® C silicone rubber grades enable the manufacture of reusable, precision-fit, fabric-reinforced silicone vacuum bags, thus ensuring cost-effective and efficient production of fiber-composite articles

One Partner with a Host of Advantages

This manifold capability gives you many advantages:
- Expertise focused on your challenges
- All-encompassing competence and technical support with formulations
- A fresh impetus thanks to interdisciplinary research activities

You also profit from the strengths of a leading, innovation-driven and globally active partner to the composites industry:
- Comprehensive support throughout your supply chain
- Formulation advice to innovative logistics development
- High-quality consultancy based on many years of market experience
- Local support from application laboratories throughout the world
- High uniformity of quality and reliability of delivery
- Optimum raw materials supply thanks to backward vertical integration
- Global availability thanks to local warehouses throughout the world
- Market-oriented developments from our in-house research facilities and cooperation with universities

Talk to Us

We look forward to developing tomorrow's solutions in partnership with you. Or visit our website at
www.wacker.com/composites

THE SUCCESS FACTOR: CONTROLLING AND OPTIMIZING PROCESSES

Most composite materials used in the world are thermosets. Thermoset composites are principally based on six resins:

- Unsaturated polyesters (UP)
- Vinyl esters (VE)
- Phenolics
- Epoxies (EP)
- Melamines
- Polyurethanes (PU)

They are processed by a number of techniques.

WACKER supplies additives, co-catalysts and process auxiliaries for high- and low-temperature processes, and is ideally placed to offer comprehensive advice.

WACKER's Portfolio for Composites Production

	Process/Technology	Performance Additives **VINNAPAS® Solid Resins** Low-profile additives for class-A surfaces
Thermoset: Closed Mold (High Quantity)		
10 – 230 °C	SMC	●
	BMC	●
	RTM	●
	Pultrusion	●
	Prepreg	
	Infusion	●
	Composite stone	
Thermoset: Open Mold (Low Quantity)		
< 50 °C	Hand lay up	
	Spray up	
	Filament winding	
Joining of Composites		

Global Production – Local Customer Support

WACKER products are manufactured at various sites worldwide according to the same quality criteria.

In addition, we have set up technical centers around the world that help you with all issues relating to product selection, production and end-product specification. Find out more at www.wacker.com.

			Process Compound
GENIOPERL® / VENTOTEC® Organosilicone Copolymers High-impact modifiers for optimizing thermosets	**GENIOSIL® Silanes** Coupling agents between organic and inorganic components	**HDK® Pyrogenic Silica** Additive for rheology control	**ELASTOSIL® C Silicone Rubber** System solution for reusable vacuum bags
●			
●			
●			
●			
●	●		●
●		●	●
●	●	●	
●		●	
●		●	
●		●	
●		●	

VINNAPAS®: LOW-PROFILE ADDITIVES FOR CLASS-A SURFACES

Perfect surfaces with no shrinkage: VINNAPAS® solid resins (PVAc) help to ensure that your products will reliably and consistently meet your customers' specifications.

UP resins are dissolved in a monomer, usually styrene. This is the only way to give UP resins the consistency to allow easy processing. Then, fillers, release agents and catalysts are added to produce composites. The catalyst initiates the curing of styrene with the polymer to yield a highly complex three-dimensional network, which together with the reinforcing fibers (glass, carbon, etc.) determines the properties of the composite part.

The Challenge: Shrinkage

A critical stage in this process is shrinkage. When unsaturated polyester resin reacts with monomeric styrene, the volume generally shrinks by 6 – 10%. This shrinkage can result in a number of defects, such as

- Cracking or warping of the molded parts
- Poor dimensional stability and
- Poor surface appearance
- E.g. orange peel

Low-profile additives are therefore an important ingredient in composite molding compounds. WACKER's VINNAPAS® solid resins offer an excellent solution in the form of homogeneous, odorless and tasteless resins, with no known harmful effects.

Antishrink Additives: Low Profile – Low Shrink

The effectiveness of a low-profile additive is measured by the reduced degree of shrinkage. This expresses the difference between the mold dimensions and the dimensions of the cured part (in percent, measured at room temperature in each case):

- Low shrink ≤ shrinkage 0.15%
- Low profile ≤ shrinkage 0.05%

VINNAPAS® solid resins, when used as low-profile additives, reach these values while also offering a range of other crucial benefits.

Class-A Surfaces

Many applications, especially in the automotive sector, require Class-A surfaces. UP resins shrink during curing in all three dimensions. Without low-profile additives, this leads to sink marks, which mar the surface appearance. VINNAPAS® reduces shrinkage to 0.05% at most. The Class-A surfaces obtained with this low shrinkage meet the strictest OEM quality specifications for smoothness and homogeneity.

High Mechanical Strength

Most low-profile additives reduce mechanical strength. VINNAPAS® is a polymer that is solid at room temperature, and remains solid, though finely distributed, in the final product. As a result, it confers desirable physical properties on the part. The mechanical strength of the product is therefore far better than with other additives with comparable volume shrinkage control.

Excellent Phase Separation

VINNAPAS® solid resins can be homogeneously mixed in by dissolving them in styrene. They are quickly and uniformly incorporated into sheet molding compounds (SMC) using, for example, magnesium oxide to control thickening. During molding, VINNAPAS® undergoes controlled phase separation, which is responsible for the desirable appearance of the part.

A Wide Product Portfolio – Good Solubility in Styrene

VINNAPAS® grades are available in a wide range of viscosities and dissolve readily in styrene. Because of this solubility, solutions can even be produced at room temperature. VINNAPAS® can therefore be used in a wide variety of formulations and processes.

Typical values for VINNAPAS® LPA solutions in styrene are:
VINNAPAS® C grades: 40 – 50%
VINNAPAS® B grades: 40 – 50%
VINNAPAS® UW grades: 30 – 40%

Suitable for a Variety of Processes

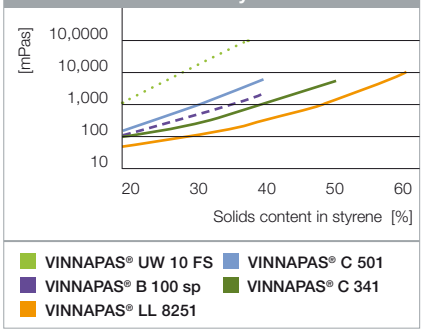
VINNAPAS® can be used in SMC, BMC, RTM and pultrusion.
In all these processes, VINNAPAS® is used as a low-profile additive to produce

- Class-A surfaces
- With high mechanical performance
- And excellent phase separation for controlled processing.

Reliability from the Market Leader

With its VINNAPAS® solid resins, WACKER has a leading market position. The tried-and-tested portfolio of specialty products includes solid resins with different molecular weights, resulting in various solution viscosities. Besides the VINNAPAS® B and UW homopolymer grades, WACKER also manufactures copolymers. Carboxylated VINNAPAS® C grades are based on vinyl acetate and crotonic acid. VINNAPAS® VL grades are copolymers of vinyl acetate and vinyl laurate.

Viscosity Ranges of Select VINNAPAS® LPAs in Styrene[1]



[1] Brookfield viscosity, 23 °C / 20 rpm

SMC/BMC Composition with VINNAPAS® Solid Resin as LPA

	Raw Material	Parts	pph (%)
Thermoset	UP resin, 65% in styrene	60.0	9.2
Low-profile additive	VINNAPAS® solid resin solution	40.0	6.2
Viscosity adjustment	Styrene 5–10 parts	7.0	1.1
Initiator	Peroxide (tert. butylperbenzoate)	1.5	0.2
Release agent	Ca stearate / Zn stearate	5.0	0.8
Filler	$CaCO_3$	162	25
Fire retardant	$Al(OH)_3$	97	15
Thickening	MgO paste 35% (CaO_3, Mg $(OH)_2$)	3.0	0.5
		486.5	75.0
Mechanical stability	Chopped glass fiber	162.5	25.0
		648.7	100.0

Overview of VINNAPAS® Low-Profile Additives

Grade	Type	Solids Content	Appearance	Acid[1] [mg KOH/g]	Viscosity[2] [mPa s]	Molecular Weight[3] [M_w]	Viscosity in Styrene[4] 40% in [mPa s]
VINNAPAS® LL 8251	Carboxylated PVAc	100%	Flakes	6–9	2.0–2.3	~ 30,000	~ 300
VINNAPAS® C 341	Carboxylated PVAc	100%	Flakes	6–8	3.5–3.8	~ 60,000	~ 1,000
VINNAPAS® C 501	Carboxylated PVAc	100%	Flakes	6–9	7.5–9.5	~ 130,000	~ 6,500
VINNAPAS® B 60 sp	PVAc	100%	Pellets	< 0.5	3.5–5.0	~ 65,000	~ 1,000
VINNAPAS® B 100 sp	PVAc	100%	Pellets	< 0.5	5.0–6.5	~ 90,000	~ 2,000
VINNAPAS® UW 1 FS	PVAc	100%	Beads	< 0.5	8.0–11.0	~ 130,000	~ 5,000
VINNAPAS® UW 4 FS	PVAc	100%	Beads	< 0.5	23–30	~ 280,000	~ 66,000
VINNAPAS® UW 10 FS	PVAc	100%	Beads	< 0.5	35–55	~ 360,000	~ 160,000

[1] Acid number: KOH in mg required to neutralize the alkali-reactive groups in 1 g VINNAPAS® LPA
[2] Conditions: 10% solution of VINNAPAS® in ethyl acetate, Höppler equipment, 20 °C
[3] SEC conditions: PS standard; THF; 60 °C; weight average
[4] Brookfield PHL 002/23 °C

GENIOPERL® AND VENTOTEC®: HIGH-IMPACT MODIFIERS FOR OPTIMIZING THERMOSETS

Until now, it had been virtually impossible to increase the impact strength of thermosets without changing the properties of the end product. GENIOPERL® and VENTOTEC® are novel high-impact modifiers that can minimize the brittleness of epoxy resins, even when added in very small amounts.

Impact Modifiers for Epoxy Resins

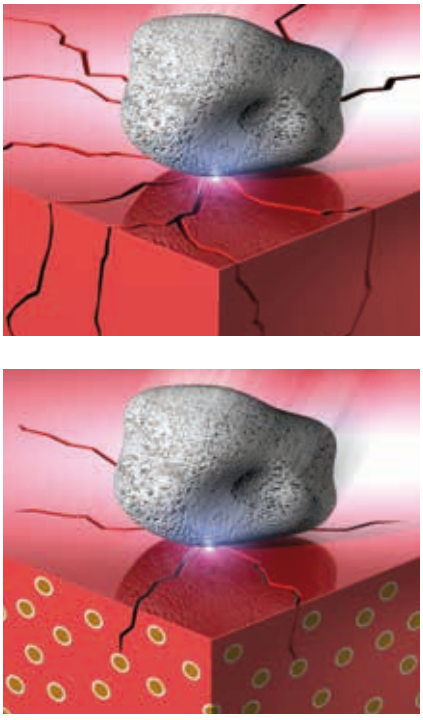
With its GENIOPERL® and VENTOTEC® lines of dispersible and high-efficiency impact modifiers, WACKER has not just launched another innovative product development – they represent an entirely new generation of products for optimizing reactive resins. The powder additives impressively combine in one product the two WACKER technologies for the production of silicones and organic polymers. The result is a highly efficient, hybrid product that makes adhesive layers stronger and more durable. The additives significantly enhance the impact strength of epoxy resins and other thermosets. In addition, the favorable basic properties of these materials are preserved unaltered. This outstanding effect can be achieved with the smallest of quantities of GENIOPERL® and VENTOTEC®, which makes for production processes that are both cost-effective and efficient.

Advantages and Disadvantages of Epoxy Resins and Other Thermosets

When engineers need a rigid plastic that can withstand high temperatures, they usually go for a thermoset. The closely crosslinked polymers feature high rigidity, good electrical properties and high mechanical and chemical resistance. They also bond well to a wide variety of different substrates. However, epoxy resins, among others, have a weak point: their brittleness makes them susceptible to damage through impacts and vibrations, especially at low temperatures. These dynamic loads can trigger cracks that spread through the material, unchecked.

Resilient to Impacts, Heat Resistant and Mechanically Strong

How can epoxy resins and other thermosets become more resilient to impacts without compromising their mechanical strength and heat resistance? With GENIOPERL® and VENTOTEC®, WACKER has the answer. The impact modifiers are firmly incorporated into the polymer matrix and evenly distribute any force acting on it, such as generated by an impact or shock, in all directions. Here, the deformation of the elastic silicone cores – as active components during impacts – is different to that of the resin matrix. This difference in deformation of polymer matrix and elastic additive creates additional cavities at the phase boundaries, which absorb the energy around the particle-resin interface. As a result, cracks in the resin matrix formed by impacts or vibrations cannot spread uncontrollably. Since the silicone domains retain their elasticity down to around minus 120 degrees Celsius, the toughening effect remains intact even at very low temperatures.



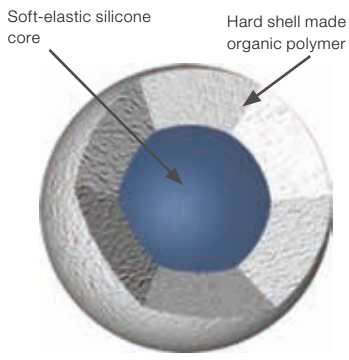
GENIOPERL® and VENTOTEC® high-impact modifiers (yellow rubber particles in second picture) prevent crack growth in thermosets.

GENIOPERL® P52 is a dispersible powder and thus particularly easy to handle and process.

The Chemical Structure of GENIOPERL® P52

The impact modifier, which is dispersible in the uncured epoxy reaction resin, consists of spherical particles of equal size. These are composed of a soft-elastic, crosslinked silicone core and a hard shell made of an organic polymer. In the powder additive, the core-shell particles are present as agglomerates with a particle size in the double-digit micron range. The agglomerates disintegrate completely when mixed into the liquid epoxy reaction resin. The core-shell particles distribute themselves evenly throughout the resin matrix. The polymer shell has a special structure that allows the particles to adhere to the reactive resin and yields a stable, fine dispersion, which makes the additive highly efficient.

Schematic Diagram of an Impact-Modifier Particle



Advantages for the User

The dispersible impact modifier eliminates undesired side effects, is easy to process and does not alter the cured resin's positive properties. The dispersion's stability, the morphology of the dispersed particles and the optimized adhesion to the resin matrix make the additive so efficient. Compared to conventional impact modifiers, relatively small amounts of GENIOPERL® P52 are sufficient to significantly minimize the brittleness of the cured epoxy resin. Since such small amounts of additive suffice, the epoxy resin retains its properties, especially its characteristic rigidity, high softening point and resistance to both high and low temperatures. Depending on requirements, the typical amount of GENIOPERL® P52 needed to toughen epoxy resins lies in the range of two to ten weight percent relative to the weight of the unfilled resin hardener. Studies by the Fraunhofer Research Institution for Polymeric Materials and Composites (PYCO) have shown that as little as five weight percent of GENIOPERL® P52 can more than double the impact strength of epoxy resins.

How Is GENIOPERL® P52 Incorporated into the Target System?

GENIOPERL® P52 is easy to handle and process, because it is a dispersible powder. The viscosity of the reaction mixture increases only slightly during mixing – another advantage of the new additive over conventional modifiers. In order to simplify processing, the uncured resin requires adequate, defined flow properties. Since the active parts are pre-structured in the dispersible additive, processors can reproducibly adjust the end properties of the modified epoxy resin. The level of toughening is not dependent on the process conditions that prevail while the resin is curing. In this way, GENIOPERL® P52 enables the manufacture of adhesive bonds with the same high quality and using the same methods, regardless of where they are produced. This is an important step toward cost-effective automated production.

Application Fields of GENIOPERL® P52

Epoxy reaction resins crosslink to yield thermosets with very high strength, heat resistance and chemical resistance. Furthermore, they adhere excellently to many different kinds of substrates. These properties explain why epoxy resins enjoy such widespread use in industry. They constitute the matrix of many structural adhesives and find use in electrical insulators, baking finishes and laminates. Their main application areas are adhesives and encapsulants for automotive engineering and aircraft construction, as well as for the electronics industry.

GENIOPERL® P52 Product Properties

Typical General Properties	Test Method	Value
Appearance		White powder
Average agglomerate size		30–100 µm
Moisture content	DIN EN ISO 787-2	< 2%
Glass transition of elastomer core	DSC/DMTA	-140 to -120
Softening range of thermoplast shell	DSC/DMTA	110 to 140

These figures are intended as a guide and should not be used in preparing specifications.

GENIOSIL®: COUPLING AGENTS BETWEEN ORGANIC AND INORGANIC COMPONENTS

Some of the most attractive applications cannot be so easily reproduced with other materials. An interesting example is composite stone, which is made possible with WACKER silanes.

Composite stone is increasingly the choice for marbled surfaces. This includes solid surfaces or quartz surfaces. Its characteristic is a high content of inorganic minerals, which are bound with polyester or polyacrylate resin and formed into large slabs.

The major advantage of this material is that it combines the appearance of natural stone with some novel properties:

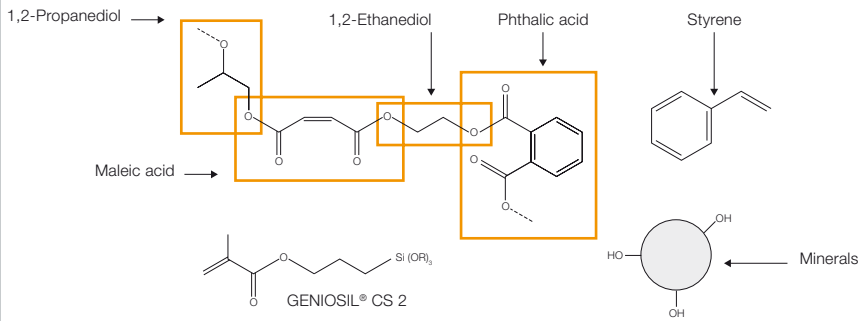
- High resource-productivity
- Large variety of shapes (because it is given the required shape during manufacture)
- Harder than natural stone
- Greater scratch resistance
- Improved dirt repellency
- Excellent mechanical properties

Composite stone products have therefore been used as flooring or wall cladding in high-traffic areas such as airports or shopping malls for a long time. There has also been a recent boom for such materials in the private sector, as kitchen countertops and bathroom furniture must meet ever rising aesthetic and quality demands.

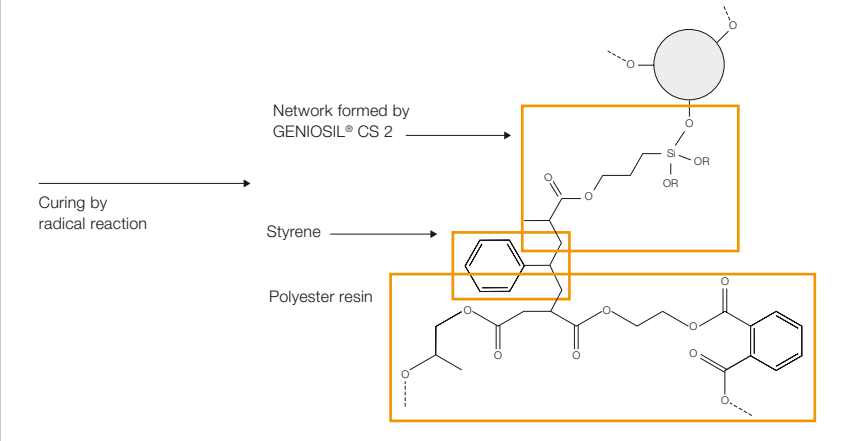
The Secret of Success: Silanes

The critical stage in the manufacture of such materials is the coupling between the organic resin and inorganic mineral. If the coupling is only physical in nature, the mineral and resin will separate under load and the material breaks. WACKER silanes create a chemical bond that renders the composite stone significantly harder even than the original.

Chemical Processes in the Manufacture of Composite Stone



Chemical Processes in the Manufacture of Composite Stone



GENIOSIL® CS 2

GENIOSIL® CS 2 is a methacrylic-functional alkoxysilane. As a bifunctional, unsaturated organic compound, GENIOSIL® CS 2 can be incorporated into organic polymers by free radical addition, where it acts as a molecular bridge between inorganic and organic substrates.

The Crucial Amount

A typical composite stone formulation contains a very high proportion of filler (> 90%), a relatively small amount of unsaturated polyester resin (< 5%) and 1 – 2% silane coupling agent (based on the resin content). The silane is the key component here, since silanes act as the chemical bond. However, 1% GENIOSIL® CS 2 is enough to transfer the strength of the hard, inorganic system to the soft, organic system.

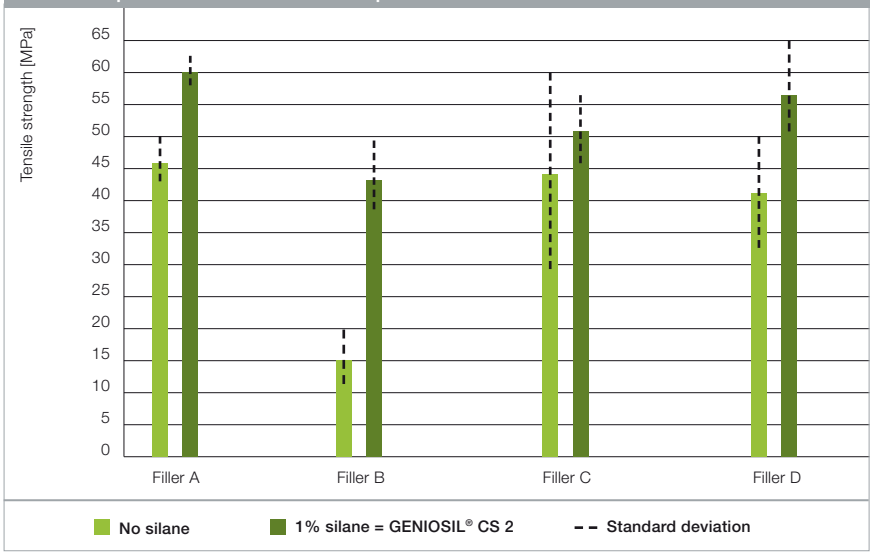
Better Mechanical Properties

Silanes improve the mechanical properties considerably. In a comparison of various composite systems with systems containing 1% silane, the flexural strength can be seen to increase considerably.

Know-How from the Inventor of Silanes

As a leading manufacturer of silicones, WACKER is vertically integrated as far back as the Mueller-Rochow synthesis of methylchlorosilane and trichlorosilane production by the Siemens process. Starting with these raw materials and the variety of chemical possibilities, WACKER produces a wide range of standard and specialty silanes. That makes WACKER one of the most important silane manufacturers in the world, with a fund of expertise in this field – both in standard and specialty silanes. For example, WACKER has a globally unique, patented process for the manufacture of alpha-silanes. WACKER experts not only have a detailed knowledge of their own products and the corresponding chemistry; WACKER is also an expert contact and reliable partner for application questions.

Silanes Improve the Mechanical Properties



GENIOSIL® CS 2 Product Properties (Suitable for Use in Composite Stone)

Product Data			
Boiling point	at 1013 mbar	°C	163
Flash point	DIN 51755	°C	50
Ignition point	DIN 51794	°C	255
Density	DIN 51757	g/cm³	0.99
Viscosity, kinematic at 25 °C	DIN 51562	mm²/s	1.29

These figures are intended as a guide and should not be used in preparing specifications.

Kindly provided by ENERCON GmbH

HDK®: THE SPECIALIST FOR PERFECT FLOW

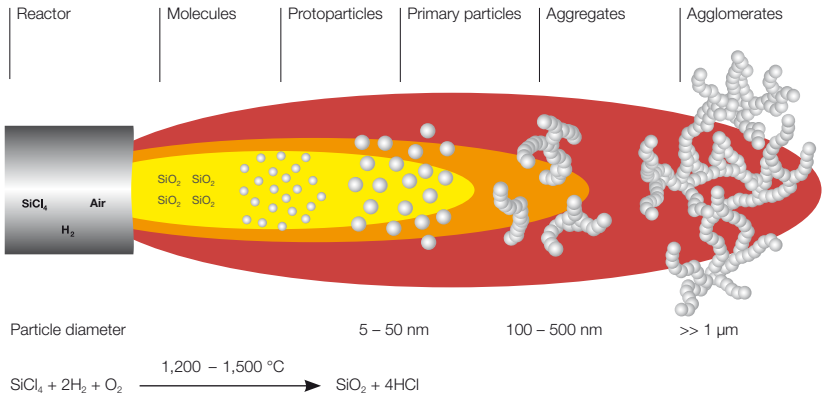
WACKER's HDK® pyrogenic silica has the all-important job of controlling flow behavior – an essential task in the manufacture of composites by hand lay up.

Unsaturated polyester resins and resin systems based on vinyl esters, epoxies and polyurethanes are used in large amounts in fiber-reinforced polymers. A key aspect is the precise adjustment of the flow behavior of the resin formulations, particularly for hand lay-up and spray-up techniques. This is the only way of producing formulations with a long shelf life that can be applied readily and that don't run off. As a rheological additive, HDK® has a shear-thinning and thixotropic effect on resin formulations. This ensures good fiber-wetting and impregnation properties during application. At the same time, the thixotropic effect of HDK® prevents the resin from seeping out of the fiber material.

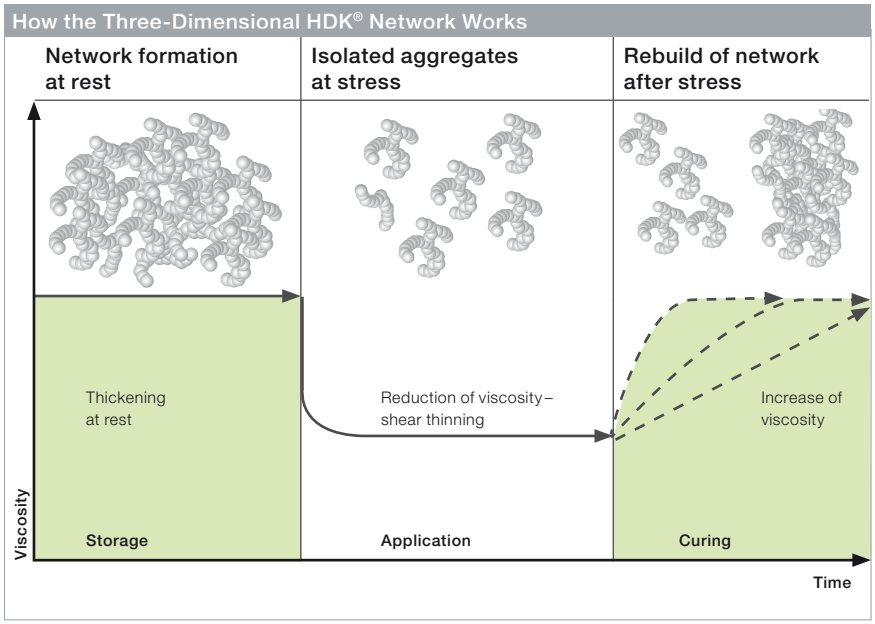
Mechanism of Rheology Control with HDK®

HDK® pyrogenic silica is generated by hydrolysis, by feeding chlorosilane into an oxyhydrogen flame. The initially formed spherical primary particles fuse into larger, highly branched units, called aggregates. On cooling, these form flaky agglomerates, about 1 to 250 µm in size. HDK® agglomerates have high specific surface areas (as per BET). The large surface-area-to-mass ratio causes strong inter-particle interactions. And that is precisely the reason for the rheological effect of HDK®.

HDK® Pyrogenic Silica – Formation in a Flame



Isolated primary particles do not exist as individual units outside the flame



Due to electrostatic interactions, HDK® dispersed in resin formulations creates a three-dimensional network, which can result in a viscosity increase up to gel-like consistency. Under shear forces, e.g. due to pumping, rolling or spraying, this network collapses and the viscosity decreases (shear thinning). As the shear force weakens (e.g. after application), the HDK® network spontaneously reforms and the viscosity increases again (thixotropy).

In this way, HDK® makes it possible to fine tune the rheology across the entire product lifecycle of a resin formulation. Very low shear rates prevail during storage and shipping. Here, HDK® prevents sedimentation of pigments and fillers. During application, HDK® provides excellent flow on the surface, but prevents dripping.

Principal Applications of HDK®

HDK® is used for rheology control in laminating resins, gel coats and topcoats. Other applications include fillers, unreinforced parts such as buttons (resin rods or sheet), adhesives and synthetic marble.

Laminating Resins

Thixotropic adjustment with HDK® ensures that the resin can optimally wet and penetrate the reinforcement. At the same time, it is prevented from seeping out and sagging on inclined surfaces. This usually requires HDK® in amounts from 0.8 to 1.5 weight percent based on the total formulation. The recommended method is to use a combination of dissolver and ultrasonic dispersion. Dispersers based on a rotor/stator principle also have a good track record. These methods are paramount in order to reduce the size of the HDK® agglomerates in the low-viscosity laminating resins and ensure viscosity characteristics with a good shelf life.

Gel Coats

Gel coats must meet the highest of demands in surface quality and weathering and chemical resistance. To this end, they are applied in high wet film thicknesses of 300 to 900 µm. Highly thixotropic formulations are needed to prevent flow defects or run-off on inclined surfaces. As such, higher dosages of 2 – 3% HDK® are normally recommended. A dissolver is generally sufficient for dispersing the HDK® in the usually pigmented and slightly more viscous gel coats.

Topcoats

The topcoat is the final decorative coating on the rough laminate surface. To optimize the flow and run-off behavior, it's advisable to render topcoats thixotropic with about 1% HDK®.

Grouts

In highly filled grouts, 0.15 – 1.0% HDK® prevents the separation of pigments, fillers and binders.

Factors Which Dominate the Rheology	
A. Coating Material	**B. HDK®**
Viscosity of resin	HDK® specific surface area
Solvent quantity	HDK® primary particle size
Polarity of resin	HDK® dispersing quality
Polarity of solvent	HDK® hydrophobization level (interfacial energy situation)
Surface-active additives	HDK® hydrophobization kind (interfacial energy situation)

Selection of Suitable Hydrophilic or Hydrophobic HDK® Grades

The rheological behavior of a resin formulation containing HDK® is, among other factors, essentially determined by the polarity of the components in the formulation (solvent, resin and HDK®) and the specific surface area of HDK® (Table 1). Conventional unsaturated polyester resins (high styrene content, non-polar) should be formulated with hydrophilic HDK®. For most laminating resins and gel coats, HDK® N20 has established itself as the universal grade, because it enables pronounced thixotropic behavior at the same time as good dispersibility. For unpigmented gel coats and topcoats with high transparency requirements, HDK® T30 and HDK® T40 are suitable alternatives.

Resin systems with polar character such as vinyl esters, epoxies and polyurethanes, as well as modern low-styrene UP resins, strongly interact with hydrophilic HDK®, which can lead to a weakening of the thixotropic effect. Here, hydrophobic HDK® is recommended, especially HDK® H15 and HDK® H13L, as well as the highly hydrophobic HDK® H17 and HDK® H18.

HDK® Hydrophilic and Hydrophobic Grades – Physicochemical Properties

		HDK® N20	HDK® T30	HDK® H15	HDK® H13L	HDK® H17	HDK® H18
Surface area (BET) of hydrophilic HDK® ISO 9277/DIN 66132	[m^2/g]	200 ± 30	300 ± 30	150 ± 20	130 ± 20	150 ± 20	200 ± 30
pH ISO 787-9 in 4% H_2O dispersion[2]	approx.	4.1	4.1	4.3	4.3	5.0	5.0
Apparent density ISO 787-11	[g/l] approx.	40	40	50	60	50	50
Loss on drying[1] ISO 787-2 2 h at 105 °C	[wt%]	< 1.5	< 1.5	< 0.6	< 0.6	< 0.6	< 0.6
Sieve residue ISO 787-18 (acc. to Mocker > 40 µm)	[wt%]	< 0.03	< 0.03	< 0.05	< 0.05	< 0.1	< 0.1
Carbon content	[wt%] approx.			1.0	1.4	4.0	4.6
Surface modification				Silane	Silane	Siloxane	Siloxane

These figures are intended as a guide and should not be used in preparing specifications.

[1] On leaving the factory
[2] In case of hydrophobic silica: in water, methanol: 1:1

Hydrophilic Hydrophobic


ARRET DEMANDE

ELASTOSIL® C: SYSTEM SOLUTIONS FOR GREATER EASE AND EFFICIENCY

Silicone rubber grades from WACKER help simplify your work processes and boost their efficiency. Reusable silicone vacuum bags eliminate time-consuming sealing with vacuum film and sealing tape during the evacuation of composites molds. This significantly reduces costs for disposal, labor and material.

WACKER's ELASTOSIL® C 1200 offers an innovative system solution for manufacturing fiber composite materials economically using an infusion or prepreg method. Our rapid-curing, two-part ELASTOSIL® C 1200 silicone rubber permits fast production of reusable, precision-fit, fabric-reinforced silicone vacuum bags in a spray-up or lay-up method. Vacuum bags make it much easier to evacuate the composites mold.

Fewer Work Steps, Reusable Products

Only a few simple working steps are needed to manufacture silicone vacuum bags – and no major investment in materials, equipment or resources is required. Thanks to silicone rubber's heat stability, the silicone bags have constant properties over a wide temperature range and are suitable for multiple reuse – more than 300 times. Once made, these bags can be placed quickly and securely over the mold before each part is produced. Repeated, time-consuming sealing with conventional vacuum film is no longer necessary. This makes the production process quicker and simpler.

Your Advantages at a Glance:

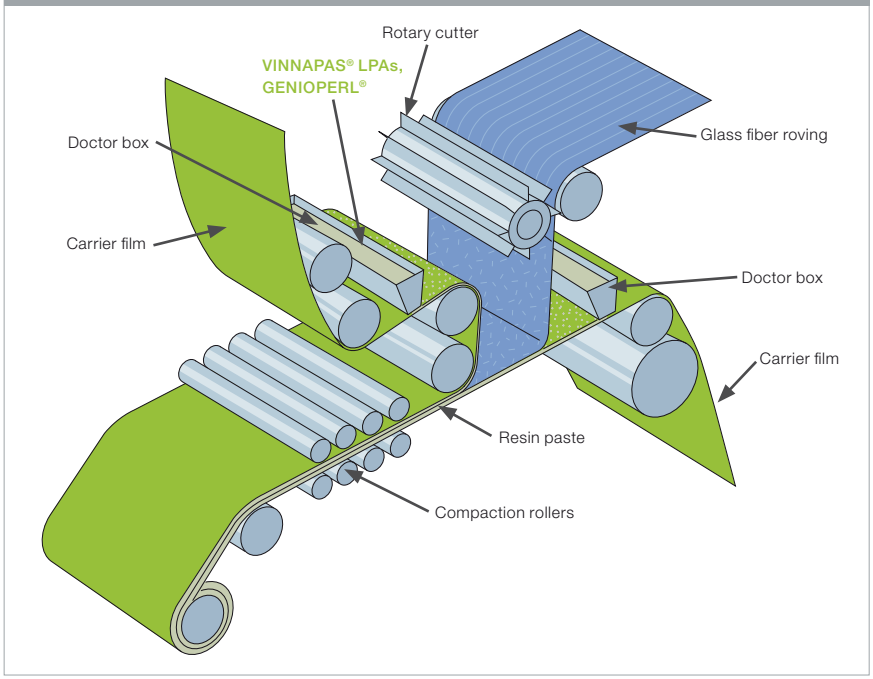
- Flexible
- Self-leveling
- Long pot life and curing times
- Suitable for large surfaces
- Suitable for vertical surfaces
- Frequent use

ELASTOSIL® C 1200 A/B – Silicone Rubber for Reusable Vacuum Bags			
Property			
Product data (catalyzed A+B)			
Pot life		[min]	20
Demolding properties		[min]	60
Product data (cured)			
Hardness, Shore A	ISO 868		25
Tensile strength	ISO 37	[N/mm²]	5
Elongation at break	ISO 37	[%]	500
Tear strength		[N/mm²]	25
Max. processing temperature		[°C]	220

For the infusion and prepreg methods, alongside resin additives, WACKER also supplies silicone rubber grades and fabrics for the production of vacuum bags. Thanks to the rubber's heat stability, the silicone vacuum bags have constant properties over a wide temperature range. Furthermore, they are suitable for multiple reuse – more than 300 times.

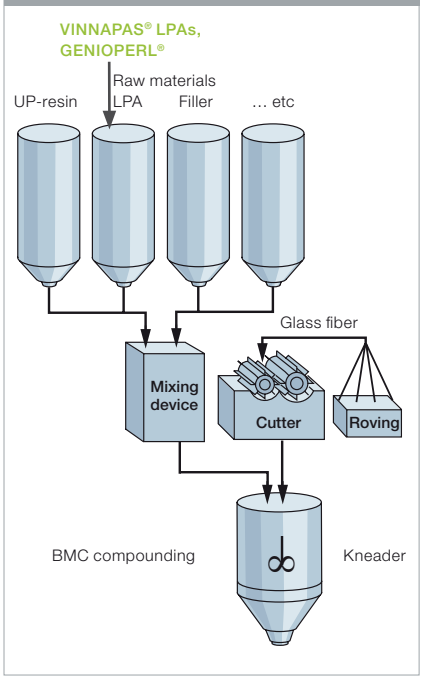
PROCESS/TECHNOLOGY

SMC



Like BMC, the SMC process is mainly used in the transportation, electrical and construction sectors.

BMC



BMC and SMC processes have more or less the same characteristics. However, BMCs contain shorter glass fibers, which allow the resin to flow easily into extremely small spaces.

Sheet molding compound (SMC) and bulk molding compound (BMC) processing are the two most widely used manufacturing techniques in closed compression molding. VINNAPAS® from WACKER is an effective low-profile additive for both processes.

Sheet Molding Compound

SMC resin mats are produced from a highly viscous fiber/resin compound. When the fiber/resin compound is processed in a closed mold under heat and pressure (approx. 70 bar), its viscosity decreases. That allows the resin containing the isotropically distributed reinforcing fibers to flow in the mold. The thermoset then cures within the closed mold.

WACKER Products Used

- VINNAPAS® LPAs
- GENIOPERL®

Bulk Molding Compound

BMC is a doughy mass that can be produced from any conventional thermoset matrix system and is processed by reaction injection molding. The BMC part can be produced as soon as the BMC compound has been mixed. The main difference from SMC is the fiber content and length.

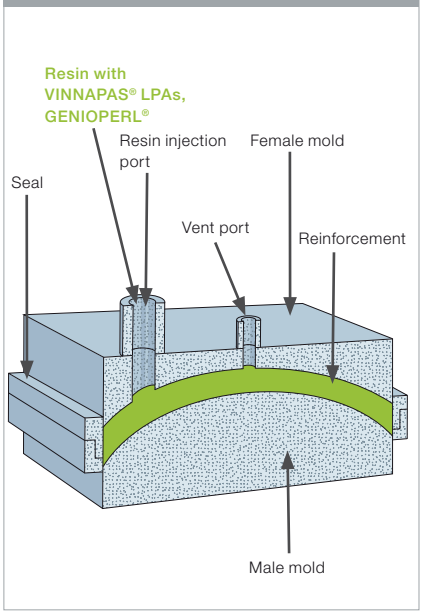
WACKER Products Used

- VINNAPAS® LPAs
- GENIOPERL®

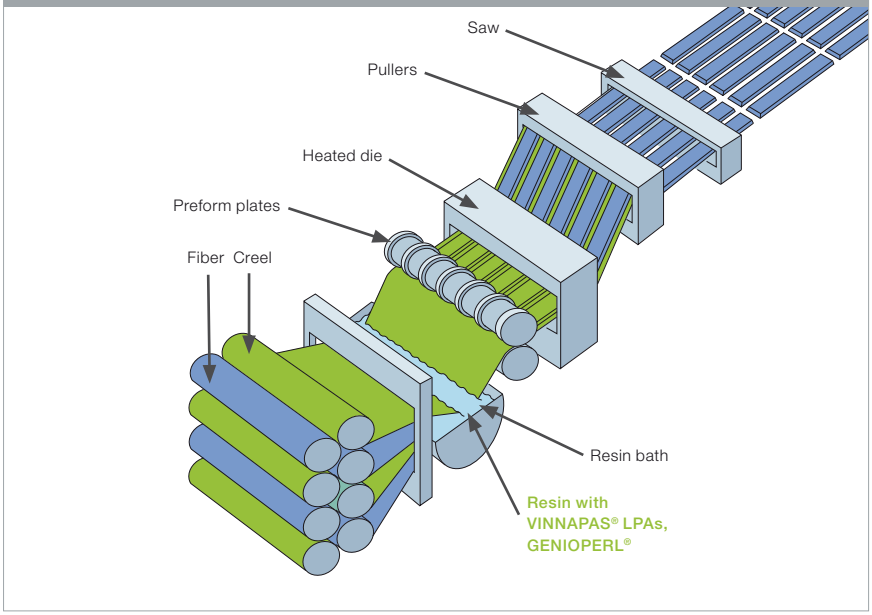
The Main Differences between SMC and BMC

	BMC	SMC
Glass fiber content	Lower	Higher
Pressure	110–150 bar	50–100 bar
Glass fiber length	6–12 mm	25–50 mm

RTM



Pultrusion



RTM: used in the transportation, wind power and construction sectors. It is particularly suitable for producing complex three-dimensional forms.

Pultrusion: used for consumer articles and in the electrical and construction sectors.

RTM

RTM (resin transfer molding) involves the injection of a low-viscosity thermoset into the closed mold under moderate pressure (usually 3.5 – 7 bar) via one or more injection ports. The injected resin fills all the voids in the mold, impregnating and wetting out the entire surface of the reinforcing material.

The reinforcement can comprise a variety of fiber types and forms, such as fiber tows, mats or woven structures. A vacuum is sometimes applied to enhance resin flow and reduce void formation. The composite part is typically heat cured.

WACKER Products Used

- VINNAPAS® LPAs
- GENIOPERL®

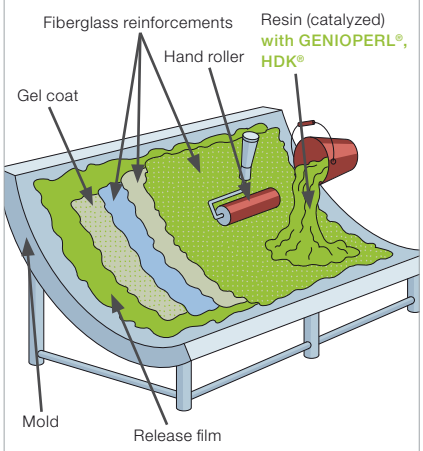
Pultrusion

In the pultrusion of thermosets, the reinforcing fibers are impregnated by passing them through a resin bath. The resin-impregnated fiber strand is then brought to the near net shape at a number of preform stations and shaped and cured in a heated mold.

WACKER Products Used

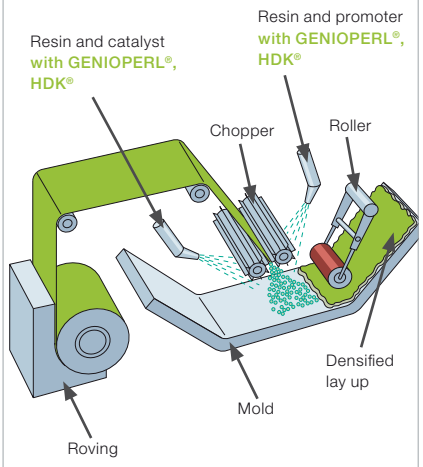
- VINNAPAS® LPAs
- GENIOPERL®

Hand Lay Up



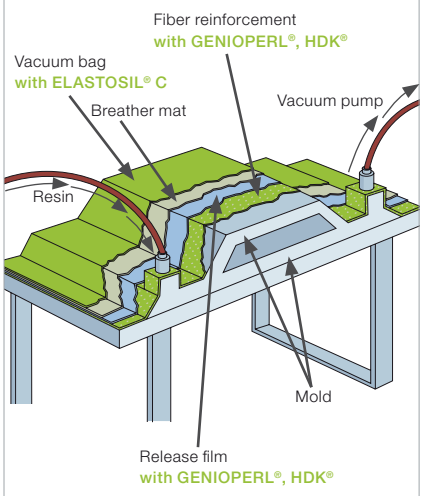
Hand lay up is the oldest composite process and is still used for many parts, especially where numbers are small.

Spray Up



Spray up processes are used in the manufacture of acrylic shell backings, for example.

Infusion



A high production quality and low emissions are major features of the infusion method.

Hand Lay Up

Following the liquid release agent (PVA, liquid wax or PTFE/silicone spray), a gel coat is applied. This is a resin coat that may contain fillers or pigments, or be reinforced with a glass fiber mat or a fine synthetic fabric. The following layers are then produced by applying resin to the surface followed by a reinforcing agent. The resin is forced through the reinforcing material to remove air and achieve complete impregnation. Spray up and hand lay up are the most widely used open-mold processes.

Among other functions, WACKER's HDK® serves as a highly specialized thixotropic agent for controlling flow behavior.

WACKER Products Used

- GENIOPERL®
- HDK®

Spray Up

Spray up methods are usually classified as contact molding. Chopped fibers and resins are charged into an open mold. In the process, the rovings are fed into a chopper and then blown into a precured resin. The advantage is the high speed at which the material can be applied. However, only relatively small volumes of reinforcing fibers can be achieved. After application, the material is usually consolidated with a hand roller in the same way as with hand lay up.

WACKER Products Used

- GENIOPERL®
- HDK®

Infusion and Prepreg Methods

The infusion method involves draping a dry fiber material over a mold coated with release agent. The fiber material is covered with peel ply and a resin distribution mesh that helps the resin to flow more evenly. A silicone vacuum bag is used to form a tight seal between this structure and the mold. The part is then evacuated by means of a vacuum pump. The air pressure presses the inserted parts together and holds them in place. The thermostated liquid resin impregnates the fiber material. Once the fibers have become fully saturated, the supply of resin is stopped. Having cured, the impregnated fiber composite material can then be demolded.

The only difference between this and the prepreg method is that the latter uses fabric pre-impregnated with resin.

To meet the needs of these methods, WACKER supplies silicone elastomers for reusable vacuum bags and additives for resins.

WACKER Products Used

- GENIOPERL®
- HDK®
- ELASTOSIL® C


Kindly provided by ENERCON GmbH

Product Overview

Products	Process/Applications					
	SMC	BMC	RTM	Infusion	Pultrusion	Spray Up
Performance Additives						
VINNAPAS®						
VINNAPAS® LL 8251	●	●	○	○	●	
VINNAPAS® C 341	●	●	○	○	●	
VINNAPAS® C 501	●	●	○		●	
VINNAPAS® B 60 sp	○	○	●	○	●	
VINNAPAS® B 100 sp	○	●	●	○	●	
VINNAPAS® UW 1 FS	○	●	○		●	
VINNAPAS® UW 4 FS	○	●	○		○	
VINNAPAS® UW 10 FS	○	●	○		○	
GENIOPERL®/VENTOTEC®						
GENIOPERL® P52	○	○	●	○	●	○
GENIOSIL®						
GENIOSIL® CS2						
HDK®						
HDK® N20				●		●
HDK® T30				○		○
HDK® H13L/H15						
HDK® H17/18						
Process Compound						
ELASTOSIL®						
ELASTOSIL® C1200 A/B				●		

● Recommended
○ Suitable



Hand Lay Up	Gelcoat (Hand Lay Up)	Topcoat (Hand Lay Up)	Grouts	Bonding Pastes	Laminating Resin	Composite Stone	Prepreg
○	○	○	●	●	○	○	○
						●	○
●	●	●	●	●	●	○	
○	●	●	○				
		●	○				
●	●	●	○	●			
							●

EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS

• Sales and production sites, plus 20 technical centers, ensure you a local presence worldwide.

WACKER is one of the world's leading and most research-intensive chemical companies, with total sales of €4.91 billion. Products range from silicones, binders and polymer additives for diverse industrial sectors to bio-engineered pharmaceutical actives and hyperpure silicon for semiconductor and solar applications. As a technology leader focusing on sustainability, WACKER promotes products and ideas that offer a high value-added potential to ensure that current and future generations enjoy a better quality of life based on energy efficiency and protection of the climate and environment. Spanning the globe with five business divisions, operating 25 production sites, WACKER is currently active in over 100 countries. The Group maintains subsidiaries and sales offices in 29 countries across Europe, the Americas and Asia – including a solidly established presence in China. With a workforce of 17,200, WACKER sees itself as a reliable innovation partner that develops trailblazing solutions for, and in collaboration with, its customers. WACKER also helps them boost their own success. Our technical centers employ local

specialists who assist customers worldwide in the development of products tailored to regional demands, supporting them during every stage of their complex production processes, if required. WACKER e-solutions are online services provided via our customer portal and as integrated process solutions. Our customers and business partners thus benefit from comprehensive information and reliable service to enable projects and orders to be handled fast, reliably and highly efficiently.

Visit us anywhere, anytime around the world at: **www.wacker.com**

All figures are based on fiscal 2011.

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