STUDY OF THE EFFECT OF POTENTIAL DIFFERENCE ON THE PHASE COMPOSITION OF NANOSTRUCTURED FILMS BASED ON CdSe

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The paper presents the results of a study of the effect of the difference in the applied potentials on the structural properties and phase composition of thin CdSe films obtained by the method of electrochemical synthesis. It has been established that a change in the difference of the applied potentials leads to a change in the morphology of the thin films obtained, as well as a reorganization of the phase composition, which can later be used in the practical application of these films.

Keywords: nanostructures; thin films; semiconductors; nanomaterials.

Introduction

One of the most rapidly developing areas of research today is the area of research of nanostructured films and devices based on them, since superfine dispersed structures cause a significant improvement, and in some cases, a fundamental change in the properties of materials [1]. Recently, a significant interest in the production of thin CdSe films by an electrochemical method has increased again [2, 3]. This is explained by the fact that the electrochemical method has a significant advantage over other methods. Differing in technological simplicity, it allows changing the electrolysis mode and electrolyte composition to change the composition, quality and properties of the films obtained. In addition, interest in CdSe is due to the great prospects for the use of such films in various areas of the semiconductor industry, primarily in the manufacture of solid-state solar cells, as well as photovoltaic and photoelectrochemical cells [4]. In most cases, the deposition is carried out on thin dielectric or metal substrates [5–8], since they are widely used in engineering, in particular, in the conversion of solar energy into electrical energy. The main attention is paid to the study of morphology and crystal structure, growth rate and photovoltaic characteristics of the films obtained.

Experimental part

Polyethylene terephthalate-based dielectric templates that have a high chemical and thermal resistance to various factors were used as substrates. To increase adhesion during synthesis, polymer templates were preliminarily subjected to chemical etching in a solution of sodium hydroxide (2.2 M) at a temperature of 85 ± 2 ° C for 180 sec. As a result of etching, the roughness degree increases from 1.2 nm to 5-10 nm, which further serves as activation centers for the growth of nanostructured films. Electrolyte composition for synthesis: 0.5 M $CdSO_4$, 5mM SeO_2. The range of applied potentials ranged from 1.0 to 2.0 V, with a step of 0.25 V.

Results and discussion

Figure 1 shows the SEM images of the films obtained.

As can be seen from the presented SEM images with a potential difference of 1.0 V, the structure of the synthesized films consists of sphere-like particles whose average size is 50-100 nm. An increase in the potential difference to 1.25 V leads to the formation of

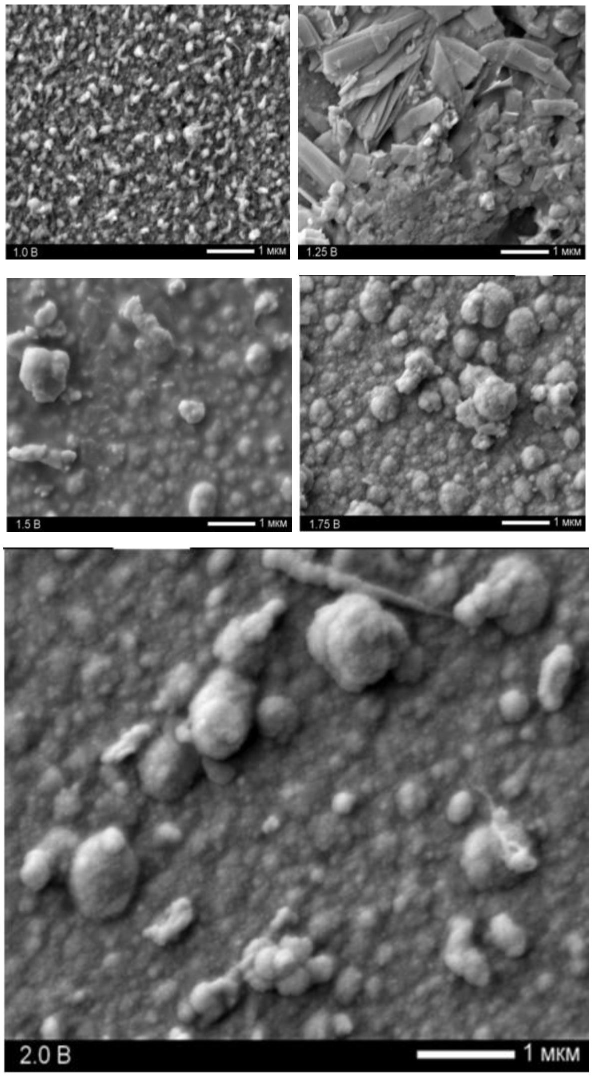

Fig. 1. SEM - images of synthesized films

diamond-shaped and dendriform-like structures on the surface of the films, the presence of which is due to the occurrence of overvoltages during the synthesis process. An increase in the potential difference of 1.5 V and above leads to the formation of spherical particles in the film structure whose average size varies from 500 to 700 nm.

To determine the effect of the difference of the applied potentials on the elemental composition of the synthesized films, the method of energy dispersive analysis was applied. Table 1 presents data on changes in the concentration of cadmium and selenium in the structure of thin films.

Table 1. Data of elemental composition

The difference of the applied potentials, V	The concentration of cadmium, %	The concentration of selenium, %
1.0	43.1±1.7	56.9±2.3
1.25	50.2±2.1	49.8±2.5
1.5	51.4±2.6	48.6±2.4
1.75	57.6±3.1	42.3±2.6
2.0	60.2±3.2	39.8±2.1

As can be seen from the presented data, an increase in the difference in the applied potentials leads to an increase in the concentration of cadmium in the structure of the films.

To determine the effect of the difference of the applied potentials on the structural characteristics of the films under study, the method of retinal-structural analysis was applied. Figure 2 shows the X-ray diffraction patterns of the studied samples.

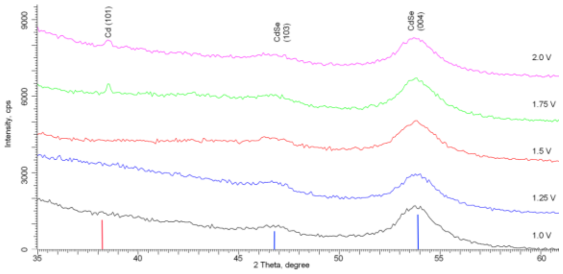

Fig. 2. X-ray diffraction patterns of thin CdSe films

As can be seen from the presented data, the form of diffraction patterns indicates X-ray diffraction on polycrystalline nanoscale structures (low intensity and wide diffraction lines). With a potential difference of 1.0–1.5 V, the structure of the films obtained is a single-phase CdSe structure with a hexagonal type crystal lattice with a selected textural direction (004). An increase in the potential difference above 1.5 V leads to the formation of new diffraction maxima in the structure characteristic of the Cd phase with a hexagonal type crystal lattice. In this case, the appearance of a second phase in the structure leads to an increase in the degree of crystallinity and a decrease in the concentration of dislocation defects that occur in the structure during the synthesis process.

Conclusions

Thus, by changing the difference of the applied potentials, it is possible to change both the morphology of the obtained thin films, and the crystal structure and phase composition, which can later be used in practical application of these films.

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