Boosting biocatalytic synthesis via photoelectrochemical microplastic valorization

Jinhyun Kim

Photobiosynthesis integrates nanomaterials with redox biocatalysts to synthesize value-added chemicals using solar energy. However, its overall reaction rate remains limited by sluggish water oxidation kinetics. To overcome this limitation, we introduce non-recyclable poly(ethylene terephthalate) (PET) microplastics as an alternative electron feedstock. A zirconium-doped hematite (Zr:α-Fe_2O_3) photoanode extracts electrons from hydrolyzed PET waste solutions derived from post-consumer plastics and transfers them to carbon-based cathodes that activate redox enzymes—including unspecific peroxygenase, L-glutamate dehydrogenase, and ene-reductase—to drive diverse biosynthetic transformations (e.g., C-H oxyfunctionalization, C=O amination, C=C asymmetric hydrogenation). This work establishes a sustainable photoelectrocatalytic strategy that simultaneously achieves environmental remediation and biocatalytic solar-to-chemical conversion, representing a step toward circular, carbon-neutral chemical manufacturing.