

WACKER

CREATING TOMORROW'S SOLUTIONS


GENIOSIL®

GENIOPLAST®

GENIOPERL®

PLASTICS INDUSTRY | PERFORMANCE ADDITIVES

SILANES AND SILICONES
FROM WACKER: BETTER YET –
ADD PERFORMANCE TO YOUR
PLASTICS!



Cars, cables, shoes, packaging, pipes, films, toys ... plastics are part of our world. And as our world changes, the demands for plastics change, too. At WACKER we help you meet these demands with unique expertise in organic and inorganic chemistry.

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KEEP PACE WITH A GROWING MARKET

From lightweight constructions in cars or airplanes to toys and packaging: plastics continue to play an increasing role in everyday life. But as application areas become broader, the performance demands grow, too. WACKER silicones and silanes make it possible to meet these demands cost efficiently.

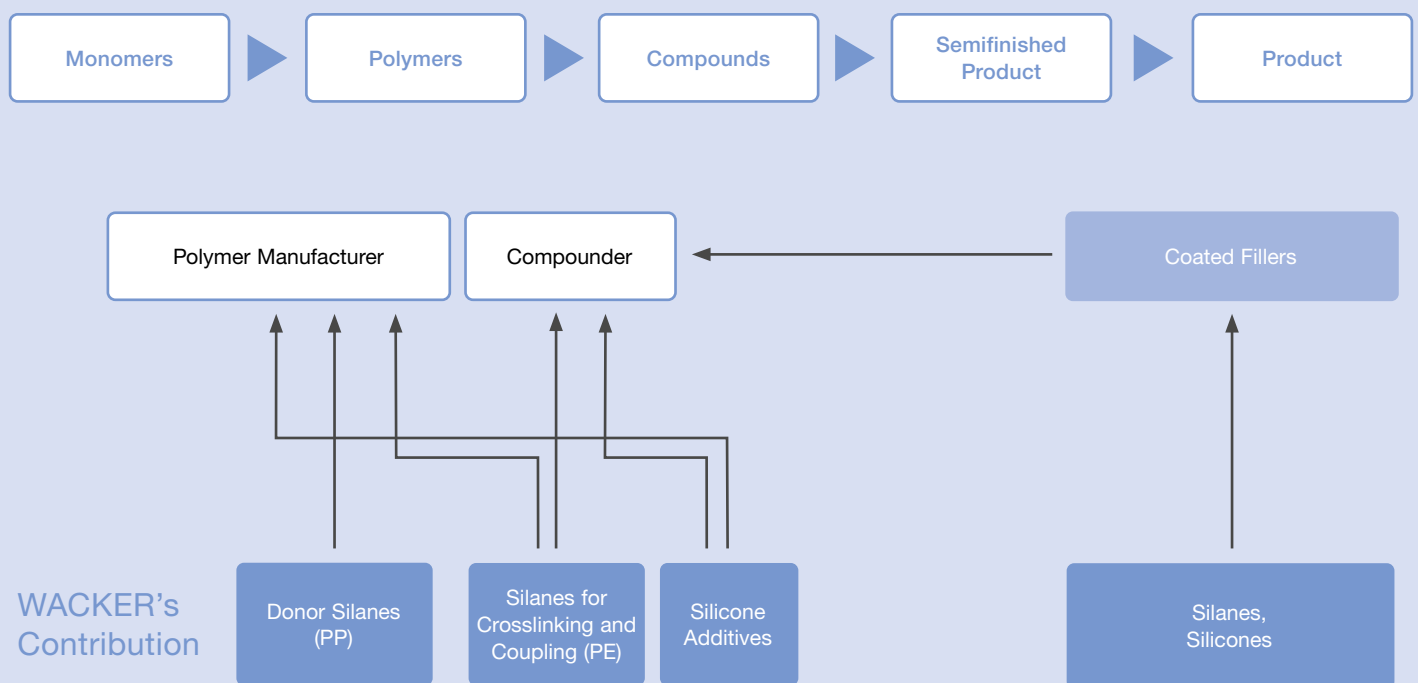
New applications open up new possibilities for plastics. But they also require plastics with new characteristics. To meet these requirements, there are two options. One is to develop novel plastics with a greater property profile: a challenging task with usually high development costs, large capital investment and long development cycles. The other is to modify existing plastics through innovative additive technology: an option which is more and more popular due to its cost efficiency.

This is reinforced by the dynamic growth of the plastic additives market worldwide. Innovation in plastics has been proven to come from additives and the performance enhancement that they provide. To realize this potential, WACKER offers you a wealth of different solutions.

WACKER is a leading chemical company with extensive expertise in silane- and silicone-based chemistry. We understand organic and inorganic chemistry, offering you innovative additives which add superior characteristics to thermoplastics.

ONE PARTNER – MANY BENEFITS

WACKER's Contribution Along Value Chain Plastics



There are various ways to enhance the performance of plastics. With WACKER you have them all at hand – from one single source.

Your Benefit

Dealing with one partner is easier and provides better results faster. Our silicones and silanes can be used at different stages of the value chain, individually or combined. This opens up choices and makes our experts valuable partners: they know from experience what will work and what the effects will be. This know-how is part of our product offering.

Our Offering

Silanes and silicones are not only essential aids for designing polymers chemically; they can also be added to polymers to modify their properties, e.g. to enhance demolding properties and surface smoothness, to maximize impact strength and flexibility, even at low temperatures, to raise resistance to environmental influences, and to distribute the filler more uniformly in the polymer while reinforcing the bond between them.

Silanes and silicones from WACKER can be used:

- For polymerization catalysis
- As process chemicals and additives
- For polymer modification
- For polymer crosslinking

STANDARD PLASTICS

CONTROLLING PROPERTIES: DONOR SILANES

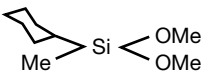
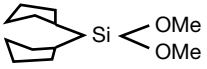


Production of polyethylene and polypropylene by polymerization of olefins in the presence of Ziegler-Natta catalysts is carried out on an industrial scale and is of major economic importance.

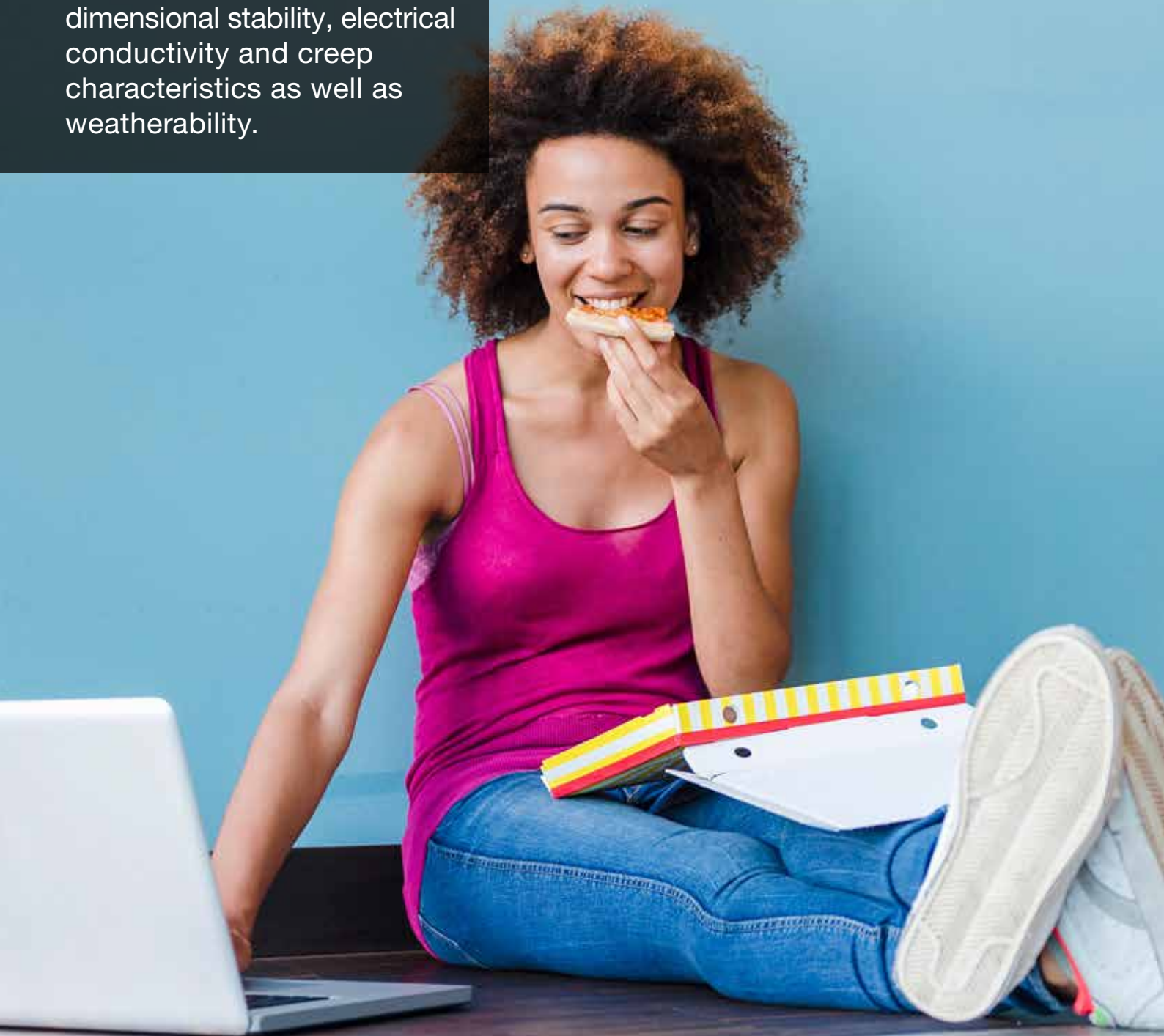
Unlike polyethylene, polypropylene and its copolymers must be stereospecific if the end products are to be of high quality and have good polymer properties. Production is therefore closely controlled to ensure a high yield of isotactic polymer. Stereospecificity can be boosted by adding special alkyl-alkoxysilanes to the catalyst. This not only increases the yield of isotactic polypropylene and promotes catalytic activity but also affords a way of controlling other important polymer properties, such as molecular weight and molecular weight distribution. Silane CHM-Dimethoxy ("donor C") and Silane CP2-Dimethoxy ("donor D") are used around the world as "donor silanes" for the production of polypropylene. Silane CHM-Dimethoxy is mainly used to manufacture PP homopolymer, and Silane CP2-Dimethoxy is primarily for PP copolymers.

The convenience of consumer goods would be unimaginable without plastic. At the same time packaging must fulfill many expectations – such as cost efficiency, high or low temperature resistance, food compliance, biodegradability. Additives are a resourceful way to balance characteristics in line with these expectations.

WACKER Silanes for the Production of Polypropylene

Silane	Chemical Name	Structural Formula
CHM-Dimethoxy	Cyclohexylmethyldimethoxysilane	
CP2-Dimethoxy	Dicyclopentylidimethoxysilane	

Silane crosslinking technology makes it possible to convert inexpensive thermoplastic polymers into crosslinked polymers. The result is a great improvement in heat and dimensional stability, electrical conductivity and creep characteristics as well as weatherability.



STANDARD PLASTICS

UPGRADING QUALITY: POLYETHYLENE CROSSLINKING AND COUPLING

Today, silane crosslinking is an established way of producing low and medium voltage cable from crosslinkable polyethylene (PEX). But technological diversity, economics and the new olefins produced by metallocene catalysis are opening up numerous other new applications. These include production of PEX pipes commonly used for hot water and underfloor heating, transfer of polyethylene technology to ethylene copolymers and polypropylene, development of new process technologies for single-parts production and the production of polyolefin foams.

PEX compounds may be produced and processed by either the SIOPLAS or the MONOSIL methods in which vinylalkoxy silanes are grafted onto the polyethylene. As with the SIOPLAS method, it is also possible to process PE and copolymer com-

pounds produced by direct copolymerization of ethylene, vinylalkoxy silane and, where appropriate, other monomers.

GENIOSIL® XL 10 and GENIOSIL® GF 56 are used for silane crosslinking and the production of crosslinkable polyolefin compounds. Faster crosslinking catalysts and the development of ambient curing systems require better storage stability of SIOPLAS compounds. Here, WACKER® Silane HD-Trimethoxy is used as a water scavenger and precuring retarder. This can increase shelf life as well as safety in the handling and processing of silane crosslinkable compounds.

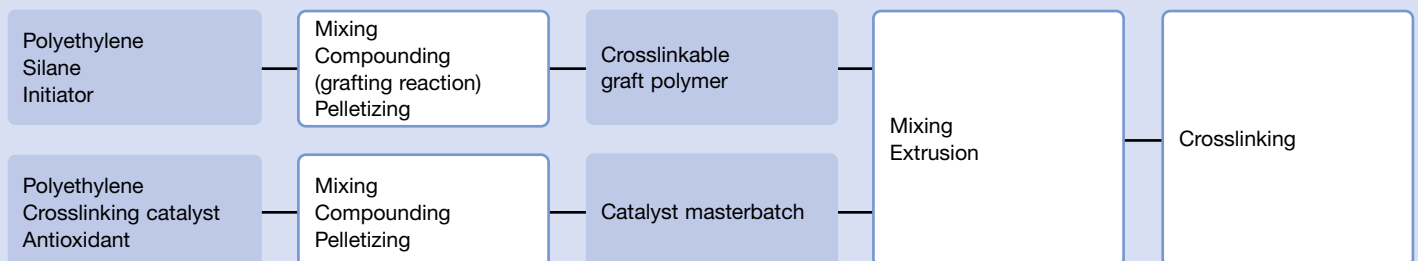
GENIOSIL® GF 51 is applied in compounds for flexible filled rubber cables and, unlike other state-of-the-art coupling agents, does not release SVHC when applied.

WACKER Silanes for Polyethylene Crosslinking and Coupling

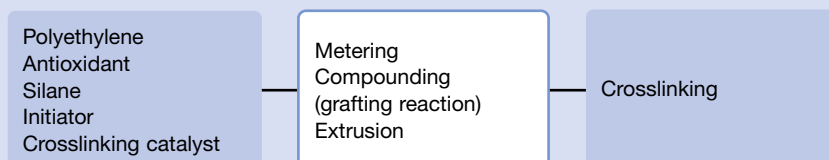
Silane	Chemical Name	Chemical Formula
GENIOSIL® XL 10	Vinyltrimethoxysilane	$H_2C=CHSi(OCH_3)_3$
GENIOSIL® GF 51	Formulated product	
GENIOSIL® GF 56	Vinyltriethoxysilane	$H_2C=CHSi(OC_2H_5)_3$
WACKER® SILANE HD-Trimethoxy	Hexadecyltrimethoxysilane	$C_{16}H_{33}Si(OCH_3)_3$

Standard Plastic

The SIOPLAS Process



The MONOSIL Process



STANDARD AND ENGINEERING PLASTICS IMPROVE PROCESSING AND QUALITY – COMPOUNDING ADDITIVES



From smartphones to portable media players: plastics are an essential part of our lives. Additives ensure that the plastic has the desired properties and improve its processability.

WACKER Product	Chemical Characteristics	Physical Characteristics
GENIOPLAST® Pellet S	Ultrahigh-molecular-weight polydimethylsiloxane in pellet form	White translucent cylindrical pellets, diameter and length each approx. 4 mm
GENIOPLAST® Pellet P Plus	Ultrahigh-molecular-weight polydimethylsiloxane in pellet form for food-contact applications	White translucent cylindrical pellets, diameter and length each approx. 4 mm
GENIOPLAST® PP50S12	Ultrahigh-molecular-weight polydimethylsiloxane masterbatch on PP carrier	White pellets of approx. 3–4 mm; also available as microgranules of approx. 1 mm
GENIOPLAST® PP20A08	Silicone copolymer masterbatch on PP carrier	White pellets of approx. 3–4 mm
GENIOPLAST® Pellet 345	Thermoplastic silicone elastomer based on proprietary silicone copolymer technology	Transparent pellets of approx. 3–4 mm
GENIOPLAST® Fluid FR	Formulation comprising high-molecular-weight polydimethylsiloxane and silicone resin	Clear, colorless, high-viscosity fluid, typical viscosity approx. 500,000 mm ² /s
GENIOPLAST® Fluid 110	Food-compliant silicone based additive specifically for PVC applications	Clear, colorless, low-viscosity fluid
GENIOPLAST® Fluid 220	Silicone based additive specifically for polyolefin applications	Clear, colorless, medium-viscosity fluid
WACKER® AK Silicone Fluids (AK 100 – AK 1,000,000)	Polydimethylsiloxanes	Clear, colorless fluids; relevant viscosity range: 100 – 1,000,000 mm ² /s
WACKER® Fluids IM and NH	Linear polydimethylsiloxanes with terminal organofunctional (carbinol, epoxy, amino) groups	Low- to medium-viscosity fluids
GENIOPERL® P 15	Polysilsesquioxane (silicone resin) microparticles	White powder
GENIOPERL® P 52	Core-shell particles consisting of a crosslinked silicone core and a shell based on an organic polymer	White powder
GENIOPERL® W 35	Functionalized silicone copolymer	Opaque, lens-shaped pellets, diameter/thickness approx. 5 mm/2 mm



GENIOPLAST® and WACKER® AK Silicone Fluids are perfect products for processing and modifying thermoplastic resins. They find applications as compounding additives for standard plastics as well as for engineering plastics.

General Benefits for Thermoplastic Polymers

On addition of 0.1 – 1%:

- Improved processing and flow properties
- Less extruder torque
- Significantly faster throughput
- Internal lubrication
- Better mold filling and mold release
- Reduced warpage of moldings

On addition of 1 – 5%:

- Better surface properties for the moldings
- Improved surface smoothness
- Lower coefficient of friction
- Greater scratch and abrasion resistance
- Better mechanical properties

Specific Gains

GENIOPLAST® Pellet S

GENIOPLAST® Pellet S is a unique product concept, providing an outstanding high loading of ultrahigh-molecular weight polydimethylsiloxane and general compatibility with thermoplastic resins. Major applications of GENIOPLAST® Pellet S comprise improved processing of cable compounds. GENIOPLAST® Pellet S is also applied for better processing and surface properties in engineering plastic compounds and for thermoplastic elastomers.

GENIOPLAST® Pellet P Plus

GENIOPLAST® Pellet P Plus provides the same benefits as GENIOPLAST® Pellet S but has been specifically developed for applications where food-contact regulations must be met.

GENIOPLAST® PP50S12

GENIOPLAST® PP50S12 is a 50% silicone gum masterbatch on PP carrier and has been specifically designed for automotive interior applications. Contrary to amides and other fatty acids, GENIOPLAST® PP50S12 does not migrate and bloom outside the interior part. Therefore, GENIOPLAST® PP50S12 does not contribute to fogging and stickiness. Main benefits are improvement of scratch performance and improvement of surface aspects (soft touch, not sticky, non-blooming).

GENIOPLAST® PP20A08

GENIOPLAST® PP20A08 is a 20% masterbatch of a proprietary silicone copolymer on PP carrier and has been specifically designed for WPC (wood-plastic composite) applications. Unlike standard lubricants (stearates, PO waxes, long chain amides), GENIOPLAST® PP20A08 does not influence the coupling agent and, in a low dosage (1–3%), has no impact on mechanical properties. Its main benefits are improvement of water absorption, reduced swelling and enhanced scratch resistance in WPC decking.

GENIOPLAST® Pellet 345

GENIOPLAST® Pellet 345 is a thermoplastic silicone elastomer based on a proprietary silicone copolymer technology. Used as an additive at a dosage level of up to 5%, GENIOPLAST® Pellet 345 improves the surface properties of organic polymers (slip, non-adhesion, scratch resistance) as well as the processing of certain TPEs. Applied in polymer blends (e.g. TPU or TPA) in amounts of 10% and above, GENIOPLAST® Pellet 345 additionally modifies physical properties (e.g. hardness, modulus and elongation).

GENIOPLAST® Fluid FR

GENIOPLAST® Fluid FR, a silicone-based flame-retardant additive, is specifically applied when balanced requirements regarding processing, surface properties and thermal/mechanical characteristics must be met.

GENIOPLAST® Fluid 110 and Fluid 220

GENIOPLAST® Fluid 110 has been specifically designed for PVC applications. GENIOPLAST® Fluid 110 has an outstanding property profile which sets it apart from conventional internal and external lubricants, improving e.g. processing, thermal stability and mechanical properties. GENIOPLAST® Fluid 220 has been developed as an additive specifically for processing of highly mineral-filled, crosslinkable polyolefin compounds.

WACKER® AK Silicone Fluids

WACKER® AK Silicone Fluids, available in viscosities ranging from 100 to 1,000,000 mm²/s, provide manifold processing benefits to standard and engineering plastics compounds. As mentioned, the range of benefits varies with the quantity added to thermoplastic resins.

WACKER® Fluids IM and NH

WACKER® Fluids IM and NH are linear polydimethylsiloxanes with terminal functional groups. They can be incorporated by chemical reaction into engineering plastics in the polymer-manufacturing step. Different functional groups – carbinol (IM 11, IM 15, IM 22), epoxy (IM 35), amino (NH15, NH 30, NH 130) – and silicone chain lengths are available and can help to improve mechanical and flow properties of TPUs, polyester and other engineering resins.

GENIOPERL® P 15

GENIOPERL® P 15 is a polysilsesquioxane micro-particle with a defined, narrow, monomodal size distribution. Due to the defined diameter, these particles offer excellent properties as an antiblock in polyolefin films even in very low concentration and therefore could provide high clarity films.

GENIOPERL® P 52

GENIOPERL® P 52 is a particulate polymer modifier in powder form. The spherical, reversibly agglomerated primary particles consist of a low-modulus, crosslinked silicone core and a shell based on an organic polymer. GENIOPERL® P 52 is used in thermoplastic and thermoset formulations to improve the toughness and impact properties.

GENIOPERL® W 35

GENIOPERL® W 35 is a functionalized silicone copolymer in pellet form. GENIOPERL® W 35 is applied in thermoset formulations like epoxy resins or vinyl esters to improve the toughness and impact properties of the cured resins. It is typically used at dosage levels of up to 5% and due to its specific structure the impact on final resin properties is almost negligible.

For more information on GENIOPLAST® and WACKER® AK Silicone Fluids, please refer to the various brochures available.

Target Polymers That Can Be Modified

Polymers that stand to benefit from WACKER silicones and silanes:

Standard Plastics

Polyethylene (PE-LD, PE-LLD, PE-HD), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS, EPS)

Engineering Plastics

Styrene copolymers (ABS, SAN, ASA), polyamide (PA), polycarbonate (PC), polymethyl methacrylate (PMMA), polyester (PET, PBT), polyacetal (POM), polyphenylene ether (PPE) and blends (PC/ABS, PC/ASA, PPE/PS, PPE/PA etc.)

Thermoplastic Elastomers

Styrene block copolymers (SBS, SEBS, SEPS), thermoplastic polyurethanes (TPU), polyolefins (TPO) and copolyester (TPE-E)

Our special brochures describe the kinds of performance improvements achievable when GENIOPLAST® additives are used for:

Polyolefin Compounds



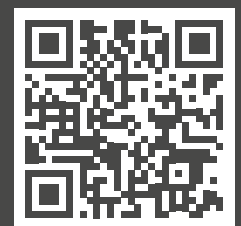
Engineering Compounds



Thermoplastic Elastomers

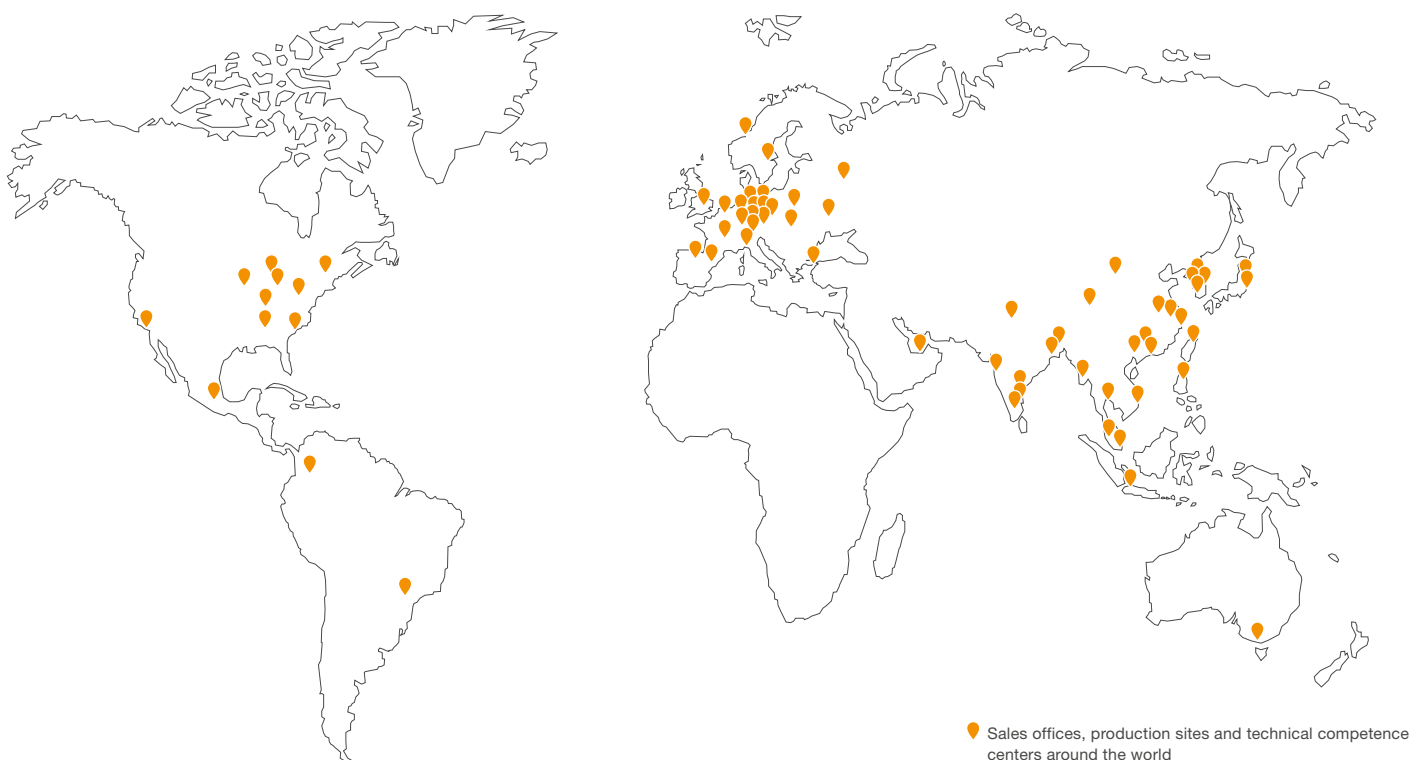


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EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS



WACKER is one of the world's leading and most research-intensive chemical companies, with total sales of €4.93bn. Products range from silicones, binders and polymer additives for diverse industrial sectors to bioengineered 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 4 business divisions, we offer our customers highly-specialized products and comprehensive service via 24 production sites, 23 technical competence centers, 14 WACKER ACADEMY training centers and 51 sales offices in Europe, North and South America, and Asia – including a presence in China. With a workforce of some 14,700, we see ourselves as a reliable innovation partner that develops trailblazing solutions for, and in collaboration with, our customers. We also help them boost their own success. Our technical competence 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



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