High-Temperature, Low-Melt Resins for Liquid Molding

Fabricating resin transfer molding (RTM) composites with zero emissions

NASA's Glenn Research Center invites companies to license or establish partnerships to develop its patented high-temperature, low-melt imide resins for fabrication of automotive components. Produced by a solvent-free melt process, these resins exhibit high glass transition temperatures (Tg = 370 to 400 °C), low-melt viscosities (10 to 30 poise), long pot-life (1 to 2 hr), and can be easily processed by low-cost RTM and vacuum-assisted resin transfer molding (VARTM). These RTM resins melt at 260 to 280 °C and can be cured at 340 to 370 °C in 2 hr, without releasing any harmful volatile compounds.

**BENEFITS**

- Clean and green technology
- Adaptable—compatible with advanced manufacturing techniques
- Longer pot life—1 to 2 hr
- Long shelf life—resins do not deteriorate over time at ambient temperatures
- Suitable for high-temperature application—performs above 300 °C
- Efficient
- Low maintenance—self-lubricating when chopped carbon fibers are added
- Lightweight—provides up to 20 percent in weight savings over metallic components
- Improved safety
- High quality—solvent-free melt process yields a more consistent product and lowers the danger of contamination in the final resin product
- Cost effective
THE TECHNOLOGY

This technology was developed to make polyimide resins from novel asymmetric dianhydrides (a-dianhydrides) and kinked diamines to achieve low-melt viscosities that are amenable to low-cost RTM and VARTM, while retaining high-temperature finished product performance above 300 °C. These a-dianhydride-based RTM imide resins display low-melt viscosities (10 to 30 poise), which cannot be achieved using normal symmetric dianhydrides.

RTM imide resins can be melted at 260 to 280 °C, and injected into fiber preforms under pressure (200 psi) or vacuum (VARTM). The resins also can be made into powder prepregs with lengthy out-time by melting the resin powders so that they fuse onto fibers.

RTM imide resins display high softening temperatures (370 to 400 °C) and excellent toughness, as evidenced by the RTM370 resin's open-hole compression strength. The resins also possess significant thermo-oxidative stability by long-term isothermal aging at 288 °C (550 °F) for 1000 hr. The unique melt process without a solvent provides a manufacturing advantage over the expensive high boiling solvents previously needed to produce oligomers. This process also eliminates the need for tedious and high-cost solvent removal.

APPLICATIONS

The technology has several potential applications:

- Injection molding of parts, such as trim, structural support plastics, gears, etc.
- Injection molding of wire and structures
- High-temperature engine components; for example, bushings and bearings
- Selective laser sintering for prototypes
- Composite ducts and tubes
- Self-lubricating parts with chopped

PUBLICATIONS

U.S. Patent 7,015,304
U.S. Patent RE43,880 E
U.S. Patent 7,381,849
U.S. Patent 7,425,650
U.S. Patent 8,093,348

SEM cross section of a composite using RTM-370 as matrix material