III-V compound semiconductor InSb films electrodeposited from aqueous citric solutions

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InSb is well known for its narrow band gap and various applications in Hall effect device, infrared detection, and magnetoresistive sensing. However, although it is considered that the electrodeposition of high quality compound InSb with precise stoichiometry at ambient temperature from aqueous solutions remains still a challenge, it is surprising that only a few studies[1-2] on this important issue can be seen.

In this work, InSb films were electrodeposited from citric aqueous solutions onto Au/Si substrates. The stoichiometry of the films was carefully tuned by controlling some factors such as citrate concentration, applied current density, pH, and the ratio of the concentration of In^{3+} ion to that of Sb^{3+} ion in the electrolyte. Compositions of InSb films were ascertained by electron probe micro-analyzer (EPMA) and microstructural features of the films were characterized by X-ray diffractometer (XRD). Surface morphology was checked by ESEM(Environmental Scanning Electron Microscopy). By measuring I-V curves and Hall effects for the films with various composition the compositional effects on the electrical properties of the electrodeposited InSb films were investigated.

All chemicals were analytical grade from Sigma-Aldrich, Inc. The electrolytes were composed of indium chloride, antimony chloride, citric acid, and potassium citrate. The substrates were commercially prepared single crystal Si wafers coated with evaporated Au layer of the thickness of 200 nm. A high purity graphite counter electrode and a silver/silver chloride reference electrode were used. The electrodeposition of InSb films was made at 30±0.1℃ under constant current conditions on the basis of the pre-carried cathodic polarization experiments.

This work shows that the stoichiometry of the electrodeposited InSb films can be controlled by some critical variables such as pH, current density, the concentration of citrate ion, and the ratio of the concentration of antimony to that of indium. Especially, the stoichiometry has a strong dependency on the applied current density and the concentration of the citrate ion.

I-V curves and Hall effects measured for films according to the compositions indicate that the electrodeposition process can be a promising method to produce high quality compound semiconductors.

Reference

1. J. Ortega, H. Herrero, J. Electrochem. Soc. 136 (1989) 3388.
2. J. -J. McChesney, J. Haigh, I. M. Dharmadasa, D. J. Mowthorpe, Opt. Mater. 6 (1996) 63.

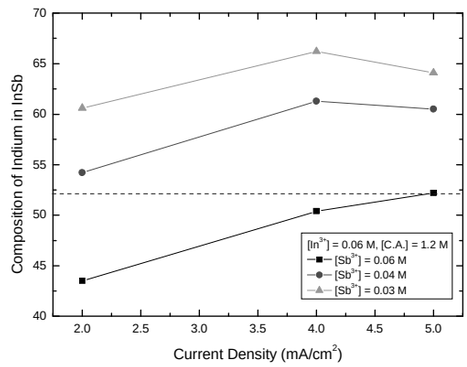

Fig. 1. The variation of the composition of indium in InSb films electrodeposited from various electrolytes containing different concentrations of antimonous ion according to the applied current densities.

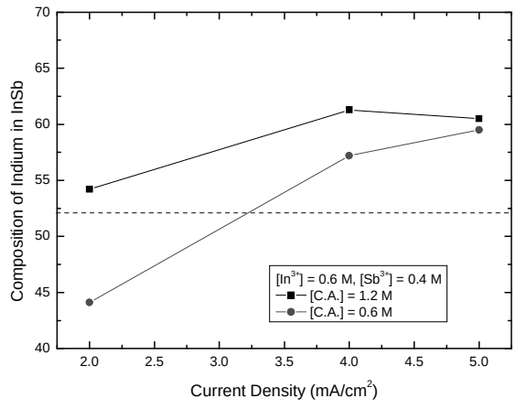

Fig. 2. The variation of the composition of indium in InSb films electrodeposited from various electrolytes containing different concentrations of citric acid according to the applied current densities.