Electronic Supplementary Material (ESI) for ChemComm.


# A route to virtually unlimited functionalization of water-soluble p-sulfonatocalix[4]arenes

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# Supplementary Information

## Contents

## *Synthesis and characterization of novel compounds*

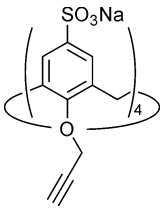
*General experimental methods:* NMR spectra were acquired on Bruker Avance 400 and Avance 600 instruments at 25 ºC if not stated otherwise, and chemical shifts are reported as ppm referenced to solvent signals. ESI mass spectra were obtained from Thermo Scientific LTQ Orbitrap and Sciex TripleTOF 5600+ spectrometers. Chemicals received from commercial sources were used without further purification. Hydrophilic/lipophilic sorbent LPS-500-H was purchased from Technosorbent. Solvents were purified and dried according to standard procedures. Calixarenes **1**,[S1] **7**,[S2] **8**,[S3] **9**,[S4] **10**,[S5] ethyl 2-azidoacetate,[S6] benzyl azide,[S7] 2-azidomethylnaphthalene,[S8] *N*-(*tert*-butoxycarbonyl)-L-phenylalanyl-$N^1$-[(1*S*)-2-azido-1-methyl-ethyl]-$N^2$-(2,4-dimethoxybenzyl)-2-methylalaninamide,[S9] and complex CuI·P(OEt)$_3$[S10] were prepared according to the published procedures.

*General procedure A (preparation of propargylated calixarene sulfonates):* To a stirred solution of a calixarene sulfonic acid/sulfonate in dimethyl sulfoxide a solution of sodium hydroxide in water was added and the mixture was stirred at room temperature for 10 min. Propargyl bromide was added and the reaction mixture was stirred at room temperature for 24 h. To the resulted homogeneous solution acetic acid (1.5 mmol per 1.0 mmol of sodium hydroxide used) was added. The mixture was stirred for 1 h, concentrated slightly under reduced pressure to remove water and volatile organics. Ethanol (5 ml per 1 ml of DMSO) was added to the resultant solution and the solid formed was collected, washed with ethanol and dried.

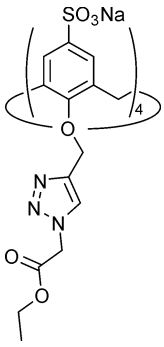
*General procedure B (preparation of triazolated calixarene sulfonates with removal of copper salts by re-complexation):* A mixture of a propargylated calixarene, an azide and CuI·P(OEt)$_3$ was suspended in a 1:4 (v/v) mixture of water with ethanol or 1,4-dioxane. The mixture was heated at stirring to nearly boiling temperature and ethanol or 1,4-dioxane was added until the reaction mixture turned nearly homogeneous. The mixture was refluxed at stirring for 6–24 h. The reaction was monitored by taking small aliquots of the reaction mixture, their concentration to dryness and acquiring $^1$H NMR spectra (in DMSO-$d_6$). When the conversion completed, the mixture was cooled to room temperature, concentrated to dryness under reduced pressure, and the residue was treated with hexane to remove most the lipophilic components. The solid residue was dissolved in 1:10 (v/v) water/ethanol mixture (100 ml per 1 mmol of starting calixarene), calixarene **7** (3 mmol per 1 mmol of starting calixarene) was added, and the resultant suspension was stirred at reflux for 2 h. After cooling, the solvents were evaporated to dryness, and the targeted water-soluble calixarene was washed out of the residue by de-ionized water. The purification procedure was repeated using a new portion of calixarene **7**. The resultant water

solution was concentrated to dryness, and the solid residue was washed with dichloromethane and dried.

*General procedure C (preparation of calixarene sulfonates with removal of copper salts by reverse-phase column separation):* The preparation steps were the same as described in *General procedure B*. After reaction completed, the solvents were removed under reduced pressure, the lipophilic compounds were washed out with hexane, and a solution of $Na_2S_2O_3 \cdot 5H_2O$ (3 mmol per 1 mmol of starting calixarene) in water (30 ml per 1 mmol of starting calixarene) was added to the residue. The mixture was stirred at room temperature for at least 2 h and then concentrated under reduced pressure. The resultant suspension was transferred into a column filled with wet LPS-500-H sorbent (50 ml per 1 mmol of starting calixarene). The water soluble inorganic compounds were eluted with 5 volumes (with respect to the sorbent volume) of de-ionized water, and the calixarene product was eluted with ethanol/water mixture (up to 1:1, v/v). The collected water/ethanol fractions were concentrated to dryness, and the resultant solid was washed once with diethyl ether and dried.

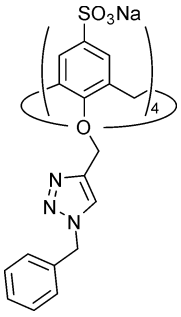



*Propargylated calix[4]arene sulfonate **2*** was prepared according to *General procedure A* from calixarene **1** (0.640 g, 0.86 mmol) and propargyl bromide (80% in toluene, 3.80 ml, 68.8 mmol) in the presence of sodium hydroxide (0.826 g, 20.64 mmol) in dimethyl sulfoxide (20 ml) and water (5 ml). Yield 0.770 g (91%), beige solid. M.p. ~ 220 °C (decomp.); $^1$H NMR (400 MHz, DMSO-$d_6$): δ = 7.19 (s, 8H; ArH), 4.85 (d, 8H, $^4J_{HH}$ = 2.4 Hz; $OCH_2$), 4.53 (d, 4H, $^2J_{HH}$ = 13.1 Hz; $ArCH_2Ar$), 3.51 (t, 4H, $^4J_{HH}$ = 2.4 Hz; CH), 3.30 (d, 4H, $^2J_{HH}$ = 13.1 Hz; $ArCH_2Ar$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 155.23, 142.58, 134.03 ($C_{Ar}$), 126.35 ($CH_{Ar}$), 80.24 (<u>C</u>CH), 78.30 (CH), 60.84 ($OCH_2$), 32.32 ($ArCH_2Ar$) ppm. ESI-MS *m*/*z*: 960.9087 $[M–Na]^-$ for $C_{40}H_{28}Na_3O_{16}S_4$ (960.9948).

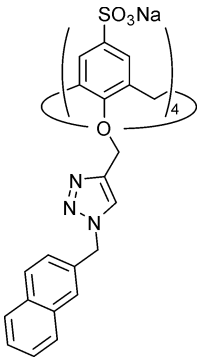



*Triazolated calix[4]arene sulfonate **3*** was prepared according to *General procedure B* from calixarene **2** (0.147 g, 0.15 mmol) and ethyl 2-azidoacetate (0.093 g, 0.72 mmol) in the presence of $CuI \cdot P(OEt)_3$ (0.032 g, 0.09 mmol) in the mixture of ethanol (10 ml) and water (1 ml) at heating for 6 h. Yield 0.168 g (75%), white solid. M. p. ~ 280 °C (decomp.). $^1$H NMR (400 MHz, DMSO-$d_6$): δ = 8.08 (s, 4H; $ArH_{Trz}$), 7.09 (s, 8H; ArH), 5.40 (s, 8H; $OCH_2Trz$ or $NCH_2$), 5.11 (s, 8H; $OCH_2Trz$ or $NCH_2$), 4.17 (q, 8H, $^3J_{HH}$ = 7.1 Hz; $C\underline{H}_2CH_3$), 4.09 (d, 4H, $^2J_{HH}$ = 12.4 Hz; $ArCH_2Ar$), 2.99 (d, 4H, $^2J_{HH}$ = 12.4 Hz; $ArCH_2Ar$), 1.20 (t, 12H, $^3J_{HH}$ = 7.1 Hz; $OCH_2C\underline{H}_3$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 167.17 (C=O), 155.35, 143.21 ($C_{Ar}$),

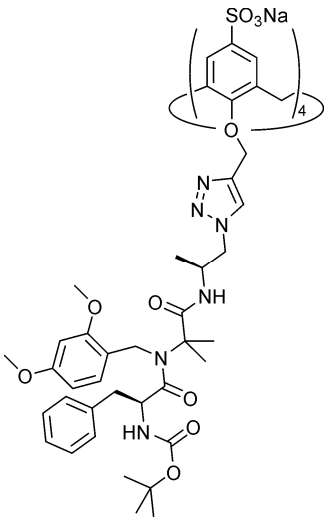
142.50 ($C_{Ar\ Trz}$), 133.73 ($C_{Ar}$), 126.20 ($CH_{Ar\ Trz}$), 125.91 ($CH_{Ar}$), 66.08 ($ArOCH_2$), 61.46 ($O\underline{C}H_2CH_3$), 50.34 ($NCH_2$), 31.45 ($ArCH_2Ar$), 13.93 ($OCH_2\underline{C}H_3$) ppm. ESI-MS *m*/*z*: 469.7510 $[M–4Na+H]^{3–}$ for $C_{56}H_{57}N_{12}O_{24}S_4$ (469.7503).



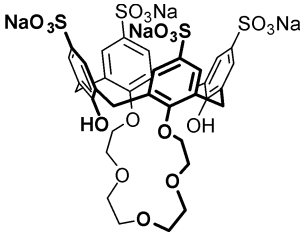

*Triazolated calix[4]arene sulfonate* ***4*** was prepared according to *General procedure B* from calixarene **2** (0.072 g, 0.07 mmol) and benzyl azide (0.2 M in toluene, 2.10 ml, 0.42 mmol) in the presence of $CuI{\cdot}P(OEt)_3$ (0.015 g, 0.042 mmol) in the mixture of 1,4-dioxane (5 ml) and water (1 ml) at heating for 8 h. Yield 0.070 g (66%), beige solid. M. p. ~ 250 °C (decomp.). $^1$H NMR (400 MHz, DMSO-$d_6$): δ = 8.07 (s, 4H; $ArH_{Trz}$), 7.36–7.21 (m, 12H; $ArH_{Ph}$), 7.19–7.10 (m, 8H; $ArH_{Ph}$), 7.02 (s, 8H; ArH), 5.55 (s, 8H; $OCH_2$ or $NCH_2$), 4.99 (s, 8H; $OCH_2$ or $NCH_2$), 4.01 (d, 4H, $^2J_{HH}$ = 12.8 Hz; $ArCH_2Ar$), 2.78 (d, 4H, $^2J_{HH}$ = 12.8 Hz; $ArCH_2Ar$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 155.23, 143.21 ($C_{Ar}$), 141.82 ($C_{Ar\ Trz}$), 136.04 ($C_{Ar\ Ph}$), 133.74 ($C_{Ar}$), 128.79 ($CH_{Ar\ Ph}$), 128.01 ($CH_{Ar\ Ph}$), 127.57 ($CH_{Ar\ Ph}$), 126.01 ($CH_{Ar}$), 125.28 ($CH_{Ar\ Trz}$), 65.61 ($OCH_2$), 52.73 ($NCH_2$), 31.77 ($ArCH_2Ar$) ppm. ESI-MS *m*/*z*: 475.0978 $[M–4Na+H]^{3–}$ for $C_{68}H_{57}N_{12}O_{16}S_4$ (475.0972).




*Triazolated calix[4]arene sulfonate* ***5*** was prepared according to *General procedure C* from calixarene **2** (0.130 g, 0.13 mmol) and 2-azidomethylnaphthalene (0.114 g, 0.62 mmol) in the presence of $CuI{\cdot}P(OEt)_3$ (0.010 g, 0.03 mmol) in the mixture of 1,4-dioxane (4 ml) and water (1 ml) at heating for 12 h. Yield 0.128 g (57%), light brown solid. M. p. > 300 °C. $^1$H NMR (400 MHz, DMSO-$d_6$): δ = 8.08 (s, 4H; $ArH_{Trz}$), 7.85–7.76 (m, 12H; $ArH_{Npht}$), 7.72 (m, 4H; $ArH_{Npht}$), 7.50–7.42 (m, 8H; $ArH_{Npht}$), 7.20–7.13 (m, 4H; $ArH_{Npht}$), 7.09 (s, 8H; ArH), 5.60 (s, 8H; $OCH_2$ or $NCH_2$), 5.00 (s, 8H; $OCH_2$ or $NCH_2$), 4.10 (d, 4H, $^2J_{HH}$ = 12.2 Hz; $ArCH_2Ar$), 2.92 (d, 4H, $^2J_{HH}$ = 12.2 Hz; $ArCH_2Ar$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 155.29, 143.23 ($C_{Ar}$), 141.93 ($C_{Ar\ Trz}$), 133.65 ($C_{Ar}$), 133.40, 132.64, 132.40 ($C_{Ar\ Npht}$), 128.55, 127.72, 127.58, 126.57, 126.48, 126.27, 125.96 ($CH_{Ar\ Npht}$), 125.32 ($CH_{Ar}$), 125.24 ($CH_{Ar\ Trz}$), 65.67 ($OCH_2$), 52.85 ($NCH_2$), 31.75 ($ArCH_2Ar$) ppm. ESI-MS *m*/*z*: 813.1805 $[M–4Na+2H]^{2–}$ for $C_{84}H_{66}N_{12}O_{16}S_4$ (813.1800).

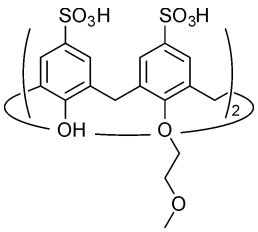


*Triazolated calix[4]arene sulfonate* ***6.*** A mixture of calixarene **2** (0.049 g, 0.05 mmol), *N*-(*tert*-butoxycarbonyl)-L-phenylalanyl-$N^1$-[(1*S*)-2-azido-1-methylethyl]-$N^2$-(2,4-dimethoxybenzyl)-2-methylalaninamide (0.175 g, 0.30 mmol), CuI·P(OEt)$_3$ (0.011 g, 0.03 mmol), ethanol (6 ml) and water (1 ml) was stirred at reflux for 8 h. After cooling, the solvents were removed under reduced pressure and the residue was dissolved in dichloromethane. The solution was washed continuously with aqueous $Na_2S_2O_3$ (5%), water, dried by $MgSO_4$ and then evaporated to almost dryness. Hexane was added, and the solid formed was collected, washed with hexane and dried. Yield 0.107 g (65%), white solid. M. p. ~ 270 °C (decomp.). $^1$H NMR (600 MHz, DMSO-$d_6$, 75 °C): δ = 7.98 (s, 4H; $ArH_{Trz}$), 7.41 (d, 4H, $^3J_{HH}$ = 8.2 Hz; $ArH_{DMB}$), 7.19–7.10 (m, 12H; $ArH_{Ph}$), 7.07 (d, 4H, $^4J_{HH}$ = 2.1 Hz; ArH), 7.06 (d, 4H, $^4J_{HH}$ = 2.1 Hz; ArH), 7.04–7.00 (m, 8H; $ArH_{Ph}$), 6.83 (d, 4H, $^3J_{HH}$ = 7.7 Hz; $CH_3CHN\underline{H}$), 6.56 (d, 4H, $^4J_{HH}$ = 2.2 Hz; $ArH_{DMB}$), 6.48 (dd, 4H, $^3J_{HH}$ = 8.2 Hz, $^4J_{HH}$ = 2.2 Hz; $ArH_{DMB}$), 6.38 (bs, 4H; $PhCH_2CHN\underline{H}$), 5.20 (d, 4H, $^2J_{HH}$ = 12.2 Hz; $OCH_2Trz$), 5.13 (d, 4H, $^2J_{HH}$ = 12.2 Hz; $OCH_2Trz$), 4.73 (d, 4H, $^2J_{HH}$ = 17.5 Hz; $NCH_{2\,DMB}$), 4.48–4.29 (m, 18H; $TrzC\underline{H}_2CH$, $NCH_{2\,DMB}$, $ArCH_2Ar$, $PhCH_2C\underline{H}$), 4.27 (d, 2H, $^2J_{HH}$ = 13.0 Hz; $ArCH_2Ar$), 4.13 (m, 4H; $CH_3C\underline{H}$), 3.79 (s, 12H; $OCH_{3\,DMB}$), 3.75 (s, 12H; $OCH_{3\,DMB}$), 2.96 (d, 2H, $^2J_{HH}$ = 13.0 Hz; $ArCH_2Ar$), 2.94–2.89 (m, 6H; $ArCH_2Ar$, $PhCH_2$), 2.69 (m, 4H; $PhCH_2$), 1.28 (s, 12H; $C(CH_3)_2$), 1.25 (s, 12H; $C(CH_3)_2$), 1.21 (bs, 36H; $OC(CH_3)_3$), 0.95 (d, 12H, $^3J_{HH}$ = 6.8 Hz; $C\underline{H}_3CH$) ppm; $^{13}$C NMR (150 MHz, DMSO-$d_6$, 75 °C): δ = 173.28, 172.05 (C=O), 159.45, 156.63 ($C_{Ar\ DMB}$), 154.55 ($CONH_{Boc}$), 142.46 ($C_{Ar}$), 141.82 ($C_{Ar\ Trz}$), 137.67 ($C_{Ar\ Ph}$), 133.46, 133.36 ($C_{Ar}$), 128.81 ($CH_{Ar\ Ph}$), 127.92 ($CH_{Ar\ DMB}$), 127.45, 125.63 ($CH_{Ar\ Ph}$), 125.38, 125.26 ($CH_{Ar}$), 124.99 ($CH_{Ar\ Trz}$), 118.66 ($C_{Ar\ DMB}$), 104.61, 98.22 ($CH_{Ar\ DMB}$), 77.73 ($O\underline{C}(CH_3)_3$), 65.45 ($OCH_2$), 61.73 ($\underline{C}(CH_3)_2$), 55.14, 54.92 ($OCH_3$), 53.19 ($PhCH_2\underline{C}H$), 52.83 ($Trz\underline{C}H_2CH$), 44.99 ($CH_3\underline{C}H$), 41.53 ($NCH_{2\,DMB}$), 37.79 ($PhCH_2$), 31.20 ($ArCH_2Ar$), 27.56 ($OC(\underline{C}H_3)_3$), 23.58, 22.73 ($C(\underline{C}H_3)_2$), 16.52 ($\underline{C}H_3CH$) ppm. ESI-MS *m*/*z*: 1074.4360 $[M–4Na+H]^{3-}$ for $C_{160}H_{197}N_{24}O_{40}S_4$ (1074.4351).

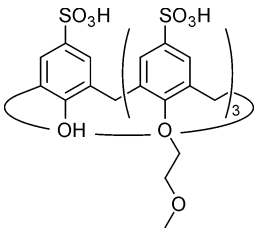


*Calix[4]arene sulfonate* ***11.*** A suspension of calixarene **8** (0.201 g, 0.25 mmol) in sulfuric acid (96%, 1.39 ml, 25.0 mmol) was stirred at room temperature for 24 h. The resultant solution was cooled (ice bath), and cooled diethyl ether (40 ml) was slowly added with stirring. The ether layer was decanted, the resulting oil was washed twice with ether and dissolved in aqueous sodium hydroxide (1 M, 3 ml). The solution was concentrated under reduced pressure, ethanol was added and the precipitate formed was collected, washed with

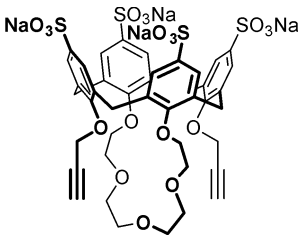
ethanol, dried and dissolved in water (1 ml). Acetic acid (0.34 ml, 6.0 mmol) was added and the mixture was stirred for 10 min. The solid formed upon addition of ethanol was collected, washed with ethanol and dried. Yield 0.225 g (91%), beige solid. M. p. > 300 °C; $^{1}$H NMR (400 MHz, DMSO-$d_6$): δ = 7.92 (s, 2H; OH), 7.41 (s, 4H; ArH), 7.19 (s, 4H; ArH), 4.29 (d, 4H, $^{2}J_{HH}$ = 13.1 Hz; $ArCH_2Ar$), 4.06–3.99 (m, 4H; $OCH_2$), 3.99–3.93 (m, 4H; $OCH_2$), 3.85–3.78 (m, 4H; $OCH_2$), 3.74–3.67 (m, 4H; $OCH_2$), 3.46 (d, 4H, $^{2}J_{HH}$ = 13.1 Hz; $ArCH_2Ar$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 153.79, 152.65, 143.51, 138.80, 131.98 ($C_{Ar}$), 126.60, 126.41 ($CH_{Ar}$), 125.97 ($C_{Ar}$), 76.78, 70.27, 70.08, 69.48 ($OCH_2$), 30.65 ($ArCH_2Ar$) ppm. ESI-MS *m*/*z*: 967.0262 $[M–Na]^-$ для $C_{36}H_{34}Na_3O_{19}S_4$ (967.0270).



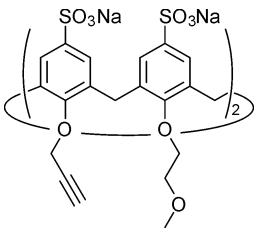

*Calix[4]arene sulfonic acid* ***12***. A solution of calixarene **9** (0.108 g, 0.20 mmol) in sulfuric acid (96%, 1.0 ml, 18.0 mmol) was stirred at room temperature for 24 h. Diethyl ether (20 ml) was slowly added to the cooled (ice bath) reaction mixture. The ether layer was decanted and a new portion of diethyl ether (10 ml) was added. The mixture was allowed to stay overnight at room temperature, and the solid formed was collected, washed with ether and dried. Yield 0.140 g (81%), pale pink solid. M. p. ~ 205 °C (decomp.); $^{1}$H NMR (400 MHz, DMSO-$d_6$): δ = 7.99 (s, 2H; OH), 7.55 (s, 4H; ArH), 7.19 (s, 4H; ArH), 4.23 (d, 4H, $^{2}J_{HH}$ = 13.2 Hz; $ArCH_2Ar$), 4.14–4.08 (m, 4H; $OCH_2$), 3.81–3.75 (m, 4H; $OCH_2$), 3.57 (d, 4H, $^{2}J_{HH}$ = 13.2 Hz; $ArCH_2Ar$), 3.45 (s, 6H; $OCH_3$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 154.57, 153.00, 143.15, 136.84, 133.21, 127.19 ($C_{Ar}$), 126.77, 126.70 ($CH_{Ar}$), 76.06, 71.12 ($OCH_2$), 58.98 ($OCH_3$), 30.53 ($ArCH_2Ar$) ppm. ESI-MS *m*/*z*: 429.0316 $[M–2H]^{2–}$ for $C_{34}H_{34}O_{18}S_4$ (429.0319).



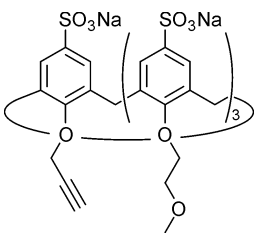

*Calix[4]arene sulfonic acid* ***13*** was prepared as described for calixarene **12** from calixarene **10** (0.480 g, 0.80 mmol) and sulfuric acid (96%, 4.0 ml, 71.9 mmol). Yield 0.63 g (85%), pale pink solid. M. p. > 300 °C; $^{1}$H NMR (400 MHz, DMSO-$d_6$): δ = 7.46 (s, 2H; ArH), 7.37 (s, 2H; ArH), 7.08 (d, 2H, $^{4}J_{HH}$ = 1.9 Hz; ArH), 7.05 (d, 2H, $^{4}J_{HH}$ = 1.9 Hz; ArH), 6.80 (s, 1H; OH), 4.43 (d, 2H, $^{2}J_{HH}$ = 12.9 Hz; $ArCH_2Ar$), 4.27 (d, 2H, $^{2}J_{HH}$ = 12.9 Hz; $ArCH_2Ar$), 4.18–4.12 (m, 2H; $OCH_2$), 4.07–4.01 (m, 2H; $OCH_2$), 4.00–3.94 (m, 4H; $OCH_2$), 3.77–3.70 (m, 2H; $OCH_2$), 3.69–3.63 (m, 2H; $OCH_2$), 3.44–3.30 (m, 13H; $OCH_3$+$ArCH_2Ar$; overlapped with water signal) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 156.49, 154.27, 153.81, 143.07, 142.16, 138.58, 134.84, 132.65, 131.61 ($C_{Ar}$), 126.83 ($CH_{Ar}$), 126.69 ($C_{Ar}$), 126.40, 126.25 ($CH_{Ar}$), 75.13, 71.46, 70.72, 70.37 ($OCH_2$), 58.27 ($OCH_3$), 30.63 ($ArCH_2Ar$) ppm. ESI-MS *m*/*z*: 458.0533 $[M–2H]^{2–}$ for $C_{37}H_{40}O_{19}S_4$ (458.0529).



*Propargylated calix[4]arene sulfonate* ***14*** was prepared according to *General procedure A* from calixarene **11** (0.099 g, 0.10 mmol) and propargyl bromide (80% in toluene, 0.460 ml, 4.00 mmol) in the presence of sodium hydroxide (0.096 g, 2.40 mmol) in dimethyl sulfoxide (4 ml) and water (1 ml). Yield 0.087 g (82%), beige solid. M. p. > 300 °C. $^{1}$H NMR (400 MHz, DMSO-$d_6$): δ = 7.41 (s, 4H; ArH), 6.95 (s, 4H; ArH), 5.53 (d, 4H, $^{4}J_{HH}$ = 2.0 Hz; OC<u>H</u>$_2$CCH), 4.40 (d, 4H, $^{2}J_{HH}$ = 12.7 Hz; ArC<u>H</u>$_2$Ar), 3.97–3.90 (m, 4H; OC<u>H</u>$_2$CH$_2$), 3.82–3.76 (m, 4H; OC<u>H</u>$_2$CH$_2$), 3.74–3.68 (m, 4H; OC<u>H</u>$_2$CH$_2$), 3.64–3.58 (m, 4H; OC<u>H</u>$_2$CH$_2$), 3.26 (d, 4H, $^{2}J_{HH}$ = 12.7 Hz; ArC<u>H</u>$_2$Ar), 3.15 (t, 2H, $^{4}J_{HH}$ = 2.0 Hz; OCH$_2$CC<u>H</u>) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 156.16, 155.10, 142.99, 141.08, 136.10, 132.01 (C$_{Ar}$), 126.03, 125.92 (CH$_{Ar}$), 81.69 (<u>C</u>CH), 77.95 (C<u>C</u>H), 73.72, 70.81, 69.88, 69.71 (CH$_2$CH$_2$), 58.34 (<u>C</u>H$_2$CCH), 31.72 (ArCH$_2$Ar) ppm. ESI-MS *m*/*z*: 488.0532 [M–4Na+2H]$^{2-}$ for $C_{42}H_{40}O_{19}S_4$ (488.0529).

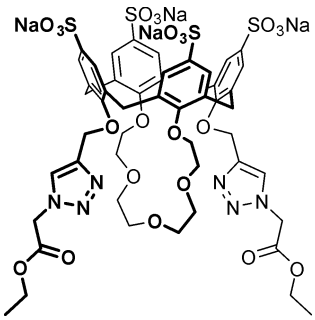


*Propargylated calix[4]arene sulfonate* ***15*** was prepared according to *General procedure A* from calixarene **12** (0.430 g, 0.50 mmol) and propargyl bromide (80% in toluene, 1.12 ml, 10.0 mmol) in the presence of sodium hydroxide (1.20 g, 30.0 mmol) in dimethyl sulfoxide (8 ml) and water (2 ml). Yield 0.460 g (90%), beige solid. M. p. > 300 °C. $^{1}$H NMR (400 MHz, DMSO-$d_6$): δ = 7.43 (s, 4H; ArH), 6.91 (s, 4H; ArH), 5.18 (d, 4H, $^{4}J_{HH}$ = 2.4 Hz; OC<u>H</u>$_2$CCH), 4.52 (d, 4H, $^{2}J_{HH}$ = 13.0 Hz; ArC<u>H</u>$_2$Ar), 3.87–3.78 (m, 8H; CH$_2$CH$_2$), 3.38 (s, 6H; OCH$_3$), 3.36 (t, 2H, $^{4}J_{HH}$ = 2.4 Hz; OCH$_2$CC<u>H</u>), 3.26 (d, 4H, $^{2}J_{HH}$ = 13.0 Hz; ArC<u>H</u>$_2$Ar) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 156.01, 155.36, 143.20, 141.17, 135.86, 132.09 (C$_{Ar}$), 126.37, 126.27 (CH$_{Ar}$), 81.02 (<u>C</u>CH), 78.15 (C<u>C</u>H), 74.10, 71.40 (CH$_2$CH$_2$), 58.88 (<u>C</u>H$_2$CCH), 58.18 (OCH$_3$), 31.57 (ArCH$_2$Ar) ppm. ESI-MS *m*/*z*: 935.1022 [M–4Na+3H]$^{-}$ for $C_{40}H_{39}O_{18}S_4$ (935.1025).

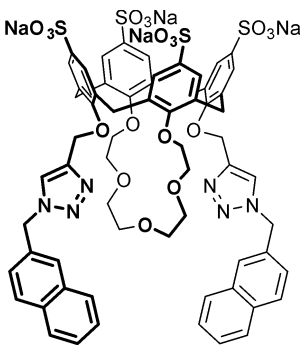


*Propargylated calix[4]arene sulfonate* ***16*** was prepared according to *General procedure A* from calixarene **13** (0.101 g, 0.11 mmol) and propargyl bromide (80% in toluene, 0.120 ml, 1.10 mmol) in the presence of sodium hydroxide (0.220 g, 5.50 mmol) in dimethyl sulfoxide (2 ml) and water (0.5 ml). Yield 0.058 g (50%), beige solid. M. p. > 300 °C. $^{1}$H NMR (400 MHz, DMSO-$d_6$): δ = 7.38 (s, 2H; ArH), 7.37 (s, 2H; ArH), 6.96 (d, 2H, $^{4}J_{HH}$ = 2.0 Hz; ArH), 6.91 (d, 2H, $^{4}J_{HH}$ = 2.0 Hz; ArH), 5.17 (d, 2H, $^{4}J_{HH}$ = 2.4 Hz; OC<u>H</u>$_2$CCH), 4.52 (d, 2H, $^{2}J_{HH}$ = 12.7 Hz; ArC<u>H</u>$_2$Ar), 4.47 (d, 2H, $^{2}J_{HH}$ = 12.7 Hz; ArC<u>H</u>$_2$Ar), 4.35–4.31 (m, 2H;

$CH_2CH_2$), 3.95–3.88 (m, 2H; $CH_2CH_2$), 3.87–3.80 (m, 4H; $CH_2CH_2$), 3.79–3.74 (m, 4H; $CH_2CH_2$), 3.36 (s, 6H; $OCH_3$), 3.35 (t, 1H, $^4J_{HH}$ = 2.4 Hz; CH), 3.30 (s, 3H; $OCH_3$), 3.25 (d, 4H, $^2J_{HH}$ = 13.2 Hz; $ArCH_2Ar$) ppm; $^{13}C$ NMR (100 MHz, DMSO-$d_6$): δ = 157.58, 156.00, 155.15, 143.00, 142.29, 141.23, 135.67, 134.47, 132.29, 132.17 ($C_{Ar}$), 126.37, 126.23, 126.01 ($CH_{Ar}$), 81.21 (CCH), 77.92 (CCH), 74.13, 72.64, 71.25, 71.20 ($CH_2CH_2$), 58.73 ($CH_2CCH$), 58.13, 58.03 ($OCH_3$), 31.67, 30.73 ($ArCH_2Ar$) ppm. ESI-MS *m*/*z*: 477.0610 $[M–4Na+2H]^{2–}$ for $C_{40}H_{42}O_{19}S_4$ (477.0607).

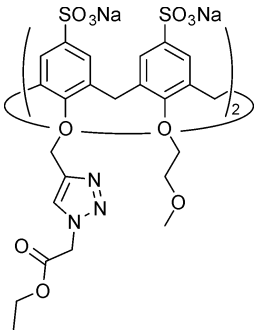



*Triazolated calix[4]arene sulfonate* ***17*** was prepared according to *General procedure B* from calixarene **14** (0.053 g, 0.05 mmol) and ethyl 2-azidoacetate (0.020 g, 0.15 mmol) in the presence of CuI·P(OEt)$_3$ (0.008 g, 0.022 mmol) in the mixture of ethanol (5 ml) and water (1 ml) at heating for 8 h. Yield 0.047 g (71%), white solid. M. p. > 300 °C. $^1H$ NMR (400 MHz, DMSO-$d_6$): δ = 8.13 (s, 2H; $ArH_{Trz}$), 7.19 (s, 4H; ArH), 6.97 (s, 4H; ArH), 6.16 (s, 4H; $OCH_2Trz$ or $NCH_2$), 5.28 (s, 4H; $OCH_2Trz$ or $NCH_2$), 4.49 (d, 4H, $^2J_{HH}$ = 12.5 Hz; $ArCH_2Ar$), 4.15 (q, 4H, $^3J_{HH}$ = 7.2 Hz; $OCH_2CH_3$), 4.15–4.08 (m, 4H; $OCH_2$), 4.01–3.92 (m, 4H; $OCH_2$), 3.59–3.51 (m, 4H; $OCH_2$), 3.23–3.15 (m, 4H; $OCH_2$), 3.16 (d, 4H, $^2J_{HH}$ = 12.5 Hz; $ArCH_2Ar$), 1.19 (t, 6H, $^3J_{HH}$ = 7.2 Hz; $OCH_2CH_3$) ppm; $^{13}C$ NMR (100 MHz, $D_2O$): δ = 168.03 (C=O), 157.65, 155.85 ($C_{Ar}$), 143.03 ($C_{Ar\ Trz}$), 137.23, 137.13, 136.68, 133.43 ($C_{Ar}$), 127.72 ($CH_{Ar\ Trz}$), 125.54, 125.43 ($CH_{Ar}$), 72.86, 70.42, 69.82 ($OCH_2CH_2$), 62.87 ($OCH_2CH_3$), 62.56 ($OCH_2Trz$), 50.53 ($NCH_2$), 31.15 ($ArCH_2Ar$), 12.94 ($CH_3$). ESI-MS *m*/*z*: 639.0884 $[M–2Na]^{2–}$ for $C_{50}H_{52}Na_2N_6O_{23}S_4$ (639.0887).

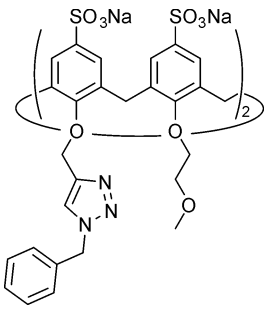



*Triazolated calix[4]arene sulfonate* ***18*** was prepared according to *General procedure C* from calixarene **14** (0.035 g, 0.03 mmol) and 2-azidomethylnaphthalene (0.015 g, 0.08 mmol) in the presence of CuI·P(OEt)$_3$ (0.003 g, 0.007 mmol) in the mixture of 1,4-dioxane (2 ml) and water (0.5 ml) at heating for 12 h. Yield 0.031 g (62%), brown solid. M. p. > 300 °C. $^1H$ NMR (400 MHz, DMSO-$d_6$): δ = 8.10 (s, 2H; $ArH_{Trz}$), 8.04–7.99 (m, 2H; $ArH_{Npht}$), 7.93–7.86 (m, 4H; $ArH_{Npht}$), 7.74–7.71 (m, 2H; $ArH_{Npht}$), 7.55–7.49 (m, 4H; $ArH_{Npht}$), 7.28 (s, 4H; ArH), 7.05–7.00 (m, 2H; $ArH_{Npht}$), 6.95 (s, 4H; ArH), 6.09 (s, 4H; $OCH_2Trz$ or $NCH_2$), 5.67 (s, 4H; $OCH_2Trz$ or $NCH_2$), 4.42 (d, 4H, $^2J_{HH}$ = 12.3 Hz; $ArCH_2Ar$), 3.97–3.88 (m, 4H; $OCH_2$), 3.81–3.72 (m, 4H; $OCH_2$), 3.34–3.25 (m, 4H; $OCH_2$), 3.11 (d, 4H, $^2J_{HH}$ = 12.3 Hz; $ArCH_2Ar$), 3.02–2.91 (m, 4H; $OCH_2$) ppm; $^{13}C$ NMR (100 MHz, DMSO-$d_6$): δ = 156.75, 155.11, 143.82 ($C_{Ar}$), 142.04 ($C_{Ar\ Trz}$), 140.84,

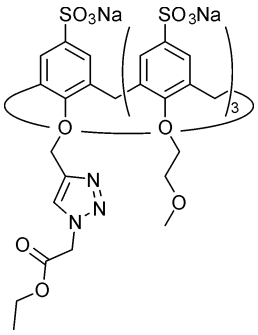
135.86, 133.74 ($C_{Ar}$), 132.76, 132.51, 132.13 ($C_{Ar\ Npht}$), 128.93, 127.77, 127.67, 126.51, 126.41, 126.26, 126.04 ($CH_{Ar\ Npht}$), 125.97, 125.73 ($CH_{Ar}$), 125.37 ($CH_{Ar\ Trz}$), 73.51, 70.50, 69.68, 69.55 ($OCH_2CH_2$), 62.26 ($OCH_2Trz$), 52.68 ($NCH_2$), 32.11 ($ArCH_2Ar$). ESI-MS *m*/*z*: 671.1326 $[M–4Na+2H]^{2–}$ for $C_{64}H_{58}N_6O_{19}S_4$ (671.1325).



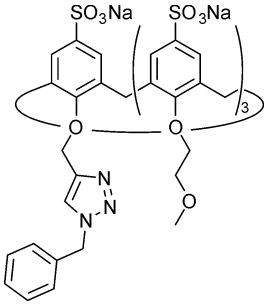
*Triazolated calix[4]arene sulfonate **19*** was prepared according to *General procedure C* from calixarene **15** (0.051 g, 0.05 mmol) and ethyl 2-azidoacetate (0.031 g, 0.24 mmol) in the presence of $CuI{\cdot}P(OEt)_3$ (0.018 g, 0.05 mmol) in the mixture of ethanol (5 ml) and water (0.5 ml) at heating for 8 h. Yield 0.027 g (42%), white solid. M. p. > 300 °C. $^1$H NMR (400 MHz, DMSO-$d_6$): δ = 8.04 (s, 2H; $ArH_{Trz}$), 7.15 (s, 4H; ArH), 7.05 (s, 4H; ArH), 5.42 (s, 4H; $OCH_2Trz$ or $NCH_2$), 5.38 (s, 4H; $OCH_2Trz$ or $NCH_2$), 4.35 (d, 4H, $^2J_{HH}$ = 12.7 Hz; $ArCH_2Ar$), 4.18 (q, 4H, $^3J_{HH}$ = 7.1 Hz; $C\underline{H}_2CH_3$), 3.95–3.88 (m, 4H; $CH_2CH_2$), 3.72–3.57 (m, 4H; $CH_2CH_2$), 3.24 (s, 6H; $OCH_3$), 3.14 (d, 4H, $^2J_{HH}$ = 12.7 Hz; $ArCH_2Ar$), 1.21 (t, 6H, $^3J_{HH}$ = 7.1 Hz; $CH_2C\underline{H}_3$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 167.24 (C=O), 156.65, 155.28 ($C_{Ar}$), 143.18 ($C_{Ar\ Trz}$), 142.11, 141.42 ($C_{Ar}$), 134.31, 132.93 ($C_{Ar}$), 126.33 ($CH_{Ar\ Trz}$), 126.11, 126.03 ($CH_{Ar}$), 73.47, 71.17 ($CH_2CH_2$), 65.28 ($OCH_2Trz$), 61.51 ($\underline{C}H_2CH_3$), 57.96 ($OCH_3$), 50.34 ($NCH_2$), 31.32 ($ArCH_2Ar$), 14.05 ($CH_2\underline{C}H_3$) ppm. ESI-MS *m*/*z*: 596.1019 $[M–4Na+2H]^{2–}$ for $C_{48}H_{52}N_6O_{22}S_4$ (596.1014).



*Triazolated calix[4]arene sulfonate **20*** was prepared according to *General procedure C* from calixarene **15** (0.051 g, 0.05 mmol) and benzyl azide (0.032 g, 0.24 mmol) in the presence of $CuI{\cdot}P(OEt)_3$ (0.018 g, 0.05 mmol) in the mixture of ethanol (5 ml) and water (0.5 ml) at heating for 8 h. Yield 0.023 g (36%), white solid. M. p. > 300 °C. $^1$H NMR (400 MHz, DMSO-$d_6$): δ = 7.98 (s, 2H; $ArH_{Trz}$), 7.43–7.37 (m, 4H; $ArH_{Ph}$), 7.34–7.28 (m, 2H; $ArH_{Ph}$), 7.18–7.14 (m, 8H; $ArH_{Ph}$+ArH), 7.00 (s, 4H; ArH), 5.57 (s, 4H; $OCH_2Trz$ or $NCH_2$), 5.42 (s, 4H; $OCH_2Trz$ or $NCH_2$), 4.28 (d, 4H, $^2J_{HH}$ = 13.0 Hz; $ArCH_2Ar$), 3.82–3.76 (m, 4H; $CH_2CH_2$), 3.64–3.58 (m, 4H; $CH_2CH_2$), 3.15 (s, 6H; $OCH_3$), 3.04 (d, 4H, $^2J_{HH}$ = 13.0 Hz; $ArCH_2Ar$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 156.56, 155.10 ($C_{Ar}$), 143.25 ($C_{Ar\ Trz}$), 142.22, 141.31 ($C_{Ar}$), 136.16 ($C_{Ar\ Ph}$), 134.62, 132.70 ($C_{Ar}$), 128.88, 128.00, 127.63 ($CH_{Ar\ Ph}$), 126.07, 126.00 ($CH_{Ar}$), 125.19 ($CH_{Ar\ Trz}$), 73.48, 71.11 ($CH_2CH_2$), 64.83 ($OCH_2Trz$), 57.90 ($OCH_3$), 52.64 ($NCH_2$), 31.36 ($ArCH_2Ar$) ppm. ESI-MS *m*/*z*: 600.1119 $[M–4Na+2H]^{2–}$ for $C_{54}H_{52}N_6O_{18}S_4$ (600.1116).



*Triazolated calix[4]arene sulfonate **21*** was prepared according to *General procedure C* from calixarene **16** (0.026 g, 0.025 mmol) and ethyl 2-azidoacetate (0.016 g, 0.125 mmol) in the presence of CuI·P(OEt)$_3$ (0.009 g, 0.025 mmol) in the mixture of 1,4-dioxane (4 ml) and water (1 ml) at heating for 24 h. Yield 0.020 g (69%), white solid. M. p. > 300 °C. $^1$H NMR (400 MHz, DMSO-$d_6$): δ = 8.04 (s, 1H; ArH$_{Trz}$), 7.19 (s, 2H; ArH), 7.15–7.10 (m, 6H; ArH), 5.38 (s, 2H; OCH$_2$Trz or NCH$_2$), 5.31 (s, 2H; OCH$_2$Trz or NCH$_2$), 4.48 (d, 2H, $^2J_{HH}$ = 12.8 Hz; ArCH$_2$Ar), 4.34 (d, 2H, $^2J_{HH}$ = 12.8 Hz; ArCH$_2$Ar), 4.22–4.15 (m, 4H; C$\underline{H}_2$CH$_3$+CH$_2$CH$_2$), 4.04–3.99 (m, 4H; CH$_2$CH$_2$), 3.85–3.81 (m, 2H; CH$_2$CH$_2$), 3.80–3.75 (m, 2H; CH$_2$CH$_2$), 3.74–3.68 (m, 2H; CH$_2$CH$_2$), 3.32 (s, 3H; OCH$_3$), 3.28 (s, 6H; OCH$_3$), 3.24 (d, 2H, $^2J_{HH}$ = 12.8 Hz; ArCH$_2$Ar), 3.16 (d, 2H, $^2J_{HH}$ = 12.8 Hz; ArCH$_2$Ar), 1.22 (t, 3H, $^3J_{HH}$ = 7.1 Hz; CH$_2$C$\underline{H}_3$) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 167.20 (C=O), 156.57, 155.04, 143.03, 141.99 (C$_{Ar}$), 141.83 (C$_{Ar\ Trz}$), 141.63, 134.04, 133.52, 133.20, 133.17 (C$_{Ar}$), 126.25, 126.10, 126.01 (CH$_{Ar}$+CH$_{Ar\ Trz}$), 73.25, 73.11, 71.16, 71.11 (CH$_2$CH$_2$), 65.48 (OCH$_2$Trz), 61.49 ($\underline{C}$H$_2$CH$_3$), 57.99, 57.96 (OCH$_3$), 50.32 (NCH$_2$), 31.21, 30.68 (ArCH$_2$Ar), 14.02 (CH$_2\underline{C}$H$_3$) ppm. ESI-MS *m*/*z*: 563.5697 [M–2Na]$^{2-}$ for C$_{44}$H$_{47}$N$_3$Na$_2$O$_{21}$S$_4$ (563.5696).



*Triazolated calix[4]arene sulfonate **22*** was prepared according to *General procedure C* from calixarene **16** (0.026 g, 0.025 mmol) and benzyl azide (0.017 g, 0.125 mmol) in the presence of CuI·P(OEt)$_3$ (0.009 g, 0.025 mmol) in the mixture of 1,4-dioxane (4 ml) and water (1 ml) at heating for 24 h. Yield 0.012 g (41%), white solid. M. p. > 300 °C. $^1$H NMR (400 MHz, DMSO-$d_6$): δ = 8.00 (s, 1H; ArH$_{Trz}$), 7.44–7.38 (m, 2H; ArH$_{Ph}$), 7.35–7.30 (m, 1H; ArH$_{Ph}$), 7.21–7.19 (m, 2H; ArH$_{Ph}$), 7.18 (s, 2H; ArH), 7.13 (s, 2H; ArH), 7.11 (d, 2H, $^4J_{HH}$ = 2.0 Hz; ArH), 7.08 (d, 2H, $^4J_{HH}$ = 2.0 Hz; ArH), 5.59 (s, 2H; OCH$_2$Trz or NCH$_2$), 5.30 (s, 2H; OCH$_2$Trz or NCH$_2$), 4.46 (d, 2H, $^2J_{HH}$ = 12.6 Hz; ArCH$_2$Ar), 4.29 (d, 2H, $^2J_{HH}$ = 12.6 Hz; ArCH$_2$Ar), 4.21–4.15 (m, 2H; CH$_2$CH$_2$), 3.98–3.92 (m, 4H; CH$_2$CH$_2$), 3.84–3.79 (m, 2H; CH$_2$CH$_2$), 3.76–3.69 (m, 2H; CH$_2$CH$_2$), 3.68–3.61 (m, 2H; CH$_2$CH$_2$), 3.31 (s, 3H; OCH$_3$), 3.23 (s, 6H; OCH$_3$), 3.22 (d, 2H, $^2J_{HH}$ = 13.0 Hz; ArCH$_2$Ar), 3.07 (d, 2H, $^2J_{HH}$ = 13.0 Hz; ArCH$_2$Ar) ppm; $^{13}$C NMR (100 MHz, DMSO-$d_6$): δ = 156.43, 154.77, 143.13, 142.05 (C$_{Ar}$), 141.83 (C$_{Ar\ Trz}$), 141.62 (C$_{Ar}$), 136.07 (C$_{Ar\ Ph}$), 134.02, 133.43, 133.09, 133.05 (C$_{Ar}$), 128.77, 127.98, 127.64 (CH$_{Ar\ Ph}$), 125.98, 125.90, 125.87 (CH$_{Ar}$), 124.98 (CH$_{Ar\ Trz}$), 73.12, 72.98, 71.11, 71.02 (CH$_2$CH$_2$), 65.41 (OCH$_2$Trz), 57.94, 57.87 (OCH$_3$), 52.65 (NCH$_2$), 31.09, 30.59 (ArCH$_2$Ar) ppm. ESI-MS *m*/*z*: 543.5932 [M–4Na+2H]$^{2-}$ for C$_{47}$H$_{49}$N$_3$O$_{19}$S$_4$ (543.5927).

## *NMR spectra of novel compounds*

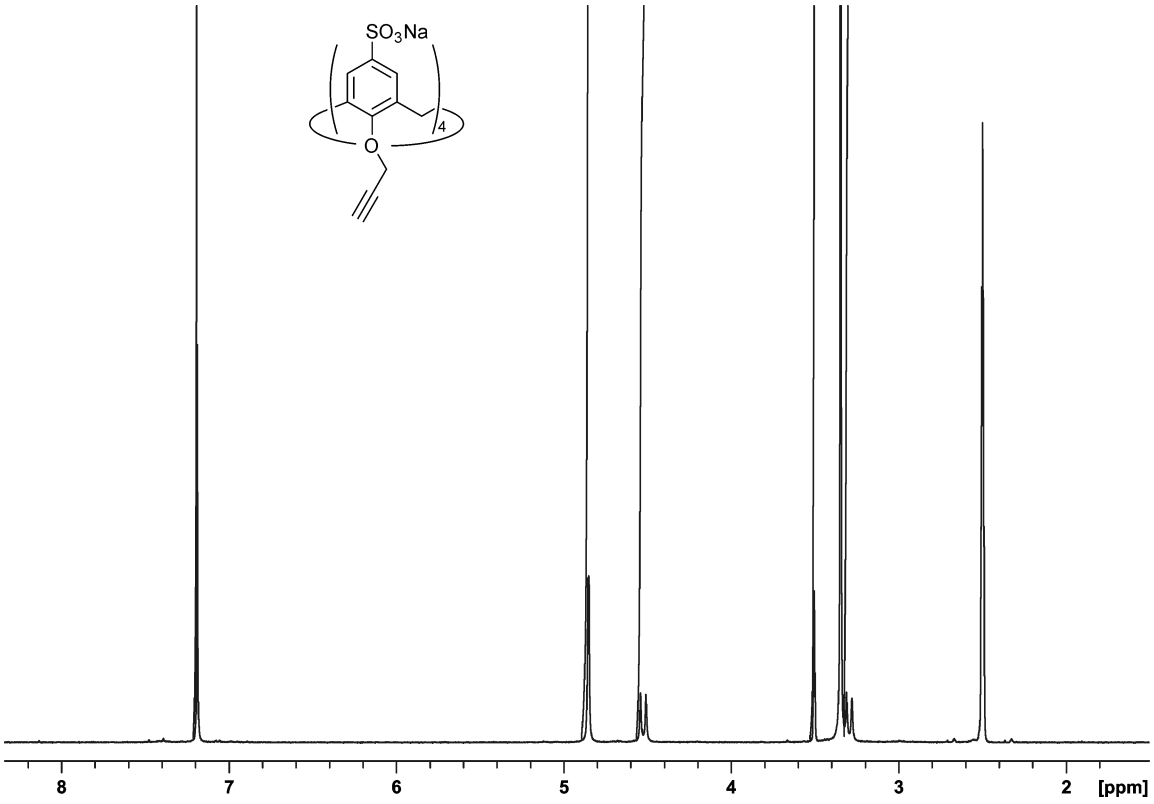



**Figure S1.** $^{1}$H NMR spectrum of calixarene **2** (400 MHz, DMSO-$d_6$).

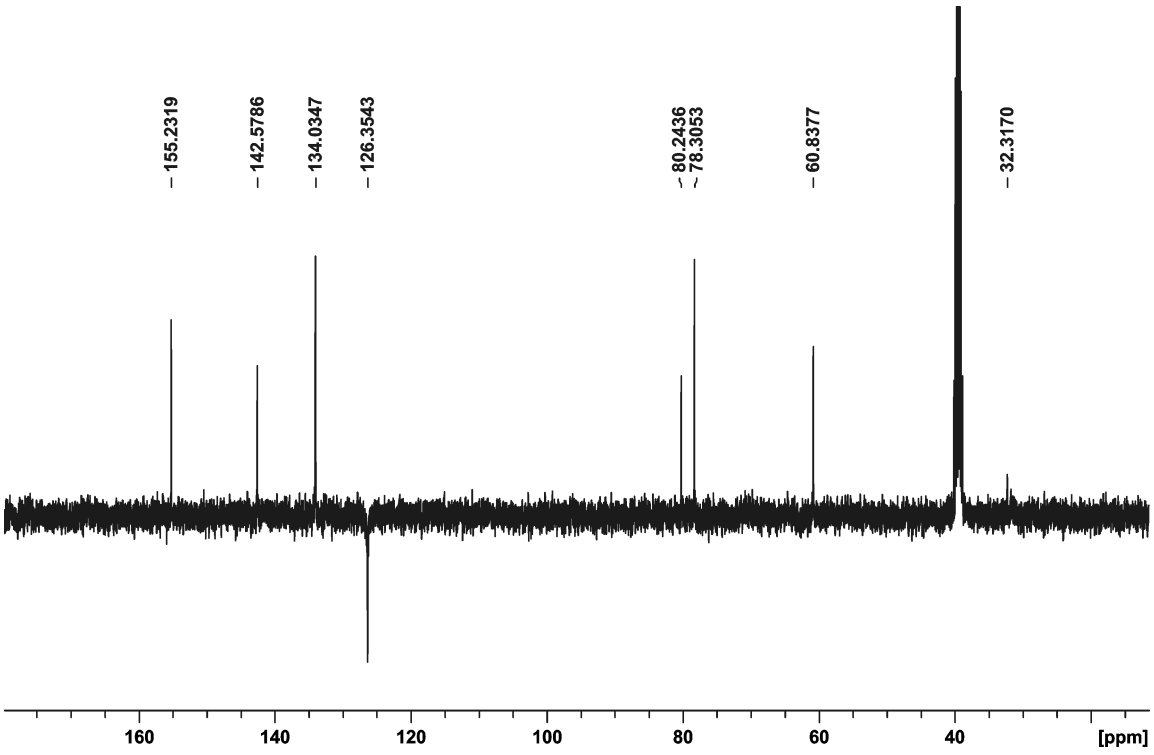



**Figure S2.** $^{13}$C NMR spectrum (APT) of calixarene **2** (100 MHz, DMSO-$d_6$).

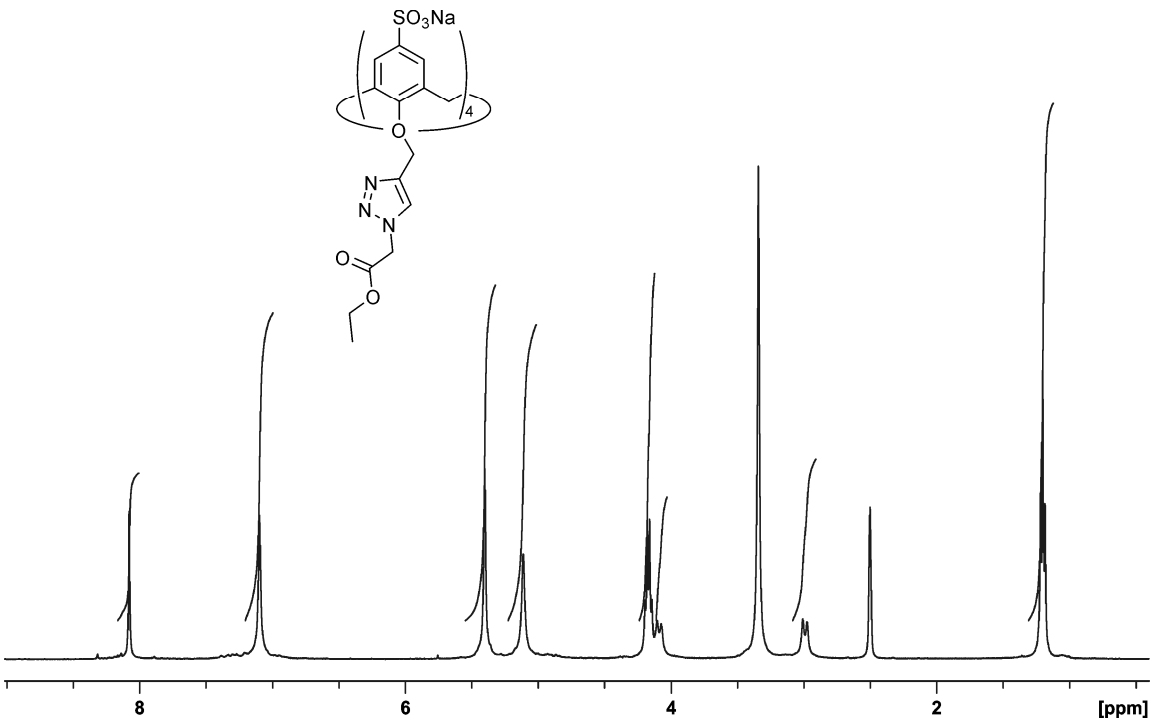



**Figure S3.** $^{1}$H NMR spectrum of calixarene **3** (400 MHz, DMSO-$d_6$).

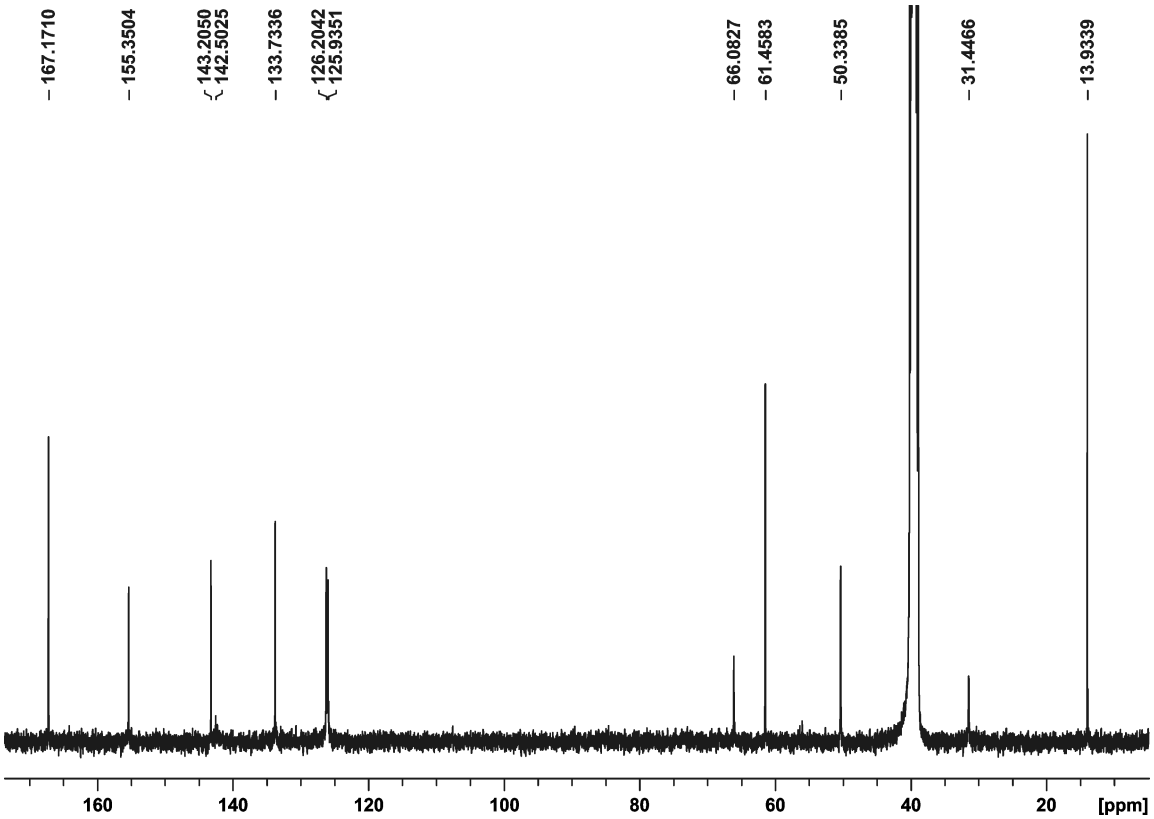



**Figure S4.** $^{13}$C NMR spectrum of calixarene **3** (100 MHz, DMSO-$d_6$).

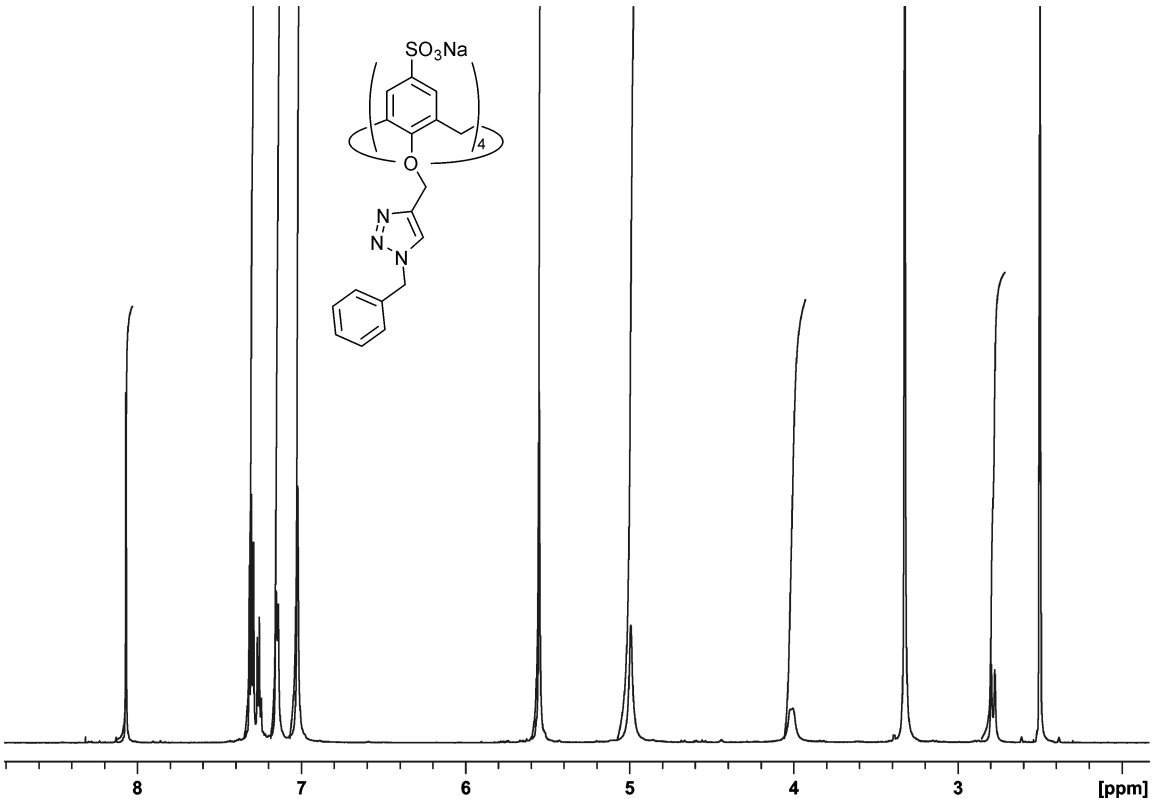



**Figure S5.** $^{1}$H NMR spectrum of calixarene **4** (400 MHz, DMSO-$d_6$).

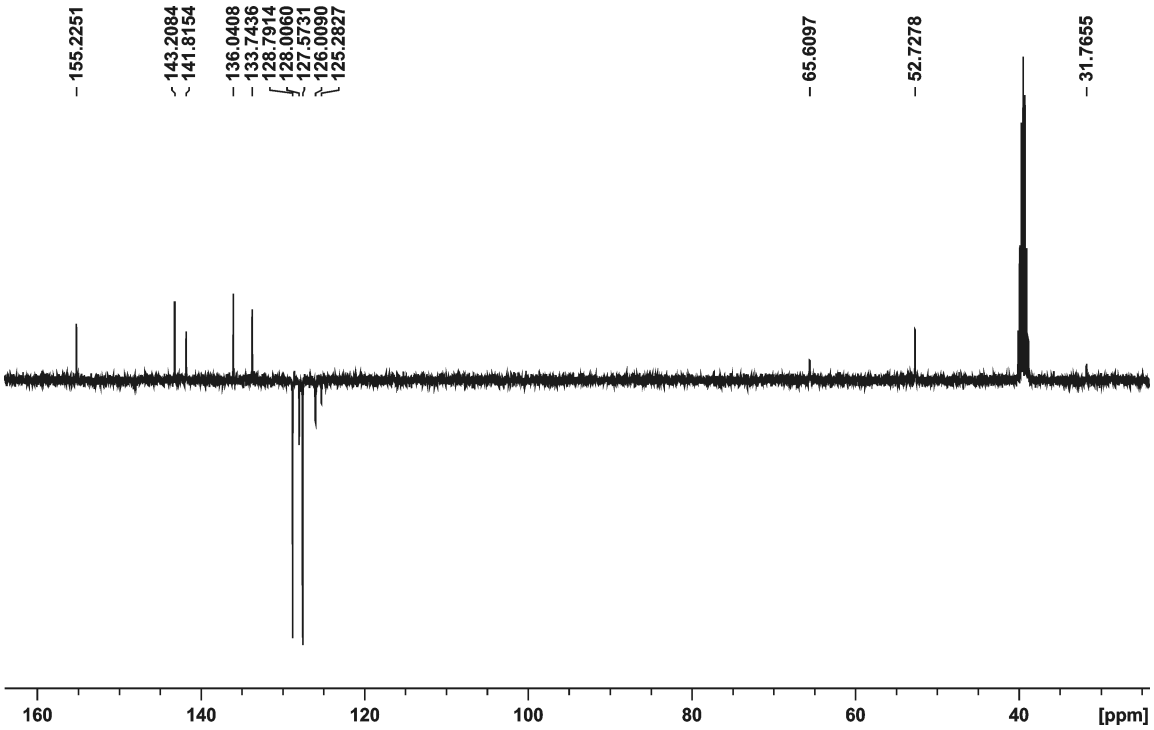



**Figure S6.** $^{13}$C NMR spectrum (APT) of calixarene **4** (100 MHz, DMSO-$d_6$).

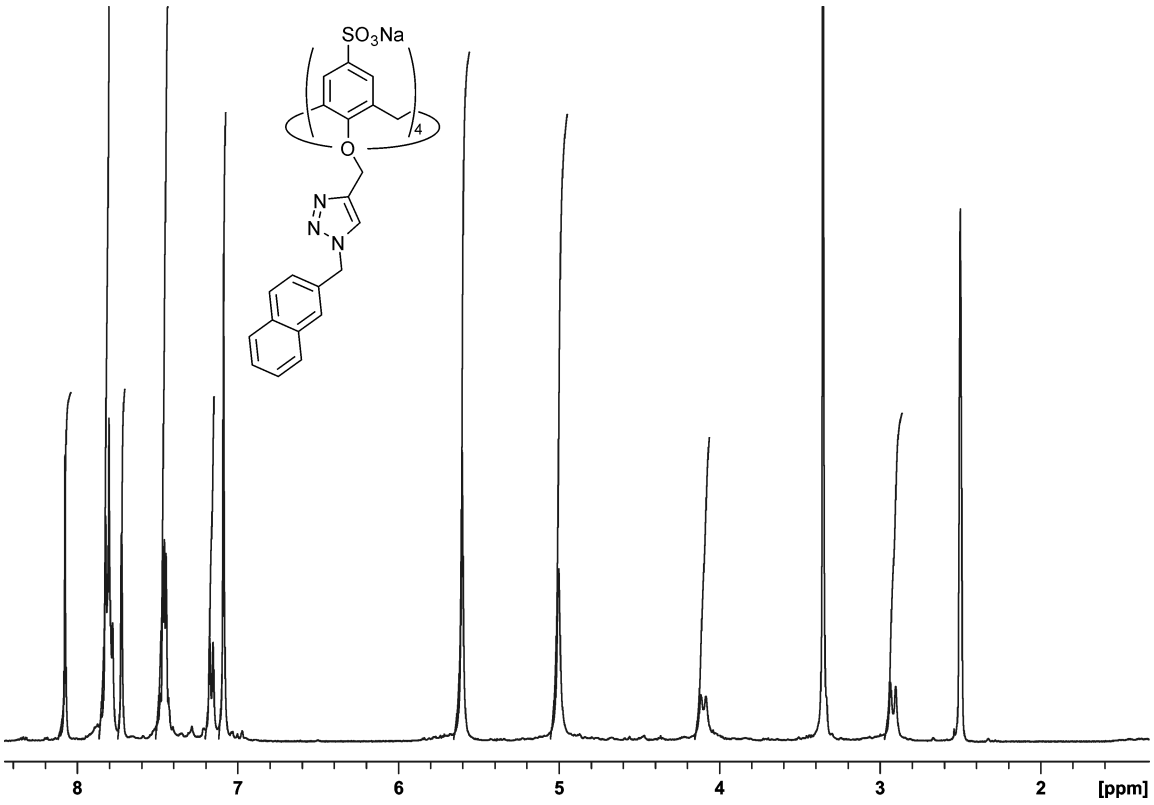



**Figure S7.** $^{1}$H NMR spectrum of calixarene **5** (400 MHz, DMSO-$d_6$).

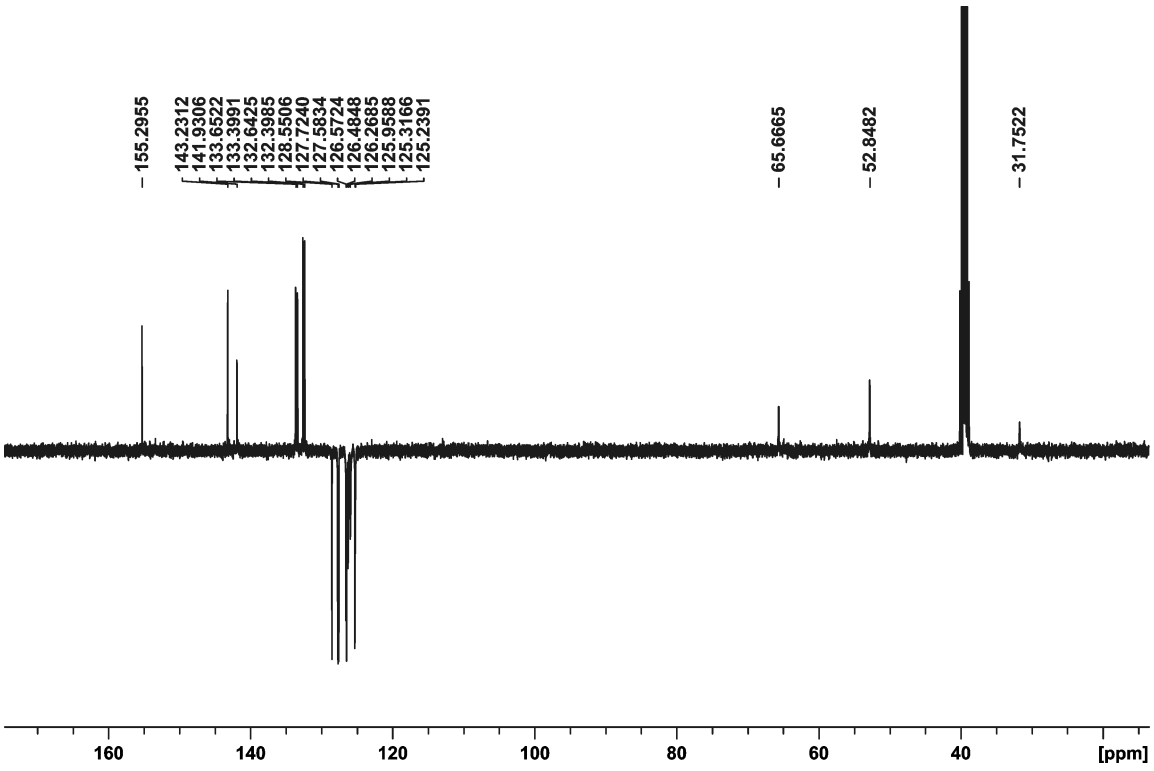



**Figure S8.** $^{13}$C NMR spectrum (APT) of calixarene **5** (100 MHz, DMSO-$d_6$).

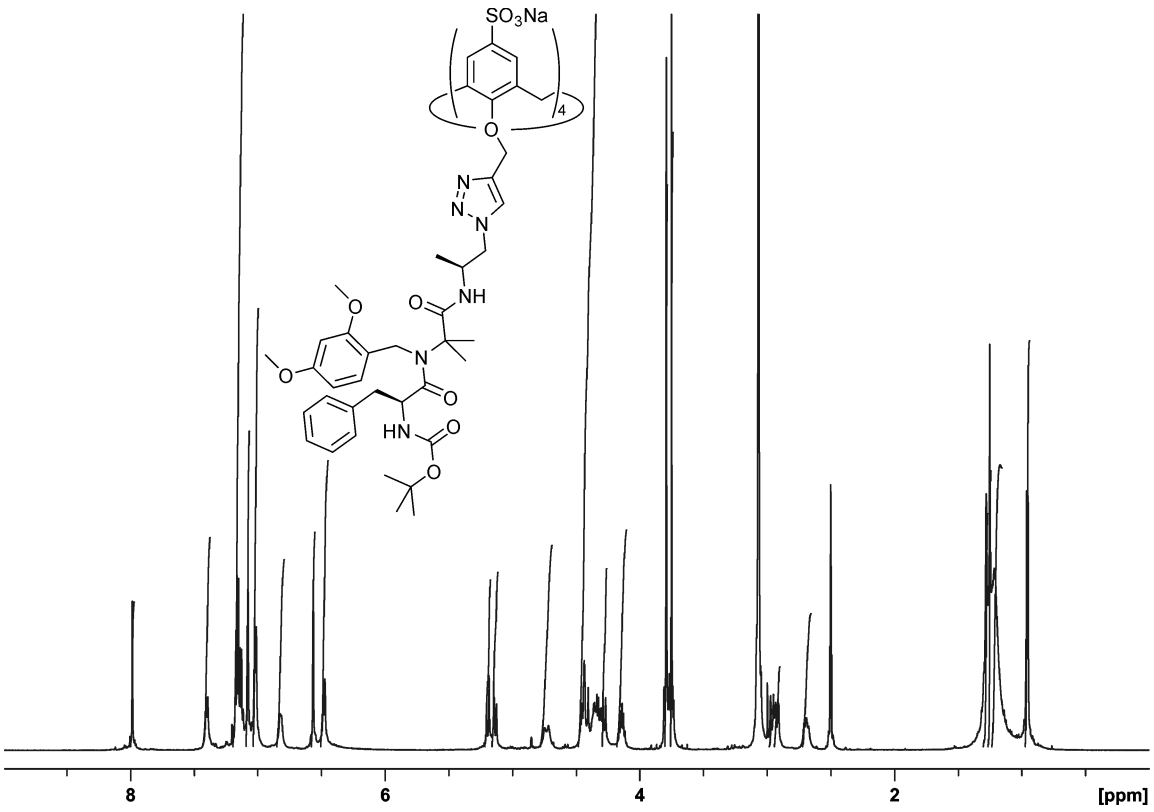



**Figure S9.** $^{1}$H NMR spectrum of calixarene **6** (600 MHz, DMSO-$d_6$, 75 °C).

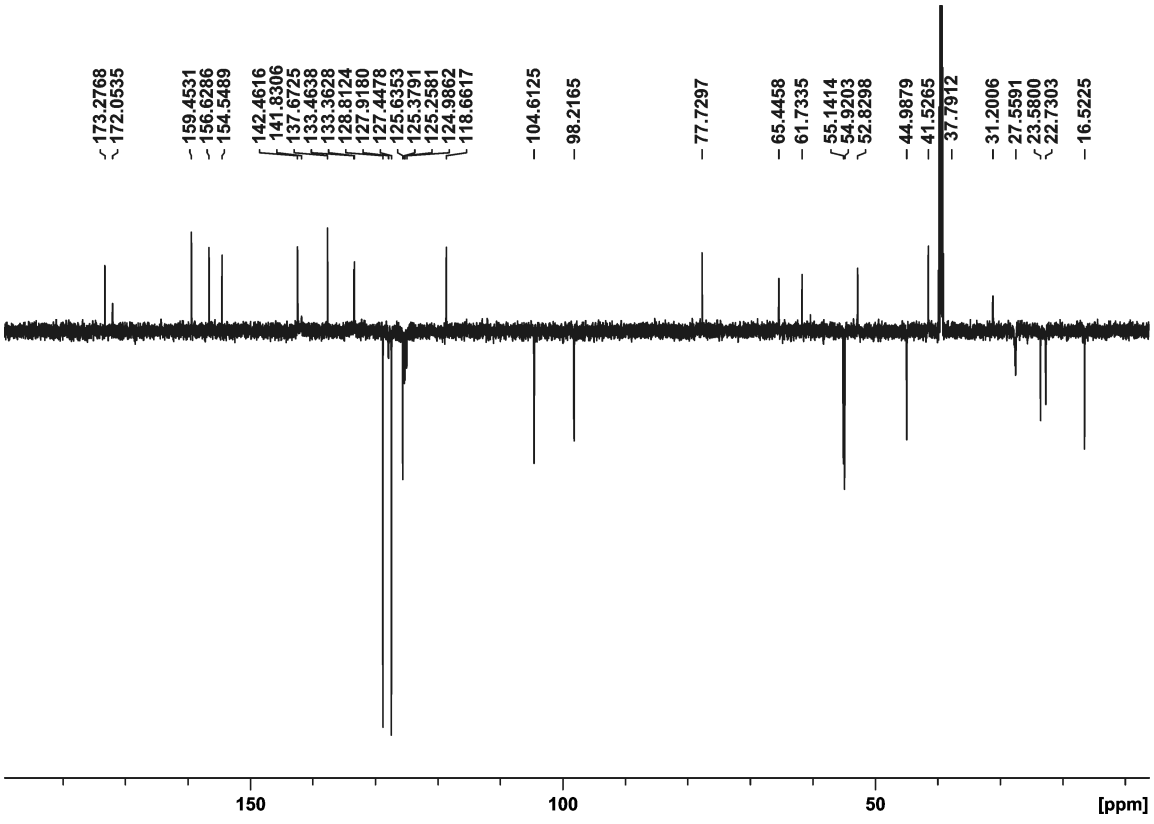



**Figure S10.** $^{13}$C NMR spectrum (APT) of calixarene **6** (150 MHz, DMSO-$d_6$, 75 °C).

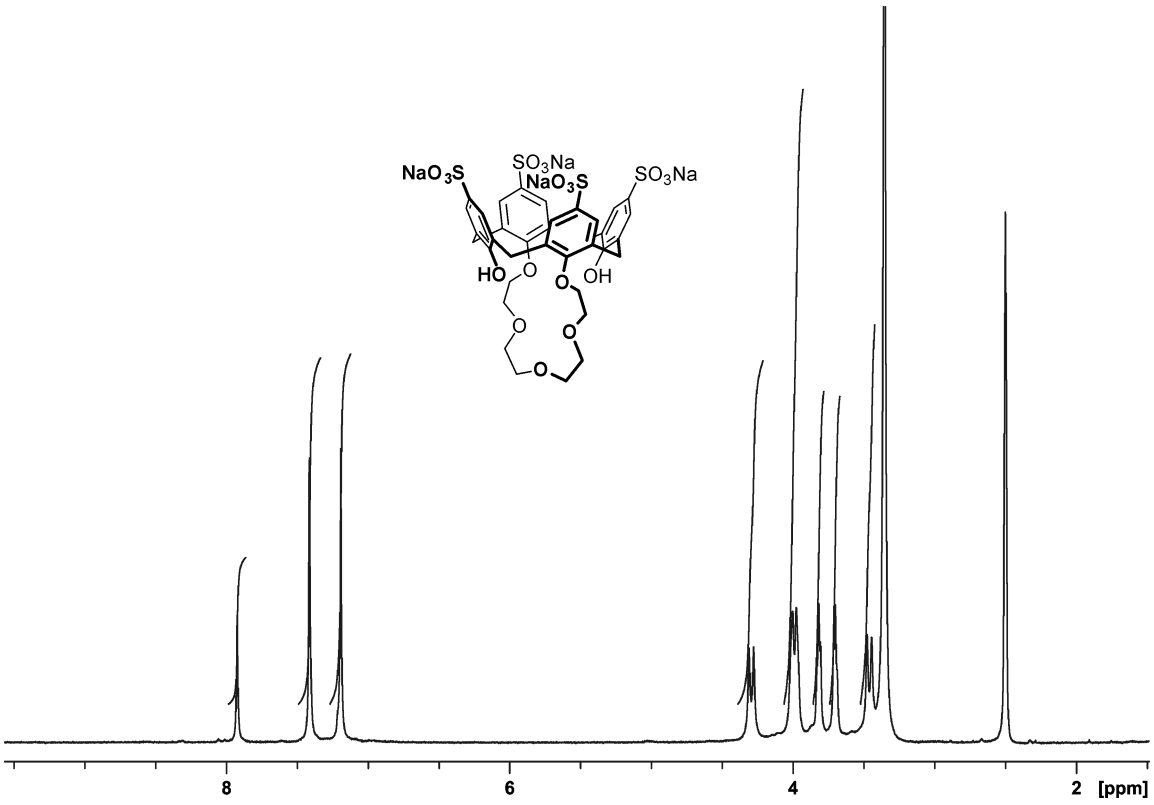



**Figure S11.** $^{1}$H NMR spectrum of calixarene **11** (400 MHz, DMSO-$d_6$).

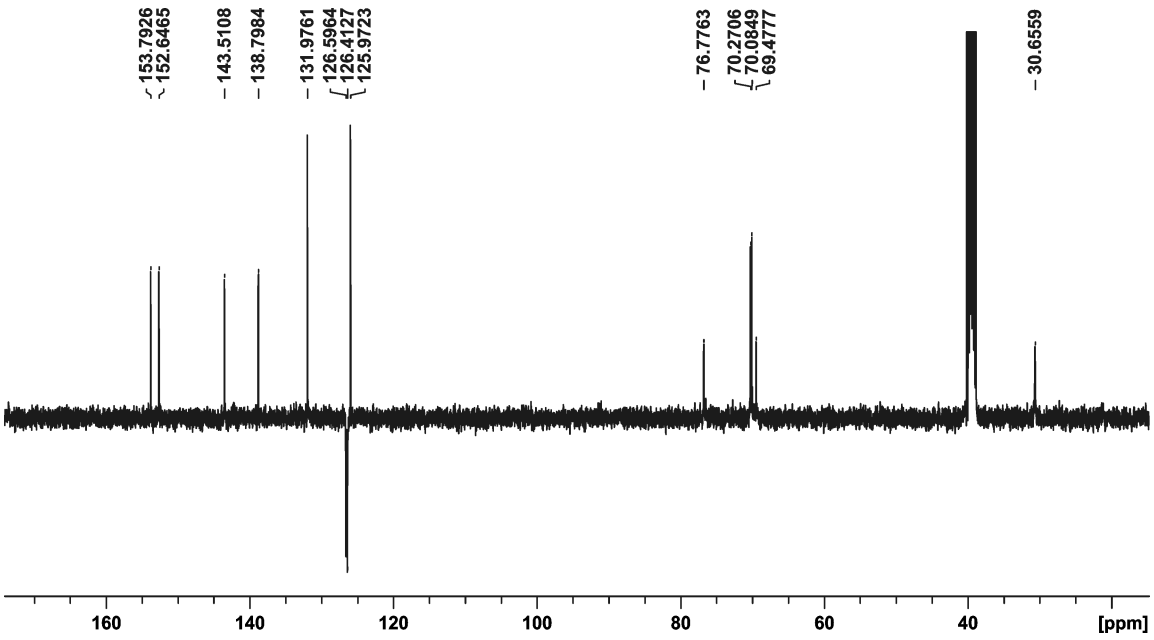



**Figure S12.** $^{13}$C NMR spectrum (APT) of calixarene **11** (100 MHz, DMSO-$d_6$).

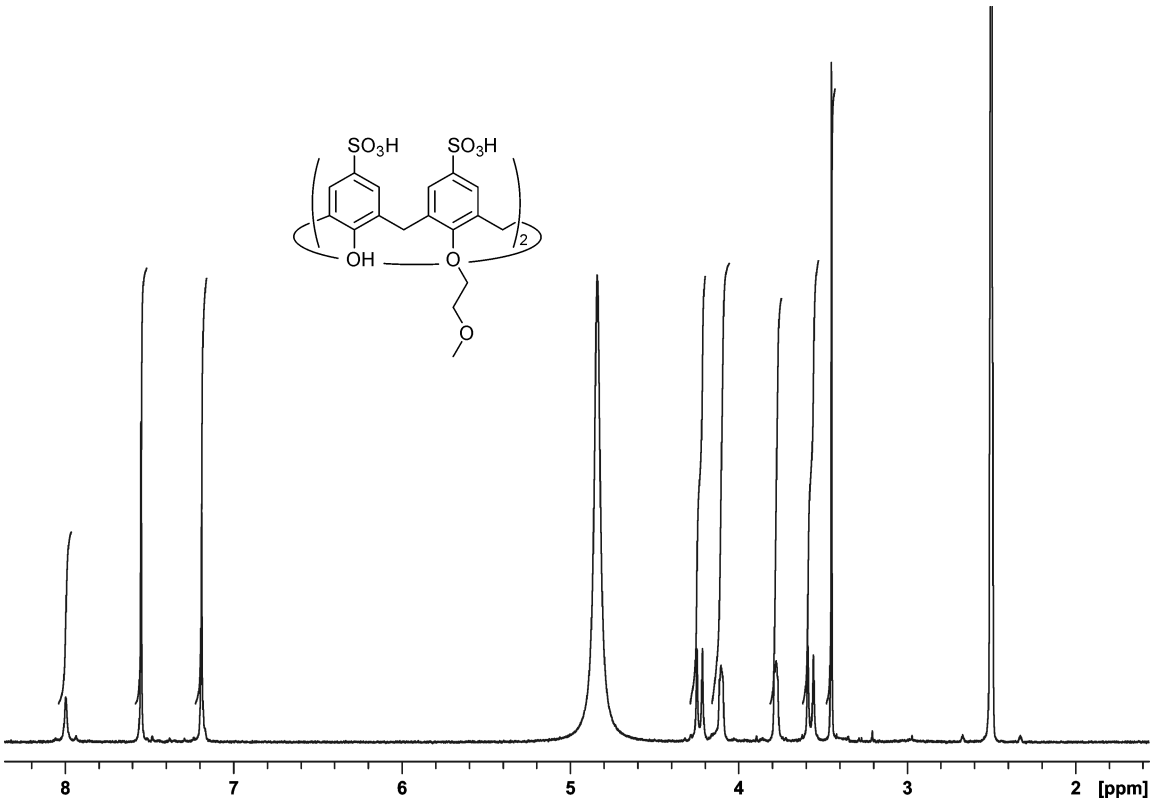



**Figure S13.** $^{1}$H NMR spectrum of calixarene **12** (400 MHz, DMSO-$d_6$).

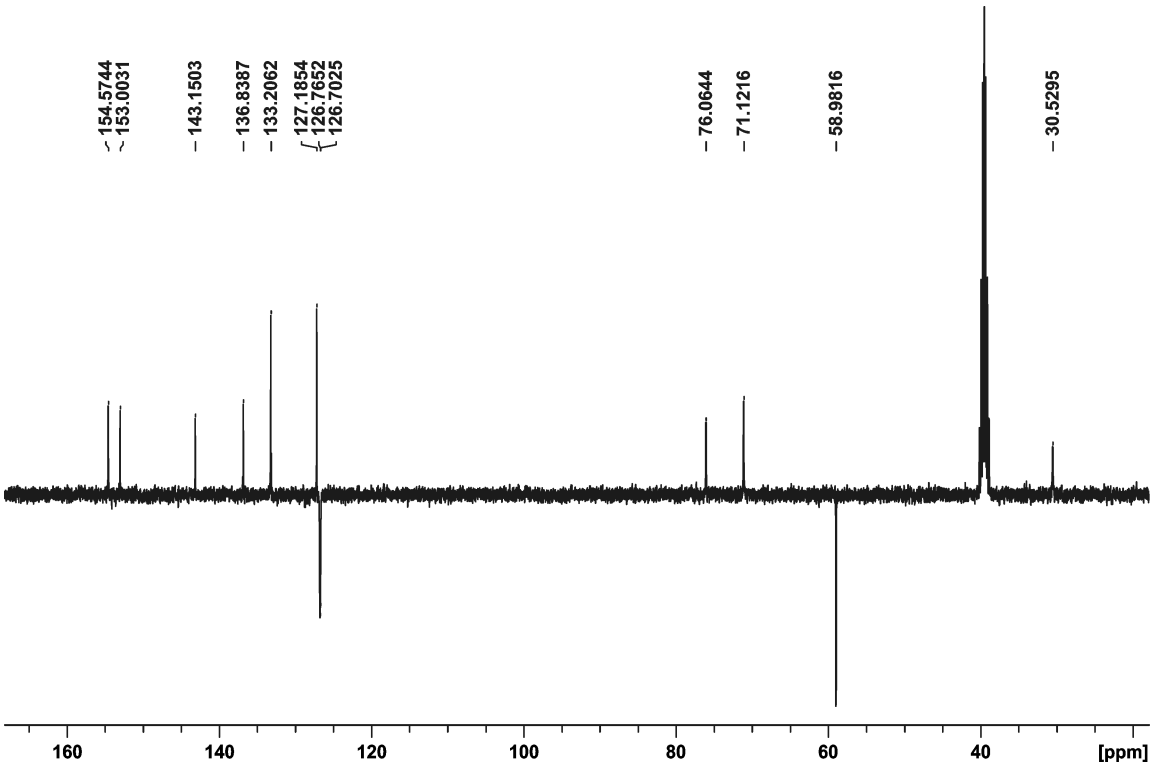



**Figure S14.** $^{13}$C NMR spectrum (APT) of calixarene **12** (100 MHz, DMSO-$d_6$).

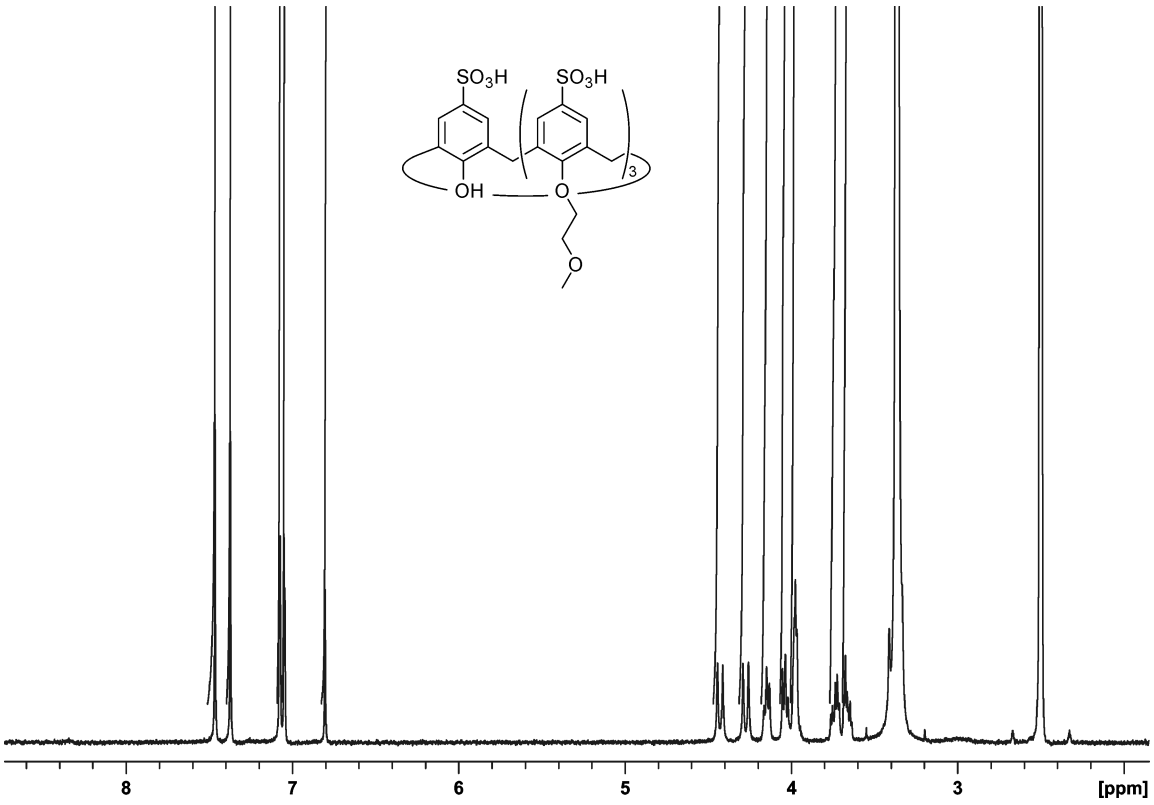



**Figure S15.** $^{1}$H NMR spectrum of calixarene **13** (400 MHz, DMSO-$d_6$).

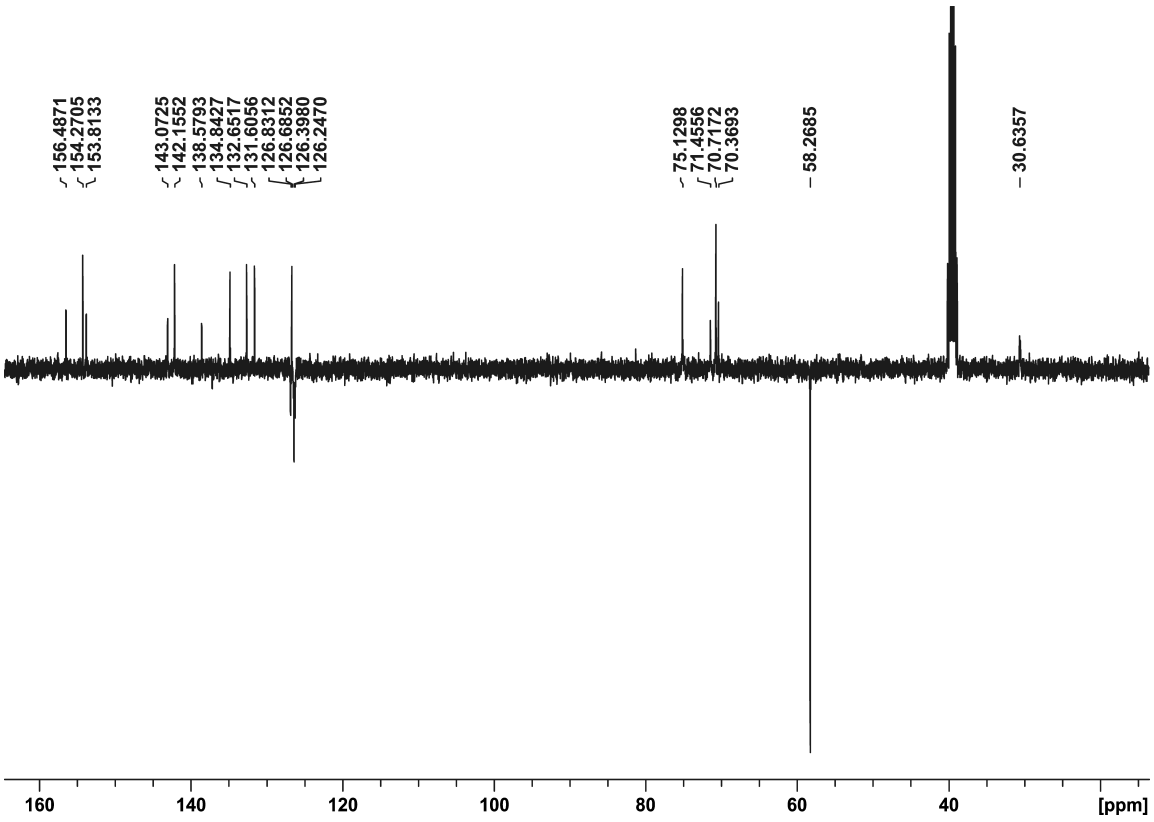



**Figure S16.** $^{13}$C NMR spectrum (APT) of calixarene **13** (100 MHz, DMSO-$d_6$).

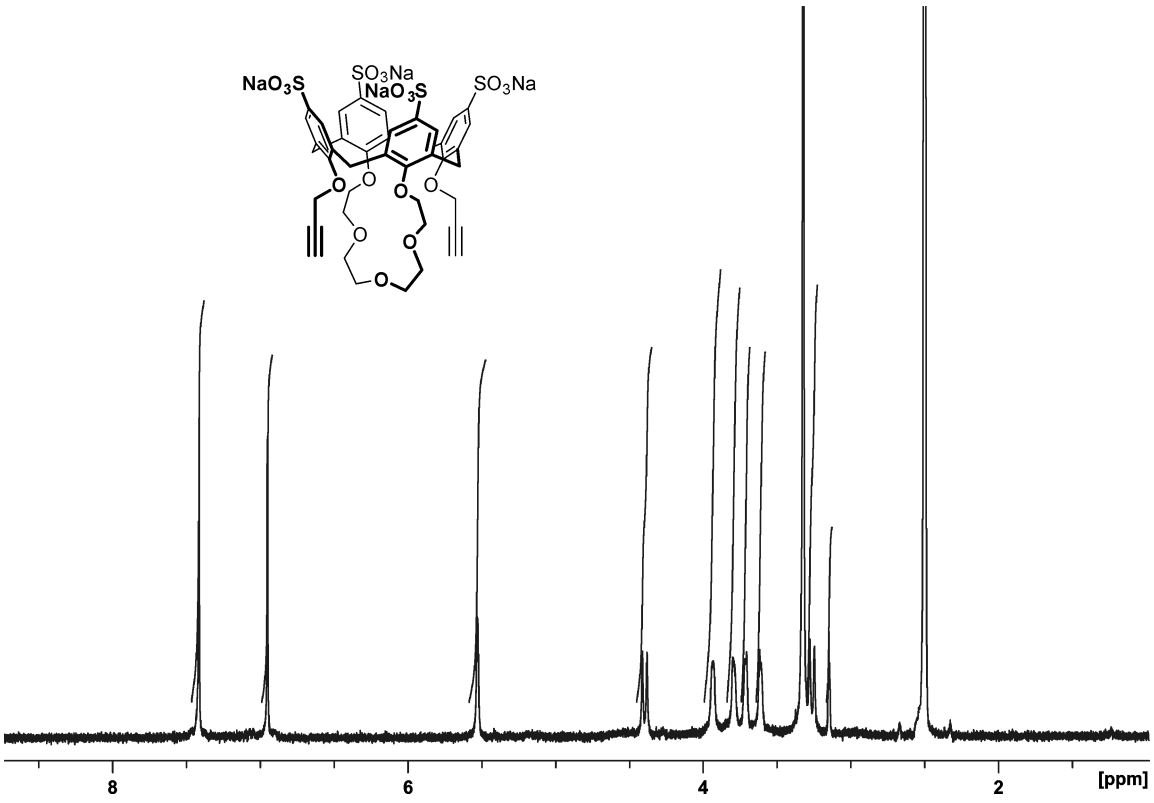



**Figure S17.** $^{1}$H NMR spectrum of calixarene **14** (400 MHz, DMSO-$d_6$).

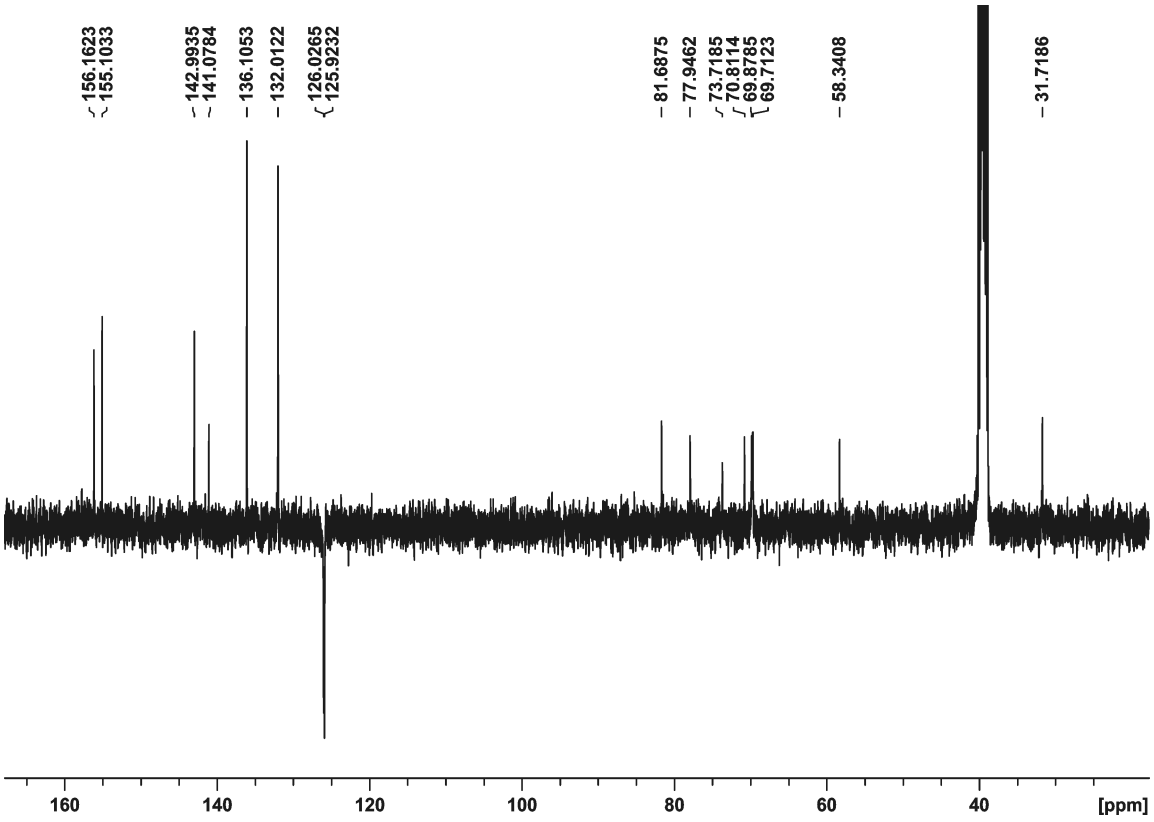



**Figure S18.** $^{13}$C NMR spectrum (APT) of calixarene **14** (100 MHz, DMSO-$d_6$).

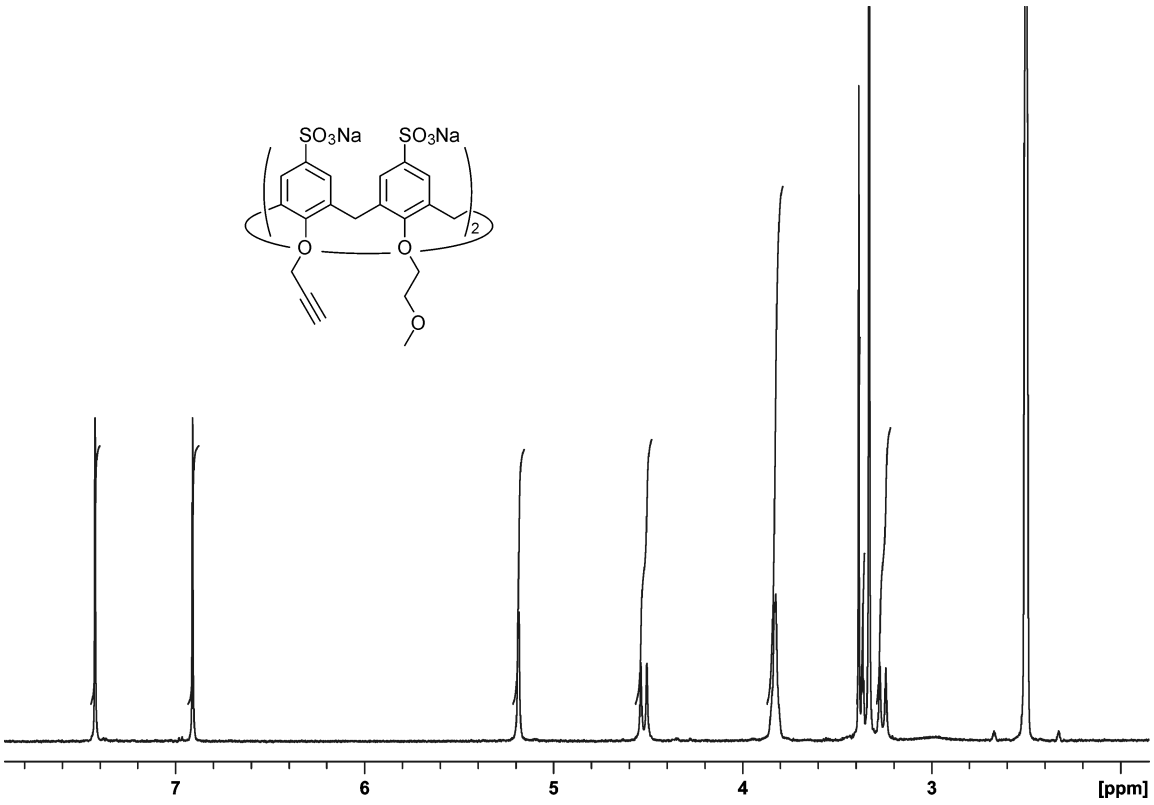



**Figure S19.** $^{1}$H NMR spectrum of calixarene **15** (400 MHz, DMSO-$d_6$).

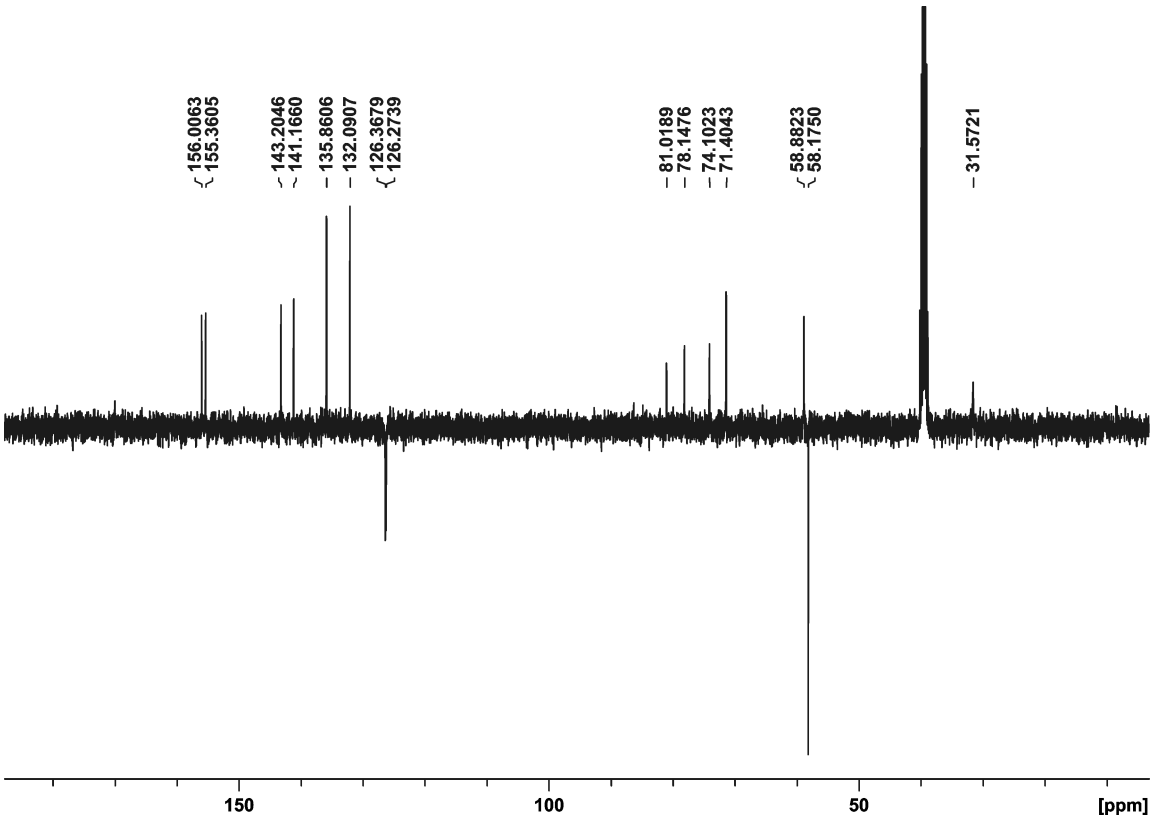



**Figure S20.** $^{13}$C NMR spectrum (APT) of calixarene **15** (100 MHz, DMSO-$d_6$).

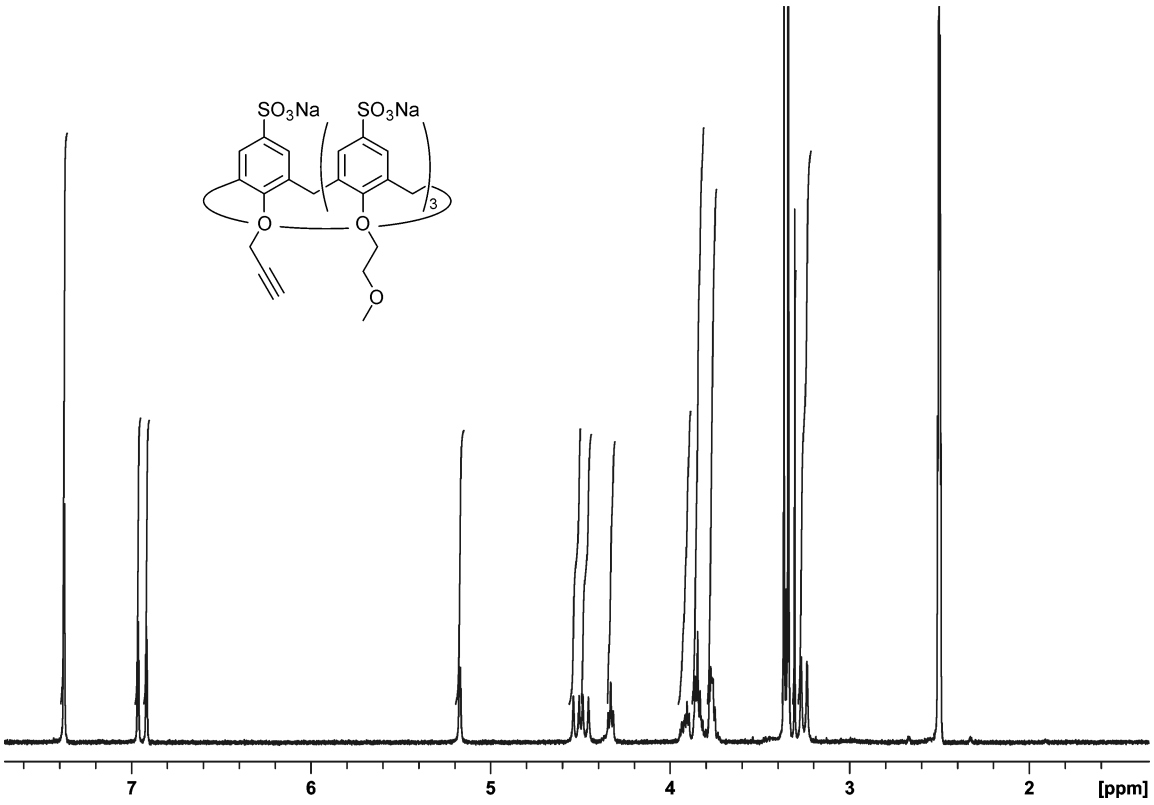



**Figure S21.** $^{1}$H NMR spectrum of calixarene **16** (400 MHz, DMSO-$d_6$).

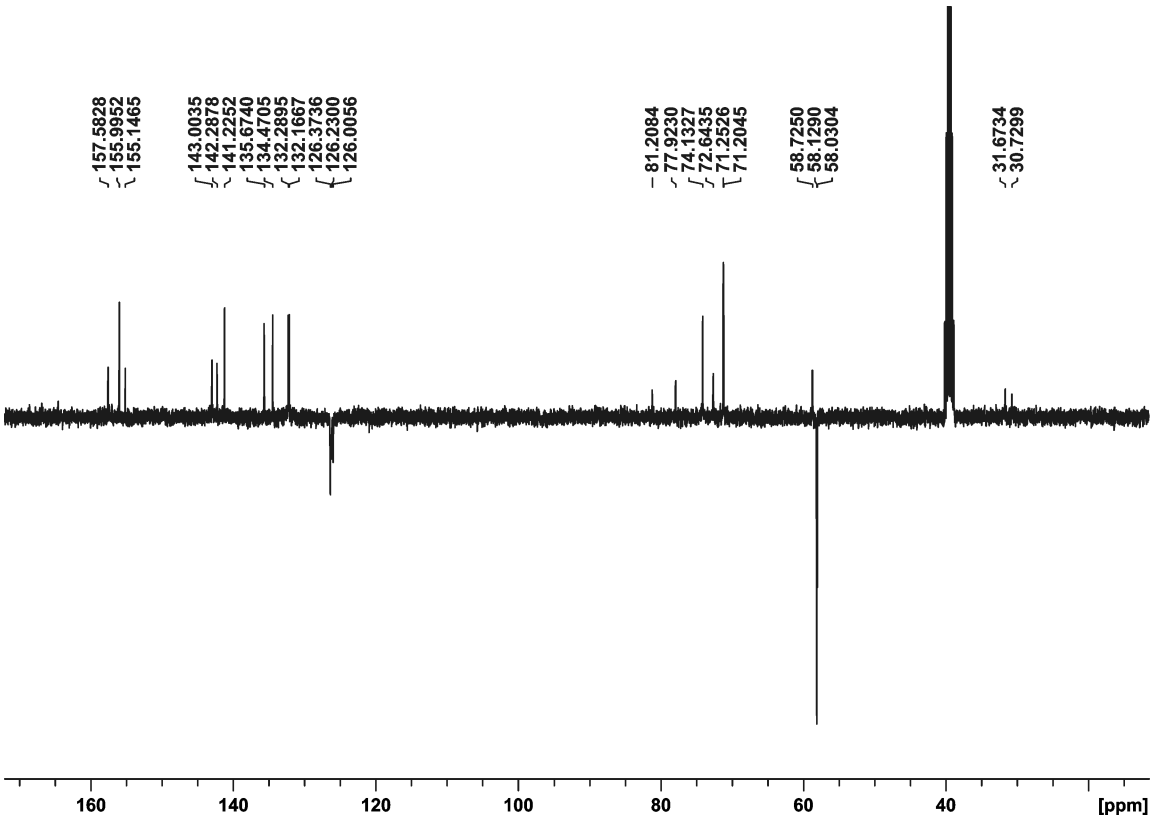



**Figure S22.** $^{13}$C NMR spectrum (APT) of calixarene **16** (100 MHz, DMSO-$d_6$).

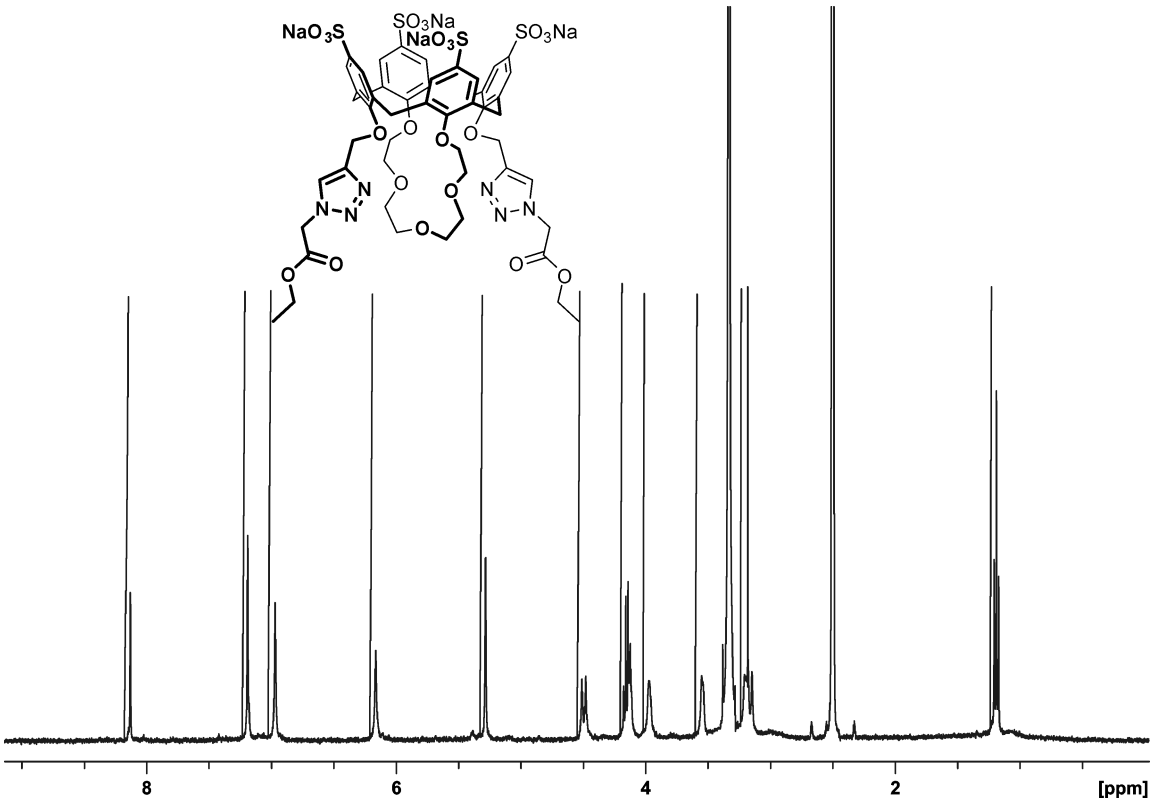



**Figure S23.** $^{1}$H NMR spectrum of calixarene **17** (400 MHz, DMSO-$d_6$).

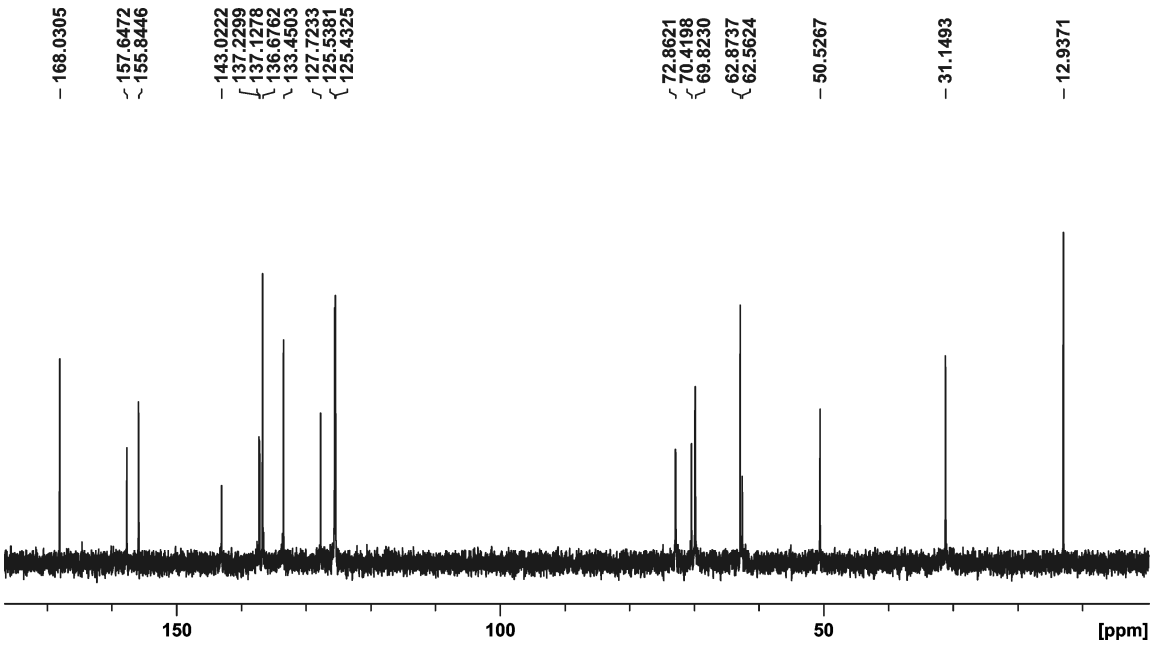



**Figure S24.** $^{13}$C NMR spectrum of calixarene **17** (100 MHz, $D_2O$).

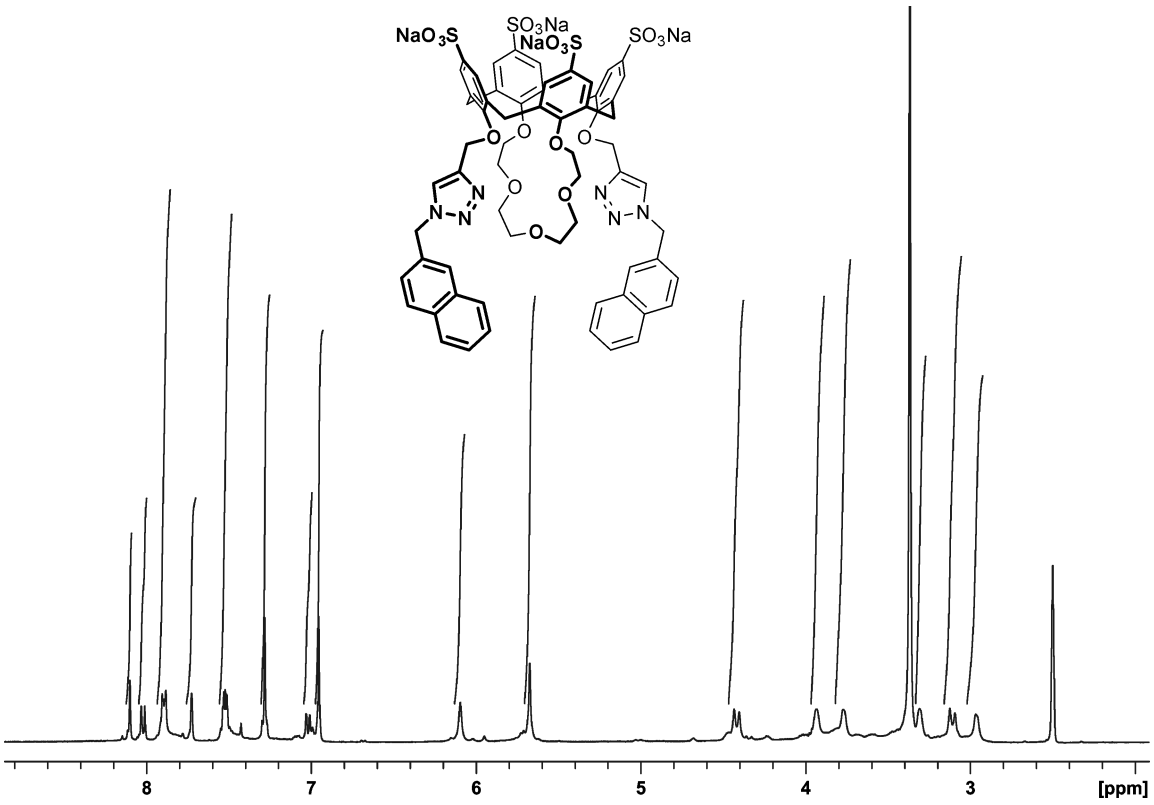



**Figure S25.** $^{1}$H NMR spectrum of calixarene **18** (400 MHz, DMSO-$d_6$).

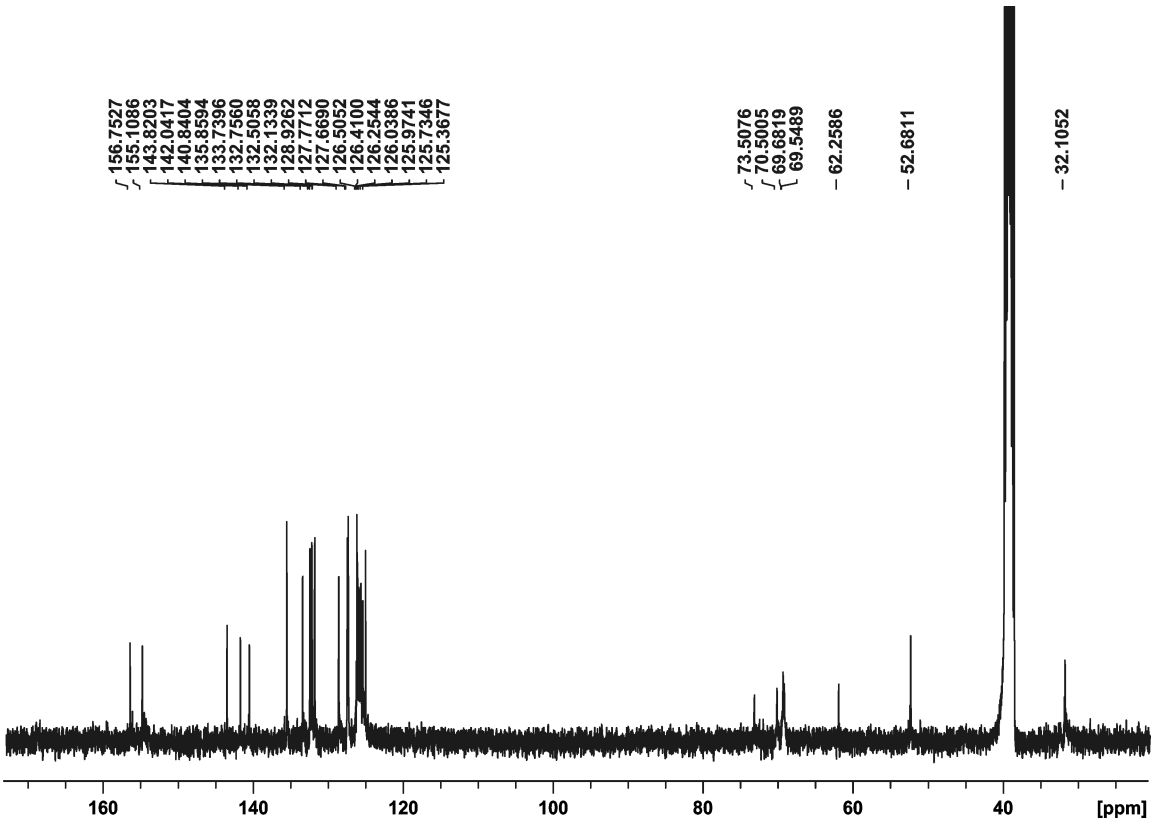



**Figure S26.** $^{13}$C NMR spectrum of calixarene **18** (100 MHz, DMSO-$d_6$).

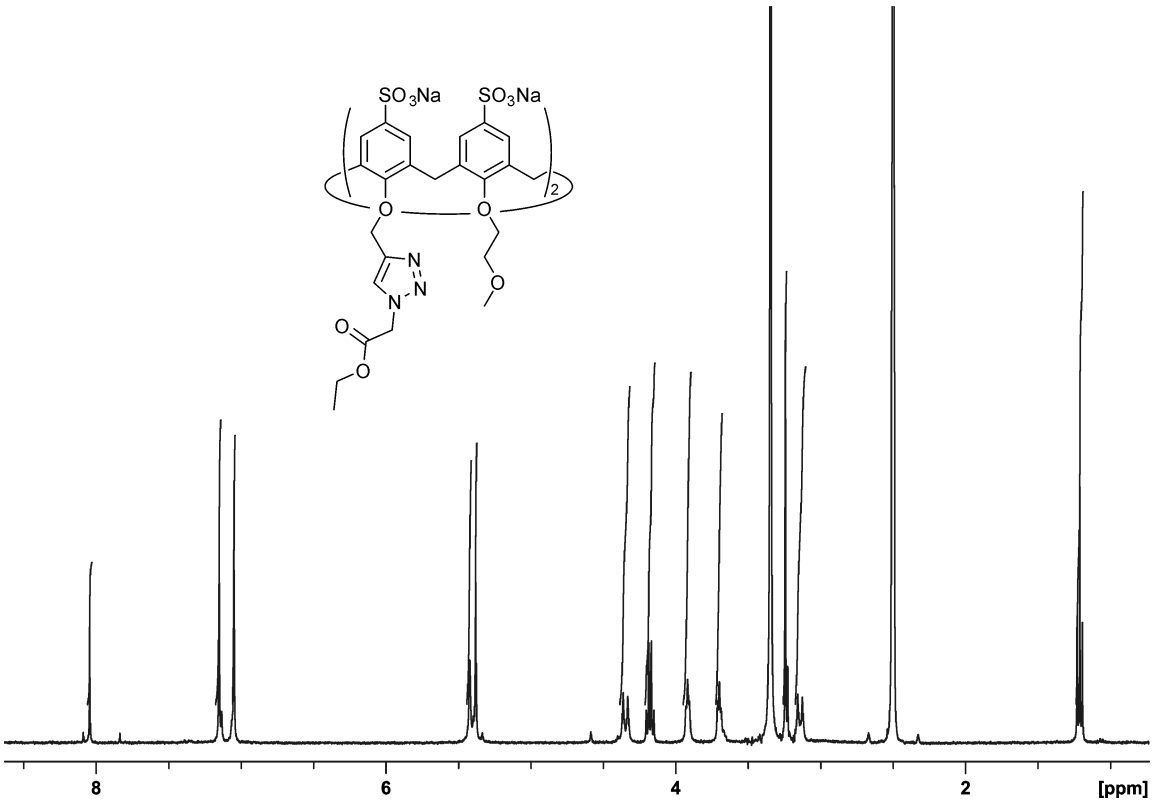



**Figure S27.** $^{1}$H NMR spectrum of calixarene **19** (400 MHz, DMSO-$d_6$).

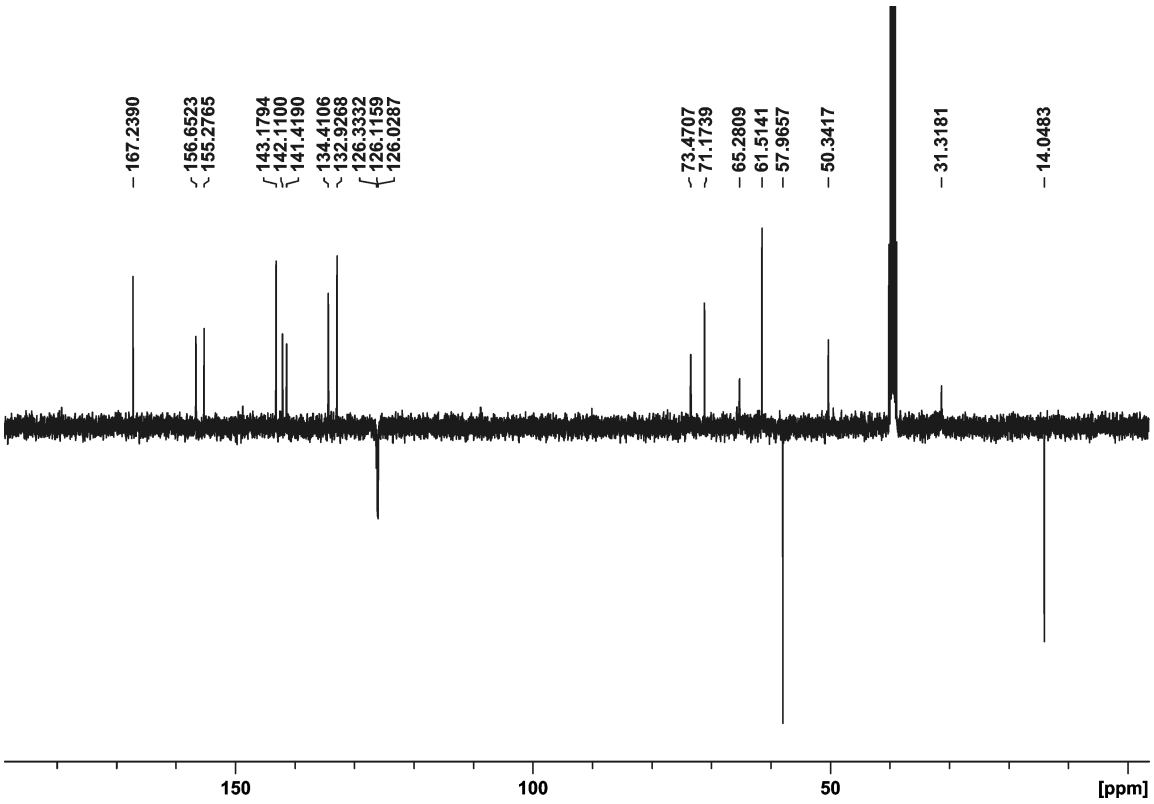



**Figure S28.** $^{13}$C NMR spectrum (APT) of calixarene **19** (100 MHz, DMSO-$d_6$).

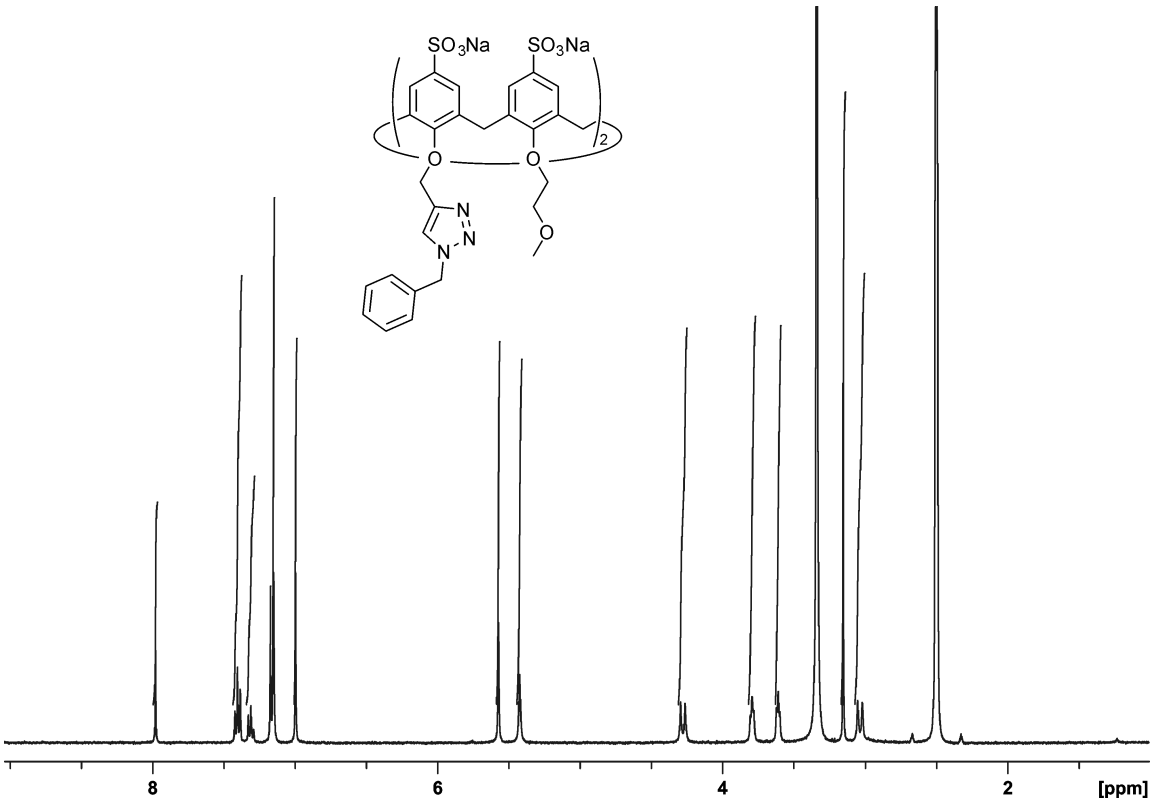



**Figure S29.** $^{1}$H NMR spectrum of calixarene **20** (400 MHz, DMSO-$d_6$).

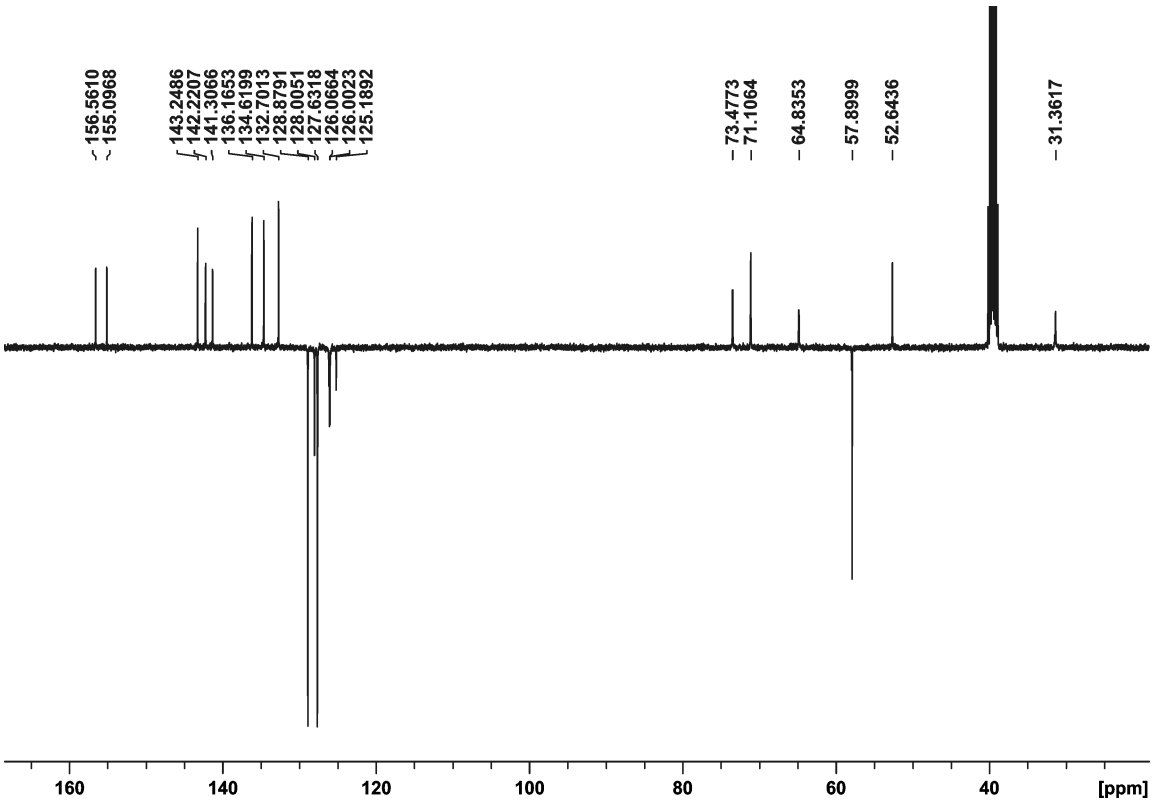



**Figure S30.** $^{13}$C NMR spectrum (APT) of calixarene **20** (100 MHz, DMSO-$d_6$).

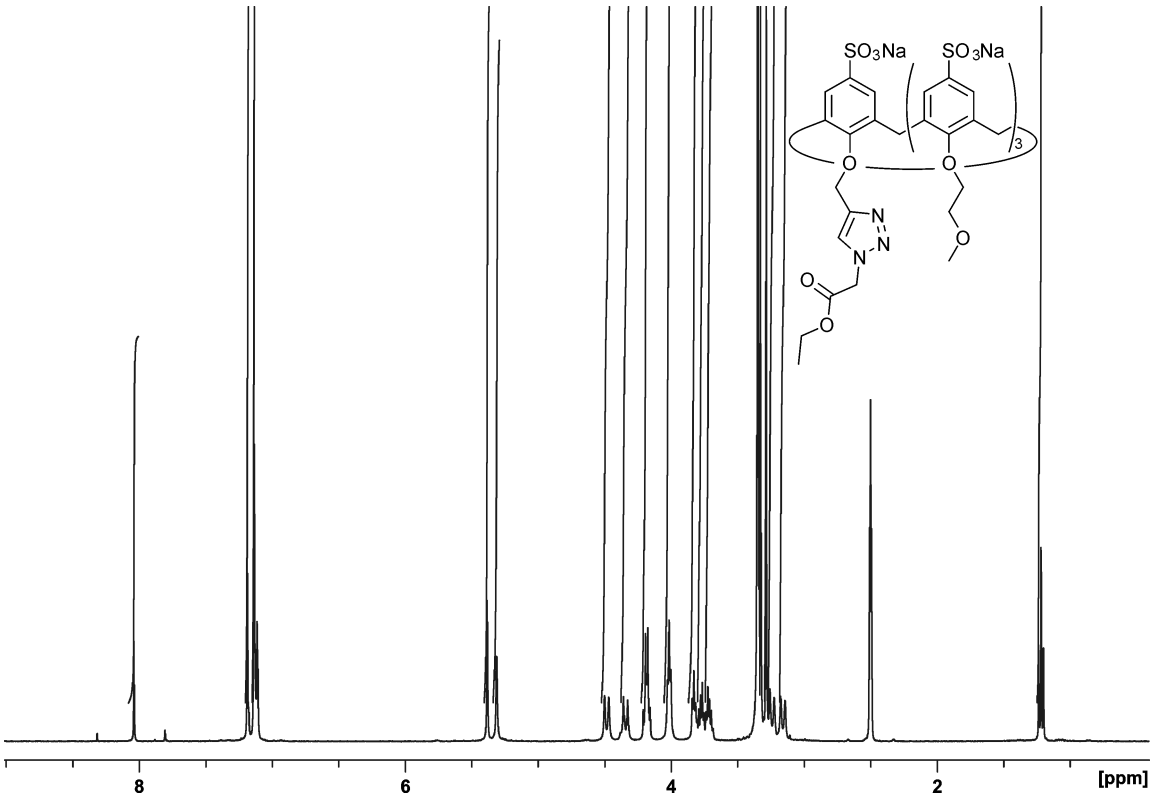



**Figure S31.** $^{1}$H NMR spectrum of calixarene **21** (400 MHz, DMSO-$d_6$).

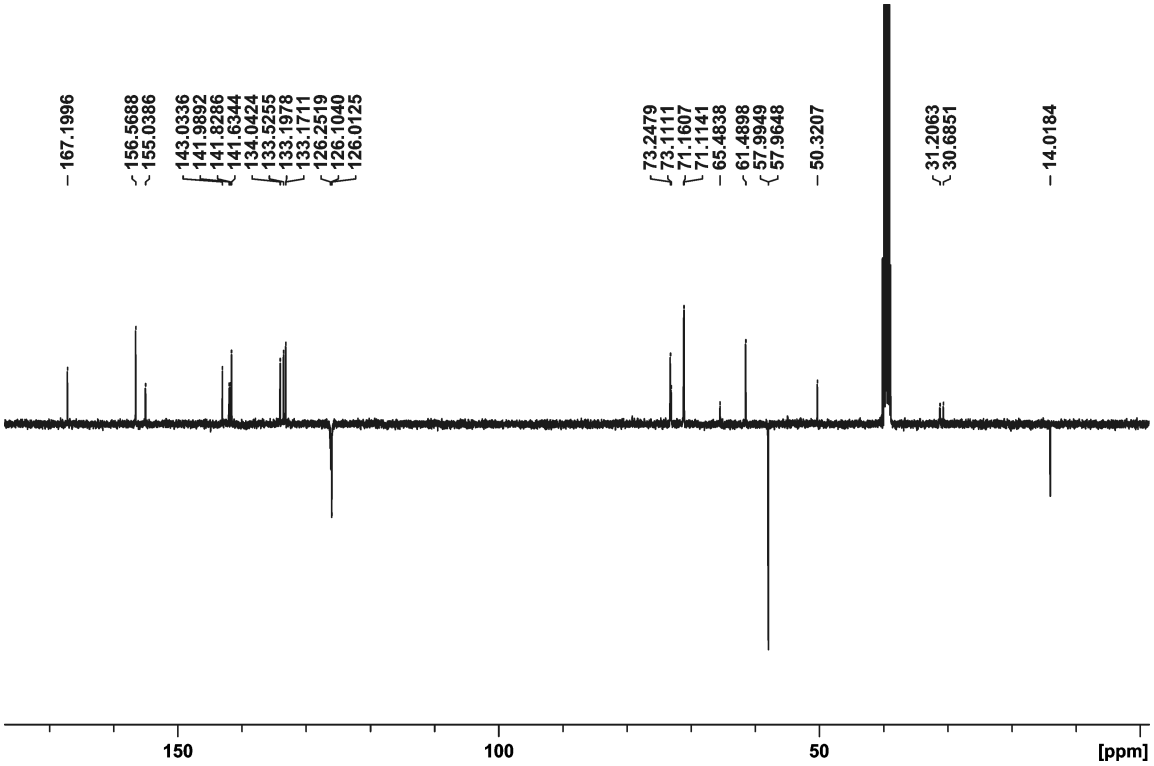



**Figure S32.** $^{13}$C NMR spectrum (APT) of calixarene **21** (100 MHz, DMSO-$d_6$).

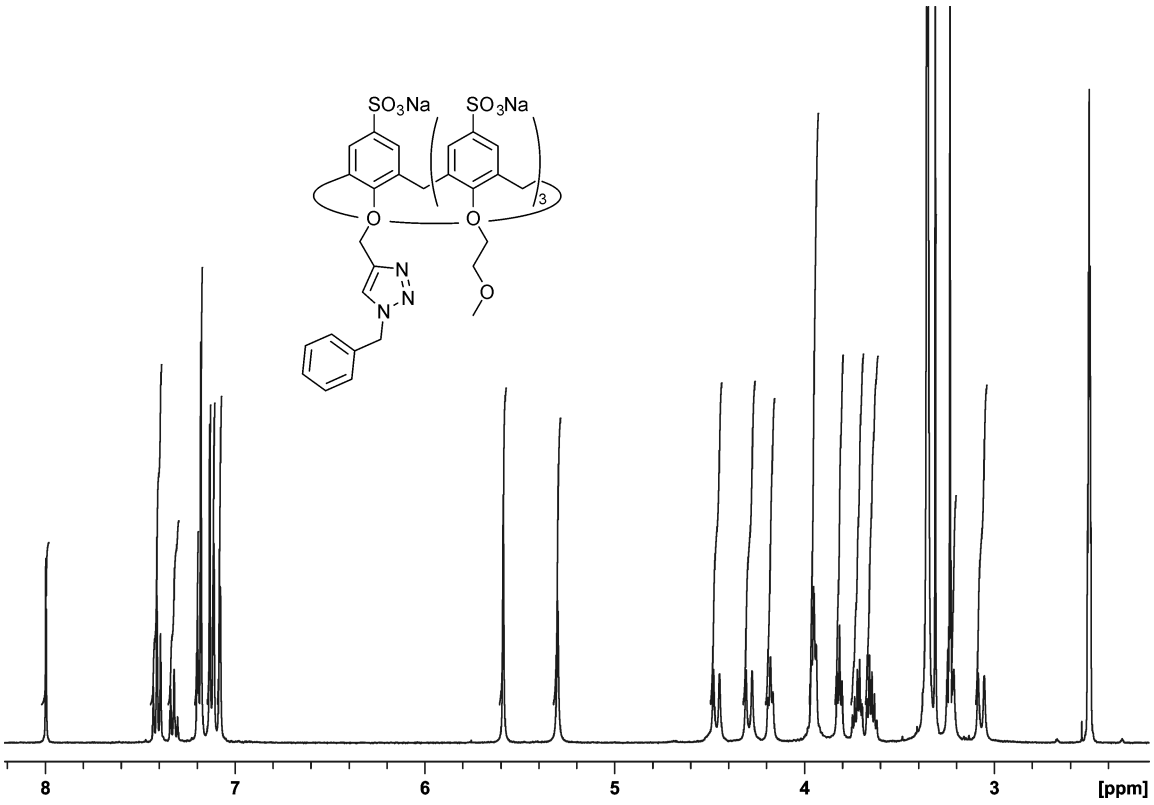



**Figure S33.** $^{1}$H NMR spectrum of calixarene **22** (400 MHz, DMSO-$d_6$).

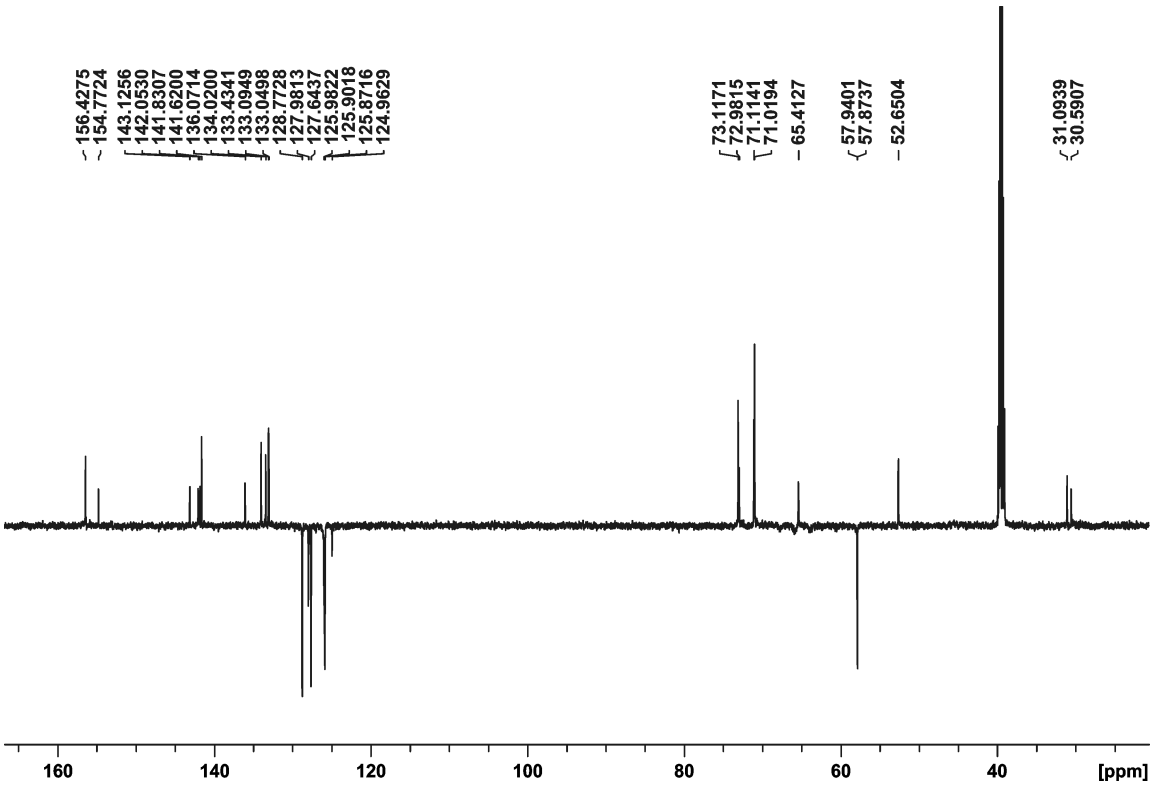



**Figure S34.** $^{13}$C NMR spectrum (APT) of calixarene **22** (100 MHz, DMSO-$d_6$).

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