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Dendrimer-Encapsulated N, Pt Co-Doped TiO_2 for the Photodegration of Contaminated Wastewater

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Abstract : Azo dye effluents, released into water bodies are not only toxic to the ecosystem but also pose a serious impact on human health due to the carcinogenic and mutagenic effects of the compounds present in the dye discharge. Conventional water treatment methods such as adsorption, flocculation/coagulation and biological processes are not effective in completely removing most of the dyes and their natural degradation by-products. Advanced oxidation processes (AOPs) have proven to be effective technologies for complete mineralization of these recalcitrant pollutants. Therefore, there is a need for new technology that can solve the problem. Thus, this study examined the photocatalytic degradation of an azo dye brilliant black (BB) using non-metal/metal codoped TiO_2. N, Pt co-doped TiO_2 photocatalysts were prepared by a modified sol-gel method using amine-terminated polyamidoamine dendrimer generation 0 (PAMAM G0), amine-terminated polyamidoamine dendrimer generation 1 (PAMAM G1) and hyperbranched polyethyleneimine (HPEI) as templates and source of nitrogen. Structural, morphological, and textural properties were evaluated using scanning electron microscopy coupled to energy dispersive X-ray spectroscopy (SEM/EDX), high-resolution transmission electron microscopy (HRTEM), X-ray diffraction spectroscopy (XRD), X-ray photoelectron spectroscopy (XPS), thermal gravimetric analysis (TGA), Fourier- transform infrared (FTIR), Raman spectroscopy (RS), photoluminescence (PL) and ultra-violet /visible spectroscopy (UV-Vis). The synthesized photocatalysts exhibited lower band gap energies as compared to the Degussa P-25 revealing a red shift in band gap towards the visible light absorption region. Photocatalytic activity of N, Pt co-doped TiO_2 was measured by the reaction of photocatalytic degradation of brilliant black (BB) dye. The N, metal codoped TiO_2 containing 0.5 wt. % of the metal consisted mainly of the anatase phase as confirmed by XRD results of all three samples, with a particle size range of 13–30 nm. The particles were largely spherical and shifted the absorption edge well into the visible region. Band gap reduction was more pronounced for the N, Pt HPEI (Pt 0.5 wt. %) codoped TiO_2 compared to PAMAM G0 and PAMAM G1. Consequently, codoping led to an enhancement in the photocatalytic activity of the materials for the degradation of brilliant black (BB).

Keywords : codoped TiO_2, dendrimer, photodegradation, wastewater
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