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Study of Performance of Si PV Cell Array Using Multiple Colour Filters

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Abstract: In this paper, an attempt has been made to evaluate the effect of colours of light on silicon photovoltaic cell. Various colour filters are used for estimating the output current performance of solar cell experimentally.With respect to colours of filter used the output voltage and output current from the photovoltaic cell is monitored. The results show that visible portion of the solar spectrum significantly influences the performance of the solar cell array.

Keywords: Solar PV array, Colour Filters, Output current, visible spectrum, Solar cell performance.

I. INTRODUCTION

Photovoltaic system is primarily used to generate electricity directly from solar energy, through the use of solar cells and similar devices. This technology has been greatly developed since the 20^{th} century and gained significant importance since the last decade. This is due to the depletion of conventional fossil fuels and adverse environmental effects during generation of energy from them. Being a tropical country close to the equator zone a large amount of sunlight is available throughout the year. This has made solar PV cell the main alternative for generating electricity. It is growing rapidly and is expected to reach full potential in the 21^{st} century. A photovoltaic generator, also known as a photovoltaic array, is the total system consisting of all PV modules connected in series or parallel with each other. Solar photovoltaic conversion efficiency has improved as the general technology has advanced. It has grown from the first passive collection method to current application method. Many studies have been done towards the next advancement for increased output and efficiency. The colour of light is determined by its wavelength as dictated in the colour spectrum. The sun emits energy in the form of electromagnetic waves. White light contains all colours of the solar spectrum. Its range is from 400 nm – 780 nm. Sunlight although is of different colour. It contains more of the high energy violet end of the spectrum. Red photons have the least energy and blue photons have the most energy. Green is between the two. The energy of the photons is determined by their frequency $E=hf$. Where E is the energy of the photon, f is its frequency in Hz, and h is Planck's constant, $h = 6.663*10^{-34}$Js. It is becoming clear that wavelength of light has a significant effect on the performance of PV cell. Currently available solar cells respond well to some, but not all, wavelengths. Research in the area of solar cells continues with an increasing interest to develop cells that will respond well at the widest range of wavelength. The aim of this study is to investigate the effect of different colour filters on the output current from the solar panel. The study is also intended to test the hypothesis stating that if the colour of light a solar panel was exposed to be changed, then the output of the solar panel would be affected.

II. THEORY

2.1 Solar Cells

Solar cells are basically wafer-based cells which are made of crystalline silicon. It is a device which converts solar energy directly into electricity by the principle of Photovoltaic effect. Its output electrical characteristics that are current, voltage and resistance vary when exposed to light. The theory of solar cell explains the process by which the light energy in photons is converted into electrical energy when a photon strikes a semiconductor device.

When a photon hits a piece of silicon, any of three things can happen:

- The photon can pass straight through the silicon. This happens generally for lower energy photons.
- The photon can get reflected off the surface.
- The photon can be absorbed by the silicon if the photon energy is higher than the silicon band gap value. This generates an electron-hole pair and sometimes heat depending on the band structure.
- When a photon is absorbed, its energy is given to an electron in the crystal lattice. Usually this electron is in the valence band and is tightly bound in covalent bonds with neighboring atoms, and therefore unable to move far. The energy given to the electron by the photon excites it into the conduction band where it is free to move around within the semiconductor. The network of covalent bonds that the electron was previously a part of now has one fewer electron. This is known as a hole. The presence of a missing covalent bond allows

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the bonded electrons of neighboring atoms to move into the hole, leaving another hole behind, thus propagating holes throughout the lattice. Thus the photons absorbed in the semiconductor create electron-hole pairs.

- A photon only needs to have energy greater than that of the band gap in order to excite an electron from the valence band into the conduction band. These higher energy photons will be absorbed by the solar cell, but the difference in energy between these photons and the silicon band gap is converted into heat rather than into usable electrical energy.

2.2 Basic Theory of Solar Filter

Filters in the form of coloured sheets are used here to filter the specific solar spectrum with respect to the colour of filter used which falls in the solar panel. Filter generally absorbs its own colour from the solar spectrum e.g. if we use a red colour filter paper it is going to absorb the red colour from the solar spectrum and will allow rest of the spectrum except the red to pass through it. Again when we use a combination of two different colour filter papers like red and green then both red and green light will be absorbed from the solar spectrum which falls in the solar panel and let remaining spectrum pass through it.

III. MATERIALS AND METHODS

The apparatus table for the experiment conducted is given in table 3.1.

Table 3.1 Apparatus for Experiment

Name of Apparatus	Range/Rating	Quantity	Makers Name
Solar Panel	6V, 100mA	1	Mikado Electronics
Digital Multimeter	DC voltage: 200mV/2V/ 20V/200V/ 600V DC current: 200mA/2mA/ 20mA/200mA/ 10A Resistance: 200Ω/2kΩ/ 20kΩ /200kΩ/ 2MΩ	1	MASTECH
Coloured Filters	-	3	-
Probes	-	As per required	-
Resistance	3.6kΩ	2	-
Bread Board	-	1	-

The output voltage and current was measured from the PV cell (naked) with the help of multimeter under the direct sunlight by connecting two resistances of value of each 3.6KΩ in Bread board. Then coloured filters were wrapped over the solar panel respectively with different coloured filter sheets and the output voltage and current were found to change and the values were recorded.

IV. RESULTS

The experimental results are recorded in Table 4.1

Table 4.1 Experimental Results

Sl. No.	Colour of sheet	Current (mA)	Voltage (100mV)	Power (mW)
1	None	72.7	64.3	467
2	Red	46.4	61.9	287
3	Green	44.7	61.9	276
4	Blue	48.7	61.9	301
5	Blue + Green	36	59.5	214
6	Blue + Red	34.4	59.5	204
7	Red + Green	32.8	59.5	195
8	Blue + Green + Red	26.9	57.5	154

The load resistance used during the experiment is 630Ω.

The variations of current, voltage and power with respect to colour of filtering sheet used are shown in Figure 4.1.

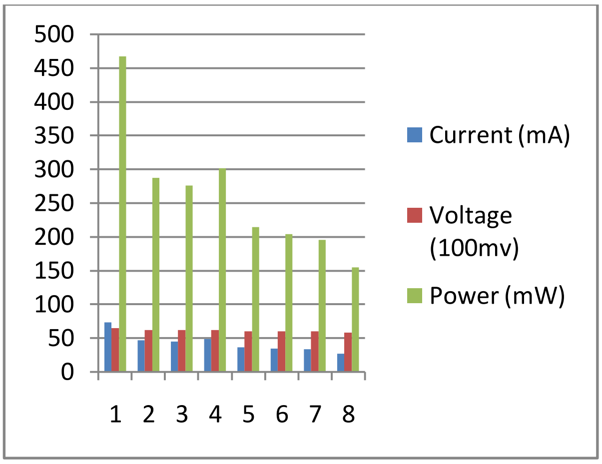

Figure 4.1 Variations of Current, Voltage and Power with Colour Filters

V. DISCUSSIONS AND CONCLUSION

With reference to the above result some unusual characteristics were observed. We can see that although the green spectrum has lower wavelength than red spectrum the current will be less when it is absent than when red spectrum is absent. Likewise current when blue and red is absent will be less than when blue and green is absent. This indicates that the cell array output changes irregularly with use of combination colour filters.

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Thus it is the intention of the authors to investigate in future into the effects of combination colour filters composed of sheets of colours which are a combination of the basic colours, with respect to current output of the solar cell array.

REFERENCES

[1]. Ahmed Elsayed Ghitas, "Studying the effect of spectral variations intensity of the incident solar radiation on the Si solar cells performance", NRIAG Journal of Astronomy and Geophysics, 2012, 1, 165-171.

[2]. R. Gottschalg et al, "Experimental study of variations of the solar spectrum of relevance to thin film solar cells", Solar Energy Materials & Solar Cells 79 (2003), 527-537.

[3]. Sudhakar K. et al, "Effect of colour filter on the performance of solar photovoltaic module", International Conference on Power, Energy and Control (ICPEC) 2013.

BIOGRAPHIES

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