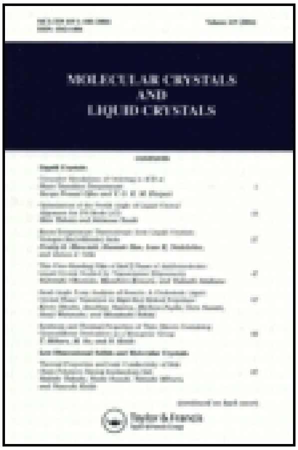

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Assembly and Photoelectrochemical Studies of TiO_2/CdS Nanocomposite Film

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TiO_2/CdS nanocomposite film was fabricated successfully based on electrostatic interaction. Combining of the two semiconductor offers an opportunity to sensitize TiO_2 nanoparticles by CdS nanoparticles, which were improved here by the photoelectrochemical and photovoltage measurements.

Keywords: TiO_2/CdS; nanocomposite film; photoelectrochemical studies

INTRODUCTION

The study of interparticles electron transfer between dissimilar semiconductor nanoparticles has received increasing investigations during the past decade.[1] [2] Charge injection from one semiconductor into another can lead to efficient and longer charge separation, which are anticipated to have potential applications in photocatalysis and solar energy conversion.[2] Therefore, organizing such kind of materials into layered structure provides possibility to fabricate a new kind of molecular or supramolecular devices. In this paper, TiO_2/CdS nanocomposite film was fabricated based on electrostatic interaction as we reported previously.[3] The photoelectrochemical and photovoltage measurements illustrated that the interesting charge separation occurred in the composite film.

EXPERIMENTAL SECTION

The Cyclic voltammograms were determined using EG & PAR Model 273 electrochemical instruments interfaced with an IBM PC. Photoelcetrochemical behaviors were measured by illuminating the alternating assembled, film-carrying ITO electrode by 500 W super high pressure mercury lamp. SCE and Pt plate was used as reference electrode and counter electrode respectively. The standard electrolyte consisted of 0.4 mol/L Na_2S and 0.1 mol/L Na_2SO_3. Surface photovoltage spectra (SPS) measurements were carried out with a solid junction photovoltage cell, ITO/sample/ITO, using a light source-monochromator-lock-in detection technique.[4]

RESULTS AND DISCUSSION

Figure 1A shows the linear scanning voltammogram of the TiO_2/CdS composite covered ITO electrode in the dark and illumination. Under irradiation, the TiO_2/CdS composite film, behaved like a typical n-type semiconductor, exhibit an anodic photocurrent, suggesting that the holes are scavenged by the electrolyte (S^{2-}) while electrons diffuse to the collecting ITO electrode.[1,5] Since the composite film is very thin, electron-hole (e^--h^+) pairs would generate in both CdS and TiO_2 under illumination with Hg-lamp. On the one hand, the photogenerated electrons in CdS then migrate to the lower lying conduction band of TiO_2, while holes remain in valance band of CdS. On the other hand, the photogenerated holes in TiO_2 would migrate to the valance band of CdS, while electrons remain in conduction band of TiO_2.[1,2] After which, the collected holes in CdS would then scavenge by the electrolyte (S^{2-}), while the collected electrons in TiO_2 diffuse to the back ITO contact to produce an anodic photocurrent.[5] From the cyclic voltammetric results (Figure 1B), it was worth mentioning that redox peaks were hardly visible, indicating that the reduction of SO_3^{2-} was virtually non-existent. These observations, especially the lack of reduction current with the TiO_2/CdS modified ITO electrodes, suggest that the coupling CdS and TiO_2 has created a sort of energy barrier that reduces the electrons losses after the charge separation and then lead to well photocurrent response.[5]

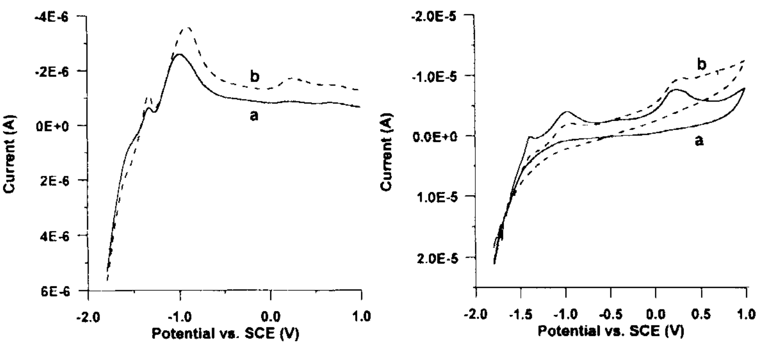

FIGURE 1A the linear scanning voltammogram, (a) dark, (b) illumination

FIGURE 1B the cyclic voltammogram, (a) dark, (b) illumination.

Figure 2 shows the surface photovoltage spectroscopy (SPS) of 8–layer TiO_2/CdS and TiO_2/PSS composite films. The surface photovoltage effect, which is produced by a change in the surface potential caused by illumination, has been successfully applied to the investigation of electron process in semiconductors. In the case of TiO_2/PSS composite film, the phtovoltage response begins at 350 nm, which is consistent with the absorption spectrum. For the TiO_2/CdS composite film, the photovoltage response appears at visible region and shows a maximum around 450 nm corresponds to a band-band transition of CdS. Compared curves a with b, it was found that the photovoltage response of TiO_2/CdS composite film was much greater than that of TiO_2/PSS, indicating the efficient phtogneration and separation of charge carries in the former composite film.

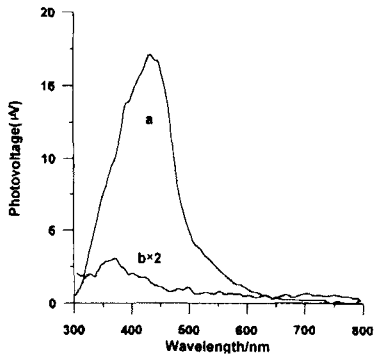

FIGURE 2 Surface photovoltage spectra of ITO electrodes modified with nanoparticle multilayer film: (a) 8 layers of TiO_2/CdS, (b) 8 layers of TiO_2/PSS.

CONCLUSION

TiO_2/CdS nanocomposite film was fabricated, in which TiO_2 and CdS nanoparticles were combined directly. Photoelectrochemical and photovoltage measurements illustrated that efficient charge transfer occurred in the TiO_2/CdS nanocomposite film.

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