Spectroelectrochemical investigation of ZnCr2O4 for high photovoltage p-type sensitized solar cells

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Sensitized-solar cells(SSCs) can be constructed from inexpensive materials at low cost and achieve a light-to-electricity conversion efficiency upto 12.3% in the lab. While this performance is better than other nanostructured solar cels, it is still insufficient for large-scale solar energy conversion. An extremely promising, under-researched route to much higher SSC efficiency is to double the device voltage by replacing the passive metal cathode with a high-performance sensitized photocathode, thereby enabling enhanced light capture of the solar spectrum. Such a tandem architecture has a theoretical maximum of ~44% for the light-to-electricity conversion when compared to the ~31% for a single junction device. To date, however, the handful of attempts to make sensitized photocathodes(p-type SSCs) have yielded very poor cell efficiencies(<1%) primarily due to the lack of nanocrystalline semiconductors with the appropriate band edge positions and hole diffusion lengths.

ZnCr2O4 nanocrystals have been synthesized via a solvothermal approach to yield colloidally stable, high surface area(>200 m2/g) nanoparticles that are suitable to make sensitized photoelectrodes. Preliminary optical and spectroelectrochemical analysis of porous ZCO electrodes in liquid junction indicate a wide band gap, p-type behavior with a flatband potential that is ~ 400mV more positive than the most studied p-type semiconductor NiO. Further conductivity measurements via electrochemical gating and impedance spectroscopy highlight the promise ZCO photoelectrodes show towards a high photovoltage p-type SSC.