Two-step chemolytic delamination of multilayer packaging films into valuable chemicals

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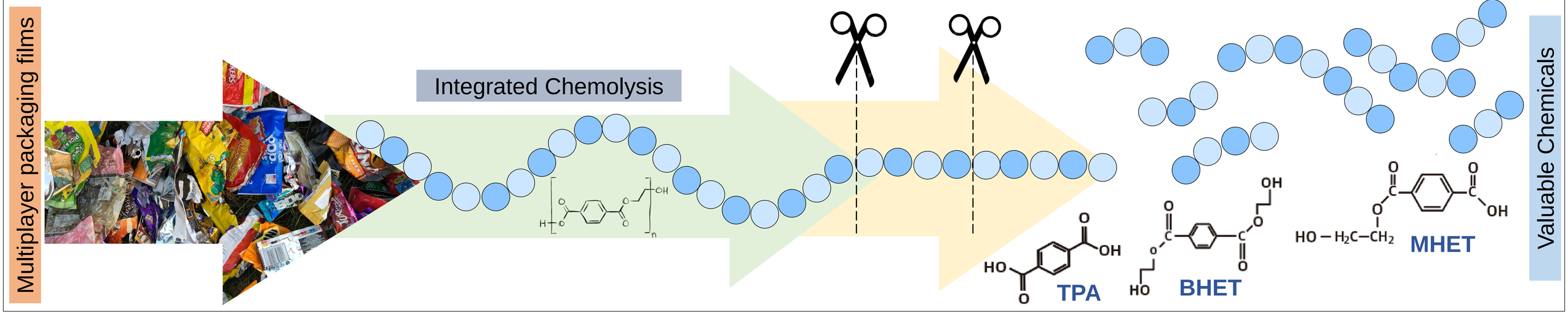
Introduction

The chemical recycling of multilayer packaging films (MPF) poses a considerable challenge due to the heterogeneity in plastic types and adhesives utilized. To address this challenge, this study used two-step integrated chemolysis to upcycle MPF. First, acids (acetic acids, formic acids, and succinic acids) were used to delaminate MPF into two layers that are made of polyethylene terephthalate (PET) or metalized PE (PE/Al). Subsequently, glycolysis is used to depolymerize the delaminated PET layer into (bis(2-hydroxyethyl) terephthalate (BHET). For higher efficiency and selectivity metal-based catalysts were utilized.



Methodology

- Acidolysis was used to delaminate MPFs into PET and PE/Al

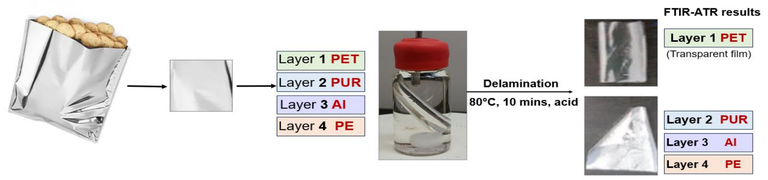


Fig 1. Delaminated films after acidolysis into different layers

- Glycolysis (with ethylene glycol) was used to depolymerize the delaminated PET film into valuable products (BHET) at 190°C for different reaction time.

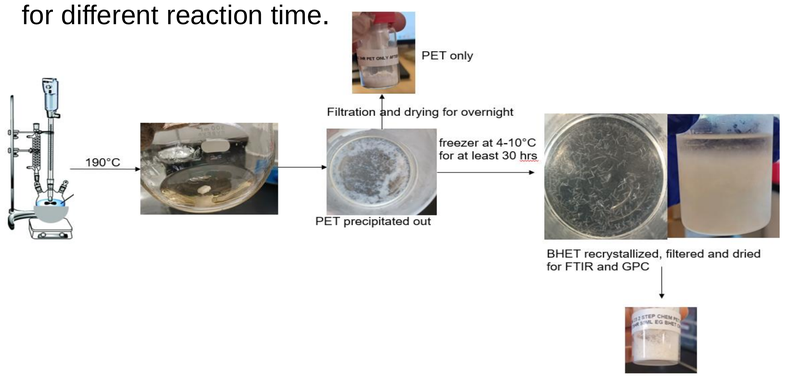


Fig 2. Glycolysis process to depolymerized delaminated PET

Results & Discussion

- Non-catalytic glycolysis leads to ~98% PET conversion with a longer reaction time (18-24 h).

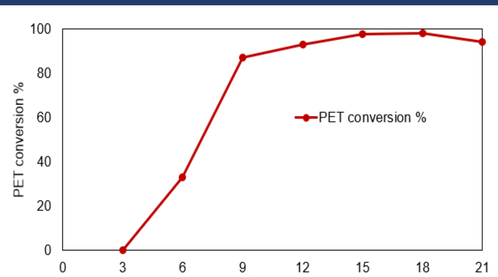


Fig 3. Non-catalytic glycolysis at 190°C for 21 h

- For higher efficiency and selectivity, zinc acetate catalyst was used at different reaction times and weight percentage loading

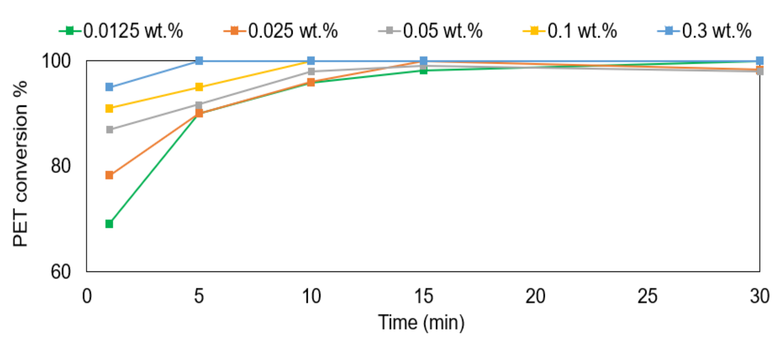


Fig 4. Catalytic glycolysis at 190°C for different reaction times

- Zinc acetate is effective in converting PET into BHET

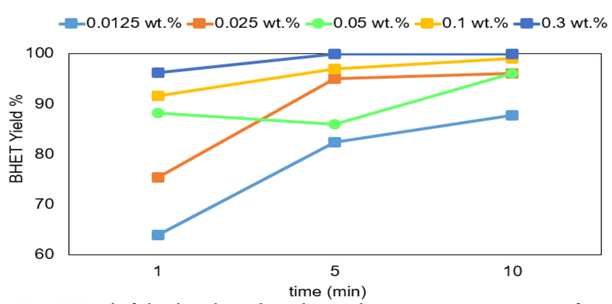


Fig 5. BHET yield obtained using zinc acetate at 190°C

- 190°C proved to be an optimal reaction condition for glycolysis

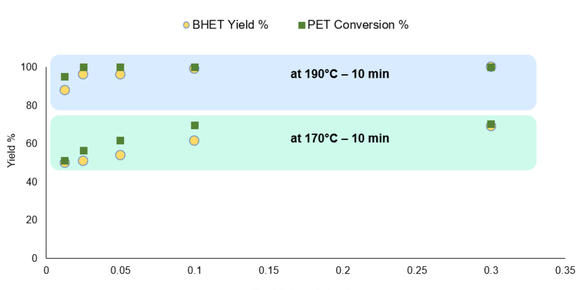


Fig 6. Effect of temperature on BHET yield and PET conversion

- Zinc acetate could be recovered and reused.

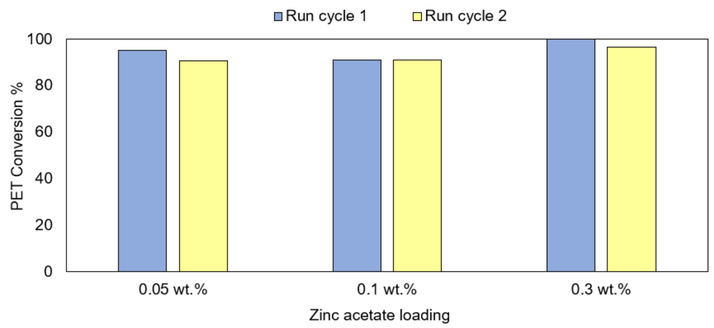


Fig 7. Zinc acetate for 2 run cycles at 190°C using recovered EG

Conclusion & Future Work

- Zinc acetate has higher conversion efficiency and selectivity towards BHET. Alongside this, other potential catalyst will be investigated for glycolysis.
- A density functional theory study is ongoing, aiming to offer a mechanistic understanding regarding the role of zinc acetate on glycolysis of PET at the atomistic and molecular levels

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