

VESTAMID® L

Polyamide 12 compounds

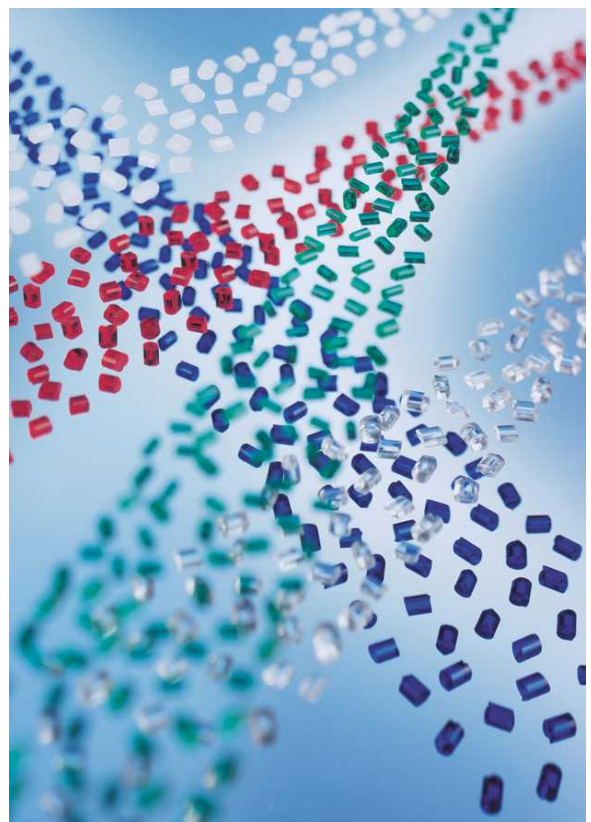
Starting from butadiene, Evonik manufactures lauro lactam, the monomer for PA 12, which is then converted by means of a polycondensation reaction into PA 12 and marketed under the name VESTAMID® L.

Outstanding cold impact strength

The (carbon)amide groups ($-\text{CO}-\text{NH}-$) in polyamides are responsible for the formation of hydrogen bonds between the macromolecular chains. The hydrogen bonds contribute to the crystallinity, increase the strength, the melting point and the chemical resistance.

The concentration of amide groups is the lowest in PA 12 compared to any other commercially available polyamide, and this determines the specific properties of PA 12:

- the lowest water absorption of all commercially available polyamides, resulting in properties which vary little with changing humidity, and in moldings with virtually unchanged dimensions
- exceptional impact and notched impact strengths, in both dry as molded state, and at temperatures well below the freezing point
- good to excellent resistance against greases, oils, fuels, hydraulic fluids, various solvents, salt solutions and etc.
- exceptional resistance to stress cracking including metal parts encapsulated by injection molding or embedded
- exceptional abrasion resistance
- low coefficient of sliding friction, in dry running against steel, polybutylene terephthalate, polyacetal and other materials
- noise and vibration damping properties
- superb fatigue resistance under high frequency cyclical loading condition
- high processability



Customized product range

The properties of PA 12 compounds can be modified to suit the requirements of many applications by incorporating various additives such as stabilizers, plasticizers, reinforcements, and fillers.

The VESTAMID® L compounds of Evonik comprise a range of various products that are customized to the requirements of processors and users. Many of the PA 12 compounds are suitable especially for the injection molding of precision parts; others have been developed specifically for the extrusion process.

Unfilled PA 12 compounds

Property	Test method	Unit	VESTAMID® L1670	VESTAMID® L1940	VESTAMID® X7373
Physical, thermal, and mechanical properties, and flammability					
Density	ISO 1183	g/cm ³	1.01	1.01	1.01
Melting temperature DSC	ISO 11357	°C	178	178	178
Temp. of deflection under load Method A Method B	ISO 75	°C °C	50 120	50 110	50 130
VICAT softening temperature Method A Method B	ISO 306	°C °C	170 140	170 140	170 150
Linear thermal expansion	ISO 11359	10 ⁻⁴ K ⁻¹	1.5	1.5	1.5
Flammability acc. UL94	IEC 60695		HB HB	HB HB	HB HB
Water absorption	ISO 62	% %	1.4 0.7	1.5 0.8	1.4 0.7
Mold shrinkage in flow direction in transverse direction	ISO 294-4, processing acc. ISO 1874-2	% %	0.9 1.1	0.85 1.15	0.95 1.15
Tensile test Stress at yield Strain at yield Stress at break Strain at break	ISO 527-1/-2	MPa % MPa %	46 6 >50	45 5 >50	47 5 >50
Tensile modulus	ISO 527-1/-2	MPa	1400	1350	1500
CHARPY impact strength	ISO 179/1eU	kJ/m ² kJ/m ²	N N	N N	N N
CHARPY notched impact strength	ISO 179/1eA	kJ/m ² kJ/m ²	4 C 5 C	6 C 6 C	6 C 6 C
Electrical properties					
Relative permittivity	IEC 60250		3.8 2.2	3.8 2.5	4.2 3.8
Dissipation factor	IEC 60250	10 ⁻⁴ 10 ⁻⁴	450 280	450 310	750 520
Electric strength	IEC 60243-1	kV/mm	27	27	30
Comparative tracking index Test solution A	IEC 60112		>600 600	>600 600	>600 600
Volume resistivity	IEC 60093	Ω cm	10 ¹⁵	10 ¹⁵	10 ¹⁵
Electrolytic corrosion	IEC 60426	Stage	A1	A1	A1

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

* Plasticized compounds were not stored in water because of slight plasticizer migration.

**ISO 294-4, specimen 60x60x2 mm

VESTAMID® L2101F	VESTAMID® L2106F	VESTAMID® L2140 L2170	VESTAMID® L2141black	VESTAMID® LX9008	VESTAMID® LX9012
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1.01	1.01	1.01	1.01	1.01	1.01
178	175	178	178	176	176
50 110	40 80	50 110	50 110	45 125	45 120
170 140	170 130	170 140	170 140	175 145	170 130
1.5	1.5	1.4	1.5	1.4	1.3
HB HB	HB HB	HB HB	HB HB	HB HB	HB HB
1.6 0.8	1.8 0.8	1.6 0.7	1.5 0.7	1.4 0.7	1.5 0.8
0.7 1.25	0.7 1.2	0.65. 1.25	0.7 1.3	** 0.25 1.9	** 1.0 1.4
45 5 >50	45 5 >50	47 5 >50	46 5 >50	42 5 48 >50	37 5 46 >50
1400	1300	1400	1500	1450	1100
N N	N N	N N	N N	N N	N N
32 C 9 C	7 C 7 C	16 C 9 C	10 C 8 C	45 P/ C 22 C	13 C 13 C

3.7 3.0	3.7 3.0	3.7 3.0	9.7 4.0	3.7 2.9	3.8 3.0
450 280	450 280	450 260	2100 1100	520 320	530 280
29	27	26	35	26	24
>600 600	>600 600	>600 600	>600 600		
10 ¹⁵	10 ¹⁵	10 ¹⁵	10 ¹²	10 ¹⁴	10 ¹⁴
A1	A1	A1	A1		

Plasticized PA 12 compounds

Property	Test method	Unit	VESTAMID® L1723	VESTAMID® L2121	VESTAMID® L2122	
Physical, thermal, and mechanical properties, and flammability						
Density	ISO 1183	g/cm ³	1.03	1.02	1.03	
Melting temperature DSC	ISO 11357	°C	173	176	173	
Temp. of deflection under load						
Method A	1.8 MPa	°C	45	45	45	
Method B	0.45 MPa	°C	95	110	95	
VICAT softening temperature	ISO 306					
Method A	10 N	°C	165	170	165	
Method B	50 N	°C	130	130	125	
Linear thermal expansion	23–55°C	ISO 11359	10 ⁻⁴ K ⁻¹	1.8	1.6	1.7
Flammability acc. UL94	1.6 mm 3.2 mm	IEC 60695		HB HB	HB HB	HB HB
Water absorption 23 °C	saturation* 23°C, 50% rel. humidity	ISO 62	% %	0.5	0.6	0.5
Mold shrinkage		ISO 294-4, processing acc. ISO 1874-2				
in flow direction			%	1.65	0.6	0.6
in transverse direction			%	1.5	1.65	1.6
Tensile test		ISO 527-1/-2				
Stress at yield			MPa	30	35	30
Strain at yield			%	27	20	26
Stress at break			MPa			
Strain at break			%	>50	>50	>50
Tensile modulus		ISO 527-1/-2	MPa	480	700	490
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	24 C 5 C	40 C 7 C	68 P 6 C

Electrical properties

Relative permittivity	23°C, 100 Hz 23 °C, 1 MHz	IEC 60250		10 3.7	6.5 3.4	10 3.3
Dissipation factor	23°C, 100 Hz 23 °C, 1 MHz	IEC 60250	10 ⁻⁴ 10 ⁻⁴	1600 1200	1900 550	1900 1000
Electric strength	K20/P50	IEC 60243-1	kV/mm	33	34	32
Comparative tracking index		IEC 60112				
Test solution A	50 drops value CTI			>600 600	>600 600	>600 600
Volume resistivity		IEC 60093	Ω cm	10 ¹²	10 ¹⁴	10 ¹³
Electrolytic corrosion		IEC 60426	Stage	A1	A1	A1

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

* Plasticized compounds were not stored in water because of slight plasticizer migration.

	VESTAMID® X7393	VESTAMID® L2124	VESTAMID® L2123	VESTAMID® X7293	VESTAMID® L2128	VESTAMID® LX9013
	1.02	1.03	1.03	1.02	1.05	1.02
	173	171	171	172	164	172
	45 115	45 90	45 80	45 100	40 70	55 130
	170 130	165 125	165 120	165 130	145 100	165 130
	1.4	1.8	1.8	1.8	1.8	1.6
	HB HB	HB HB	HB HB	HB HB	HB HB	HB HB
	0.6	0.5	0.6	0.5	0.5	0.6
	0.8 1.35	0.7 1.55	0.65 1.4	0.65 1.35	0.65 1.2	0.35 1.45
	31 28 >50	26 31 >50	24 32 >50	27 32 >50	18 45 >50	- - 43 >50
	580	400	370	400	230	410
	N N	N N	N N	N N	N N	N N
	115 P 8 C	150 P 6 C	115 P 13 C	130 P 7 C	N 6 C	140 P 7 C

	7 4.2	12 3.8	10 3.6	11 4.6	17 3.8	12 3.4
	1900 1100	1600 1500	2000 1100	2000 1900	3000 2400	5000 1000
	27	32	29	30	31	22
	>600 600	>600 600	>600 600	>600 600	>600 600	>600 600
	10 ¹²	10 ¹²	10 ¹²	10 ¹²	10 ¹⁰	10 ¹⁰
		A1	A1		A1	

Reinforced, filled and flame retardant PA 12 compounds

Property	Test method	Unit	VESTAMID® L-GF15	VESTAMID® L1833	VESTAMID® L-GF30
Physical, thermal, and mechanical properties, and flammability					
Density	ISO 1183	g/cm ³	1.12	1.18	1.24
Melting temperature DSC	ISO 11357	°C	178	178	178
Temp. of deflection under load Method A Method B	ISO 75	°C °C	160 175	164 175	165 175
VICAT softening temperature Method A Method B	ISO 306	°C °C	175 170	175 175	175 175
Linear thermal expansion 23–55°C	ISO 11359	10 ⁻⁴ K ⁻¹	0.8	0.7	0.6
Flammability acc. UL94	IEC 60695		HB V-2	HB V-2	HB HB
Water absorption	ISO 62	% %	1.3 0.6	1.2 0.6	1.1 0.5
Mold shrinkage in flow direction in transverse direction	ISO 294-4, processing acc. ISO 1874-2	% %	0.35 0.65	0.2 0.65	0.15 0.65
Tensile test Stress at yield Strain at yield Stress at break Strain at break	ISO 527-1/-2	MPa % MPa %	95 6	105 6	120 5
Tensile modulus	ISO 527-1/-2	MPa	3900	5300	6500
CHARPY impact strength	ISO 179/1eU	kJ/m ² kJ/m ²	75 C 80 C	83 C 95 C	85 C 100 C
CHARPY notched impact strength	ISO 179/1eA	kJ/m ² kJ/m ²	17 C 11 C	20 C 16 C	23 C 21 C

Electrical properties

Relative permittivity	23°C, 100 Hz 23°C, 1 MHz	IEC 60250		4.0 3.4	4.1 3.4	4.1 3.4
Dissipation factor	23°C, 100 Hz 23°C, 1 MHz	IEC 60250	10 ⁻⁴ 10 ⁻⁴	380 260	370 260	310 330
Electric strength	K20/P50	IEC 60243-1	kV/mm	44	41	44
Comparative tracking index Test solution A	50 drops value CTI	IEC 60112		>600 600	>600 600	>600 600
Volume resistivity		IEC 60093	Ω cm	10 ¹⁵	10 ¹⁵	10 ¹⁵
Electrolytic corrosion		IEC 60426	Stage	A1	A1	A1

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

* Test specimen 127x12.7x3.2 mm

VESTAMID® L1930	VESTAMID® L-GB30	VESTAMID® X7166	VESTAMID® X7167	VESTAMID® X7229
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1.24	1.25	1.06	1.05	1.06
178	178	178	178	175
130 170	55 150	50 140	50 130	40 130
175 170	175 155	175 150	175 150	170 150
0.5	1.3	-	-	0.8
HB HB	HB HB	V-0 V-0	V-2 V-2	V-2 V-2
1.1 0.5	1.1 0.5	1.3 0.6	1.5 0.6	1.5 0.6
0.7 0.6	1.2* 1.2*	0.65 0.75	0.6 0.95	0.55 0.8
69 4 60 10	47 5 38 37	47 5 >50	48 5 >50	36 17 >50
4000	2000	1800	1700	1000
70 C 65 C	160 C 160 C	65 C 80 C	N N	N N
10 C 11 C	6 C 6 C	3 C 5 C	9 C 6 C	11 C 5 C

4.1 3.4	4.1 3.5	3.6	3.6	5
310 240	310 230	340	380	1700
40	31	28	28	27
>600 600	>600 600	>600 600	>600 600	>600 600
10 ¹⁵	10 ¹⁵	10 ¹⁴	10 ¹⁴	10 ¹³
	A1		A1	

Permanently antistatic and conductive, black PA 12 compounds

Property	Test method	Unit	VESTAMID® L-R3-MHI	VESTAMID® L-R4-MHI	VESTAMID® L-R7-MHI
Physical, thermal, and mechanical properties, and flammability					
Density	ISO 1183	g/cm ³	1.10	1.06	1.08
Melting temperature DSC	ISO 11357	°C	178	178	178
	2 nd heating				
Temp. of deflection under load Method A	ISO 75	°C	50	50	50
Method B		°C	130	130	130
VICAT softening temperature Method A	ISO 306	°C	175	175	175
Method B		°C	140	140	140
Linear thermal expansion	ISO 11359	10 ⁻⁴ K ⁻¹	1.8	1.8	1.7
Flammability acc. UL94	IEC 60695		HB HB	HB HB	HB HB
Water absorption	ISO 62	%	1.5	1.5	1.5
		%	0.8	0.5	0.7
Mold shrinkage in flow direction	ISO 294-4, processing acc. ISO 1874-2	%	1.45	1.75	1.4
in transverse direction		%	1.55	1.65	1.45
Tensile test	ISO 527-1/-2				
Stress at yield		MPa	38	36	36
Strain at yield		%	5	8	6
Stress at break		MPa		33	
Strain at break		%	>50	42	>50
Tensile modulus	ISO 527-1/-2	MPa	1600	1250	1400
CHARPY impact strength	ISO 179/1eU				
CHARPY notched impact strength	ISO 179/1eA				

Electrical properties

Isolation resistance	IEC 60167	Ω	10 ⁴	10 ⁵	10 ⁷
Volume resistivity	IEC 60093	Ω cm	10 ⁴	10 ⁵	10 ⁷

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

* Plasticized compounds were not stored in water because of slight plasticizer migration.

	VESTAMID® L-R9-MHI	VESTAMID® L-R3-EI	VESTAMID® LX9102	VESTAMID® L-R2-GF25
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	1.08	1.06	1.12	1.27
	178	178	171	178
	50 130	60 130	55 120	170 175
	175 140	175 140	169 136	175 170
	1.7	1.5	1.5	1
	HB HB	HB HB	HB HB	HB HB
	1.5 0.7	1.2 0.5	1.5 0.5	1.2 0.5
	1.4 1.45	1.55 1.6	1.35 1.5	0.3 0.85
	37 6 >50	42 9 36 44	32 37 39 >50	120 5
	1400	1500	640	6500
	N N	N N	N N	75 C 70 C
	60 P 12 C	21 C 9 C	90 P 5 C	12 C 11C

	10 ⁹	10 ³	10 ⁴	10 ²
	10 ⁹	10 ³	10 ⁴	10 ²

Resistance against heat, radiation, and chemical attack

For thermoplastics to perform optimally over long periods within aggressive environments (UV radiation, hot air, etc.), it is necessary to incorporate the appropriate stabilizers.

Heat aging

Appropriate heat stabilizers improve the long-term performance of polyamides when used in air under higher temperatures. Except for some special products, all VESTAMID® L compounds are usually equipped with an optimal stabilizer package.

Hydrolysis resistance

Polycondensation products, to which polyamides also belong, have a limited resistance against hot water or moist air at higher temperatures. However, compared with other polyamides, PA 12 exhibits good hydrolysis resistance. PA 12 is gradually degraded by hot water. Compounds with a higher molecular mass will last longer than grades with a lower molecular mass. Hydrolysis occurs more rapidly in acid media than in neutral or alkaline ones. Up to temperatures of 70 to 80°C standard grades can be regarded as practically stable against pure water attack.

UV resistance

Exposure to short wave light of wavelengths less than 400 nm causes an accelerated decrease in molecular mass, leading to the embrittlement of moldings or semi-finished products. The deterioration can be reduced substantially by adding light stabilizers. UV absorbers and radical scavengers improve weathering performance remarkably. The best protection against irradiation, however, is obtained by using suitable grades of carbon black if blackening can be done. The addition of pigments can have either a stabilizing or sensitizing effect. Additionally, mechanical properties can be affected by carbon black or pigments.

Resistance against ionizing radiation

PA 12 has a high resistance to ionizing radiation.

Chemical resistance

PA 12 is highly resistant against chemically induced stress cracking. For details please contact the indicated persons.

Abrasion and frictional properties

Polyamides are characterized by a very high abrasion resistance. Harder compounds have a higher abrasion than softer materials. The abrasion increases again only in the case of very soft compounds.

For bearings or sliding parts the abrasion is of less importance than the coefficient of sliding friction. The coefficient depends on the bearing load, rotational speed, surface structure, or hardness of the mating surface, and the temperature. The coefficient of friction of polyamide against metal is lower than of metal against metal.

Whenever the application of lubricants may cause problems, PA 12 should be the first choice for the manufacture of bearings. Nevertheless, it should be mentioned that the optimum solution is offered by the use of bearings which were lubricated in assembly (maintenance free bearings). The high chemical resistance of PA 12 allows the use of practically all lubricants. As a result of lubrication, the coefficient of friction is considerably reduced and wear is practically eliminated.

On a final note, we would like to point out one special advantage that VESTAMID L2101 has at very low temperature. Under cryogenic conditions, it serves excellently as shot granules for deburring rubber parts.



Physiological and toxicological evaluation of VESTAMID® compounds

Please direct all questions on the toxicological properties of VESTAMID® compounds and relevant analysis pertaining their contact with foodstuffs to the indicated contact address. Here you will also receive the up-to-date safety data sheets of VESTAMID®.

Food contact

Uniform regulations for plastics that come into contact with foodstuffs exist at the European level. The consolidated EU Directive 2002/72/EC and its amendments apply. It lists approved monomers and 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.

The basic VESTAMID® grades of the PA 12 range have been approved by the European Union for direct contact with foodstuffs, since lauro lactam, the fundamental monomer of VESTAMID®, was positively listed. A migration value limit for lauro lactam of 5 mg per kilogram was imposed, which must be tested on the finished article itself and be kept within limits there.

In accordance with 21 CFR, § 177.1500, „Nylon Resins“, US FDA (Food and Drug Administration) approval for nylon-12 is only valid for films up to a thickness of 0.0016 inches (i.e., 40 µm). This approval covers the basic products VESTAMID® L1600, L1700, L1901 und L2101F. However, the restrictions exclude the contact with alcohol containing food or beverages. It has to be observed that heat sterilization of these non-stabilized compounds does not exceed 120°C for 30 minutes. If a stabilization or the use of special additives should be essential, we provide information on request.

Environment and ecological safety

VESTAMID® compounds are non-hazardous and not harmful to water. They are not subject to any particular safety regulations. Disposal can be done by land filling or incinerating together with normal household rubbish, provided that local ordinances permit this. Reprocessing is however preferable and is also of interest for economic reasons.

No dangerous by-products are formed if VESTAMID® is processed properly. Care should be taken, however, to ventilate the working area properly as it is required when processing thermoplastics – especially for compounds containing flame retardants or plasticizers.

Compounds containing flame retardants do not contain any brominated biphenyls or diphenylethers. In addition, grades with flame retardants free of halogen or phosphorous compounds can be supplied.

No pigments or additives containing cadmium are used.



® = registered trademark

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