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Submitted on November 07, 2017.

Thematic course: Chemical bath synthesis of metal chalcogenide films. Part 35.

Chemical bath deposition of Cu_2Se films with sodium selenosulfate

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Keywords: copper(I) selenide, thin films, chemical bath deposition, ionic equilibriums, boarder conditions for deposition.

Abstract

Thin films of copper(I) selenide are widely used in optoelectronics and solar energetics because of optimal values of band gap energy equal to 1.1-2.3 eV. Chemical deposition from aqueous environments has significant perspective among existing methods of obtaining Cu_2Se thin films. This method eliminates the need for complex expensive equipment, high temperature heating and deep vacuum. Literature analysis shows domination of prescriptive approach to chemical deposition of copper(I) selenide thin films. Calculation method for predicting the boarder conditions for the formation of individual metal chalcogenides phases was used in this work and had been also widely tested on practice. Boarder conditions for the formation of copper(I) and copper(II) selenides were determined at the temperature of 298 K in two reaction systems: "$CuCl_2$ – $NH_2OH{\cdot}HCl$ – Na_2SeSO_3" and "$CuCl_2$ – KSCN – $NH_2OH{\cdot}HCl$ – Na_2SeSO_3" using selenosulfate of sodium as chalcogenizer. It's shown that acidic pH range is the most preffered for chemical deposition of copper(I) selenide solid phase. Simultaneously conditions for deposition of copper hydroxides CuOH and $Cu(OH)_2$ were found. These hydroxides accompanying the formation of the sulfide. According to calculated concentrations of components in the reaction mixtures and pH in the both systems for bath deposition mirror polycrystalline layers of copper(I) selenide were synthesized. Layers had good adhesion to sitall substrate and thickness of 100-500 nm depending on the chosen conditions. The films were formed of crystals which average size is 80-450 nm. Due to results of energy-dispersion analysis the elemental composition of the films was investigated. The using of sodium selenosulfate as chalcogenizer and muriatic hydroxylamine provides reducing medium in reactor and causes the reduction of bivalent copper to monovalent condition and causes formation of Cu_2Se solid phase. Deposed layers are characterized with relatively high stoichiometry of formula composition. According to results of thermoEMF method the layers have hole type conductivity.

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