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Review on -Hybrid Composite Materials for Structures

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ABSTRACT

The review article of this paper represents the reduced availability of natural resources, the increasing costs of production, and the apparent limit to our ability to fabricate high strength-to-weight metallic components necessitated the development of new materials to meet the demands of aerospace technology. These materials are called advanced composite materials and will be used to replace some of the metals currently used in aircraft construction. Advanced composites are materials consisting of a combination of high-strength stiff fibers embedded in a common matrix (binder) material, generally laminated with plies arranged in various directions to give the structure strength and stiffness. The much stiffer fibers of boron, graphite, and Kevlar have given composite materials structural properties superior in strength to the metal alloys that they have replaced

Keywords: Hybrid Composites, Hybridization, Tibological Properties.

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INTRODUCTION

Composite material is a material or alloy mixture with the reinforcement and made from two or more essential materials with pointedly different physical or chemical properties that, when combined, produce a material with physiognomies different from the specific components. The specific constituents remain separate and distinct within the finished structure. The novel material may be favoured for many reasons: common examples include materials which are stronger, lighter, or less expensive when associated to traditional materials. More recently, researchers have also commenced to actively include sensing, actuation, computation and communication into composites, which are known as Hybrid Materials

HYBRID COMPOSITES

Hybrid composites are constructed from a matrix, microfillers, traditional fillers, and rarely from glass fibers. Depending on the size of the traditional fillers, these can be divided into coarse and fine hybrid composites. They are always highly filled, their Young's modulus is dentin-like, and the radioopacity is good. In coarse hybrid composites the traditional fillers are about 3–5 µm and their characteristics are comparable to those of traditional composites. In fine hybrid composites the size of the traditional fillers is 2 µm. The surface is nearly smooth, acceptable to polish, and wear of the restoration and the antagonists can be equal to those of human enamel. The stability of the restoration is good.

HYBRIDIZATION

Hybrid composites use more than one kind of reinforcement in the same matrix; hence, the idea is to get the synergistic effect of the properties of reinforcements on the overall properties of composites. With hybrid composites it may be possible to have greater control of the properties, achieving a more favorable balance between the advantages and disadvantages inherent in any composite material. Earlier attempts at hybridization were made by combining stiffer fibers (carbon and boron) with more compliant fibers (glass and Kevlar) to increase the strain to failure of the composite and hence enhanced impact properties. Besides improving the impact performance, the incorporation of glass fibers reduces the cost and improves the fatigue resistance of the hybrid composites [2]. This is attributed to the increased stiffness of the composite because of carbon fibers. Works done on carbon–glass fiber hybrid composites showed that factors controlling monotonic tensile (and compression) failure do not necessarily continue to determine failure under cyclic loading conditions, and that for fatigue applications there appear to be positive benefits in using hybrids in place of single fiber composites [3].

Hybrid composites are materials that are fabricated by combining two or more different types of fibers within a common matrix. There are several definitions of hybrid composites given by various researchers. Thwe and Liao [4] defined hybrid composites as a reinforcing material incorporated in a mixture of different matrices. On the other hand, Fu et al. [5] explained that these composites are a reinforcing material that is incorporated into two or more reinforcing and filling materials that are present in a single matrix [5]. Hybrid composites are more advanced than other fiber-supported composites, and have a wider range of potential applications. Previous studies on natural–synthetic fiber hybrid composites have primarily focused on reducing the use of synthetic fibers [6–8]. Furthermore, a previous study described the potential advantages associated with natural–synthetic fiber hybridization [9].

The performance of hybrid composites is a weighted sum of the individual constituents in which there is a more favorable balance between the inherent advantages and disadvantages. The benefits of one type of fiber could complement properties that are lacking in other types of constituents in the hybrid composites. As a result, a balance in cost and performance could be achieved through proper material design [10]. A few examples of hybrid composites include kenaf–aramid with Kevlar [11], woven jute/glass fabric [12], and sisal fiber-reinforced polyester composites with the addition of carbon [13]. Hani et al. [14] also investigated woven coir–Kevlar hybrid composites, and found that coconut coir could be used to replace some of the synthetic fibers within the composite, which would consequently improve the resistance of the material to high speed impact and penetration.

PROPERTIES OF HYBRID COMPOSITES

The properties of a hybrid composite can be influenced by the orientation of the fibers, fiber content and length, layering patterns of the two fibers, their intermingling capacities, fiber-to-matrix interface, and also the failure strain of single fibers.

A hybrid composite can be used for primary structures in commercial, industrial, aerospace, marine, and recreational structures. It has a wide array of benefits in the aerospace industry, such as great fatigue and corrosion resistance, and excellent impact resistance. The most significant advantage is weight reduction, where it could generate savings in the range of 20%–50%. Furthermore, the mechanical properties can be tailored by “lay-up” design, with tapering thicknesses of reinforcing fabric and changing orientation.

TRIBOLOGICAL PROPERTIES OF HYBRID COMPOSITES IN BUILDING STRUCTURES

Hybrid composites are developed to display combined component properties. Adding a reinforcing agent can be in the form of fillers, short fibers, or fabrics to formulate the hybrid composites with various forms of reinforcing pairs. The reinforcement selection is an important factor for addressing the suitability of hybrid composites in tribological applications. The hybrid composites developed in combination with natural and synthetic fibers have enhanced mechanical properties and can be suitable for tribological applications with higher loading. Wear debris, fiber breakage, voids, matrix loss, debonding, and transfer surface are the primary wear mechanisms in the rubbing action of hybrid composites. Including fillers is the important factor influencing their tribological characteristics. The improved mechanical strength with increased tribological efficiency, however, depends on the uniform dispersion of the fillers. The transfer layer plays an important role in assessing the tribological quality of composites based on the polymer. The existence of the transfer layer can be achieved by maintaining low friction and reduced wear through protective shielding.

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