Room Temperature Graphitization using Ni Nanoparticles as a catalyst

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Introduction: Graphene, 2-dimensional carbon nanomaterial, is recently one of the most advanced materials for up-scaling in environment-friendly industrial applications [1]. Thus, the low-temperature growth is one of the challenges in the graphene research field. So, many efforts have been devoted to achieve it. Recently, the major development has been made in the field of low-temperature growth of graphene by metal catalysts, such as nickel (Ni) and copper (Cu) [2]. However, more efforts are still needed to understand the growth mechanism. Here we report a great decrease in graphitization temperature using well-known catalyst Ni.

Experimental: Amorphous carbon films with Ni nanoparticles (NPs) were deposited onto microgrids and SiO_2/Si substrate by a simple one-step magnetron sputtering method at room temperature (RT) and 50 °C. The graphitization was observed by transmission electron microscopy (TEM; JEM ARM 200F) operated at 200 kV) and Raman spectroscopy (NRS 3300 laser Raman spectrometer). In order to investigate the effect of Ni oxide, 2 types of samples, namely films with and without the inclusion of oxide NPs, were prepared. High purity Ar (99.999%) was used as a sputtering gas.

Result and discussion: The amorphous carbon surrounding and in-between the Ni NPs started to be graphitized during the film deposition even at RT and 50 °C. The graphitization was confirmed by high-resolution TEM (HR-TEM) and Raman spectra, disclosing a clear 2D peak as shown in **Fig. 1(a)** [3]. During the film deposition, the agglomeration of NPs would occur. In this agglomeration process, the solubility of C would slightly decrease with increasing NP size, yielding a graphitized layer behind the trace of moving agglomerated NPs as shown in **Fig (b)**. In contrast, a Ni-C film with the inclusion of partially oxidized NPs showed the less graphitization even at the elevated deposition temperature. So, metal NPs is promising for the low-temperature graphitization.

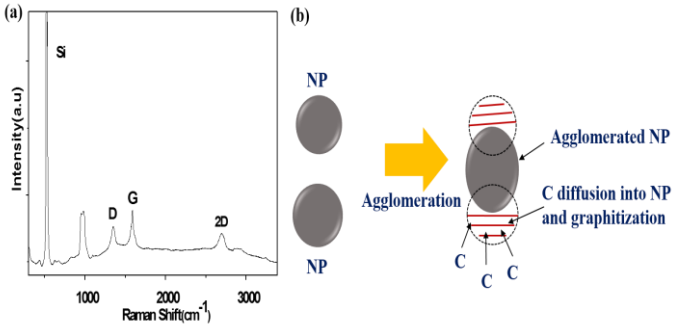

Fig. 1 (a) Raman spectrum of Ni-C film deposited at RT and (b) schematic illustrations of the graphitization in agglomeration process during the film deposition.

References

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