Supporting Information

Design, synthesis and cytotoxic activity of water-soluble quinones with dibromo-p-benzoquinone cores and amino oligo(ethylene glycol) side chains against MCF-7 breast cancer cells

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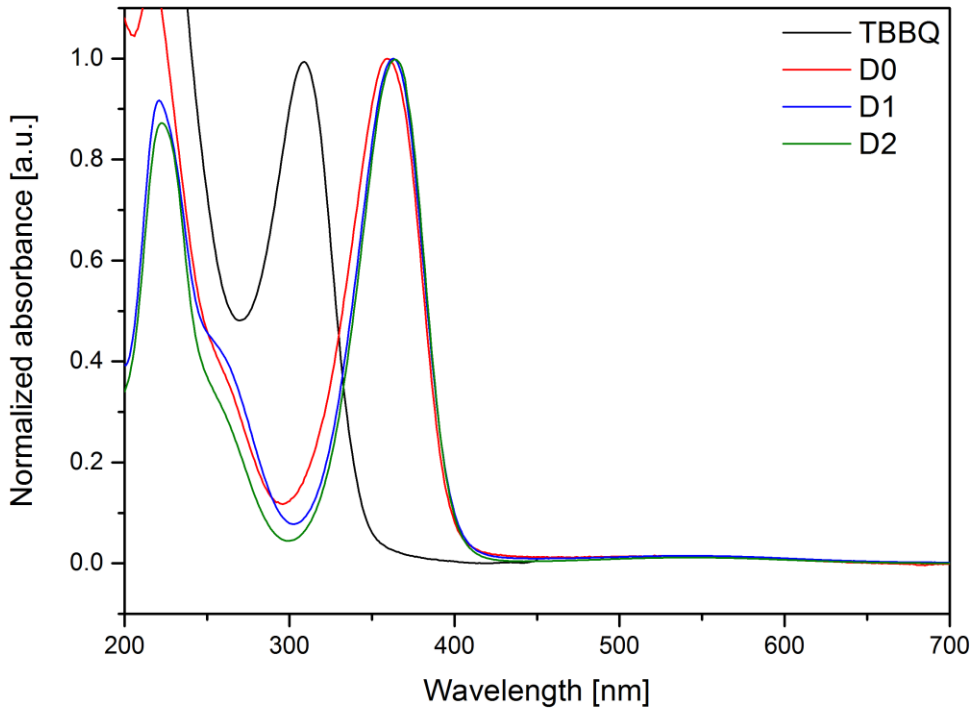


Figure S1: UV/Vis spectra of bromanil, **D0**, **D1** and **D2** in water recorded at 25 °C (normalized to the absorbance of the quinone core).

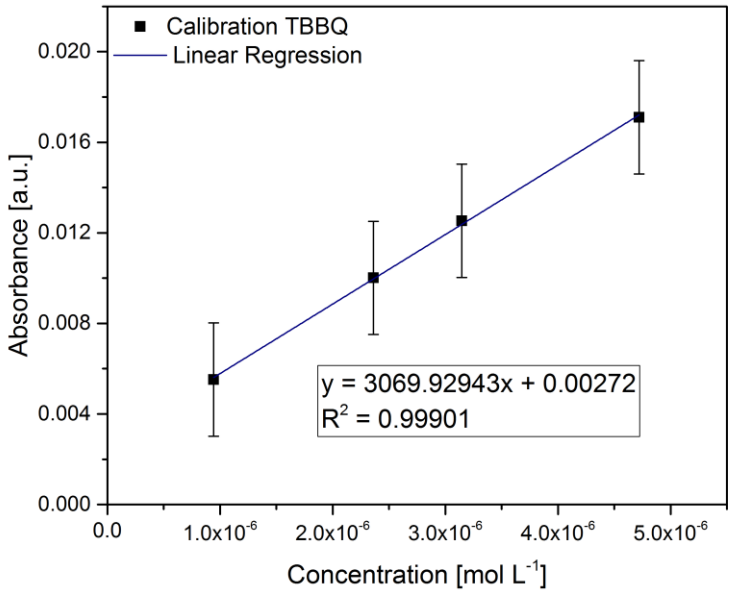


Figure S2: Linear regression of bromanil (TBBQ) in water. Error bars refer to the standard deviation obtained from three individually prepared stock solutions and the dilution series.

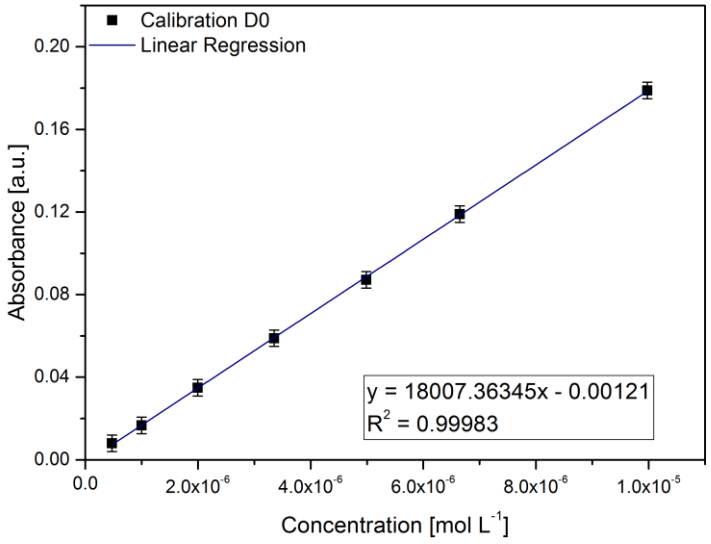


Figure S3: Linear regression of compound **D0** in water. Error bars refer to the standard deviation obtained from three individually prepared stock solutions and the dilution series.

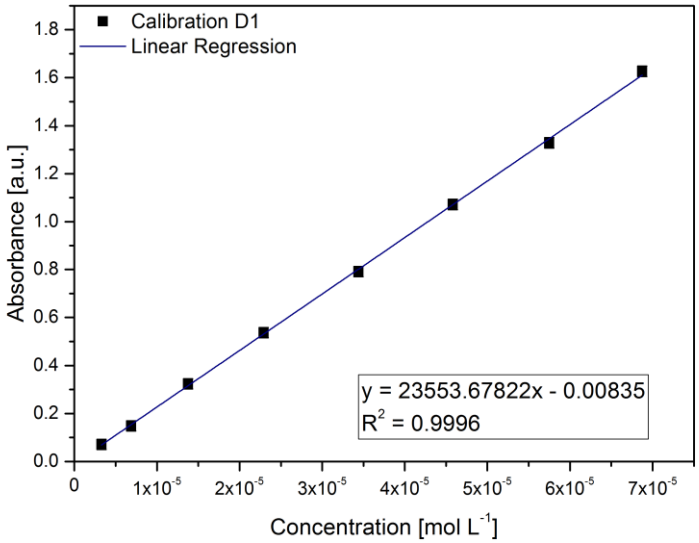


Figure S4: Linear regression of compound **D1** in water. Error bars refer to the standard deviation obtained from three individually prepared stock solutions and the dilution series.

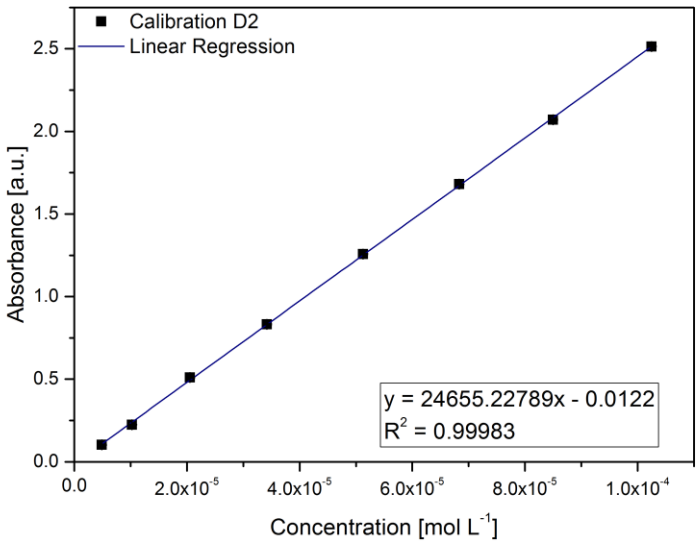
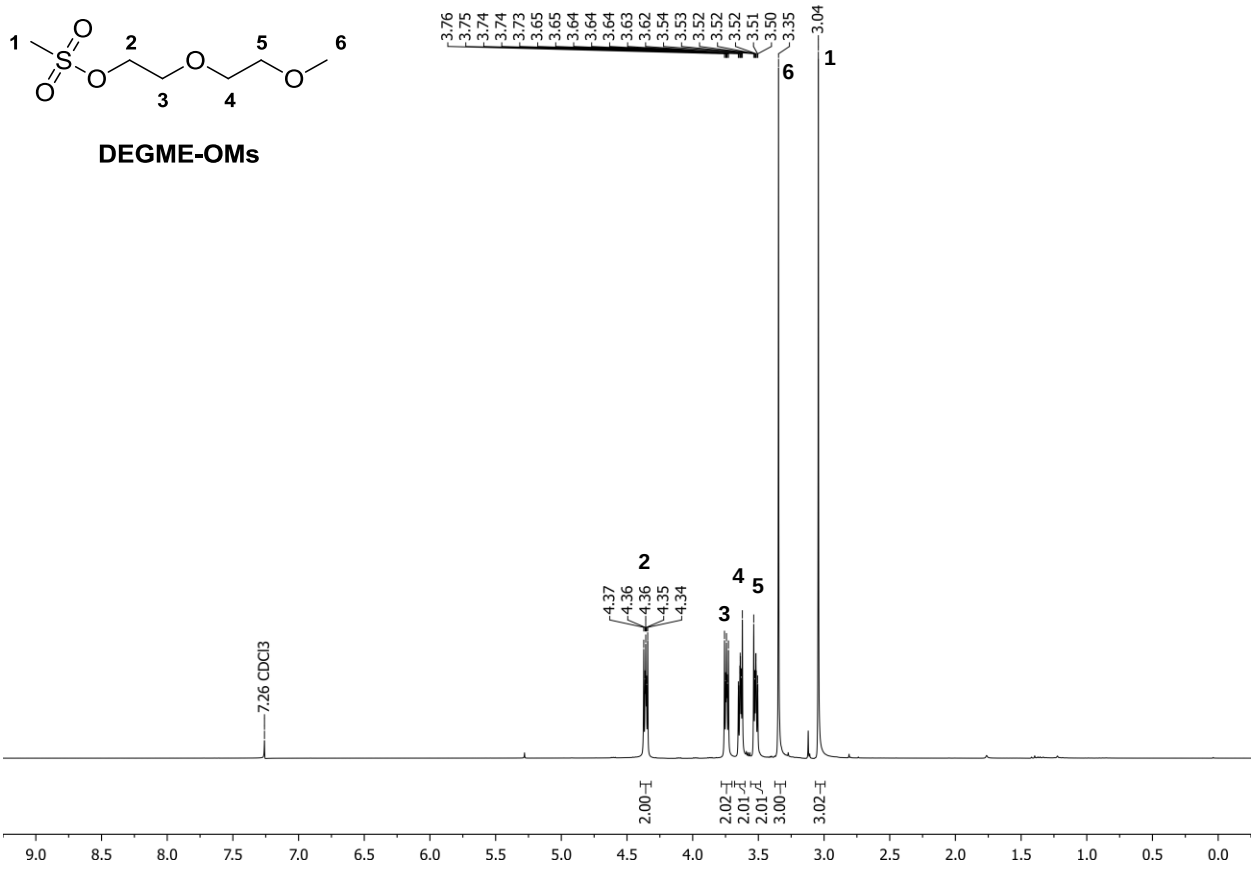


Figure S5: Linear regression of compound **D2** in water. Error bars refer to the standard deviation obtained from three individually prepared stock solutions and the dilution series.



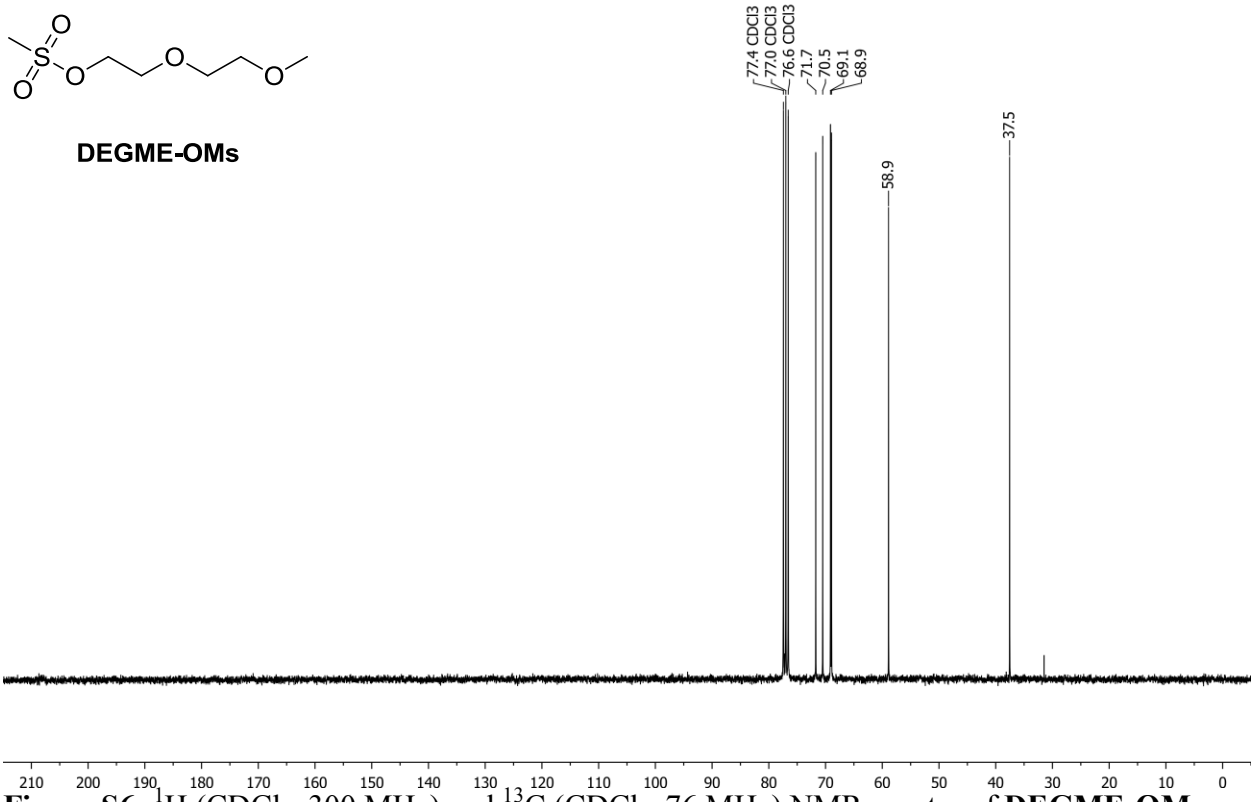
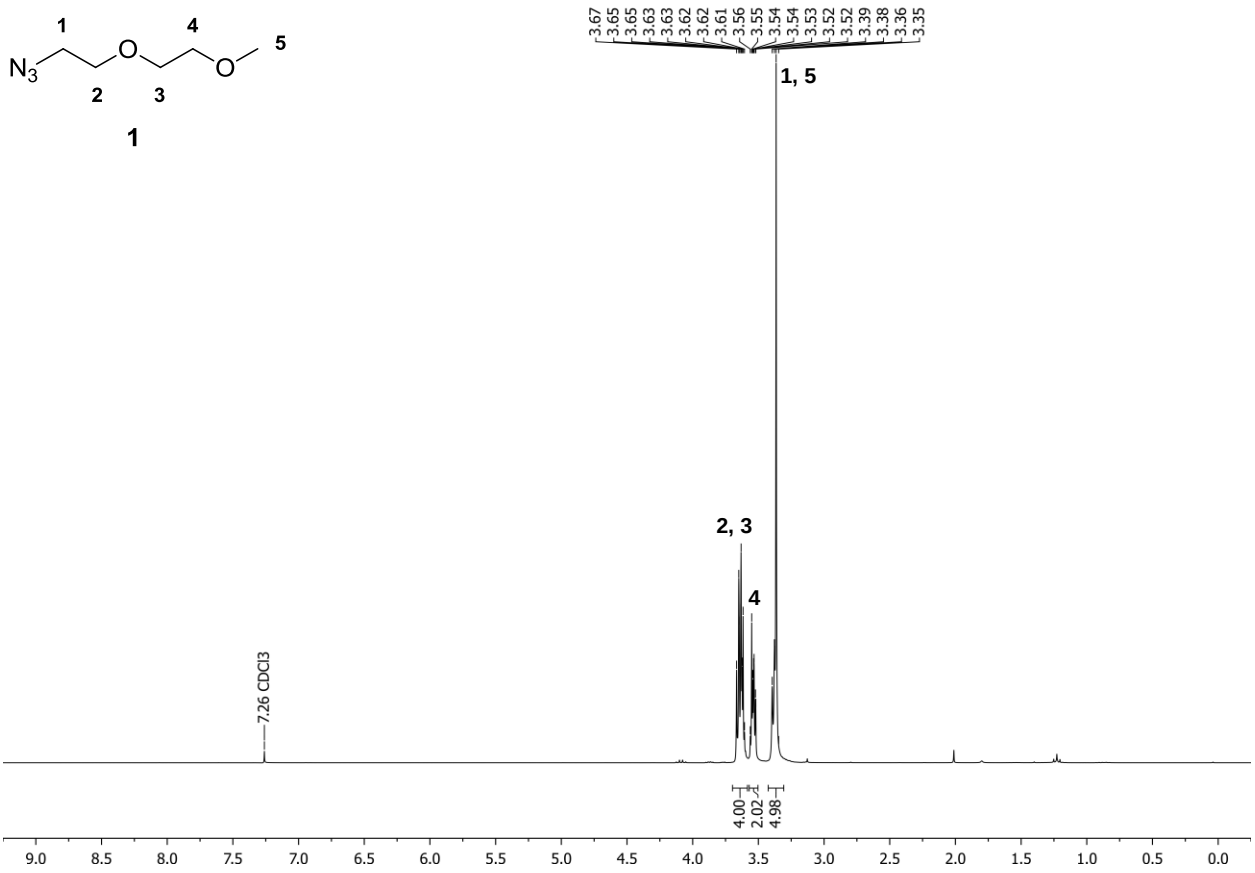


Figure S6: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of **DEGME-OMs**.



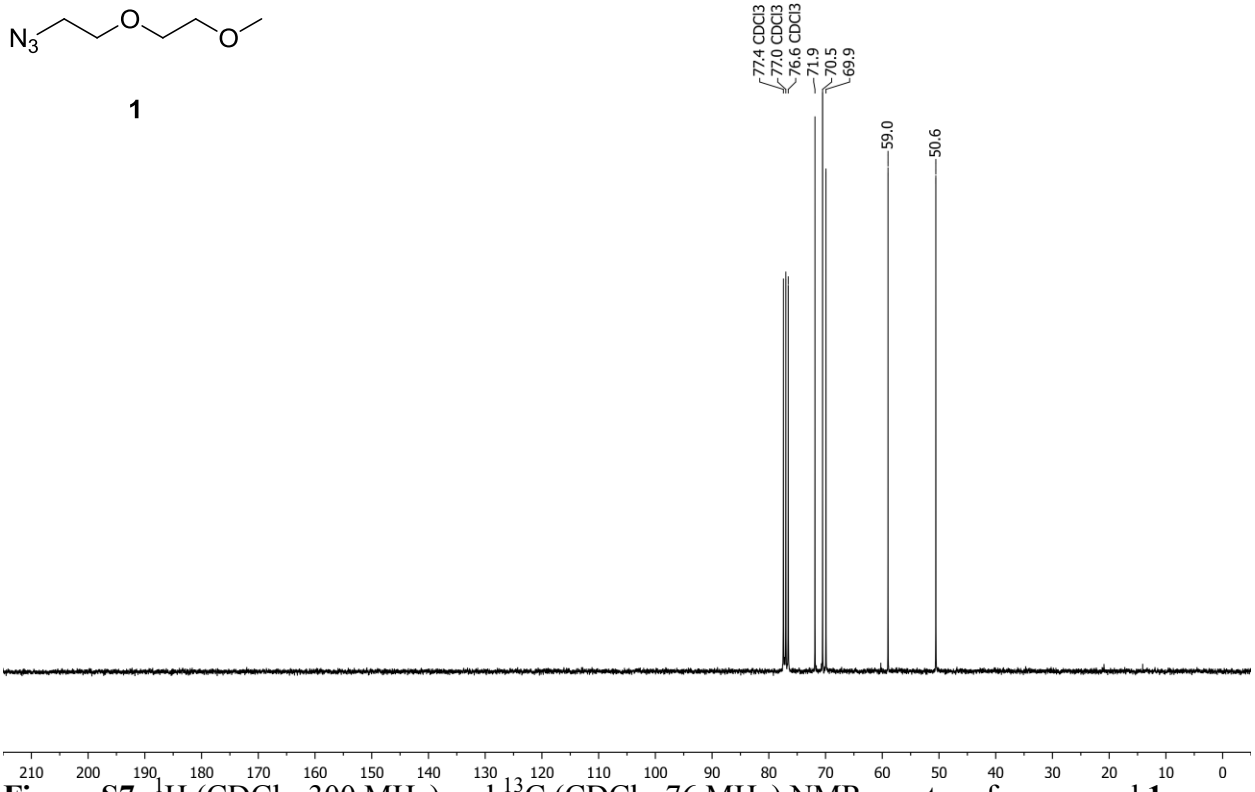
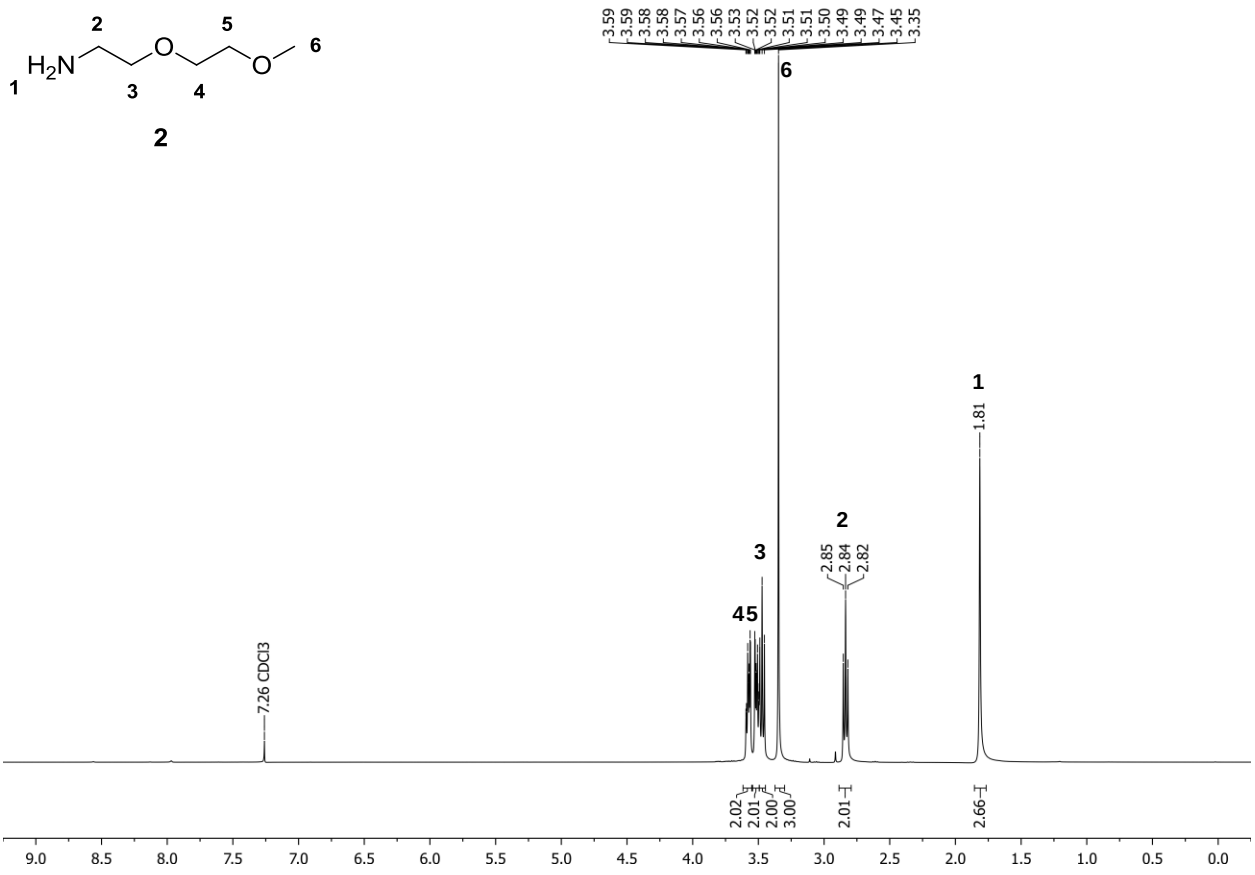


Figure S7: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **1**.



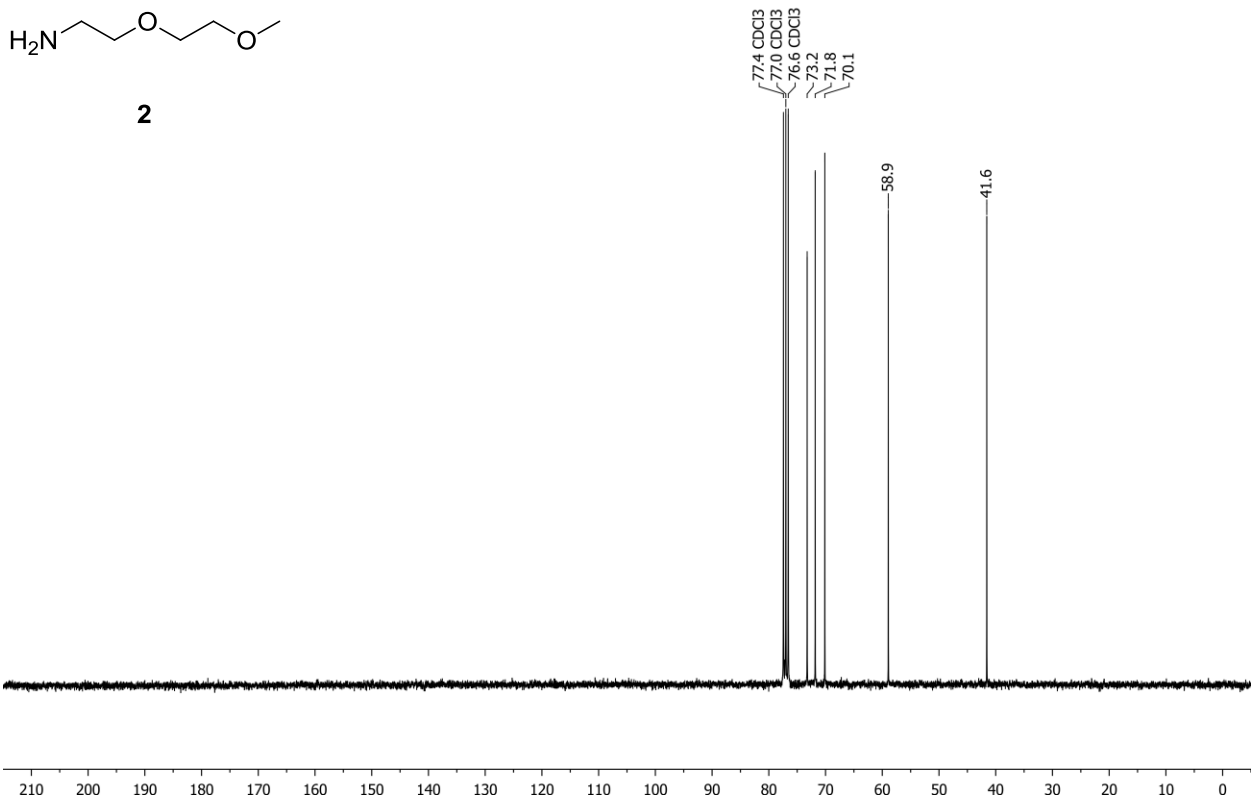
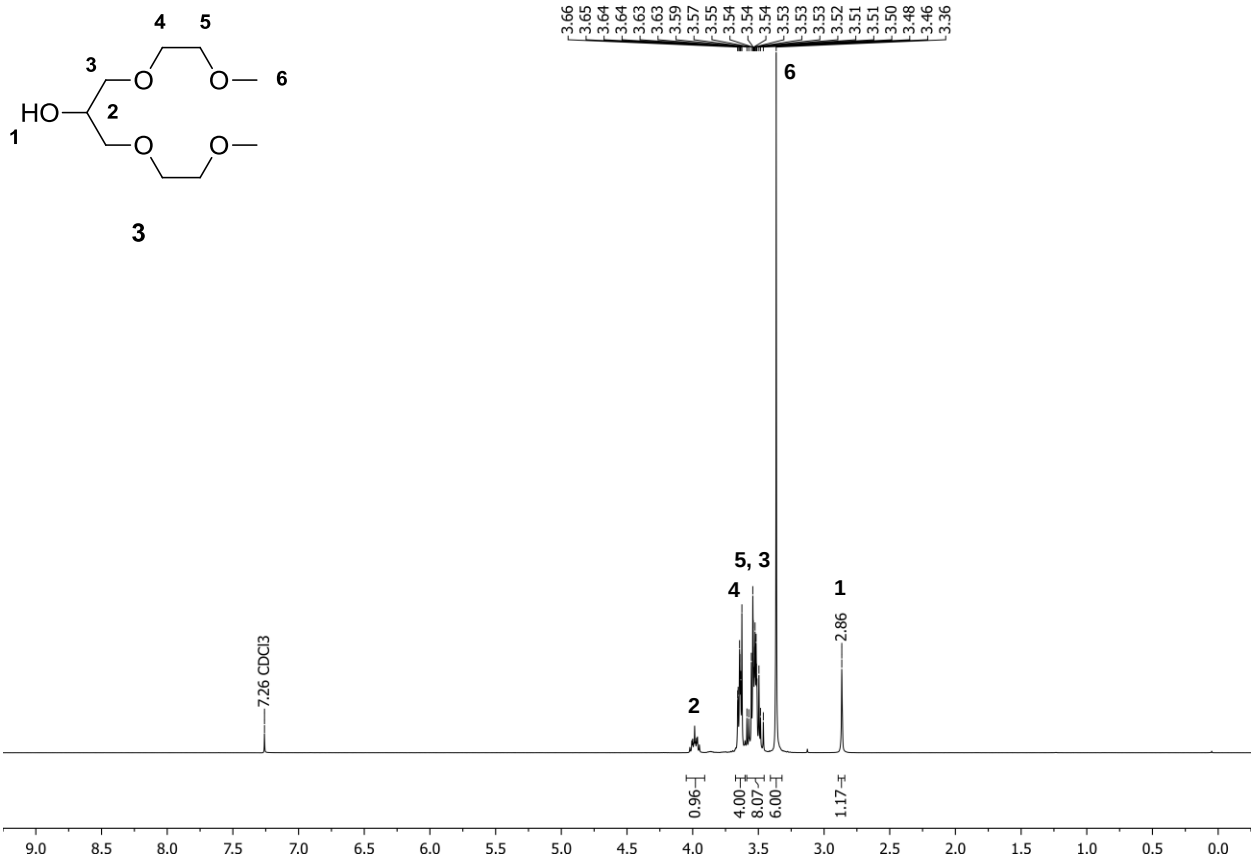


Figure S8: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **2**.



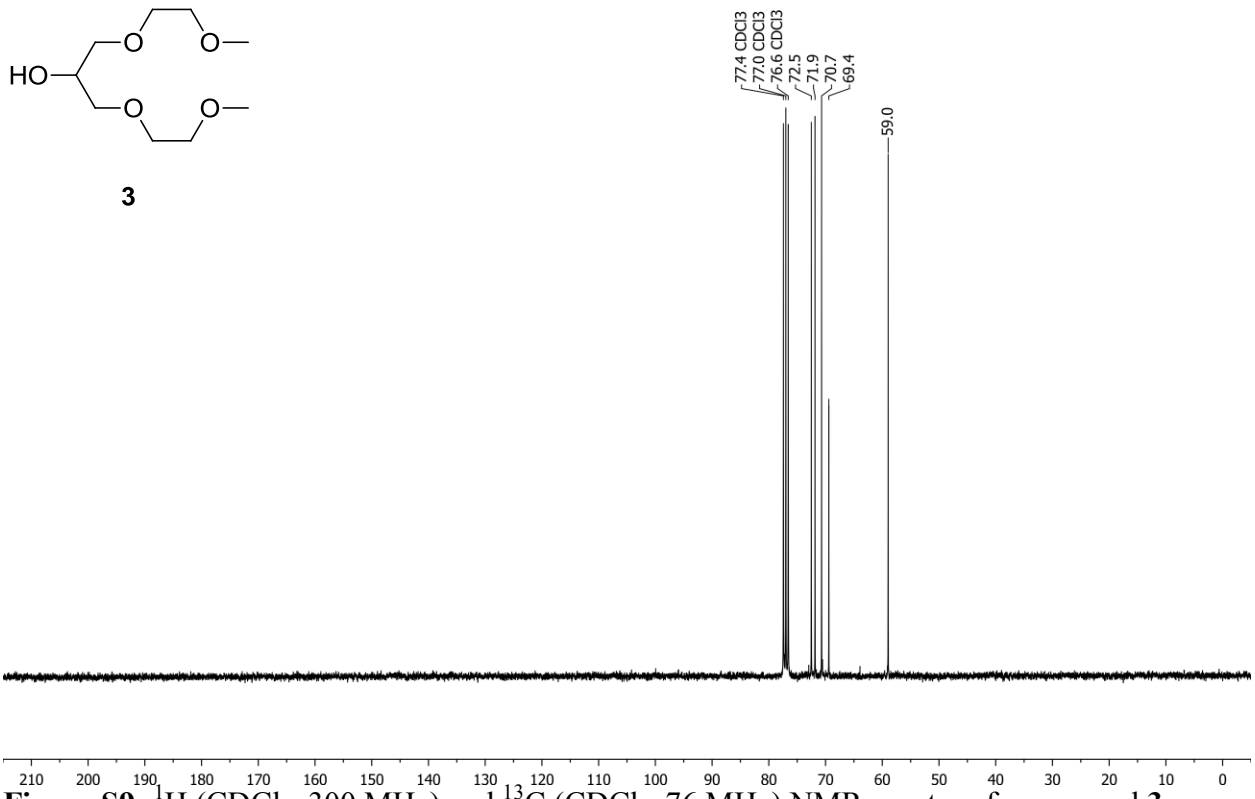
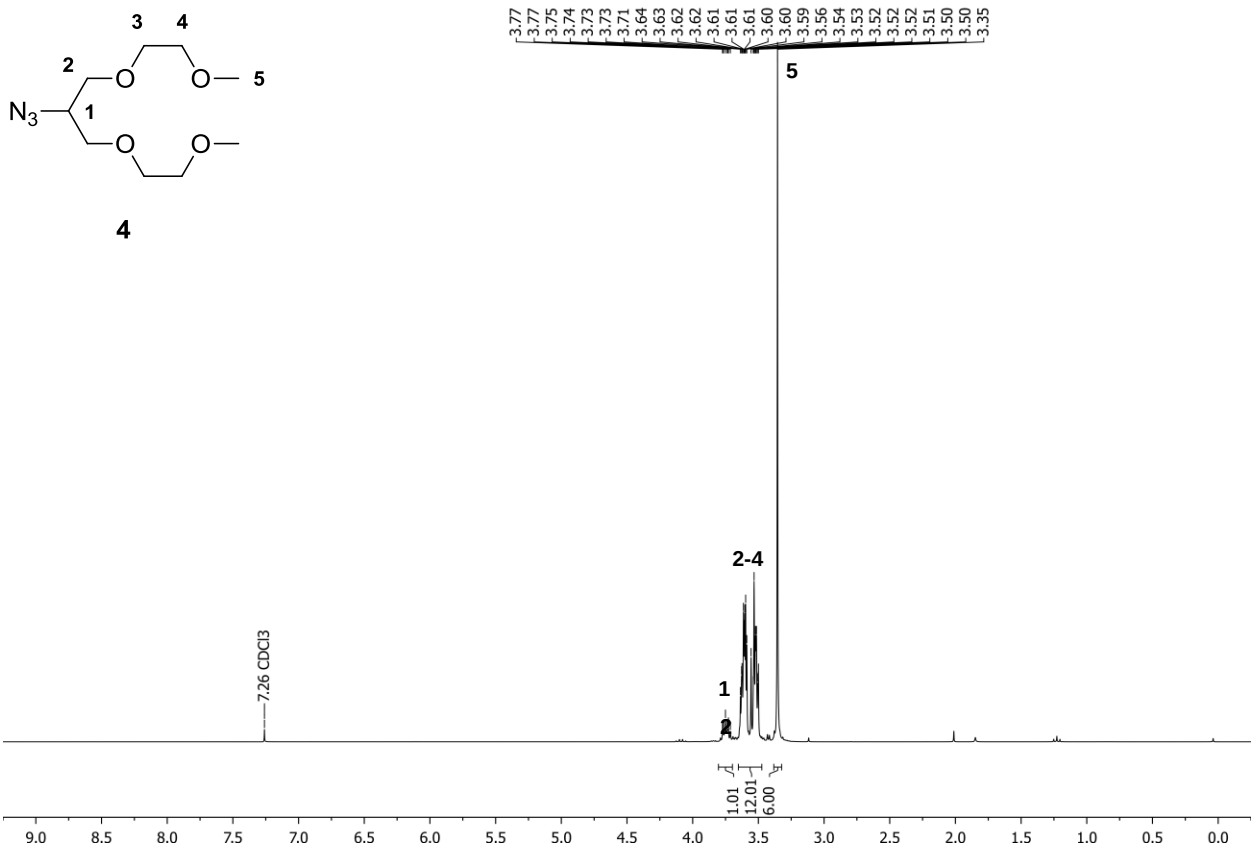


Figure S9: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **3**.



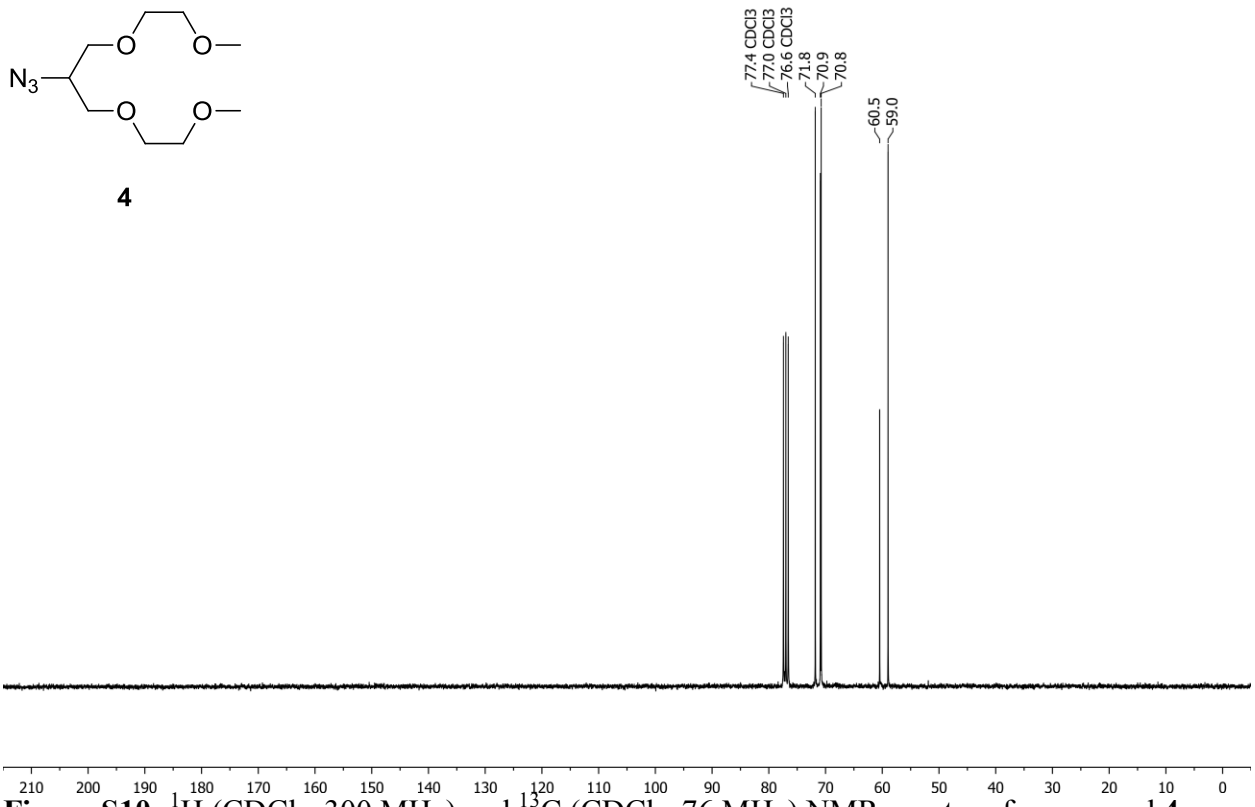
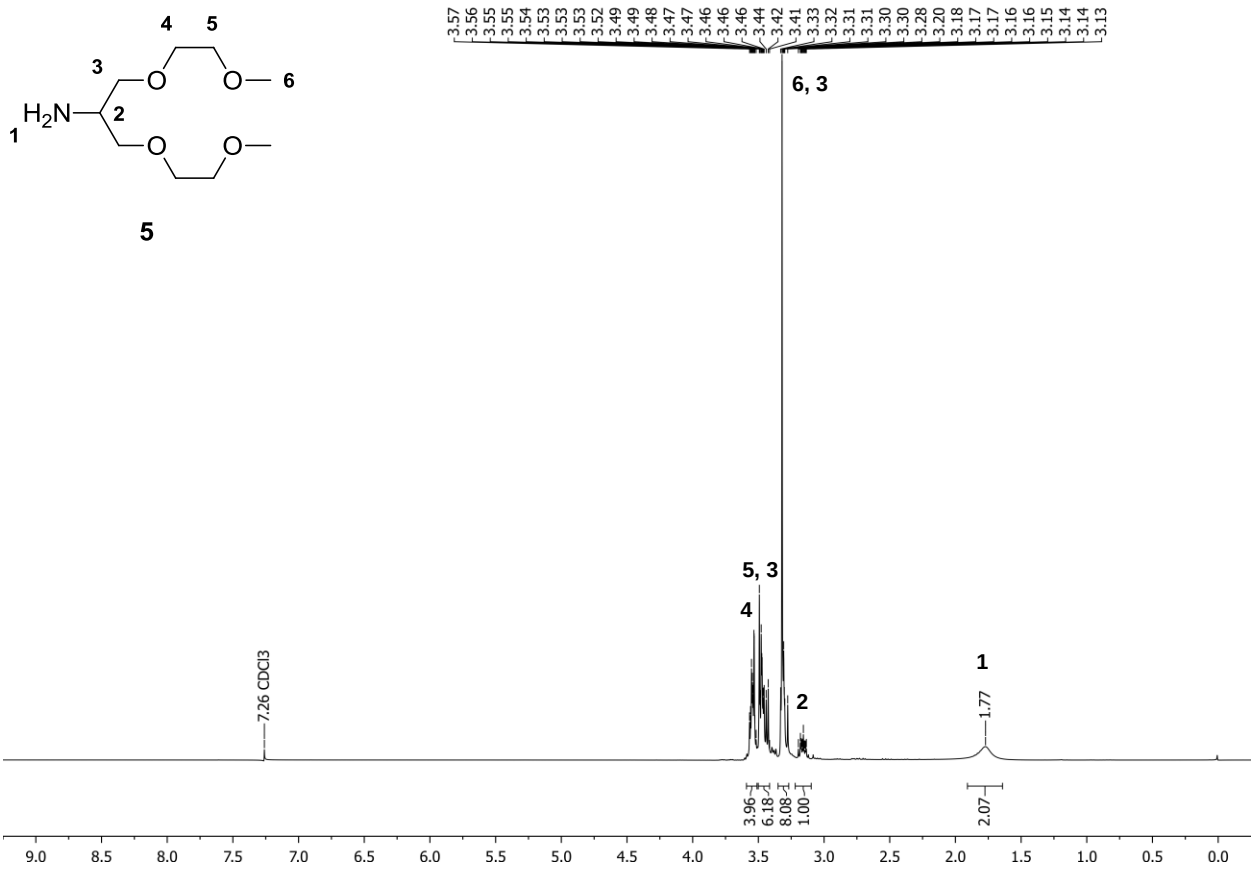


Figure S10: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **4**.



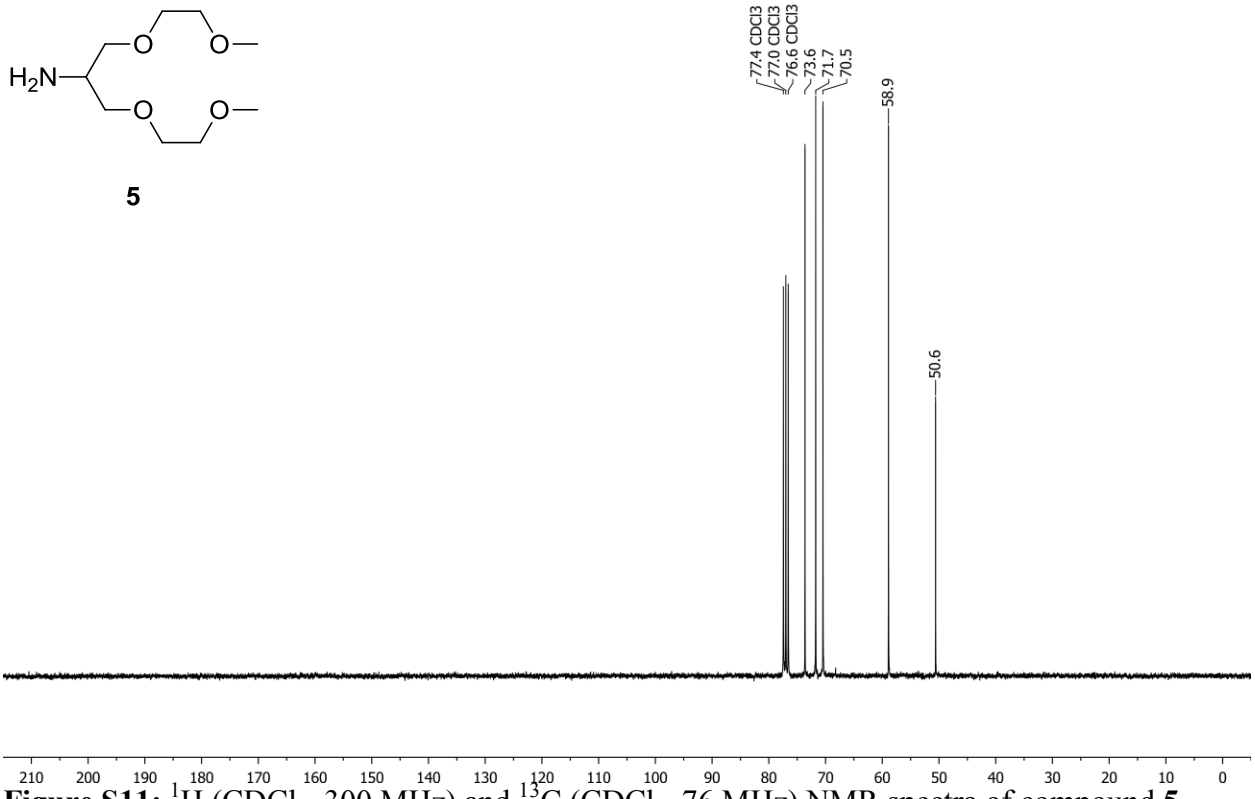


Figure S11: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **5**.

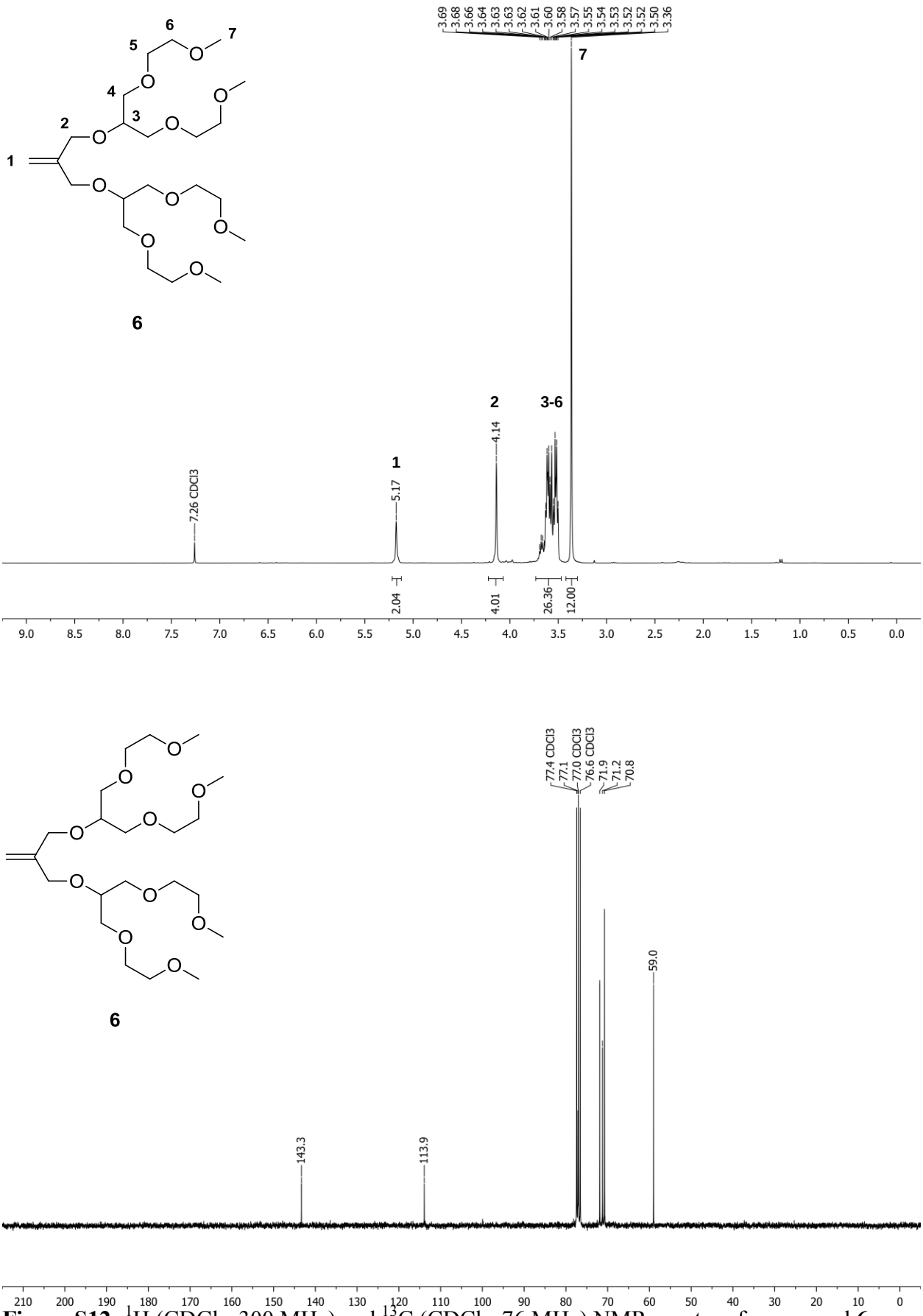


Figure S12: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **6**.

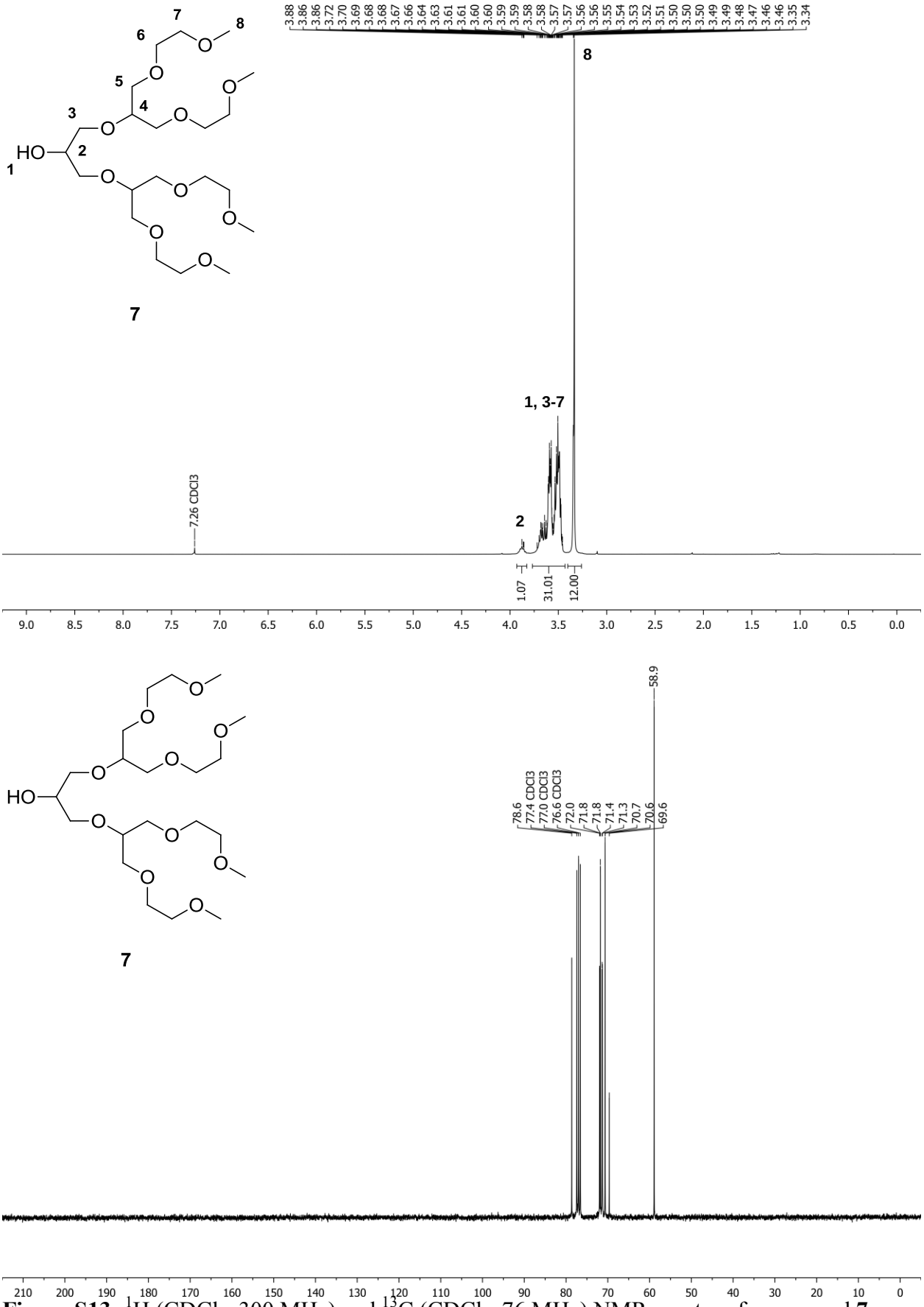


Figure S13: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **7**.

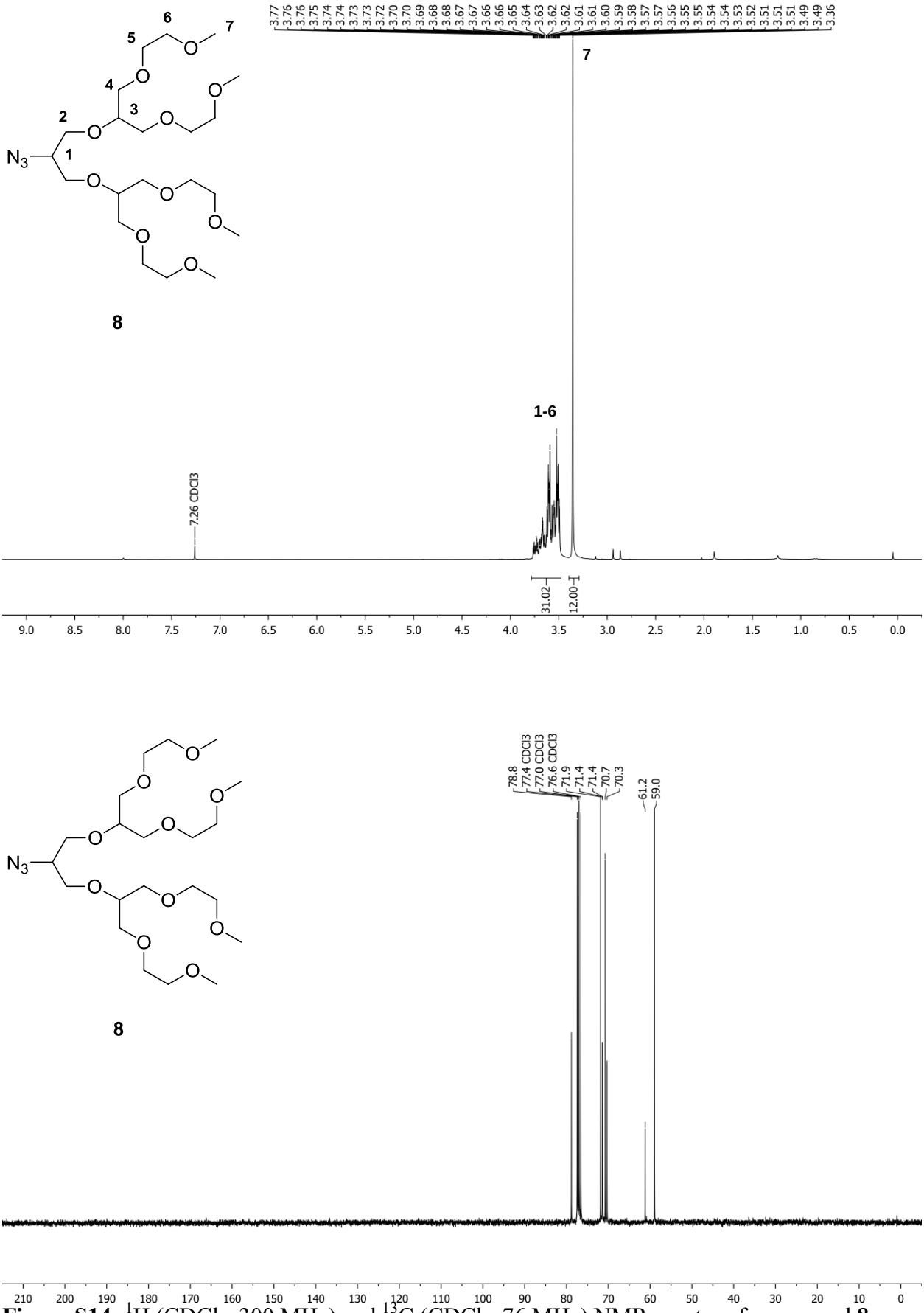
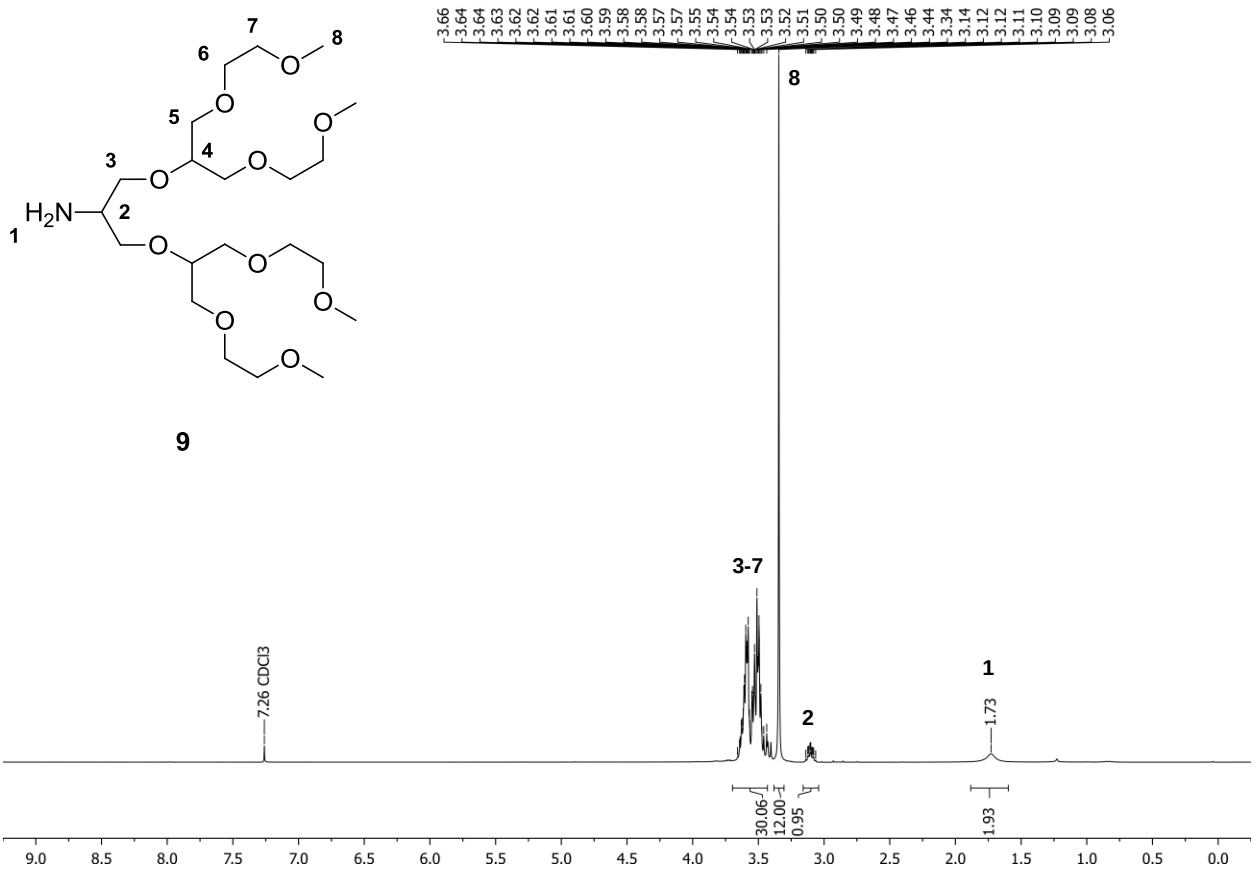


Figure S14: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **8**.



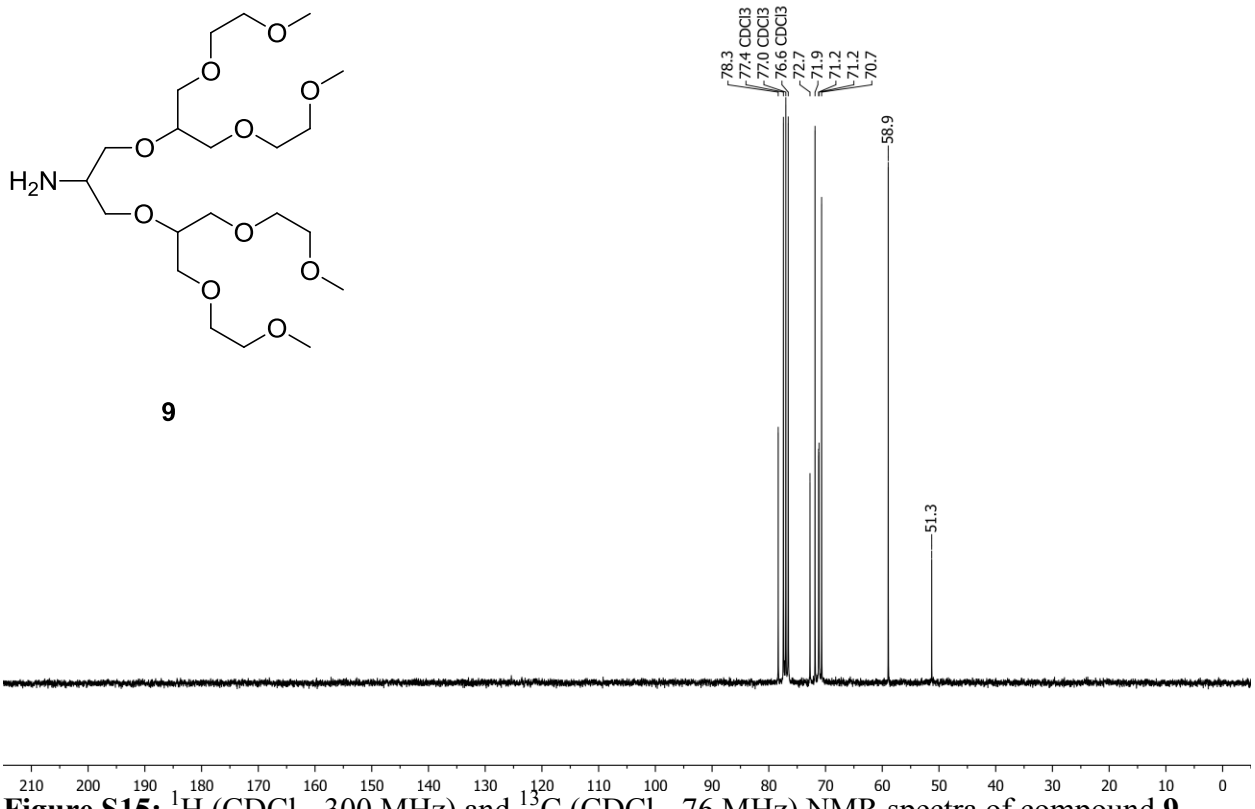


Figure S15: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **9**.

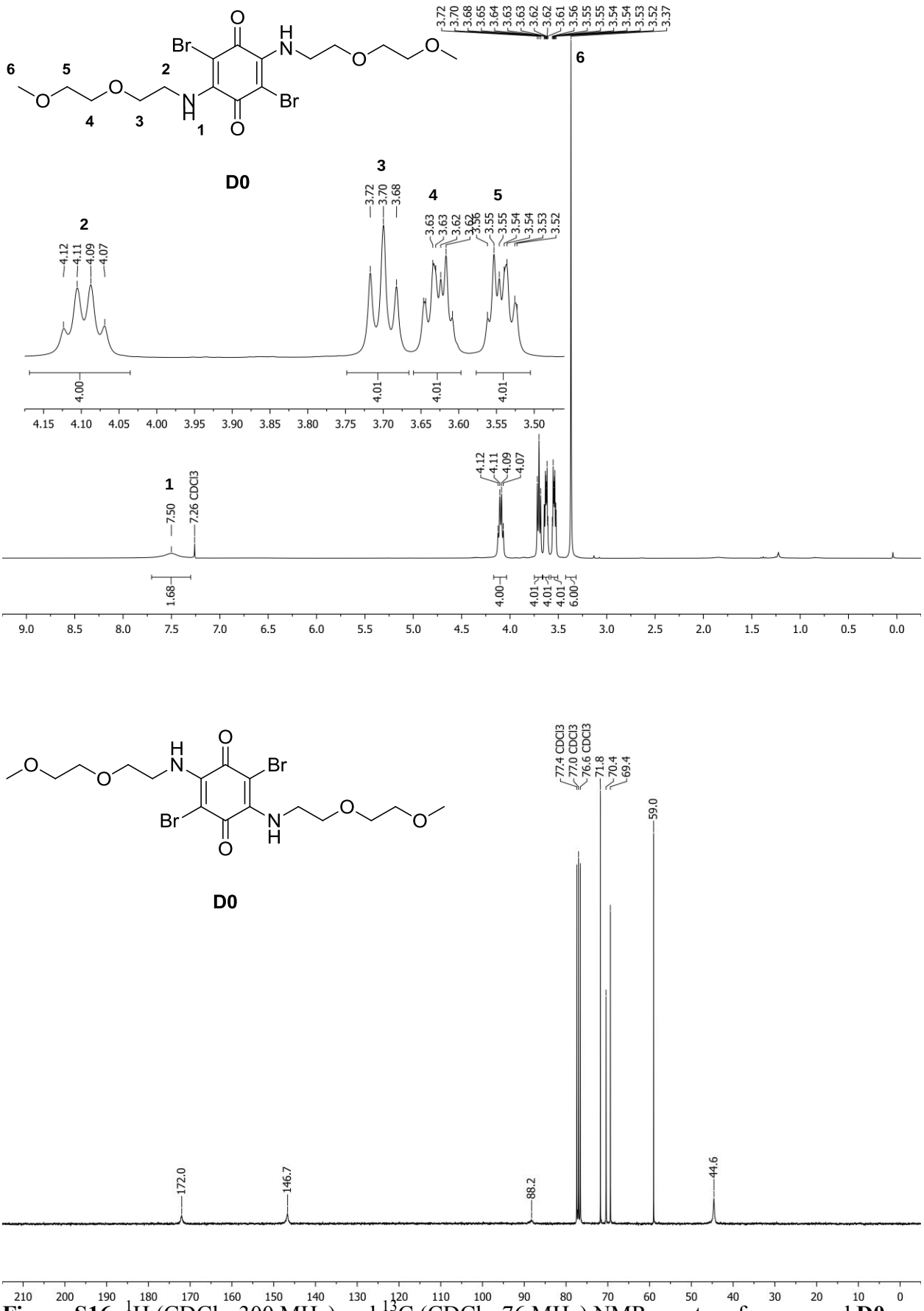


Figure S16: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **D0**.

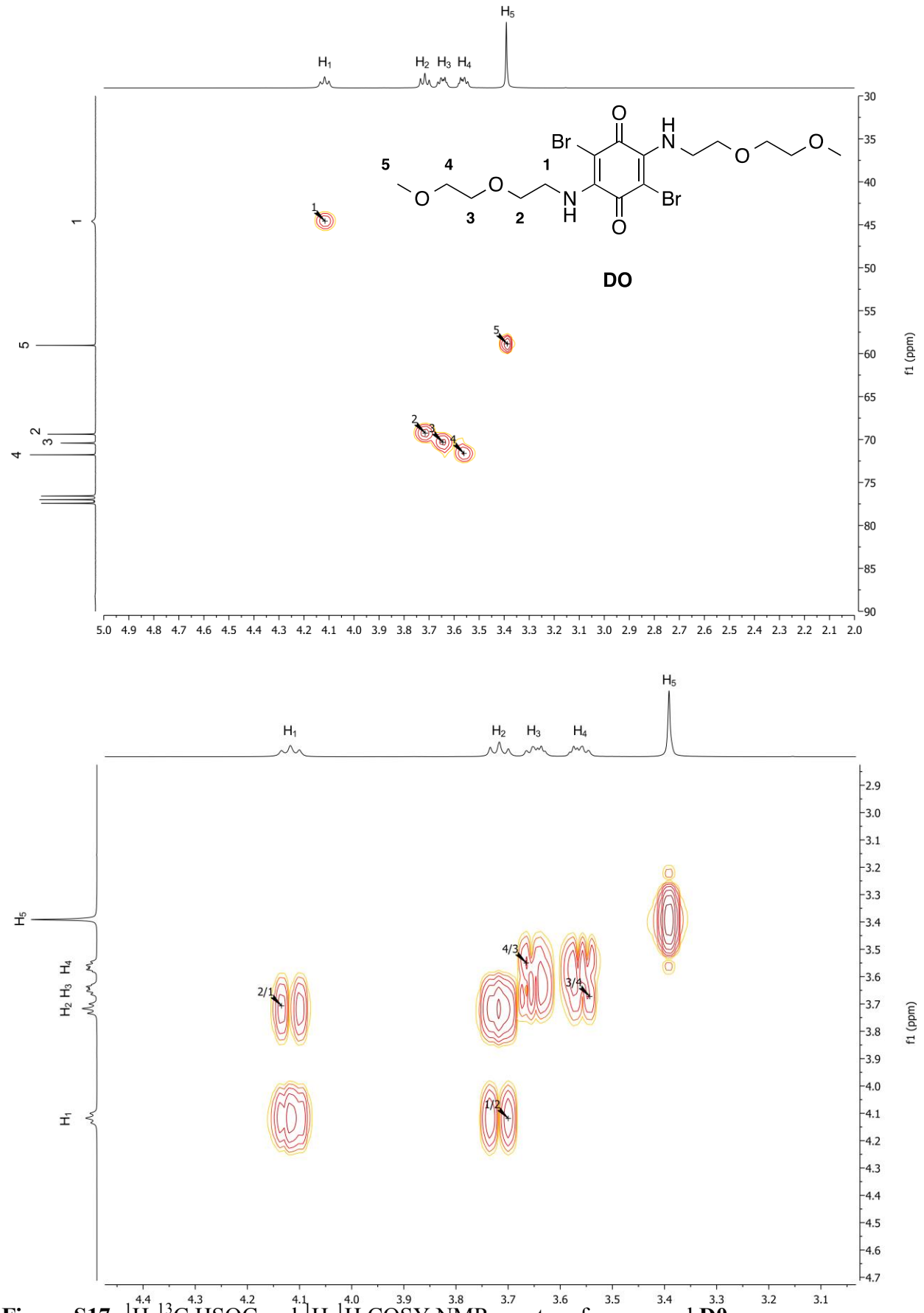
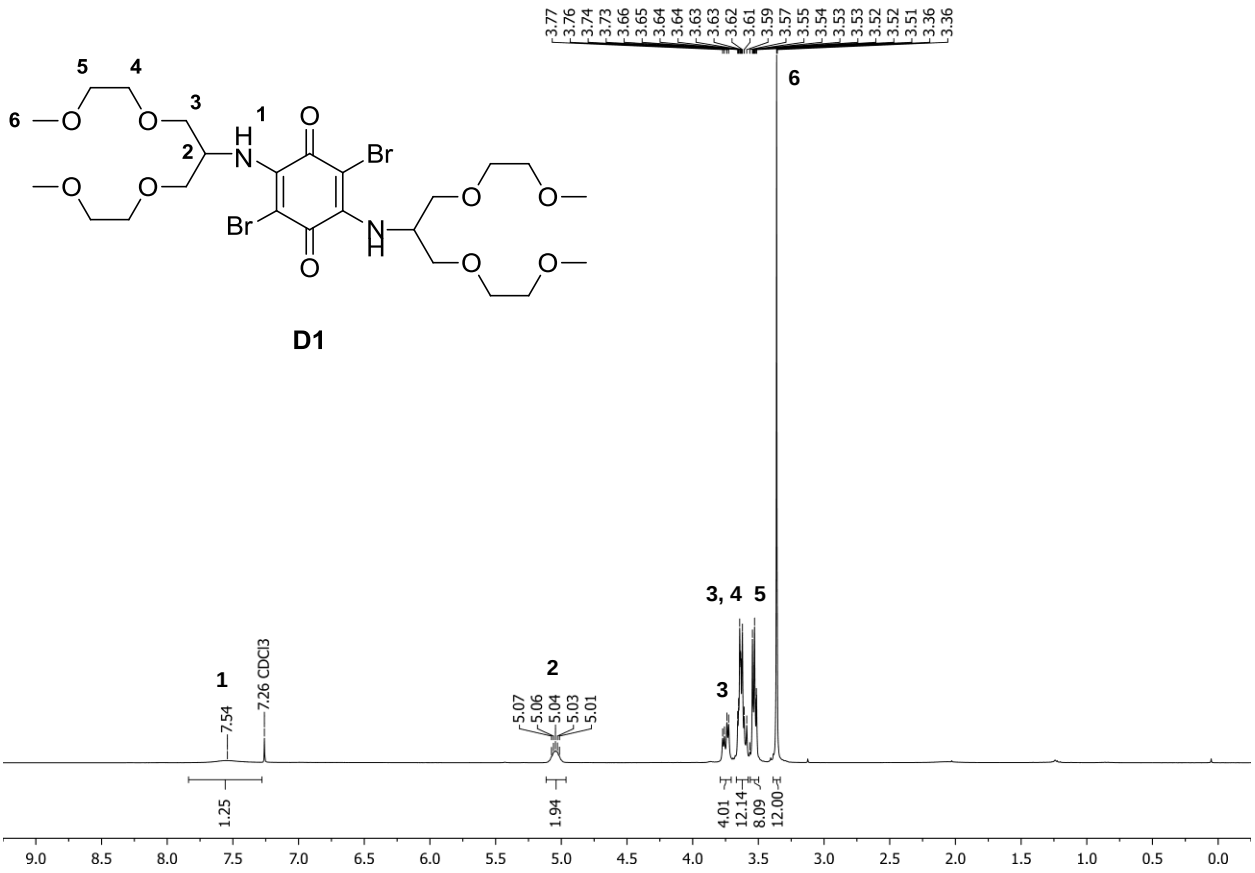


Figure S17: ^{1}H-^{13}C HSQC and ^{1}H-^{1}H COSY NMR spectra of compound **D0**.



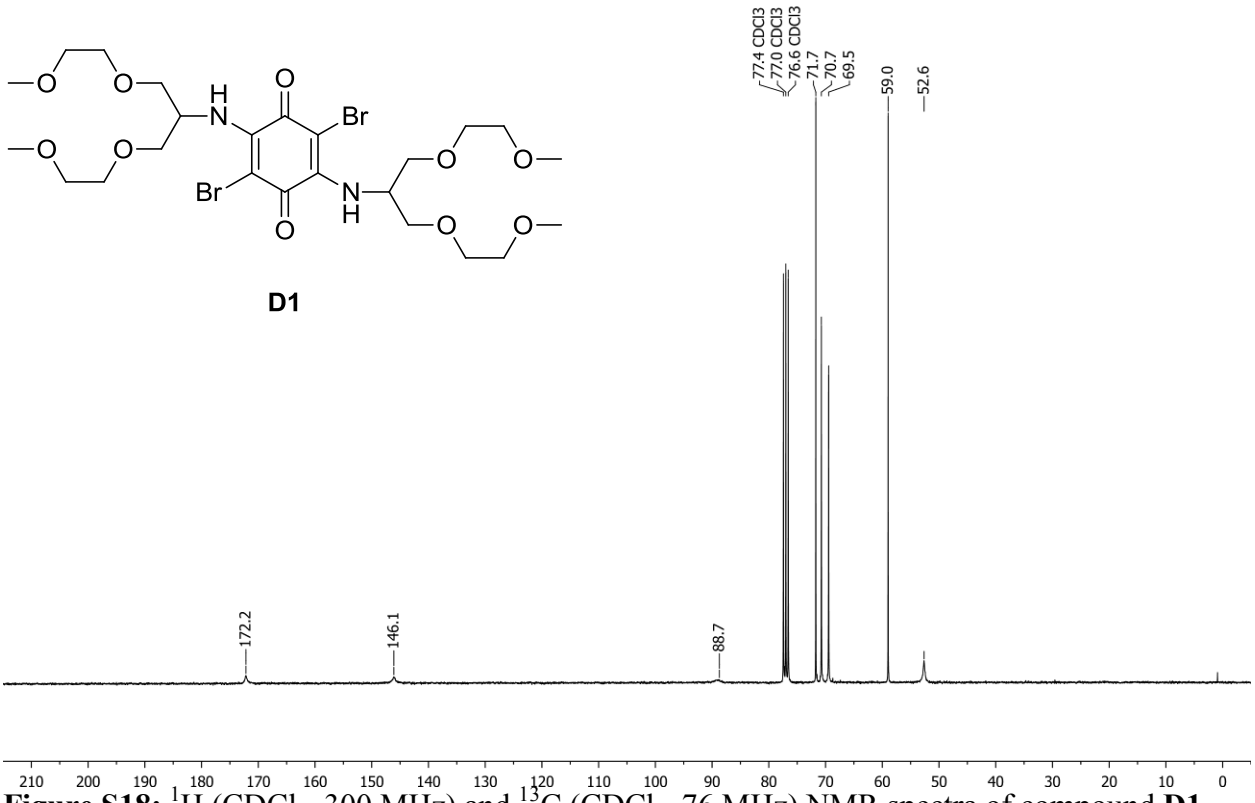


Figure S18: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **D1**.

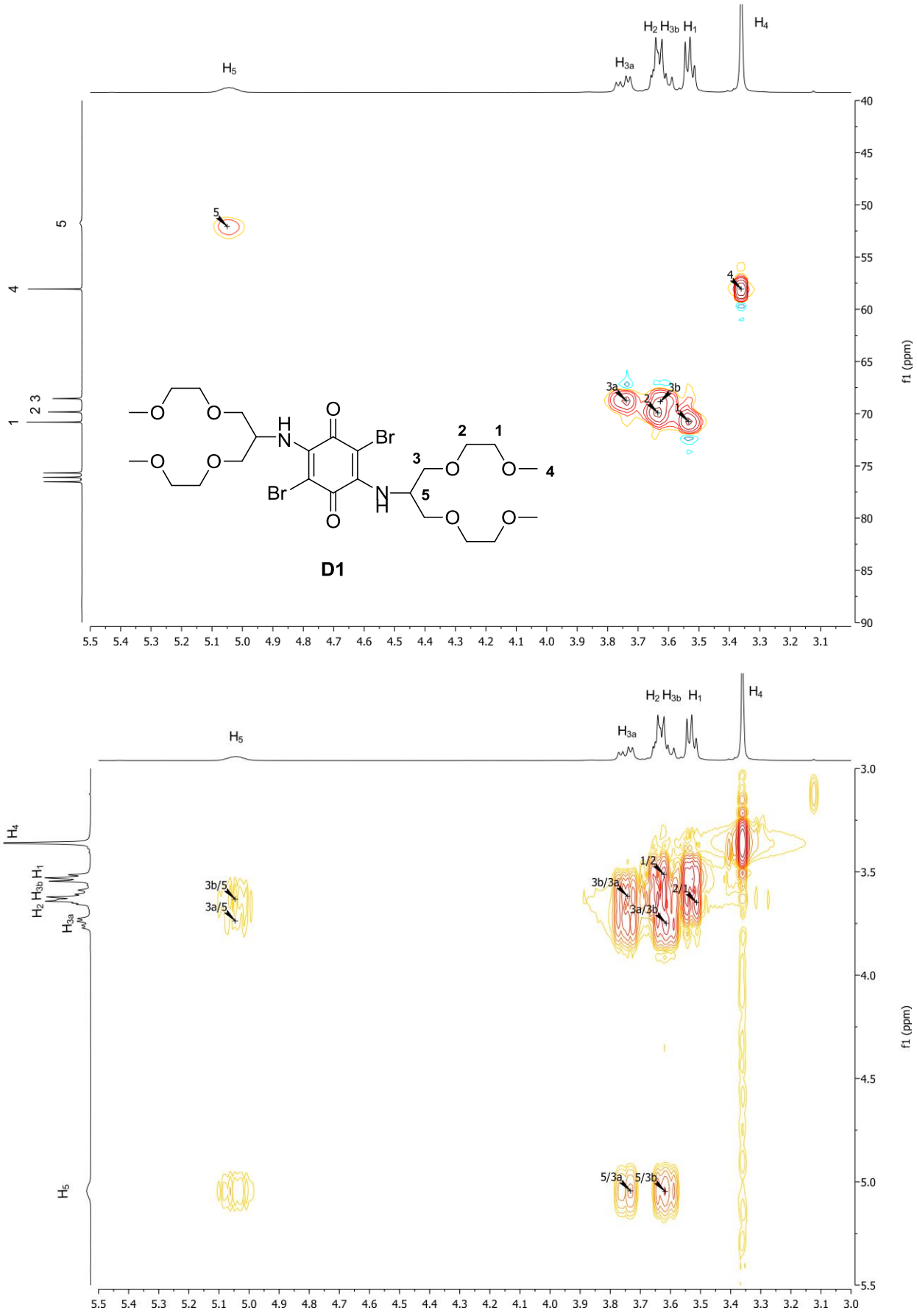


Figure S19: ^{1}H-^{13}C HSQC and ^{1}H-^{1}H COSY NMR spectra of compound **D1**.

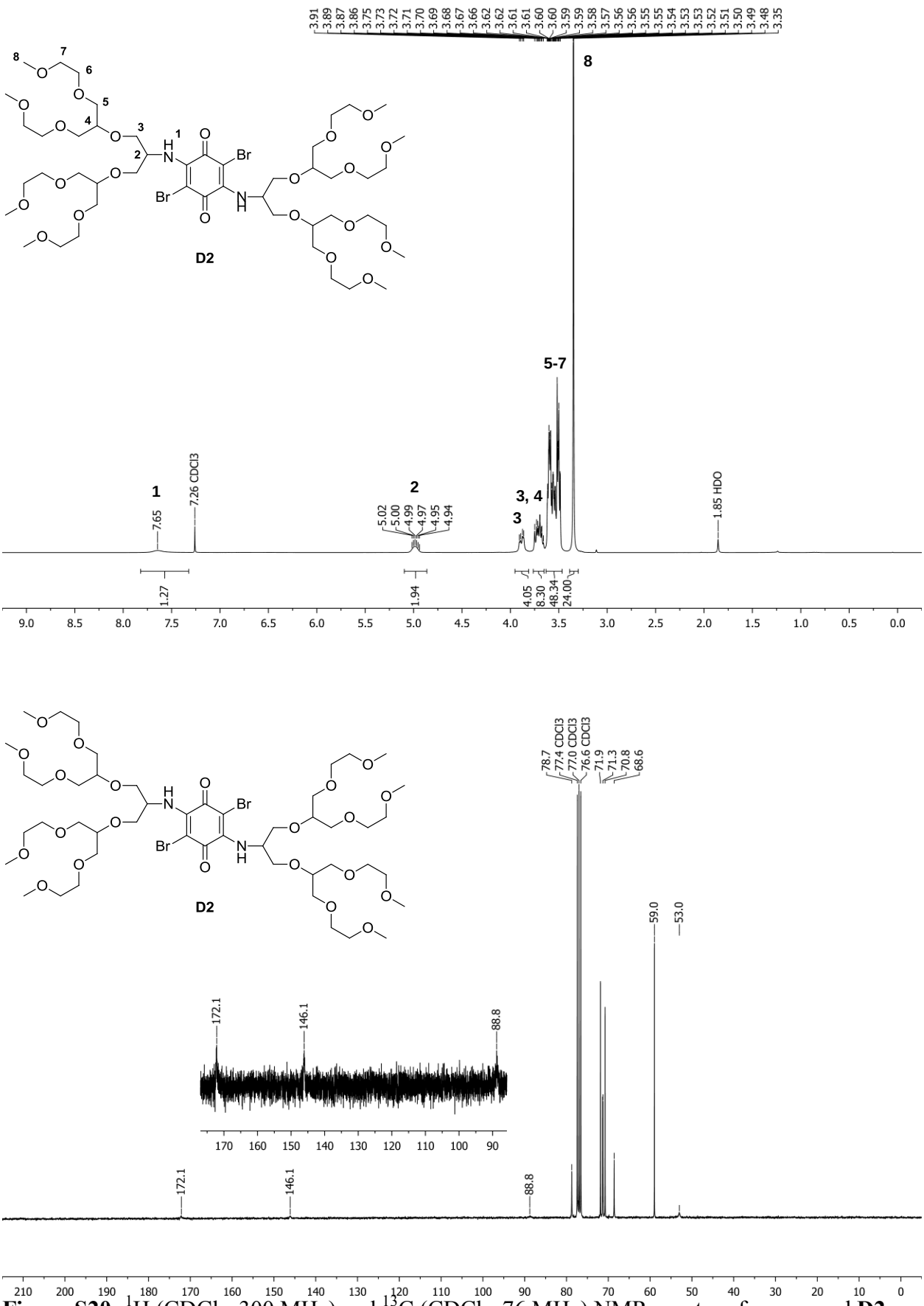


Figure S20: ^{1}H ($CDCl_3$, 300 MHz) and ^{13}C ($CDCl_3$, 76 MHz) NMR spectra of compound **D2**.

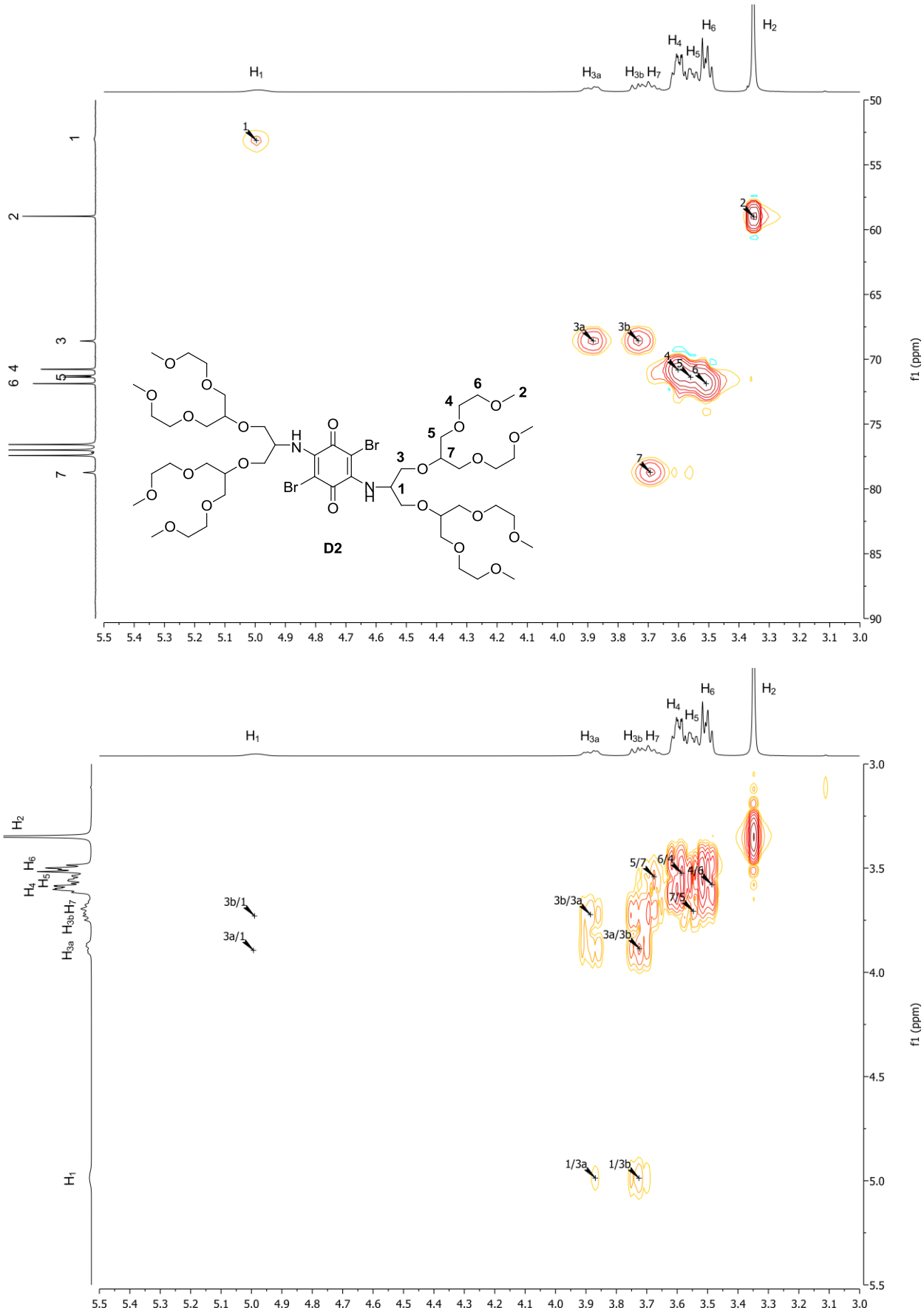


Figure S21: ^{1}H-^{13}C HSQC and ^{1}H-^{1}H COSY NMR spectra of compound **D2**.

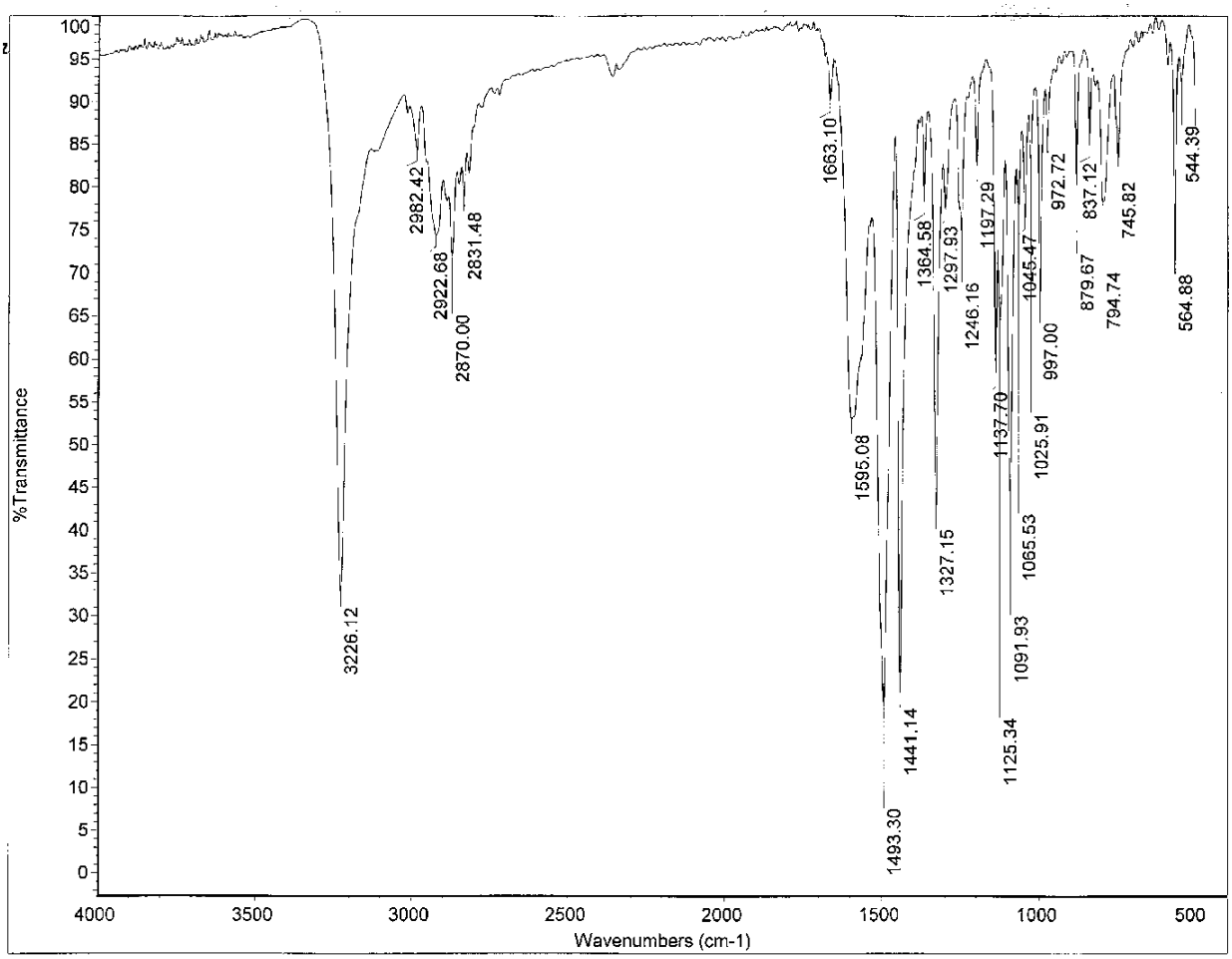


Figure S22: FTIR (KBr) spectrum of compound **D0**.

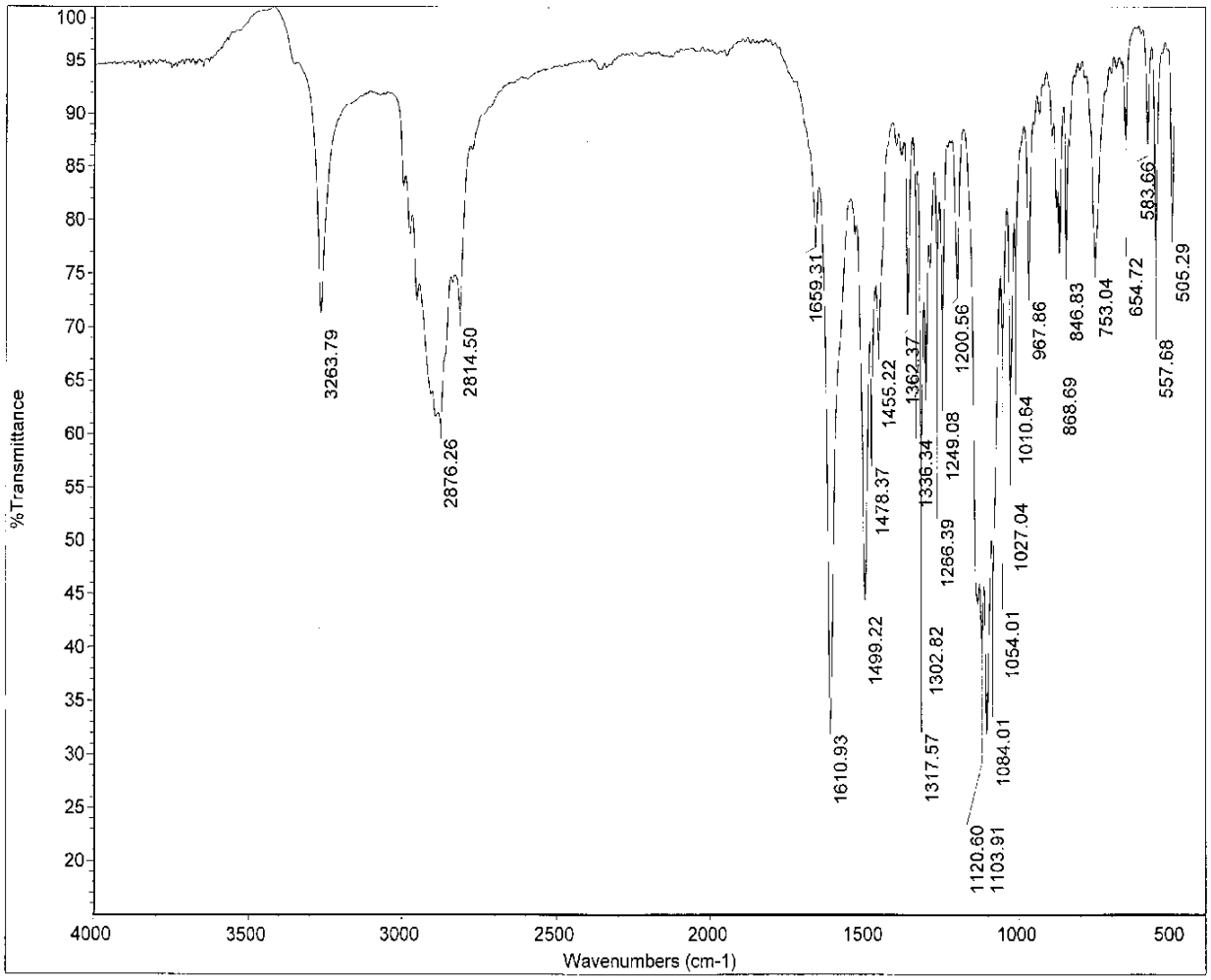


Figure S23: FTIR (KBr) spectrum of compound **D1**.

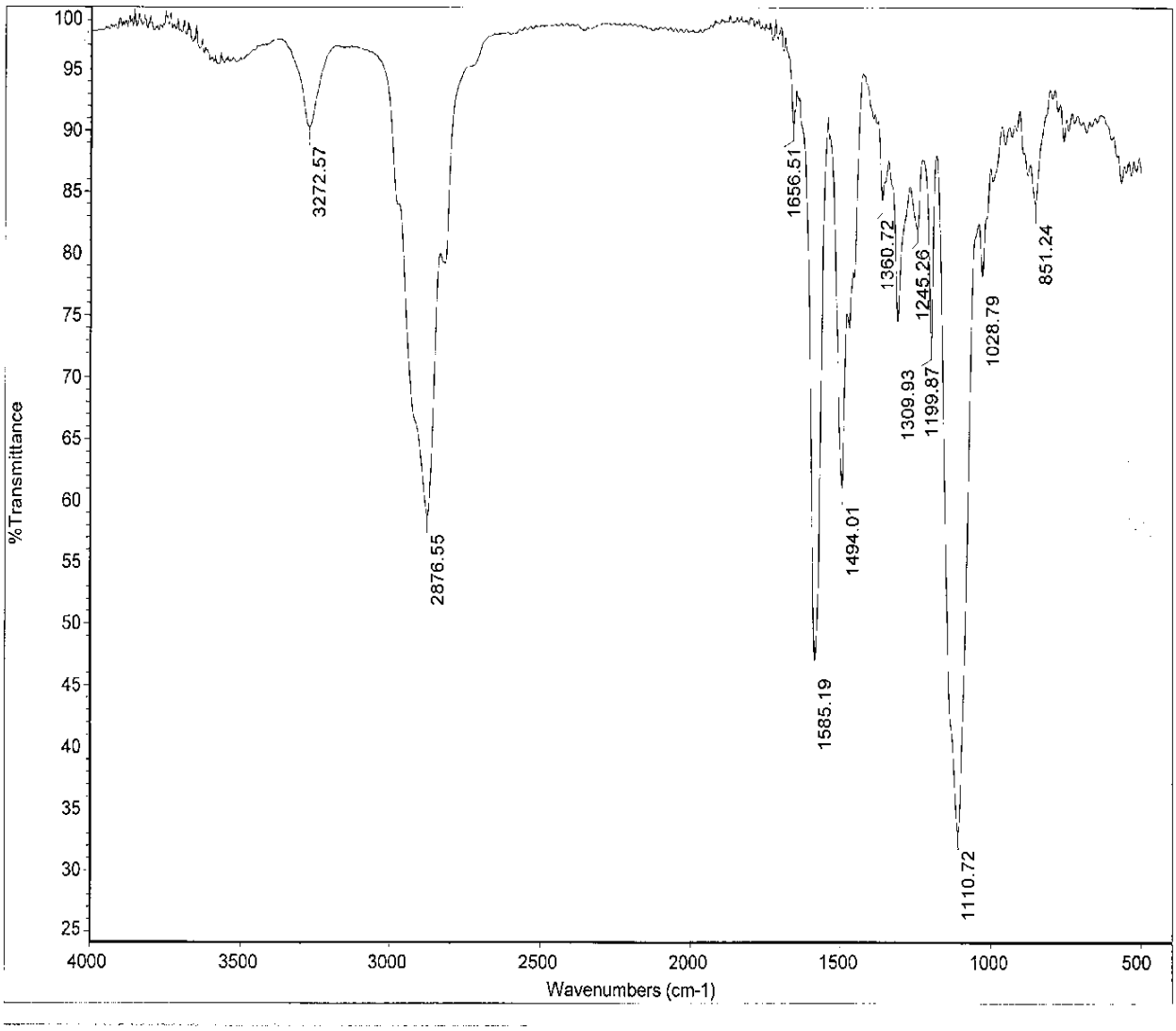
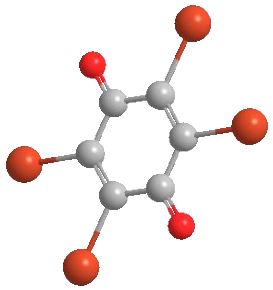


Figure S24: FTIR (KBr) spectrum of compound **D2**.

Supplementary computational data for Tetrabromo-1,4-benzoquinone (TBBQ)



----------MM2 Minimization----------

Pi System: 7 4 1 3 9 6 8 10

Warning: Some parameters are guessed (Quality = 1).

Iteration 5 Steric Energy 59.574 RMS Gradient 3.337 RMS Move 0.0017

Iteration 10 Steric Energy 59.227 RMS Gradient 1.449 RMS Move 0.0020

Iteration 15 Steric Energy 59.165 RMS Gradient 0.561 RMS Move 0.0009

Iteration 20 Steric Energy 59.154 RMS Gradient 0.225 RMS Move 0.0006

Iteration 25 Steric Energy 59.152 RMS Gradient 0.037 RMS Move 0.0000

Iteration 30 Steric Energy 59.152 RMS Gradient 0.010 RMS Move 0.0000

Iteration 30: Minimization terminated normally because the gradient norm is less than the minimum gradient norm

Stretch: 3.2426

Bend: 2.0037

Stretch-Bend: 0.2079

Torsion: -1.6000

Non-1,4 VDW: 0.4876

1,4 VDW: 15.6496

Dipole/Dipole: 39.1605

Total Energy: 59.1518 kcal/mol

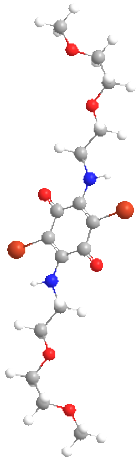
Calculation ended

---------- Property Broker ----------

Model: Bromanil

Molecular Networks: LogP = 2.56888 Log Units

Supplementary computational data for compound D0



----------MM2 Minimization----------

Pi System: 9 5 6 3 1 7 4 10 8 11

Warning: Some parameters are guessed (Quality = 1).

Iteration 5 Steric Energy 69.333 RMS Gradient 2.399 RMS Move 0.0020

Iteration 10 Steric Energy 68.672 RMS Gradient 0.645 RMS Move 0.0009

Iteration 15 Steric Energy 68.559 RMS Gradient 0.399 RMS Move 0.0010

Iteration 20 Steric Energy 68.524 RMS Gradient 0.179 RMS Move 0.0001

Iteration 25 Steric Energy 68.515 RMS Gradient 0.086 RMS Move 0.0001

Iteration 30 Steric Energy 68.512 RMS Gradient 0.086 RMS Move 0.0003

Iteration 35 Steric Energy 68.510 RMS Gradient 0.061 RMS Move 0.0001

Iteration 40 Steric Energy 68.510 RMS Gradient 0.024 RMS Move 0.0000

Iteration 45 Steric Energy 68.509 RMS Gradient 0.023 RMS Move 0.0000

Iteration 50 Steric Energy 68.509 RMS Gradient 0.013 RMS Move 0.0000

Iteration 55 Steric Energy 68.509 RMS Gradient 0.012 RMS Move 0.0000

Iteration 60 Steric Energy 68.509 RMS Gradient 0.015 RMS Move 0.0001

Iteration 65 Steric Energy 68.509 RMS Gradient 0.014 RMS Move 0.0001

Iteration 68: Minimization terminated normally because the gradient norm is less than the minimum gradient norm

Stretch: 3.9157

Bend: 10.5420

Stretch-Bend: 0.7847

Torsion: -0.9110

Non-1,4 VDW: -0.1408

1,4 VDW: 30.0274

Dipole/Dipole: 24.2909

Total Energy: 68.5090 kcal/mol

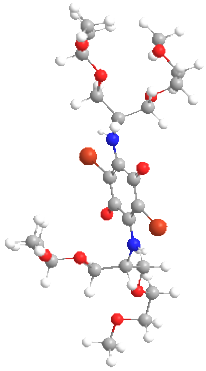
Calculation ended

---------- Property Broker ----------

Model: D0

Molecular Networks: LogP = 1.27353 Log Units

Supplementary computational data for compound D1



----------MM2 Minimization----------

Pi System: 9 5 6 3 1 7 4 10 8 11

Warning: Some parameters are guessed (Quality = 1).

Iteration 5 Steric Energy 94.283 RMS Gradient 2.276 RMS Move 0.0018

Iteration 10 Steric Energy 93.186 RMS Gradient 0.672 RMS Move 0.0008

Iteration 15 Steric Energy 93.050 RMS Gradient 0.452 RMS Move 0.0016

Iteration 20 Steric Energy 92.991 RMS Gradient 0.170 RMS Move 0.0001

Iteration 25 Steric Energy 92.977 RMS Gradient 0.116 RMS Move 0.0001

Iteration 30 Steric Energy 92.971 RMS Gradient 0.127 RMS Move 0.0001

Iteration 35 Steric Energy 92.967 RMS Gradient 0.068 RMS Move 0.0001

Iteration 40 Steric Energy 92.963 RMS Gradient 0.063 RMS Move 0.0002

Iteration 45 Steric Energy 92.963 RMS Gradient 0.024 RMS Move 0.0000

Iteration 50 Steric Energy 92.962 RMS Gradient 0.024 RMS Move 0.0001

Iteration 55 Steric Energy 92.962 RMS Gradient 0.011 RMS Move 0.0000

Iteration 60 Steric Energy 92.962 RMS Gradient 0.019 RMS Move 0.0000

Iteration 65 Steric Energy 92.962 RMS Gradient 0.014 RMS Move 0.0000

Iteration 70 Steric Energy 92.962 RMS Gradient 0.009 RMS Move 0.0000

Iteration 70: Minimization terminated normally because the gradient norm is less than the minimum gradient norm

Stretch: 5.4321

Bend: 19.7986

Stretch-Bend: 1.5398

Torsion: 0.5976

Non-1,4 VDW: -5.6916

1,4 VDW: 46.7254

Dipole/Dipole: 24.5596

Total Energy: 92.9615 kcal/mol

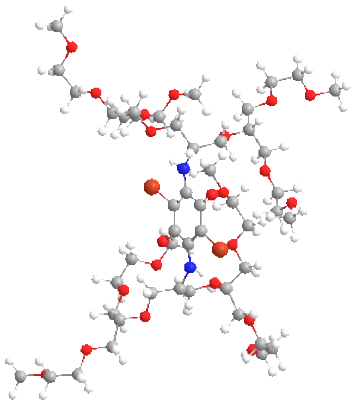
Calculation ended

---------- Property Broker ----------

Model: D1

Molecular Networks: LogP = 0.623454 Log Units

Supplementary computational data for compound D2



----------MM2 Minimization----------

Pi System: 9 5 6 3 1 7 4 10 8 11

Warning: Some parameters are guessed (Quality = 1).

Iteration 5 Steric Energy 150.246 RMS Gradient 1.855 RMS Move 0.0017

Iteration 10 Steric Energy 148.252 RMS Gradient 0.811 RMS Move 0.0005

Iteration 15 Steric Energy 148.013 RMS Gradient 0.528 RMS Move 0.0007

Iteration 20 Steric Energy 147.885 RMS Gradient 0.113 RMS Move 0.0002

Iteration 25 Steric Energy 147.847 RMS Gradient 0.068 RMS Move 0.0002

Iteration 30 Steric Energy 147.829 RMS Gradient 0.075 RMS Move 0.0001

Iteration 35 Steric Energy 147.824 RMS Gradient 0.041 RMS Move 0.0000

Iteration 40 Steric Energy 147.822 RMS Gradient 0.071 RMS Move 0.0002

Iteration 45 Steric Energy 147.819 RMS Gradient 0.028 RMS Move 0.0000

Iteration 50 Steric Energy 147.818 RMS Gradient 0.017 RMS Move 0.0000

Iteration 55 Steric Energy 147.818 RMS Gradient 0.027 RMS Move 0.0001

Iteration 60 Steric Energy 147.817 RMS Gradient 0.015 RMS Move 0.0000

Iteration 65 Steric Energy 147.816 RMS Gradient 0.014 RMS Move 0.0000

Iteration 70 Steric Energy 147.816 RMS Gradient 0.018 RMS Move 0.0000

Iteration 75 Steric Energy 147.816 RMS Gradient 0.017 RMS Move 0.0001

Iteration 80 Steric Energy 147.815 RMS Gradient 0.017 RMS Move 0.0001

Iteration 85 Steric Energy 147.815 RMS Gradient 0.017 RMS Move 0.0001

Iteration 90 Steric Energy 147.814 RMS Gradient 0.024 RMS Move 0.0002

Iteration 95 Steric Energy 147.813 RMS Gradient 0.021 RMS Move 0.0003

Iteration 100 Steric Energy 147.812 RMS Gradient 0.016 RMS Move 0.0002

Iteration 105 Steric Energy 147.811 RMS Gradient 0.030 RMS Move 0.0002

Iteration 110 Steric Energy 147.810 RMS Gradient 0.020 RMS Move 0.0001

Iteration 115 Steric Energy 147.809 RMS Gradient 0.035 RMS Move 0.0002

Iteration 120 Steric Energy 147.809 RMS Gradient 0.021 RMS Move 0.0000

Iteration 125 Steric Energy 147.808 RMS Gradient 0.019 RMS Move 0.0001

Iteration 130 Steric Energy 147.808 RMS Gradient 0.032 RMS Move 0.0001

Iteration 135 Steric Energy 147.807 RMS Gradient 0.019 RMS Move 0.0000

Iteration 140 Steric Energy 147.807 RMS Gradient 0.013 RMS Move 0.0000

Iteration 145 Steric Energy 147.806 RMS Gradient 0.019 RMS Move 0.0001

Iteration 150 Steric Energy 147.806 RMS Gradient 0.021 RMS Move 0.0001

Iteration 155 Steric Energy 147.805 RMS Gradient 0.018 RMS Move 0.0000

Iteration 160 Steric Energy 147.805 RMS Gradient 0.012 RMS Move 0.0000

Iteration 165 Steric Energy 147.805 RMS Gradient 0.010 RMS Move 0.0000

Iteration 165: Minimization terminated normally because the gradient norm is less than the minimum gradient norm

Stretch: 10.2587

Bend: 36.5067

Stretch-Bend: 3.5720

Torsion: 5.2563

Non-1,4 VDW: -33.5113

1,4 VDW: 98.2928

Dipole/Dipole: 27.4296

Total Energy: 147.8048 kcal/mol

Calculation ended

---------- Property Broker ----------

Model: D2-new

Molecular Networks: LogP = -1.40629 Log Units
