## DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

Temperature sensing is important in many fields, including nano- and micro-electronics, biology and clinical diagnostic. When an electric current passes through the material it generates heat. Understanding where the temperature rises in an electronic system helps engineers design reliable, high-performing devices, like processors for computers and cell phones. While the thermal effects in macro scale circuits are well understood, when the device dimensions approach nanometers and it consist of just a few molecules, the classical physics no longer describes the relationship between heat and electric current. Temperature is also a key parameter in clinical diagnostic. The first signature of many diseases is the appearance of thermal singularities. Moreover, in biological systems, temperature determines e.g. cell division rates, thus the precise temperature mapping with high spatial resolution is of great concern, stimulating considerable interest in nanothermometry.

Over the years different nanothermometers, based on various temperature dependent effects, have been developed. Among them, luminescence nanothermometry might be distinguished. It uses luminescent material with temperature-dependent optical properties. When the environment temperature is varied, the emission response of such device is changed, i.e. its intensity is modified and/or the spectral peak position shifts. As a result, the read-out from a nanothermometer is attained electrically by analysis the voltage shift with temperature as well as remotely by analysis of the emission spectra.

In this project we will investigate semiconductor based nanothermometers. Investigated structures will consist of an active region, based on a so-called resonant tunneling diode. The design determines the optical and electrical properties of the device. While a semiconductor-based nanothermometer (gallium arsenide) has been already presented in the literature, there is no information available on analogous structures utilizing other materials like antimonides. Such a material system offers many advantages. First and foremost, the substantial flexibility of band gap engineering allows designing structures with high peak currents at low voltages. The former factor is essential for applications in high-speed optoelectronics, whilst the low voltage indicates low power consumption.

The main goal of the project is to investigate the optical properties of nanothermometer structures. Particular attention will be focused on determination of the energy structure of the so-called resonant tunneling diode being a part of the active region of tested samples. Advanced experimental and theoretical studies will be performed by means of optical spectroscopy techniques and energy structure simulations, respectively. Since the active region is expected to emit radiation in the mid-infrared spectral region beyond 3 μm, Fourier-transform infrared spectrometer will be employed. The emission properties of given samples will be tested in a function of crystal lattice temperature in order to find out if the design of grown samples is suitable for application in nanothermometry. It is also expected that a two-dimensional electron gas will be present just after the active region i.e. at the interface of active region and absorption layer. The electron charge accumulated at this particular interface is responsible for the prevailing transport property of the semiconductor nanothermometer - the linear voltage-temperature response. As a result the detection of quantum states related to the two dimensional electron gas is crucial for the optimization of the design of the operational device.