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Design and synthesis of photoelectrodes for solar fuel production

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Sunlight is a clean, renewable and abundant energy source on the earth. Its conversion to hydrogen has been considered an ideal solution to counter the depletion and environmental problems of fossil fuels. Photoelectrochemical (PEC) water splitting is an ideal technology for the purpose since H_2 could be produced directly from abundant and renewable water and solar light from the process. The key to the technology is photoelectrodes made of small band gap semiconductors of photocatalytic properties. The materials should have high efficiency, high stability and low cost. In addition to the discovery of new materials, the structure and morphology of the known materials could be controlled to enhance the performance of the photoelectrodes. In this talk, the concepts of materials design and their examples will be proposed for efficient photoelectrodes of PEC cells for visible light water splitting. Particularly, we will discuss the material designs including (i) p-n heterojunction photoanodes for effective electron-hole separation, (ii) electron highway to facilitate interparticle electron transfer, (iii) metal or anion doping to improve conductivity of the semiconductor and to extend the range of light absorption, (iv) one-dimensional nanomaterials to secure a short hole diffusion distance and vectorial electron transfer and (v) loading co-catalysts for facile charge separation.

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