HL 32: Spin Phenomena in Semiconductors

Time: Wednesday 15:00–16:15 Location: EW 015

HL 32.1 Wed 15:00 EW 015

Hole spin coherence in InAs/InAlGaAs self-assembled quantum dots emitting at telecom wavelengths. — Eiko Evers[1], Natalia Kopteva[1], •Vitalie Nedelea[1], A Kors[2], Ranbir Kaur[2], Johann Reithmaier[2], Mohamed Benyoucef[2], Manfred Bayer[1], and Alex Greilich[1] — [1]Experimentelle Physik 2, Technische Universität Dortmund, 44221 Dortmund, Germany — [2]Institute of Nanostructure Technologies and Analytics (INA), CINSaT, University of Kassel, D-34132 Kassel, Germany

We report measurements of the longitudinal and transverse spin relaxation times of holes in an ensemble of self-assembled InAs/InAlGaAs quantum dots (QDs) emitting in the telecom spectral range. The spin coherence of a single carrier is determined by spin mode locking in the inhomogeneous ensemble of QDs. By modelling the signal, the hole spin coherence time can be extracted to be in the range of T2 = 0.02 - 0.4 *s. The longitudinal spin relaxation time T1 = 0.5 *s is measured by the spin inertia method. Using the spin mode-locking method, we could deter mine the range of the achievable spin coherence of holes, which exceed previously measured values in similar types of QDs by at least an order of magnitude. The longitudinal spin lifetime of 0.5 μs is also extended and currently provides the upper limit for the spin coherence.

HL 32.2 Wed 15:15 EW 015

Long-Range Proximity Effect in Magnetite Hybrid Ferromagnet-Semiconductor — Ina Kalitukha[1,2], •Eyüp Yalcin[1], Olga Ken[1,2], Vladimir Korenev[1,2], Ilya Akimov[1,2], Carolin Harkort[1], Grigorii Dimitriev[2], Dennis Kudlacik[1], Victor Sapega[2], Vitalie Nedelea[1], Evgeny Zhukov[1,2], Dmitri Yakovlev[1,2], Al Banshchikov[2], Andrey Kaveev[2,3], Grzegorz Karczewski[4], Tomasz Wojtowicz[5], Martina Müller[6], and Manfred Bayer[1] — [1]Experimentelle Physik 2, Technische Universität Dortmund, 44227 Dortmund, Germany — [2]St. Petersburg, Russia — [3]St. Petersburg, Russia — [4]Institute of Physics, Polish Academy of Sciences, PL-02668 Warsaw, Poland — [5]International Research Centre MagTop, Institute of Physics, Polish Academy of Sciences, PL-02668 Warsaw, Poland — [6]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany

We studied long-range proximity effect in hybrid ferromagnet-semiconductor structure between the ferromagnetic (FM) semimetal magnetite (Fe_3O_4) layer and CdTe quantum well (QW) using time-integrated and time-resolved photoluminescence (PL) spectroscopy techniques. The magnetite FM layer and a CdTe QW are separated by a 10 nm thick (Cd,Mg)Te barrier. The proximity effect is manifested in the circularly polarized photoluminescence corresponding to the recombination of photoexcited electrons with holes bound to shallow acceptors in the QW induced by the FM layer.

HL 32.3 Wed 15:30 EW 015

Extended Spin Lifetimes in Transition Metal Doped Hybrid Lead Halide Perovskites — •Jonathan Zerhoch[1,2,3], Stanislav Bodnar[1], Jamie Lerpiniere[4], Shangpu Liu[1,2,3], Timo Neumann[2,3,5], Barbara Sergl[2,3], Markus W. Heindl[1,2,3], Andrii Shcherbakov[1,2,3], Ahmed Elghandour[6], Rüdiger Klingeler[6], Alison Walker[4], and Felix Deschler[1] — [1]Physikalisch-Chemisches Institut, Universität Heidelberg — [2]Walter Schottky Institut, Technische Universität München — [3]Physics Department, TUM School of Natural Sciences, Technische Universität München — [4]Department of Physics, University of Bath — [5]Cavendish Laboratory, University of Cambridge — [6]Kirchhoff Institut für Physik, Universität Heidelberg

The outstanding optoelectronic properties of hybrid metal halide perovskites, and their strong spin-orbit coupling, enable efficient manipulation of the charge carrier's angular momentum. In this work, we investigate the dominant spin relaxation mechanism in $CH_3NH_3PbBr_3$ polycrystalline thin films with nominal doping levels up to 50% with the transition metal Mn^{2+} . We investigate the spin relaxation times in these paramagnetic hybrid semiconductors with ultrafast circularly polarized broadband transient absorption spectroscopy at cryogenic temperatures. Using quantitative theoretical analysis of the photoexcitation cooling processes, we identify increased carrier momentum scattering rates extending the spin relaxation lifetimes by a factor of three. We explain this observation with motional narrowing effects in the paramagnetic ensemble of Mn^{2+} impurities.

HL 32.4 Wed 15:45 EW 015

Extension of the coherent optical response from the trions localized in InGaAs quantum dots — •Alexander Kosarev[1,2], Artur Trifonov[2,3], Irina Yugova[3], Iskander Yanibekov[3], Sergey Poltavtsev[2,3], Aleksandr Kamenskii[2], Sven Scholz[4], Carlo Alberto Sgroi[4], Arne Ludwig[4], Andreas Wieck[4], Dmitri Yakovlev[2], Manfred Bayer[2], and Ilya Akimov[2] — [1]Technical University Berlin, Germany — [2]Technical University Dortmund, Germany — [3]St. Petersburg, Russia — [4]Ruhr-University Bochum, Germany

A sequence of optical pulses can store the optical fields in the ensemble of quantum emitters and subsequently retrieve them in the form of photon echoes (PE). The limiting factor for such storage is the decoherence time of the quantum emitter, which can be extended by transferring the coherence from the emitter to its spin degrees of freedom, which was earlier seen in bulk material and quantum wells. In the work, we report such an extension of the coherent response by an order of magnitude to 4 ns, observed on the negatively charged InGaAs self-assembled quantum dots using three-pulse spin-dependent PE in the moderate transverse magnetic field. We revealed that the non-zero transverse hole g-factor must be accounted in the temporal evolution of such systems because of its strong impact on the long-lived PE signal. Thus, transfer of the coherence from the emitter to the optical degrees of freedom with a subsequent retrieval was first observed in ensembles of the quantum dots, non-zero transverse hole g-factor was accounted in the existing model to describe evolution of such system.

HL 32.5 Wed 16:00 EW 015

Magnetic transparent conductors for spintronics — •Pino D'Amico[1], Alessandra Catellani[1], Alice Ruini[2], Stefano Curtarolo[3], Marco Fornari[4], Marco Buongiorno Nardelli[5], and Arrigo Calzolari[1] — [1]Istituto Nanoscienze CNR-NANO-S3, I-4115 Modena, Italy — [2]Dipartimento FIM Universitá di Modena e Reggio Emilia, I-41125 Modena, Italy — [3]Department of Materials Science and Engineering, Duke University, Durham, NC 27708, USA — [4]Department of Physics, Central Michigan University, Mt. Pleasant, MI 48859 — [5]Department of Physics, University of North Texas, Denton, TX 76203, USA

Transparent Conductors (TCs) exhibit optical transparency and electron conductivity, and are essential for many opto-electronic and photo-voltaic devices. The most common TCs are electron-doped oxides, which have few limitations when transition metals are used as dopants. Non-oxides TCs have the potential of extending the class of materials to the magnetic realm, bypass technological bottlenecks, and bring TCs to the field of spintronics. In this contribution we propose new functional materials that combine transparency and conductivity with magnetic spin polarization that can be used for spintronic applications, such as spin filters. By using high-throughput first-principles techniques, we identified a large number of potential TCs, including non-oxides materials. Our results indicate that proper doping with transition metals introduces a finite magnetization that can provide spin filtering up to 90% in the electrical conductivity, still maintaining a transparency greater than 90%.