

## Description

### The material

Polypropylene, PP, first produced commercially in 1958, is the younger brother of polyethylene - a very similar molecule with similar price, processing methods and application. Like PE it is produced in very large quantities (more than 30 million tons per year in 2000), growing at nearly 10% per year, and like PE its molecule-lengths and side-branches can be tailored by clever catalysis, giving precise control of impact strength, and of the properties that influence molding and drawing. In its pure form polypropylene is flammable and degrades in sunlight. Fire retardants make it slow to burn and stabilizers give it extreme stability, both to UV radiation and to fresh and salt water and most aqueous solutions.

### Composition

$(CH_2-CH(CH_3))_n$

### Image



### Caption

Polypropylene is widely used in household products.

## General properties

Density	890	-	910	kg/m <sup>3</sup>
Price	1.166	-	1.283	EUR/kg

## Mechanical properties

Young's modulus	0.896	-	1.55	GPa
Shear modulus	0.3158	-	0.5483	GPa
Bulk modulus	2.5	-	2.6	GPa
Poisson's ratio	0.4052	-	0.4269	
Yield strength (elastic limit)	20.7	-	37.2	MPa
Tensile strength	27.6	-	41.4	MPa
Compressive strength	25.1	-	55.2	MPa
Elongation	100	-	600	%
Hardness - Vickers	6.2	-	11.2	HV
Fatigue strength at 10 <sup>7</sup> cycles	11.04	-	16.56	MPa
Fracture toughness	3	-	4.5	MPa.m <sup>1/2</sup>
Mechanical loss coefficient	0.02581	-	0.04464	

## Thermal properties

Thermal conductor or insulator?	Good insulator			
Thermal conductivity	0.113	-	0.167	W/m.K
Thermal expansion coefficient	122.4	-	180	μstrain/°C
Specific heat	1870	-	1956	J/kg.K
Melting point	149.9	-	174.9	°C
Glass temperature	-25.15	-	-15.15	°C
Maximum service temperature	100	-	115	°C

Minimum service temperature -123.2 - -73.15 °C

### Electrical properties

Electrical conductor or insulator?	Good insulator		
Electrical resistivity	3.3e22	-	3e23 μohm.cm
Dielectric constant (relative permittivity)	2.1	-	2.3
Dissipation factor (dielectric loss tangent)	3e-4	-	7e-4
Dielectric strength (dielectric breakdown)	22.7	-	24.6 1000000 V/m

### Optical properties

Transparency	Translucent		
Refractive index	1.5	-	1.52

### Eco properties, material production

Embodied energy	75.4	-	83.3 MJ/kg
CO2 footprint	2.07	-	2.29 kg/kg

### Eco properties, processing

Polymer molding energy	9.477	-	11.58 MJ/kg
Polymer extrusion energy	3.317	-	4.054 MJ/kg

### Eco properties, recycling and disposal

Recycle	✓
Downcycle	✓
Combust for energy recovery	✓
Biodegrade	✗
Landfill	✓
A renewable resource?	✗

#### Recycle mark



### Environmental notes

PP is exceptionally inert and easy to recycle, and can be incinerated to recover the energy it contains. PP, like PE and PVC, is made by processes that are relatively energy-efficient, making them the least energy-intensive of commodity polymers. Its utility per kilogram far exceeds that of gasoline or fuel-oil (and its energy is stored and still accessible), so that production from oil will not disadvantage it in the near future

### Processability

Castability	1	-	2
Moldability	4	-	5
Machinability	3	-	4
Weldability	5		

### Durability

Flammability	Flammable
Fresh water	Very good
Salt water	Very good
Weak acids	Very good
Strong acid	Very good
Weak alkalis	Very good
Strong alkalis	Very good

Organic solvents  
Sunlight (UV radiation)  
Oxidation at 500C

Average  
Good  
Very poor

## Supporting information

### Design guidelines

Standard grade PP is inexpensive, light and ductile but it has low strength. It is more rigid than PE and can be used at higher temperatures. The properties of PP are similar to those of HDPE but it is stiffer and melts at a higher temperature (165 - 170 C). Stiffness and strength can be improved further by reinforcing with glass, chalk or talc. When drawn to fiber PP has exceptional strength and resilience; this, together with its resistance to water, makes it attractive for ropes and fabric. It is more easily molded than PE, has good transparency and can accept a wider, more vivid range of colors. PP is commonly produced as sheet, moldings fibers or it can be foamed. Advances in catalysis promise new co-polymers of PP with more attractive combinations of toughness, stability and ease of processing. Mono-filaments fibers have high abrasion resistance and are almost twice as strong as PE fibers. Multi-filament yarn or rope does not absorb water, will float on water and dyes easily.

### Technical notes

The many different grades of polypropylene fall into three basic groups: homopolymers (polypropylene, with a range of molecular weights and thus properties), co-polymers (made by co-Polymerization of propylene with other olefines such as ethylene, butylene or styrene) and composites (polypropylene reinforced with mica, talc, glass powder or fibers) that are stiffer and better able to resist heat than simple polypropylenes.

### Typical uses

Ropes, general polymer engineering, automobile air ducting, parcel shelving and air-cleaners, garden furniture, washing machine tank, wet-cell battery cases, pipes and pipe fittings, beer bottle crates, chair shells, capacitor dielectrics, cable insulation, kitchen kettles, car bumpers, shatter proof glasses, crates, suitcases, artificial turf, thermal underwear.

### Tradenames

Adpro, Amoco, Appryl, Aqualoy, Astryn, Cefor, Comalloy, Comshield, Dypro, EA36NA, Eltex P, Empee, Escorene, Ferrex, Ferrolene, Fortilene, Fotilene, Hifax, Hostalen PP, Latene, Marlex, Moplen, Multi-Flam, Multi-Pro, Nortuff, Novalen, Novolen, Nyloy, Petrothene, Polyfort, Polypro, Precolor, Pro Fax, Propak, Rexflex, Stamylyn, Starlylen, Statoil, Technoprene, Thermocomp, Vestolen, WPP, Washpen

## Links

Reference

ProcessUniverse

Producers