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PHOTOVOLTAICS AND ITS DEVELOPMENT IN UZBEKISTAN

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ANNOTATION

This article examines photovoltaics and its development in Uzbekistan. The meaning of the term "photovoltaics" has been studied in detail. There is information on the types of photovoltaic devices, solar energy for transportation and energy transportation. The basic parameters of solar elements are analyzed.

Keywords: photovalta, solar energy, photosensitive elements, electricity, alternative sunlight, perovskite devices, solar cells, recombination.

INTRODUCTION

Photovoltaics is a method of generating electricity using photosensitive elements to convert solar energy into electricity. The term "photovoltaic" refers to the normal operating mode of a photodiode, in which an electric current is generated only from converted light energy. Eugene Katz on how to convert solar energy into electricity and how to transmit it How to convert solar energy into electricity? Can you ride on solar energy? Physicist Eugene Katz talks about what solar energy allows today. In the project "World of Things." What is the future? ", Together with the Foundation for Infrastructure and Educational Programs (RUSNANO Group) we will talk about the latest discoveries and promising achievements in the field of materials science. For more than thirty years I I have developed new materials and devices to convert light into electricity, and for the last twenty years I have been at the National Center for Solar Energy at Ben Gurion University in Israel. is a direct conversion field. In such devices, the semiconductor layer absorbs light, resulting in empty electron-hole pairs and is separated if there is an installed electric field. You can generate electricity only in this case, not alternating, but constant. And we mainly produce alternating current Since we use it both in t and in daily life, an additional inverter device is installed that converts alternating current into direct current.

An alternative to this approach is the conversion of sunlight into heat first, then into electricity (thermo-solar production). Light evaporates like water at high densities (using solar concentrators — mirrors or specially designed lenses). The steam produced in this way rotates the turbine, creating an alternating current. The final step in changing the quality of electric generators in traditional power plants is to burn these fuels (coal, gas, petroleum products). Thus, we can create a high-efficiency hybrid PV panel device. Light that is not absorbed by it passes through, is absorbed by the water heater, and steam is generated. In this case, there is an opportunity to save energy. the scheme of a hybrid photovoltaic-thermoset plant does not differ from how it works.

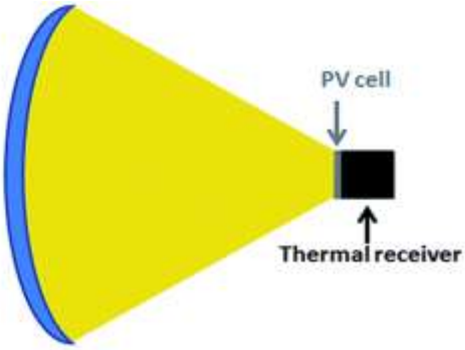


Diagram of a hybrid photovoltaic-thermosolar plant.

Hybrid devices Solar and wind power plants are very common today. But this is not actually a hybrid. The fact is that wind turbines can not be placed close to each other: they simply do not work. Thus, a large amount of space is left unused. It can be busy with photovoltaic batteries. In terms of area use, such a station can be called a hybrid, but you should understand that these two types of stand-alone devices.

Varieties of photovoltaic devices

Direct conversion of energy can be done in a variety of ways - for example, flat panels fixed to the ground, roofs, and so on. And you can collect light not with photovoltaic panels, but with the aforementioned solar concentrators, mirrors, or lenses. Thus, the light intensity increases sharply and the area of expensive semiconductor converters decreases. These concentrators are called photovoltaics (CPV). Today, this method is losing ground because the cost of flat panels based on crystalline silicon has dropped dramatically in the last few years. And if we are talking about large-scale power generation, of course, the method of energy conversion will win because of silicon batteries lying on the roof, in the field or elsewhere. Apparently, this trend will continue in the near future.

Attempts are being made to produce solar cells not from inexpensive inorganic semiconductors such as silicon or gallium arsenide, but from cheap materials such as organic materials (conductive polymers, fullerenes, etc.). In fact, to make a solar silicon cell, you have to get very pure silicon, and then you have to grow an expensive crystal. The melting and crystallization temperature of silicon is -1400 ° C, which means that a lot of energy is also needed for heating. The resulting crystal is then divided into plates, from which instruments are made, the organic solar cell can be printed on a printer at room temperature. It is not difficult to understand that less energy is required for this. In addition, organic solar cells can be easily bent and given the desired shape. However, the main obstacle in this direction is that these devices are very unstable. Under the influence of light, air and temperature, their effectiveness decreases sharply. For comparison, silicon solar cells today have a lifespan of more than 20 years. Now generating electricity using silicon semiconductor solar cells is not a dream, but a reality at the level of generating terawatt electricity with an efficiency of about 20%. The silicone direction won because of its stability and high efficiency. The record values of the efficiency of silicon solar cells exceeded 26% and almost approached the theoretical limit. What's next? Perovskite-based solar cells Recently, a new family of hybrid organic-inorganic semiconductors based on metal-halogen perovskites was discovered, followed by solar cells based on them. Just like organic solar cells, they can be obtained from solutions, i.e. they can be printed on a printer. At the same time, such devices today demonstrate much higher efficiency than "organic". The first perovskite-based solar cells (4 J. Kojjima, K. Teshima, Y. Shirai, T. Miyasaka. Organometal halide perovskites as visible light sensors for photovoltaic cells) were obtained in 2009 in the group of Japanese professor Tsutomu Miyasaka. Journal of the American Chemical Society, 131,6050 (2009)., The efficiency was less than 4% and today it has reached 24%.

Perovskit devices can also be combined with silicone devices. Each semiconductor material is called a band gap. Photons are only absorbed with energy greater than this range. For example, silicon has a gap in the range of -1.1 eV (electron volts). This means that silicon cells absorb only part of the solar spectrum, which limits their efficiency.Silicon solar cells are active in infrared and ultraviolet perovskite. Today, the task of hundreds and possibly thousands of laboratories around the world is to create tandem silicon-perovskite solar cells that effectively absorb a wide range of sunlight. If this task is accomplished, the actual values of conversion efficiency on an industrial scale will exceed 30%. The main disadvantage of this material is that it is very unstable and breaks down quickly. To solve this problem, you need to understand why degradation occurs. One of the mechanisms of instability of such structures is related to the ionic nature of the chemical bonds of these materials. M. V. Xenkin, K.M. Anoop, E. A. Katz, and I. Visoli-Fisher. Deterioration of various solar cells: Lessons for the stability of Perovskit photovoltaics. It is very easy to destroy such a structure - it interacts with light, heat, water or oxygen in the air. On the other hand, there is still no agreement among researchers on how to measure the degradation and stability of such devices. M. V. Xenkin, K. M. Anoop, I. Visoli-Fisher, Y. Galagan, F. Di Giacomo, BR Patil, G. Sherafatipur, V. Turkovich, H.- G. Ruban, M. Madsen, T. Merckx, G. Uytterhoeven , JPA Bastos, T. Aernouts, F. Brunetti, M. Lira-Kantu, and EA Katz. For performance and stability of Perovskite photovoltaics. I think that work in this direction can lead to a revolution in the large-scale production of solar energy. Green and A. Ho-Beyli.Perovskit Solar Cells: The Birth of a New Era in Photovoltaics. ACS Energy Letters, 2, 822 (2017).

Solar energy for transportation

Solar radiation has a number of disadvantages in terms of converting it into electricity. Sufficiently low-power light falls to the ground, as mentioned above, only 1000 W / m2. Roughly speaking, if the efficiency of a solar cell is 20%, such a panel can produce only 200 watts per square meter. The power produced is directly proportional to the area. So let's say it's very difficult to build a car or an airplane with solar panels. The power received from the panels will not be sufficient for normal operation of the engines. Such machines must have very large wings to collect the required amount of light. Since we have concluded that the area of an aircraft or car is not enough for their operation, there is a need to produce fuel using solar energy (solar fuel). Research in this area is certainly promising. At the same time, there is a lot of interest in electric cars right now. We don't want cars to burn gasoline and produce CO_2 because it's harmful from an environmental point of view. If all cars are powered by electric motors, it is worth thinking about where we get a lot of electricity to recharge the batteries. To do this, it is necessary to build new stations and burn more coal, gas and oil. Therefore, of course, the widespread introduction of electric vehicles should be accompanied by the expansion of solar energy.

About energy transportation

About energy transportation Solar radiation is higher in the South and less in the North. But at the same time, the separation of solar radiation on Earth is much more democratic than, for example, the separation of hydrocarbon sources. I can cite an interesting example of international cooperation in this area. Since 2012, I have been a member of the International Council of Experts under the Chilean National Commission for Science and Technology Development (Expert Panel for the National Commission for Scientific and Technological Research in Chile, CONICYT). In northern Chile, there is the high-altitude Atacama Desert, which has one of the highest levels of solar radiation on the planet. At the same time, copper, one of the country's main economic sources, is produced and the population lives in extreme poverty: until recently, there was almost no clean water. And they began to introduce solar photovoltaics, becoming a world leader in the rate of introduction of such systems. At one time, the Chileans were able to generate surplus electricity. Then came the idea of selling it abroad. The most convenient in this regard are neighboring Argentina and Peru. But there are political differences between Argentina and them, historical complaints about each other, and Peru, the cheapest electricity producer. Then an interesting idea came true: Chileans sell solar energy in Peru during the day and buy cheap Peruvian electricity at night. If high-temperature superconductors operating at room temperature are detected, transmission without loss of electrical energy will be possible. Meanwhile, long-distance electricity transmission is limited. One of the possible technological solutions is related to the above-mentioned possibility of storage and transportation of solar fuel, for example, hydrogen obtained by electrolysis or photoelectrolysis of water. In the second case, we are approaching the possibility of artificial photosynthesis. There is also the idea of creating a solar station in geostationary orbits and generating solar electricity in space. Why is this good? First, the power of sunlight is 30% more than on Earth, because most of the sunlight is absorbed into our atmosphere. Second, there is a constant spectrum of sunlight. Using photovoltaic batteries, electricity generated in space can power, for example, a laser or microwave generator, which sends monochromatic light or microwave light anywhere on Earth. Here, they are received by solar panels or antennas to change microwave radiation. The conversion efficiency of monochromatic light can be very high - up to 80%. Although such projects continue to be funded by a number of state space agencies and private companies, they still remain in the realm of fantasy, primarily due to the cost of launching cargo into orbit.

Modern photovoltaic batteries that generate electricity from solar energy.

Basic parameters of solar elements

To understand how solar cells work, we need to know its basic parameters. The basic parameters of a solar cell are determined from its volt-ampere characteristics.

The main parameters of solar cells include:

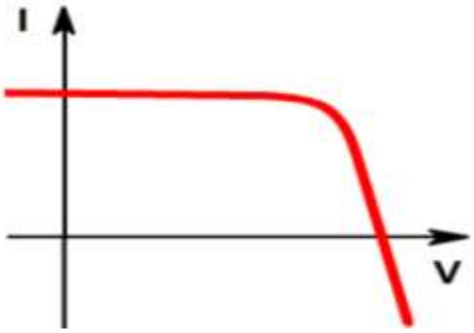
1. Short circuit current - Isc
2. Salt walking voltage - Voc

3. Filling factor - FF
4. Profitability ratio.

The volt-ampere characteristic of a solar cell represents the volt-ampere characteristic of a diode in the dark and the light superposition of a solar cell. Illumination of solar cells adds light to darkness, and the diode equation:

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

Takes the form (2.1). Here I0 is the saturation darkness and Isc is the light current. These parameters can be found from the volt-ampere characteristic.



Salt walking mode. In the example of the P-n transition, let's look at the salt walk mode (no chain).
Lighting generates electron-cavity pairs in a semiconductor.
Non-core carriers diffuse along the semiconductor;

If they can reach OPZ before they recombine, they will spread to the opposite side, where they will be the main carrier, and the probability of their recombination will be sharply reduced. As a result, excess light-generating carriers accumulate in opposite parts of the p-n junction. Thus, the non-primary drift current is increased by the light-generating medium. In the opposite parts of the p-n junction, the excess primary charges create an electric field. The area of the excess light carriers is opposite to the p - n transition area; this leads to a reduction of the barrier for the main carriers and an increase in the diffusion current.

Salt walking voltage. The maximum voltage that can be generated in a solar cell. The diffusion current compensates for the light drift current. At the opposite poles of the P-n junction, a Voc voltage is generated.
This is the maximum voltage that a solar cell can produce.
Equation for the volt-ampere characteristic of a solar cell:

$$J = J_0\left(\exp\left(\frac{qV}{nkt}\right) - 1\right) - J_{sc} \quad (2.2)$$

Voc can be defined as the current equal to zero in the solar cell equation:

$$V_{oc} = \frac{nkT}{q}\ln\left(\frac{I_{sc}}{I_0} + 1\right) \quad (2.3)$$

The rated 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) How many carriers have reached the OPZ in the separation area, i.e. by the diffusion length of the non-main carriers.

2) With the magnitude of the dark current determined by the recombination rate of the non-principal carriers.

Thus, the salt walking voltage is an indicator of recombination in the solar cell; to avoid recombination as much as possible to increase the voltage.

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 Isc.

A short circuit is the maximum current that a solar cell can produce.

$$J = J_0\left(\exp\left(\frac{qV}{nkT}\right)-1\right)-J_{sc}, J_{sc} \approx J_L \quad (2.4)$$

The short circuit current is determined by the following factors:

1. With the surface of the solar element.
2. With the amount and spectral composition of the photon.
3. With the optical properties of the absorber (with absorption and reflection coefficients)
4. With the probability of accumulation of carriers.

To increase the current:

-Decrease the return from the semiconductor and the metal contacts.

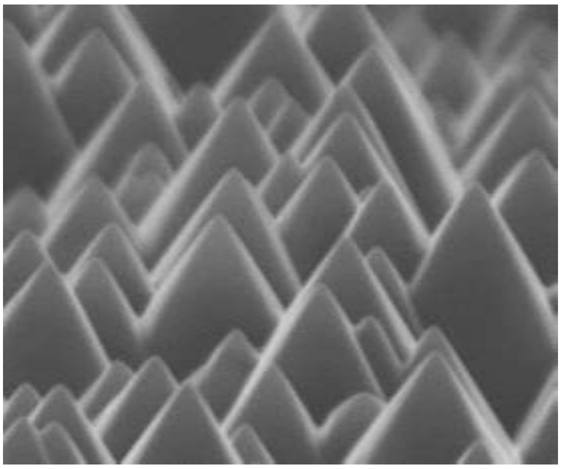
-Increasing the absorption in the semiconductor.

-Reduction of recombination.

Non-return coatings:

- Anti-retardant coatings are transparent films of known thickness and refractive index.
- The return from the semiconductor is reduced due to interference.
- An important material for the element silicon (Si) is silicon nitride (SiNx).

Texturing. Texting increases the percentage of absorbed radiation and the percentage of optical path. Silicon solar cells are textured by liquid chemical treatment. NaOH is treated anisotropically for monocrystalline silicon in KOH. HF, HNO3, H2SO4 are isotropically processed for polycrystalline silicon



The texture of the surface of the solar cell.

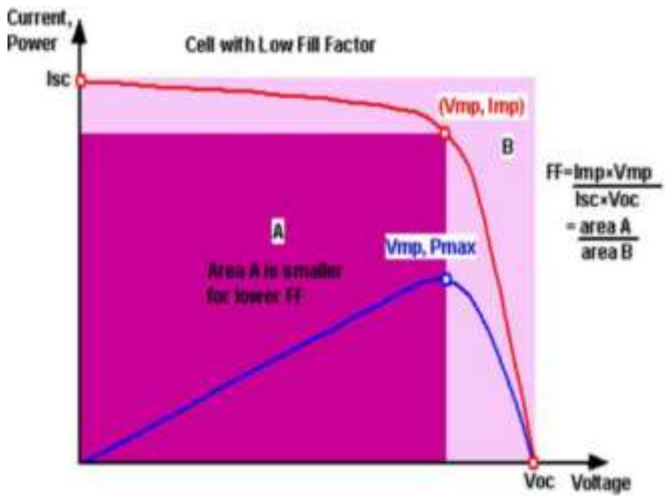
Recombination in the solar element. Recombination affects both current and voltage, so reducing it is important for solar cells. Usually recombination is divided into two components; semiconductor size recombination and surface recombination. Base defects occur at the expense of the boundaries of the ridges and entrances. Crystal growth can be reduced with the help of special technologies. There are two main ways to reduce surface recombination: 1) Area passivity; 2) Passivation with a dielectric film.

The peak power of the photo solar cell corresponds to a voltage around 0.47V. Thus, in order to properly evaluate the efficiency of a solar cell, as well as to compare the elements under the same conditions, it is necessary to load it in such a way that the output voltage is 0.47 V.

Fill ratio. Short-circuit current and single-pass voltage are the maximum current and voltage that can be obtained from a solar cell. However, the power of the solar cell is zero at these two points. The charge factor, often referred to as "FF", is the maximum power of a solar cell that corresponds to Voc and Isc.

FF is defined as the ratio of the maximum power of a solar cell to the product Voc and Isc.

$$FF = \frac{V_{MP} I_{MP}}{V_{oc} I_{sc}}$$



2.5 - picture. Dependence of the output current (red line) and power (blue line) of a solar cell.

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

$$P_{\max} = V_{oc} I_{sc} FF$$

$$\eta = \frac{V_{oc} I_{sc} FF}{P_{in}}$$

Here: Voc is the salt walking voltage; Isc - short circuit current; FF - fill factor; η is the efficiency

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.

-The efficiency ratio also depends on:

- Spectrum;

-The intensity of incoming solar radiation;

-The temperature of the solar cell;

-Solar elements on Earth are measured at AM1.5 and 25 0.

- Solar cells for space use are measured at AM 0.

The principle of operation of the solar cell is based on the transition phenomenon p - n.

The effect of temperature on the solar cell. Like all other semiconductor devices, the solar cell 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.

The most important parameter related to temperature changes is the walking voltage.

When the element is heated to 25 C 0 to 1 degree, it loses a voltage of 0.002 V, 0.4% / degree.

On a sunny day, the cell heats up to 60-70 C0 and loses 0.07-0.09 V. This is the main reason for the decrease in the efficiency of the solar cell. This leads to a voltage drop generated by the element.

-The increase in temperature has a strong effect on the module:

-Reduces voltage;

-Reduces output power;

-Increases the voltage associated with thermal expansion;

-Increases the rate of degradation by about twice every 10 degrees of temperature.

Factors influencing the heating of the solar cell:

• Return to the surface of the module;
• Module operating point;
• Absorption of light by a photoelectric module in areas not occupied by solar cells;
• Infrared light absorption by the module;
• The density of the solar cell.

Heat consumption in solar modules. The operating temperature of the solar module is the result of the balance between the heat produced in the module and the heat dissipated into the environment.

• Three main mechanisms of heat exchange:

- Thermal conductivity;
- Convection;
- Radiation.

• Thermal conductivity - occurs due to the thermal gradient between the module and other objects and the environment surrounding the module.

• The convective heat exchange of a solar module occurs when its surface is irradiated in the wind.

An arbitrary object emits radiation depending on its temperature.

Characteristic degradation and failure. Some types of distortion and mechanism of degradation that reduce output power or lead to module failure:

-Surface contamination;

-Fenced with trees;

-Degradation of the solar cell;

- Short circuit in the element;
- Thermal stress on a solar cell, hail or damage to the element's production;
- Interruption in the connection scheme;
- Interruption in the module;
- Damage to the glass;
- Delamination of the module;

CONCLUSION

In conclusion, it is important to note that photovoltaics and its development in Uzbekistan is important. The term "photovoltaic" refers to the normal operation of a photodiode, in which electricity is generated only from converted light energy. Solar radiation has a number of disadvantages in terms of converting it into electricity. Modern photovoltaic batteries, which generate electricity from solar energy, have become in demand today. The basic parameters of a solar cell are determined from its volt-ampere characteristics. The main parameters of solar elements include: short-circuit current - Isc; salt walking voltage - Voc; fill factor - FF; efficiency.

REFERENCES

1) Resolution of the President of the Republic of Uzbekistan dated May 5, 2015 No. PP-2343 "On the program of measures for the introduction of energy-saving technologies and systems."
2) Khayriddinov B.E., Kholmirzaev N.S. Sattorov AS “Physical bases of use of solar energy” (textbook), T .: Science, 2010. 280 bet.
3) AT Mamadalimov, MNTursunov "Physics and technology of semiconductor solar cells." Textbook. T.Universitet, 2002.- 94
4) Abdiev U.B., Ismoilov E.O. Formation of fundamental concepts of solar photovoltaics in physics education in secondary schools. Journal "Modern Education", 2014, issue 1. –21–24-b.
5) Abdiev U.B., Ismoilov E.O., Muhammadieva G.N. The use of new pedagogical technologies in the teaching of elective subjects "Heliotechnics and non-conventional energy sources" in physics education in higher education institutions. Journal "Modern Education", 2014, issue 2. –18–21-b.
6) T.A.Sodiqov, B.E.Khayriddinov. "Solar energy storage". –T., “Fan”, 1986. p.55.
7) Abdiev U.B. Unconventional energy sources in physics education. - Termez, 2013.
8) https://yuz.uz/uz
9) https://xs.uz/
10) https://ru.wikipedia.org/
11) http://hyperphysics.phy-astr.gsu.edu/