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INFRARED GENERATOR TYPE PHOTORECEIVE

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Article history:		**Abstract:**
Received:	10th November 2021	The article describes a solar device for generating electrostatic fields by means of a miniature non-volatile power source of an autonomous type of an optical beam. The device is a transformation of infrared radiation into visible light. A system of equations for a functional signal conversion device is given in the article
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As is known, electrostatic fields are widely used in many branches of science and technology. Various types of instruments and devices are used to create electrostatic fields. In these devices, traditional energy sources are accepted as a source of electrical energy. In these sources of electrical energy, electrostatic fields are created at the expense of much higher energies. Nowadays, thanks to advances in the field of optoelectronics and solar technology, it becomes possible to develop advanced methods for obtaining strong electrostatic fields due to low-amplitude solar radiation energy. The desire to reduce energy costs by opto-solar technology is accompanied by a radical decrease in the cost and size of devices, this circumstance opens the way to miniaturization of devices and devices.

Such developments stimulate numerous one of the most promising and rapidly developing branches of modern science and technology. The development trend of which is due to the energy received from renewable sources. Therefore, research and development in this area, which is one of the most urgent tasks of our time to improve the technology and technology of optoelectronic solar devices and devices.

Apart from this, thanks to the use of solar optoelectronics, new types of solar optoelectronic devices appear that have a number of important advantages, a more detailed discussion of which will be carried out in this and subsequent chapters of the dissertation. The elements of optoelectronic circuits are photo-emitters and photodetectors - devices that perform two main operations for the mutual conversion of electrical and optical signals. According to the functional feature, photodetectors are divided into two groups: a) directly generating electrical voltage when illuminated (photogenerators or generator-type photodetectors) and b) changing the distribution of voltage from an external source in the circuit under the action of the roof (photodetectors). A photoemitter is a light source (IS), as an IS it can serve as incandescent lamps, gas discharge lamps, electroluminophores, injection diodes (LEDs), lasers.

All of the above ICs are artificial ICs. The main parameters of artificial ISs are quantum yield, response time (sec), maximum photon flux (cm^{-2}, sec^{-1}), spectral line width (EE). Artificial ISs are mainly used in semiconductor microelectronics. In semiconductor solar technology, solar radiation is used as an IC. As noted above, the optocoupler of semiconductor solar technology is a solar optoelectronic device.

By the example of an optocoupler, it is easy to illustrate the richness of the possibilities of optoelectronics, due to the combination of two types of bonds. Optocoupler with a direct optical connection forms an amplifier of electrical signals fig.1.

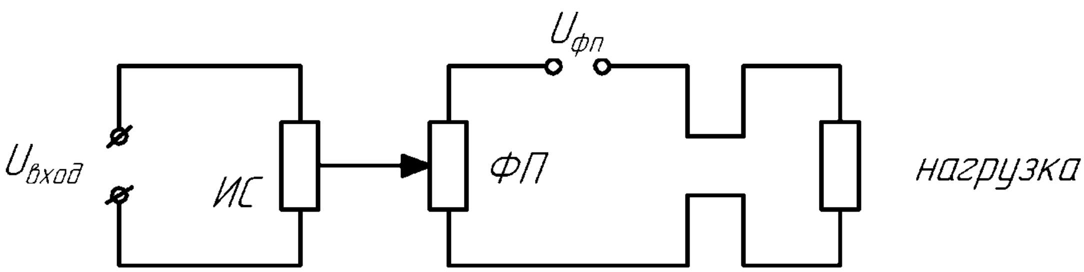
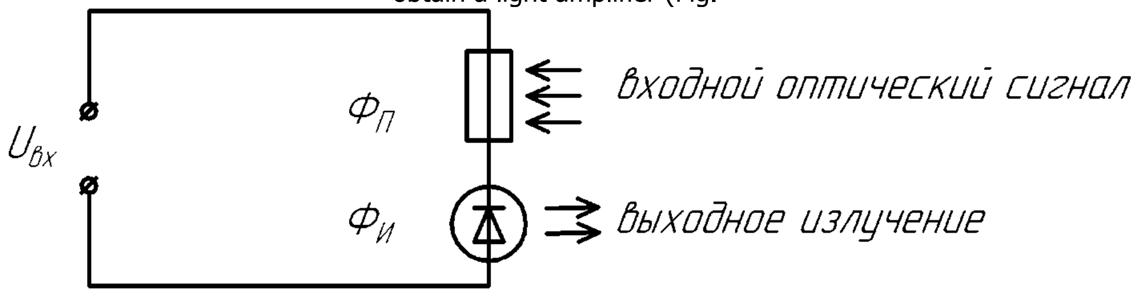


Fig. 1. Optocoupler with direct optical coupling.

By creating an electrical direct connection between the components in the optocoupler instead of an optical one, we obtain a light amplifier (Fig.



2).

Fig.2. Light amplifier.

In addition, it is possible to carry out spectral transformation, for example, the transformation of infrared radiation (IR) into visible light. Thus, with the help of an optocoupler with a direct optical connection, three operations can be carried out simultaneously: spectral conversion; amplification and stabilization of the luminous flux.

Properly designed generator-type photodetectors (GTPh) and made of high-active photoelectric material work with high efficiency, but losses are inevitable in it. If each incident photo produced one pair of "electron-hole" and these carriers all to one would reach the corresponding electrodes without losing their energies, the GTPh would work with maximum efficiency.

However, in real conditions such a case is never observed. In reality, energy losses are unavoidable in the GTPh. All energy losses in the GTPh can be divided into two groups.

The first group of losses is formed from the following parts:

1) Part of the light flux incident on the surface of the photodetector (Ph) Ф is reflected and, therefore, does not participate in the creation of current carriers;

2) The second part of the light flux Ф passes through the entire talc of the semiconductor and does not participate in the photovoltaic process. Let's designate it through Fpr.;

3) The third part - let's denote it by Фн. - is absorbed by the thickness of the semiconductor, but current carriers are not created. This type of radiation absorption is called photoelectrically inactive absorption.

So the light loss Фсв. are the sum: Фсв=Фотр+Фпр+Фн. Let us now turn to the analysis of the energy losses arising as a result of the formation of pairs and the pressure of current carriers in the thickness of the phase transition. They also consist of several parts:

1) Part of the photo-active light flux absorbed by a semiconductor - it is equal to Ф - Фсв., Creates electron-hole pairs. However, not all electrons and holes reach their electrodes. In the process of their movement, some of them necessarily re-combine. In this case, recombination is accompanied by the transfer of energy to the crystal lattice of the semiconductor;

2) The very movement of electrons and holes through the thickness of the semiconductor and through the contacts of the ФП is also accompanied by a loss of energy;

3) In each ФП there are shunt resistances. During the movement of photocarriers through the shunt resistance, both photoelectrons and photoholes leak;

4) During the movement of photocarriers, a collision of carriers with atoms of the lattice occurs, as a result, there is a transition of carriers from higher levels to lower ones in the aisles of the same energy zone. This process is accompanied by energy losses.

1) According to the above analysis and in accordance with the requirements of the theory, in order to manufacture a highly efficient GTPh, it is necessary:

2) 1) In the material from which the GTPh is made, the lifetime of photocarriers should be maximum;

3) 2) In the process of manufacturing GTPh, it is necessary to find such technological methods that would ensure the formation of a p–n junction located at a distance less than the diffusion length from the upper electrode;

4) 3) To create a highly efficient GTPh, the design of the device must meet the optimal parameters such as the depth of the pn junction, the width of the junction, the diffusion length, the surface recombination rate, and the size of the photoactive region where the electron-hole pair is generated. If the above requirements are met, the recombination of photocarriers decreases, and most of the electron-hole pairs will be able to reach the pn junction.

5) If the GTPh is used as a converter of solar radiation into electricity, then the PGT operates in the solar cell (SC) mode. For solar cells, the most probable and promising material, in addition to Si, is also thin films of chalcogenides and heterophotocells (HPh). Recently, solar energy has been widely used in world practice [2, 3]. In addition, GTPh is used in optoelectronics to create various optoelectronic devices and devices [1, 4, 5, 6]. In these devices, the GTPh operates in the *APhV*-element mode. As it is known [1] *APhV*-elements is a current generator and as a source of high voltage can only work on a highly intelligent load. Therefore, *APhV*-elements can be used to create strong electrostatic fields as a miniature non-volatile power source of an autonomous type of optoelectronics [7]. Any functional circuit of an optocoupler can be represented as a closed ring of signal transformations, consisting

of five links. Such links are: LED, light guide, photodetector, photodetector circuit and functional signal conversion devices (output working device). Each link is characterized by its transfer function.

The transfer function of each ФП is its photoefficiency coefficient $\beta = \frac{\partial I_\Phi}{\partial B}$ if I_Φ и B are measured in numbers, then the value of β will coincide with the quantum efficiency [1]. Under stationary conditions, the complete system of equations for an optocoupler with direct optical coupling consists of the equations of its components. A direct-coupled optocoupler operates as an electrical amplifier with an optical input, where the input is the light emitter circuit (sunlight, LED, etc.), and the output is the load in the ФП circuit (Fig. 3).

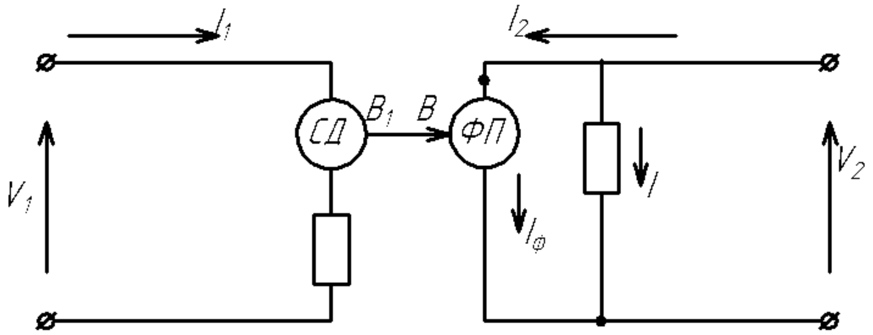


Fig.3. Scheme of an optocoupler with a direct optical connection.

For such an optocoupler, we can write the following system of equations,

$I_1 = I_1(V_1)$, $I_2 = I_\Phi + I(V_2)$

$B_1 = B_1(I_1)$, $B = B(B_1)$

$I_\Phi = G(B(B_1[I_1(V_1)]))V_2$

This system of equations makes it possible to analyze and calculate optoelectronic circuits with direct optical coupling. Moreover, various ФП differ from each other not only in functional properties, but in differential resistance.

If the GTPh, operates in the SC mode, depending on the spectral region of solar radiation, a scheme (Fig. 4) is selected for the location of the p-p junction with respect to light. collection of media.

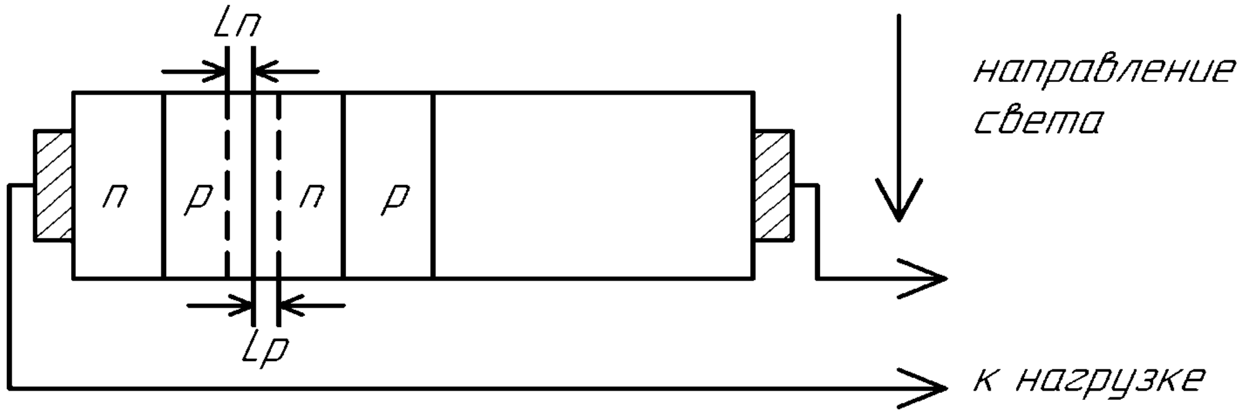


Fig.4. The arrangement of pn junctions in a semiconductor crystal is parallel to the incidence of solar radiation

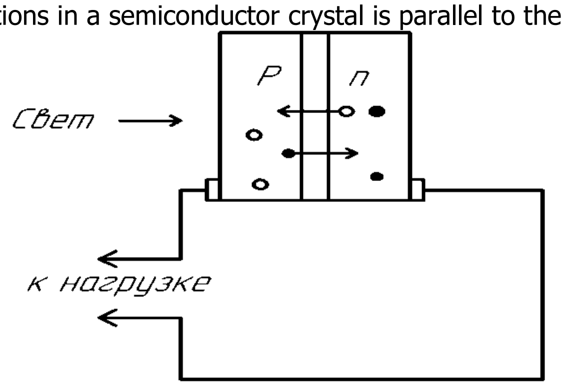


Fig.5. The arrangement of *p-n* junctions in a semiconductor crystal is perpendicular to the incidence of solar radiation.

In the short-wavelength region of the spectrum, a structure (Fig-5) with a perpendicular arrangement of the *p-n* junction is used, since in this case an increase in the collection efficiency is observed, as a result, a significant photo-E.D.C can be obtained on a single illuminated surface of the solar cell.

In the proposed device, in the ИС and ФП circuits of the optoelectronic device, the role of electric power is performed by solar energy. In addition, unlike other similar optoelectronic devices, in this device, light is converted not into an electric current [8, 9] but into an electric field. For the operation of many optoelectronic devices, it is necessary to create strong electric fields. Large electric fields are widely used in electronics, quantum electronics and various branches of micro and optoelectronics. With the use of this device, the reliability, autonomy and energy independence of optoelectronic devices is ensured. In addition, the possibility of microminiaturization of such optoelectronic devices opens up, in this way the non-contact remote controllability of optoelectronic devices improves and the sensitivity of such devices increases by several orders of magnitude.

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