"Stainless" Gold Nanorods: Preserving Shape, Optical Properties, and SERS Activity in Oxidative Environment

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Gold nanorods (Au NRs) are intensively investigated as SERS-active materials. Their localized surface plasmon resonance (LSPR), which gives rise to a strong enhancement of the local electromagnetic field near their surface, can be tuned over a wide range of wavelengths (from Vis to NIR) by adjusting their aspect ratio. As a result, they can be suitably designed to match the energy of different Raman laser sources and control charge-transfer processes with specific target molecules.

However, one of the main limitations to the application of gold nanorods (Au NRs) as Surface Enhanced Raman Scattering (SERS) probes for *in situ* monitoring of chemical and biochemical processes is their instability in oxidative environments, like those occurring in degradation of organic pollutants, as well as in monitoring of cellular oxidative stress. Oxidative environments induce progressive anisotropic shortening of the NRs, which are eventually dissolved once this process has been completed. As a result, the SERS response is not reproducible and progressively vanishes during the experiment. Finding SERS-active Au NRs that can tolerate harsh conditions without altering their optical properties and SERS response is a key step toward a full exploitation of their unique capabilities.

Here we will compare the resistance to oxidation of two types of Au NRs (type A and B), obtained respectively through traditional, hexadecyltrimethylammonium bromide (CTAB)- and binary-surfactant mixture routes. A careful control of the key parameters influencing the oxidation process (size of the NRs, concentration of the free Br- ions) allowed the selection of Au NRs that can tolerate oxidative environment without any modification of their optical properties. Their superior performance is demonstrated in a series of SERS experiments under oxidative conditions, in which the degradation of different organic dyes (methylene blue and crystal violet) can be monitored through several detection cycles carried out on the same clusters of Au NRs.[1]

These hallmarks make these "stainless" Au NRs attractive tools for ultrasensitive diagnostic under real working conditions and were also exploited for developing 3D SERS-active platforms based on cellulose supports.

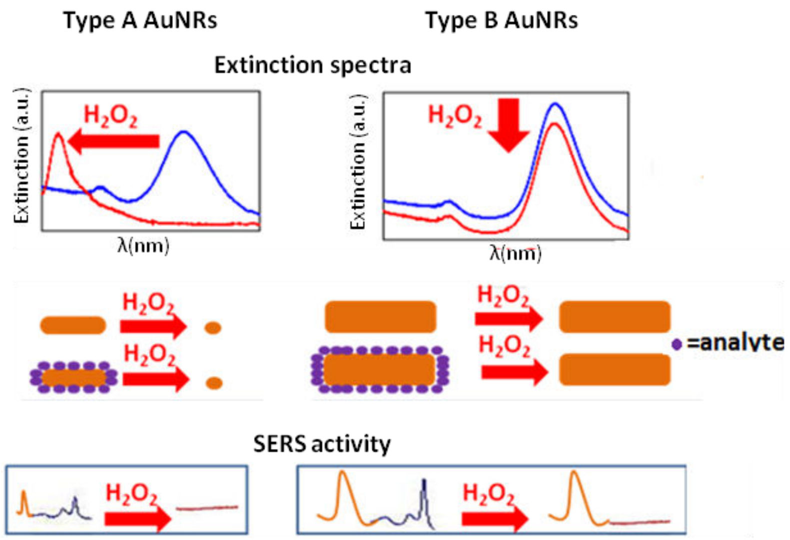

Figure 1. Comparison between the behavior of Type A and Type B AuNRs, before and after the addition of an oxidant: extinction and SERS spectra.

References

[1] Vassalini. I., Rotunno, E., Lazzarini, L., Alessandri, I. *ACS Appl. Mater. Interfaces.* **7,** 18794 (2015).