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The principle of operation of semiconductor photocells and to study the properties of complex structural components

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Abstract: This article discusses the principle of operation of the structure of complex semiconductor photocells, their properties and in what areas they are used.

Keywords: Photocell (FE), Solar cells (QE), frontal layer, optical absorption, semiconductor (NO), radiation, thermoregulation, silicon wafers.

Introduction

Currently, the main substance used in the manufacture of solar panels is silicon (Si), which accounts for 90% of the material used. Because silicon is the most studied theoretically and practically, it is based on a relatively inexpensive and simple method of making p-n transition solar cells (QE). In addition to silicon, there are many semiconductor materials such as GaAs, CdTe, JnP, AlSb that can form QEs. However, the technology to create QE based on them is not yet well developed in all but GaAs. GaAs-based FEs have many higher quality characteristics than silicon FEs, but their creation efforts are much higher.

In general, the cost of electricity generated in QE is more expensive than the traditional method, while the creation of high-capacity QFES suitable for industrial use is being delayed. In this area, the issue of reducing the cost of electricity generated by QFES has become a major problem of photovoltaic energy. Attempts to reduce the cost of electricity generated by QEs can be attributed mainly to the implementation of the following activities, namely:

- Strengthen research aimed at further production of high-quality silicon in order to change the QE and increase its efficiency;

- Creation of new and effective forms of FE;

- Expanding the production of QEs and components on the basis of low-cost silicon;

Use of simplified QE creation technologies.

In the preparation of QE, the interaction of solar radiation with YaO material, the processes of absorption and emission of photon energy by electrons in the material are important. It is known that the total absorption of solar radiation in YaO depends mainly on the width of the forbidden area of YaO.

The magnitude of Eg determined from optical absorption measurements often depends on the concentration of free charge carriers in the YaO material, the temperature, and the presence of the input energy levels in the forbidden area. If the conditions at the bottom of the conduction band and above the valence band are filled with charge carriers, then Eg for the input YaO materials can be the same as the value corresponding to the pure specific material. If the field generated by the inputs merges with the nearest allowed field boundary (for example, the case observed when a large number of inputs are entered), then Eg decreases. Such a decrease in Eg affects the main absorption limit, while the efficiency of FE created on the basis of such YaO decreases.

The spectral characteristics of the absorption coefficient show that a very large part of the solar spectrum can be converted into electricity using a silicon material. For example, for solar radiation outside the atmosphere (AM O) this is 74%. However, if GaAs YaO 'is taken as the material, only 63% of solar radiation can be converted into electricity. However, since the value of l at the main absorption limit of "irregular" optical transitions is not large, the thickness of silicon QE should not be less than 250 μm for the absorption of the entire given solar spectrum. However, for similar conditions, the thickness of the GaAs material should be 2-5 μm. Therefore, it is always necessary to take into account that these properties of the spectral characteristic are of great importance in the development of high-efficiency and thin-layer QE.

If the energy of photons falling on the surface of YaO is low and cannot absorb electrons from the valence band to the conduction band as a result of absorption, the electron can move to unauthorized areas inside the crystal under the influence of radiation. A study of such long-wave absorption properties in YaO materials revealed that there are several types of absorption. In particular, absorption in spatial lattice oscillations, absorption in entrances, absorption in excitons. Absorption spectra provide useful and all-round useful information about the crystal structure, including the degree of alloying, the activation energy of the inputs, and their energy levels in the forbidden area. For example, on the basis of absorption spectra, it is possible to determine the presence of atoms of certain substances in silicon.

In YaO 'materials based on the photoelectric effect, the p-n is converted to QE, which consists of transition structures, and the incident sunlight is converted directly into electrical energy. Therefore, unlike p-n junction photoresistors and photoresistors, QEs do not need an external voltage source, they are themselves an electrical source. 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%.

A relatively active solution to this problem will depend on the development of a field theory of the electronic structure of YaO materials, the technology of purification of materials from inputs and controlled introduction of inputs, as well as the theory of p-n transition. Advances in the technology of growing pure semiconductor materials have made it possible to produce efficient FEs.

. *The uniform formation of p and n-type conductivity pairs in YaO relative to the depth of the material is very important in the process of diffusion of charges towards the p-n junction and in the p-n junction. Therefore, in QEs with many p-n junctions (when photovolts consist of a large number of micro QEs), their p-n junctions are placed parallel to the incident optical radiation.*

It should be noted that in micro QEs with relatively small parallel p-n junctions, the magnitude of the recombination event relative to the perpendicular p-n junctions has been determined theoretically and practically. Therefore, in order to increase the spectral efficiency of shortwave rays on the surface of this type of QE exposed to solar radiation, it is advisable to form an additional thin layer with a reverse type of conductivity with additional inputs. That is, it is advisable to return to a partially perpendicular construction element. The pn junction of solar elements is connected in the right direction in the operating mode, i.e. the formation of unbalanced charge carriers on both sides of the pn junction as a result of the effect of optical radiation, which pn o 'indicates that the tooth is connected in the correct direction.

In the highly alloyed frontal layer, the diffusion path length of non-basic charge carriers is 0.2–0.6 μm, while at the base of the element, this size ranges from 100–250 μm, and these values are determined by the charge concentration and QE depends on the mode of *technological operations performed during the preparation process.*

A relatively small value of the diffusion length in the doped frontal layer requires a shallower p-n-junction (in modern CEs, the thickness of the frontal layer is taken equal to 0.3–0.5 μm). However, in order to use the main part of the solar radiation incident on the QE, i.e. hn> Eg, the thickness of the solar cell base must be at least 200 microns. Although silicon wafers of this thickness are relatively machinable, they can absorb up to 93-95% of the radiation. The resistance of the base area is not very high because the current flows perpendicular to the thick base.

The first layer of the omic contact to be made is made of aluminum. Because aluminum is an introductory p-material, it provides good ohmic contact with silicon and is then coated with an alloy of Ti, Pd, Ag or Ni and the desired pripoy (indium, lead or tin).

The resistance of the frontal n-layer of the solar cell is relatively large and can reach 50-100 Ohm / cm.

In order to achieve such resistance, one by one layers of the above materials are laid. These processes require the prevention of electrical perforation of the frontal thin layer.

Research shows that if the contact material on the frontal thin layer is first applied as a coating to the entire surface and then a certain shape is applied by chemical absorption by photolithographic process, many micro-perforated areas appear on the frontal surface.

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