Description for the general public

Carbon foams are carbon materials of the new generation, characterized by a significant degree of porosity and large specific surface. They were produced for the first time in 1960s by W. Ford. However, they did not generate a lot of interest among scientists, and it was only at the turn of centuries that there started detailed research into them. The definition of a carbon foam was developed by J. Klett: *a porous carbon product containing regularly shaped, predominantly concave, homogeneously dispersed cells which interact to form a three-dimensional array throughout a continuum material of carbon (matrix), predominantly in the non-graphitic state.* Klett tested many carbon foams in terms of their possible application, and his works resulted in numerous patents.

Carbon foams may be obtained from various raw materials, both renewable and non-renewable, with the use of various methods. The raw materials for production of carbon foams may be classified into two groups, depending on their capacity for graphitization. There are graphitizing raw materials which are able to subordinate the internal structure under the influence of very high temperatures (2800/3000^{o}C), and include hard and brown coals, pitches, coke tar and petroleum-based materials. The other group of compounds, which includes resins, polymer compounds and renewable raw materials, is characterized by lack of the capacity for graphitization, so the structure of the foams obtained from them is cured at the system carbonization temperature (ca. 800/1100^{o}C).

All the methods of obtaining carbon foams described in publications and patents, comprise 3 main stages. The first one consists in isolating the raw material and its initial processing, then material foaming, and the final stage consisting in consolidating the structure of the carbon foam, i.e. carbonization. What is important during the production of carbon foams, is both the chemical composition of the raw material, as well as the temperature, pressure and additives applied in the process. All those factors impact the development of pore size, and the consolidation of structure, so the method of obtaining foams significantly impacts their internal properties.

The research task stated in this project is to determine the impact of the method of obtaining carbon foams on their morphology as well as their mechanical, thermal and electrical properties. For that purpose, various methods will be used to produce carbon foams from a mixture of polymer resins, and there will be conducted studies into the obtained foams. The following methods will be applied in the project: the pressure method with a blowing agent, conducted at different pressure conditions, the non-pressure method with a blowing agent at atmospheric pressure, and the method combining the raw material self-foaming stage with the stage of thermal consolidation (carbonization) of the structure. Foam morphology will be determined with the use of electron scanning microscopy, optical microscopy, and a porosimeter (device for determining the amount and size of pores in the given material). There will be determined the density of the foams obtained, as well as their thermal properties. The project is planned to make use of a mixture of epoxy resin and phenol-formaldehyde resin as the starting raw material. That mixture has not been used for production of carbon foams, so the conducted experiments will additionally allow to determine the possibility of replacing more expensive raw materials, such as cyanate resin, with a cheaper and more available mixture of resins.