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The appearance of anisotropic optical absorption, ground state energy, and crystal growth of CdSe quantum dots adsorbed on the (001) and (102) surfaces of anatase-TiO_2

The present study focuses on the effect of the substrate surfaces with different crystal orientations on optical absorption and ground state energy in a system comprising CdSe quantum dots (QDs) adsorbed on (001) and (102) surfaces of anatase-TiO_2(A-TiO_2). We applied photoacoustic (PA) spectroscopy based on the photothermal phenomenon to characterize the optical absorption, not only in the bandgap absorption but in the sub-bandgap region owing to high sensitivity. Photoelectron yield (PY) spectroscopy is useful for determining the absolute ground state energy level of QDs. Adsorption time dependence by absorbance measurements shows that (1) the adsorption rate of CdSe QDs on A-TiO_2(001) is higher than that of A-TiO_2(102) in agreement with our DFT calculations ((001) >> (101) > (102)), and (2) the diameter increasing rate of CdSe QDs on A-TiO_2(102) is higher than that of A-TiO_2(001), indicating the anisotropic crystal growth. The ground state energy levels of CdSe QDs on A-TiO_2(102) are deeper than those on A-TiO_2(001), suggesting the impossibility of the sensitization from the excited state of CdSe QDs to the conduction band of A-TiO_2(102). Deeper value of the ground state energy level of CdSe QDs on A-TiO_2(102) than those on A-TiO_2(001) is the possibility due to the difference of the permittivity of A-TiO_2(001) and A-TiO_2(102).

Biography

Taro Toyoda has completed his DSc from Tokyo Metropolitan University and Assistant Research Officer at National Research Council of Canada. After working at Fuji Electric Company and Nippon Mining Company, he was appointed as a Professor of The 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 quantum dot solar cells. He has published more than 200 papers in reputed journals.

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