Modular and Rapid Access to Amphiphilic Homopolymers via Successive Chemoselective Post-Polymerization Modification

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Table of Contents

Experimental Section:

Instrumentation

^{1}H and ^{13}C NMR spectra were recorded on an Inova 500 spectrometer. ^{1}H NMR chemical shifts in $CDCl_3$, CD_3OD, or DMSO-d_6 are referenced to TMS (δ 0.00 ppm), CHD_2OD (3.31 ppm), or CHD_2SOCD_3 (2.50 ppm), respectively. ^{13}C NMR chemical shifts in $CDCl_3$ are referenced to chloroform (77.16 ppm).

Size-exclusion chromatography was performed in *N*,*N*-dimethylacetamide with 50 mM LiCl at 50 °C and a flow rate of 1.0 mL/min (Agilent isocratic pump, degasser, and autosampler; columns: PLgel 5 μm guard + two ViscoGel I-series G3078 mixed bed columns, molecular weight range $0-20 \times 10^3$ and $0-100 \times 10^4$ g/mol). Detection consisted of a Wyatt Optilab T-rEX refractive index detector operating at 658 nm and a Wyatt miniDAWN Treos light scattering detector operating at 659 nm. Absolute molecular weights and molecular weight distributions were calculated using the Wyatt ASTRA software.

HRMS was conducted with an Agilent 6220 time-of-flight (TOF) mass spectrometer using the electrospray ionization (ESI) ion source.

Transmission electron microscopy was conducted on an H-700 from Hitachi High Technologies America, Inc., Schaumber, IL USA. Digital images were acquired with a Veleta 2k × 2k camera and iTEM software (Olympus Soft-Imaging Solutions Corp., Lakewood, CO). Electron Microscopy Sciences Formvar Carbon Film on 400 mesh nickel grids (FCF400-Ni) were used for all measurements. Samples were prepared at either 1 mg/mL or 0.5 mg/mL and 10 μL of solution was spotted on the grid for 30 s. The excess solvent was wicked off and the grid air-dried.

Multi-angle dynamic light scattering (DLS) and static light scattering (SLS) measurements were performed on an ALV/CGS-3 four-angle, compact goniometer system (Langen, Germany), which consisted of a 22 mW HeNe linear polarized laser operating at a wavelength of λ = 632.8 nm and scattering angles from θ = 42–150°.

For DLS, fluctuations in the scattering intensity were measured via a ALV/LSE-5004 multiple tau digital correlator and analyzed via the intensity autocorrelation function (g(2)(τ)). Decay rates, Γ, were obtained from single-exponential fits using a second-order cumulant analysis, and the mutual diffusion coefficient, D_m, was calculated through the relation

$$\Gamma = q^2 D_m \tag{S1}$$

where q^2 is the scalar magnitude of the scattering vector. The hydrodynamic radius (R_h) was calculated through the Stokes-Einstein equation

$$D_m \approx D_T = \frac{k_B T}{6\pi\eta_s R_h} \tag{S2}$$

where D_m is approximately equal to the tracer diffusion coefficient, D_T, k_B is the Boltzmann constant, T is the absolute temperature, and η_s is the solvent viscosity.

For SLS, radius of gyration, R_g, and molecular weight, M_w, were determined using the Zimm equation, which is a measure of the inverse scattering intensity as a function of the concentration of solution and scattering angle:

$$\frac{Kc}{R_\theta} = \frac{1}{M_w}\left(1 + \frac{q^2}{3}R_g\right) + 2B_2 c \tag{S3}$$

where K is the optical constant, R_θ is the Rayleigh ratio, B_2 is the second virial coefficient, and c is the concentration of the polymer solution. A double extrapolation to zero concentration and zero angle will produce a y-intercept of $1/M_w$, while B_2 and R_g can be extracted from the slopes of the zero-angle and zero-concentration extrapolation lines, respectively.

Depolarized dynamic light scattering (DDLS) measurements were performed on a Brookhaven Instruments (Holtsville, NY) BI-APDX detector/goniometer, which consisted of a 22 mW HeNe linear polarized laser operating at a wavelength of λ = 632.8 nm and scattering angles from θ = 60–120°. A Glan-Thomson polarizer was equipped in line with the scattered light and oriented perpendicular to the detector polarizer such that minimum scattering intensity was achieved in the presence of only solvent. Fluctuations in the scattering intensity were measured via a TubroCorr digital correlator, and analyzed via the intensity autocorrelation function ($g(2)(\tau)$).

All light scattering samples were performed at 25 °C, diluted to corresponding concentrations in 18 MΩ water, passed through 0.45 μm PVDF syringe filter, and placed into a borosilicate, pre-cleaned cuvette for analysis.

Zeta-potential and pH-dependent size studies were performed with a Malvern Zetasizer Nano ZS (Model No. ZEN 3600, Malvern Instruments Ltd., Worcestershire UK) using a Malvern DTS1070 cell. Solutions with concentrations of 1.0 mg polymer/mL of pH 1, 2, 3, 4, and 7 were used. The pH 1, 2, and 3 solutions were made via serial dilution of stock HCl solution. pH 4 and 7 buffer solutions were used for the remaining measurements.

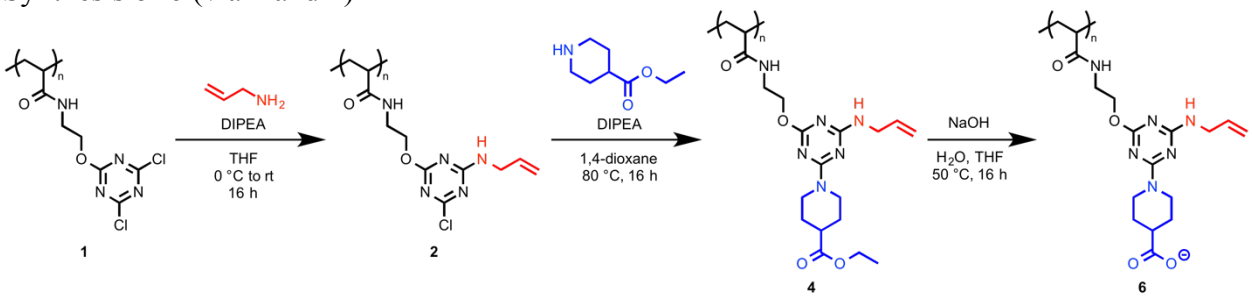
Fluorescence data were collected via a FluoTime 100 Fluorescence Lifetime Spectrometer.

Dynamic interfacial tensions of oil-water interfaces were measured by pendant drop tensiometry using a commercially available Kruss DSA 100. In this method, a droplet aqueous phase (polymer in water) was suspended on the tip of a 14-gauge needle and surrounded by 1-dodecene in a quartz cuvette. Assuming that the axisymmetric drop is in hydrodynamic equilibrium, the drop shape is imaged and fit to the Young-Laplace equation to determine the dynamic interfacial tension as a function of time.

Oil-in-water emulsions were created by combining 10 wt% 1-dodecene with 90 wt% aqueous solution. This mixture was then sonicated for 10 min using a Fisher Scientific Ultrasonic Dismembrator (Model 100) in a cool water bath to maintain sample temperature. Initial emulsion drop size distributions were measured by dynamic light scattering with a Malvern Instruments Zetasizer Nano ZS.

For dialysis, 3500 molecular weight cut-off Spectra/Por® 3 membranes were used.

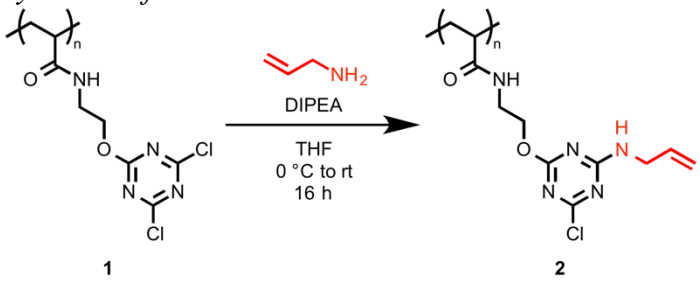
Synthesis of **6** (via **2** and **4**)



*Synthesis of **1***

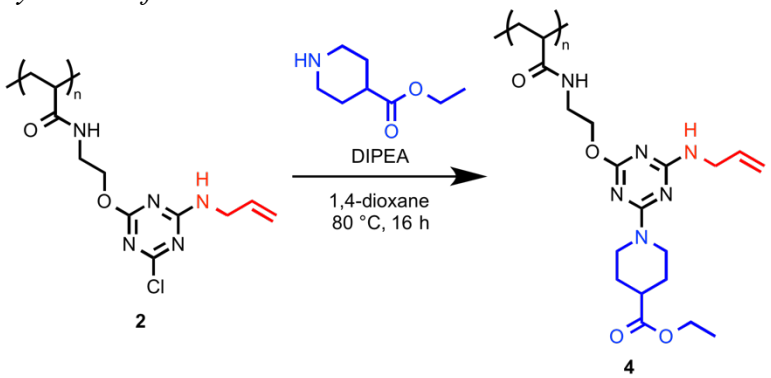
1 ($M_{n,SEC\text{-}MALS}$ = 19,300 g/mol, M_w/M_n = 1.05) was prepared according to the literature.[1]

*Synthesis of **2***



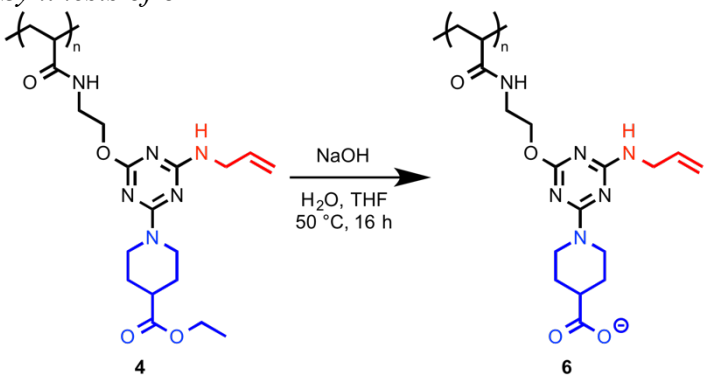
Allylamine (0.171 mL, 2.28 mmol) was added to a stirred solution of **1** (600 mg, 2.28 mmol) and DIPEA (0.437 mL, 2.51 mmol) in THF (6.0 mL) at 0 °C. The reaction mixture was stirred at 0 °C for 3 h, warmed to room temperature over ca. 1 h, and stirred for an additional 12 h. The solution was dialyzed against THF and concentrated. The resulting material was dissolved in THF, precipitated into cold diethyl ether, filtered, and dried to yield **2** as an off-white solid ($M_{n,SEC\text{-}MALS}$ = 20,700 g/mol, M_w/M_n = 1.04).

*Synthesis of **4***



Ethyl isonipecotate (0.299 mL, 1.94 mmol) was added to a stirred solution of **2** (500 mg, 1.76 mmol) and DIPEA (0.338 mL, 1.94 mmol) in 1,4-dioxane (5.0 mL). The reaction mixture was stirred at 80 °C for 16 h. The solution was cooled to room temperature, dialyzed against THF, and concentrated. The resulting material was dissolved in THF, precipitated into cold diethyl ether, filtered, and dried to yield polymer **4** as an off-white solid ($M_{n,SEC\text{-}MALS}$ = 30,500 g/mol, M_w/M_n = 1.06).

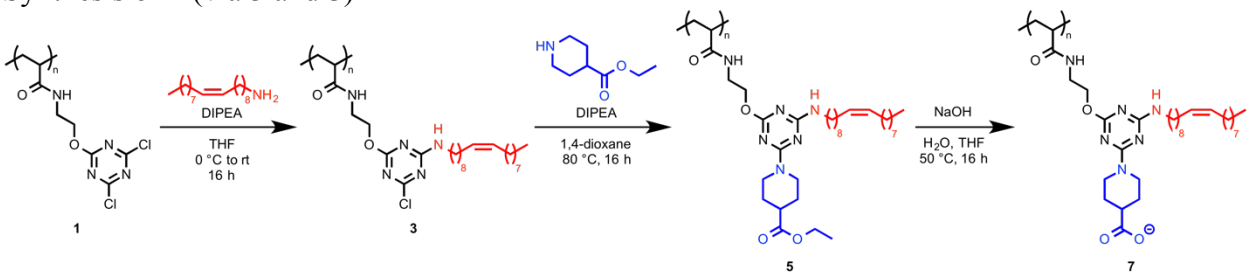
Synthesis of ***6***



4 **6**

Aqueous NaOH (1.0 M, 4.0 mL) was added to a stirred solution of **4** (400 mg, 0.989 mmol) in THF (4.0 mL). The reaction mixture was stirred at 50 °C for 16 h. The solution was cooled to room temperature, dialyzed against water, and lyophilized to yield polymer **6** as a white solid.

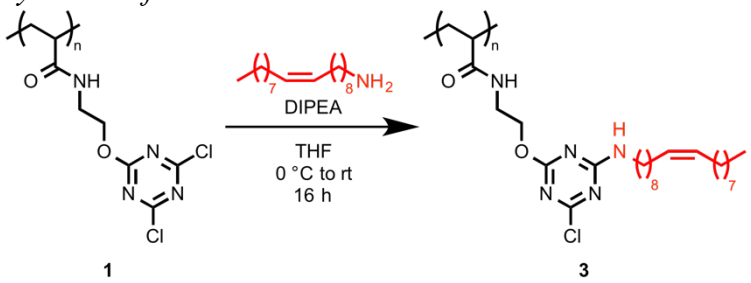
Synthesis of **7** (via **3** and **5**)



*Synthesis of **1***

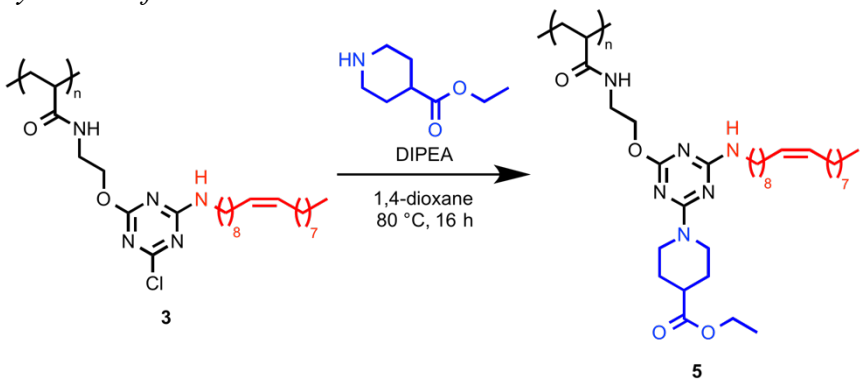
1 ($M_{n,SEC\text{-}MALS}$ = 19,300 g/mol, M_w/M_n = 1.05) was prepared according to the literature.[1]

*Synthesis of **3***



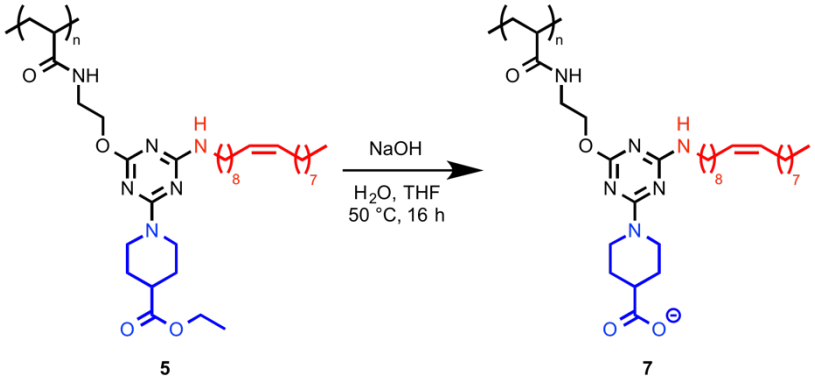
Oleylamine (0.750 mL, 2.28 mmol) was added to a stirred solution of **1** (600 mg, 2.28 mmol) and DIPEA (0.437 mL, 2.51 mmol) in THF (6.0 mL) at 0 °C. The reaction mixture was stirred at 0 °C for 3 h, warmed to room temperature over ca. 1 h, and stirred for an additional 12 h. The solution was dialyzed against THF and concentrated. The resulting material was dissolved in THF, precipitated into cold methanol, filtered, and dried to yield **3** as an off-white solid ($M_{n,SEC\text{-}MALS}$ = 37,900 g/mol, M_w/M_n = 1.06).

*Synthesis of **5***



Ethyl isonipecotate (0.274 mL, 1.78 mmol) was added to a stirred solution of **3** (800 mg, 1.62 mmol) and DIPEA (0.310 mL, 1.78 mmol) in 1,4-dioxane (8.0 mL). The reaction mixture was stirred at 80 °C for 16 h. The solution was cooled to room temperature, dialyzed against THF, and concentrated. The resulting material was dissolved in THF, precipitated into cold methanol, filtered, and dried to yield polymer **5** as an off-white solid ($M_{n,SEC\text{-}MALS}$ = 45,400 g/mol, M_w/M_n = 1.06).

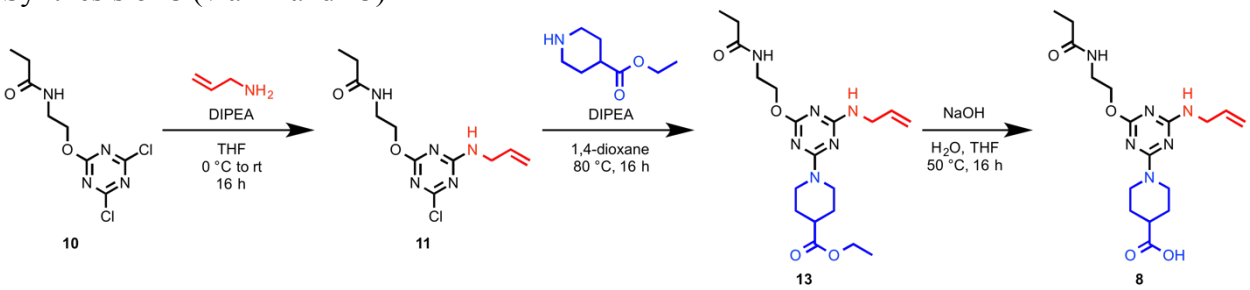
Synthesis of 7



5 **7**

Aqueous NaOH (1.0 M, 5.0 mL) was added to a stirred solution of **5** (500 mg, 0.832 mmol) in THF (5.0 mL). The reaction mixture was stirred at 50 °C for 16 h. The solution was cooled to room temperature, dialyzed against water, and lyophilized to yield polymer **7** as a white solid.

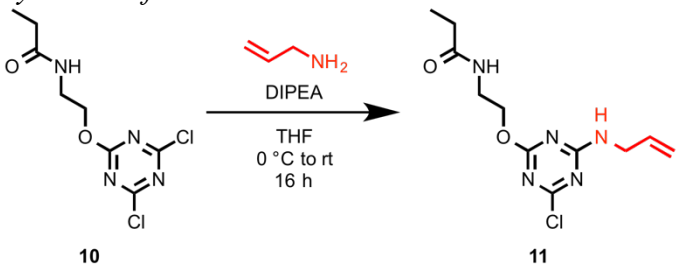
Synthesis of **8** (via **11** and **13**)



*Synthesis of **10***

10 was prepared according to the literature.[1]

*Synthesis of **11***



Allylamine (0.283 mL, 3.77 mmol) was added to a stirred solution of **10** (1.00 g, 3.77 mmol) and DIPEA (0.722 mL, 4.15 mmol) in THF (10.0 mL) at 0 °C. The reaction mixture was stirred at 0 °C for 3 h, warmed to room temperature over ca. 1 h, and stirred for an additional 12 h. The reaction solution was concentrated, and the resulting material was dissolved in DCM (10 mL). The organic layer was washed with saturated aqueous NH_4Cl (10 mL × 2) and brine (10 mL), dried (Na_2SO_4), filtered, and concentrated to give the product as an off-white solid.

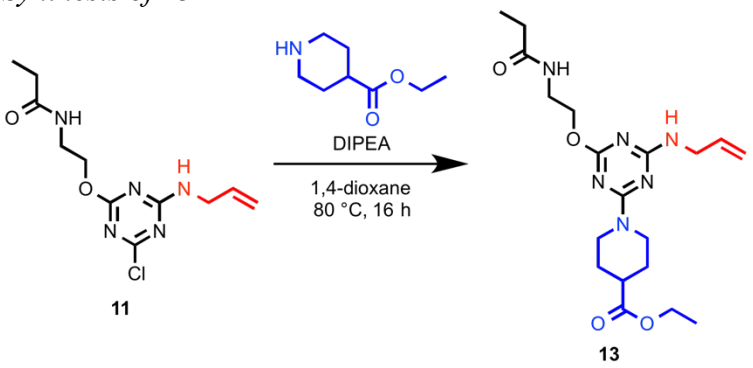
^{1}H NMR (500 MHz, $CDCl_3$, mixture of rotamers): δ 6.14 (br s, 1H, N*H*CH_2), 6.03 (br s, 1H, CON*H*), 5.87 (m, 1H, CH_2CH=CH_2), 5.25 (m, 1H, CH=C$H_E$$H_Z$), 5.20 (m, 1H, CH=C$H_E$$H_Z$), 4.44 (t, J = 4.9 Hz, 2H, CH_2CH_2O), 4.10 (m, 2H, NHCH_2CH), 3.65 (dt, J = 5.6, 5.2 Hz, 2H, NHC$H_2$$CH_2$), 2.22 (q, J = 7.2 Hz, 2H, CH_2C=O), and 1.15 (t, J = 7.6 Hz, 3H, CH_2CH_3).

^{13}C NMR (125 MHz, $CDCl_3$, mixture of rotamers): δ 174.1, 170.8, 170.2, 167.1, 132.9, 117.2, 67.6, 43.6, 38.5, 29.7, and 9.8.

IR (neat): 3301, 3261, 3125, 3084, 2982, 2962, 2939, 1716, 1635, 1569, 1524, 1427, 1414, 1404, 1331, 1300, 1226, and 803 cm^{-1}.

HRMS (ESI-TOF): Calculated for $C_{11}H_{16}NaClN_5O_2^+$ $[M + Na]^+$ requires 308.0885; found 308.0890.

Synthesis of ***13***



Ethyl isonipecotate (0.50 mL, 3.27 mmol) was added to a stirred solution of **11** (850 mg, 2.97 mmol) and DIPEA (0.57 mL, 3.27 mmol) in 1,4-dioxane (8.5 mL). The reaction mixture was stirred at 80 °C for 16 h. The solution was cooled to room temperature and concentrated, and the resulting material was dissolved in DCM (10 mL). The organic layer was washed with saturated aqueous NH_4Cl (10 mL × 2) and brine (10 mL), dried (Na_2SO_4), filtered, and concentrated to give the product as an off-white solid.

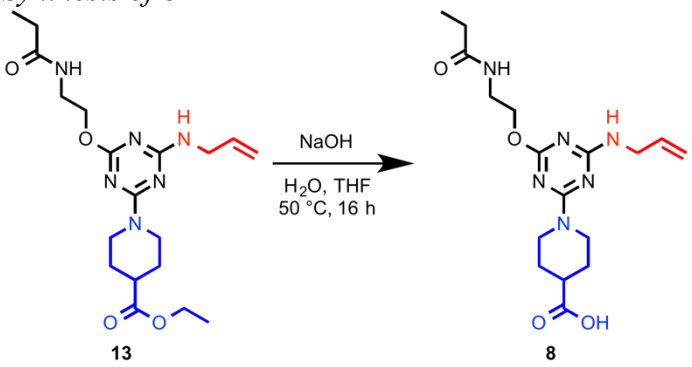
^{1}H NMR (500 MHz, $CDCl_3$): δ 6.07 (br s, 1H, N*H*CO), 5.90 (ddt, *J* = 17.3, 10.5, 5.5 Hz, 1H, CH_2CH=CH_2), 5.22 (dd, *J* = 17.2, 1.4 Hz, 1H, CH=CH_EH$_Z$), 5.18 (br s, 1H, N*H*CH_2), 5.13 (dd, *J* = 10.3, 1.2 Hz, 1H, CH=CH$_E$*H*$_Z$), 4.59 (m, 2H, CH_2CH_2O), 4.37 [m, 2H, N(CH_aH_b)$_2$], 4.15 (q, *J* = 7.1 Hz, 2H, OCH_2CH_3), 4.03 (dd, *J* = 5.7, 5.7 Hz, 2H, $NHCH_2CH$), 3.62 (m, 2H, $NHCH_2CH_2$), 3.00 [m, 2H, N(CH_aH_b)$_2$], 2.55 (m, 1H, $CHCO_2Et$), 2.20 (q, *J* = 7.6 Hz, 2H, CH_2C=O), 1.94 [m, 2H, N($CH_2CH_aH_b$)$_2$], 1.67 [m, 2H, N($CH_2CH_aH_b$)$_2$], 1.26 (t, *J* = 7.2 Hz, 3H, OCH_2CH_3), and 1.14 (t, *J* = 7.6 Hz, 3H, $COCH_2CH_3$).

^{13}C NMR (125 MHz, $CDCl_3$): δ 174.7, 174.6, 174.0, 170.9, 165.9, 134.8, 116.1, 65.9, 60.7, 43.4, 42.9, 41.5, 41.5, 38.9, 30.4, 29.8, 28.0, 14.3, and 9.9.

IR (neat): 3299, 3259, 3096, 2977, 2942, 2859, 1726, 1645, 1627, 1577, 1549, 1505, 1312, 1183, 1146, 1042, and 805 cm^{-1}.

HRMS (ESI-TOF): Calculated for $C_{19}H_{31}N_6O_4^+$ $[M + H]^+$ requires 407.2411; found 407.2411.

Synthesis of ***8***



Aqueous NaOH (1.0 M, 8.0 mL) was added to a stirred solution of **13** (800 mg, 1.97 mmol) in THF (8.0 mL). The reaction mixture was stirred at 50 °C for 16 h. The solution was cooled to room temperature and concentrated to remove most of organic solvents. The resulting solution was acidified with aqueous HCl (1.0 M) and extracted with DCM (10 mL × 3). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated to give the product as an off-white solid.

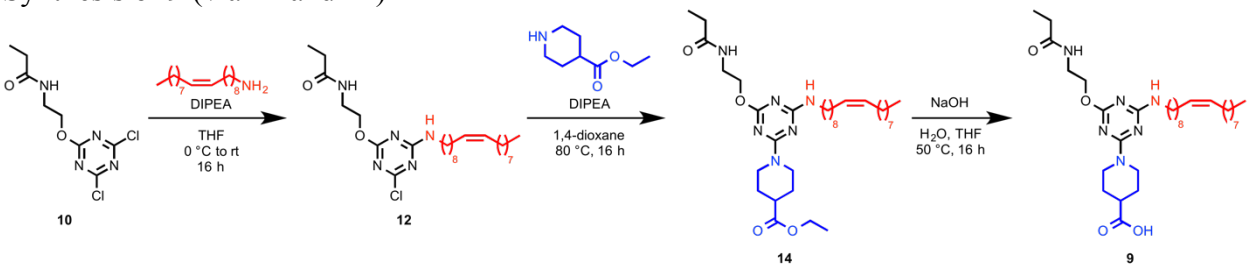
^{1}H NMR (500 MHz, $CDCl_3$): δ 6.37 (br s, 1H, N*H*CO), 6.30 (br s, 1H, N*H*CH_2), 5.89 (ddt, *J* = 17.2, 10.5, 5.5 Hz, 1H, CH_2CH=CH_2), 5.22 (dd, *J* = 17.2, 1.4 Hz, 1H, CH=C$H_E$$H_Z$), 5.13 (dd, *J* = 10.3, 1.3 Hz, 1H, CH=$CH_E$$H_Z$), 4.57 (m, 2H, CH_2CH_2O), 4.36 [m, 2H, N(CH_aH_b)$_2$], 4.02 (t, *J* = 5.5 Hz, 2H, NHCH_2CH), 3.62 (m, 2H, NHC$H_2$$CH_2$), 3.05 [m, 2H, N($CH_aH_b$)$_2$], 2.58 (m, 1H, C*H*$CO_2$Et), 2.22 (q, *J* = 7.6 Hz, 2H, CH_2C=O), 1.98 [m, 2H, N($CH_2CH_aH_b$)$_2$], 1.70 [m, 2H, N($CH_2CH_aH_b$)$_2$], and 1.14 (t, *J* = 7.5 Hz, 3H, $COCH_2CH_3$).

^{13}C NMR (125 MHz, $CDCl_3$): δ 179.2, 178.9, 176.0, 174.5, 165.3, 134.6, 116.1, 65.9, 43.4, 43.0, 43.0, 41.3, 38.9, 29.8, 29.6, 28.0, and 9.9.

IR (neat): 3277, 3165, 3084, 2962, 2866, 1699, 1642, 1584, 1496, 1259, 1090, 1015, and 806 cm^{-1}.

HRMS (ESI-TOF): Calculated for $C_{17}H_{27}N_6O_4^+$ $[M + H]^+$ requires 379.2090; found 379.2090.

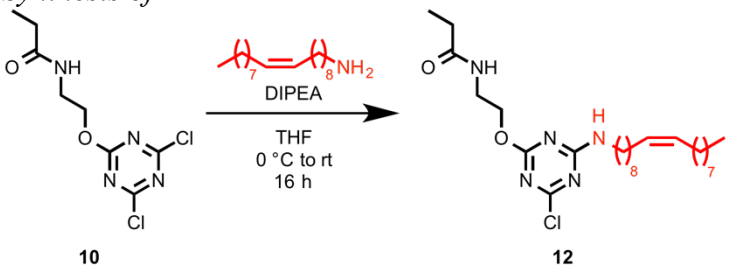
Synthesis of **9** (via **12** and **14**)



*Synthesis of **10***

10 was prepared according to the literature.[1]

*Synthesis of **12***



Oleylamine (1.24 mL, 3.77 mmol) was added to a stirred solution of **10** (1.00 g, 3.77 mmol) and DIPEA (0.722 mL, 4.15 mmol) in THF (10.0 mL) at 0 °C. The reaction mixture was stirred at 0 °C for 3 h, warmed to room temperature over ca. 1 h, and stirred for an additional 12 h. The reaction solution was concentrated, and the resulting material was dissolved in DCM (10 mL). The organic layer was washed with saturated aqueous NH_4Cl (10 mL × 2) and brine (10 mL), dried (Na_2SO_4), filtered, and concentrated to give the product as an off-white solid.

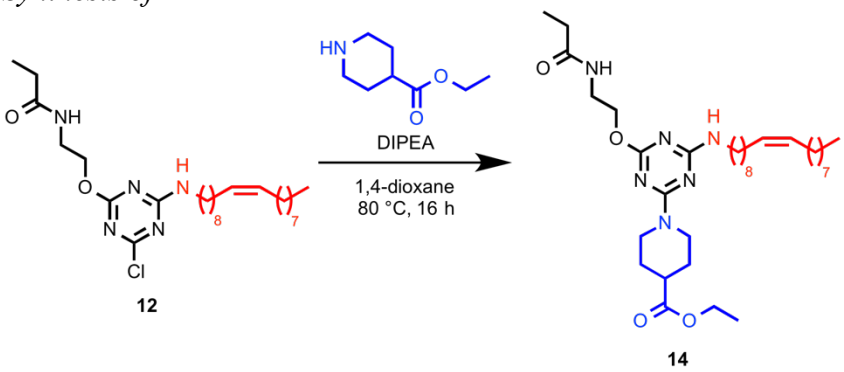
^{1}H NMR (500 MHz, $CDCl_3$, mixture of rotamers): δ 5.99 (br s, 1H, N*H*CH_2), 5.82 (br s, 1H, CON*H*), 5.36 (m, 2H, CH_2CH=$CH$$CH_2$), 4.44 (t, J = 4.9 Hz, 2H, CH_2CH_2O), 3.65 (dt, J = 5.3, 4.9 Hz, 2H, $NHCH_2CH_2O$), 3.43 (dt, J = 6.7, 6.5 Hz, 2H, $NHCH_2CH_2CH_2$), 2.21 (q, J = 7.5 Hz, 2H, CH_2C=O), 2.01 (m, 4H, CH_2CH=$CHCH_2$), 1.59 (pentet, J = 6.6 Hz, 2H, $NHCH_2CH_2CH_2$), 1.38–1.23 [m, 22H, $NHCH_2CH_2(CH_2)_5CH_2CH$=$CHCH_2(CH_2)_6CH_3$], 1.15 (t, J = 7.6 Hz, 3H, CH_3CH_2CO), and 0.88 (t, J = 6.6 Hz, 3H, $CH_2CH_2CH_3$).

^{13}C NMR (125 MHz, $CDCl_3$, mixture of rotamers): δ 174.1, 170.8, 170.5, 167.0, 130.2, 129.8, 67.6, 41.5, 38.5, 32.0, 29.9, 29.9, 29.8, 29.7, 29.7, 29.6, 29.5, 29.4, 29.3, 29.2, 27.4, 27.3, 26.9, 22.8, 14.3, and 9.8.

IR (neat): 3280, 3259, 2920, 2852, 1662, 1614, 1576, 1540, 1464, 1413, 1404, 1337, 1296, 1228, 1060, and 799 cm^{-1}.

HRMS (ESI-TOF): Calculated for $C_{26}H_{47}ClN_5O_2^+$ $[M + H]^+$ requires 496.3405; found 496.3405.

*Synthesis of **14***



Ethyl isonipecotate (0.50 mL, 3.21 mmol) was added to a stirred solution of **12** (1.45 g, 2.92 mmol) and DIPEA (0.56 mL, 3.21 mmol) in 1,4-dioxane (14.5 mL). The reaction mixture was stirred at 80 °C for 16 h. The solution was cooled to room temperature and concentrated, and the resulting material was dissolved in DCM (10 mL). The organic layer was washed with saturated aqueous NH_4Cl (10 mL × 2) and brine (10 mL), dried (Na_2SO_4), filtered, and concentrated to give the product as an off-white solid.

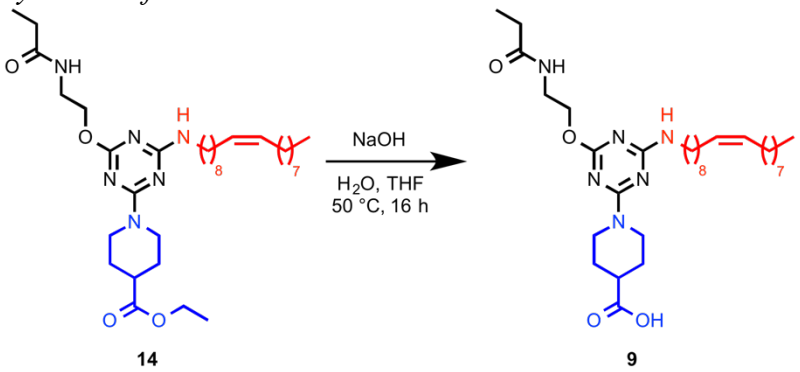
^{1}H NMR (500 MHz, $CDCl_3$): δ 6.07 (br s, 1H, N*H*CO), 5.36 (m, 2H, CH_2CH=$CHCH_2$), 5.05 (br s, 1H, N*H*CH_2), 4.59 (m, 2H, CH_2CH_2O), 4.36 [m, 2H, $N(CH_aH_b)_2$], 4.15 (q, J = 7.1 Hz, 2H, OCH_2CH_3), 3.62 (m, 2H, $NHCH_2CH_2O$), 3.37 (dt, J = 6.7, 5.8 Hz, 2H, $NHCH_2CH_2CH_2$), 3.00 [m, 2H, $N(CH_aH_b)_2$], 2.55 (m, 1H, $CHCO_2Et$), 2.20 (q, J = 7.6 Hz, 2H, CH_2C=O), 2.02 (m, 4H, CH_2CH=$CHCH_2$), 1.95 [m, 2H, $N(CH_2CH_aH_b)_2$], 1.67 [m, 2H, $N(CH_2CH_aH_b)_2$], 1.59 (pentet, J = 6.7 Hz, 2H, $NHCH_2CH_2CH_2$), 1.38–1.23 [m, 25H, $NHCH_2CH_2(CH_2)_5CH_2CH$=$CHCH_2(CH_2)_6CH_3$ and OCH_2CH_3], 1.14 (t, J = 7.5 Hz, 3H, CH_3CH_2CO), and 0.88 (t, J = 6.6 Hz, 3H, $CH_2CH_2CH_3$).

^{13}C NMR (125 MHz, $CDCl_3$): δ 174.7, 174.6, 174.0, 170.5, 165.9, 130.1, 129.9, 65.9, 65.7, 60.7, 42.9, 41.6, 41.5, 41.0, 39.0, 32.0, 29.9, 29.9, 29.8, 29.8, 29.7, 29.7, 29.6, 29.5, 29.4, 28.1, 28.0, 27.4, 27.3, 27.0, 22.8, 14.4, 14.2, and 9.9.

IR (neat): 3295, 3264, 2923, 2852, 1729, 1648, 1634, 1585, 1549, 1503, 1442, 1363, 1315, 1183, 1043, and 805 cm^{-1}.

HRMS (ESI-TOF): Calculated for $C_{34}H_{61}N_6O_4^+$ $[M + H]^+$ requires 617.4751; found 617.4751.

*Synthesis of **9***



Aqueous NaOH (1.0 M, 11.0 mL) was added to a stirred solution of **14** (1.10 g, 1.78 mmol) in THF (11.0 mL). The reaction mixture was stirred at 50 °C for 16 h. The solution was cooled to room temperature and concentrated to remove most of organic solvents. The resulting solution was

acidified with aqueous HCl (1.0 M) and extracted with DCM (10 mL × 3). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated to give the product as an off-white solid.
^{1}H NMR (500 MHz, $CDCl_3$): δ 6.32 (br s, 1H, N*H*CO), 6.22 (br s, 1H, N*H*CH_2), 5.36 (m, 2H, CH_2CH=$CH$$CH_2$), 4.57 (m, 2H, CH_2CH_2O), 4.35 [m, 2H, $N(CH_aH_b)_2$], 3.61 (m, 2H, $NHCH_2CH_2O$), 3.35 (m, 2H, $NHCH_2CH_2CH_2$), 3.06 [m, 2H, $N(CH_aH_b)_2$], 2.60 (m, 1H, $CHCO_2Et$), 2.22 (q, J = 7.6 Hz, 2H, CH_2C=O), 2.00–1.93 [m, 6H, CH_2CH=$CHCH_2$ and $N(CH_2CH_aH_b)_2$], 1.69 [m, 2H, $N(CH_2CH_aH_b)_2$], 1.56 (pentet, J = 6.4 Hz, 2H, $NHCH_2CH_2CH_2$), 1.38–1.20 [m, 22H, $NHCH_2CH_2(CH_2)_5CH_2CH$=$CHCH_2(CH_2)_6CH_3$], 1.14 (t, J = 7.6 Hz, 3H, CH_3CH_2CO), and 0.88 (t, J = 6.5 Hz, 3H, $CH_2CH_2CH_3$).
^{13}C NMR (125 MHz, $CDCl_3$): δ 179.5, 179.0, 178.9, 174.5, 165.2, 130.1, 129.9, 65.9, 43.0, 41.3, 41.0, 41.0, 38.9, 32.7, 32.0, 29.9, 29.9, 29.8, 29.8, 29.8, 29.7, 29.6, 29.6, 29.5, 29.4, 28.0, 27.4, 27.3, 27.0, 22.8, 14.3, and 9.9.
IR (neat): 3278, 2922, 2853, 1701, 1586, 1541, 1504, 1449, 1369, 1314, 1227, and 805 cm^{-1}.
HRMS (ESI-TOF): Calculated for $C_{32}H_{57}N_6O_4^+$ $[M + H]^+$ requires 589.4437; found 589.4437.

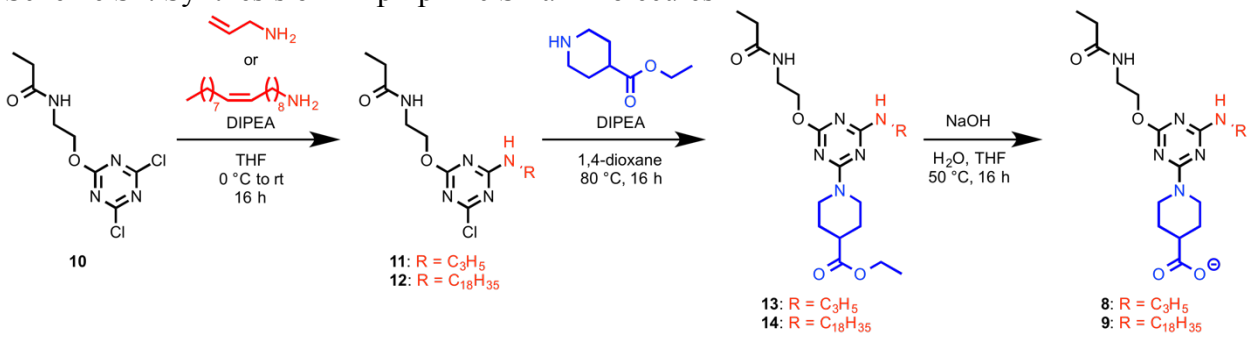
Formation of Aggregates

Amphiphilic homopolymer **6** (10 mg) was dissolved in methanol (0.5 mL). The solution was added dropwise to a stirring solution of water (10 mL). The resulting solution was stirred overnight to allow organic solvents to evaporate. A serial dilution was performed to prepare samples with different concentrations. The process was repeated for amphiphilic homopolymer **7** and small molecules **13** and **14** using THF (0.5 mL) as a solvent.

Encapsulation of Pyrene

Pyrene (5.0 mg) in acetone (1.0 mL) was added to vials. Acetone was vaporized by nitrogen flow to coat the interior surface of the vials with pyrene. Aqueous solution (1.0 mL) containing polymeric aggregates were added to each vial, and these solutions were allowed to sit overnight.

Scheme S1. Synthesis of Amphiphilic Small Molecules



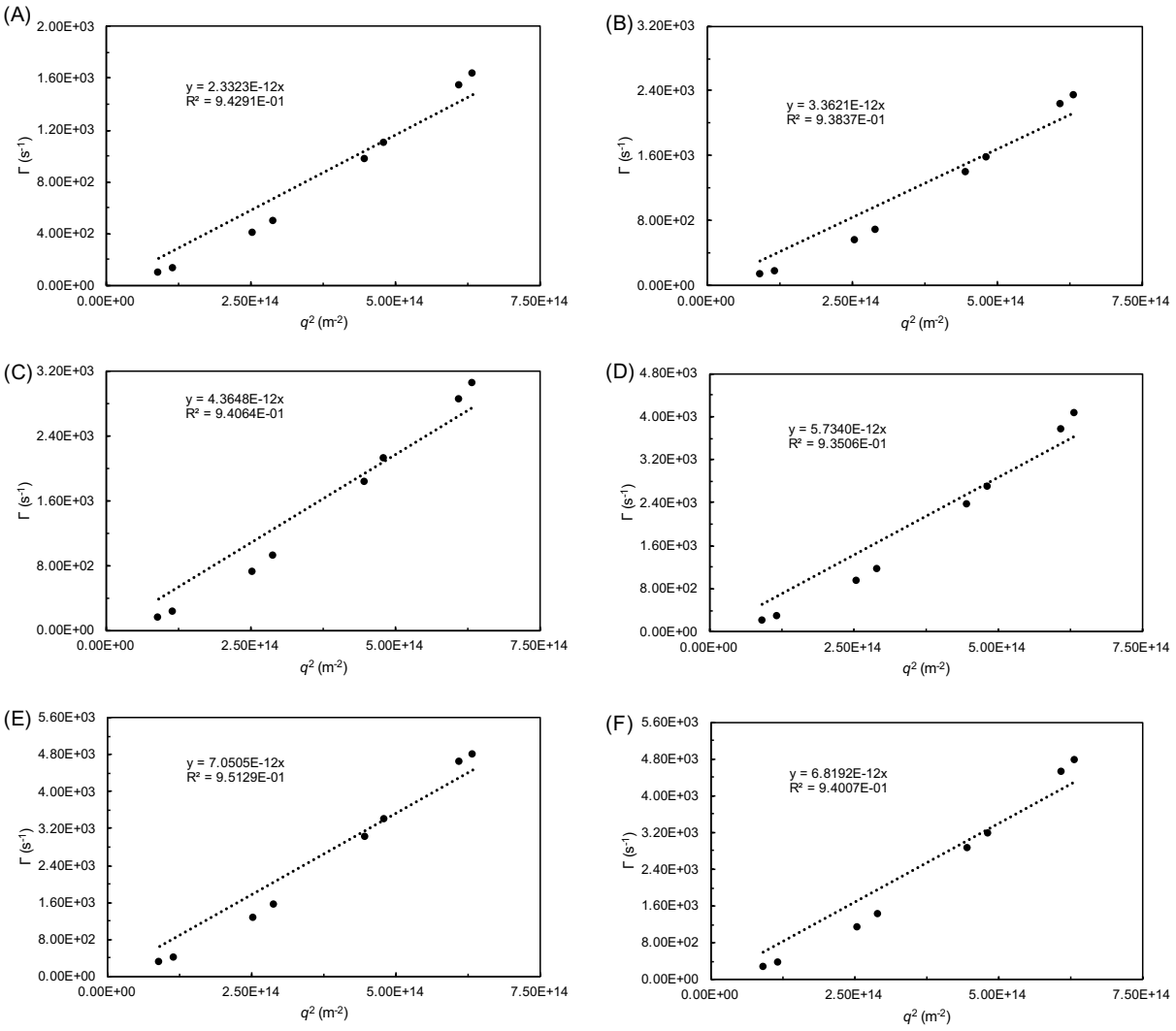


Figure S1. DLS Γ versus q^2 plots for **6** at (A) 9.66 mg/mL, (B) 4.79 mg/mL, (C) 2.41 mg/mL, (D) 0.933 mg/mL, (E) 0.467 mg/mL, (F) 0.243 mg/mL.

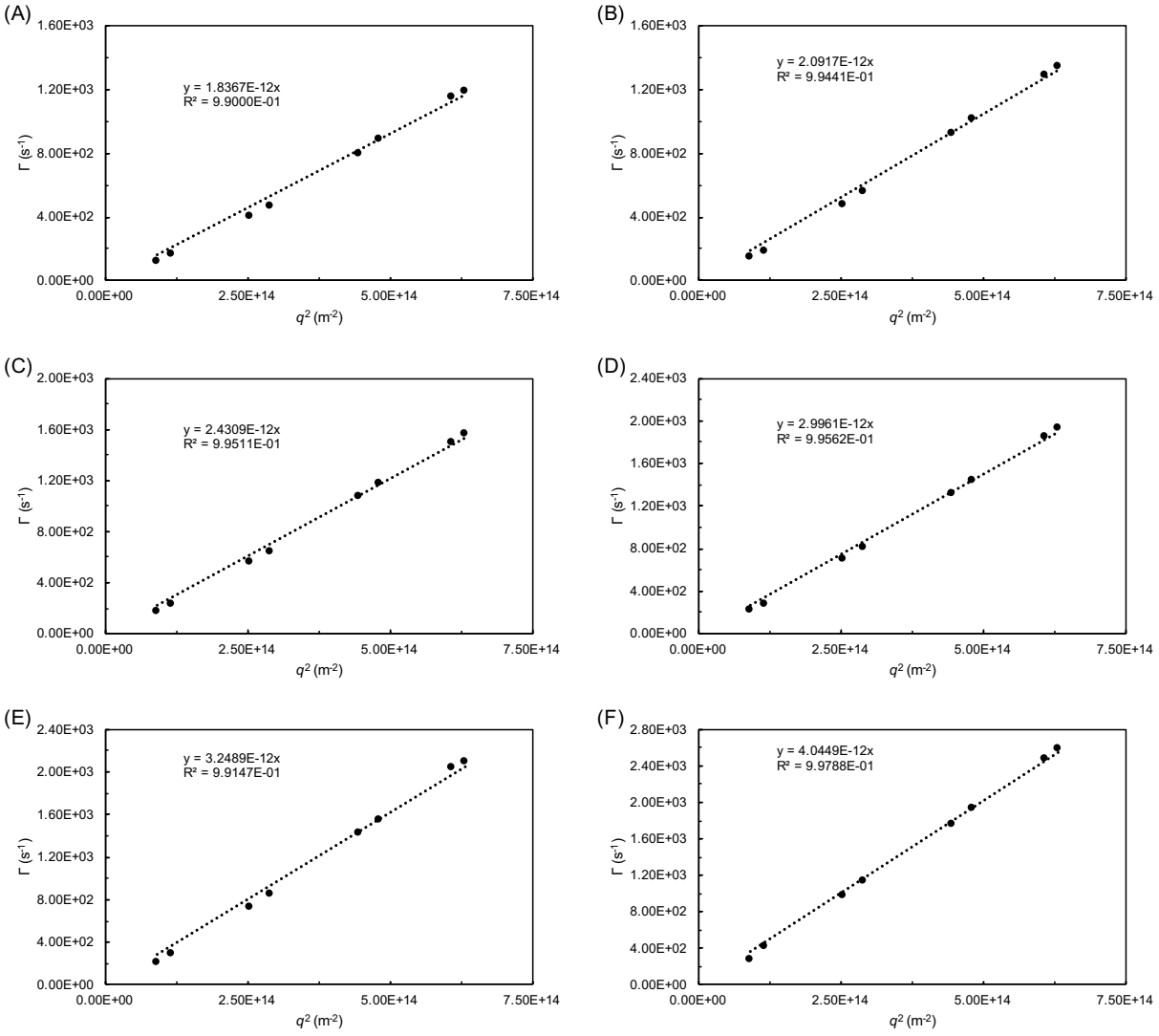


Figure S2. DLS Γ versus q^2 plots for **7** at (A) 9.60 mg/mL, (B) 4.81 mg/mL, (C) 2.38 mg/mL, (D) 0.965 mg/mL, (E) 0.480 mg/mL, (F) 0.239 mg/mL.

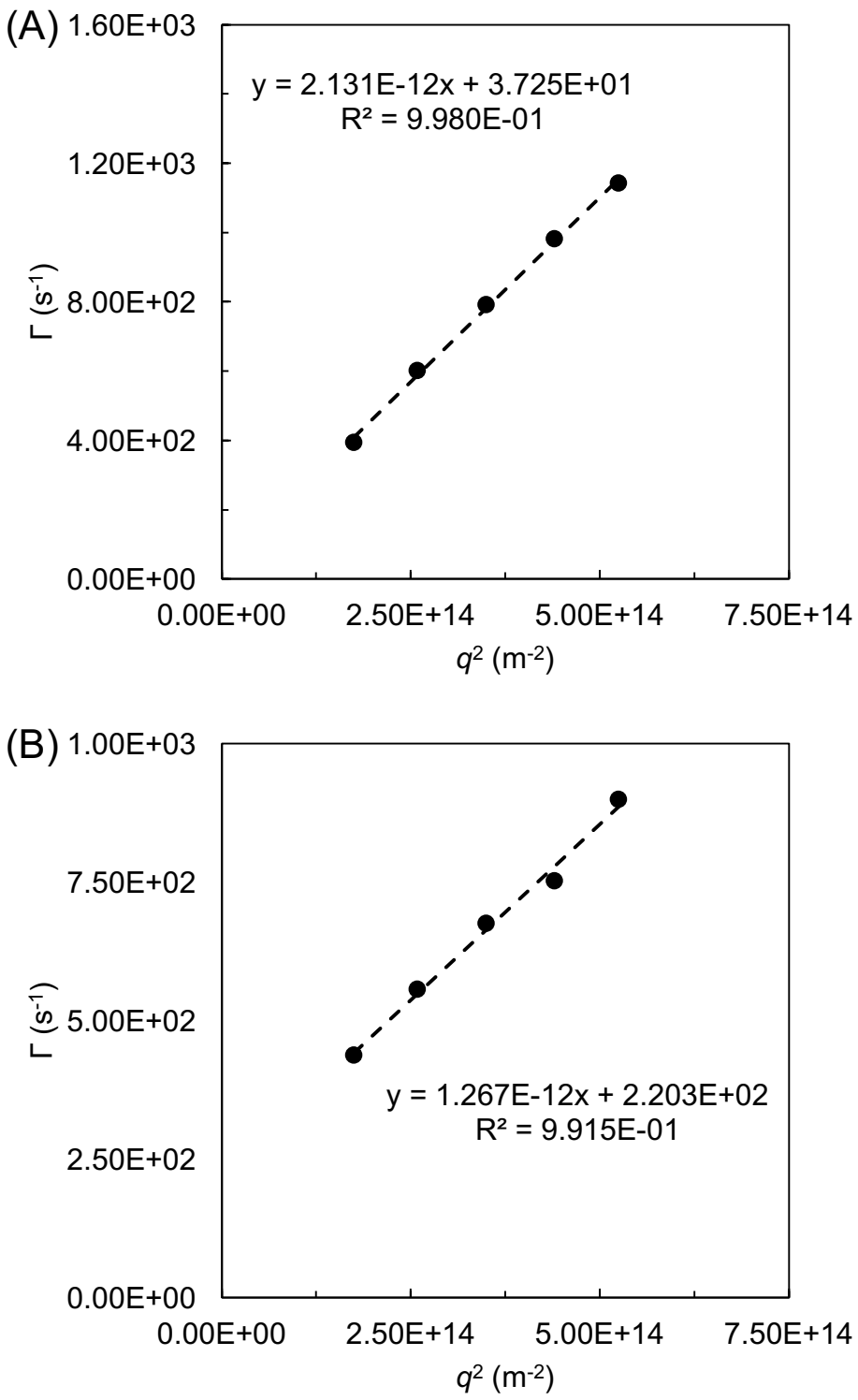
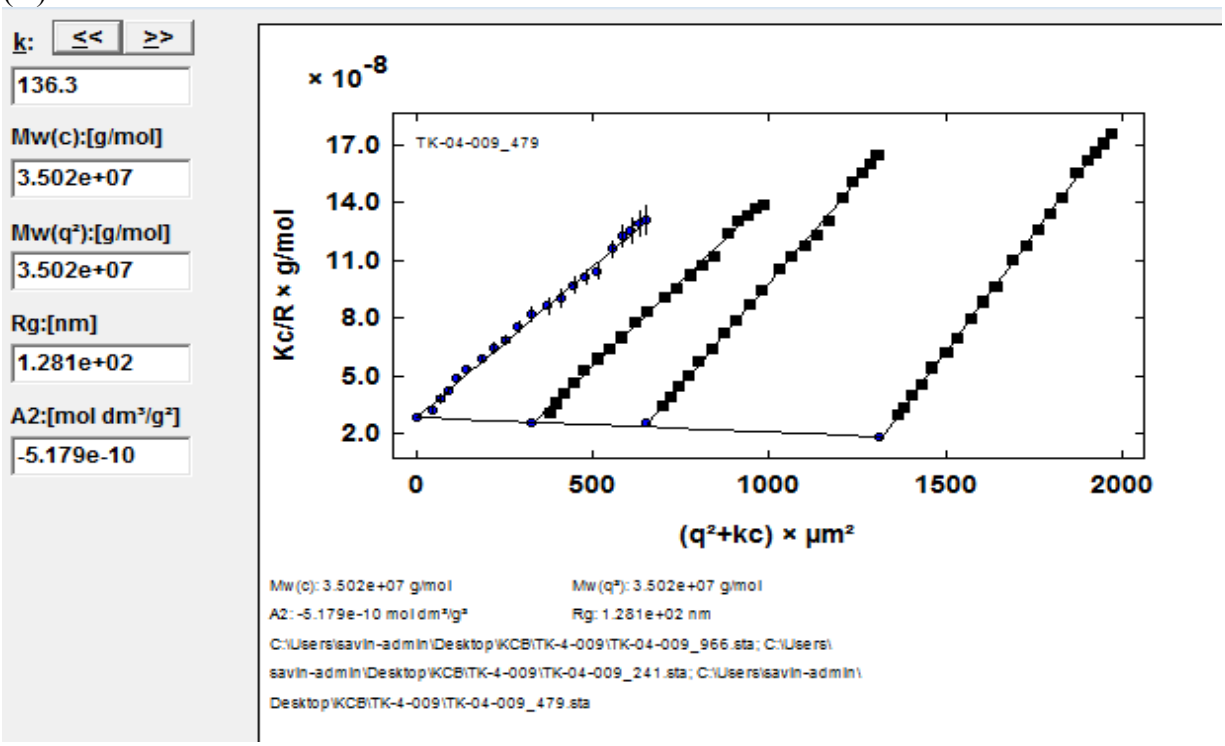


Figure S3. DDLS Γ versus q^2 plots for (A) **6** and (B) **7** at 10 mg/mL.

(A)



(B)

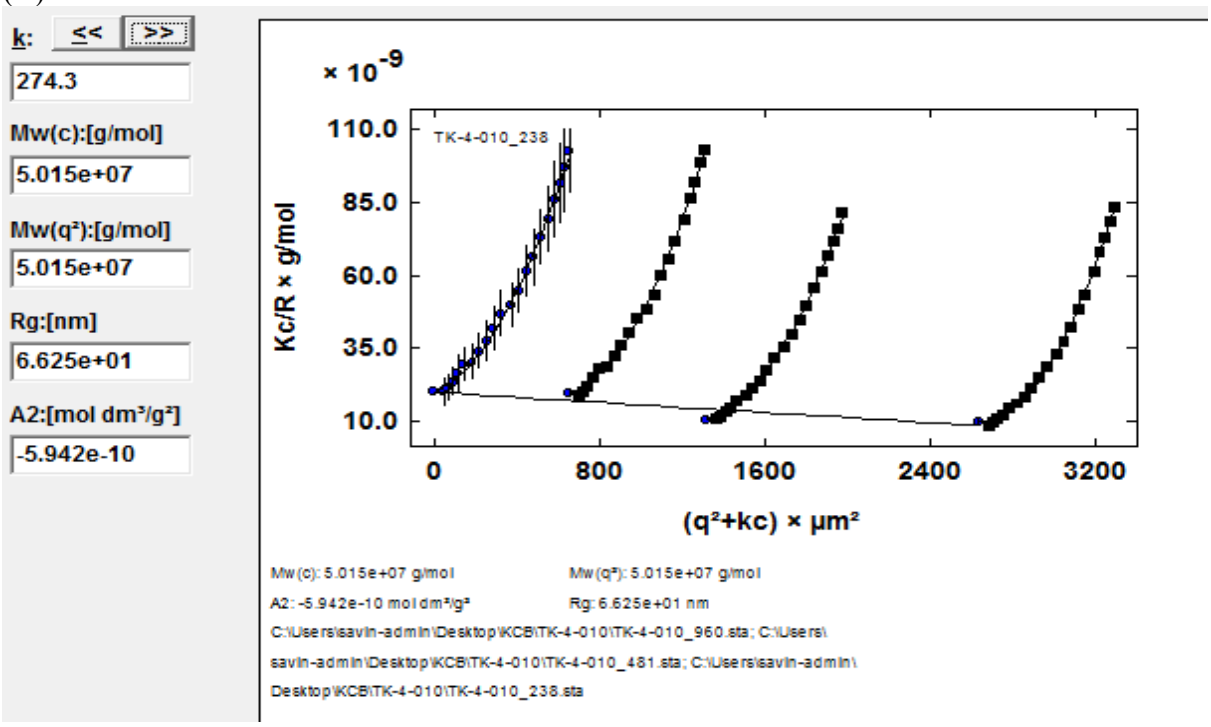


Figure S4. Zimm plot for (A) **6** and (B) **7**.

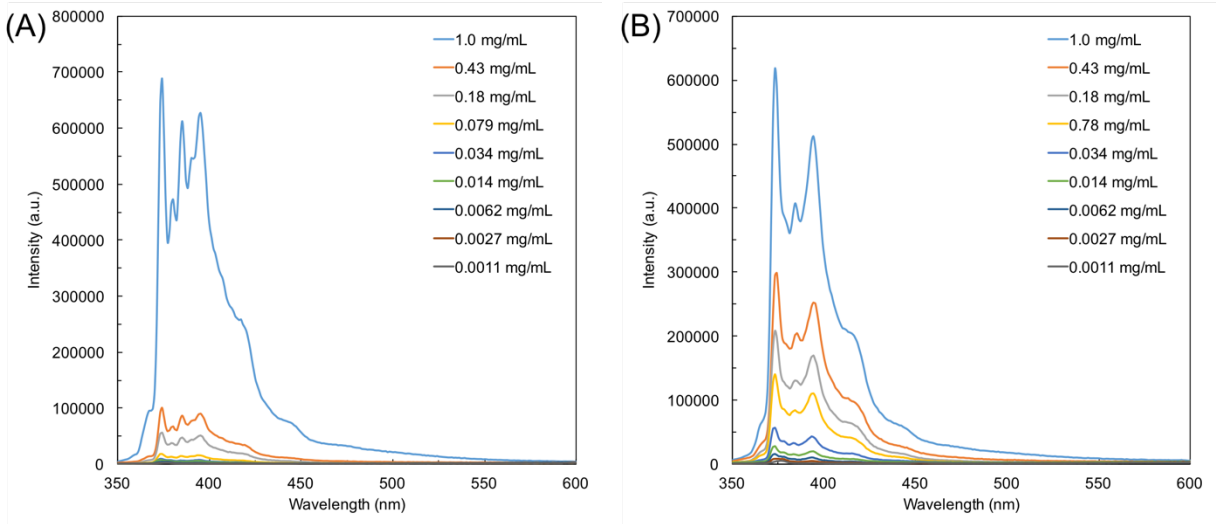


Figure S5. Fluorescence spectra of pyrene with aggregates for (A) **6** and (B) **7**.

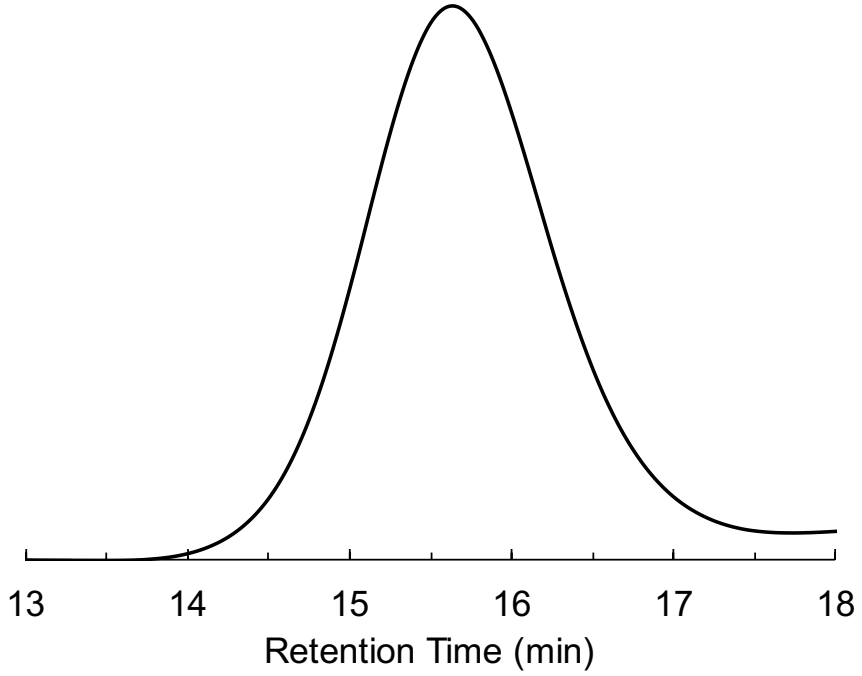


Figure S6. SEC trace of **1**. ($M_{n,SEC\text{-}MALS}$ = 19,300 g/mol, M_w/M_n = 1.05)

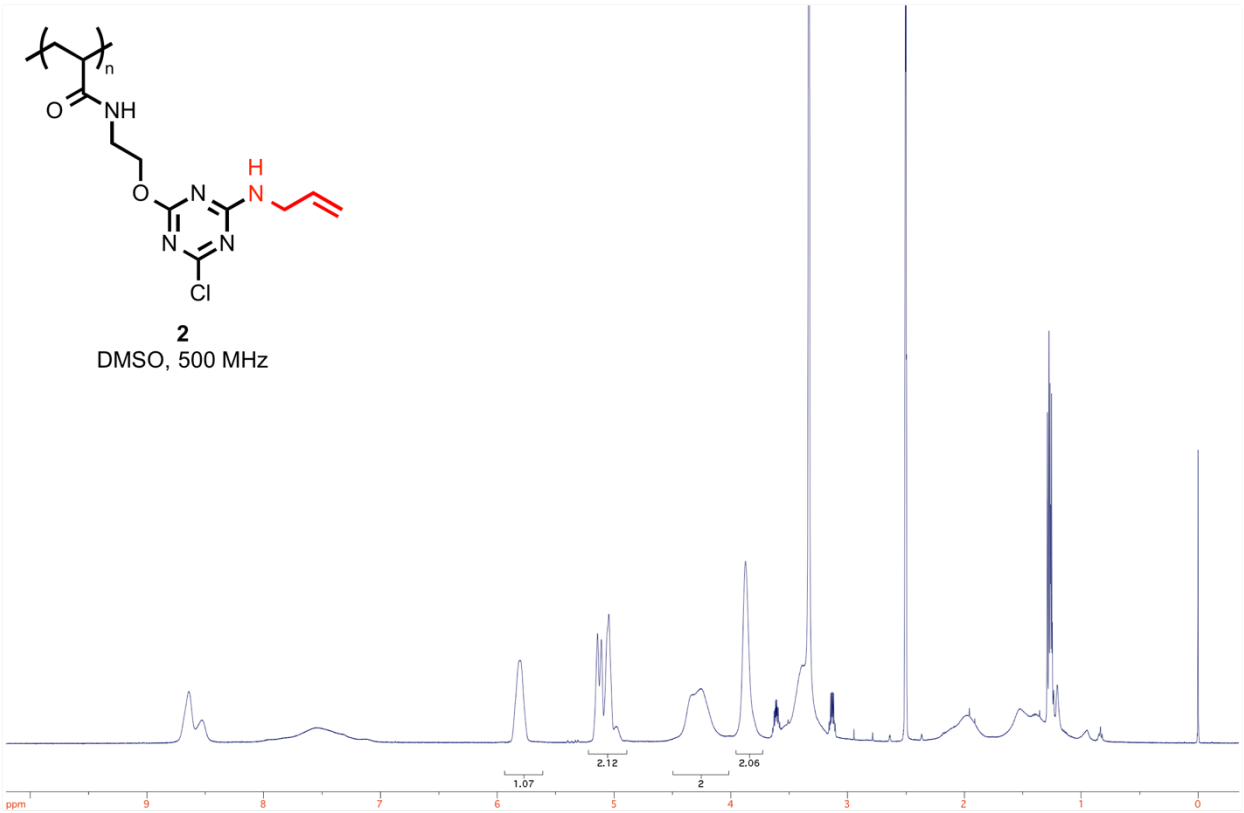


Figure S7. ^{1}H NMR spectrum of **2**.

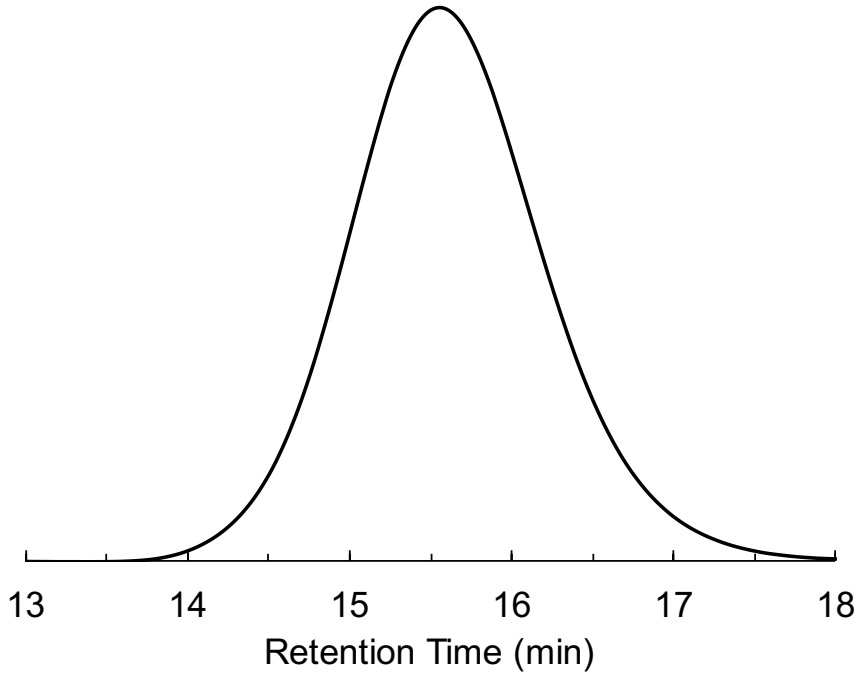


Figure S8. SEC trace of **2**. ($M_{n,SEC\text{-}MALS}$ = 20,700 g/mol, M_w/M_n = 1.04)

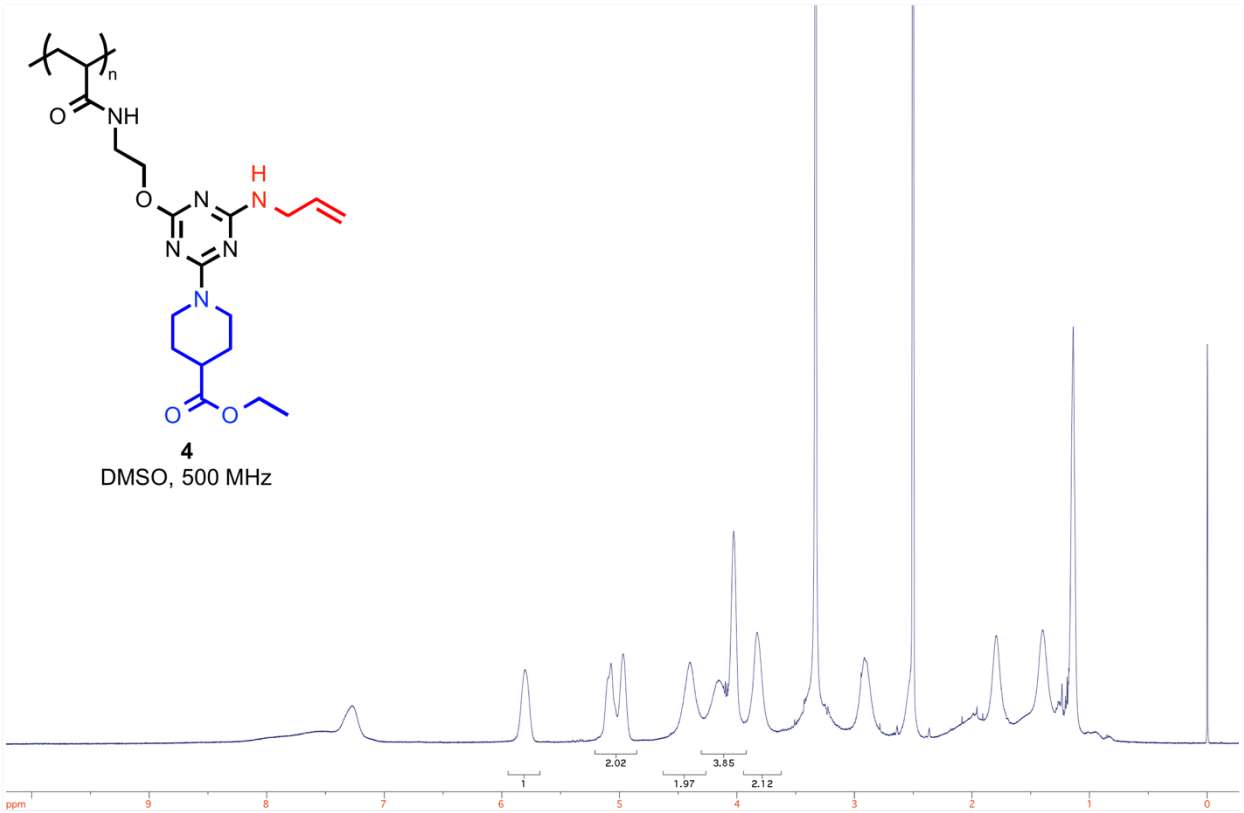


Figure S9. ^{1}H NMR spectrum of **4**.

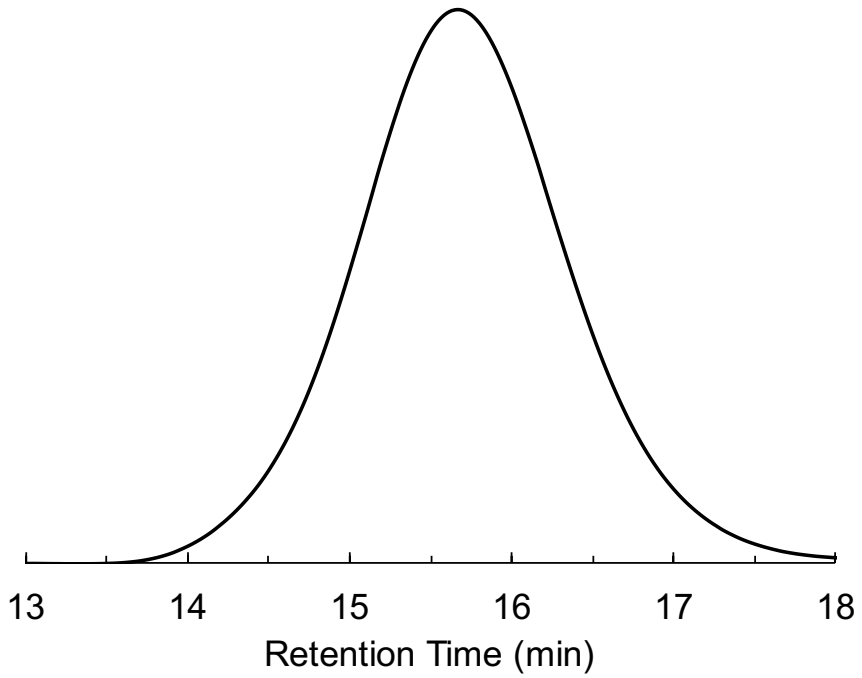


Figure S10. SEC trace of **4**. ($M_{n,SEC\text{-}MALS}$ = 30,500 g/mol, M_w/M_n = 1.06)

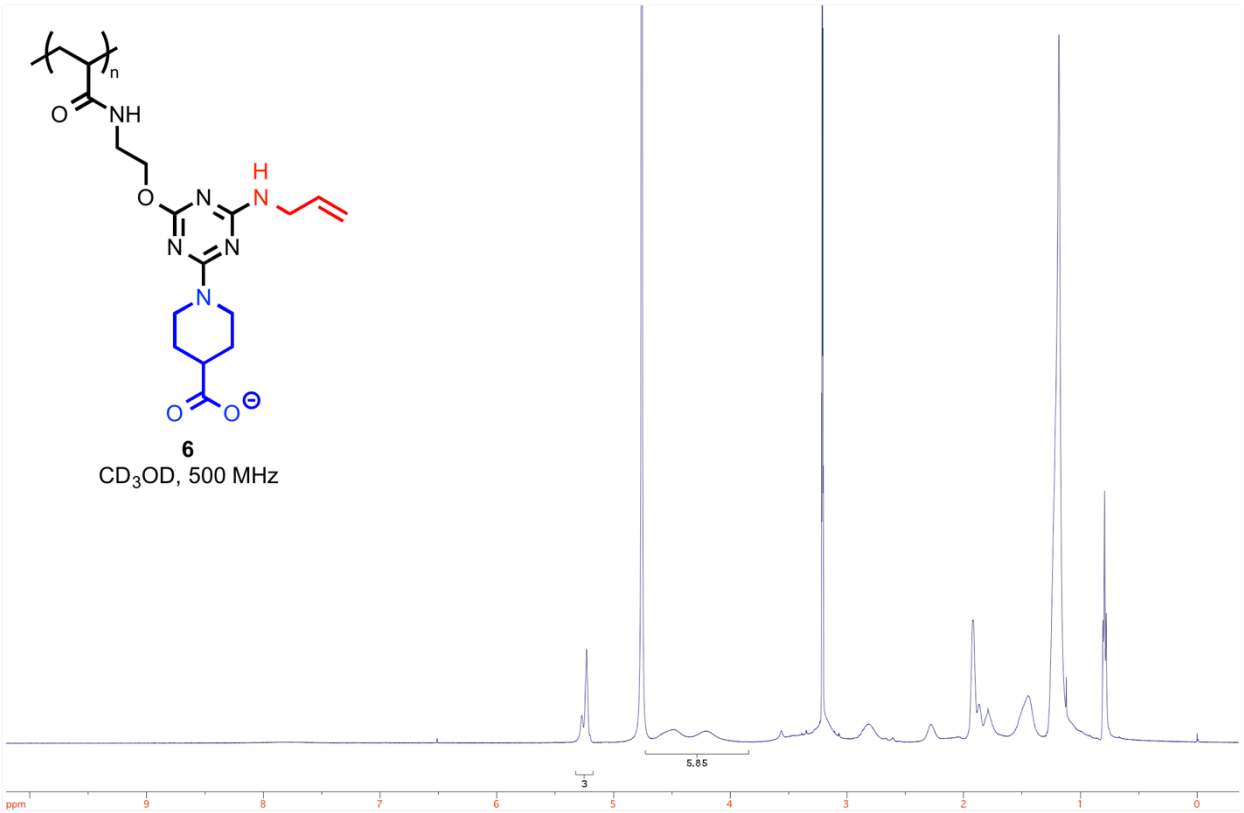


Figure S11. ^{1}H NMR spectrum of **6**.

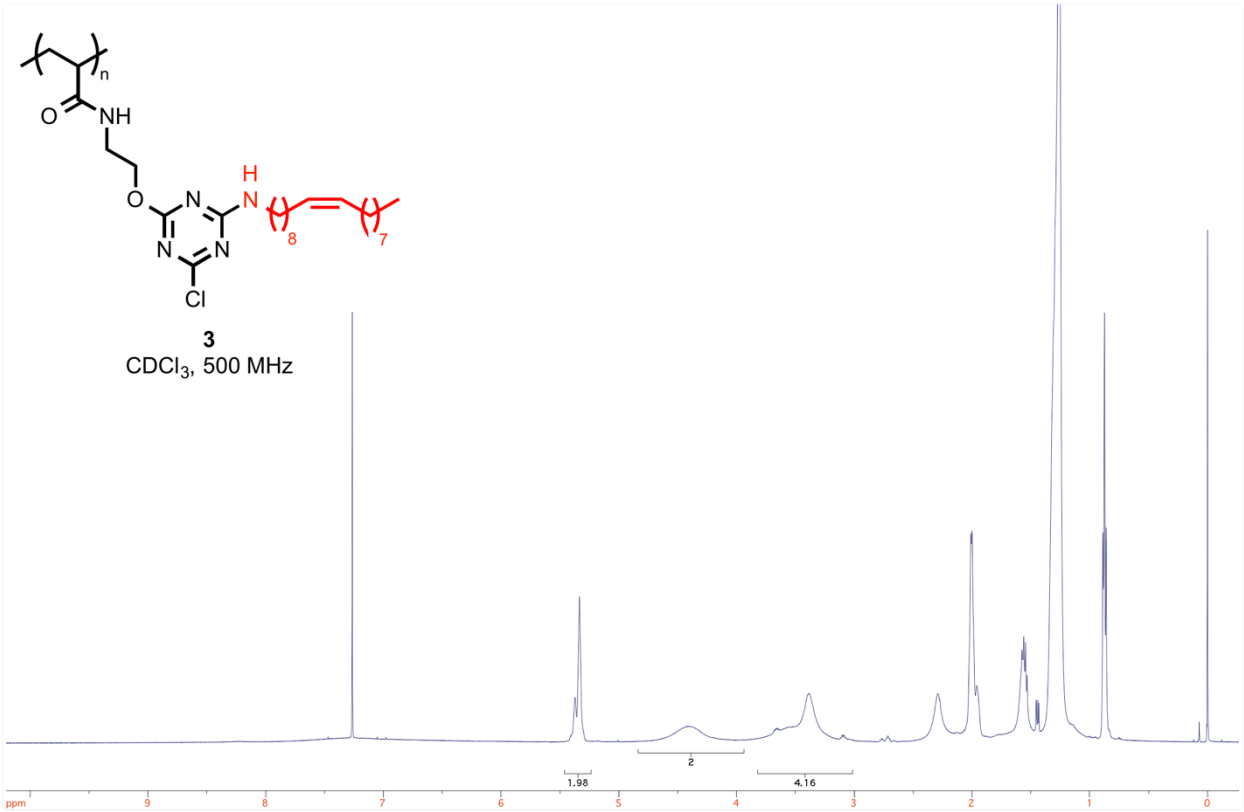


Figure S12. ^{1}H NMR spectrum of **3**.

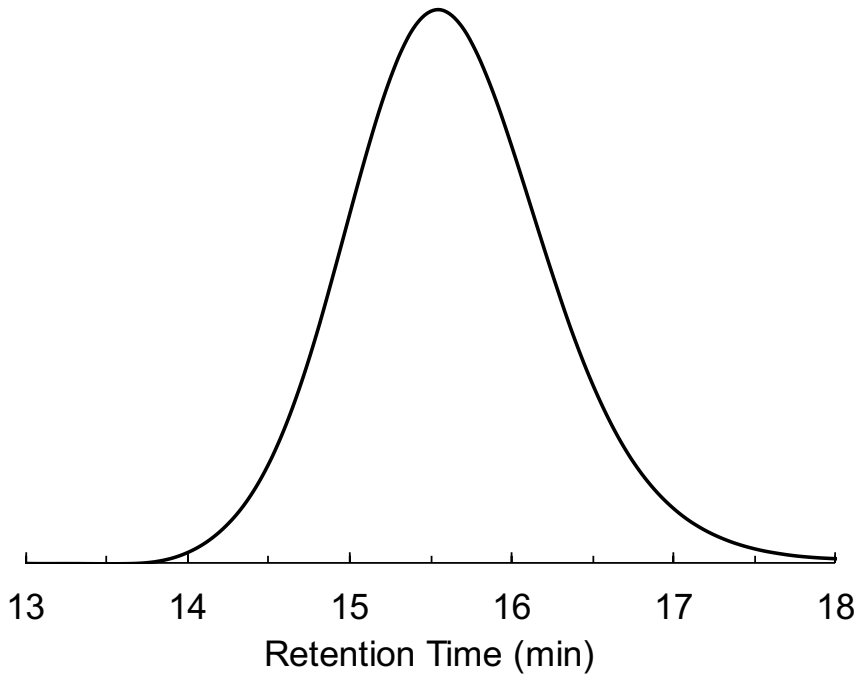


Figure S13. SEC trace of **3**. ($M_{n,SEC\text{-}MALS}$ = 37,900 g/mol, M_w/M_n = 1.06)

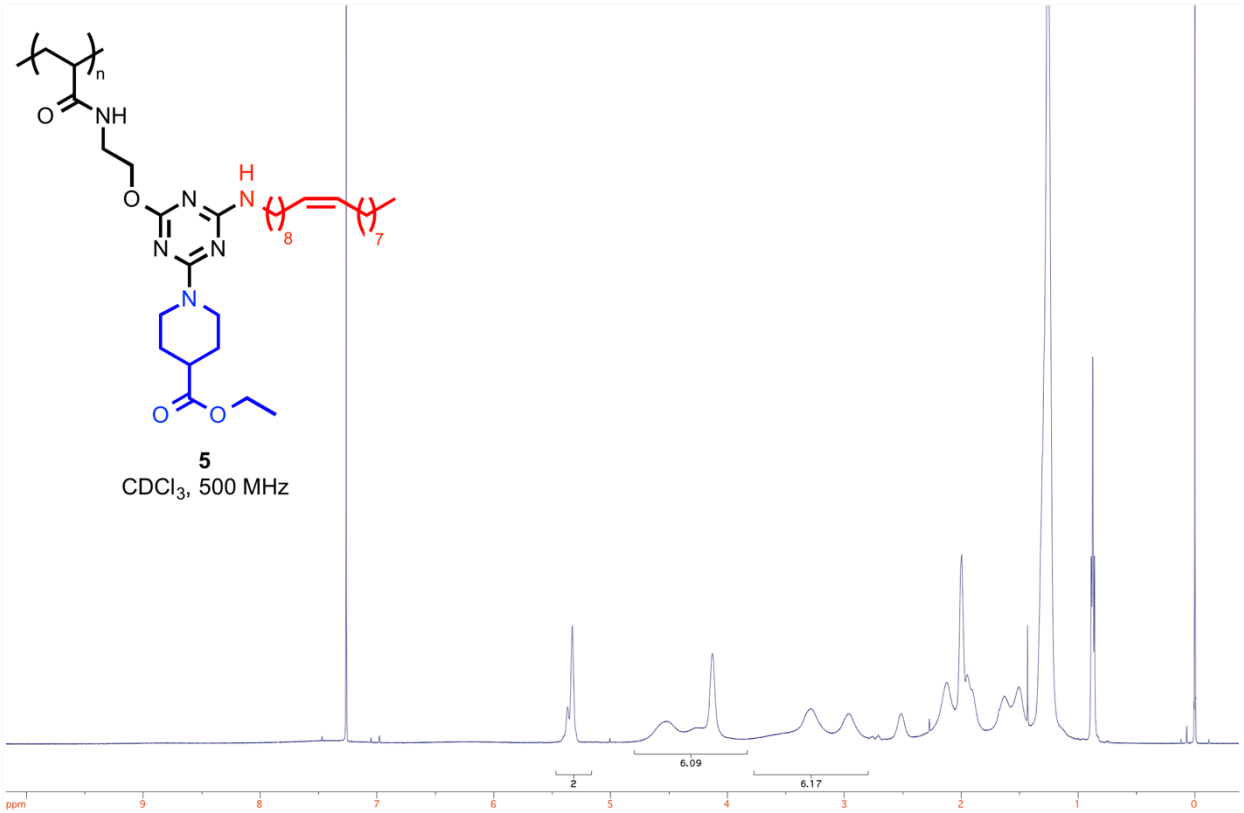


Figure S14. ^{1}H NMR spectrum of **5**.

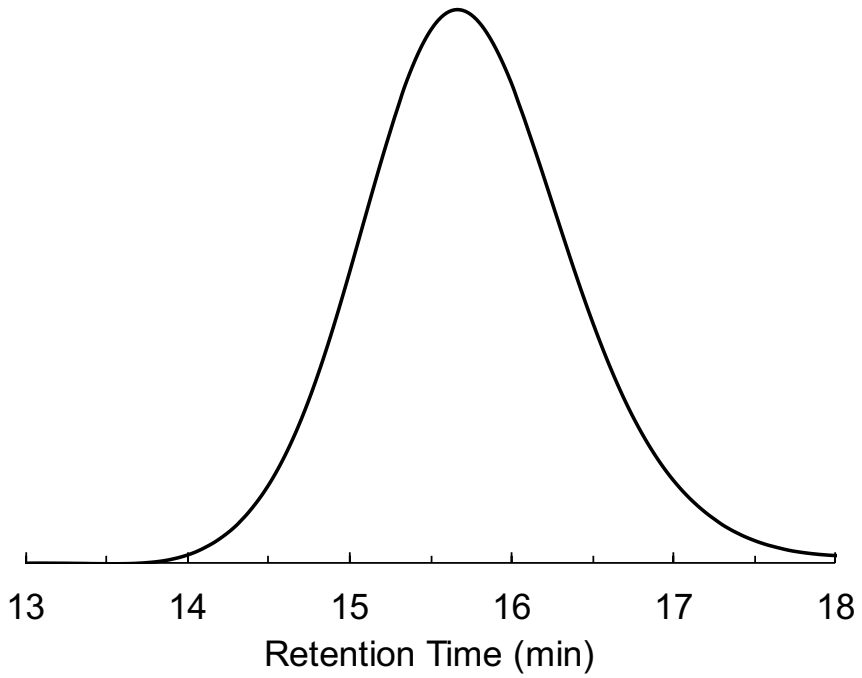


Figure S15. SEC trace of **5**. ($M_{n,SEC\text{-}MALS}$ = 45,400 g/mol, M_w/M_n = 1.06)

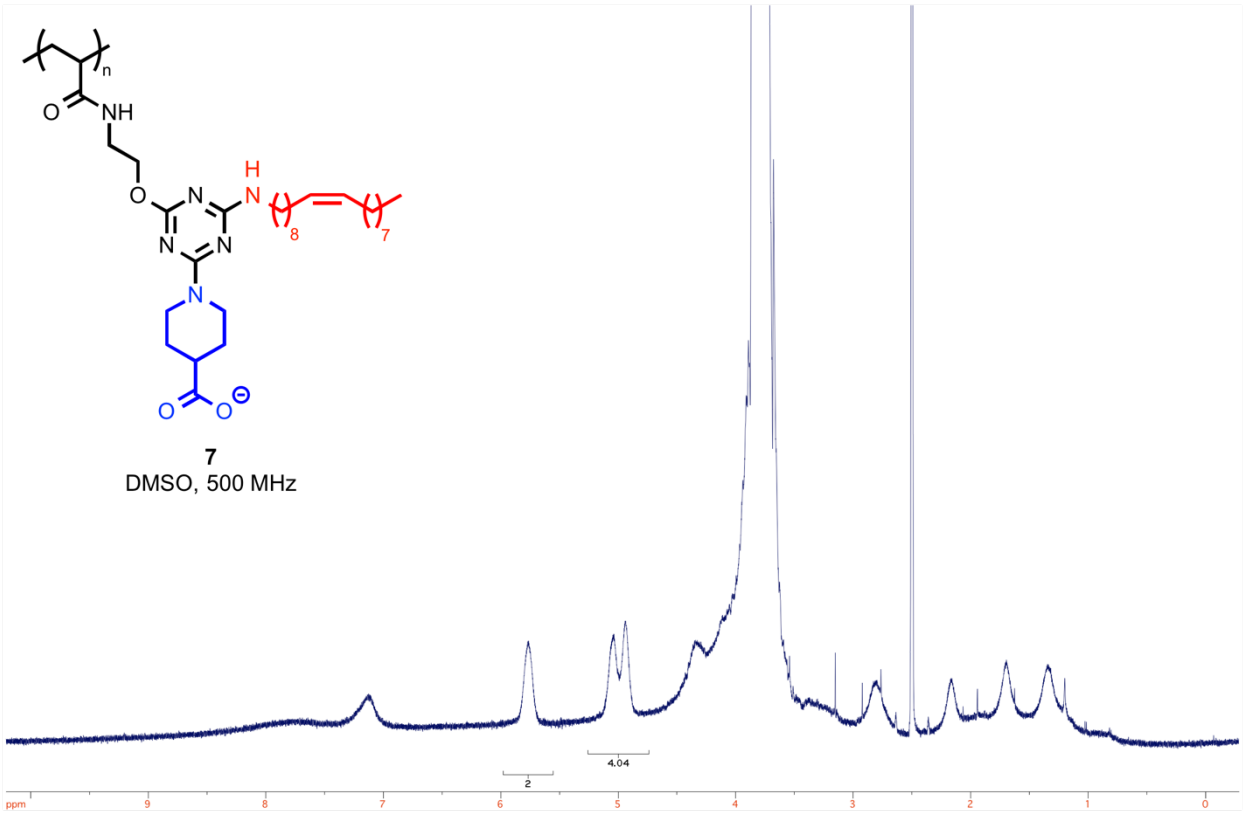


Figure S16. ^{1}H NMR spectrum of **7**.

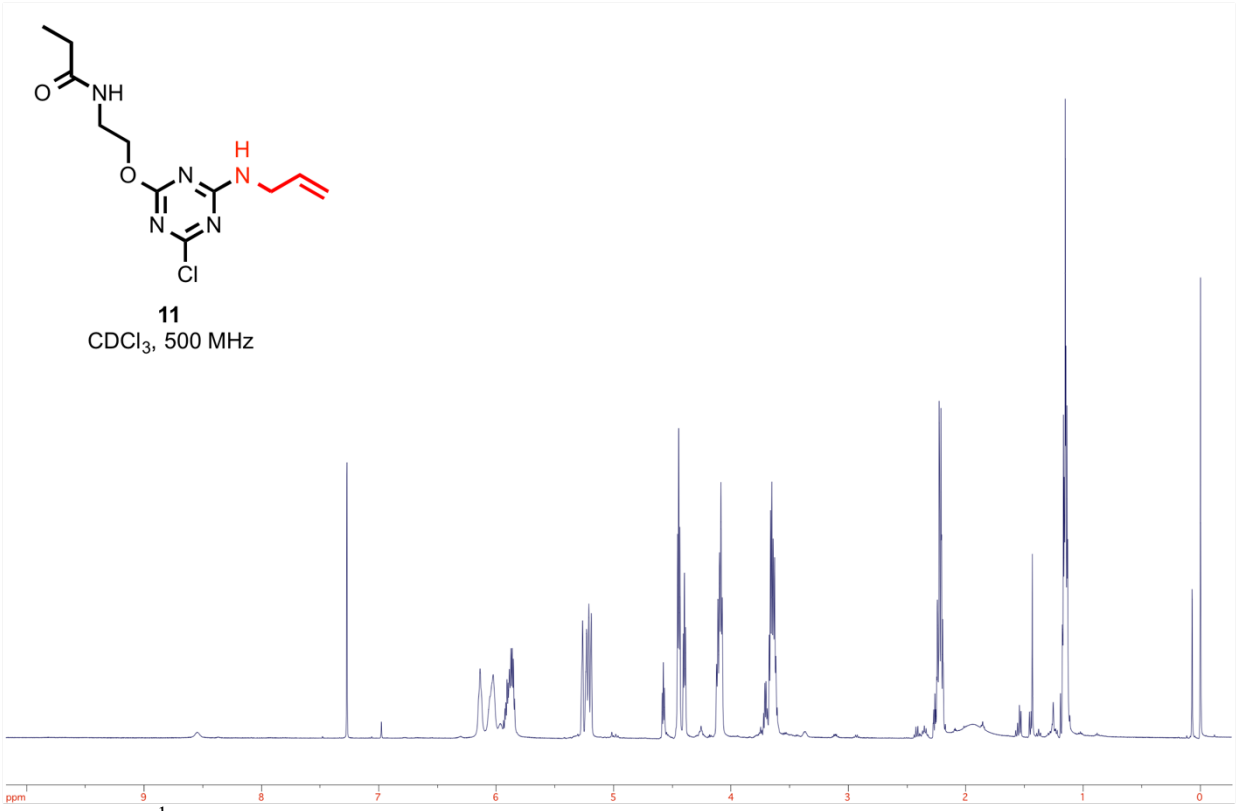


Figure S17. ^{1}H NMR spectrum of **11**.

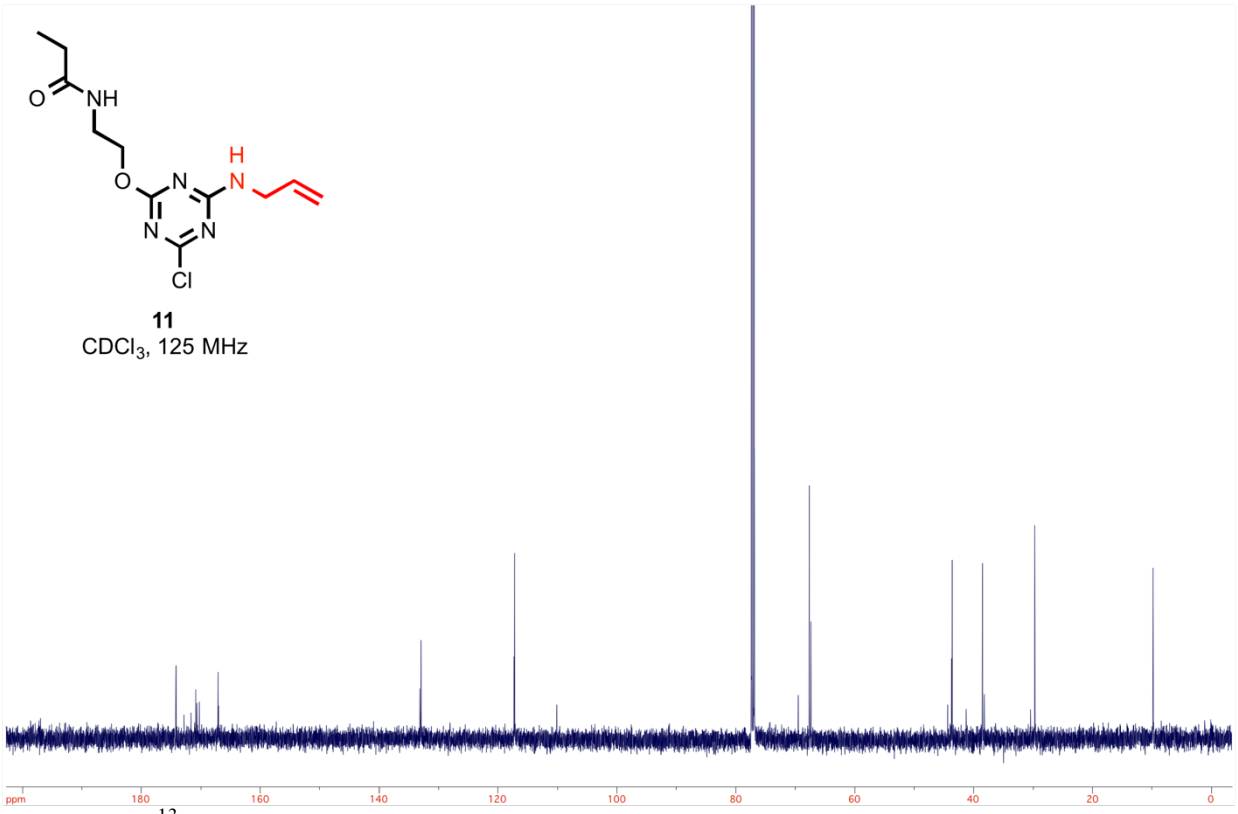


Figure S18. ^{13}C NMR spectrum of **11**.

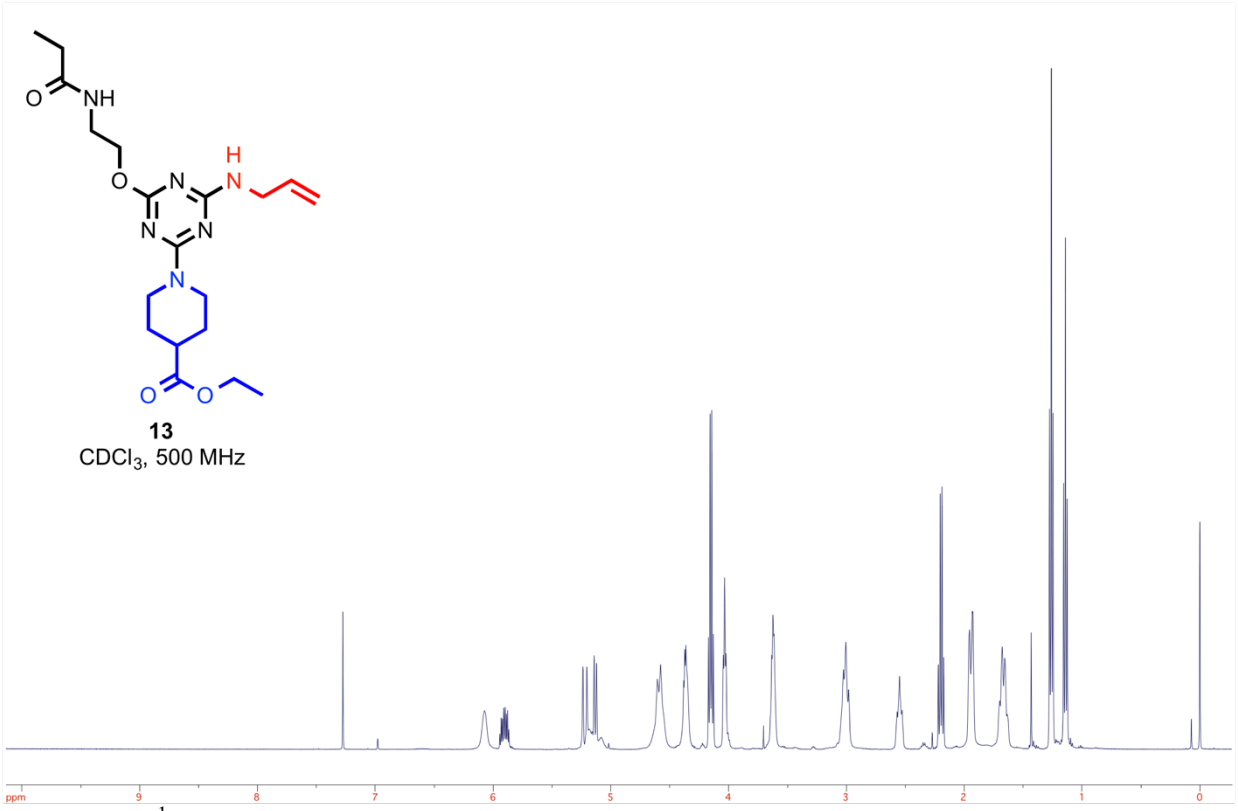


Figure S19. ^{1}H NMR spectrum of **13**.

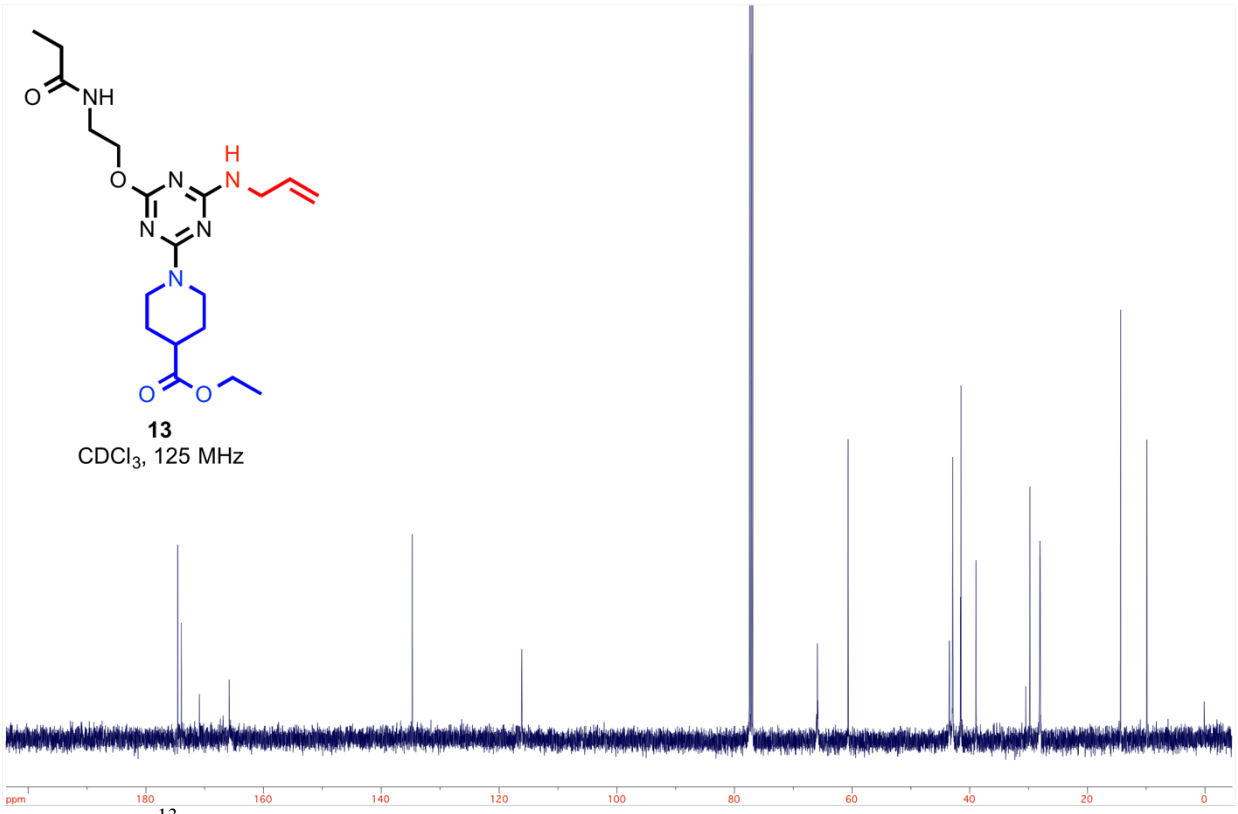


Figure S20. ^{13}C NMR spectrum of **13**.

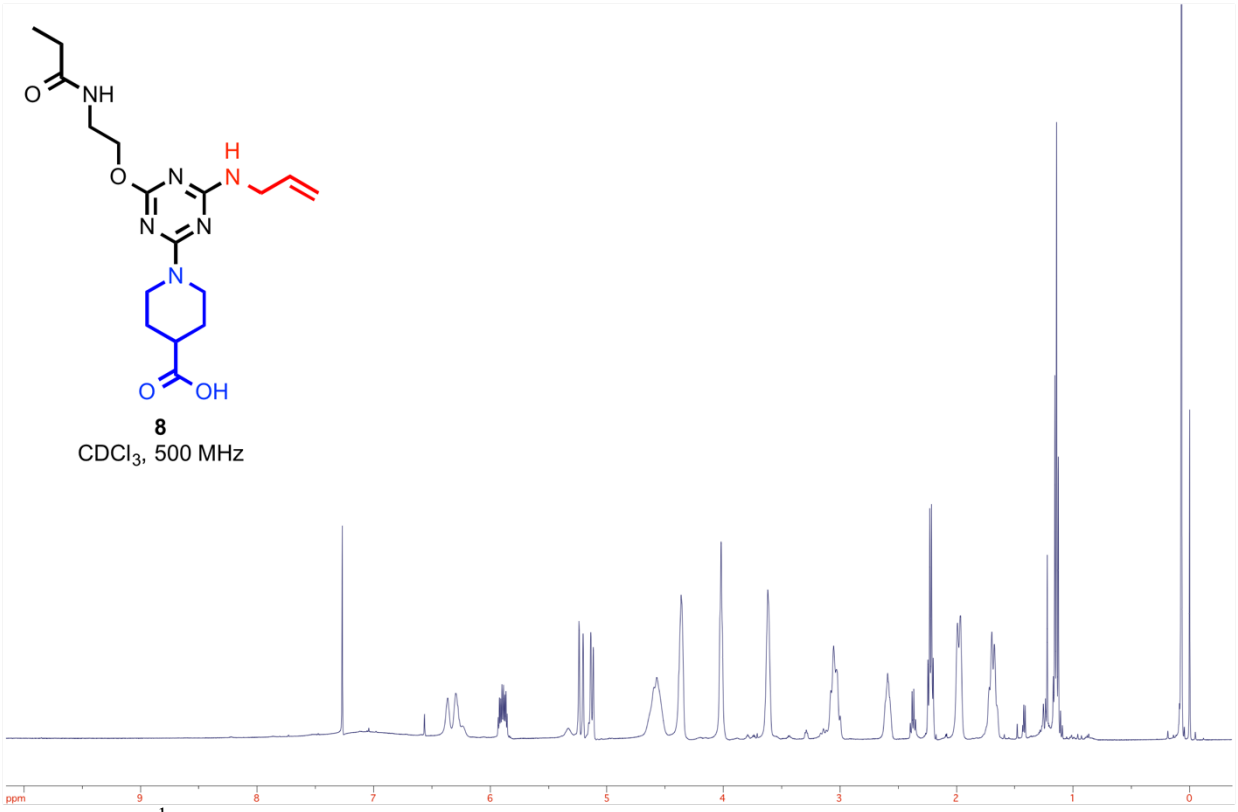


Figure S21. ^{1}H NMR spectrum of **8**.

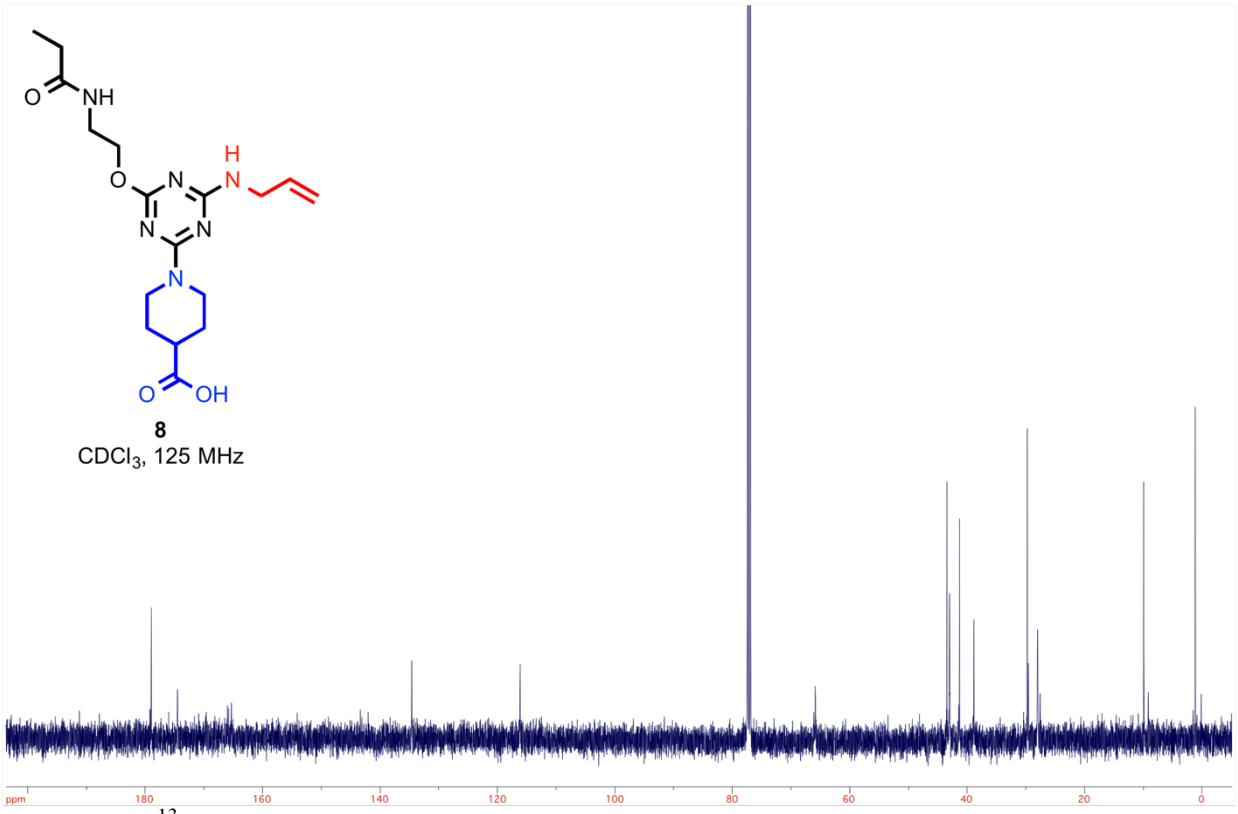


Figure S22. ^{13}C NMR spectrum of **8**.

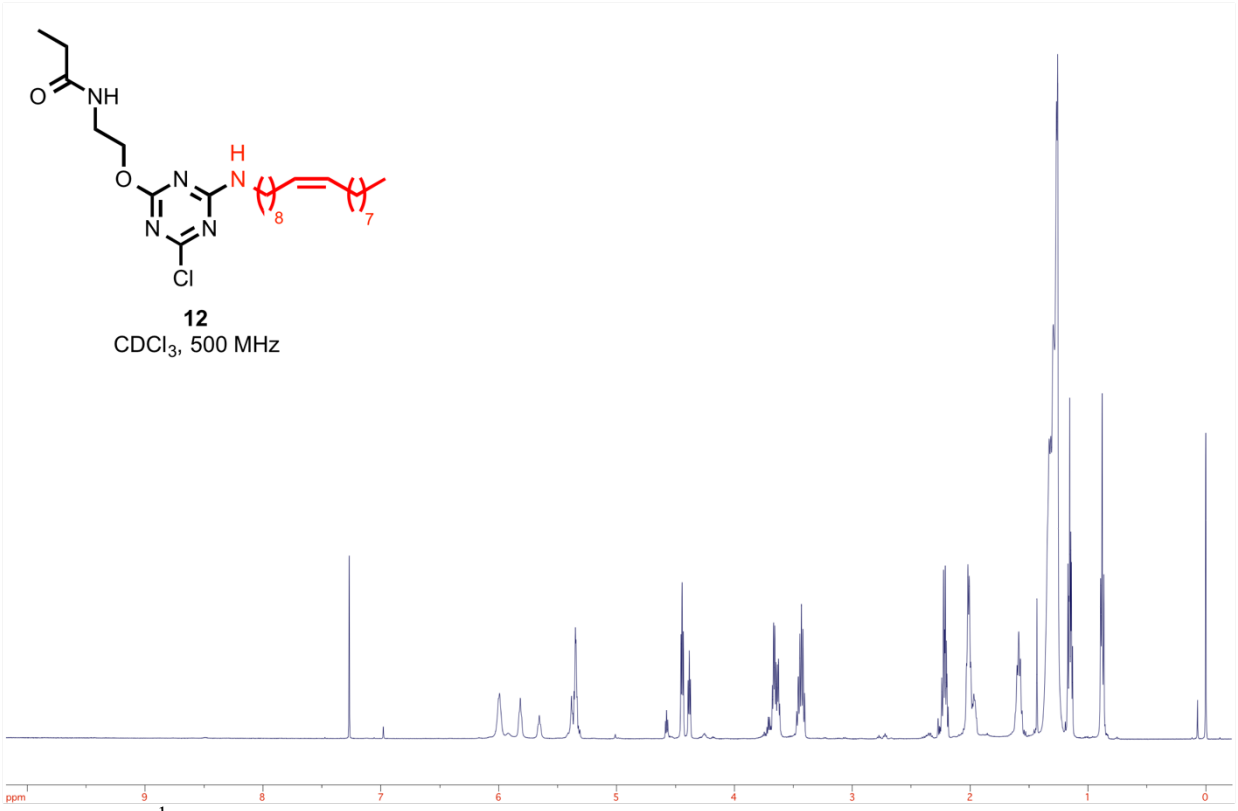


Figure S23. ^{1}H NMR spectrum of **12**.

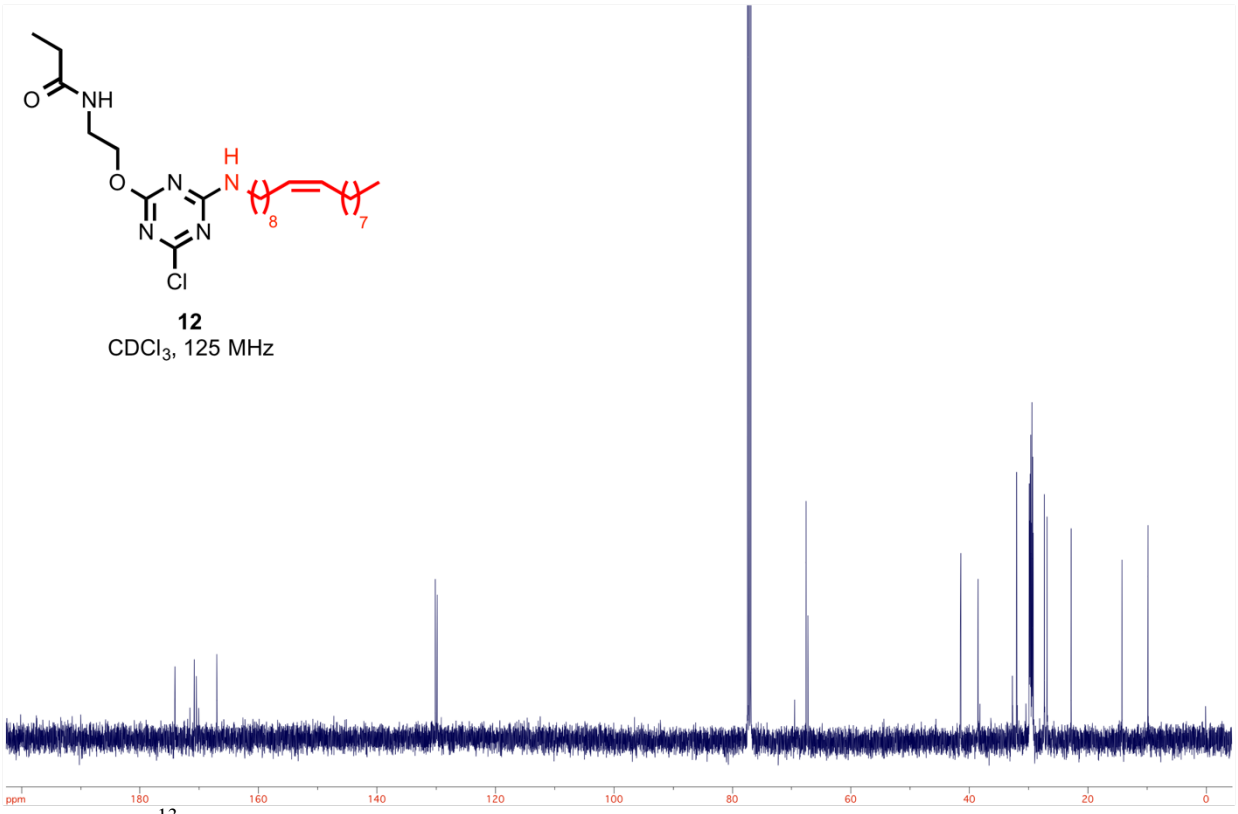


Figure S24. ^{13}C NMR spectrum of **12**.

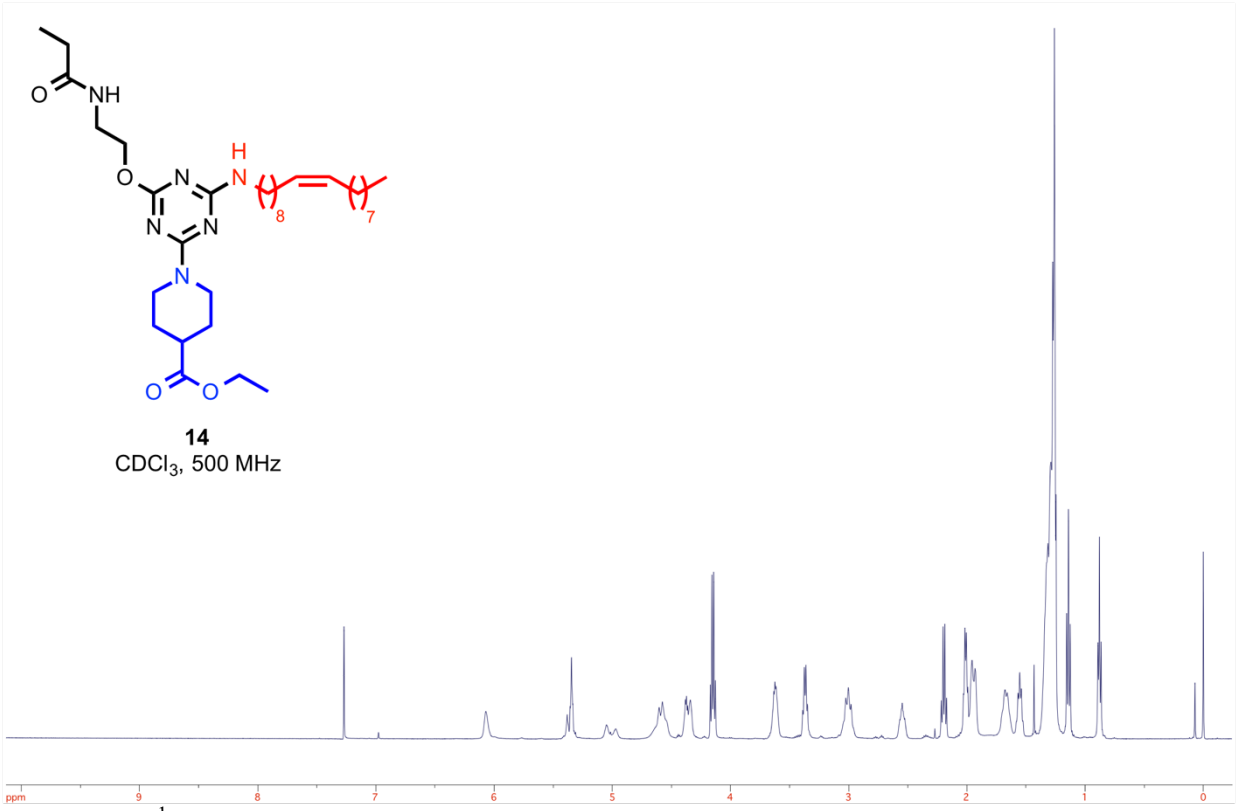


Figure S25. ^{1}H NMR spectrum of **14**.

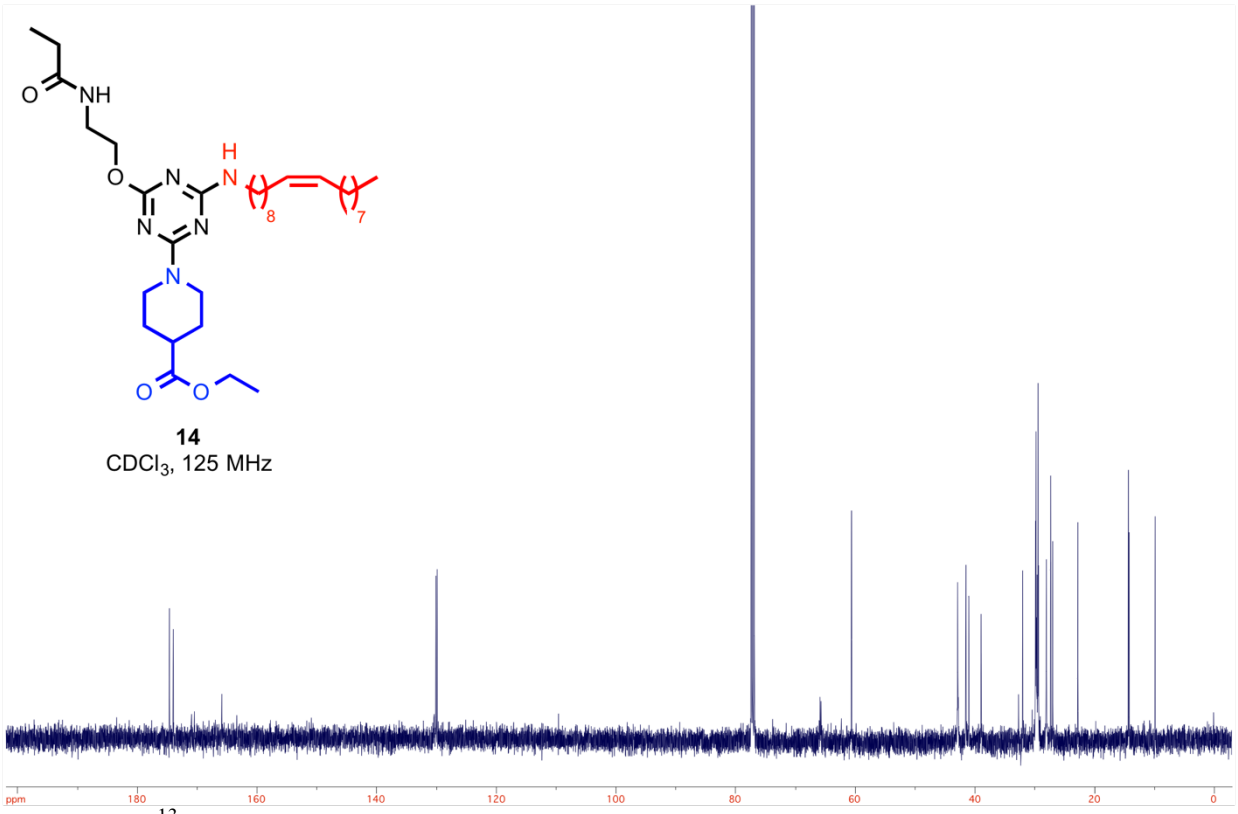


Figure S26. ^{13}C NMR spectrum of **14**.

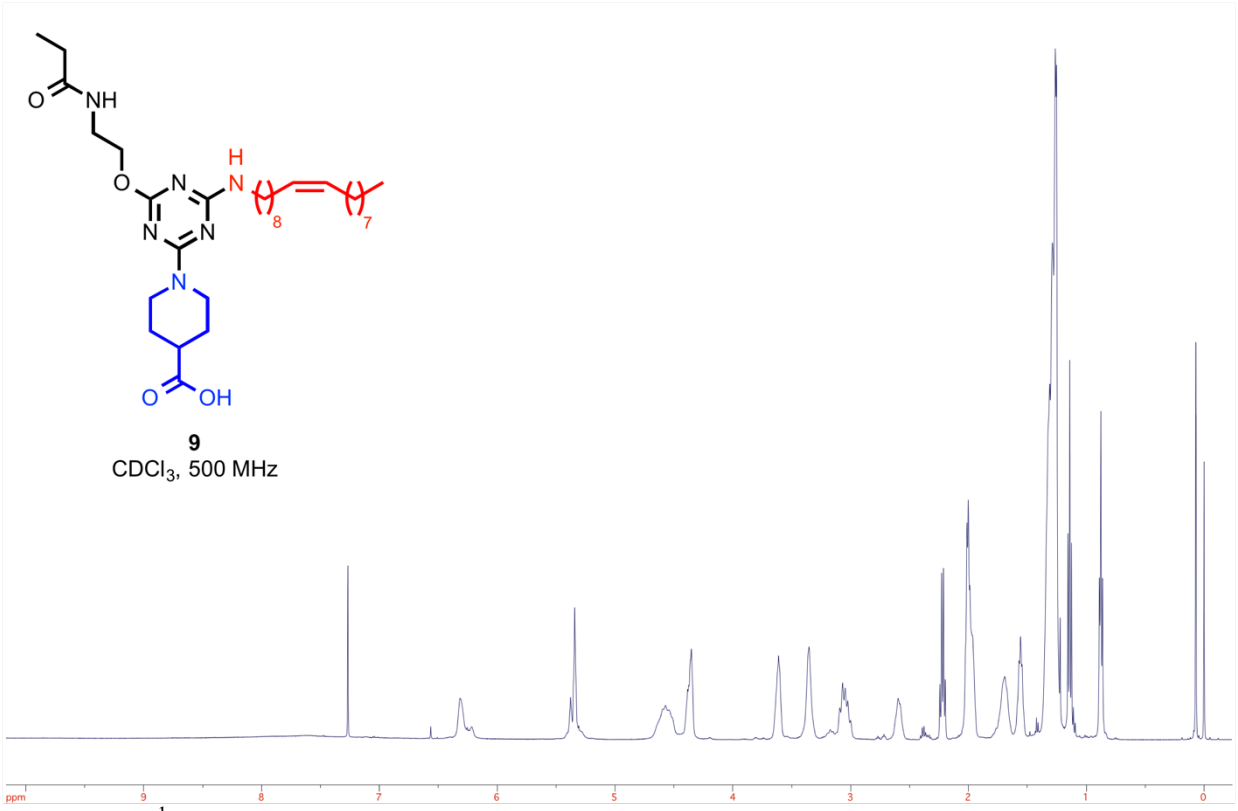


Figure S27. ^{1}H NMR spectrum of **9**.

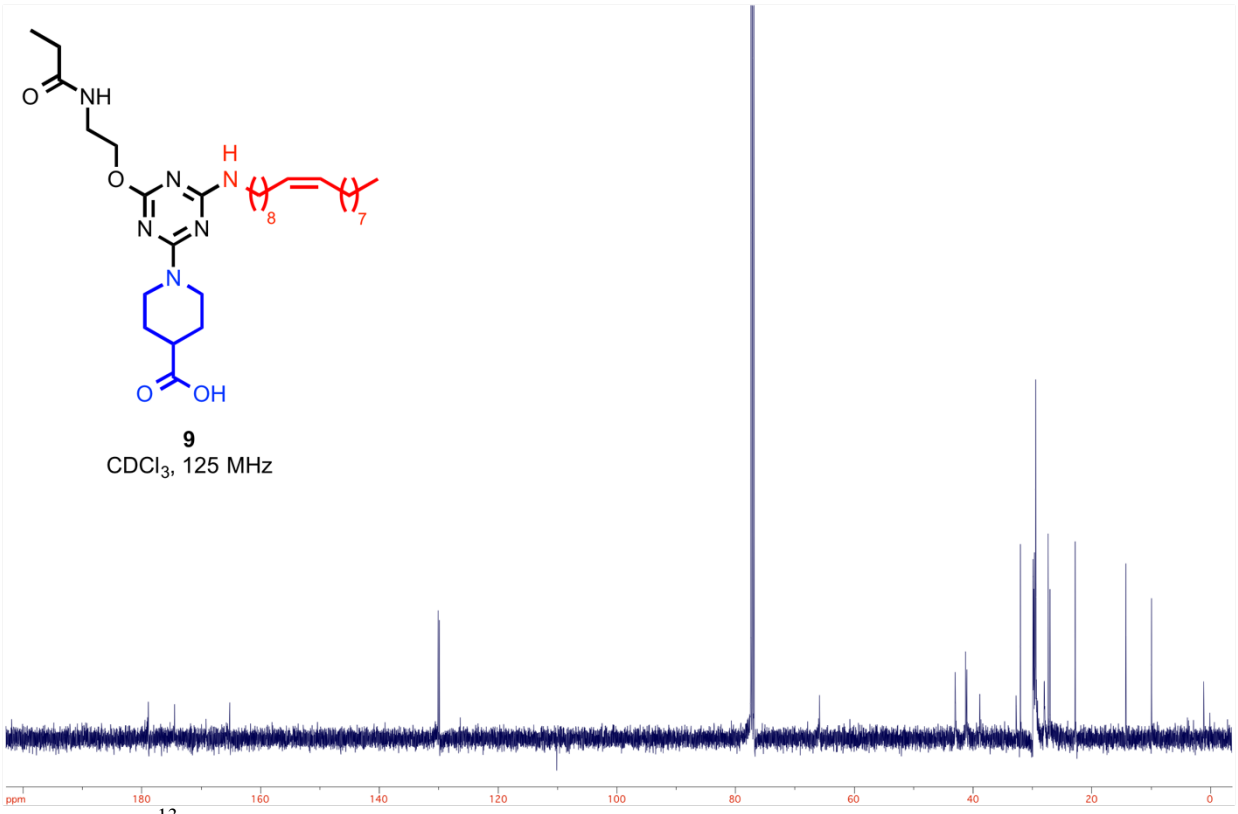


Figure S28. ^{13}C NMR spectrum of **9**.

References:

1 T. Kubo, C. A. Figg, J. L. Swartz, W. L. A. Brooks and B. S. Sumerlin, *Macromolecules*, 2016, **49**, 2077.