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Editorial

Structurally and Elementally Promoted Nanomaterials for Photocatalysis

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Due to the increasingly polluted environment and the gradual depletion of fossil fuel reserves, the development of renewable technologies for environmental remediation and energy production is highly desirable. The photoenergy, specifically the solar energy, represents the ultimate energy source to sustain all lives on our planet and is also the energy source of the fossil fuels that are driving our technology. Thus, the direct harvest and conversion of solar energy into usable energy format are urgently required and considerably meet the requirements for the current issues on environment and energy, in which photocatalysis process initiated on nanomaterials is a crucial element, due to its inexpensive and clean nature by using abundant, cheap, and environmental friendly chemical reagents, energy source, and catalysts without secondary pollution [1]. Generally, nanomaterials for photocatalysis focus mainly on four aspects, namely, photocatalytic degradation of organic pollutants, photocatalytic water splitting to produce H_2 and O_2, photocatalytic reduction of CO_2, and photocatalytic synthesis for organic substances [2].

Nanostructured materials have attracted considerable attention for photocatalysis due to their unique physical and chemical properties in comparison to their bulk counterparts. These diverse nanostructures such as nanocrystals, nanopores, nanotubes, nanorods, nanowires, and other more complex hierarchical architectures with large surface areas, high surface to volume ratios, and numerous accessible catalytic active sites as well as efficient mass transport have been demonstrated to show extraordinary photocatalytic activity [3]. On the other hand, the manipulation of chemical compositions of nanomaterials is also effective in improving their photocatalysis performance, aiming at altering the electronic structures of catalysts and their surface properties. One of the well-known examples is the chemically doping of foreign elements which can greatly regulate the optical property of the resultant nanostructured TiO_2, leading to extended photoabsorption range and reducing the recombination of photoinduced electrons and holes [4].

Therefore, engineering of both the chemical composition and the morphology is of significant importance in promoting the specific photocatalytic activity of nanomaterials, which are extensively utilized by the novel works involved in this special issue, including 1 review article and 12 research papers. The review article summarized the hierarchical architectures from inorganic nanocrystal self-assembly, which show collective properties that differ from individual nanocrystals and bulk samples and exhibit many superiority in mass transfer and light harvesting, thus finding great application potential in photoenergy storage and conversion including photodegradation, photocatalytic H_2 production, photocatalytic CO_2 conversion, and sensitized solar cells.

In the research articles, different synthetic strategies were employed to construct delicate semiconductor nanostructures for photocatalysis, that is, synthesis of hierarchically porous α-FeOOH, macroporous TiO_2, and mesoporous TiO_2-SnO_2 nanocomposites via a polystyrene microsphere-templating route for high-performance photodegradation of organic dyes, sonochemical preparation of mesoporous N-doped TiO_2 nanoparticles for Rhodamine B photodegradation, solvothermal synthesis of Zn_2SnO_4 nanocrystals with high methyl orange depredating property, and fabrication of flower-like Cu_2ZnSnS_4 nanoflakes through a microwave-assisted solvothermal pathway with a direct band gap of 1.52 eV for efficient photoresponse.

Moreover, a comprehensive study was estabilished for the synthesis of Cu-TiO_2 nanotubes by electrochemical anodization and wet impregnation for UV photocatalysis removal of low-concentration Pb (II) ions. Mesoporous nanocrystalline titania photocatalysts were prepared in both acidic and basic media with the assistance of micellar surfactants, showing high photocatalytic activity in naphthalene degradation. The visible-light driven photocatalytic and photoelectrocatalytic degradation of humic acid was achieved by Cu/N codoped TiO_2 films grown on Ti substrates.

We do believe that these review and research articles will not only enrich our knowledge on promoting the nanophotocatalysis in structural and elemental aspects but also indicate the existence of a lot more technological issues which make this field more attractive and challenging.

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