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Thermoplastics, Compounding of Engineering

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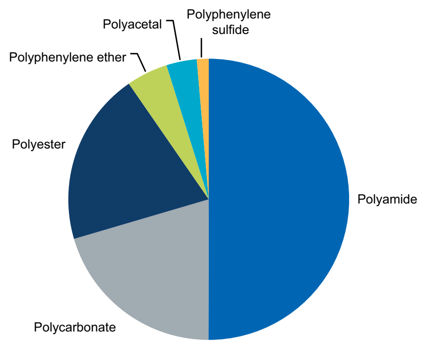
Abstract

Engineering polymers provide a combination of high strength and light weight—characteristics that make these high-value, specialty polymers attractive replacements for metals in many different applications. Such qualities make engineering resins suitable for diverse applications, including parts for transportation, electrical/electronics, construction, medical, and appliances.

This study focuses on the compounding of the larger-volume engineering thermoplastic (ETP) resins: polyamides (PA; also known as nylons), polyesters (PBT and PET), polycarbonates (PC), polyphenylene ethers (PPE), polyacetals (POM), and polyphenylene sulfides (PPS). Most compounders, especially independent compounders, will purchase resins on the merchant market, often compounding both commodity resins and ETP resins. Engineering thermoplastics are often compounded with glass fibers, carbon fibers, (inorganic) fillers, and other additives including antioxidants, antistatic agents, chemical blowing agents, heat stabilizers, impact modifiers (elastomers), light stabilizers, lubricants, and slip additives or nucleating agents.

The following pie chart shows world consumption of engineering thermoplastics by type:

World consumption of engineering thermoplastics—2016



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Engineering thermoplastics compete not only against metals and glass in various applications, but also against each other and with lower-cost polymers such as ABS and polypropylene (PP). In particular, PP is a real threat to the ETP business, especially to the nylon segment, since it can be made into parts that are lighter, but with comparable properties at continuous-use temperatures below 130°C.

ETPs are primarily processed into molded parts and objects. Usually, the polymers are compounded for injection-molding applications with the addition of fibers (primarily glass and carbon for reinforcement), mineral fillers (for reinforcement), and a variety of plastics additives such as impact modifiers, lubricants, thermal and ultraviolet (UV) stabilizers, pigments,

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and other materials. The effect of incorporating additives can be pronounced. For example, a general-purpose polycarbonate that exhibits a tensile strength of 69 million pascals (MPa), when modified or reinforced with 30% glass fiber, will show a tensile strength of 145 MPa.

Compounds can often be designed to meet a customer's needs better and/or less expensively than neat (uncompounded) resins or non-polymer-based materials. Since compounds can be designed to have only the minimum properties required, the user does not have to purchase "overengineered" materials. Thermoplastics can also be blended with other thermoplastics to modify properties. Blends are covered in this report.

Transportation and electrical/electronic applications account for the majority of ETP consumption. The transportation market includes automotive, truck/bus, motorcycle, marine and aerospace applications. All electrical/electronic components used in vehicles are included in the transportation market segment. Consumption in this segment represents approximately 40–45% of the total compounding market. The electrical/electronic market (market share of 35–40%) includes electromechanical (e.g., coils, bobbins, relays) and electronic components (e.g., connectors, sockets, switches). Other segments include business equipment housings (market share of 10–15%) and industrial applications (market share of 5%) including material and fluid handling equipment and plumbing/irrigation components.

Among the trends in the ETP compounding industry are the following:

- **Increased globalization.** Compounders in more-developed countries are establishing operations in less-developed and more rapidly growing areas. East Asia, especially China, is a major location for new compounding capacity. Conversely, some Asian compounders have established operations in North America and Europe to service their Asia-based customers that are globalizing their operations.

- **Greener ETPs**. The green movement has prompted interest in the development of materials that are renewable, including polymeric materials. As an example, door bolsters on the 2013 Ford Escape are being made with PP reinforced with *kenaf*, a tropical plant related to cotton, to reduce weight of the bolsters by 25%. Polyamides are now commercialized that are derived from biorenewable sources.

- **Increased use of recycled materials**. PET engineering resin has long been derived from postconsumer PET bottles and other recycled sources. There are efforts to incorporate more regenerated or scrap polyamide and bio-based PBT into engineering thermoplastics.

- **Greater use of carbon fibers, long glass fibers, and nanoscale particles as reinforcing agents**. Although these materials are quite costly, they provide needed properties when incorporated into ETPs for highly demanding applications.

The global ETP market will grow at an average annual rate of almost 4% for the major ETPs, with PPE and PPS growing at rates of 4–7% overall.

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