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THE VALUE OF EFFICIENCY & ENERGY GAP FOR DIFFERENT DYE SOLAR CELLS

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ABSTRACT

In this study we found the values of both energy gap (E_g) and efficiency for different dye- sensitized solar cells (DDSSCs) using Ultra violet-visible spectroscopy technique. Three samples of solar cells were prepared by depositing the solution of dye (Ecrchrom Black T, Rohadamin B and Coumarin 500) on ITO, and electrodes was silver (Ag))by Spin Coating.

Keywords: *Ecrchrom Black T, Rohadamin B, and Coumarin 500, solar cells, efficiency, energy gap.*

I. INTRODUCTION

Solar cell is tool semiconductor that converts solar energy into electrical energy. Silicon is the best semiconductor material used today in the manufacture of the solar cell the wide spread of it is due to high ratio of the abundance of the silicon in the land cost of production is also reasonable and the efficiency is high compared to other cells, however silicon cells suffer from the high cost and difficulty of manufacturing beside complexity associated with the formation of crystals of silicon [1, 2, 3].

This has led scientists to think in the manufacture of solar cells from other materials. So there were attempts for manufacture solar cells using polymers and dyes[4,5,6]. Dye-sensitized solar cells (DSSC) are devices that convert solar energy to electricity using low-cost and non-toxic materials [7]. Because of their remarkable photo conversion efficiency of over 14% reached by molecular engineering of organic sensitizers [8] and over 21% for panchromatic dye-sensitized cell in conjunction with a Perovskite cell using a system of spectral splitting [9] this technology is becoming a credible alternative for the most popular first generation silicon-based inorganic solar cells. The transparent photo anode inform of a mesoporous layer of a nano crystalline wide-band gap semiconductor (mostly TiO_2) with adsorbed monolayer of dye molecules deposited onto transparent conductive oxide (TCO) glass substrate and the counter electrode made of TCO glass coated with a thin platinum catalytic layer, between which there is an liquid electrolyte containing mostly I / - - I3 redox couple, form a typical DSSC [7, 10]. Te efficiency of DSSCs is limited by the electron transfer processes proceeding at the oxide semiconductor/dye/electrolyte interfaces. Among others, the charge recombination and exaction dissociation are generally recognized as the basic electronic processes limiting the efficiency of photovoltaic devices. Ultrafast electron transfer to TiO_2 conduction band from metal-to-legend charge transfer (MLCT) photo excited state of Ru-bipyridyl dyes can occur from a single state (1MLCT) as well as from a triplet state (3MLCT) as a result of heavy metal atom induced efficient intersystem crossing (~10^{-12} s) while for pure organic dyes this electron transfer occurs efficiently only from a single excited state due to spin-forbidden singlet-to-triplet intersystem crossing process[11]. This primary charge separation step in DSSCs has been extensively studied by femtosecond transient absorption spectroscopy [11,12,13] however, the exact nature of the spatial separation of charge carriers involving possibly an intermediate stage of geminate electron-hole (e-h) pairs or exiciplex states is not fully understood so far[13,14] .

II. MATERIALS AND METHODS

Three samples of dye solar cells were made by depositing the solution of three type of dyes (Ecrchrom Black T, Rohadamin B and Coumarin 500) on ITO and electrodes was silver (Ag))by Spin Coating technique.

Another layer was deposited from dye on a layer of (MEH-PPV). The fabrication process started by preparing the MEH-PPV and the dye of interest then spin coated it indium tin oxide glass. Silver (Ag) electrode was used to complete the formation of organic dye sensitized solar cell.

The formed cells were characterized by Ultra violet-visible spectroscopy, Electrical circuit containing the (voltmeter and Ammeter and a light source Lamp and a solar cell). The solar cell was exposed to light and the current and voltages of the cell were recorded.

III. RESULTS & DISCUSSION

These are the results of efficiency and energy gap for the three samples
(Ecrchrom Black T, Rohadamin B and Coumarin 500). fig (1), (2), (3), (4), (5), (6), (7) and Table (1).

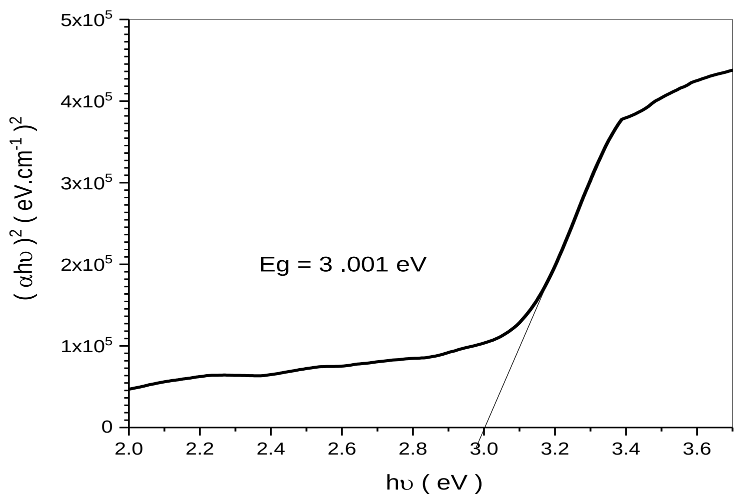

Fig (1) the Optical Energy Band Gap Spectra for The Rhodamine B Dye

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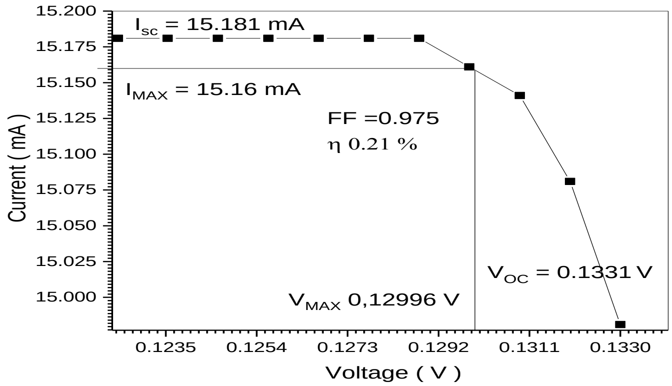

Fig (2) I–V Curves of Rhodamine B Dye

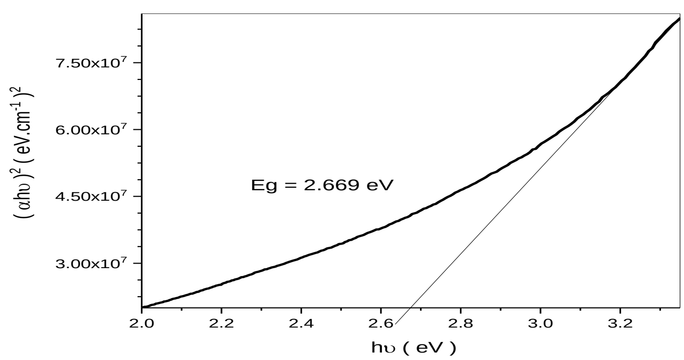

Fig (3) the Optical Energy Band Gap Spectra for the Coumarin 500 Dye

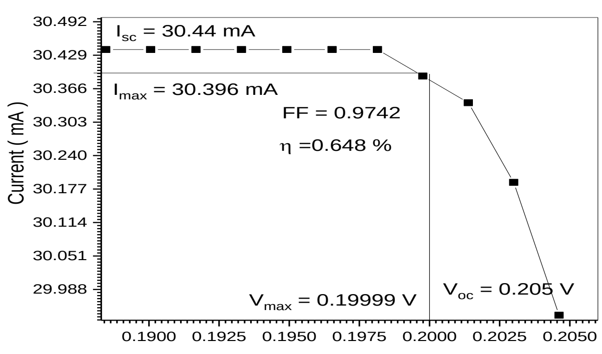

Fig (4) I–V curves of Coumarin 500 Dye

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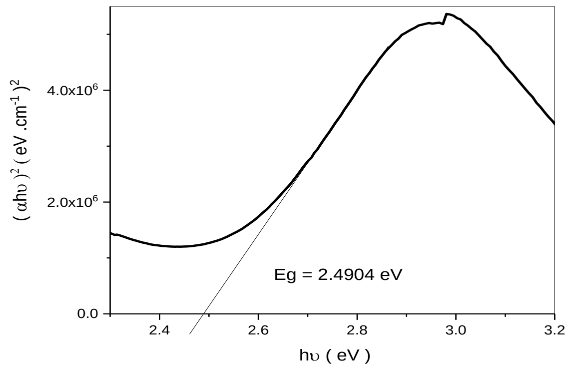

Fig (5) the Optical Energy Band Gap Spectra for the Ecrchrom Black T Dye

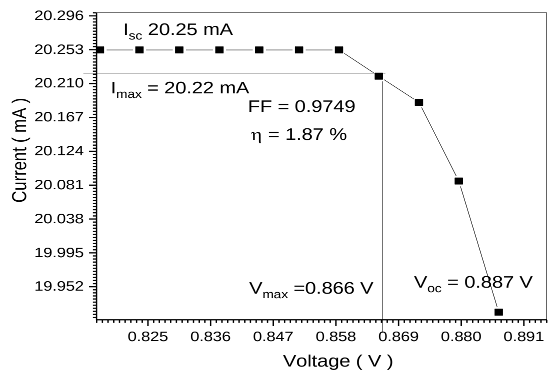

Fig (6) I–V curves of Ecrchrom Black T dye

Table (1) I–V reading of (Ecrchrom Black T, Rohadamin B and Coumarin 500) DSSCs with different energy band gaps

Sample No	I_{sc} (mA)	I_{max} (mA)	V_{max} (V)	V_{oc} (V)	FF	J_{sc} (mA.cm^{-2})	η %	Energy Band Gap (eV)
Rohadamin B	20.25	20.22	0.866	0.8887	0.9749	3.24	1.87	2.49
Coumarin 500	30.44	30.396	0.19999	0.205	0.9742	4.8704	0.648	2.669
Ecrchrom Black T	15.181	15.16	0.12996	0.1331	0.975	2.4289	0.21	3.001

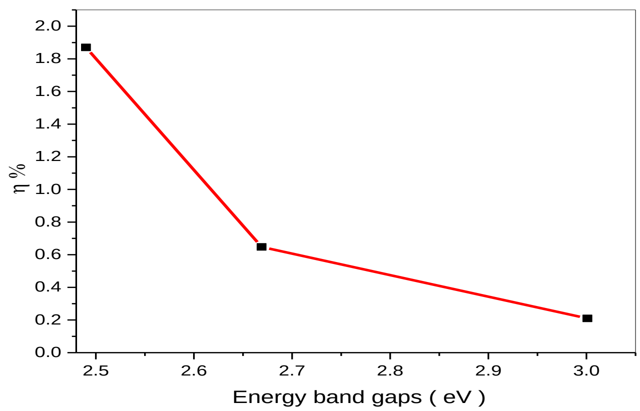

Fig (7) Relationship between Efficiencies versus energy band gaps of (Ecrchrom Black T, Rohadamin B and Coumarin 500) DSSCs

Discussion

The optical energy band gap of (Ecrchrom Black T, Rohadamin B and Coumarin 500) was determined using the absorption spectra. According to the absorption coefficient (α) for direct band gap material is given by the relation

$$\alpha h\nu = B(h\nu - E_g)^n$$

Where E_g the energy gap, constant *B* is different for different transitions, ($h\nu$) is energy of photon and (n) is an index which assumes the values 1/2, 3/2, 2 and 3 depending on the nature of the electronic transition responsible for the reflection. And by extrapolating the straight thin portion of the curve to intercept the energy axis, the value of the energy gap has been to found be (2.669 eV for Rohadamin B, 2.669 eV for Coumarin 500 and 3.009 eV for Ecrchrom Black T) as show in fig (1),(3) and (5).

Fig(2),(4) and (6) shows the current-voltage characteristics obtained from the measured values this measurement was taken from solar cell of the structure (ITO/ (Ecrchrom Black T, Rohadamin B and Coumarin 500) Dyes / MEH-PPV/Ag), the short-circuit current (I_{sc}) are (20.25 mA for Rohadamin B, 30.44 mA for Coumarin 500 and 15.181 for Ecrchrom Black T), the open-circuit voltage (V_{oc}) are (0.887 V for Rohadamin B, 0.205 V for Coumarin 500 and 0.1331 V for Ecrchrom Black T), fill factor (FF) are (0.9749 for Rohadamin B, 0.942 for Coumarin 500 and 0.975 for Ecrchrom Black T), and the efficiency are (1.87 % for Rohadamin B, 0.648 % eV for Coumarin 500 and 0.21 % for Ecrchrom Black T) .

The energy band gaps effect on the efficiency it is very interesting to note that table (1) indicates the increase of energy band gaps and the increases of the solar cell efficiency in general. This is since the energy band gaps increase enables electrons having lower excitation energy to become free electron in a conduction band thus increasing the electric solar efficiency (by rated 3% for 1 eV) as show in fig (7).

IV. CONCLUSION

As the energy band gaps decreases the efficiency increases. This is since the energy band gaps decrease enables electrons having lower excitation energy to become free electron in a conduction band thus increasing the electric solar efficiency rated (3% with 1 eV) for (Ecrchrom Black T, Rohadamin B and Coumarin 500) DSSCs.

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