3D Carbon Fiber Production with High Surface Area

Secondary and tertiary carbon filaments form a filamentous carbon network with high surface area.

Carbon fiber composites (CFCs) are used in the fabrication of advanced composite materials for applications such as aerospace, civil engineering, military, automobile and sporting goods. These materials are highly sought after for their high strength, low weight, low thermal expansion, and reasonable cost. In general, carbon-reinforced composite materials comprise of carbon fibers and a matrix, which can be constructed using materials such as polymers, carbons, ceramic, metals and glass. The matrix must have the ability to transfer stress between fibers so that all the fibers used are effective in bearing the load. However, one of the major problems associated with CFC materials relates to the poor adhesion or weak bonding between the carbon fibers and matrix molecules. The degree of adhesion between them depends considerably on the surface properties of the carbon fibers. The surface area is a critical parameter that influences the interaction of a carbon fiber with the matrix materials and hence its behavior in a composite. Numerous attempts have been made to improve bonding, consisting mostly of chemical and physical modifications to the surface of the fiber. Unfortunately, these techniques offer rather limited capabilities for increasing the interfacial surface area between the carbon fiber and the matrix.

Technical Details
UCF researchers have discovered a method for producing three-dimensional (3D) carbon fibers. These fibers have a surface area approximately two orders of magnitude greater than the surface area of primary fibers. They are composed of original carbon fibers with secondary carbon filaments (SCFs) grown thereon. Additional tertiary carbon filaments can also be grown from the surface of SCFs, forming a filamentous carbon network with high surface area. The presence of carbon filaments enhances the interfacial bonding between the fiber and the matrix, which greatly reduces the problems associated with the delamination of the composite materials. Furthermore, the strong micromechanical interaction with the matrix due to the increased surface area, allows the 3D carbon fibers to efficiently bind with metal, ceramic, glass, and concrete matrices, resulting in a wide range of applications.

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Tech Fields
Carbon Nanotubes

Keywords
carbon fiber composite (CFC), carbon filaments, carbonaceous gases (CG), pyrocarbon

Benefits
• Timely, cost effective and continuous manufacturing process
• Manufacturing is not sensitive to small amounts of contaminants, allowing the use of industrial grade carbonaceous gases
• Length and thickness of filaments are highly controllable and customizable
• Original carbon fibers are protected during production of the composite materials

Applications
• Composite materials, adsorbents, catalyst supports, fuel cells, capacitors, medicine, refrigeration, and environmental control

US Issued Patents
6,787,229 B1
7,816,004 B1
8,119,198 B2

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