HL 25: Focus Session: Young Semiconductor Forum

The young semiconductor forum gives a platform for post-docs at all career stages to present themselves and their scientific ideas. It consists of an oral session with invited talks about their work and/or scientific vita. With this format, we hope to attract both postdocs and senior researchers and decision makers to join this forum: for postdocs, to give them a platform to present themselves, and for professors, to meet the next generation of scientists.

Organized by Rudolf Bratschitsch, Alexander Holleitner, and the AGyouLeaP (Lucas Kreuzer and Aisha Aqeel)

Time: Wednesday 9:30–12:15 Location: POT/0251

Invited Talk HL 25.1 Wed 9:30 POT/0251
Quantum dots for single-electron current sources — •Johannes C. Bayer, Thomas Gerster, Dario Maradan, Niels Ubbelohde, Klaus Pierz, Hans W. Schumacher, and Frank Hohls — Physikalisch-Technische Bundesanstalt, 38116 Braunschweig, Germany

Generating accurate currents can be achieved in an elegant and direct way by applying a periodic signal to a tunable barrier quantum dot. Such devices are called single-electron pumps (SEPs) due to their capability of emitting a well defined number of n electrons per cycle of an external drive. With driving frequency f and elementary charge e this leads to a controlled and clocked current of $I = nef$, thereby providing a suitable basis for a quantum current standard. While individual SEPs can already achieve errors in the sub-ppm range for currents of the order $I \approx 100$ pA [1], implementing larger systems consisting of multiple well-performing SEPs remains a challenging task. We here present DC transport as well as pumping characteristics of multiple SEP devices toward scaling to higher currents.

[1] F. Stein, et. al., Metrologia 54, S1-S8 (2017)

Invited Talk HL 25.2 Wed 10:00 POT/0251
Optical readout of reconfigurable in-plane magnetic domains in CrSBr — •Aleksandra Łopion[1], Pierre-Maurice Piel[1], Manuel Terbeck[1], Jan-Hendrik Larusch[1], Jakob Henz[1], Marie-Christin Heissenbüttel[2], Thorsten Deilmann[2], Michael Rohlfing[2], Zdenek Sofer[3], and Ursula Wurstbauer[1] — [1]Physikalisches Institut and Center for Soft Nanoscience (SoN), University of Münster, Wilhelm Klemm Str. 10, Münster, 48149, Germany — [2]Institut für Festkörpertheorie, University of Münster, Wilhelm Klemm Str. 10, Münster, 48149, Germany — [3]Department of Inorganic Chemistry, University of Chemistry and Technology, Prague Technická 5, Prague, 616628, Czech Republic

Two-dimensional van der Waals (vdW) magnets have overcome the Mermin-Wagner expectation by hosting long-range order while remaining tunable through stacking, strain, gating, and external fields. Their reconfigurability and hysteresis are attractive for information technologies, particularly when antiferromagnetic (AFM) multistability is accessed and read optically. We discover a reconfigurable multilayer magnetic domain structure in the A-type antiferromagnetic semiconductor. The layered out-of-plane domain structure can be tuned by external stimuli and read out via domain-modulated optical contrast. This coupled magnetic-optical functionality demonstrates the possibility of encoding, processing, and storage of information in magnetic textures with a photonic-compatible readout. The domain landscape highlights CrSBr as a platform for "intelligent matter" and a building block for ultracompact opto-spintronic memories and neuromorphic hardware.

Invited Talk HL 25.3 Wed 10:30 POT/0251
Ferroelectric switching in Mn-doped epitaxial $BaTiO_3$ films and superlattices on silicon — •Alfredo Blázquez Martínez[1], Valentin Väinö Hevelke[1,2], Ibukun Olaniyan[1,2], Minh-Anh Luong[1,3], Ines Häusler[1], Sven Wiesner[1], Christoph T. Koch[4], Dong-Jik Kim[1], and Catherine Dubourdieu[1,2] — [1]Helmholtz-Zentrum Berlin fur Materialien und Energie, 14109 Berlin, Germany — [2]Freie Universität Berlin, 14195 Berlin, Germany — [3]CEMES-CNRS and Université de Toulouse, F-31055 Toulouse, France — [4]Humboldt-Universität zu Berlin, 12489 Berlin, Germany

The integration of epitaxial ferroelectric oxides on silicon remains a key challenge for realizing energy-efficient and CMOS-compatible nanoelectronic devices. Among these materials, barium titanate ($BaTiO_3$) is a prototypical perovskite ferroelectric with a high remanent polarization and a low coercive field. Molecular beam epitaxy (MBE) enables the growth of high-quality epitaxial $BaTiO_3$ on Si, yet these films typically show high leakage currents, which preclude polarization measurements and the realization of functional devices on Si. Here, we demonstrate robust ferroelectric hysteresis in epitaxial $BaTiO_3$ films grown on p-type Si using Mn doping. The introduction of a suitable amount of Mn suppresses leakage currents by up to seven orders of magnitude. We will then discuss the properties of (Mn-doped $BaTiO_3/SrTiO_3)_n$ superlattices hosting vortex polar textures of a few nanometers in diameter. This work highlights Mn-doping as an effective path to reduce leakage currents in epitaxial $BaTiO_3$ heterostructures to enable future topotronic devices integrated monolithically on semiconductors.

15 min. break

Invited Talk HL 25.4 Wed 11:15 POT/0251
Tunability of quantized Hall plateaus — •Serkan Sirt[1], Vladimir Umansky[2], and Stefan Ludwig[1] — [1]Paul-Drude-Institut für Festkörperelektronik, Leibniz-Institut im Forschungsverbund Berlin e.V., Berlin, Germany — [2]Weizmann Institut of Science, Rehovot, Israel

The textbook single-particle description of the quantum Hall effect based on the Landauer-Büttiker picture explains the extent of quantized Hall plateaus as a function of magnetic field in terms of disorder-broadened Landau levels. In contrast, the screening theory includes electron-electron interactions and predicts the formation of extended Hall plateaus based on the confinement potential, without the need for disorder [1].

To test these contrasting models, we investigate the tunability of the plateaus in gate-defined Hall bars. We employ a global top gate to deplete the two-dimensional electron system and an additional screen gate on the sample surface, separated by an insulating layer, to define the Hall bar. Varying the gate voltages allows us to tune the edges of the Hall bar continuously from hard to soft confinement. We find that, for softer confinement, the plateaus become wider by extending to lower magnetic fields. These results support the screening theory and are inconsistent with the Landauer-Büttiker picture.

This work establishes a new method for controlling and manipulating quantized Hall plateaus, which may become relevant for quantum Hall metrology and quantum technology applications.

[1] R. R. Gerhardts, Phys. Status Solidi B 245, 378 (2008)

Invited Talk HL 25.5 Wed 11:45 POT/0251
How to achieve high gain in organic photodetectors? — •Johannes Benduhn — Institute of Applied Physics, TU Dresden, Germany — German Centre for Astrophysics, Görlitz, Germany

Organic photodetectors (OPDs) match their inorganic counterparts in performance, with additional features like semitransparency, flexibility, and narrowband detection, opening new sensing applications. However, high-gain OPDs are challenging due to disorder. This work discusses two alternative principles to achieve gain.

The first approach uses unbalanced charge-carrier transport. Photogenerated charges accumulated near one of the contacts generate a local field that triggers charge injection of charges from the external circuit into the active layer. Under dark conditions, this injection is absent; therefore, these devices reach impressive EQE values of 1,000-10,000 %. However, the underlying microscopic mechanisms remain unclear. Here, we precisely tune the interface layers via vacuum deposition, enabling us to reveal the injection mechanism.

Another solution is photoactive transistors. We introduce vertical organic-permeable base transistors (OPBTs) that operate at low driving voltages and achieve high switching speeds. We report, for the first time, a photogating effect in OPBTs. By leveraging the unique structure of OPBTs and conducting a detailed investigation into the underlying charge-storing mechanism, we have achieved record responsivity values reaching 10^9 A/W, specific detectivities of 10^{15} Jones (based on noise measurements), and retention times exceeding 10^5 s. [1]

[1] Schröder, Benduhn *et al.* Nature Photonics 19, 1088-1098 (2025).