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The Effect of Temperature on Photodiodes

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Abstract

In this work the effect of temperature and magnetic flux intensity as well on the output of three samples of photodiodes was studied . The current value in both light and darkness was calculated and found.

Key wards: light current, dark current, magnetic flux intensity, photodiode.

Introduction

Many people now put solar PV panels on their roofs to take advantage of the (still) generous self generation **feed in tariff** and the export tariff available when you sell power back to the grid. For every 1kWh of electricity produced regardless of whether you use it in the home or sell it back to the grid you get 15.44 pence (if you sell it to the grid you get an additional 4.5 pence).It goes without saying that maximising the amount of electricity you produce (i.e. number of kWhs) is key to ensuring healthy returns on investment and shortening the payback periods. So you can start not only making money by producing electricity via the subsidies available, but also use the electricity you produce to lower you bills. One of the key factors impacting the amount of electricity your solar panels produce is the temperature at which they operate. It is easy to presume that more sun and therefore more heat result in more electricity but this is wrong. Different solar panels react differently to the operating ambient temperature, but in **all** cases the efficiency of a solar panel decreases as it increases in temperature. The impact of temperature on solar panel efficiency is known as the temperature coefficient.

The Temperature Coefficient

If you look at the datasheet provided by your solar panel manufacturer they will refer to a term normally described as the temperature coefficient pMax. This value, which is normally given in the form of negative percentage, reveals the impact of temperature on the panel.

Solar Panels are power tested at 25^0C, so the temperature coefficient percentage illustrates the change in efficiency as it goes up or down by a degree. For example if the temperature coefficient of a particular type of panel is -0.5%, then for every 1^0C rise, the panels maximum power will reduce by 0.5%.So on a hot day, when panel temperatures may reach 45^0C, a panel with a temperature coefficient of -0.5% would result in a maximum power output reduction of 10%. Conversely, if it was a sunny winter's morning, the panels will actually be more efficient.
Each type of solar cell has a different temperature coefficient detailed below

- Both Monocrystalline and Polycrystalline cells have a temperature coefficient pMax of between -0.45% to -0.50%
- Amorphous based thin film panels have a rating of between -0.20% to -0.25%.
- The Hybrid solar cells currently on the market sit in the middle with a temperature coefficient pMax of between -0.32%

Experimental Setup

Materials

-Different photodiodes (Sample 1 (S1) , sample 2 (S2), sample 3 (S3)
- Magnetic sensor specifications: Leybold Didatic GmbH, 220-240V, Sensor length 8.9cm.
-Powerful magnet specifications: two coils of 10,000 turns and 5A current.
-Sealed lead acid rechargeable battery "SUNCA", 9V.
-Digital multimeter, Voltage range: 200mV—1000V
Current range: 200mA--200μA
-Thermometer range: -10ºC--50ºC.
- Beaker and ice cubes.
-Connecting wires.

Method

Part One

The diode is placed on the beaker containing water of normal temperature (308K); the magnetic flux is exposed vertical on the photo diode, at fixed value of **9.87mT**, then the ice cubes are added, reading of voltage and current were taking for different values of temperatures in both light and darkens.

Part Two

Different values of magnetic intensity values and repeating the same stapes.

Results

Table (1) Sample 1 (S1)

Magnetic flux intensity = 9.87 mT

Temp.	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Ln I_L	Ln L_D	1/T
308	9.38	1.062	9.00	1.019	0.060	0.019	0.0032
303	9.39	1.063	9.11	1.019	0.061	0.019	0.0033
298	9.41	1.065	9.17	1.039	0.063	0.038	0.0034
293	9.43	1.068	9.20	1.042	0.065	0.041	0.0034
288	9.45	1.070	9.22	1.044	0.068	0.043	0.0035
283	9.48	1.074	9.24	1.046	0.071	0.045	0.0035
280	9.50	1.080	9.26	1.049	0.077	0.047	0.0036
273	9.53	1.081	9.88	1.051	0.078	0.050	0.0037

In light

In dark

Table (1-a) Sample 1 (S1)

Without the effect of magnetic flux intensity

Temp.	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Ln I_L	Ln L_D	1/T
308	9.20	1.044	8.14	0.924	0.043	-0.079	0.0032
303	9.27	1.052	8.18	0.928	0.050	-0.747	0.0033
298	9.30	1.055	8.22	0.933	0.053	-0.069	0.0034
293	9.35	1.061	8.30	0.942	0.059	-0.060	0.0034
288	9.39	1.065	8.33	0.946	0.063	-0.056	0.0035
283	9.43	1.070	8.37	0.950	0.068	-0.051	0.0035
280	9.48	1.076	8.41	0.954	0.073	-0.047	0.0036
273	9.50	1.078	8.45	0.959	0.075	-0.042	0.0037

In light

In dark

Table (2)Sample 2 (S2)

Magnetic flux intensity = 9.87 mT

Temp.	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Ln I_L	Ln I_D	1/T
308	10.79	0.863	10.00	0.72	-0.145	-0.33	0.0032
303	10.85	0.868	10.11	0.729	-0.142	-0.316	0.0033
298	10.87	0.870	10.14	0.731	-0.140	-0.313	0.0034
293	10.92	0.874	10.16	0.733	-0.135	-0.311	0.0034
288	10.95	0.876	10.18	0.734	-0.132	-0.311	0.0035
283	10.96	0.877	10.20	0.736	-0.131	-0.306	0.0035
280	10.98	0.878	10.21	0.737	-0.130	-0.305	0.0036
273	10.99	0.879	10.23	0.738	-0.129	-0.304	0.0037
	In light		In dark				

Table (2-a)Sample 2 (S2)

Without the effect of magnetic flux intensity

Temp.	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Ln I_L	Ln I_D	1/T
308	10.33	0.826	9.65	0.772	2.342	-0.259	0.0032
303	10.40	0.832	9.68	0.774	2.342	-0.256	0.0033
298	10.47	0.837	9.71	0.777	2.352	-0.252	0.0034
293	10.50	0.84	9.74	0.779	-0.172	-0.250	0.0034
288	10.52	0.842	9.79	0.783	-0.172	-0.245	0.0035
283	10.59	0.847	9.83	0.786	2.360	-0.241	0.0035
280	10.63	0.850	9.87	0.790	2.290	-0.236	0.0036
273	10.66	0.853	9.90	0.792	-0.159	-0.233	0.0037
	In light		In dark				

Table (3)Sample 3 (S3)

Magnetic flux intensity = 9.87 mT

Temp.	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Ln I_L	Ln I_D	1/T
308	11.88	1.224	10.92	1.126	0.202	0.119	0.0032
303	11.90	1.227	10.94	1.128	0.205	0.120	0.0033
298	11.92	1.229	10.97	1.131	0.206	0.123	0.0034
293	11.93	1.230	10.99	1.133	0.207	0.125	0.0034
288	11.94	1.231	11.00	1.134	0.207	0.126	0.0035
283	11.95	1.232	11.17	1.152	0.209	0.141	0.0035
280	11.96	1.233	11.18	1.153	1.209	0.142	0.0036
273	11.98	1.235	11.20	1.155	0.211	0.144	0.0037

In light In dark

Table (3-a)Sample 3 (S3)

Without the effect of magnetic flux intensity

Temp. (ºC)	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Magnetic flux intensity (mT)	I_{light} - $I_{darkness}$
308	11.88	1.225	10.92	1.126	39.7	0.099
303	11.70	1.206	10.90	1.124	31.00	0.082
298	11.64	1.2	10.87	1.121	30.60	0.079
293	11.50	1.186	10.81	1.114	30.51	0.072
288	11.48	1.184	10.80	1.113	20.66	0.071
283	11.43	1.178	10.71	1.104	20.76	0.074
280	11.40	1.175	10.68	1.01	19.96	0.165
273	11.38	1.173	10.64	1.097	19.50	0.076

In light In darkness

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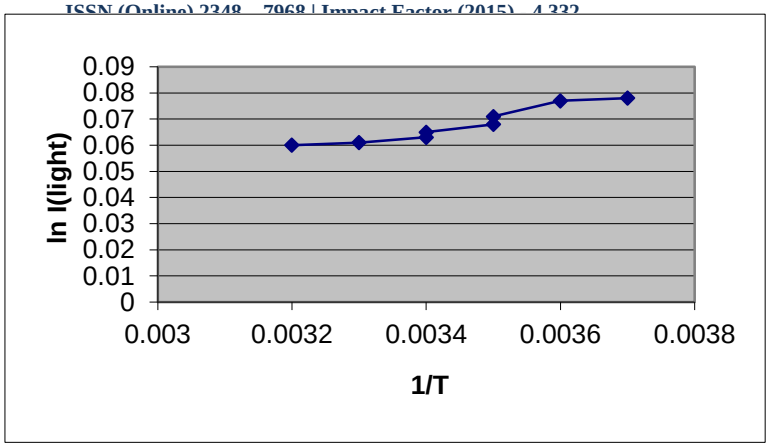

Fig (1) Sample 1 (S1)- The relation between ln I_{light} & 1/T with effect of Magnetic flux intensity = 9.87 mT

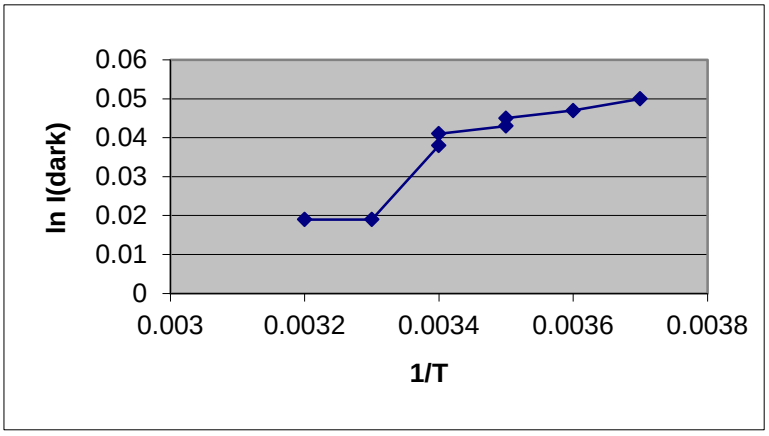

Fig (1-a) Sample 1 (S1)- The relation between ln I_{dark} & 1/T without effect magnetic flux

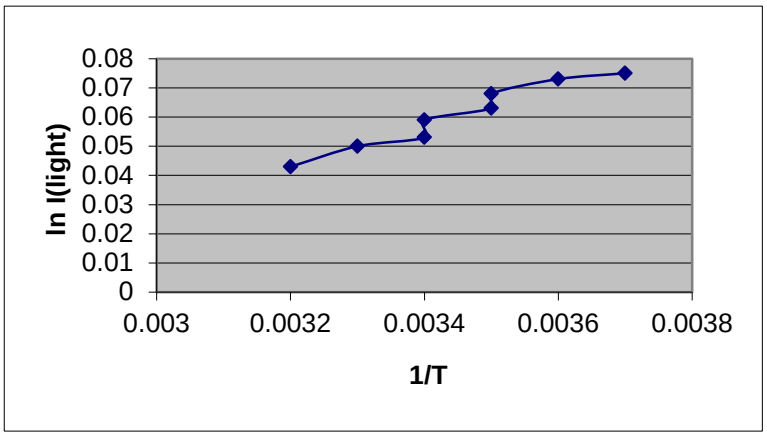

Fig (2) Sample 2 (S2)- The relation between ln I_{light} & 1/T with effect of Magnetic flux intensity = 9.87 mT

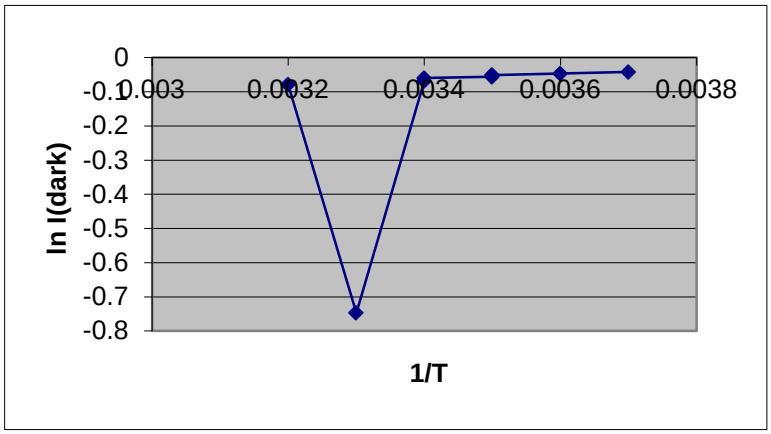

Fig (2-a) Sample 2 (S2)- The relation between ln I_{dark} & 1/T without effect magnetic flux

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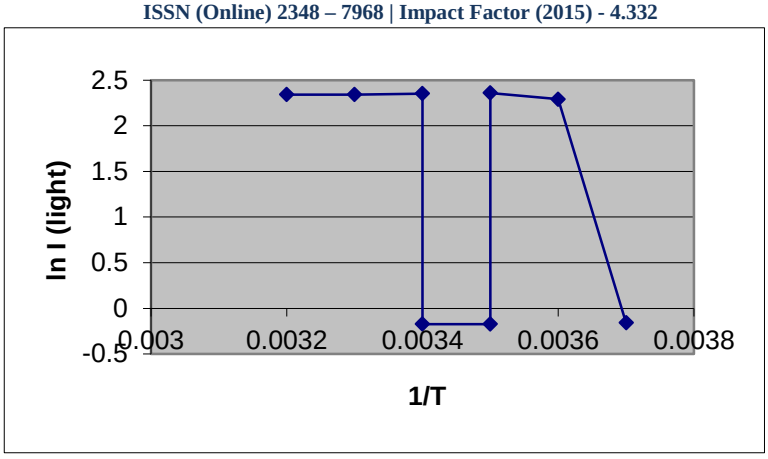

Fig (3) Sample 3 (S3)- The relation between ln I_{light} & 1/T with effect of Magnetic flux intensity = 9.87 mT

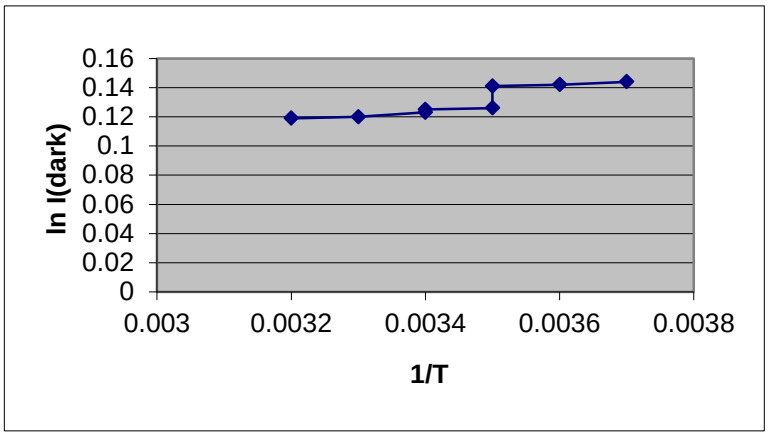

Fig (3-a) Sample 3 (S3)- The relation between ln I_{dark} & 1/T without effect magnetic flux

Conclusion

There is a direct effect on I_L and I_D in the presence of magnetic field.

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