APPLICATION OF PHOTOVOLTAIC EFFECTS TO ENERGY SAVING MATERIALS

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Abstract: This paper provides information on how to apply photovoltaic effects to energy efficient materials. This article will show you how to focus on photovoltaic effects and their energy savers and choose the right materials to use them in their best form. The paper provides more knowledge on how to integrate photovoltaic effects into energy efficient materials and helps to create innovations in this field.

Key words: photovoltaic effect, photodiode, photovoltaic module, semiconductor, photoelectric effect.

Photovoltaic effects are experienced by energy-saving materials, which means that energy-saving materials for photovoltaic devices convert photon energy into electrical energy. When photons hit the photovoltaic material, they leave the electron beam by giving the electrons an energy level, displacing the electrons and thus creating a potential difference in the electrical charges. This potential difference is visible in electrical measurements and its stored energy can be stored in energy packs.

Photovoltaic effects can therefore have several useful directions, such as the following examples:

Electric power generation: Electric power generation can be done by converting photons into electricity through photovoltaic effect. This can be used to repair prototypes such as batteries and accumulators.

For weapon systems: Photovoltaic panels or modules can be an important resource for the maintenance of intelligent weapon systems.

Energy disclosure: Photovoltaic panels and modules can be used as a product according to the smart definition.

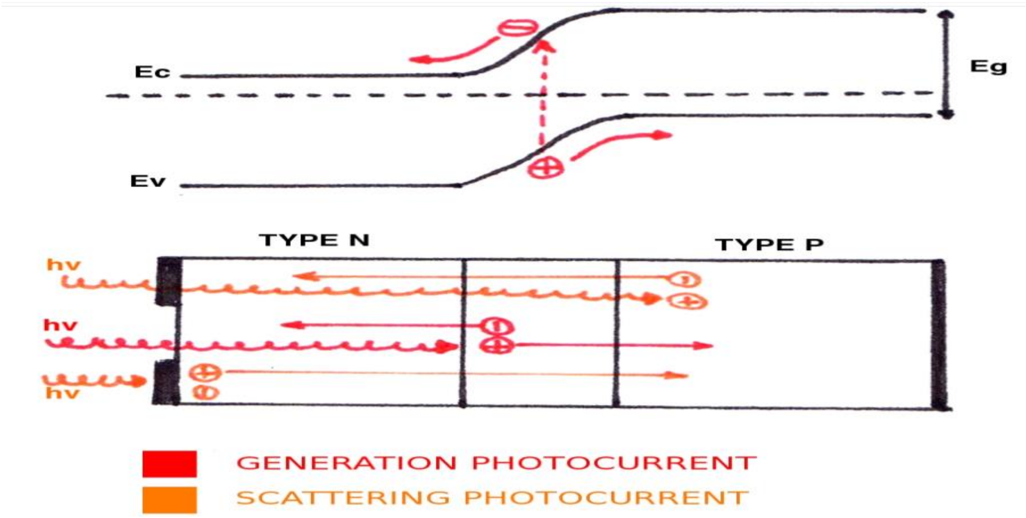
For application and utilities: Once the photovoltaic effect is accelerated, it can be used for applications and utilities.

In all ways, the application of photovoltaic effects to energy-saving materials continues to be tested, and these technologies are considered emerging phenomena.

Photovoltaic effect is the generation of voltage and electric current in the material under the influence of light. The photovoltaic effect is closely related to the photoelectric effect. For both events, light is absorbed, which excites an electron or other charge carrier to a higher energy state. The main difference is that the term photovoltaic effect is usually used when the electron is removed from the material (usually into a vacuum) and the photovoltaic effect is when the excited charge carrier is still inside the material. In both cases, the electric potential (or voltage) is created by the separation of charges, and light must have enough energy to overcome the potential barrier to be excited. The physical nature of the difference is usually that photoelectric emission separates charges by ballistic conduction and photovoltaic emission separates them by diffusion, but some concepts of "heat-carrying" photovoltaic devices blur the distinction [1-3].

The first demonstration of the photovoltaic effect was in 1839 by Edmond Becquerel using an electrochemical cell. In his Comtes rendus de l'Académie des Sciences, he explained his discovery of "the generation of an electric current when two platinum or gold plates immersed in an acid, neutral, or alkaline solution are unevenly exposed to solar radiation.

The first solar cell, consisting of a layer of selenium covered with a thin gold film, was tested by Charles Fritts in 1884, but it had very poor efficiency. However, the most familiar form of the photovoltaic effect comes from solid-state devices, mainly photodiodes. When sunlight or other light of sufficient energy falls on the photodiode, the electrons present in the valence band gain energy and become excited and move to the conduction band and become free. These excited electrons scatter and some reach the rectification junction (typically a diode p-n junction) where they are accelerated into the n-type semiconductor material by an applied potential (Galvani potential). This creates electromotive force and electric current, and thus some of the light energy is converted into electrical energy. The photovoltaic effect can also occur when two photons are absorbed simultaneously in a process called the two-photon photovoltaic effect [4-8].



Band diagram of the photovoltaic effect. Photons transfer their energy to electrons in quasi-neutral regions. These go from the valence band to the conduction band. Depending on their location, the electrons and holes are accelerated by the drift electric field E_{drift}, which gives the generation photocurrent, or the diffusion of the electric field E_{scatt}, which gives the emission photocurrent.

In addition to the direct photovoltaic excitation of free electrons, an electric current can also be generated through the Seebeck effect. When conductors or semiconductors are heated by the absorption of electromagnetic radiation, the heating can cause increased temperature gradients in the semiconductor material or differences between the materials. These thermal differences can in turn create voltages as electron energy levels shift differently in different regions, which in turn creates a potential difference between regions that creates an electric current. The relative contribution of the photovoltaic effect to the Seebeck effect depends on many properties of the constituent materials [9-11].

All of the above effects produce direct current, the first demonstration of the alternating current photovoltaic (AC PV) effect was made in 2017 by Dr. Haiyang Zou and Professor Zhong Lin Wang at the Georgia Institute of Technology. photo voltaic effect. An alternating current in non-equilibrium conditions that occasionally shines at a junction or interface of a material. Photovoltaic power effect is based on the capacitive model, the current is strongly dependent on the frequency of the chopper. The photovoltaic effect is the result of the relative shift and alignment between the quasi-Fermi levels of the semiconductors adjacent to the junction/interface under mismatch conditions. Electrons flow back and forth in the external circuit to balance the potential difference between the two electrodes. An organic solar cell with no initial carrier concentration has no photovoltaic effect.

The operation of the photovoltaic module depends on the environmental conditions, mainly on the global incident radiation in the plane of the module. At the same time, the temperature of the p-n junction also affects the main electrical parameters: short-circuit current ISC, open-circuit voltage VOC and maximum power Pmax. The first studies on the behavior of PV cells under different conditions of G and T were several decades ago.1-4 In general, it is known that VOC shows a significant inverse correlation with T, while for ISC, this correlation is up to 'directly, but weaker, so this increase does not compensate for the decrease in VOC. As a result, Pmax decreases as T increases. This relationship between the output power of a solar cell and its junction operating temperature depends on the semiconductor material, and it is related to the effect of temperature on the concentration, lifetime and mobility of the internal carriers, that is, electrons and holes [12-13].

Semiconductors are a large group of substances. They include the following chemical elements: germanium, silicon, boron, carbon, phosphorus, sulfur, chromium selenium, gray tin, tellurium, iodine, some chemical compounds and a large number of organic substances. A limited number of semiconductor materials are used in electronics. is used. It is primarily silicon and gallium arsenide. A number of substances such as magnesium, boron, phosphorus is used as mixtures. Semiconductors used in electronics have a much more refined crystal structure, their atoms are located in a precise periodic sequence at constant distances from each other in space, forming a crystal lattice. The most common semiconductors in electronics - germanium and silicon - have a diamond-like structure. In such a lattice, each atom of a substance is surrounded by four such atoms and is located at the apex of a regular tetrahedron. Each atom in the crystal lattice is electrically neutral. The forces holding the atoms in the lattice nodes have a quantum mechanical character; they appear due to exchange of valence electrons of interacting atoms. Such a connection of atoms is called a covalent bond, for its creation a pair of electrons is needed. In the outer layer of germanium and silicon, which are tetravalent elements, there are four covalent bonds with four nearby atoms. In the seen ideal lattice, all electrons are connected to their atoms. Small energetic effects from heating or radiation can cause some valence bonds to break in the lattice. In this case, the valence electron is separated from its atom and moves to a new stable state, and it has the ability to move along the crystal lattice. The mobile electrons separated from such a valence bond are called conduction electrons. They cause the semiconductor to conduct electricity, which is called electron conductivity [14-15].

The minimum amount of energy required to remove a valence electron from an atom and make it mobile depends on the structure of the DE lattice and is a parameter of the semiconductor. electrons occupy the entire zone of energy levels and is called the conduction zone.

The energy state of valence electrons also forms the so-called valence zone. Between the maximum value of the valence band and the minimum value of the conduction band, there cannot be electrons in the energy band; this is called the forbidden zone. The width of the band gap determines the energy required to release a valence electron to ΔE, that is, the ionization energy of a semiconductor atom. Thus, from an energetic point of view, the removal of a valence electron from an atom and its transformation into a conduction electron corresponds to the removal of electrons from the valence band to the conduction band. When a valence bond is broken and an electron goes from an atom to a lattice, an unfilled bond is formed, with valence electrons from adjacent bonds to the unfilled bond, which have an uncompensated positive charge equal to the electron charge. because of its easy transition, this is facilitated by thermal motion in the crystal, in which the position (called a hole) left by the valence electron moves chaotically in the lattice. In the presence of an external field, the hole also moves in the direction of the field, which corresponds to carrying a positive charge, that is, an electric current. The electrical conductivity of a semiconductor in this form is called the electrical conductivity with holes. The one seen above was called electron conduction, in which free electrons were the cause. It is accepted to call a semiconductor that has only its own atoms in lattice nodes a special conductor; all dimensions related to it are determined by the index I (intrinsic - private, taken from the English word).

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