INFLUENCE OF REDUCTION TIME ON THE BIOSYNTHESIS OF GOLD NANOPARTICLES

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Biological methods using bacteria, fungi (1) or other biological materials (2,3) for the synthesis of metal and semiconductor nanoparticles represent a relatively unexplored and underexploited alternative, but had led to little advances with respect to size and shape control. Understanding biochemical processes that lead to the formation of nanoscale inorganic materials is therefore potentially appealing as environmentally friendly alternatives to chemical methods for nanoparticle synthesis.

Our previous studies on the influence of pH on the shape and size of crystals showed that at pH 7 the yield of the reduction process was greater, with the formation of globular particles with a great uniformity of sizes (around 30 nm).

Here, we study the influence of time in the biological synthesis of gold nanoparticles by a single-step, room-temperature reduction of aqueous chloroaurate ions by brown algae (F*ucus vesiculosus).*

Seaweed was collected from La Toja Island (Pontevedra) in the spring of 2003. The biomass was carefully washed with deionized water and oven dried. The dried biomass was ground and sieved to 0.5 mm in order to have particles of uniform size and more area exposed to gold. Different algae and gold concentrations in solution were used to check that the influence of reaction time was similar after modifying the process variables.

The reaction was followed by potentiometry and UV-vis-NIR spectroscopy. Besides, samples taken out at different times (15 min, 2 h, 6 h and 24 h) were analysed using a high resolution JEOL JEM-3000 F Field Emission Electron Microscope.

Data obtained showed a fast reduction of gold (15 min for high algae concentrations and 1.5 h for low concentrations) (Figure 1). The gold atoms form clusters that evolve to the formation of small nuclei of approximately 5 nm from which the cristal growth started until each particle reached a size between 30 and 40 nm (Figure 2). There was a relationship between size and optical properties and the end of the growth process seems to be related to a large decrease of solution potential (Figure 3).

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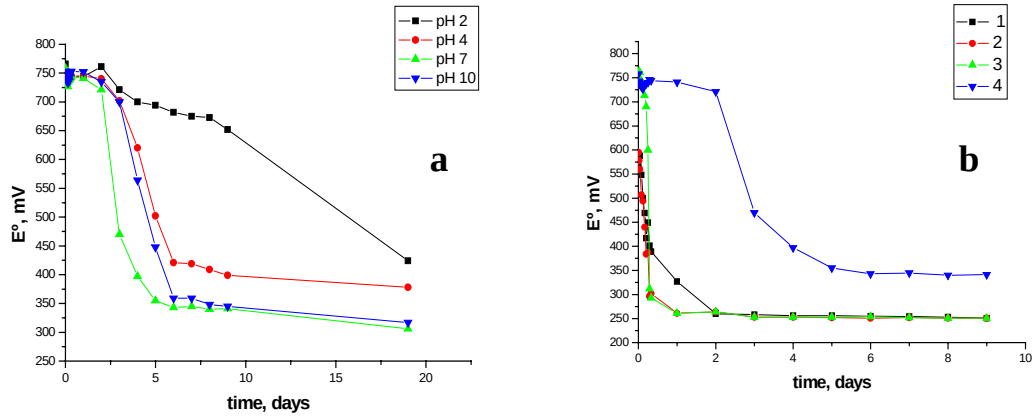

Fig.1. Evolution of the reduction potential as a function of: a) pH and b) gold concentration in solution and biomass dosage at pH 7: 1) 10 ppm Au^{3+}, 0.5 g/l biomass, 1) 10 ppm Au^{3+}, 0.5 g/l biomass, 2) 10 ppm Au^{3+}, 1 g/l biomass, 3)100 ppm Au^{3+}, 2 g/l biomass, 4)100 ppm Au^{3+}, 0.5 g/l biomass.

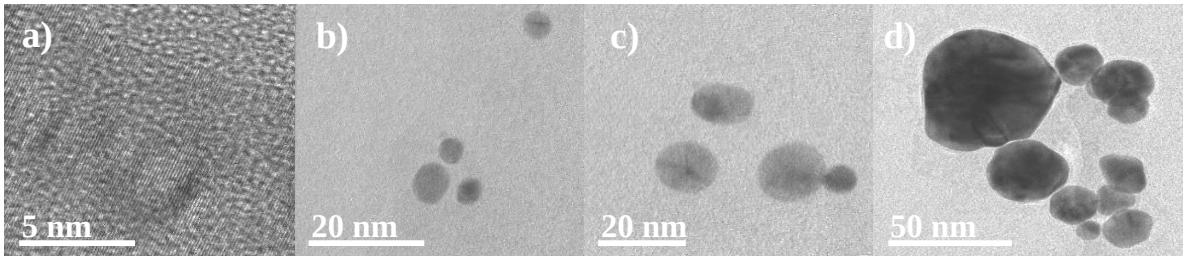

Fig.2. TEM images mapping the morphology changes: a) 15 min, b) 2 h, c) 6 h, d) 24 h

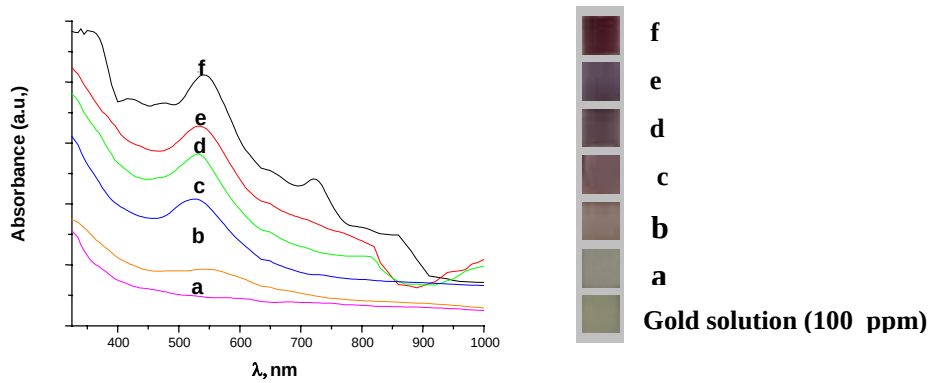

Fig.3. Time-dependent UV-vis spectra showing the degree of reduction: a) 15 min, b) 2 h, c) 6 h, d) 24 h, e) 48 h, f) 72 h.