

Polyamide

Thermoplastic 

Trade Names

- Adell
- Akulon
- Amilan
- Ashlene
- Capron
- Celstran
- Minlon
- Nybex
- PA
- Rilsan
- Ultramid
- Vestamid
- Vydyn
- Zytel

Manufacturer

Adell Plastics, Inc.
 DSM Engineering
 Toray Industries
 Ashley Polymers
 Allied-Signal Corporation
 Hoescht Celanese
 E.I. DuPont
 Ferro Corporation
 Bay Resins
 Atochem N.A.
 BASF
 Huls America
 Monsanto Chemical
 E.I. DuPont

General Description

Polyamide, commonly called nylon, is a semi-crystalline thermoplastic which is composed of linear aliphatic segments that are connected by amide linkages. Polyamide can be produced either by the polymerization of a lactam and an amino acid or a dibasic acid and a diamine. The wide variety of routes by which nylon can be produced, make it possible to tailor the backbone to meet specific needs. The various types of nylon are identified by number designations which represent the number of carbon atoms in each of the starting materials. For example, nylon 6/6 is made from the 6-carbon hexamethylenediamine and a 6-carbon adipic acid. Specialty grades available include lubricated, plasticized, flame retardant, and glass filled. In 2004, the price of nylon 6 ranged approximately from \$2.60 to \$16.50 per pound at truckload quantities.

General Properties

All nylons absorb moisture from the atmosphere, and the water that enters their structure causes dimensional changes and acts as a plasticizer. These factors must be taken into account when designing a critical part constructed of polyamide. The plastic is inexpensive and has excellent tensile strength which are reasons for its widespread use as a fiber. Unfilled polyamide is biologically inert, and most grades have been cleared for food contact use by the FDA. Nylons are resistant to many chemicals, including ketones, fully halogenated hydrocarbons, esters, fuels, and brake fluids. Polar solvents tend to be absorbed much like water and strong acids; oxidizing agents and some concentrated salts will attack them. Gradual oxidation occurs in polyamide at elevated temperatures, but short-term exposures can exceed 400°F (200°C). Some heat-stabilized grades have been rated up to 265°F (130°C) for electrical applications, but mechanical application ratings are lower.

Typical Properties of Polyamide		
	American Engineering	SI
Processing Temperature	425°F to 545°F	218°C to 285°C
Linear Mold Shrinkage	0.007 to 0.018 in./in.	0.007 to 0.018 cm/cm
Melting Point	420°F to 430°F	216°C to 221°C
Density	68.7 to 73.0 lb./ft. ³	1.10 to 1.17 g/cm ³
Tensile Strength, Yield	5.0 to 15.0 lb./in. ² x 10 ³	3.5 to 10.5 kg/cm ² x 10 ²
Tensile Strength, Break	7.4 to 12.5 lb./in. ² x 10 ³	5.2 to 8.8 kg/cm ² x 10 ²
Elongation, Break	10 to 300%	10 to 300%
Tensile Modulus	1.0 to 5.0 lb./in. ² x 10 ⁵	0.7 to 3.5 kg/cm ² x 10 ⁴
Flexural Strength, Yield	9.5 to 19.0 lb./in. ² x 10 ³	6.7 to 13.4 kg/cm ² x 10 ²
Flexural Modulus	1.2 to 4.9 lb./in. ² x 10 ⁵	0.8 to 3.4 kg/cm ² x 10 ⁴
Compressive Strength	1.2 to 14.2 lb./in. ² x 10 ³	0.8 to 10.0 kg/cm ² x 10 ²
Izod Notched, R.T.	0.5 to 2.5 ft.-lb./in.	2.7 to 13.5 kg cm/cm
Hardness	R70 - R120 Rockwell	R70 - R120 Rockwell
Thermal Conductivity	1.2 to 2.0 BTU-in./hr.-ft. ² -°F	0.17 to 0.29 W/m-°K
Linear Thermal Expansion	3.9 to 6.0 in./in.-°F x 10 ⁻⁵	7.0 to 10.8 cm/cm-°C x 10 ⁻⁵
Deflection Temperature @ 264 psi	110°F to 410°F	43°C to 210°C
Deflection Temperature @ 66 psi	250°F to 420°F	121°C to 216°C
Continuous Service Temperature	175°F to 240°F	79°C to 116°C
Dielectric Strength	300 to 500 V/10 ⁻³ in.	1.2 to 2.2 V/mm x 10 ⁴
Dielectric Constant @ 1 MHz	3.1 to 4.1	3.1 to 4.1
Dissipation Factor @ 1 MHz	3.1 to 4.1	3.1 to 4.1
Water Absorption, 24 hr.	0.25 to 3.0%	0.25 to 3.0%

Typical Applications

- **Automotive** – Electrical connectors, wire jackets, emission canisters, light duty gears, fan blades, brake fluid and power steering reservoirs, valve covers, steering column housings, emission control valves, mirror housings
- **Electronic** – Cable ties, plugs, connectors, coil forms, terminals
- **Consumer goods** – Ski boots, ice skate supports, racquetball racquets, ballpoint pens
- **Miscellaneous** – Oven cooking bags, gun stocks, air conditioner hoses, brush bristles, sutures, fishing line, mallet heads, combs, furniture parts

ADHESIVE SHEAR STRENGTH

(psi)
(MPa)

Polyamide

LOCTITE®	UNFILLED RESIN	ROUGHENED	ANTIOXIDANT	UV STABILIZER	IMPACT MODIFIER	FLAME RETARDANT	LUBRICANT #1	LUBRICANT #2	GLASS FILLER	TALC FILLER	PLASTICIZER	ANTISTATIC
	11 rms	15 rms	0.35% Irganox B1171	0.63% Chimacorb 944	5% EXL 3607	18% PO-64P 44% Antimony Oxide	0.5% Aluminum Stearate	0.5% Mold Wiz INT-33PA	30% Type 3450 Glass Fiber	30% Mistran CB Talc	4% Keltan-Flex 8450	5% Larostat HTS 906
Loctite® 380™ Black Max® Instant Adhesive, Rubber Toughened	2450 16.9	2450 16.9	2450 16.9	2450 16.9	>2200* >15.2*	1700 11.7	1450 10.0	2450 16.9	2450 16.9	2450 16.9	3300 22.8	2450 16.9
Loctite® 401™ Prism® Instant Adhesive, Surface Insensitive <i>MEDICAL: Loctite® 401™ Prism® Instant Adhesive, Surface Insensitive</i>	4500 31.0	4500 31.0	4500 31.0	4500 31.0	>4500* >31.0*	4500 31.0	4500 31.0	>4500* >31.0*	>4700* >32.4*	2200 15.2	>4550* >31.4*	>3100* >21.4*
Loctite® 401™ Prism® Loctite® 770™ Prism® Primer <i>MEDICAL: Loctite® 401™ Prism® / Loctite® 770™ Prism® Primer</i>	1600 11.0	1600 11.0	250 1.7	1600 11.0	>1650* >11.4*	1600 11.0	350 2.4	550 3.8	150 1.0	2100 14.5	650 4.5	350 2.4
Loctite® 414™ Super Bonder® Instant Adhesive, General Purpose	4100 28.3	4100 28.3	4100 28.3	4100 28.3	>4300* >29.7*	4100 28.3	4600 31.7	>3750* >25.9*	>4450* >30.7*	2750 19.0	>4450* >30.7*	>4100* >28.3*
Loctite® 330™ Depend® Adhesive, Two-Part No-Mix Acrylic	450 3.1	450 3.1	450 3.1	450 3.1	450 3.1	450 3.1	450 3.1	450 3.1	450 3.1	450 3.1	450 3.1	450 3.1
Loctite® 3105™ Light Cure Adhesive, <i>MEDICAL: Loctite® 331™ Light Cure Adhesive</i>	1400 9.7	1400 9.7	1400 9.7	1400 9.7	1400 9.7	1400 9.7	1400 9.7	1050 7.2	1400 9.7	1400 9.7	1400 9.7	1400 9.7
Loctite® 4307™ Flashcure® Light Cure Adhesive	>1150* >7.9*											
Loctite® H3000™ Speedbonder™ Structural Adhesive, General Purpose	950 6.6											
Loctite® H4500™ Speedbonder™ Structural Adhesive, Metal Bonder	400 2.8											
Loctite® 3032™ Adhesive, Polyolefin Bonder	550 3.8											
Loctite® E-00CL™ Hysol® Epoxy Adhesive, Low Odor	400 2.8											
Loctite® E-90FL™ Hysol® Epoxy Adhesive, Flexible	600 4.1											
Loctite® E-30CL™ Hysol® Epoxy Adhesive, Glass Bonder <i>MEDICAL: Loctite® M-31CL™ Hysol® Epoxy Adhesive, Glass Bonder</i>	800 5.5											
Loctite® E-20HP™ Hysol® Epoxy Adhesive, Fast Setting <i>MEDICAL: Loctite® M-21HP™ Hysol® Epoxy Adhesive, Fast Setting</i>	600 4.1											
Loctite® E-214HP™ Hysol® Epoxy Adhesive, High Strength	650 4.1											
Loctite® Fixmaster® High Performance Epoxy	550 3.8											
Loctite® 1942™ Hysol® Hot Melt Adhesive, EVA Based	300 2.1											
Loctite® 7804™ Hysol® Hot Melt Adhesive	200 1.4											
Loctite® 3631™ Hysol® Hot Melt Adhesive, Urethane	1000 6.9											
Loctite® U-05FL™ Hysol® Urethane Adhesive, High Strength	700 4.8											
Loctite® Fixmaster® Rapid Rubber Repair	50 0.3											
Loctite® 5900® Flange Sealant, Heavy Body RTV Silicone	250 1.7											

Nylon 6-Capron 8202 produced by Allied-Signal

Adhesive Performance

Loctite® 401™ Prism® and 414™ Super Bonder® Instant Adhesives achieved the highest bond strengths, typically in excess of 4000 psi. Loctite® 380™ Black Max® Instant Adhesive, a rubber toughened adhesive, achieved the second highest bond strengths, followed by Loctite® 3105™ Light Cure Adhesive. Loctite® 4307™ Flashcure® Light Cure Adhesive also achieved a bond strength that resulted in substrate failure. Loctite® Fixmaster® Rapid Rubber Repair achieved the lowest overall bond strength. All other adhesives tested generally achieved good bond strength.

Surface Treatments

The use of Loctite® 770™ Prism® Primer, in conjunction with Loctite® 401™ Prism® Instant Adhesive, or Loctite® 4011™ Prism® Medical Device Instant Adhesive with Loctite® 7701™ Prism® Primer, caused either no effect, or a statistically significant decrease in the bondability of nylon 6, on all of the formulations which were evaluated.

Other Important Information

- Polyamide is compatible with all Loctite® brand adhesives, sealants, primers, and activators.
- Surface cleaners: isopropyl alcohol, Loctite® ODC-Free Cleaner & Degreaser.

NOTES:

◆ The force applied to the tests' specimens exceeded the strength of the material, resulting in substrate failure before the actual bond strength achieved by the adhesive could be determined.

□ The addition of the indicated additive (or surface roughening) caused a statistically significant decrease in the bond strength within 95% confidence limits.

□ The addition of the indicated additive (or surface roughening) caused a statistically significant increase in the bond strength within 95% confidence limits.