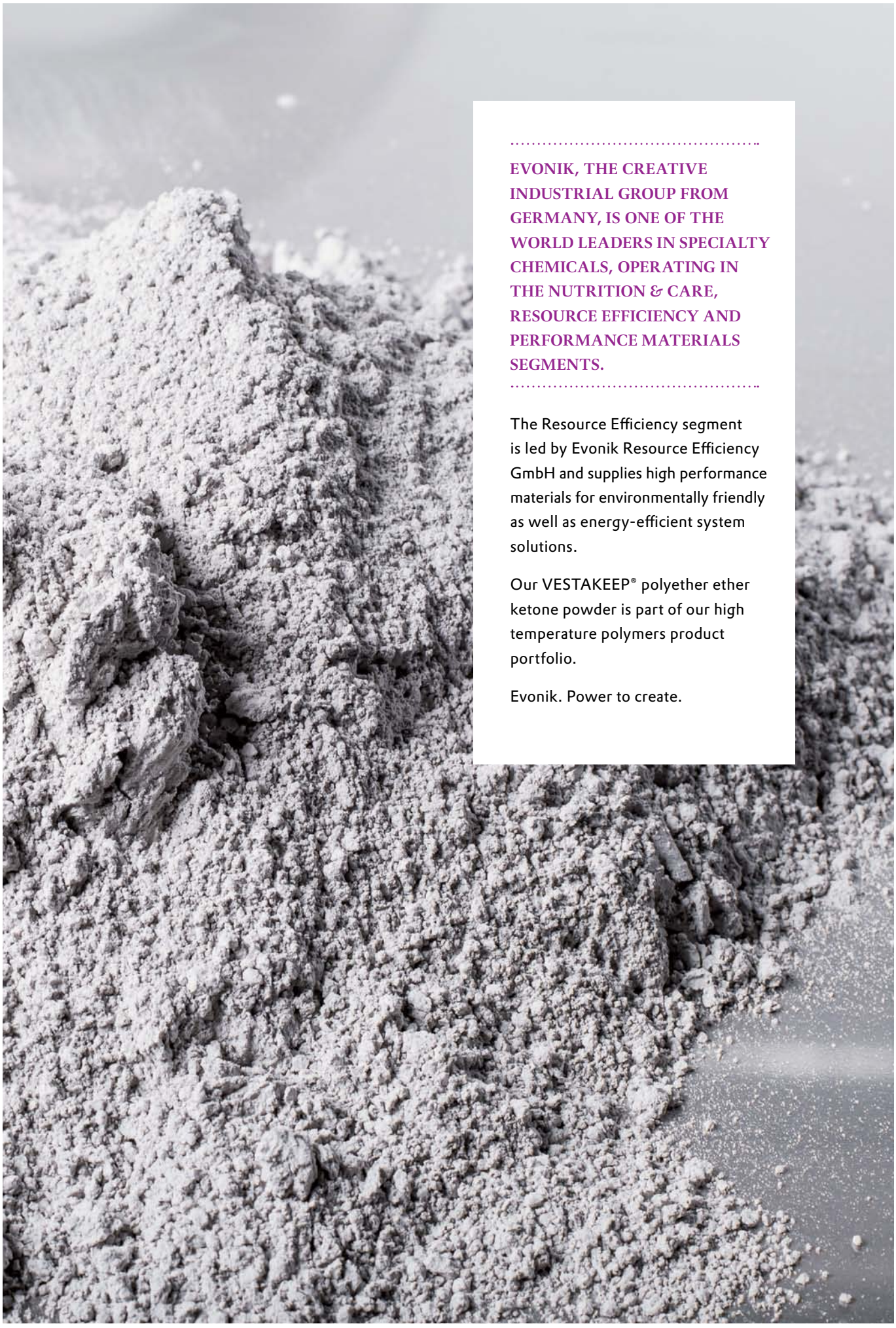
HIGH PERFORMANCE IN POWDER FORM

Polyether Ether Ketone Powders

VESTAKEEP®

EVONIK
POWER TO CREATE

CONTENT

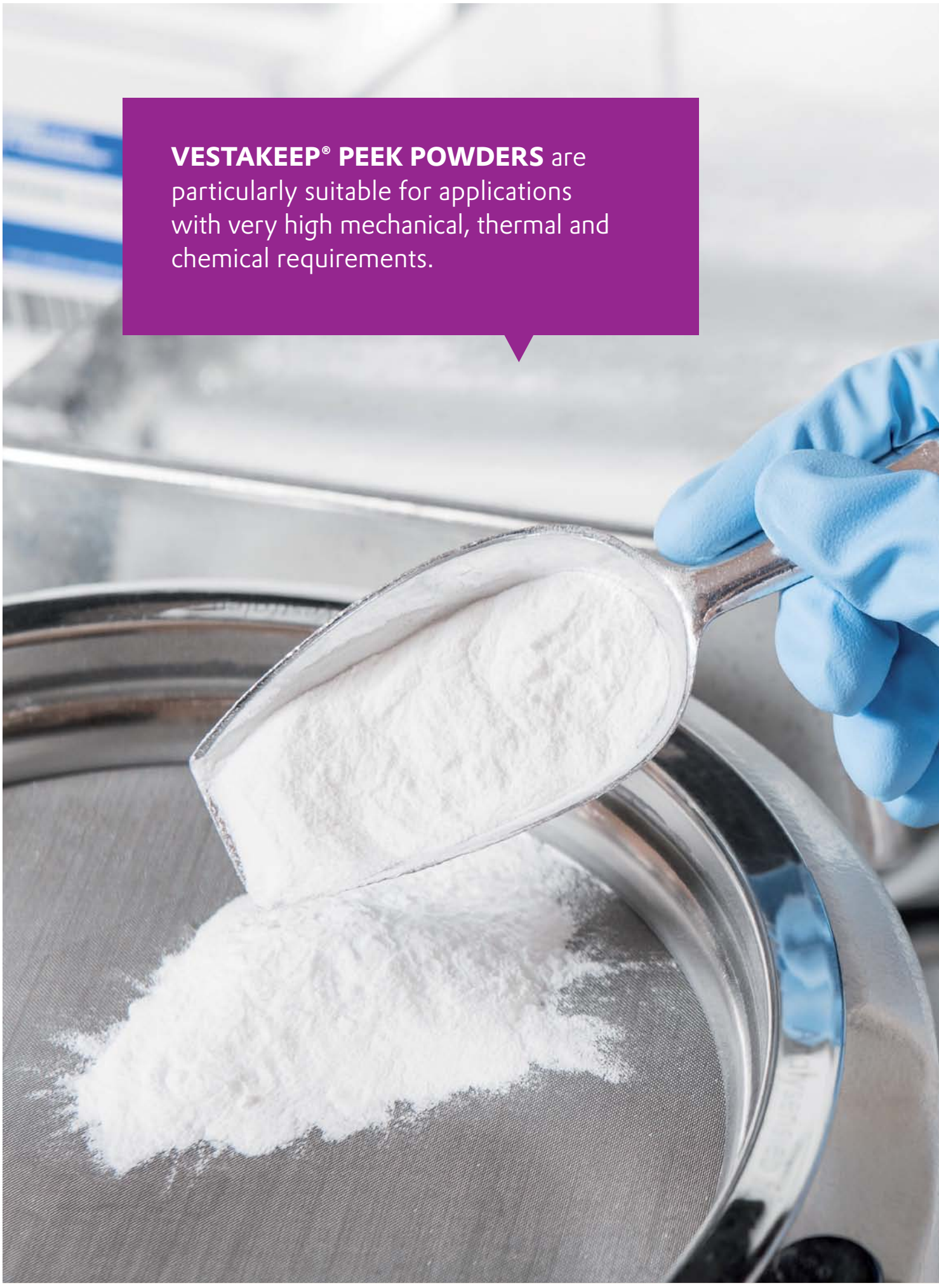


EVONIK, THE CREATIVE INDUSTRIAL GROUP FROM GERMANY, IS ONE OF THE WORLD LEADERS IN SPECIALTY CHEMICALS, OPERATING IN THE NUTRITION & CARE, RESOURCE EFFICIENCY AND PERFORMANCE MATERIALS SEGMENTS.

The Resource Efficiency segment is led by Evonik Resource Efficiency GmbH and supplies high performance materials for environmentally friendly as well as energy-efficient system solutions.

Our VESTAKEEP® polyether ether ketone powder is part of our high temperature polymers product portfolio.

Evonik. Power to create.



VESTAKEEP® PEEK POWDERS are particularly suitable for applications with very high mechanical, thermal and chemical requirements.

HIGH PERFORMANCE **IN POWDER FORM**

Evonik markets its VESTAKEEP® compounds and powders worldwide. A proven quality management system—from development, through production, all the way to quality assurance—ensures the high quality of products entering the market.

Our system is certified to ISO 9001:2008 and ISO 14001:2009, and is constantly optimized. Over the years, numerous customers have tested this quality system and confirmed its superiority.

This brochure provides an overview of the properties and applications of VESTAKEEP® powders, which are available in various particle sizes and viscosities (molecular weights), for different processing methods, as well as processing instructions.

VESTAKEEP® PEEK is particularly characterized by the following material properties

- Very high heat deflection temperature
- High stiffness
- Low water absorption and therefore high dimensional stability
- High hardness
- Good strength
- Excellent sliding friction behavior
- Very minimal abrasion
- Good electrical properties
- Excellent chemical resistance
- Excellent hydrolytic stability
- Good processability
- No tendency to stress cracks

PROPERTIES

Example: VESTAKEEP® 2000 P measured on a tensile bar

MANUFACTURE

VESTAKEEP® PEEK is polycondensed from the building blocks hydroquinone and 4,4´-difluorobenzophenone in a multi-stage process.

The base grades have a melt viscosity of 100 to 5000 Pas, measured at 400 °C and a shear rate of 1 s^{-1}.

APPLICATION

VESTAKEEP® powders can be used in a wide range of applications, for example in electrical, electronic, and communications engineering, and also in the automotive, aviation and food industries.

They can be processed with a number of methods, such as compression molding, electrostatic powder spraying, flame spraying, and scattering. They can also be used as a suspension in aqueous as well as solvent-based systems.

CHEMICAL RESISTANCE

Due to its chemical structure VESTAKEEP® PEEK features an outstanding chemical resistance.

Physical and thermal properties and fire behavior		Test method	Unit	VESTAKEEP® 2000 P
Density	23 °C	ISO 1183	g/cm³	1.30
Melting range	DSC, 2nd heating		°C	approx. 340
Volume flow rate (MVR)	380 °C / 5 kg	ISO 1133	cm³/10 min	70
Temperature of deflection under load	Method A: 1.8 MPa	ISO 75-1/2	°C	155
	Method B: 0.45 MPa	ISO 75-1/2	°C	205
Linear thermal expansion	23 °C - 55 °C, longitudinal	ISO 11359	$10^{-4}\,K^{-1}$	0.6
Flammability acc. UL94	3.2 mm	IEC 60695		V-0
Glow wire test	GWIT 2 mm	IEC 60695-2-12/13	°C	800
	GWFI 2 mm	IEC 60695-2-12/13	°C	960
Mechanical properties				
Tensile test	50 mm / min	ISO 527-1/-2		
Stress at yield		ISO 527-1/-2	MPa	100
Strain at yield		ISO 527-1/-2	%	5
Strain at break		ISO 527-1/-2	%	30
Tensile modulus		ISO 527-1/-2	MPa	3700
CHARPY impact strength	23 °C	ISO 179/1eU	kJ/m²	N
	-30 °C	ISO 179/1eU	kJ/m²	N
CHARPY notched impact strength	23 °C	ISO 179/1eA	kJ/m²	6 C
	-30 °C	ISO 179/1eA	kJ/m²	6 C

DELIVERY

Powder:
in 10 kg boxes with moisture-proof PE liners. A pallet holds 25 boxes with a total weight of 250 kg.

Fine powder:
in 15 kg boxes with moisture-proof PE liners. A pallet holds 25 boxes with a total weight of 375 kg. We can also deliver in bulk packaging upon request.

Under normal storage conditions, storage time is practically unlimited as long as the packaging has not been damaged. You should avoid storing at temperatures above 45 °C.

Like other partially crystalline polyaryl ether ketones, unmodified VESTAKEEP® appears amber-colored in the melt and grayish in its solid crystalline state (natural colors). VESTAKEEP® PEEK is translucent in its solid, amorphous state and has a characteristic amber color.

The powders are available in the five viscosity series VESTAKEEP® 1000, 2000, 3000, 4000 and 5000 where 1000 indicates the lowest viscosity and 5000 the highest.

VESTAKEEP® POWDER **PROCESSING**

COATING PROCESSES

Electrostatic spraying
In the EPS (electrostatic powder spraying) process, the powder is electrostatically charged by an electrical field of high field strength on the spray nozzle.

Flame spraying
In this process, the combustion of a gas/oxygen mixture generates the thermal energy to melt the powder and warm the surface of the substrate. A carrier gas—normally compressed air—serves as the medium for transporting the melted particles to the substrate surface.

The advantages of this process include low investment costs and the option of coating large parts on site, without an oven. VESTAKEEP® 2000 FS is best suited for this application because it has a sufficiently low melt viscosity.

Dispersion coating
Dispersions based on VESTAKEEP® fine powder can be used to coat metal surfaces. These can be processed by dipping or by spray gun. Dispersions are particularly suitable for the manufacture of thin layers and for geometries that cannot be electrostatically coated. No costly equipment is needed. Medium-viscosity VESTAKEEP® powder is especially suitable for dispersion coating. They have good flow properties and result in smooth surface coatings.

Pretreatment

No matter the coating process: The better the pretreatment, the better the adhesion. This is why the parts to be coated must be prepared by sandblasting and degreasing in suitable solvents prior to coating. This step removes impurities and prepares the surface of the metal for optimal adhesion.

Corundum or steel greet should be used as the blasting agent. Spherical blasting agents like glass pearls are not suitable because they do not roughen the surface. Blasted grease- and oil-free metal parts corrode very quickly, and should therefore be processed as soon as possible after blasting.

A primer for improving adhesion is not required. Zinc and iron phosphating should also be avoided. These conversion layers begin to disintegrate above 200 °C and generate a separating layer, which impairs adhesion.

Aftertreatment

Before cooling, the parts should be heated in an oven until the coating is evenly melted on them. The degree of crystallinity can be set through the cooling process. Water and sudden cooling result in amorphous and therefore transparent coatings. The crystallinity of amorphous layers can be increased by conditioning the coating. This is usually done at 200 °C in a circulating air oven. The amount of time required depends on the mass of the coated parts.

Concerning components with a large thermal mass, slow cooling rates can result in cracks in the coating. In these cases the suitable cooling rates should be determined empirically. Chilling in water can lead to thermal shock and should be avoided.

COMPOSITES

Fiber composites
To produce fiber composites, unidirectional fiber layouts or fabrics, glass, carbon or aramid fibers are impregnated with VESTAKEEP® as a matrix. Powder or dispersion coating processes are the preferred technologies. For the production of composites, we recommend the low-viscosity VESTAKEEP® powders of the 1000 and 2000 series. The particle size depends on the process. FP and UFP powders are preferred.

COMPRESSION MOLDING

Compression molding produces molded parts by subjecting them to pressure in a mold. The properties of compression molded parts are different from those of injection-molded parts. Normally, pressed parts have a higher level of crystallinity, and are therefore more rigid and solid but also harder and more brittle.

The compression molding cycle includes

- Compressing the polymer in a mold
- Heating the system above the melt temperature
- A holding phase for further compressing
- A cooling phase

P and FP powder grades are normally used in compression molding. If granulates would be used, the air inclusion would be too large, and with finer powders the molds are difficult to fill. Here, bridging can also cause air pockets, which results in porous components. By adding PTFE, graphite, nanoscale titanium oxide or silicon oxide, glass or carbon fibers, for example, certain properties such as surface hardness, frictional coefficient and abrasion resistance can be selectively improved.

To prevent bubble formation through moisture, the powder should be dried for 3 hours at 150 °C or overnight at 120 °C, either in the drying cabinet or in the mold prior to processing.

For easier demolding, small amounts (2 to 3%) of PTFE can be added to the powder. Before the mold is heated, the powder is compressed to allow air to escape. Processing parameters such as pressure, temperature, holding time, etc. depend on the quantity of powder, the surface area and geometry of the mold, and must be determined case by case.

To prevent stresses in the part, cooling should be slow and controlled and not exceed 40 K/hour. At approximately 140 to 150 °C, the part can be removed from the mold.

VESTAKEEP® POWDERS
PRODUCT OVERVIEW

VESTAKEEP® Easy Slide P
New PEEK powders for tribological coatings

VESTAKEEP® POWDER GRADES

VESTAKEEP® POWDER	High viscosity	Medium viscosity	Low viscosity	Average particle size (d50) [µm]	Particle size distribution [µm]	Scattering powder	Compression molding	Flame spraying	Electrostatic spraying	Suspension
5000 P	●				approx. 500 - 2,500	●	●			
5000 FP	●			approx. 65			●		●	
5000 UFP20	●			approx. 20					●	
4000 P	●				approx. 500 - 2,500	●	●			
4000 FP	●			approx. 60			●		●	
2000 P		●			approx. 500 - 2,500	●	●			
2000 FS		●		approx. 110		●	●	●		
2000 FP		●		approx. 55			●		●	
2000 UFP20		●		approx. 20					●	●
2000 UFP10		●		approx. 10					●	●
1000 P			●		approx. 500 - 2,500	●	●			
1000 FS			●	approx. 110		●	●	●		
1000 FP			●	approx. 55			●		●	
1000 UFP20			●	approx. 20					●	●
1000 UFP10			●	approx. 10					●	●
1000 UFP5			●	approx. 5					●	●

KEY TO PRODUCT DESCRIPTION

P	Powder
FP	Fine powder
UFP	Ultrafine powder

VESTAKEEP®	2000	UFP	20
Trade name	Viscosity	Ultrafine powder	Average particle size d50 in micrometers

TOXICOLOGICAL EVALUATION, SAFETY AND ENVIRONMENTAL COMPATIBILITY

INFORMATION AND TIPS

VESTAKEEP® powders are water-insoluble, solid polymers. Because of their high molecular weight, they are not absorbed through the skin, or through the respiratory or gastrointestinal tracts. VESTAKEEP® powders are, therefore, largely physiologically inert and do not cause systemic toxicity.

As in the case of other inert dusts, exposure to VESTAKEEP® dusts could possibly result in mechanical irritation in the upper respiratory passages and the mucous membranes of the eye. Product dust can remove the skin's natural moisture, and this dryness can cause patchy irritation. Sensitization of the skin is not expected.

Steps must always be taken to ensure adequate ventilation and exhaust when processing thermoplastics.

Based on our best current understanding, VESTAKEEP® powders do not have any adverse effects on man, animals, plants, or microorganisms. For labeling in accordance with applicable legislation, as well as the water hazard classification, please consult the most recent safety data sheet.

VESTAKEEP® powders can be disposed of in accordance with local regulations. The EU safety data sheet for VESTAKEEP® contains more information. For environmental and economic reasons, recycling of the product is preferred.

Your direct contacts

Dr. Frank Schubert
PHONE +49 2365 49-5636
frank.fs.schubert@evonik.com

Michael Smolka
PHONE +49 2365 49-6733
michael.smolka@evonik.com

Evonik Resource Efficiency GmbH
High Performance Polymers
45764 Marl, Germany

PHONE +49 2365 49-9227
FAX +49 2365 49-809227
evonik-hp@evonik.com

www.vestakeep.com
www.evonik.com

EVONIK
POWER TO CREATE