International Conference
ONLINE
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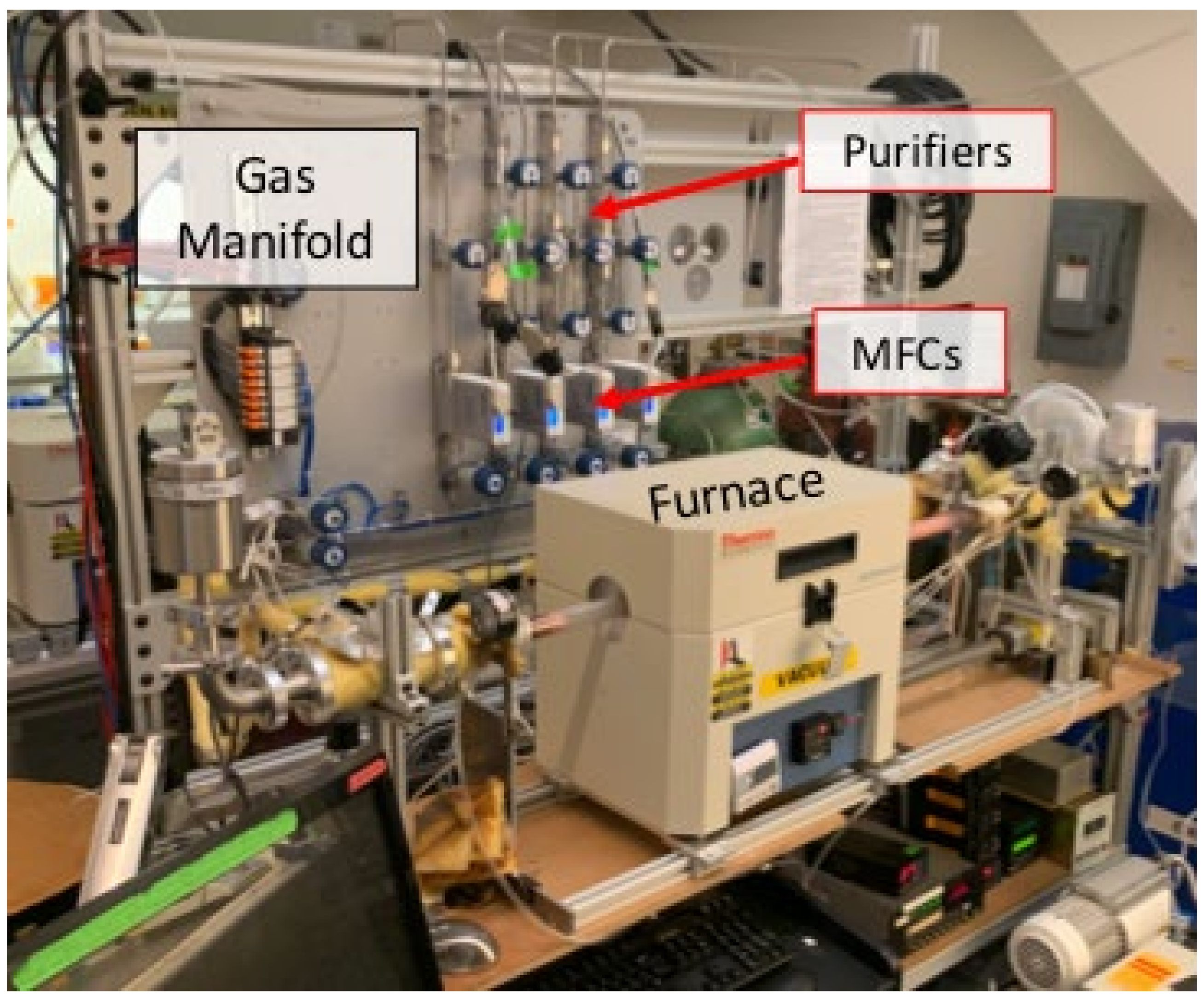
GRAPHENE FOR US

Epitaxial ultraclean, wrinkle-free graphene growth on Cu(111) in an oxygen-free environment

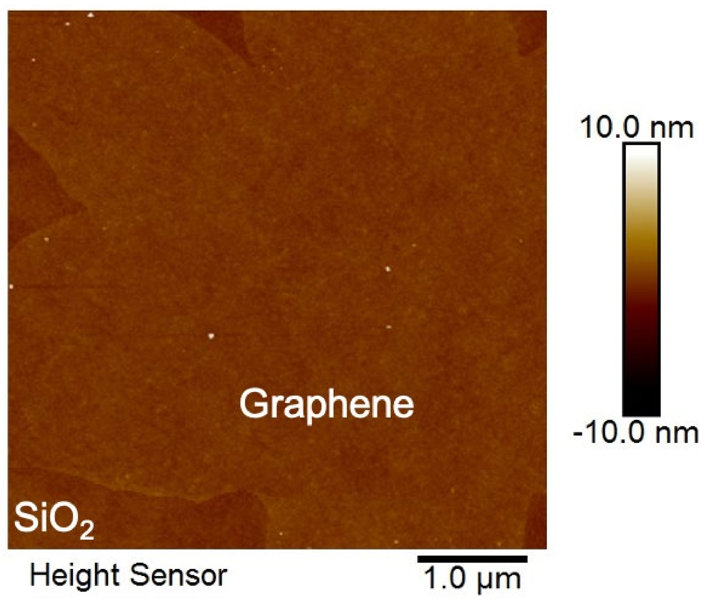
Chemical vapor deposition (CVD)-derived graphene performance has shown to deteriorate with surface wrinkles, folds, and transfer-related contaminations. Towards the stitching-up phase of the graphene growth, the lack of active catalytic copper surface slows down the growth rate and leads to an excess of amorphous carbon formation. With the integration of an oxygen-free growth environment and a Cu(111) growth substrate; flat, clean, and intrinsic defect-free graphene can be reproducibly grown with an enhanced growth rate via low pressure CVD (LPCVD). The resulting sheet of graphene shows an epitaxial relationship with the substrate. Contamination-free graphene surface also enables clean transfer due to the absence of amorphous carbon and structural defects in the graphene sheet. Electrical measurements with h-BN encapsulation demonstrates carrier mobility comparable to exfoliated graphene, with ballistic transport characteristics at low temperature.

Oxygen Free System Design and Growth Quality

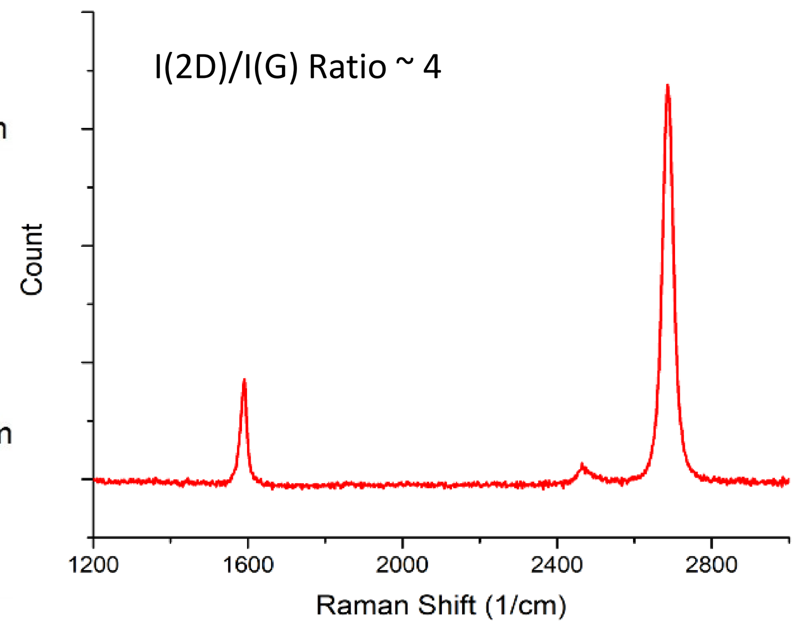
- ULSI grade gas feedstock (99.9999% purity)
- Gas purifiers to reduce oxygen species from gas source (O_2< 1ppb)
- Helium-leak detection to optimize system leak integrity
- Load-lock installed to minimize pump down and O_2 contamination

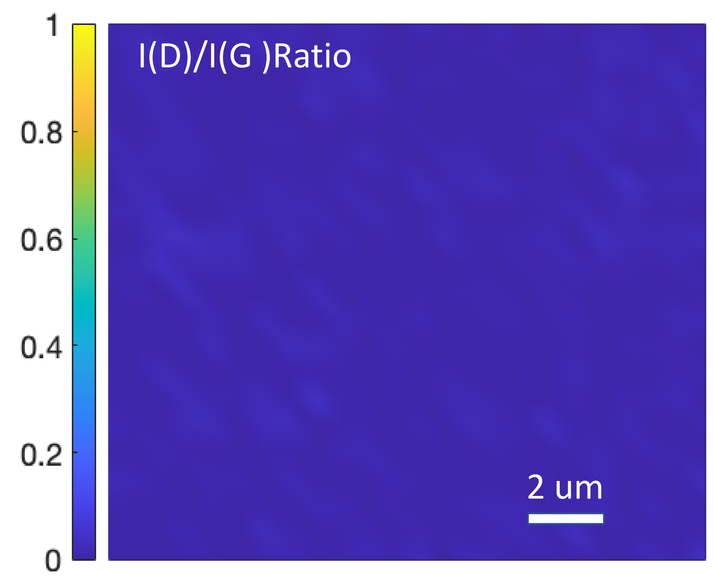


System Layout



Residue free transfer

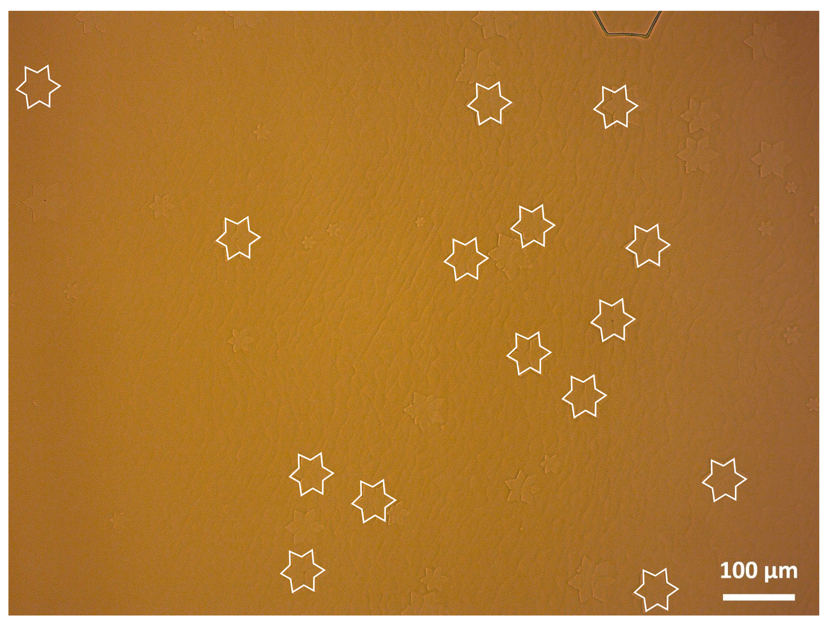


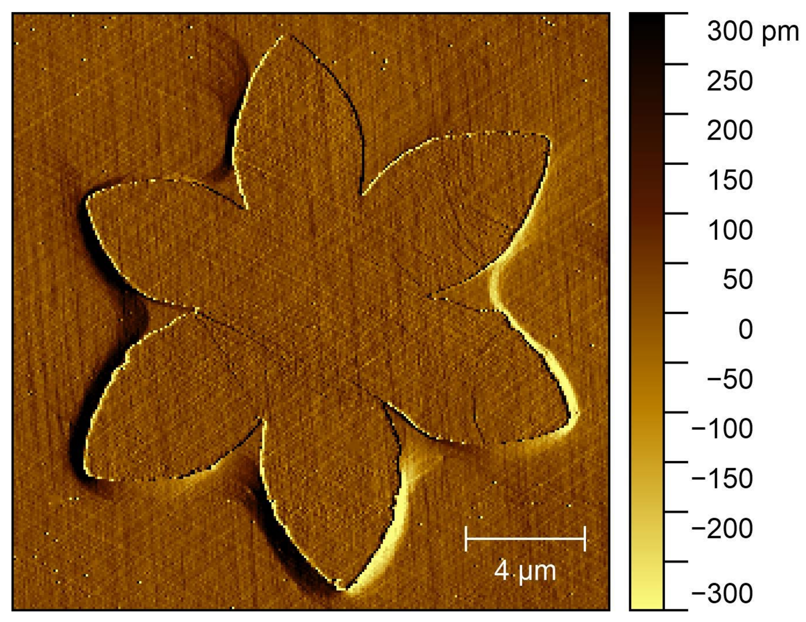


Raman Characterization

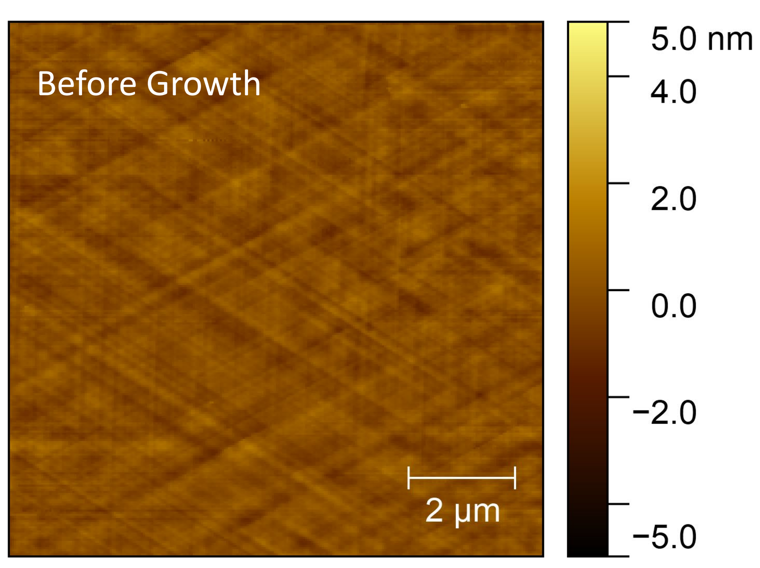
Single crystal Cu(111) substrate for high quality epitaxial graphene growth

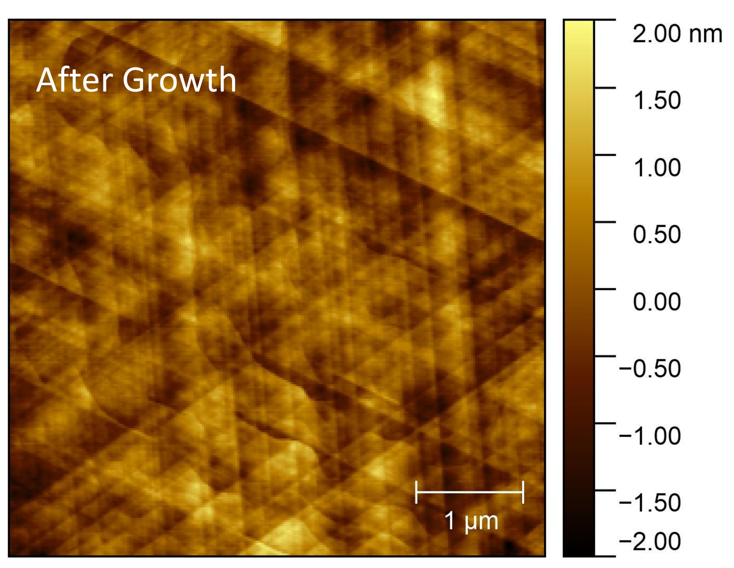
- 12h anneal in atmospheric pressure oxygen environment before sputtering copper
- DC sputtering copper ~ 1000 nm
- Post annealing in H_2 / Ar environment for 4h to recrystallize film to single crystal
- Preserved surface flatness after growth (~ 2nm roughness)
- O_2 annealing produces better crystallinity



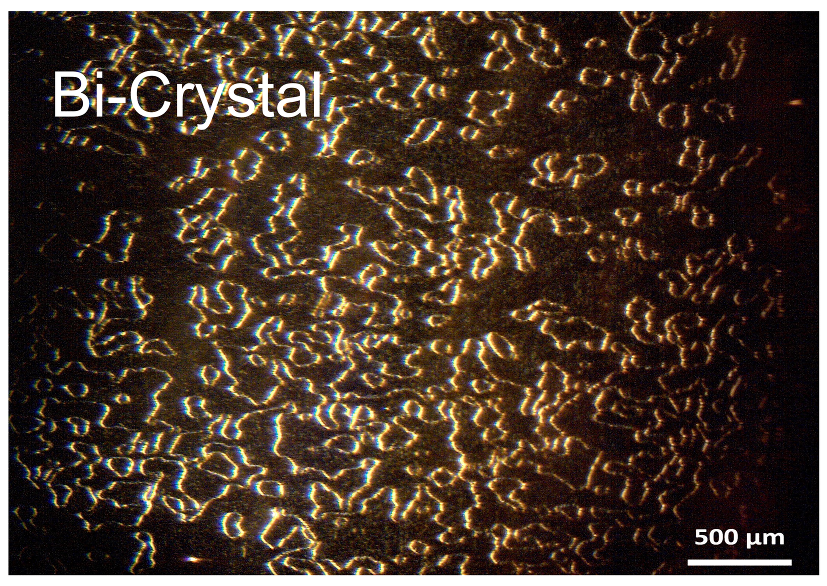


Aligned grains on substrate

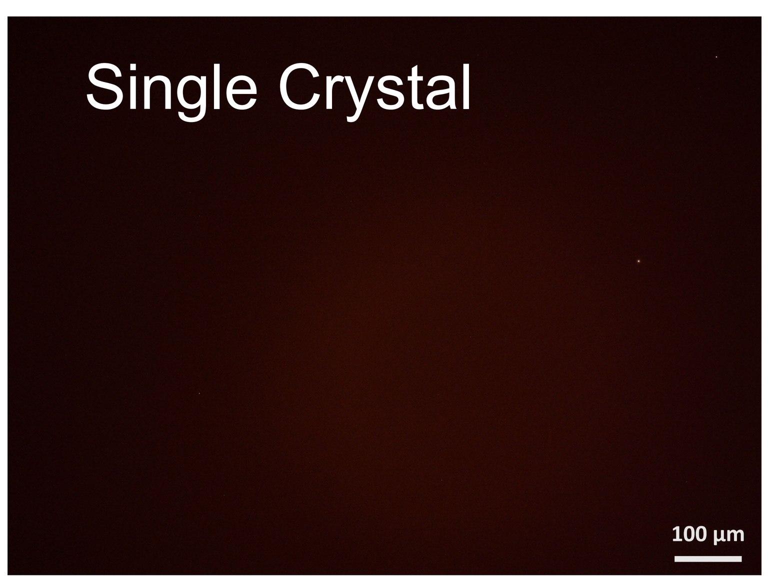




Surface roughness is preserved after growth



Acid Pretreatment



Oxygen Pretreatment

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