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Title: Tandem Junction Si Microwire Based Devices for Water Splitting

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Abstract:

We have developed a microwire based Si/WO_3 tandem junction device for photo-assisted hydrogen production via water splitting. The device consists of an n-type Si microwire array with a heavily doped, radial p^+-Si emitter, forming a buried Si n/p^+ junction. Coating each Si microwire are two conformal layers consisting of a sputtered ITO contact layer below an electrodeposited WO_3 photoanode layer. Upon immersion in solution the WO_3 forms a semiconductor/liquid junction with solution, completing the tandem junction device.

Non-aqueous photoelectrochemical characterization of the buried Si n/p^+ junction showed V_{OC}=500mV and J_{SC}=10 mA-cm^{-2} with respect to both ferrocene and coblatocene redox couples. Aqueous photoelectrochemical characterization (1M H_2SO_4) of the WO_3/liquid junction showed V_{OC} = 700mV and J_{SC}=0.8mA-cm^{-2} with respect to the oxygen evolution reaction (OER). Complete device characterization in 1M H_2SO_4 showed a V_{OC}=1.2V and a J_{SC}=0.5mA cm^{-2} with respect to the OER at 1 Sun illumination. Light concentration (12 Suns) yielded a V_{OC} greater than the water splitting potential enabling successful unassisted H_2 (g) generation.

Recent work has focused on integration of Mo doped $BiVO_4$ (Mo:BiVO4) in place of WO_3 to increase performance. Results on planar Si n/p^+ junctions demonstrate V_{OC} = 1.5V vs OER with current densities >0.6 mA-cm^{-2} at the hydrogen evolution potential. Current work is focused on microwire Si/Mo:BiVO4 devices for unassisted water splitting.