Influence of Different Size TiO_2 Mixture in Nanostructured Anatase-Type TiO_2 Electrodes Characterized with Photoacoustic and Photoelectrochemical Current Spectroscopies

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Nanocrystalline TiO_2 has received much interest because of its strong role in applications such as photoelectrochemical solar cells and photocatalysis.[1,2)] Recently, photoelectrochemical currernt (PEC) properties depend on the nanostructure in the TiO_2 electrodes (different porosity and morphology).[1)] In this work, we investigate the influence of different size TiO_2 mixture in nanostructured anatase-type TiO_2 photoelectrodes on optical absorption and PEC properties. Five kinds of TiO_2 electrodes were prepared with a mixture of 27nm TiO_2 nanoparticles in 15 nm TiO_2 nanoparticles. Moreover, we adsorbed CdSe quantum dots (QDs) onto the TiO_2 electrodes.[3)] The use of CdSe QDs as sensitizers has some advantage in solar cell applications.[4)] Firstly, the energy gap of the QDs can be tuned by controlling their size to match the spectral distribution of sunlight. Secondly, the QDs have a large optical absorption coefficients and intrinsic dipole moments. The optical absorption of the electrodes was characterized with photoacoustic (PA) method. It detects a signal directly proportional to the thermal energy (by nonradiative processes) in which optical absorption information can be involved. PA signal is less sensitive to light scattering effects.

Figure 1 shows the PA spectra of TiO_2 electrodes for different 27nm TiO_2 contents with CdSe QDs adsorption for 48 hours. Redshift of the PA spectra can be clearly observed. Relative to bandgap of bulk CdSe, the optical absorption in the PA spectra show blueshift, indicating the quantum confinement effects. The increase of the PA intensity is low up to 75% content However, the PA intensity of 100% content is much higher than the others, indicating that the growth of the QDs in the electrodes with 100% content is different from that of other contents. Figure 2 shows the PEC spectra of TiO_2 electrodes for different 27nm TiO_2 contents with CdSe QDs adsorption for 48 hours. The photosensitization of the TiO_2 electrodes in the visible region resulting from CdSe QDs adsorption can be observed. The PEC intensity depends on the 27 nm TiO_2 content and shows a maximum around a content of 75%. The decrease of the PEC intensity at higher content might be correlated with different porosity, morphology, and interface characteristics. Figure 3 shows the PA spectra of TiO_2 electrodes with CdSe QDs adsorption for different adsorption time with 27nm TiO_2 content of 75%. Redshift of the PA spectra can be clearly observed owing to the quantum confinement of CdSe QDs. Figure 4 shows the PEC spectra of TiO_2 electrodes with CdSe QDs adsorption for different adsorption time for 27nm TiO_2 content of 75%. The PEC intensity depends on the adsorption time and shows a maximum around an adsorption time of 48 hours.

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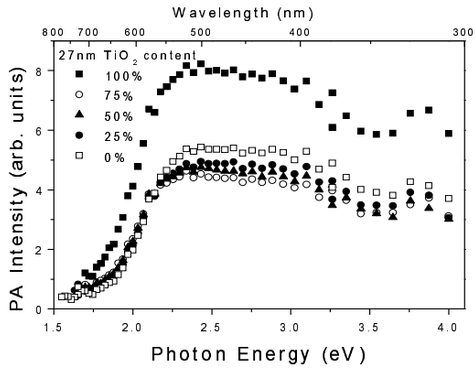

Fig. 1. PA spectra of TiO_2 electrodes for different 27 nm TiO_2 content with CdSe QDs adsorption (48 hours).

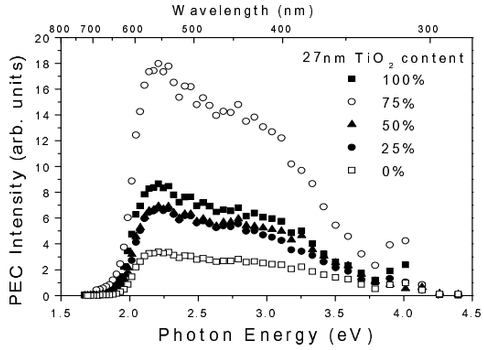

Fig. 2. PEC spectra of TiO_2 electrodes for different 27 nm TiO_2 content with CdSe QDs adsorption of 48 hours.

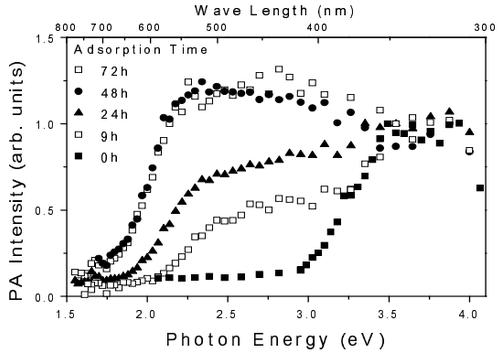

Fig. 3. PA spectra of TiO_2 electrodes for different CdSe QDs adsorption time with 27 nm TiO_2 content of 75%.

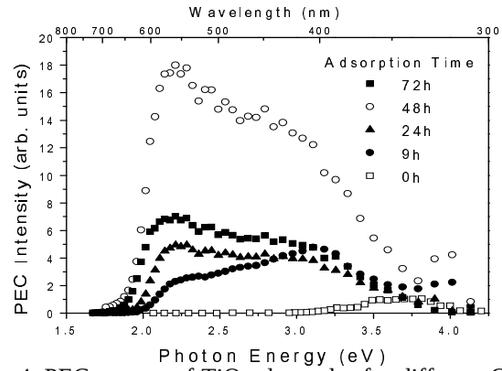

Fig. 4. PEC spectra of TiO_2 electrodes for different CdSe QDs adsorption time with 27 nm TiO_2 content of 75%.

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