Controllable synthesis of gold nanoparticles with ultrasmall sizes and high monodispersity via continuous supplement of precursor

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Supporting Information

Details of estimating gold concentration in solution by XANES edge-jump

According to the fundamental principle of x-ray absorption, after a beam of x-ray (the initial intensity is I_0) passes through a cell of solution with thickness d along the beam direction, the intensity of outcome x-ray is reduced to $I_1=I_0 \exp(-\mu_E d)$. Here μ_E is the linear x-ray absorption coefficient of the solution at x-ray energy E. The edge jump (J) is defined as the difference between μd just above and below the absorption edge E_0, i.e.,

$$J = (\mu_{E0+\delta E} - \mu_{E0-\delta E}) \cdot d \quad (1)$$

For a sample containing many different elements, the absorption coefficient is given by

$$\mu = \rho \sum_i \frac{n_i}{N} \sigma_i \quad (2)$$

Here ρ is mass density of the material as a whole, n_i/N is the mole fraction of element i, and σ_i is the absorption cross section of element i. Substituting Eq. (2) into (1), we have

$$J = [\frac{\rho}{N} \sum_i n_i \sigma_{i,E0+\delta E} - \frac{\rho}{N} \sum_i n_i \sigma_{i,E0-\delta E}] \cdot d \quad (3)$$

Here, $\sigma_{i,E0+\delta E}$ and $\sigma_{i,E0-\delta E}$ are the absorption cross section for element i just above and below the absorption edge E_0 of element j (here it is Au). In the energy range from $E_0-\delta E$ to $E_0+\delta E$, the changes of absorption cross section for other elements are very small and could be neglected, hence Eq. (3) could be simplified to

$$J = \rho \frac{n_j}{N} [\sigma_{j,E0+\delta E} - \sigma_{j,E0-\delta E}] \cdot d \quad (4)$$

The above Eq. (4) shows that the edge-jump is proportional to the total content of element j dissolved in the solution. Based on it, we estimated the temporal evaluation of Au content in the solution, which is plotted as Figure 4(b) in the manuscript.

Synthesizing gold nanoparticles in benzene:

The precursor $AuClPPh_3$ (0.375 mmol) and the surfactant dodecanethiol (48 μl) were mixed in the solvent of benzene (21 ml). Then reducing agent tert-butylamine-borane (3.75 mmol) was injected to the solution. The reactions were carried out at room temperature under vigorous stirring (600-800 rpm).

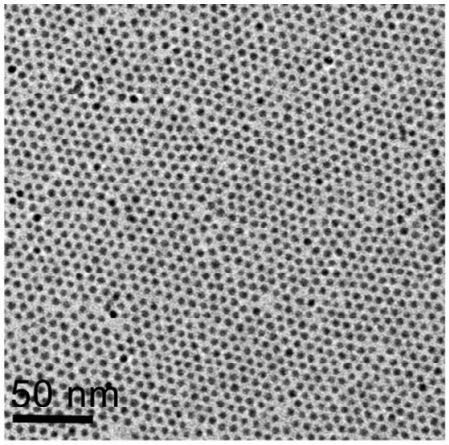

Figure S1. The TME image of gold nanocrystals prepared in the solvent of benzene. The mean diameter of these nanoparticles is 3.0 nm.

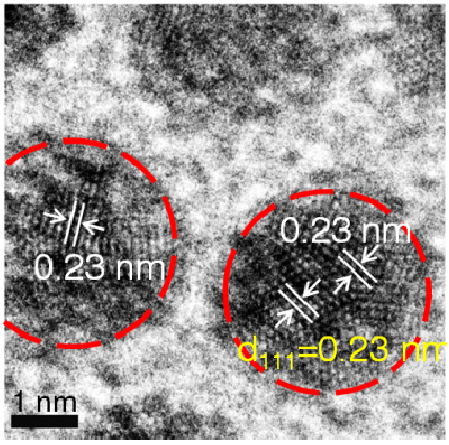

Figure S2. The high energy-resolution TEM image of 3.3 nm gold nanoparticles.