National Aeronautics and
Space Administration

Polymer Matrix Nanocomposites

To improve material durability, thermal stability, and mechanical performance of epoxy resins

TECHNOLOGY OPPORTUNITY

Researchers at NASA's Glenn Research Center have developed new methods for strengthening epoxy resins without diminishing toughness or altering existing processing procedures. The two related technologies both involve controlled placement and dispersion of nanoparticles within an epoxy matrix. One method (LEW–18474–1) includes selectively placing organically modified clays into an aromatic/alkoxy-blended resin to create a nanocomposite that provides increased strength and stiffness without sacrificing toughness in the cured epoxy or prepreg. A second method (LEW–18648–1) incorporates nanoparticles (clays and carbon nanofibers and nanotubes) into epoxy resins that have been processed with thermoplastic tougheners, thereby improving strength, ductility, glass transition temperature (Tg), and conductivity.

BENEFITS

- **Enhances performance:** Provides better strength, stiffness, ductility, and conductivity (when using carbon nanoparticles) without compromising toughness or Tg
- **Improves material yield stress:** Increases yield stress 40 to 100 percent while maintaining or improving toughness
- **Easy to implement:** During resin transfer molding, melt viscosity remains unchanged and material processing methods are unchanged
- **Simple and accessible method:** Uses commercially available starting materials and requires no special equipment
- **Enables more efficient and lightweight vehicles:** Toughened epoxies can reduce vehicle weight by 20 percent

APPLICATIONS

These technologies are beneficial for making composite structures that require strength and toughness. Potential applications include

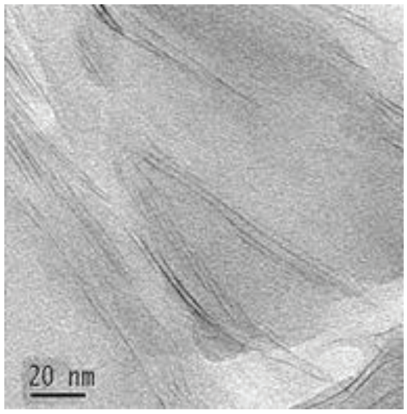
- Automotive body components (e.g., timing belt covers)
- Engine parts (e.g., turbines and fan blades)
- High-temperature engine structures
- Fuel cell storage tanks
- Composite tanks for high-pressure natural gas storage
- Ballistic impact armor

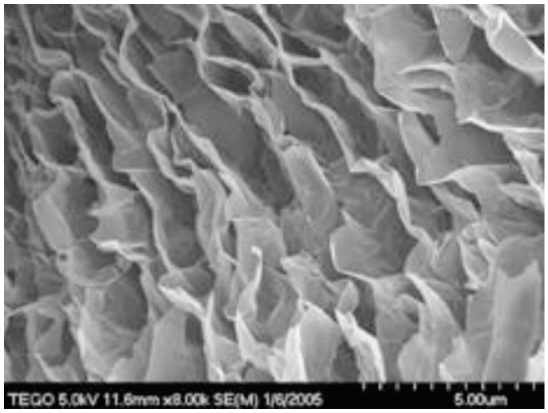
HOW IT WORKS

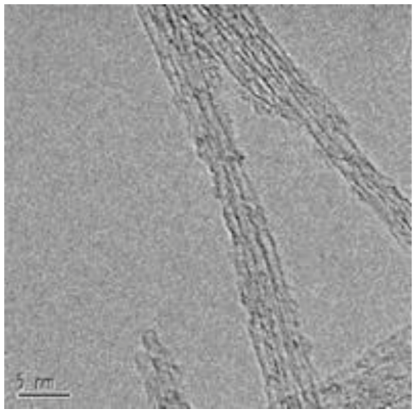
Nanoscale clays and graphene have been dispersed in a variety of polymer matrices for the purpose of improving their physical, thermal, and barrier performance. NASA has improved nanoparticle dispersion and compatibility with the matrix, leading to significant increases in thermal stability, oxidation resistance, and mechanical strength. The platelet morphology of both clay and graphene has provided considerable reductions in gas permeation through a polymer matrix. Because nanoparticle loadings typically range from 0.5 to 5 weight percent, the resulting composite is lightweight.

WHY IT IS BETTER

NASA's innovation improves upon the strength and modulus of an epoxy-clay nanocomposite while also improving (or maintaining) the resin toughness and ductility. The resulting nanocomposites also demonstrate reduced gas permeation and improved electrical and thermal conductivity. Recent improvements in barrier performance enable their use in polymer matrix composite gas tanks. The technology can also be used as a filler in polymer composites to improve strength and stiffness without adding weight.







PATENTS

Glenn has filed patent applications for this technology.

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 polymer matrix nanocomposites (LEW–18474–1 and LEW–18648–1).

FOR MORE INFORMATION

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

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