

HL 17: Invited Talk Limmer

Time: Tuesday 10:00–10:45

Location: H15

Invited Talk HL 17.1 Tue 10:00 H15
Magnetic anisotropy and magnetization switching in ferromagnetic GaMnAs — ●WOLFGANG LIMMER — Institut für Halbleiterphysik, Universität Ulm, 89069 Ulm, Germany

Characteristic features of semiconductor spintronics such as the anisotropic magnetoresistance or the spin-polarization of charge carriers are intimately connected with the macroscopic magnetization in a ferromagnetic semiconductor. The orientation of the magnetization is controlled by magnetic anisotropy which predominantly arises from crystal symmetry, sample geometry, and strain. A detailed knowledge of this anisotropy is indispensable for the design of novel spintronic devices.

In this talk, angle-dependent magnetotransport is demonstrated to be an excellent tool for probing magnetic anisotropy as an alternative to the standard ferromagnetic-resonance method. Moreover, its ability to trace the movement of the magnetization vector in a variable external magnetic field makes it ideally suitable for studying magnetization switching, a potential basic effect in future logical devices. Experimental data recorded from a variety of different GaMnAs samples are analyzed by means of model calculations which are based on a series expansion of the resistivity tensor, a numerical minimization of the free enthalpy with respect to the magnetization orientation, and the assumption that the GaMnAs layers under study consist of single ferromagnetic domains.

HL 18: Photonic crystals I

Time: Tuesday 10:45–12:45

Location: H13

HL 18.1 Tue 10:45 H13
Photonic Crystal functional elements based on optically anisotropic materials and large-scale devices — ●PATRICK MACK^{1,2}, DANIEL HERMANN¹, MATTHIAS SCHILLINGER¹, SERGEI MINGALEEV^{1,3}, and KURT BUSCH¹ — ¹Institut für Theoretische Festkörperphysik, Universität Karlsruhe (TH), Germany — ²Institut für Nanotechnologie, Forschungszentrum Karlsruhe, Germany — ³Bogolyubov Institute for Theoretical Physics, Kiev, Ukraine

We present device designs in macroporous silicon photonic crystals based on the infiltration of individual pores with liquid crystals which yield actively tunable photonic devices. These designs have been developed via a photonic Wannier function approach that allows the characterization of such devices via complex transmittance and reflectance coefficients. As a result, individual devices may be represented by small frequency-dependent scattering matrices. In turn, these scattering matrices form the basis of a quantitative circuit theory that allows to design complex functional elements that are very hard to handle with other simulation techniques.

HL 18.2 Tue 11:00 H13
Fabrication of 3D photonic crystal structures by two-photon polymerization technique — ●ALEKSANDR OVSIANIKOV and BORIS CHICHKOV — Hollerithallee 8

Two-photon polymerization technique can be considered as an enabling technology for the fabrication of 3D photonic crystals, especially those with introduced defects. Here, we report on our recent progress in the fabrication of 3D polymeric photonic crystals and investigation of their optical properties. Most of the materials used for 2PP were developed for lithographic applications and have a refractive index of the order of 1.6. We have investigated many of such materials and their structural stability by 2PP technique. Further prospects of 2PP technology will be discussed.

HL 18.3 Tue 11:15 H13
Plasmon hybridization in stacked cut-wire metamaterials near metal films — ●NA LIU¹, HONGCANG GUO¹, LIWEI FU¹, HEINZ SCHWEIZER¹, STEFAN KAISER², and HARALD GIESSEN¹ — ¹4. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70500, stuttgart, Germany — ²1. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70500, stuttgart, Germany

Abstract: We introduce a simple and convenient method to stack artificial units for metamaterials in the third dimension. Cut-wires and cut-wire pairs are placed above a metal film so that image cut-wires or cut-wire pairs are induced by the metal mirror when illuminated by light [1], which is equivalent to stacking two or four layers of cut-wires. The optical properties of cut-wires and cut-wire pairs above metal mirrors are investigated experimentally and numerically. The resonant plasmon modes are interpreted utilizing directly stacked cut-wire structures according to the method of plasmon hybridization [2]. Furthermore, the frequencies of different plasmon modes as a function of cut-wire separation are explored numerically. This method should pave the road towards a fundamental understanding of the electronic

and optical properties of 3D metamaterials.

[1] V. A. Podolskiy, A. K. Sarchev, and V. M. Shalaev, Opt. Express 2003, 11, 735. [2] E. Prodan, C. Radloff, N. J. Halas, and P. Norlander, Science 2003, 302, 419.

HL 18.4 Tue 11:30 H13
Wasserstoffsensoren auf Basis metallischer photonischer Kristalle — ●REGINA ORZEKOWSKY, ANDREAS SEIDEL und HARALD GIESSEN — 4. Physikalisches Institut, Universität Stuttgart, Germany

Aus Sicherheitsgründen sind günstige Wasserstoffsensoren Voraussetzung für die marktreife Umsetzung von wasserstoffbetriebenen Fahrzeugen oder elektronischen Geräten. Bisher sind Wasserstoffsensoren sehr teuer und benötigen elektrische Leitungen in einer potentiell explosionsgefährdeten Umgebung. Wir stellen einen optischen Wasserstoffsensoren auf Basis eines metallischen oder dielektrischen photonischen Kristalls vor. Wir verwenden dabei eine Wolfram-Trioxid-Wellenleiterschicht unter einem Gitter aus metallischen oder dielektrischen Nanodrähten. Die Nanostrukturen werden mit Interferenzlithographie oder Elektronenstrahlolithographie hergestellt. Die optischen Eigenschaften der Wellenleiterschicht und somit die Polaritonresonanzen des metallischen photonischen Kristalls werden durch den gasochromen Effekt verändert. Das Detektionsprinzip wird erklärt und die Funktionsweise des Wasserstoffsensors experimentell nachgewiesen. Da unser Detektionsprinzip auf einem optischen Effekt beruht, kann das sensitive Element von der Elektronik isoliert und dadurch sicherer werden. Wir erwarten, daß dieser Sensor sowohl billiger in der Herstellung als herkömmliche Wasserstoffsensoren sein wird, als auch gleichzeitig robust, klein und wiederverwendbar.

HL 18.5 Tue 11:45 H13
Fabrication of silicon inverse woodpile photonic crystals — ●MARTIN HERMATSCHEWILER¹, MARTIN WEGENER^{1,2}, GEOFFREY ALLEN OZIN³, ALEXANDRA LEDERMANN², and GEORG VON FREYMANN² — ¹DFG-Center for Functional Nanostructures (CFN) and Institut für Angewandte Physik, Universität Karlsruhe (TH), 76131 Karlsruhe — ²Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, 76021 Karlsruhe — ³Department of Chemistry, University of Toronto, Toronto, Ontario M5S 3H6, Canada

We fabricate silicon inverse woodpile structures for the first time. Direct laser writing of polymeric templates and a novel silicon-single-inversion procedure [1] lead to structures with gap/midgap ratios of 14.2% centered at 2.5 μm wavelength.

First, polymer templates are fabricated by direct laser writing or other means. Next, we deposit a thin silica coating via atomic layer deposition (ALD) on the polymer and - without removing the polymer - infiltrate the composite structure with Si via Si chemical vapor deposition (CVD). The silica shell provides sufficient and reliable stabilization for the high temperature CVD process. Finally, the silica is etched out and the polymer is calcined in air, leading to a Si inverse woodpile structure. Optical measurements and comparison to band-structure and scattering-matrix calculations reveal a gap/midgap ratio of 14.2% centered at 2.5 μm . An optimized structure could open a band

gap with a gap/midgap ratio of up to 20.5%.

[1] M. Hermatschweiler et al., submitted (2006).

HL 18.6 Tue 12:00 H13

Strong Circular Dichroism from Chiral 3D Photonic Crystals — ●MICHAEL THIEL¹, MANUEL DECKER², MARTIN WEGENER¹, STEFAN LINDEN², and GEORG V. FREYMAN² — ¹Institut für Angewandte Physik, Universität Karlsruhe (TH), Wolfgang-Gaede-Straße 1, D-76131 Karlsruhe — ²Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, D-76021 Karlsruhe

Chiral photonic crystals allow for photonic stop bands for circularly polarized light connected with pronounced circular dichroism[1] which can potentially be used for applications, e.g., as compact *thin-film* optical diodes[2]. We have fabricated high-quality polymeric 3D spiral photonic crystals[3] via direct laser writing[4]. The measured transmittance spectra of these low-index contrast structures reveal spectral regions where the transmittance is below 5 % for one circular polarization and larger than 95 % for the other – for just eight lattice constants along the propagation direction[1]. These polarization stop bands occur if the pitch of the light spiral matches the pitch of the dielectric spiral. As expected from the symmetry, the transmittance spectra are closely similar if both the sense of rotation of the dielectric spirals and that of the incident light field are changed simultaneously. Our experimental results agree well with theory. Additionally, we present a novel chiral 3D layer-by-layer structure as an alternative to the discussed circular dichroitic 3D spiral photonic crystals.

[1]*M. Thiel et. al., Adv. Mater., in press (2006). [2]*J. Hwang et. al., Nature Mater., 4, 383 (2005). [3]*K. K. Seet et. al., Adv. Mater., 17, 541 (2005). [4]*M. Deubel et. al., Nature Mater., 3, 444 (2004).

HL 18.7 Tue 12:15 H13

Silicon-based Photonic Crystal Gas Sensors — ●STEFAN SCHWEIZER¹, TORSTEN GEPPERT¹, ANDREAS VON RHEIN¹, SUSANNE HARTWIG², JÜRGEN WÖLLENSTEIN², ARMIN LAMBRECHT², and RALF WEHRSPHON¹ — ¹Institut für Physik, Universität Halle-Wittenberg, 06099 Halle — ²Fraunhofer Institut Physikalische Messtechnik, Heidenhofstr. 8, 79110 Freiburg

The bandstructure of photonic crystals offers intriguing possibilities for the manipulation of electromagnetic waves. We suggest utilization of photonic crystals as an optical sensor in the infrared spectral region for qualitative and quantitative gas analysis. Taking advantage of the low group velocity and certain mode distributions for some k-points in the bandstructure of a photonic crystal should enable the realization of very compact sensor devices for mobile applications. We prepared sensing elements based on macroporous silicon photonic crystals consisting of up to 1000 of pore rows and measured the transmission with and without gas through the porous sensing element. We observed an enhancement in sensitivity of about 3 to 4 compared to a gas cell without a photonic crystal. Limitations of this technology being based on low group velocity modes inside photonic crystals are discussed.

HL 18.8 Tue 12:30 H13

GaAs pyramids as alternative micro-cavities — ●MATTHIAS KARL¹, FRANK M. WEBER¹, JAIME LUPACA-SCHOMBER¹, WOLFGANG LÖFFLER¹, SHUNFENG LI¹, THORSTEN PASSOW¹, JACQUES HAWECKER², DAGMAR GERTHSEN², HEINZ KALT¹, and MICHAEL HETTERICH¹ — ¹Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe (TH), 76128 Karlsruhe, Germany — ²Laboratorium für Elektronenmikroskopie and CFN, Universität Karlsruhe (TH), 76128 Karlsruhe, Germany

Pyramidal resonators are promising optical micro-cavities since they have great potential as small-mode volume resonators to enhance light-matter interaction.

Our resonators are fabricated from a molecular-beam epitaxy-grown layer structure containing an AlAs/GaAs distributed Bragg reflector as the bottom mirror. The pyramidal resonators on top are achieved by a combination of electron-beam lithography and wet chemical etching utilizing an AlAs sacrificial layer. The pyramids contain In(Ga)As quantum dots which – excited by a 532 nm cw laser – serve as a broad-band light source in the spectral range from 900 nm to 1000 nm. Optical cavity modes in these pyramids are identified and investigated using temperature-dependent measurements in a confocal micro-photoluminescence set-up.

HL 19: Spin controlled transport I

Time: Tuesday 10:45–13:00

Location: H14

HL 19.1 Tue 10:45 H14

Control of electron spin and orbital resonance in quantum dots through spin-orbit interactions — ●PETER STANO and JAROSLAV FABIAN — University of Regensburg

Dynamics of a single electron in coupled lateral quantum dots in the presence of a static and oscillating electric and magnetic fields as well as phonon-induced relaxation and decoherence is investigated. Using symmetry arguments it is shown that spin and orbital resonance can be efficiently controlled by spin-orbit couplings. The so called easy passage configuration is shown to be particularly suitable for magnetic manipulation of spin qubits, ensuring long spin relaxation time and protecting the spin qubit from electric field disturbances connected with on-chip manipulation.

HL 19.2 Tue 11:00 H14

Spin transport anisotropy in (110) GaAs — ●ODILON D. D. COUTO JR¹, FERNANDO IKAWA², JÖRG RUDOLPH¹, RUDOLF HEY¹, and PAULO V. SANTOS¹ — ¹Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5–7, 10117 Berlin, Germany — ²Universidade Estadual de Campinas, IFGW, CP-6165, Campinas-SP, 13083-970, Brazil

Mobile piezoelectric potentials are used to coherently transport electron spins in GaAs (110) quantum wells (QW) over distances exceeding 60 μm . We demonstrate that the dynamics of mobile spins under external magnetic fields depends on the direction of motion in the QW plane. The weak piezoelectric fields impart a non-vanishing average velocity to the carriers, allowing for the direct observation of the carrier momentum dependence of the spin polarization dynamics. While transport along [001] direction presents high in-plane spin relaxation rates, transport along $\bar{1}10$ shows a much weaker external field dependence due to the non-vanishing internal magnetic field. We show that the anisotropy is an intrinsic property of the underlying GaAs matrix, associated with the bulk inversion asymmetry contribution to the

SO-coupling.

HL 19.3 Tue 11:15 H14

Magnetotransport through nanoscale constrictions in ferromagnetic (001)-(Ga,Mn)As — ●MARKUS SCHLAPPS¹, MATTHIAS DÖPPE¹, STEFAN GEISSLER¹, THOMAS IMLOHN¹, JANUSZ SADOWSKI², WERNER WEGSCHEIDER¹, and DIETER WEISS¹ — ¹Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany — ²Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

The resistance measured across a small (Ga,Mn)As island detached by nanoconstrictions from (Ga,Mn)As input leads displays unusual magnetoresistance (MR) behavior [1,2]. As in previous studies [1] a huge magnetoresistance was found for nanoconstrictions in the tunneling regime. For slightly wider junctions (on the verge of tunneling) we observed an enhanced anisotropic magnetoresistance together with pronounced jumps as a function of the in-plane magnetic field [3]. This behavior is ascribed to in-plane switching of the magnetization into the easy axis. We investigate the angular dependence of the MR for a tunneling device and discuss the correlation to the TAMR (Tunneling Anisotropic Magneto Resistance) that has been reported previously [2]. In addition we present data of (Ga,Mn)As wires with only one nanoconstriction.

[1] C. Rüster et al.: PRL 91, 216602 (2003)

[2] A. D. Giddings et al.: PRL 94, 127202 (2005)

[3] M. Schlapps et al.: phys. stat. sol. (a) 203, No. 14, 3597 (2006)

HL 19.4 Tue 11:30 H14

Tunneling Anisotropic Magnetoresistance and Spin-Orbit Coupling in tunnel structures with single-crystal GaAs barriers — ●MICHAEL LOBENHOFER¹, JÜRGEN MOSER¹, EVA BRINKMEIER¹, ALEX MATOS-ABIAGUE², DIETER SCHUH¹, WERNER WEGSCHEIDER¹, JAROSLAV FABIAN², and DIETER WEISS¹ — ¹Institut für Experi-