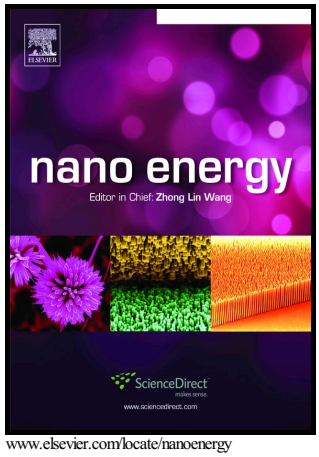

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PII: S2211-2855(16)30317-2
DOI: http://dx.doi.org/10.1016/j.nanoen.2016.08.029
Reference: NANOEN1442

To appear in: *Nano Energy*

Received date: 15 June 2016
Revised date: 3 August 2016
Accepted date: 10 August 2016

Cite this article as: Qianqian Zhang, Tianliang Xiao, Nana Yan, Zhaoyue Liu, Jin Zhai and Xungang Diao, Alternating Current Output from a Photosynthesis Inspired Photoelectrochemical Cell, *Nano Energy* http://dx.doi.org/10.1016/j.nanoen.2016.08.029

Alternating Current Output from a Photosynthesis-Inspired Photoelectrochemical Cell

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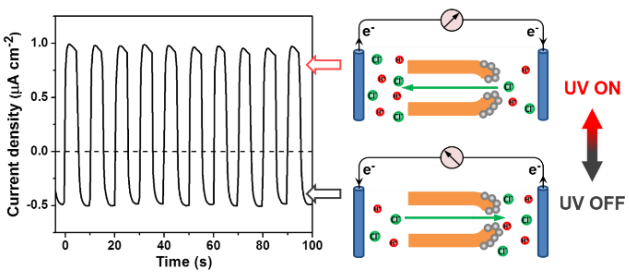
Abstract

Photosynthesis involves two opposite directions of proton flux across the photosynthetic membrane through embedded proton pumps and proton channels, which provides a biological prototype for designing new photovoltaic systems with alternating current (AC) generation. Here, Pt nanoparticles (Pt NPs) unilaterally covered TiO_2 nanoporous membrane, owing to similar characteristics with natural photosynthetic membrane, is employed to construct a photoelectrochemical cell with AC output through the combination with electron donor and acceptor. Ultraviolet light (UV) irradiation induces protons consumption and generation respectively in the two parts of solution across the membrane via asymmetric photochemical reactions. The resulting concentration gradient of HCl powers the generation of a forward photocurrent. Turning UV illumination off causes a reversed transmembrane HCl concentration gradient mainly because hydrogen atoms adsorbed on Pt NPs are oxidized to be protons, which leads to a reversal in the direction of the current. Upon illumination periodically switching on and off, a continuous and steady AC is generated from the photoelectrochemical cell. Moreover, the waveform of AC is adjustable, and a stable square-wave signal can be obtained by optimizing light on/off frequency and proton source concentration in this system.

Graphical abstract



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