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Thematic course: Chemical bath synthesis of metal chalcogenide films. Part 32.

Influence of the particle size forming polycrital $Cd_xPb_{1-x}S$ films on the composition

© **Larisa N. Maskaeva**,[1,2+] **Anastasia D. Kutyavina**,[1] **Vyacheslav F. Markov**,[1,2*] **Roman E. Yagovitin**,[1] and **Irina V. Vaganova**[2]

[1] *Physical and Colloid Chemistry department. Ural Federal University Named after the First President of Russia B.N. Yeltsin. Mira St., 19. Yekaterinburg, 620002. Sverdlovsk Region. Russia. Phone: +7 (343) 375-93-18. E-mail: mln@ural.ru*

[2] *Chemistry and Combustion Process Department. Ural State Fire Service Institute of Emergency Ministry of Russia. Mira St., 22. Yekaterinburg. 620062. Sverdlovsk Region. Russia. Phone: +7 (343) 360-81-68.*

*Supervising author; [+]Corresponding author

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Abstract

The variability of electro-physical properties of films of solid substitutional $Cd_xPb_{1-x}S$ solutions makes them promising as functional materials for optoelectronics, nanoelectronics, sensor engineering, and solar power engineering. Researchers often prefer chemical deposition from aqueous media among all the methods for the production of these films. It is technologically simple and allows obtaining the layers of solid solutions with a high level of supersaturation for CdS substitutional component. A good correlation between the linear sizes of the microcrystallites forming films and the content of the substitutional component in the solid solution was determined at chemical bath synthesis of $Cd_xPb_{1-x}S$ films in the ammonium-citrated, ethylenediamine, and ethylenediamine-citrated reaction systems. The range of linear sizes with the minimum diameter of crystallite grains (0.03-0.04 μm) corresponds to the most enriched solid $Cd_xPb_{1-x}S$ solution for CdS component, where x = 0.116 mol. %, deposited in the ammonium-citrated system. In the ethylenediamine-citrated system the maximum of cadmium content in $Cd_xPb_{1-x}S$ (x = 0.187) corresponds to the particle size 35-40 nm. Two extreme points corresponding to the maximum content of CdS in the solid $Cd_xPb_{1-x}S$ solution (x = 0.062 and 0.089) are observed on the curve of cadmium sulphide content for the ethylenediamine reaction mixture. The values of the substitutional component correspond to the average size of crystallites about 35 nm. Discovered behavior of the dependences "particle size – composition" proves the pronounced size effect while formation of films of supersaturated solid $Cd_xPb_{1-x}S$ solutions by chemical deposition. It is connected with the increasing of the contribution of the surface energy of the particles into Gibbs free energy at decreasing their linear sizes. The system realizes its free energy into the formation of highly supersaturated solid solutions. The limits of the mutual solubility of its components broaden even in the ranges of relatively low temperatures of the synthesis.

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