

Abstract

Graphene research is nowadays one of the worldwide most prominent fields of interest in material science due to many extraordinary properties of graphene and related materials. However, the different techniques of synthesis and subsequent handling and/or treatment have a substantial impact on the properties of the graphene and thus a lot of efforts have been focused on developing of the advanced methods for graphene preparation and characterization.

Graphene can be easily produced by oxidation and consequent exfoliation of the bulk graphite; however, resulting graphene oxide needs to be reduced back to graphene-like structure due to partial restoration of sp^2 network. Herein, a detailed study of the structural evolution of the graphene oxide during electrochemical treatment has been performed using X-ray photoelectron, Raman and infrared spectroscopies and the results were compared with non-oxidized graphene nano-platelets. Additionally, graphene oxide in composite with $LiFePO_4$ olivine material, which is electrochemically almost inactive in a freshly made state, has been tested by repeated electrochemical cycling. Using various electrochemical methods, the progressive electrochemical activity enhancement has been observed and spontaneous graphene reduction was identified as responsible for this phenomenon.

The second part of this work deals with mono- and bilayer graphene under uniaxial in plane loading. Generally, strain and even doping are present in graphene simultaneously and both play an important role in the changes of its electronic structure. The behavior of various strained graphene samples transferred onto the target polymer substrates were examined by Raman spectroscopy and discussed with respect to presence of cracks, wrinkles, grain boundaries and loss of bilayer lattice periodicity. Further, the level of stress and doping transferred to the crystal from the substrate was calculated by the vector analysis method with a specific adjustment for the uniaxial strain.

Finally, a new method for spectroelectrochemical characterization of isolated strained 2D crystals has been established.

Key words: graphene, Raman spectroscopy, spectroelectrochemistry