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TO STUDY THE ELECTROPHYSICAL PROPERTIES OF CdTe LAYER ON SILICON BASE AND THE EFFECT OF CREATED HETEROSTRUCTURE ON MOISTURE

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Annotation

In this article, we are talking about semiconductor materials science, creating heterostructures based on cadmium telluride films obtained on a Si substrate and obtaining contacts on the created system. The morphology of the obtained films, the number of elements in the films, their distribution, and the size of polycrystalline particles were studied using modern instruments. The change in the volt-ampere characteristics of the obtained heterostructures depending on the humidity has been studied.

Keywords: materials science, semiconductor, fundamental, metals, silicon, mechanical engineering, cadmium tellurium, solid solution, technology, vacuum electronics, moisture, sensor, epitaxial layer, diffusion

Introduction

At present, in the field of semiconductor devices, there are mainly basic materials such as Silicon (Si), Germany (Ge), and semiconductor compounds A^3B^5 and A^2B^6, for example arsenid galliy (GaAs), phosphid galliy (GaP), antimonid indium (InSb), cadmium telluride (CdTe), cadmium sulphide (CdS) and a number of other compounds and their solid solutions are being used. In some cases, it is possible to replace them with one – with the other, but in a number of cases there is no possibility to replace them with another.

At this time, while the study of the possibilities and properties of some solid solutions is in its initial state, theoretically, some classes of semiconductor solid solutions, which are said to be practically (by experience), were not taken at all. From this it follows that until now, in order to perfect certain semiconductor solid solutions, their method of cultivation and facilitate the management of their physical properties - simplification, as well as to clarify new areas of application, solid solutions with semiconductor properties izlash are considered an incredibly relevant direction.

It is also worth noting that the compounds A^3B^5 and A^2B^6, as well as the solid solutions obtained on their basis, are considered relatively expensive materials.

Proceeding from the above, the interest of the researchers at the next moment is focused on the study of volumetric and pleural heterostructures, consisting of various semiconductors.

Basically, this interest will undoubtedly be of great importance if these heterostructures are based on Silicon (Si), On which the technology of obtaining and electrophysical and photoelectric properties have been sufficiently studied. The field of application of plyoncal and volumetric semiconductor heterostructures is the creation of a variety of sensors [1-4] for example, there may be moisture sensors that monitor the environment or agricultural products in the process of cultivation or storage, respectively.

Relevance of The Topic

One of the future bright – looking materials in creating semiconductor devices (nuclear radiation detectors, photoconductors and generally different sensors) within A^2B^6 compounds is cadmium telluride and cadmium sulphide. From the point of view of the physics of the semiconductor solar elements, Si-CdTe, Si-CdS systems – pleural heterostructures – are of particular importance as a new object of study. It is worth noting that silicon is the most common element in the Earth's crust.

Currently, the technology of obtaining and cleaning silicon is well developed, so silicon is the main material for the microelectronics and electronics industry. Combining the advantages of the semiconductor properties of cadmium telluride and cadmium sulphide with silicon is an urgent task, in particular, the creation of heterostructures with an ideal Diapason diagram between cadmium telluride, cadmium sulphide and Silicon opens up new opportunities in semiconductor instrumentation.

The Experimental Part

Obtaining a wide class of compounds and solid solutions of silicon-based semiconductor materials undoubtedly plays an important role in semiconductor physics and semiconductor instrumentation.

Therefore, in this study, it is aimed at obtaining a layer of Telluride cadmium film at a pressure of ~ 10^{-4} Torr using the method of throwing in a vacuum into a poly - and mono crystal silicon base of different types and creating a heterostructure on its basis. The thickness of the base is 350 – 400 microns [5-6].

In Silica analysis of the CdTe layer was carried out and electrophysical and photoelectric properties, moisture sensitivity studies were conducted and results were analyzed.

Technological conditions for the cultivation of the Telluride cadmium layer in a vacuum to the silicon base (the temperature of the source to which the base and the throwing is required, the temperature interval, the intermediate distance between the base and the source, the ratio of the source and the legalizing primes material and other parameters) were determined by the experimental method. Prior to the cultivation process, Poly - and Silicon diapers were subjected to appropriate mechanical and chemical treatment. So, as a base, both n-type and p-type silicon soles were used.

For this situation, the semiconductor serves as a component of Silicon diapers (poly - or mono - silicon), heterostructures and semiconductor devices based on them.

For this reason, the inter-phase silicon base and the A^2B^6 joint layer formed in the process of growth will be particularly important in relation to the section boundary (transition area), the silicon base and the growing layers, that is, it will determine the subsequent characteristics of the extracted layers.

From a practical point of view, the use of Si-CdTe - heterostructure is considered to be a promising system in the creation of various semiconductor devices and devices, including moisture sensors, in a broad sense, according to our assumption.

The structural distribution of chemical elements on the surface of the resulting layer surface was investigated. The analysis was carried out using EDS LINK ISIS (energy – Dispersion spectrumometri) at microanalyticeksieksi Jeol – JXA – 8900, measuring error ±2%. S'yamga condition V=20gv, I=10nA. Etalons net Hale Si, Te and Cd. The results of the measurements and the microfotographs are presented in picture 1.

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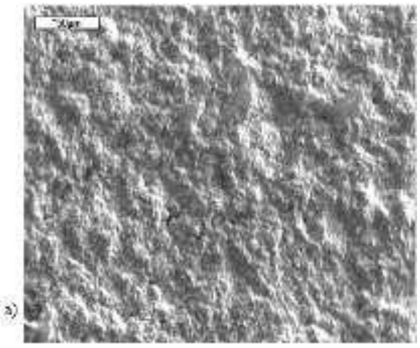
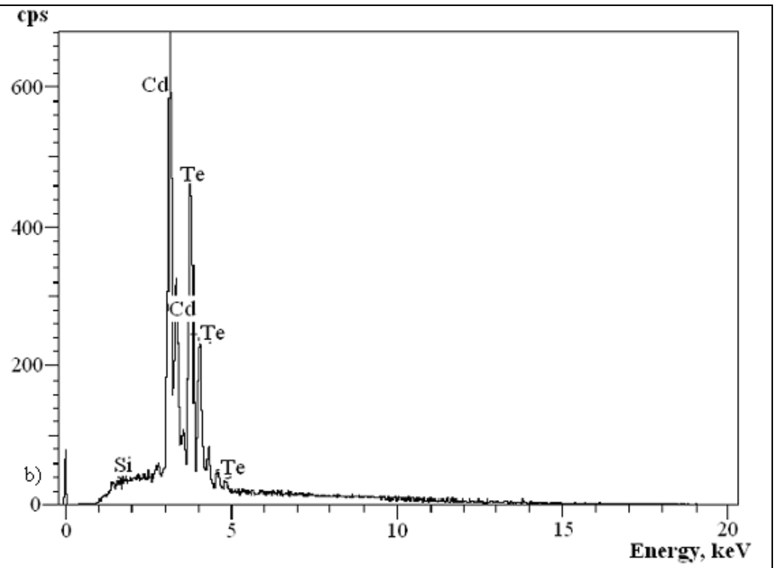
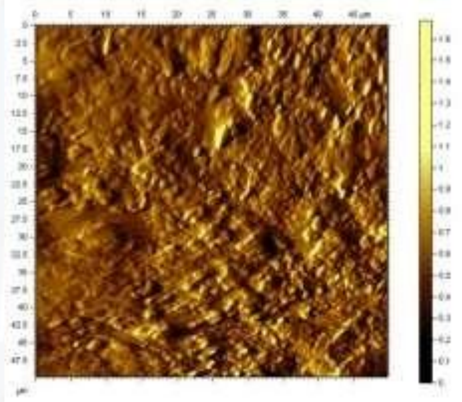
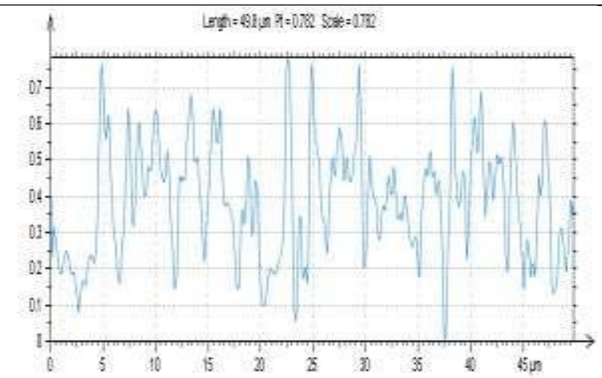
	
1a-picture. Microfotography of the layer surface	1b-picture. Distribution spectrum of layer elements by surface obtained from measurements

For the purpose of a clear understanding of the obtained layers, "Agilent Technologies 5500 AFM – Mode III – komplekt BA210" atomic power microscope shows the surface of the layer, the relief appearance obtained by the side of the layer, 3D photography and the dimensions of the polycystallic particles in the layer and the results of their distribution studies (picture 2).

	
2a-picture. Topography of polycrystalline film grown on Si-base (view from above)	2b-picture. Relief view of polycrystalline film on the side, which is grown on the Si-base

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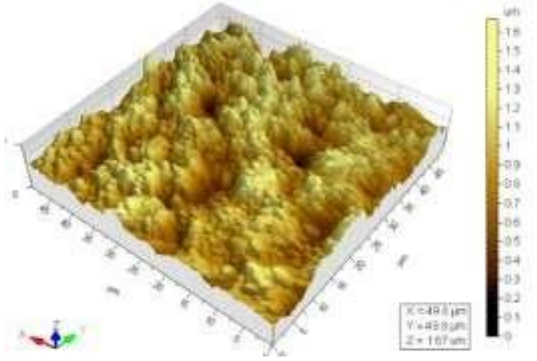
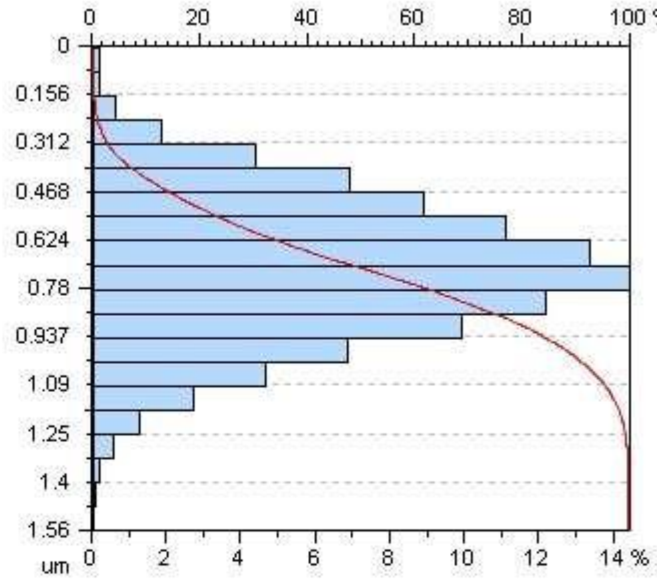


2d-picture. 3D view of polycrystalline sheet grown on Si-base



2E-picture. Distribution of the size of grown polycrystalline grains (the largest size is 780 nm)

Measurements were made on several points. From the measurements conducted on the dependence of chemical elements on the thickness of the layer, one can see that the conducted in all directions, the results from the measurements are almost the same, the average deviation is not more than 5%.

The results of the tests carried out show that in the transition layer a solid solution of Silicon – Telluride cadmium is formed in an area of thickness equal to 3 – 4 microns. In the process of layer growth, tellurium is diffused into the ~1,0-1,5 µm surface layer of the silicon base. In turn, the epithelial layer with a thickness of ~ 1 – 1.5 µm thick is also diffused. This phenomenon is due to the fact that in this case, the silicon base and the crystal lattice of the growing layer and other physico – chemical parameters are mutually coordinated, which subsequently leads to the growth of the CdTe - layer into the Si - base.

The obtained heterostructure was measured in volts – Ampere characteristic and sensitivity to moisture. to the p-Si-pCdTe - heterostruktura, a Shotki barrier (Barer Shottki) was created on account of the launch of indium in a vacuum (Figure 3). Strong legirled 500Å layer, CdTe-layer was taken over. In this case, the Si-CdTe temperature was kept in the range of 90-120°C.

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Water, which surrounds us, is one of the components of the atmosphere around us: it is one of the most necessary components of all living beings: for the world of humans, animals and plants.

Water, which is extremely necessary for life – it is desirable if moisture is maintained in a certain amount. Simply put, the process of storing agricultural products grown in ombor or winter crops grown in ombor requires a certain optimum humidity, depending on the different vegetation period. From this comes such a conclusion that it is required to constantly measure the humidity.

To measure the humidity, the performance is based on various physical laws, and the use of receiving and transmitting devices (sensors), which are made on different technologies.

It is possible to distinguish mainly the following types of sensors:

• capacitive: extremely durable and reliable; cheap; wide range of performance;

• resistive: the cheapest at the moment, the size is miniature.

The performance of capacitive humidity sensors is based on the dependence of the sensing element electric capacitance on the humidity of the environment and substance.

The principle of operation of resistive moisture sensors is based on the dependence of the electrical resistance of the sensing element on the humidity of the environment and the substance.

Our research is carried out mainly on moisture resistance sensors.

MOISTURE RESISTANCE SENSORS

The resistance of many nonmetallic conductors will depend on the amount of water contained in them. On the basis of this principle, moisture resistance sensors are created.

The raised solid causes the absorption of the water molecule, the resistance between the electrodes (contacts), this process is recorded using an electronic scheme. The first moisture sensor of this type was created by F.E.Danmor in 1935 year, its water - absorbing (moisture-absorbing) layer consisted of a solution of LiCl (2-5)% in water. In this case, the water absorption property of the layer is used. The hygroscopic LiCl layer absorbs water molecules and holds itself like an electrolyte with the ability to conduct a current.

Placed in the sensor, the hygroscopic layer of the LiCl absorbs water vapor from the atmosphere and creates conductivity between the electrodes, as a result of which an electric current is formed between the electrodes. The change in the relative humidity of the sensor resistance created on the basis of the semiconductor layer system under the glass [7] was considered in the study. In this study, measurements of the thickness of the semiconductor layer was 330 nm and were conducted at different frequencies (120 Gts and 1 kGts). When measuring jumps at 120 Gts and 1 kg, with an increase in humidity, the sensor resistance decreased from 50 to 95%, that is, respectively, 450 and 550 times. When the layer thickness is 400 nm, the above conditions have not changed, it is said that when measurements are made, respectively, the resistance of the sensor is reduced to 60 and 140 times. According to the authors, when the thickness of the semiconductor layer is small, the higher the sensitivity of the sensor is explained by the higher the concentration of moisture in the thin layer samples.

At present, with the increase in the frequency of the resistance of the sensor there or decreased by 1,2 times. When exposed in combination with moisture, there was an average decrease in resistance in 500 times. Proceeding from this, we can conclude that a decrease in the resistance of the sensor or an increase in the electrical conductivity of the semiconductor layer is due to an increase in the concentration of charge carriers.

The effective concentration of charge carriers can increase on account of the following factors:

• the ingress of water molecules into the semiconductor layer, as well as into the alloying element, changes the properties of the layer;;

• the occurrence of Komplex between the semiconductor and water molecules in the heterostructure due to the migration of charge;

• the presence of polar-bound water molecules in this process is due to the presence of water molecules in the process of charge transport, since the measurements were carried out on a variable current, which leads to the formation of a silicate current in solid bodies [8].

Research work was carried out in order to investigate the sensitivity of the In-contact system to moisture, which is self-conducting electrical current, which has a heterostructural and high

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conductivity, based on the Si - CdTe-system, obtained by the method of blowing in a vacuum on the basis of a solid or semi-conductor, silicon base. Between the resulting layer and the silicon base, in our opinion, the okcid layers are formed as follows: SiO, SiO_2 or CdO. It will be possible to control the size of the grown layer, its thickness and the size of the particles of the polycrystalline layer and the density of their placement on the surface of the base, that is, the size of the pores between the polycrystalline particles, the temperature of the base and the source being blown, the time of the Flying of the For example, as a result of increasing the temperature of the base, it is possible to reduce the size of the polycrystalline particles grown and increase the density of their placement on the surface of the base.

The average value of the cross-section of the porosity contained in the polycrystalline layer is the indicator that the dimensions should be sufficient for the passage of water molecules. If we take the water molecule in the form of a balloon, its size is equal to $\approx 2{,}7 \cdot 10^{-10}$ m.

The CdO-molecule is soluble in water. The data were obtained using electrodes that compress the contacts obtained from the in-hand side of the sheet and silicon base.

Polycristall CdTe layer pores and CdO oxide layer absorb water molecules contained in the air. According to the above data, the amount of water molecules ingested by the layer is directly proportional to the partial pressure of water vapor and inverse to the absolute temperature.

The resulting layer is comparable resistance $(10^6\text{-}10^8\ )Om \cdot sm$ as a result of, as well as the formation of a large comparative resistance CdO, we can see the system as a dielectric material. The dielectric absorption and comparative resistance of the layer will depend on the amount of water swallowed. For this reason, it will also be possible to use the new semiconductor heterostructure as a sensitive element of moisture sensors [Y]. The resistance range of the resistive element of this type of sensors lies in the range from $1\,KOm$ to 100 MOm.[9].

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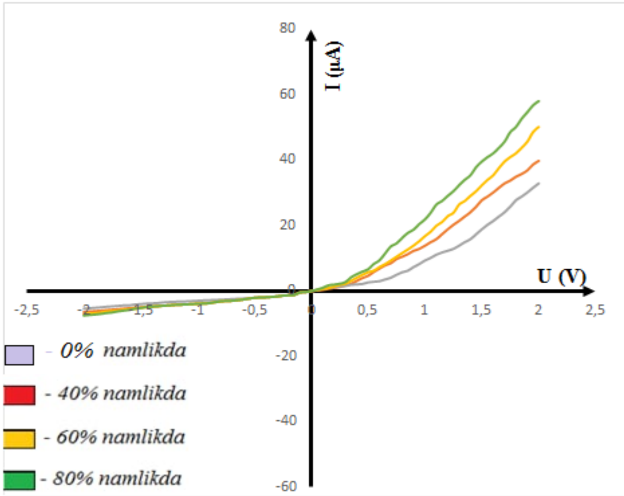
We had to determine the reaction of the heterostructure obtained during our studies to moisture. The obtained and conducted experiments are still considered primary studies.

To do this, primary verification of the dependence of the value of the Vine on the percentage of moisture was carried out. Work was carried out to measure the Vax s of the created heterostructure. To do this, during the baking process, a special device was created to keep the amount of moisture unchanged and measured.

According to the results of Oingan, the VAX of heterostructure on different humidity was drawn (pichture-5).

From the link it can be seen that with an increase in the amount of moisture in the chamber, an increase in the value of the current can be seen.



5-picture. VAX measured in different humidity

The disadvantage of the resistive sensors is that if the water uses an eriydigan coating, its values in the process of condensation are prone to silencing, and if it works in an environment of high changing temperatures, it has a sufficiently large dependence on temperature.

The main advantages of resistive damp sensors are: low cost of the tank, long-term stability due to the small size, simplicity of the method of obtaining. The service life of these sensors can be up to 5 years and even higher.

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CONCLUSION

From the data of the results of the experimental obtained and conducted with the help of microanalizers, as well as the measurement of electrophysical properties conducted in a special chamber, one can see that in fact a layer of cadmium telluride was obtained on the silicon base. Between the base and the layer formed a solid solution of these pairs, the thickness of which is 3 – 4 microns.

It is possible to observe the sensitivity of the structure to moisture from the data obtained from the measurements of the VAX conducted in heterostructures created on the basis of a pair of Si and CdTe. If by the end of this research, it will be possible to perfect the creation of moisture sensors that are widely used in various sectors of the public economy, including the agricultural sector.

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