NANOPARTICLES-DOPED LIQUID CRYSTAL INFILTRATED MICROSTRUCTURED OPTICAL FIBERS WITH ENHANCED EFFICIENCY OF ELECTRIC FIELD TUNABILITY

Recently a new research line in nanoparticles-doped liquid crystals has been initiated. This combination of liquid crystals (NCs) with nanoparticles (NPs) is considered to be the next milestone in developing a new class of optofluidic systems. The presence of NP in LC material results in significant improvement of electro-optical parameters of LC-based devices and systems.

One of the promising ideas is to **introduce NPs-doped LCs into microstructured optical fibers (MOFs)** that may result in significant improved efficiency of electric field tuning. MOFs, also known as photonic crystal fibers (PCFs), have attracted an increased scientific interest mainly due to their outstanding properties, and variety of design. Propagation of light can be governed by one of two principal guiding mechanisms responsible for light trapping within the core, and can be dynamically changed by introducing NP-doped LCs into the air-channels broadening the applicability of PCFs. These kind of photonic structures are often referred to photonic liquid crystal fibers whose optical properties can be tuned by external physical factors such as temperature, strain, pressure, electric or magnetic fields.

In the following project we will **focus on development of a novel and innovative class of optofluidic microstructures composed of MOFs infiltrated with highly tunable LCs doped with metallic NPs** in order to enhance efficiency of electric field tunability envisaged for prospective optical fiber device applications. The initial phase of the project will be focused on definitions and specifications of: (i) new generation of LC materials, (ii) microstructured fibers and (iii) optofluidic devices to be designed and developed in subsequent stages of the project. While interaction between light and LCs can be used in many ways, the optical properties of LC-based optofluidic devices strongly depend on the particular LC structure and/or material applied. The primary tasks include selection, elaboration and characterization of metallic NPs for application in fabrication of MOFs infiltrated with NPs-doped LCs. In principle application of these non-standard materials allows for shortening of the switching/reaction times and lowering bias (Fredericks) thresholds. The final stage involves optimization of the materials, structures and optical fiber configurations in order to deliver relevant all-fiber demonstrators of the new technology. Additionally experiments will be initiated in order to obtain fully-defined and controllable molecular orientation of LC within the host structures.

<u>To summarize, our primary objectives include</u>**:** (i) Definition, selection, elaboration, and characterization of NPs, LC materials of a new generation, and customized MOFs with properties and parameters suitable for all-fiber devices with enhanced efficiency of electric field tunability (ii) Design (based on numerical simulations) and fabrication of NPs-doped LC infiltrated MOFs (iii) Proof-of-concept tests performed for experimental confirmation of enhanced electric field tunability efficiency in NP-doped LC infiltrated MOFs and their assembling with existing photonic systems (iv) Final optimization of the materials, structures and optical fiber configurations: relevant all-fiber demonstrators of the new technology will be delivered.

The final goals of our project involve the use of innovative design and fabrication processes including manufacturing of host MOFs, syntheses of LCs with specific parameters and their orientation within host structures and selection of appropriate NPs. The result of our project will be design of **novel all-fiber demonstrators of the enhanced electric field tunability** taking novelty that will uniquely originate from implementation of specific MOFs as well NPs-doped LCs. Application of nematics doped with nanoparticles should have a positive impact on possibility of the optical properties tuning (e.g. shortening the switching times and lowering the threshold bias for electro-optic effects). The main advantage of proposed solution is its **compactness, simplicity and relatively low-cost**, while its principle benefit arises from the direct access to unique and exceptionally established material and fabrication facilities allowing for customized MOFs to be fabricated and particular LC materials of a novel generation to be synthesized.