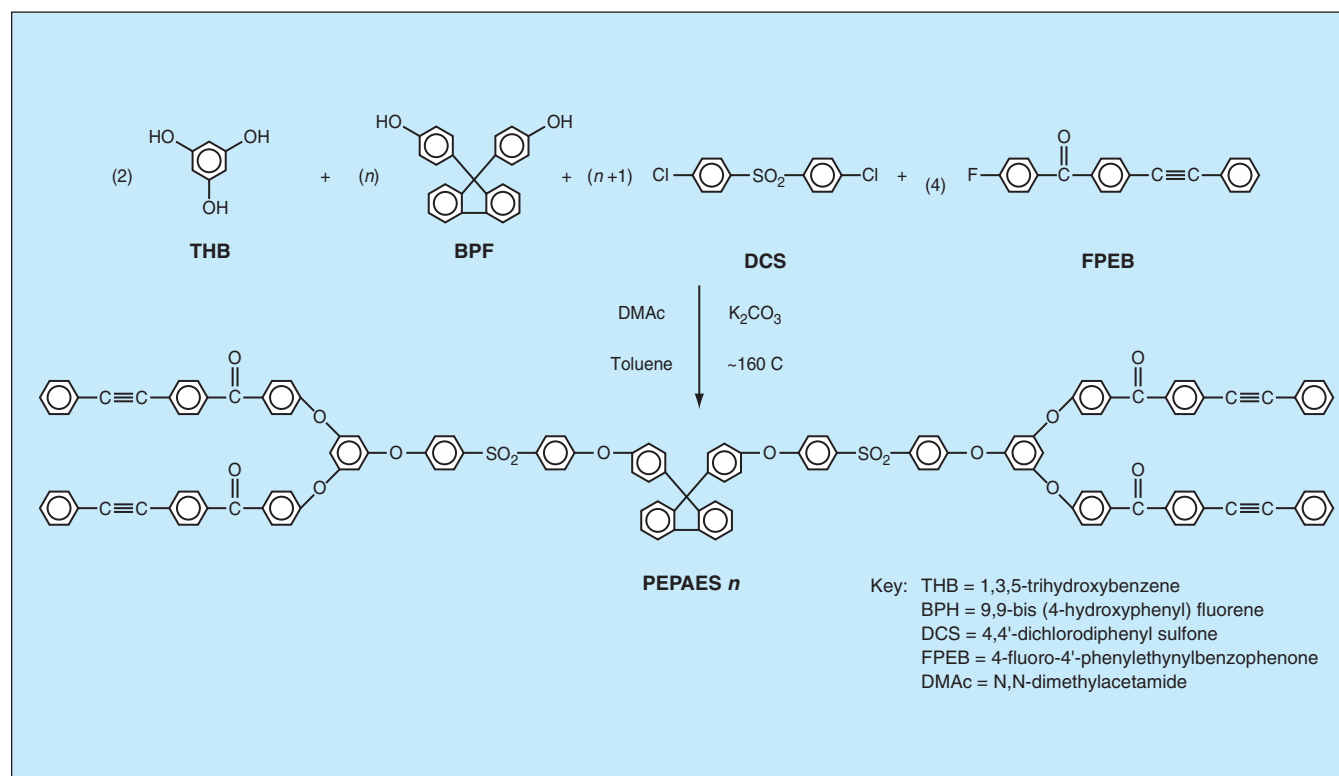


High-Performance Polymers Having Low Melt Viscosities

Mixtures of differently shaped molecules have properties superior to the corresponding linear polymers.

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A Phenylethynyl Poly(Arylene Ether) Sulfone (PEPAES) or, more accurately, a mixture of PEPAES molecules having different values of the integer n , is synthesized according to this reaction scheme.

High-performance polymers that have improved processing characteristics, and a method of making them, have been invented. One of the improved characteristics is low (relative to corresponding prior polymers) melt viscosities at given temperatures. This characteristic makes it possible to utilize such processes as resin-transfer molding and resin-film infusion and to perform autoclave processing at lower temperatures and/or pressures. Another improved characteristic is larger processing windows — that is, longer times at low viscosities. Other improved characteristics include increased solubility of uncured polymer precursors that contain reactive groups, greater densities of cross-links in cured polymers, improved mechanical properties of the cured polymers, and greater resistance of the cured polymers to chemical attack.

The invention is particularly applicable to poly(arylene ether)s [PAEs] and polyimides [PIs] that are useful as adhesives, matrices of composite materi-

als, moldings, films, and coatings. PAEs and PIs synthesized according to the invention comprise mixtures of branched, linear, and star-shaped molecules. The monomers of these polymers can be capped with either reactive end groups to obtain thermosets or nonreactive end groups to obtain thermoplastics. The synthesis of a polymeric mixture according to the invention involves the use of a small amount of a trifunctional monomer. In the case of a PAE, the trifunctional monomer is a trihydroxy-containing compound — for example, 1,3,5-trihydroxybenzene (THB). In the case of a PI, the trifunctional monomer is a triamine — for example, triamino pyrimidine or melamine. In addition to the aforementioned trifunctional monomer, one uses the difunctional monomers of the conventional formulation of the polymer in question (see figure).

In cases of nonreactive end caps, the polymeric mixtures of the invention have melt viscosities and melting temperatures lower than those of the corre-

sponding linear polymers of equal molecular weights. The lower melting temperatures and melt viscosities provide larger processing windows.

In cases of reactive end caps, the polymeric mixtures of the invention have lower melt viscosities before curing and the higher cross-link densities after curing (where branching in the uncured systems would become cross-links in the cured systems), relative to the corresponding linear polymers of equal molecular weights. The greater cross-link densities afford increased resistance to chemical attack and improved mechanical properties.

This work was done by Brian J. Jensen of Langley Research Center. Further information is contained in a TSP (see page 1).

This invention has been patented by NASA (U.S. Patent Nos. 5,965,687 and 6,191,252). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Langley Research Center, at (757) 864-3521. Refer to LAR-15534.