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Size-homogeneous gold nanoparticle decorated on graphene via MeV electron beam irradiation

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Recently graphene has emerged as a fascinating 2D system in condensed-matter physics as well as a new material for the development of nanotechnology. The unusual electronic band structure of graphene allows it to exhibit a strong ambipolar electric field effect with high mobility. These properties lead to the possibility of its application in high-performance transparent conducting films (TCFs). Compared to indium tin oxide (ITO) electrodes, which have a typical sheet resistance of ∼60 Ω/sq and ∼85 % transmittance in the visible range (400?900 nm), the CVD-grown graphene electrodes have a higher/flatter transmittance in the visible to IR region and are more robust under bending. Nevertheless, the lowest sheet resistance of the currently available CVD graphene electrodes is higher than that of ITO.

Here, we report an ingenious strategy, irradiation of MeV electron beam (e-beam) at room temperature under ambient condition, for obtaining size-homogeneous gold nanoparticle decorated on graphene. The nano-particlization promoted by MeV e-beam irradiation was investigated by transmission electron microscopy, electron energy loss spectroscopy elemental mapping, and energy dispersive X-ray spectroscopy. These results clearly revealed that gold nanoparticle with 10 ∼ 15 nm in mean size were decorated along the surface of the graphene after 1.5 MeV-e-beam irradiation. A chemical transformation and charge transfer for the metal gold nanoparticle were systematically explored by X-ray photoelectron spectroscopy and Raman spectroscopy. This approach advances the numerous applications of graphene films as transparent conducting electrodes.

Keywords: Graphene, MeV electron beam, Gold nanoparticle