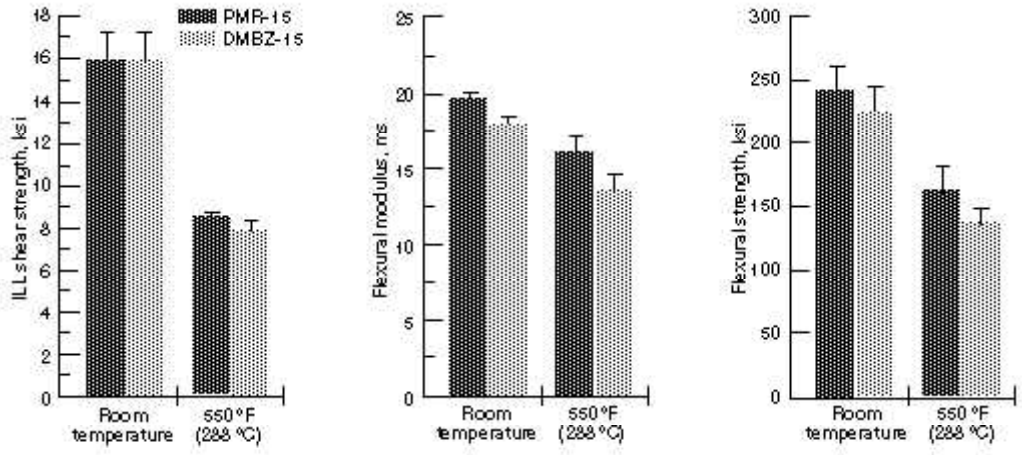
DMBZ Polyimides Provide an Alternative to PMR-15 for High-Temperature Applications

PMR-15, a high-temperature polyimide developed in the mid-1970's at the NASA Lewis Research Center, offers the combination of ease of processing, low cost, and good stability and performance at temperatures up to 288 °C (500 °F). This material is widely regarded as one of the leading high-temperature matrix resins for polymer-matrix-composite aircraft engine components. PMR-15 is widely used in both military and civilian aircraft engines. The current worldwide market for PMR-15 is on the order of 50,000 lb, with a total sales of around $5 to $10 million.

However, PMR-15 is made from methylene dianiline (MDA), a known animal mutagen and a suspected human mutagen. Recent concerns about the safety of workers involved in the manufacture and repair of PMR-15 components have led to the implementation of costly protective measures to limit worker exposure and ensure workplace safety. In some cases, because of safety and economic concerns, airlines have eliminated PMR-15 components from engines in their fleets.

Current efforts at Lewis are focused on developing suitable replacements for PMR-15 that do not contain mutagenic constituents and have processability, stability, and mechanical properties comparable to that of PMR-15. A recent development from these efforts is a new class of thermosetting polyimides based on 2,2'-dimethylbenzidine (DMBZ). Autoclave processing developed for PMR-15 composites was used to prepare low-void-content T650-35 carbon-fiber-reinforced laminates from DMBZ-15 polyimides. The glass transition temperatures of these laminates were about 50 °C higher than those of the T650-35/PMR-15 composites (400 versus 348 °C). In addition, DMBZ-15 polyimide composites aged for 1000 hr in air at 288 °C (500 °F) had weight losses close to those of comparable PMR-15 laminates (0.9 versus 0.7 percent). The elevated (288 °C) and room-temperature mechanical properties of T650-35-reinforced DMBZ-15 polyimide and PMR-15 laminates were comparable (see figure). Standard Ames tests are being conducted on this diamine to assess its mutagenicity.



Elevated and room-temperature mechanical properties of DMBZ and PMR-15 composites. Left: Interlaminate strength. Center: Flexural modulus. Right: Flexural strength.