Beneath the Moiré: Decoupling Intrinsic and Graphene-Induced Properties in Intercalated 2D Films

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Intercalation of epitaxial graphene on silicon carbide has opened a powerful route to atomically thin films that remain stable under ambient conditions, protected by a van der Waals–bound graphene capping layer. This platform offers a dual advantage: it enables controlled tuning of graphene's electronic properties via proximity effects, while granting access to a rich spectrum of emergent 2D phenomena within the intercalated layer itself, including quantum spin Hall insulators (QSHI) and superconductors [1-6].
However, a central challenge in this field is disentangling the intrinsic structural and electronic properties of the intercalant from those arising due to the presence of the graphene capping layer, evident, for example, in the moiré structures commonly observed in scanning tunneling microscopy (STM) (Fig. 1**a**) [3].
In this talk, I will elucidate the influence of graphene on intercalated 2D films through a direct comparison with their pristine, graphene-free counterparts. Using indenene and bismuthene as case examples – indium and bismuth realizations of the QSHI phase on SiC(0001) – I first examine the growth with and without graphene, using STM and angle-resolved photoemission spectroscopy (ARPES). I then address their electronic properties, highlighting significant charge transfer to graphene and demonstrating orbital-selective tunneling that allows minimizing the moiré modulation in STM images, as evidenced by bias-dependent imaging of the indenene and graphene lattices (Fig. 1**b**,**c**). These results provide direct access to the intrinsic structure of the intercalated films and enable a sophisticated assessment of graphene–intercalant coupling.

References:
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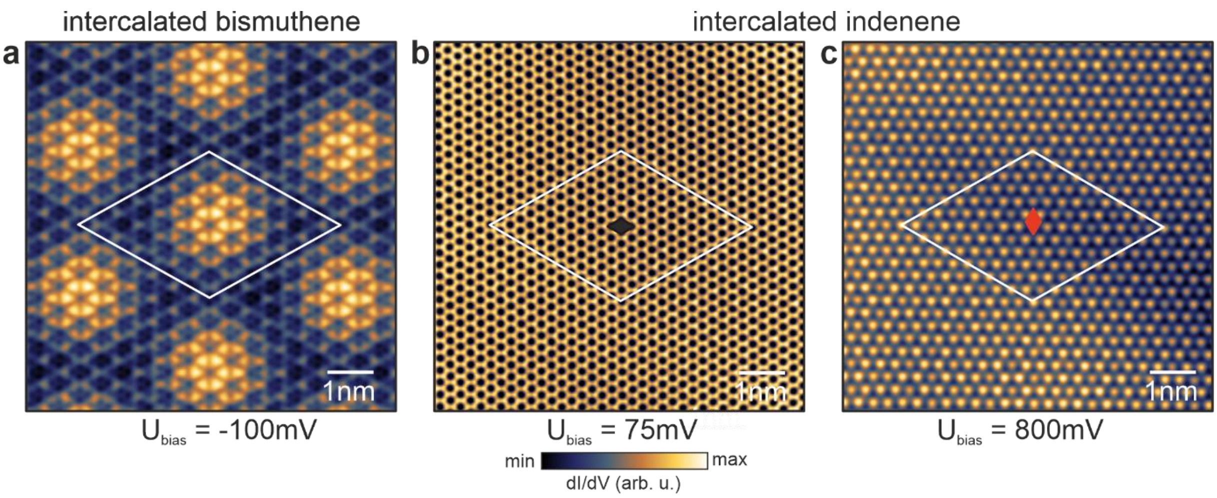

Fig. 1: STM lock-in dI/dV maps taken in constant height mode showing **a** the pronounced moiré unit cell (white rhombus) of intercalated bismuthene and **b**,**c** the bias-selective tunneling into either **b** graphene p_z-orbitals (black unit cell), or **c** indium p_z-orbitals in the case of intercalated indenene (red unit cell).