

Retained Carrier-Mobility and Enhanced Plasmonic-Photovoltaics of Graphene via ring-centered η^6 -Functionalization and Nanointerfacing

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Binding graphene with auxiliary nanoparticles for plasmonics, photovoltaics, and/or optoelectronics, while retaining the trigonal-planar bonding of sp^2 hybridized carbons to maintain its carrier-mobility, has remained a challenge. The conventional nanoparticle-incorporation route for graphene is to create nucleation/attachment sites via "carbon-centered" covalent functionalization, which changes the local hybridization of carbon atoms from trigonal-planar sp^2 to tetrahedral sp^3 . This disrupts the lattice planarity of graphene, thus dramatically deteriorating its mobility and innate superior properties. Here, we show large-area, vapor-phase, "ring-centered" hexahapto (η^6) functionalization of graphene to create nucleation-sites for silver nanoparticles (AgNPs) without disrupting its sp^2 character. This is achieved by the grafting of chromium tricarbonyl [$Cr(CO)_3$] with all six carbon atoms (sigma-bonding) in the benzenoid ring on graphene to form an (η^6 -graphene) $Cr(CO)_3$ complex. This nondestructive functionalization preserves the lattice continuum with a retention in charge carrier mobility (9% increase at 10 K); with AgNPs attached on graphene/n-Si solar cells, we report an ~ 11 -fold plasmonic-enhancement in the power conversion efficiency (1.24%).

References

- [1] Retained Carrier-Mobility and Enhanced Plasmonic-Photovoltaics of Graphene via ring-centered η^6 Functionalization and Nanointerfacing Songwei Che, Kabeer Jasuja, Sanjay K. Behura, Phong Nguyen, T. S. Sreeprasad, and Vikas Berry Nano Letters 2017 17 (7), 4381-4389

Figures

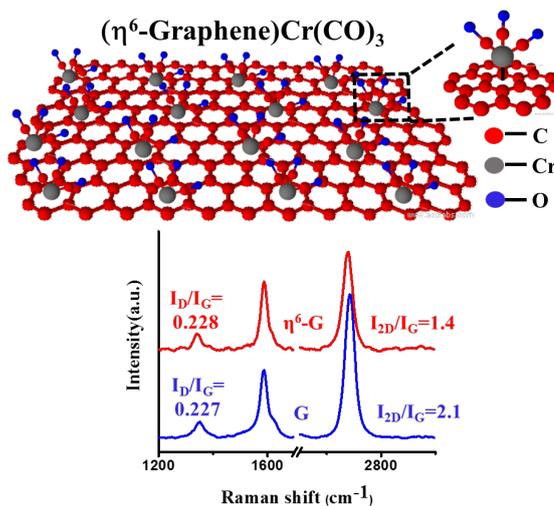


Figure 1: Schematic of hexahapto-functionalized graphene [(η^6 -graphene) $Cr(CO)_3$]. Raman spectra obtained by averaging the circle area of graphene without (blue line) and with hexahapto functionalization (red line).

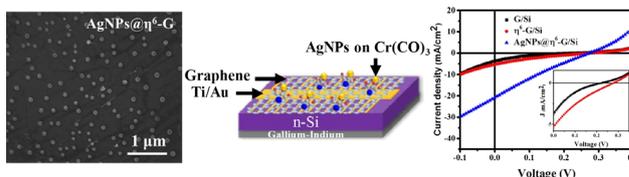


Figure 2: FESEM images of η^6 -functionalized graphene with silver nanoparticles. J vs. V characteristics curves of solar cells with AM 1.5G illumination, the inset is an enlarged view of G/Si and η^6 -G/n-Si.