

Tytuł projektu
Badania nad syntezą i zastosowaniami pian grafenowych
Project title
Studies on the Synthesis of Graphene Foams of Diversified Application
Dyscyplina /Area of science
Nauki chemiczne
PROJECT DESCRIPTION
<p>Project goals</p> <ul style="list-style-type: none"> • To use hard and soft templating for the synthesis of multifunctional graphene foams • To explore diversified applications based on outstanding graphene properties: electric, thermal, magnetic etc. • To elaborate guidelines for synthesis upscaling above laboratory level • To elaborate patent application to the National Patent Office of Poland • To strengthen international cooperation by participating at conferences <p>Outline</p> <p>The aim of the project is to develop a method of obtaining the so-called graphene foams, i.e., porous materials with a remarkable surface area, whose walls with nanometric thickness are constructed of parallel oriented and interconnected graphene flakes. Graphene foams have a number of potential applications due to the unique properties graphene, i.e., a building material of the walls, namely excellent electrical conductivity, thermal conductivity, chemical resistance and unconventional mechanical properties. Therefore, graphene foams may be used as electrode materials (tailored electrical conductivity and pore structure), energy storage (pore structure and thermal conductivity), magnetic shielding materials (generation of local counter magnetic domains), filtering materials (tailored pore structure), liquids transporting materials (intensive capillary pulling), materials for heat transfer (high thermal conductivity), etc.</p> <p>The basic assumption for the planned methods for the synthesis of graphene foams will be the use of commonly available starting materials such as powdered graphene and graphite. The starting materials will serve as a source of graphene flakes released in the exfoliation process, which will then be transformed into the walls of graphene foams. This approach will make the planned research more oriented to practical applications of the obtained graphene foams and towards the implementation of the synthesis methods</p>

into practice. The Research and Modeling Group for New Materials Research Synthesis (head: Prof. Jerzy P. Łukaszewicz) conducts research on wet and electrochemical exfoliation of graphene. These studies are combined with three-dimensional structuring by hard-templating of exfoliated graphene flakes into the concerned graphene sponges / foams.

Work plan

1. Wet and microwave exfoliation of powdered graphene and graphite.
2. Formation of mixtures from exfoliated graphene flakes, hard and soft templates and so-called binders that combine graphene flakes.
3. Alternative synthesis pathway exploiting so called “blowing” procedure.
4. Carbonization of graphene / template / binder mixtures obtained by soft and hard templating.
5. Enrichment of graphene foams with heteroatoms: nitrogen, sulfur, transition metals.
6. Physico-chemical characterization of graphene foams by instrumental methods: nitrogen adsorption (porous structure and surface area), elemental analysis (chemical composition), XPS spectroscopy (chemical structure of the surface), X-ray (crystal structure), Raman spectroscopy (identification of graphene agglomeration degree), SEM / HRTEM microscopy (identification of spatial structure).
7. Research on selected applications of graphene foams: electrode material, liquid transporter and heat transporter.

Literature

M. Inagaki, J. Qiu, Q. Guo, Carbon 87 (2015) 128-152
Q. Zhang et al., Journal of Analytical and Applied Pyrolysis 129 (2018) 150-153
T. Chen et al., Journal of Analytical and Applied Pyrolysis 113 (2015) 539-544
K. Zhang et al., Journal of Analytical and Applied Pyrolysis 117 (2016) 290-295

Required initial knowledge and skills of the PhD candidate

- ➔ Analytical thinking
- ➔ Eager to learn
- ➔ Understanding of materials synthesis and chemistry
- ➔ Thinking oriented on innovation and application
- ➔ Understanding of carbon material science
- ➔ Eager to work hard

Zgłaszający projekt/ Author of the project	
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