Analysis of the magnetic interactions in the two- and three-dimensional graphene oxide structures

The aim of the project is characterization of the magnetic interactions in modified two- (2D) and three-dimensional (3D) graphene oxide (GO) structures. Graphene oxide is a single-layered graphite oxide structure, which similarly graphene to consist of hexagonal layered carbon rings with honeycomb structure. However, in contrary to graphene, graphene oxide is rich in structural defects and lot of different oxygen functional groups introduced during graphite oxidation which allow to obtain modified graphene material for different potential applications. Single-layered GO is 2D structure. However, gels made of GO flakes form 3D structures. The aim of the project assume conducting basic research related to analysis of magnetic interactions occurring in 2D and 3D GO structures. Magnetic properties of graphene structures depend on material aging, purity and modification. Graphene oxide will be synthesized via modified Hummers method. This method involves 2 steps: oxidation of graphite and exfoliation of expanded synthesized graphite oxide into single-layered graphene oxide. Obtained 2D GO flakes will be modified via reduction (rGO), hydrogenation (hGO) and NH_3 functionalization (aGO). The influence of the edge and surface modification of the graphene flakes onto magnetic properties will be investigated. The crucial information is influence of the material aging process, which has essential impact of potential application of GO in electronics, supercapacitors or energy storage systems. In case of GO based 3D structures, 3 different gels will be prepared: i) water-filled hydrogels, ii) dried hydrogels with collapsed structure called xerogels and iii) air-filled hydrogels – aerogels – obtained via freeze drying process. Hydrogels will be synthesized by sol-gel method in assistance of reduction via typical chemical reduction agents and transition metal ion chlorides. The presence of the metal ions is important due to possession of magnetic moments modified magnetic interactions in graphene oxide structures and present signal in electron paramagnetic resonance spectroscopy (EPR). This effect allow to determine homogeneity of ions dispersion and concentration in gel pore structures. Moreover, xero- and aerogels of GO will be immersed in transition metal chloride solutions in order to estimate adsorption capacity. This study has crucial meaning for potential application of GO aero- and xerogels in form of heavy metal absorbers and filters in water purification, respectively. The basic magnetic measurements will be performed by EPR and magnetic susceptibility. Physicochemical characterization of obtained structures via spectroscopic and microscopic techniques will be performed after each step of preparation.