Editorial

TiO₂ Photocatalytic Materials 2013

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Semiconductor photocatalysis has been intensively studied in recent years and has been shown to be an effective method for solving the serious environmental pollution and energy shortage problems. Among various semiconductor photocatalysts, titania has attracted more and more attention because of its biological and chemical inertness, strong oxidation and reduction power, and long-term stability against photocorrosion. However, the high recombination rate of the photoinduced electron-hole pairs and narrow light-response range for TiO₂ significantly reduces its photocatalytic performance. To enhance the photocatalytic performance of TiO₂, some modification methods including doping, noble metal deposition, surface sensitization, and coupling of two semiconductors have been proposed.

This special issue contains 14 papers, which are mainly related to pollutant decomposition and environmental purification. Among them, 5 papers are about doping of TiO₂, 3 papers deal with the composite of two semiconductors, 3 papers are devoted to TiO₂ nanoparticles, 2 papers focus on TiO₂ nanotube array films, and 1 paper is related to mesoporous membranes. A brief summary of all fourteen accepted papers is provided below.

In "The photocatalytic property of nitrogen-doped TiO₂ nanoball film," the authors describe the fabrication and photocatalytic performance of N-doped TiO₂ nanoball film by anodic oxidation method. The results indicate that N-doping greatly enhances visible light absorption of TiO₂ and

reduces nanoball diameter. N-doped TiO₂ nanoball films exhibit a stronger photocatalytic activity than pure TiO₂ films.

The paper "photocatalytic degradation of methyl violet with TiSiW₁₂O₄₀/TiO₂" reports the photocatalytic degradation of methyl violet using TiSiW₁₂O₄₀/TiO₂ as a novel ecofriendly catalyst under simulated natural light irradiation. The results demonstrate that at optimal conditions, the degradation rate of methyl violet is as high as 82.4% after 3 h simulated natural light irradiation. The photocatalytic reaction of methyl violet can be expressed as first-order kinetic model.

The paper "The synergistic effect of nitrogen dopant and calcination temperature on the visible light-induced photoactivity of N-doped TiO₂" presents the synergistic effect of nitrogen content and calcination temperatures on the photocatalytic performance of TiO₂ catalysts prepared by solgel method. The results indicate that N-doping enhances the visible light photocatalytic activity of TiO₂. N-dopant retards the anatase to rutile phase transformation. Nitrogen atoms are incorporated into the interstitial positions of the TiO₂ lattice. The N-doped TiO₂ catalyst prepared with ammonia to titanium isopropoxide molar ratio of 2.0 and calcined at 400°C shows the best photocatalytic activity.

The paper "Characterization and photocatalytic activity of TiO₂ nanotube films prepared by anodization" describes fabrication of TiO₂ nanotube (TNT) array films by anodization

method in NH_4F electrolyte solution. Photocatalytic decomposition of methylene blue indicates that the reaction rate constants by TNT films are higher than P-25 films at comparable thickness. Reaction rate constants by TNT films increase with increasing film thickness, but the enhancement is retarded when the length of TNT reaches 2200 nm due to the limited penetration of incident UV light.

The paper “*Dyes degradation with Fe-doped titanium nanotube photocatalysts prepared from spend steel slag*” reports fabrication of the TiO_2 nanotube (TNT) and Fe-doped TNT photocatalysts. The decolorizing efficiency decreases with increasing initial MB concentration, and a higher efficiency is observed under UV-light illumination. However, excessive Fe loading reduces the efficiency, and 1.13 wt% Fe loading is found to be the optimal addition.

The paper “*Fabrication and photocatalytic property of one-dimensional $\text{SrTiO}_3/\text{TiO}_{2-x}\text{N}_x$ nanostructures*” describes preparation and photocatalytic performance of one-dimensional $\text{SrTiO}_3/\text{TiO}_{2-x}\text{N}_x$ nanostructures by the hydrothermal method. As compared with the $\text{TiO}_{2-x}\text{N}_x$ nanoparticles, the absorption performance of $\text{SrTiO}_3/\text{titanate}$ nanotubes or $\text{SrTiO}_3/\text{TiO}_{2-x}\text{N}_x$ nanorods is depressed. The $\text{SrTiO}_3/\text{TiO}_{2-x}\text{N}_x$ nanorods present better photocatalytic activity than the $\text{TiO}_{2-x}\text{N}_x$ nanoparticles or nanorods.

In “*Synthesis of nanostructured anatase mesoporous membranes with photocatalytic and separation capabilities for water ultrafiltration process*,” the mesoporous anatase membranes are fabricated for water ultrafiltration (UF) process with photocatalytic and physical separation capabilities. Photocatalytic activity of the membranes is evaluated by the photodegradation of methyl orange. The anatase membranes exhibit good homogeneity, with the surface area of $32.8 \text{ m}^2/\text{g}$, the mean pore size of 8.17 nm, and the crystallite size of 9.6 nm. The methyl orange removal efficiencies by the mesoporous membrane based on physical separation and coupling photocatalytic technique are 52 and 83%, respectively.

In “*Correlation of photocatalysis and photoluminescence effect in relation to the surface properties of $\text{TiO}_2:\text{Tb}$ thin films*,” the structural, optical, photoluminescence, and photocatalytic properties of TiO_2 and $\text{TiO}_2:(2.6 \text{ at. \% Tb})$ thin films are investigated and compared. Optical properties measurements indicate that the incorporation of Tb into TiO_2 matrix does not change significantly the thin films transparency. The incorporation of 2.6 at. % Tb increases the photocatalytic activity more than two times as compared to undoped TiO_2 .

The paper “*photoelectrocatalytic performance of benzoic acid on TiO_2 nanotube array electrodes*” reports the adsorption, degradation rate, and reaction characteristics of benzoic acid degradation by analyzing the changes in the photogenerated $I-t$ profiles. This work will provide new insights into the degradation characteristics, reaction mechanism, and reaction kinetics of aromatic organic compounds on the TNA electrode surface.

The paper “*Photocatalytic degradation of 2,4-dichlorophenol using nanosized $\text{Na}_2\text{Ti}_6\text{O}_{13}/\text{TiO}_2$ heterostructure particles*” reports preparation of $\text{Na}_2\text{Ti}_6\text{O}_{13}/\text{TiO}_2$ composite particles by a reverse microemulsion method. The photocatalytic activity of the samples is evaluated by degradation of

2,4-dichlorophenol (2,4-DCP) under 40 W ultraviolet lamp irradiation. The results show that the synthesized nanobelts $\text{Na}_2\text{Ti}_6\text{O}_{13}/\text{TiO}_2$ heterostructures have typical width from 80 to 100 nm, thickness less than 40 nm, and length up to 5 μm . Such $\text{Na}_2\text{Ti}_6\text{O}_{13}/\text{TiO}_2$ composite particles exhibit better photocatalytic activity than P25- TiO_2 .

In “*Nanocrystalline N-doped TiO_2 powders: mild hydrothermal synthesis and photocatalytic degradation of phenol under visible light irradiation*,” N-doped TiO_2 powders are prepared using technical guanidine hydrochloride, titanil sulfate, and urea as precursors by hydrothermal method. The UV-visible absorption spectra show that the absorption edge of the N-doped TiO_2 powders red shifts into the visible light region.

In “*Release of volatile compounds from polymeric microcapsules mediated by photocatalytic nanoparticles*,” a suitable method is proposed for the solar-activated controlled release of volatile compounds from polymeric microcapsules bonded with photocatalytic nanoparticles. These reservoirs can find potential application including controlled release of insecticides, repellents, or fragrances. The surface of the microcapsules is functionalized with TiO_2 nanoparticles. Upon ultraviolet irradiation, redox mechanisms are initiated on the semiconductor surface, resulting in the dissociation of the polymer chains of the capsule wall and, finally, volatilization of the encapsulated compounds.

In “*Synthesis, characterization, and photocatalysis of well-dispersible phase-pure anatase TiO_2 nanoparticles*,” high-purity anatase TiO_2 nanoparticles are fabricated by an improved sol-hydrothermal method. The photocatalytic performance of TiO_2 nanoparticles is evaluated by using photocatalytic degradation of X-3B and X-BR solutions. The results indicate that the as-prepared TiO_2 exhibits higher photocatalytic activity than P25. Also, the as-synthesized TiO_2 can settle down and be separated easily after the photocatalytic reaction.

The paper “*Physicochemical study of photocatalytic activity of TiO_2 supported palygorskite clay mineral*” reports the influence of physicochemical parameters, namely, the photocatalyst loading, dye concentration, and pH of polluted solutions on the degradation efficiency of Orange G (OG) solutions in the presence of clay mineral containing TiO_2 .

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