Sciforum-195478: Heterogeneous Catalysis for the Hydrolytic Depolymerization of Poly(3-hydroxybutyrate)

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Introduction. Polyhydroxyalkanoates (PHAs) are bio-based and biodegradable polyesters considered promising alternatives to conventional plastics. Among them, poly(3-hydroxybutyrate) (PHB) stands out for its excellent barrier properties, making it attractive for packaging applications. Although PHB is biodegradable, this feature is generally regarded as an end-of-life pathway rather than a true recycling strategy. Therefore, chemical recycling into monomers represents a more effective route for achieving circularity. Despite its potential, conventional hydrolytic processes often require harsh conditions, leading to high energy demand, by-product formation, and difficult purification. Consequently, developing efficient and selective depolymerization strategies under mild and sustainable conditions is essential for enabling circular economy approaches for PHB. In this study, we investigated the catalytic hydrolytic depolymerization of PHB under mild conditions using heterogeneous catalysts.

Materials and methods. Hydrolytic depolymerisation experiments under batch conditions were performed using a stainless-steel autoclave equipped with a magnetic stirrer and a Teflon® inset at moderate temperature (far below polymer melting point) using water as solvent. An analytical protocol was established to identify the reaction product based on NMR, HPLC, GC-MS and GC-FID. Catalysts were characterized by XRD, N_2 physisorption and NH_3-TPD experiments.

Results and discussion. Several heterogeneous catalysts, including TiO_2, BEA and ZSM-5 zeolites, were screened for the hydrolytic depolymerization of PHB. Catalyst performance was evaluated in terms of PHB conversion and selectivity toward 3-hydroxybutyric acid (3HBA), the main hydrolysis product. The most promising catalysts were further investigated through kinetic studies and catalyst reusability tests. These findings highlight the potential of heterogeneous catalysis as an effective strategy for controlled PHB depolymerization and contribute to the development of more sustainable chemical recycling approaches.