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Reactive extrusion and in situ compatibilization of poly lactic acid and poly glycerol succinate: A sustainable way for toughening of PLA

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Glycerol is the primary co-product of biodiesel production with an estimated worldwide production of about 6 billion lbs per year by 2020. This biobased molecule is envisioned as a precursor for polymer synthesis among many other chemical syntheses which can be performed using glycerol as starting molecule. Succinic acid is a dicarboxylic acid which can now be commercially obtained from renewable resources through fermentation of biomass derived sugars. When these two monomers are combined, a biobased polymer termed poly glycerol succinate (PGS) is formed which has not yet found applications in the material science field limiting its adoption at commercial scale. In this work we have synthesized and employed PGS as a blending partner for PLA aiming to improve the tensile toughness of the blend system. The influence of the main synthesis parameters for PGS (molar ratio of reactants, monomer type and temperature of synthesis) in the mechanical behavior of PLA/PGS blends was investigated and a preferred set of synthesis conditions leading to an effective PLA toughening has been selected. Moreover, reactive extrusion has been performed utilizing free radical initiators in order to improve the compatibility of the phases in the blend. For this purpose a third monomer, maleic anhydride, was employed in the synthesis to create unsaturated poly glycerol succinate co maleate (PGSMA) polyesters which allows them to react from the unsaturation point in subsequent processing steps. It was seen that the addition of maleic anhydride as a monomer for the synthesis of PGSMA allows for the in situ compatibilization of PLA and PGSMA phases through the formation of PLA-g-PGSMA copolymers. With the in situ compatibilization effect taking place an effective toughening of PLA was achieved increasing the elongation at break of the blend from 3% for neat PLA to 150% for an 80/20 wt% PLA/PGSMA blend created in reactive extrusion mode.

Biography

Manju Misra is a professor in the School of Engineering and holds a joint appointment in the Dept. of Plant Agriculture at the University of Guelph. Dr. Misra's current research focuses primarily on novel bio-based composites and nanocomposites from agricultural and forestry resources for the sustainable bio-economy targeting the development of bio-based and eco-friendly alternatives to the existing petroleum-based products. She has authored more than 500 publications, including 280+ peer-reviewed journal papers, 24 book chapters, and 15 granted patents. She was an editor of the CRC Press volume, "Natural Fibers, Biopolymers and Biocomposites," Taylor & Francis Group, Boca Raton, FL (2005); American Scientific Publishers volume "Packaging Nanotechnology", Valencia, California, (2009) and "Polymer Nanocomposites", Springer (2014). She was the chief editor of "Biocomposites: Design and Mechanical Performance" Woodhead Publishing (2015). She was the 2009 President of the BioEnvironmental Polymer Society (BEPS). She is one of the Associate Editors of the journal "Advanced Science Letters". In 2012, Dr. Misra received the prestigious "Jim Hammer Memorial Award" in Texas, USA from the BioEnvironmental Polymer Society.

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