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Research Article

STRUCTURAL STUDIES OF FILMS CADMIUM TELLURIDE GROWN ON SILICON SUBSTRATES

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ABSTRACT

Cadmium telluride films are grown on single-crystal silicon substrates by vacuum deposition in a quasi-closed volume. CdTe films were studied by atomic force and scanning electron microscopy.

KEYWORDS

Cadmium tellurium, silicon, films, composition, structure, temperature.

INTRODUCTION

Synthesis of polycrystalline films based on CdTe with the possibility of controlling, activating or inhibiting electronic processes at the crystallite boundary by technological methods and studying their structure and electro-optical properties are important and relevant not only in scientific but also in practical terms. In addition, in this regard, polycrystalline structures grown on single-crystal silicon substrates are of great interest recently.

The determining factor affecting the structure and perfection in the process of growth of a CdTe binary compound with given electrophysical and photoelectric parameters is the pressure of Cd and Te vapors, respectively, the source temperature, the substrate temperature, and the cooling temperature. The advantages of this method are the purity of the deposited material under high vacuum, the uniformity of the synthesized film; versatility. Films are deposited on metals, alloys, semiconductors, and dielectrics with the possibility of using masks to fabricate layers with a given configuration.

Experiment

Polycrystalline films of cadmium telluride were obtained on single-crystal silicon substrates by vacuum deposition in a quasi-closed volume [1]. In many cases, a CdTe film on Si grows polycrystalline [2–5]; in addition, during the chemical deposition of CdTe, some components react with the silicon substrate to form the Si_2Te_3 silicon sesquitelluride phase [6].

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Cadmium telluride (CdTe) is a direct-gap semiconductor of the A2B6 group with a band gap of 1.49 eV [7]. In recent years, interest in CdTe has noticeably increased due to its widespread use in the creation of solar batteries, ionizing radiation detectors, and photodetectors [7,8]. Due to the optimal scattering, electrical and optical characteristics, cadmium telluride is effective for the manufacture of photoresistors, solar cells, schematic analysis of radioactivity, elemental infrared optics, etc. It is widely used in optical and electronic technology. Silicon (Si) is often used as a substrate.

In the process of optimizing the growth of CdTe films, single-crystal silicon substrates underwent standard chemical treatment to remove the oxide layer and passivate the surface. The initial thick oxide was removed from the substrate surface in concentrated hydrofluoric acid HF. Then the substrate was placed in a hot solution of $NH_4OH:H_2O_2:H_2O$ in a ratio of 1:4:20. In this case, a thin oxide layer was formed, which was then removed in a 0.5% aqueous solution of HF. After each operation, rinsing in deionized water was carried out. As a result of such treatment, the surface became passivated (hydrogenated) [4]. The samples were attached to the carrier with presser feet in a laboratory fume hood. Exposure to air did not exceed 10-15 minutes.

After preliminary heating for 4 hours at a temperature of 160°C, the samples were annealed at T=550°C for 15 min to remove the passivating layer. The Si-CdTe heterosystem is highly mismatched both in terms of the crystal lattice parameters of the substrate and film (at room temperature; a& = 0.5431 nm, ds<Ps = 0.6477 nm) and in polarity and valence of the film and substrate materials. Therefore, the main part of the

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defects in the creation of the Si - CdTe structure is laid at the heterointerface. At present, the main methods for reducing the density of defects at the Si±CdTe heterointerface are pre-epitaxial modification of the surface structure of the Si substrate with elements of groups V and VI. For example, the authors of [1] showed that pretreatment of the silicon surface with arsenic and the use of algo-layer epitaxy at the initial stages of buffer layer growth can significantly improve the structural perfection of the CdTe layer.

It was found that the process of tellurium adsorption on the silicon surface can be divided into stages: at sample temperatures below 170 °C, a polycrystalline CdTe film grows, this process is not limited in any way, and a polycrystalline CdTe film of any thickness can be grown. In the sample temperature range above 170–350°C, regardless of the flux density and exposure time, the number of tellurium atoms from CdTe on the silicon surface does not exceed 20% of the number of atoms in the volume under study. If the sample has a temperature of more than 350°C, tellurium is not detected on the surface and no superstructural rearrangements are observed.

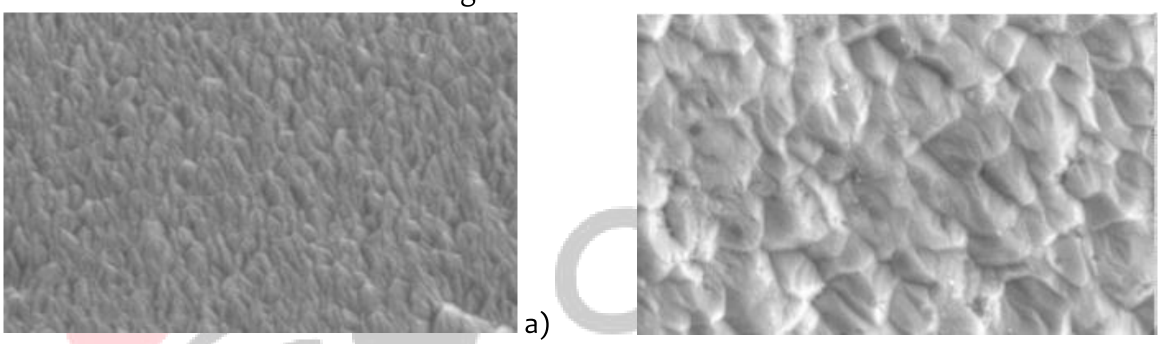

Fig. 1. SEM image of the surface of a CdTe film on a ground (a) and polished (b) Si substrate.

The resulting Si - CdTe heterostructures, where CdTe films grown by sputtering in a quasi-closed volume on single-crystal silicon substrates, were studied by atomic force and scanning electron microscopy (Fig. 1). The roughness of Si films varies in the range of 34–87 nm with an average grain size in the range of 2.5–5 µm. The film grown on it has a large crystallinity, pure, the size of which varies from 3.5 to 4 microns. In contrast to the film on a polished surface, the roughness of silicon increased on a polished surface has increased significantly and is 87.5 nm. X-ray diffraction analysis showed that the polycrystalline structure of a semi-thin CdTe film thickness varies within 150–200 µm.

The preparation of films with different morphological surfaces and the possibility of growing crystalline films with a grain size of 2.5 to 5 µm and a thickness of 34.07 to 87.49 nm on a silicon substrate are shown. The composition of the film grown on the Si substrate includes: Cd - 50.44 % atoms, Te - 48.75 % atoms and they contain up to 0.82 % aluminium.

CONCLUSION

In the future, the study of the properties of Si-CdTe heterostructures and its Si2Te3 transition layer, the effect on the electrical and optical properties of the Si-CdTe heterosystem and other photosensitive devices based on them for a wide range of applications, creates great scientific and practical interest.

REFERENCES

1. Million A., Dhar N.K., Dinan J.N. Heteroepitaxy of CdTe on {21l} Si substrates by Molecular beamepitaxy // J. Crystal. Growth. -1996.159.- pp.76.
2. Feng K. A., Hu X.M., Lin Z., Xing Y.R. The structures and transformations on Si(113) surface//Appl.Surf.Sci.1997.120.P.94.
3. Muzafarova S.A. Study of photosensitive SDS structures based on cadmium telluride. // PhD thesis. - 1983. - Tashkent.
4. Abdulin V.V. Structure and properties of CdTe films obtained by synthesis from organometallic compounds on GaAs / V.V. Abdulin, Yu.V. Arafenin, A.N. Pugachevsky, I.V. Sobinin. Journal of technical physics, - 1988. 58. - pp.1991.
5. Belyaev A.P., Rubets V.P., Nuzhdin M.Yu. Electrical properties of cadmium telluride films synthesized in a thermal field of a temperature gradient / A.P. Belyaev, V.P. Rubets, M.Yu. Nuzhdin. Semiconductors, -2003. T. 37. No. 6. - pp. 671-673.
6. Bletskan D.I., Kabatsii V.N., Sakal T.A. Obtaining and structure of layered crystals Si2Te3// Surface investment X-ray Synchrotron and Neutron Techniques.Reads.54.–2006.
7. Polycrystalline Semiconductors, Physical Properties and Applications, Ed. G. Harbeke- M.: Mir. -1989. – pp. 344.
8. Sultonov N.S. Study of the structure of cadmium telluride films obtained on single-crystal substrates / Bulletin of the National University. - 2006, No. 5. - pp. 96-102.