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EFFECT OF CALCINATION TEMPERATURE ON PHOTOCATALYTIC PERFORMANCE OF NATURALLY AVAILABLE ILMENITE

P.P.N.N. Wickramasinghe*, S.H.R.T. Sooriyagoda and C.R. Munasinghe

Department of Physics, University of Colombo, Colombo, Sri Lanka.
*2020s18254@stu.cmb.ac.lk

Photocatalytic degradation of organic pollutants is a key challenge in developing sustainable and efficient wastewater treatment technologies. However, many conventional photocatalysts are costly and exhibit low efficiency under visible light. In this study, the potential of natural ilmenite as a visible-light-active photocatalyst was investigated. To enhance its performance, ilmenite was milled and thermally treated (calcined) at various temperatures to induce structural transformations, followed by characterisation using X-ray diffraction (XRD), UV-visible diffuse reflectance spectroscopy (DRS), and scanning electron microscopy. XRD analysis revealed that calcination below 800 °C resulted in unreacted ilmenite. Higher temperatures above 1000 °C resulted in primarily Fe_2TiO_5 and TiO_2 (rutile). Calcination between 800 °C and 1000 °C led to the formation of mixed oxide phases such as α-Fe_2O_3, TiO_2 (rutile) and Fe_2TiO_5. These structural changes enhance light absorption and charge carrier mobility. The DRS analysis revealed a direct bandgap of 2.34 eV for milled ilmenite. When the calcinated temperature of milled ilmenite increased from 700 °C to 1000 °C, the direct bandgap energy narrowed down from 2.30 eV to 2.09 eV. Ilmenite samples calcined at 900 °C and 1000 °C achieved a notable degradation efficiency of approximately 17%, as determined by methylene blue, within 2.0 h under pH 7.0 conditions. Although the band structures of the calcined ilmenite sample are more preferable for lower recombination and active in visible light than TiO_2 (anatase), commercially available TiO_2 (anatase) exhibited a degradation efficiency of approximately 22% under 2.0 h of visible light irradiation at pH = 7.0, due to its high crystallinity and large surface area. Although its efficiency does not surpass that of commercial TiO_2, the enhanced activity of high-temperature-calcined ilmenite highlights the role of multiphase oxide structures in improving charge dynamics. Given its natural abundance and low cost, thermally modified ilmenite offers a compelling pathway toward affordable and sustainable photocatalysts for water purification.

Keywords: Calcination, Ilmenite, Photocatalytic activity, Visible-light conditions