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Photoinduced interfacial electron transfer dynamics of CdSe quantum dots on single crystal rutile TiO_2 (001), (110), and (111) surfaces

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Semiconductor quantum dots (QDs) have been studied for their light harvesting capability. Although, a major breakthrough in conversion efficiency of QD-solar cells has yet to be reported. The reason is lack of fundamental understanding of the surface chemistry of QD. For QDs on TiO_2, the heterogeneity can be caused by distributions of a number of properties of TiO_2 and QDs. Their complecities hinder the understanding of important factors that control the photoinduced interfacial electron transfer (PIET). Herein, we report a stydy of PIET dynamics of CdSe QDs on well characterized single crystal rutile-TiO_2 . To characterize the adsorption of CdSe QDs on single crystal rutile-TiO_2, we used photoacoustic (PA) spectroscopy. Photoelectron yield (PY) spectroscopy was applied to characterize the valence band maximum of the TiO_2 single crystals. The position of VBM for (111) surface is higher than those for the (110) and (001) surfaces. Transient grating (TG) method was applied to study the PIET dynamics. Basically, TG method depends on the refractive index changes due to photoexcited carriers. Pump beam was set at a wavelenght of 500 nm with a pulse width of 150 fs and probe pulse (775 nm) was delayed by an optical delay line (0 - 400 ps). The PIET rate constant of CdSe QDs increases with the increase of free-energy change. The change of the PIET rate constant on the (111) surface is higher than those on the other surfaces, indicating the difference in crystal binding and the overlap of wave fundtions at the QDs/TiO_2 interface.

Biography

Taro Toyoda has completed his D.Sc. from Tokyo Metroplitan University and Research Associate at National Research Council of Canada. He is a Project Professor of University of Electro-Communications. His research focuses on basic studies of optical properties in semiconductor quantum dots including photoexcited carrier dynamics and their applications to photovoltaic solar cells. He has published more than 200 papers in reputed journals.

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