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Using variable interfacial adhesion characteristics within a composite to improve flexural strength and decrease fiber volume

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Abstract

This paper investigates the impact of using amine functionalised fibers in composite "hybrid" laminates to improve interfacial shear strength (IFSS) and reduce laminate weight. A comparison of single fiber fragmentation testing (SFFT) and short beam shear testing (SBS) showed that 103.6% improvements of IFSS at a single fiber level only translate to a 23.3% improvement in SBS testing. However, localised use of both functionalised and non-functionalised T300 fibers in a "hybrid interface" laminate improved IFSS by 56.7%. Hence this study shows that careful placement of fibers and localised manipulation of the interface characteristics can be used to great effect when designing a composite material. Ultimately the use of a hybrid interface approach was able to provide a weight reduction of 11.27% while not sacrificing flexural strength compared to the baseline T300 fibers.

Keywords Interfacial Adhesion, Carbon Fiber, Interface, Surface Modification

1. Introduction

While interfaces may only account for a tiny fraction of the overall volume in a composite they are essential for the integrity and performance of the material [1-5]. Unfortunately, composite materials are prone micro-cracking and interfacial debonding, despite being identified a major problem for composite decades prior [6-9], these limitations still remain prominent mechanisms for failure restricting the full mechanical potential of a composite materials to be realised. Typically, the only attempt to maximise interfacial adhesion are made by varying the surface treatments, either pre- or post-manufacture, and by the application of a resin 'compatible' sizing layer. Nevertheless, improving the interfacial adhesion in a composite is to circumvent inherent limitations associated with these materials.

A vast body of research focussing on the manipulation of the carbon fiber to matrix interface currently exists. These approaches have included sizing composition research [10-14], oxidation techniques [5, 15-18] and surface grafting [19-28], to name a few. Each of these methods has been met with mixed success. Of these, electro-grafting of functional groups onto the surface fiber has shown some of the greatest promise, with improvements of more than 200% in Interfacial Shear Strength (IFSS) have been observed [19], however these have been limited to testing on a single fiber microscopic scale.

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