

In medical practice, an advanced experience is essential for correct interpretation of symptoms and later on, diagnosis, which almost always needs to be supported by a series of laboratory tests. These are often very time-consuming – take even up to a few days – what allows for the spreading and progression of the disease, makes the treatment longer, less successful and more expensive. For this reason, laboratory diagnostics is one of the most dynamically developing areas of modern medicine. Great investments are made all over the world on the development of novel, more effective, faster, and more functional biosensing architectures and diagnostics protocols. The biggest challenges while developing new diagnostic systems are: to decrease the time of the analysis; to conduct the tests in resource-limited settings; to handle limited volume of analyzed samples; to increase sensitivity; to offer flexibility of the sensor, which could allow for optimization of sensitivity and selectivity depending on the desired target.

Currently, scientific efforts are focused primarily on improving the sensitivity and speed of diagnostic devices, because accurate and fast medical diagnostics is crucial for fighting with a majority of health issues, which include fast-spreading bacterial or viral infection, as well as fast-progressing cancer. Inflammation as a first in organism indicator that signalizes the presence of the threat, and under normal conditions is followed by a healing process. However, in many cases, inflammation continuous and is an initiator of the development and progression of various diseases. Thus, following the markers of inflammation - especially directly where the inflammation occurs – could be a useful factor to study by a clinical tool in the fast evaluation of patients with inflammatory processes.

The main goal of this project is to design, develop and fully characterize a probe-like fiber optic sensor that will face all the mentioned above challenges. The end-face of the optical fiber modified using nano-films and thanks to chemically functionalization will be able to identify the inflammation state through selected inflammatory markers. With highly precise, repeatable manufacturing and microscale size, the proposed device will allow for fast, sensitive, selective and in-spot detection of a target of interest in very small volumes. What is more, it will make possible to detect the biomarkers not only in simple test solutions, but also in complex biological media. A combination of the optical fiber with specially designed nano-films will increase the flexibility of the device allowing adjustment and tuning its sensitivity depending on the targeted molecule to obtain the most accurate results.

To achieve the goal of the project, we will undertake the following steps. First, we will design the nano-structure at the end-face of the fiber using numerical analysis. Next, end-faces of the optical fibers will be nano-coated according to the design using advanced deposition methods, such as physical and chemical vapor deposition, as well as atomic layer deposition. Prepared sensors will be optimized towards the properties of the inflammatory markers, namely myeloperoxidase or neutrophil elastase. The optimization process will be followed by chemical functionalization of the nano-films to immobilize the specific receptors – antibodies – which will allow selective detection of the biomarkers. At the final stages, we will develop a sensing procedure and its optimization, which will verify also the application of the sensor in environmental conditions as for in vivo examinations, i.e. inside living organisms.