FLXR ENGINEERING

TECHNICAL DATA SHEET
3D PRINTING FILAMENT

PEN Natural

GENERAL INFORMATION

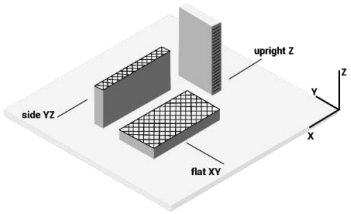
Engineered from the same high-quality polymer used in vaccine, anesthetic and pharmaceutical packaging, **P**oly**E**thylene **N**aphthalate (PEN) meets industry standards - USP<88> Class VI, USP<87>, ISO 10993-4, -10, ADCF, EU 10/2011, EU 1935/2004, and FDA 21 CFR 177.1637 – as confirmed by testing on 3D-printed specimen. This makes PEN ideal for biotech, medical, chemical and food-processing applications. Its biocompatible nature and low extractable potential (*0.4 mg/m²*) support up to 24-hour skin and tissue contact, as well as indirect blood exposure where applicable. Manufactured via life science extrusion line without processing aids and antioxidants, PEN delivers exceptional purity, safety, and non-toxicity. In also offers outstanding chemical resistance - surpassed only by PEEK and PPS – with excellent mechanical strength, temperature stability, high transparency and liquid-tight prints, making it suitable as an eco-friendly replacement for PTFE in relevant industries. Moreover, PEN retains its dimensional stability under autoclaving, EtO, gamma, and e-beam sterilization.

In additive manufacturing, PEN prints smoothly on an enclosed desktop 3D printer using a 0.2-0.6 mm nozzle. Overall, its balance of safety, performance, and cost-effectiveness makes PEN ideal for biotech devices, diagnostic equipment, chemical devices, and cosmetic & food-processing machinery components.

IMPORTANT KEY FEATURES

- Exceptional chemical resistance (refer to chemical resistance table)
- USP<88> Class VI, USP<87> and ISO 10993-4 standards for biocompatibility
- FDA 21 CFR 177.1637 – ensure consumer health and safety
- Temperature resistance: 127°C (pre-annealing), 173 °C (annealed)
- Easy 3D printing on desktop printer, even with a 0.2-0.25 mm nozzle

MATERIAL PROPERTIES



The FDM process creates parts with a layered structure, causing mechanical properties to be anisotropic based on print orientation.[*1]

- Flat XY orientation: predominant mechanical strength from infill
- Side YZ orientation: predominant mechanical strength from walls
- Upright Z orientation: interlayer adhesion strength.

	Test Method[#]	PEN Natural		
	ISO 527-2	XY	YZ	ZX
Tensile strength (MPa)	50 mm/min	75.2	51.9	22.2
Elongation (%)	50 mm/min	10.1	2.4	0.5
Tensile modulus (MPa)	1 mm/min	2717	2435	2534
	ISO 178:2019			
Flexural strength (MPa)	2 mm/min	100.3	-	43.1
Flexural modulus (MPa)	2 mm/min	2263	-	1976
	ISO 180:2019			
Izod impact strength (kJ/m²)	notched	3.1	-	1.9
	ISO 75-2/B			
HDT (pre-annealed) (°C)	0.45 MPa	130	-	-
HDT (pre-annealed) (°C)	1.82 MPa	121	-	-
	ISO 10993-18			
Extractables (mg/m²)		0.4	-	-

#: 3rd party testing by: SGS

CHEMICAL RESISTANCE TABLE *2

Organic Solvent	PEN Natural	PVDF
Acetic acid (20%)	A	A
Acetone	B	D
Alcohols	A	A
Chloroform	C	A
Dimethyl sulfoxide	C	C
Ethers	A	A
Ethyl acetate	A	D
Gasoline	A	A
Hexane	A	A
Methyl ethyl ketone	A	C
Toluene	A	A

Inorganic Solvent	PEN Natural	PVDF
Ammonium chloride (25%)	A	A
Ammonia aq. (28%)	C	A
Hydrochloric acid (37%)	A	A
Hydrogen peroxide (30%)	A	A
KOH (30%)	B	A
NaCl sat. solution	A	A
$NaHCO_3$ sat. solution	A	A
NaOCl	A	A
NaOH (30%)	A	A
Nitric acid (20%)	A	A
Sulfuric acid (10%)	A	A

FILAMENT SPECIFICATION

Diameter (mm)	1.75 ± 0.03 & 2.85 ± 0.06
Color	Translucent
Net filament weight (g)	200 & 1,000

PRINTING PROPERTIES

Nozzle sizes (mm)	0.2 - 0.6	Recommend stainless steel or hardened steel
Nozzle temperature (°C)	270 - 285	Recommended settings, may different according to printer and object
Bed temperature (°C)	70 - 100	
Speed (mm/s)	50 - 70	For 1st layer and walls
	100 - 140	For infill or draft prototypes
Part cooling fan (%)	0 - 10	May use higher cooling speed for bridges
Retraction speed (mm/s)	30 - 45	
Retraction length (mm)	2 - 7	2 - 4 mm for DD; 4 - 7 mm for Bowden
Bed adhesive	glue stick or PVP	
Storage	vacuum with desiccant	Long term storage
	dry-box (RH <20%)	During use and printing
Drying	70 - 80 °C for 4 - 6 hours	Prior to use and If excessive stringing or surface defects
Support material	HIPS or PVA	

NOTES

*1 The values reported in TDS represent the average from a batch of 10 test specimens. For tensile, flexural, and impact properties of the 3D printed test specimens were produced using a 0.4 mm nozzle, 100% infill, print speed of 60mm/s, a nozzle temperature of 270°C and a build plate temperature of 75°C. FLXR Engineering is continuously working on expanding the TDS data

*2 The chemical resistance of PEN is evaluated by the following test method:

- Specimens are immersed in the chemical (liquid) at 23°C for 30 days.
- Ranking definition: A: weight change <1%, tensile strength retained > 95%; B: weight change between 1~10%, tensile strength retained > 75%; C: weight change >10%, tensile strength retained < 75%; D: swelled or dissolved within 120 hours.

DISCLAIMER

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