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Controlled Intermittent Interfacial Bond Concept for Composite Materials

A new bond concept will enhance the fracture resistance (fracture toughness) of a high-strength filamentary composite without degrading its tensile strength or elastic modulus. This controlled intermittent interfacial bond strength concept provides a means for tailoring the strength and toughness of a composite to applications such as aircraft structures and armor. Once the composite system and a suitable surface treatment are chosen, a wide spectrum of mechanical properties can be obtained by simply varying the ratio of the volume of treated filament to the total volume of filament and the length of the individual treated region. Therefore, one composite system combined with a controlled intermittent filament treatment can be used in place of a number of different composite systems and surface treatments.

This concept provides more economical composite systems, tailored for specific applications, and a composite material with mechanical properties, such as tensile strength, fracture strain, and fracture toughness, that can be optimized. It can be applied to all composite systems employing high-strength, high-modulus fibers and filaments. Candidate composite systems include fiberglass, boron-epoxy, boron-polyimide, graphite-epoxy, graphite-polyester, and similar composites. Although the concept is generally directed to ceramic-polymer systems, certain metallic-metallic composite systems might be amenable to the controlled intermittent interfacial bond strength concept.

Given a composite system and a proved surface treatment, the only other variables left to consider are length of the individual treated area and length of the repeat distance. In the boron-epoxy system where the adhesion between the matrix and the filament is too high for optimum toughness, the surface treatment consists of coating the filament with a substance which diminishes the adhesion between the filament and the epoxy. The length of the uncoated region has to be greater than some multiple of the critical transfer length. It is the uncoated regions that transfer the majority of the composite stress into the filaments and render strength to the composite. The remainder of the filament is coated and therefore has considerably lower interfacial strength. The uncoated areas act as crack stoppers and fracture retarders and increase the fracture toughness of the composite material.

Note:

Requests for further information may be directed to:

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NASA has decided not to apply for a patent.

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