

Supplementary Material (ESI) for RSC Advances  
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## Highly monodisperse zwitterion functionalized non-spherical polymer particles with tunable iridescence

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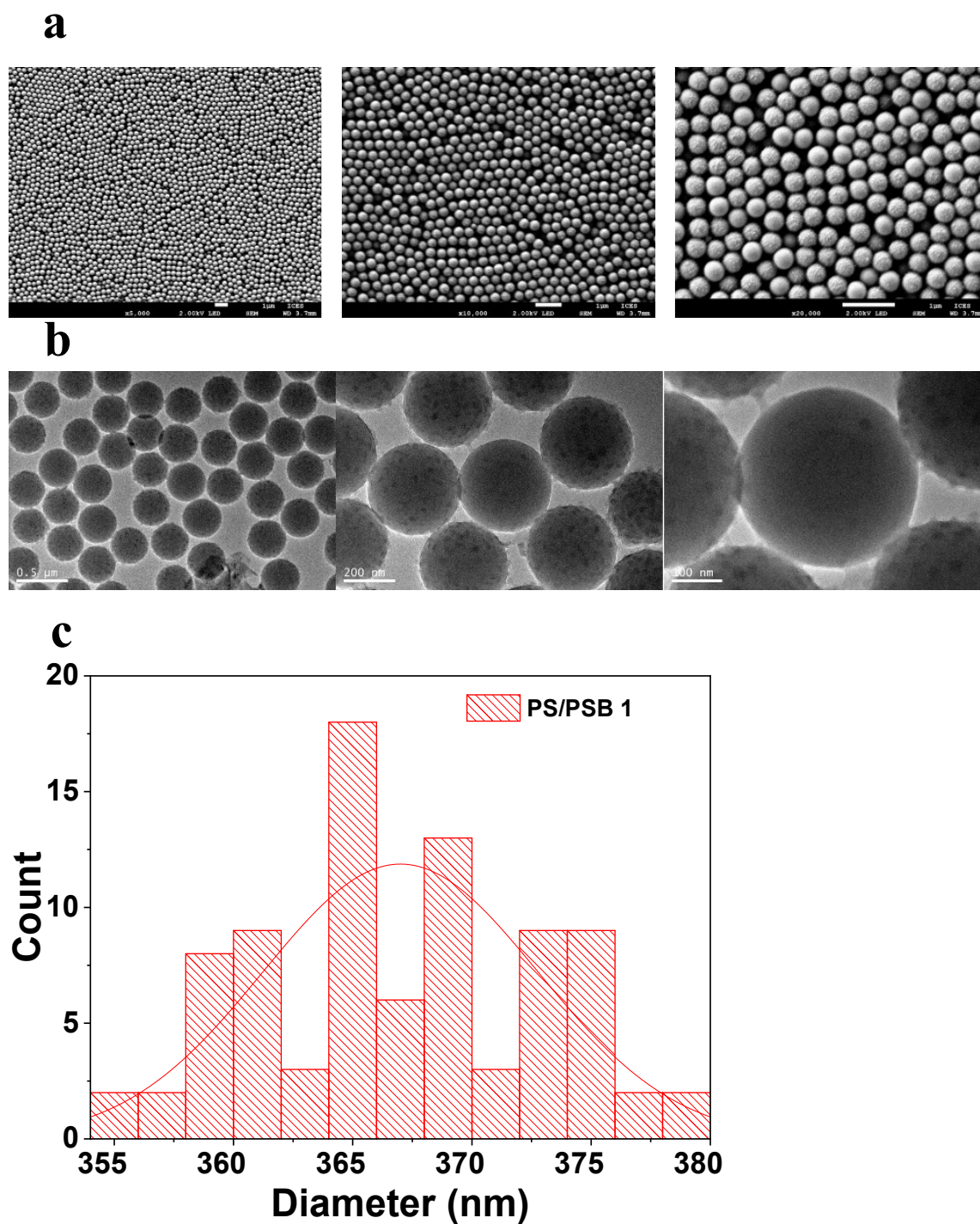
**Figure S3.** XPS of PS/PSB particles

**Figure S4.** FT-IR of PS/PSB particles

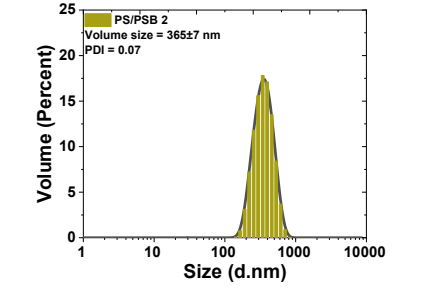
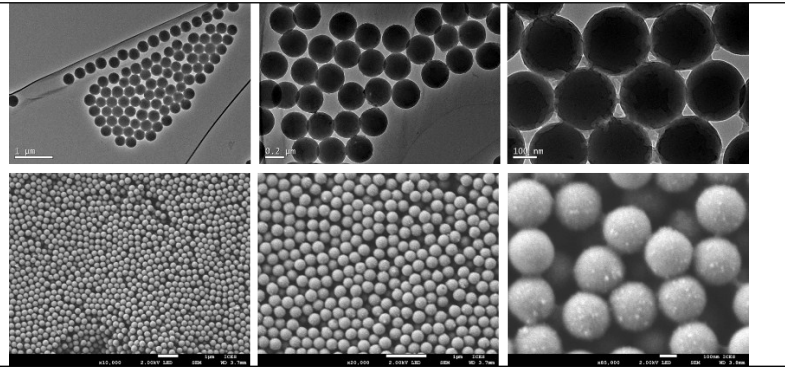
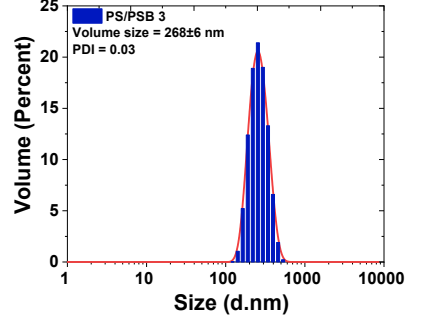
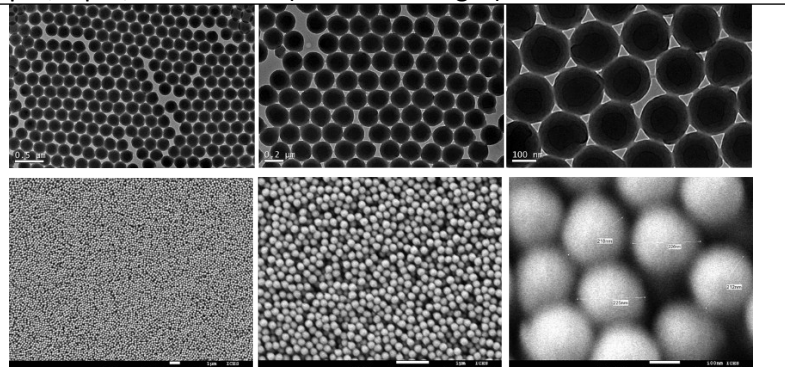
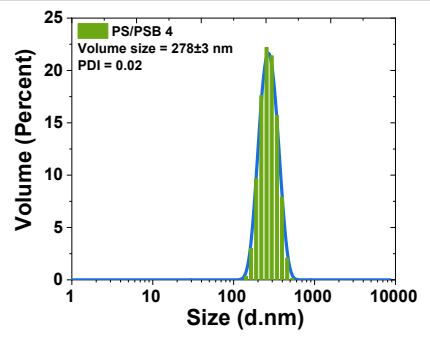
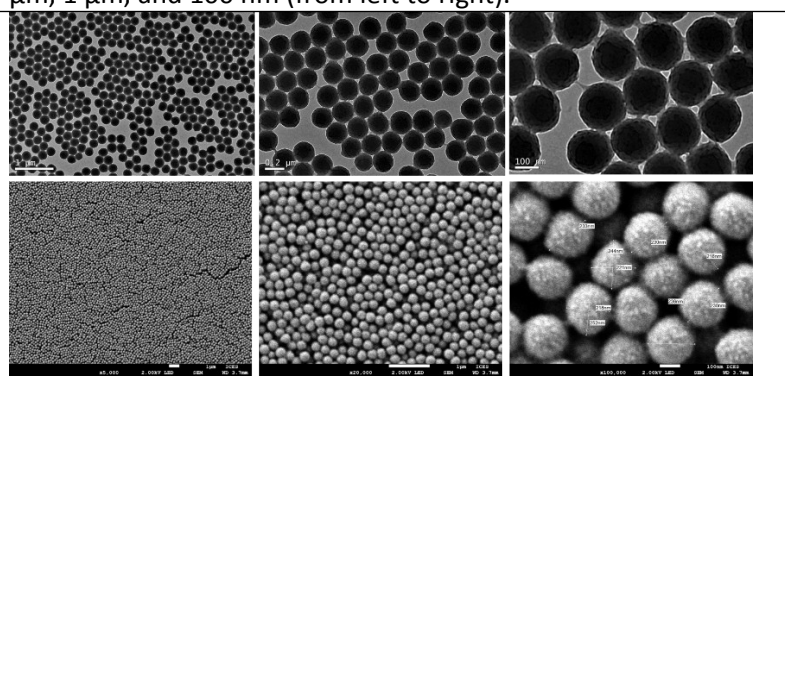
**Figure S5.** TGA of PS/PSB particles

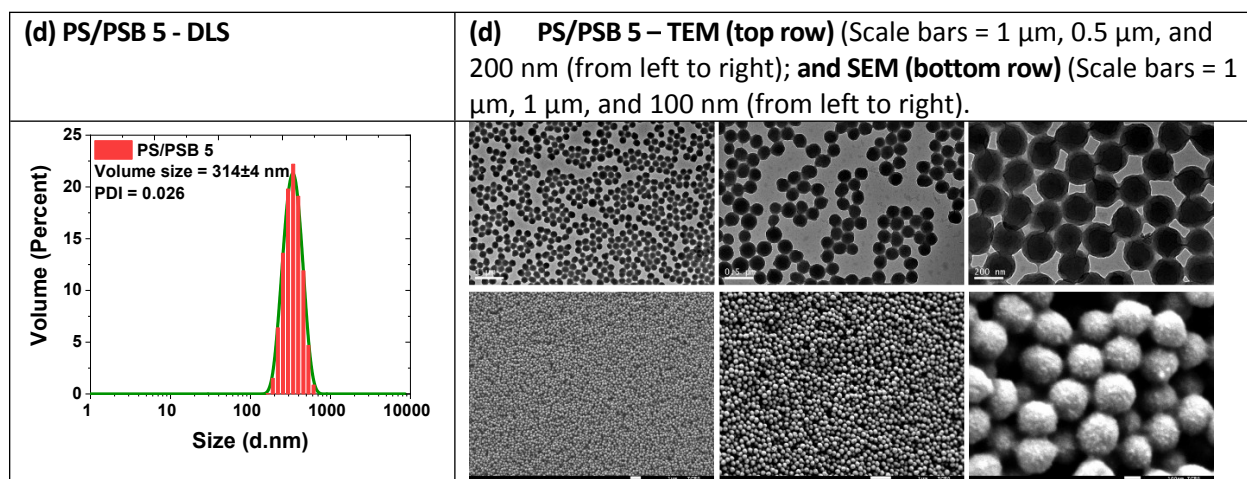
**Figure S6.** SEM image of colloidal PC arrays of PS/PSBs

**Figure S7.** SEM image of colloidal PC arrays of PS/PSB 5



**Fig. S1** (a) SEM (Scale bars = 1  $\mu\text{m}$ , 1  $\mu\text{m}$ , and 1  $\mu\text{m}$  (from left to right)); and (b) TEM (Scale bars = 0.5  $\mu\text{m}$ , 0.2  $\mu\text{m}$ , and 0.2  $\mu\text{m}$  (from left to right)); images of PS/PSB 1 at different magnification of PS/PSB 1 and (c) size distribution of PS/PSB 1 as determined by SEM.

<p><b>(a) PS/PSB 2 - DLS</b></p>	<p><b>(a) PS/PSB 2 – TEM (top row)</b> (Scale bars = 1 <math>\mu\text{m}</math>, 0.2 <math>\mu\text{m}</math>, and 100 nm (from left to right); <b>and SEM (bottom row)</b> (Scale bars = 1 <math>\mu\text{m}</math>, 1 <math>\mu\text{m}</math>, and 100 nm (from left to right).</p>
	
<p><b>(b) PS/PSB 3 - DLS</b></p>	<p><b>(b) PS/PSB 3 – TEM (top row)</b> (Scale bars = 0.5 <math>\mu\text{m}</math>, 0.2 <math>\mu\text{m}</math>, and 100 nm (from left to right); <b>and SEM (bottom row)</b> (Scale bars = 1 <math>\mu\text{m}</math>, 1 <math>\mu\text{m}</math>, and 100 nm (from left to right).</p>
	
<p><b>(c) PS/PSB 4 - DLS</b></p>	<p><b>(c) PS/PSB 4 – TEM (top row)</b> (Scale bars = 1 <math>\mu\text{m}</math>, 0.2 <math>\mu\text{m}</math>, and 100 nm (from left to right); <b>and SEM (bottom row)</b> (Scale bars = 1 <math>\mu\text{m}</math>, 1 <math>\mu\text{m}</math>, and 100 nm (from left to right).</p>
	



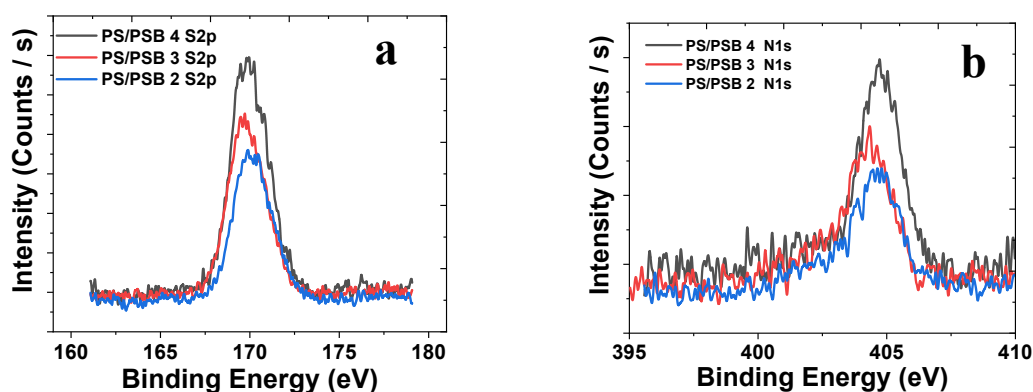
**Fig. S2** The size distribution from DLS measurement in DI water, TEM and SEM images of as-synthesized (a) PS/PSB 2, (b) PS/PSB 3, (c) PS/PSB 4, and (d) PS/PSB 5 colloids respectively. Transmission electron micrograph (TEM, top) images of dried PS/PSB particles at different magnification. Scale bars = 1  $\mu\text{m}$ , 0.5  $\mu\text{m}$ , and 200 nm (from left to right); Scanning electron micrograph (SEM, bottom) images of dried PS/PSB particles at different magnification. Scale bars = 1  $\mu\text{m}$ , 1  $\mu\text{m}$ , and 100 nm (from left to right).

**Table S1.** Characterization of PS/PSB particles

Entry	Polymer code	<sup>a</sup> SB (% w/w)	<sup>b</sup> M <sub>n,SEC</sub> (g/mol)	<sup>b</sup> PDI <sub>SEC</sub>	Solid content (%)	Volume fraction (Wv%)	<sup>c</sup> D <sub>v</sub> (nm)	<sup>c</sup> D <sub>v</sub> / D <sub>n</sub> (nm)	SSA ×10 <sup>5</sup> cm <sup>2</sup> g <sup>-1</sup>	Number of particles mL <sup>-1</sup> ×10 <sup>11</sup>	<sup>e</sup> Weight loss of SB (%)
1.	PS/PS B 1	1.5	110k	2.62	6.3	6.0	455±10	1.13 ± 0.03	1.3	2.4	0.95
2.	PS/PS B 2	3.1	185k	2.81	6.7	6.4	365 ±7	1.27 ± 0.04	1.8	3.2	-
3.	PS/PS B 3	6.1	160k	2.47	8.2	7.7	268±6	1.17 ± 0.03	2.3	5.2	1.31
4.	PS/PS B 4	8.6	114k	2.2	6.6	6.3	278 ±3	1.14 ± 0.02	2.2	4.1	-
5.	PS/PS B 5	9.9	213	2.8	7.1	6.7	314±4	1.14 ± 0.02	1.9	3.9	3.74

Sty: styrene; SB: sulfobetaine monomer; polymerization temperature and time: 70 °C and 24 h; <sup>a</sup>SB (% w/w) content to styrene ratio. <sup>b</sup>soluble fraction of PS/PSB in THF was used for GPC analysis using linear polystyrene as standard; <sup>c</sup>D<sub>v</sub> and D<sub>n</sub> is the volume-average and number-average diameter, determined by DLS. D<sub>v</sub> /D<sub>n</sub> is the particle size distribution. SSA = specific surface area of the particles; DLS principle is based on spherical object, the reported diameters and their surface area and number of particle calculation is semi-quantitative due to non-spherical nature of PS/PSB particles. <sup>d</sup>weight loss of SB determined by TGA.

### X-ray photoelectron spectroscopy (XPS) analysis

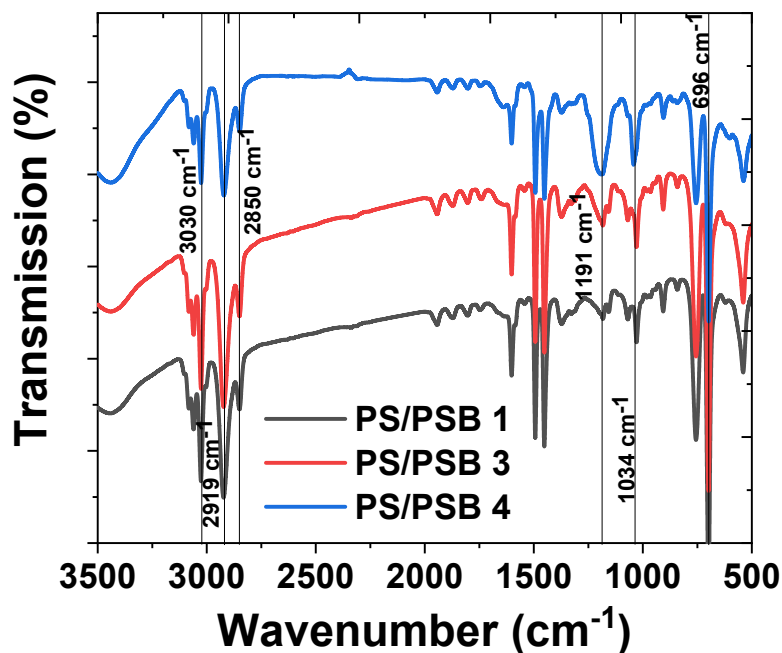


**Fig. S3** XPS spectra of PS/PSBs (a) S 2p region and (b) N1s region.

The sulfur and nitrogen content of the PS/PSB particles could be observed on the zwitterion group functionalized polystyrene. The detailed XPS analysis of PS/PSBs is shown in Fig. S5. The peak around 404 eV corresponds to the quaternary ammonium N1s peak in the sulfobetaine group. The S2p peak at around 169 eV attributed to the sulfonate and sulfate of sulfobetaine and initiator further proves the surface is well distributed by PSB on the surface of PS. The intensity of PS/PSB 3 and 4 are higher than that of PS/PSB 2 thus indicating the increase in concentration of sulfobetaine content. Both FTIR and XPS data confirmed the efficient functionalization through copolymerization using sulfobetaine monomer via aqueous emulsifier-free emulsion polymerization to obtain monodisperse PS/PSB non-spherical particles.



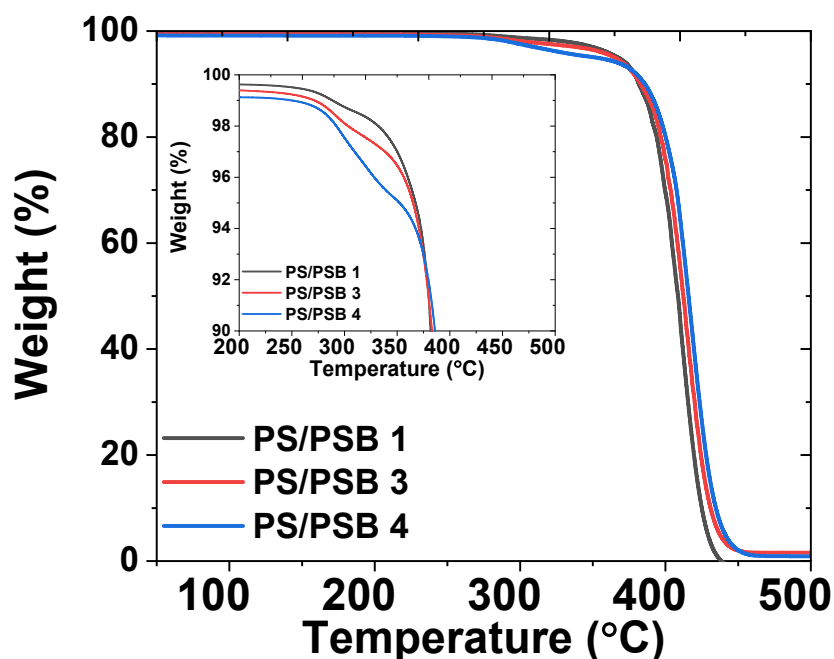
### FTIR analysis



**Fig. S4** FTIR spectra of PS/PSB 1, PS/PSB 3 and PS/PSB 4.

The strong absorption bands at 1191 cm<sup>-1</sup> and 1034 cm<sup>-1</sup> are associated with the stretching vibration of quaternary ammonium and sulfonate group of PSB respectively (Fig. S6). The intensity of these two bands increased with the increasing concentration of SB. The bands at 3030 cm<sup>-1</sup>, 2919 cm<sup>-1</sup>, and 2850 cm<sup>-1</sup> are due to the C-H stretching vibration of PS. The peaks at 1601 cm<sup>-1</sup> and cm<sup>-1</sup> are associated with the C=C stretching of the phenyl group of PS. The characteristic aromatic CH out of the plane bend at 696 cm<sup>-1</sup> also confirmed the presence of polystyrene.

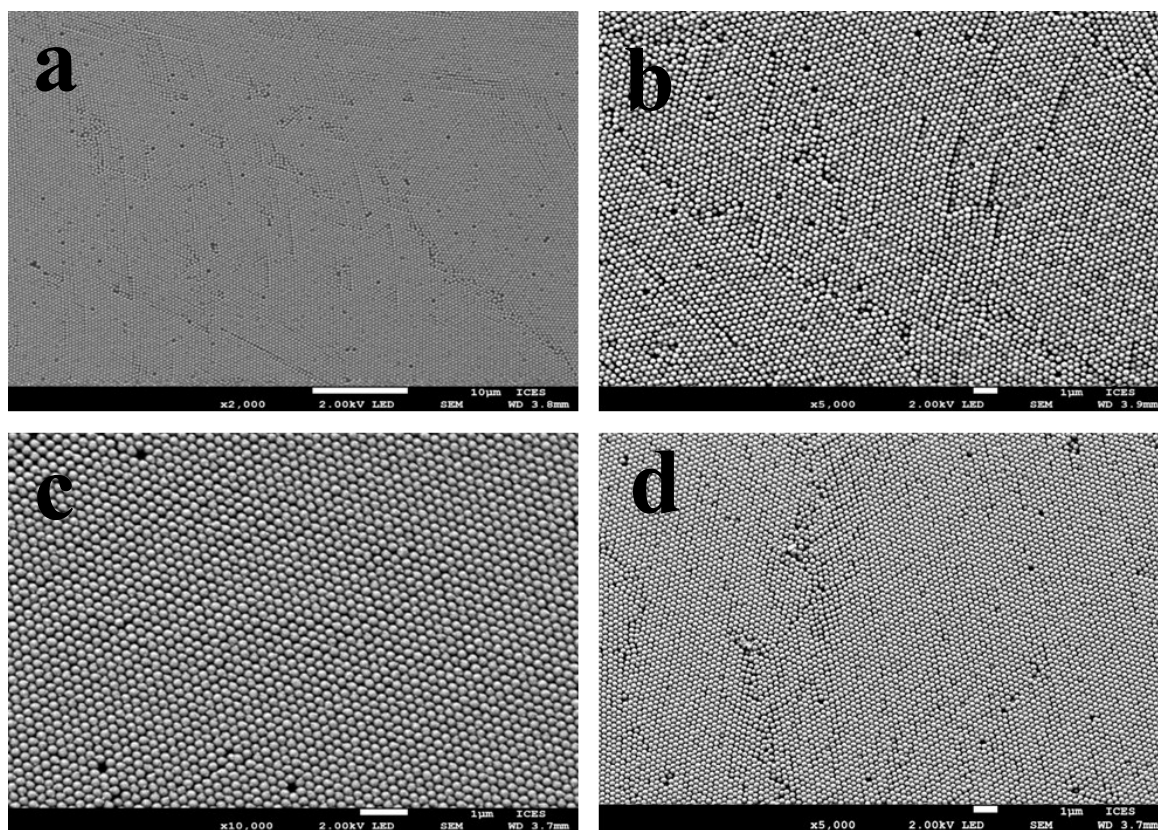
### Thermogravimetric analysis (TGA)



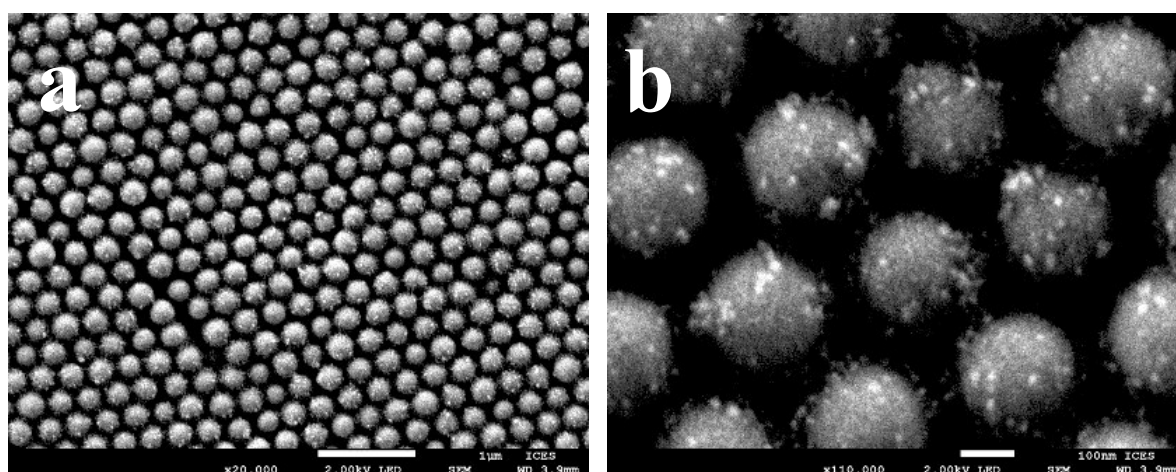
**Fig. S5** TGA of PS/PSB particles under nitrogen atmosphere at a heating rate of 10 °C/min.

Unlike the polystyrene which shows a single step degradation, PS/PSB showed two step degradation. The first step of degradation occurs near 325 °C and associated with the loss of the side chain zwitterionic group of polysulfobetaine. The degradation temperature of SB component of PS/PSB is somewhat lower than that of pure polystyrene. The temperature that corresponds to 1-5 % weight loss of the original sample correlated with the sulfobetaine content in PS/PSB. The second step of degradation occurs at 429 °C and is due to the loss of polystyrene. As shown clearly in the inset of Figure S5, the thermal stability of PS/PSB lowers with increasing SB content.





**Fig. S6** SEM image of self-assembled colloidal PC of (a) PS/PSB 1; (b) PS/PSB 2; (c) PS/PSB 3; (d) PS/PSB 4; Scale bar = 1 µm.



**Fig. S7** SEM images of colloidal PC array of (a) PS/PSB 5; (b) expansion of PS/PSB 5 (a); Scale bar= 1 µm.