Core-shell plasmonic nanoparticles for via surface-enhanced Raman scattering applications

Background. Surface enhanced Raman scattering (SERS) has received increasing interest due to its capability of amplifying Raman signals by several orders of magnitude.[1-2] As a non-invasive method, SERS has demonstrated its great applications in various fields, such as chemical sensing, environmental monitoring, food safety, anticounterfeiting labels, and medical diagnosis and treatment.[3-6] In these applications, SERS-active substrates, typically noble metal nanoparticles, play an essential role to achieve the satisfied performance in both detection sensitivity and selectivity. It has been well-known that size, shape, and surface roughness of the metal nanoparticles, as well as their surface modification and aggregation, can significantly impact the electromagnetic field in the vicinity of the nanoparticles, thus resulting in different SERS performance.[7] Besides the increasing exploration on the SERS applications, research in the fields of design and fabrication of novel SERS substrates is still very active. Specifically, scientists are interested in studying the impact of ligand on the nanoparticle morphology, fabricating SERS nanoparticles with internal molecular standards, and exploring the influence of adsorption of multiple ligands on the nanoparticle aggregation and stability.[8]

Research Approach. In this REU project, we will work on design of novel core-shell nanoparticles for various SERS applications. Our goal is to use organic ligands to modulate the nanoparticle morphology, to insert molecular standards in core-shell nanoparticles, and to fabricate SERS materials with multiple labels for anticounterfeiting applications. This research project is built on our existing experience in tuning the morphology of gold nanostars and their applications in anticounterfeiting labels.[9-11] We will design new core-shell nanostars that will include a layer of desired molecular probes, which might serve as an internal standard in a SERS measurement. We will further investigate the adsorption of various chemicals on the surface of gold nanostars, as well as resulting SERS spectra which might including Raman bands of multiple surface ligands. It is of particularly interest to figure out the impact of adsorbed ligands to the colloidal stability of the gold nanostars. Last but not the least, it is anticipated to use the synthesized core-shell gold nanostars to make protocol type of anticounterfeiting labels (Figure 1).

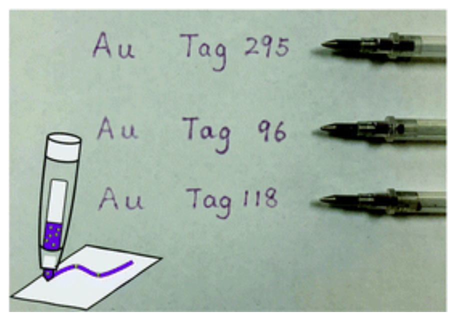

Figure 1. Prototype of a ballpoint pen that can do simple writing with SERS inks.

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