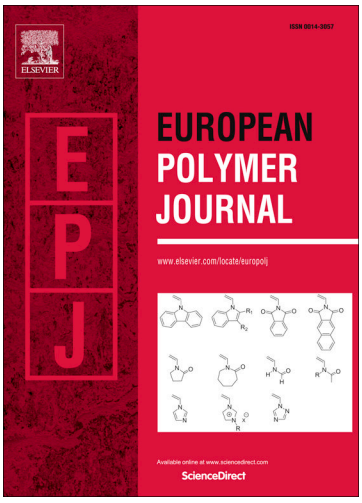

Effect of toughening agents on the properties of Poplar Wood Flour/Poly (Lactic Acid) Composites fabricated with Fused Deposition Modeling

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Effect of toughening agents on the properties of Poplar Wood Flour/Poly (Lactic Acid) Composites fabricated with Fused Deposition Modeling

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Abstract: This study was aimed at improving the toughness and interfacial properties of poplar wood flour/polylactic acid (PLA) composites by Fused Deposition Modeling. The effect of toughening agents was discussed. The results showed that, the addition of thermoplastic polyurethane (TPU) significantly increased the impact strength of composites by 51.31%.Comparing to other toughening agents, such as polycaprolactone (PCL) and poly (ethylene-co-octene) (POE), the compatibility between wood flour and PLA was superior when TPU was used. With the addition of TPU, the complex viscosity and the storage modulus of the composites were highly increased. The graft copolymers (GC), synthesized by free-radical melt grafting using glycidyl methacrylate as a graft monomer and dicumyl peroxide as an initiator, were used as compatibilizers in the composites. With the addition of 5wt% wood flour loading, the grafting degree of GC was enhanced by 61.54%. At a 2wt% loading of the GC, the impact strength and tensile strength of composites increased by 7.75% and 8.39%, respectively, and the interfacial adhesion of the ternary composites were improved.

Keywords: Polylactic acid, Biocomposites, Toughening Agents, Glycidyl Methacrylate Grafted Polylactic Acid, Fused Deposition Modeling

1. Introduction

3D printing is a technique of additive manufacturing (AM) or rapid prototyping (RP)[1]. The three-dimensional entities can be rapidly generated by adding layers under the computer control[2].Fused Deposition Modeling(FDM) is the most rapid diffused prototyping technology[3], which can be used to fabricate prototypes with complex structures and shapes using thermoplastics, such as acrylonitrile butadiene styrene (ABS) and polylactic acid (PLA)[4, 5]. The prototypes are built in computer-aided design software[6], and then exported as a Surface Tessellation Language (STL) file. The STL file is further sliced into a data file, made up of G-code, by layers[7] and finally sent to the FDM printing machine[8]. As a potential and environmental-friendly polymer, PLA is widely-used in the 3D printing manufacturing[9].

With the growing environmental concerns and the shortage of natural resources, biodegradable materials have become a hot topic in current research. PLA, as an important kind of aliphatic polyesters, is a biodegradable and environmentally friendly polymer[10, 11]. The monomer of PLA is