SAPC2021
International Conference on Sugar Palm and Allied Fibre Polymer Composites 2021

INVITED SPEAKER 3

PROGRESS IN PLANT FIBER REINFORCED POLYMER COMPOSITES

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ABSTRACT

Environmental awareness across the world has motivated researchers to focus their attention on the use of cellulosic fiber as reinforcement in polymer matrices. Lignocellulosic fibers are an abundantly available resource in all countries, which is cheap and easily renewable. Also, due to their properties, cellulosic plant fibers exhibit a great potential for use in polymer reinforcement. As a result, considerable research and development efforts have been directed towards the use of cellulosic fibers as a reinforcing material in composites. The use of cellulosic fiber reinforced composites has continuously increased during recent years, which benefits the cultivation of fiber plants and the economy of the country. This research area continues to be of interest to both industry and academia, the use of cellulosic fibers in composite applications being investigated throughout the world. Cellulosic fiber reinforced composites are reasonably strong, lightweight, harmless to human health and the environment, and biodegradable, hence they have the potential to be used in various applications. Recent progress in cellulosic fiber composites research has illustrated their great potential as structural components in automobiles, aerospace structures, construction, and building, and so forth. This study is an effort to create awareness about the research works that have been published in the field of natural fiber composites. This short review briefly illustrates the main paths and results of major research published in the field of natural fiber reinforced polymer composites.

Keywords: Plant fiber, polymer composites.

INTRODUCTION

Natural materials are play an important role in the advancement [1], [2]. As a result, breakthroughs in biomaterials have influenced progress of mankind. Plant fibers are the oldest known fibers that people have cultivated and made, evoking their civilization and journey [3-5]. Plant fibers are widely accessible as agricultural crops in tropical locations. These plant fibers are extremely light, renewable, and cost-effective. Also, abundant availability and accessibility of plant fibers are the primary drivers of a growing interest in sustainable technologies. The investigation on plant fibers has accelerated in recent years, which could lead to a diversification of fiber sources as well as a reduction in material costs [6]–[8]. Because of the recent drop in fossil fuel output and increased environmental consciousness, the exploitation of natural fibers from plants has sparked a lot of interest and has become a critical topic. Plant fibers benefit both the industrial and rural economies in terms of economic and social benefits. Plant fibers have significant future growth potential due to strong market demand for environmentally sustainable materials, and government legislation requiring eco-friendly items. Plant fibers are made up of cellulose, hemicellulose, lignin, and pectin, which are bonded together by wax and other impurities, as well as moisture. Plant fibers can be extracted from stems, leaves, fruits, seeds, straws, and other parts of the plant [9]–[12]. Cellulose is defined as a non-branched macro-molecule containing chains of variable length of 1–4 linked β-danhydroglucopyranose units. It provides strength, stiffness, and structural stability to the fiber. Along with cellulose, one of the imperative constituents of natural cellulosic fibers is hemicellulose, which is the second most abundant family of naturally occurring polymers [12], [13]. Among the constituents of the cell wall, lignin is a highly branched polymer. It has been found to serve as matrix material in plants, along with hemicellulose, embedding cellulose fibers. Fiber extraction is a crucial step in fiber research that involves using proper techniques to remove or separate fibers from their source. The most commonly used chemical treatments are presented in Figure 1. For fiber extraction, mechanical, chemical, and retting processes are utilized, with the method chosen based on the type of plant material. Being hydrophilic, for preparing composites, natural fibers must first be treated to make them more compatible with hydrophobic thermosets and thermoplastics [14-18]. Chemical treatment of natural fibers allows reducing their hydrophilic characteristics. Surface treatments can lead to improved adhesion between

Article history:
Received: 30 November 2021
Accepted: 1 December 2021
Published: 11 December 2021

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ISBN: 978-967-26474

the surface of the fiber and the polymer matrix. A variety of chemical and surface treatments have been reported by many researchers [19]–[22].

BIOCOMPOSITES

The plant fiber reinforced polymer composites are called as "Green composites" or "Biocomposites" that may be simply discarded after usage without damaging the environment or creatures, indicating their eco-friendliness. Furthermore, as people become more aware of environmental issues, development toward green composites has become a major trend in industry and society. The plant fiber reinforced polymer composites have been widely used in a variety of applications for decades, owing to their promising potentials in comparison to synthetic materials [22], [23]. To address the environmental concerns raised by the use of synthetic fibers, academics and researchers are using plant fibers as a reinforcing material in polymer composites to replace synthetic fibers that are harmful to the environment. It is believed that the share of natural fiber composites in the market of engineering materials will reach 6500 million dollars in 2021. This type of composites is claimed to offer environmental advantages, such as reduced dependence on nonrenewable energy/material sources, lower pollutant emissions, enhanced energy recovery, and end–of-life biodegradability of components. Many components in various sectors are now made from natural fiber reinforced composite materials, which are mainly based on polymers with reinforcing natural fibers, primarily, jute, flax, hemp, kenaf, wood and so forth, In the aerospace sector, components such as tails, wings, propellers and helicopter fan blades are manufactured from natural fiber composites [24], [25]. The potential applications of natural fibers in other sectors such as automotive (door frames, door shutters, window frames, mirror casings), marine (boat hulls, fishing rods), building and construction (roofing sheets, bricks, furniture panels, storage tanks, pipelines), sports & leisure goods (ice skating boards, bicycle frames, baseball bats, tennis racket, fork, helmet, postboxes), electronics appliances (laptop and mobile cases, chip boards, projector and voltage stabilizer covers), as well as in pipes carrying coal dust, in construction of weapons and industrial fans, in the manufacture of textiles, paper and packaging [25].

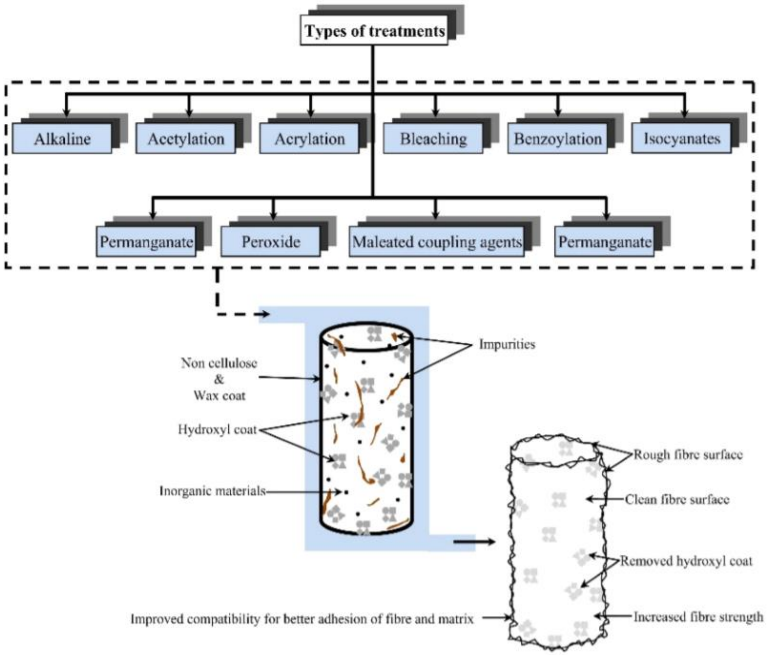

Figure 1: Different types of treatments on natural fibers

CONCLUSIONS

Plant fiber based polymer composites are utilized for a variety of applications in everyday life due to their light weight, high mechanical strength, and acoustic and thermal insulation properties. Plant fiber based polymer composites are increasingly being used in a range of applications, including construction and building, locomotives, furniture, and the packaging industry. Plant fiber composites still have several limitations, such as moisture sensitivity and low tolerance to harsh operational circumstances, which restrict their service life. As a result, there is a a significant effort to expand the use of plant fibers in other industries such as maritime, wind energy, aircraft, sports and recreation, and so on. Green materials are the future trend, and plant fiber is a big part of it. More research should be focused on getting better properties.

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ISBN: 978-967-26474