

# Quantum Efficiency ( $\Phi$ ) Enhancement of p-CuI Sensitized LB Films of Methylviolet-C18 by Minimizing Dye Aggregates

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## Introduction

It is well known that the spectral response of wide band gap semiconductor materials can be extended to the visible region by deposition of suitable dyes on the surface (Senadeera et al., 2005; Fernando et al., 2013). In addition to the adjustability of the spectral response, dye sensitized solar cells have several advantages (Kubo et al., 2002). The dye sensitized photocurrent is rather insensitive to the impurities and the defects of the semiconductor. When dyes with intense absorption bands are deposited, the light absorption at the sensitized surface becomes much higher than a bare semiconductor surface. Although the absorption properties of the dye increases with the concentration of the absorbed dye on the semiconductor surface, a dye sensitized photocurrent enhancement cannot be observed with the increase of the number of dye molecules on the semiconductor because of the energy dissipative processes of the excited states of the dye and the recombination of photogenerated charge carriers (Fernando et al., 1994).

## Methodology

Commercially available well cleaned copper sheets (1cmx3cm) were used to deposit p-CuI nano thin films from the following method. A solution of CuI was prepared by dissolving 5mg of CuI in 10ml of moisture free acetonitrile. CuI colloidal solution was lightly spread on the well cleaned copper surface until forming a thickness  $\approx 5.0 \mu\text{m}$  to prepare Cu/p-CuI photoelectrodes. Cu/p-CuI photoelectrodes were used to deposit LB films. Experimental set up used for LB deposition is shown in the Fig.1 (Fernando et al., 2013). 2M KI and  $1 \times 10^{-4}$  M  $\text{Na}_2\text{H}_2\text{PO}_4$ -  $\text{Na}_2\text{HPO}_4$  pH=6 buffer solution was used as the electrolyte. AFM pictures of the samples were obtained using a Park's AFMXE-70 Instrument. Photocurrent quantum efficiency ( $\Phi\%$ ) was calculated using the following equation,

$$\Phi\% = [\text{number of electrons created} / \text{number of photons incident}] \times 100\% \quad (1)$$

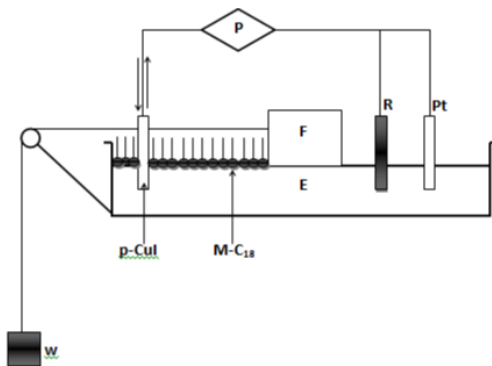


Fig.1 P- Potentiostat R- Reference Electrode Pt- Platinum counter electrode E- Electrolyte F-Floater W- Weight

### Results and Discussion

Fig.2 shows the AFM micrographs of M-C18 LB films deposited on conductive glass plates at +0.3V vs AgCl/Ag. In case of the films deposited on glass plates at +0.3V show a homogeneous surface morphology as shown in the figure. Formation of the homogeneous surface morphology may be due to the formation of ordered monomer molecular arrangement.

Fig.3 and Fig.4 show the variation of the photocurrent quantum efficiency with number of M-C18 LB monolayers deposited on p-CuI at different applied potentials. It is clearly seen an enhancement of the photocurrent occurs with the LB films deposited potentials are more positive. Further an optimum surface concentration can be observed in each case. It is interesting to mention that the optimum surface concentration of M-C18 LB films increases when the deposition applied potential increases towards positive side enhancing the maximum photocurrent quantum efficiencies. Table-1 shows the variation of maximum photocurrent quantum efficiency ( $\Phi_{max}\%$ ) with LB deposition applied potential. Maximum photocurrent quantum efficiency reached was  $\approx 22\%$  at +0.3V vs AgCl/Ag .

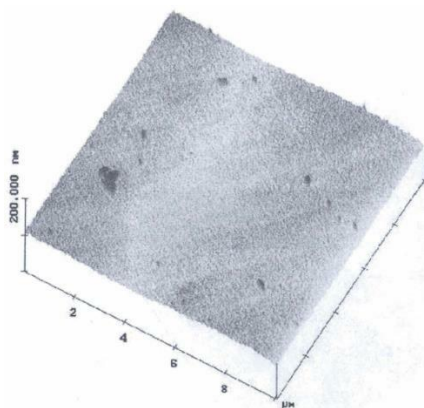


Fig.2 AFM image for the 18 monolayers of C<sub>18</sub>-MERO-C<sub>18</sub> LB films prepared at +0.3V vs Ag/AgCl applied potential

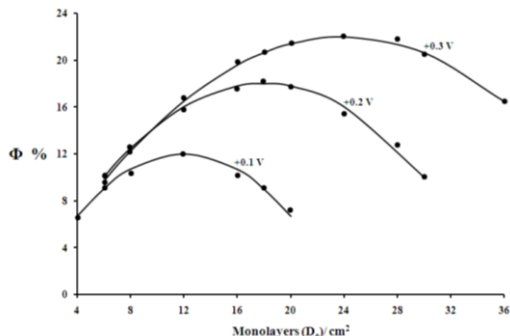


Fig.3 The variation of photocurrent quantum efficiency ( $\Phi\%$ ) with number of M-C<sub>18</sub> Monolayers deposited at different positive applied potentials in the presence of (10<sup>-3</sup>M) Fe<sup>2+</sup> /Fe<sup>3+</sup> (10<sup>-3</sup>M) at  $\lambda = 560\text{nm}$

Table 1: Optimum number of monolayer / optimum photocurrent quantum efficiency at different applied potential.

Applied Voltage (V)	D <sub>op</sub> (cm }	Φ <sub>Max</sub> %
+0.1	12	12
+0.2	18	18
+0.3	24	22

**Conclusions**

Photocurrent quantum efficiencies for both PECs and DSSCs are increased for the LB films of M-C<sub>18</sub> prepared at positive biased potentials minimizing the formation of M-C<sub>18</sub> dye aggregates. The power conversion efficiency reached for DSSC is 2% for the films deposited at +0.3V vs Ag/AgCl. Photocurrent quantum efficiencies for the p-CuI/M-C<sub>18</sub> photoelectrode are increased for the LB films of M-C<sub>18</sub> prepared at positive biased potentials minimizing the formation of M-C<sub>18</sub> dye aggregates.

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