STUDYING THE EFFICIENCY OF SOLAR ELEMENTS DEPENDING ON THE ANGLE OF LIGHT INCIDENCE

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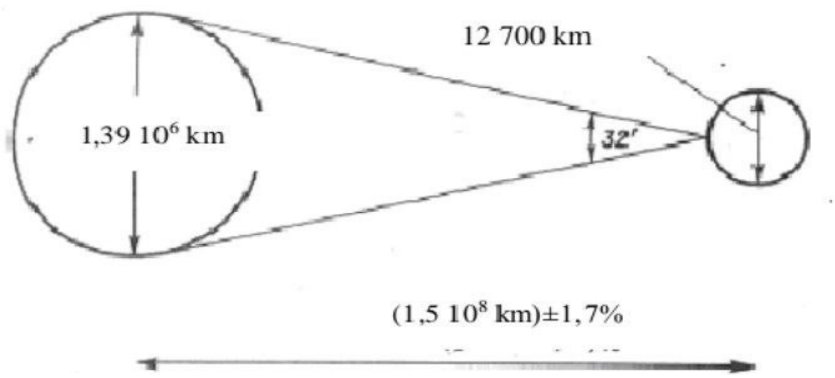
Abstract: in this thesis, in order to increase the efficiency of solar panels and ensure the production of more electricity, the change of photoelectric parameters of solar panels depending on the angle of incidence of light is studied. The obtained results show that the sun sets at a lower angle to the horizon in winter compared to other seasons, and due to this, solar panels produce less electricity. In order to solve this problem and to change the angle of installation of solar panels in winter, the dependence of the efficiency of solar panels on the angle of incidence of light was studied.

Keywords: solar cell, sunset angle, useful work coefficient, volt-ampere characteristic.

The study of solar elements and its research necessarily begins with the measurement of the main photoelectric parameters. We also tried to measure the volt-ampere characteristics of the solar cell and panel during our research. We determine the angle of incidence of the light falling on the solar element and panel as follows. First, the location of the sun is found based on time and coordinates [1]. Second, the angle of descent is determined depending on the location of the sun [2].

In the sky, the Sun appears to us as a circular arc at an angle of about half a degree. The edges of the Sun's halo have a sharp boundary, and its radius can be measured with a high enough precision (one arcsecond). Such measurements show that the angular diameter of the Sun varies slightly throughout the year (31′31″ at aphelion (early July), 32′35″ at perihelion (early January)). These changes are related to the slightly lengthening and shortening of the distance between the Sun and the Earth due to the ellipticity of the orbit.

Figure 1 shows the Earth and the Sun in relation to each other. The eccentricity of the Earth's orbit is that the distance between the Sun and the Earth varies by 1.7%. In one astronomical unit, equal to the average distance between the Sun and the Earth, the Sun is visible to an observer on Earth at an angle of 320. Outside the Earth's atmosphere, the intensity of the Sun's rays is constant.



For the theoretical analysis of the physical phenomena occurring in the elements of the sun, we can approach classically. The transmission and return coefficients of the surface can be determined by the angle of incidence and refraction of the light falling on the surface, the refractive indices of the media. Fresnel coefficients (formula 1) are mainly used in this.

$$r_1=\frac{n_1\cos\beta-n_2\cos\gamma}{n_1\cos\beta+n_2\cos\gamma}$$

$$t_1=\frac{2n_1\cos\beta}{n_1\cos\beta+n_2\cos\gamma}$$

$$r=\frac{n_1\cos\gamma-n_2\cos\beta}{n_1\cos\gamma+n_2\cos\beta}$$

$$t=\frac{2n_1\cos\beta}{n_1\cos\gamma-\cos\beta} \qquad (1)$$

Here: n_1 is the refractive index of the first medium, n_2 is the refractive index of the second medium, β is the angle of incidence of light, γ is the angle of refraction of light.

Using the Fresnel coefficients, we can determine the parts of the light that return and pass through the surface (Formula 2).

$$R=\frac{r_0^2+r_1^2}{2}$$

$$T=\frac{n_1\cos\gamma}{n_0\cos\beta}\cdot\frac{1}{t} \qquad (2)$$

Here: R is the return coefficient, T is the transmission coefficient. To determine the absorption in the layers, the Burger-Lambert law is used (Formula 3).

$$I=I_0e^{-\alpha d} \qquad (3)$$

Here: d is the layer thickness, a is the absorption coefficient of the material, I0 is the initial light intensity, I is the light intensity after the d layer.

An experiment was carried out under natural sunlight with a solar intensity of 0.7 solar cells with a size of 1 cm2. The base of the solar cell is p-type monocrystalline silicon and its surface is covered with 100 nm thick SiNx. Coordinates where this experiment was conducted: 40°440°47′17″, 72°22′217′17″ time: 17.03.2020 13:00. That is, all these and subsequent experiments were conducted at Andijan State University in Uzbekistan.

The angle of incidence of light changes depending on the position of the sun. Therefore, in this paper, the dependence of the main photoelectric parameters of silicon solar cells on the angle of incidence is studied.

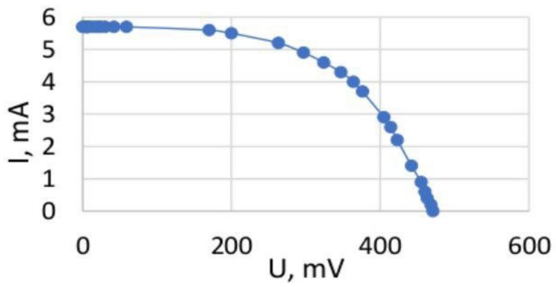


Figure 1. I-V characteristic measured in normal sunlight at 0.7 solar intensity of a Sinx-coated silicon-based solar cell with p-type base size of 1 cm^2

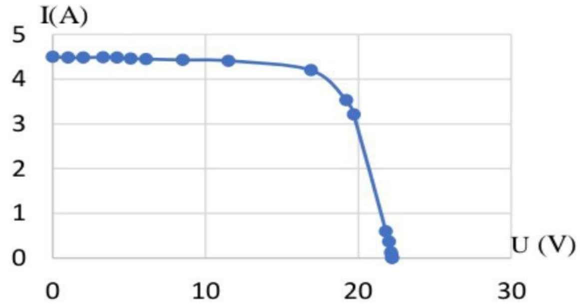
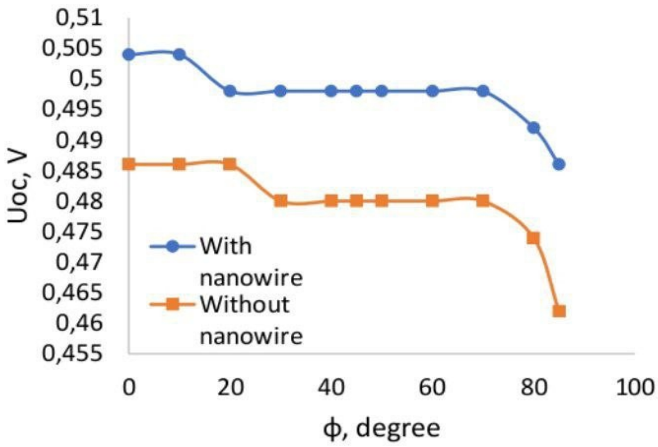
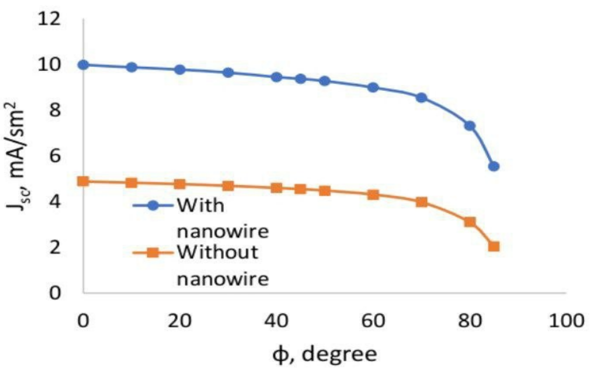


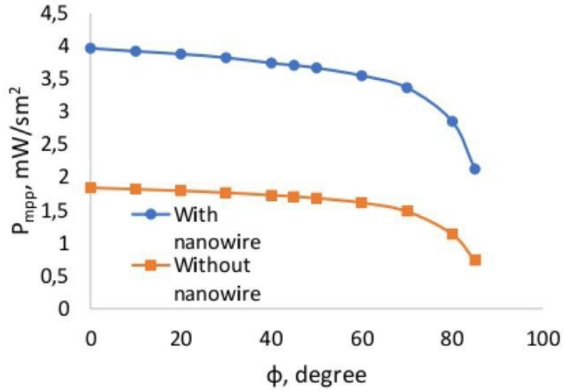
Figure 2. I-V characteristic of a solar panel made of 36 monocrystalline silicon photovoltaic cells



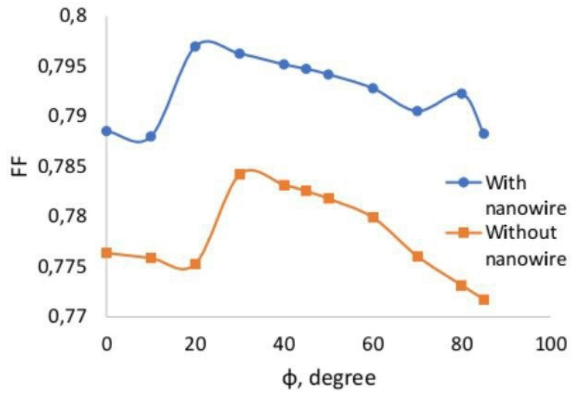
Rasm 3. The graph of the dependence of the operating voltage of a nanoparticle-incorporated and a simple silicon-based solar cell on the angle of incidence of light



Rasm 4. Graph of dependence of short-circuit current density on light incidence angle of nanoparticle-incorporated and simple silicon-based solar cell



Rasm 5. Graph of the maximum power of a nanoparticle-incorporated and simple silicon-based solar cell versus the angle of incidence of light



Rasm 6. The graph of the filling factor of a nanoparticle-incorporated and a simple silicon-based solar cell as a function of the angle of incidence of light

The dependence of the short-circuit current, the maximum power and the filling factor on the angle of incidence of light is similar to the dependence of the operating voltage on the angle of incidence of gravity. The results obtained above show that all the photoelectric parameters of nanoparticle-incorporated solar cells are better than those of a normal solar cell. However, the change of photoelectric parameters depending on the angle of light incidence is approximately the same.

In summary, the angle of incidence (AM) refers to the amount of light reaching the solar panel. This angle measures the amount of light falling on the bottom of the solar panel. The AM angle is determined by the angle of the solar panel and determines the amount of light that can be transmitted to the efficiency of the solar panel.

Learning the right ratio between the angle of incidence of light and the efficiency of the solar panel makes it easier to convert light energy into electricity. If the angle of incidence of light increases, the efficiency of the solar panel increases. This increases the ability of the solar panel to use solar energy in an efficient way.

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