Richard P. Feynman gave a famous lecture at an American Physical Society in the 50s. The title was „There's Plenty of Room at the Bottom". This lecture is considered nowadays as an origin of the nanotechnology. Feynman described in his lecture a new possibilities with techniques that can manipulate in the nanometer scale. At present the nanotechnology is a well established and fast growing field of knowledge with broad spectrum of applications. One field of the particular interests are the active heat controlling devices which a thermal diode is an example. The thermal diode behaves similar to the electric diode. It allows the heat to flow in one direction with small resistance and in opposite direction with large resistance. The main difference is that the electric diode controls the flow of the electricity and the thermal diode controls the flow of the heat. The basic heat carrier in semiconductors and insulators is a quasiparticle called phonon. Phonon properties can be tuned with the use of phononic crystals (materials with periodic change of elastic properties).
Controlling the heat in nanoscale is critical for many engineering processes. (i) Impeding and (ii) facilitating the heat transfer are the two groups of the phonon transport research. The first group has the application in heat rejection in Li-Ion batteries used in electric vehicles and portable electronics (heat dissipation). The second group is used in thermoelectric (TE) materials which can directly convert heat to electricity (energy harvesting). One of the example of application is the Internet of Things (IoT) where batteries and wires can be replaced by the TE devices.

The main objective of this project is to design, fabricate and measure the thermal properties of the thermal diode based on silicon membrane phononic crystals. To make this possible a computer simulations are the necessary step to optimize the structure in order to enhance the difference between the amount of heat flowing in opposite directions. Next the designed structure will be fabricated using the Focused Ion Beam technique and finally the Raman thermometry will examine its thermal properties.

Successful realization of the thermal diode will be a milestone to achieve a distant goal of narrowing the gap between the experimental studies and the industry application of active heat controlled devices.