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Reducing our Plastic Imprint

Enhanced Biodegradation of Polyethylene terephthalate (PET) Via Microwave Assisted Green Bio-Based Deep Eutectic Solvent Pre-Treatment Technique

Muhammad Azeem* [1] , Olivia Adly[1] ,Margaret E. Brennan Fournet[1],

[1] Materials Research Institute, Technological university of the Shannon, Athlone Campus, N37 HD68 Ireland

Introduction

Most plastics degradation methods are currently inefficient and are limited by processing difficulties, quality loss and diminished value. This research focuses on the development of novel mechano-chemical disintegration processes for the breakdown of waste plastics. The outputs will be biocatalysed and used as building blocks for new polymers or other bioproducts.

Aim

The aim of the project is to use innovative green pre-treatment processes to recover lower molecular weight compounds/oligomers which will generate high performance new polymers or bioproducts.

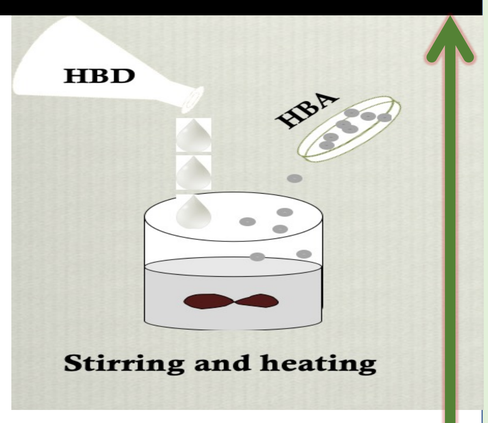
Objectives

- Utilization of environment friendly Deep eutectic solvents (DESs) based microwave technology (MW) in degradation of plastics (PET).
- To demonstrate enhanced biotransformation(using LCC variant) of PET plastics waste into monomers by developing an optimized enzymatic hydrolysis technique.

Methods

1. Synthesis of suitable DESs
(via stirring and heating at desired ratios (1:1:1))

Urea	Choline Chloride	glycerol



2. Development of efficient microwave treatment of PET powder under optimized conditions using Box-Behnken Design (BBD).

Exposure time: 90 seconds,
Power: 350 W,

3. Characterisations (Fourier transform infrared spectroscopy (FTIR), Differential Scanning Calorimetry (DSC) , Thermal gravimetric analysis(TGA)

Results

FTIR:

- Formation of new hydrogen bonds depicts successful synthesis of DES.
- Formation of OH group in oligomers which is not present in reference due to formation of chains containing OH,CH end groups.
- Reduction in peaks 1341 and 1241 depicts amorphous nature of materials as shown in Figure.1

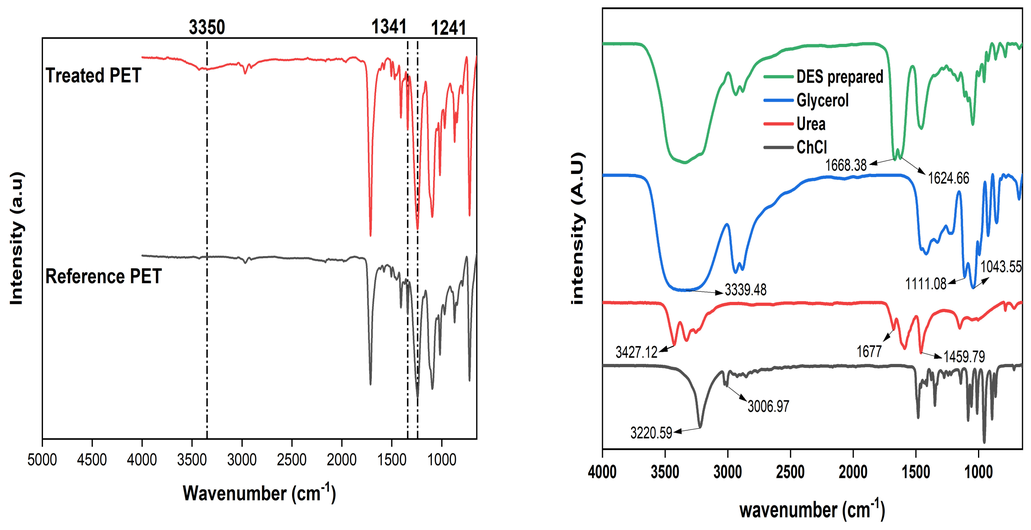


Figure 1: FTIR analysis of DES, Pure PET and Treated PET

TGA:

The reference PET has main weight loss at 395^{0}C as a result of thermal decomposition but treated PET showed a lower weight loss temp around 130^{0}C .it could be because of decrease in thermal stability depicting lower molecular weight product formation as shown in Figure.2

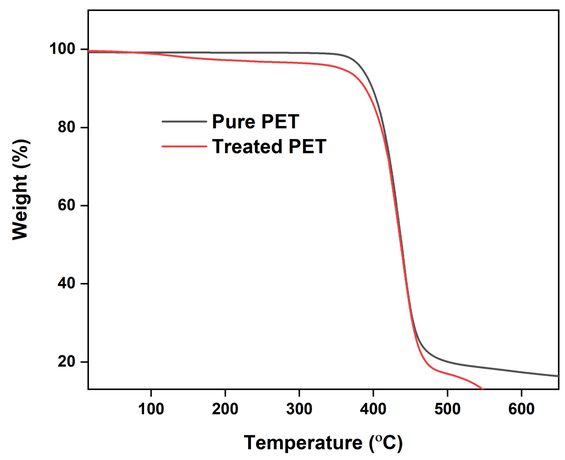
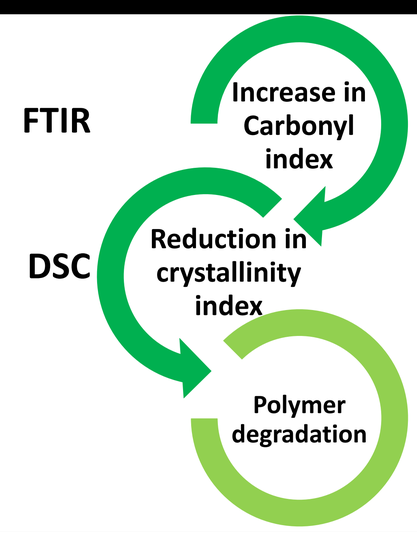


Figure 2: TGA analysis of Pure PET and Treated PET

Conclusions

- FTIR, TGA, and DSC spectra of the residual PET obtained after treatment with the microwave-assisted DES technique showed a significant increase in residual PET carbonyl index and percentage weight loss at onset temperature of degradation and reduction of PET crystallinity



Future Work

- Enzymatic degradation analysis will be carried out on treated plastics
- Effect of ultrasonication coupled with microwave will be evaluated.

References

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2. T. Aarthi, M. S. Shaama, and G. Madras, “Degradation of water soluble polymers under combined ultrasonic and ultraviolet radiation,” Ind. Eng. Chem. Res., vol. 46, no. 19, pp. 6204–6210, 2007, doi: 10.1021/ie070287+.

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Acknowledgements

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