A Peeling Systematic Study: Holistic Catalyst Design for 2D Material Application

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The homogeneous and repeatable transfer of 2D materials (2DMs) remains a significant bottleneck in the field both for characterization of chemical vapor deposition (CVD) grown materials and the reproducibility of devices made from them. A dry-peeling transfer is thought to be the cleanest and most efficient method of 2DM application, owing to the lack of ionic etchants and catalyst preservation during the transfer process. Specific orientations of metals are often employed for 2D material synthesis due to various growth-based advantages: e.g. reported higher quality, epitaxial or wrinkle-free graphene on Cu(111)[1]. Whilst these catalysts may be ideal for the growth of 2D materials, we show that when integrated into a process chain of device fabrication, there are more ideal choices that result in a higher quality final product.

Here we utilize large scale data acquisition and processing techniques to enable a holistic development route through the copper-oxide-graphene growth and transfer parameter space and demonstrate a clear path that leads to both epitaxially aligned graphene growth and a high propensity for mechanical delamination: maximizing both transfer and quality. We identify the ideal Cu orientation and reproduce it over larger areas utilizing recently developed single-crystal catalyst production methods[2]. We characterize this CVD graphene to show that the quality is comparable to that of exfoliated material, with the added benefit of reproducibility available over much larger areas. Finally we utilise a similar cross-correlative methodology to characterise CVD h-BN growth and application to demonstrate a similar moral: The whole application process must be holistically considered to develop an ideal material synthesis methodology.

REFERENCES

[1] Deng, B. et al. ACS Nano 2017, 11 (12), 12337–12345.
[2] Burton, O. J. et al. ACS Nano 2020, 14, 13593–13601.