



Nanorattles improve plasmonic sensitivity

Yuriy Khalavka, Jan Becker and Carsten Sönnichsen

University of Mainz, Institute of Physical Chemistry, Jakob-Welderweg 11, 55128, Mainz
Http://www.nano-bio-tech.de



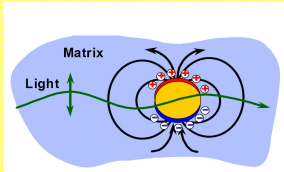
ABSTRACT

The unique optical properties of Au nanoparticles have attracted interest since ancient times. Recently it was shown that gold nanoparticles can be used as optical sensors, contrast agents and photothermal inducers. Their relevance to sensing lies in the fact that the frequency of the plasmon oscillations depends on the refractive index of the immediate environment.

Here we report a strategy for the preparation of the novel structures: nanorattles, based on gold nanorods. We have discovered that these hollow nanorattles show improved optical sensitivity and are more stable than silver coated rods.

Optical properties of metal nanoparticles:

Plasmons in metal nanoparticles lead to efficient light scattering at the plasmon frequency of the particle.



The resonance wavelength strongly depends on refractive index of the embedding medium

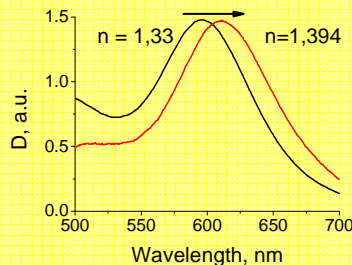


Figure 2. Spectral shift for nanorattles based on gold nanorods. Sensitivity up to 230 nm/RIU has been achieved.

Growth process

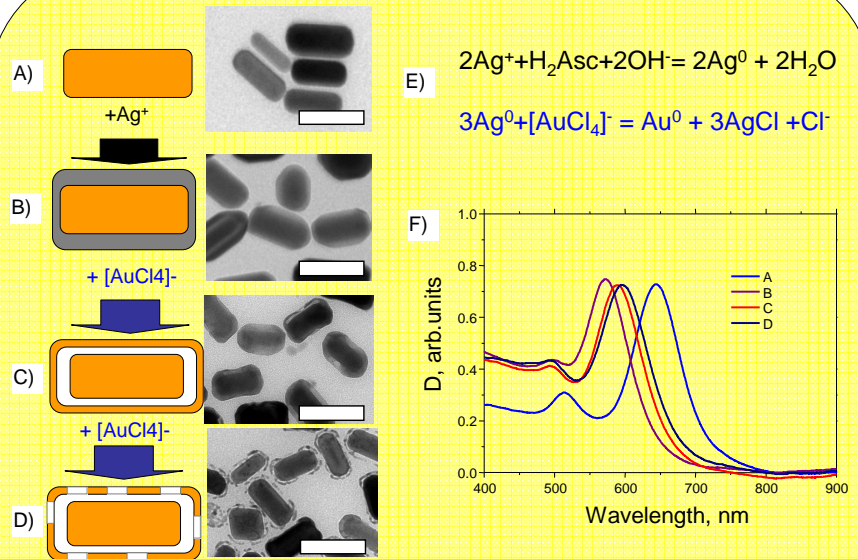


Figure 3. Growth of nanorattles. Deposition of a silver layer (black arrow). By reaction with Au-ion (blue arrows) a shell of Ag-Au grows and then transforms into a cage by further silver dealloying. Insets A-D) showing TEM images corresponding to all the steps. Scalebars are 50 nm F) Extinction spectra, corresponding to steps A-D, as indicated.

Cages are more sensitive than gold rods, cubes and spheres (at short wavelenghtes) and more stable than silver coated particles

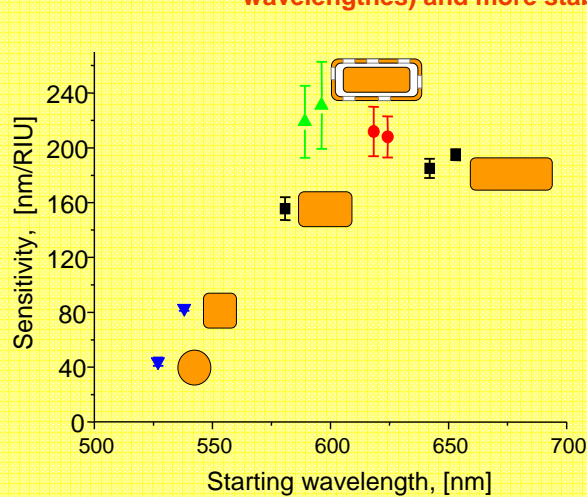


Figure 4. Sensitivity of different gold nanostructures. Data for spheres, cubes and rods with short aspect ratio taken from: *Chen et al. Langmuir, 24 (10), 5233-5237, 2008.*

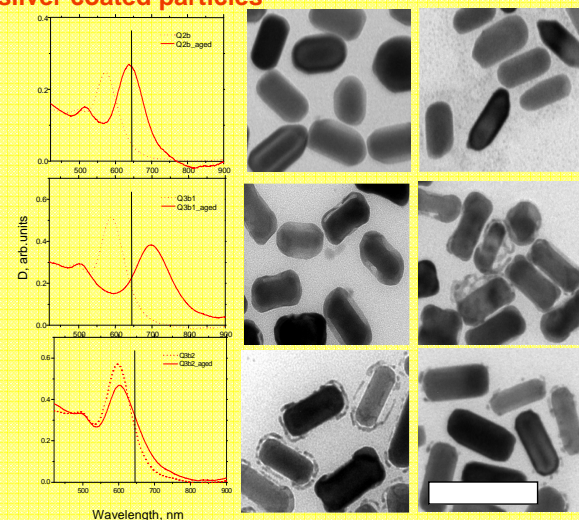


Figure 5. Spectra (left column) and TEM images of freshly prepared (middle) and aged particles (right). Silver coated rods (upper row), nanorattles with closed outer shell (middle row), and the porous gold nanorattles (bottom row). It is clear that particles in a cage keep their resonance wavelength better than silver coated rods. Scalebar is 50 nm

