Protein – ligand interactions are fundamental to almost all processes occurring in living organisms. The ligands are most often ions, low-molecular weight compounds, peptides, nucleic acids and other proteins. This binding is most often reversible, highly specific and crucial in the regulation of the cell cycle. The interaction of proteins with ligands is also important in the development of new pharmaceuticals. The research for low molecular weight compounds (new drugs) that inhibiting enzymes and modulating the processes of protein complex formation is the foundation of modern medicine. Due to such extensive meaning, understanding of protein - ligand systems has become an important issue. Currently, tests based on the interaction of proteins with ligands are used not only for scientific purposes, but also have significance in diagnostics.

Biosensors are common devices for studies the interactions of protein - ligand. The main element of biosensors is a biological component integrated with a suitable transducer. The transducer is the part of the sensor, which converts chemical information into a measurable signal. The signal is proportional to the concentration of the analyzed substance. The basis for the efficient functioning of biosensors is the selection of an appropriate biological component that will react in a specific way with the analyzed substance. The most popular protein components in biosensors are usually antibodies. The main advantage of antibodies is the highly specific binding of antigens. This property of antibodies increases sensitivity and specificity of such immunosensors.

Depending of the kind of transducer the biosensors can be divided into few groups (optical, mechanical or electrical biosensors). Nowadays, optical biosensors based on surface plasmon resonance (SPR) are becoming more and more important. They are widely used in scientific and pharmaceutical research, food research and in medical diagnostics. SPR is a phenomenon that occurs in thin conducting films at an interface between media of different refractive index. Changes in the solute concentration at the sensor surface (for example caused by specific interaction of ligand with analyte) cause changes in the refractive index of the solution which can be measured as an SPR response. The basic element in the SPR is a thin layer of gold on the sensor surface.

The main advantage of SPR technique indicates of biosensing without requiring any types of labeling (fluorescent, colorimetric, radioactive), which could interfere with the biosensing process, sensitivity, and real-time monitoring of biomolecule binding. In SPR techniques, the protein - ligand interaction is monitored directly in real time. Unfortunately, label-free SPR-based biosensing has low sensitivity for applications with small molecules and low concentrations of analyte. Nowadays, to improve the biosensing performance, researchers have proposed various types of material for the enhancement of optical properties of the transducer in SPR sensor.

The aim of the project is focused on the development of a new type of highly sensitive biosensor with graphene oxide (GO) and/or GO hybrids with polymers and silver/copper nanoparticles, as supporting layer on the gold surface in the SPR biosensor. We postulate that due to several physicochemical advantages as well as optical properties, GO can be a good enhancer of SPR signal. Gold surface of the SPR sensor coated by GO will increase the sensitivity of SPR biosensor. Moreover, the biochemical properties of GO, as well as its versatile surface with various functional groups (epoxy, carboxyl, hydroxyl-group), enables facile covalent and noncovalent immobilization of biomolecules. The modification of graphene oxide with popular polymers such as poly-L-lysine, poly-L-arginine or polyethylene glycol will increase GO biocompatibility and will reduce its cytotoxicity. Furthermore, the addition of silver/copper nanoparticles will provide additional enhancement of the surface plasmon resonance signal.

In this project, several issues will be addressed and investigated as: the reproducible method for efficiently covering gold surface by GO, the number of GO layers needed to significantly enhance the SPR signal and the stability of obtained biosensor surface. The second part of the project will be dedicated to immobilization of proteins on the GO surface for interaction with analytes and for avoiding non-specific binding of other components. The functionality and sensitivity of the prepared immunosensors will be determined during a series of measurements of the interactions between antibodies and antigens. The planned research will contribute to the broadening of knowledge in the field of modern materials such as graphene oxide in physicochemistry and biochemistry with a special focus on SPR immunosensors.