Beluns® Plastic

PAI Sheet, Rod

Property

Product Name: PAI.
Chemical Name and Synonym: Polyamide-imides.

Material Names

PAI is sold under a variety of brand names including Torlon 4200

PAI

Polyamide-imides are either thermosetting or thermoplastic, amorphous polymers that have exceptional mechanical, thermal and chemical resistant properties. Polyamide-imides are used extensively as wire coatings in making magnet wire. They are prepared from isocyanates and TMA (trimellic acid-anhydride) in N-methyl-2-pyrrolidone (NMP). A prominent distributor of polyamide-imides is Solvay Specialty Polymers, which uses the trademark Torlon.

Polyamide-imides display a combination of properties from both polyamides and polyimides, such as high strength, melt processibility, exceptional high heat capability, and broad chemical resistance. Polyamide-imide polymers can be processed into a wide variety of forms, from injection or compression molded parts and ingots, to coatings, films, fibers and adhesives. Generally these articles reach their maximum properties with a subsequent thermal cure process.

The earliest route to polyamide-imides is the condensation of an aromatic diamine, such as methylene dianiline (MDA) and trimellitic acid chloride (TMAC). Reaction of the anhydride with the diamine produces an intermediate amic acid. The acid chloride functionality reacts with the aromatic amine to give the amide bond and hydrochloric acid (HCl) as a by-product. In the commercial preparation of polyamideimides, the polymerization is carried out in a dipolar, aprotic solvent such as N-methylpyrrolidone (NMP), dimethylacetamide (DMAC), dimethylformamide (DMF), or dimethylsulfoxide (DMSO) at temperatures between 20-60 °C. The byproduct HCl must be neutralized in situ or removed by washing it from the precipitated polymer. Further thermal treatment of the polyamideimide polymer increases molecular weight and causes the amic acid groups to form imides with the evolution of water.

This is the primary route to polyamide-imides which are used as wire enamels. A diisocyanate, often 4,4 ’ -methylenediphenyldiisocyanate (MDI), is reacted with trimellitic anhydride (TMA). The product achieved at the end of this process is a high molecular weight, fully imidized polymer solution with no condensation byproducts, since the carbon dioxide gas byproduct is easily removed. This form is convenient for the manufacture of wire enamale or coatings. The solution viscosity is controlled by stoichiometry, monofunctional reagents, and polymer solids. The typical polymer solids level is 35-45% and it may be diluted further by the supplier or user with diluents.

Molded or machined articles

The polyamide-imides used for molded articles are also based on aromatic diamines and trimellitic acid chloride, but the diamines are different from those used in the products used for coatings and the polymer is more fully imidized prior to compounding and pelletizing. Resins for injection molding include unreinforced, glass-fiber reinforced, carbon fiber reinforced, and wear resistant grades. These resins are sold at a relatively low molecular weight so they can be melt processed by extrusion or injection-molding. The molded articles are then thermally treated for several days at temperatures up to 260 °C (500 °F). During this treatment, commonly referred to a postcure, the molecular weight increases through chain extension and the polymer gets much stronger and more chemically resistant. Prior to postcure, parts can be reground and reprocessed. After postcure, reprocessing is not practical.

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