Fiber-Reinforced Reactive Nano-Epoxy Composites

Marshall Space Flight Center, Alabama

An ultra-high-molecular-weight polyethylene/matrix interface based on the fabrication of a reactive nano-epoxy matrix with lower surface energy has been improved. Enhanced mechanical properties versus pure epoxy on a three-point bend test include: strength (25 percent), modulus (20 percent), and toughness (30 percent). Increased thermal properties include higher Tg (glass transition temperature) and stable CTE (coefficient of thermal expansion). Improved processability for manufacturing composites includes faster wetting rates on macro-fiber surfaces, lower viscosity, better resin infusion rates, and improved rheological properties. Improved interfacial adhesion properties with Spectra fibers by pullout tests include initial debonding force of 35 percent, a maximum pullout force of 25 percent, and energy to debond at 65 percent. Improved mechanical properties of Spectra fiber composites (tensile) aging resistance properties include hydrothermal effects.

Polymerization Initiated at the Sidewalls of Carbon Nanotubes

Lyndon B. Johnson Space Center, Houston, Texas

A process has been developed for growing polymer chains via anionic, cationic, or radical polymerization from the side walls of functionalized carbon nanotubes, which will facilitate greater dispersion in polymer matrices, and will greatly enhance reinforcement ability in polymeric material.

Aryl bromide functionalized carbon nanotubes are dispersed in 5-mL tetrahydrofuran (THF), and a solution of n-butyllithium (5 mL, 2.19 M in hexane) was added at 23 °C, and the solution stirred for 10 min. The stirring was then turned off, and the nanotubes were allowed to settle out of solution. After settling, the excess n-butyllithium solution was removed from the reaction vessel via cannula, and the nanotubes were washed three times with dry THF (10 mL) to remove traces of n-butyllithium.

With this innovation, high-performance composite materials have been created, including carbon fibers/nano-epoxy, glass fibers/nano-epoxy, aramid fibers/nano-epoxy, and ultra-high-molecular-weight polyethylene fiber (UHMWPE).

This work was done by Wei-Hong (Katie) Zhong of North Dakota State University for Marshall Space Flight Center. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32666-1.

Metal-Matrix/Hollow-Ceramic-Sphere Composites

Goddard Space Flight Center, Greenbelt, Maryland

A family of metal/ceramic composite materials has been developed that are relatively inexpensive, lightweight alternatives to structural materials that are typified by beryllium, aluminum, and graphite/epoxy composites. These metal/ceramic composites were originally intended to replace beryllium (which is toxic and expensive) as a structural material for lightweight mirrors for aerospace applications. These materials also have potential utility in automotive and many other terrestrial applications in which there are requirements for lightweight mate-