Formation of predominant interstitial N–TiO₂ using physical preparation under microwave irradiation for Reactive Red 4 dye removal

M.S. Azami a,b, W.I. Nawawi a,c,*, D.S.M. Shukri a

aPhotocatalysis Laboratory, CBERG, Faculty of Applied Sciences, Universiti Teknologi MARA, 02600 Arau, Perlis, Malaysia, Tel. +60 49882305; Fax: +6049882026; email: wi_nawawi@perlis.uitm.edu.my (W.I. Nawawi), Tel. +60 167603950; email: saifuddinazami@gmail.com (M.S. Azami), Tel. +60137143940; email: dyia839@perlis.uitm.edu.my (D.S.M. Shukri)
bFaculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
cDepartment of Chemistry, University of York, Heslington, York, YO10 5DD, UK

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ABSTRACT

Interstitial nitrogen titanium dioxide (N–TiO₂) has been synthesized from solid-state microwave irradiation of commercial TiO₂ (P25) and urea, which is in contrast to other solid-state methods that give substitutional N–TiO₂. N–TiO₂ was characterized by powder X-ray diffraction (XRD), N₂-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 TiO₂ 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–TiO₂ showing that urea was completely decomposed in modified TiO₂. 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–TiO₂ and it is almost similar to characteristic of substitutional N–TiO₂. Thus, the combination of substitutional and interstitial called interstitial N 2p is suggested in our prepared N–TiO₂ sample. The photocatalytic activities of N–TiO₂ and pristine TiO₂ 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–TiO₂ whereas no photocatalytic degradation was observed using pristine TiO₂.

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