

Electron scattering in graphene with NaCl nanoparticles adsorbed

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Since planar, two-dimensional graphene structures enable facile and homogeneous functionalization, it is commonly expected that graphene will find a wide range of applications in many devices like ultrasensitive, label-free miniaturized electrostatic or electrochemical sensors. Recently, the use of graphene in an active fluid flow sensor has been considered. When thinking about this particular application, besides determining the influence of the liquid flow rate on graphene's electric response, it is very important to study the impact of fluids themselves on graphene layer's properties. In our studies, using Atomic Force Microscopy (AFM), Electron Spin Resonance (ESR), contactless electron transport measurements and Raman spectroscopy, we investigated electron scattering mechanisms in epitaxial graphene, grown on Cu, transferred into SiC substrate and exposed to 0.06 M NaCl solution. The functionalization of graphene with NaCl microcrystals was confirmed by AFM and ESR techniques. Contactless magnetoconductance measurements showed the weak localization effect for temperatures below 50 K (fig. 1a and b). The elastic intervalley and long-range scattering lengths did not change after NaCl treatment, whereas the coherence length was reduced. Temperature dependence of the coherence length showed electron-electron scattering as the main inelastic scattering mechanism, and a change from ballistic to diffusive regime in electron transport after NaCl treatment (fig. 1c). However, the main reason for the reduction of the coherence length at low temperatures for the NaCl-treated graphene sample was additional temperature independent inelastic scattering responsible for electron spin flip scattering, which we associated with the presence of NaCl nanoparticles on the graphene surface. The Raman spectroscopy showed that the intensity of the D and D' bands increased for the sample after its immersion in NaCl solution (fig. 2a). Statistical analysis of the intensities of the D, D' and G bands indicated that the scattering is caused by both decoration of the existing defects (vacancies and grain boundaries) with NaCl nanoparticles which increased the efficiency of the scattering processes, and creation of a new type of defects, i.e. on-site defects caused by the decoration of the graphene surface with NaCl nanoparticles. The energy shifts of the 2D and G bands proved that NaCl deposition on the graphene surface did not change carrier concentration but reduced compressive biaxial strain in a graphene layer (fig. 2b). This work was partially supported by the NCN grant no 2012/07/B/ST3/03220 (Poland), NCBiR grant GRAF-TECH/NCBR/02/19/2012 (Poland), and European Union Seventh Framework Programme grant agreement no 604391 Graphene Flagship.

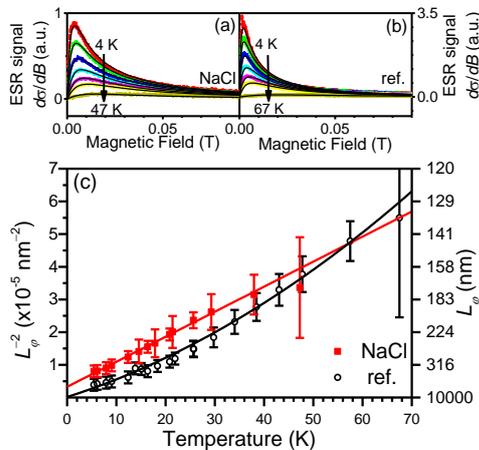


Fig. 1. Weak localization signal measured at different temperatures for graphene after (a) and before (b) immersion in NaCl solution and the temperature dependence of coherence length (c).

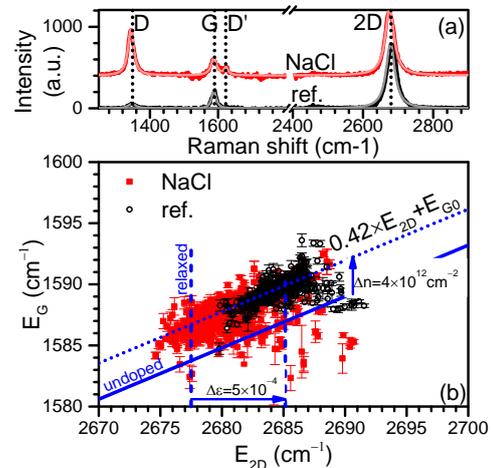


Fig. 2. (a) Raman spectra of graphene after and before immersion in NaCl solution and (b) the correlation of G and 2D bands energies.