

VESTAMID® E

Polyamide 12 elastomers

PA 12 elastomers, the most important subgroup of polyamide elastomers, belong to the increasingly important material class of thermoplastic elastomers (TPE). Because of their excellent properties, they are indispensable in many applications. Evonik markets its PA 12 elastomers under the brand VESTAMID® E.



There must be something at the bottom of it! Could it be VESTAMID®E?

High elasticity and recovery

PA 12 elastomers are block copolymers consisting of PA 12 segments and polyether segments. PA 12-rich products have the major properties of PA 12, while the elastomer characteristics become more apparent with increasing polyether content. That is the polymers become more flexible, with higher impact strength at cold temperatures.

Compared to other contending thermoplastic elastomers, PA 12 elastomers are distinguished by the following properties:

- low density.
- highly resistant to chemicals and solvents
- easy to process, color and overmold
- easy decoration by means of heat transfer printing
- excellent impact strength at low temperatures
- hardness and flexibility vary over a wide range
- high elasticity and good recovery
- mechanical properties only slightly temperature-dependent
- free of volatile or migrating plasticizers

Customized product range

The PA 12 elastomer compounds we sell are suitable both for precision injection molding and for high-performance extrusion processing, for example, for making tubing and films. We deliver unstabilized or heat- and light-stabilized products, according to the customer's needs.

The names of the PA 12 elastomer commercial products begin with the trade name VESTAMID®, followed by a capital "E" for elastomers and a two-digit number indicating the Shore hardness D of the product. Example: VESTAMID® E47.

Other formulation components and properties are indicated by capital letters and numbers preceded by a hyphen:

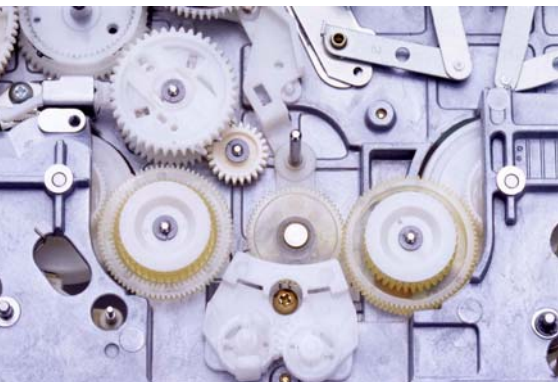
- S1 Compound is heat-stabilized.
- S3 Compound is heat- and light (UV)-stabilized.
- S4 Compound is heat- and light (UV)-stabilized.

Developmental products are designated by the trade name VESTAMID and an "X" or "EX" followed by a four-digit number. This number is arbitrary, however, and provides no information on the modification of the compound. Example: VESTAMID® EX9200.

VESTAMID® E compounds and their typical applications

VESTAMID®	stabilized against	Shore hardness D*	Typical applications
E40-S1	heat	40	noiseless gears, seals, functional elements of sports shoes, process aids in the extrusion of thermoplastic polyurethanes, films
E40-S3	heat and light		
E47-S1	heat	47	sports shoe soles, packaging films, non-skid surfaces, sports glasses, protective goggles
E47-S3	heat and light		
E55-S1	heat	55	alpine ski boots components, sports shoe soles, pneumatic lines, rolls, technical films
E55-S3	heat and light		
E58-S4	heat and light	59	Transparent sport shoe soles
E62-S1	heat	62	alpine ski boots, noiseless gears, conveyor belts
E62-S3	heat and light		
EX9200	heat and light	68	alpine ski boots, noiseless gears, conveyor belts

* according to ISO 868



Mechanical properties

Among the polyamides, PA 12 has the lowest water absorption and therefore features particularly high dimensional stability and little influence of moisture on the mechanical properties. These advantages are transferred to the PA 12 elastomers. Therefore, mechanical data on as-injection-molded and conditioned products differ only slightly.

Hardness and strengths

In the case of rubbers, the products are commonly classified according to Shore hardness. For a direct comparison, thermoplastic elastomers are categorized similarly. Shore hardness D is used for the harder types while Shore hardness A is used for the softer ones. Essentially, the range from hard thermoplastics with a Shore hardness of D 72 to soft rubbers with a Shore hardness of A 70 can be covered with polyamide elastomers by varying the block composition. No other thermoplastic elastomer covers such a large range. Evonik is currently selling VESTAMID® E products with Shore hardnesses from D 68 to D 40.

Temperature dependence

In numerous applications for PA 12 elastomers, the relatively low temperature-dependence of the mechanical properties is of crucial importance.

Permanent set

Among the thermoplastic elastomers, PA 12 elastomers feature high recovery following deformation. For the permanent set according to ISO 815, for example, the following data were found:

Permanent set according to ISO 815

VESTAMID®	23°C	70°C	100°C
E40-S3	32%	47%	84%
E62-S3	34%	48%	85%

Abrasion behavior

Even with very abrasive friction pairs, VESTAMID® elastomers exhibit favorable abrasion behavior. This property is prized for many heavy-duty applications, such as in sports articles. Thanks to the high elasticity of VESTAMID® elastomers, surfaces can recover from distortions if they have not been severely damaged. This is referred to as the “self-healing” effect.

Abrasive behavior of PA 12 elastomers

VESTAMID®	Shore hardness D	DIN 53754 mg/100 revolutions	DIN 53516 mm/40m rubbing distance
E40-S3	40	20	105
E47-S3	47	-	63
E55-S3	55	8-9	50
E62-S3	62	9-10	47

Major properties of PA 12 elastomers of different hardnesses compared with PA 12

Properties	Test method	Unit	VESTAMID® E with Shore hardness D						PA 12
			30*	40	47	55	62	68*	
Density at 23°C	ISO 1183	g/cm ³	1.01	1.01	1.02	1.03	1.03	1.03	1.01
Tensile modulus	ISO 527 - 1/-2	MPa	45	85	115	240	360	500	1500
IZOD notched impact strength at -30°C	ISO 180/1A	kJ/mm ²	N	N	N	N	N	N	N
Vicat softening temperature	ISO 306	°C	90	125	140	160	165	170	174

Important properties of PA 12 elastomers

Property	Test method	Unit	VESTAMID® E40-S3	VESTAMID® E47-S3	VESTAMID® E55-S3
Physical, thermal, and mechanical properties, and flammability					
Shore hardness D	ISO 868		40	47	55
Density	ISO 1183	g/cm ³	1.01	1.02	1.03
Viscosity number	ISO 307		190	190	190
Temp. of deflection under load Method A Method B	1.8 MPa 0.45 MPa	ISO 75 °C °C	55	45 65	45 90
VICAT softening temperature Method A Method B	10 N 50 N	ISO 306 °C °C	125 60	140 70	160 100
Linear thermal expansion 23–55°C longitudinal transverse	ISO 11359	10 ⁻⁴ K ⁻¹ 10 ⁻⁴ K ⁻¹	2.4 2.1	2.3 2.1	2.0 2.0
Flammability acc. UL94 1.6 mm	IEC 60695		HB	HB	HB
Water absorption 23 °C, saturation	ISO 62	%	1.0	1.0	1.1
Mold shrinkage in flow direction in transverse direction	determined on 3mm sheets with film gate at rim, mold temp. 80 °C	% %	0.6 – 0.9 0.7 – 1.3	0.6 – 1.0 0.9 – 1.5	0.6 – 1.1 0.9 – 1.5
Tensile test Stress at yield Strain at yield Stress at 50 % strain Tensile strength Strain at break	ISO 527-1/-2	MPa % MPa MPa %	9.5 17 >200	12 23 >200	17 38 >200
Tensile modulus	ISO 527-1/-2	MPa	80	120	220
Tensile creep modulus 1000 h	ISO 899-1	MPa	60	90	100
CHARPY impact strength 23 °C -30 °C	ISO 179/1eU	kJ/m ² kJ/m ²	N N	N N	N N
CHARPY notched impact strength 23 °C -30 °C	ISO 179/1eA	kJ/m ² kJ/m ²	N N	N N	N 22 C

Electrical properties

Relative permittivity 23°C, 100 Hz 23 °C, 1 MHz	IEC 60250		7.5 4.9	8.5 4.7	9.5 4.3
Dissipation factor 23°C, 100 Hz 23 °C, 1 MHz	IEC 60250	10 ⁻⁴ 10 ⁻⁴	700 1200	1200 1300	950 1100
Electric strength K20/P50	IEC 60243-1	kV/mm	35	37	38
Comparative tracking index Test solution A CTI	IEC 60112		600	600	600
Volume resistivity	IEC 60093	Ω cm	10 ¹¹	10 ¹¹	10 ¹¹
Spec. surface resistance	IEC 60093	Ω	10 ¹³	10 ¹³	10 ¹³

N = no break, P = partial break, C = complete break

HB = horizontal burning

	VESTAMID® E58-S4	VESTAMID® E62-S3	VESTAMID® EX9200
	58	62	68
	1.02	1.03	1.01
	180	190	190
	35 55	45 100	45 100
		165 110	170 130
		2.0 2.0	1.6 1.6
	HB	HB	HB
		1.1	1.5
		0.6 - 1.1 0.9 - 1.4	
	39 >200	23 42 >200	31 19 27 >200
	185	370	700
		200	
	N N	N N	N N
	N 5 C	120 P 8 C	33 P 6 C

		9.0 4.0	7.4 4.6
		1000 1200	1500 760
		39	30
		600	600
		10 ¹²	10 ¹¹
		10 ¹⁴	10 ¹³

Chemical and solvent resistance

Because they are more closely related to polyamides than other thermoplastic elastomers, VESTAMID® elastomers are relatively stable toward a variety of chemicals. Noteworthy is the good stability toward diluted hydrochloric and sulfuric acid and alkalis and the low degree of swelling particularly of the harsher products when exposed to ASTM oil, even at 100°C. The same applies to hydraulic fluids. There is little swelling in aliphatic solvents and alcohols. In aromatic solvents, while the softer VESTAMID® elastomers swell quite a bit, the mechanical properties are not lost dramatically.

Overmolding and bonding

All VESTAMID® elastomers can be welded to each other and to VESTAMID® L (PA 12). This applies in particular to the overmolding of compounds of different hardness or colorability. This property is taken advantage of quite often in the manufacture of multi-component and multi-colored parts of sports articles such as special sports shoe soles or ski boots.

An elevated mass temperature of up to 300°C, a high injection speed and high dwell pressure are recommended for overmolding. Better layer adhesion can be achieved if the mold temperature is raised to 100°C. However, a lower processing temperature can be helpful for more-transparent overmolding.

VESTAMID® elastomers can also be bonded to many other polymers by overmolding. In adhesion tests, the results listed in the table were obtained. Special polyamide adhesives are used for adhesion bonding.

Lamination strength during overmolding of VESTAMID® E with different polymers

Polymer	PP	PE	PA 6	PA 66- GF30	PA 12	PA 12- PEBA	PBT	POM	PET/ PBT	TPU	PS
Adhesion	-	-	+	+	+	+	+	-	-	+	+/-

Printability

In recent years, creating designs on injection moldings and films has become increasingly important in processing the surfaces of high-quality consumer goods. VESTAMID® elastomers lend themselves excellently to decorative application by means of thermodiffusion printing processes. In particular, brilliant decorative films, which have been used as highly attractive protective films in the sports article sector, can be manufactured by sublimation printing and state-of-the-art digital printing processes.

Films of VESTAMID® EX9200 several tenths of a millimeter thick are sufficiently transparent and are frequently sublimation-printed on the bottom side. The colorants penetrate the film up to 200 micrometers. The film itself then acts as a protective layer and the print motifs are almost indestructible. Frequently the decorative films are manufactured by co-extrusion in multiple layers—sometimes made of different VESTAMID® compounds—to achieve an optimum between surface protection, design and bondability with substrates.

Approvals

S1-stabilized VESTAMID® E compounds can be used in contact with foodstuffs if migration limit values are heeded. They satisfy the requirements of the directive 2002/72/EC and their amendments. Processors of S1-stabilized VESTAMID® E compounds have licenses for applications in medical technology, for example, in the manufacture of catheters.

Our experts will answer your specific questions.



Supply and coloring

VESTAMID® E compounds are delivered as a dry, ready-to-process granulate in moisture-proof bags with a net weight of 25 kg. By mutual agreement we also deliver VESTAMID® E in 1,000 kg octabins. The compounds can be processed immediately after the packaging has been opened, without any further pre-drying. The storage time of unopened packaging is almost unlimited under ordinary storage conditions, unless the packaging is damaged.

Like all partially crystalline polyamides, VESTAMID® is colorless when molten and whitish-opaque in the solid state (natural color). The same applies to PA 12 elastomers. Films up to several hundred micrometers in thickness, however, are still transparent enough that they can be used, for example, as decorative films with printing on the bottom side.

Most compounds are delivered either naturally colored or black. Others exhibit a specific color produced by the additives used. In appropriate lot sizes, specially colored molding materials can be delivered. Colorants containing lead and cadmium are essentially not used.

VESTAMID® E resins can also be colored during processing. In this case, master batches based on PA 12 are the choice here. Dry coloring with fine-powdered colorants is also possible but inconvenient, thus precluding pneumatic conveying of the granulate. Colorant pastes with a "neutral" base (e.g., polyethylene) may be incompatible with VESTAMID® E compounds, thus resulting in flaws and inhomogeneity. Therefore, the compatibility of the colorant paste must definitely be pre-tested.

Processing VESTAMID® E

VESTAMID® E compounds can be used in all injection molding and extrusion machines suitable for polyamides. With proper processing, no noxious by-products are produced. As a general practice in the processing of thermoplastics, we recommend that the production room be sufficiently ventilated.

Recommendations for melt and mold temperatures

VESTAMID®	Melt temp. [°C]	Mold temp. [°C]
E40-S1, S3	170-210	20-40
E47-S1, S3	180-220	
E55-S1, S3	190-230	
E62-S1, S3		
E58-S4	190-230	
EX9200	200-240	

For processing VESTAMID® E compounds, the moisture content must be less than 0.1% by weight. The granules must be dried only if the package has been damaged or was opened for more than two hours. In these cases, the compounds must be dried for 4 to 12 hours at 80-100°C, preferably in a dehumidified air drying oven. The bags should be stored for about one day at the ambient temperature of the machine before processing to avoid condensation of moisture on the granules.

Like most polymers, VESTAMID® E is miscible with very few other plastics. Therefore, all machines must essentially be cleaned before processing. HDPE or PP is recommended for cleaning. Talcum-filled PP is particularly suitable.



August 2011

® = registered trademark

This information and all technical and other advice are based on Evonik's present knowledge and experience. However, Evonik assumes no liability for such information or advice, including the extent to which such information or advice may relate to third party intellectual property rights. Evonik reserves the right to make any changes to information or advice at any time, without prior or subsequent notice. EVONIK DISCLAIMS ALL REPRESENTATIONS AND WARRANTIES, WHETHER EXPRESSED OR IMPLIED, AND SHALL HAVE NO LIABILITY FOR, MERCHANTABILITY OF THE PRODUCT OR ITS FITNESS FOR A PARTICULAR PURPOSE (EVEN IF EVONIK IS AWARE OF SUCH PURPOSE), OR OTHERWISE. EVONIK SHALL NOT BE RESPONSIBLE FOR CONSEQUENTIAL, INDIRECT OR INCIDENTAL DAMAGES (INCLUDING LOSS OF PROFITS) OF ANY KIND. It is the customer's sole responsibility to arrange for inspection and testing of all products by qualified experts. Reference to 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 Industries AG High Performance Polymers 45764 Marl Germany
PHONE +49 2365 49-9878 **E-MAIL** evonik-hp@evonik.com www.vestamid.com



EVONIK
INDUSTRIES