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AREA: Synthesis and characterization of catalysts and adsorbents.

Structural characteristics of CoAl materials Obtained by coprecipitation at high and low supersaturation, with application in the glycolysis of bottle-grade PET

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Abstract

The massive consumption of poly(ethylene terephthalate) (PET) polymers, especially in single-use packaging, requires waste management policies that are sometimes absent and therefore cause environmental problems. The depolymerization of PET by glycolysis with ethylene glycol (EG) in the presence of a catalyst leads to the production of the monomer bis-(2-hydroxyethyl) terephthalate (BHET), which can reduce the demand for fossil resources for the production of PET. In this work, CoAl materials were synthesized by co-precipitation at high supersaturation (a.s.) and low supersaturation (b.s.) using carbonate or terephthalate as interlamellar anions, identified as CoAl or CoAl-T, respectively. These catalysts were calcined at 400°C and identified as CoAl (a.s.)c, CoAl (b.s.)c, CoAl-T(a.s.)c, CoAl-T(b.s.)c., then they were applied in the glycolysis of PET (bottle grade post-consumer) in the presence of EG to obtain its monomer. The reaction conditions used were 0.5% catalyst: PET, EG: PET 5, at ~200°C for 60 min, as described in previous work (Arcanjo et. al. 2023). The XRD results show that a low crystallinity hydrotalcite phase was the main diffractogram pattern observed for all the materials, except for CoAl a.s.T which shows characteristics of an amorphous material, without a well-defined crystalline structure. N_2 adsorption/desorption results indicate that all CoAl and CoAl-T calcined materials are mesoporous. CoAl-T materials present an H2(b) type hysteresis loop, characteristic of materials with complex porosity, which undergo the strong influence of network effects; on the other hand, CoAl materials present H5 type loop, whose main characteristic is associated with a porosity composed of open or partially blocked pores. Textural analysis shows CoAl-T(a.s.), CoAl-T(b.s.) and CoAl a.s. presented smaller surface areas like 106 $m^2.g^{-1}$, 105 $m^2.g^{-1}$ and 103 $m^2.g^{-1}$, respectivelly, while CoAl b.s. presented a greater surface area of 125 $m^2.g^{-1}$. The application of these materials in the glycolysis of bottle-grade PET shows that the best PET conversion performances were observed as follows: CoAl-T (b.s.) (68.2%) > CoAl-T (a.s.) (62.6%) > CoAl (b.s.) (58.6%) > CoAl (a.s.) (41.2%). BHET yield and selectivity of BHET (sel. of monomer) also followed this order. These results observed in Figure 1 may be associated with the larger average pore diameter size of CoAl-T (b.s.), ~170 Å, which was higher than that observed for the other materials with pore diameters between 104 and 149 Å. Characterization of the products demonstrated that BHET was the main product obtained. ^{1}H-NMR analysis shows the main protons of BHET. DSC analysis shows a characteristic BHET melting point around 110 °C, which coincides with all the products and differs from the melting point observed for the PET at 250 °C. Future tests to improve the efficiency of PET conversion can be carried out with the inclusion of other metals in these catalysts.

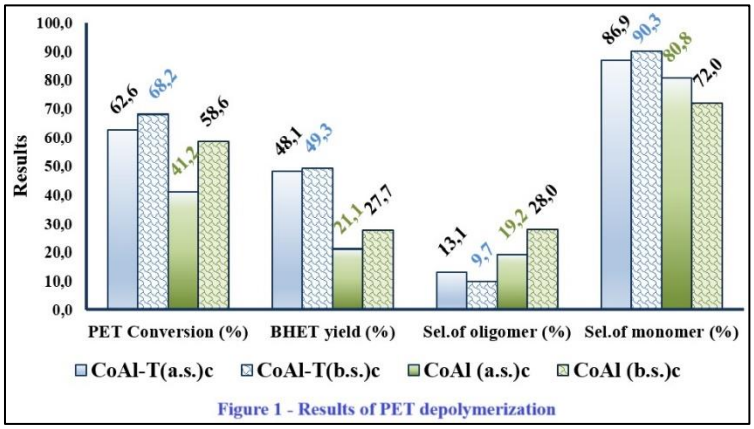

Figure 1 - Results of PET depolymerization

Keywords: Depolymerization, catalysts, glycolysis, PET, BHET.

References

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