Fabrication of ultra-monodisperse colloidal gold nanorods by means of femtosecond laser irradiation

P. Díaz-Núñez[1], G. González-Rubio[2,3], A. Rivera[1], A. Prada[1], G. Tardajos[2], J. González-Izquierdo[4], L. Bañares[2,4], P. Llombart[2], L. G. Macdowell[2], M. Alcolea Palafox[2], J. M. Perlado[1], L. M. Liz-Marzán[3,5,6] , O. Peña-Rodríguez[1], and A. Guerrero-Martínez[2]

[1]Instituto de Fusión Nuclear "Guillermo Velarde", Universidad Politécnica de Madrid, Spain
[2]Departamento de Química Física I, Universidad Complutense de Madrid, Spain
[3]Bionanoplasmonics Laboratory, CIC biomaGUNE, San Sebastián, Spain
[4]Centro de Láseres Ultrarápidos, Universidad Complutense de Madrid, Spain
[5]Ciber de Bioingeniería, Biomateriales y Nanomedicina, San Sebastián, Spain
[6]Ikerbasque, Basque Foundation for Science, 48013 Bilbao, Spain

---

The optical response of gold nanorods strongly depends on their aspect ratio, defined as the quotient of their length and diameter, which defines the position of its longitudinal localized surface plasmon resonance (LSPR). Besides, in the colloidal synthesis of gold nanorods exists an inherent level of polidispersity in size and shape that affects the aspect ratio of the nanorod dispersion. Then, The polidispersity in terms of aspect ratio greatly affects their optical behaviour by broadening their absorption band and lowering its intensity, which could compromise its feasibility for technological applications that require optimal coupling between the plasmon resonance and the excitation wavelength.

Here, a method based on femtosecond laser irradiation is presented to reduce the aspect ratio polidispersity in a way that the irradiated colloids present an exceptional ultranarrow LSPR, near the theoretical limit. The irradiation regime is characterized by a gentle multishot reduction of the aspect ratio, barely affecting the nanoparticle shape and size [1].

This kind of monodisperse nanoparticles has the potential use for optical data storing applications [2] and for information encryption [3,4].

References

[1] G. González-Rubio, P. Díaz-Núñez, et al. "Femtosecond laser reshaping yields gold nanorods with ultranarrow surface plasmon resonances." Science 358(6363):640–644, 2017.

[2] P. Zijlstra, J. W. M. Chon, and M. Gu, "Five-dimensional optical recording mediated by surface plasmons in gold nanorods." Nature, vol. 459, no. 7245, pp. 410–413, 2009.

[3] Y. Li, X. Zhou, et al. (2017). "Patterned photonic crystals for hiding information." Journal of Materials Chemistry C, 5(19), 4621–4628.

[4] X. Wang, J. Feng, H. Yu, et al., "Anisotropically Shaped Magnetic/Plasmonic Nanocomposites for Information Encryption and Magnetic-Field-Direction Sensing," Research, vol. 2018, Article ID 7527825, 13 pages, 2018.