Gold Nanoparticles for Plasmonics and Medicine

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Abstract:

Gold-bioconjugates are studied worldwide and promising for new technologies for health. In the long term, biodegradable gold nanoparticles (NPs) are expected to have a large impact on diagnosis through the development of new contrast agents for imaging or new ultrasensitive sensors. Gold-NPs have a high potential as contrast agents for several bioimaging modalities such as computed tomography, photoacoustic imaging, dark field scattering, multiphoton luminescence, high frequency ultrasound, quantitative phase contrast. New therapies and surgeries will develop because these gold-nano are also able to generate Reactive Oxygen Species (ROS) and heat.

Our research activities concentrate on the synthesis and assembly of gold nanoparticles of **high quality** to provide **original materials** for plasmonics since 2008. The irradiation of gold NPs by **short laser pulses** sets off a cascade of complex transient phenomena. Following this irradiation, one observe exaltation and confinement of the incident light at the surface of the NP but also singlet oxygen generation and ROS through the injection of hot electrons (or hot holes) to a nearby molecule. In short, gold nanoparticles are **nanosources of light, heat and hot carriers** and the **morphology of the NP is a key point** for these three characteristics because competitive relaxation processes depend on the size, shape and aspect ratio of NP.

We use colloidal chemistry to synthesize **gold nanoparticles of controlled shape and size**. The figure illustrates some of the gold NPs we propose. Contrary to spherical and rod-shaped NPs that are commercially-available, other shapes such as cubes, triangles .. and plates with tunable sizes are only produced in our lab and in few laboratories worldwide. In literature, triangular-gold nanoplates are already used for ultrasensitive sensing, and the construction of original plasmon-based optical devices. The recent discovery of a third and fourth biological transparency windows centered respectively at 1.8µm and 2.2µm and the recent commercialization of new NIR-lasers make gold-nanoplates attractive for biomedicine in this still unexplored spectral domain. The synthesis of highly uniform shapes relies on trial and error procedure because it is very hard to predict the right recipe and additional purification steps are also often required. **In the future**, we are eager to widen the application range of these NPs to medicine through **new collaborations either with biochemists for appropriate biofunctionalization, biophysicists for imaging and physicians for therapy.** As a first step towards this objective, we are developing recipes to produce $Au@SiO_2$ core-shell NP while waiting for precise specifications.

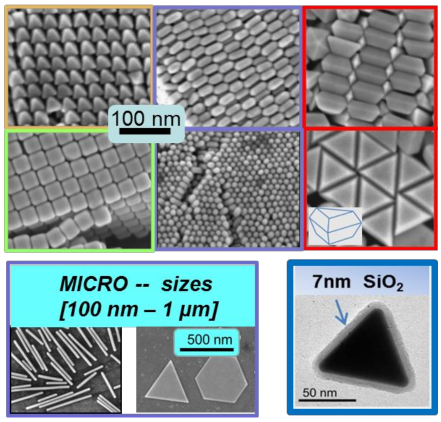

Figure 1: illustration of some of the monodisperse gold particles (nano- and micro-) and gold hybrids (Au@SiO2) that have been synthesized, with tunable sizes and thicknesses.