

EVALUATION OF GIANT BAMBOO FIBERS COMPONENTS BY INFRARED SPECTROSCOPY*

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Abstract

Due to growing concern about the ambient impacts, lignocellulosic fibers are being investigated to replace the synthetic ones in polymer composites. The giant bamboo fiber, a relatively unknown lignocellulosic fiber with potential for composite reinforcement, still needs to be characterized for possible engineering applications. However, the giant bamboo fiber has low adhesion with the polymeric matrix. In order to understand the interaction that occurs between the bamboo fiber and the polymer matrix, it is necessary to evaluate its physical and chemical characteristics. Therefore, the present work analyzed the giant bamboo fiber by means of Fourier Transform Infrared (FTIR) spectroscopy. The spectrum revealed main absorption bands typical of giant bamboo fiber specific molecular interactions.

Keywords: Giant bamboo fibers; FTIR analysis; Natural fibers.

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1 INTRODUCTION

The engineering application of lignocellulosic fibers, natural fibers extracted from cellulose-containing is presently considered an environmentally correct alternative to replace more expensive, non recyclable and energy-intensive synthetic fibers [1-3]. For the current situation of our planet, natural fibers are regarded as “green” environmentally friendly materials. They are abundant, renewable, biodegradable, and recyclable, above all, neutral with respect to carbon dioxide emission, associated with global warming and greenhouse effect.

The FTIR characterization is an important indicative on the possibility of fiber integration with the environmental and composite polymer matrices. Furthermore, FTIR could also indicate the effective transformation occurring in the fiber molecular structure due to physical and chemical treatments. Peaks of FTIR spectra are assigned to molecular contributions that permit not only to interpret possible interactions but also to determine the crystallinity index. Table 1 presents some important infrared absorption bands characteristic of cellulignin samples [4,5].

TABLE 1. FTIR Adsorption bands of lignin

Position (cm ⁻¹)	Band origin
3450-3400	O-H stretching
3050-2840	C-H stretching (aliphatic+aromatic)
1740-1710	C=O stretching (unconjugated ketone, ester or carboxylic groups)
1675-1660	C=O stretching in conjugation to aromatic ring
1605-1600	Aromatic ring vibrations
1515-1505	Aromatic ring vibrations
1470-1460	C-H deformations
1430-1425	Aromatic ring vibrations
1370-1365	C-H deformations
1330-1325	Syringyl ring breathing
1275-1270	Guaiacyl ring breathing
1230-1220	C-C, C-O stretch
1172	C-O stretching of conjugated ester groups in grass lignins
1085-1030	C-H, C-O deformations
835	C-H out of plane in p-hydroxyphenyl units

2 MATERIALS AND METHODS

The basic material used in this work was the culm of giant bamboo (*Dendrocalmus Giganteus*) supplied by a producer in the state of Rio de Janeiro, southeast of Brazil. Fibers were manually stripped off from dried culms, with a sharp razor blade. The longitudinal direction of the fiber coincides with that of the culm and corresponds to the natural direction of the bamboo cellulose fibrils. The FTIR analysis was conducted in a model IR PRESTIGE 21-FTIR-SHIMADZU. The Giant Bamboo fiber sample was prepared according to the following procedure. First, the Giant Bamboo fibers were grended in a ceramic pestle until powder, which was then mixed with KBr particles, suitable for FTIR analysis. The compound was then pressed to produce a film in the condition required for testing.

3 RESULTS AND DISCUSSION

The FTIR spectrum for the untreated giant bamboo fiber is shown in the Fig. 1. In this figure one notice different absorption bands in the spectra from 4000 to 400 cm^{-1} . The absorption band around 3400 cm^{-1} is certainly, Table 1, due to hydroxyl (OH) stretching vibration. According to Ibrahim et al [6], this O-H stretching may be associated with absorbed alcohols found in cellulose, hemicellulose, lignin, extractives and carboxylic acids, quoting Khan et al [7]. The absorption band around 2870 cm^{-1} is due to C-H stretching (see Table 1), a characteristic of any natural fiber. The presence of a band at about 2150 cm^{-1} could not be identified with any molecular origin. The bands at 1740 cm^{-1} and around 1670 cm^{-1} may be related to C = O stretching, as indicated in Table 1. According to Ibrahim et al ⁶, bands in these regions could be attributed to vibration of the alpha-keto carbonyl for cellulose. The Bands 1515 cm^{-1} and 1430 cm^{-1} represent a aromatic ring vibrations. Bands 1470 cm^{-1} and in the range from 1370 to 1250 cm^{-1} , Table 1, are associated with C-H deformation and lignin (syringic and guaiacyl ring breathing) as suggested by Ibrahim et al ⁶. Finally C-H and C-O deformation in Table 1 arises from ether linkage. The Band 1172 cm^{-1} , table 1, is possible C-O stretching of conjugated ester groups in grass lignins. Indeed, the present work result of giant bamboo fibers spectrum, Fig. 1, shows a relatively small O-H stretching band, 3400 cm^{-1} . On the other hand, the C-H and C-O deformation band, 1080 cm^{-1} in the present giant bamboo fiber.

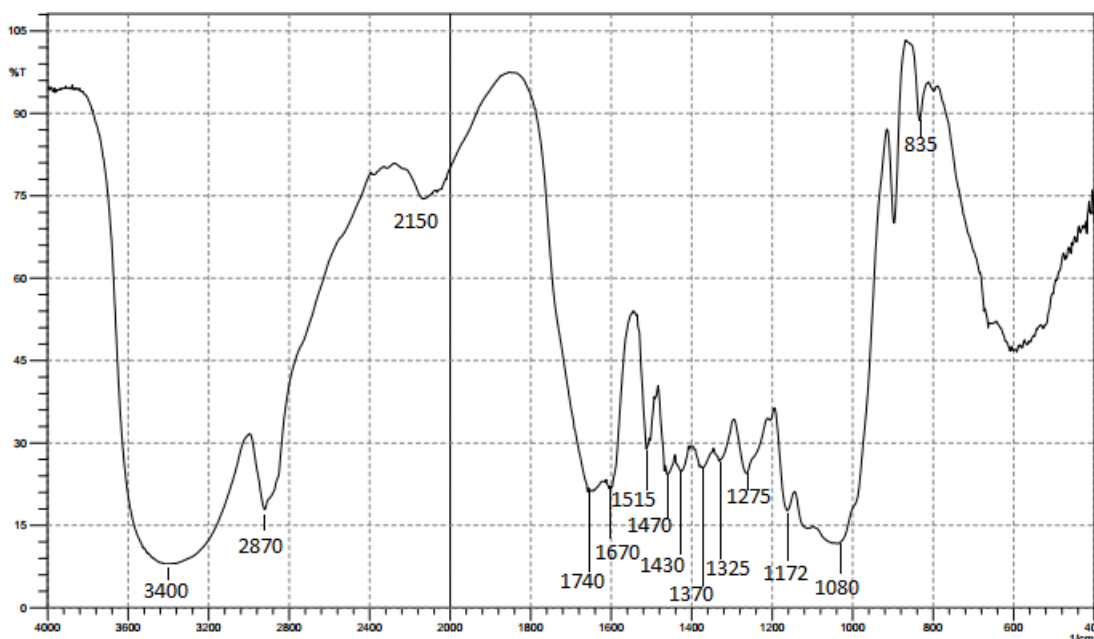


Figure 1. FTIR spectrum of common giant bamboo fiber

At this point of the present investigation, it is only possible to speculate that the relatively small O-H stretching band at 3400 cm^{-1} might be associated with limited reactive efficiency of the hydroxyl at the Giant Bamboo fiber surface. This could represent facility for water desorption as well as hemicellulose and lignin decomposition. The accentuated band at 1040 cm^{-1} might represent a difficult for ether radicals to decompose.

4 CONCLUSIONS

- A clear adsorption band at 2150 cm^{-1} for the present work was not found in the other fibers.
- The hydroxyl stretching band around 3400 cm^{-1} is relatively small. This would be associated with easier surface water desorption and hemicellulose/lignin decomposition.
- The C-H / C-O deformation band around 1080 cm^{-1} is more accentuated than the corresponding in the giant bamboo fiber waste.

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