ETH zürich

Licensing Opportunity

Bulk depolymerization of commercial PMMA

Application

Large volumes of commercial PMMA need recycling every year. The presented depolymerization method offers producers of plastics the regeneration of monomers, thus, a contribution to the circular economy. The depolymerization method works in bulk and at low temperature without compromising on quality, purity and yield.

Features & Benefits

- Batch processing
- Low temperature, thermal reaction
- Solvent free
- Compatible with a range of molecular weight materials

Publication

- "Lower-temperature bulk depolymerization of commercial polymethacrylates", *Nat. Chem.* (2026) https://doi.org/10.1038/s41557-026-02232-4
- Patent pending

transfer

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Technology Readiness Level

1 2 3 **4** 5 6 7 8 9

Background

Poly(methyl methacrylate), also known as PMMA, acrylic, acrylic glass, Plexiglas, Lucite and Perspex is found in many materials. Recyling of the plastic waste is a main goal to achieve a sustainable and resource-conserving future. Depolymerizing vinyl polymers is challenging because of their stable all-carbon backbones. Conventional methods rely on very high temperatures (>400 °C) which are energy-intensive and create odorous byproducts. Recent approaches rely on “designer polymers” and cannot be applied to commercial products or rely on high dilutions to achieve monomer regeneration.

Invention

A thermal method, operating aound 200°C, depolymerizes PMMA even with high molecular weights (1’000’000 g/mol). The radical reaction is initated by N-hydroxyimides and peroxides, which are essential components as the degradation occurs through the N-OH bonds. Multiple initiation points on the polymer backbone lead to the concurrent scission and depolymerzation. The reaction occurs in the kneaded polymer melt. The monomer directly evaporates from the polymer melt and is obtained in high purity. A reaction typically takes 2-5 hours.

No special designer polymer needs to be synthesized for the chemistry to work. The method is therefore directly applicable to commercial products such as Plexiglas®.

The method has been tested in the laboratory. N-hydroxytetrachlorophthalimide gives near quantitative yields. Alternate N-hydroximides can also be used with differing yields.