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NASA TECH BRIEF

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Photosensitive Filler Minimizes Internal Stresses in Epoxy Resins

The problem:

Most cured high-heat distortion epoxy resins are in a stressed condition, which reduces their strength and causes deterioration of related physical properties. The stress is caused by internal shrinkage during curing or polymerization. Normal techniques to minimize detrimental high shrinkage include curing at relatively low temperatures and adding inert fillers to decrease the exothermic heat of reaction. These techniques have their inherent disadvantages which make their use under certain conditions unsatisfactory.

The solution:

Add a photosensitive filler, such as cinnamic acid resins and cinnamal ketones, to a curable epoxy resin mixture in the amount of 1% to 3% by weight of the resin mixture.

How it's done:

The addition of the fillers before cure does not inhibit the curing or polymerization of the epoxy system since the volumetric addition of the filler is minute. The resultant mixture is then cured in the conventional fashion, as by the addition of heat or a catalyst. After curing, the epoxy resin, if clear, displays internal isoclinic stress lines when viewed under polarized light. The epoxy resin is then exposed to a strong ultraviolet light source. Such exposure is for a time sufficient to allow the photosensitive filler to polymerize and relieve the internal stresses. When the epoxy resin is again viewed under polarized light, it is observed that the internal stress lines have disappeared. This indicates an epoxy resin that has high resistance to thermal shock and conditioning.

Notes:

1. This method to relieve internal stress eliminates the use of inert fillers. They frequently tend to settle out of solution before curing thus producing a nonuniform and weakened structural system. Inert fillers invariably lower the continuous service temperature or heat distortion point of an epoxy system.
2. The epoxy system currently used as an adhesive for the ULD ceramic module can be modified to utilize a photosensitive additive. Removal of the carbon-black additive (for detection of misplaced epoxy) would allow the use of a photosensitive additive, producing a higher thermal shock property.
3. This epoxy system could be used to produce storage lightweight epoxy tools which would have a longer life span in the high ultraviolet radiation environment of outer space.
4. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10227

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA, Code GP, Washington, D.C. 20546.

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