Po68

Characterization of Interfacial and Mechanical Properties Between Fiber and Polymer Matrix in Composite Materials

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Introduction

The trend toward biobased materials is not only interesting in terms of environmental impact but also constitutes an alternative solution to fossil-based materials. Therefore, many scientists investigate thepossibilities to reinforce some polymers with plant fibers [1,2]. However, the poor adhesion between fiber and matrixis the major problem when applying natural fibers [3,4]. Surface modification of fibers is necessary for improving their performance [5–7]. Therefore, the use of surfactants should have a significant impact on enhancing the mechanical properties of biocomposites. Good quality of dispersion-wettability and a homogeneous distribution of fiber within the matrix, as well as the level of interfacial interaction between the filler and the polymer, are the key points for the production of polymeric biocomposites withsignificantly improved properties [8].

Experimental/Theoretical Study

The polymer used in this work is Poly (lactic acid) (2003D grade) in the form of pellets. it was procured fromNature Works LLC, USA. Alfa used was collected from the M'sila region of Algeria. The surfactant has beenkindly given by BYK-CHEMIE whose properties are reported previously [9]. Biocomposites based on PLA and 30 wt% of treated or untreated alfa fibers, were performed using a twin-screw extruder (type 5&15 micro compounder DSM Xplore method) at a uniform temperature (180 °C) and a constantscrew rotation speed (50 tr/min). The samples with 1 mm thickness were prepared by compression molding (CARVER press) at T = 180 °C and P = 1.3 MPa for 5 min.

Results and Discussion

The mechanical properties of PLA and compositesindicate that surface treatment leads to an increase in flexural modulus. Indeed, we obtained a value of 4800 MPa for virgin PLA and 4900 and 29000 MPa for the composites before and after treatment, respectively. This increase in the modulus indicates that the rigidity of the composites is increased. Since stiffness is not very sensitive to the modification of interfacial adhesion and interaction [10]. Really, it can be explained only from the change of the deformation mechanism. The rigidity and the good dispersion of fiber after treatment lead to changes in interaction and chain mobility. So, the use of the dispersing agent enhances the dispersion state of rigid fiber which prevents the movement of PLA chains and increases the modulus. This result is confirmed by SEM analysis (Figure 1). As can be seen, SEM micrographs of the treated composites (figure1.b) indicated clearly that better fiber dispersion is achieved and the clogging issueis alleviated, arising from alfa agglomerates during processing.

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Conclusion

The results indicated that the addition of surfactant had beneficial effects on the PLA/alfa composites, resulting inhomogenous load distribution and strong adhesion between the fiber and the PLA matrix. The comparative study showed that the treatment effect of fiber is more pronounced using surfactant.

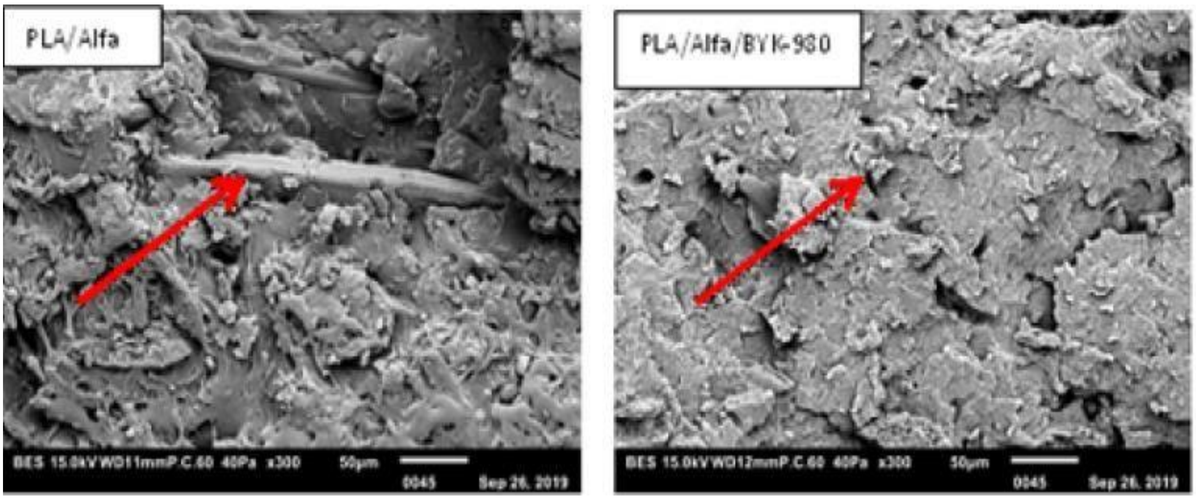

Figure 1. SEM micrographs of the fracture surface of a (PLA)/alfa composite (_50 magnification). (a) PLA alfa, (b) PLA/alfa/ BYK W-980.

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