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NASA TECH BRIEF

New Class of Thermosetting Plastics Has Improved Strength, Thermal and Chemical Stability

The problem:

To develop thermoset plastics having high hydrocarbon content, high strength modulus (stiffness), thermal stability, humidity resistance, and workability in the precured state. Such plastics would find use as matrices in the preparation of chemically stable ablative materials for rocket nose cones or nozzles, and for other uses where materials with these properties are desired.

The solution:

A new class of thermosetting plastics, designated cyclized polydiene urethane resins, have been developed to meet the above conditions. One series of these polydiene polymers is called cyclized polybutadiene urethane (HYSTL) resins which are rich in hydrocarbons and consist of molecular chains of cross-linked, condensed cyclohexane rings interconnected by urethane bonds.

Another series, called cyclized polyisoprene-urethanes, yields plastics consisting of molecular chains cross-linked, condensed methylcyclohexane rings interconnected by urethane bonds and thus are very similar to the cyclized polybutadiene-urethanes.

How it's done:

The polybutadiene resin is formed by reacting a long chain 1,2-polybutadiene diol with a diisocyanate at moderate temperatures and then initiation of the free radical induced cyclization of the pendant vinyl groups. The polyisoprene resin employs 3,4-polyisoprene diol in the reaction instead of the 1,2-polybutadiene diol. These cyclized polydiene-urethane resins have several unique features including: low density, high chemical resistance, easily processed, high thermal stability, resistance to water absorption, high resistance to UV exposure, high compressive strength, and high carbon content.

Notes:

1. It is believed that these polydiene-urethane polymer systems can be used as high temperature adhesives, matrices for reinforced structural plastics, and for the preparation of plastic parts which have chemical and moisture resistance and dimensional stability.
2. The reinforced structures prepared using these classes of resins exhibited high thermal, oxidative, hydrolytic, and chemical stability. Structural plastics prepared using these resin systems show promise for use in ablative materials, deep submergence ocean vessels, and lightweight structural plastics. The use of cyclized polybutadiene urethane resin systems permits preparation of composite structures by vacuum bag lay-up methods, preimpregnation and pressing, tape winding and curling, and filament winding procedures. The reinforced structural plastic can be prepared without the elimination of volatile matter, thus permitting use of processing techniques which require relatively low mechanical pressures.
3. Both the polybutadiene and polyisoprene resins can be used as high temperature adhesives having thermal stability in excess of 400°C. These adhesives also exhibit excellent oxidation and chemical stability and can be applied at moderate temperatures to effect the adhesive bonding.

(continued overleaf)

4. Polydiene-urethane resins can also be used as protective coatings, showing exceptional chemical resistance in particular. It is possible to apply the coating in the form of an aerosol, paint, and dip either in a carrier or in the neat liquid uncured form. The protective coating is practically colorless, consequently, pigments of dyes can be formulated into the mixture to provide desirable colors.
5. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B67-10197

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457 (f)], to the TRW Systems, One Space Park, Redondo Beach, California 90278.

Source: H. R. Lubowitz, E. A. Burns, and B. Dubrow of TRW Systems under contract to Lewis Research Center

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