Charge-transfer-induced suppression of galvanic replacement and synthesis of (Au@Ag)@Au double shell nanoparticles for highly uniform, robust and sensitive bioprobes

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Abstract

In the field of sensing and diagnostics, Ag@Au core-shell nanoparticles (NPs) have become intriguing biological probes because of the beneficial coupling of the two metals. The Ag core provides high enhanced-Raman activity, while the Au shell provides excellent chemical stability and a great reactivity with sulfur containing biomolecules. Aqueous synthesis techniques for Ag NPs are advantageous for biological applications because the resulting NPs can often be used directly, yet these techniques typically provide unstable Ag NPs of low monodispersity, or with a size that is difficult to control. In addition, it is still challenging to synthesize well-defined uniform Ag@Au NPs because the Ag core is easily etched away due to the galvanic replacement reaction between Au ions and the Ag metal cores which causes gaps in the Au shell or hollow sections at the interface of the core and the shell.

In this research, we successfully synthesize double shell (Au@Ag)@Au NPs without any defects or gaps in the structure. The synthesis is accomplished through suppression of the galvanic replacement reaction caused by an electron transfer phenomenon. The resulting NPs are monodisperse with a thin and uniform second Au shell. In addition, (Au@Ag)@Au double shell NPs have resistance to oxidation, high stability in the presence of salt, also give strong surface-enhanced Raman scattering (SERS) intensity, and therefore are ultimately expected to lead to novel probes for biomolecular sensing and diagnostics.

Keywords: *Core-shell nanoparticle, Gold, Silver, Galvanic replacement, Electron transfer.*