CRYSTALLOGRAPHIC STRUCTURE, TEXTURE AND PREFERENTIAL ORIENTATION IN VEILS

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The crystal structure of AIIBVI films deposited on amorphous substrates usually does not differ from the structure of single crystals and powders. For example, CdS has a hexagonal structure, and CdTe has a cubic structure. If both modifications can exist at room temperature, the problem becomes more complicated. ZnS films taken on a substrate heated to 2000C by one-step sputtering method have mostly cubic (low temperature) modification. Gasochemical ZnS films are usually hexagonal, even though they are grown at temperatures below the lattice transition temperature (10200C) from cubic to hexagonal.

In the literature on films grown on amorphous substrates, some preferential crystal orientations are soon reported. This conclusion also applies to curtains AIIBVI. Usually, in the growth of these curtains, densely packed crystallographic planes are parallel to the substrate. In general, the orientation of these curtains is not important from the point of view of optical, fluorescent and photoconductive properties, the large surface area of the curtains is important for effective use of these properties. The curtains, which are put on glass substrates by the gasochemical method, have a very high orientation of the crystals in the direction perpendicular to the substrate. At the same time, the orientation in the plane parallel to the base is completely random. This situation applies to curtains with a thickness of several microns to tens of microns. Preliminary investigations were carried out on fluorescent ZnS curtains. The axes of almost all crystallites of veils lie within a cone of 5-100 with an axis normal to the surface of the substrate.

This conclusion is made from the strong X-ray reflection [0001]. A typical reflectance curve for a well-oriented curtain is shown in Figure 2.4. The half width of the misorientation angle is about 4^0.

X-ray diffraction results investigated on CdS screens show that the samples taken on glass substrates can be divided into four classes:

1) amorphous layers;
2) irregularly oriented layers;
3) layers oriented along the [1011] axis;
4) Layers oriented along the [0001] s-axis.

The last, perpendicular orientation to the surface of the substrate is most often observed. Orientation in the direction parallel to the substrate is not observed at all.

These data refer to layers obtained by the gas-chemical method. In the vacuum condenser obtained by the one-stage dusting method, a perpendicular orientation to the base corresponding to the fourth class is observed. The average diameter of crystallites can reach 100 μm at the base temperature of 150-2200C. The orientations observed in the growth of ZnS and CdS films are also suitable for CdTe films. Photovoltaic effects in cadmium telluride When excited with light corresponding to specific or intrinsic absorption, all AIIBVI compounds exhibit a photovoltaic effect to one degree or another. We are not interested here in the effects of perturbation with quanta with energies higher than the energy band gap, as the aim of the work is to investigate the prospects of using CdTe layers in solar cells. Unlike many other effects, photovoltaic effects are determined by non-essential charge carriers. Photovoltaic effects are based on the separation of photon-generated electron-hole pairs near potential barriers. Potential barriers are formed at the electrode-semiconductor boundary, at various r-n transitions. In other cases, potential barriers may be associated with internal boundaries of crystallites.

We are interested in the effects conditioned by the potential barriers, rather than considering bulk photovoltaic effects. More attention will be paid to CdTe and CdS barriers, where the main considerations will be focused on single barrier phenomena and the data will be presented in terms of solar energy conversion problems. Synthesis of n- and r-type CdTe single crystal is not a big problem today. p-n homojunctions can be obtained in CdTe and Cd-enriched (Zn, Cd)Te crystallites. In transitions with a depth of 10-30 μm, it is possible to generate a simple driving voltage on the order of the width of the forbidden zone, but at the same time, it is observed that the photovoltaic currents have very small values. This is due to the very small lifetime of non-major charge carriers. According to calculations, these times are 10-11s smaller. Therefore, light cannot be effectively changed in such transitions due to the provisions of Chapter I. Examination of In2O3 – CdTe p-n heterojunctions obtained on the basis of moderately or strongly doped r-type CdTe even showed that the residence time of non-main charge carriers in r-type CdTe single crystals is lower than 10-11 s. But even if charge carriers have a long lifetime in r-type weakly doped CdTe, it cannot be used for solar energy conversion due to its high resistance. Therefore, although CdTe has the optimal width of the forbidden zone for photovoltaic conversion of solar energy and is the only AIIBIV material on the basis of which it is possible to create low-mass n- and p-type crystals, monocrystalline homotransparencies formed from CdTe have no prospects for solar energy. In other words, the r-field in such converters plays only the role of a filter of incident radiation.

Investigation of the internal photovoltaic effect in Cu2-xTe-CdTe heterojunctions based on both gas chemical barriers and single crystals was carried out in order to obtain efficient solar cells. Effective photovoltaic conversion was observed in the heterojunction between r-type Cu2-xTe and n-type CdTe. Figure 2.4 shows the schematic construction of the elements obtained in n-type gas-chemical layers. Metal or glass was used as the base material; they are coated with a conductive CdS:Ga,I layer. The Cu2-xTe layer is formed by treating the surface of n-type CdTe with a heated water solution containing copper ions.

In this case, a 10nm r-type twisted layer is formed. The index (2-x) means that less copper enters the layer compared to the stoichiometric composition of Cu2Te. The resistance is about 100 Ohm/cm2. In the near-infrared and visible regions, the layer will not have strong absorption. Photovoltaic spectral sensitivity is similar to that of CdTe because electron-hole pairs are mainly generated near the $Cu_{2-x}Te$–CdTe boundary of CdTe.

In terms of their photovoltaic characteristics, elements made on the basis of poly and monocrystalline curtains hardly differ. The f.i.c. of the initially obtained batteries 6-7.5% (per 1cm2 surface of the element). The accumulated f.i.c. under short-circuit conditions (the ratio of the number of electron-hole pairs to the quantum energy close to Eg) is much higher and can reach 90%, taking into account the light reflection from the surface. The main difference between layered and monocrystalline cells is the higher shear stress in monocrystalline cells. Under solar illumination (~100 mW/cm^2), the voltage at room temperature can reach 1/3 to ½ of the band gap, and at 100K is about half of the band gap.

In the $Cu_{2-x}Te$-CdTe elements, it is revealed that in n-type CdTe, with a high concentration of charge carriers ($n \approx 2\cdot 10^{17} cm^{-3}$), the residence time of minor carriers can be $\tau \sim 5\cdot 10^{-10}s$. Monochromatic sensitivity decreases with increasing wavelength. This can be explained by the fact that not all non-major carriers diffuse into the transition and accumulate there. This can be explained by the fact that not all non-major carriers diffuse into the transition and accumulate there. According to the picture, it is possible to obtain the optimal total F.I.K in the CdTe-based elements with an electron concentration of $2\cdot 10^{15} cm^{-3}$. Hence, the efficiency of CdTe-based solar cells depends on the concentration of the underlying current carriers. The field generated at the transition either increases the diffusion residence time of non-main carriers - holes, or allows them to drift. The transition area in such a material is so wide (about 0.75 μm), electron-hole pairs of specific conductivity are generated directly inside it and are able to drift under the influence of the field.

Among heterojunctions consisting of $A^{II}B^{VI}$ thin films for solar cells, initially, the best results were shown by heterojunctions based on copper sulfide $Cu_{2-x}S$ and cadmium sulfide CdS. There are two types of such photocells: back barrier and front barrier. In the frontal barrier structure, CdS is sprayed on a heated molybdenum or copper substrate in a quasi-closed volume (in some cases, a zinc coated polyimide tape is also used) by vacuum sputtering. Different contacts are formed on the surface of the layer to efficiently collect the output power.

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