MBE growth of GaAsBi/GaAs on (100) and (411) GaAs Substrates

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The GaAsBi heterostructure system has attracted much attention recently, due to large ban gap reduction (62 meV/%) with augmentation of small number of Bi atoms in GaAs. In addition, the growth of GaAsBi on high index substrates instead of (100) GaAs substrates by MBE is expected to change the growth mode drastically, modifying the incorporation behavior of Bi atom into the epitaxial layer. This concept was also applied for GaAsBi growth on GaAs (511), (411) and (111) by MOVPE and on (311)B by MBE for thick GaAsBi layer. However, limited investigation was carried out on this concept to the date. The MBE growth of GaAsBi/GaAs MQWs on high index oriented (411)A and (411)B substrates are good candidates to accomplish; expected from the results reported by us which shows longer PL wavelength for both (411)A and (411)B compared with together grown (100) GaAs sample.

In this work, we investigating the growth of GaAsBi/GaAs thick layer on (411)A and (411)B GaAs substrates by MBE at different Bi concentration. The surface morphology of GaAsBi layer was observed by atomic force microscopy. The Bi concentration was calculated by x-ray diffraction. Optical properties are characterized by photoluminescence. After the growth of 500 nm GaAs buffer layers, a thick layer of GaAsBi was grown on (100) and (411)A and (411)B GaAs substrates at T_{sub} = 350-380 °C.

The GaAsBi layer surface morphology was observed for all samples. We found self-assembled three dimensional pyramidal-shaped and dot-like features on (411)A and (411)B sample for 250 nm thick GaAsBi layer grown at 350 °C for 1μm/hr growth rate as seen in fig.1. While sample with 30 nm thickness grown at 350 °C for 0.4μm/hr growth rate shows small dots like surface morphology. These features are probably induced due to the difference in atomic arrangement of the substrate orientation. We have also investigated the p-i-n GaAsBi/GaAs structure and it has 60 nm thick GaAsBi layer grown on (411)A & (411)B at different Bi % from 0.4 to 7% Bi content. We observed the clear PL red shift upto 4.5 % Bi concentration from 926 to 1112 nm for (100), 935 to 1078 nm for (411)A and 922 to 1145 nm for (411)B sample respectively, with sharp PL peak, but for higher Bi%, we obtained double PL peak and broad XRD spectrum, which clearly indicate the presence of structural defects. However, (411)B sample shows comparatively longer wavelength than (411)A and (100).

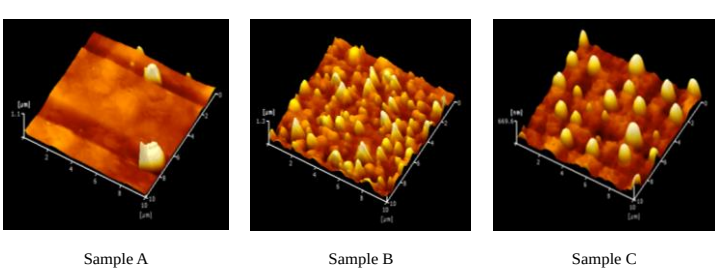

Fig. 1 AFM images of 10×10 μm^2 area for 250 nm GaAsBi layer grown on (100), (411)A and (411)B substrate.