Graphene spintronics: An experimental update

Bart van Wees

Zernike Institute of Advanced Materials, University of Groningen, Groningen, The Netherlands

(b.j.van.wees@rug.nl)

I will give an update of the current status of graphene spintronics in our group. In 2007 the first observation of spin transport and spin manipulation in a graphene field effect transistor was reported [1]. Since then the key issue has become to investigate the mechanisms which produce spin relaxation, in particular spin-orbit interaction, and how they depend on the graphene quality and graphene substrate (exfoliated graphene on SiO2, CVD grown graphene, graphene on SiC, suspended graphene). Recently we have investigated spin transport in devices with a suspended graphene layer [2]. Here we observed a spin relaxation time of about 200 ps. However, the analysis shows that this time is limited by the (lower) spin relaxation times in the non-suspended graphene regions. Thus, only a lower bound on the spin relaxation time could be established. Another choice of substrate is boron nitride, which provides a crystalline flat substrate. Here we could observe (at room temperature) spin transport over the maximum length achieved sofar (about 20 micrometers) [3]. Our analysis shows that both D'Yakonov-Perel (where the spin relaxation time scales with the inverse of the momentum scattering time) and Elliot Yafet (where the spin relaxation time is proportional to the momentum scattering time) spin relaxation mechanisms are present. Next I will show recent experiments which aim to investigate the interaction between the electronic and the nuclear spins. For this we have investigated spin transport in graphene with 100% C13, where all nuclei have spin 1/2. We observed high quality spin transport [4], and I will discuss our experiments to search for dynamic nuclear spin polarization. Finally we have compared spin transport in graphene on SiC. We find that we can explain the long spin relaxation times and short spin diffusion times [5] found in monolayer graphene on SiC (0001) by a model which includes localized states in the buffer layer, thus enhancing the effective g factor by more than an order of magnitude [6]. Future developments will be discussed.

References

[1] N. Tombros et al., Nature 448, 571 (2007)

[2] M. Guimaraes et al., Nano Letters 12(7), 3512 (2012)

[3] P. Zomer et al., arXiv: 1209.1999v1, submitted to Phys. Rev. Lett.

[4] M. Woijtaszek, in preparation

[5] T. Maassen et al., Nano Letters, 12 (3), 1498-1502 (2012)

[6] T. Maassen et al., arXiv:1208.3129v1, submitted to Phys. Rev. Lett.