Contactless weak localization measurements of graphene implanted with He^+ ions

Piotr Mickiewicz[1], Grzegorz Gawlik[2], Paweł Ciepielewski[2], Włodzimierz Strupiński[2], Jacek M. Baranowski[2], Maria Kamińska[1], Aneta Drabińska[1]

[1] *Faculty of Physics, University of Warsaw, Pasteura 5, Warsaw*
[2] *Institute of Electronic Materials Technology, Wólczyńska 133, Warsaw*

Scattering mechanisms determine graphene electrical properties and therefore they are crucial while considering its possible applications. On the other hand, contactless electron transport measurements of weak localization give the opportunity for direct studies of the influence of external factors on graphene scattering mechanisms without any redundant modifications of the sample. For this reason, the series of He^+ ions implanted samples with increasing ion concentration dose up to 2×10^{15} cm^{-2} has been studied and compared to the reference sample. The estimated defect concentration in graphene was approximately three orders of magnitude smaller comparing to the ion dose.

Weak localization effect was strongest in the reference sample, decreased with increasing ion concentration and vanished completely for value 2×10^{15} cm^{-2} (fig. 1). Fitting the obtained spectra with the literature model function [1] showed that implantation did not change elastic scattering lengths. Interestingly, for small ion concentration the coherence length decreased slowly with its increase, while for concentration between 1×10^{14} and 2×10^{14} cm^{-2} it dropped drastically. The temperature dependence of the inverse of the square of the coherence length (L_φ^{-2}) shows that this dramatic difference of the coherence length is correlated with conversion from the ballistic to the diffusive electron transport regime [2, 3]. Simultaneously, the increasing zero-temperature offset in this dependence indicates growing impact of additional spin-flip scattering even for the lowest ion concentration.

Observed effects reveal strong influence of the ion implantation to the graphene electron properties and scattering mechanisms.

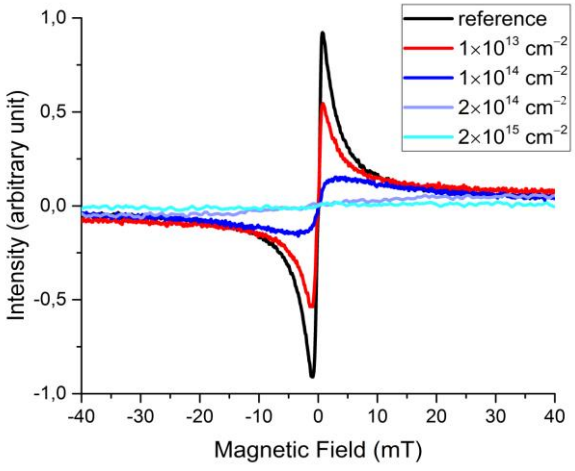

Figure 1: Spectra measured at 2 K for the reference sample and samples with specified other ion concentrations.

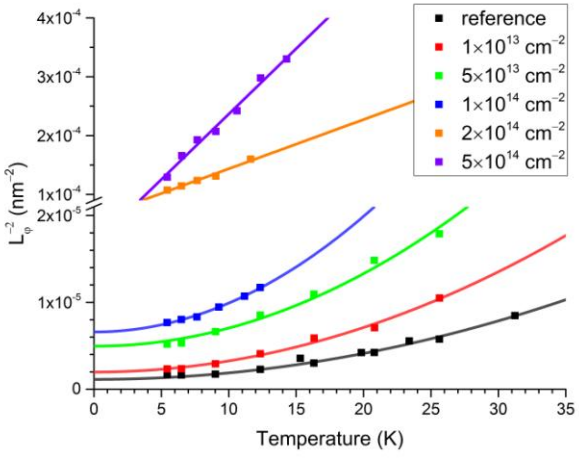

Figure 2: L_φ^{-2} temperature dependence for all measured samples.

[1] E. McCann, et al., *Phys. Rev. Lett.* **97**, 14, 2006.
[2] B. N. Narozhny, et al., *Phys. Rev. B* **65**, 180202, 2002.
[3] B. L. Altshuler, et al., *J. Phys. C Solid State Phys.* **15**, 7367, 1982.