

Supporting Information

New Aldehyde-Functional Methacrylic Water-Soluble Polymers

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Supporting Information for:

Experimental

Materials

All reagents were used as received unless otherwise stated. Methyl methacrylate (MMA), isopropylidene glycerol pentaethylene glycol ether, 4-methoxyphenol (MEHQ), titanate catalyst and ammonium 2-sulfatoethyl methacrylate (SEM, supplied as a 26% w/v aqueous solution) were provided by GEO Specialty Chemicals (Hythe, UK). 4,4'-Azobis(4-cyanopentanoic acid) (ACVA; > 98%), glycine (\geq 98%), lysine (\geq 98%), cysteine (97%), sodium periodate (NaIO_4 , \geq 99.8%), sodium cyanoborohydride (NaCNBH_3 , 95%), sodium nitrate (NaNO_3 , 99%), tris(hydroxymethyl)aminomethane (TRISMA, \geq 99.8%), tris(hydroxymethyl)aminomethane hydrochloride (TRIS HCl, \geq 99%), sodium dihydrogen phosphate (NaH_2PO_4 , \geq 99%), [2-(methacryloyloxy)ethyl] trimethylammonium chloride (METAC, supplied as an 80% w/w aqueous solution), d_8 -toluene, and deuterium oxide (D_2O) were purchased from Sigma-Aldrich, UK.

2-Cyano-2-propyl dithiobenzoate (CPDB, >97%) was purchased from Strem Chemicals Ltd (Cambridge, UK). 2,2'-Azobis[2-(2-imidazolin-2-yl)propane]dihydrochloride (VA-044, $\geq 97\%$) was purchased from Wako Chemicals (Germany). 4-(((2-(Carboxyethyl)thio)carbonothioyl)thio)-4-cyano-pentanoic acid (CECPA, > 95%) was kindly provided by Boron Molecular (Melbourne, Australia). 2-(Methacryloyloxy)ethyl phosphorylcholine (MPC) was kindly provided by Biocompatibles (Farnham, UK). Dimethylformamide (DMF), dichloromethane and methanol were purchased from Fisher Scientific (UK).

Methods

¹H NMR spectroscopy. Spectra were recorded in D₂O using a 400 MHz Bruker Avance-400 spectrometer at 298 K with 16 scans being averaged per spectrum.

¹³C NMR spectroscopy. Broadband ¹H-decoupled ¹³C spectra were acquired at 100 MHz using a Bruker Avance-400 spectrometer operating at 298 K. All spectra were recorded in D₂O with between 128 and 10 240 scans being averaged per spectrum.

Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) Spectroscopy. Spectra were recorded using a Perkin Elmer FTIR Spectrum Two equipped with UATR Two diamond with 32 scans being averaged per spectrum.

DMF Gel Permeation Chromatography (GPC). DMF GPC was used to determine the number-average molecular weights (M_n), weight-average molecular weights (M_w) and dispersities (\mathcal{D}) of PGEO5MA₃₇, PAGEO5MA₃₇, PAGEO5MA₃₀ (obtained by homopolymerization of AGEO5MA), PEG₁₁₃ homopolymers, P(GEO5MA_n-*stat*-AGEO5MA_m)₃₇ copolymers and also the PEG₁₁₃-PGEO5MA₃₇ diblock copolymer. The instrument set-up comprised two Agilent PL gel 5 μ m Mixed-C columns and a guard column connected in series to an Agilent 1260 Infinity GPC system operating at 60 °C. The GPC eluent was HPLC-grade DMF containing 10 mmol LiBr at a flow rate of 1.0 mL min⁻¹, the copolymer concentration was typically 1.0% w/w and calibration was achieved using either a series of ten near-monodisperse poly(methyl methacrylate) standards ranging from 1 080 g mol⁻¹ to 1 020 000 g mol⁻¹ or ten near-monodisperse poly(ethylene oxide) standards ranging from 3 800 g mol⁻¹ to 780 000 g mol⁻¹. Chromatograms were analyzed using Agilent GPC/SEC software.

Aqueous Gel Permeation Chromatography (GPC). PGEO5MA₃₇-PMETAC₅₀ and PAGEO5MA₃₇-PMETAC₅₀ diblock copolymers were analyzed at 0.5% w/w concentration in an acidic aqueous buffer comprising 0.50 M acetic acid and 0.30 M NaH₂PO₄ adjusted to pH 2 using concentrated HCl. The GPC set-up comprised an Agilent 1260 Infinity series degasser and pump, an 8 μ m Agilent PL Aquagel-OH 30 column and a 5 μ m Agilent PL Aquagel-OH 20 column. A series of ten near-monodisperse poly(ethylene oxide)

standards ranging from 3 800 g mol⁻¹ to 780 000 g mol⁻¹ were used for calibration. A refractive index detector was employed at 35 °C and the flow rate was 1.0 mL min⁻¹.

0.5% w/w PGEO5MA₃₇-PMPC₅₀ and PAGEO5MA₃₇-PMPC₅₀ diblock copolymers were analyzed using an eluent comprising 0.20 M NaNO₃ and 0.05 M TRISMA buffer adjusted to pH 7 using concentrated HCl. The GPC set-up comprised an Agilent 1260 Infinity series degasser and pump, an 8 μm Agilent PL Aquagel-OH 30 column and a 5 μm Agilent PL Aquagel-OH 20 column. A series of ten near-monodisperse poly(ethylene oxide) standards ranging from 3 800 g mol⁻¹ to 780 000 g mol⁻¹ were used for calibration. A refractive index detector was employed at 35 °C and the flow rate was 1.0 mL min⁻¹.

0.5% w/w PGEO5MA₃₇-PSEM₅₀ and PAGEO5MA₃₇-PSEM₅₀ diblock copolymers were analyzed using an eluent comprising 0.20 M NaNO₃ and 0.05 M TRISMA buffer adjusted to pH 7 using concentrated HCl. The GPC set-up comprised an Agilent 1260 Infinity series degasser and pump, an 8 μm Agilent PL Aquagel-OH 40 column and a 5 μm Agilent PL Aquagel-OH 30 column. A series of ten near-monodisperse poly(ethylene oxide) standards ranging from 3 800 g mol⁻¹ to 780 000 g mol⁻¹ were used for calibration. A refractive index detector was employed at 35 °C and the flow rate was 1.0 mL min⁻¹.

Elemental microanalysis. CHN contents were determined using an Elementar vario MICRO cube analyzer.

Liquid Chromatography–Mass Spectrometry (LC-MS). Mass spectrometry analysis was conducted using an Agilent 6530 Accurate-Mass Q-TOF instrument connected to an Agilent 1260 Infinity liquid chromatograph equipped with an Agilent extended C18 2.1 mm x 50 mm column. The mobile phase consisted of solvent A (0.1 % aqueous formic acid) and solvent B (acetonitrile with 0.1% formic acid) run as a gradient ranging from 5 % to 95 % solvent B over a 10 min period. The injection volume was 1.0 μL and the flow rate was 0.40 ml min⁻¹. Samples were analyzed using the electrospray ionization (ESI) positive mode unless otherwise stated.

OH Number and Water Content. OH numbers were determined by titration according to ASTM E 326 using a Mettler Toledo T70 Titroprocessor. Water contents were determined by titration according to ASTM E 203 using a Metrohm 787 KF Titrator.

4-Methoxyphenol (MeHQ) Inhibitor Content. The MeHQ content was determined according to ASTM D 3125 using a ThermoScientific Evolution 220 UV-visible spectrophotometer.

Synthesis

Transesterification of isopropylidenglycerol penta(ethylene glycol) ether to afford IPGEO5MA

A 5 L transesterification rig equipped with an air sparge was charged with isopropylidenglycerol penta(ethylene glycol) ether (4.26 mol, 1500 g), MMA (22.97 mol, 2300 g) and MEHQ (10.4 mmol, 1.30

g). This reaction mixture was heated to 115 °C at a constant air sparge rate of 300 mL min⁻¹. Water/MMA distillate was periodically removed from the still head until the headspace reached a constant temperature (~100 °C) after 2 h. The reactor was periodically topped up with MMA to maintain a constant reaction volume. Titanate catalyst (2.0 g) was added by syringe and transesterification was allowed to proceed for 2 h under partial take-off conditions. At this point, the head temperature reached 95 °C and the reaction was switched to 'run and bump' conditions. Thus, the still head was allowed to fill up prior to draining in order to concentrate methanol within the distillate. The still head was drained every 20 min for 2 h, after which transesterification was deemed complete. The reaction mixture was allowed to cool overnight. The following day, MMA was stripped from the same rig at 80 °C under vacuum for 2 h. Deionized water (400 g) was added and allowed to react for 1 h at 80 °C in order to deactivate the titanate catalyst. The resulting precipitate was removed by filtration and the water was removed under vacuum at 80 °C for 2 h. The resulting colourless liquid (IPGEO5MA, 1500 g) had a water content of 0.01 % w/w and an OH number of 2.63 mg KOH g⁻¹. If full conversion had been achieved, an OH number of 0 mg KOH g⁻¹ would be expected in the absence of any water. Thus, the measured value indicates that high conversion was achieved for this transesterification reaction.

Acidic Deprotection of IPGEO5MA

IPGEO5MA (1500 g) was treated with an Ambersep 900 OH resin (150 g) to remove MEHQ inhibitor. The reaction solution was stirred for 20 min at 22 °C and the resin was removed by filtration. The residual level of MEHQ was determined to be 25 ppm using UV spectroscopy and this was subsequently topped up to 100 ppm by adding fresh MEHQ (0.92 mmol, 0.115 g). The IPGEO5MA was placed in a 3 L flask followed by addition of deionized water (300 g) and concentrated HCl (11 g). This reaction mixture was stirred for 48 h using a 300 mL min⁻¹ air sparge, while water was periodically topped up to maintain a constant reaction volume. The resulting homogeneous solution was neutralized using an ion exchange resin (150 g), which was then removed by filtration. Finally, water was removed from the reaction solution at 50 °C under vacuum for 4 h prior to analysis. The resulting yellowish liquid had a water content of 0.3 % w/w and an OH number of 289 mg KOH g⁻¹. If full conversion had been achieved, an OH number of 294 mg KOH g⁻¹ would be expected in the absence of any water. Thus, high conversion was achieved for this acid deprotection. Elemental microanalyses: C, 52.59; H, 8.66; N, 0.0%. C₁₇H₃₂O₉ requires C, 52.69; H, 8.22; N, 0.0%; FTIR (ATR ν_{\max} , cm⁻¹): 3442 (-OH, H-bonded), 2870 (C-H stretch), 1716 (C=O ester), 1637 (C=C stretch), 1453 (-CH₃), 1403 (-OH bending, alcohol), 1098 (C-O stretch, aliphatic ether); ¹H NMR (400 MHz; D₂O), *J* values given in Hz, δ = 1.86 (3H, s, CH₃C), 3.39-3.78 (22H, m, CH₂CH₂O), 3.80 (1H, m, CH₂CHOHCH₂OH), 4.26 (2H, t, 4.5 Hz, CH₂CH₂O),

5.66 (1H, s, CH₂CH₂), 6.08 (1H, s, CH₂CH₂); ¹³C NMR (125 MHz, D₂O) δ = 159.56, 135.73, 127.04, 71.75, 70.33, 69.77, 68.63, 64.23, 62.60, 17.45; MS ESI positive m/z (M+H)⁺ requires 381.4, found 381.2.

Oxidation of GEO5MA using NaIO₄ and isolation of AGEO5MA monomer

GEO5MA monomer (0.026 mol, 10 g) and NaIO₄ (0.026 mol, 5.62 g) were dissolved in water (150 g) and stirred in the dark at 22 °C. The extent of oxidation of the *cis*-diol group to afford an aldehyde (or hydrated geminal diol) group was determined to be ≥ 99% within 5 min by ¹H NMR spectroscopy. The AGEO5MA monomer was purified by extraction with dichloromethane and excess solvent was removed under reduced pressure to give a yellowish viscous liquid (7.5 g, 82%). ¹H NMR spectroscopy studies in *d*₈-toluene indicated that, after drying, the purified AGEO5MA monomer was predominantly in its aldehyde form (62%) with the remaining 38% corresponding to its hydrated geminal diol form. Elemental microanalyses: 62% C₁₆H₂₈O₈ + 38% C₁₆H₃₀O₉ requires C, 54.13%; H, 8.16%; N, 0.0%. Found: C, 53.97%; H, 7.98%; N, 0.0%. FTIR (ATR ν_{max}, cm⁻¹): 3425 (-OH, H bonded), 2870 (C-H stretch), 1716 (C=O ester), 1637 (C=C stretch), 1453 (-CH₃), 1404 (-OH bending, alcohol), 1098 (C-O stretch, aliphatic ether); ¹H NMR (400 MHz; D₂O), *J* values given in Hz, δ = 1.87 (3H, s, CH₃C), 3.43 (2H, d, *J* 4.5 Hz, CH₂C(OH)₂H), 3.59-3.69 (17H, m, CH₂CH₂O), 3.76 (2H, t, *J* 4.5 Hz, CH₂CH₂O), 4.27 (2H, t, 4.5 Hz, C(=O)OCH₂CH₂), 5.09 (1H, m, CHC(OH)₂), 5.67 (1H, s, CH₂CH₂), 6.09 (1H, s, CH₂CH₂), 9.52 (1H, s, C(=O)H); ¹³C NMR (125 MHz, D₂O) δ = 202.9, 169.4, 135.8, 126.9, 88.4, 73.5, 69.7, 68.7, 64.2, 17.5. MS ESI positive m/z (M+Na)⁺ requires 389.4, found 389.2.

Synthesis of PAGEO5MA₃₀ homopolymer by RAFT aqueous solution polymerization

AGEO5MA monomer (4.31 mmol, 1.50 g), CECPA RAFT agent (0.14 mmol, 0.0441 g), VA-044 initiator (29 μmol, 0.0093 g; CECPA/VA-044 molar ratio = 5.0) and H₂O (8.8 g) were weighed into a 30 mL sample vial. The reaction solution was degassed *via* N₂ purge for 30 min before placing the sample vial into an oil bath set at 50 °C for 5 h. The polymerization was quenched by removing the sample vial from the oil bath and exposing the reaction mixture to air. The AGEO5MA conversion was determined to be more than 99% by ¹H NMR spectroscopy by comparing the integrated monomer vinyl signals at 5.69 and 6.11 ppm to the integrated signal assigned to the two oxymethylene protons attached to the ester group for the monomer (4.12 ppm) and polymer (4.38 ppm), respectively.

Synthesis of PGEO5MA₃₇ homopolymer by RAFT solution polymerization in ethanol

GEO5MA monomer (0.079 mol, 30.0 g), CPDB RAFT agent (1.97 mmol, 0.437 g) and ACVA initiator (0.395 mmol, 0.111 g; CPDB/ACVA molar ratio = 5.0) were weighed into a 100 mL round-bottomed flask. Ethanol (20 g) was added and the reaction solution was degassed *via* N₂ purge for 40 min. Then the reaction mixture was heated for 120 min by immersing the flask in an oil bath set at 70 °C. The polymerization was quenched by removing the flask from the oil bath and exposing the reaction mixture

to air. The GEO5MA conversion was 72% as determined by ^1H NMR spectroscopy by comparing the integrated monomer vinyl signals at 5.66 and 6.14 ppm to the integrated signal assigned to the two oxymethylene protons attached to the ester group for the monomer (4.16 ppm) and polymer (4.31 ppm), respectively. The crude PGEO5MA was precipitated into excess diethyl ether to remove unreacted GEO5MA and any other impurities, filtered and redissolved in methanol. After reprecipitation into excess diethyl ether, the product was redissolved in water and freeze-dried to produce a viscous red liquid. The mean DP of the purified PGEO5MA₃₇ was determined to be 37 by end-group analysis using ^1H NMR spectroscopy: the integrated five aromatic protons assigned to the dithiobenzoate chain-end at 7.34-8.03 ppm were compared to the two oxymethylene proton signals attached to the ester group at 4.02-4.34 ppm and also to the five methacrylic backbone signals at 0.78-2.71 ppm.

Oxidation of PGEO5MA₃₇ homopolymer using NaIO₄

The oxidation of PGEO5MA₃₇ using a NaIO₄/*cis*-diol molar ratio of unity is representative of the general protocol. PGEO5MA₃₇ homopolymer (15.7 μmol , 0.22 g) was added to 2.0 mL of a 0.29 M aqueous solution of NaIO₄ to give a polymer concentration of 10% w/w. This reaction mixture was stirred for 30 min at 22 °C. The extent of oxidation was determined by ^1H NMR spectroscopy by comparing the integrated proton signals assigned to the aldehyde proton at 9.51 ppm and the proton adjacent to the geminal diols at 5.13 ppm to that of the two oxymethylene protons attached to the ester group at 4.11 ppm. The resulting PAGEO5MA₃₇ solution was purified by dialysis against deionized water for two days (with three changes of water per day). Partial oxidation of PGEO5MA₃₇ was achieved in essentially the same way. However, a lower NaIO₄/*cis*-diol molar ratio was used in each case.

Synthesis of a PGEO5MA homopolymer by free-radical polymerisation in aqueous solution

GEO5MA monomer (1.31 mmol, 0.5 g), ACVA initiator (32.9 μmol , 0.0092 g) and water (10 g) were weighed into a 27 mL sample vial. The reaction solution was degassed *via* N₂ purge for 30 min. The reaction mixture was then heated for 18 h by immersing the sample vial in an oil bath set at 70 °C. The polymerization was quenched by removing the vial from the oil bath and exposing the reaction mixture to air. The GEO5MA conversion was more than 99% as determined by ^1H NMR spectroscopy (the integrated monomer vinyl signals at 5.66 and 6.14 ppm were compared to the integrated signal assigned to the two oxymethylene protons attached to the ester group for the monomer (4.16 ppm) and polymer (4.31 ppm), respectively). Selective oxidation of this polydisperse homopolymer ($M_n = 124\ 100\ \text{g mol}^{-1}$; $\mathcal{D} = 4.55$, as indicated by DMF GPC analysis vs. a series of PMMA calibration standards) was achieved under the same conditions as those employed for the near-monodisperse PGEO5MA₃₇ homopolymer.

Derivatization of PAGEO5MA₃₇ homopolymer with various amino acids

The following protocol for the reductive amination of PAGEO5MA₃₇ with glycine is representative. PAGEO5MA₃₇ (1.00 g of a 10% w/w aqueous solution), glycine (0.31 mmol, 23.4 mg) and excess NaCNBH₃ (0.77 mmol, 48.1 mg) were weighed into a 15 mL sample vial. A glycine/aldehyde molar ratio of unity was employed in combination with a 2.45-fold excess of NaCNBH₃. The reaction mixture was stirred at 35 °C for 48 h to ensure full conversion of aldehyde to the corresponding secondary amine *via* the imine intermediate. The overall conversion was determined by ¹H NMR spectroscopy by comparing the integrated residual geminal diol signal at 5.10 ppm with the five methacrylic backbone protons at 0.78-2.71 ppm. The resulting aqueous solution of glycine-functionalized PAGEO5MA₃₇ was purified by dialysis against deionized water for two days (with at least three water changes per day). Essentially the same protocol was used for cysteine (0.31 mmol, 37.8 mg) and lysine (0.31 mmol, 45.7 mg) instead of glycine.

Synthesis of PEG₁₁₃-PGE05MA₅₀ diblock copolymer via RAFT aqueous solution polymerization of GEO5MA

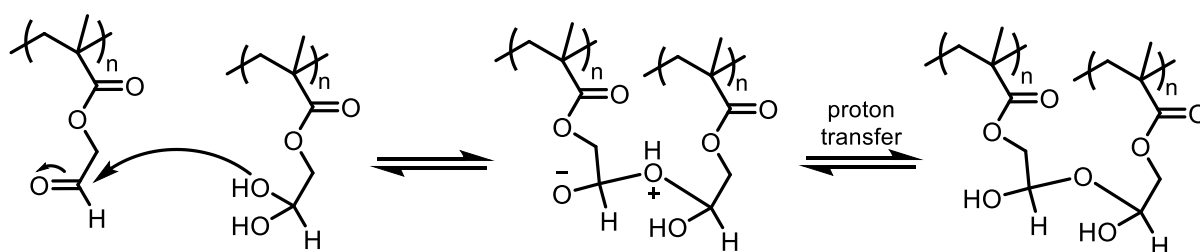
A trithiocarbonate-capped PEG₁₁₃ macro-CTA (52.5 μmol, 0.281 g), GEO5MA monomer (2.62 mmol, 1.00 g), VA-044 initiator (10.5 μmol, 3.4 mg) and water (1.93 g) were weighed into a 15 mL sample vial. A macro-CTA/initiator ratio of 5.0 was employed and a copolymer concentration of 40% w/w was targeted. The reaction solution was degassed for 30 min before placing the sample vial into an oil bath set at 50 °C for 18 h. The polymerization was quenched by removing the vial from the oil bath and exposing the reaction mixture to air. The GEO5MA monomer conversion was determined to be more than 99% by ¹H NMR spectroscopy (the integrated vinyl monomer signals at 5.66 and 6.08 ppm were compared to that of the two oxymethylene protons attached to the ester group in the GEO5MA repeat units at 4.26 ppm).

Synthesis of PGE05MA₃₇-PX₅₀ diblock copolymers via RAFT aqueous solution polymerization

The synthesis of a PGE05MA₃₇-PMPC₅₀ diblock copolymer is representative and was conducted as follows. PGE05MA₃₇ macro-CTA (16.9 μmol, 0.241 g), MPC monomer (0.847 mmol, 0.25 g), ACVA initiator (4.23 μmol, 1.2 mg) and water (1.97 g) were weighed into a 15 mL sample vial. A total copolymer concentration of 20% w/w was targeted and a macro-CTA/initiator ratio of 4.0 was employed. The reaction solution was degassed for 30 min before placing the sample vial into an oil bath set at 70 °C for 18 h. The MPC conversion was determined to be more than 98% by ¹H NMR spectroscopy (the integrated vinyl monomer signals at 6.56-6.11 ppm were compared to the methacrylic backbone signals at 0.31-2.46 ppm). The other two diblock copolymers were prepared by replacing the MPC monomer with either METAC (0.120 mmol, 0.32 g of an 80% w/w stock solution) or SEM (0.110 mmol, 0.96 g of a 26% w/w stock solution).

Oxidation of PEG₁₁₃-PGE05MA₃₇ and PGE05MA₃₇-PX₅₀ diblock copolymers using NaIO₄

The oxidation of the *cis*-diol units in PEG₁₁₃-PGE05MA₅₀ is representative of the general protocol. A 40% w/w aqueous PEG₁₁₃-PGE05MA₅₀ solution (2.60 g, 1.04 g dry weight PEG₁₁₃-PGE05MA₃₇, 0.11 mmol) was added to 5.6 ml of a 0.38 M aqueous solution of NaIO₄. The resulting ~15% w/w copolymer solution was stirred at 22 °C for 30 min and the extent of oxidation was determined by ¹H NMR spectroscopy (the integrated signals for the aldehyde proton at 9.51 ppm and the proton adjacent to the geminal diol at 5.13 ppm were compared to that for the signal at 4.11 ppm corresponding to two oxymethylene protons attached to the ester group). The resulting diblock copolymer solution was purified by dialysis against deionized water for two days (with three changes of water per day).



Scheme S1. Crosslinking side reaction that can occur between aldehyde and geminal diol groups on PAGMA.

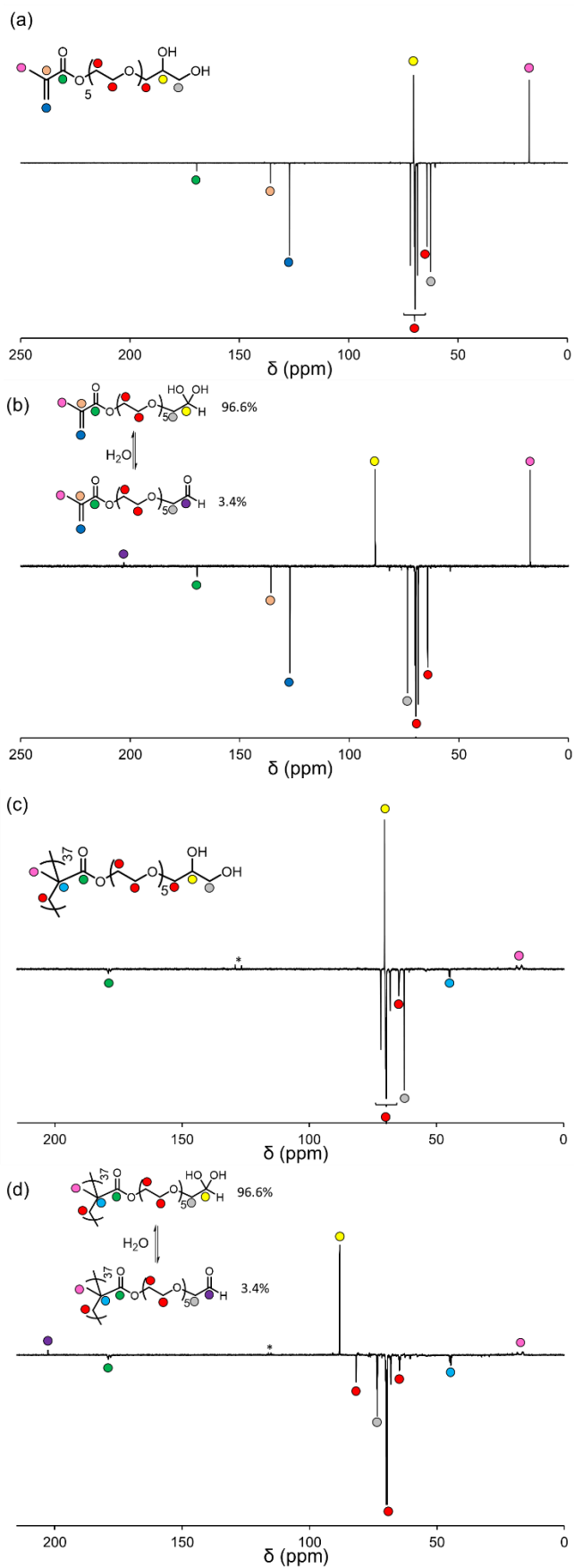


Figure S1. Assigned DEPTQ ^{13}C NMR spectra (D_2O , 100 MHz) recorded for (a) GEO5MA monomer, (b) AGEO5MA monomer, (c) PGEO5MA₃₇ homopolymer and (d) PAGEO5MA₃₀ homopolymer (* indicate signals from RAFT chain ends).

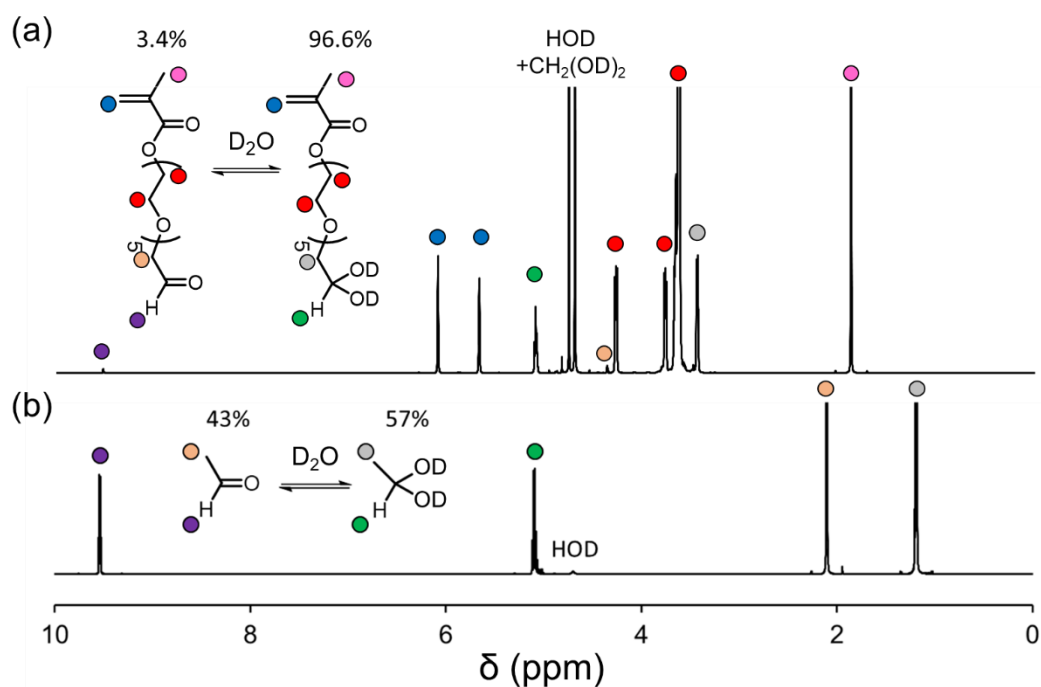


Figure S2. Assigned ^1H NMR spectra (D_2O) recorded for (a) AGEO5MA monomer and (b) acetaldehyde (used as a reference compound). In the former case, the aldehyde group is mainly present in its hydrated geminal diol form.

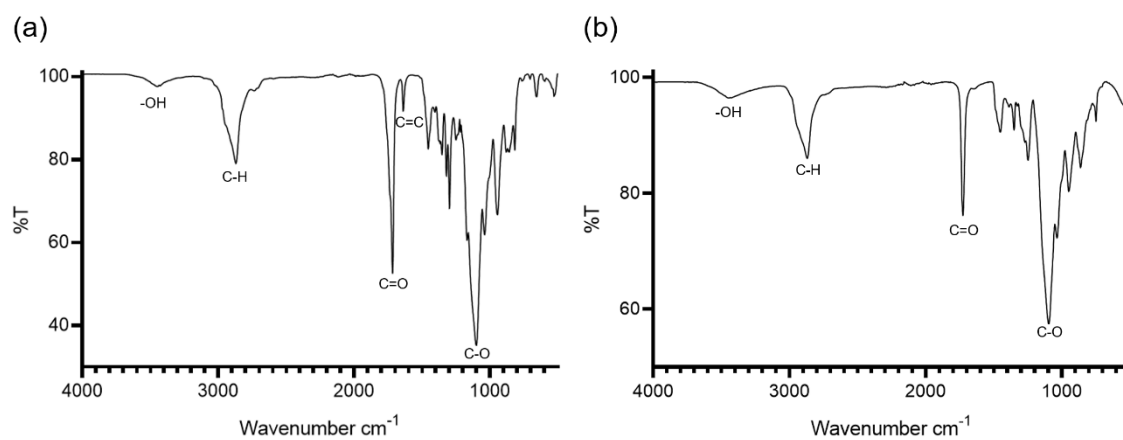


Figure S3. FT-IR spectra recorded at $22\text{ }^\circ\text{C}$ for (a) AGEO5MA monomer and (b) PAGEO5MA homopolymer. [N.B. There is no detectable aldehyde carbonyl band in these spectra. This is because this group is mainly present in its hydrated geminal diol form. The relatively small number of aldehyde groups indicated by ^1H NMR spectroscopy studies (see Figure 1b in the main manuscript) would only be expected to produce a very weak band, which is dominated by the strong *methacrylic ester* band that absorbs at a very similar wavenumber (1716 cm^{-1})].

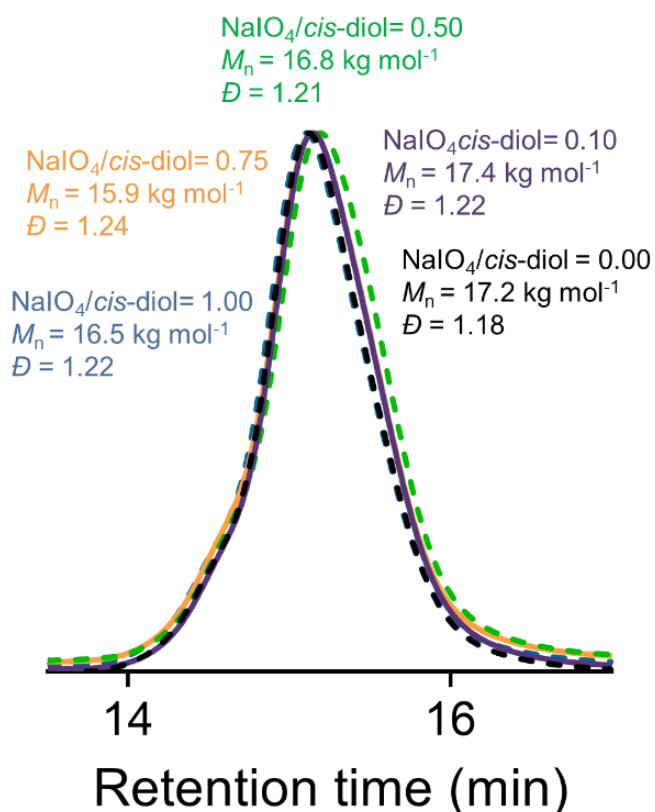


Figure S4. DMF GPC traces (vs. PMMA calibration standards) recorded for a PGE05MA_{37} precursor, $\text{P}(\text{GEO5MA}_n\text{-stat-AGE05MA}_m)_{37}$ statistical copolymers (where $m = 0.11, 0.49$ and 0.78 , when using a $\text{NaIO}_4/\text{cis-diol}$ molar ratio of 0.10, 0.50 or 0.75, respectively) and PAGE05MA_{37} ($\text{NaIO}_4/\text{cis-diol}$ molar ratio = 1.00). The desired degree of aldehyde functionality is achieved (within experimental error) when using sub-stoichiometric amounts of periodate and such selective oxidation has essentially no effect on the molecular weight distribution curve of the PGE05MA_{37} precursor.

Table S1. Summary of the aqueous solubilities observed for PAGE05MA_{37} and PAGMA_{39} prepared at various concentrations.

PAGE05MA ₃₇ concentration		PAGMA ₃₉ concentration		Water soluble?	
% w/w	mol dm ⁻³	% w/w	mol dm ⁻³	PAGE05MA ₃₇	PAGMA ₃₉
1.5	0.0012	1.5	0.0027	Soluble	Insoluble
2.0	0.0016	2.0	0.0036	Soluble	Insoluble
3.5	0.0027	-	-	Soluble	-
10	0.0079	10	0.0196	Soluble	Insoluble
15	0.0118	-	-	Insoluble	-

All experiments were conducted at 22 °C using a $\text{NaIO}_4/\text{cis-diol}$ molar ratio of unity.

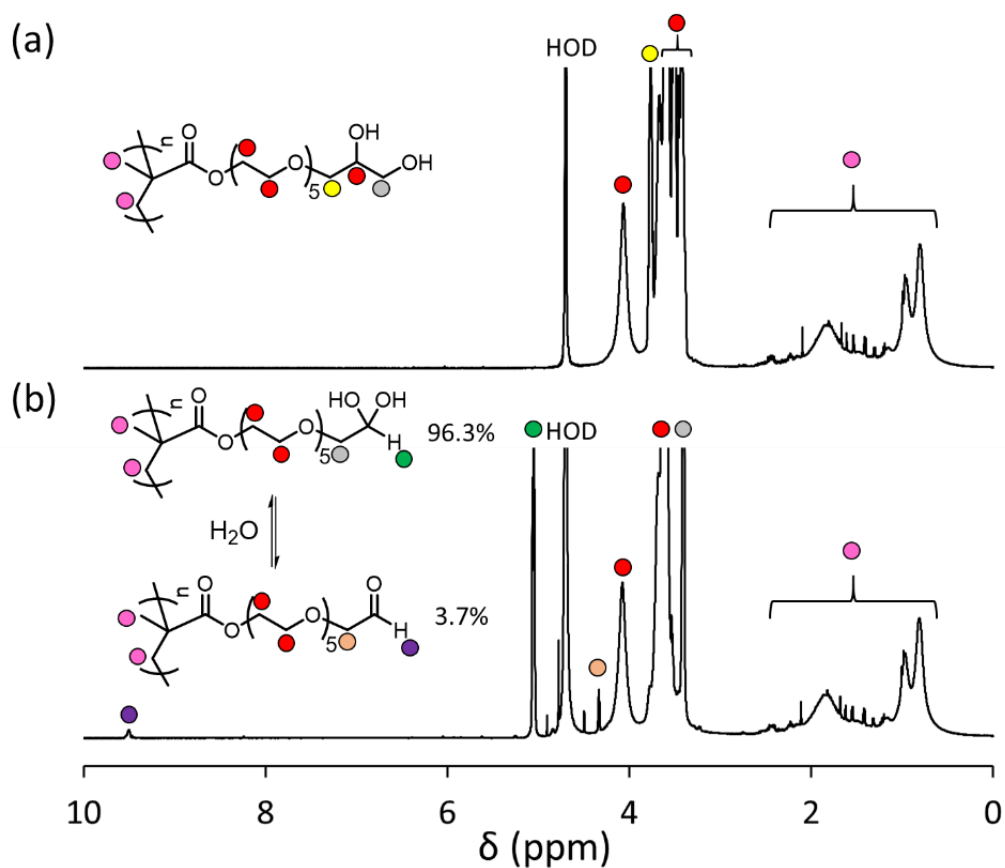


Figure S5. Assigned ¹H NMR spectra (D₂O) recorded for (a) PGEO5MA synthesized by free-radical polymerisation and (b) PAGEO5MA synthesized by oxidising PGEO5MA using NaIO₄.

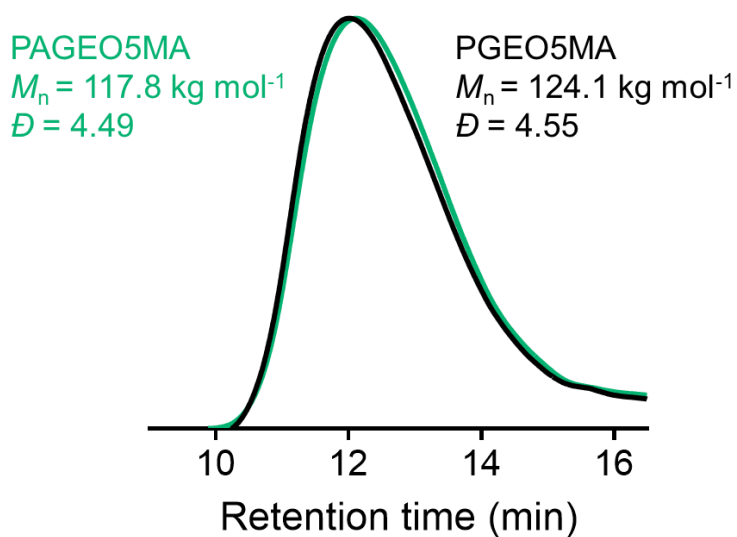


Figure S6. DMF GPC traces (vs. PMMA standards) recorded for PGEO5MA and PAGEO5MA homopolymers synthesized *via* free-radical polymerization in water.

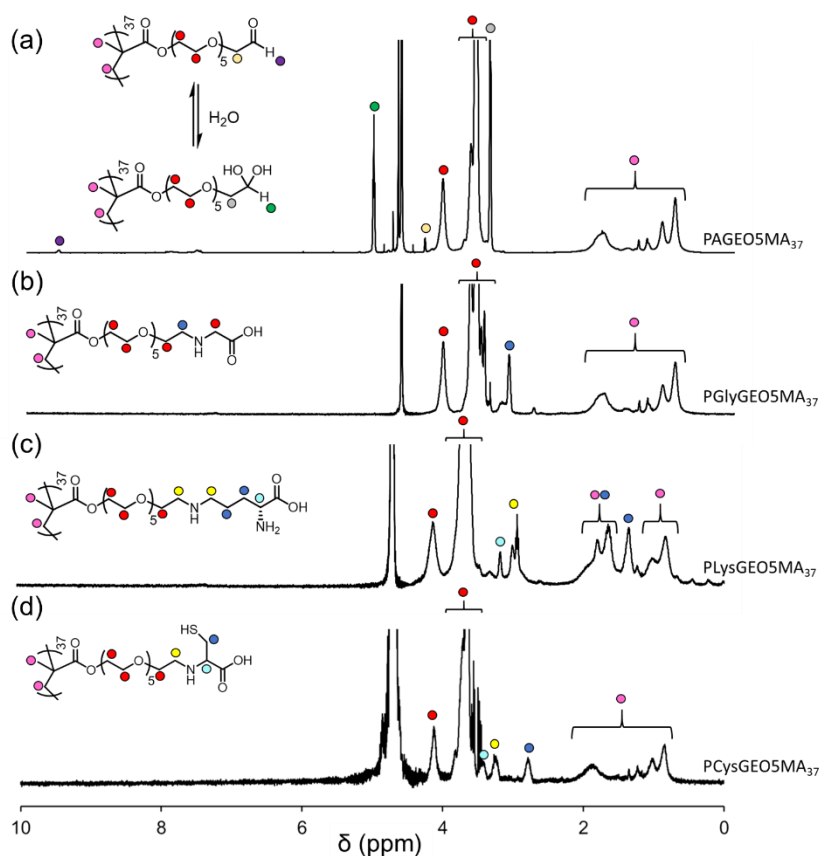


Figure S7. Assigned ^1H NMR spectra (D_2O) recorded for (a) PAGEO5MA₃₇, (b) PGlyGEO5MA₃₇, (c) PLysGEO5MA₃₇ and (d) PCysGEO5MA₃₇.

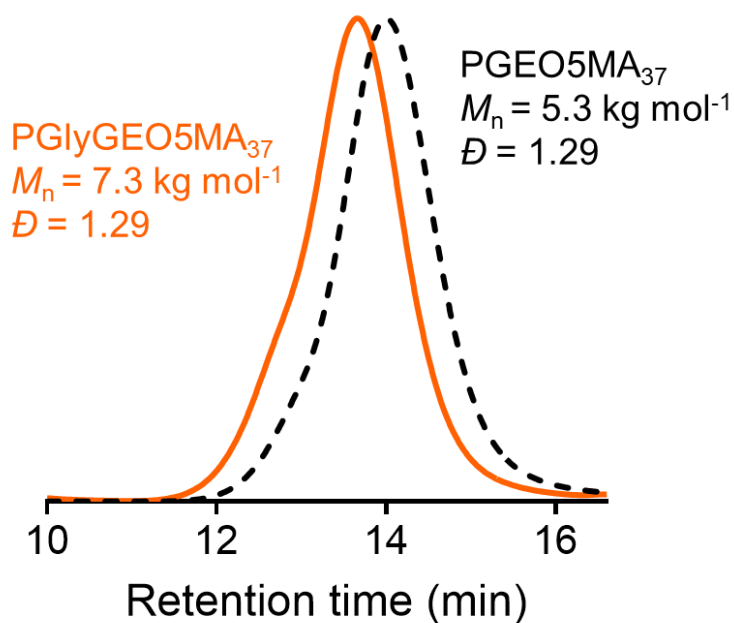


Figure S8. Aqueous GPC traces (vs. PEG/PEO calibration standards) recorded for PGEO5MA₃₇ and PGlyGEO5MA₃₇. After periodate oxidation, derivatization with glycine leads to a systematic shift in the molecular weight distribution curve but the dispersity (\mathcal{D}) remains narrow.

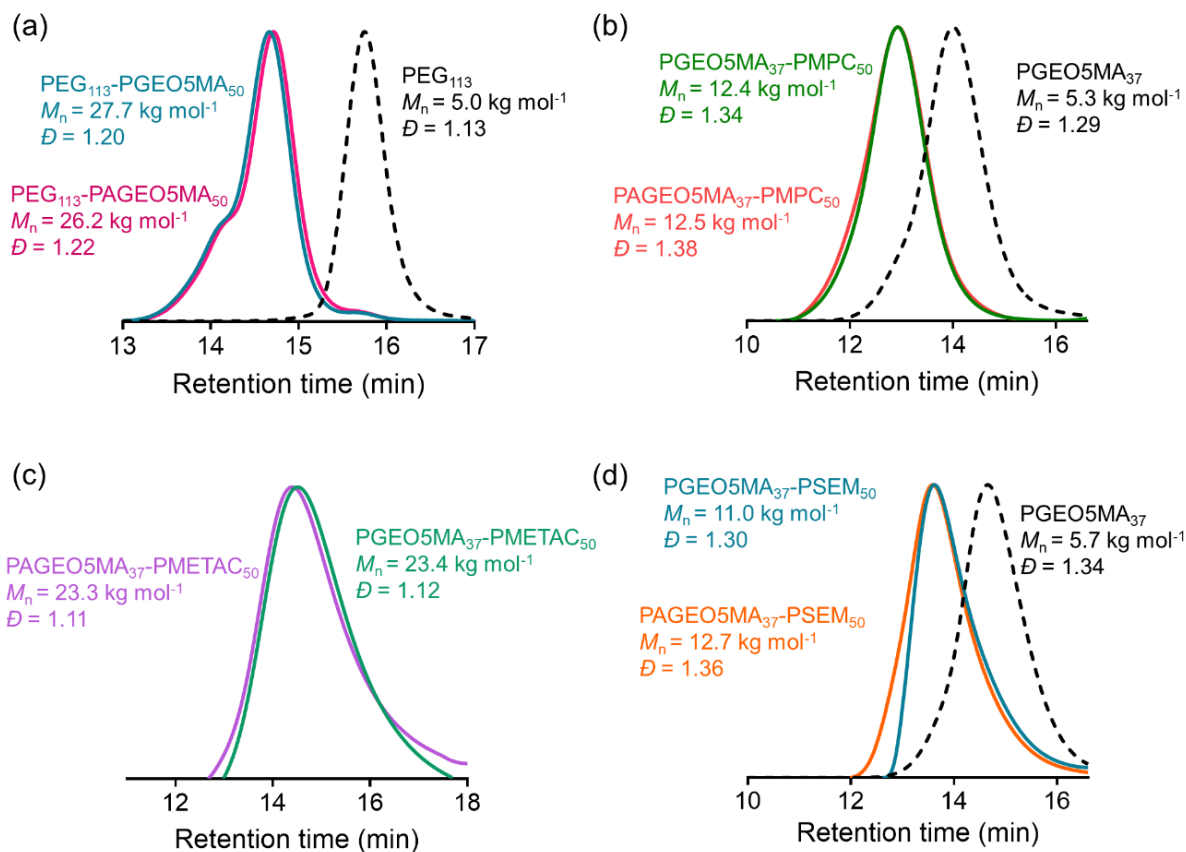


Figure S9. DMF GPC traces (vs. PEG/PEO calibration standards) recorded for (a) PEG₁₁₃-PGEO5MA₅₀, PEG₁₁₃-PAGEO5MA₅₀ and PEG₁₁₃ and aqueous GPC traces (vs. PEG/PEO calibration standards) recorded for (b) PGEO5MA₃₇-PMPC₅₀, PAGEO5MA₃₇-PMPC₅₀ and PGEO5MA₃₇, (c) PGEO5MA₃₇-PMETAC₅₀, PAGEO5MA₃₇-PMETAC₅₀ and (d) PGEO5MA₃₇-PSEM₅₀, PAGEO5MA₃₇-PSEM₅₀ and PGEO5MA₃₇. In the case of (a), (b) and (d), there is a substantial shift in molecular weight for the diblock copolymer relative to its corresponding homopolymer. Unfortunately, in (c) it was not possible to record the GPC curve for the PGEO5MA₃₇ precursor using this particular eluent (0.5 M acetic acid, 0.3 M NaH₂PO₄ pH 2). In all four cases, selective oxidation of the pendent *cis*-diol groups using sodium periodate had minimal effect on the molecular weight distribution.