

## **Task in the NanoEngineering Program**

Topic: Development of an RTD Module for the Electronic Readout of a Terahertz Biosensor

### **Task:**

In the BHE research group, integrated terahertz emitters based on resonant tunneling diodes (RTDs) are being developed for sensor and communication applications. A metasensor is formed by a periodic metastructure whose resonance frequency shifts in response to changes in its dielectric environment—such as coupling to resonances of organic molecules, proteins, or nanoparticles. This sensor type is particularly well-suited for biological thin-film systems, as the field enhancement provided by the metastructure enables significantly higher sensitivities compared to conventional transmission-based sensors. By measuring the shift in resonance frequency as a function of analyte concentration, the metastructure can be used as a highly sensitive sensor. Currently, this frequency shift is typically determined through labor-intensive, laser-based terahertz spectroscopy.

The goal of this work is therefore to couple the metasensor to an electronic oscillator based on a resonant tunneling diode (RTD), thereby transferring the frequency shift directly onto the RTD. Key tasks include the design and fabrication of suitable metastructures via deposition onto silicon wafers, the integration of the metastructure into a functional RTD module, and experimental validation in a free-space measurement setup. Additionally, nanoparticles will be generated via laser ablation and subsequently functionalized with proteins—this part of the work will be carried out in collaboration with the Barcikowski research group. As a secondary objective, an appropriate electromagnetic (EM) simulation framework will be established to model the interaction between the active RTD oscillator and the passive metastructure.