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Thematic course: Chemical bath synthesis of metal chalcogenide films. Part 39.

Chemical bath deposition of ZnS films by thioacetamide

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Abstract

ZnS thin films are promising as a buffer layer in solar cells, which can be basis of photovoltaic cells, photoelectric sensors, and light-emitting diodes. For the preparation of thin ZnS films by chemical bath deposition, thioacetamide or thiourea is used as a chalcogenization agent, and ammonia, triethanolamine and sodium citrate are mainly used as ligands, carrying out the process in an alkaline medium. In the present work, in order to predict the conditions of hydrochemical deposition of ZnS films, we have analyzed ionic equilibria in two reaction systems "$ZnCl_2$ – NH_4OH – CH_3CNH_2" and "$ZnCl_2$ – CH_3CSNH_2 – $KHC_8H_4O_4$" that differ in acidity of the medium. An analysis of ionic equilibrium showed that in the first bath ~80% of the metal is in the form of a neutral hydroxo complex $Zn(OH)_2$ at pH > 7, and in the second more than 98% of zinc is present as acetate complexes $Zn(CH_3COO)^+$ and $Zn(CH_3COO)_2$ in the range of pH from 0 to 7. The thermodynamic evaluation of the boundary conditions for the formation of zinc sulfide made it possible to conclude that a zinc sulfide film can be formed in both systems without the admixture of $Zn(OH)_2$ hydroxide. ZnS films were obtained by hydrochemical deposition with thick about 100 nm from both systems. Using local energy-dispersive elemental analysis, it was found that the average ratio between the main elements of Zn and S in the layers obtained in an alkaline medium is 49.48 and 50.52 at.%, and in the synthesized from acidic solutions – 50.35 and 49.65 at.%. According to the data of electron microscopy, up to 85% of the agglomerates have an average size of 200-450 nm that formed from ZnS particles growing in an alkaline reaction bath. At the same time, there are aggregates whose dimensions reach 700 nm. The layers that deposited from relatively acidic solutions are distinguished by a higher degree of dispersion. Here up to ~90% of the film-forming particles is in the nanoscale range from 50 to 90 nm.

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