

## VESTAMID® *Terra* Because we care

Technical biobased polyamides which achieve performance by natural means

Evonik Industries AG has recently developed and is pushing a new line of bio-based polymers under the existing family trade name VESTAMID®. There are currently three products within this new group of polyamides available that are partially or entirely based on renewable feedstocks:

- VESTAMID® *Terra* HS (PA610)
- VESTAMID® *Terra* DS (PA1010)
- VESTAMID® *Terra* DD (PA1012)

*Ricinus communis*, the castor bean plant grows in arid area, hence its cultivation neither affects food production nor does it cause land use change. The monomers used in the Vestamid® *Terra* line are derived from castor bean oil.

The VESTAMID® *Terra* products are available in pellet form as a base polymer. Our expertise is to provide tailored solutions for specific application fields. This has led to the development of a wide range of compounds which can contain, e.g. various stabilizers, flame retardants, fiber reinforcements, colouring agents, etc. Detailed information can be obtained upon request.



## Terra HS

VESTAMID® *Terra* HS is partly based on renewable raw materials and fills the performance gap between the commodity and the niche long-chain nylons.

VESTAMID® *Terra* HS is the polycondensation product of 1,6-hexamethylene diamine (H) and 1,10-decanedioic acid (sebacic acid—S). Because sebacic acid is derived from castor oil, VESTAMID® *Terra* HS is a material that is partly based on renewable resources.

Technically speaking, VESTAMID® *Terra* HS occupies a position between the high-performance polyamide 612 and the standard polyamides PA 6 and PA 66.

VESTAMID® *Terra* HS is semicrystalline and thus has high mechanical resistance and chemical stability. Due to its higher melting point, VESTAMID® *Terra* HS has the highest heat deflection temperature of VESTAMID® *Terra* series.

### Important properties of VESTAMID® *Terra* HS

Property	Test method	Unit	HS16	HS18	HS22	HS18-GF30
Viscosity number	ISO 307	cm <sup>3</sup> /g	160	180	220	180
Melting temperature	ISO 11357	°C	223	223	223	223
Glass transition temp.		°C	48	48	48	48
Water absorption at RT	Evonik	%	3.3	3.3	3.3	2.3
Density	ISO 1183	g/cm <sup>3</sup>	1.06	1.07	1.08	1.32
VICAT softening temp. Method B 50 N	ISO 306	°C	196	196	196	217
Tensile test	ISO 527					
Stress at yield		MPa	61	61	61	147
Strain at yield		%	5	5	5	4
Strain at break		%	>50	> 50	> 50	4
Tensile modulus	ISO 527	MPa	2100	2100	2100	8300
CHARPY 23 °C	ISO 179/1eU	kJ/m <sup>2</sup>	N	N	N	89 C
impact strength -30 °C		kJ/m <sup>2</sup>	N	N	N	88 C
CHARPY notched 23 °C	ISO 179/1eA	kJ/m <sup>2</sup>	6 C	7 C	7 C	16 C
impact strength -30 °C		kJ/m <sup>2</sup>	6 C	6 C	6 C	10 C
Biobased content	ASTM 6866	% of C	63	63	63	44
Global warming potential <sup>1)</sup>	ISO 14040	kg CO <sub>2eq</sub>	4.6	4.6	4.6	5.1

N = no break

C = complete break

1) Reference year: 2010, Evaluation method: CML2001

## Terra DS

VESTAMID® Terra DS is 100 percent natural and in many applications outperforms the niche long-chain nylons.

VESTAMID® Terra DS is the polycondensation product of 1,10-decamethylene diamine (D) and 1,10-decanedioic acid (sebacic acid—S). Because both monomers are derived from castor oil, VESTAMID® Terra DS is a material that is based 100 percent on natural resources.

Technically speaking, VESTAMID® Terra DS occupies a position between the high-performance long-chain polyamides such as PA 12 and PA 1212 and the standard polyamides PA 6 und PA 66, which have a shorter chain length.

VESTAMID® Terra DS is semicrystalline, which is the reason for its high mechanical resistance and chemical stability. It absorbs only little water. As a result its mechanical properties vary little when exposed to changing environmental humidity, and the material features a high dimensional stability.

Despite its crystallinity, VESTAMID® Terra DS can be used to manufacture films with good transparency. Compounds based on VESTAMID® Terra DS have high melting points. In turn, high heat deflection temperatures result, which can be advantageous for some applications.

Because of its chemical and physical properties, and the plant origin of its monomers, VESTAMID® Terra DS is an interesting addition to conventional longer-chain polyamides, and it also meets the growing demand for materials made from renewable raw materials.

### Important properties of VESTAMID® Terra DS

Property	Test method	Unit	DS16	DS18	DS22	DS18-GF30
Viscosity number	ISO 307	cm <sup>3</sup> /g	160	180	220	180
Melting temperature	ISO 11357	°C	200	200	200	200
Glass transition temp.		°C	37	37	37	37
Water absorption at RT	Evonik	%	1.8	1.8	1.8	1.4
Density	ISO 1183	g/cm <sup>3</sup>	1.05	1.06	1.07	1.29
VICAT softening temp. Method B 50 N	ISO 306	°C	171	171	171	196
Tensile test	ISO 527					
Stress at yield		MPa	54	54	54	136
Strain at yield		%	5	5	5	4
Strain at break		%	>50	> 50	> 50	5
Tensile modulus	ISO 527	MPa	1700	1700	1700	7400
CHARPY 23 °C	ISO 179/1eU	kJ/m <sup>2</sup>	N	N	N	95 C
impact strength -30 °C		kJ/m <sup>2</sup>	N	N	N	96 C
CHARPY notched 23 °C	ISO 179/1eA	kJ/m <sup>2</sup>	7 C	7 C	11 C	19 C
impact strength -30 °C		kJ/m <sup>2</sup>	7 C	7 C	14 C	11 C
Biobased content	ASTM 6866	% of C	100	100	100	70
Global warming potential <sup>1)</sup>	ISO 14040	kg CO <sub>2eq</sub>	4.0	4.0	4.0	4.6

N = no break

C = complete break

1) Reference year: 2010, Evaluation method: CML2001

## Terra DD

VESTAMID® Terra DD is partly based on renewable raw materials and in general has the highest performance of all the bio-based polyamides

VESTAMID® Terra DD is the polycondensation product of 1,10-decamethylene diamine (D) and 1,12-dodecanedioic acid (D). The 1,12-dodecanedioic acid (D) is typically sourced from a petroleum production route, but can also be sourced via palm kernel oil. Because both monomers can be derived from plant oils, VESTAMID® Terra DD is a material that is based 45% to 100% on natural resources.

VESTAMID® Terra DD depicts 1,12-dodecanedioic acid from fossil resources, where as DD-G depicts the monomer from biomass resources.

Technically speaking, VESTAMID® Terra DD is similar to other high-performance long-chain polyamides such as PA 12 and PA 11. It shows a very high impact strength and heat resistance.

Due to its semi-crystalline morphology, VESTAMID Terra DD provides an excellent chemical resistance, e.g., against greases, oils, fuels and hydraulic fluids. It is the best choice in applications where stiffness and impact strength are required.

### Important properties of VESTAMID® Terra DD

Property	Test method	Unit	DD 16	DD 18	DD 22	DD18-GF30
Viscosity number	ISO 307	cm <sup>3</sup> /g	160	180	220	180
Melting temperature	ISO 11357	°C	190	190	190	190
Glass transition temp.		°C	35	35	35	35
Water absorption at RT	Evonik	%	1.6	1.6	1.6	0.8
Density	ISO 1183	g/cm <sup>3</sup>	1.03	1.04	1.05	1.25
VICAT softening temp. Method B 50 N	ISO 306	°C	154	154	154	177
Tensile test	ISO 527					
Stress at yield		MPa	40	40	40	106
Strain at yield		%	5	5	5	6
Strain at break		%	>50	>50	>50	7
Tensile modulus	ISO 527	MPa	1300	1300	1300	6080
CHARPY 23 °C impact strength -30 °C	ISO 179/1eU	kJ/m <sup>2</sup> kJ/m <sup>2</sup>	N N	N N	N N	81 C 93 C
CHARPY notched 23 °C impact strength -30 °C	ISO 179/1eA	kJ/m <sup>2</sup> kJ/m <sup>2</sup>	12 C 16 C	12 C 16 C	24 C 32 C	18 C 12 C
Biobased content	ASTM 6866	% of C	45-100	45-100	45-100	31-70
Global warming potential <sup>1)</sup>	ISO 14040	kg CO <sub>2eq</sub>	5.2	5.2	5.2	5.8

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1) Reference year: 2010, Evaluation method: CML2001

® = registered trademark

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