Effect of chlorophyll LSC film thickness on the solar cell performance

Ahmed F.Atwan[1], Ali H.Al-Hamadani [2], Raheem Hussein Rhaif [1]

[1]Al-Mustansiriyah University, College of Education, Physics Department
[2]University of Technology, Renewable Energies Technology Center

Abstract

In the present work Chlorophyll dye has been used as solar concentrator in order to improve the performance of solar cells by manufacturing a thick film of epoxy doped with a suitable concentration of this material. The samples (thick films) are prepared by dissolve the chlorophyll dye in chloroform solvent then add this solvent dye into epoxy solvent and mixing them with slow motion .The produced film is made with different thickness (0.25,0.50,0.75,1 and 2mm) for specific dye concentration($8.42x10^{-3}$ mole / liter). The results indicated that the epoxy is a good substrate material due to low absorption in visible region .Also the results indicated that the solar cell performance is improved with present of chlorophyll dye. Also, the best improvement is got in low thickness (0.25) of the film.

1. Introduction

PV systems for remote applications typically include three basic elements: one PV panel that converts solar radiation into electricity, a means to store the electricity produced by the PV panel, which is normally an electrochemical battery, and an electronic device that helps control the flows of electricity within the system, thus protecting the battery by properly dispatching available energy. A variety of devices capable of using electricity to provide comfort, entertainment and other services for the benefit of the user are then attached to the PV system by means of the electronic charge controller (ECC) [1].

1.1 Concentrating Solar Power (CSP)

Concentrating Solar Power uses renewable solar resource to generate electricity while producing very low levels of greenhouse-gas emissions. Thus, it has strong potential to be a key technology for mitigating climate change. In addition, the flexibility of CSP plants enhances energy security. Unlike solar photovoltaic (PV) technologies, CSP has an inherent capacity to store heat energy for short periods of time for later conversion to electricity [2].

1.2 Luminescent Solar Concentrators (LSC)

Luminescent solar concentrators (LSCs) are based on the entrance of solar radiation into a homogeneous medium collector containing a fluorescent species in which the emission bands have little or no overlap with the absorption bands. This emission is trapped by total internal reflection and concentrated at the edge of the collector by the geometrical shape which is usually a thin plate. Thus the concentration of light trapped in the plate is proportional to the ratio of the surface area to the edges [3]. The luminescent solar concentrator (LSC) offers the promise of reducing the cost of photovoltaic energy conversion by the use of high gain concentrators which do not require tracking. The conceptual operation of the LSC is based on light pipe trapping of luminescence induced by the absorption of solar radiation. A transparent material, such as Plexiglas, is impregnated with guest luminescent absorbers such as organic dye molecules .Solar photons entering the upper face of the plate are absorbed, and photons are then emitted. Snell's law dictates that a large fraction of these luminescent photons will be trapped by total internal reflection [4]

2. EXPERIMENTAL

2-1 Preparation of chlorophyll

Chlorophyll has been prepared by using almadnos in a laboratory. This is done through the following steps:

1. Almadnos leaves are cut into small pieces.
2. Adding chloroform solvent to almadnos juice and leaving it for an hour.
3. Isolating the solution from Impurities by using nomination papers.
4. Using a bottle to isolate solution from water.
5. Leaving the solution for a period of times until we get the desired concentrations**.**

2.2 Polymer (Epoxy Resin)

Polymer Epoxy consists of two materials. The first is called (epoxy resin) and symbolizes (A) and the second is called (hardener) symbolizes (B) which helps to the interlocking chains of polymeric among them when mixing two materials .These two materials mix in ratio depending on type of epoxy .

Table 1: The main properties of Epoxy

Trade name	CONCRESIVE® 1320
Colour	Limpid
Boiling point	260 C^o
Company	Badische Anilin-und Soda Fabrik (BASF), Germany
Specific gravity of mixed material	1.06
Service temp .range	(20-80) ^{0}C
Physical state	Liquid
Final cure	7 days (35^{0}C)

2.3 Solution preparation

Solution of concentration for solvent is prepared by weighting an appropriate amount of the material by using a balance having sensitivity of 10^{-4} g. According to the following equation.

$W=\frac{M_W \times V \times C}{1000}$ ………………. (2-1)

The prepared solutions are diluted by using the following equation:-

$C_1V_1=C_2V_2$ ……………….. (2-2)

3. Results and Discussions

The present work investigated the effect of thickness of chlorophyll LSC film on the solar cell performance. The experiments was carried out with new conditions those related to input power. The results indicate that the maximum bias voltage, approximately, constant while the maximum current and thus the maximum output power (see table 2) levels increase with decrease of LSC film thickness as show if figures 1 to 5 .This behavior can be explained as follow: high thickness means long optical path and thus high percent of attenuation of incident radiation due to absorption and vice versa. Consequently, at low film thickness (0.25mm) there is high incident power and high output power.

Table 2: I-V characteristics of solar cell with LSC film of 8.42x10^{-3}mol/l

Thickness mm	V_{now}	V_{open}	I_{short}	P_{max}	V_{max}	I_{max}	FF
2	2.567	6.950	39.5	241.2	6.234	38.7	0.878
1	6.991	7.067	37.1	242.0	6.524	37.1	0.923
0.75	6.847	6.882	39.5	248.2	6.415	38.7	0.913
0.50	6.897	6.912	40.0	255.3	6.384	40.0	0.923
0.25	6.912	6.845	42.0	260.8	6.255	41.7	0.907

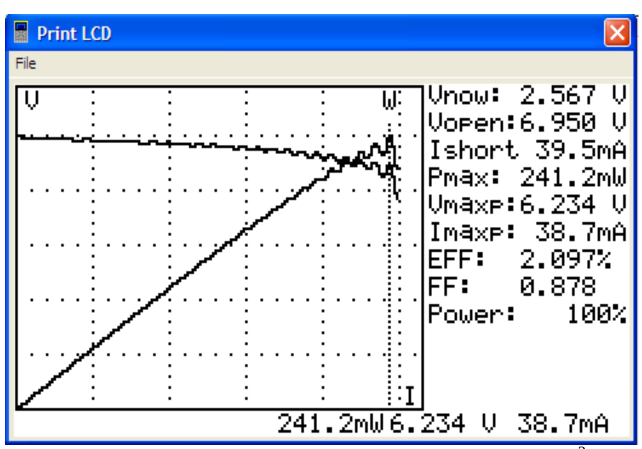

Figure 1: Current-Voltage curve solar cell using LSC Chlorophyll (8.4298×10^{-3} mol/L) with 2mm thickness

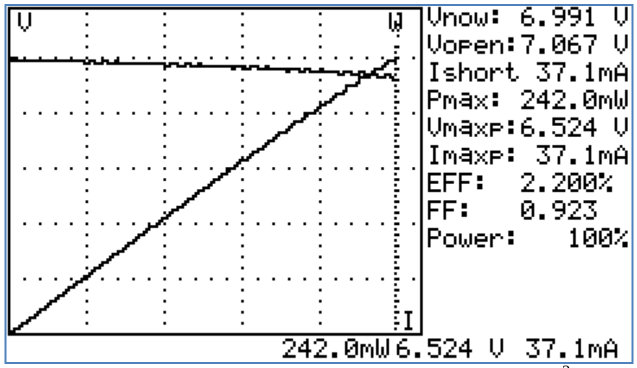

Figure 2: Current-Voltage curve solar cell using LSC Chlorophyll (8.42×10^{-3} mol/L) with 1mm thickness

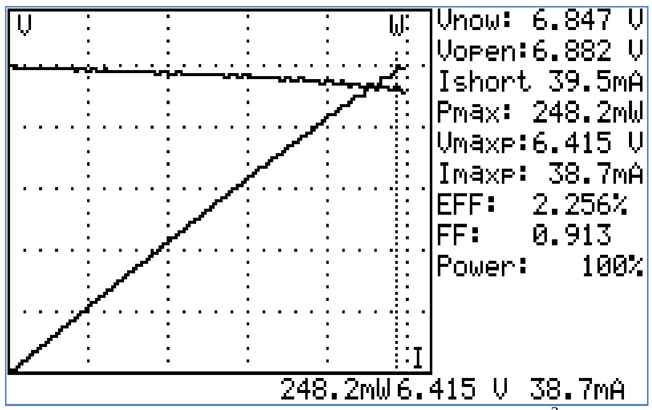

Figure 3: Current-Voltage curve solar cell using LSC Chlorophyll (8.42×10^{-3} mol/L) with 0.75 mm thickness

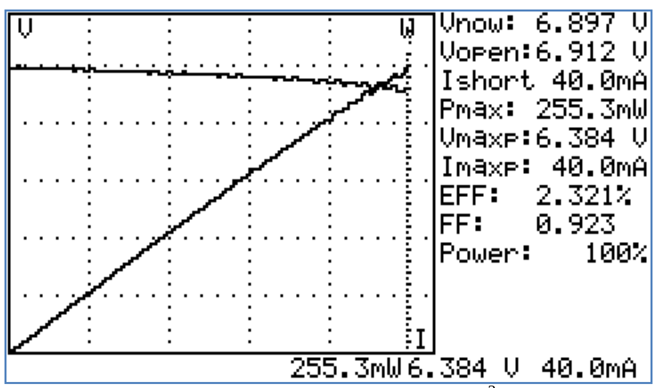

Figure 4: Current-Voltage curve solar cell using LSC Chlorophyll (8.42×10^{-3} mol/L) with 0.5 mm thickness

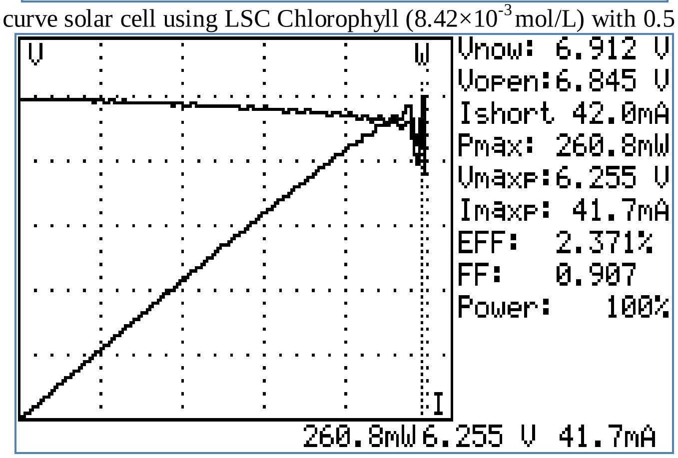

Figure 5: Current-Voltage curve solar cell using LSC Chlorophyll (8.42×10^{-3} mol/L) with 0.25 mm thickness**.**

Conclusions

During the present study, LSC is promised technique in solar energy improvement field.

References

[1] Martinot E, Ramankutty R, Rittner F, The GEF Solar PV Portfolio: Emerging Experience and Lessons, Monitoring and Evaluation Working Paper 2, GEF pre-publication draft (Aug. 2000).
[2] IEA,"Concentrating Solar Power"2010, International Energy Agency, Paris, OECD/IEA, 2010.
[3] Renata Reisfeld"New developments in luminescence for solar energy utilization ", Optical Materials 32, 850–856, (2010) .
[4] J. S. Batchelder, A. H. Zewail, and T. Cole"Luminescent solar concentrators", APPLIED OPTICS Vol. 20, No. 21, 3733-3754,1981.