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Growth and characterization of n-type and p-type Aluminum Antimonides

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III-V semiconductors, such as III-nitrides, III-arsenides, III-phosphides, and III-antimonides, have been applied in optoelectronic devices and electronic sensors as light-emitting diodes, solid-state lighting, optical storages and semiconductor detectors. In this project, the growth of high crystalline quality AlSb films with suitable optical and electrical properties has been investigated in order to develop AlSb-based room-temperature radiation detectors. By using X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Raman Spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), I-V characteristics and Hall-Effect measurements, the crystal structure, surface morphology, optical properties and electrical properties of AlSb films were analyzed. □400-nm-thick AlSb films were prepared by RF-magnetron sputtering process in argon atmosphere at a pressure of 10-2 mbar, a power of 250 W and the ratio of Al and Sb of 85:15. In order to generate the n-type and p-type AlSb films, Cu and Si doping in AlSb films were performed by the ratio of Al, Sb and dopants of 82:14:4. As shown in Fig.1, undoped and doped AlSb films were achieved with a single crystal plane of (111), a lattice constant of 6.095 Å and a crystal size of 0.88 nm. To analyze the crystalline quality of AlSb films, Raman spectroscopy indicates all AlSb films with strains and lower crystalline quality by Si and Cu doping as presented in Fig.2. By I-V measurements in Fig.3, the electrical conductance of AlSb:Cu, AlSb:Si and undoped AlSb were obtained as 8.13, 0.36 and 0.28 m□-1, respectively. Moreover, Hall-Effect measurement approves of n-type AlSb films by Cu doping and p-type AlSb films by Si doping with quite high carrier concentrations about 1017 cm-2 but still low carrier mobility. In further, PN junction didoes will be designed on Si substrates to develop the AlSb-based room-temperature radiation detectors.

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