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Proximity-induced superconductivity in epitaxial topological insulator/superconductor heterostructures

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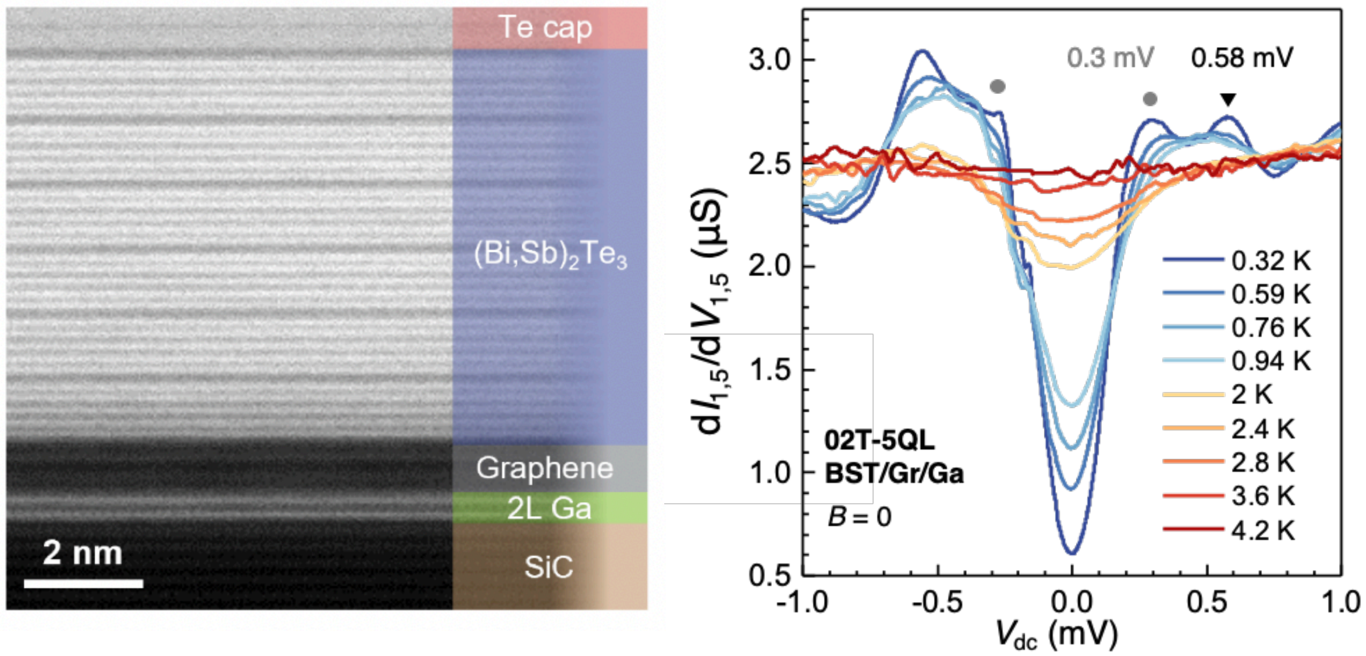
The search for an unusual form of superconductivity known as **topological superconductivity** has attracted a great deal of attention of the quantum materials community because of its fundamental novelty and potential applications in fault-tolerant quantum computing technology. A hybrid structure of a topological insulator and an s-wave superconductor is expected to host topological superconductivity. A thin-film material platform is particularly useful in building devices and device applications.

An IRG team has developed a new synthetic approach to overcome prior growth challenges to realize a thin-film topological insulator/superconductor hybrid structure. This approach produced high-quality epitaxial $(Bi,Sb)_2Te_3$/graphene/two-atomic-layer gallium heterostructures with atomically abrupt interfaces that shows robust proximity-induced superconductivity in the Dirac surface states of the $(Bi,Sb)_2Te_3$ film, thus fulfilling a necessary step to the creation of a topological superconductor. This work paves the path to explorations of topological superconductivity and quantum computing circuitry in a scalable material platform.



Left: Cross-sectional STEM showing the atomically sharp interfaces between $(Bi,Sb)_2Te_3$, graphene and two-layer Ga in a thin-film heterostructure grown by a combination of molecular beam epitaxy and confinement heteroepitaxy.

Right: Transport tunneling spectroscopy shows a proximity-induced superconducting gap at 0.3 mV and the Ga superconducting gap at 0.58 mV.