ZnO-MnO_2 core-shell nanocomposites as a promising visible-light driven photocatalyst for pollutants removal

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Water crisis is the problem that needed much attention due to the growing scarcity of fresh water throughout the world. This situation raised alarm especially in a highly dense populated area particularly in developing countries where lack of fresh and clean water caused deteriorating of human health. Various approaches such as activated carbon [1, 2], precipitation [3], coagulation [4, 5], membrane [6, 7] and reverse osmosis [8] had been used in water treatment. Unfortunately, those treatments have been causing secondary pollution because the treatment transformed the pollutants from one phase to another, leaving the residual in the water system. Semiconductor nanomaterials based on photocatalytic treatment using solar energy is a potentially clean in this environment remediation. Photocatalytic degradation of harmful organic compound is the most efficient green method for water treatment [9]. In fact, dye stuff activities, which are highly concentrated organic compounds that found in the discharge waste water, are the main cause of water pollution.

Heterogeneous photocatalysis by semiconductors is widely applied to environment remediation under solar energy. The application of zinc oxide (ZnO) as photocatalyst is widely studied because of its wide bandgap (3.37 eV) and large binding energy (60 meV). Besides, it is chemically stable and cheap. However, ZnO has low quantum efficiency of photocatalytic reactions and is ineffective in utilizing the visible light to degrade organic pollutants [10]. Therefore, various methods have been investigated to narrow the bandgap of ZnO and increase the efficiency of photocatalytic activity in visible light region. Example of these methods are doping nonmetal on ZnO [11] and implantation of metal [12].

Core-shell nanocomposites (CSNs) is a new functional material for the environment remediation [13]. In this work, both photocatalytic activity of MnO_2 nanoparticles and ZnO nanoparticles were studied separately. Flower-like MnO_2 nanoparticles were synthesized via hydrothermal method using analytical grade potassium permanganate (VII) and manganese sulfate hydrate as precursors. Rod-like ZnO nanoparticles were synthesized using sol gel method. The photodegradation efficiency of both ZnO and MnO nanoparticles have been studied under UV light and visible light, respectively. The results show that the photodegradation efficiency of ZnO nanoparticles is four times higher than MnO_2 nanoparticle under UV light. The rate constant of ZnO and MnO_2 are 0.02749 min^{-1} and 0.0067 min^{-1} respectively. Nevertheless, formation of core-shell ZnO-MnO_2 nanocomposites could enhance the photocatalytic activity in degrading organic dyes particularly under visible light irradiation. These ZnO-MnO_2 nanocomposites were synthesized via hydrothermal method.

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