# DS 33: Poster: Thin Films: Applications, Transport and Phase Change Materials

Time: Wednesday 15:00–18:00 Location: P1A

DS 33.1 Wed 15:00 P1A

**Towards a large-scale quantum simulator at room temperature** — Philipp J. Vetter[1], Thomas Unden[1], Nikolas Tomek[1], Tamara Sumarac[2], Elana K. Urbach[2], Timo Weggler[1], •Maximilian G. Hirsch[1], Hideyuki Watanabe[3], Kohei M. Itoh[4], Boris Naydenov[5], Mikhail D. Lukin[2], Martin B. Plenio[6], and Fedor Jelezko[1] — [1]Institute for Quantum Optics and Center for Integrated Quantum Science and Technology, Universität Ulm — [2]Department of Physics, Harvard University — [3]Correlated Electronics Group, Electronics and Photonics Research Institute, National Institute of Advanced Industrial Science and Technology, Tsukuba — [4]Department of Applied Physics and Physico-Informatics, Faculty of Science and Technology, Keio University — [5]Helmholtz-Zentrum Berlin für Materialien und Energie — [6]Institute for Theoretical Physics and Center for Integrated Quantum Science and Technology, Universität Ulm

Quantum simulators enable the study of strongly-correlated many-body systems that may exhibit exotic phases, such as spin liquids and supersolids. We present our progress of creating a large-scale quantum simulator at room-temperature, which is based on the nitrogen vacancy center in diamond, coupled to surrounding nuclear spins. We demonstrate the fabrication of a 1 nm thin 13C layer in diamond which is polarized and coherently controlled by the NV center. 2D-Materials which offer a clearly identifiable symmetry and thickness are transferred onto the diamond surface. The nuclear spins within the transferred flake are sensed via the NV center aiming for full polarization.

DS 33.2 Wed 15:00 P1A

**MoS2 as universal charge selective layer in Sb2S3 based TF solar cells** — •Leonid Shupletsov[1,2], Pascal Büttner[1], Yuanyuan Cao[1], and Julien Bachmann[1,3] — [1]FAU, IZNF, Cauerstraße 3, 91058 Erlangen, Germany — [2]FHI, Faradayweg 4-6, 14195 Berlin, Germany — [3]Institute of Chemistry, Saint Petersburg State University, Universitetskii pr. 26, 198504 St. Petersburg, Russia

To comply with the rising demand in green energy, new durable photovoltaic devices, which use earth abundant, non-toxic and affordable materials, are required. Antimony (III) sulphide (Sb2S3), with a direct band gap of 1.7 eV and very high absorption coefficient, is a promising absorption material candidate for novel thin film (TF) photovoltaics. Better charge selective materials must be found to achieve economically viable efficiencies, and avoid organic compounds. We demonstrate the proof of principle for the utilization of bulk MoS2 as a universal selective carrier material in Sb2S3 based TF solar cells, capable of replacing the usually organic hole transport (HTL) and the metal oxide electron transport layers (ETL). Cyclovoltammetric deposition of uniform amorphous MoS2 thin films from aqueous solution on ITO with tens of nanometres thickness was optimized and compared to atomic layer deposition (ALD). Thermal treatment was employed to convert the as grown layers into a crystalline phase. The layer properties vary depending on the deposition method which allowed to build devices with MoS2 as ETL, HTL or both. High current extraction was achieved with MoS2 replacing both charge selective layers. This study shows the great tunability and application potential of bulk MoS2.

DS 33.3 Wed 15:00 P1A

**Lithographical Fabrication of Single Crystal OFET Arrays by Area Selective Growth and Solvent Vapor Annealing** — •Zhifang Wang[1,2], Hong Wang[1], Wenchong Wang[1], and Lifeng Chi[2] — [1]Physikalisches Institut and Center for Nanotechnology (CeNTech), Universität Münster, 48149 Münster, Germany. — [2]Jiangsu Key Laboratory for Carbon-Based Functional Materials & Devices, Institute of Functional Nano & Soft Materials (FUNSOM), Joint International Research Laboratory of Carbon-Based Functional Materials and Devices, Soochow University, 199 Ren'ai Road, Suzhou, 215123, Jiangsu, P.R. China

OFET arrays based on miniaturized organic single crystals play an important role in reading-out circuit, which is crucial for high peformance and high level integration organic electronics. Here, we achieved high uniformity and high density single crystal OFET arrays by using a lithography compatible strategy that combines area selective growth and subsequent solvent vapor annealing process. The organic semiconductor molecule triethylsilylethynyl anthradithiophene (TES-ADT) can first selectively grow on prepatterned drain-source electrodes, then further convert into discrete single crystals by solvent vapor annealing. The results show that the crystals very uniform in size, with two orders of improvement in carrier mobility in comparison to that of amorphous/polycrystalline film. With the method, crosstalk between devices can be completely surpressed. OFET and basic logic gate arrays with reading-out electrodes are further demonstrated.

DS 33.4 Wed 15:00 P1A

**Transport properties in thin films of the chiral RhSi compound** — •Hua Lv, Anastasios Markou, and Claudia Felser — Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

Unconventional chiral fermions attract a lot of attention due to their unusual quantum phenomena and unique electrical properties, such as quantized photogalvanic optical response. Recent studies demonstrated the large surface Fermi arc [1] and quantized photocurrent in bulk RhSi crystal [2].

In this work, we systematically study the magneto transport properties of magnetron sputtered RhSi films with different thickness. We find the surface scattering plays an important role in the thinner films and Kohler's rule dominates the longitudinal magnetoresistance.

References:
[1] Daniel S. Sanchez et al, Nature 567, 500-505 (2019).
[2] Dylan Rees et al, arXiv: 1902.03230v2.

DS 33.5 Wed 15:00 P1A

**Magnetoconductance of Bi quantum films in parallel magnetic fields** — •Doaa Abdelbarey[1], Christoph Tegenkamp[1,2], and Herbert Pfnür[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover — [2]Institut für Physik, TU Chemnitz

Bismuth has attracted a lot of interest because of its unique electronic properties such as low carrier concentrations and high carrier mobilities, In particular, strong Rashba splitting of the edge states appears in quantum films generated by epitaxial growth. Thus high-quality thin films open new pathways to tailor the electronic properties further. Magneto-conductance of films grown epitaxially on Si(111) with a thickness of 10 to 100 bilayers (BL) was measured at T= 9 K in parallel magnetic fields up to 4T. For B-fields in plane and parallel to the current direction only WAL is observed irrespective of thickness. However, if the B-fields are in plane, but perpendicular to the current, a crossover from weak anti-localization (WAL) to weak localization (WL) and back is seen for films up to 70 BL. For thicker films only WAL is observed. The observed coherent part of conductance in parallel B-fields perpendicular to current is characterized by an intriguing change from strong to weak coupling between edge states as a function of layer thickness and their hybridization with the quantized bulk states.

DS 33.6 Wed 15:00 P1A

**In-operando studies on thiophene based organic field-effect transistors** — •Manuel Johnson[1], Tim Hawly[1], Baolin Zhao[2], Marcus Halik[2], and Rainer Fink[1] — [1]Lehrstuhl für Physikalische Chemie II, FAU Erlangen-Nürnberg, Germany — [2]Lehrstuhl für Werkstoffwissenschaften II, FAU Erlangen-Nürnberg, Germany

Organic field effect transistors have drawn growing interest for novel electronic applications like backplanes for flexible displays or low-cost circuits for sensor applications. Main reason for this has been their increased performance due to the development of materials with improved charge carriers mobility and environmental stability [1]. Nevertheless, there are still open questions regarding charge carrier transport and its mechanism. To address this issue we performed Raman and Kelvin probe force microscopy studies to get an insight into our devices, based on pentacene and different thiophene derivatives while operating the devices. We observe a permanent change in the surface potential after the first device stress (i.e. functional operation) and a reversible potential increase during device operation. Furthermore, we found that the permanent potential change is homogenous across the device while the reversible effect is strongly correlated to the local microstructure. We interpret these findings as different effects of charge trapping, whereby the permanent charge trapping takes place inside the dielectric layer while the reversible charge trapping happens inside the organic semiconductor film and at the organic-dielectric interface. This research is funded by the DFG within GRK1896.

[1] D. Natali, et al., Adv. Mater. 2012, 24, 1357

DS 33.7 Wed 15:00 P1A

**Investigation of Superconductivity in the Phase Change Material $In_3Sb_1Te_2$** — •Lisa Metzner[1], Elisabeth-Annemarie Gerhorst[1], Patrick Juraschitz[1], and Matthias Wuttig[1,2] — [1]I. Physikalisches Institut (IA), RWTH Aachen University, 52056 Aachen, Germany — [2]JARA - FIT, RWTH Aachen University, Germany

Due to their unique physical properties, phase change materials (PCM) are promising candidates for future data storage applications. By applying electrical or laser pulses, they can be switched rapidly and reversibly between an amorphous and a crystalline state which show a big contrast in optical and electrical properties. It has been shown, that these chalcogenide-based materials can be classified by a unique bonding mechanism, called metavalent bonding, which can account for many of the special properties of these materials. When these materials are put on a map, besides their suitability for memory applications, many topological insulators, good thermoelectrics or superconductors can be identified, since strong electron-phonon interactions play a prominent role in these metavalent materials.
The aim of this work is to investigate the superconductivity in the phase change material $In_3Sb_1Te_2$. Therefore, thin film samples for both structural characterization and electrical transport measurements are deposited by sputter deposition. Furthermore, tunnel contacts are produced to analyse the superconducting energy gap alongside the critical temperatures and fields for films of various thicknesses.

DS 33.8 Wed 15:00 P1A

**Electrical and Thermal Transport Properties of Ion-Beam Sputtered Epitaxial Manganite Perovskite Films** — •Tim Sievert, Gottfried Schnabel, Birte Kressdorf, Jörg Hoffmann, and Christian Jooss — Institut für Materialphysik, Georg-August-Universität Göttingen

Perovskite oxides are a promising class of materials for microelectronics and energy harvesting. Strongly correlated manganite thin films reveal interesting transport properties which can be drastically altered by phase transitions. Due to their dependence on strain, off-stoichiometry and point defects, they are influenced by ion beam sputtering conditions. Thus, it is crucial to understand the impact of fabrication on the resulting material and fundamental processes within the material.

In this contribution we examine the interrelation between fabrication parameters, growth and film properties like strain, composition, electric and thermal transport of manganite perovskites, such as $La_{1-x}Sr_xMnO_3$, $Pr_{1-x}Ca_xMnO_3$ on $SrTiO_3(100)$ substrates. The temperature dependence of thermal, electrical and optical conductivity as well as magnetization between 5 K to 400 K are correlated with the microstructure and phase transitions in order to improve the understanding of the impact of defects on the phase diagram and transport phenomena. For the study of photo-electric characteristics, steps into the growth of optically transparent conducting contacts are pursued based on sputtering of indium tin oxide films.