

VESTOSINT®

POLYAMIDE 12 POWDERS FOR DEMANDING COATING APPLICATIONS



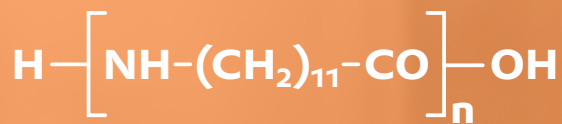
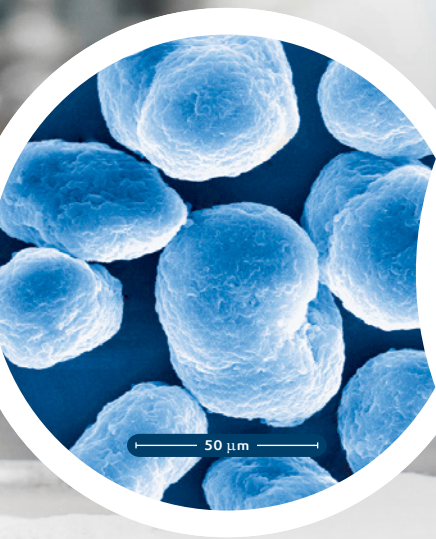


EVONIK IS ONE OF THE WORLD LEADERS IN SPECIALTY CHEMICALS.

Evonik goes far beyond chemistry to create innovative, profitable and sustainable solutions for customers. More than 32,000 employees work together for a common purpose: We want to improve life, day by day.

The High Performance Polymers Business Line produces customized products, systems, and semi-finished products based on high performance polymers. Our plastics have proven their worth in various applications for more than 50 years.

Evonik. Leading beyond Chemistry.



CHEMISTRY

VESTOSINT® stands for high-performance powders manufactured by a special physical process and features a nearly round geometry. Therefore, they are eminently suited particularly for coatings.

Evonik manufactures lauro lactam, the monomer of polyamide 12 (PA 12), derived from butadiene. Polyamide 12 has the lowest amide group concentration of all commercially available polyamides, allowing for lower moisture absorption and maintenance of mechanical stability while under conditions of changing humidity.

CONTENT

Introduction	3
Properties	4
Applications	6
Processing & Technology	8
Environment & Quality	10
Products & Delivery	11



PHYSICAL PROPERTIES

Melting Temperature

Density 23°C

Water absorption

100°C, immersion

23°C, 96% r.h.

23°C, 50% r.h.

Tensile test*1

Stress at yield

Strain at yield

Stress at break

Strain at break

Shore hardness D

Ball indentation hardness

Abrasion

CS17, 500g

S33, 500g

*1 tested on a tensile bar

→ PROPERTIES OF UNPIGMENTED VESTOSINT® COATINGS

PROPERTIES

PA12 powders offer similar superior property characteristics as PA12 granules, which includes:

- high toughness
- very good resistance to greases, oils, fuels, hydraulic fluids, water, alkalis, saline solutions and many organic solvents
- very good stress crack resistance, even when exposed to chemicals
- low coefficient of sliding friction and high abrasion resistance even when running dry
- noise and vibration dampening

In addition, the coating powder manufactured from the base polymers with technically challenging processes affords other physical, chemical and electrical properties that make it perfect for a broad spectrum of applications:

- high mechanical strength, elasticity and surface hardness
- low water absorption and water vapor permeability
- high resistance even in warm and detergent-containing water
- low thermal conductivity
- good electrical insulation and dielectric strength
- easy to clean
- no surface fouling

VESTOSINT® maintains these properties even at extreme sub-freezing temperatures. VESTOSINT® coated objects are not only protected from abrasion, scratching and impact abuse but also, from chemicals and corrosion. The protective action increases proportionally to the layer thickness, up to 500 microns.

Test method	Unit	Value
DIN EN ISO 11357-1	°C	180
DIN 66137-1/-2	g/cm ³	1.04
DIN EN ISO 62	%	1.93
DIN EN ISO 62	%	1.33
DIN EN ISO 62	%	0.52
DIN EN ISO 527-1/-2	MPa	43
DIN EN ISO 527-1/-2	%	6
DIN EN ISO 527-1/-2	MPa	49
DIN EN ISO 527-1/-2	%	311
ISO 868		75
ISO 2039-1	N/mm ³	90
ISO 9352	mg/100 turns	<1
ISO 9352	mg/100 turns	<15

ELECTRICAL PROPERTIES		Test method	Unit	Value dry	Value wet*1
Relative permittivity					
23°C, 1 MHz	DIN VDE 0303-4			3.8	6.7
Dissipation factor					
23°C, 1 MHz	DIN VDE 0303-4			5 x 10 ⁻²	17 x 10 ⁻²
Volume resistivity*2	IEC 62631-3-2		Ω/cm	1 x 10 ¹³	
Breakdown voltage AC*3	IEC 60243-1		kV	>20	
Breakdown voltage DC*3	IEC 60243-2		kV	>40	
Electric strength AC*3	IEC 60243-1		kV/mm	>60	
Electric strength DC*3	IEC 60243-2		kV/mm	>120	
CTI, Prüflösung A	DIN IEC 60112		-	475 - 0.13	
THERMAL PROPERTIES		Test method	Unit	Value	
Thermal linear expansion	ISO 11359		10 ⁻⁴ · K ⁻¹	1.09	
Thermal conductivity	ISO 22007-4		W · m ⁻¹ · K ⁻¹	0.23 - 0.29	
Specific heat	DIN EN ISO 11357-4		J · g ⁻¹ · K ⁻¹	0.23 - 0.29	

The values shown in the tables are typical values which are not statistically secured. These values can vary significantly e.g. depending on the color, coating quality and conditions, conditioning etc.

*1 after immersion in water at 23°C
 *2 23°C, 50% r.h., 300 μm
 *3 K20/P25, 300 μm

Safe for food contact

Special VESTOSINT® powder coatings are licensed for direct contact with non-alcoholic foods in most color formulations, both by EU authorities and by the United States Food and Drug Administration (FDA). In addition, coatings based on special VESTOSINT® powder grades satisfy even the most rigorous criteria for contact with drinking water. Product safety information can be provided upon request.

High impact strength

The drop-weight test according to DIN EN ISO 6272 demonstrates the excellent impact strength of VESTOSINT® coatings. A 2 kilogram ball-pen hammer falls onto a 1 mm-thick VESTOSINT®-coated metal sheet. The indentation formed is up to 5 or more millimeters deep. Even under a blow from the maximum falling height of 1 meter, the coating, though deformed, does not tear.

Abrasion resistance

The abrasion resistance is proven by TABER test.

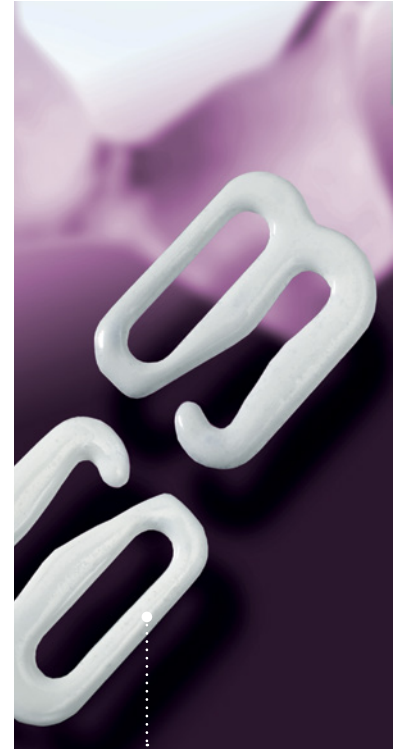
Easy to clean*

Thanks to the non-porous smooth surface, VESTOSINT® coatings are not susceptible to microbial growth and are easy to clean. They do not allow for any points of entry for microorganisms.

*according to W270 approval



DISHWASHER
RACKS



MINICOATING

→ VESTOSINT®

APPLICATIONS

Parts for the automobile industry

The high impact strength and abrasion resistance favor the high-performance polymer powder VESTOSINT® for use in the automobile industry. Example application include automobile hood props, seat belt anchors, springs and latches. High stress components such as safety belt holders acquire their major safety feature only as a result of the VESTOSINT® coating. It covers the metal edge of the component, thus protecting the belt from cuts in emergencies.

Wire products

Thanks to the optimized particle size distribution of the powders, a non-porous coating is ensured on wire products such as dishwasher racks, shopping carts and furniture. The high resistance of VESTOSINT® coatings to hot, rinsing agent containing water and its elasticity are of prime importance for dishwasher racks. Therefore, the dishes are preserved and protected during wash and rinse cycles. In addition, the coating absorbs impact and noise while providing abrasion resistance and long term reliability.

Medical supplies

VESTOSINT® powders are used for medical applications due to the smooth surface which prevents bacteria growth. In addition, VESTOSINT® coated parts may be sterilized.



MEDICAL TOOLS

AUTOMOBILE PARTS

FILE RAILS

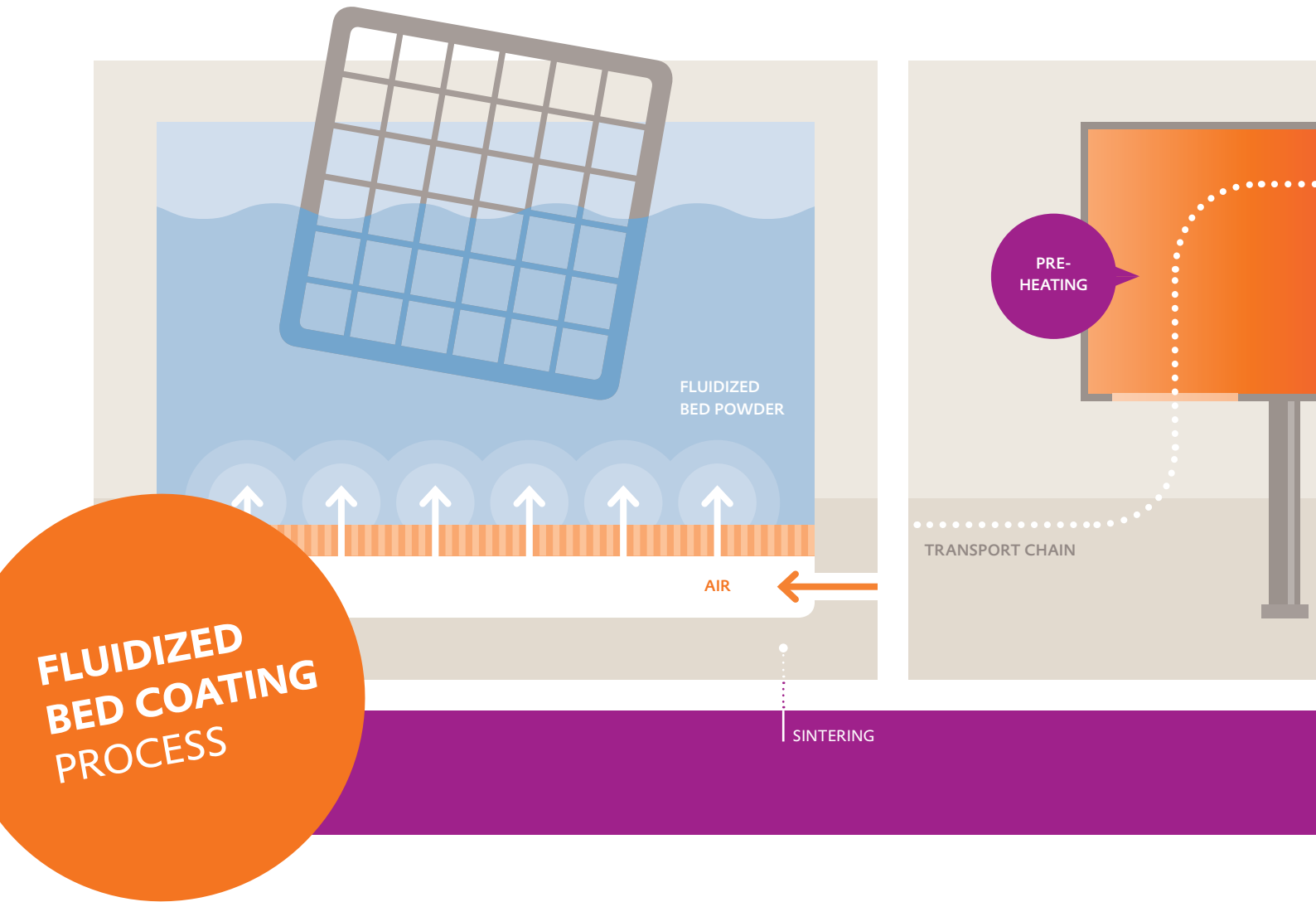
CRANKSHAFTS

Pipelines and fittings

Plastic coatings have long been used with success in pipelines and fittings. The protective layer applied by the fluidized bed coating process resists high corrosive stresses. Mechanical strength; elasticity, even at low temperatures; good resistance to chemical; and corrosion resistance are key requirements for pipes and fittings. VESTOSINT® PA12 powder coatings may also be used for cooling water lines; in naval construction and plant and power plant lines due to the property characteristics.

Industrial items

Other industrial applications such as printing rollers, gasoline pump levers, hydraulic cylinders or hanging file holder rods benefit in particular from the chemical resistance, wear resistance and abrasion resistance of VESTOSINT® coating powders.



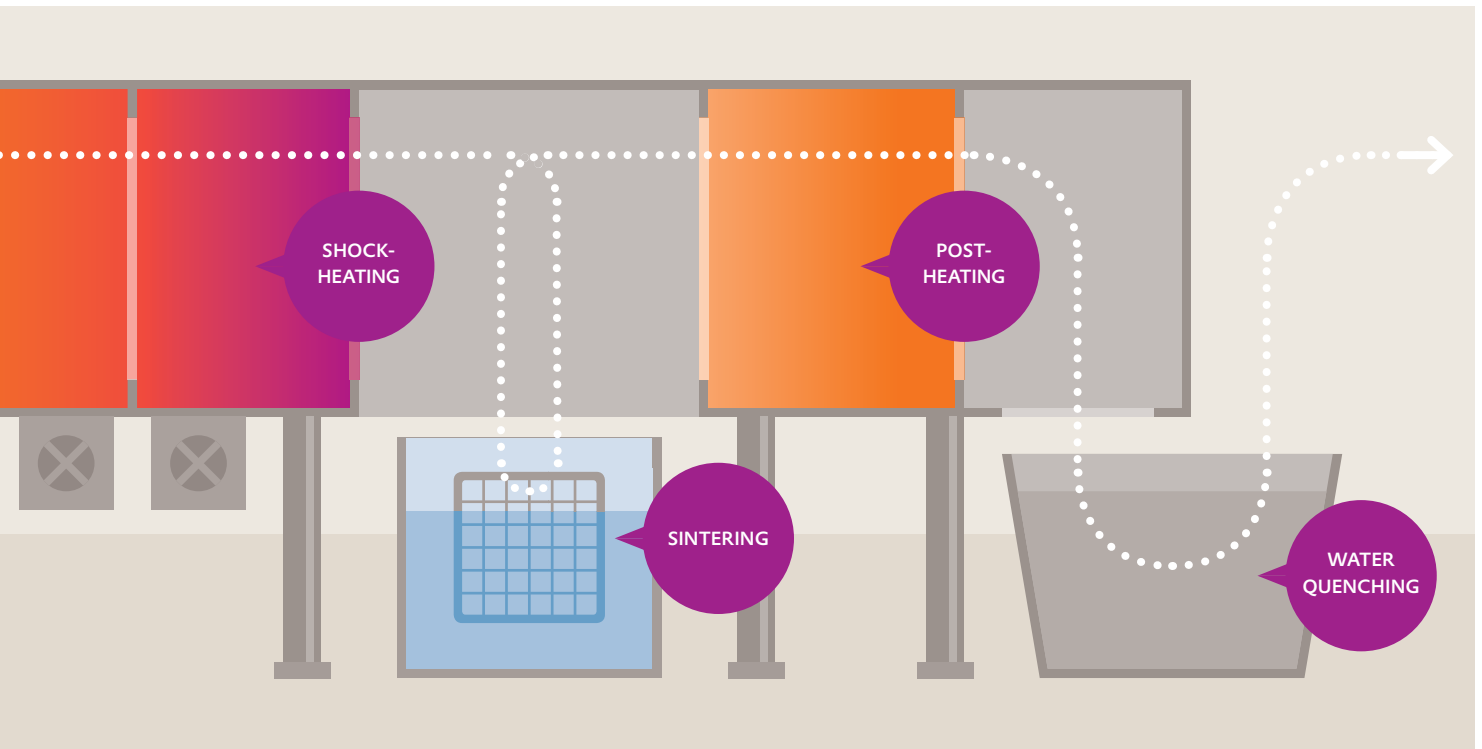
PROCESSING

When metals are coated with polyamides, the positive properties of the two materials are combined. Fluidized bed coating technology is the most cost-effective method for coating preheated, preferably metallic objects with plastics. It consists of a combination of fluidized bed and immersion processes. With an economical equipment investment, layer thicknesses of 250 - 500 microns are achieved; even coatings of 1 - 2 millimeters are possible.

A fluidized bed coating pan consists of the powder container and the air receiver, separated by a porous fluidizing bottom. Oil- and dust-free air flows into the air receiver and passes through the fluidizing bottom in the form of fine bubbles. It transforms the sintering powder to the fluidized state resembling boiling liquid.

The fluidized bed coating powder has a particle size distribution ranging from 30 to 250 microns and is adjusted so as not to produce dust. Metal substrates of any geometry constructed of steel, metal

alloys or aluminum can be coated. To do this, dip the pieces in fluidized VESTOSINT® powder. The powder sinters to the surface of the substrate and fuses into a smooth surface thanks to its residual heat. Depending on the desired coating thickness, the pieces are heated to 230 - 450 °C and dipped for 2 - 10 seconds. The process operates without solvent. Materials that change their shape, lose their properties or generate gases during the above described procedure cannot be coated.



Minicoating process

The main fields of application of minicoating includes the coating of clips for the undergarment industry and component coating for the electric and automobile industries.

The principle of minicoating is similar to that of fluidized bed coating. Hot (small) parts drop into a fluidized VESTOSINT® powder pan. As they fall, the powder sinters to the metallic surface. Subsequently, the objects are conveyed out of the VESTOSINT® container in a vibrating trough and the surface is further smoothed, no matter the shape of the articles being coated.

Flame spraying

In the flame spraying process, VESTOSINT® is fed into a flame spraying gun, melted by an enclosing, circular flame, and applied on the surface to be coated. Because the process is mobile, it is used particularly in general repair work and in the coating of pipes, tanks, and other applications.

Warm spraying

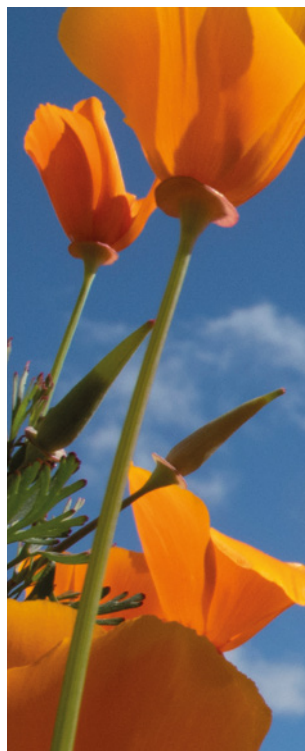
Warm spraying is also possible on demand.

DESIGN RECOMMENDATIONS

Essentially, all materials suitable for coating because of their physical properties can be coated with VESTOSINT®.

Depending on the requirements of the applications, a special pretreatment of the pieces may be necessary, including the use of adhesives. The best possible corrosion protection for steel and other metals in external applications is achieved when the parts are degreased, blasted and primed before coating.

ENVIRONMENT, QUALITY, PRODUCTS AND DELIVERY



PHYSIOLOGICAL, TOXICOLOGICAL AND MEDICAL COMPLIANCE

Physiological and toxicological evaluation

The department of Environment, Health and Safety, responsible for the High Performance Polymers Business Line, provides a survey of the toxicological properties of VESTOSINT® powders or compliance relating to contact with foods. This department is also responsible for providing information on product safety and writing EC safety data sheets for VESTOSINT®. Please send inquiries, for US Material Safety Data Sheets, to the contact addresses provided.

Food contact and regulations

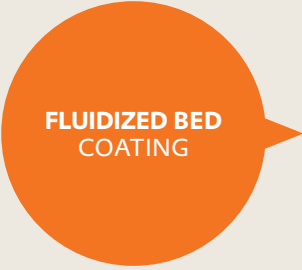
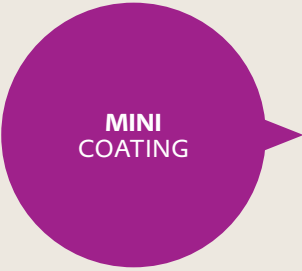
Due to various product formulations it is not possible to make any general statements in regards to food contact regulations. For further information, please contact the listed contact person.

Medical applications

For medical applications, the European approval procedure is laid out in Directive 93/42/EEC. The national implementation of this directive into German law is the Medizinproduktegesetz (Medical Products Act) of August 1994. The detailed procedure to be followed is described in the pertinent international and national standards (e.g., ISO 10993, DIN EN 30993-1).

The DAB monographs (German Pharmacopoeia, current edition) or those of the European Pharmacopoeia (current edition 2008) can be used as supplementary regulatory works to make the decision in special cases.

Manufacturers of medical device applications are responsible for submitting their coated parts to the relevant test conditions for their end use requirements. Our staff can provide product related information based on experiences with the various approval processes.

→ PRODUCT OVERVIEW		VESTOSINT®	D50 [µm]	Comment
 <p>FLUIDIZED BED COATING</p>	1101 white		100	
	1111 natural 9.0001		90	
	1111 colored		90	
	1141 white		100	basis for colored powder*
	1141 colored		100	
 <p>MINI COATING</p>	1301 white		100	low-viscosity, easy flowing for high-surface-area parts
	1164 white		50	improved flowability
	2157 natural color		55	basis for color minicoat grades

* Wide range existing color formulations. Special color adjustments upon request.

ENVIRONMENTAL ASPECTS, QUALITY AND DELIVERY

Environmental impact and safety

VESTOSINT® powders are non-toxic, not subject to labeling under the hazardous materials regulation and are not water-polluting. They can be disposed of in land-fills or incinerated as normal household waste in accordance with local ordinances. The EC Safety Data Sheet for VESTOSINT® provides further instructions.

If VESTOSINT® powders are properly processed, no hazardous by products are formed. Cadmium-containing pigments are not used at all.

VESTOSINT® powders are combustible. At mass temperatures above 350 °C, flammable gases are formed by degradation. Combustion with sufficient air supply yields CO, CO₂, H₂O and nitrogen-containing compounds as end products. Since the spectrum of cracking and combustion products greatly depends on the combustion conditions, it is not possible to make any general statements here.

Quality

Our proven quality management system, from development, through production, to quality assurance, ensures a high level of quality for our VESTOSINT® powders. We are continually optimizing our ISO 9001:2008 quality management system, which has been in place since 1992.

Supply form

VESTOSINT® powders are offered in a range of particle size distributions tailored to the different processing methods. The upper particle size limit is about 250 microns. Delivery is in bags with 20 kilograms net weight or in octabins with 800 kilograms net weight. A unit of shipment consists of a pallet with 50 bags or one octabin. In rooms protected from the weather, the shelf life is at least 2 years from the production date if the packaging is not damaged or opened. A storage temperature of 45 °C should not be exceeded. The product should be processed on a first in first out basis. As system solution providers, we offer special powders for individual applications.

This information and any recommendations, technical or otherwise, are presented in good faith and believed to be correct as of the date prepared. Recipients of this information and recommendations must make their own determination as to its suitability for their purposes. In no event shall Evonik assume liability for damages or losses of any kind or nature that result from the use of or reliance upon this information and recommendations.

EVONIK EXPRESSLY DISCLAIMS ANY REPRESENTATIONS AND WARRANTIES OF ANY KIND, WHETHER EXPRESS OR IMPLIED, AS TO THE ACCURACY, COMPLETENESS, NON-INFRINGEMENT, MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE (EVEN IF EVONIK IS AWARE OF SUCH PURPOSE) WITH RESPECT TO ANY INFORMATION AND RECOMMENDATIONS PROVIDED. Reference to any trade names used by other companies is neither a recommendation nor an endorsement of the corresponding product, and does not imply that similar products could not be used. Evonik reserves the right to make any changes to the information and/or recommendations at any time, without prior or subsequent notice.

® = registered trademark

Evonik Operations GmbH

High Performance Polymers
45764 Marl
Germany

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

www.vestosint.com
www.evonik.com

01/EU