Enhancement of conversion efficiency of solar cells with different thickness of fluorescent coloring agent

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Abstract

Different coating layers of fluorescent agent (FCA) on the solar cells were used. An increase of 35% in the energy conversion efficiency of the solar cell have been obtained. This increase is attributed to the reduction of the reflected light. eflection spectra show low values at higher thickness which explained the increase of the conversion efficiency with inereases of layer thickness.

Introduction

Unfortunately, the silicon solar cell spectral responses dose not totally concide with the solar radiation. To overcome this obstacles, one should modified this spectrum by partially shifting part of solar spectrum using organic dyes [1, 2]. It was shown that the transformation of the wavelength could significantly enhance the spectral sensitivity of silicon solar cell from the deep UV and through most of the visible region [3]. When a solar cell is exposed to light, the dye is chemically excited, and it injects electrons into the semiconductor to create an electrical current. Researches point out that dye-based cells are cheaper to produce and could eventually bring the cost of solar-generated electricity down from the current $10 per kilowatt hour to 50 cents [4]. Conversion energy efficiency (η) of the solar cells can be calculated using the equation [5]. $\eta = I_m V_m / P_1.A$ where (I_m, V_m) are the maximum power point, P_1 is the incident solar power density and A is the effective area of the solar cell. It was shown that coatings of yellow and pink fluorescent colaring agent on the solar cell give 17-27% increase in energy conversion efficiency of the solar cell due to reduction of the reflection of the incident light at the surtace of FCA. The reflectivities showed low values at the excitation wavelengths, where the incident light was absorbed to excite FCA [6,7]. This paper proposes coating of fluorscent coloring agent Rohdamine-

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B (Rh-B) of different thicknesses on the surface of the solar cells.

Experimental

Silicon solar cell of diameter (10) cm was used of a surface area (78.5$\pm$1.5) cm^2 thickness (0.5$\pm$0.15) mm. The applied base material of solar cell is a single- crystalline silicon which is n-type on the sensitized face. The cell was supplied with tin-plated connections, which can be solderd using all usual soldering process. The short- circuit current (1sc) and open-voltage (Voc) are measurd using (7045 digital multimeter) supplied by electro plan company. Solar intensity meter 118 from instruments Haenni Mesgerate was used to give the radiation incident on the solar cell. The temperature of the solar cell is measured by digital thermometer model (2754-PT 100). A coating of fluorescent coloring agent were prepared by mixing four time of poly. Vinyl. Alcohol (PVA) to one of Rh-B dye of concentration 2×10^{-5} mole/ l, and was coated on the solar cell and dried at room temperature. The excitation and emission spectra of FCA was measured by means of Perkin-Elmer fluorescent spectrometer while a perkin-Elmer Lambda –9 spectrometer was used for measuring the absorptance and transmittance and reflectance spectra.

Results & Discussion

Figure (1) shows the absorption and emission spectra of the FCA dissolved in distluted water. The emission wavelength is ~ 600 nm. Figure (2) shows the absorption of the FCA film as a function of the wavelength. The absorption is increased as the thickness of the coating film is increased. Figure (3) shows the transmittance of the FCA film. The transmittion of light at emission wavelength is decreased as the thickness is increased, while Fig. (4) shows the reflectance of the FCA films with different thickness. The reflectance is increased with decreasing the thickness and the reduction of the reflectance cause an increase in the energy conversion efficiences of the solar cell. Table (1) shows the electrical characteristics and energy conversion efficiency of the solar cell with and without the FCA coatings. Figure (5) shows the behavior of solar cell efficiency as a function of sheet thickness, It is seen that increase in η as the coating thickness is increased. This result is agreement with others [8]. The effiiciency of silicon solar cell was 5.17%, it become 6.98% after coating. The coating gives about 35% increase in the energy conversion efficiency of the solar cell. The increase or decrease in the energy conversion efficiency of the solar cell module is dominated by the positive effect of decreasing the reflectivity due to the absorption of the exciting light and by the negative effect of the scattering, which is caused by the isotropic re-emission of the flourescent light from the fluorscent molecular exaitation by the light of these wavelength and the shift in the solar radiation spectram towards higher wavelengths [9]. Halogen lamp was used as a source of radiation at acertain from the solar cell. The incident solar power density was 100 W/m^2.

Table 1
Solar cell paramneters without and with FCD coating

Coating thickness (mm)	Voc (V)	Isc (mA)	I_m (mA)	V_m (V)	η %	P (W/m^2)	% Δη
0	0.4797	193.28	160.5	0.251	5.176	100	-
0.5	0.4754	173.0	160.81	0.3152	6.65	97	28.47
1.0	0.4757	178.89	159.27	0.3186	6.733	96	30.08
1.5	0.4758	181.2	160.6	0.3133	6.747	95	30.35
2.5	0.4768	183.7	160.22	0.3161	6.791	95	31.20
3.5	0.4770	185.0	159.91	0.3225	6.988	94	35.00

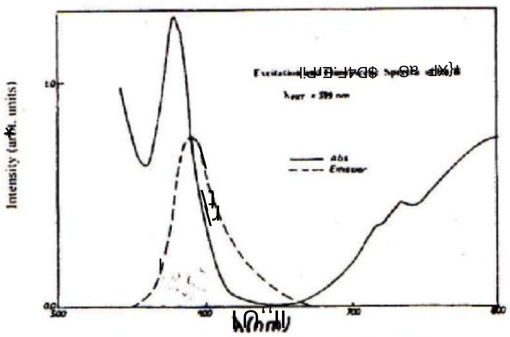

Fig (1) Absorption and emission spectra of Rh-B.

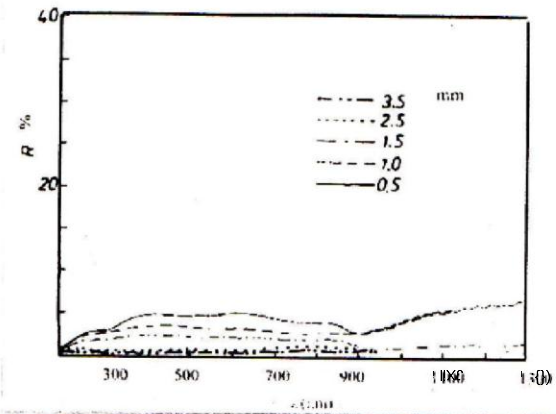

Fig (4) Reflectance of the FCA films with different thicknesses

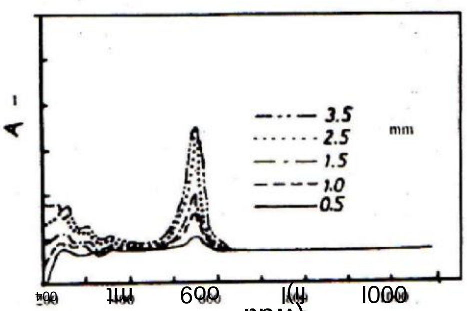

Fig.(2) Absorption of FCA films as function of the wavelength and various thicknesses.

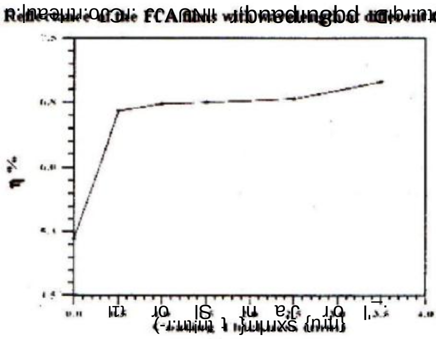

Fig (5) [illegible]

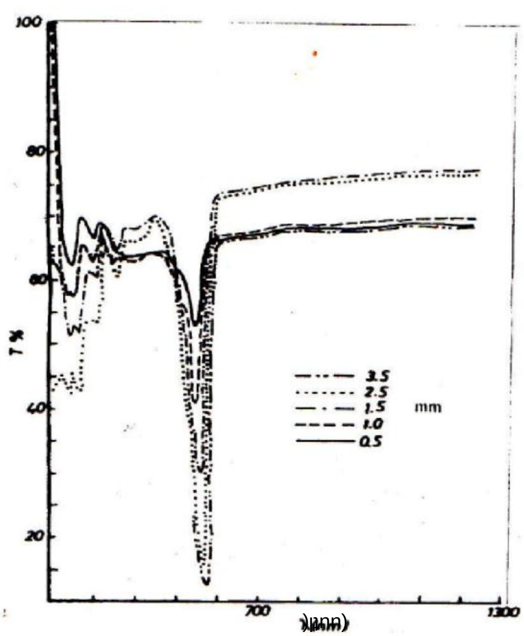

Fig (3) Transmittance of the FCA film as a function of the wavelength

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تحسين كفاءة تحويل الخلايا الشمسية باستخدام سمك مختلفة من الصبغة الملونة المتفلورة

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الخلاصة

استخدمت طبقات مختلفة من الصبغات الملونة المتفلورة وقد أدى ذلك إلى زيادة كفاءة تحويل الخلية الشمسية بمقدار ٣٥%. أن هذه الزيادة في الكفاءة تعود إلى نقصان كمية الضوء المنعكس من على سطح الخلية الشمسية. وقد لوحظ طيف الانعكاس نقصان الانعكاسية عند زيادة السمك وهذا يفسر زيادة كفاءة تحويل الخلية الشمسية بزيادة سمك طبقة الصبغة.