Designing A Visible Light Driven TiO_2-Based Photocatalyst by Doping and Co-Doping with Niobium (Nb) and Boron (B)

ABSTRACT

Water pollution has emerged as a significant worldwide issue, with organic pollutants being a key contributor. Titanium dioxide (TiO2) has demonstrated promising photocatalytic performance in removing organic pollutants under ultraviolet (UV) irradiation. However, the wide band gap (3.2 eV) of TiO_2 results in low absorption capacity of visible light, hindering its overall efficiency in degrading organic pollutants. To address the limitation, this research aimed to synthesize visible light-driven TiO2 photocatalyst with different polymorphs (anatase and rutile) and investigate the effect of various doping combination (Nb, B and Nb,B) and concentrations (0.25, 0.50, 0.75 and 1.00 mol%) on the photodegradation efficiency towards methylene blue (MB) dye solution. Anatase phase was obtained when TiO2-based nano powders were calcined at 400 °C, while the rutile phase was formed at 900 °C based on XRD analyses. Additionally, the morphology analyses revealed that the particle size of anatase is much smaller than that of rutile. The presence of dopants further reduced the particle size of both anatase and rutile phases. Based on UV-Vis absorbance spectra analyses, the anatase Nb,B-TiO_2 with 0.50 mol% of dopant concentration exhibited the best photocatalytic performance towards MB. Moreover, the anatse phase of 0.50 mol% Nb,B-TiO_2 showed the narrowest band gap of 2.74 eV compared to the TiO2 (3.4 eV), representing a reduction of 19.41 %, according to UV-Vis analyses. These outcomes suggest the potential application of anatase phase of 0.50 mol% Nb,B-TiO_2 in treating organic pollutants in wastewater under visible light conditions in future.