Catalyst Integration and Surface Protection of Water-Splitting Photoelectrochemical Cells for Hydrogen Production Applications

Altoaimi, Dana (School: Kingdom Schools)

One challenge that currently faces the solar industry is the storage and transportation of this abundant energy. To mitigate this issue, solar energy can be converted to a different source of energy: hydrogen. Hydrogen is a zero-emission, renewable fuel with a high energy density that could be produced through water splitting by photoelectrochemical cells (PECs). With the emergence of different economically competitive solar devices, such as perovskites, PECs are still unique in their potential for application as cost-efficient, solar-to-hydrogen converting devices. However, the challenge with these cells is that they rapidly lose their stability due to corrosion when submerged in water. This novel research deposited a thin film of a non-corrosive semiconductor material, TiO2, by sputtering as a surface-protecting layer on an InGaP/GaAs/Ge PEC. Because the Ge bottom of junction of this cell does not require further stabilization, the protective layer is applied to the top junction of the PEC only. A Pt catalyst was also integrated on top of the protective thin film. The non-corrosive TiO2 thin film was characterized using X-Ray Diffraction (XRD), Atomic Force Microscopy (AFM), Ultraviolet Photoluminescence (UV-PL), and Raman Spectroscopy. Characterization measurements confirmed that higher temperatures lead to a more crystalline layer of the deposited material. The TiO2 protective thin film maintained a solar-to-hydrogen (STH) efficiency near 10% in cyclic voltammetric and chronoamperometric data, and also confirmed the increase in stability of the cell. Sputtering TiO2 as a low-cost protective layer is a promising technique for practical PEC solar-to-hydrogen production.

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