

The primary scientific objective of this project is to design and fabricate modern metasurfaces whose geometry is programmable by an external magnetic field, and to investigate the effect of selected parameters of such systems on the way the metasurface interacts with the incident terahertz electromagnetic wave. There is no doubt that techniques related to the use of electromagnetic waves in the terahertz frequency range (0.1-10 THz) have a vast development potential in a variety of industries, ranging from telecommunications, where the development is toward the development of higher operating frequency bands, through new solutions in widely understood electronics, to interdisciplinary issues, such as the study of biological material and chemical substances using sensors that utilize THz waves. Unquestionably, the possibility of utilizing artificial structures - metamaterials, whose complex, specially designed internal structure makes it possible to alter their fundamental physical properties - for instance, it is possible to obtain a negative value for the refractive index or negative values for the electric or magnetic permeability coefficients - will play a significant role here. This unique structure of metamaterials offers whole new ways of interacting with electromagnetic waves, which has already led to significant advances in several technological domains. In the presented project, significant emphasis is paid to two-dimensional structures (metasurfaces) whose specified geometric properties may be reconfigured. This makes the use of such a surface far more versatile, since its interaction with electromagnetic waves varies as its shape changes. This sort of structure may be reconfigured in a variety of ways, such as by altering the conductivity of the material with temperature (using vanadium dioxide), for instance. Use an electromechanical microcircuit (MEMS) that is actuated electrostatically, thermally, or magnetically in an alternative approach. In the case of thermally regulated MEMS, slow tuning speed is an issue. Electrostatic control is the easiest to build, but it has the smallest tuning range. Due to the availability of a large tuning range for electromechanical microcircuits, the magnetic technique is one of the best alternatives here. Therefore, in this project, we chose to present the option of tuning in three dimensions utilizing a magnetic field, which provides possibly more controllable electromechanical microcircuits for tuning metasurfaces. The project will solve the following fundamental concerns about the planned metasurface structures:

- optimization of metasurface geometries. The optimal surface will be reconfigured with the magnetic field to the greatest extent, allowing for a deeper interaction with the THz wave;
- examination of the influence of selected geometrical and magnetic parameters of the designed metasurfaces on their effective ability to the desired interaction with the THz wave;
- exploration of the possibility of using other metasurface reconfiguration techniques in conjunction with the MEMS technique;
- study of the dynamics of the interaction between the metasurface and the THz wave;
- determination of the impact of continuous cyclic operation on the generated metastructure (and, as a result, its interaction with the THz wave).

The research carried out in this project will be a milestone in the development of the technique of reconfigurable metasurfaces designed for terahertz frequencies.