

Si 기판위 GaAs 성장에 대한 TEM 연구
(A TEM study on GaAs film on Si substrate)

Sahn Nahm, Hee Tae Lee, Kyoung Ik Cho

Electronics Telecommunication Research Institute, Daedog Science Town, P. O. Box 8,
Daejeon, 305-606

The epitaxial growth of GaAs film on Si substrate has been a subject of great interests because of the desire to combine the best of two semiconductors' properties. However, high density of defects due to the differences in lattice parameters and thermal expansion coefficients limit the quality of GaAs film. The formation of crystal defects depends on the details of growth condition. In this work, GaAs films were grown on the vicinal Si (001) substrate by a modified two-step molecular beam epitaxy (MBE) method, and the interfacial defect structure at each growth stages was investigated using transmission electron microscopy (TEM).

In order to study the initial stage of growth, amorphous GaAs film deposited on Si substrate at 80 °C in MBE system was furnace-annealed (solid phase epitaxy: SPE) at 300 °C for 10 minutes in the N₂ atmosphere (sample 1). For the complete growth of GaAs film, substrate temperature was slowly increased to 580 °C and main GaAs film with 0.5 μm was grown after crystallization of amorphous GaAs buffer layer in MBE system (sample 2). Finally, to decrease the density of defects, rapid thermal annealing (RTA) treatment was carried out on sample 2 at 900 °C for 10 seconds (sample 3). The Si substrate used in this work was tilted by 4° from [001] to [110] direction. The details of substrate cleaning and growth procedures have been discussed in elsewhere [1]. The cross-sectional and plan-view TEM samples were prepared by mechanical grinding and subsequent ion milling at liquid nitrogen temperature. Philips CM20 T/STEM microscope was used to observe the samples.

For GaAs film deposited 80 °C and annealed 300 °C, the size of the most of islands was observed as ~ 10 nm but large islands (~ 40 nm) were also observed. Misfit dislocations were found in both small and large islands at this early stage of growth and stacking faults are expected to exist. Grid-like dislocations consisting of Lomer and 60° dislocations were observed at the interface of GaAs/Si system grown at 580 °C. Stacking faults were also observed at the area away from the interface. However, after RTA treatment at 900 °C for 10 seconds, only Lomer dislocations were observed. The distance between Lomer dislocations was measured as ~ 10 nm.

References

- [1] K. I. Cho, W. K. Choo, J. Y. Lee, S. C. Park, and T. Nishinaga, *J. Appl. Phys.* **69** 237, 1991.