Backside Carbon Gettering Approach for Layer Controlled CVD Growth of Graphene and Its Advanced Characterization

By

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Date: 15 December 2017 (Friday)
Time: 10:30
Venue: Room 4582 (Lift 29-30)

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Abstract

Since the discovery of graphene in 2004, this two-dimensional (2D) material has attracted a plenty of research interest owing to its unique set of extraordinary properties. Graphene already has shown a great potential for a broad spectrum of applications in the field of energy, environment and optoelectronic devices. Chemical vapor deposition (CVD) technique appeared to be the most promising method to meet the ever-increasing demand of high quality graphene. However, the underlying mechanism of CVD growth is yet uncertain and requires further investigation with the aim of getting profound understanding about layer controlled graphene growth. The theme of this PhD work is to provide insight into the mechanism of multilayer graphene (MLG) growth on the Cu foil via CVD and subsequently providing the strategy to obtain exclusively single layer graphene (SLG) with superior quality. In first part of the dissertation, we presented our unique backside carbon gettering (BCG) approach to mitigate the MLG growth on the copper (Cu) foil using a nickel support substrate during CVD process. Carbon gettering effect of nickel restricted the carbon diffusion to the top surface of the Cu foil, steering us to grow exclusive SLG growth. Besides, BCG approach assisted in lowering down the nucleation density of the single-crystal graphene domains by two orders of magnitude, enabling us to obtain large size single-crystal graphene domain with 6 mm of lateral size. In the second part, we demonstrated unusual characterization of CVD grown graphene using surface enhanced Raman scattering (SERS) and time-of-flight secondary ion mass spectrometry (ToF-SIMS) techniques. We provided a facile method of preparing a SERS active substrate by oxidizing the nickel titanium (NITi) alloy. The Raman enhancement of graphene on such substrate was a function of oxide layer thickness. Finally, we explored the potential of ToF-SIMS technique for characterizing graphene and beyond 2D materials. This ultra-sensitive surface technique facilitate us to probe the film uniformity over the large area and revealing individual layers of as-grown multilayer graphene film directly on the growth substrate.