

PA 2200
PA12

EOS GmbH - Electro Optical Systems

Product Information

This whitish fine powder PA 2200 on the basis of polyamide 12 serves with its very well-balanced property profile a wide variety of applications.

Laser-sintered parts made from PA 2200 possess excellent material properties:

- high strength and stiffness
- good chemical resistance
- excellent long-term constant behaviour
- high selectivity and detail resolution
- various finishing possibilities (e.g. metallisation, stove enamelling, vibratory grinding, tub colouring, bonding, powder coating, flocking)
- bio compatible according to EN ISO 10993-1 and USP/level VI/121 °C
- approved for food contact in compliance with the EU Plastics Directive 2002/72/EC (exception: high alcoholic foodstuff)

Typical applications of the material are fully functional plastic parts of highest quality. Due to the excellent mechanical properties the material is often used to substitute typical injection moulding plastics. The biocompatibility allows its use e.g. for prostheses, the high abrasion resistance allows e.g. the realisation of movable part connections.

Mechanical properties	Value	Unit	Test Standard
Flexural Modulus, 23°C	1500	MPa	ISO 178
Flexural Strength	58	MPa	ISO 178
Izod Impact notched, 23°C	4.4	kJ/m ²	ISO 180/1A
Izod Impact unnotched, 23°C	32.8	kJ/m ²	ISO 180/1U
Shore D hardness (15s)	75	-	ISO 868
Ball indentation hardness	78	MPa	ISO 2039-1

3D Data	Value	Unit	Test Standard
Tensile Modulus (X Direction)	1700	MPa	ISO 527-1/-2
Tensile Modulus (Y Direction)	1700	MPa	ISO 527-1/-2
Tensile Modulus (Z Direction)	1650	MPa	ISO 527-1/-2
Tensile Strength (X Direction)	48	MPa	ISO 527-1/-2
Tensile Strength (Y Direction)	48	MPa	ISO 527-1/-2
Tensile Strength (Z Direction)	47	MPa	ISO 527-1/-2
Strain at Break (X Direction)	24	%	ISO 527-1/-2
Charpy impact strength (+23°C, X Direction)	53	kJ/m ²	ISO 179/1eU
Charpy notched impact strength (+23°C, X Direction)	4.8	kJ/m ²	ISO 179/1eA
Thermal Conductivity (X Direction)	0.144	W/(m K)	DIN 52616
Thermal Conductivity (Y Direction)	0.144	W/(m K)	DIN 52616
Thermal Conductivity (Z Direction)	0.127	W/(m K)	DIN 52616

Thermal properties	Value	Unit	Test Standard
Melting temperature (10°C/min)	176	°C	ISO 11357-1/-3
Vicat softening temperature A	181	°C	ISO 306
Vicat softening temperature (50°C/h 50N)	163	°C	ISO 306

Other properties	Value	Unit	Test Standard
Density (lasersintered)	930	g/cm ³	EOS Method

Characteristic

Processing

Laser Sintering

Delivery form

White

Chemical Resistance

General Chemical Resistance

Ecological valuation

US Pharmacopeia Class VI Approved

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PA 2200 is a non-filled powder on basis of PA 12.

General Properties

Property	Measurement Method DIN/ISO	Units	Value
Water absorption	ISO 62 / DIN 53495		
100°C, saturation in water		%	1.93
23°C, 96% RF		%	1.33
23°C, 50% RF		%	0.52

Property	Measurement Method DIN/ISO	Unit	Value
Coefficient of linear thermal expansion	ISO 11359 / DIN 53752-A	$\times 10^{-4}/K$	1.09
Specific heat	DIN 51005	J/gK	2.35

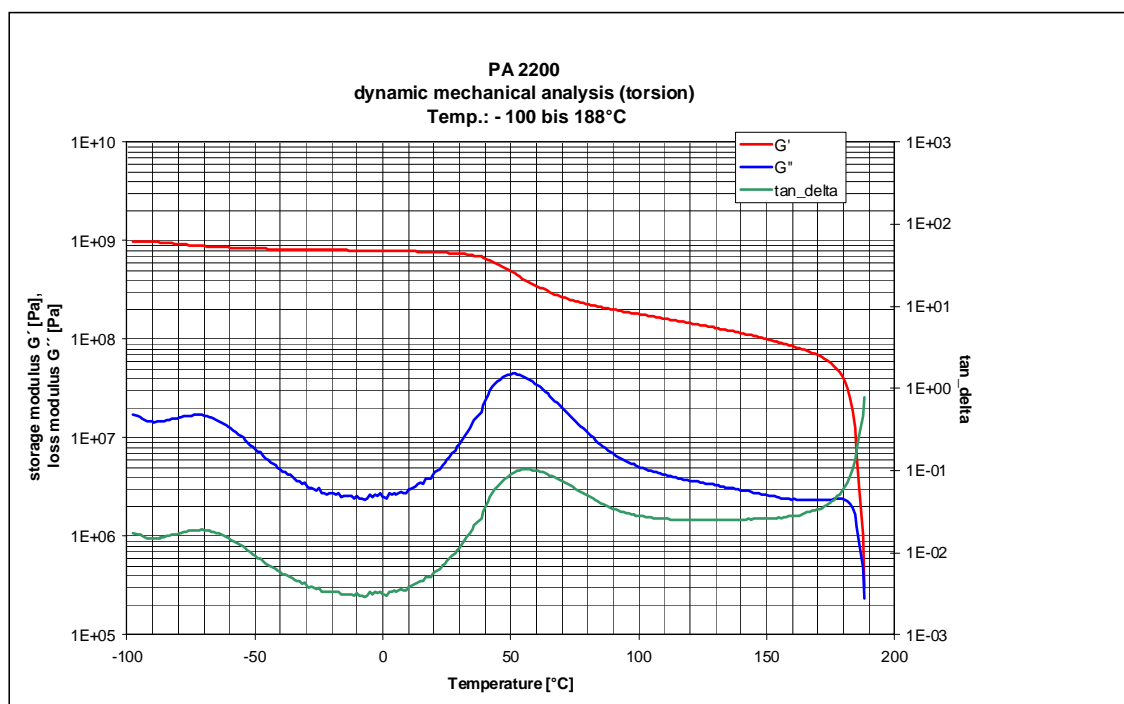
Thermal properties of sintered parts

Property	Measurement Method DIN/ISO	Unit	Value
Thermal conductivity	DIN 52616		
vertical to sintered layers		W/mK	0.144
parallel to sintered layers		W/mK	0.127

Product Information

Short term influence of temperature on mechanical properties

An overview about the temperature dependence of mechanical properties of PA 12 can be retrieved from the curves for dynamic shear modulus and loss factor as function of temperature according to ISO 537.



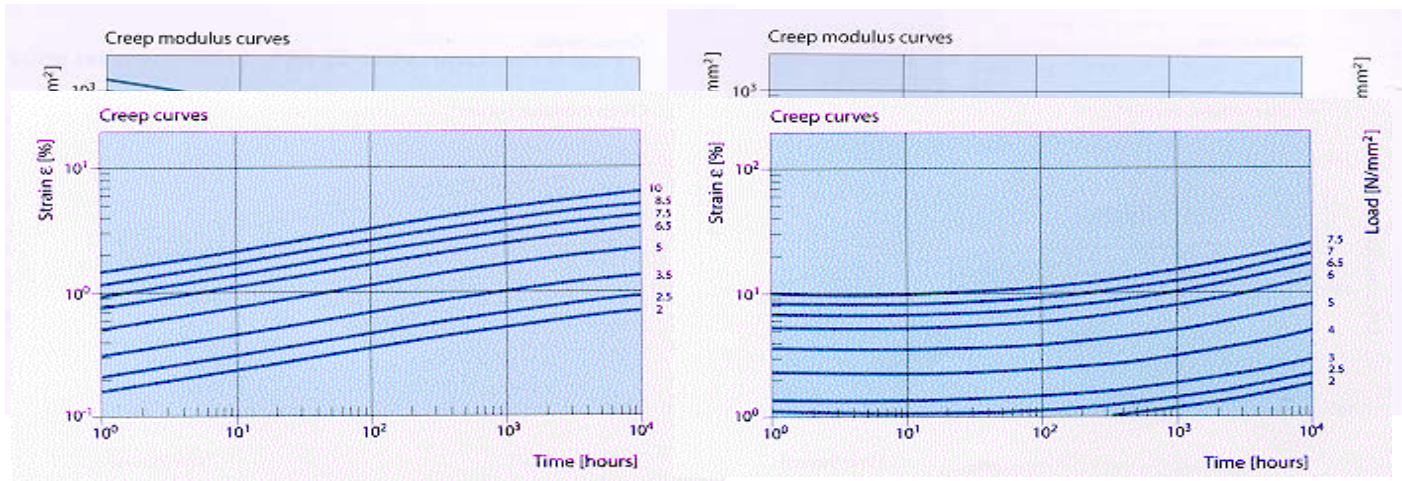
In general parts made of PA 12 show high mechanical strength and elasticity under steady stress in a temperature range from - 40°C till + 80°C. Short time loading of parts made of PA 12 without stress is possible up to 160°C.

Long term properties under mechanical load and temperature

In general thermoplastics have higher mechanical strength under short term load than under long term load (> 1000 h) as result of creep. This occurs mostly at higher temperatures and leads to a reduction of modulus (creep modulus). Usually the creep resistance (mechanical properties under continuous load) is determined with the uniaxial tensile creep test (DIN 53444) under different loads and temperatures.

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Creep modulus curves PA 12 at T = 23°/100°C



Creep elongation curves PA 12 at T = 23°C/100°C

Electrical Properties

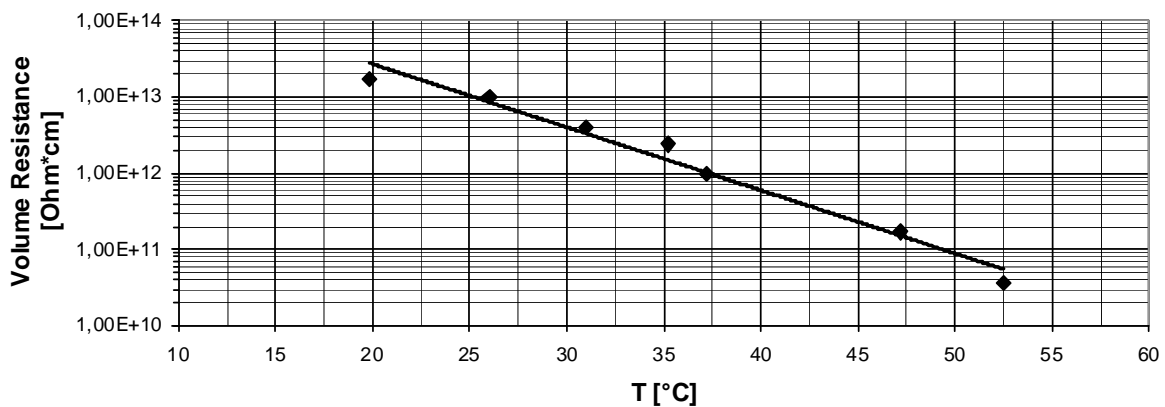
Property	Measurement Method DIN/ISO	Unit	Value
Volume Resistance	DIN 53482 IEC-Publ. 93	$\Omega \cdot \text{cm}$	$10^{13} - 10^{15}$
Surface Resistance	DIN 53482 IEC-Publ. 93	Ω	10^{13}
Relative Permittivity (1 kHz)	DIN53483 IEC-Publ. 250	10^2 Hz	3,8
Dielectric strength	DIN 53481	kV/mm	92
Dielectric dissipation faktor (1 kHz)	DIN 53483 IEC-Publ. 250	-	0.05 - 0.09

The electrical properties depend on temperature and relative air humidity strongly. The above mentioned values characterize polyamide 12 at following conditions: storage at 23°C, 50% air humidity up to saturation.

Product Information

The details contained herein characterize the electrical behaviour of material and not of a specified building part. The details are based on our present state of knowledge and experience. We do, however, pass them without any warranty or property assurance.

Temperature dependence of Volume Resistance of PA 12



Flammability / Burning Behaviour

The powder contains no flame retardants, parts made of PA 2200 can burn.

Property	Measurement Method DIN/ISO	Unit	Value
Flammability	IEC 60707 *		
	ISO 1210	Klasse (1,6 mm)	HB
	UL94*	Klasse (1,6 mm)	HB
			(horizontal burning)

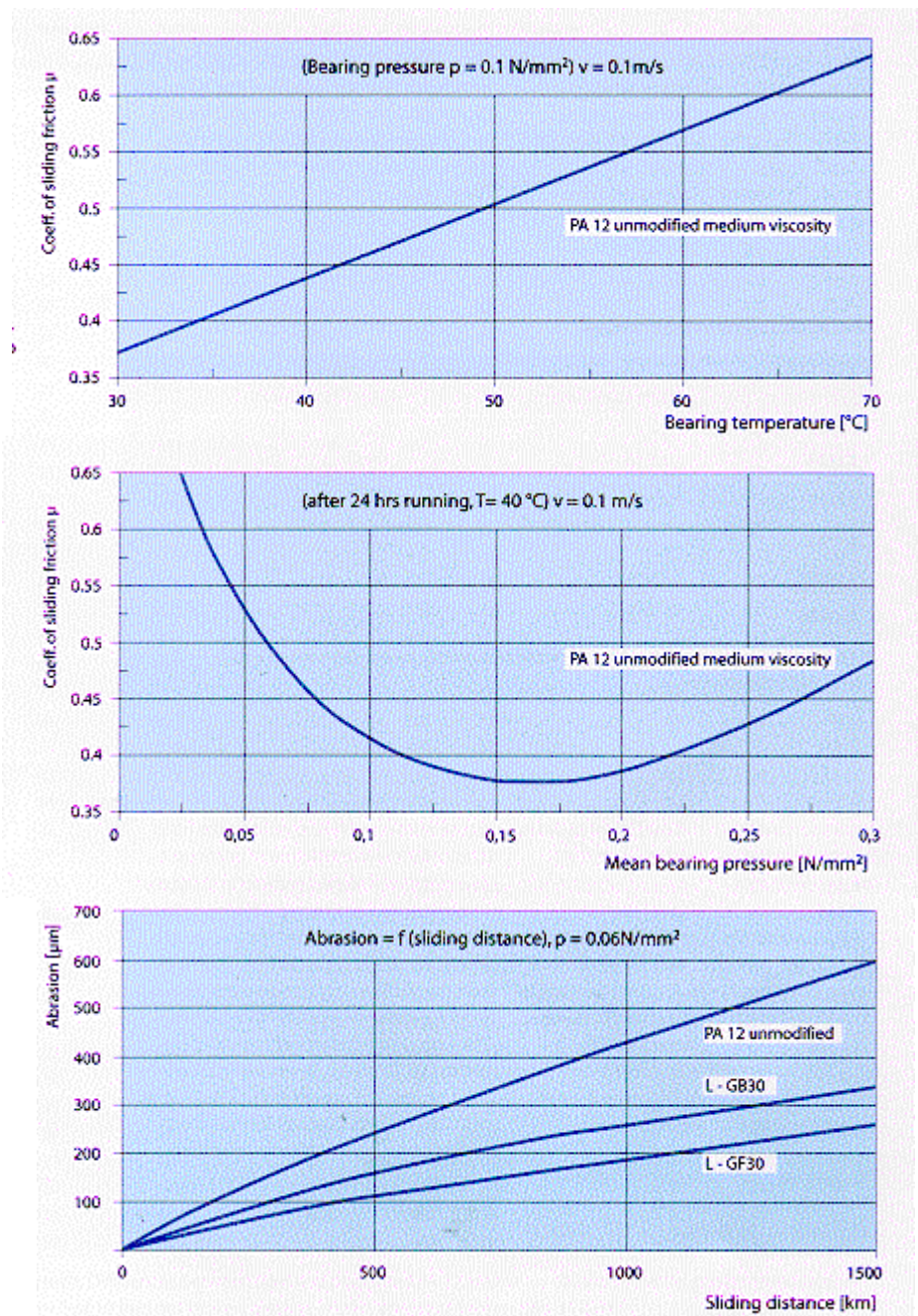
*) flammability test as approval for electrical application

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Product Information

Frictional Properties, Abrasion and Wear

Polyamid 12 is characterized by a low coefficient of friction and by very good abrasion resistance.



Coefficient of sliding friction in dependence of bearing temperature (Lubrimeter test acc. A. Bartel)

Coefficient of sliding friction as function of pressure load (Lubrimeter test acc. A. Bartel))

Abrasion on bearing as function of the sliding distance and PA12-modification (L-GB30/glass spheres; L-GF30-glass fibres)

Product Information

Abrasion of sintered parts according to Taber-Test

Material	Measurement Method DIN/ISO	Unit	Value
PA 2200	DIN 53754	mg/2000 U	34
PA 3200 GF	DIN 53754	mg/2000 U	30

Chemical Resistance of PA 12

+ = resistant - = non-resistant ⊕ = practically resistant
 O = conditional resistant ⊗ = little resistant

Duration		6 Months	4 Weeks
Medium	Concentration	20°C	60°C
Aceton	100	+	+
Battery acid	10	⊗	-
Formic acid		+	O
Ammonia, aqueous solution	Conz.	+	+
Aniline	100	⊕	
Apple juice		+	+
Asphalt		+	+
Barium salts		+	+
Petrol		+	+
Benzene	100	+	O
Beer		+	
Break fluid		+	+
Butane Gas	100	+	+
Butane liquid	100	+	
Butter		+	

Product Information

Duration		6 Months	4 Weeks
Medium	Concentration	20°C	60°C
Chrome acid	10	-	-
Cyclohexanone	100	+	O
Dibutylphtalate (Vestinol®C)		+	+
Diethyl-Ether (Kp 35°C)	100	⊕	
Diocetylphthalate (Vestinol ®AH)		+	+
Dixan®Base	useable	+	+
Acetic acid	10	+	⊗
Ethyl-Acetate		+	⊕
Ethyl-Alkohol, denature	100	+	⊕
Fish		+	
Hydrofluoric acid	40	⊗	-
Anti freezer		+	+
Dishes cleaner		+	+
Glycerine	100	+	+
Glycol	100	+	+
Fuel Oil		+	+
coffee, drinkable		+	
Caustig	50	+	+
Potassium Chlorate aqueous solution	cold, saturated (7,3)	⊕	O
Potass. Permanganate aqueous solution	cold, saturated (6,4)	⊗	-
Linseed Oil		+	+

Product Information

Duration		6 Months	4 Weeks
Medium	Concentration	20°C	60°C
Methanol	100	+	⊕
Milk		+	+
Lactid Acid aqueous solution	10	⊕	○
Sodium-Chloride aqueous solution	cold saturated	+	+
Sodium-Hypochloride, aqueous solution	5	⊕	⊗
Sodium hydroxid	50	+	+
Ozone (0,5 ppm)		○	
Paraffin	100	+	+
Persil®Base	useable	+	+
Petroleum	100	+	+
Propane Gases	100	+	+
Pyridine	100	+	
Rum	40	+	+
Nitric Acid	10	-	-
Salt Acid	10	-	-
Soft Soap		+	+
Sulfur	100	+	+
Sulfur Acid	10	⊕	⊗
Sea Water		+	+
Silicon Oil		+	+
Edible Oil, animal + vegetable		+	+

Product Information

Prüfdauer		6 Monate	4 Wochen
Medium	Konzentration	20°C	60°C
Toluene	100	+	⊗
Tomato Juice		+	+
Trichlorethylene	100	O	⊗
Water	100	+	+
Hydrogen-Peroxide aqueous solution	30	+	
Whiskey	40	+	
Xylene	100	+	O
Citric acid aqueous solution	cold saturated	+	O
Lemon juice		+	+
Sugar solution	every	+	+

Zertifikat , Biokompatibilität PA 2200



**BIOCOMPATIBILITY
CERTIFICATE**

Testmaterial: PA 2200

Supplier: EOS GmbH
Pasinger Strasse 2, D-82152 Planegg

Studies performed: The following studies were performed in order to determine the biocompatibility of the product PA 2200 according to ISO 10993-1:

CYTOTOXICITY
SENSITISATION, polar extract
SENSITISATION, non-polar extract
INTRACUTANEOUS REACTIVITY

Results: The product did not show any adverse effects in the studies performed. Therefore, the biocompatibility of the test material was proved.

BSL BIOSERVICE Scientific Laboratories GmbH Munich
Behringstraße 6
D-82152 Planegg


Dr. Achim Albrecht
Biological Safety Testing
Date: April 10, 2001

