Elaboration of manufacturing technology of SERS platforms on functionalized by etching GaN substrates as sensors for examination of medical and biological molecules

Our project is focused on development of manufacturing technology of SERS (*Surface enhanced Raman spectroscopy*) platforms with high enhancement factor and on application of these platforms for studying medical and biological molecules. Our previous study resulted in development of new generation of SERS platforms based on photo-etched GaN epitaxial layers. The "sensitivity" of these substrates expressed by enhancement factor (EF) is in the range of 10^5-10^7, and is comparable with usually reported EF values for differently designed platforms. The EF parameter can be markedly enlarged by creation and multiplication of so-called "hot-spots", i.e. places showing highest plazmonic effect on the examined organic molecules using Raman method. The main aim of research project is to explore the possibility of creating the hot spots using complex etching procedure. Pilot studies have already shown that the deep hexagonal pits formed on screw dislocations results in increased SERS efficiency (EF higher of one order magnitude) performed on test molecules. Based on literature data a model was proposed, which explains formation of hot-spots inside the pits. We plan to elaborate the two-steps etching procedure (orthodox etching to produce pits followed by photo-etching to produce nano-pillars on dislocation in GaN heteroepitaxial layers) and to verify this concept of hot-spots formation. Apart from the understanding of the phenomenology of hot-spots formation, the high efficiency GaN-based platforms will be used for SERS study of biological and medical samples. Different bacteria, vegetative cells and endospores will be examined using our SERS platforms at Military Academy of Technology in Warsaw and at Consortium CREO in Italy.

Using our SERS platform we plan also to recognize the possibility of detecting the mutations of ctDNA in the blood of the cancer patients. This is a challenging and risky task, but if successful, could be a real milestone in reveling the early stages of cancer in the human body. This part of the project will be realized in collaboration with Holycross Cancer Center in Kielce and with the Chemistry Department of Warsaw University. Both fields of application of SERS method are important taking into account continuous threat of terrorist attack with chemical or biological warfare agents and the increasing number of cancer patients.