Water-Dispersible Silver Nanoclusters: Synthesis and Characterization

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Abstract

We report here a route to synthesize small water-dispersible silver nanoclusters (also known as Atomic Quantum Clusters - AQCs) in the absence of any type of surfactant or stabilizing agent, through an easy and versatile potentiostatic method based on a bottom-up electrochemical synthesis of nanoparticles[1]. The small size of the nanoclusters, comparable to Fermi wavelength of the electron (~0.52 nm for silver), places AQCs in the scale range where quantum confinement effects govern the material properties. Because of this, AQCs behave like molecules, displaying delocalized molecular orbitals, similar to those observed in HOMO and LUMO orbitals of single molecules, and exhibiting new and interesting physical and chemical properties derived from their small size, such as photoluminescence[2,3] or magnetism[4,5]. The stability, biocompatibility and fluorescence of silver AQCs allow to apply them in very different fields, such as catalysis, biosensing and nanomedicine. In fact, results about the biological activity of silver sub-nanometric quantum clusters will be shown here. Different techniques were employed in order to characterize the structure of the synthesized silver nanoclusters, such as spectroscopy (UV-Vis, Fluorescence), mass spectrometry (ESI – Electrospray Ionization), atomic force microscopy (AFM) and electrochemical techniques as for example cyclic voltammetry (CV).

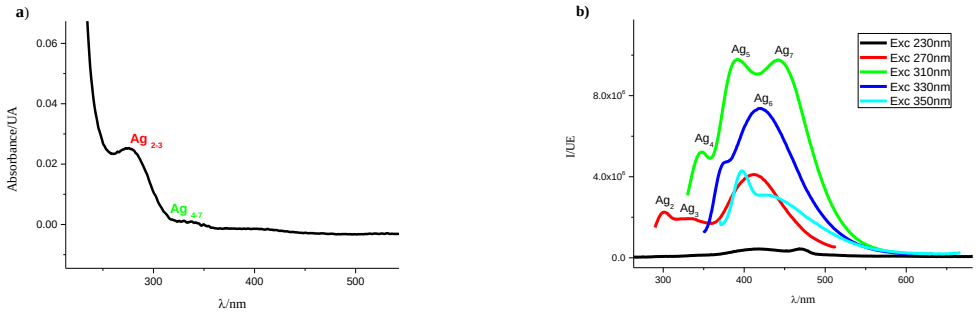

Fig 1. Characterization by Absorption and Fluorescence spectrophotometer of a sample of silver AQCs. **a)** UV-Vis absorption spectrum, **b)** Emission spectra measured at exciting wavelengths between 230 and 350 nm.

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[1] Manfred, T. Reetz; Wolfgang Helbig., *J. Am. Chem. Soc.*, **116** ***(16)*** (1994) 7401–7402.
[2] Schaeffer, N.; Tan, B.; Dickinson, C.; Rosseinsky, M. J.; Laromaine, A.; McComb, D. W.; Stevens, M. M.; Wang, Y.; Petit, L.; Barentin, C.; Spiller, D.G.; Cooper, A. I.; Levy, R., *Chem. Commun*., (2008) 3986.
[3] Haekkinen, H., *Chem. Soc. Rev,* **37** (2008) 1847.
[4] Moro, R.; Yin, S.; Xu, X.; de Heer, W. A., Phys Rev Lett., **93** (2004) 086803.
[5] Ledo-Suarez, A.; Rivas, J.; Rodriguez-Abreu, C.; Rodriguez, M. J.; Pastor, E.; Hernandez-Creus, A.; Oseroff, S.B.; Lopez Quintela, M. A., *Angew. Chem. Int. Ed*., **46** (2007) 8823.