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Removal of naphthalene from simulated wastewater through adsorption-photodegradation by ZnO/Ag/GO nanocomposite

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Abstract

In this study, a ZnO/Ag/GO nanocomposite was synthesised and used as photocatalyst for effective photodegradation of naphthalene from simulated wastewater under visible light. Chemical and morphological characterisation were successfully done using XRD, PL, UV–vis, FTIR, XPS, FESEM and HRTEM analytical tools. Photocatalytic degradation experiments were first carried out under dark conditions and then under visible-light irradiation. Adsorption study of naphthalene prior to photocatalysis using synthesised material was thoroughly done by studying the kinetics and adsorption isotherm models. All as-synthesised materials (ZnO nanoparticles, binary ZnO/Ag, and ternary ZnO/Ag/GO nanocomposites) followed pseudo-second-order kinetics and the Freundlich adsorption isotherm, confirming the adsorption on hetero-structural surface. ZnO/Ag/GO could successfully adsorb 80% naphthalene in 20 min, with 500 mg.g-1 adsorption capacity. High adsorption of naphthalene molecules on ZnO/Ag/GO surfaces trigger improved photodegradation efficiency upon light irradiation. Incorporation of plasmonic Ag nanoparticles and 2D graphene oxide (GO) to ZnO semiconductor improved the photocatalytic degradation efficiency of naphthalene, achieving up to 92% degradation in 50 min. The photodegradation of naphthalene follows the Langmuir-Hinshelwood kinetics model and was found acceptable to express the photodegradation rate. Furthermore, the ZnO/Ag/GO photocatalyst could easily be recycled and reused for five cycles, maintaining up to 85% of its photodegradation efficiency.