

PREPARATION AND CHARACTERIZATION OF BENZYLATED KENAF FIBER REINFORCED CELLULOSE DIACETATE BIOCOMPOSITE

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1 Introduction

In these years, polymer composites filled with nature fiber have attracted a lot of attention due to the increasing environmental problems.

Cellulose diacetate (CDA), as a cellulose derivative, has been widely used as engineering plastic in industry. As a natural fiber, kenaf is well known as a cellulosic source with economic and ecological advantages. Kenaf exhibits a low density, non-abrasiveness during processing, high specific mechanical properties, and biodegradability. In our previous research, Cellulose diacetate (CDA)/kenaf fiber biocomposites were prepared using a melting process. The incorporated kenaf fiber improved the mechanical and thermal properties of CDA[1].

However, the absence of melting properties and high hydrophilic properties limit the further application of kenaf fiber in composites because of its high degree of crystallinity and three-dimensional net structure.

In order to overcome these problems, many kinds of chemical modification, such as saline modification, esterification, and etherification, have been used to improve the thermo and mechanic properties of natural fibers[2].

In our research, kenaf was heterogeneous benzylated in aqueous solution. By introducing the large non-polar benzyl group into the cellulose material, kenaf can transform into a thermoplastic and hydrophobic one[3]. Then this benzylated kenaf fibre was compound with the plasticized CDA by Hakke mixer. The structural feature of the benzylated fibre was determined by Fourier transform infrared (FTIR) spectroscopy. The mechanical properties were investigated by a universal tensile tester (UTM).

2 Experiments

2.1 materials

Kenaf fiber was purchased from Soo Trading Co., Ltd, South Korea. Kenaf fiber was ca. 1 m in length and 1-2mm diameter, and it was ground into short fiber, 1-2mm in length and 30-40 μ m in diameter before use. Benzyl chloride (97%) was purchased by Sigma.

2.2 Benzylation of kenaf

Kenaf fiber was added into a NaOH aqueous solution with strong mechanically stirring and refluxing with water. The temperature was raised to 110°C and benzyl chloride was added into the mixture. After reaction, the products were washed and dried in the vacuum oven.

2.3 Plasticization of CDA and Manufacturing of the CDA/ benzylated Kenaf Composite

The CDA was plasticized by mixing the appropriate amounts of CDA, TA and ESO in a high speed mechanical mixer for 2 min. The mixture in zipper bag was then dried overnight in a vacuum oven. CDA and the benzylated kenaf fiber were put in a Haake mixer (Haake Rheomix 600, Germany). The mixture was then dried in an oven.

2.4 Characterizations

A Bruker tensor 27 Fourier Transform Infrared (FTIR) spectrometer was used to analyze changes in chemical structure of kenaf fiber. All samples were prepared by the potassium bromide pallet technique. CDA/ benzylated kenaf mixers were injection molded to yield a dog-bone shaped product that could be used for the mechanical tests based on ASTM D 638. The tensile strength of the sheets was measured on a universal tensile tester at a speed of 10.0mm/min.

3 Results and Discussion

Kenaf fiber was successfully converted into a thermoplastic and hydrophobic material by benzylation in aqueous alkaline solution. The FTIR spectra of the neat kenaf and kenaf benzylation for 3 h are presented in Fig. 1.

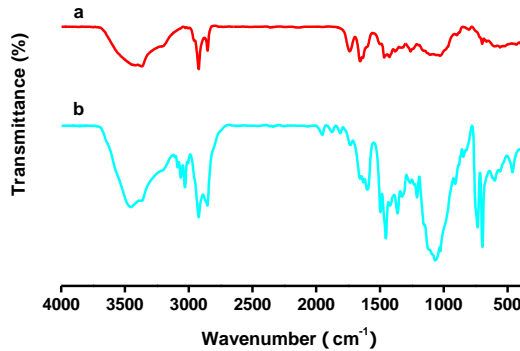


Fig.1. Infrared spectra of (a) neat kenaf fiber and (b) kenaf fiber benzylation for 3 h

The chemical structure of kenaf after the introduction of the benzyl group varied according to the reaction time. The hydroxyl vibration absorption at about 3500 cm^{-1} was decreased after benzylation, while the absorptions at $1800\text{--}1950$, 1600 , 736 and 695 cm^{-1} increased, indicating the formation of mono-substituted benzene rings[4]. The peak in the spectrum of the more highly benzylation kenaf at $1206\text{--}1207\text{ cm}^{-1}$ was assigned to the asymmetric and symmetric axial deformations of the C-O-C bonds of alkyl-aryl ethers, which were not observed for the neat kenaf.

The tensile strengths and young's modules of CDA blend with the benzylation kenaf fiber are resulted in Tab.1. The CDA/ benzylation kenaf composite is 46 MPa in tensile strength and 1849 MPa in young's module. The tensile strength is enhanced to 1.5 times than that of the plasticized CDA and the young's modulus is enhanced to 2 times than that of the plasticized CDA. This supposed to be that the outer shell of the fiber was melted in blend process which can reinforce the interfacial adhesion with CDA matrix, while the inner core of the fibers was retained so as to function as a reinforcing element[4].

Table.1. Mechanical properties of the CDA/ benzylation kenaf prepared by a Haake mixer

No.	CDA (wt%)	Kenaf (wt%)	Benzyl time (h)	σ (MPa)	E (MPa)
1	100	0	0	34	1288
2	70	30	3	51	2804

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