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Research Article

Synthesis and Characterization of Cellulose from Green Bamboo by Chemical Treatment with Mechanical Process

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Bamboo cellulose was prepared by chemical process involving dewaxing, delignification, and mercerization process. Four samples namely, green bamboo fiber (GBF), dewaxed bamboo fiber (DBF), delignified bamboo fiber (DLBF), and cellulose fiber (CF) had been analysed. FTIR and TGA analysis confirmed the removal of hemicellulose and lignin at the end stage of the process. FTIR results reveal that the D-cellulose OH group occurred at 1639 cm^{-1} region. SEM micrograph showed that mercerization leads to fibrillation and breakage of the fiber into smaller pieces which promote the effective surface area available for contact. Barrer, Joiyner, and Halenda (BJH) method confirmed that the effective surface area of CF is two times larger compared to GBF. CF showed the highest activation energy compared to GBF. It indicates that CF was thermally stable.

1. Introduction

In recent years, many research works have been performed on the use of cellulose fibers as a reinforcing material for composites. This is mainly due to their high strength and stiffness combined with low weight and biodegradability. Application of cellulose nanofibers in polymer reinforcement is a relatively new research field [1]. Cellulose fibers are the most abundant renewable raw material for composite fabrication. According to Habibi et al. (2010), annual production of cellulose is more than 7.5×10^{10} tons [2]. Regardless of the sources, cellulose consists of high molecular weight homopolymer of β-1,4-linked anhydro-D-glucose units. The repeat segment is a dimer of glucose called cellobiose [3].

Cellulose fibers have certain disadvantages including quality variations, moisture absorption, and poor compatibility with the hydrophobic polymer matrix. Lack of good interfacial adhesion, low melting point, and poor resistance towards moisture limit the usage of plant cellulose fiber. Therefore, pretreatment is needed to modify the fiber surface. Chemical pretreatment limits the moisture absorption process and increases the surface roughness [4]. Among the various pretreatments available, acetylation, mercerization, peroxide, benzoylation, graft copolymerization, and bacterial cellulose treatment are the best methods for surface modification of fiber. For instance, mercerization leads to breaking down fiber bundle into smaller fibers. This treatment also effectively removes lignin and hemicellulose. Mercerization increases the number of possible reactive sites and allows for better fiber wetting [4]. As a result, mercerization had long lasting effect on the mechanical properties of fibers, mainly on fiber strength and stiffness [5].

Surface area analysis is done by BJH method, developed by Barrer, Joiyner, and Halenda. This method is widely used to obtain mesopore volume and mesopore size distribution [6]. This method determines pore area and specific pore volume by using adsorption and desorption techniques. An adsorption isotherm is obtained by measuring the amount of gas adsorbed across a wide range of relative pressures at constant temperature (77 K) using liquid nitrogen. Conversely,