EVONIK INDUSTRIES

VESTAKEEP® PEEK

Polyether Ether Ketone Compounds

VESTAKEEP®

Evonik. Power to create.

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 brings together Evonik's activities in specialty chemicals for industrial applications. The Resource Efficiency segment supplies high performance materials for environmentally friendly as well as energy-efficient systems.

Our VESTAKEEP® polyether ether kentone compounds are part of our high temperature polymers product portfolio.

Evonik. Power to create.

Directory

VESTAKEEP® PEEK

VESTAKEEP® compounds are particularly suitable for applications in which extremely high mechanical, thermal, and chemical requirements must be met.

Introduction

Evonik markets its VESTAKEEP® compounds worldwide. A proven quality management system ensures a high level of quality for the products introduced on the market, from development through production, and to quality assurance.

Our system is ISO 9001:2008 and ISO 14001:2009 certified and is continually optimized. A large number of customers have tested this quality system over the years and have attested to its excellence.

This brochure provides an overview of the properties and applications of VESTAKEEP® molding compounds.

VESTAKEEP® powders and products for medical applications are covered in two separate brochures.

VESTAKEEP® compounds are particularly characterized by the following material properties:

- very high heat resistance
- high rigidity
- low water absorption and therefore high dimensional stability
- high hardness
- good strength
- excellent sliding friction behavior, minimal abrasion
- good electrical characteristics
- excellent chemical resistance
- excellent hydrolytic stability
- good processability
- low tendency to form stress cracks

PEEK is the official abbreviation for polyether ether ketone according to ISO 1043. In this brochure it will be used only in this context.

Manufacture

VESTAKEEP® PEEK is polycondensed from the building blocks hydrochinone and 4,4´-difluorobenzophenone in a multistage process.

The base grades have a melt viscosity of 100 - 5,000 Pas, measured at 400 °C, and a shear of 1 sec^{-1}.

To meet the requirements of different applications, manufacturers can adjust the properties of pure PEEK selectively by adding various additives:

- Processing aids facilitate demolding.
- Fillers and reinforcing materials increase rigidity and dimensional stability upon exposure to heat. Chopped carbon fibers are most effective for this. Minerals and glass microbeads also counteract the tendency to warp.

Delivery

As granules:

in boxes with a total content of 25 kg. Twenty-five boxes with a total weight of 625 kg fit on one pallet.

As a powder:

in 10 kg boxes, each box having one polyethylene liner. Twenty-five boxes with a total weight of 250 kg fit on one pallet.

As a fine powder:

in 15 kg boxes, each box having one polyethylene liner. Twenty-five boxes with a total weight of 375 kg fit on one pallet. We will also deliver in bulk packaging upon request.

Under normal storage conditions, storage time is practically unlimited provided that the packaging has not been damaged. Avoid storing at temperatures above 45°C.

Like other partially crystalline polyaryl ether ketones, unmodified VESTAKEEP® PEEK 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. We deliver most compounds in their natural colors. Others have a certain color inherent to them because of the additives they contain.

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

Technical service - CAE support

Our technical service includes comprehensive application engineering advice with the aim of jointly working out technically demanding system solutions with our customers. This also includes support from various CAE methods in the development of molds and molded parts.

We perform processing simulations of the injection-molding process from the filling phase to the holding-pressure phase, including the calculation of shrinkage and distortion, with modern software. This enables us to provide the following data as early as during the product development phase

- **Processing process:**

  e.g., fillability of the mold, resulting process parameters like pressure and temperature distributions, cooling system, influence of various processing parameters

- **Component properties:**

  e.g., location of weld lines, air bubbles, shrinkage and distortion, fiber orientation

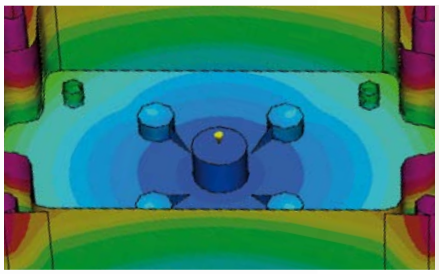
- **Manufacturing costs:**

  required machine size, cycle time, complexity of molded part/mold

As a rule, we require that our customers provide us with an IGES file describing the geometry of the part and, depending on the problem definition, information regarding constraints, such as mold and process requirements. We will enter relevant material properties such as shear viscosity, thermal conductivity and PVT behavior into the calculation.

The results from the simulation calculation support further design and optimization of the molded part and its associated injection mold. This frequently results in a reduction of cost-intensive modifications and in the number of iterative loops on the mold and molded part.

Our qualified teams discuss the problem definition and results with the customer and jointly work out solutions.



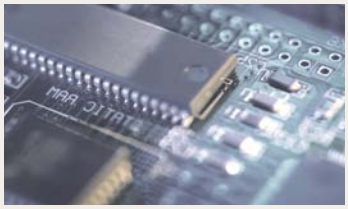
Filling study example of a sample part

VESTAKEEP®
Applications

Table 1: **Relevant properties of polyether ether ketones for particular applications**

	Automotive	Aerospace and rail cars	Machinery and apparatus construction
High temperature resistance	●	●	●
Chemical resistance	●	●	●
Hydrolysis resistance	●	●	●
Physical stability	●	●	●
Wear resistance	●	●	●
Fire behavior		●	
Toxic fumes *		●	
Electrical properties		●	
Degassing			
Ion extraction			
Dimensional stability	●	●	●
Processability	●	●	●
Sterilizability			

VESTAKEEP® compounds can be used for a wide range of applications, such as in electrical, electronic, and communications engineering and in the automotive industry.



Electrical and cable	Electronics and semiconductors	Medical technology	Food processing industry
●	●		
●	●	●	●
●	●	●	●
●	●	●	●
●	●		●
●	●		
●	●		
●	●	●	
●	●		
●	●	●	●
●	●	●	●
		●	●

*"Free of toxic fumes" does not apply to compounds containing PTFE.
See Page 26, „Information about environmental compatibility and safety"

VESTAKEEP®
Overview

Commercial products

The PEEK compounds from Evonik include a variety of different products that have been matched to the requirements of processors and end consumers. Table 2 provides an overview of the characteristics of the most important products and their typical applications. More detailed information about most of these compounds can be found in Tables 3 and 4. For further information about the other compounds, please contact the persons indicated.

Powders

In addition we offer VESTAKEEP® PEEK as powders. They can be used in a wide range of applications, for example, in the food, electrical, electronics, and information technology sectors and in the automotive industry. The powders are processed by a number of different means: press sintering, electrostatic powder spraying, flame spraying, and sprinkling, or as a suspension, both in aqueous and in solvent-containing systems.

Please take note of the details in our brochure "VESTAKEEP®–Polyether Ether Ketone Powders ". Our employees will be happy to provide further information and support.

Development products

Development products are usually designed for a specific application. When we introduce a product onto the market, the findings and feedback we receive allow us to optimize it further. Consequently, a change in the formulation or manufacturing process may lead to some slight changes in the product's properties. We immediately notify our customers of any changes to the material's composition and how these may influence the quality or specifications of the product itself. If you're looking for a product with a special requirements profile, please contact the person indicated. We've tested nearly 200 materials regarding VESTAKEEP® PEEK.

Processing

Extensive information how to process VESTAKEEP® PEEK compounds can be found in the brochure "VESTAKEEP® PEEK processing".

Campus®

Other properties of VESTAKEEP® compounds and material information on the other plastics of the Resource Efficiency segment are contained in the plastics data base Campus®[1], which is updated regularly.

You'll find Campus on the Web at **www.campusplastics.com**

[1] Campus® is the registered trademark of CWF GmbH/Frankfurt (Main)

VESTAKEEP® Grades

5000 P	4000 P	3300 P	2000 P	1000 P
5000 G	L 4000 G	3300 G	2000 G	1000 G
ground	4000 GHP	3300 GHP	2000 G black	compounded
5000 FP	4000 G black		2000 G blue	1000 GF30
compounded	ground		ground	1000 CF40
5000 CF30	4000 FP		2000 FP	1000 CF30
	compounded		2000 UFP20	
	4000 GF30		compounded	
	4000 GF30 black		2000 GF30	
	4000 GF15		2000 GF20	
	4000 FC30		2000 GF15	
	4000 CF30		2000 FC30	
	4000 CF10		2000 CF40	
	4000 CC20		2000 CF30	
			2000 CF20	
			2000 CF10	
			Easy Slide I*	

For more information about our VESTAKEEP® PEEK medical applications please request a copy of the separate brochure "Biomaterials for medical applications."

Special viscosities with reinforcement plus wear-resistant settings on request.

G	Granules
P	Powder
FP	Fine powder
GHP	High purity granules
UFP	Ultrafine powder
GF	Glass fiber
FC30	PTFE/graphite/carbon fiber (10:10:10)
CF	Carbon fiber
CC20	Ceramic-filled 20%
*	modified for low friction

VESTAKEEP®
Properties

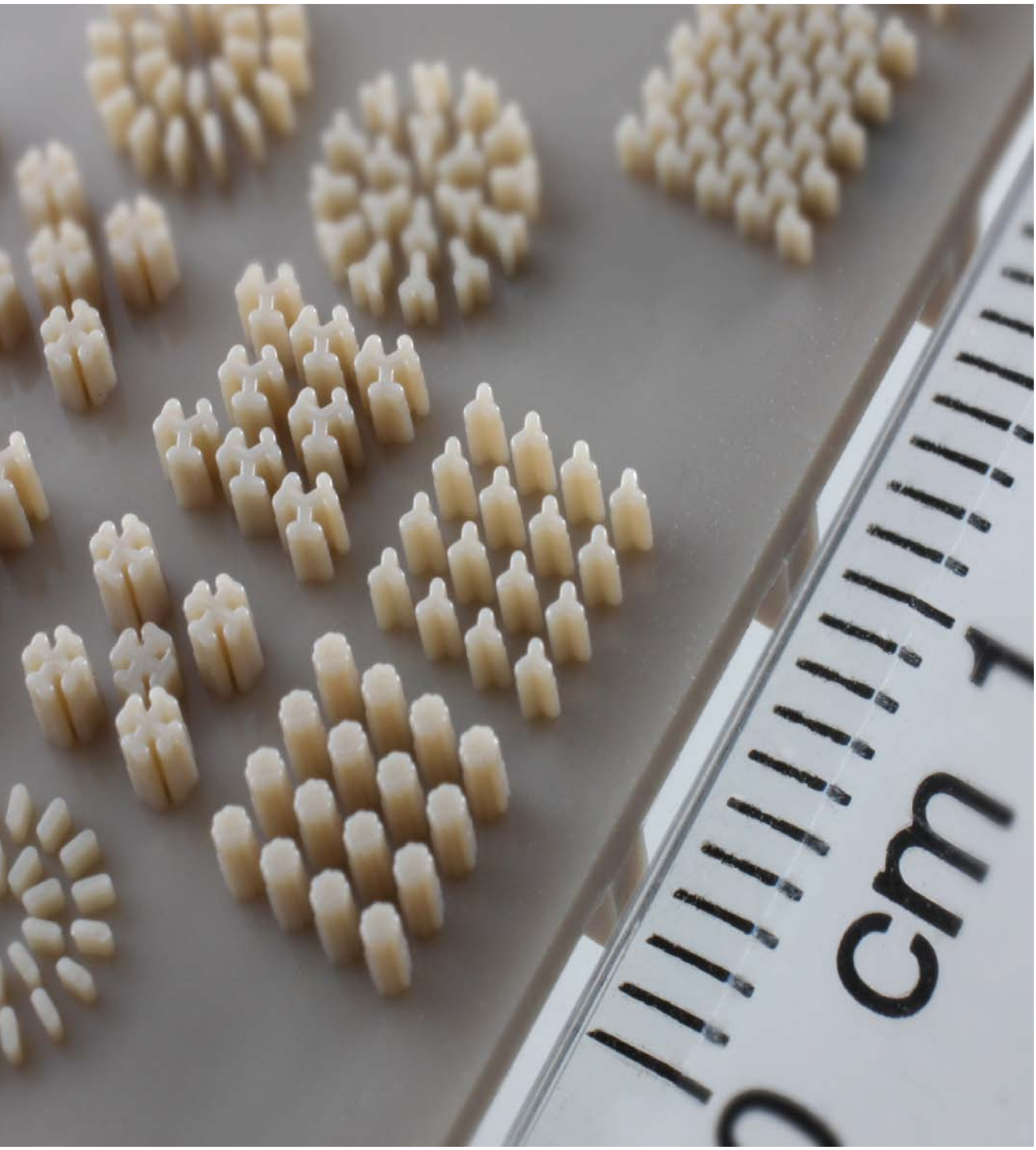


Table 2: **Overview of VESTAKEEP® compounds and their properties**

	Properties*			
VESTAKEEP®	Filler content	Viscosity	Applications	Processing
1000 G	unreinforced	low-viscosity, easy-flowing		IM
2000 G	unreinforced	medium-viscosity		IM, E
2000 G black	unreinforced	medium-viscosity		IM, E
2000 G blue	unreinforced	medium-viscosity	Base grades for products such as gear parts	IM, E
3300 G	unreinforced	medium-viscosity		E
3300 GHP	unreinforced	medium-viscosity, special filtration	Cable, filaments, films	E
L 4000 G	unreinforced	high-viscosity	Base grades for, e.g., gear parts, films, sheets, semi-finished goods, mechanically high-loaded parts	E, (IM)
4000 GHP	unreinforced	high-viscosity, special filtration		E, (IM)
5000 G	unreinforced	high-viscosity	Mechanically high-loaded parts demanding high ductility, tick-walled tubing and sheets	E, (IM)
1000 GF30	30% glass fibers	low-viscosity		IM
2000 GF15	15% glass fibers	medium-viscosity		IM
2000 GF20	20% glass fibers	medium-viscosity	Compounds with increased rigidity used for machinery, apparatuses and vehicles and in the electrical industry	IM
2000 GF30	30% glass fibers	medium-viscosity		IM
4000 GF15	15% glass fibers	high-viscosity		IM
4000 GF30	30% glass fibers	high-viscosity	Compounds with increased or high rigidity, partially low warpage, e.g. for housing parts	IM, (E)
4000 GF30 black	30% glass fibers	high-viscosity		IM, (E)
1000 CF30	30% carbon fibers	low-viscosity	Injection molding parts	IM
1000 CF40	40% carbon fibers	low-viscosity	Injection molding parts, e.g., parts to be plated	IM
2000 CF10	10% carbon fibers	medium-viscosity	Injection molding parts	IM
2000 CF20	20% carbon fibers	medium-viscosity	Injection molding parts	IM
2000 CF30	30% carbon fibers	medium-viscosity	Injection molding parts, parts in tribological pairing	IM
2000 CF40	40% carbon fibers	medium-viscosity	Injection molding parts, rigid machinery parts	IM
4000 CF10	10% carbon fibers	high-viscosity	Injection molding parts	IM, (E)
4000 CF30	30% carbon fibers	high-viscosity	Injection molding parts, parts in tribological pairing	IM, (E)
5000 CF30	30% carbon fibers	ultra high-viscosity	Injection molding parts	IM
2000 FC30	10% carbon fibers 10% graphite 10% PTFE	medium-viscosity	Parts in tribological pairing	IM
4000 FC30	10% carbon fibers 10% graphite 10% PTFE	high-viscosity	Parts in tribological pairing	E, IM
Easy Slide I	modified for low friction	medium-viscosity	Parts in tribological pairing, high demanding wear resistance	IM
4000 CC20	20% ceramics	high-viscosity	Parts for semiconductor industry	E, IM

IM = Injection molding E = Extrusion *All grades are lubricated for improved processing

Table 3: **Chemical resistance of VESTAKEEP® PEEK**

			Class
Environment	Concentration	Temperature [°C]	VESTAKEEP® 2000 G
Nitric acid	10%	23	A
	30%	23	A
	50%	23	B
	10%	100	A
	30%	100	B
	50%	100	C
Acetic acid	80%	23	A
		100	B
Methyl acetone	100%	23	B
		100	C
Sulfuric acid	40%	23	A
		100	A
Methanoic acid	100%	23	B
		100	C

Chemical resistance

When using polymers, mostly knowledge of the chemical resistance in the medium or environment in which they are being used is just as important as exact knowledge of the mechanical load-bearing capacity because attacks by specific chemicals can severely impact the materials' performance.

All in all, in addition to the fluoropolymers, VESTAKEEP® PEEK features a diversified chemical resistance and is therefore a popular choice among HT polymers.

To determine the chemical resistance, the VESTAKEEP® PEEK specimens were preconditioned for 24 hours at a temperature of 200°C in a nitrogen atmosphere and then fully exposed to the corresponding chemicals at temperatures of 23°C and 100°C for 1,000 hours.

After being kept in storage for 1,000 hours, the VESTAKEEP® PEEK specimens were subjected to precise testing. Each specimen was analyzed in detail, especially with regard to changes in weight, color and possible changes in behavior in the pull test (DIN 53504-S3A).

	Change in weight after 1,000 hours		Remaining elongation after 1,000 hours	
VESTAKEEP® L 4000 G	VESTAKEEP® 2000 G	VESTAKEEP® L 4000 G	VESTAKEEP® 2000 G	VESTAKEEP® L 4000 G
A	0.4%	0.6%	89.6%	95.0%
A	0.4%	0.6%	93.5%	94.0%
B	0.7%	0.6%	115.2%	109.1%
A	0.6%	0.6%	90.0%	89.3%
B	2.4%	1.3%	–	–
C	–	–	–	–
A	0.1%	0.5%	106.9%	93.7%
B	1.6%	3.6%	113.4%	96.1%
B	0.2%	0.1%	87.9%	97.4%
C	7.5%	7.6%	295.2%	121.9%
A	0.2%	0.1%	135.9%	93.0%
A	0.3%	0.3%	114.3%	92.4%
B	1.1%	1.1%	125.1%	80.7%
C	6.2%	6.4%	205.6%	105.5%

A Excellent resistance with no or only very little change in weight, color or surface

B Good resistance with no noticeable effects on weight, color or surface

C Poor resistance with very noticeable effects on weight, color or surface

For more information on our VESTAKEEP® PEEK medical applications please request a copy of the separate brochure "Biomaterials for medical applications."

Tribological properties

Tribology deals with friction, lubrication, and wear to bodies that come into contact with each other. The following table shows the initial results of a tribological test with a slide in form of a pin made of VESTAKEEP® and a rotating disk made of 100Cr6 steel.

The velocity was set at 0.5 m/s, and a total distance of 2,000 m was measured. Additional tests are being conducted with longer total distances. Please ask the indicated contact persons about the current status of these tests.

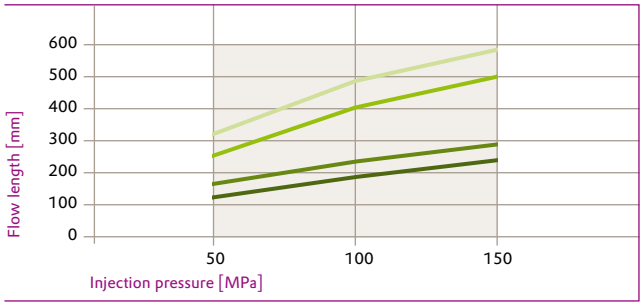
Flow behavior

The following illustrations serve as guide for selecting a grade in terms of the flowability of VESTAKEEP® compounds. They show how injection pressure affects the flow length of unreinforced and reinforced compounds. The values were obtained at a mold temperature of 180°C and at a processing temperature ranging from 360 to 400°C. The results are based on a flow spiral of 6 mm by 2 mm.

Table 4: **Tribological properties**

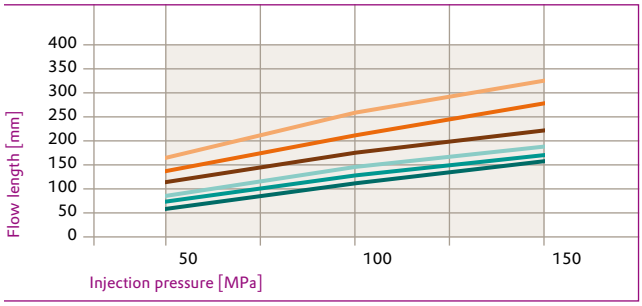
		VESTAKEEP®			
	Temperature, load	2000 G	L 4000 G	2000 FC30	4000 FC30
Coefficient of sliding friction	23 °C, 1 N	0.4	0.4	0.33	0.31
	23 °C, 20 N	0.35	0.41	0.23	0.25
	200 °C, 1 N	–	–	0.26	0.32
	200 °C, 20 N	–	–	0.3	0.32
Wear [10^{-6} mm^3/Nm]	23 °C, 1 N	9.1	9.14	6.87	3.31
	23 °C, 20 N	16.68	10.48	0.26	0.52
	200 °C, 1 N	–	–	12.6	20
	200 °C, 20 N	–	–	6.9	5.76

Flow behavior of unreinforced VESTAKEEP® grades



VESTAKEEP® 1000 G
VESTAKEEP® 2000 G
VESTAKEEP® L 4000 G
VESTAKEEP® 5000 G

Flow behavior of VESTAKEEP® 2000 and 4000 compounds



VESTAKEEP® 2000 FC30
VESTAKEEP® 2000 GF30
VESTAKEEP® 2000 CF30
VESTAKEEP® 4000 FC30
VESTAKEEP® 4000 GF30
VESTAKEEP® 4000 CF30

Table 5: **Weld line strength**

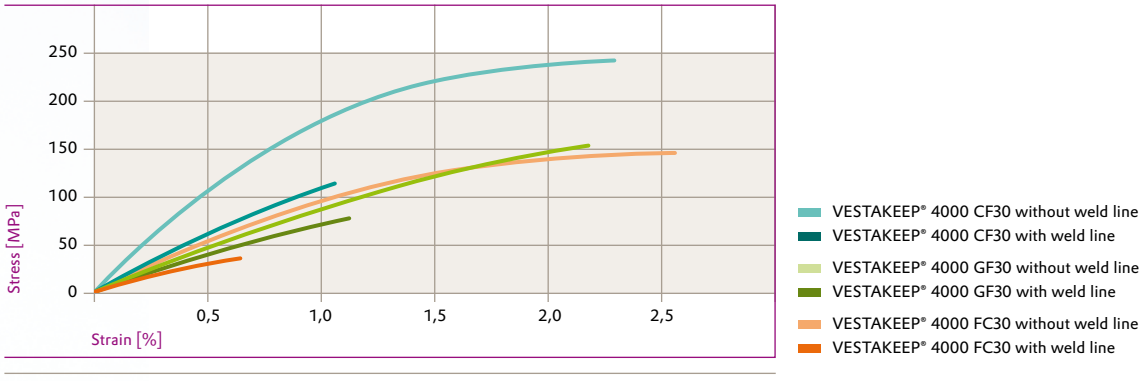
		Stress at yield [MPa]	
VESTAKEEP®	ISO 527-1/-2	without weld line	with weld line
2000 G	50 mm/min	100	99
L 4000 G	50 mm/min	96	95
		Tensile strength	
2000 CF30	5 mm/min	235	100
4000 CF30	5 mm/min	236	111
2000 GF30	5 mm/min	161	79
4000 GF30	5 mm/min	152	82
2000 FC30	5 mm/min	150	43
4000 FC30	5 mm/min	146	41

Weld line strength

For the purpose of determining weld line strength, tensile test bars 150 x 10 x 4 mm^3 in size were made on an experimental mold. If the runner inserts are replaced, the mold can produce test bars with and without a weld line. The mold surface temperature for all tensile bars was set to 180 °C.

Testing was done under standard conditions according to ISO 527. The results are summarized in the table above. It is obvious for unfilled molding compounds that the weld line leads to practically no decline in the stress at yield, while for filled molding compounds tensile strength declines by 50 to 70%.

Weld line strength of various VESTAKEEP® grades



VESTAKEEP®
Characterization

Table 4: **Characterization of VESTAKEEP® compounds**

Physical and thermal properties and fire behavior		Standard	Unit	VESTAKEEP® base grades 1000 G	2000 G	3300 G 3300 GHP
Density	23 °C	ISO 1183	cm^3/10 min	1.30	1.30	1.30
Melting range	DSC, 2nd heating		°C	approx. 340	approx. 340	approx. 340
Melt volume-flow rate (MVR)	380 °C / 5 kg	ISO 1133	cm^3/10 min	150	70	20
	400 °C / 21,6 kg	ISO 1133	cm^3/10 min			
Temperature of deflection under load	Method A: 1.8 MPa	ISO 75-1/2	°C	155	155	155
	Method B: 0.45 MPa	ISO 75-1/2	°C	205	205	205
Vicat softening temperature	Method A: 10 N	ISO 306	°C	335	335	335
	Method B: 50 N	ISO 306	°C	310	310	305
Linear thermal expansion	23 °C - 55 °C, longitudinal	ISO 11359	10^{-4} K^{-1}	0.6	0.6	0.6
Oxygen index	3.2 mm	ISO 4589	%	38	38	38
Flammability acc. UL94	3.2 mm	IEC 60695		V-0	V-0	V-0
Glow wire test	GWIT 2 mm	IEC 60695-2-12/13	°C	800	800	800
	GWFI 2 mm	IEC 60695-2-12/13	°C	960	960	960
Water absorption, saturation	23 °C	ISO 62	%	0.5	0.5	0.5
Mechanical properties						
Tensile test	50 mm / min	ISO 527-1/-2				
Stress at yield		ISO 527-1/-2	MPa	100	100	95
Strain at yield		ISO 527-1/-2	%	5	5	5
Strain at break		ISO 527-1/-2	%	15	30	30
Tensile test	5 mm / min	ISO 527-1/-2				
Tensile strengtht		ISO 527-1/-2	MPa			
Strain at break		ISO 527-1/-2	%			
Tensile modulus		ISO 527-1/-2	MPa	3800	3700	3500
CHARPY impact strength	23 °C	ISO 179/1eU	kJ/cm^2	N	N	N
	-30 °C	ISO 179/1eU	kJ/cm^2	N	N	N
CHARPY notched impact strength	23 °C	ISO 179/1eA	kJ/cm^2	5 C	5 C	6 C
	-30 °C	ISO 179/1eA	kJ/cm^2	6 C	6 C	6 C
Electrical properties						
Comparative tracking index	CTI	IEC 60112		200	200	200
	Test solution A: 100 drops value	IEC 60112		175	175	175
Electric strength	K20/P50	IEC 60243-1	kV/mm	16	16	16
	K20/K20	IEC 60243-1	kV/mm	19	19	19
Relative permittivity	50 Hz	IEC 60250		2.8	2.8	2.8
	1 kHz	IEC 60250		2.9	2.9	2.9
	1 MHz	IEC 60250		2.8	2.8	2.8
Dissipation factor	1 kHz	IEC 60250		0.003	0.003	0.003
	1 MHz	IEC 60250		0.005	0.005	0.005
Volume resistance		IEC 60093	Ohm	10^{14}	10^{14}	10^{14}
Volume resistivity		IEC 60093	Ohm*cm	10^{15}	10^{15}	10^{15}
Surface resistance		IEC 60093	Ohm	10^{14}	10^{14}	10^{14}
Spec. surface resistance		IEC 60093	Ohm	10^{15}	10^{15}	10^{15}

[1] The results of these new compounds have been generated from a low number of production lots. Therefore, they are preliminary and not yet the result of a statistical evaluation. They must not be used to establish specifications.

Glass fiber-reinforced VESTAKEEP® compounds

L 4000 G 4000 GHP	5000 G	1000 GF30[1)]	2000 GF15[1)]	2000 GF20[1)]	2000 GF30	4000 GF15[1)]	4000 GF30
1.30	1.30			1.43	1.50	1.41	1.50
approx. 340	approx. 340	approx. 340	approx. 340	approx. 340	approx. 340	approx. 340	approx. 340
12	7	27	ca. 75**	27	25*	15.5***	
							32
155	155				323		312
205	205				338		335
335	335				340		340
305	305				335		335
0.6	0.6				0.3		0.3
36	36				45		45
V-0	V-0	V-0			V-0	V-0	V-0
825	850				825		825
960	960				960		960
0.5	0.5				0.4		0.4
95	90					140	
5	5					3.1	
25	35					3.5	
		190	120	163	170		160
		2.5	2.5	3.2	2		2
3500	3500	10900	6500	8100	10600	7700	10800
N	N	66 C		63 C	55 C	67 C	70 C
N	N	63 C	50 C	65 C	65 C	78 C	75 C
7 C	9 C	8 C			10 C	10 C	11 C
6 C	8 C	8 C	5 C		8 C		9 C
200	200				200		200
175	175				175		175
16	16				16		16
19	19				19		19
2.8	2.8				3.4		3.4
2.9	2.8				3.3		3.3
2.8	2.8				3.3		3.3
0.003	0.003				0.002		0.002
0.005	0.005				0.004		0.004
10^{14}	10^{15}				10^{14}		10^{14}
10^{15}	10^{15}				10^{15}		10^{15}
10^{14}	10^{14}				10^{14}		10^{14}
10^{15}	10^{14}				10^{15}		10^{15}

* 400 °C/5 kg ** 380 °C/10 kg *** 400 °C/10 kg N =no break C = complete break, incl. hinge break H

Table 5: **Characterization of VESTAKEEP® compounds**

				Carbon-reinforced VESTAKEEP® compounds		
Physical and thermal properties and fire behavior		Standard	Unit	**1000 CF30**	**1000 CF40**	**2000 CF10[1)]**
Density	23 °C	ISO 1183	cm^3/10 min	1.40	1.44	
Melting range	DSC, 2nd heating		°C	approx. 340	approx. 340	approx. 340
Melt volume-flow rate (MVR)	380 °C / 5 kg	ISO 1133	cm^3/10 min	26*	19	approx. 35
	400 °C / 21,6 kg	ISO 1133	cm^3/10 min		60	
Temperature of deflection under load	Method A: 1.8 MPa	ISO 75-1/2	°C	325	330	
	Method B: 0.45 MPa	ISO 75-1/2	°C	339	340	
Vicat softening temperature	Method A: 10 N	ISO 306	°C	344	343	337
	Method B: 50 N	ISO 306	°C	339	340	
Linear thermal expansion	23 °C - 55 °C, longitudinal	ISO 11359	10^{-4} K^{-1}	0.11	0.1	
Oxygen index	3.2 mm	ISO 4589	%	>50	47	
Flammability acc. UL94	1.6 mm	IEC 60695		V-0	V-0	
Glow wire test	GWIT 2 mm	IEC 60695-2-12/13	°C	875	875	
	GWFI 2 mm	IEC 60695-2-12/13	°C	960	960	
Water absorption, saturation	23 °C	ISO 62	%	0.4	0.4	
Mechanical properties						
Tensile test	50 mm / min	ISO 527-1/-2				
Stress at yield		ISO 527-1/-2	MPa			160
Strain at yield		ISO 527-1/-2	%			3
Strain at break		ISO 527-1/-2	%			3.5
Tensile test	5 mm / min	ISO 527-1/-2				
Tensile strengtht		ISO 527-1/-2	MPa	245	260	
Strain at break		ISO 527-1/-2	%	1.5	1.4	
Tensile modulus		ISO 527-1/-2	MPa	23000	29000	9000
CHARPY impact strength	23 °C	ISO 179/1eU	kJ/cm^2	45 C	45 C	30 C
	-30 °C	ISO 179/1eU	kJ/cm^2	45 C	45 C	30 C
CHARPY notched impact strength	23 °C	ISO 179/1eA	kJ/cm^2	7 C	6 C	5 C
	-30 °C	ISO 179/1eA	kJ/cm^2	7 C	6 C	4 C
Electrical properties						
Relative permittivity	50 Hz	IEC 60250				
	1 kHz	IEC 60250				
	1 MHz	IEC 60250				
Dissipation factor	50 Hz	IEC 60250				
	1 kHz	IEC 60250				
	1 MHz	IEC 60250				
Volume resistance		IEC 60093	Ohm			
Volume resistivity		IEC 60093	Ohm*cm			
Surface resistance		IEC 60093	Ohm			
Spec. surface resistance		IEC 60093	Ohm			

[1)] The results of these new compounds have been generated from a low number of production lots.
Therefore, they are preliminary and not yet the result of a statistical evaluation. They must not be used to establish specifications.

						VESTAKEEP® special grades			
2000 CF20[1)]	**2000 CF30**	**2000 CF40[1)]**	**4000 CF10[1)]**	**4000 CF30**	**5000 CF30[1)]**	**2000 FC30**	**4000 FC30**	**Easy Slide I [1)]**	**4000 CC20**
	1.39			1.40	1.40	1.44	1.44		1.49
approx. 340	approx. 340	approx. 340	approx. 340	approx. 340	approx. 340	approx. 340	approx. 340	approx. 340	approx. 340
68	19*	30**	6			19*		18	9
				22	9		39		
	330			325	324	320	310	321	155
	340			335	338	337	330	338	210
	343			343	341	340	340		335
	340			340	339	335	335		305
	0.1			0.1		0.2	0.2	0.1	0.45
	47			47	>50	44	44		
	V-0	V-0		V-0	V-0	V-0	V-0		V-0
	875			850	875	900	900		
	960			960	960	960	960		
	0.4			0.4	0.4	0.4	0.4		0.4
204			147					160	98
2.1			3					2.6	5
			4					2.4	20
	240	280		240	230	150	140		
	1.7	1.6		2	2	2	2		
15300	22000	31300	9000	23000	22500	12300	11500	11200	4200
47 C	45 C	53 C		60 C	59 C	40 C	45 C		N
47 C	45 C	53 C		60 C		40 C	45 C		P
6 C	8 C	9 C	8 C	11 C	12 C	6 C	8 C		6 C
6 C	8 C	7 C	7 C	9 C		5 C	7 C		7 C
						6.1	6.1		
						5.5	5.5		
	17			17		4.9	4.9		3.8
						0.07	0.07		
						0.04	0.04		
	0.23			0.23		0.02	0.02		0.02
	10^5			10^5		10^5	10^5	10^6	
	10^6			10^6		10^7	10^7	10^5	
	10^5			10^5		10^5	10^5	10^5	
	10^6			10^6		10^6	10^6		

*400 °C/5 kg **400 °C/10 kg N =no break C = complete break, incl. hinge break H P = partial break

Physiological and toxicological evaluation

The Environment, Health, Safety & Quality Department, which is responsible for the High Performance Polymers Business Unit, provides general information on the toxicological properties of VESTAKEEP® compounds and relevant analysis pertaining to their contact with foodstuffs. The department is also responsible for providing information about product safety and producing the EC Safety Data Sheets for VESTAKEEP®. Please direct all questions on the subject to the indicated contact persons.

VESTAKEEP® compounds are water-insoluble, solid polymers that are largely inert physiologically. No toxicity is expected from single contact or even multiple contacts, because VESTAKEEP® products are not absorbed either through the skin or through the gastrointestinal tract.

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. Irritation or sensitization of the skin is not expected. Based on our best current understanding, VESTAKEEP® does not have any adverse effects on man, animals, plants, or micro-organisms.

Please direct any further questions regarding product safety to the indicated contact persons.

Food Contact

EU-Status

Uniform regulations for plastics that come into contact with foodstuffs exist at the European level. The consolidated EU Directive 2002/72/EC applies. It lists approved monomers and, since December 31, 2006, approved plastic additives as positive. In other words, in Europe only approved monomers and additives on the EU positive lists may come into contact with food.

Many of our unreinforced and glass fiber-reinforced VESTAKEEP® compounds are approved for direct food contact in the European Union because the monomers and additives on which they are based satisfy the above Guideline and its updates. Restrictive migration values must be observed on the finished article and, for glass fiber-reinforced VESTAKEEP® grades, special marketing conditions and conditions of use must also be observed (principle of "Mutual Recognition").

FDA status

In the United States, the FDA Regulation 21 CFR 177.2415 covers plastics that come into contact with food. Since the polymers on which many of our unreinforced and glass fiber-reinforced VESTAKEEP® compounds are based meet these regulations, these compounds are suitable for food-contact applications in the United States pursuant to Section 177.2415 for articles intended for repeated use.

For further information, please contact the indicated contact persons.

Medical applications

For medical applications, the European approval procedure is laid down in Directive 93/42/EEC.

Evonik supplies VESTAKEEP® product families for medical applications tested in a comprehensive testing program.

For more information please contact us and request a copy of the separate brochure "Biomaterials for medical applications."

Environmental compatibility and safety

VESTAKEEP® compounds are non-hazardous substances that are not governed by any particular safety regulations. They can be disposed of in accordance with local ordinances. Further information can be found in the EC safety data sheet for VESTAKEEP®. Recycling is, however, preferred and advisable for economic reasons.

No dangerous byproducts are formed if VESTAKEEP® is processed properly. Care should be taken, however, to ventilate the working area properly. Detailed directions about handling VESTAKEEP® products can be found in the brochure "VESTAKEEP® PEEK processing".

Degradation of the material during processing is shown by a discoloration of the melt. Degraded material should be quickly removed from the machine and cooled under water in order to minimize any troublesome smells or fumes.

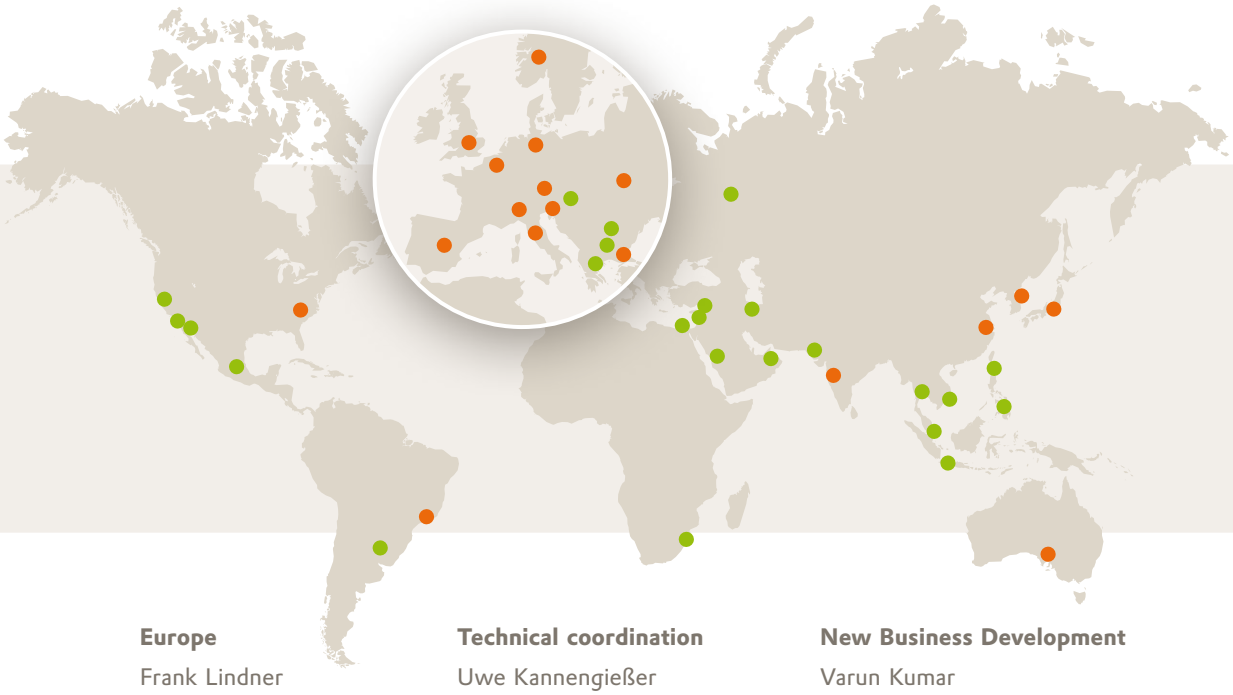
No pigments or additives containing cadmium are used.

VESTAKEEP® compounds are noncombustible. Flammable gases can be released at melt temperatures above 450 °C. Since the spectrum of crack and combustion products greatly depends on the combustion conditions, it is not possible to make any general statements here.

VESTAKEEP® compounds, which are filled with PTFE (FC grades), can release highly toxic and caustic gases at temperatures exceeding 380 °C.

If conditions leading to this decomposition are not avoidable, direct exposure of the employees must be prevented, e.g. by an efficient withdrawal of exhaust air. In addition to our instructions, please also comply with the safety data sheet for the compound in question.

VESTAKEEP® compounds can be easily recycled. The properties of the recyclates are only slightly affected. For questions regarding the recycling of VESTAKEEP® compounds, please contact the indicated contact persons.



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