HL 25: Spin controlled transport I

Time: Tuesday 14:15–15:30 Location: EW 202

HL 25.1 Tue 14:15 EW 202

Origins of the anisotropic magnetoresistance in GaMnAs — •Karel Vyborny[1] and Tomas Jungwirth[1,2] — [1]Institute of physics, Academy of Sciences of the Czech Republic, Cukrovarnicka 10, Praha 6, CZ–16253, Czech Republic — [2]School of Physics and Astronomy, University of Nottingham,* Nottingham NG7 2RD, United Kingdom

The bandstructure of the magnetic semiconductor GaMnAs within the mean-field kinetic-exchange model is sufficiently simple so as to allow to open the blackbox of numerical simulations of the conductivity tensor. The full (six-band, non-spherical) model can be cut down to an analytically tractable one while the numerical results of the AMR (relative difference of resistance under two orientations of magnetisation) do not change qualitatively.

Our calculations are based on the Boltzmann semiclassical formula for conductivity. Results suggest that the scattering on Mn impurities is responsible for the sign and order of magnitude of the AMR which is dominantly of the non-crystalline type in GaMnAs.

HL 25.2 Tue 14:30 EW 202

Magneto-photogalvanic effect in (110) GaAs semiconductor quantum wells — •Peter Olbrich[1], Vasily V. Bel'kov[1,2], Dieter Schuh[1], Werner Wegscheider[1], Wilhelm Prettl[1], and Sergey D. Ganichev[1] — [1]Terahertz Center, University of Regensburg, 93040, Regensburg, Germany — [2]A.F. Ioffe Physico-Technical Institute, Russian Academy of Sciences, 194021 St. Petersburg, Russia

We report on the observation of a magneto-photogalvanic effect (MPGE) [1] in (110)-grown GaAs semiconductor quantum wells. The MPGE so far has been demonstrated only in (001)-grown GaAs, InAs, SiGe and GaN quantum wells where its microscopic origin is the zero-bias spin separation [2]. The latter is caused by spin-dependent scattering of electrons due to a linear-in-k terms in the scattering matrix elements. Here we provide experimental and theoretical analysis of the MPGE current in (110)-grown GaAs showing that it is driven by asymmetric processes in excitation and relaxation of a Drude-like heated electron gas and reflects the contribution of structure inversion asymmetry. The results agree with the phenomenological description based on the symmetry. We demonstrate that the MPGE due to an in-plane magnetic field is only observed for asymmetric structures and vanishes if QWs are symmetric. Therefore it is an ideal tool to probe the symmetry of (110)-grown quantum wells, which is of importance to achieve long spin relaxation times.

[1] V.V. Bel'kov *et al.*, *J. Phys.: Cond. Mat.* **17**, 3405 (2005).
[2] S.D. Ganichev *et al.*, *Nature Physics* (London) **2**, 609 (2006).

HL 25.3 Tue 14:45 EW 202

Strain-dependent magnetic anisotropy in GaMnAs on InGaAs templates — •Joachim Däubler, Michael Glunk, Stephan Schwaiger, Lukas Dreher, Wladimir Schoch, Rolf Sauer, and Wolfgang Limmer — Institut für Halbleiterphysik, Universität Ulm, 89069 Ulm

We have systematically studied the influence of strain on the magnetic anisotropy of GaMnAs by means of HRXRD reciprocal space mapping and angle-dependent magnetotransport. For this purpose, a series of GaMnAs layers with Mn contents of $\sim$5% was grown by low-temperature MBE on relaxed InGaAs/GaAs templates with different In concentrations, enabling us to vary the strain in the GaMnAs layers continuously from tensile to compressive, including the unstrained state. Considering both, as-grown and annealed samples, the anisotropy parameter describing the uniaxial out-of-plane magnetic anisotropy has been found to vary linearly with hole density and strain. As a consequence, the out-of-plane direction gradually undergoes a transition from a magnetic hard axis to a magnetic easy axis from compressive to tensile strain. The experimental results are quantitatively compared with theoretical calculations based on the Zener mean-field model proposed by T. Dietl et al. [Phys. Rev. B 64, 195205 (2001)].

HL 25.4 Tue 15:00 EW 202

Magneto-gyrotropic photogalvanic effects due to inter-subband absorption in quantum wells — •Helgi Diehl[1], Vadim Shalygin[2], Sergey Danilov[1], Sergey Tarasenko[3], Vasily Bel'kov[3], Dieter Schuh[1], Werner Wegscheider[1], Wilhelm Prettl[1], and Sergey Ganichev[1] — [1]Terahertz Center, University of Regensburg, 93040 Regensburg, Germany — [2]St. Petersburg State Polytechnical University, 195251 St. Petersburg, Russia — [3]A.F. Ioffe Physico-Technical Institute, Russian Academy of Sciences, 194021 St. Petersburg, Russia

We report on the observation of the magneto-gyrotropic photogalvanic effect [1] due to inter-subband transitions in (001)-oriented GaAs quantum wells. This effect is related to the gyrotropic properties of the structures. It is shown that inter-subband absorption of linearly polarized radiation may lead to spin-related as well as spin-independent photocurrents if an external magnetic field is applied in the plane of the quantum well. The experimental results are analyzed in terms of the phenomenological theory and microscopic models based on either asymmetric optical excitation or asymmetric relaxation of carriers in **k**-space. We observed resonant photocurrents not only at oblique incidence of radiation but also at normal incidence demonstrating that conventionally applied selection rules for the inter-subband optical transitions are not rigorous.

[1] S.D. Ganichev and W. Prettl, *Intense Terahertz Excitation of Semiconductors*, (Oxford University Press, 2006).

HL 25.5 Tue 15:15 EW 202

Micro coils for spin manipulation in semiconductors — •Chen Yuansen[1], Simon Halm[1], Tilmar Kümmell[1], Gerd Bacher[1], Tomasz Wojtowicz[2], Grzegorz Karczewski[2], and Wiater Maciej[2] — [1]Werkstoffe der Elektrotechnik,Universtät Duisburg-Essen, BismarckStr.81,47057,Duisburg,Germany — [2]Institute of Physics, Polish Academy of Science, Al.Lotnikow 32/46 02-668 Warsasw, Poland

In the research field of spintronics, local spin manipulation in semiconductors is one of the main goals. We used micro-structured aluminum coils to generate a switchable magnetic field in a CdMnTe/CdMgTe diluted magnetic semiconductor (DMS) quantum well (QW). As the effective g factor in a DMS QW is large (~200 at 4K), carrier spin states can efficiently be manipulated even with low magnetic fields. Inside the coil area a magnetic field of several 10mT is obtained which allows to partly align the Mn2+ ions spins, and, via the sp-d exchange interaction, to polarize the spins of optically generated excitons. We investigated the spin polarization inside the micro coils by means of micro-photoluminescence spectroscopy. Without the need of an external magnetic field, we observed a spin polarization of up to +/-1.5% at 4K by introducing a positive or negative current, respectively. By applying current pulses, the spin polarization could be switched and measured with 100 ns time resolution. The current induced spin polarization is observed up to 40K. It was found that heat produced by the current disorders the Mn2+ spins and thus competes with the ordering achieved by the current-induced magnetic field.