ABSTRACT


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COLLEGE: Sciences and Humanities

DATE: July 2020

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Persistent organic pollutants have been a global threat. The need for a cost-effective and environmentally benign method for the degradation of these contaminants has led to tremendous research in photocatalysis. Bismuth based semiconductors have emerged as very promising visible light-activated catalysts. In this thesis, we introduce a method to control the heterostructure of Cu₂O/BiOBr via a low-temperature hydrothermal procedure. Controlling the reaction conditions via in situ and sequential approaches enabled the preparation of well-interfaced Cu₂O nano cubes over BiOBr nanosheets. The size, composition, morphology, and structure of the material were characterized by transmission electron microscope (TEM), scanning electron microscope (SEM), energy dispersive spectroscopy (EDS), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS). The TEM and SEM illustrated the well-formed cubic shape of the Cu₂O nanoparticles as well as the tetragonal structure of BiOBr nano material. XRD patterns that showed the crystal phase of the composite was obtained and the EDS showed that Bi,
Cu, and Pd were present in the composite. XPS spectra showed the surface chemical composition and the chemical states of BiOBr/Cu$_2$O matching those of literature. The activity and stability of the photocatalysts and the role of scavengers were evaluated in the degradation of rhodamine B and methyl orange organic dyes. Tuning the composition of the heterostructured photocatalysts led to substantial increase in the photocatalytic degradation of both cationic and anionic organic contaminants. BiOBr/Cu$_2$O photocatalyst was employed in the photocatalytic degradation of glyphosate, a widely used herbicide that has shown adverse effects on human health and its toxic by-product α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid (AMPA). The composite photocatalyst demonstrated complete degradation of glyphosate within 10 minutes of light irradiation with a rate constant of 0.3674 min$^{-1}$ using sequential synthesis route. Palladium nanodomains were anchored selectively on the surface of Cu$_2$O via a light-activated deposition approach. The multicomponent Pd/BiOBr/Cu$_2$O photocatalyst demonstrated diminished photocatalytic degradation activity compared to the bare material. The stability of the BiOBr/Cu$_2$O photocatalyst was evaluated by following the degradation of rhodamine B for 4 consecutive cycles. There was high activity and substantial stability of the BiOBr/Cu$_2$O photocatalyst in the degradation of Rhodamine B under simulated sunlight.