Role of Defect Density of Cu Substrate on Graphene Nucleation

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Abstract

The unique properties of large area graphene are crucially dependent on its grain size.[1,5] Microstructural design for the desired grain size requires a fundamental understanding of graphene nucleation and growth. For chemical vapor deposition of graphene on copper surface, the nucleation can be controlled by controlling the copper surface defect density and gas-phase supersaturation of carbon precursor. Here, we show that graphene nucleation density closely follows copper surface defect density under low supersaturations. We were able to control the latter by annealing copper prior to graphene growth. Nucleation density of graphene was estimated from the scanning electron microscope (SEM) images of isolated graphene grain in early stages of growth. The surface defect density was quantified by etch-pit measurements and by grain-misorientation plots. Among surface defects, dislocations are most potent graphene nucleation sites, as they are activated at the lowest supersaturation of gas-phase carbon precursor. As a proof, we generate dislocations in copper surface by indentation and show that nucleation of graphene occurs only at those locations and nowhere else. To summarize these findings, we have sketched a supersaturation plot, incorporating two basic growth parameters, temperature and flow rate of carbon precursor and identify the defect dominated growth regime. This study not only will help in understanding the basic of nucleation of graphene on copper but also to engineer the desired microstructure of graphene.

Reference:

Figure 1. Effect of defects on graphene nucleation: SEM images showing that nucleation occurs only on the dislocation sites (pointed by circle) at low supersaturation.