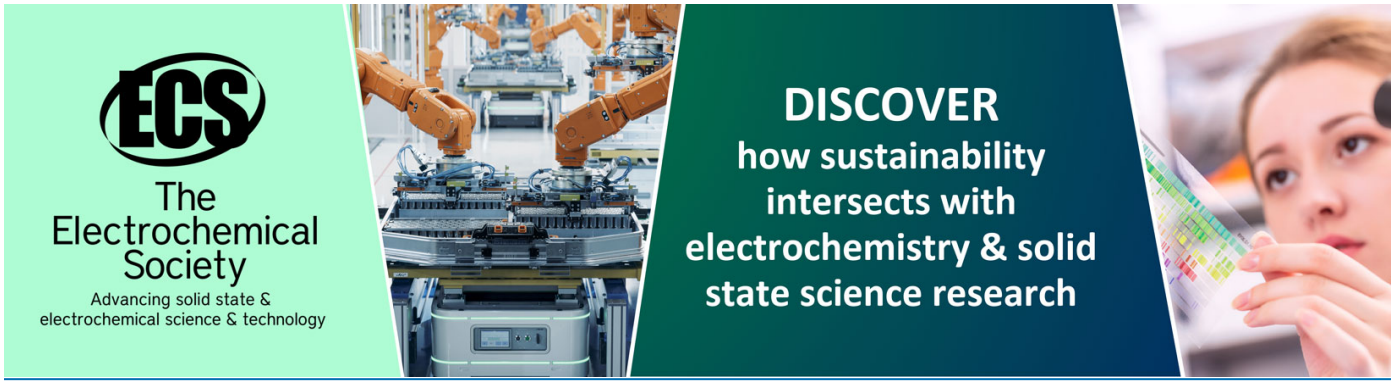
Effect of laser fluencies on solar cell characterization of $(CdO)_{1-x}:Sb_x$/PSi thin films by laser induce plasma



Effect of laser fluencies on solar cell characterization of $(CdO)_{1-x}:Sb_x$/PSi thin films by laser induce plasma.

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Abstract: In this paper, Cadmium Oxide: Antimony has been deposited on porous silicon substrate using laser induces plasma technique. The solar cell parameters fill factor and efficiency; have been analyzed through changing of laser energy. The results shown that the change in electron mobility resulting from the change in laser energy leads to significant improvement in fill factor and efficiency. Moreover, there is slight improvement in the efficiency of CdO: Sb/Psi solar cell as a result of changing the thickness of CdO: Sb.

Keywords: Laser Induce Plasma, Cadmium Oxide, Doped Antimony, Porous Silicon, Solar Cell

1-Introduction

The scientists are more focused to design new devices nowadays. In order to have more flexibility in devices design, they have to develop a new semiconductor with specific features. It is being thought that Cadmium Telluride Oxide is very good to use for making solar cell, because CdO is a photovoltaic material and has optimal electronic and optical characteristics to make a solar cell [1].

CdO has been used as a window layer since it has a band gap around 2.4 eV and a pretty high transmittance. Recently there are some researchers who have used the CdO thin films for low resistivity by using different techniques of deposition [2-4]. In this work the

preparation and characterization of large area n-type conducting CdO films have been reported for the first time as low cost technique, viz. the chemical bath deposition.

Thin films of cadmium oxide (CdO) and other materials like SnO_2, ZnO, $In_2O_3$are transparent conducting oxides (TCO) and have shown promising perspectives for a variety of applications in modern optoelectronic and photovoltaic devices. The existing preliminary results showed that cadmium oxide has large electrical conductivity and large optical transmittance in the range of visible region So CdO is a promising material can be used for solar cell devices [5,6].

All previous works have showed that CdO thin films are n-type and have a range of band gape from (2.3 to 2.7) eV[7,8]. Based on these existing results and pervious research results, CdO is very good candidate material that can be used as a window layer , e.q. CdO/CdTe and CdO/CIS hetro-junctions. Several deposition techniques like spray pyrolysis, sputtering, and chemical bath deposition have been used to prepare CdO [9,10,11].

2- Experimental procedure

The CdO:Sb thin films were deposited by Laser induced plasma on porous silicon Fig.(1) shows a schematic diagram for the PLD system. All the work has been done under vacuum pressure of 10^{-2} mbar by using Varian DS219 Rotary pump. Nd:YAG laser has been used with a harmonic frequency (λ = 1064 nm, 10 ns, 6 Hz).Quartz lens (f = 10 cm)used to focus Nd:YAG laser onto CdO:Sb target to prepare the CdO:Sb films on Porous Sisubstrate. The experiments have been done at room temperature. The CdO:Sbtarget was ablated by 150 pulses. The laser pulse energy was varied in the range (300-700) mJwith increment200 mJ in each step and laser fluencies was varied in the range (0.2388 -0.557)J/cm^2.

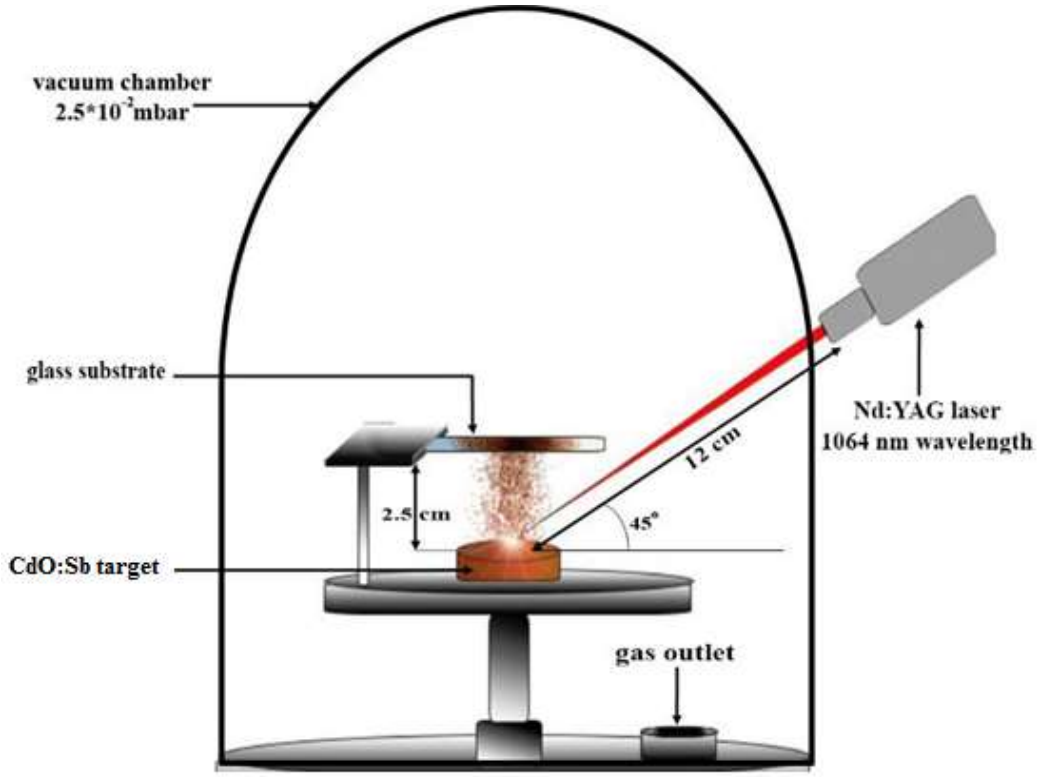

Fig.(1). *Experimental representation of PLD technique.*

3-Results and Discussion

The I-V characteristics of n-CdO:Sb/p-PSi solar cell in both dark and under illumination using power densities equal to 102 mW/cm^2 with the applied forward and reverse bias at different laser fluencies were shown in Figs. (2 to 5).In general the forward current higher than revers current.

Clearly from these figures, the increase of the bias voltage leads to increase the trend of the photocurrent density curve . But the reverse behavior of the depletion region, by increasing the forward voltage the depletion region will be decreased. This increase in the depletion layer will lead to increase the photocurrent density.

The results showed that increase the laser energy increased the photocurrent density. The laser treatment leads to increase in the grain size, as well as it leads to reduce the grain

boundaries. Hence as a result, it will improve the structure of the thin films which is going to lead to increase the mobility and increase the photocurrent density too.

The solar cell parameters such as V_o, I_{sc}, I_m, V_m, FF and the solar cell efficiency were calculated from these figures as shown in Table (1). This table shows that the optimum laser fluencies with highest efficiency for all pure samples, and the samples deposited on porous Si better than that deposited on Si wafers. The figures show, the efficiency of $(CdO)_{1-x}:Sb_x$/porous silicon solar cells by different laser fluencies and composition (x). The best results come out from this research are at laser fluencies 0.55 J/cm^2 and composition at x= 0.5.

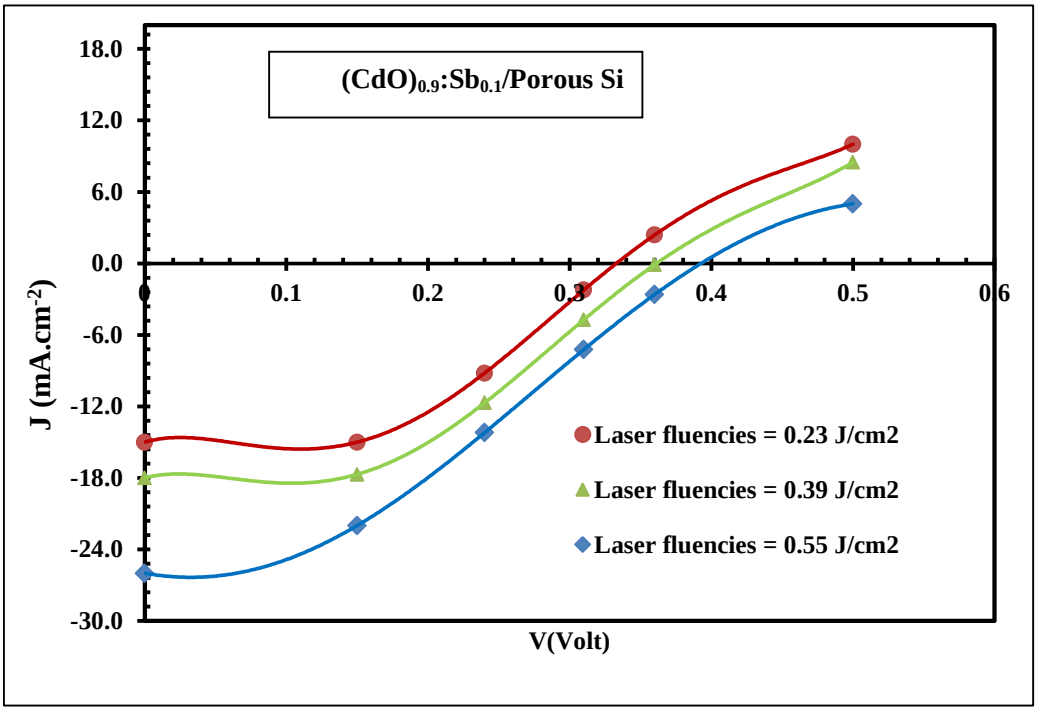

Fig. (2). I-V characteristics for $(CdO)_{0.9}:Sb_{0.1}$/Porous Sihetero-junction Solar Cell at X=0.1 in case of under illumination.

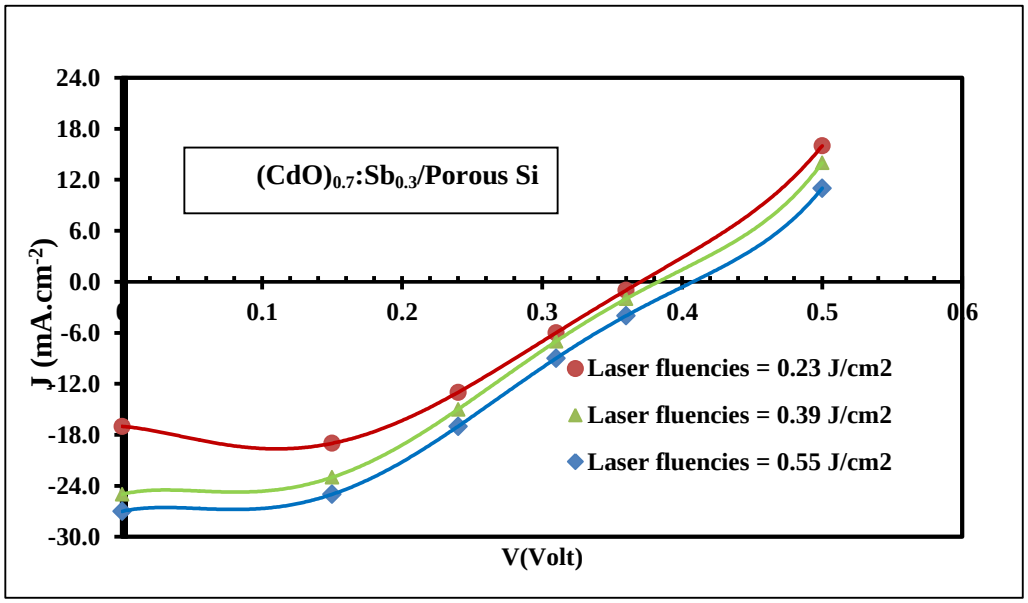

Fig. (3). I-V characteristics for $(CdO)_{0.7}:Sb_{0.3}$/Porous Sihetero-junction Solar Cell at X=0.3 in case of under illumination

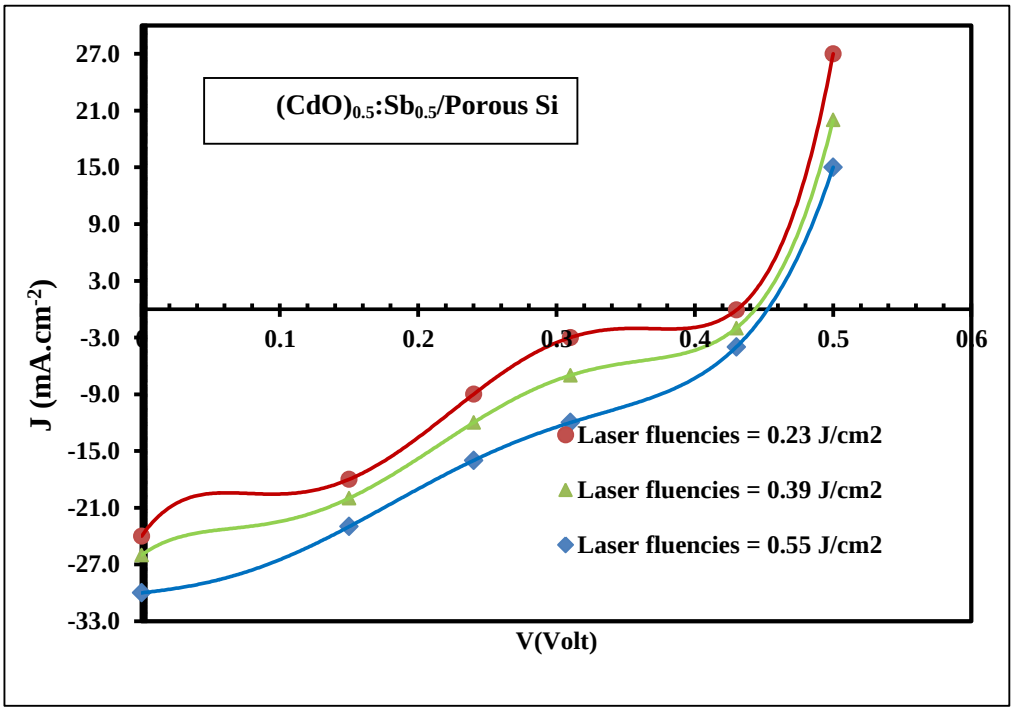

Fig. (4). I-V characteristics for $(CdO)_{0.5}:Sb_{0.5}$/Porous Sihetero-junction Solar Cell at X = 0.5 in case of under illumination

Table (1) I-V Parameters for($CdO)_{1-x}$:Sb_x /porous-Si solar cell.

Target	Composite (x)	Laser fluencies (J/cm^2)	Vmax (V)	Jmax (mA/cm^2)	□□□□□□□
$(CdO)_{0.9}$:$Sb_{0.1}$	0.1	0.23	0.12	20	2.35
$(CdO)_{0.9}$:$Sb_{0.1}$	0.1	0.39	0.135	22	2.91
$(CdO)_{0.9}$:$Sb_{0.1}$	0.1	0.55	0.15	24	3.52
$(CdO)_{0.7}$:$Sb_{0.3}$	0.3	0.23	0.15	18	2.64
$(CdO)_{0.7}$:$Sb_{0.3}$	0.3	0.39	0.16	20	3.13
$(CdO)_{0.7}$:$Sb_{0.3}$	0.3	0.55	0.18	22	3.88
$(CdO)_{0.5}$:$Sb_{0.5}$	0.5	0.23	0.16	18.5	2.9
$(CdO)_{0.5}$:$Sb_{0.5}$	0.5	0.23	0.175	19.5	3.34
$(CdO)_{0.5}$:$Sb_{0.5}$	0.5	0.39	0.19	21	3.91

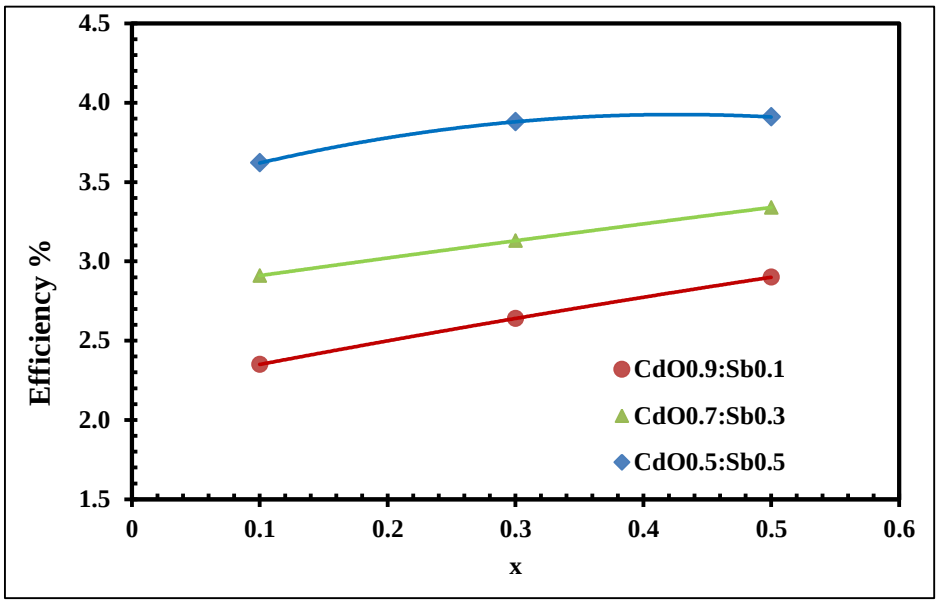

Fig. (5). Variation of efficiency as a function of composition (x) with different laser fluencies.

4-Conclusions

The $(CdO)_{1-x}$:Sb_x/Psisolar cell was fabricated by laser induce plasma technique. The current–voltage characteristics of the $(CdO)_{1-x}$:Sb_x/Psisolar cell showed the best results come out from this research was at laser fluencies 0.55 J/cm^2 and composition at x= 0.5 and the efficiency increased from 2.35 to 3.91.

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