Study on Power Generation Efficiency of Solar Film

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***Abstract*—It was studied experimentally that The variation of the open circuit voltage and temperature of a single solar film during the heating process under different illumination On this basis, by measuring the voltage generated by a single solar film under a voltage regulator, the number of multi-films which could be obtain a stable 5V voltage was designed and calculated, and the circuit was designed for charging mobile phones and Charging Treasure or field tents.**

Keywords—solar film; illumination; power generation intensity; open-circuit voltage style

I. INTRODUCTION

Whether in disaster areas or in the field, electric power was particularly scarce. At present, most of the positioning and rescue devices used depend on electric energy[1,2,3]. According to previous surveys in disaster areas, it was found that food, electric power and medical equipment were the most scarce in disaster areas [4,5]. Compared with the traditional thick solar panels, the advantages of solar thin film are: its power generation performance was very good at low light level; there will be no internal short-circuit problem at all; solar thin film cells were easy to carry, flexible and light weight [6,7].

II. EXPERIMENTAL PURPOSE

1. The relationship between the surface temperature of solar thin film and the open circuit voltage of thin film was studied under certain illumination intensity.

2. By measuring the voltage generated by a single solar film under a voltage regulator, the number and circuit of multiple films which could obtain a stable 5V voltage were designed and calculated, which could be used to charge mobile phones and Charging Treasure or field tents.

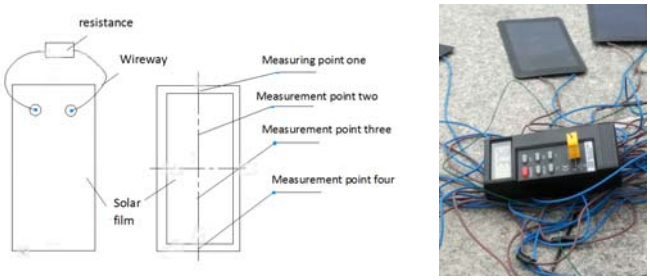
III. EXPERIMENTAL INSTRUMENTS

The instruments used were Ulide UT383 illuminometer, Tess TES1310 contact thermometer and Wenbeier flexible solar cell sheet (i.e. solar thin film).

According to the different materials, silicon solar cells were divided into three categories: single crystal silicon solar cells, polycrystalline silicon thin film solar cells and amorphous silicon thin film solar cells [8,9]. Amorphous silicon solar power film was used by us. The solar film was CIGS solar film.

IV. EXPERIMENTAL PRINCIPLE

Connect the solar film to the voltage regulator through the wire, and use the multimeter to measure the voltage under the sun as the scale of power generation efficiency; select four points on the surface of the solar film to measure the surface temperature of the solar film respectively, then take the average value as the temperature of the solar film at the current moment[10,11], put the illuminator next to the solar film to measure the illumination at the current moment; measure the temperature rise and decrease[12,13], The temperature of solar energy film was lowered by cold-packed ice. As shown in Figure I, Figure II.



a Circuit Diagram b measuring point c The experimental scenario

FIGURE I. MEASURING CIRCUIT DIAGRAM

Put the ice on the solar film and wait to cool down to about 10 degrees. Contact the pen of the multimeter at both ends of the voltage regulator and remove the ice. You can see the change of the thermometer indication and the rapid change of the multimeter voltage. Take a picture with the surface thermometer corresponding to the middle point as the reference and record the indication of the multimeter, thermometer and illuminometer at the same time (illuminometer). Indicators should be kept within a certain range. As shown in Figure II.

FIGURE II COOLING

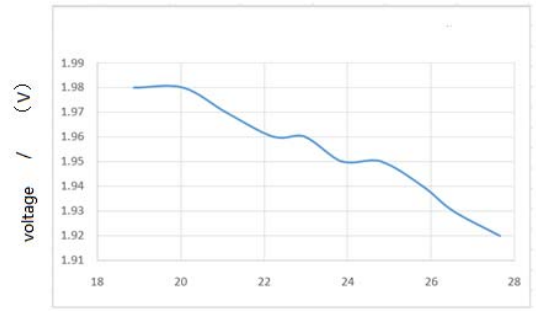


FIGURE III. VOLTAGE VS. FILM TEMPERATURE AT 3200 * 10LUX ILLUMINATION

V. EXPERIMENTAL STUDY

A. *The Variation of Open-circuit Voltage with Temperature of Single Film*

We selected six sets of gradients from 2000 * 10 lux to 10000 * 10 lux as the initial conditions of the experiment [14], On the gradient of each illuminance, the surface temperature of the solar film was reduced to less than 20 degrees Celsius and recorded in the heating process, The open-circuit voltage of a single solar film and the average temperature above the four measuring points of the solar film at this moment were shown in the following image.

It can be seen from Figure III that when the illumination was lower than 3500X10lux, the output voltage decreases with the increase of the film temperature, and the minimum voltage of the film was around 27 degrees Celsius. The output voltage reaches its maximum in the range of 17 degree to 20 degrees Celsius.

It can be seen from Figure IV that when the illumination was 5500X10lux and the temperature of the film was 22°C to 24°C, the open circuit voltage reaches the maximum of 2.04v. When the temperature reaches the maximum value of 30°C, the voltage was dropped to the lower of 1. 99v.

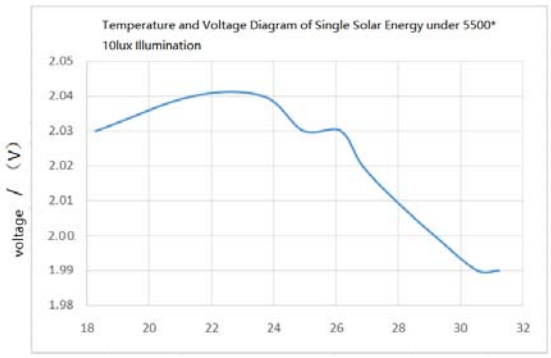


FIGURE IV. VOLTAGE VS. FILM TEMPERATURE AT 5500*10LUX ILLUMINATION

When the luminance was 8000X10lux, the temperature of the solar film was between 24°C and 29°C, the open circuit voltage reaches a maximum of 2.04v. When the temperature reaches a maximum of 40°C, the voltage drops to a minimum of 1.98v.

As can be seen from Figure V, when the luminance was 10000X10lux, the voltage of the solar film gradually decreases with the increase of temperature. The open circuit voltage fluctuates between 25°C and 29°C, and when the temperature reaches the maximum, the voltage drops to 2.05v.

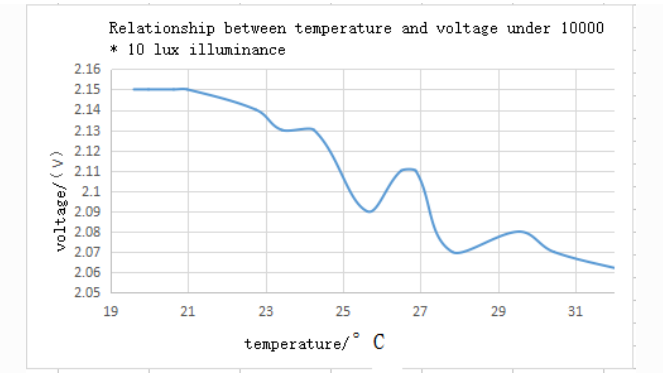


FIGURE V. VOLTAGE VS. FILM TEMPERATURE 10000 *10LUX ILLUMINATION

As can be seen from the images in Figure III to Figure V, under the condition that the luminance of each gradient was basically unchanged during the experiment, the open circuit voltage of the solar film decreases with the increase of the surface temperature, and the maximum voltage occurs between 20 - 27°C of the solar film temperature.

B. *Circuit Design*

Through the above experiments, it was found that a single solar film could generate 2v voltage at the maximum under a voltage stabilizer. After calculation and design, a stable 5V voltage was obtained by connecting six and six solar films in parallel after every six solar films were connected in series, and then the mobile phone and charging treasure could be charged.

On the basis of 12 solar films, six or six solar films were connected in series and two or two solar films were connected in parallel, as shown in the circuit diagram of Figure VI. The experimental scenario was shown in Figure VII.

When the circuit was switched on, the voltage at both ends of each solar film was about 1.5V and the current at each branch was about 0.5A Therefore, the total output voltage and output current for this connection will be 9V and 1A respectively. Then connect the LM7805 module of TELESKY (Haiyan Security Technology) at the end of the circuit, that was, the 5V step-down power supply module board, so that the output of the total circuit was about 5V, 1A. On this basis, USB mother ports were connected at both ends of the module board to access charging treasure with conversion efficiency of 90 %. After actual test, it takes 3.5 hours to charge 1800mAh, that was, 514.3mAh in one hour [15]. The application of solar power film in tents is shown in Figure VIII.

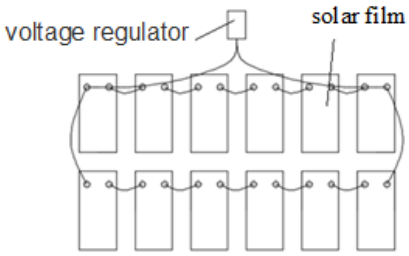


FIGURE VI. CIRCUIT DIAGRAM

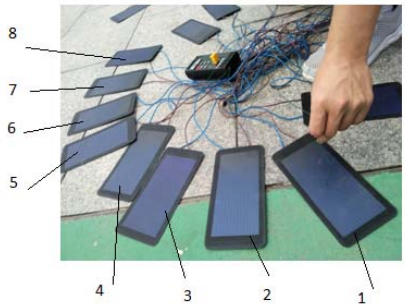


FIGURE VII. EXPERIMENTAL SCENARIO

FIGURE VIII. APPLICATION OF SOLAR POWER GENERATION FILM IN TENT

VI. CONCLUSION

1. Under different illumination, the open circuit voltage of a single piece of solar film decreases with increasing surface temperature, and the maximum voltage occurs between 20-27 °C of the surface temperature of the solar film. The solar film in this temperature range was highest power generation efficiency under the same lighting conditions

2. For a single solar film, the power generation voltage can reach 2.15V at 10000*10lux illumination.

3. According to the above experimental calculation and design, a stable rated 5V voltage of 4.92v can be obtained by connecting six and six solar films in series and then charging the mobile phone and charging treasure.

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