Wenbo Xin et al., J Nanomed Nanotechnol 2014, 5:5
http://dx.doi.org/10.4172/2157-7439.S1.018

OMICS Group Conferences
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4th International Conference on
Nanotek & Expo

December 01-03, 2014 DoubleTree by Hilton Hotel San Francisco Airport, USA

Synthesis of well-defined and ultra-thin gold nanoplates on plasma-activated graphene

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Graphene decorated with well-defined gold nanocrystals form functional nanocomposites that have many potential applications in electronics, optical sensors and Raman signal enhancers. These materials are commonly produced indirect reduction of gold precursors like $HAuCl_4$ or $KAuBr_4$ by graphene. However, in order to reduce surface energy, this generally forms approximately spherical, zero dimensional, gold nanoparticles. For tailorable electrical and optical properties, two dimensional gold structures such as nanoplates are usually obtained with the assistance of templates and surfactants. Unfortunately, these processes are inefficient, complicated and time-consuming. Here, we demonstrate an *in-situ*, efficient and surfactant-free synthesis of ultra-thin (~20nm) and high aspect ratio (50:1) gold nanoplates. The synthesis includes two steps: (1) Oxidize graphene surfaces with atmospheric pressure plasma for ~30 seconds and (2) Directly reduce $KAuBr_4$ solutions with the activated graphene for two hours. Experimental results from EDS, TEM and SAED show that the plates are pure gold and have a single crystalline FCC structure with {111} oriented basal planes. We also show that the Raman scattering signal from gold nanoplates deposited graphene was significantly enhanced by 10-fold.

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