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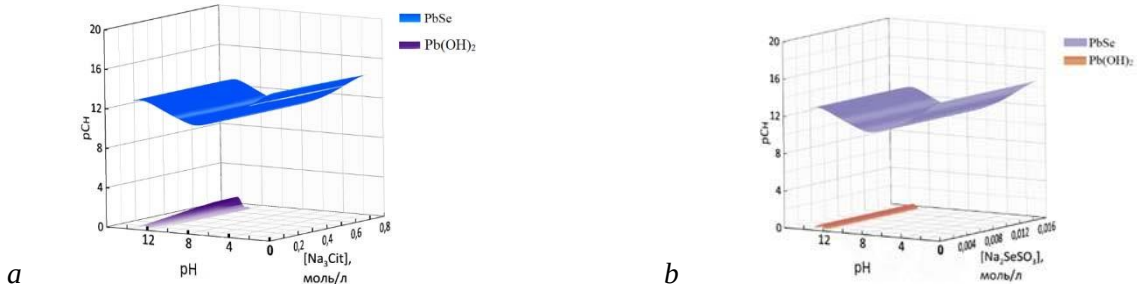
THERMODYNAMIC ESTIMATION OF THE EFFECT OF HALCOGENIZER AND LIGAND ON THE CHEMICAL DEPOSITION OF PbSe FILMS

A. V. Belceva,[1] V. M. Yurk,[1] I. V. Zarubin,[1] L. N. Maskaeva,[1,2] V. F. Markov[1,2]

[1]Ural Federal University named after the first President of Russia B.N. Yeltsin, 620002, Ekaterinburg, 19 Mira St.
[2]Ural Institute of State Fire Service of the Ministry of Emergency Situations of Russia. 620002, Ekaterinburg, 22 Mira St. E-mail: mln@ural.ru

Abstract. Lead selenide PbSe thin films are functional materials which are widely used in highly sensitive photodetectors, devices for monitoring high-temperature technological processes in metallurgy, thermal imaging, pyrometry and photovoltaics. A large number of scientific works are devoted to the synthesis of PbSe films by chemical bath deposition. The reaction mixtures are given which include the salt of lead, the ligand and the chalcogenization agent, but without explaining the reasons for their choice.

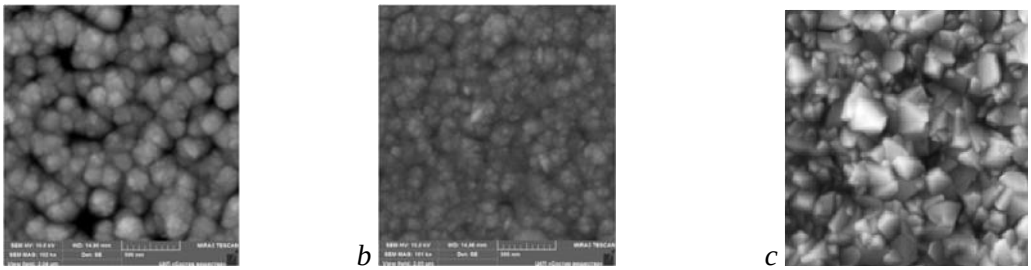
In this work, a thermodynamic approach is used to select the conditions for the formation of a solid PbSe phase. As an example, Figure 1 shows the assessment of the effect of pH solution, the ligand content and chalcogenization agent on the concentration region of PbSe formation and the impurity hydroxide $Pb(OH)_2$ in $PbAc_2$ – Na_3Cit – Na_2SeSO_3 system.



a *b*

Figure 1. Dependence of the boundary condition of PbSe and Pb(OH)2 formation on pH solution and the concentration of ligand (a) and chalcogenization agent (b) in $PbAc_2$ – Na_3Cit – Na_2SeSO_3 reaction system. Calculations were performed at $[PbAc_2]$ = 0.05 M, $[Na_2SeSO_3]$ = 0.007 M, T = 298 K

The concentration regions located between the surfaces responding to the formation of PbSe and $Pb(OH)_2$ correspond to the predicted formation of one solid phase of lead selenide. In the area of pH and ligand concentrations (chalcogenization) below the plane responsible for the formation of the impurity phase co-precipitation of selenide and lead hydroxide occurs. The formation of the $Pb(OH)_2$ phase is possible in a narrow range of pH = 11-13. Figure 2 shows that the nature of the chalcogenization agent and the ligand in the reaction bath significantly affects the architecture and size of the crystallites of PbSe films, and, therefore, their functional properties.



a *b* *c*

Figure 2. SEM images PbSe thin films deposited on glass substrate from the reaction systems $PbAc_2$ – Na_3Cit –NH_4OH using Na_2SeSO_3 (*a*), N_2H_4CSe (*b*) and $PbAc_2$ – En –NH_4Ac –Na_2H_4CSe (*c*)

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