Optical Absorption Characterization of CdSe Quantum Dots on Different TiO$_2$ Morphologies

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We have studied the optical absorption of CdSe quantum dots (QDs) adsorbed on inverse opal TiO$_2$ (IO-TiO$_2$) and nanoparticulate TiO$_2$ (NP-TiO$_2$) films by using photoacoustic (PA) spectroscopy [1]. CdSe QDs were grown on IO-TiO$_2$ and NP-TiO$_2$ films by a successive ionic layer adsorption and reaction (SILAR) method [2] with different cycles. The average diameter of CdSe QDs for each adsorption cycle can be estimated by applying effective mass approximation [3] to the PA spectra. The growing size of CdSe QDs on the TiO$_2$ films with increasing cycles was confirmed by a redshift in the optical absorption spectra. The average diameter of CdSe QDs on IO-TiO$_2$ films agreed with that on NP-TiO$_2$ ones, indicating that the growing size was independent of the morphology because QD growth mechanism associated with a chemical reaction was occurred on the QDs [4]. However, the CdSe QDs on NP-TiO$_2$ films had more amounts than that on IO-TiO$_2$ ones by measuring the optical absorbance, indicating the different number of active site (an initial stage that can develop to a QD) on both IO-TiO$_2$ and NP-TiO$_2$ films. Moreover, the steepness factor $\sigma$ (slope of an exponential optical absorption tail) was estimated [5] from the PA spectrum. The $\sigma$ of CdSe QDs on IO-TiO$_2$ films was lower than that on NP-TiO$_2$ ones, indicating that the CdSe QDs on IO-TiO$_2$ films produced more disorder and surface states than NP-TiO$_2$ ones in case of smaller size. Subsequently, the $\sigma$ showed toward constant in case of larger size similar to the tendency on NP-TiO$_2$ films.