# CMCC Mechanochemistry Discussions

#### **Online Seminar Series**

# Mechano-Catalytic Depolymerization of Plastic Waste

## Livestreaming at 10:00 AM (CT)

## **THURS., October 17, 2024**

#### on the CMCC YouTube Channel: https://www.youtube.com/channel/UC 7eCYPKbGTKpg07W2bNABxg



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Genentech

Only 12% of plastic waste is recycled, mainly because the predominantly applied technique of melting and reextrusion produces a lower quality material. Alternatively, chemical depolymerization can produce monomers to However, depolymerization via thermal and even catalytic pyrolysis of make high-quality plastics again. commodity polymers such as polypropylene (PP) offers only low selectivities and low-value product mixtures, due to the high temperature applied, which is required for thermal C-C bond cleavage. The Vollmer Group researches several strategies to design better chemical recycling strategies using heterogenous catalysts. The focus of this lecture is mainly on the investigation of polymer conversion in a mechano-chemical ball mill reactor, which allows us to achieve conversion at room temperature instead of the more than 500 °C used in the state-of-the-art pyrolysis process. It was previously found that organic radicals can form even at -196 °C when PP is exposed to mechanical force, and this effect is exploited for plastic recycling to chemical building blocks. The Vollmer team combines mechano-chemical bond scission with heterogeneous catalysis by directly functionalizing the surface of ceramic grinding spheres to create catalytically active sites. This has led to the discovery of a new catalytic mechanism, where the activated surface of the grinding spheres can interact with the organic radicals formed by the mechano-chemical action of colliding grinding spheres. This is fundamentally different from thermal conversion using typical heterogeneous catalysts, such as solid acids, where the polymer backbone C-C bonds are activated via the formation of carbocations. The catalytic grinding spheres also allows to overcome difficulties in contacting porous catalyst materials with bulky polymer molecules that are encountered in thermal catalysis. The superiority of the catalytic spheres over catalysts is evidenced by the lack of activity of powder catalysts in the ball mill. The contact between the polymer and the catalyst surface is ensured by the repeated ball-ball and ballwall collision in the ball mill. In addition, high mixing by the ball mill action avoids clogging observed in conventional reactors because of the high viscosity of molten polymer.

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