

TOP TEN SUSTAINABLE CHEMISTRY PAPERS

THESE ARE the most-read papers in sustainable or ‘green’ chemistry from *Environmental Science & Technology*, *Environmental Science & Technology Letters* and *ACS Sustainable Chemistry & Engineering* over the past 12 months.

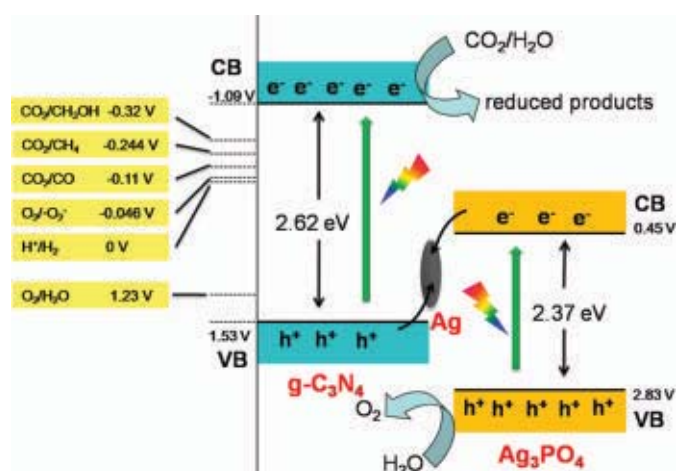
New Application of Z-Scheme $\text{Ag}_3\text{PO}_4/\text{g-C}_3\text{N}_4$ Composite in Converting CO_2 to Fuel

Yiming He[†], Lihong Zhang[‡], Botao Teng[‡], and Maohong Fan^{**}

[†] University of Wyoming, Laramie, Wyoming, USA [‡] Zhejiang Normal University, Jinhua, Zhejiang, China

Environ. Sci. Technol., **2015**, 49 (1), pp 649–656

DOI: 10.1021/es5046309



This research was designed for the first time to investigate the activities of photocatalytic composite, $\text{Ag}_3\text{PO}_4/\text{g-C}_3\text{N}_4$, in converting CO_2 to fuels under simulated sunlight irradiation. The composite was synthesized using a simple in situ deposition method and characterized by various techniques including Brunauer–Emmett–Teller method (BET), X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), UV–vis diffuse reflectance spectroscopy (DRS), photoluminescence spectroscopy (PL), and an electrochemical method. Thorough investigation indicated that the composite consisted of Ag_3PO_4 , Ag, and $\text{g-C}_3\text{N}_4$. The introduction of Ag_3PO_4 on $\text{g-C}_3\text{N}_4$ promoted its light absorption performance. However, more significant was the formation of heterojunction structure between Ag_3PO_4 and $\text{g-C}_3\text{N}_4$, which efficiently promoted the separation of electron–hole pairs by a Z-scheme mechanism and ultimately enhanced the photocatalytic CO_2 reduction performance of the $\text{Ag}_3\text{PO}_4/\text{g-C}_3\text{N}_4$. The optimal $\text{Ag}_3\text{PO}_4/\text{g-C}_3\text{N}_4$ photocatalyst showed a CO_2 conversion rate of $57.5 \mu\text{mol h}^{-1} \cdot \text{g}_{\text{cat}}^{-1}$, which was 6.1 and 10.4 times higher than those of $\text{g-C}_3\text{N}_4$ and P25, respectively, under simulated sunlight irradiation. The work found a new application of the photocatalyst, $\text{Ag}_3\text{PO}_4/\text{g-C}_3\text{N}_4$, in simultaneous environmental protection and energy production. ■

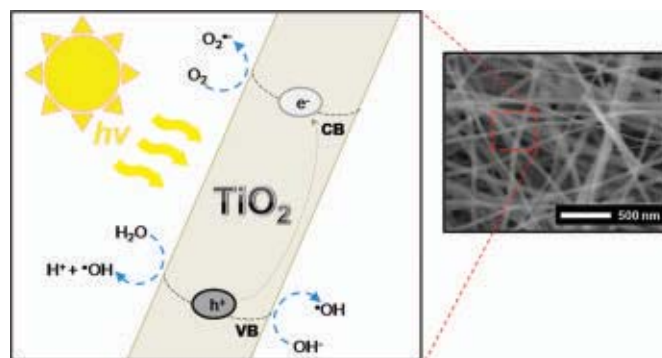
Tailored Synthesis of Photoactive TiO_2 Nanofibers and Au/TiO_2 Nanofiber Composites: Structure and Reactivity Optimization for Water Treatment Applications

Michael J. Nalbandian[†], Katherine E. Greenstein[‡], Danmeng Shuai[‡], Miluo Zhang[‡], Yong-Ho Choa[§], Gene F. Parkin[‡], Nosang V. Myung^{**}, and David M. Cwiertyny^{**}

[†] University of California—Riverside, California, USA [‡] University of Iowa, Iowa City, Iowa, USA [§] Hanyang University, Ansan, Kyeonggi-do, Korea

Environ. Sci. Technol., **2015**, 49 (3), pp 1654–1663

DOI: 10.1021/es502963t



Titanium dioxide (TiO_2) nanofibers with tailored structure and

composition were synthesized by electrospinning to optimize photocatalytic treatment efficiency. Nanofibers of controlled

diameter (30–210 nm), crystal structure (anatase, rutile, mixed phases), and grain size (20–50 nm) were developed along with composite nanofibers with either surface-deposited or bulk-integrated Au nanoparticle cocatalysts. Their reactivity was then examined in batch suspensions toward model (phenol) and emerging (pharmaceuticals, personal care products) pollutants across various water qualities. Optimized TiO₂ nanofibers meet or exceed the performance of traditional nanoparticulate photocatalysts (e.g., Aeroxide P25) with the greatest reactivity enhancements arising from (i) decreasing diameter (i.e., increasing surface area), (ii) mixed phase composition [74/26 (± 0.5) % anatase/rutile], and (iii) small amounts (1.5 wt %) of surface-deposited, more so than bulk-integrated, Au nanopar-

ticles. Surface Au deposition consistently enhanced photoactivity by 5- to 10-fold across our micropollutant suite independent of their solution concentration, behavior that we attribute to higher photocatalytic efficiency from improved charge separation. However, the practical value of Au/TiO₂ nanofibers was limited by their greater degree of inhibition by solution-phase radical scavengers and higher rate of reactivity loss from surface fouling in nonidealized matrixes (e.g., partially treated surface water). Ultimately, unmodified TiO₂ nanofibers appear most promising for use as reactive filtration materials because their performance was less influenced by water quality, although future efforts must increase the strength of TiO₂ nanofiber mats to realize such applications. ■

Influence of Biogas Flow Rate on Biomass Composition During the Optimization of Biogas Upgrading in Microalgal-Bacterial Processes

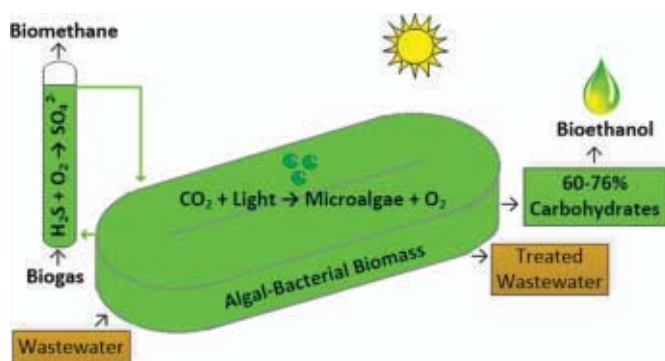
Mayara L. Serejo^{†‡}, Esther Posadas[†], Marc A. Boncz[‡], Saúl Blanco[§], Pedro García-Encina[†], and Raúl Muñoz^{**}

[†] University of Valladolid, Spain [‡] Federal University of Mato Grosso do Sul, Campo Grande, Brazil [§] University of León, Spain *Environ. Sci. Technol.*, **2015**, 49 (5), pp 3228–3236

DOI: 10.1021/es5056116

The influence of biogas flow rate (0, 0.3, 0.6, and 1.2 m³ m⁻² h⁻¹) on the elemental and macromolecular composition of the algal-bacterial biomass produced from biogas upgrading in a 180 L photobioreactor interconnected to a 2.5 L external bubbled absorption column was investigated using diluted anaerobically digested vinasse as cultivation medium. The influence of the external liquid recirculation/biogas ratio ($0.5 < L/G < 67$) on the removal of CO₂ and H₂S, and on the concentrations of O₂ and N₂ in the upgraded biogas, was also evaluated. A L/G ratio of 10 was considered optimum to support CO₂ and H₂S removals of 80% and 100%, respec-

tively, at all biogas flow rates tested. Biomass productivity increased at increasing biogas flow rate, with a maximum of 12 ± 1 g m⁻² d⁻¹ at 1.2 m³ m⁻² h⁻¹, while the C, N, and P



biomass content remained constant at $49 \pm 2\%$, $9 \pm 0\%$, and $1 \pm 0\%$, respectively, over the 175 days of experimentation. The high carbohydrate contents (60–76%), inversely correlated to biogas flow rates, would allow the production of ≈ 100 L of ethanol per 1000 m³ of biogas upgraded under a biorefinery process approach. ■

Re-Designing of Existing Pharmaceuticals for Environmental Biodegradability: A Tiered Approach with β -Blocker Propranolol as an Example

Tushar Rastogi, Christoph Leder, and Klaus Kümmerer*

Leuphana University Lüneburg, Germany *Environ. Sci. Technol.*, **2015**, 49 (19), pp 11756–11763

DOI: 10.1021/acs.estlett.6b00046

Worldwide, contamination of aquatic systems with micropollutants, including pharmaceuticals, is one of the challenges for sustainable management of water resources. Although micropollutants are present at low concentrations, many of them raise considerable toxicological concerns, particularly when present

as components of complex mixtures. Recent research has shown that this problem cannot be sustainably solved with advanced effluent treatment. Therefore, an alternative that might overcome these environmental problems is the design of new pharmaceutical molecules or the redesign of existing pharmaceutical molecules that present the functionality needed for their application and have improved environmental biodegradability. Such redesigning can be performed by small molecular changes in the drug molecule with intact drug moiety which could incorporate the additional attribute such as biodegradability while retaining its pharmacological potency. This proof of concept study provides an approach for the rational redesign of a given pharmaceutical (Propranolol as an example). New derivatives with small molecular changes as compared to