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ABSTRACTS

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Efficiency of pristine and composite BiOX (X=Cl, Br, I) photoctalysts using uv and visible light

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Heterogeneous photocatalysis offers a promising solution to many problems, from treating recalcitrant organic pollutants to the environmentally friendly synthesis of valuable compounds. TiO_2 and ZnO, the most widespread photocatalysts, have several advantageous properties but are primarily active under UV irradiation. The use of photocatalysts activated by visible light can significantly reduce operating costs, primarily via the utilization of solar radiation. The production of a visible light active photocatalyst with high efficiency and relatively low production cost is still an unsolved problem.

Bismuth-oxyhalides (BiOX) are an emerging family of photocatalytic materials. While excitation of BiOF and BiOCl requires UV light, BiOBr and especially BiOI can be excited using visible irradiation due to the relatively small bandgap energy. Moreover, their efficiency can be increased by their composites. The combination of two appropriate BiOX photocatalysts results in higher photostability and activity due to the enhanced charge separation via heterojunction.

Our work aimed to synthesize pristine and composite BiOX photocatalysts and test their efficiency under UV (398 nm) and visible (400-700 nm) irradiation using LED light sources. The crystal structure, light absorptivity, and bandgap values have been investigated with appropriate methods. Transformation of 1,4-benzoquinone to 1,4-hydroquinone was used to characterize charge separation efficiency under various irradiations in O_2-free suspensions. The transformation of 1,4-hydroquinone in O_2-containing suspension can happen via reaction with superoxide radical ($O_2^{\bullet-}$) or photogenerated holes. The latter process produces 1,4-hydroquinone, while the reaction with superoxide radical results mainly in ring-opening products. Thus, the formation rate of products gives information about the oxidizing ability of photogenerated holes and the formation ability of $O_2^{\bullet-}$. Photocatalysts were also tested for removing sulfamethoxypyridazine, a sulfonamide antibiotic. The formation of products was also studied in the case of each target substance. The reduction capability of BiOCl and BiOBr was superior compared to BiOI, probably due to the fast recombination of photogenerated charges for BiOI. However, BiOI was significantly more efficient for hole-initiated oxidation of 1,4-hydroquinone, especially under visible light irradiation. BiOI/BiOCl and BiOI/BiOBr composites were synthesized using solvothermal synthesis and mechanical mixing (ball milling). Some composites synthesized by the solvothermal method proved significantly better efficiency than the pristine ones, especially under visible light irradiation, while mechanical mixtures were less effective even under the mild ball milling conditions, probably due to structural changes.

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