DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

The main aim of this project is study of the atomic structure and properties of one of the many known types of carbon materials - glassy carbon. Glass-like carbon has a unique combination of properties and that is why it is used in numerous industrial applications, e.g. in production of electrodes or high-temperature crucibles, and in medical applications. Currently it is considered as a material for the production of heart valves. Glassy carbon is hard, has low density and high surface area, is impermeable to gases, resistant to high temperature and chemically stable, can be easily polished, and above all, it is biocompatible and can be used as an implant. Therefore, this material is an extremely interesting topic of research.

Unfortunately, the origin of glassy carbon properties, such as great hardness, closed porosity and resistance to graphitization, has not already been satisfactorily clarified. The most important factor, beside the production agents, that affects the properties of materials is their structure at the atomic scale. Despite decades of research, the structure of glassy carbon has not been described in details. A discussion on finding the correct model of atomic structure and the mechanism of formation of pores in glassy carbon, as well as in other forms of porous carbons, is still ongoing. Whereas, it was showed that the heat-treatment up to 3000°C leads to significant changes in the structure and properties. Therefore, it is planned to investigate a series of glassy carbon samples produced by pyrolysis that means by thermal decomposition of furfuryl alcohol polymer at different temperatures in the range 600 - 2700 ° C. A detailed analysis of changes in mechanical properties and porosity following in the pyrolysis process is crucial for determination of the structure-properties correlations. In the final step of the project, it is intended to propose a model of the structure of glass-like carbon, which will explain resistance to graphitization and the unique properties of this form of carbon. A precise description of glassy carbon atomic arrangement may help in the characterization of other types of porous carbons. Studies on carbon biomaterials are very important to the selection of appropriate construction materials for medical implants. Composites based on glassy carbon can be a crucial change in implant technology.

Implementation of the proposed research project will be conducted using advanced experimental methods and computer simulations. The traditional method of X-ray and neutron diffraction will be used to determine features of the atomic structure. However, the analysis of diffraction results will be performed in an unconventional way - by using the so-called pair distribution function of atoms. This function is a tool for finding atomic arrangement in materials, which are characterized by a lack of perfect crystalline structure - unlike in graphite or diamond. Computer simulations will be used to create systems of atoms on the basis of which theoretical diffraction data will be calculated. Atomistic models which fit simultaneously experimental diffraction data, explain the origin of glassy carbon properties, such as high hardness and the presence of closed porosity, will be looking for. Hardness measurements will be performed by nanoindentation technique with using an indenter of radius of one-billionth of a meter. The pore structure features will be revealed on the basis of X-ray scattering under small angles.