Silicon Nanowire Array Photocathodes Coupled with Earth-Abundant Catalysts for Efficient Solar Hydrogen Evolution

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Abstract
Converting solar energy into chemical energy in the form of hydrogen (H_2) has been broadly considered as an elegant and promising approach to the storage of solar energy. To this end, efficient, low-cost, and stable semiconductor photoelectrodes are needed in order to make the widespread deployment of photoelectrochemical cells viable and the converted solar H_2 fuel economically competitive. In this presentation, we report our recent progress in developing silicon nanowire array based photocathodes for solar-driven H_2 evolution. Two types of photocathodes will be presented: 1) silicon microwire arrays coupled with electrodeposited molybdenum oxysulfide (MoO_xS_y) catalysts [1]; and 2) silicon nanowire arrays coupled with the emerging cobalt phosphide (Co-P) catalysts [2]. We will show that by rational structural design, both photocathodes exhibit outstanding activity and stability towards solar-driven H_2 evolution reaction, when compared to those of silicon nanowire arrays decorated with benchmark platinum nanoparticles. We believe that the silicon nanowire arrays coupled with either MoO_xS_y or Co-P Earth-abundant catalysts hold substantial promise for use as low-cost, efficient photocathodes in photoelectrochemical cells.

References

[1] X.Q. Bao, D.Y. Petrovykh, P. Alpuim, D.G. Stroppa, N. Guldris, H. Fonseca, M. Costa, J. Gaspar, C.H. Jin, L.F. Liu*, Nano Energy, in revision.
[2] X.Q. Bao, M. F. Cerqueira, P. Alpuim, L.F. Liu, Chem. Commun. 2015 DOI: 10.1039/c5cc02331a

Figures

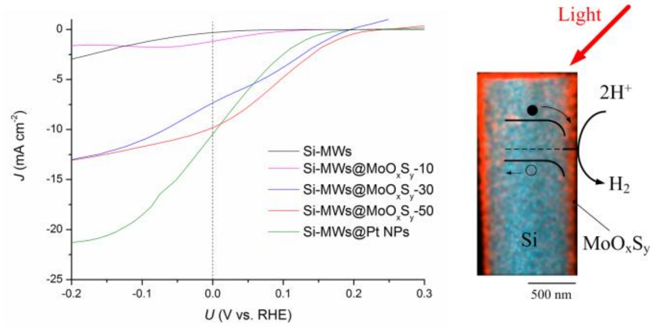

Figure 1: (left) J-U profiles of Si-MWs@MoO_xS_y photocathodes; (right) Elemental map of a single Si-MW@MoO_xS_y.

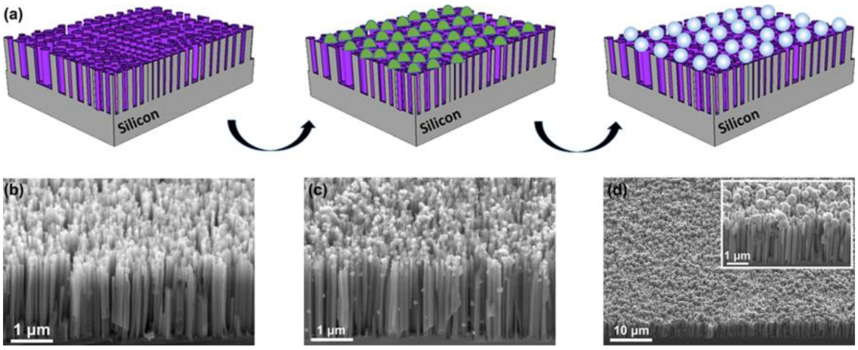

Figure 2. (a) Schematic illustration of the fabrication of Co-P sphere decorated SiNW arrays. Representative SEM micrographs of (b) the as-obtained SiNW arrays; (c) SiNW arrays coupled with photo-electrodeposited Co NPs, and (d) SiNW/Co-P-500 prepared by a phosphorization treatment at 500 °C for 6 h in high-purity N_2.