Gold-coated harmonic nanoparticles for multi-modal targeted imaging and treatment of cancer

R. Taitt, E. Millet, M. Urbain, V. Kilin, Y. Mugnier, L. Bonacina, A. Géloën, R. Le Dantec, Y. Chevolot, V. Monnier

(1) Université de Lyon, Institut des Nanotechnologies de Lyon UMR CNRS 5270, Ecole Centrale de Lyon, 36 Avenue Guy de Collongue, F-69134 Ecully, France.
(2) Université Savoie Mont Blanc, SYMME, F-74000 Annecy, France.
(3) Université de Genève, GAP-Biophotonics, 22 chemin de Pinchat, Carouge, 1211 Geneva 4, Switzerland.
(4) Université de Lyon, CARMEN INSERM U1060, INSA Lyon, F-69621 Villeurbanne, France.

In moving towards more efficient and targeted treatment of cancer, the design of systems capable of simultaneously imaging and providing treatment is now imperative. Nanostructures are proposed as ideal platforms for such multi-modal systems as the nanostructure itself can have enhanced optical or therapeutic capabilities, but additionally, the main property gained at this scale, increased surface area to volume ratio, allow for the incorporation and grafting of different compounds and bio-molecules onto a single particle. This allows for some degree of creativity in conceptualizing what combination of materials will give the greatest advantage. With respect to advances in cancer treatment, gold nanostructures have been demonstrated as photothermal agents in laser-mediated localized hyperthermic treatment of cancer\(^1\), due to its ability to convert incident light energy corresponding to its plasmon resonance band into thermal energy, and by careful manipulation of the nanostructure design, the characteristic plasmon band can be tuned. Additionally, inorganic harmonic nanoparticles have recently emerged as viable tissue imaging probes for multi-photon microscopies due to their inherent non-linear optic activity that allows the second harmonic generation (SHG) of an incident light beam\(^2\). Their attractiveness when compared to traditional fluorescent probes lies in the absence of photo bleaching, the tuneability of the excitation and emission wavelengths and the inherent high resolution of multi-photon microscopy.

The aim of this work is to encapsulate harmonic nanoparticles of lithium niobate (LiNbO\(_3\)) with a gold shell, where both core and shell are activated under near infrared (NIR) light, to allow for the imaging and photothermal treatment of cancer cells. The controlled thickness of this gold shell is a crucial step in this work because it directly influences the plasmon band position in the NIR spectral region. Therefore, we will detail our synthesis protocol for growing a homogenous gold shell onto LiNbO\(_3\) nanoparticles using an ion-reducible layer-by-layer approach to precisely control shell thickness and consequently the plasmon band position. SHG emission of these core-shell nanoparticles will then be investigated.

References
2- D. Staedler, ACS Nano 6, 2542 (2012).

Corresponding author email: rachael.taitt@ec-lyon.fr