

**Protect your cables
from any harm with
HIGH-PERFORMANCE
POLYMERS**



Evonik's innovative materials and processes provide solutions for better cost efficiency, more environmentally friendly systems and give materials more resistance to chemical or mechanical stresses.

With our customized high-performance materials, we improve your quality of life. Today and tomorrow.

As a technology leader with almost 60 years of experience, we create high-performance polymers, foams and membranes that take your products to the top!

Efficiency and reliability are our key drivers when developing sustainable, customized solutions for our customers. Our goal is to design products for the future that hold up to the challenge of elevating your quality of life – every day.

Materials from Evonik have been protecting cables as sheathing or protection tubing for many years. Continuous improvements have made these materials the first choice for the electronics and cable industry.



**We take you to the top with our
HIGH-PERFORMANCE POLYMERS**

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HIGH-PERFORMANCE POLYMERS for cable design

PRODUCTS

Evonik Industries manufactures a range of polyamide, polybutylene terephthalate and polyetheretherketone extrusion grades for cable and wire coating, jacketing, fiber optical jacketing, loose tubes, and cable protection tubing and profiles.

- **VESTAMID® L** polyamide 12 (PA 12) for cable and wire coating/jacketing and cable protection tubes
- **VESTAMID® E** polyamide 12 elastomer (PEBA) for highly flexible cable coating and jacketing
- **VESTODUR®** polybutyleneterephthalate (PBT) for fiber optical jacketing and loose tubes
- **VESTAKEEP® PEEK** polyetheretherketone for cable and wire coating for high end applications

Which material fits the demands?

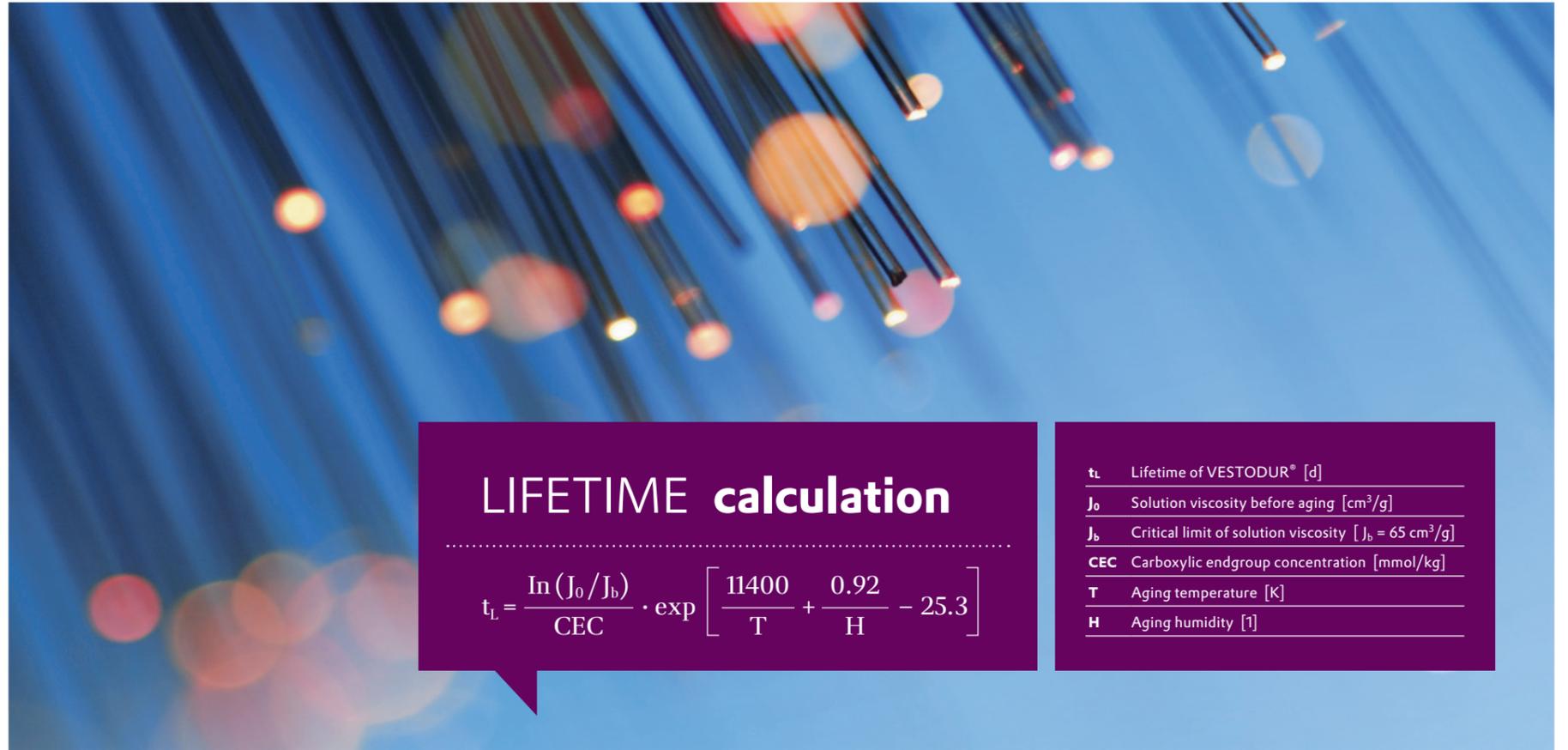
Evaluation from bad to outstanding | -
+++

Suitable materials for various applications

Material	Temperature stability	Hydrolysis resistance	Chemical resistance
PA 12	++	++	++
PA 12 elastomers	+	+	+
PBT	++	-	+
PEEK	+++	+++	+++

Application	VESTAMID® L PA 12	VESTAMID® E PA 12 elastomer	VESTODUR® PBT	VESTAKEEP® PEEK
Fiber optical cable	●	●	●	
Polymer optical fiber cable	●			●
Wire sheathing	●			●
Fuel cable	●			
Aviation / aerospace	●			●
Rodent and termite protection	●			
Non-halogenated flame retardant	●	●	●	●

FIBER OPTIC cables



LIFETIME calculation

$$t_L = \frac{\ln(J_0/J_b)}{CEC} \cdot \exp \left[\frac{11400}{T} + \frac{0.92}{H} - 25.3 \right]$$

t_L	Lifetime of VESTODUR® [d]
J_0	Solution viscosity before aging [cm ³ /g]
J_b	Critical limit of solution viscosity [$J_b = 65 \text{ cm}^3/\text{g}$]
CEC	Carboxylic endgroup concentration [mmol/kg]
T	Aging temperature [K]
H	Aging humidity [%]

Fiber optic cables

A fiber optic cable offers many advantages. It can support a much wider range of uses than any conventional copper cable. Fiber optic cables are light-weight and small yet extremely rugged.

The dielectric nature of optical fibers makes them immune to electromagnetic interference. The optical fibers in a cable must be protected against any mechanical stresses caused by manufacturing and the various ambient conditions encountered during the life of the cable. This protection is achieved in a combined way:

- by the individual protection of the fibers with VESTAMID® or VESTODUR®
- by the protection provided by the cable construction

Material requirements

Materials which can be used for secondary fiber optic jacketing have to meet the following requirements

- Easy processability with high melt strength
- Low thermal expansion coefficient
- High flexural modulus with good kink resistance
- Stress cracking resistance against filling compounds and solvents such as alcohols and ketones, used in splicing operations
- Low moisture absorption
- Good hydrolysis resistance
- High compressive strength
- Flame retardant (optional)

Considering the various polymers which would be appropriate for secondary fiber optic jacketing, only a few materials will meet these requirements.

VESTAMID® and VESTODUR® compounds have consistent product quality offering easy processability with trouble-free continuous production. These engineering thermoplastics have outstanding properties for chemical resistance, dimensional stability, and hydrolysis resistance.

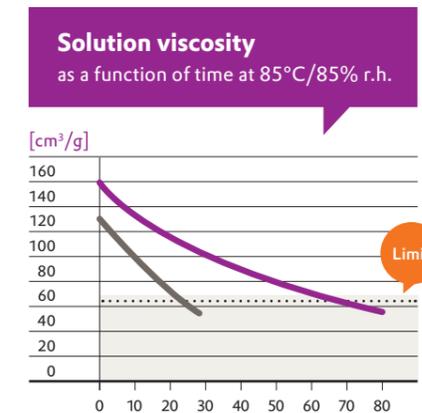
Hydrolysis resistance

Hydrolysis is known as a primary cause of degradation of thermoplastic polyesters at elevated temperatures. Compared to PA 12, standard PBT resins have minor hydrolysis resistance.

Evonik therefore developed PBT grades with improved hydrolysis resistance such as VESTODUR® 3013, a compound with very good hydrolysis resistance.

Compared to standard PBT resins, this grade exhibits a threefold improvement in lifetime expectations. Lifetime is determined by the loss of the mechanical integrity of the material. Below the critical viscosity number of $65 \text{ cm}^3/\text{g}$, PBT becomes brittle.

The speed of degradation of PBT is determined by the carboxylic endgroup concentration (CEC) of the polymer. The higher the CEC at the beginning of aging, the faster degradation occurs.



The figure shows the viscosity number curve at constant temperature and humidity for fiber optic buffer tubes produced from a standard PBT and VESTODUR® 3013 as a function of time. In a study, we examined the lifetime of VESTODUR® in terms of ambient temperature and humidity, solution viscosity, and carboxylic endgroup concentration.

With the formula above, the lifetime of a fiber optic buffer tube can be calculated for any given temperature and humidity.

TIGHT & SEMI-TIGHT buffer cables

- Outer jacketing
- Aramid yarns
- Inner coating | VESTAMID® | VESTODUR®
- Jelly
- Optical fiber

Design for fiber optic cables

Fiber optic cables are designed to meet a variety of operational specifications for different applications. In order to limit the number of designs, a universal cable concept would be very attractive but cannot be realized.

The following chapters describe some common cable designs from the market:

- ➔ Tight and semi-tight buffer cables
- ➔ Loose tube cables
- ➔ Polymer optical fibers

Tight & semi-tight buffer cables

Tight and semi-tight jacketing is mainly used for indoor cables, patch cord cables or connector pig-tails. One optical fiber in the core is protected by a multi-layer cable construction.

Benefits using VESTAMID®

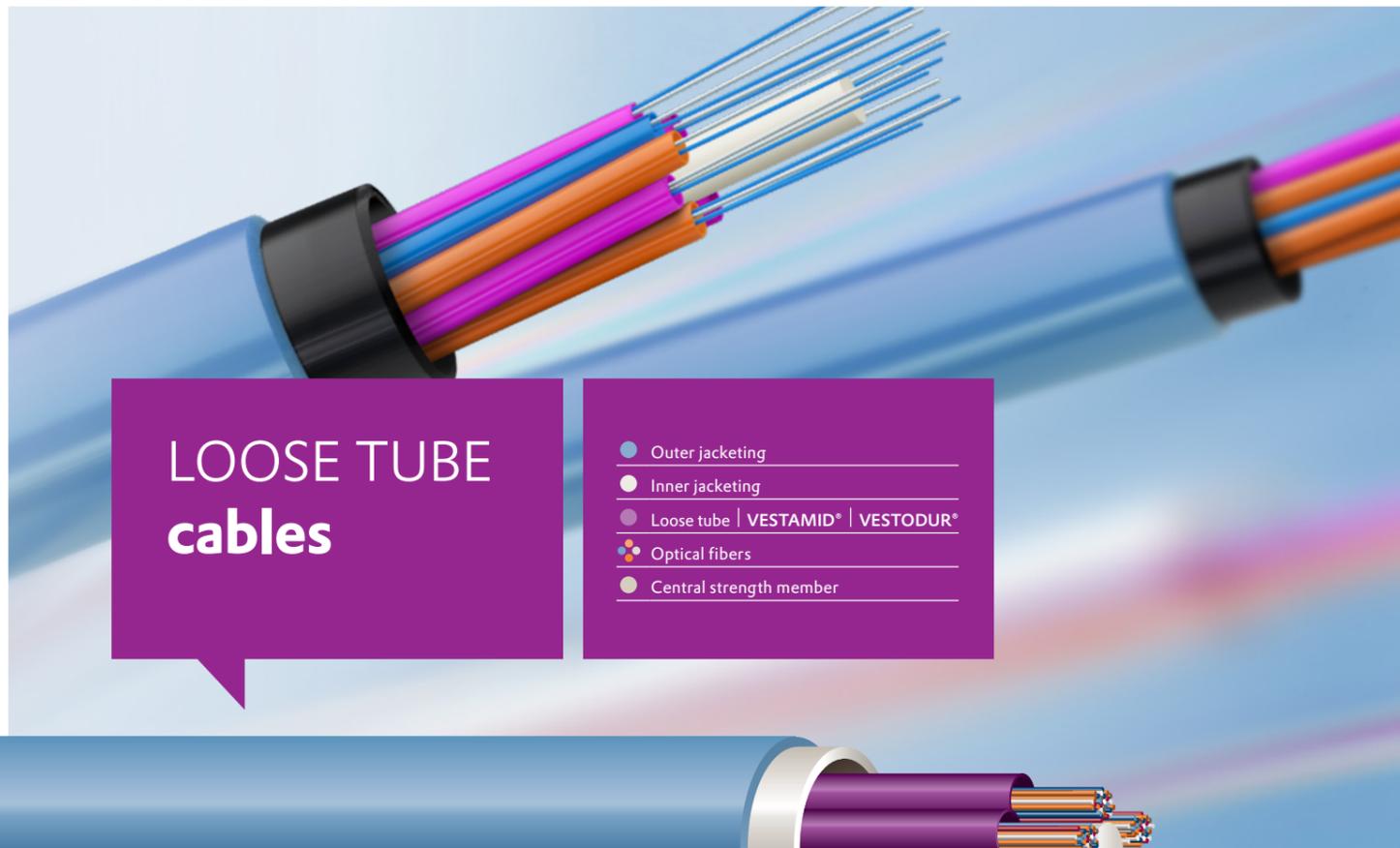
- ➔ Low water absorption
- ➔ Very high chemical resistance, e.g. against fuels, oils, filling compound, petro jelly
- ➔ High hydrolysis resistance
- ➔ Excellent cold impact performance
- ➔ High hardness and abrasion resistance
- ➔ High dynamic load behavior
- ➔ Excellent properties in case of fire (with flame retardant)

Benefits using VESTODUR®

- ➔ Excellent processability
- ➔ Good kink resistance
- ➔ High compressive strength
- ➔ Low thermal expansion coefficient
- ➔ High chemical resistance, e.g. against filling compound, petro jelly
- ➔ Good hydrolysis resistance
- ➔ Low moisture absorption
- ➔ Good properties in case of fire (with flame retardant)

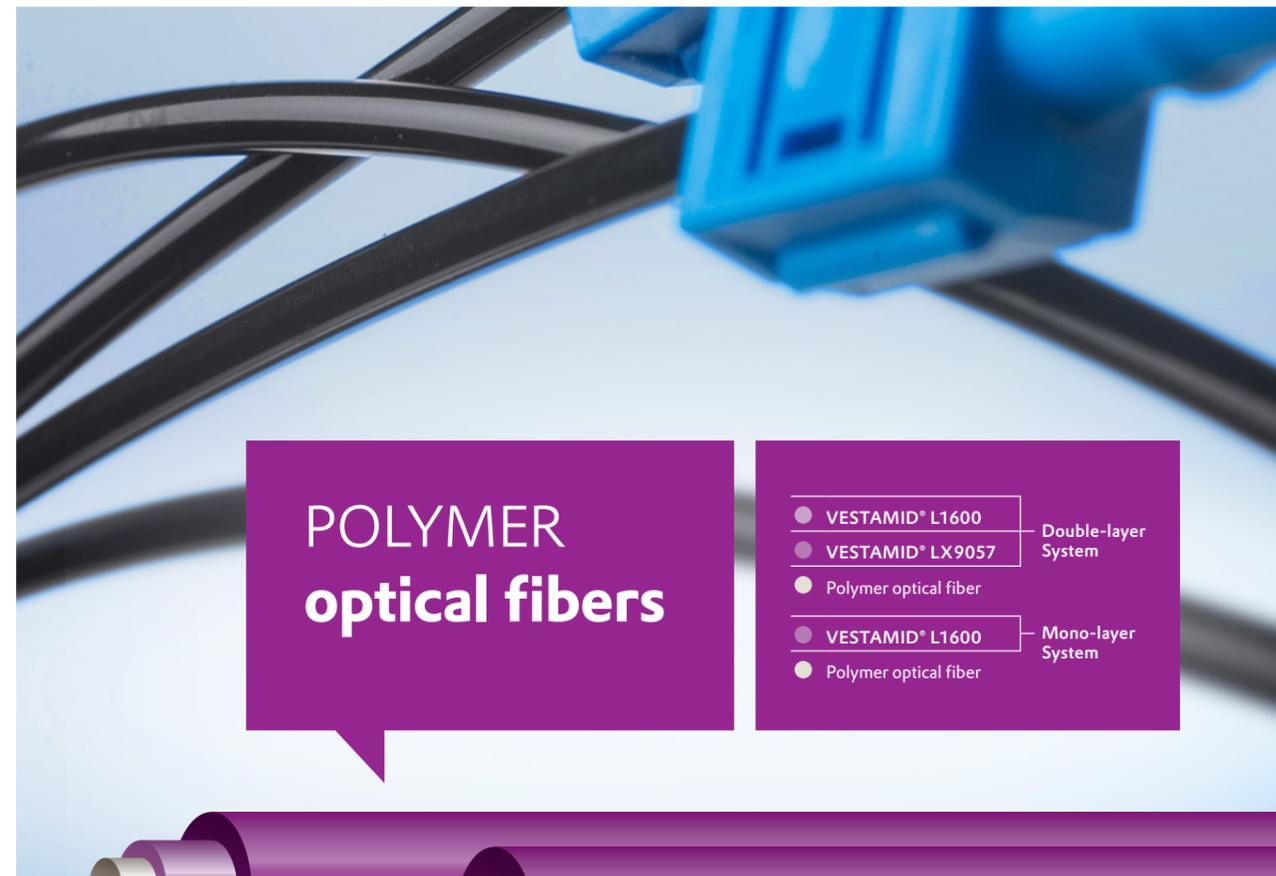
Recommended grades for secondary coating

Characteristic	Non-flame retardant	Flame retardant
High stiffness	VESTAMID® L1670	
	VESTODUR® 3013	VESTAMID® X7166
	VESTODUR® X7396	VESTAMID® X7167
High flexibility	VESTAMID® E62-S3	
	VESTODUR® X4159	VESTAMID® LX9057



LOOSE TUBE cables

- Outer jacketing
- Inner jacketing
- Loose tube | VESTAMID® | VESTODUR®
- Optical fibers
- Central strength member



POLYMER optical fibers

- VESTAMID® L1600
 - VESTAMID® LX9057
 - Polymer optical fiber
- Double-layer System
- VESTAMID® L1600
 - Polymer optical fiber
- Mono-layer System

Loose tube cables

In the loose tube design each fiber or multifiber bundle is held loosely inside a polymer tube. The tube is normally filled with a moisture repellent jelly compound. The jelly-filled tube gives the fibers excellent protection against various external forces acting on the cable. None of these forces will be transferred directly to the fibers. In addition, the tubes are stranded around the central strength member (helically or SZ). This design yields in a strain relief effect and this is the most important advantage of the loose tube design.

The cable core is protected by various wrappings, polymer jackets, and additional reinforcements in the form of strength member layers or armoring.

Recommended grades as a mechanical protection for loose fiber bundle cables are:

- VESTAMID® L1940 and VESTAMID® L2140
- VESTODUR® 3013 and VESTODUR® X7396

Benefits using VESTAMID® or VESTODUR®

- High line speeds (up to 400 m/min)
- High stability during extrusion (less scrap)
- Fast crystallization for better fiber excess length control
- High chemical resistance (filling compound, inhibits H₂O penetration)
- Good hydrolysis resistance
- In compliance with Belcore test (85 °C/85 % r.h.)

Polymer optical fibers

A single or dual-layer jacket system protects the optical data carrier, a PMMA fiber. The inner sheath adheres firmly to the PMMA core. In addition to providing mechanical protection, it increases the refractive index by virtue of its black color, so that light scattering is avoided and optical transmission improved. It is also suitable for laser welding, so that the optical plug-in connectors can be welded on. By contrast, the outer layer adheres only slightly to the first so that the system can be easily fabricated.

The following POF systems are commonly available on the market:

- Double-layer system with an outer layer consisting of VESTAMID® LX9057, a halogen-free flame retardant PA 12, and an inner layer made from VESTAMID® L1600, a non-stabilized PA 12
- Mono-layer system made of VESTAMID® L1670

Benefits using VESTAMID®

- High flexibility / bending radius
- Low weight
- Low water absorption
- Very high chemical resistance
- High hydrolysis resistance
- Excellent burning properties (two-layer system)
- Two layers avoid migration of additives (no attenuation)

Cable PROTECTION



Cable protection tubes and profiles

Corrugated cable protection tubes for railways, tunnels, factories and public buildings, as well as profiles for aircrafts, must fulfill special requirements.

VESTAMID® polyamide 12 provides excellent dynamic load behavior, chemical resistance, impact strength, especially cold impact strength, as well as high abrasion resistance and thermostability.

In addition, the mentioned applications call for materials that

- do not contain halogens or phosphorus
- are self-extinguishing
- have a high oxygen index (LOI), and release little smoke and toxic gases in case of fire

We therefore recommend the grades VESTAMID® X7167, X7229 without halogenated and phosphorus-containing flame retardants, and EX9203 black for cable protection tubing and profiles.

In addition, products like VESTAKEEP® L4000 G and VESTAKEEP® 5000 G are suitable for convoluted and corrugated tubes. The high temperature resistant PEEK is inherently flame retardant, has a high LOI, a low smoke density, and releases no toxic gases in case of fire.

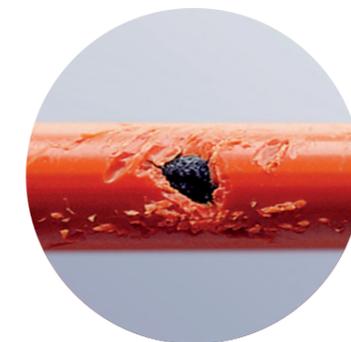
Ant, termite and rodent resistant cable jacketing

Telephone operators in certain countries in the southern hemisphere such as in Australia, India, and Brazil have specified PA 12 compounds as a protective cladding for underground cables.

In addition to its particularly high weathering resistance, rigid VESTAMID® compounds have a high degree of ant and termite resistance.

The outstanding toughness also protects telecommunication cables against attacks by rodents. While standard polyethylene (PE) jacketing is destroyed by rats within two days, rodents stop gnawing cables protected with polyamide 12 grades VESTAMID® L1940, L2140, or L2170, after six days because they fail to make any progress.

The same happens with ant and termite attacks: Not only do termites gnaw the cable sheathing, they also secrete aggressive formic acid, which can corrupt the cable sheathing. PA 12 has excellent resistance to formic acid; it does not swell, and prevents gnawing attacks.



Approval

VESTAMID® L is approved by

Laboratory Animal Science, Fudan, China, JB/T10696.9-2011, and by

Union of Wildlife at Justus-Liebig-University, Gießen, Germany

Wire INSULATION



SUPPLY &
quality

Wire insulation

VESTAMID® and VESTODUR® are not only used to protect optical fibers, these engineering thermoplastics are also processed into copper wire insulation. For these purposes, VESTAMID® grades are distinguished by their

- Exceptional high mechanical strength
- Outstanding chemical resistance
- Low sliding friction coefficient
- Exceptional abrasion resistance
- Excellent weathering resistance

Suitable grades for wire insulation

- VESTODUR® X9426
- VESTAMID® L1670
- VESTAMID® X7166
- VESTAMID® LX9057



Grades for high operating temperatures

For continuous operating temperatures up to 260 °C, we deliver various PEEK grades for metal wire insulation.

Typical products are

- VESTAKEEP® 2000 G for high line speed
- VESTAKEEP® 3300 G for improved ductility
- VESTAKEEP® 3300 G High Purity for very thin coatings
- VESTAKEEP® 5000 G for highest ductility

Benefits using VESTAKEEP®

Metal wire insulation with VESTAKEEP® offers

- Highest possible chemical resistance
- High resistance to electromagnetic radiation
- Outstanding long-term temperature performance
- Self-extinguishing with high LOI and low smoke densities
- High dielectric strength at high temperature levels
- Design options for ultrathin jackets

Delivery and handling

VESTAMID® and VESTODUR® compounds are delivered dry in moisture-proof bags or in octabins. Therefore, further drying before processing is not required. The compounds will absorb moisture from the atmosphere. The amount absorbed depends on the ambient conditions of the area where they are used. During processing, a dehumidifying hopper dryer is therefore recommended. The temperature may be set at 60 to 80 °C.

Granules from opened or damaged bags must be dried in a desiccant type dryer for a minimum of 2 hours at 120 to 125 °C for VESTODUR® and for VESTAMID®

at 90 to 100 °C, or on trays in layers not exceeding 2 to 3 cm thickness at a temperature of 120 °C for VESTODUR® and 90 to 100 °C for VESTAMID® in a circulating air oven for about 5 hours. The moisture content must not exceed 0.05 % for VESTODUR® or 0.10 % for VESTAMID®.

VESTAKEEP® compounds are packed in 25 kg boxes with PE liners. The water content of the compounds should not exceed 0.25 %.

Detailed product property values can be found in our database.



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