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Characterization of Curaua Fiber

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This paper describes the chemical, thermal and thermomechanical characterization of curaua fiber. The research of the thermal and thermomechanical properties of natural fibers is of major interest, considering their increasing utilization in several applications, and the large temperature range to which the fibers are submitted.

Keywords: Curaua Fiber; DSC; TG; TMA; XRD

INTRODUCTION

There is a growing interest in the use of agro-fibers as reinforcing components for thermoplastics. Since natural fibers are biodegradable, low density, low cost, renewable, and environmentally fiendly. Natural fibers, especially curaua, have some outstanding properties so that these fibers can be used for application besides the traditional fibers (ramie, sisal, and jute).

Curaua fiber is lignocellulosic material extracted from the plant *Ananas erectifolius* - It is a hydrophilous species from the Amazon region. Its leaves are hard, erect and have flat surfaces. The leaves are about one meter long, or more, and 4 cm wide. The plant requires 2,00 mm or more of annual precipitation, preferring silil-humus soils, but also grows in clay-sillic soils. Indians commonly use it for hammocks and fishing lines. Eight months old leaves can reach up 1.5 m in length, and 50-60 leaves per year. The dry fiber

content in leaves is about 5-8%. The fiber is commonly extracted by a primitive process called "forca" (hanger), washed and beaten with a circular rod and left in water in order to mercerize for 36 hours[1]. They are again washed and allowed to dry. Curaua is very competitive among the traditional fibers, always ranking in the top three for economical analysis and top four for stiffness [2].

EXPERIMENTAL

The thermal behavior study was performed using thermogravimetric analysis (TG) and differential scanning calorimetry (DSC) techniques, between 18°C and 600°C, -50°C and 300°C, respectively, for 10°/min heating rate under air atmospheres.

The measurements of the Thermomechanical Analysis (TMA) were conducted in a helium atmosphere. The following temperature program was used at –50 - 420°C, heating rate 5°C/min. For the measurements, a single fiber and in comparation eight (bundles) fibers were taken to place in the tension sample holder. The load amounted to 5 cN.

The curaua fibers were submitted to chemical analyses. It was analyzed by standard procedures (TAPPI)[3]. Crystallinity Index values have been calculated by using the method X-ray diffraction (XRD) described by Buschle-Diller and Zeronian [4].

RESULTS

Of the curve corresponding to DSC of the curaua fiber, was observed that, a endothermic peak in approximately 173°C that can be associated the occurrence of the rupture of inter and intramoleculares linkages. Around to 270°C an endothermic peak is observed regarding the beginning of the degradation of the cellulose.

TG was used to evaluate the alterations at level of thermal stability of the samples. The results of the analyses obtained for the curaua fiber showed loss of water and of some components up to 200°C; in the range above 250°C the

beginning of the degradation of the chemistry structures of the components of the fibers followed by the carbonization, with loss of mass that vary of the range from 18 to 85%. Illustrations of the curves TG demonstrated that the limit for application of the fiber is around 225°C. Already, in the range of 250 to 400°C occurs the degradation of the cellulose [5].

Thermomechanical Analysis (TMA) have been used for evaluate the dimensional stability. of the natural fibers. The single fiber shows a thermomechanical effect at -15°C. The break onset is achieved at 315°C. In the bundle the change of expansion is missed at low temperature. Here a significant change can be observed at 220°C (onset). After another onset at 313°C, the expansion of the bundle reaches a maximum at 328°C before it drastically returns due to retraction. The break point of the bundle is at 376°C. Again the single fiber has a lower mechanical stability. Strong differences can be seen in the expansion coefficients (α). In the temperature range between -50°C to 20°C the bundles has an α of 10.57×10^{-6} while the single fiber shows an α of 38.07×10^{-6} due to big expansion at -15°C. The expansion coefficient between 20°C and the break point 328°C (bundle) respectively 325°C (single fiber) amounts to 43.41×10^{-6} for the bundle and 57.49×10^{-6} for the single fiber.

The results of the chemical characterization and of the crystallinity index of the curaua fibers are summarized in the Table I, in which the presence of a high cellulose content is verified.

TABLE I: Chemical analysis and crystallinity index of curaua fibers

Characteristics	%
Humidity	7.92
Ash *	0.79
Solubility hot water	1.03
Solubility NaOH 1%	19.3
Solubility ciclohexane:ethanol, 1:1 *	0.48
Holocellulose *	91.8
Cellulose *	70.7
Klason Lignin *	11.1
Crystallinity Index *	75.6

(*water free)

All these results showed that use of curaua fiber for composite materials or new products with new interesting properties is possible. Furthermore, agro-based countries like Brazil can have social-economical advantages with these developments.

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