

# Polypropylene (PP)

---

## INTRODUCTION

Polypropylene (PP) is a linear hydrocarbon polymer, expressed as  $C_nH_{2n}$ . PP, like polyethylene (see HDPE, L/LLDPE) and polybutene (PB), is a polyolefin or saturated polymer.

Polypropylene is one of those most versatile polymers available with applications, both as a plastic and as a fibre, in virtually all of the plastics end-use markets.



Patterson & Rothwell Ltd. Mount Pleasant St.  
Mount Pleasant Industrial Estate, Oldham OL4 1HH

Tel: **0161 621 5000**

email: [sales@patterson-rothwell.co.uk](mailto:sales@patterson-rothwell.co.uk)

[www.patterson-rothwell.co.uk](http://www.patterson-rothwell.co.uk)

## PROPERTIES

(Semi-rigid, translucent, good chemical resistance, tough, good fatigue resistance, integral hinge property, good heat resistance).

Production of polypropylene takes place by slurry, solution or gas phase process, in which the propylene monomer is subjected to heat and pressure in the presence of a catalyst system. Polymerisation is achieved at relatively low temperature and pressure and the product yielded is translucent, but readily coloured. Differences in catalyst and production conditions can be used to alter the properties of the plastic.

PP does not present stress-cracking problems and offers excellent electrical and chemical resistance at higher temperatures. While the properties of PP are similar to those of Polyethylene, there are specific differences. These include a lower density, higher softening point (PP doesn't melt below 160°C, Polyethylene, a more common plastic, will anneal at around 100°C) and higher rigidity and hardness. Additives are applied to all commercially produced polypropylene resins to protect the polymer during processing and to enhance end-use performance.

## GRADES AVAILABLE

Three types of polypropylene are currently available. Each suits particular specifications and costing (although there is often some overlap).

**Homopolymers** - A General Purpose Grade that can be used in a variety of different applications.

**Block copolymers** - incorporating 5-15% ethylene, have much improved impact resistance extending to temperatures below -20°C. Their toughness can be further enhanced by the addition of impact modifiers, traditionally elastomers in a blending process.

**Random copolymers** - incorporate co-monomer units arranged randomly (as distinct from discrete blocks) along the polypropylene long chain molecule. Such polymers typically containing 1-7% ethylene are selected where a lower melting point, more flexibility and enhanced clarity are advantageous.

Different PP grades are available dependent on the application and chosen processing method.



Patterson & Rothwell Ltd. Mount Pleasant St.  
 Mount Pleasant Industrial Estate, Oldham OL4 1HH  
 Tel: **0161 621 5000**  
 email: [sales@patterson-rothwell.co.uk](mailto:sales@patterson-rothwell.co.uk)  
[www.patterson-rothwell.co.uk](http://www.patterson-rothwell.co.uk)

## PHYSICAL PROPERTIES

Tensile Strength	0.95 - 1.30	N/mm <sup>2</sup>
Notched Impact Strength	3.0 - 30.0	Kj/m <sup>2</sup>
Thermal Coefficient of expansion	100 - 150	x 10 <sup>-6</sup>
Max Cont Use Temp	80	oC
Density	0.905	g/cm <sup>3</sup>

## RESISTANCE TO CHEMICALS

Dilute Acid	****
Dilute Alkalis	****
Oils and Greases	**variable
Aliphatic Hydrocarbons	*
Aromatic Hydrocarbons	*
Halogenated Hydrocarbons	*
Alcohols	****

## KEY

\*poor                      \*\* moderate                      \*\*\* good                      \*\*\*\* very good



Patterson & Rothwell Ltd. Mount Pleasant St.  
Mount Pleasant Industrial Estate, Oldham OL4 1HH  
Tel: **0161 621 5000**  
email: [sales@patterson-rothwell.co.uk](mailto:sales@patterson-rothwell.co.uk)  
[www.patterson-rothwell.co.uk](http://www.patterson-rothwell.co.uk)

## **APPLICATIONS**

Polypropylene can be processed by virtually all thermoplastic-processing methods. Most typically PP Products are manufactured by: Extrusion Blow Moulding, Injection Moulding, and General Purpose Extrusion. Expanded Polypropylene (EPP) may be moulded in a specialist process.

### **Flexible Packaging**

PP is one of the leading materials used for film extrusion and has in recent years benefited versus cellophane, metals and paper on account of its superior puncture resistance, low sealing threshold and competitive price. PP Film is available either as Cast Film or bi-axially orientated PP (BOPP). The film market may be divided in to three main sectors:

Food and Confectioneries

Tobacco

Clothing

The food and confectioneries sector is the largest of the film markets with usage ranging from confectioneries to crisps and biscuits. Tobacco products represent a significant market for PP (second largest after food and confectioneries). Rigid packaging subdivides into a multitude of packaging applications from caps and closures to pallets and crates.

### **Rigid Packaging**

Reusable and collapsible/stackable crates are a great application for PP, providing ease to transport (both full and empty) and allow simple, safe and efficient storage of products and are ideal for Just-in-Time (JIT) storage solutions. As a consequence, supermarkets are beginning to revert to use and similar products are finding application in the automotive supply chain.

Caps and Closures manufactured of PP have benefited from growth in the PET bottle market, particularly for mineral water containment and that of edible oil.

PP is blow moulded to produce bottles for the packaging of a range of products including condiments, detergent and toilet-ries markets.

PP thin-walled containers (e.g. yoghurt pots) are also common. PP competes with PS in this field, offering a cheaper material option (processing costs can, however, offset this benefit). PP is semi-crystalline product and consequently has a narrower processing window than PS and tends to display higher shrinkage. Modern thermoforming machinery is capable (with two sets of tools) of processing either PP or PS, consequently the future infiltration of PP is very much dependent on price fluctuations.



Patterson & Rothwell Ltd. Mount Pleasant St.  
Mount Pleasant Industrial Estate, Oldham OL4 1HH  
Tel: **0161 621 5000**  
email: [sales@patterson-rothwell.co.uk](mailto:sales@patterson-rothwell.co.uk)  
[www.patterson-rothwell.co.uk](http://www.patterson-rothwell.co.uk)

## **Automotive**

In the automotive sector PP is utilised as a monomaterial solution for automotive interiors. The monomaterial dashboard is becoming increasingly achievable, PP film cushioning, film skins, and powder slush moulding and even blow moulded parts with integral PP textile covers are emerging. Bumpers, cladding, and exterior trim are also available manufactured from polypropylene. Polypropylene developed for such applications provides low coefficient of linear thermal expansion and specific gravity, high chemical resistance and good weatherability, processability and impact/stiffness balance. Improvements with colour-at-the-press and pre-coloured PP have also reduced or eliminated the need for painting in some applications.

## **Consumer Products**

Products classified in this sector are Housewares, Furniture, Appliances, Luggage, Toys, Battery Cases and other “durable” items for home, garden or leisure use. Injection Moulding dominates the conversion process used for these products.

## **Fibre**

PP Fibre is utilised in a host of applications including tape, strapping, bulk continuous filament, staple fibres, spunbound, and continuous filament

## **Industrial**

PP is used to manufacture a range of Sheet, Pipe, Compounding and Returnable Transport Packaging (RTP). With the exception of RTP where Injection Moulding is used, extrusion dominates the conversion process used for these products. Some PP is utilised by the construction sector, most notable domestic drainage pipes

## **History of PP, BP and Innovene**

Professor Giulio Natta produced the first polypropylene resin in Spain in 1954. Natta utilised catalysts developed for the polyethylene industry and applied the technology to propylene gas. Commercial production began in 1957 and polypropylene usage has displayed strong growth from this date. The versatility of the polymer (the ability to adapt to a wide range of fabrication methods and applications) has sustained growth rates enabling PP to challenge the market share of a host of alternative materials in plethora of applications.

BP is the world’s second largest Polypropylene producer and has held a technology leadership position in PP resin, process and catalyst technology since the polymer was first commercialised in the 1950s. Polypropylene is consistently one of the fastest growing thermoplastics, with expected future growth of about 6 percent each year.

The European PP business has plants in Belgium (Geel & Lillo), UK (Grangemouth) and France (Sarralbe & Lavera) producing Homopolymer, Block and Random Copolymers. The Geel plants are ex-Amoco, while the plants at Lillo and Sarralbe were acquired from Solvay in November 2001. At the termination of the Appryl joint venture between BP and TotalFinaElf, BP acquired the PP plant at Grangemouth and 50% of Lavera.