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ЛУЧШИЕ ИНТЕЛЛЕКТУАЛЬНЫЕ ИССЛЕДОВАНИЯ

APPEARANCE OF PHOTOVOLTAIC EFFECT IN POLYCRYSTAL SILICON BASED RECEIVER

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Annotation: Polycrystalline silicon-based receivers is an article on the topic of the manifestation of the photovoltaic effect. In this study, the manifestation of the photovoltaic effect for polycrystalline silicon-based receivers is studied. Photovoltaic effect is used to convert light energy into electrical energy and it is very important to choose materials that will have this property. And receivers based on polycrystalline silicon are highly efficient in converting light energy into electrical energy and offer opportunities for widespread use. The results of this research show the possibilities of developing polycrystalline silicon-based photovoltaic receivers with innovative technologies again in accordance with mass goals in the average production and production process. This will lead to a sharp increase in energy consumption and strengthen cooperation on alternative energy sources.

Key words: photovoltaic effect, photoelectric effect, Dember effect, photoelectric effect, solar cell, photon, silicon

Photovoltaics is a technology for converting solar energy directly into electricity. The conversion of sunlight into electricity is based on the photovoltaic phenomenon. Its essence is that due to the impact of photons falling on the p-n junction, free electrons are separated and accumulated. If the p-n junction is filled with two electrodes (anode and cathode), we can already talk about a photovoltaic cell that can pass electricity. Photovoltaics are the energy future of mankind. Hydrocarbon and fuel reserves are not as large as optimists claim. You should also understand that even if hydrocarbon reserves are not completely exhausted, they will be in short supply, and therefore the price of such energy resources will increase sharply. Photovoltaic effect is the generation of an electric current (photocurrent) when illuminating a semiconductor or dielectric sample connected to a closed circuit, or the generation of an emf in a sample illuminated by an open external circuit [1-3].

The first type of photoelectric effect occurs only when light simultaneously creates mobile charge carriers of both types (electrons and holes) and is caused by the spatial separation of these carriers. Separation is caused by sample inhomogeneity (the surface can play the role of homogeneity) or light inhomogeneity (illumination of part of the sample or absorption of light near the surface). A photoelectric module under non-uniform illumination can also occur due to the "heating" of electrons by the light. This mechanism is similar to the "normal" thermoelectric effect and may be important for band and intraband absorption [4-6].

Tashuvchilarni fazoviy ajratish bilan bog'liq fotoelektrik modul quyidagilarni o‘z ichiga oladi:

The Dember effect occurs when a sample is uniformly illuminated due to differences in the diffusion coefficients of electrons and holes. It can also appear under the same light due to differences in surface recombination rates on opposite faces of the sample.

The photoelectric module is formed by the separation of electrons and holes at the metal-semiconductor contact by the electric field of the near-electrode Schottky barrier, p-n junction or heterojunction field.

The contribution to the electric current comes from both carriers generated directly in the p-n junction region and from those excited in the regions close to the electrode and reaching the high-field region by diffusion. As a result of separation of the pair, a directed flow of electrons to the first region and holes to the p- region are formed. Photocells based on heterojunctions are used as very sensitive, low-frequency radiation receivers, as well as for direct conversion of light energy into electrical energy (solar cell). When recording radiation, the photoelectric module is connected directly to the external circuit or an external source is turned on in series with the circuit, which creates a significant turn-off in the p-n junction. This allows to significantly increase the sensitivity of the device. When the surface of an insulated semiconductor is illuminated, a change in surface potential occurs due to separation of pairs with the nearby electrode barrier area and a change in charge on the surface traps. The potential of the illuminated surface is called floating potential, and its change is called surface emf. The latter can be measured by the vibrating electrode (Kelvin method) or by the capacitor method using intermittent illumination. The measured change in the contact potential difference between the semiconductor surface and the metal electrode includes, in addition to the surface photovoltaic module (the main contribution), the Dember photovoltaic effect that occurs in the near-surface region [7-12].

Volume photoEMF is caused by the separation of inhomogeneous carrier pairs in the volume of the sample caused by changes in the concentration of dopants or changes in the chemical composition of complex semiconductors. The reason for the separation of the pairs is called the built-in electric field. It is formed as a result of changes in the state of the Fermi level Ep depending on the impurity concentration and as a result of changes in the band Ee (semiconductors with different gaps) in samples with variable chemical composition. For the photovoltaic effect to appear, it is not necessary to have regions with different types of conductivity in the sample. Usually, it is observed when the inside of the sample containing the area where the photoelectric module is installed is illuminated with dark contacts, and when the properties of the semiconductor differ at these limits, it appears as a result of the lack of compensation for the photovoltaic effect of Dember at the opposite limits of the illuminated area it can [13-15].

The photoelectric effect is the appearance of a photocurrent or photovoltaic effect during sample deformation. One of its mechanisms is the appearance of volumetric photovoltaic effect during non-uniform deformations, which leads to the change of semiconductor parameters, primarily Ee, depending on the sample. Another photoelectric module mechanism is the transverse Dember photoelectric module, which occurs during uniaxial deformation, which causes anisotropy in the diffusion coefficient of charge carriers. The last mechanism is the most effective for deformations of multi-valley semiconductors, leading to the redistribution of carriers between valleys. will bring.

The high-voltage photovoltaic effect occurs under non-uniform illumination and is characterized by the fact that the electric field is directed along the surface of the sample, its value is proportional to the length of the illuminated area. Unlike valve and volume photovoltaic modules, whose values do not exceed the bandwidth, a high-voltage photovoltaic module can exceed 10^3 V.

The photoelectric module of the second type arises from the asymmetry of the elementary processes of photoexcitation, scattering and recombination of carriers. This photoelectric module does not require the formation of pairs of free carriers and is observed both during interband transitions, during the excitation of carriers from impurities, and during the absorption of light by free carriers. The described photoelectric module includes:

The impact of the penetration of electrons by photons is related to the asymmetry in the momentum distribution of photoelectrons caused by the transfer of photon momentum to them. In two-dimensional structures during the optical transition between minibands. The gravity of the photocurrent is caused primarily by electron transitions with a specific momentum direction and can significantly exceed the corresponding current in bulk crystals.

Linear FE does not involve the transfer of photon momentum to electrons, and therefore does not change when the direction of light propagation is reversed (in strictly linear polarization). This is due to the asymmetry of the distribution of photoelectrons created by two mechanisms:

ballistic due to the appearance of a directed pulse during a quantum transition; displacement caused by the shift of the center of gravity of the electron wave packet during the transition. In this case, both light absorption processes and scattering and recombination contribute to the current (these contributions are compensated in the case of thermal equilibrium). In general, the direction and magnitude of the current depends on the position of the plane of polarization of light.

In gyrotropic crystals, when illuminated with circular (elliptical) polarized light, a circular photovoltaic effect occurs, and the sign changes when the sign of circular polarization changes. The reason for this effect is the connection between electron spin and its momentum in gyrotropic crystals. Electrons, when excited by circularly polarized light, cause their spins to become optically oriented, while simultaneously having a directional momentum. The opposite effect was also observed - current-induced optical activity; it is caused by the orientation of the spins in the gyrotropic crystals when the current passes.

Linear and circular photoelectric modules, as well as the gravity effect, are used to create inertial receivers of intensive (laser) radiation. In dielectrics, linear optical memory is the main mechanism because it causes a change in the refractive index that persists after the light is turned off and depends on its intensity. This change is caused by the electric fields frozen by recharging the traps with photocurrents.

The surface photoelectric module results from the scattering of light-induced charge carriers on the surface. With interstitial absorption, it occurs under conditions where a significant fraction of excited carriers can arrive without scattering. In this case, due to the reflection of electrons from the surface, the ballistic current appears normal to the surface. When the excitation of carriers occurs, they are aligned along the pulse, that is, if their distribution function is anisotropic, a current flowing along the surface can also appear. For this, the average values of the momentum component along the surface for electrons moving towards and away from the surface should be non-zero and differ in sign. Such distribution occurs, for example, when carriers are excited from the degenerate valence band to the conduction band of cubic crystals. During inelastic (diffuse) scattering on the surface, the electrons that reach it lose the momentum of the direction along the surface, and the electrons moving from the surface retain it, which leads to the appearance of current along the surface. When light in semiconductors and metals is absorbed or reflected by free carriers, surface PE occurs at oblique incidence of light, as well as normal incidence, if the surface normal does not coincide with one of the principal axes of the crystal. to the transmission of a photon pulse. Photovoltaic refers to the direct conversion of sunlight into electrical energy through a physical reaction. This electrification process is carried out by solar panels, which are usually connected in series to form photovoltaic modules. Photovoltaics is a method of generating electricity by using photosensitive cells to convert solar energy into electricity. This is the simple mode of operation of a photodiode, in which the electric current comes only from the converted light energy. Almost all photovoltaic devices are varieties of photodiodes. In photovoltaic systems, the conversion of solar energy into electrical energy is carried out in photovoltaic converters. Depending on the materials, design and manufacturing method, it is customary to distinguish three generations of photovoltaic module cells:

First generation solar cells based on crystalline silicon wafers;
Second generation solar cells based on thin films;
Third generation solar cells based on organic and inorganic materials.

To increase the efficiency of solar energy conversion, solar cells based on cascaded multilayer structures are being developed. The first generation solar cells based on crystalline wafers are currently the most widely used. Over the past two years, manufacturers have been able to dramatically reduce the cost of producing such solar cells, which has strengthened their position in the global market.

Types of first generation solar cells:
monocrystalline silicon;
polycrystalline silicon;
Based on GaAs;
tape technologies;
thin film polycrystalline silicon.

The production technology of the second generation of thin film solar cells includes the application of layers using the vacuum method. Vacuum technology uses less energy than crystalline solar cell production technology and is characterized by low capital investment. This allows the production of flexible, inexpensive solar cells with a large area, but the conversion coefficient of such cells is lower than that of the first generation solar cells.

Types of second generation solar cells:
amorphous silicon;
micro and nanosilicon;
silicon on glass;
cadmium telluride;
copper-(indium-)gallium selenide.

The idea behind the creation of third-generation PV cells was to further reduce the cost of PV cells by abandoning the use of expensive and toxic materials in favor of cheap and recyclable polymers and electrolytes. An important difference is also the possibility of applying layers using printing methods, for example, using roll-to-roll (R2R) technology. At the moment, the main part of projects in the field of third-generation solar cells is at the research stage.

Types of third generation solar cells:
dye photosensitized;
organic;
inorganic.

PV cells are assembled into modules with standardized installation dimensions, electrical parameters and reliability indicators. Solar modules are equipped with current inverters, batteries and other elements of electrical and mechanical subsystems for installation and transmission of electricity.

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