Chemical Recycling - Beyond Thermal Use of Plastic and other Waste
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Incorporation of Predetermined Breaking Points as a Pathway for Chemically Recycling Polyurethanes and other Plastics Materials

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Abstract

At present, more than 11 mio. t/a of polyurethanes are produced annually worldwide. Production residues and polyurethane materials at the end of their life time are recycled mostly thermally. With regard to sustainability, chemical recycling of polyurethane materials to generate new polymer building blocks would be desirable.

Conventional polyurethane materials are highly resistant to chemical degradation. After mechanical shredding, high temperatures up to 170°C and large amounts of reagents – solvents, bases, acids or other catalysts have been reported for the chemical degradation step.

We have explored the option to provide polyurethane materials with predetermined breaking points. Oxymethylene groups degrade at moderate temperatures of about 60°C unless they are kinetically stabilized against depolymerization. Oxymethylene moieties are derived from oligomerization of formaldehyde and constitute sustainable C1 building blocks as formaldehyde is obtained readily by partial oxidation of methanol from biologic origin.

Polyurethane materials comprising polyoxymethylene groups degrade in weakly basic media at temperatures around 100 °C. Such polyurethane materials degrade, thus, under much milder conditions than conventional polyurethanes. The product mixture of polyols and polyamines is readily recycled as building block into the production of new polyurethanes and other materials.

The lecture will place the technology of predetermined breaking points as a pathway for chemically recycling polymeric materials into a wider context. Opportunities and limitations will be explored.