The development of biological sensors and progress in medical diagnostics are strongly determined by the availability of modern sensors, that offer competitive performance and accuracy. Scientists working on the development of a new type of biosensors have been focusing for a long time at achieving simultaneously low limit of detection of a particular compound or ion, high specificity (ability to distinguish chemically similar molecules) and high sensitivity (ability to distinguish between similar concentrations for the same species). In laboratories, however, they often examine simplified systems and conduct experiments in highly idealized conditions (*e.g.* with little or no potentially interfering substances or ions). Nature can not afford such luxury, nor can it arbitrary change the conditions of a particular process. Therefore, it has evolved numerous molecules and mechanisms that provide both selective and specific interaction with certain molecules or ions (*e.g.* $H^{+,}$ Ca^{2+} ions).

The aim of this project is to develop, fabricate and test a new class of optical sensors, based on the use of nature-inspired short peptides (fragments of proteins), known to react by changing its secondary structure in response to pH variations (concentration of hydrogen ions) or biologically important metals ions concentration (*e.g.* Ca^{2+}). In other words, such a peptide upon pH variation may unfold from a regular spatial system of the amino acid chain (*e.g.* α-helix or β-sheet) into a chaotic structure or vice versa - fold into an ordered structure. The sensor operation will be based on SERS (surface-enhanced Raman scattering) effect, which requires the attachment of a peptide to Ag or Au nanostructures, using the amino acid being a chemical "anchor" and incorporating the aromatic amino acid to the sequence (or using native one), as a specific marker ("probe"), that will give the dominant Raman scattering signal, when measuring the response of the sensor. Due to the nature of SERS phenomenon, the signal intensity from the amino acid "probe" will strongly depend on the distance from the surface of the nanostructure, which in turn will be determined by the degree and manner of peptide chain folding.
These changes in the intensity of the SERS signal will be used to determine the concentration of ions that change the conformation of the peptide.

Knowledge of the exact pH and/or monitoring its variations is often a critical parameter in medicine. Abnormal pH values may be a signal of pathogenic changes or decide on the toxicity of a given fluid (including biofliuds). In turn, calcium ions are unique ions in biology, signaling both important life functions and cellular death. They regulate many different cellular processes, and their selection for this function by evolution is most likely due to their high bioavailability. The development of analytical methods necessary to determine physiological concentration of calcium ions and also slight changes in pH is still challenging. Therefore, the construction of new sensors for the determination of pH and Ca(II) ions, using specialized peptide structural motifs, seems to be a reliable and promising method, especially in combination with sensitive SERS spectroscopy.