

Master Thesis Task in the NanoEngineering Program

Topic: Optimization of p-InGaAs Base Layers and Their Integration into an MOVPE Process for Submicrometer InP Double-Heterojunction Bipolar Transistors (DHBTs)

Task:

In the research group BHE, InP-based double heterostructure bipolar transistors (DHBTs) for high-frequency applications are investigated using metalorganic vapor phase epitaxy (MOVPE). A high level of p-doping in the DHBT base is essential to achieve a low base resistance, which directly translates into a high maximum oscillation frequency (f_{max})—a key parameter for the realization of high-frequency amplifiers and oscillators.

The base resistance consists of two components: the sheet resistance of the p-InGaAs base layer and the contact resistance between the p-InGaAs and the base metal. To minimize both contributions, the sheet resistance must be as low as possible while simultaneously maintaining a high hole concentration.

During the growth of highly p-doped InGaAs, unintended hydrogen passivation of acceptors must be avoided. Furthermore, the quality of the p-InGaAs layer must be preserved throughout the subsequent growth of the DHBT structure and during the following submicrometer fabrication process.

This work aims to optimize the sheet resistance and hole concentration in the p-InGaAs base layer within a complete DHBT structure. Epitaxially grown DHBT layer structures will first be processed into large-area test structures to extract TLM (transmission line method) and Hall measurement data, enabling the determination of hole sheet concentration and mobility. Additionally, optimized DHBT structures will be fabricated into submicrometer-scale transistors via a submicrometer chip process, allowing for further validation of the base resistance through small-signal parameter extraction.