Stage 1 – Project Results Summary/2022

Sensors array development and characterisation

Task 1.1: Deposition of nanocrystalline graphene layers by plasma-enhanced chemical vapour deposition. The introduction of heteroatoms into the structure of nanocrystalline graphene leads to changes in electrochemical properties due to the doping effect manifested by the heteroatom in the carbon structure, which can improve the transducer properties towards higher performance in applications for the detection of organic substances from various samples. The addition of nitrogen atoms into the structure of the carbon material is achieved by incorporating them into the graphitic carbon structure in the form of pyridine, pyrrole or graphitic nitrogen. During the growth process of NCG, 2 different ammonia streams were used in the composition of the precursor mixture to achieve doping with nitrogen atoms in the graphitic lattice at different heteroatom concentrations: N-NCG-2 and N-NCG-3.

Task 1.2: Synthesis, targeted derivatisation and physicochemical characterisation of GQDs. Depending on the working temperature and the duration of the synthesis process, carbon nanostructures with diameters in the order of 2 to 50 nm can be obtained. Based on the previously gained experience, it was decided to work with the graphene nanostructures obtained by the hydrothermal method in a single step using a microwave reactor and a microwave oven. The optimisation process took into account the suitable carbon source, the reaction time and the power used.

Task 1.3: Development of a sensor network. The electrochemical cell consisted of 3 electrodes, the working electrode being one of the 2 transducers modified by P1-IMT, the reference electrode Ag/AgCl (BioLogic) and the counter electrode Pt wire (BioLogic). To compare the results, an electrochemical cell was used, which also consisted of 3 electrodes. The only difference was the working electrode, which was a classic glass-carbon electrode (BioLogic, OD: 6 mm). A volume of 500 mL was used in the cell.

Task 1.4: Electrochemical characterisation of the developed sensor array. The peak spacing (ΔEp) was 0.46 V for glassy carbon, 0.42 V for N-NCG-2 and 0.46 V for N-NCG-3. The peak intensity for the N-NCG-2 sensors (440 µA) is almost 20 times higher than for the classical glassy carbon electrode (22 µA), and for the N-NCG-3 sensors (464 µA) the current intensity is about 21 times higher.