Abstract

The thesis entitled **"Triphenylamine-Based Conjugated Microporous Polymers: A Promising Platform for Photocatalysis and Environmental Remediation"** focuses on the rational molecular design of triphenylamine (TPA)-based conjugated microporous polymers (CMPs) as versatile, metal-free platforms for photocatalysis, environmental remediation, and chemical sensing. By integrating TPA-centered donor–acceptor architectures with systematic acceptor engineering through functional group modification, heteroatom incorporation, and atomic-level substitution, the study elucidates fundamental structure–property–performance relationships governing optical absorption, electronic band structure, charge-transfer dynamics, and exciton separation. These design strategies enable efficient visible-light harvesting, prolonged charge-carrier lifetimes, and controlled oxygen activation, resulting in tunable reactive oxygen species (ROS) generation and significantly enhanced photocatalytic activity across diverse reaction systems. Beyond pollutant degradation, the developed CMPs demonstrate broad multifunctionality, enabling heterogeneous photocatalytic organic transformations, selective adsorption of environmentally relevant contaminants such as dyes and iodine, and integrated sensing and degradation of organic micropollutants. The incorporation of heteroatom-rich and π-extended building blocks further enhances adsorption capacity, selectivity, and recyclability. Importantly, this work establishes acceptor-engineered CMPs capable of ROS-free, chemically orthogonal dual redox photocatalysis, allowing simultaneous uranium reduction and antibiotic oxidation under mild conditions with exceptional efficiency and stability. Overall, this thesis advances molecular-level design principles for TPA-based CMPs and highlights their promise as sustainable, recyclable materials for advanced photocatalytic and environmental remediation applications.

Keywords: Triphenylamine; Conjugated microporous polymers; Band-gap engineering; Reactive oxygen species; Photocatalysis; Environmental remediation.