

Supporting information

Kinetically controlled synthesis of ultra-small silica nanoparticles and ultra-thin coating

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Theoretical sizes of silica growth

The total volume of TEOS added for the synthesis of silica seeds and sub-sequential seeded growth is 30 μL . Assuming that all the Si in the TEOS is converted to silica NPs, we got the mass equivalent as follow:

$$\frac{\rho_{TEOS}V_{TEOS}}{M_{TEOS}} \cdot M_{SiO_2} = N \cdot \frac{4}{3}\pi\left(\frac{D_x}{2}\right)^3 \cdot \rho_{SiO_2}$$

where M is the molecular weight, ρ is the mass density, V of the volume of TEOS added, N is the number of silica NPs in the solution, and D_x is the size of silica NPs. We use the final size of silica NPs (17.8 nm) to calibrate the whole system since we assume that all the precursors are reacted in the end. We can then predict the growth pattern as

$$D_x = 17.8 \times \sqrt[3]{\frac{V_x}{30}}$$

which is the formula for the red dash line in Fig. 2e. The deviation at the beginning is mainly because there is still some partially reacted silica species in the solution at that time point.

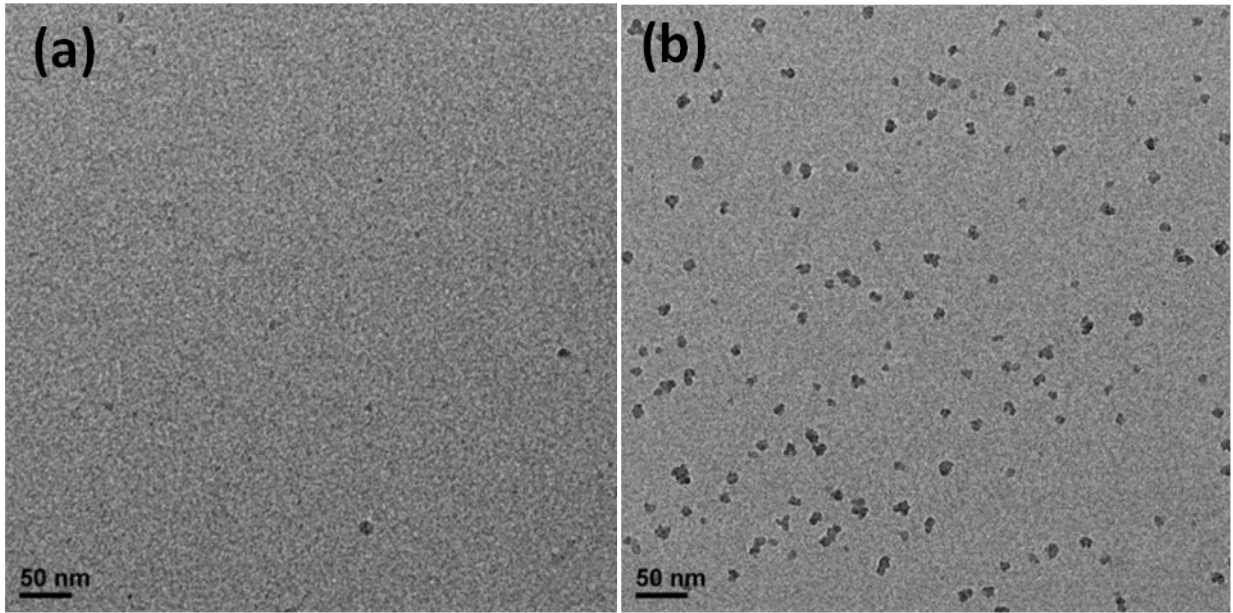


Fig. S1 Synthesis of poly(silicic acid) with low concentration of TEOS (2 $\mu\text{L}/\text{mL}$). TEM images of (a) dried silicate solution (b) after the silicate solution was charged into ethanol.

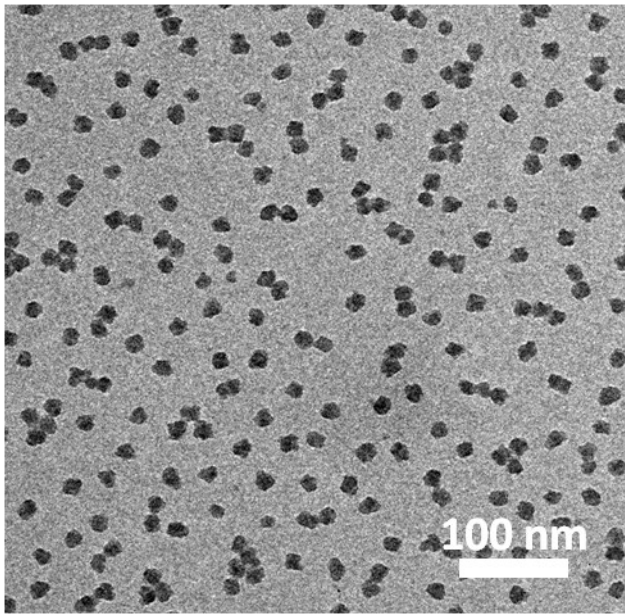


Fig. S2 TEM image of Silica NPs stored for two months at ambient condition without any strong aggregation.

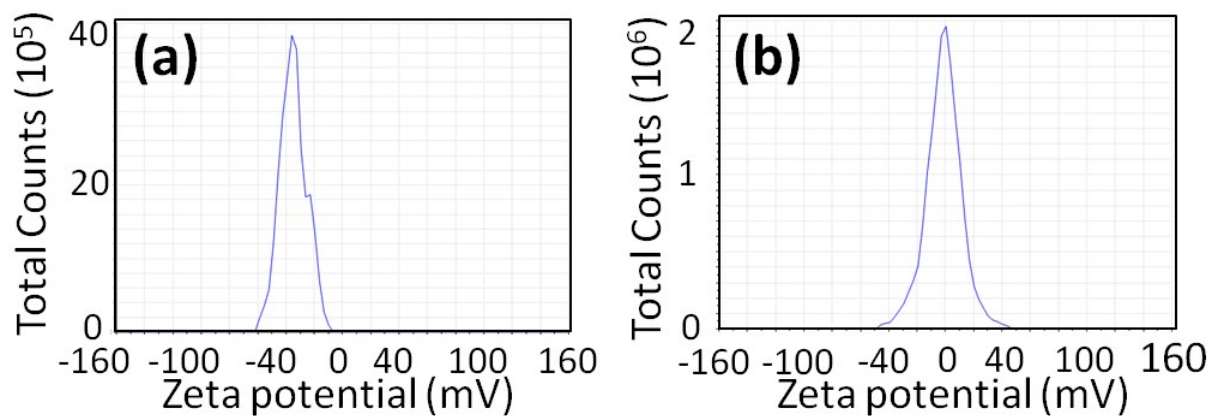


Fig. S3 Zetapotentials of (a) Stöber silica and (b) the silica synthesized with pure water only.

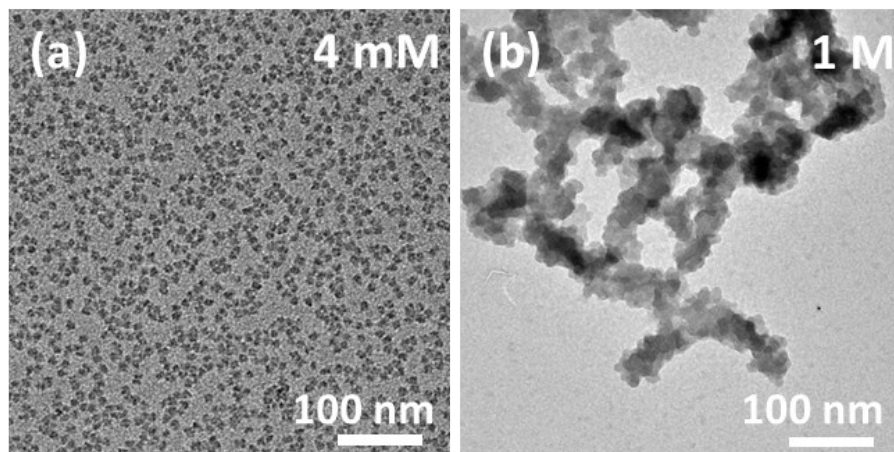


Fig. S4 TEM images of silica NPs with presence of salt (NaCl) with concentration of (a) 4 mM and (b) 1 M.

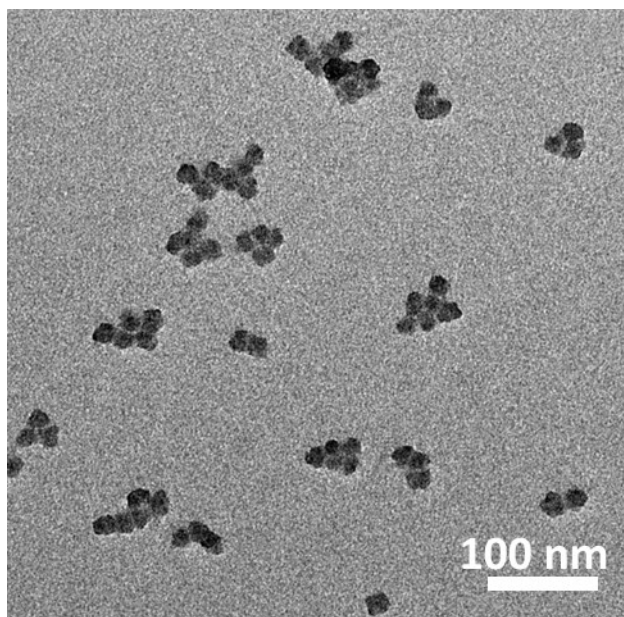


Fig. S5 TEM image of silica NPs after heating (90 °C) for 2 hrs without showing any evidence of dissolution but strong aggregation, meaning the breaking of hydration layer.

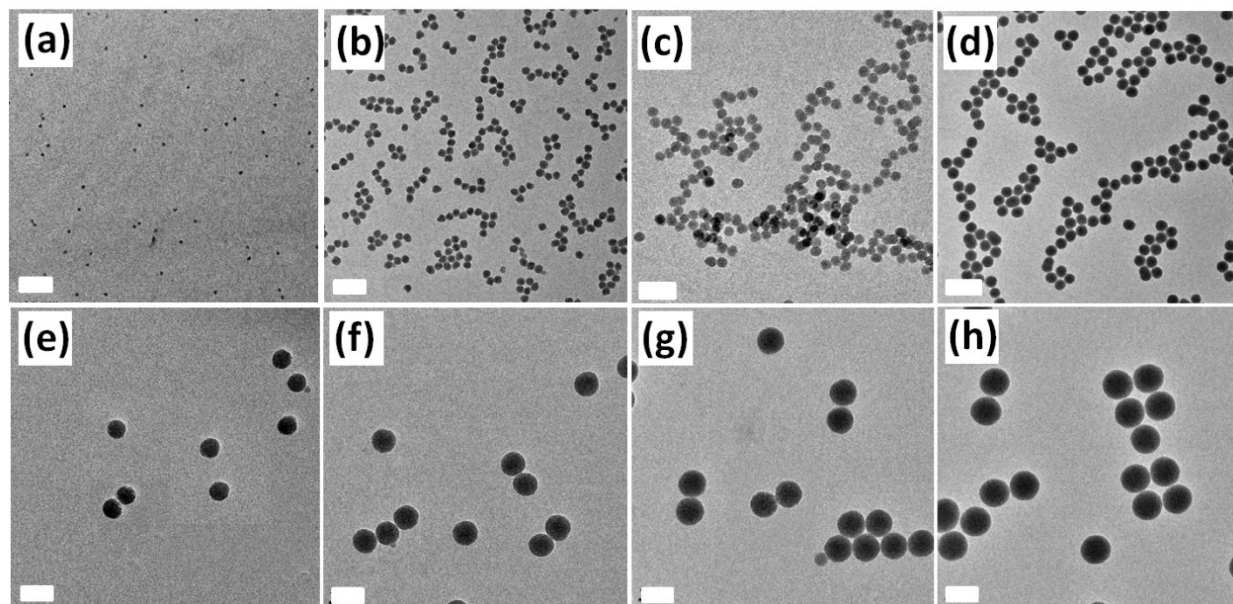


Fig. S6 The TEM image of silica NPs with different sizes, which were grown from 10 nm silica seeds in (a). The growth condition is the same as Stöber method except the amount of TEOS being added is varied from (b) 3 μL , (c) 5 μL , (d) 8 μL , (e) 10 μL , (f) 15 μL , (g) 20 μL , and (h) 25 μL . All the scale bars are 100 nm.

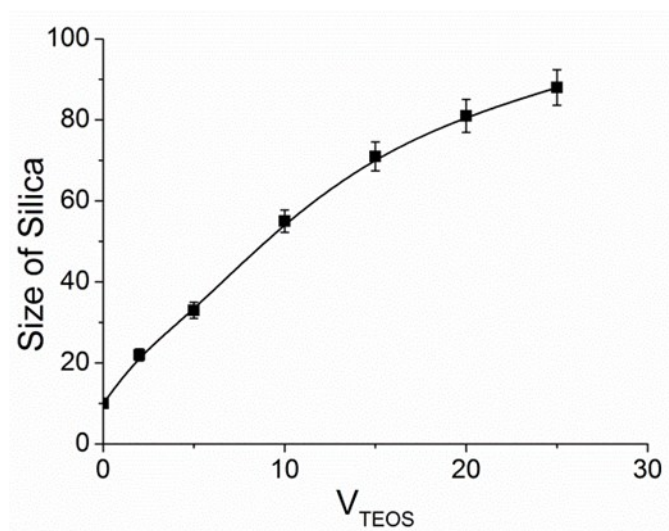


Fig. S7 Correlation of silica NP size with the TEOS added in for the growth.

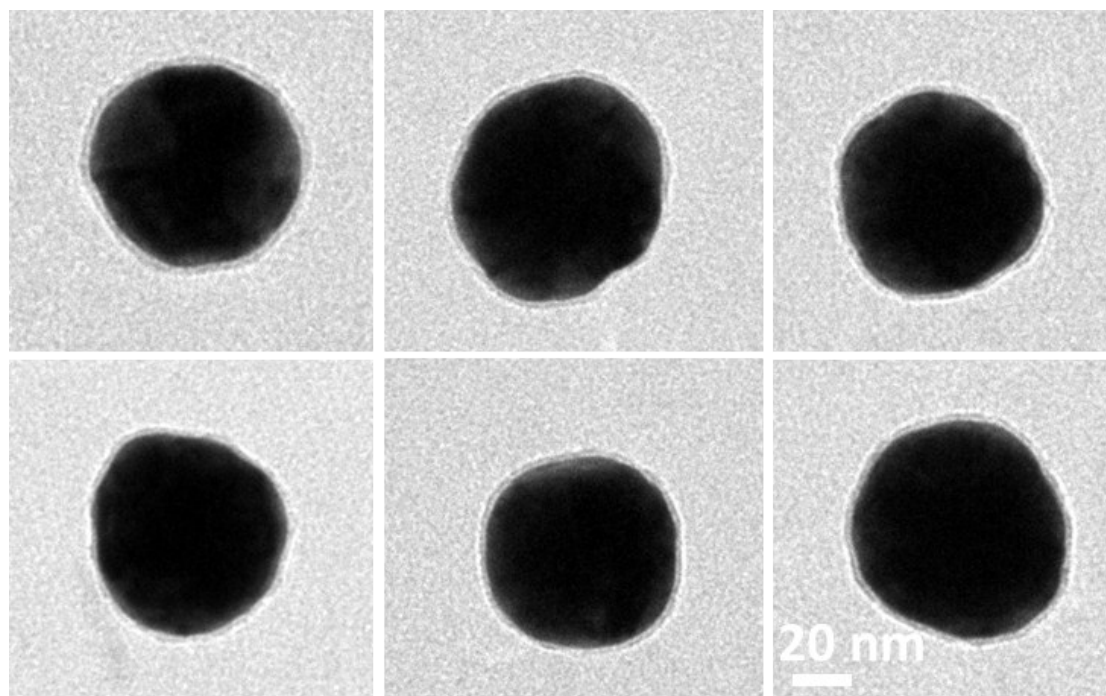


Fig. S8 Merged TEM images of Au@SiO₂ with shell thickness of ~3 nm, showing relative uniform coating.