HL 39: Posters II (Topological insulators; Graphene; Spintronics and spin physics; Quantum information science)

Presenters are kindly requested to be near their poster for at least one hour in the time between 14:00-16:00 or to leave a note about their availability for discussions.

Time: Tuesday 14:00–20:00 Location: Poster F

HL 39.1 Tue 14:00 Poster F

Magnetic and structural stability of topological-insulator / ferromagnet hybrid structures during thermal annealing procedures — •Michal Vališka[1], Martin Vondráček[2], Hubert Steiner[3], Gunther Springholz[3], Václav Holý[1], Vladimír Sechovský[1], and Jan Honolka[2] — [1]DCMP, Charles University, Prague, Czech Republic — [2]IoP, Academy of Sciences of the Czech Republic, Prague, Czech Republic — [3]HFP, Johannes Kepler Universität, Linz, Austria

Magnetic atoms in the vicinity of the topologically protected surface states (TTS) of 3D topological insulators could break time-reversal symmetry and open efficient spin-flip channels for backscattering processes. We have shown earlier that single magnetic adatom spins situated on Bi_2Se_3 surfaces randomly fluctuate at temperatures T∼4 K[1]. In order to achieve stable exchange fields, our present work focuses on MBE-grown heterostructures consisting of thin surface layers of pure Bi_2Se_3 and a buried, remanently magnetized Mn-doped layer. The heterostructure is sealed by a protective Se capping. We present an optimized Se capping and decapping procedure of Mn-doped samples under UHV conditions. Surface properties after decapping are controlled by PEEM and XPS measurements, and the TSS state is monitored in situ by k-PEEM. The important question of potential changes of the magnetic properties of Mn-doped layers (1-10%) due to diffusion effects during decapping at elevated temperatures is addressed via measurements of the bulk magnetization using SQUID.

[1] J. Honolka, et al., Physical Review Letters 108, 256811 (2012)

HL 39.2 Tue 14:00 Poster F

Strain-tuning of Dirac states at the SnTe (001) surface — •Matthias Drüppel, Peter Krüger, and Michael Rohlfing — Institut für Festkörpertheorie, Westfälische Wilhelms-Universität, 48149 Münster, Germany

The topological crystalline insulator SnTe belongs to the recently discovered class of materials in which a crystalline symmetry ensures the existence of topologically protected Dirac like surface states. In contrast to topological insulators, this symmetry can be broken via deformations of the crystal. This opens up new possibilities of manipulating the Dirac states and inducing a controllable gap. Here, we have employed density-functional theory to investigate the response of the Dirac states to lattice deformations [1].

The (001) surface exhibits four Dirac cones which lie at non-time-reversal-invariant points close to $\overline{\mathrm{X}}$, along the projection of the $(\bar{1}10)$ and (110) mirror planes. Our calculations show that a gap of up to ≈ 30 meV can be introduced via lattice deformations that break at least one of these mirror symmetries. Remarkably, distortions at the *surface only* can already open up the gap, even though bulk properties are not changed.

The gap is formed at either all four or just two cones, depending on the direction of the displacement vector, making it possible to create a state where gaped and non-gaped Dirac cones coexist. Notably, if the whole slab is distorted, bulk bands are being pushed into the gap making the whole system metallic.

[1] M. Drüppel *et al.*, Phys. Rev. B 90, 155312 (2014)

HL 39.3 Tue 14:00 Poster F

Vapor phase deposition of bismuth selenide on hexagonal boron nitride — •Shaham Jafarpisheh[1], Regine Ockelmann[1], Kenji Watanabe[2], Takashi Taniguchi[2], Bernd Beschoten[1], and Christoph Stampfer[1,3] — [1]JARA-FIT and 2nd Institute of Physics, RWTH Aachen University, 52074 Aachen, Germany — [2]National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan — [3]Peter Grünberg Institute (PGI-9), Forschungszentrum Jülich, 52425 Jülich, Germany

Three dimensional topological insulators (TIs) have shown unique electronic band structures making them promising materials for future spintronic devices. Topological insulators are materials with electrically insulating bulk while having gapless spin-polarized surface states with a linear dispersion relation which are topologically protected against backscattering resulting in a spin-polarized current on the surface of these materials. Among various materials predicted to show topological insulating properties, Bi2Se3 is in particular interesting because of its band structure and its relatively large bulk band gap of 0.3 eV which is much larger than the room temperature energy scale. In this study we report the vapor phase deposition of large area Bi2Se3 thin flakes on atomically flat surface of hexagonal boron nitride (hBN). Atomic force microscopy (AFM) and Raman spectroscopy were used to characterize the synthesized flakes. Finally, e-beam lithography and metallization is used to make electrical contacts on the as-grown Bi2Se3 flakes for further characterization by electron transport measurements.

HL 39.4 Tue 14:00 Poster F

Cd_3As_2 Nanowires by Chemical Vapour Deposition — •Piet Schönherr and Thorsten Hesjedal — Department of Physics, Clarendon Laboratory, University of Oxford, Oxford OX1 3PU, United Kingdom

Cd_3As_2 has been well known for its very high mobility. Recently, it was discovered that the material displays two Dirac points with linearly dispersing states that are stabilized by crystal symmetry (three-dimensional Dirac semimetal). The Dirac cones live in three-dimensional k-space unlike topological insulators that only have two-dimensional Dirac cones on their surface. This makes Cd_3As_2 a three-dimensional analogue of graphene.

We present the growth and characterisation of Cd_3As_2 nanowires including results from electric transport measurements. Nanowires with a diameter as small as 10 nm were grown in a self-catalysed vapour-liquid-solid process using chemical vapour deposition. We analyse the growth mechanism and compare the vibrational modes of Cd_3As_2 nanostructures with bulk samples.

HL 39.5 Tue 14:00 Poster F

Heteroepitaxial $YBiO_3$ thin films grown by pulsed laser depostion — •Marcus Jenderka, Marius Grundmann, and Michael Lorenz — Institut für Experimentelle Physik II, Universität Leipzig, Linnéstraße 5, D-04103 Leipzig. Germany

The cubic perovskite $YBiO_3$ (YBO) has recently been predicted to be a novel oxide topological insulator candidate by first-principles calculations [1]. In the past, YBO was used as a buffer layer for the high-temperature superconductor $YBa_2Cu_3O_{7-y}$. [2] Its large bulk band gap and high bulk resistivity distinguishes YBO from conventional TIs such as Bi_2Te_3. [3,4] Thus, room-temperature operation and the separation of surface from bulk degrees of freedom promise better TI-based devices.

Here, we report on heteroepitaxy of YBO thin films grown by pulsed laser deposition (PLD) on $LaAlO_3$ single crystalline substrates. Resistivity dependent on magnetic field and film thickness is measured from 300 to 15 K to find signatures of a topological insulator phase.

[1] H. Jin *et al.*, Scientific Reports **3**, 1651 (2013).
[2] G. Li *et al.*, J. Mater. Res. **22**, 2398-2403 (2007).
[3] Y. Xia, Y. *et al.*, Nat. Phys. **5**, 398-402 (2009).
[4] H. Zhang *et al.*, Nat. Phys. **5**, 438-442 (2009).

HL 39.6 Tue 14:00 Poster F

Comprehensive study of undoped Bi_2Se_3 microflakes via structural, chemical and transport investigations — •Dominic Lawrenz[1], Christian Riha[1], Franz Herling[1], Olivio Chiatti[1], Srujana Dusari[1], Jaime Sanchez-Barriga[2], Anna Mogilatenko[3], Lada Yashina[4], Sergio Valencia[2], Ahmet Ünal[2], Oliver Rader[2], and Saskia Fischer[1] — [1]Neue Materialien, Institut für Physik, Humboldt Universität zu Berlin, 12489 Berlin, Germany — [2]Helmholtz-Zentrum-Berlin für Materialien und Energie, 12489 Berlin, Germany — [3]Ferdinand-Braun-Institut, 12489 Berlin, Germany — [4]Department of Chemistry, Moscow State University, 119992 Moscow, Russia

Surface states of topological insulators are expected to show peculiar electrical transport properties [1]. The remaining bulk conductivity, however, renders these elusive in transport measurements so far.

A combined investigation of single-crystalline Bi_2Se_3 was undertaken to obtain a comprehensive picture. The band structure of the bulk material was investigated via ARPES. Flakes from the bulk to the thin-film range (thicknesses from 270 nm to 70 nm) were then exfoliated. Their crystal structure was investigated by HRTEM and the chemical composition by EDX and X-PEEM. Hall measurements of the conductivity were undertaken to determine the charge carrier mobility and density. Our results confirm the high quality of the material. The temperature dependence of the conductivity and magnetoresistance down to 0.3 K are presented and discussed.

[1] Hasan, Kane, *Rev. Mod. Phys.* **82**, 3045 (2010)

HL 39.7 Tue 14:00 Poster F

Electron dynamics of the topological insulator Sb_2Te_2S — •Anna Sophia Ketterl[1], Thomas Kunze[1], Daniel Przyrembel[1], Dominic Lawrenz[1,3], Evgeny Chulkov[2], and Martin Weinelt[1] — [1]Freie Universität Berlin, Germany — [2]UPV/EHU San Sebastian, Spain — [3]Humbold Universität Berlin, Germany

We investigate the electron dynamics of the topological insulator Sb_2Te_2S by means of time-resolved two-photon photoemission measurements with an angle-resolving time-of-flight spectrometer.

Sb_2Te_2S is p-doped and exhibits a Dirac cone 0.3 eV above the Fermi energy at the center of the Brillouin zone. In our experiment, the Dirac cone is populated by an infrared pump-pulse *via* direct absorption and interband scattering from the conduction band. In the Dirac cone we observe picosecond lifetimes. The spectra hint at a stepwise relaxation *via* small-energy transfer processes and strong surface-to-bulk coupling. Cooling of the system leads to faster electron dynamics.
The observed dynamics are governed by electron-phonon and defect scattering. Thus our measurements confirm the supercollision model which was proposed for graphene.[1]

Quality and component stoichiometries of the samples were studied by XPS after different preparation methods. We find that Sb_2Te_2S is rather inert and only slowly oxidizes after cleaving under ambient conditions.
[1] J. C. W. Song *et. al.*, *Phys. Rev. Let.* **109**, 106602 (2012).

HL 39.8 Tue 14:00 Poster F

Fabrication and characterization of InAs/GaSb compound quantum wells for electrically tunable topological insulator devices — •Georg Knebl, Pierre Pfeffer, and Martin Kamp — Technische Physik, Universität Würzburg, Deutschland

InAs/GaSb compound quantum wells (CQW) sandwiched between two AlSb barrier layers were proposed by Liu et al. [1] to show a topological phase similar to the one realized in HgTe/CdTe [2]. While in the HgTe/CdTe system the transition from the normal to the topical insulator state can only be tuned by a variation of the quantum well thickness, for InAs/GaSb CQWs this is predicted to be tunable by the gate voltage. Our structures are fabricated by molecular beam epitaxy on GaSb and GaAs substrates, with an additional buffer structure on the latter ones. We will present results on the growth and fabrication of gated CQW structures for quantum spin Hall field effect transistors. Transport data and reversible light induced switching of majority carriers from electrons to holes will be shown.

[1] C. Liu, T. Hughes, X.-L. Qi, K. Wang, and S.-C. Zhang, Quantum Spin Hall Effect in Inverted Type-II Semiconductors, Phys. Rev. Lett., vol. 100, no. 23, p. 236601, Jun. 2008.

[2] M. König, S. Wiedmann, C. Brüne, A. Roth, H. Buhmann, L. W. Molenkamp, X.-L. Qi, and S.-C. Zhang, Quantum spin hall insulator state in HgTe quantum wells., Science, vol. 318, no. 5851, pp. 766-70, Nov. 2007.

HL 39.9 Tue 14:00 Poster F

Suspended graphene nanoribbons fabricated by electron beam-induced nano-etching — •Alessio Miranda, Jens Sonntag, Benedikt Sommer, Daniel Braam, Günther Prinz, Martin Geller, and Axel Lorke — Faculty of Physics, Universität Duisburg-Essen, Lotharstraße 1 Duisburg, 47058 Germany

Suspended graphene without any contact to a substrate is the ultimate two-dimensional system based on the honeycomb lattice structure of carbon atoms. However, the fabrication of nanodevices in suspended graphene needs a processing technique that preserves ideally its lattice structure or should be at least minimally invasive. We use here a fabrication technique based on electron beam induced nano-etching, which can cut suspended graphene with a resolution down to 7 nm. We show its use for the fabrication of suspended nanoribbons (GNR) and nanoribbons with asymmetric width (nanoconstrictions). The structural quality of suspended graphene after the cut is investigated using both 2D Raman spectroscopy and electrical characterization. Comparison of Raman maps taken on the same area before and after cutting confirm that the lattice structure still has a high quality. The electrical measurements of graphene nanoribbons show the characteristic conductance diamond as a function of drain and backgate voltage. Asymmetric nanoribbons show current rectification as a function of the drain voltage. The dependence of the rectification ratio on the back gate voltage is also studied.

References: [1] C. Thiele, et al. Carbon 64, 84 (2013). [2] B. Sommer, et al., Scientific Reports, submitted (2014).

HL 39.10 Tue 14:00 Poster F

Optical spectroscopy on ultrathin $NbSe_2$ and $NbSe_2$-semiconductor heterostructures — •Sven Gelfert[1], Nicola Paradiso[1], Gerd Plechinger[1], Philipp Nagler[1], Philipp Tonndorf[2], Steffen Michaelis de Vasconcellos[2], Rudolf Bratschitsch[2], Christoph Strunk[1], Christian Schüller[1], and Tobias Korn[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg, Germany — [2]Physikalisches Institut, Westphälische Wilhelms-Universität Münster, 48149, Münster, Germany

$NbSe_2$ is a layered transition metal dichalcogenide with a superconducting transition. By applying an exfoliation method, it can be thinned down to a few molecular layers and be transfered onto a Si/SiO_2 substrate. We have produced $NbSe_2$ flakes with "terraces" of different thickness down to the nanometer scale. In Raman measurements we observed a layer-dependent frequency shift in the characteristic phonon modes.

Furthermore, we have produced heterostructures by combining singlelayer WSe_2 and $MoSe_2$ with ultrathin $NbSe_2$. In time-resolved photoluminescence experiments on these heterostructures we observed a dynamic charge transfer between the semiconducting layer and the adjacent $NbSe_2$. We have analysed the photocarrier dynamics of both, isolated $WSe_2/MoSe_2$ single layers, and heterostructures, as a function of temperature.

HL 39.11 Tue 14:00 Poster F

Stacked Graphene nanostructures produced from transfered layers — •Christopher Belke, Dmitri Smirnov, Johannes C. Rode, Hennrik Schmidt, and Rolf J. Haug — Institut für Festkörperphysik, Leibniz Universität Hannover, D-30167 Hannover, Germany

Here we report on graphene sheets, stacked by a transfer method [1] to produce novel complex layersystems.
Graphene is exfoliated on a thin PMMA layer, which can be detached from the silicon wafer. This layer is then placed on other graphene mono- or bilayer flakes.
The samples were characterized at low temperatures and in dependence of a magnetic field. Measurements show interesting novel effects, e. g. high resistance extrema near the charge neutrality point and magnetic field independent oscillations.

[1] C. Dean et al. Nature Nanotechnology **5**, 722 (2010)

HL 39.12 Tue 14:00 Poster F

Hartree-Fock theory in the full Brillouin zone of graphene — •Prakash Parida[1], Maxim Trushin[2], Tobias Stauber[3], and John Schliemann[1] — [1]Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany — [2]Department of Physics, University of Konstanz, D-78457 Konstanz, Germany — [3]Departamento de Teoría y Simulación de Materiales, Instituto de Ciencia de Materiales de Madrid, CSIC, E-28049 Madrid, Spain

Within the Hartree-Fock approximation, we explore how pseudospin texture and conductivity in the full Brillouin zone of graphene can be tuned by the electron-electron interactions. The pseudospin texture in the in-plane phase remains same as that of the non-interacting case. In the out-of-plane phase, the exchange interaction lifts the singularity of the pseudospin vector field at the Dirac point and the z-component of pseudospin orientation becomes maximum at the Dirac point. We find a semimetal-insulator transition at a critical value of $\alpha = \alpha_c$ (α = effective fine structure constant). The exchange interaction breaks the parity and the broken symmetry state in turn becomes the ground state in the pseudospin out-of-plane phase for $\alpha > \alpha_c$. While the renormalization of the Fermi velocity occurs in the in-plane gapless phase, a gap is generated in the broken symmetry out-of-plane phase. Finally, the out-of-plane pseudospin component shows optical valley Hall effect and polarization sensitive interband optical absorption.

HL 39.13 Tue 14:00 Poster F

Quantitative transmission electron microscopy of two-dimensional transition metal dichalcogenides — •Florian Winkler[1], Amir H. Tavabi[1], Emrah Yucelen[2], Beata E. Kardynal[3], and Rafal E. Dunin-Borkowski[1] — [1]Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons and Peter Grünberg Institute 5, Research Centre Jülich, Germany — [2]FEI Company, Achtseweg Noord 5, 5600 KA Eindhoven, The Netherlands — [3]Peter Grünberg Institute 9, Research Centre Jülich, Germany

Layered transition metal dichalcogenides (TMDs) have been the subject of intense research for applications in nanoelectronics. Strong spin-orbit interactions combined with a direct bandgap in monolayers of MX_2 (M: Mo, W; X: S, Se) have been shown to make TMDs very attractive for spintronics and valleytronics. The layered structures of TMDs make them ideal for quantitative studies using transmission electron microscopy (TEM), which can further be compared with device performance. Here, we study WSe_2 samples with thicknesses of between 1 and 4 monolayers using several quantitative TEM techniques, including off-axis electron holography and high-angle annular dark-field scanning TEM. We show that challenges associated with sample contamination, sample stability and and electron-beam-induced charging can be minimised through experimental design and a careful choice of imaging parameters. We perform statistical analyses of phase shifts measured using medium-resolution and high-resolution off-axis holography to measure the mean inner potentials of the samples and the numbers of S or Se atoms in individual atomic columns, respectively.

HL 39.14 Tue 14:00 Poster F

Bend Resistance in Nanoscale Epitaxial Bilayer Graphene Cross Junctions — •Epaminondas Karaissaridis[1], Claudia Bock[1], Florian Speck[2], Thomas Seyller[2], and Ulrich Kunze[1] — [1]Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum — [2]Technische Physik, Technische Universität Chemnitz

We investigated inertial-ballistic transport in nanoscale orthogonal cross junctions prepared on epitaxial bilayer graphene on SiC(0001) [1]. The average film thickness of 1.8 layers was determined by XPS measurements. Hall bars were used to characterize the graphene bilayer by Hall measurements in a temperature range of 1.5 K $\leq T \leq$ 300 K. At low temperatures ($T \leq 50$ K) a mobility of $\mu \approx 1400$ $cm^2/(Vs)$ and an electron density of $n \approx 4 \cdot 10^{12}$ cm^{-2} were determined. 50 nm wide cross junctions were studied in bend resistance geometry by DC measurements. We obtained a negative bend resistance of $R = -525$ Ω at $T = 4.2$ K indicating ballistic transport. The measured bend resistance is three times higher than the value obtained from similar devices on monolayer graphene [2, 3]. Even at $T = 100$ K, we determined a negative bend resistance of $R = -110$ Ω which promises ballistic transport well above 100 K. We suppose that the enhanced bend resistance in bilayer graphene is a consequence of its bandgap. This results in a depletion region that reduces scattering at the edges which is an important scattering mechanism in narrow graphene channels.

[1] T. Ohta *et al.*, Science **313**, 951 (2006).
[2] S. Weingart *et al.*, Appl. Phys. Lett. **95**, 262101 (2009).
[3] C. Bock *et al.*, Nanotechnology **23**, 395203 (2012).

HL 39.15 Tue 14:00 Poster F

Correlation between structural and electrical properties of transition metal dichalcogenide transistors — •Florian Winkler[1], Sven Borghardt[2], Martial Duchamp[1], Rafal E. Dunin-Borkowski[1], and Beata E. Kardynal[2] — [1]Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons and Peter Grünberg Institute 5, Research Centre Jülich, Germany — [2]Peter Grünberg Institute 9, Research Centre Jülich, Germany

Layered transition metal dichalcogenides (TMDs) have been researched intensively as materials for low power transistors. Strong spin orbit interactions combined with a direct bandgap in monolayers of MX_2 (M: Mo, W; X: S, Se) make them very attractive for spintronics and valleytronics. The realization of the promise offered by these materials depends on the ability to access their intrinsic properties, rather than measuring the effect of the environment.

In this work, we compare the electrical conductance of TMD field effect transistors with the structural properties of TMD films that were prepared in the same way. We study several combinations of channel materials (WSe_2 and MoS_2) and metals (Sc, Ti/Au, Pd) prepared using different techniques and measured under different conditions. We show clear correlations between the level of contamination of the films and their measured electrical characteristics. We discuss the effect of metal deposition on the compositions and properties of the TMD films. The results strongly suggest that the performance of TMD transistors is limited by the contamination of the channel material, as well as by interactions of metals with the TMD during metal deposition.

HL 39.16 Tue 14:00 Poster F

Scanning Tunneling Microscopy And Spectroscopy of Metallic Islands on Graphene/Cu and Graphene/SiO_2 — •Anne Holtsch, Tobias Euwens, and Uwe Hartmann — Institut für Experimentalphysik, Universität des Saarlandes, Saarbrücken

Using scanning probe techniques we investigate how graphene interacts electronically with various types of substrates in the presence of metallic islands. In the case of transition metals, due to the hybridization of their d orbital the p_z orbital of graphene, the band structure is significantly altered with respect to graphene [1]. By contrast, the interaction is expected to be much weaker for insulating SiO_2. Using scanning tunneling spectroscopy (STS) the different effects of the two substrates Cu and SiO_2 are investigated for absent and present metallic islands. The islands made from gold, nickel, or cobalt are put onto graphene by in-situ evaporation. Afterwards their relative orientation with respect to the graphene lattice was observed by scanning tunneling microscopy (STM). We further heat the system to induce intercalation of the metallic islands, resulting in a second change of the band structure of the sample. Due to specific Moiré patterns the intercalation processes are observable in STM images. Our goal is to evaluate how strongly the band structure measured via STS depends on the material properties of both the substrate and the metallic islands.

[1] E. N. Voloshina and Yu. S. Dedkov, Mater. Res. Express 1, 035603 (2014), arXiv:1405.2556.

HL 39.17 Tue 14:00 Poster F

Electrostatic induced graphene superlattice — •Nicolas Kurz — Institute of Nanotechnology, Karlsruhe Institute of Technology, Hermann-von-Helmholtz Platz 1, D- 76021 Karlsruhe, Germany

Graphene exhibits extraordinary transport properties such as extremly high electron mobility or outstanding thermal conductivity. What is maybe the most fascinating aspect of graphene is its linear dispersion in the vicinity of the K point, which is, hence, called Dirac point. It was predicted that by applying a periodic potential to graphene, the band structure can reveal extra Dirac points. So far the emergence of additional dirac points has been observed experimentally when graphene was put on top of hexagonal boron nitride, having same lattice structure and similar lattice constant. Due to the Van- der Waals interaction, a Moiré pattern is created which induces a superlattice.
However, this method lacks of tunability of the superlattice potential. We try to overcome this problem by using a special patterned metal gate which generates a 1D periodic potential. We use electron beam lithography and graphene encapsulated between hexagonal boron nitride in order to enhance the graphene's transport properties. These type of heterostructure has been become known as 'Van der Waals heterostructures' recently. We use a home-made transfer set-up and mechanical exfoliated material for the assembly of the heterostructure.

HL 39.18 Tue 14:00 Poster F

Graphene Ruthenium Complex Phototransistors — •Nicolai Walter — Institute of Nanotechnology, Karlsruhe Institute of Technology, Hermann-von-Helmholtz Platz 1, D- 76021 Karlsruhe, Germany

Graphene exhibits interesting electronic, optical, and mechanical properties, e.g. ultrahigh charge carrier mobility, broad spectra transmission, and superior strain resistance. These features make graphene a promising material in a variety of fields, i.a. flexible electronics.

However, due to the negligible thickness (atomic monolayer) and therefore small optical absorption together with short recombination times an efficient photodetection is not possible with bare graphene. This issue can be addressed by using graphene heterostructures where other materials or structures make up for those shortcomings.

We investigate graphene heterostructure phototransistors, consisting of a layer of photoactive ruthenium complex molecules imbedded between two cvd graphene sheets. The molecules are functionalized by pyrene moieties which enable them to attach to the graphene surface by π-π-stacking. In order to apply a defined amount of molecules a nanoimprint technique is applied using PDMS stamps aiming towards a monolayer of molecules. After the fabrication of test samples, the interaction between the ruthenium complex molecules and the graphene is to be investigated by measuring the change in electronic properties with illumination. In order to further determine the type of photoresponse, a temperature dependence measurement shall be conducted within a cryostat down to 4 K.

HL 39.19 Tue 14:00 Poster F

Thermal induced lattice distortion of diluted magnetic semiconductors — •Holger Göhring, Michael Paulus, Thomas Büning, Simon Wulle, Karin Esch, Christian Sternemann, Manfred Bayer, and Metin Tolan — Fakultät Physik/DELTA, Technische Universität Dortmund, 44221, Germany

Diluted magnetic semiconductors, which combine the properties of semiconductors and ferromagnets have been an important subject in materials science. Semiconductors with Curie temperatures above room temperature could revolutionize the field of spintronics by allowing control of the magnetization via application of voltage as observed e.g. for the ferromagnetic material galfenol. Magnetic semiconductors, which are currently under investigation, still show a rather low Curie temperature making them inapplicable for application. However, GaMnAs seems to be a promising candidate for high Curie temperature material. GaMnAs is typically grown epitaxially on GaAs substrates with a limited manganese content of a few percent. This system was studied intensively in the past years. To understand the relation between ferromagnetic and structural properties, high resolution x-ray diffraction experiments were performed at beamline BL9 of DELTA using a photon energy of 20 keV and a helium flow cryostate setup. The small changes in the GaMnAs lattice were determined by measuring both, the GaAsMn (004) and the GaAs(004) reflection of the substrate which serves as an internal reference. Our investigation hints on an impact of the ferromagnetic order on the lattice of GaMnAs. However, the data analysis is still in progress.

HL 39.20 Tue 14:00 Poster F

Modeling Magnetism of Diluted Magnetic Semiconductors using the Gutzwiller Method — •Thorben Linneweber — Technische Universität Dortmund, Lehrstuhl für Theoretische Physik II, 44221 Dortmund

Diluted magnetic semiconductors are materials in which magnetic ions substitutionally or interstitially replace a fraction of the cations of the semiconductor host material. We aim to describe the magnetic properties of $Cd_{1-x}Mn_xTe$ by combining the theory of strongly correlated electrons to semiconductor band theory. We use a multiband hubbard model with s,p-orbitals for the host and s,p,d-orbitals for the manganese ions. The one-particle hamiltonian is obtained via downfolding from DFT calculations using the Wannier90 Code. The effect of the strongly correlated Mn d-electrons is treated within the Gutzwiller method. To model the diluted nature of the magnetic substitutions a supercell approach is incorporated. As the manganese magnetic moment is known to be close to a $S = 5/2$ state the central question is how much this state is an atomic-like Hund's rule state. One of our further goals is to extract the coupling constants for a Heisenberg model.

HL 39.21 Tue 14:00 Poster F

Strain-controlled magnetically doped III-V semiconductors — •Stefan Stagraczyński[1], Czesław Jasiukiewicz[2], Vitalii Dugaev[2], and Jamal Berakdar[1] — [1]Institute für Physik, Martin-Luther-Universität Halle-Wittenberg, 06120 Halle(Saale), Germany — [2]Department of Physics, University of Technology, 35-959 Rzeszów, Poland

We investigate the 6-band Kane model for the valence band structure of III-V magnetic semiconductors, motivated by finding a general way to effectively control magnetic properties which are strongly coupled with elastic properties. In particular, we map out how uni/bi-axial strain can be used to tune the system. We analyze the complex dependence of total energy on the applied magnetization and compressive/tensile strain under selected hole concentrations and explain the effects of magnetic anisotropy in semiconductors. As an example, we have chosen the GaMnAs semiconductors system. Applying strain the has a strong impact on the total energy and can increase the magnetic anisotropy substantially. Further, we find the dependency of the total energy on the hole concentration in the presence of strain, magnetization and its direction. The results show symmetry properties, the importance of strain and magnetization in the semiconductors system.

HL 39.22 Tue 14:00 Poster F

Hole spin g-factor anisotropy in coupled GaAs/AlAs quantum wells — •Michael Kempf[1], Christian Gradl[1], Dieter Schuh[1], Dominique Bougeard[1], Roland Winkler[2], Christian Schüller[1], and Tobias Korn[1] — [1]Universität Regensburg, D-93040 Regensburg, Germany — [2]Northern Illinois University, DeKalb, Illinois 60115, USA

Using time resolved Kerr rotation (TRKR) we measured the spin dynamics of hole ensembles at low temperatures in undoped coupled quantum well (QW) structures prepared on GaAs substrates with different growth directions. By gating the double QW system we were able to separate the optically generated electron-hole-pairs into the different QW's, leading to a dominance of holes in the broader QW. As a result, we achieved spin dephasing times of several hundreds of picoseconds for the hole ensembles.

Thus, we were able to measure a strong anisotropy of the in-plane hole g-factor. For this, we altered the direction of the magnetic field applied with respect to the QW [1-10] axis in the QW plane. The arising results were in good agreement with numerical expectations.

HL 39.23 Tue 14:00 Poster F

Persistent Spin States in Two-Dimensional Hole Gases in Strained Quantum Wells — •Paul Wenk[1], Michael Kammermeier[1], Klaus Richter[1], Roland Winkler[2], and John Schliemann[1] — [1]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]Department of Physics, Northern Illinois University, IL 60115 DeKalb, US

In 2003 a particular relation between the spin-orbit coupling (SOC) due to bulk inversion asymmetry (Dresselhaus type SOC) and structure inversion asymmetry (Rashba type SOC) in two-dimensional (2D) electron systems has been found which gives rise to a spin-preserving symmetry.[1] Accordingly, we investigate in our present work the conditions for long-living spin-states in 2D hole gases in zincblende type semiconductor heterostructures. Extending our previous results on the persistent spin helix[5] by including, in addition to both Rashba and Dresselhaus SOC, a shear stress and a symmetric in-plane strain allows for the identification of new persistent spin states. The latter are in contrast to previous results[4,5] which require restrictions on the band model parameters (here the Luttinger parameters) which are difficult to realize in real materials.

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[1] Schliemann *et al.*, PRL **90** 146801 (2003)
[2] Bernevig *et al.*, PRL **97** 236601 (2006)
[3] Kohda *et al.*, PRB **86** 081306 (2012)
[4] Sacksteder *et al.* PRB **89**, 161307(R) (2014)
[5] Dollinger *et al.* PRB **90**, 115306 (2014)

HL 39.24 Tue 14:00 Poster F

(Magneto-)Optical Characterization of Sputter Deposited $La_{0.75}Sr_{0.25}MnO_3$ Thin Films — •Patrick Thoma[1], Manuel Monecke[1], Oana T. Ciubotariu[1,2], Roxana Dudric[2], Dietrich R. T. Zahn[1], and Georgeta Salvan[1] — [1]Semiconductor Physics, Technische Universität Chemnitz, D-09107 Chemnitz, Germany — [2]Faculty of Physics, Babes-Bolyai University Cluj-Napoca, RO-400084 Cluj-Napoca, Romania

$La_{1-x}Sr_xMnO_3$ (LSMO) is considered as a promising material for spintronic devices. Furthermore, via changing preparation conditions and/or stoichiometry of LSMO, one can tune the magnetic and transport properties[1].

LSMO with x = 0.33 has been widely investigated in this context. Here, $La_{0.75}Sr_{0.25}MnO_3$ thin films of different thicknesses ranging from 10 to 300 nm were grown on (111) p-doped Silicon with native SiO_2 by pulsed radio frequency magnetron sputtering at room temperature. The oxygen flow rate during the deposition process as well as the post-annealing temperature were optimized in order to obtain smooth (roughness < 1 nm) and crystalline films.

Access to the dielectric function was provided by measuring and modelling spectroscopic ellipsometry data and by recording magneto-optical Kerr effect (MOKE) spectra the off-diagonal elements of the dielectric tensor were evaluated.

[1]Majumdar, S., van Dijken, S.: Pulsed laser deposition of $La_{1-x}Sr_xMnO_3$: thin-film properties and spintronic applications. Journal of Physics D (2014)

HL 39.25 Tue 14:00 Poster F

Effect of Surface Acoustic Wave Induced Strain on Spin Dynamics — •Johannes Wanner[1], Ulrich Eckern[1], and Cosimo Gorini[2] — [1]Institute of Physics, University of Augsburg, 86135 Augsburg, Germany — [2]Faculty of Physics, University of Regensburg, 93040 Regensburg, Germany

Surface acoustic waves (SAW) have proven to be useful for driving charge and spin in quantum wells. By effectively separating spatially electrons and holes, spin transport by a SAW eludes the Bir-Aronov-Pikus relaxation mechanism. The piezo-electric in-plane field of the SAW allows to concentrate carriers in narrow pockets [1]. The suppression of the Dyakonov-Perel' spin relaxation mechanism based on the dominating spin-orbit interactions (Dresselhaus and Rashba) can thus be explained [2]. In this work, we study additional relaxation mechanisms, namely spin-orbit interaction due to strain and an out-of-plane electric field.

[1] H. Sanada et al., Phys. Rev. Lett. **106**, 216602 (2011); O. Couto et al., Phys. Rev. B **78**, 153305 (2008)
[2] J. Wanner et al., Adv. Mater. Interfaces **1**, 1400181 (2014)

HL 39.26 Tue 14:00 Poster F

Spectroscopy of surface-induced noise using shallow spins in diamond — •Christoph Müller[1], Thomas Unden[1], Yoav Romach[2], Lachlan Rogers[1], Boris Naydenov[1], Liam McGuinness[1], Nir Bar-Gill[2], and Fedor Jelezko[1] — [1]Institute for Quantum Optics and Center for Integrated Quantum Science and Technology, University of Ulm, 89081 Ulm, Germany — [2]The Racah Institute of Physics, The Center for Nanoscience and Nanotechnology, The Hebrew University of Jerusalem, Jerusalem 91904, Israel

Nitrogen-vacancy centres (NV) in diamond located a few nanometers below the surface were exploit to gain insight into the dynamics of the surface noise spectrum they experience. A double-Lorentzian noise spectrum was resolved, consisting of a slow component arising from spin-spin interactions of an electronic spin bath and a faster component related to phononic coupling. Dynamical decoupling sequences were used to decouple the NV spin from this surface noise and enhance their coherence properties.

HL 39.27 Tue 14:00 Poster F

NMR spectroscopy with single spin sensitivity — •Himadri Chatterjee[1], Christoph Müller[1], Xi Kong[1,2], Jiangming Cai[3], Junichi Isoya[4], Jiangfeng Du[2], Martin Plenio[3], Boris Naydenov[1], Liam McGuinness[1], and Fedor Jelezko[1] — [1]Institute for Quantum Optics, Ulm University, Albert-Einstein-Allee 11, Ulm 89081, Germany — [2]Synergetic Innovation Center of Quantum Information and Quantum Physics, University of Science and Technology of China, Hefei 230026, China — [3]Institute for Theoretical Physics, Albert-Einstein Allee 11, University of Ulm, Ulm D-89081, Germany — [4]Research Center for Knowledge Communities, University of Tsukuba, 1-2 Kasuya, Tsukuba, Ibaraki 305-8550 Japan

Nitrogen-vacancy (NV) centres in diamond located as close as a few nanometers to the diamond surface were exploit as a NMR quantum sensor to detect signals from strongly coupled nuclear spins placed on the surface. We achieved depth calibration for the NV in the range of tenth of nanometers by using 1-H spins and detection of down to 4 individual spins by using 29-Si. Using advanced techniques from signal processing (compressed sensing) the location of these spins could be calculated with Angström resolution.

HL 39.28 Tue 14:00 Poster F

Creation and Stabilization of Shallow Nitrogen-Vacancy Centers by Surface Plasma Termination — •Christian Osterkamp[1], Johannes Lang[1], Jochen Scharpf[1], Christoph Müller[1], Liam Paul McGuiness[1], Thomas Diemant[2], Rolf Jürgen Behm[2], Boris Naydenov[1], and Fedor Jelezko[1] — [1]Institut für Quantenoptik, Ulm University, Albert-Einstein-Allee 11, 89081 Ulm, Germany — [2]Institut für Oberflächenchemie und Katalyse, Ulm University, Albert-Einstein-Allee 47, 89081 Ulm, Germany

Nitrogen-vacancy centers (NV) in diamond a few nanometers below the crystal surface can be used as magnetic field sensors with very high sensitivity and spatial resolution. The fluorescence of single NVs can be detected and it's electron spin can be polarized, read-out and manipulated at ambient conditions. We created shallow NV centers by nitrogen delta doping during a plasma enhanced chemical vapor deposition (PECVD) growth process. After stabilizing the NV's negative charge state by a SF6 plasma treatment, the hydrogen nuclear magentic resonance signal from protons in the immersion oil were detected.

HL 39.29 Tue 14:00 Poster F

All-optically induced EPR in Mn-doped quantum wells — •Markus Kuhnert, Ilya Akimov, Dimitri Yakovlev, and Manfred Bayer — TU Dortmund

The field of spintronics, which in contrast to electronics, uses the spin instead of charge as information carrier, presents many interesting possibilities. For proper implementation of spintronic devices, research of adequate materials and methods is required. Here we present the results of our research into Manganese doped GaAs quantum wells, which might offer long lived spin coherence as well as spin manipulation mediated by the magnetic Manganese ions.

Following initial studies of electron lifetime in Manganese-doped GaAs quantum wells via time resolved Kerr effect and time resolved Photoluminescence measurements, further investigation into such samples is done by Electron paramagnetic resonance measurements. In this case, a method of all optical Electron paramagnetic resonance was developed. This is achieved by intensity modulation of the incident laser beam by a frequency of about 9.2 GHz and applying varying external magnetic fields.

HL 39.30 Tue 14:00 Poster F

Spin Noise Spectroscopy on single InAs Quantum Dots — •Julia Wiegand[1], Ramin Dahbashi[1], Jens Hübner[1], Klaus Pierz[2], Arne Ludwig[3], Andreas Wieck[3], and Michael Oestreich[1] — [1]Leibniz Universität Hannover, Institut für Festkörperphysik, Abteilung Nanostrukturen, Appelstraße 2, D-30167 Hannover, Germany — [2]Physikalisch Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig, Germany — [3]Ruhr-Universität Bochum, Angewandte Festkörperphysik, Universitätsstraße 150, D-44801 Bochum, Germany

The spin dynamics of electrons and holes confined in InAs quantum dots (QDs) are of particular interest for future applications in solid state quantum information processing. We employ spin noise spectroscopy (SNS) to access the intrinsic spin dynamics of confined carriers in individual QDs [1]. Measurements of single heavy hole spin dynamics reveal very long spin lifetimes up to 180 μs and a strong dependence of the longitudinal heavy hole spin relexation time for low magnetic fields [2]. The observed parasitic influence of charge fluctuations in the QD vicinity can be reduced by embedding the QDs in a Schottky diode structure. This also yields the advantages of deterministic charge control and tuning of the QD resonance via the quantum confined Stark effect.

[1] J. Hübner, F. Berski, R. Dahbashi, and M. Oestreich, physica status solidi (b) **251**, 1824 (2014).

[2] R. Dahbashi, J. Hübner, F. Berski, K. Pierz, and M. Oestreich, Phys. Rev. Lett. **112**, 156601 (2014).

HL 39.31 Tue 14:00 Poster F

Spin noise spectroscopy of artificial atoms in isotopically enriched ^{28}Si:P — •Michael Beck[1], Helge Riemann[2], Jens Hübner[1], and Michael Oestreich[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstr.2, D-30167 Hannover — [2]Leibniz-Institut für Kristallzüchtung, Max-Born-Str. 2, D-12489 Berlin

Spins of donor atoms in a silicon host are promising candidates for the implementation of quantum information devices [1]. The decoupling of donor atoms from the nuclear spin bath of the host lattice by means of isotopical enrichement leads to very long coherence times of donor electron spins [2]. Here, we will employ semiconductor spin noise spectroscopy [3] to investigate the spin dynamics of donor bound electrons in ^{28}Si:P in the millikelvin temperature regime. The nonperturbative character of this method allows for the extraction of the intrinsic electron spin coherence time and is anticipated to reveal additional dephasing mechanisms at ultra low temperatures.

[1] B.E. Kane, Nature **393**, 133 (1998).
[2] A.M. Tyryshkin, S. Tojo, J.J.L Morton, H. Riemann, N.A. Abrosimov, P. Becker, HJ. Pohl, T. Schenkel, M.L.W Thewalt, K.M. Itoh, S.A. Lyon, Nature Matter. **11**, 143, (2012).
[3] J. Hübner, F. Berski, R. Dahbashi and M. Oestreich, physica status solidi (b) **251**, 1824 (2014).

HL 39.32 Tue 14:00 Poster F

Stokes Polarimetry of the Voigt Effect in Semiconductors — •Pavel Sterin, Fabian Berski, Agnes Beichert, Jens Hübner, and Michael Oestreich — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstr. 2, D-30167 Hannover, Germany

The recently observed intriguing connection between spin-polarization control of optically injected carriers by linearly polarized light and magnetically induced birefringence raises the need in a method of precise characterization of the light beam polarization [1]. This birefringence in non-centrosymmetric materials under the influence of magnetic fields is known as the macroscopic Voigt effect and can cause significant changes of the degree of linear polarization. The change in polarization scales with the second power of the applied transversal magnetic field strength and depends strongly on parameters like the angle of incidence, the sample temperature, and the laser energy.

Here, we employ a self-built Stokes polarimeter and develop a customized Mueller-matrix formalism, which allows us to recover all important magnetic field dependent polarization properties of the light. We accurately investigate this setup and determine its limitations and applicability for such highly sensitive measurements [2].

[1] K. Schmalbuch, S. Göbbels, P. Schäfers, C. Rodenbücher, P. Schlammes, T. Schäpers, M. Lepsa, G. Güntherodt, B. Beschoten, Phys. Rev. Lett., **105**, 246603 (2010) [2] C. Flueraru, S. Latoui, J. Besse, P. Legendre, IEEE T INSTRUM MEAS, **57**, 731 (2008)

HL 39.33 Tue 14:00 Poster F

Optical analysis of ultrapure GaAs:Si for spintronics — •Magnus Neumann[1], Fabian Berski[1], Andreas Wieck[2], Jens Hübner[1], and Michael Oestreich[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstr. 2, 30167 Hannover — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum

Isolated donor electron spins in GaAs are suitable candidates for performing quantum information processing. Their intrinsic spin dynamics can be probed by spin noise spectroscopy [1] which requires detailed knowledge of the donor bound exciton resonances and other related optical transitions in the spectral window of interest. Therefore we perform optical absorption measurements in the (D^0X) regime on a free-standing layer of high quality MBE-grown GaAs with residual impurity density of $n \sim 10^{14}\,\mathrm{cm}^{-3}$. Besides the well-known bound exciton transitions we quantify the pronounced peak-splitting of the free exciton resonance which is consistently explained within the exciton-polariton framework [2]. A quantative lineshape analysis confirms the high purity of our sample [3] and helps to monitor the (D^0X) occupancy.

[1] J. Hübner, F. Berski, R. Dahbashi, and M. Oestreich, physica status solidi (b) **251**, 1824 (2014).
[2] E.S. Koteles, J. Lee, J.P. Salerno, and M.O. Vassell, Phys. Rev. Lett. **55**, 867 (1985).
[3] W.L. Bloss, E.S. Koteles, E.M. Brody, B.J. Sowell, J.P. Salerno, and J.V. Gormley, Solid State Communications **54**, 103 (1985).

HL 39.34 Tue 14:00 Poster F

Enhanced spin noise spectroscopy by interferometric detection — •Jennifer Haack, Ramin Dahbashi, Fabian Berski, Jens Hübner, and Michael Oestreich — Leibniz Universität Hannover, Institut für Festkörperphysik, Abteilung Nanostrukturen, Appelstraße 2, D-30167 Hannover, Germany

We present an enhanced method for minimally invasive measurements of the spin dynamic. In the past few years spin noise spectroscopy (SNS) has emerged into a versatile tool to study different semiconductor spin systems [1], e.g., bulk GaAs, quantum wells, and even individual quantum dots [2]. Especially the measurements on single hole spins in InAs quantum dots have pointed out very long spin lifetimes but despite very low laser intensities there was still a significant perturbation limiting the detectable intrinsic hole spin lifetime [2]. Therefore we introduce homodyne detection as an extension to the standard SN detection. Homodyne detection amplifies the signal by a local oscillator interfering with the conventional SN probe laser. We show a first experimental validation of this detection scheme yielding an increased signal to noise ratio in the well understood example system of Rb vapor [3].

[1] J. Hübner, F. Berski, R. Dahbashi, and M. Oestreich, physica status solidi (b) **251**, 1824 (2014).
[2] R. Dahbashi, J. Hübner, F. Berski, K. Pierz, and M. Oestreich, Phys. Rev. Lett **112**, 156601 (2014).
[3] H. Horn, G.M. Müller, E. Rasel, L. Santos, J. Hübner, and M. Oestreich, Phys. Rev. A **84**, 043851 (2011).

HL 39.35 Tue 14:00 Poster F

Controlling the frequency of ultra-fast polarization oscillations in Spin-VCSELs — •Markus Lindemann[1], Henning Höpfner[1], Nils C. Gerhardt[1], Martin R. Hofmann[1], Tobias Pusch[2], and Rainer Michalzik[2] — [1]Photonics and Terahertz Technology, Ruhr-University Bochum, 44780 Bochum, Germany — [2]Institute of Optoelectronics, Ulm University, 89081 Ulm, Germany

Spin-polarized optoelectronic devices offer several advantages in comparison to their conventional counterparts. One of these benefits is the possibility of polarization manipulation, as the optical polarization degree is connected with the carrier spin via the optical selection rules. The modulation speed of the spin is fast in comparison to the modulation frequency of the laser's intensity, which is limited by the dynamics of the carrier-photon system. Therefore the polarization modulation bandwidth generally exceeds the direct intensity modulation bandwidth. Due to cavity anisotropies the VCSEL bears two orthogonal linear polarized modes. In case of spin-injection, both modes evolve lasing operation simultaneously. This leads to an oscillation in the circular polarization degree. By switching this oscillation on and off with spin injection, short polarization bursts can be generated (H. Höpfner et al, Appl. Phys. Lett., 104, 022409 (2014)). The frequency of this oscillation and therefore the minimal width of the polarization bursts depend on the frequency distance of the two VCSEL modes exclusively. This is determined by the birefringence of the lasing material. We investigate optimization strategies to reach very high oscillation frequencies by manipulating the birefringence via mechanical strain.

HL 39.36 Tue 14:00 Poster F

Characterization of nitrogen-vacancy centers (NVs) in ^{13}C controlled diamond layers produced by CVD growth — •Alexander Geier, Christian Osterkamp, Boris Naydenov, and Fedor Jelezko — Institut für Quantenoptik, Ulm University, Albert Einstein Allee 11, Ulm 89081, Germany

Optical read-out and spin manipulation makes the negatively charged nitrogen-vacancy center's (NV) electron spin one of the leading solid-state quantum bits operating under ambient conditions. For quantum technology applications it is necessary to create NVs on demand. We produce NV centers by delta doping during a plasma enhanced chemical vapor deposition (PECVD) process. By changing the ratio of ^{12}C/ ^{13}C atoms in the growth chamber we are able to produce isotopically pure diamonds. A well controlled ^{13}C concentration is important for creating a quantum register where an NV is coupled to several nearby ^{13}C atoms[1], [2].

[1]: Childress et al., *Coherent Dynamics of Coupled Electron and Nuclear Spin Qubits in diamond*, in: Science Vol. 314 no.5797 pp. 281-285 DOI:10.1126/science.1131871(2006)
[2]: Waldherr et al., *Quantum Error Correction in a Solid-State Hybrid Spin Register*, in: Nautre 506(7487), S.204-207, DOI: 10.1038/nature12919 (2014)

HL 39.37 Tue 14:00 Poster F

Microstrip resonators for silicon-carbide quantum microwave emitters — •Johannes Fichtner[1], Andreas Sperlich[1], Hannes Kraus[1], Georgy Astakhov[1], and Vladimir Dyakonov[1,2] — [1]Experimental Physics VI, Julius Maximilian University of Würzburg, 97074 Würzburg — [2]ZAE Bayern, 97074 Würzburg

Silicon vacancies in silicon carbide (SiC) were recently found to possess an unique excitation pathway. Optical pumping results in deactivation into a metastable state, which then selectively populates the higher energy ±3/2 manifold of the spin quartet ground state. This population inversion allows stimulated emission of radiation [1].

When placed in a resonator, microwave amplification in SiC vacancies is possible. The amplification (gain) is highly dependent on the filling factor of the resonator. Our approach to increase the gain is the use of microstrip resonators instead of usual box resonators. A microstrip is an electrical transmission line consisting of a conduction strip separated from a conducting ground plane by a dielectric.

Here we present the first results on our circuit board design and its performance. The most important properties of the microstrip waveguide are its characteristic impedance and resonance frequency. The influence of the resonator geometry were studied. Effects of different edge shapes (so called mitred bends) and feed line gaps were also examined.

[1] H. Kraus, V. Soltamov, D. Riedel, S. Väth, F. Fuchs, A. Sperlich, P. Baranov, V. Dyakonov and G. Astakhov, Nat. Phys. 10, 157 (2014)

HL 39.38 Tue 14:00 Poster F

Small nuclear spin environments in graphene quantum dots — •Daniel Hetterich, Moritz Fuchs, and Björn Trauzettel — Institute for Theoretical Physics IV , University of Würzburg

Graphene based quantum dots (QD) constitute interesting systems for both quantum computation and the physics of quantum information. An electron spin confined to such a QD is in contact with a bath of nuclear spins via an anisotropic hyperfine interaction (HI). If the HI is the most important interaction, the spins form a star-like system with the electron spin in its center. Most interestingly, isotopic purification allows to change the ratio of spin carrying ^{13}C with respect to spinless ^{12}C and, hence, to control the number K of nuclear spins. In order to complement previous studies of the anisotropic HI in graphene for large bath sizes, we investigate the spin dynamics for a small number of nuclear spins by means of exact diagonalization. Considering different types of initial states and various configurations of the nuclei within the dot, we analyze the time evolution of the electron spin with a focus on equilibration. The results of our simulations are in accordance with analytical estimations.