SUPPORTING INFORMATION

Omniphilic Polymeric Sponges by Ice Templating

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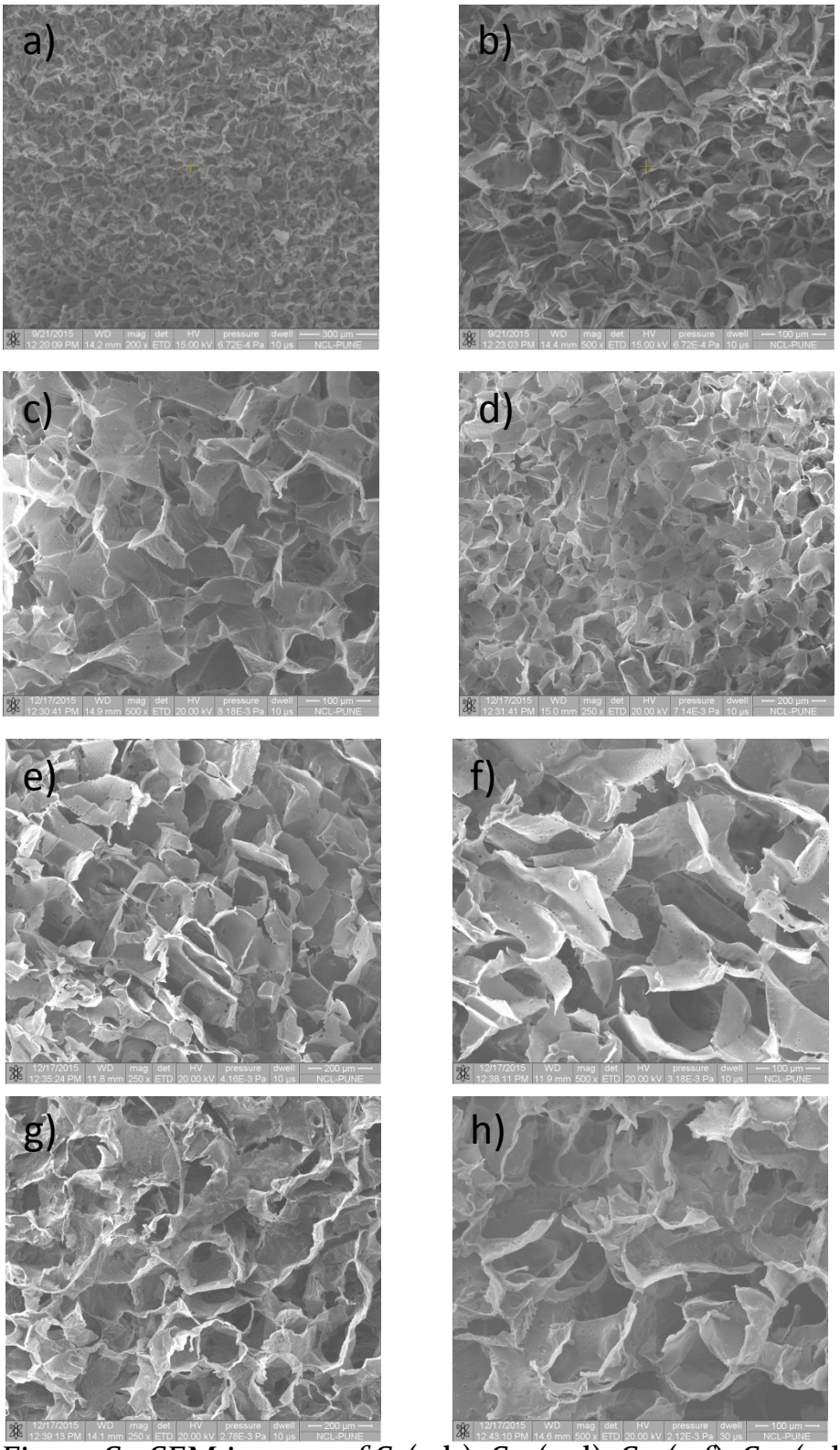


Figure S1: SEM images of S_o(a,b); S_{C4}(c,d); S_{C8}(e,f); S_{C17}(g,h) at different magnifications.

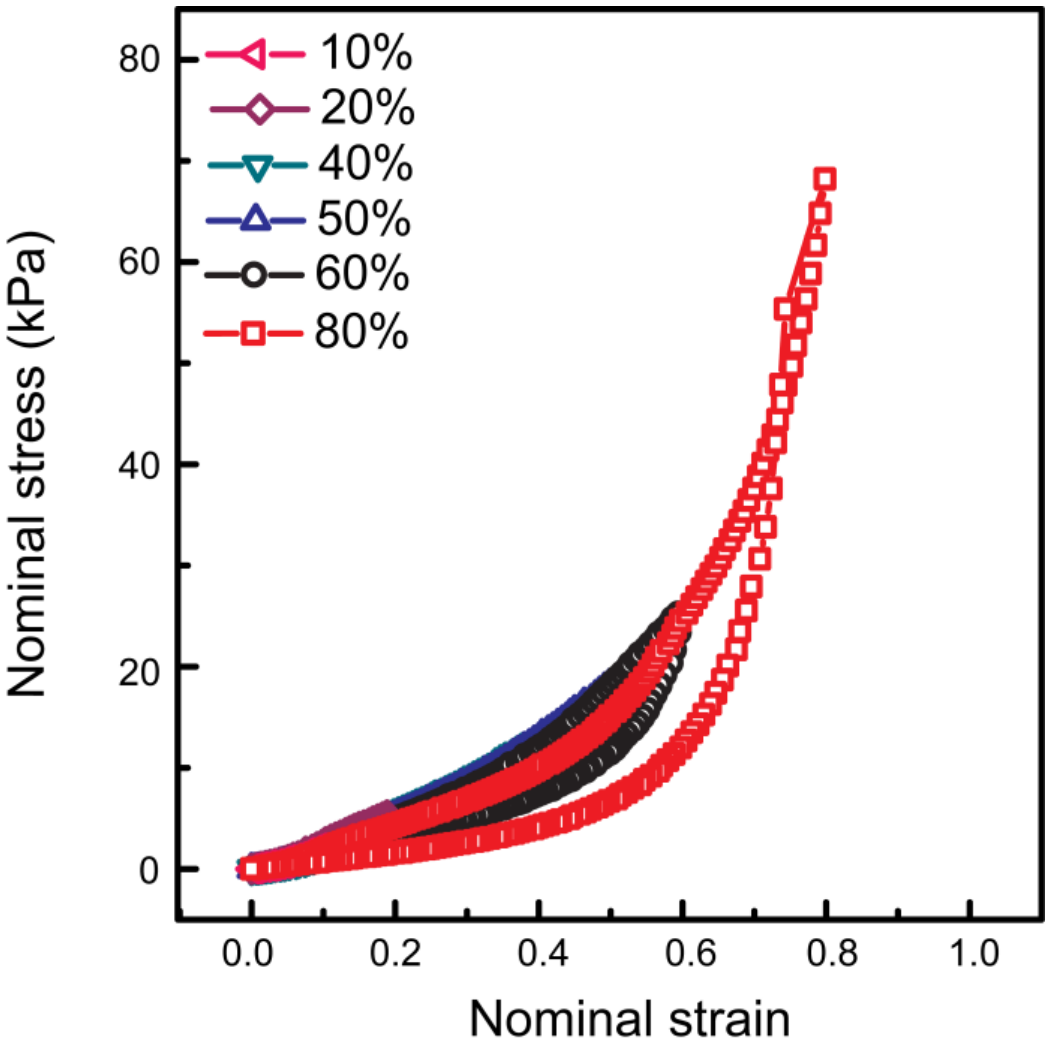


Figure S2: Compression-expansion of S_{C17} at different strain in hexane

Table S1: Estimation of hexane recovery after 70% compressive strain.

No. Of expm.	Wt. of empty Tube(mg)	Wt. of tube+ Hexane (mg)	Wt. of hexane recovered (mg)(y)	%Hexane recovery (x/y)*100
1	1019	1142	124	80%
2	1014	1142	129	83%
3	1022	1155	133	84%

Dry weight of sponge (S_{C17}) 10.8 mg

Hexane soaked sponge (S_{C17}) 165 mg

Weight of hexane in the uncompressed sponge (x) 154.2 mg

The sponge was compressed up to 70% of its original height

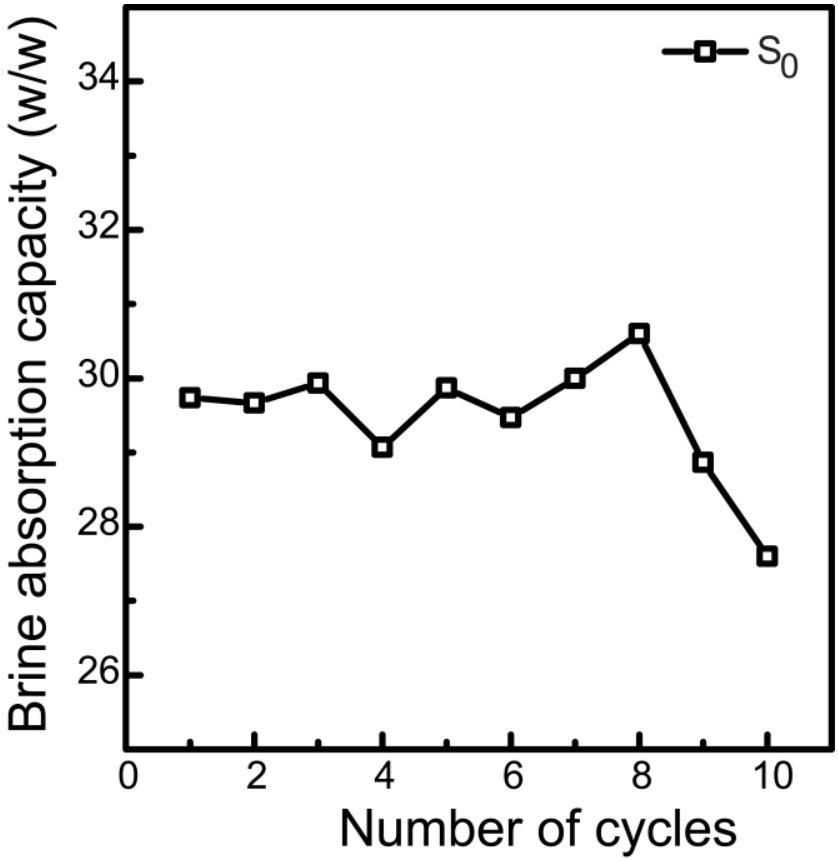


Figure S3: Absorption capacity of brine by S_o

Unidirectional freezing to create sponges with anisotropic pore structure:

Preparation of anisotropic sponges: 1.44 ml water and 36 mg (360 µl of 100 mg/ml stock solution) PEI were vortexed in a plastic tube for 2 min. To this polymer solution, 30 µl of 1, 4-butanediol diglycidyl ether (crosslinker) was added and mixed thoroughly using a vortex mixer. The solution was then immediately transferred in to a 4 ml plastic cuvette and dipped in a liquid nitrogen (LN_2) bath, and is held for > 1 min, until the entire solution is frozen. The frozen solution was immediately transferred to a freezer at -15°C and was stored for 48 hours to allow the crosslinking reaction to proceed. After the crosslinking, the sponge was taken out from the cuvette and washed with water. SEM images of the samples cut along the freezing direction (Figure S4 a,b) show that the pore structure along the freezing direction is anisotropic. As a control, we prepared sponges with an isotropic pore structure by holding a plastic cuvette containing an aqueous solution of polymer and crosslinker in a chamber at low temperature to allow isotropic freezing (rather than dipping in LN_2). The solution was frozen and the frozen sample was transferred to a freezer at -15°C for 48 hours. This sample was processed in the same way as the anisotropic sample. SEM images of the isotropic sponge are shown in Figure S4 c, d.

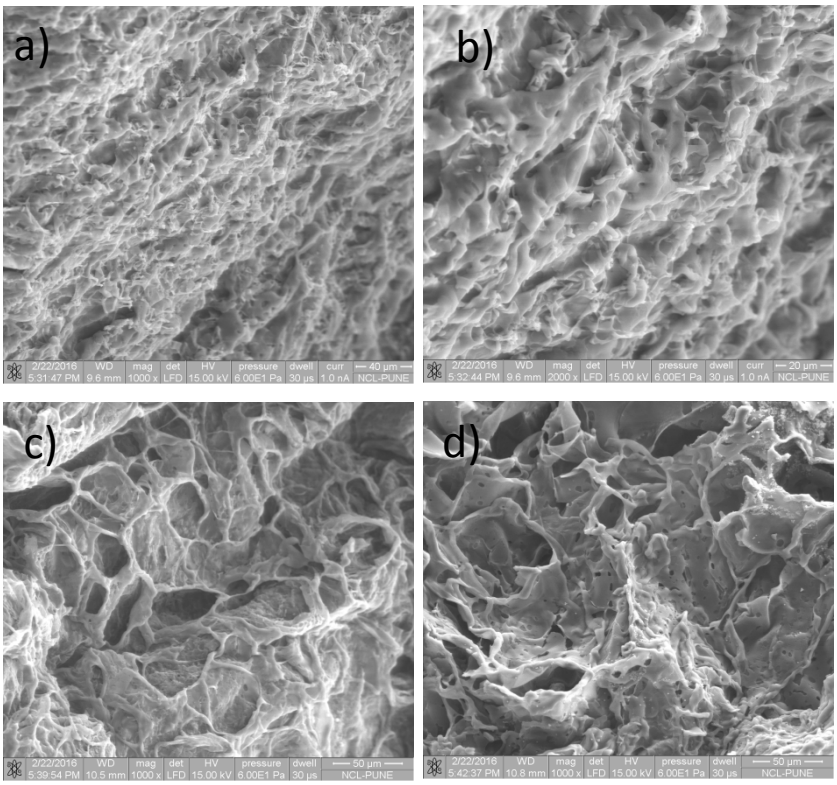


Figure S4: SEM images of anisotropic sponge (a-b) and isotropic sponge (c, d). (a-b) are the images of a small section of the sponge cut along the freezing axis. (e) and (f) are images of isotropic sponge.

To examine the kinetics of solvent uptake in the sponges, we oven dry the sponges and then cut them with a sharp blade into the shape of a rectangular parallelopipid, with one side along the freezing direction. This sponge is then immersed into water (containing red dye, for ease of visualization) and the height of the water front was recorded with a camera. From this video data, we extract the average height of the water front, as a function of time, using a PYTHON code.

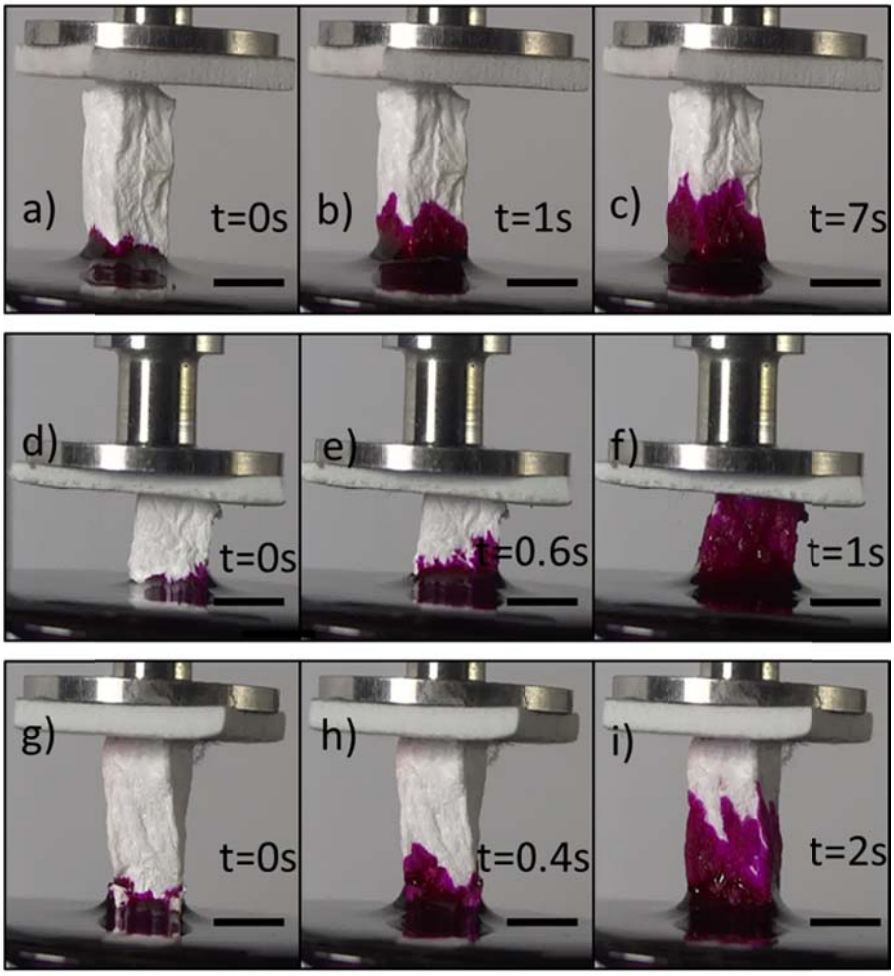


Figure S5: Water absorption kinetics of anisotropic sponge (a-c) represent water uptake perpendicular freezing axis and (d-f) along the freezing axis. (g-i) time dependent water imbibition by the isotropic sponge. For clarity water is dyed red. The scale bars corresponds to 4mm.

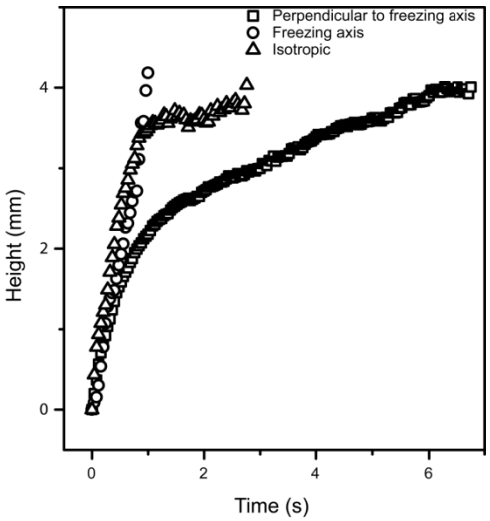


Figure S6: Height of the water front as a function of time during absorption by anisotropic and isotropic sponges.

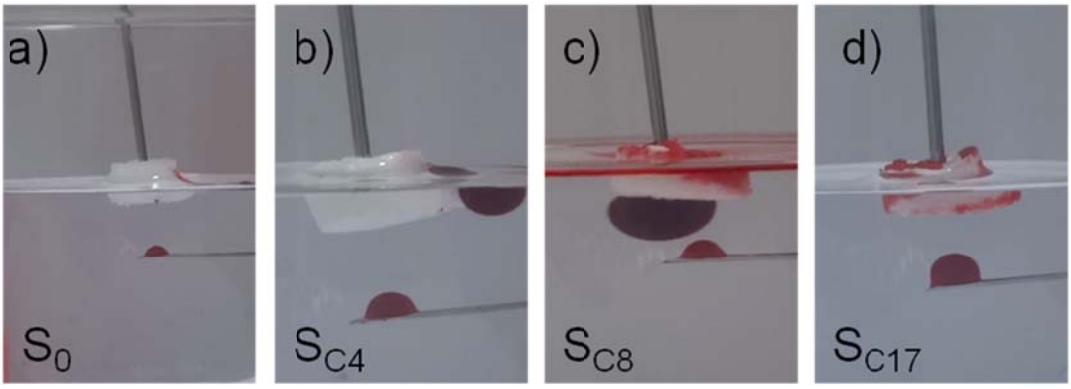


Figure S7: Interaction of hexane drop (red) released underwater with sponges (a) S_o, (b) S_{C4}, (c) S_{C8} and (d) S_{C17}held, spanning the air water interface. The hexane rises and spreads on the water surface. In (a) and (b), the sponge does not absorb the hexane drop. Rather, the hexane drop simply spreads over the surface of the wet sponge. In (b), when the hexane contacts the sponge at the air-water interface, there is some absorption within the sponge. However, this is not visible in the photograph. In contrast, in (c), the hexane rises to the interface and is visibly partially absorbed by the sponge. In (d), the hexane is absorbed as it contacts the sponge underwater, before the hexane rises to the air-water interface.

Preparation of surfactant solutions:

200 mg surfactant, 500 µl hexane and 50 ml water were mixed together at 5000 rpm for 10 min using IKA Ultratrax mixture. The emulsion was then allowed to equilibrate for 12hours before the absorption experiments. 10 ml of the aliquot was taken into 15 ml glass vials each and stirred in presence of S_o, S_{C4} and S_{C17} sponges respectively for 24 hours. After 24 hours, hexane and the surfactant in the oil phase was extracted from the emulsion with 5ml dichloromethane (DCM) in a 25ml separatory funnel. The extracted mixture was then allowed to pass through a silica column with small amount of sodium sulphate to remove surfactant and trace amount of water. The purified solvent mixtures (hexane in DCM) were stored in sealed glass vials and stored at cold environment to ensure no loss of solvent due to evaporation. The amount of unabsorbed hexane was then calculated with the help of Gas-Chromatography (GC).

For GC measurement, 1 µl of the purified aliquot was injected in Gas-Chromatography instrument (Agilent Technologies, 7890B GC system).We set the oven temperature at 40^0C with 2^0C/min ramp and heated upto 100^0C with 1 min initial hold time.

We observe, DCM peak is present at 3.7min and expected hexane peak at 4.18 is disappeared. We have estimated the hexane quantity from the area under the curve at~ 4.18 with respect to the DCM peaks for S_o, S_{C4} and S_{C17} in CTAB and SDS stabilized emulsions (Figure S5 a-f).

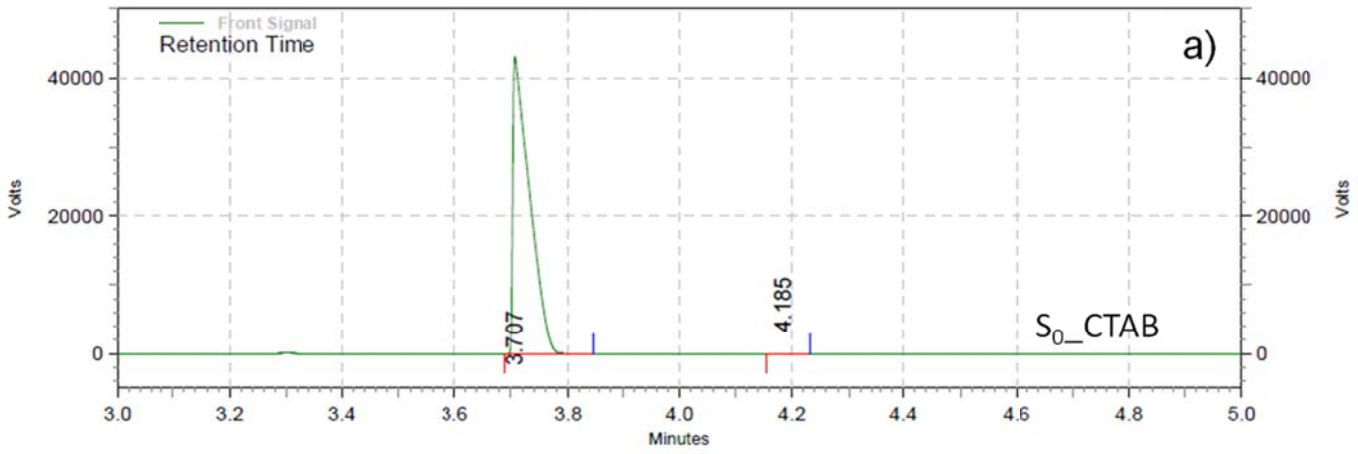
Control experiments:

For control experiments, we measure amount of hexane from the CTAB and SDS stabilized emulsions respectively, 24 hours after stabilization following the same experimental protocol mentioned earlier (Figure S5 g and h).

Calibration experiment:

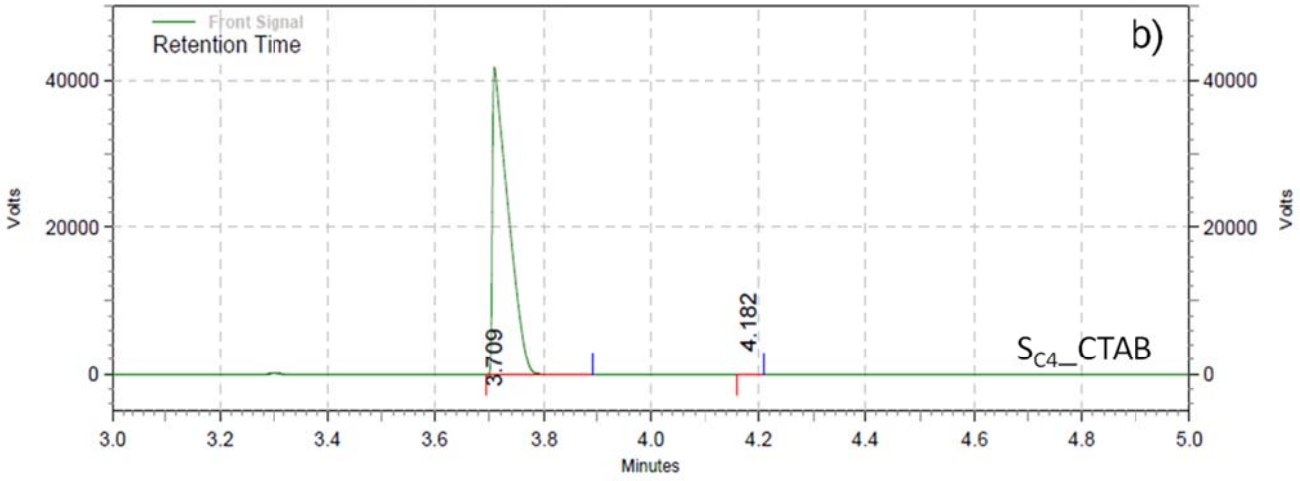
For calibration experiment, 25µl hexane was mixed with 2.5ml DCM and 1µl of the aliquot was injected (Figure S5 i).

To ensure the exact peak position of hexane in a hexane/DCM mixture, we have also performed an experiment with only hexane. It indicates that hexane peak appear~4.18 min for the setup method (Figure S5 j).



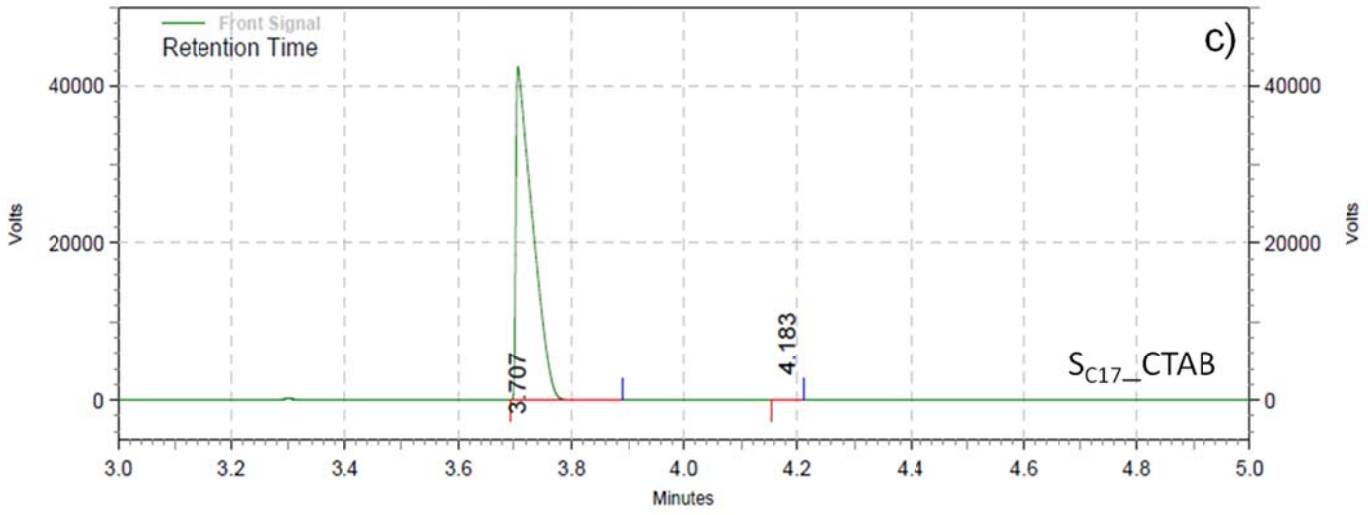
Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.707	223032012	100.00	110083854	100.00
4.185	2517	0.00	1469	0.00
Totals	223034529	100.00	110085323	100.00



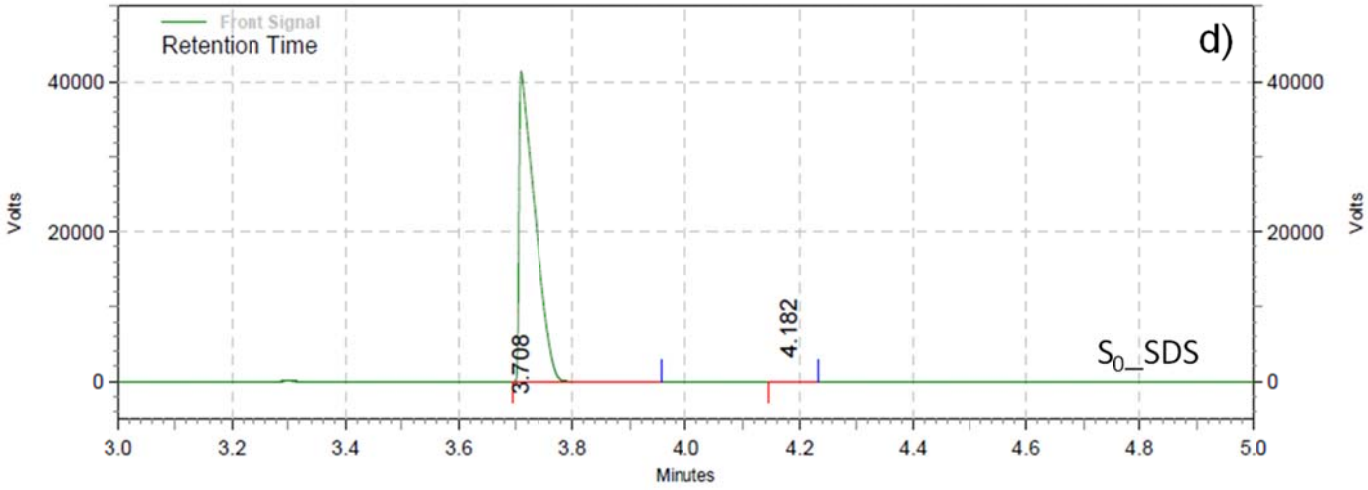
Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.709	211804612	100.00	106814148	100.00
4.182	1610	0.00	1162	0.00
Totals	211806222	100.00	106815310	100.00



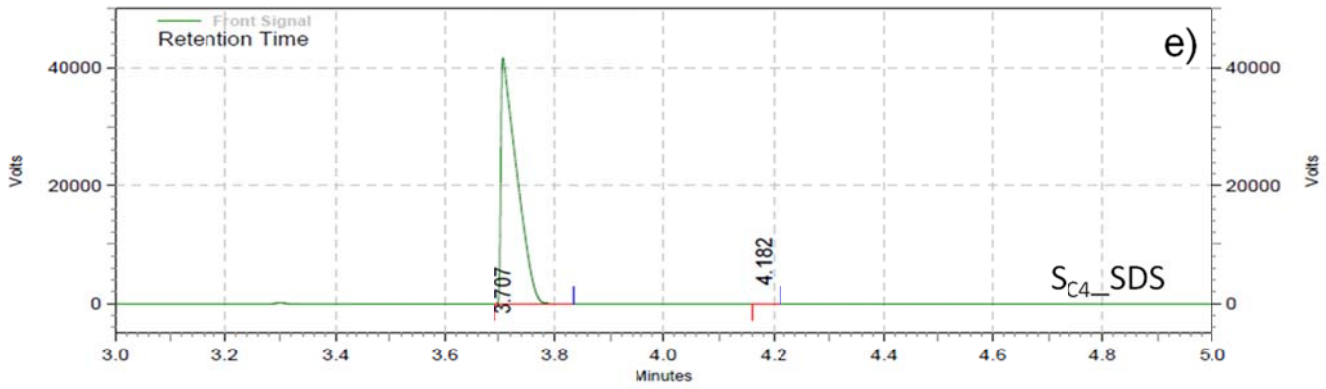
Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.707	216517153	100.00	108587188	100.00
4.183	2398	0.00	1625	0.00
Totals	216519551	100.00	108588813	100.00



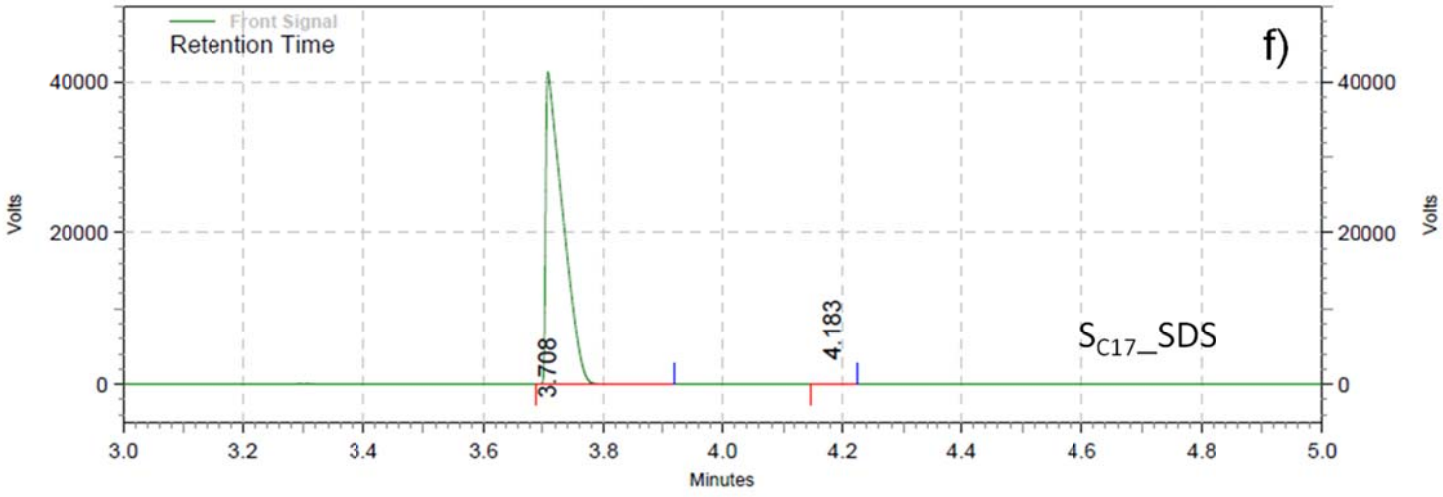
Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.708	210235607	100.00	105847848	100.00
4.182	2813	0.00	1603	0.00
Totals	210238420	100.00	105849451	100.00



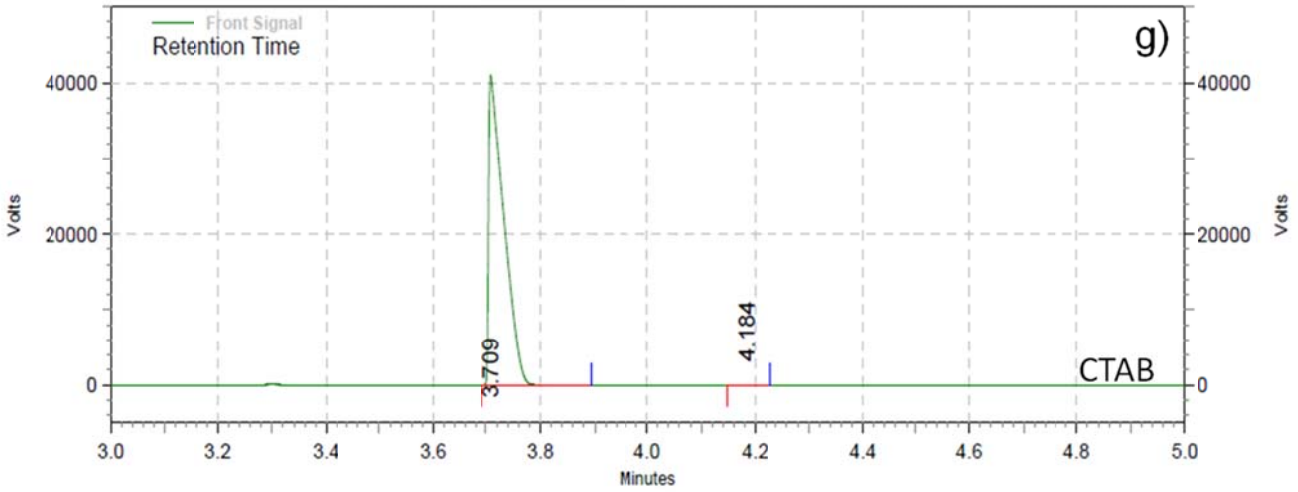
Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.707	208373151	100.00	106538343	100.00
4.182	2685	0.00	1923	0.00
Totals	208375836	100.00	106540266	100.00



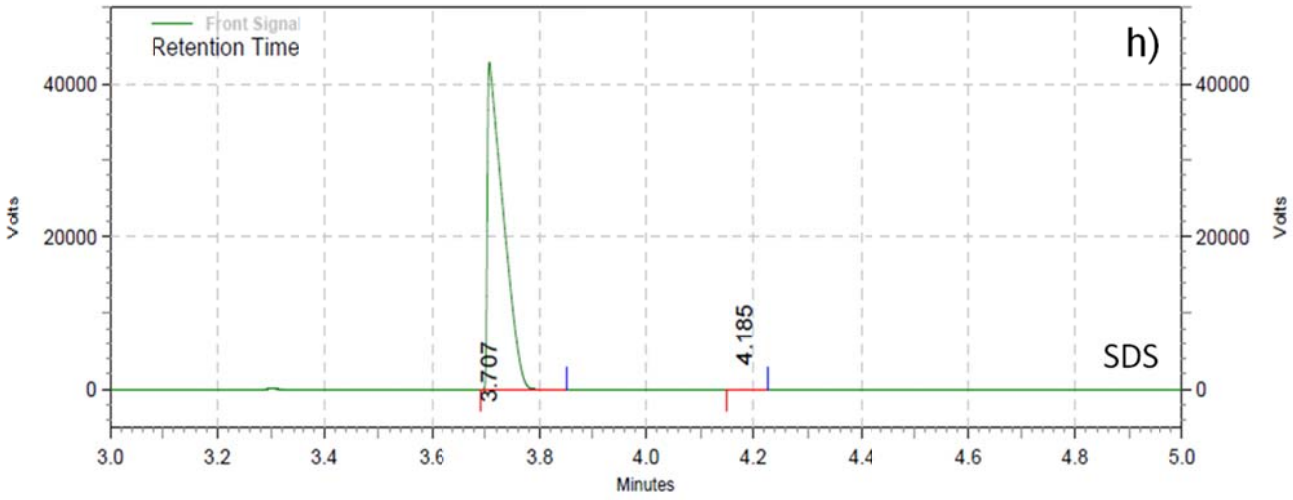
Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.708	206057563	100.00	105729624	100.00
4.183	4280	0.00	2832	0.00
Totals	206061843	100.00	105732456	100.00



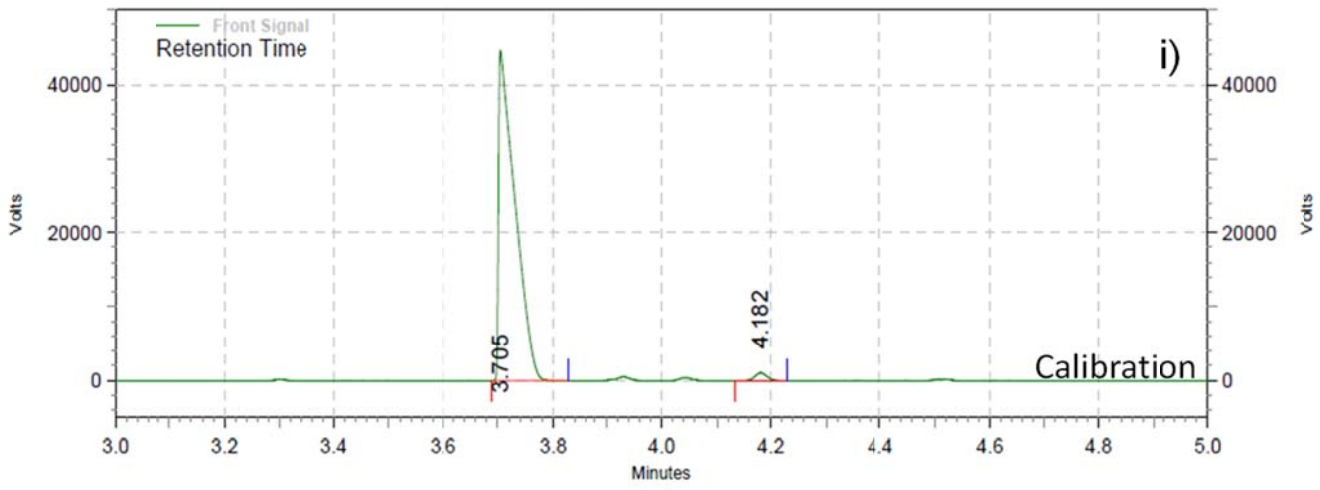
Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.709	202898477	99.99	104963295	99.98
4.184	28997	0.01	20235	0.02
Totals	202927474	100.00	104983530	100.00



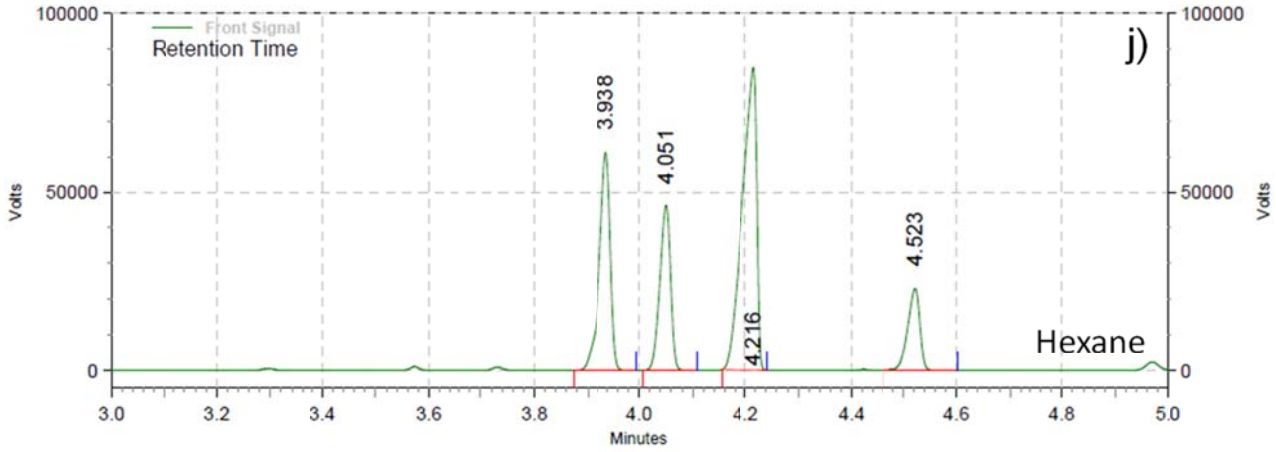
Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.707	220210445	99.98	109626456	99.97
4.185	42237	0.02	29037	0.03
Totals	220252682	100.00	109655493	100.00



Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.705	233896471	98.37	113974874	97.74
4.182	3881641	1.63	2633295	2.26
Totals	237778112	100.00	116608169	100.00



Front Signal
Results

Retention Time	Area	Area %	Height	Height %
3.938	234857756	25.67	156720450	28.43
4.051	164655216	18.00	118490614	21.50
4.216	423017733	46.23	216948836	39.36
4.523	92470941	10.11	59070582	10.72
Totals	915001646	100.00	551230482	100.00

Figure S8: Estimation of hexane absorption from (a-c) CTAB and (d-f) SDS stabilized emulsions by S_o, SC_4 and S_{C17} sponges respectively. Control

experiments with CTAB (g) and SDS (h).Calibration plot for hexane/DCM system (i) and for only hexane (j).