Graphene and carbon nanotubes belong to the large group of carbonaceous nanostructures. These structures show interesting and varied properties. Graphene is an allotrope form of carbon with monoatomic thickness, made of carbon atoms forming crystal lattice similar to honeycomb. Nanotubes can be imagined as graphene sheet rolled up into a seamless cylinder. One sheet of graphene forms single walled carbon nanotube, and multi walled carbon nanotubes are made of several nanotubes one within another.

Characteristic feature of carbon nanotubes and graphene derivatives is high specific surface area, which might exceed 1000 m^2/g. It means, that total surface of 1 g of such materials could cover the surface of two tennis courts. This attribute allows to use such material as adsorbent. Adsorbents are materials characterized by large specific surface area, which attracts other materials or particles to their surface by non-chemical bonds. These materials are often modified to adsorb more selectively, for example heavy metal cations. Combination of carbon nanostructures with phosphonic acid derivatives should enhance their adsorption capacity. This project is focused on carbon nanotubes and graphene derivatives with phosphonic groups.

Organic derivatives of phosphonic acids are known and applied in different fields of life. Phosphonic acids derivatives are used in chemistry, as complexing agents in chromatography or for selective extraction of elements. One of their most important features is the ability to form complexes with calcium ions and to disperse impurities, so they are used as detergents. They show positive interaction with metallic surfaces, inhibiting their corrosion. Bisphosphonic derivatives are commonly used as drugs for osteoporosis treatment.

We believe, that nanostructures, presented in the project, functionalized with phosphonic groups will show higher sorption ability towards heavy metal cations and alkaline earth metal ions, because of the high affinity of phosphonic groups to those ions and well developed specific surface area. Moreover, exceptional structure of carbon nanotubes and graphene favors adsorption of aromatic compounds such as popular organic dyes. The so called decolorization of water is problematic, because of the diverse structure and chemical stability of common dyes. Carbonaceous nanomaterials show high sorption ability of dyes, caused by interactions between molecules and nanostructure walls. High surface area, negative polarization due to hydrolysis of phosphonic groups makes the phosphonated carbonaceous nanostructures attractive for cationic dyes removal from wastewaters.

The uses of carbonaceous nanomaterials in different fields are really promising and the aim of this work is the preparation of novel materials, focusing on their adsorption properties. However, functionalization of carbonaceous nanomaterials with phosphonic groups offers great potential for wider applications, for example in conducting plastics, thermal conductors, energy storage, conductive adhesives, thermal interface materials, structural materials, catalysts, biological applications, air and water filtration, ceramics and so on. Effective functionalization by low-cost methods and detailed characterization of synthesized nanomaterials is, however, the first step towards utilizing the whole spectrum of their applications.