Currently, a lot of researched is aimed at developing new technologies for fiber optic communication and fiber optic sensing systems. Photonic crystal fibers, due to their unique optical properties, seem to be a great candidate for next generation all-optical systems. These fibers can be designed to by highly birefringent, non-linear or to transmit only selected wavelengths. This makes them particularly suitable for sensing applications. Aside from photonic crystal fibers, there is a lot of focus on utilizing fibers with periodic variations of refractive index, such as fiber Bragg gratings and long-period fiber gratings, as single-parameter or multiparameter sensors. Long-period fiber gratings (period >100μm) are gaining lots of attention as they can be sensitive to deformations (e.g. strain, bending and twisting), temperature and external refractive index. However, these gratings are not widely used commercially yet as the technology is still being developed and more extensive research in the field is required. The research conducted within this project will be focused on extending the current scientific knowledge regarding this topic.

The main scientific goal of the project is to examine the propagation properties of solid-core photonic crystal fibers with various types of stable liquid crystal-based periodic structures in the cladding. It is thought that such structures can operate as tunable long-period fiber gratings and be fabricated without introducing any changes to the fiber's core. Liquid crystal-based materials seem to be a perfect candidate for the purpose of this research as they are characterized by high birefringence and sensitivity to external factors such as electric field and temperature, which will allow for easy tuning of the gratings.

The samples will be prepared by infiltrating the photonic crystal fiber with a composite material consisting of a nematic liquid crystal doped with monomer and photoinitiator. Selective photopolymerization technique will be utilized to create polymer-stabilized periodic structures in the photonic crystal fiber. The periodic changes of refractive index in the fiber's cladding will be achieved either by stabilizing periodic changes of liquid crystal's molecular arrangement or by utilizing the fact that the presence of the polymer network itself can modify the material's refractive index. Depending on the molecular arrangement of the periodic structures, the propagation properties of the gratings can be either highly polarization-dependent or independent of polarization of the propagating beam. In both cases, the polymer-stabilized sections of the samples will exhibit lower sensitivity to external factors such as temperature and electric field than the non-polymerized ones. As a result, it should be possible to modify the effective refractive index of the fiber's cladding by changing the sample's temperature or applying external electric field. These changes should be clearly visible in the propagating spectrum.

The proposed project will result in development of new types of long-period fiber gratings, and possibly fiber Bragg gratings, that are easily tunable and highly sensitive to external factors due to the presence of liquid crystal material. It is thought that the obtained results can be a foundation for development of highly sensitive all-optical sensors suitable for measuring various physical quantities.