Synthesis of Graphene Balls by Carbon Segregation from Nickel Nanoparticles

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We report the fabrication of multilayer graphene balls (GBs) by template-directed carbon segregation using nickel nanoparticles (Ni-NPs) as template materials. To maintain the ball shape of the template Ni-NPs, we used a carburization process using polyol solution as carbon source, and a thermal annealing process to synthesize graphene layers via carbon segregation on the outer surface of the Ni-NPs. The resulting GBs were hollow structures composed of multilayer graphene after the removal of core Ni-NPs, and the thickness of the graphene layers and the size of GBs were tunable by controlling the graphene synthesis conditions. X-ray diffraction (XRD) analysis and in situ transmission electron microscope (TEM) characterization revealed that carbon atoms diffused effectively into the Ni-NPs during the carburization step, and that the diffused carbon atoms in Ni-NPs segregated and successfully formed graphene layer on the surface of the Ni-NPs during thermal annealing. We also performed the further heat treatment at high temperature to improve the quality of graphene layer, resulting high crystalline GBs.