Dependency of morphological and mechanical performance of PLA/PBAT blends and their reactively compatibilized counterparts on the melt viscoelastic properties of blending components

Aylin Altınbay Bekem[1,2], Ceren Özsaltık[1], Yavuz Akdevelioğlu[1], Burcu Özdemir[1] Mohammadreza Nofar[1*]

[1] Sustainable & Green Plastics Laboratory, Metallurgical & Materials Engineering Department, Faculty of Chemical and Metallurgical Engineering, Istanbul Technical University, Istanbul, 34469, Turkey

[2] Metallurgical & Materials Engineering Department, Yildiz Technical University, Esenler, 34210, Istanbul Turkey

abekem@yildiz.edu.tr; ozsaltik16@itu.edu.tr; akdevelioglu@itu.edu.tr; ozdemirburcu@itu.edu.tr; nofar@itu.edu.tr

*Corresponding author email: nofar@itu.edu.tr

Abstract

The effect of processing temperature and thereby the viscoelastic behavior of blending components on the morphological and final performance of polylactide (PLA)/polybutylene adipate terephthalate (PBAT) blends has not been disclosed properly in the literature. This study examines the effect of processing temperature on the compatibilization efficiency of Joncryl chain extender (CE) in PLA/PBAT (75wt/25wt) blend systems. An amorphous PLA (aPLA) was selected as the matrix to be able to melt process at lower temperatures. In aPLA/PBAT blends with 0.5 wt% CE, the internal melt mixing processing temperatures of 150, 170, 190, and 210^{o}C were selected while the rpm and mixing time were constant. The reactivity of CE with blending components at various processing temperatures was separately controlled through small amplitude oscillatory shear (SAOS) rheological analysis. The rheological and scanning electron microscopy (SEM) analyses of each blend system was conducted along with their tensile and impact test examinations. A significant enhancement in complex viscosities of PLA was recorded specifically when processed at higher temperatures. This was due to the increased reactivity of CE with the polymer melt although the PLA thermal stability decreased at higher temperatures. On the other hand, as a polyester, although the reactivity of PBAT with CE was expected to be significant, less significant viscoelastic enhancements was observed in PBAT with CE compounds. According to the SEM images, the interfacial coherency of aPLA and PBAT increased at higher temperatures due to the easier molecular interpenetration of the blending components as well as the more efficient compatibilization effect of CE. Moreover, the CE incorporation refined the PBAT droplet size in aPLA matrix. With the increase in CE compatibilization efficiency, the impact strength of the blends also showed noticeable improvements.

Keywords: PLA, PBAT, blend, chain extender, viscoelastic properties, rheological properties