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Emergent superconductivity in few-layer stanene and superconductor-insulator transitions in BSCCO flakes

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Abstract: Two-dimensional (2D) crystalline superconductors attract growing interests as they exhibit rich quantum phenomena. Here we report two methods of addressing 2D superconductivity. First, we epitaxially grow high quality stanene films—the ultrathin form of gray tin (111) [1]—and discover superconductivity starting in bilayer stanene [2]. This finding is unexpected because bulk gray tin is semi-metallic and non-superconductive. We modulate the superconducting properties by substrate engineering. Through transport and angle-resolved photoemission spectroscopy, we reveal the two-band nature of this two-dimensional superconductor. Our experimental studies are further supported by first-principles calculations, which suggest a topological non-trivial band structure. Secondly, we exfoliate thin BSCCO flakes down to 4 unit cells and still retain the high temperature superconductivity [3]. We then modulate the carrier density in BSCCO flakes continuously by using a novel solid state gating technique. This back-gating technique allows us to realize the superconductor-insulator transition. We further study the corresponding evolution of the density of states by using planar tunnel junctions of graphite/BSCCO. The combination of gate tuning and tunneling spectroscopy shall be easily applicable to address other 2D materials.

References

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