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Structural Fibers coated with Nanowires for Polymer Composites

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Patent pending

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Background

In the design of fiber reinforced composites such as carbon fibers, the fiber-matrix interface quality is critical in determining the mechanical properties of the composite. Enhanced chemical interaction at the interface or a large fiber surface area improves interfacial adhesion. Techniques like “whiskerization” using carbon nanotubes and silicon carbides have been used to increase the interfacial quality. Also, interleave materials are used to improve the inter-laminar properties of the composite. However, these methods are detrimental to the in-plane properties of the composite and they significantly degrade the mechanical properties of the fiber due to the high temperature processing required.

Invention Description

Researchers at Arizona State University have developed a method for enhancing the fiber-matrix interfacial strength. This technique is based on the growth of nanowires (such as ZnO) on structural fibers (such as carbon fiber) under low temperature conditions (<90°C). This method has been found to increase the surface area of the carbon fiber by about 1000 times. The carboxyl functional groups in the carbon fiber and a good wetting property of the epoxy render a stronger chemical bond with ZnO than other compounds.

The single fiber tensile test shows that the growth of ZnO nanowires does not affect the in plane properties of the carbon fibers. The single fiber fragmentation test shows that the presence of ZnO nanowires increases the interfacial shear strength by up to 350%. The shear strength can be further increased by controlling the growth of nanowires and by optimizing the properties of the ZnO nanowires. The technique thus produces a fiber reinforced composite with increased strength and toughness without compromising on the in-plane properties.

Potential Applications

- Useful in the Aerospace, Defense and automobile industry to reduce the weight of components without compromising the strength
- Lighter and stronger designs in sports equipments, cycles, fishing rods and fiber boats
- In the manufacture of support structures, casings and bases in the electronics and communication industry
- Niche applications in the structural engineering that require high strength, light weight and durability

Benefits and Advantages

- Significant increase (up to 350%) in the interfacial shear strength
- Does not affect the in-plane properties of the composite
- Enhanced load transfer between the fiber and matrix material
- Semi-conductive and piezoelectric properties of ZnO may lead to multi-functional applications
- Does not affect the structural properties of the carbon fiber due to low temperature conditions involved