Supporting Information

Synthesis and Complex Self-Assembly of Amphiphilic Block Copolymers with a Branched Hydrophobic Poly(2-oxazoline) into Multicompartment Micelles, Pseudo-Vesicles and Yolk/Shell Nanoparticles

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1. NMR spectrum of PEO-Nos

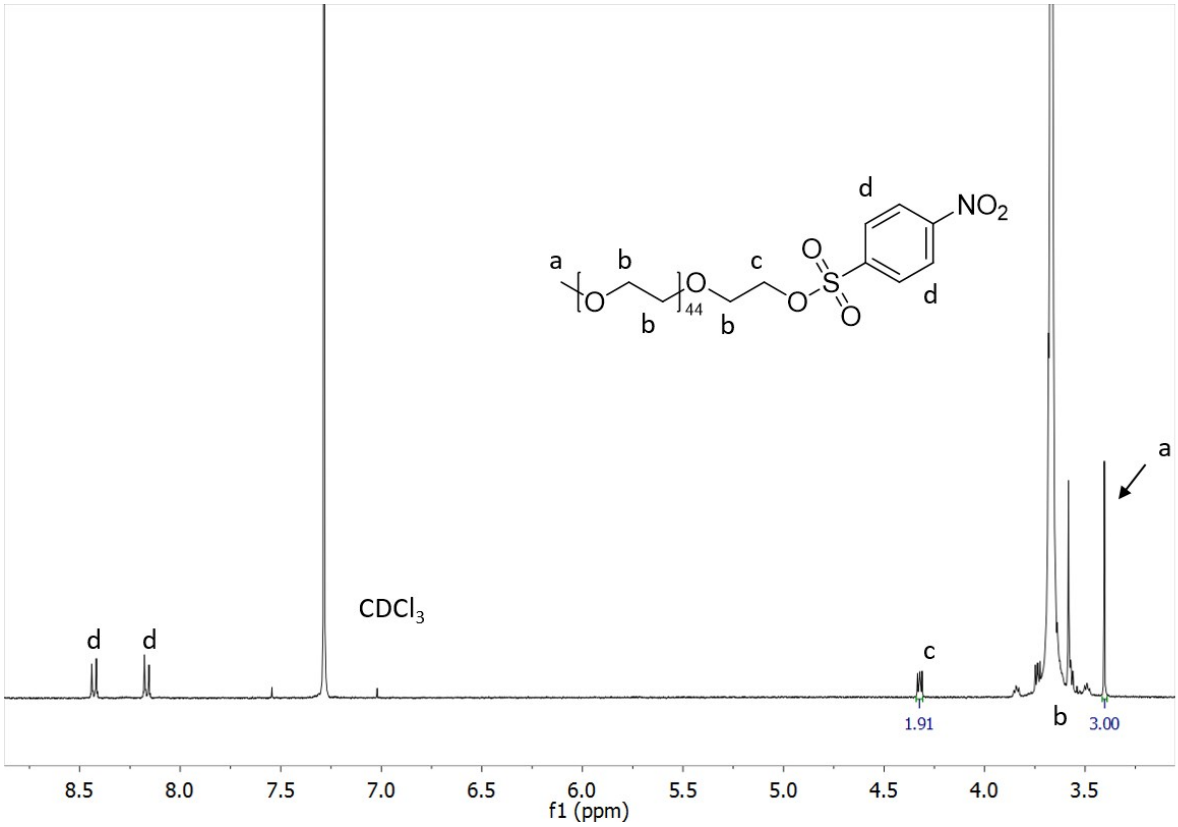


Figure S1 - Representative ^{1}H NMR ($CDCl_3$) of PEO-Nos.

We integrate the peak a as a reference to determine the integration of the peak c which should in value be equal to two if we had 100% nosylation. The difference between the theoretical value of 2 (100%) and the experimental integration of the peak "c" yield the nosylation ratio.

Nosylation ratio (%) = 100 - ((2-1.91)/2)*100 = 96%

2. Synthesis of PEO-*b*-PEHOx polymers

a. Polymerisation of PEHOx using PEO-Tos as macroinitiator in chlorobenzene at different temperatures

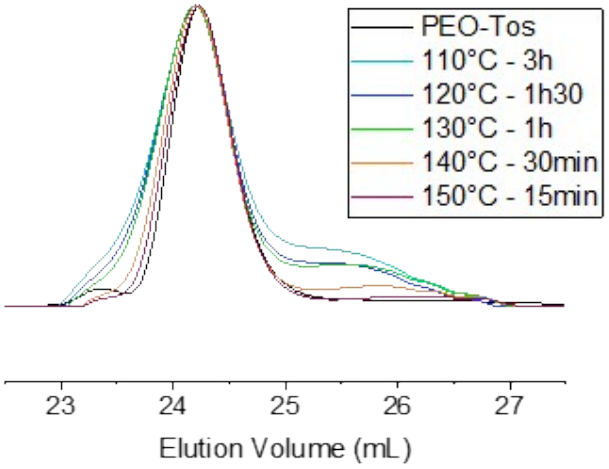


Figure S2 - GPC traces ($CHCl_3$) of the microwave-assisted polymerization of EHOx on PEO-Tos in chlorobenzene at different temperatures. The monomer concentration was set to 1M and a monomer-to-initiator ratio of 100 was used. With increasing temperature, a shorter polymerization time was used to account for faster kinetics of the polymerization due the temperature increase.

b. Polymerisation of PEHOx using PEO-Nos as macroinitiator in chlorobenzene at different temperatures

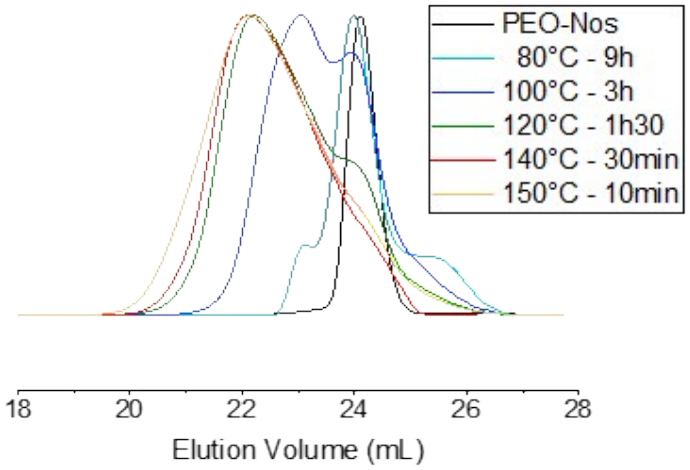
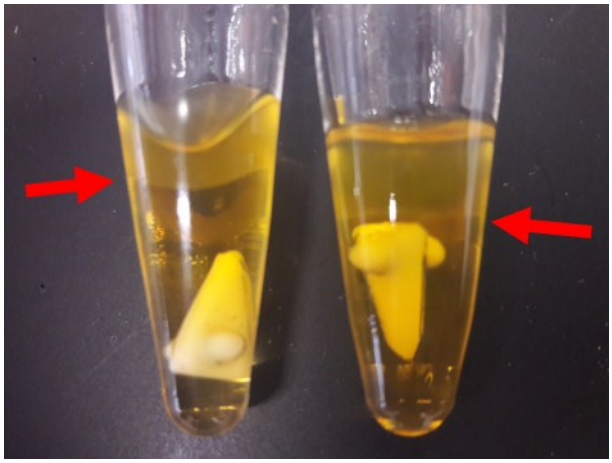


Figure S3 - GPC traces ($CHCl_3$) of the microwave-assisted polymerization of EHOx on PEO-Nos in chlorobenzene at different temperatures. The monomer concentration was set to 1M and a monomer-to-initiator ratio of 100 was used. The different polymerization time at different temperature account for the decrease in reactivity with decreasing temperature.



c. Solubility issue of growing PEO-*b*-PEHOx in sulfolan

Figure S4 - Picture of two microwave vials after polymerization of EHOx on PEO-Nos in sulfolane showing two different phases due two low solubility of the PEHOx block.

d. Calculation of EHOx block length by ^{1}H NMR

The block ratio of AB PEO-*b*-PEHOX was determined by integrating the PEO backbone peak at 3.60 ppm as a reference (always 45 units for 2000 Da PEO used) to integrate peaks of PEHOx side chain at 0.86 and 1.24 ppm and calculate the EHOx block length as summarized in the following Table S1.

Table S1 -Calculations of EHOx block length. [a] Integral "a" (m, 6H, CH_3)) 0.86 ppm. [b] Integral "b" (m, 9H, $CH(CH_2CH_3)$-$CH_2CH_2CH_2CH_3$)) 1.24 ppm. [c] Calculated via N(EHOx length)= (a/6+b/9)/2

Diblock copolymers	Integral "a"[a]	Integral "b"[b]	EHOx Length[c]
PEO_{45}-*b*-$PEHOx_8$	46	71	8
PEO_{45}-*b*-$PEHOx_{26}$	153	230	26
PEO_{45}-*b*-$PEHOx_{40}$	240	356	40
PEO_{45}-*b*-$PEHOx_{57}$	344	516	57
PEO_{45}-*b*-$PEHOx_{95}$	565	860	95
PEO_{45}-*b*-$PEHOx_{128}$	764	1160	128
PEO_{45}-*b*-$PEHOx_{151}$	901	1360	151
PEO_{45}-*b*-$PEHOx_{171}$	1014	1563	171

3. Determination of the glass transition temperature (T_g)

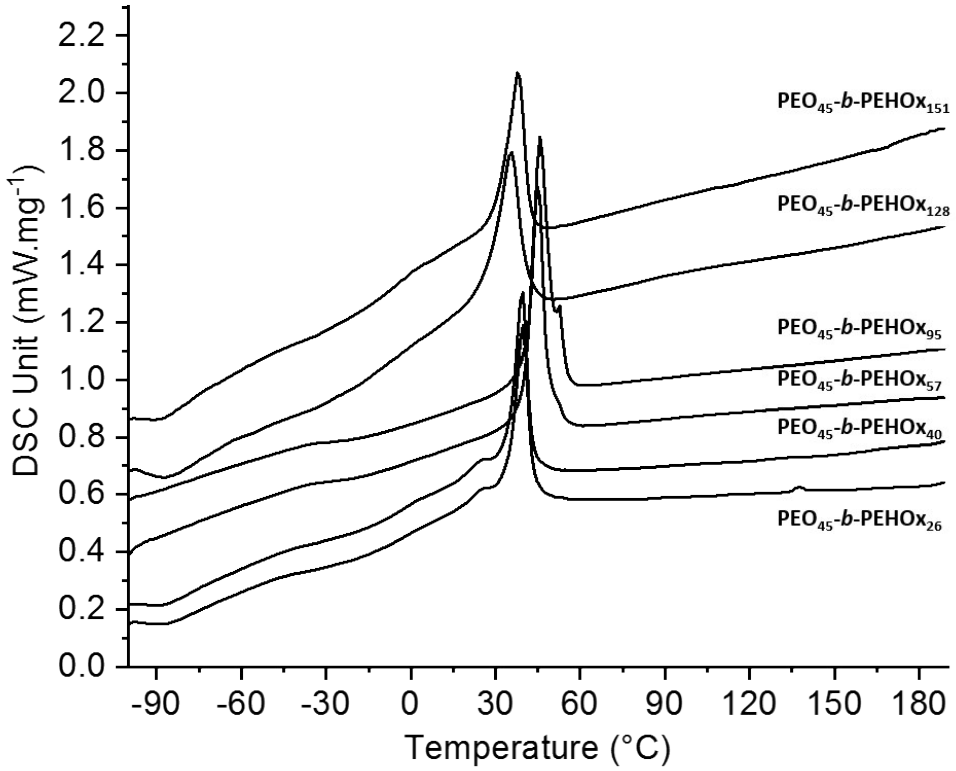


Figure S5 – DSC measurements of diblocks copolymers: (starting from the bottom) PEO_{45}-*b*-$PEHOx_{26}$, PEO_{45}-*b*-$PEHOx_{40}$, PEO_{45}-*b*-$PEHOx_{57}$, PEO_{45}-*b*-$PEHOx_{95}$, PEO_{45}-*b*-$PEHOx_{128}$ and PEO_{45}-*b*-$PEHOx_{151}$

4. Self-Assembly of PEO-*b*-PEHOx polymers

a. Reaching quickly stable self-assembled structures by solvent switch

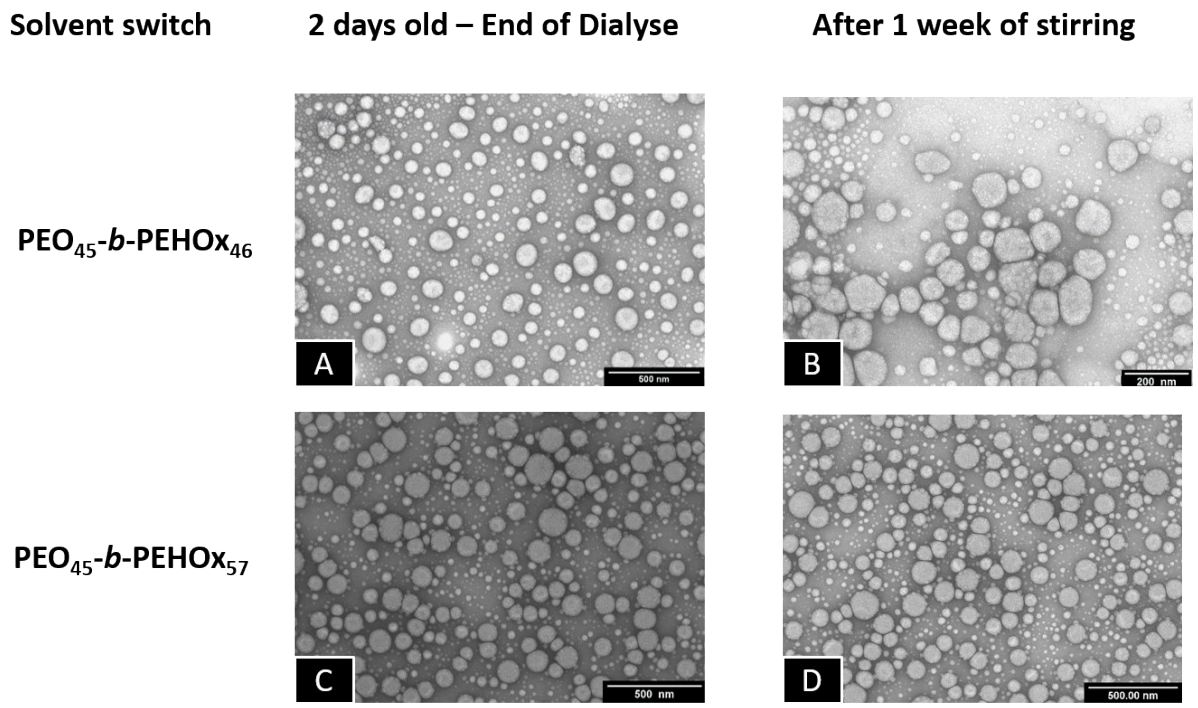


Figure S6 – Representative TEM images of self-assemblies formed by solvent switch method of PEO_{45}-*b*-$PEHOx_{46}$ and PEO_{45}-*b*-$PEHOx_{57}$. after: (left) 2 days of dialysis and (right) 2 days of dialysis and 1 week of stirring. Scale bar 200 nm – D. Scale bars 500 nm – A, C, D.

b. Supplementary Cryo-TEM images of SS of PEO_{45}-*b*-$PEHOx_{95}$

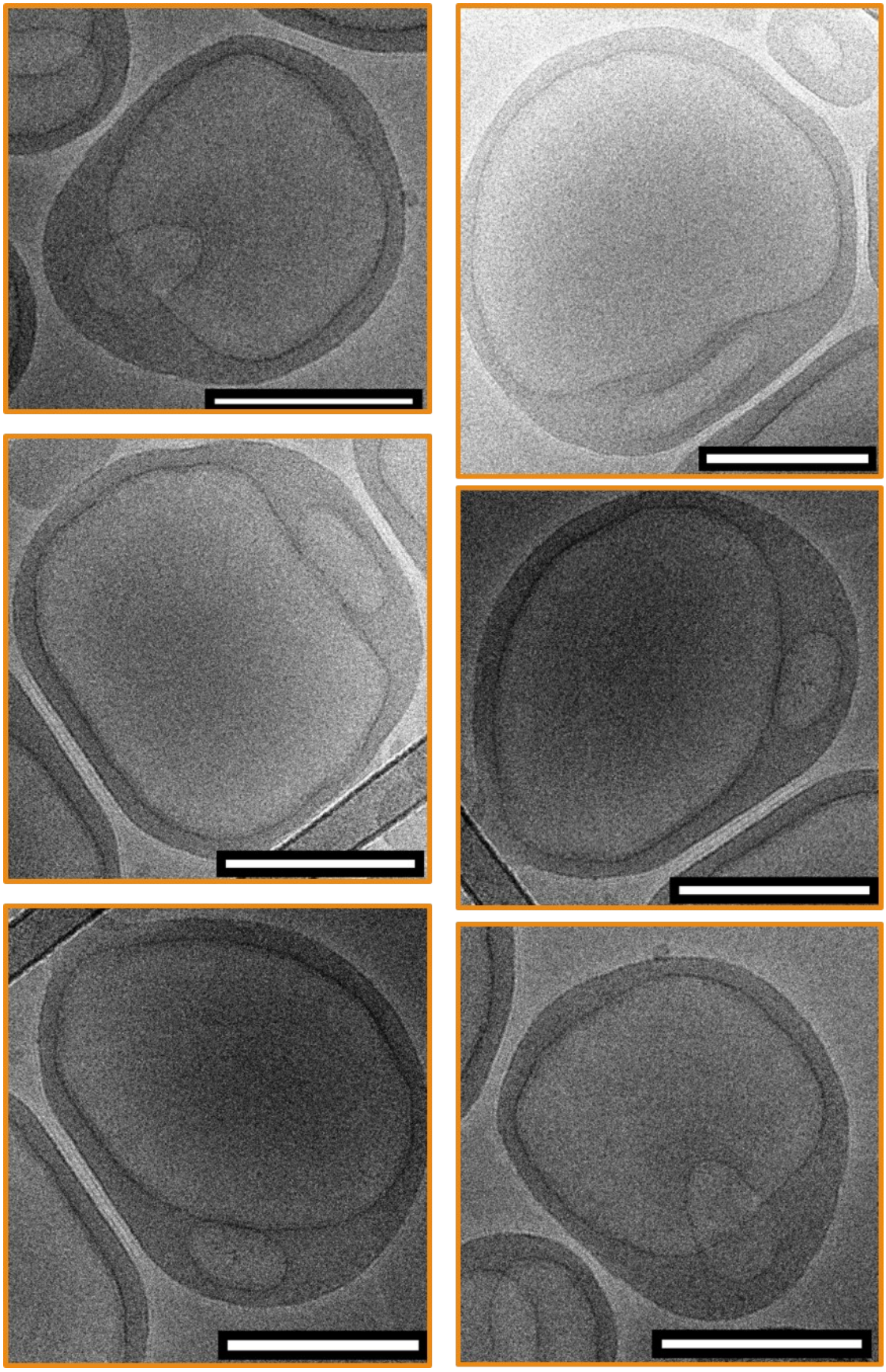


Figure S7 – Supplementary Cryo-TEM images of SS of PEO_{45}-*b*-$PEHOx_{95}$. Scale bars 200 nm

c. Supplementary Cryo-TEM images of SS of PEO_{45}-*b*-$PEHOx_{128}$

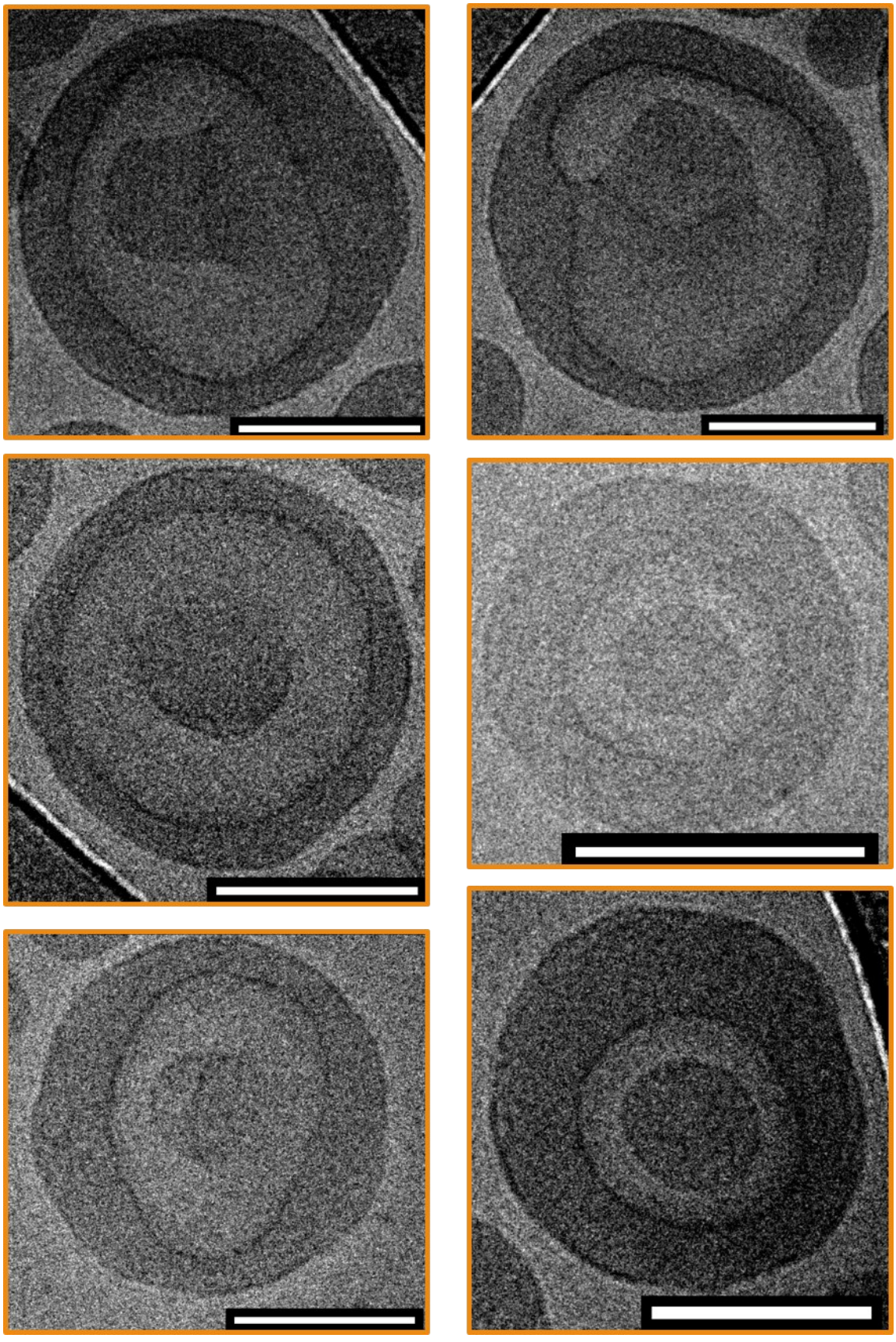


Figure S8 -Supplementary Cryo-TEM images of PEO_{45}-*b*-$PEHOx_{128}$. Scale bars 100 nm

d. Determination of dn/dc value for SLS study

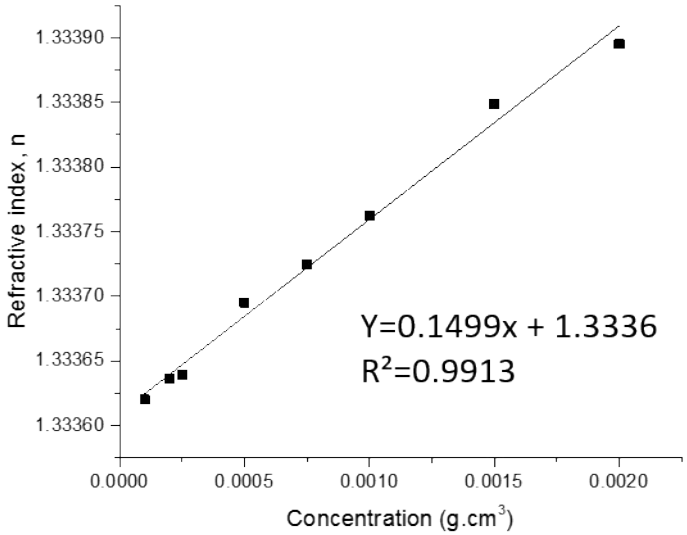


Figure S9 – Determination of the refractive index increment value, dn/dc, of PEO-*b*-PEHOx

e. MIE plot and DLS profile

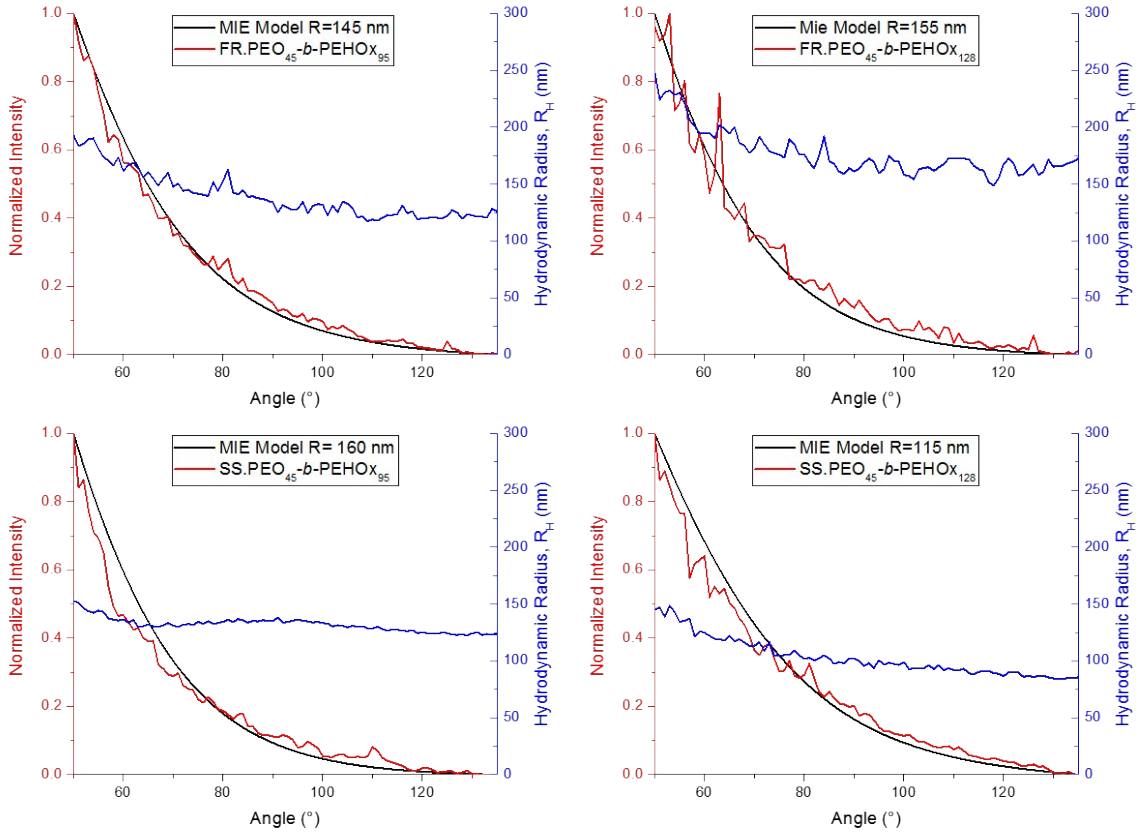


Figure S10 – MIE plot and DLS profiles of FR and SS of PEO_{45}-*b*-$PEHOx_{95}$ and PEO_{45}-*b*-$PEHOx_{128}$

f. Representative TEM and Cryo-TEM in high resolution of the MCMs

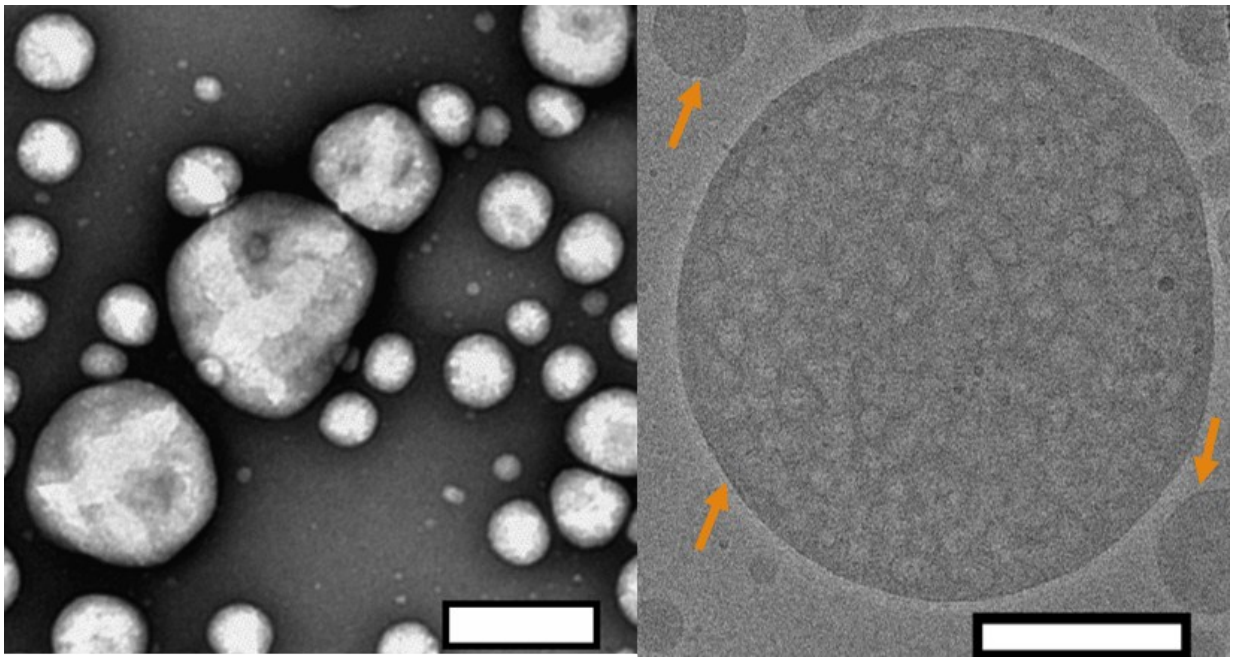


Figure S11 – Representative TEM and Cryo-TEM images of a multicompartment micelle (MCM) formed by the FR of PEO_{45}-*b*-$PEHOx_{128}$. Scale bars 200 nm. The orange arrows highlight the black halo of PEO corona.

g. MCMs formed are near equilibrium self-assembled structures

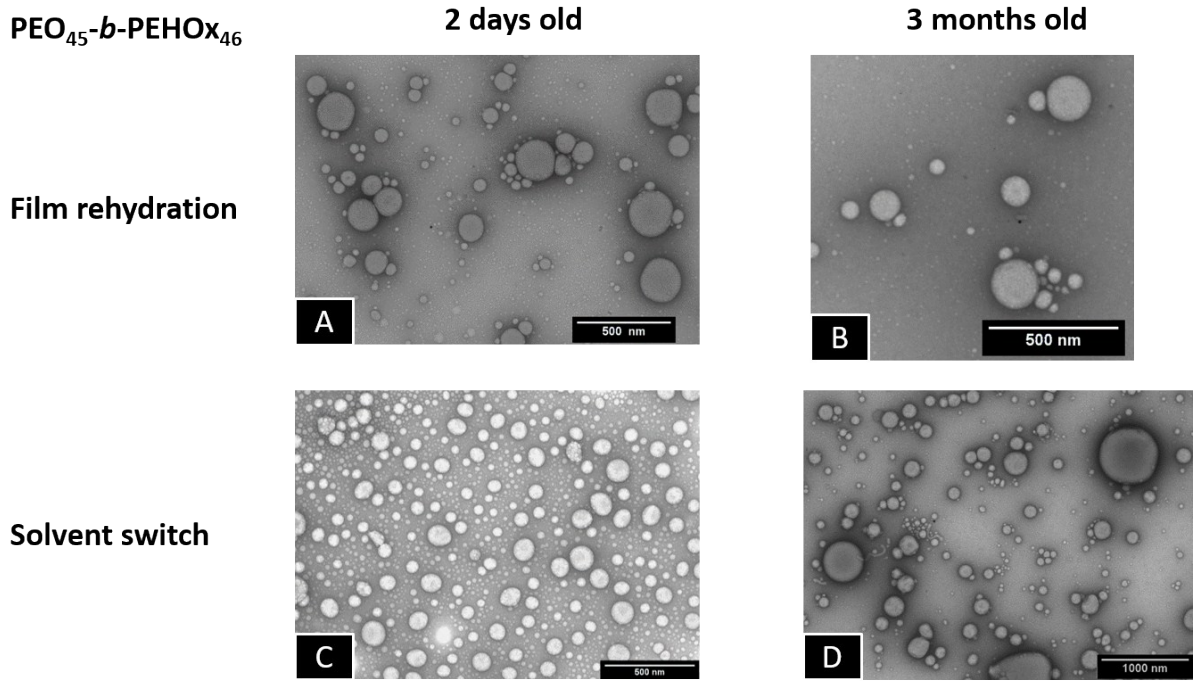


Figure S12 – Representative TEM images of PEO_{45}-*b*-$PEHOx_{46}$ showing the stability of the spherical nanoparticles, MCMs, over months. Scale bars 500 nm – A, B, C. Scale bars 1000 nm – D.

h. Representative TEM and Cryo-TEM in higher resolution of the pseudo-vesicles

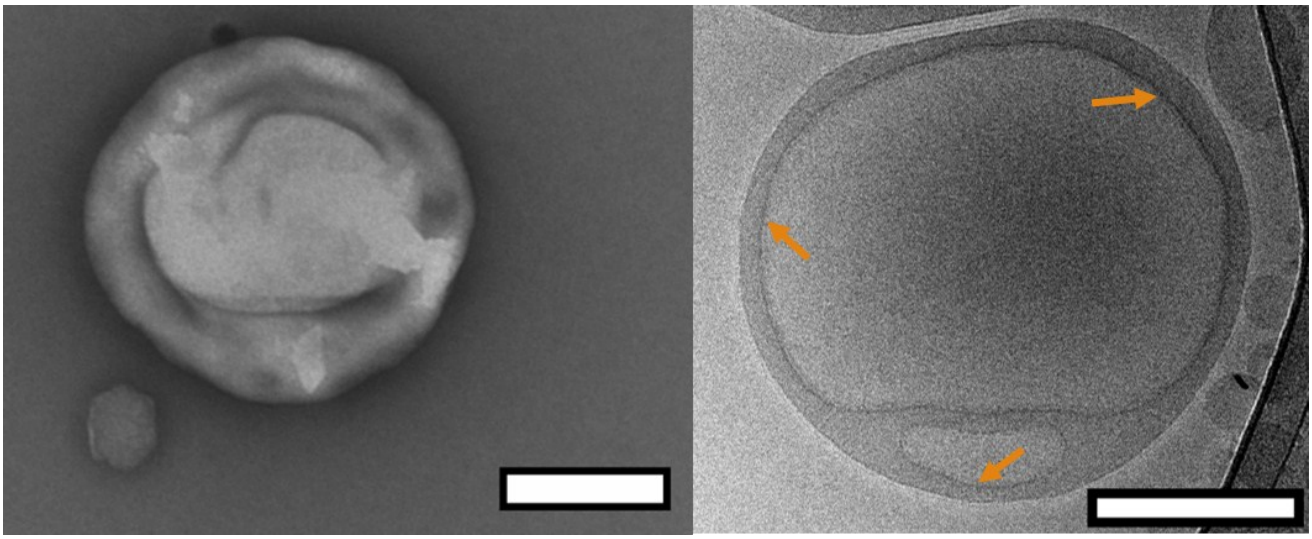


Figure S13 – Representative TEM and Cryo-TEM images of a pseudo-vesicle formed by the SS of PEO_{45}-b-$PEHOx_{95}$. Scale bars 200 nm. The orange arrows highlight the black halo of PEO corona.

i. Other morphology of pseudo-vesicles – 3 hollow cavities

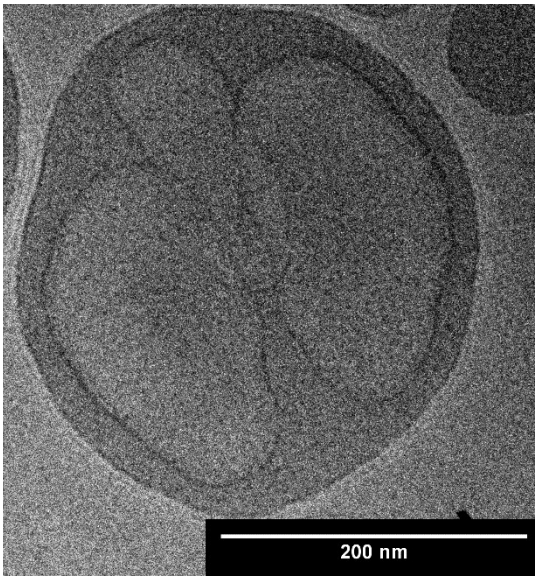


Figure S14 – Representative Cryo-TEM images of SS of PEO_{45}-*b*-$PEHOx_{95}$ showing the other morphologie of the pseudo-vesicles. Scale bar 200 nm.

j. Representative NMR spectrum of pseudo-vesicles and yolk/shell nanoparticles

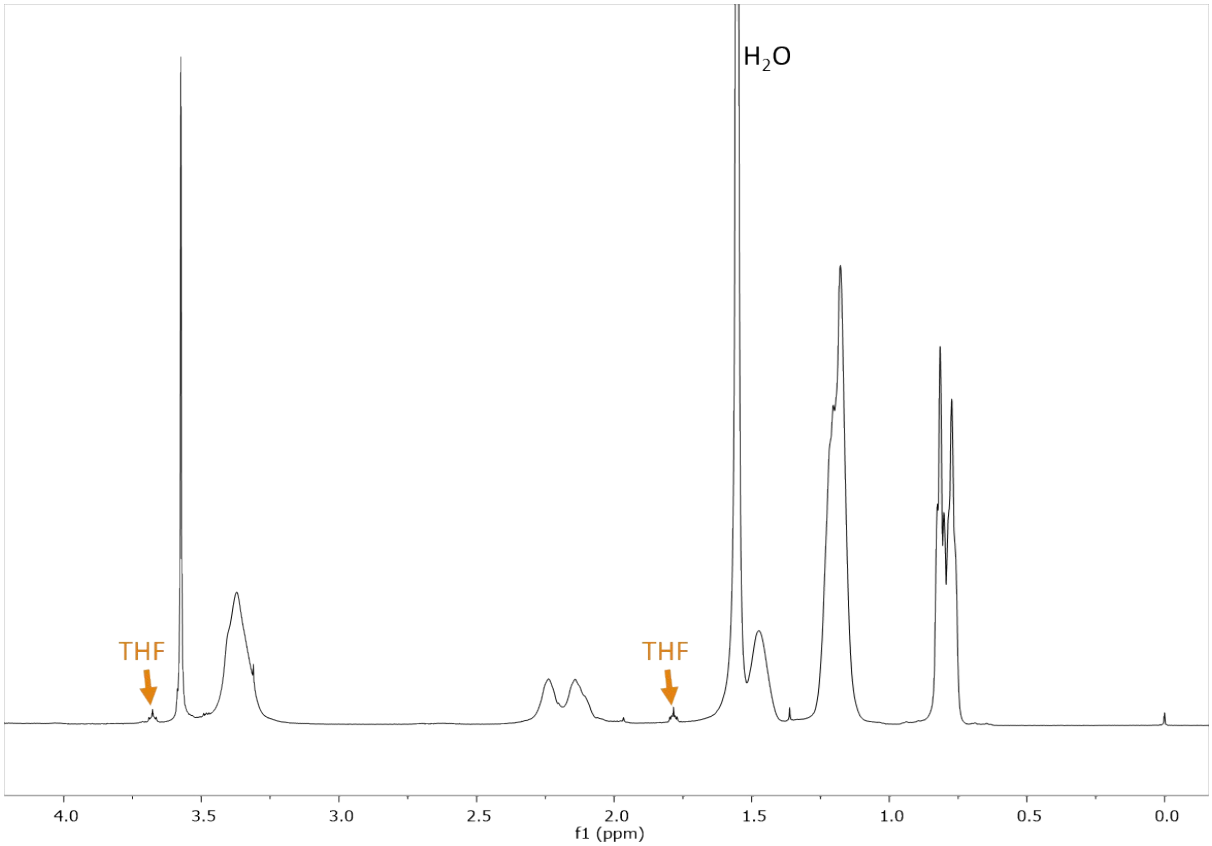


Figure S15 - Representative ^{1}H NMR ($CDCl_3$) of pseudo-vesicles and yolk/shell nanoparticles showing the remaining traces of THF after self-assembly by solvent switch.

l. Membrane thicknesses of various pseudo-vesicles and yolk/shell nanoparticles

Table S2 - Compilation of the membrane thicknesses of all observed pseudo-vesicles and yolk/shell nanoparticles determined by Cryo-TEM. For yolk/shell nanoparticles, each single nanoparticle is highlighted by the thicker border. [a] corresponds to the radius of the micellar core.

PEO_{45}-b-$PEHOx_{95}$	$l_{membrane}$ [nm]	PEO_{45}-*b*-$PEHOx_{128}$	$l_{membrane}$ [nm]
Pseudo-vesicles	18.4 ± 1.6	Yolk/Shell nanoparticles	36.8 ± 1.6
	17.3 ± 1.9		17.2 ± 1.1
	13.8 ± 1.4		26.7 ± 1.2[a]
	14.1 ± 2.2		41.3 ± 5.0
	24.3 ± 5.3		36.1 ± 1.1[a]
	25.7 ± 6.7		18.0 ± 3.3
	20.2 ± 4.1		20.2 ± 5.1
	17.7 ± 3.9		36.9 ± 2.3[a]
	15.5 ± 2.5		14.6 ± 2.1
	15.2 ± 1.9		34.5 ± 0.7[a]
	14.2 ± 1.6		51.0 ± 3.6
	14.3 ± 2.5		25.1 ± 3.0
	16.9 ± 2.2		40.4 ± 0.8[a]
	13.7 ± 1.9		22.5 ± 2.3
	17.9 ± 2.7		17.6 ± 0.4[a]
	18.2 ± 3.1		37.8 ± 3.7
	14.6 ± 1.9		20.2 ± 2.0
	20.0 ± 4.5		15.7 ± 0.4[a]
	25.9 ± 14.0		23.5 ± 2.1
	23.6 ± 7.4		40.2 ± 4.1
	15.5 ± 2.0		27.5 ± 0.9[a]
	18.6 ± 4.1		19.7 ± 3.0
	22.7 ± 4.8		59.6 ± 5.2
	18.3 ± 4.4		31.2 ± 1.1[a]
	17.3 ± 3.4		
	18.4 ± 3.0		
	14.6 ± 2.3		
	16.4 ± 3.4		
	16.5 ± 3.8		

m. Representative TEM and Cryo-TEM in higher resolution of the yolk/shell nanoparticles

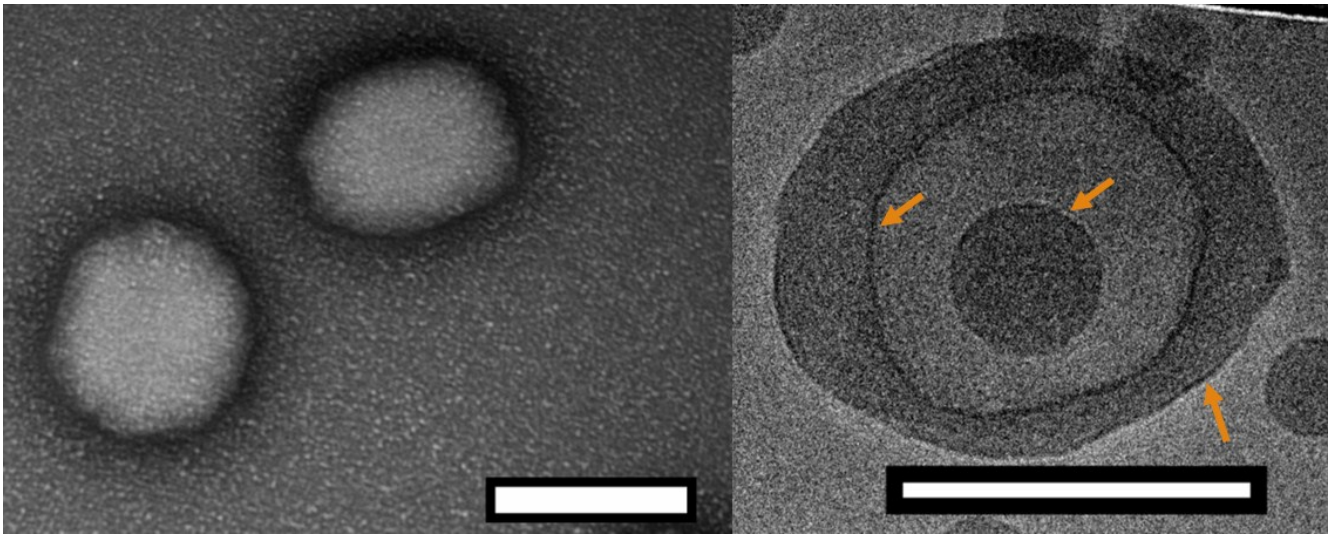


Figure S16 – Representative TEM and Cryo-TEM images of a yolk/shell nanoparticle formed by the SS of PEO_{45}-*b*-$PEHOx_{128}$. Scale bars 200 nm. The orange arrows highlight the black halo of PEO corona.

5. Length of the respective polymers and blocks

a. Random conformation of PEO (coil)

PEO has a an average bond length of 146 pm[1] (d = 146 pm = 1.46 Å) and has about 3 bonds per repeating unit (l=3). To end-to-end distance in the random coil, the tetraedric bond angle (109.5 degrees), the effective bond length and the number of repeating units must be taken in to account. PEO-45 has 45 repeating units (n=45).

$$R_{eff} = \frac{1 + cos\theta}{1 - cos\theta} * \sqrt{n * l} * d * sin\left(\frac{109.5}{2}\right)$$

$$R_{eff} = \frac{1.33}{0.67} * \sqrt{3 * 45} * 1.46A * 0{,}81 = 28\ A = 2.8nm$$

b. Stretched conformation of PEHOX

Although the average bond length of PEHOX is not reported, the chemical structure is similar to PEO (however, Nitrogen instead of Oxygen). Since any changes of the average bond length are not likely to be substantial, we rounded the above distance to 145 pm as bond length and 109.5 as angle for a perfect tetrahedron.

$$r_{contour} = n * l * \sin\left(\frac{\theta}{2}\right)$$

$$r_{contour} = 3 * 46 * 145nm * \sin\left(\frac{109.5}{2}\right) = 16.3nm \quad \text{for PEHOx-46}$$

$$r_{contour} = 3 * 57 * 145nm * \sin\left(\frac{109.5}{2}\right) = 20.2nm \quad \text{for PEHOx-57}$$

$$r_{contour} = 3 * 95 * 145nm * \sin\left(\frac{109.5}{2}\right) = 33.7nm \quad \text{for PEHOx-95}$$

For the block-copolymers, the contour length of PEO has to be taken into account as well:

$$r_{contour} = 3 * 45 * 146nm * \sin\left(\frac{109.5}{2}\right) = 16.1nm \quad \text{for PEHOx-46}$$

The overall length of PEO_{45}-*b*-$PEHOx_{46}$ is therefore 32.3 nm

The overall length of PEO_{45}-*b*-$PEHOx_{57}$ is therefore 36.1 nm

The overall length of PEO_{45}-*b*-$PEHOx_{95}$ is therefore 50.0 nm

1. H. Lee, R. M. Venable, A. D. MacKerell and R. W. Pastor, *Biophys. J.*, 2008, **95**, 1590-1599.