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STUDYING THE BASIC PARAMETERS OF MODERN PHOTO ELEMENTS

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Abstract
This article discusses the main parameters of modern photocells. Because in order to determine the effectiveness of photocells and conduct new research on them, we first need to know their basic parameters. Determined parameters can lead to certain conclusions about the use of photocells and increase their efficiency.

Keywords: Photocell, short-circuit current, salt walking voltage, charging factor, efficiency, temperature, volt-ampere characteristic, p-n junction.

Introduction

In semiconductor materials based on the photoelectric effect, in a photocell consisting of p-n junction structures, the incident sunlight is converted directly into electrical energy. Therefore, the photocell does not need an external voltage source, unlike photoreceptors and photoresistors [3]. This effect has been studied as the photoelectric properties of selenium and copper oxide for more than a hundred years, but their efficiency (F.I.K.) did not exceed 0.5% [4].

To determine the effectiveness of photocells and to conduct new research on them, we first need to know their basic parameters. Determined parameters can lead to certain conclusions about the use of photocells and increase their efficiency.

The basic parameters of a photocell can be determined mainly from its volt-ampere characteristics (Figure 1). The main parameters of photocells include:

- Short circuit current - I_{sc}
- Salt walking voltage - V_{oc}
- Filling factor - ff
- Efficiency of the photocell - η.

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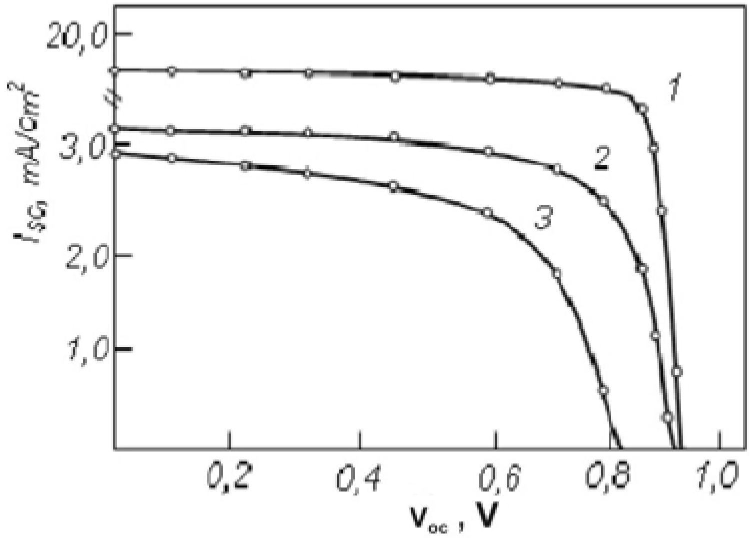

Figure 1. A typical volt-ampere characteristic of a photocell.

The volt-ampere characteristic of a photocell is the volt-ampere characteristic of a diode in the dark and the light super-position of a solar cell. Under the influence of light, the volt-ampere characteristic shifts down to the fourth quarter, which is the useful power. Illumination of photocells adds light to darkness, and the diode equation:

$$I = I_0\left(e^{\frac{qV}{kT}} - 1\right) \quad (1)$$

takes the form of. Here I_0 - is the saturation dark current, I - is the current.
These parameters can be calculated from the volt-ampere characteristic.

Short Circuit

When the voltage is zero (that is, the solar cell is short-circuited), the current flowing through the solar cell. The short circuit current is usually denoted by I_{sc}.

Short circuit current is the maximum current that a photocell can produce.

$$J = J_0\left(\exp\left(\frac{qV}{nkT}\right) - 1\right) - J_{sc}, J_{sc} \approx J_L \quad (2)$$

The short circuit current is determined by the following factors:
– With the surface of the solar cell.
– With the amount and spectral composition of the photon.
– With optical properties of the absorber (with absorption and reflection coefficients)
– With the probability of accumulation of carriers [6].

Salt walking voltage

The maximum voltage that can be generated in a photocell. The diffusion current compensates for the light drift current. At the opposite poles of the p-n junction, a salvage voltage (V_{oc}) is formed [1]. This is the maximum voltage that can be generated in a photocell. Equation for the volt-ampere characteristic of a photocell:

$$J = J_0 \left(\exp\left(\frac{qV}{nkT} \right) - 1 \right) - J_{sc} \quad (3)$$

V_{oc} can be defined as the current equal to zero in the photocell element equation:

$$V_{oc} = \frac{nkT}{q} \ln\left(\frac{I_{sc}}{I_0} + 1 \right) \quad (4)$$

Salt travel voltage depends on the amount of excess light carriers accumulated on the opposite side of the p-n junction. The number of carriers is determined by:

1. By how many carriers have reached the separation area, that is, by the diffusion length of the non-main carriers.
2. The magnitude of the dark current determined by the recombination rate of non-basic carriers. [5].

Fill ratio

The short-circuit current and the single-pass voltage are the maximum current and voltage that can be obtained from this photocell. However, the photoelectric power is zero at both points. The filling factor, often referred to as "ff " is the maximum power of a photocell in accordance with V_{oc} and I_{sc} [7-8].

ff is defined as the ratio of the maximum power of the photocell to the product V_{oc} and I_{sc}.

$$ff = \frac{V_{mp} I_{mp}}{V_{oc} I_{sc}} \quad (5)$$

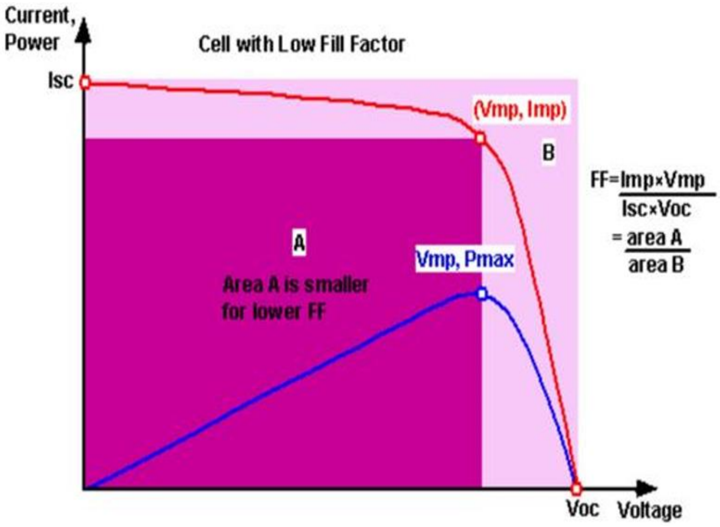

Figure 2 Dependence of the output current (red line) and power (blue line) of the photocell.

The efficiency of the photocell

The efficiency of a solar cell is defined as the electrical part of the incident energy:

$$P_{max} = V_{oc} I_{sc} ff \quad (6)$$

$$\eta = \frac{V_{oc} I_{sc} ff}{P_m} \quad (7)$$

Here: V_{oc} is the salt walking voltage; I_{sc} - short circuit current; ff - filling factor; η - efficiency factor [9-10].

Efficiency is a common parameter by which the efficiency of two solar cells can be compared. The efficiency is defined as the ratio of the energy produced by a solar cell to the energy of incident solar radiation [2].

Profitability also depends on:

– Spectrum;
– Intensity of incident solar radiation;
– The temperature of the photocell;

The effect of temperature on the photocell

Like all other semiconductor devices, the photocell is sensitive to temperature changes. An increase in temperature changes many of the characteristics of the semiconductor, reducing the width of the band gap. This can be thought of as an increase in the energy of the electrons in the valence band, so less energy is needed to move to the free state (Figure 3) [11].

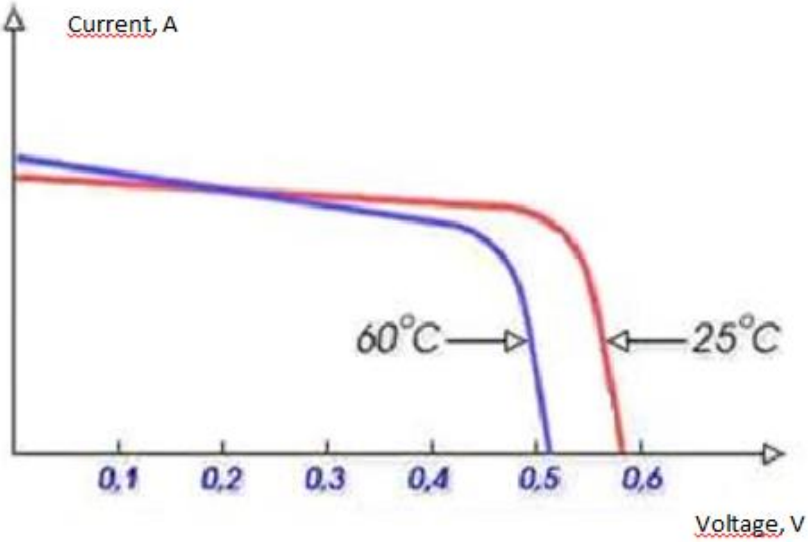

Figure 3 Graph of volt-ampere characteristic for 25 °C and 60 °C temperatures.

The most important parameter that changes with temperature is the voltage. When the element is heated from 25ºC to 1 degree, it loses a voltage of 0.002 V, which is 0.4% of the temperature. On a sunny day, the cell heats up to 60-70ºC and loses 0.07-0.09 V. This is the main reason for the decrease in the efficiency of the photocell [12-13]. This leads to a voltage drop generated by the element. The increase in temperature has a significant effect on the module. They can be divided into the following basics:

– Reduces voltage;
– Reduces output power;
– Increases the voltage associated with thermal expansion;
– Increases the degradation rate by about twice every 10 degrees of temperature.

From the experimental analysis, it can be concluded that the role of semiconductors, which form the basis of photocells, is important in obtaining electricity from the sun. If we look at the above results, we can see that as the temperature increases, the voltage decreases, and as a result, the efficiency decreases. From this it can be seen that it is advisable to use elements that have the highest efficiency and low cost of semiconductors used in photocells.

References

1. D.D. Alijanov, U.A. Axmadaliyev, N.A. Topvoldiyev. (2021). Types of siliconINTERNATIONAL SCIENTIFIC JOURNAL «GLOBAL SCIENCE AND INNOVATIONS 2021: CENTRAL ASIA» . Types of silicon-based solar elements and their effectiveness (стр. 73-76). TINTERNATIONAL SCIENTIFIC JOURNAL
2. Xayriddinov B.E., Xolmirzaev N.S. Sattorov A.S Quyosh energiyasidan foydalanishning fizik asoslari(o‘quv qo‘llanma), T.: Fan, 2010 y. 280 bet.
3. Авезов Р.А.,Авезова Н.Р.,Матжанов Н.А.Гелиотехника 2012;С. 17-24
4. N. A. Kozimjonov. CALCULATION, RECORDING, PASSING AND TRANSMISSION OF EFFECTS OF SUNLIGHT ON N-P PHOTO ELECTRIC BATTERIES OF DIFFERENT THICK THICKNESS WITH THE PROGRAM OF PV LIGHTHOUSE. GALAXY INTERNATIONAL INTERDISCIPLINARY RESEARCH JOURNAL (GIIRJ) Volume 9, Issue 12, December, 2021. 1108-1113
5. Cu_2ZnSnS_4 Thin Film Solar Cells: Present Status and Future Prospects http://dx.doi.org/10.5772/50702.
6. Wang W., Winkler M. T., Gunawan O., Gokmen T., Todorov T. K., Zhu Y., Mitzi D. B. Device Characteristics of CZTSSe Thin-Film Solar Cells with 12.6% Efficiency. In: Advanced Energy Materials, DOI: 10.1002/aenm.201301465.
7. Kozimjonov Nozimjon Azimjon o‘g‘li. FOTOELEMENTLARNING ISHLAB CHIQARISHDA MONOKRISTALL, POLIKRISTALL VA AMORF KREMNIY YARIMO‘TKAZGICH MODDALARNI TUTGAN O‘RNI. NAMANGAN MUHANDISLIK-TEXNOLOGIYA INSTITUTI ILMIY-TEXNIKA JURNALI. VOL 6 – Maxsus son (2) 2021. 439-443
8. М.С.Гук. Спектры комбинационного рассеяния, электрические и фотолюминицентные свойства полупроводниковых материалов $Cu_2Zn(Sn,Ge,Si)(S,Se)_4$ и $(Fe,Mn)In_2S_4$. Докторская диссертация. Кишинев, 2014.
9. Хонбутаева Дилноза Алимжоновна, Козимжонов Нозимжон Азимжон угли, Абдувохидов Муроджон Комилович, Мирзаалимов Авазбек Алишерович, Мирзаалимов Наврузбек Алишер угли, Гуламов Жасурбек Журахон угли, ВЛИЯНИЕ ГАММА-ИЗЛУЧЕНИЯ НА СОЛНЕЧНУЮ БАТАРЕЮ, Научный журнал Издается ежемесячно с декабря 2013 года Является печатной версией сетевого журнала Universum: технические науки, 75-77.
10. Исроилжон БОЛТАБОЕВ. ҚУЁШ ПАНЕЛЛАРИНИ ҚАНДАЙ ТАНЛАШ КЕРАК? “Ўзбекгидроэнергетика” илмий-техник журнали, 2022*№1. 69-70.

WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 3, Issue 6, June, 2022

11. Alijanov D.D., Topvoldiyev N.A. (2021). SOLAR TRACKER SYSTEM USING ARDUINO. Theoretical & Applied Science, 249-253
12. Alijanov D.D., Topvoldiyev N.A. (2022). PHYSICAL AND TECHNICAL FUNDAMENTALS OF PHOTOELECTRIC SOLAR PANELS ENERGY. Theoretical & Applied Science, 501-505.
13. Komilov M.M, Topvoldiyev N.A. (2022). DETERMINING THE TIME DEPENDENCE OF THE CURRENT POWER AND STRENGTH OF SOLAR PANELS BASED ON THE EDIBON SCADA DEVICE. Web of Scientist: International Scientific Research Journal, 1902-1906.