Microplasma-Assisted Synthesis of GQD-AgNP Nanohybrids for SERS-based Detection

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Recently experimental and theoretical works have reported that graphene quantum dots (GQDs) a unique form of zero dimensional nanostructure, and their exceptional properties including low toxicity, photo-stability, biocompatibility and the tunable optoelectronic properties such as photoluminescence (PL) make them promising in biosensing applications. Surface-enhanced Raman scattering(SERS) is an ultra-sensitive analytical technique for trace molecules detection. While the potential of SPR metals (e.g. Au and Ag) and graphene for SERS has been demonstrated, but the work of GQDs applied as SERS substrates is still lacking. The conventional approaches to synthesis GQD-metal nanohybrids including UV irradiation and wet-chemistry reduction are time-consuming and requiring toxic chemicals.

Here we demonstrate a facile synthesis of GQD-AgNP nanohybrids using the atmospheric-pressure microplasma-assisted electrochemistry. Microplasmas are defined as gaseous discharges formed in electrode geometries where at least one dimension is less than 1mm and can be operated stably with an aqueous solution as an electrode at ambient condition. Energetic species formed in the microplasma are capable to initiating electrochemical reactions and nucleating metal nanostructures in solutions without chemical reducing agents. By carefully adjusting the plasma parameters (i.e. time, current, and voltage), the microplasma-assisted electrochemical reaction showed the possibility to grow Ag nanostructures onto the GQD surfaces within minutes. Detailed transmission electron microscopy (TEM) characterizations show that the morphologies of as-produced nanohybrids could be controlled to form the heterodimeric nanostructures. Systematic Raman study using R6G as the Raman probe indicated the as-produced GQD-AgNP nanohybrids can further enhance SERS performance in our study.

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