Preparation and Characterization of Amino-Silanized Opuntia Cladode Fibre and Fumed Silica Toughened Epoxy Composite

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M. P. Sudeshkumar · R. Ramadoss · Veerasundaram Jayaseelan · Vijayananth Suyamburajan

Abstract

The purpose of this study was to develop and describe the mechanical, wear, and electrical characteristics of epoxy composites reinforced with opuntia cladode short fiber (OCF) and fumed silica (FS). The primary objective of this study was to determine how the addition of silane treated fumed silica particle improves the load bearing and wear properties of novel opuntia cladode fiber-epoxy composite. The cladode of the opuntia plant was used to create the opuntia fiber, whereas fumed silica was purchased in its finished form. The laminates were made using a manual layup method and tested as per ASTM specifications. According to the end results the tensile strength, flexural strength, impact toughness, hardness, and adhesion strength were all found to rise by 35.2%, 31.4%, 91.4%, 1.3%, and 6.2%, respectively, for composite designation E0 having 30 vol.% of OCF. Similar improvements were seen in load bearing and dielectric characteristics after adding 2 vol. % of fumed silica. The sp. wear rate was measured at 0.0174 mm3/Nm after 30% OCF was added to the composite E0. The 2.0 vol.% fumed silica composite also has the lowest COF and sp. Wear rate, at 0.44 and 0.005 mm3/Nm, respectively. When calculating the maximum dielectric constant and dielectric loss, the N4 composite was found to have values of 6.8 and 1.4, respectively. The SEM fractography proves that the silane-treatment enhanced the dispersion of fumed silica in the matrix and reinforced the fiber-matrix contact. These properties enhanced natural fibre composites could be used in transportation sector to aerospace and consumer electronic divisions where product size and weight is highly concern.

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ORIGINAL PAPER

Preparation and Characterization of Amino-Silanized Opuntia Cladode Fibre and Fumed Silica Toughened Epoxy Composite

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Abstract
The purpose of this study was to develop and describe the mechanical, wear, and electrical characteristics of epoxy composites reinforced with opuntia cladode short fiber (OCF) and fumed silica (FS). The primary objective of this study was to determine how the addition of silane treated fumed silica particle improves the load bearing and wear properties of novel opuntia cladode fiber-epoxy composite. The cladode of the opuntia plant was used to create the opuntia fiber, whereas fumed silica was purchased in its finished form. The laminates were made using a manual layup method and tested as per ASTM specifications. According to the end results the tensile strength, flexural strength, impact toughness, hardness, and adhesion strength were all found to rise by 35.2%, 31.4%, 91.4%, 1.3%, and 6.2%, respectively, for composite designation E0 having 30 vol.% of OCF. Similar improvements were seen in load bearing and dielectric characteristics after adding 2 vol. % of fumed silica. The sp. wear rate was measured at 0.0174 mm^3/Nm after 30% OCF was added to the composite E0. The 2.0 vol.% fumed silica composite also has the lowest COF and sp. Wear rate, at 0.44 and 0.005 mm^3/Nm, respectively. When calculating the maximum dielectric constant and dielectric loss, the N4 composite was found to have values of 6.8 and 1.4, respectively. The SEM fractography proves that the silane-treatment enhanced the dispersion of fumed silica in the matrix and reinforced the fiber-matrix contact. These properties enhanced natural fibre composites could be used in transportation sector to aerospace and consumer electronic divisions where product size and weight is highly concern.

Keywords Composites · Polymer · Silica · Fibre · Filler · Wear · Dielectric

1 Introduction

Stronger, lighter, and, most significantly, less energy-intensive materials are needed in most technical applications, especially in the automobile and aerospace sectors, since they would minimize excessive fuel consumption and the associated carbon dioxide emissions [1]. In this connection the natural fibers and filler particles are the basis for the innovative biomaterials being developed by scientists throughout the world [2]. Researchers from all around the world are focusing on biocomposites because of how versatile they are, how cheap they are, and how much money they save. New fiber discovery as well as the acquisition and development of bio fillers [3] are now the primary areas of study. Since most of the fibers such as bagasse, jute, aloevera, etc.… are readily available they are serving composite making process over a decade [4, 5]. However there are still new fibers are pop up in the line such as Opuntia fiber. It has good mechanical and load bearing properties as other natural fibres has. Opuntia cladodes are thought to owe its mechanical qualities to a network of small fibers with a hierarchical, hexagonal reticular structure [6]. There are some related research were incepted recent days amid researchers since the opuntia fibers are sustainable and eco-friendly. In this way epoxy composites may be strengthened by nopal fibers from cacti, as described by Lahouaria et al. [7]. In this research, author used Cactus fibers and investigated the mechanical properties. Author confirmed that the

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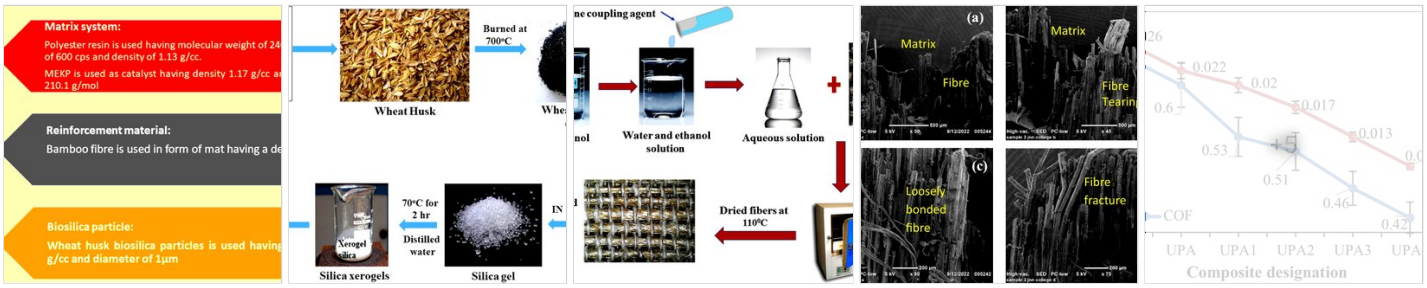

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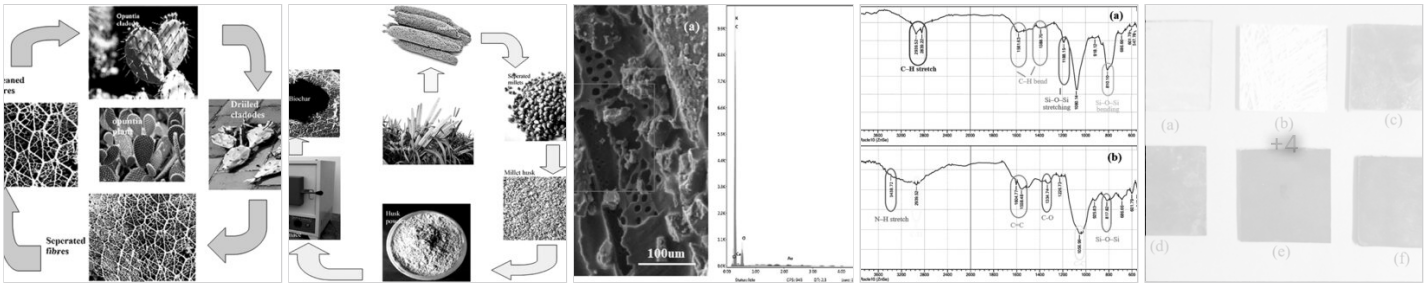

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In this study for diverse technical applications, a composite made of epoxy was created in using pearl millet biochar (PMB) and opuntia cladode short fiber (OCF). This study's primary objective was to create a biocomposite from agricultural waste and assess its suitability for usage as a structural material. Both the opuntia cladode and the pearl millet husk are non-edible dry land species that are produced in large...

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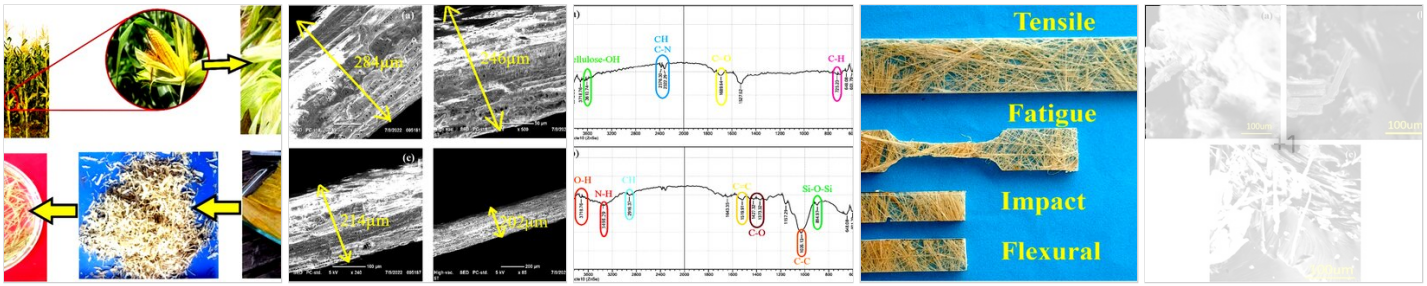

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R. Kirubagharan · S. Dhanabalan · T. Karthikeyan

This study examined the role of maize (corn) husk fiber and its surface treatment pattern in an epoxy matrix by assessing its mechanical characteristics and fatigue behavior. The main objective of this study was to analyze the effect of alkali-silane treatment on the composite's characteristics utilizing strength factor methods. Varying weight percentages of base and silane durations were employed to create a variety ...

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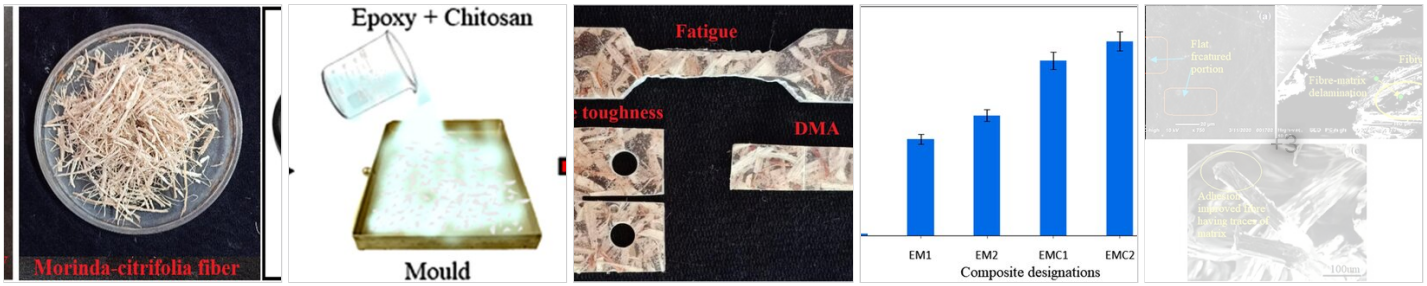

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Venu Jaiganesh · G Manikandan · P Gurusamy · Kaliappan Seeniappan

In the present study, tensile fatigue, fracture toughness, and dynamic mechanical analysis (DMA) properties of silane-modified chitosan particles and Morinda citrifolia fiber (MCF)-reinforced epoxy composites were examined. The main of this research was to reveal how the silane-modified chitosan and novel MCF improve the time-dependent and thermo-mechanical behavior of epoxy-based composites. The MC...

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Polymer Composites

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In this research, citron peel biochar and opuntia-cladode fibers (OCF) reinforced epoxy composites were fabricated and characterized for mechanical, wear, and electrical properties. The biochar was prepared from the waste peels of citron edible fruit whereas the opuntia fiber was from the cladode of the opuntia plant. The laminates were fabricated by hand layup process and evaluated in accordance with the ASTM...

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