NASA TECH BRIEF

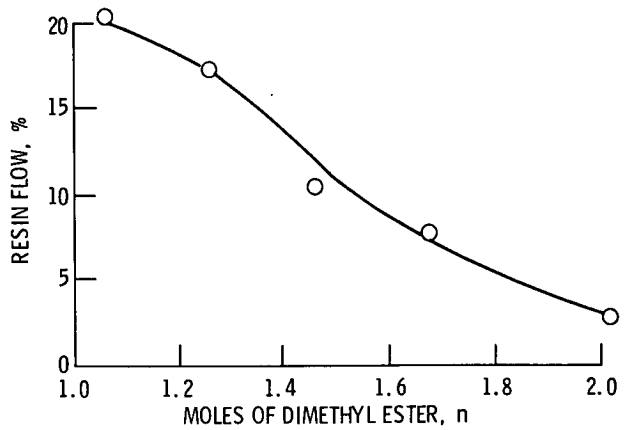
Lewis Research Center

Tailor Making High Performance Graphite Fiber Reinforced PMR Polyimides

The effectiveness of the in situ polymerization of monomer reactants (PMR) approach for preparing high temperature fiber-reinforced polyimide composites for use at 589 K (600°F) has been demonstrated (see Notes). In the PMR approach, the reinforcing fibers are impregnated with a solution containing a mixture of the following monomers: (a) a dimethyl ester of an aromatic tetracarboxylic acid, (b) an aromatic diamine, and (c) the monomethyl ester of a dicarboxylic acid. The molar ratio of a:b:c is n:(n+1):2. The monomers are essentially nonreactive at room temperature but react in situ at elevated temperatures forming thermally stable polyimides.

The polyimide matrix resin having the best overall balance of properties at 589 K (600°F) is prepared from a mixture of dimethyl ester of 3,3′-4,4′-benzophenonetetra-carboxylic acid, 4,4′-methylene diamine and the monomethyl ester of 5-norbornene-2,3-dicarboxylic acid in which n = 2.087. This resin exhibited lower flow values (3%) than normally obtained with epoxy resins (as much as 24%).

Recent studies have demonstrated the versatility of the PMR approach for tailor making polyimide matrix resins with a wide range of flow characteristics (see figure). By simply adjusting the molar ratio of the reactants in the monomer mixture, resins having flow values of as much as 20% can be achieved. Moreover, the higher flow value PMR resins have use temperatures up to 561 K (550°F), which is nearly 366 K (200°F) above the use temperature for epoxies. For example, after 600 hours exposure at 561 K (550°F), graphite fiber reinforced laminates made from these high flow PMR polyimides exhibited excellent strength and weight retention (70-78% strength retention and less than 4% composite weight loss).



Notes:

1. This process can be applied to the fabrication of compressor fan blades, guide vanes and cowls for jet engines, as well as centrifugal impellers and other aerospace or commercial structures requiring high quality, high temperature resin matrix composite construction.
2. The PMR polyimides were previously described in NASA Tech Briefs 71-10442, "Thermally Stable Polyimides from Solutions of Monomeric Reactants," and 73-10014, "Technique for the Polymerization of Monomers for PPQ/Graphite Fiber Composites."
3. Further information about this process is available in the following reports:

   NASA TM-X-71616 (N74-34960), Tailor Making High Performance Graphite Fiber Reinforced PMR Polyimides

   NASA TN-D-6877 (N72-29598), Addition Type Polyimides from Solutions of Monomeric Reactants

   Copies may be obtained at cost from:

   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B75-10137
4. Specific technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B75-10137

(continued overleaf)

Patent Status:
NASA has decided not to apply for a patent.

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