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Characterization of Hibiscus Flower as a Potential Source of Electric Supply

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Abstract. Deriving energy from plant has generated new technologies that are impressive. The success of harnessing energy in plants means that a global challenge has been truly solved. In this paper, the focus was to improve upon the plasmon technology in converting light to electricity such as photovoltaic. A metallic coated plant extract (MCPE) was synthesized and characterized in an unusual characterization set-up to determine the basic properties required for the plasmon technology. The MCPE was found to have band gap of 3.15 eV and possesses the basic properties of electron clouds oscillating about a mean position. This result means that the MCPE is a bio-particulate option that can replace the inorganic nanoparticles in the plasmon experiment. Further work on testing the MCPE in plasmon set-up is recommended.

1. Introduction

Energy gotten from plants can be considered as green energy. This can also be called clean energy. In recent times the world has turned its attention on harnessing clean energy. This is as a result of the growing environmental pollution caused from the use of other source of energy like the use of fossil fuels. This comes as a realisation of the fact that we cannot afford to rely on the fossils fuels that we have used in the past although they have served us well over the years. Energy exist in different in different forms Chemical, mechanical, electrical and many other forms [1]. Plants use sunlight to generate energy through the process of photosynthesis. This is also the process by which plants store their foods. Plants convert solar energy to chemical energy. Nevertheless, chemicals found in plants can also be used to generate various forms of energy an example is chemical energy from teraoxosulphatesixacid [2].

The benefits of energy generated from plants: It is a renewable source of energy [3]; It is economical (It is affordable in commercial quantities to the public) [3]; It is easier to convert them from one form to another unlike crude oil (a non-renewable energy source) [4]; It is safe (due to the flexibility and its natural production process) [4]; It reduces the green house gas emissions, air and water pollution; It is available at all times; It is very profitable as it saves money meant for paying of utility bills. The disadvantage of deriving energy from plant is the cost of generating for massive population.

In recent times, scientists have shown different ways of generating energy from plants. Mehedi et al. [5] worked on the juice of Bryophyllum pinnatum leaf using zinc and copper plates to generate electricity. The authors reported that this project is viable in the advancement of Nano-power plant in off-grid regions. Alok [6] reported the efforts of nations to fund the 'artificial leaf' project. This project involves working out exactly how leaves use sunlight to make useful molecules to generate clean fuels such as hydrogen and methanol that would be used in fuel cells to make electricity or to power super-clean vehicles. Peng et al. [7] analyzed the characteristic of Aloe Barbadensis Miller (Aloe Vera) leaves in terms of electrical energy generation under specific experimental setups. They reported that 1111.55uW electrical power was harvested from the Aloe Vera with 24 pairs of electrodes, hence with improvement on the experiment set-up, this project have high prospect. Montalbano [8] reported the current scientific project that could generate 150 volts per leaf that is enough to power 100 LED light bulbs simultaneously. Hence, green plants could become one of the most potent future electricity generators that integrate perfectly with natural environments. This project is sustainable because green plants are accessible globally. Researchers have advanced into capturing electrons from the plants before the energy is stored as sugar using nanotubes [9]. With this technique, electricity (of about 1.1. V) is siphoned off from the plant. This process can be optimized using genetic engineering could be used in tandem with the technology to create plants specifically designed for electricity generation. Amaya [10] reported some on-going research that proved that regular cottonwood tree with about 50,000 leaves could harness a maximum of 80W of energy, which is sufficient to carry out charging batteries of smaller appliances in off-grid set ups. This research focuses on the energy generation from plants using its optical properties.

2. Methodology

The hibiscus flower was extracted using the ethanol solution as described in ref [12-13]. The extract was then doped with 0.01 mole of silver nitrate salt. The mixture was stirred under room temperature to give a homogenous compound as shown in Figure 3. The mechanical spray was used to disperse 0.3ml of the extract on the monocrystalline module. Two modules were used for the experiment. The unsprayed module was used as the control to monitor the progression of the SSB. The dataset was logged-in automatically into an SD card that was attached to an ardriuno set-up. Mathematical formulae were used to estimate the absorbance and band gap of the SSB at its liquid state.
The technique used for the experimental set-up was derived from the Fresnel equation that describes the reflection and transmission within multiple media. The integrated second layer is the photovoltaic module while the first layer is the metallic coated plant extract. It is believed that the sunlight first travels through the metallic coated plant extract before reaching unto the PV were measurements can be obtained in form of voltages. The power transmission coefficient of sunlight can be estimated via the s polarization

$$T_s = 1 - \left| \frac{n_1 \cos\theta_i - n_2 \cos\theta_t}{n_1 \cos\theta_i + n_2 \cos\theta_t} \right|^2 \quad (1)$$

and for p polarization

$$T_p = 1 - \left| \frac{n_2 \cos\theta_i - n_1 \cos\theta_t}{n_2 \cos\theta_i + n_1 \cos\theta_t} \right|^2 \quad (2)$$

where n_1 and n_2 are the refractive index of metallic coated plant extract and PV module respectively. θ_i and θ_t is the angle of incidence and transmission, respectively. The Brewster's angle is given as $\theta_i = \arctan\left(\frac{n_2}{n_1}\right)$.

Based on the theoretical relationship and the experimental set-up, the power transmission coefficient operates via the p polarization. It is expected that the difference in the voltage measurement on the sprayed and unsprayed are significant to understand the physics of the metallic coated plant extract (MCPE).

3. Results and Discussion

The voltage measurement on both the sprayed and unsprayed photovoltaic module is presented in Figure 1. The plant extract is in its aqueous form when the measurement was taken. Generally, the sprayed PV module had higher voltage measurement than the unsprayed PV module. It is observed that the metallic coated plant extract improved the voltage generation >7%. The interesting physics of the metallic coated plant extract is that it transforms the solar irradiance signal into peaks (Figure 1). The other properties of the material are presented in Figure 2 and 3.

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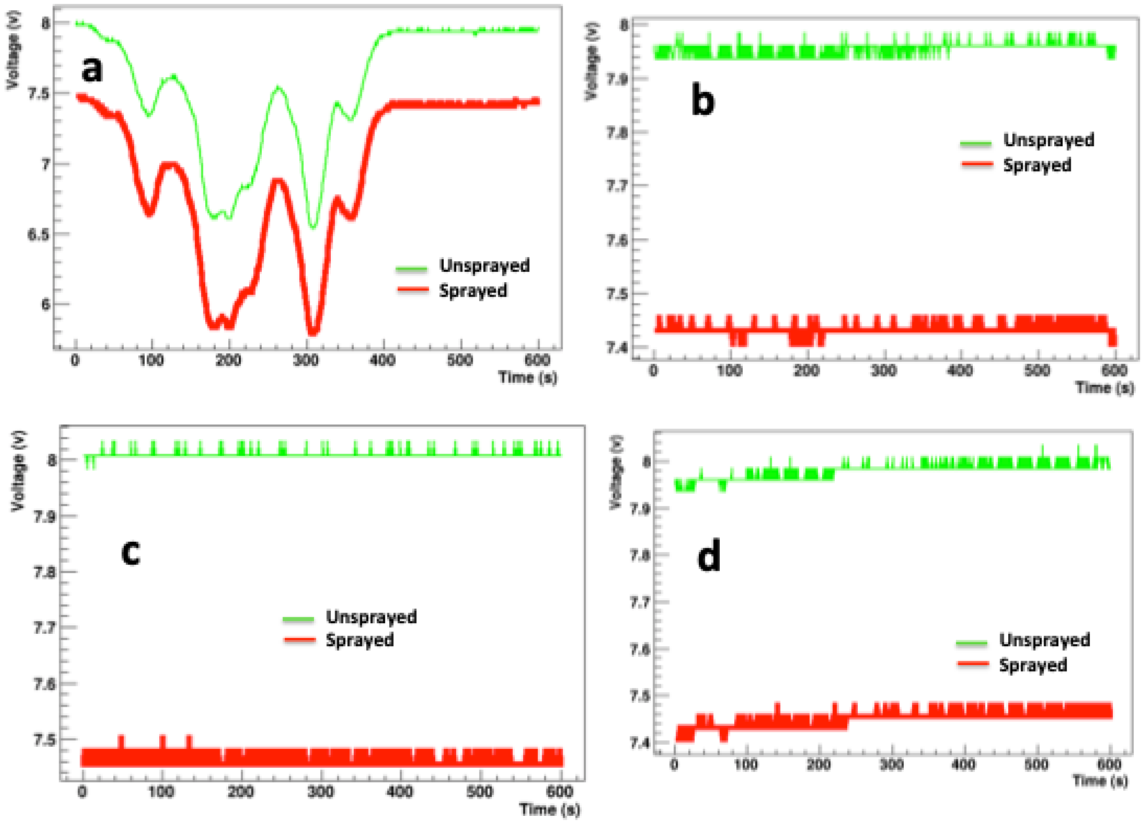

Figure 1. Voltage characteritics of the MCPE on PV module

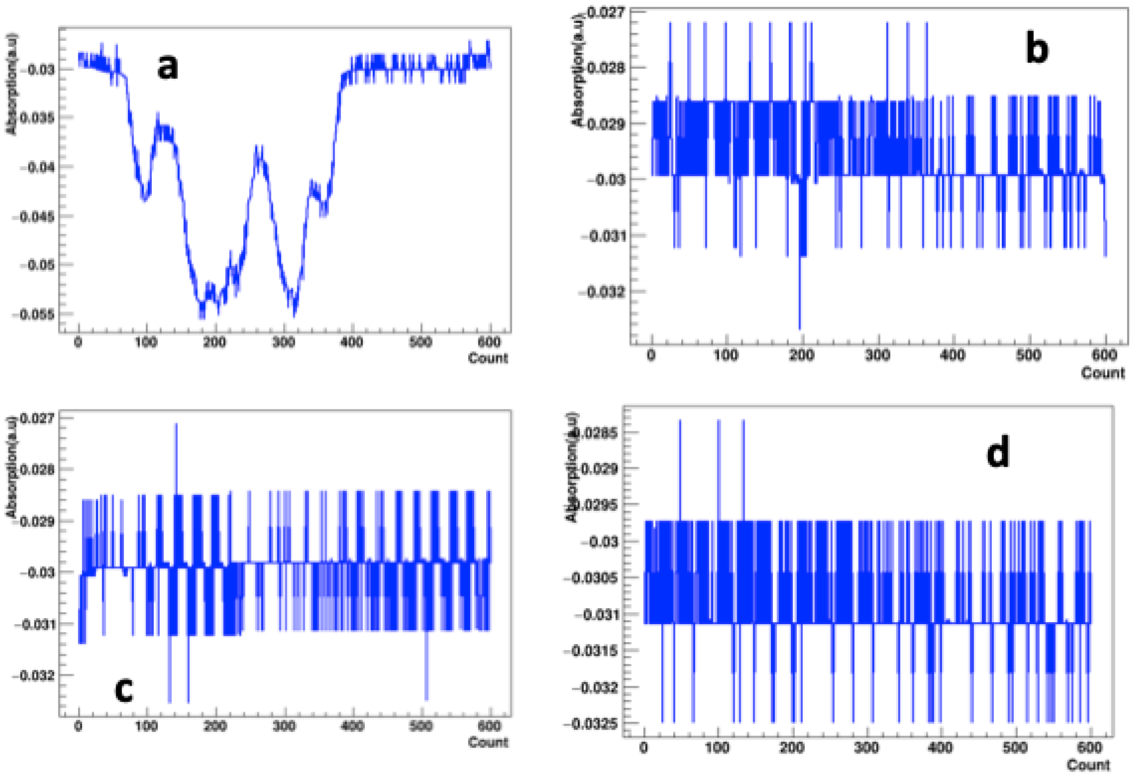

Figure 2. The absorbance of MCPE

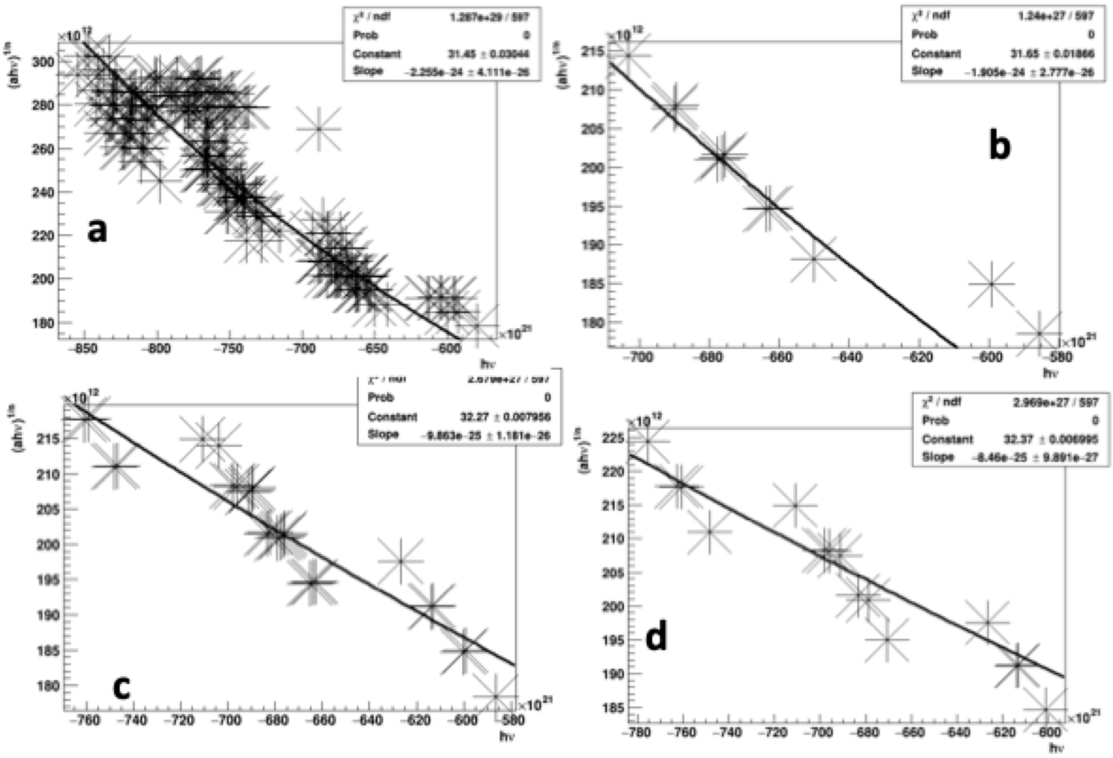

Figure 3. Band gap estimation of MCPE

The pattern of the voltage generation is directly proportion to the variation of the solar irradiance. Hence, an almost stable voltage generation is because of the stable solar irradiance at the point when the voltage was measured. Also, it is observe that peaks of the sprayed PV and the curves of the unsprayed module is seen to oscillate about an equilibrium position. This features show that the MCPE is a solid-state device. Hence possess an inherent quality that can transform light waves to electricity. In this sense, we do not refer to dye sensitized solar cell (DSSC). This device may be closely related to rectennas or plasmonic device [14]. The absorbance of the MCPE reveals that the material has four absorption levels that control its operation. Under harsh solar irradiance, the four absorption levels expand or contracts to form series of peaks along a curve-like path. The absorbance of the MCPE was estimated using

$$A = -\log\frac{I}{Io} = -\log\left(\frac{V_{sample} - V_{zero}}{V_{solvent} - V_{zero}}\right) \tag{3}$$

Where A is the absorption, V_{sample} is the voltage on the clean PV module; $V_{solvent}$ is the voltage of the sprayed PV module. V_{zero} is the differential voltages between the sprayed and unsprayed PV module. From Figure 3, the band can be obtained using

$$y = mx + C \tag{4}$$

where $y = (ahv)^{1/n}$, $x = hv$, m is the slope and C is the constant or intercept. The band gap is calculated via the intercept as

$$BG = \frac{C}{n} \tag{5}$$

where n is the dilution factor given as 10. Hence, the band gap of the MCPE at aqueous state 3.15 eV. The oscillating pattern of the MCPE and its low band gap are closely synonymous to the oscillating clouds of electrons that are found on the surface of nanoparticles of certain metals [15].

4. Conclusion

The reality of conversion of leaves or flowers to sources of electricity is becoming clearer by the day. From the idea of dye solar cell, to circuitory conversion of plant energy, to nano-power plant are all evidence that more inventions would emerge until a clean source that have high capacity to generate electricity is found. This experiment has successfully introduced a component of the plasmon technology to generate electricity from sunlight. This biological approach is sustainable than the current nanoparticles used for plasmon energy generation. Further work is proposed in testing this sample in a complete plasmon set-up.

5. Acknowledgments

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