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Synthesis of MOF-2 Particles and Preparation of PAL/PBAT/MOF Nano composites

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ABSTRACT

This study investigates the impact of incorporating MOF-2 into PLA/PBAT blends to enhance their properties. Results show increased crystallinity and improved phase morphology, indicating enhanced compatibility. Additionally, MOF-2 addition strengthens networks and reduces water vapor permeability, suggesting its potential as a compatibilizer and enhancer of gas barrier in PLA/PBAT blends.

1 Introduction

There is a growing interest in developing new biodegradable polymers to solve the problems of fossil resources and environmental pollution associated with conventional plastics. Both polylactide (PLA) and poly(butylene adipate-co-terephthalate) (PBAT) are biodegradable polymers and are thermoplastics that can be processed using most conventional polymer processing methods. PLA has high strength and modulus (63 MPa and 3.4 GPa respectively) but is brittle (elongation at break 3.8%), whereas PBAT is flexible and tough (elongation at break 710%). Given their complementary properties, blending PLA with PBAT becomes a natural choice to improve the properties of PLA without compromising its biodegradability [1-3]. However, the immiscibility of PLA/PBAT blends, as with polymer blends, results in materials with poor interfacial adhesion and hence poor mechanical properties [4].

2 Experimental

The present study describes the effect of the addition of MOF-2 on the morphology and properties of a PLA/PBAT blend containing 80 wt% PLA. Various experimental techniques including X-ray diffraction (XRD), scanning electron microscopy (SEM), rheological measurements and water vapor permeability (WVP) were used to discuss the state of dispersion of the nanofiller and its mixture.

3 Results and Discussion

X-ray diffraction analysis (XRD) showed a slight increase in the crystallinity rate of the PLA/PBAT matrix with increasing MOF-2 content, which is due to the fact that the addition of MOF-2 promotes the mobility of the PLA/PBAT macromolecular chains. From scanning electron microscopy (SEM) micrographs, it was demonstrated that the PLA/PBAT blend was an immiscible system, and the phase morphology of ternary blends was significantly improved, indicating that MOF-2 particles affect and enhance material compatibility. Ternary nanocomposites, especially those prepared with 5 and 7 wt% of MOF-2, showed an increase in the complex viscosity (η*) and storage modulus (G') at low frequencies, indicating the formation of stronger percolated networks and the achievement of a good dispersion state. Besides, the water vapor permeability of matrix drastically decreased after blending with MOF-2 which confirms the results obtained using rheological measurements.

4 Conclusions

We have successfully prepared biodegradable PLA/PBAT nanocomposite films containing (1-7 wt%)

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MOF-2 metal-organic framework using melt extrusion, followed by melts compression molding. The crystallinity rates of biodegradable PLA/PBAT blend, measured with XRD, showed an increase with increasing MOF-2 concentration. SEM observations, which show that PBAT is evenly distributed throughout the PLA matrix, verified the immiscibility of PLA/PBAT. Furthermore, by acting as a compatibilizer, the addition of MOF-2 greatly enhanced the interaction and compatibility at the interface between PLA and PBAT. Furthermore, the rheological behavior of the PLA/PBAT biodegradable blend is significantly impacted by the addition of MOF-2, leading to the formation of solid-like networks in hybrid materials. This resulted in a long

diffusion path through the nanoblend films, which significantly reduced the water vapor permeability. Therefore, we can conclude that MOF-2 is an ideal component for compatibilizing PLA/PBAT blends but also for improving functional properties such as the barrier effect to gas.

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