

Electronic Supplementary Information

Soft Matter manuscript

‘Foams Stabilized with Solid Particles
Carrying Stimuli-responsive Polymer Hairs’

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Table S1. Reaction conditions for the atom transfer radical polymerization of DEA using AMBEP^{a)} and molecular weights and their distributions data for PDEA_n-based macroinitiators.

		PDEA ₃₀ -PS ^{b)}	PDEA ₆₀ -PS ^{c)}	PDEA ₉₀ -PS ^{d)}
AMBEP	(g)	0.528	0.264	0.176
DEA	(g)	10.0	10.0	10.0
Isopropanol	(mL)	10.0	10.0	10.0
Cu(I)Cl	(g)	0.178	0.089	0.061
Bpy	(g)	0.562	0.281	0.188
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M_n (cal) ^{e)}	(g/mol)	11613	22700	33845
M_n (GPC) ^{f)}	(g/mol)	18100	22200	26000
M_w (GPC) ^{g)}	(g/mol)	20000	25000	29800
M_w/M_n ^{h)}		1.10	1.12	1.14
M_n (¹ H NMR) ⁱ⁾	(g/mol)	12800	23100	34300
DP ^{j)}		33	61	91

^{a)} 25 °C, 24 h, N₂

^{b)} AMBEP / DEA / Cu(I)Cl / Bpy, 1 / 60 / 2 / 4 (molar ratio)

^{c)} AMBEP / DEA / Cu(I)Cl / Bpy, 1 / 120 / 2 / 4 (molar ratio)

^{d)} AMBEP / DEA / Cu(I)Cl / Bpy, 1 / 180 / 2 / 4 (molar ratio)

^{e)} Theoretical number-average molecular weight

^{f)} Number-average molecular weight determined by GPC

^{g)} Weight-average molecular weight determined by GPC

^{h)} Polydispersity determined by GPC

ⁱ⁾ Number-average molecular weight determined by ¹H NMR spectroscopy

^{j)} Degree of polymerization determined by ¹H NMR spectroscopy

Table S2. Recipes for syntheses of the PDEA_n-PS latex particles by dispersion polymerization^{a)}.

		PDEA ₃₀ -PS	PDEA ₆₀ -PS	PDEA ₉₀ -PS
PDEA ₃₀ -MAI ^{b,c)}	(g)	2.787	—	—
PDEA ₆₀ -MAI ^{b,c)}	(g)	—	5.455	—
PDEA ₉₀ -MAI ^{b,c)}	(g)	—	—	3.250
VA-086 ^{b,c)}	(g)	0.623	0.623	0.249
Styrene ^{c)}	(g)	25	25	10
Isopropanol	(mL)	250	250	100

^{a)} 80 °C, 1 week, N₂, 300 rpm, $R_i = 7.93 \times 10^{13} \text{ mL}^{-1} \text{ s}^{-1}$

^{b)} PDEA-MAI / VA-086, 1/10 (molar ratio)

^{c)} Azo group / styrene, 1/100 (molar ratio)

Table S3. Particle size measured for PDEA_n-PS particles at various stirring rates in dispersion apparatus. Measurements were conducted at pH 10 and 0.1 M NaCl. See also Figure S3 for particle size distribution curves.

	<i>n</i> = 30 <i>D_v</i> / nm	<i>n</i> = 60 <i>D_v</i> / nm	<i>n</i> = 90 <i>D_v</i> / nm
1000 rpm	21380 ± 45810	18000 ± 27450	28280 ± 41090
2000 rpm	690 ± 280	10670 ± 4560	17570 ± 23670
3000 rpm	680 ± 240	7310 ± 3000	9450 ± 7540

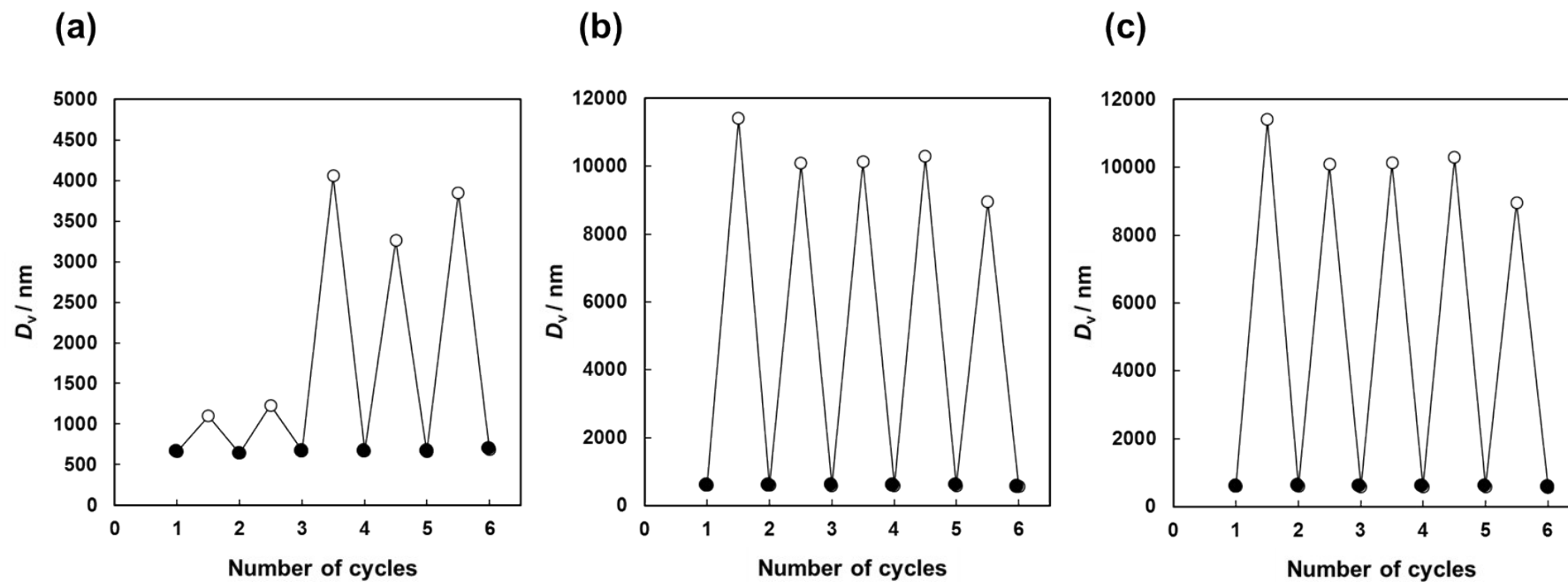


Figure S1. Volume-average diameters of the PDEA_n-PS particles versus the number of pH cycles between pH 3 and pH 10: $n =$ (a) 30, (b) 60, (c) 90.

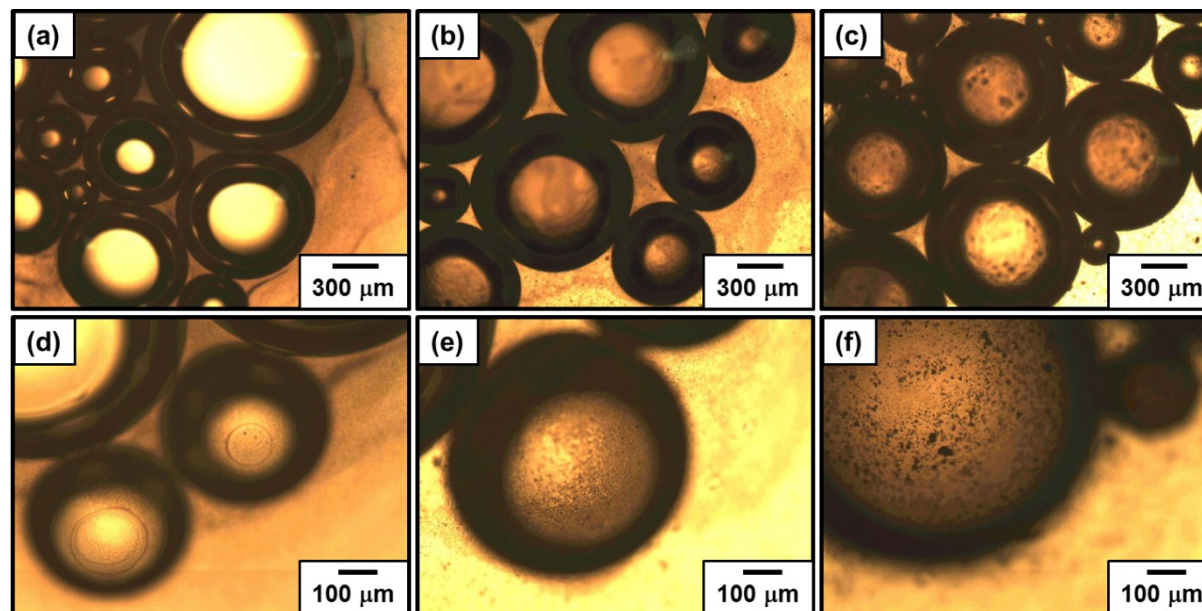
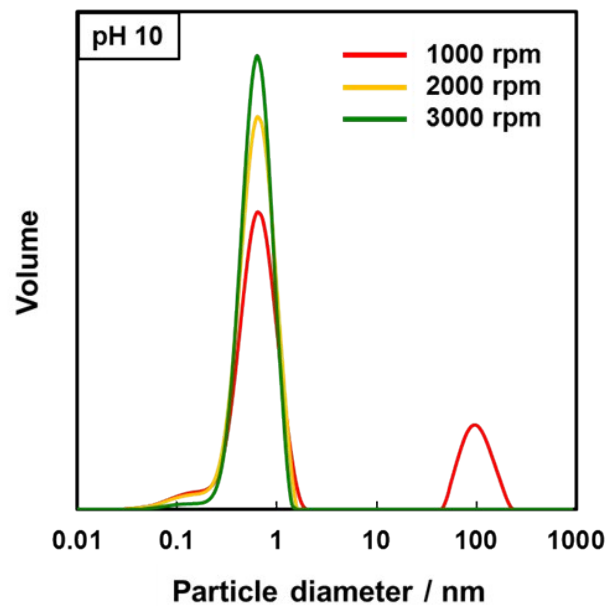
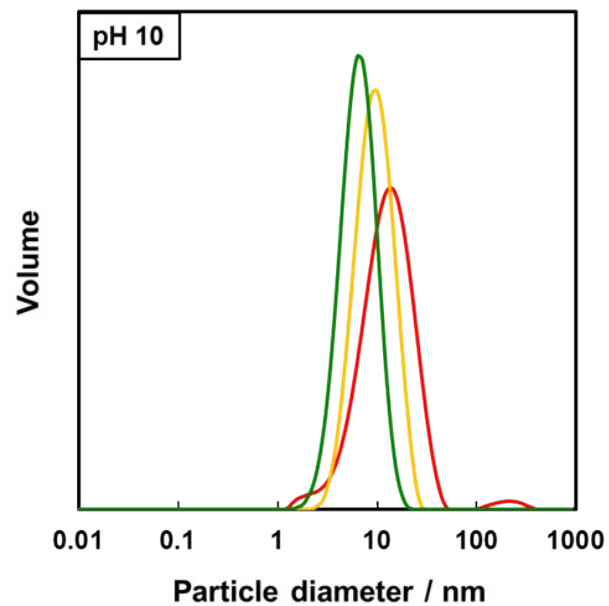


Figure S2. Optical microscopy images of bubbles stabilized with PDEA_n-PS particles ($n =$ (a, d) 30, (b, e) 60 and (c, f) 90) at pH 10. Figs. (d-f) are magnified images of Figs. (a-c), respectively. Bubbles were prepared using a touch mixer.

(a) PDEA₃₀-PS



(b) PDEA₆₀-PS



(c) PDEA₉₀-PS

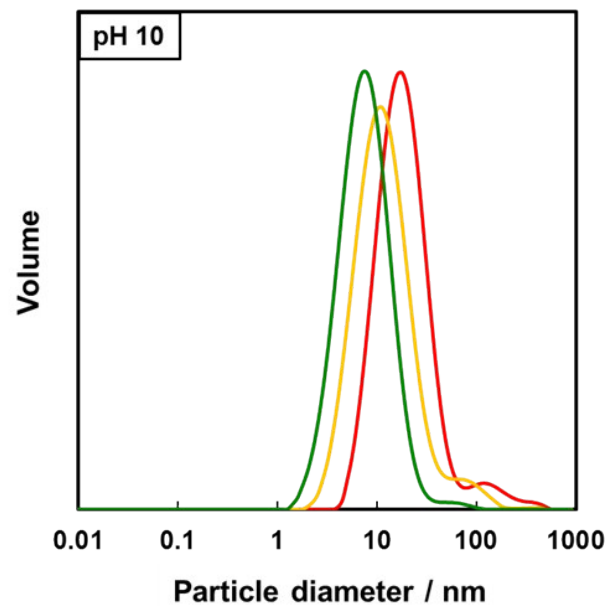


Figure S3. Particle size distribution curves obtained for PDEA_n-PS particles at various stirring rates in dispersion apparatus. Measurements were conducted at pH 10 and 0.1 M NaCl.

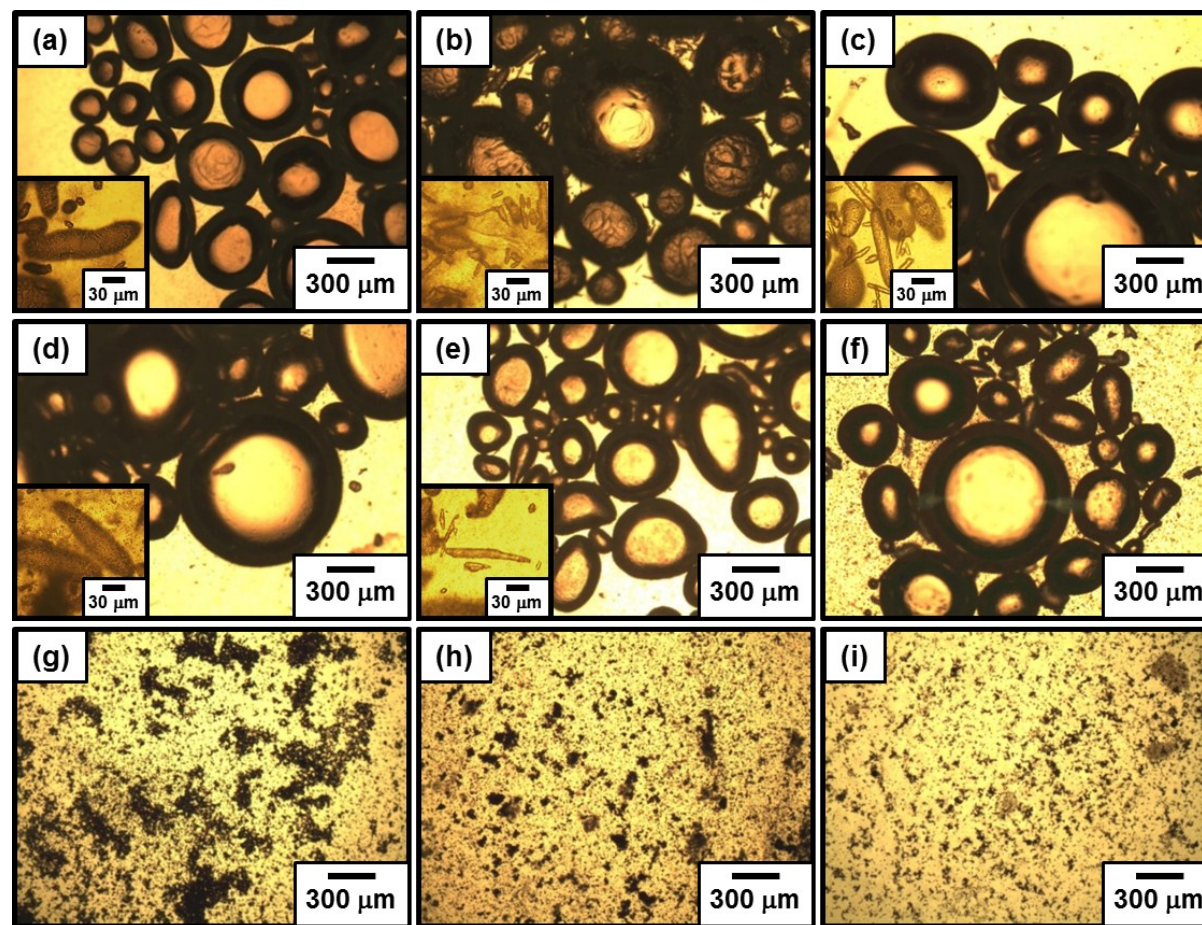
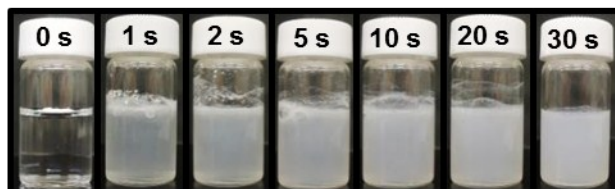


Figure S4. Optical microscopy images of foams stabilized with PDEA₆₀-PS particles (pH 10, 0.1 M NaCl) prepared at particle concentrations of (a) 0.5 wt%, (b) 1.0 wt%, (c) 2.0 wt%, (d) 5.0 wt%, (e) 10.0 wt%, (f) 15.0 wt%, (g) 20.0 wt%, (h) 30.0 wt% and (i) 40.0 wt%. Insets in Figs. (a-e) are magnified images showing non-spherical bubbles stabilized with PDEA₆₀-PS latex particles.

Dispersal experiments

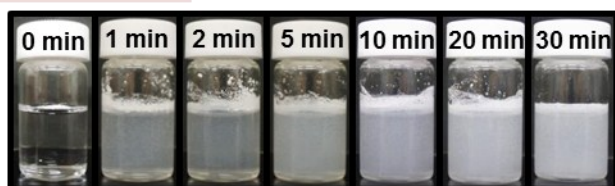
(8.0 g distilled water+ 0.01 g dried PDEA-PS powder)

Homogenizer



Dispersal
~ 20 s

Touch mixer

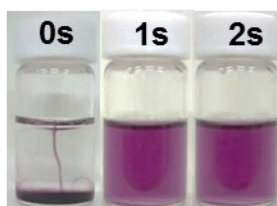


Dispersal
> 30 s

Mixing experiments

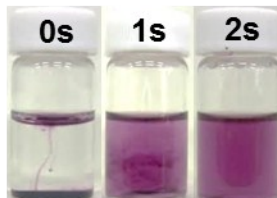
(8.0 g water + one droplet of Alizarine Blue Black B aqueous solution: 2.5 wt%)

Homogenizer



Homogeneous < 1 s

Touch mixer



Homogeneous ~ 2 s

Figure S5. A comparison of mixing efficiencies of the homogenizer and the touch mixer.

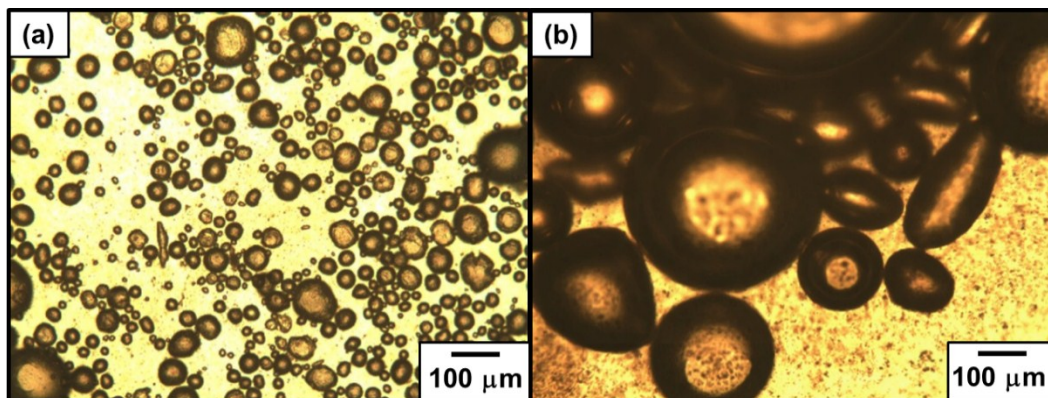


Figure S6. Optical microscopy images of bubbles stabilized with PDEA₆₀-PS particles (10 wt%, pH 10, 0.1 M NaCl). Preparation conditions: (a) homogenizer, 20000 rpm; (b) touch mixer, 2500 rpm.