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TiO2 Nanowires as Efficient Heterogeneous Photocatalysts for Waste-Water Treatment

Authors : Gul Afreen, Sreedevi Upadhyayula, Mahendra K. Sunkara

Abstract : One-dimensional (1D) nanostructures like nanowires, nanotubes, and nanorods find variety of practical application owing to their unique physico-chemical properties. In this work, TiO₂ nanowires were synthesized by direct oxidation of titanium particles in a unique microwave plasma jet reactor. The prepared TiO₂nanowires manifested the flexible features, and were characterized by using X-ray diffraction, Brunauer-Emmett-Teller (BET) surface area analyzer, UV-Visible and FTIR spectrophotometers, Scanning electron microscope, and Transmission electron microscope. Further, the photodegradation efficiency of these nanowires were tested against toxic organic dye like methylene blue (MB) and the results were compared with the commercial TiO₂. It was found that TiO₂ nanowires exhibited superior photocatalytic performance (89%) as compared to commercial TiO₂(75%) after 60 min of reaction. This is attributed to the lower recombination rate and increased interfacial charge transfer in TiO₂ nanowire. Pseudo-first order kinetic modelling performed with the experimental results revealed that the rate constant of photodegradation in case of TiO₂ nanowire was 1.3 times higher than that of commercial TiO₂. Superoxide radical (O₂˙[−]) was found to be the major contributor in the photodegradation mechanism. Based on the trapping experiments, a plausible mechanism of the photocatalytic reaction is discussed.

Keywords : heterogeneous catalysis, photodegradation, reactive oxygen species, TiO_2 nanowires
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