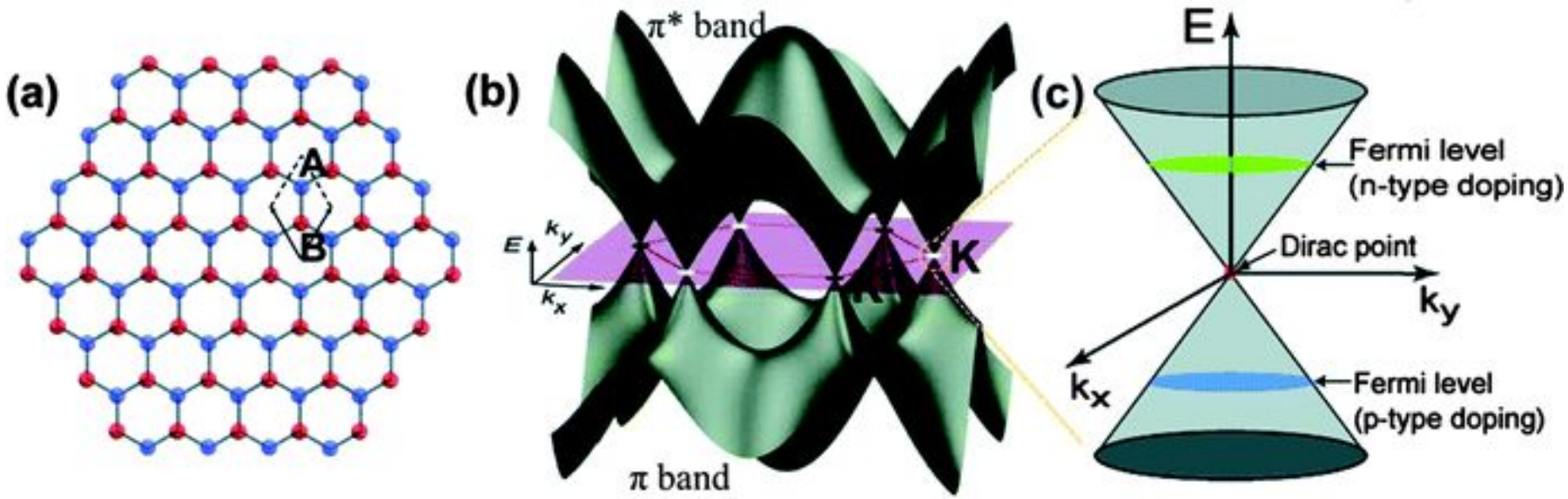
Substrate-mediated Band Gap Engineering in Graphene

Ben Safvati

References:

- Phys. Rev. Lett. 115, 136802 (2015).
- Nano Lett. 17, 2681 (2017)

Electronic Properties of Graphene

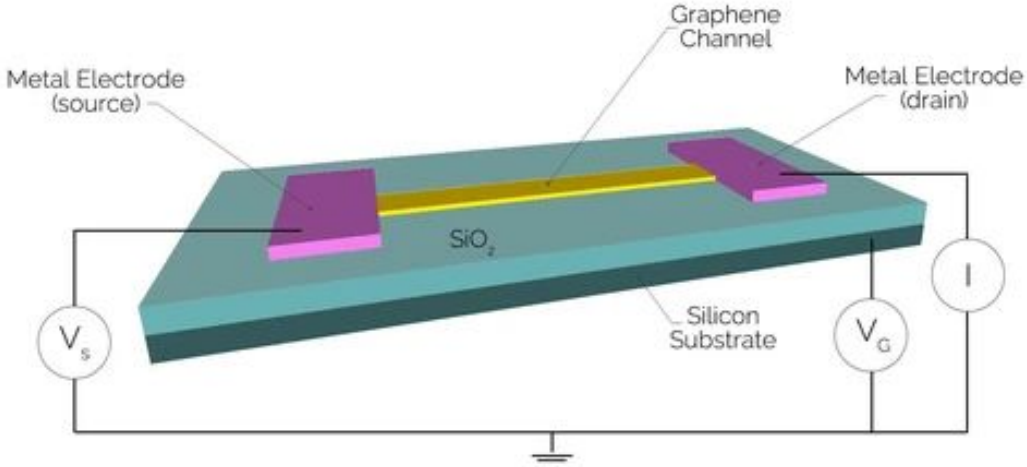


- Linear dispersion near Fermi level leads to high conductivity, semi-ballistic electron transport with limited backscattering.
- Sublattice symmetry guarantees semimetal properties, bands symmetric about zero energy.

Why Make Graphene a Semiconductor?

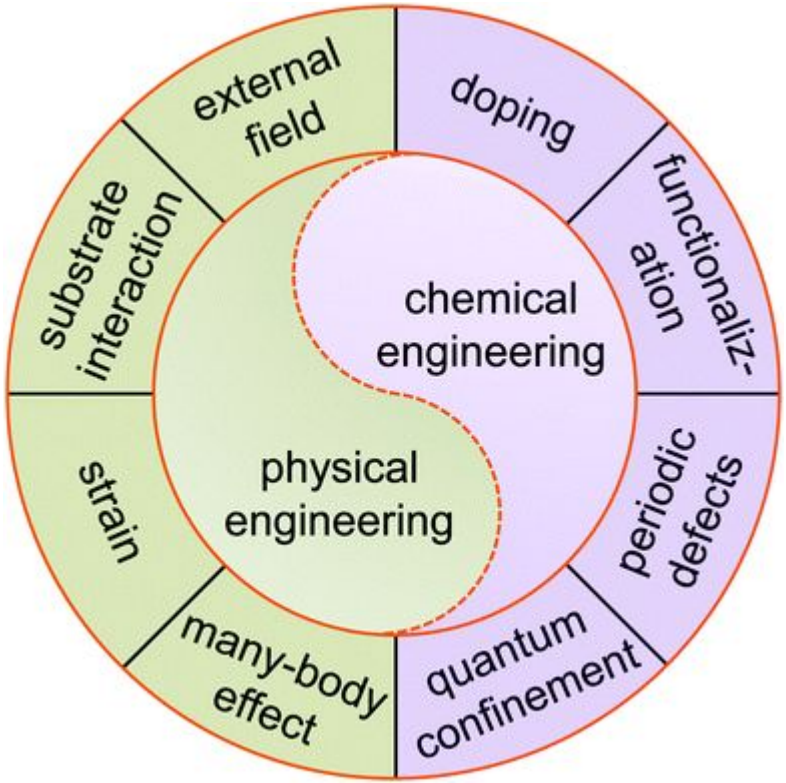
Advantages of Graphene

- 2D structure preserves space and prevents boundary effects on conductivity.
- Exceptional thermal dissipation.
- High carrier mobility for faster electronic computing.



Main component of digital electronics is the transistor.

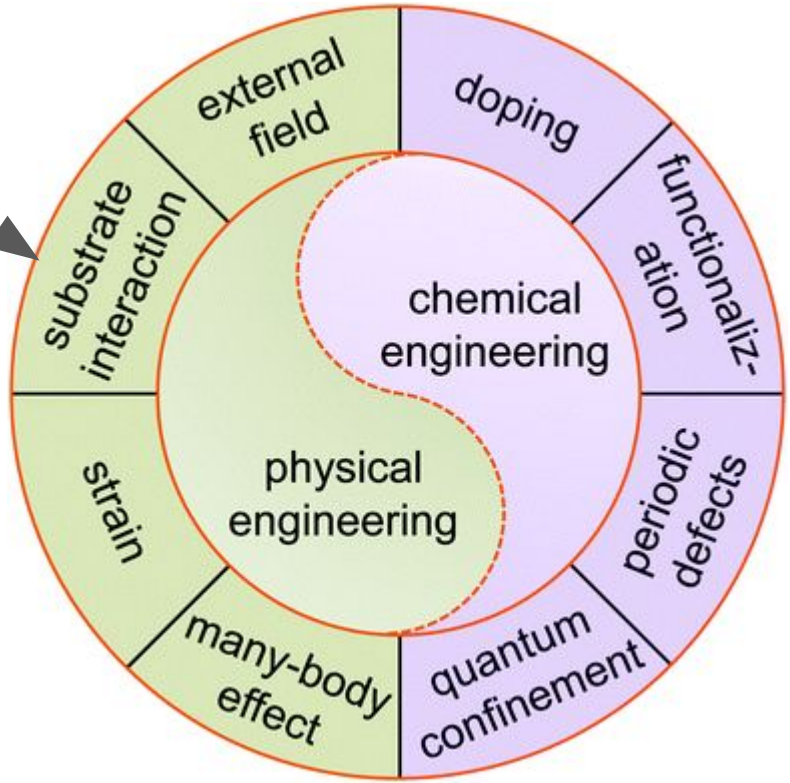
How to Open a Band Gap in Graphene



Not mentioned: Bond texture patterning (e.g. Kekule)

How to Open a Band Gap in Graphene

Focus of this presentation.



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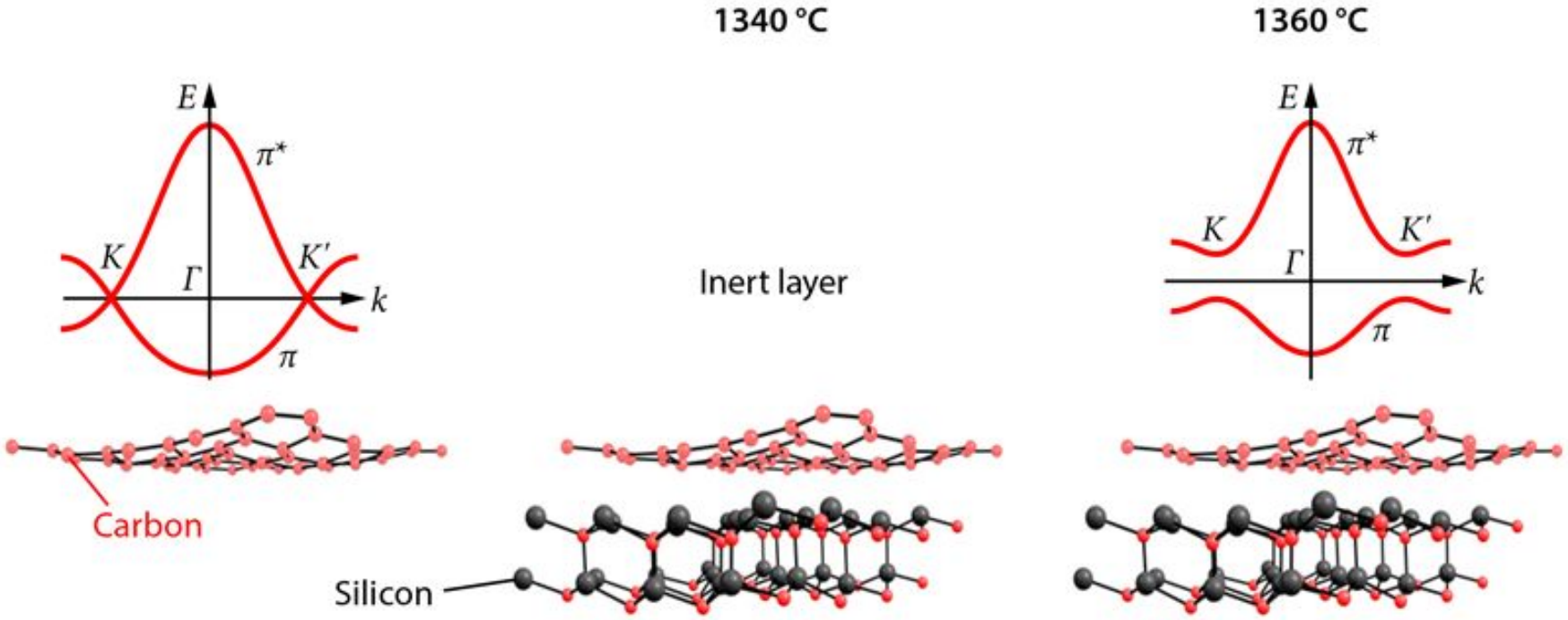
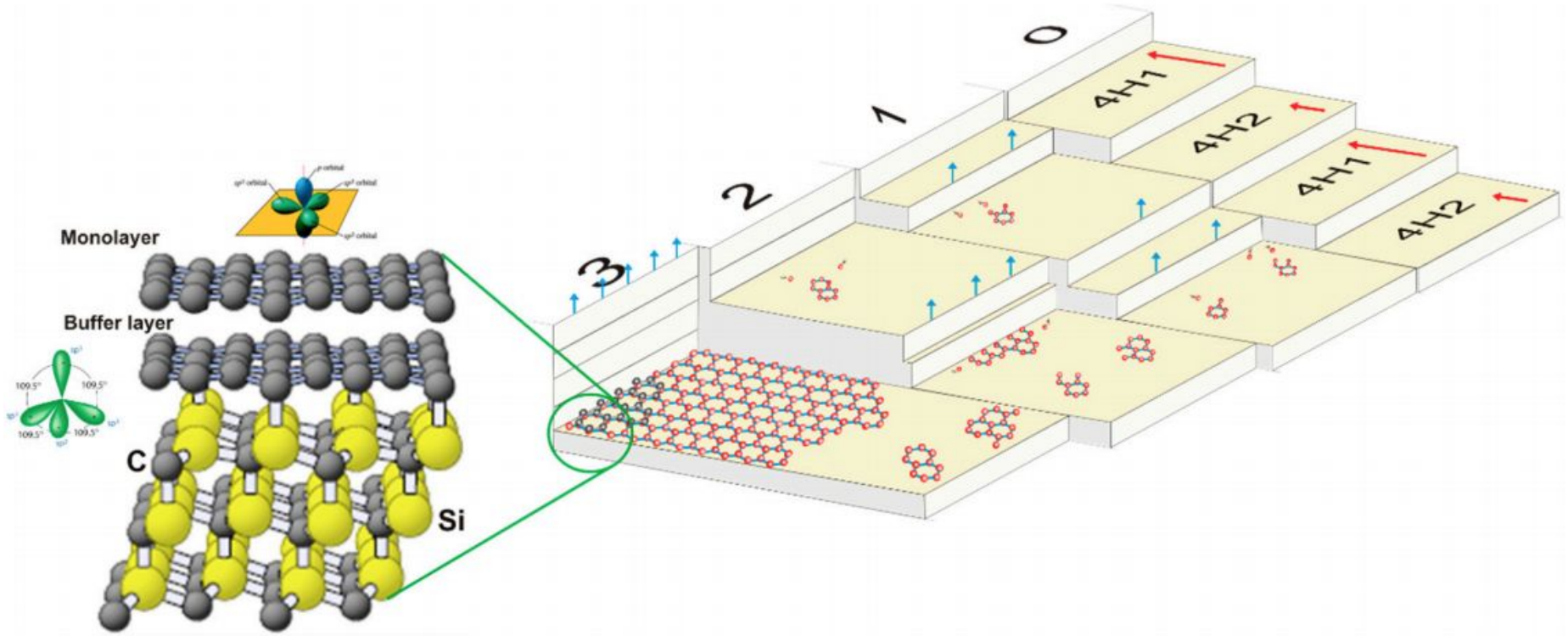
Review of different methods:
https://doi.org/10.1039/C7CS00836H

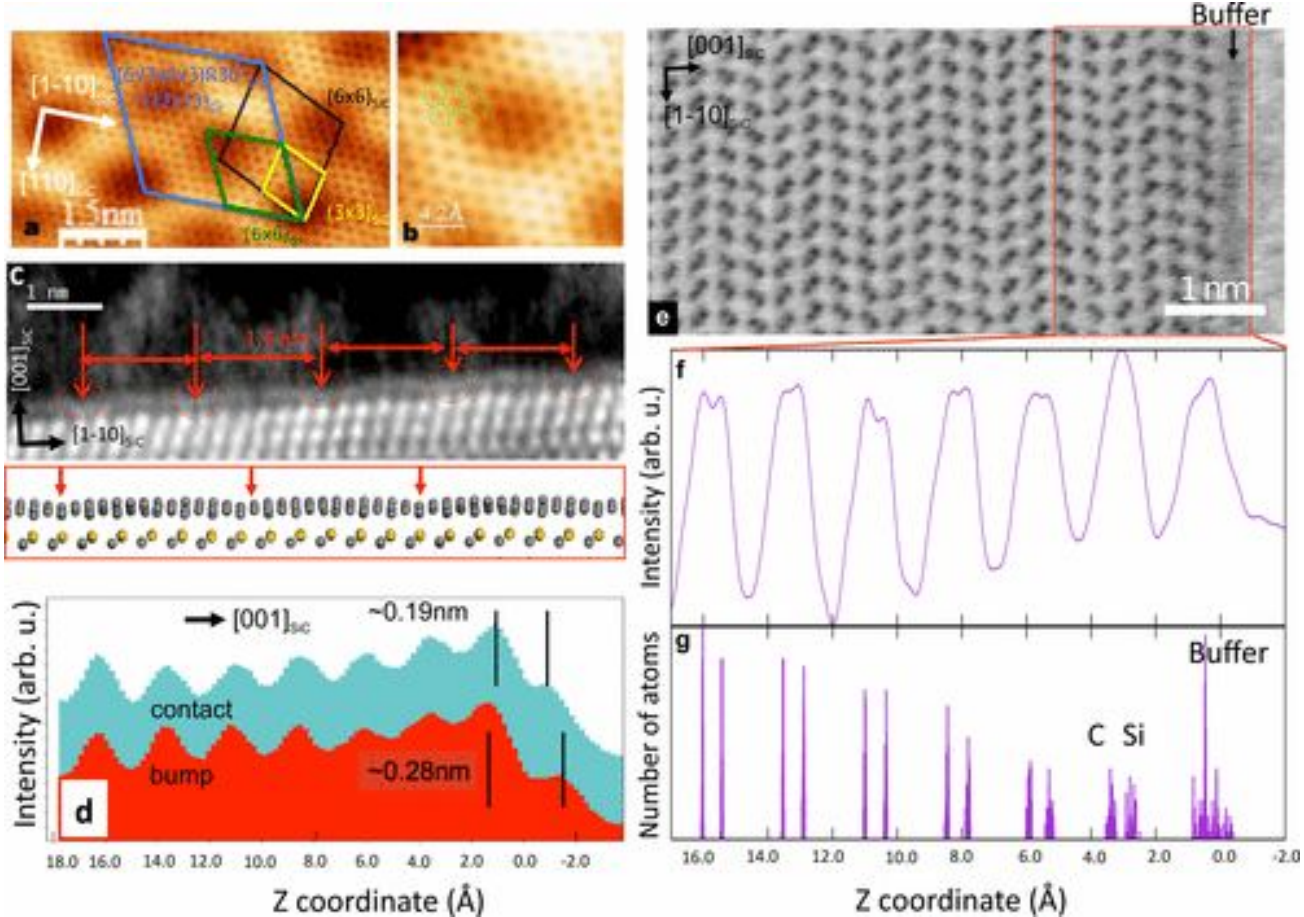
Epitaxial Growth of Graphene Over SiC



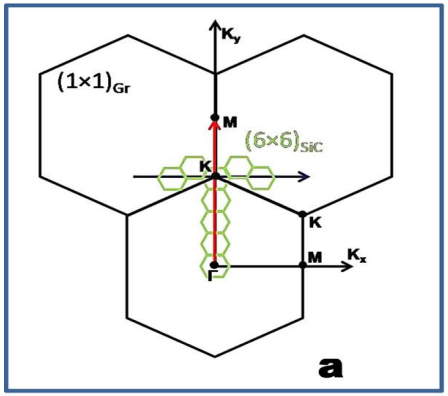
Epitaxial Growth of Graphene Over SiC

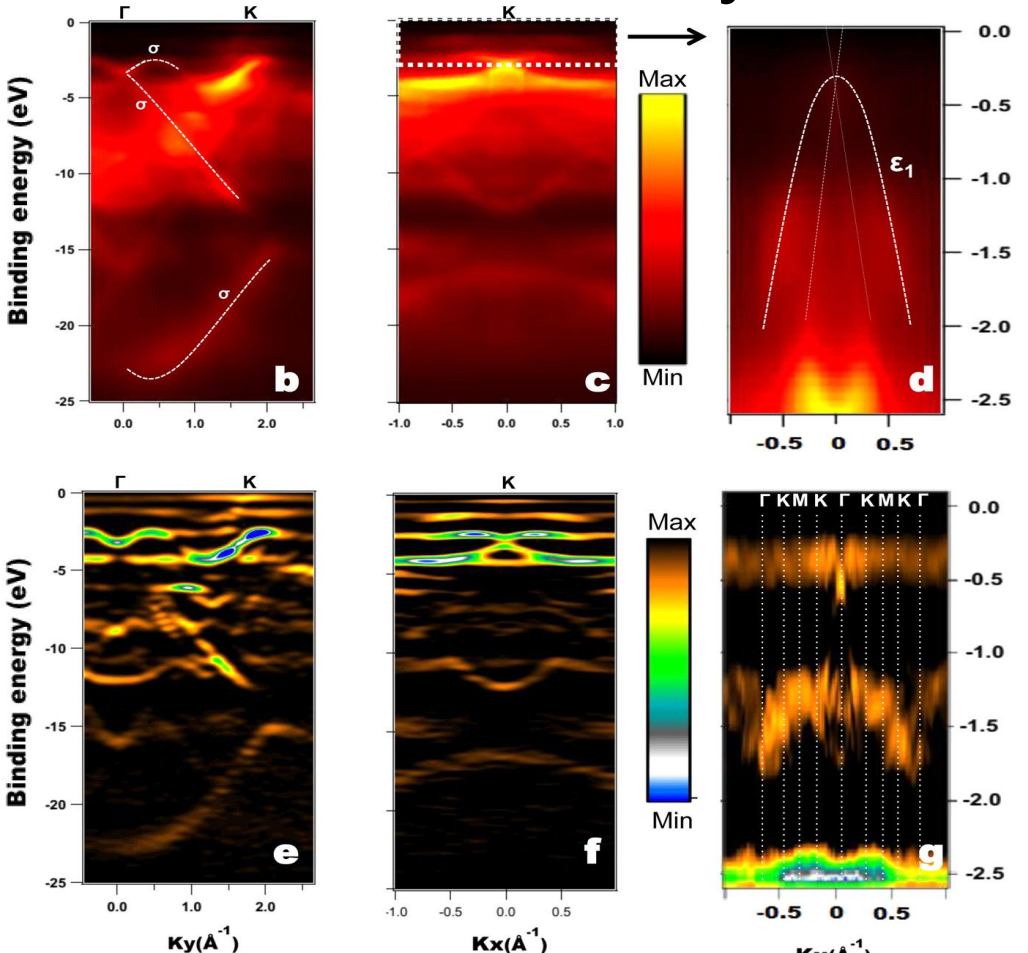


STM Characterization of Superlattice

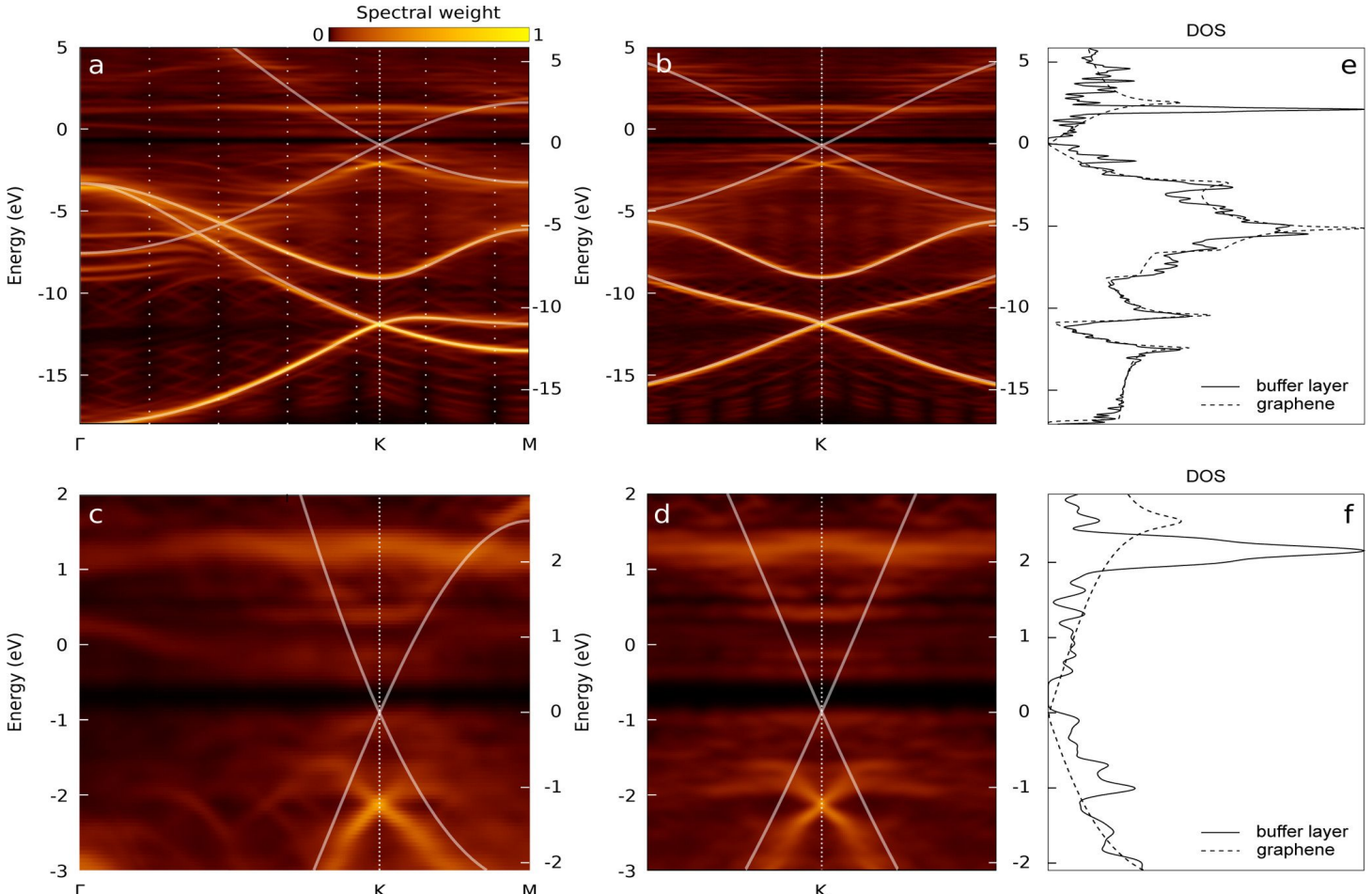


ARPES measurement of Buffer Layer Bands





DFT-TB Reconstruction of Band Structure



Conclusions

- Graphene epitaxially grown onto Silicon Carbide with specific annealing temperatures can create a semiconducting graphene layer with periodic covalent bonding to the SiC.
- The substrate-mediated super-periodicity opens the band gap at the Dirac point in the uncoupled sections of buffer layer Graphene
- STM analysis of the surface confirms that defects, uniform bonding to SiC, and edge effects are not responsible for the induced band gap.
- Result demonstrates the ability of band gap engineering by controlling the underlying growth substrate.