EQUATE SEMINAR SERIES

Physical and Electronic Properties of Two-dimensional Layered Materials: In4Se3 , TiS3, ZrS3, HfS3, AND GeI2

As transistor widths shrink down to a few nanometers, two-dimensional (2D) materials can help combat gate leakage and boost the ON-state current. These materials can also endure considerable gate biases without going through an electrical breakdown, implying devices based on these materials may not require an insulating gate dielectric. However, as things stand, 2D semiconductors that are scalable down to the nanometer range are few and far between because edge scattering and edge states dominate for transistors narrower than 10 nm. Furthermore, the transfer of 2D semiconductor flakes is not amenable to large scale low-dimensional device manufacturing. One logical and effective route to circumvent this ordeal would be to look for 2D materials that possess quasi-one-dimensional (quasi-1D) chains where the undesirable edge effects are suppressed. Therefore, the research presented in this dissertation is dedicated to the investigation and understanding of the physical and electronic properties of some of the 2D materials lacking the abovementioned edge disorders. The quasi-1D materials whose physics is explored in this work are: In4Se3, TiS3, ZrS3, HfS3, and GeI2. Chemically, these materials are dissimilar in that In4Se3, TiS3, ZrS3, HfS3 are all transition metal trichalcogenides (TMTs), whereas GeI2 is not. Physically, however, they are alike as they all possess the much-coveted quasi-1D structure. Moreover, when considered together, these quasi-1D systems could add versatility to the "zoo" of 2D material "creatures". The TMTs may be used in nanodevices relying on low- and mid-band gap semiconductors, while the wide-band gap of GeI2 may be exploited for high-temperature device applications. Eventually, the high Z of hafnium in HfS3 and the breaking of inversion symmetry at the surface of GeI2, intrinsically leading to enhanced spin-orbit coupling in these materials, would be worth capitalizing on for fabrication of semiconductor-based spintronic devices.

PRESENTED BY: ARCHIT DHINGRA

March 30, 4 p.m. | 110 Jorgensen Hall | Zoom link to follow