Appl. Chem. Department Seminar

九州大学
分子システム科学センター（CMS）
Center for Molecular Systems（CMS）
Kyushu University

Electrochemical Polymer Upcycling and Mechanofluorescent Materials: Molecular Design for Sustainable and Functional Polymer Systems

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Abstract: The development of next-generation polymer materials requires strategies that address both sustainability and advanced functionality. In my lecture I will first focus on our recently disclosed strategy for electrochemical upcycling of poly(vinyl chloride) (PVC), one of the world's most widely used yet environmentally challenging commodity plastics. We have developed paired electrochemical strategies that combine cathodic PVC dechlorination with anodic synthesis of cyclic halo acetals, efficiently converting liberated chloride into valuable molecular building blocks. These intermediates provide access to previously inaccessible cyclic ketene acetal monomers, which can be polymerized via radical ring-opening polymerization to afford functional, biodegradable polyesters and poly(amino esters). By integrating polymer recycling with synthetic monomer production in a single undivided electrochemical process, this work establishes a sustainable platform for simultaneously valorizing plastic waste and expanding the toolbox of degradable polymer materials.

The second part highlights the development of mechanofluorescent elastomers capable of reporting local mechanical forces through reversible changes in molecular conformation. We have designed a non-scissile ureido-benzoxazole mechanophore that undergoes force-induced excited-state intramolecular proton transfer (ESIPT), producing a reversible fluorescence response during mechanical deformation. Combining spectroscopy, optomechanical experiments, and molecular simulations reveals that mechanofluorescence originates from subtle changes in local chain mobility and to a smaller extent force transduction through the polymer backbone. These findings establish a mechanistic framework for conformational mechanophores and provide new opportunities for non-destructive imaging of stress distributions in soft materials. This work is carried out within the framework of the Collaborative Research Centre *Defects to Effects in Soft Matter*, where we investigate how structural defects and local heterogeneities govern macroscopic material properties.

Together, these examples illustrate how fundamental concepts in synthetic, supramolecular, and polymer chemistry can be combined to address pressing challenges in sustainable materials science while creating functional polymers with emergent properties for future applications.