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Modifications of TiO_2 Nanotube Arrays for Photoelectrochemical Water Splitting under Solar Light

Eun Heui Gwag

The Graduate School of EEWS, Korea Advanced Institute of Science and Technology,

291 Daehak-ro, Daejeon, Republic of Korea 34141

The photoelectrochemical (PEC) water splitting with TiO_2 as photoanode have been largely studied to using solar energy as a source. However, TiO_2 have significant challenges; relatively large band gap, fast recombination speed of photo-generated electron and hole. We then tried two modifications to absorb visible light and suppress recombination. One is using localized surface plasmonic resonance (LSPR) with Au nanoparticles onto TiO_2 nanotube. We varied the size of Au nanoparticle, which is crucial factor for LSPR and PEC performance. Through conductive AFM measurement, we found that Schottky barrier height is decreased with smaller Au nanoparticle because of the stronger local electric field at the interface of Au and TiO_2 and larger number of activated electrons around the Fermi level. Therefore, smaller Au nanoparticles shown higher IPCE performance both under ultraviolet and visible light, as photoinduced electrons can easily overcome the Schottky barrier and transfer to the conduction band of TiO_2 via interband transition and LSPR transition, as well as tunneling effect. The other is carbon doping to introduce defect level in TiO_2 bands and to form oxygen vacancies, which act as temporal trap sites for photoinduced holes, thus suppress recombination of charge carriers. We compared quantitative effect of carbon dopant on PEC system, and the number of available charge carriers is corresponded to the amount of carbon dopant. This is well agreed with more efficient photocatalytic activity. Finally, Au nanoparticles deposition and carbon doping onto TiO_2 nanotube surface allow charge carriers longer life time with enhanced PEC performance under solar light, include visible light.

CV: MSc. Eun Heui Gwag
Born in 1992 in Republic of Korea, Eun Heui Gwag graduated with a BSc in Chemical and Biomolecular Engineering from the Korea Advanced Institute of Science and Technology (KAIST) in 2016. She then went to the graduate school of EEWS (Energy, Environment, Water and Sustainability) of KAIST, where she obtained her MSc degree in 2018. During this time, she did research on the enhancement of photoelectrochemical reactions with modified TiO_2 nanotubes under solar light.