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Editorial

TiO_2-Based Nanomaterials: Design, Synthesis, and Applications

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Nanostructure materials with specific properties or activities are not expected in bulk phase and have already led to a breakthrough in various fields of research and application. Within these nanomaterials, TiO_2-based nanomaterials attracted great interest and intensive researches due to their merits of high specific surface area, proper electronic band structure, high quantum efficiency, chemical innerness, and stability (Figure 1). Over the past decades, derivations from TiO_2-based nanostructures materials constructed by various techniques, for example, assisted-template method [1, 2], hydrothermal treatment [3–5], and electrochemical anodic oxidation [6–9], have extensively been investigated for many potential applications, including environmental photocatalysis/adsorbent, dye-sensitized solar cell, and biomedical implants [10–13].

This special issue is focused on the rational design, environmental-friendly synthesis strategies and promising applications based on hierarchical TiO_2-based nanostructured materials. Some of researched works collected by this issue are as follows.

Z. H. Luo et al. in "Correlation between the Photocatalytic Degradability of PAHs over Pt/TiO_2-SiO_2 in Water and Their Quantitative Molecular Structure" reported photocatalytic character and kinetics of six polycyclic aromatic hydrocarbons (PAHs) in Pt/TiO_2-SiO_2 suspension. The results show that the degradation of high molecular weight (HMW) PAHs, PYR, BaP, and DahA were accelerated significantly in the presence of Pt/TiO_2-SiO_2, while the degradation efficiency of low molecular weight (LMW) PAHs, NP, FL, and PHE were inhibited under the same experimental conditions. More impressing, the photocatalytic degradability of 67 PAHs was predicted and verified in a way by comparing against the maximum GAP of PAHs that could be photocatalytically degraded and the minimum GAP of PAHs that could not be photocatalytically degraded in this study.

A. Asghar et al. in "Comparison of Adsorption Capability of Activated Carbon and Metal Doped TiO_2 for Geosmin and 2-MIB Removal from Water" presented a facile method to synthesis of the Fe doped and Pt doped TiO_2 nanoparticles. Compared with granular activated carbon which is the most widely used water purification, such doped TiO_2 nanoparticles demonstrated their potential application for Geosmin and 2-MIB adsorbent because of their smaller size, larger surface, and more active adsorption site. The present experimental results suggest that metal doped titania nanoparticles demonstrate significant adsorption potential for the accelerated removal for earthy-musty odor producing compounds in the drinking water.

Y. H. Lin et al. in "Facile Synthesis and Characterization of N-Doped TiO_2 Photocatalyst and Its Visible-Light Activity for Photo-Oxidation of Ethylene" adopted a facile wet chemical method to construct highly photoactive nitrogen doped TiO_2 (N-TiO_2) powders with visible responsive capability, and utilized the N-TiO_2 powder for the visible-light

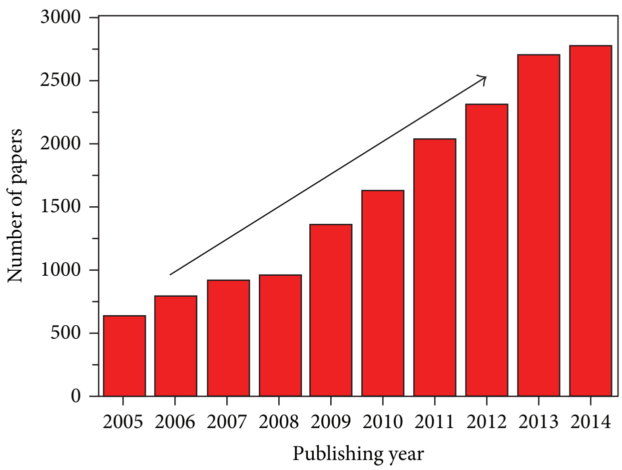

Figure 1: The number of papers published with "nano∗ and TiO_2" or "nano∗ and titanate" as the keywords in the article title from 2005 to 2014.

photocatalytic degradation of ethylene pollutant. Compared to commercial P25, the photocatalytic results demonstrated that the TiO_2 powder with or without N-doping was a higher efficient photocatalyst. Moreover, the author deeply studied and discussed the photocatalytic mechanism under visible-light irradiation.

M. Fujita et al. in "Preparation of Oleyl Phosphate-Modified TiO_2/Poly(methyl methacrylate) Hybrid Thin Films for Investigation of Their Optical Properties" employed oleylphosphate modified TiO_2 nanoparticles to prepare polymethylmethacrylate- (PMMA-) based hybrid materials via the ex situ route. The hydrophobic modification of TiO_2 nanoparticle surfaces through stable Ti-O-P bonds was verified to effectively suppress the aggregation of TiO_2 nanoparticle in polymer matrices to achieve high refractive index. The composite thin film exhibited the highest refractive index ($n = 1.86$) with 20 vol% content of TiO_2 and still kept excellent optical transparency even with a TiO_2 content up to 70 mass%. We believe that the strategy with the ex situ route for preparation of TiO_2/polymer hybrids after surface modification enables us to control the refractive indices easier than the in situ route and would have huge impact in optical films related to TiO_2 nanoparticles.

W. Guan et al. in "Preparation and Photocatalytic Performance of Nano-TiO_2 Codoped with Iron III and Lanthanum III" synthesized metal (Fe^{3+}, La^{3+}) doping nanoscale titanium dioxide (nano-TiO_2) via sol-gel method to improve its photocatalytic activity and utilization of visible light. The modified sol-gel method was verified to be an effective technique for codoping the TiO_2 lattice with Fe^{3+} and La^{3+} and restricted the growth of doped TiO_2 crystal. Furthermore, the catalytic mechanism which was revealed for metal doping of nano-TiO_2 was proposed. Codoping of nano-TiO_2 with the tombarthite metal mixture had a synergistic effect on the photodegradation reaction of methyl orange. The codoped nano-TiO_2 exhibited superior photocatalytic activity compared to the sum of the single-doped nano-TiO_2 samples. This work provided a potentially attractive and effective approach for TiO_2 photocatalysis to resolve the environmental problem.

X. H. Dai et al. in "Attenuating Immune Response of Macrophage by Enhancing Hydrophilicity of Ti Surface" constructed Ti samples with high contrast of surfaces hydrophilicity. Experimental results showed that highly hydrophilic Ti surface (Ti-H_2O_2) yielded good biocompatibility and less multinucleated cells formation in vitro. The secretion of TNF-α and IL-10 quantified by ELISA revealed that more hydrophilic Ti surface leads to lower activation status of macrophages. Moreover, the NF-κB assay revealed that NF-κB/TNF-α might be the possible mechanism underlying behind surface hydrophilicity modulating immune response. All these results suggested that hydrophilic Ti surface might be more favorable in attenuating macrophage immune response via NF-κB signaling, which may provide new insight in surface-designing of novel implant devices.

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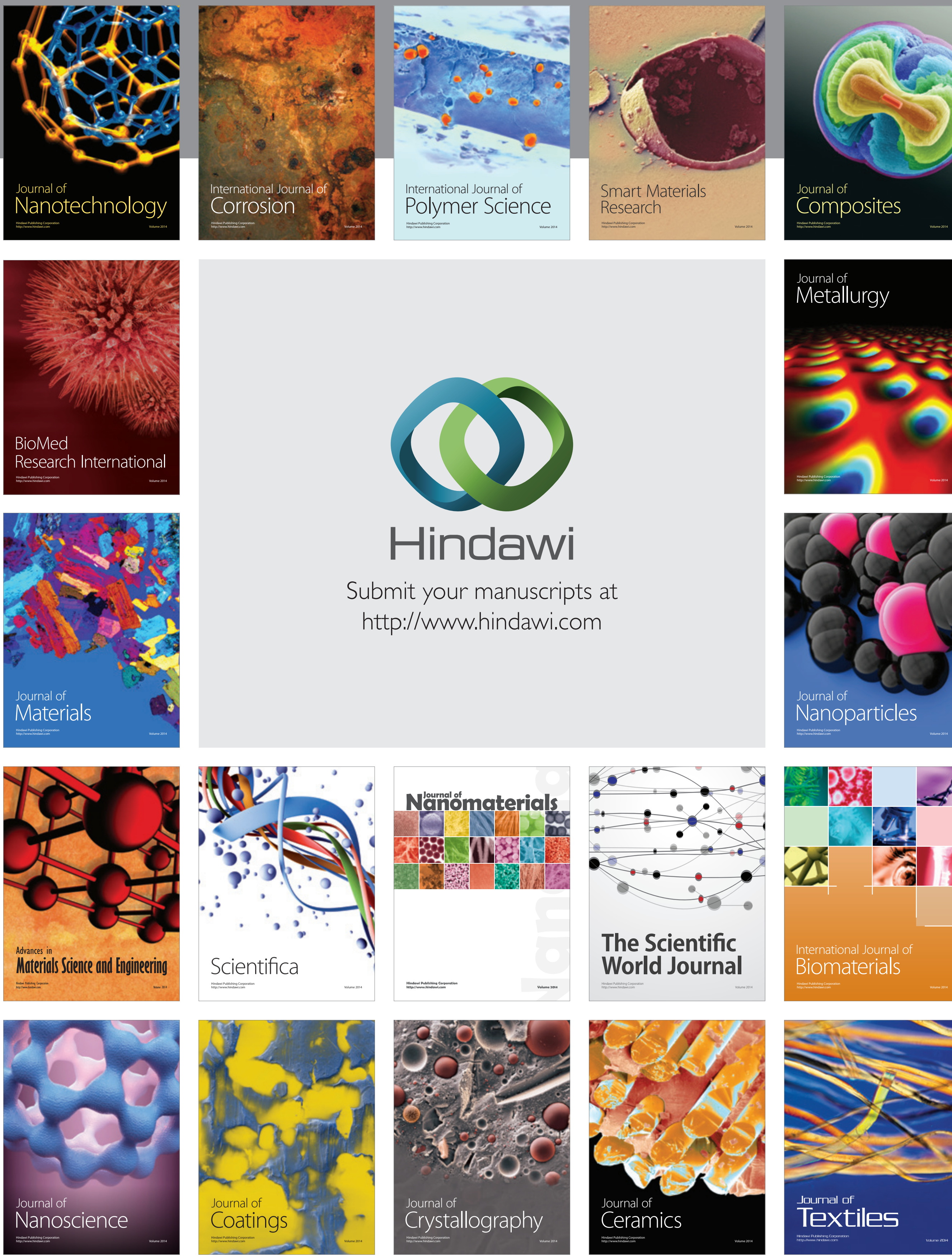
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