Bachelor Thesis Task in the Program Electrical and Electronic Engineering, ISE

Topic: X-ray Diffraction Analysis of Epitaxially Grown Semiconductor Structures for High-Frequency Electronic Devices

Task:

The field is investigating high-performance heterojunction bipolar transistors (HBT) and resonant tunneling diodes (RTD) for high-frequency applications based on the indium phosphide semiconductor material system. The necessary semiconductor layers for the HBTs are produced locally using metal-organic vapor phase epitaxy (MOVPE), while molecular beam epitaxy (MBE) is used for the RTDs. The vertical layer structure and the quality of the grown layers are crucial factors that determine the performance of the resulting devices. A powerful tool for analyzing the grown layers is high-resolution X-ray diffraction (XRD), which can be used to investigate layer thicknesses, material composition, and stresses in the material, among other aspects.

This thesis will examine various layer stacks for use in HBTs and RTDs. For the HBTs, the focus will be on the sharpness of InP/InGaAs heterojunctions that have been optimized in a growth campaign. In the area of RTDs, the influence of various design parameters of the layer stack on the performance of the resulting devices will be investigated. To do this, the layer stacks must first be thoroughly examined using XRD measurements before processing. The tasks include carrying out the measurements with an appropriate configuration of the measurement setup and analyzing the results through simulation and adjusting the layer stacks based on the measurements. Additionally, a sensitivity study will be conducted to identify which characteristic features of the measured spectra are particularly suitable for determining critical layer parameters.

The insights gained from the X-ray diffraction analysis will then be correlated with results from other characterization methods, such as atomic force microscopy and photoluminescence measurements, as well as measurements of the fabricated devices.