Abstract

論文の内容の要旨

論文題目　InAs/GaSb および InAs/GaAs 歪みヘテロエピタキシャル結晶の高品質化
Title of Dissertation

氏名　奥村滋一
Name of Author

In the fields of tensile-strained hetero epitaxial growth of III-V compound semiconductor by molecular beam epitaxy method, the pits on InAs layer on GaSb formed by the tensile strain and the dislocations in GaAs cover layer on InAs quantum dots formed by the anisotropic tensile strain were studied by focusing on the similarities between the two material systems.

Before the InAs hetero epitaxial growth on GaSb, GaSb homo epitaxial growth was investigated to prepare a highly flat underlying surface. Two-step high and low temperature growth sequence was proposed, and extremely flat surface was obtained.

Adapting the flat surface obtained by two-step growth sequence, InAs bulk hetero epitaxial growth on GaSb was investigated for obtaining flat with pit-free surface applicable to the contact layer of GaSb-based device application. Pits with high index plane were observed on the InAs surface at relatively higher As_2 pressure or lower growth temperature. Pits are not conducive to lattice relaxation, but formation of high index planes as a part of strain energy relaxation. Although these pits on InAs are suppressed or reduced by reducing the As_2 pressure or increasing the growth temperature, growth method for suppressing the pits with higher tolerance is needed.

In establishing a growth method that effectively suppresses pits of InAs on GaSb, the growth sequence was focused on same as the case of GaSb homo epitaxial growth. By adapting initial low

and subsequent high temperature growth sequence, extremely flat surface of InAs on GaSb was obtained. This owes to the following two factors: (1) high flatness of initial InAs layer under suppressed Sb carryover, and (2) higher (001) plane preference of InAs subsequent high temperature growth.

Focusing on the similarity with InAs growth on GaSb, InGaAs/GaAs growth on InAs QDs was investigated to obtain high optical property from two aspects of InAs QDs growth and subsequent InGaAs/GaAs cover growth. Growth temperature dependence of InAs QDs revealed that the dislocations mainly act as a non-radiative recombination center to degrade the PL characteristics. Relatively higher height InAs QDs caused the dislocation formation at cover layer directly above QDs. To clarify the mechanism of the dislocation formation, relationship with the surface morphology after cover layer growth was investigated under the various cover layer growth condition. This reveals that pit formed directly above the QD is the starting point for dislocation formation during the subsequent high temperature GaAs growth. Same as InAs/GaSb system, ensuring the surface flatness of initial low temperature cover layer is the important factor for fabricating the high-quality GaAs/InAs QDs structure with suppressed dislocations.