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Spectral Filtering Copper Coated Hibiscus-Methanol Extract for Photovoltaic Module Applications

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Abstract*: *This research focuses on ways to protect the photovoltaic solar panel from harmful radiation during harsh weather conditions. The bio-filter made up of copper coated hibiscus extract from methanol was proposed. It was discovered that the bio-filter was able stabilize the fluctuations and in some cases improved on the output of the PV panel. It was recommended that the onward study on this kind of bio-filter would enhance higher patronage of PV products in the African market.

Keywords* : *oltaic, bio-filter, spectral filtering, solar energy, energy

I. INTRODUCTION

Solar irradiance can be captured and converted into some useful forms of energy, such as heat and electricity using different invented technologies [1-3]. The first part of the conversion process is the conversion of energy from the sun (solar energy) into electricity using PV modules to capture the energy from the sun and convert it to useful electricity [4]. Solar power could be considered a key to a clean energy future as it possesses such characteristics such as being generated from a clean and renewable source of energy, there are no harmful emissions released into the atmosphere such as CO2 and the likes as electricity is produced and due to its ability to generate electricity without needing fuel, it has no variable cost therefore it is inexpensive [5].

The solar market has improved with the developed countries taking good advantage of the solar power grid system. For example, the first quarter of 2019, the U.S. solar market made over 2 million installations that can be estimated as 2.7 gigawatts direct current [6]. China has grown radically over the last eight years, with 175 GW of installations have been adjudged to have stimulated the domestic and foreign market [7]. This policy has strengthened China's manufacturing base.

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A grid-connected solar farm or grid-connected solar power system is connected to the utility grid as an electricity generating solar PV power system. A grid-connected solar system comprises of one or more inverters, solar panels, a power conditioning unit and equipment for grid connection. They can range from small residential and commercial rooftop installed systems to large solar power grid and stations (Figure 1). Unlike stand - alone power systems, due to their expensive nature, a grid-connected system does not involve an inbuilt battery solution method. The grid-connected photovoltaic system supplies the excessive power to the utility grid sometimes beyond the requirement of the connected load.

Figure 1:Cornell's Sutton solar farm, Geneva [8].

PV and array modules are only one part of a PV system. The PV system also includes mounting structures pointing panels towards the sun, along with components taking the direct current electricity generated by modules and converting it to the alternating current used to power most household appliances [9-11]. A single PV device is known as a cell. Usually a single cell is small, generating about one or two watts of power. They are connected together in a series of chains to create larger units known as panels so as to increase the power output of these cells. It is possible to use panels individually or to connect several panels to form arrays [12].

The salient question is why has the African solar adventure grown over the years? Aside the politics of developed world power market domination. There is the basic challenge of solar panel in the region dropping performance to about 60% in the first year of purchase. The closest reason adduced to this observation is the reality of harsh weather that destroys solar panels in the region [13]. In this paper, we examined a way of reducing the effect of harsh weather on solar panel.

This process involves the process of spectra filtering using bio-filters. This paper introduces a simple way of resolving this challenge in the tropical belt of Africa.

II. MATERIALS AND METHODS

The materials used for thus experiment includes: three 3W Monocrystalline solar panels; three 4W polycrystalline solar panels; 2mm Connecting wires; data logger; digital Multimeter; retort stand, solarimeter. The rating of the monocrystalline solar panel is: open circuit voltage (voc) =10.8v; short circuit current(isc) = 418mA; maximum power voltage(vmp) = 8.2v; and maximum power current (imp) = 366mA. The rating of the polycrystalline solar panel is: open circuit voltage (Voc) = 22.466V; short circuit current (Isc) = 0.235A; maximum power voltage (Vmp) = 18.436V; and maximum power current (Imp) = 0.220A. The plant extract was obtained from Hibiscus Sabdariffa. Before this experiment, it is widely known that the hibiscus extract are used for flavours, medicinal, pharmaceuticals, agrochemicals, fragrances, and local dyes [14-16]. The major component in the flower is the cyanidin 3- sophoroside. The Hibiscus sabdariffa flower (Figure 2) was blended with methanol and filtered. The filtrate collected into a beaker. The 10 ml of the filtrate was mixed with 0.0045 mole of Cu(NO3)2.3H2O and left a day to enable proper dissolution of copper. The data logger can accommodate four panels in total (two monocrystalline and two polycrystalline). One monocrystalline and polycrystalline panel was unsprayed and the other two panels (monocrystalline and polycrystalline) were sprayed. The unsprayed panels were used as control mechanism to monitor the sprayed panels. Before the panels were sprayed, it was cleaned with distilled water. The panels were afterwards put under the sun and the readings from the panels were recorded on the logger and stored in an SD card.

Figure 2: Hibiscus sabdariffa L. flower

III. RESULTS AND DISCUSSION

Figure 3 presents the solar. It is observed that the radiation fluctuation is high. The solar radiation was at all time high for the period of measurement. Figure 4a presents the graph of current against time for both sprayed and unsprayed panel of the monocrystalline panel. The current of the sprayed panel is lower than that of the unsprayed panel. However, it can be seen that the sprayed panel (bio-filter) was able stabilize the fluctuations. In the polycrystalline panel shows that sprayed panel is higher than that of the unsprayed panel (Figure 4b). It has ben confirmed that the bio-filter is a good bio-filter.

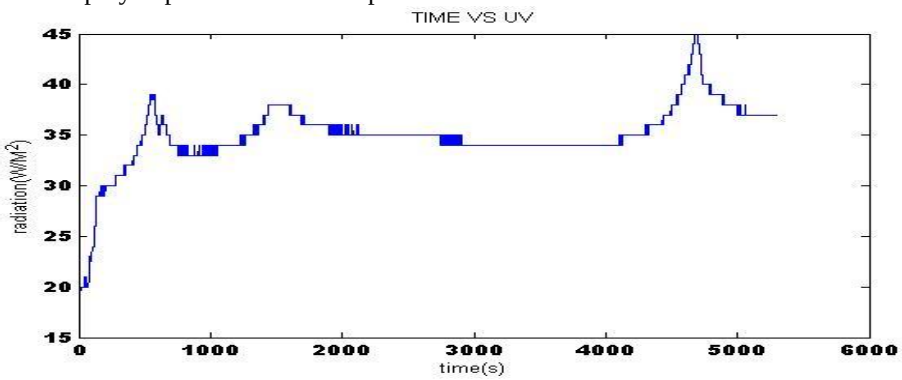


Figure 3: Solar radiation during experimentation.

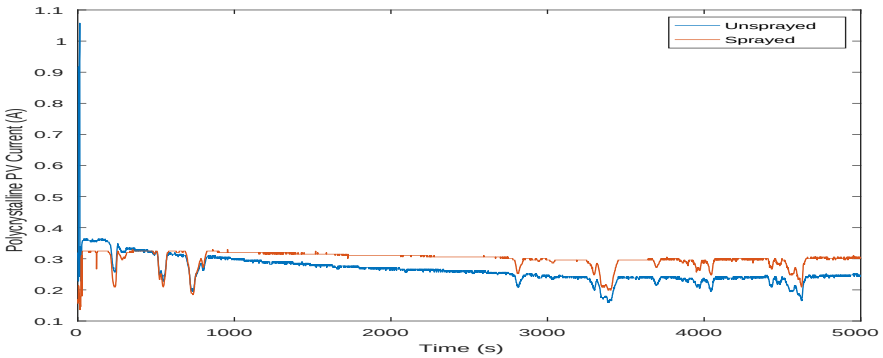


Figure 4: Current production for (a) monocrystalline panel (b) polycrystalline panel

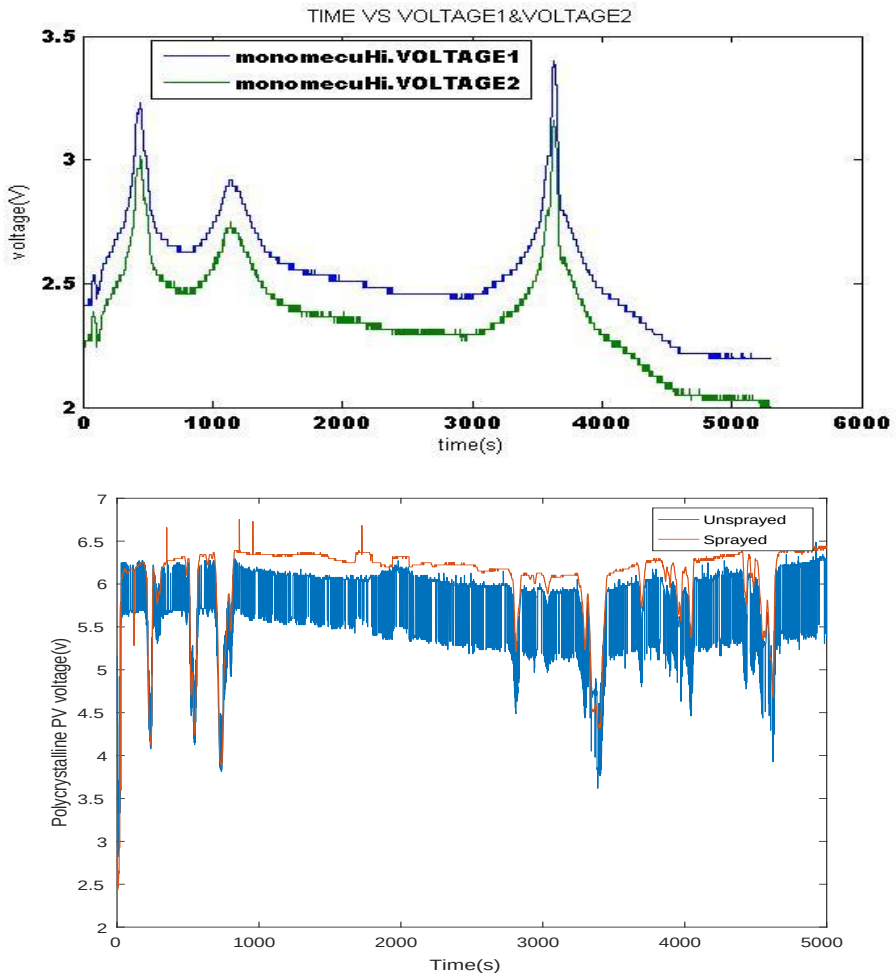
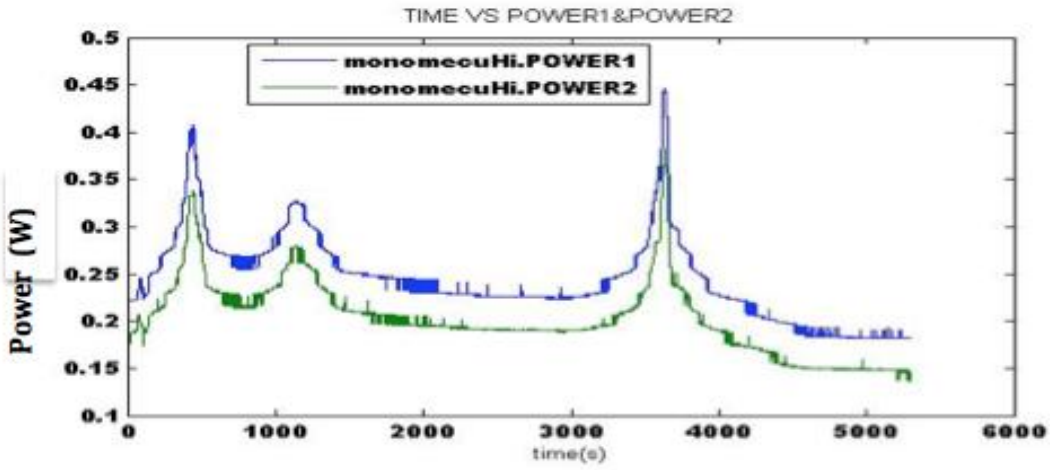


Figure 5: Voltage production for (a) monocrystalline panel (b) polycrystalline panel

Figure 5a shows the voltage generation in the sprayed and unsprayed panel against time of the monocrystalline panel. The voltage of the unsprayed panel was found to be higher than the voltage of the sprayed panel. Very significantly, the graph trend for radiation pattern and voltage generation was almost the same - inferring the amount of solar radiation is directly proportional to voltage. The polycrystalline panel shows that the voltage in the sprayed panel was higher and more stable compared to the unsprayed panel (Figure 5b). This is second evidence that the bio-filter is an effective device to curb the harsh weather conditions affecting the PV panels in the tropical belt of Africa.



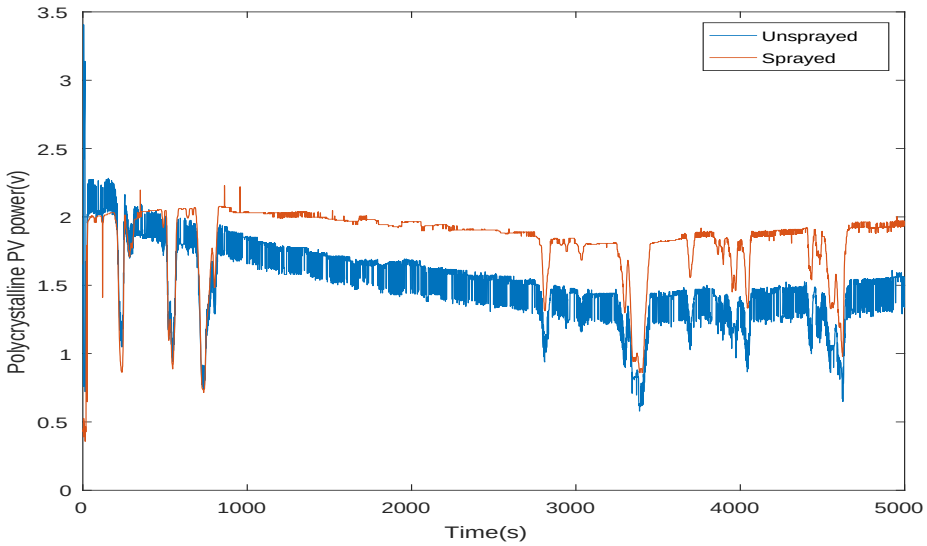


Figure 6: Power production for (a) monocrystalline panel (b) polycrystalline panel

Figure 6a presents the graph of power against time for the sprayed and unsprayed panel against time of the monocrystalline panel. The power of the sprayed panel is lower than that of the unsprayed panel. Like the voltage production, it has same trend as the solar radiation - inferring the amount of solar radiation is directly proportional to power generated in the solar panel. The polycrystalline panel shows that the power in the sprayed panel was higher and more stable compared to the unsprayed panel (Figure 6b).

IV. CONCLUSION

From the measured parameters in both the polycrystalline and monocrystalline PV panel, it can be concluded that the copper coated methanol extracted hibiscus extract is a good candidate as bio-filter. This means that to a large extent, the harsh weather conditions streaming harmful radiation onto the PV panel can be controlled. The onward study on this kind of bio-filter would enhance higher patronage of PV products in the African market.

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