Hetero-epitaxial growth mechaism of Ⅲ-V material by molecular beam epitaxy

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In this thesis, a hetero-epitaxial growth mechanism of Ⅲ-V materials by molecular beam epitaxy (MBE) is studied.

The effective As flux intensity is determined by the transition in the reflection high-energy electron-diffraction pattern. The precise control of the effective As flux intensity is achieved by this method. The MBE growth model that consider the surface precursor states is proposed. The growth model is applied to the composition ratio control of the GaAsP growth. The dependence of the composition ratio on the growth condition is derived from the growth model.

The growth process of the GaAs heteroepitaxy on a GaP (001) substrate is studied. The GaAs layer grows in 2D (two-dimentional) layer by layer mode up to 2ML(monolayer). The lattice mismatch between the sample and the growth layer is completely accommodated by the strain. The 2D growth mode changes to 3D (three-dimentional) nucleation one when the layer thickness becomes over 2ML. The islands formed during 3D growth mode are directly observed by scanning-tunneling microscopy. The strain of the growth layer also begin to decrease over 2ML in thickness. The island formation and the relief of the strain occur at the same time. The growth mode changes from 3D to 2D again at 15nm by the coalescence of islands.

The two-step growth method is applied to the GaAs heteroepitaxy on GaP substrate and the effect of the GaAs thin film formed between the growth layer and the substrate is studied.