University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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MSc (Amirkabir University Technology, 2010)
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"Optimization of Growth Conditions of GaAs1-xBix Alloys for Laser Applications"

Department of Electrical and Computer Engineering

Friday, March 18, 2016
2:30 P.M
Engineering Office Wing
Room 430

Supervisory Committee:
Dr. Thomas Tiedje, Department of Electrical and Computer Engineering, University of Victoria (Supervisor)
Dr. Tao Lu, Department of Electrical and Computer Engineering, UVic (Member)
Dr. Rodney Herring, Department of Mechanical Engieering, UVic (Outside Member)

External Examiner:
Dr. Erol Girt, Department of Physics, Simon Fraser University

Chair of Oral Examination:
Dr. Peter Dukes, Department of Mathematics and Statistics, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

GaAsBi is a relatively unexplored alloy with interesting features such as a large bandgap reduction for a given lattice mismatch with GaAs substrates and good photoluminescence which make it promising for long wavelength light detection and emission applications.

In this research, the molecular beam epitaxy (MBE) method was used to grow epi-layers and hetero-structures. A Vertical-external-cavity surface-emitting-laser (VECSEL) was grown as a part of collaboration with Tampere University in Finland. The process of laser growth promoted the writer's skills in the growth of hetero-structures and led into an investigation of the effect of growth conditions on GaAsBi optical properties with important results. For instance, when the substrate temperature during growth was reduced from 400°C to 300°C and all other growth conditions were fixed, the Bi concentration in the deposited films increased from 1% to 5% and the photoluminescence (PL) intensity decreased by more than a factor of 1000. This is an indication of the importance of growth temperature in GaAsBi crystal quality.

N+/P junctions were grown for the deep level transient spectroscopy (DLTS) experiments in collaboration with Simon Fraser University. The DLTS measurements showed that lowering the GaAsBi growth temperature increases the deep level density by a factor of 10. These deep levels are the source of non-radiative recombination and decrease the PL intensity.

The structural properties of GaAsBi were investigated by high resolution x-ray diffraction and polarized PL and revealed long distance atomic arrangement (Cu-Pt ordering) in GaAsBi. The measurements showed that the ordering is more probable at high growth temperature. This can be due to the larger mobility of the atoms on the surface at high growth temperatures that allows them to find the ordered low energy sites.