Exploring and controlling ABC-stacked graphene domains in epitaxial graphene

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In graphene, emergent properties such as superconductivity and ferroelectricity have been observed in ABC-stacked domains, typically obtained through exfoliation followed by precise mechanical twisting and alignment with the desired orientation. This process is challenging and non-scalable.
Here, we demonstrate that ABC-stacked graphene can be obtained using a scalable growth technique, namely, the thermal decomposition of silicon carbide. Using conductive atomic force microscopy, we identified distinct conductivity patterns in untwisted trilayer epitaxial graphene on silicon carbide. These patterns revealed the presence of ABA and ABC domains, matching the conductivity differences observed in twisted exfoliated graphene and those predicted by density functional theory. The size and geometry of the stacking domains depend on the interplay between strain, solitons crossing, and the shape of the three-layer regions [1]. Furthermore, we showed that by controlling the strain of the graphene lattice, we can tune the dimension and geometry of moiré patterns (Fig. 1). This study demonstrates the potential of the thermal decomposition method for producing ABA/ABC domains, paving the way for future applications in electronic and optoelectronic devices.

References:
[1] M. Rejhon et al., Proc. Natl. Acad. Sci. U.S.A. 121 (50) e2408496121, (2024).

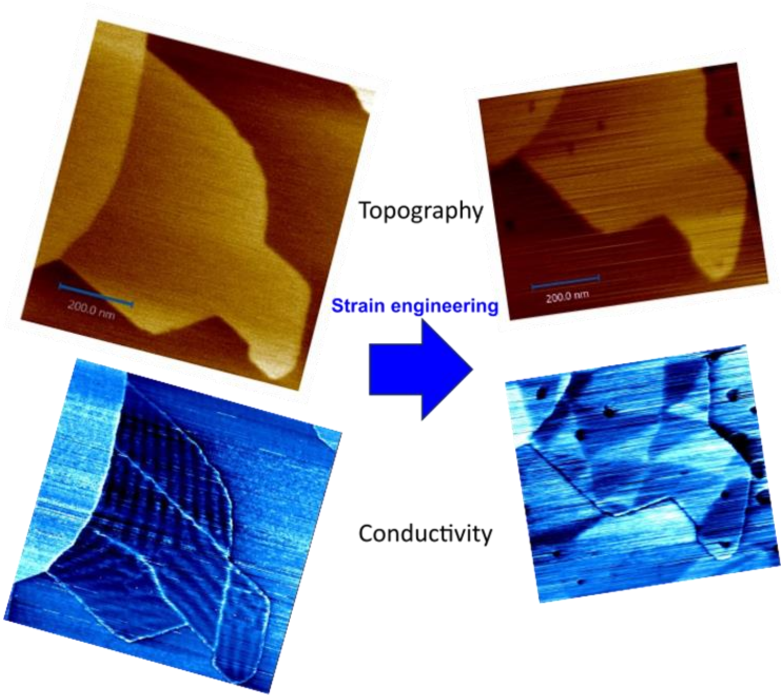

Fig. 1: Topography and local conductivity channel before and after strain engineering via hydrogen intercalation.