

PROJECT ASSIGNMENT MPA20

IN THE MASTER'S PROGRAM

Topic: Investigation of Nonlinear Dynamics of Resonant Tunneling Diode Oscillators

Task:

In the terahertz (THz) range between 300 GHz and 4 THz, many novel applications are currently emerging: contactless material detection and characterization, ultrafast wireless data transmission of several Tbit/s, and detection of hidden objects in robotics and security applications. For these application areas, compact signal sources and detectors are needed that can efficiently provide high output power, detect with high sensitivity and low noise, and be produced in a compact, robust, and cost-effective manner.

In the Collaborative Research Center/Transregio 196 (SFB/TRR196) MARIE, we investigate the resonant tunneling diode (RTD), a device based on the quantum mechanical tunneling effect, which can generate signals up to 2 THz to date. By improving the vertical structure of the semiconductor, the manufacturing processes of the devices, and their integration into arrays, we aim to enhance the performance of these THz components. In mobile application scenarios, electronic beam steering is gaining importance. There are concepts for realizing phase control and thus beam steering through the so-called "injection locking."

In the context of this work, a setup for measuring injection locking will be realized. This includes implementing an integration concept for the individual RTD oscillator chips, as well as the metrological realization and model-based description. Both individual RTD oscillators and arrays will be available. The measurement setup will enable free-space measurements on wafers and modules. Subsequently, initial measurements for injection locking will be conducted. An approach for determining the output power of the RTD is also necessary. Since the measurements in the THz range are sufficiently complex, initial approaches to understanding the dynamics of the RTD oscillators will be developed.

- Realization of the integration concept (flip-chip bonding, wafer dicing, chip/lens bonding process, wire bonding)
- Implementation of a measurement setup for conducting measurements on wafers and modules
- Establishing power measurements on RTD oscillators
- Injection locking measurement on individual RTD oscillators and arrays
- Optional: 3D EM field simulations