One-step synthesis of spontaneously graphitized nanocarbon using Co-nanoparticles

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Introduction: Graphene is recently one of the most advanced materials for up-scaling in environment-friendly industrial applications due to its incomparable electronic, optical, thermal conductivity, and mechanical properties [1]. In the graphene research, one of the big issues is its low-temperature growth. So, many efforts have been devoted to achieve it. Recently, Ni in nanoparticle (NP) form was demonstrated to be promising for the low-temperature graphitization in the solid phase reaction [2]. Co is a well-known catalyst for graphene growth and possesses a higher C solubility than Ni. Here, we challenged a spontaneous graphitization at room temperature (RT) by a simple one-step synthesis of Co-C films for the first time, leading to a strategy to achieve the ultra-low temperature graphene growth [3].

Experimental: Amorphous carbon (a-C) films containing metallic Co NPs were deposited onto microgrids and SiO_2/Si substrates by a magnetron sputter-deposition technique at RT using a C target with an attachment of a small Co platelet. The thin films thus prepared were characterized by transmission electron microscopy (TEM), Raman spectroscopy, x-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS).

Result and Conclusion: TEM with a fast Fourier-transform (FFT) revealed the short-range ordering of the lattice corresponding to graphite (002) between Co NPs in the a-C matrix as shown in **Fig. 1(a)**. The 2D peak and graphite (002) peak were clearly observed in Raman and XRD spectra, respectively. XPS analyses revealed the metallic state of Co NPs and sp^2 graphitization, as shown in **Fig. 1(b)**. 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. Thus, the Co NPs exhibited higher catalytic activity in spontaneous graphitization at low-temperature than Ni-NPs prepared under the same conditions. So, the metallic NPs were concluded to be promising as the catalyst for the ultra-low temperature graphitization in the solid phase reaction.

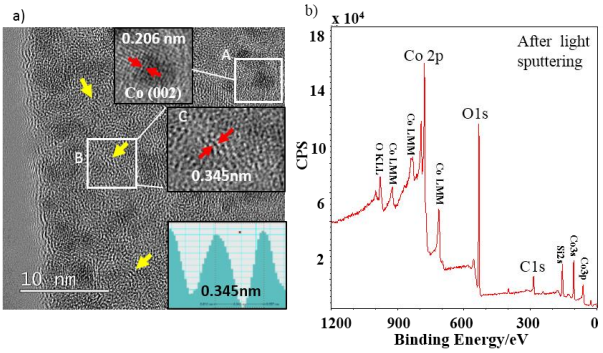

Fig. 1 (a) TEM image of a Co-C film deposited on a microgrid. (b) XPS spectra of a Co-C film deposited on a SiO_2/Si substrate at RT after the removal of the surface contamination.

References

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