E1-04 Enhanced photocurrent with p-Cu_2O photochemical cell

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Photoelectrochemical cells based on p-Cu_2O have attracted continuing interest as a means of solar energy conversion into electricity. The chief disadvantage of PECs related to p-Cu_2O is the instability from photocorrosion. A simple device based on p-Cu_2O was made by heating a copper plate in the air after deposition of a thin Au layer on the copper plate. This simple device exhibited remarkable stability and a higher photocurrent quantum efficiency when a thin NiO layer was on the surface.

Spectral response of bare p-Cu_2O has a photocurrent maximum. It is known that the p-Cu_2O layers prepared on copper substrates heating in the air are very thin and have very thin space charge layers, so that, the high energy photons larger than band gap of p-Cu_2O are absorbed in a very thin surface layer of p-Cu_2O. Since the volume of this layer is small, concentration of free carriers (both electrons and holes) inside the surface layer becomes very high, which causes a sharp increase in the recombination rate and a decrease in their life time. Here, enhancement of photocurrent quantum efficiency and disappearence of the photocurrent maximum for bare p-Cu_2O was observed, after adding Au and NiO. Reason for the above enhancement can be explained as follows. Au and NiO are known as good hole transfer and electron transfer catalysts. Adding Au and NiO layers to the bare p-Cu_2O, photogenerated holes and electrons tunnel towards Au and NiO, suppressing the recombination rate further. Even for high energy photons (larger than the band gap energy) a large number of photogenerated carriers are created in a small volume of surface layer of semiconductor and are separated quickly suppressing the recombination rate, remarkabaly.

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