Supporting information for manuscript

Production of Concentrated Pickering Emulsions with Narrow Size Distributions using Stirred Cell Membrane Emulsification

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S1. Silica nanoparticle charging behavior: The influence of pH and electrolyte concentrations on the silica nanoparticles dispersions is presented. The i.e.p. for the silica dispersions occurs between pH 2 – 3. As the pH increases the negative magnitude of the zeta potential value also increases. By increasing the NaCl electrolyte concentration the magnitude of the zeta potential at each pH decreases.

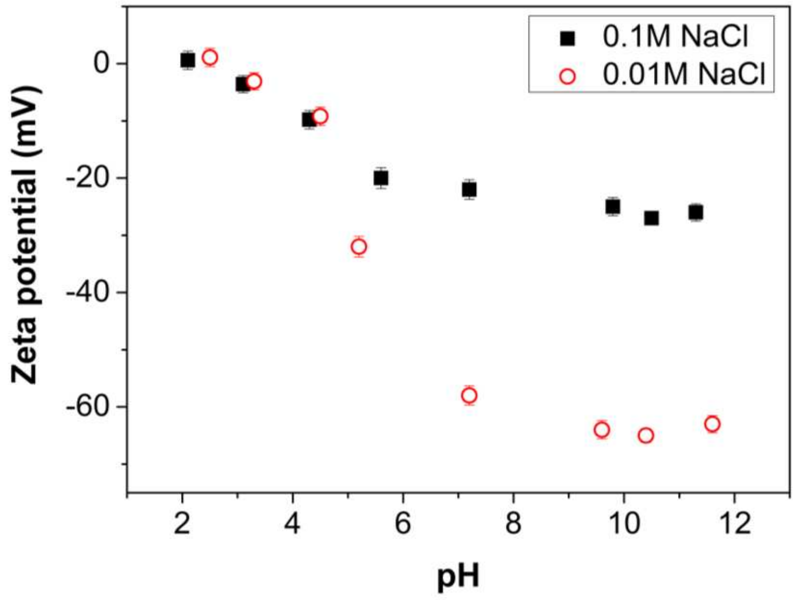

Figure S 1. Effect of pH and NaCl electrolyte concentration on the zeta potential of the silica nanoparticles in solution.

S2. Aggregation behavior of the silica nanoparticles: Although the primary particle size of the particles is 12 nm they aggregate when dispersed in water. At pH 6 and 0.1 M NaCl, the hydrodynamic diameter of these particle dispersions stirred at 1250 rpm is around 185 ±10 nm. These sizes remain consistent as a function of typical emulsification times as shown in Figure S2. The dispersions do undergo slow sedimentation taking several days to clear water if left standing still.

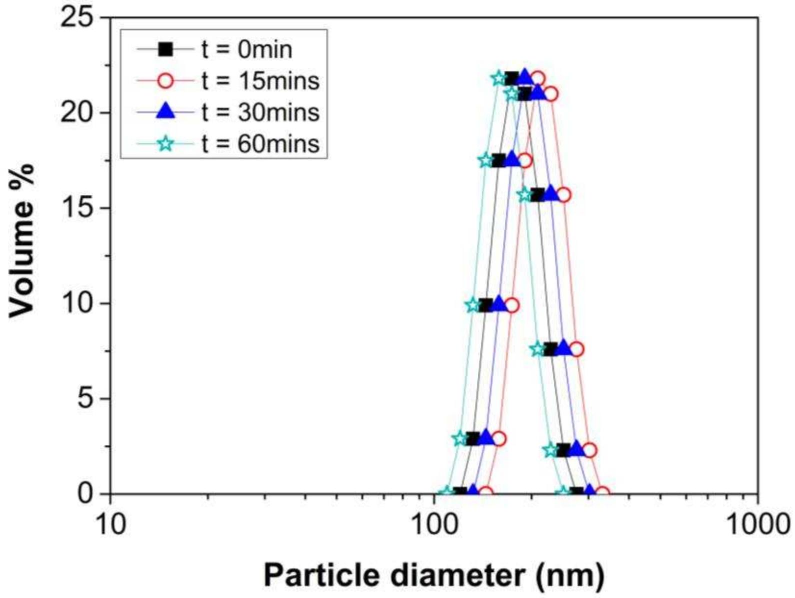

Figure S 2. Particle size distribution of the silica nanoparticle dispersions as a function of time prepared at pH 6, 0.1M NaCl and agitated at 1250 rpm.

S3. Bulk emulsion studies: Preliminary bulk emulsion studies using the silica nanoparticles and tricaprylin oil at pH 6 at different electrolyte concentrations. Increasing the concentration leads to improvements in emulsion stability.

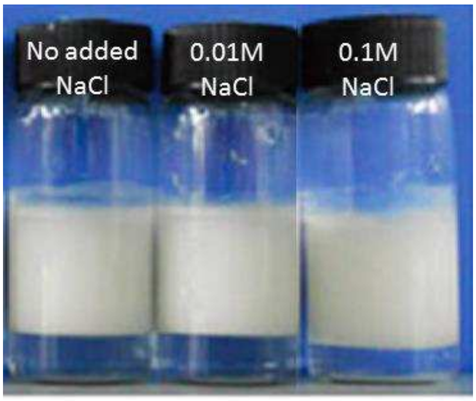

Figure S 3. Preliminary emulsion studies investigating the bulk stabiliy of tricaprylin oil droplets in water (oil to water ratio = 50:50) stabilized by silica nanoparticles. The nanoparticles are dispersed at pH 6 in different electrolyte concentrations.

S4. Impact on emulsion formation: Assuming a diffusion limited adsorption process, simple calculations can be made to evaluate whether there are enough particles in the bulk to stabilise emulsions and whether they can reach the interface fast enough.

Calculations – Based on particles with a hydrodynamic diameter of 185 nm at a concentration of 4 wt% to stabilise an oil volume fraction of 10%.

Table S 1. Droplet coverage data at an oil volume fraction of 10%

Volume of 1 particle	3.3157×10^{-21}	m^2
Density of silica	60	kg/m^3
Mass of 1 particle	1.9894×10^{-19}	kg
Total number of particles in continuous phase	$1.8096 \times 10^{+16}$	
Volume of oil droplet	4.1635×10^{-14}	m^2
Total no of droplets	240181583	
Surface area of droplet	5.8096×10^{-09}	m^2
Area occupied by HCP packing	1.2811×10^{-13}	m^2
Total no of particles to cover all droplets	$1.0892 \times 10^{+13}$	
For 1 droplet	45347	

Based on particles with a hydrodynamic diameter of 185 nm at a concentration of 4 wt% to stabilise an oil volume fraction of 50%.

Table S 2. Droplet coverage data at an oil volume fraction of 50%

Volume of 1 particle	3.32×10^{-21}	m^2
Density of silica	60	kg/m^3
Mass of 1 particle	1.99×10^{-19}	kg
Total number of particles in continuous phase	$1.01 \times 10^{+16}$	
Volume of oil droplet	4.08×10^{-13}	m^2
Total no of droplets	$1.23 \times 10^{+08}$	
Surface area of droplet	2.66×10^{-08}	m^2
Area occupied by HCP packing	1.28×10^{-13}	m^2
Total no of particles to cover all droplets	$2.55 \times 10^{+13}$	
For 1 droplet	207582	

Based on particles with a hydrodynamic diameter of 185 nm at a concentration of 4 wt% to stabilise an oil volume fraction of 70%.

Table S 3. Droplet coverage data at an oil volume fraction of 70%

Volume of 1 particle	3.32×10^{-21}	m^2
Density of silica	60	kg/m^3
Mass of 1 particle	1.99×10^{-19}	kg
Total number of particles in continuous phase	$6.03 \times 10^{+15}$	
Volume of oil droplet	2.81×10^{-12}	m^2
Total no of droplets	$2.49 \times 10^{+07}$	
Surface area of droplet	9.62×10^{-08}	m^2
Area occupied by HCP packing	1.28×10^{-13}	m^2
Total no of particles to cover all droplets	$1.87 \times 10^{+13}$	
For 1 droplet	751088	

Diffusion time of particles – Based on particle size of 185 nm and Debye length in 0.1 M NaCl

Table S 4. Particle diffusion data during emulsification process

Diffusion Coefficient	2.35×10^{-12}	m^2/s
Debye Length	1×10^{-09}	m
Diffusion Time	2.12×10^{-07}	s