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Evaluation of Structural, Tensile and Thermal Properties of Banana Fibers

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ABSTRACT

Recognizing the importance of properties of the plant fibers for their use in polymeric composites and nonavailability of data on tensile, thermal, and other properties of banana fibers of Karnataka (India), a study was undertaken with the objective of determining some of these properties. This article presents determination of structural aspects of the fibers by Fourier transform infrared (FTIR) spectroscopy and X-ray diffraction (XRD) techniques; obtaining stress-strain curves and tensile properties by tensile testing; finally, thermal properties by differential scanning calorimetry and thermogravimetric analysis. FTIR spectrum of banana fibers showed aromatic character, while XRD results indicated the fiber to have mainly the cellulose I structure and crystallinity index of 52%. Thermal-degradation details of fiber samples were revealed by thermal studies. Stress-strain curves of banana fibers suggested their brittle nature with moderate values of tensile strength, but low percentage elongation. Weibull analysis of obtained tensile strength values revealed variation of "characteristic strength" values from 3800 MPa at 99% reliability to 22,700 MPa with 0.01% reliability. Morphology studies revealed the number of defects along the length of the fiber, while fractured surface exhibited flat surface with intracellular fractures clearly indicating brittle nature of the fiber.

KEYWORDS

Banana fiber; chemical structure; fractography; tensile strength; thermal properties; Weibull analysis

摘要

鉴于植物纤维的性质对于其在聚合物复合材料中使用的重要性，并且卡纳塔克（印度）香蕉纤维在拉伸、热性能和其它性质方面的数据缺乏，本文进行了研究以确定其中部分性质。本研究首先通过傅里叶变换红外（FTIR）光谱和X射线衍射（XRD）技术测定纤维的结构，再通过拉伸试验获得应力-应变曲线和拉伸性能，最后通过差示扫描量热法和热重量分析获得热性能。根据试验，香蕉纤维的FTIR光谱表现出芳香特性，而XRD结果表明纤维主要具有纤维素I结构和52%的结晶度指数。通过热研究揭示了纤维样品的热降解细节。香蕉纤维的应力-应变曲线表明其脆性具有中等拉伸强度值，但百分比伸长率较低。获得的拉伸强度值的威布尔分析显示，"特征强度"值在3800 MPa条件下可靠性为99%，在22,700 MPa条件下可靠性降到仅为0.01%。形态学研究显示了沿纤维长度的缺陷数目，而断裂表面显示了平坦表面，细胞内裂缝则清楚地表明纤维的脆性。

关键词

香蕉纤维；化学结构；断裂；拉伸强度；热性能；威布尔分析

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