Graphene growth at 150°C using novel catalysts: Why do catalysts act as catalysts?

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Graphene is one of the hottest materials in nanotechnology and nanomaterials science. The subjects to be solved for realizing myriads of applications include their lower temperature growth directly onto substrates. In this report, based on the findings of the in-situ transmission electron microscopy (TEM) observations of the graphitization process, a challenge towards the graphene growth at lower temperatures will be dealt with [1, 2].

The key in this investigation is the selection of the catalyst. In order to survey the catalytic property in graphitization in in-situ TEM for various metals, metal included amorphous carbon nanofibers (CNFs) were prepared by the Ar^+ ion irradiation onto an edge of a carbon foil with a simultaneous supply of various kinds of metals at room temperature [3-6]. The samples thus prepared were resistively heated during the current-voltage (I-V) measurement while observing the structural change (graphitization) [3-6]. After the selection of the catalyst, stacked films of amorphous carbon and the catalyst metal were deposited onto SiO_2 and glass substrates, and then were annealed in vacuum at the temperatures as low as 150-250°C for the graphene formation.

In-situ TEM observation revealed that Sn and In were quite promising for the low temperature graphene growth. Encouraged by this findings, stacked films of Sn/carbon or In/carbon were deposited onto SiO_2/Si and glass substrates. The thin film samples thus prepared were simply annealed at 150-250°C under vacuum condition. Figure 1 shows a typical example of a Raman spectrum for the 200°C annealed sample, revealing the sharp and intense G and 2D peaks almost without D peak. Although the domain size of the graphene formed was still small, a few 10 μm at the moment, this approach will open up a new route for the transfer free and position controlled graphene growth at low temperatures.

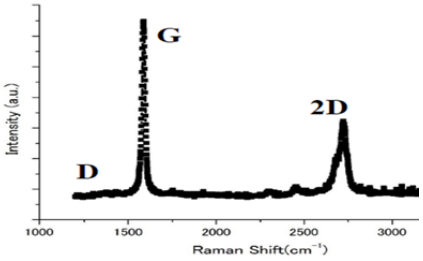

Figure 1. Typical Raman spectrum attained for an In/C film sample vacuum-annealed at 200°C.

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