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Determination of Energy Changes and Length of Micro Cracks Formed in Cotton Fibre Reinforced Natural Composite Laminate Due to Environmental Degradation.

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Abstract

This study is to know the effect of biodegradation on the cotton fiber reinforced composites. Four types of cotton fiber reinforced composites were prepared in hand layup process by using matrixes Plaster of paris POP, wheat starch WS, rice starch RS and urea formal dehyde UF. The tensile tests were conducted as per ASTM D 638 .Initially tensile test were conducted on few of them. Other samples were exposed to atmospheric air for six months and then the tensile test is conducted on them, the strengths of all the samples were found to be lowered considerably. The starch and Urea formal dehyde composites were found degraded. But the POP composites were not degraded. The sum of the lengths of micro cracks was calculated for the degraded laminates.

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Keywords: Natural composite materials, Starch composites, Degradation of natural composites, Tensile test, Plaster of paris, Urea formal dehyde resin

1. Introduction

Currently fiber reinforced composite materials are replacing the conventional structural materials. Though

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they have the advantage of being non – corrosive, have low strength to weight ratio and have designing flexibility yet their production involves hazardous atmospheric pollution that stunts plant growth and reduces the yield. So, thrust is on replacing the existing based composites with suitable eco friendly materials.

Mechanical properties of composite materials is decreased by biodegradation process [1]. The natural fiber reinforced biodegradable polymer composites have very bright future and find wide range of application in the industry [2]. V. Alvarez et al [3] conducted tensile tests on sisal fiber/starch based composites and obtained tensile strength values in between 11.5 and 19 MPa . All the natural fibers are very hydrophic materials and they are strongly influenced by water [4]. The water molecules enter the free space of micro voids and diffuse rapidly along the fiber matrix interphase [5]. Exposure to moisture results in significant drops in mechanical properties due to the degradation of the fiber – matrix interphase[6]. The moisture affects fiber/matrix bond or interface region and the fiber itself, leading to effect on overall composite performance [7].The I R spectra of natural fibers gave different results in degradation test[8]. Degradation of the composites is independent of the initial fiber treatment; it is independent of whether the fiber is treated with chemical or not [9]. In contradiction, the chemical treated fibers absorb less moisture than the untreated fibers [10]. The macroscopic and microscopic changes confirms the decrease in the tensile strength of the composite due to degradation[11]. A.S.Singha et al [12] found the tensile strength of S.Cillaire fiber – Rnf in between 9 – 14 MPa.. Tensile properties of the PLA/RS composites decreases drastically on exposing the samples to natural weathering conditions [13]. In case of Polybutylene succinate composites the drastic degradation took place between 80 to 120 days, with degradation being little for 80 days[14].The tensile strength decreased considerably depends on burial time. The increase in the starch content increases the degradation [15]. The bio degradation increases with the starch content in composite material. [16].The starch is degraded easily through moisture absorption due to its hydrophilic nature [17]. The degradation rate of starch – PHBV is intermediate to those that contain 100 % of starch and 100% PHBV [18]. When it is buried in the soil, the potato starch is consumed which makes the composite to degrade [19]. When the PVA composites are exposed to the Aspergillus niger fungus, the SEM images show the fungal [20]. Between PCL/starch and PCL/clay/starch composites, PLC /Starch composites degrade easily and the clay content becomes more recalcitrant to degradation. [21].

2. Bio Degradation

Water accumulates in the composite on moisture absorption. This water in the composite is in two forms, one is free water which can travel through micro voids and cracks, and the other one is bound water which is attached to polar groups of the polymer. Excessive water absorption makes more bound water in the composite. This water penetrates into the cellulose network of the fiber and spaces between the fibrils.. This may cause surface crazing, osmotic cracking and matrix micro cracking. The voids in composites increase with time at the interfacial regions of fiber and resin.

3. Materials and methods

3.1. Materials:

All the materials are taken from medical suppliers to ensure the absence of fungus or bacteria. All the composites are prepared approximately 40% of resin and 60% fiber.

3.2. Preparation method of composite laminates:

All the composite laminates are prepared by hand layup process. The composite laminate prepared by