The morphology investigation of the cadmium sulphide thin films for solar cell applications

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Introduction

The solar cells on the basis of cadmium telluride (CdTe) have recommended themselves as a perspective thin film technology of the future market of renewable energy. In spite of that the Silica solar cells are still dominant, CdTe occupies about 7% of the this market and is the first of technologies of the second generation which has effectively carried out a jump to the mass introduction.

In the solar cells based on cadmium telluride the n-type of conductivity CdS layer (2.4 eV bandgap) directly contacts with p-CdTe and form p-n heterojunction. The CdS layer is not a photoelectricity active layer but has a «window» function. The solar irradiation penetrates under CdS into the photoelecticly active CdTe layer (absorber). As a rule, the CdS layer must be as thin as possible in order to permit to the best part of photons with energy, higher than its bandgap, to reach the CdTe and, therefore, to provide the higher values of photoelectric current. But too thin CdS layer increases the possibility of a local by-passing.

Methods

The CdS thin films were deposited onto glass substrates by the method of the open evaporation in vacuum. The investigated thin films were obtained with different thicknesses (determined by different deposition time τ) at the same T_S and T_E. The substrate temperature T_S was 470 K, the evaporation temperature was $T_E = 880$ K. The thicknesses of thin films were set by deposition time $\tau = (60 - 150)$ sec. The SEM analysis used for morphology investigation of the obtained polycrystal CdS thin films.

Results

a) b)

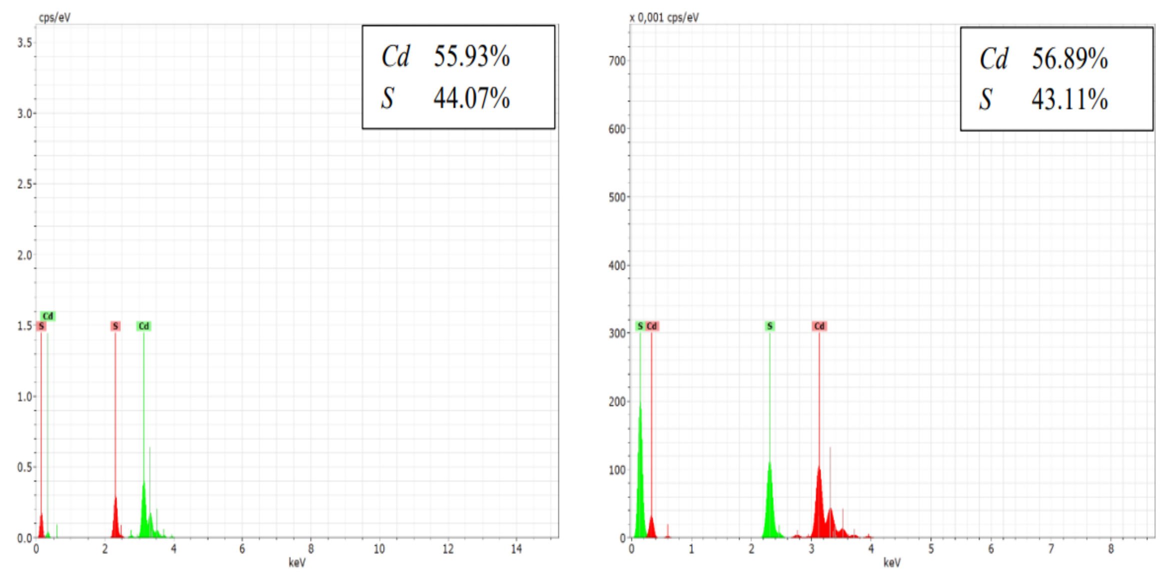
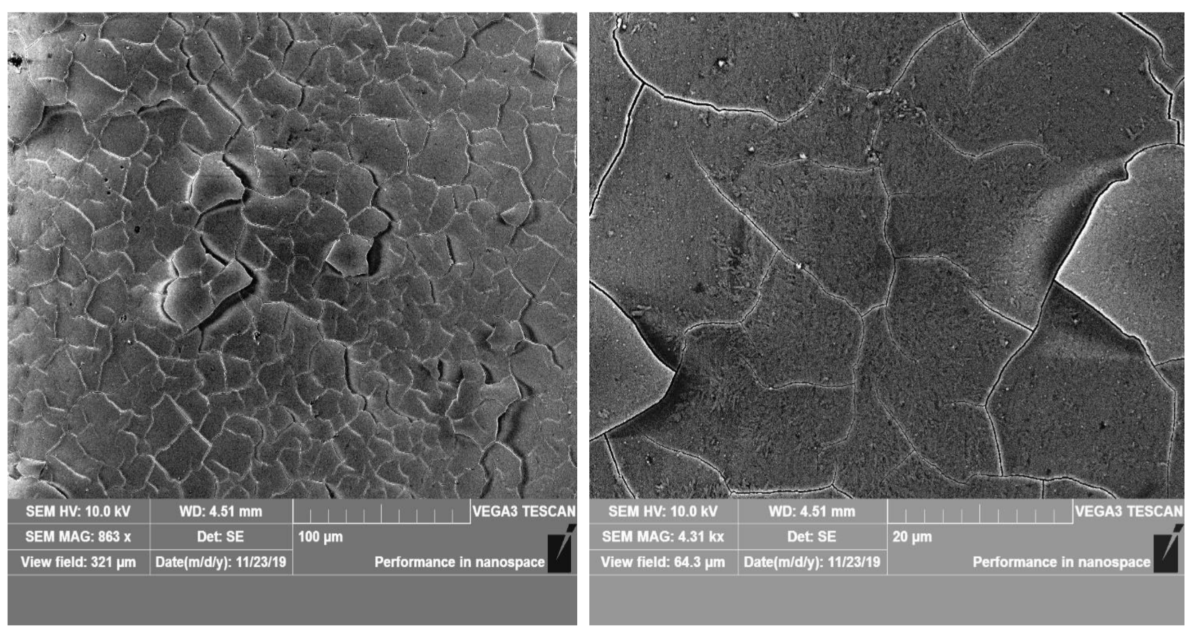


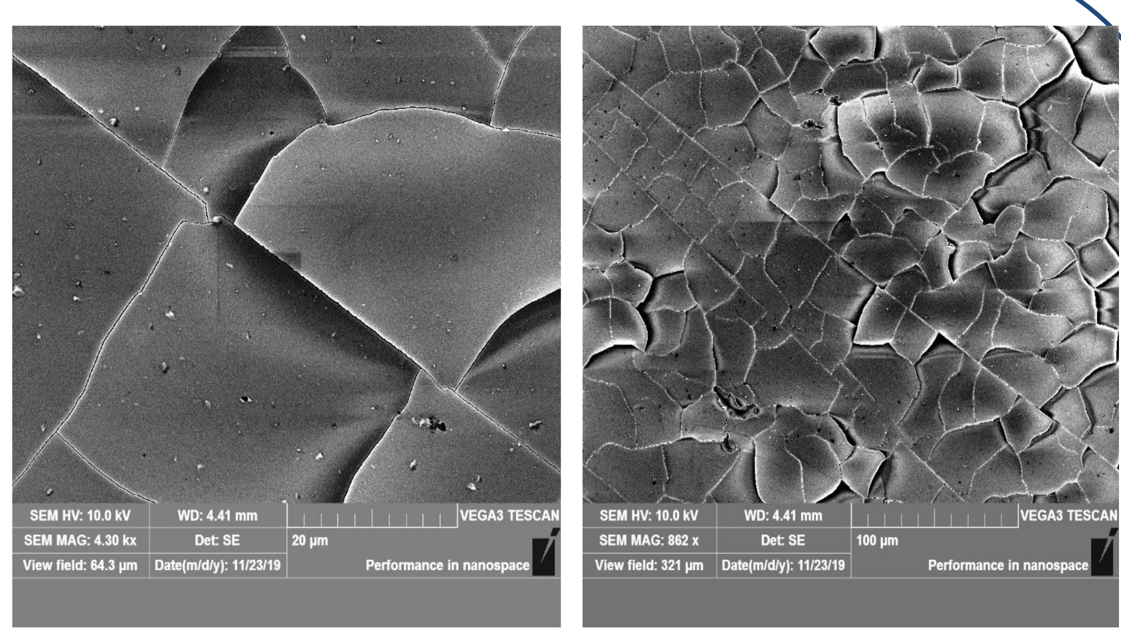
Fig. 1. The EDS spectrum of CdS/glass thin films: a) sample 1b, b) sample 2b.

In fig. 1 EDS spectra for samples 1b, 2b, of the different thicknesses are represented. It has been determined, that the deposited films are characterized with the stoichiometric composition irrespective of film thickness. According to the data of phase analysis for the thin films CdS/glass, the percents of the atomic mass amount: Cd ~ 55% and S ~ 43%.



a) b)

Fig. 2. CdS sample 1b (T_S = 470 K, T_E = 880 K, τ = 90 sec, d = 560 μm).



a) b)

Fig. 3. CdS sample 2b. (T_S = 470 K, T_E = 880 K, τ = 60 sec, d = 420 μm).

The morphology of the thin films CdS has been investigated on the basis of the data of scan electronic microscopy. In fig. 2 – 3 SEM – pictures of the films are represented. It has been determined that scales type of the surface structure is characteristic for smaller widths of films. The presence and the size of these plates are directly dependent on the time of deposition.

For the films of small width the combining of such plates in some complexes, which are represented in fig. 2a and fig. 3a is observed. The sizes of these plate complexes and their number decrease as width of films decreases.

Conclusions

Specifically, it has been concluded that the increasing of the deposition time results in the decreasing of the lateral size of scales: from about 30 mm during the deposition time 60 sec to about 20 mm during the deposition time 90 sec. Due to the reduction of the surface plates in size, we can assume that with increasing of deposition time, the process of their fusion begins. A further increase of the deposition time leads to blurred outlines of such plates, and for the thickest films they are absent.

References

1. Philipps, S. Warmuth, W. photovoltaics report – Fraunhofer ISE; 2016, web-source: https://www.ise.fraunhofer.de/en/publications/studies/photovoltaics-.