# *Abstract*

The semiconductor alloy GaAsBi has attracts increasing interest in the last few years owing to their potential application in optoelectronic devices operating in the near to long infrared wavelength regions with enhanced capability. This thesis reports structural and the optical properties of GaAsBi/GaAs multiple quantum wells (MQWs) grown on GaAs by molecular beam epitaxy (MBE). GaAsBi/(Al)GaAs MQWs are considered to be a good candidate for infrared optoelectronic devices. The growth of MQWs requires an abrupt interface between the layers. Fabrication of GaAsBi/(Al)GaAs MQWs with abrupt composition profile of bismuth (Bi) is obstructed by strong surface-segregation tendency of Bi atoms. Bi atoms are incorporated not only in GaAsBi layers but also into the successive (Al)GaAs barrier layers. Sometimes structural defects are formed dependent on growth condition. In order to improve the structural and optical quality of GaAsBi/GaAs MQWs, modifications in the growth is reported. In the growths, two-substrate-temperatures (TST) technique was used, where GaAsBi layers were grown at $T_{\mathrm{GaAsBi}} = 350\,^{\circ}\mathrm{C}$ and GaAs layers at $T_{\mathrm{GaAs}} = 550\,^{\circ}\mathrm{C}$. The TST technique procedure proves as a very efficient method to reduce Bi segregation and thus increase the quality of the layers and interfaces. Investigations of the microstructure using transmission electron microscopy (TEM) also reveal laterally homogeneous MQWs free of extended defects. Furthermore, Bi distribution profile across the MQWs region using TEM techniques shows the uniform Bi distribution with significantly reduction in Bi segregation for GaAsBi/GaAs MQWs growth using TST. These improvements positively reflect in the optical properties too.

We have reported the growth of GaAsBi/GaAs MQWs by using TST on (100) and high index surface i.e. (411)A, (411)B, (775)B and (221)B GaAs substrates for the first time by MBE under various $As_4$ and Bi beam equivalent pressure (BEP) and have been investigated using optical and structural characterization. High resolution x-ray diffraction (HRXRD) analysis indicates Bi incorporation enhancement with increasing $As_4$ BEP. The Bi content increases up to 4 % in proportional to the Bi BEP and decreases in a higher Bi BEP region than a specific value. The surface of the top GaAsBi layer for every sample shows no sign of Bi droplet formation even for the MQWs grown at highest Bi supply. While high $As_4$ supply prevents roughening of GaAsBi layer surface for MQWs at $T_{\mathrm{GaAs}}$ = 550 ° C is observed. Moreover, the growth of GaAsBi-bulk-thick-layer grown at 350 °C on high index surface shows self-assembled three dimensional pyramidal-shaped on (411)A and dot-like feature formation on (411)B, (775)B and (221)B GaAs substrates.

The photoluminescence emission from the MQWs grown on (100) and high index substrates show longer wavelength than a thick GaAsBi layer with the same Bi composition from ever reported. The material grown using the TST approach is of high optical device quality as demonstrated by the successful realization of p-i-n diode structures based on $GaAs_{0.96}Bi_{0.04}$/GaAs MQWs with room temperature electroluminescence emission at 1.23 µm.