National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Materials and Coatings

Vertically Aligned Carbon Nanotubes

Formation of a composite with improved through thickness conductivity, interlaminar strength, fracture toughness and impact resistance

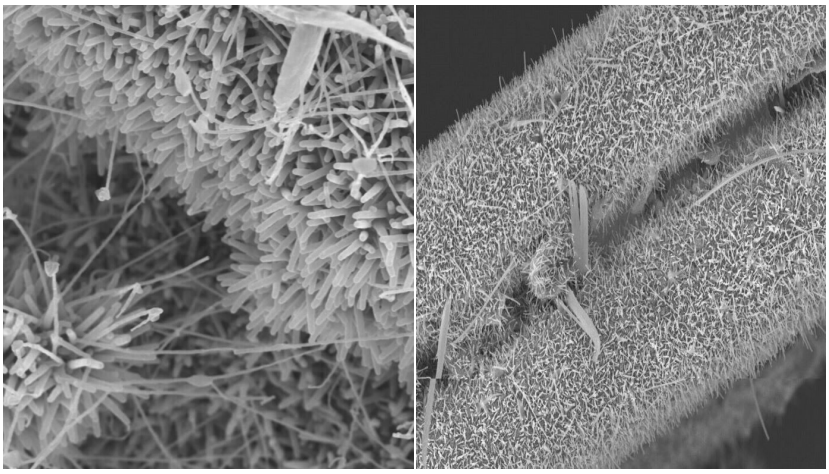
Innovators at NASA's Glenn Research Center have developed a polymer matrix composite composed of layers that alternate between a thin carbon fiber veil layer coated with nanotubes and a thicker base carbon fiber reinforcement layer. The alternating fiber layers are held together by a curable epoxy resin. The resulting composite material provides improved interlaminar strength, fracture toughness and impact resistance. The carbon fiber veils can be evenly distributed throughout the composite or targeted to specific areas of a part that are likely to require reinforcement. For example, veils can be selectively situated at a leading edge of a wind turbine blade, a helicopter blade, an engine component, an air foil, or an aircraft nose section. Since the veils themselves do not impart strength or stiffness to the composite structure, any damage to the veils does not affect the integrity of the composite structure. The embedded carbon nanotubes can provide through thickness thermal and electrical conductivity. The electrically conductive nature of the nanocomposite veils allows for their application for added lightning strike protection and electromagnetic protection.

BENEFITS

- Allows formation of polymer matrix composite with improved damage tolerance, improved interlaminar strength and improved fracture toughness
- Flexible fabrication process allows veils to be distributed throughout the composite or selectively used in certain areas of a part that are likely to be subject to impacts
- Easy ability to modify the veil substrate materials and nanotube materials that can be used to fabricate the improved polymer matrix composite
- The carbon veil substrate and/or the conductive carbon nanotubes can be coated with metal particles to further increase the thermal and electrical capacity of the composite

THE TECHNOLOGY

Formation of the inventive polymer composite matrix begins by growing carbon nanotubes directly on a veil substrate. The carbon nanotubes are grown from both sides of a non woven carbon fiber mat. The carbon nanotubes can be single or multi walled and can be grown to predetermined lengths. The veiled substrate is positioned between carbon fiber/ polymer prepreg layers such that the carbon nanotubes protrude into the reinforcement layers. The polymer composite matrix formed following curing of the resin exhibits improved interlaminar strength, fracture toughness and impact resistance. Because of the thinness of the veil layer, electricity can pass from conductive carbon nanotubes on one side of the veil to conductive carbon nanotubes on the other side of the veil. Electricity can also pass between two veils intercalated into the same reinforcement layer when the length of the nanotubes is sufficiently long enough to provide overlap within the reinforcement layers.



APPLICATIONS

The technology has several potential applications:

- Nanomaterials (carbon nanotubes, graphene, nanofibers, nanoparticles, nanowires)
- Aerospace
- Automotive
- Power (ultracapacitors, windmill blades, thermal cells, batteries, fuel cells, solar cells, LEDs)
- Composites

PUBLICATIONS

Patent No: 10,759,140

US 8,609,750

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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.

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More Information

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