Electronic Supplementary Information

Zwitterionic Poly(sulfobetaine methacrylate)s in Water: From Upper Critical Solution Temperature (UCST) to Lower Critical Solution Temperature (LCST) with Increasing Length of One Alkyl Substituent on the Nitrogen Atom

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**Experimental Section**

**Materials.** 2-(Methylamino)ethanol (99%), triethylamine (99%), 1,3-propanesultone (99%), trifluoroethanol (>99%), bromoethane (99%), 1-bromopropane (99%), 1-bromobutane (99%), 1-bromopentane (99%), 1-bromohexane (98%), 1-bromoheptane (>98%) were purchased from Alfa Aesar and used as received. Hydroquinone (99%) was obtained from Acros Organics. Methacryloyl chloride (97%, Sigma-Aldrich) was distilled under vacuum prior to use. 2-(N,N-Dimethyl)aminoethyl methacrylate (98%) was purchased from Aldrich and used as received for the synthesis of monomer M1. 2,2,2-Trifluoroethanol (99.9%) was obtained from Oakwood Chemical and used as received. Azobisisobutyronitrile (AIBN, 98%, Sigma-Aldrich) was recrystallized from ethanol, dried under high vacuum, and then stored in a refrigerator. Acetonitrile (99%, Aldrich) was dried with 4 Å molecular sieves (Aldrich). Chain transfer agent n-butyl (2-cyano-2-propyl) trithiocarbonate was synthesized according to a literature procedure and described in a previous publication. The water used for the preparation of polymer solutions was obtained from a Milli-Q Plus (Millipore) water purification system. All other chemical reagents were obtained from either Aldrich or Fisher/Acros and used without further purification.

**Characterization.** The $^1$H and $^{13}$C NMR spectra were recorded on a Varian VNMRS 500 MHz or a Mercury 300 MHz spectrometer, and the residual solvent proton signal was used as the internal standard. The mass spectroscopy (ESI MS) experiment was performed using a QStar Elite (Applied Biosystems) with a TOF (time-of-flight) analyzer and CEM (channel electron multipliers) detectors. The ESI MS samples were prepared by dissolving zwitterionic monomers in Milli-Q water with a concentration of 10 μg/g. Size exclusion chromatography (SEC) of zwitterionic polymers was performed using a SEC system with a 515 HPLC pump from Waters equipped with a refractive index detector from Knauer (RI detector K-2301), one PSS Suprema 10 μm guard
column (50 × 8 mm) and three PSS Suprema 10 μm columns (each 300 × 18 mm, 100 Å, 3000 Å, and 10000 Å). A 0.2 M sodium nitrate aqueous solution was used as the eluent, and the flow rate was set at 1.0 mL/min for the analysis. The SEC system was calibrated with a set of narrow disperse PEO standards, and the data were processed using Cirrus GPC/SEC software (Polymer Laboratories, Inc.). The monomers and polymers were freeze-dried using a LABCONCO 76705 Series Freeze Dryer.

**Synthesis of Zwitterionic Sulfobetaine Methacrylate Monomers (M1-M7).** Zwitterionic sulfobetaine methacrylate monomers were prepared according to Scheme 1. M1 was synthesized in one step by the reaction between commercially available 2-(N,N-dimethyl)aminoethyl methacrylate and 1,3-propanesultone. All other zwitterionic sulfobetaine methacrylate monomers were made through three steps. The following shows the detailed procedures for the synthesis of 3-((2-(methacryloyloxy)ethyl)(methyl)(n-hexyl)ammonio)-propane-1-sulfonate (M6).

2-(Methylamino)ethanol (7.013 g, 0.0934 mol) was weighed into a 100 mL three-necked round bottom flask equipped with a stir bar. The flask was placed in an oil bath with a preset temperature of 50 °C. 1-Bromohexane (18.818 g, 0.114 mol) was added dropwise into the flask from an addition funnel at 50 °C, and the reaction was allowed to proceed for 3 h. After the addition of a solution of NaOH (5.682 g, 0.142 mol) in H₂O (14 mL), the mixture was stirred at 50 °C overnight. The reaction mixture was then transferred to a separatory funnel and extracted with methylene chloride (30 mL) three times. The combined organic phase was then washed by saturated NaCl aqueous solution (20 mL) twice. The organic layer was dried by anhydrous Na₂SO₄; the solvent was removed using a rotavapor, and the product, 2-(hexyl(methyl)amino)ethan-1-ol, was dried under high vacuum to obtain a colorless oil (12.047 g, 79.7 % yield).
The organic layer was dried by anhydrous Na₂SO₄ and concentrated by rotary evaporator. The precipitate was removed by filtration, and the solution was transferred to a separatory funnel and washed with saturated NaHCO₃ aqueous solution (50 mL) three times and saturated NaCl aqueous solution (50 mL) twice. The organic layer was dried by anhydrous Na₂SO₄ and concentrated by rotary evaporator. The product was purified by distillation under vacuum with the addition of a small amount of inhibitor butylated hydroxytoluene, yielding a clear liquid (8.992 g, 52.6% yield). ¹H NMR (CDCl₃, 300 MHz), δ (ppm) = 3.56 (q, HOCH₂CH₂-, 2H), 2.97 (t, HOCH₂CH₂-, 1H), 2.50 (t, HOCH₂CH₂-, 2H), 2.37 (t, HOCH₂CH₂N(CH₃)(CH₂CH₂CH₂CH₂CH₂CH₃), 2H), 2.22 (s, HOCH₂CH₂N(CH₃)(CH₂CH₂CH₂CH₂CH₂CH₃), 3H), 1.57-1.38 (m, HOCH₂CH₂N(CH₃)(CH₂CH₂CH₂CH₂CH₂CH₃), 2H), 1.29-1.25 (m, -N(CH₃)(CH₂CH₂CH₂CH₂CH₂CH₃), 6H), 0.88 (t, -N(CH₃)(CH₂CH₂CH₂CH₂CH₂CH₃), 3H). ¹³C NMR (CDCl₃, 500 MHz), δ (ppm) = 71.90, 64.69, 62.47, 48.74, 31.26, 29.46, 25.98, 22.45, 13.84.

2-(n-Hexyl(methyl)amino)ethan-1-ol (11.977 g, 75.2 mmol) and triethylamine (9.055 g, 89.5 mmol) were dissolved in chloroform (15 mL) in a 100 mL three-necked flask and cooled in an ice/water bath for 10 min. Methacryloyl chloride (8.647 g, 82.7 mmol) was then added dropwise into the mixture over a period of 15 min at 0 °C while stirring. The reaction mixture was allowed to warm to room temperature naturally and stirred overnight. The precipitate was removed by filtration, and the solution was transferred to a separatory funnel and washed with saturated NaHCO₃ aqueous solution (50 mL) three times and saturated NaCl aqueous solution (50 mL) twice. The organic layer was dried by anhydrous Na₂SO₄ and concentrated by rotary evaporator. The product was purified by distillation under vacuum with the addition of a small amount of inhibitor butylated hydroxytoluene, yielding a clear liquid (8.992 g, 52.6% yield). ¹H NMR (CDCl₃, 300 MHz), δ (ppm) = 6.07 (s, CHH=C(CH₃) -, 1H), 5.52 (s, CHH=C(CH₃) -, 1H), 4.21 (t, -COOCH₂CH₂N-, 2H), 2.65 (t, -COOCH₂CH₂N-, 2H), 2.36 (t, -COOCH₂CH₂N(CH₃)CH₂CH₂-, 2H), 2.26 (s, -COOCH₂CH₂N(CH₃)CH₂-, 3H), 1.91 (s, CH₂=C(CH₃)COO-, 3H), 1.51-1.34 (m, -CH₂N(CH₃)CH₂CH₂CH₂CH₂CH₂CH₃, 2H), 1.34-1.18 (m, -CH₂N(CH₃)CH₂CH₂CH₂CH₂CH₂CH₃, 6H), 0.86 (t, -N(CH₃)CH₂CH₂CH₂CH₂CH₂CH₃, 3H). ¹³C NMR (CDCl₃, 500 MHz), δ (ppm) = 167.34, 136.27, 125.42, 62.69, 57.99, 55.38, 42.69, 31.76, 27.19, 27.05, 22.60, 18.28, 14.01.
2-(Methyl(n-hexyl)amino)ethyl methacrylate (8.982 g, 39.5 mmol), 1,3-propanesultone (5.067 g, 41.5 mmol), and hydroquinone (64 mg) were dissolved in dry acetonitrile (12.026 g) in a 100 mL three-necked flask with a stir bar. The reaction mixture was stirred at 90 °C for 48 h. After acetone (30 mL) was added into the flask, a white solid was observed in the flask. The white solid was collected and dissolved with Milli-Q water, followed by washing with diethyl ether to remove the inhibitor. The product was freeze-dried using a LABCONCO 76705 Series Freeze Dryer and obtained as a white solid (7.487 g, 54.2 % yield). 1H NMR (D2O, 300 MHz), δ (ppm) = 6.25 (s, CHH=C(CH3)=-, 1H), 5.88 (s, CHH=C(CH3)-, 1H), 4.75-4.56 (m, -COOCH2CH2N-, 2H), 3.98-3.79 (m, -COOCH2CH2N-, 2H), 3.64 (t, -N+CH3CH2CH2SO3-, 2H), 3.50 (t, -CH2N+(CH3)(CH2CH2CH2CH2CH2CH2CH2SO3-, 2H), 3.25 (s, -COOCH2CH2N(CH3)-, 3H), 3.06 (t, -NCH2CH2CH2SO3-, 2H), 2.40-2.22 (m, -N(CH3)CH2CH2CH2SO3-, 2H), 2.03 (s, CH2=C(CH3)COO-, 3H), 1.96-1.74 (m, -NCH2CH2CH2CH2CH2CH3, 2H), 1.54-1.29 (m, -NCH2CH2CH2CH2CH2CH3, 6H), 0.96 (t, -NCH2CH2CH2CH2CH2CH3, 3H). 13C NMR (D2O, 500 MHz), δ (ppm) = 168.47, 135.15, 127.90, 62.73, 60.60, 59.99, 58.30, 48.74, 47.28, 30.49, 25.19, 21.79, 21.60, 17.96, 17.43, 13.30. MS: m/z cal C16H31NO5S [M+H]+: 350.1956; found: 350.1931; mass error: 7.14 ppm.

Similar procedures were used for the synthesis of other monomers. The characterization data are shown below. The 1H NMR spectra of M1-M7 are shown in Figure S1.

M1. 1H NMR (D2O with 0.5 M NaCl, 500 MHz), δ (ppm) = 6.23 (s, -C(CH3)=CHH, 1H), 5.85 (s, -C(CH3)=CHH, 1H), 4.75-4.68 (m, -COOCH2CH2N-, 2H), 3.94-3.87 (m, -COOCH2CH2N-, 2H), 3.66 (t, -NCH2CH2CH2SO3-, 2H), 3.30 (s, -N(CH3)2-, 6H), 3.06 (t, -N(CH3)2CH2CH2SO3-, 2H), 2.40-2.28 (m, -CH2CH2CH2SO3-, 2H), 2.01 (s, -OOC(CH3)=CH2, 3H). 13C NMR (D2O with 0.5 M NaCl, 500 MHz), δ (ppm) = 168.88, 135.47,
128.49, 63.73, 62.96, 59.00, 52.06, 47.70, 18.72, 18.15. MS: m/z cal C_{11}H_{21}NO_{5}S [M+H]^+: 280.1174; found: 280.1198; mass error: 8.57 ppm.

**M2.** $^1$H NMR (D₂O, 300 MHz), δ (ppm) = 6.19 (s, -C(CH₃)=CHH, 1H), 5.82 (s, -C(CH₃)=CHH, 1H), 4.74-4.59 (m, -COOCH₂CH₂N-, 2H), 3.88-3.77 (m, -COOCH₂CH₂N-, 2H), 3.65-3.50 (m, -N(CH₂CH₃)CH₂CH₂CH₂SO₃⁻, 4H), 3.19 (s, -N(CH₃)CH₂CH₃, 3H), 3.02 (t, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.36-2.18 (m, -NCH₂CH₂CH₂SO₃⁻, 2H), 1.98 (s, -OOC(CH₃)CH₂, 3H), 1.42 (t, -N(CH₃)CH₂CH₃, 3H). $^{13}$C NMR (D₂O, 500 MHz), δ (ppm) = 168.38, 135.09, 127.67, 59.89, 59.34, 58.15, 58.12, 48.09, 47.15, 17.80, 17.25, 7.19. MS: m/z cal C₁₂H₂₃NO₅S [M+H]^+: 294.1330; found: 294.1322; mass error: 2.72 ppm.

**M3.** $^1$H NMR (D₂O, 300 MHz), δ (ppm) = 6.23 (s, -C(CH₃)=CHH, 1H), 5.86 (s, -C(CH₃)=CHH, 1H), 4.74-4.66 (m, -COOCH₂CH₂N-, 2H), 3.93-3.81 (m, -OCH₂CH₂N-, 2H), 3.62 (t, -NCH₂CH₂CH₂SO₃⁻, 2H), 3.45 (t, -NCH₂CH₂CH₃, 2H), 3.24 (s, -N(CH₃)CH₂CH₂CH₃, 3H), 3.05 (t, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.41-2.18 (m, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.01 (s, -OOC(CH₃)CH₂, 3H), 1.95-1.79 (m, -N(CH₃)CH₂CH₂CH₃, 2H), 1.05 (t, -N(CH₃)CH₂CH₂CH₃, 3H). $^{13}$C NMR (D₂O, 500 MHz), δ (ppm) = 168.40, 135.09, 127.66, 63.93, 60.50, 59.93, 58.14, 48.60, 47.14, 17.84, 17.24, 15.26, 9.67. MS: m/z cal C₁₃H₂₅NO₅S [M+H]^+: 308.1487; found: 308.1488; mass error: 0.32 ppm.

**M4.** $^1$H NMR (D₂O, 300 MHz), δ (ppm) = 6.23 (s, -C(CH₃)=CHH, 1H), 5.86 (s, -C(CH₃)=CHH, 1H), 4.75-4.65 (m, -COOCH₂CH₂N-, 2H), 3.94-3.81 (m, -COOCH₂CH₂N-, 2H), 3.62 (t, -NCH₂CH₂CH₂SO₃⁻, 2H), 3.49 (t, -N(CH₃)CH₂CH₂CH₂CH₃, 2H), 3.24 (s, -N(CH₃)CH₂CH₂CH₂CH₃, 3H), 3.05 (t, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.40-2.20 (m, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.01 (s, -OOC(CH₃)CH₂, 3H), 1.91-1.75 (m, -N(CH₃)CH₂CH₂CH₂CH₃, 2H), 1.54-1.36 (m, -N(CH₃)CH₂CH₂CH₂CH₃, 2H), 1.02 (t, -
N(CH₃)CH₂CH₂CH₂CH₃, 3H). ¹³C NMR (D₂O, 500 MHz), δ (ppm) = 168.38, 135.10, 127.70, 62.42, 60.48, 59.95, 58.16, 48.62, 47.17, 23.51, 19.02, 17.86, 17.26, 12.75. MS: m/z cal C₁₄H₂₇NO₅S [M+H]^+; 322.1643; found: 322.1652; mass error: 2.79 ppm.

**M5.** ¹H NMR (D₂O, 300 MHz), δ (ppm) = 6.23 (s, -C(CH₃)=CHH, 1H), 5.86 (s, -C(CH₃)=CHH, 1H), 4.75-4.65 (m, -COOCH₂CH₂N-, 2H), 3.94-3.81 (m, -COOCH₂CH₂N-, 2H), 3.62 (t, -NCH₂CH₂CH₂SO₃⁻, 2H), 3.49 (t, -N(CH₃)CH₂CH₂CH₂CH₂CH₃, 2H), 3.24 (s, -N(CH₃)CH₂CH₂CH₂CH₂CH₃, 3H), 3.05 (t, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.40-2.20 (m, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.01 (s, -OOCCH₃=CH₂, 3H), 1.93-1.75 (m, -N(CH₃)CH₂CH₂CH₂CH₂CH₃, 2H), 1.47-1.36 (m, -N(CH₃)CH₂CH₂CH₂CH₂CH₃, 4H), 0.96 (t, -N(CH₃)CH₂CH₂CH₂CH₂CH₃, 3H). ¹³C NMR (D₂O, 500 MHz), δ (ppm) = 166.03, 132.67, 125.41, 60.29, 58.10, 57.60, 55.91, 46.24, 44.91, 25.28, 19.12, 18.90, 15.55, 15.02, 10.77. MS: m/z cal C₁₅H₂₉NO₅S [M+H]^+; 336.1800; found: 336.1823; mass error: 6.84 ppm.

**M7.** ¹H NMR (D₂O, 300 MHz), δ (ppm) = 6.24 (s, -C(CH₃)=CHH, 1H), 5.87 (s, -C(CH₃)=CHH, 1H), 4.75-4.63 (m, -COOCH₂CH₂N-, 2H), 3.97-3.80 (m, -COOCH₂CH₂N-, 2H), 3.63 (t, -N(CH₃)CH₂CH₂CH₂SO₃⁻, 2H), 3.49 (t, -N(CH₃)CH₂CH₂CH₂CH₂CH₂CH₃, 2H), 3.24 (s, -N(CH₃)CH₂CH₂CH₂CH₂CH₂CH₂CH₃, 3H), 3.06 (t, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.39-2.20 (m, -NCH₂CH₂CH₂SO₃⁻, 2H), 2.02 (s, -OOCCH₃=CH₂, 3H), 1.93-1.75 (m, -N(CH₃)CH₂CH₂CH₂CH₂CH₂CH₂CH₃, 2H), 1.55-1.24 (m, -N(CH₃)CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₃, 8H), 0.94 (t, -N(CH₃)CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₃, 3H). ¹³C NMR (D₂O, 500 MHz), δ (ppm) = 168.39, 135.07, 127.74, 62.60, 60.55, 59.89, 58.17, 48.57, 47.15, 30.75, 27.83, 25.38, 21.80, 21.53, 17.85, 17.27, 13.28. MS: m/z cal C₁₇H₃₃NO₅S [M+H]^+; 364.2113; found: 364.2141; mass error: 7.69 ppm.

**Synthesis of Zwitterionic Polymers.** Zwitterionic polymers were made by reversible
addition-fragmentation chain transfer polymerization using \( n \)-butyl (2-cyano-2-propyl) trithiocarbonate as chain transfer agent (CTA, Scheme 1). The following shows the detailed procedure for the synthesis of P6 from M6. Monomer M6 (0.300 g, 0.858 mmol), CTA (0.052 g of a stock solution of CTA dissolved in 2,2,2-trifluoroethanol (TFE) with a concentration of 30.67 mg/g, 0.00683 mmol), AIBN (0.020 g of a stock solution dissolved in TFE with a concentration of 20.10 mg/g, 0.00245 mmol), TFE (1.377 g), and DMF (58 mg) as internal standard were combined in a 25 mL 2-necked round bottom flask, and a small amount of sample was taken out for \(^1\)H NMR spectroscopy analysis. Three cycles of freeze-pump-thaw were performed to degas the reaction mixture. The flask was then placed in a 70 °C oil bath and the polymerization proceeded for 30 h. The reaction was stopped by removing the flask from the oil bath and cooling it in an ice water bath; a small amount of sample was taken out for \(^1\)H NMR spectroscopy analysis. The polymer, P6, was purified by dialysis against DI water using Fisherbrand dialysis tubing with MWCO of 3500 for 2 days, and water was changed frequently. The mixture was concentrated using an air stream of flow and then freeze-dried (0.146 g). The polymer was characterized by \(^1\)H NMR spectroscopy and aqueous SEC analysis. The SEC sample was prepared by dissolving P6 in 0.2 M NaNO\(_3\) aqueous solution at a concentration of 2.5 mg/mL. SEC results: \( M_n,SEC = 14.1 \) kDa and \( D = 3.10 \), relative to PEO standards.

Other zwitterionic polymers were prepared and purified by using similar procedures, and characterized by \(^1\)H NMR spectroscopy and SEC analysis. For SEC characterization, the polymer concentration was 1.0 mg/mL for P1, P2-1, P2-2, P3-1, P3-2, and P4, and 2.5 mg/mL for P5-1 and 5-2 in 0.2 M aqueous NaNO\(_3\) solution. P7 was not soluble in water, and we did not attempt to analyze its molecular weight. The SEC results are summarized in Table 1. The \(^1\)H NMR spectrum and SEC trace for each sample are presented below (Figure S2-S11).
Determination of Cloud Points of Thermoresponsive Polymers, P1, P5-1, P5-2, and P6, in Water at Various Concentrations from the Plots of Transmittance Recorded at 500 nm Using a UV-vis Spectrometer versus Temperature. For each polymer, the solution with the highest concentration as shown in Figure 2 was prepared first by dissolving a certain amount of the polymer in a calculated amount of Milli-Q at either an elevated temperature (50 °C for P1) or in an ice/water bath (for P5-1, P5-2, and P6). Lower concentration solutions were prepared by diluting the concentrated aqueous solution with Milli-Q water. The transmittance of a polymer solution in a 3.5 mL quartz cell at wavelength of 500 nm as a function of temperature was recorded using a T6U UV-Visible spectrophotometer equipped with a Peltier temperature controller system (PTC-2) in conjunction with UVWIN software version 6.1.0 (Persee Analytics, Inc.) in either a cooling (for P1 solutions) or a heating process (for solutions of P5-1, P5-2, and P6). The polymer solution was equilibrated at each temperature for 1 min with a heating/cooling rate of about 1 °C/min prior to the data recording. The cloud point was defined as the temperature at which a 50% transmittance change occurred. For the cooling-heating (for P1) and the heating-cooling (for P5-1, P5-2, and P6) cycles shown in Figure S12, once the transmittance measurement was taken at the lowest temperature or highest temperature, the temperature of the solution was raised or decreased following the same aforementioned procedure.

Effect of Addition of NaCl on Cloud Point of 1 wt% Polymer Solution for P1, P5-1, P5-2, and P6. For each polymer, a 1 wt% solution was prepared by dissolving the polymer in a predetermined amount of Milli-Q water. The cloud point was determined by visual inspection using an Isotemp water bath (Fisher Scientific, model 3006). The temperature of the water bath was decreased (for P1) or increased (for P5-1, P5-2, and P6) in a stepwise fashion and at each selected temperature, the sample was equilibrated for 1 min. When the solution turned cloudy, the
temperature was recorded as the cloud point. Note that the difference between the cloud points
determined by a UV-vis spectrometer and by visual inspection was < 1 °C. Subsequently, a
calculated amount of NaCl in the solid form was added and dissolved. The cloud point of the new
solution was again determined by the same method. The process was repeated for other
concentrations of NaCl. Since the amount of solid NaCl was small, the volume of the solution was
negligible.

References:

1. Fu, W. X.; Bai, W.; Jiang, S. S.; Seymour, B. T.; Zhao, B. “UCST-Type Thermostresponsive
Figure S1. $^1$H NMR spectrum of (A) M1 in D$_2$O with 0.5 M NaCl, (B) M2 in D$_2$O, (C) M3 in D$_2$O, (D) M4 in D$_2$O, (E) M5 in D$_2$O, (F) M6 in D$_2$O, and (G) M7 in D$_2$O at room temperature.
Figure S2. (A) $^1$H NMR spectrum in D$_2$O with 0.5 M NaCl and (B) size exclusion chromatography trace of P1.

Figure S3. (A) $^1$H NMR spectrum in D$_2$O and (B) size exclusion chromatography trace of P2-1.
Figure S4. (A) $^1$H NMR spectrum in D$_2$O and (B) size exclusion chromatography trace of P2-2.

Figure S5. (A) $^1$H NMR spectrum in D$_2$O and (B) size exclusion chromatography trace of P3-1.
Figure S6. (A) $^1$H NMR spectrum in D$_2$O and (B) size exclusion chromatography trace of P3-2.

Figure S7. (A) $^1$H NMR spectrum in D$_2$O and (B) size exclusion chromatography trace of P4.
Figure S8. (A) $^1$H NMR spectrum in D$_2$O and (B) size exclusion chromatography trace of P5-1.

Figure S9. (A) $^1$H NMR spectrum in D$_2$O and (B) size exclusion chromatography trace of P5-2.
Figure S10. (A) $^1$H NMR spectrum in D$_2$O and (B) size exclusion chromatography trace of P6.

Figure S11. $^1$H NMR spectrum of P7 in D$_2$O with 0.2 M NaNO$_3$. 
Figure S12. Plots of transmittance recorded at 500 nm using a UV-vis spectrometer versus temperature for new 1 wt% solutions of (A) P1, (B) P5-1, (C) P5-2, and (D) P6 in Milli-Q water from both heating and cooling processes. The data were obtained from cooling-heating processes for P1 and heating-cooling processes for P5-1, P5-2, and P6.
Figure S13. Plots of cloud point for P1, P5-1, P5-2, and P6 at a concentration of 1 wt% versus NaCl concentration from both heating and cooling processes.