

ROBL-CRG

**Experiment title:****Investigation of the shape of the chemical composition profile in InGaAs/GaAs heterostructures****Experiment number:**

20\_02\_042

**Beamline:**

BM 20

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9

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**Report:**

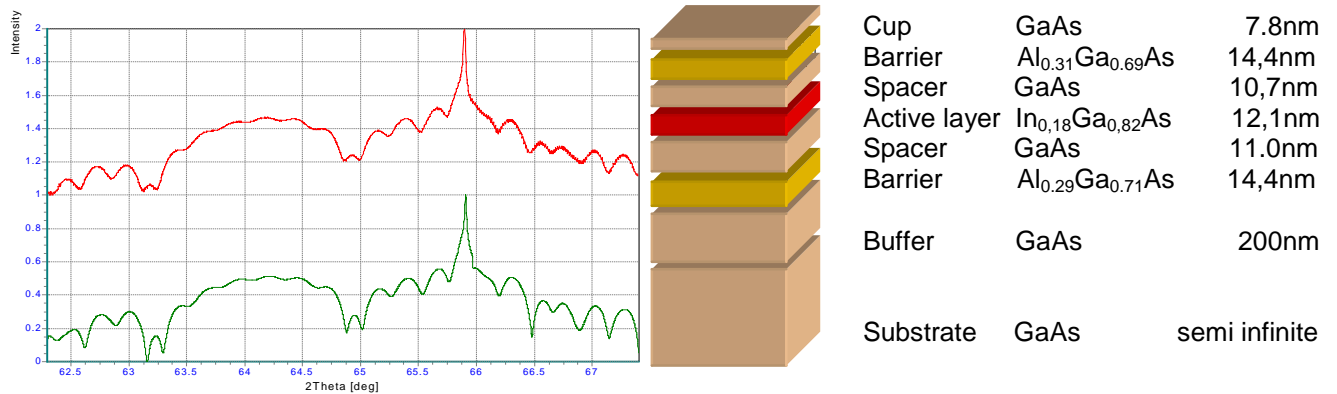
The ability of manufacturing heterostructures consisting of thin crystalline layers differing in their chemical composition and thickness is vital to the technology of semiconducting lasers and resonance diodes. In order to acquire laser action, it is essential to produce high quality multilayered crystals with sharp interfaces between succeeding layers. It is very difficult to accomplish this goal if there is a great lattice mismatch between layers, what refers especially to quantum wells applied to lasers and diodes, because in this case the lattice strain is often exploited to obtain a desired band structure. For such heterostructures the chemical composition profile undergoes the greatest disturbances in the vicinity of the interface in relation to the assumed one. The aim of this project was to investigate the chemical composition profile in the growth direction of heterostructures making quantum wells with very thin active  $\text{In}_x\text{Ga}_{(1-x)}\text{As}$  layers. Since the total thickness of the heterostructure is very small ( $d < 500\text{Å}$ ) the synchrotron radiation was used.

**Experimental method**

Two kinds of heterostructures were investigated:

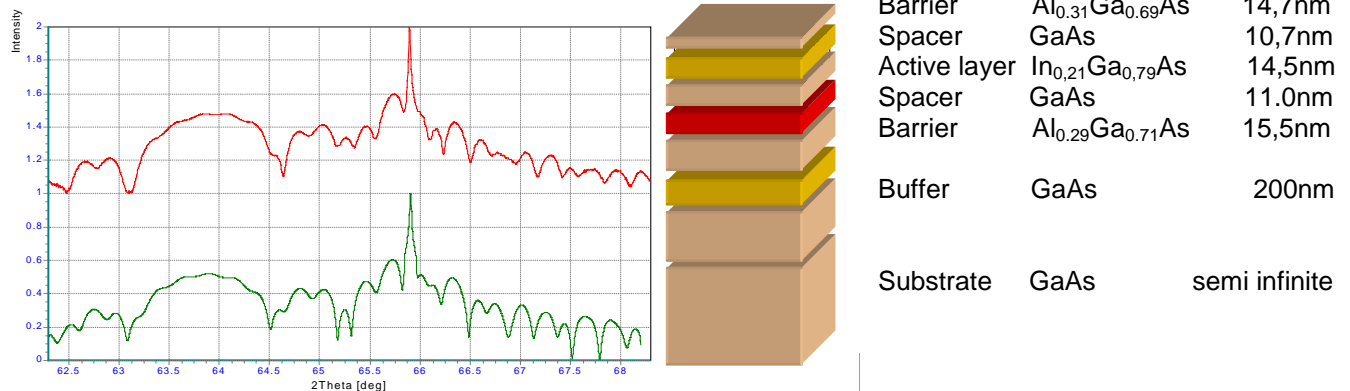
1. Laser structure as shallow and wide quantum well with wide barriers.
2. Structure of resonant tunneling diode (RTD) composed of deep and narrow quantum well with narrow barriers.

The determination of the chemical composition profile in the growth direction of the investigated heterostructures was carried on by means of the computer simulations based on Darwin dynamical diffraction theory.



*Experimental (top) and calculated (bottom) diffraction profiles for heterostructure growth rate 2ML/s, T=700C*

*Diagram representation of the heterostructure*



*Experimental (top) and calculated (bottom) diffraction profiles for heterostructure growth rate 0,5ML/s, T=700C*

*Diagram representation of the heterostructure*

Applying synchrotron radiation in the experiment it was possible to determine the real structure of the very thin buried active layer.

On the basis of the experimental results and conducted simulation the chemical composition profile of investigated heterostructures was determined as a function of a growth rate. It was found that lower growth rate results in greater discrepancy between obtained and expected results. It was also established that the symmetric AlGaAs barriers stabilize the profile of InGaAs active layer (there is greater discrepancy between the expected and real chemical composition profiles in case of heterostructure with only one barrier between active layer and substrate). These results allow us to draw conclusions concerning deposition of In and Ga atoms as a function of growth conditions and contribute to the program dedicated to producing laser and resonant diode structures.