HYDROPHILIC GOLD NANORODS FOR BIOTECHNOLOGICAL APPLICATIONS

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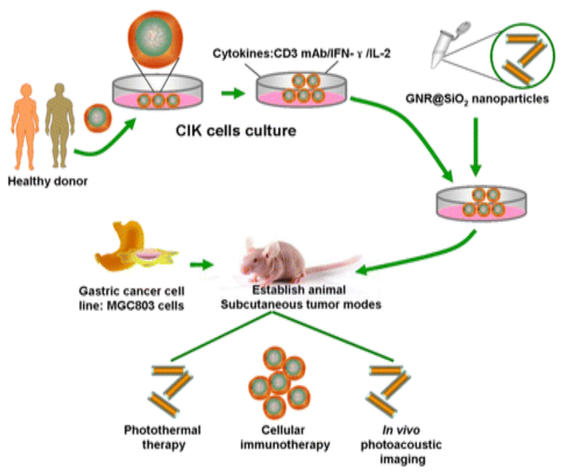
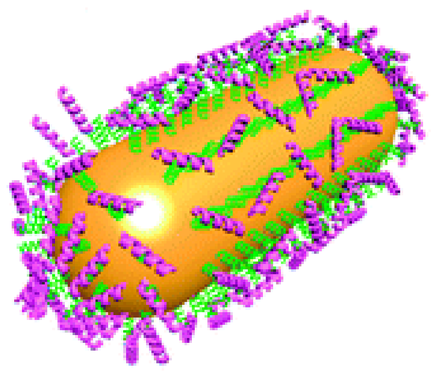
Gold nanorods (AuNRs) are being applied as imaging/diagnostic tools, as drug and gene delivery systems, as photothermal therapy agents and for biotechnologies generally. Their wide success is due to their unique chemical and physical properties, biocompatibility, and well-established and versatile strategies for surface modification.[1-4]



Different approaches to loading and unloading therapeutic molecules on gold nanorods were proposed:

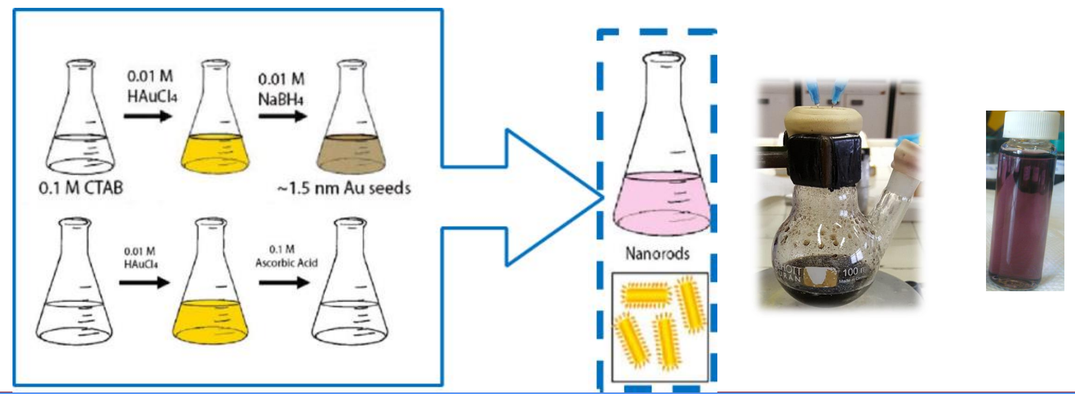
(a) partitioning and diffusion of hydrophobic molecules in a surfactant bilayer;
(b) surface complexation, by anchoring drugs through Au–S (or Au–N) bonds;
(c) drugs complexed to functional groups of capping agents;
(d) loading by electrostatic conjugation and electrostatic assembly.



GOAL: Synthesis of AuNRs with the aim to obtain strongly hydrophilic anisotropic nanomaterials, suitable for drug delivery and photothermal therapy. AuNRs were synthetized by seed mediated methods in two steps and after carefully purification they were investigated by means of UV-Vis-NIR Fourier Transform Infrared Spectroscopy (FT-IR) and Synchrotron Radiation induced X-ray Photoelectron Spectroscopy (SR-XPS). Moreover, Transmission Electron Microscopy (TEM) observations confirmed the nanosize, useful for biomedical applications.

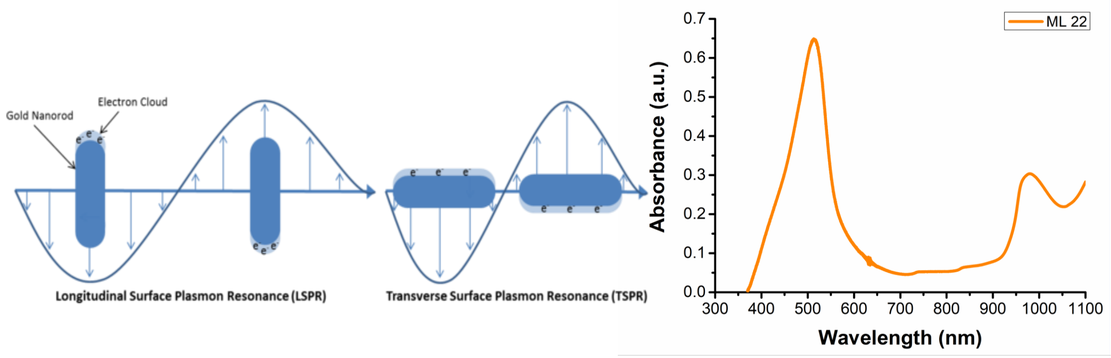
AuNRs Synthesis

Synthesis involves 2 steps: in the first the seed solution is prepared and then in the second silver nitrate, auric tetrachloric acid, seed solution and ascorbic acid are mixed to grow the rods.



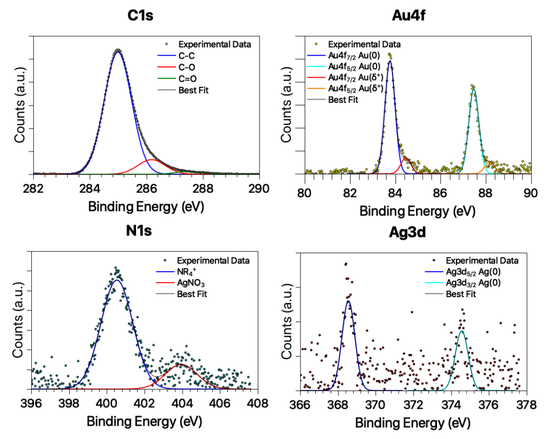
UV-Vis-NIR studies

The AuNRs have two SPR bands: transverse and longitudinal. The plasmonic gold nanorod is more easily polarized longitudinally, meaning the SPR occurs at a lower energy, and thus higher wavelength. As the aspect ratio (ratio of length to width) of a nanorod is increased for a fixed diameter, the longitudinal and transverse plasmon resonances are both affected; however, the longitudinal axis is more polarizable and more sensitive to aspect ratio changes. In gold nanorods, the longitudinal surface plasmon resonance (LSPR) wavelength can be tuned from 550 nm to over 2000 nm by adjusting to longer aspect ratios, while the transverse surface plasmon resonance (TSPR) remains relatively constant at ~510 – 520 nm.



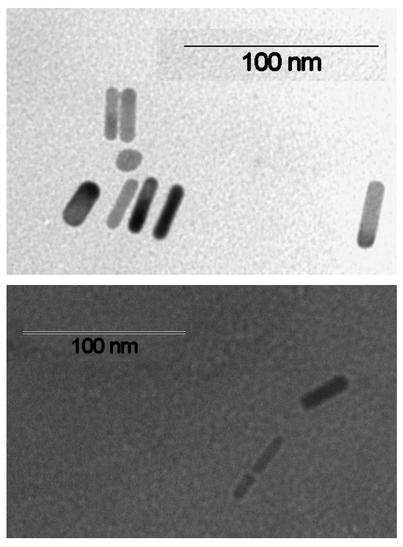
SR-XPS Investigations

SR-XPS analysis carried out at C1s, N1s, Au4f and Ag3d core levels confirmed the NRs chemical composition and allowed to assess the capping agents molecular stability. A very small amount of silver is observed, as expected by the synthetic procedure. Au4f signal has two components: the most intense spin-orbit pair is due to metallic gold atoms at the NR core, the signal at higher BE values is attributed to partially positively charged gold atoms at the NR surface.
This behavior is similar to the one observed for gold nanoparticles stabilized by organic ligands [5].



TEM studies

Transmission electron microscopy plays a pivotal role in investigating nanomaterials' structures and linking properties associated with the nanoscale of materials and to their bulk behavior.
In this case the TEM studies allow to observe AuNRs with size in the range of 20-80 nm.



CONCLUSIONS and PERSPECTIVES

Hydrophilic gold nanorods were synthesized and functionalized by ascorbic acid (AA) and cetyl trimethyl ammonium bromide (CTAB). SR-XPS investigations allowed to examine the chemical structure and the interaction between capping agents and metal surface.
TEM studies showed AuNRs with size in the range of 20-80 nm.
These results show strongly hydrophilic and stable AuNRs as promising systems for drug delivery and photothermal therapy applications.

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References:
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