Electronic Supplementary Material (ESI) for Journal of Materials Chemistry

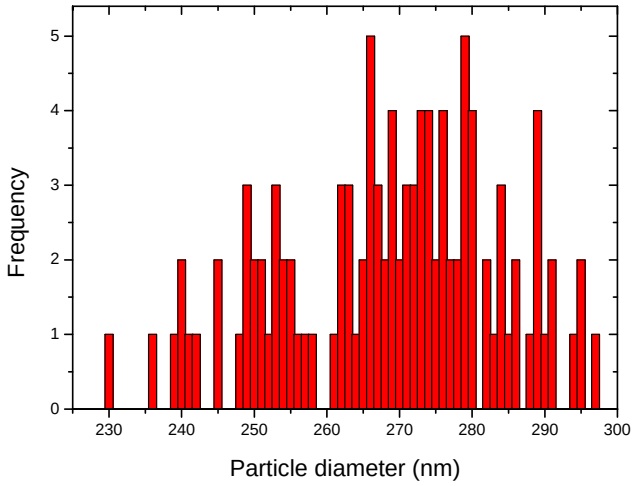
Electronic Supplementary Information

A Facile Method to the Synthesis of highly Monodisperse Silica@Gold@Silica Core-Shell-Shell Particles and their Use in the Fabrication of Three-Dimensional Metallodielectric Photonic Crystals

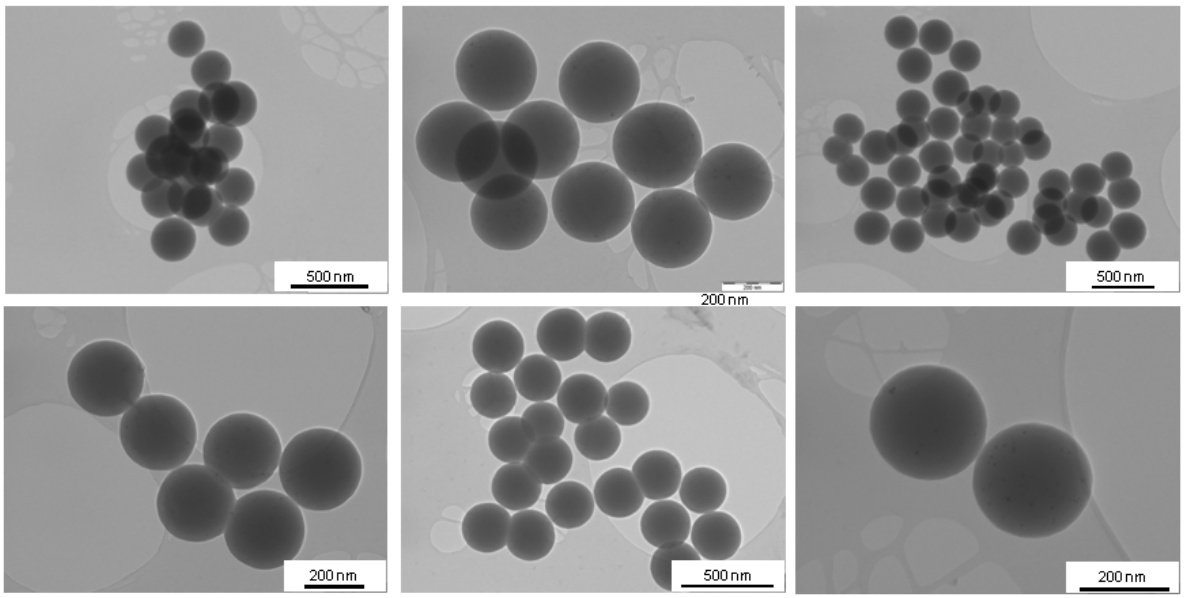
Sibu C. Padmanabhan,*[a] Joe McGrath,[a] Maria Bardosova,[a] Martyn E. Pemble*[a,b]

[a] *Tyndall National Institute, University College Cork, Lee Maltings, Cork, Ireland. Fax: +353 21 4904467; Tel: +353 21 4904406; E-mail:sibu.padmanabhan@tyndall.ie*
[b] *Department of Chemistry, University College Cork, Cork, Ireland*
Fax: +353 21 4904467; Tel: +353 21 4904456; E-mail: martyn.pemble@tyndall.ie

Electronic Supplementary Information 1 (ESI 1)

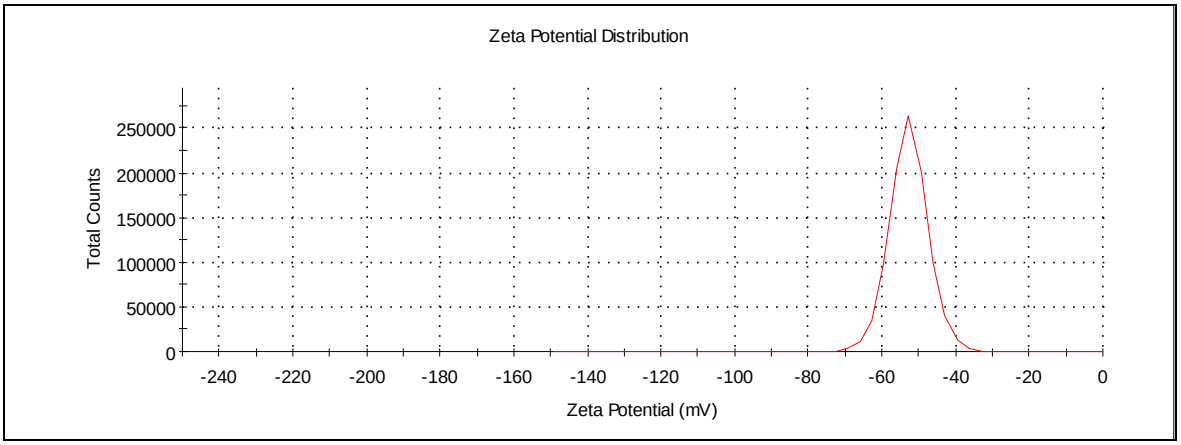


ESI 1: Figure 1. Particle size distribution of CSS particles measured from TEM.

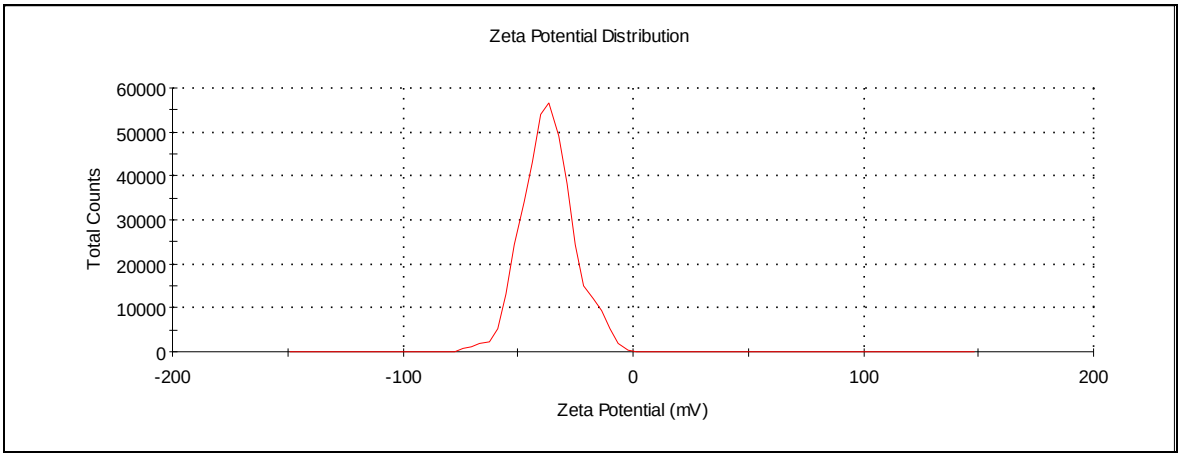


ESI 1: Figure 2. TEM images of the CSS particles used for measuring the particle size distribution.

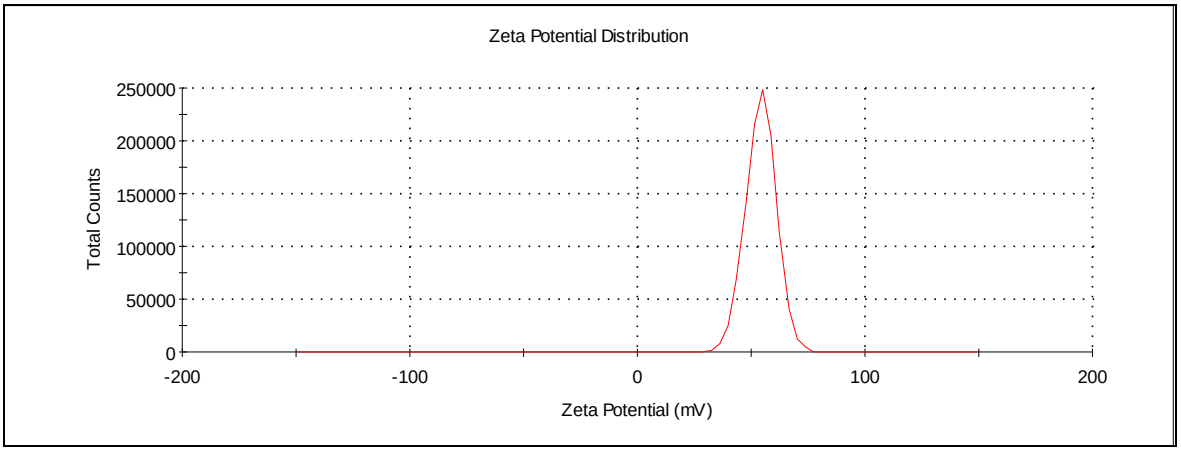
Electronic Supplementary Information 2 (SI 2)



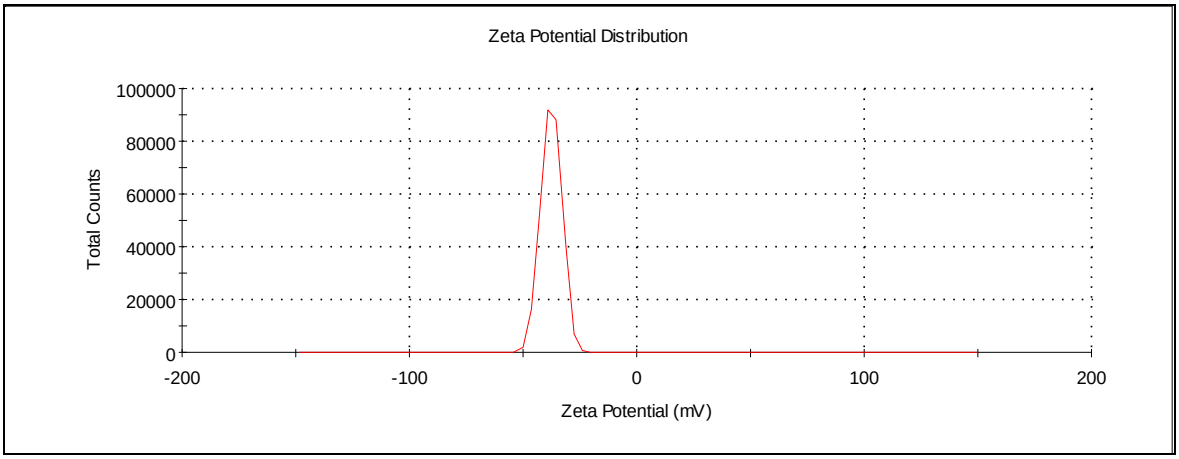
ESI 2: Figure 1. ζ-potential graph of silica sol



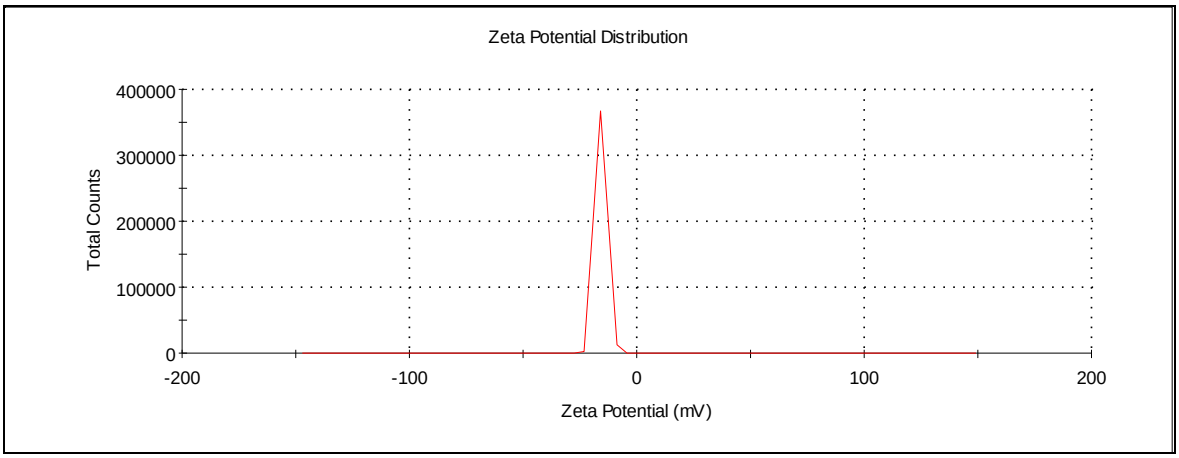
ESI 2: Figure 2. ζ-potential graph of Au sol



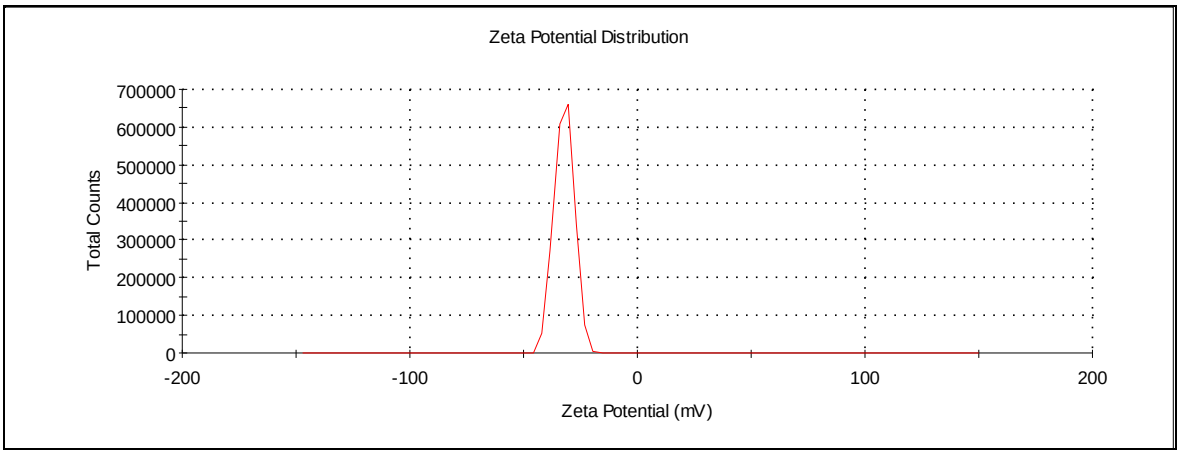
ESI 2: Figure 3. ζ-potential graph of silica@PEI sol



ESI 2: Figure 4. ζ-potential graph of silica@Au sol

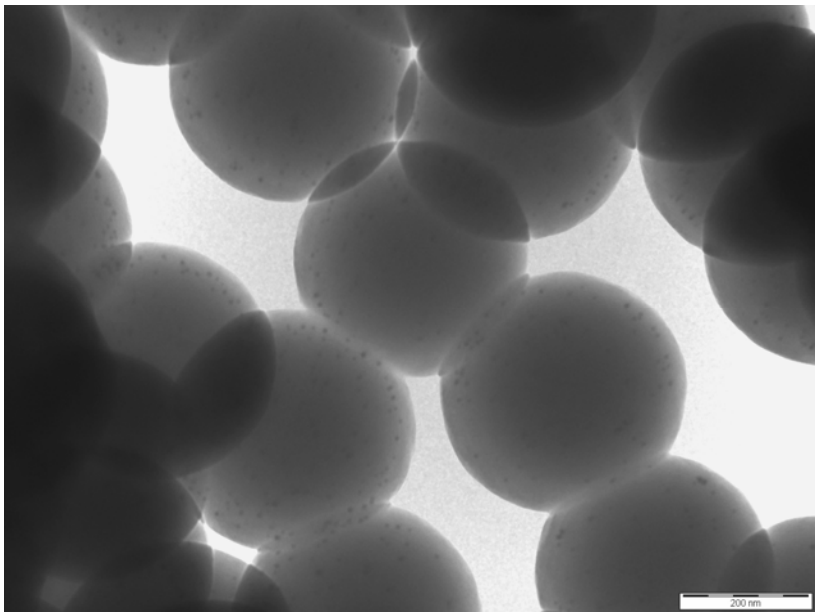


ESI 2: Figure 5. ζ-potential graph of silica@Au-1,3-DAP sol

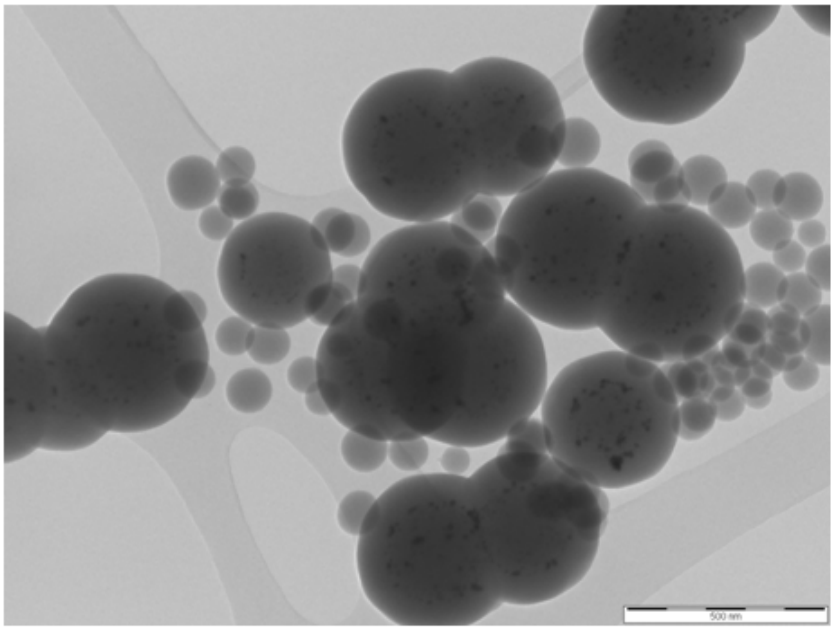


ESI 2: Figure 6. ζ-potential graph of silica@Au@silica sol

Electronic Supplementary Information 3 (SI 3)

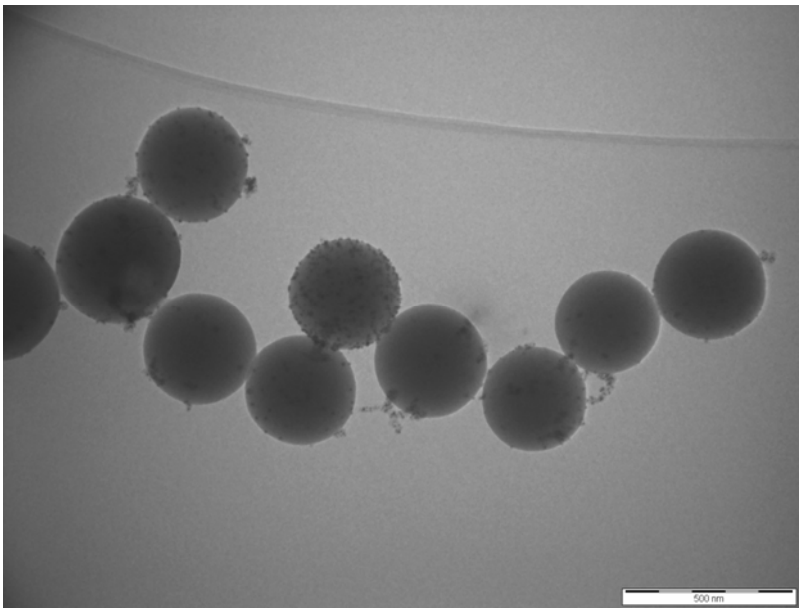


ESI 3: Figure 1. TEM image of aggregated silica@Au@silica particles prepared by a similar procedure but without the DAP washing step.

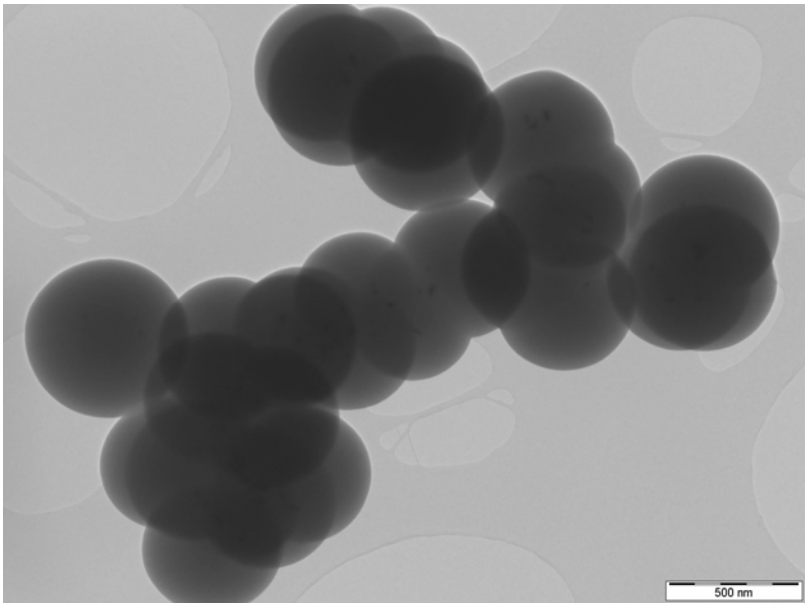


ESI 3: Figure 2. TEM image of particles when the reaction was carried out by a similar procedure but without the DAP washing step. We can see aggregated CSS particles and core-free silica particles here.

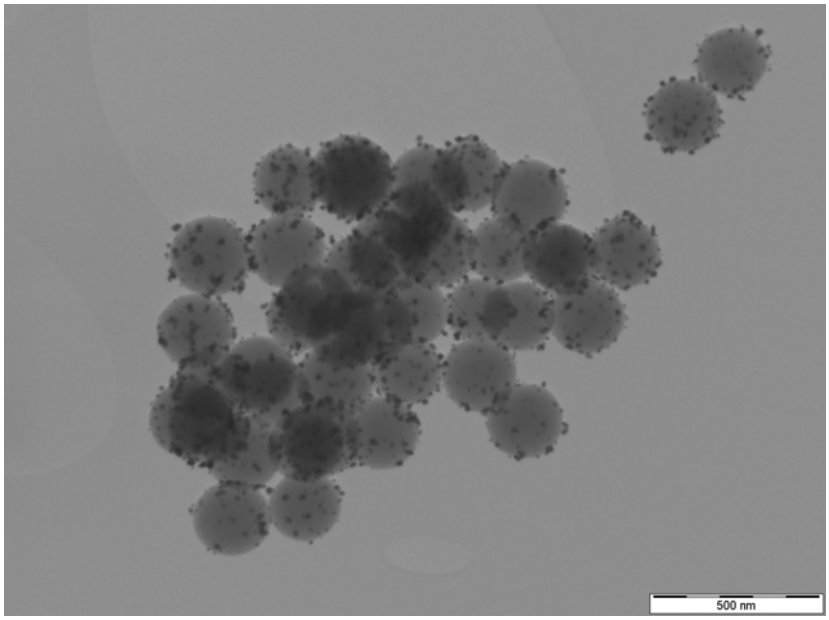
Electronic Supplementary Information 4 (SI 4)



ESI 4: Figure 1. TEM image of the particles obtained when the reaction was carried out without the DAP modification keeping all steps the same of the reported procedure. The citrate on the surface of Au NPs and unreacted PEI on the silica surface, if any, seem to be insufficient for a consistent silica shell formation.



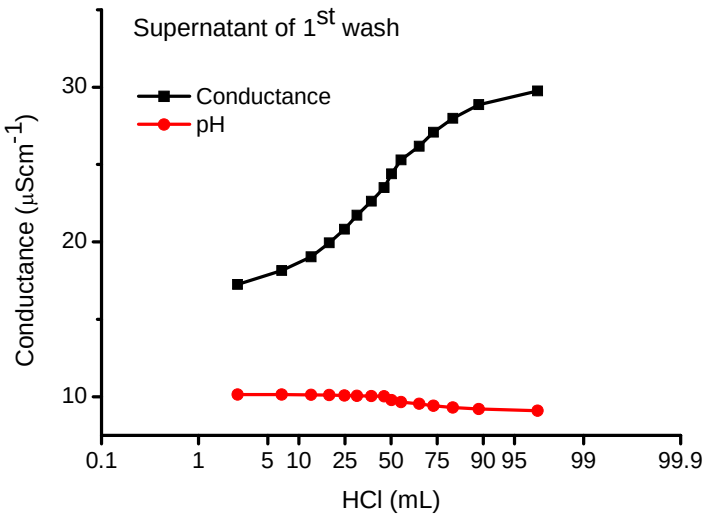
ESI 4: Figure 2. TEM image of the particles obtained when the reaction was carried out with DAP for both surface modification and hydrolysis – condensation steps keeping all the parameters same of the reported procedure. Lots of aggregated particles can be observed in place of the required monodispersed CSS particles.



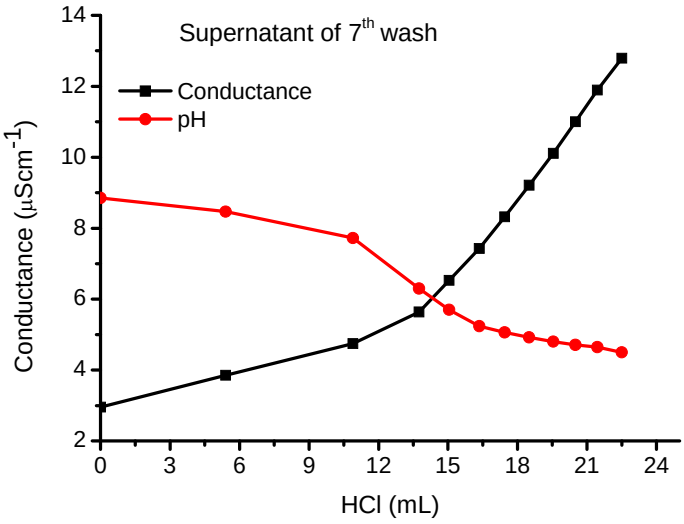
ESI 4: Figure 3. TEM image of the particles obtained when the reaction was carried out with DMDDA modification (instead of DAP modification) followed by hydrolysis – condensation by DMDDA keeping all the parameters same of the reported procedure. No silica shell formation is observed showing the crucial role of DAP.

Electronic Supplementary Information 5 (SI 5)

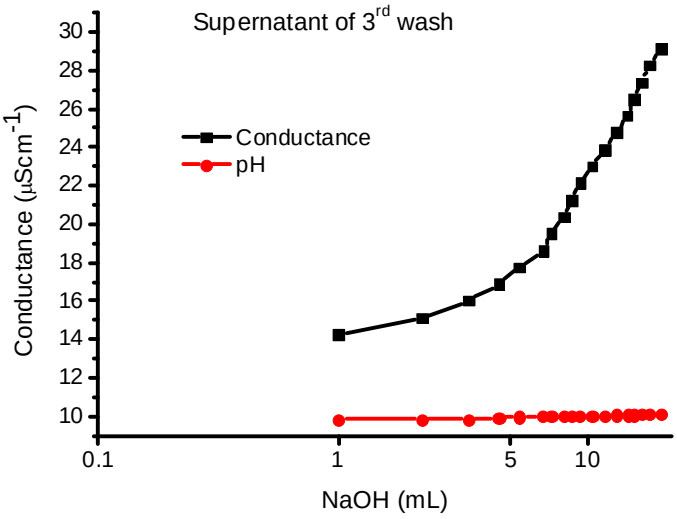
Conductometric titrations of the supernatants have been carried out to determine the presence of both free- and bound-amines in solutions. Free-amines have been determined by titrating with 0.5 mM HCl and bound-amines by titrating with 0.5 mM aqueous NaOH solution. Only representative results are presented here.



ESI 5: Figure 1. Conductometric titration curve of the first supernatant of CSS sample. Change in pH with respect to HCl titrated is also plotted. The solution has a high enough conductance in the beginning compared to pure Millipore water (0.271 μScm^{-1}) and follows a pattern as predicted for solutions containing free–amines.

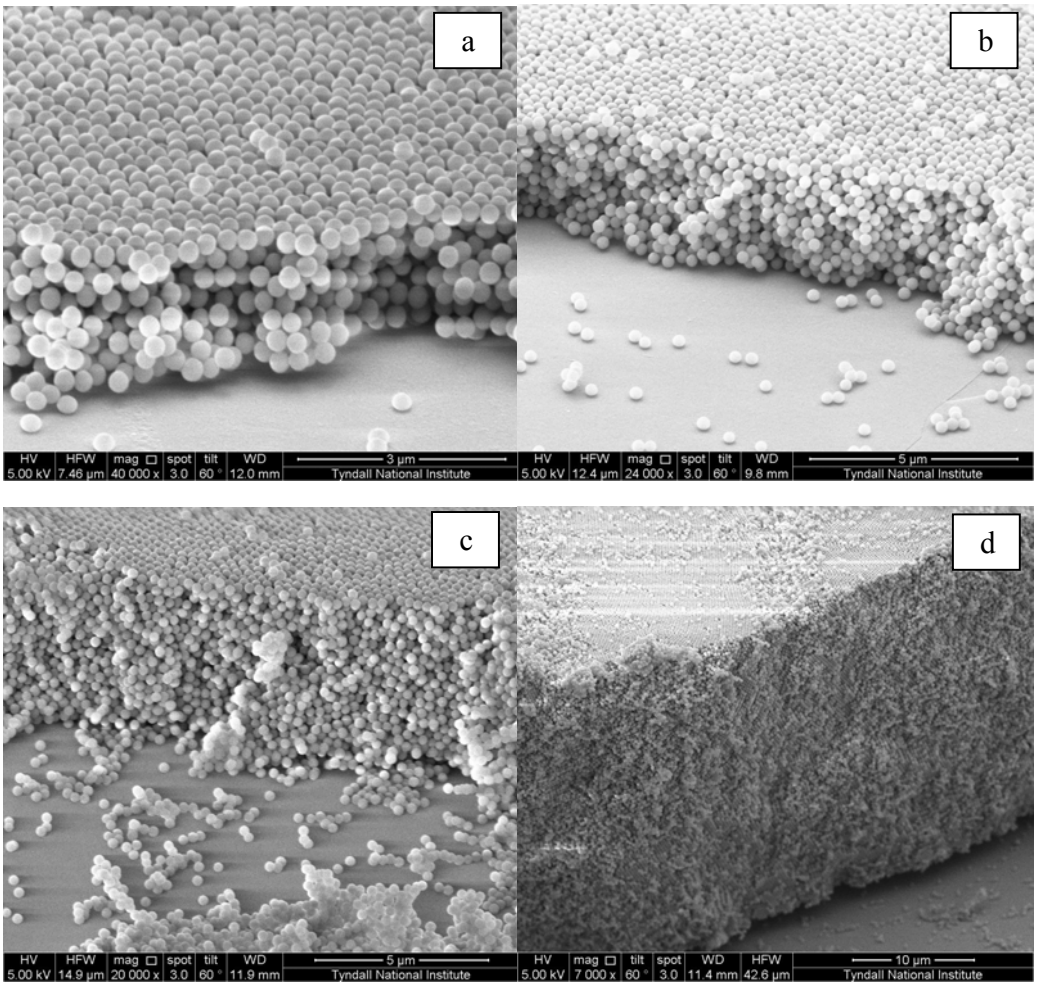


ESI 5: Figure 2. Conductometric titration curve of the 7th supernatant of CSS sample. Change in pH with respect to HCl titrated is also plotted. The solution shows a higher conductance than pure Millipore water (0.271 μScm^{-1}) and follows a pattern as predicted for solutions containing free–amines.



ESI 5: Figure 3. Conductometric titration curve of the 3rd supernatant of CSS sample. Change in pH with respect to NaOH titrated is also plotted. The solution has a high enough conductance in the beginning compared to pure Millipore water (0.271 μScm^{-1}) and follows a pattern as predicted for solutions containing bound–amines.

Electronic Supplementary Information 6 (SI 6)



ESI 6: Figure 1.SEM cross-section images of disordered fcc crystals of different layer thickness and their respective reflectance spectra obtained at 10° incidence to the surface normal. Spectra from bottom to top are MDPC and the spectra corresponding to images a to d. The reflectance intensity was found to be very much reduced for the thicker sample, may be due to the maximum loss of light as a result of the light travelling through not so ordered structure causing losses due to multiple incoherent scattering.