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Synthesis of Ultra-Homogeneous Gold Nanoparticles

Eduardo Méndez, Santiago Botasini
Laboratorio de Biomateriales, Instituto de Química Biológica, Facultad de Ciencias, UdelaR.
Iguá 4225, Montevideo, Uruguay
emendez@fcien.edu.uy; sbotasini@fcien.edu.uy

Extended Abstract

Gold nanoparticles are widely used in many fields, especially in analytical chemistry, medicine and engineering. In the literature, many methods provide easy and reproducible ways to synthesize these nanoparticles with different sizes and forms [1]. However, narrowing the size distribution is still a challenge, particularly in aqueous methods of synthesis. Ideally, it is desirable to have uniform nanoparticles; however, the nucleation and growth mechanism tend to produce a broad size distribution. For large particles, some authors propose controlling size by a kinetical seed-growth approach, but the challenge remains in the synthesis of the initial uniform seeds [2,3]. The present work focuses on the synthesis of ultra- uniform gold nanoparticles by a combined strategy of a modified Turkevich method and filtration step. The results showed that the synthesis follows a complex mechanism where the ratio between the gold (III) and sodium citrate, and the pH play a major role in the final size distribution. The synthesized ultra-narrow size distribution was achieved by adjusting the pH of the solvent between 7.5 and 8. The results were confirmed by High-Resolution Transmission Electron microscopy (HRTEM) images, spectrophotometry (UV-Vis), and Dynamic Light Scattering (DLS). The synthetized nanoparticles have an average diameter of 15 nm and 26 nm by HRTEM and DLS, respectively. The average polydispersity index was <0.05 giving a strong evidence of the monodisperse nature of the synthesized nanoparticles. In addition, we study the particle stability with different capping agents and conditions such as temperature, salt concentration, and storage time. The Nanoparticles were stable at temperatures lower than 40ºC and only a small change in size was observed at higher temperatures. Molecules with thiol groups such as 11-mercaptoundecanoic acid increased the nanoparticle stability with the salt concentration. However, it was less effective in preserving the nanoparticle size and polydispersity with the storage time. With the proper capping agent (polyethylene glycol and citrate), the nanoparticles were stored without any change in the homogeneous size distribution for at least one month.

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