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Remediation of Dye Contaminated Wastewater Using N, Pd Co-Doped TiO_2 Photocatalyst Derived from Polyamidoamine Dendrimer G1 as Template

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Abstract : The discharge of azo dyes such as Brilliant black (BB) into the water bodies has carcinogenic and mutagenic effects on humankind and the ecosystem. Conventional water treatment techniques fail to degrade these dyes completely thereby posing more problems. Advanced oxidation processes (AOPs) are promising technologies in solving the problem. Anatase type nitrogen-platinum (N, Pt) co-doped TiO_2 photocatalysts were prepared by a modified sol-gel method using amine terminated polyamidoamine generation 1 (PG1) as a template and source of nitrogen. The resultant photocatalysts were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), UV-Vis diffuse reflectance spectroscopy, photoluminescence spectroscopy (PL), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy (RS), thermal gravimetric analysis (TGA). The results showed that the calcination atmosphere played an important role in the morphology, crystal structure, spectral absorption, oxygen vacancy concentration, and visible light photocatalytic performance of the catalysts. Anatase phase particles ranging between 9- 20 nm were also confirmed by TEM, SEM, and analysis. The origin of the visible light photocatalytic activity was attributed to both the elemental N and Pd dopants and the existence of oxygen vacancies. Co-doping imparted a shift in the visible region of the solar spectrum. The visible light photocatalytic activity of the samples was investigated by monitoring the photocatalytic degradation of brilliant black dye. Co-doped TiO_2 showed greater photocatalytic brilliant black degradation efficiency compared to singly doped N-TiO_2 or Pd-TiO_2 under visible light irradiation. The highest reaction rate constant of 3.132 x 10-2 min^{-1} was observed for N, Pd co-doped TiO_2 (2% Pd). The results demonstrated that the N, Pd co-doped TiO_2 (2% Pd) sample could completely degrade the dye in 3 h, while the commercial TiO_2 showed the lowest dye degradation efficiency (52.66%).

Keywords : brilliant black, Co-doped TiO_2, polyamidoamine generation 1 (PAMAM G1), photodegradation
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