NEF-P010

Improved Electrical Properties of Graphene Transparent Conducting Films Via Gold Doping

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Graphene, with its unique physical and structural properties, has recently become a proving ground for various physical phenomena, and is a promising candidate for a variety of electronic device and flexible display applications. The physical properties of graphene depend directly on the thickness. 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, the chemical vapor deposition (CVD) synthesized graphene electrodes have a higher 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 1.0 MeV-e-beam irradiation. The fabrication high-performance TCF with optimized doping condition showed a sheet resistance of ~150 Ω/sq at 94% transmittance. 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, Transparent conducting film