# Gold or silver nanoparticles decorating superparamagnetic calcium ferrite nanoparticles for application in SERS

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Ultrasensitive detection of trace analytes is essential in many fields, from clinical diagnostics and drug discovery, to public safety and environmental protection. Surface-enhanced Raman scattering (SERS) has demonstrated a tremendous potential for the analysis of several biological and chemical targets, including small molecules, DNA, proteins and cells, at trace or even at single-molecule levels. SERS-based nanobiosensors originate from the combination of SERS, nanomaterial and biomaterial forms [1]. SERS nanotags, resulting from integration of silver or gold nanostructures with Raman active molecules, have been recently explored for detection, sensing and imaging [2]. These systems have "hot spots" at nanoscale junctions and interstices of the SERS nanostructures, affording enormous Raman enhancement factors on the order of $10^{14} - 10^{15}$ and leading to superb detection sensitivity. SERS nanotags robustness and high density of Raman-active molecules provide unique and uniform signals. The possibility of including efficient magnetic properties in the nanotags allows guided transport within an organism. Also, it allows concentration of targeted molecules connected to the SERS nanotags, thus further improving the detection sensitivity [3].

In this work, we report the synthesis of Ag and Au nanoparticles capped with either cysteamine or cysteine. Purification of these NPs (using centrifugation steps) turned out to originate irreversible aggregation (Fig. 1), so that the coupling of NH_2 groups from Au (or Ag) nanoparticles to OH groups of magnetic calcium ferrite ($CaFe_2O_4$) nanoparticles (MNPs) would not work as expected. Therefore, naked metallic Ag or Au nanoparticles were produced and connection to calcium ferrite was performed by first attaching cysteine to the MNPs and then using the resulting SH pending groups to interact with the metallic surface.
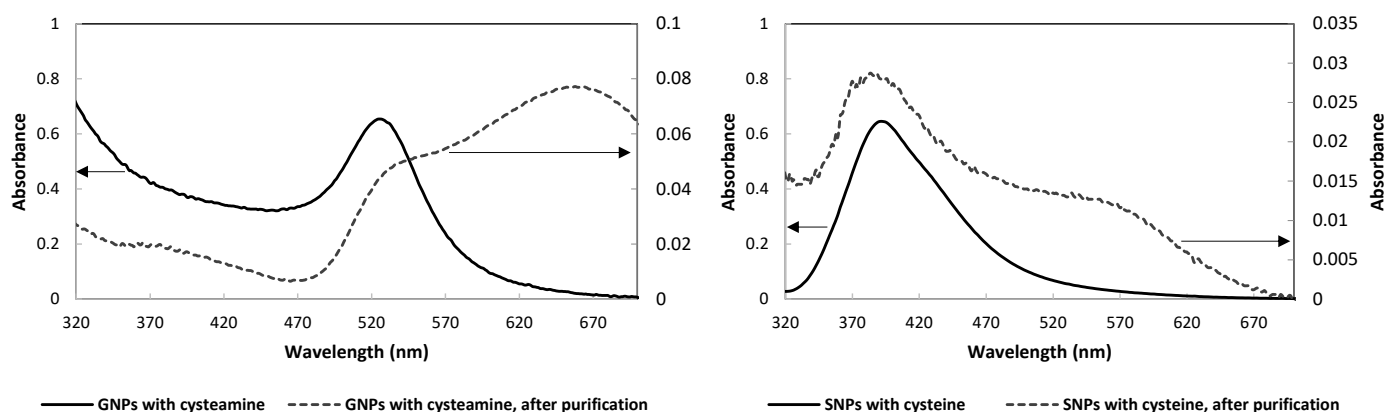
Fig. 1: Absorption spectra of gold nanoparticles (GNPs) (left) and silver nanoparticles (SNPs) (right).

1) X. M. Qian *et al.*, *Chem. Soc. Rev.,* **2008**, *37*, 912.
2) Y. Wang *et al.*, *Chem. Rev.,* **2014**, *113*, 1391.
3) P. Yuanfeng *et al.*, *Biosensors and Bioelectronics,* **2016**, *79*, 574.