Covalent [2]catenane and [2]rotaxane synthesis via a δ-amino acid template

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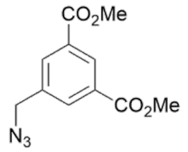
Experimental Procedures

General methods and materials

Reactions were carried out under air and without additional measures such as drying unless stated otherwise. Heating and stirring was performed using oil baths and standard thermostatized stirring plates and Teflon stirring beans. Thin layer chromatography (TLC) was performed on Merck TLC plates (0.25 mm) precoated with silica gel 60 F254. Flash column chromatography was performed using Macherey-Nagel Silica 60 (particle size 0.04–0.063 mm) under compressed air flow or a Buchi C-850 automatic column machine with FlashPure silica cartridges. Where PE is noted as an eluent, 40-60°C petroleum ether was used. Starting materials and reagents were used as supplied by commercial vendors. Anhydrous CH_2Cl_2, MeCN and THF were obtained from pre-dried materials via an MBRAUN SPS-800 machine and stored under N_2 atmosphere, anhydrous MeOH was dried over 3Å molecular sieves (MS) for 20 hours and stored over fresh 3Å MS under a N_2 atmosphere. MS were dried at 250°C *in vacuo* for 8 hours before use and stored under N_2 atmosphere. Bruker DRX-300, 400 and 500 MHz instruments were used to record NMR spectra. Chemical shifts (δ) are reported in ppm relative to residual un-deuterated solvent peaks. Data of the recorded ^{1}H NMR spectra are described as follows: chemical shift (multiplicity, coupling constant when applicable, number of H). The following abbreviations are used to report the multiplicities: s (singlet), d (doublet), t (triplet), q (quartet), quint (quintet), dd (doublet of doublet), m (multiplet). High-resolution mass spectra (HRMS) were recorded on an AccuTOF GC v 4g, JMST100GCV mass spectrometer (JEOL, Japan) and HR-ToF Bruker Daltonik GmbH (Bremen, Germany) Impact II, an ESI-ToF MS capable of resolution of at least 40,000 FW HM. The FD/FI probe was equipped with an FD Emitter, Carbotec, FD = 10 µm. Current rate = 51.2 mA/min over 1.2 min using field desorption (FD) as an ionization method. IR spectra were recorded on a Bruker Alpha FTIR apparatus.

Azido ester 14:



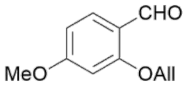
Trimesic acid (16.0 g, 76.1 mmol, 1.0 equiv.) was dissolved in 280 mL of MeOH, to which 4 mL H_2SO_4 was added dropwise under stirring. The resulting mixture was refluxed for 16 hours, then cooled to 0°C. The solid residue was obtained by filtration and dried under reduced pressure to remove MeOH. The crude was then dissolved in 40 mL CH_2Cl_2, washed 2×20 mL aqueous saturated $NaHCO_3$ solution, dried over $MgSO_4$ and concentrated *in vacuo* to give trimethyl benzene-1,3,5-tricarboxylate (16.8 g, 88%), which was used without further purification. ^{1}H NMR data matched those reported in literature.[1]

Trimethyl benzene-1,3,5-tricarboxylate (8.00 g, 31.7 mmol, 1.0 equiv.) was suspended in 700 mL of MeOH, to which 1.0M aqueous NaOH (28.5 mL, 28.5 mmol, 0.9 equiv.) was added dropwise. After stirring for 16 hours at room temperature, the crude mixture was concentrated *in vacuo* and the solid residue was partitioned between 100 mL CH_2Cl_2 and 100 mL aqueous saturated $NaHCO_3$ solution. The organic layer was extracted 3×100 mL aqueous saturated $NaHCO_3$ and the combined aqueous layers were acidified to ca. pH 2 with 32% HCl. The resulting precipitate was filtered and rinsed 3 times with AcOEt to give 3,5-bis(methoxycarbonyl)benzoic acid (5.79 g, 76%), which was used without further purification. ^{1}H NMR data matched those reported in literature.[1]

3,5-bis(methoxycarbonyl)benzoic acid (5.79 g, 24.3 mmol, 1.0 equiv.) was dissolved in 60 mL of anhydrous THF under a N_2 atmosphere and a solution of $BH_3{\cdot}Me_2S$ (4.6 mL, 48.6 mmol, 2.0 equiv.) in 24 mL of THF was added dropwise. After stirring the resulting mixture for 16 hours at room temperature, 85 mL of MeOH were added and the mixture was stirred for an additional hour. The crude mixture was then concentrated *in vacuo*, diluted in 120 mL of AcOEt and washed with 100 mL of H_2O, 100 mL of saturated aqueous $NaHCO_3$ and 100 mL of brine, dried over $MgSO_4$ and concentrated *in vacuo* to give dimethyl 5-(hydroxymethyl)isophthalate (4.22 g, 77%), which was used without further purification. ^{1}H NMR data matched those reported in literature.[1]

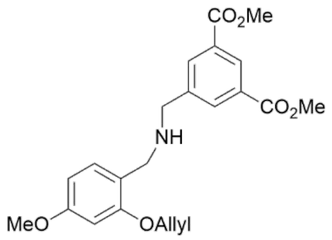
Dimethyl 5-(hydroxymethyl)isophthalate (2.22 g, 9.89 mmol, 1.0 equiv.) was dissolved in $SOCl_2$ (1.44 mL, 19.8 mmol, 2.0 equiv.) and the mixture was brought to reflux for 1.5 hours, then diluted in 40 mL $CHCl_3$. The resulting solution was washed with 50 mL of 1M NaOH, the aqueous phase was extracted with 20 mL $CHCl_3$. The combined organic layers were then washed with brine, dried over $MgSO_4$ and concentrated *in vacuo*. The crude chloride product obtained was immediately used in the following step, by first dissolving it in 35 mL of acetone and 12 mL of H_2O, then adding NaN_3 (3.99 g, 61.3 mmol, 6.0 equiv.). After refluxing the mixture for 15 hours, the crude product was diluted in 90 mL of $CHCl_3$, washed 2 times with brine, dried over $MgSO_4$ and concentrated *in vacuo* to give azido ester template **14** (2.24 g, 88%), which was used without further purification. ^{1}H NMR data matched those reported in literature.[1]

2-allyloxy-4-methoxybenzaldehyde 15:



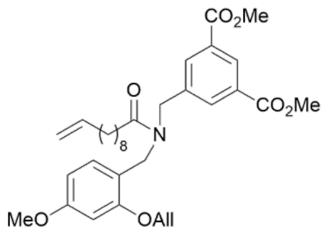
2-Hydroxy-4-methoxybenzaldehyde (3.04 g, 20.0 mmol, 1.0 equiv.) was dissolved in 40 mL of anhydrous DMF, to which K_2CO_3 (5.52 g, 40.0 mmol, 2.0 equiv.) and allyl bromide (3.50 mL, 40.0 mmol, 2.0 equiv.) were added. The resulting suspension was stirred for 24 hours at room temperature under a N_2 atmosphere, then diluted in 200 mL of a 4:1 PE/AcOEt mixture, washed 3×100 mL of H_2O, washed with brine, dried over $MgSO_4$ and concentrated *in vacuo* to give 2-allyloxy-4-methoxybenzaldehyde **15** (3.65 g, 95%) as a yellow solid which was used without further purification. ^{1}H NMR data matched those reported in literature.[2]

Secondary amine 16:



Azido ester **14** (2.24 g, 8.99 mmol, 1.0 equiv.) was dissolved in 50 mL of Et_2O, to which PPh_3 (2.59 g, 9.89 mmol, 1.1 equiv.) was added in portions. After 20 minutes H_2O (178 µL, 9.89 mmol, 1.1 equiv.) was added. After stirring for 5 hours at room temperature, the crude mixture was concentrated *in vacuo*, then redissolved in 30 mL of MeOH. 2-allyloxy-4-methoxybenzaldehyde **15** (1.90 g, 9.89 mmol, 1.1 equiv.) was added and the mixture stirred at 35°C for 18 hours. Then the solution was cooled to 0°C and $NaBH_4$ (749 mg, 19.8 mmol, 2.2 equiv.) was added in portions. After 30 minutes, the mixture was allowed to room temperature and stirred for an additional 2 hours, then concentrated *in vacuo* and partitioned between 100 mL of AcOEt and 100 mL aqueous saturated $NaHCO_3$. The aqueous layer was extracted 2×50 mL AcOEt and the combined organic layers were dried over $MgSO_4$ and concentrated *in vacuo*. The crude product was dry loaded onto celite and purified by column chromatography (PE/AcOEt with 2.5% v/v Et_3N 3:1 → 2:1) to give secondary amine **16** (2.99 g, 83%) as a faint yellow oil, which slowly solidifies at room temperature. R_f=0.34 (PE/AcOEt 1:1+2.5% Et_3N); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 (s, 1H), 8.19 (d, J = 1.7 Hz, 2H), 7.11 (d, J = 8.8 Hz, 1H), 6.47 – 6.39 (m, 2H), 6.00 (m, 1H), 5.36 (dd, J = 17.3, 1.6 Hz, 1H), 5.24 (dd, J = 10.5, 1.5 Hz, 1H), 4.51 (d, J = 5.1 Hz, 2H), 3.92 (s, 6H), 3.83 (s, 2H), 3.77 (s, 3H), 3.76 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.3, 160.1, 157.6, 141.7, 133.6, 133.1, 130.7, 130.6, 129.3, 120.6, 117.4, 104.1, 99.7, 68.7, 55.4, 52.3, 52.1, 48.4; IR (neat): ν_{max}/cm^{-1} 2951, 2838, 1722, 1611, 1588, 1505, 1433, 1327, 1289, 1242, 1201, 1164, 1128, 1043, 1004, 928, 830, 786, 755, 721; HRMS (FD$^+$) *m/z* calcd for $C_{22}H_{25}N_1O_6$ $[M^{\bullet+}]$ 399.1676, found 399.1677.

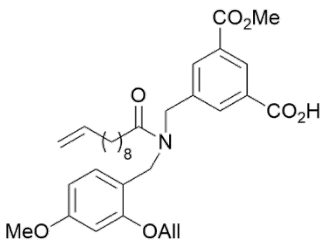
Tertiary amide 17:



10-undecenoic acid (2.76 g, 15.0 mmol, 2.0 equiv.) was dissolved in 20 mL $CHCl_3$ and $SOCl_2$ (2.20 mL, 30.0 mmol, 4.0 equiv.) was added to it. After stirring at 60°C for 2.5 hours, the crude acyl chloride was concentrated *in vacuo*, diluted in 30 mL of anhydrous CH_2Cl_2 and added dropwise to a solution of secondary amine **16** (2.99 g, 7.49 mmol, 1.0 equiv.) and Et_3N (4.20 mL, 30.0 mmol, 4.0 equiv.) in 70 mL of anhydrous CH_2Cl_2 kept at 0°C under a N_2 atmosphere. Once addition was complete, the reaction mixture was allowed to room temperature and stirred for 18 hours, then dry loaded onto silica and purified by column chromatography (PE/AcOEt 3:1 → 2:1) to give tertiary amide **17** (3.81 g, 90%) as a faint yellow oil as a 7:3 mixture of rotamers.

R_f=0.37 (PE/AcOEt 2:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.59 (s, 0.3H), 8.55 (s, 0.7H), 8.01 (s, 1.4H), 7.97 (s, 0.6H), 7.31 (d, J = 8.4 Hz, 0.3H), 6.96 (d, J = 8.3 Hz, 0.7H), 6.46 (dd, J = 8.3, 2.4 Hz, 1H), 6.38 (dd, J = 12.6, 2.3 Hz, 1H), 6.07 – 5.90 (m, 1H), 5.90 – 5.75 (m, 1H), 5.39 – 5.15 (m, 2H), 5.05 – 4.90 (m, 2H), 4.67 – 4.61 (m, 2H), 4.48 – 4.43 (m, 3H), 4.40 (d, J = 5.2 Hz, 1H), 3.96 (s, 1.8H), 3.94 (s, 4.2H), 3.80 (s, 2.1H), 3.79 (s, 0.9H), 2.52 (t, J = 7.6 Hz, 1.4H), 2.33 (t, J = 7.5 Hz, 0.6H), 2.10 – 1.99 (m, 2H), 1.78 – 1.63 (m, 2H), 1.43 – 1.23 (m, 10H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.1, 173.6, 166.2, 165.9, 160.6, 160.2, 157.5, 157.3, 139.3, 139.2, 138.9, 133.1, 132.8, 132.8, 131.7, 131.5, 131.1, 130.7, 129.7, 129.4, 128.6, 118.2, 118.2, 117.5, 116.7, 114.1, 104.8, 104.2, 99.6, 99.2, 68.9, 68.8, 55.4, 55.3, 52.4, 52.3, 50.3, 47.8, 46.4, 43.1, 33.8, 33.8, 33.4, 33.2, 29.5, 29.4, 29.3, 29.1, 29.1, 28.9, 28.9, 25.4, 25.3; IR (neat): ν_{max}/cm^{-1} 2925, 2853, 1723, 1641, 1611, 1588, 1506, 1458, 1432, 1359, 1326, 1290, 1239, 1200, 1166, 1125, 1042, 1002, 926, 833, 754, 721; HRMS (FD$^+$) *m/z* calcd for $C_{33}H_{43}N_1O_7$ $[M^{\bullet+}]$ 565.3034, found 565.3060.

Carboxylic acid 18:

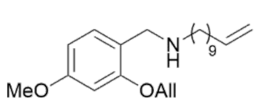


Diester **17** (2.81 g, 4.97 mmol, 1.0 equiv.) was dissolved in 100 mL of MeOH, to which 1.0M NaOH (5.10 mL, 5.10 mmol, 1.05 equiv.) was added dropwise. The resulting mixture was stirred under reflux for 16 hours, then cooled to room temperature and acidified to pH 1 with ca. 10 mL 1M $KHSO_4$. The mixture was then partitioned between 200 mL H_2O and 200 mL AcOEt. The aqueous layer was extracted 2×100 mL AcOEt and the combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated *in vacuo*. The crude product was dry loaded onto silica and purified by column chromatography (PE/AcOEt 2:1 → 1:1

→ 1:2) to give carboxylic acid **18** (2.21 g, 81%) as a colorless glass as a 3:1 mixture of rotamers, as well as the diester starting material **17** (334 mg, 12%).

R_f=0.20 (PE/AcOEt 1:1); ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.65 (s, 0.25H), 8.59 (s, 0.75H), 8.10 – 7.95 (m, 2H), 7.29 (d, J = 8.4 Hz, 0.25H), 6.96 (d, J = 8.3 Hz, 0.75H), 6.45 (dd, J = 8.3, 2.3 Hz, 1H), 6.40 – 6.30 (m, 1H), 6.06 – 5.70 (m, 2H), 5.38 – 5.13 (m, 2H), 5.02 – 4.85 (m, 2H), 4.70 – 4.61 (m, 2.5H), 4.50 – 4.42 (m, 3H), 4.39 (d, J = 5.2 Hz, 0.5H), 3.95 (s, 0.75H), 3.92 (s, 2.25H), 3.78 (s, 2.25H), 3.76 (s, 0.75H), 2.55 (t, J = 7.5 Hz, 1.5H), 2.36 (t, J = 7.6 Hz, 0.5H), 2.00 (p, J = 6.7 Hz, 2H), 1.78 – 1.62 (m, 2H), 1.41 – 1.18 (m, 10H); ^{13}C NMR (101 MHz, CDCl$_3$) δ 174.6, 174.1, 169.9, 169.6, 166.1, 165.9, 160.6, 160.3, 157.5, 157.3, 139.2, 139.2, 138.8, 133.7, 132.8, 132.7, 132.1, 132.1, 131.8, 131.2, 130.8, 130.8, 130.3, 130.2, 130.0, 128.8, 118.3, 118.0, 117.6, 116.5, 114.1, 114.1, 104.8, 104.3, 99.6, 99.3, 68.9, 68.8, 55.4, 55.3, 52.5, 52.3, 50.3, 47.9, 46.6, 43.2, 33.8, 33.8, 33.8, 33.5, 33.3, 31.9, 29.7, 29.7, 29.6, 29.5, 29.5, 29.4, 29.4, 29.3, 29.2, 29.1, 29.1, 29.0, 28.9, 28.9, 25.4, 22.7, 14.1; IR (neat): ν_{max}/cm^{-1} 2925, 2853, 1723, 1640, 1610, 1588, 1507, 1461, 1433, 1421, 1360, 1293, 1255, 1223, 1200, 1167, 1127, 1042, 1020, 998, 928, 833, 755, 679; HRMS (FD$^+$) *m/z* calcd for $C_{32}H_{41}N_1O_7$ $[M^{\bullet+}]$ 551.2878, found 551.2886.

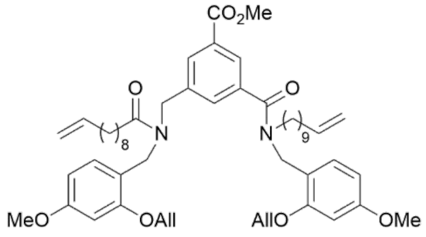
Amine 19:



10-Undecen-1-amine[3] (2.02 g, 12.0 mmol, 1.0 equiv.) was dissolved in 60 mL of absolute MeOH, to which 2-allyloxy-4-methoxybenzaldehyde (2.31 g, 12.0 mmol, 1.0 equiv.) was added. After stirring at room temperature for 16 hours, the crude mixture was cooled to 0°C and NaBH$_4$ (908 mg, 24.0 mmol, 2.0 equiv.) was added in portions. The resulting mixture was stirred for 1 hour, then warmed to room temperature and stirred for 1 additional hour. Subsequently, the crude was concentrated *in vacuo* and partitioned between 80 mL of AcOEt and 80 mL of a NaHCO$_3$ saturated aqueous solution. The aqueous layer was extracted 2×40 mL of AcOEt and the combined organic layers were washed with brine, dried over MgSO$_4$ and concentrated *in vacuo* to give secondary amine **19** (4.07 g, 98%) as a dark amber oil which was used without further purification.

^{1}H NMR (400 MHz, CDCl$_3$) δ 7.19 – 7.12 (m, 1H), 6.48 – 6.40 (m, 2H), 6.11 – 5.98 (m, 1H), 5.87 – 5.73 (m, 1H), 5.41 (dd, J = 17.3, 1.7 Hz, 1H), 5.28 (dd, J = 10.5, 1.5 Hz, 1H), 5.03 – 4.89 (m, 2H), 4.53 (d, J = 5.1 Hz, 2H), 3.78 (s, 3H), 3.76 (s, 2H), 2.58 (t, J = 7.3 Hz, 2H), 2.08 – 1.98 (m, 2H), 1.50 (t, J = 7.2 Hz, 2H), 1.36 (t, J = 7.3 Hz, 2H), 1.31 – 1.23 (m, 10H); ^{13}C NMR (101 MHz, CDCl$_3$) δ 160.0, 157.6, 139.2, 133.2, 130.7, 120.7, 117.3, 114.1, 104.1, 99.7, 68.7, 55.3, 48.9, 48.8, 33.8, 29.8, 29.5, 29.5, 29.4, 29.1, 28.9, 27.4; IR (neat): ν_{max}/cm^{-1} 3076, 2923, 2852, 1639, 1612, 1588, 1505, 1461, 1442, 1422, 1361, 1332, 1287, 1258, 1198, 1163, 1127, 1044, 1025, 996, 910, 832, 788, 722, 632, 568; HRMS (FD$^+$) *m/z* calcd for $C_{22}H_{35}N_1O_2$ $[M^{\bullet+}]$ 345.2662, found 345.2677.

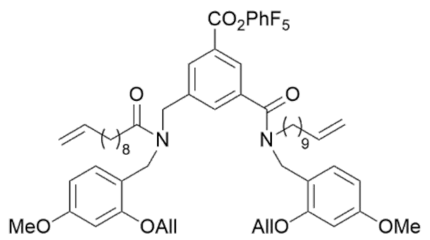
Bisamide 6:



Carboxylic acid **18** (2.21 g, 4.01 mmol, 1.0 equiv.) was suspended in 100 mL of anhydrous CH$_2$Cl$_2$ under a N$_2$ atmosphere and HOBt (596 mg, 4.41 mmol, 1.1 equiv.), DMAP (49 mg, 0.40 mmol, 0.1 equiv.), DCC (2.72 g, 13.2 mmol, 3.3 equiv.) were added. Finally, amine **19** (1.52 g, 4.41 mmol, 1.1 equiv.) in 10 mL of anhydrous CH$_2$Cl$_2$ was added and the resulting mixture was stirred at room temperature for 17 hours. The crude mixture was dry loaded onto silica and purified by column chromatography (PE/AcOEt 3:1 → 2:1 → 1:1) to give bisamide **6** (3.22 g, 91%) as a colorless oil as a mixture of 4 rotamers.

R_f=0.64 (PE/AcOEt 1:1); ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.03 – 7.89 (m, 1H), 7.85 – 7.72 (m, 1H), 7.42 (s, 1H), 7.38 – 7.27 (m, 0.75H), 7.25 – 7.16 (m, 0.25H), 6.99 (d, J = 8.2 Hz, 0.5H), 6.95 – 6.82 (m, 0.5H), 6.55 – 6.31 (m, 4H), 6.12 – 5.70 (m, 4H), 5.48 – 5.09 (m, 4H), 5.04 – 4.86 (m, 4H), 4.74 (s, 1H), 4.65 – 4.30 (m, 9H), 3.96 – 3.84 (m, 3H), 3.83 – 3.70 (m, 6H), 3.54 – 3.31 (m, 1.25H), 3.11 – 3.00 (m, 0.75H), 2.51 – 2.39 (m, 1.25H), 2.33 – 2.17 (m, 0.75H), 2.10 – 1.96 (m, 3H), 1.96 – 1.85 (m, 1H), 1.75 – 1.53 (m, 3H), 1.47 (s, 1H), 1.42 – 0.96 (m, 22H); ^{13}C NMR (101 MHz, CDCl$_3$) δ 174.1, 173.4, 170.7, 166.3, 166.1, 160.5, 160.4, 160.2, 157.6, 157.5, 157.3, 157.2, 156.9, 139.3, 139.2, 139.2, 139.1, 139.0, 138.8, 137.7, 133.1, 132.9, 132.9, 132.8, 131.4, 130.8, 130.5, 130.3, 129.5, 129.1, 128.6, 128.6, 128.3, 128.3, 128.1, 126.9, 126.5, 118.2, 118.1, 118.0, 117.8, 117.6, 117.5, 117.3, 117.0, 116.7, 114.1, 104.7, 104.3, 104.2, 99.8, 99.7, 99.6, 99.5, 99.3, 69.0, 68.9, 68.8, 68.7, 55.4, 55.4, 55.3, 52.3, 52.2, 52.2, 50.2, 49.0, 48.3, 47.8, 47.6, 46.0, 45.0, 44.7, 43.1, 41.6, 33.9, 33.8, 33.8, 33.4, 33.1, 31.9, 29.7, 29.7, 29.6, 29.5, 29.5, 29.4, 29.4, 29.3, 29.2, 29.1, 29.1, 28.9, 28.3, 27.2, 27.1, 26.6, 25.6, 25.4, 24.9, 22.7, 14.1; IR (neat): ν_{max}/cm^{-1} 2924, 2852, 1725, 1637, 1612, 1588, 1506, 1462, 1419, 1360, 1291, 1254, 1236, 1199, 1164, 1117, 1042, 1021, 998, 911, 833, 774, 633; HRMS (FD$^+$) *m/z* calcd for $C_{54}H_{74}N_2O_8$ $[M^{\bullet+}]$ 878.5440, found 878.5433.

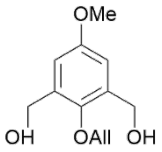
Pentafluorophenol ester 20:



Methyl ester **6** (1.71 g, 1.95 mmol, 1.0 equiv.) was dissolved in 200 mL of a THF/H_2O/MeOH 2:2:1 mixture, to which a 1M NaOH (19.5 mL, 19.5 mmol, 10 equiv.) solution was added. After stirring at room temperature for 17 hours, the crude mixture was concentrated *in vacuo* to remove most of the THF and MeOH and subsequently acidified to pH 1 with 1M $KHSO_4$. The resulting mixture was extracted with 3×125 mL EtOAc, then the combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated *in vacuo*. The crude carboxylic acid was dissolved in 60 mL of anhydrous CH_2Cl_2 under a N_2 atmosphere and pentafluorophenol (718 mg, 3.90 mmol, 2.0 equiv.), DiPEA (1.02 mL, 5.85 mmol, 3.0 equiv.) and HBTU (1.11 g, 2.93 mmol, 1.5 equiv.) were added. The resulting mixture was stirred for 23 hours at room temperature and subsequently dry loaded onto silica and purified by column chromatography (PE/EtOAc 4:1 → 3:1 → 2:1) to give pentafluorophenol ester **20** (1.87 g, 93%) as a faint yellow oil.

R_f=0.29 (PE/AcOEt 3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 – 8.05 (m, 1H), 7.98 – 7.87 (m, 1H), 7.62 – 7.46 (m, 1H), 7.39 – 7.21 (m, 1H), 7.08 – 6.88 (m, 1H), 6.59 – 6.33 (m, 4H), 6.15 – 5.73 (m, 4H), 5.50 – 5.14 (m, 4H), 5.06 – 4.89 (m, 4H), 4.79 (s, 1H), 4.71 – 4.33 (m, 9H), 3.87 – 3.72 (m, 6H), 3.52 – 3.39 (m, 1H), 3.16 – 3.05 (m, 1H), 2.59 – 2.42 (m, 2H), 2.11 – 1.97 (m, 4H), 1.83 – 1.47 (m, 4H), 1.45 – 1.01 (m, 22H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.2, 170.1, 161.9, 160.6, 160.5, 160.3, 157.5, 157.4, 157.2, 142.6, 139.9, 139.7, 139.2, 139.2, 138.1, 136.7, 133.0, 132.8, 132.8, 132.7, 132.2, 131.0, 130.5, 129.0, 128.6, 128.6, 127.9, 127.1, 118.3, 118.0, 117.9, 117.8, 117.7, 117.1, 116.5, 114.1, 104.8, 104.3, 99.7, 99.6, 99.5, 69.0, 68.9, 68.8, 55.4, 55.3, 50.2, 48.4, 48.1, 47.8, 46.4, 45.1, 41.7, 33.8, 33.8, 33.2, 29.5, 29.5, 29.4, 29.4, 29.3, 29.2, 29.1, 29.1, 28.9, 28.9, 28.4, 27.2, 27.1, 26.6, 25.4; IR (neat): ν_{max}/cm^{-1} 3077, 2925, 2853, 1761, 1637, 1612, 1588, 1519, 1507, 1463, 1419, 1360, 1291, 1257, 1222, 1199, 1165, 1124, 1077, 1041, 994, 911, 833, 788, 744, 628, 556; HRMS (FD$^+$) *m/z* calcd for $C_{59}H_{71}F_5N_2O_8$ [$M^{\bullet+}$] 1030.5125, found 1030.5108.

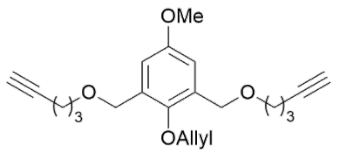
dibenzyl alcohol 21:



2-Hydroxy-5-methoxy-1,3-benzenedimethanol[4] (10.5 g, 57.1 mmol, 1.0 equiv.) was dissolved in 80 mL of anhydrous DMF under a N_2 atmosphere. K_2CO_3 (20.7 g, 150 mmol, 3.0 equiv.) was added, followed by dropwise addition of Allyl bromide (4.9 mL, 57.1 mmol, 1.0 equiv.) in 15 mL anhydrous DMF. After stirring for 24 hours at room temperature, the mixture was slowly poured into 150 mL H_2O and extracted with 3×100 mL EtOAc. The combined organic layers were washed with 2×100 mL aqueous saturated NH_4Cl, 2×100 mL H_2O, brine, dried over $MgSO_4$ and concentrated *in vacuo* to give dibenzyl alcohol **21** (10.4 g, 81%) which was used without further purification.

^{1}H NMR (300 MHz, $CDCl_3$) δ 6.88 (s, 2H), 6.19 – 6.00 (m, 1H), 5.42 (dd, J = 17.2, 1.6 Hz, 1H), 5.29 (dd, J = 10.4, 1.4 Hz, 1H), 4.70 (s, 4H), 4.39 (dt, J = 5.6, 1.2 Hz, 2H), 3.80 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.2, 148.3, 135.2, 133.6, 117.9, 113.5, 75.7, 61.1, 55.6; IR (neat): ν_{max}/cm^{-1} 3264, 2917, 2873, 2831, 1478, 1453, 1414, 1350, 1308, 1236, 1211, 1191, 1145, 1055, 1036, 982, 948, 931, 853, 812, 700, 663, 617, 559, 537; HRMS (FI$^+$) *m/z* calcd for $C_{12}H_{16}O_4$ [$M^{\bullet+}$] 224.1043, found 224.1044.

Allyl protected dialkyne 22:

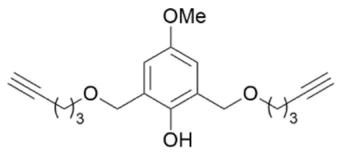


Dibenzyl alcohol **21** (1.12 g, 5.00 mmol, 1.0 equiv.) was dissolved in 40 mL of anhydrous CH_2Cl_2 and cooled to -10°C under a N_2 atmosphere. Then Et_3N (1.7 mL, 12 mmol, 2.4 equiv.) was added, followed by dropwise addition of MsCl (0.85 mL, 11.0 mmol, 2.2 equiv.). After stirring at -10°C for 3 hours, the reaction was quenched with 20 mL of H_2O. The aqueous layer was then separated and extracted 2×20 mL CH_2Cl_2 and the combined organic layers were washed with 2×20 mL H_2O, brine, dried over $MgSO_4$ and concentrated *in vacuo* at room temperature. This intermediate mesylate product is unstable and can degrade upon storage, so it was used immediately.

4-pentyn-1-ol (1.34 g, 16.5 mmol, 3.3 equiv.) was dissolved in 10 mL of anhydrous THF under a N_2 atmosphere and cooled to 0°C. Then 60% NaH in mineral oil (0.600 g, 15.0 mmol, 3 equiv.) was added in portions and the resulting suspension was stirred for 30 minutes before being added dropwise to a solution of crude mesylate product in 30 mL of anhydrous THF kept at 0°C. Once addition was complete, the reaction mixture was heated to reflux for 2 hours and then cooled to room temperature. The crude mixture was poured into 100 mL of saturated aqueous NH_4Cl and extracted 3×20 mL EtOAc. The combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated *in vacuo*. The crude product was dry loaded onto silica and purified by column chromatography (PE/EtOAc 9:1) to give allyl protected dialkyne **22** (1.47 g, 83%) as a colorless oil.

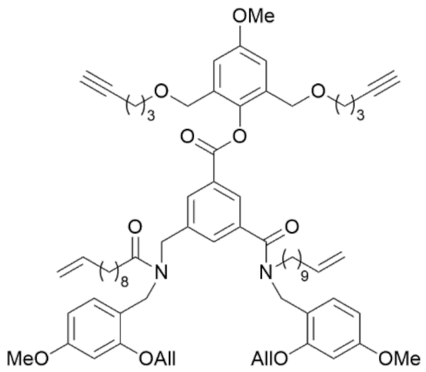
R_f=0.44 (PE/AcOEt 8:2); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.89 (s, 2H), 6.06 (d, J = 17.2 Hz, 1H), 5.41 (dd, J = 17.2, 1.7 Hz, 1H), 5.25 (dd, J = 10.5, 1.5 Hz, 1H), 4.52 (s, 4H), 4.32 (d, J = 5.5 Hz, 2H), 3.79 (s, 3H), 3.59 (t, J = 6.2 Hz, 4H), 2.31 (td, J = 7.1, 2.7 Hz, 4H), 1.94 (t, J = 2.7 Hz, 2H), 1.83 (p, J = 6.6 Hz, 4H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.0, 148.7, 133.9, 132.6, 117.1, 114.0, 83.9, 75.9, 69.0, 68.6, 67.9, 55.5, 28.7, 15.3; IR (neat): ν_{max}/cm^{-1} 3292, 2935, 2863, 1606, 1468, 1440, 1409, 1361, 1321, 1287, 1248, 1198, 1152, 1100, 1056, 987, 930, 858, 805, 635, 558; HRMS (FD$^+$) *m/z* calcd for $C_{22}H_{28}O_4$ $[M^{\bullet+}]$ 356.1982, found 356.1993.

Dialkyne ring fragment 5:



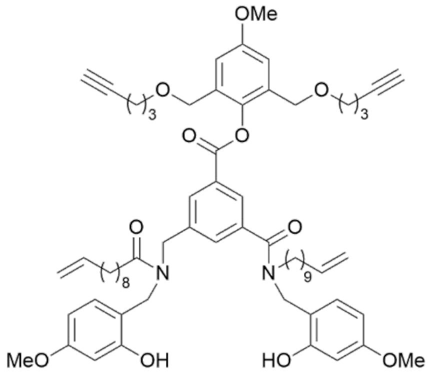
Allyl protected dialkyne **20** (1.40 g, 3.92 mmol, 1.0 equiv.) was dissolved in 20 mL of absolute MeOH under a N_2 atmosphere, then K_2CO_3 (1.51 g, 11.0 mmol, 3.0 equiv.) was added. The resulting suspension was sparged with N_2 for 15 minutes, then $Pd(PPh_3)_4$ (42.2 mg, 36.5 µmol, 1.0 mol%) was added. After stirring at room temperature for 15 hours, 1M $KHSO_4$ was added until a pH of ca. 6 was achieved, then 200 mL of H_2O was added and the resulting mixture was extracted 3×40 mL EtOAc. The combined organic layers were then washed with brine, dried over $MgSO_4$ and concentrated *in vacuo*. The crude product was dry loaded onto silica and purified by column chromatography (PE/EtOAc 19:1 → 9:1 → 8:2) to give dialkyne ring fragment **5** (1.09 g, 88%) as a colorless oil.
R_f=0.59 (PE/AcOEt 7:3); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (s, 1H), 6.71 (s, 2H), 4.61 (s, 4H), 3.75 (s, 3H), 3.63 (t, J = 6.2 Hz, 4H), 2.32 (td, J = 7.1, 2.7 Hz, 4H), 1.95 (t, J = 2.7 Hz, 2H), 1.91 – 1.79 (m, 4H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.7, 147.6, 124.7, 113.3, 83.6, 70.1, 69.1, 68.7, 55.8, 28.5, 15.3; IR (neat): ν_{max}/cm^{-1} 3384, 3290, 2929, 2865, 1611, 1483, 1440, 1366, 1323, 1222, 1192, 1151, 1098, 1078, 1056, 944, 860, 786, 638; HRMS (ESI$^-$) *m/z* calcd for $C_{19}H_{23}O_4$ $[M-H]^-$ 315.1602, found 315.1605.

Ester 23:



Pentafluorophenol ester **20** (1.87 g, 1.81 mmol, 1.0 equiv.) was dissolved in 90 mL of anhydrous MeCN under a N_2 atmosphere, to which phenol **7** (860 mg, 2.72 mmol, 1.5 equiv.), Cs_2CO_3 (3.54 g, 10.9 mmol, 6.0 equiv.) and 4.5 g of 4Å molecular sieves were added. After stirring for 21 hours at room temperature, the suspension was filtered over celite with some EtOAc and the filtrate was dry loaded onto silica and purified by column chromatography (PE/EtOAc 4:1 → 3:1 → 2:1) to give ester **23** (1.95 g, 93%) as a faint yellow oil.
R_f=0.47 (PE/AcOEt 1:2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.20 – 8.04 (m, 1H), 8.00 – 7.90 (m, 1H), 7.57 – 7.43 (m, 1H), 7.35 – 7.28 (m, 0.5H), 7.23 – 7.19 (m, 0.5H), 7.08 – 6.86 (m, 3H), 6.54 – 6.35 (m, 4H), 6.12 – 5.86 (m, 2H), 5.85 – 5.72 (m, 2H), 5.47 – 5.20 (m, 4H), 5.04 – 4.88 (m, 4H), 4.77 (s, 1H), 4.69 – 4.29 (m, 13H), 3.88 – 3.68 (m, 9H), 3.52 – 3.33 (m, 5H), 3.10 (s, 1H), 2.45 (d, J = 7.3 Hz, 2H), 2.21 (s, 4H), 2.02 (d, J = 6.7 Hz, 4H), 1.86 (s, 2H), 1.72 (d, J = 6.3 Hz, 8H), 1.42 – 0.98 (m, 22H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.3, 170.6, 164.1, 160.5, 160.4, 160.2, 157.7, 157.5, 157.3, 157.2, 139.6, 139.3, 139.2, 139.2, 138.0, 133.1, 132.9, 132.9, 132.8, 132.2, 132.2, 131.0, 130.9, 130.0, 129.9, 129.3, 129.0, 128.4, 128.3, 127.2, 118.3, 117.9, 117.6, 116.6, 114.1, 113.3, 113.1, 104.7, 104.7, 104.4, 104.2, 99.7, 99.7, 99.5, 83.8, 83.8, 69.0, 68.9, 68.8, 68.5, 67.9, 67.8, 55.6, 55.4, 55.3, 47.9, 47.8, 46.3, 44.9, 41.7, 33.8, 33.8, 33.1, 29.5, 29.5, 29.5, 29.4, 29.4, 29.4, 29.3, 29.1, 28.9, 28.9, 28.6, 28.4, 27.1, 27.1, 26.7, 25.4, 25.4, 15.2; IR (neat): ν_{max}/cm^{-1} 3296, 2924, 2853, 1738, 1636, 1611, 1588, 1533, 1506, 1464, 1440, 1419, 1362, 1291, 1257, 1227, 1195, 1169, 1116, 1102, 1043, 1020, 997, 912, 833, 788, 749, 722, 633, 557; HRMS (FD$^+$) *m/z* calcd for $C_{72}H_{94}N_2O_{11}$ $[M^{\bullet+}]$ 1162.6852, found 1162.6864.

Bisphenol 7:

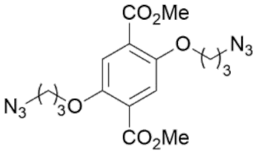


Allyl protected bisphenol **23** (1.17 g, 1.00 mmol, 1 equiv.) was dissolved in 40 mL of anhydrous CH_2Cl_2 under a N_2 atmosphere, to which $Pd(PPh_3)_4$ (57.8 mg, 50.0 µmol, 5.0 mol%) was added. Subsequently, a solution of $PhSiH_3$ (260 mg, 2.41 mmol, 2.4 equiv.) in 10 mL of anhydrous CH_2Cl_2 was added dropwise over 30 minutes. After stirring at room temperature for an additional hour, the crude mixture was dry loaded onto silica and purified by column chromatography (PE/EtOAc 4:1 → 3:1 → 2:1 → 1:1) to give bisphenol **7** (1.04 g, 96%) as a faint yellow oil. Note that the progress of the reaction was monitored by ^{1}H

NMR, since product and starting material could not be separated on a TLC plate.

R_f=0.68 (PE/AcOEt 1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.65 (s, 1H), 9.54 (s, 1H), 8.20 (s, 1H), 8.07 (s, 1H), 7.52 (s, 1H), 7.04 (d, J = 8.4 Hz, 1H), 6.97 (s, 2H), 6.84 (d, J = 8.4 Hz, 1H), 6.56 (d, J = 2.6 Hz, 1H), 6.49 (d, J = 2.6 Hz, 1H), 6.43 (dd, J = 8.3, 2.6 Hz, 1H), 6.33 (dd, J = 8.3, 2.6 Hz, 1H), 5.86 – 5.71 (m, 2H), 5.02 – 4.87 (m, 4H), 4.63 (d, J = 20.4 Hz, 4H), 4.41 (s, 6H), 3.85 (s, 3H), 3.79 (s, 3H), 3.72 (s, 3H), 3.46 (t, J = 6.1 Hz, 4H), 3.24 (t, J = 7.9 Hz, 2H), 2.35 (t, J = 7.5 Hz, 2H), 2.20 (td, J = 7.1, 2.6 Hz, 4H), 2.01 (q, J = 6.7 Hz, 4H), 1.85 (t, J = 2.6 Hz, 2H), 1.77 – 1.60 (m, 8H), 1.40 – 1.12 (m, 22H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 176.1, 171.9, 163.5, 161.8, 161.7, 157.7, 157.6, 139.9, 139.2, 139.1, 137.8, 136.8, 132.4, 132.1, 132.0, 132.0, 130.6, 129.9, 129.6, 128.0, 114.2, 114.2, 113.9, 113.7, 113.7, 106.1, 105.8, 102.7, 83.8, 68.8, 68.6, 68.2, 55.6, 55.3, 55.2, 50.0, 48.8, 46.3, 45.4, 33.8, 33.8, 33.3, 29.5, 29.4, 29.4, 29.3, 29.3, 29.1, 29.1, 28.9, 28.6, 28.3, 26.9, 25.2, 15.2; IR (neat): ν_{max}/cm^{-1} 3289, 3075, 2924, 2853, 1739, 1612, 1507, 1466, 1436, 1363, 1323, 1289, 1231, 1170, 1102, 1053, 1036, 997, 964, 911, 849, 786, 750, 724, 637; HRMS (ESI^{+}) *m/z* calcd for $C_{66}H_{87}N_2O_{11}$ [M+H^{+}] 1083.6304, found 1083.7099.

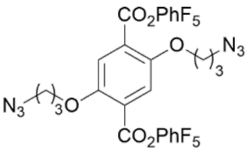
Methyl ester template 24:



3-azido-1-methanesulfonate-1-propanol[5] (5.77 g, 32.2 mmol, 2.5 equiv.) was dissolved in 65 mL of anhydrous DMF under a N_2 atmosphere, to which dimethyl 2,5-dihydroxyterephthalate[6] (2.91 g, 12.9 mmol, 1.0 equiv.) and K_2CO_3 (4.45 g, 32.2 mmol, 2.5 equiv.) were added. After stirring for 16 hours at 80°C, the suspension was cooled to room temperature and partitioned between 100 mL of H_2O and 100 mL of EtOAc. The aqueous layer was extracted 2×50 mL EtOAc and the combined organic layers were washed with 2×50 mL H_2O, brine, dried over $MgSO_4$ and concentrated *in vacuo*. The crude product was dry loaded onto silica and purified by column chromatography (PE/EtOAc 4:1) to give methyl ester template **24** (4.30 g, 85%) as a faint yellow oil.

R_f=0.24 (PE/AcOEt 3:1); ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.39 (s, 2H), 4.10 (t, J = 5.8 Hz, 4H), 3.89 (s, 6H), 3.56 (t, J = 6.5 Hz, 4H), 2.06 (p, J = 6.2 Hz, 4H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 165.6, 151.7, 124.4, 116.9, 66.3, 52.3, 48.0, 28.8; IR (neat): ν_{max}/cm^{-1} 2951, 2880, 2091, 1726, 1707, 1502, 1467, 1435, 1408, 1382, 1345, 1299, 1231, 1196, 1098, 1044, 979, 919, 882, 787, 751, 626, 556; HRMS (FD^{+}) *m/z* calcd for $C_{16}H_{20}N_6O_6$ [M$^{\bullet+}$] 392.1439, found 392.1453.

Pentafluorophenol ester template 4:

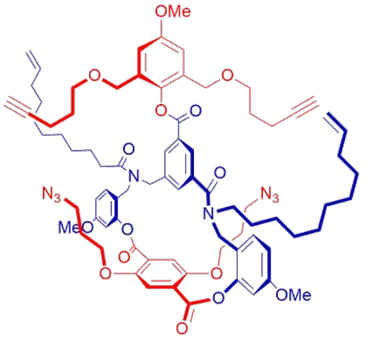


Methyl ester template **24** (4.30 g, 11.0 mmol, 1.0 equiv.) was dissolved in 75 mL of a 2:1 THF/MeOH mixture, to which a solution of KOH (2.46 g, 43.8 mmol, 4.0 equiv.) in 25 mL H_2O was added. After stirring for 16 hours at room temperature, most of the volatile solvents were removed *in vacuo* and the resulting crude mixture was acidified to pH 1 with 1M $KHSO_4$. The solid precipitate was filtered and washed with 2×20 mL H_2O, 10 mL EtOH, suspended in 20 mL of toluene and concentrated *in vacuo* to give the crude diacid (3.22 g, 80%) which was used without further purification.

The crude diacid (3.22 g, 8.84 mmol, 1 equiv.) was suspended in 90 mL of anhydrous CH_2Cl_2 under a N_2 atmosphere, to which DiPEA (6.2 mL, 35.4 mmol, 4 equiv.), pentafluorophenol (4.88 g, 26.5 mmol, 3 equiv.) and HBTU (10.1 g, 26.5 mmol, 3 equiv.) were added. After stirring at room temperature for 16 hours the crude mixture was dry loaded on silica and purified by column chromatography (PE/EtOAc 9:1 → 8:2) over a short column to remove baseline impurities. The product was then recrystallized from EtOAc and heptane to give pentafluorophenol ester template **4** (5.10 g, 83%) as a white solid.

R_f=0.31 (PE/AcOEt 9:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (s, 2H), 4.22 (t, J = 5.8 Hz, 4H), 3.57 (t, J = 6.5 Hz, 4H), 2.11 (p, J = 6.2 Hz, 4H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 160.5, 152.7, 122.2, 117.2, 66.4, 47.9, 28.7; IR (neat): ν_{max}/cm^{-1} 2100, 1771, 1519, 1470, 1415, 1387, 1298, 1231, 1185, 1143, 1034, 996; HRMS (FD^{+}) *m/z* calcd for $C_{26}H_{14}F_{10}N_6O_6$ [M$^{\bullet+}$] 696.0810, found 696.0840.

Bislactone 8:

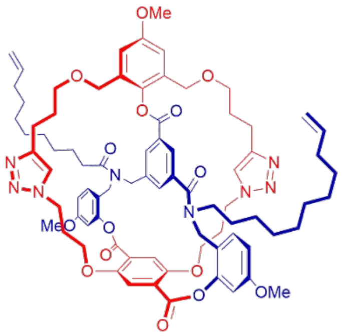


Bisphenol **7** (837 mg, 772 µmol, 1.0 equiv.) was dissolved in 386 mL of anhydrous MeCN under a N_2 atmosphere, to which 8.0 g of 4Å MS and Cs_2CO_3 (2.52 g, 7.72 mmol, 10 equiv.) were added. Finally, pentafluorophenol ester template **4** (565 mg, 811 µmol, 1.05 equiv.) was added and the suspension was stirred for 16 hours at 45°C before being filtered over celite with some EtOAc. The crude filtrate was dry loaded onto silica and purified by column chromatography (PE/EtOAc 9:1 → 8:2 → 2:1) to give bislactone **8** (838 mg, 77%) as a colorless oil.

R_f=0.34 (PE/AcOEt 1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (s, 0.5H), 7.88 – 7.73 (m, 2H), 7.65 – 7.41 (m, 2H), 7.36 – 7.27 (m, 2H), 7.02 – 6.77 (m, 6H), 6.42 –

6.23 (m, 0.5H), 5.87 – 5.69 (m, 2H), 5.04 – 4.86 (m, 4H), 4.75 – 4.52 (m, 1H), 4.37 (s, 4.5H), 4.29 – 4.09 (m, 4.5H), 3.92 – 3.76 (m, 9H), 3.64 – 3.52 (m, 2H), 3.52 – 3.35 (m, 6H), 3.12 – 2.82 (m, 2H), 2.42 – 2.27 (m, 1.5H), 2.26 – 2.06 (m, 5.5H), 2.06 – 1.91 (m, 6H), 1.90 – 1.78 (m, 2H), 1.78 – 1.55 (m, 7H), 1.54 – 0.93 (m, 28H); ^{13}C NMR (101 MHz, CDCl$_3$) δ 173.5, 169.0, 163.7, 160.7, 159.7, 157.7, 151.7, 150.7, 149.6, 139.8, 139.2, 139.1, 138.6, 138.1, 135.1, 132.7, 132.1, 130.0, 127.0, 121.1, 119.6, 117.8, 115.6, 114.2, 114.1, 113.4, 113.1, 111.9, 111.8, 109.3, 107.7, 83.8, 76.3, 68.9, 68.8, 68.6, 68.0, 66.3, 55.6, 55.6, 55.6, 50.9, 48.0, 47.8, 46.6, 44.2, 34.0, 33.8, 33.3, 31.4, 30.2, 29.7, 29.5, 29.4, 29.3, 29.2, 29.1, 29.1, 28.9, 28.9, 28.6, 27.8, 26.5, 25.4, 25.1, 22.7, 15.2, 14.1; IR (neat): ν$_{max}$/cm^{-1} 3295, 2925, 2853, 2096, 1740, 1618, 1504, 1464, 1412, 1388, 1362, 1288, 1254, 1224, 1180, 1151, 1101, 1035, 1010, 950, 912, 874, 747, 633, 556, 465; HRMS (ESI$^+$) *m/z* calcd for C$_{80}$H$_{99}$N$_8$O$_{15}$ [M+H$^+$] 1411.7224, found 1411.7260.

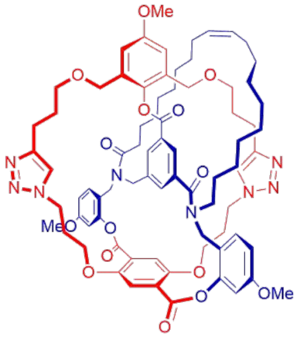
Triazole macrocycle 1:



Azidoalkyne **8** (838 mg, 594 µmol, 1.0 equiv.) was dissolved in 600 mL of CH$_2$Cl$_2$ under a N$_2$ atmosphere, to which TBTA (94.6 mg, 178 µmol, 0.3 equiv.) was added. The resulting solution was sparged with N$_2$ for 1 hour before addition of Cu(MeCN$_4$)BF$_4$ (56.0 mg, 178 µmol, 0.3 equiv.). After heating at reflux for 16 hours, the solvent was removed *in vacuo* and the crude mixture dry loaded onto silica and purified by column chromatography (AcOEt/PE 2:1 → 3:1 → 4:1 → AcOEt) to give triazole macrocycle **1** (652 mg, 78%) as a white foam.

R$_f$=0.24 (AcOEt/PE 2:1); ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.30 – 7.72 (m, 4H), 7.72 – 7.43 (m, 1.5H), 7.39 – 7.20 (m, 1.5H), 7.15 – 6.94 (m, 1H), 6.94 – 6.71 (m, 5H), 6.61 (s, 1H), 6.11 – 5.90 (m, 1H), 5.88 – 5.69 (m, 2H), 5.65 – 5.25 (m, 1H), 5.05 – 4.83 (m, 4H), 4.83 – 3.93 (m, 14H), 3.93 – 3.69 (m, 9H), 3.67 – 3.17 (m, 4.5H), 2.82 – 2.09 (m, 10H), 2.09 – 1.90 (m, 4.5H), 1.88 – 1.54 (m, 6H), 1.41 – 0.78 (m, 28H); ^{13}C NMR (101 MHz, CDCl$_3$) δ 173.5, 168.8, 165.1, 163.3, 160.8, 159.5, 157.2, 152.7, 151.5, 151.1, 150.5, 150.2, 149.2, 142.6, 142.2, 142.1, 139.3, 139.2, 139.1, 139.0, 137.8, 136.0, 132.8, 132.0, 131.6, 129.5, 124.8, 120.8, 119.5, 115.5, 115.2, 115.0, 114.3, 114.2, 114.1, 114.1, 114.1, 114.0, 112.0, 111.4, 109.7, 108.0, 76.4, 71.0, 70.8, 70.5, 66.5, 65.7, 55.7, 55.6, 55.6, 51.6, 46.1, 45.2, 43.3, 34.9, 33.8, 33.8, 33.8, 33.8, 33.2, 31.9, 31.4, 30.2, 29.7, 29.7, 29.6, 29.5, 29.5, 29.4, 29.4, 29.4, 29.3, 29.2, 29.2, 29.1, 29.1, 29.1, 29.0, 29.0, 29.0, 28.9, 28.9, 28.9, 27.9, 26.9, 26.8, 25.5, 25.4, 25.2, 22.7, 22.2, 14.1; IR (neat): ν$_{max}$/cm^{-1} 2922, 2852, 1741, 1632, 1506, 1465, 1414, 1256, 1194, 1105, 1051; HRMS (FD$^+$) *m/z* calcd for C$_{80}$H$_{99}$N$_8$O$_{15}$ [M+H$^+$] 1411.7224, found 1411.7169.

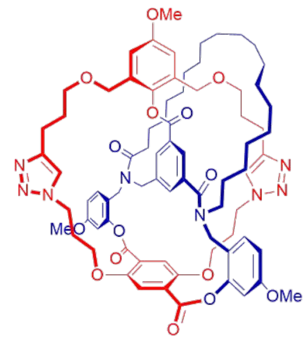
Alkene bismacrocycle 25:



Triazole macrocycle **1** (200 mg, 142 µmol, 1.0 equiv.) was dissolved in 140 mL of dichloroethane under a N$_2$ atmosphere. After sparging the solution with N$_2$ for 1 hour, Grubbs 2nd generation catalyst (48.2 mg, 56.8 µmol, 0.4 equiv.) was added and the reaction mixture sparged for an additional 10 minutes. After heating at reflux for 20 hours, the solvents were removed *in vacuo* and the crude product was purified by column chromatography (EtOAc in CH$_2$Cl$_2$ 33% → 55% → 80%) to give bismacrocycle **25** (82.7 mg, 42%) as a brown glass, as well as triazole macrocycle starting material **1** (50.1 mg, 25%) which was subjected to identical reaction conditions to give bismacrocycle **25** (14.4 mg, 29%). Longer reaction times lead to decomposition of the product and overall lower yields.

R$_f$=0.18 (AcOEt/PE 9:1); ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.07 (s, 0.5H), 7.97 (d, J = 6.0 Hz, 1H), 7.91 – 7.74 (m, 2.5H), 7.68 (s, 1H), 7.30 (d, J = 6.3 Hz, 1H), 6.93 (dd, J = 6.1, 2.6 Hz, 1H), 6.91 – 6.75 (m, 5H), 6.69 (s, 0.5H), 6.55 (s, 0.5H), 6.20 (s, 0.5H), 5.96 (dd, J = 14.9, 8.9 Hz, 1H), 5.48 – 5.17 (m, 2.5H), 4.94 (d, J = 17.1 Hz, 1H), 4.85 – 4.68 (m, 2H), 4.68 – 4.15 (m, 11H), 3.88 (s, 3H), 3.85 – 3.79 (m, 6H), 3.79 – 3.63 (m, 1.5H), 3.60 – 3.36 (m, 3H), 3.35 – 3.21 (m, 1H), 3.08 – 2.96 (m, 0.5H), 2.77 – 2.06 (m, 10H), 2.03 – 1.57 (m, 10H), 1.51 – 0.61 (m, 28H); ^{13}C NMR (101 MHz, CDCl$_3$) δ 174.0, 174.0, 169.1, 169.0, 168.8, 163.7, 163.6, 163.5, 163.3, 162.2, 162.1, 162.1, 162.0, 160.8, 159.6, 159.6, 157.2, 157.2, 157.1, 152.4, 152.2, 151.7, 151.6, 151.6, 150.6, 150.5, 150.5, 149.4, 149.4, 149.3, 147.2, 146.9, 146.2, 146.1, 145.5, 145.5, 142.8, 142.7, 142.2, 140.6, 140.0, 139.9, 138.4, 138.1, 136.0, 136.0, 132.8, 132.7, 132.3, 132.2, 132.2, 131.5, 131.4, 131.2, 131.1, 130.8, 130.5, 130.3, 130.2, 130.1, 130.0, 129.5, 128.4, 128.3, 128.1, 127.8, 127.6, 127.4, 125.4, 125.2, 124.5, 124.0, 123.9, 123.9, 121.3, 121.1, 121.1, 121.0, 120.9, 120.8, 120.0, 119.6, 119.4, 118.8, 116.0, 115.9, 115.9, 115.5, 115.2, 115.1, 111.9, 111.5, 111.4, 109.8, 109.7, 108.1, 108.0, 71.5, 71.4, 71.0, 70.8, 70.6, 70.5, 70.3, 69.8, 66.4, 66.4, 65.9, 65.4, 60.4, 55.7, 55.7, 55.6, 51.9, 51.7, 46.4, 46.2, 46.0, 45.8, 45.5, 45.1, 45.0, 43.5, 43.2, 33.3, 33.1, 32.6, 32.6, 32.3, 32.1, 30.6, 30.5, 30.0, 29.9, 29.8, 29.8, 29.7, 29.6, 29.5, 29.5, 29.4, 29.3, 29.3, 29.3, 29.1, 29.0, 28.9, 28.9, 28.8, 28.8, 28.4, 28.3, 28.1, 27.9, 27.7, 27.4, 27.3, 27.1, 25.8, 25.6, 25.4, 25.2, 22.4, 22.2, 22.1, 21.8, 21.7, 14.2; IR (neat): ν$_{max}$/cm^{-1} 2924, 2853, 1739, 1619, 1505, 1465, 1432, 1414, 1389, 1363, 1320, 1288, 1253, 1186, 1151, 1105, 1049, 966, 912, 731; HRMS (FD$^+$) *m/z* calcd for $C_{78}H_{95}N_8O_{15}$ [M+H$^+$] 1383.6911, found 1383.6917.

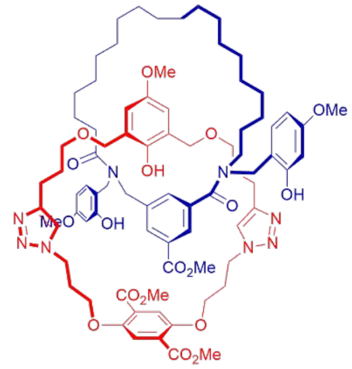
Precatenane 9:



Alkene bismacrocycle **25** (99.2 mg, 71.7 µmol, 1.0 equiv.) was dissolved in 8 mL of THF under a N_2 atmosphere, to which 4 mL of absolute MeOH were added, followed by 10% Pd/C (22.9 mg, 21.5 µmol, 0.3 equiv.). The suspension was sparged with H_2 for 10 minutes, then stirred for 20 hours at 50°C under a H_2 atmosphere. The crude reaction mixture was then cooled to room temperature, flushed with N_2 and filtered over celite with some THF. The crude product was purified by column chromatography (AcOEt/CH_2Cl_2 1:1 → 7:3 → 8:2) to give precatenane **9** (65.4 mg, 66%) as a colorless glass.

R_f=0.20 (AcOEt/CH_2Cl_2 7:3); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (s, 0.5H), 7.97 (s, 1H), 7.90 – 7.66 (m, 3H), 7.29 (d, J = 8.5 Hz, 1H), 6.94 (t, J = 2.9 Hz, 1H), 6.91 – 6.74 (m, 5H), 6.69 (s, 0.5H), 6.51 (s, 0.5H), 6.19 (s, 0.5H), 5.95 (dd, J = 14.9, 8.6 Hz, 1H), 5.42 (s, 0.5H), 5.32 (s, 0.5H), 5.02 (d, J = 17.0 Hz, 0.5H), 4.89 – 4.02 (m, 14.5H), 3.87 (s, 3H), 3.84 – 3.78 (m, 6H), 3.74 (dd, J = 15.1, 9.2 Hz, 1.5H), 3.57 – 3.36 (m, 3H), 3.30 (dd, J = 15.6, 9.4 Hz, 1H), 3.03 – 2.91 (m, 0.5H), 2.75 – 2.07 (m, 12H), 2.06 – 1.86 (m, 2H), 1.85 – 1.55 (m, 5H), 1.54 – 0.60 (m, 32H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.1, 169.2, 168.8, 163.8, 163.7, 163.6, 163.3, 162.3, 162.1, 160.8, 159.6, 159.6, 157.3, 157.2, 152.3, 152.1, 151.6, 151.6, 150.5, 150.5, 149.4, 149.4, 147.1, 146.9, 146.1, 145.3, 142.8, 142.2, 140.6, 140.0, 138.3, 138.1, 136.0, 136.0, 132.8, 132.7, 132.3, 132.2, 131.4, 131.2, 131.0, 130.6, 128.6, 128.2, 127.7, 127.4, 125.3, 125.1, 124.4, 124.2, 124.0, 123.9, 121.4, 121.1, 121.0, 121.0, 121.0, 120.8, 120.0, 119.6, 119.4, 118.7, 116.1, 116.1, 116.0, 115.6, 115.3, 115.2, 111.9, 111.5, 111.5, 109.8, 109.6, 108.1, 108.0, 71.4, 71.2, 71.0, 70.7, 70.6, 70.5, 70.3, 69.7, 66.5, 66.4, 66.0, 65.4, 55.7, 55.7, 55.6, 52.0, 51.7, 46.4, 46.2, 46.1, 46.0, 45.9, 45.6, 45.1, 44.9, 43.4, 43.1, 33.6, 33.4, 31.9, 30.3, 30.2, 30.1, 30.0, 30.0, 29.8, 29.8, 29.7, 29.7, 29.6, 29.5, 29.5, 29.4, 29.4, 29.3, 29.3, 29.2, 29.1, 29.1, 29.0, 28.9, 28.9, 28.8, 28.4, 28.2, 28.0, 27.8, 27.6, 27.3, 27.0, 25.7, 25.5, 24.9, 22.7, 22.4, 22.1, 21.7, 14.1; IR (neat): ν_{max}/cm^{-1} 2926, 2853, 1740, 1619, 1505, 1465, 1432, 1414, 1389, 1363, 1320, 1289, 1254, 1186, 1151, 1105, 1049, 965, 913, 730; HRMS (ESI$^+$) *m/z* calcd for $C_{78}H_{97}N_8O_{15}$ [M+H$^+$] 1385.7068, found 1385.7056.

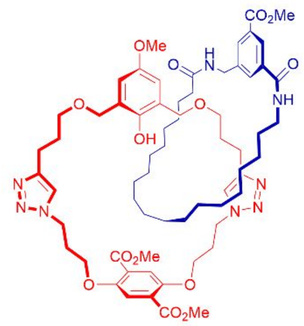
Trisphenol [2]catenane 10:



Precatenane **9** (65.4 mg, 47.2 µmol, 1.0 equiv.) was dissolved in 5 mL of warm anhydrous THF under a N_2 atmosphere, to which 5 mL of anhydrous MeOH was added, followed by K_2CO_3 (2.45 g, 17.7 mmol, 375 equiv.). The resulting suspension was stirred vigorously for 5 hours at room temperature and then neutralized with ca. 2 mL AcOH and subsequently dry loaded onto silica. The crude product was purified by column chromatography (MeOH in CH_2Cl_2 1% → 2% → 5%) to give trisphenol [2]catenane **10** (58.8 mg, 84%) as a colorless glass.

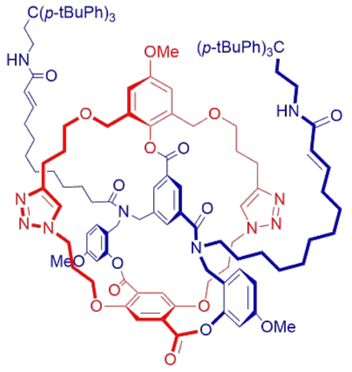
R_f=0.42 (MeOH in CH_2Cl_2 5%); ^{1}H NMR (400 MHz, CDCl3) δ 9.95 – 9.49 (m, 2H), 8.09 – 7.85 (m, 1H), 7.72 (s, 0.5H), 7.62 – 7.29 (m, 3.5H), 7.19 (d, J = 14.0 Hz, 1H), 7.10 – 6.97 (m, 1H), 6.76 (d, J = 8.1 Hz, 1H), 6.67 – 6.24 (m, 5H), 5.34 (s, 0.5H), 4.95 – 4.24 (m, 9H), 4.15 (d, J = 9.9 Hz, 2.5H), 3.88 (d, J = 12.5 Hz, 9H), 3.78 (d, J = 13.6 Hz, 6H), 3.66 (s, 3H), 3.55 (s, 4H), 3.21 (s, 3H), 2.67 (s, 2H), 2.53 – 2.12 (m, 6.5H), 1.92 (s, 4H), 1.62 (d, J = 7.9 Hz, 4H), 1.44 (s, 1.5H), 1.36 – 0.69 (m, 37H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 177.3, 176.2, 172.3, 165.6, 165.1, 165.0, 161.6, 161.5, 157.6, 157.6, 152.3, 151.6, 146.7, 146.1, 137.9, 136.4, 132.5, 132.3, 131.2, 127.2, 127.0, 125.1, 123.4, 121.9, 115.9, 115.3, 114.4, 106.0, 105.4, 102.6, 76.2, 71.7, 70.9, 70.3, 68.8, 63.9, 63.5, 55.6, 55.3, 52.5, 52.4, 52.3, 49.3, 49.1, 45.7, 45.6, 45.4, 33.8, 32.9, 31.9, 31.9, 31.9, 29.8, 29.7, 29.7, 29.6, 29.5, 29.5, 29.5, 29.4, 29.3, 29.3, 29.2, 29.1, 28.9, 28.7, 28.5, 27.2, 27.1, 25.1, 24.8, 22.7, 22.7, 22.6, 14.1; IR (neat): ν_{max}/cm^{-1} 3138, 2925, 2853, 1723, 1615, 1506, 1465, 1436, 1389, 1290, 1239, 1207, 1161, 1101, 1038, 964, 848, 787, 774, 732; HRMS (FD$^+$) *m/z* calcd for $C_{81}H_{109}N_8O_{18}$ [M+H$^+$] 1481.7854, found 1481.7841.

[2]catenane 2:



Trisphenol [2]catenane **10** (58.8 mg, 39.7 µmol, 1.0 equiv.) was dissolved in 2 mL of $CHCl_3$ and the solution was cooled to 0°C. Subsequently, Et_3SiH (63.4 µL, 397 µmol, 10 equiv.) was added, followed by dropwise addition of 2 mL of TFA. The mixture was allowed to warm to room temperature and stirred over a period of 2 hours before 24 mL of toluene were added and the crude was quickly concentrated *in vacuo* to remove all solvents. The crude product was purified by column chromatography (MeOH in CH_2Cl_2 1% → 2% → 3% → 4%) to give [2]catenane **2** (32.6 mg, 68%) as a colorless glass. R_f=0.32 (MeOH in CH_2Cl_2 5%); ^1H NMR (500 MHz, $CDCl_3$) δ 8.27 (s, 1H), 7.99 (s, 1H), 7.81 (s, 1H), 7.55 (s, 1H), 7.40 (s, 2H), 7.34 (s, 1H), 6.73 (s, 1H), 6.60 (s, 1H), 4.70 (s, 4H), 4.50 (s, 2H), 4.38 (s, 3H), 4.18 (s, 1H), 3.87 (d, J = 9.5 Hz, 12H), 3.73 (s, 4H), 3.59 (s, 2H), 3.41 (s, 2H), 3.24 (s, 1H), 3.02 (s, 1H), 2.74 (s, 2H), 2.56 – 2.28 (m, 6H), 1.96 (s, 4H), 1.62 (s, 2H), 1.42 (s, 2H), 1.25 (s, 4H), 1.19 – 0.83 (m, 28H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 173.4, 166.4, 166.3, 165.1, 165.0, 152.5, 151.6, 151.4, 147.9, 146.8, 146.6, 139.1, 135.6, 132.4, 131.8, 130.5, 127.6, 124.6, 124.1, 124.0, 123.4, 122.5, 116.1, 114.8, 113.6, 71.1, 70.5, 70.2, 69.3, 64.1, 63.8, 55.8, 52.3, 52.3, 45.9, 45.8, 43.3, 40.0, 36.1, 29.6, 29.5, 29.4, 29.3, 29.3, 29.3, 29.1, 29.1, 29.0, 29.0, 28.5, 26.7, 25.4, 22.4, 22.2; IR (neat): ν_{max}/cm^{-1} 3331, 2925, 2852, 1722, 1655, 1600, 1541, 1505, 1436, 1408, 1388, 1311, 1239, 1206, 1132, 1099, 1057, 980, 918, 836, 788, 754, 730, 645, 508; HRMS (FD^+) *m/z* calcd for $C_{65}H_{93}N_8O_{14}$ [$M+H^+$] 1209.6805, found 1209.6889.

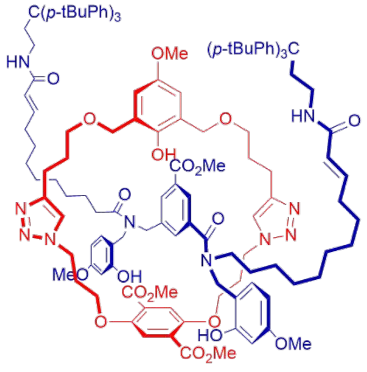
Prerotaxane 12:



Triazole macrocycle **1** (100 mg, 70.8 µmol, 1.0 equiv.) and alkene stopper **11**[7] (144 mg, 283 µmol, 4 equiv.) were dissolved in 23 mL of CH_2Cl_2 under a N_2 atmosphere and the resulting solution was sparged with N_2 for 30 minutes. Then Grubbs 2nd generation catalyst (12.0 mg, 14.2 µmol, 0.2 equiv.) was added and sparging was continued for 10 minutes. After stirring for 19 hours at reflux the crude reaction mixture was concentrated, dry loaded onto silica and purified by column chromatography (EtOAc in CH_2Cl_2 20% → 40% → 60% → 80%) to give prerotaxane **12** (127.2 mg, 76%) as a brown glass.

R_f=0.38 (EtOAc/PE 9:1); ^1H NMR (400 MHz, $CDCl_3$) δ 8.17 – 7.74 (m, 4H), 7.72 – 7.55 (m, 1H), 7.38 – 7.13 (m, 24H), 6.98 (s, 1H), 6.93 – 6.57 (m, 8H), 6.54 – 6.46 (m, 0.5H), 6.30 – 6.17 (m, 0.5H), 6.10 – 5.93 (m, 1H), 5.62 – 5.28 (m, 3H), 5.28 – 5.02 (m, 2H), 4.73 – 4.05 (m, 14H), 3.90 – 3.68 (m, 11H), 3.64 – 3.21 (m, 4H), 3.13 (s, 4H), 2.87 – 2.65 (m, 4H), 2.62 – 1.89 (m, 18H), 1.77 – 1.58 (m, 4H), 1.53 – 0.99 (m, 80H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.5, 171.1, 168.8, 166.0, 166.0, 165.9, 165.1, 163.3, 162.5, 160.8, 159.5, 157.1, 152.7, 151.5, 151.2, 150.5, 150.2, 149.2, 148.5, 148.4, 147.2, 147.0, 146.6, 144.4, 144.3, 144.2, 144.0, 144.0, 142.6, 142.3, 142.1, 139.9, 138.1, 137.8, 136.0, 132.8, 132.0, 131.6, 131.1, 130.5, 129.6, 129.0, 128.7, 128.5, 125.9, 125.5, 124.7, 124.4, 123.6, 123.5, 123.5, 121.4, 121.0, 120.7, 120.0, 119.5, 118.6, 115.6, 115.2, 115.0, 112.0, 111.4, 109.8, 108.0, 76.2, 71.0, 70.7, 70.5, 66.5, 65.6, 60.4, 55.7, 55.7, 55.7, 55.6, 54.5, 54.5, 51.6, 46.0, 45.3, 43.3, 41.5, 40.0, 37.2, 34.5, 34.3, 34.1, 33.8, 33.2, 31.9, 31.9, 31.6, 31.4, 31.2, 29.9, 29.7, 29.4, 29.2, 29.2, 29.1, 29.0, 28.9, 28.6, 28.2, 27.8, 26.7, 25.4, 25.3, 25.1, 22.7, 22.5, 22.2, 21.9, 21.1, 14.2, 14.2; IR (neat): ν_{max}/cm^{-1} 2957, 2929, 2858, 1741, 1670, 1620, 1506, 1463, 1440, 1413, 1392, 1362, 1320, 1287, 1255, 1185, 1152, 1106, 1049, 1016, 910, 840, 821, 730, 646, 588; HRMS (FD^+) *m/z* calcd for $C_{148}H_{185}N_{10}O_{17}$ [$M+H^+$] 2374.3914, found 2374.3952.

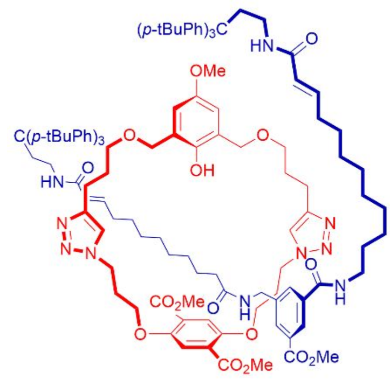
Trisphenol [2]rotaxane 13:



Prerotaxane **12** (127 mg, 53.6 µmol, 1.0 equiv.) was dissolved in 6 mL of anhydrous THF under a N_2 atmosphere, to which 6 mL of anhydrous MeOH were added, followed by K_2CO_3 (2.78 g, 20.1 mmol, 375 equiv.). After stirring at room temperature for 6 hours, the crude reaction mixture was neutralized with ca. 2 mL of AcOH and dry loaded onto silica. The crude product was purified by column chromatography (EtOAc in CH_2Cl_2 30% → 40% → 60%) to give trisphenol [2]rotaxane **13** (99.2 mg, 75%) as a colorless glass.

R_f=0.42 (EtOAc/CH_2Cl_2 1:1); ^1H NMR (400 MHz, $CDCl_3$) δ 9.83 – 9.58 (m, 2H), 8.02 (s, 1H), 7.94 – 7.83 (m, 1H), 7.80 (s, 0.5H), 7.70 (s, 0.5H), 7.65 – 7.58 (m, 1H), 7.54 (s, 1H), 7.46 (s, 1H), 7.35 – 6.98 (m, 27H), 6.86 – 6.68 (m, 2H), 6.61 (d, J = 9.9 Hz, 2H), 6.54 (d, J = 12.9 Hz, 1H), 6.51 – 6.38 (m, 2H), 6.31 (d, J = 8.4 Hz, 2H), 5.54 – 5.31 (m, 2H), 5.14 – 5.02 (m, 1H), 4.79 – 4.26 (m, 14H), 4.02 – 3.86 (m, 5H), 3.86 – 3.65 (m, 14H), 3.65 – 3.57 (m, 3H), 3.57 – 3.45 (m, 4H), 3.23 – 3.10 (m, 4H), 2.95 – 2.84 (m, 1H), 2.78 (t, J = 7.3 Hz, 3H), 2.72 – 2.50 (m, 6H), 2.49 – 2.28 (m, 5H), 2.19 (t, J = 7.6 Hz, 1H), 2.08 (q, J = 7.3 Hz, 2H), 1.94 – 1.77 (m, 4H), 1.75 – 1.53 (m, 4H), 1.27 (d, J = 4.9 Hz, 79H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 176.1, 176.1, 172.0, 171.8, 171.2, 166.0, 165.9, 165.7, 165.6, 165.5, 165.2, 165.1, 161.6, 161.6, 161.6, 161.5, 157.6, 157.5, 152.5, 152.4, 151.4, 148.5, 148.5, 148.2, 147.9, 147.0, 146.9, 144.3, 144.3, 144.1, 144.0, 144.0, 142.5, 142.1, 137.5, 137.4, 136.7, 136.5, 132.4, 132.4, 132.0, 131.3, 131.3, 129.6, 128.9, 128.7, 127.4, 127.3, 124.7, 124.6, 124.5, 124.3, 124.1, 123.8, 123.7, 123.6, 123.5, 122.7, 122.5, 122.4, 116.2, 114.3, 114.2, 114.1, 114.1, 114.0, 114.0, 105.9, 105.6, 102.7, 102.6, 102.5, 98.4, 70.3, 70.2, 70.2, 70.1, 64.2, 62.0, 60.4, 55.6, 55.6, 55.3, 55.3, 55.2, 54.5, 54.2, 54.1, 52.6, 52.2, 52.2, 51.7, 49.9, 49.8, 48.7, 46.0, 45.8, 45.3, 44.7, 40.0, 39.9, 37.2, 34.3, 34.3, 34.1, 33.2, 33.1, 31.9, 31.7, 31.5, 31.4, 31.2, 30.8, 29.7, 29.5, 29.4, 29.3, 29.3, 29.2, 29.1, 29.0, 28.3, 28.2, 28.2, 28.0, 27.7, 26.9, 26.7, 25.1, 25.0, 23.4, 22.7, 22.4, 21.8, 21.1, 14.2, 1.0; IR (neat): ν_{max}/cm^{-1} 2952, 2930, 2859, 1725, 1671, 1619, 1507, 1462, 1435, 1408, 1390, 1362, 1289, 1268, 1239, 1204, 1162, 1102, 1058, 1037, 1016, 965, 910, 841, 822, 787, 731, 646, 588; HRMS (FD$^+$) *m/z* calcd for $C_{151}H_{197}N_{10}O_{20}$ [M+H$^+$] 2470.4700, found 2470.4694.

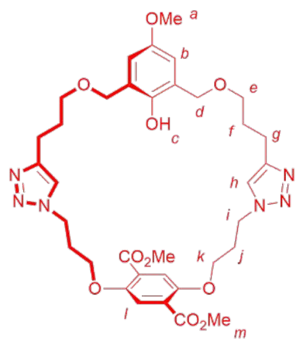
[2]rotaxane 3:



Trisphenol [2]rotaxane **13** (83.9 mg, 34.0 µmol, 1.0 equiv.) was dissolved in 2.5 mL of $CHCl_3$ and the solution was cooled to 0°C. Subsequently, Et_3SiH (54.2 µL, 340 µmol, 10 equiv.) was added, followed by dropwise addition of 2.5 mL of TFA. The mixture was allowed to warm to room temperature and stirred over a period of 2 hours before 60 mL of toluene were added and the crude was quickly concentrated *in vacuo* to remove all solvents. The crude product was purified by column chromatography (MeOH in CH_2Cl_2 1% → 2% → 3%) to give [2]rotaxane **3** (37.5 mg, 50%) as a colorless glass.

R$_f$=0.32 (MeOH in CH_2Cl_2 5%); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.27 (s, 0.5H), 8.13 (s, 0.5H), 7.95 (s, 0.5H), 7.85 (s, 0.5H), 7.83 (s, 0.5H), 7.72 (s, 0.5H), 7.66 (s, 1H), 7.60 (s, 1H), 7.34 (s, 1H), 7.29 (s, 1H), 7.28 – 7.12 (m, 25H), 6.91 (s, 0.5H), 6.72 (s, 1H), 6.66 – 6.42 (m, 3.5H), 5.76 (s, 0.5H), 5.66 (s, 0.5H), 5.51 – 5.38 (m, 2H), 5.06 – 4.92 (m, 1H), 4.77 – 4.54 (m, 4H), 4.48 – 4.26 (m, 5H), 4.09 (s, 1H), 3.99 – 3.88 (m, 4H), 3.86 (s, 1.5H), 3.83 (s, 1.5H), 3.80 (s, 3H), 3.76 (s, 3H), 3.68 – 3.61 (m, 3H), 3.55 – 3.41 (m, 4H), 3.35 (s, 1H), 3.16 (s, 2H), 3.05 (s, 2H), 2.97 (s, 1H), 2.82 – 2.56 (m, 8H), 2.37 (s, 4H), 2.19 (s, 1H), 2.12 – 2.03 (m, 2H), 1.96 – 1.73 (m, 7H), 1.67 – 1.48 (m, 2H), 1.43 – 0.76 (m, 78H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 173.3, 166.2, 166.0, 165.2, 165.1, 152.5, 152.4, 151.5, 148.5, 148.4, 147.8, 146.9, 144.5, 144.0, 143.5, 139.7, 139.1, 135.4, 131.4, 131.3, 130.8, 130.4, 128.7, 127.2, 124.7, 124.7, 124.6, 123.8, 123.6, 123.4, 122.7, 116.3, 114.3, 113.9, 70.2, 64.3, 55.7, 54.6, 54.4, 52.3, 52.2, 45.9, 42.9, 42.6, 40.3, 40.0, 37.1, 36.5, 35.9, 34.3, 31.9, 31.8, 31.4, 29.7, 29.5, 29.3, 29.1, 29.0, 28.2, 28.1, 27.0, 25.7, 25.4, 22.1; IR (neat): ν_{max}/cm^{-1} 3296, 2956, 2930, 2861, 1725, 1668, 1541, 1508, 1461, 1437, 1407, 1390, 1362, 1268, 1241, 1207, 1141, 1105, 1058, 1016, 978, 910, 841, 822, 788, 732, 647, 588; HRMS (FD$^+$) *m/z* calcd for $C_{135}H_{181}N_{10}O_{16}$ [M+H$^+$] 2198.3652, found 2198.3578.

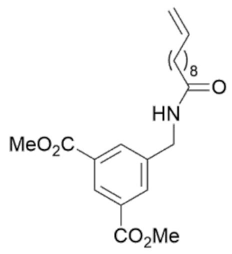
Trivial triazole macrocycle 26:



Methyl ester template **24** (294 mg, 0.750 mmol, 1.0 equiv.), dialkyne ring fragment **5** (237 mg, 0.750 mmol, 1.0 equiv.) and DiPEA (52.2 µL, 0.300 mmol, 0.4 equiv.) were dissolved in 750 mL of CH_2Cl_2 under a N_2 atmosphere. After sparging the solution with N_2 for 2 hours, $Cu(MeCN)_4BF_4$ (70.8 mg, 0.225 mmol, 0.3 equiv.) was added and the resulting reaction mixture was heated at reflux for 16 hours. The crude mixture was then concentrated *in vacuo*, dry loaded onto silica and the product was purified by column chromatography (MeOH in CH_2Cl_2 2% → 3% → 4%) to give trivial triazole macrocycle **26** (34.7 mg, 6.5%) as a colorless glass. Note that when using TBTA in place of DiPEA higher yields could be obtained, but the product could not be completely separated from TBTA.

R$_f$=0.23 (MeOH in CH_2Cl_2 5%); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (s, 1H), 7.35 (s, 2H), 7.31 (s, 2H), 6.65 (s, 2H), 4.66 (t, J = 5.9 Hz, 4H), 4.50 (s, 4H), 3.90 (s, 6H), 3.83 (t, J = 5.6 Hz, 4H), 3.74 (s, 3H), 3.51 (t, J = 6.1 Hz, 4H), 2.76 (t, J = 7.7 Hz, 4H), 2.39 (t, J = 5.9 Hz, 4H), 1.94 (p, J = 6.4 Hz, 4H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.3, 152.6, 151.6, 148.2, 147.0, 124.6, 124.1, 122.8, 116.3, 114.1, 70.4, 69.8, 64.4, 55.9, 52.4, 45.9, 29.4, 29.3, 22.4; IR (neat): ν_{max}/cm^{-1} 3382, 3136, 2949, 2866, 1724, 1653, 1616, 1551, 1466, 1436, 1408, 1387, 1356, 1309, 1237, 1207, 1150, 1101, 1053, 976, 916, 868, 788, 729, 646, 529, 482; HRMS (FD$^+$) *m/z* calcd for $C_{35}H_{44}N_6O_{10}$ [M$^{\bullet +}$] 708.3113, found 708.3096.

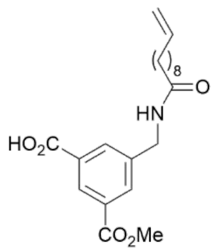
Amide 27:



Azido ester **14** (600 mg, 2.40 mmol, 1.0 equiv.) was dissolved in 20 mL of Et_2O, to which PPh_3 (694 mg, 2.64 mmol, 1.1 equiv.) was added, followed by 50 µL of H_2O. After stirring at room temperature for 24 hours, the crude amine was concentrated *in vacuo*, diluted in 30 mL of anhydrous CH_2Cl_2 under a N_2 atmosphere and cooled to 0°C. To the crude amine solution, Et_3N (1.33 mL, 9.60 mmol, 4.0 equiv.) was added, followed by dropwise addition of a solution of freshly made 10-undecenoyl chloride in 10 mL of anhydrous CH_2Cl_2. 10-Undecenoyl chloride was obtained by dissolving 10-undecenoic acid (884 mg, 4.8 mmol, 2.0 equiv.) in 5 mL of $CHCl_3$ and stirring at 60°C for 2 hours after addition of $SOCl_2$ (0.700 mL, 9.60 mmol, 4.0 equiv.), then concentrating the mixture *in vacuo* and diluting it under a N_2 atmosphere. Once addition of 10-undecenoyl chloride was complete, the mixture was allowed to warm to room temperature and stirred for 24 hours. The crude product was dry loaded onto silica and purified by column chromatography (PE/EtOAc 2:1 → 1:1 → 1:2) to give amide **27** (710 mg, 76%) as a white powder.

R_f=0.39 (PE/EtOAc 1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.56 (t, J = 1.6 Hz, 1H), 8.12 (d, J = 1.6 Hz, 2H), 5.92 (s, 1H), 5.87 – 5.72 (m, 1H), 5.02 – 4.88 (m, 2H), 4.53 (d, J = 6.0 Hz, 2H), 3.93 (s, 6H), 2.28 – 2.19 (m, 2H), 2.07 – 1.97 (m, 2H), 1.72 – 1.60 (m, 2H), 1.42 – 1.21 (m, 10H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.2, 166.0, 139.6, 139.2, 132.8, 131.0, 129.8, 114.2, 52.4, 42.8, 36.7, 33.8, 29.3, 29.3, 29.1, 28.9, 25.7; IR (neat): ν_{max}/cm^{-1} 3283, 2918, 2849, 1720, 1634, 1539, 1434, 1325, 1271, 1245, 1205, 1127, 1108, 992, 915, 753, 721; HRMS (FD$^+$) *m/z* calcd for $C_{22}H_{31}N_1O_5$ ($M^{\bullet+}$) 389.2197, found 389.2216.

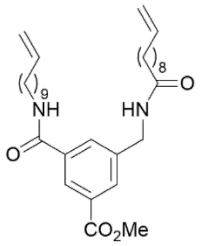
Carboxylic acid 28:



Dimethyl ester **27** (710 mg, 1.82 mmol, 1.0 equiv.) was dissolved in 28 mL of absolute MeOH, to which 1M NaOH (1.86 mL, 1.91 mmol, 1.05 equiv.) was added dropwise. After stirring under reflux for 19 hours the crude reaction mixture was cooled to room temperature and acidified to pH 1 with 1M $KHSO_4$ and then partitioned between 80 mL H_2O and 80 mL EtOAc. The aqueous layer was then extracted 2×40 mL EtOAc and the combined organic layers were dried over $MgSO_4$ and concentrated *in vacuo*. The crude product was dry loaded onto silica and purified by column chromatography (EtOAc/PE 1:1 → 3:1 → EtOAc) to give carboxylic acid **28** (551 mg, 81%) as a white solid.

R_f=0.20 (streaks) (EtOAc); ^{1}H NMR (400 MHz, CD_3OD) δ 8.47 (s, 1H), 8.16 (s, 1H), 8.12 (s, 1H), 5.87 – 5.70 (m, 1H), 5.00 – 4.86 (m, 2H), 4.47 (s, 2H), 3.93 (s, 3H), 2.27 (t, J = 7.4 Hz, 2H), 2.01 (q, J = 6.8 Hz, 2H), 1.63 (q, J = 7.2 Hz, 2H), 1.41 – 1.21 (m, 10H); ^{13}C NMR (101 MHz, CD_3OD) δ 175.0, 167.1, 166.1, 140.3, 138.7, 132.7, 132.2, 131.4, 130.6, 129.0, 113.4, 51.6, 42.0, 35.7, 33.5, 29.1, 29.0, 28.9, 28.8, 28.7, 25.7; IR (neat): ν_{max}/cm^{-1} 3293, 3076, 2925, 2853, 2478, 1724, 1639, 1545, 1459, 1434, 1351, 1302, 1238, 1206, 1125, 1030, 994, 909, 756, 722, 684, 632, 570, 478; HRMS (FD$^+$) *m/z* calcd for $C_{21}H_{30}N_1O_5$ [$M+H^+$] 376.2118, found 376.2109.

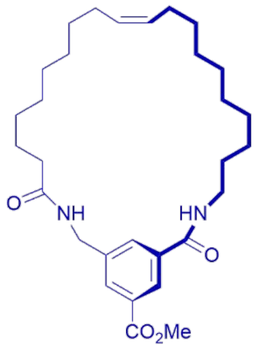
Bisamide 29:



Carboxylic acid **28** (311 mg, 0.830 mmol, 1.0 equiv.) was suspended in 30 mL of anhydrous CH_2Cl_2 under a N_2 atmosphere, to which DiPEA (289 µL, 1.66 mmol, 2 equiv.), HBTU (472 mg, 1.24 mmol, 1.5 equiv.) and 10-Undecen-1-amine[3] (169 mg, 0.996 mmol, 1.2 equiv.) were added. After stirring at room temperature for 20 hours, the crude mixture was washed with 2×20 mL 1M HCl, 2×20 mL H_2O, dried over $MgSO_4$ and concentrated *in vacuo*. The crude product was dry loaded onto silica and purified by column chromatography (EtOAc in CH_2Cl_2 10% → 20% → 40%) to give bisamide **29** (329 mg, 75%) as a white solid.

R_f=0.16 (EtOAc in CH_2Cl_2 20%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (s, 1H), 7.83 (s, 1H), 7.70 (s, 1H), 6.90 (t, J = 5.8 Hz, 1H), 6.86 (t, J = 5.9 Hz, 1H), 5.84 – 5.68 (m, 2H), 5.00 – 4.85 (m, 4H), 4.29 (d, J = 6.0 Hz, 2H), 3.82 (s, 3H), 3.36 (q, J = 6.8 Hz, 2H), 2.21 (t, J = 7.7 Hz, 2H), 2.06 – 1.93 (m, 4H), 1.66 – 1.53 (m, 4H), 1.40 – 1.18 (m, 22H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.7, 166.6, 166.1, 139.7, 139.1, 139.1, 135.4, 130.9, 130.5, 130.4, 126.6, 114.2, 114.1, 52.3, 42.6, 40.3, 36.5, 33.8, 33.8, 29.5, 29.5, 29.4, 29.4, 29.3, 29.1, 28.9, 28.9, 27.1, 25.7; IR (neat): ν_{max}/cm^{-1} 3264, 3080, 2921, 2851, 1727, 1635, 1600, 1553, 1465, 1451, 1434, 1422, 1374, 1343, 1289, 1254, 1202, 1106, 991, 909, 755, 720, 665; HRMS (FD$^+$) *m/z* calcd for $C_{32}H_{50}N_2O_4$ [$M^{\bullet+}$] 526.3765, found 526.3757.

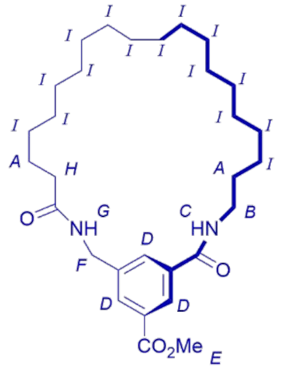
Trivial alkene macrocycle 30:



Bisalkene **29** (329 mg, 0.625 mmol, 1.0 equiv.) was dissolved in CH_2Cl_2 under a N_2 atmosphere and the solution was sparged with N_2 for 1 hour. Then Grubbs 2nd generation catalyst (53.1 mg, 62.5 µmol, 0.1 equiv.) was added and the mixture was heated at reflux for 16 hours. The crude product was then concentrated *in vacuo*, dry loaded onto silica and purified by column chromatography (CH_2Cl_2/EtOAc 9:1 → 8:2 → 6:4) to give trivial alkene macrocycle **30** (62.7 mg, 20%) as a white solid.

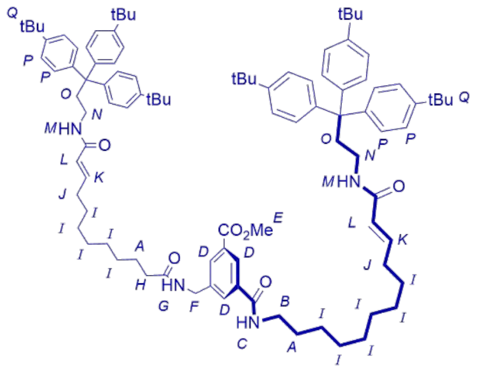
R_f=0.19 (CH_2Cl_2/EtOAc 6:4); ^{1}H NMR (400 MHz, $CDCl_3$+CD_3OD) δ 8.29 (s, 1H), 7.95 (s, 1H), 7.79 – 7.71 (m, 1H), 7.44 (s, 1H), 7.23 (s, 1H), 5.34 – 5.19 (m, 2H), 4.39 (s, 2H), 3.88 (s, 3H), 3.36 (t, J = 6.9 Hz, 2H), 2.19 (t, J = 7.6 Hz, 2H), 2.03 – 1.86 (m, 4H), 1.62 – 1.52 (m, 4H), 1.38 – 1.12 (m, 22H); ^{13}C NMR (101 MHz, $CDCl_3$+CD_3OD) δ 174.6, 167.2, 166.6, 139.7, 135.7, 131.4, 130.6, 130.6, 130.4, 130.1, 130.0, 127.5, 52.4, 42.6, 40.2, 36.3, 32.3, 32.1, 29.5, 29.2, 29.2, 29.1, 29.1, 29.0, 29.0, 28.9, 28.7, 28.6, 28.1, 27.0, 26.9, 26.8, 25.5; IR (neat): ν_{max}/cm^{-1} 3262, 3085, 2919, 2849, 1727, 1656, 1634, 1605, 1570, 1550, 1452, 1434, 1422, 1373, 1342, 1290, 1254, 1201, 1106, 1035, 967, 755, 717, 665, 508; HRMS (FD$^+$) *m/z* calcd for $C_{30}H_{46}N_2O_4$ [$M^{\bullet+}$] 498.3452, found 498.3432.

Trivial bisamide macrocycle 31:



Trivial alkene macrocycle **30** (59.9 mg, 120 μmol, 1.0 equiv.) was dissolved in a warm 2:1 THF/MeOH mixture. Once cold, 10%w/w Pd/C (25.6 mg, 24 μmol, 0.2 equiv.) was added under a N_2 atmosphere and the suspension was sparged with H_2 for 10 minutes, then stirred at 50°C under a H_2 atmosphere for 20 hours. The crude mixture was then cooled to room temperature, flushed with N_2 and filtered over celite. To ensure complete dissolution of the product, before filtration the mixture was diluted with an equal amount of THF/MeOH and warmed. The crude product was concentrated *in vacuo* and purified by column chromatography (EtOAc in CH_2Cl_2 10% → 20% → 40%) to give trivial bisamide macrocycle **31** (56.6 mg, 94%) as a white solid. R_f=0.19 (CH_2Cl_2/EtOAc 6:4); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28 (s, 1H), 8.11 – 8.03 (m, 1H), 7.95 (s, 1H), 6.30 (s, 1H), 5.98 (s, 1H), 4.50 (d, J = 6.0 Hz, 2H), 3.93 (s, 3H), 3.47 (q, J = 6.8 Hz, 1.5H), 3.22 (q, J = 7.2 Hz, 0.5H), 2.33 (t, J = 7.6 Hz, 0.5H), 2.24 (t, J = 7.6 Hz, 1.5H), 1.64 (q, J = 7.4 Hz, 4H), 1.25 (d, J = 5.6 Hz, 26H), 0.87 (q, J = 6.7 Hz, 4H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.1, 174.1, 167.0, 166.9, 166.5, 139.7, 135.9, 135.8, 131.7, 130.8, 130.8, 127.3, 52.5, 43.1, 43.0, 40.4, 40.3, 36.5, 36.4, 32.0, 29.8, 29.8, 29.7, 29.7, 29.6, 29.6, 29.5, 29.4, 29.4, 29.3, 29.2, 29.1, 29.0, 29.0, 29.0, 28.9, 28.9, 28.9, 28.8, 28.7, 28.7, 28.6, 28.6, 26.8, 25.4, 22.8, 22.7, 14.2, 1.2, 1.1; IR (neat): ν_{max}/cm^{-1} 3261, 3087, 2921, 2850, 1728, 1656, 1634, 1605, 1572, 1553, 1462, 1453, 1434, 1422, 1374, 1342, 1291, 1254, 1201, 1106, 1035, 983, 755, 714, 665; HRMS (FD$^+$) *m/z* calcd for $C_{30}H_{48}N_2O_4Na$ [M+Na$^+$] 523.3506, found 523.3525.

Trivial thread 32:



Bisalkene **29** (91.5 mg, 174 μmol, 1.0 equiv.) was dissolved in 43.5 mL of CH_2Cl_2 under a N_2 atmosphere. After addition of alkene stopper **11**[7] (355 mg, 696 μmol, 4.0 equiv.) the solution was sparged with N_2 for 30 minutes, then Grubbs 2nd generation catalyst (29.5 mg, 34.0 μmol, 0.2 equiv.) was added and the reaction mixture was stirred for 20 hours at reflux. Then the mixture was concentrated *in vacuo* and the product was purified by column chromatography (EtOAc in CH_2Cl_2 10% → 20% → 30%) to give trivial thread **32** (179 mg, 69%) as a brown glass.

R_f=0.35 (MeOH in CH_2Cl_2 5%); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.23 (s, 1H), 7.98 (s, 1H), 7.87 (s, 1H), 7.26 – 7.18 (m, 24H), 6.86 (t, J = 5.7 Hz, 1H), 6.76 – 6.64 (m, 3H), 5.49 (d, J = 15.3 Hz, 2H), 5.30 (t, J = 5.9 Hz, 1H), 5.24 (t, J = 5.9 Hz, 1H), 4.67 (d, J = 8.3 Hz, 0.5H), 4.40 (d, J = 5.9 Hz, 1.5H), 3.85 (s, 3H), 3.39 (q, J = 6.6 Hz, 2H), 3.11 (q, J = 6.5 Hz, 4H), 2.75 (t, J = 7.3 Hz, 4H), 2.19 (t, J = 7.6 Hz, 2H), 2.07 (q, J = 7.1 Hz, 4H), 1.86 (d, J = 12.6 Hz, 1H), 1.68 – 1.51 (m, 3H), 1.40 – 1.17 (m, 76H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 173.6, 166.5, 166.2, 166.1, 166.1, 148.5, 144.3, 144.3, 144.0, 139.9, 135.6, 131.2, 130.8, 130.7, 128.7, 126.7, 124.8, 123.7, 123.6, 54.5, 52.4, 48.9, 42.8, 40.3, 40.0, 37.2, 36.5, 34.3, 34.0, 32.0, 31.9, 31.4, 29.6, 29.5, 29.4, 29.4, 29.3, 29.2, 29.2, 29.2, 29.1, 29.1, 28.9, 28.3, 28.2, 27.0, 25.7, 25.7, 25.0; IR (neat): ν_{max}/cm^{-1} 3284, 3082, 2959, 2928, 2856, 1728, 1641, 1546, 1509, 1459, 1394, 1362, 1269, 1205, 1112, 1016, 978, 910, 840, 821, 754, 733, 705, 587, 577; HRMS (FD$^+$) *m/z* calcd for $C_{100}H_{137}N_4O_6$ [M+H$^+$] 1490.0533, found 1490.0489.

NMR Spectra

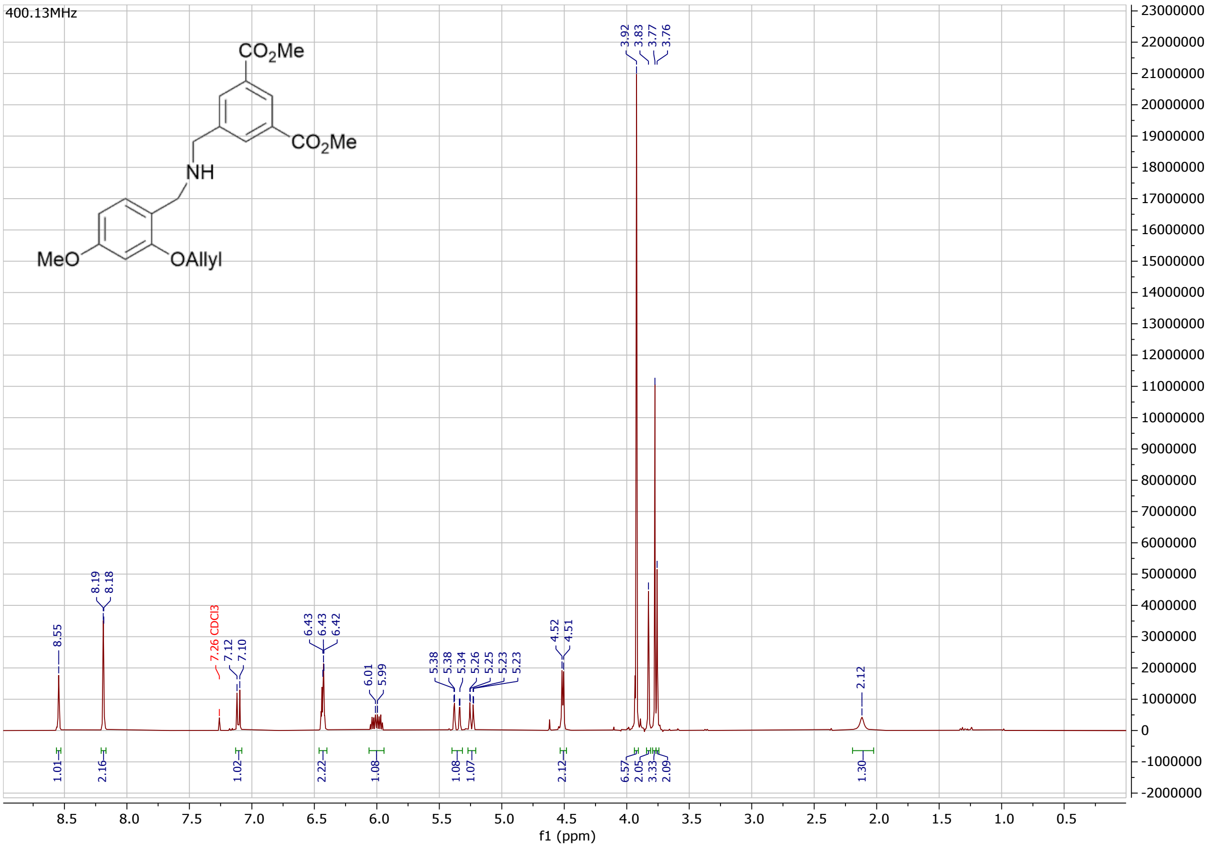


Figure S1. ^{1}H NMR spectrum of compound **16** in $CDCl_3$ at 400MHz.

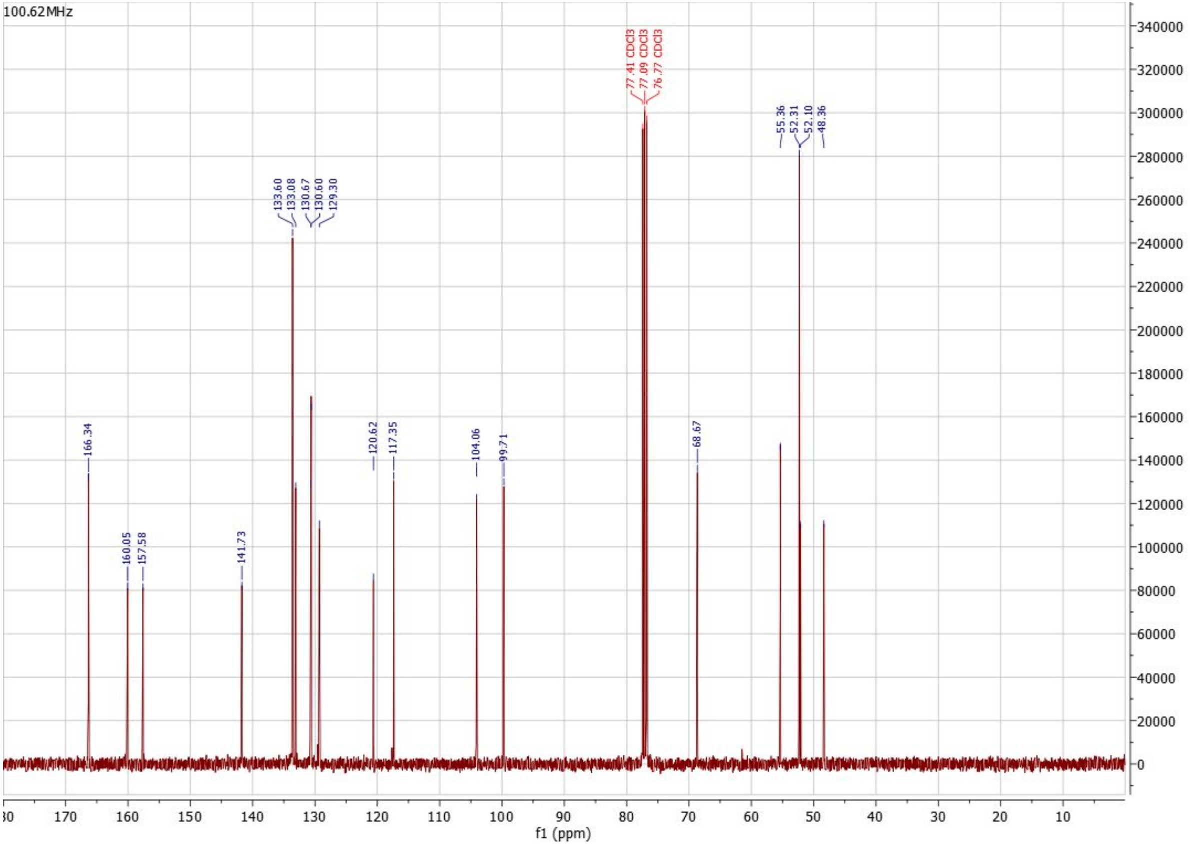


Figure S2. ^{13}C NMR spectrum of compound **16** in $CDCl_3$ at 400MHz.

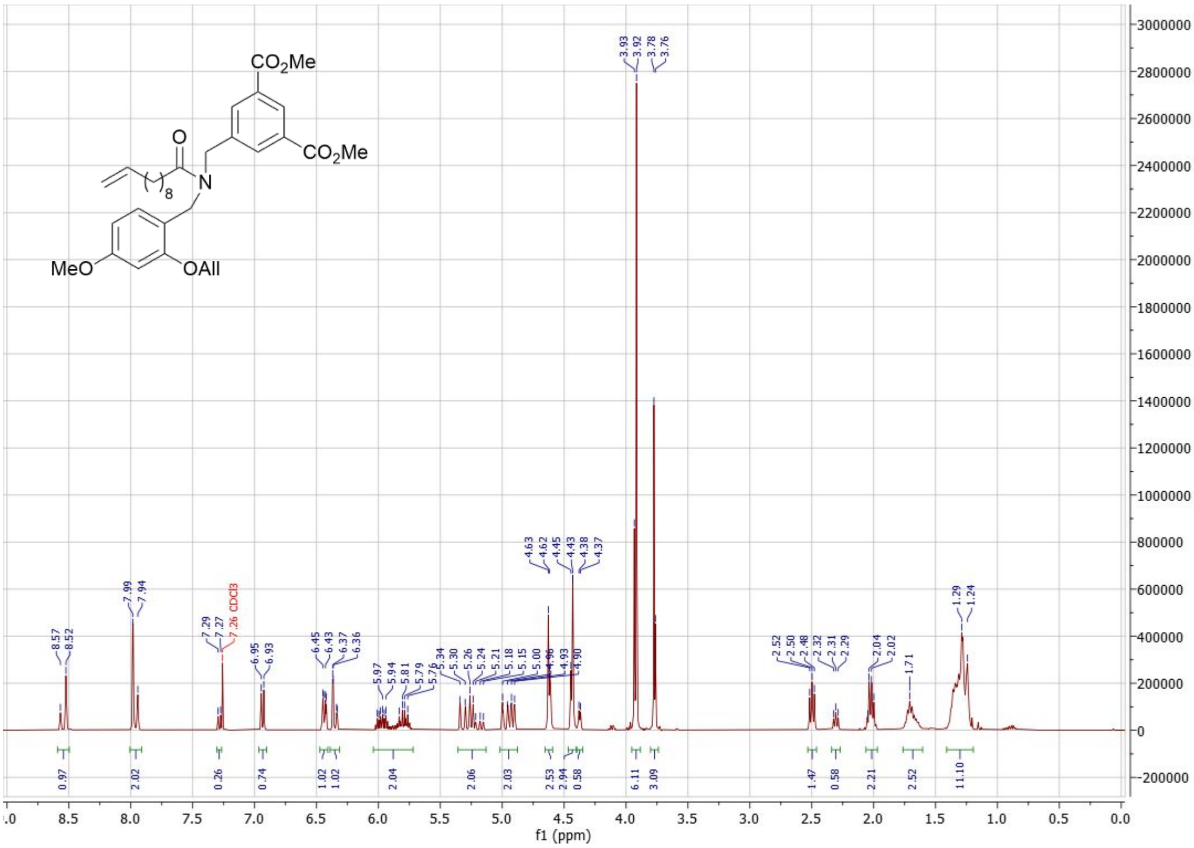


Figure S3. ^{1}H NMR spectrum of compound **17** in $CDCl_3$ at 400MHz.

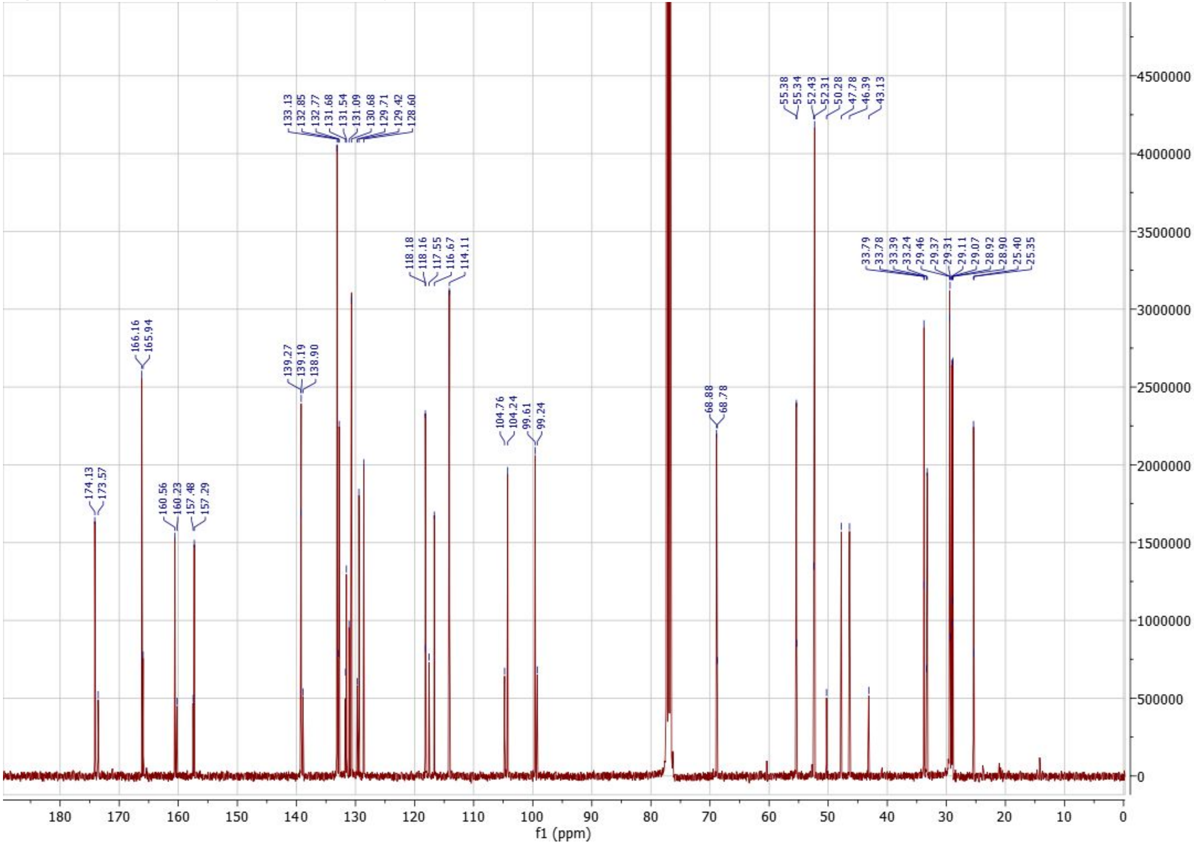


Figure S4. ^{13}C NMR spectrum of compound **17** in $CDCl_3$ at 400MHz.

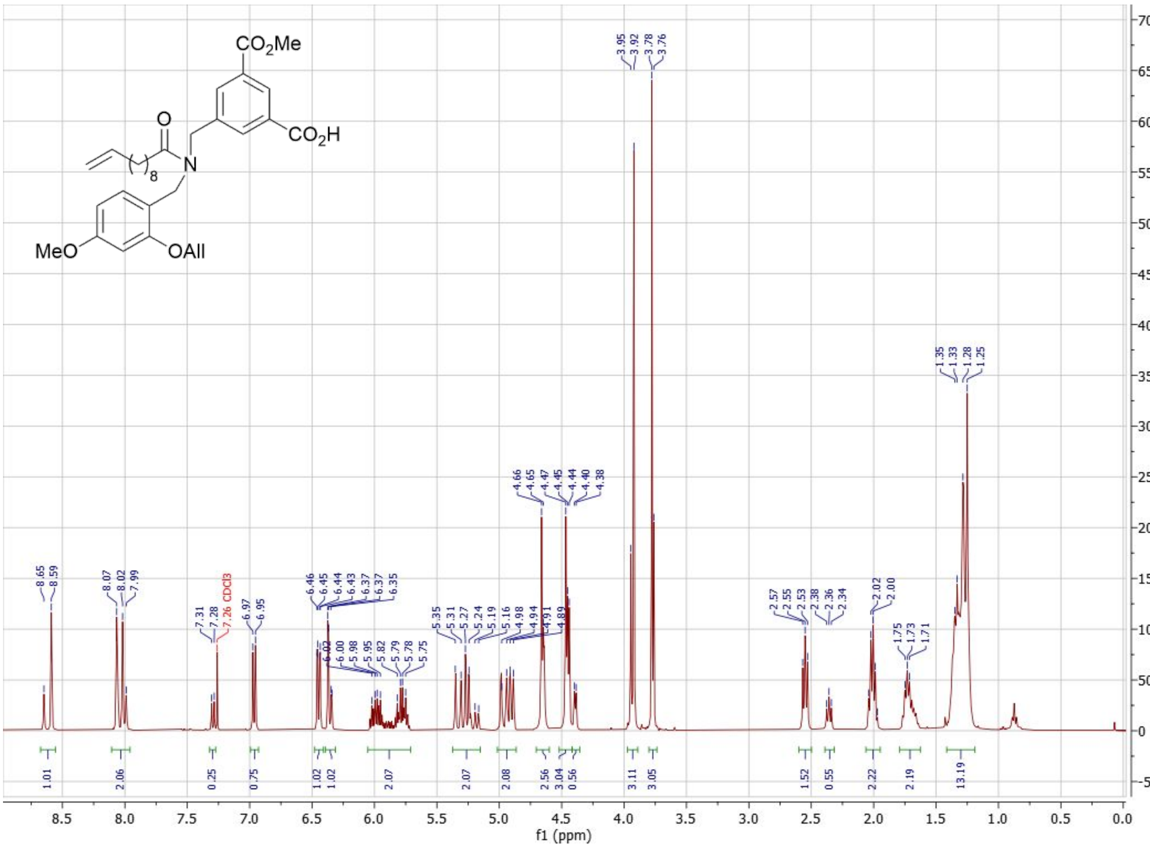


Figure S5. ^{1}H NMR spectrum of compound **18** in $CDCl_3$ at 400MHz.

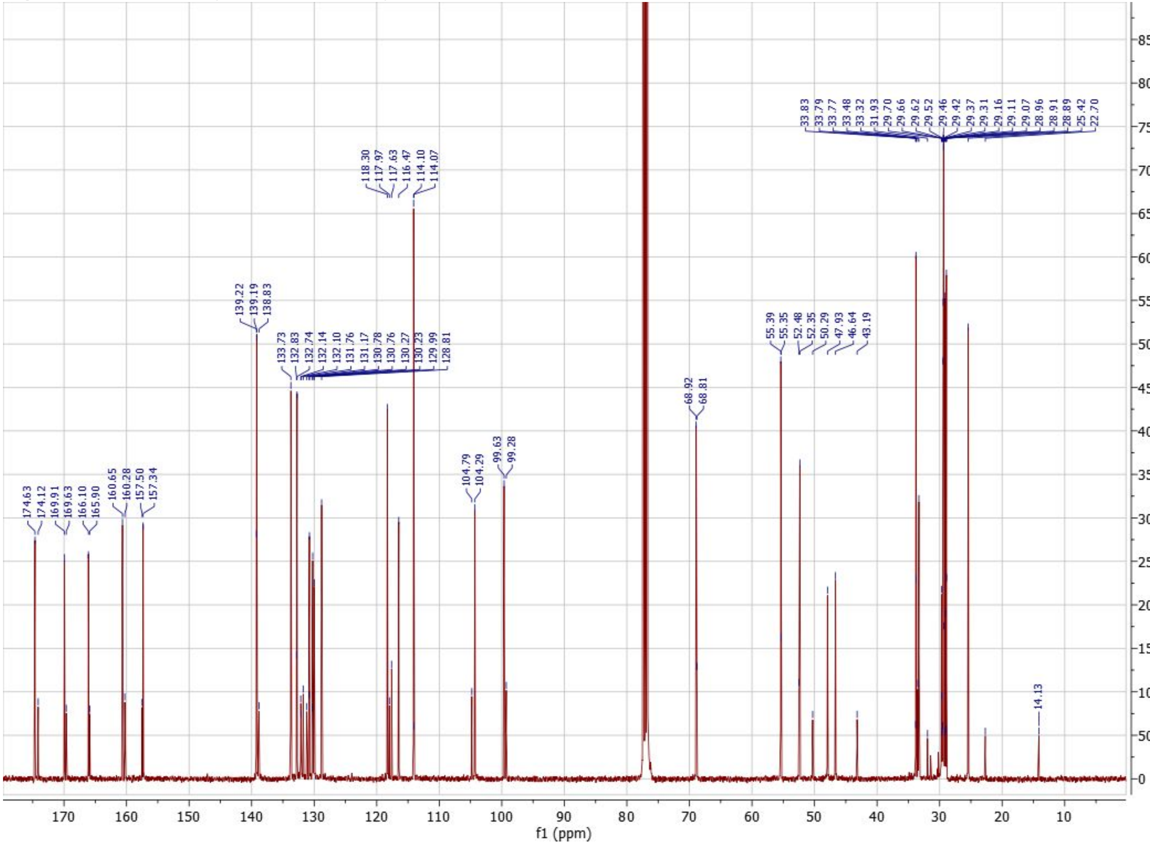


Figure S6. ^{13}C NMR spectrum of compound **18** in $CDCl_3$ at 400MHz.

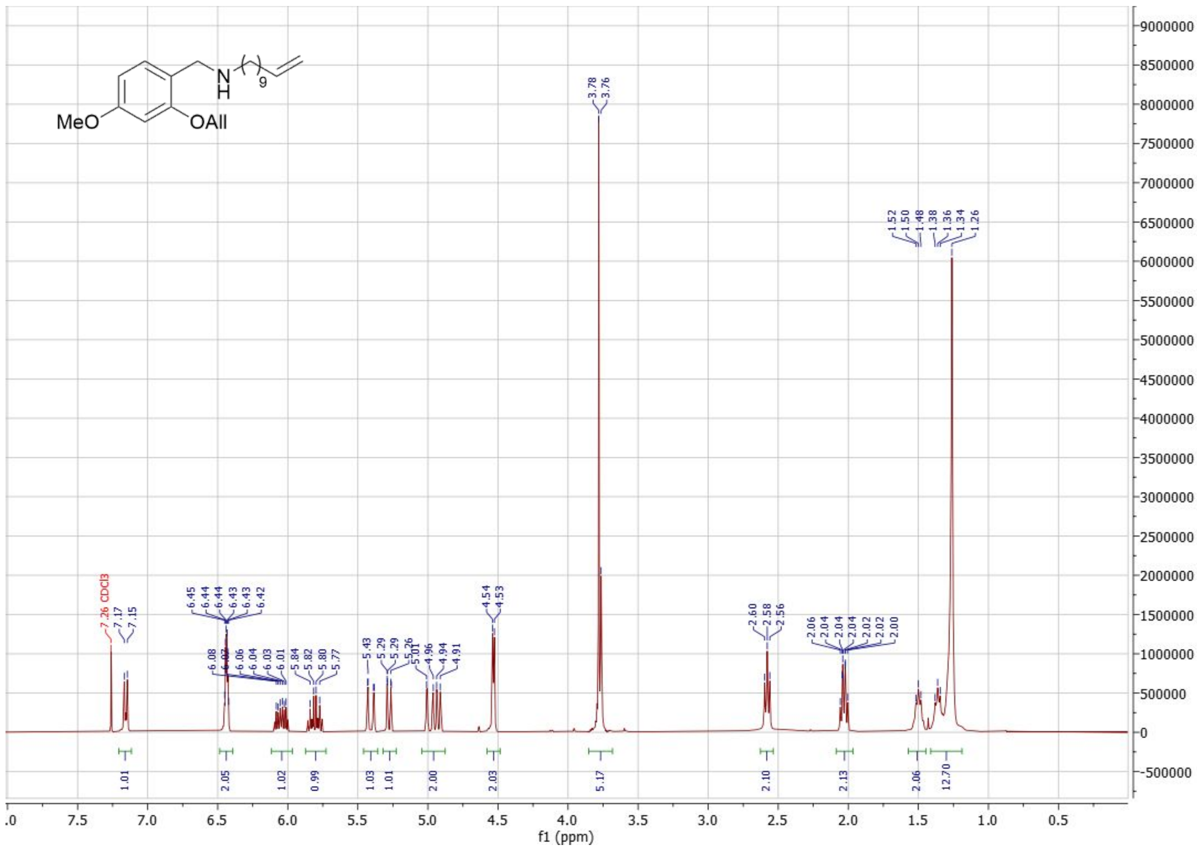


Figure S7. ^{1}H NMR spectrum of compound **19** in $CDCl_3$ at 400MHz.

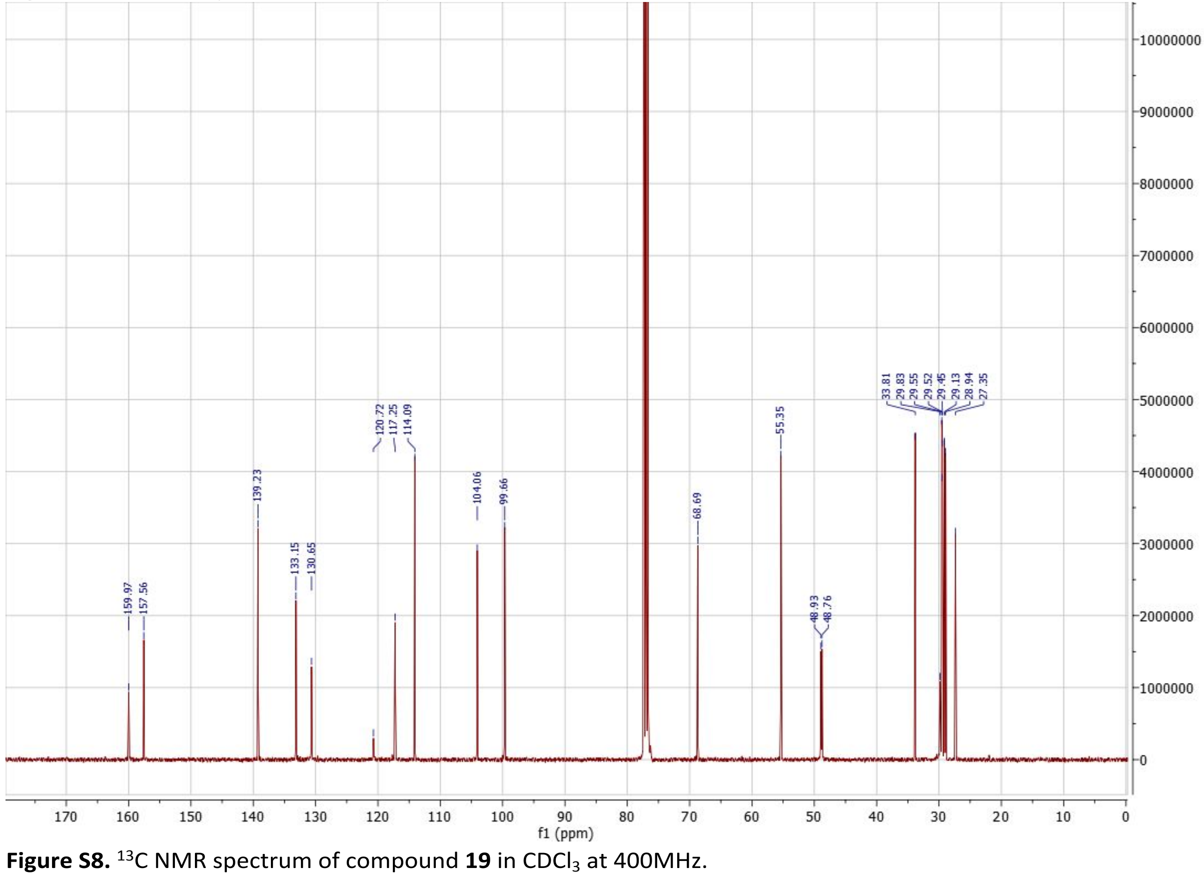


Figure S8. ^{13}C NMR spectrum of compound **19** in $CDCl_3$ at 400MHz.

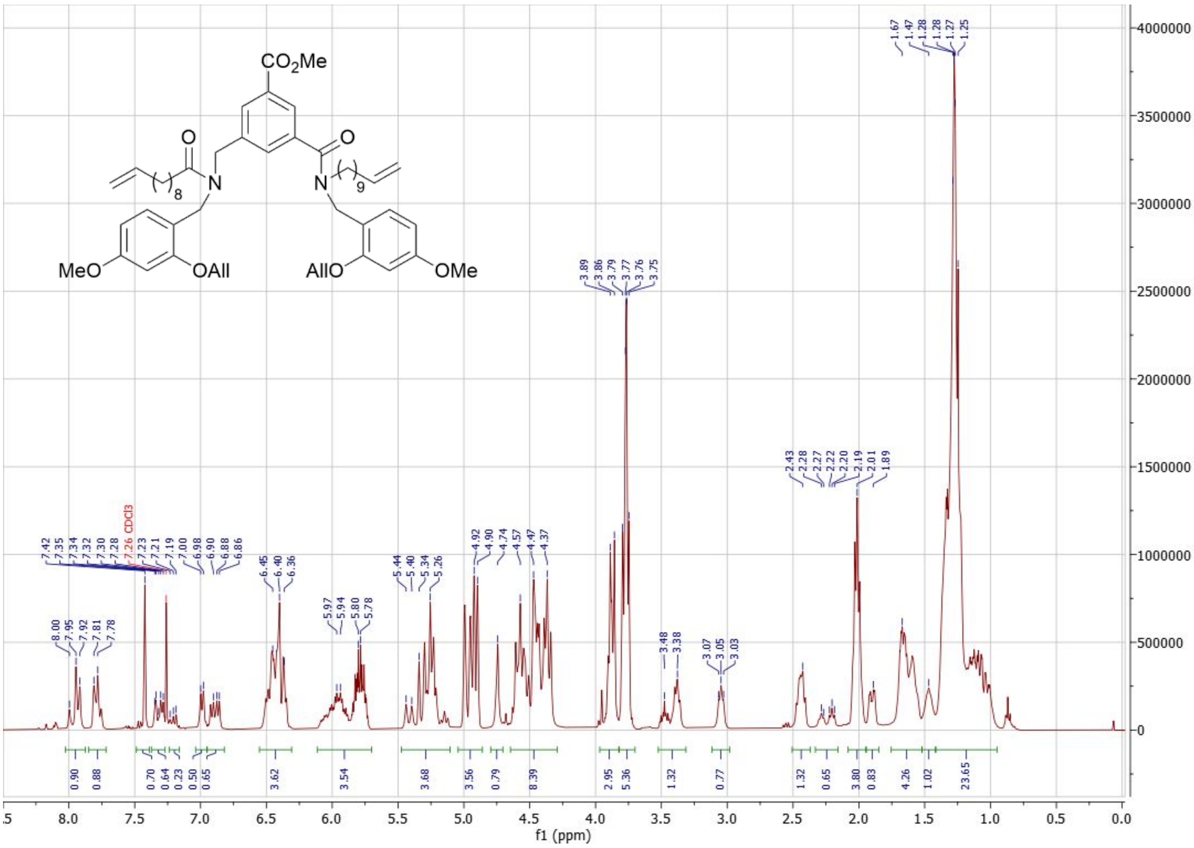


Figure S9. ^{1}H NMR spectrum of compound **6** in $CDCl_3$ at 400MHz.

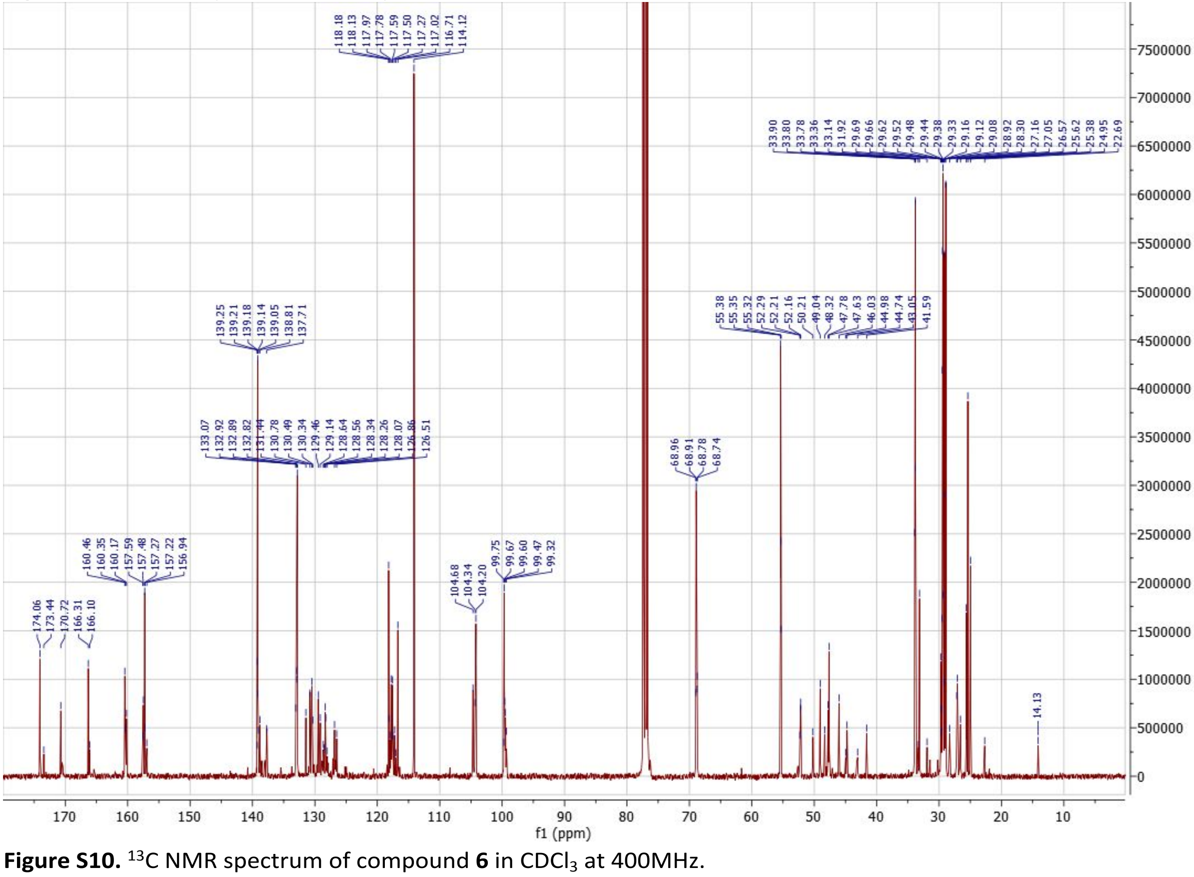


Figure S10. ^{13}C NMR spectrum of compound **6** in $CDCl_3$ at 400MHz.

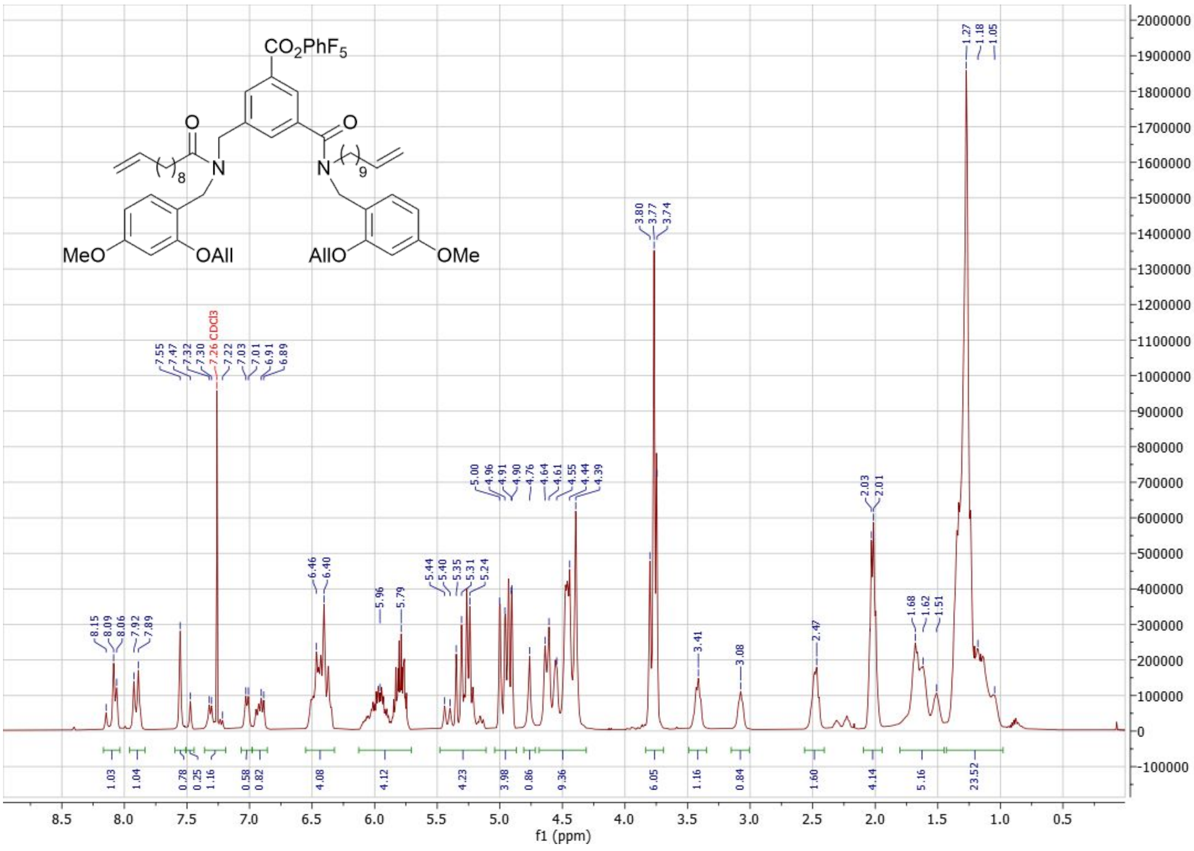


Figure S11. ^{1}H NMR spectrum of compound **20** in $CDCl_3$ at 400MHz.

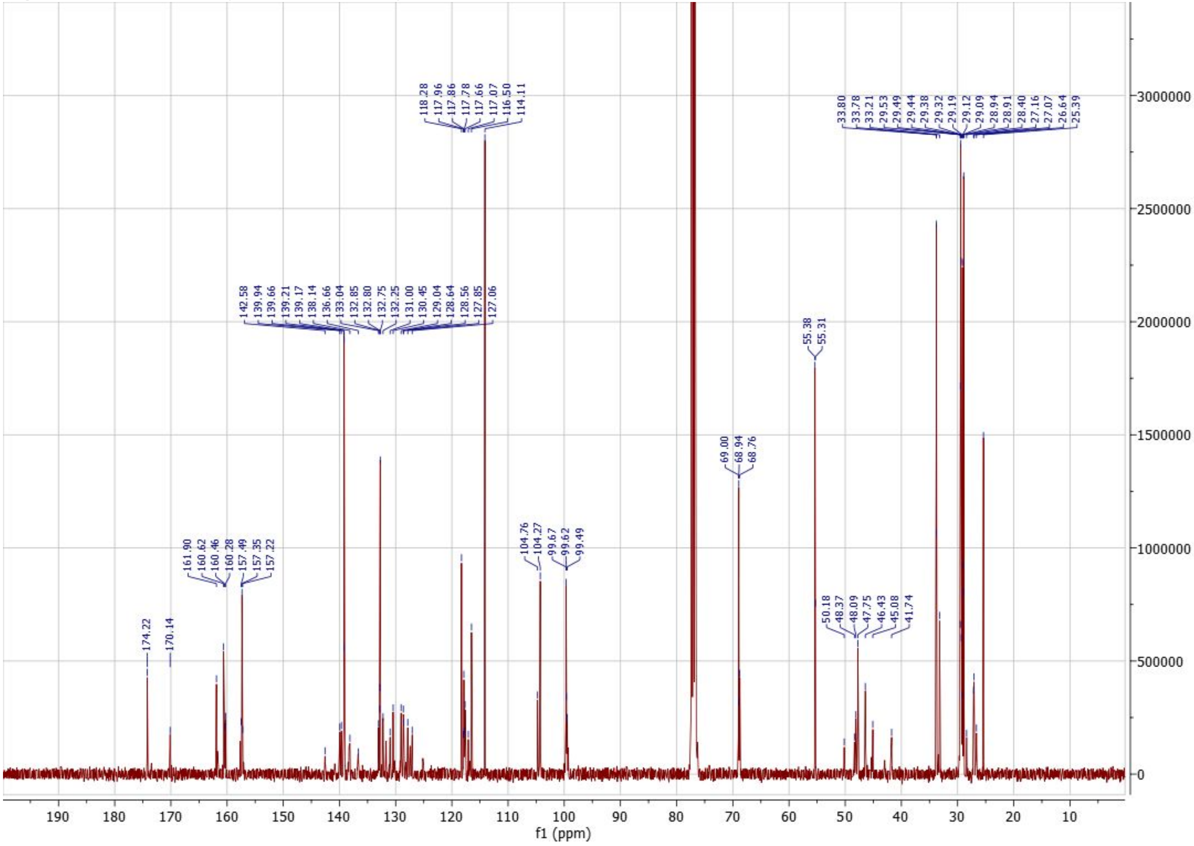


Figure S12. ^{13}C NMR spectrum of compound **20** in $CDCl_3$ at 400MHz.

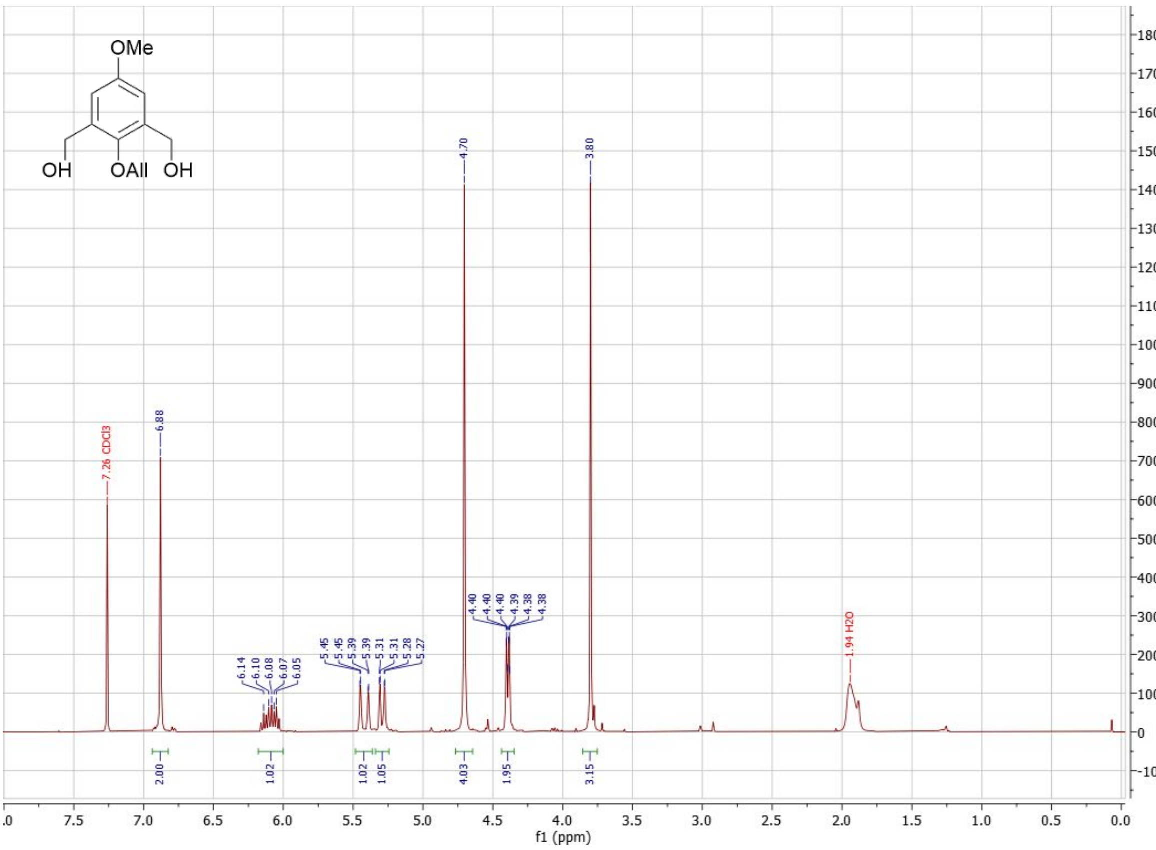


Figure S13. ^{1}H NMR spectrum of compound **21** in CDCl$_3$ at 300MHz.

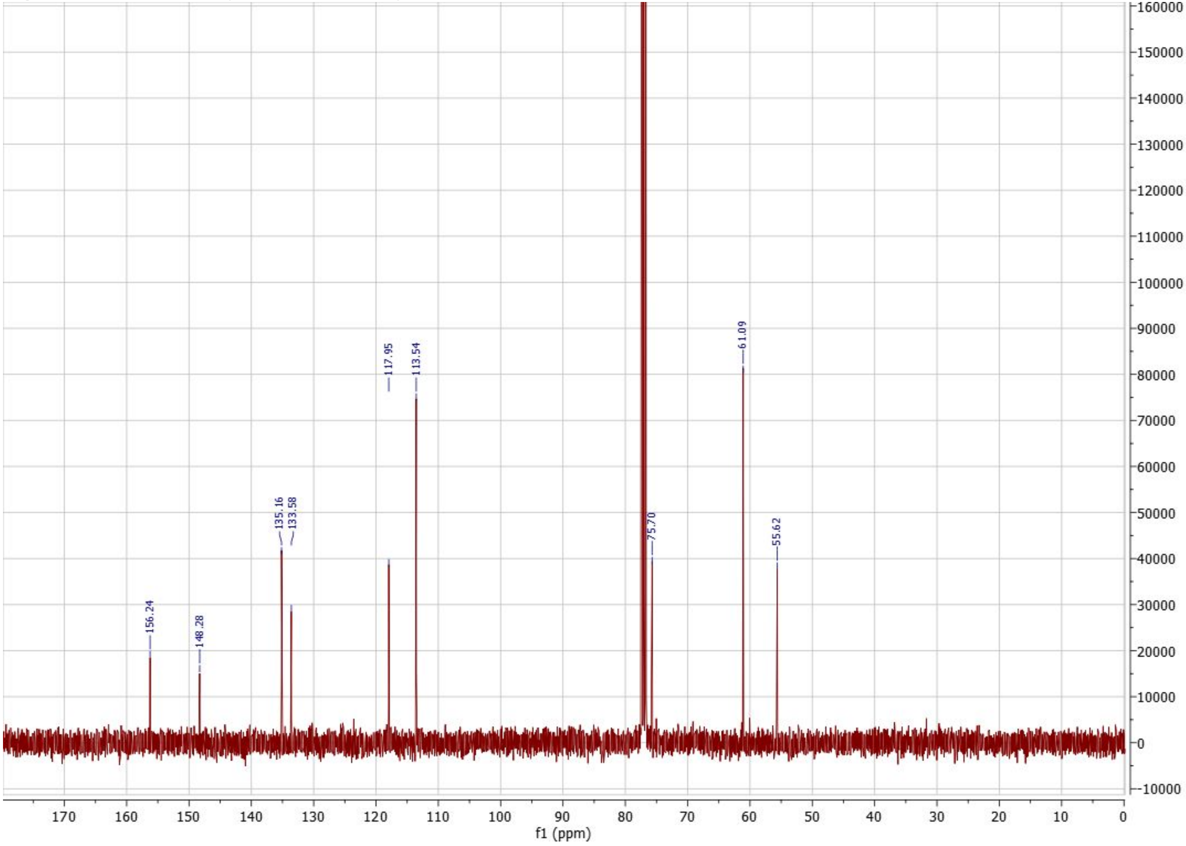


Figure S14. ^{13}C NMR spectrum of compound **21** in CDCl$_3$ at 300MHz.

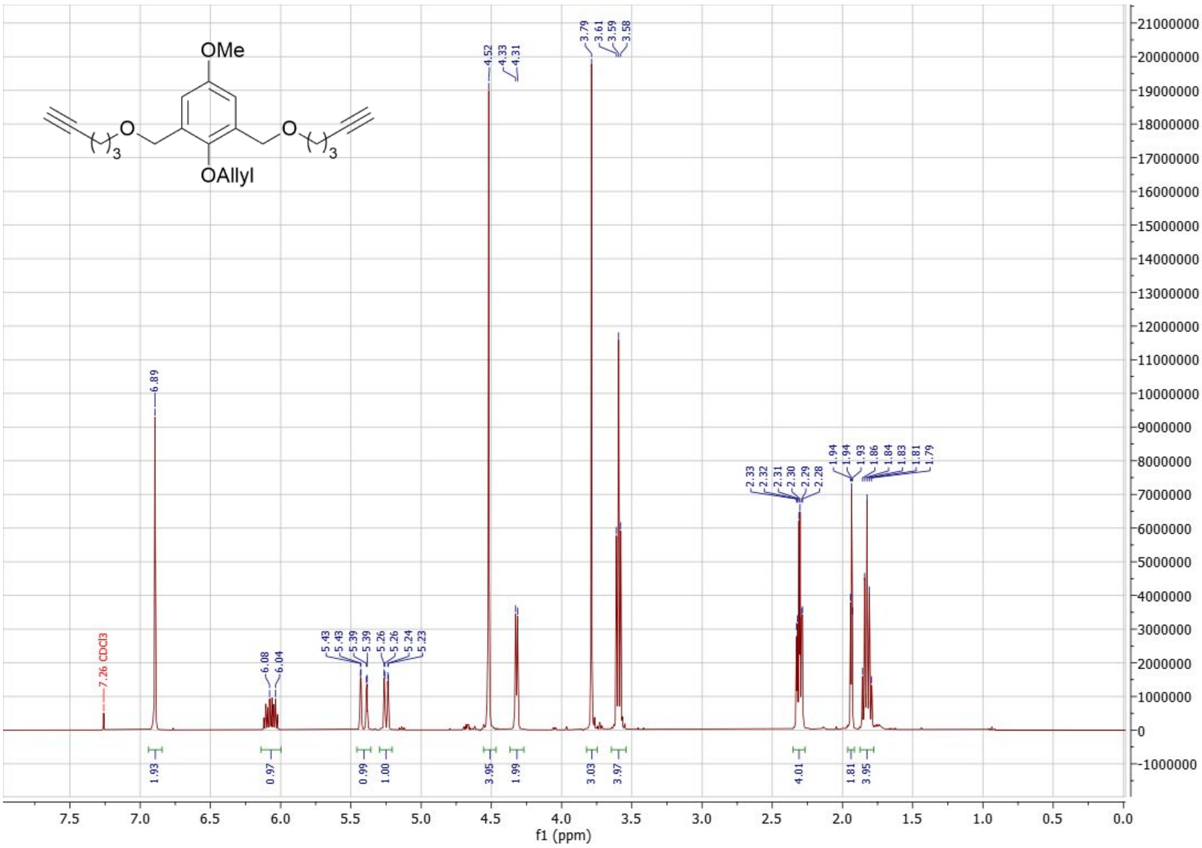


Figure S15. ^{1}H NMR spectrum of compound **22** in $CDCl_3$ at 400MHz.

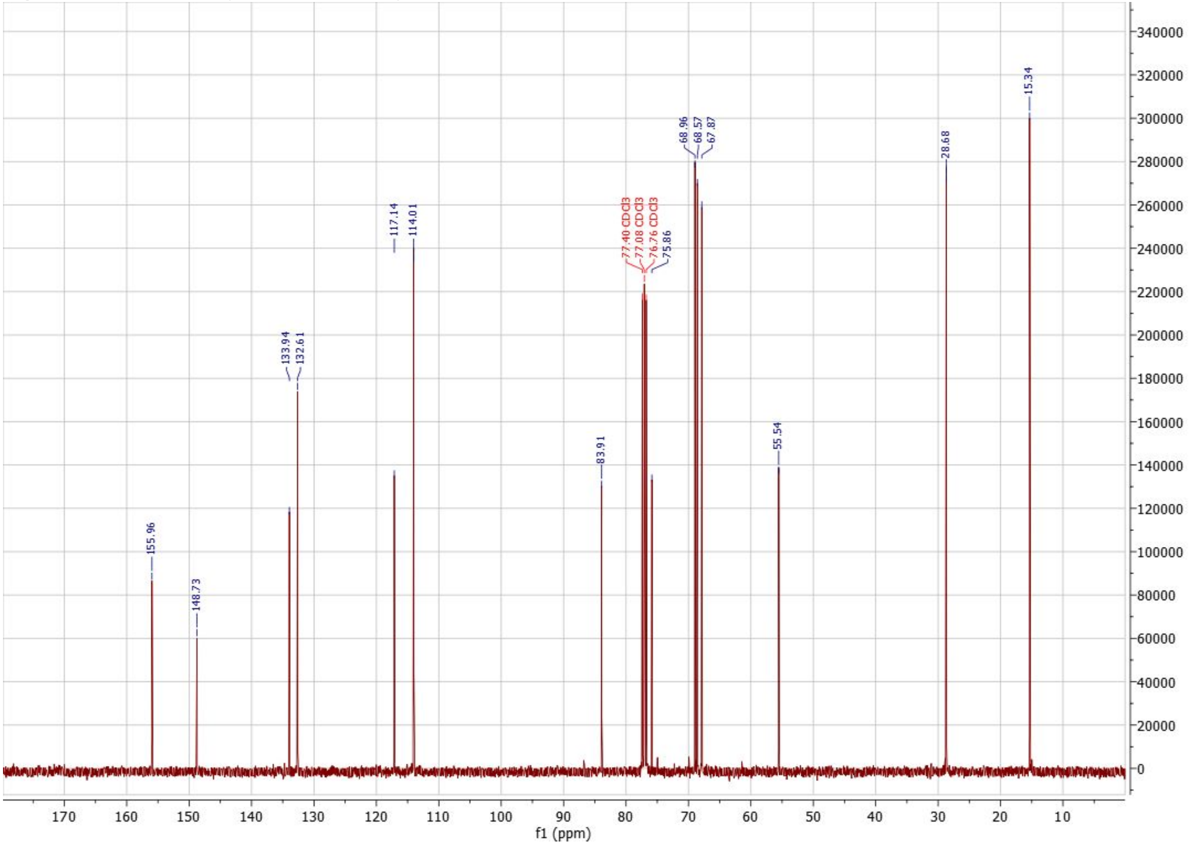


Figure S16. ^{13}C NMR spectrum of compound **22** in $CDCl_3$ at 400MHz.

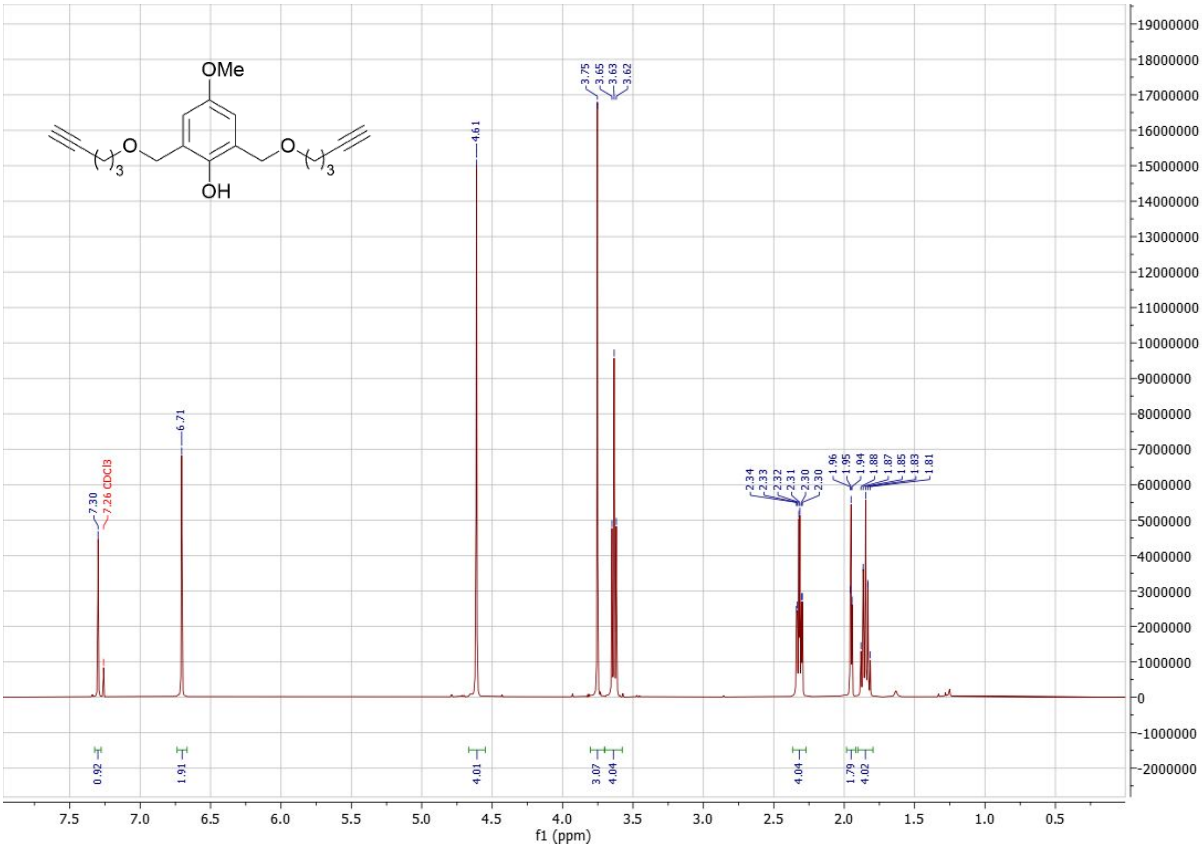


Figure S17. ^{1}H NMR spectrum of compound **5** in $CDCl_3$ at 400MHz.

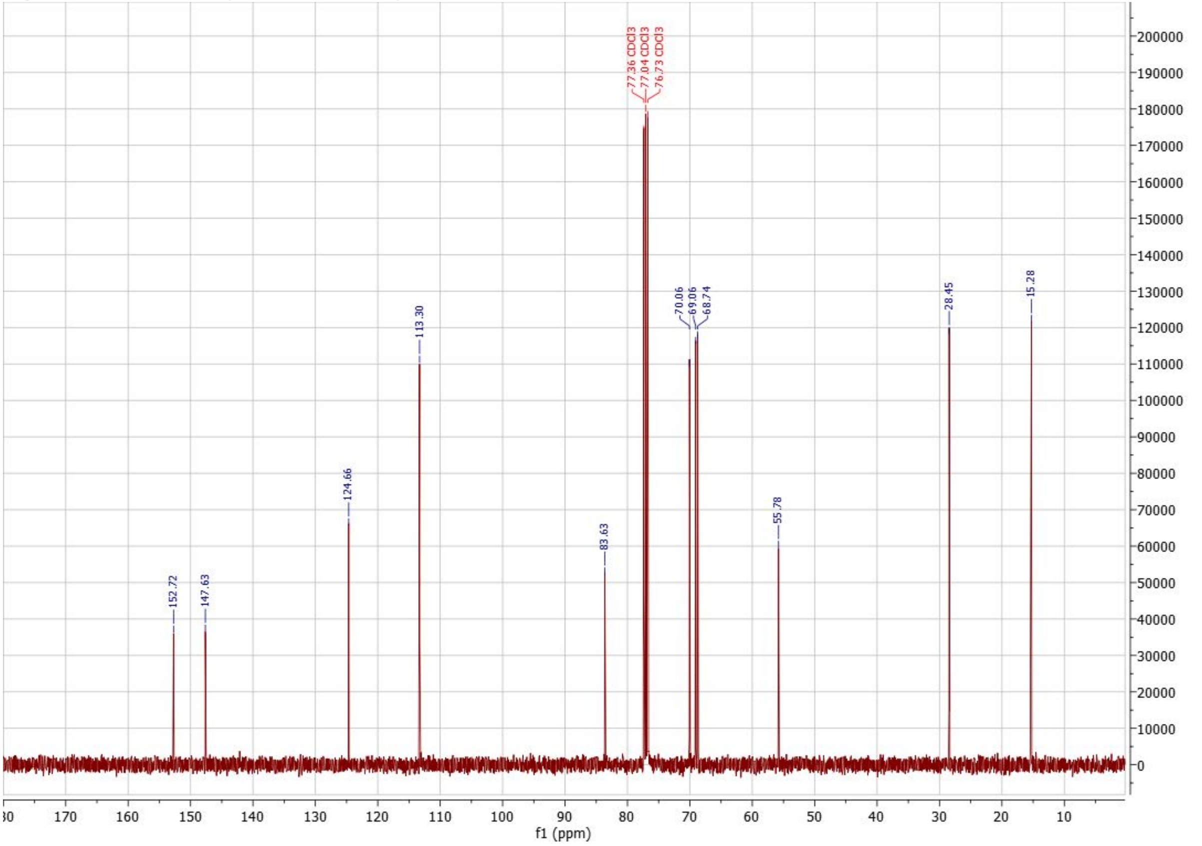


Figure S18. ^{13}C NMR spectrum of compound **5** in $CDCl_3$ at 400MHz.

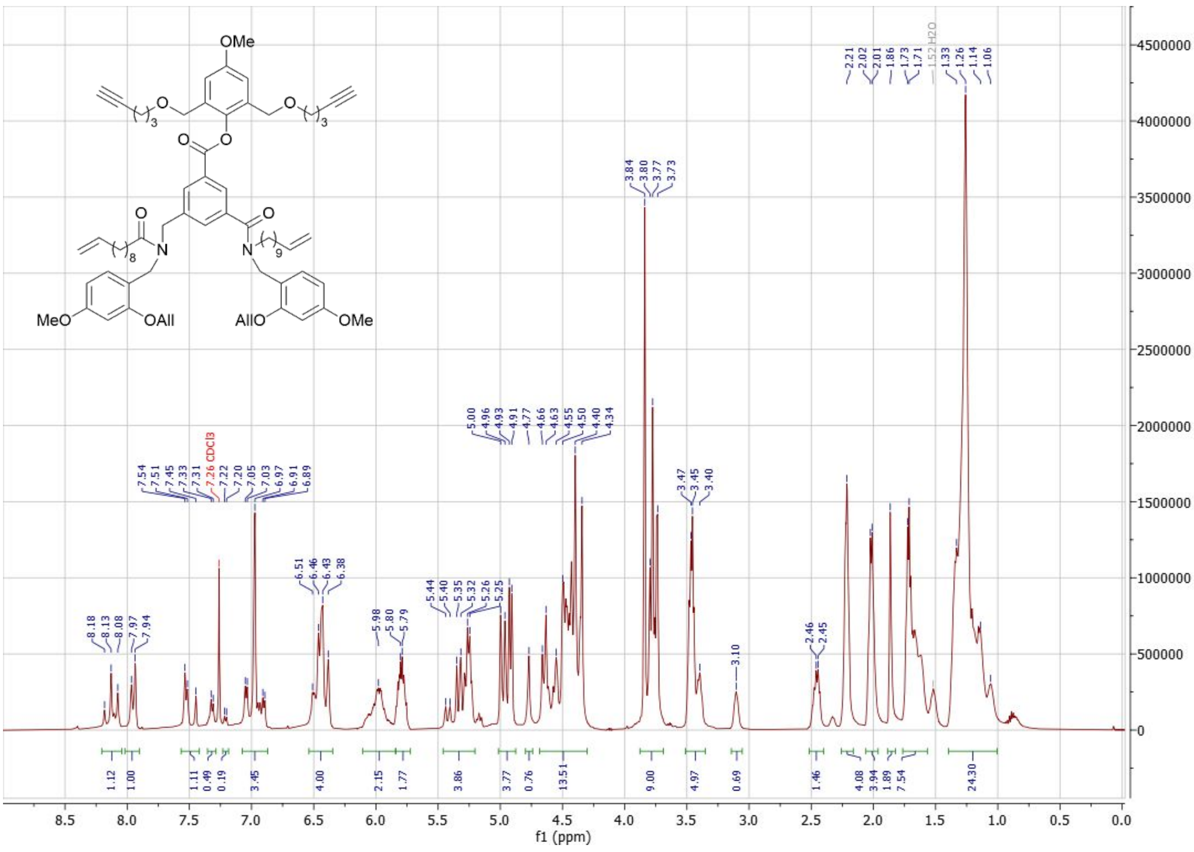


Figure S19. ^{1}H NMR spectrum of compound **23** in $CDCl_3$ at 500MHz.

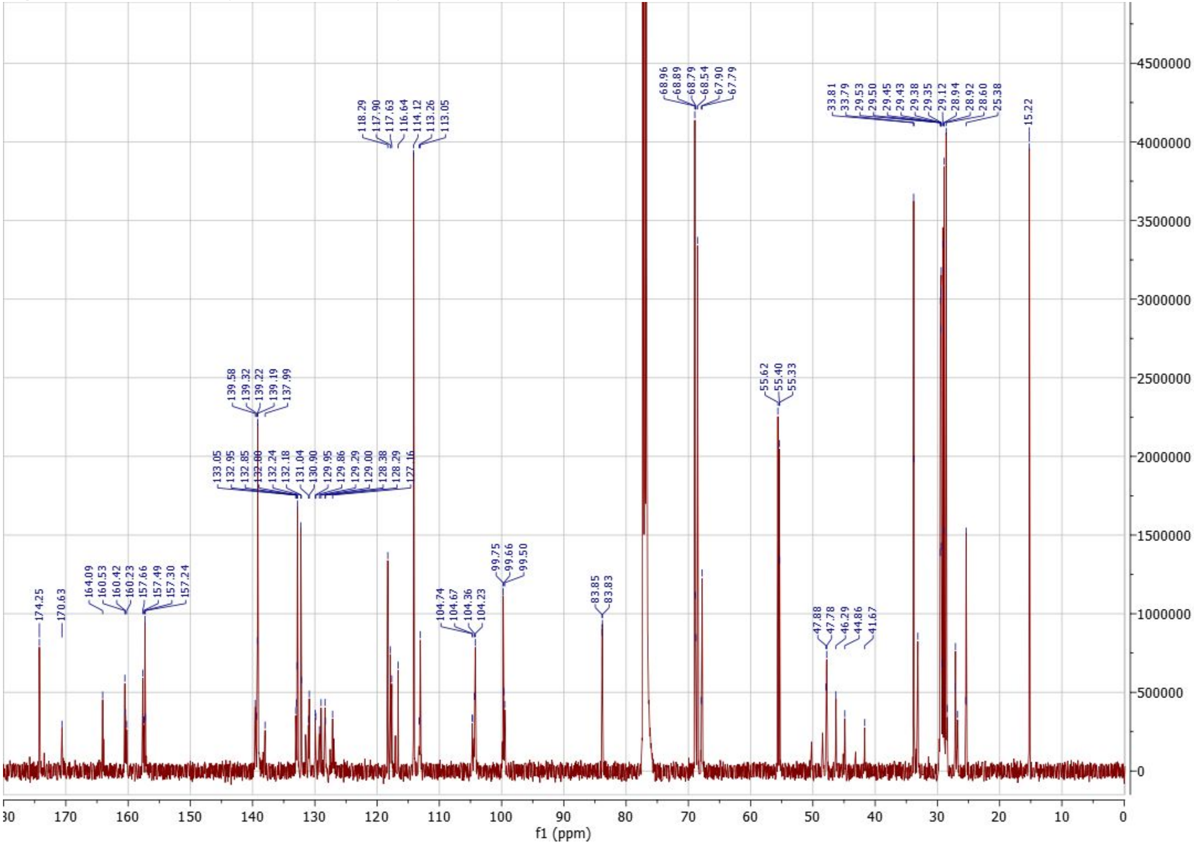


Figure S20. ^{13}C NMR spectrum of compound **23** in $CDCl_3$ at 500MHz.

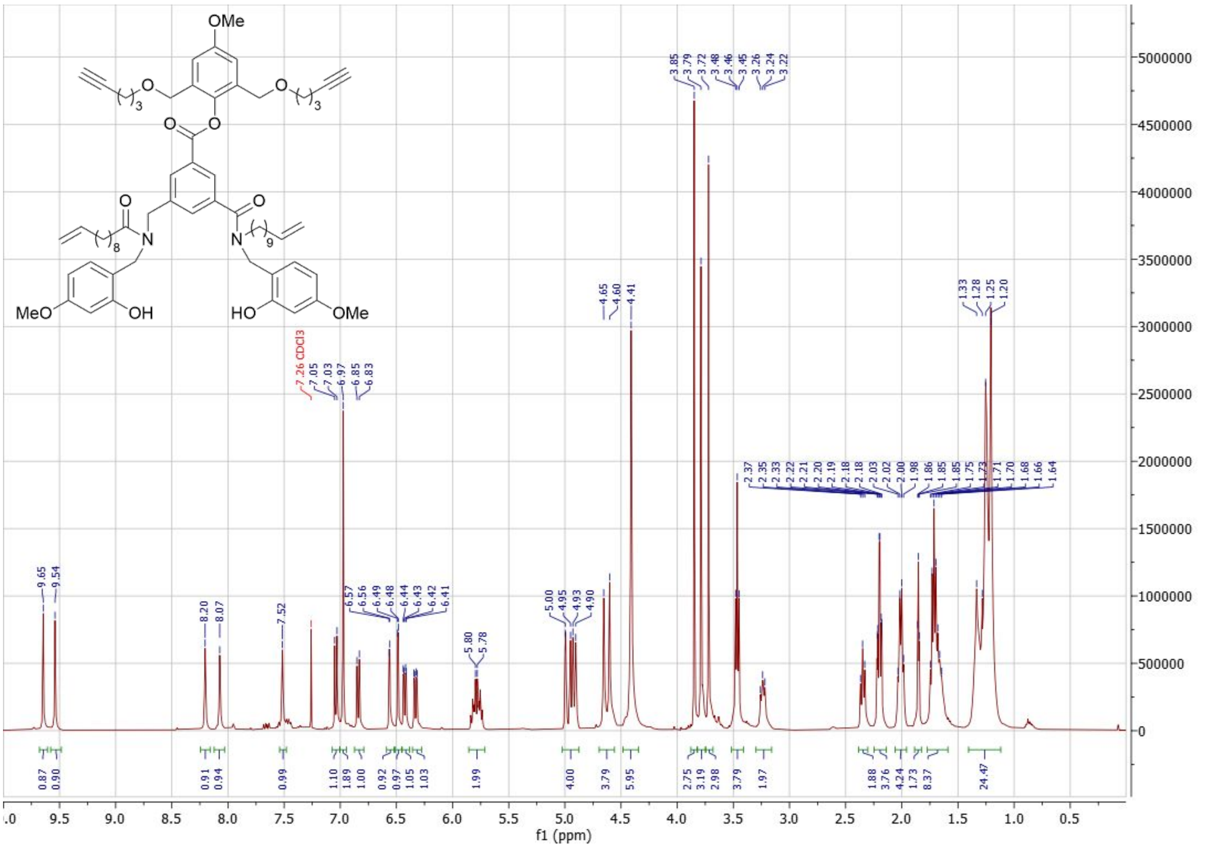


Figure S21. ^{1}H NMR spectrum of compound **7** in $CDCl_3$ at 400MHz.

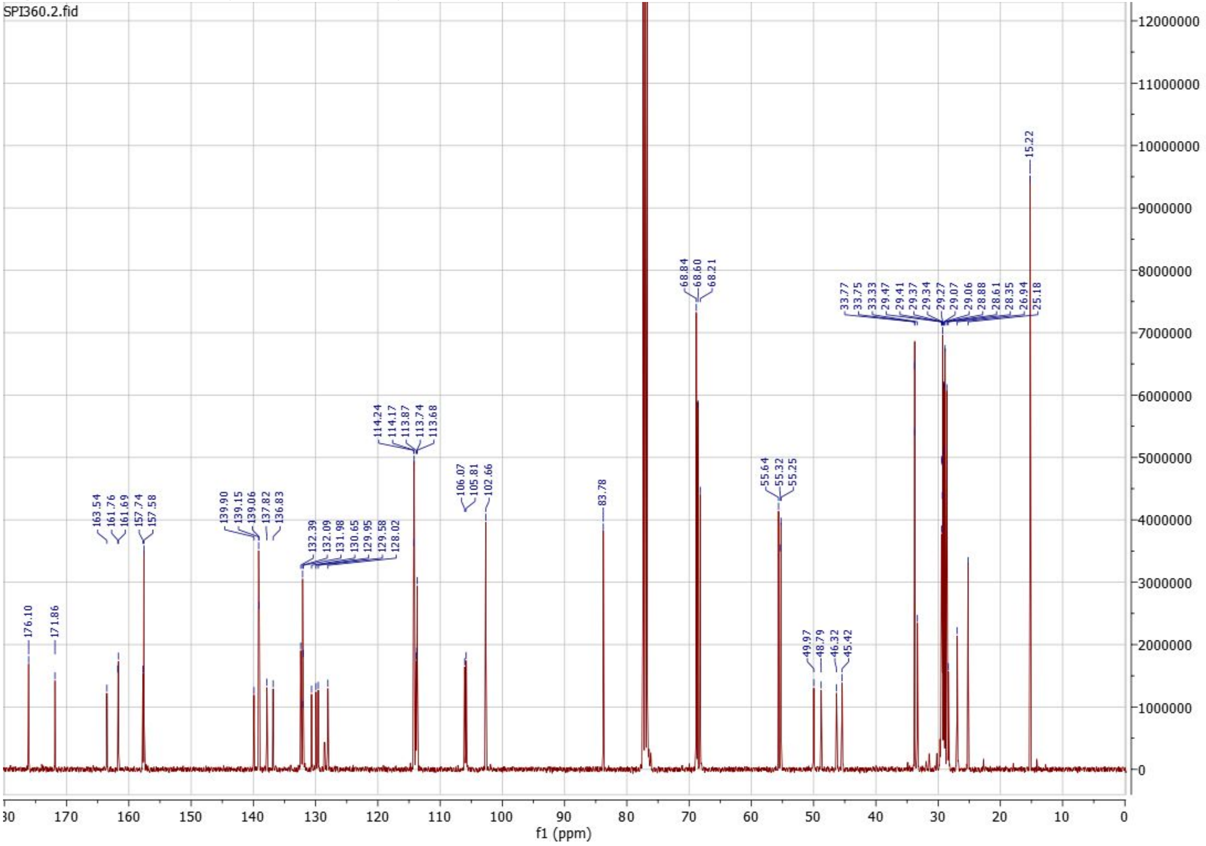


Figure S22. ^{13}C NMR spectrum of compound **7** in $CDCl_3$ at 400MHz.

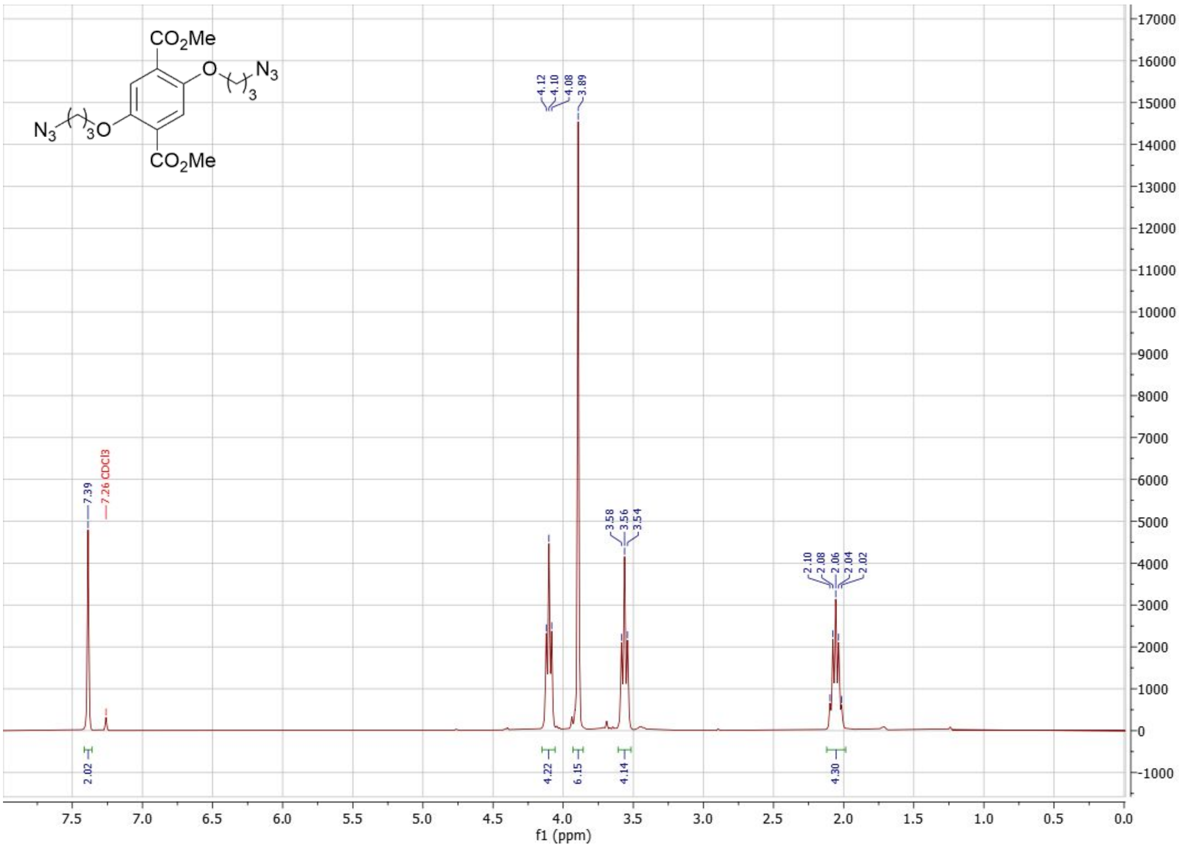


Figure S23. ^{1}H NMR spectrum of compound **24** in CDCl$_3$ at 300MHz.

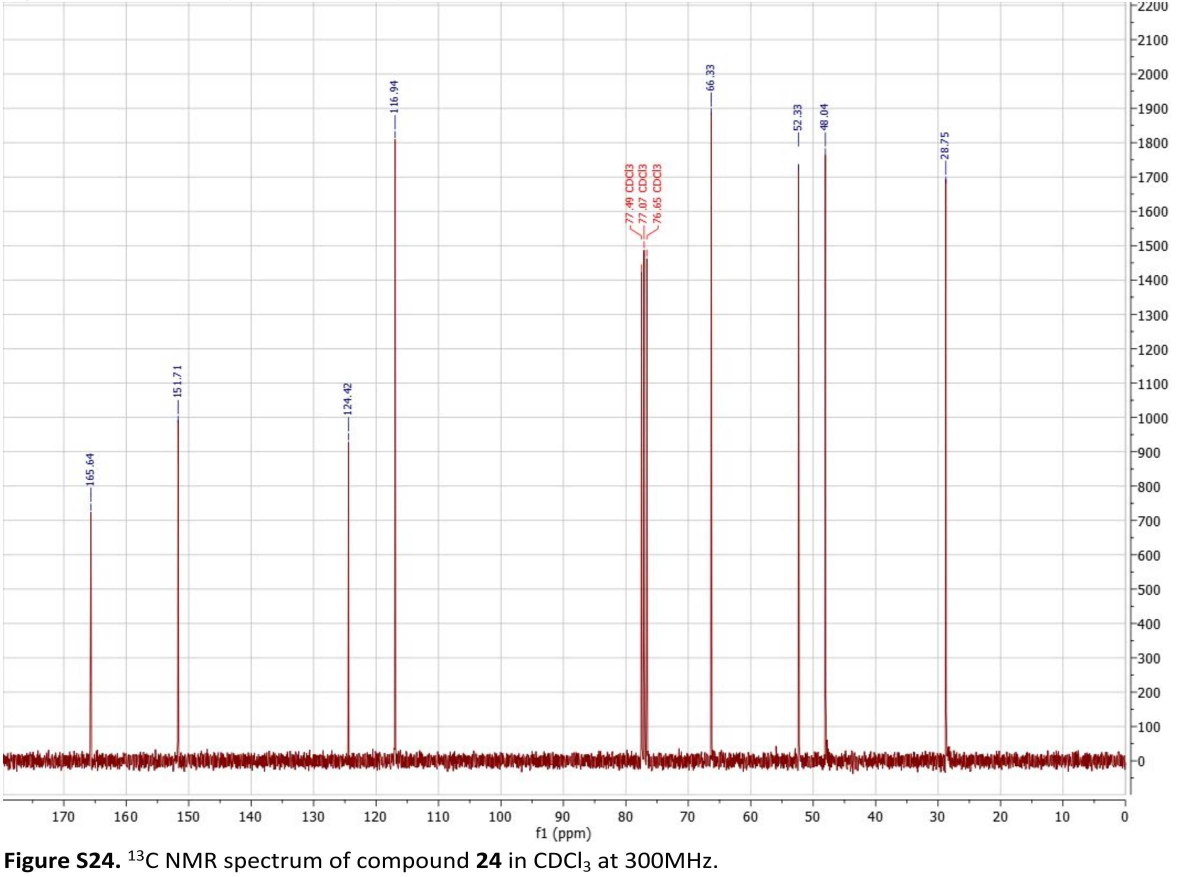


Figure S24. ^{13}C NMR spectrum of compound **24** in CDCl$_3$ at 300MHz.

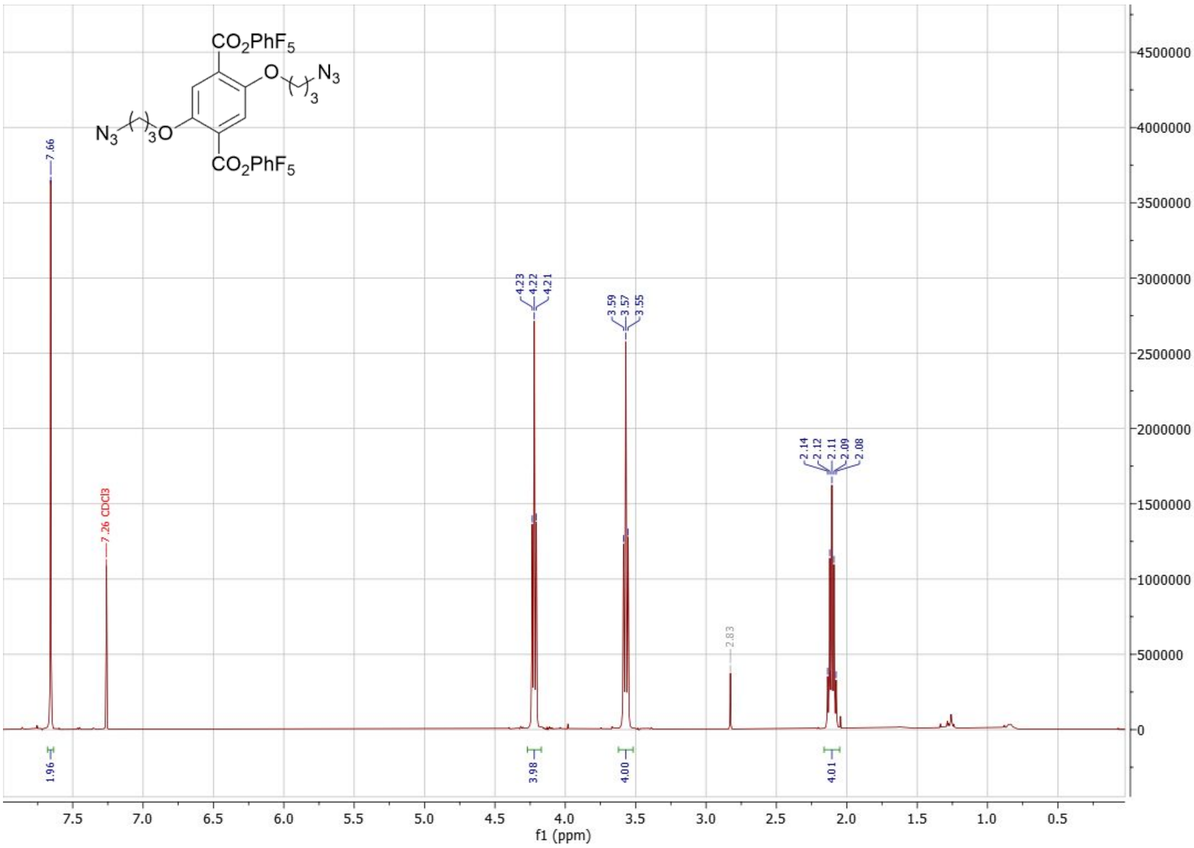


Figure S25. ^{1}H NMR spectrum of compound **4** in CDCl$_3$ at 400MHz.

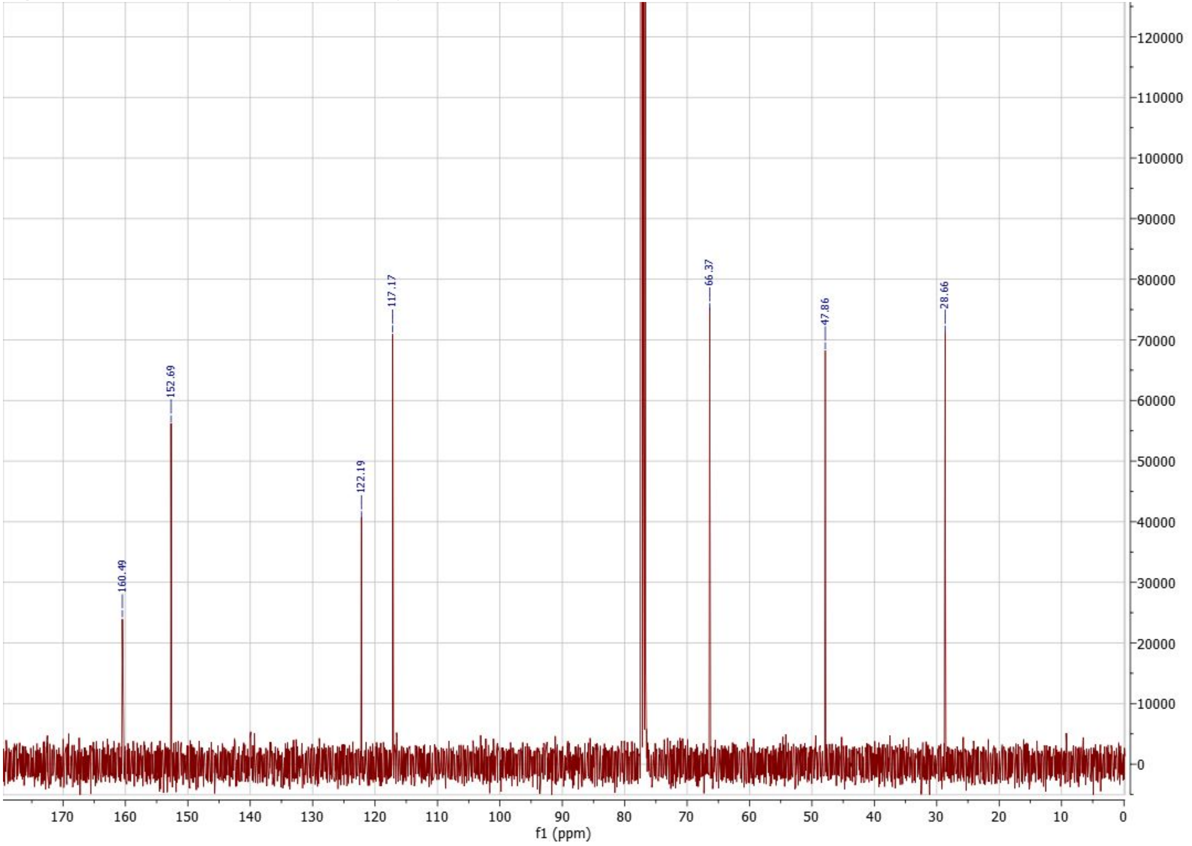


Figure S26. ^{13}C NMR spectrum of compound **4** in CDCl$_3$ at 400MHz.

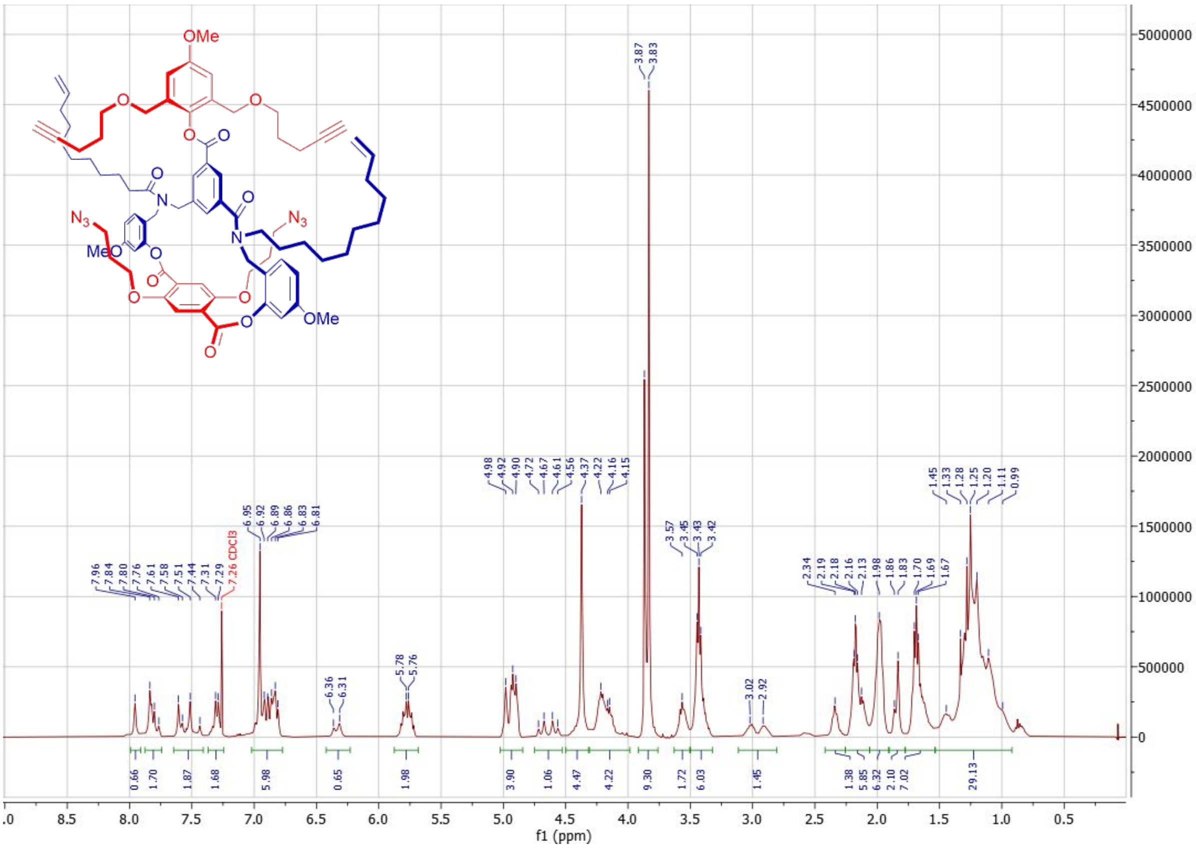


Figure S27. ^{1}H NMR spectrum of compound **8** in CDCl$_3$ at 400MHz.

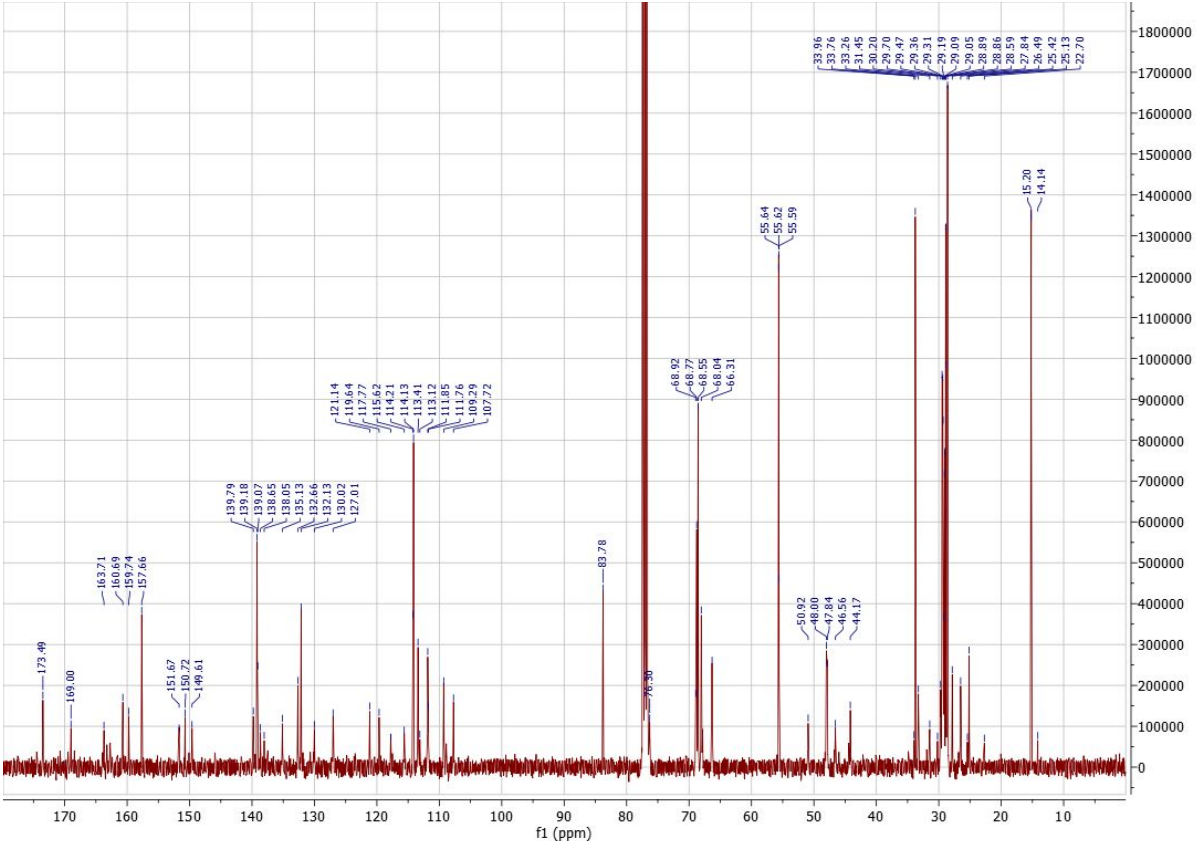


Figure S28. ^{13}C NMR spectrum of compound **8** in CDCl$_3$ at 400MHz.

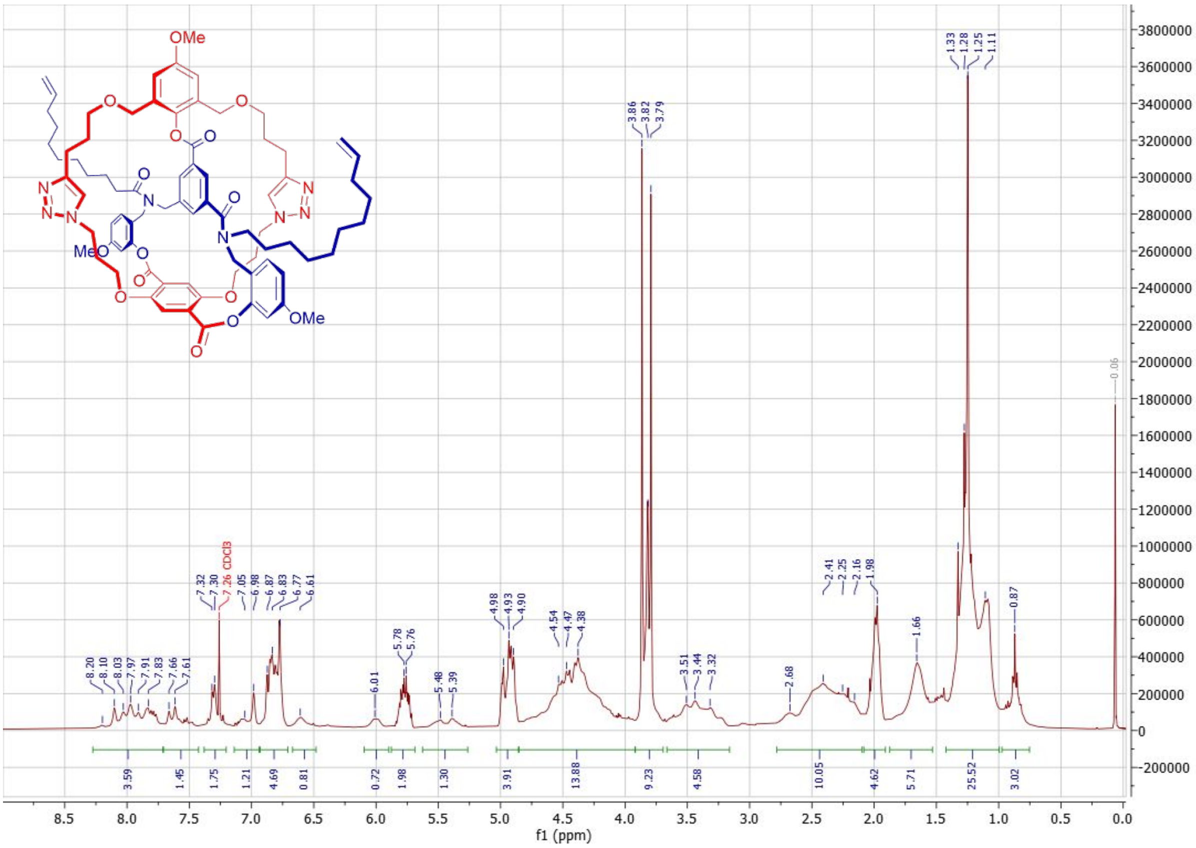


Figure S29. ^{1}H NMR spectrum of compound **1** in $CDCl_3$ at 400MHz.

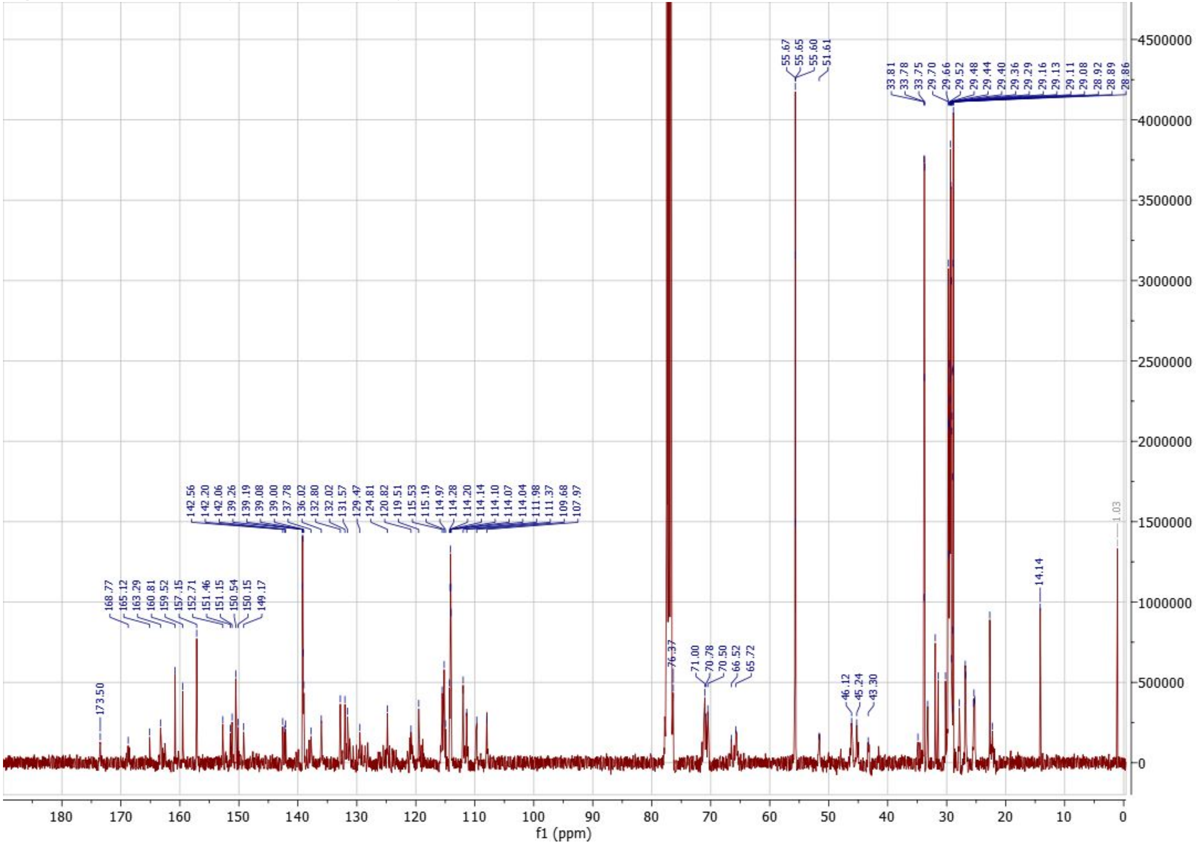


Figure S30. ^{13}C NMR spectrum of compound **1** in $CDCl_3$ at 400MHz.

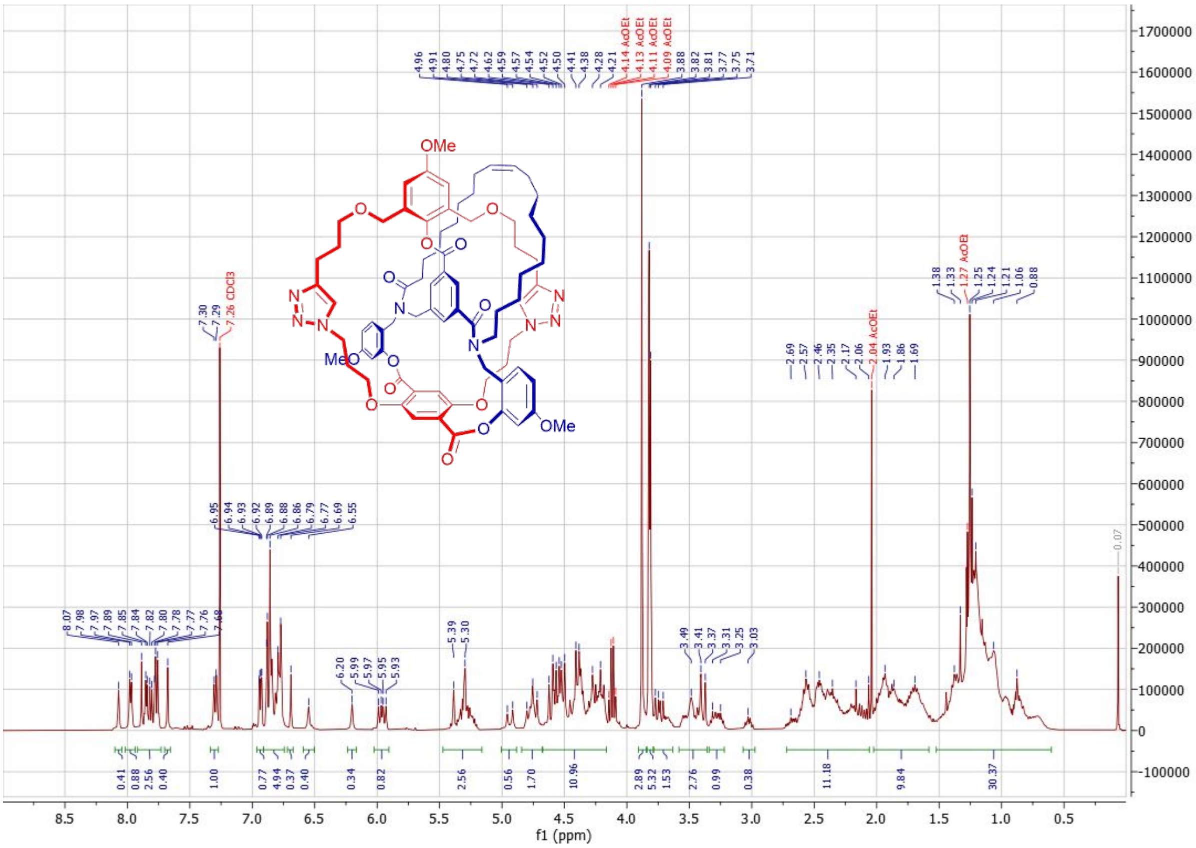


Figure S31. ^{1}H NMR spectrum of compound **25** in $CDCl_3$ at 400MHz.

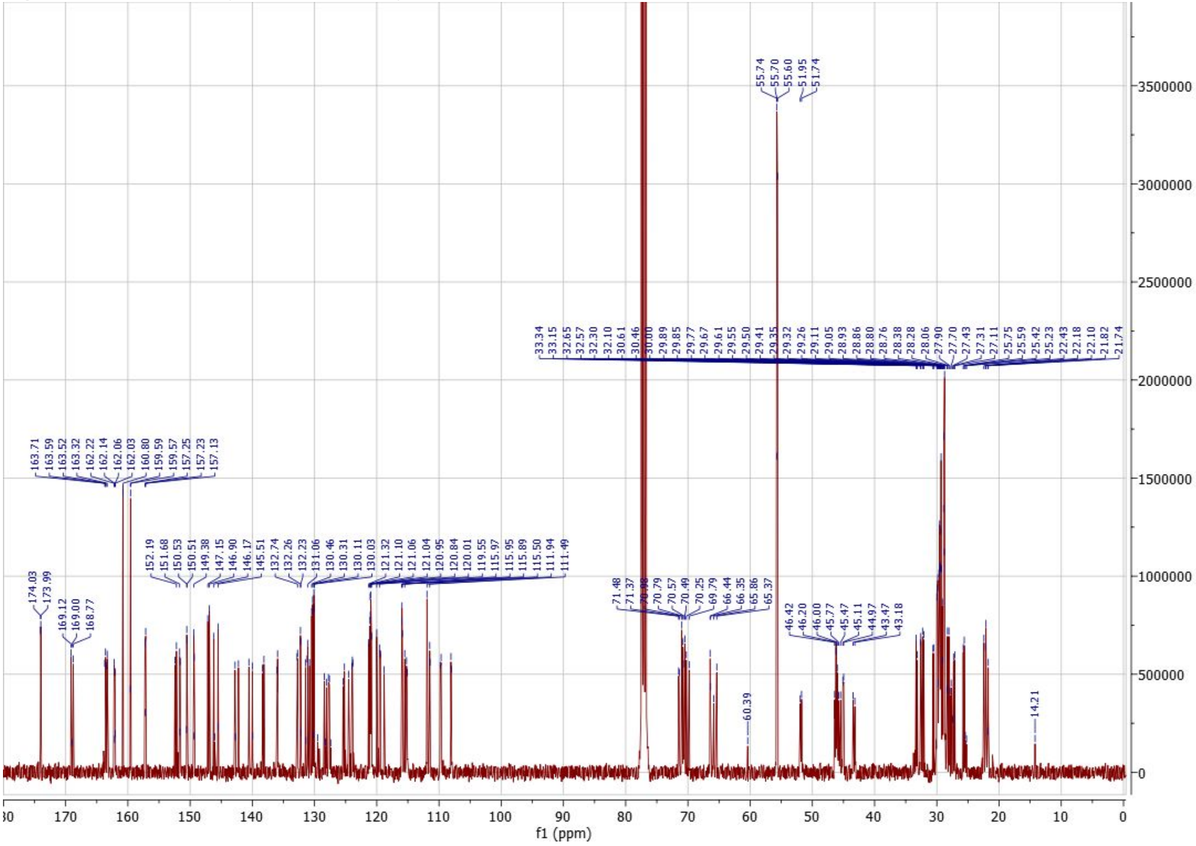


Figure S32. ^{13}C NMR spectrum of compound **25** in $CDCl_3$ at 400MHz.

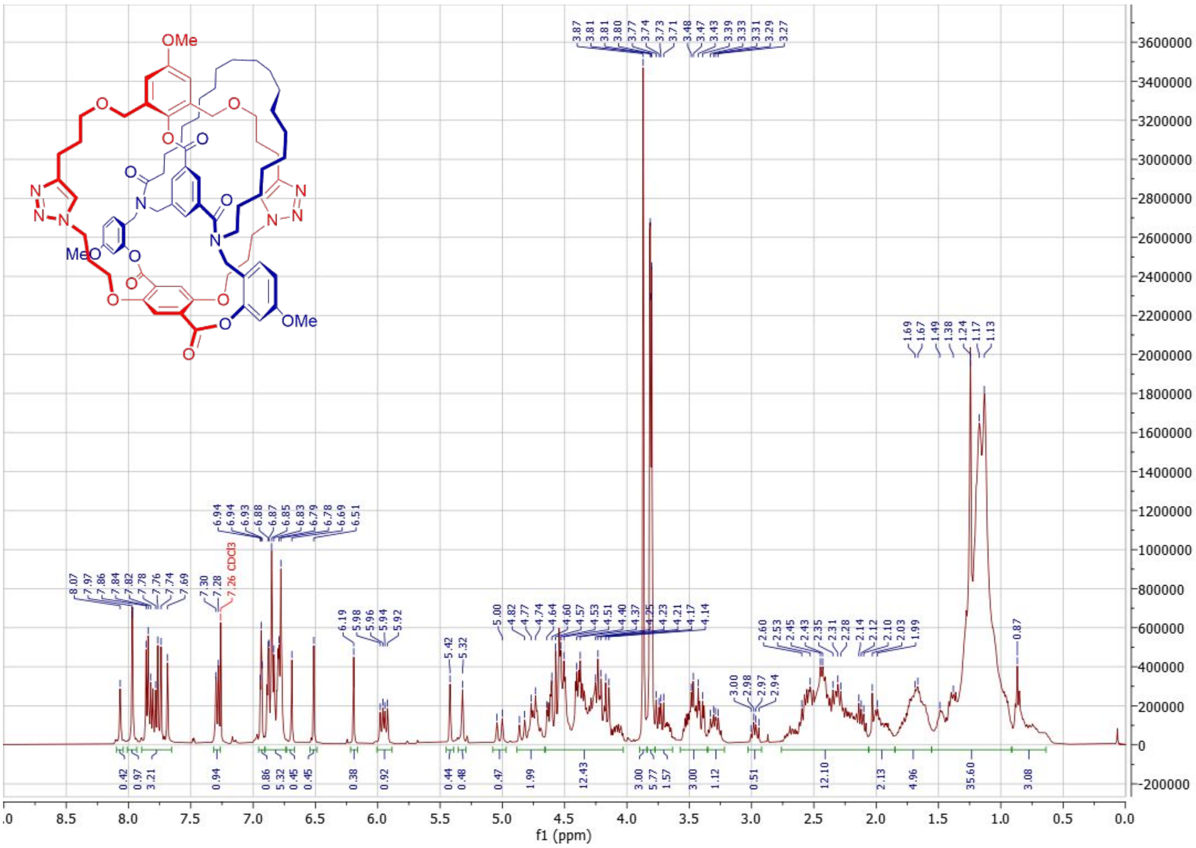


Figure S33. ^{1}H NMR spectrum of compound **9** in $CDCl_3$ at 400MHz.

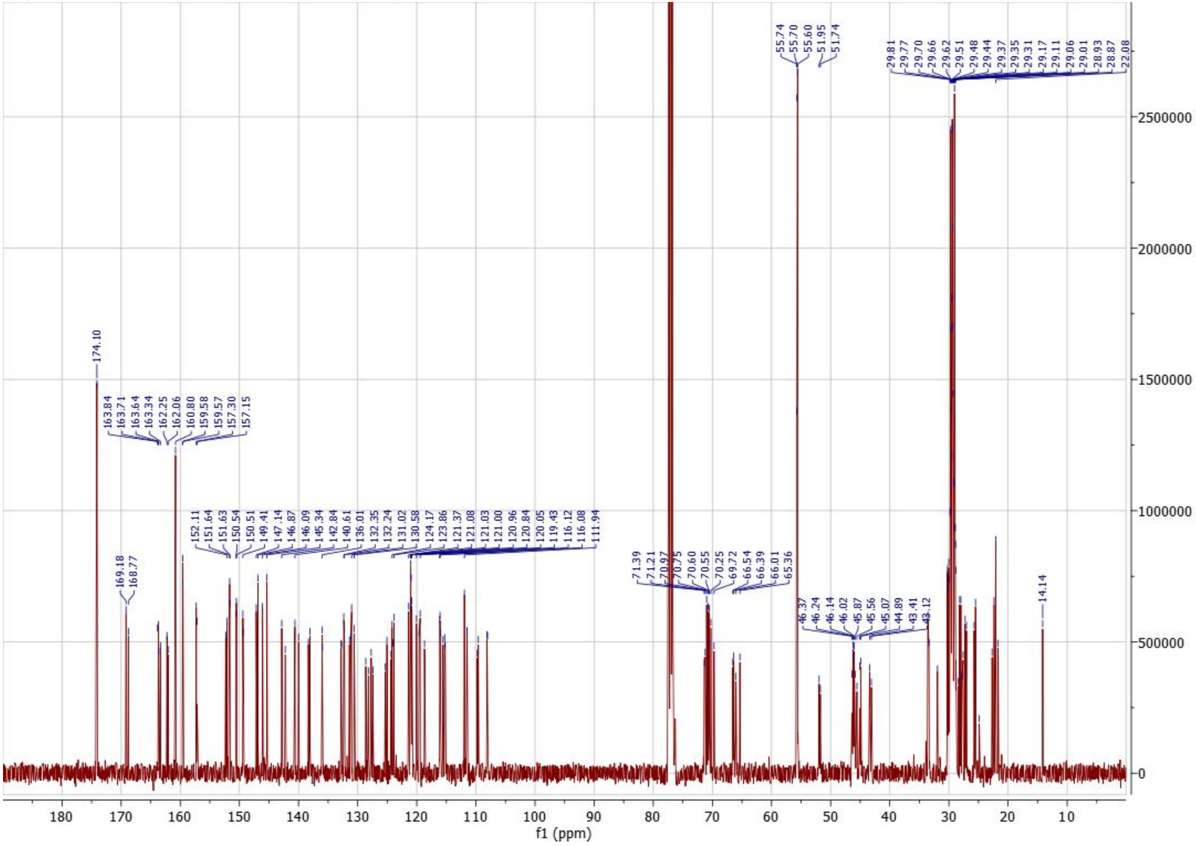


Figure S34. ^{13}C NMR spectrum of compound **9** in $CDCl_3$ at 400MHz.

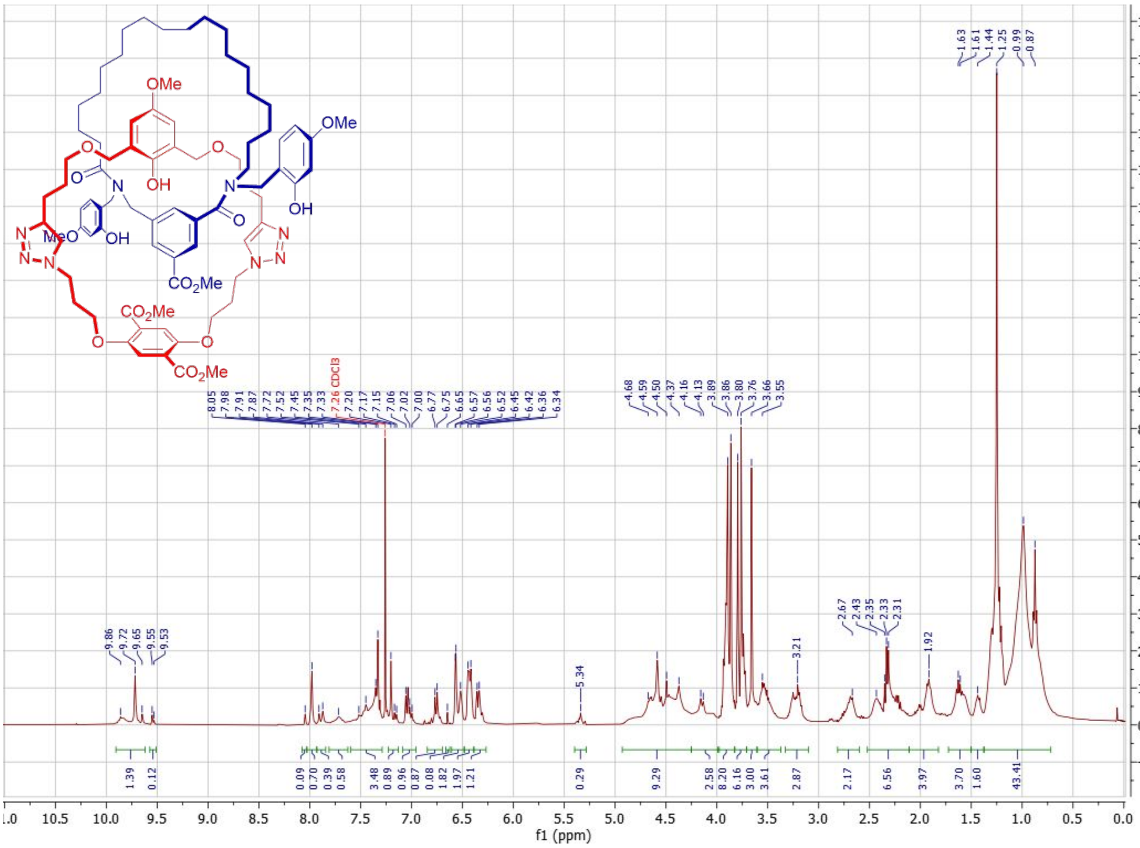


Figure S35. ^{1}H NMR spectrum of compound **10** in $CDCl_3$ at 400MHz.

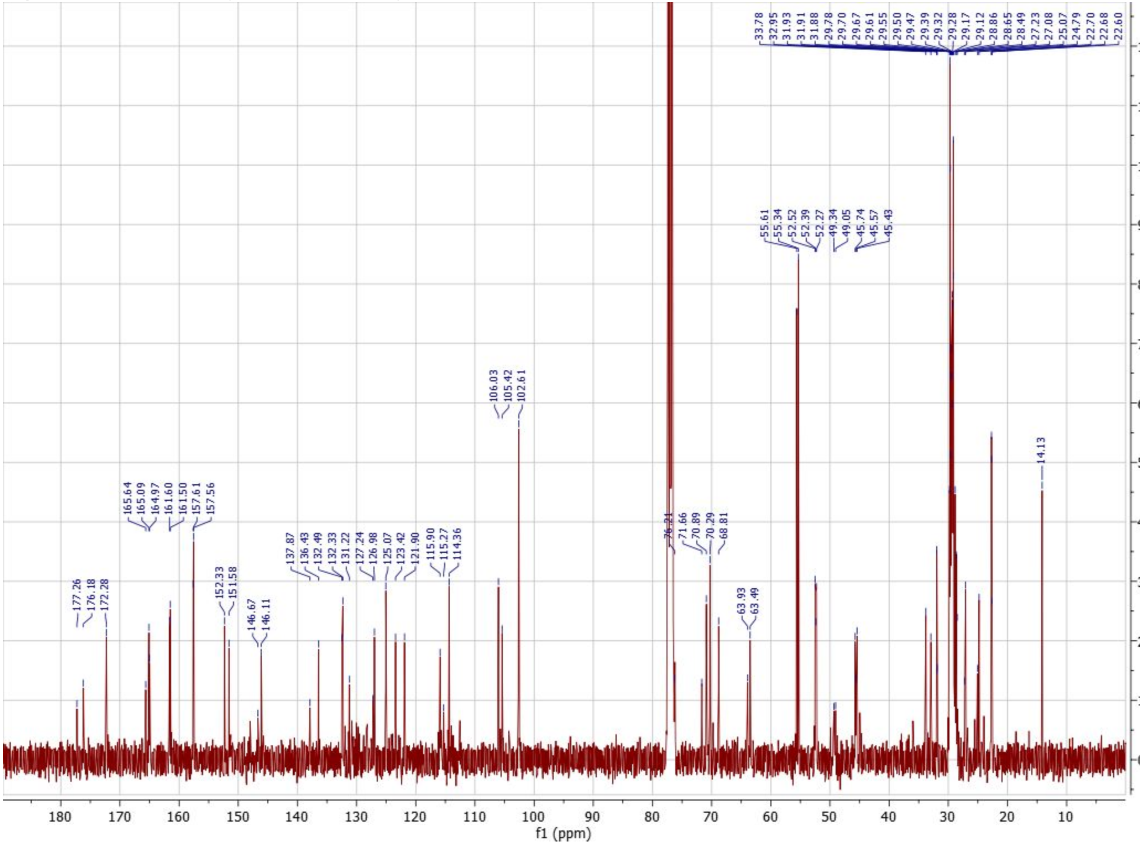


Figure S36. ^{13}C NMR spectrum of compound **10** in $CDCl_3$ at 400MHz.

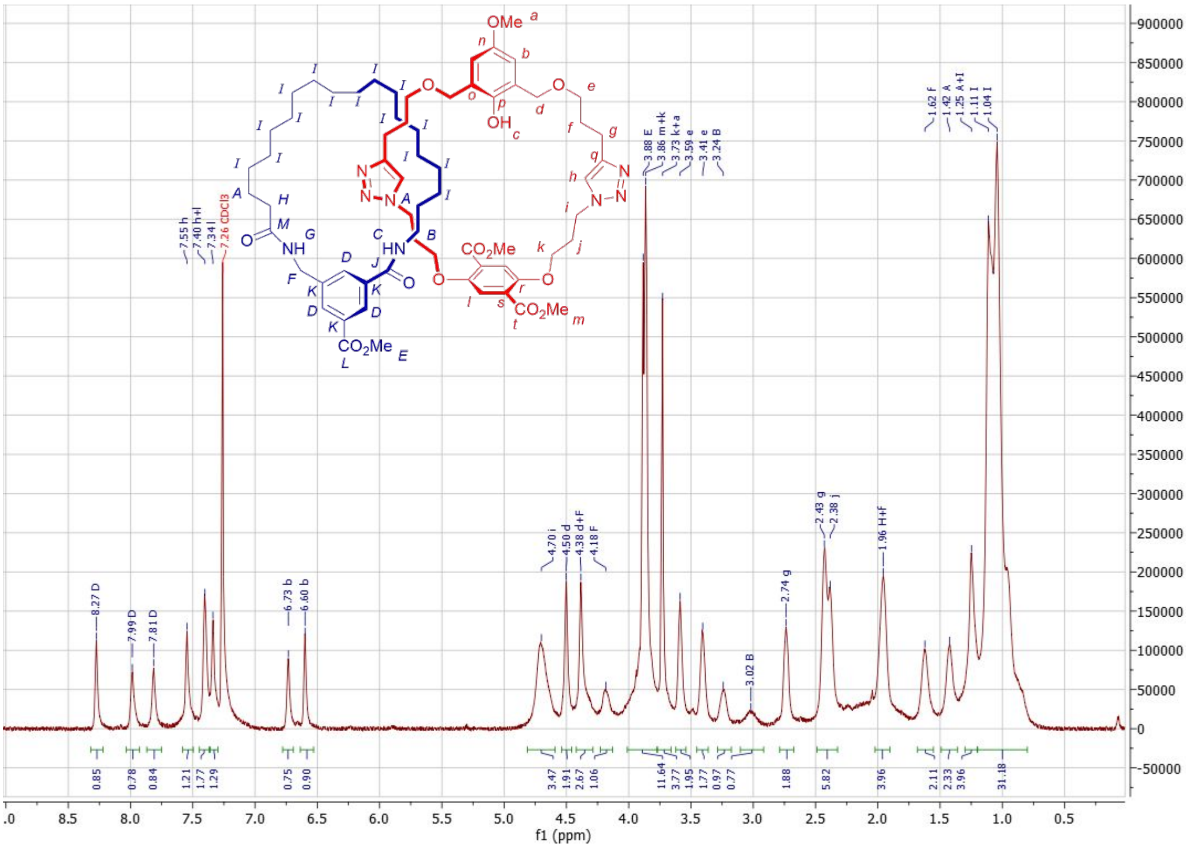


Figure S37. ^1H NMR spectrum of compound **2** in $CDCl_3$ at 500MHz.

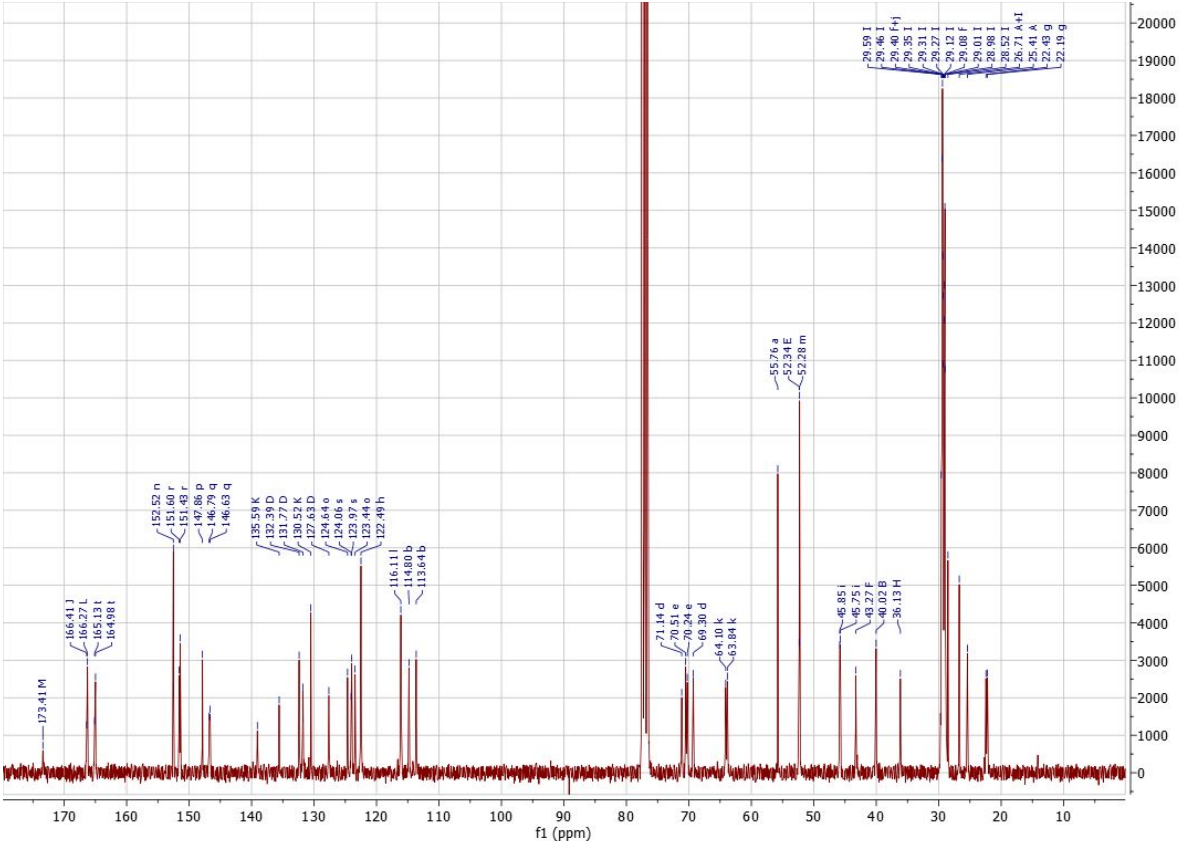


Figure S38. ^{13}C NMR spectrum of compound **2** in $CDCl_3$ at 500MHz.

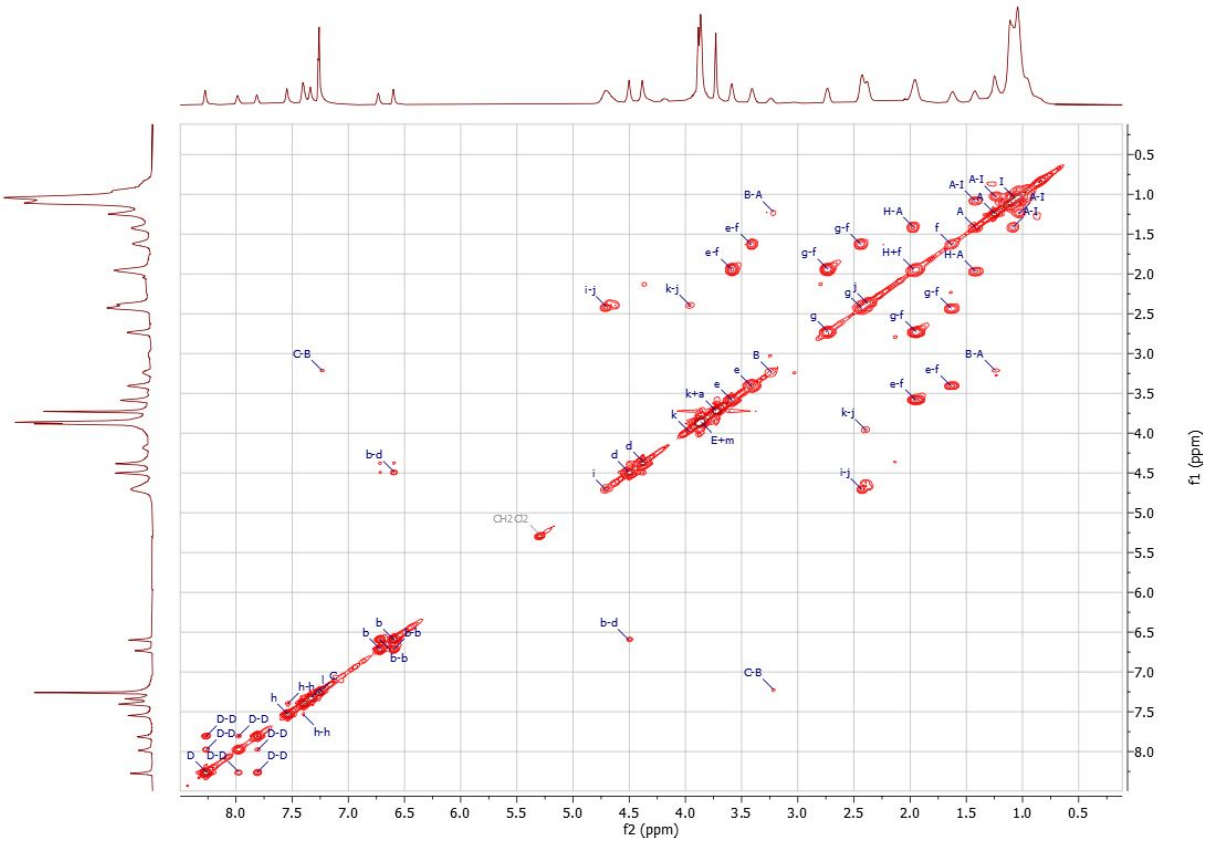


Figure S39. COSY NMR spectrum of compound **2** in $CDCl_3$ at 500MHz.

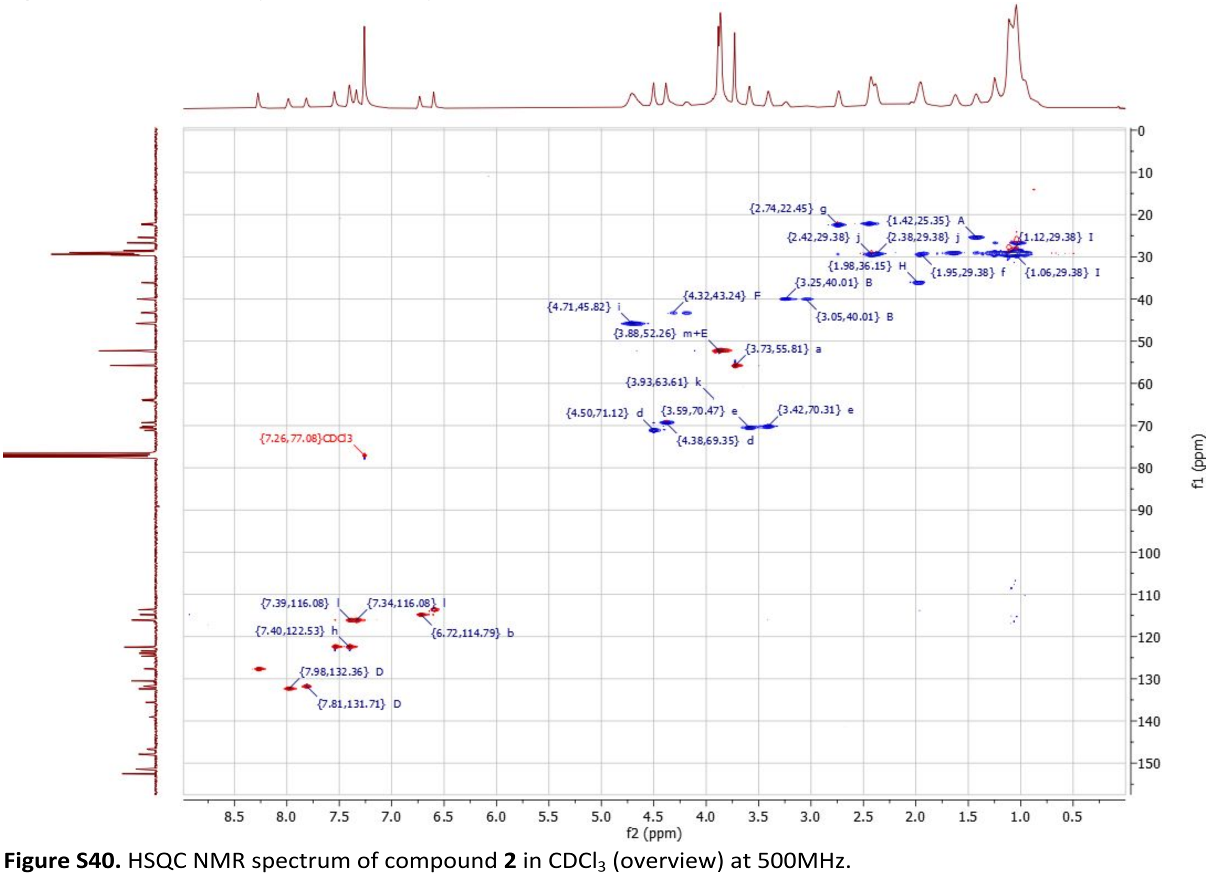


Figure S40. HSQC NMR spectrum of compound **2** in $CDCl_3$ (overview) at 500MHz.

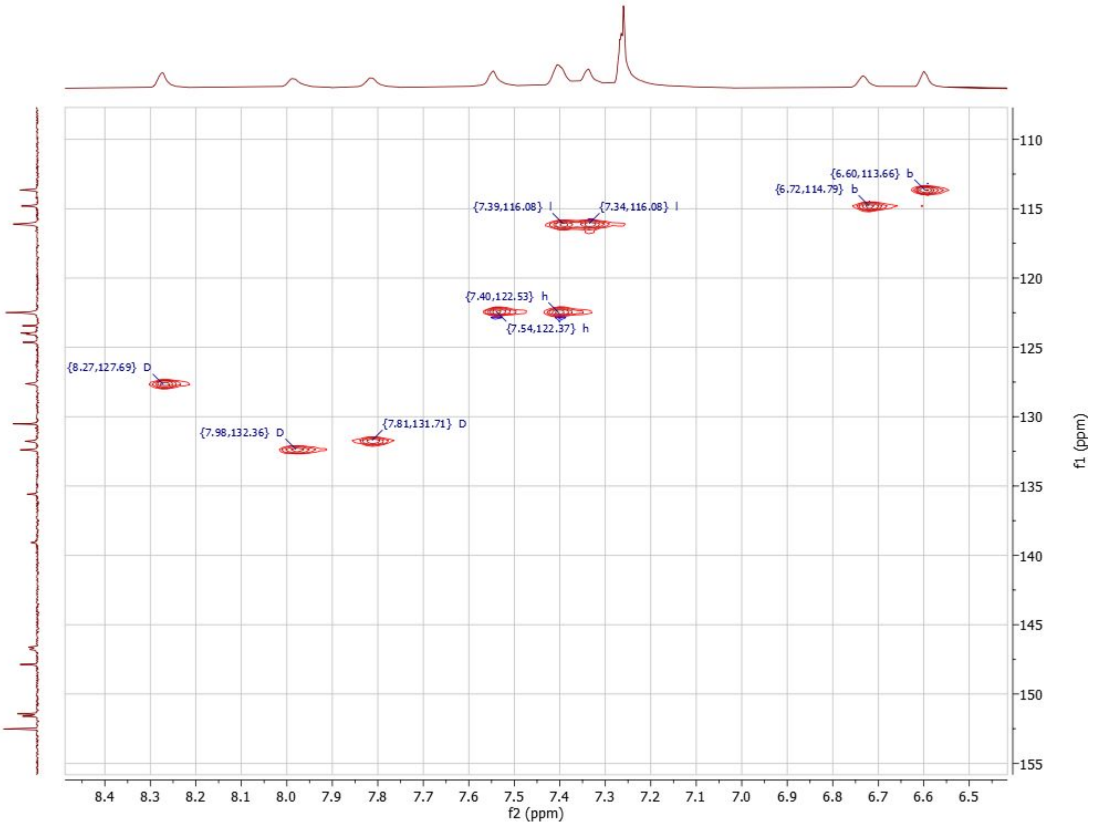


Figure S41. HSQC NMR spectrum of compound **2** in CDCl$_3$ (aromatic region) at 500MHz.

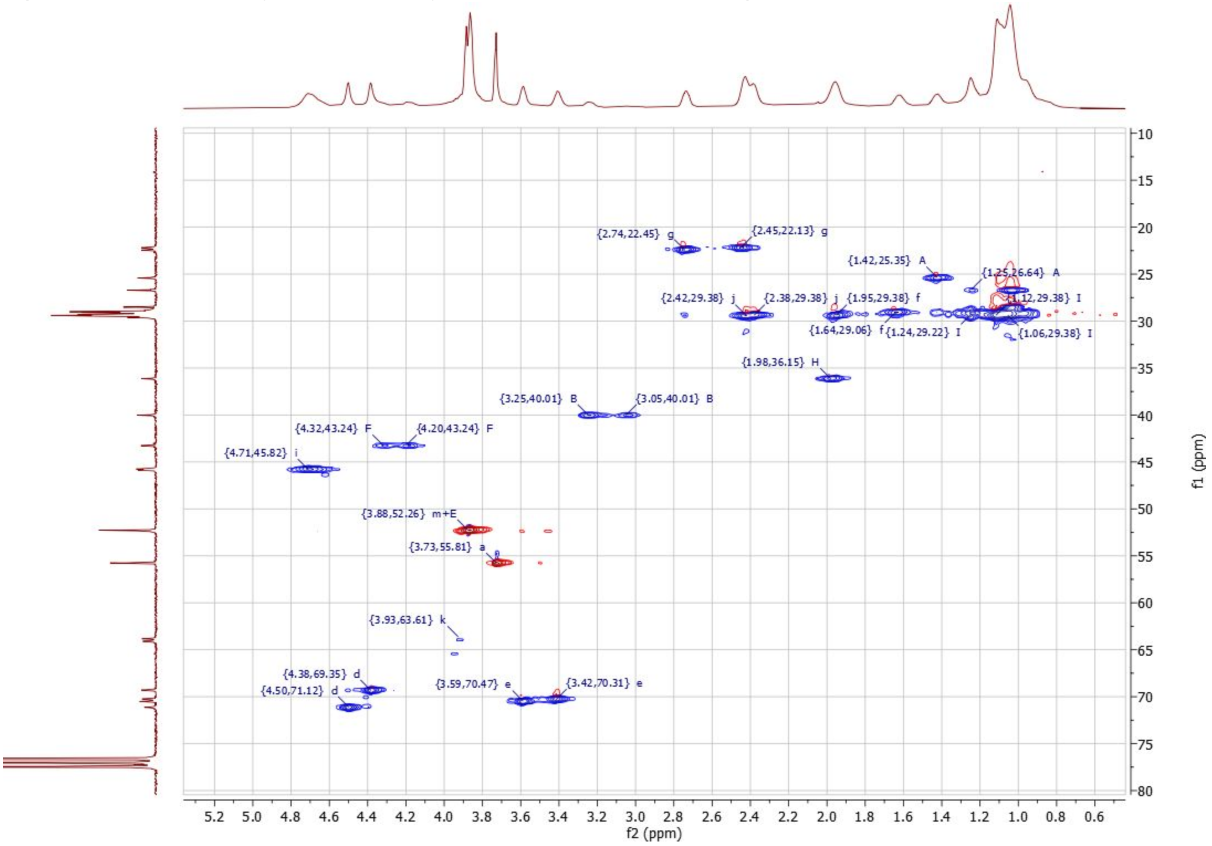


Figure S42. HSQC NMR spectrum of compound **2** in CDCl$_3$ (aliphatic region) at 500MHz.

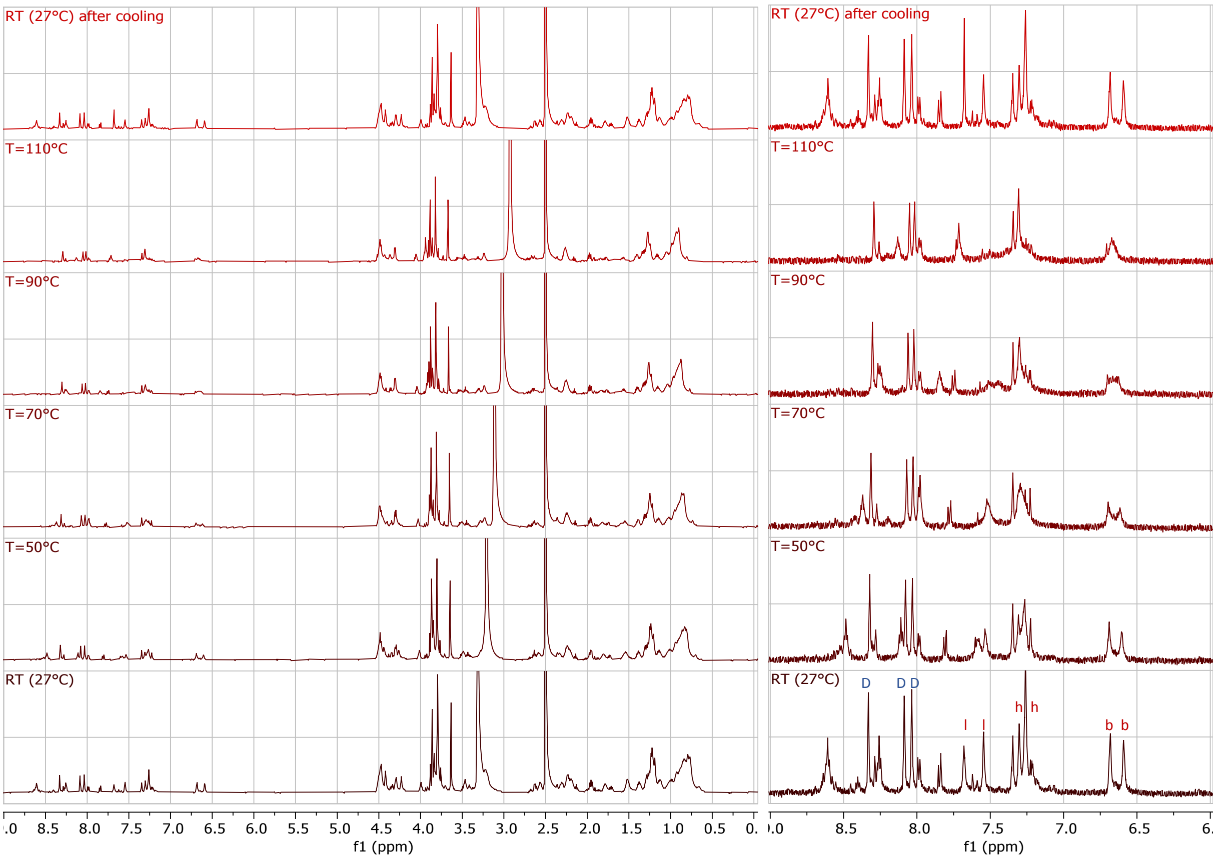


Figure S43. Variable temperature NMR spectra of compound **2** in $(CD_3)_2SO$ at 500MHz.

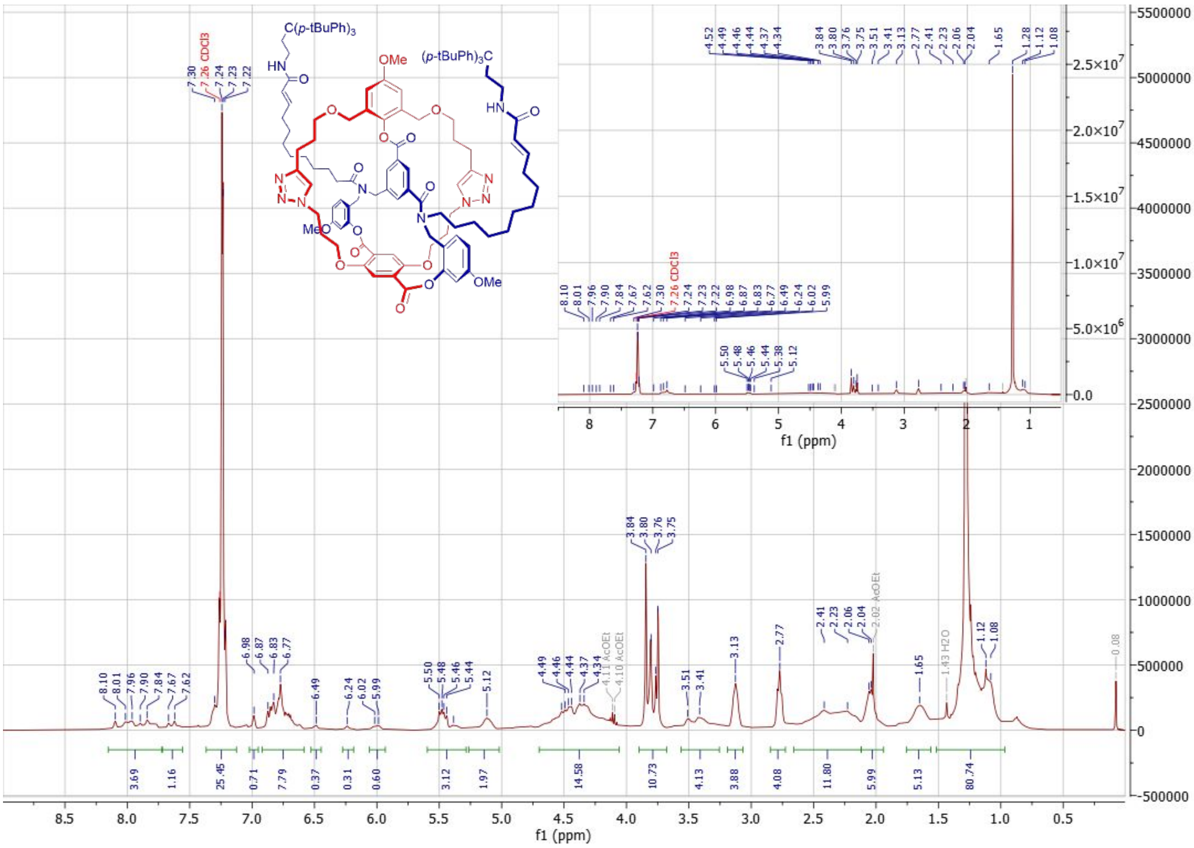


Figure S44. ^1H NMR spectrum of compound **12** in $CDCl_3$ at 400MHz.

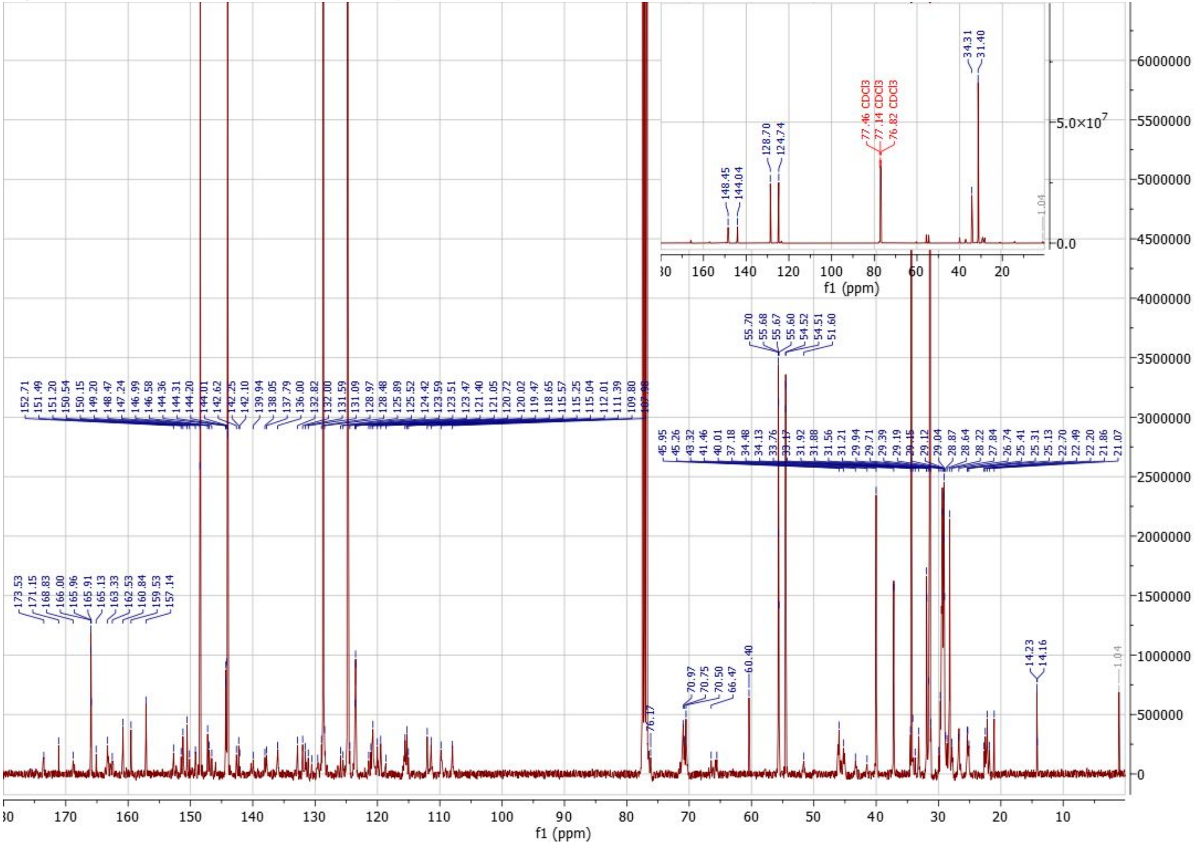


Figure S45. ^{13}C NMR spectrum of compound **12** in $CDCl_3$ at 400MHz.

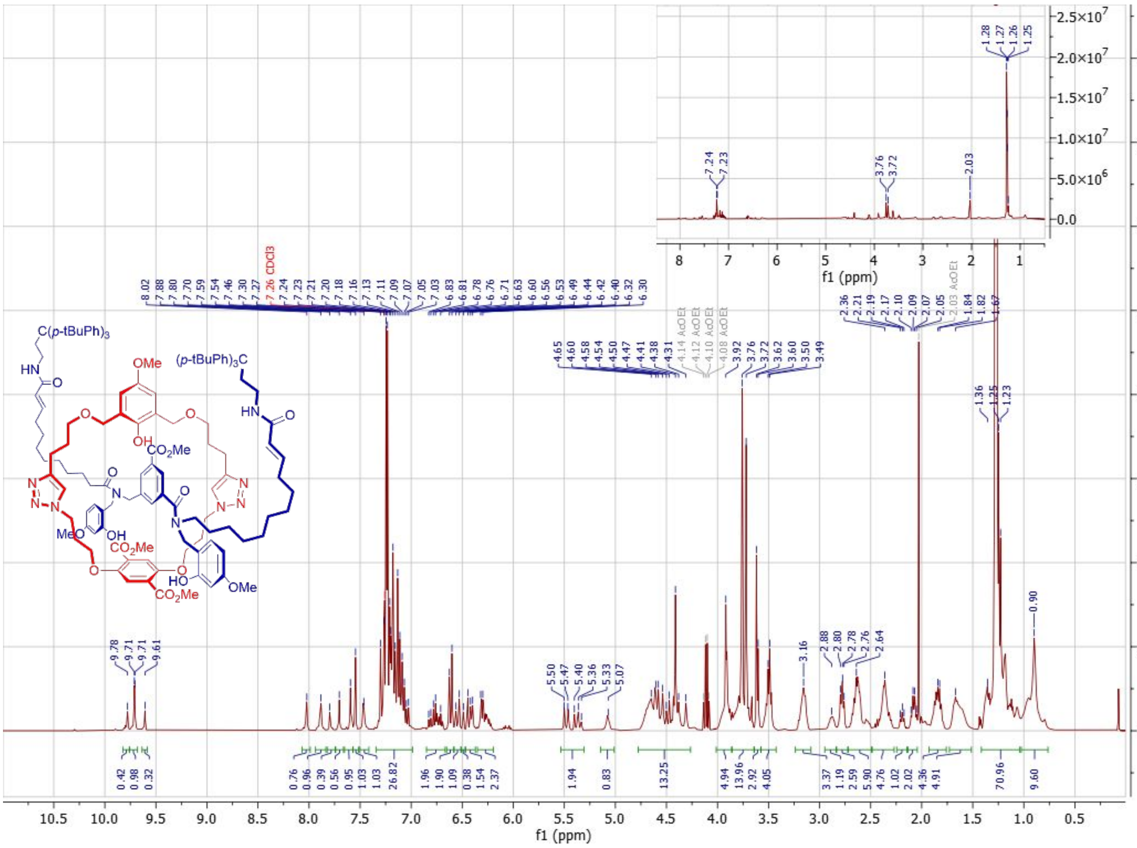


Figure S46. ^{1}H NMR spectrum of compound **13** in $CDCl_3$ at 400MHz.

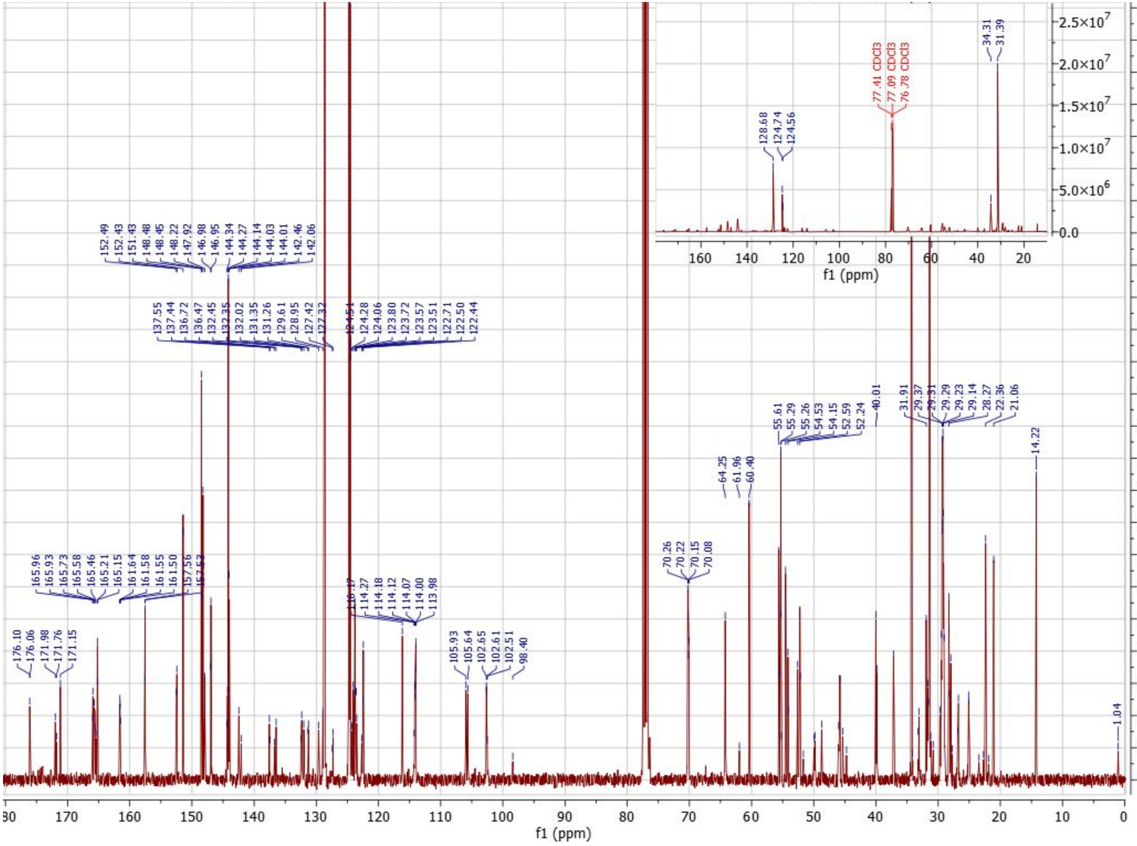


Figure S47. ^{13}C NMR spectrum of compound **13** in $CDCl_3$ at 400MHz.

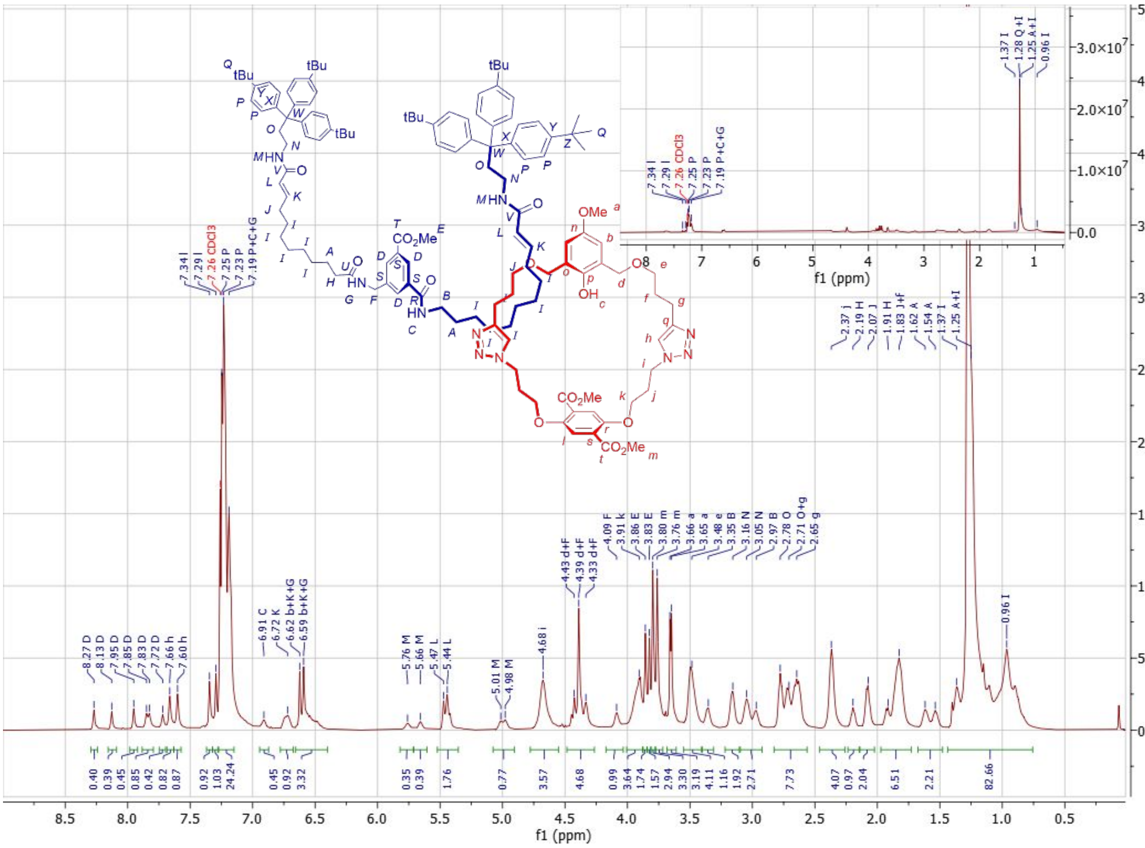


Figure S48. ^{1}H NMR spectrum of compound **3** in $CDCl_3$ at 500MHz.

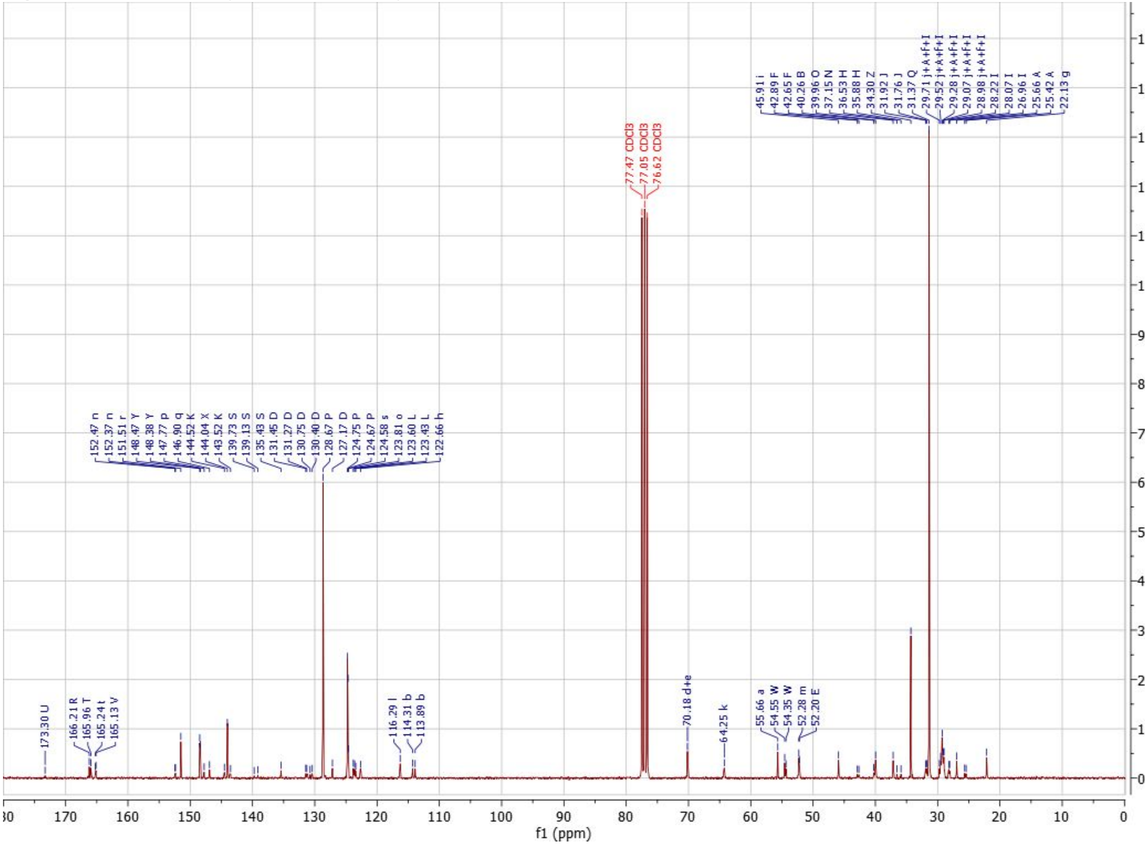


Figure S49. ^{13}C NMR spectrum of compound **3** in $CDCl_3$ (overview) at 500MHz.

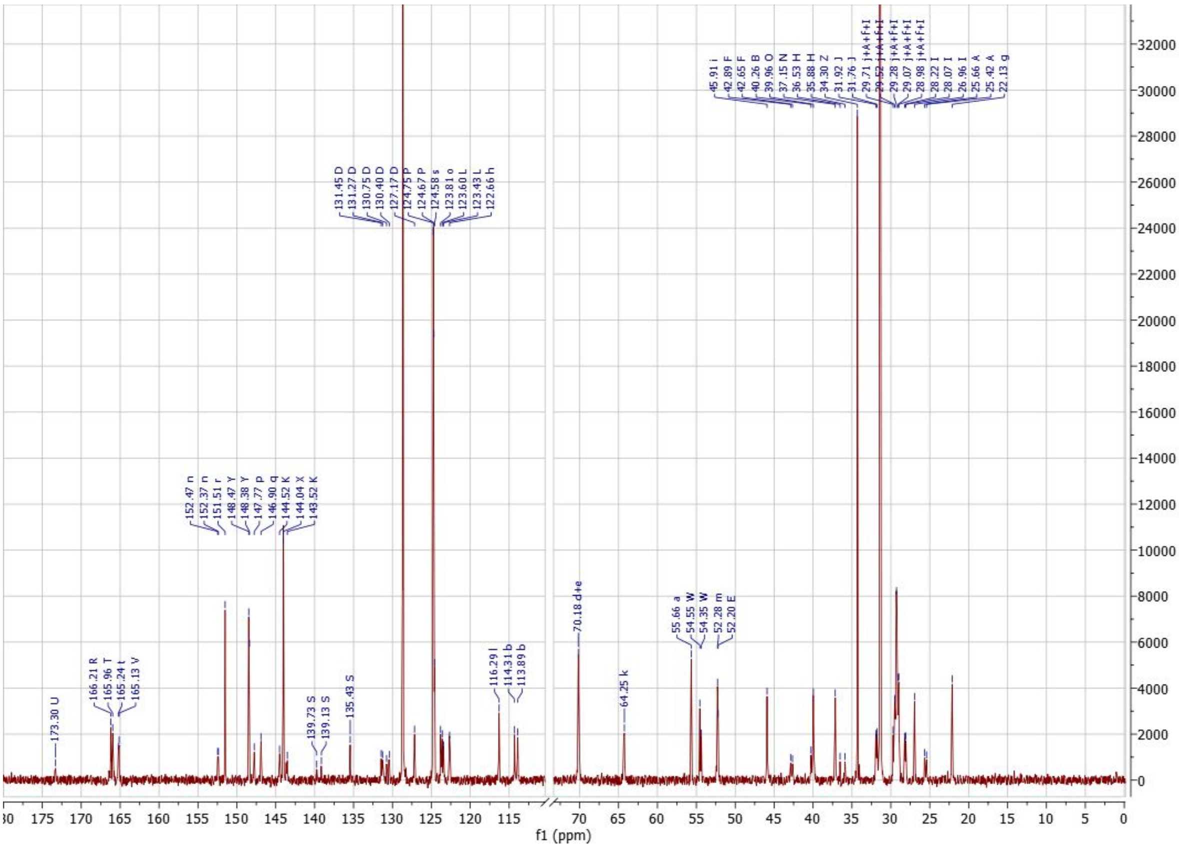


Figure S50. ^{13}C NMR spectrum of compound **3** in $CDCl_3$ (detail) at 500MHz.

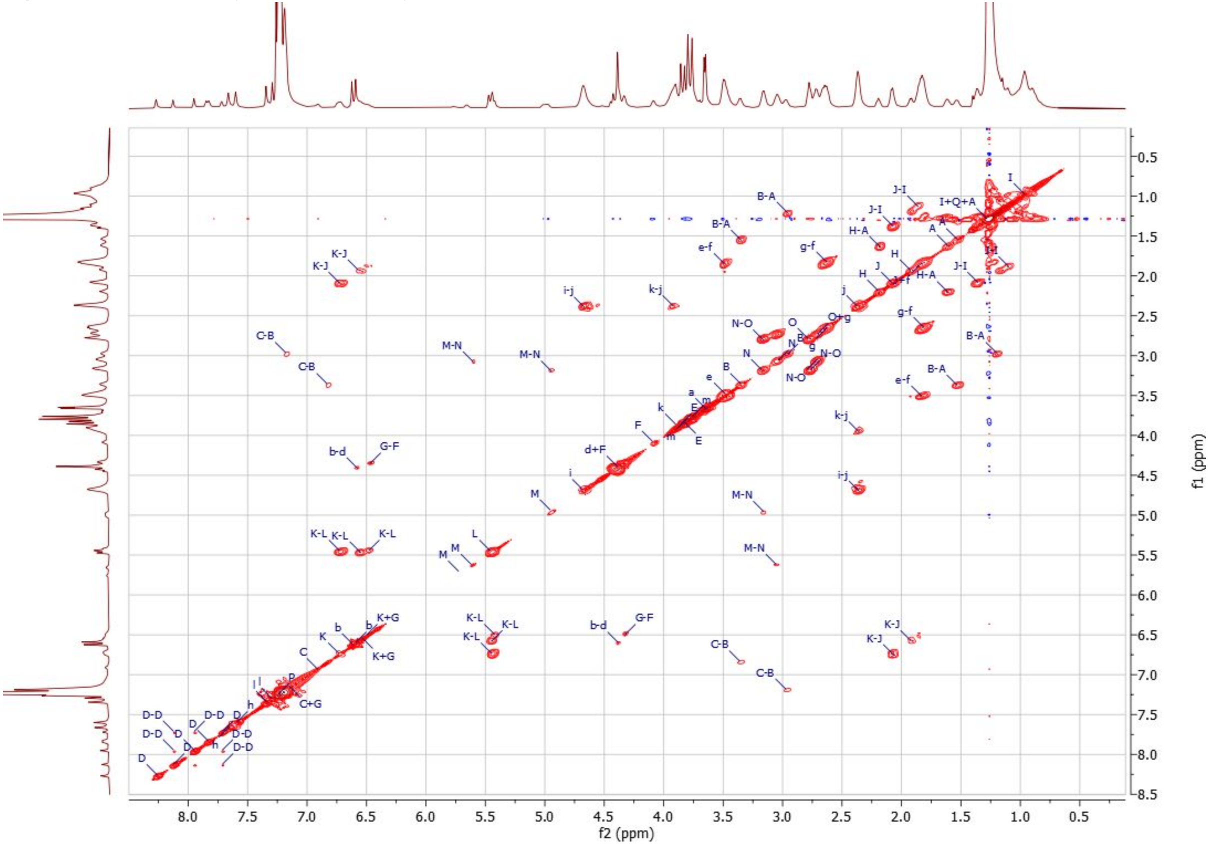


Figure S51. COSY NMR spectrum of compound **3** in $CDCl_3$ (overview) at 500MHz.

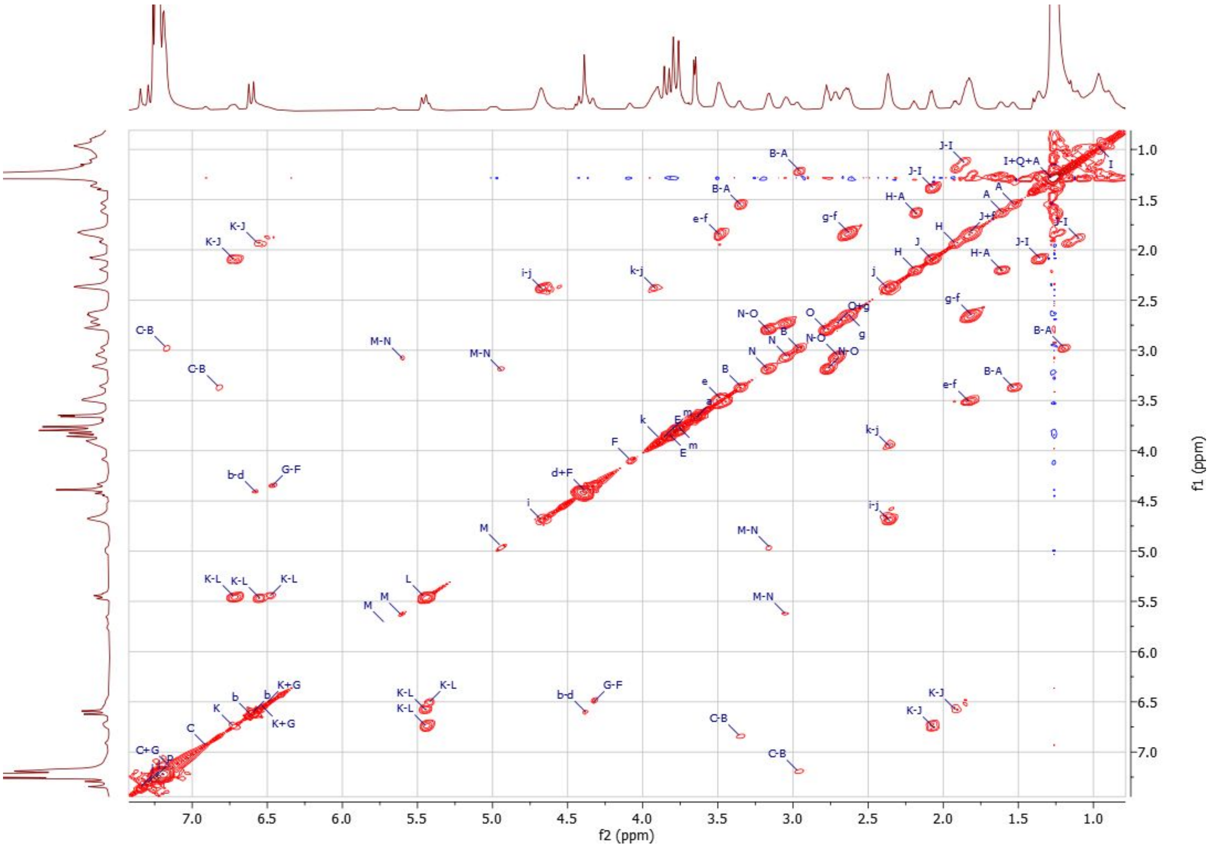


Figure S52. COSY NMR spectrum of compound **3** in $CDCl_3$ (detail) at 500MHz.

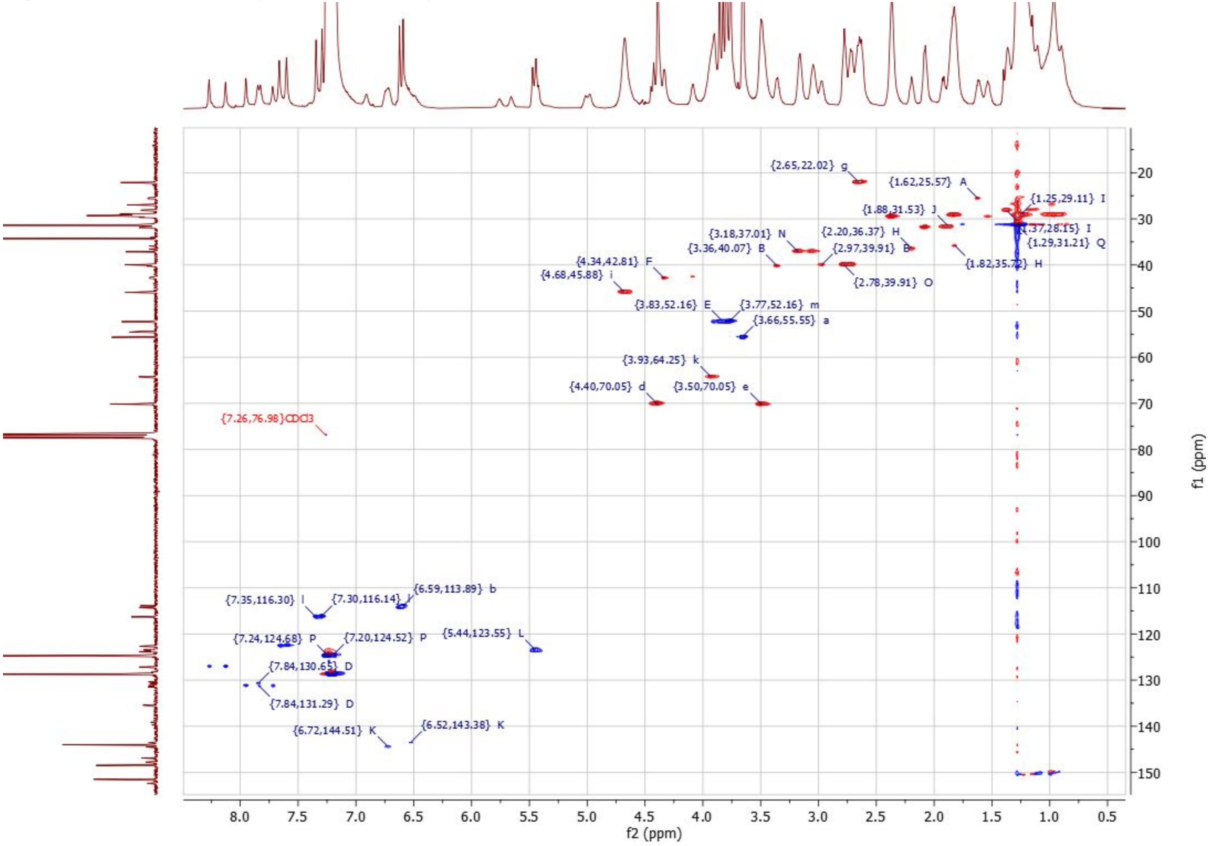


Figure S53. HSQC NMR spectrum of compound **3** in $CDCl_3$ (overview) at 500MHz.

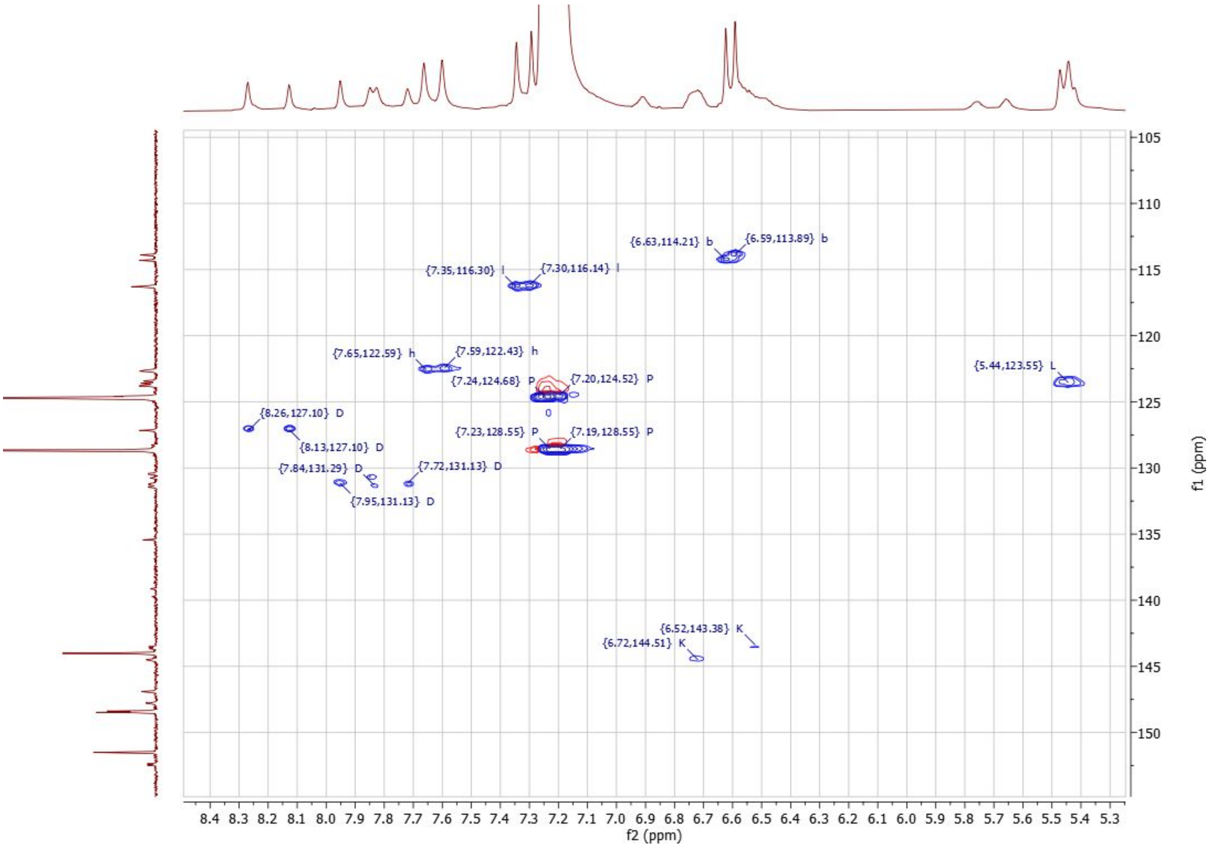


Figure S54. HSQC NMR spectrum of compound **3** in $CDCl_3$ (aromatic region) at 500MHz.

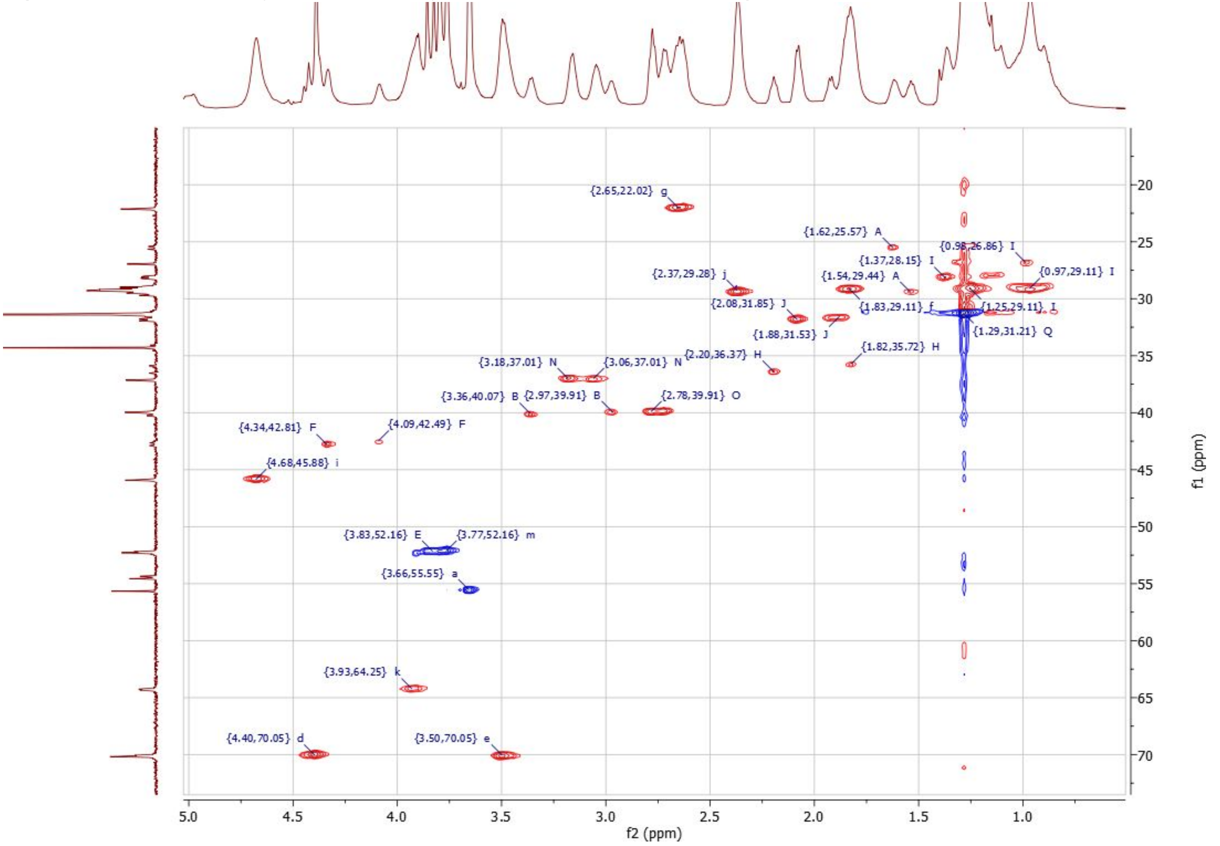


Figure S55. HSQC NMR spectrum of compound **3** in $CDCl_3$ (aliphatic region) at 500MHz.

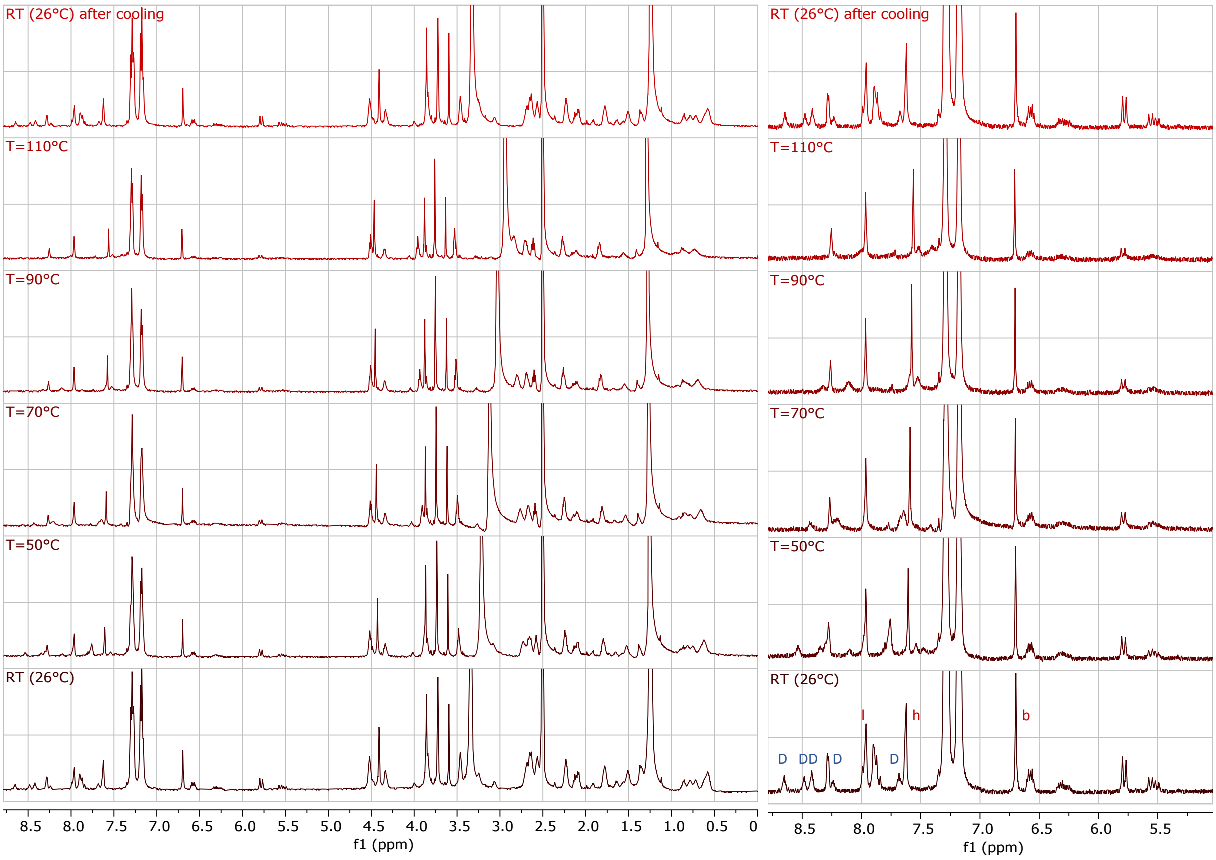


Figure S56. Variable temperature NMR spectra of compound **3** in $(CD_3)_2SO$ at 500MHz.

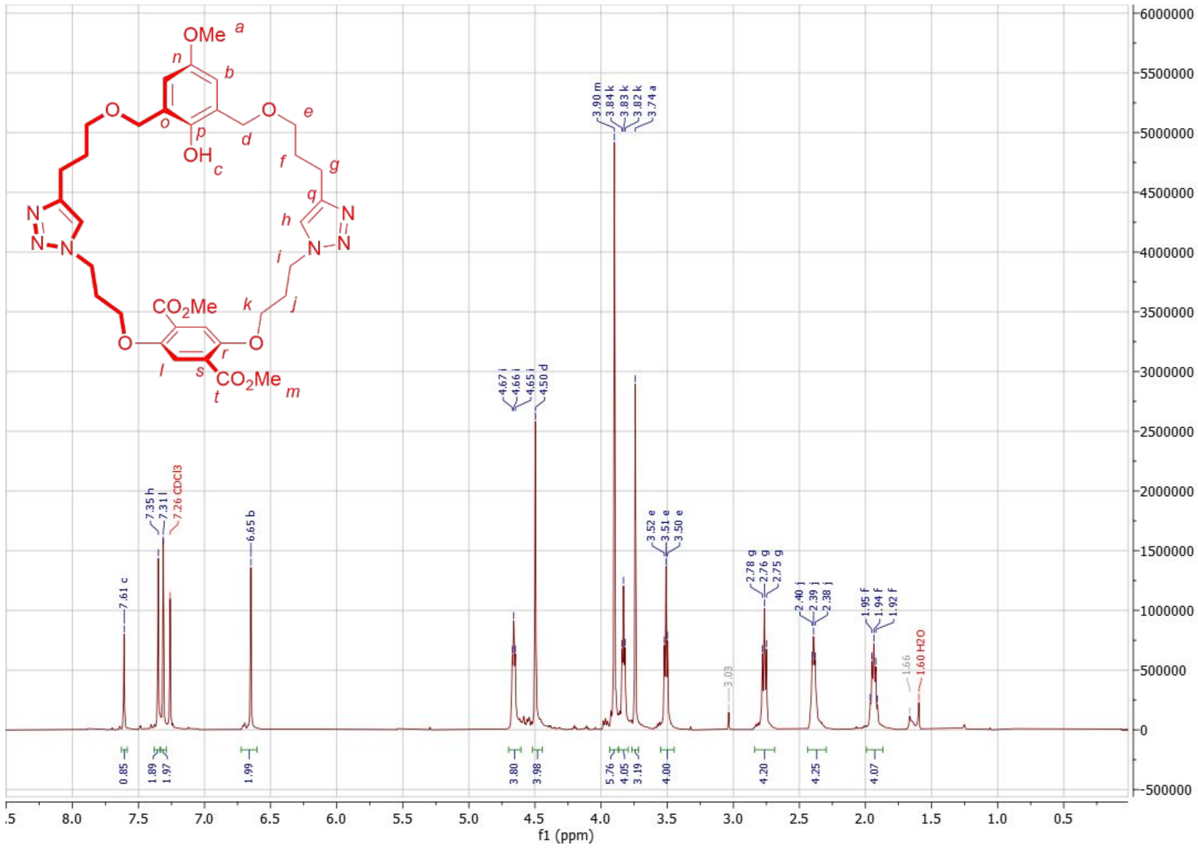


Figure S57. ^{1}H NMR spectrum of compound **26** in $CDCl_3$ at 500MHz.

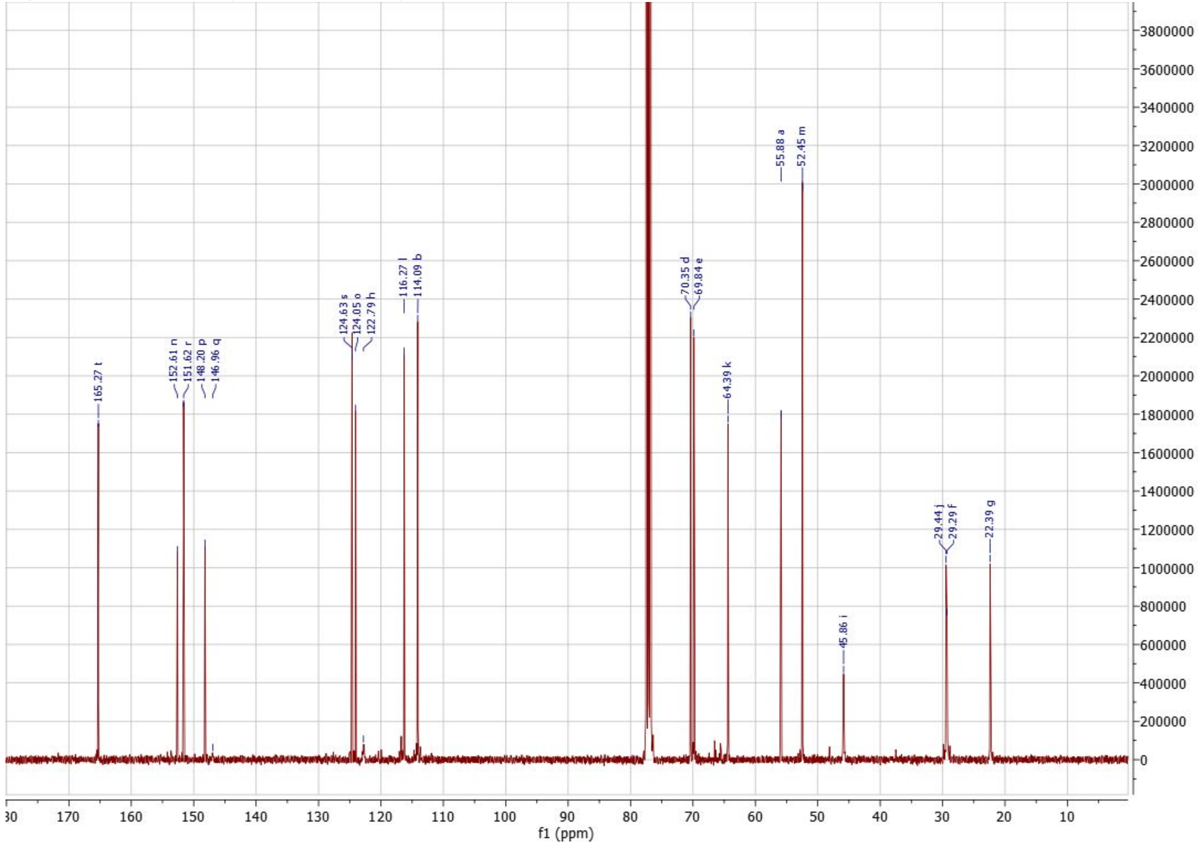


Figure S58. ^{13}C NMR spectrum of compound **26** in $CDCl_3$ at 500MHz. Note triazole signals *q* and *h* are barely visible at room temperature, a second ^{13}C NMR spectrum at -20°C is available were these peaks appear sharper.

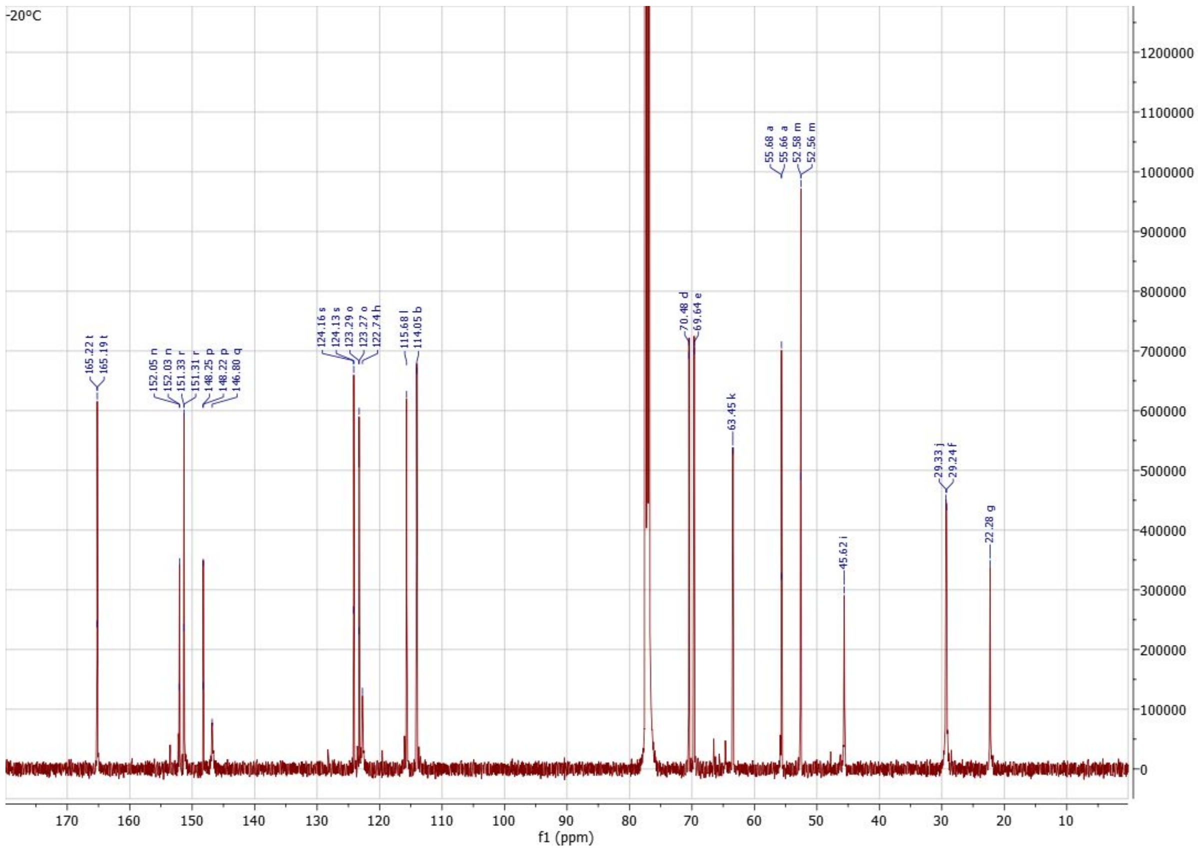


Figure S59. ^{13}C NMR spectrum of compound **26** in $CDCl_3$ at -20°C at 500MHz.

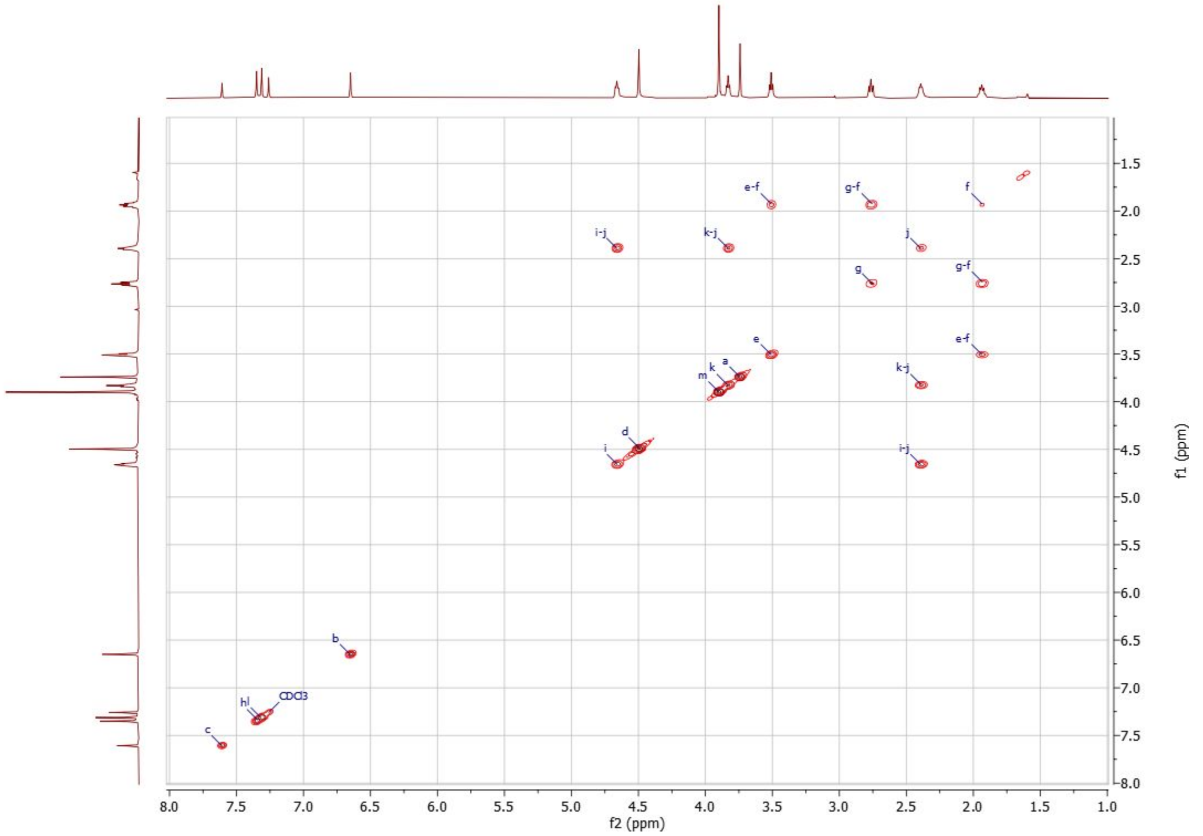


Figure S60. COSY NMR spectrum of compound **26** in $CDCl_3$ at 500MHz.

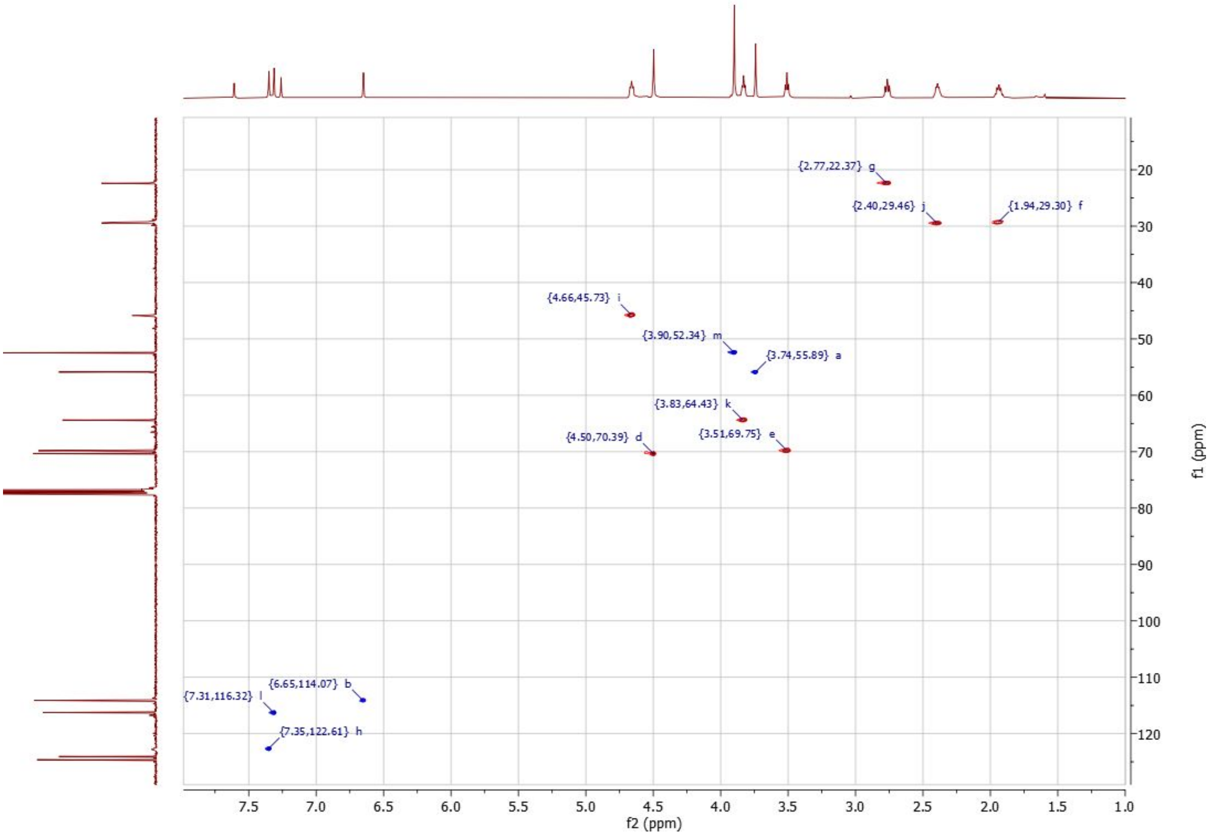


Figure S61. HSQC NMR spectrum of compound **26** in $CDCl_3$ at 500MHz.

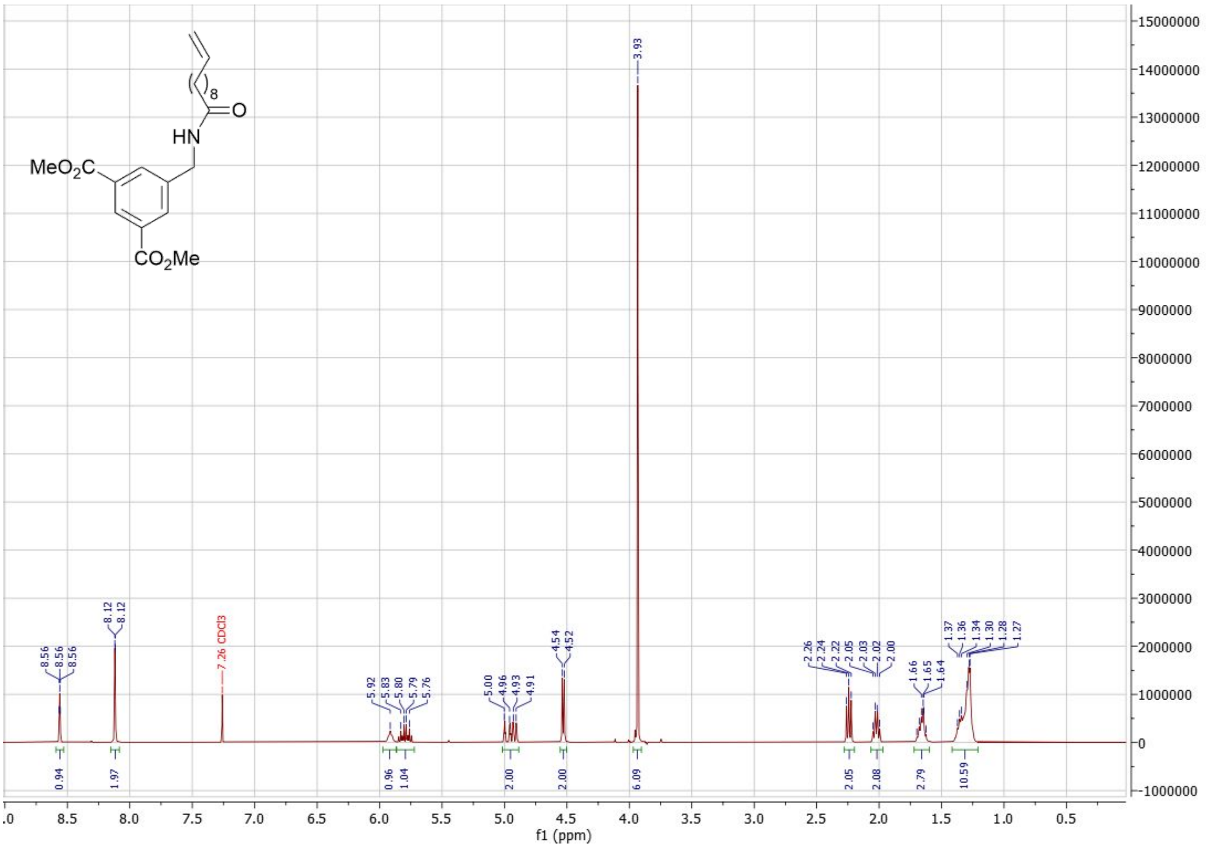


Figure S62. ^{1}H NMR spectrum of compound **27** in $CDCl_3$ at 400MHz.

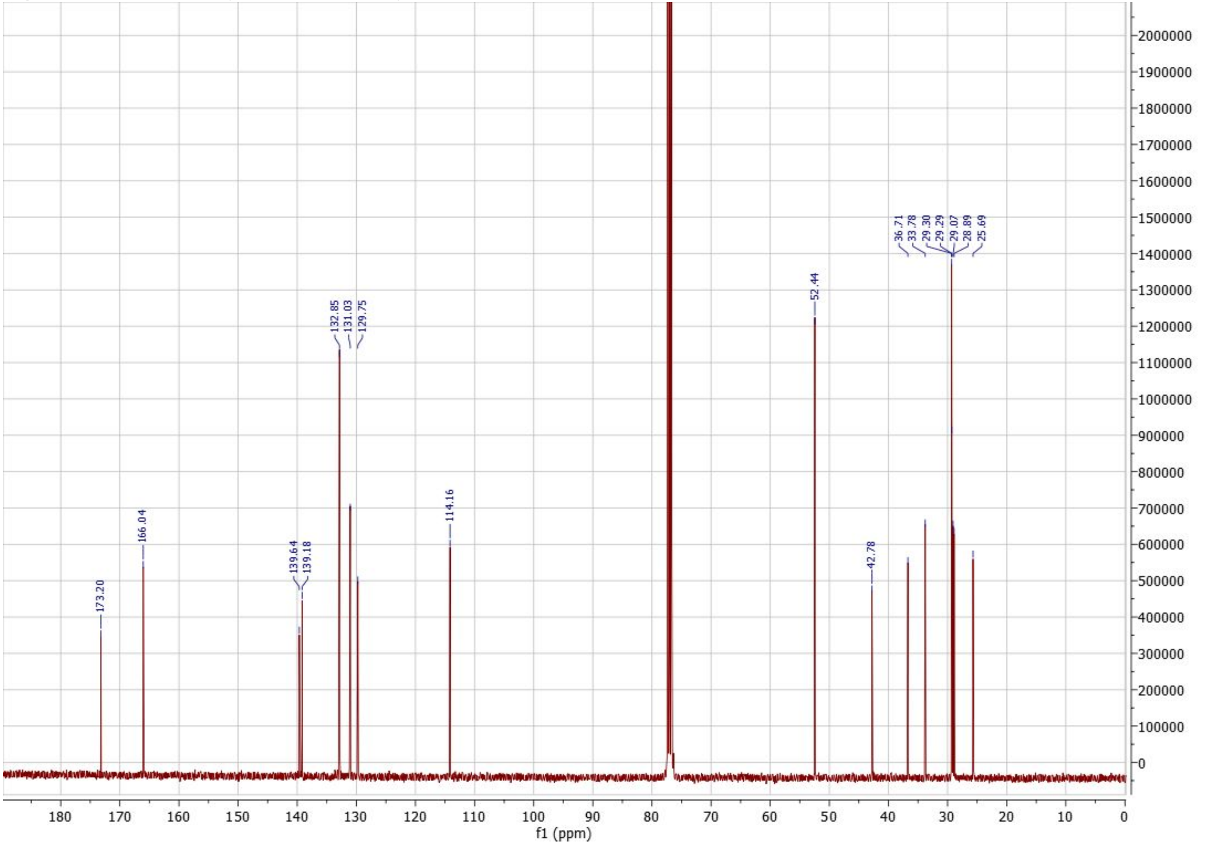


Figure S63. ^{13}C NMR spectrum of compound **27** in $CDCl_3$ at 400MHz.

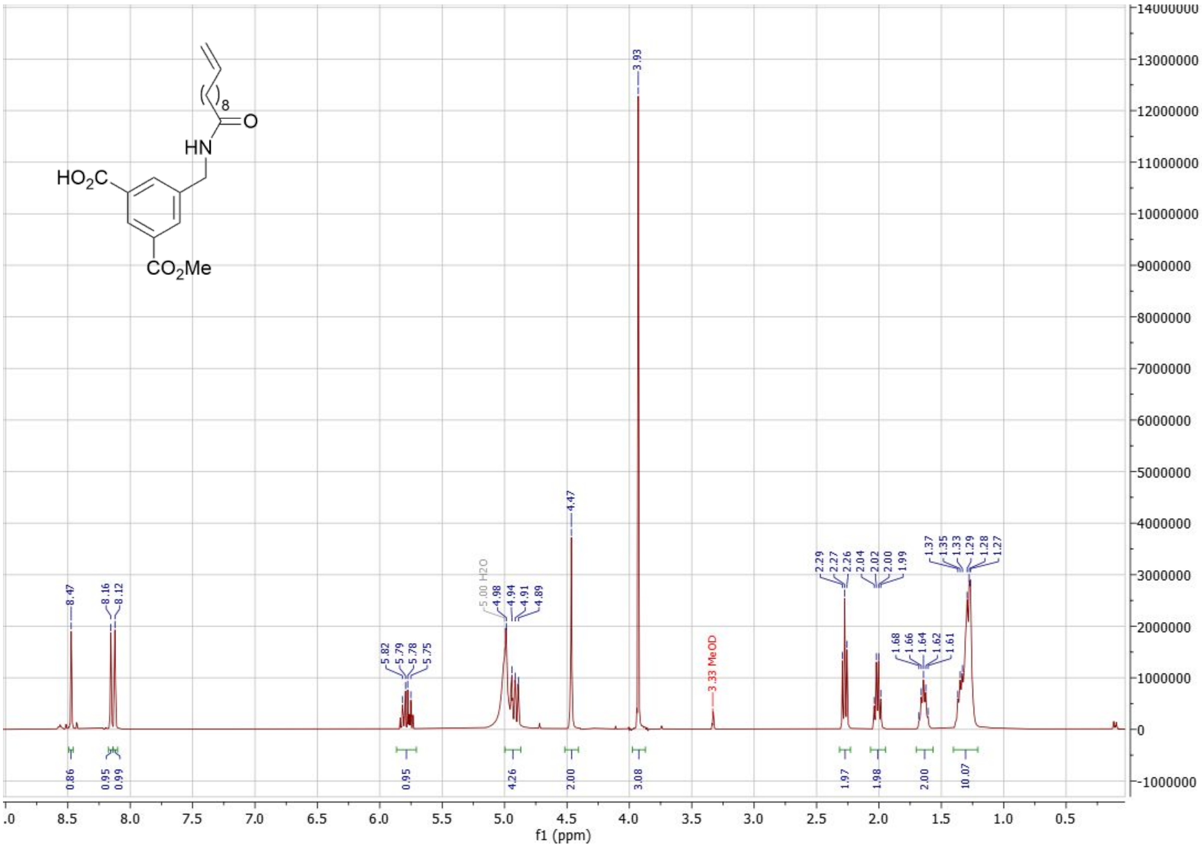


Figure S64. ^{1}H NMR spectrum of compound **28** in CD_3OD at 400MHz.

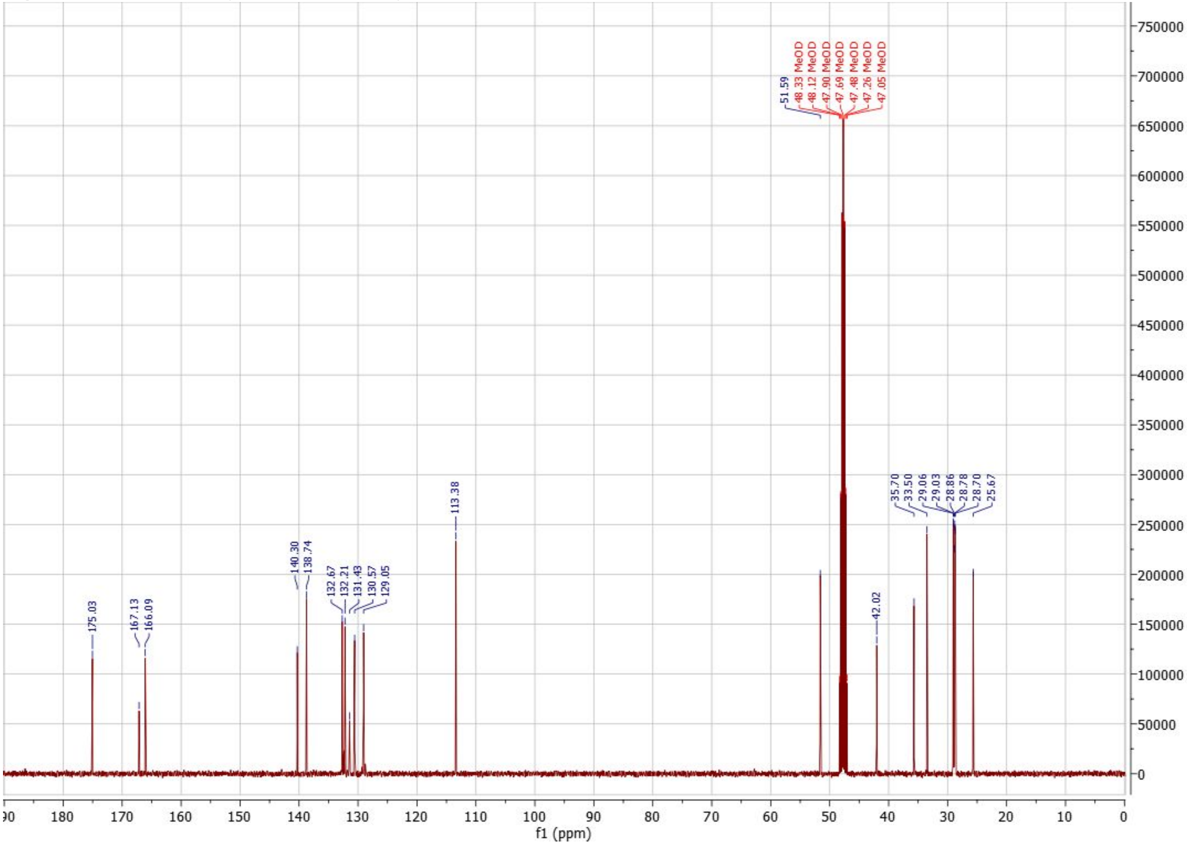


Figure S65. ^{13}C NMR spectrum of compound **28** in CD_3OD at 400MHz.

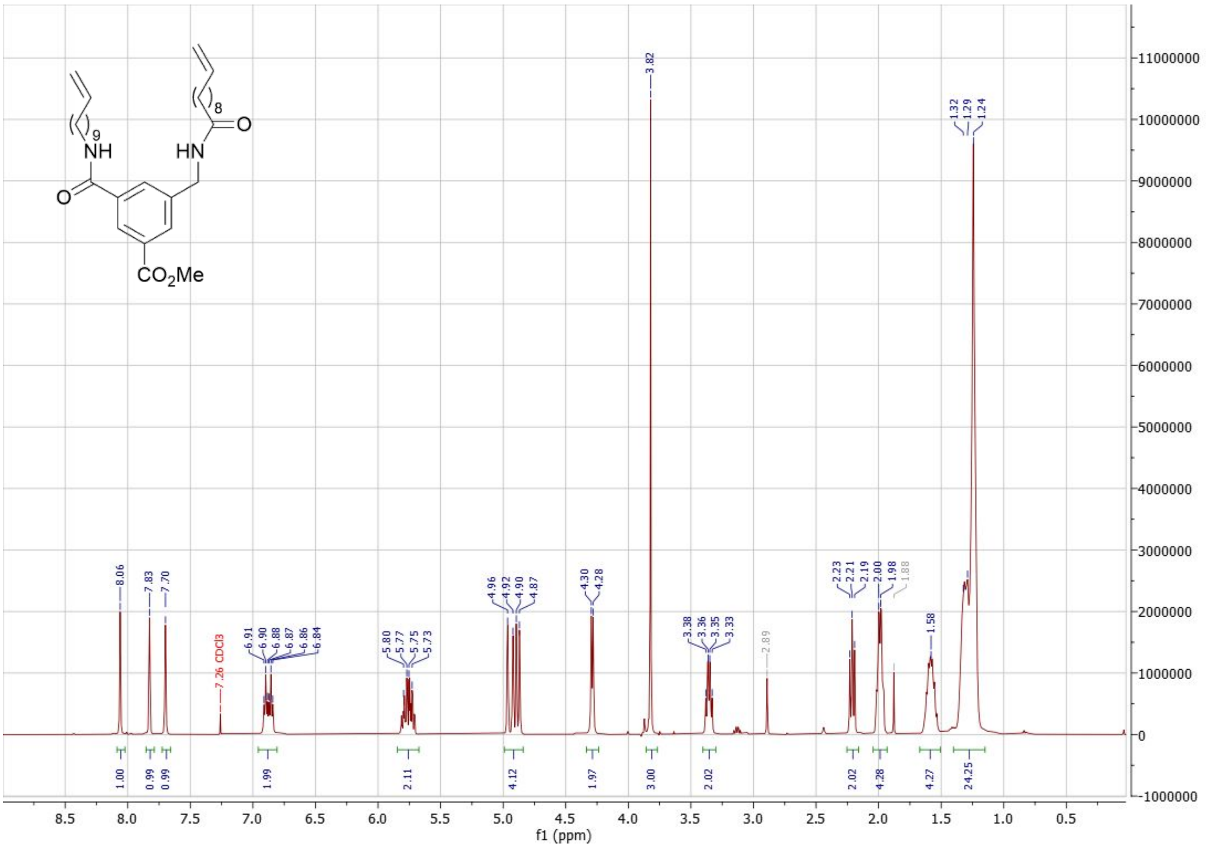


Figure S66. ^{1}H NMR spectrum of compound **29** in $CDCl_3$ at 400MHz.

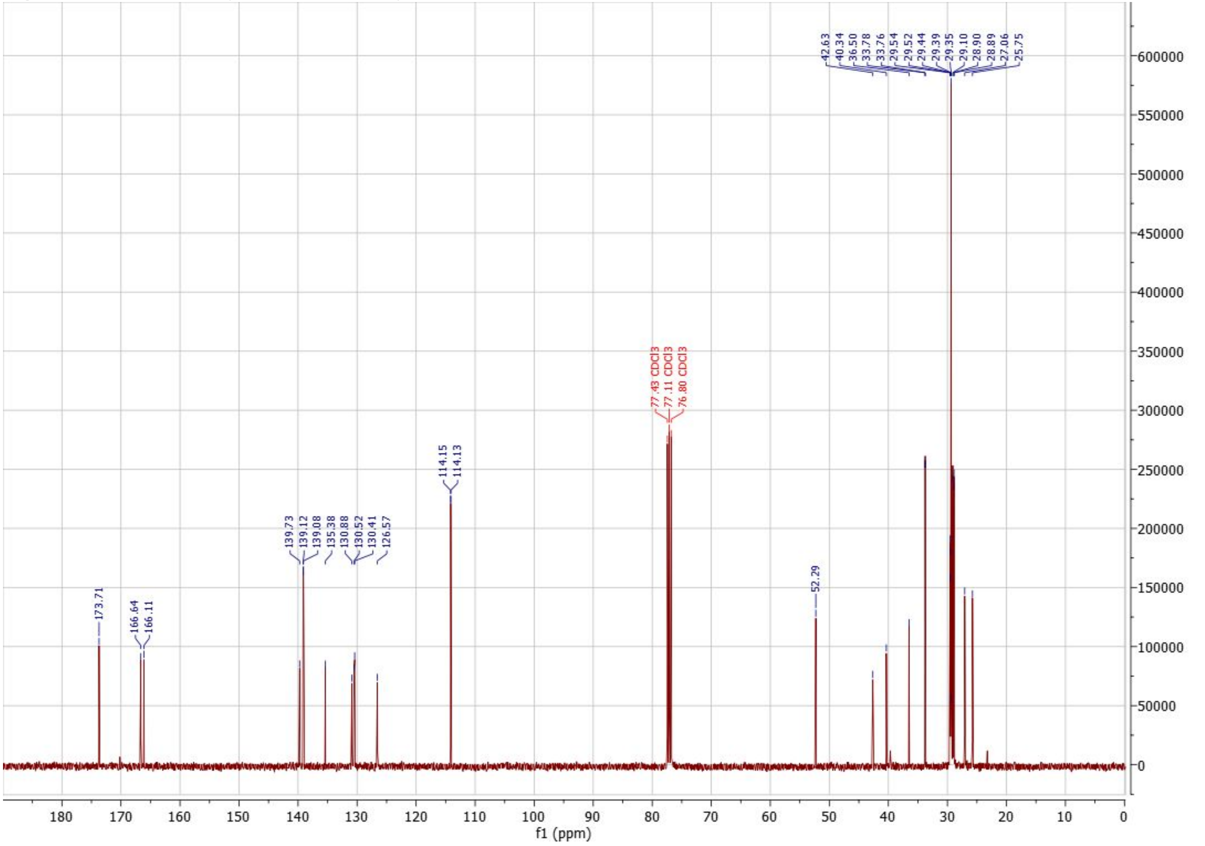


Figure S67. ^{13}C NMR spectrum of compound **29** in $CDCl_3$ at 400MHz.

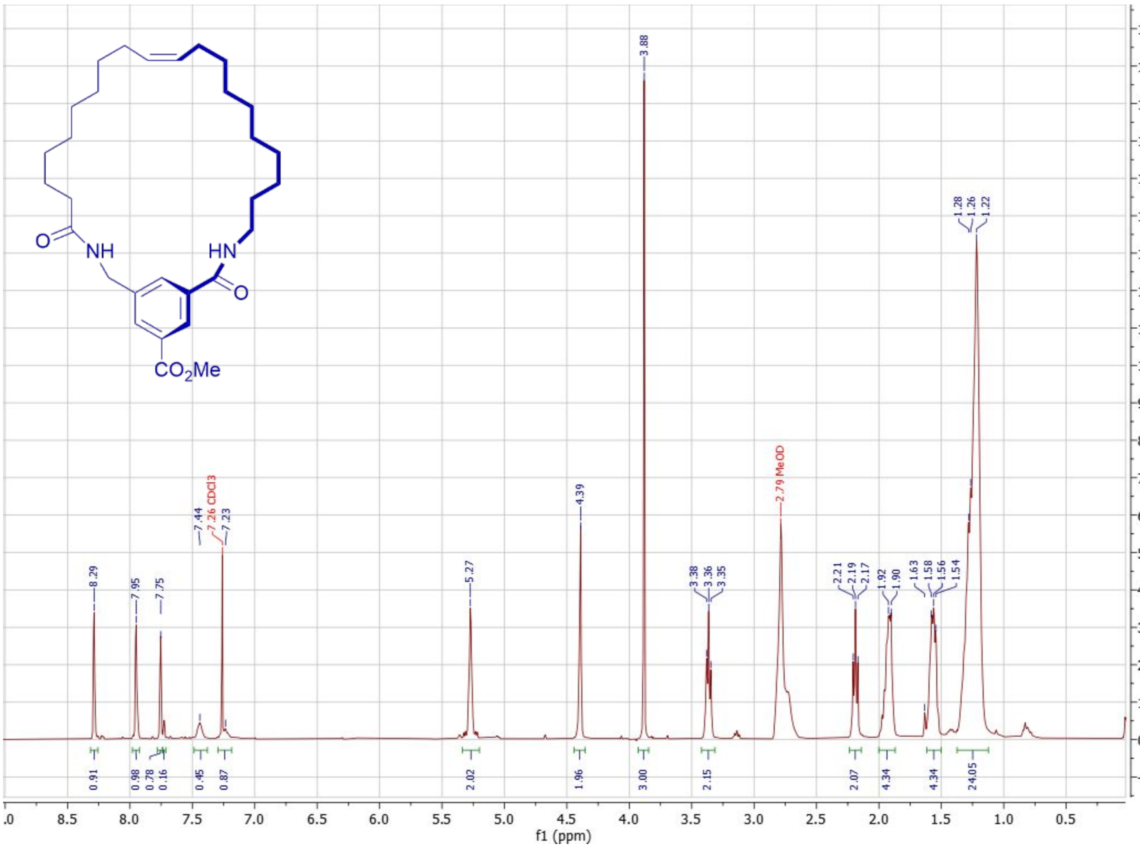


Figure S68. ^{1}H NMR spectrum of compound **30** in CDCl$_3$+CD$_3$OD at 400MHz.

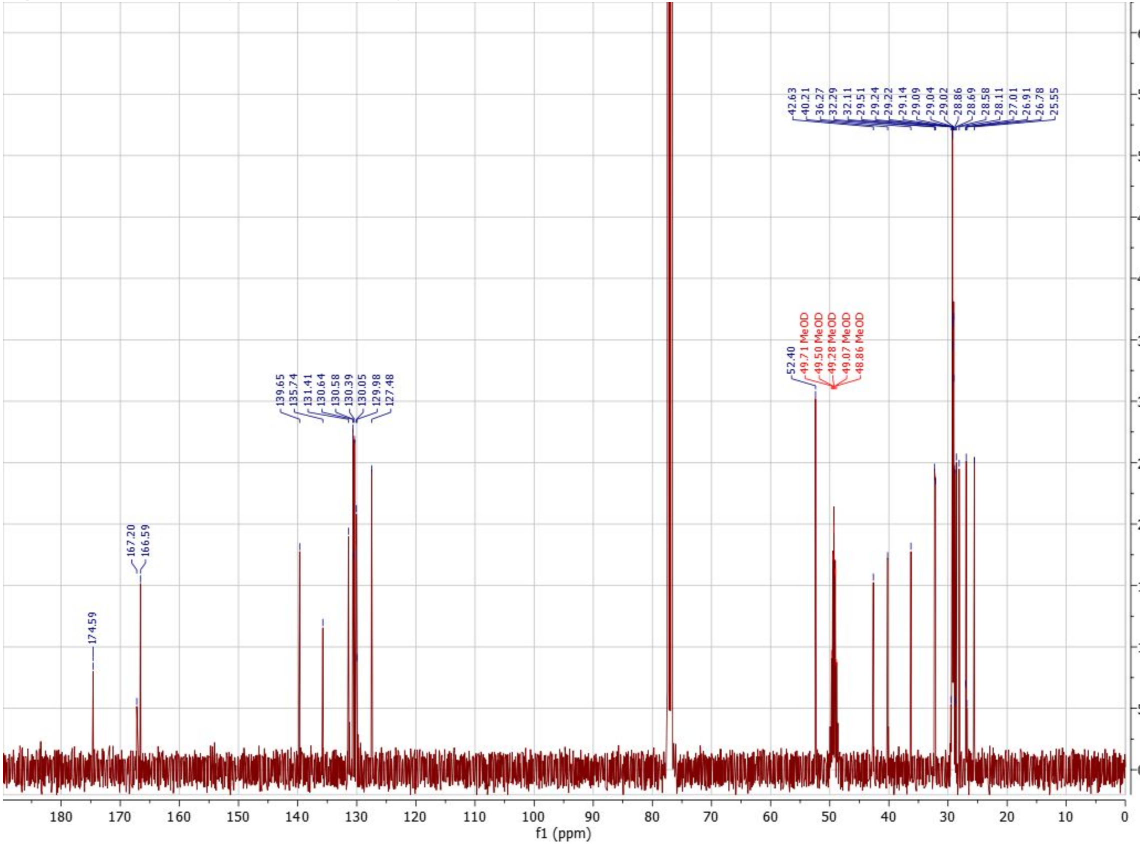


Figure S69. ^{13}C NMR spectrum of compound **30** in CDCl$_3$+CD$_3$OD at 400MHz.

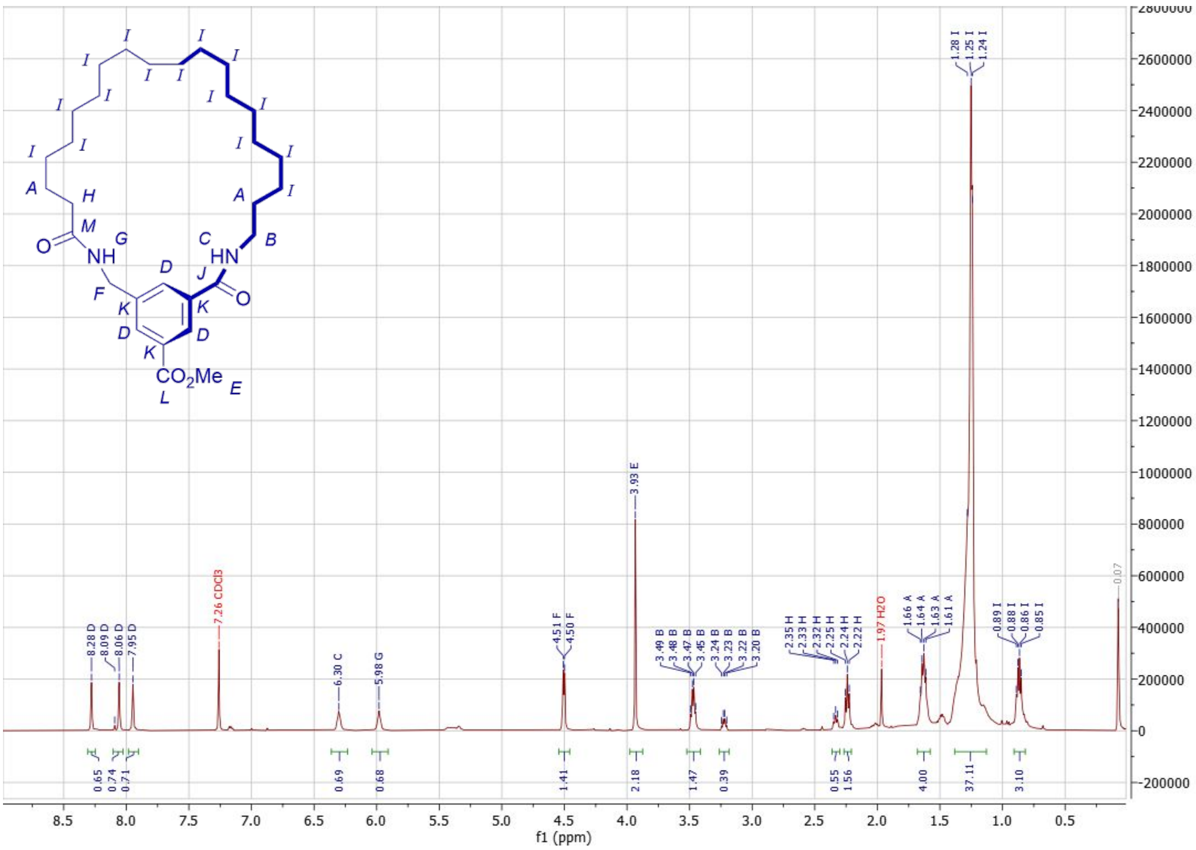


Figure S70. ^{1}H NMR spectrum of compound **31** in $CDCl_3$ at 500MHz.

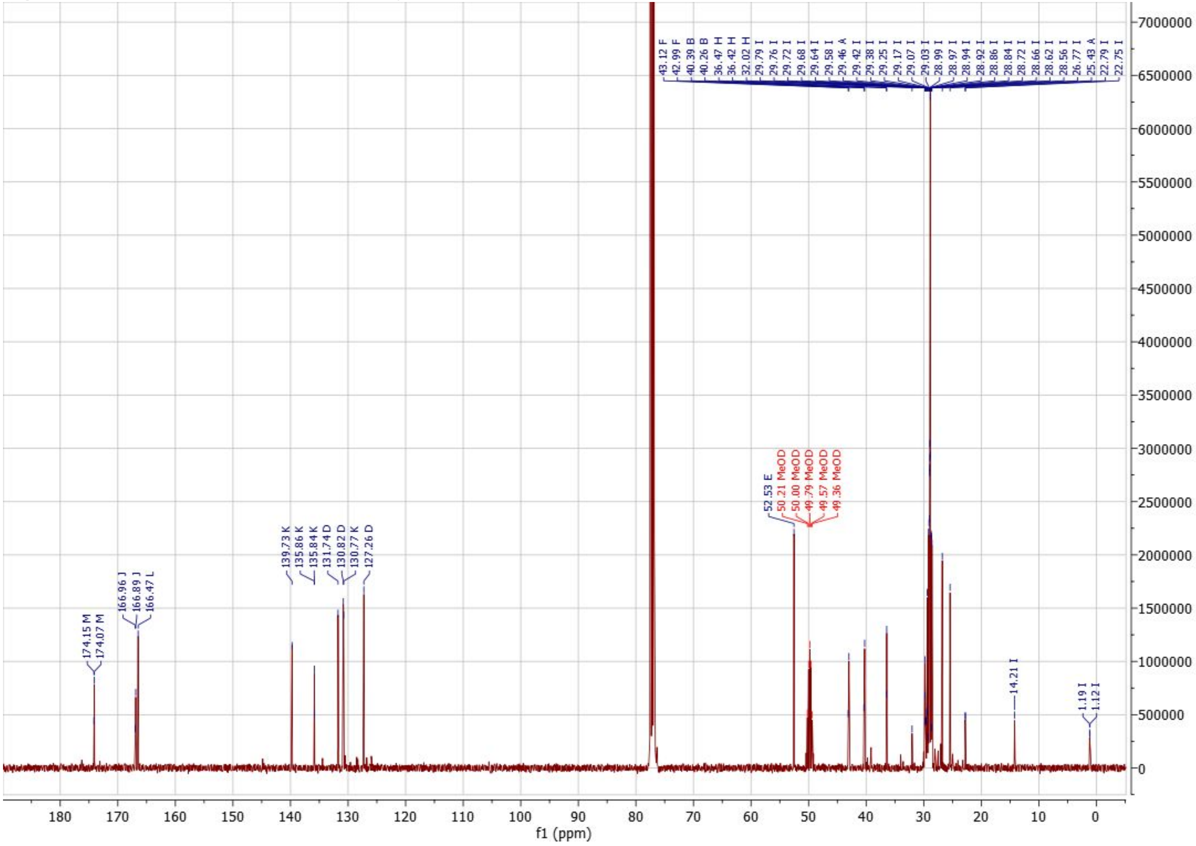


Figure S71. ^{13}C NMR spectrum of compound **31** in $CDCl_3$ at 500MHz. A drop of CD_3OD was added for this measurement only to increase solubility, allowing a more concentrated sample.

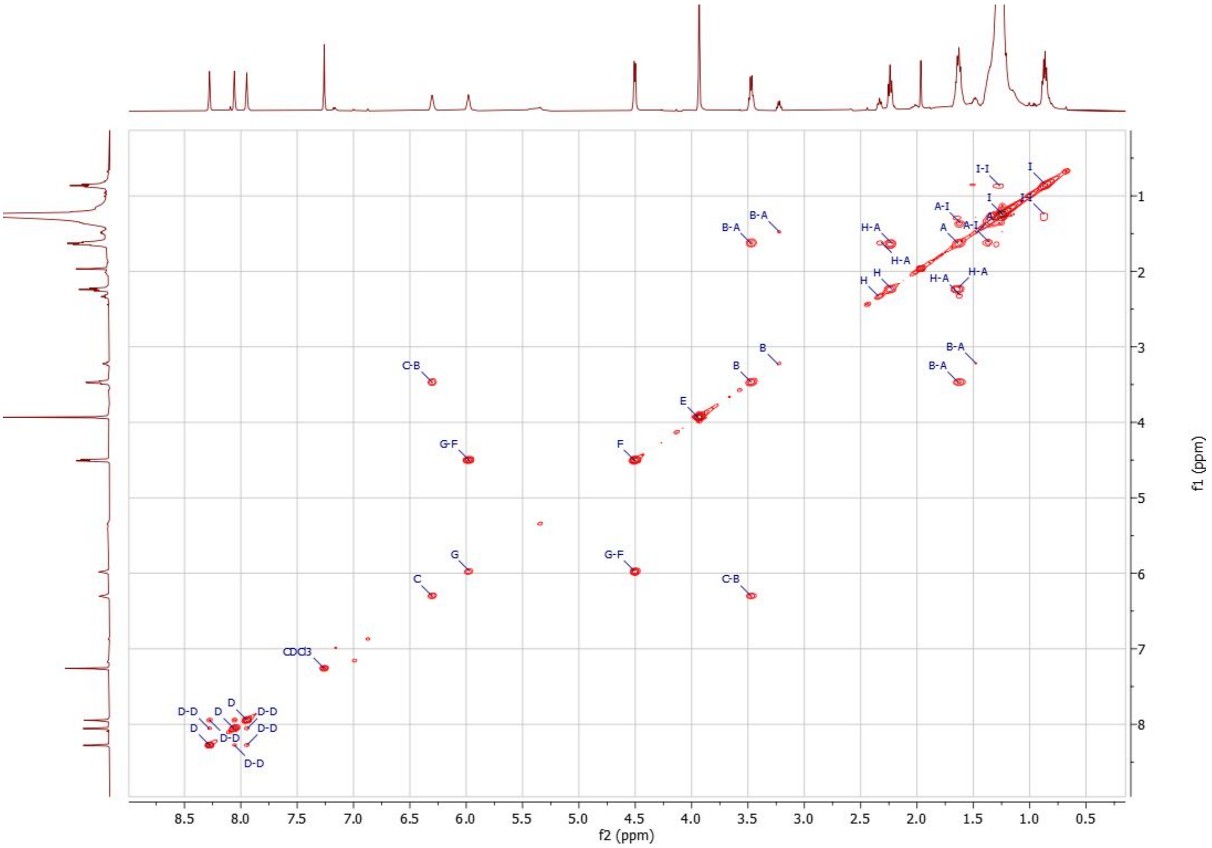


Figure S72. COSY NMR spectrum of compound **31** in $CDCl_3$ at 500MHz.

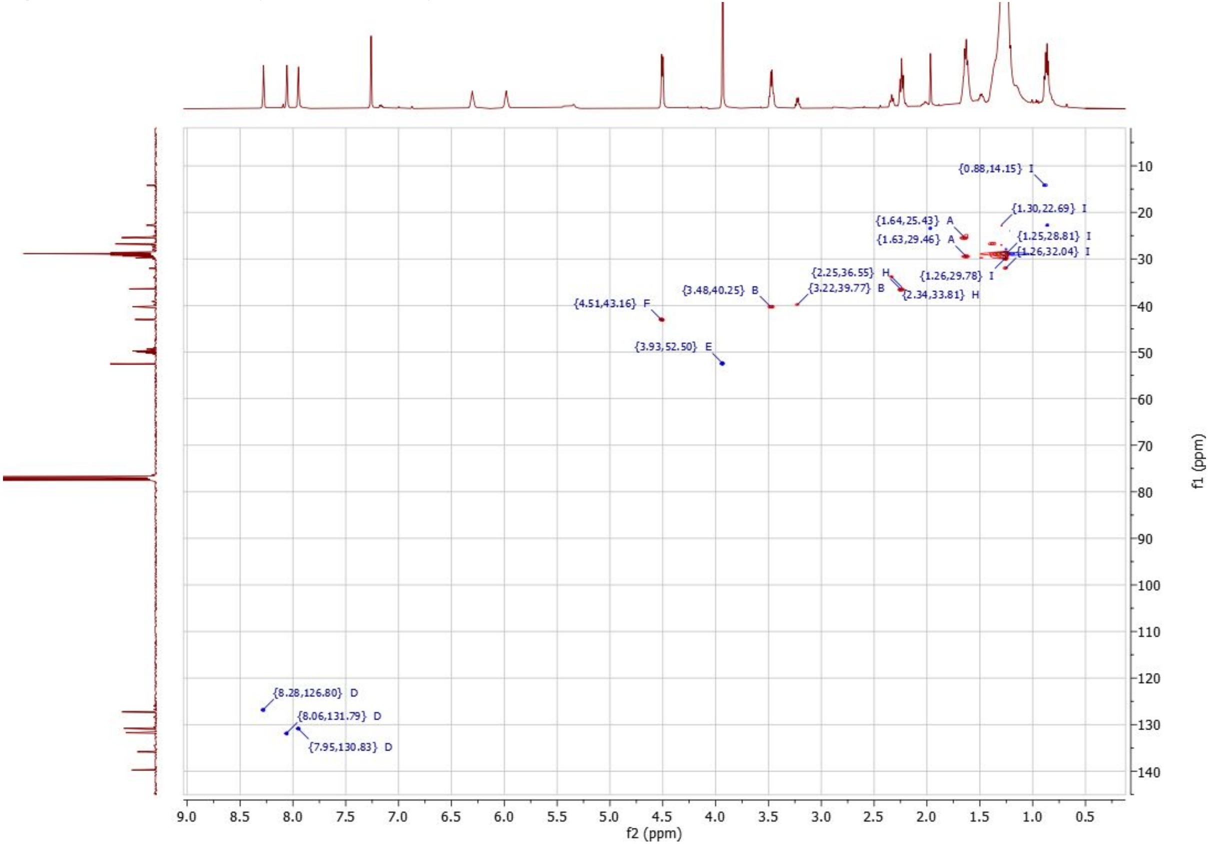


Figure S73. HSQC NMR spectrum of compound **31** in $CDCl_3$ at 500MHz.

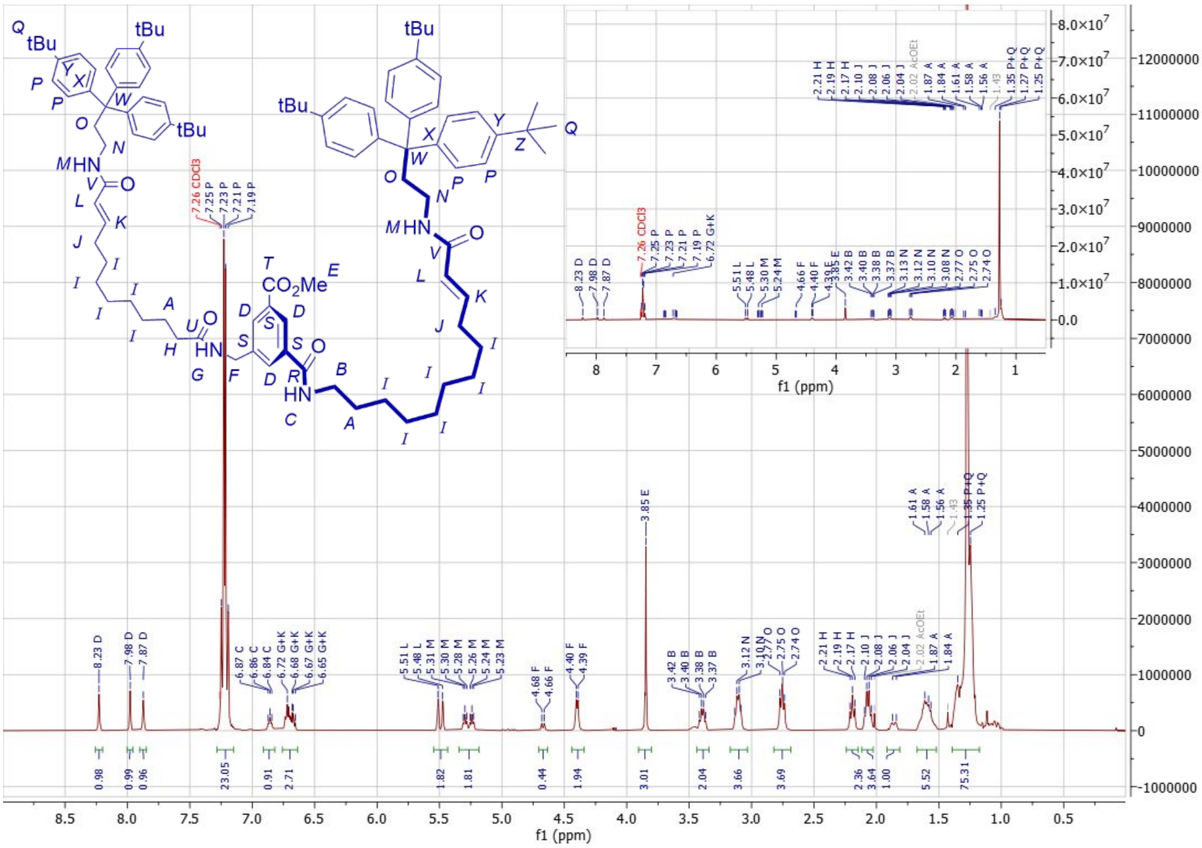


Figure S74. ^{1}H NMR spectrum of compound **32** in CDCl$_3$ at 500MHz.

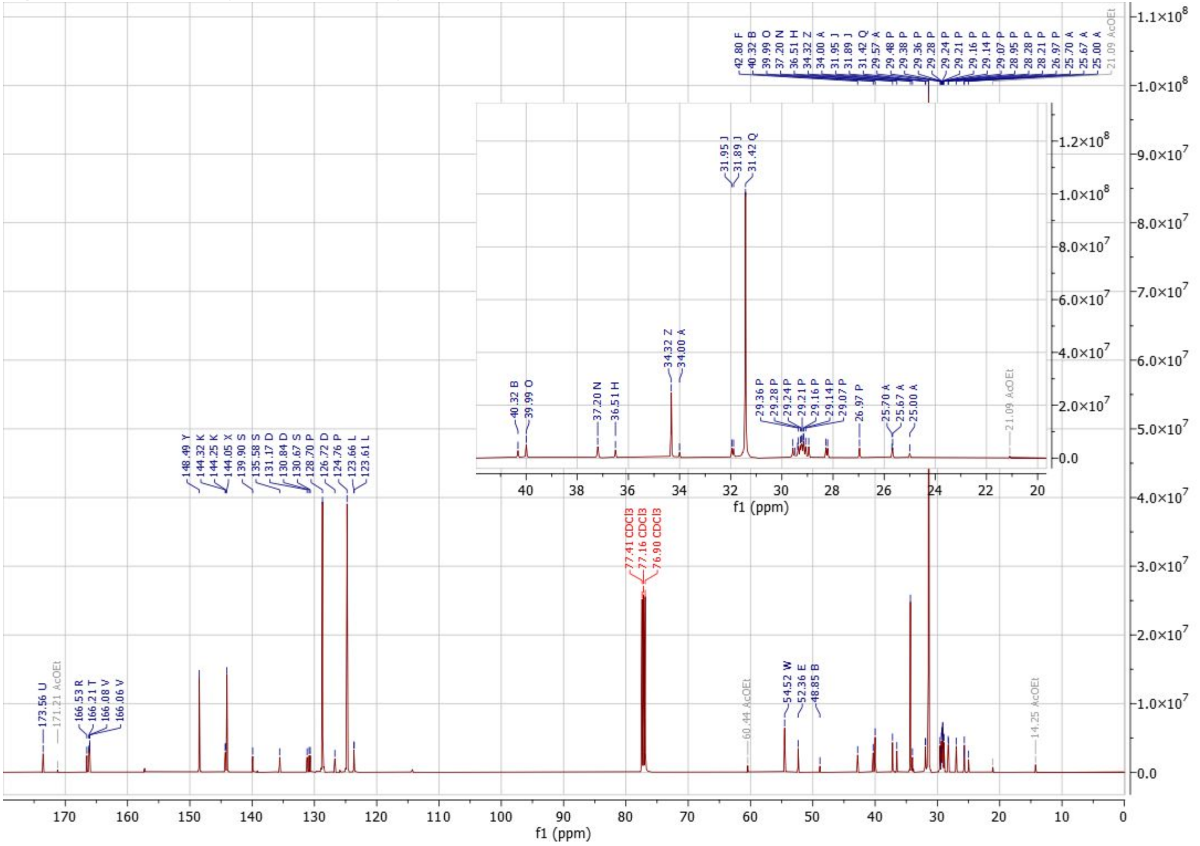


Figure S75. ^{13}C NMR spectrum of compound **32** in CDCl$_3$ at 500MHz.

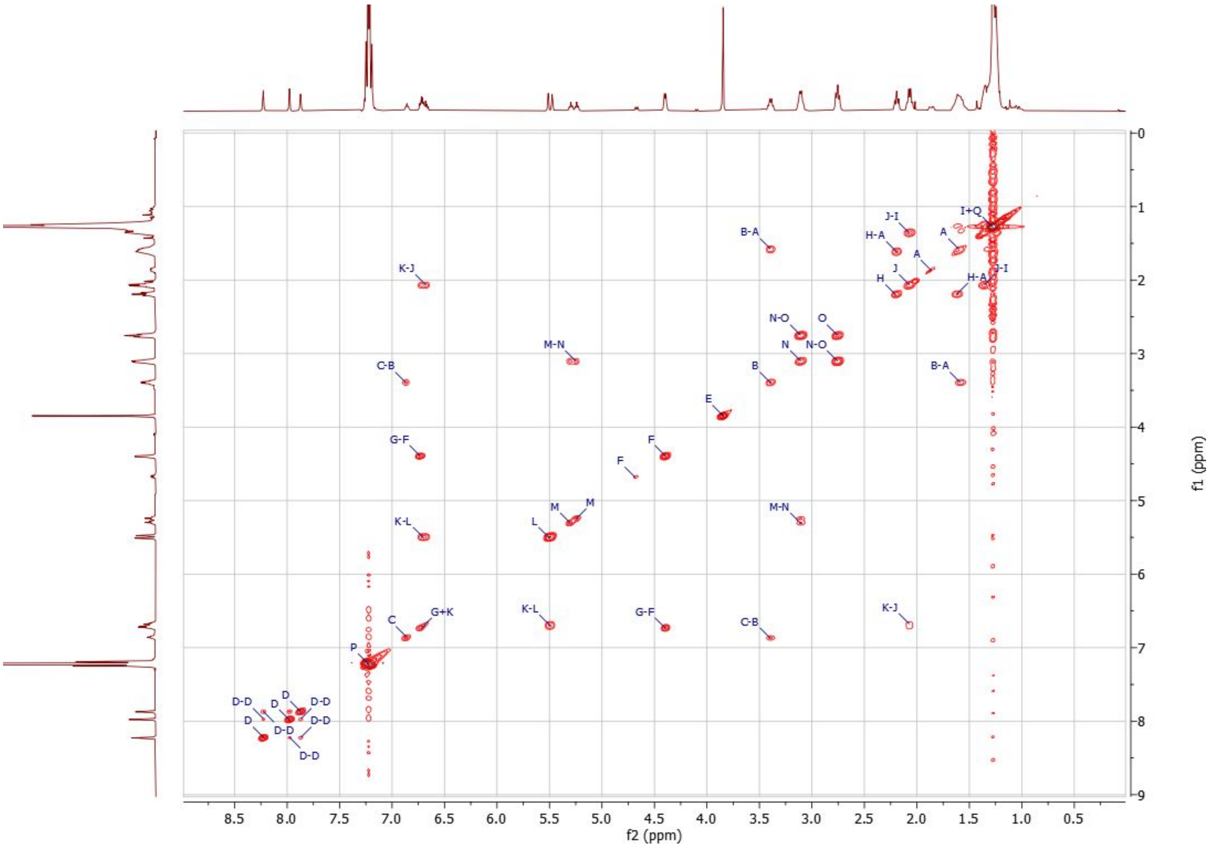


Figure S76. COSY NMR spectrum of compound **32** in $CDCl_3$ at 500MHz.

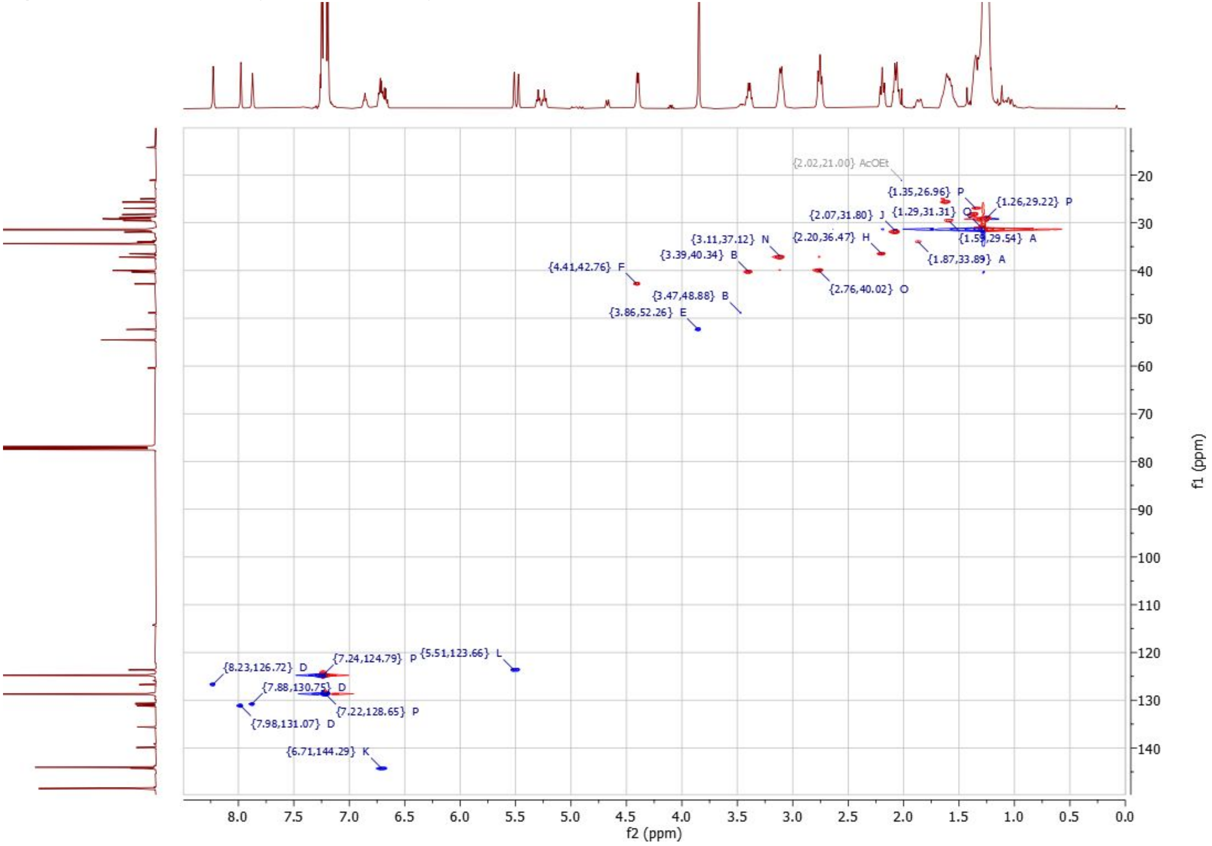


Figure S77. HSQC NMR spectrum of compound **32** in $CDCl_3$ at 500MHz.

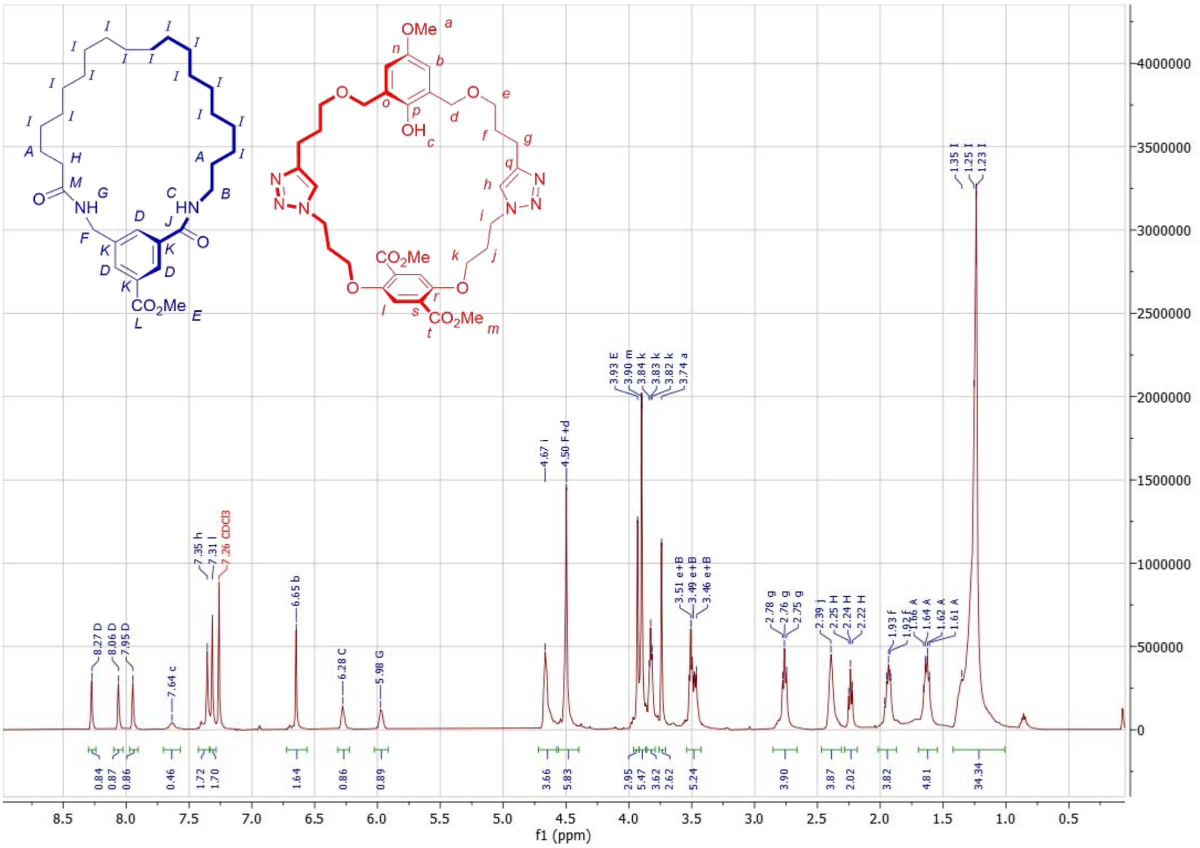


Figure S78. ^{1}H NMR spectrum of an equimolar mixture of macrocycles **26** and **31** in $CDCl_3$ at 500MHz.

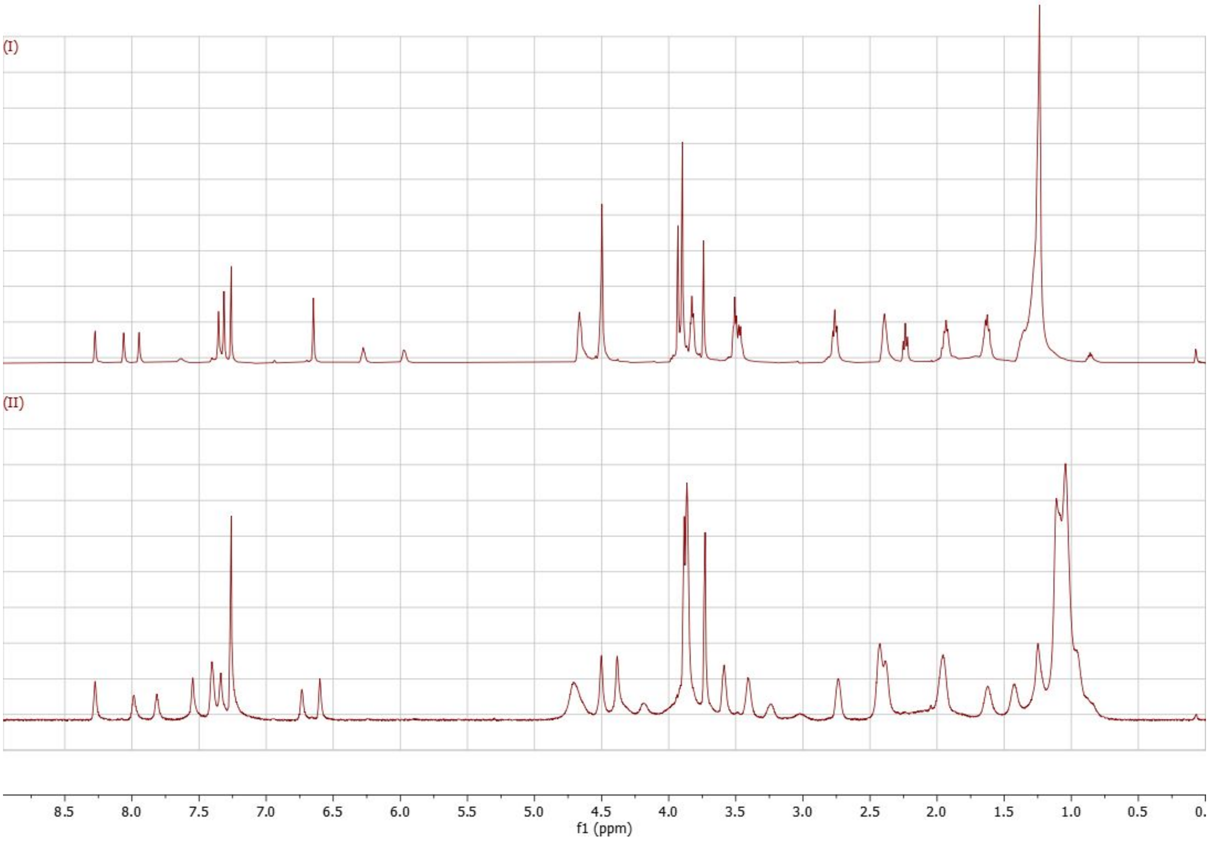


Figure S79. Comparison between ^{1}H NMR spectra of an equimolar mixture of macrocycles **26** and **31** (I) and [2]catenane **2** (II) in $CDCl_3$ at 500MHz.

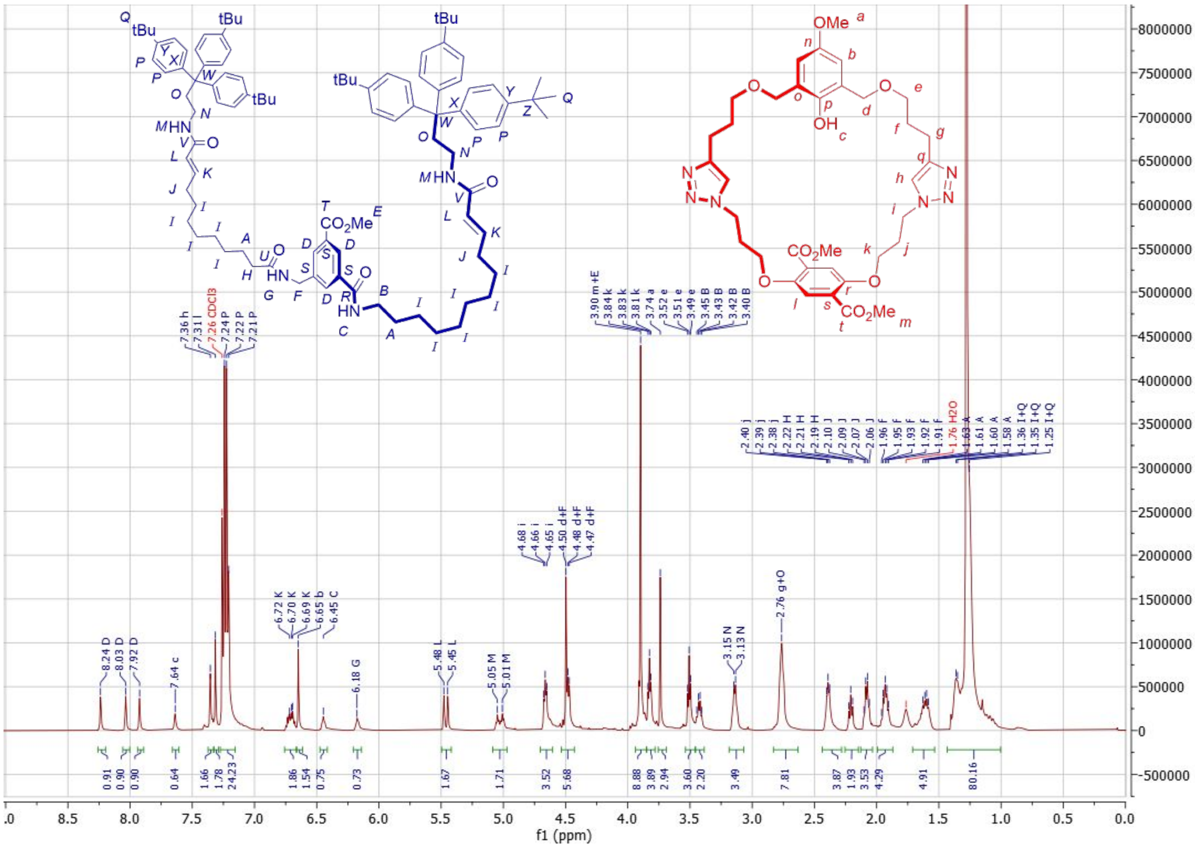


Figure S80. ^{1}H NMR spectrum of an equimolar mixture of macrocycle **26** and thread **32** in $CDCl_3$ at 500MHz.

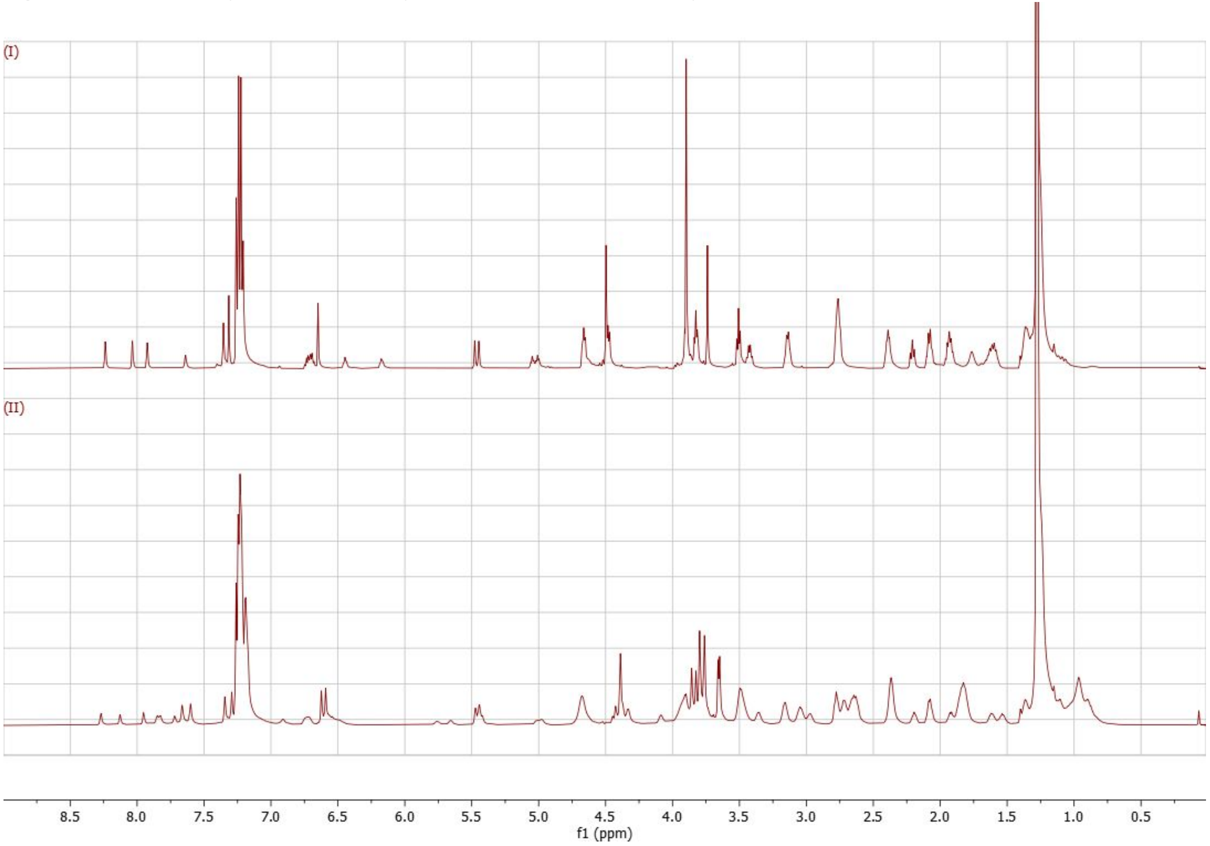


Figure S81. Comparison between ^{1}H NMR spectra of an equimolar mixture of macrocycle **26** and thread **32** (I) and [2]rotaxane **3** (II) in $CDCl_3$ at 500MHz.

Mass Spectra

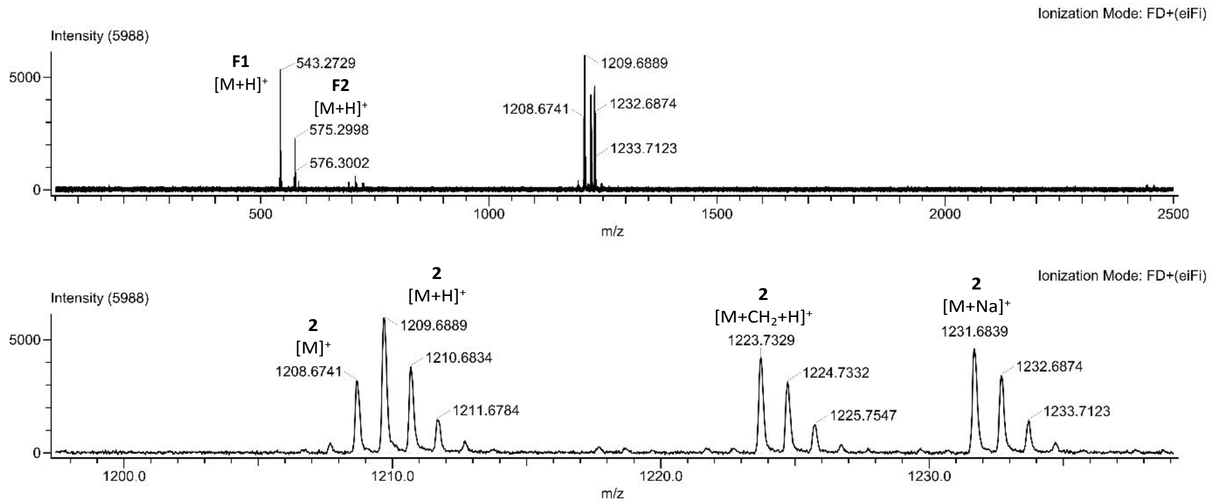


Figure S82. Mass spectrum (FD$^+$) of [2]catenane **2**. The ions labelled by **F1** and **F2** (Figure S82) most likely arise by ionization of species formed by thermal decomposition of the parent compound **2** during the FD process.

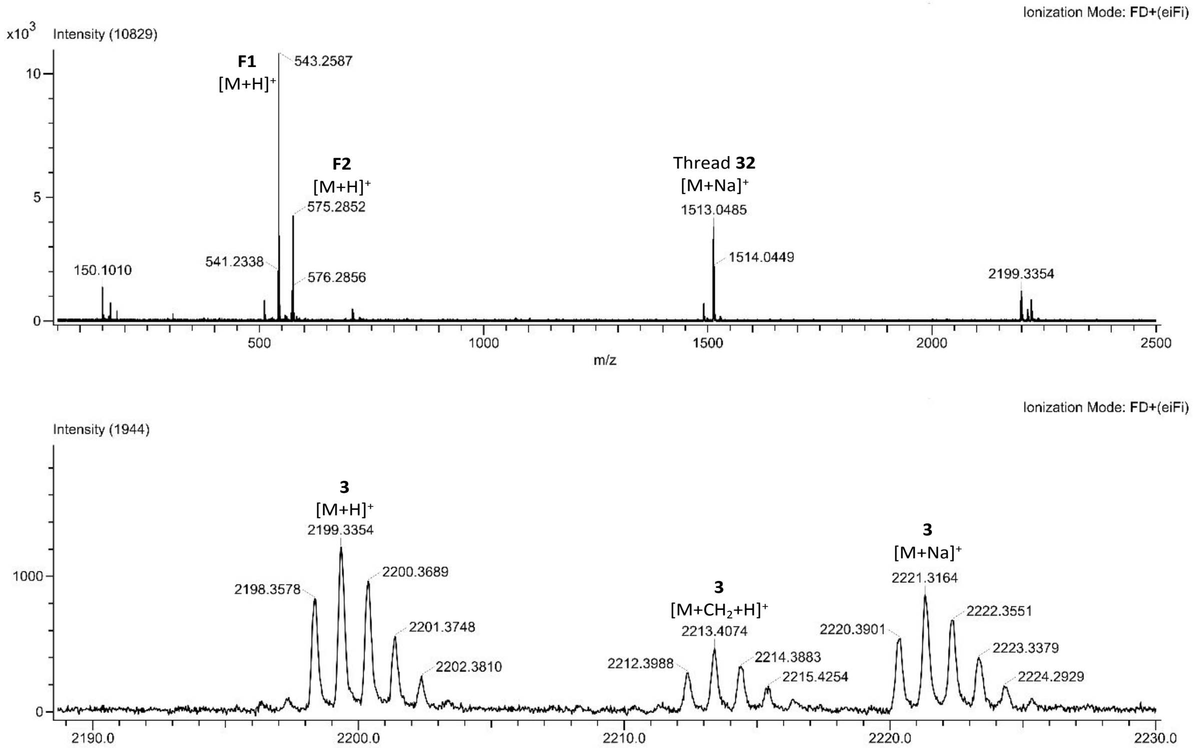
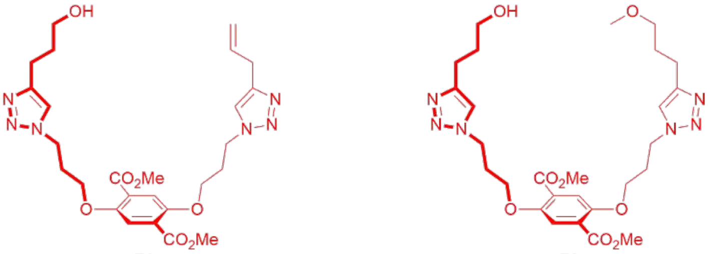


Figure S83. Mass spectrum (FD$^+$) of [2]rotaxane **3**. The ions labelled by **F1** and **F2** most likely arise by ionization of species formed by decomposition of the parent compound **3** during the FD process. The methylene adduct could indicate a byproduct formed during the cross metathesis reaction.



F1 **F2**

Figure S84. Proposed structures of macrocycle decomposition products **F1** and **F2**.

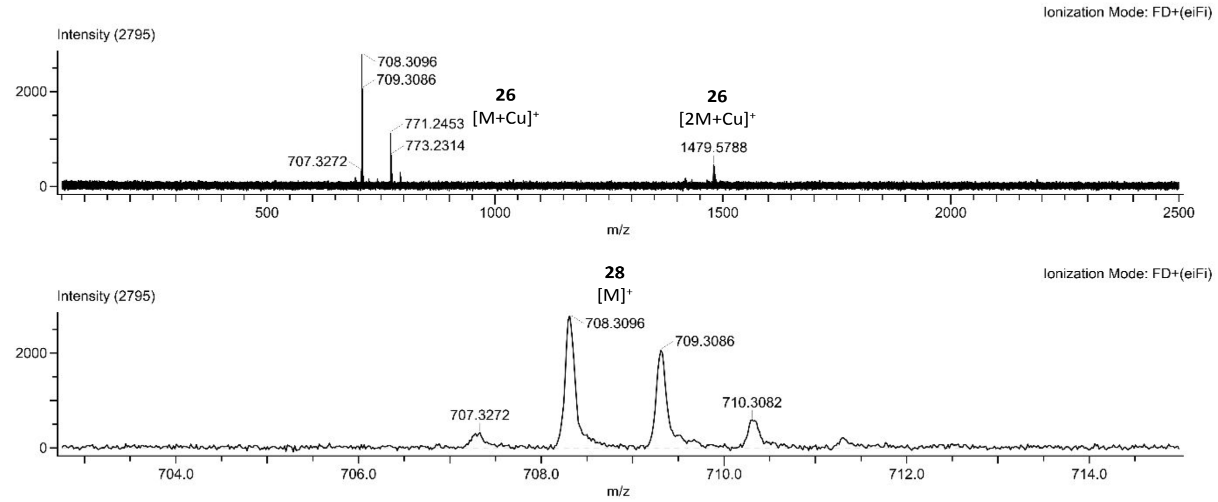


Figure S85. Mass spectrum (FD$^+$) of macrocycle **26**.

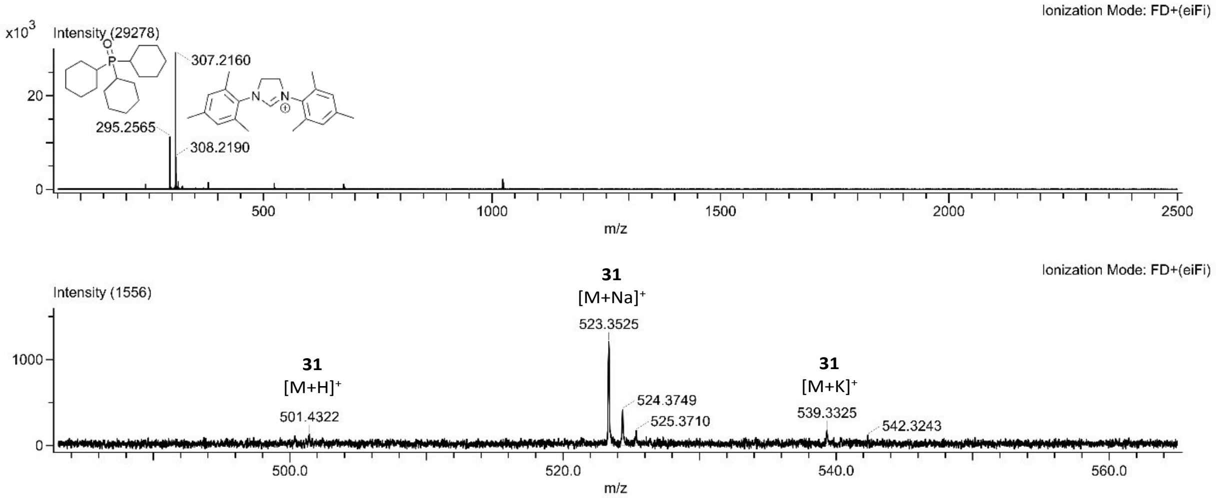


Figure S86. Mass spectrum (FD$^+$) of macrocycle **31**. The prominent impurities are due to traces of Grubbs 2nd generation catalyst, used in the synthesis of this compound.

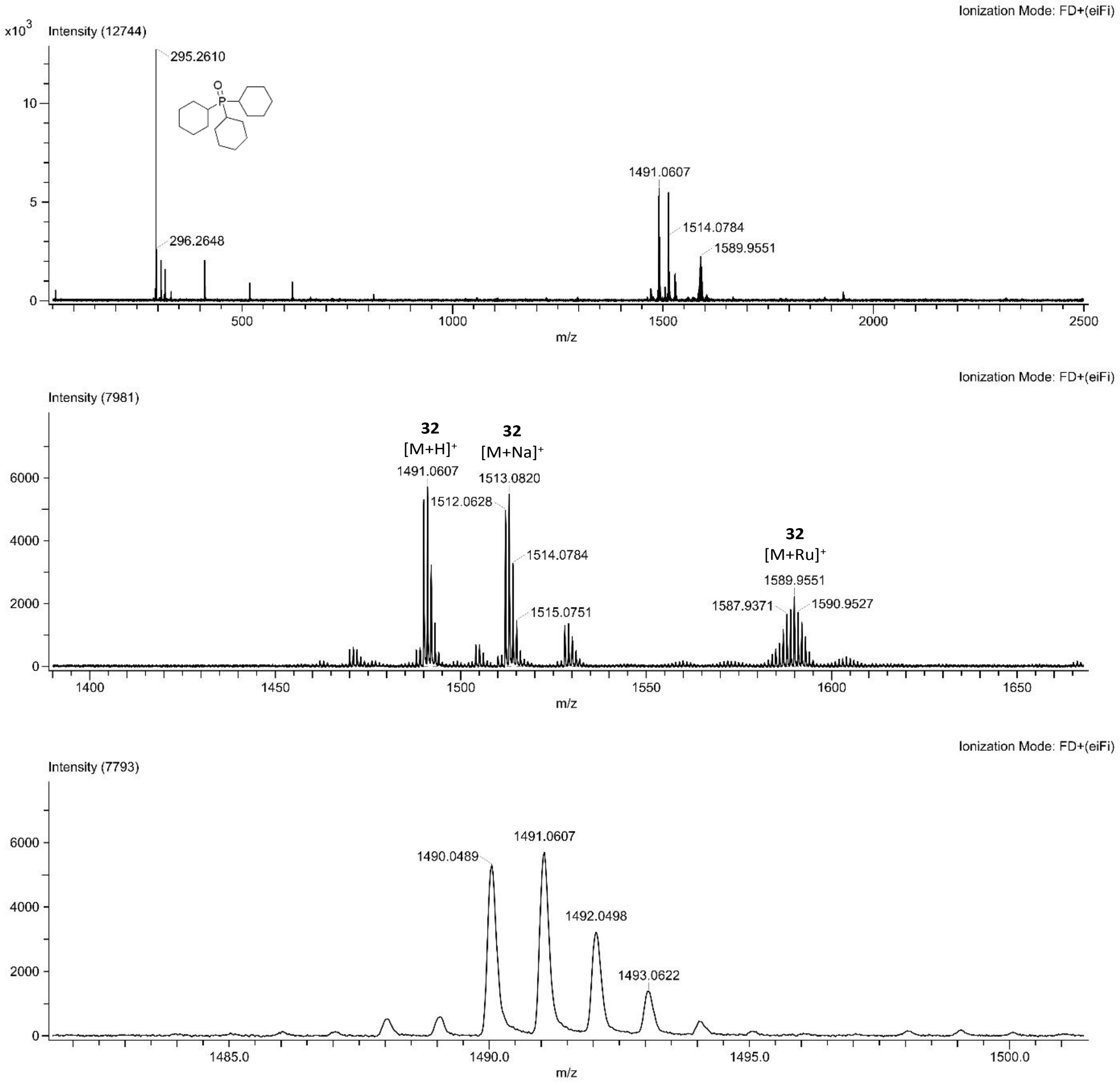


Figure S87. Mass spectrum (FD$^+$) of thread **32**.

DFT Calculations

DFT geometry optimizations were performed at the PM6/6-31G* level of theory using the Gaussian 09 (revision D01) program suite.[8,9]

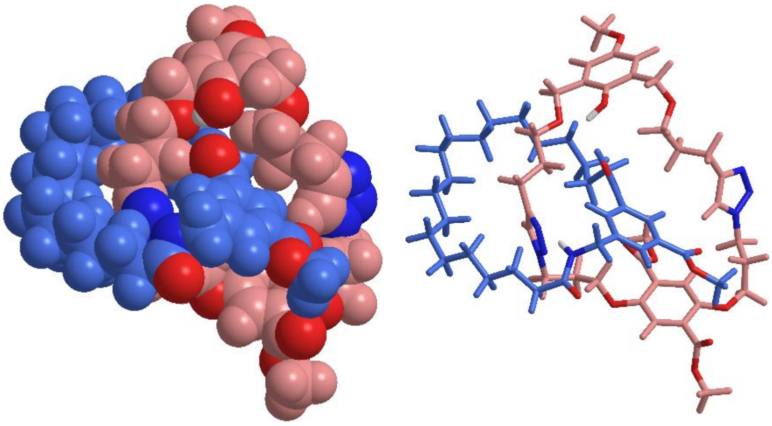


Figure S88. Front view of space filling (left) and tube (right) representations of the calculated structure of [2]catenane **2**. C and H atoms have been colored light blue or light red based on the parent fragment.

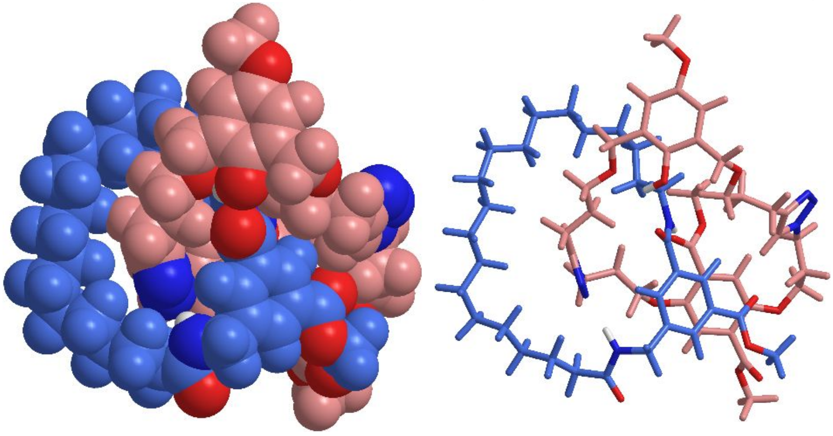


Figure S89. Top view of space filling (left) and tube (right) representations of the calculated structure of [2]catenane **2**. C and H atoms have been colored light blue or light red based on the parent fragment.

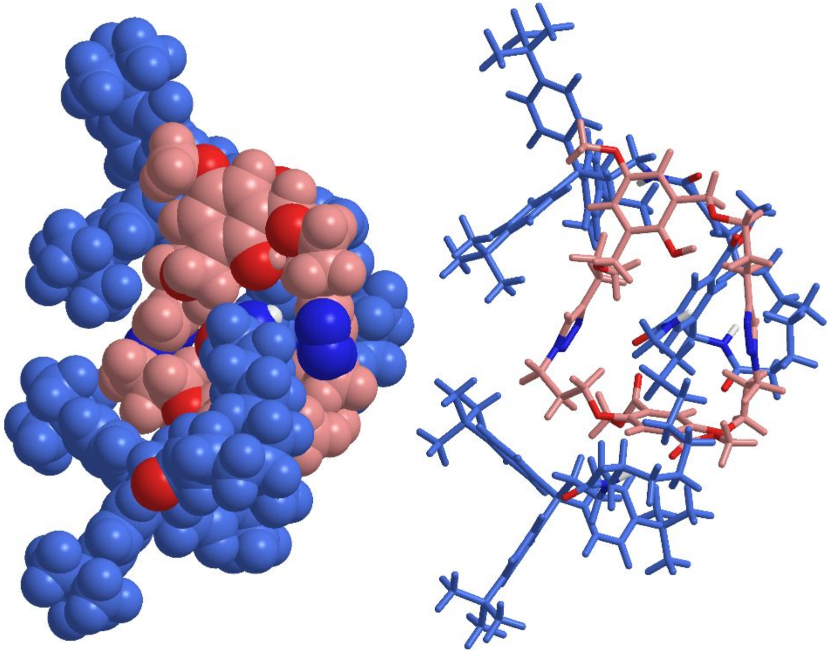


Figure S90. Front view of space filling (left) and tube (right) representations of the calculated structure of [2]rotaxane **3**. C and H atoms have been colored light blue or light red based on the parent fragment.

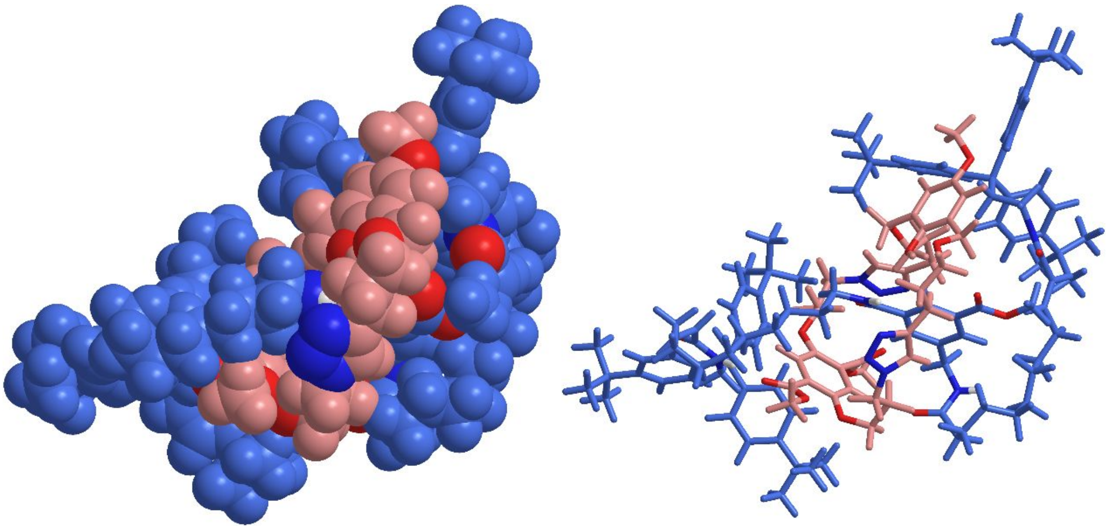


Figure S91. Side view of space filling (left) and tube (right) representations of the calculated structure of [2]rotaxane **3**. C and H atoms have been colored light blue or light red based on the parent fragment.

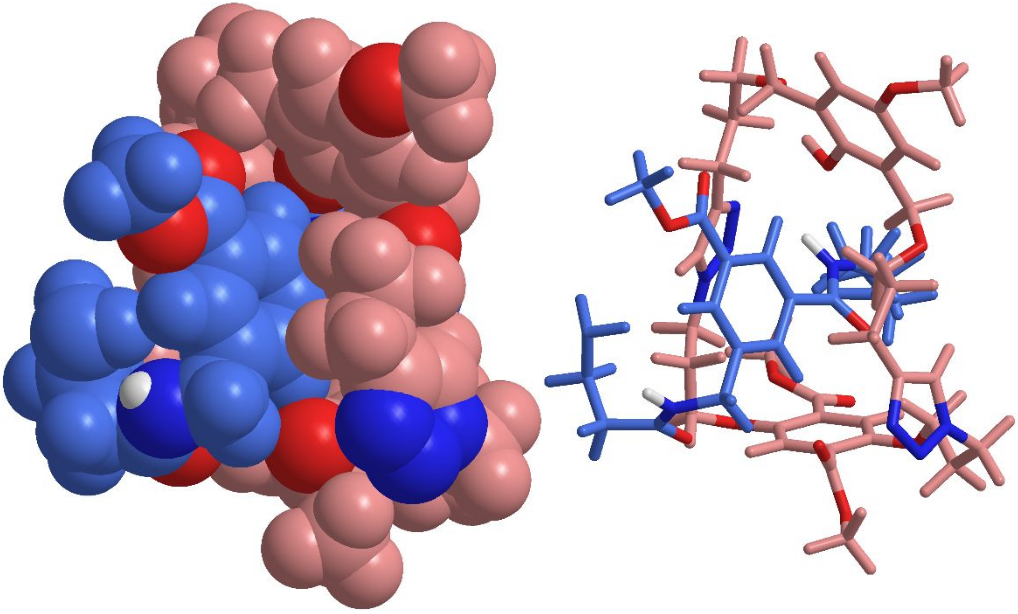


Figure S92. Front view of space filling (left) and tube (right) representations of the calculated structure of [2]rotaxane **3**. C and H atoms have been colored light blue or light red based on the parent fragment. The stoppers and part of the thread have been omitted for clarity.

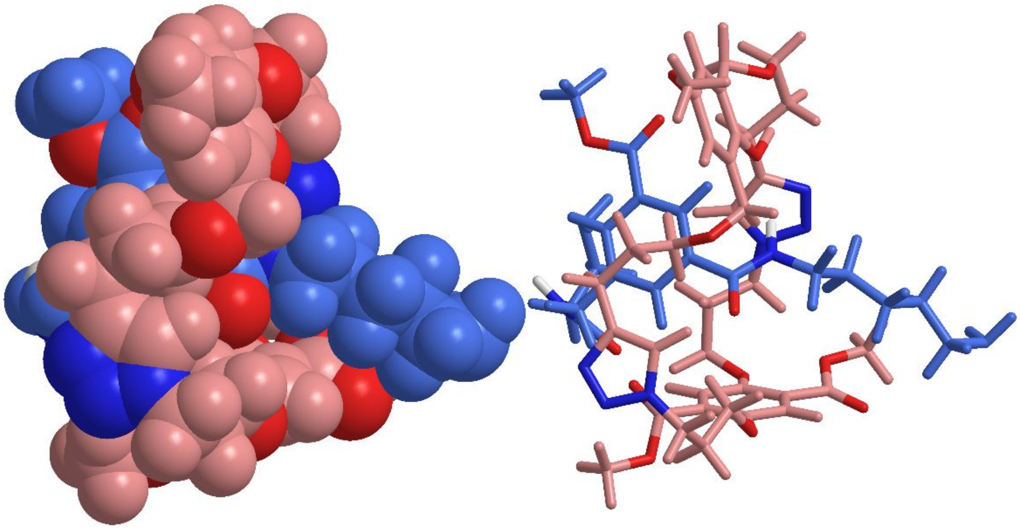


Figure S93. Side view of space filling (left) and tube (right) representations of the calculated structure of [2]rotaxane **3**. C and H atoms have been colored light blue or light red based on the parent fragment. The stoppers and part of the thread have been omitted for clarity.

XYZ-coordinates of calculated structure of [2]catenane 2

C	0.607275	-1.214569	2.52845
C	1.686104	-1.942203	3.05235
C	2.995408	-1.491741	2.83918
C	3.217021	-0.309339	2.11831
C	2.140365	0.421098	1.59340
C	0.838137	-0.044069	1.79247
C	1.433665	-3.193447	3.86132
C	-0.349525	0.719729	1.28304
O	-1.336107	0.940867	1.97554
N	-0.254564	1.171767	-0.02350
N	0.751419	-4.223341	3.05042
C	1.329665	-5.474508	2.83007
C	-1.350530	1.942910	-0.66408
C	-1.768486	1.279194	-1.98587
C	0.566435	-6.398022	1.89994
O	2.387938	-5.778905	3.36079
C	-2.538529	2.250743	-2.88841
C	-3.977013	2.506701	-2.41873
C	-4.954048	1.431595	-2.91205
C	-6.393904	1.747967	-2.48633
C	-7.367518	0.597170	-2.76913
C	-7.070162	-0.647671	-1.92215
C	-8.169512	-1.706364	-2.06559
C	-0.915088	-6.544025	2.26176
C	-1.687245	-7.327304	1.18930
C	-3.186691	-7.010581	1.26660
C	-3.985373	-7.697729	0.15100
C	-5.392333	-7.098226	0.00692
C	-5.359752	-5.711683	-0.65243
C	-6.718706	-5.005998	-0.56251
C	-6.708633	-3.671538	-1.31991
C	-8.004244	-2.882310	-1.09352
C	4.586067	0.214005	1.89119
O	4.908633	1.105598	1.12620
O	5.492184	-0.429979	2.68176
C	6.892480	-0.046833	2.54915

H	-0.423314	-1.548874	2.69448
H	3.850328	-2.051527	3.23508
H	2.330593	1.349934	1.04749
H	0.801397	-2.948178	4.74889
H	2.387928	-3.620192	4.26690
H	0.516200	0.888451	-0.63500
H	-0.089532	-3.932955	2.54865
H	-0.995070	2.984943	-0.83251
H	-2.225441	2.016551	0.03372
H	-0.875276	0.900887	-2.52378
H	-2.394711	0.385425	-1.76079
H	1.670157	-6.015771	0.86119
H	1.064967	-7.390497	1.91111
H	-2.544292	1.861195	-3.92488
H	-1.997911	3.217222	-2.94202
H	-4.008808	2.557605	-1.30672
H	-4.305542	3.503409	-2.76950
H	-4.902163	1.341323	-4.01335
H	-4.649633	0.444845	-2.51206
H	-6.416779	2.002518	-1.40014
H	-6.742853	2.658875	-3.01024
H	-7.337919	0.333536	-3.84407
H	-8.401786	0.944482	-2.57648
H	-6.947020	-0.359723	-0.85367
H	-6.094170	-1.075937	-2.22437
H	-9.161563	-1.241550	-1.89685
H	-8.191362	-2.081375	-3.10751
H	-1.016883	-7.040681	3.24565
H	-1.375931	-5.539640	2.37976
H	-1.306877	-7.067253	0.18227
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H	-3.587735	-7.308298	2.25384
H	-3.331714	-5.910807	1.20358
H	-3.444879	-7.619338	-0.81160
H	-4.063376	-8.781648	0.36090
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H	-5.875556	-7.036243	1.00130
H	-4.579863	-5.087799	-0.16863
H	-5.050796	-5.810978	-1.71010
H	-6.983463	-4.838743	0.49946
H	-7.513160	-5.661501	-0.96887
H	-6.559486	-3.855263	-2.40082
H	-5.836000	-3.058185	-0.99245
H	-8.876445	-3.558166	-1.20318
H	-8.042572	-2.517505	-0.04913
H	7.316171	-0.357721	3.50966
H	7.321615	-0.621505	1.71303
H	6.989817	1.029275	2.38405
C	-0.351959	4.185060	2.40463
C	0.743945	4.391275	1.36137
C	-3.853232	4.062943	2.01047
C	-3.302298	5.353248	2.25366
C	-3.816573	6.437926	1.56297
C	-4.879311	6.239797	0.64816
C	-5.442466	4.986616	0.42855
C	-4.931169	3.879240	1.13375
O	-3.281879	3.043666	2.72346
C	-5.585919	2.539475	0.97184

C	-2.189053	5.529333	3.25778
O	-4.499581	1.587442	0.81794
C	-4.927523	0.198787	0.89331
C	-3.672947	-0.554524	0.46697
C	-3.871218	-2.072766	0.44847
C	6.368069	0.103212	-1.60688
C	4.193932	-1.612247	-1.98997
C	4.046762	-0.238511	-2.23930
C	5.148759	0.614147	-2.06178
C	6.510909	-1.285491	-1.34558
C	5.429402	-2.133109	-1.54469
O	-0.905690	5.514300	2.61202
C	2.041197	4.939851	1.97637
C	3.127270	4.989046	0.96829
C	3.874876	3.943673	0.40682
N	4.727390	4.568641	-0.51247
N	4.505168	5.921872	-0.49464
N	3.570213	6.186020	0.36701
C	5.678175	3.928578	-1.43937
C	6.708786	3.064885	-0.70124
C	7.554423	2.251664	-1.67288
O	7.508918	0.824553	-1.37862
C	-2.657785	-2.725029	-0.10024
C	-2.216204	-2.802346	-1.43252
N	-0.997777	-3.487879	-1.36647
N	-0.719975	-3.796104	-0.06711
N	-1.686439	-3.359703	0.69494
C	-0.068268	-3.778291	-2.47921
C	0.922980	-2.629484	-2.68893
C	1.969746	-2.530620	-1.57952
O	3.256887	-2.579304	-2.27942
O	-5.265085	7.419503	0.03789
C	-6.351845	7.358762	-0.91330
C	2.775651	0.385312	-2.68501
O	1.652755	0.256938	-2.23808
O	3.029268	1.244925	-3.72369
C	1.895483	1.992128	-4.24859
C	7.800537	-1.840349	-0.84497
O	8.279522	-1.767159	0.26174
O	8.405689	-2.533273	-1.86458
C	9.683324	-3.158121	-1.55668
H	0.028849	3.827700	3.37596
H	-1.143512	3.494114	2.05216
H	0.938663	3.439649	0.83369
H	0.374704	5.108783	0.59548
H	-3.412691	7.442239	1.69692
H	-6.262932	4.848580	-0.26689
H	-3.400469	2.141246	2.26287
H	-6.217433	2.472261	0.05513
H	-6.186233	2.278916	1.86382
H	-2.204522	6.538332	3.71525
H	-2.238907	4.759369	4.05195
H	-5.230857	-0.019531	1.93094
H	-5.783191	0.037178	0.20343
H	-3.341586	-0.184415	-0.53293
H	-2.839045	-0.284872	1.16098
H	-4.080826	-2.445893	1.47567
H	-4.766591	-2.356474	-0.16497

H	5.032673	1.682014	-2.28173
H	5.512208	-3.210669	-1.37151
H	1.843974	5.958400	2.38727
H	2.356194	4.323270	2.84337
H	3.878994	2.884560	0.61023
H	6.187027	4.726535	-2.03445
H	5.094778	3.297192	-2.16280
H	7.348772	3.701609	-0.05672
H	6.204461	2.373048	0.02457
H	7.297548	2.399990	-2.73505
H	8.642809	2.419561	-1.52855
H	-2.665019	-2.443582	-2.33689
H	0.474871	-4.730603	-2.25660
H	-0.662169	-3.955252	-3.40558
H	0.393571	-1.657309	-2.79192
H	1.452454	-2.780571	-3.65908
H	1.874105	-1.612509	-0.97610
H	2.000129	-3.414657	-0.91523
H	-6.083754	6.719882	-1.75913
H	-7.270399	7.025240	-0.42266
H	-6.433616	8.408383	-1.22579
H	2.367952	2.633244	-5.00218
H	1.177680	1.298625	-4.69574
H	1.431217	2.576524	-3.44718
H	9.903917	-3.706879	-2.47877
H	10.426126	-2.380409	-1.35453
H	9.574347	-3.826366	-0.69641

XYZ-coordinates of calculated structure of [2]rotaxane 3

C	2.784577	-6.791147	-4.84476
C	3.372452	-5.563109	-5.55303
C	2.823995	-3.597213	-0.61402
C	0.602196	-2.031357	-1.22077
C	1.446141	-2.461580	-2.25367
C	2.564013	-3.243094	-1.94631
C	1.984494	-3.158320	0.42218
C	0.862316	-2.386236	0.11046
C	-0.109239	-1.865575	1.13255
C	1.120050	-2.078829	-3.67876
C	-0.170594	-4.035917	-4.55468
C	-0.073247	-5.376067	-5.26073
C	0.287698	-6.488341	-4.26903
C	1.738448	-6.462621	-3.76978
C	4.438707	-4.839878	-4.71991
O	-1.210981	-3.629938	-4.05153
N	0.996373	-3.275747	-4.54142
C	4.844209	-3.503778	-5.35884
C	6.247717	-3.040387	-4.94696
N	-0.340307	-2.652349	2.24400
O	-0.698749	-0.799144	0.96631
C	-1.353211	-2.260613	3.25923
C	-2.311147	-3.428565	3.53271
C	-3.559189	-2.947910	4.28065
C	-4.453624	-4.122934	4.70480
C	-5.903729	-3.663498	4.88552
C	-6.825177	-4.779542	5.39320
C	-8.310259	-4.402651	5.27204
C	-8.842650	-3.532307	6.41929

C	-8.271620	-2.107234	6.43700
C	-8.616025	-1.328974	5.20340
C	-7.707942	-0.653564	4.49467
C	-8.064280	0.174300	3.30781
N	-7.609734	-0.330082	2.09427
O	-8.676515	1.233178	3.37811
C	-7.848375	0.391770	0.81983
C	-6.998747	1.672442	0.73706
C	-6.418021	3.768481	-0.53825
C	-6.032515	4.296066	-1.78044
C	-5.167016	5.388261	-1.85539
C	-4.659837	5.993185	-0.69404
C	-5.062381	5.478230	0.54611
C	-5.928246	4.384563	0.62310
C	-7.410380	1.727426	-1.68763
C	-6.182891	1.287003	-2.21386
C	-6.144542	0.443892	-3.32073
C	-7.328827	0.000670	-3.93682
C	-8.549118	0.420873	-3.39636
C	-8.590542	1.270737	-2.28457
C	-7.416917	2.606099	-0.43503
C	-8.767190	3.294345	-0.21297
C	-9.314014	4.073051	-1.24762
C	-10.527049	4.742368	-1.08047
C	-11.233666	4.656270	0.12799
C	-10.673703	3.896814	1.16673
C	-9.459370	3.226999	1.00218
C	6.387847	-2.722173	-3.49082
C	7.383739	-1.968482	-3.01515
C	7.569471	-1.733171	-1.55527
N	7.760113	-0.404220	-1.20685
O	7.596655	-2.629165	-0.71635
C	8.037805	0.006762	0.19167
C	7.049073	1.056917	0.71648
C	6.325166	3.465559	0.95635
C	5.965770	4.629391	0.26293
C	4.931507	5.448874	0.72440
C	4.239234	5.143003	1.90322
C	4.632369	4.001234	2.62178
C	5.664657	3.184953	2.16193
C	8.681544	2.977995	1.24325
C	9.227738	4.253978	1.00467
C	10.336162	4.700801	1.71788
C	10.941617	3.892246	2.69850
C	10.381870	2.635809	2.95077
C	9.264761	2.185403	2.23607
C	7.444199	2.540858	0.45453
C	7.644220	2.663056	-1.05716
C	6.528716	2.638429	-1.91474
C	6.689948	2.673820	-3.29792
C	7.969750	2.731373	-3.87710
C	9.078905	2.737761	-3.02269
C	8.920105	2.703722	-1.63326
C	3.991419	-4.442731	-0.26803
O	4.230282	-4.975322	0.79672
O	4.805989	-4.621632	-1.35989
C	6.077837	-5.299795	-1.12886
C	-3.752848	7.220646	-0.80248

C	-2.765924	7.060822	-1.97682
C	-2.931619	7.441946	0.48357
C	-4.656440	8.445833	-1.04556
C	-7.239029	-0.945820	-5.13538
C	-6.752931	-2.317215	-4.62257
C	-6.235178	-0.382186	-6.16326
C	-8.596971	-1.127097	-5.84103
C	-12.554615	5.394782	0.35350
C	-13.199217	5.847462	-0.97171
C	-12.257549	6.634664	1.22158
C	-13.555876	4.472776	1.07980
C	3.052697	5.974894	2.39532
C	1.769051	5.184994	2.06681
C	2.988653	7.354454	1.71267
C	3.160181	6.198243	3.91753
C	12.151668	4.423995	3.47018
C	13.175098	5.019746	2.48158
C	12.856628	3.319326	4.28054
C	11.654147	5.517534	4.43700
C	8.119370	2.731532	-5.40019
C	7.039293	3.623594	-6.04305
C	7.952443	1.275004	-5.88274
C	9.498202	3.259665	-5.83997
H	2.342335	-7.469139	-5.60180
H	3.607375	-7.373802	-4.38252
H	2.558788	-4.859998	-5.83061
H	3.819502	-5.882693	-6.51670
H	-0.267945	-1.390642	-1.44794
H	3.246707	-3.589878	-2.73642
H	2.229858	-3.419366	1.46776
H	0.159073	-1.492444	-3.71853
H	1.903457	-1.405493	-4.09500
H	-1.058532	-5.594217	-5.72723
H	0.649752	-5.356387	-6.10096
H	-0.398690	-6.427282	-3.38758
H	0.076217	-7.468247	-4.74366
H	1.965038	-5.487625	-3.29743
H	1.833022	-7.203322	-2.94782
H	4.078000	-4.666632	-3.67872
H	5.324615	-5.495022	-4.60632
H	1.874443	-3.686682	-4.87879
H	4.819124	-3.590334	-6.46469
H	4.104814	-2.719461	-5.10590
H	6.993460	-3.825338	-5.20839
H	6.532249	-2.160662	-5.56431
H	0.170874	-3.514462	2.42085
H	-0.829115	-1.953848	4.19210
H	-1.909763	-1.364744	2.89020
H	-2.613071	-3.911287	2.57998
H	-1.796479	-4.223603	4.11017
H	-3.272335	-2.360452	5.17355
H	-4.129958	-2.252424	3.63194
H	-4.413696	-4.932268	3.93842
H	-4.066255	-4.578350	5.63461
H	-6.289372	-3.273256	3.91644
H	-5.947290	-2.806223	5.59145
H	-6.576994	-5.027741	6.44223
H	-6.642748	-5.706899	4.81652

H	-8.912603	-5.331778	5.22838
H	-8.485492	-3.888993	4.30455
H	-9.948161	-3.487064	6.35264
H	-8.619412	-4.018557	7.38959
H	-8.659063	-1.559806	7.32294
H	-7.166135	-2.160946	6.57764
H	-9.672172	-1.341677	4.92104
H	-6.650017	-0.625473	4.75478
H	-7.131903	-1.235065	2.03639
H	-7.610174	-0.293400	-0.02361
H	-8.931710	0.647542	0.73768
H	-7.076656	2.224051	1.69936
H	-5.925637	1.409374	0.62265
H	-6.416316	3.859615	-2.70388
H	-4.895517	5.780003	-2.83524
H	-4.718756	5.937550	1.47202
H	-6.240250	4.021390	1.60427
H	-5.243492	1.598826	-1.74632
H	-5.172217	0.126072	-3.70581
H	-9.491705	0.088702	-3.82785
H	-9.561830	1.566318	-1.88519
H	-8.784115	4.160277	-2.19593
H	-10.912339	5.339529	-1.90465
H	-11.185646	3.821574	2.12657
H	-9.064267	2.647727	1.85003
H	5.638339	-3.164569	-2.82169
H	8.140362	-1.515162	-3.65522
H	7.689020	0.342073	-1.89697
H	7.995714	-0.901319	0.84543
H	9.083405	0.390926	0.23931
H	6.029282	0.876881	0.29859
H	6.932588	0.892243	1.81336
H	6.487183	4.910640	-0.65293
H	4.667950	6.330788	0.14126
H	4.117999	3.738298	3.54652
H	5.959196	2.313291	2.75807
H	8.773778	4.902836	0.25477
H	10.735855	5.693630	1.51289
H	10.806172	1.981951	3.71154
H	8.855289	1.201937	2.48084
H	5.514046	2.592172	-1.49977
H	5.804461	2.659415	-3.93546
H	10.089292	2.766686	-3.43013
H	9.810908	2.700732	-1.00263
H	6.293288	-5.764199	-2.09330
H	6.813130	-4.511168	-0.87402
H	5.993150	-6.034496	-0.32373
H	-3.281508	7.014266	-2.94202
H	-2.066321	7.901203	-2.02776
H	-2.169495	6.138660	-1.87827
H	-3.576782	7.651848	1.34428
H	-2.256222	8.297620	0.37644
H	-2.321112	6.568692	0.72884
H	-5.240764	8.336622	-1.96559
H	-5.371531	8.579570	-0.22591
H	-4.071315	9.366004	-1.13092
H	-7.443025	-2.726007	-3.87642
H	-6.672868	-3.042597	-5.43661

H	-5.769913	-2.243185	-4.14513
H	-6.524825	0.624387	-6.48257
H	-6.182294	-1.013503	-7.05486
H	-5.223693	-0.316735	-5.74830
H	-9.342545	-1.575527	-5.17612
H	-8.993665	-0.169911	-6.19565
H	-8.504008	-1.784969	-6.71102
H	-13.384865	4.995617	-1.63433
H	-14.160064	6.340713	-0.79352
H	-12.565184	6.560374	-1.50880
H	-11.825427	6.352128	2.18763
H	-13.165423	7.210867	1.42014
H	-11.539430	7.298748	0.72883
H	-14.527820	4.959069	1.20365
H	-13.714367	3.545238	0.51949
H	-13.202335	4.194306	2.07861
H	1.768922	4.200667	2.55008
H	0.876341	5.719724	2.40190
H	1.676586	5.014610	0.98775
H	3.903865	7.929904	1.88774
H	2.152245	7.946311	2.09911
H	2.846111	7.267334	0.63017
H	2.357271	6.847268	4.28122
H	3.091036	5.258141	4.47474
H	4.112884	6.669871	4.18091
H	12.771981	5.885441	1.94629
H	14.079766	5.353459	2.99966
H	13.475949	4.280060	1.73194
H	12.199966	2.891706	5.04504
H	13.737183	3.713592	4.79919
H	13.198474	2.504292	3.63357
H	12.478040	5.936404	5.02280
H	11.177407	6.344841	3.90115
H	10.915401	5.118640	5.14026
H	7.082324	4.644388	-5.64686
H	7.167212	3.685655	-7.12838
H	6.027960	3.244527	-5.85910
H	8.717757	0.623785	-5.44888
H	8.037827	1.207735	-6.97185
H	6.974452	0.870992	-5.60212
H	9.576828	3.296143	-6.93178
H	9.672232	4.275102	-5.46688
H	10.315079	2.625616	-5.48035
C	2.554360	0.384563	1.03247
C	3.409355	1.447040	0.34459
C	3.744373	-2.259906	3.65830
C	3.641469	-0.855687	3.60133
C	4.801927	-0.088368	3.73449
C	6.030011	-0.730552	3.92398
C	6.141323	-2.129057	3.96773
C	4.990100	-2.906273	3.82001
O	2.572568	-2.968853	3.52635
C	5.100713	-4.402866	3.78329
C	2.314735	-0.175725	3.38972
O	3.970672	-4.915658	4.54955
C	3.694586	-6.328861	4.34298
C	2.244524	-6.461415	3.88513
C	2.057263	-6.038734	2.42445

C	-3.705138	-0.358091	-0.50530
C	-3.927913	-3.051380	-1.18859
C	-4.578597	-2.575986	-0.02567
C	-4.461908	-1.225251	0.30596
C	-3.072786	-0.833979	-1.66710
C	-3.176459	-2.189641	-1.99854
O	2.419502	0.863486	2.40112
C	3.040136	1.658308	-1.12579
C	1.758468	2.382280	-1.31074
C	0.757725	2.709810	-0.38445
N	-0.212073	3.391157	-1.12987
N	0.181415	3.455311	-2.43862
N	1.340943	2.874769	-2.56481
C	-1.503146	3.914231	-0.63894
C	-2.635878	2.904700	-0.81998
C	-2.471310	1.662885	0.04801
O	-3.744611	0.950320	-0.08046
C	0.651418	-6.136974	1.96481
C	0.144235	-6.043477	0.65463
N	-1.238333	-6.198174	0.79325
N	-1.543298	-6.374714	2.11300
N	-0.446686	-6.342202	2.81798
C	-2.291731	-6.198626	-0.24444
C	-1.918447	-5.376548	-1.47977
C	-3.170992	-5.073199	-2.30191
O	-4.146483	-4.378231	-1.47288
O	7.243364	-0.054874	4.01050
C	7.219930	1.183717	4.76392
C	-5.371166	-3.428633	0.88992
O	-6.232441	-3.058252	1.66430
O	-5.003860	-4.747207	0.80352
C	-5.643093	-5.660168	1.74135
C	-2.263326	0.009337	-2.59185
O	-1.061332	-0.013095	-2.74687
O	-3.073710	0.823944	-3.33648
C	-2.419431	1.646708	-4.34882
H	3.026807	-0.610163	1.01132
H	1.525982	0.316166	0.62784
H	3.318685	2.404052	0.90944
H	4.488204	1.174122	0.42369
H	4.728179	0.998105	3.66776
H	7.121759	-2.582433	4.10580
H	2.687685	-3.918317	3.92410
H	6.018277	-4.776914	4.27092
H	5.044562	-4.773751	2.73527
H	1.516289	-0.889726	3.11394
H	2.003796	0.393424	4.28859
H	4.407198	-6.775968	3.63189
H	3.846697	-6.770051	5.34662
H	1.899495	-7.506753	4.02613
H	1.583566	-5.856889	4.54472
H	2.426637	-4.986317	2.28815
H	2.715720	-6.643932	1.76079
H	-4.951812	-0.819937	1.19868
H	-2.666769	-2.577610	-2.89391
H	3.864043	2.227919	-1.62693
H	2.988660	0.682955	-1.65864
H	0.691241	2.506895	0.67019

H	-1.751407	4.858818	-1.20841
H	-1.390543	4.203582	0.43083
H	-3.609311	3.396547	-0.57544
H	-2.740416	2.613803	-1.88728
H	-1.613567	1.019331	-0.22236
H	-2.421317	1.890773	1.12875
H	0.651893	-5.884899	-0.27514
H	-2.520995	-7.253879	-0.51932
H	-3.235923	-5.769970	0.21120
H	-1.174617	-5.904913	-2.12248
H	-1.430900	-4.419791	-1.18670
H	-2.936102	-4.480807	-3.21165
H	-3.748651	-5.976204	-2.57305
H	6.741188	1.970509	4.16182
H	6.718367	1.046903	5.72466
H	8.287976	1.394542	4.90155
H	-6.698815	-5.403252	1.88021
H	-5.515435	-6.634276	1.26217
H	-5.092815	-5.589171	2.69811
H	-1.489582	2.083827	-3.95641
H	-2.216033	1.019339	-5.22015
H	-3.175519	2.410945	-4.55770

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