Holistic approach to scalable 2D material processing from optimized CVD graphene catalysts to dry-transfer

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The reliable and complete transfer of CVD-grown 2D materials into van der Waals heterostructures remains a bottleneck in both the fabrication of high quality devices (see e.g. [1]) and the device reproducibility. Here, we utilize large-scale data acquisition and correlative processing techniques to allow a holistic route through the copper-oxide-graphene growth and transfer parameter space. We identify a crystallographic Cu orientation that allows the growth of epitaxially aligned CVD graphene with a high propensity to delamination and reproduce it over larger areas utilizing recently developed single-crystal catalyst production methods [2]. We demonstrate that this CVD graphene can be dry transferred with high efficiency (>95%) and encapsulated by hexagonal boron nitride to yield room temperature carrier mobilities over 40,000 $cm^2/(Vs)$ at a carrier density of $1\times10^{12}/cm^2$.

References

[1] M. Schmitz, et al., 2D Materials, 7 (2020) 041007
[2] O. J. Burton, et al., ACS Nano, 14 (2015) 13593

Figure

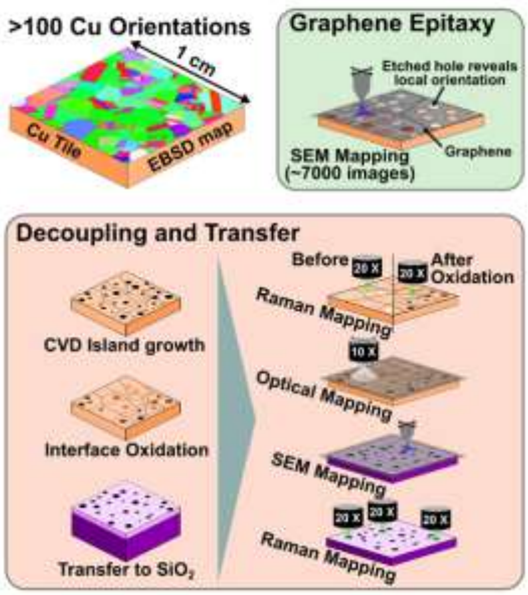

Figure 1: Schematic summary of holistic, high-throughput characterization methodology. The epitaxial growth of CVD graphene was studied on over 100 different crystallographic Cu orientations. The Cu-to-graphene interface oxidation and the quality of dry transferred CDV graphene onto Si/SiO_2 substrates was mapped by Raman spectroscopy, optical microscopy and electron microscopy for these Cu catalyst crystal orientations, ultimately making up a combined metric indicating the best compromise of parameters. The optimum Cu orientation is then reproducibly created using a scalable epitaxial growth platform, enabling high yield graphene island transfer.