Materials for photoelectrochemical water splitting

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Abstract

A photoelectrochemical (PEC) water splitting device with a 10% solar-to-hydrogen (STH) conversion efficiency and 10 years lifetime was referred as the “Holy Grail” of chemistry [1]. This has been a significant materials challenge for decades [2].

While metal oxides based materials may be stable in aqueous solutions, key issues are wide band gap, band-edges mismatch and their low STH efficiencies. Different techniques have been studied for lowering the band gaps; and tandem cells [3-6] have been developed to solve the band-edges mismatch of metal oxides. Further approaches should focus on overcoming the intrinsic low STH, by considering absorption, charge mobility, recombination, interfacial kinetics, etc

On the other hand, III-V materials have suitable band gaps and high STH efficiencies. The band edge mismatch was successfully solved by a monolithic PEC/PV tandem cell design [7]. The trade-off is the stability of III-V materials in aqueous solution. NREL have been investigating the corrosion of III-V materials by analyzing the tested surfaces and solutions. Different surface modification methods including coating, ion bombardment and surface nitridation were tested for protecting the III-V materials and mitigating the corrosion issue. A combined approach, both solid surface treatment and inhibition from electrolyte, may be required to approach the “Holy Grail”.

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