Molecular beam epitaxy growth and bandgap measurements of InAsSbBi

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The molecular beam epitaxy growth of the III-V semiconductor alloy InAsSbBi is investigated for growth temperatures ranging from 400 to 430 °C, As/In flux ratios of 0.91 and 0.94, Sb/In flux ratios of 0.10 and 0.12, and Bi/In flux ratios of 0.05 and 0.10. Bismuth readily incorporates at growth temperatures around 300 °C, but results in material with limited optical quality. Conversely, higher growth temperatures around 400 °C yield improved optical performance, but with limited Bi incorporation. The fraction of the Bi flux incorporated is observed to decay exponentially with a 17 °C characteristic temperature in the high temperature growth regime as shown in Fig. 1. Furthermore, when the As/In flux ratio is increased significantly above stoichiometry, the Bi incorporation decreases as As out-competes Bi for group V lattice sites as shown by the solid square. Quaternary alloys such as InAsSbBi possess two degrees of freedom that allow the bandgap to be specified independently of strain. Photoluminescence spectroscopy is used to examine the temperature dependent bandgap and optical properties of InAsSbBi, while x-ray diffraction is used to determine strain. The bandgap as a function of temperature is shown in Fig. 2, where an Einstein single oscillator model fit to the data (solid curves) provides the zero temperature bandgap energy. A bandgap bowing model is developed and employed to determine the InAsSbBi composition from the measured bandgap and strain.

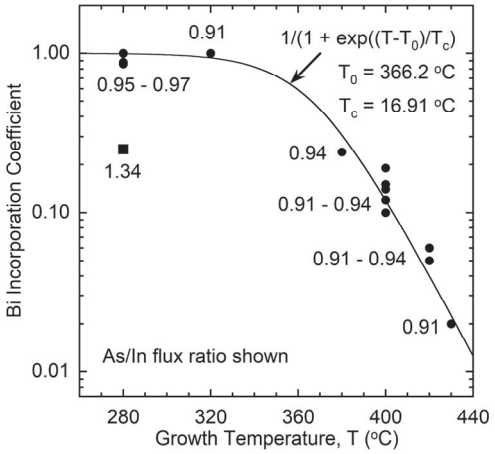

Figure 1. Fraction of incident Bi flux incorporated as a function of growth temperature for near stoichiometric As fluxes shown as solid circles. The solid square shows reduced Bi incorporation at low temperature when a typical As overpressure is used.

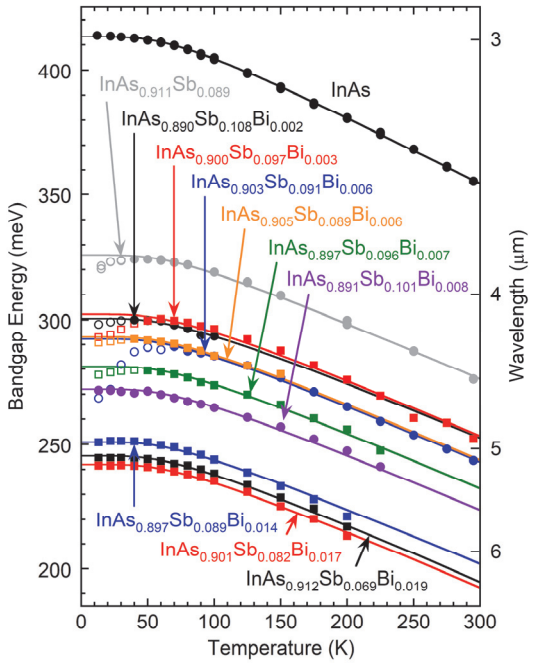

Figure 2. InAsSbBi bandgap energy as a function of temperature and composition.

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