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Effect of thermoplastic starch on mechanical properties of biodegradable PBSA/TPS film

Supanut Phattarateera*[a], Ajcharaporn Aontee[b], Charinee Winotapun[c] Pramote Kumsangd, Nantaya Junsook[e], Noppadon Kerddonfag[f]
National Metal and Materials Technology Center, National Science and Technology Development Agency, Thailand Science Park, Pathumthani, Thailand
[a*]s.phattarateera@yahoo.com (Corresponding author), [b] ajcharaporn.aon@mtec.or.th, [c]charinew@mtec.or.th
[d]pramotk@mtec.or.th, [e]nantaya.jun@mtec.or.th, [f]noppadk@mtec.or.th

Abstract

This study investigates the effect of thermoplastic starch (TPS) content on the mechanical property of TPS/polybutylene succinate-co-adipate (PBSA) film. The PBSA was chosen as a major phase due to its superior mechanical properties. Due to the high price of PBSA, TPS was selected as a minor phase. The PBSA/TPS blend was prepared as a masterbatch (50:50 w/w) using a twin-screw extruder and the masterbatch was dry blended with neat PBSA resin to obtain the final PBSA/TPS blends with TPS concentrations of 5, 10, and 20 wt%. The processing parameters were precisely controlled to obtain a total film thickness of 0.030 mm. During the blowing film process, all PBSA/TPS blend exhibited stabilized film bubbles with "pocket" shape similar to that of LDPE, whereas neat PBSA showed a less stabilized, long-stalked bubble. It was noticed that the addition of TPS led to an improvement of bubble stability. The SEM micrographs revealed an incompatibility between TPS and PBSA but a well-dispersed TPS domain in the major PBSA matrix in all film compositions. From DSC results, the crystallinities of PBSA matrix phase of all samples did not significantly affect by blending with TPS. Meanwhile, the tensile moduli of all PBSA blends did not changed from that of neat PBSA. With small TPS content of 5 wt %, the PBSA/TPS film exhibited an improvement of tensile strength at yield point compared with that of neat PBSA (37±1 MPa and 24±1 MPa, respectively). With higher TPS content of 10 and 20 wt%, the tensile strength of PBSA/TPS film dropped to 33±2 MPa and 26±1, respectively. The migration of small molecules, which acted as plasticizers, from TPS to PBSA phase could lead to a lower mechanical strength. In addition, the elongation at break of TPS/PBSA films declined significantly with increasing TPS contents. Thus, a TPS content of 10 wt% is an optimal level recommended balancing between cost saving and overall mechanical properties of TPS/PBSA films and lends themselves to single-use packaging applications.

Keywords: TPS, PBSA, mechanical properties, OTR