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Formation of predominant interstitial N–TiO_2 using physical preparation under microwave irradiation for Reactive Red 4 dye removal

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ABSTRACT

Interstitial nitrogen titanium dioxide (N–TiO_2) has been synthesized from solid-state microwave irradiation of commercial TiO_2 (P25) and urea, which is in contrast to other solid-state methods that give substitutional N–TiO_2. N–TiO_2 was characterized by powder X-ray diffraction (XRD), N_2-adsorption surface area measurement, Fourier transformed infra-red (FTIR), X-ray photoelectron spectroscopy (XPS) and UV-Vis diffuse reflectance spectroscopy (UV-Vis DRS). FTIR, XPS and UV-Vis DRS indicate that interstitial doping of N has occurred in the TiO_2 lattice. Ti–O–N detected by FTIR at 1,449 cm^{-1} contributed to the N–O bond. There is no C=O bond in N–TiO_2 showing that urea was completely decomposed in modified TiO_2. This N–O bond is also proved by XPS on deconvolution peaks detected at 404.8 and 531.5 eV in N 1s and O 1s, respectively. UV-Vis DRS analysis revealed the formation of N 2p state ca. 0.12 eV above valence band in N–TiO_2 and it is almost similar to characteristic of substitutional N–TiO_2. Thus, the combination of substitutional and interstitial called interstitial N 2p is suggested in our prepared N–TiO_2 sample. The photocatalytic activities of N–TiO_2 and pristine TiO_2 were compared for the photodegradation of the dye reactive red 4 (RR4) under visible light irradiation from an LED source. Complete bleaching occurred within 60 min using N–TiO_2 whereas no photocatalytic degradation was observed using pristine TiO_2.

Keywords: Interstitial N 2p; Nitrogen doping; Photocatalysis; Microwave; Reactive red 4 dye

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