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NASA TECH BRIEF

Development of Improved Potting and Conformal Coating Compounds

A program was conducted to develop improved organic potting and conformal coating (encapsulating) materials for protection of fragile electronic components and circuitry from mechanical shock and vibration, moisture, and corrosion. The materials were required to meet stringent specifications covering mechanical and electrical properties and resistance to thermal shock and cycling, radiation, flammability, and sterilizing agents (dry heat and ethylene oxide) for certain space applications. The results of the development program are summarized below.

Potting Compounds

Epoxy resins have a combination of desirable characteristics, such as ready cure and good chemical and thermal stability, that make them particularly suitable for potting resins. Considerable improvement in thermal cycling performance was realized with the development of an experimental epoxy resin based on 1,4-bis-[3-(0-2,3-epoxypropoxyphenyl) propyldimethylsilyl] benzene. This material closely approached specification requirements with respect to thermal cycling performance. Dielectric constants were well below 3.0, while dissipation factors approached the objective of 0.005.

Within experimental limits the performance of a potting resin prepared from bisphenol A diglycidyl ether (a commercial product) and xylylenediamine compared favorably under thermal cycling conditions with the experimental epoxy resin but was slightly inferior in dielectric constant and fluidity of the resin mix.

Correlation of thermal cycling evaluations of these and other experimental epoxy resins with expansion coefficient data did not indicate a simple, direct relationship. It was concluded that factors such as modulus and transition temperature of the resin also affect the performance under thermal cycling conditions.

Polyisocyanurate compositions were considered to be potentially useful as potting materials because of their good thermal stability, low temperature curability, and excellent dielectric constants and dissipation factors. Cordwood modules potted with polyisocyanurate compositions were tested and found to be inferior to epoxy resin-potted modules. The shrinkage-on-cure of two unfilled isocyanurate compositions was determined and found to be 5 and 17 percent depending on molecular weight of the monomer.

Conformal Coatings

Various elastomeric materials were prepared and evaluated for application as conformal coatings. The major effort was on materials prepared from a commercial hydroxy-terminated hydrocarbon prepolymer. By reaction of this prepolymer with excess hexamethylene diisocyanate or tolylene diisocyanate, versatile reactive intermediates were prepared for further polymerization to urea-, urethane-, oxazolidone- and isocyanurate-linked polymers.

Urethane and urea-urethane-linked conformal coatings showed a combination of properties superior to that of conventional materials and closely approximates specification objectives. These elastomeric coating materials had high tensile strength and elongation, good low-temperature flexibility, and dielectric constants well below 3.0. They showed good compatibility with ethylene oxide and no damage to printed circuit boards under thermal cycling conditions. The isocyanurate-linked polymers cured less readily and had low tensile strengths and elongations. In addition, the curing reaction was adversely sensitive to moisture.

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Their dielectric constants and dissipation factors were excellent, however.

The oxazolidone-linked hydrocarbon material resulting from the combination of the more reactive oxirane and isocyanate intermediates approached the tensile-strength and elongation requirements and showed a satisfactory dielectric constant. The utility of the oxazolidone-linking reaction depends on the degree of improvement in properties that can be attained with a better catalyst or more reactive intermediates.

Two types of epoxy systems were investigated for the preparation of elastomeric materials. The reaction of epoxy intermediates with amine-terminated hydrocarbon prepolymer produced elastomeric materials having good dielectric constants but low tensile strengths and elongations. Considerable improvement in this system is believed possible.

Elastomeric epoxy coatings were also prepared by reactions of monomeric secondary diamines with diepoxy intermediates. High tensile strengths and elongation were offset by poor dielectric properties and poor compatibility with ethylene oxide.

Note:

No further documentation is available. Inquiries may be directed to:

Technology Utilization Officer
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Patent Status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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