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Thematic course: Chemical bath synthesis of metal chalcogenide films. Part 41.

Effect of Sr^{2+} ions on deposition kinetics, composition and morphology of PbS thin films

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Abstract

Lead sulphide thin films are one of the most sensitive materials in the visible and near-IR spectral ranges (0.4-3.0 μm) and due to this, they are widely used in optoelectronics. One of the most promising methods for the synthesis of this semiconductor material is chemical bath deposition from aqueous solutions. At the same time, doping additives used to improve the properties of the deposited films. In this paper, we consider the effect of strontium cations Sr^{2+} on the deposition kinetics of the solid lead sulfide phase, as well as on the thickness, morphology and elemental composition of chemically produced PbS films. According to the results of the study of the precipitation kinetics of PbS(Sr) solid phase, it was found that the introduction of strontium chloride into the reactor inhibits the formation of PbS solid phase during the deposition of PbS films and contributes to a significant increasing of the induction period of its formation.Polycrystalline films of lead sulfide were synthesized by hydrochemical precipitation from the ammonium-citrate reaction mixture with the addition of ammonium iodide and strontium chloride on substrates of glass and glass. The thickness of the films obtained decreased from 400 nm for individual PbS to 350 nm for doped with iodine PbS (I). The thickness reduced from 300 to 150 nm with an increase in the content of strontium chloride in the reaction mixture from $5 \cdot 10^{-5}$ to $5 \cdot 10^{-3}$ mol/l. The EDX analysis has observed that PbS, PbS(I) and PbS(I,Sr) films have deficient in sulfur, the iodine content decreases from 1.4 to 1.0 at.% when strontium enters in the semiconductor structure. Electron microscopy has shown that adding ammonium chloride to the reactor leads to crushing of crystallites with a clear edges and an average size of grains for individual PbS film from 300 nm up to ~150 nm. The minimum salt content of strontium ($5 \cdot 10^{-5}$ mol/l) increases by ~2 times the proportion of nanoparticles forming the PbS (I, Sr) film, and at the maximum concentration ($5 \cdot 10^{-3}$ mol/l) their content is slightly reduced from 14 to 11%.

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