Liguid Phase Epitaxial Growth of the Alloy Semiconductors in In–Ga–Al–Sb System

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This dissertation describes the thermodynamic analysis of the In-Ga-Al-Sb phase diagrams and tecniques of low-temperature liquid phase epitaxial (LPE) growth of the (In, Ga, Al) Sb quaternary alloys.

To calculate the In-Ga-Al-Sb phase diagram, Redlich-Kister expression was introduced to the analysis of the phase diagrams in all the binary (Al-Sb, Ga-Sb, In-Sb) and ternary (In-Ga-Sb, Ga-Al-Sb, In-Al-Sb) systems constructing the quaternary system. The calculated results of all the binary and ternary phase diagrams showed good agreement with experimental data. Using interaction parameters obtained from the calculation, the In-Ga-Al-Sb quaternary phase diagram was calculated.

The LPE growth procedure was improved to prepare the saturated solution at a low temperature. Using the improved procedure, (In, Ga, Al)Sb alloys were grown on GaSb at 450°C successfully. An (In, Ga)Sb buffered layer was introduced to reduce the strain in the (In, Ga, Al)Sb grown layer. The LPE growth was performed under the conditions of various composition ratios of Al to Ga ($X_{Al}X_{Ga}$). From this experiment, the energy gap, and the lattice constant of (In, Ga, Al)Sb grown layers were obtained as a function of X_{Al}/X_{Ga}.

These experimental results confirmed the reliability of the thermodynamic analysis in the quaternary system, and provided the data to control the energy gap and the lattice constant of (In, Ga, Al)Sb grown layers for device application.