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Effects of Au Nanoparticle Monolayer on or Under Graphene for Surface Enhanced Raman Scattering

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Since first discovery of strong Raman spectrum of molecules adsorbed on rough noble metal, surface enhanced Raman scattering (SERS) has been widely used for detection of molecules with low concentration. Surface plasmons at noble metal can enhance Raman spectrum and using Au nanostructures as substrates of SERS has advantages due to it has chemical stability and biocompatibility. However, the photoluminescence (PL) background from Au remains a problem because of obtaining molecular vibration information. Recently, graphene, two-dimensional atomic layer of carbon atoms, is also well known as PL quenchers for electronic and vibrational excitation. In this study, we observed SERS of single layer graphene on or under monolayer of Au nanoparticles (NPs). Single layer graphene is grown by chemical vapor deposition and transferred onto or under the monolayer of Au NPs by using PMMA transfer method. Monolayer of Au NPs prepared using Langmuir-Blodgett method on or under graphene surface provides closed and well-packed monolayer of Au NPs. Scanning electron microscopy (SEM) and Raman spectroscopy (WItec, 532 nm) were performed in order to confirm effects of Au NPs on enhanced Raman spectrum. Highly enhanced Raman signal of graphene by Au NPs were observed due to many hot-spots at gap of closed well-packed Au NPs. The results showed that single layer graphene provides larger SERS effects compared to multilayer graphene and the enhancement of the G band was larger than that of 2D band. Moreover, we confirm the appearance of D band in this study that is not clear in normal Raman spectrum. In our study, D band appearance is ascribed to the SERS effect resulted from defects induced graphene on Au NPs. Monolayer film of Au NPs under the graphene provided more highly enhanced graphene Raman signal compared to that on the graphene. The Au NPs-graphene SERS substrate can be possibly applied to biochemical sensing applications requiring highly sensitive and selective assays.

Keywords: Graphene, SERS, Nanoparticles