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Ultrafast, optimized hydrolytic depolymerization of polyethylene terephthalate using a dissolution/degradation approach

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Abstract: Directed thermo-mechano-chemical-irradiative methodologies which can permeate the significant plastic chemical resistance are central to achieving circularity in the life cycles of plastics. Here a novel combined deep eutectic solvent (DES) microwave irradiation technique for fast, high efficiency, high yield polyethylene terephthalate (PET) hydrolytic depolymerization with high amenability for sustainable industrial scalability is presented. In this work, depolymerization of PET was performed using a dissolution/degradation approach. A dual functioning DES served as the solubilizing and catalysing agent for PET alkaline hydrolysis. Microwave (MW) irradiation was utilized for facilitating the depolymerization process with high energy efficiency. The PET depolymerization process was optimized using box behnken design while studying the volume of DES, concentration of depolymerizing agent and MW irradiation time as independent variables. A percentage weight loss of PET reaching 84% was obtained in 90 seconds of MW irradiation. Various characterization techniques such as FTIR, DSC and HPLC validated the depolymerization of PET and obtained monomers (mainly terephthalic acid (TPA)). Finally, a postconsumer PET sample was also evaluated to prove that the developed dissolution/degradation approach could have practical application in market. Post analysis, the insoluble matter content was calculated to be 3.70% and the yield of pure TPA was 95.54%.

Keywords: polyethylene terephthalate; deep eutectic solvent; hydrolysis; dissolution; microwave irradiation; recycling

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