Tailoring the shape of core-shell Au-Ag nanoparticles for SERS

I. Haidar¹, A. Chevillot-Biraud, S. Lau-Truong¹, N. Félidj¹, L. Boubekeur-Lecaque*¹

(1) Laboratoire ITODYS UMR 7086, Université Paris Diderot, Sorbonne Paris Cité, 15 rue J-A de Baïf, 75205 Paris Cedex 13, France

The shape and size control of metal nanoparticle at the nanoscale is a crucial step in the development of diverse applications ranging from catalysis to plasmonics and surface-enhanced Raman spectroscopy (SERS). Among the nanomaterials reported, Au and Ag nanoparticles are the most popular and their geometry-dependent optical properties have been extensively studied. In particular, the seed-mediated growth method proved to be a very powerful route to fine-tune the size, morphology and elemental composition of the nanoparticle by simply reducing additional metal ions on pre-existing metal seeds. The formation of core-shell hybrid nanostructures where gold nanorods (Au NRs) serve as template for the overgrowth of Pd, Pt and Ag shell has been described. [1] Specifically, silver-coated Au nanorods of various shapes have been synthesized by adjusting the conditions (ligand, additives, solvent, temperature, etching...). Still, the exact mechanism of Ag anisotropic deposition for some specific shapes remains to be unraveled. [2]

We present a novel method for the synthesis of a series of anisotropic core-shell Au@Ag of various shapes starting with the same AuNR template. The control of Ag overgrowth on single crystalline gold nanorods was mainly tailored by organic ligand (additive) added in the growth medium. [3] The combination of UV-visible extinction spectroscopy and SEM provided information about morphology at each step of the overgrowth process and transient morphological changes. Surfactant halide counter-ion exchange on the gold surface and coordination of the organic additive were clearly revealed by SERS and XPS. This study has contributed to establishing the key parameters that govern the overgrowth mechanism.

The core-shell Au@Ag nanoparticles obtained via this synthetic strategy tend to self-assemble on large area on solid substrate (silicon, or glass). Through a bottom-up approach, these densely packed nanoparticle films showed very promising SERS-active substrates in terms of homogeneity, stability over time and overall cost-effectiveness.

References

Corresponding author email: leila.boubekeur@univ-paris-diderot.fr