NASA TECH BRIEF
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Preparing Thermoplastic Aromatic Polyimides

A method has been developed for preparing aromatic polyimides with significantly reduced glass-transition temperatures and without the accompanying loss of high-level thermo-oxidative stability which has been typical. This has been made possible by the use of diamine monomers with specific stereoisomeric features.

The reduced glass-transition temperatures lead to a softened state in the polyimides which permits them to be processed readily into such useful articles as sheets, thin films, fibers, foams, and molded or laminated pieces. This process also permits cross-linking or curing such polymers by means of a postforming step in which the glassy transition (softening) temperatures are increased so that the shaped polymer article can be used at temperatures greater than those at which they were formed.

Polyimides prepared by this process display outstanding physical and chemical properties. This makes them suitable for fabrication into shaped articles such as films, fibers, and laminated composites of reinforced resins. These articles have high tensile and flexural properties as well as excellent thermal and thermo-oxidative stability.

The decreased glass-transition temperatures of these polymers result from one or both of the amine groups of the aromatic diamine being substituted on the benzene rings meta to the group connecting the benzene rings. This leads to softening of the polyimides when they are heated above the glass-transition temperatures and, thus, contributes to vastly improved processing characteristics for the polyimides. The glass-transition diamines are as much as 50° to 75° C lower than those for polyimides made from the p,p′-diamines customarily used in polyimide preparation.

The polyimides are prepared by reacting the m,m′-(3,3′-) and m,p′-(3,4′-) diaryl diamines with pyromellitic dianhydride or 3,3′,4,4′-benzophenone tetracarboxylic acid dianhydride in an organic solvent, which dissolves at least one of the reactants, for a time and at a temperature sufficient to give a polyamide acid. This polyamide acid is heated to 100° C for sufficient time to remove the solvent after which the acid is converted to the polyimide by heating at 200° C for 1 to 2 hours. The resulting polyimide can have glass-transition or softening temperatures from 210° to 250° C, depending upon the nature of the diamine. Facile processing of the polyimides, such as compression molding, can be accomplished at this stage. A subsequent post-cure of 300° C or higher serves to increase the glass-transition (softening) temperature of the polymeric article to near 300° C.

Note:

Requests for further information may be directed to:

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Patent status:

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