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Thematic course: Chemical bath synthesis of metal chalcogenide films. Part 42.

Experimental verification of the deposition regions of PbSe by sodium selenosulfate and selenourea in the presence of various ligands

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Abstract

Calculation of ionic equilibria in the reaction system for synthesis of PbSe thin films was carried out. Three reaction systems containing the following combinations of reagents were considered: sodium citrate with liquid ammonia and sodium selenosulfate (system 1) or selenourea (system 2) used as chalcogenizer, ethilendiamine, sodium acetate and selenourea (system 3).The main lead complex compoundsprevented the fast PbSe formation in system 1 and 2 in region of pH of intensive selenosulfate and selenourea decomposition were hydroxo-citrate complexes. In the system 3 complexes with ethilendiamine and acetate-ions played the most significant role. For evaluating the deposition conditions of the main and impurity phases (metal hydroxides and cyanamides) by thermodynamic calculations taking into account the sizes of critical nucleis, the boundary conditions and regions of formation of PbSe, $Pb(OH)_2$, $PbCN_2$ in the studied reaction systems were found. The calculation results are presented in the form of three-dimensional dependencies in the coordinates "indicator of the initial concentration of the metal salt – pH of the solution – ligand concentration" and "indicator of the initial concentration of the metal salt – pH of the solution – concentration of the chalcogenizer". Based on the calculations and preliminary experiments, the compositions of the discussed reaction mixtures were formed for the chemical bath deposition of PbSe films, which, in addition to the main components, included a dopant in the form of ammonium iodide. In the synthesis process at a temperature of 353 K (system 1 and 2) for 60 minutes and 308 K for 90 minutes (system 3), using all the studied reaction systems on glass substrates, homogeneous PbSe layers with a thickness of ~500 to ~700 nm were obtained. The ratio between the main elements of Pb and Se in the film varies between 0.98-1.32, and the iodine content is 7-11 at.% depending on the composition of the reaction bath.

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