Growth Process and Strain Relaxation in Lattice Mismatched Heteroepitaxy by Molecular Beam Epitaxy

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Heteroepitaxial growth of strained materials has much attention in order to realize new devices. It is well known for strained heteroepitaxy, the growth mode changes from two-dimensional to three-dimensional at a certain critical thickness. Recently, formation of coherent island structures by three-dimensional growth and application to quantum dots are reported. The growth mechanism of the growth mode transition should be clarified to increase the critical thickness of the growth mode transition for the fabrication of quantum layers and to control the size of the island structure which is necessary to use this island structure as a quantum dot. The growth mode transition of strained GaAs heteroepitaxial growth on GaP (001) by molecular beam epitaxy is studied in detail by analyses of reflection high-energy electron diffraction (RHEED). The surface stoichiometry and reconstruction fo GaP (001) is investigated by RHEED and surface photo absorption methods. The summary of this paper is as follows. (i) The surface of GaP has P stabilized surface in spite of the existence of excess Ga. (ii) The strain of the grown film is relaxed from the beginning of heteroepitaxial growth within one monolayer. It is caused by elastic relaxation. (iii) The growth process consists of (a) the formation of metastable layer structure, and (b) the transformation of the grown film structure from a layer to islands. There are possibilities of obtaining a quantum dot structure of a desired size by adjusting the growth rate, and the increase of the critical thickness of the growth mode transition by increase of the Ga deposition rate.