EVALUATION OF THE THERMAL PROPERTIES OF LOW DENSITY POLYETHYLENE COMPOSITES WITH BAMBOO FIBERS (PEBD /BAMBOO FIBERS COMPOSITES) BY DIFFERENTIAL SCANNING CALORIMETRY(DSC) AND THERMOGRAVIMETRIC ANALYSIS

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Abstract
Considering the necessity of the development of environmentally sustainable materials and processes and the occurrence of a great diversity of bamboo species in Brazil, and the same still little used by western society, the objective of this work was to prepare and process LDPE (Low Density Polyethylene) / Bamboo fibers, evaluating the thermal and mechanical properties of the obtained composites. Composites containing 10.0, 20.0, and 30.0 wt.% of bamboo fibers were processed. The composites were characterized by thermal tests of Differential Exploration Calorimetry (DSC) and Thermogravimetry (TGA). The results of the thermal characterization showed that the obtained composites showed modifications of properties, in relation to the polymer matrix (LDPE). The work showed that it is feasible the use of bamboo fibers in composites involving thermoplastic polymer matrix and lignocellulosic fibers. The composites obtained will have applications in packages processed by thermoforming.
Keywords: *Polymer composites, polymer characterization, polyethylene, bamboo fibers.*

Introduction

Brazil has the highest diversity and highest rate of endemic bamboo forests in all of Latin America: there are 137 species, representing 32% of Latin American species, and 17 genera or 85%, with the states of São Paulo, Minas Gerais, Santa Catarina, Bahia and Paraná, have the largest diversity of bamboo forests. The Atlantic Forest is the main responsible for this diversity, ie it extends from Paraíba to Rio Grande do Sul. Relevant studies have been developed in some research centers, and interest in its application has been growing in general. However, its potential has still been little explored [1].

The study of mechanical and thermal behavior of thermoplastic composite of bamboo fiber polypropylene matrix (PP / bambo fiber, Phyllostachys Eduli) was performed by varying the average fiber size, fiber content in the composites and the use of agent compatibilizer PP-g-MA (maleic anhydride grafted polypropylene homopolymer) [2].

The use of natural fibers in commercial polymeric products, therefore, is interesting from an environmental point of view, as they are biodegradable materials originating from renewable natural resources, low cost, low density, and use in conventional processing equipment. Plant fibers, in addition to being renewable, widely cultivable materials, are non-abrasive, moldable when used in compounds, are anisotropic, porous and viscoelastic. Studies of lignocellulosic materials as reinforcements in composites with thermoplastic or thermoset matrices, enabled the production of materials for vehicles, furniture, packaging, insulating materials, gardening, agriculture and also in construction [3].

Low Density Polyethylene (LDPE) has a unique combination of properties: toughness, high impact resistance, high flexibility, good processability, stability and remarkable electrical properties, high chemical and solvent resistance and low cost and can be processed by extrusion, blow molding and injection molding. It has wide application, being used as films for industrial and agricultural packaging, films for liquid and solid food packaging, laminated and plasticized food films, pharmaceutical and hospital packaging, toys and household goods, wire and cable coating, tubes. and hoses, disposable and absorbent diapers, pads in general [4].

Considering the need for the development of environmentally sustainable materials and processes and the occurrence of great diversity of bamboo species in Brazil, being the same still little used by western society, the objective of this project was to prepare and process LDPE (Low Density Polyethylene) composites.) / bamboo fibers, evaluating the thermomechanical and structural properties of the composites obtained for the production of packaging films.

Experimental

Materials

For this work the following materials were used: Low Density Polyethylene - BF032HC from supplier Brasken, Bamboo Fibers from supplier Aprobambu - Brazilian Bamboo Producers Association.

Methodology

Composite Preparation

The composites were weighed and mixed in calander processing at a temperature 180ºC, at concentrations according to Table 1 below.

Materials	PEBD	Bamboo Fiber
PEBD	100 phr	-
PEBD + 10% FB	100 phr	10 phr
PEBD + 20% FB	100 phr	20 phr
PEBD + 30% FB	100 phr	30 phr

Table 1 - Concentration of composites in phr.

After mixing, the composites were fragmented in a knife mill and then processed in injection molding to obtain specimens.

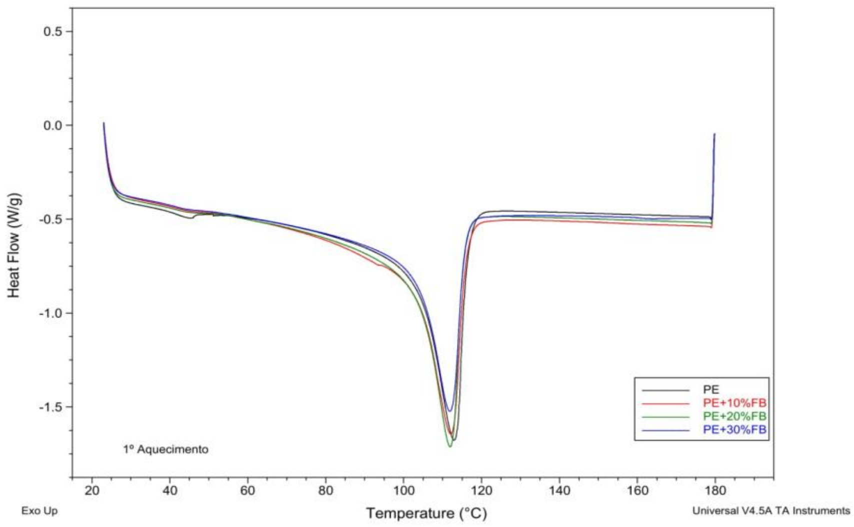
Characterization of materials and composites

Low density polyethylene, bamboo fibers, and low density polyethylene (LDPE) / bamboo fibers composites were subjected to the following tests: Thermogravimetric Analysis (TGA), with heating from 23ºC to 800ºC, and heating rate 20ºC/min; Differential Exploratory Calorimetry (DSC). With heating from 23ºC to 180ºC, and heating rate 10ºC.

Results and discussion

Differential Exploratory Calorimetry (DSC) Tests

Thermogram 1 presents the Differential Exploratory Calorimetry (DSC) tests according to ASTM D 3418.

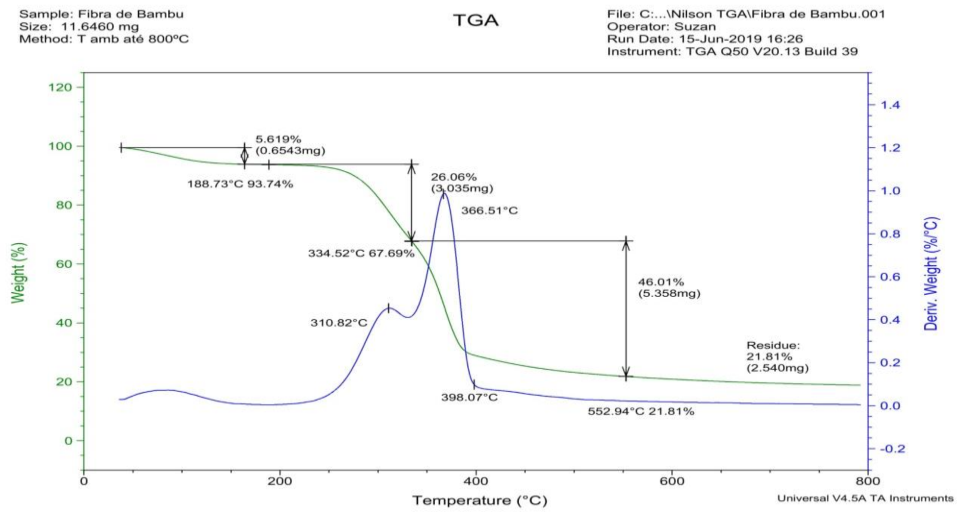


Thermogram 1 - Comparative Differential Exploratory Calorimetry (DSC) curves.

Analyzing the comparative curves obtained by Differential Exploratory Calorimetry, it is observed that the first order transition temperature of LDPE was little affected by the presence of bamboo fiber.

Results of Thermogravimetric Analysis (TGA)

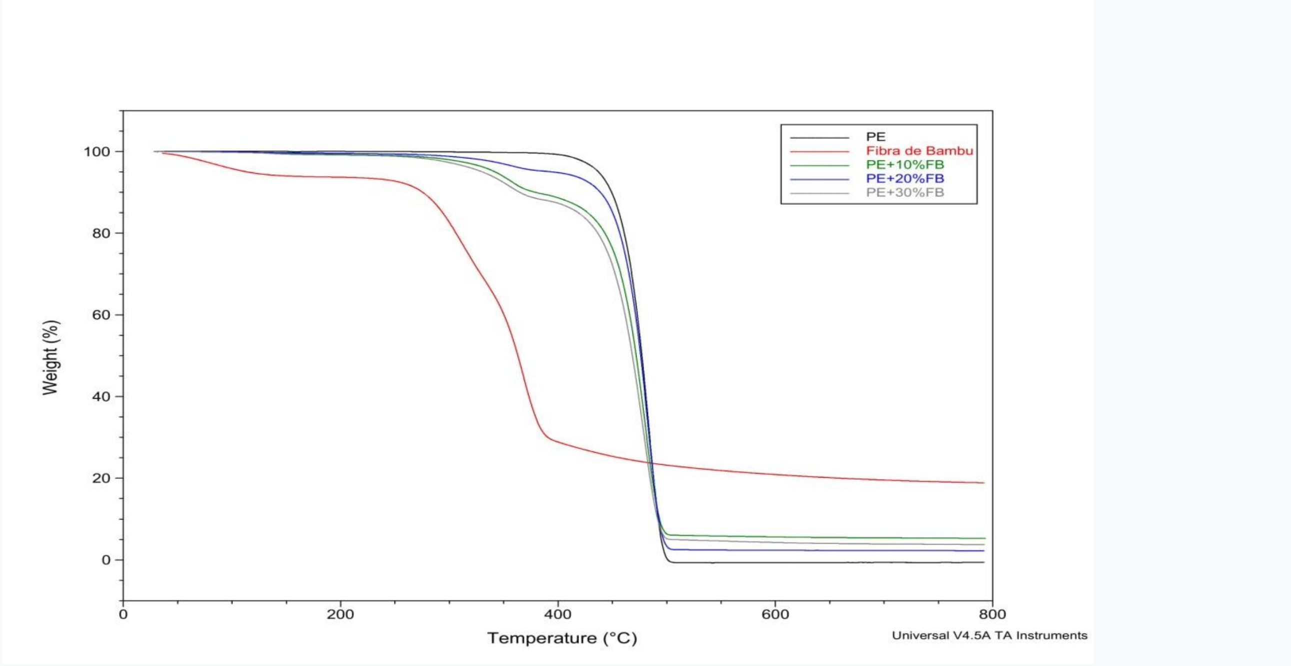
Thermogram 2 presents the Thermogravimetry (TGA), bamboo fiber test, according to ASTM D 6370.



Thermogram 2 - Thermogravimetry (TGA), bamboo fiber.

In bamboo fiber TGA it is possible to highlight two events: the first, below 100ºC, which is the mass loss related to water loss associated with fiber moisture. In the second event, there is the decomposition that indicates the presence of the three basic components: hemicellulose, cellulose and lignin. The first peak refers to hemicellulose and cellulose, and the second peak refers to lignin. The decomposition range for bamboo fiber is between 190ºC and 400ºC, with the peak temperature at decomposition around 376ºC.

Thermogram 3 presents, comparatively, the Thermogravimetry (TGA), bamboo fiber and composites tests, according to ASTM D 6370.



Thermogram 3 - Comparative TGA curves of composites.

Through the comparative curve of the thermal stability of the composites, it was observed that the incorporation of bamboo fiber did not cause significant changes in the thermal stability of the LDPE, which begins its decomposition around 340ºC, and its peak around 484ºC. With the addition of bamboo fiber, the temperature of the LDPE decomposition peak decreases by a maximum of 7ºC.

Conclusions

• Characterization results showed that the properties studied underwent changes with the presence of different concentrations of bamboo fibers in polymeric matrices (polymer composite materials).
• With increasing fiber concentration there was an insignificant displacement of the glass transition temperature (Tg) of the LDPE polymeric matrix, indicating that bamboo fibers had little effect on this property.
• It can be concluded that the tests showed changes in properties as the concentration of bamboo fiber in the LDPE polymeric matrix increased.
• TGA tests showed the thermal stability of the materials involved (LDPE and bamboo fibers) for processing at temperatures of approximately 200ºC.

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