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Preparation and Properties of Polylactic Acid/MDI Modified Thermoplastic Starch Blends

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Abstract : Polylactide (PLA) and thermoplastic starch (TPS) are the most promising bio-based materials presently available on the market. Polylactic acid is one of the versatile biodegradable polyester showing wide range of applications in various fields and starch is a biopolymer which is renewable, cheap as well as extensively available. The usual increase in the cost of petroleum-based commodities in the next decades opens bright future for these materials. Their biodegradability and compostability was an added advantage in applications that are difficult to recycle. Currently, thermoplastic starch (TPS) has been used as a substitute for synthetic plastic in several commercial products. But, TPS shows some limitations mainly due to its brittle and hydrophilic nature, which has to be resolved to widen its application.The objective of the work we report here was to initiate chemical modifications on TPS and to build up a process to control its chemical structure using a solution process which can reduce its water sensitive properties and then blended it with PLA to improve compatibility between PLA and TPS. The method involves in cleavage of starch amylose and amylopectin chain backbone to plasticize with glycerol and water in batch mixer and then the prepared TPS was reacted in solution with diisocyanates i.e, 4,4'-Methylenediphenyl Diisocyanate (MDI).This diisocyanate was used before with great success for the chemical modification of TPS surface. The method utilized here will form an urethane-linkages between reactive isocyanate groups (–NCO) and hydroxyl groups (-OH) of starch as well as of glycerol. New polymer synthesised shows a reduced crystallinity, less hydrophilic and enhanced compatibility with other polymers. The TPS was prepared by Haake Rheomix 600 batch mixer with roller rotors operating at 50 rpm. The produced material is then refluxed for 5hrs with MDI in toluene with constant stirring. Finally, the modified TPS was melt blended with PLA in different compositions. Blends obtained shows an improved mechanical properties. These materials produced are characterized by Fourier Transform Infrared Spectra (FTIR), DSC, X-Ray diffraction and mechanical tests.

Keywords : polylactic acid, thermoplastic starch, Methylenediphenyl Diisocyanate, Polylactide (PLA)
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