

The project's main scientific goal is in vivo Raman spectroscopy study of the temperature-induced self-healing process in neutron-irradiated epitaxial graphene

Graphene is a 2D material with unique properties, discovered in 2004 by K. Novoselov and A. Geim. It has been the most intensively studied material in recent years. Graphene is a material with a wide range of applications in new technologies due to its unique properties. Quasi-free-standing (QFS) properties of the epitaxial graphene sheets can be achieved through hydrogen intercalation of the carbon buffer layer. Łukasiewicz Research Network – IMIF produces an innovative Hall effect sensor using QFS epitaxial graphene technology on silicon carbide (SiC) and dielectric passivation with aluminum oxide. It is an ideal platform for magnetic field detection at significantly elevated temperatures, as high as 770 K, and under neutron radiation. Depending on the neutron fluence and the temperature, the epitaxial graphene and silicon carbide substrate can be destroyed. However, annealing at temperatures above 473 K results in self-healing of the epitaxial graphene, most likely through diffusion of hydrogen atoms.

Temperature annealing of epitaxial graphene samples after neutron irradiation and simultaneous Raman measurements will allow a detailed step-by-step analysis of the graphene self-healing process. Additional characterization of the structures at each step using atomic force microscopy (AFM), scanning electron microscopy, transmission electron microscopy, and electrical measurements will provide a complete and detailed image of the entire process. An essential aspect of Raman spectroscopy is its non-destructive nature and the absence of sample preparation problems for measurement. The substrate for epitaxial graphene plays a crucial role in its electrical parameters due to spontaneous polarization. Therefore, changes in SiC and their effects on graphene will also be investigated in detail.

The literature review has revealed the need for further research in this area. This research is unique, there is only one publication worldwide that reports on the effect of neutrons with a fluence of 6.6×10^{17} on epitaxial graphene. Detailed research in this area is particularly important in the development of fusion reactors, which are expected to be one of the future sources of renewable energy. In addition, the knowledge gained will help develop better graphene-based heterostructures widely used in microelectronics.