Abstract

Background: The removal of textile wastes is a priority due to their mutagenic and carcinogenic properties. In this study, bismuth oxyhalide was used in the removal of methylene blue (MB) which is a textile waste. The main objective of this study was to develop and investigate the applicability of a bismuth oxyhalide ($BiOBr_zI_{(1-z)}$) solid solutions in the photodegradation of MB under solar and ultraviolet (UV) light irradiation.

Methods: Bismuth oxyhalide ($BiOBr_zI_{(1-z)}$) ($0 \leq z \leq 1$) materials were successfully prepared through the hydrothermal method. Brunauer-Emmett-Teller (BET), transmission electron microscope (TEM), X-ray diffractometer (XRD), and scanning electron microscope (SEM) were used to determine the surface area, microstructure, crystal structure, and morphology of the resultant products. The photocatalytic performance of $BiOBr_zI_{(1-z)}$ materials was examined through methylene blue (MB) degradation under UV light and solar irradiation.

Results: The XRD showed that $BiOBr_zI_{(1-z)}$ materials crystallized into a tetragonal crystal structure with (102) peak slightly shifting to lower diffraction angle with an increase in the amount of iodide (I^-). $BiOBr_{0.6}I_{0.4}$ materials showed a point of zero charge of 5.29 and presented the highest photocatalytic activity in the removal of MB with 99% and 88% efficiency under solar and UV irradiation, respectively. The kinetics studies of MB removal by $BiOBr_zI_{(1-z)}$ materials showed that the degradation process followed nonlinear pseudo-first-order model indicating that the removal of MB depends on the population of the adsorption sites. Trapping experiments confirmed that photogenerated holes (h^+) and superoxide radicals ($^{\bullet}O_2^-$) are the key species responsible for the degradation of MB.

Conclusions: This study shows that bismuth oxyhalide materials are very active in the degradation of methylene blue dye using sunlight and thus they have great potential in safeguarding public health and the environment from the dye's degradation standpoint. Moreover, the experimental results agree with nonlinear fitting.