TT 38: Topology and symmetry protected materials & Topological insulators – Poster (joint session O/TT)

Time: Tuesday 14:00–16:00 Location: P2

TT 38.1 Tue 14:00 P2

Manipulation of topological surface states by switchable molecules. — Lukas Staiger[1], Jannis Lessmeister[1], •Ralf Hemm[1], Juliusz Wolny[1], Volker Schünemann[1], Martin Aeschlimann[1], and Benjamin Stadtmüller[2] — [1]Department of Physics and Research Center OPTIMAS, RPTU University Kaiserslautern-Landau, 67633 Kaiserslautern, Germany — [2]Institute of Physics, University of Augsburg, 86159 Augsburg, Germany

Three-dimensional topological insulators host spin-momentum-locked surface states protected by time-reversal symmetry, giving them potential for spintronic devices. Controlling these states remains challenging but is crucial for opening gaps, shifting the Dirac point and tailoring spin textures for applications. In our work, we utilize a monolayer of the spin-crossover complex $Fe(phen)_2(SCN)_2$ on the topological insulator Bi_2Se_3 to break the time-reversal symmetry of the substrate. Employing angle-resolved photoemission spectroscopy, we trace the evolution of the electronic structure as a function of molecular coverage and temperature. Despite a conspicuous energy shift and modified dispersion, there is no clear evidence for a band gap opening after deposition of a molecular monolayer. Concurrently, additional spectral weight from molecular orbitals emerges, and thermally and optically driven spin-crossover transitions in the $Fe(phen)_2(SCN)_2$ layer induce changes in the Dirac-point energy and spectral weight. Our findings demonstrate that a spin-crossover overlayer can quantitatively alter the dispersion of topological surface states, while allowing them to exist due to strong interactions between molecules and surfaces.

TT 38.2 Tue 14:00 P2

Deciphering the complex surface of the topological phase in the polar semiconductor BiTeI — •Adrian Weindl, Christoph Setescak, and Franz J. Giessibl — Faculty of Physics, University of Regensburg, D-93053 Regensburg, Germany

BiTeI is a semiconductor consisting of polar layers that can form Rashba spin-split p-n junctions on its surface due to stacking faults. It has been shown that gentle annealing can transform the surface of BiTeI into a topological insulator with spin-polarized surface modes exhibiting linear dispersion. Previous LEED and RHEED measurements revealed that the surface undergoes a structural change from a non-centrosymmetric triple-layer structure to a quintuple-layer structure. However, the exact surface structure remains elusive. Using scanning tunneling microscopy, atomic force microscopy, and Kelvin probe force spectroscopy we study the surface before and after annealing with atomic resolution. We show that the annealing results in different surface phases that are highly sensitive to the annealing temperature: a chemically homgeneous phase at around 240°C and a inhomogeneous phase with strong charge disorder at 250°C. We determine the termination of each phase and confirm that the surface exhibits the signature of a topological surface state even in the strongly disordered phase.

TT 38.3 Tue 14:00 P2

THz-driven nonlinear dynamics studied with high-power THz sources — Atiqa Arshad[1,2], Jan-C Deinert[2], Igor Ilyakov[2], Andreas Gebauer[2], Anjan Kumar N M[1], and •Stefan Kaiser[1] — [1]TU Dresden,Germany — [2]HZDR, Dresden,Germany

THz pump-photoelectron spectroscopy (ARPES) probe is currently being implemented at the THz facility TELBE at Helmholtz-Zentrum Dresden-Rossendorf. This unique combination of high-field terahertz excitation and tr-ARPES probe will enable groundbreaking experiments on solid surfaces and interfaces. To this aim we have set up a high-repetition rate THz source driven by a 180 W laser source yielding $>$ 50 mW THz output power. We report on the THz generation and characterization scheme as well as on first experiments. A highly promising material class to be studied with these light sources is BiTeI, a dual topological insulator that exhibits two different types of surface states on different interfaces. We present our study on the complex nonlinear dynamics, in particular THz harmonic generation in these compounds.

TT 38.4 Tue 14:00 P2

The quasi one-dimensional van der Waals material α-Bi_4Br_4 — •Jonathan K. Hofmann[1,2], Serhii Kovalchuk[1,3], Mingqian Zheng[4], Yuqi Zhang[4], Vasily Cherepanov[1], Timofey Balashov[1], Jin-Jian Zhou[4], Zhiwei Wang[4], Yugui Yao[4], Irek Morawski[3], F. Stefan Tautz[1,2], Felix Lüpke[1,5], and Bert Voigtländer[1,2] — [1]Peter Grünberg Institut (PGI-3), Forschungszentrum Jülich, Germany — [2]Experimentalphysik IV A, RWTH Aachen University, Germany — [3]Institute of Experimental Physics, University of Wrocław, Poland — [4]Key Laboratory of Advanced Optoelectronic Quantum Architecture and Measurement, Beijing Institute of Technology, China — [5]II. Physikalisches Institut, Universität zu Köln, Germany

α-Bi_4Br_4 is a quasi-one-dimensional material: covalently bonded Bi_4Br_4 chains are arranged in parallel, side-by-side and layer-by-layer, with van der Waals gaps in between. Bulk α-Bi_4Br_4 is higher-order topological insulator. At step edges on the (001) surface, quantum spin Hall (QSH) edge states are present. Using a scanning tunneling microscope (STM), we observe a significant shift of the chains, relative to each other, which we attribute to shear stress. Scanning tunneling spectroscopy reveals that the edge states are robust against the strain. Density functional theory confirms that a strained monolayer of Bi_4Br_4 is a QSH insulator with $\mathbb{Z}_2 = 1$. Furthermore, we use a four-tip STM to analyze the electrical transport of α-Bi_4Br_4 *in situ*.