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Computer-aided characterization of CdS based photoelectrochemical solar cells

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Photoelectrochemical solar cells using CdS films deposited by spray pyrolysis, silk screen printing and chemical bath deposition methods have been characterized for all their parameters by a computer program. The program and the results are presented.

Key words: Photoelectrochemical cells, solar cells, cadmium sulphide

INTRODUCTION

The design of a photoelectrochemical cell (PEC) and its power output are interrelated to many parameters. The optimization of these parameters through routine calculations is cumbersome and time consuming. Hence, a computer program has been developed to simultaneously derive these parameters using the Gauss- Siedel method. PEC cells developed with CdS photoanodes using spray pyrolysis, (SP) silk screen printing (SSP) and chemical bath deposition (CBD) methods [1-3] are characterized and compared.

ELECTRODES AND PEC CELL DESIGN

CdS in thin films was prepared on tin oxide conducting substrates. These photoanodes were dipped in argon purged 1M NaOH - 0.1M Na_2S - 0.1M S polysulphide electrolyte with a Pt counter electrode. I - V curves were recorded using a 250W tungsten halogen lamp.

COMPUTER PROGRAM

The I-V relation of a PEC cell can be given as

$$I = Io[\exp q(V - IRs)/Akt - 1] + [V - IRs]Gsh - Iph$$

This equation is nonlinear which is solved numerically using the Gauss-Siedel method. The five parameters Iph, Io, Rs, Gsh and A are denoted A(1), A(2), A(3), A(4) and A(5). The program has been developed in such a way that just I- V values and approximate A value are to be given as input. The flow diagram is given in Fig. 1.

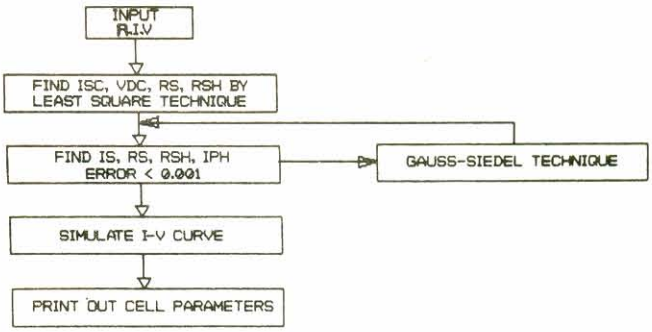

Fig. 1: General flow diagram of the parameter evaluation Gauss-Siedel method

RESULTS AND DISCUSSION

Figure 2 shows the experimental and computer fit I-V curves for cells with SP CdS films. The result indicates the best overall fit throughout the curve. The parameters obtained from the best fit are given in Table I for all the three films.

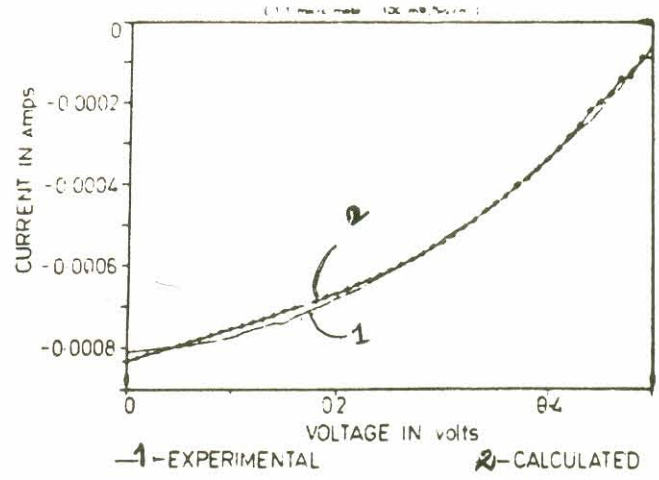

Fig. 2: Comparison of experimental and computer fit I-V curves Spray pyrolysed CdS film (1.1 micrometre, 100 mw/sq cm)

A cursory comparison of the different parameters,

TABLE–I: Parameters obtained from the best fit for PEC cells using CdS films

Parameters		PEC cells based on CdS photoanodes by		
		SP	SSP	CBD
Photocurrent	Iph(a)	9.8×10^{-4}	2.8×10^{-4}	7.7×10^{-4}
Saturation current	Io (A)	6.6×10^{-8}	3.4×10^{-11}	1.5×10^{-7}
Series resistance	Rs(Ω)	233	541	155
Shunt resistance	Rsh(Ω)	1282	2535	487
Diode quality factor	A	2.2	0.8	1.1
Open circuit voltage	Voc(V)	0.518	0.321	0.216
Short circuit current	Isc(mA)	0.81	0.231	0.58
Efficiency	η	0.71	0.027	0.075
Fill factor	FF	0.39	0.39	0.36

especially, Iph, Voc, η and FF indicate the acceptable quality of SP CdS based cells over the others. A diode quality factor of 2.2 has been obtained indicating a good junction formation of the constructed PEC cells.

CONCLUSION

The developed computer program facilitates an easy evaluation of the PEC cell parameters. The derived cell parameters indicate that the CdS photoanodes prepared by the SP technique show the best performance.

REFERENCES

1. R Krishnakumar, Y Ramprakash, V Subramanian, K Chandrasekhara Pillai and A S Lakshmanan, *Opt Mat Tech Ener Eff and Solar Ener Conv - IV* (Ed) C M Lampert, *Proc. SPIE*, **562** (1985) p 187
2. Y Ramprakash, V Subramanian, R Krishnakumar A S Lakshmanan and V K Venkatesan, *SESI J*, **1** (1987) 41
3. Y Ramprakash, V Subramanian, R Krishnakumar, A S Lakshmanan and V K Venkatesan, *J Power Sources*, **24** (1988) 41