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VISIBLE-LIGHT SENSITIVE PHOTOCATALYSTS BY NITROGEN MODIFICATION FOR VOC DESTRUCTION

W. Den[1], H.L. Bai[2], Y.W. Yang[2], L.P. Shiao[1]
[1]*Department of Environmental Science, Tunghai University, Taichung, Taiwan*
[2]*Institute of Environmental Engineering, National Chiao Tung University, Taiwan*

Gas-phase photocatalysis using titanium dioxide has been regarded as an attractive technology for the control of VOC emissions. However, TiO2 requires ultraviolet irradiation exceeding the bandgap energy of 3.0 eV (wavelength < 400 nm), hence effectively eliminating the utilization of solar and interior lighting for photo-activation. Recently, a number of studies have demonstrated that incorporation of anionic species into the Ti3+ sites induces an oxygen vacancy band just below the conduction band edge, thereby narrowing the bandgap energy for photo-excitation for TiO2. In this study, we have characterized the nitrogen-modified pure anatase TiO2 powders by two different approaches – the first being calcination of the powders in an NH3-enriched atmosphere, and the second being surface treatment by radio-frequency plasma in N2 environment. The optimum treatment conditions for both approaches were evaluated based on the light absorptivity in the visible spectra (wavelength < 600nm). Analyses by X-ray photoelectron spectroscopy showed distinct peaks (396 eV and 400 eV) that typified the presence of N-bonding, with the plasma-treated powders exhibiting more intense peak at 396 eV. The differences in the surface N-bonding may have resulted in the substantially higher visible-light absorptivity by the plasma-treated TiO2. Furthermore, the photocatalytic function of the doped TiO2 powders was examined in a batch chamber subjected to monochromic UV (365 nm) or visible (500 nm) light irradiation at adjustable intensities. Both nitrogen-modified samples showed significant decomposition (> 70% destruction efficiencies) of isopropanol vapor (< 1500 ppmv) under visible light.