

Thematic course: Chemical bath synthesis of metal chalcogenide films. Part 33.

## Experimental verification of the ranges of CdS and PbS co-deposition by thiocarbamide in the presence of triethanolamine

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### Abstract

Ionic equilibria were calculated in the reaction systems for obtaining films of substitutional CdPbS solid solutions by chemical bath co-deposition of lead and cadmium sulfides. Three reaction systems were studied with the following combinations of complexing agents: triethanolamine and ammonia (triethanolamine-ammonium system), triethanolamine and sodium citrate (triethanolamine-citrated system), and triethanolamine and ethylenediamine (triethanolamine-ethylenediamine system). Thiocarbamide was used as a chalcogenizer for sulfide deposition.

Lead and cadmium hydroxyl complexes are the main complexes preventing rapid formation of lead and cadmium sulfides in the triethanolamine-ammonium system in the pH ranges of intense decomposition of thiocarbamide. The contribution of triethanolamine and ammonia to complex formation is negligible at certain ligand concentrations in this system. In the triethanolamine-citrated bath both cadmium and lead exist in the form of hydroxyl-citrated complexes in the solution at pH of sulfide chemical deposition. Lead also forms  $\text{Pb}(\text{OH})_4^{2-}$  hydroxyl complex. Complexes of cadmium with ethylenediamine are prevailing component in the alkaline ranges in the triethanolamine-ethylenediamine system, whereas lead mainly exists in the form of hydroxyl complexes.

Boundary conditions and ranges of formation of CdS, PbS,  $\text{Cd}(\text{OH})_2$ ,  $\text{Pb}(\text{OH})_2$ ,  $\text{CdCN}_2$ ,  $\text{PbCN}_2$  were determined to evaluate deposition conditions of major and impurity phases (metal hydroxides and cyanamides) by thermodynamic calculations considering sizes of critical nucleus in the studied reaction systems. The results of calculations are presented as 3D dependences of “initial concentration of metal salt - pH of the solution – concentration of ligand”. The reaction mixtures for film chemical deposition were composed based on the calculations and the preliminary experiments. Homogeneous CdPbS layers with thickness 100-300 nm were obtained on siall substrates for all studied reaction systems at 373 K.

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