Designing conjugated polymers for visible-light-driven photocatalysis

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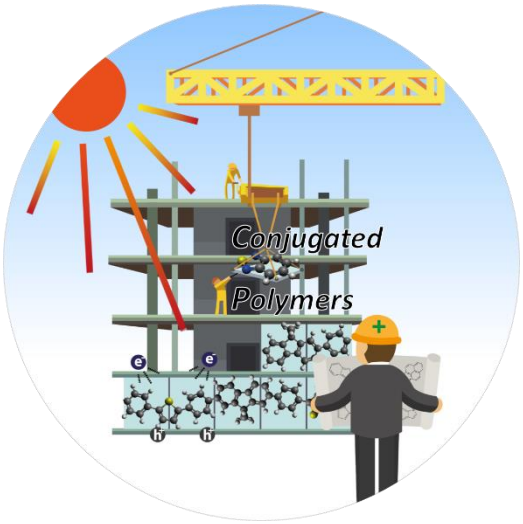

Conjugated polymers (CPs) have emerged as a new class of organic heterogeneous photocatalysts for visible-light-mediated photoredox reactions. The CPs have been established as a potential alternative to resolve critical drawbacks of traditional molecular photocatalysts due to their structural durability, non-toxicity by the absence of metals, and designability. In this talk, I will present how we engineer the band structures and wetting properties of CPs for targeted applications. Via a typical donor (D)-acceptor (A) combination, the redox potential of CP could be systematically aligned to tackle highly demanding reactions such as visible-light-induced C-C bond formation by reductive dehalogenation. The D-A modulation further allowed asymmetric multi-domains in a single CP, leading to enhanced charge separation by intramolecular energy transfer. Along with the band engineering, we approach the wettability control of CPs by the side-chain functionalization. A linear chain CP can be designed to have different terminal groups such as amine and ionic liquid (IL) for initiating a reversible wettability change. For instance, the amine-based CP exhibited reversible hydrophilicity using CO_2 molecules as an external stimulus. In the case of IL-terminated CP, the polymer chain could have a latent reactivity to transform into nanoparticles, membranes, and hydrogels through free-radical polymerization, providing a series of photocatalytic platforms. A simple anion exchange on the IL position allows the switchable wettability of the platforms. This talk will provide a general design concept to fine-tune the structure and property of CPs for targeted photocatalytic chemical transformations under visible light.

Selected publications:

1. Solar-driven H_2O_2 production via cooperative auto- and photocatalytic oxidation in fine-tuned reaction media, *Energy Environ. Sci.* in press (2022.10).
2. Hydrophilic photocatalytic membrane via grafting conjugated polyelectrolyte for visible-light-driven biofouling control, *Appl. Catal. B Environ.* 282, 119587 (2020.09).
3. Designing conjugated porous polymers for visible light-driven photocatalytic chemical transformations, *Mater. Horiz.* 7, 15-31 (2019.09).
4. Conjugated polymer hydrogel photocatalysts with expandable photoactive sites in water, *Chem. Mater.* 31, 3381-3387 (2019.04).
5. CO_2-Triggered Switchable Hydrophilicity of Heterogeneous Conjugated Polymer Photocatalyst for Enhanced Catalytic Activity in Water, *Angew. Chem. Int. Ed.,* 57, 2967-2971, (2018.01).