Gold and silver nanoparticles: synthesis, properties, and applications in life sciences

Sara Cerra[1,*], Tommaso A. Salamone[1], Farid Hajareh Haghighi[1], Ilaria Fratoddi[1]
[1]*Chemistry Department, University La Sapienza, Rome, Italy*

**sara.cerra@uniroma1.it*

Abstract
Scientific research in the nanomaterials field is constantly evolving, paving the way towards the development of new materials and the discovery of new applications [1]. Materials in the nanoscale range (1-100 nm) exhibit fascinating properties which cannot be achieved by their bulk counterparts, *i.e.*, light absorption and scattering, high surface-to-volume ratio, surface reactivity, electrical and magnetic properties, melting temperature and catalytic activity [2]. Among these, functionalized noble metal nanoparticles (MNPs, M = Au, Ag) depict a suitable platform for the development of efficient multi-functional responsive systems with potential applications in life sciences [3,4]. Plasmonic nanoparticles, *i.e.*, gold and silver nanoparticles (AuNPs, AgNPs) bear several advantages such as small size, high reproducibility, ease of surface functionalization and colloidal stability. Particularly attracting are their optical properties based on the collective oscillation of free conduction electrons that lead to the occurrence of the localized surface plasmon resonance (LSPR) phenomenon [5,6]. In this seminar, I will show some of the applications of metal nanoparticles in the field of drug delivery, sensing and optoelectronics. Indeed, due to the strong spectral dependence of LSPR on material composition, size, shape, and environment, these resonances can be used in a wide range of chemical and physical processes. The synthetic versatility allows to obtain functionalized metal surfaces with neutral or charged, hydrophilic or hydrophobic, organic, or organometallic mono- and bi-functional thiol molecules. Moreover, colloidal MNPs can be manipulated to induce self-assembly into complex structures, 2D or 3D networks that show collective properties. Extensive morphostructural studies are possible through conventional techniques (UV-Visible, FT-IR, NMR, DLS and ζ-potential), supported by modern techniques such as: AFM, FESEM-EDX, SAXS and SR-XPS for the physicochemical characterization of samples.

[1] S. Gottardo, A. Mech, J. Drbohlavová, A. Małyska, S. Bøwadt, J.R. Sintes and H Rauscher, *NanoImpact*, 2021, **21**, 100297, DOI. 10.1016/j.impact.2021.100297.
[2] T.A. Saleh, *Environ. Technol. Innov.*, 2020, **20**, 101067, DOI. 10.1016/j.eti.2020.101067.
[3] X.Y. Wong, A. Sena-Torralba, R. Alvarez-Diduk, K. Muthoosamy and A. Merkoçi, *ACS Nano*, 2020, **14**, 2585-2627, DOI. 10.1021/acsnano.9b08133.
[4] I. Fratoddi, S. Cerra, T.A. Salamone, R. Fioravanti, F. Sciubba, E. Zampetti, A. Macagnano, A. Generosi, B. Paci, F.A. Scaramuzzo, R. Matassa, G. Familiari, C. Battocchio, M. Marsotto, P. Papa and A. Bearzotti, *ACS Appl. Nano Mater.*, 2021, **4**, 2930-2940, DOI. 10.1021/acsanm.1c00074.
[5] M.S. Kang, S.Y. Lee, K.S. Kim and D.-W. Han, *Pharmaceutics*, 2020, **12**, 701, DOI. 10.3390/pharmaceutics12080701.
[6] I. Fratoddi, C. Battocchio, G. Iucci, D. Catone, A. Cartoni, A. Paladini, P. O'Keeffe, S. Nappini, S. Cerra and I. Venditti, *Appl. Sci.*, 2021, **11**, 2472. DOI. 10.3390/app11062472.