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Electronic states and photocatalytic activities of TiO₂ modified with metal nanoparticles studied by far-ultraviolet spectroscopy

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Attenuated total reflection-far ultraviolet (ATR-FUV) spectra of TiO₂ and Au-, Pd-, Pt-modified TiO₂ were measured. The deposition of metal nanoparticles substantially changed the spectral shape, which indicates changes in the electronic states of TiO₂. The decrease in the absorption intensity in the longer wavelength region suggests an electron transfer from TiO₂ to metal nanoparticles, while the increase in the shorter wavelength region reveals the enhancement of charge separation. In order to discuss the degree of spectral changes, an integrated intensity ratio of absorption in the 150-180 nm regions to that in the 270-300 nm regions is calculated. The strong positive correlation between the intensity ratio and the work function difference indicates that the larger work function difference results in the increased electron inflow from TiO₂ to the metal, and thus, a larger enhancement of the charge separation. Next, photocatalytic activities of TiO₂ and TiO₂ modified with metal nanoparticles were estimated by a photo-degradation reaction of methylene blue. There is also strong positive relationship between the photocatalytic activity and work function of each metal. Therefore, the photocatalytic activity of TiO₂-based materials is strongly related to the spectral shapes in the FUV region. These results have demonstrated that ATR-FUV spectroscopy holds considerable promise as a novel method to investigate the electronic states of materials, especially semiconductor materials such as TiO₂.

Biography

Ichiro Tanabe has completed his PhD in March 2013 at the age of 28 years from Tokyo University and postdoctoral studies from Kwansei Gakuin University School of Science and Technology. He is the JSPS (The Japan Society for the Promotion of Science) research fellowship for young scientist. His research interests are far-ultraviolet spectroscopy and electronic states of photo-functional materials such as titanium dioxide and metal nanoparticles. He has published more than 10 papers in reputed journals and been commended by five domestic and international conferences.

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