Photo-thermal Chemical Vapor Deposition of Graphene on Copper

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Chemical vapor deposition (CVD) using metal catalyst as a target substrate is an effective way to produce large-area high-quality graphene [1]. An alternative for typically used CVD with resistive heating is photo-thermal chemical vapor deposition (PTCVD) utilizing halogen lamps as a heat source. PTCVD demonstrates a very high growth rate of high-quality single-layer graphene on copper, achieving a short growth time of 20-60 s to complete a continuous graphene film compared to 20-30 minutes using typical tubular furnaces [2].

The growth temperature is the most important factor due to hydrocarbon dissociation on the surface of the copper catalyst. In this study, graphene was synthesized under different PTCVD process parameters. It was found that PTCVD can produce high-quality single-layer graphene, which has high intensity ratio of the 2D and G bands ($I_{2D}/I_G$), at 935 - 950 °C using a growth time of 60 s with a gas ratio (CH$_4$: H$_2$) of 4 : 1 in low pressure (~ 10 mbar). The annealing prior to the growth was varied from 5 to 15 minutes. The influence of the heating rate and the cooling rate from growth temperature were studied. Typically, Raman histograms show intensity ratio of the D and G bands ($I_D/I_G$) lower than 0.1, which corresponds to very low defect density [3, 4].