Synthesis of gold, silver and gold-silver nanostructures from organometallic precursors. plasmonic, bactericidal and catalytic properties.

Miguel Monge, Julián Crespo, Jorge García-Barrasa, José M. López-de-Luzuriaga, M. Elena Olmos

Universidad de La Rioja, Departamento de Química. Grupo de Síntesis Química de La Rioja, UA-CSIC. Complejo Científico Tecnológico. Madre de Dios 51. E-26004 Logroño (Spain)
miguel.monge@unirioja.es

The synthesis and study of new noble metal nanostructures is one of the hottest research topics in the last years due to broad range of properties that can be reached at the nanometer size scale. This include plasmonic, bactericidal or catalytic properties and they can be tuned by varying the physical size, shape and composition of the nanostructures.[1,2]

By the use of our experience in gold and silver organometallic chemistry we have developed a new approach for the synthesis of gold, silver and gold-silver nanostructures that is the decomposition under mild conditions of perhalophenyl organometallic precursors of these metals, in the presence of several types of organic stabilizers, leading to colored stable colloidal solutions.

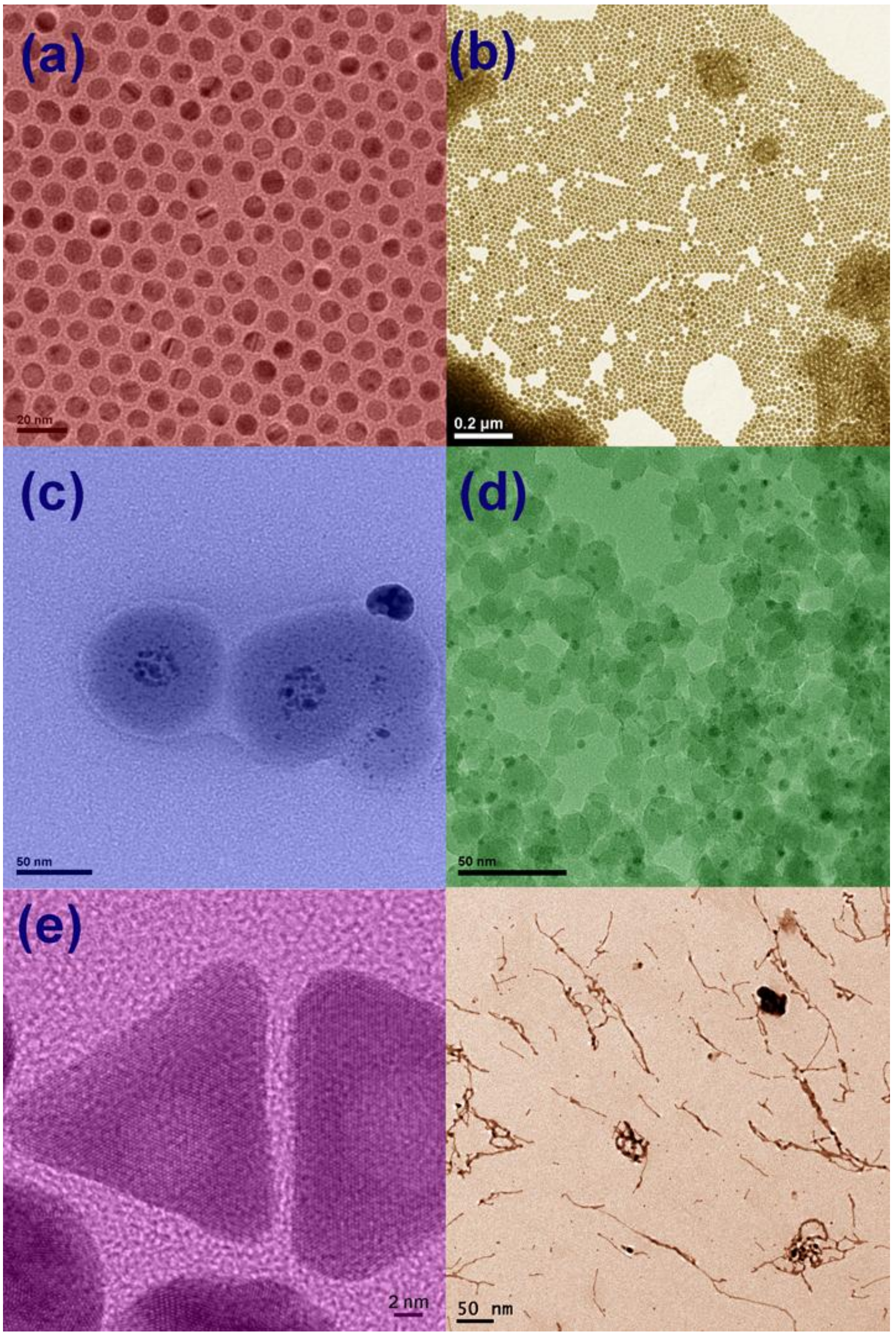
Monometallic silver and gold nanoparticles have been synthesized by the decomposition of the organometallic complex $[Ag(C_6F_5)]$ or $[Au(C_6F_5)(tht)]$ (tht = tetrahydrothiophene), respectively. The presence of long alkyl chain ligands such as amines, thiols or carboxylic acids or the presence of polymers like poly(vinyl)pyrrolidone (PVP), cellulose acetate (CA) or, even, SiO_2-PVP nanocomposites has allowed us the stabilization of small size nanoparticles. We have studied both the surface plasmon resonance displayed by colloidal solutions of these nanoparticles, as well as the bactericidal or catalytic properties of some of them.[3-5]

The synthesis of gold-silver nanostructures has been carried out using the heterometallic complex $[Au_2Ag_2(C_6F_5)_4(Et_2O)_2]_n$ that is the unique source of both metals in the decomposition reaction. We have obtained alloyed gold-silver nanoparticles of different sizes and shapes depending on the reaction conditions and stabilizing agents. The use of nuclear magnetic resonance in solution and the characterization of the nanoparticles through their surface plasmon resonance bands allowed us to study the mechanism of formation of these bimetallic nanoparticles.

References

[1] C. N. R. Rao, A. Müller, A. K. Cheetham (Eds). The Chemistry of Nanomaterials. Synthesis, Properties and Applications Vols. 1 and 2. (Wiley-VCH Verlag, Weinheim, 2004).
[2] C. N. R. Rao, A. Müller, A. K. Cheetham (Eds). Nanomaterials Chemistry. Recent Developments and New Directions. (Wiley-VCH Verlag, Weinheim, 2007).
[3] E. J Fernández, J. García-Barrasa, A. Laguna, J. M López-de-Luzuriaga, M. Monge, C. Torres Nanotechnology **19** (2008) 185602 (6pp).
[4] J. García-Barrasa, J. M López-de-Luzuriaga, M. Monge, K. Soulantika, G. Viau J. Nanopart. Res. **13** (2011) 791-801.
[5] J. García-Barrasa, J. M López-de-Luzuriaga, M. Monge Cent. Eur. J. Chem. **9** (2011) 7-19.

Figure 1



Some examples of metal nanostructures synthesized from organometallic precursors: (a) PVP stabilized Ag nanoparticles; (b) hexadecylamine stabilized Au-Ag nanoparticles; (c) SiO_2-PVP stabilized Ag nanoparticles; (d) Ag nanoparticles at the surface of SiO_2 nanoparticles; (e) hexadecylamine stabilized Au-Ag hollow nanoprisms and (f) oleic acid stabilized Au-Ag ultrathin nanowires.