

Title : Microwave Synthesis of Bismuth-Rich Oxyiodide for Photooxidation of Arsenite (As(III))

Author(s) : Ms. Thanchanok Charoensuk

Student ID : 640510038

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Advisor(s) : Associate Professor Dr. Sulawan kaowpong

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ABSTRACT

Semiconductor-mediated photocatalysis is a promising technology for addressing water contamination caused by pollutants. Bismuth oxyiodide (BiOI) is a notable photocatalytic material due to its unique layered crystal structure and visible light responsiveness, providing excellent physicochemical and photocatalytic properties. However, the photocatalytic efficiency of BiOI is limited by the high recombination rate of photogenerated electron-hole pairs, resulting from its narrow energy band gap (1.77 eV), which reduces its utilization efficiency. Additionally, the low reduction ability of electrons in the conduction band (CB) and low oxidation ability of hole in the valence band (VB) restrict its broader photocatalytic applications. Bismuth-rich oxyiodide ($\text{Bi}_x\text{O}_y\text{I}_z$) exhibits tunable elemental ratios and adjustable electronic band level. Increasing the Bi content leads to more negative CB and more positive VB potentials. In this research, $\text{Bi}_x\text{O}_y\text{I}_z$ (BiOI, $\text{Bi}_7\text{O}_9\text{I}_3$, and $\text{Bi}_5\text{O}_7\text{I}$) were successfully synthesized using a cyclic microwave irradiation method (640 W, 5 cycles). The effect of NaOH contents on the formation of material was investigated. The results demonstrated that the NaOH content influenced the ratios of x, y and z in $\text{Bi}_x\text{O}_y\text{I}_z$. BiOI was obtained when 0, 2, and 4 mmol NaOH were added to the reaction. In contrast, $\text{Bi}_7\text{O}_9\text{I}_3$ and $\text{Bi}_5\text{O}_7\text{I}$ were formed when 6 and 8 mmol NaOH were used, respectively. Among the studied photocatalysts, $\text{Bi}_5\text{O}_7\text{I}$ exhibited the highest photooxidation efficiency for the highly toxic arsenite (As(III)), converting it into environmentally safer arsenate (As(VI)). Within 360 min under visible light, $\text{Bi}_5\text{O}_7\text{I}$ and $\text{Bi}_7\text{O}_9\text{I}_3$ oxidized 98.80% and 77.90% of As(III) (20 ppm), respectively, while BiOI oxidized only 3.20%. The enhanced photocatalytic performance of $\text{Bi}_5\text{O}_7\text{I}$ and $\text{Bi}_7\text{O}_9\text{I}_3$ compared to BiOI was attributed to the efficient separation and migration of photogenerated

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charge carriers as well as the favorable electronic band positions. These factors improved the redox ability of the charge carriers, leading to an increasing the generation of active species.