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ENHANCED PHOTOCATALYTIC ACTIVITY OF Fe DOPED ZnO NANOPARTICLES AND THE INFLUENCE OF CO-POLLUTANTS

N. Lokuge[1] and C. Thambiliyagodage[2*]

[1]Institute of Chemistry Ceylon, Adamantane House, Rajagiriya, Sri Lanka
[2]Faculty of Humanities and Sciences, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
[*]charitha.t@sliit.lk

The release of dyes from various sources to water bodies has caused significant hazardous effects on the environment. This study evaluated the photocatalytic activity of the Fe doped ZnO nanoparticles synthesized by the co-precipitation method at different Fe concentrations: 0.025, 0.05, 0.075, and 0.1% respective to Zn. The effect of various co-pollutants on the photodegradation of methylene blue (MB) studied in this work was not reported elsewhere. Synthesized nanoparticles were characterized by Powder X-ray Diffractometry (PXRD) and Raman spectroscopy. PXRD patterns show the presence of ZnO crystal structure. Upon doping Fe, no significant changes in the PXRD peak positions and lattice parameters were observed, and peaks corresponding to oxide phases of iron were absent, revealing proper doping of Fe^{3+} to ZnO lattice. Raman spectra of the 0.1% Fe doped and undoped ZnO nanoparticles were identical except for the slight shifts in the Raman shifts, which indicate proper doping of Fe^{3+}. The Fe doped ZnO nanoparticles were more effective in photodegrading MB under sunlight than ZnO nanoparticles. Photocatalytic activity increased with increasing dopant concentration where the highest rate constant (0.03426 min^{-1}) was obtained with 0.05% Fe doped ZnO. With a further increase in Fe concentration, photocatalytic activity decreased due to electron-hole pair recombination. The effect of co-pollutants on photocatalytic activity was investigated using Rhodamine B (RhB), Pb^{2+}, PO_4^{3-} and $S_2O_3^{2-}$ ions. The presence of Rhodamine B slightly decreased the rate constant for the photodegradation of MB (0.01816 to 0.01341 min^{-1}), and doped nanoparticles were effective in degrading RhB in addition to MB. The presence of Pb^{2+} (0.01455 to 0.00572 min^{-1}) and PO_4^{3-} (0.02448 to 0.01497 min^{-1}) ions significantly decreased the rate constants for the photodegradation of MB, while $S_2O_3^{2-}$ ion has increased the photocatalytic activity (0.01983 to 0.02143 min^{-1}). The presence of RhB resulted in an overall negligible decremented effect. Presence of Pb^{2+} and PO_4^{3-} ions showed a considerable inhibitory effect on the degradation efficiency. The Pb^{2+} ion competes with MB for ZnO surface, PO_4^{3-} neutralizes MB limiting the adsorption and $S_2O_3^{2-}$ acts as an electron acceptor.

Keywords: Fe doped ZnO, Pb^{2+}, PO_4^{3-}, Rhodamine B, $S_2O_3^{2-}$