FAST MOVING FRONTS - 2009

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Luis Liz-Marzan talks with *ScienceWatch.com* and answers a few questions about this month's Fast Moving Front in the field of Chemistry. The author has also sent along images of their work.

Article: Synthesis and optical properties of gold nanodecahedra with size control
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SW: Why do you think your paper is highly cited?

Nanoparticle size and shape control is a hot topic within nanoscience and nanotechnology. Although chemical methods for the synthesis of gold nanoparticles have been reported since 150 years ago, and dozens of papers are still published every month, our report deals with an extremely controlled production of nanoparticles with highly regular geometry (decahedrons or pentagonal bipyramids) in a wide range of sizes.

Additionally, the paper demonstrates how to manipulate the crystalline structure (and, in turn, the shape) of the final nanoparticles, through proper choice of the initial seeds. Finally, the careful demonstration that the optical properties of such well-defined, though anisotropic nanoparticles can be accurately predicted, makes it a round piece of work in this hot area. In my opinion, this serves as an inspiration to other researchers in the field.

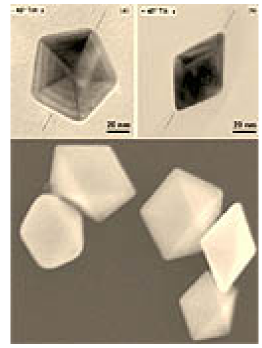
SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

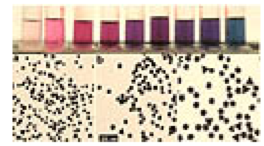
The paper describes a new synthesis protocol, which can be (and has already been) used for nanocrystal size and shape manipulation, by simply tuning the reaction conditions. This general protocol (seeded growth in N,N-dimethylformamide (DMF), one of the usual organic solvents for numerous processes) can thus be used for the fabrication of gold and silver nanoparticles with variable sizes and shapes and, in turn, with tunable optical properties.

SW: Would you summarize the significance of your paper in layman's terms?

Nanotechnology deals with the atom-by-atom manipulation of matter in the nanometer scale. We use chemical processes to do so in such a way that nanoscale pieces of gold (or other metals) can be fabricated with pretty much the same size and a very regular shape (with 10 flat external faces enclosing a decahedron). These pieces of gold (nanoparticles) are dispersed in a solvent, so that they do not cluster together and thus their single-particle properties are preserved. Additionally, by changing the average size of the particles, the color (optical properties) of such solutions can be varied at will. These optical properties can be exploited in a number of applications, for example in ultrasensitive detection of diseases or contaminants.

Figures:





\+ View larger image & details

SW: How did you become involved in this research and were any particular problems encountered along the way?

My education was in the field of Physical Chemistry, and in particular in Colloid Chemistry. My Ph.D. thesis (1989-1992) was already related to the controlled fabrication of nanomaterials using colloidal solutions. Soon, I realized that these systems had plenty of possibilities, not only from the point of view of understanding size-dependent properties, but also with respect to a wide range of applications where such properties could be exploited.

Starting my own research group, which could compete at an international level, was a hard job because of the low level of funding on R&D in Spain, when I returned from a postdoctoral stay abroad. The group is currently well established, both regarding funding and external recognition by our peers.

SW: Where do you see your research leading in the future?

The production of monodispersed nanoparticles with well-defined morphologies is still a challenge in many ways, as well as the controlled assembly of such nanoparticles, and we shall continue working in these directions. However, the research of my group is gradually leading toward more practical applications of the systems and properties we have been studying for some 12 years now. The design of both localized surface plasmon resonance (LSPR) biosensors and surface-enhanced Raman scattering (SERS) substrates, for applications in diagnostics, are currently active areas of research and we foresee more intensive involvement in these directions.

SW: Do you foresee any social or political implications for your research?

As indicated above, if we succeed in developing novel diagnostic tools which are more sensitive or simpler to implement in everyday life, we shall definitely make a huge social impact. Early detection of cancer or other infectious diseases can significantly contribute to improve the quality of life for all citizens. Equally important might be the ultrasensitive detection of contaminants in the environment or chemical weapons.

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Figure 1:

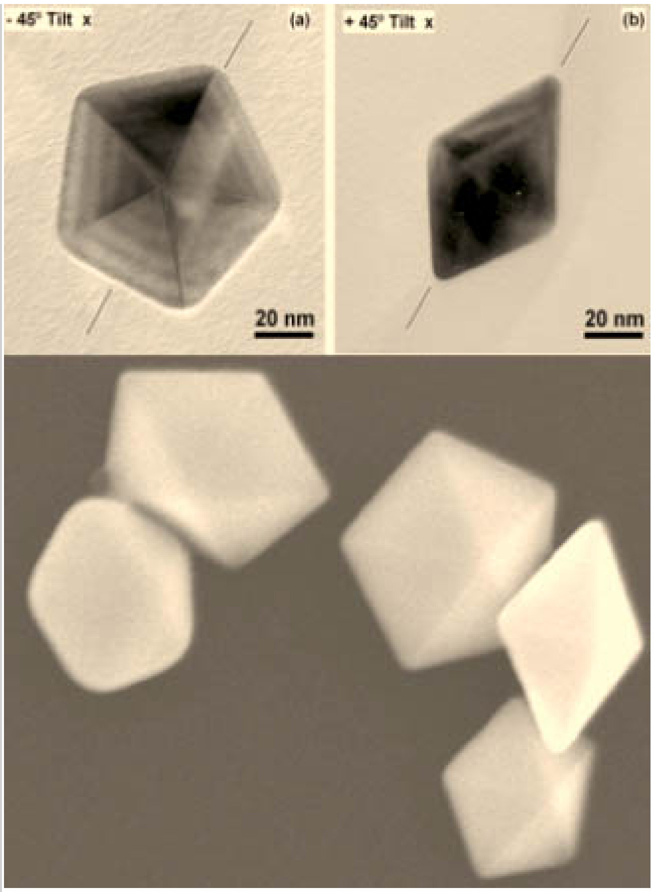

Figure 1:
Transmission (TEM, left) and scanning (SEM, right) electron microscopy images illustrating the morphology of gold nanodecahedra (pentagonal bipyramids).

Figure 2:

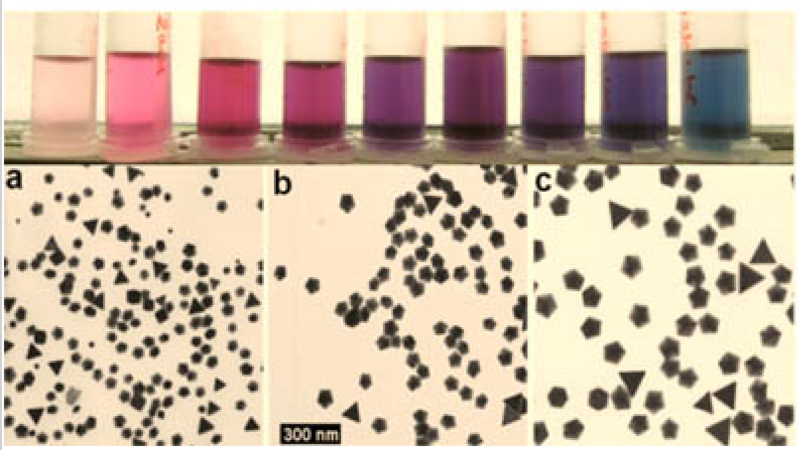

Figure 2:
Top: Photograph of dispersions of gold nanodecahedra with different particle sizes (increasing from left to right). Bottom: TEM images of decahedral Au nanoparticles prepared by seeded growth in DMF, using different amounts of Au seed solution. The scale is the same in all TEM images.

Keywords: nanoparticle size and shape control, chemical methods for the synthesis of gold nanoparticles, decahedrons or pentagonal bipyramids, anisotropic nanoparticles, N,N-dimethylformamide, tunable optical properties, production of monodispersed nanoparticles, well-defined morphologies, localized surface plasmon resonance biosensors, surface-enhanced Raman scattering substrates.

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