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Research Article

OPTICAL AND ELECTRICAL PROPERTIES OF SEMICONDUCTOR CRYSTALS

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ABSTRACT

Electronic elements are mainly made on the basis of semiconductor materials. Therefore, knowing the optical and photoelectric properties of electronic elements requires studying the structure of semiconductor materials, their differences from metals and dielectric materials, and the properties that are directly fundamental to semiconductor materials.

KEYWORDS

Semiconductor materials, shell, crystal, positive charges.

INTRODUCTION

We will consider the formation of solids from the point of view of electron theory on the example of semiconductor materials. In the process of formation of a solid body, atoms are brought closer to each other to such a degree that, as a result, the generalization of electrons in the outer shell is formed. Instead of individual orbits of individual electrons in an atom, generalized collective orbits are formed, and the shells in the atom unite into spheres, and they remain belonging to the crystal as a whole. The character of the movement of electrons changes completely, the electrons located in a certain atom and in a certain energy level have the opportunity to move to another neighboring atom in this energy level without changing their energy, and therefore, free movement of electrons is observed in the crystal [1-4].

THE MAIN PART

If the valence region of the substance is not fully occupied, but the energy distance to the conduction region is relatively small (less than 2 eV), such substances are called semiconductors. The properties of semiconductors, especially electrical conductivity, depend on the external environment, especially the properties of semiconductors, especially electrical conductivity, depend on the external environment, especially temperature [10-15]. An increase in temperature (T) leads to an exponential increase of current carriers in the transition of the amount of electrons to the valence and conduction field and the increase in electrical conductivity (σ)

$$\sigma = A\exp\left(-E_g / 2kT\right) \qquad (1)$$

causes it to change according to the equation. Here k is Bolsman's constant, A is an invariant quantity characterizing the substance.

The electrical conductivity of metals is determined by the temperature dependence of the electron mobility due to the fact that the concentration of free electrons does not change, and it gradually decreases with increasing temperature. By the above equation, we get the following expression

$$\ln\sigma = \ln A - E_g / 2kT \qquad (2)$$

This equation can be represented graphically in semi-logarithmic coordinates. The resulting straight line and its tangent φ determine the width of the band gap, which is the main parameter of semiconductor materials $E_g = 2kT\varphi$. It should be noted that the sloping straight line, i.e., the change of electrical conductivity depending on the logarithm, has such an appearance only for materials with specific conductivity, $1/T$ free of clean inputs.

In semiconductors $\ln\sigma$ the connection $1/T$ from to is complicated, it can consist of two oblique straight lines and are connected to each other by a horizontal part. It is possible to determine the state of the energy levels of the entrances located $\ln\sigma = \ln A - E_g / 2kT$ in the forbidden area using the tangent of the inclined straight line obtained from the equation obtained as a result of the measurement in low temperature conditions. In the case of high-temperature conditions, it is possible to determine the size of the forbidden area of semiconductor materials, that is, Eg.

The interaction of light radiation with the semiconductor material, absorption and release of photon energy by electrons in the material are important in the manufacture of electronic elements [14-18].

In quantum mechanics, elementary particles, including electrons, are also considered to have wave properties. That is why, in addition to energy (E) and momentum (R), the reproducibility of their λ wavelengths ν and wave vector (h - Planck's constant) are $K = P / h$ also used in studying the movement of elementary particles. Here $E = h\nu$ and $P = h / \lambda$ are equal to . The zonal structure of the crystal can be illustrated by E – K diagrams. Here, the energy is expressed in electron volts (eV) in parts of the wave vector K - the crystal lattice constant. At the same time, the direction of the crystal lattice is indicated by indicators on the K axis. With the help of the E-K diagram, it is possible to determine the nature of inter-field transitions in a semiconductor material, including whether the transition is "correct" or "incorrect".

The magnitude of Eg, determined from the measurement of optical absorption, often depends on the concentration of free charge carriers in the semiconductor material, the temperature, and the existence of energy levels of the entrances in the forbidden region. If the states at the bottom of the conduction band and above the valence band are filled with charge carriers, then Eg for quasiconductive materials can be greater than the value corresponding to a purely intrinsic material. If the field formed by inputs converges to the nearest permissible field boundary (for example, the observed case when a large number of inputs are introduced), then Eg decreases. Such a decrease in Eg affects the main absorption limit.

Absorption coefficient in a semiconductor material α usually of wave energy $1/\alpha$ is determined by e times decreasing in the distance and

$$N = N_0 \exp(-\alpha\ell)$$

is found from. Here, N is the density of the photon flux entering the depth in the semiconductor material, and N_0 is the density of the photon flux crossing the surface of the material.

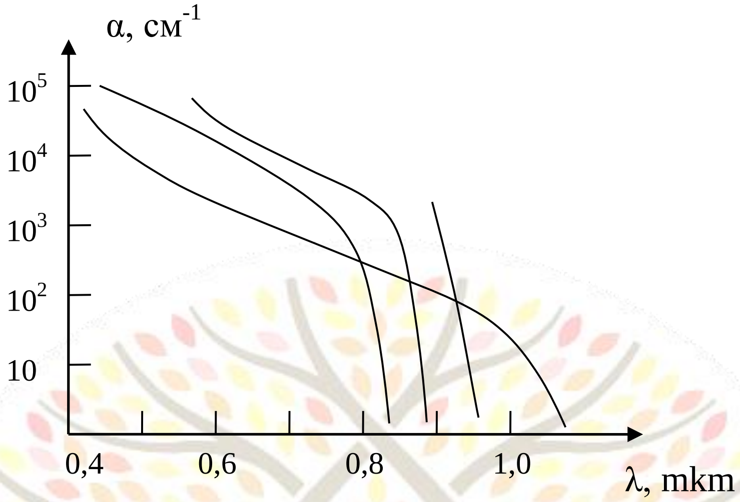

Fig. 1 Energy change of the optical absorption index for some semiconductor materials. 1 – Si, 2 – CdTe, 3 – GaAs, 4 – InP.

The absorption coefficient of the material α is related to the absorption index K. Thus, it is possible to find the values of K and for this $\alpha = 4\pi K / \lambda$ substance by changing the intensity of optical radiation passing through samples of semiconductor material of known and exact thickness.

Figure 1 shows α the variation of energy with respect to some semiconductor materials from which electronic elements are made. It can be seen from the figure that the spectral characteristics of the absorption index differ greatly in the given semiconductor materials, and this difference mainly depends on their field structure and the character of optical transitions.

CdTe, GaAs, and InP materials have direct field-field optical transitions, which quickly rise to the level of photons with energy greater than Eg in the radiation spectrum.

In silicon materials, the absorption process occurs through irregular energy transitions starting from 1.1 eV, and this requires the participation of both light quantum and lattice vibration quantum-photons. Therefore, the absorption rate increases gradually. Only when the photon energy reaches 2.5 eV, the field-field transitions become direct transitions and the absorption increases dramatically.

The spectral characteristic of the absorption coefficient shows that using silicon material, a very large part of the solar spectrum can be converted into electricity. For example, for solar radiation outside the atmosphere (AM 0) it is 74%. However, if GaAs semiconductor is used as a material, only 63% of solar radiation can be converted into electrical energy. However, the thickness of the silicon solar cell should not be less than 250 μm for the absorption of the entire spectrum of the solar spectrum, since the value of is not large at the main absorption limit of "incorrect" optical transitions. However, for the same conditions, the thickness of the GaAs material is sufficient to be 2-5 μm. Therefore, it is necessary to always take into account that these features of the spectral characteristics are of great importance in the development of high-efficiency and thin-film solar cells.

If the energy of the photons falling on the surface of the semiconductor is low, and as a result of absorption, they cannot release electrons from the valence region to the conduction region, then the electron can move to the forbidden regions inside the crystal under the influence of radiation. For such a case, the spectral characteristic of absorption can be felt in the long-wavelength part after the main absorption limit. Such absorption is called absorption of free charge carriers, and this process depends on the concentration of such charge carriers. Since free charge carriers depend on the concentration of readily ionizable inputs, absorption is directly related to it. As a result of studying the characteristics of such long-wave absorption in semiconductor materials, several types of absorption have been identified. Including absorption in spatial lattice vibrations, absorption in entrances, absorption in excitons. An exciton is a bound electron-hole pair that does not change the concentration of charge carriers. Because inside the crystal there are not individual electron or hole movements, but bound state movements.

Absorption spectra provide all-round useful information about the crystal structure, including the level of doping, the activation energy of entrances and their energy levels located in the forbidden zone. For example, it is possible to determine the presence or absence of oxygen in silicon on the basis of absorption spectra (9 μm). The reflection coefficient R in the long-wave range of the spectrum is observed to increase sharply with the increase of such inputs.

CONCLUSION

The technology of mechanical and chemical processing of semiconductor materials used in the field of electronics was realized as follows. Semiconductor materials are mainly grown in wafer form (slitok). The diameter, weight, and length of the YOmbi can be different. Chemical treatment. During this technological process, mainly the surface of semiconductor materials is affected, and among them are chemical and mechanical polishing (polishing), chemical cleaning (cleaning) and chemical etching (travlenie) processes, and these processes are carried out in a special laboratory during the BMI process. increased. Chemical decomposition process. It was used to remove layers with deformation caused by mechanical processing on the surface of semiconductor materials to the limit of pure surface. In some cases, it is also used to reduce the thickness of the NAO.

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