National Aeronautics and
Space Administration

High-Temperature, Low-Melt Resins for Liquid Molding

Fabricating resin transfer molding (RTM) composites with zero emissions

TECHNOLOGY OPPORTUNITY

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 (T_g = 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:** Solvent-free melt process produces zero emissions
- **Easy to adopt:** Compatible with current 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 applications:** Performs above 300 °C, exceeding conventional RTM resins such as epoxy and bismaleimides, which have use temperatures around 177 and 232 °C, respectively
- **Efficient:** Enables direct net shape production from monomers by injection molding and resin transfer molding to afford final products
- **Low maintenance:** Self-lubricating when chopped carbon fibers are added
- **Lightweight:** Provides up to 20 percent in weight savings over metallic components
- **Improved safety:** Eliminates the need for hazardous organic solvents
- **High quality:** Solvent-free melt process yields a more consistent product and lowers the danger of contamination in the final resin product
- **Cost effective:** Production of a low-melt viscosity polyimide resin using a solvent-free melt process reduces the cost of manufacturing

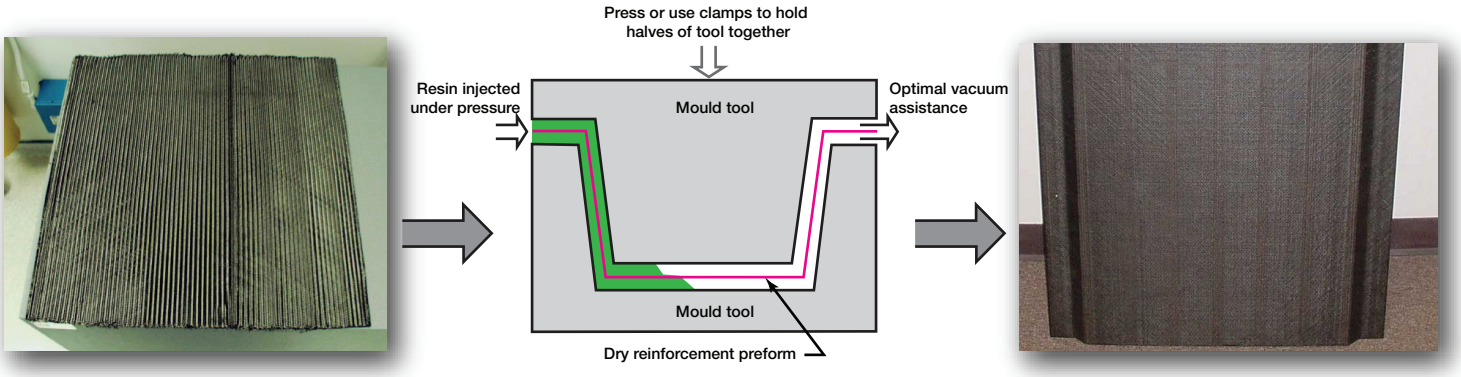
APPLICATIONS

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

Fabrication Methods:
- RTM and VARTM

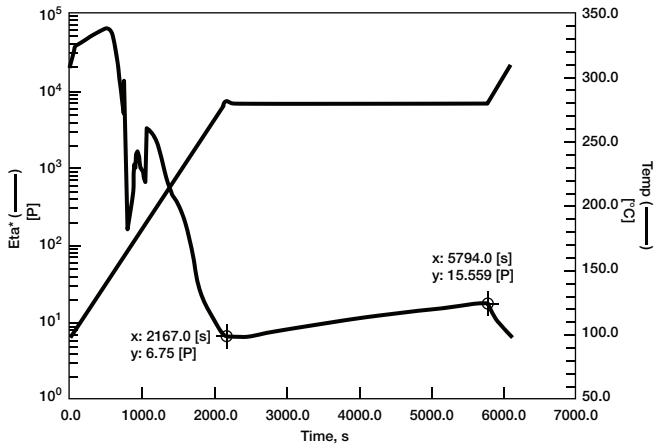
TECHNOLOGY DETAILS

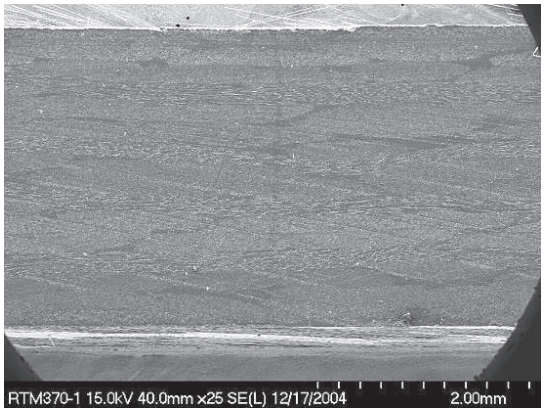
This technology was developed to make polyimide resins from novel asymmetric dianhydrides (a-dianhydrides) and kinked diamines to achieve low-melt viscosities that are amenable to low-cost RTM and VARTM, while retaining high-temperature finished product performance above 300 °C. These a-dianhydride-based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



HOW IT WORKS

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.





WHY IT IS BETTER

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.

PATENTS

Glenn has patented this technology (U.S. Patent No. 7,015,304).

LICENSING AND PARTNERING OPPORTUNITIES

Glenn's Office of Technology Partnerships and Planning seeks to transfer technology to and from NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Solvent-Free Low-Melt Viscosity Imide Resins (LEW–17618–1).

FOR MORE INFORMATION

For more information about this and other technology licensing opportunities, please contact

Office of Technology Partnerships and Planning
NASA Glenn Research Center
Email: otpp@grc.nasa.gov
Phone: 216–433–9701