Supporting Information

Free Radical Polymers with Tunable and Selective Bio- and Chemical Degradability

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General procedures. ^{1}H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectra were recorded on a Varian 400 spectrometer in deuterated chloroform unless stated otherwise. Chemical shifts are reported in ppm and referenced to tetramethylsilane and chloroform (proton and carbon). Column chromatography was performed on a Biotage SP1 Flash Purification System using FLASH 40+M and FLASH 25+M cartridges. Size exclusion chromatography was performed on a Waters 2695 Separation Module equipped with four 5 μm Water columns (300 × 7.7 mm), connected in series with increasing pore size (10^2, 10^3, 10^4, and 10^6 Å), and a Waters 2414 Refractive Index Detector and Waters 2996 Photodiode Array Detector. For size exclusion chromatography analysis (SEC) of poly(methyl methacrylate) polymers THF was used as eluent, while for the analysis of poly(*N*,*N*-dimethylaminoethyl methacrylate) and poly(2-hydroxyethyl methacrylate) polymers DMF was used as eluent. In all cases poly(methyl methacrylate) standards were used for calibration. Infrared spectra were recorded on a Perkin Elmer Spectrum 100 with a Universal ATR sampling accessory. 6-Mercapto-1-hexanol (97%) was purchased from Fluka, methyl methacrylate (99%), 2-hydroxyethyl methacrylate (99+%), *N*,*N*-dimethylaminoethyl methacrylate (99%), α-bromomethyl acryclic acid (98%), chlorobenzene (99%), tri-n-butylphosphine (%), hydrazine 35 wt% in water and 2,2'-azobis(2-methylpropionitrile) (AIBN) (98%) were purchased from Aldrich and 2-chloro-1-methylpyridinium iodide (97%) and sodium methoxide 30 wt% in methanol were purchased from ACROS. Methyl methacrylate was filtered over activated neutral alumina prior to use. Methoxycarbonylbenzyl dithiobenzoate (MCBDB) was synthesized following a literature procedure;[1] modified literature procedures were used to synthesize [(6-hydroxyhexyl)-thiomethyl]acryclic acid and 3-methylidene-1-oxa-5-thiacycloundecan-2-one.[2-5]

Synthesis of [(6-hydroxyhexyl)thiomethyl]acryclic acid, (1). Triethylamine (5.18 mL, 37.3 mmol) was added dropwise to a cooled (0ºC) solution of α-bromomethylacrylic acid (3.07 g, 18.6 mmol) in dichloromethane (100 mL). 6-Mercapto-1-hexanol (2.50 g, 18.6 mmol) was added over a period of 15 min, and the reaction mixture was stirred for 20 h. A solution of ammonium sulfate (9.0 g, 78.8 mmol) and sulfuric acid (5 mL, 2M, 10 mmol) in water (100 mL) was cooled to 0ºC, and the reaction mixture was poured into it. This mixture was extracted with diethyl ether (3 × 60 mL), the organic phase was

dried with magnesium sulfate and solvent was removed under reduced pressure, yielding a white solid. (3.72 g, 92%) δ_H (400 MHz): 6.33 (s, 1H), 5.76 (s, 1H), 3.62 (t, 2H), 3.38 (s, 2H), 2.42 (t, 2H), 1.58 (m, 4H), 1.38 (m, 4H). δ_C (100 MHz): 170.9, 161.4, 136.9, 128.0, 70.7, 62.9, 32.5, 31.7, 29.2, 28.6, 25.4. ESI-MS: 219.10 ($M+H^+$), 241.08 ($M+Na^+$), 257.06 ($M+K^+$) FT-IR, ν: 3106, 2925, 2855, 1707, 1676, 1621, 1466, 1444, 1408, 1336, 1312, 1233, 1213, 1073, 1-54, 970, 896, 811, 758, 720.

Synthesis of 3-methylidene-1-oxa-5-thiacycloundecan-2-one, (2). [(6-hydroxy-hexyl)thiomethyl] acryclic acid (1.50 g, 6.87 mmol) was dissolved in a mixture of dichloromethane (60 mL) and triethylamine (7.65 mL, 55.0 mmol), and added *via* syringe pump over a period of 8 h to a refluxing solution of 2-chloro-1-methylpyridinium chloride (7.02 g, 27.5 mmol) in dichloromethane (650 mL). The reaction mixture was cooled down to room temperature and filtered. Solvent was removed under reduced pressure. The solids were dissolved in water (100 mL) and extracted with diethyl ether (3 × 30 mL). The extracts were dried with magnesium sulfate and removal of solvent gave an orange liquid. The liquid was purified *via* column chromatography, yielding a white solid. (410 mg, 30%) R_f 0.70 (dichloromethane). δ_H (400 MHz): 6.11 (s, 1H), 5.27 (s, 1H), 4.16 (t, 2H), 3.35 (s, 2H), 2.54 (t, 2H), 1.84-1.57 (m, 8H). δ_C (100 MHz): 166.4, 138.6, 126.8, 66.3, 32.8, 30.5, 25.8, 24.2, 23.8, 22.8. ESI-MS: 201.09 ($M+H^+$), 223.07 ($M+Na^+$), 239.06 ($M+K^+$). FT-IR, ν: 3105, 2931, 2854, 1711, 1634, 1468, 1459, 1443, 1390, 1354, 1302, 1284, 1236, 1197, 1132, 1059, 988, 971, 863, 815, 760, 731.

Synthesis of [(2-carboxyethyl)thiomethyl]acryclic acid, (3). α-Bromomethylacrylic acid (8.50 g, 51.5 mmol) was dissolved in 50 mL of dichloromethane and cooled to 0ºC. Triethylamine (15.6 g, 154.6 mmol) was slowly added to the solution. After complete addition, 3-mercaptopropionic acid (5.74 g, 54.0 mmol, 1.05 eq.) was added dropwise. The mixture was stirred overnight and a precipitate of triethylammonium bromide formed. Solvent was removed under reduced pressure and the solids were suspended in dichloromethane. The suspension was extracted with a 50:50 mixture (150 mL) of water and saturated aqueous sodium carbonate. The water layer was washed with dichloromethane (150 mL), diethyl ether (2×150 mL) and subsequently acidified with 2M hydrochloric acid. The water layer was

extracted with diethyl ether (3×150 mL), the organics were dried over magnesium sulfate and solvent was removed under reduced pressure yielding a white powder. (9.38 g, 96%) δ_H (400 MHz, DMSO-d_6): 12.43 (s, 2H), 6.01 (s, 1H), 5.66 (s, 1H), 3.29 (s, 2H), 2.53 (t, 2H), 2.47 (t, 2H). δ_C (100 MHz, DMSO-d_6): 173.14, 167.24, 137.67, 125.50, 34.18, 31.76, 25.82. FT-IR, ν: 3115, 3031, 2930, 2636, 1685, 1625, 1441, 1412, 1316, 1239, 1214, 1165, 1136, 921, 814, 757.

Synthesis of 3-methylidene-1,9-dioxa-5,12,13-trithiacyclopentadecane-2,8-dione, (4). [(2-Carboxyethyl)thiomethyl]acryclic acid (640 mg, 3.4 mmol) was dissolved in a mixture of dry THF (25 mL) and dichloromethane (25 mL), which was cooled to 0ºC. Oxalylchloride (1.70 g, 13.4 mmol, 4 eq.) was added slowly. After complete addition, a drop of DMF was added. The solution was left stirring for 2 h. Formation of the acid chloride was confirmed by FT-IR. Solvent was removed under reduced pressure and the remaining oil was immediately dissolved in dry dichloromethane (50 mL) and taken up in a syringe. 2,2'-Dithiodiethanol (519 mg, 3.4 mmol) was dissolved in dry THF (25 mL) and taken up in a syringe as well. Both solutions were added *via* syringe pump to a solution of triethylamine (1.36 g, 13.4 mmol) in dry dichloromethane (200 mL) over 30 min. The solution was left stirring for another 15 min and solvent was removed under reduced pressure yielding a brown solid. THF (25 mL) was added and the resulting suspension was filtered in order to remove triethylammonium chloride salts. The solution was evaporated to dryness again and the remaining oil was purified *via* column chromatography yielding a clear liquid that slowly crystallized. The product was dissolved in a mixture of dichloromethane and hexane (1:9) and slow evaporation of solvent afforded white crystals. (154 mg, 15%) R_f 0.45 (ethyl acetate:hexane, 1:3). δ_H (400 MHz): 6.22 (s, 1H), 5.70 (s, 1H), 4.48 (t, 2H), 4.34 (t, 2H), 3.42 (s, 2H), 3.02 (t, 2H), 2.94 (t, 2H), 2.82 (t, 2H), 2.67 (t, 2H). δ_C (100 MHz): 171.7, 166.1, 137.3, 126.9, 63.0, 62.8, 37.8, 37.3, 34.6, 33.6, 27.7. ESI-MS: 309.03 ($M+H^+$), 331.01 ($M+Na^+$), 346.99 ($M+K^+$). FT-IR, ν: 2969, 2897, 1728, 1717, 1626, 1487, 1452, 1424, 1403, 1383, 1356, 1325, 1284, 1239, 1221, 1189, 1173, 1150, 1133, 1116, 1071, 972, 947, 935, 926, 889, 849, 814, 778, 759.

Synthesis of 3-methylidene-1,9-dioxa-5-thiacyclopentadecane-2,8-dione, (5). [(2-Carboxyethyl)-thiomethyl]acryclic acid (629 mg, 3.3 mmol) was converted into the diacid chloride as described above. The oil was dissolved in dry dichloromethane (50 mL) and taken up in a syringe. 1,5-Pentanediol (344 g, 3.3 mmol) was dissolved in a mixture of dry THF (15 mL) and dichloromethane (10 mL) and taken up in a syringe. Both solutions were added *via* syringe pump to a solution of triethylamine (1.34 g, 13.2 mmol) in dry dichloromethane (200 mL) over 30 min. The solution was left stirring for another 15 min and solvent was removed under reduced pressure yielding a brown solid. THF (25 mL) was added and the resulting suspension was filtered in order to remove triethylammonium chloride salts. The solution was evaporated to dryness again and the remaining oil was purified *via* column chromatography yielding a clear liquid that crystallized at -20ºC. (210 mg, 25%) R_f 0.38 (ethyl acetate:hexane, 1:3). δ_H (400 MHz): 6.20 (s, 1H), 5.60 (s, 1H), 4.30 (t, 2H), 4.20 (t, 2H), 3.47 (s, 2H), 2.81 (t, 2H), 2.61 (t, 2H), 1.64 (m, 6H). δ_C (100 MHz): 171.7, 166.1, 137.0, 127.0, 63.9, 63.1, 34.4, 34.3, 27.9, 27.6, 21.3. ESI-MS: 259.10 ($M+H^+$), 281.08 ($M+Na^+$), 297.06 ($M+K^+$). FT-IR, ν: 2957, 2917, 1721, 1631, 1457, 1424, 1385, 1325, 1303, ,1183, 1130, 1038, 935, 813.

Synthesis of 3-methylidene-1,5,9-trithiacyclopentadecane-2,8-dione, (6). [(2-Carboxyethyl)-thiomethyl]acryclic acid (1.16 g, 6.10 mmol) was converted into the diacid chloride as described above. The oil was dissolved in dry dichloromethane (50 mL) and taken up in a syringe. 1,6-Hexanedithiol (917 mg, 6.10 mmol) was dissolved in dry THF (25 mL) and taken up in a syringe. Both solutions were added *via* syringe pump to a solution of triethylamine (2.47 g, 24.4 mmol) in dry dichloromethane (200 mL) during 30 min. The solution was left stirring for another 15 min and solvent was removed under reduced pressure yielding a yellow solid. THF (25 mL) was added and the resulting suspension was filtered in order to remove triethylammonium chloride salts. The solution was evaporated to dryness again and the remaining oil was purified *via* column chromatography, yielding a clear liquid. (48 mg, 3%) R_f 0.65 (ethyl acetate:hexane, 1:3). δ_H (400 MHz): 6.04 (s, 1H), 5.59 (s, 1H), 3.41 (s, 2H), 3.02 (t, 2H), 2.96 (t, 2H), 2.80 (t, 2H), 1.60 (m, 4H), 1.41 (m, 4H). δ_C (100 MHz): 197.7, 193.0, 144.9, 122.5, 33.5, 28.7,

28.6, 27.8, 27.6, 27.5, 26.2, 26.0. ESI-MS: 259.10 ($M+H^+$), 281.08 ($M+Na^+$), 297.06 ($M+K^+$). FT-IR, ν: 2924, 2854, 1752, 1682, 1662, 1624, 1409, 1289, 1231, 1151, 1046, 983, 915, 745.

Synthesis of 2-hydroxyethyl 2-([3-(2-hydroxyethoxy)-3-oxopropyl]thiomethyl)prop-2-enoate, (7). [(2-Carboxyethyl)thiomethyl]acryclic acid (906 mg, 4.76 mmol) was dissolved in a mixture of dry THF (10 mL) and dichloromethane (10 mL) and cooled to 0ºC. Oxalylchloride (2.42 g, 19.04 mmol, 4 eq.) was added to the solution. After complete addition a drop of DMF was added. After 2 h FT-IR analysis confirmed complete formation of the diacid chloride. Solvent was removed under reduced pressure and the remaining yellow oil was dissolved in dichloromethane (50 mL). This solution was slowly added to a solution of ethylene glycol (5.91 g, 92.52 mmol, 10 eq. with respect to the acid chloride groups) and triethylamine (1.93 g, 19.07 mmol, 2 eq.) in dichloromethane (50 mL). After complete addition, the solution was left stirring for 1 h. Solvent was removed under reduced pressure and the resulting mixture was purified *via* column chromatography, yielding a clear liquid. (630 mg, 48%) R_f 0.45 (ethyl acetate). δ_H (400 MHz): 6.28 (s, 1H), 5.70 (s, 1H), 4.33 (t, 2H), 4.23 (t, 2H), 3.86 (m, 2H), 3.81 (m, 2H), 3.43 (s, 2H), 2.76 (t, 2H), 2.65 (t, 2H). δ_C (100 MHz): 172.2, 166.2, 136.6, 127.1, 66.6, 66.3, 60.7, 60.6, 60.5, 34.4, 32.9, 26.4, 21.1, 14.2. ESI-MS: 279.09 ($M+H^+$), 301.07 ($M+Na^+$), 317.05 ($M+K^+$). FT-IR, ν: 3317, 2940, 2874, 1722, 1455, 1397, 1325, 1259, 1189, 1084, 1034, 882, 860, 797, 733.

Synthesis of 13,13-dimethyl-3-methylidene-1,9,12,14-tetraoxa-5-thia-13-silacyclohexadecane-2,8-dione, (8). 2-Hydroxyethyl 2-([3-(2-hydroxyethoxy)-3-oxopropyl]thiomethyl)prop-2-enoate (182 mg, 0.66 mmol) was dissolved in dichloromethane (10 mL) and taken up in a syringe. Dichlorodimethylsilane (85 mg, 0.66 mmol) was dissolved in dichloromethane (10 mL) and also taken up in a syringe. Both solutions were added simultaneously to a solution of triethylamine (267 mg, 2.64 mmol) in dichloromethane (50 mL) over 10 min. After addition, the solution was left stirring for 30 min and solvent was removed under reduced pressure. The remaining liquid was purified *via* column chromatography yielding a clear liquid. (25 mg, 11%) R_f 0.45 (ethyl acetate:hexane, 1:3). δ_H (400 MHz): 6.27 (s, 1H), 5.74 (s, 1H), 4.30 (t, 2H), 4.19 (t, 2H), 3.94 (t, 2H), 3.89 (t, 2H), 3.45 (s, 2H), 2.83 (t, 2H),

2.66 (t, 2H), 0.17 (s, 6H). δ_C (100 MHz): 172.0, 166.42, 138.4, 127.6, 66.4, 65.8, 61.0, 60.8, 35.6, 34.3, 32.8, 27.5, -2.9. ESI-MS: 259.10 ($M+H^+$), 281.08 ($M+Na^+$), 297.06 ($M+K^+$). FT-IR, ν: 3500, 2958, 1724, 1630, 1406, 1378, 1325, 1303, 1257, 1188, 1130, 1100, 952, 843, 800.

Synthesis of copolymers. For each type of copolymer (methyl methacrylate, 2-hydroxyethyl methacrylate and *N,N*-dimethylaminoethyl methacrylate) a representative experimental procedure is given.

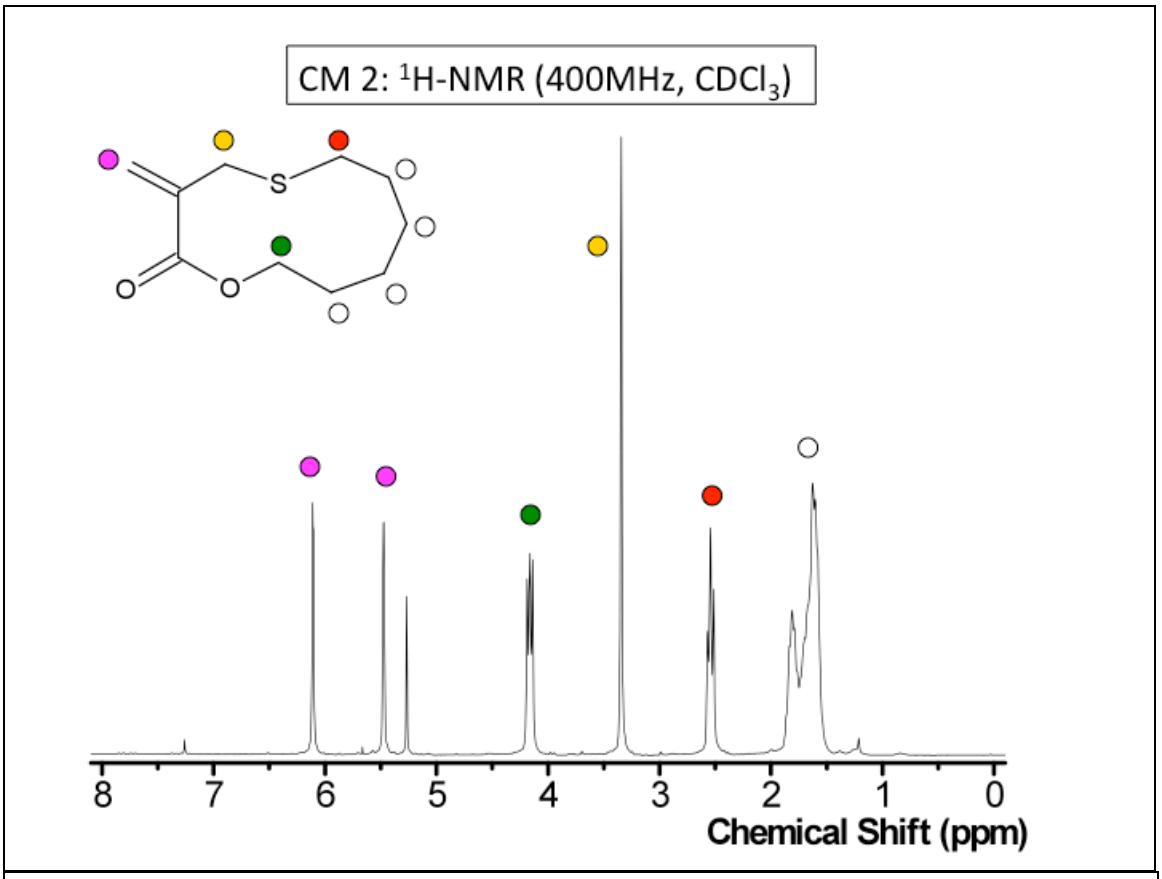
Synthesis of poly(methyl methacrylate)-co-(3-methylidene-1-oxa-5-thiacycloundecan-2-one) 1%, (P1a). A 5 mL ampoule with stir-bar was filled with methyl methacrylate (0.50 g, 5.00 mmol), cyclic monomer **2** (10.0 mg, 50 μmol), chlorobenzene (0.50 g, 4.44 mmol), AIBN (stock solution in chlorobenzene: 10 g/L, 0.27 mg, 1.6 μmol) and methoxycarbonylbenzyl dithiobenzoate (stock solution in chlorobenzene, 100 g/L, 2.5 mg, 8.3 μmol). Oxygen was removed *via* three freeze-pump-thaw cycles, and the ampoule was flame-sealed and heated at 70ºC for 17 h. The ampoule was opened and the reaction mixture was diluted with dichloromethane (2 mL) and precipitated in hexanes (100 mL), yielding the polymer as a pink powder. (Yield: 239 mg; ^{1}H NMR: 59% conv.; GPC: $M_n = 3.7 \times 10^4$ g/mol, $M_w = 5.3 \times 10^4$ g/mol, PDI: 1.42) δ_H (400 MHz): 6.17 (s, 1H), 5.46 (s, 1H), 4.07 (t, 2H), 3.60 (b, n × 3H), 3.40 (b, 2H), 2.43 (b, 2H), 2.03-0.75 (b, n × 5H).

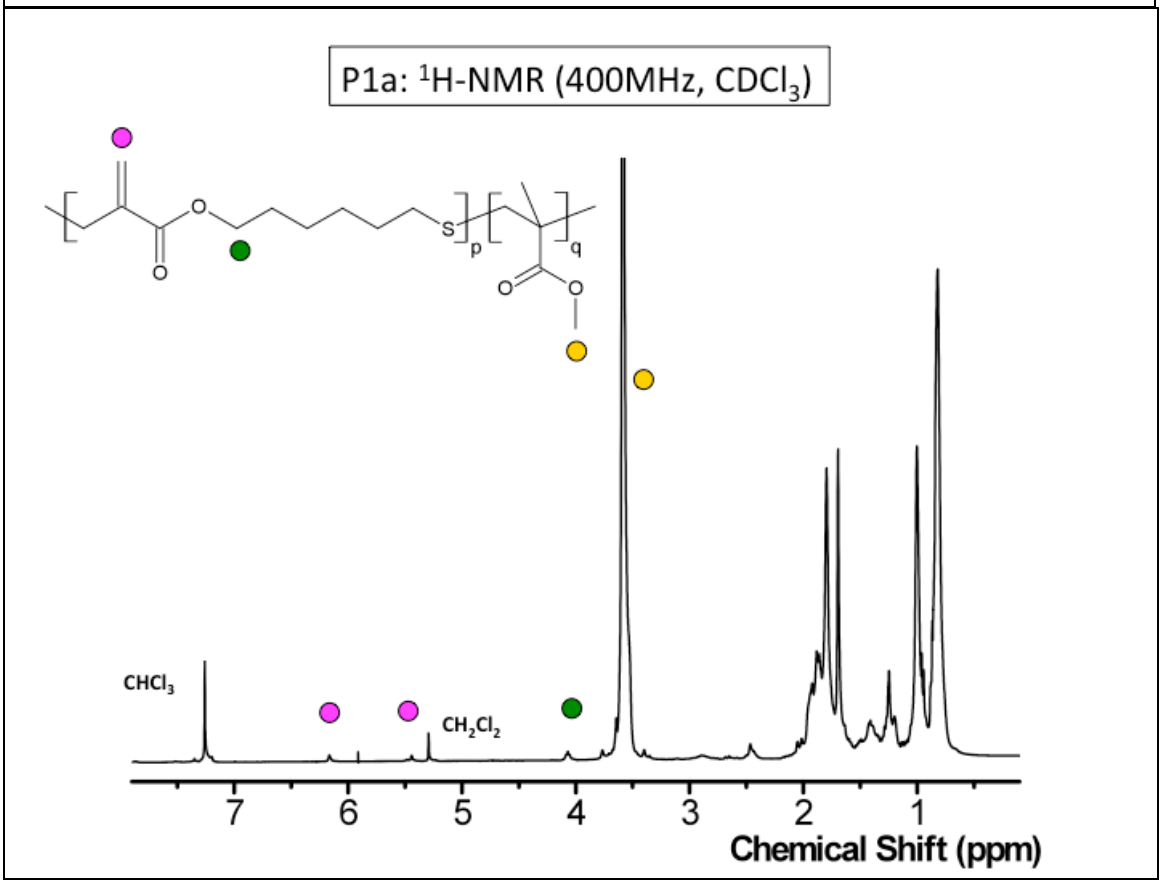
Synthesis of poly(2-hydroxyethyl methacrylate)-co-(3-methylidene-1,9-dioxa-5,12,13-trithiacyclopentadecane-2,8-dione) 1%, (P11). A 5 mL ampoule equipped with stir-bar was filled with 2-hydroxyethyl methacrylate (0.43 g, 3.30 mmol), cyclic monomer **4** (10.0 mg, 32 μmol), *N,N*-dimethyl formamide (0.45 g, 6.16 mmol), AIBN (stock solution in chlorobenzene: 10 g/L, 0.25 mg, 1.5 μmol) and methoxycarbonylbenzyl dithiobenzoate (stock solution in chlorobenzene, 100 g/L, 2.3 mg, 7.6 μmol). Oxygen was removed *via* three freeze-pump-thaw cycles, and the ampoule was flame-sealed and heated at 70ºC for 3 h. The ampoule was opened and the reaction mixture was diluted with methanol (2 mL) and precipitated in diethyl ether (100 mL), yielding the polymer as a pink wax. (Yield: 90 mg; ^{1}H NMR: 31% conv., $M_n = 3.2 \times 10^4$ g/mol; GPC: $M_n = 6.6 \times 10^4$ g/mol, $M_w = 8.9 \times 10^4$ g/mol, PDI: 1.35) δ_H (400

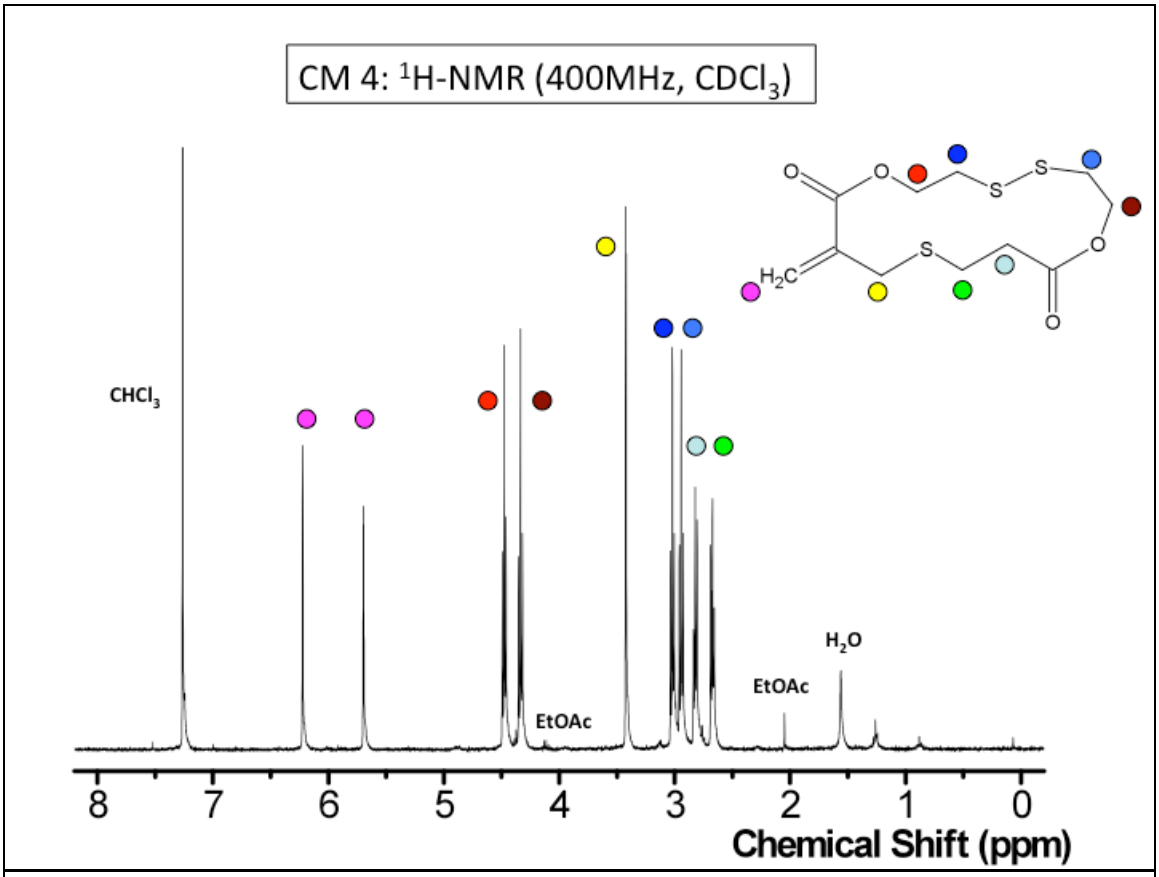
MHz, DMSO-d_6): 6.12 (s, 1H), 5.71 (s, 1H), 4.83 (m, n × 1H), 3.89 (b, n × 2H), 3.58 (b, 2H), 2.15-0.60 (b, n × 5H).

Synthesis of poly(*N,N*-dimethylaminoethyl methacrylate)-co-(3-methylidene-1,9-dioxa-5-thiacyclopentadecane-2,8-dione) 1%, (P9). A 5 mL ampoule equipped with stir-bar was filled with *N,N*-dimethylaminoethyl methacrylate (0.30 g, 1.91 mmol), cyclic monomer **5** (25.0 mg, 97 μmol), chlorobenzene (0.33 g, 2.89 mmol), AIBN (stock solution in chlorobenzene: 10 g/L, 0.11 mg, 0.66 μmol) and methoxycarbonylbenzyl dithiobenzoate (stock solution in chlorobenzene, 100 g/L, 1.0 mg, 3.3 μmol). Oxygen was removed *via* three freeze-pump-thaw cycles, and the ampoule was flame-sealed and heated at 70ºC for 17 h. The ampoule was opened and the reaction mixture was diluted with dichloromethane (2 mL) and precipitated in cold diethyl ether (cooled with dry-ice) (100 mL), yielding the polymer as a pink wax. (Yield: 121 mg; ^{1}H NMR: 49% conv.; GPC: $M_n = 2.8 \times 10^4$ g/mol, $M_w = 4.3 \times 10^4$ g/mol, PDI: 1.54) δ_H (400 MHz): 6.14 (s, 1H), 5.53 (s, 1H), 4.25 (m, 4H), 4.05 (b, n × 2H), 2.55 (b, 2H), 2.27 (b, 6H), 2.00-0.75 (b, n × 5H).

Selected ^{1}H-NMR spectra of cyclic monomers and their copolymers.






CM 4: ^{1}H-NMR (400MHz, $CDCl_3$)
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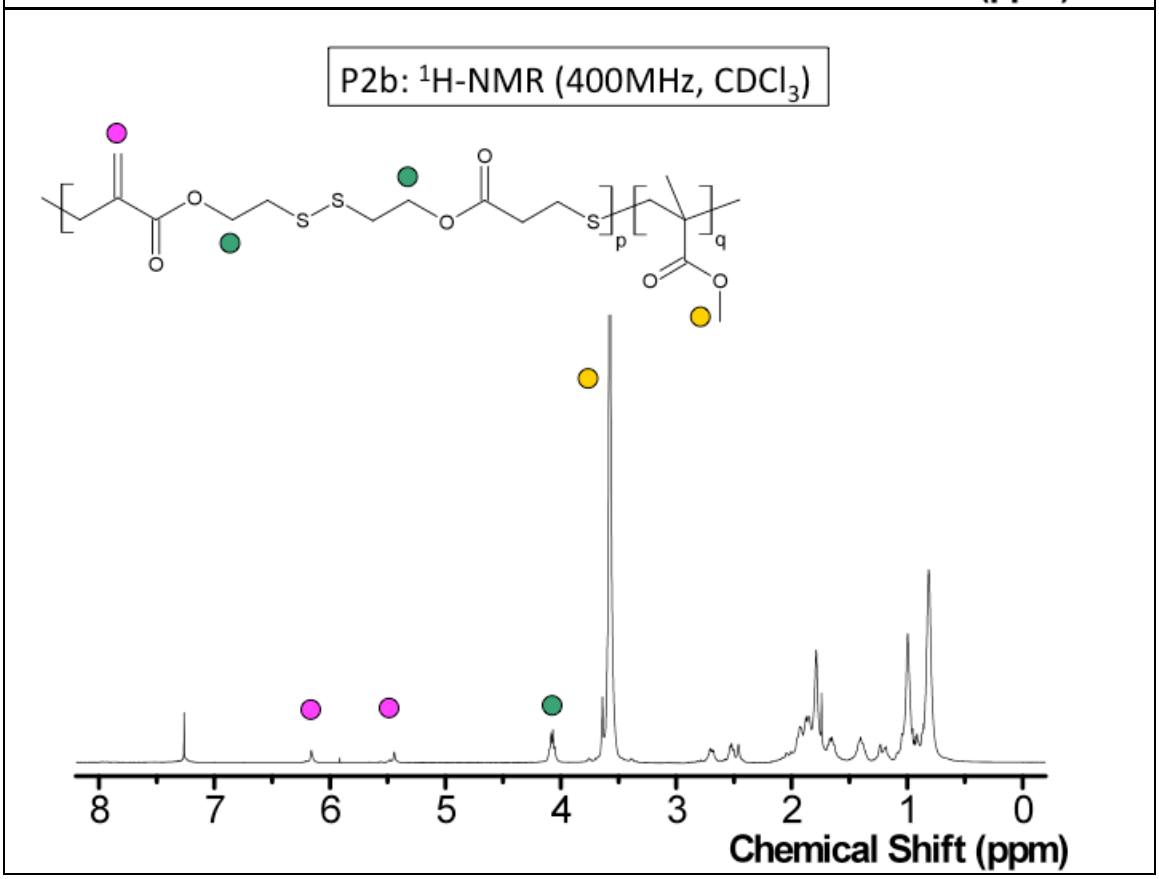
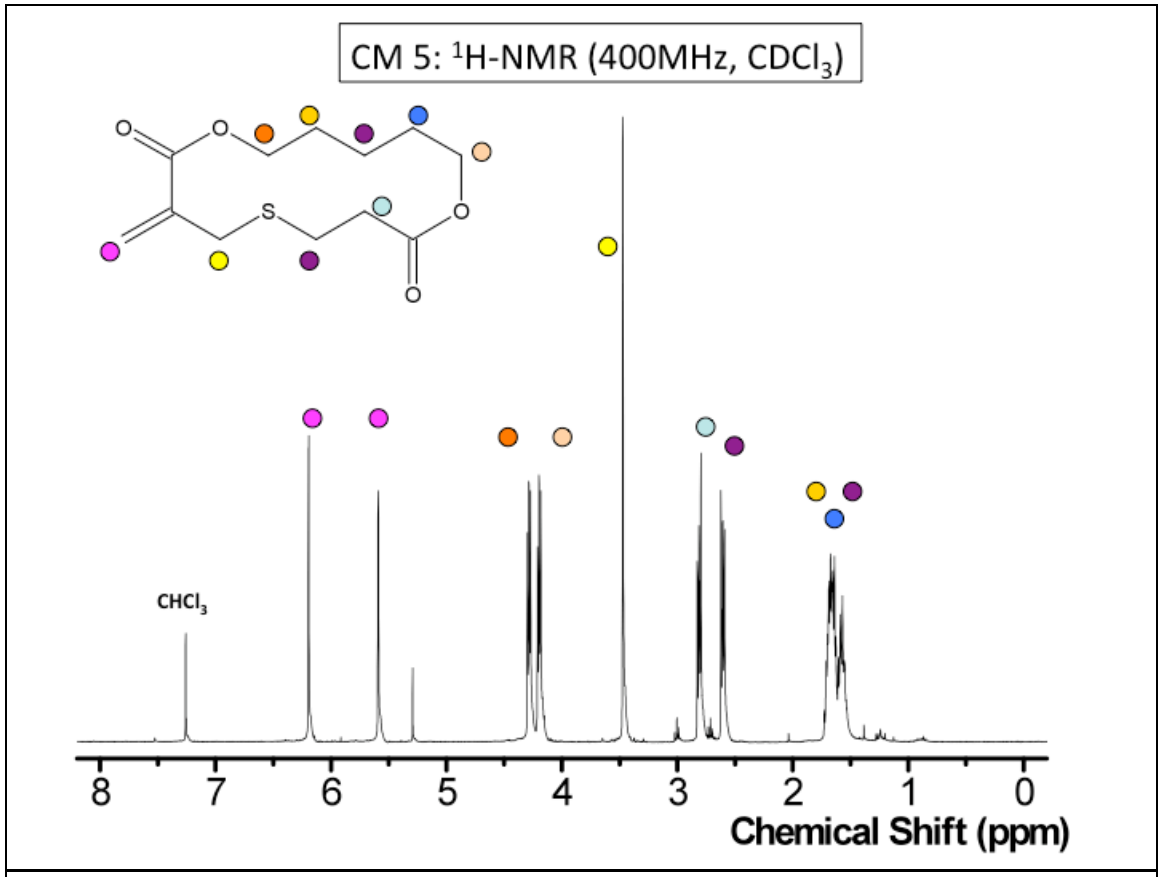
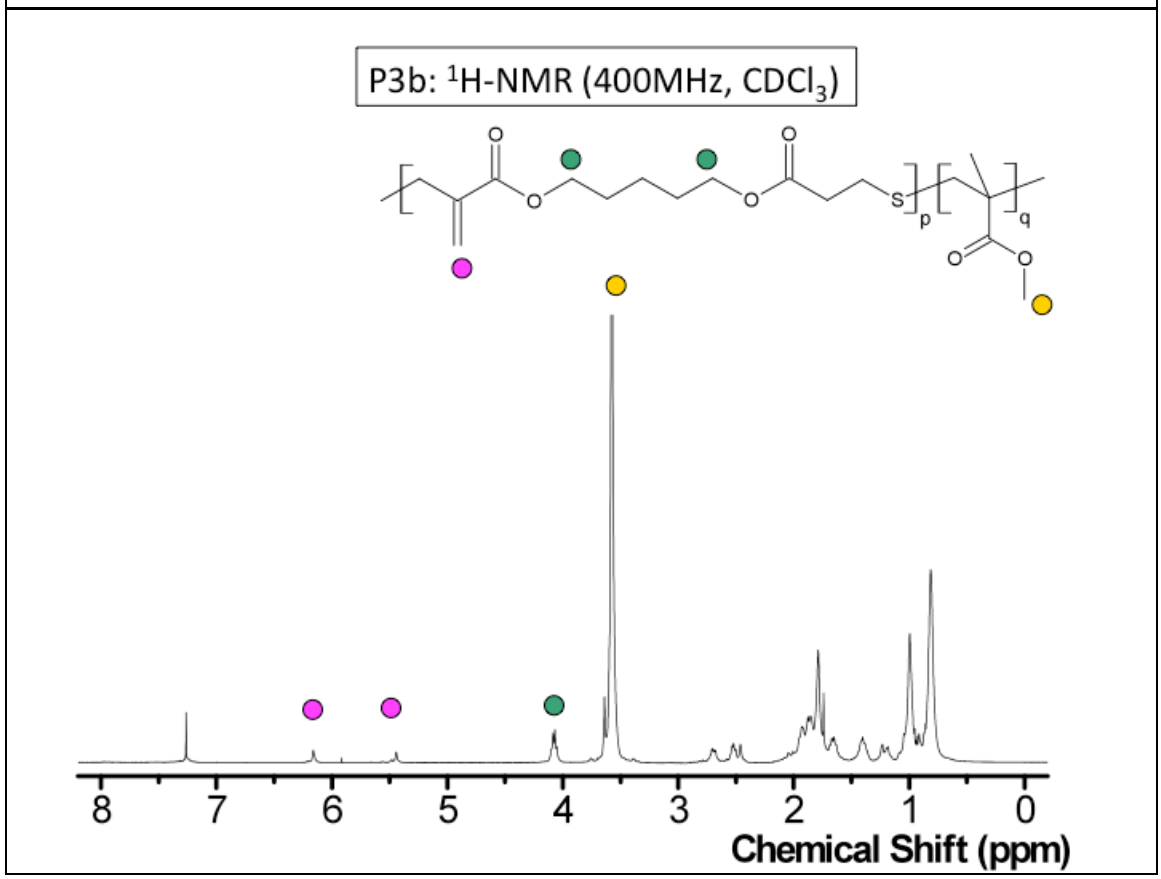
EtOAc
EtOAc
H_2O
8 7 6 5 4 3 2 1 0
Chemical Shift (ppm)


P2b: ^{1}H-NMR (400MHz, $CDCl_3$)
8 7 6 5 4 3 2 1 0
Chemical Shift (ppm)


CM 5: ^{1}H-NMR (400MHz, $CDCl_3$)
$CHCl_3$
8
7
6
5
4
3
2
1
0
Chemical Shift (ppm)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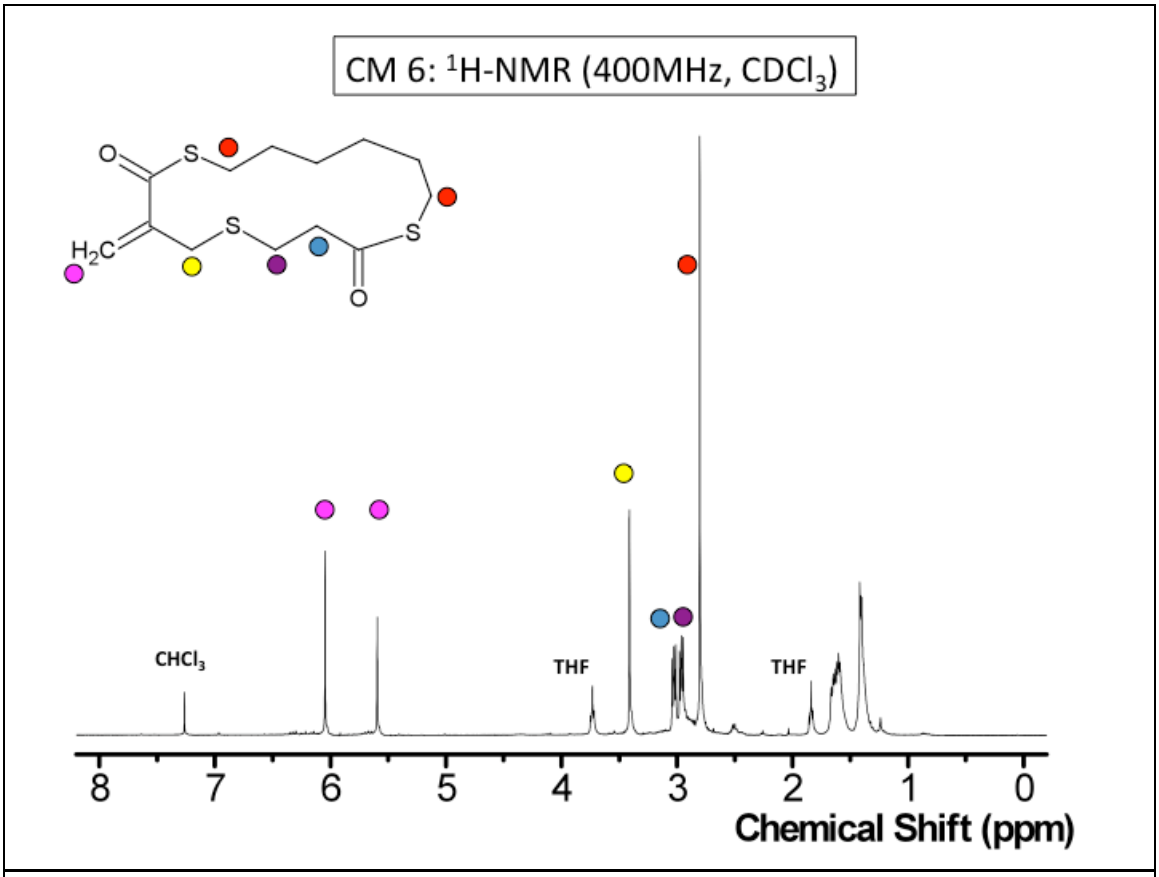
8
7
6
5
4
3
2
1
0
Chemical Shift (ppm)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S
S
S
O
H_2C
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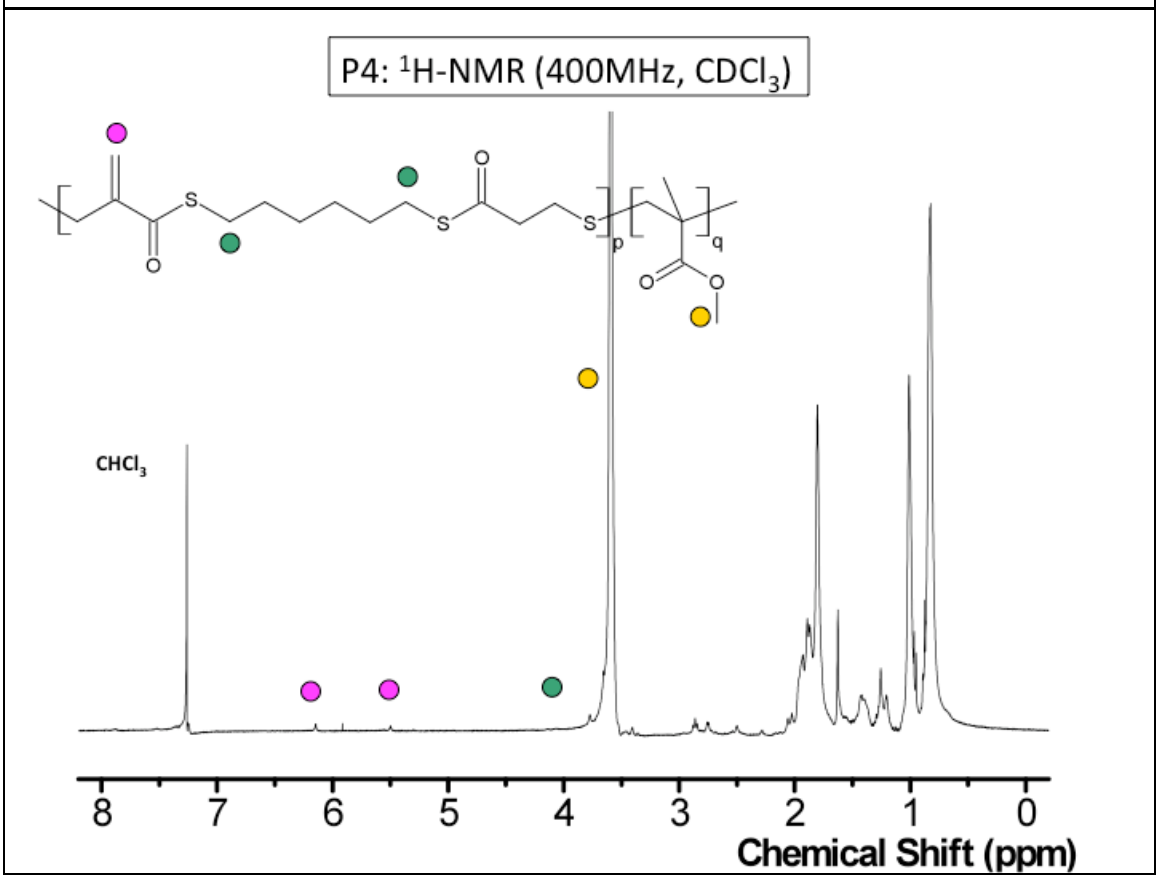
THF
8
7
6
5
4
3
2
1
0
Chemical Shift (ppm)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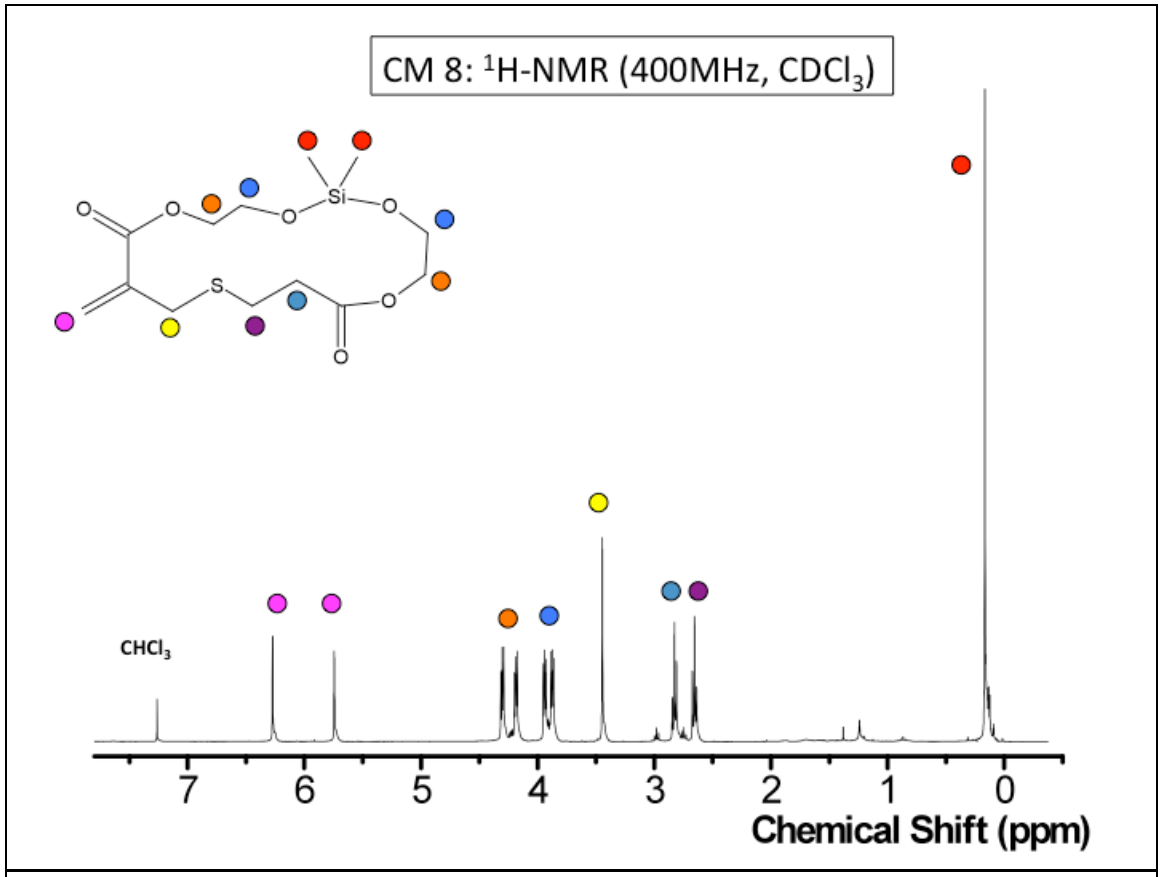
S
S
O
O
p
q
O
O
$CHCl_3$
8
7
6
5
4
3
2
1
0
Chemical Shift (ppm)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O
S
$CHCl_3$
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6
5
4
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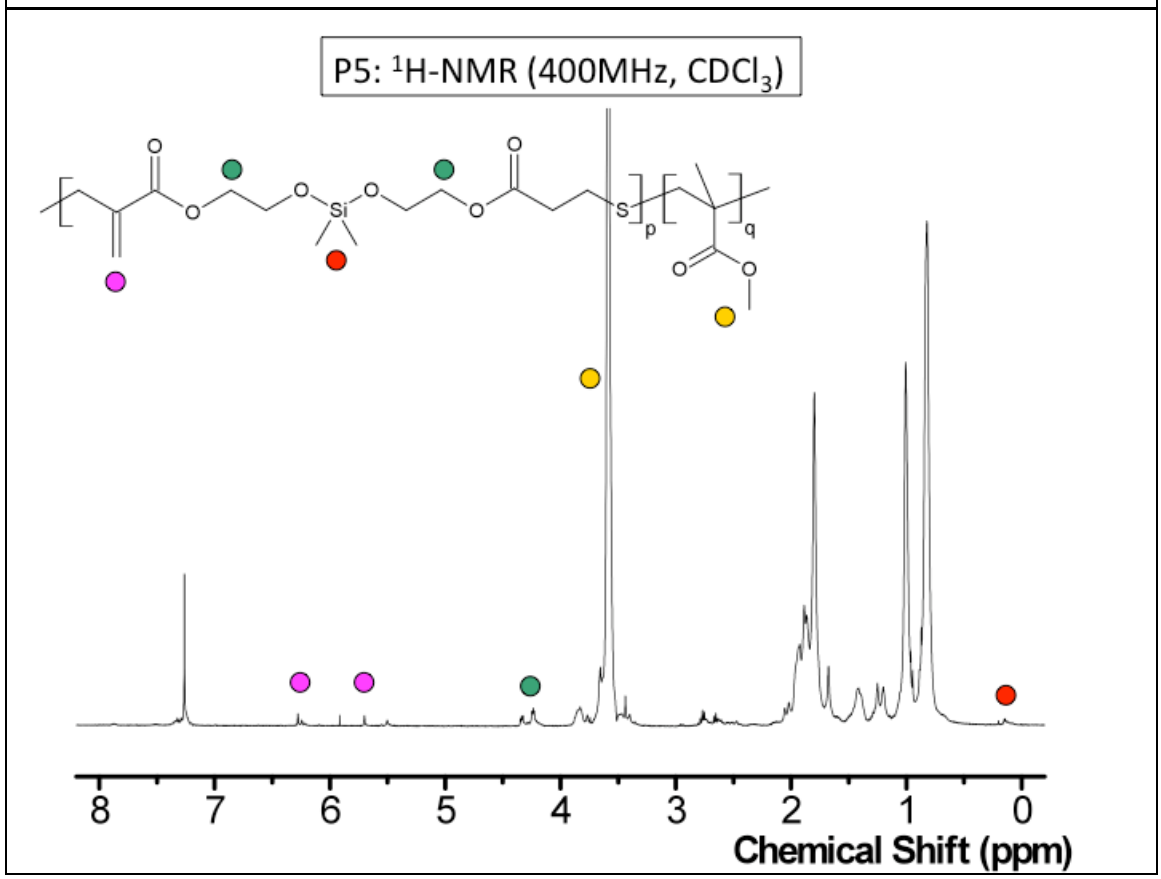
Chemical Shift (ppm)


P5: ^{1}H-NMR (400MHz, $CDCl_3$)
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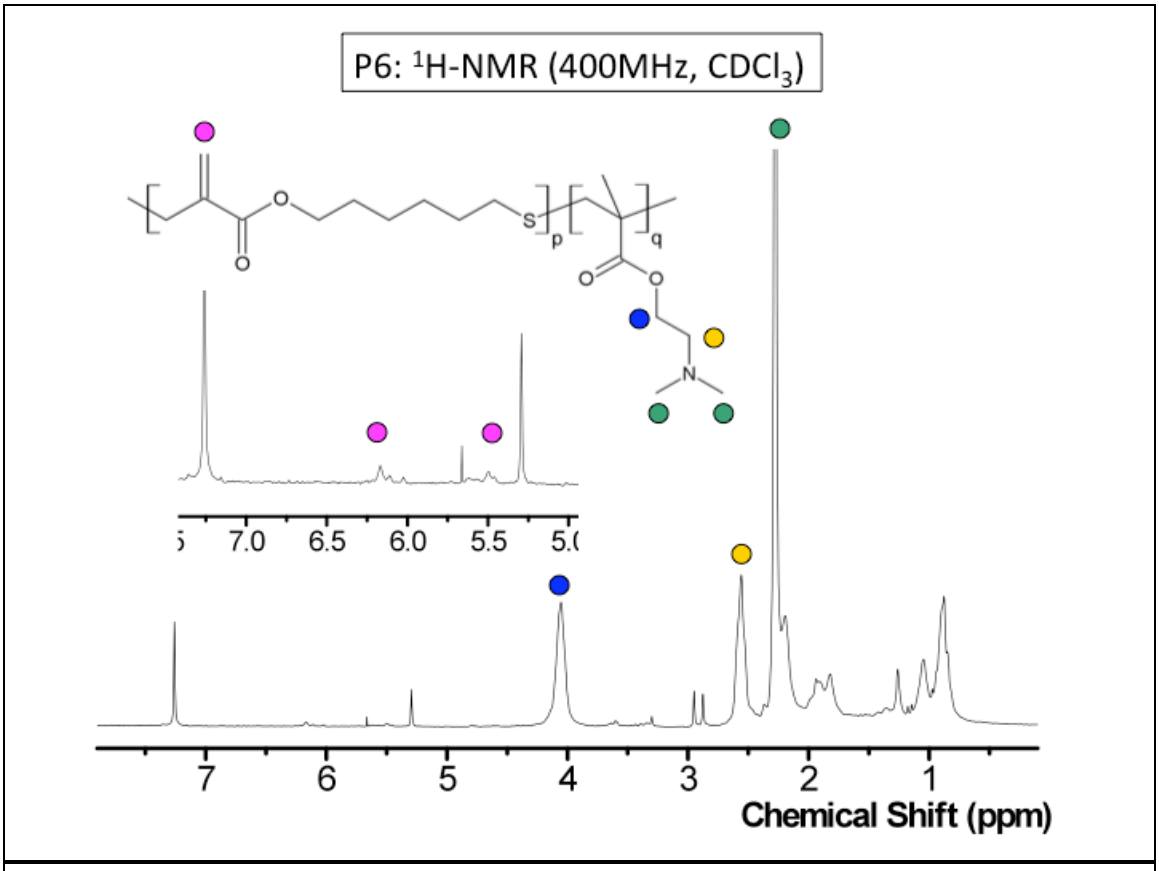
O
S
p
q
8
7
6
5
4
3
2
1
0
Chemical Shift (ppm)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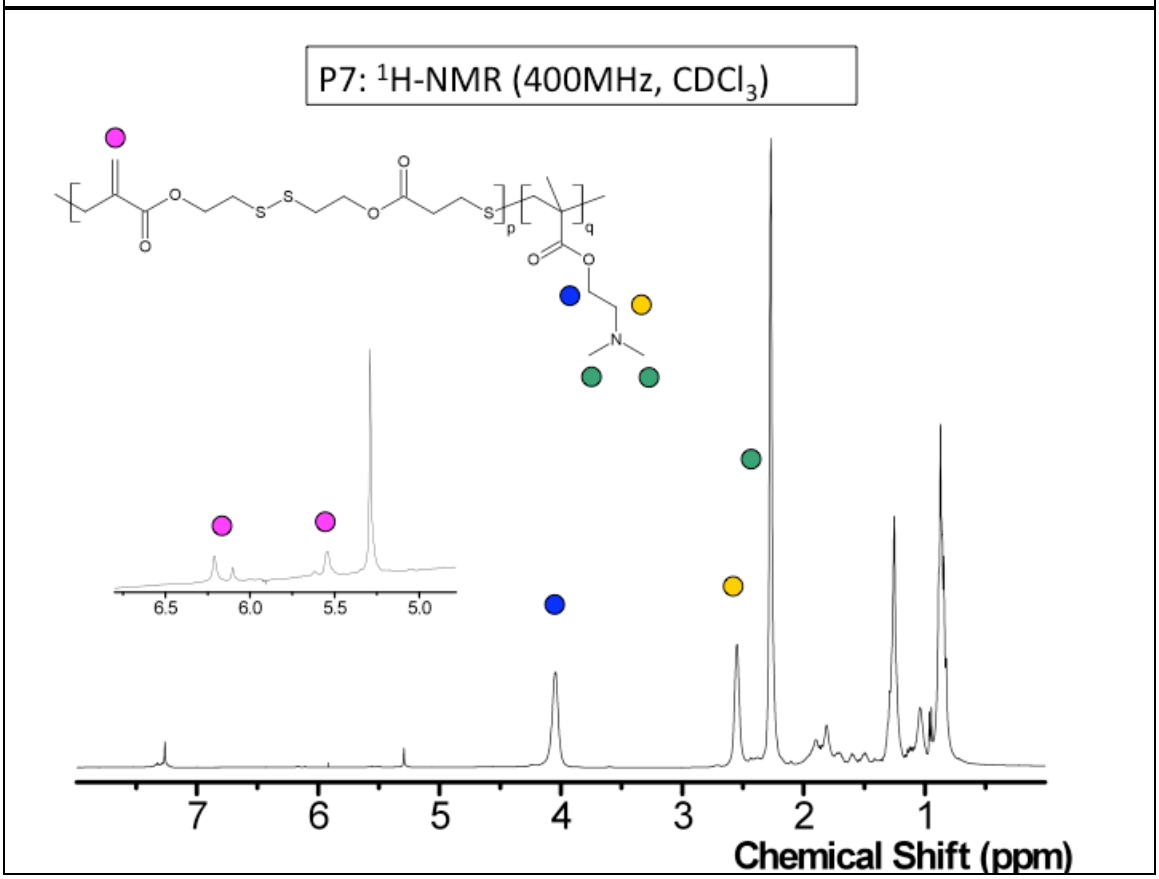
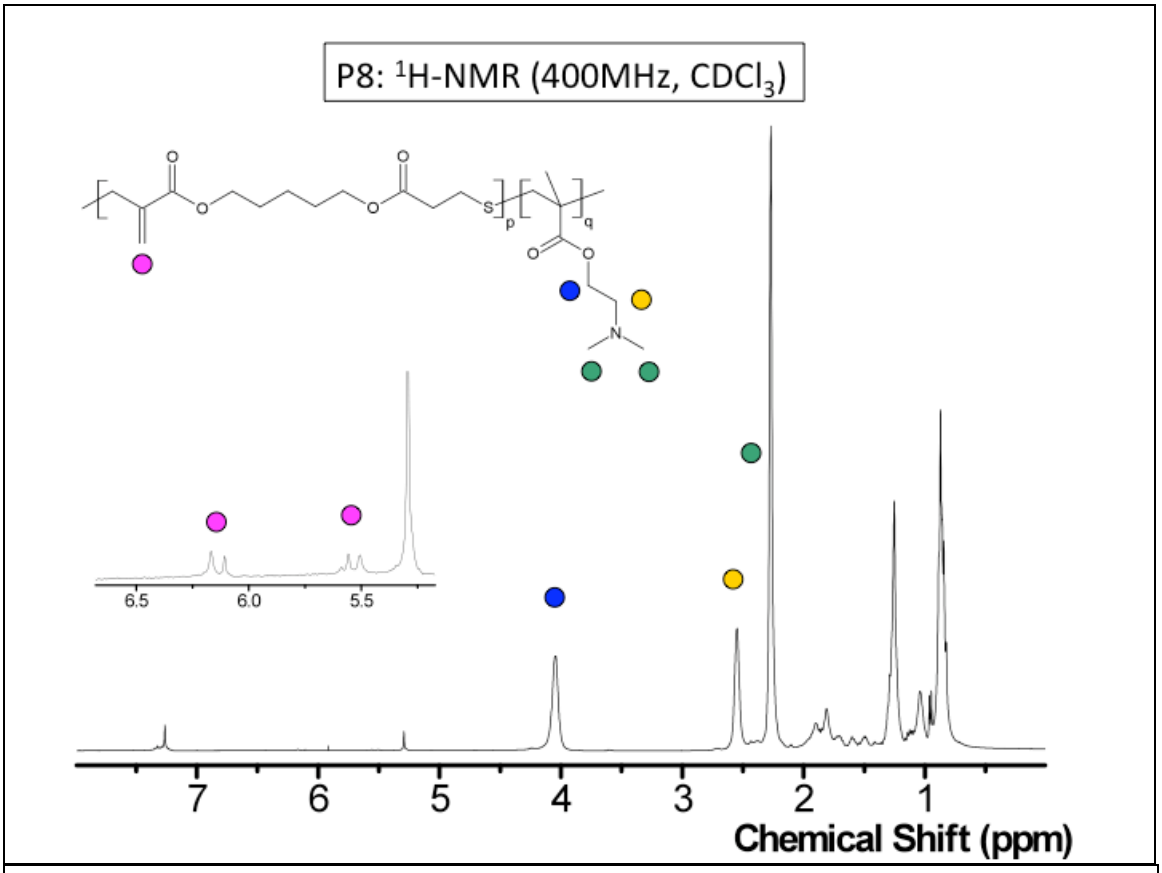
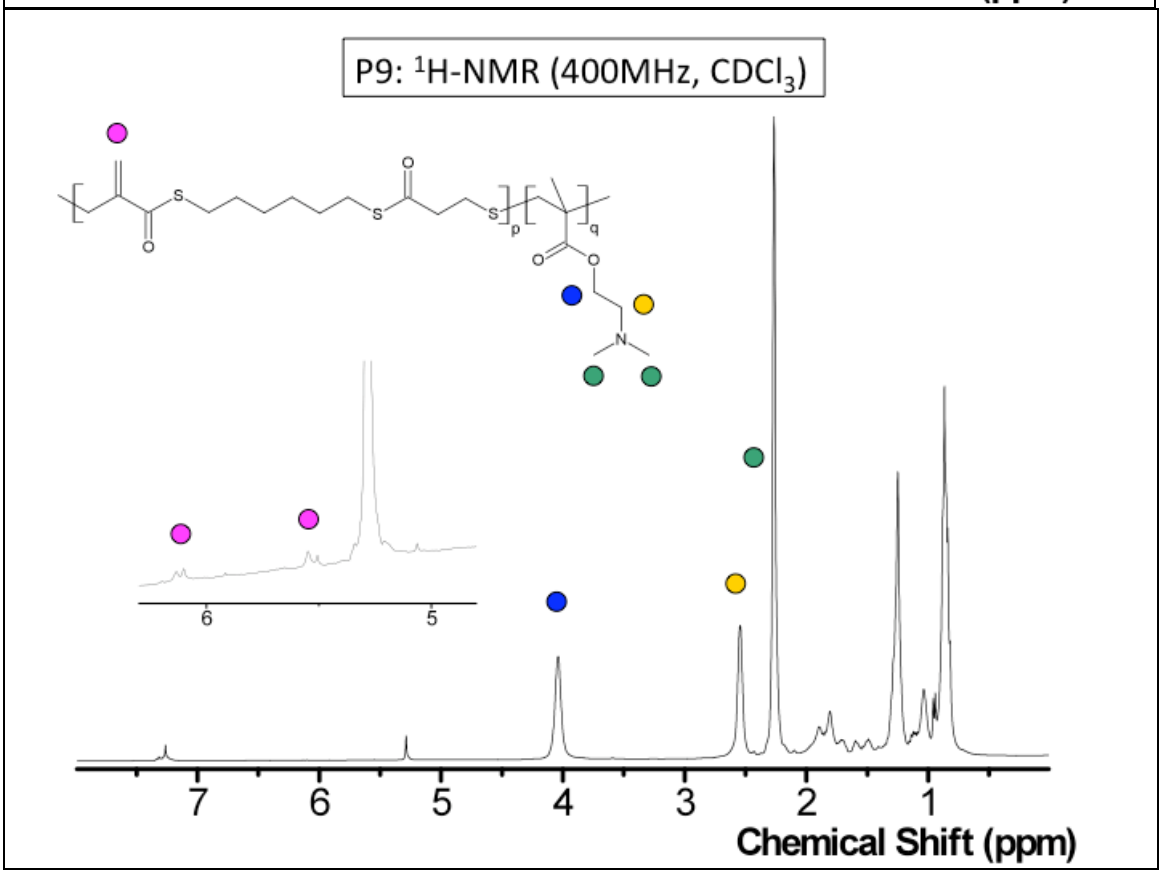
6.5
6.0
5.5
7
6
5
4
3
2
1
Chemical Shift (ppm)


P7: ^{1}H-NMR (400MHz, $CDCl_3$)
6.5
6.0
5.5
5.0
7
6
5
4
3
2
1
Chemical Shift (ppm)


P8: ^{1}H-NMR (400MHz, $CDCl_3$)
6.5
6.0
5.5
7
6
5
4
3
2
1
Chemical Shift (ppm)


P9: ^{1}H-NMR (400MHz, $CDCl_3$)
6
5
7
6
5
4
3
2
1
Chemical Shift (ppm)

Chemical degradation experiments.

Ester cleavage. Poly(methyl methacrylate) copolymers **P1-4** (30 mg) were dissolved in THF (2 mL) and sodium methoxide (30 μL of a 30 wt% solution in methanol) was added to the solution, and the mixture was stirred for 30 min. THF was evaporated and 1.2 M aqueous hydrochloric acid (1 mL) was added, and the mixture was extracted with ethyl acetate (2 mL). The organic phase was dried with magnesium sulfate and dried *in vacuo*. The polymer sample was analyzed with size exclusion chromatography. The same conditions were used for poly(*N,N*-dimethylaminoethyl methacrylate) copolymers **P6-9**, but instead of aqueous hydrochloric acid, saturated aqueous sodium carbonate was used, in order to prevent protonation of the amines. Poly(2-hydroxyethyl methacrylate) copolymers **P10-13** were dissolved in methanol (2 mL) and degraded with three drops of concentrated sulfuric acid. After 30 min, the sample was dried and water was added to the solids. Filtration yielded the polymers, which were analyzed with size exclusion chromatography.

Disulfide reduction. Copolymers **P2**, **P7**, **P11** and **P14** (30 mg) containing disulfide moieties were dissolved in THF or methanol and hydrazine (30 μL of a 35 wt% solution in water) was added to the solutions. The mixtures were stirred for 30 min and the same workup was employed as described before. Alternatively, 30 μL of tri-*n*-butylphosphine was added to the copolymers, together with 100 μL of water; the mixtures were stirred for 30 min, followed by the same workup.

Thioester cleavage. Cleavage of thioester moieties was performed either with sodium methoxide (30 μL of a 30 wt% solution in methanol) and 30 mg of the corresponding thioester containing copolymers (**P4**, **P9**, **P13**), or with sodium thiomethoxide (30 mg) and the corresponding copolymers. The same workup was employed as described above.

Sequential disulfide reduction and ester cleavage. Copolymer **P15** (30 mg) containing both disulfide and diester moieties was dissolved in THF and hydrazine (30 μL of a 35 wt% solution in water) was added to the solution. The mixture was stirred for 30 min and the same workup was employed as described before. The polymer sample was analyzed with size exclusion chromatography. The hydrazine

degradation product was then dissolved in THF (2 mL) and sodium methoxide (30 μL of a 30 wt% solution in methanol) was added to the solution, and the mixture was stirred for 30 min. The same workup as described above was employed and the polymer sample was analyzed with size exclusion chromatography.

Degradation of reference polymers. Homopolymers of MMA, DMAEMA and HEMA were subjected to the same degradation procedures, to ensure that no covalent bonds were broken in the degradation processes, and that no reaction with pendant ester groups on the polymer, i.e. methyl ester, 2-hydroxyethyl ester and *N,N*-dimethylaminoethyl ester.

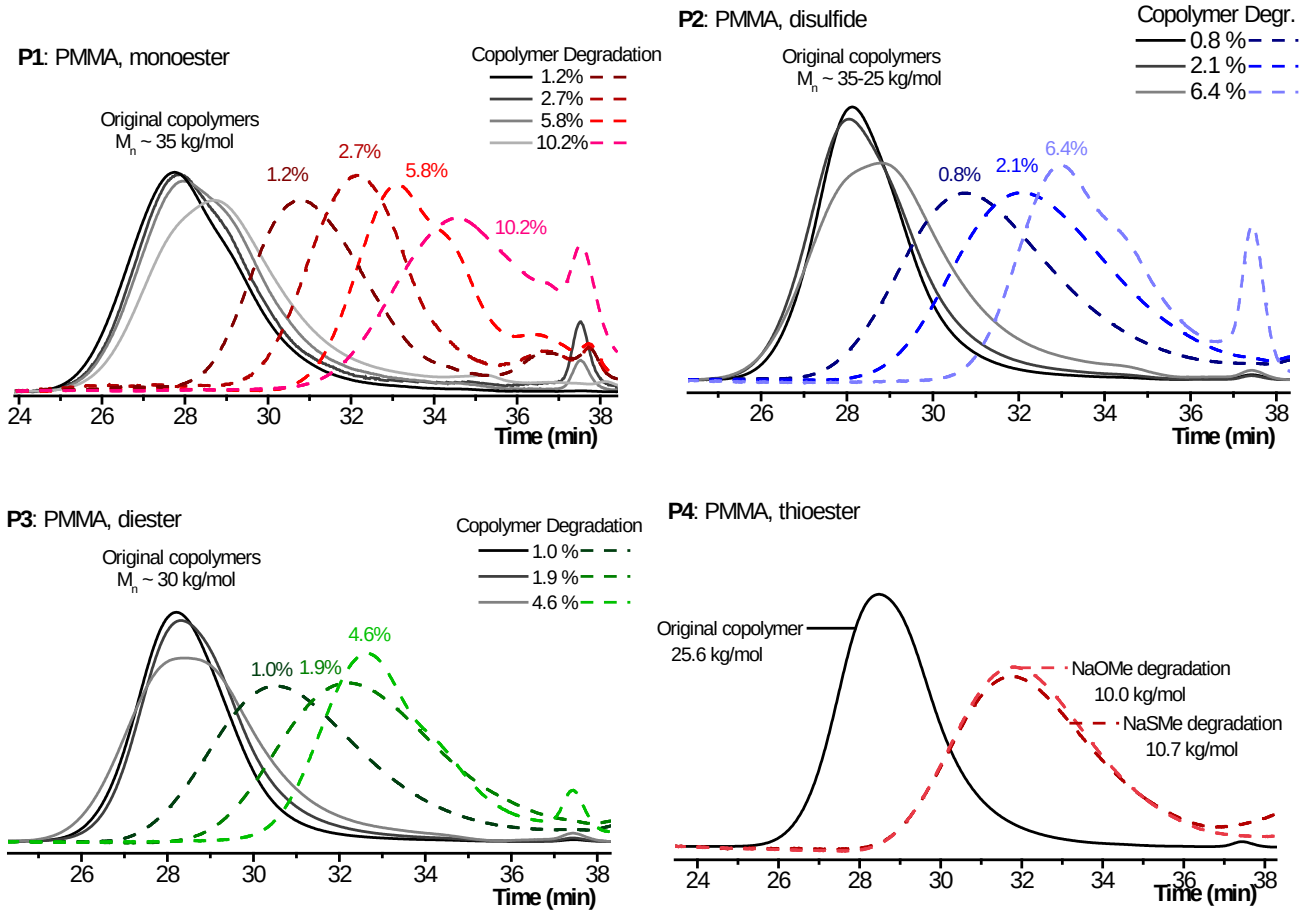
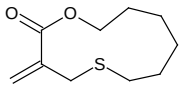
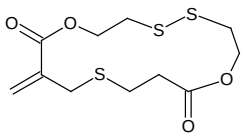
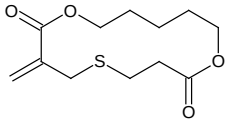
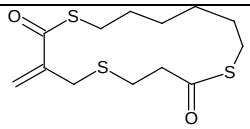
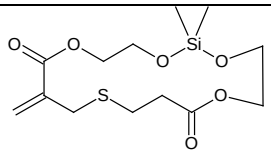
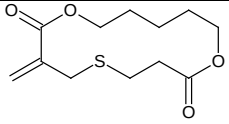
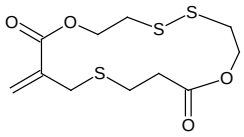


Figure S1. SEC traces of copolymers **P1-4** (solid lines) and their degradation products (dashed lines).

Table S1. Selected ^{1}H NMR and SEC data for PMMA copolymers and their degradation products.

	Cyclic monomer	Original copolymer			Ester degradation	Disulfide/thioester degradation
		Incorporation[a] (%)	M_n[b] (10^4 g/mol)	PDI[b] (-)	M_n[b] (10^3 g/mol)	M_n[b] (10^3 g/mol)
P1a		1.3	3.7	1.42	9.9	
P1b		2.7	4.2	1.47	6.2	
P1c		5.8	3.7	1.54	1.8	
P1d		10.2	2.0	2.08	0.7	
P2a		0.8	3.6	1.35	10.0	11.9
P2b		2.1	3.2	1.57	5.7	
P2c		6.4	2.5	1.70	2.9	
P3a		1.4	4.6	1.79	11.1	
P3b		1.9	2.2	1.54	5.5	
P3c		4.6	3.0	1.56	3.5	
P4		0.9	2.6	1.41	10.0	10.7
P5		1.6	1.0	1.52		
P15	 	0.8 0.3	9.1	1.28	12.8	42.9

[a] NMR data; [b] SEC-data, based on PMMA standards.

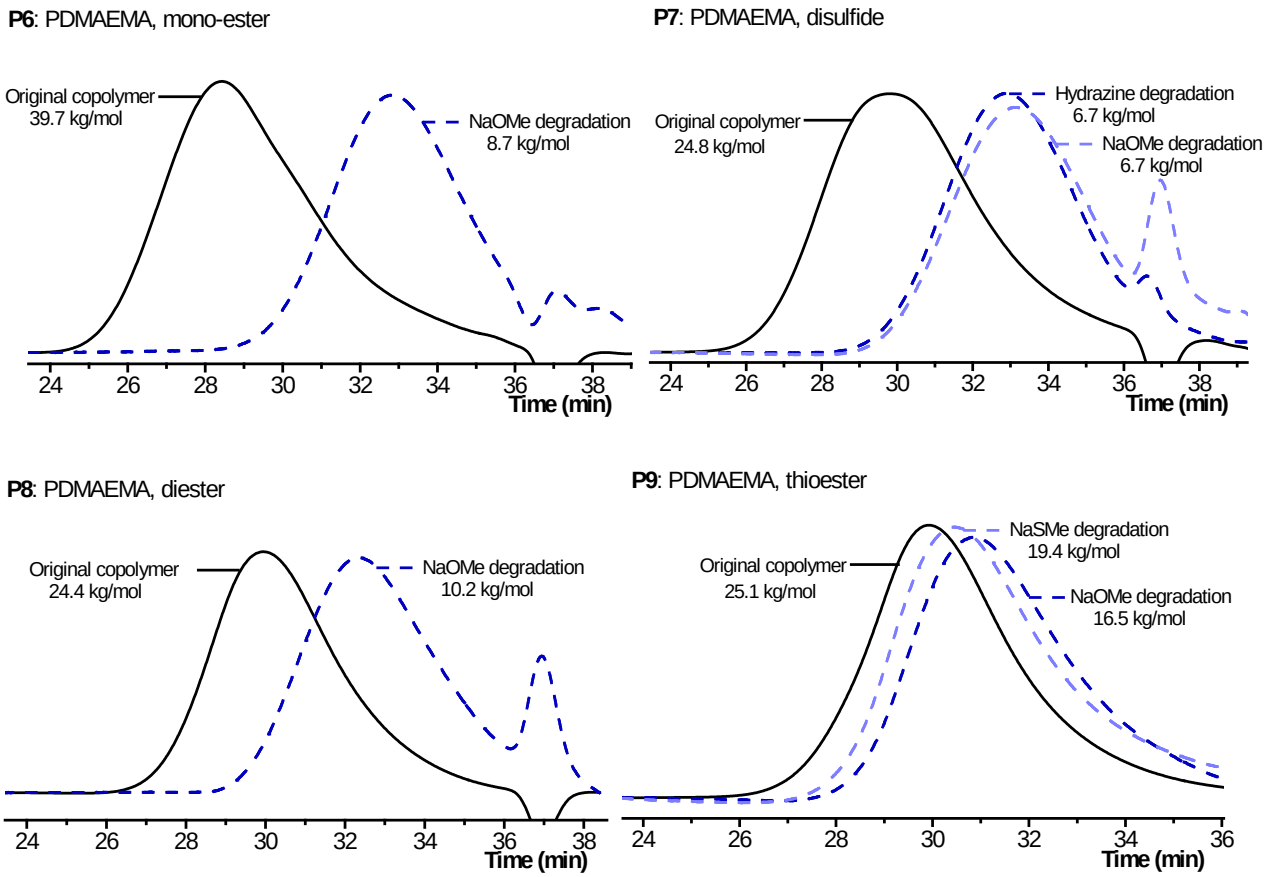
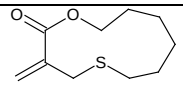
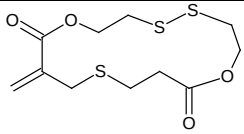
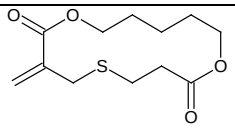
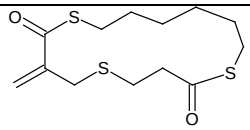


Figure S2. SEC traces of copolymers **P6-9** (solid lines) and their degradation products (dashed lines).

Table S2. Selected ^{1}H NMR and SEC data for PDMAEMA copolymers and their degradation products.

	Cyclic monomer	Original copolymer			Ester degradation	Disulfide/thioester degradation
		Incorporation[a] (%)	M_n[b] (10^4 g/mol)	PDI[b] (-)	M_n[b] (10^3 g/mol)	M_n[b] (10^3 g/mol)
P6		1.0	4.0	2.04	8.7	
P7		1.1	2.5	1.70	6.7	6.7
P8		1.1	2.4	1.70	10.2	
P9		0.8	2.8	1.54	19.4	16.5

[a] NMR data; [b] SEC-data, based on PMMA standards.

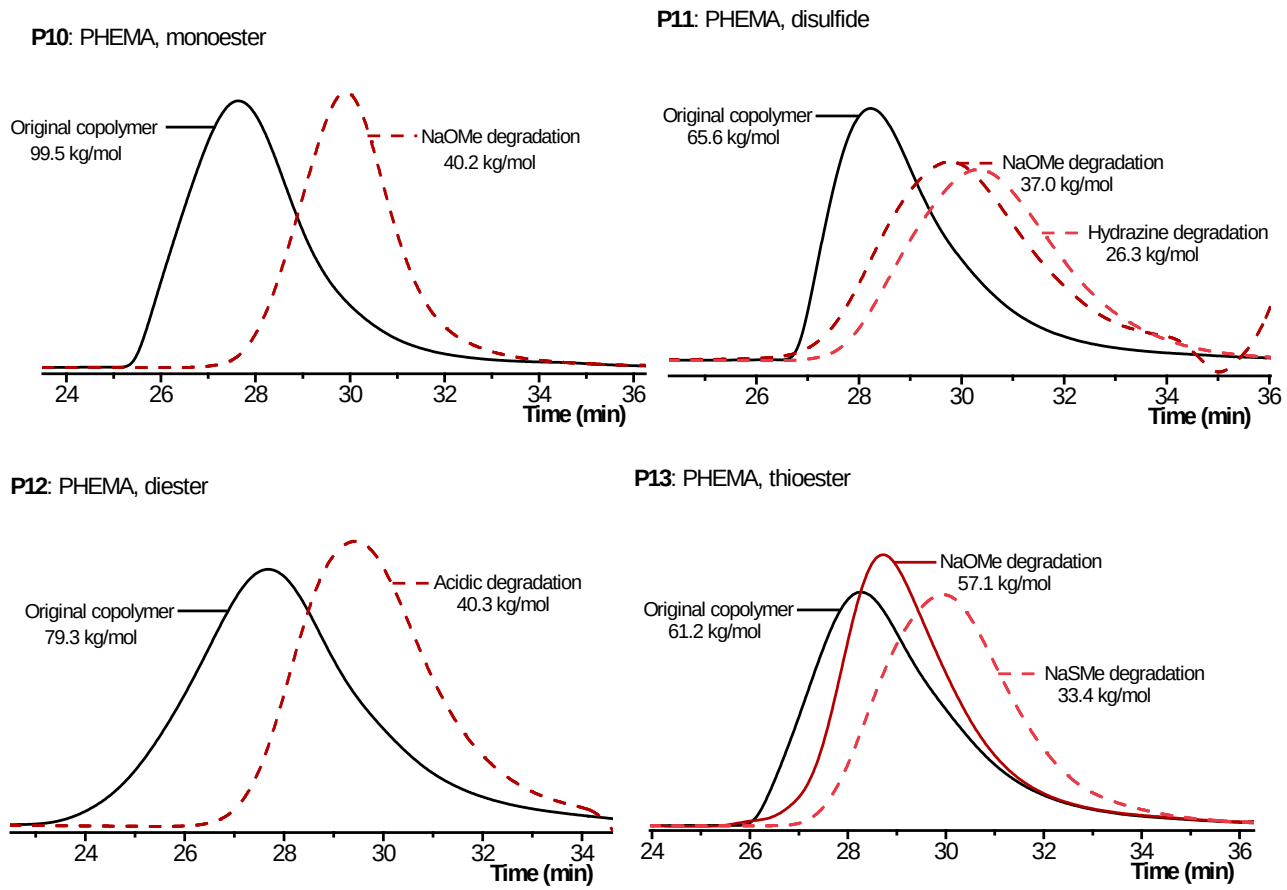
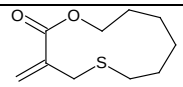
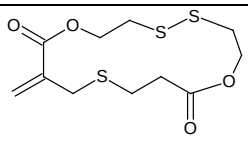
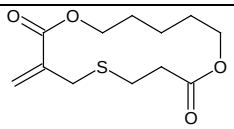
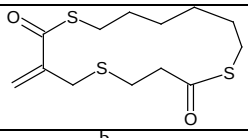


Figure S3. SEC traces of copolymers **P10-13** (solid lines) and their degradation products (dashed lines).

Table S3. Selected ^{1}H NMR and SEC data for PHEMA copolymers and their degradation products.

	Cyclic monomer	Original copolymer				Ester degradation	Disulfide/thioester degradation
		Incorp.[a] (%)	M_n[a] (10^4 g/mol)	M_n[b] (10^4 g/mol)	PDI[b] (-)	M_n[b] (10^4 g/mol)	M_n[b] (10^4 g/mol)
P10		1.2	4.4	9.9	1.43	4.0	
P11		1.0	3.2	6.6	1.35	3.7	2.6
P14		5.0	5.7	7.4	1.86		0.73
P12		1.0	3.8	7.9	1.40	4.0	
P13		0.7	3.2	6.1	1.54	5.7	3.3

[a] NMR data; [b] SEC-data, based on PMMA standards; PMMA standards lead to an overestimation of molecular weight.

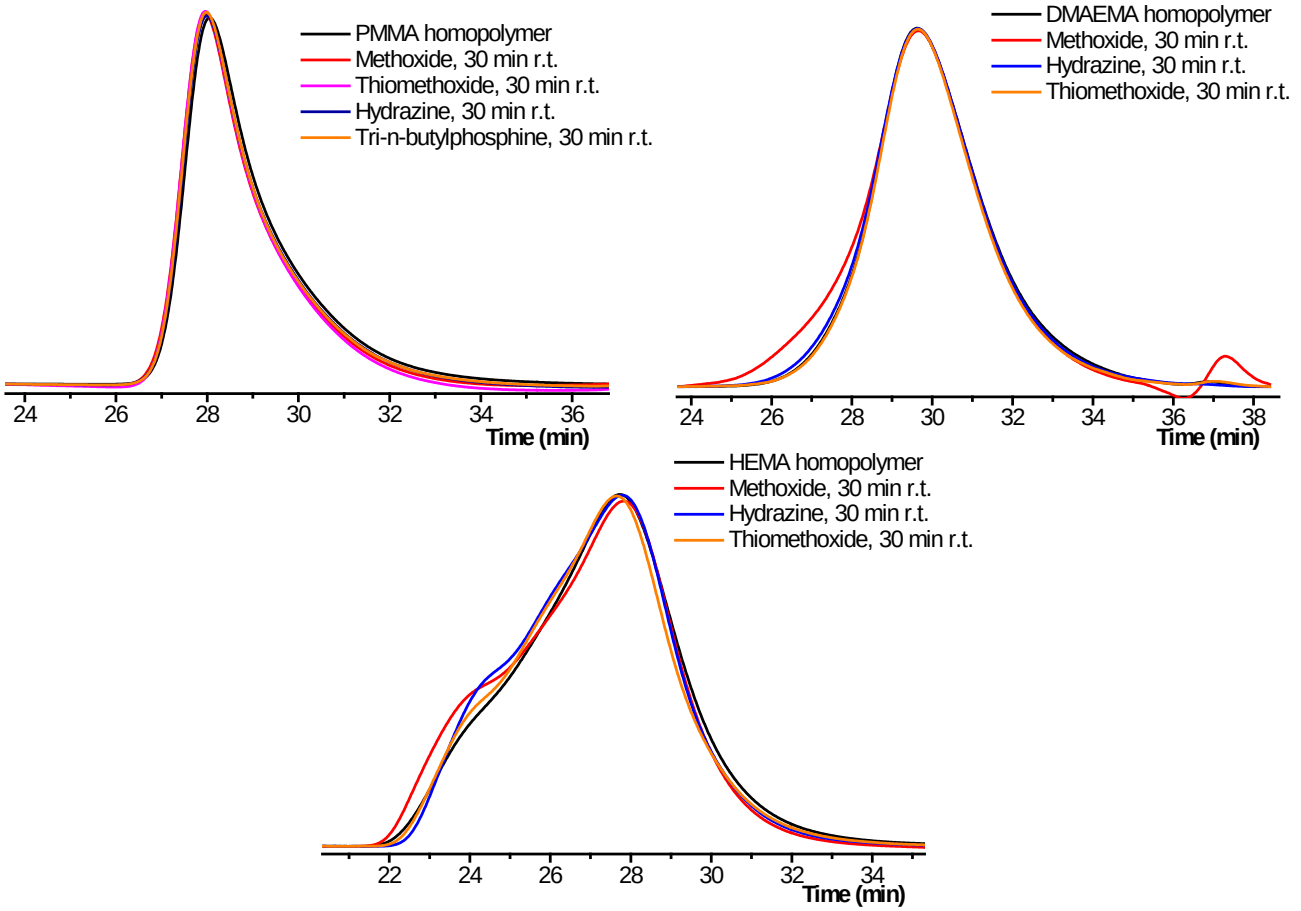


Figure S4. SEC traces of PMMA, PDAEMA and PHEMA homopolymers, before and after degradation.

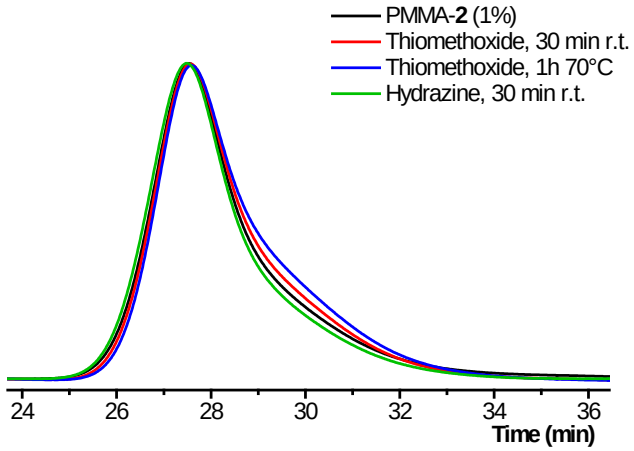


Figure S5. SEC traces of PMMA copolymers of cyclic monomer **2** (1%), before and after degradation.

References.

1. Perrier, S.; Takolpuckdee, P.; Westwood, J.; Lewis, D. M., *Macromolecules* **2004,** 37, 2709-2717.
2. Evans, R. A.; Moad, G.; Rizzardo, E.; Thang, S. H., *Macromolecules* **1994,** 27, 7935-7937.
3. Meijs, G. F.; Morton, T. C.; Rizzardo, E.; Thang, S. H., *Macromolecules* **1991,** 24, 3689-3695.
4. Phelan, M.; Aldabbagh, F.; Zetterlund, P. B.; Yamada, B., *Polymer* **2005**, (46), 12046-12056.
5. Rizzardo, E.; Evans, R. A.; Moad, G.; Thang, S. H. Int. Pat. Appl. PCT/AU93/00667, WO 94/14792.