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Effect of barium salt on deposition kinetics, morphology and composition of chemically precipitated PbS films

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Abstract

Thin films of lead sulfide obtained by various physicochemical methods are widely used as IR detectors, ion-selective sensors, sensors of temperature and humidity, in solar radiation converters due to a high absorption coefficient in the infrared spectrum of 1-3 μm. Researchers note technological simplicity, the absence of high temperatures and vacuum, as well as the possibility of light doping of lead sulfide films during their production by chemical bath deposition from aqueous media. In the present work, we studied the kinetics of hydrochemical deposition of the solid PbS phase from the ammonium citrate reaction mixture. The introduction of barium chloride $BaCl_2$ into the reactor in the concentration range from $0.5 \cdot 10^{-5}$ to $5 \cdot 10^{-3}$ mol/l has led to an increase in the induction deposition period from 5 to 30 minutes. In this work, polycrystalline films of individual lead sulfide were synthesized, as well as PbS layers doped with iodine and additionally barium with salt content in the last mixtures from $0.5 \cdot 10^{-5}$ to $5 \cdot 10^{-3}$ mol/l. The film thickness varied from 350 to 210 nm. An elemental EDX analysis of the obtained PbS films was performed. For the main components contained in the layers (Pb and S), insignificant non-stoichiometry in composition was established. The morphology of films of PbS during their doping with iodine and barium undergoes significant changes. Thus, if an individual PbS is formed from particles whose average size is 250 nm, then introduction of ammonium iodide into the solution leads to the appearance of grains with an average size of 150-200 nm, and adding the barium salt results a slight increase in the grain size up to 150-300 nm. The share of nanoparticles in these layers is 1-4%. The histograms of the distribution of particles in the films, both for individual and doped PbS, are monomodal.

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