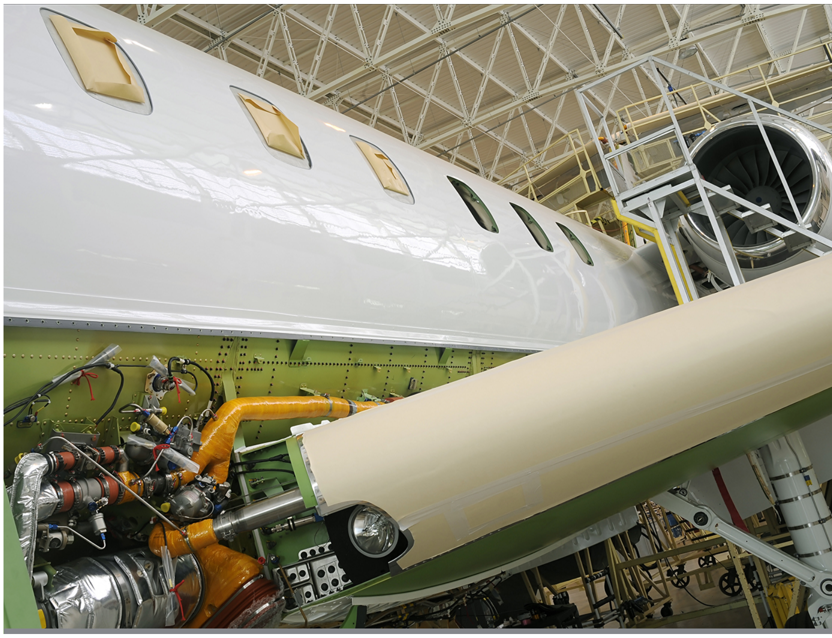


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Materials and Coatings

Resin Transfer Molding (RTM) 370 Resin for High-Temperature Applications

A solvent-free, low-melt process for creating a high-performance resin with zero emissions

Innovators at NASA's Glenn Research Center have developed a Resin Transfer Molding (RTM) imide resin known as RTM370 that is generated using a revolutionary, solvent-free process. Its many desirable properties earned it a prestigious R&D 100 Award in 2017. RTM370 has a high glass transition temperature (T_g = 370°C), low-melt viscosity (20 to 30 poise), and long shelf life (up to 2 hours). It can perform at temperatures exceeding 300°C. It melts at 260 to 280°C and can be cured at 340 to 370°C without releasing any harmful or volatile compounds. It is suitable for composite fabrication by injection molding, RTM, resin film infusion (RFI), or vacuum-assisted resin transfer molding (VARTM). Furthermore, carbon fiber filled RTM370 is adaptable to additive manufacturing and can be printed into composite parts by laser sintering - a major breakthrough in high-temperature composite fabrication. These cutting-edge carbon fiber composites can replace any metallic part, providing high-quality, lightweight materials to a variety of industries at low-cost.

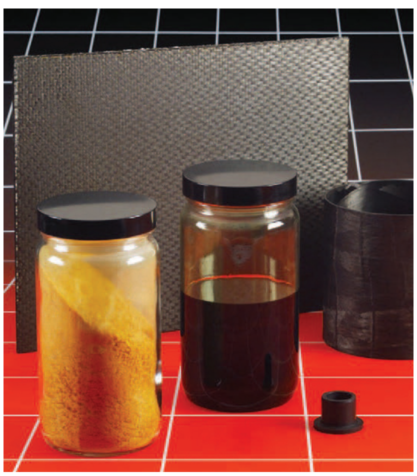
BENEFITS

- High-temperature capability: Retains mechanical properties at extremely high temperatures (up to 315°C)
- Long pot-life: Maintains suitable viscosity for RTM and RFI (20 to 30 poise) for 1 to 2 hours
- Lightweight: Components made from RTM370 are 30 percent lighter than metallic parts
- Clean and green: This solvent-free production process does not produce any harmful, volatile compounds
- Excellent impact-resistance and char yield: RTM370 composites demonstrate high impact resistance and outstanding abrasion resistance at ambient and high temperatures

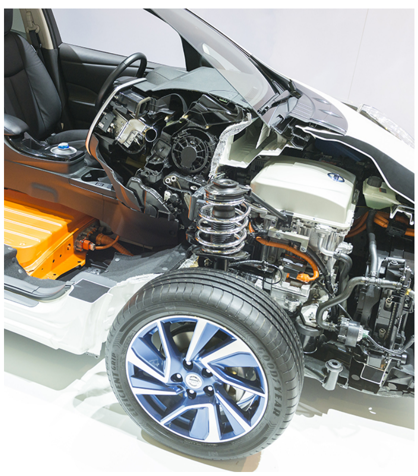
THE TECHNOLOGY

RTM370 imide resin was developed to address the limitations of conventional imide resins, which are generated from commercially available symmetrical biphenyl dianhydride and oxydianiline (ODA). These resins form symmetrical dianhydride or diamine compounds that result in a substance with much higher viscosity than is viable for RTM, RFI, and VARTM. RTM370 harnesses the unique properties of asymmetric biphenyl dianhydride (a-BPDA) used in combination with a kinked ODA and a 4-(Phenylethynyl) phthalic anhydride endcap to form a mixture that can be melted without the use of solvents, and achieve the desired low-melt viscosity. RTM370 displays a high softening temperature (T_g = 370°C) and can be melted at 260-280°C. It can then be injected into fiber preforms under pressure (200 psi) or through a vacuum (VARTM) to form composites with excellent toughness. The resin can also be made into powder prepregs by melting the resin powders so that they fuse onto fibers. Recently, carbon fiber filled RTM370 imide resins have been fabricated into composites by laser sintering. This exciting advancement in additive manufacturing represents a new frontier for high-temperature composites.

Not only are RTM370 composites lightweight, durable, and impact-resistant, they also possess outstanding abrasion resistance and significant thermo-oxidative stability (as demonstrated in long-term isothermal aging at 288°C for 1,000 hours). In summary, this groundbreaking approach yields a vastly superior resin for fabricating high-quality composites with improved performance, durability, and adaptability. RTM370's unique, solvent-free melt process is simpler, more environmentally friendly, and more cost-effective than competing systems, lending it broad appeal for a variety of Earth-based applications.



This novel, solvent-free process generates high-performing RTM370 imide resins



RTM370 composites can replace heavy metallic parts found in automotive engines

APPLICATIONS

The technology has several potential applications:

- Mechanical systems
- Oil and gas
- Construction
- Electronics
- Aerospace
- Automotive
- Marine
- Commercial space

PUBLICATIONS

Patent No: 7,015,304; RE43,880; 7,425,650; 7,381,849; 8,093,348; 8,993,710; 10,059,682

Patent Pending

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

LEW-17618-1, LEW-17618-1-REIS, LEW-17904-1, LEW-17904-2, LEW-18236-1, LEW-18236-2, LEW-19348-1, LEW-19649-1, LEW-TOPS-115

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