Kinetic studies on water-soluble gold nanoparticles coordinated to poly(vinylpyrrolidone): isotropic to anisotropic transformation and morphology

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Abstract

The growth kinetics, isotropic-to-anisotropic transformation, structural properties and surface morphology of polyvinylpyrrolidone (PVP)-coordinated gold nanoparticles are reported in this work. The reduction of gold ions, kinetics, and growth mechanism of gold nanoparticles, and the coordination between PVP and gold are explored for the first time in this single report. The layer-by-layer growth mechanism (adsorption of gold ions to the nuclei and their subsequent reduction) was observed in the growth of isotropic nanoparticles during the initial stage of the reaction, whereas the Ostwald ripening mechanism (growth of larger particles at the expense of smaller particles) was observed in the growth of the anisotropic nanoparticles in the later stage of the reaction. The surface plasmon resonance band for the anisotropic nanoparticles (average size for a typical sample was ca. 9 nm) was blue-shifted (20 nm) toward that of the isotropic nanoparticles (whose average size is much smaller than that of the anisotropic nanoparticles). The increased effective electron density on the surface of anisotropic particles was the cause of this blue shift. The resultant gold colloids were very stable because the PVP molecules were coordinated through both the C–N and C=O groups, instead of the C=O group alone. The positions of the surface plasmon band and morphology of the gold products were strongly dependent on the amount of PVP.