Graphene Nucleation Control: Methods for Analysis and Quality Control

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Abstract
CVD is emerging as the industrially dominant growth technique for "electronic-grade", mono- or few-layer large-area films of 2D materials.[1] A crucial aspect of such CVD process development is to control nucleation of the 2D material effectively, as this dictates the texture of the growing 2D film. However, there is little understanding what the key mechanisms are that allow achieving a low graphene nucleation density. Here, we use time-of-flight secondary ion mass spectrometry (SIMS) to depth- and surface-profile the Cu foils after the various CVD process stages in unprecedented detail (Fig. 1). This enables us to unambiguously show the critical importance of carbon impurities and the mechanism by which oxygen scavenges unwanted impurities.[2] Focusing on scalable graphene manufacturing in a commercial CVD reactor, with 50 cm^2-sized Cu foils over which graphene is grown homogeneously, we investigate spectroscopic imaging ellipsometry (SIE) as a quick method to characterise layer number and coverage on the catalyst directly (Fig. 2). The implications of these findings are discussed regarding high-throughput mono-layer graphene CVD with domain sizes >1 mm and generalized guidelines for the most efficient pre-treatment methods for Cu catalysed graphene CVD are established.

References

[1] Hofmann, et al. , J.Phys.Chem.L., 6 (2015) 2714
[2] Braeuninger-Weimer, et al. , Chem.Mater, 28 (2016) 8905

Figures

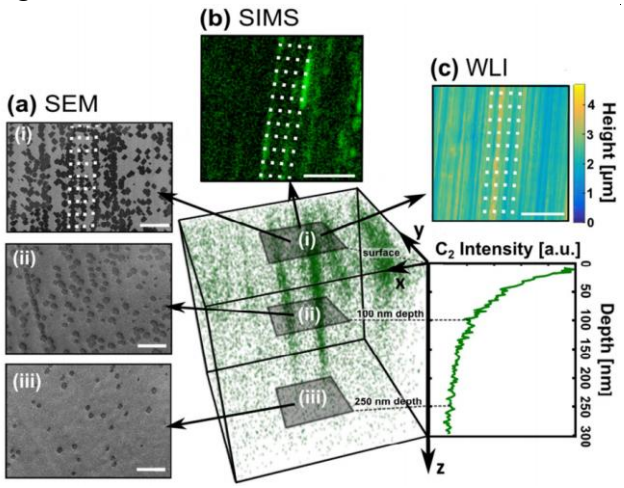

Figure 1: SIMS measurement on catalyst foils to understand graphene nucleation.

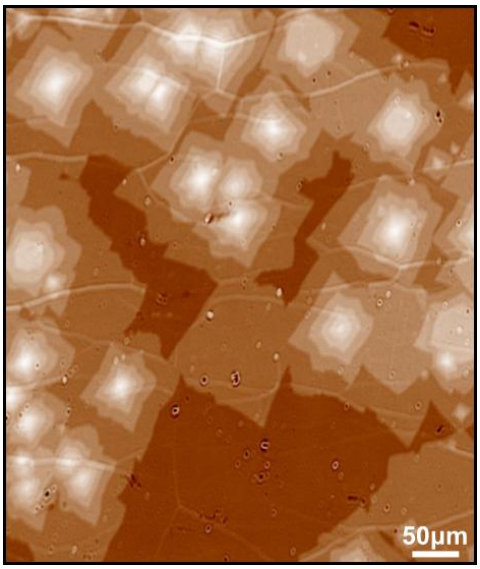

Figure 2: Fast mapping of graphene by spectroscopic imaging ellipsometry (SIE) for coverage and number of layer analysis on the catalyst directly.