Z-Scheme Photocatalysis: A More Systematic Approach with ALPHA-Fe2O3@Au@P-SiO2@Cu2O Nanostructure

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Hydrogen gas has the potential to be a clean source of energy and can be used in fuel cells, but current methods of H2 production such as natural gas reforming use non-renewable resources and contribute to global warming. Photocatalytic water splitting is an environmentally friendly alternative for generating H2 but there is a lack of efficient photocatalysts. The aim of this project was to create a photocatalyst to increase the efficiency of H2 production. The fundamental concept behind the way photocatalysts function is by the generation of electron hole pairs. In a semiconductor, when an electron is excited by light, it will leave behind a positively charged hole. These electron hole pairs carry out redox reactions that split water to produce H2. However, when the electrons lose energy and return back to their hole (recombination), they no longer carry out redox reactions. In order to reduce the rate of recombination, the structure of the photocatalyst was modeled after the z-scheme mechanism. Z-scheme photocatalysts mimic the light reactions of photosynthesis by using two-light sensitive semi-conductors and an electron conductor, which acts as the electron transport chain. This photocatalyst was created by synthesizing FeOOH nanorods as a template, which were then coated with gold nanoparticles. This was coated with SiO2 and the sample was calcined. The silica was etched to create a porous silica shell. CuCl2 solution was mixed with Fe2O3-Au-SiO2 solution to obtain the photocatalyst Fe2O3-Au-SiO2-Cu2O, which was tested and compared with other photocatalysts in a photocatalytic chamber using gas chromatography. More than 2 times the hydrogen was produced compared with the Fe2O3-Au-Cu2O photocatalyst, and about 16 times more was produced compared to using Au alone.