Nano-Micro Conference

Abstract View Online

Facile Development of Nanostructured Photocatalysts for CO_2 Capture and Conversion

Wei-Ning Wang*

Department of Mechanical and Nuclear Engineering, Virginia Commonwealth University, 800 E. Leigh St., Richmond, Virginia, United States of America

Corresponding Author. Email: wnwang@vcu.edu

Received: 30 May 2017, Accepted: 17 June 2017, Published Online: 27 October 2017

Citation Information: Wei-Ning Wang, Nano-Micro Conference, 2017, 1, 01047 doi: 10.11605/cp.nmc2017.01047

Abstract

The continuous reliance on fossil fuel-based energy is inevitable. Rational strategies to reduce carbon dioxide (CO_2) emissions are thus highly demanded. Developing efficient photocatalysts that can harness solar energy appears to be a promising methodology to capture and recycle CO_2 as a fuel feedstock. The conversion efficiency of the current photocatalysts, however, is generally very low due to various limiting factors, such as fast electron-hole recombination rates, narrow light absorption range, and backward reactions. Thus, developing strategies to overcome the above limitations is an important task in this field.

Here we present several strategies through controlled synthesis to address the aforementioned limitations toward enhancing the overall CO_2 conversion efficiency. Examples of novel photocatalysts being explored include mesoporous nanocomposite particles (i.e., Cu-TiO_2-SiO_2) [1,2], 1D structured Pt-TiO_2 thin films [3], CuO-ZnO heterojunction nanowires [4], and crumpled graphene-based nanoballs [5,6]. Systematic materials characterization and photocatalysis analysis of the materials, by electron microscopy, X-ray diffraction, gas chromatography, X-ray photoelectron spectroscopy, in-situ diffuse reflectance infrared Fourier transform spectroscopy, and femtosecond time-resolved transient absorption spectroscopy, aid in understanding the quantitative CO_2 photoreduction pathways and the correlations between materials properties and CO_2 photoreduction performance.

References

[1] W.N. Wang; J. Park; P. Biswas, Rapid synthesis of nanostructured Cu-TiO_2-SiO_2 composites for CO_2 photoreduction by evaporation driven self-assembly. Catalysis Science & Technology. 1, 593-600 (2011). doi:10.1039/C0CY00091D

[2] Y. Li; W.N. Wang; Z.L. Zhan; M.H. Woo; C.Y. Wu; P. Biswas, Photocatalytic reduction of CO_2 with H_2O on mesoporous silica supported Cu/TiO_2 catalysts. Applied Catalysis B: Environmental. 100, 386-392 (2010). doi:10.1016/j.apcatb.2010.08.015

[3] Wei-Ning Wang; Woo-Jin An; Balavinayagam Ramalingam; Somik Mukherjee; Dariusz M. Niedzwiedzki; Shubhra Gangopadhyay; Pratim Biswas, Size and structure matter: enhanced CO_2 photoreduction efficiency by size-resolved ultrafine Pt nanoparticles on TiO_2 single crystals. Journal of the American Chemical Society. 134, 11276-11281 (2012). doi:10.1021/ja304075b

[4] Wei-Ning Wang; Fei Wu; Yoon Myung; Dariusz M. Niedzwiedzki; Hyung Soon Im; Jeunghee Park; Parag Banerjee; Pratim Biswas, Surface engineered CuO nanowires with ZnO islands for CO_2 photoreduction. ACS Applied Materials & Interfaces. 7, 5685-5692 (2015). doi:10.1021/am508590j

[5] W. N. Wang; Y. Jiang; J. Fortner; P. Biswas, Nanostructured graphene-titanium dioxide composites synthesized by a single-step aerosol process for photoreduction of carbon dioxide. Environmental Engineering Science. 31, 428 (2014). doi:10.1089/ees.2013.0473

[6] Y. Nie; W. N. Wang; Y. Jiang; J. Fortner; P. Biswas, Crumpled reduced graphene oxide-amine-titanium dioxide nanocomposites for simultaneous carbon dioxide adsorption and photoreduction. Catalysis Science & Technology. 6, 6187-6196 (2016). doi:10.1039/C6CY00828C

Open Access