

Reconfiguring the stacking order of graphite via anodic bonding

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Abstract

Rhombohedral graphene and graphite support surface flat bands whose dispersion scales as a power of the layer number, providing an ideal playground for strong correlation and topological phenomena [1,2]. Exploring these ABC-stacked materials therefore offers a route to discover many-body phases within a simple carbon system. However, ABC stacking is thermodynamically unstable and presents only a small fraction of natural graphite, so mechanical exfoliation yields only small, scarce rhombohedral flakes [3]. We show that anodic bonding technique can reconfigure the stacking order of graphite and consistently produce homogeneous, large-area rhombohedral multilayer graphene (Figure 1), and ARPES measurements on pentalayer ABC graphene clearly reveal the expected two flat bands, especially along the Γ -K direction (Figure 2). This simple method overcomes the materials bottleneck and enables systematic investigation of correlated and topological phases in ABC-stacked carbon systems.

References

- [1] Cao, Y., *Nature Nanotechnology*, 19(2) (2024) 139–140
 - [2] Nemes-Incze, P., *Nature Nanotechnology* 20(2) (2025) 187–188
 - [3] Lui, C.H., et al., *Nano letters* 11(1) (2011) 164–169
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Figures

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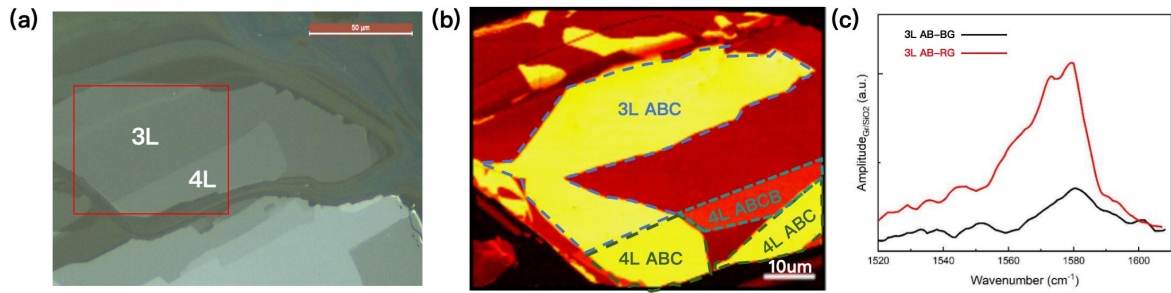


Figure 1: Characterization of rhombohedral graphene fabricated by anodic bonding. (a) Optical micrograph showing a 3-layer (3L) and 4-layer (4L) flake. **(b)** Infrared scattering scanning near-field optical microscopy (IR-SNOM) map of the flake in the red rectangle in (a), with ABC-stacked (3L ABC and 4L ABC) and ABCB-stacked (4L ABCB) regions outlined, the other red parts represent 3L Bernal-stacked region. **(c)** Fourier-transform infrared (FTIR) spectra comparing a 3L Bernal graphene (black) and a 3L rhombohedral graphene flake (red) obtained by anodic bonding.

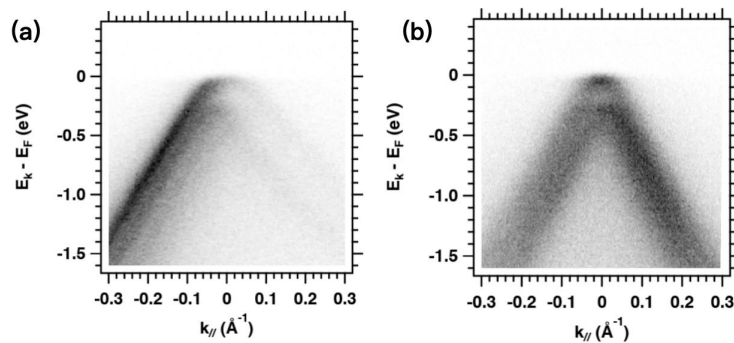


Figure 2: Angle-resolved photoemission spectroscopy on pentalayer rhombohedral graphene produced via anodic bonding reveals clear flat-band signatures along both the Γ -K **(a)** and K-K **(b)** directions.