Modified graphene oxide in preconcentration and determination of trace metal ions

Graphene oxide (GO) is one of the most interesting carbon nanomaterials that have been used in analytical chemistry in recent years. Such an interest in GO can be explained by its excellent adsorptive properties, which result from its large surface area and presence of functional groups containing oxygen atoms, i.e. carbonyl, hydroxyl and epoxy ones. Oxygen-functional groups on the surface of GO are responsible for metal ions complexation. Unfortunately, GO is not selective toward metal ions. Therefore, in order to improve the selectivity of GO, it is necessary to modify its structure.

The aim of the PhD thesis was the synthesis of chemically modified GO that can be used for the development of new analytical procedures enabling determination of metal ions. New adsorbents such as GO-SH, GO-1N, GO-2N i GO-3N were prepared through grafting silanes containing thiol and different number of amino groups on the GO surface, respectively. They were characterized by scanning electron microscopy, X-ray photoelectron spectroscopy and X-ray fluorescence spectrometry. In the next step adsorptive properties of nanomaterials were investigated. The parameters such as pH, sample volume and contact time between analytes and adsorbent were evaluated. Then, the maximum adsorption capacity of the GO derivatives were determined.

Due to excellent dispersibility of developed GO-based nanomaterials in water, they were applied in dispersive micro-solid phase extraction (DMSPE) for preconcentration of metal ions. Total-reflection X-ray fluorescence spectrometry (TXRF) was used for determination of Co(II), Ni(II), Cu(II), As(III), Cd(II) and Pb(II) ions adsorbed on the GO-SH surface. The proposed procedure allows achieving low detection limits ranging from 0.054–0.11 ng mL^{-1}. The GO-1N was applied for preconcentration of Pb(II) and Cr(VI) ions. In that case electrothermal atomic absorption spectrometry (ET–AAS) and energy-dispersive X-ray fluorescence spectrometry (EDXRF) were used as detection techniques which allowed to obtain very low detection limits, i.e. 0.009 and 0.17 ng mL^{-1} for Pb(II) and Cr(VI), respectively. The developed methods were successfully applied for the analysis of lake, river, tap and sea water.