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Surface Plasmon Effect in Hot Electron Based Photovoltaic Devices

이영근[1], 정찬호[1], 박종혁[2], 박정영[1]

[1]EEWS Graduate School, KAIST (Korea Advanced Institute of Science and Technology),
[2]ETRI (Electronics and Telecommunications Research Institute), Daejeon, Korea

Nanometer-sized noble metals can trap and guide sunlight for enhanced absorption of light based on surface plasmon that is beneficial for generation of hot electron flows. A pulse of high kinetic energy electrons (1-3 eV), or hot electrons, in metals can be generated after surface exposure to external energy, such as in the absorption of light or in exothermic chemical processes. These energetic electrons are not at thermal equilibrium with the metal atoms. It is highly probable that the correlation between hot electron generation and surface plasmon can offer a new guide for energy conversion systems [1-3]. We show that hot electron flow is generated on the modified gold thin film (<10 nm) of metal-semiconductor (TiO2) Schottky diodes by photon absorption, which is amplified by localized surface plasmon resonance. The short-circuit photocurrent obtained with low energy photons (lower than bandgap of TiO2, ~3.1-3.2 eV) is consistent with Fowler's law, confirming the presence of hot electron flows. The morphology of the metal thin film was modified to a connected gold island structure after heating to 120, 160, 200, and 240^{o}C. These connected island structures exhibit both a significant increase in hot electron flow and a localized surface plasmon with the peak energy at 550-570 nm, which was separately characterized with UV-Vis [4]. The result indicates a strong correlation between the hot electron flow and localized surface plasmon resonance with possible application in hot electron based solar cells and photodetectors.

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