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International Journal of Nano Studies & Technology (IJNST)
ISSN 2167-8685

Photocatalyst Nanomaterials for Environmental Challenges and Opportunities

Editorial

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Received: October 11, 2012
Published: November 20, 2012

Citation: Koo Y, Collins B, Sankar J, Yun Y (2012) Photocatalyst Nanomaterials for Environmental Challenges and Opportunities, Int J Nano Stud Technol, 1(2e), 1-2. **doi: http://dx.doi.org/10.19070/2167-8685-120002e**

Climate change caused by fossil-fuel use and other natural causes as well as Western and Asian economic growth driven by excessive consumption is among the biggest environmental challenges of the 21st century. Advances in nanotechnology bring a new tool set to remediate environmental challenges such as pollutant removal, anti-terror, air/liquid/soil filtration, and carbon dioxide conversion to hydrocarbons. As innovative engineered nanomaterials emerge, it is critical to establish the fundamental science of these new materials so that their utility is optimized and unintended consequences of their use are avoided.

The potential of photoelectrocatalyst nanomaterials is significant for environmental clean-up, pollution control, chemical/biological weapon remediation, emission filtration, and carbon dioxide conversion. In principle, catalyzed reactions energized by natural sunlight can be used to clean water, remove toxic chemicals, and create fuel and synthon stock and can be achieved using titanium dioxide particle systems [1]. Photoactive properties of titanium dioxide particles such as super-hydrophilicity, self-cleaning, and anti-bacterial qualities, were enhanced by doping with novel metals (Pt, Pd, Au, Ag, Cu, or Ni) and carbon nanomaterials (carbon nanotubes, graphene) [2-8]. Further tailoring of TiO_2 nanoparticle systems is under development to be used for air and water pollution removal for industrial and defense purposes. Even though photocatalytic reaction of TiO_2 was developed in the early 1970's [9], nanoscaled applications of the materials is improving catalytic efficiency and allowing smarter functionalities through chemical and physical alteration.

A potential promise of TiO_2 nanoparticles science is the catalytic conversion of carbon dioxide into useful hydrocarbons driven by sunlight energy. Carbon dioxide is a thermodynamically stable molecule and a significant amount of energy is required for catalytic reaction; however photocatalyst utilizing TiO_2 nanoparticles have been shown to convert CO_2 and water vapor into hydrocarbon fuels using sunlight [10]. Modification of TiO_2 nanoparticles by doping with metals can tune band-gap properties and decrease exciton recombination rates, which eventually increase the availability of electron and holes for chemical conversion of substrates (CO_2 and H_2O, for example) and increases visible light sensitivity which allows for more efficient harvesting of the solar spectrum. Other nanoparticle systems can be assembled with the TiO_2 particles to tune and improve catalytic efficiency. Carbon nanomaterials are such a promising material due to their light absorption properties, electron storage capabilities, and electronic behavior, tunable from metallic to semiconductor. Additionally smart TiO_2 systems can be developed into sensors such as antiterrorism and bioweapon neutralization due to their chemical and electrical properties. As Dr. Richard Feynman said, "there's plenty of room at the bottom" [11]; we envision there is still a lot of room for TiO_2 nanotechnology to innovate positively for human and earthly welfare.

In conclusion, new photocatalyst nanomaterials like TiO_2 coupled with metals, functional polymers, and carbon nanomaterials are targeted to yield smart materials that exhibit outstanding photocatalytic reactivity under sunlight, biological and chemical inertness, nontoxicity, long-term stability, and that can be interfaced with electronic and photonic systems. As this science develops, the sustainability of such materials and their net impact on global health will be a focus of the fields of engineering and science. Optimally, the application of these smart materials can mitigate the deterioration of our natural environment and improve clean air, potable water, and wastewater treatment through the removal of toxic pollutants. Further applications include the inactivation of organisms such as bacteria, viruses, and cancer. The impact of efficient, sustainable photocatalytic particles has many useful and practical applications that could ultimately result in a simpler, more efficient, and equitable economic systems.

Acknowledgment

This research was partially supported by BAA11-001 Long Range Board Agency for Navy and Marine Corps Science and Technology Program.

References

[1]. C.S. Uyguner-Demirel, M. Bekbolet, Significance of analytical parameters for the understanding of natural organic matter in relation to photocatalytic oxidation, Chemosphere 84 (2011) 1009–1031
[2]. Ya-Lei Chen, Yao-Shen Chen, Hao Chan, Yao-Hsuan Tseng, Shu-Ru Yang, Hsin-Ying Tsai, Hong-Yi Liu, Der-Shan Sun, Hsin-Hou Chang, The Use of Nanoscale visible light-responsive photocatalyst TiO2-Pt for the elimination of soil-borne pathogens, PLoS One 7 (2012) e31212.

[3]. Jiaguo Yu, Lifang Qi, and Mietek Jaroniec, Hydrogen production by photocatalytic water splitting over Pt/TiO2 Nanosheets with exposed (001) facets, J. Phys. Chem. C 114 (2010) 13118-13125.

[4]. Zhi Wei She, Shuhua Liu, Michelle Low, Shuang-Yuan Zhang, Zhaolin Liu, Adnen Mlayah, and Min-Yong Han, Janus Au-TiO2 photocatalysts with strong localization of plasmonic near-fields for efficient visible-light hydrogen generation, Adv. Mater. 24 (2012) 2310-2314.

[5]. M. Behpour, S. M. Ghoreishi , F. S. Razavi , Photocatalytic activity of TiO2/Ag nanoparticle on degradation of water pollutions, Digest Journal of Nanomaterials and Biostructures, 5 (2010) 467-475.

[6]. Raffaele Marotta, Ilaria Di Somma, Danilo Spasiano, Roberto Andreozzi and Vincenzo Caprio, An evaluation of the application of a TiO2/Cu(II)/solar simulated radiation system for selective oxidation of benzyl alcohol derivatives, J Chem. Technol. Biotechnol. (2012)

[7]. Jiaguo Yu, Yang Hai, and Bei Cheng, Enhanced photocatalytic H2-production activity of TiO2 by Ni(OH)2 cluster modification, J. Phys. Chem. C 115 (2011) 4953-4958.

[8]. Yanhui Zhang, Nan Zhang, Zi-Rong Tang and Yi-Jun Xu, Improving the photocatalytic performance of graphene-TiO2 nanocomposites via a combined strategy of decreasing defects of graphene and increasing interfacial contact, Phys. Chem. Chem. Phys. 14 (2012) 9167-9175.

[9]. A. Fujishima and K. Honda, Electrochemical photolysis of water at a semiconductor electrode, Nature 238 (1972) 37-38

[10]. S.C. Roy, O.K. Varghese, M. Paulose, C.A. Grimes, Toward solar fuels: photcatalytic conversion of carbon dioxide of hydrocarbons, ACS Nano, 4 (2010) 1259-1278.

[11]. Richard Feynman, There's plenty of room at the bottom, Engineering and Science, 23(5) (1960) 22-36.