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ELECTROCHEMICAL PHOTOCELL USING Li DOPED CdS FILM ANODE

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The doping of Li in a sprayed CdS film electrode results in a significant increase in the anodic photocurrent at this electrode. The quantum yield for the electron flow at short-circuit current condition of the photocell using the Li doped CdS film anode amounts to 50% at wavelengths shorter than 480nm and is several times greater than that using an undoped CdS film anode.

We have already proposed an electrochemical photocell using a sprayed CdS film anode as a possible sunlight energy convertor.[1)] Similar results were reported by other investigators.[2)] A chemical spray deposition technique we used for the film preparation has a practical significance, since it enables us to prepare a large electrode area by a rather simple operation. The energy conversion efficiency of the photocell thus fabricated, however, is as yet too low for the practical use.

One way to improve the energy conversion efficiency may be to enhance the photosensitivity of a CdS film by improving the crystallinity of this film or doping appropriate impurities in the film. It has been already reported that photoconducting properties of a sprayed CdS film can be improved by Li or Cu doping.[3)] We investigated in this work whether such an improvement in photoconducting properties could lead to the improvement in electrochemical characteristics or not. In this paper, only important results are described on the effect of Li doping on the photoanodic polarization behavior of a sprayed CdS film electrode and the output characteristics of the photocell using this film anode.

A CdS film was prepared by spraying 0.01M $CdCl_2$ + 0.01M $CS(NH_2)_2$ + xM LiOH($0 \leqq x \leqq 0.005$) solution onto a transparent conducting SnO_2-coated glass heated at 340°C. Other spraying conditions are given in the preceding paper.[1)] The photocell capable of the backwall illumination[1)] was used. An electrolyte for the photocell is 1M NaOH + 1M Na_2S + 1M S solution. A 500W Xe lamp was used as a light source and the spectral distribution of the quantum yield for the photocell was determined by using monochromator and a calibrated thermopile.

Figure 1 shows current - potential curves for illuminated CdS film electrodes prepared by spraying solutions containing various concentrations of LiOH. The doping of Li in the film scarcely change the photocurrent onset potential but remarkably contributes the increase in the photocurrent. A CdS(0.001M LiOH) film electrode exhibits the largest photocurrent. Similar results were also obtained under the front-

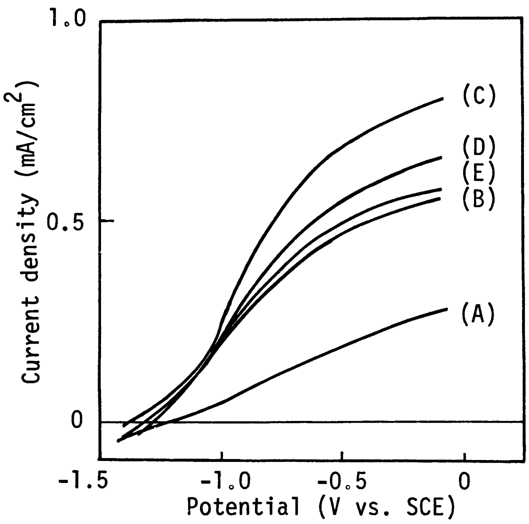

Fig.1 Photoanodic polarization curves for sprayed CdS(Li doped) electrodes in an aqueous polysulfide electrolyte
LiOH concentration in the spray solution
(A);0M, (B);0.0001M, (C);0.001M,
(D);0.002M, (E);0.005M

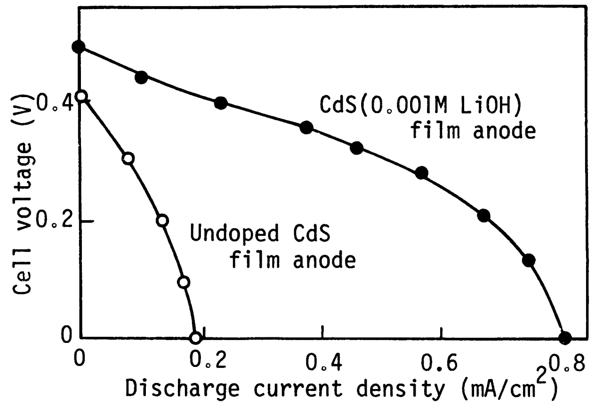

Fig.2 Output characteristics for the photocell using undoped or Li doped CdS film anode
Irradiance; White light, 61mW/cm²

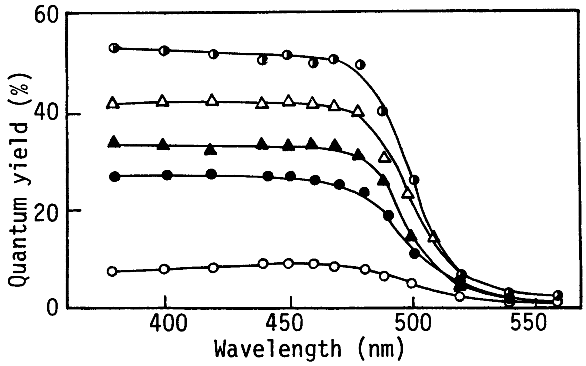

Fig.3 Quantum yield - wavelength curves for the short-circuit current of CdS(Li doped)/polysulfide electrolyte/Pt photocell
LiOH concentration in the spray solution
o;0M, ●;0.0001M, o;0.001M, △;0.002M, ▲;0.005M

wall mode of illumination. This means that the photocurrent increase by Li doping is associated with the improve- of the photosensitivity of CdS films.

Output power was greatly increased by Li doping (Fig.2), as can be expected from the results of Fig.1. The maximum power conversion efficiency with monochromatic light of 480nm is about 0.5% for the photocell using an undoped CdS film anode and 2-4% for that using a Li doped CdS(0.0001M-0.005M) film anode. The quantum yield for the short-circuit current of the photocell using a CdS (0.001M LiOH) film anode amounts to 50% under illumination at wavelengths shorter than 480nm and is several times greater than that using an undoped CdS film anode, as shown in Fig.3.

The improvement of the photosensitivity by Li doping is perhaps caused by the decrease in the number of the recombination center and/or the formation of sensitizing centers. The photocurrent increase by Li doping may be also associated with the change in the carrier density, which leads to the change in the space charge layer thickness, and in the absorption coefficient of a CdS film. This mechanism is under study and will be discussed in detail in a subsequent paper.

References

1)M.Tsuiki, H.Minoura, T.Nakamura, and Y.Ueno, J. Appl. Electrochem., 8,523(1978).
2)P.Chartier, S.S.Fall, M.Faye, M.Cadene, and G.W.Cohen-solal, Compt. Rend. Acad. Sc. Paris, 284, Série C, 437(1977).
3)E.Imaoka, H.Watanabe, and M.Wada, Ohyo Butsuri, 41,989(1972).

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