

Supporting Information

Synthesis of silica nanoparticles (SNPs)

Three types of effects have been studied in the synthesis of well dispersed silica nanoparticles. For the effect of ammonia water, a mother solution containing ethanol (130ml) and deionized water (15ml) was prepared in a 250 ml three-necked flask under magnetic stirring. TEOS (8 ml) was then added into the solution. Ammonia water (10-25 ml) was added as a catalyst 30 min later.

For the effect of water volume, a mother solution containing ethanol (130ml) and deionized water (8-25ml) was prepared in a 250 ml three-necked flask under magnetic stirring. TEOS (8 ml) was then added into the solution. 14 ml of ammonia water was added as a catalyst 30 min later.

For the effect of TEOS volume, a mother solution containing ethanol (130ml) and deionized water (15ml) was prepared in a 250 ml three-necked flask under magnetic stirring. TEOS (7-20ml) was then added into the solution. 14 ml of ammonia water was added as a catalyst 30 min later. The temperature of the mixture for all effect studies was maintained at $21^{\circ}\text{C} \pm 0.05^{\circ}\text{C}$ until the end of the reaction. All reaction mixtures were magnetically stirred with water circulation cooling until a white turbid suspension was observed.

Purification of silica nanoparticles (SNPs)

The synthesized suspension was purified by centrifugation (Centurion Scientific, K3 series) at 6000rpm for 20 min. After centrifugation, the supernatant solution was discarded and deionized water was used as dispersant for silica nanoparticles. The purification step was repeated three times to obtain pure silica nanoparticles. After purification, the purified silica nanoparticle products were re-dispersed into deionized water with 12 wt. % solid content. The

silica particle solutions were then placed in a shaking water bath for 3 hours at controlled temperature of 65°C. The silica nanoparticle solution after the aging process was used for subsequent experiments.

Table S1 Effect of ammonia water volume on silica particle sizes

| Ammonia water volume (ml) | Silica particle sizes (nm) | Polydispersity Index (PDI) |
|------------------------------|-------------------------------|----------------------------|
| 10 | 232.4 | 0.013 |
| 15 | 227.6 | 0.005 |
| 20 | 222.2 | 0.005 |
| 25 | 198.8 | 0.005 |

where ethanol is 130ml, water is 15ml and TEOS is 8ml.

Table S2 Effect of deionized water (H₂O) volume on silica particle sizes

| Deionized water volume (ml) | Silica particle sizes (nm) | Polydispersity Index (PDI) |
|--------------------------------|-------------------------------|----------------------------|
| 8 | 161.2 | 0.054 |
| 10 | 187.0 | 0.005 |
| 12 | 189.1 | 0.019 |
| 15 | 197.9 | 0.005 |
| 20 | 190.9 | 0.005 |
| 25 | 193.6 | 0.008 |

where ethanol is 130ml, ammonia water is 14ml and TEOS is 8ml.

Table S3 Effect of TEOS volume on silica particle sizes

| TEOS volume (ml) | Silica particle sizes (nm) | Polydispersity Index (PDI) |
|---------------------|-------------------------------|----------------------------|
| 7 | 198.8 | 0.005 |
| 8 | 207.1 | 0.034 |
| 10 | 224.3 | 0.034 |
| 12 | 232.0 | 0.002 |
| 14 | 258.7 | 0.005 |
| 16 | 288.2 | 0.005 |
| 20 | 295.3 | 0.016 |

where ethanol is 130ml, ammonia water is 14ml and water is 15ml.