O 10: Poster Session I: Topological insulators

Time: Monday 10:30–12:30 Location: P

O 10.1 Mon 10:30 P

Topologization of beta-antimonene on Bi2Se3 via proximity effects — •Kris Holtgrewe[1], Conor Hogan[2], and Simone Sanna[1] — [1]Justus-Liebig-Universität, Gießen, Germany — [2]Institute of Structure of Matter (ISM-CNR), Rome, Italy

Thin antimony (Sb) layers adsorbed on bismuth selenide (Bi_2Se_3) are an exciting van der Waals heterostructure system. While the substrate is a topological insulator (TI), thin sheets of the β-phase of antimony are topologically trivial (CI). So, the question arises whether the topological surface states form at the substrate-adlayer interface or whether the TI/CI boundary shifts downwards (trivialization of the substrate) or upwards (topologization of the adlayer). In this theoretical work, we apply density functional theory to model heterostructures of single and double bilayers of antimonene on a bismuth selenide substrate. After investigating the structural details, we analyse the space- and spin-resolved electronic band structure. We show that the topological surface states of the pristine Bi_2Se_3 substrate migrate to the top antimony bilayer, while their unique helical spin texture is preserved. The topologization of the Sb sheets is a consequence of the complex hybridization process between the bands of the substrate and the sheets.

O 10.2 Mon 10:30 P

Dirac Fermions in a Two-Dimensional Triangular Indium Layer on SiC(0001) — •Maximilian Bauernfeind[1,3], Jonas Erhardt[1,3], Philipp Eck[2,3], Jörg Schäfer[1,3], Simon Moser[1,3], Domenico Di Sante[2,3], Ralph Claessen[1,3], and Giorgio Sangiovanni[2,3] — [1]Physikalisches Institut, Universität Würzburg, D-97074 Würzburg, Germany — [2]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, D-97074 Würzburg, Germany — [3]Würzburg-Dresden Cluster of Excellence ct.qmat, Universität Würzburg, D-97074 Würzburg, Germany

The Kane-Mele model provides an intuitive strategy to realize non-trivial topology in two-dimensional honeycomb lattices. Graphene, the most prominent representative of this class, lacks spin-orbit coupling (SOC), which prevents the formation of a sizeable bulk band gap and the utilization of the topological phase at reasonable temperatures. By enriching the orbital subspace and concomitantly switching to a triangular lattice, new possibilities arise. Here, we demonstrate by angle-resolved photoelectron spectroscopy that a triangular indium lattice grown on SiC(0001) - indenene - hosts massive, i.e., gapped Dirac Fermions at the K-point. The opening of this topologically non-trivial gap of approx. 100 meV relies on the strong local SOC. The in-plane inversion symmetry breaking induced by the substrate counteracts the topology but produces on the other hand a distinctive charge localization that directly reflects the non-trivial topological character of indenene, which allowed us to identify this new quantum spin Hall insulator by scanning tunneling microscopy.

O 10.3 Mon 10:30 P

Lifting topological protection in a quantum spin Hall insulator — •Raul Stühler[1], André Kowalewski[1], Felix Reis[1], Dimitri Jungblut[1], Fernando Dominguez Tijero[1,2], Johannes Weis[1], Benedikt Scharf[1], Werner R. Hanke[1], Gang Li[3], Joerg Schaefer[1], Ewelina M. Hankiewicz[1], and Ralph Claessen[1] — [1]Universität Würzburg and Würzburg-Dresden Cluster of Excellence ct.qmat, Germany — [2]Technische Universität Braunschweig, Germany — [3]ShanghaiTech University, China

The recently discovered monolayer system bismuthene/SiC(0001) is a promising candidate for the realization of a room-temperature quantum spin Hall (QSH) effect [1]. As expected for a QSH insulator, the electronic edge channels do not show any signs of backscattering from kinky edge sections that would manifest in interference phenomena [2]. Notwithstanding, topological protection against defect scattering may become lifted when two helical edge channels are brought into direct proximity, resulting in quantum interference. By scanning tunneling microscopy we study phase-slip domain boundaries (DB) with limited longitudinal extent. By spectroscopic means we scrutinize quasiparticle interference along these one-dimensional topographic defects that points towards a linear electronic dispersion. We discuss our findings as possible quantum interference between coupled helical edge states formed in the vicinity of a DB, accompanied by lifting the topological protection via hybridization.

[1] F. Reis et al., Science **357**, 287–290 (2017).
[2] R. Stühler et al., Nature Physics **16**, 47–51 (2020).

O 10.4 Mon 10:30 P

2D to 3D crossover in topological insulators — •Corentin Morice[1], Thilo Kopp[2], and Arno Kampf[3] — [1]Institute for Theoretical Physics Amsterdam and Delta Institute for Theoretical Physics,University of Amsterdam, 1098 XH Amsterdam, The Netherlands — [2]Center for Electronic Correlations and Magnetism, Experimental Physics VI,Institute of Physics, University of Augsburg, 86135 Augsburg, Germany — [3]Center for Electronic Correlations and Magnetism, Theoretical Physics III,Institute of Physics, University of Augsburg, 86135 Augsburg, Germany

At the heart of the study of topological insulators lies a fundamental dichotomy: topological invariants are defined in infinite systems, but their main footprint, surface states, only exists in finite systems. In systems in the slab geometry, namely infinite in two dimensions and finite in one, the 2D topological invariant was shown to display three different types of behaviours. In the limit of zero Dirac velocity along z, these behaviours extrapolate to the three 3D topological phases: trivial, weak and strong topological insulators. We show analytically that the boundaries of these regions are topological phase transitions of particular significance, and allow one to fully predict the 3D topological invariants from finite-thickness information. Away from this limit, we show that a new phase arises, which displays surface states but no band inversion at any finite thickness, disentangling these two concepts closely linked in 3D.

O 10.5 Mon 10:30 P

Temperature Evolution of the Magnetic Gap in the Ferromagnetic Topological Insulator $MnSb_2Te_4$ probed by Scanning Tunneling Spectroscopy — •Philipp Küppers[1], Stefan Wimmer[2], Andreas Ney[2], Jannik Zenner[1], Marcus Liebmann[1], Markus Morgenstern[1], Günther Bauer[2], and Gunther Springholz[2] — [1]II. Institute of Physics B and JARA-FIT, RWTH Aachen Unversity, 52074 Aachen, Germany — [2]Institut für Halbleiter- und Festkörperphysik, Johannes Kepler Universität, Altenberger Straße 69, 4040 Linz, Austria

$MnSb_2Te_4$ has recently been established as a ferromagnetic topological insulator with out-of-plane anisotropy and large Curie temperature T_C = 40-50 K [1]. Here, we show that it exhibits a band gap at the Fermi level that closes rather precisely at T_C using scanning tunneling spectroscopy (STS) down to 4 K. At 4K, the gap has an average size of 17 meV exhibiting spatial fluctuations due to disorder with strength 11 meV and correlation length 2nm. We also applied in-plane magnetic fields in order to close the gap by changing of the magnetic orientation.

[1] Wimmer et al., arXiv:2011.07052 (2020)