Directing Chiral Induction in Hollow Helical Organic Nanotubes

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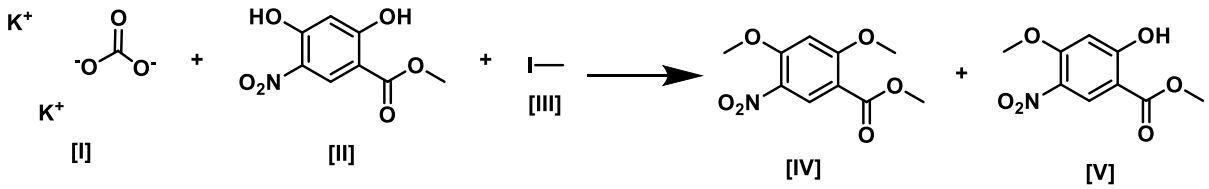
Contents

Instruments

All ^{1}H NMR, ^{13}C NMR spectra were recorded on a Bruker Avance III (400 MHz and 300 MHz) FT NMR spectrometer. Chemical shifts for ^{1}H and ^{13}C were given in ppm relative to the residual solvent peak ($CDCl_3$: 7.27 for ^{1}H; $CDCl_3$: 77.16 for ^{13}C). MALDI-ToF mass spectra were measured on a Bruker ultraflextremeTM using trans-2-[3-(tert-butylphenyl)-2-methyl-2-propenylidene]malononitrile (DCTB) as matrix and sodium trifluoroacetate (NaTFA) or silver trifluoroacetate (AgTFA) as the counter ion source. HR-MS (ESI+) mass spectra were measured on a double-focusing (BE geometry) magnetic sector mass spectrometer DFS (ThermoFisher Scientific, Bremen, Germany); solid probe inlet; EI at 70 eV; source temperature 200°C; acceleration voltage 5 kV; electric scan mode; mass range 300–350*m/z at 10'000 resolution (10% valley definition)and scan rate of 100–200s per decade; mass accuracy ≤ 2ppmafter calibration with perfluorokerosene (PFK, Fluorochem, Derbyshire, UK). Relative molecular weights and molecular weight distributions were measured by size exclusion chromatography (SEC) with either chloroform ($CHCl_3$) or dimethylformamide (DMF) as eluent with a flow rate of 1 mL/min at 40°C and 60°C, respectively. The chloroform SEC system was calibrated with polystyrene standards, and the dimethylformamide SEC was calibrated with polyethylene oxide standards, ranging from 103 to 3×106 Da. Both SECs are an automated PSS security System (Agilent Technologies 1260 infinity ll) with a set of two MZ-Gel SD plus linear columns (300 x 8 mm, 5 µm particle size) for CHCl3 SEC and two Agilent PolarGel M columns (ID = 7.5 mm, L = 300 mm, particle size = 8 µm) for DMF SEC. Signals were recorded by an interferometric refractometer (Agilent 1260 series) (as refractive index or RI traces). All polymer samples were filtered through a PTFE syringe membrane filter (0.45 µm pore size, VWR) before SEC measurements. Circular dichroism spectra were recorded using an Applied Photophysics Chirascan™ CD spectropolarimeter (Applied Photophysics Ltd., Leatherhead, UK). The instrument employs a highly collimated xenon arc lamp as the light source, a monochromator system for wavelength selection, and dual photomultiplier detectors to enable sensitive measurements across the far-UV to near-UV range. The Chirascan system integrates automated temperature control with a Peltier temperature controller. Measurements were performed using a [specify path length, e.g. 0.1 cm or 1 cm] quartz cuvette. UV–Vis absorption spectra were recorded on a JASCO V-630 double-beam spectrophotometer (JASCO Corporation, Tokyo, Japan). The instrument operates with a deuterium lamp (UV region) and a tungsten–halogen lamp (visible region) as light sources and utilizes a 1200 lines/mm diffraction grating monochromator. Detection is achieved using a silicon photodiode detector, covering the 190–1100 nm wavelength range with a spectral bandwidth of 1.5 nm. Measurements were carried out at room temperature using standard quartz cuvettes. Fluorescence spectra were recorded on a JASCO FP-6200 spectrofluorometer (JASCO Corporation, Tokyo, Japan). The instrument is equipped with a 150 W xenon arc lamp as the excitation source and uses a diffraction grating monochromator for wavelength selection in both the excitation and emission channels. Emission was detected with a photomultiplier tube (PMT).

Synthesis

Intermediate 1

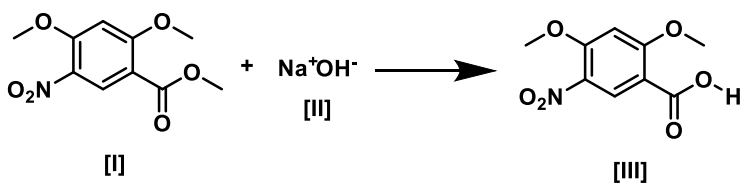


II (1 equiv., 2 g), and III (3 equiv., 2.65 mL) were dissolved in 25 mL dry DMF, followed by the addition of potassium carbonate (4 equiv., 7.7 g), which immediately showed a yellow coloration. The mixture was heated at 35°C for 48 hours. During the work-up, a large amount of water was needed to dissolve the yellow paste, which was probably the potassium salt of II. TLC analysis after the work-up showed two spots only: one at the non-polar region (15% ethyl acetate-hexane) and the other at the polar region (30% ethyl acetate-hexane). Unreacted II (and therefore the low yield of the final product) was removed from the mixture during the work-up with water. Column chromatography was performed to isolate both spots, and ^{1}H NMR analysis suggested the non-polar product was V (300 mg, 9.38% yield), whereas the polar spot was the desired product, Intermediate 1 (IV) (1.2 g, 35.3% yield).

V: δ_H (300 MHz, Chloroform-*d*) 11.43 (1 H, s), 8.57 (1 H, s), 6.58 (1 H, s), 4.02 – 3.86 (7 H, m). δ_C (75 MHz, Chloroform-*d*) 169.79, 167.11, 159.89, 132.75, 130.22, 105.35, 101.70, 62.65, 57.49, 53.34, 10.37.

IV: δ_H (300 MHz, Chloroform-*d*) 8.62 (1 H, s), 6.53 (1 H, s), 4.03 (6 H, d, *J* 7.7), 3.89 (3 H, s), 0.07 (0 H, s). δ_C (75 MHz, Chloroform-*d*) 164.61, 164.12, 158.33, 131.94, 131.62, 111.84, 96.55, 56.90, 56.83, 52.36.

Intermediate 2

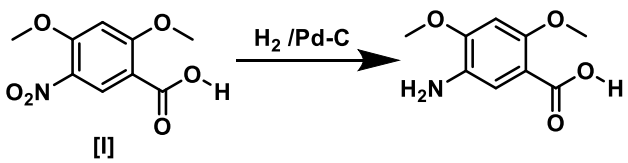


I (1 equiv., 1.2 g) was dissolved in a 30 mL THF and 30 mL methanol mixture. NaOH (3 equiv., 600 mg) dissolved in 10 mL water was added to the mixture, and it was stirred for 24 h at 40°C. HPLC analysis showed that I was fully consumed, and a new peak at the polar region was observed. The solvent was evaporated, and the crude was suspended in water, followed by

the addition of 2 M aqueous HCl until the pH of the solution reached 3 or 4. A white solid formation was observed which was filtered and dried (1 g, 88.6% yield).

δ_H (300 MHz, DMSO-d_6) 12.90 (1 H, s), 8.36 (1 H, s), 6.86 (1 H, s), 4.01 (6 H, d, *J* 16.8). δ_C (75 MHz, DMSO-d_6) 164.82, 164.04, 157.58, 130.83, 130.08, 112.18, 98.29, 57.26, 56.93.

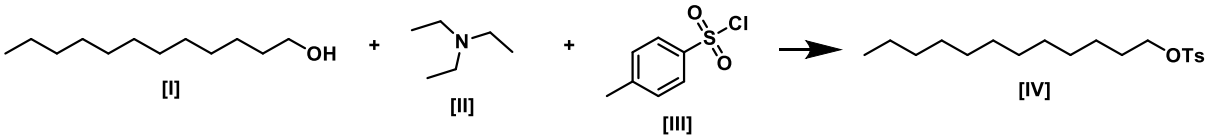
A



In a high-pressure tube, I (400 mg) was dissolved in 10 mL THF, and Pd-C (10 wt.%, 40 mg) was added. The tube wall was washed with 15 mL THF, followed by adding 10 mL methanol. To avoid fire, it is important to entirely suspend the Pd-C in THF before introducing methanol to the mixture. The tube was pressurized with hydrogen gas (30 bar) at 35°C for 12 h, upon which complete conversion of I to the amine could be visualized with HPLC analysis. The mixture was passed through celite to remove Pd-C from the product; the organic solvents were evaporated first under a rotary evaporator and then under the Schlenk vacuum to give the crude product A, which was used without further purification (323 mg, 93% yield).

δ_H (300 MHz, DMSO-d_6) 7.07 (1 H, s), 6.87 (2 H, d, *J* 0.7), 6.62 (2 H, d, *J* 10.7), 3.85 (3 H, d, *J* 5.5), 3.77 (3 H, d, *J* 3.9). δ_C (75 MHz, DMSO-d_6) 166.82, 151.77, 151.46, 150.38, 139.18, 130.99, 128.03, 124.90, 115.87, 112.24, 98.10, 57.06, 55.64, 34.38, 30.42, 22.44, 21.03.

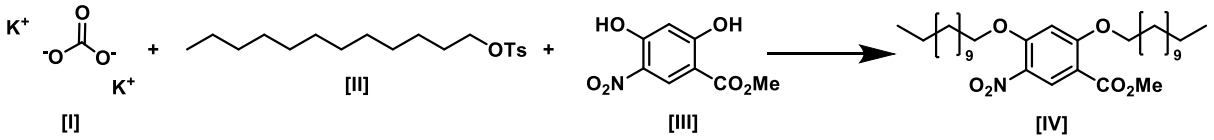
Intermediate 3



Intermediate 3 was synthesized according to the same protocol as used for intermediate 10, using I (1.2 equiv., 9.65 mL), II (1.2 equiv., 6 mL), and III (1 equiv., 6.8 g) to get the product IV after purification as a battery solid (11 g, 91% yield).

δ_H (300 MHz, Chloroform-*d*) 7.84 – 7.74 (2 H, m), 7.40 – 7.29 (2 H, m), 4.02 (2 H, t, *J* 6.5), 2.45 (3 H, s), 1.71 – 1.52 (3 H, m), 1.36 – 1.17 (20 H, m), 0.93 – 0.82 (3 H, m). δ_C (75 MHz, Chloroform-*d*) 144.73, 133.42, 129.93, 128.03, 70.86, 32.06, 29.75, 29.64, 29.54, 29.48, 29.08, 28.96, 25.47, 22.83, 21.78, 14.27.

Intermediate 4

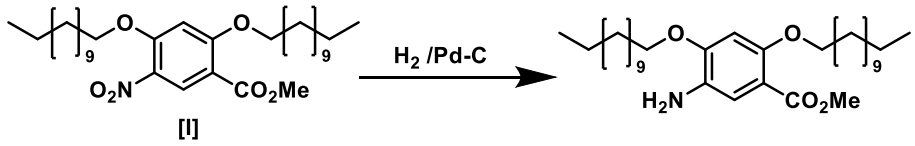


Intermediate 4 was synthesized according to the same protocol as intermediate 1 using I (4.5 equiv., 4.4 g), II (2.5 equiv., 6 g), and III (1 equiv., 1.52 g) to produce IV after purification as a yellow solid (3.04 g, 77.5% yield).

A non-polar impurity was observed when TLC analysis of the crude was performed after the work-up procedure. Therefore, column chromatography was performed first using 2% ethyl acetate-hexane, then at 4% to remove the impurity. Afterward, the product was eluted with 8% ethyl acetate-hexane.

δ_H (300 MHz, Chloroform-*d*) 8.59 (1 H, s), 6.47 (1 H, s), 4.10 (4 H, dt, *J* 11.6, 6.4), 3.87 (3 H, s), 2.02 – 1.76 (4 H, m), 1.61 – 1.44 (6 H, m), 1.27 (39 H, d, *J* 4.8), 0.96 – 0.79 (6 H, m). δ_C (75 MHz, Chloroform-*d*) 164.38, 164.05, 157.83, 131.92, 131.49, 111.67, 97.90, 70.13, 69.84, 52.19, 32.06, 29.81, 29.79, 29.74, 29.72, 29.69, 29.64, 29.50, 29.41, 29.40, 29.01, 28.95, 25.97, 22.84, 14.27.

Intermediate 5

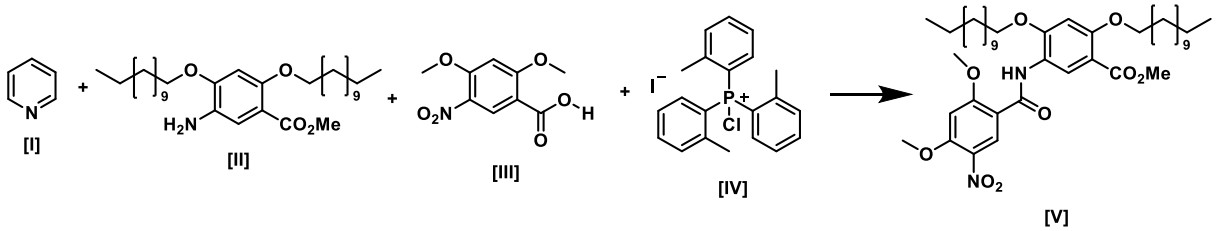


Intermediate 5 was synthesized according to the same protocol as used for A using I (3.63 mmol, 2 g) and Pd-C (200 mg) to obtain the product after purification as a grey solid (1.73 g, 91.5% yield).

Column chromatography was performed first with 20% ethyl acetate-hexane to remove a non-polar impurity, then at 50% ethyl acetate-hexane to obtain the product.

δ_H (300 MHz, Chloroform-*d*) 7.27 (1 H, s), 6.44 (1 H, s), 3.98 (4 H, dt, *J* 18.5, 6.6), 3.84 (3 H, s), 1.82 (4 H, dt, *J* 14.7, 7.0), 1.47 (4 H, t, *J* 7.2), 1.26 (36 H, s), 0.93 – 0.82 (6 H, m). δ_C (75 MHz, Chloroform-*d*) 166.71, 153.93, 151.34, 129.55, 117.77, 112.28, 100.10, 71.19, 68.64, 51.76, 32.07, 29.84, 29.81, 29.79, 29.75, 29.72, 29.68, 29.60, 29.55, 29.51, 29.29, 26.21, 26.17, 22.85, 14.28.

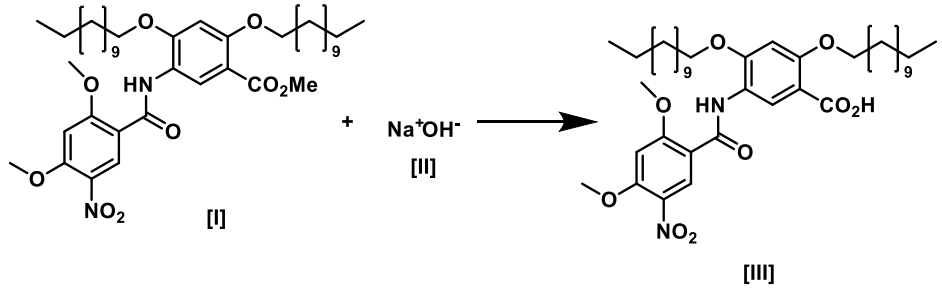
Intermediate 6



II (1 equiv., 1.15 mmol, 600 mg), and III (1.2 equiv., 1.38 mmol, 315 mg) were dissolved in 7 mL dry CHCl3 (0.2 M w.r.t III) followed by the addition of I (6.6 equiv., 7.6 mmol, 0.6 mL). The resulting mixture was cooled to 0°C using an ice bath. In a separate flask, IV (1.8 equiv., 2 mmol, 970 mg) was dissolved in 10 mL dry CHCl3 (0.2 M), and the solution was added to the pre-cooled mixture. The ice bath was removed, and the mixture was stirred overnight at room temperature. TLC analysis showed full consumption of II. The solvent was removed in the rota-vap, and then methanol was added to the flask, which immediately produced a yellow precipitate, which was collected and further washed with methanol to give the pure product V as a yellow solid (820 mg, 97.4% yield, 1.12 mmol).

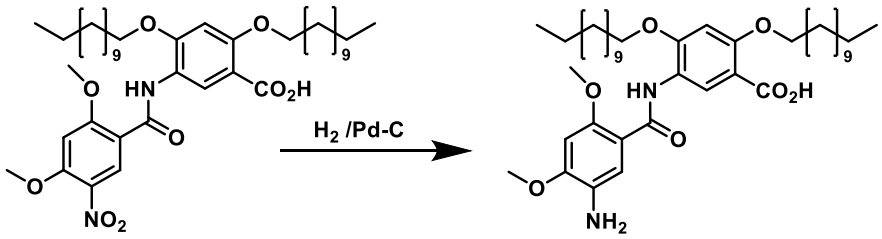
δ_H (300 MHz, Chloroform-*d*) 9.82 (1 H, s), 9.06 (1 H, s), 8.95 (1 H, s), 6.50 (1 H, s), 6.42 (1 H, s), 4.13 (3 H, s), 4.12 – 3.94 (7 H, m), 3.87 (3 H, s), 1.88 (3 H, dq, *J* 25.2, 6.7), 1.33 (1 H, s), 1.27 (20 H, s), 1.25 (6 H, d, *J* 1.8), 0.93 – 0.82 (5 H, m), 0.07 (1 H, s).

Intermediate 7



Intermediate 7 was synthesized according to the same protocol (except here the solution was refluxed overnight) as used for intermediate 2, using I (1 equiv., 820 mg) and II (3 equiv., 135 mg) to obtain the product as a white solid (770 mg, 95.7% yield).

B



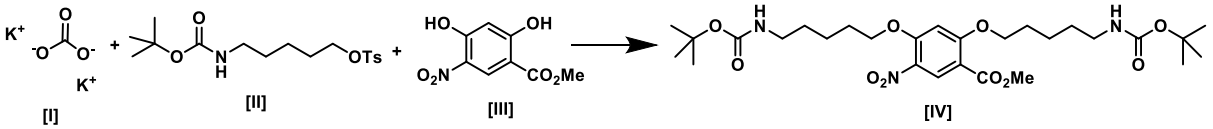
[I]

B was synthesized according to the same protocol as used for A, using I (770 mg) and Pd-C (80 mg) to obtain the product as a white solid (703 mg, 95.3% yield).

δ_H (300 MHz, Chloroform-*d*) 10.69 (1 H, s), 10.13 (1 H, s), 9.26 (1 H, s), 7.66 (1 H, s), 6.98 (1 H, d, *J* 0.7), 6.47 (2 H, d, *J* 4.8), 4.13 (5 H, dt, *J* 23.2, 6.6), 3.94 (7 H, d, *J* 15.2), 3.80 – 3.69 (1 H, m), 3.66 (3 H, s), 2.00 – 1.80 (5 H, m), 1.43 (12 H, s), 1.26 (30 H, d, *J* 3.2), 0.93 – 0.82 (9 H, m). δ_C (75 MHz, Chloroform-*d*) 163.04, 154.50, 153.30, 151.40, 151.03, 135.89, 130.51, 128.39, 125.66, 125.28, 123.62, 117.95, 114.44, 96.38, 96.17, 70.79, 69.35, 68.13, 57.17, 55.85, 34.38, 32.06, 30.46, 29.82, 29.78, 29.72, 29.70, 29.60, 29.54, 29.50, 29.42, 29.19, 26.01, 25.76, 22.84, 21.34, 14.28.

HR-MS (ESI) calculated for $C_{40}H_{65}O_7N_2[M+H]^+$: 685.47863, Found: 685.47977.

Intermediate 8



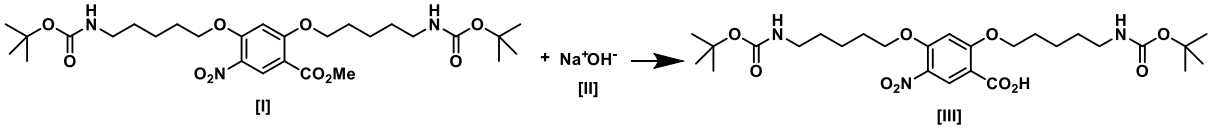
[I] [II] [III] [IV]

Intermediate 8 was synthesized according to the same protocol as used for intermediate 1, using I (4.5 equiv., 5 g), II (2.5 equiv., 7.1 g), and III (1 equiv., 1.7 g) to give the product as a white solid (2.72 g, 59% yield).

Column chromatography was first performed at 30% ethyl acetate-hexane to remove excess II, then at 50% ethyl acetate-hexane to obtain the desired product.

δ_H (300 MHz, Chloroform-*d*) 8.59 (1 H, s), 6.47 (1 H, s), 4.68 (1 H, s), 4.59 (1 H, s), 4.12 (4 H, dt, *J* 11.0, 6.2), 3.87 (3 H, s), 3.15 (5 H, s), 1.96 – 1.85 (4 H, m), 1.65 – 1.52 (10 H, m), 1.44 (3 H, s), 1.43 (18 H, s). δ_C (75 MHz, Chloroform-*d*) 164.21, 164.02, 157.75, 156.19, 131.92, 131.49, 111.67, 97.92, 69.88, 69.52, 62.90, 52.22, 32.43, 30.04, 29.81, 29.70, 28.57, 28.52, 23.23, 23.14, 23.05.

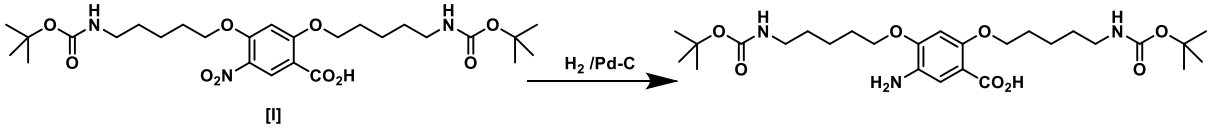
Intermediate 9



Intermediate 9 was synthesized according to the same protocol as used for intermediate 2, using I (1 equiv., 2.70 g), and II (3 equiv., 560 mg) to give the product as a yellow solid (2.52 g, 95% yield).

δ_H (300 MHz, Chloroform-*d*) 8.73 (1 H, s), 6.55 (1 H, s), 4.63 (2 H, s), 4.20 (4 H, dt, *J* 28.4, 6.3), 3.15 (4 H, s), 2.02 – 1.86 (4 H, m), 1.68 – 1.53 (6 H, m), 1.44 (20 H, d, *J* 1.3). δ_C (75 MHz, Chloroform-*d*) 158.39, 132.75, 98.43, 70.65, 63.30, 32.83, 30.45, 30.20, 28.98, 28.87, 28.80, 23.56, 23.44.

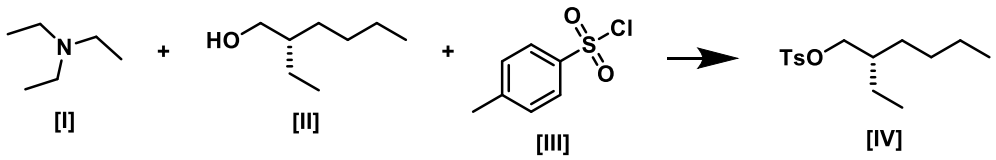
C



C was synthesized according to the same protocol as used for monomer A, using I (1 equiv., 2.5 g) and Pd-C (250 mg) to give the product as a red solid in quantitative yield.

δ_H (300 MHz, Chloroform-*d*) 7.63 (1 H, s), 6.48 (1 H, d, *J* 9.2), 4.60 (1 H, s), 4.26 – 4.09 (2 H, m), 4.07 (2 H, s), 3.15 (4 H, d, *J* 6.3), 1.90 (5 H, d, *J* 7.5), 1.43 (18 H, d, *J* 3.8), 1.27 (2 H, s).

Intermediate 10

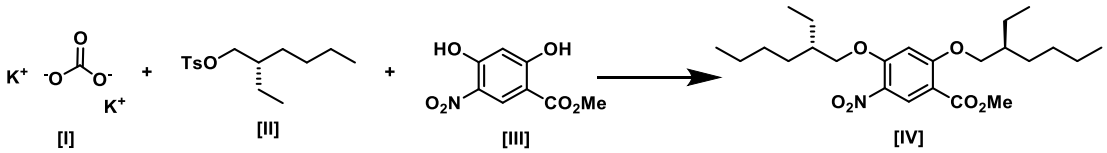


II was synthesized according to a previously described procedure[1].

Tosyl chloride (III) (1 equiv., 55 mmol, 10.5 g) and (S)-2-ethylhexan-1-ol (II) (1.1 equiv., 60.6 mmol, 7.9 g) were dissolved in 60 mL dry DCM followed by the dropwise addition of triethylamine (1.2 equiv., 66 mmol, 9.2 mL). A white suspension was observed, and the resulting mixture was stirred overnight, upon which full consumption of II was observed. Then, the mixture was worked up with DCM and brine. The organic part was collected, dried over $MgSO_4$, concentrated, followed by purification by silica-gel column chromatography (5% ethyl acetate-hexanes) to obtain the product IV as a colorless liquid (12.7 g, 81% yield, 44.7 mmol).

δ_H (300 MHz, Chloroform-*d*) 7.84 – 7.73 (2 H, m), 7.39 – 7.28 (2 H, m), 3.99 – 3.84 (2 H, m), 2.44 (3 H, s), 1.63 – 1.45 (1 H, m), 1.41 – 1.03 (7 H, m), 0.89 – 0.73 (6 H, m). δ_C (75 MHz, Chloroform-*d*) 144.72, 133.24, 129.89, 128.03, 72.62, 39.17, 29.91, 28.77, 23.35, 22.95, 21.75, 14.08, 10.87.

Intermediate 11

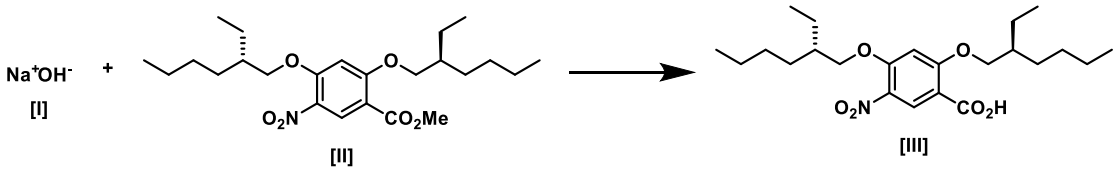


III was synthesized according to a previously described procedure[1].

III (1 equiv., 9.38 mmol, 2 g) and II (2.25 equiv., 21.1 mmol, 6 g) were dissolved in 25 mL dry DMF, followed by the addition of potassium carbonate (4.5 equiv., 42.2 mmol, 5.8 g) which immediately showed a yellow coloration. The mixture was heated at 100°C for 24 hours. The resulting red solution was transferred into a separating funnel containing water. Then, the mixture was worked up with ethyl acetate and brine. The organic part was collected, dried over $MgSO_4$, concentrated, and further purified by column chromatography (2% ethyl acetate-hexanes) to obtain the product IV as a light-yellow liquid (3 g, 73% yield, 6.9 mmol).

δ_H (300 MHz, Chloroform-*d*) 8.61 (1 H, s), 6.47 (1 H, s), 4.10 – 3.91 (4 H, m), 3.87 (3 H, s), 1.81 (2 H, hept, *J* 6.2), 1.66 – 1.52 (1 H, m), 1.58 – 1.48 (1 H, m), 1.54 – 1.45 (1 H, m), 1.51 – 1.32 (2 H, m), 1.38 – 1.20 (7 H, m), 0.93 (11 H, dtd, *J* 10.3, 7.3, 1.7). δ_C (75 MHz, Chloroform-*d*) 164.56, 164.18, 158.05, 131.85, 131.58, 111.65, 97.61, 72.20, 71.87, 52.18, 39.48, 39.43, 30.48, 30.42, 29.22, 27.07, 23.85, 23.83, 23.14, 23.08, 14.22, 14.20, 11.28.

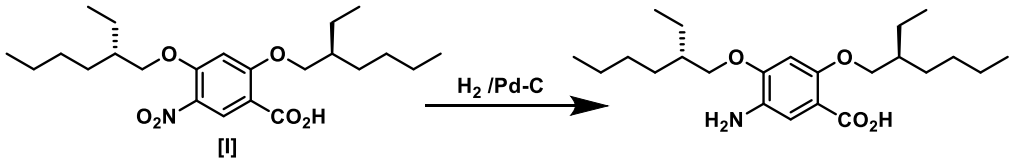
Intermediate 12



II (1 equiv., 4 mmol, 1.76 g) was dissolved in a 30 mL THF and 30 mL methanol mixture. NaOH (3 equiv., 12 mmol, 483 mg) dissolved in 10 mL water was added to the mixture, and it was stirred for 24 h at room temperature. HPLC analysis showed that II was fully consumed, and a new peak at the polar region was observed. The solvent was evaporated, and the crude was suspended in water, followed by the addition of 2 M aqueous HCl until the pH of the solution reached 3 or 4. A sticky, colorless solid formation was observed. The aqueous layer was extracted with ethyl acetate, and the organic layer was collected, dried, and concentrated to obtain the crude product III, which was used for the next step without any further purification (1.46 g, 85.7% yield, 3.45 mmol).

δ_H (300 MHz, Chloroform-*d*) 10.37 (0 H, s), 8.79 (0 H, s), 6.57 (0 H, s), 4.22 – 3.98 (2 H, m), 2.04 (0 H, s), 1.97 – 1.72 (1 H, m), 1.64 – 1.51 (1 H, m), 1.56 – 1.31 (3 H, m), 1.37 – 1.19 (2 H, m), 1.04 – 0.85 (5 H, m). δ_C (75 MHz, Chloroform-*d*) 164.02, 158.38, 133.76, 132.54, 109.76, 97.65, 73.31, 72.58, 60.55, 39.40, 39.38, 30.59, 30.37, 29.18, 29.15, 24.03, 23.79, 23.06, 23.00, 21.21, 14.35, 14.19, 14.13, 11.27, 11.25.

E

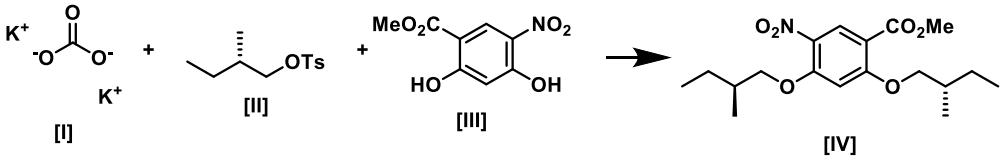


[I]

In a high-pressure tube, I (0.75 mmol, 320 mg) was dissolved in 10 mL THF, and Pd-C (10 wt.%, 32 mg) was added. The tube wall was washed with 15 mL THF, followed by adding 10 mL methanol. To avoid fire, it is important to entirely suspend the Pd-C in THF before introducing methanol to the mixture. The tube was pressurized with hydrogen gas (30 bar) at 35°C for 12 h, upon which complete conversion of I to the amine could be visualized with HPLC analysis. The mixture was passed through celite to remove Pd-C from the product; the organic solvents were evaporated first under a rotary evaporator and then under the Schlenk vacuum to give the crude product, which was used without further purification.

δ_H (300 MHz, Chloroform-*d*) 7.48 (0 H, s), 6.98 (0 H, d, *J* 0.7), 6.45 (0 H, s), 4.07 (1 H, d, *J* 5.4), 3.93 (1 H, d, *J* 5.4), 2.27 (0 H, d, *J* 0.7), 1.80 (1 H, dt, *J* 12.3, 6.1), 1.56 – 1.39 (5 H, m), 1.45 – 1.27 (5 H, m), 0.93 (6 H, dt, *J* 10.6, 7.1). δ_C (75 MHz, DMSO-d_6) 167.24, 151.74, 151.42, 149.99, 139.46, 131.31, 125.18, 115.93, 99.93, 72.34, 70.47, 34.66, 30.70, 30.23, 30.13, 28.81, 28.78, 23.66, 23.56, 22.79, 22.68, 21.32, 14.24, 14.17, 11.28, 11.13.

Intermediate 13



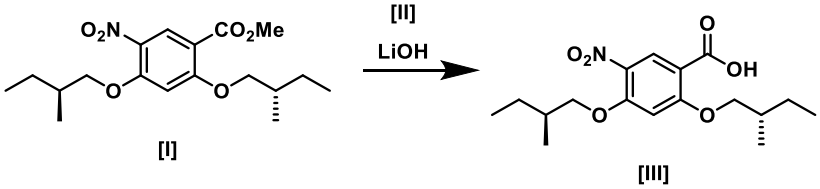
[I] [II] [III] [IV]

It was synthesized according to the previous protocol using I (4.5 equiv., 5.9 g), II[2] (2.5 equiv., 5.7 g), and III (1 equiv., 2 g) to give the product as an orange solid (2.93 g, 87.2% yield).

Column chromatography was first performed at 3% ethyl acetate-hexane, then at 5% ethyl acetate-hexane to obtain the product.

δ_H (300 MHz, Chloroform-*d*) 8.60 (1 H, s), 6.45 (1 H, s), 4.04 – 3.82 (4 H, m), 3.87 (3 H, s), 2.07 – 1.86 (2 H, m), 1.73 – 1.51 (2 H, m), 1.45 – 1.33 (1 H, m), 1.38 – 1.18 (2 H, m), 1.08 (6 H, dd, *J* 6.8, 3.7), 0.96 (7 H, td, *J* 7.5, 2.6).

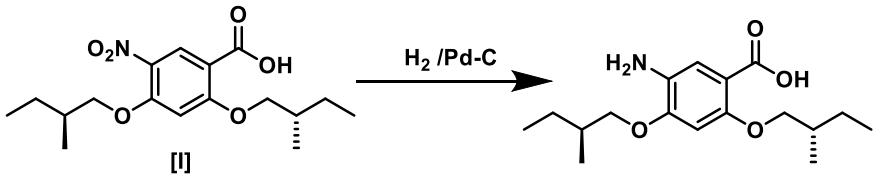
Intermediate 14



III was synthesized according to the same protocol as used for intermediate 2, using I (1 equiv., 1.9 g), and II (3 equiv., 400 mg) to give the product a creamy light-yellow solid (1.73 g, 93.1% yield).

δ_H (400 MHz, Chloroform-*d*) 8.79 (1 H, s), 6.55 (1 H, s), 4.20 – 4.04 (2 H, m), 4.06 – 3.89 (2 H, m), 2.01 (2 H, ddq, *J* 25.8, 12.8, 6.5), 1.61 (2 H, dq, *J* 13.1, 6.5), 1.46 – 1.29 (2 H, m), 1.11 (6 H, dd, *J* 14.5, 6.8), 0.99 (6 H, dt, *J* 15.1, 7.5), 0.85 (1 H, s).

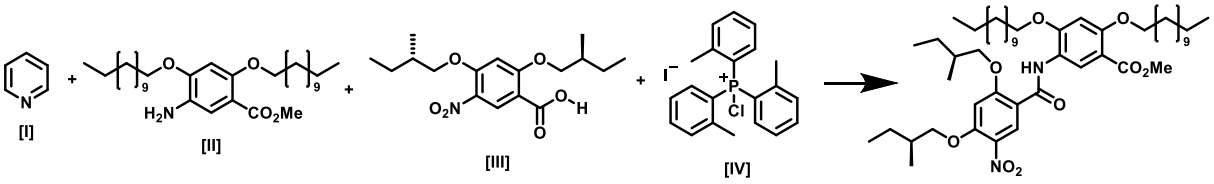
F



F was synthesized according to the previous protocol using I (1 equiv., 230 mg) and Pd-C (23 mg) to give the product a dark solid in quantitative yield.

δ_H (400 MHz, Chloroform-*d*) 10.97 (1 H, s), 7.48 (1 H, s), 6.44 (1 H, s), 4.04 (1 H, dd, *J* 8.8, 5.7), 4.00 – 3.86 (2 H, m), 3.83 (1 H, dd, *J* 8.8, 6.4), 3.67 (2 H, s), 1.96 (2 H, dp, *J* 12.9, 6.5), 1.68 – 1.55 (1 H, m), 1.41 – 1.22 (3 H, m), 1.08 (6 H, t, *J* 6.6), 0.98 (6 H, td, *J* 7.5, 1.4), 0.84 (1 H, s).

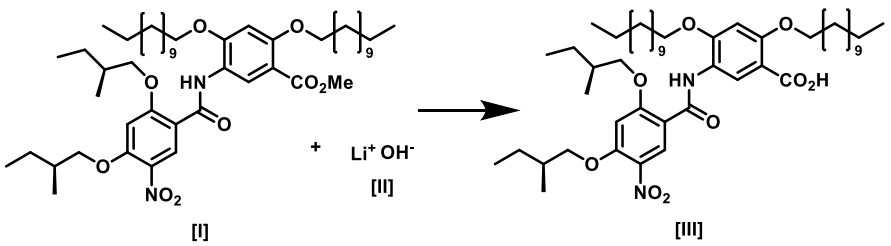
Intermediate 15



It was synthesized according to the previous protocol using I (5 equiv., 0.17 mL), II (1 equiv., 225 mg), III (1.1 equiv., 162 mg), and IV (1.5 equiv., 303 mg) to give the product as a yellow solid in quantitative yield after precipitation from methanol (349 mg, 96% yield).

δ_H (300 MHz, Chloroform-*d*) 9.49 (1 H, s), 8.90 (2 H, d, *J* 11.8), 6.52 (2 H, d, *J* 7.2), 4.21 – 3.98 (6 H, m), 4.03 – 3.82 (6 H, m), 2.11 – 1.76 (6 H, m), 1.71 – 1.20 (41 H, m), 1.07 (6 H, dd, *J* 11.5, 6.7), 1.03 – 0.82 (13 H, m). δ_C (75 MHz, Chloroform-*d*) 165.82, 161.20, 160.96, 157.37, 156.84, 131.53, 125.57, 120.58, 114.96, 97.88, 75.46, 74.70, 69.21, 51.85, 34.82, 34.50, 32.08, 32.04, 29.79, 29.52, 29.18, 26.24, 26.11, 26.02, 25.95, 22.84, 16.77, 16.61, 14.27, 11.50, 11.36.

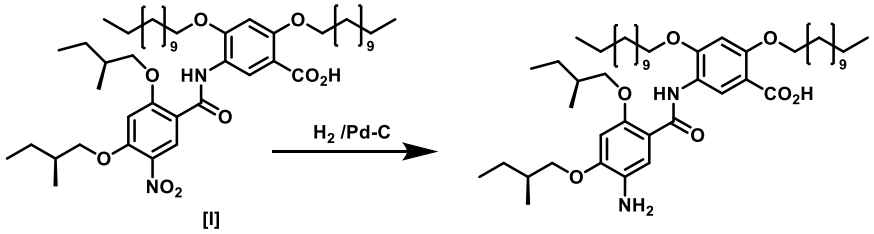
Intermediate 16



It was synthesized according to the same protocol as used for intermediate 2, using I (1 equiv., 300 mg) and II (3 equiv., 26 mg) to give the product as a light-yellow solid (255 mg, 86.4% yield).

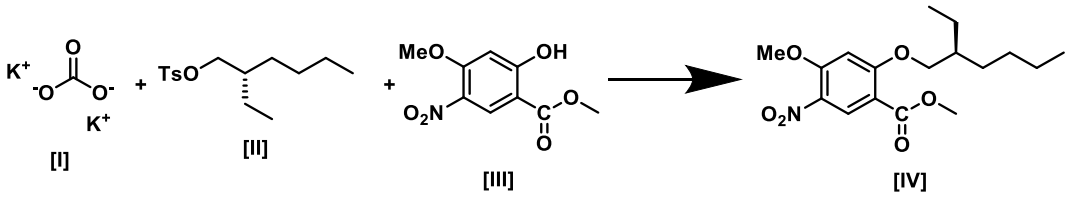
δ_H (300 MHz, Chloroform-*d*) 10.66 (1 H, s), 9.39 (1 H, s), 8.93 (1 H, s), 8.84 (1 H, s), 6.51 (2 H, d, *J* 1.9), 4.16 (5 H, dt, *J* 21.9, 6.8), 4.08 – 3.86 (3 H, m), 2.11 – 1.87 (3 H, m), 1.91 – 1.77 (3 H, m), 1.52 – 1.19 (27 H, m), 1.07 (6 H, dd, *J* 8.2, 6.7), 1.03 – 0.82 (11 H, m), 0.07 (1 H, s).

G



Monomer G was synthesized according to the same protocol as used for A, using I (1 equiv., 190 mg) and Pd-C (20 mg) to give the product as a dark solid in quantitative yield.

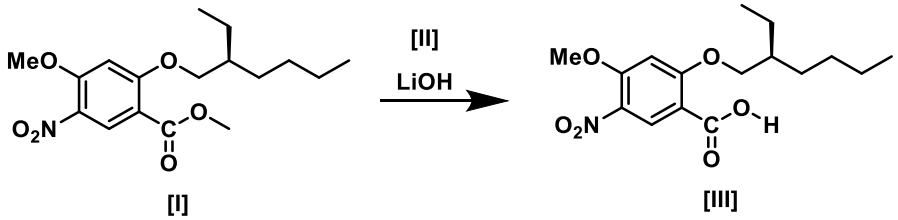
Intermediate 17



IV was synthesized according to the same protocol as used for intermediate 1, using I (2.5 equiv., 285 mg), II (1.3 equiv., 303 mg), and III (1 equiv., 186 mg) to give the product as a creamy solid. Unfortunately, product IV could not be isolated in a pure manner (unreacted III was also there) after column chromatography, but the desired pure compound was obtained in the next step.

δ_H (400 MHz, Chloroform-*d*) 11.42 (0 H, s), 8.60 (1 H, d, *J* 19.4), 6.58 (0 H, s), 6.50 (1 H, s), 4.06 – 3.95 (8 H, m), 3.88 (3 H, s), 3.55 (1 H, s), 2.90 (0 H, s), 1.82 (1 H, p, *J* 5.9), 1.66 – 1.50 (1 H, m), 1.48 (1 H, dd, *J* 15.2, 8.1), 1.42 – 1.23 (4 H, m), 1.02 – 0.81 (10 H, m).

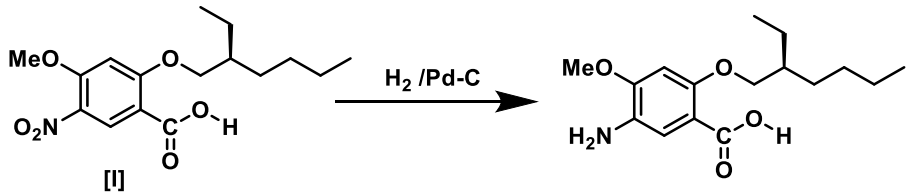
Intermediate 18



III was synthesized according to the previous protocol using I (1 equiv., 134 mg) and II (4 equiv., 40 mg) to give the product creamy solid (121 mg, 94.4% yield).

δ_H (400 MHz, Chloroform-*d*) 8.80 (1 H, s), 6.59 (1 H, s), 4.19 (2 H, d, *J* 5.4), 4.06 (3 H, s), 1.88 (1 H, h, *J* 6.0), 1.62 – 1.41 (3 H, m), 1.40 – 1.28 (5 H, m), 1.31 – 1.22 (2 H, m), 1.03 – 0.83 (7 H, m).

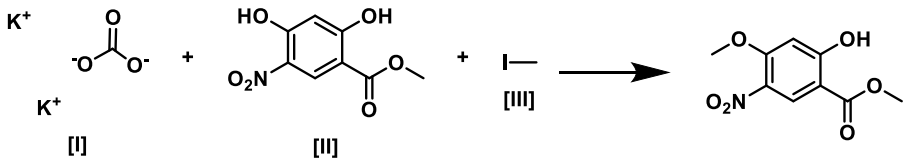
H



H was synthesized according to the previous protocol using I (1 equiv., 120 mg) and Pd-C (15 mg) to give the product as a dark solid in quantitative yield.

δ_H (400 MHz, Chloroform-*d*) 10.92 (1 H, s), 7.48 (1 H, s), 6.98 (1 H, s), 6.47 (1 H, s), 4.08 (2 H, d, *J* 5.4), 3.93 (3 H, s), 3.92 (0 H, d, *J* 4.8), 1.81 (1 H, p, *J* 6.0), 1.61 – 1.40 (2 H, m), 1.43 (6 H, s), 1.38 – 1.21 (7 H, m), 1.02 – 0.81 (8 H, m).

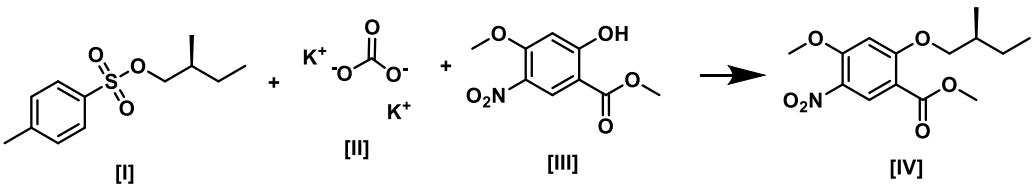
Intermediate 19



Intermediate 19 was synthesized according to the same protocol (except here the heating temperature was 25°C for 2 days) as used for intermediate 1, using I (1.5 equiv., 4.8 g), II (1 equiv., 5 g), and III (1.2 equiv., 1.76 mL). Column chromatography first at 5% to 8% ethyl acetate-hexane to remove unreacted II, then at 10%-15% to obtain the product as a light yellow solid (2.53 g, 47.4% yield, 11.1 mmol).

δ_H (300 MHz, Chloroform-*d*) 11.39 (1 H, s), 8.53 (1 H, s), 6.55 (1 H, s), 3.97 (7 H, d, *J* 3.9), 1.39 – 1.20 (1 H, m).

Intermediate 20

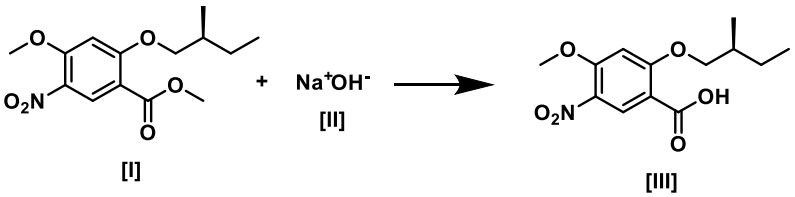


IV was synthesized according to the previous protocol (except here the heating temperature was 115°C for 2 days) using I (1.2 equiv., 1.9 g), II (2 equiv., 1.8 g), and III (1 equiv., 1.5 g).

Column chromatography first at 10% to 15% ethyl acetate-hexanes to remove unreacted III (200 mg), then at 20% ethyl acetate-hexanes to obtain the product as a colorless solid (1.0 g, 51% yield, 3.36 mmol).

δ_H (300 MHz, Chloroform-*d*) 8.63 (1 H, s), 6.49 (1 H, s), 4.03 (3 H, s), 4.01 – 3.84 (2 H, m), 3.88 (3 H, s), 1.97 (1 H, dp, *J* 13.0, 6.4), 1.63 (1 H, ddd, *J* 13.3, 7.6, 5.7), 1.46 – 1.22 (1 H, m), 1.10 (3 H, d, *J* 6.7), 0.98 (3 H, t, *J* 7.4). δ_C (75 MHz, Chloroform-*d*) 164.31, 158.28, 131.71, 112.04, 97.11, 74.43, 56.87, 52.22, 34.87, 26.05, 16.63, 11.49.

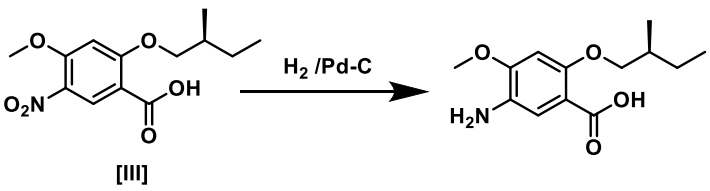
Intermediate 21



It was synthesized according to the previous protocol using I (1 equiv., 900 mg) and II (3 equiv., 365 mg) to give the product a white solid (798 mg, 93.1% yield).

δ_H (300 MHz, Chloroform-d) 8.79 (1 H, s), 6.58 (1 H, s), 4.21 – 4.04 (2 H, m), 4.05 (3 H, s), 2.13 – 1.96 (1 H, m), 1.60 (1 H, dqd, J 13.0, 7.5, 5.5), 1.49 – 1.28 (1 H, m), 1.25 (0 H, s), 1.12 (3 H, d, J 6.8), 1.01 (3 H, t, J 7.4). δ_C (75 MHz, Chloroform-*d*) 164.09, 162.48, 158.60, 132.68, 110.27, 97.21, 75.74, 57.15, 34.67, 26.14, 16.69, 11.39.

I

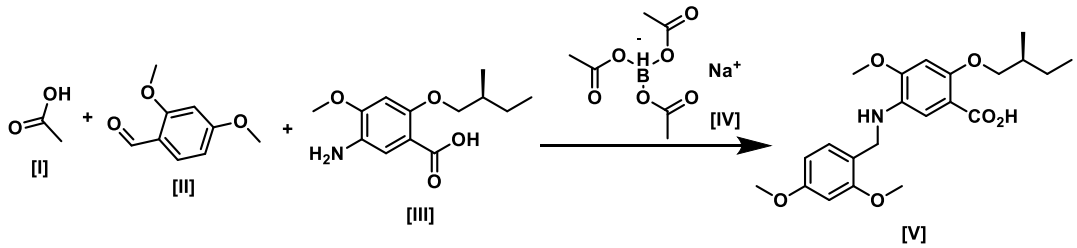


Monomer I was synthesized according to the previous protocol using I (600 mg) and Pd-C (60 mg) to obtain the product as a grey solid.

δ_H (300 MHz, DMSO-d_6) 7.06 (1 H, s), 6.58 (1 H, s), 3.95 – 3.76 (6 H, m), 1.76 (3 H, td, *J* 6.8, 3.5), 1.52 (1 H, d, *J* 6.9), 1.38 – 1.12 (3 H, m), 1.10 – 0.76 (7 H, m). δ_C (75 MHz, DMSO-d_6) 166.88, 151.28, 150.49, 131.09, 124.93, 115.72, 112.17, 98.97, 74.57, 67.05, 55.67, 54.92, 48.63, 34.47, 34.41, 30.45, 25.54, 25.16, 16.45, 11.24.

HR-MS (ESI) calculated for $C_{13}H_{20}O_4N[M+H]^+$: 254.13868, Found: 254.13844.

J

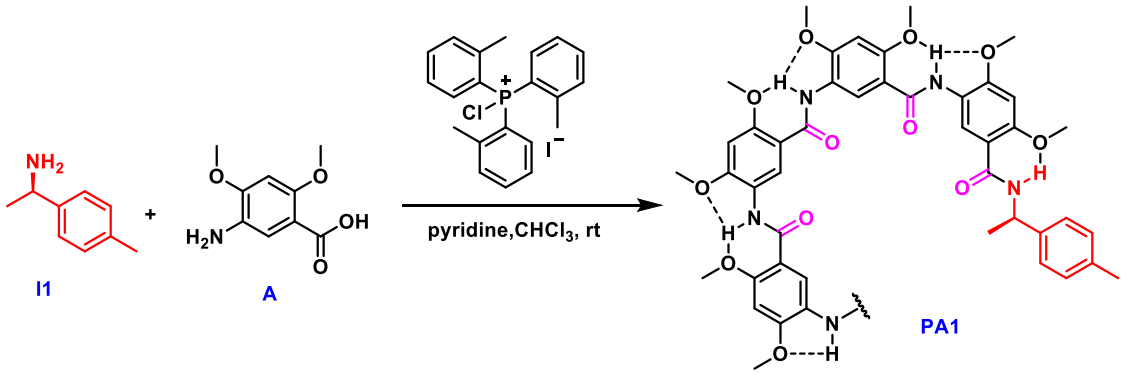


In a round-bottom flask, II (1 equiv., 0.79 mmol, 131 mg) and III (1 equiv., 0.79 mmol, 200 mg) were dissolved in 10 mL dry DCM, followed by the addition of acetic acid (5 equiv., 3.95 mmol, 0.23 mL). The mixture was stirred at room temperature for 1h, after which a reddish coloration was observed. Then, the mixture was cooled to 0°C, and IV (2.2 equiv., 1.73 mmol, 368 mg) was added as a solid pinch-wise. Then, the mixture was stirred overnight at room temperature. The next day, the mixture was quenched with water and worked up with DCM and brine. The organic layer was collected, dried, concentrated, and further purified by column chromatography (20% to 30% ethyl acetate-hexane) to obtain the product as a red solid (291 mg, 91.3% yield, 0.72 mmol).

δ_H (300 MHz, Chloroform-*d*) 11.07 (1 H, s), 7.44 (1 H, s), 7.20 (1 H, d, *J* 8.2), 6.50 – 6.38 (3 H, m), 4.28 (2 H, s), 4.12 – 3.91 (2 H, m), 3.96 – 3.76 (9 H, m), 2.08 – 1.87 (1 H, m), 1.67 – 1.46 (1 H, m), 1.44 – 1.20 (1 H, m), 1.07 (3 H, d, *J* 6.8), 0.98 (3 H, t, *J* 7.4). δ_C (75 MHz, Chloroform-*d*) 166.14, 160.42, 158.74, 152.23, 150.91, 133.80, 130.14, 119.62, 113.13, 109.96, 104.05, 98.78, 96.17, 76.05, 55.94, 55.54, 55.52, 43.03, 34.89, 26.23, 16.77, 11.40.

HR-MS (ESI) calculated for $C_{22}H_{28}O_6N[M-H]^-$: 402.19221, Found: 402.19190.

Polymerization



In a Schlenk flask, the PHOS reagent (48 equiv., 710 µmol, 331 mg) was weighed inside the glovebox and then taken outside and kept under Ar with an Ar gas balloon. Dry chloroform (2.3 mL) was added to the flask to make the concentration of the reagent 0.3 M. Then to it, pyridine (80 equiv., 1.18 mmol, 0.1 mL) was added, followed by a solution of I1 (1 equiv., 14.8 µmol, 2 mg dissolved in 0.1 mL dry chloroform). In a vial, monomer A (16 equiv., 237 µmol, 47 mg) dissolved in a mixture of 0.1 mL pyridine (80 equiv. more so total of 160 equiv. of pyridine was used for the polymerization), 0.3 mL N, N-dimethylacetamide, and 0.8 mL $CHCl_3$ (overall monomer concentration being 0.2 M). The turbid solution was gently heated, upon which a clear solution was observed, which was then added slowly to the Schlenk flask using a syringe pump (0.07 mL/h). After the end of the addition, TLC analysis was performed to confirm the full consumption of the monomer. Unfortunately, a turbid solution was observed, which indicated limited solubility of the polymer PA1. The resulting solution was concentrated under reduced pressure and then triturated with methanol to obtain a reddish precipitate. The precipitate was soluble in pure DMF at a concentration of 2 mg/mL but, possibly due to aggregation, was impossible to pass through a 0.45 µm syringe filter.

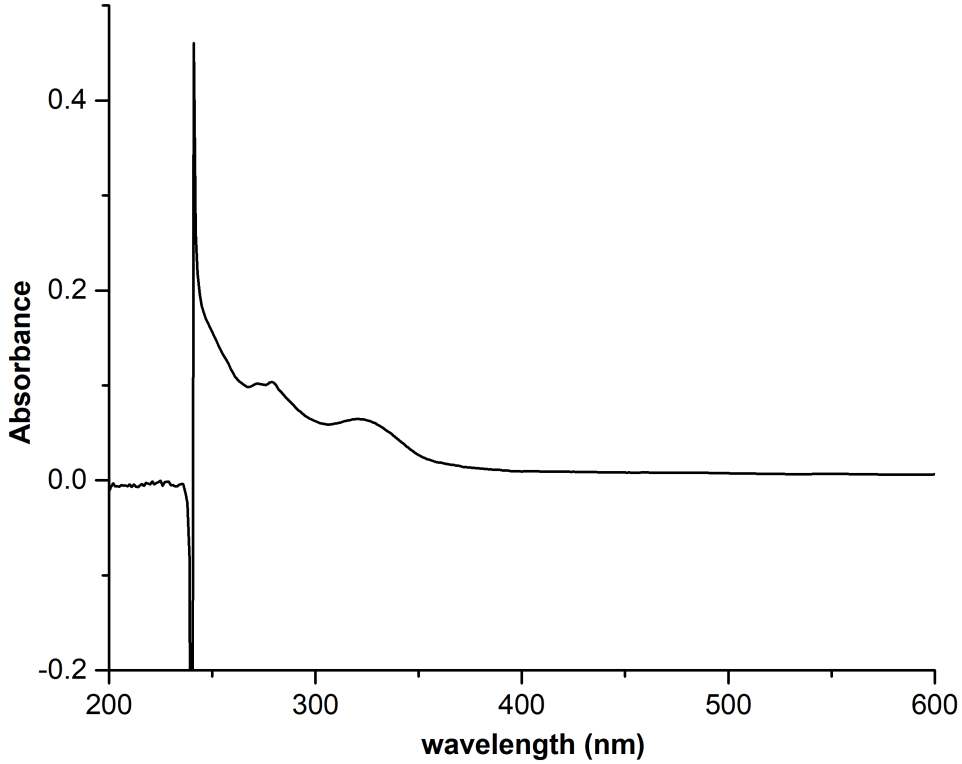
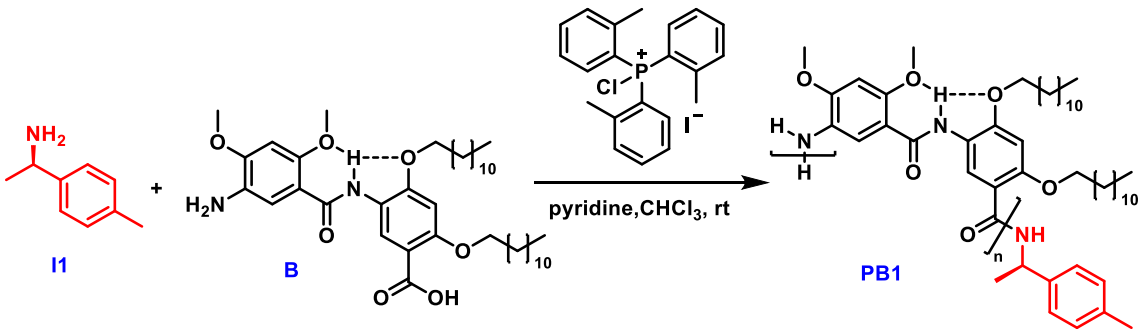


Fig. S1: UV-VIS (20°C, 0.01 mg/mL) spectrum of PA1 in $CHCl_3$.



PB1 was synthesized according to the similar protocol as described for PA1 using the following stoichiometries: I1 (1 equiv., 1 mg), B (8 equiv., 41 mg), the PHOS reagent (24 equiv., 83 mg), pyridine (80 equiv., 0.05 mL) except here DMAc was not needed to solubilize the monomer rather first 50% of the pyridine was added to the monomer and then the monomer was diluted with required amount of chloroform (0.45 mL, 0.13 M w.r.t B) followed by gentle warming that made the monomer fully soluble. PB1 was purified via simple trituration with methanol, which produced a yellow polymer that showed very high solubility in chloroform.

$M_{n,theo.}$= 5.3 kDa; $M_{n,SEC\ (DMF)}$ = 4.8 kDa, Đ= 1.09.

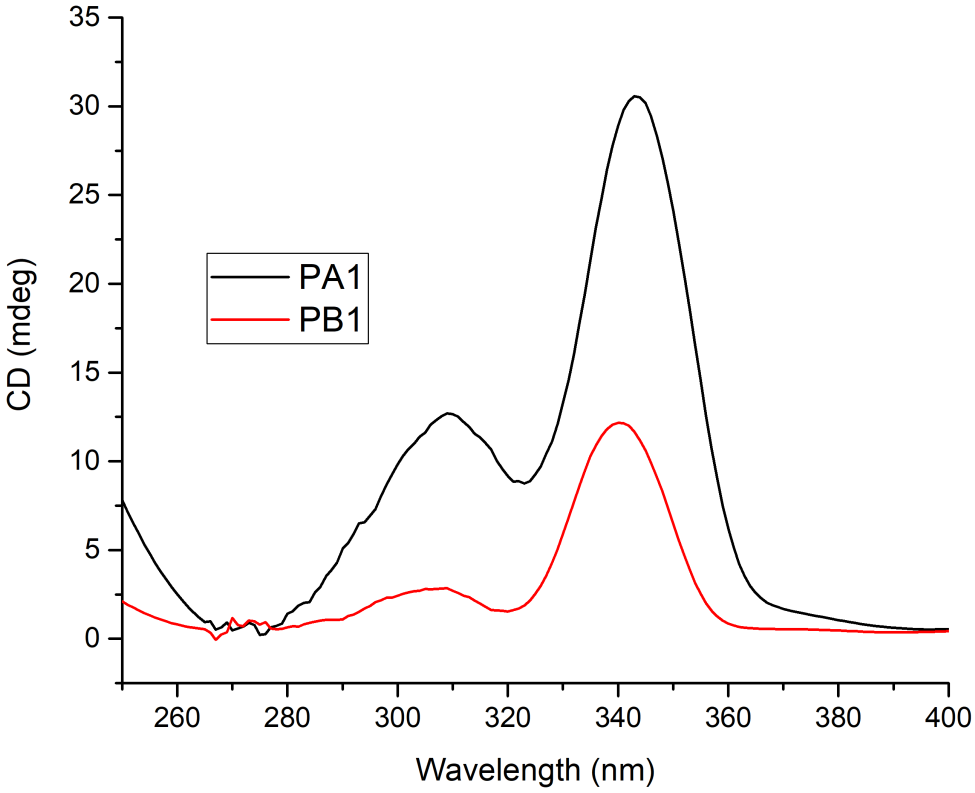


Fig. S2: Comparison of CD (20°C, 0.1 mg/mL) spectra of PA1 and PB1 in DMF.

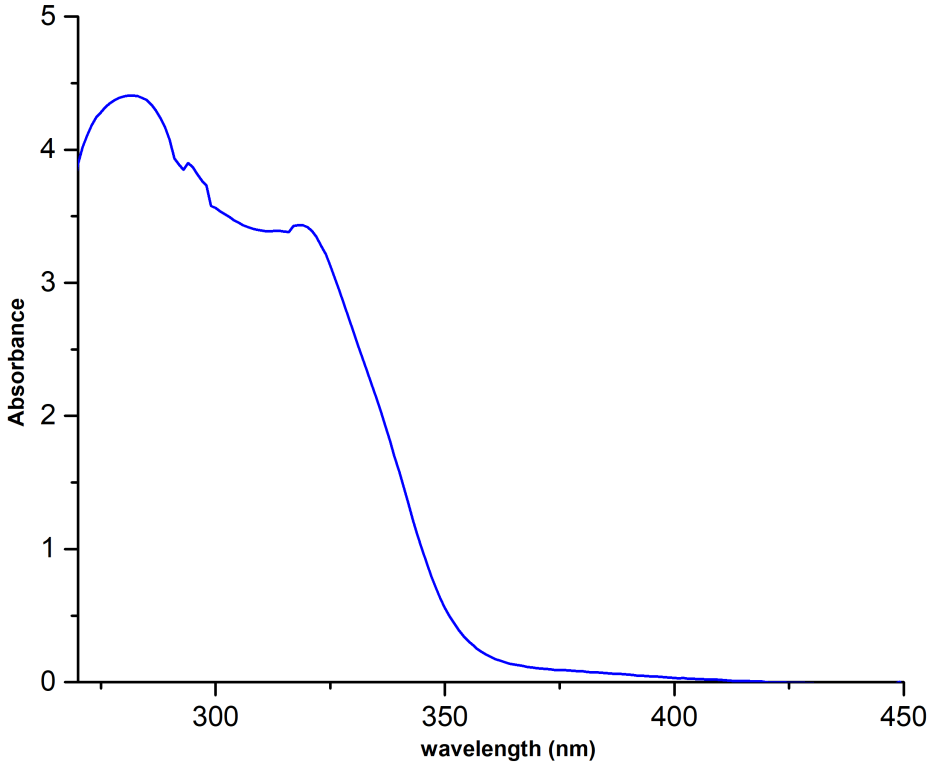


Fig. S3: UV-VIS (20°C, 0.1 mg/mL) spectrum of PB1 in $CHCl_3$.

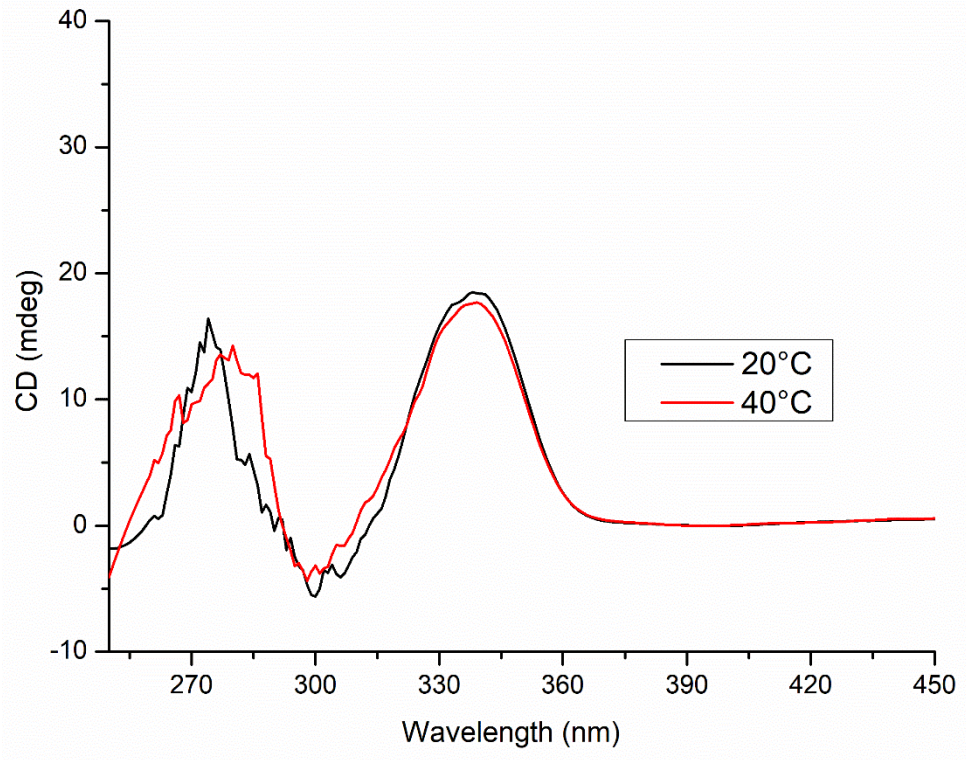


Fig. S4: CD (0.1 mg/mL) spectrum of PB1 in $CHCl_3$ at different temperatures.

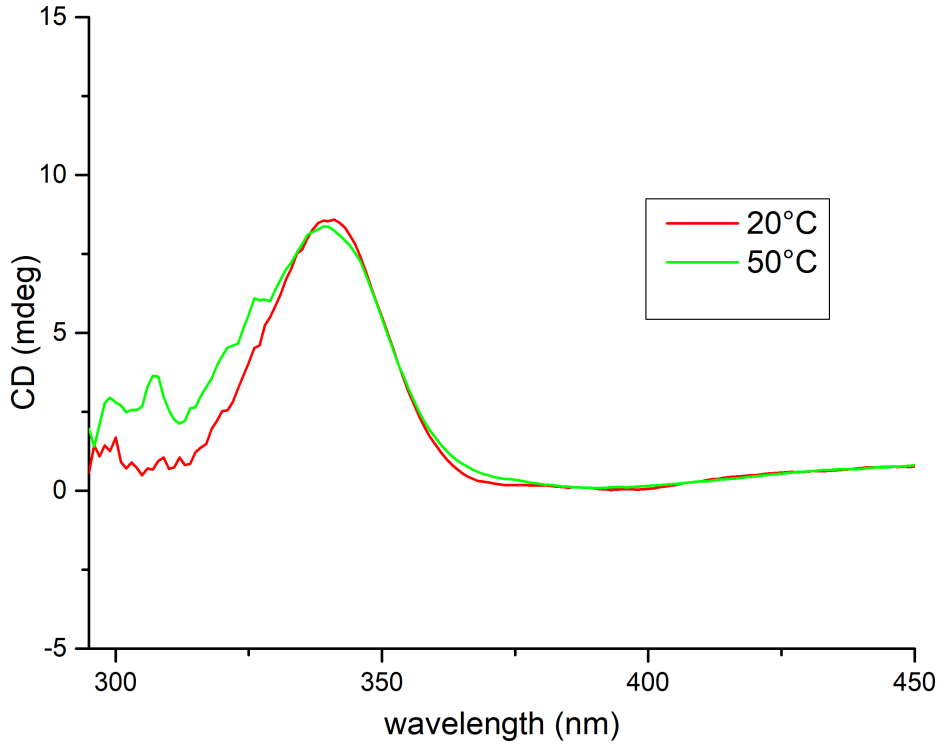


Fig. S5: CD (0.1 mg/mL) spectrum of PB1 in $CHCl_3$ + MeOH at different temperatures.

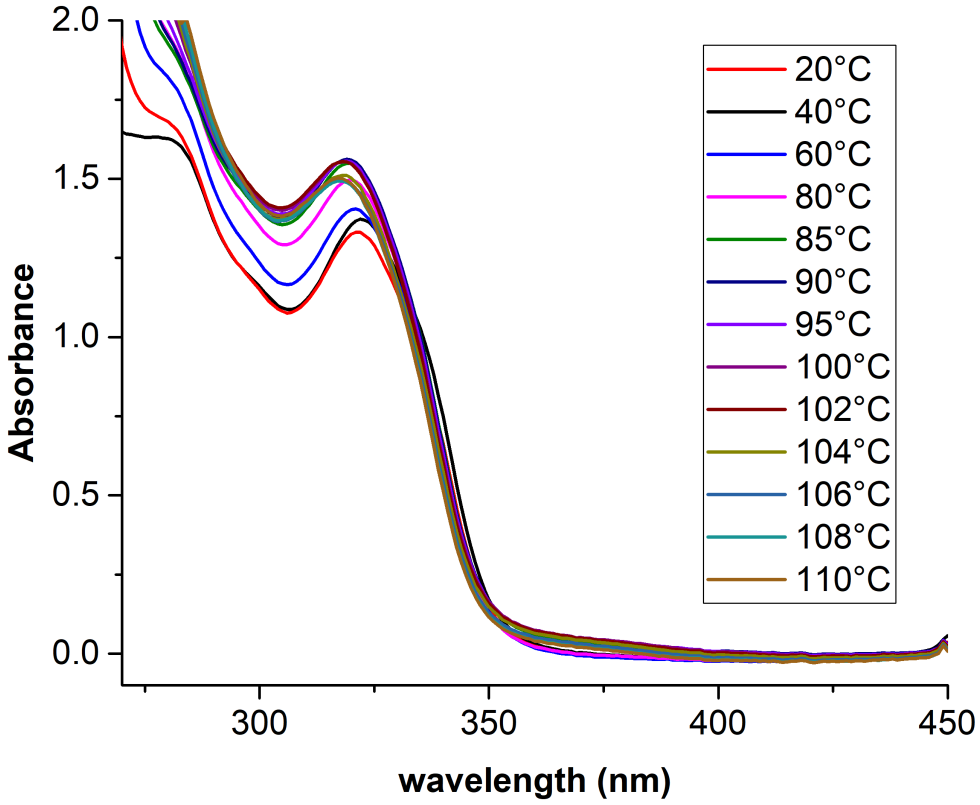


Fig. S6: UV-VIS (20°C, 0.05 mg/mL) spectrum of PB1 in DMF at different temperatures.

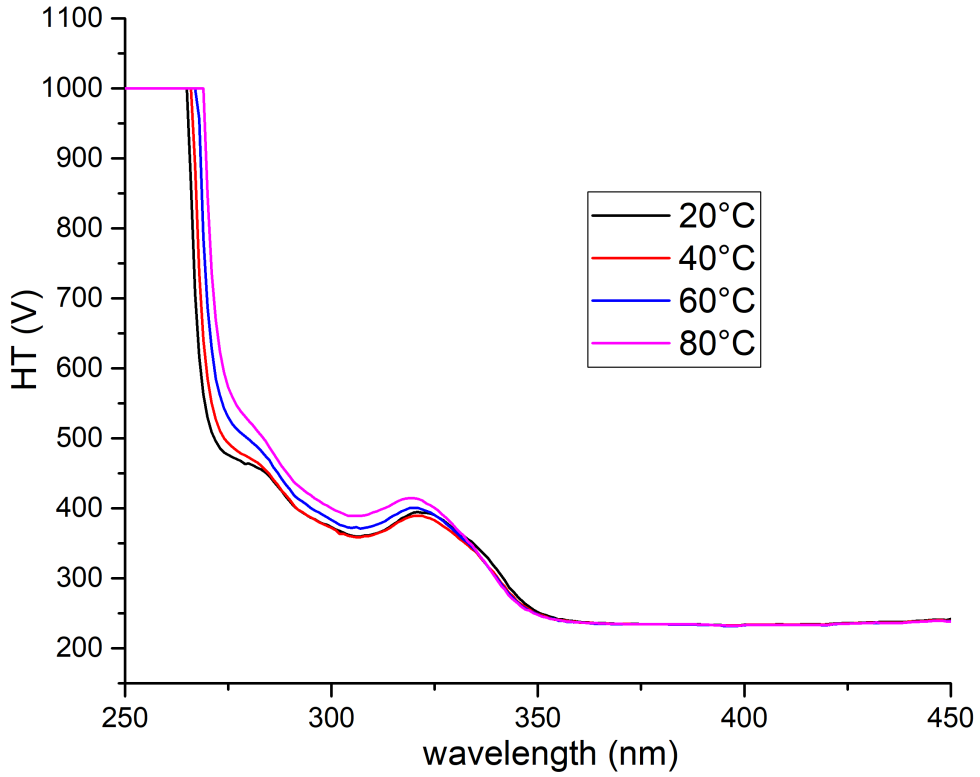
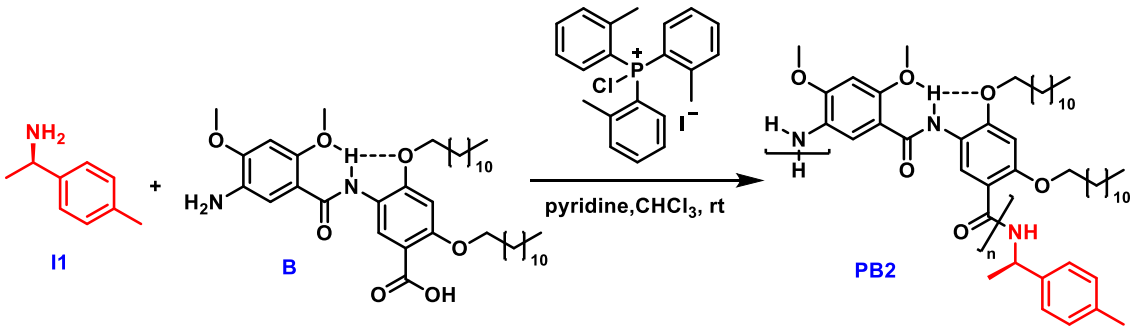


Fig. S7: High Tension Voltage vs. wavelength (20°C, 0.05 mg/mL) spectrum of PB1 in DMF at different temperatures.



PB2 was synthesized according to a similar protocol as described for PB1 using the following stoichiometries: I1 (1 equiv., 0.5 mg), B (16 equiv., 41 mg), the PHOS reagent (48 equiv., 83 mg), and pyridine (160 equiv., 0.05 mL). A polymer could be precipitated from methanol, which was not soluble in DMF.

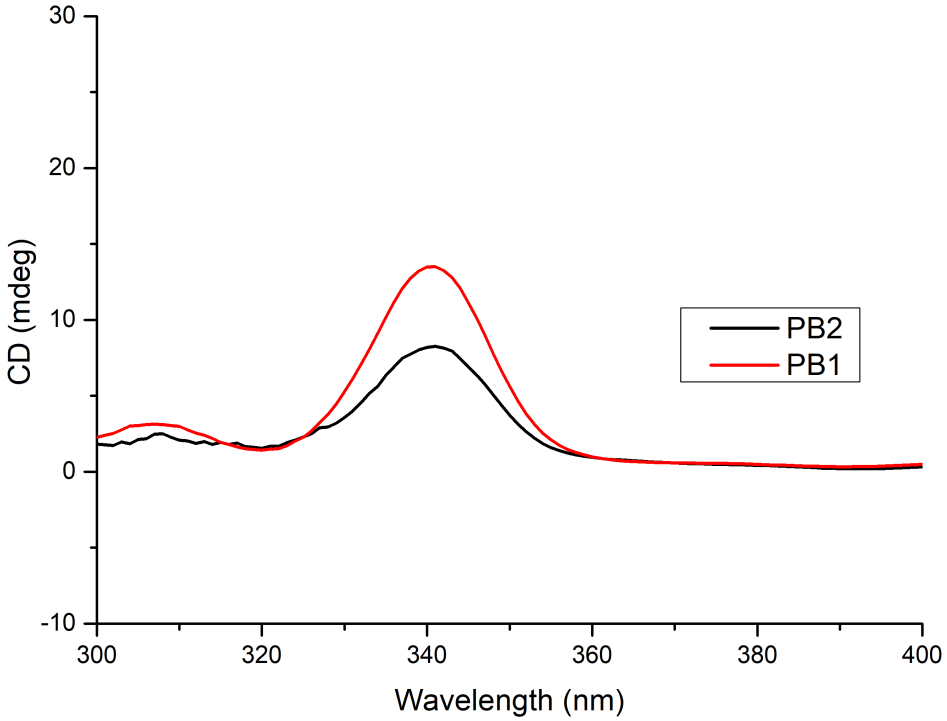
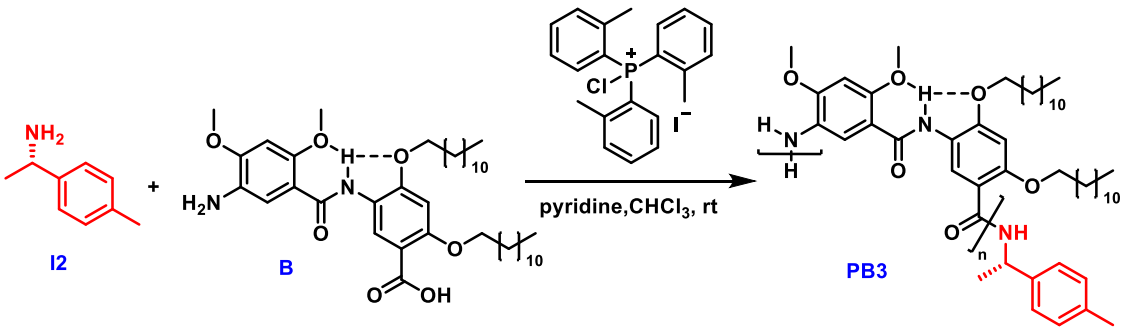


Fig. S8: Comparison of CD (20°C, 0.1 mg/mL) spectra of PB1 and PB2 in DMF.



PB3 was synthesized according to a similar protocol as described for PB1 using the following stoichiometries: I2 (1 equiv., 1 mg), B (8 equiv., 41 mg), the PHOS reagent (24 equiv., 83 mg), and pyridine (80 equiv., 0.05 mL). A polymer could be precipitated from methanol, which was not soluble in DMF.

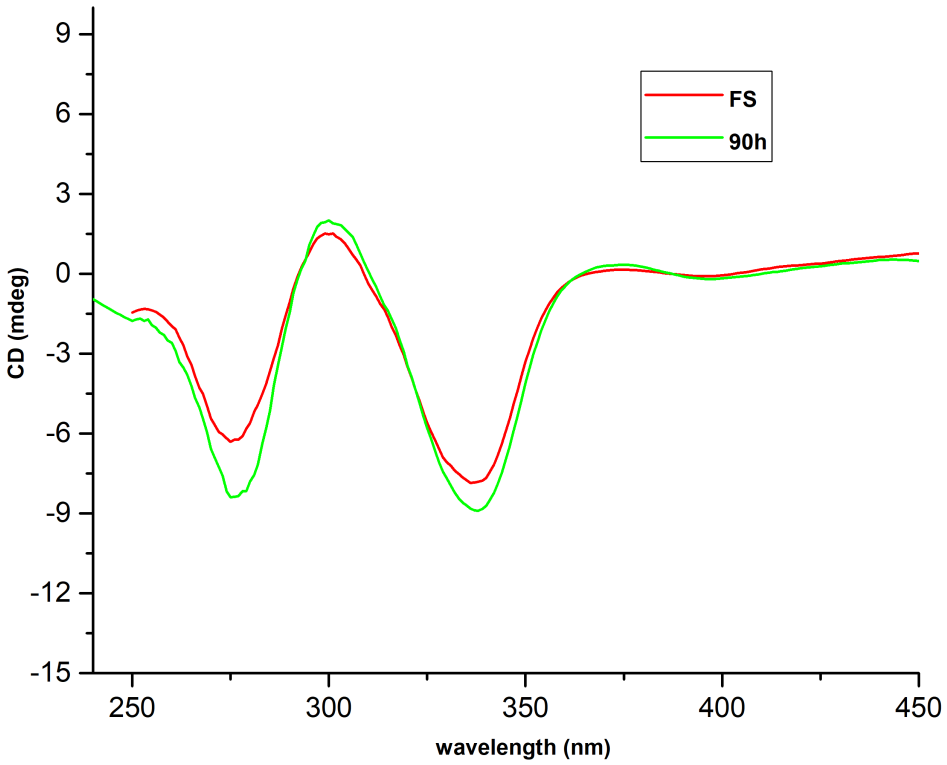


Fig. S9: CD (20°C, 0.1 mg/mL) spectra of PB3 in $CHCl_3$ at different time intervals.

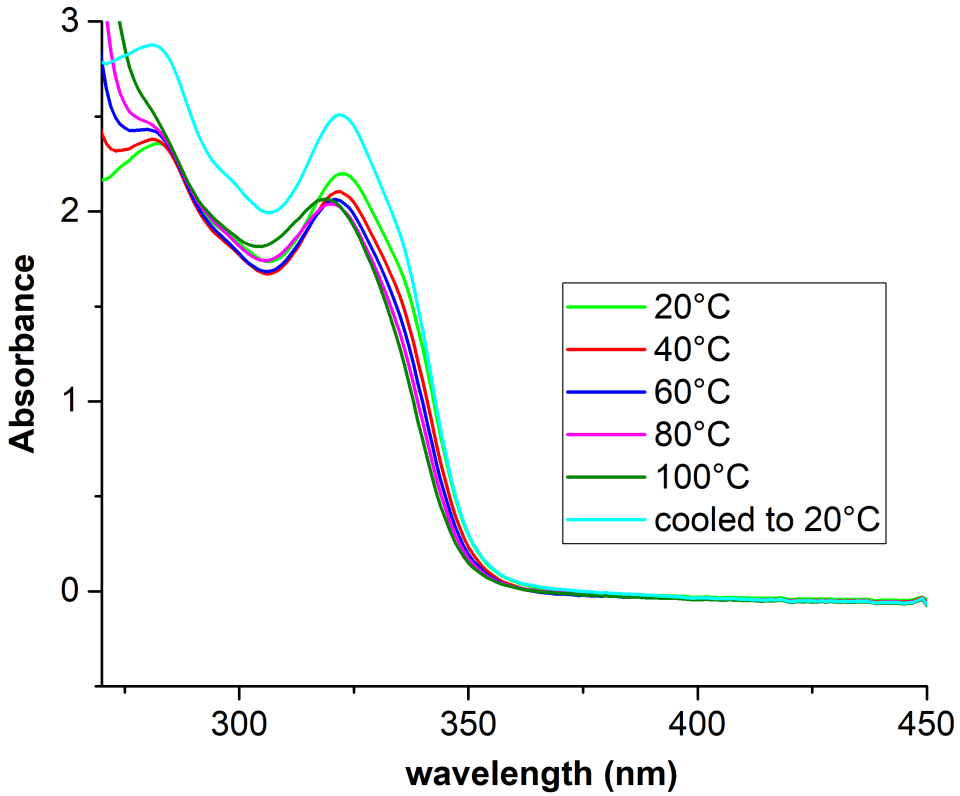


Fig. S10: UV-VIS (20°C, 0.05 mg/mL) spectrum of PB3 in DMF at different temperatures.

MD simulations

All simulations were carried out using *Amber24 and AmberTools25*[3,4,5] with a three-stage protocol consisting of (i) vacuum energy minimization, (ii) short equilibration molecular dynamics (MD) using a Born implicit solvent model, and (iii) long-timescale production MD under the same vacuum GB conditions.

1. Vacuum Energy Minimization. The system was first subjected to energy minimization in the gas phase to remove unfavorable steric contacts and relax local geometries. A total of 5000 minimization steps were performed, using 2500 steps of steepest descent followed by 2500 steps of conjugate gradient minimization. No periodic boundary conditions were applied (*ntb*=0), and all non-bonded interactions were computed without a cutoff (*cut*=999.9 Å). The implicit solvent model was disabled (*igb*=0), corresponding to a true vacuum environment.

2. Short Vacuum MD Equilibration (GB Model). Following minimization, the structure was equilibrated by a short 1 ns vacuum MD simulation using the Generalized Born (GB) implicit solvent model (*igb*=1). Temperature control at 300 K was achieved using a Langevin thermostat (*ntt*=3) with a collision frequency of 1 ps^{-1}. A 1 fs timestep was used, and coordinates and

energies were recorded every 100 steps. As in the minimization stage, the system was simulated without a cutoff (*cut*=999 Å), ensuring full long-range electrostatics in vacuum.

3. Production Vacuum MD (100 ns, GB Model). Equilibration was followed by a 100 ns production MD simulation in vacuum using the same GB implicit solvent (igb=1, Hawkins–Cramer–Truhlar (HCT) Model) and Langevin thermostat conditions. A 1 fs timestep was used for a total of 100,000,000 MD steps. Temperature was maintained at 300 K, and random seeds were regenerated automatically (*ig* = –1). Energies and coordinates were written every 1000 steps (1 ps). All simulations were performed without periodic boundaries and with an effectively infinite non-bonded cutoff (*cut* = 999 Å).

Helix diameter, pitch and length were averaged over the last 50ns of the production run.

Hawkins–Cramer–Truhlar Model was chosen as it allows for a rapid estimation of helical geometries where the sterics of the helical side chain dominate the folding geometry rather than side-chain explicit solvent interactions.

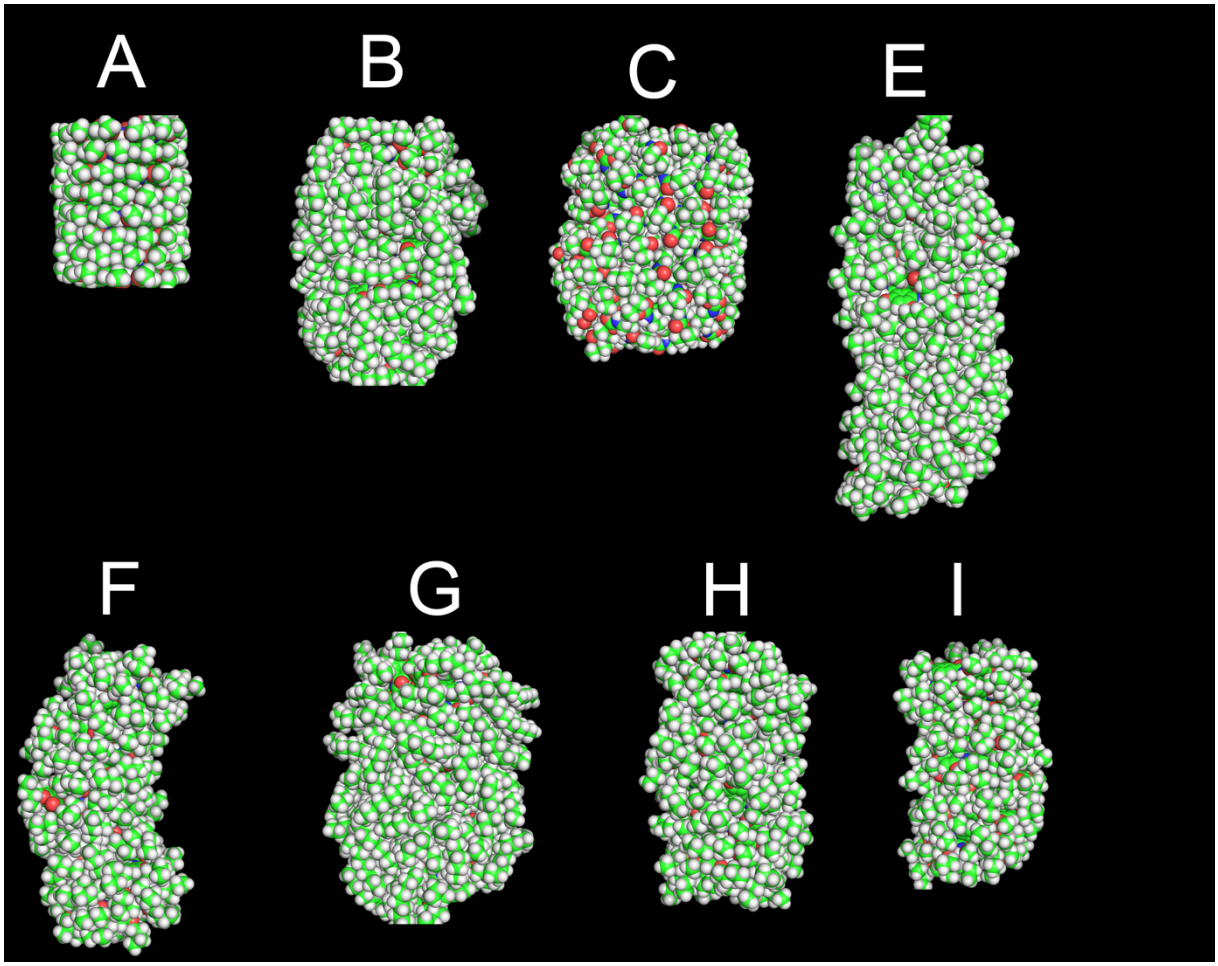
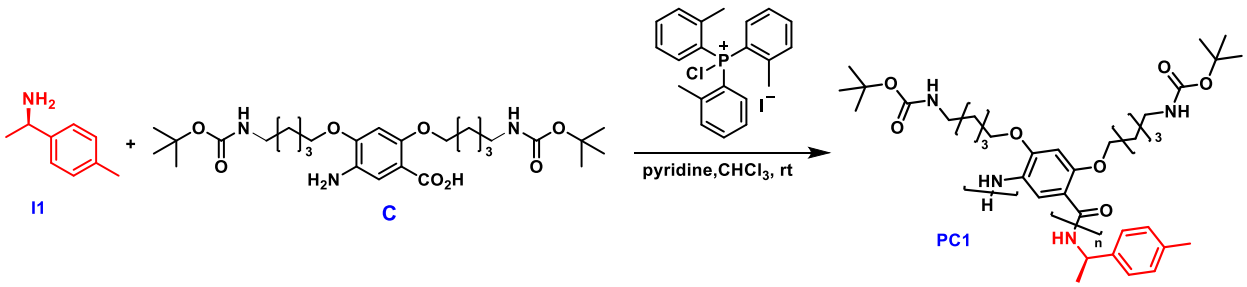


Fig. S11: Molecular dynamics simulation snapshots of helices simulated for polymers of monomers A-I. A degree of polymerization DP=60 was used for monomers A, C, E, F, H, I. A degree of polymerization DP=30 was used for monomers B, G. The image was taken from the last frame of the 100ns production run.

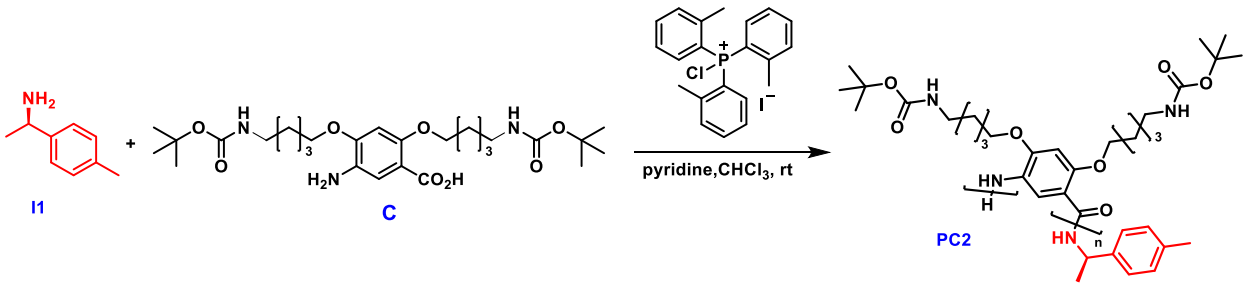
Table S1: Comparison of geometric descriptors for helices consisting of 60 phenyl units (DP=30 or 60) simulated for monomers A-I.

polymer from monomer	DP	pitch (Å)	phenyl rings per turn	helix length (Å)	# of turns
A	60	3.45	7.26	29.8	8.5
B	30	5.35	6.82	42.1	9.1
C	60	4.14	6.21	38.4	9.8
E	60	6.43	6.30	64.1	9.6
F	60	5.80	6.50	51.2	9.6
G	30	5.27	6.68	45.5	9.2
H	60	5.10	6.64	44.6	9.3
I	60	4.90	6.61	40.1	8.9



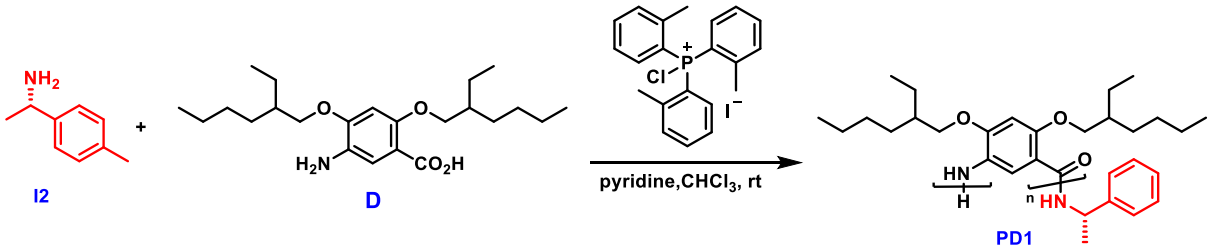
PC1 was synthesized according to the similar protocol as described for PB1 using the following stoichiometries: I1 (1 equiv., 1.4 mg), C (20 equiv., 112 mg), the PHOS reagent (60 equiv., 290 mg), pyridine (200 equiv., 0.05 mL) except C was fully solubilized in pure $CHCl_3$ and the resulting polymer was soluble in CHCl3 as well; therefore the polymer was purified via recycling size exclusion chromatography to obtain PC1 as a red solid.

$M_{n,\,SEC\,(DMF)}$ = 11 kDa, Đ= 1.08.



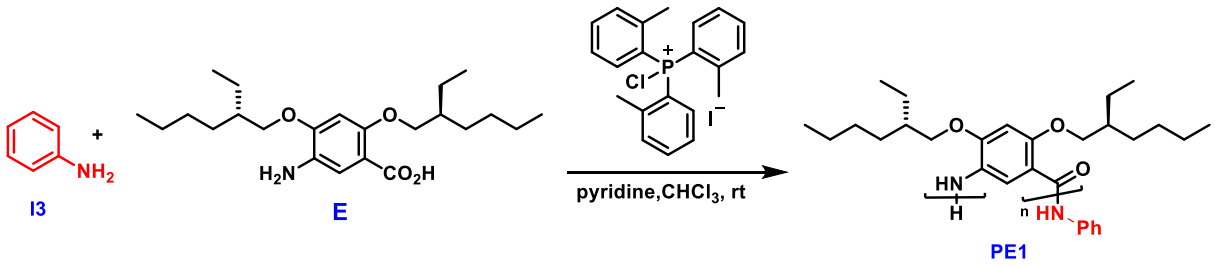
PC2 was synthesized according to the similar protocol as described for PC1 using the following stoichiometries: I1 (1 equiv., 0.3 mg), C (50 equiv., 60 mg), the PHOS reagent (150 equiv., 155 mg), pyridine (500 equiv., 0.09 mL). PC2 was also purified by RGPC.

$M_{n,\,SEC\,(DMF)}$ = 25.5 kDa, Đ= 1.09



PD1 was synthesized according to a similar protocol as described for PC1 using the following stoichiometries: I2 (1 equiv., 1.0 mg), D (25 equiv., 73 mg), the PHOS reagent (75 equiv., 259 mg), pyridine (250 equiv., 0.15 mL). PD1 was also purified by RGPC.

$M_{n,\,SEC\,(DMF)}$ = 14.1 kDa, Đ= 1.06

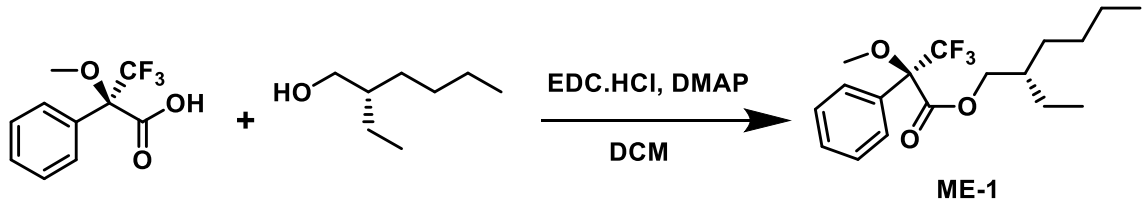


PE1 was synthesized according to a similar protocol as described for PC1 using the following stoichiometries: I3 (1 equiv., 1.0 mg), E (25 equiv., 106 mg), the PHOS reagent (60 equiv., 301 mg), pyridine (200 equiv., 0.18 mL). PE1 was also purified by RGPC.

$M_{n,\,SEC\,(DMF)}$ = 8.2 kDa, Đ= 1.09

Synthesis of Mosher esters (ME)

To proof that the side chain chiral (S)-2-ethylhexan-1-ol synthesized from the described procedure was actually enantiomerically pure, we synthesized the corresponding Mosher ester (ME-1) from it as shown below. A comparison with the Mosher ester (ME-2) synthesized from the commercially available racemic 2-ethylhexan-1-ol clearly indicated the enantiomeric purity of the synthesized side group in this study.



ME-1

In a vial, (S)-2-ethylhexan-1-ol (0.95 equiv., 37 mg), (R)-(+)-α-Methoxy-α-trifluoromethylphenylacetic acid (Mosher's acid) (1 equiv., 70 mg), DMAP (0.2 equiv., 7.3 mg) were dissolved in 5 mL of dry DCM and cooled in an ice-bath. To it, EDC.HCl (1.5 equiv., 86 mg) was added as a solid and the solution was stirred at room temperature overnight. TLC analysis (2% EA-Hex) showed formation of a non-polar spot. The solution was directly charged in a small silica-gel column and flushed with pure DCM to obtain the product ME-1 as a colorless liquid (65 mg, 63% yield).

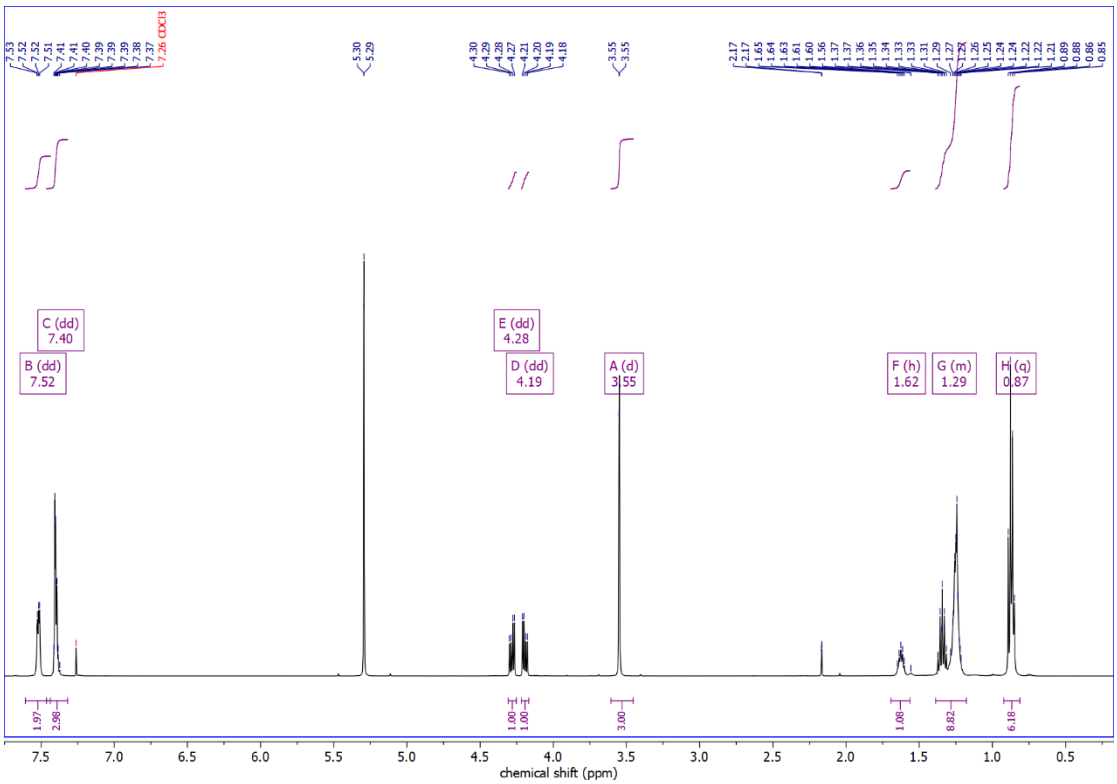


Fig. S12: ^{1}H NMR ($CDCl_3$, 500 MHz) of ME-1.

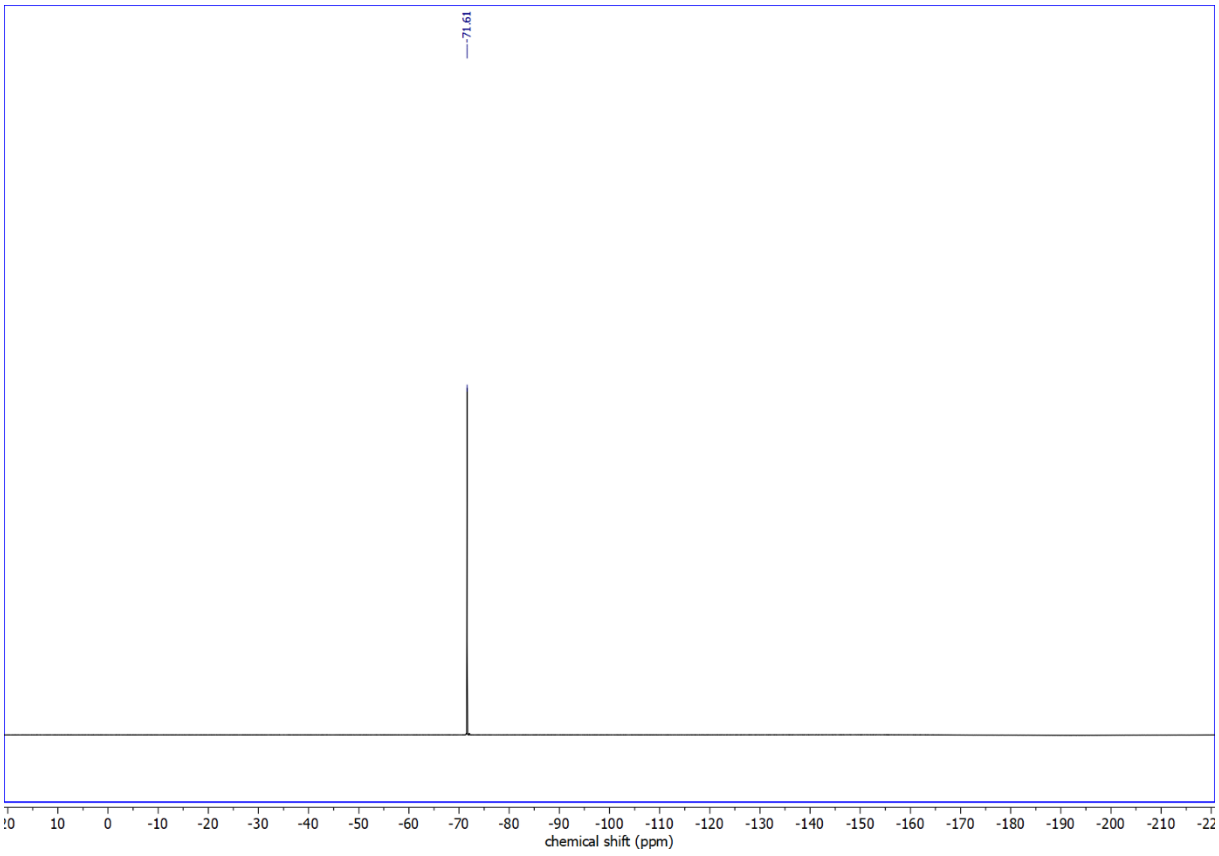
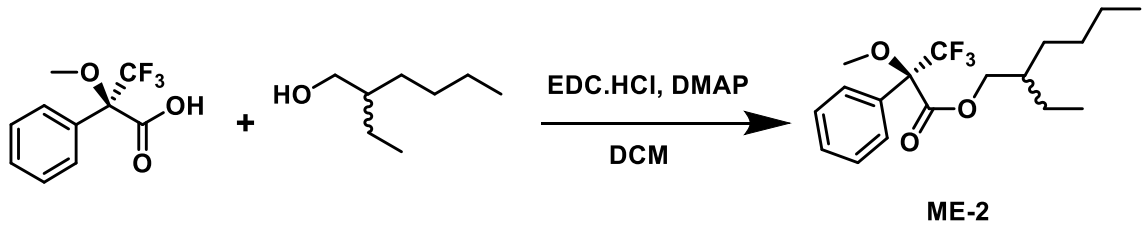


Fig. S13: ^{19}F NMR ($CDCl_3$, 470 MHz) spectrum of ME-1.



ME-2

ME-2 was synthesized according to the same procedure as described for ME-1.

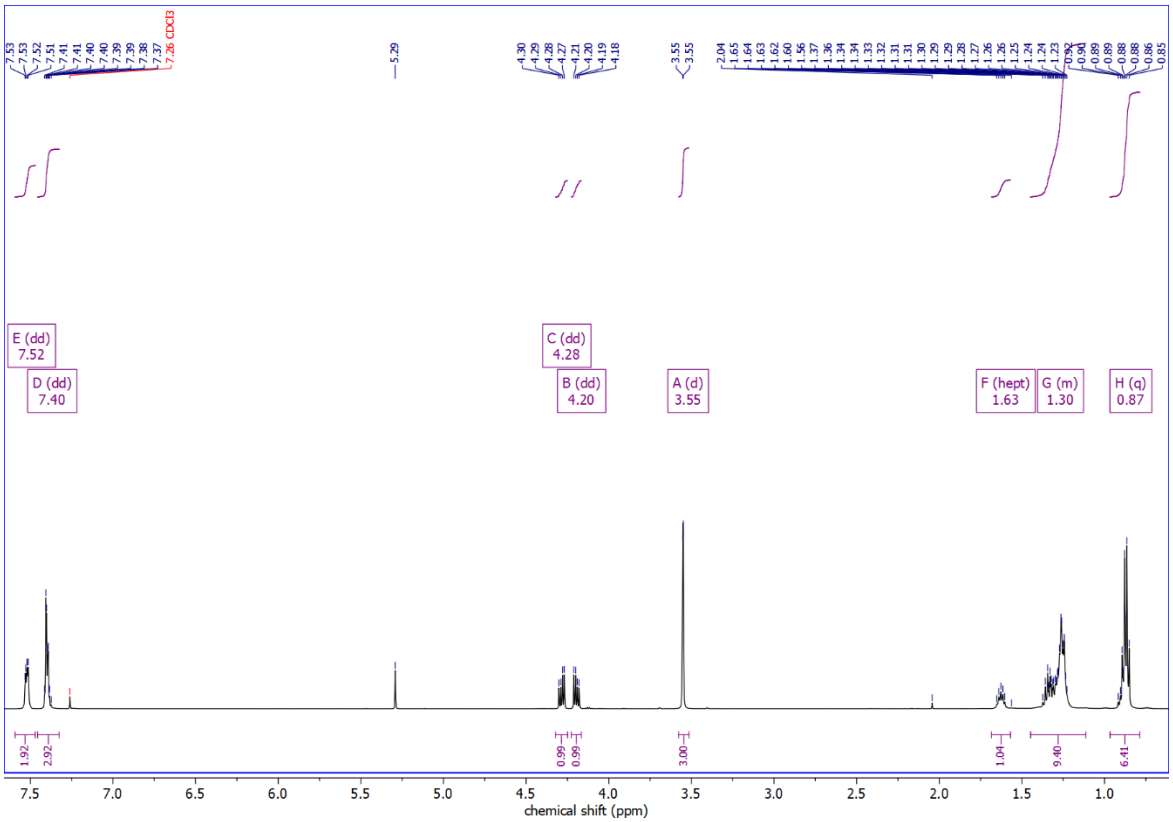


Fig. S14: ^{1}H NMR ($CDCl_3$, 500 MHz) of ME-2.

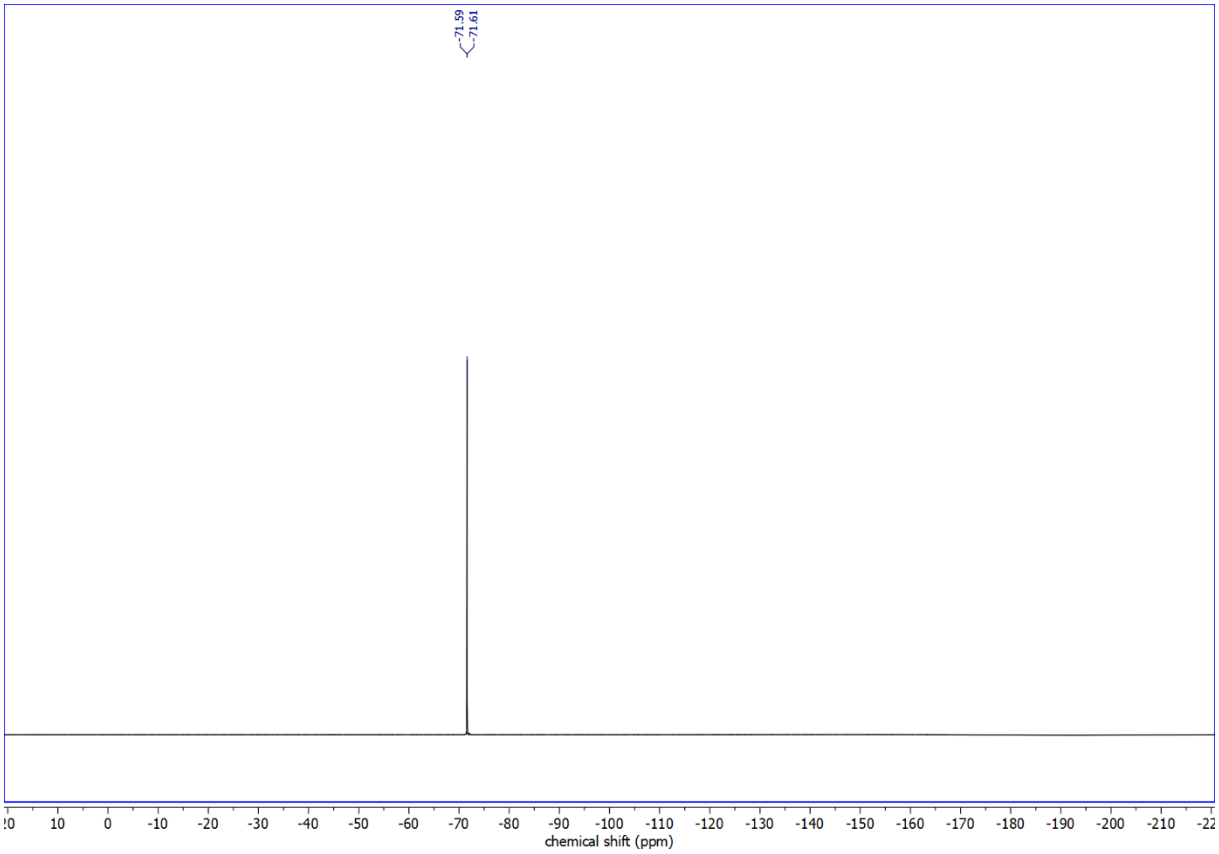


Fig. S15: ^{19}F NMR ($CDCl_3$, 470 MHz) spectrum of ME-2.

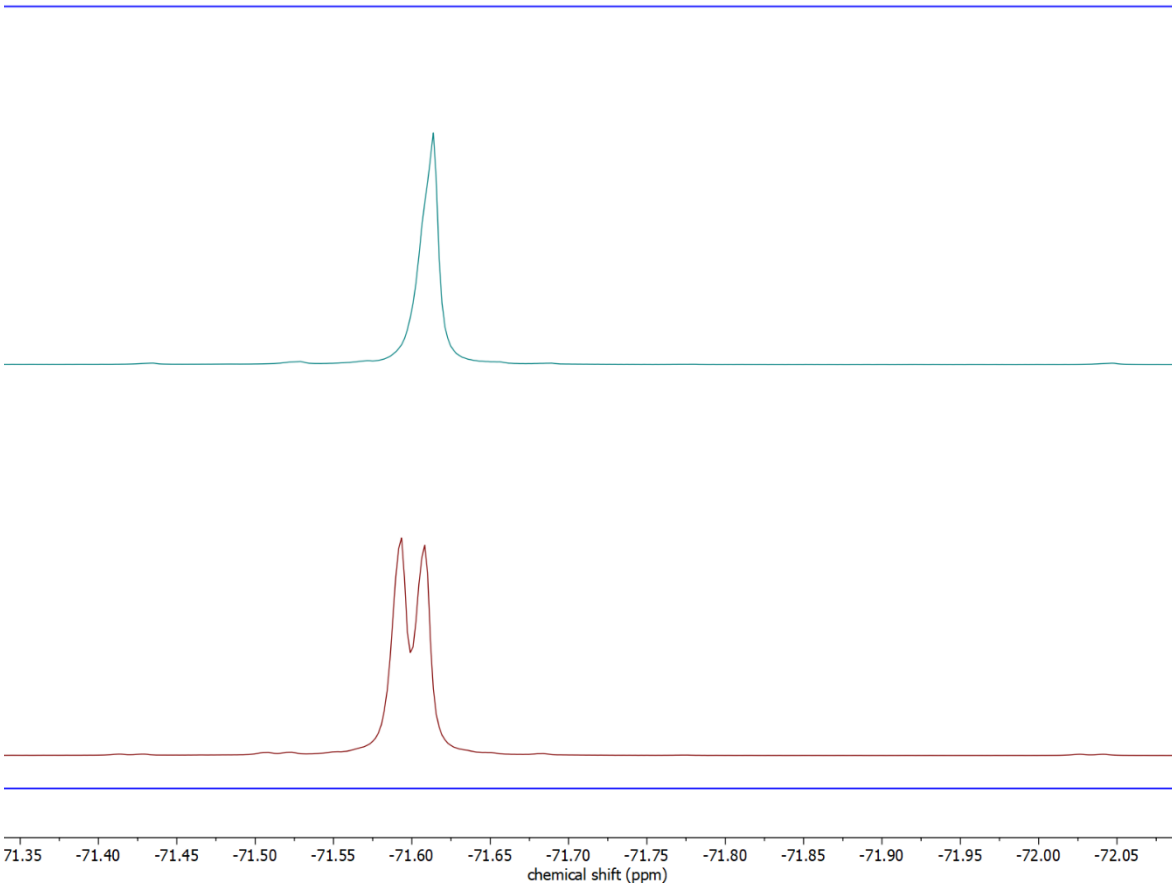


Fig. S16: Comparison of zoomed ^{19}F NMR spectra of ME-1 (top) vs. ME-2 (bottom).

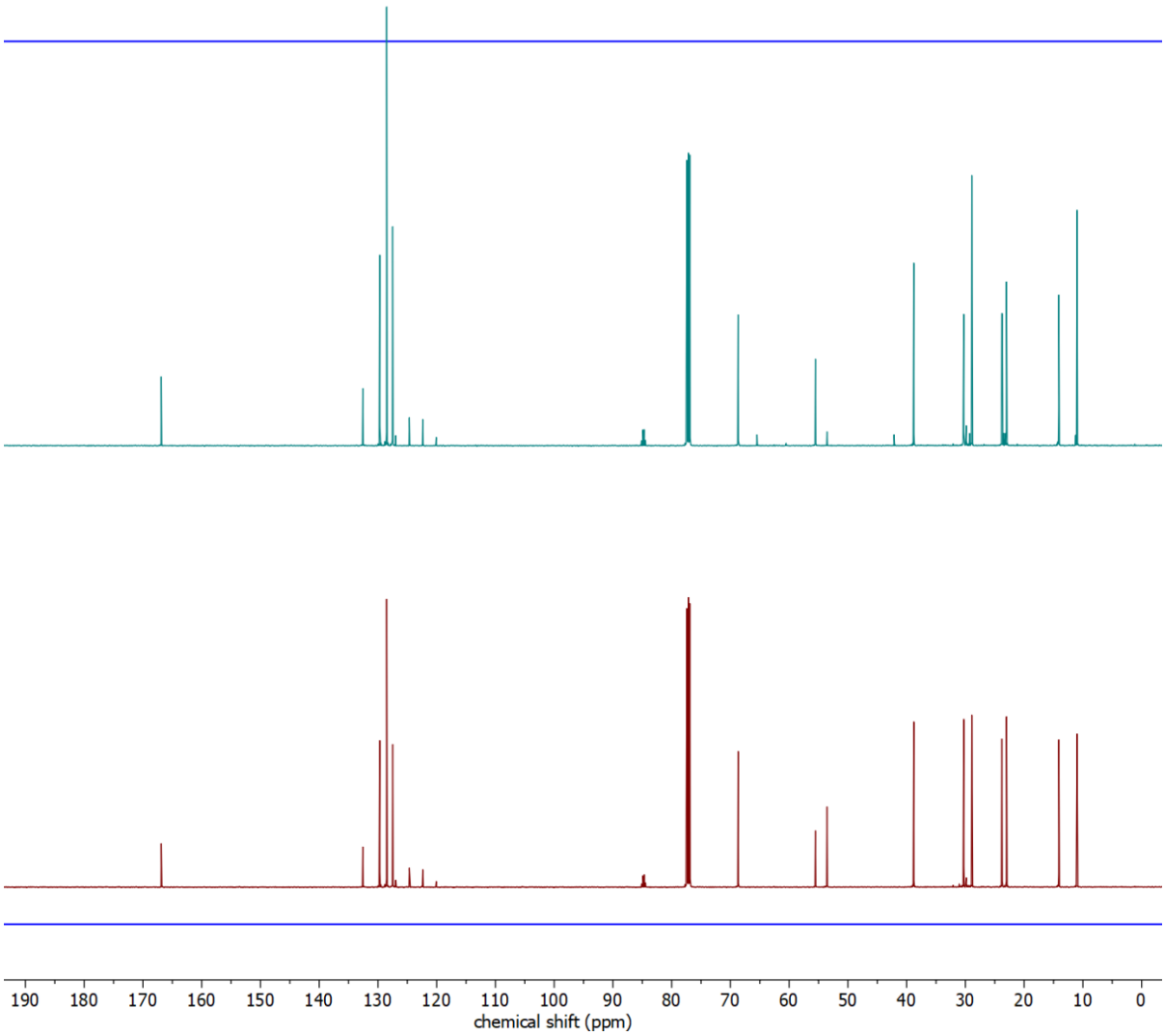


Fig. S17: Comparison of ^{13}C NMR spectra ($CDCl_3$, 125 MHz) of ME-1 (bottom) vs. ME-2 (top).

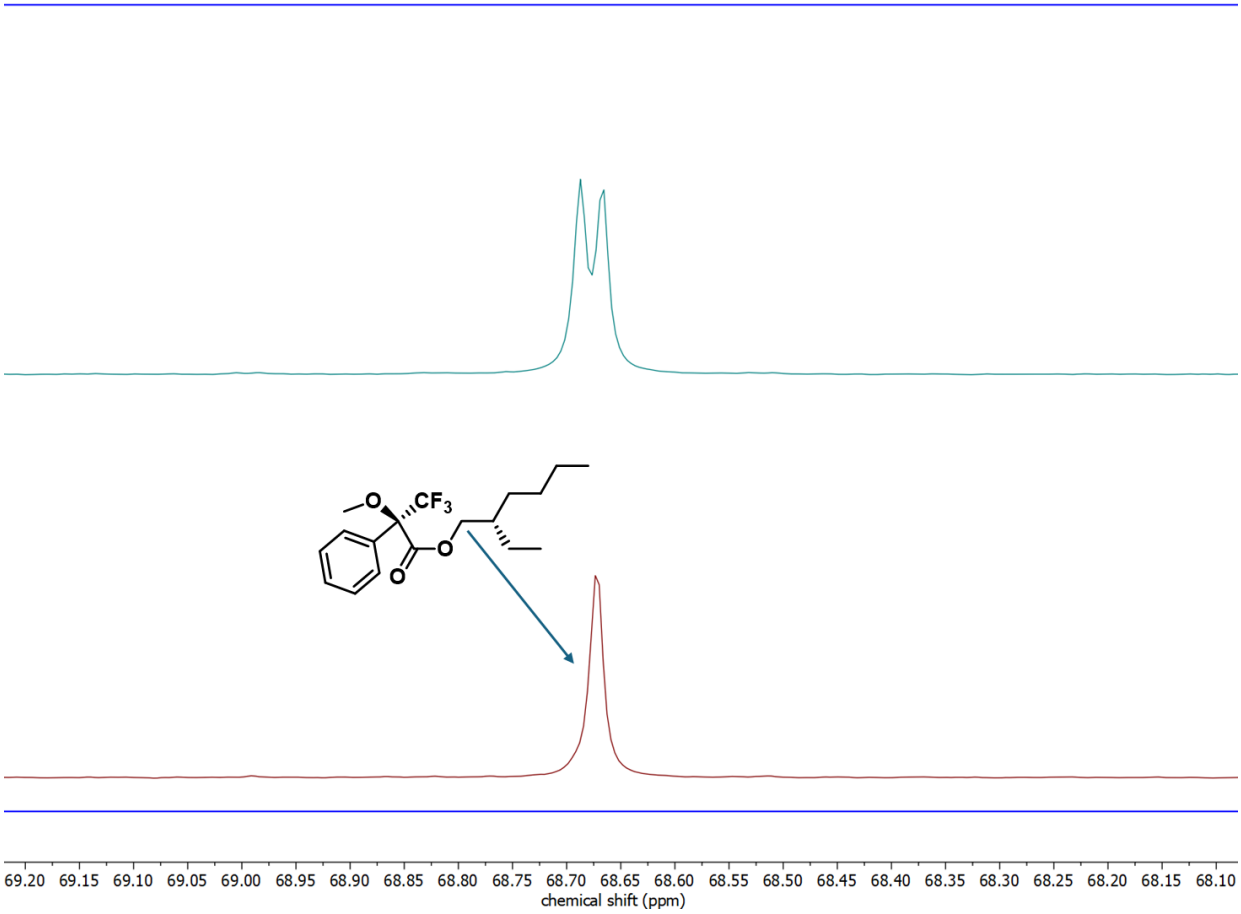


Fig. S18: Comparison of zoomed ^{13}C NMR spectra ($CDCl_3$, 125 MHz) of ME-1 (bottom) vs. ME-2 (top).

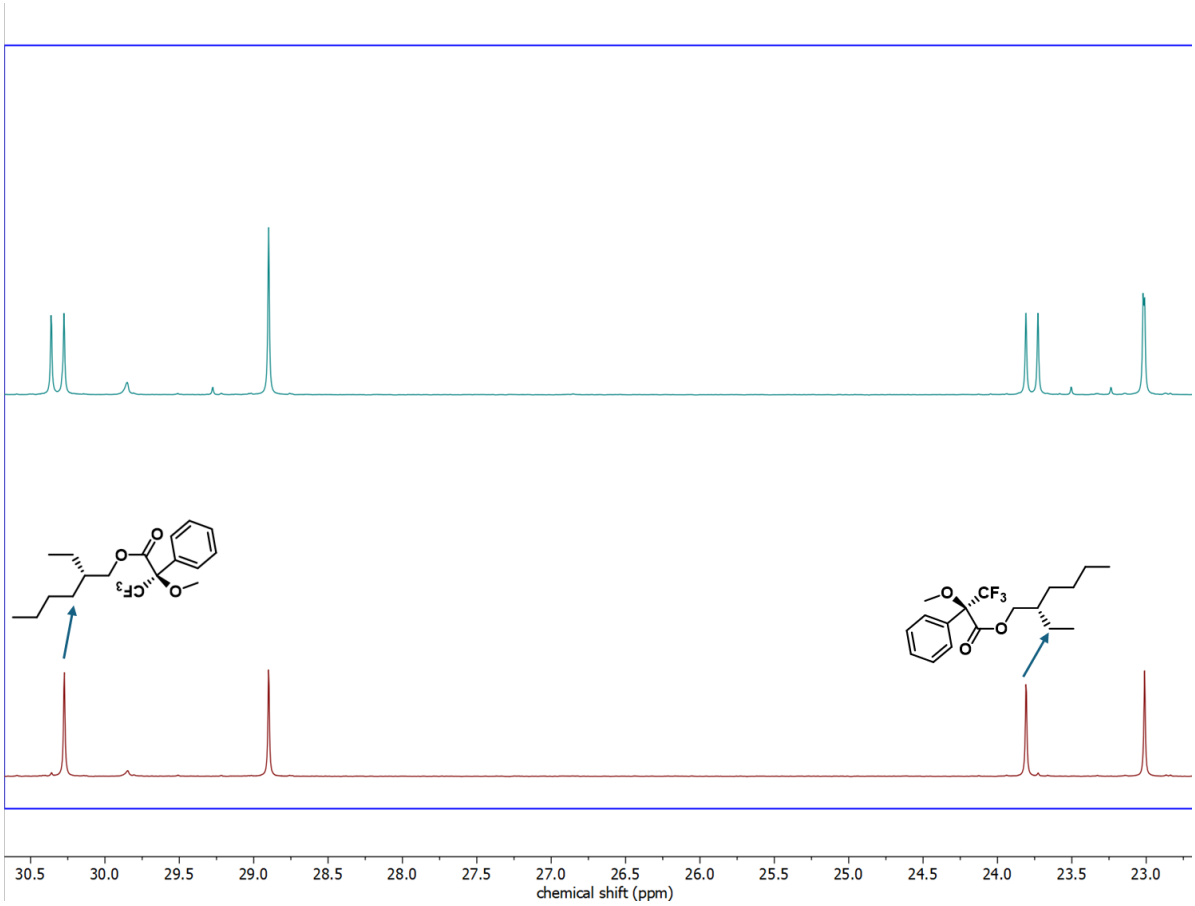
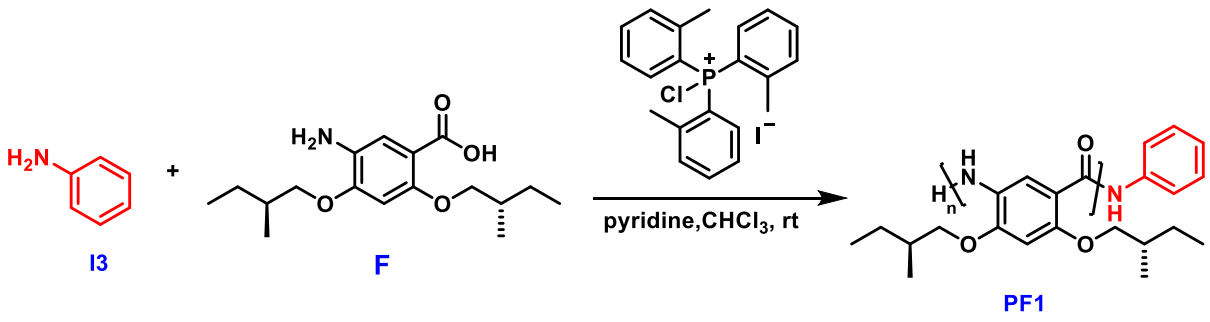
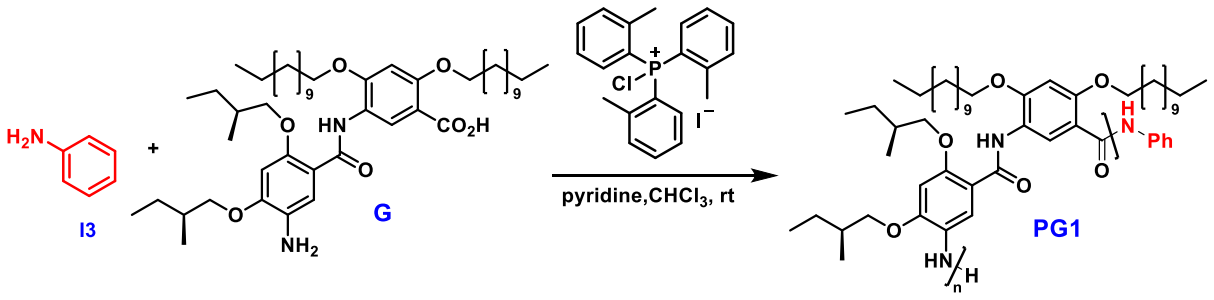


Fig. S19: Comparison of zoomed ^{13}C NMR spectra ($CDCl_3$, 125 MHz) of ME-1 (bottom) vs. ME-2 (top).



PF1 was synthesized according to a similar protocol as described for PC1 using the following stoichiometries: I3 (1 equiv., 1.0 mg), F (16 equiv., 54 mg), the PHOS reagent (48 equiv., 240 mg), pyridine (160 equiv., 0.14 mL). The polymer PF1 was purified by trituration with methanol, followed by collecting with centrifugation as a dark solid.

$M_{n,\ SEC\ (DMF)}$ = 5.6 kDa, Đ= 1.07



PG1 was synthesized according to a similar protocol as described for PC1 using the following stoichiometries: I3 (1 equiv., 1.0 mg), G (8 equiv., 69 mg), the PHOS reagent (24 equiv., 121 mg), pyridine (80 equiv., 0.07 mL). The polymer PG1 was purified by trituration with methanol to obtain a yellow solid.

$M_{n,\ SEC\ (DMF)}$ = 2.8 kDa, Đ= 1.05

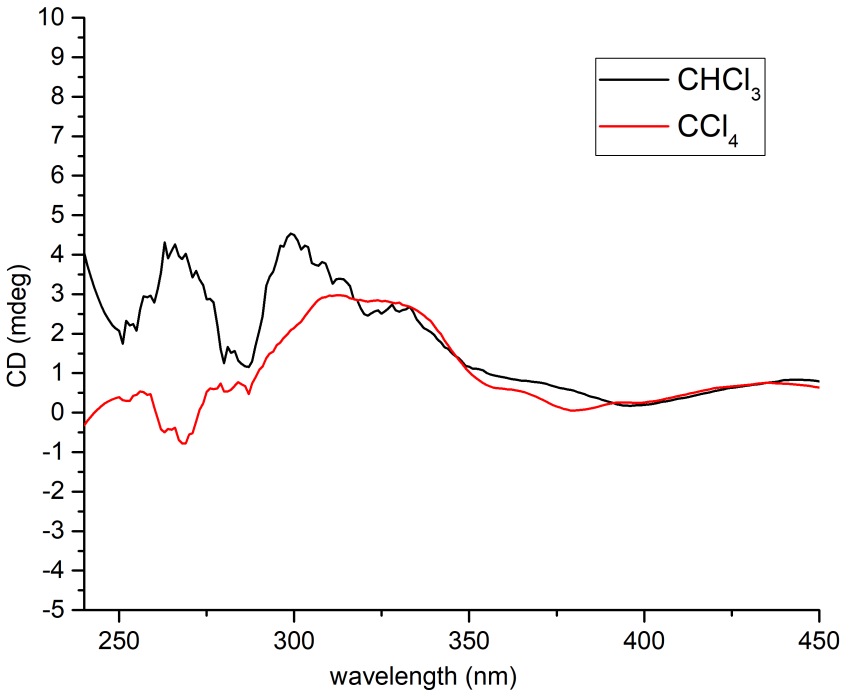


Fig. S20: CD (20°C, 0.1 mg/mL) spectra of PG1 in both solvents.

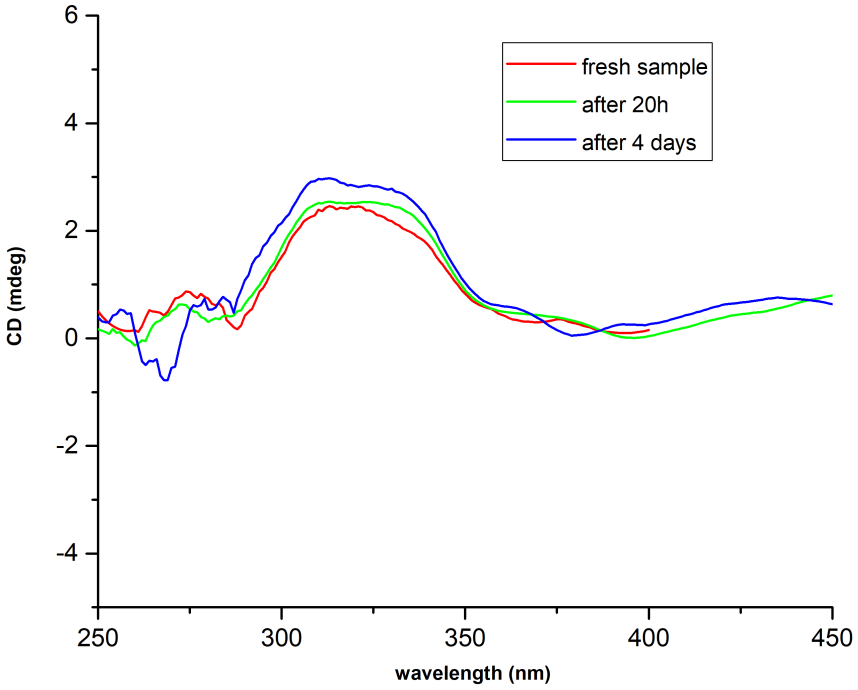
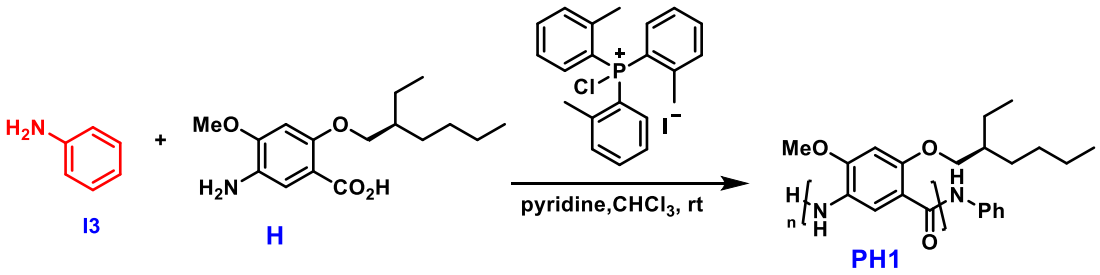
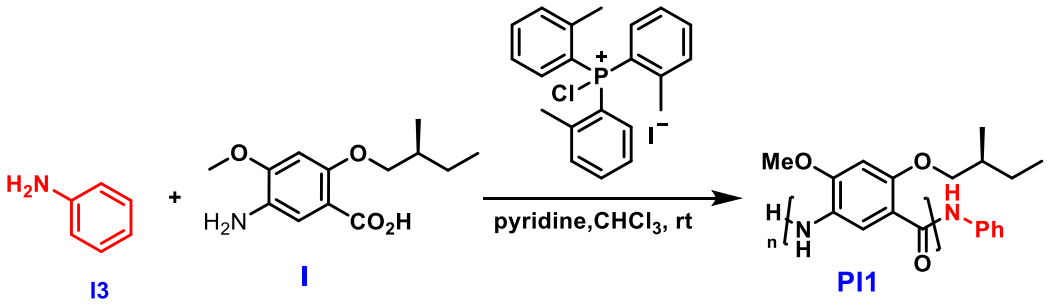


Fig. S21: CD (20°C, 0.1 mg/mL) spectra of PG1 in CCl_4 over time.



PH1 was synthesized according to a similar protocol as described for PC1 using the following stoichiometries: I3 (1 equiv., 1.0 mg), H (16 equiv., 51 mg), the PHOS reagent (48 equiv., 241 mg), pyridine (160 equiv., 0.14 mL). The polymer PG1 was purified by recycling GPC to obtain a dark solid with a quantitative yield.

$M_{n,\,SEC\,(DMF)}$ = kDa, Đ= 1.09



PI1 was synthesized according to the similar protocol as described for PC1 using the following stoichiometries: I3 (1 equiv., 2.0 mg), I (16 equiv., 88 mg), the PHOS reagent (48 equiv., 482 mg), pyridine (160 equiv., 0.28 mL). After the end of the polymerization, a turbid solution was observed, indicating precipitation of the polymer. The polymer also showed very low solubility in DMF. The polymer PI1 was purified by trituration with methanol to obtain a yellow solid in quantitative yield. PI1 was insoluble in DMF at a concentration of 2 mg/mL.

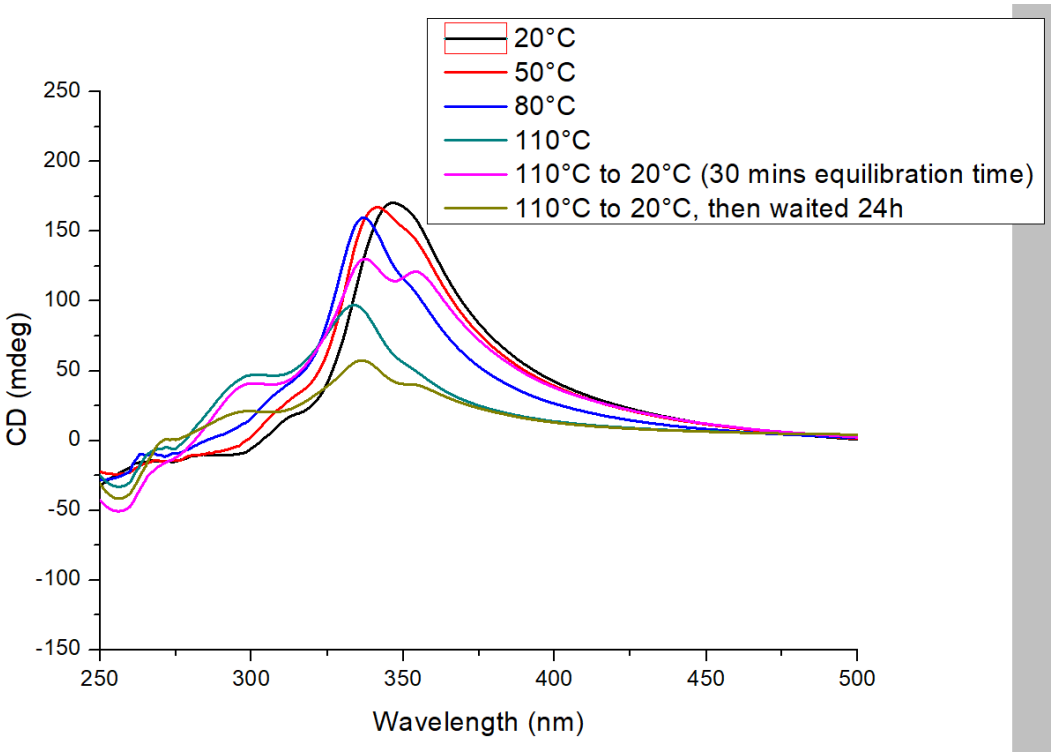


Fig. S22: CD (20°C, 0.1 mg/mL) spectra of PI1 in DMF over different temperatures.

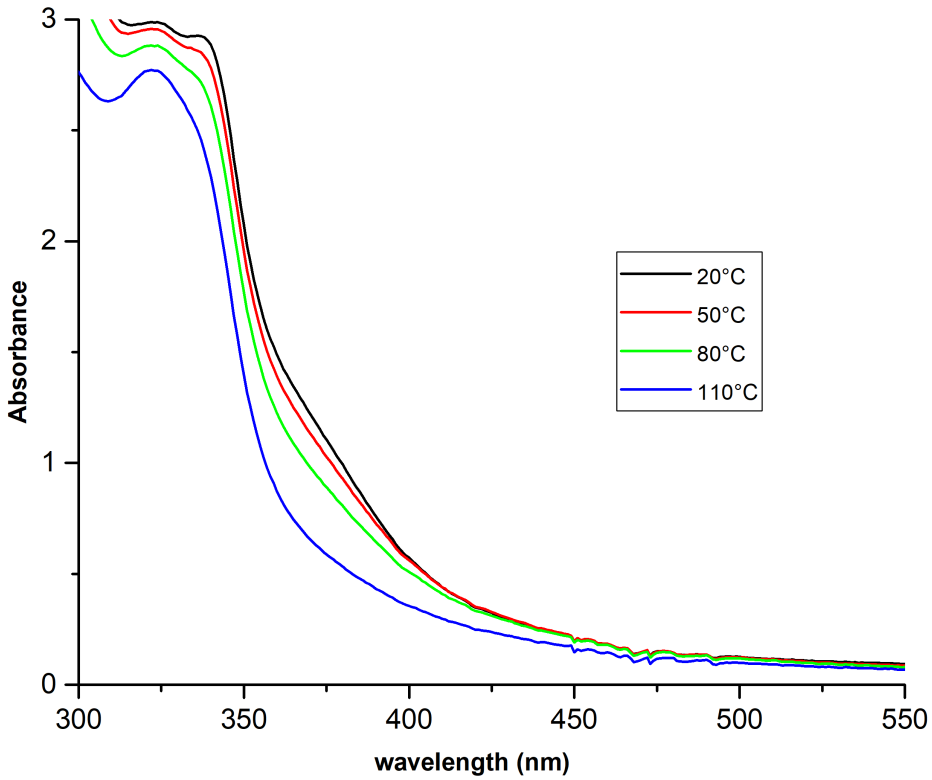


Fig. S23: UV-VIS spectrum (20°C) of PI1 at different temperature in DMSO at 0.1 mg/mL concentration.

Calculation of dissymmetry factor or g-factor

In circular dichroism (CD),

ε = molar extinction coefficient (absorption) for unpolarized light.

$\Delta\varepsilon = \varepsilon L - \varepsilon R$ = molar circular dichroism = difference in molar extinction coefficient between left and right circularly polarized light.

The dissymmetry factor is defined as:

$$g = \frac{\Delta\varepsilon}{\varepsilon}$$

From Beer–Lambert law:

$A = \varepsilon c l$

Where A = absorbance (no units), $c = \text{molar}$ concentration (mol/L), l = path length (cm).

For the circular dichroism signal (difference between left and right), we similarly have:

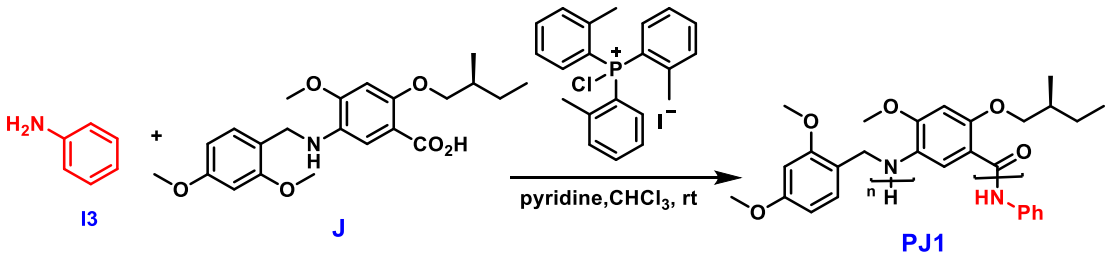
$\Delta A = \Delta\varepsilon c l$

Relating ellipticity (θ) to ΔA, we have,

θ (mdeg) ≈32980×ΔA

Putting it all together

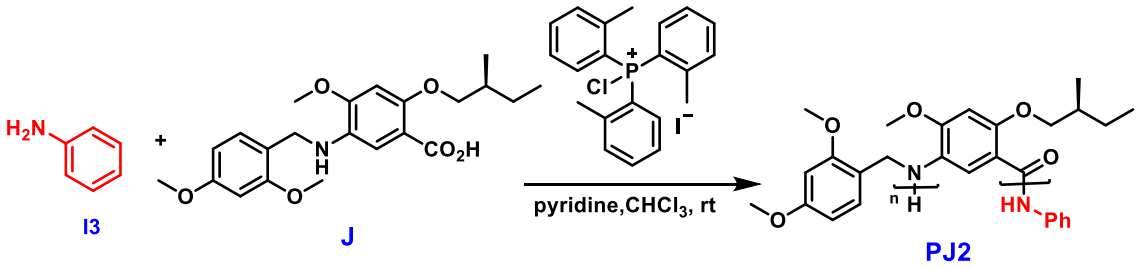
$$g = \frac{\Delta\varepsilon}{\varepsilon} = \frac{\Delta A/cl}{A/cl} = \frac{\Delta A}{A} = \frac{\theta\ (\mathrm{mdeg})}{32980 \times A} = \frac{508\ (\mathrm{mdeg})}{32980 \times 1.55} = 9.9 \times 10^{-3}$$ at λ_{max} = 358 nm.



PJ1 was synthesized according to a similar protocol as described for PC1 using the following stoichiometries: I3 (1 equiv., 1.0 mg), J (16 equiv., 70 mg), the PHOS reagent (48 equiv., 240 mg), pyridine (160 equiv., 0.14 mL). The polymer was purified via trituration with methanol to obtain a yellow solid.

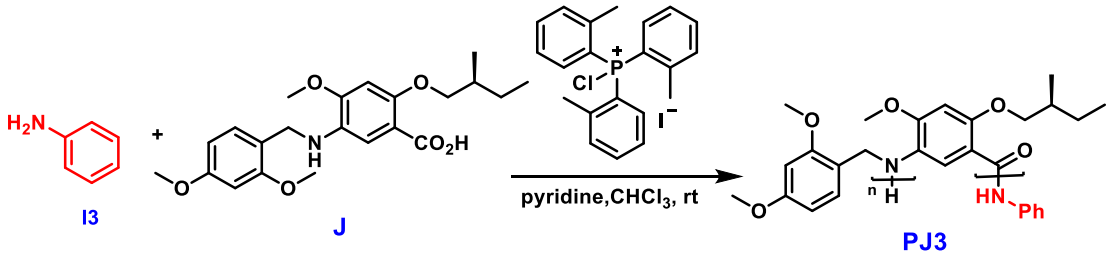
This time SEC analysis could be performed in chloroform and DMF solvents.

$M_{n,\ SEC\ (DMF)}$ = 16 kDa, Đ= 1.34



PJ2 was synthesized according to a similar protocol as described for PC1 using the following stoichiometries: I3 (1 equiv., 0.6 mg), J (32 equiv., 84 mg), the PHOS reagent (90 equiv., 270 mg), pyridine (320 equiv., 0.17 mL). The polymer PJ2 was purified via trituration with methanol to obtain a yellow solid.

$M_{n,\ SEC\ (DMF)}$ = 31.8 kDa, Đ= 1.32



PJ3 was synthesized according to a similar protocol as described for PC1 using the following stoichiometries: I3 (1 equiv., 0.4 mg), J (50 equiv., 87 mg), the PHOS reagent (150 equiv., 300 mg), pyridine (500 equiv., 0.17 mL). The polymer PJ3 was purified via trituration with methanol to obtain a yellow solid.

$M_{n,\,SEC\,(DMF)}$ = 50 kDa, Đ= 1.28

Deprotection of DMB groups

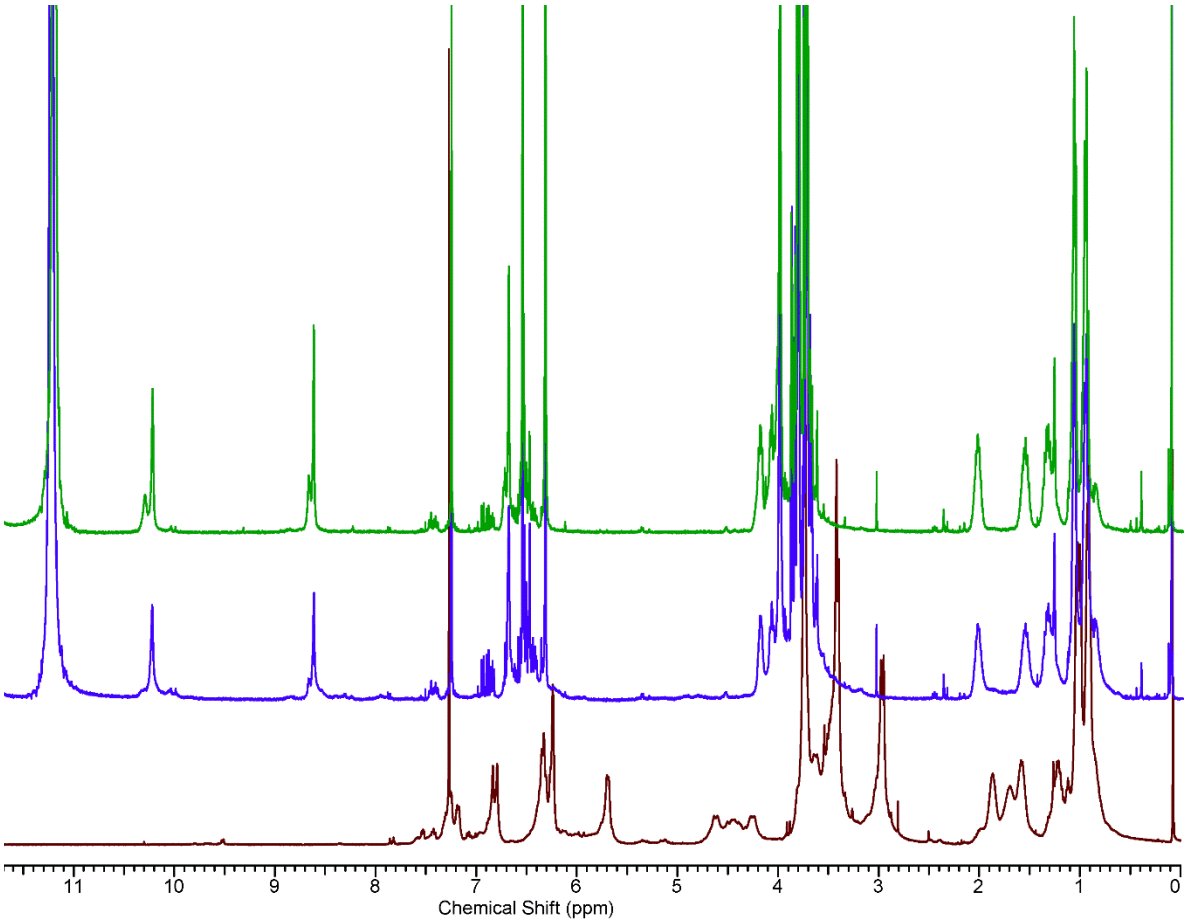


Fig. S24: ^{1}H NMR in-situ deprotection of PJ1 via excess trifluoracetic acid (TFA). Bottom spectrum showed PJ1 before the addition of the acid whereas the top two spectrum showed cleavage of the DMB groups.

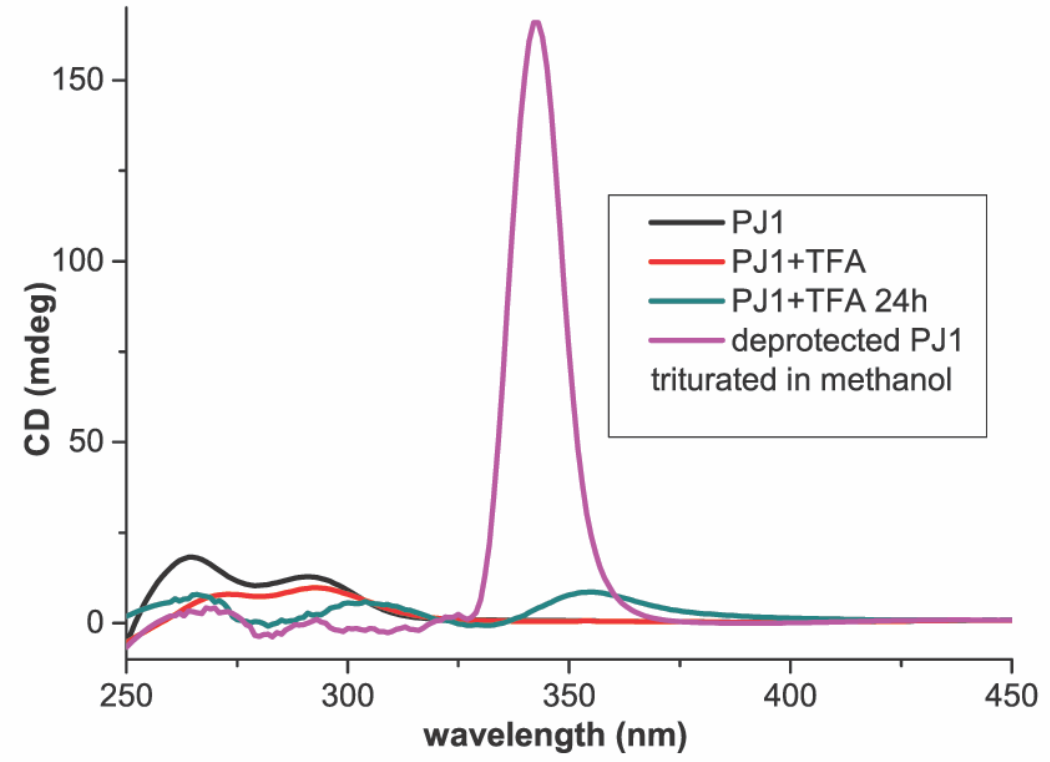


Fig. S25: CD (20°C, 0.1 mg/mL) spectra of PJ1 before and after acid treatment.

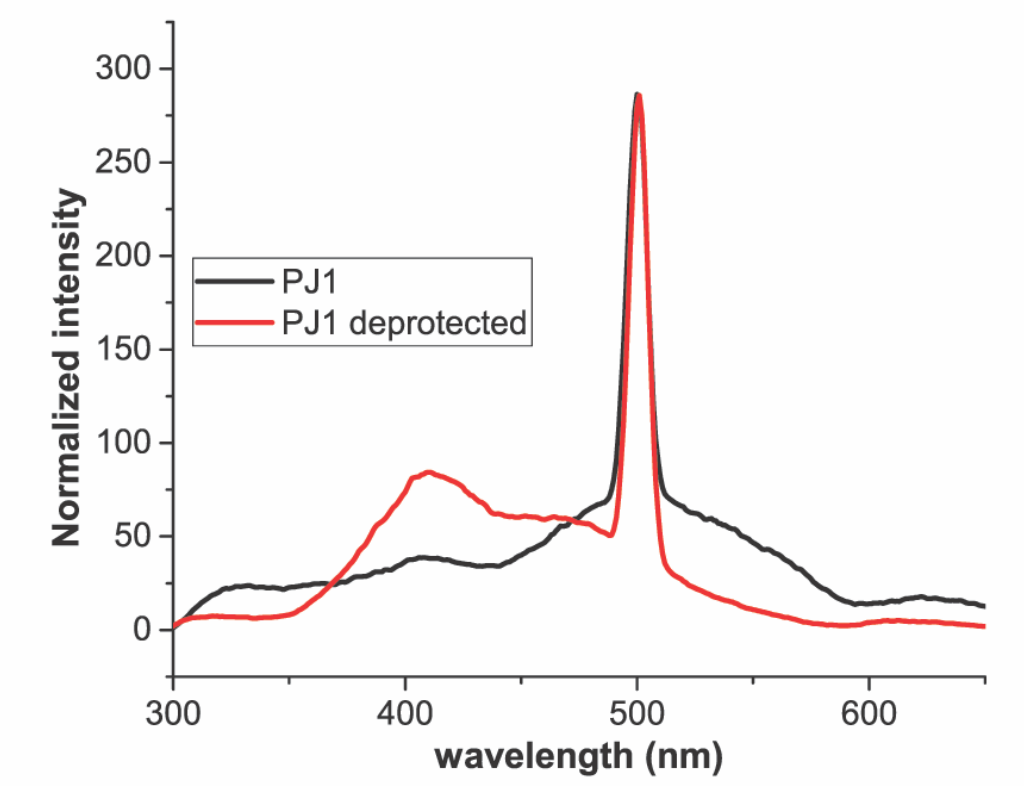


Fig. S26: Fluorescence spectrum of PJ1 in $CHCl_3$ at the protected (black curve) and the deprotected (red curve) stage.

NMR spectra

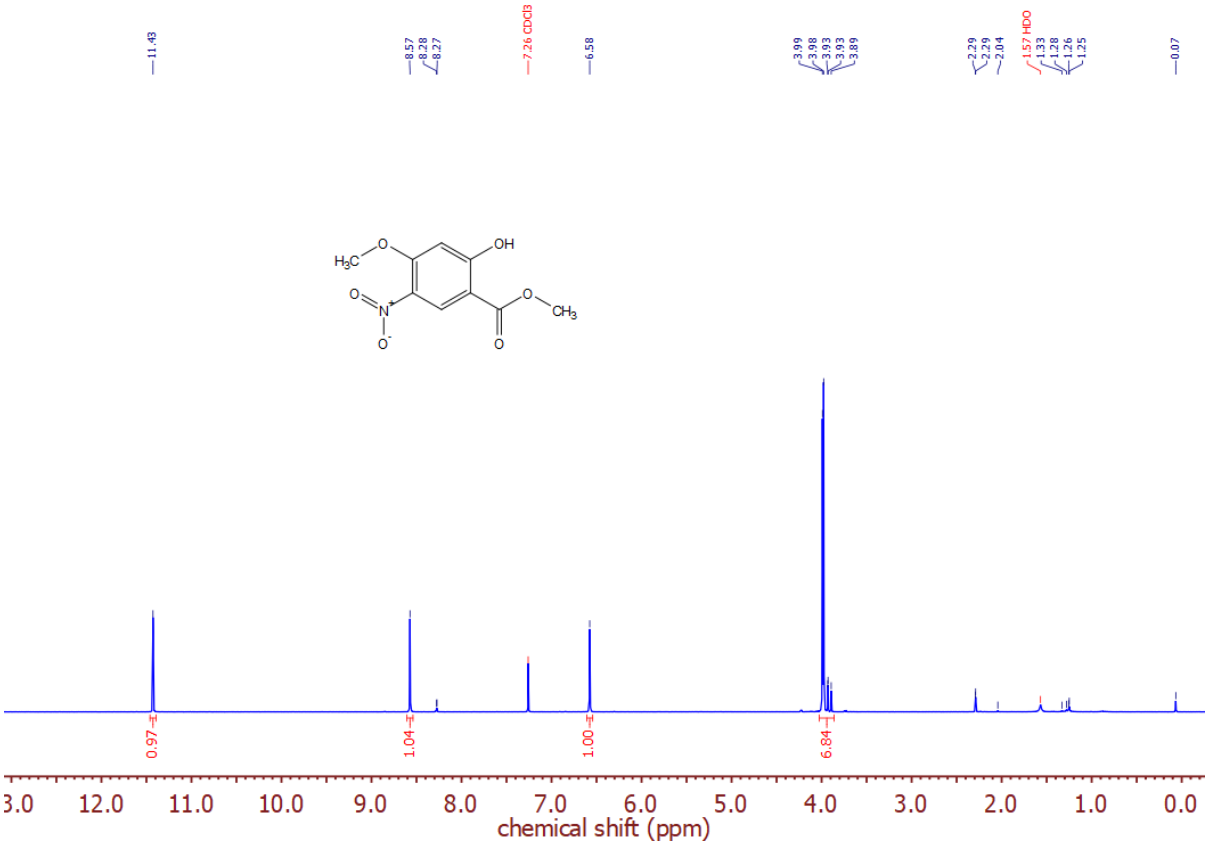


Fig. S27: ^{1}H NMR (300 MHz, $CDCl_3$) of compound V.

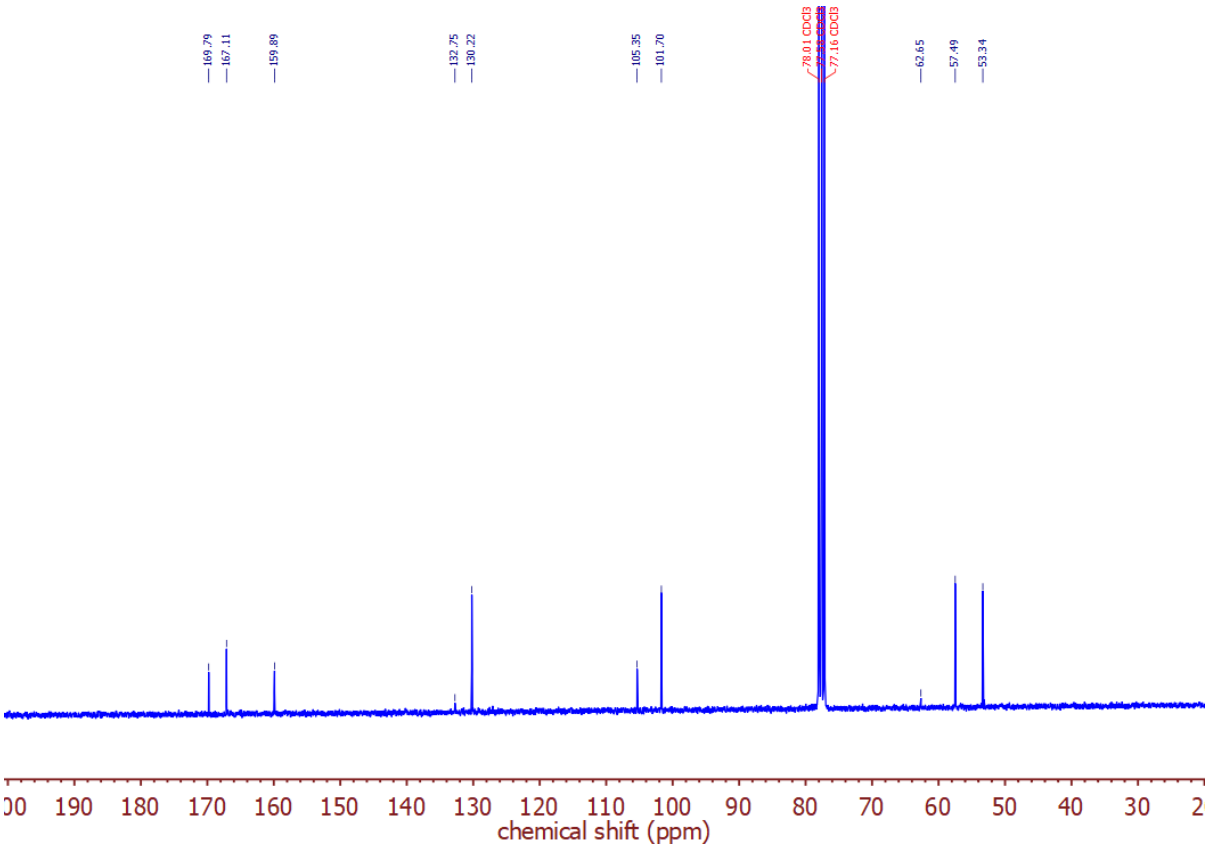


Fig. S28: ^{13}C NMR (101 MHz, $CDCl_3$) of compound V.

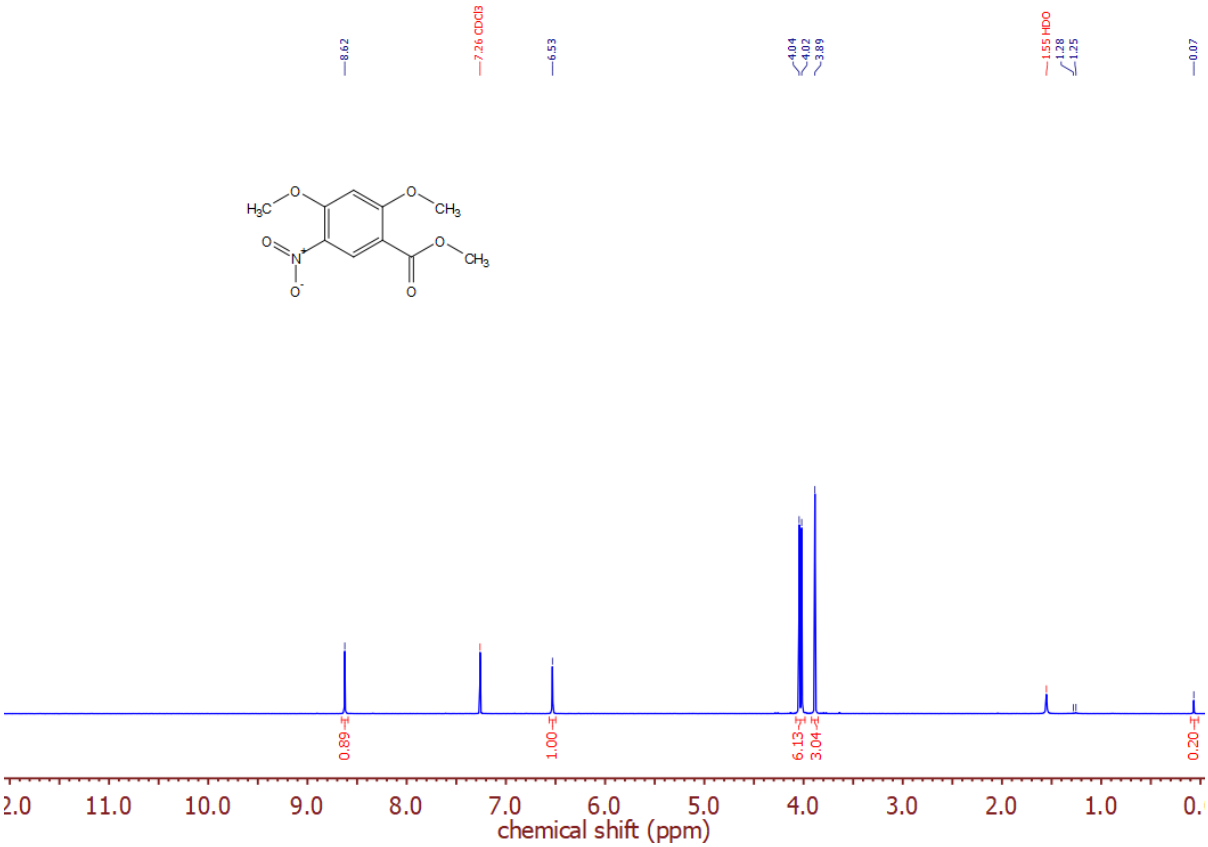


Fig. S29: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 1.

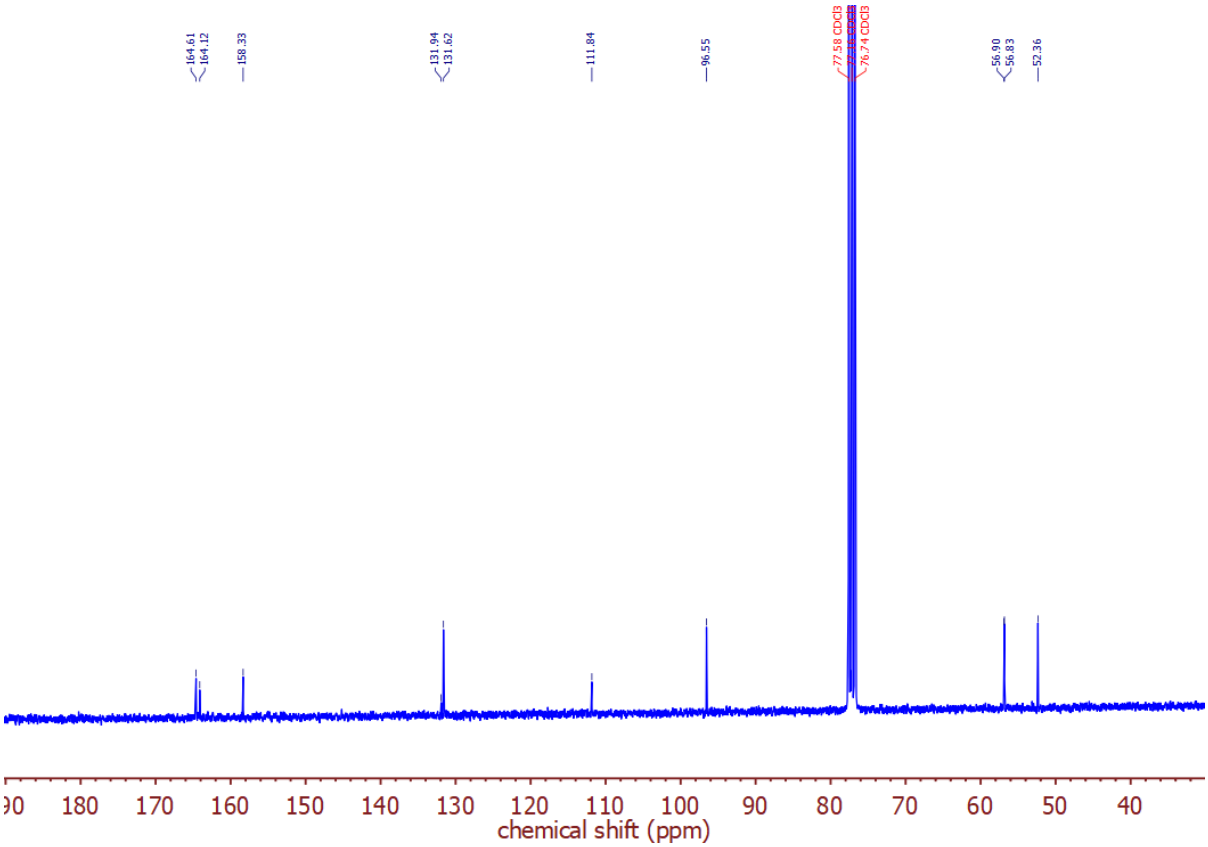


Fig. S30: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 1.

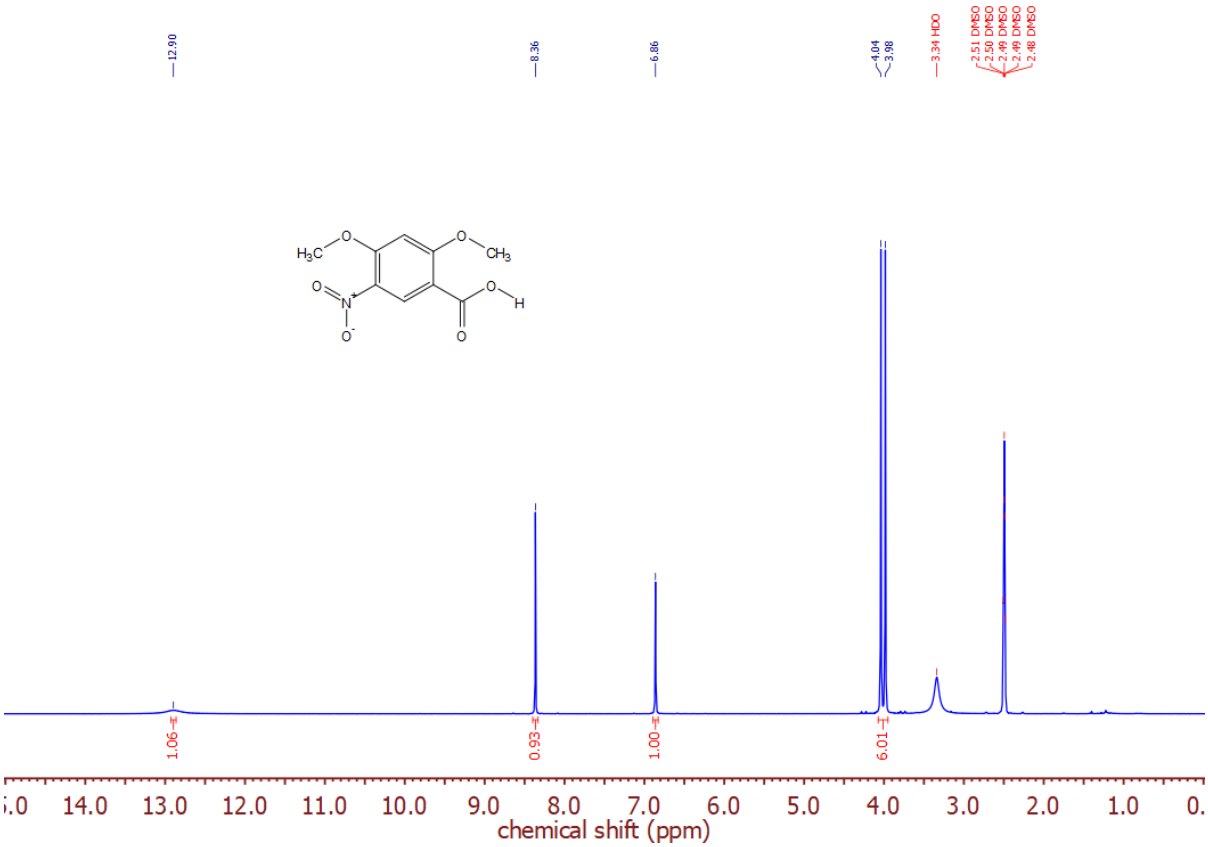


Fig. S31: ^{1}H NMR (300 MHz, DMSO-D6) of intermediate 2.

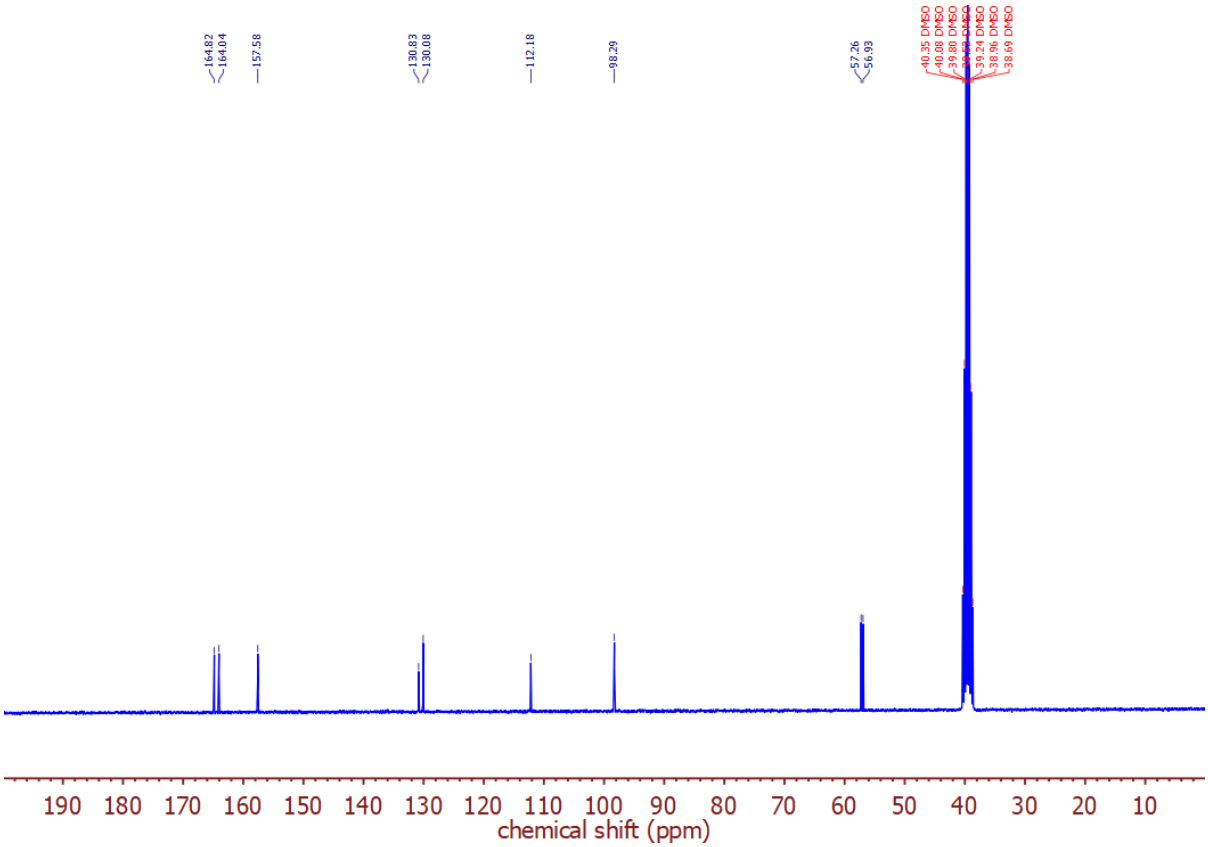


Fig. S32: ^{13}C NMR (101 MHz, DMSO-D6) of intermediate 2.

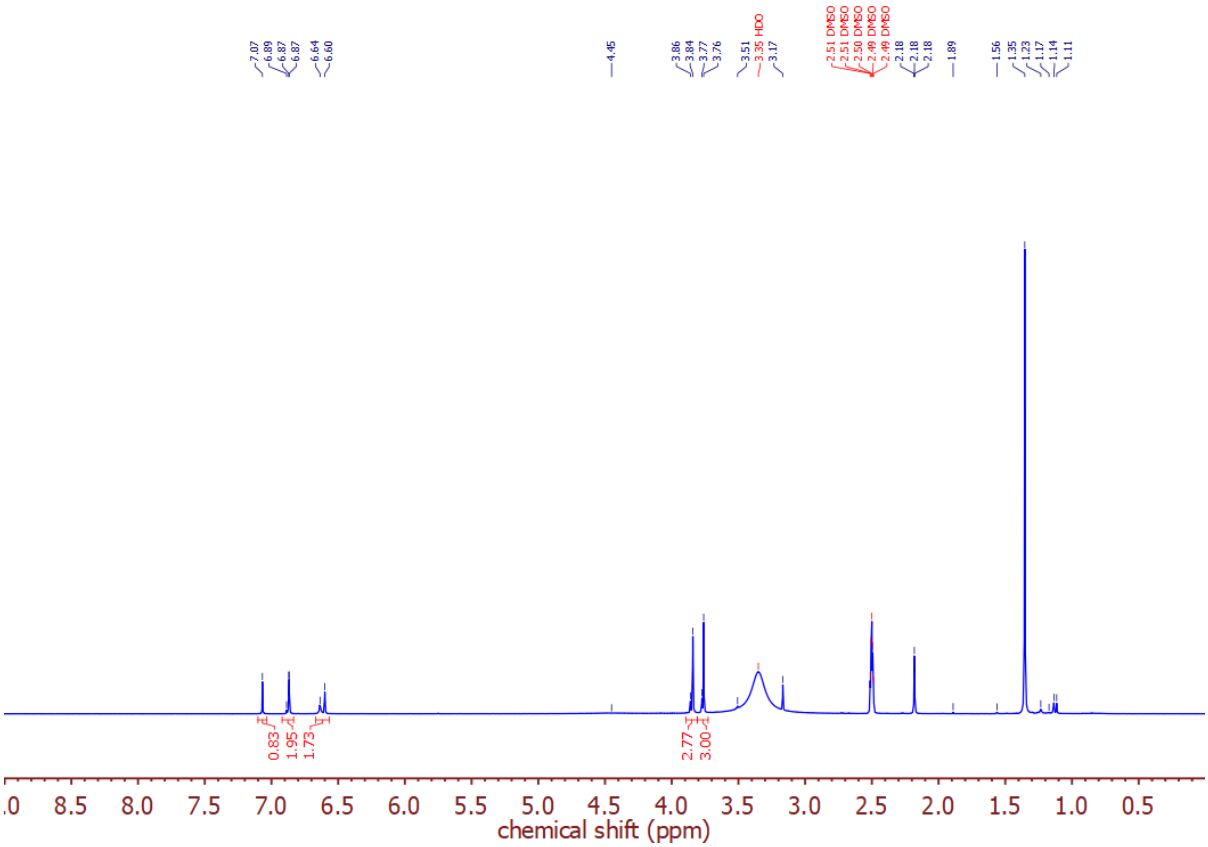


Fig. S33: ^{1}H NMR (300 MHz, DMSO-D6) of compound A.

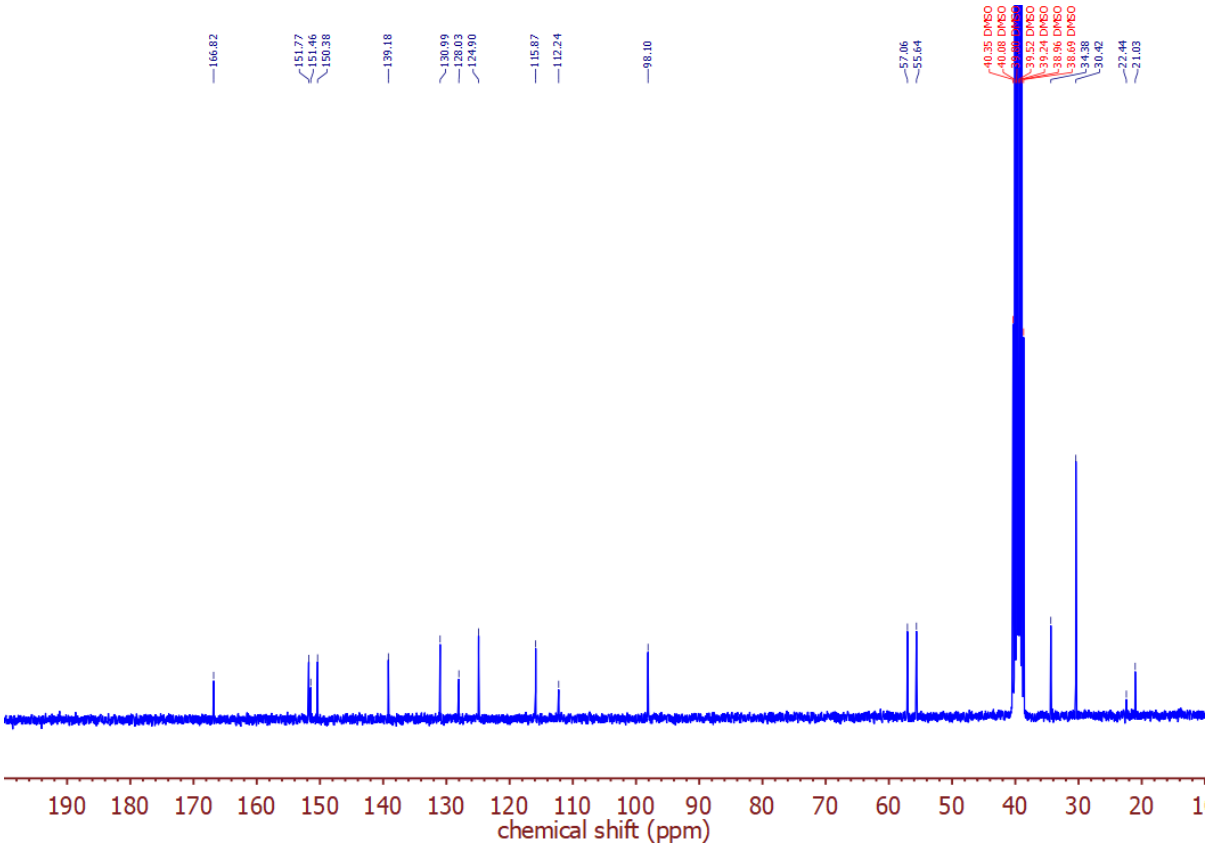


Fig. S34: ^{13}C NMR (101 MHz, DMSO-D6) of compound A.

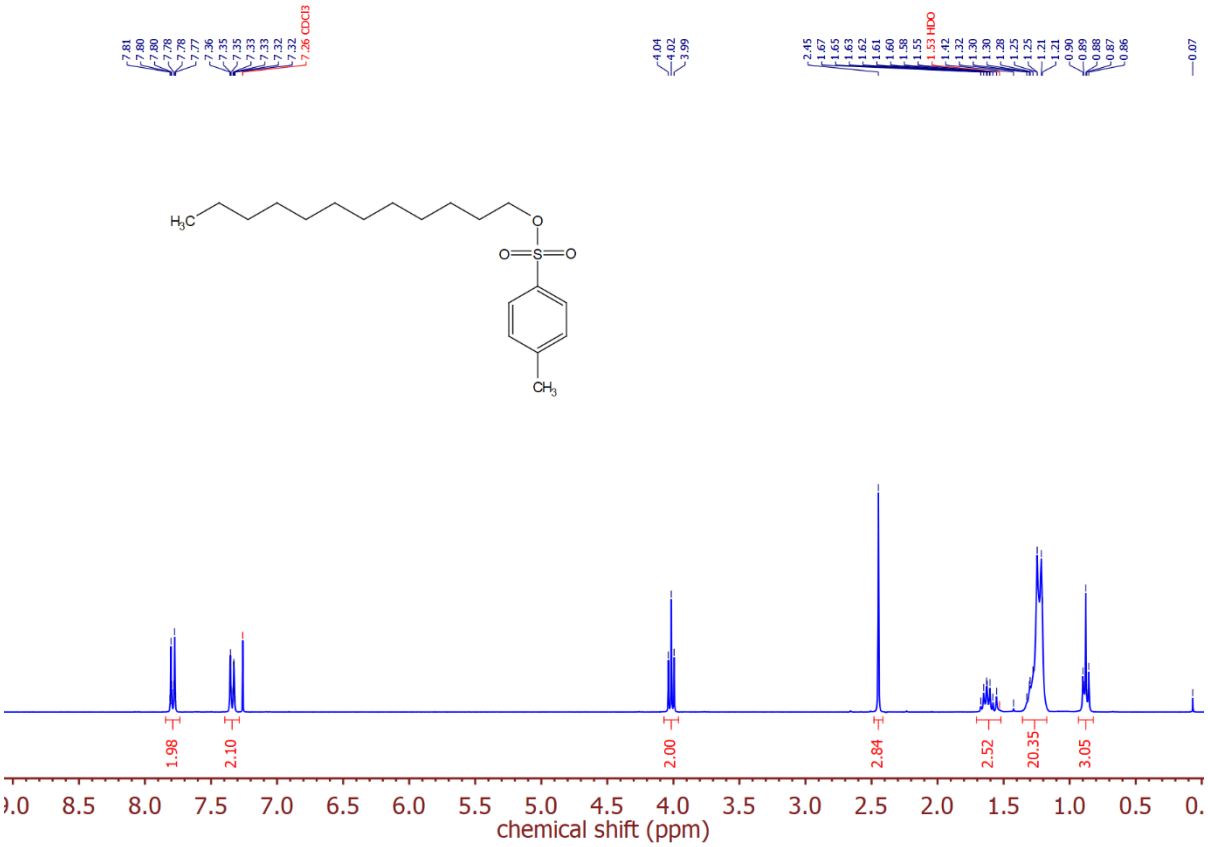


Fig. S35: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 3.

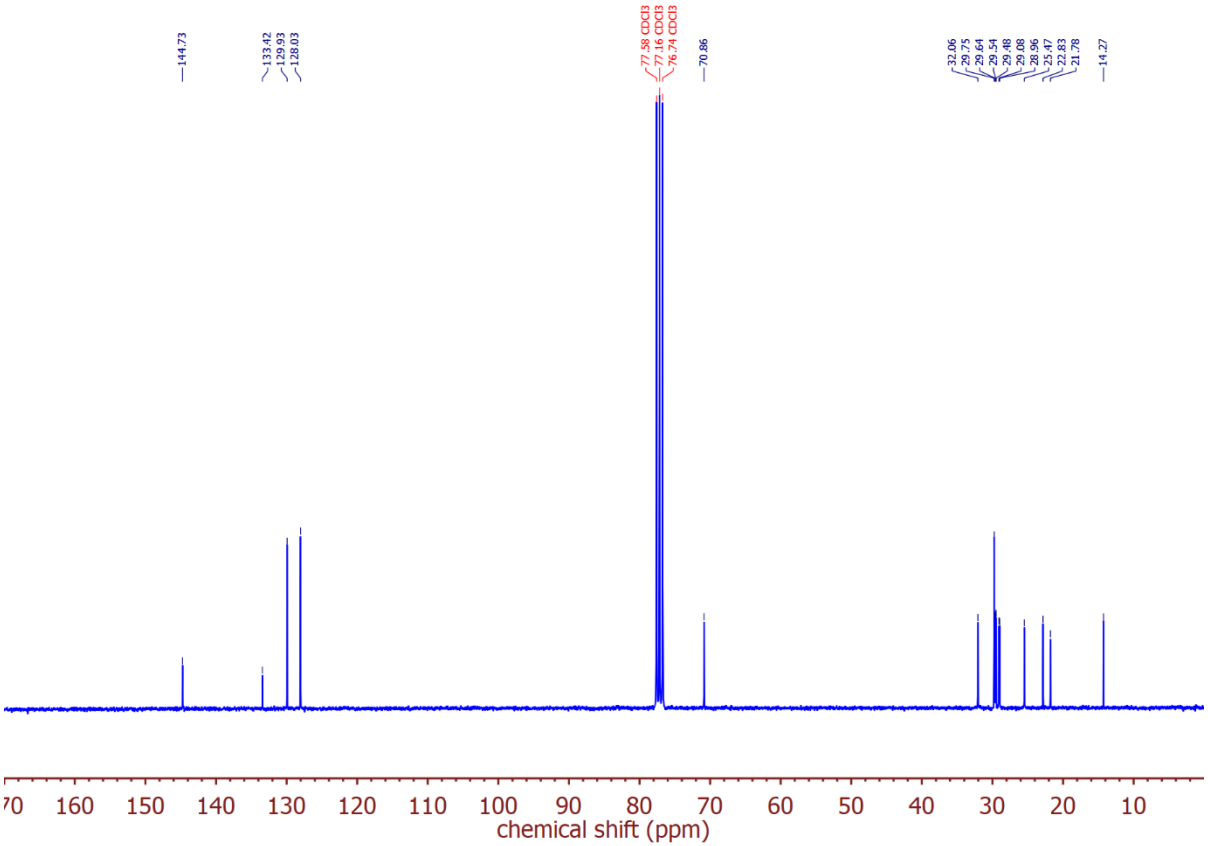


Fig. S36: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 3.

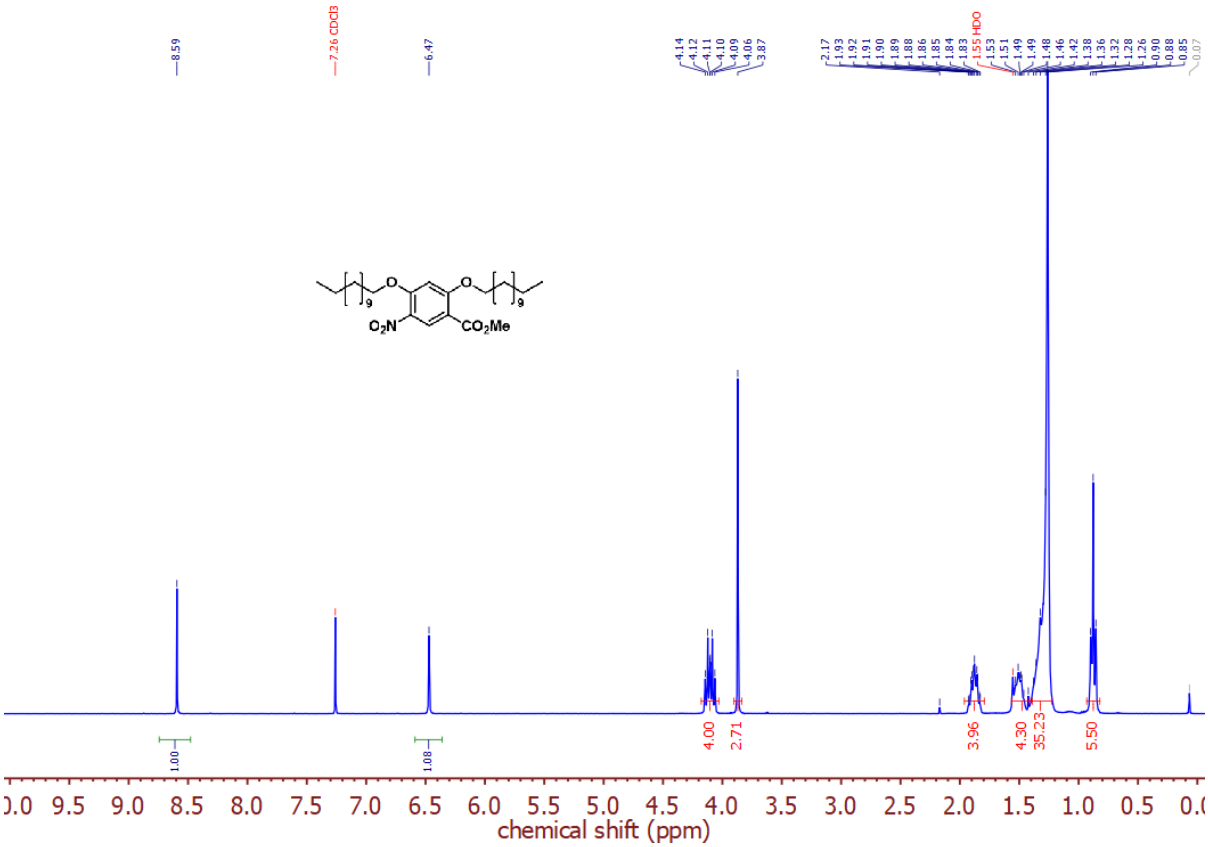


Fig. S37: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 4.

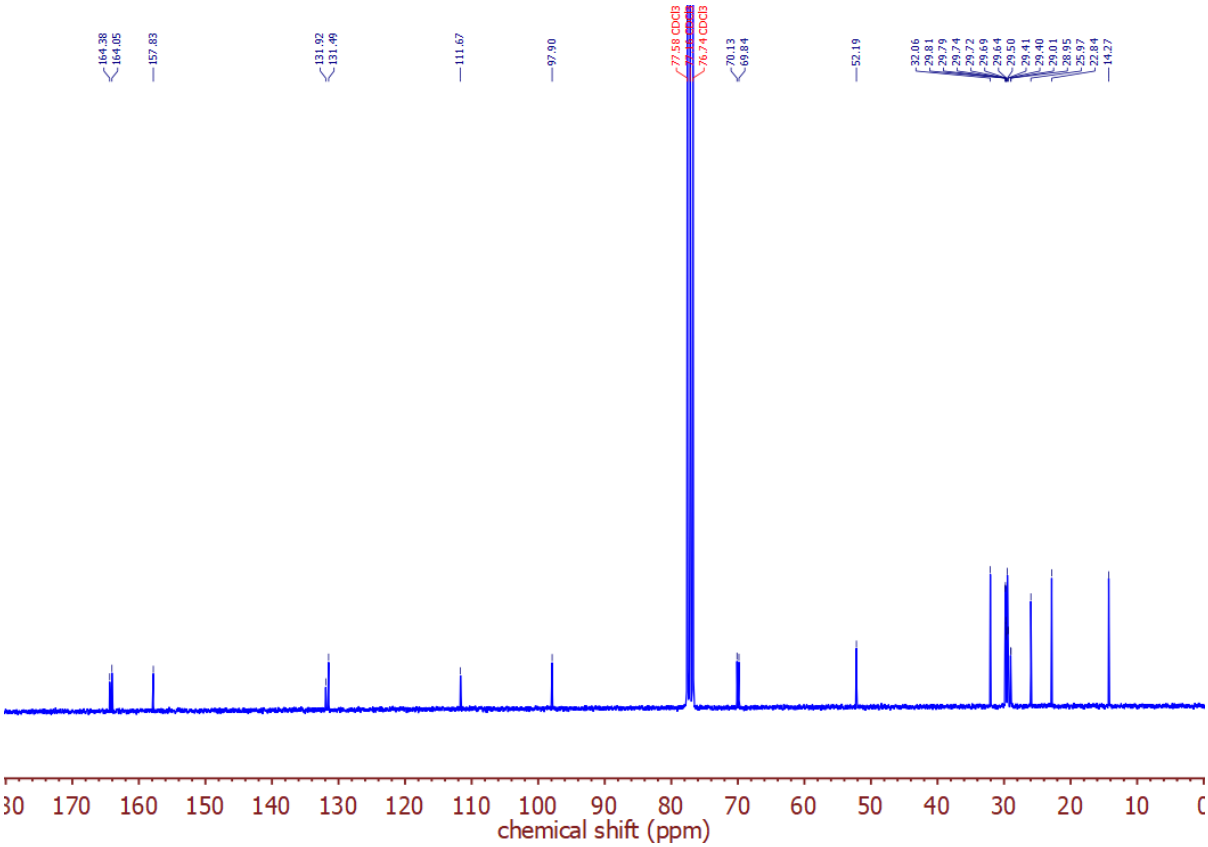


Fig. S38: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 4.

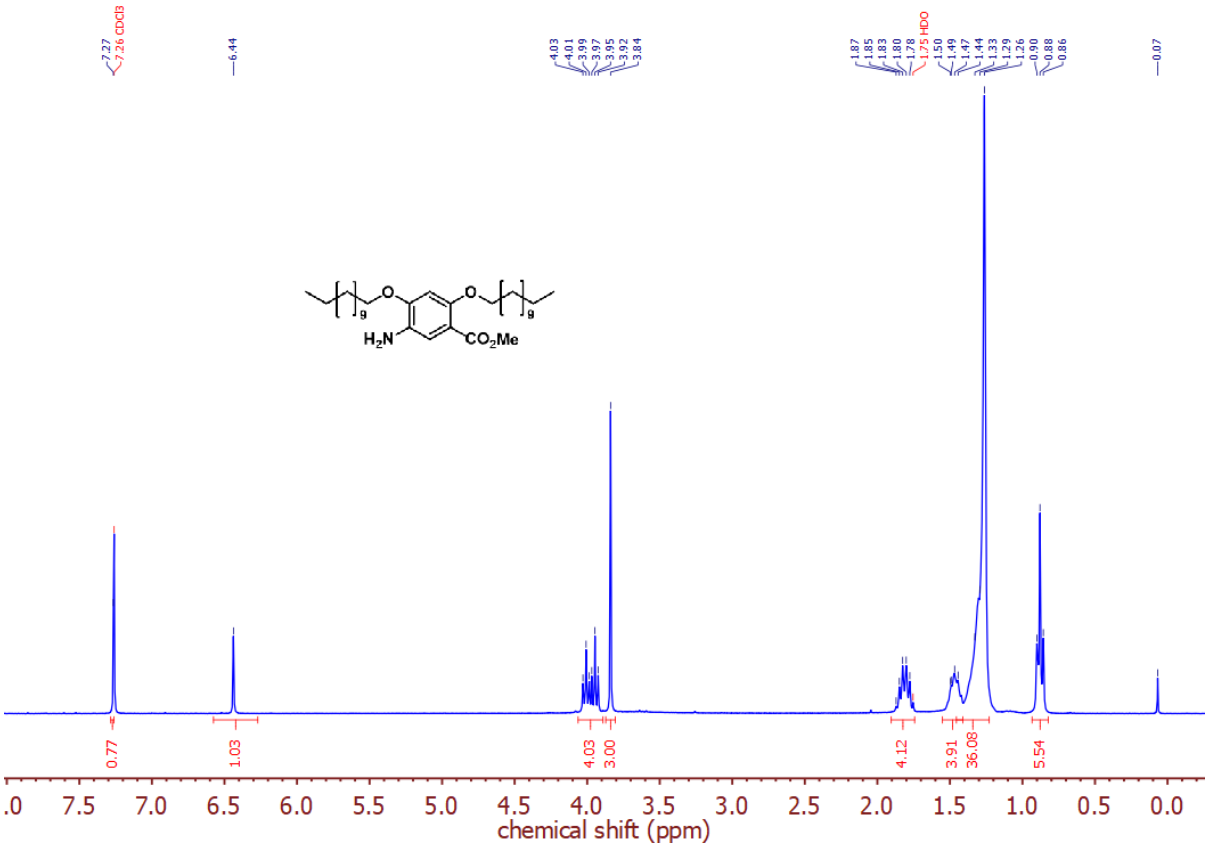


Fig. S39: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 5.

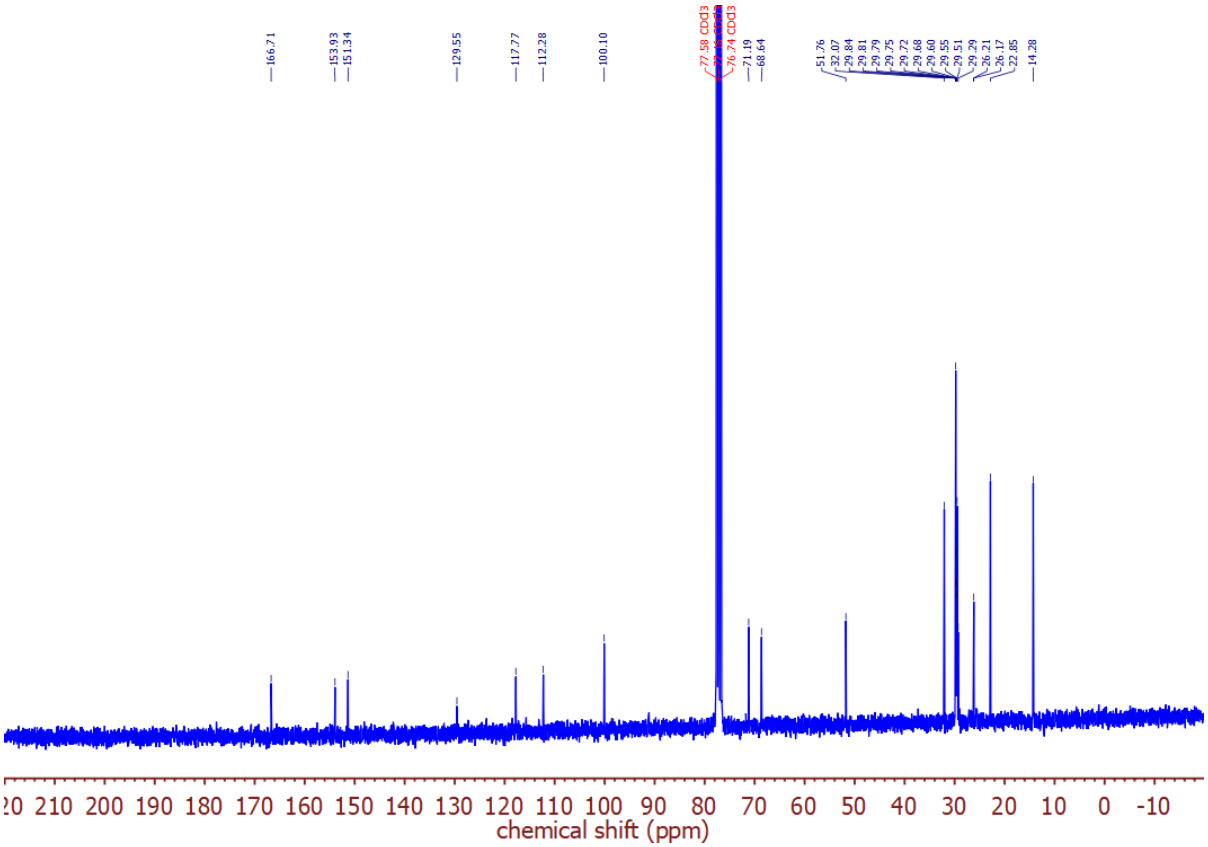


Fig. S40: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 5.

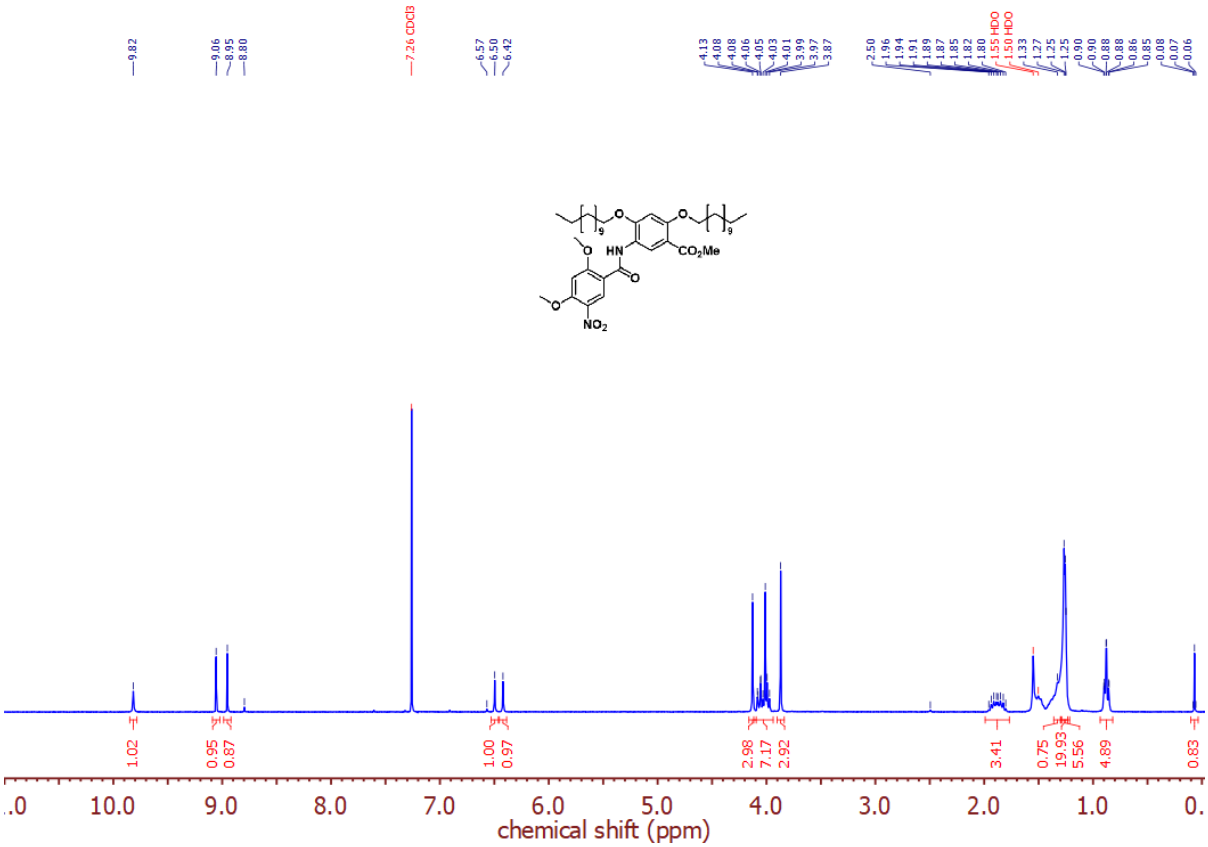


Fig. S41: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 6.

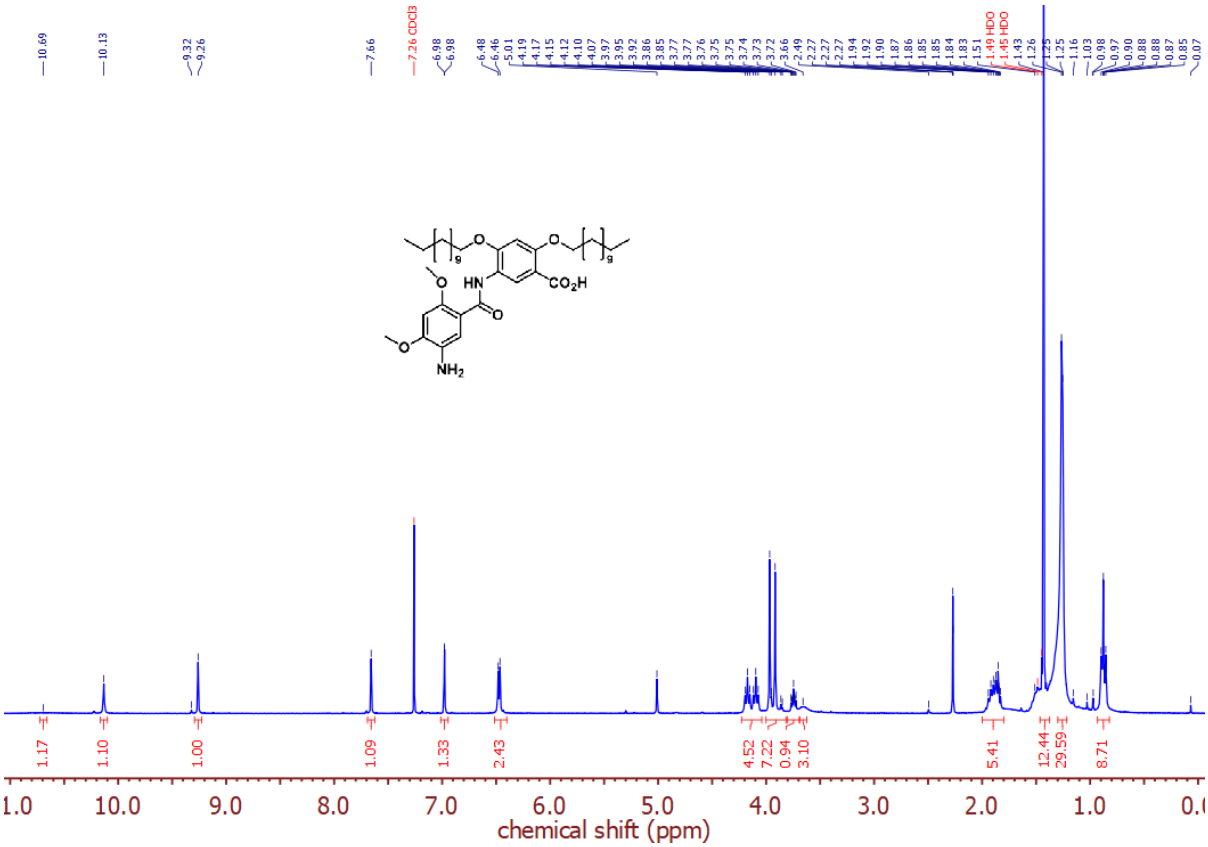


Fig. S42: ^{1}H NMR (300 MHz, $CDCl_3$) of compound B.

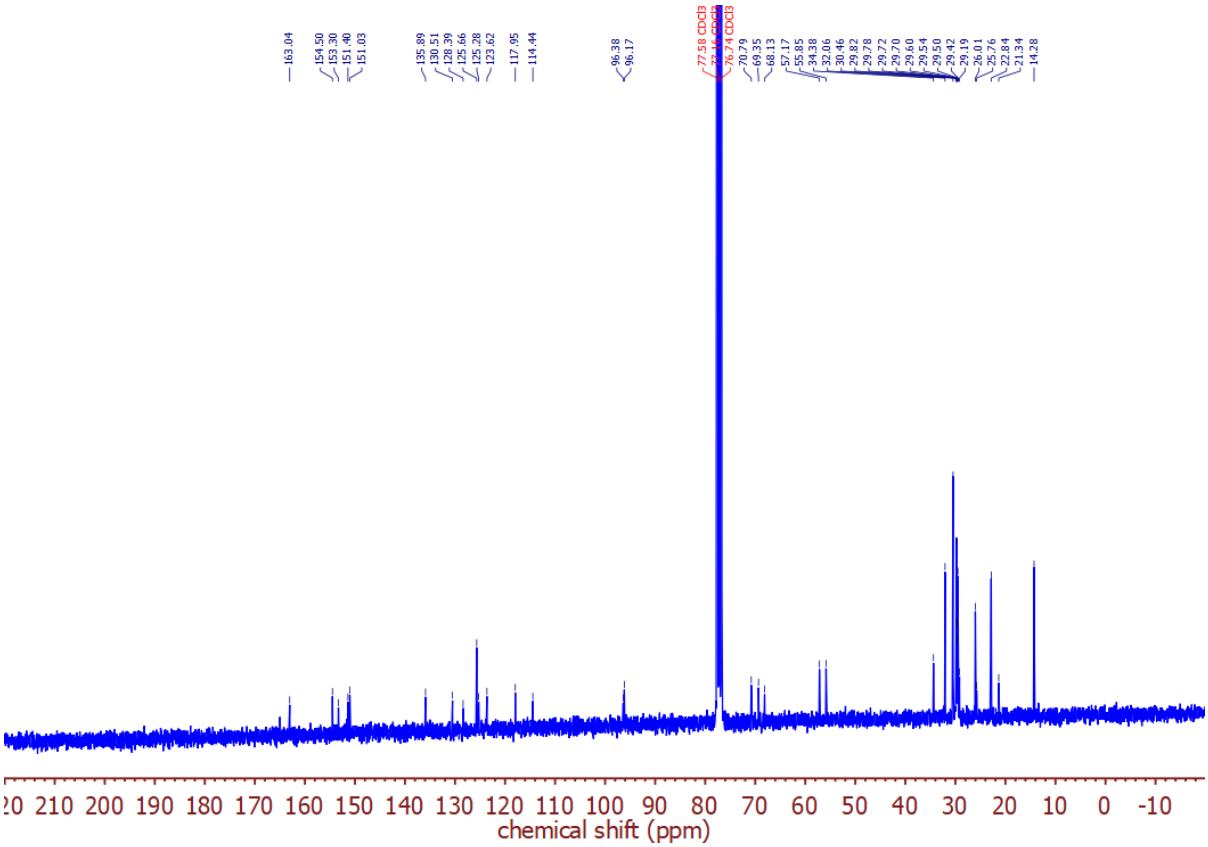


Fig. S43: ^{13}C NMR (101 MHz, $CDCl_3$) of compound B.

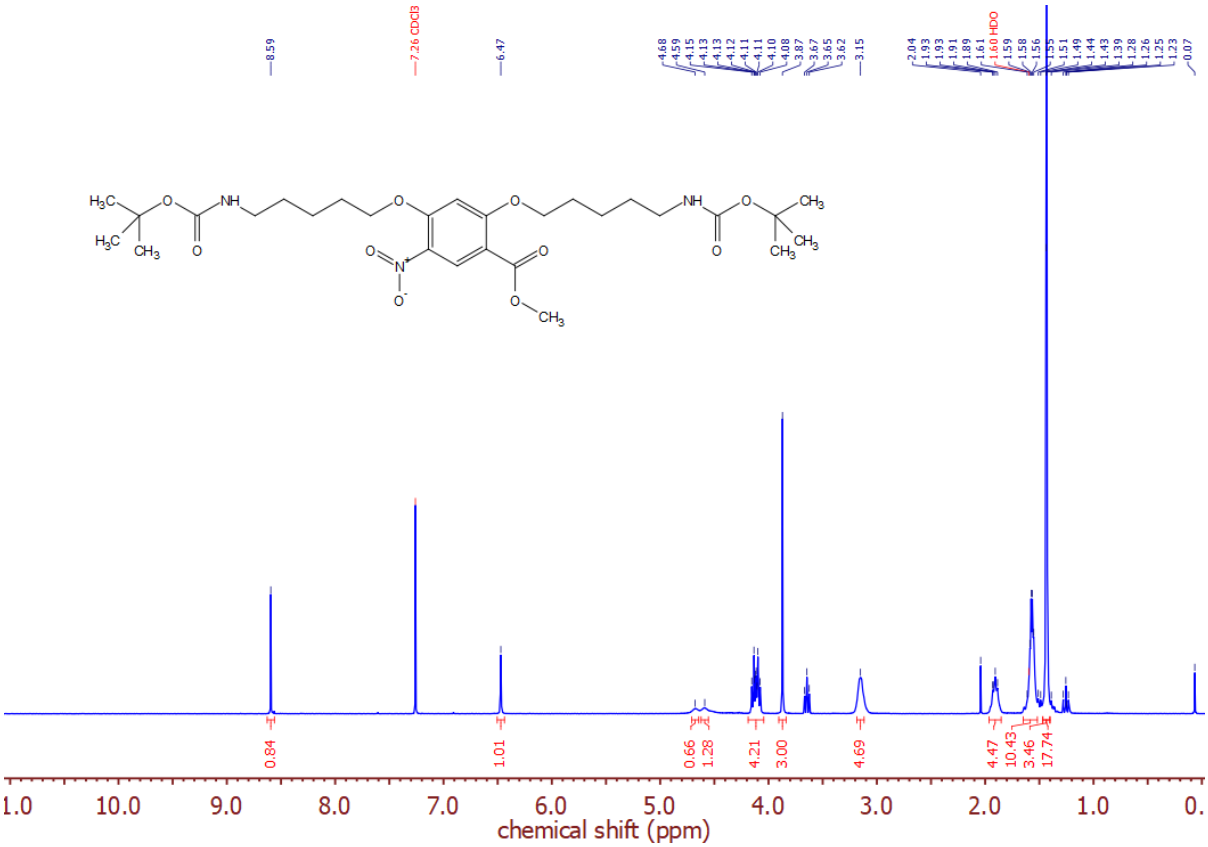


Fig. S44: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 8.

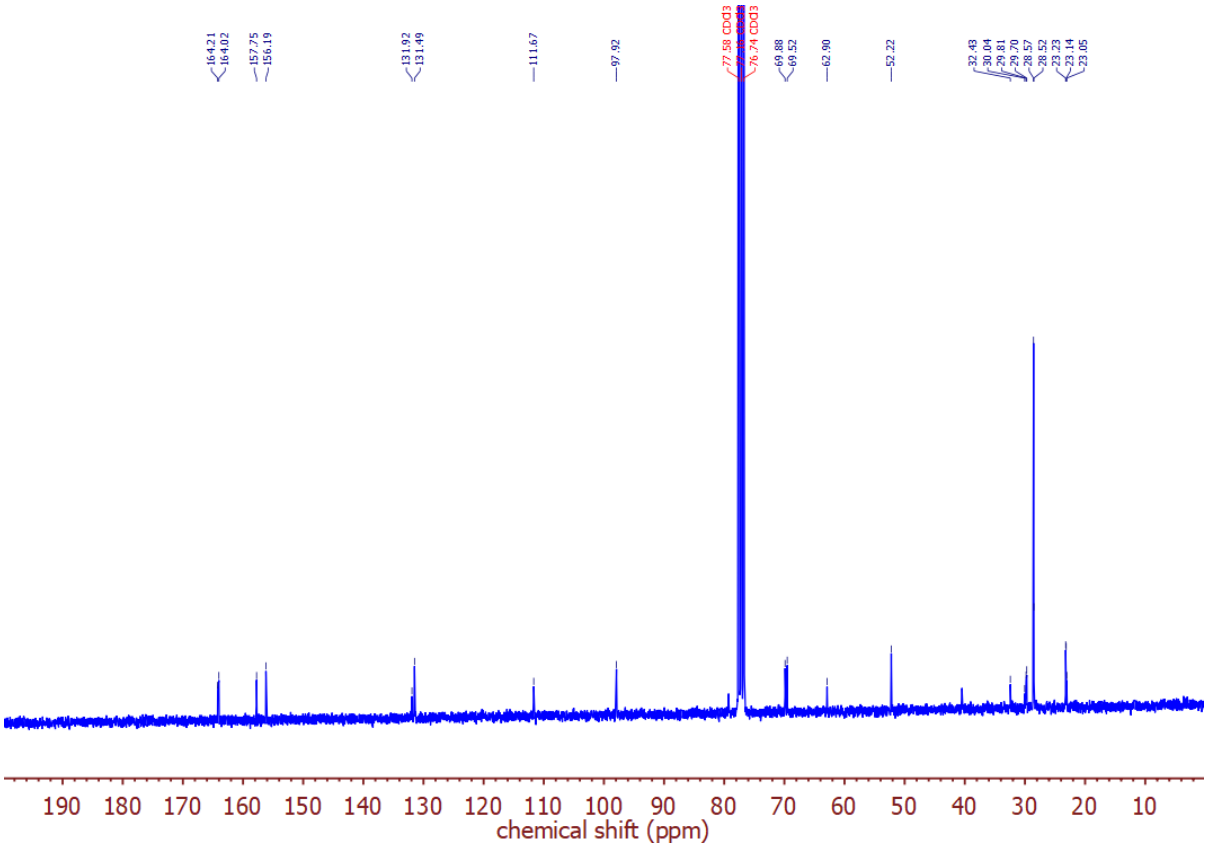


Fig. S45: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 8.

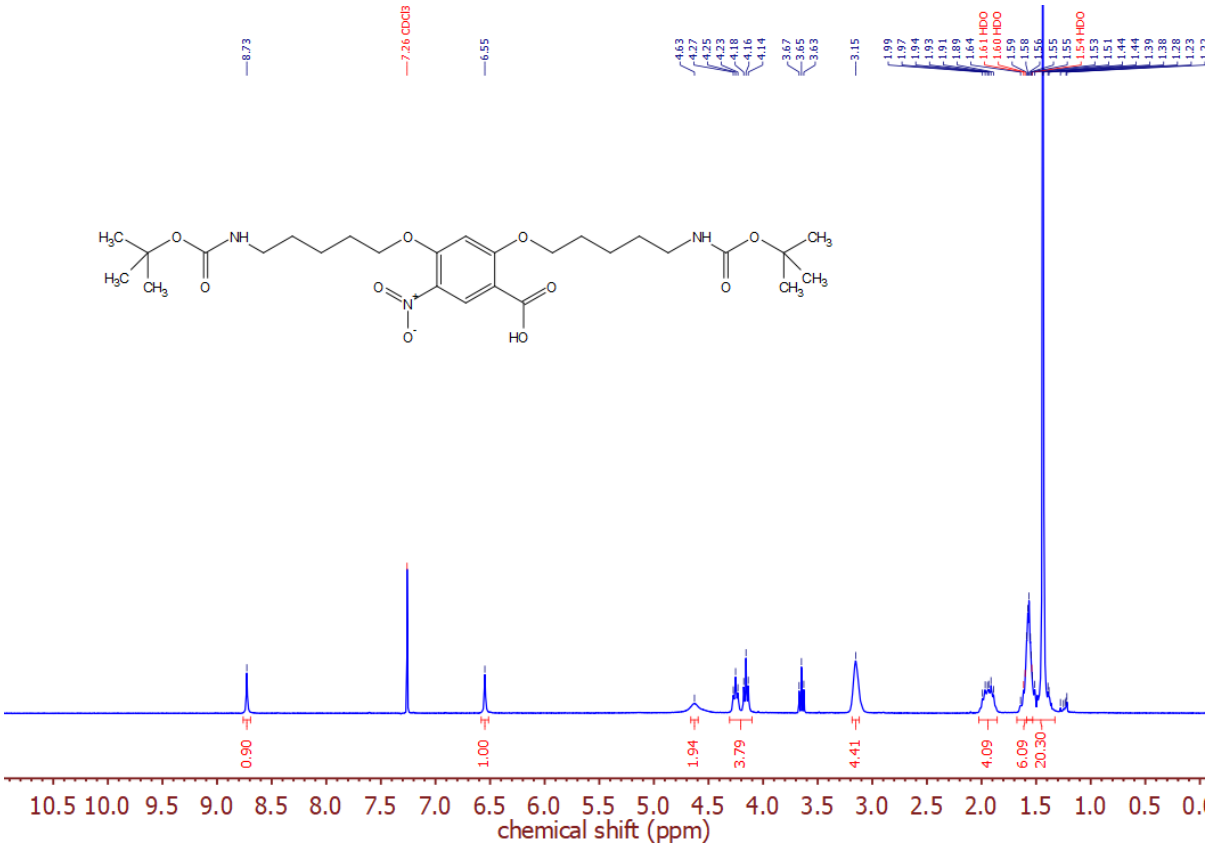


Fig. S46: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 9.

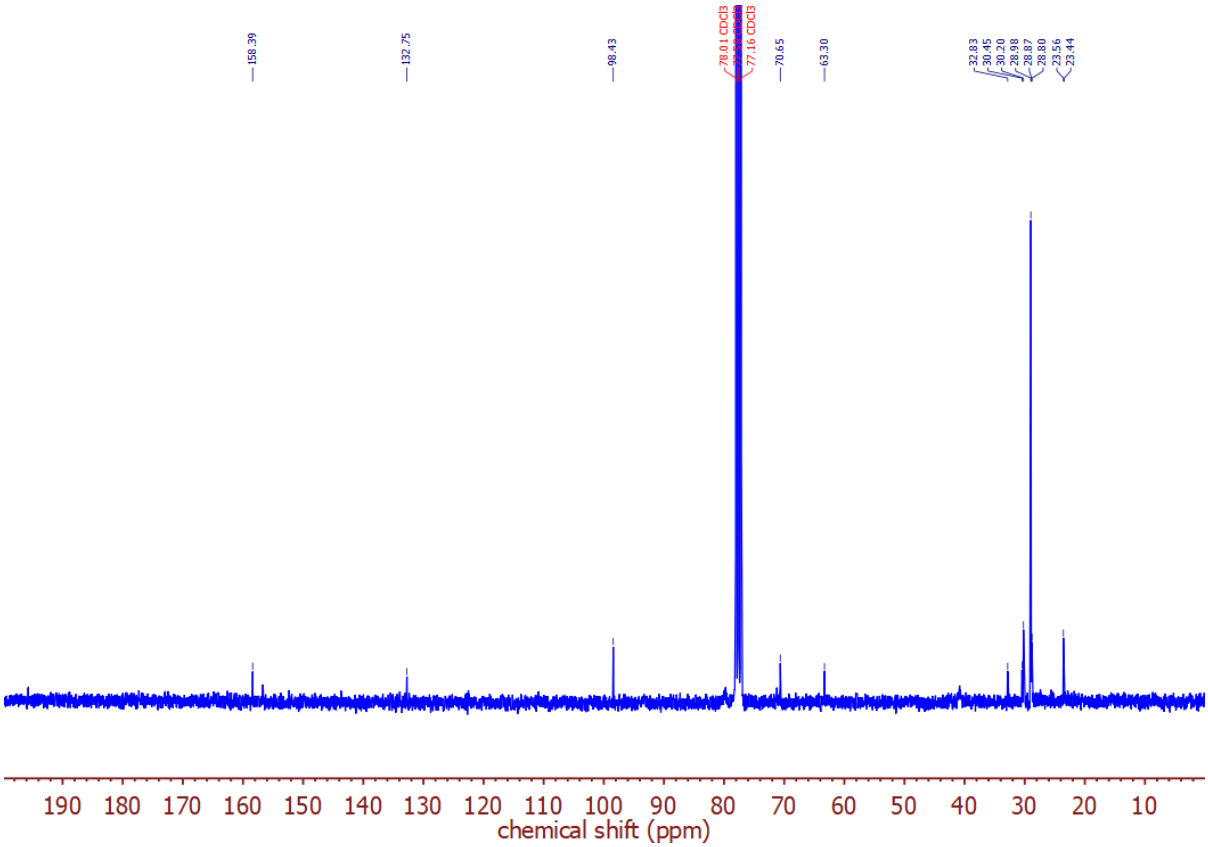


Fig. S47: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 9.

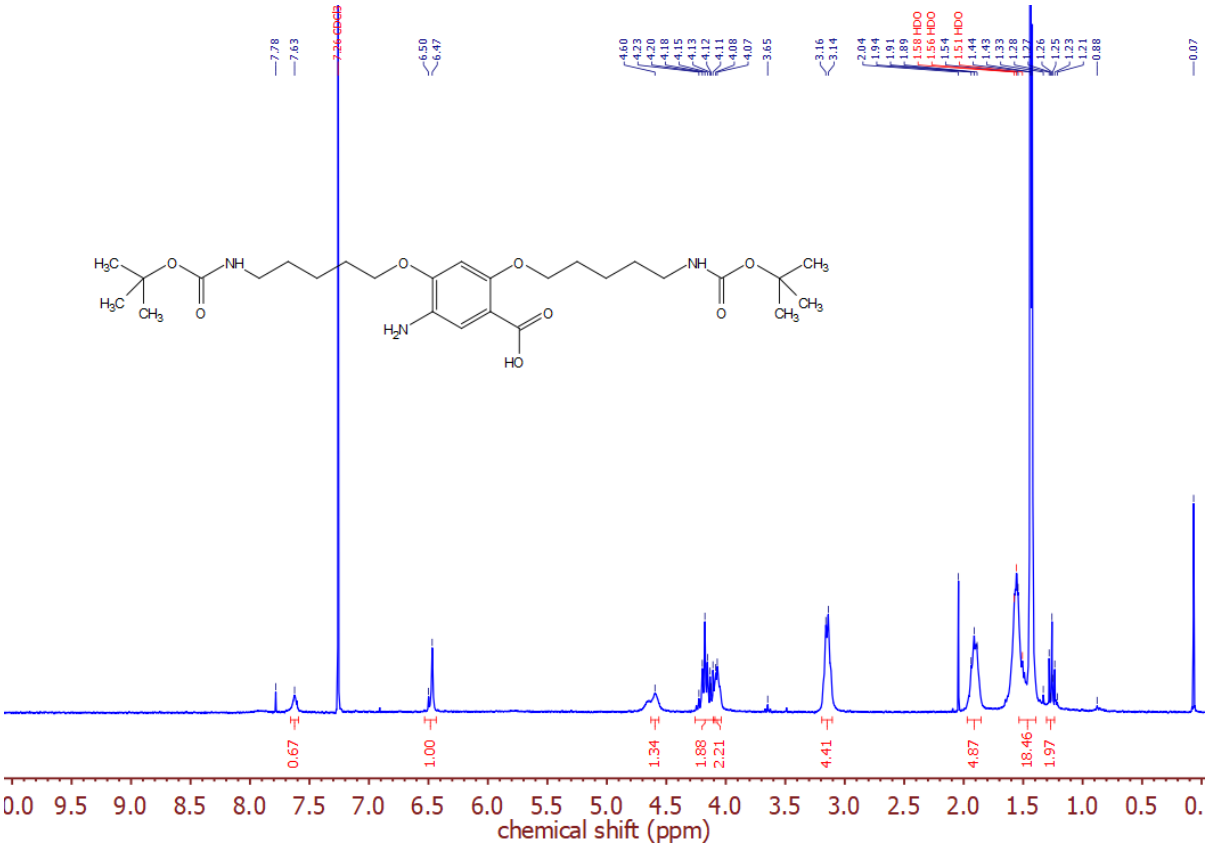


Fig. S48: ^{1}H NMR (300 MHz, $CDCl_3$) of compound C.

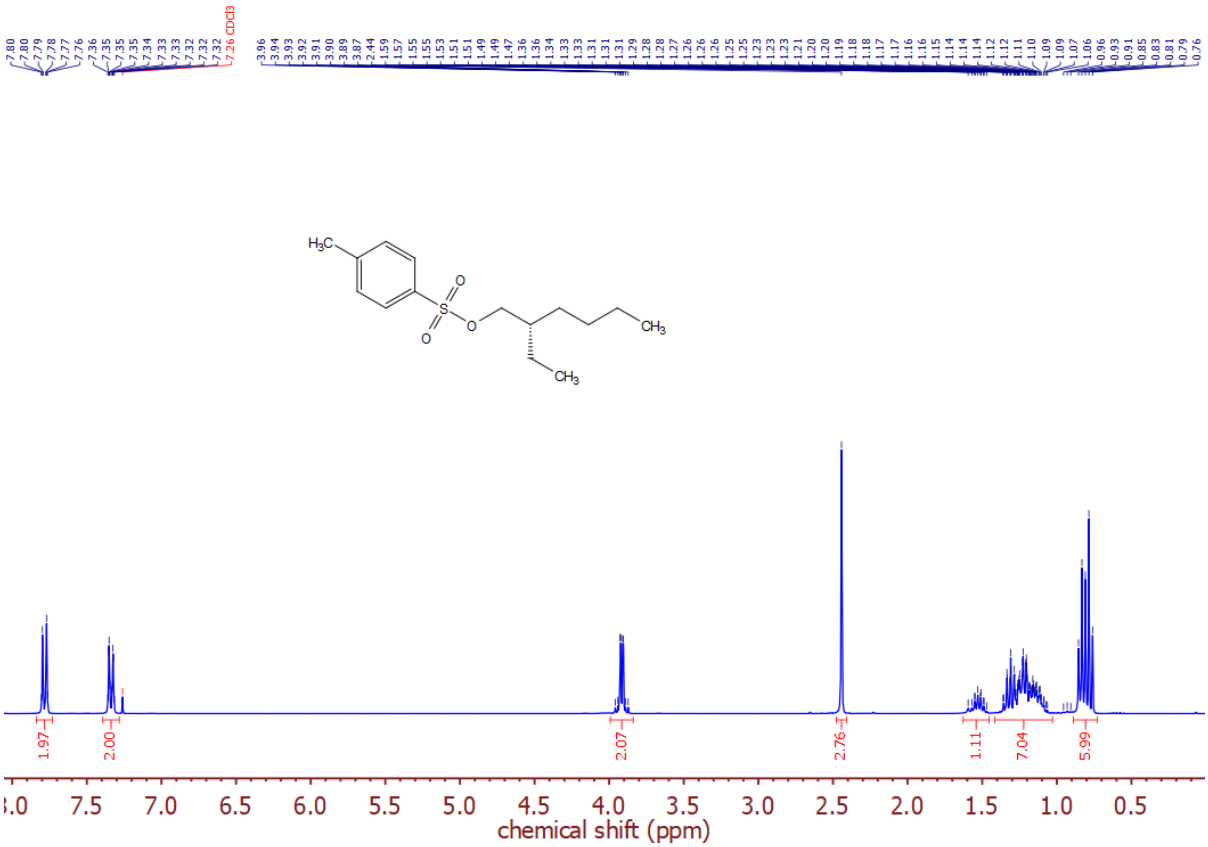


Fig. S49: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 10.

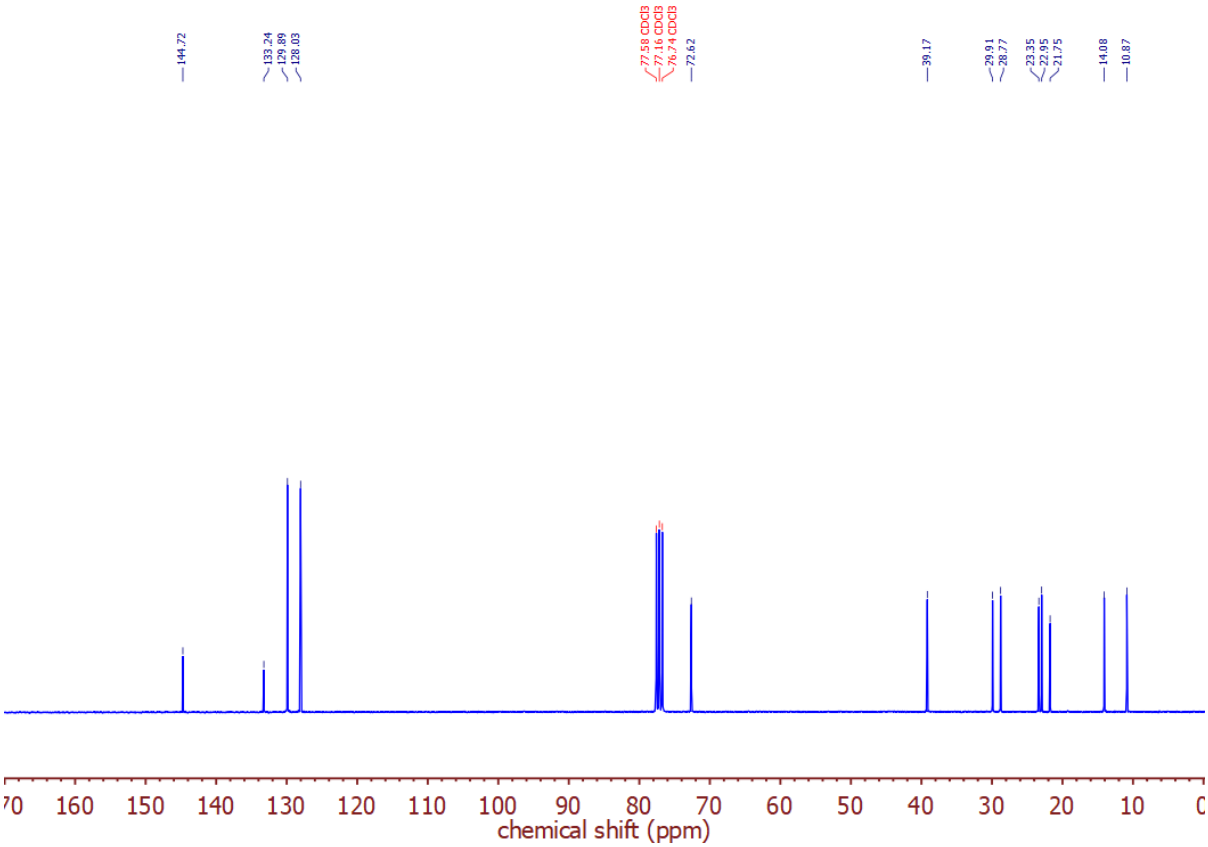


Fig. S50: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 10.

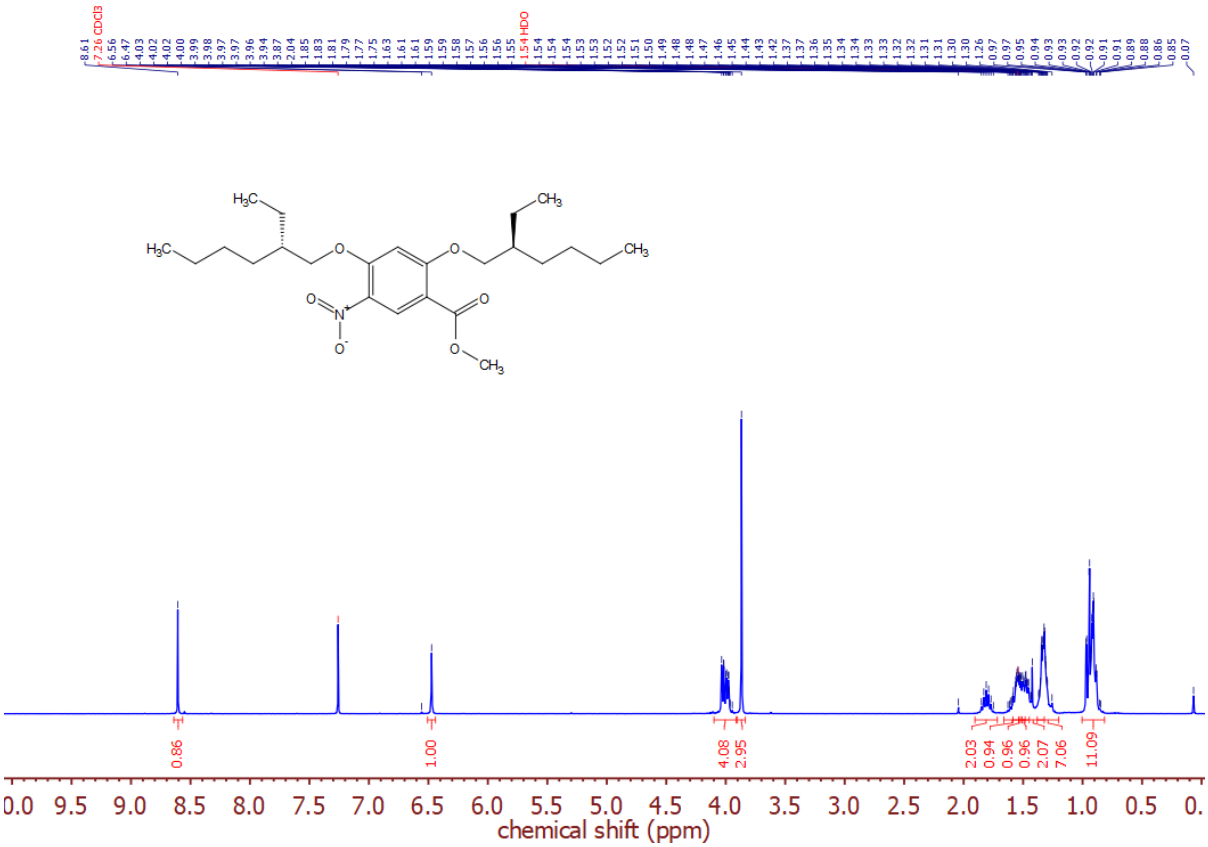


Fig. S51: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 11.

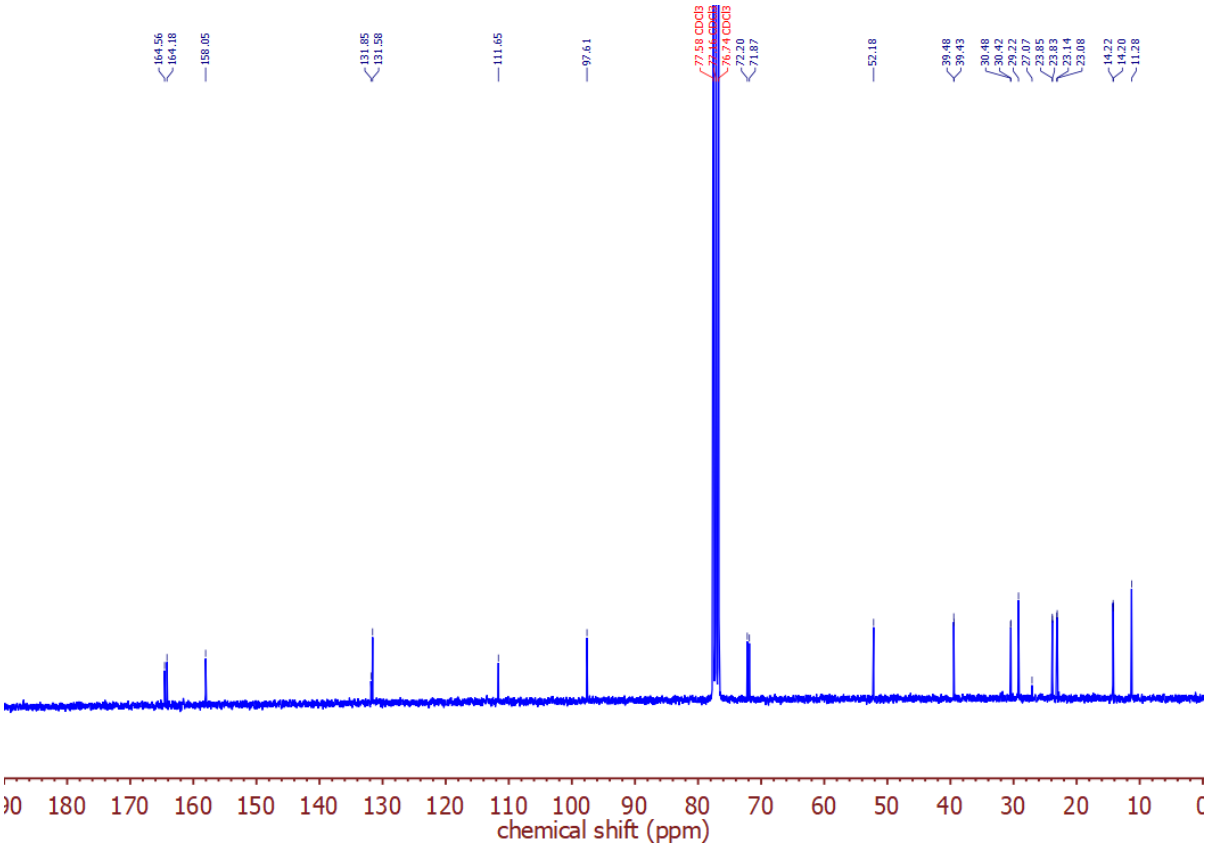


Fig. S52: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 11.

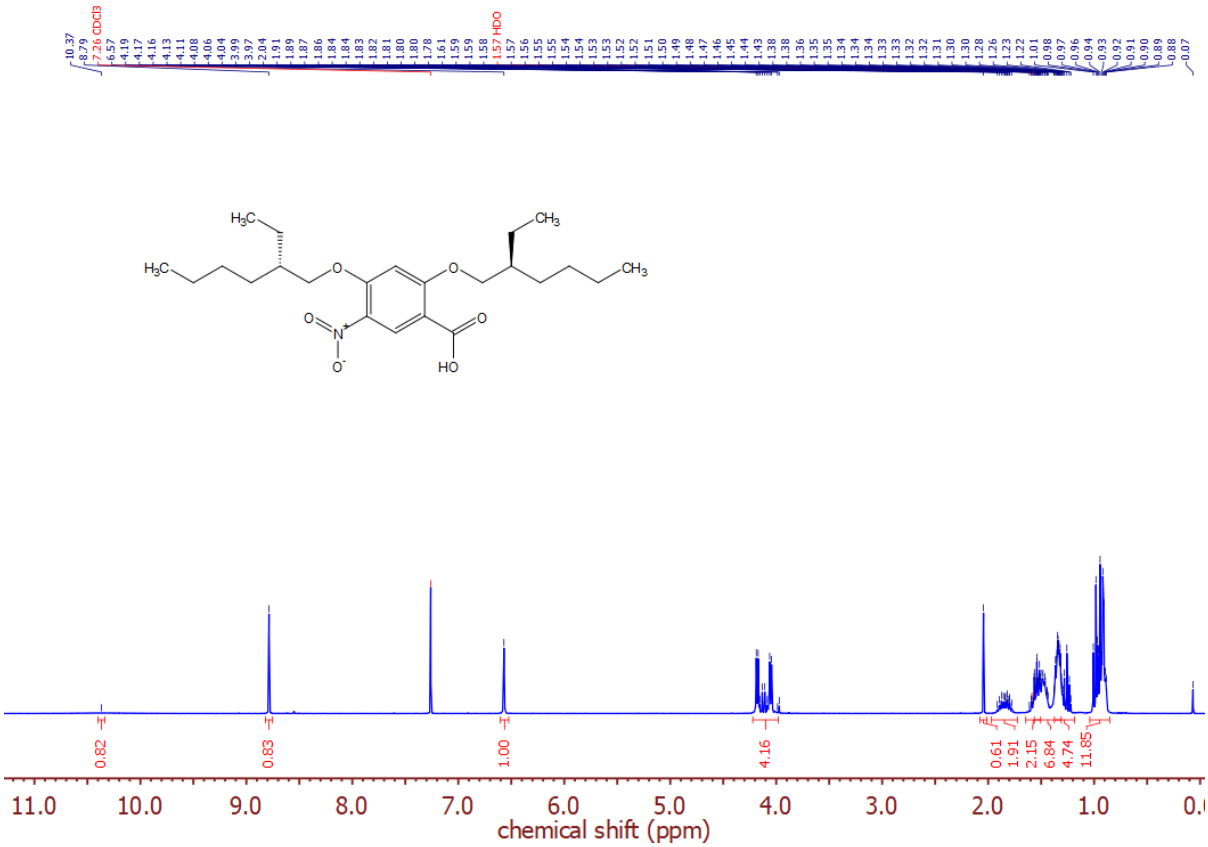


Fig. S53: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 12.

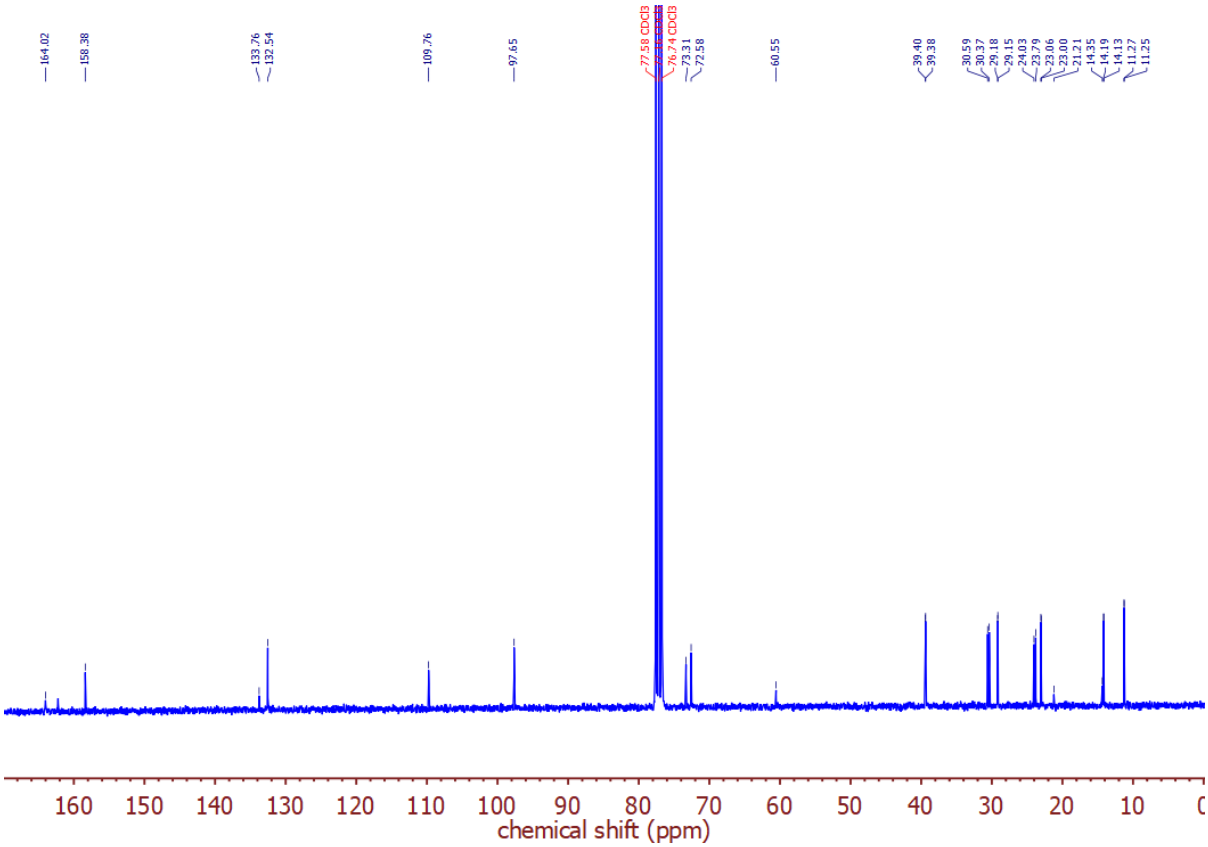


Fig. S54: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 12.

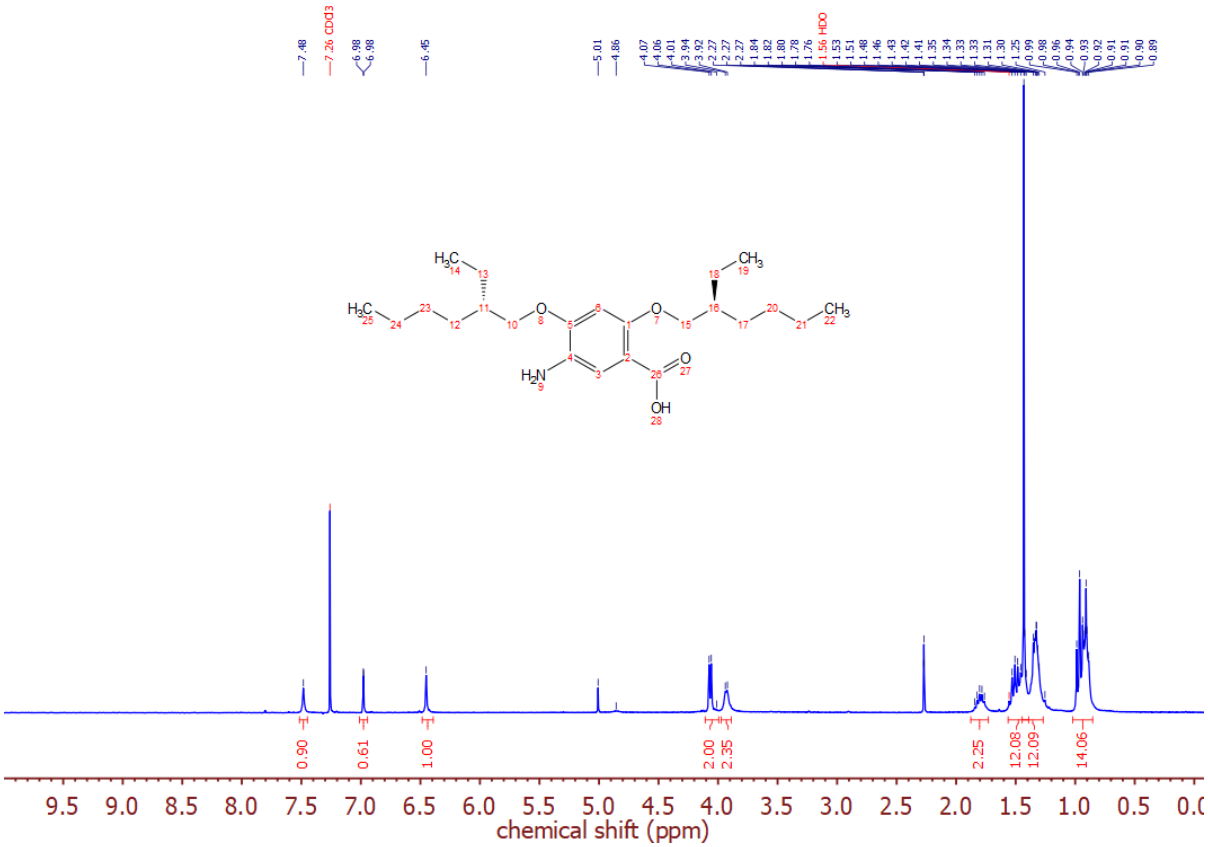


Fig. S55: ^{1}H NMR (300 MHz, $CDCl_3$) of compound E.

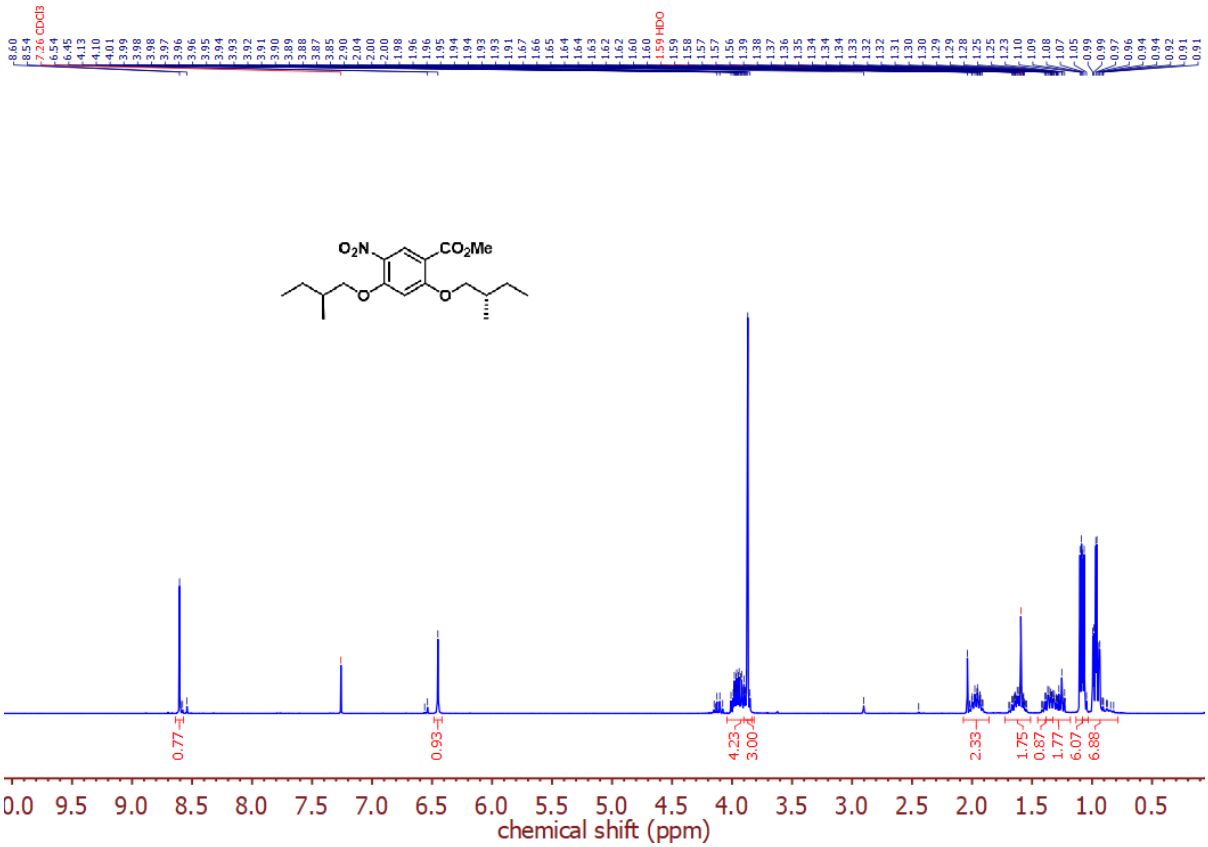


Fig. S56: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 13.

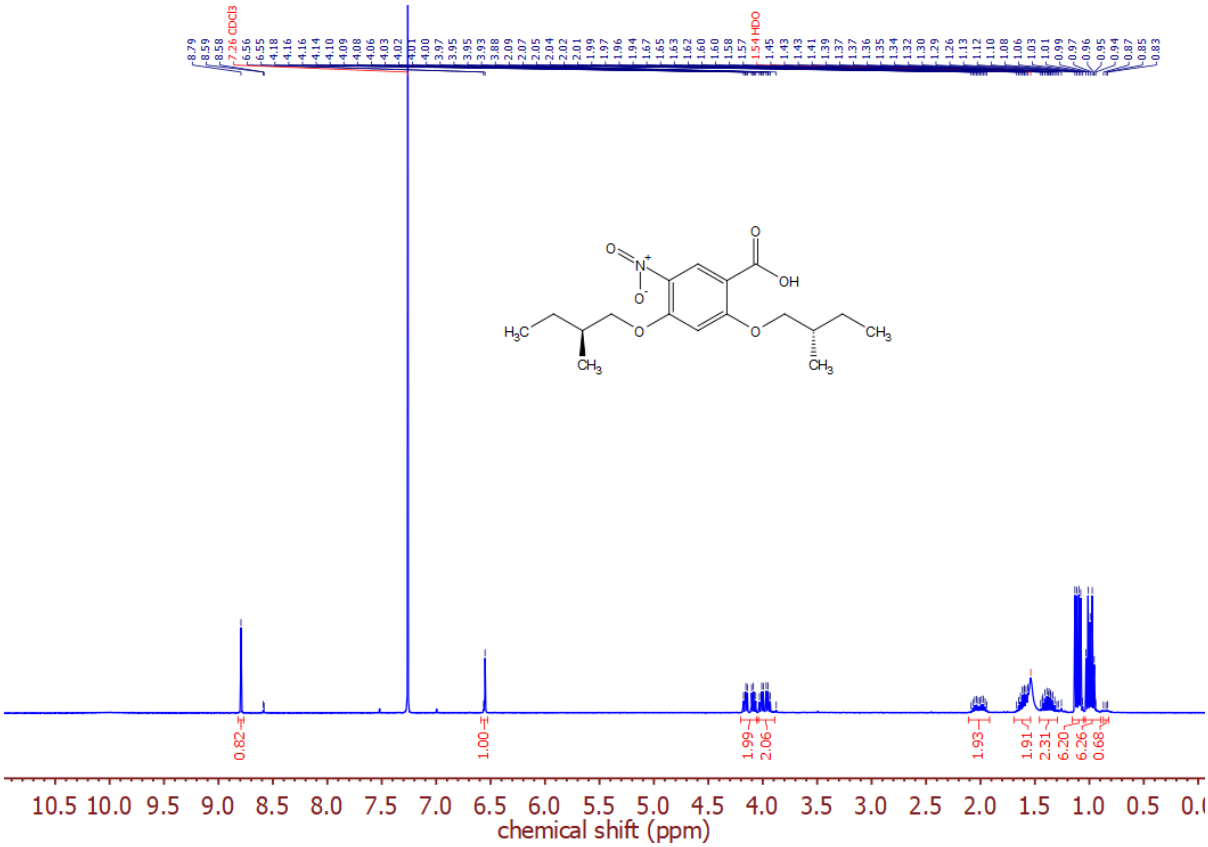


Fig. S57: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 14.

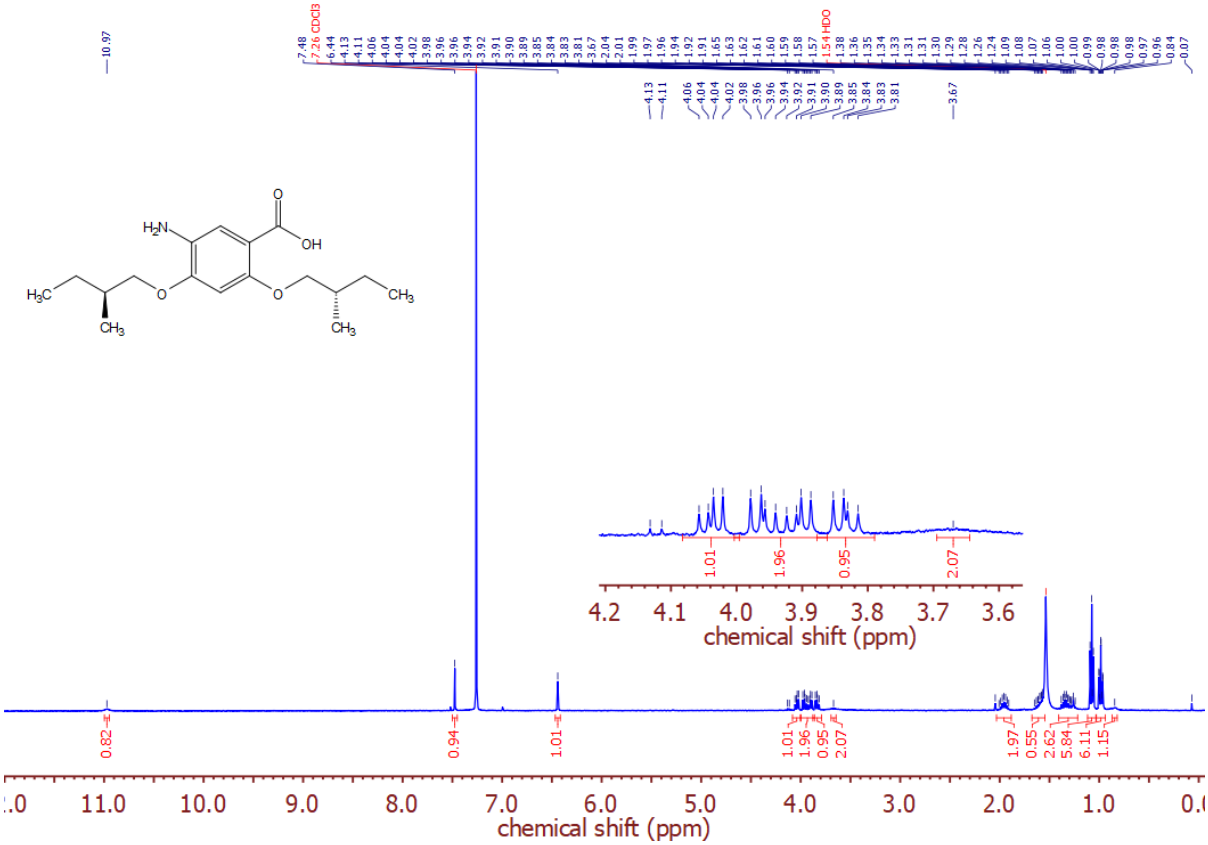


Fig. S58: ^{1}H NMR (300 MHz, $CDCl_3$) of compound F.

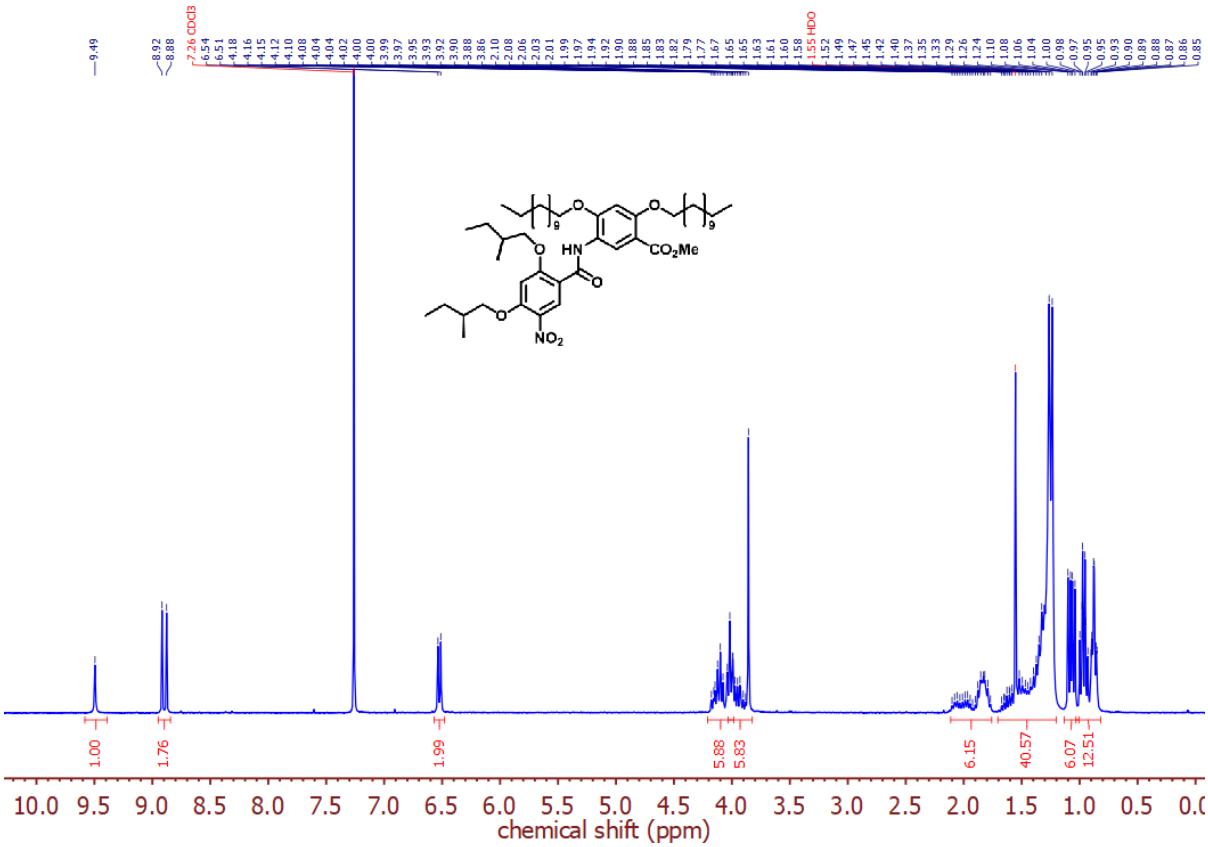


Fig. S59: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 15.

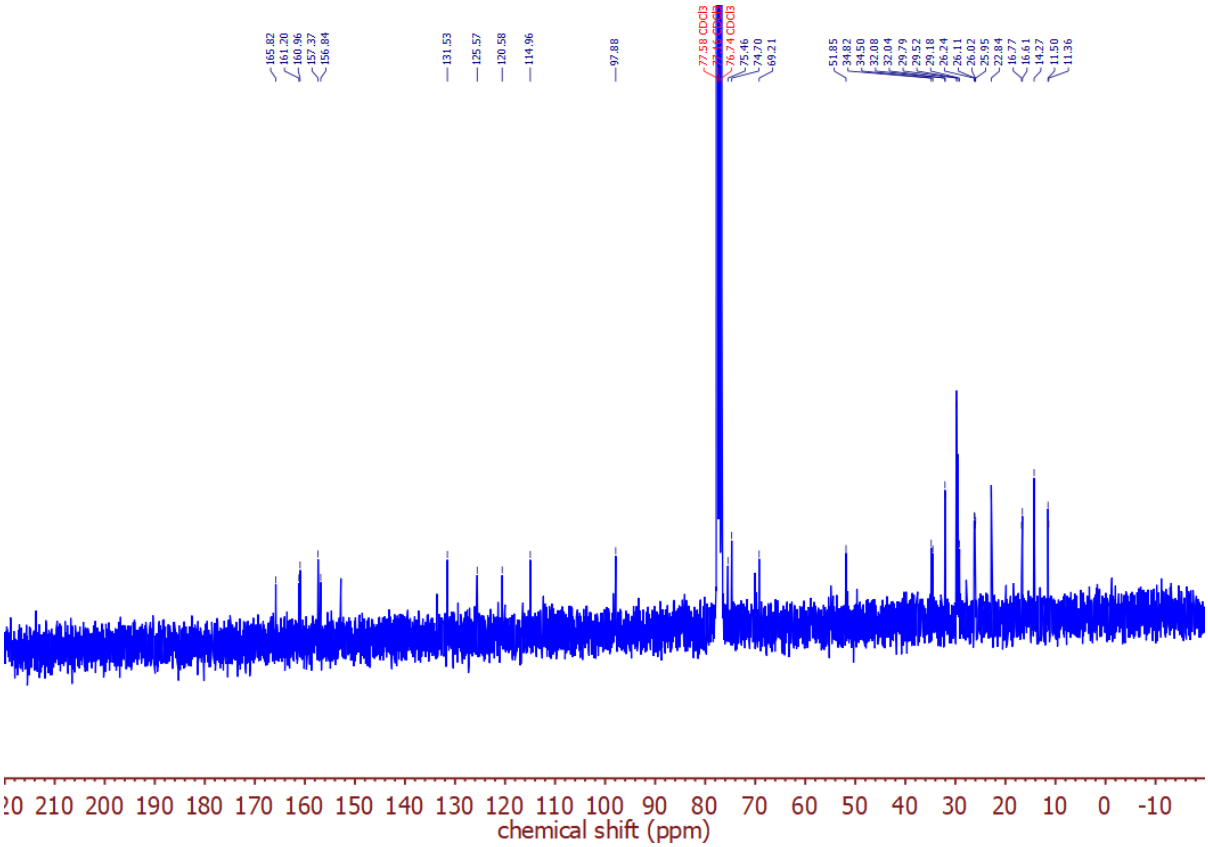


Fig. S60: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 15.

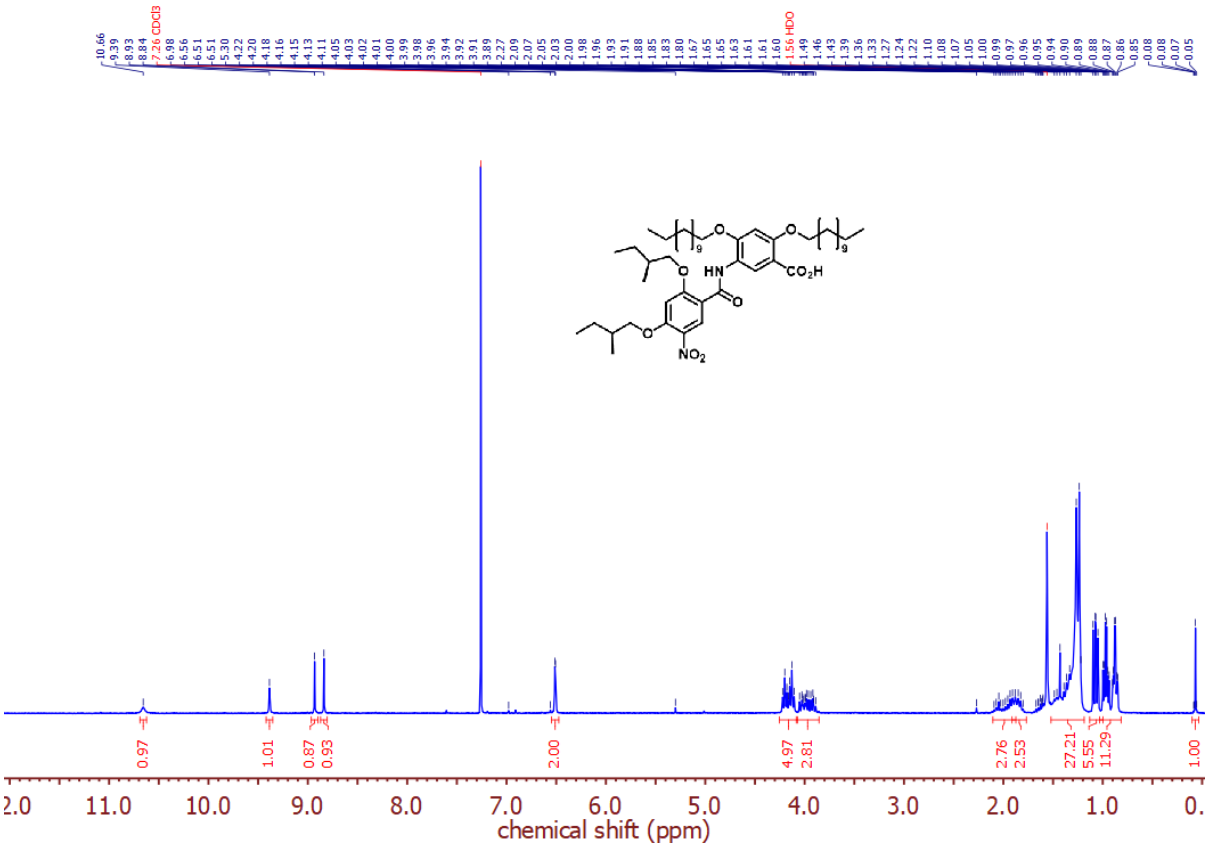


Fig. S61: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 16.

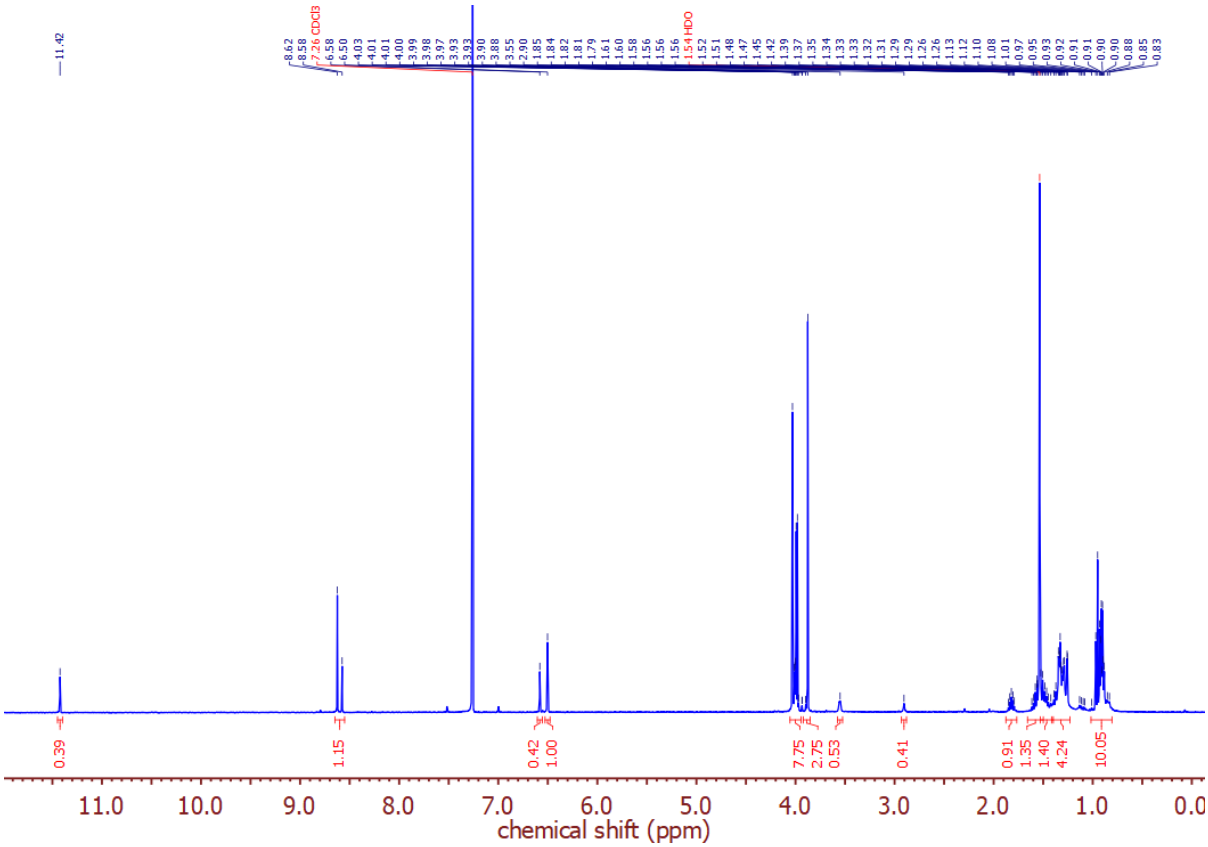


Fig. S62: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 17.

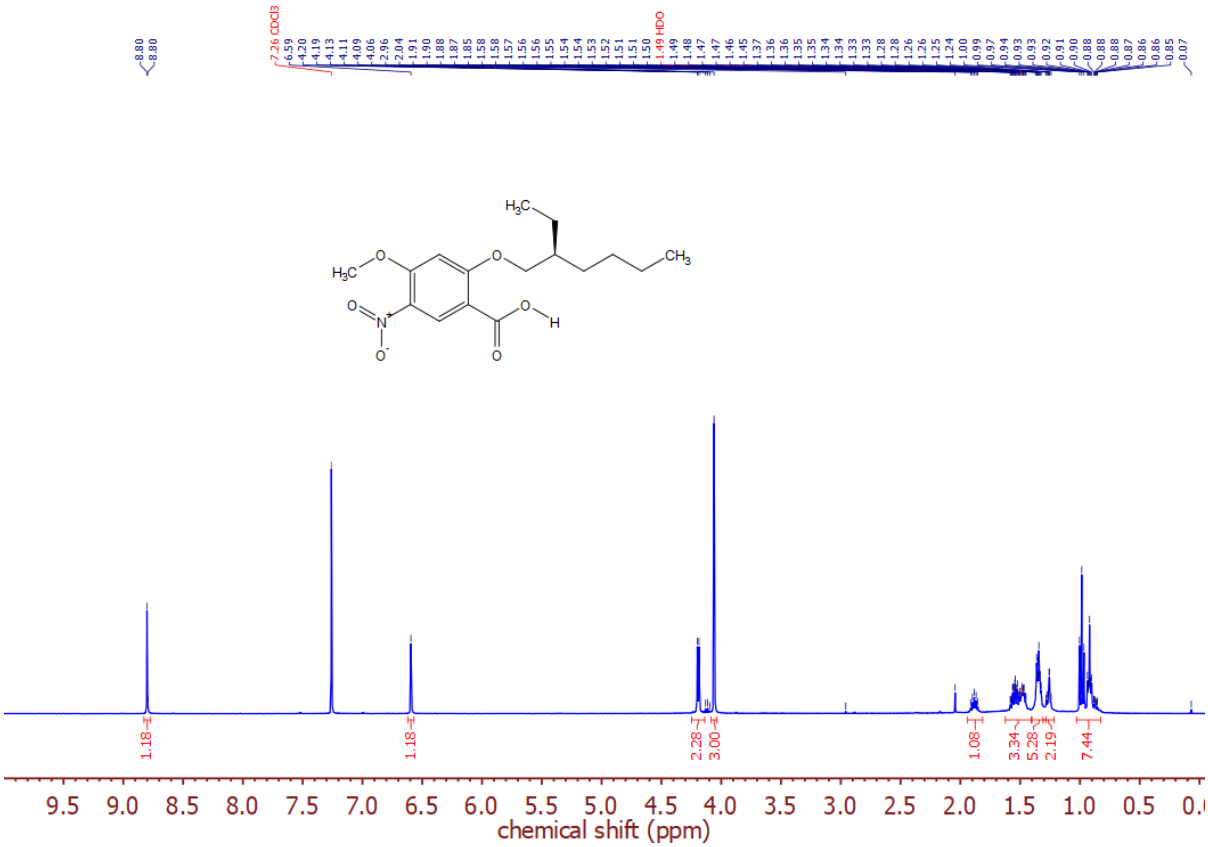


Fig. S63: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 18.

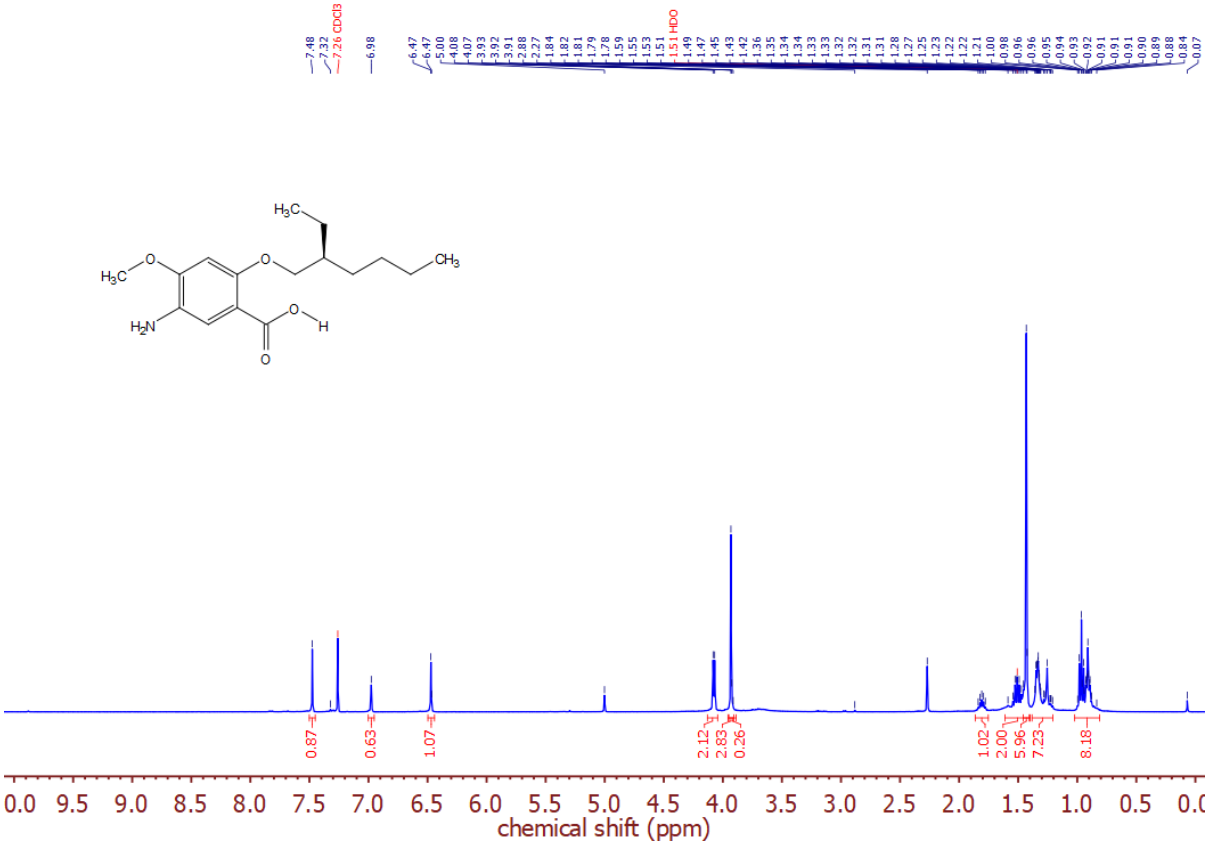


Fig. S64: ^{1}H NMR (300 MHz, $CDCl_3$) of compound H.

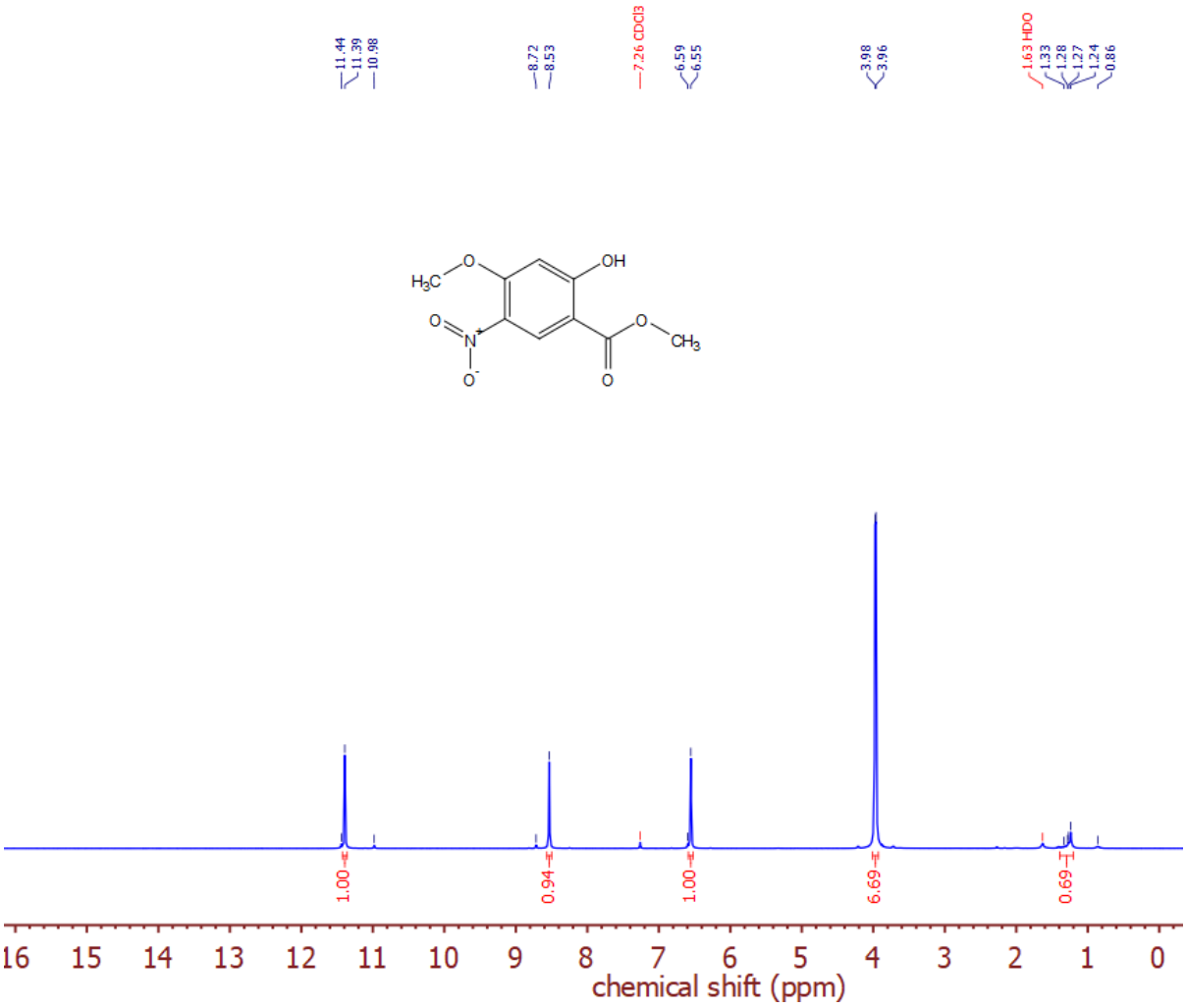


Fig. S65: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 19.

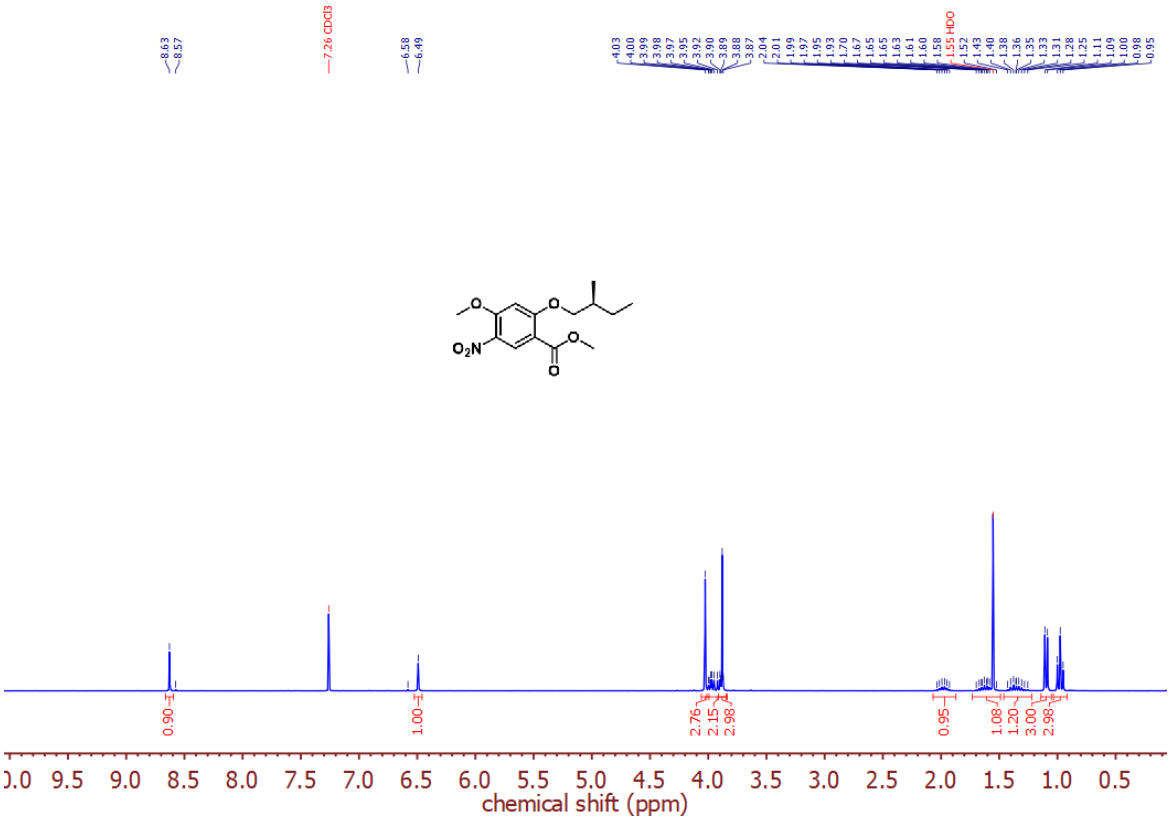


Fig. S66: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 20.

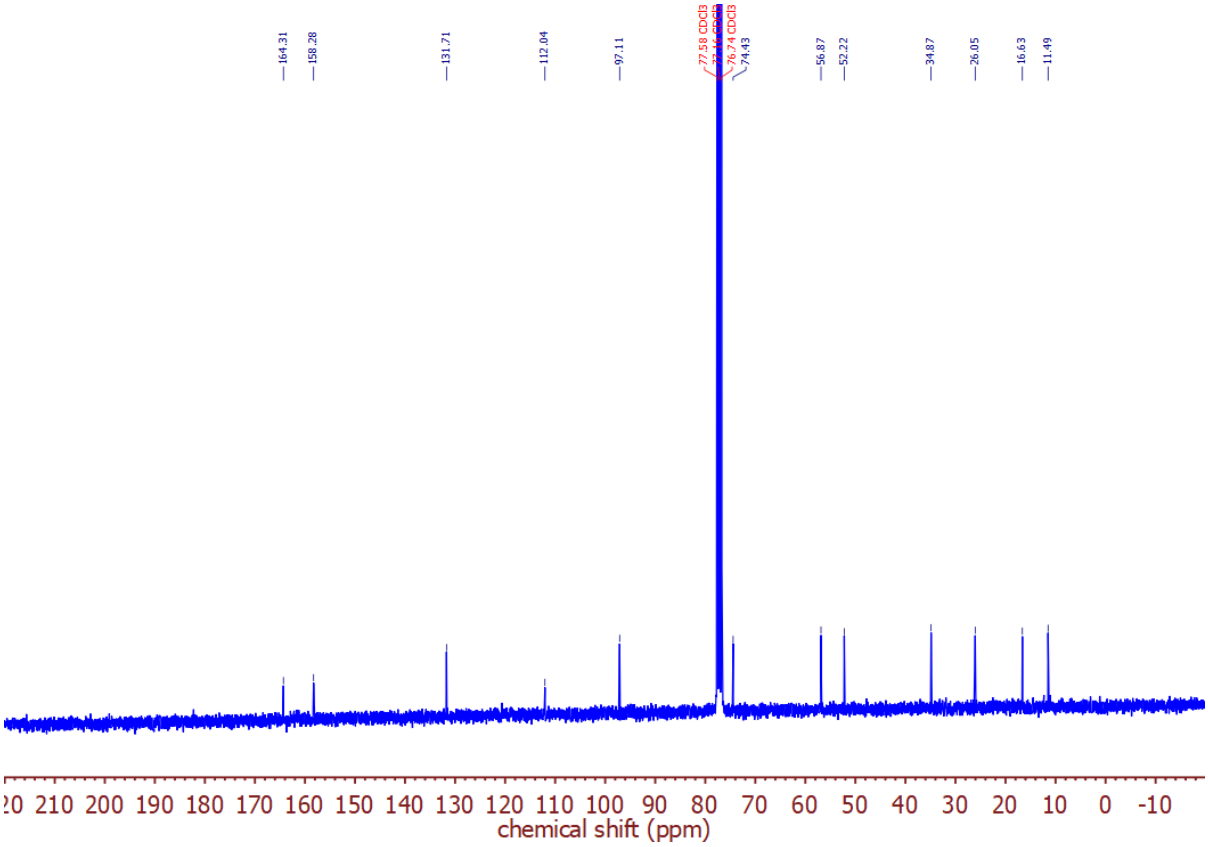


Fig. S67: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 20.

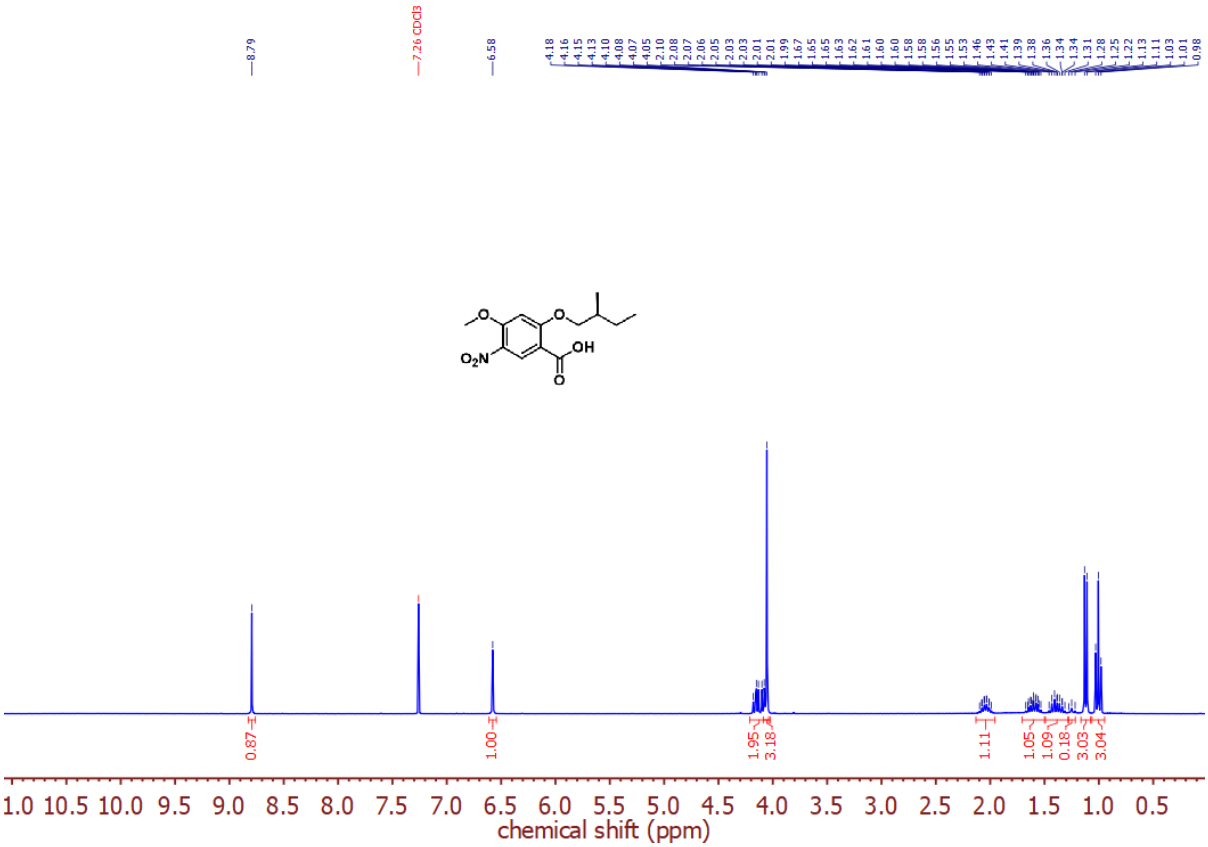


Fig. S68: ^{1}H NMR (300 MHz, $CDCl_3$) of intermediate 21.

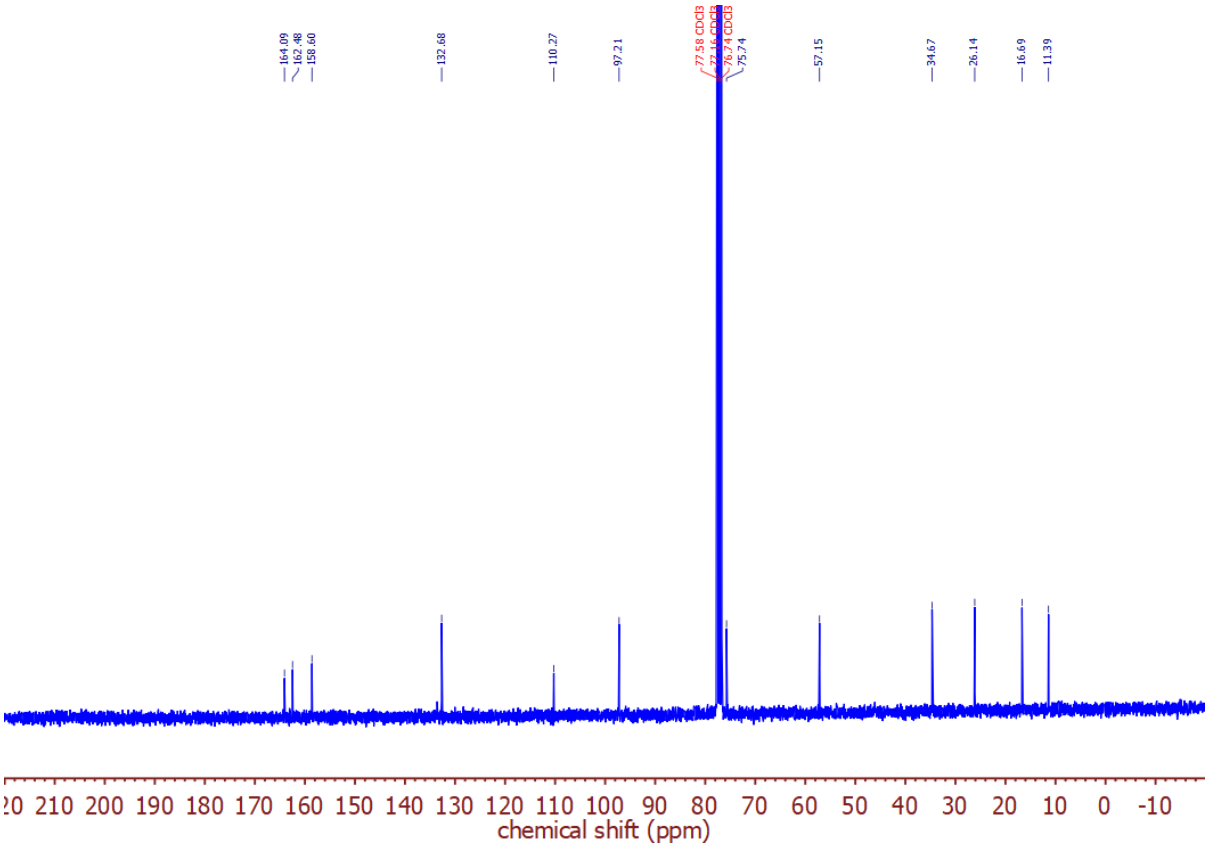


Fig. S69: ^{13}C NMR (101 MHz, $CDCl_3$) of intermediate 21.

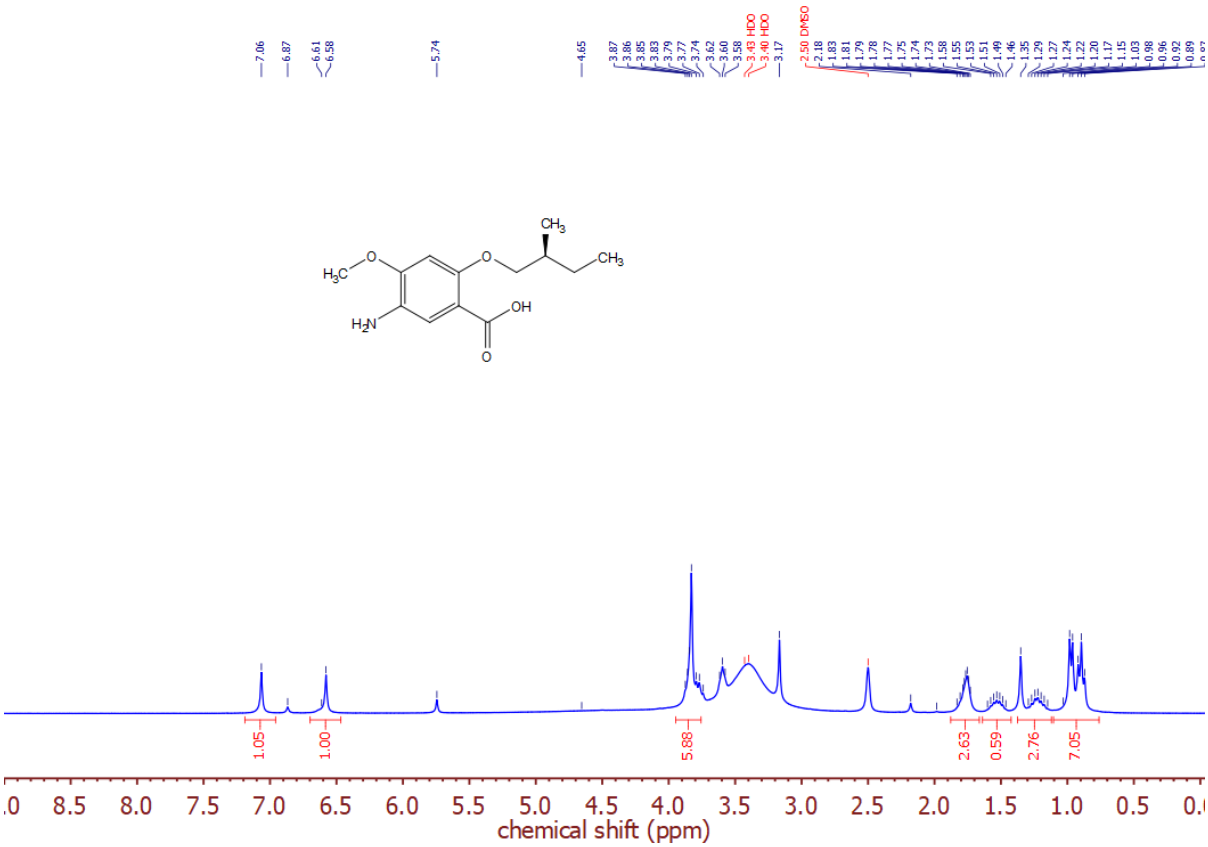


Fig. S70: ^{1}H NMR (300 MHz, DMSO-D6) of compound I.

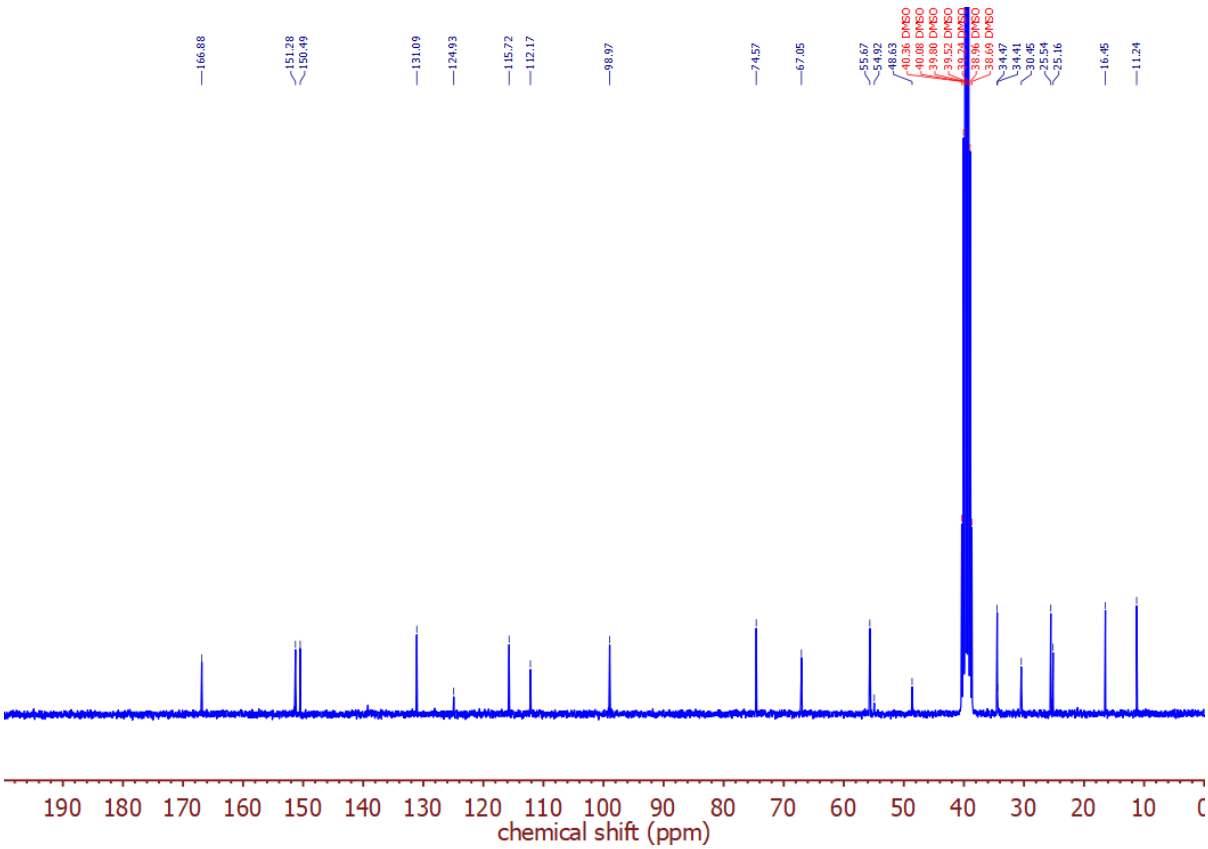


Fig. S71: ^{13}C NMR (101 MHz, DMSO-D6) of compound I.

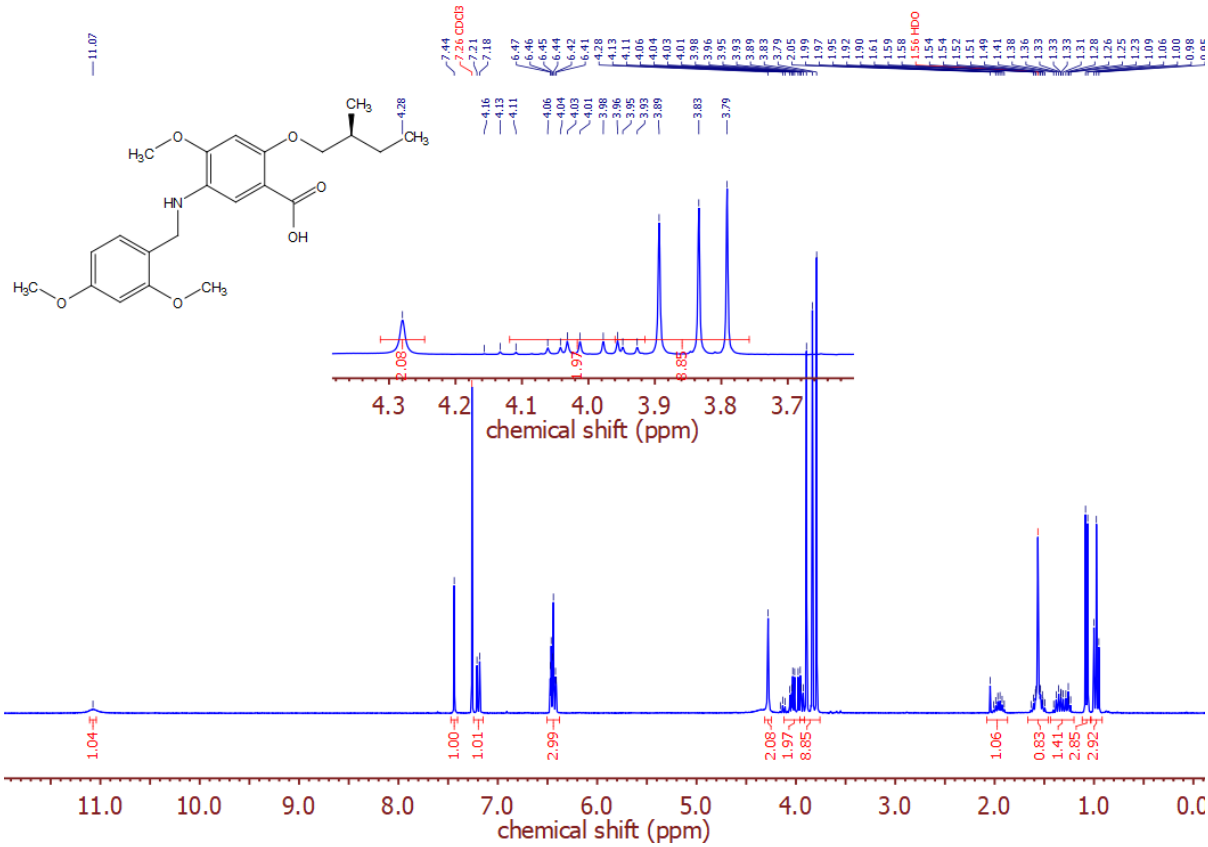


Fig. S72: ^{1}H NMR (300 MHz, DMSO-D6) of compound J.

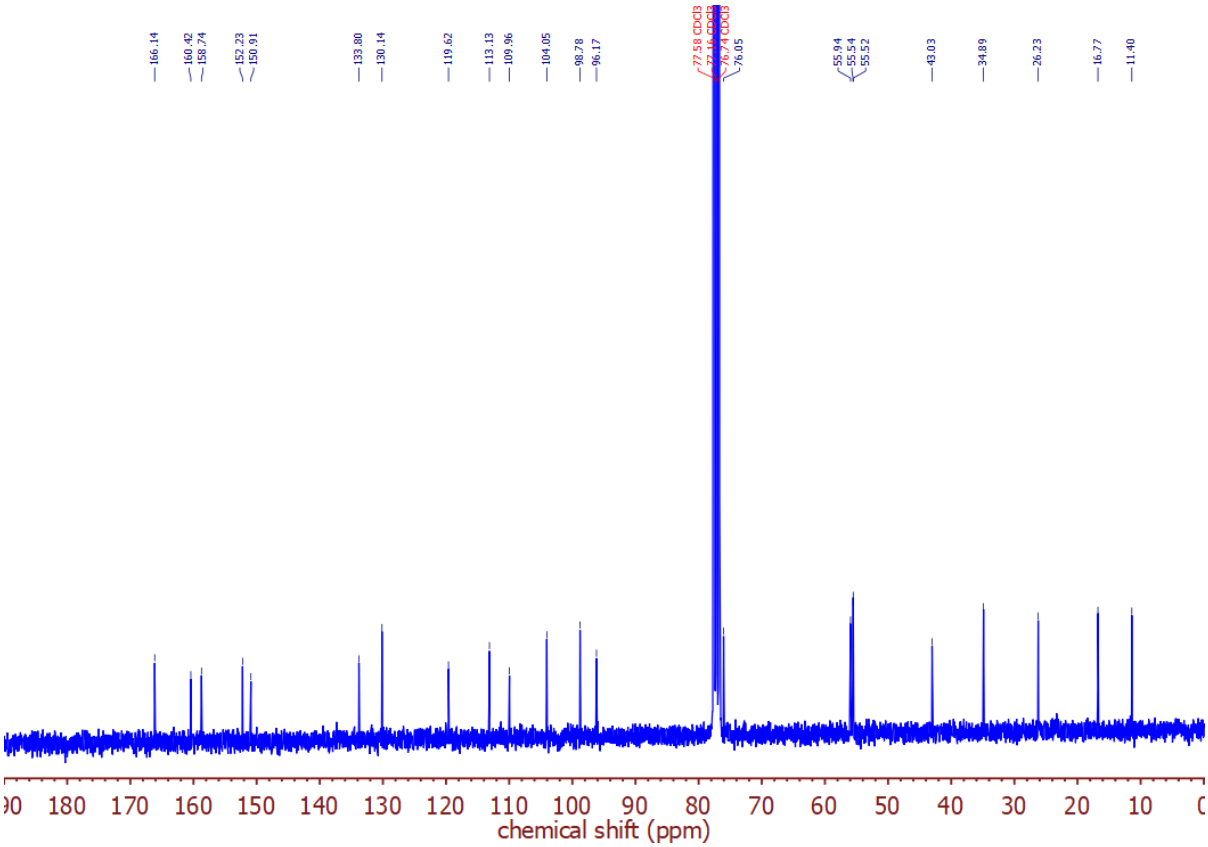


Fig. S73: ^{13}C NMR (101 MHz, $CDCl_3$) of compound J.

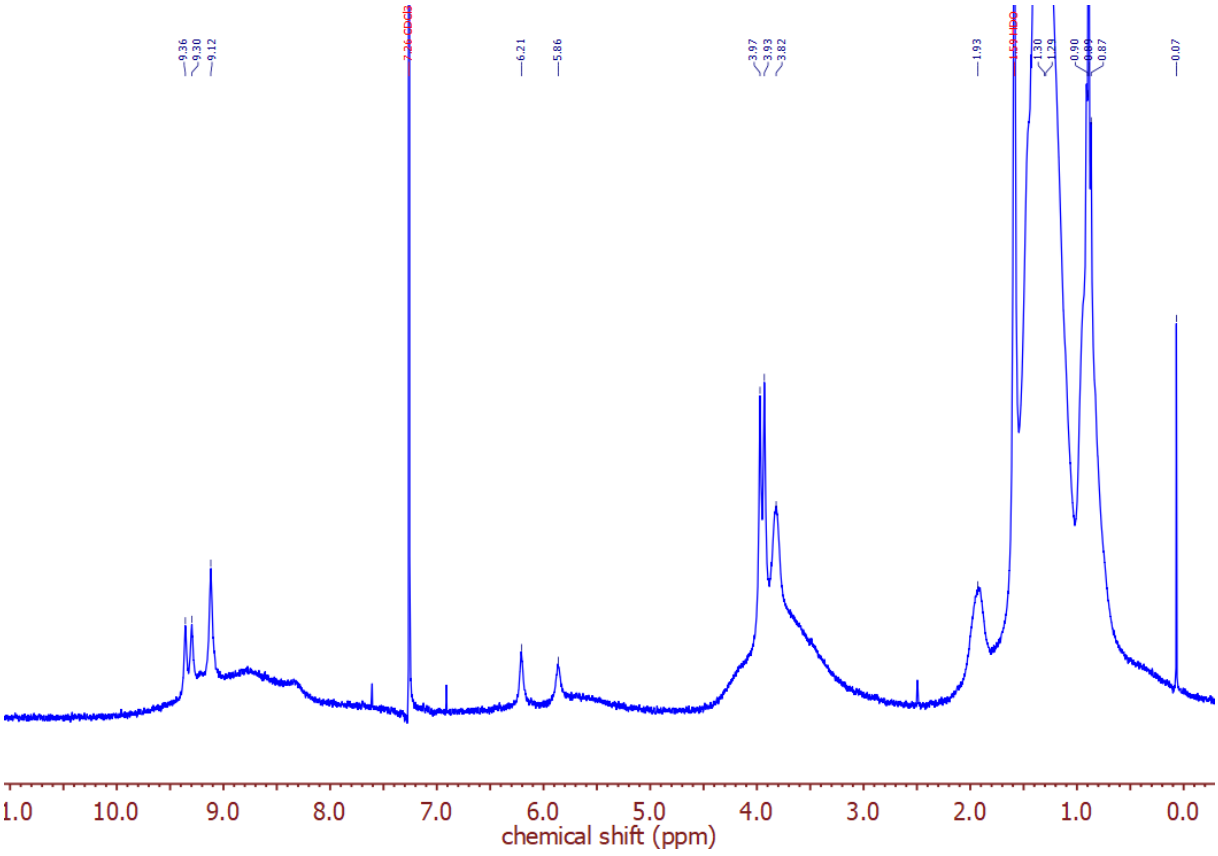


Fig. S74: ^{1}H NMR (300 MHz, $CDCl_3$) of PB1.

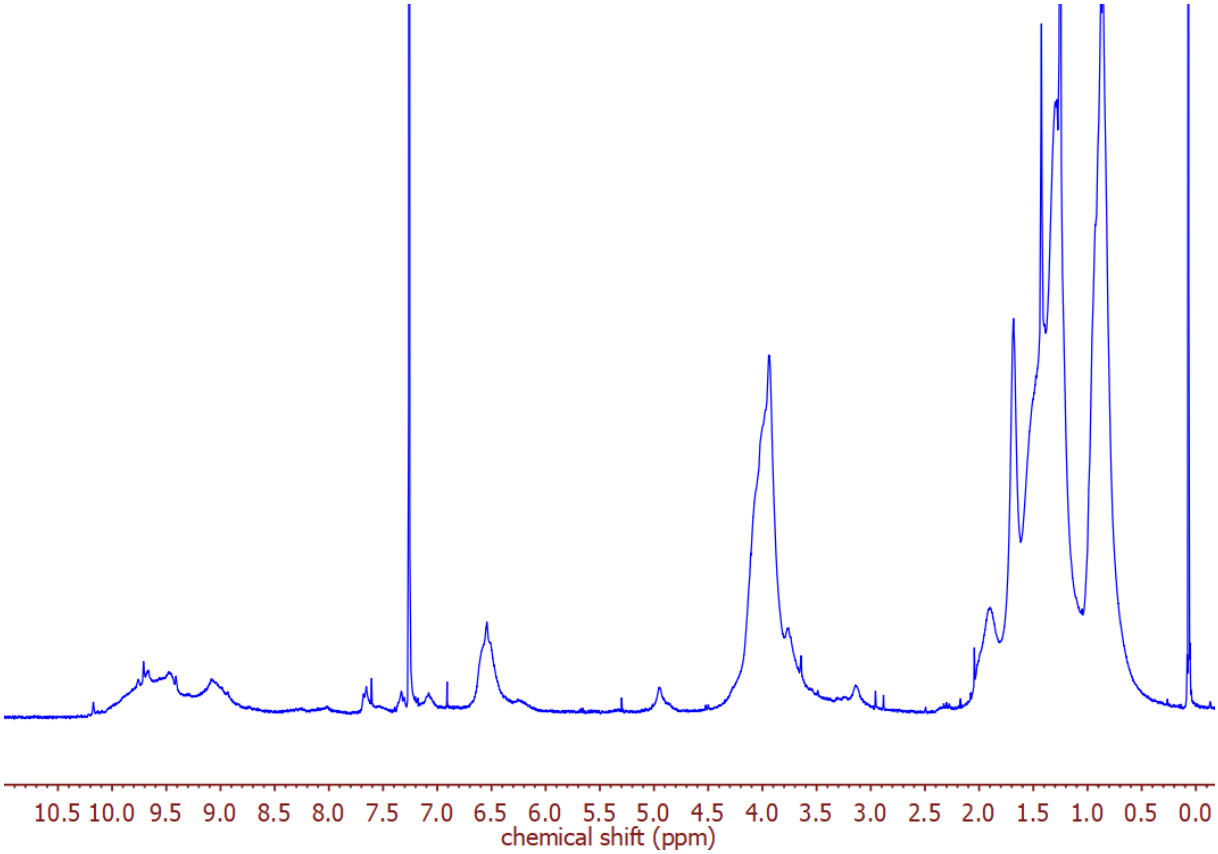


Fig. S75: ^{1}H NMR (300 MHz, $CDCl_3$) of PH1.

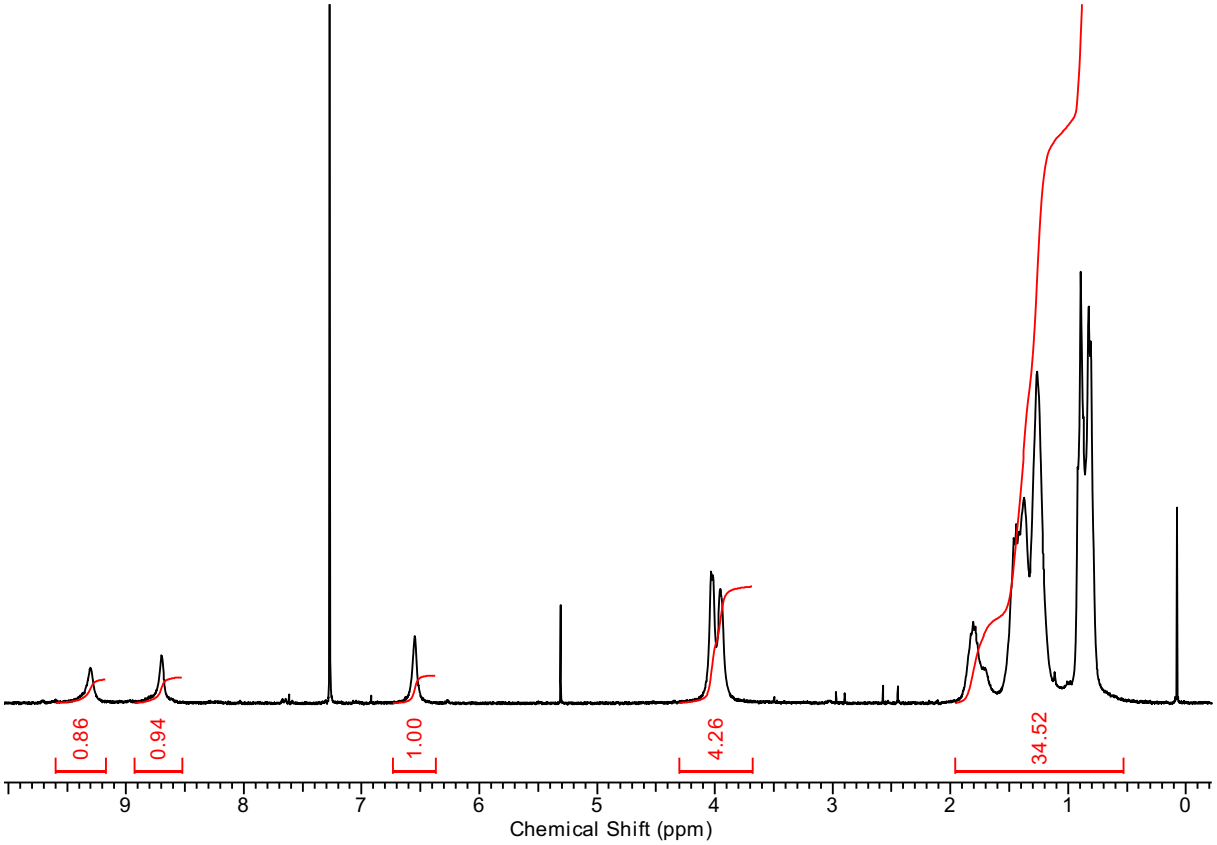


Fig. S76: ^{1}H NMR (300 MHz, $CDCl_3$) of PD1.

SEC data

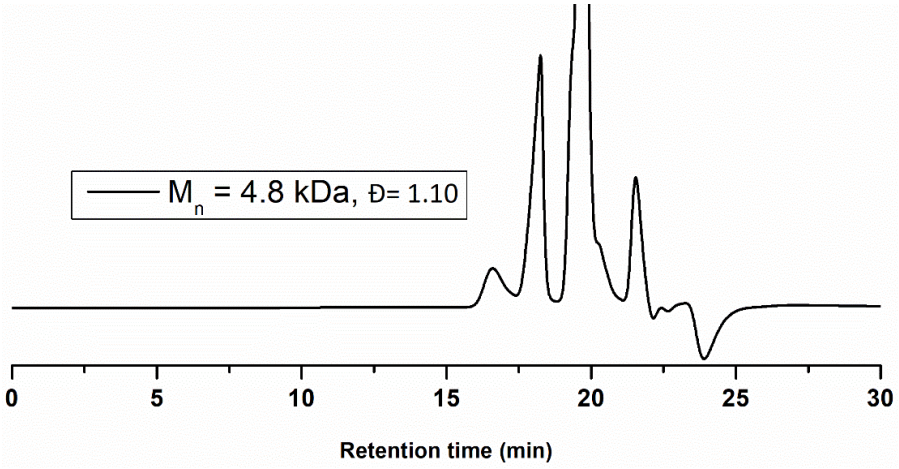


Fig. S77: SEC (DMF) elugram of PB1.

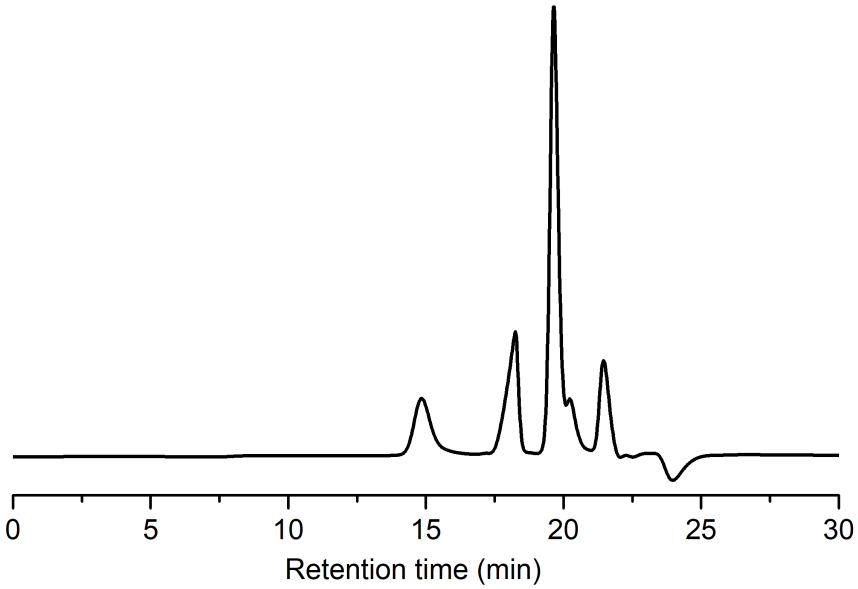


Fig. S78: SEC (DMF) elugram of PC2.

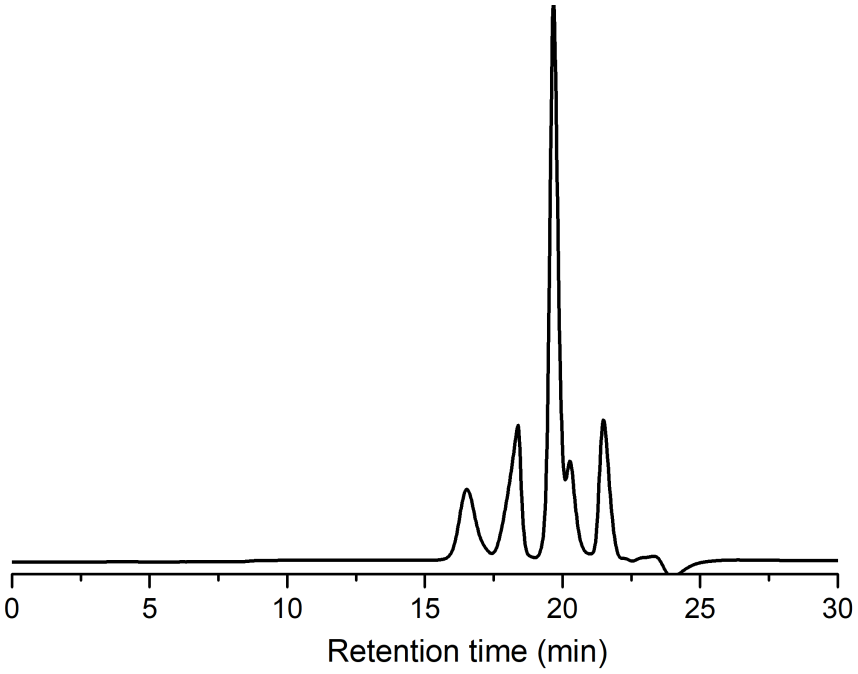


Fig. S79: Crude SEC (DMF) elugram of PF1.

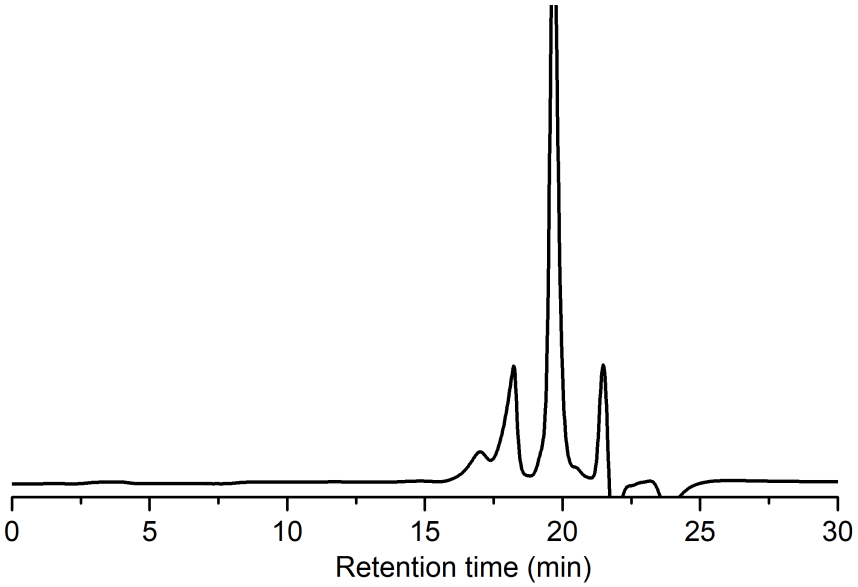


Fig. S80: Crude SEC (DMF) elugram of PH1.

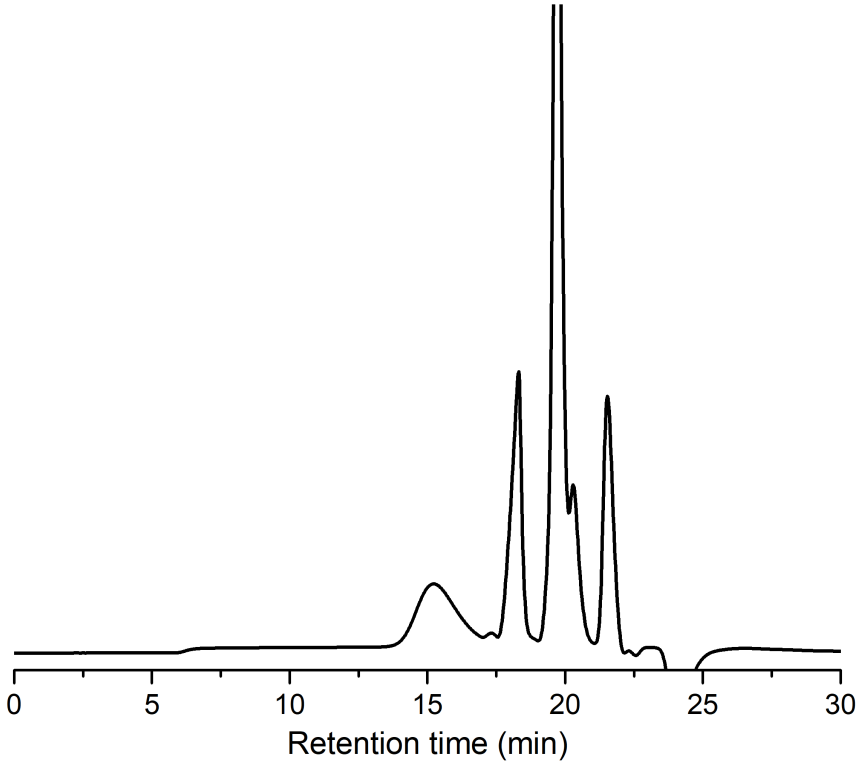


Fig. S81: SEC (DMF) elugram of PJ2.

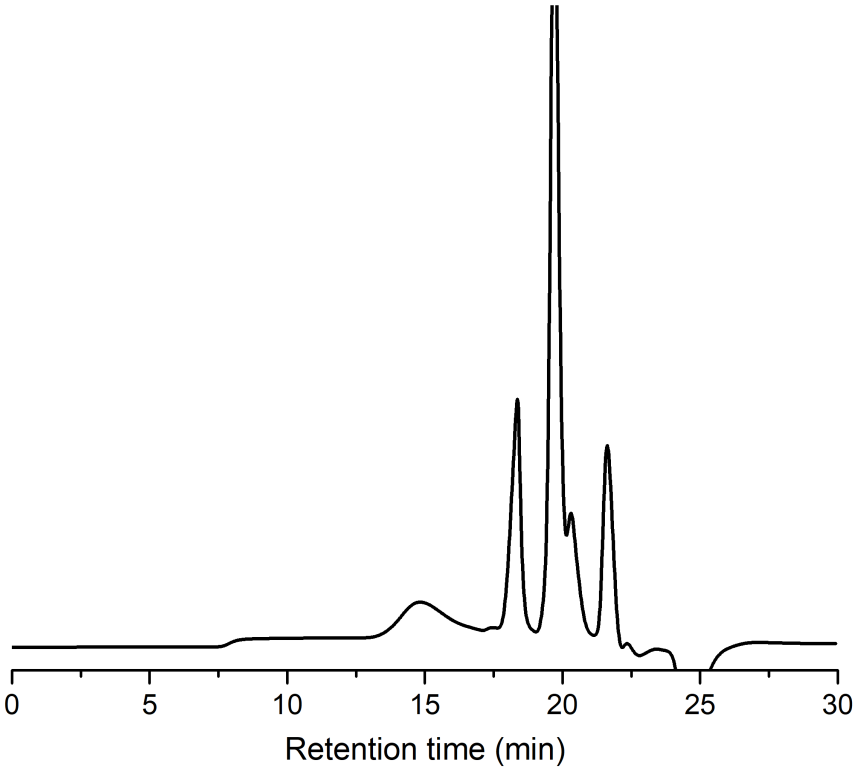
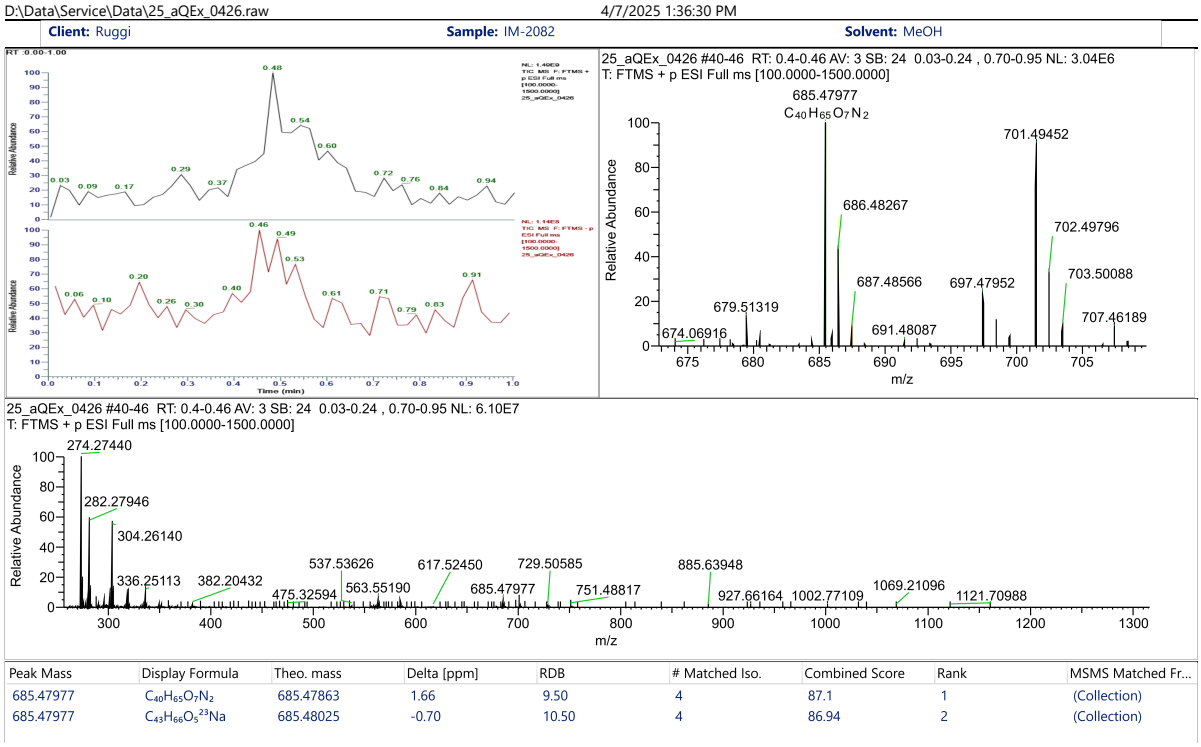


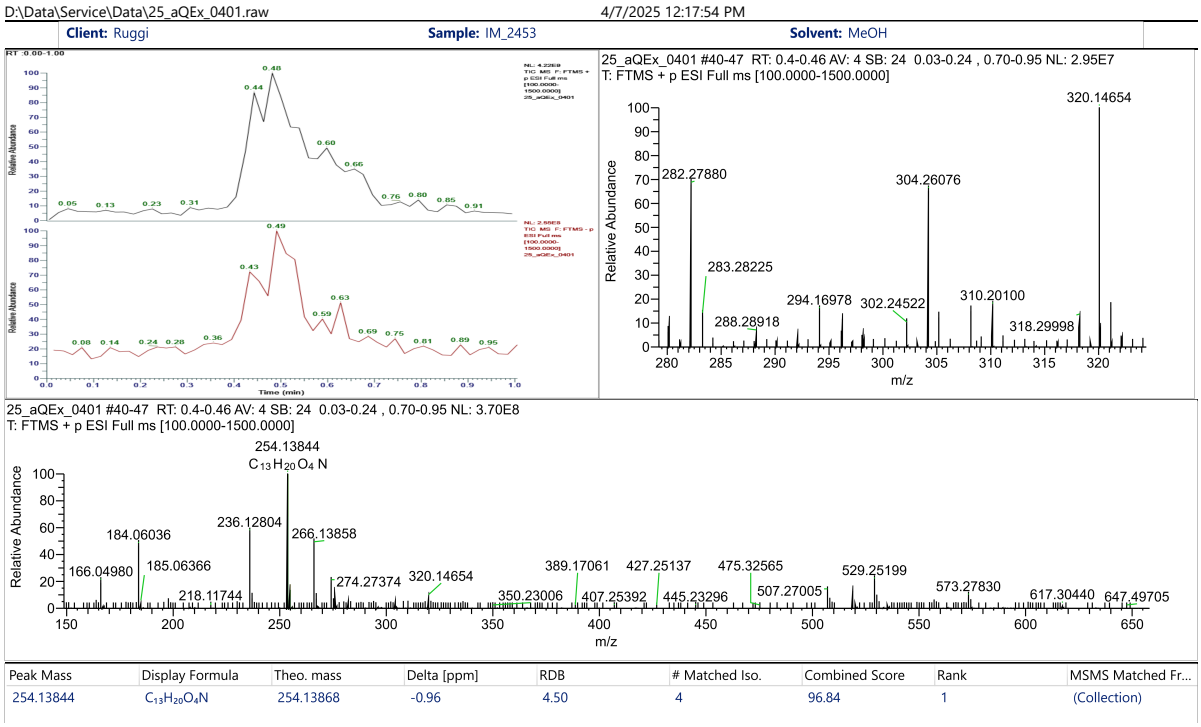
Fig. S82: SEC (DMF) elugram of PJ3.

HRMS data



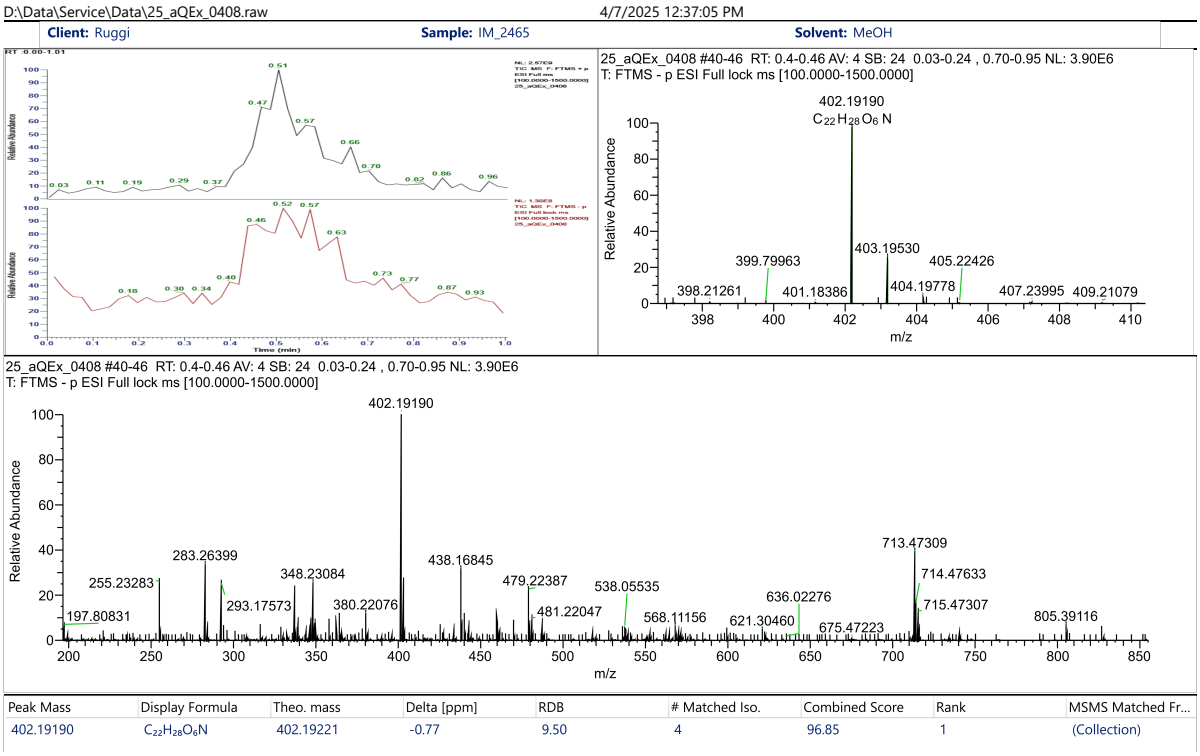
Peak Mass	Display Formula	Theo. mass	Delta [ppm]	RDB	# Matched Iso.	Combined Score	Rank	MSMS Matched Fr...
685.47977	$C_{40}H_{65}O_7N_2$	685.47863	1.66	9.50	4	87.1	1	(Collection)
685.47977	$C_{43}H_{66}O_5{}^{23}Na$	685.48025	-0.70	10.50	4	86.94	2	(Collection)

Fig. S83: HRMS data for compound B.



Peak Mass	Display Formula	Theo. mass	Delta [ppm]	RDB	# Matched Iso.	Combined Score	Rank	MSMS Matched Fr...
254.13844	$C_{13}H_{20}O_4N$	254.13868	-0.96	4.50	4	96.84	1	(Collection)

Fig. S84: HRMS data for compound I.



Peak Mass	Display Formula	Theo. mass	Delta [ppm]	RDB	# Matched Iso.	Combined Score	Rank	MSMS Matched Fr...
402.19190	$C_{22}H_{28}O_6N$	402.19221	-0.77	9.50	4	96.85	1	(Collection)

Fig. S85: HRMS data for compound J.

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