Studies on Liquid Phase Hetero Epitaxy of GaInP and GaInAs Alloys by Compositional Conversion Technique

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III-V alloy semiconductor crystals are of vital importance in fabrication of optoelectronic and high-speed devices since the desired band-gap energy and lattice constants can be achieved by controlling their compositions. However, it is difficult to realize the layer-mode growth of different compositional alloys on commercially available compound substrates by LPE(liquid phase epitaxial) techniques.

This thesis describes the growth of GaInP and GaInAs alloy layers with desired composition grown on GaP and GaAs substrates using the compositional conversion technique. The compositional conversion consists of two growth processes : the heteroepitaxial growth process of InP on GaP and InAs on GaAs, with a 7.5% lattice mismatch, and the compositional conversion process from InP and InAs to GaInP and GaInAs alloys.

First, the growth experiment of InP on GaP was carried out. It was found a good single crystal layer could be grown on a GaP substrate at higher growth temperature than 750℃. For the sake of compositional conversion, it was brought into contact with a Ga-In-P saturated solution and kept at a constant temperature in isothermal conditions. A relatively good GaInP layer was obtained by conversion. A GaInAs layer was also obtained as the same way using an InAs layer grown on a GaAs substrate at the growth temperature higher than 700℃.

Furthermore, to have a better understanding of this mechanism, a solid-liquid diffusion numerical simulation model was applied. Numerical solutions agree with experimental results and explain well the conversion phenomenon.

Finally, to obtain better GaInP grown layers than conversion layers, the homoepitaxial growth of GaInP layers with same composition of GaInP conversion layers was carried out. The quality of homoepitaxial layer was better than the conversion layer by measurement of photoluminescence.

Growth techniques proposed in this thesis will be able to contribute to realization of new functional devices which make the most of advantages of alloy semiconductors.