DS 21: Layer Properties I: Electronic Properties

Time: Wednesday 9:30–10:45 Location: CHE 91

DS 21.1 Wed 9:30 CHE 91

Band structures of HgTe films from the cyclotron resonance — •Jan Gospodaric[1], Alexey Shuvaev[1], Vlad Dziom[1], Alena Dobretsova[2], Nikolay Nikolaevich Mikhailov[2], Ze Don Kvon[2], Elena Novik[3,4], and Andrei Pimenov[1] — [1]Institute of Solid State Physics, Vienna University of Technology, 1040 Vienna, Austria — [2]Rzhanov Institute of Semiconductor Physics and Novosibirsk State University, Novosibirsk 630090, Russia — [3]Institute of Theoretical Physics, Technische Universität Dresden, 01062 Dresden, Germany — [4]Dresden High Magnetic Field Laboratory (HLD-EMFL), Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany

An essential part of understanding the properties of materials is knowing their band structure. One of the most standardized methods to acquire the band structure of solids is provided by angle-resolved photoemission spectroscopy (ARPES), which provides access to the electronic structures of the area close to the surface of the sample (typical depths in Ångström range). However, in 2D heterostructures, additional buffer and capping layers limit this procedure. Here we present the results of an alternative method to obtain the band dispersion of such samples by probing the cyclotron resonance of the free carriers in thin films based on the HgTe. With the presented technique we can map both the electron and hole part of the band structures of HgTe films in semimetallic and topological insulating phases. The resulting band pictures overlap well with the theoretical results, provided by the $\mathbf{k} \cdot \mathbf{p}$ model.

DS 21.2 Wed 9:45 CHE 91

In-situ probing of the thickness-dependent electronic properties of BaBiO3 — •Rosa Luca Bouwmeester, Kai Sotthewes, and Alexander Brinkman — University of Twente, Enschede, the Netherlands

Being the parent compound of the high-Tc superconductors BaPb1-xBixO3 and Ba1-xKxBiO3, single crystal BaBiO3 has been studied extensively. Its insulator band gap is thought to be due to a breathing distortion [1,2,3]. In recent years, the thickness of BaBiO3 thin films is taken as a new degree of freedom to study its influence on the electronic properties [4,5,6]. In the ultra-thin limit, metallicity is predicted because the breathing distortion is suppressed. Experimentally, no insulator-to-metal transition has yet been observed. Here, in-situ scanning tunneling microscopy (STM) studies are performed on BaBiO3 thin films with thicknesses in the range of 4 unit cells to 50 nm. For the first time, in the ultra-thin limit, metallic behavior is observed.

References

[1] H. Sato et al., Nature 338, 241-243 (1989)
[2] S. Pei et al., Phys. Rev. B 41, 4126 (1990)
[3] K. Inumaru et al., Phys. Rev. B 78, 132507 (2008)
[4] G. Kim et al., Phys. Rev. Lett. 115, 226402 (2015)
[5] H.G. Lee et al., APL Materials 6, 016107 (2018)
[6] M. Zapf et al., Phys. Rev. B 99, 245308 (2019)

DS 21.3 Wed 10:00 CHE 91

Magnetodielectric Effect and Interface Couplings in LaMnO3/LaNiO3 Superlattices — •Philipp Ksoll[1], Vladimir Roddatis[2], and Vasily Moshnyaga[1] — [1]1. Physikalisches Institut, Uni Göttingen — [2]Institut für Materialphysik, Uni Göttingen

Multifunctional double perovskites, e.g. ferromagnetic insulating La2NiMnO6, have recently gained strong interest because of their rich physics and prospects for technological applications due to the magnetodielectric (MD) effect. To study the origin of MD coupling, epitaxial superlattices of (LaMnO3)n/(LaNiO3)n (LMO/LNO) with n varying from 20 u.c. down to one monolayer (n=1 yields La2NiMnO6) have been grown on Nb-doped SrTiO3(111) at relatively low (Tlow˜650°C) and high (Thight˜900°C) T by metalorganic aerosol deposition (MAD) technique, equipped with in situ optical ellipsometry. SLs grown at Tlow show an enhanced exchange bias field, HEB˜40 Oe, and large coercive fields, Hc˜800 Oe, as well as a suppressed saturation magnetization (msat,650°C˜1/2*msat,900°C) as compared to those measured for SLs grown at 900°C. This means that the structure of interfaces and interfacial LMO/LNO magnetic coupling may be influenced by growth conditions. A relatively slow growth kinetics at 650°C seems to suppress the charge transfer between Mn and Ni cations, resulting an enhanced antiferromagnetic coupling between Mn3+ and Ni3+. Taking into account the data of in situ ellipsometry, we further performed measurements of dielectric constant for SLs with n=2, 5 at T=5-400 K and for frequencies, f=10E-6 - 2*10E6 Hz, to elucidate the role of LMO/LNO interfaces in the MD effect.

DS 21.4 Wed 10:15 CHE 91

Orbital- and thickness dependent band engineering of $\mathbf{WSe_2}$ by potassium surface functionalization — •Tom Klaproth[1], Carsten Habenicht[1], Roman Schuster[1], Bernd Büchner[1,2], Martin Knupfer[1], and Andreas Koitzsch[1] — [1]Leibniz Institute for Solid State and Materials Research, Helmholtzstrasse 20, 01069 Dresden, Germany — [2]Institute of Solid State Physics, TU Dresden, 01069 Dresden, Germany

Atomically thin transition metal dichalcogenides (TMDC) are promising candidates for implementation in next generation semiconducting devices, for which effective methods of property engineering are urgently needed. Alkali metal deposition is an important tool to tune the electronic properties of TMDCs and 2D materials in general. Here, by applying angle-resolved photoemission, electron-energy loss spectroscopy and density functional theory, we monitor how exactly potassium deposition alters the electronic structure of WSe_2, a prototypical TMDC with large spin-orbit coupling. We find that the changes of the electronic structure are more complex than previously anticipated.

There are two main features: i) The bandstructure shifts down on a thickness dependent rate, implying effective electron delocalization. ii) The density of selenium *vs* tungsten states depends on the doping level, which leads to changes of the optical response beyond increased dielectric screening. Our work gives detailed insight into the effects of potassium deposition on WSe_2, provides microscopic understanding thereof and improves the basis for property engineering of 2D materials.

DS 21.5 Wed 10:30 CHE 91

Material selection and diffusion control for electrochemical metallization memory by using nano-pillar structure diffusion barrier — •Yen Kai Cheng — Department of Material Science and Engineering, National Tsing Hua University, Hsinchu 30013, Taiwan

Ag and Cu based electrodes with TiOx and HfOx based electrolytes electrochemical metallization (ECM) random access memory is a promising candidate for nonvolatile memory applications due to its simple structure and excellent performances. However, several challenges are needed to solve as the cell area is scaled down, especially for the device reliability and variability. Since the formation and rupture of the conductive filaments is stochastic, the injection of cations plays a critical role in improving the reliability and variability. In this study, two directions are considered, First, the combinations of different electrode/electrolyte cause the diffusivity differences, result in different degrees of cation injections and LRS retention failure times. Second, an Al2O3 layer with nano-pillar array architecture inserted between the electrode and switching layer is demonstrated. The width between the nano-pillar is tunable from 10 nm to 30 nm by changing the coverage of Al2O3 layer. The Al2O3 layer is served as the barrier that restrained the Ag and Cu atoms to diffuse into the electrolyte. With this architecture design, the resistive switching behaviors not only show different degrees of multi-level storage potential, but also provide a roadmap and show which kind of electrode/electrolyte has the potential in the neuron application.