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Nano Green Composites- An Overview

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Abstract

This paper presents an over view on completely biodegradable composites also called green composites. Recent trends in development of new materials are more focused on eco-friendly materials, in order to overcome degradation problem material scientists finding newer materials which are alternative to synthetic conventional materials. Natural fibers from plant and animal sources are extracted and used as reinforcement, biodegradable matrix like natural starch; natural gums were used to prepare composite materials. To achieve higher strength fibers/matrix/filler materials were used in nano size. Most of structural components were fabricated using Nano composites for different applications like automobile, packaging, etc. this paper presents an overview of preparation of nano composites in terms of processing and mechanical properties.
Keywords: Natural fibers, Nano composites, matrix, reinforcement, mechanical properties.

INTRODUCTION

Composites materials are classified into three major types: polymer matrix, metal matrix and ceramic matrix composites. Among these wide range of products are developed in polymer matrix composites due ease of fabrication, flexibility, cost etc,. For the Developments of polymer based composites most of the industries were used synthetic matrix which is based on petroleum products. One of the main draw backs of these synthetic polymer composites are non biodegradable which increases landfills there by polluting environmental problems.
To overcome these ecological issues researchers over the globe are finding newer materials which are biodegradable in nature also satisfying the needs of the product strength. Most interestingly all the materials which are called biodegradable composites or green composites were developed from natural resources, i.e fibers and matrix which are derived from plant or animal sources.

Properties of the composites are governed by properties of matrix and fibers, recent advancement in natural fiber composites are extended till nano scale to improve the properties of biocomposites.

Bio-fibers are renewable fibers that can be obtained from plant, animal and mineral resources and are used as reinforcing materials in development of green composite. The classification of bio-fibers based on their origin is shown in Table 1.

Table 1 Classification of bio-fibers

Bio Fibers	*Examples*
Animal fiber	Wool/hair—sheep, camel, rabbit hair goat hair, yak, horse hair, Silk
Mineral	Asbestos, wollastonite
Plant fiber	Stalk fiber—bamboo, wheat, rice, grass, barley, corn, maize, oat Fruit fiber—coconut, betelnut Seed fiber—cotton, oil palm, kapok, alfalfa Leaf fiber—sisal, banana, palm, date palm, pineapple, henequen, agave Bast fiber—hemp, jute, banana, flax, kenaf sugarecane, ramie, roselle

Reproduced from Refs. Mohanty et al. (2002), Holbery and Houston (2006), Thakur et al. (2014) ref [2-4]

Most of Bio polymers are prepared from natural sources, in a recent development some of them are chemically modified for tailor made results. Some of the commonly used biodegradable matrix are poly lactic acid, poly hydroxyl butyrate, starch etc. in these most of the bio composites are prepared from poly lactic acid (PLA).

In this paper the discussion is restricted only about the green composites which are developed using poly lactic acid.

Literature review on PLA based composites.
Several papers and research works are reported on biodegradable composites. In this study green composites developed using PLA are discussed with respect to their mechanical, thermal properties. PLA is one of the families of aliphatic polyesters made from α-hydroxyl acids. PLA is derived from agricultural sources, mainly corn and sugar cane; it has excellent biodegradability and compost ability. Moreover, the strength and modulus of PLA are fairly high. The glass transition temperature of PLA is between 50°C and 70°C, thus, the PLA polymer is stiff and brittle at room temperature, the melting point of PLA polymer is variable in the range from 130°C to 230°C [5].

Hemp –PLA composites

Hu and Lim investigated [6] the mechanical properties of hemp-PLA composites, the tensile strength, elastic modulus and flexural strength decrease as fibre content increase. Due to the poor fibre wetting at high fibre content, this is due to the insufficient resin fraction to wet all the fibre surfaces.

Sawpan et al. successfully evaluated the fracture toughness of hemp-PLA composite by single-edge-notched-bending test. The fracture toughness of the composite is lower than the neat PLA and decreases with the increase of fibre content. This could be caused by the increased stress concentration and PLA matrix crystallinity [7]

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Sisal fiber –PLA composites

Wu investigated mechanical properties of Short sisal fibre reinforced PLA composites by varying fibre content (10 - 40 %). The samples of composites were prepared using melt blending followed by hot compression [8]. It is observed that the tensile stress decreases with the increase of fibre content. It was also found that the sisal–modified PLA (acrylic acid-grafted PLA) composites have significantly higher tensile stress at break than the unmodified PLA at the full range of fibre contents. This could be due to the improvement in the interfacial bonding through covalent linkages between fibre and matrix or hydophobisation of the cellulose surface [9].

Banana fibre–PLA composites

Banana fibre–PLA composites were developed by shih et al.,using melt blending method[10]. The tensile, flexural and impact properties of silane treated and untreated banana fibre-PLA were assessed. Both treated and untreated composites have higher tensile and flexural properties but lower impact strength than the neat PLA matrix. Moreover, the treated banana fibre-PLA shows higher tensile and flexural strength, and elongation at break compared to the untreated composite

Nano fibers/filler with PLA matrix.

Eng et al investigated dynamic mechanical properties of bio composites which has prepared using Nano clay PLA/PCL/oil palm fibers. The stiffness and storage modules of composites increased due to presence of Nano clay [11].

Hong and Kim investigated on PLA/cellulose/ Nano whiskers reinforced composites which was prepared from melt molding technique, the dynamic mechanical properties was evaluated. It is found that storage modulus were increases due to presence of Nano whiskers [12].

CONCLUSION

Out of many biopolymers availability only PLA is focused in this paper because easily available in market, low cost and easy to process. There is many other bio polymers like cellulose, starch and lignin etc, are being using from many researchers for various applications. Utilization of Nano size particles in biodegradable composites has some future potential especially in drug delivery system.

Incorporation of natural fibers/fillers in the form of Nano particles for the preparation of biodegradable composites will increase mechanical properties which is well suited for single use materials where low load application serves. Overall the biodegradable composites or Green composites are environmental friendly.

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