

Crystalline face engineering in diverse bismuth oxyhalides for enhanced amoxicillin removal from water

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In recent decades, the increasing presence of antibiotics in wastewater has become a critical issue, as their persistence contributes to the evolution of antibiotic-resistant bacteria (ARB) and genes (ARGs), impacting aquatic ecosystems and posing significant threats to human health [1]. To address this concern, heterogeneous photocatalysis, have emerged as promising solutions. In this context, in recent decades, bismuth-based materials, particularly bismuth oxyhalides (BiOX, where X = Cl, Br, or I), have gained attention due to their easy synthesis, high chemical stability, unique layered structure, and prolonged lifetime of electric charges after light irradiation [2]. BiOXs are semiconducting materials with a distinctive tetragonal crystal structure in which $[\text{Bi}_2\text{O}_2]$ slabs are alternated with double slabs of halogen atoms, creating an internal static electric field perpendicular to the layers [3]. This unique configuration facilitates the transport of photo-induced electrons and holes within the crystal, promoting charge carrier separation and thereby enhancing photocatalytic activity. The photocatalytic performance of BiOXs can be further optimized by tailoring their exposed crystal facets, which significantly influence their surface reactivity and charge dynamics. Indeed, the growth of specific crystal facets can be tuned by carefully designing the synthesis process, manipulating factors such as reaction temperature and time, solvent selection, use of capping agents, and choice of an appropriate halogen precursor. In this study, the preparation of BiOX photocatalysts – specifically BiOBr and BiOCl – obtained using potassium (K) and calcium (Ca) salts as halogen precursors was investigated. The XRD diffractograms (Figure 1A) highlighted the impact of the halogen source on the BiOX crystal structure, favoring the formation of the

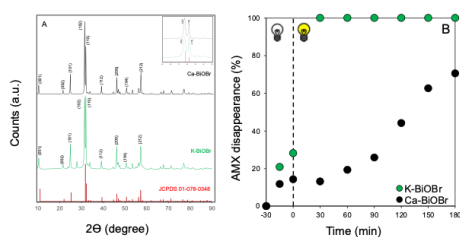


Figure 1: A) XRP diffractogram of BiOBr from potassium and calcium salts; B) AMX (10 mg/L) photodegradation tests using 0.25 g/L BiOBr under simulated sunlight (35 W/m²).

(110) crystal facet when K-salts were used [4]. This observation helped explain the photocatalytic results obtained for Amoxicillin (AMX) degradation. By way of example, when BiOBr from K-salts was used (Figure 1B), complete AMX degradation was achieved within 30 minutes of irradiation, whereas BiOBr prepared from Ca-salts showed a slower degradation, reaching about 70% AMX degradation after 180 minutes of irradiation. A similar behavior was observed with BiOCl. In

conclusion, the tunability of BiOX crystal facets offers a powerful strategy to optimize their photocatalytic activity, enhancing their effectiveness in addressing antibiotic pollution in wastewater. By harnessing sunlight, these materials show great promise for sustainable water treatment applications.

References

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