

Stoichiometric FeTe is a Superconductor

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In this talk, I will first briefly introduce the molecular beam epitaxy (MBE) growth mechanism, and then focus on our recent progress in the MBE growth of FeTe films and heterostructures. FeTe, unlike its superconducting isostructural counterpart FeSe, has long been regarded as an antiferromagnetic (AFM) metal sans superconductivity. Over the past five years, my group has employed MBE to synthesize a series of FeTe-based heterostructures, in which superconductivity consistently emerges. More recently, we developed an approach to grow FeTe thin films followed by post-growth annealing under a Te flux. Using spin-polarized scanning tunneling microscopy and spectroscopy (STM/S), we show that the AFM order in as-grown FeTe films originates from interstitial Fe atoms that disrupt the ideal 1:1 stoichiometry. Remarkably, removing these interstitial Fe atoms via Te annealing produces stoichiometric FeTe films that exhibit no AFM order and instead display robust superconductivity with a critical temperature of ~ 13.5 K. This superconducting state is further confirmed by the observation of Cooper-pair tunneling, zero electrical resistance, and the Meissner effect. Based on these results, we establish a new phase diagram for Fe_{1+x}Te and demonstrate that stoichiometric FeTe is inherently a superconductor, overturning a long-held view that it is an AFM metal [1]. Building on the superconducting stoichiometric FeTe films, we further used MBE to grow a one-quintuple-layer trigonal $(\text{Bi,Sb})_2\text{Te}_3$ layer on top of six-unit-cell tetragonal FeTe. We realized moiré engineering of Cooper-pair density modulation (CPDM) states and demonstrated that CPDM states are a universal phenomenon in moiré superconductors [2].

[1] Yan et al., Nature **652**, 342–348 (2026).

[2] Wang et al., Nature **652**, 335–341 (2026).