



Photocatalytic degradation of Direct Red 80 using ZnO/ZnTiO₃/Zn₂Ti₃O₈ ternary nanocomposite

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ABSTRACT

In the present study, novel zinc titanate-based nanocomposites were synthesized via an one-step sol–gel process. The crystalline structural, morphological and optical properties of the samples were characterized. Effect of Ti:Zn molar ratio on the structures and crystalline phase of the composites was investigated. ZnO/ZnTiO₃/Zn₂Ti₃O₈ ternary heterojunction catalyst obtained by Ti:Zn molar ratio of 1:1. The photocatalytic activity of the prepared nanocomposites with various Ti:Zn molar ratio was investigated for Direct Red 80 (DR80) degradation in aqueous solution. Excellent photocatalytic activity of ZnO/ZnTiO₃/Zn₂Ti₃O₈ nanocomposite exhibited 93.6% degradation of DR80 after 90 min irradiation which is 1.24 times of DR80 degradation using ZnO nanoparticles. The enhanced photocatalytic performance could be attributed to the formation of ZnTiO₃ as dominant phase and the heterojunction of electrons among ZnTiO₃, Zn₂Ti₃O₈ and ZnO, which enabled electron transfer in the nanocomposite, suppressed electron–hole pair recombination, and encouraged a wider light absorption by photocatalyst. The effect of main operating conditions on the photocatalytic degradation of dye was investigated using ZnO/ZnTiO₃/Zn₂Ti₃O₈ nanocomposite and optimum conditions were determined for degradation. The stability and cyclic efficiency of ZnO/ZnTiO₃/Zn₂Ti₃O₈ photocatalyst were investigated. Finally, the kinetic studies revealed the photocatalytic degradation kinetics of DR80 would follow a pseudo-second-order reaction.

Keywords: Zinc titanate; ZnO/ZnTiO₃/Zn₂Ti₃O₈ nanocomposite; Photocatalytic degradation; Direct Red 80 (DR80); Kinetic study

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