

High Yield Large Single Domain Rhombohedral Graphene Flakes using Anodic Bonding

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Rhombohedral Graphene is one of the possible stacking orders of Graphene layers in few layer Graphene. Recently, a plethora of strongly correlated quantum phases has been found in rhombohedral Graphene. Unfortunately, due to the metastability of rhombohedral Graphene in ambient conditions, previously, yields as low as 20-30% have been reported, slowing down the research on rhombohedral Graphene and hampering any potential technological application. Here we present how Anodic Bonding, a standard technique in semiconductor packaging, can be used to reliably produce up to 100 micron long, single domain rhombohedral Graphene flakes with a yield exceeding 80%.

These flakes can be transferred from the substrate via quasi dry transfer, in this case no hBN is necessary. Dry transfer methods are also possible after rehydrating the glass substrate.

We hope that this technique will allow for a speed-up and facilitate the fabrication of rhombohedral Graphene devices and increase the applicability of rhombohedral Graphene.

Topological Wigner Molecule Crystal in Transition-Metal Dichalcogenide Moiré Superlattices

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As a versatile platform for exploring exotic quantum phases, moiré superlattices, ranging from twisted graphene to twisted transition metal dichalcogenides, have been intensively studied. In this work, based on exact diagonalization and Hartree-Fock mean-field calculations, the interaction-driven topological phases are investigated in hole-doped twisted bilayer MoS₂ at the high filling factor $\nu = 3$. Besides the nematic insulator and quantum anomalous Hall phases, the topological Wigner molecule crystal (TWMC) phase is found in the phase diagram. The emergence of TWMC is characterized by the enhanced dimer bonding between trimer molecules trapped in the honeycomb moiré potential, resulting in the hole charge density splitting from one to three peaks in each trimer molecule. The nontrivial topology of TWMC is identified by the nonzero $\mathbb{Z}_2$ Berry phase and fractionally filled topological corner states. Combining topological and Wigner physics, our results demonstrate the formation of TWMC in moiré superlattices, which can be detected by state-of-the-art scanning tunneling microscopy measurements.

Unveiling the Magnetic Phase transitions and Critical behavior in itinerant intermetallic ferromagnet Mn_2Ga_5

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USTC

Mn_2Ga_5 , Itinerant Ferromagnet, Magnetic phase transitions, RKKY long-range interactions, Magnetic Anisotropy

Tailoring Altermagnetic α -MnTe Thin Films via Epitaxial Growth

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Tailoring altermagnetism in α -MnTe thin films via molecular beam epitaxy (MBE) is essential for exploring novel quantum states and elucidating underlying physical mechanisms. Here, we report a systematic study of MnTe thin film growth on InP (111) substrates, realizing high-quality epitaxy on both terminations. Crucially, the substrate termination determines the resulting phase: InP (111)-A stabilizes the altermagnetic α -MnTe phase, whereas InP (111)-B favors the zinc-blende β -MnTe phase, as further corroborated by transmission electron microscopy. Angle-resolved photoemission spectroscopy (ARPES) measurements directly reveal the characteristic altermagnetic band splitting in α -MnTe, in sharp contrast to the semiconducting band structure of β -MnTe. Furthermore, the altermagnetic properties of α -MnTe are systematically investigated by reducing the thickness from 30 uc to 6 uc. This dimensional crossover suppresses the antiferromagnetic (AFM) transition temperature and reveals synergistic modifications on the electronic structure arising from reduced dimensionality and interfacial coupling. Our work establishes a systematic MBE growth protocol for high-quality α -MnTe thin films and facilitates further understanding of dimensional effects and interfacial interactions in altermagnets.

Topological Band Engineering of One-Dimensional π -d Conjugated Metal-Organic Frameworks

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One-dimensional (1D) π -d conjugated metal-organic frameworks (c-MOFs) have garnered widespread research interest in chemical energy storage and conversion. In this work, we introduce a universal principle to engineer the topological bands of 1D c-MOFs. Connected by d orbitals of transition metals, two equivalent hidden molecular π orbitals in 1D c-MOFs can generate a staggered hopping within and between the organic ligands, forming Su-Schrieffer-Heeger-shaped 1D topological bands. Guided by this discovery, we investigate the electronic structures of the typical 1D c-MOF assembled from Ni atoms and 2HQDI (QDI = 2,5-diamino-1,4-benzoquinonediimine) precursors (NiQDI) by first-principles calculations, revealing 1D topological bands around the Fermi level. Due to local bonding variations at the QDI terminations, these two hidden molecular π orbitals become atomically bonded but electronically separated at the edge QDI, creating spatially localized in-gap topological edge states at the end of the NiQDI chain. This definitive signature for 1D topological bands is identified through differential conductance spectra in scanning tunneling microscopy measurements. Our results provide conclusive experimental evidence for topological bands in 1D c-MOFs, paving the way for exploring the topological physics in organic materials through frontier molecular orbitals.

Atomic-Limit Mott Insulator in [4]Triangulene Frameworks

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Triangulene, one unique class of zigzag-edged triangular graphene molecules, has attracted tremendous research interest. In this work, as an ultimate phase of the Mott insulator, we present the realization of the atomic-limit Mott insulator in experimentally synthesized [4]triangulene frameworks ([4]-TGFs) from first-principles calculations. The frontier molecular orbitals of the nonmagnetic [4]triangulene consist of three coupled corner modes. After the isolated [4]triangulene is assembled into [4]-TGF, one special enantiomorphic flat band is created through the coupling of these corner modes, which is identified to be a second-order topological insulator with half-filled topological corner states at the Fermi level. Moreover, [4]-TGF prefers an antiferromagnetic ground state under Hubbard interactions, which further splits these metallic zero-energy states into an atomic-limit Mott insulator with spin-polarized corners. Since the fractional filling of topological corner states is a smoking-gun signature of higher-order topology, our results demonstrate a universal approach to explore the atomic-limit Mott insulators in higher-order topological materials.

Anomalous Thermodynamic Properties of Water Molecules

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Unlike ordinary liquids, water exhibits various anomalous thermodynamic behaviors. This phenomenon has been known for centuries. However, the mechanisms by which such anomalous thermodynamic behaviors of water are generated have remained unclear for a long time. However, we recently elucidated the thermodynamic mechanism that produces the positive and negative thermal expansion of water by relating it to the functional shapes of the interactions between water molecules. Furthermore, we have solved the mysteries of temperature changes in the specific heat at constant pressure and isothermal compressibility. Thus, we clarified that the anomalous thermodynamic behavior of water is a phenomenon produced by the anomalous thermodynamic properties of the water molecules. We believe that all other theories proposed thus far, such as the liquid-liquid phase transition being the cause of negative thermal expansion, are completely off the mark. These are the views of people losing sight of the essence of the anomalous phenomena.

Noise field analysis of two-body loss in two-terminal transport through a one-dimensional chain

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Coupling to the environment induces dissipation and fundamentally alters the transport properties of systems. In the context of open quantum systems, such quantum transport setups have been experimentally realized, particularly in ultracold atomic gases, through the controlled introduction of particle loss. While one-body loss has been extensively studied both theoretically and experimentally, the theoretical framework for two-body loss remains incomplete. This is due to the intrinsically many-body nature of two-body loss, which makes it difficult to analyze by means of conventional theoretical approaches based on the quantum master equation.

Recently, a noise field approach has been developed, in which particle loss is treated as stochastic fluctuations. This framework enables quantum many-body calculations in a field-theoretical manner, analogous to those for isolated quantum systems [1, 2]. Motivated by these advances, we present a self-consistent analysis of dissipation effects arising from two-body loss. Specifically, we investigate two-terminal transport through a one-dimensional chain subject to localized pairwise loss at the central site. By representing two-body loss in terms of noise fields, we perform an analysis that incorporates dissipative effects to all orders in perturbation theory within the self-consistent Born approximation.

Our analysis reveals that the effective strength of pairwise dissipation depends on the occupation number at the lossy site, leading to a weaker suppression of the particle current compared to one-body loss [3]. Our results obtained with normal reservoirs are in agreement with recent experimental observation using superfluid reservoirs in ultracold atomic gases [4].

Reference

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Density functional study of flexural rigidity of strained graphene

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We obtain the flexural rigidity of graphene from the curvature energy of carbon nanotubes (CNTs). Using density functional theory, we calculate the curvature energy of CNTs with various chirality, which shows the well-known inverse-square dependence on the radius. Here the proportionality coefficient is half of the flexural rigidity of pristine graphene. When each CNT is compressed or expanded along the radial or axial direction, the change in its curvature energy originates from the change in the curvature itself and from the strain-induced change in the flexural rigidity of graphene. From the curvature energies of CNTs compressed or expanded radially or axially, we obtain the flexural rigidity of graphene strained uniaxially or biaxially. We analyze the dependence of the flexural rigidity of uniaxially strained graphene on the strain and bending directions, and compare the flexural rigidity of biaxially strained graphene with those of uniaxially strained ones.

Density functional study of atomic and electronic structures at noble metal/black phosphorus interfaces

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We study atomic and electronic structures of noble metal/black phosphorus interfaces using density functional theory. To consider the experimentally observed corrugated interface, we place black phosphorus layers in contact with a corrugated noble metal (Au, Ag) surface and optimize positions of the phosphorus atoms by minimizing the total energy of the system. For comparison, we also consider an atomically flat interface. For each interface, we calculate the binding energy and analyze the charge transfer and charge density distribution. We compare these properties between the two interface types to determine the energetic stability of the corrugated noble metal/black phosphorus interface and to understand the effect of surface corrugation on the overall electronic structure.