Ultimately Thin Sliding Ferroelectrics

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Abstract

A discrete response of crystalline matter structures is pivotal to the ongoing information revolution. The direct way to switch the properties and response of a given structure is to modify its crystalline symmetries by changing the relative atomic positions. Structural rearrangements, however, are challenging due to the solid interatomic bonds involved, which limits current technologies to alternating electronic orders without moving the atoms. Interestingly, layered 2D crystals enable efficient control of atomic scale shifts along their van der Waals (vdW) interfaces. The layers exhibit discrete sliding steps between meta-stable crystalline configurations in response to external electric fields or stress.

The talk outlines the many possible vdW polytypes in mono and binary compounds, their typical stacking energies, orbital inter-layer overlaps, and discrete symmetries. The distinct response of each polytype, its internal charge redistribution, electric polarization, and underlying band structure are further discussed with emphasis on our recent reports of interfacial ferroelectricity [1], ladder-like cumulative polarization [2], doping-dependent polarization in elemental graphitic polytypes [3], and the microscopic switching dynamics between polytypes. Lastly, I will describe our efforts to extend this conceptual "Slide-Tronics" [1] switching mechanism to efficient swapping between structural symmetries and lattice orientations.

[1] "Interfacial ferroelectricity by van-der-Waals sliding" https://www.science.org/doi/10.1126/science.abe8177

[2] "Cumulative Polarization in Conductive Interfacial Ferroelectrics" https://www.nature.com/articles/s41586-022-05341-5

[3] "Spontaneous Electric Polarization in Graphene Polytypes" https://arxiv.org/abs/2305.10890

Biography

Currently, I'm heading the Quantum Layered Matter Group at Tel Aviv University (as Assoc. Prof.). The group explores correlated electronic phases in 2D devices. Based on our resent observations we have founded "SlideTro" LTD, a spin-off company focused on electronics using layered materials.

During my post-doc with Nobel laureate Andre Geim at the University of Manchester UK, we explored hydrodynamic, ballistic, and superconducting flows of electrons in graphene heterostructures. My PhD with Prof. Yoram Dagan at TAU was focused on superconductivity and magnetism at correlated oxide interfaces.