

UPCYCLING POLYOLEFINS VIA SELECTIVE CATALYTIC CONVERSIONS

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Abstract: We are investigating catalytic materials that regulate the cleavage of C–H bonds or C–C bonds in polyolefins, to introduce functional groups at selected positions or to create narrow distributions of shorter, partially deconstructed chains. This approach, involving a collaborative team, involves the design and synthesis of 3D porous inorganic metal oxide architectures which contain catalytic sites in well-defined positions in the material, along with spectroscopic investigations and theoretical models of polymer adsorption and translocation in the pores. In parallel, we are developing catalytic sites and reactions that break C–C and C–H bonds in aliphatic hydrocarbon polymers. As these catalytic sites are incorporated into 3D architectures and studied in polyolefin deconstruction reactions, our team is developing theoretical, kinetic models and in situ spectroscopic methods for studying the ‘macromolecular’ mechanisms that influence the average chain lengths of products and the dispersity of product distributions.

Such approaches using micro or mesoporous materials can lead to processive catalysis, whereby a polymer chain is adsorbed into the pores of the inorganic oxide and is successively cleaved into smaller fragments without release of the ever-shortening polymer chain. Nanoparticles, responsible for C-C cleavage, localized in the pores at uniform distances from the pore mouth, then cleave polyolefin chains into semi-regular smaller chain lengths. We will present our studies of these architectures and catalytic reactions in the selective deconstruction of polyolefins.

Bio: Aaron Sadow is Professor in the Department of Chemistry at Iowa State University. He serves as Energy Frontier Research Center Director of the Institute for Cooperative Upcycling of Plastics (iCOUP), a Basic Energy Sciences (BES) program funded by the Department of Energy and as lead Principal Investigator in the Catalysis Research Program at Ames Laboratory. Sadow earned a B.S. from Penn State in 1997 working with Ayusman Sen on polyester synthesis and a Ph.D. in chemistry from the University of California, Berkeley in 2003, where he worked with T. Don Tilley developing new catalytic organometallic methods for organosilane polymerization and methane utilization. He worked as a postdoc at the Swiss Federal Institute of Technology (ETH Zürich) with Antonio Togni on asymmetric phosphination before initiating his independent career as a scientist at Iowa State and Ames Laboratory in 2005. His expertise includes homogeneous, and surface organometallic chemistry, polymer chemistry, asymmetric catalysis, and rare earth chemistry.