Growth-controlled synthesis of polymer-coated colloidal-gold nanoparticles using electrospray-based chemical reduction

ABSTRACT

In this study, the controlled nucleation and growth of gold nanoparticles (GNPs) were investigated using a self-repelled mist in a liquid chemical reaction environment. An electrospray-based chemical reduction method was conducted in the aqueous region and at room temperature to synthesize the polymeric-stabilized gold nanoparticles. The electrospray technique was used to atomize a hydrogen tetrachloraurate (III) ($HAuCl_4$) precursor solution into electrostatically charged droplets. The atomized droplets were dispersed in an aqueous reaction bath containing L-ascorbic acid as a reducing agent and polyvinylpyrrolidone (PVP) as a stabilizer. The effect of the electrospray parameters, specifically the flow rate and electrospray droplet size, as well as the reaction conditions such as the concentration of reactants, pH, and stabilizer (PVP), were investigated. The mean diameter of the GNPs increased from around 4 to 9 nm with an increase in the electrospray flow rate, droplet size, and current passing through the electrospray jet. Spherical and monodispersed GNPs were synthesized at a relatively high flow rate of 2 mL/h and a moderate concentration of 2 mM of precursor solution. The smallest-sized GNP with a high monodispersity was obtained in the reaction bath at a high pH of 10.5 and in the presence of PVP. It is expected that continuous and mass production of the engineered GNPs and other noble metal nanoparticles could be established for scaling up nanoparticle production via the proposed electrospray-based chemical reduction method.

Keyword: Electrospray; Gold nanoparticles; Chemical reduction method; L-ascorbic acid; PVP; Aqueous medium