Graphene-enabled 2D Quantum Materials

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Quantum materials (QMats) are prime candidates for next-generation energy-efficient technologies, such as topological quantum computing, quantum sensing, and neuromorphic computing. While van der Waals 2D materials exhibit a compellingly wide range of exotic and potentially useful properties such as charge density waves, topological insulator edges, and superconductivity, one can also realize these properties by *stabilizing new 2D allotropes of traditionally 3D superconductors and magnets*. In this talk I will discuss our pioneering work in confinement heteroepitaxy (CHet) that enables the creation of 2D forms of 3D materials (e.g. 2D-GaN,[1] 2D-Ga, In, Ag) (Fig. 1a) and *decouples* the growth of the metals from other 2D layers, thereby enabling a new platform for creating artificial quantum lattices (AQLs) with atomically sharp interfaces and designed properties (Fig. 1b). As a specfic example, we synthesize plasmonic layers that exhibit >2000x improvement in nonlinear optical properties, and 2D-superconductors combined with topological insulators as the building block of next generation "2D" topological superconductors. Confinement heteroepitaxy opens up avenues for enabling a virtual "legoland" of hybrid quantum materials.

References

1. Two-dimensional gallium nitride realized via graphene encapsulation. Nature Materials 15, 1166–1171

Figures

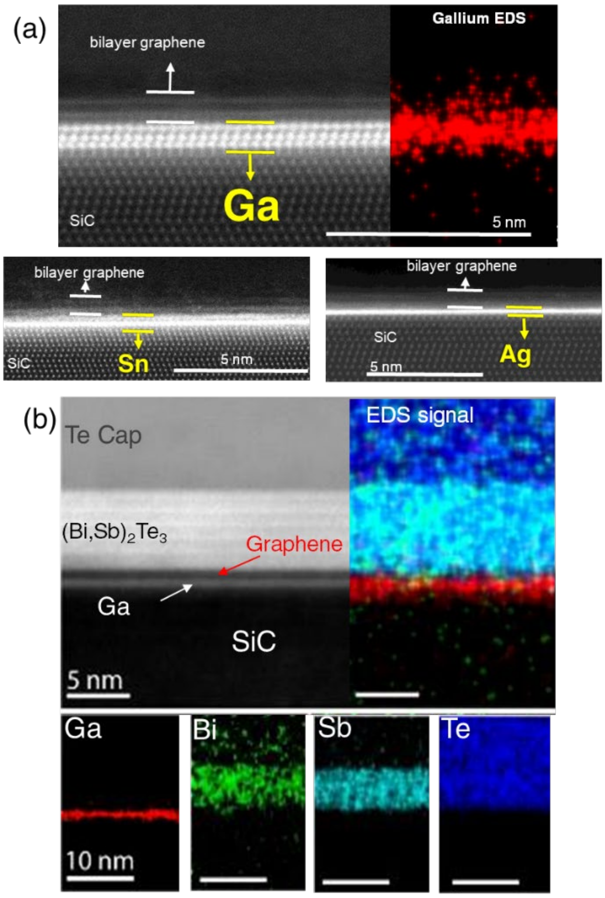

Figure 1: (a) 2D metals enabled by Confinement heteroepitaxy; (b) advanced Artificial quantum Layer of (Bi,Sb)2Te3/Graphene/2D-Ga as a foundational system for topological superconductivity.