DEVELOPMENT OF SERS PLATFORM FOR THE DETECTION OF RHODAMINE 6G BY UTILIZING GRAPHENE QUANTUM DOTS ON HYBRID CORE-SHELL PD@AG NPS

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ABSTRACT

Along with the large surface area and high localized surface plasmon resonance (LSPR), bimetallic or core-shell nanoparticles (NPs) can be employed in a surface-enhanced Raman spectroscopy (SERS) substrate [1]. The plasmonic metallic NPs such as silver (Ag) and palladium (Pd) have been exposed as a novel approach for the engineering of the SERS substrate with their better stability and bio-compatibility [2]. Metal film thickness-induced solid-state dewetting (SSD) [3] approach can offer the dynamic evolution of the bimetallic NPs like hybrid core-shell Pd@Ag NPs with the Ag NPs as secondary background NPs as displayed in Fig. 1(a). As compared to the monometallic Ag and Pd NPs, the hybrid core-shell Pd@Ag NPs exhibited an improved frequency of plasmonic LSPR as shown in Fig 1(a-1). The narrowing LSPR peaks shown a blue shift due to the unique morphology of core-shell Pd@Ag NPs with the evolved background Ag NPs.

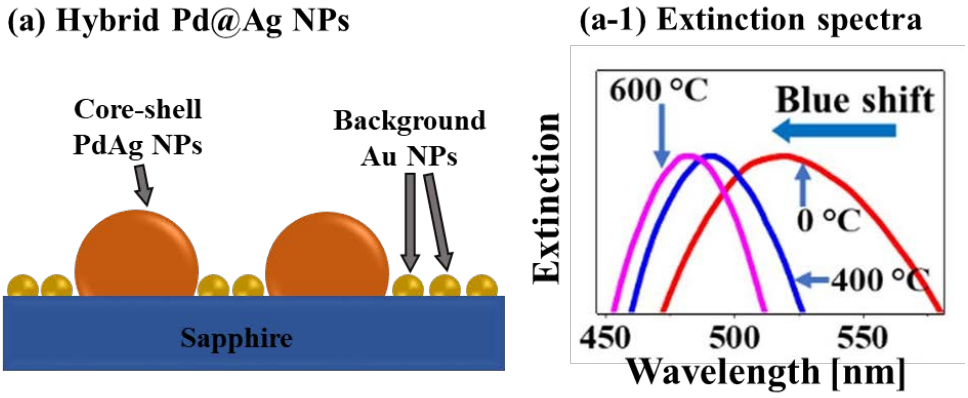

Figure 1. (a) Schematic of Pd@Ag hybrid core-shell NPs fabricated by the solid-state dewetting method. (a-1) Extinction spectra of Pd@Ag hybrid core-shell NPs [4].

In this work, the Rhodamine 6G (R6G) organic molecule has been used as an analyte to explore the improved SERS performance with the incorporation of graphene quantum dots (GQDs) on the hybrid core-shell Pd@Ag NPs as represented in Fig. 2(a). The hybrid nano-architecture of GQD/HNPs provides greatly influenced e-filed with the denser hotspots in between the small spacing of particles and background Ag NPs [5]. The dangling bonds on the GQDs edge effectively adsorb the probe molecules R6G [6], which revealed a significant improvement in SERS with lower R6G molarity. The dramatic enhancement in SERS signals can be attributed to the combined effect of chemical and electromagnetic enhancement through GQDs and plasmonic hybrid core-shell Pd@Ag NPs respectively, as displayed in Fig 2 (b) and 2(c).

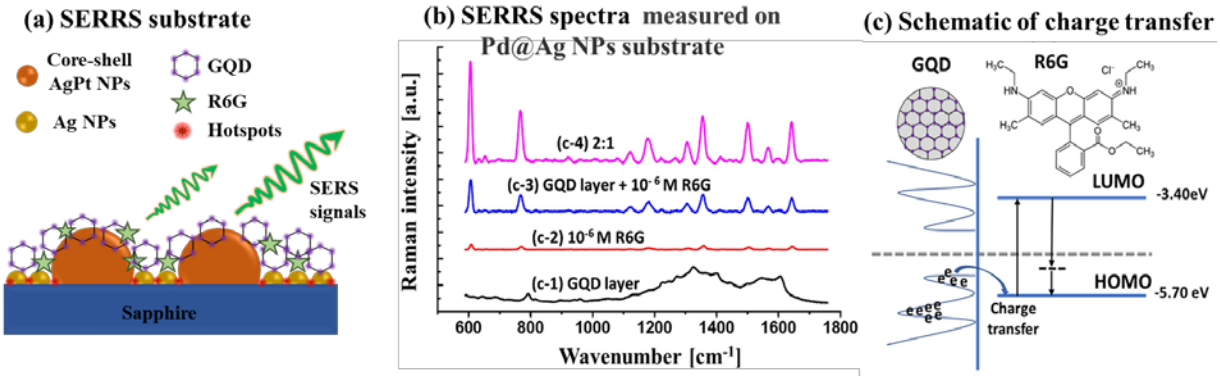

Figure 2. (a) Schematic of SERS substrate constructed on the Pd@Ag core-shell NPs and GQDs. (b) SERS spectra measured on the Pd@Ag core-shell hybrid NPs substrate. (c) schematic of ground-state charge transfer mechanism with the GQDs for SERS enhancement [4].

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Author Contributions

Sanchaya Pandit: Conceptualization, Methodology, Writing - review & editing.

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Rakesh Kulkarni: Data curation. Rutuja Mandavka: Data curation. Shusen Lin: Data curation. Jihoon Lee: Conceptualization, Methodology, Writing - review & editing.

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