Large-scale single-crystal monolayer graphene grown on insulating substrates

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Abstract

The growth of inch-scale high-quality graphene on insulating substrates is desirable for electronic and optoelectronic applications, but remains challenging due to the lack of metal catalysis. Here we demonstrate the wafer-scale synthesis of adlayer-free ultra-flat single-crystal monolayer graphene on sapphire substrates. We converted polycrystalline Cu foil placed on Al_2O_3(0001) into single-crystal Cu(111) film via annealing, and then achieved epitaxial growth of graphene at the interface between Cu(111) and Al_2O_3(0001) by multi-cycle plasma etching-assisted–chemical vapour deposition. Immersion in liquid nitrogen followed by rapid heating causes the Cu(111) film to bulge and peel off easily, while the graphene film remains on the sapphire substrate without degradation. Field-effect transistors fabricated on as-grown graphene exhibited good electronic transport properties with high carrier mobilities. This work breaks a bottleneck of synthesizing wafer-scale single-crystal monolayer graphene on insulating substrates and could contribute to next-generation graphene-based nanodevices.

References

[1] Li, Junzhu, et al. Nature Materials (2022): 1-8.

Figures

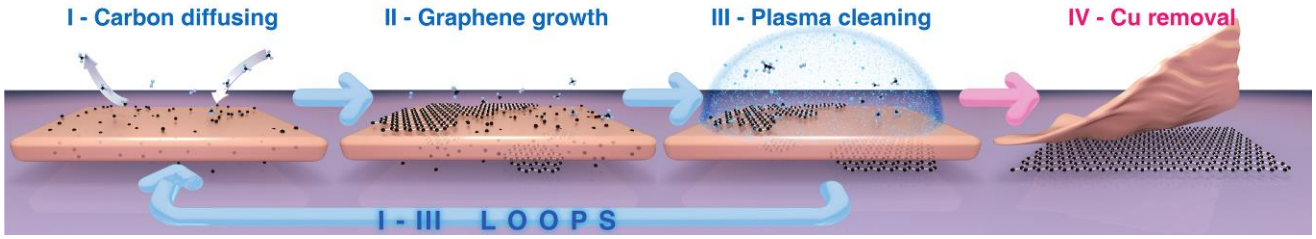

Figure 1: Schematic of the graphene growing during MPE–CVD.

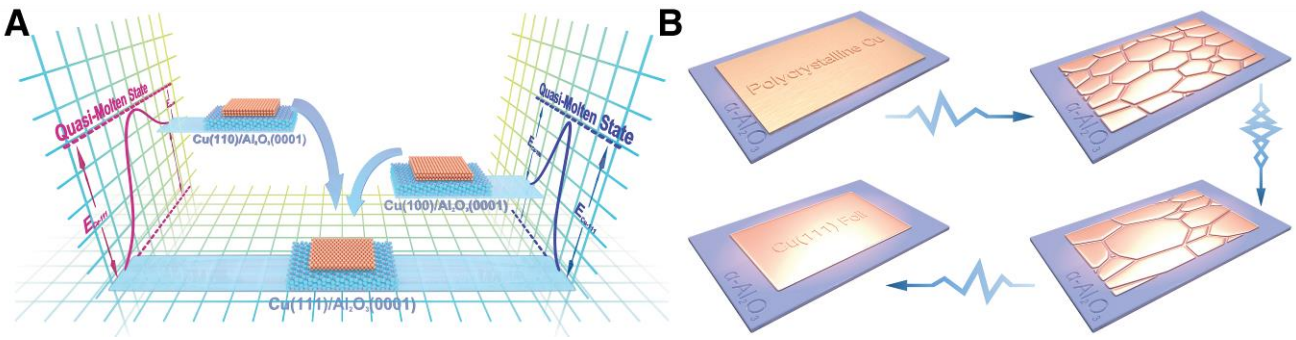

Figure 2: Schematic of the transformation process from a commercial polycrystalline Cu foil into a single-crystal Cu(111) film on Al_2O_3(0001).