ETH zürich

Licensing Opportunity

Upcycling styrenic (co)polymers into valuable platform chemicals

Application

This method depolymerizes aromatic vinyl-based polymer waste, particularly styrenic polymers, by converting them into platform chemicals (i.e., ethylbenzene, toluene, and isopropylbenzene). Mild reaction temperatures and a transition-metal-free initiator qualify this method for polymer waste recycling and sustainable chemical manufacturing.

Features & Benefits

- Selective and high-yielding process
- Low reaction temperatures, H_2 pressures, and short reaction times
- Depolymerization initiators based on earth-abundant, low-cost, and recyclable metal hydrides such as KH/C

Publication

- Publication pending
- Patent pending

transfer

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Technology Readiness Level

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

Background

The widespread use of chemically stable styrenic polymers such as polystyrene (PS) and styrene-butadiene rubber (SBR) generates large volumes of waste that are challenging to recycle. Yet practical approaches for the chemical recycling of such polymers remain underdeveloped. High reaction temperatures and toxic, costly, and scarce transition metals are typically required for depolymerization catalysis, yielding a mixture of small hydrocarbons.

Invention

This invention relates to upcycling waste polymers into useful platform chemicals, primarily alkylated aromatics. Alkali metal hydrides act as strong electron donors to initiate, under low H_2 pressure, the hydrogenative depolymerization of styrenic polymers and copolymers. The polymer is kept with catalytic amounts of a recyclable initiator (such as KH/C) in a hydrocarbon solvent for several hours at 160–220°C under several bar of H_2. Following this reaction time, KH/C is recycled and reused, and the styrenic polymer transforms into monomeric alkylated aromatic compounds.

This method applies to various vinyl-based aromatic and heteroaromatic polymers and copolymers beyond polystyrene comprising styrene-butadiene rubber, poly(4-vinyl pyridine), and styrene-acrylonitrile resin.

The method has successfully been tested in the lab on the above-mentioned polymers and copolymers. For instance, polystyrene transforms into a ca. 6:1:1 molar mixture of ethylbenzene, toluene, and isopropylbenzene.