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Enzymatic degradation of low molecular weight polyurethane model systems in ionic liquids

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PURPOSE OF THE ABSTRACT
The high increase in the production of a wild range of manmade polymers has become a huge threat to the environment due to their unabated disposal. The polymeric materials have very stable chemical bonds, and their xenobiotic nature marks them a rising problem all around the globe. Among them, the polyurethane family of polymers account for the highest market share owing to their high resilience, durability, and versatility which ultimately leads to the generation of huge volumes of plastic waste, posing severe environmental problems. [1] Polyurethane (PU) is synthesized from two monomers, a diol and a highly toxic and reactive isocyanate in the presence of some additives. The resulting polymer is characterized for the urethane bond in its structure, being necessary the use of severe reaction conditions (i.e. >200 °C) to obtain the depolymerization of this chemical structure. [2] Moreover, state-of-the-art chemical methods for recycling are not adequate for handling the current volumes of waste. [3]
In this work, it is proposed a new sustainable approach towards PU degradation by means of using Ionic Liquids (IL) and enzymes as catalysts. ILs are exceptional non-aqueous reaction media for carrying out both chemo- and biocatalytic processes and they also have been shown to be an excellent tool to integrate reaction and separation steps. [4] This study aimed at developing a green recycling pathway for PU by means of a PU-model system. Different enzyme families coupled with an IL/(bio)catalysts system have been assayed under mild reaction conditions. The results shown that the combination of suitable IL (e.g., [C4mim] [NTf2], [N4111] [NTf2], etc), and biocatalyst results in an excellent synergy able to break the intra-molecular urethane bond of this molecule.

FIGURES

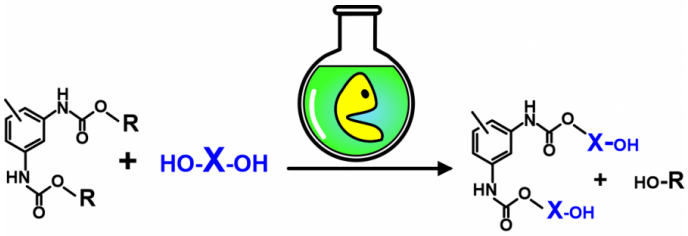

FIGURE 1

Figure 1

Schema of the degradation reaction of a polyurethane model system by using an IL/enzyme catalyst system

FIGURE 2

KEYWORDS

applied biocatalysis | ionic liquids | sustainable chemistry | polyurethane

BIBLIOGRAPHY