Electrical and Photoelectrochemical Properties of WO_3/Si Tandem Photoelectrodes

Supporting Information

Robert H. Coridan, Matthew Shaner, Craig Wiggenhorn, Bruce S. Brunschwig, and Nathan S. Lewis*

Kavli Nanoscience Institute, Beckman Institute and Joint Center for Artificial Photosynthesis

Division of Chemistry and Chemical Engineering

210 Noyes Laboratory, 127-72

California Institute of Technology

Pasadena, CA 91125

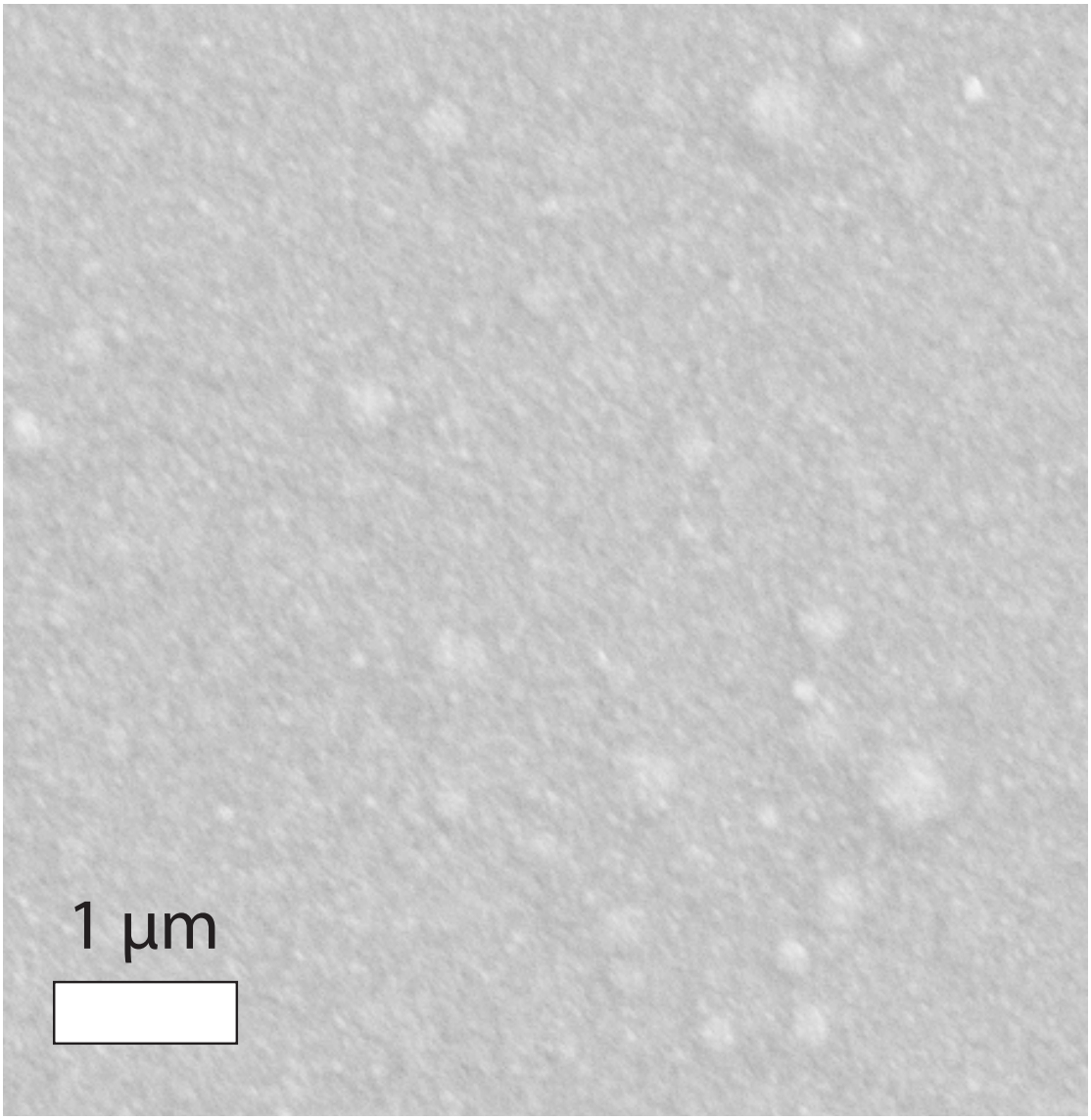

Figure SI.1 - SEM image of an electrodeposited WO_3 film on p-Si, showing nanocrystalline grains that are 50-200 nm in diameter. This 300 nm thick film was prepared by two 15 min cycles of galvanodynamic electrodeposition, after which the film was annealed in air at 500°C.

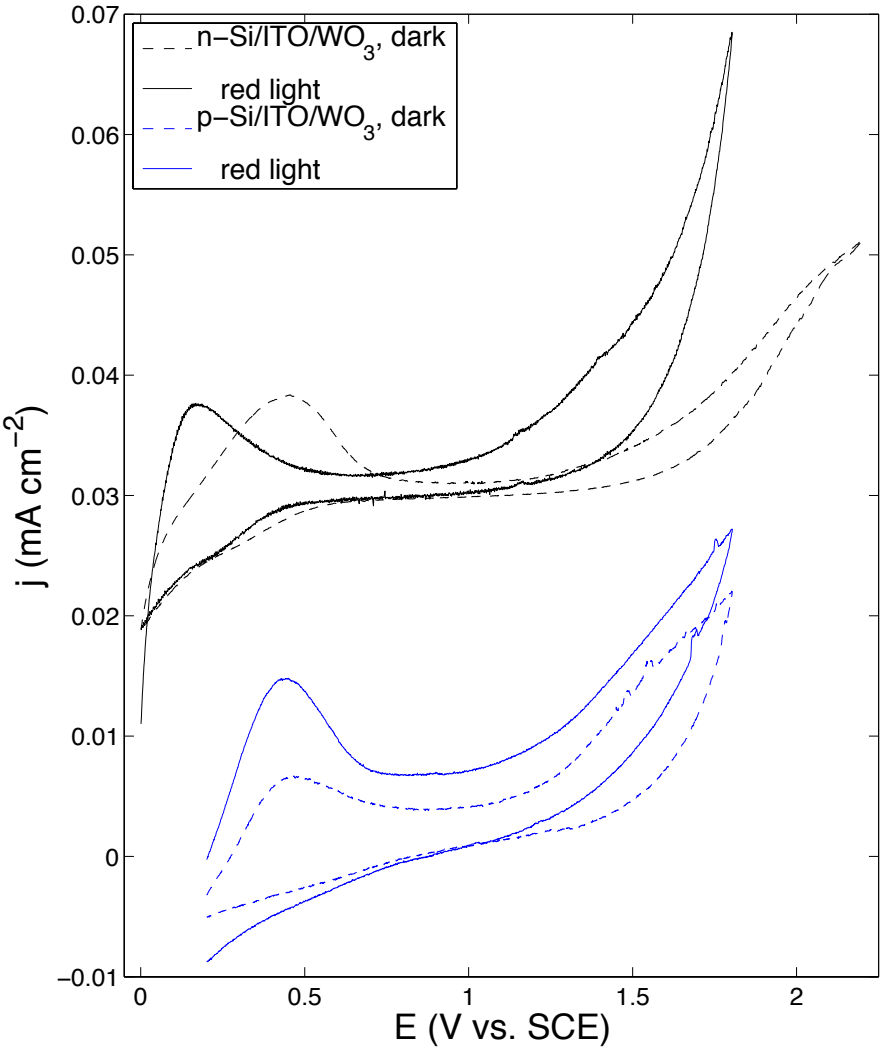

Figure SI.2 - Cyclic voltammagrams for p-Si/ITO/n-WO_3 (blue) and n-Si/ITO/n-WO_3 (black, shifted by +0.03mA cm^{-2} for clarity). The solid scans are illuminated with a solar simulator (AM1.5), with an additional red filter (Hoya R-60, Edmund Optics) placed between the lamp and the electrode. The red filter cuts off all illumination under 575nm, and can only excite carriers in the Si (E_{gap}=1.1eV, ie., capable of absorbing photons with wavelength < 1100nm). WO_3 has a band-gap of E_{gap}=2.7eV, which requires photons with wavelengths < 460nm to create electron-hole pairs. Red illumination (solid lines) demonstrates photovoltage (shift to negative potential for the onset of anodic current) only for the n-Si/ITO/n-WO_3 electrode. This photovoltage is generated by the n-Si/ITO Schottky junction that acts in tandem with the n-WO_3/liquid junction when exposed to the full AM1.5 spectrum. This demonstrates that the n-Si/ITO/n-WO_3 photoelectrode can utilize a larger portion of the solar spectrum as a monolithic device.

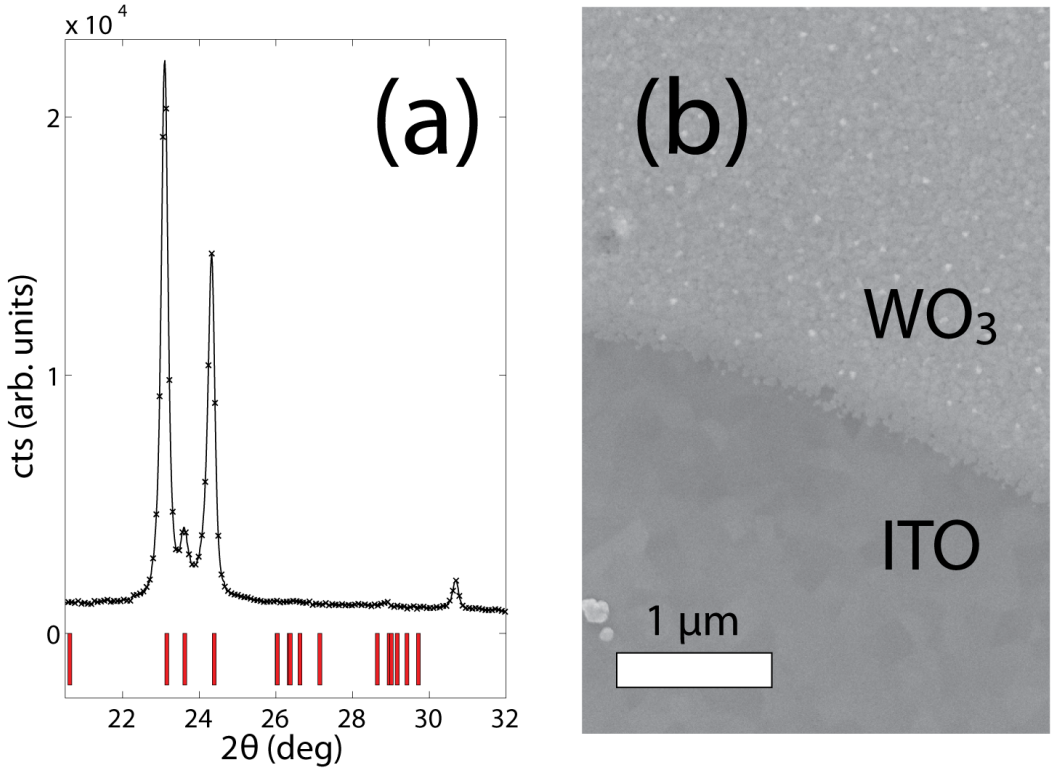

Figure SI.3 - (a) XRD data for a ITO/n-Si substrate with a thin film of electrodeposited WO3, corrected for finite substrate thickness. The peak at 2θ=30.6° is the <222> peak of crystalline ITO that appeared after the sample had been annealed [1]. (b) SEM micrograph of WO3 electrodeposited on an p-Si/ITO substrate. The bare ITO is visible on the left side of the image.

1. Purica, M.; Iacomi, F.; Baban, C.; Prepelita, P.; Apetroaei, N.; Mardare, D.; Luca, D., *Thin Solid Films* **2007,** *515* (24), 8674-8678.