Colloids and Surfaces A: Physicochem. Eng. Aspects 418 (2013) 7–15

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Effect of physical adhesion on mechanical behaviour of bamboo fibre reinforced thermoplastic composites

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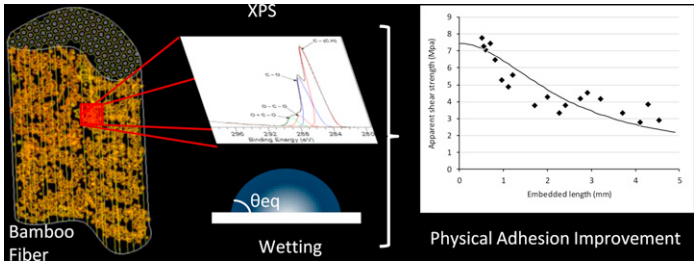
HIGHLIGHTS

- The wetting of bamboo fibres conforms well to the molecular-kinetic theory (MKT).
- Meaningful information on the interfacial interactions was obtained.
- X-ray photoelectron spectroscopy analysis was consistent with wetting measurements.
- Surface energy components of bamboo fibres and matrices were matched.
- Physical adhesion was improved as revealed by pull-out and three point bending tests.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 24 September 2012
Received in revised form 7 November 2012
Accepted 7 November 2012
Available online 16 November 2012

Keywords:
Interface
Wetting
Fibre-matrix bond
Photoelectron spectroscopy (XPS)
Bamboo
Natural fibre composites
Molecular kinetic theory
Composites

ABSTRACT

Systematic experimental results describing the dynamic wetting properties of bamboo fibres were analysed by applying the molecular-kinetic theory of wetting. Results suggest that the bamboo fibre surface represents a well-defined system for wetting analysis. The surface free energy components were calculated according to the acid–base theory. These values were then used to calculate the theoretical work of adhesion, spreading coefficient, wetting tension, and interfacial energy. The wetting behaviour of various thermoplastic matrices (polypropylene, maleic anhydride-grafted polypropylene, polyvinylidene-fluoride, and polyethylene-terephthalate) was characterized. Surface chemical components were identified using XPS. Additionally, transverse 3-point bending tests and single fibre pull-out tests were performed. This integrated physical–chemical–mechanical approach was used to study the effect of adhesion on the mechanical strength of thermoplastic composites reinforced with bamboo, showing that increase in physical adhesion can explain the improved interfacial and longitudinal strength in bamboo polyvinylidene-fluoride (PVDF) composites compared to the other thermoplastic matrices used in this study. Surface energy components of bamboo fibres and PVDF were matched, resulting in an improvement of the physical adhesion.

1. Introduction

The interaction between the reinforcing fibre and the matrix has a significant effect on the properties of the composite since the stress transfer and the load distribution efficiency at the interface is determined by the degree of adhesion between the components.

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http://dx.doi.org/10.1016/j.colsurfa.2012.11.018