UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF ZnO/CdS PHOTOCATALYST FOR METHYLENE BLUE DEGRADATION UNDER LED LIGHT

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ABSTRACT

Implementation of technology based on renewable energy sources is crucial to maintain environmental sustainability. However, the problems with conventional photocatalyst, zinc oxide (ZnO) are fast recombination, large band gap and require high consumption light source. Thus, this study found that zinc oxide loaded cadmium sulphide (ZnO/CdS) composite photocatalyst works in the light-emitting diode (LED) visible light range was synthesized for degradation of methylene blue (MB). The ZnO was prepared using the solid-state method and impregnated with CdS via the wet-impregnation process. The characterization of composite was carried out using N_2 sorption analysis using Brunauer-Emmett-Teller (BET) method, Field Emission Scanning Electron Microscope (FESEM), X-Ray Diffraction (XRD) and Ultraviolet-Visible-near-IR spectrophotometer (UV-Vis-NIR). Furthermore, the photocatalytic degradation of MB solution was tested in a photocatalytic reactor equipped with a 21-Watt LED visible lamp as a source of light energy, gas diffuser, and magnetic stirrer. Besides, the effect of operating parameters such as the different molar ratios of ZnO to CdS, initial concentration, pH of the MB solution, and amount of catalyst on the photocatalytic activity was analysed and discussed. The successful of ZnO band gap tailoring from 3.30 eV into 2.46 eV with CdS in the composite photocatalyst. The ZnO/CdS photocatalyst shows high crystallinity with the formation of coral-like morphology by tiny 3D geometric structure. The elemental compound of Zn, O, Cd and S presence were confirmed by EDX analysis. Meanwhile the surface area of ZnO/CdS was found to be 13.664 $m^2 g^{-1}$. It was found that the ZnO/CdS photocatalyst completely degrades the MB solution up to 100% with a 3:1 molar ratio of ZnO:CdS (Z3C1), 300 mL of 100 mg/L MB solution at pH 9, 0.5 g of Z3C1 photocatalyst within 90 minutes reaction time. A scavenger test was carried out to identify the major active species that responsible for the degradation of MB solution. The capturing of the hydroxyl radical $OH^{\bullet}$ and superoxide anion radical $^{\bullet}O_2^-$ by scavenger reagents reducing the degradation of MB, hence it proved that the Z3C1 photocatalyst initiates the photodegradation of MB instead of the only adsorption. Meanwhile, the reusability of Z3C1 photocatalyst shows the ability of the catalyst to be recycled resulting in 100%, 66.8%, 50.3%, and 46.4% degradation from the first to the fourth cycle, respectively, due to the deactivation of the catalyst caused by leaching of active sites and photo-corrosion. In conclusion, the ZnO/CdS is promising as a highly potential photocatalyst for the degradation of organic pollutants especially MB in LED visible light energy.

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