Mechanically Tough, Recyclable Polymers (Nov 2015)

The Center for Sustainable Polymers represents a unique environment for collaborative research, allowing researchers from University of Minnesota, Cornell University, and the University of California, Berkeley to combine their broad expertise to tackle significant challenges in addressing challenges in polymer chemistry. Due to the ubiquity of polymers in everyday life, this drive toward sustainability represents an essential challenge, which requires highly collaborative research to optimally address.

Thermosets are a class of polymeric materials used in everyday life for applications requiring mechanically strong and durable materials; however, nearly all commodity thermosets are non-repairable, thus, they must be disposed of after failure and are generally considered non-sustainable materials. Therefore, the drive to develop materials with similar strength that can be recycled represents a significant challenge in the field of polymer science. To develop materials that satisfy these challenging demands, researchers in the Center for Sustainable Polymers have developed a class of cross-linked polyhydroxyurethanes that demonstrate mechanical properties competitive with traditional thermoset polymers and can be recycled simply via compression molding at elevated temperatures. Inspired by an emerging class of materials known as vitrimers, the researchers developed a novel route to polyurethanes that contain dynamic bonds at elevated temperatures, and importantly, they avoided the use of toxic isocyanate monomers traditionally used in polyurethane synthesis. Professor William Dichtel and graduate student David Fortman of Cornell University utilized their experience in organic synthesis and networked organic materials to develop efficient conditions for the synthesis of these unique materials. To fully characterize the resulting materials and analyze their recyclability, the team relied on the polymer characterization expertise of Professor Marc Hillmyer and graduate student Jacob Brutman of the University of Minnesota. Materials of this nature are often difficult to fully analyze experimentally; therefore, Professor Chris Cramer of University of Minnesota added theoretical insights to allow for a better understanding of the chemical processes that underlie the recyclability of these materials. These findings (DOI: 10.1021/jacs.5b08084) have been highlighted as a spotlight article by the Journal of the American Chemical Society (DOI: 10.1021/jacs.5b11738), indicating the broad appeal; the collaborative Center for Sustainable Polymers environment will allow for further exploration of similar materials to expand upon these exciting results.

J. Am. Chem. Soc. 2015, DOI: 10.1021/jacs.5b08084
http://pubs.acs.org/doi/10.1021/jacs.5b11738