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Fabrication of Hot Electron Based Photovoltaic Systems using Metal-semiconductor Schottky Diode

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It is known that a pulse of electrons of high kinetic energy (1-3 eV) in metals can be generated with the deposition of external energy to the surface such as in the absorption of light or in exothermic chemical processes. These energetic electrons are not in thermal equilibrium with the metal atoms and are called "hot electrons". The concept of photon energy conversion to hot electron flow was suggested by Eric McFarland and Tang who directly measured the photocurrent on gold thin film of metal-semiconductor (TiO_2) Schottky diodes [1]. In order to utilize this scheme, we have fabricated metal-semiconductor Schottky diodes that are made of Pt or Au as a metallic layer, Si or TiO_2 as a semiconducting substrate. The Pt/TiO_2 and Pt/Si Schottky diodes are made by PECVD (Plasma Enhanced Chemical Vapor Deposition) for SiO_2, magnetron sputtering process for TiO_2, e-beam evaporation for metallic layers. Metal shadow mask is made for device alignment in device fabrication process. We measured photocurrent on Pt/n-Si diodes under AM1.5G. The incident photon to current conversion efficiency (IPCE) at different wavelengths was measured on the diodes. We also show that the steady-state flow of hot electrons generated from photon absorption can be directly probed with Pt/TiO_2 Schottky diodes [2]. We will discuss possible approaches to improve the efficiency of photon energy conversion.

[1] McFarland, E.W. & Tang, J. "A photovoltaic device structure based on internal electron emission." Nature 421, 616-618 (2003).

[2] G. A. Somorjai, H. Frei, and J. Y. Park, "Advancing the Frontiers in Nanocatalysis, Biointerfaces, and Renewable Energy Conversion by Innovations of Surface Techniques" J. . Am. Chem. Soc. 131, 16589-16605 (2009).