Polycarbonate PC

INTRODUCTION

Transparency, excellent toughness, thermal stability and a very good dimensional stability make Polycarbonate (PC) one of the most widely used engineering thermoplastics. Compact discs, riot shields, vandal proof glazing, baby feeding bottles, electrical components, safety helmets and headlamp lenses are all typical applications for PC.

Polycarbonate is most commonly formed with the reaction of bis-phenol A (produced through the condensation of phenol with acetone under acidic conditions) with carbonyl chloride in an interfacial process. PC falls into the polyester family of plastics.

Polycarbonate remains one of the fastest growing engineering plastics as new applications are defined; global demand for PC exceeds 1.5 million tons.

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PROPERTIES

Polycarbonates are strong, stiff, hard, tough, transparent engineering thermoplastics that can maintain rigidity up to 140oC and toughness down to -20°C or special grades even lower. The material is amorphous (thereby displaying excellent mechanical properties and high dimensional stability), is thermally resistant up to 135oC and rated as slow burning. Special flame retardant grades exist which pass several severe flammability tests.

Constraints to the use of PC include limited chemical and scratch resistance and it's tendency to yellow upon long term exposure to UV light. However these constraints can be readily overcome by adding the right additives to the compound or processing through a co-extrusion process.

GRADES AVAILABLE

Polycarbonate is available in a number of different grades dependent on the application and chosen processing method. The material is available in a variety of grades such as film, flame retardant, reinforced and stress crack resistant, branched (for applications requiring high melt strength) and other speciality grades. Also blends of PC are available with e.g. ABS or Polyesters, widely used in automotive industry.

Processing of PC generally falls into:

Injection Moulding

Structural Foam Moulding

Extrusion

Vacuum Forming

Blow Moulding

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PHYSICAL PROPERTIES

Tensile Strength	70 - 80	N/mm2
Notched Impact Strength	60 - 80	Kj/m2
Thermal Coefficient of expansion	65	x 10-6
Max Cont Use Temp	125	oC
Density	1.20	g/cm3

RESISTANCE TO CHEMICALS

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

KEY

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

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APPLICATIONS

In recent years Polycarbonate blends have become increasingly commercially important. PC is widely used in blends due to its excellent compatibility with a range of polymers. Typical blends include rubber modified PC, improving impact properties, PC/PBT blends, which allow toughness to be retained at lower temperatures and having improved fuel and weather resistance. Amongst the most significant are those incorporating ABS (Acrylonitrile Butadiene Styrene). PC/ABS blends exhibit high melt flow, very high toughness at low temperatures and improved stresscrack resistance compared to PC.

All Blends are produced using a compounding step to blend the polymers. This compounding technology is very important for creating the optimal morphology and interaction between the two phases. In combination with the right additive know-how (flame retardant, stabilisation, reinforcement) blends are obtained with an optimally balanced set of properties.

PC finds usage in a host of markets, notably in the automotive, glazing, electronic, business machine, optical media, medical, lighting and appliance markets

Electrical & Electronics (E&E)

The largest UK application for PC is in the optical media market (i.e. usage in computer and audio compact discs). This is followed by an assortment of sheeting and glazing applications. The rest of the market consists of electrical and electronics (hosting applications in the business machine and telecommunications market), followed by transportation (including automotive), appliances, packaging, and other miscellaneous uses.
Miniaturisation fast product cycles make the E&E market one of the most demanding for Engineering Plastics. Demands include high service temperature, spike temperature resistance, ductility and toughness in thin sections, and flammability. All of this must be delivered consistently throughout the world, with co-ordinated engineering, market development, and technical service. In the E&E market our materials are well suited to internal components and current carrying devices.

Typical examples of applications of technology are within:

- power distribution (covers and housings)
- connectors
- electrical household appliances
- mobile phones
- electrical chargers
- lighting
- battery boxes

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Automotive

The use of Engineering Plastics in automotive applications is nearing its fiftieth anniversary. PC has been part of this history and continues to bring innovation, which allows automakers to produce lighter, stronger, and more durable components.

Typical PC and PC-blend applications include:

- automotive lighting
- head lamp lenses
- dashboards
- interior cladding
- exterior parts (bumpers, bodypanels)

General Industries / Packaging

While automotive and E&E markets tend to drive the technological breakthroughs in materials, other industries develop their own unique uses for Engineering Plastics.
In most of these industries durability, cost effectiveness, and appearance are the driving factors in material selection.

The largest of these markets include:

- power tools
- baby bottles
- water dispensers
- garden equipment
- furniture (office & institutional)
- sporting goods
- medical applications

HISTORY

The discovery of Polycarbonate dates back to 1898 when Einhorn, a German chemist, observed the formation of an in-soluble, infusible solid, while endeavouring to prepare cyclic carbonates by reacting hydroquinone with phosgene. In 1902, Bischoff and Hedenström obtained similar cross-linked, high-molecular-weight Polycarbonate; Dr WH Carothers extended work on the product. It was not, however, until 1953 that Bayer laboratories produced linear thermoplastic Polycarbonate of high molecular weight. In 1957 Bayer and General Electric announced independent development of PC and in the summer of 1960 both companies began commercial production.
Xantar® C is a family of products based on blends of PC and ABS in different Ratios, also containing flame retardant grades, whereas Stapron E is the trade name of blends of PC with polyesters (Arnite PET and PBT).