The popularity of electrochemical sensors is growing exponentially. Some of them have a chance to change the face of our civilization forever, allowing for ultrasensitive detection of threats related to the occurrence of pathogens, such as cancer cells, viruses, bacteria, and others. The functioning of sensors in molecular recognition systems in chemistry and biology is associated with the charge transfer across the electrode/electrolyte interphase. The created electrical system is characterized based on the analysis of electric signals, while the process kinetics significantly depends on biosensor surface heterogeneity.

As a result of the project implementation, the title Au-Minecraft will be built, i.e. a system that will detect changes in impedance signals resulting from changes in heterogeneity level, caused by intentional and controlled disturbance of the sensor surface geometry. This task will be possible thanks to the innovative use of gold nanostructures, appropriately surface-modified to identify host-guest interactions. The self-organization of these nanostructures as a result of an electric field or the occurrence of specific intermolecular interactions will allow for a significant increase in the sensitivity and selectivity of detection. The detection system will be verified by tests carried out on different macromolecule structures, i.e. selected proteins, enzymes, and DNA.

The project will examine and determine how changes in the self-organization of gold nanostructures will affect charge flow in diffusion areas. A direct result of the work will be a description of electron transfer mechanisms, allowing a deeper understanding of the processes occurring on the sensor surface. Our results will contribute to the creation of a new type of electrochemical sensors, enabling, among others simultaneous detection of multiple substances.

The proposed experimental approach is based on impedance and optoelectric measurements, as well as dedicated microscopic tools supported by molecular modeling. The wide spectrum of research will allow for proper consideration of the kinetics and mechanism of processes occurring on the self-organizing surface of the sensor.