Graphene-mediated Surface Enhanced Raman Spectroscopy for Detection of Biomolecules and DNA Hybridization

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Abstract

In this work, we prepared graphene-mediated surface-enhanced Raman scattering (G-SERS) substrates comprising few-layer graphene nanosheets decorated gold and silver nanoparticles for bio-nanotechnology. Raman spectroscopy is a surface-sensitive and nondestructive inelastic light scattering technique. SERS, a specialized form, is useful for rapid and precise identification of biological molecules, industrially relevant chemical dyes at ultralow concentration and monitoring DNA hybridization. This phenomenon is due to the enhanced Raman signals by several orders of magnitude on SERS-active surfaces. While the key point of SERS technology is the nanoscale metal particles, which generates localized surface plasmon resonances in response to laser excitation, the resulting electromagnetic enhancement, controlled diameter and inter-particle gap of metal nanoparticles on graphene supports offer an advance toward sensitive G-SERS substrates via localized hybridization at graphene-metal interfaces. We have used thermal reduction technique to produce functionalized graphene and wet chemistry for size tunable gold and silver nanoparticles as cost-effective facile synthesis approaches for strategic G-SERS platforms. Simple and high-throughput arrays ('biochips') are developed by decorating graphene nanosheets with gold and silver nanoparticles as well as sandwiching gold and silver nanoparticle and few-layer graphene for cascaded signal amplification to differentiate among nucleotide bases (adenine; A, thymine; T, cytosine; C, guanine; G), DNA hybridization through complementary single-stranded DNA as a probe and to detect beta-carotene and malachite green chemical dye.