Microplasma-assisted Fabrication of Graphene-Quantum-Dot/Noble-NP heterostructures for Biosensing and Catalysis

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Abstract

Recently graphene quantum dot (GQD), a unique type of graphene derivatives, has stimulated a lot of attentions due to their exceptional properties including low toxicity, photo-stability, biocompatibility and excellent solubility, making them promising for biosensing. Moreover, bio-compatible gold (Au) and silver (Ag) nanostrutures can provide great electromagnetic fields generated upon excitation of their localized surface plasmon resonance, allowing surface-enhanced Raman scattering (SERS) occurred for an ultra-sensitive molecular-level detection [1] and catalysis [2].

However, the conventional approaches to prepare such nanoheterostructures are usually complicated, time consuming, inefficiency, and high temperature required. Here we demonstrate a facile synthesis of GQD/AuNP and GQD/AgNP heterostructures by using atmospheric-pressure microplasmas. Microplasmas [3] are defined as gaseous discharges formed in electrode geometries where at least one dimension is less than 1μm. Due to surface volume change, microplasmas can be operated stably with an aqueous solution as an electrode at atmospheric pressure. Energetic species formed in the microplasma are capable to initiating electrochemical reactions and nucleating particles in solution without chemical reducing agents. Detailed microscopic and spectroscopic characterizations indicate that the morphology and size distribution of as-produced GQD/AuNP and GQD/AgNP nanoheterostructures can be controlled by the reaction conditions. The SERS and photoluminescence (PL) spectroscopic studies [4] further explore the optical properties of as-produced GQD/AuNP and GQD/AgNP nanoheterostructures and suggest that GQDs/AuNPs nanoheterostructures can performed as an effective material for SERS-based and PL-based biomolecular sensing and chemical catalysis of 4-nitrophenol.

References

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