Synthesis of Size-Controlled Gold Nanoparticles by Sonoelectrochemical Methods

Yu-Chuan Liu*, and Li-Huei Lin

Department of Chemical Engineering, Vanung University, 1, Van Nung Road, Shuei-Wei Li, Chung-Li City, Tao-Yuan, Taiwan, R.O.C.

In recent years, nano-structured materials have been the focus of scientific research[1,2] due to their unusual properties of optical,[3] chemical,[4] photoelectrochemical,[5] and electronic[6] properties. The number of potential applications of these nanoparticles, like proteins detection[7] and catalysts,[8] is rapidly growing because of their unique electronic structure and extremely large surface areas. The developed methods to nanoparticles fabrication include chemical reduction,[9] sonochemical reduction,[10] laser ablation,[11] annealing form high-temperature solutions, metal evaporation, and Ar^+ ion sputtering,[6] etc. As we know, it is useful to develop effective methods for the size- and shape-controlled synthesis of metal nanoparticles due to these properties significantly affecting their corresponding characterization. Generally, electrochemistry has not been employed for preparing large quantity of metal nanoparticles, but some advantages of electrochemical methods over chemical ones are the high purity of the particles and the particle size control by adjusting applied potentials or current densities. In this work, we use electrochemical ORC roughening procedure to obtain gold-containing complexes in a 0.1 N HCl aqueous solution from a gold substrate. Then size-controlled gold nanoparticles are immediately synthesized in the same solution without addition of any stabilizer by a sonoelectrochemical reduction method with different overpotentials.

First, the gold foil electrode was cycled in a deoxygenated aqueous solution of 100 mL containing 0.1 N HCl from -0.28 to +1.22 V vs Ag/AgCl at 500 mV/s with 100 scans. The durations at the cathodic and anodic vertexes are 10 and 5 s, respectively. Immediately, the gold working electrode was replaced by a platinum substrate, and different cathodic overpotentials were applied under sonification and slight stirring to synthesize Au nanoparticles.

Figure 1 demonstrates the absorption maximum bands of gold nanoparticles synthesized by sonoelectrochemical reduction at different cathodic overpotentials. The absorption maximum band at 516 nm with a cathodic overpotential of 0.2 V performs red shifts to 522 and 529 nm with more cathodic overpotentials of 0.4 and 0.6 V, respectively. Clearly, more cathodic overpotential takes an advantage of short reaction time but makes the sacrifice of larger particle sizes obtained.

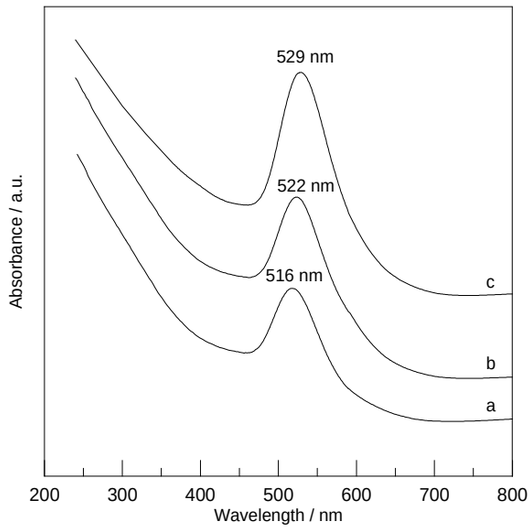

Figure 1. UV-vis spectra of gold nanoparticles synthesized by sonoelectrochemical reduction at different cathodic overpotentials from the OCP of 0.82 V vs Ag/AgCl in the solution containing Au complexes: (a) 0.2 V; (b) 0.4 V; (c) 0.6 V.

Acknowledgments

The authors thank the National Science Council of the Republic of China (NSC-92-2214-E-238-001) and Vanung University for their financial support.

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