Unraveling the nature of NIR resonant nanoparticles

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Since the first report on plasmonic nanoparticle-based photothermal tumor therapy, several nanoparticle structures have been developed with one main focus: to tune the plasmon resonance frequency into the near-infrared window of biological tissue. One method proposed to create such nanoparticles relies on the reduction of gold salt by sodium sulfide. The formation of a strong NIR extinction peak was observed, the origin of which has been matter of a longstanding debate. By means of HRTEM and X Ray absorption techniques we have characterized the products of this controversial synthesis. Only metallic gold nanostructures are formed, mainly icosahedrons and very thin triangles. Different reduced sulfur species are adsorbed on the particles, mostly sulfides and polysulfides, similarly to what is found on planar gold surfaces. Therefore this precludes the idea that oxidized sulfur species are the actual reducing agents for Au(III) ions.

To shed light on the type of nanoparticle responsible for the NIR resonance we developed a new sorting method capable of distinguishing different nanostructures by using their strong scattering force to print them at specific locations onto hard substrates. By arresting the synthesis at different times, and using focused lasers whose wavelengths were tuned to the respective resonances, we are able to separate the nanoparticles based on their plasmon resonances. This enables us to acquire single particle Rayleigh scattering spectra and compare those with the morphology of the nanoparticles obtained through scanning electron microscopy. We found that the thin gold nanotriangles are responsible for the observed NIR resonance.

Knowing the size and shape of the NIR resonant particles and the species adsorbed to their surfaces enables us to develop accurate strategies for purification and post functionalization to anchor biomolecules that can improve the efficiency and applicability of cancer treatments.

Figures

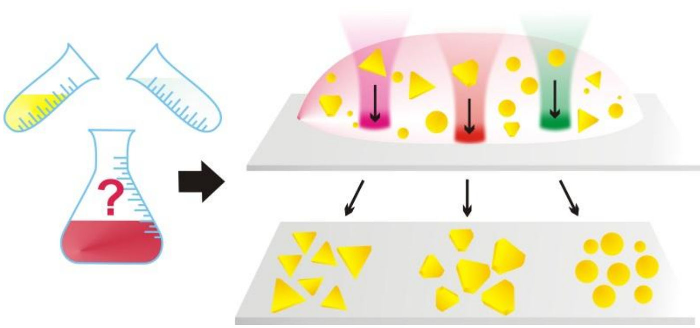

Figure 1: Scheme of the synthesis of gold nanostructures and the optical sorting method by their plasmon resonance.