Constructing Earth-Abundant Core Shell Plasmonic Photocatalysts for Hydrogen Production via Water Splitting

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Currently, new alternatives for greenhouse gases are of great interest, and hydrogen is a major player in the race for a new source of fuel. Hydrogen can be produced through a photocatalytic water splitting process, and although titanium dioxide (TiO_2) is a well known photocatalyst, factors such as its high recombination rate and an absence of a visible light absorption peak hinders its performance. By constructing transition metal-metal oxide core shell nanostructures (CSNs) that introduce copper (Cu) as a co-catalyst core, these issues with the semiconductor can be addressed. To create novel and efficient photocatalysts for hydrogen production, synthesis methods for earth abundant core shell Cu@TiO_2 nanostructures were designed. To construct these CSNs, a Cu core was synthesized with controlled size and morphology through a modified sol-gel method using Hexamethylenediamine as a capping agent and glucose as a reducing agent. Then, titanium dioxide was coated on the metal core, and the samples were calcined. The CSNs were characterized through TEM imaging, UV-vis spectroscopy, and a photocatalytic test based on light irradiation. Through a photocatalytic chamber, it was found that industrial grade TiO_2 produced the least amount of hydrogen, while prepared hollow TiO_2 produced twice as much as the industrial type, and Cu@TiO_2 produced the greatest amount of hydrogen. Cu successfully accelerated semiconductor-light reactions by expanding the absorption spectra of TiO_2, lowering the band gap, and reducing recombination. In addition, Cu is a cost-effective and earth-abundant potential co-catalyst, which makes the metal convenient for large scale manufacturing. Therefore, the Cu@TiO_2 CSNs proved to be efficient photocatalysts that should be further explored.

Awards Won:

Fourth Award of $500