When a molecule approaches and hits a surface of a solid, two things may happen. It can bounce back or interacts with it through different forces The latter case have the most interesting possibilities and practical implications. That interaction is called adsorption, solid material is an adsorbent and the molecule adsorbed is called adsorbate.

In general, adsorption involves accumulation of molecules at a gas-solid or gas-liquid interface. Adsorbate can interact with solid surface through: (1) weak intermolecular forces (e.g. van der Waals interactions) or (2) strong interactions with formation of chemical bonds. First is called physical adsorption (physisorption), and the latter is chemical adsorption (chemisorption). Physisorption is characterized by reversibility, i.e. adsorbed molecule can be desorbed without changes in chemical structure, while in chemisorption a molecule upon desorption can dissociate into constituents groups and desorbed species are not identical as adsorbed molecules. However, it has to be emphasized that there is no sharp distinction between them, and intermediate cases exist

Adsorbents are synthetic or natural materials with microcrystalline or amorphous structure. Adsorption can be influenced by numerous factors, e.g. temperature of adsorption process. However, the most significant is the adsorbent and its properties. The adsorption properties of a given solid material depend strictly on its physicochemical properties – pore volume, specific surface area, pore size distribution, and type of functional groups on the surface. Materials with high surface area and pore volume are preferred, because they poses high adsorption capacity. Among commonly used adsorbents, in practical applications, are: activated carbon, silica gel, activated alumina, and zeolites.

As mentioned before adsorption processes are of unprecedented importance for science, industry and domestic applications. Thus, there is a growing demand for adsorbents with unique properties, engineered specifically for given application. Among emerging materials with interesting adsorption properties are: metal organic frameworks, porous polymer or carbon nanoparticles. Moreover, currently there is the abundance of chemically and/or physically modified adsorbents under investigation – introduction of new functional groups to the structure of the adsorbent can be a source of a unique and beneficial selectivity towards selected chemical compound / group of chemical compounds.

Owing to their unique properties, carbon nanoparticles (carbon nanofibers, carbon nanotubes, fullerenes, graphene or asphaltenes) present potential to revolutionize the world similarly as silicone have had. However, for standalone applications a transition of nanoparticles to three dimensional macroscopic architectures is required. However, it may not be a simple transition with preservation of starting material's (nanoparticles) properties, but macroscopic object can exhibit new quality – not necessarily superior. Transformation into 3D objects can be achieved through aerogels - a class of light-weight, 3D structures with interconnected pore network, high surface area and pore volume. Aerogels are characterized by very high strength-to-weight and surface area-to-volume ratios. The performance and applicability of carbon nanoparticles-based aerogels are being investigated in different applications e.g. sensors for pressure and chemical vapour detection, electrodes in supercapacitors, catalysis, bioengineering, electrodes in Li-ion batteries, separation techniques or desalinization processes. Most of the mentioned works is focused on applications and their ultimate goal is to prove the applicability of aerogels for certain technological solutions. As such, gathered information about nature of aerogels, their structure, properties and intermolecular interactions are limited and incomplete.

Research project **"Preparation and investigation of carbon-based 3D porous structures (aerogels) structural properties and intermolecular interactions at solid/gas interface"** aims to investigate the physical and chemical structure of the carbon-based aerogel's surface. As a raw material for aerogels synthesis, carbon nanotubes, graphene and asphaltenes will be used. Moreover surface forces of aerogels will be investigated by analysis of interactions of chemical compounds at solid/gas interface. Fundamental research conducted in this project will increase the knowledge about carbon nanomaterials properties, possibility of translation of their beneficial properties into 3D macroscopic structures and will give insight into mechanisms of adsorption on the synthesized aerogel surface. This kind of basic research is essential step on the road to comprehensive knowledge about the nature of this type of materials.