Title: Tandem Junction Si Microwire Based Devices for Water Splitting

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Abstract:

We have developed a microwire based Si/WO₃ 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 WO₃ photoanode layer. Upon immersion in solution the WO₃ forms a semiconductor/liquid junction with solution, completing the tandem junction device.

Non-aqueous photoelectrochemical characterization of the buried Si n/p⁺ junction showed $V_{OC}=500$ mV and $J_{SC}=10$ mA·cm⁻² with respect to both ferrocene and coblatocene redox couples. Aqueous photoelectrochemical characterization (1M H₂SO₄) of the WO₃/liquid junction showed $V_{OC}=700$ mV and $J_{SC}=0.8$ mA·cm⁻² with respect to the oxygen evolution reaction (OER). Complete device characterization in 1M H₂SO₄ showed a $V_{OC}=1.2$ V and a $J_{SC}=0.5$ mA·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 H₂ (g) generation.

Recent work has focused on integration of Mo doped BiVO₄ (Mo:BiVO₄) in place of WO₃ to increase performance. Results on planar Si n/p⁺ junctions demonstrate $V_{OC} = 1.5$ V 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.