Control over the morphology of metal nanoparticles (NPs) in combination with mechanic understanding is a crucial step for the development of modern nanoscience and nanotechnology. Nanoscale galvanic replacement reaction has been widely used as a convenient approach for the transformation of solid NPs into corresponding porous/hollow NPs, in which pore size and chemical composition controls their optical and catalytic properties. Galvanic replacement reaction on Au@Ag core-shell NPs lead to the formation of nanorattles with complex chemical composition, while preserve the morphology of sacrificial template. The internal electromagnetic hot spots of plasmonic nanorattles make them ideal for plasmon-enhanced applications. Recently, the three-dimensional (3D) morphological and chemical architectural transformations associated with the formation process of nanorattles were revealed by quantitative EDX tomography technique for simultaneous elucidation of 3D morphological and chemical architectural transformations involved during the transformation.\(^1\) The presence of reducing agent lead to such unconventional mechanistic path, in which galvanic replacement dominates in the initial stages of the reaction, while overgrowth suppress the dealloying process in the later stages of the reaction.

Herein we demonstrate that in the presence of high gold salt concentrations the overall process lead to the formation of closed hollow plasmonic nanoparticles. Interestingly, the addition of different molecules during the synthesis of the nanorattles lead to its encapsulation within the inner void. This approach allowed us to codified the plasmonic particles with a library of Raman active molecules leading to the formation ultrasensitive SERS-encoded nanoparticles.

![Figure 1](image)

**Figure 1.** (A) Representative TEM image of the closed Au nanorattles. (B) 3D visualization of the tomographic reconstruction along different views of an Au nanorattle. (C) SEM images of the hierarchical nanoparticles assembly (C) STEM image and EDX mapping showing the Au and Ag distribution. (D) SERS spectra of different Au nanorattles encoded with several Raman reporters as indicated.

**References**


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