Si 기판위에 MBE로 성장된 GaAs 박막의 초기성장에 관한 연구
(TEM study on the initial growth stage of GaAs film grown by MBE)

남산, 김상기, 조경익, 김경수
한국전자통신연구소 반도체연구단

The epitaxial growth of GaAs film on Si substrate has been a subject of great interest because of the opportunity to combine the best properties of the two materials. However, high density of defects due to the differences in lattice parameters and thermal expansion coefficients limit the quality of GaAs films. In this work, GaAs films were grown on the vicinal Si (001) substrate by a modified two-step molecular beam epitaxy (MBE), and growth mode at intial growth stage and defect structure at each growth stage were investigated using TEM.

In order to study the initial stage of growth, amorphous GaAs films with 18 nm were deposited on Si at 353 K in MBE and they were furnace-annealed at 573K for 5 min, 10 min, and 20 min . For the complete growth of the GaAs film, the substrate temperature of the GaAs film was slowly increased to 853 K and main GaAs fillm of 0.5 μm was grown after crystallization of the amorphous GaAs butter layer in the MBE system. Both cross section and plane view TEM samples were prepared by the conventional method. A philips CM20 T/STEM microscope was used to observe the samples.

From the initial stage of growth, GaAs islands grow with three dimensional growth mode and GaAs islands are nucleated on the atomic step edge as well as on the terrace with symmetrical shape. Furthermore, at the very initial stage of growth, island growth proceeds via the growth of (001) plane followed by the lateral spread of (111) plane. Therefore, GaAs islands have the arrow shape before coalescence takes place. From the plane view sample, GaAs islands were identified by Moire pattern and they can be devided into two groups according to the size and spacing of Moire pattern. For most GaAs islands, the size is ~10 nm and the spacing of Moire pattern is about 5 nm same as that of Moire pattern due to (220) beam. However, for some islands, their size is large (~40 nm) and Moire spacing is 2.5 nm. The difference in Moire spacing could be explained using the rotation of GaAs islands. Misfit dislocations and stacking faults were already formed at the initial growth stage. Stacking faults and misfit dislocations were also observed in GaAs films grown at 853K .