chemistry proceedings

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Abstract

Ultrafast, Optimized Hydrolytic Depolymerization of Polyethylene Terephthalate Using a Dissolution/Degradation Approach †

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† Presented at the 2nd International Electronic Conference on Catalysis Sciences—A Celebration of Catalysts 10th Anniversary, 15–30 October 2021; Available online: https://sciforum.net/event/ECCS2021.

Abstract: Directed thermo-mechano-chemical-irradiative methodologies that can permeate 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 catalyzing 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 s 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 91.54%.

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

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Citation: Attallah, O.A.; Janssens, A.; Azeem, M.; Fournet, M.B. Ultrafast, Optimized Hydrolytic Depolymerization of Polyethylene Terephthalate Using a Dissolution/Degradation Approach. *Chem. Proc.* **2022**, *6*, 7. https://doi.org/10.3390/ECCS2021-11111

Academic Editor: Vincenzo Vaiano

Published: 14 October 2021

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Supplementary Materials: The poster presentation is available online at https://www.mdpi.com/article/10.3390/ECCS2021-11111/s1.

Author Contributions: O.A.A. Conceptualization, Data curation, Investigation, Writing and reviewing original draft; A.J. practical experimenting; Writing original draft; M.A. Analysis, Data curation; M.B.F. Supervision, Validation, Writing original draft. All authors have read and agreed to the published version of the manuscript.

Funding: This project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 870292 (BIOICEP) and was supported by the National Natural Science Foundation of China (grant numbers: Institute of Microbiology, Chinese Academy of Sciences: 31961133016; Beijing Institute of Technology: 31961133015; Shandong University: 31961133014).

Institutional Review Board Statement: Non applicable.

Informed Consent Statement: Non applicable.

Data Availability Statement: Non applicable.

Conflicts of Interest: The authors declare no conflict of interest.