MA 43: Joint Session "Graphen: Spin Transport" (jointly with DS, DY, HL, O, TT)

Time: Thursday 15:00–16:45 Location: H 1012

Topical Talk MA 43.1 Thu 15:00 H 1012

Spin transport in graphene — •Bernd Beschoten — II. Institute of Physics, RWTH Aachen University and JARA: Fundamentals of Future Information Technology, 52074 Aachen

Graphene is considered as promising candidate for spintronics applications. The reason is the weak spin-orbit coupling, the absent hyperfine interaction and the observation of micrometer long spin relaxation lengths [1]. So far most spin transport studies have focused on single layer graphene (SLG). However, bilayer graphene (BLG) has unique electronic properties, which differ greatly from those of SLG by its effective mass of carriers, interlayer hopping and electric-field induced band gap. Our studies of spin transport in BLG as a function of mobility μ, minimum conductivity, charge carrier density and temperature reveal the importance of the D'yakonov - Perel' (DP)-type spin scattering mechanism [2]. In BLG samples, the spin relaxation time τ_s scales inversely with μ both at room temperature and at low temperatures. τ_s times of up to 2 ns are observed in samples with the lowest mobility. We discuss the role of intrinsic and extrinsic factors that could lead to the dominance of the DP-type spin scattering mechanism in BLG. Remarkably, similar spin transport properties are also observed in large area graphene grown by the CVD method on copper foils demonstrating the potential of CVD graphene in spintronics devices [3].

Work supported by DFG/FOR 912.

[1] N. Tombros *et al.*, Nature 448, 571 (2007).
[2] T.-Y. Yang *et al.*, Phys. Rev. Lett. 107, 047206 (2011).
[3] A. Avsar *et al.*, Nano Letters 11, 2363 (2011).

Invited Talk MA 43.2 Thu 15:30 H 1012

Long spin relaxation times in epitaxial graphene on SiC(0001) — •Thomas Maassen[1], Jan Jasper van den Berg[1], Natasja IJbema[1], Felix Fromm[2], Thomas Seyller[2], Rositsa Yakimova[3], and Bart Jan van Wees[1] — [1]Zernike Institute for Advanced Materials, University of Groningen, The Netherlands — [2]Lehrstuhl für Technische Physik, Universität Erlangen-Nürnberg, Germany — [3]Department of Physics, Chemistry and Biology (IFM), Linköping University, Sweden

Spin transport in graphene draws great interest because of recent promising measurements at room temperature (RT). At the same time the limiting factor for spin relaxation seems to be the substrate. By replacing the commonly used SiO_2 substrate we aim to observe improved spin transport. We developed an easy process to prepare lateral spin-valve devices on epitaxial grown monolayer graphene on SiC(0001), that enables us to upscale the production to wafer size. We examine the spin transport properties of this material by performing nonlocal spin-valve and Hanle spin precession measurements. We observe the longest spin relaxation time τ_S in single layer graphene at RT (1.5 ns) and $T = 4.2$ K (2.3 ns), while the spin diffusion coefficient is strongly reduced by nearly 2 orders of magnitude. The increase in τ_S is probably related to the changed substrate, while the small value for D_S is until now unexplained. Nevertheless, the high values for τ_S, combined with the easy production method on a large scale, clear the way for graphene based spintronic devices and applications in the future.

MA 43.3 Thu 16:00 H 1012

Manipulation of spin transport properties in graphene — •Frank Volmer[1,2], Tsung-Yeh Yang[1,2], Eva Maynicke[1,2], Marc Drögeler[1,2], Sebastian Bläser[1,2], Gernot Güntherodt[1,2], and Bernd Beschoten[1,2] — [1]II. Institute of Physics, RWTH Aachen University, 52074 Aachen, Germany — [2]JARA: Fundamentals of Future Information Technology, 52074 Aachen, Germany

It has been shown that the dominant spin relaxation mechanism in bilayer graphene is of the D'yakonov-Perel' type [1]. In this case the spin dephasing time increases with decreasing momentum scattering time or, respectively, with decreasing charge carrier mobility.

Therefore, it is desirable to control and to manipulate the mobility of a single device in order to get a further insight into the dephasing mechanisms. As the charge transport through the two-dimensional graphene is known to be strongly affected by adatoms, it is furthermore interesting to explore their influence on the spin transport. Hence we use current annealing, chemical solvents and electron beam induced deposition to add or to remove impurities on the graphene surface and study their influence on the spin transport properties.

First results indicate that even in single-layer graphene devices (nonlocal spin valves with Co/MgO injectors) a D'yakonov-Perel'-type dephasing mechanism is dominating.

This work has been supported by DFG through FOR 912.

[1] T.-Y. Yang *et al.*, Phys. Rev. Lett. 107, 047206 (2011)

MA 43.4 Thu 16:15 H 1012

Anisotropic super-spin at the end of a carbon nanotube — •Manuel J. Schmidt — RWTH-Aachen, Deutschland

The interplay of edge magnetism and spin-orbit interactions is studied theoretically on the basis of zigzag ends of carbon nanotubes. Spin-orbit coupling, generally weak in ordinary graphene, is strongly enhanced in nanotubes and thus cannot be neglected at low energies. In the present case it leads to a magnetic anisotropy on the order of 10 mK. Also the relation to correlated topological edge states is shortly discussed.

Carbon nanotubes with zigzag ends have localized electronic states at those ends. These localized states correspond to the edge states in graphene and are equally susceptible to Coulomb interactions. The latter drive a transition, known as edge magnetism in graphene. However, due to the very limited spatial size of this magnetic state, it should not be considered as a symmetry broken state but rather as a super-spin, composed of a few individual electron spins. Without spin-orbit interaction, the ground state of this super-spin would be 2S+1 fold degenerate. Finite spin-orbit coupling, however, breaks this degeneracy in such a way that the true ground state is unique and time-reversal invariant. Furthermore, it turns out that the magnitude of this effect may be tuned by a partial suppression of the magnetism (tunable edge magnetism).

15 min. break