1. General Experimental Methods

All non-aqueous reactions were carried out using oven-dried or flame-dried glassware under a positive pressure of dry nitrogen or argon unless otherwise noted. Solvents were purified by distillation and dried by passage over activated alumina under an argon atmosphere (H_2O content <30 ppm, Karl-Fischer titration). Unless indicated otherwise, reactions were magnetically stirred and monitored by thin layer chromatography (TLC) using Merck Silica Gel 60 F254 plates and visualized by UV light. In addition, TLC plates were stained using ceric ammonium molybdate or potassium permanganate stain. Chromatographic purification of products was performed on E. Merck Silica Gel 60 (230–400 mesh) using a forced flow of eluant at 0.3–0.5 bar pressure. Concentration under reduced pressure was performed by rotary evaporation at 40 °C (unless otherwise specified) at the appropriate pressure. NMR spectra were measured on Bruker instruments operating at 400 MHz and 100 MHz for ^{1}H and ^{13}C acquisitions, respectively. Chemical shifts are reported in ppm with the solvent resonance as the internal standard. Data are reported as follows: s = singlet, br s = broad singlet, d = doublet, t = triplet, q = quartet, m = multiplet. Mass spectra were recorded by the MS service at Technion-Israel Institute of Technology. ESI-MS (*m*/*z*): was recorded on a Waters Micromass LCT premier instrument at 70 eV in the positive or negative mode. APCI was recorded on the same instrument using 70% acetonitrile/30 % water at 0.2 mL flowrate.

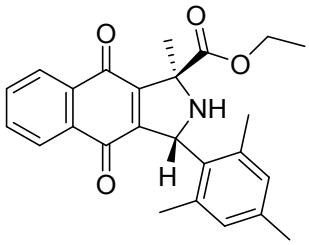
EPR spectra were recorded at room temperature on a Bruker EMX-10/12 X-band (ν = 9.3 GHz) digital EPR spectrometer. All EPR spectra were recorded at the nonsaturating microwave power of 1.0 mW, 100 kHz magnetic field, and modulation of 1.0 G amplitude, sweep time 41.9 sec, conversion time 40.96 msec, time constant 40.96 msec, and receiver gain 4.48×10^{3}. The digital field resolution was 1024 points per spectrum allowing all hyperfine splittings to be measured directly with accuracy better than 0.1 G. EPR spectra processing and simulation were performed with the Bruker WIN-EPR and SimFonia software. The g-factor values of novel nitroxyl radicals (g = 2.0055 ±0.0001) were determined using 2,2,6,6-tetramethylpiperidine-N-oxyl (TEMPO) as a reference (g = 2.0058). All spectra were recorded in degassed benzene or toluene solutions at 0.4-2

mM M) contained in 5 mm glass tubes.

2. Experimental data:

1,3 dipolar cycloaddition Reactions[1, 2]

Ethyl-3-mesityl-1-methyl-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11a)



A suspension of alanine ethyl ester hydrochloride (4.92 g, 32.0 mmol, 1.2 equiv.), mesitaldehyde (3.96 g, 26.7 mmol, 1.0 equiv.) and $MgSO_4$ (3.84 g, 32.0 mmol, 1.2 equiv.) in DCM (50 mL) was stirred at 0°C. TEA (3.23 g, 32.0 mmol, 1.2 equiv.) was added dropwise. The reaction was allowed to warm to room temperature and stirred overnight. Diethyl ether (60 mL) was added and the solution was filtered. The filtrate was washed with water and brine, dried over magnesium sulfate and concentrated *in vacuo* to give the corresponding imine **10a** (5.96 g, 24.1 mol) in 90% of yield, which was used in the next step without further purification. Imine (1.0634 g, 4.3 mmol, 1.0 equiv.) was dissolved in 25 mL of toluene and 1,4 naphthaquinone (0.693 g, 4.3 mmol, 1.0 equiv.) was added to the reaction mixture. The reaction mixture was heated to reflux under argon overnight. Upon completion of the reaction, the reaction mixture was concentrated under high vacuum and the product was purified by flash chromatography using ethyl acetate/hexane as an eluent provided the desired diketone as a yellow solid (0.814 mg, 2.02 mmol, 47% yield). The structure of quinone **11a** was confirmed by NMR. The stereochemistry was determined after reduction to the hydroquinone and silylation with TIPS-Cl (See below)

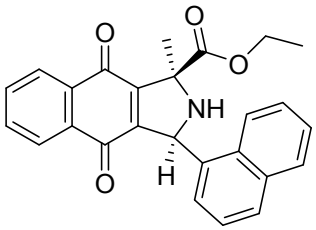
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (t, *J* = 8.1 Hz, 1H), 8.02 – 7.95 (m, 1H), 7.79 – 7.66 (m, 2H), 6.90 (s, 1H), 6.76 (s, 1H), 5.98 (s, 1H), 4.31 – 4.16 (m, 2H), 2.50 (s, 3H), 2.24 (d, *J* = 4.5 Hz, 6H), 1.74 (s, 3H), 1.26 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 182.4, 181.7, 171.7, 151.2, 149.2, 137.5, 137.2, 136.9, 133.9, 133.7, 133.2, 132.9, 131.9, 131.1, 129.4, 126.5, 126.4, 70.2, 61.8, 22.6, 20.9, 20.8, 20.5 , 14.0.

IR (thin film) 3106, 2614, 2448, 1759, 1672, 1589, 1566, 1339, 1247, 1206, 1128, 1009, 851, 722 cm^{-1}.

HRMS (ESI+): m/z [M + H^+] calcd for $C_{25}H_{26}NO_4^+$: 404.1856; found: 404.1638

Ethyl-1-methyl-3-(naphthalen-1-yl)-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11c)



A suspension of alanine ethyl ester hydrochloride (2.0 g, 13.3 mmol, 1.2 equiv.), 1-napthaldehyde (1.73 g, 11.21 mmol, 1.0 equiv.) and $MgSO_4$ (1.6 g, 13.3 mmol, 1.2 equiv.) in DCM (30 ml) were stirred at 0°C. TEA (1.34 g, 13.3 mmol, 1.2 equiv.) was added dropwise. The reaction was allowed to warm at r.t. and stirred overnight. Diethyl ether (50 ml) was added and the solution was filtered. The filtrate was washed with water and brine, dried over magnesium sulfate and concentrated in *vacuo* to give the corresponding imine **10c** (2.80 g, 0.01 mol) in 99% yield which was used in the next step without further purification. Imine (1.8 g, 7.05 mmol, 1.0 equiv.) was dissolved in 20 ml of toluene and 1,4 naphthaquinone (1.116 g, 7.05 mmol, 1.0 equiv.) was added to the reaction mixture. The reaction mixture was heated to reflux under argon overnight. Upon completion of the reaction, the reaction mixture was concentrated under high vacuum and the product was purified by flash chromatography using ethyl acetate/hexane as an eluent provided the desired quinone **11d** as a yellow solid (1.8 g, 4.4 mmol, 63% yield). The structure of **11c** was confirmed by X-Ray and NMR.

X-ray See enclosed cif file **Szpilman10.cif**.

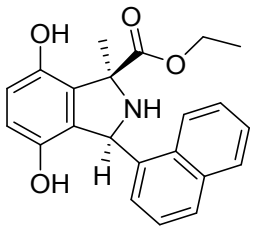
^{1}H NMR (400 MHz, Acetone) δ 8.36 (m, *J* = 14.5, 8.4 Hz, 2H), 8.23 (d, *J* = 7.6 Hz, 1H), 7.97 (d, *J* = 8.0 Hz, 1H), 7.81 (d, *J* = 8.2 Hz, 1H), 7.55 (m, *J* = 18.7, 13.2, 7.3 Hz, 4H), 7.28 (t, *J* = 7.6 Hz, 1H), 6.80 (s, 1H), 6.51 (s, 1H), 3.90 (t, *J* = 6.8 Hz, 2H), 1.83 (s, 3H), 0.74 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 182.4, 181.9, 172.9, 149.8, 136.7, 134.3, 134.1, 133.9, 133.4, 133.1, 131.5, 129.1, 128.9, 126.8, 126.7, 126.7, 126.1, 125.4, 125.1, 123.6, 71.7, 61.9, 31.1, 24.9, 14.1.

IR (thin film) 3323, 2986, 2653, 1694, 1633, 1597, 1442, 1398, 1295, 1252, 1223, 979, 769 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{26}H_{24}NO_4^+$: 414.1700; found: 414.1698

Ethyl 4,7-dihydroxy-1-methyl-3-(naphthalen-1-yl)isoindoline-1-carboxylate (11d)



Imine **10c** (2.235 g, 7.7 mmol, 1.0 equiv.) was dissolved in 42 ml of toluene and 1,4 benzoquinone (0.8323 g, 7.7 mmol, 1.0 equiv.) was added to the reaction mixture. The reaction mixture was heated to reflux under argon overnight. Upon completion of the reaction, the reaction mixture was concentrated under high vacuum and the product was purified by flash chromatography using ethyl acetate/hexane as an eluent provided the product **11e** as a white solid, 83% yield (2.3311 g, 0.0065 mol).

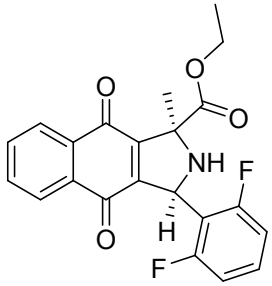
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (d, *J* = 8.3 Hz, 1H), 7.95 – 7.86 (m, 2H), 7.78 (d, *J* = 8.2 Hz, 1H), 7.61 – 7.47 (m, *J* = 21.0, 6.9 Hz, 3H), 7.37 – 7.28 (m, 1H), 7.01 (d, *J* = 7.1 Hz, 1H), 6.72 (dd, *J* = 20.1, 8.5 Hz, 2H), 6.30 (s, 1H), 3.91 (q, *J* = 7.1 Hz, 2H), 3.08 (broad, 1H), 2.87 (broad, 1H), 2.09 (s, 1H), 1.73 (s, 3H), 0.87 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 193.84, 146.99, 146.85, 140.04, 135.13, 132.84, 132.26, 130.45, 129.43, 128.31, 126.71, 126.23, 126.16, 125.14, 117.52, 116.95, 71.01, 61.90, 29.84, 26.08, 13.99.

IR (thin film) 3401, 2971, 2953, 2882, 1726, 1682, 1491, 1379, 1338, 1265, 1169, 1117, 1009, 949, 906, 779 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{22}H_{21}NO_4^+$: 364.1543; found: 364.158

Ethyl-3-(2,6-difluorophenyl)-1-methyl-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11e)



A suspension of alanine ethyl ester hydrochloride (1.71 g, 11.13 mmol, 1.2 equiv.), 2,6-difluorobenzaldehyde (1.317 g, 9.274 mmol, 1.0 equiv.) and $MgSO_4$ (1.336 g, 11.13 mmol, 1.2 equiv.) in DCM (30 mL) was stirred at 0°C. TEA (0.938 g, 9.274 mmol, 1.0 equiv.) was added dropwise. The reaction was allowed to warm to room temperature and stirred overnight. Diethyl ether (40 mL) was added and the solution was filtered. The filtrate was washed with water and brine, dried over magnesium sulfate and concentrated *in vacuo* to give the corresponding imine **10e** (2 g) in 89% of yield, which was used in the next step without further purification. Imine **10e** (2 g, 8.29 mmol, 1.0 equiv.) was dissolved in 50 mL of toluene and 1,4-naphthaquinone (1.312 g, 8.3 mmol, 1.0 equiv.) was added to the reaction mixture. The reaction mixture was heated to reflux under argon overnight. Upon completion of the reaction, the reaction mixture was concentrated under high vacuum and the product was purified by flash chromatography using ethyl acetate/hexane as an eluent provided the quinone **11e** as a green solid (2.571 mg, 6.472 mmol, 78% yield). The relative stereochemistry was determined to be *cis* by NOESY NMR.

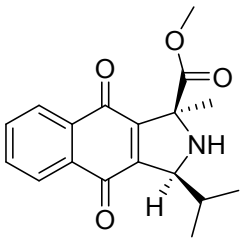
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 7.1 Hz, 1H), 8.05 (d, *J* = 7.1 Hz, 1H), 7.87 – 7.78 (m, 2H), 7.04 (d, *J* = 5.5 Hz, 2H), 6.89 (t, *J* = 8.6 Hz, 1H), 6.23 (s, 1H), 4.40 – 4.29 (m, 2H), 2.13 (s, 3H), 1.31 (t, *J* = 7.0 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.5, 180.2, 167.2, 164.4, 161.9, 146.4, 144.4, 134.7, 132.5, 132.4, 126.9, 112.4 – 112.0, 105.6, 73.3, 65.9, 64.0, 21.9, 13.7.

IR (thin film) 3319, 3077, 2984, 2937, 1735, 1664, 1624, 1584, 1442, 1328, 1304, 1238, 1107, 1015, 981, 857, 734, 703 cm^{-1}.

HRMS (ESI+): m/z [M + H^+] calcd for $C_{22}H_{18}F_2NO_4^+$: 398.1198; found: 398.1204

Methyl-3-isopropyl-1-methyl-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11f) [2, 3]



Procedure for the 1,3 dipolar cycloaddition of aliphatic substituted isoindoline, adapted from literature: A suspension of alanine ethyl ester hydrochloride (1.0 g, 6.51 mmol, 1.2 equiv.), isobutyraldehyde (0.391 g, 5.435 mmol, 1.0 equiv.) and $MgSO_4$ (0.783 g, 6.51 mmol, 1.2 equiv.) in DCM (20 ml) was stirred at 0°C. TEA (1.34 g, 6.51 mmol, 1.2 equiv.) was added dropwise. The reaction was allowed to warm at r.t. and stirred overnight. Diethyl ether (30 ml) was added and the solution was filtered. The filtrate was washed with water and brine, dried over magnesium sulfate and concentrated in *vacuo* to give the corresponding imine **10f** in 76% (0.648 g, 0.004 mol) of yield which was used in the next step without further purification.

To the solution of $Cu(MeCN)_4BF_4$ (27.46 mg, 0.0873 mmol, 3 mol%), α-iminoester (457.4 mg, 2.91 mmol, 1 equiv.) and DIPEA (75.22 mg, 0.582 mmol, 20 mol%) in 10ml toluene was added 1,4-naphthaquinone (552.26 mg, 3.492 mmol, 1.2 equiv.). The mixture was allowed to stir at r.t. until the progress of the reaction (followed by TLC) was stopped. The solvent was removed in *vacuo* and column chromatography on silica gel (EtOAc/ hexane) afforded the pure product as a yellow solid **11f**, 39% yield (355.1

mg, 1.1345 mmol). The structure of quinone **11f** was confirmed by NMR and X-ray crystallography.

X-ray See enclosed cif file **szpilman12.cif**.

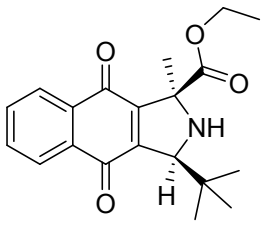
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 – 8.04 (m, 2H), 7.75 – 7.70 (m, 2H), 4.64 (d, *J* = 2.9 Hz, 1H), 3.71 (s, 3H), 2.55 – 2.43 (m, 1H), 1.72 (s, 3H), 0.98 (d, *J* = 7.0 Hz, 3H), 0.72 (d, *J* = 6.8 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 183.2, 181.9, 173.3, 149.4, 149.1, 133.9, 133.8, 133.2, 133.1, 126.5, 126.4, 70.6, 68.3, 52.5, 31.0, 24.6, 20.5, 15.9.

IR (thin film) 3359, 2969, 2877, 1732, 1661, 1592, 1456, 1376, 1340, 1309, 1264, 1177, 1103, 1022, 983, 893, 780 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{18}H_{20}NO_4^+$: 314.1345; found: 314.1368

Ethyl-3-(tert-butyl)-1-methyl-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11g)



A suspension of alanine ethyl ester hydrochloride (2.69 g, 1.6 mmol, 1.2 equiv.), pivalaldehyde (1.26 g, 1.4 mmol, 1.0 equiv.) and $MgSO_4$ (1.92 g, 1.6 mmol, 1.2 equiv.) in DCM (44 ml) was stirred at 0°C. TEA (2.2316 g, 1.6 mmol, 1.2 equiv.) was added dropwise. The reaction was allowed to warm at r.t. and stirred overnight. Diethyl ether (30 ml) was added and the solution was filtered. The filtrate was washed with water and brine, dried over magnesium sulfate and concentrated in *vacuo* to give the corresponding imine **10g** in 68% of yield (1.7268 g, 1.975 mmol) which was used in the next step without further purification.

To a solution of $Cu(MeCN)_4BF_4$ (18.6374 mg, 0.0592 mmol, 3 mol%), α-iminoester (365.7 mg, 1.975 mmol, 1 equiv.) and DIPEA (51.0498 g, 0.395 mmol, 20 mol%) in 7 ml toluene was added 1,4-naphthaquinone (312 mg, 1.975 mmol, 1 equiv.). The mixture was allowed to stir at r.t. until the progress of the reaction (followed by TLC) was stopped. The solvent was removed in *vacuo* and column chromatography on silica gel (EtOAc/

hexane) afforded the pure product as a yellow solid **11g**, 19% yield (128.8 mg, 0.375 mmol).

X-ray See enclosed cif file **szpilman9.cif**.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 – 8.04 (m, *J* = 4.8 Hz, 2H), 7.76 – 7.72 (m, *J* = 9.0 Hz, 2H), 4.48 (s, 1H), 4.19 (d, *J* = 7.1 Hz, 2H), 1.70 (s, 3H), 1.23 (t, *J* = 7.1 Hz, 3H), 0.97 (s, 9H).

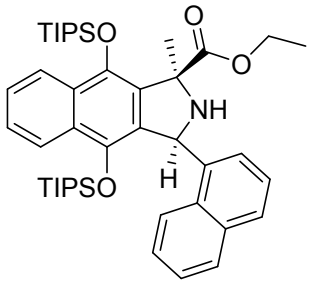
^{13}C NMR (101 MHz, $CDCl_3$) δ 183.91, 181.90, 172.92, 150.70, 150.36, 133.81, 133.64, 132.86, 126.68, 126.20, 72.32, 70.32, 61.44, 50.96, 37.11, 27.61, 25.66, 14.14.

IR (thin film) 3354, 2970, 2880, 1724, 1660, 1618, 1590, 1468, 1370, 1331, 1259, 1169, 1106, 1023, 939, 865, 767 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{20}H_{23}NO_4^+$: 341.1627; found: 341.1629

Silylation

Ethyl-1-methyl-3-(naphthalen-1-yl)-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12c)



General procedure for TIPS protection: Quinone **11c** (8.0 g, 1.93 mmol, 1.0 equiv.) was dissolved in 39 ml of ether and 39 ml 10% aqueous solution of $Na_2S_2O_4$ was added to it at 0°C. The reaction mixture was warmed to 30°C under argon and was stirred until the ether layer brightened. The mixture was extracted with ether, dried over Na_2SO_4. The solvent was evaporated with minimal exposure to air. The resulting napthhydroquinone compound was immediately used in the next reaction without any purification. hydroquinone (800 mg, 1.626 mmol, 1 equiv.) and DMAP (0.019 g, 0.1626 mmol, 0.1 equiv.) were dissolved in 2.5 ml of dry DMF under argon. DIPEA (1.42 ml, 8.13 mmol, 5 equiv.) was added to the reaction mixture under the stirring. TIPS chloride (1.11 g, 4.065 mmol, 5.82 mmol, 2.5 equiv.) was added to the reaction mixture and the stirring proceeded until no starting material and mono product remained according to TLC using

EtOAc and hexane as an eluent. Upon completion of the reaction, it was quenched by the addition of water. The reaction mixture was diluted with EtOAc. The organic phase was washed with water and dried over Na_2SO_4, filtered and concentrated on a rotary evaporator. Purification of the product by flash chromatography (5% EtOAc/hexanes) afforded the desired compound **12c** as a light yellow solid, yield 81% (0.95 g, 1.322 mmol).

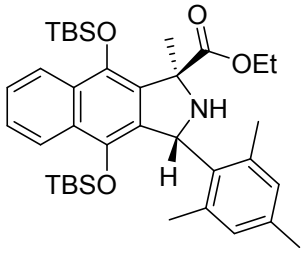
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (s, 1H), 8.33 (s, 1H), 8.20 – 8.04 (m, 2H), 7.86 (d, *J* = 8.1 Hz, 1H), 7.71 (d, *J* = 8.1 Hz, 1H), 7.60 (t, *J* = 7.4 Hz, 1H), 7.57 – 7.42 (m, 3H), 7.22 (t, *J* = 7.7 Hz, 1H), 6.89 (d, *J* = 7.0 Hz, 1H), 6.49 (s, 1H), 3.78 (q, *J* = 7.0 Hz, 2H), 1.92 (s, 3H), 1.48 (dq, *J* = 14.6, 7.3 Hz, 3H), 1.19 (d, *J* = 7.5 Hz, 9H), 1.14 (d, *J* = 7.5 Hz, 9H), 1.12 – 1.08 (m, 3H), 0.95 (d, *J* = 7.4 Hz, 9H), 0.80 (t, *J* = 7.1 Hz, 3H), 0.57 (d, *J* = 7.4 Hz, 9H).

^{13}C NMR (101 MHz, C_6D_6) δ 167.5, 142.2, 142.1, 139.8, 139.7, 139.1, 138.6, 131.1, 129.1, 128.8, 128.7, 126.1, 125.9, 125.4, 124.2, 123.7, 123.3, 123.2, 81.0, 62.5, 53.7, 29.6, 21.0, 20.3, 20.2, 20.2, 18.6, 18.6, 18.4, 18.4, 15.0, 14.4, 13.9.

IR (thin film) 2939, 2864, 1728, 1600, 1507, 1361, 1246, 1016, 987, 882, 760, 677, 646 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{44}H_{64}NO_4Si_2^+$: 726.4368; found: 726.4393

Ethyl 4,9-bis((tert-butyldimethylsilyl)oxy)-3-mesityl-1-methyl-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12a)



Compound **12a** was prepared and isolated as a white solid, 41% yield (127 mg, 0.2 mmol) following the general procedure for TIPS protection at 60 °C starting from quinone **11a** (200 mg, 0.4932 mmol, 1 equiv.).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 – 8.06 (m, *J* = 6.6, 3.1 Hz, 1H), 7.99 – 7.91 (m, 1H), 7.43 – 7.34 (m, *J* = 6.5, 3.3 Hz, 2H), 6.86 (s, 1H), 6.70 (s, 1H), 5.86 (s, 1H), 4.17 (q, *J* = 14.7, 7.5 Hz, 2H), 2.59 (s, 3H), 2.22 (s, 3H), 2.05 (s, 1H), 1.81 (s, 3H), 1.60 (s, 3H), 1.34

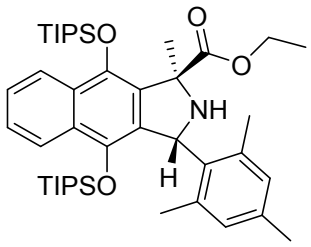
– 1.23 (m, 2H), 1.17 – 1.06 (m, 12H), 0.92 – 0.87 (m, *J* = 7.3 Hz, 3H), 0.72 (s, 9H), 0.44 (s, 3H), 0.23 (s, 3H), 0.15 – 0.02 (m, *J* = 20.5 Hz, 6H), -0.02 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.89, 140.33, 139.65, 138.01, 137.28, 136.80, 133.33, 132.67, 131.29, 131.01, 129.36, 129.10, 128.34, 124.54, 123.91, 123.52, 122.98, 68.29, 61.52, 61.29, 26.92, 25.75, 25.48, 22.93, 20.80, 20.66, 19.93, 19.44, 17.97, 14.07, -1.17, -1.87, -3.41, -3.56.

IR (thin film) 2930, 2895, 1738, 1603, 1465, 1359, 1253, 1119, 1084, 1013, 950, 903, 880, 772, 682 cm^{-1}.

HRMS (ESI+): m/z [M^+] calcd for $C37H55NO4Si2^+$; 634. 3742 found: 634.3827

Ethyl-3-mesityl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12b)



Compound **12b** was obtained as a white solid in 51% yield (480 mg, 0.6683 mmol) following the general procedure for TIPS protection starting from quinone **11a** (598 mg, 1.32 mmol, 1 equiv.). The structure was also confirmed by X-ray crystallography.

X-ray See enclosed cif file **szpilman3.cif**.

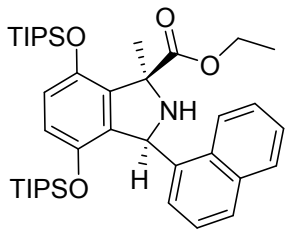
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (s, 2H), 7.39 (s, 2H), 6.84 (s, 1H), 6.69 (s, 1H), 5.95 (s, 1H), 4.23 – 4.03 (m, 2H), 2.54 (s, 3H), 2.21 (s, 3H), 1.78 (s, 3H), 1.62 (s, 3H), 1.43 (dt, *J* = 14.9, 7.4 Hz, 3H), 1.15 (d, *J* = 7.6 Hz, 9H), 1.10 (d, 3H), 1.06 (d, *J* = 7.4 Hz, 12H), 1.01 (d, *J* = 6.7 Hz, 9H), 0.66 (d, *J* = 7.1 Hz, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.9, 141.7, 141.2, 137.9, 137.2, 136.8, 133.2, 132.2, 131.2, 130.7, 129.4, 129.3, 128.4, 124.6, 124.2, 123.0, 122.7, 68.3, 61.7, 61.2, 20.9, 18.5, 18.0, 17.6, 15.1, 14.4.

IR (thin film) 1705, 1602, 1457, 1358, 1249, 1115, 1090, 1043, 880, 797 cm^{-1}.

HRMS (ESI+): m/z [M^+] calcd for $C_{43}H_{67}NO_4Si_2^+$: 717.4609; found: 717.4641

Ethyl-1-methyl-3-(naphthalen-1-yl)-4,7-bis((triisopropylsilyl)oxy)isoindoline-1-carboxylate (12d)



Compound **12d** was synthesized in 73% yield (674 mg, 0.9971 mmol) as a white solid following the general procedure for TIPS protection starting from hydroquinone **11d** (500 mg, 1.37 mmol, 1 equiv.).

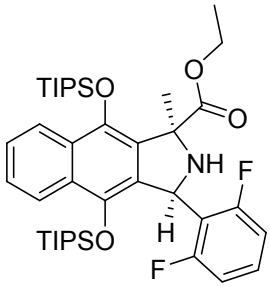
^{1}H NMR (400 MHz, Acetone) δ 8.37 (d, *J* = 8.3 Hz, 1H), 7.88 (d, *J* = 7.7 Hz, 1H), 7.75 (d, *J* = 8.1 Hz, 1H), 7.48 (dd, *J* = 16.3, 8.0 Hz, 2H), 7.32 (t, *J* = 7.7 Hz, 1H), 7.13 (d, *J* = 7.0 Hz, 1H), 6.79 (d, *J* = 8.6 Hz, 1H), 6.73 (d, *J* = 8.6 Hz, 1H), 6.38 (s, 1H), 3.87 (dt, *J* = 10.7, 3.5 Hz, 2H), 1.76 (s, 3H), 1.48 – 1.35 (m, 3H), 1.17 (d, *J* = 7.4 Hz, 18H), 0.95 (t, *J* = 7.1 Hz, 6H), 0.78 (d, *J* = 7.2 Hz, 18H).

^{13}C NMR (101 MHz, Acetone) δ 174.81, 146.59, 146.13, 140.38, 136.70, 135.56, 135.25, 133.20, 129.51, 128.37, 126.68, 126.16, 126.05, 125.22, 118.72, 118.15, 71.00, 61.28, 25.18, 18.78, 18.75, 18.46, 18.33, 18.30, 14.40, 14.19, 13.70.

IR (thin film) 3354, 2940, 2867, 1729, 1488, 1388, 1265, 1106, 984, 913, 880, 850, 803, 780, 731, 674 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{40}H_{61}NO_4Si_2^+$: 676.4261; found: 676.4212

Ethyl-3-(2,6-difluorophenyl)-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12e)



Compound **12e** was synthesized in 62% yield as white solid (888 mg, 1.247 mmol) following the general procedure for TIPS protection starting from quinone **11e** (800 mg, 2 mmol, 1 equiv.).

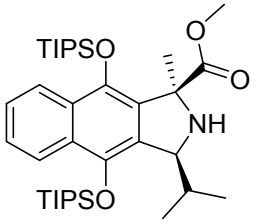
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (td, *J* = 7.9, 4.5 Hz, 2H), 7.47 – 7.42 (m, 2H), 6.74 (d, *J* = 6.3 Hz, 2H), 6.66 – 6.59 (m, 1H), 5.72 (s, *J* = 6.3 Hz, 1H), 3.93 (dt, *J* = 13.3, 6.7 Hz, 2H), 1.84 (s, 3H), 1.41 (dq, *J* = 14.8, 7.5 Hz, 3H), 1.25 – 1.18 (m, 3H), 1.14 (d, *J* = 7.5 Hz, 9H), 1.09 (d, *J* = 7.5 Hz, 9H), 1.06 – 1.03 (m, 12H), 0.93 (t, *J* = 7.1 Hz, 3H), 0.81 (d, *J* = 7.4 Hz, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.8, 164.2, 161.7, 147.2, 142.5, 141.5, 130.2, 129.56, 129.0, 128.7, 125.0, 124.6, 123.1, 122.9, 111.1, 110.9, 102.5, 69.8, 64.5, 61.3, 25.2, 18.5, 18.4, 18.0, 17.9, 14.9, 14.5, 13.7.

IR (thin film) 3323, 2943, 2866, 1719, 1596, 1458, 1254, 1114, 1013, 990, 881, 762, 674 cm^{-1}.

HRMS (ESI+): m/z [M^+] calcd for $C_{40}H_{59}NO_4F_2Si_2^+$: 711.3951; found: 711.3959

Methyl-3-isopropyl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12f)



Compound **12f** was synthesized in 61.5% yield (434.5 mg, 0.6918 mmol) as a white solid following the general procedure for TIPS protection starting from quinone **11f** (355.1 mg, 1.1256 mmol, 1 equiv.).

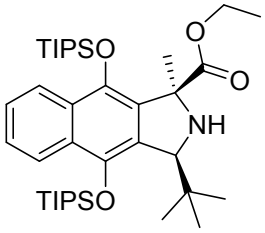
^{1}H NMR (400 MHz, C_6D_6) δ 8.31 (d, *J* = 8.1 Hz, 1H), 8.19 (d, *J* = 8.1 Hz, 1H), 7.35 – 7.24 (m, 2H), 4.82 (d, *J* = 2.1 Hz, 1H), 3.46 (s, 3H), 2.88 (m, *J* = 6.8, 4.8 Hz, 1H), 1.91 (s, *J* = 13.9 Hz, 3H), 1.58 – 1.46 (m, 3H), 1.38 – 1.26 (m, 4H), 1.19 – 1.10 (m, 30H), 1.05 (d, *J* = 7.4 Hz, 9H), 0.81 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (101 MHz, C_6D_6) δ 174.2, 142.2, 141.3, 131.3, 131.0, 130.1, 128.1, 124.9, 124.2, 123.2, 123.0, 30.9, 26.6, 20.9, 18.7, 18.6, 18.2, 18.2, 15.7, 15.4, 14.7.

IR (thin film) 3360, 2950, 2802, 1724, 1459, 1441, 1361, 1263, 1086, 1016, 881, 797, 762, 674, 642, 505 cm^{-1}.

HRMS (ESI+): m/z [M $^+$] calcd for $C_{36}H_{62}NO_4Si_2^+$: 628.4217; found: 628.4211

Ethyl-3-(tert-butyl)-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12g)



Compound **12g** was synthesized in 10% yield (12 mg, 0.0187 mmol) as a white solid following the general procedure for TIPS protection starting from quinone **11g** (100 mg, 0.2911 mmol, 1 equiv.).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 – 8.07 (m, 1H), 8.01 – 7.95 (m, 1H), 7.37 (p, *J* = 6.6 Hz, 2H), 4.57 (s, 1H), 4.15 (tdd, *J* = 17.9, 9.0, 5.4 Hz, 2H), 1.71 (d, *J* = 9.8 Hz, 3H), 1.48 – 1.35 (m, 3H), 1.31 – 1.24 (m, *J* = 14.8, 7.5 Hz, 3H), 1.21 – 1.13 (m, 12H), 1.10 (d, *J* = 7.5 Hz, 9H), 1.05 (d, *J* = 7.5 Hz, 9H), 0.91 (d, *J* = 7.4 Hz, 9H), 0.83 (s, 9H).

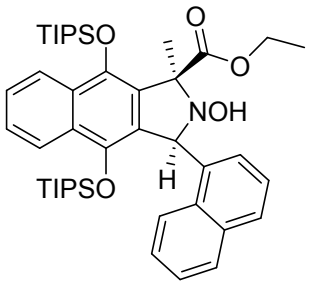
^{13}C NMR (101 MHz, $CDCl_3$) δ 174.93, 142.23, 141.47, 134.66, 130.09, 128.11, 124.23, 123.75, 122.96, 122.81, 70.36, 69.32, 60.93, 39.17, 28.67, 27.61, 18.56, 18.40, 18.28, 18.16, 14.89, 14.35, 14.15.

IR (thin film) 3354**,** 2970, 2880, 1724, 1660, 1618, 1590, 1468, 1331, 1259, 1169, 1106, 1023, 939, 865, 767, 719, 638, 564 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{38}H_{65}NO_4Si_2^+$: 656.4525; found: 656.453

Oxidation to hydroxylamine and nitroxide

Ethyl-2-hydroxy-1-methyl-3-(naphthalen-1-yl)-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (13c)

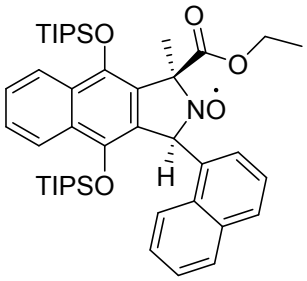


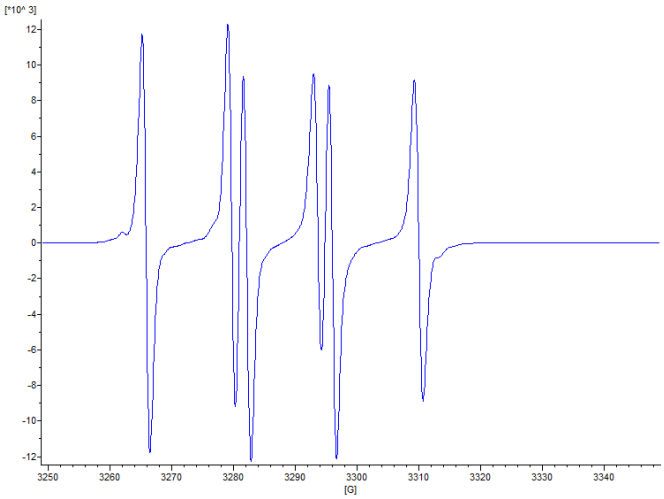
General procedure for amine oxidation: TIPS protected amine **12c** (100 mg, 0.13 mmol, 1 equiv.) was dissolved in 2.5 ml of dry DCM. $NaHCO_3$ (22 mg, 0.26 mmol, 2.0 equiv.) was added to stirred solution under N_2 followed by the addition of purified *m*CPBA (36 mg, 0.16 mmol, 1.3 equiv.). The reaction was stirred several minutes until full conversion of the starting material according to TLC (15% ether/pentane). Upon completion of the reaction the solvent was evaporated under reduced pressure at room temperature and the crude mixture was purified by flash chromatography using ether/pentane as an eluent to get hydroxylamine **13c** and nitroxide **14c** as an inseparable mixture (59 mg, 0.08 mmol, 63% yield). IR, ESR, NMR and HRMS studies confirmed the presence of hydroxylamine **13c** and nitroxide **14c** as a mixture

IR: *v* 3417, 1714, 1459, 1396, 1287, 1256, 1083, 990, 761, 645 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{44}H_{64}NO_5Si_2^+$: 742.4318; found: 742.4313

Ethyl-3-(naphthalen-1-yl)-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate-N-oxyl (14c)





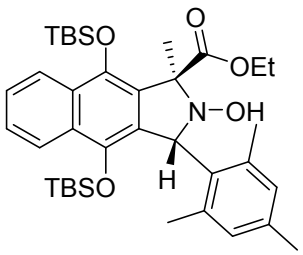
The mixture of hydroxylamine and nitroxide is oxidized quantitatively to radical **14c** upon exposure to air. Radical **14c** was found to be stable for more than 12 months as a solid.

IR (thin film) 3417, 1714, 1459, 1396, 1287, 1256, 1083, 990, 761, 645 cm^{-1}.

HRMS (ESI+): m/z [M + H^+] calcd for $C_{44}H_{64}NO_5Si_2^+$: 742.4245; found: 742.4242

ESR (benzene) g= 2.0055, *aN* = 13.94 G, *aH* =16.3 G

Ethyl-4,9-bis((tert-butyldimethylsilyl)oxy)-2-hydroxy-3-mesityl-1-methyl-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (13a)



Compounds **13a** was synthesized in 26% yield (13.7 mg, 0.021 mmol) as a white solid following the general procedure for TIPS protection starting from amine **12a** (50 mg, 0.0788 mmol).

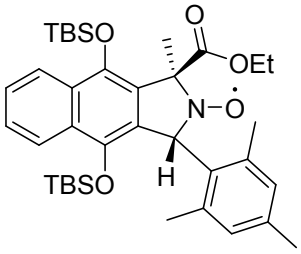
^{1}H NMR (400 MHz, C_6D_6) δ 8.32 – 8.15 (m, 2H), 7.33 – 7.19 (m, 2H), 6.85 (s, 1H), 6.75 (s, 1H), 6.07 (s, 1H), 4.32 – 4.13 (m, *J* = 22.0, 7.1 Hz, 2H), 4.11 (s, 1H), 2.68 (s, 3H),

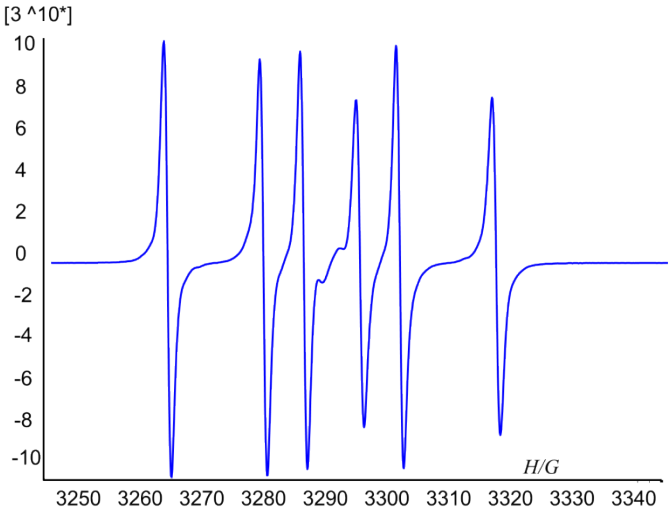
2.20 (s, 3H), 2.15 (s, 3H), 2.02 (s, 3H), 1.13 (s, 9H), 0.96 (t, J = 7.1 Hz, 3H), 0.78 (s, 9H), 0.41 (s, 3H), 0.14 (s, 3H), 0.06 (s, 3H), -0.09 (s, 3H).

^{13}C NMR (101 MHz, C_6D_6) δ 140.83, 140.55, 138.86, 138.42, 137.22, 136.87, 135.38, 132.12, 131.36, 131.31, 129.99, 129.37, 128.82, 128.30, 128.06, 127.94, 127.82, 126.04, 124.97, 124.78, 124.60, 123.68, 123.51, 72.48, 67.14, 60.85, 29.46, 27.03, 25.74, 21.48, 20.88, 20.41, 19.52, 18.24, 14.70, 14.22, -1.34, -1.96, -3.11, -3.25.

IR (thin layer) 3437, 2929, 2857, 1712, 1607, 1465, 1363, 1257, 1084, 1012, 939, 783, 682 cm^{-1}.

Ethyl-4,9-bis((tert-butyldimethylsilyl)oxy)-2-hydroxy-3-mesityl-1-methyl-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate-N-oxoyl (14a)



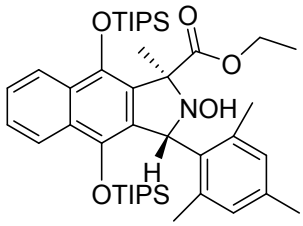


The mixture of **13a** and hydroxylamine **14a** described above was dissolved in benzene and exposed to air. This led to complete conversion into the radical **14a**. Evaporation of the solvent afforded nitroxide **14a** in quantitative yield as a solid..

ESR (benzene) g= 2.0055, aN = 15.65 G, aH =22.13G

HRMS (ESI+): m/z [M $^+$] calcd for $C_{43}H_{68}NO_5Si_2^+$: 649.3619; found: 649.3624

Ethyl-2-hydroxy-3-mesityl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (13b):



Compound **12a** (99 mg, 0.138 mmol, 1 equiv.) was dissolved in 2.5 mL of dry DCM. $NaHCO_3$ (23 mg, 0.276 mmol, 2.0 equiv.) was added to the stirred solution under N_2 followed by the addition of purified m-CPBA (36 mg, 0.206 mmol, 1.5 equiv.). The reaction was stirred several minutes until full conversion of the starting material according to TLC using 15% ether/pentane. Upon completion of the reaction the solvent was evaporated at reduced pressure at room temperature and the crude mixture was purified by flash chromatography using ethyl acetate/hexane as an eluent to get hydroxylamine and nitroxyl radicals as a solid (81 mg, 80% yield). It proved possible to obtain a pure sample of hydroxylamine **13a** from additional column chromatography. The structure of hydroxylamine **13aa** was confirmed by NMR and X-ray crystallography.

X-ray See enclosed cif file **szpilman2.cif**.

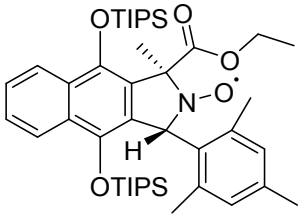
^{1}H NMR (400 MHz, C_6D_6) δ 8.32 (d, *J* = 8.6 Hz, 1H), 8.21 (d, *J* = 8.6 Hz, 1H), 7.36 – 7.22 (m, 2H), 6.86 (s, 1H), 6.75 (s, 1H), 6.11 (s, 1H), 4.26 – 4.15 (m, 3H, OH), 2.67 (s, 3H), 2.21 (s, 3H), 2.15 (s, 3H), 2.04 (s, 3H), 1.58 – 1.50 (m, 3H), 1.22 – 1.15 (m, 20H), 1.08 (d, *J* = 7.5 Hz, 9H), 0.98 (t, *J* = 7.1 Hz, 3H), 0.80 (d, *J* = 7.3 Hz, 9H).

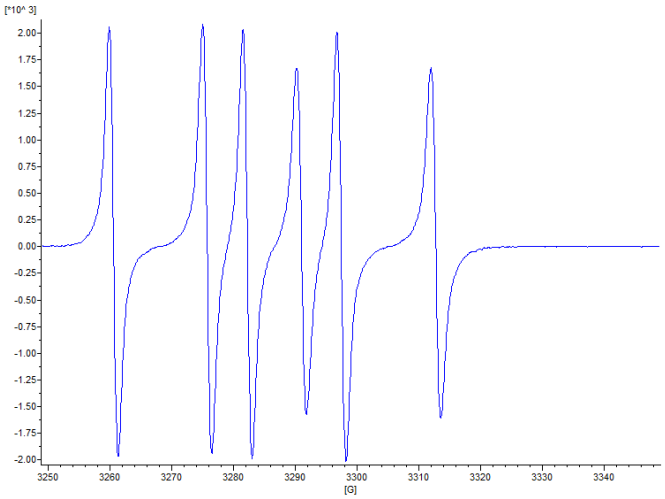
^{13}C NMR (101 MHz, C_6D_6) δ 172.3 ($\underline{C}O_2Et$), 142.3, 141.8 ($\underline{C}$, Ar), 140.6 ($\underline{C}$, Ar), 138.5 ($\underline{C}$, Ar), 136.9 ($\underline{C}$, Ar), 132.3 ($\underline{C}$, Ar), 131.4 ($\underline{C}$H, Ar), 129.6 ($\underline{C}$, Ar), 129.5 ($\underline{C}$H, Ar), 129.1 ($\underline{C}$, Ar), 128.7 ($\underline{C}$, Ar), 125.6 ($\underline{C}$, Ar), 125.0 ($\underline{C}$H, Ar), 124.8 ($\underline{C}$H, Ar), 123.1 ($\underline{C}$H, Ar), 123.0 ($\underline{C}$H, Ar), 72.4 ($\underline{C}$-NO), 67.6 ($\underline{C}$H-NO), 60.8 ($\underline{C}H_2$), 18.7 ($\underline{C}H_3$), 18.6 ($\underline{C}H_3$), 18.1 ($\underline{C}H_3$), 17.9 ($\underline{C}H_3$), 15.3 ($\underline{C}H_3$), 14.8 ($\underline{C}H_3$/$\underline{C}$H).

IR: *v* 3307, 2905, 2865, 1778, 1457, 1362, 1239, 1122, 1007, 883 cm^{-1}.

HRMS (ESI+): *m/z* [M $^+$] calcd for $C_{43}H_{68}NO_5Si_2^+$: 734.4631; found: 734.4615

Ethyl-3-mesityl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate-N-oxyl (14b):





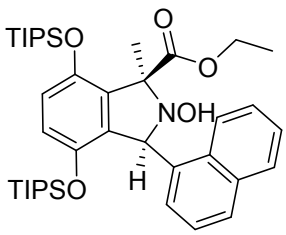
A mixture of **13a** and hydroxylamine **14a** (75 mg, 0.102 mmol) was dissolved in benzene and exposed to air. This led to complete conversion into the radical **13a** after 4 days. Evaporation of the solvent afforded nitroxide **14a** in (75 mg, quantitative yield) as a solid. A 2 mM solution of **14a** in toluene was stored at RT for more than 2 months without any observable degradation.

IR: *v* 2910, 2871, 1762, 1463, 1371, 1221, 1131, 993 cm^{-1}.

HRMS (ESI+): *m/z* [M+H$^+$] calcd for $C_{43}H_{68}NO_5Si_2^+$: 734.4631; found: 734.4621

ESR (benzene) g= 2.006, *a*N = 15.2 G, *a*H = 21.8G

Ethyl-2-hydroxy-1-methyl-3-(naphthalen-1-yl)-4,7-bis((triisopropylsilyl)oxy) isoindoline-1-carboxylate (13d)



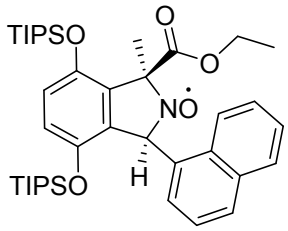
Compounds **13d** and **14d** were synthesized as a mixture in 63% yield (59 mg, 0.08 mmol) following the general procedure for amine oxidation. Upon completion of the

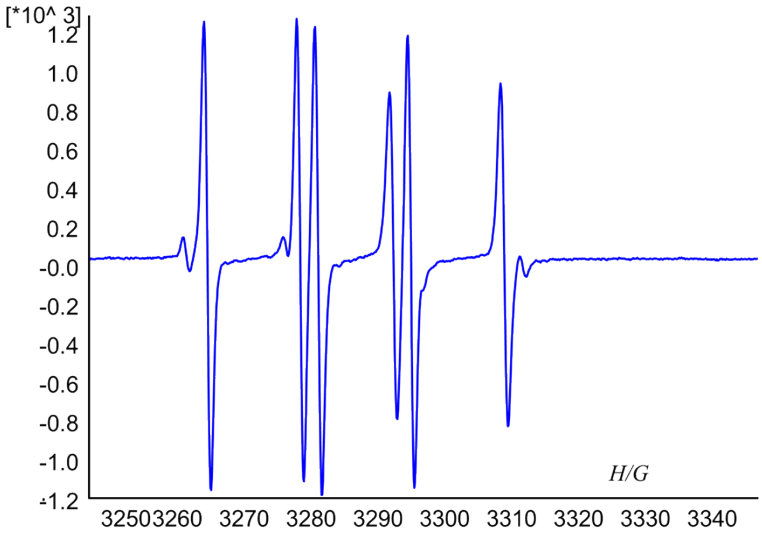
reaction the solvent was evaporated without heating and the crude mixture was purified by flash chromatography using ether/pentane as an eluent to get hydroxylamine and nitroxide as an inseparable mixture. ESR and HRMS confirmed the presence of hydroxylamine and nitroxide together as an inseparable mixture.

IR: *v* 3417, 1714, 1459, 1396, 1287, 1256, 1083, 990, 761, 645 cm^{-1}.

HRMS (ESI+): m/z [M^+] calcd for $C_{40}H_{62}NO_5Si_2^+$: 692.4161; found: 692.4155

Ethyl-2-hydroxy-1-methyl-3-(naphthalen-1-yl)-4,7-bis((triisopropylsilyl)oxy)isoindoline-1-carboxylate-N-oxyl (14d)

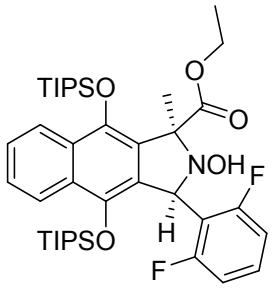




Radical **14d** was prepared by exposure of **13d** to air.

ESR (benzene) g= 2.0055, *aN* = 13.9 G, *aH* =16.6 G

Ethyl-3-(2,6-difluorophenyl)-2-hydroxy-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (13e)



Compounds **13e** was synthesized in 55% yield (28.6 mg, 1.247 mmol) as a light yellow solid following the general procedure for amine oxidation starting with protected amine **12e** (800 mg, 2 mmol).

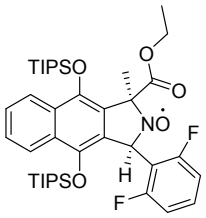
^{1}H NMR (400 MHz, C_6D_6) δ 8.31 (dd, *J* = 14.0, 8.2 Hz, 2H), 7.38 (dt, *J* = 15.0, 6.8 Hz, 2H), 7.17 – 7.09 (m, 2H), 6.71 – 6.63 (m, 1H), 4.80 (s, 1H), 4.29 – 4.08 (m, 2H), 2.21 (s, 3H), 1.66 – 1.54 (m, 3H), 1.28 (d, *J* = 7.6 Hz, 9H), 1.24 (d, *J* = 7.5 Hz, 9H), 1.21 – 1.16 (m, 3H), 1.08 (d, *J* = 7.4 Hz, 9H), 1.01 (t, *J* = 7.1 Hz, 3H), 0.83 (d, *J* = 7.3 Hz, 9H).

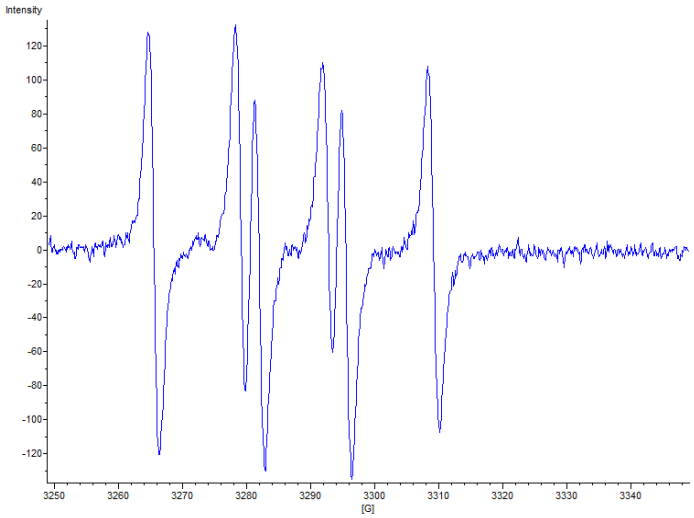
^{13}C NMR (101 MHz, C_6D_6) δ 172.11, 164.76, 162.30, 145.08, 142.25, 142.07, 130.16, 129.31, 128.97, 128.06, 125.35, 125.23, 123.88, 123.22, 123.05, 112.97, 112.73, 103.16, 73.88, 73.11, 61.12, 18.57, 17.96, 17.75, 15.82, 15.29, 14.59, 14.15.

IR (thin film) 3427, 2944, 2867, 1710, 1598, 1459, 1366, 1287, 1255, 1114, 1087, 1017, 989, 905, 882, 767, 737, 678 cm^{-1}.

HRMS (ESI+): m/z [M $^{+}$] calcd for $C_{40}H_{59}NO_5F_2Si_2^{+}$: 727.3900; found: 727.3915

Ethyl-3-(2,6-difluorophenyl)-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate-N-oxyl (14e)

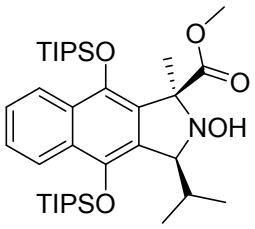




Hydroxylamine **13e** is to radical **14e** upon exposure to air. Radical **14e** was found to be decompose rapidly in solution during preparation.

ESR (benzene) g= 2.0055, *aN* = 13.6 G, *aH* =16.6 G

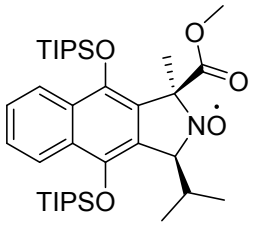
Methyl-2-hydroxy-3-isopropyl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (13f)

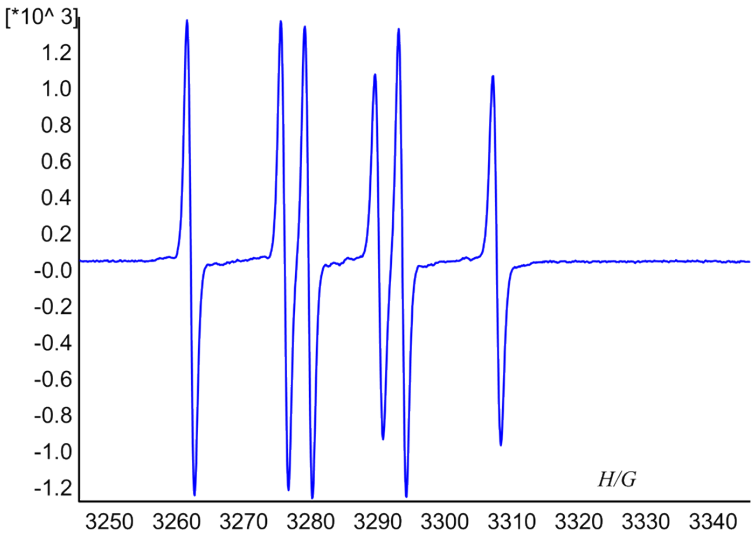


Compound **13f** and **14f** were synthesized as a mixture in 74% yield (75.4 mg, 0.117 mmol) following the general procedure for amine oxidation. Upon completion of the reaction the solvent was evaporated without heating and the crude mixture was purified by flash chromatography using ether/pentane as an eluent to get hydroxylamine and nitroxide as an inseparable mixture. NMR, ESR and HRMS confirmed the presence of hydroxylamine and nitroxide together as an inseparable mixture.

HRMS (ESI+): m/z [M $^{+}$] calcd for $C_{36}H_{61}NO_5Si_2^{+}$: 734.4631; found: 734.4615 (suitable for nitroxide)

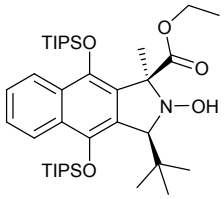
Methyl-3-isopropyl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate-N-oxyl (14f)





Radical **14f** was isolated along with hydroxylamine **13f** as described above. Hydroxylamine **13f** is oxidized quantitatively to radical **14f** upon exposure to air. Radical **ESR** (benzene) g= 2.0055, aN = 14.0 G, aH =17.5 G

Ethyl-3-(tert-butyl)-2-hydroxy-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate-N-oxyl 13g

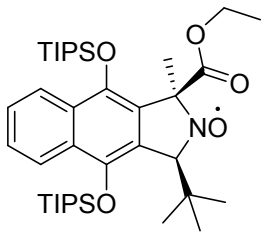


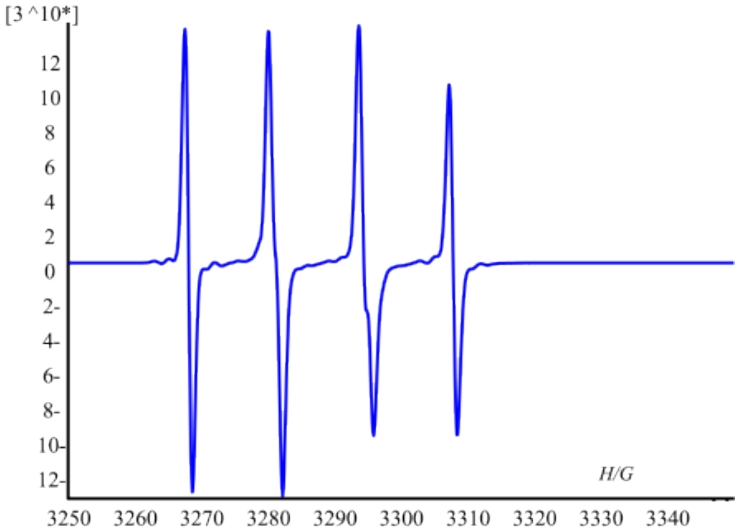
Compounds **13g** and **14g** were synthesized as a mixture in 71% yield (8.9 mg, 0.0132 mmol) following the general procedure for amine oxidation. Upon completion of the reaction the solvent was evaporated without heating and the crude mixture was purified by flash chromatography using ether/pentane as an eluent to get hydroxylamine and nitroxide as an inseparable mixture. NMR, ESR and HRMS confirmed the presence of hydroxylamine and nitroxide together as an inseparable mixture.

IR (thin film) 3598, 2962, 2931, 2867, 1720, 1556, 1461, 1381, 1288, 1209, 1131, 1075, 1040, 895, 775, 755, cm^{-1}.

HRMS (ESI+): m/z [M $^{+}$] calcd for $C_{38}H_{64}NO_5Si_2^{+}$: 670.4318; found: 670.4362

Ethyl-3-(tert-butyl)-2-hydroxy-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate-N-oxyl (14g)





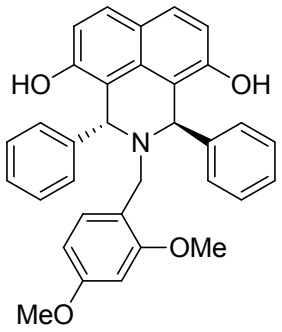
Radical **14g** was isolated along with hydroxylamine **13g** as described above. Hydroxylamine **13g** is oxidized quantitatively to radical **14g** upon exposure to air.

ESR (benzene) g= 2.0055, aN = 12.5 G, aH =13.7 G

Synthesis of Isoazaphenalene nitroxides

Cyclization:

2-(2,4-Dimethoxy-benzyl)-1,3-diphenyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (17a)



2,4-Dimethoxybenzylamine (1.56 g, 9.36 mmol, 1.5 equiv.) and benzaldehyde (3.97 g, 3.8 ml, 37.44 mmol, 6 equiv.) were stirred in a round flask under nitrogen for 45 min. 2,7- naphthalenediol (1 g, 6.24 mmol, 1 equiv.) was added into the reaction mixture and the stirring was continued for 3 days. A hemiaminal product was formed. 30 mL of dry DCM and TsOH (1.780 g, 9.36 mmol, 1.5 equiv.) were added. The reaction mixture was stirred until all of the hemiaminal was consumed. Saturated $NaHCO_3$ was added for extraction. The organic layer was dried over Na_2SO_4 and the solvent was removed under vacuum. The product was purified by flash chromatography (20% EtOAc in hexane) to get a white solid, 95% yield (2.98 g, 5.92 mmol).

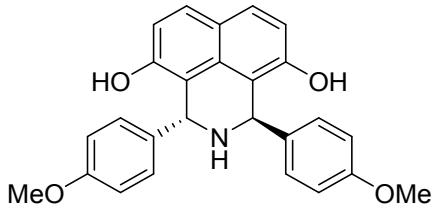
^{1}H NMR (400 MHz, Acetone) δ 7.93 (s, 2H), 7.55 (d, J = 8.7 Hz, 2H), 7.23 (d, J = 8.3 Hz, 1H), 7.16-7.07 (m, 10H), 6.85 (d, J = 8.7 Hz, 2H), 6.44 (d, J = 1.9 Hz, 1H), 6.39 (dd, J = 8.4, 1.6 Hz, 1H), 5.31 (s, 2H), 3.71 (s, 3H), 3.68 (s, 3H), 3.58 (d, J = 15.0 Hz, 1H), 3.29 (d, J = 15.1 Hz, 1H).

^{13}C NMR (101 MHz, Acetone) δ 159.6, 158.4, 150.3, 143.0, 131.1, 129.7, 129.5, 127.3, 127.2, 126.3, 123.1, 119.5, 118.1, 115.3, 104.6, 97.9, 58.7, 54.6, 54.6, 44.9.

IR (thin film) 3481, 3391, 2983, 1610, 1587, 1503, 1418, 1034, 824, 700 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{33}H_{30}NO_4^+$: 504.2175; found: 504.2148.

1,3-Bis-(4-methoxy-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (17b)



Compound **17b** was afforded as yellow solid, 94% yield (4.8 g, 0.0116 mol) following the same procedure described for compound **17d**.

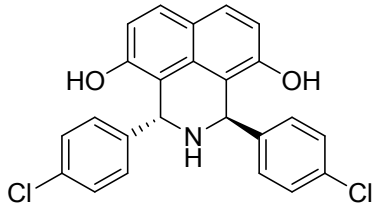
^{1}H NMR (400 MHz, DMSO-d_6) δ 9.01 (s, 2H), 7.49 (d, J = 8.8 Hz, 2H), 6.93 (m, 4H), 6.75 (m, 6H), 5.07 (s, 2H), 3.64 (s, 6H).

^{13}C NMR (101 MHz, DMSO) δ 158.1, 150.4, 137.3, 132.3, 129.3, 127.5, 122.8, 116.9, 115.3, 113.5, 55.4, 53.2.

IR (thin film) 3491, 3392, 2984, 1618, 1597, 1513, 1428, 1044, 825, 701 cm^{-1}

HRMS (ESI+): *m/z* [M + H$^+$] calcd for $C_{26}H_{24}NO_4^+$: 414.1705; found: 414.1704

1,3-Bis-(4-chloro-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (17c)



Compound **17c** was isolated as an yellow solid, 88% yield (2.3 g, 0.005 mol) following the same procedure described for compound **17d**.

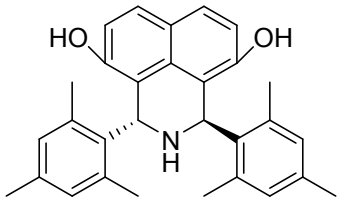
^{1}H NMR (400 MHz, DMSO-d_6) δ 9.23 (s, 2H), 7.54 (d, J = 8.8 Hz, 2H), 7.24 (d, J = 7.9 Hz, 4H), 7.08 (d, J = 8.1 Hz, 4H), 6.85 (d, J = 8.7 Hz, 2H), 5.14 (s, 2H).

^{13}C NMR (101 MHz, DMSO) δ 150.6, 144.2, 132.0, 131.2, 130.3, 128.2, 128.0, 122.8, 115.9, 115.3, 53.4.

IR (thin film) 3421, 3396, 1629, 1619, 1513, 1371, 1365, 1275, 1055, 898, 859 cm^{-1}

HRMS (ESI+): *m/z* [M + H$^+$] calcd for $C_{24}H_{18}Cl_2NO_2^+$: 422.0715; found: 422.0714

1,3-Bis-(2,4,6-trimethyl-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (17d/e)



General procedure for isoazaphenalene cyclization: 2,7-dihydroxy-napthalene (2.5 g, 15.62 mmol, 1.0 equiv.) was added to a stirred solution of Mesitaldehyde (5.7 g, 39.06 mmol, 2.5 equiv.) and NH_4OAc (1.4 g, 18.74 mmol, 1.2 equiv.) in ethanol (30 ml). After refluxing at 80 °C for 48h, the reaction mixture was concentrated on a rotary evaporator. The residue was partitioned between saturated aqueous sodium bicarbonate solution (50 ml) and EtOAc (250 ml). The layers were separated and the aqueous layer was washed with EtOAc (2 x 75 ml). The combined organic layers were dried over anhydrous sodium sulfate, filtered, concentrated on a rotary evaporator, and purified by silica gel chromatography (40% EtOAc/hexanes) to afford **17d** as a light yellow solid, 70% (4.77 g, 10.93 mmol).

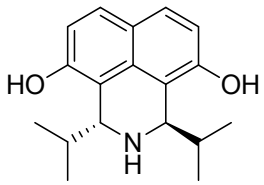
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, *J* = 8.8 Hz, 2H), 6.92 (s, 2H), 6.86 (d, *J* = 8.8 Hz, 2H), 6.80 (s, 2H), 5.80 (s, 2H), 2.32 (s, 6H), 2.27 (s, 6H), 1.83 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 149.9, 138.4, 137.7, 137.7, 134.0, 131.7, 131.5, 130.4, 128.2, 124.7, 116.4, 115.4, 50.8, 20.9, 20.8, 20.8.

IR (thin film) 3426, 3386, 1629, 1609, 1513, 1331, 1300, 1265, 1052, 890, 849 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{30}H_{32}NO_2^+$: 438.2428; found: 438.2436.

(1,3-diisopropyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (17f/g)



General procedure for aliphathic izoazaphenalene cyclization: 1ml of a solution of 7N ammonia in methanol was added to 1.9 mmol of freshly distilled aliphatic aldehyde. The reaction mixture was stirred for 30 min. and 2,7 naphthalenediol (0.63 mmol) was

added to the mixture. The reaction mixture was stirred until full consumption of 2,7 naphthalenediol (several days). The solvent was evaporated and the product was purified by column chromatography over silica gel to afford **17f** as a yellow solid, 91% yield (163.4 mg, 0.5733mmol)

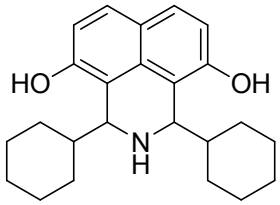
^{1}H NMR (400 MHz, MeOD) δ 7.58 (d, *J* = 8.8 Hz, 2H), 6.91 (d, *J* = 8.8 Hz, 2H), 4.70 (d, *J* = 6.5 Hz, 2H), 2.89 – 2.78 (m, 2H), 0.98 (d, *J* = 7.0 Hz, 6H), 0.88 (d, *J* = 6.9 Hz, 6H).

^{13}C NMR (101 MHz, MeOD) δ 153.3, 130.9, 130.2, 124.2, 116.1, 111.5, 57.1, 49.0, 37.4, 19.6, 17.5.

IR (thin film) 3046, 2961, 2871, 1620, 1568, 1507, 1464, 1299, 1267, 1199, 1146, 831 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{18}H_{24}NO_2^+$: 286.1807; found: 286.1800.

1,3-dicyclohexyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (I)



Compound **I** was isolated as an orange solid, 91% yield (531.44 mg, 1.456 mmol) following the same procedure described for compound **17f**.

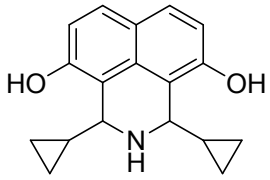
^{1}H NMR (400 MHz, Acetone) δ 7.45 (d, *J* = 8.7 Hz, 2H), 6.91 (d, *J* = 8.7 Hz, 2H), 4.33 (d, *J* = 6.4 Hz, 2H), 2.36 – 2.24 (m, 2H), 1.70 – 1.62 (m, 4H), 1.61 – 1.52 (m, 4H), 1.49 – 1.40 (m, 7.8 Hz, 4H), 1.15 – 1.02 (m, 8H).

^{13}C NMR (101 MHz, Acetone) δ 150.9, 132.8, 127.4, 124.4, 118.0, 115.8, 54.5, 40.5, 31.3, 29.8, 28.7, 27.6, 27.5, 27.4.

IR (thin film) 2923, 2852, 1621, 1566, 1507, 1451, 1396, 1266, 1198, 1143, 830 cm^{-1}

HRMS (APCI+): *m/z* [M + H^+] calcd for $C_{24}H_{32}NO_2^+$: 366.2428; found: 366.2413.

1,3-dicyclopropyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (II)



Compound **II** was isolated as a brown solid, 95% yield (855.304 mg, 3.04 mmol) following the same procedure described for compound **17f**.

^{1}H NMR (400 MHz, MeOD) δ 7.50 (d, *J* = 8.8 Hz, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 3.92 (d, *J* = 9.0 Hz, 2H), 1.36 – 1.24 (m, 2H), 0.85 – 0.76 (m, 2H), 0.70 – 0.62 (m, 2H), 0.62 – 0.50 (m, 4H).

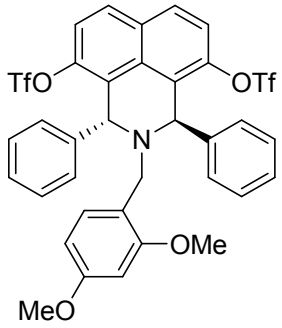
^{13}C NMR (101 MHz, MeOD) δ 151.0, 127.6, 127.1, 121.9, 113.5, 112.1, 54.8, 17.2, 6.6, 1.4.

IR (thin film) 3332, 3265, 1648, 1621, 1465, 1276, 1218, 1031, 982, 837, 779, 723 cm^{-1}

HRMS (APCI+): *m/z* [M + H^+] calcd for $C_{18}H_{20}NO_2^+$: 282.1489; found: 282.1476.

Triflation

Trifluoro-methanesulfonic acid 2-(2,4-dimethoxy-benzyl)-1,3-diphenyl-9-trifluoromethanesulfonyloxy-2,3-dihydro-1H-benzo[de]isoquinolin-4-yl ester (18a)



A stirred solution of the cyclic diol **17a** (0.5 g, 0.993 mmol, 1 equiv.) in 20 ml of dry DCM was cooled to 0 °C with an ice bath under argon. Et_3N (0.83 ml, 5.958 mmol, 6 equiv.) and DMAP (12.13 mg, 0.099 mmol, 0.1 equiv.) were added into the stirred solution. A solution of triflic anhydride (0.50 ml, 2.97 mmol, 3 equiv.) in 2 ml of dry DCM was added drop wise into the reaction mixture. After all the starting material was

reacted (in about 30 min.) according to TLC (20% EtOAc in hexane) the reaction was quenched with water. The organic layer was extracted, washed with brine and dried over Na_2SO_4. The solvent was removed under vacuum. The crude product was purified by column chromatography on silica gel with elution by 10% EtOAc in hexane to give the desired bistriflate product as a yellow solid, 95% yield (0.94 mmol, 0.72 g).

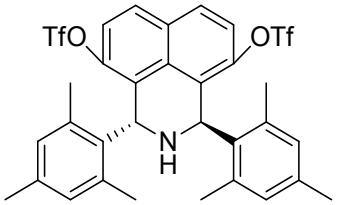
^{1}H NMR (400 MHz, Acetone) δ 8.28 (d, *J* = 9.1 Hz, 2H), 7.64 (d, *J* = 9.1 Hz, 2H), 7.30 (d, *J* = 4.9 Hz, 6H), 7.18 – 7.06 (m, 5H), 6.54 (s, 1H), 6.44 (d, *J* = 8.4 Hz, 1H), 5.49 (s, 2H), 3.77 (s, 6H), 3.66 (d, *J* = 14.6 Hz, 1H), 3.40 (d, *J* = 14.6 Hz, 1H).

^{13}C NMR (101 MHz, Acetone) δ 160.2, 158.5, 143.8, 138.9, 131.4, 130.2, 129.8, 129.8, 129.6, 129.6, 128.2, 127.9, 121.2, 117.5, 105.0, 98.0, 58.8, 54.7, 54.6, 44.5.

IR (thin film) 2833, 1613, 1589, 1505, 1419, 1206, 1133, 1033, 857, 837, 774, 700 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{35}H_{28}F_6NO_8S_2^+$: 768.1161 found: 768.1182.

Trifluoro-methanesulfonicacid-9-trifluoromethanesulfonyloxy-1,3-bis-(2,4,6-trimethyl-phenyl)-2,3-dihydro-1H-benzo[de]isoquinolin-4-yl ester (18d)



Triflic anhydride (3.9 ml, 22.88 mmol, 2.5 equiv.) was added to a stirred solution of diol **17d** (4.0 g, 9.15 mmol, 1.0 equiv.) and pyridine (2.2 ml, 27.45 mmol, 3.0 equiv.) in dry DCM (50 ml) at 0 °C. After 30 minutes the reaction mixture was quenched by adding saturated $NaHCO_3$ solution. The reaction mixture was partitioned between saturated aqueous sodium bicarbonate solution (50 ml) and DCM (200 ml). The layers were separated and the aqueous layer was washed with DCM (2 x 75 ml). The combined organic layers were washed with 10% HCl solution and dried over anhydrous Na_2S0_4, filtered, concentrated on a rotary evaporator, and purified by silica gel chromatography (10% EtOAc/hexanes) to afford the desired triflate **18d** as a light yellow solid 94% yield (6.03 g, 8.60 mmol).

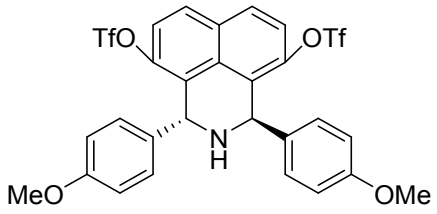
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 9.1 Hz, 2H), 7.45 (d, *J* = 9.0 Hz, 2H), 6.92 (s, 2H), 6.74 (s, 2H), 5.93 (s, 2H), 2.27 (s, 6H), 2.24 (s, 6H), 1.52 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.8, 137.7, 137.2, 136.4, 133.5, 132.1, 131.7, 131.3, 130.8, 130.1, 129.0, 120.4, 51.4, 20.9, 20.8, 20.0.

IR (thin film) 2920, 1612, 1508, 1424, 1376, 1326, 1165, 969, 888, 728, 706, 576, 507 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{32}H_{30}F_6NO_6S_2^+$: 702.1414; found: 702.1426.

1,3-bis(4-methoxyphenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diyl bis(trifluoromethanesulfonate) (18b)



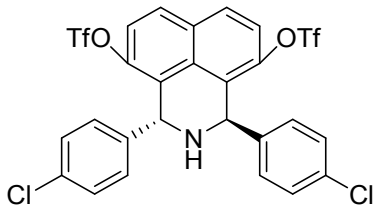
Compound **18b** was isolated as an yellow solid, 95% yield (1.557 g, 2.299 mmol) following the same procedure described for compound **18d**, starting from diol **17b**.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 9.1 Hz, 2H), 7.48 (d, *J* = 9.1 Hz, 2H), 6.99 (d, *J* = 8.6 Hz, 4H), 6.82 (d, *J* = 8.6 Hz, 4H), 5.52 (s, 2H), 3.79 (s, 6H).

^{13}C NMR (101 MHz, CDCl3) δ = 159.4, 143.6, 132.8, 131.4, 131.1, 129.3, 129.2, 129.2, 121.0, 120.1, 116.9, 114.2, 55.4, 54.2.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{28}H_{22}F_6NO_8S_2^+$: 678.0691; found: 678.0690.

1,3-bis(4-chlorophenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diyl bis(trifluoromethanesulfonate) (18c)



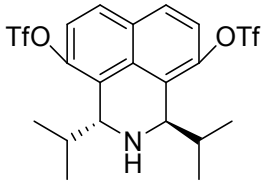
Compound **X** was afforded as yellow solid 95% yield (769 mg, 1.1248 mmol) following the same procedure described for compound 18d, starting from diol **18c**.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 9.1 Hz, 2H), 7.49 (d, *J* = 9.1 Hz, 2H), 7.27 (d, *J* = 8.3 Hz, 4H), 7.00 (d, *J* = 8.4 Hz, 4H), 5.50 (s, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 143.6, 138.9, 134.2, 131.5, 130.8, 129.8, 129.4, 129.1, 128.2, 121.1, 120.1, 116.9, 54.2.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{26}H_{16}F_6NO_6S_2Cl_2^+$: 685.9700; found: 685.9680.

1,3-diisopropyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diyl bis(trifluoromethanesulfonate) (18f)



Compound **X** was afforded as a brown solid in 64% yield following the same procedure described for compound **18d**, starting from diol **17f**.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 8.9 Hz, 2H), 7.41 (d, *J* = 9.0 Hz, 2H), 4.43 (d, *J* = 5.5 Hz, 2H), 2.36 (dd, *J* = 13.3, 6.8 Hz, 2H), 0.96 (d, *J* = 6.8 Hz, 6H), 0.79 (d, *J* = 6.7 Hz, 6H).

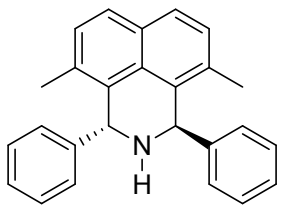
^{13}C NMR (101 MHz, $CDCl_3$) δ 143.12, 131.44, 130.52, 128.45, 120.94, 120.34, 117.23, 55.25, 30.85, 20.04, 17.50.

IR (thin film) 2976, 2935, 2879, 1415, 1204, 1161, 1133, 1095, 885, 831, 731 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{20}H_{22}NO_6S_2F_6^+$: 550.0793; found: 550.0766.

Methylation via Stille reaction

4,9-Dimethyl-1,3-diphenyl-2,3-dihydro-1H-benzo[de]isoquinoline (19a)



LiCl (0.11 g, 2.6 mmol, 10 equiv.) was placed in a 10 ml 2 necked flask, dried with an heat gun under high vacuum and pursed with argon for 3 times. After the LiCl was cooled to r.t. 2 ml of dry DMF were added, followed by the addition of cyclic bistriflate

18a (0.20 g, 0.26 mmol, 1 equiv.) and Me_4Sn (0.072 ml, 0.52 mmol, 3 equiv.). The mixture was stirred for 15 min. then $(Ph_3P)_2PdCl_2$ was added (0.018 g, 0.026 mmol, 0.1 equiv.). The reaction mixture was heated to 125 °C When all the starting material was reacted (and no mono product was left) the heating was stopped and the reaction was quenched by adding water to the reaction mixture. The product was extracted with DCM and dried over Na_2SO_4. The solvent was removed under vacuum. The crude product was purified by column chromatography on silica gel with elution by 5% EtOAc in hexane to give the desired dimethyl product as a yellow solid, 95% yield (0.125 g, 0.24 mmol).

^{1}H NMR (400 MHz, Acetone) δ 7.67 (d, J = 8.3 Hz, 2H), 7.19-7.11 (m, 9H), 7.00-6.98 (m, 4H), 6.49 (d, J = 2.0 Hz, 1H), 6.40 (d, J = 8.5 Hz, 1H), 5.22 (s, 2H), 3.75 (s, 3H), 3.72 (s, 3H), 3.65 (d, J = 14.9 Hz, 1H), 3.38 (d, J = 15.1 Hz, 1H), 1.98 (s, 6H).

^{13}C NMR (101 MHz, Acetone) δ 159.7, 158.4, 141.3, 134.3, 130.9, 130.7, 130.2, 129.1, 128.6, 127.7, 126.8, 125.9, 119.0, 104.7, 98.0, 61.1, 54.7, 54.6, 44.6, 19.6.

IR (thin film) 2833, 1607, 1584, 1503, 1414, 1153, 1102, 1031, 832, 773, 697 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{35}H_{34}NO_2^+$: 500.2590; found: 500.2598.

A 10 ml round flask was equipped with a condenser and a stirring bar. DMB protected amine prepared in the previous step (0.35 g, 0.7.mmol, 1 equiv.) was dissolved in 2 ml of TFA and 3 ml of toluene under nitrogen. The reaction mixture was heated to 120 °C and was stirred for 16h. After all the starting material was consumed, the reaction mixture was cooled to r.t. and sat. $NaHCO_3$ was added. The reaction mixture was extracted with DCM and dried over Na_2SO_4. The solvent was removed under vacuum. The crude product was purified by column chromatography on silica gel with elution by 5% EtOAc in hexane to give the desired deprotected amine as a white solid**,** 88% yield (0.210 g, 0.602 mmol).

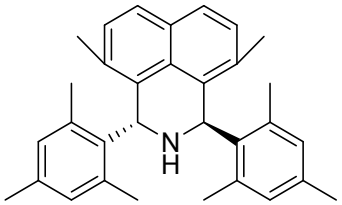
^{1}H NMR (400 MHz, Acetone) δ 7.74 (d, J = 8.3 Hz, 2H), 7.30 – 7.18 (m, 8H), 7.07 (d, J = 6.6 Hz, 4H), 5.36 (s, 2H), 1.99 (s, 6H).

^{13}C NMR (101 MHz, Acetone) δ 144.9, 133.8, 131.9, 131.6, 130.9, 129.2, 129.2, 127.6, 127.2, 57.6, 20.5.

IR (thin film) 1598, 1510, 1490, 1452, 1155, 1042, 879, 755, 738, 699 cm^{-1}

HRMS (ESI+): m/z [M + H^+] calcd for $C_{26}H_{24}N^+$: 350.1909; found: 350.1868.

4,9-Dimethyl-1,3-bis-(2,4,6-trimethyl-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline (19d)



LiCl (0.6 g, 14.2 mmol, 10 equiv.) was activated by using heating under high vacuum for 30 min. and the flask was filled with argon. Dry DMF (10 ml) was added to this reaction vessel. Solid triflate **18d** (1.0 g, 1.42 mmol, 1.0 equiv.) was added to the reaction mixture. Me_4Sn (1.0 ml, 7.1 mmol, 3.0 equiv.) was added to the reaction mixture at r.t. The mixture was stirred for 15 min. and then $(PPh_3)_2PdCl_2$ (0.2 g, 0.284 mmol, 0.2 equiv.) was added to the reaction mixture and allowed the reaction mixture to stir at 125 °C for 30 min. Upon completion of the reaction, it was quenched with H_2O and the reaction mixture diluted with 500 ml of EtOAc. The reaction mixture was partitioned between H_2O (50 ml) and EtOAc (500 ml). The organic part was then washed with 10% KF solution and dried over anhydrous sodium sulfate, filtered, concentrated on a rotary evaporator, and purified by silica gel chromatography (5% EtOAc/hexanes) to afford the desired amine **19d** as a light yellow solid, 95% yield (0.584 g, 1.35 mmol) .

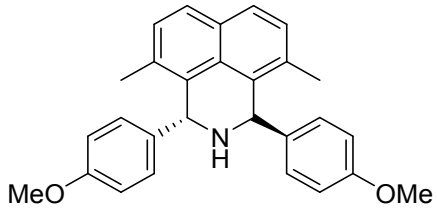
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.3 Hz, 2H), 7.17 (d, *J* = 8.3 Hz, 2H), 6.88 (s, 2H), 6.67 (s, 2H), 5.74 (s, 2H), 2.30 (s, 6H), 2.25 (s, 6H), 1.97 (s, 6H), 1.43 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 137.2, 137.0, 136.7, 136.1, 134.1, 131.2, 130.8, 130.7, 130.6, 129.7, 128.2, 126.2, 53.6, 20.8, 20.8, 20.7, 20.3.

IR (thin film) 2959, 2919, 1609, 1511, 1419, 1327, 1268, 1141, 1081, 877, 845, 824, 642 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{32}H_{36}N^+$: 434.2843; found: 434.2841.

1,3-bis(4-methoxyphenyl)-4,9-dimethyl-2,3-dihydro-1H-benzo[de]isoquinoline (19b)



Compound **19b** was prepared as a yellow solid, 90% yield (272 mg, 0.6642 mmol) following the same procedure described for compound **19d**, starting from triflate **19b**.

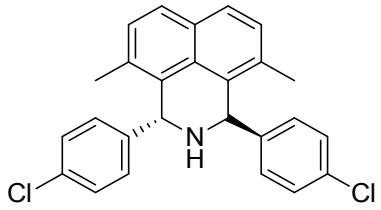
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.3 Hz, 2H), 7.20 (d, *J* = 8.3 Hz, 2H), 6.98 (d, *J* = 8.5 Hz, 4H), 6.78 (d, *J* = 8.5 Hz, 4H), 5.31 (s, 2H), 3.77 (s, 6H), 2.02 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 158.7, 135.9, 132.6, 131.3, 131.0, 129.9, 129.4, 128.6, 126.5, 114.0, 56.4, 55.4, 20.6.

IR (thin film) 2998, 2923, 2833, 1581, 1505, 1448, 1325, 1241, 1171, 1030, 830, 786, 689, 654 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{28}H_{28}NO_2^+$: 410.2120; found: 410.2133.

1,3-bis(4-chlorophenyl)-4,9-dimethyl-2,3-dihydro-1H-benzo[de]isoquinoline (19c)



Compound **19c** was prepared as a yellow solid, 95% yield (282 mg, 0.674 mmol) following the same procedure described for compound **19d**, starting from triflate **18c**.

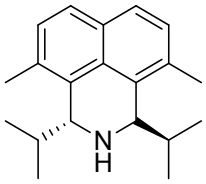
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.3 Hz, 2H), 7.23 (d, *J* = 8.3 Hz, 6H), 7.00 (d, *J* = 8.3 Hz, 4H), 5.30 (s, 2H), 2.01 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 142.0, 133.0, 131.5, 131.4, 131.0, 128.9, 128.7, 126.9, 56.4, 20.6.

IR (thin film) 3047, 1448, 1402, 1353, 1172, 1085, 1011, 879, 824, 646 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{26}H_{22}NCl_2^+$: 418.1129; found: 418.1126.

1,3-diisopropyl-4,9-dimethyl-2,3-dihydro-1H-benzo[de]isoquinoline (19f)



Compound **19f** was prepared as a red oil, 88% yield (450.7 mg, 1.6016 mmol) following the same procedure described for compound **19d**, starting from triflate **18f**.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 8.3 Hz, 2H), 7.17 (d, *J* = 8.3 Hz, 2H), 4.29 (d, *J* = 6.4 Hz, 2H), 2.44 (s, 6H), 2.18 (dq, *J* = 13.4, 6.7 Hz, 2H), 0.88 (d, *J* = 6.9 Hz, 6H), 0.71 (d, J = 6.7 Hz, 6H).

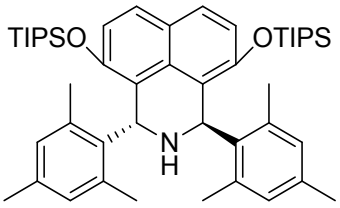
^{13}C NMR (101 MHz, $CDCl_3$) δ 134.5, 130.5, 129.3, 129.3, 128.4, 125.1, 56.6, 31.4, 20.4, 20.4, 17.6.

IR (thin film) 3043, 2955, 2922, 2866, 2773, 1508, 1461, 1379, 1170, 1096, 829, 798, 767, 695 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{20}H_{28}N^+$: 282.2222; found: 282.2215.

Silylation

4,9-Bis-triisopropylsilanyloxy-1,3-bis-(2,4,6-trimethyl-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline (19e)



TIPSCl (4.88 ml, 22.87 mmol, 2.5 equiv.) was added to a stirred solution of diol **17d** (4.0 g, 9.15 mmol, 1.0 equiv.) and imidazole (3.1 g, 45.75 mmol, 5 equiv.) in dry DMF (50 ml) at 0 °C. Then reaction mixture was stirred at 60 °C for 2h. Upon completion of the reaction, it was quenched by addition of a 10% $NaHCO_3$ solution. The reaction mixture was diluted with EtOAc. The organic portion was washed with water and dried over anhydrous sodium sulfate, filtered, concentrated on a rotary evaporator. Purification of the product by flash chromatography (5% EtOAc/hexanes) afforded the desired ester **19e** as a light yellow solid, 95 yields (6.5 g, 8.7 mmol).

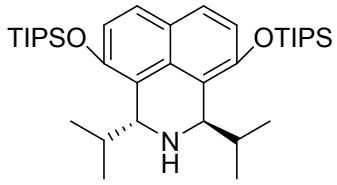
^{1}H NMR (400 MHz, C_6D_6) δ 7.58 (d, J = 8.8 Hz, 2H), 6.99 (d, J = 8.8 Hz, 2H), 6.80 (s, 2H), 6.63 (s, 2H), 5.98 (s, 2H), 2.36 (s, 6H), 2.11 (s, 6H), 1.99 (s, 1H), 1.80 (s, 6H), 1.05-0.99 (m, 6H), 0.99 (d, J = 6.5 Hz, 18H), 0.94 (d, J = 6.8 Hz, 18H).

^{13}C NMR (101 MHz, C_6D_6) δ 149.4, 137.4, 137.1, 136.4, 135.1, 133.9, 130.6, 129.7, 127.3, 125.0, 123.1, 117.0, 51.7, 21.1, 20.5, 20.3, 17.8, 13.5.

IR (thin film) 2865, 1615, 1459, 1446, 1386, 1255, 1212, 1177, 943, 882, 844, 819, 687 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{48}H_{72}NO_2Si_2^+$: 750.5102; found: 750.5700.

1,3-diisopropyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[de]isoquinoline (19g)



Compound **19g** was obtained as red oil in 66% yield (278 mg, 0.4645 mmol) following the general procedure for TIPS protection described for **19e**.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (d, *J* = 8.8 Hz, 2H), 6.86 (d, *J* = 8.8 Hz, 2H), 4.33 (d, *J* = 6.1 Hz, 2H), 2.48 (dq, *J* = 13.3, 6.7 Hz, 2H), 1.33 (dt, *J* = 14.7, 7.4 Hz, 6H), 1.15 (d, *J* = 7.5 Hz, 18H), 1.11 (d, *J* = 7.4 Hz, 18H), 0.93 (d, *J* = 6.9 Hz, 6H), 0.72 (d, *J* = 6.7 Hz, 6H).

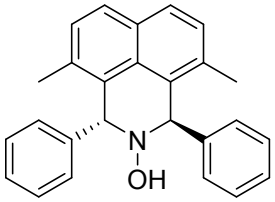
^{13}C NMR (101 MHz, $CDCl_3$) δ 148.67, 131.96, 126.03, 124.36, 123.15, 118.08, 77.16, 54.90, 30.27, 20.46, 18.28, 18.24, 17.52, 13.44.

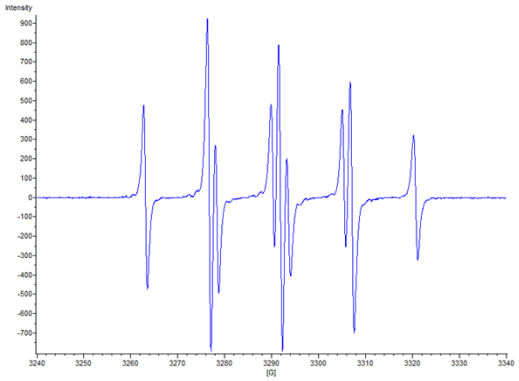
IR (thin film) 2945, 2863, 1614, 1503, 1460, 1357, 1300, 1254, 1068, 995, 933, 881, 825, 777, 679 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{36}H_{64}NO_2Si_2^+$: 598.4470; found: 598.4416.

Oxidation of Amines to Hydroxylamines and Nitroxides

4,9-dimethyl-1,3-diphenyl-1H-benzo[de]isoquinolin-2(3H)-ol (20a) and nitroxide 21a



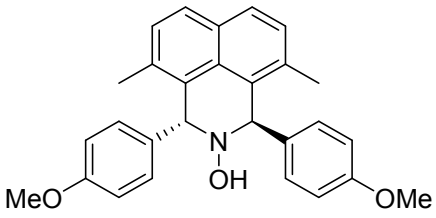


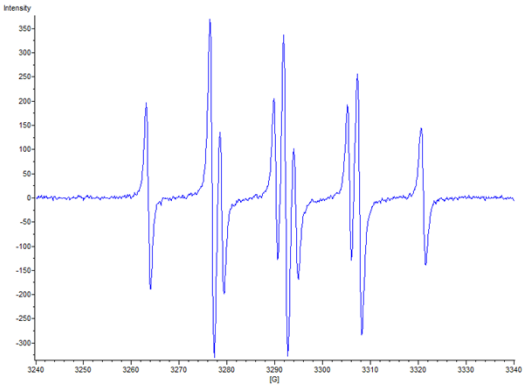
Compound **20a** was synthesized following the same procedure described for compound **20e**, starting from amine **19a**. Full conversion was observed after 20 minutes. However, this hydroxylamine was not stable and it started decomposing after purification to give the nitrone. The sample could not be analyzed by NMR spectrum since it contained small amounts of nitroxide **21a**, The nitroxide component was analyzed by ESR**.**

ESR (benzene) g= 2.006, aN = 13.6 G, aH(2H)=15.3 G

HRMS (ESI+): m/z [M + H^+] calcd for $C_{26}H_{22}NO^+$:365.46; found: 364.1705

1,3-bis(4-methoxyphenyl)-4,9-dimethyl-1H-benzo[de]isoquinolin-2(3H)-ol (20b) and nitroxide 21b



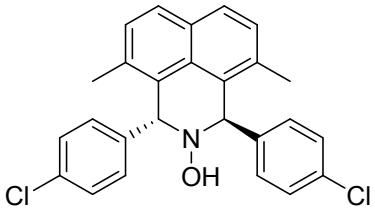


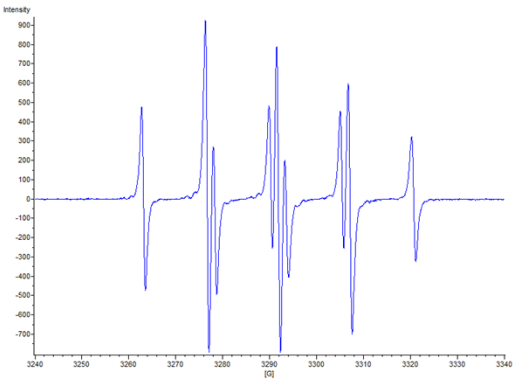
Compound **20b** was synthesized following the same procedure described for compound **20e**, starting from amine **19b**. Full conversion was observed after 20 minutes. However,

this hydroxylamine was not stable and it started decomposing after purification to give the nitrone. The sample could not be analyzed by NMR and HRMS, but it contained small amounts of nitroxide **21b** which could be analyzed by ESR**.**

ESR (benzene) g= 2.006, *aN* = 13.6 G, *aH*(2H)=15.5 G

1,3-bis(4-chlorophenyl)-4,9-dimethyl-1H-benzo[de]isoquinolin-2(3H)-ol (20c) and nitroxide 21c

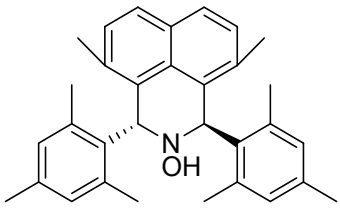




Compound **20c** was synthesized following the same procedure described for compound **20e**, starting from amine **19c**. Full conversion was observed after 20 minutes. However, this hydroxylamine was not stable and it started decomposing after purification to give the nitrone. The sample could not be analyzed by NMR and HRMS, but it contained small amounts of nitroxide **21c** which could be analyzed by ESR**.**

ESR (benzene) g= 2.006, *aN* = 13.45 G, *aH* (2H)=15.2 G

4,9-Dimethyl-1,3-bis-(2,4,6-trimethyl-phenyl)-1H,3H-benzo[de]isoquinolin-2-ol (20d)



Compound **20d** was obtained as a white solid 70% yield (0.360 g, 0.80 mmol) following the general procedure for TIPS protection.

X-ray See enclosed cif file **Szpilman-13B.cif**.

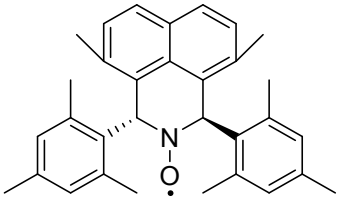
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 8.2 Hz, 2H), 7.19 (d, *J* = 8.3 Hz, 2H), 6.90 (s, 2H), 6.67 (s, 2H), 5.97 (s, 2H), 4.57 (s, 1H), 2.36 (s, 6H), 2.25 (s, 6H), 1.99 (s, 6H), 1.37 (s, 6H).

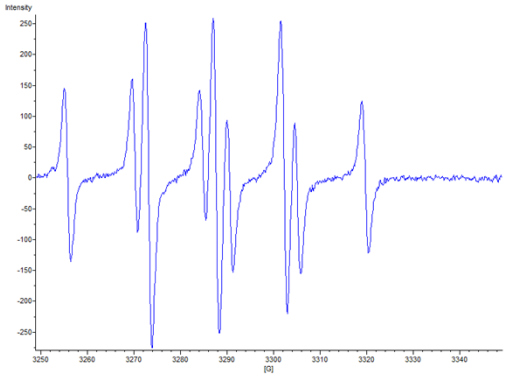
^{13}C NMR (400 MHz, C_6D_6) δ 140.3, 138.5, 136.6, 133.7, 132.8, 132.0, 131.5, 131.1, 131.0, 131.0, 130.0, 129.1, 128.1, 126.9, 63.0, 21.8, 21.7, 20.8, 20.5.

IR (thin film) 2917, 1610, 1574, 1522, 1480, 1448, 1374, 1218, 1200, 1062, 1026, 847, 813 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{32}H_{36}NO^+$: 450.2792; found: 450.2756.

4,9-Dimethyl-1,3-bis-(2,4,6-trimethyl-phenyl)-1H,3H-benzo[de]isoquinolin-N-oxyl (21d)





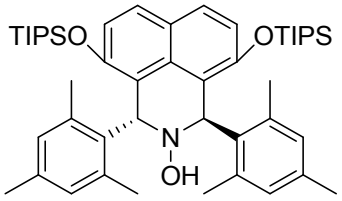
Ag_2O (0.41 g, 1.78 mmol, 4.0 equiv.) was added to a stirred solution of hydroxylamine **20d** (0.2 g, 0.445 mmol, 1.0 equiv.) in dry benzene (5 ml) at r.t. Upon completion, after 4h (monitored by TLC), of the reaction, the reddish yellow colored reaction mixture was filtered through a pad of celite and concentrated on a rotary evaporator at r.t. The product was purified by column chromatography to afford the desired nitroxide **21d** as a light yellow solid 76% yield (0.150 g, 0.3382 mmol) The nitroxide was characterized by mass spectrum and ESR measurement.

IR (thin film) 1610, 1571, 1523, 1481, 1449, 1394, 1215, 1212, 1067, 1045, 848, 789 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{32}H_{35}NO^+$: 449.2719; found: 459.2733.

ESR (benzene) g= 2.006, *aN* = 14.5 G, *aH*(2H)=17.5 G

4,9-Bis-triisopropylsilanyloxy-1,3-bis-(2,4,6-trimethyl-phenyl)-1H,3H-benzo[de]isoquinolin-2-ol (20e)



*m*CPBA (0.274 g, 1.59 mmol, 1.5 equiv.) was added in portion wise manner to a stirred solution of amine **19e** (1.0 g, 1.33 mmol, 1.0 equiv.) and $NaHCO_3$ (0.168 g, 2.0 mmol, 1.5 equiv.) in dry DCM (50 ml) at 0 °C. After 10 min., no amine could be observed by TLC and the reaction was concentrated on a rotary evaporator at r.t., and purified by silica gel chromatography (10% EtOAc/hexanes) to afford the desired hydroxylamine **20e** as a white solid (1.07 g, 1.4 mmol, 95%). The ^{1}H and ^{13}C NMR measured at r.t. showed signal broadening for the benzylic hydrogens and carbons due to the existence of two interconverting conformations of similar stability. Accordingly, spectra were also recorded at 50 °C for better visibility of benzyl protons and carbons. Values of ^{1}H NMR were written from the experiment carried out at 50 °C. Value of benzylic carbon (δ 60.4) was found from the experiment carried out at 50 °C. The structure was also confirmed by X-ray crystallography. See enclosed cif file.

X-ray See enclosed cif file **sa1hfinal.cif**.

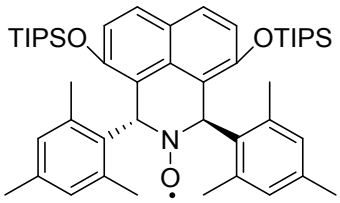
^{1}H NMR (300 MHz, C_6D_6) δ 7.51 (d, *J* = 8.7 Hz, 2H), 6.95 (d, *J* = 8.8 Hz, 2H), 6.83 (s, 2H), 6.60 (s, 2H), 6.05 (s, 2H), 4.14 (s, 1H), 2.36 (br s, 6H), 2.09 (s, 6H), 1.75 (br s, 6H), 0.92-0.79 (m, 42H).

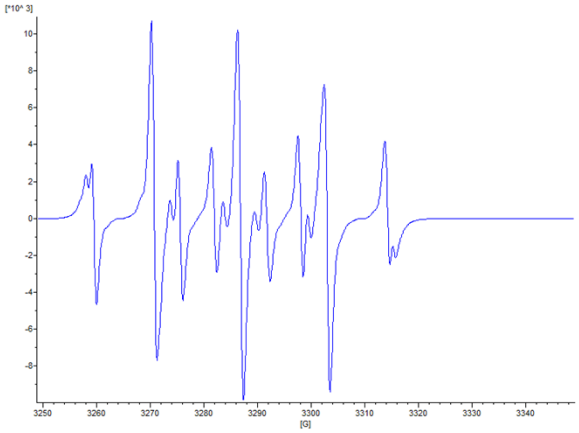
^{13}C NMR (101 MHz, C_6D_6) δ 150.8, 133.5, 130.7, 129.4, 124.2, 119.3, 117.6, 60.4, 20.5, 17.7, 13.4.

IR (thin film) 2943, 2865, 1615, 1503, 1328, 1213, 1140, 942, 786, 687, 643 cm^{-1}.

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{48}H_{72}NO_3Si_2^+$: 766.5046; found: 766.5085.

4,9-Bis-triisopropylsilanyloxy-1,3-bis-(2,4,6-trimethyl-phenyl)-1H,3H-benzo[de]isoquinolin-N-oxyl (21e)





Ag_2O (0.6 g, 2.6 mmol, 10 equiv.) was added to a stirred solution of hydroxylamine **20e** (0.2 g, 0.261 mmol, 1.0 equiv.) in dry benzene (5 ml) at r.t. After 6h, upon completion of the reaction, the orange colored reaction mixture was filtered through a pad of celite and it was concentrated on a rotary evaporator at r.t. to afford the desired nitroxide **21e** as a reddish brown solid (0.18 g, 0.24 mmol, 90%). This nitroxide was characterized by mass spectrum and ESR measurements. The ESR spectrum showed evidence of two conformations of similar stability. The two spectra coalesced by heating to 80°C. The individual spectra were deconvoluted by computational simulation of the individual spectra. The data for both are given here.

IR (thin film) 1617, 1503, 1488, 1456, 1367, 1215, 1140, 942, 789, 689, 678 cm^{-1}

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{48}H_{71}NO_3Si_2^+$: 765.4972; found: 765.4970.

ESR

Conformation 1: (benzene) g= 2.006, *aN* = 16.1 G, *aH*(2H) = 11.3 G

Conformation 2: (benzene) g= 2.006, *aN* = 15.7 G, *aH*(2H) = 12.2 G

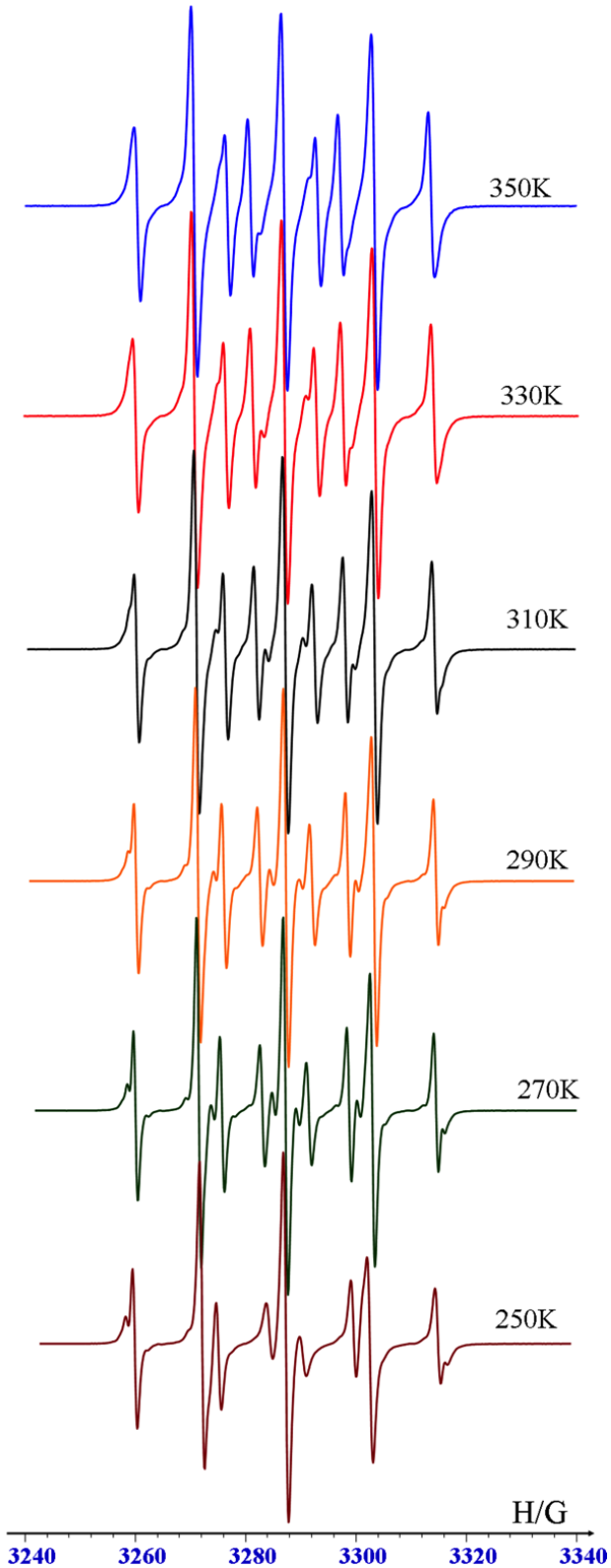
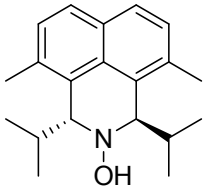


Figure ESI1. ESR spectra of temperature evolution of radical (**21e**) stored for 9 months at -15 °C: measured at 350K **:** *aN* = 16.34 G, *aH*(2H) = 10.36 G; Measured at 250K - *aN* = 15.8 G, *aH*(2H) = 12.7 G.

1,3-diisopropyl-4,9-dimethyl-1H-benzo[de]isoquinolin-2(3H)-ol (20f) and 1,3-diisopropyl-4,9-dimethyl-1H-benzo[de]isoquinolin-2(3H)-N-oxyl (21f)



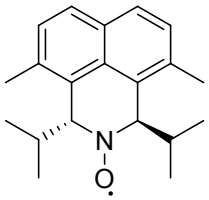
Compound **20f** was synthesized in 40% yield (69 mg, 0.2344 mmol) following the same procedure described for compound **20e**, starting from amine **19f**. The sample of hydroxylamine **20f** contained small amounts of nitroxide **21** which could be separated by flash chromatography and analyzed by ESR**.**

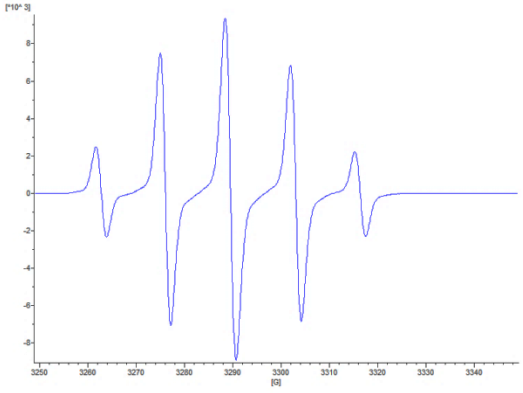
^{1}H NMR (400 MHz, C_6D_6) δ 7.47 (d, *J* = 8.2 Hz, 2H), 7.07 (d, *J* = 8.2 Hz, 2H), 4.65 (d, *J* = 5.2 Hz, 2H), 2.39 – 2.29 (m, 2H), 2.26 (s, 6H), 0.95 (t, *J* = 7.8 Hz, 6H), 0.88 (d, *J* = 6.8 Hz, 6H).

^{13}C NMR (101 MHz, C_6D_6) δ 132.6, 131.4, 130.4, 129.2, 129.0, 128.1, 126.0, 67.2, 32.1, 21.5, 20.7, 20.3.

IR (thin film) 2958, 2923, 2869, 1724, 1531, 1501, 1452, 1363, 1237, 1188, 1137, 1077, 951, 834 cm^{-1}

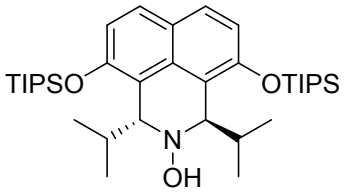
HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{20}H_{28}NO^+$: 298.2165; found: 298.2055

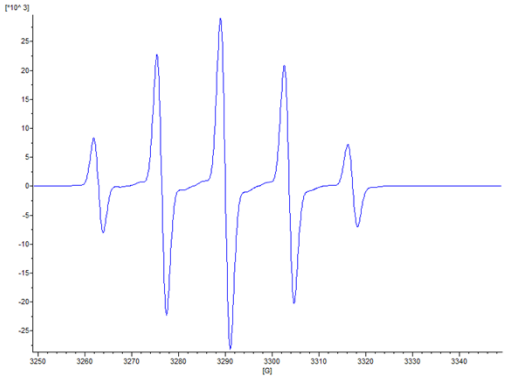




ESR (benzene) g= 2.006, *aN* = *aH*(2H)=13.5 G

1,3-diisopropyl-4,9-bis((triisopropylsilyl)oxy)-1H-benzo[de]isoquinolin-2(3H)-ol (20g) and nitroxide 21g





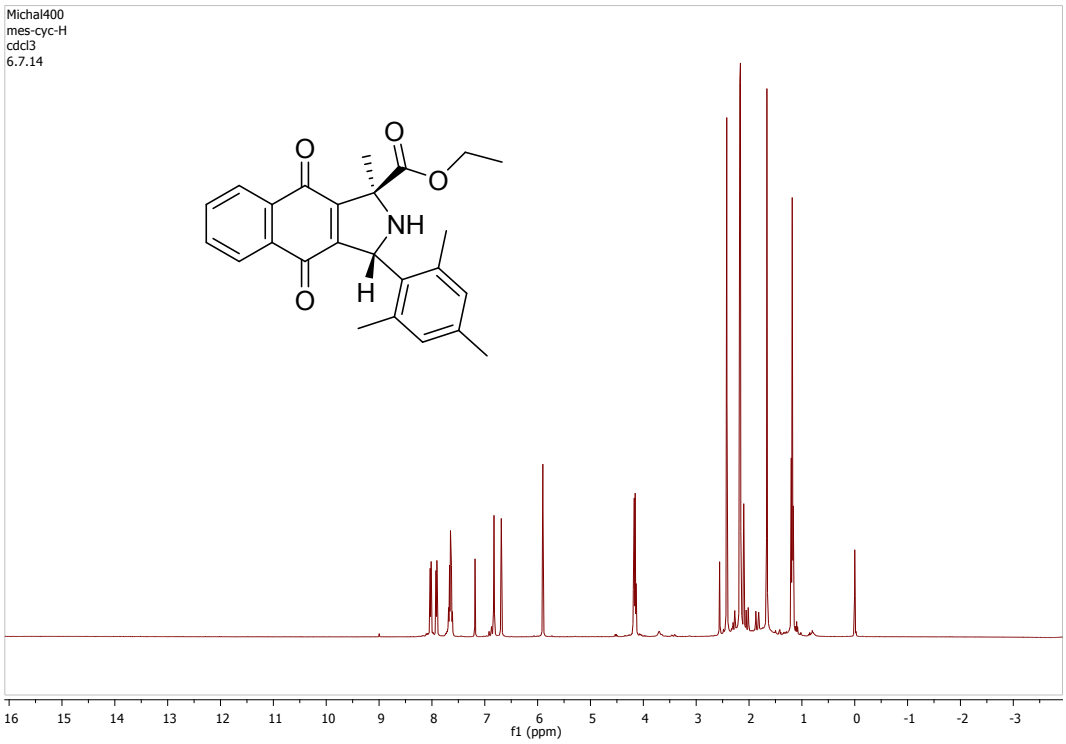
Compound **20g** was synthesized following the same procedure described for compound **20e**, starting from amine **19g**. Full conversion was observed after 20 minutes. However, this hydroxylamine was not stable and it started decomposing after purification to give the nitrone. The sample could not be analyzed from NMR spectrum because it contained nitroxide **21g** which could be analyzed by ESR**.**

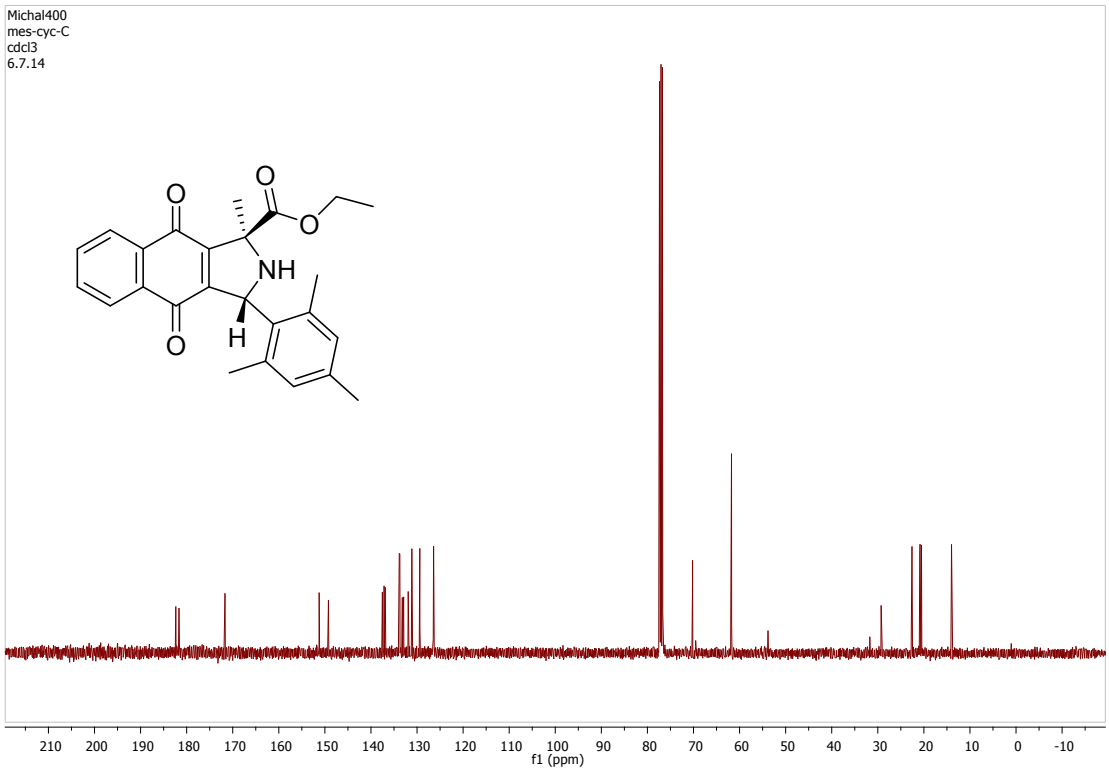
ESR (benzene) g= 2.006, *aN* = , *aH*(2H)=13.5 G

HRMS (ESI+): *m/z* [M + H^+] calcd for $C_{36}H_{64}NO_3Si_2^+$: 614.4419; found: 614.4420.

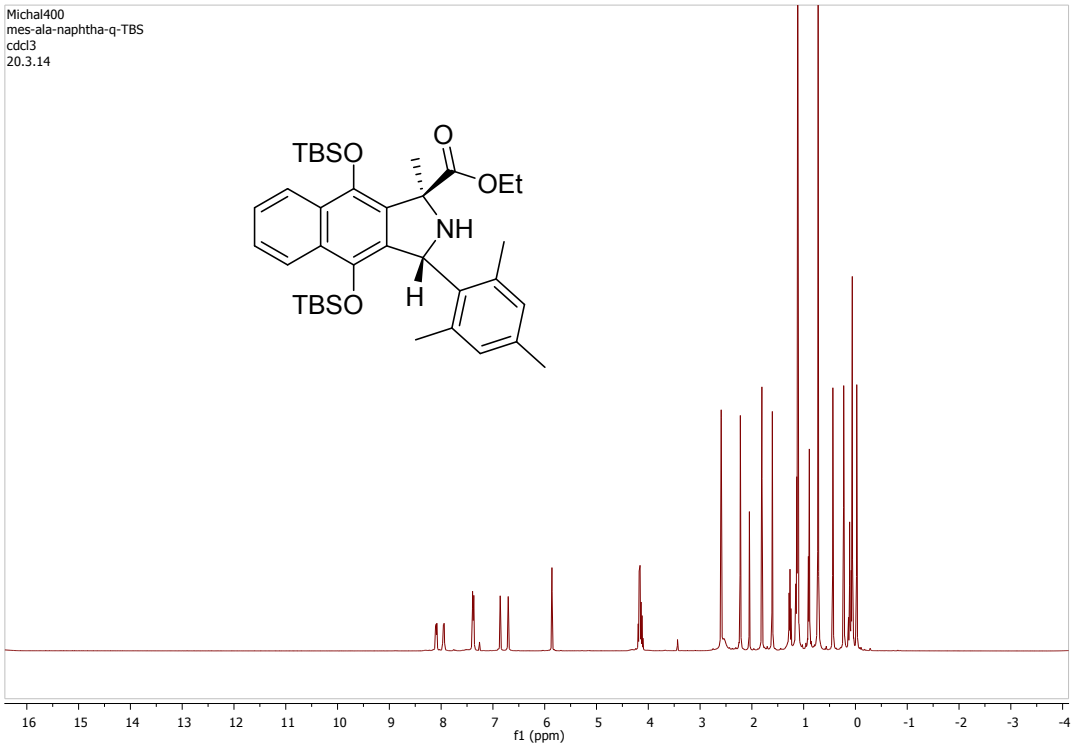
3. NMR spectra:

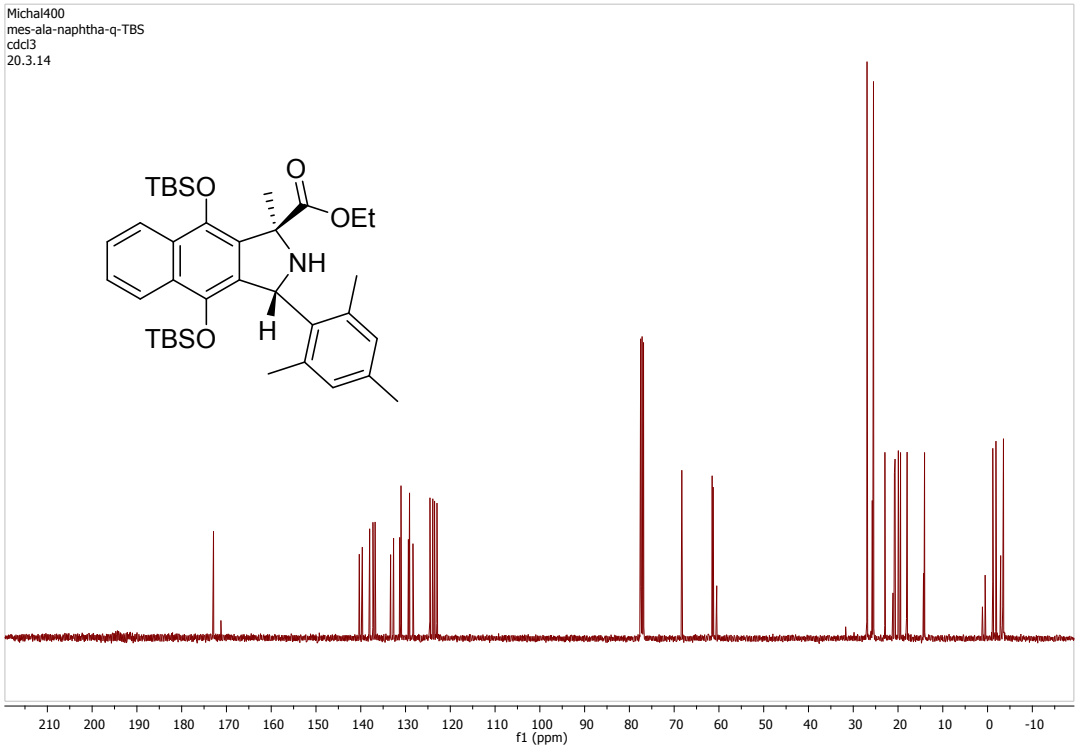
Ethyl-3-mesityl-1-methyl-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11a)



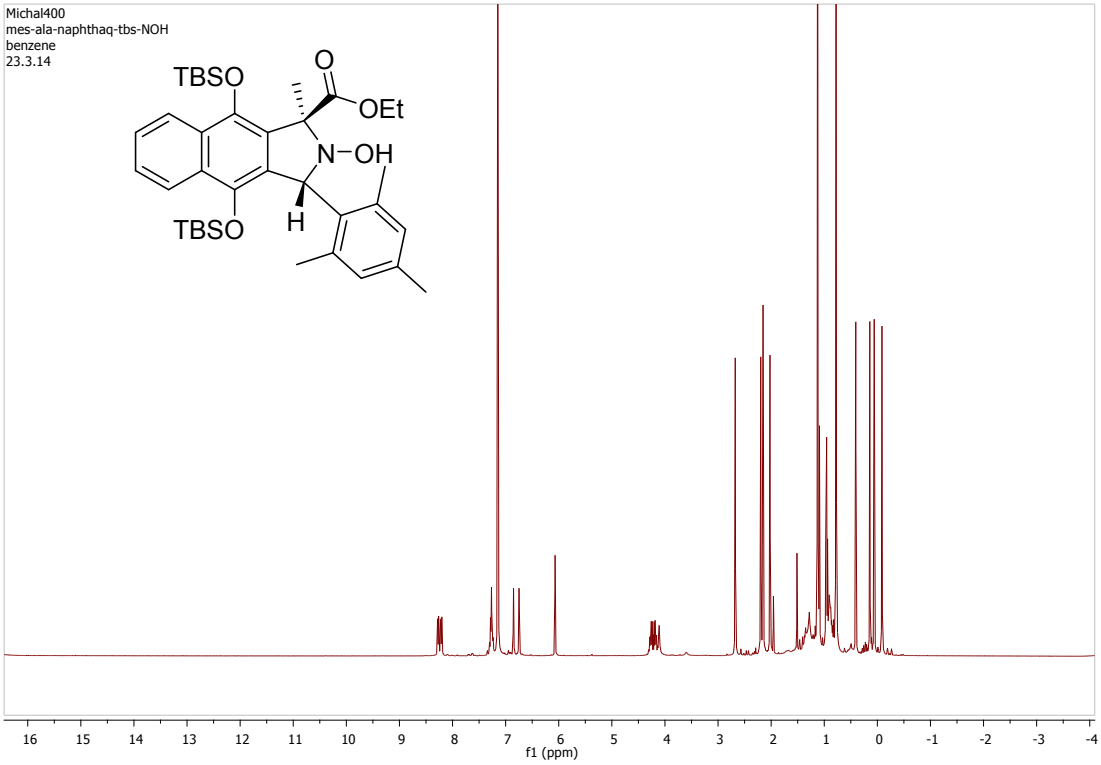


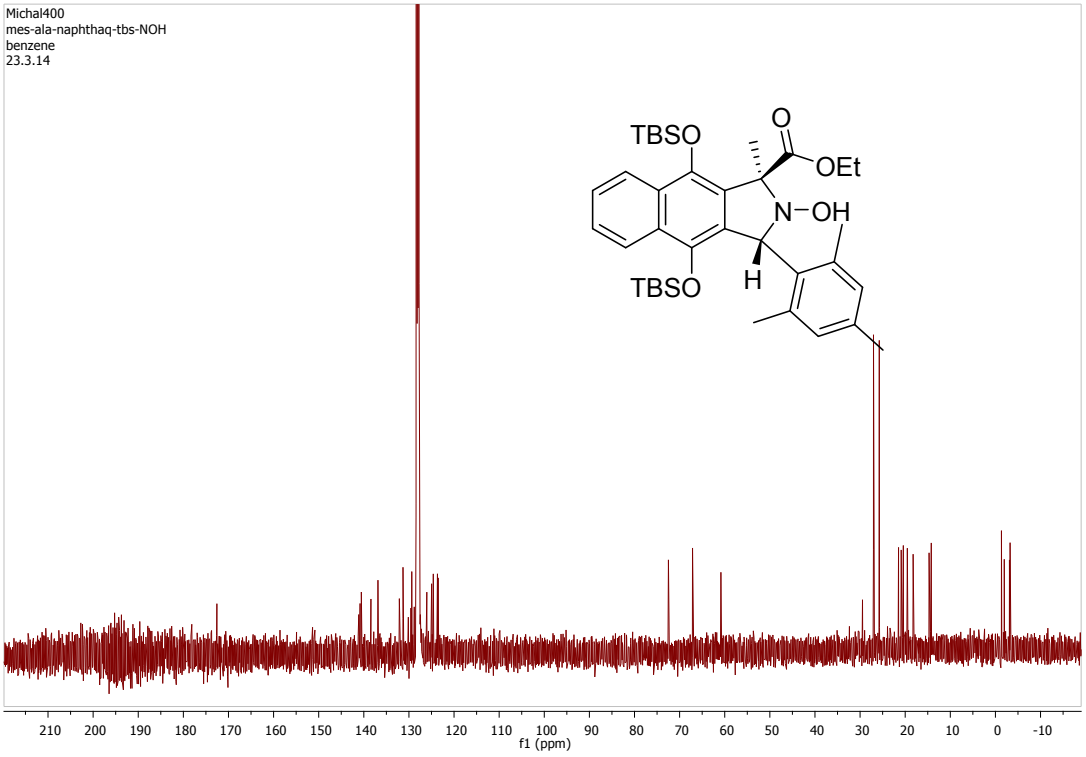
Ethyl-4,9-bis((tert-butyldimethylsilyl)oxy)-3-mesityl-1-methyl-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12a)



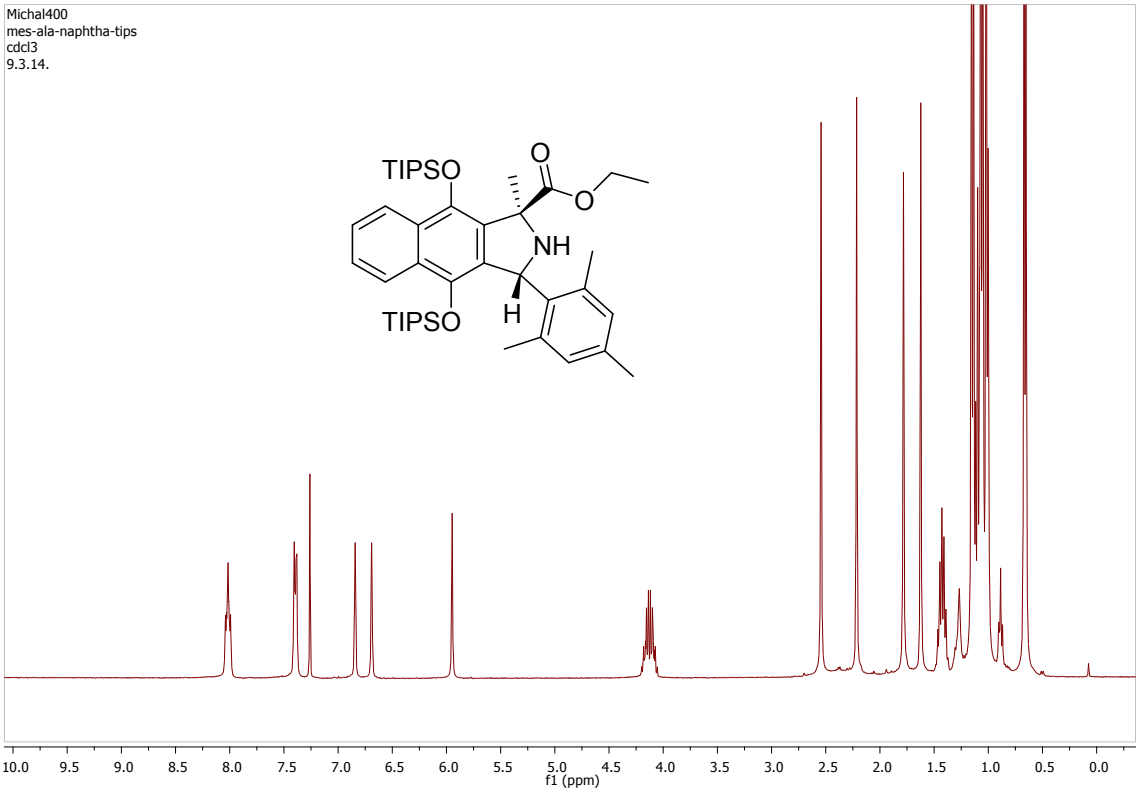


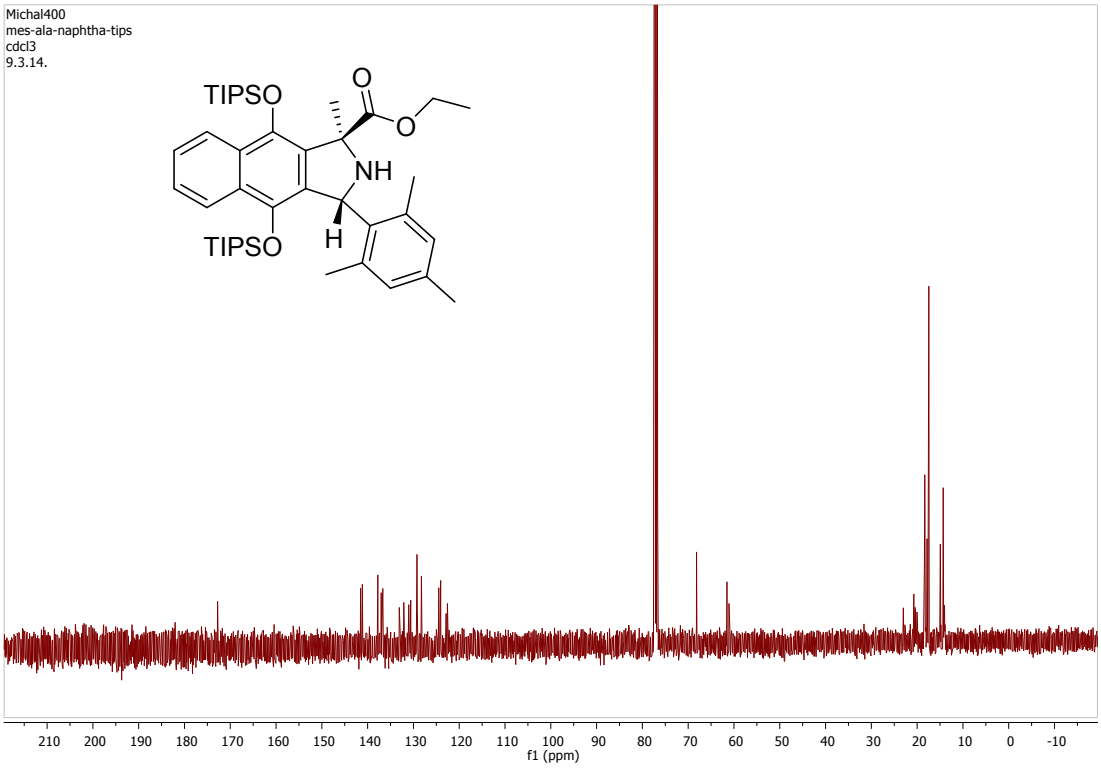
Ethyl-4,9-bis((tert-butyldimethylsilyl)oxy)-2-hydroxy-3-mesityl-1-methyl-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (13a)



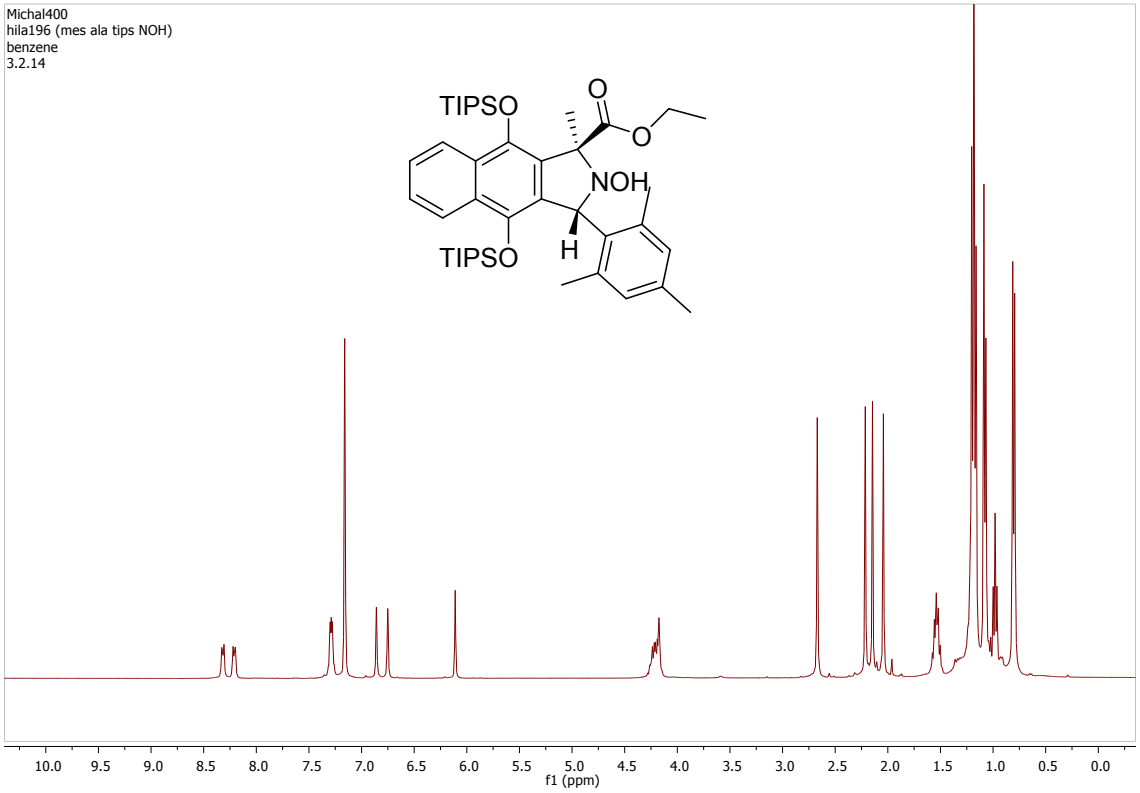


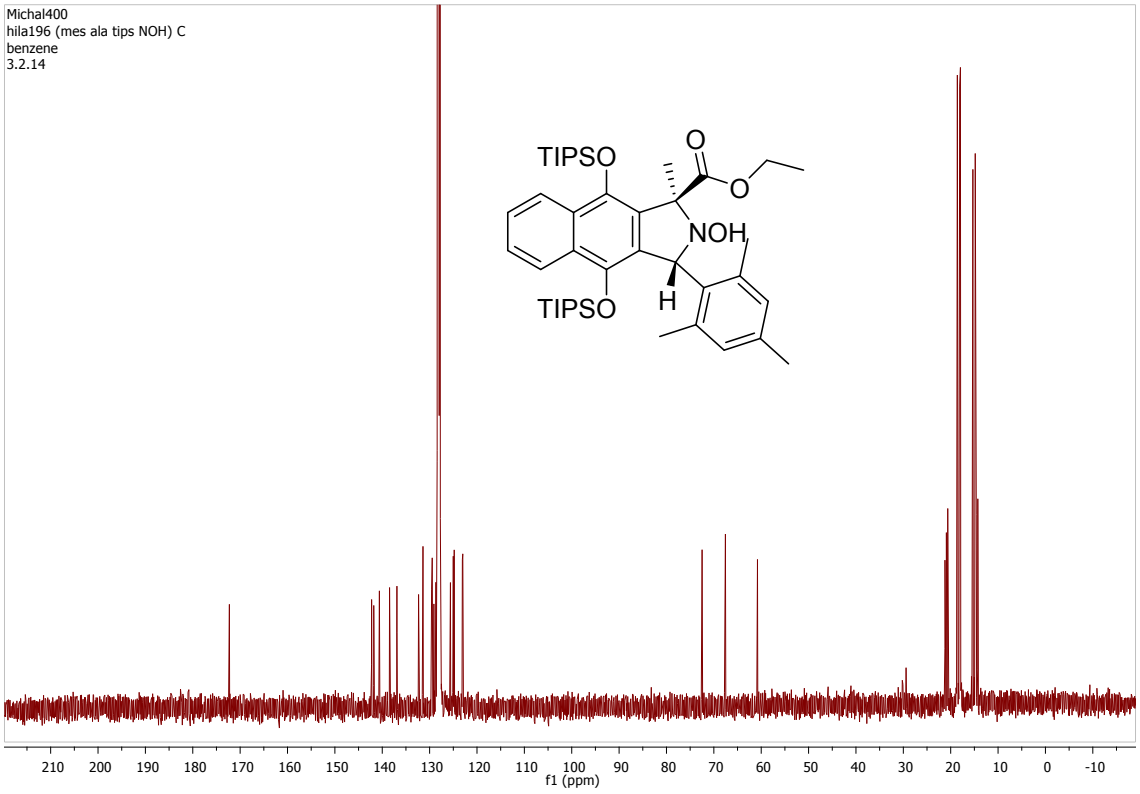
Ethyl-3-mesityl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12b)



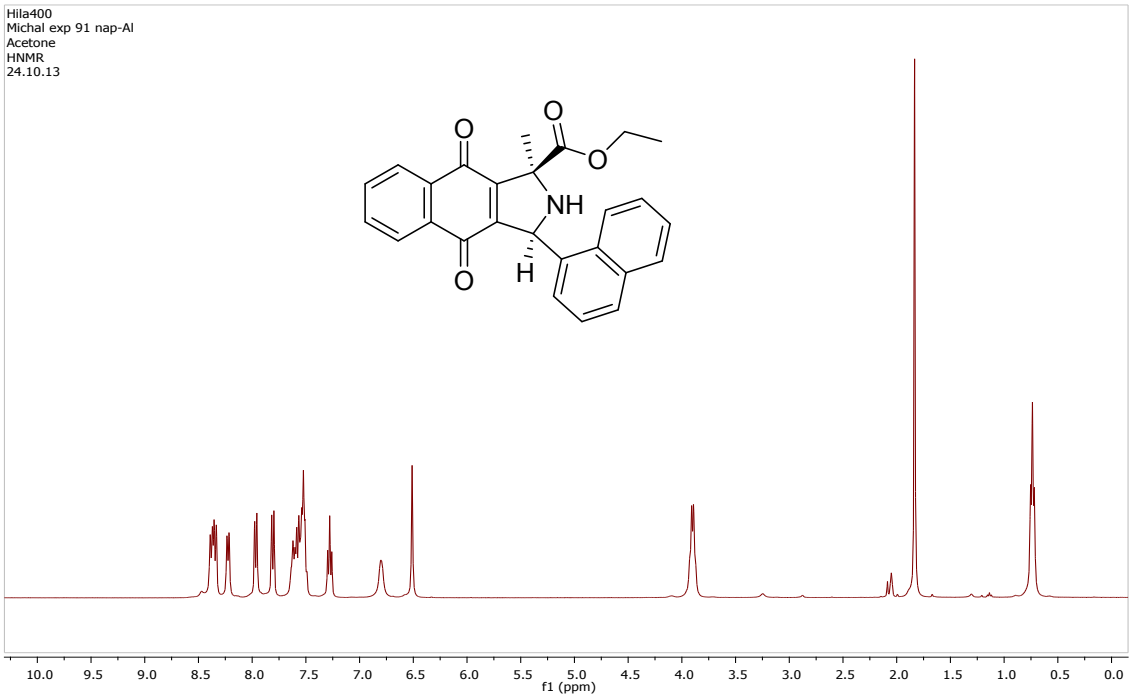


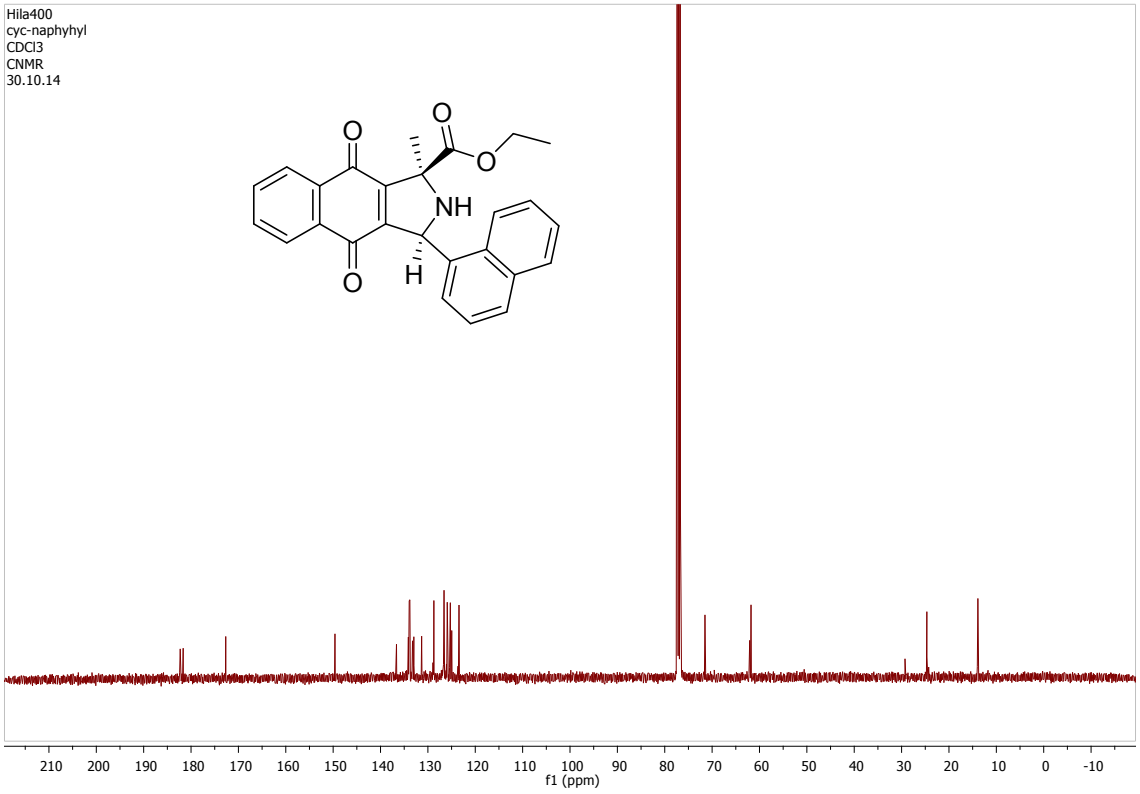
Ethyl-2-hydroxy-3-mesityl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (13b)



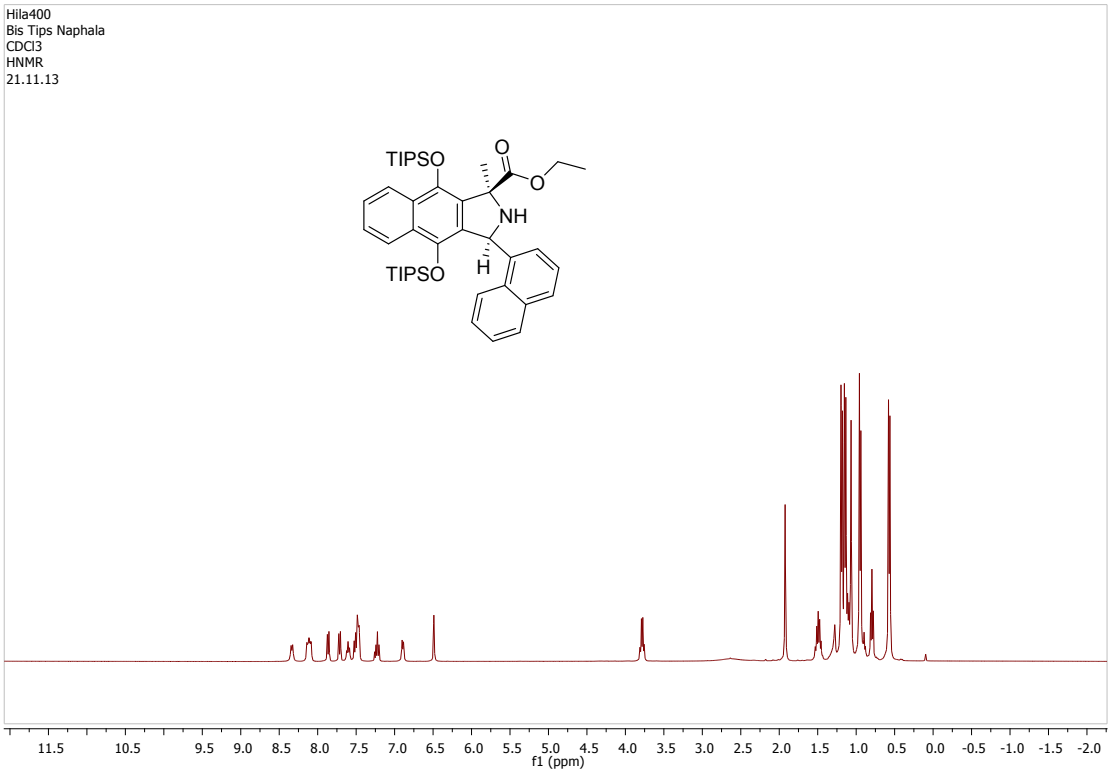


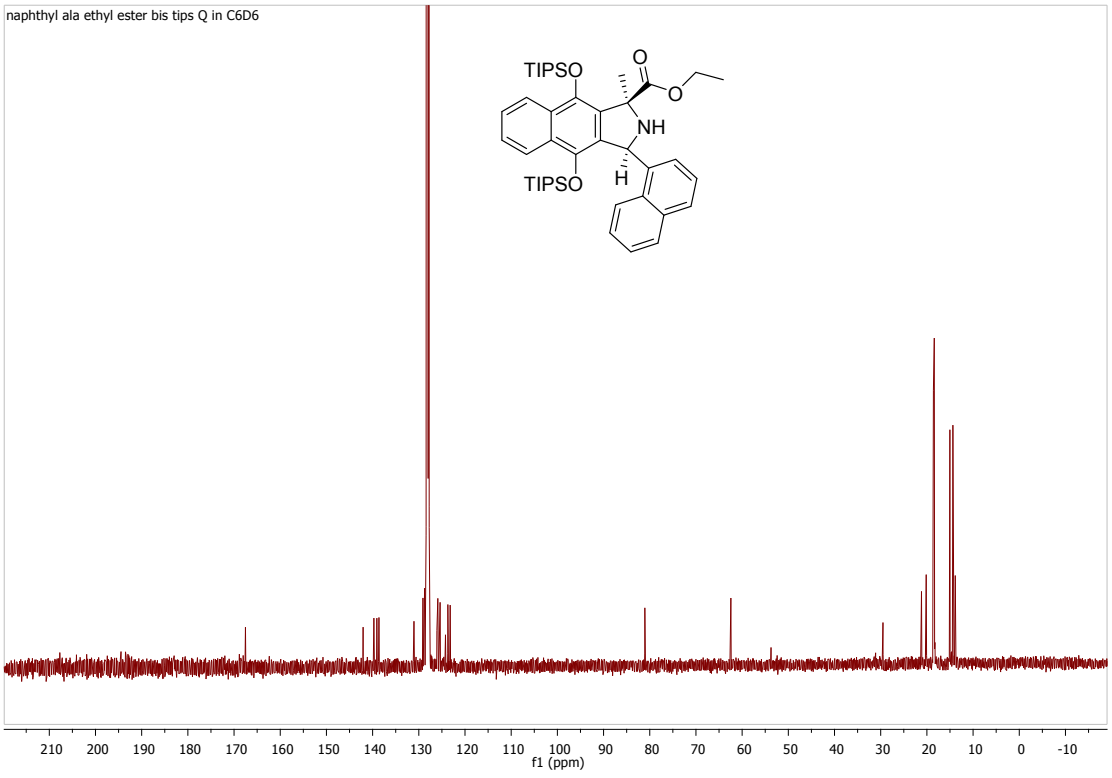
4. Ethyl-1-methyl-3-(naphthalen-1-yl)-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11c)



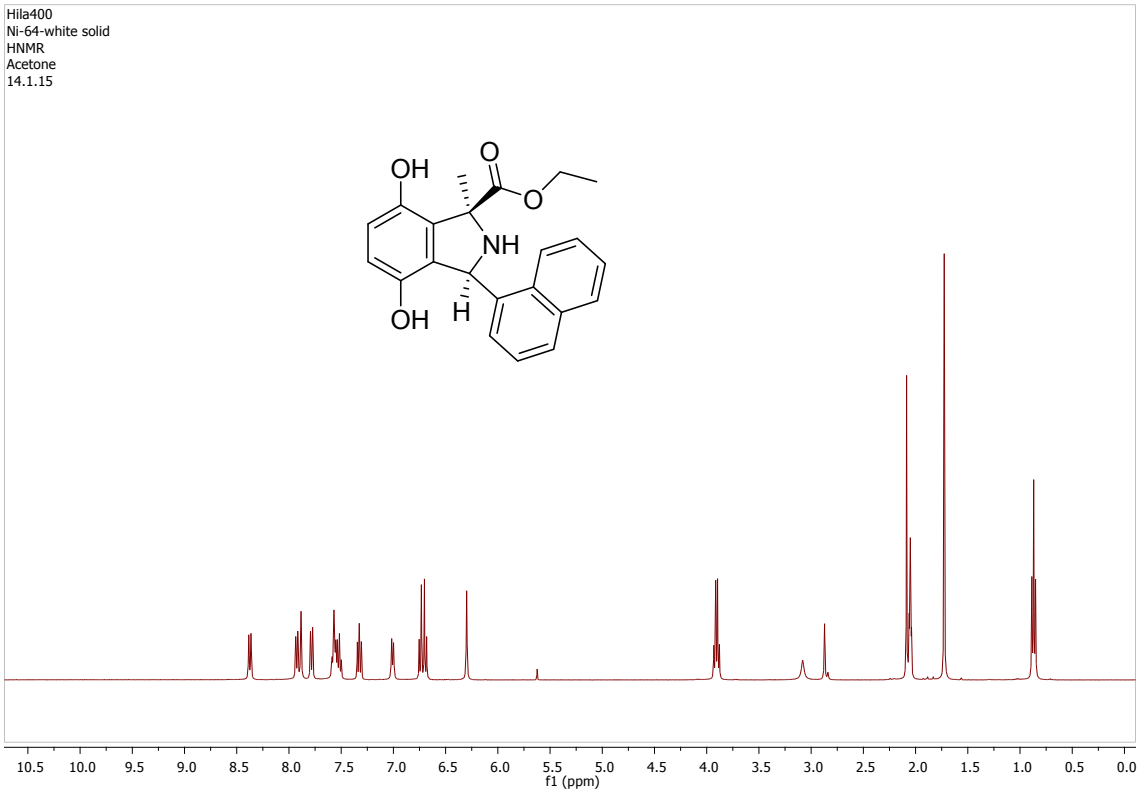


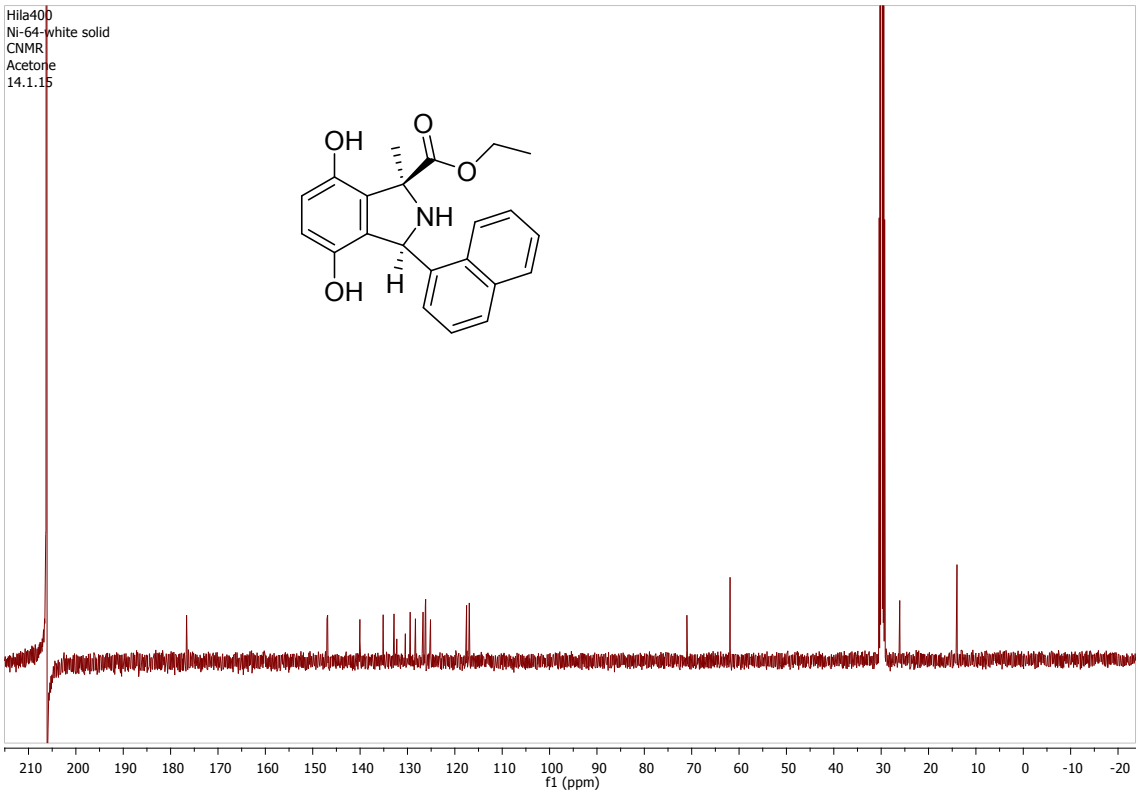
Ethyl-1-methyl-3-(naphthalen-1-yl)-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12c)



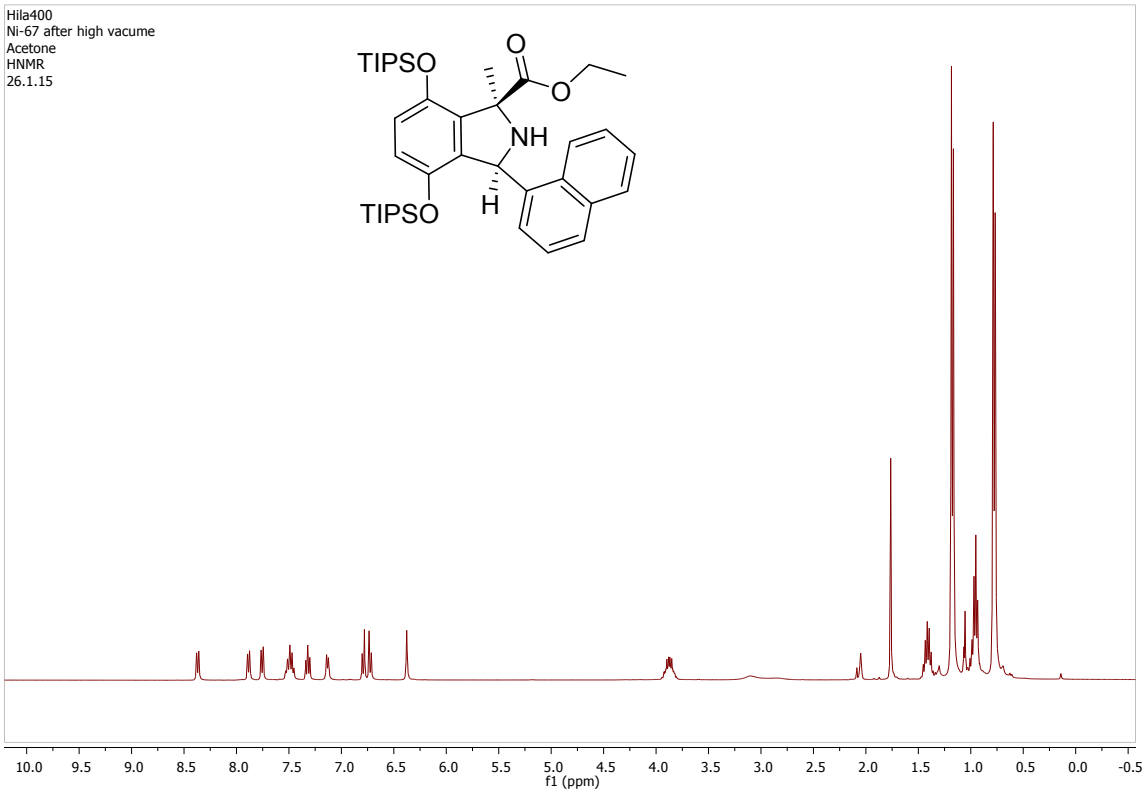


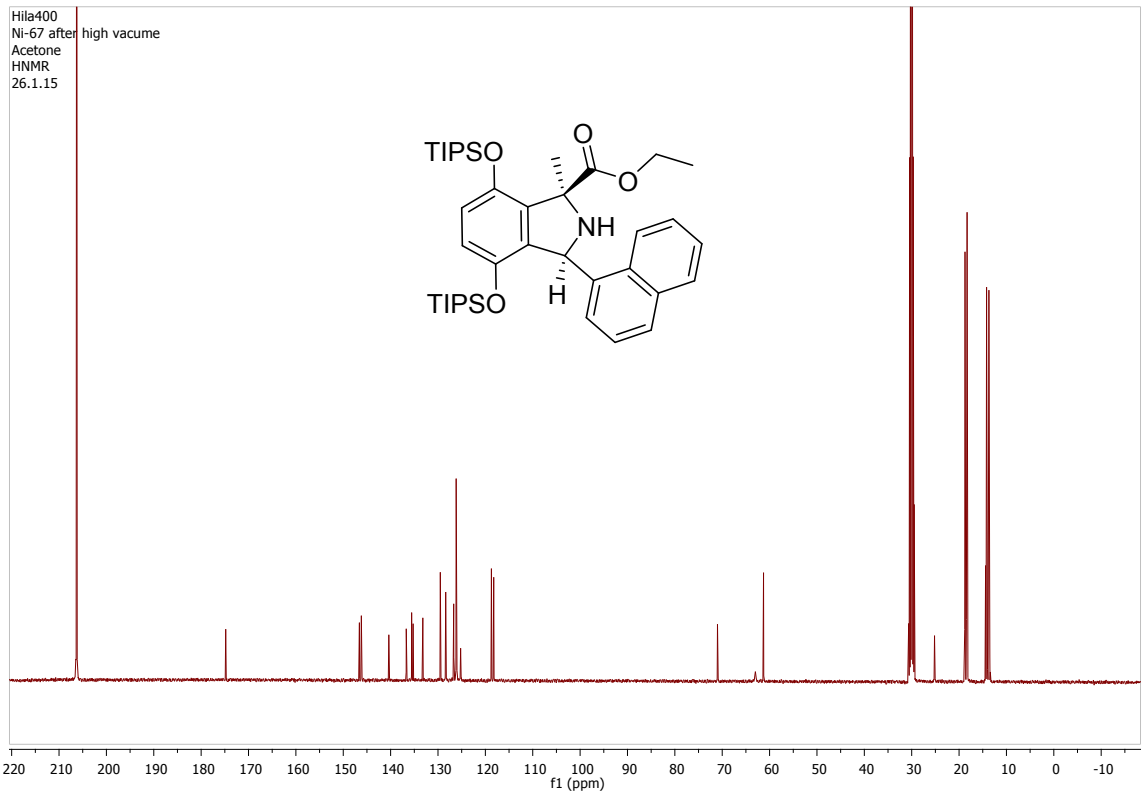
Ethyl 4,7-dihydroxy-1-methyl-3-(naphthalen-1-yl)isoindoline-1-carboxylate (11d)



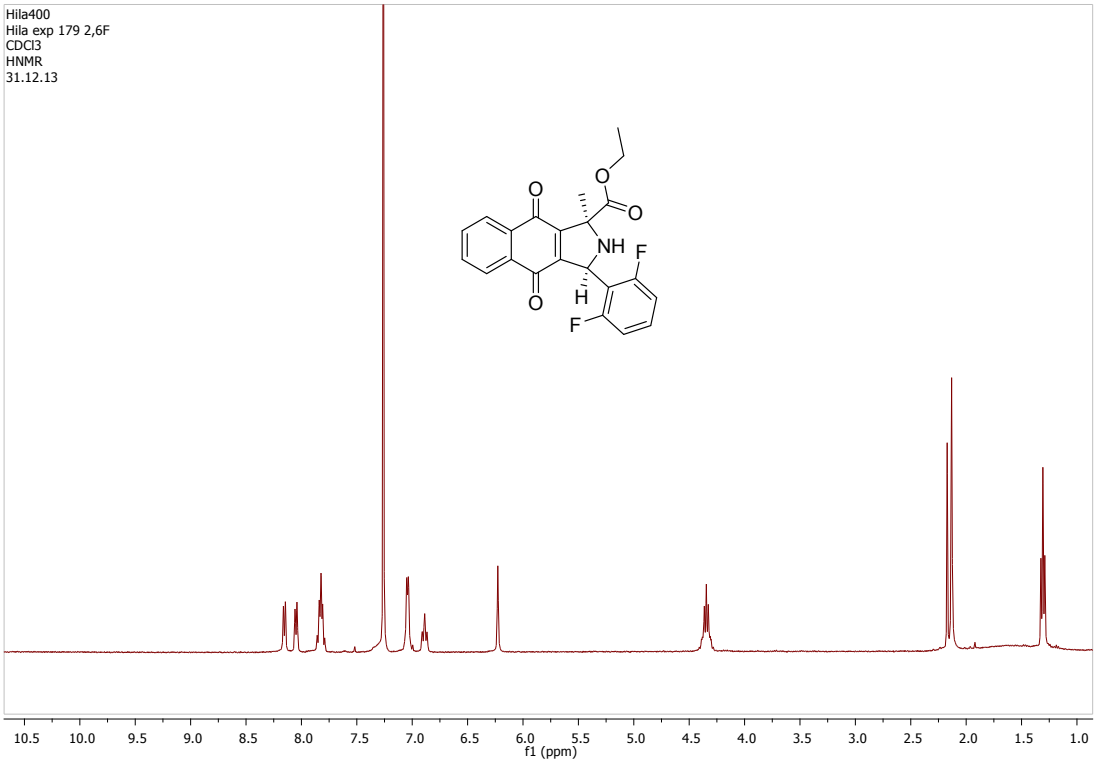


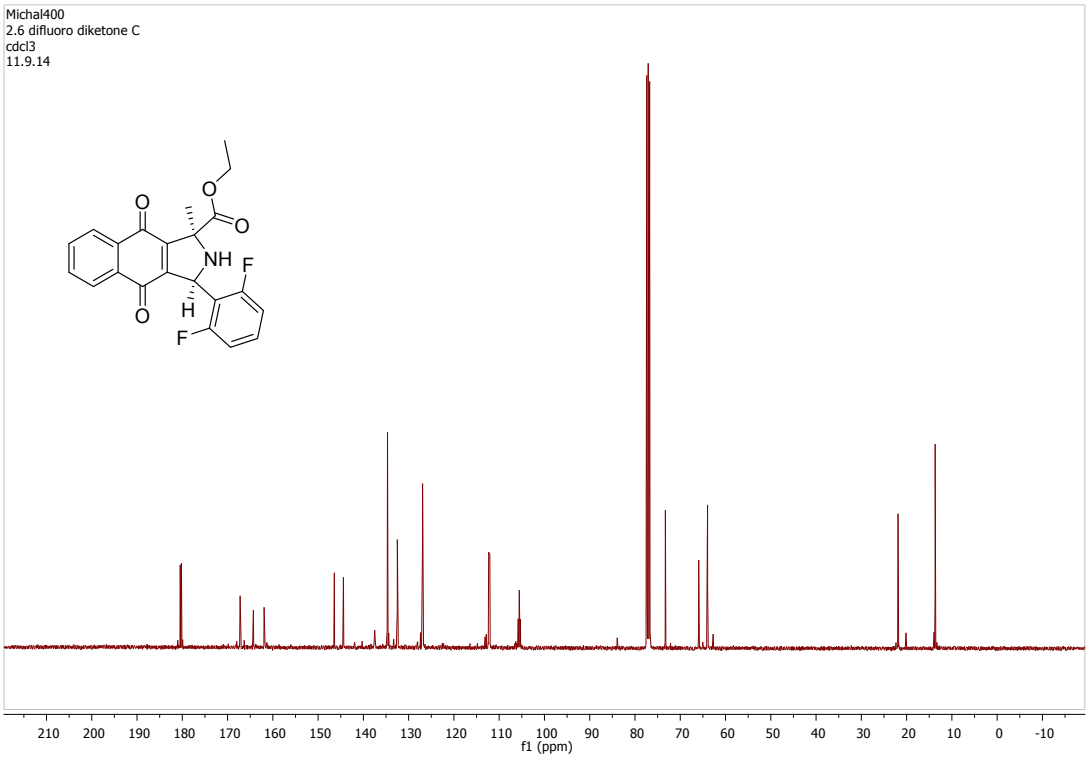
Ethyl-1-methyl-3-(naphthalen-1-yl)-4,7-bis((triisopropylsilyl)oxy)isoindoline-1-carboxylate **(12d)**



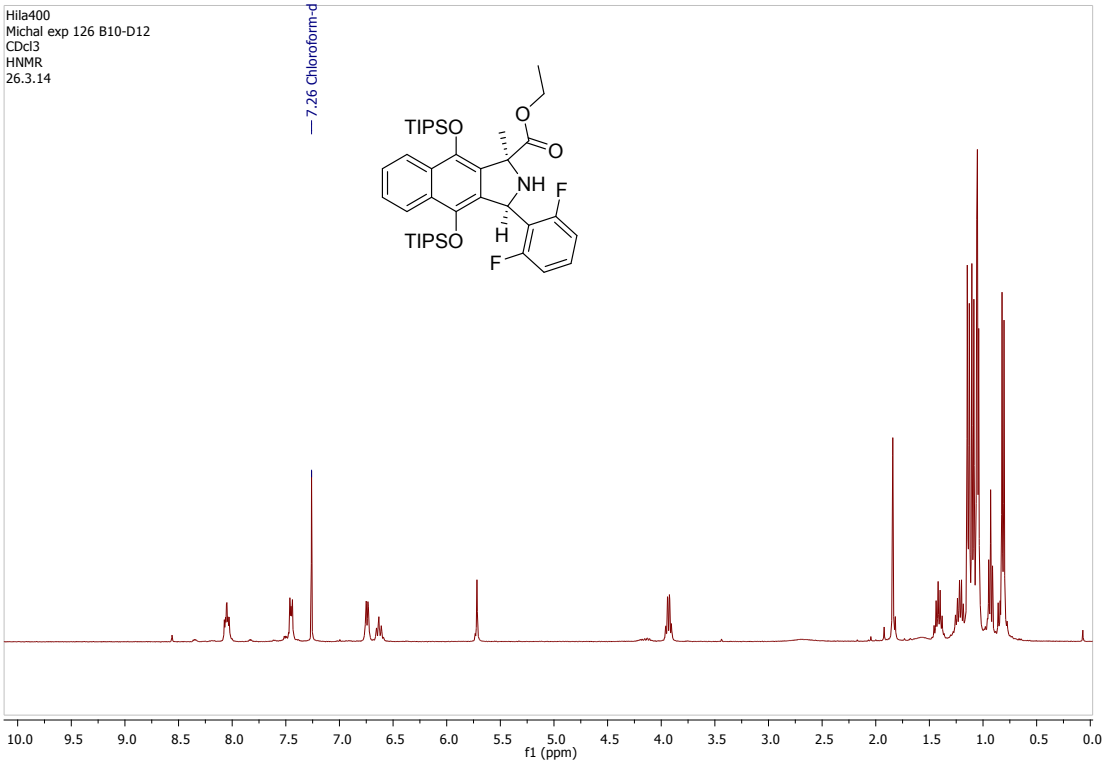


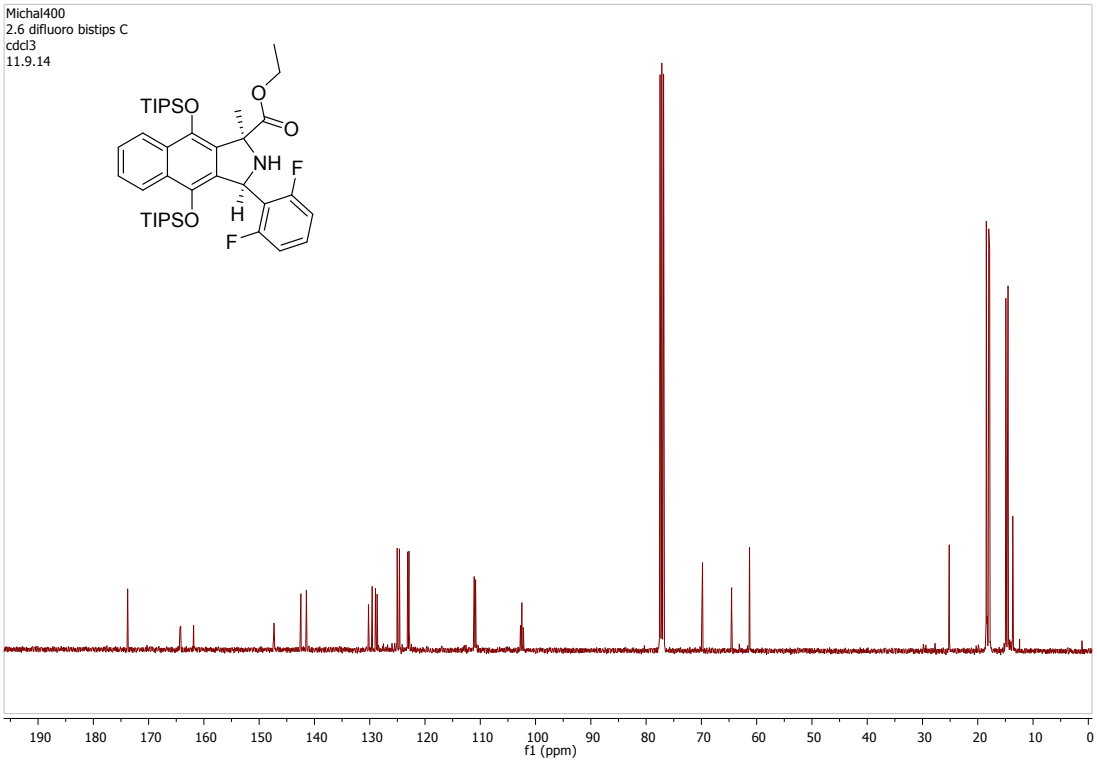
Ethyl-3-(2,6-difluorophenyl)-1-methyl-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11e)



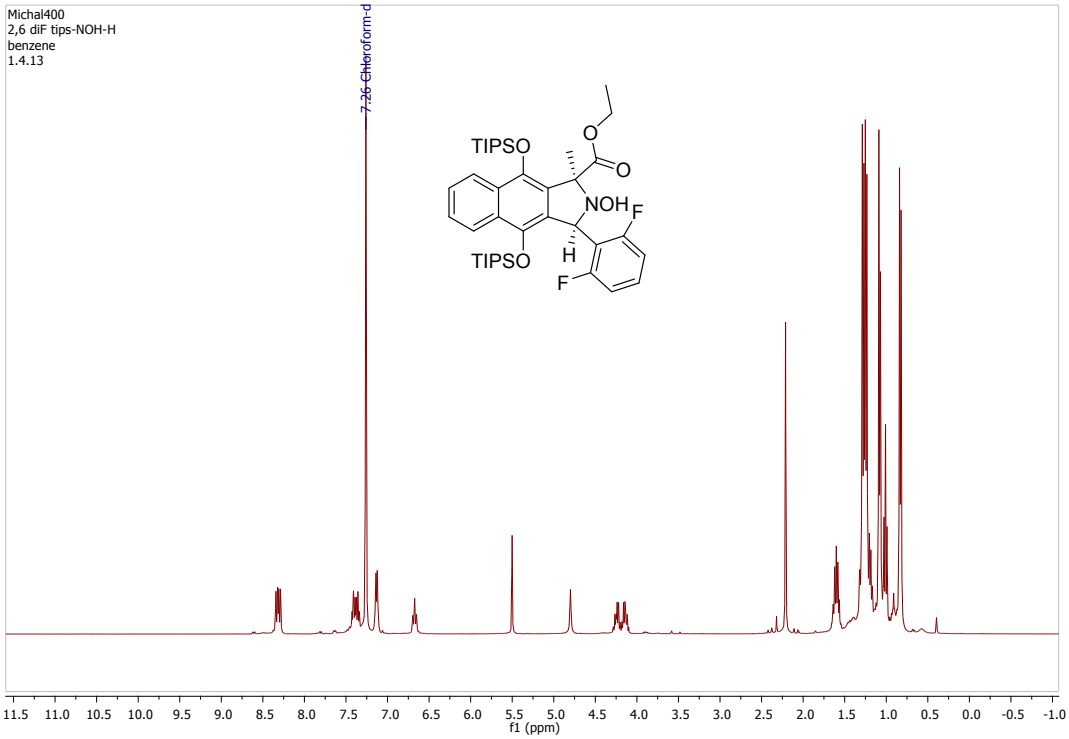


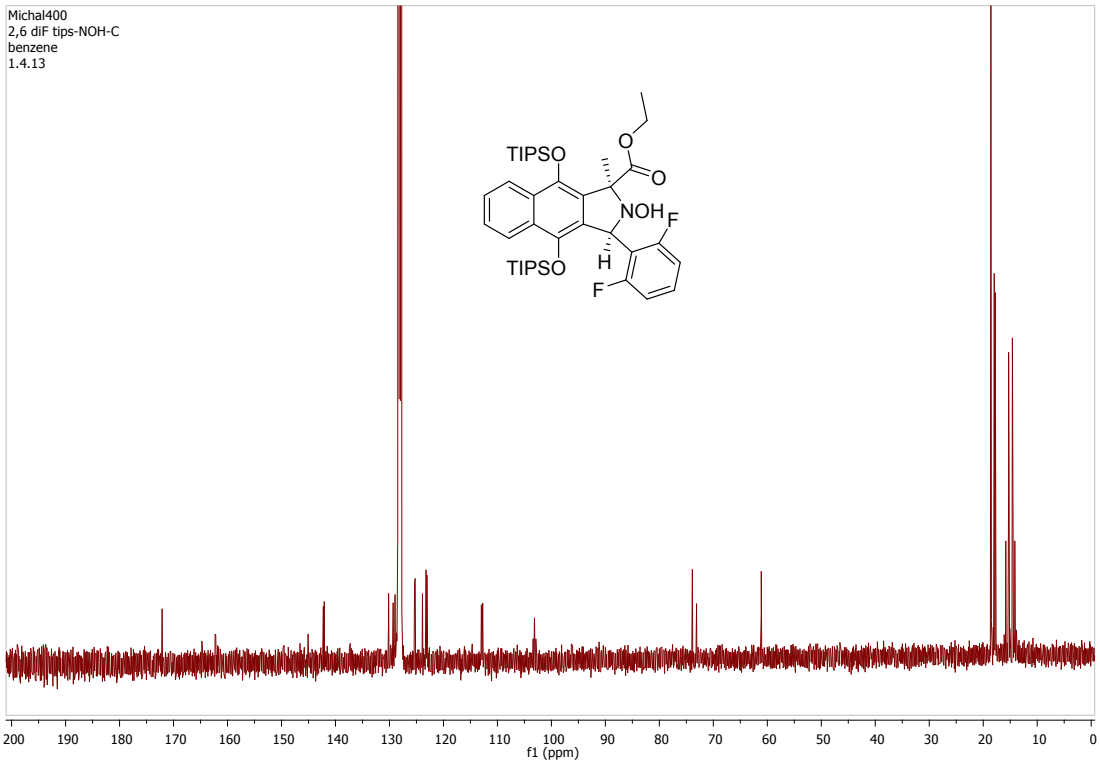
Ethyl-3-(2,6-difluorophenyl)-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12e)



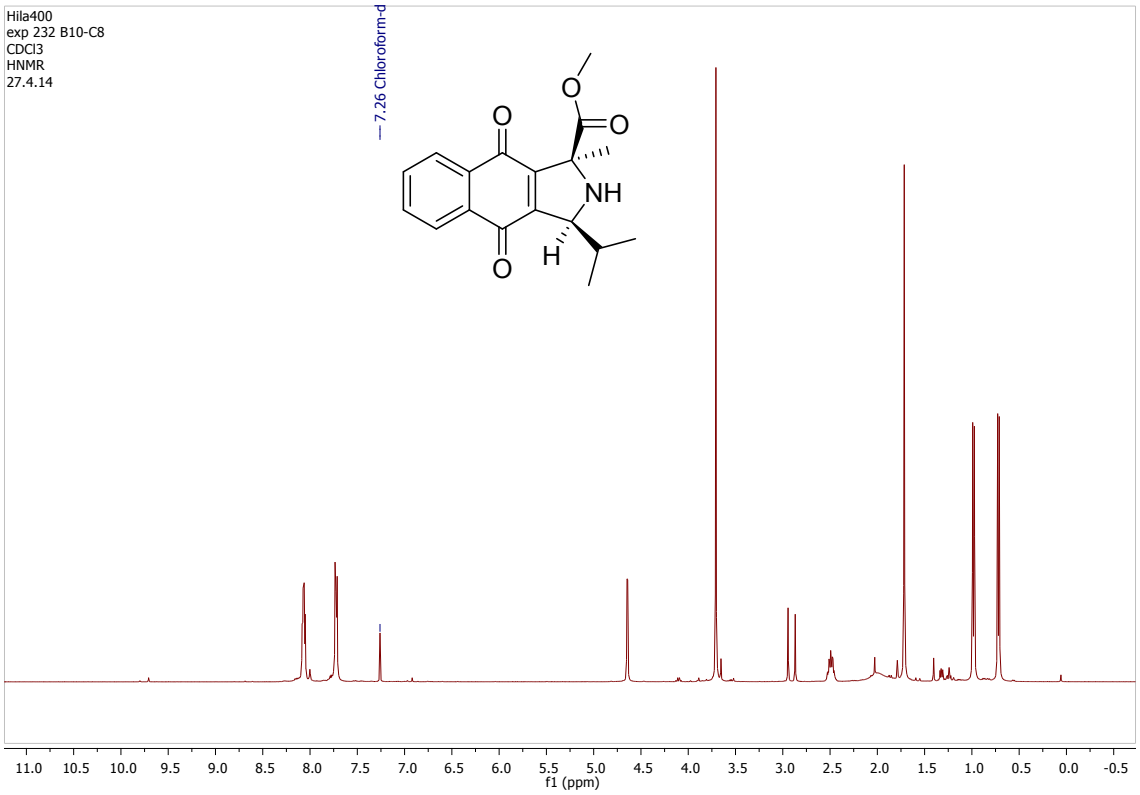


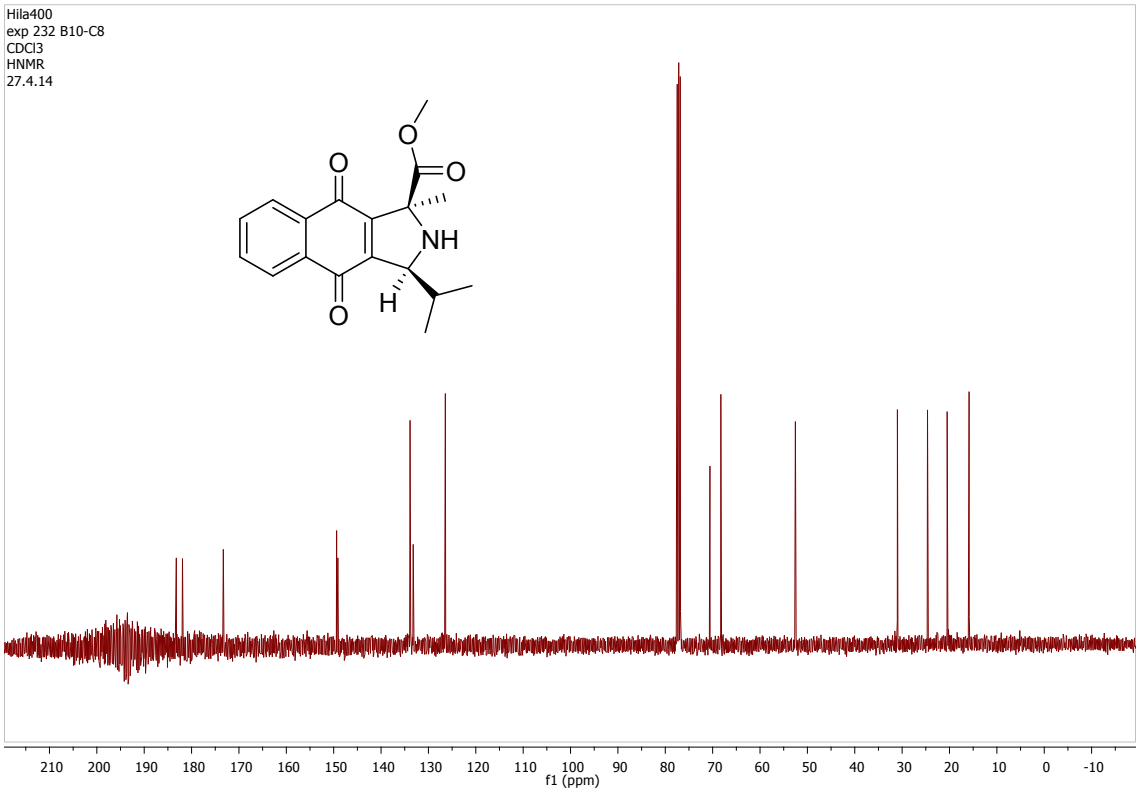
Ethyl-3-(2,6-difluorophenyl)-2-hydroxy-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (13e)



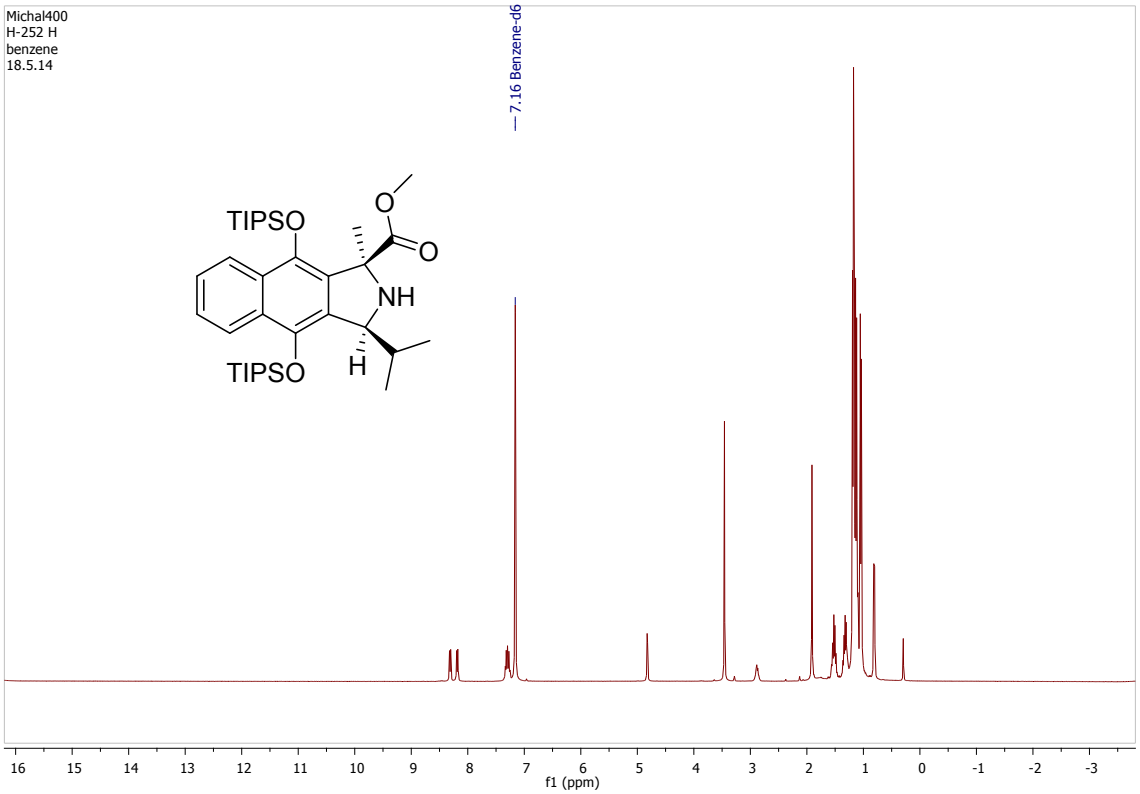


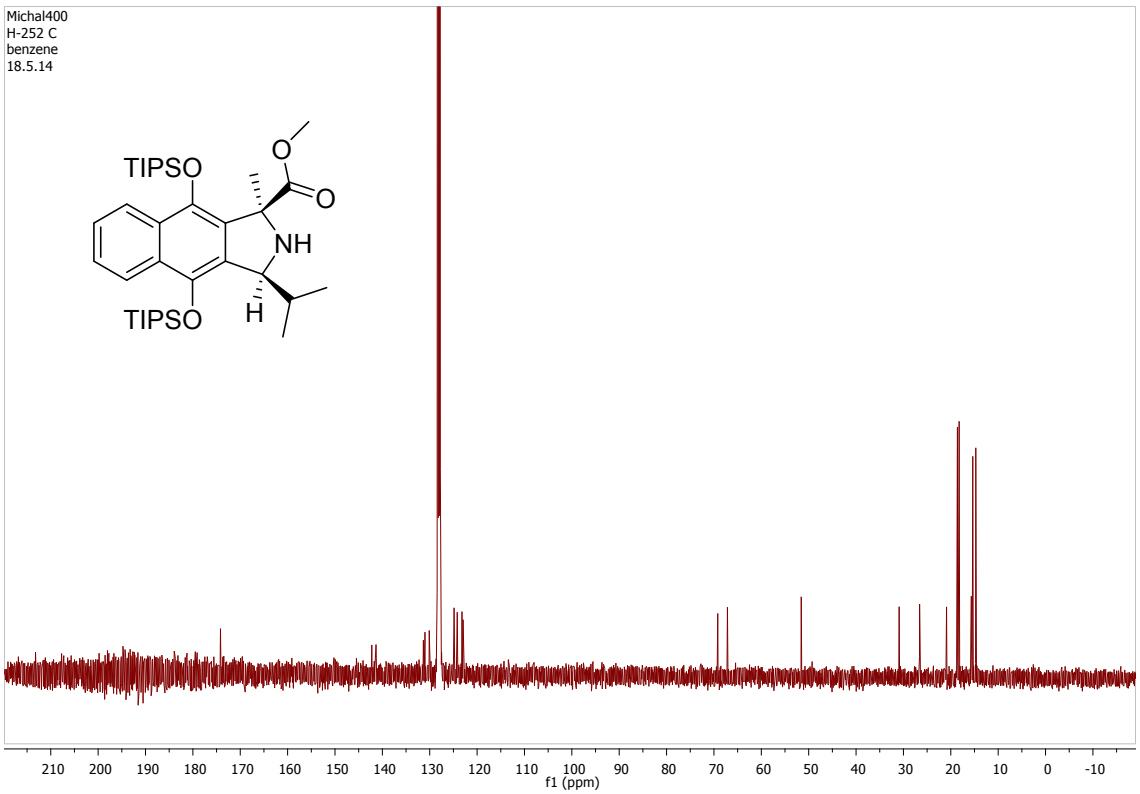
Methyl-3-isopropyl-1-methyl-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11f)



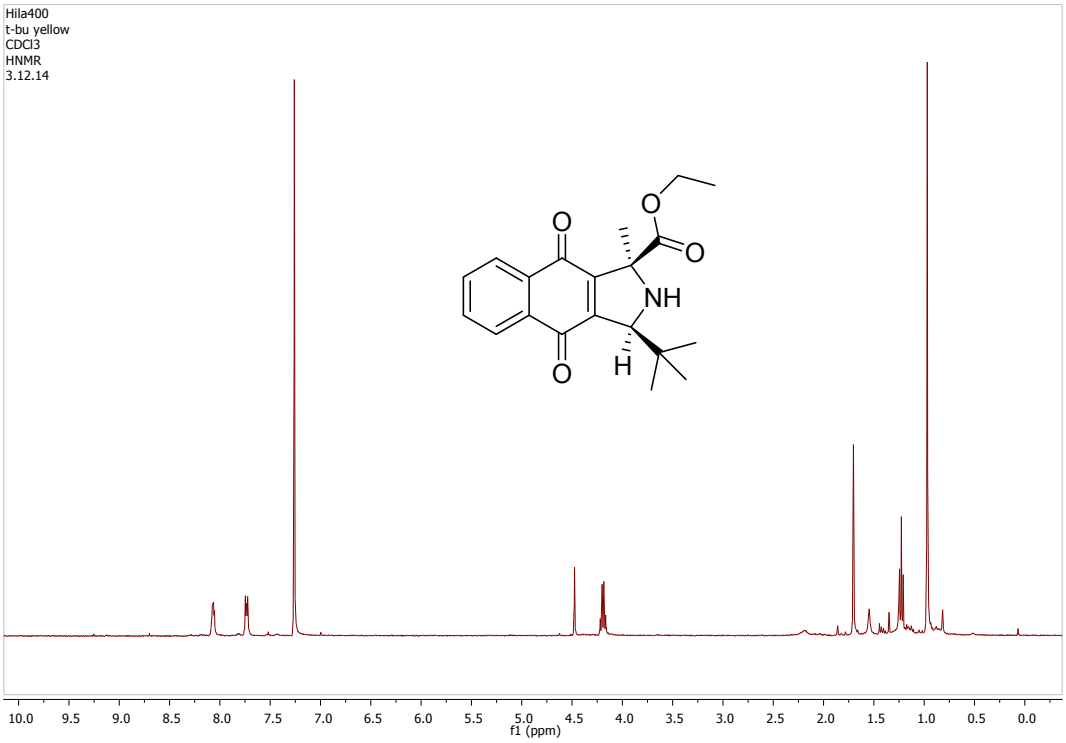


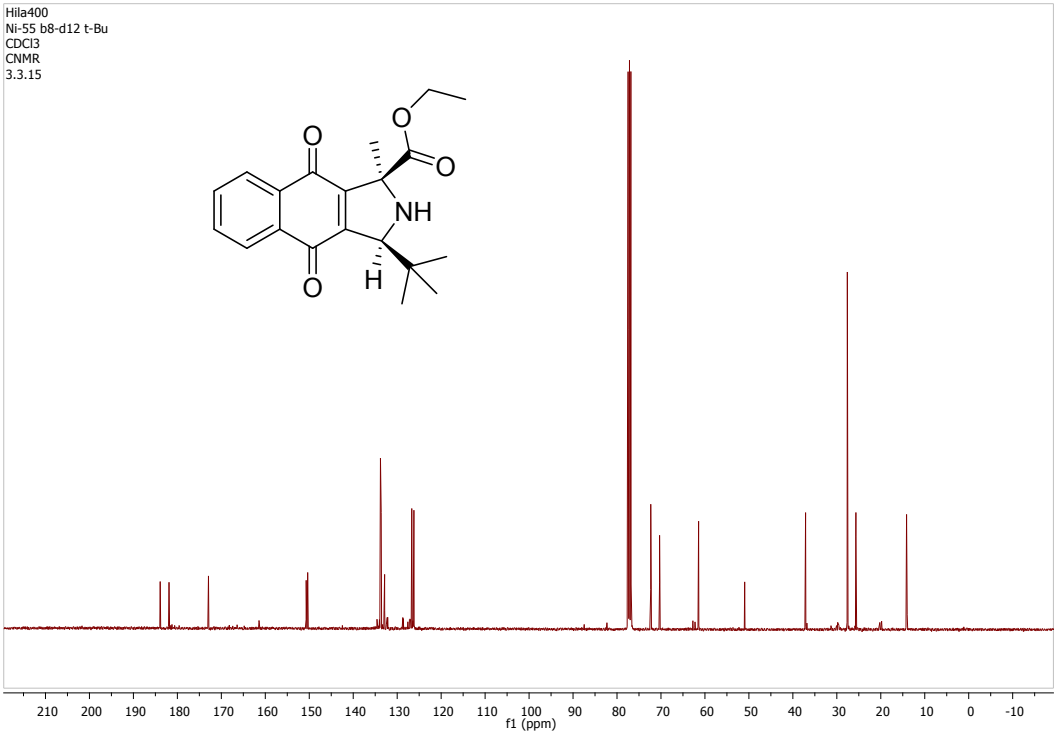
Methyl-3-isopropyl-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate (12f)



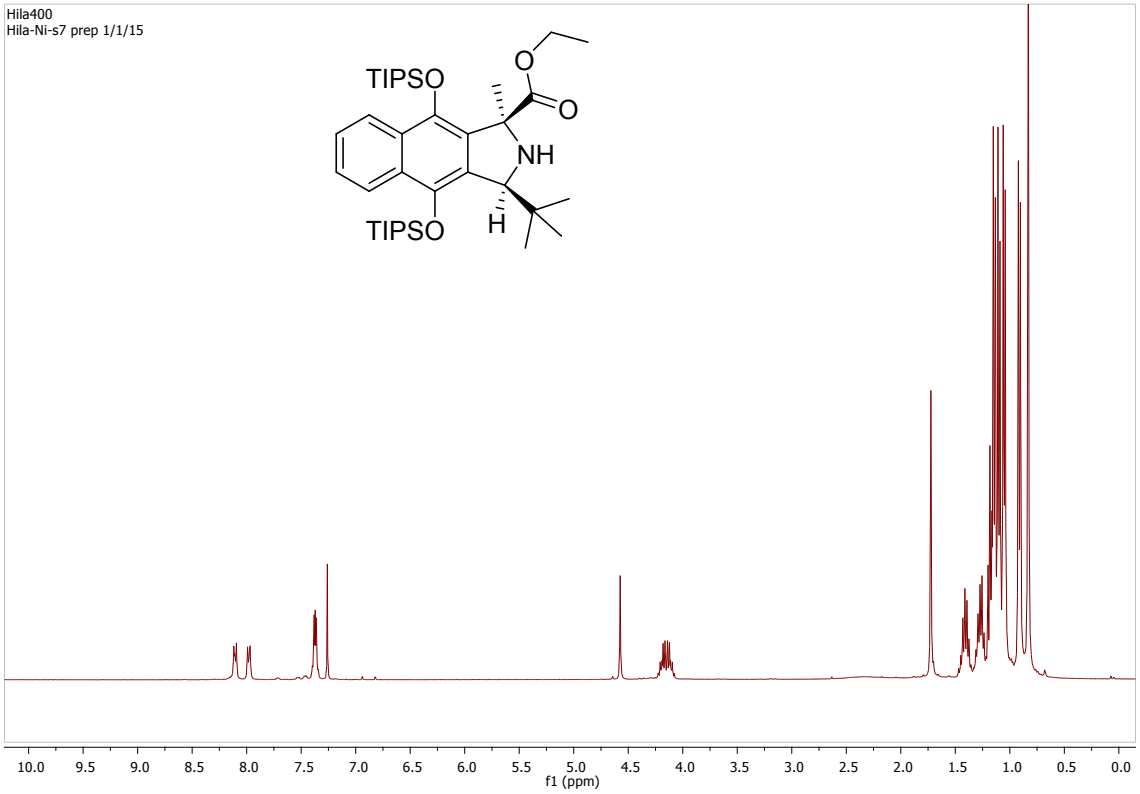


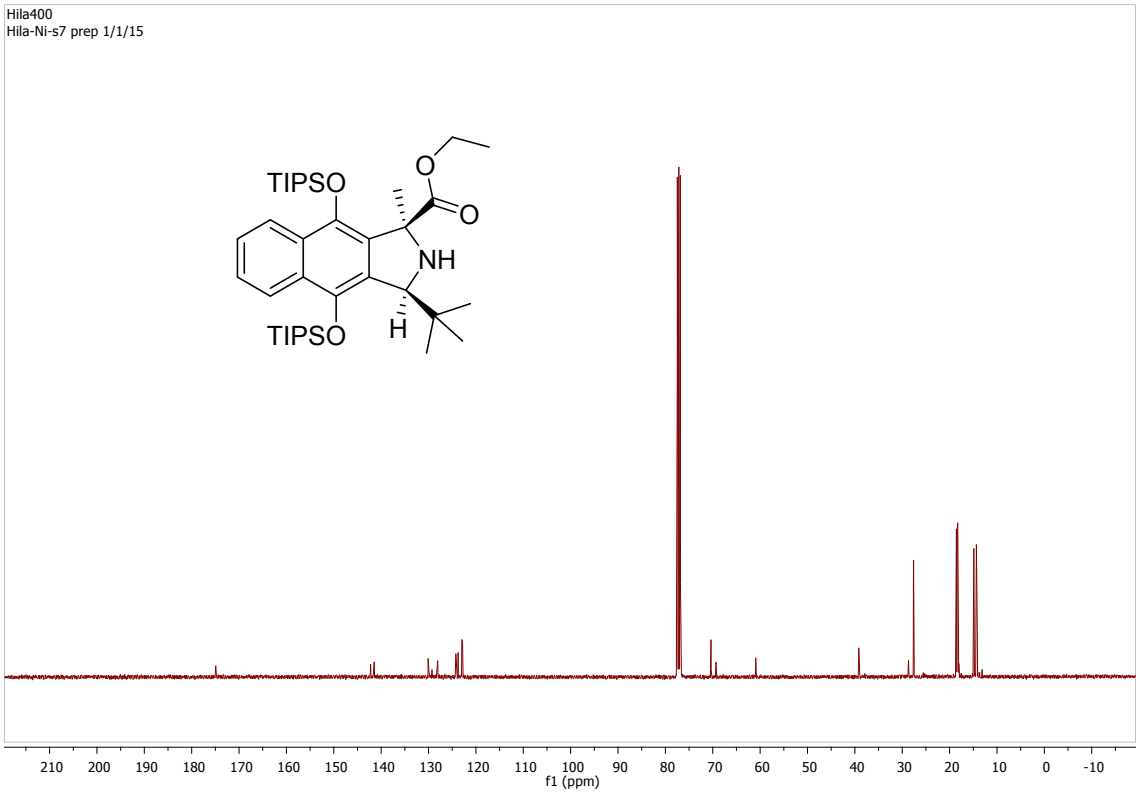
Ethyl-3-(tert-butyl)-1-methyl-4,9-dioxo-2,3,4,9-tetrahydro-1H-benzo[f]isoindole-1-carboxylate (11g)



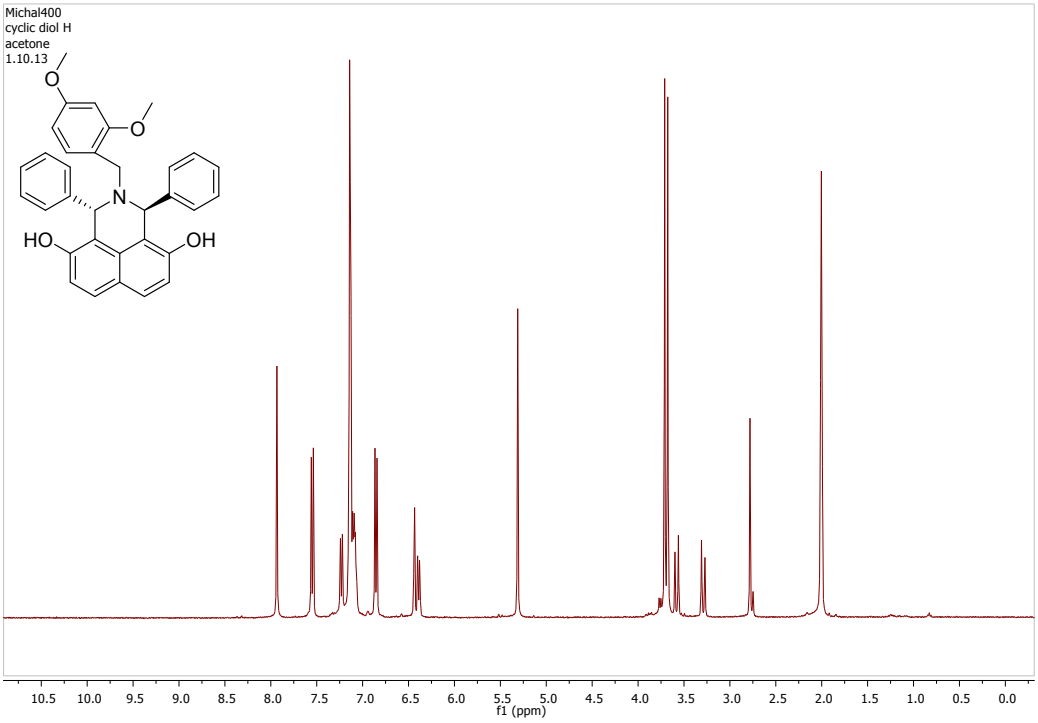


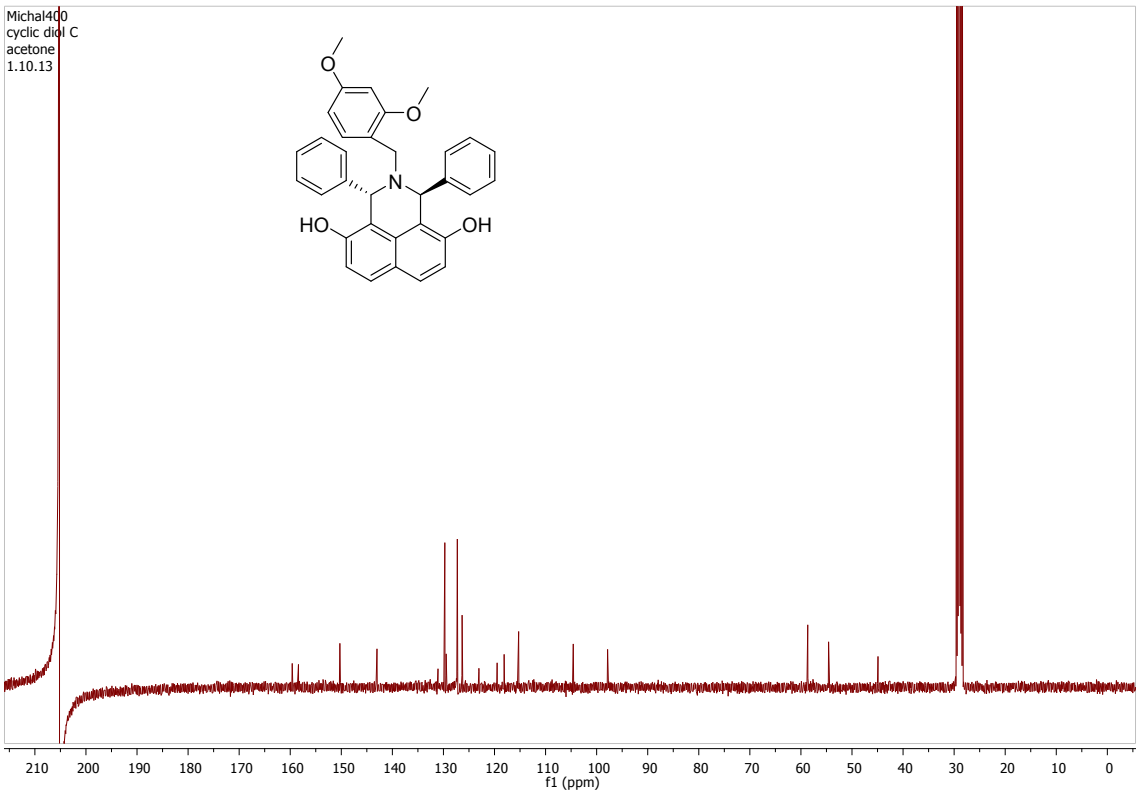
Ethyl-3-(tert-butyl)-1-methyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[f]isoindole-1-carboxylate **(12g)**



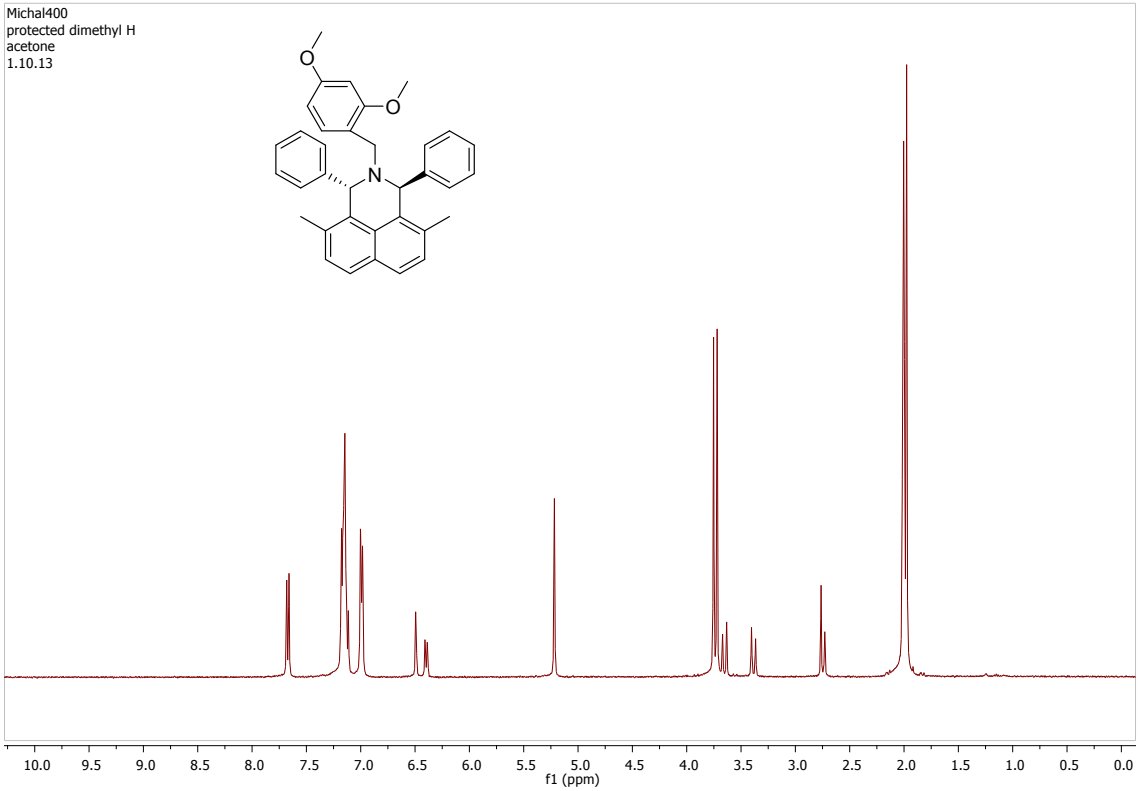


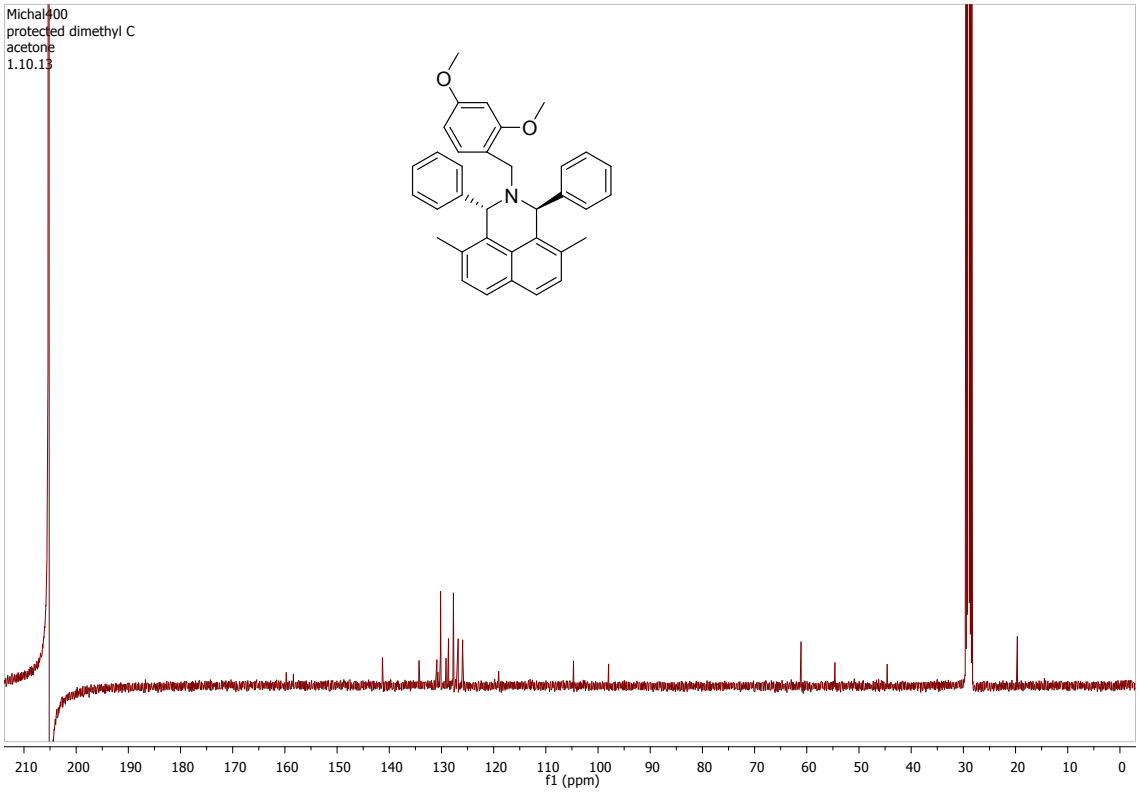
2-(2,4-Dimethoxy-benzyl)-1,3-diphenyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol **(17a)**



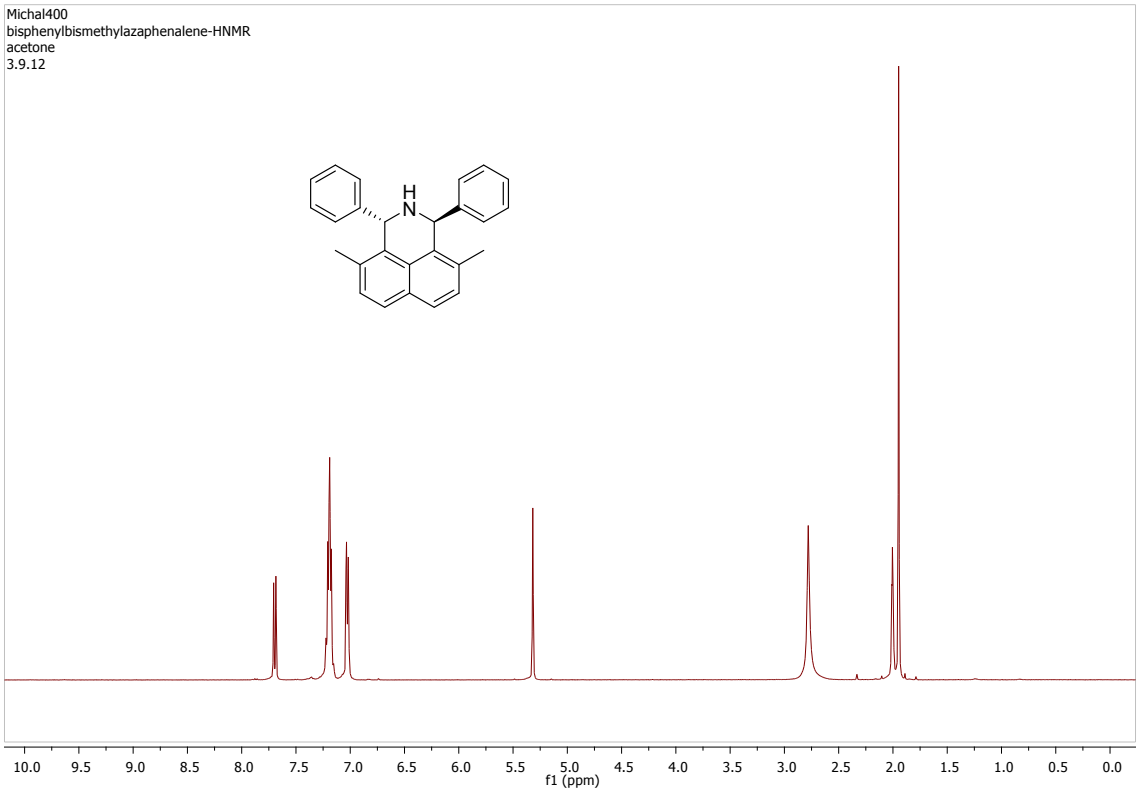


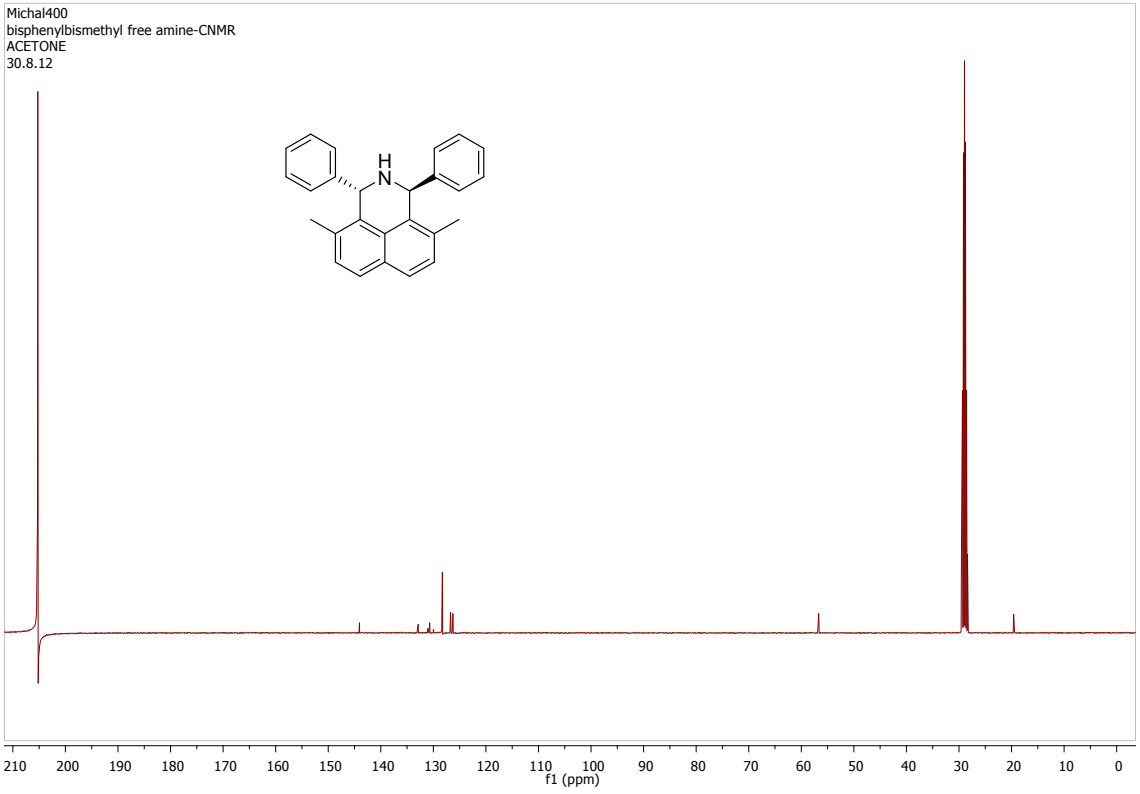
2-(2,4-dimethoxybenzyl)-4,9-dimethyl-1,3-diphenyl-2,3-dihydro-1H-benzo[de]isoquinoline



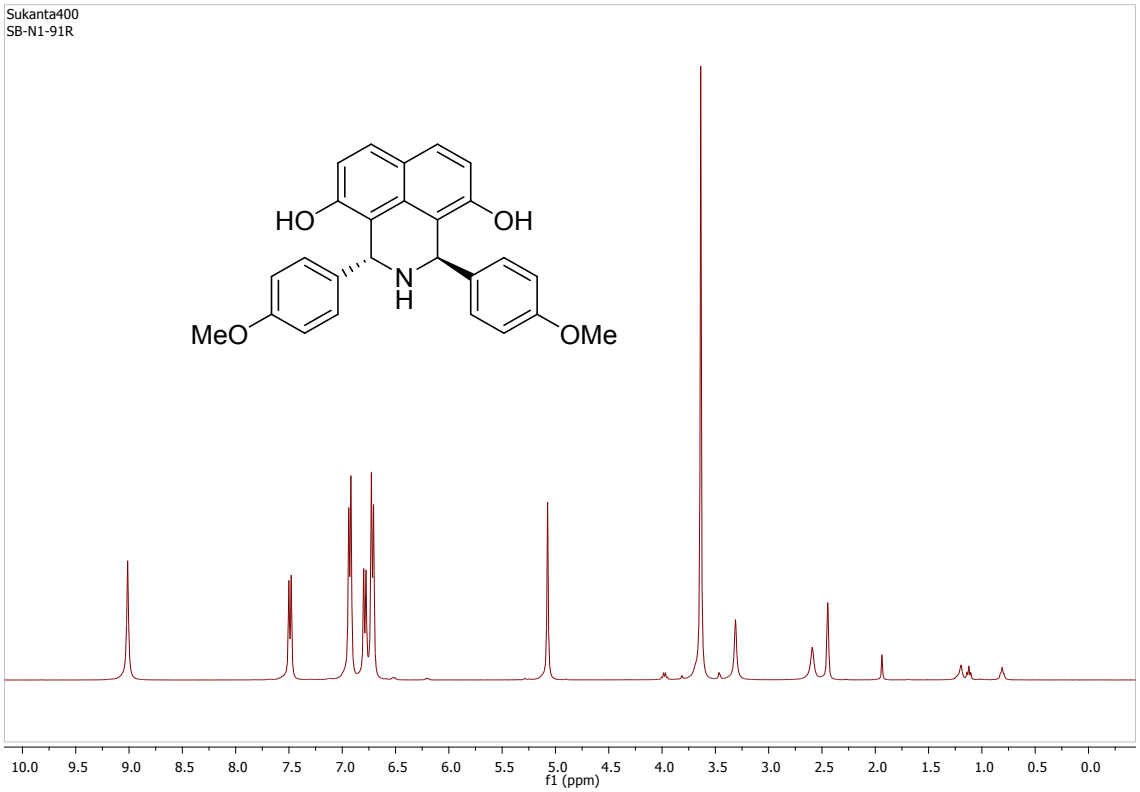


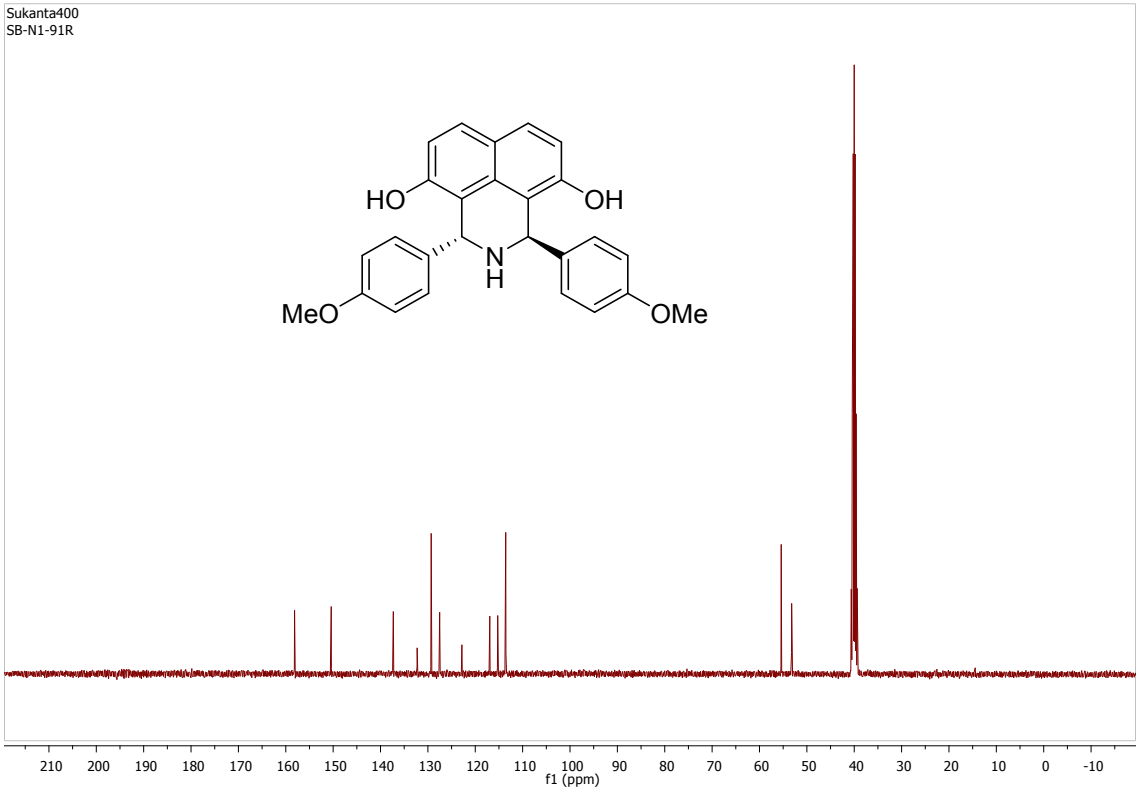
4,9-Dimethyl-1,3-diphenyl-2,3-dihydro-1H-benzo[de]isoquinoline (19a)



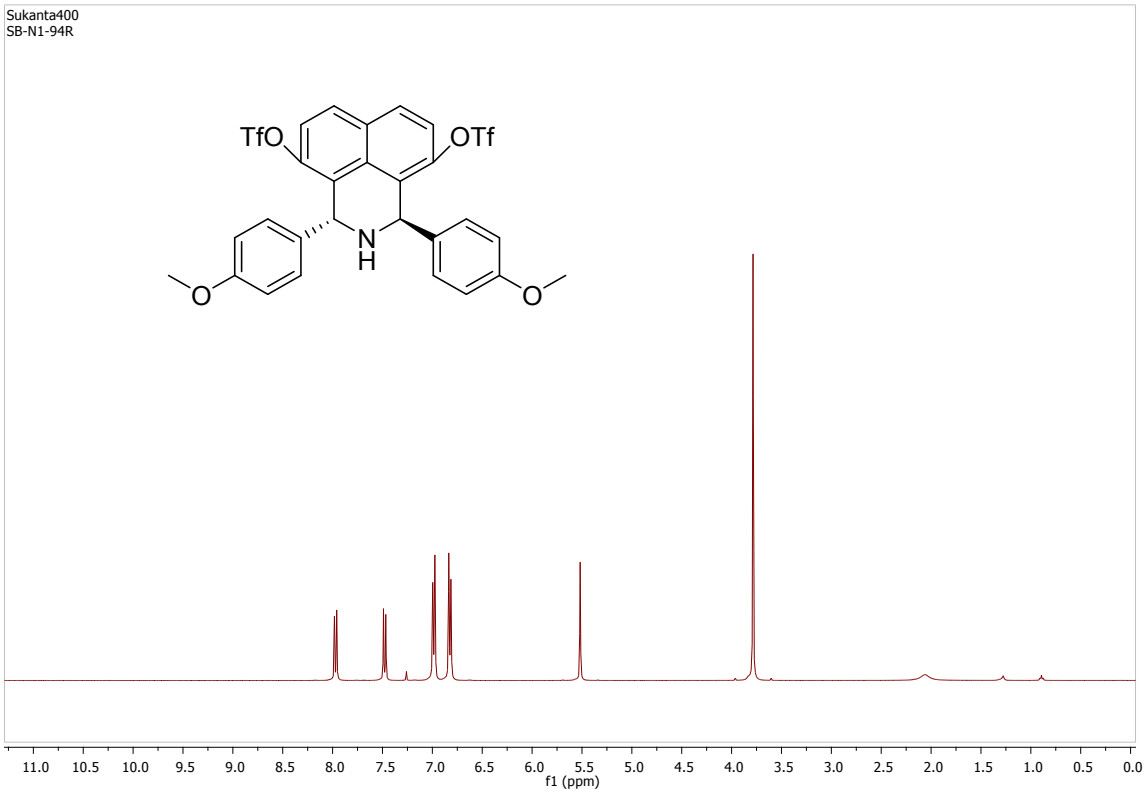


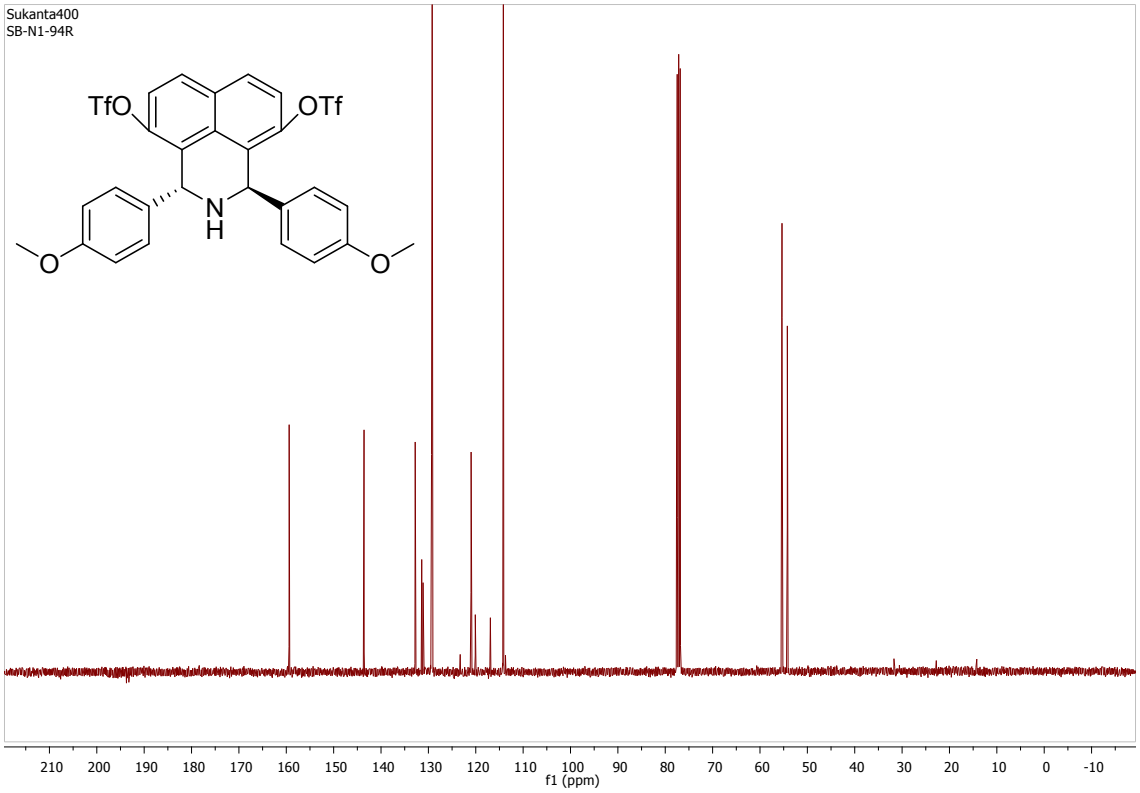
1,3-Bis-(4-methoxy-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (17b)



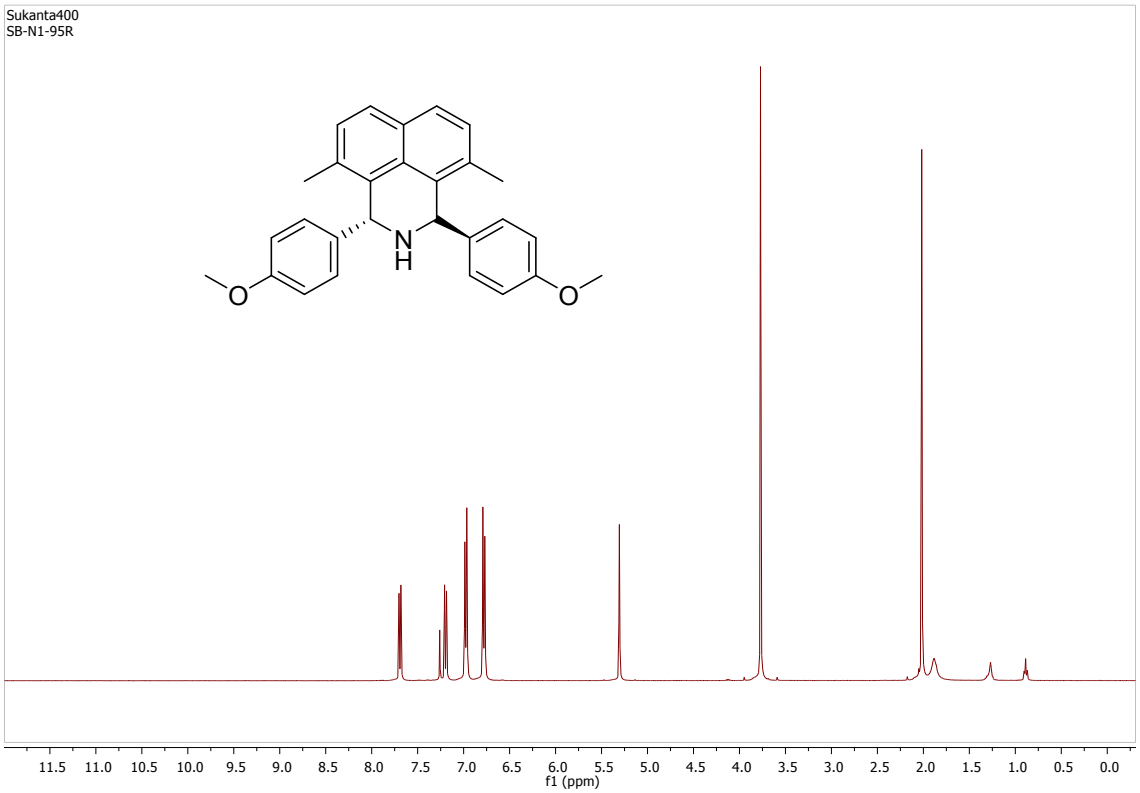


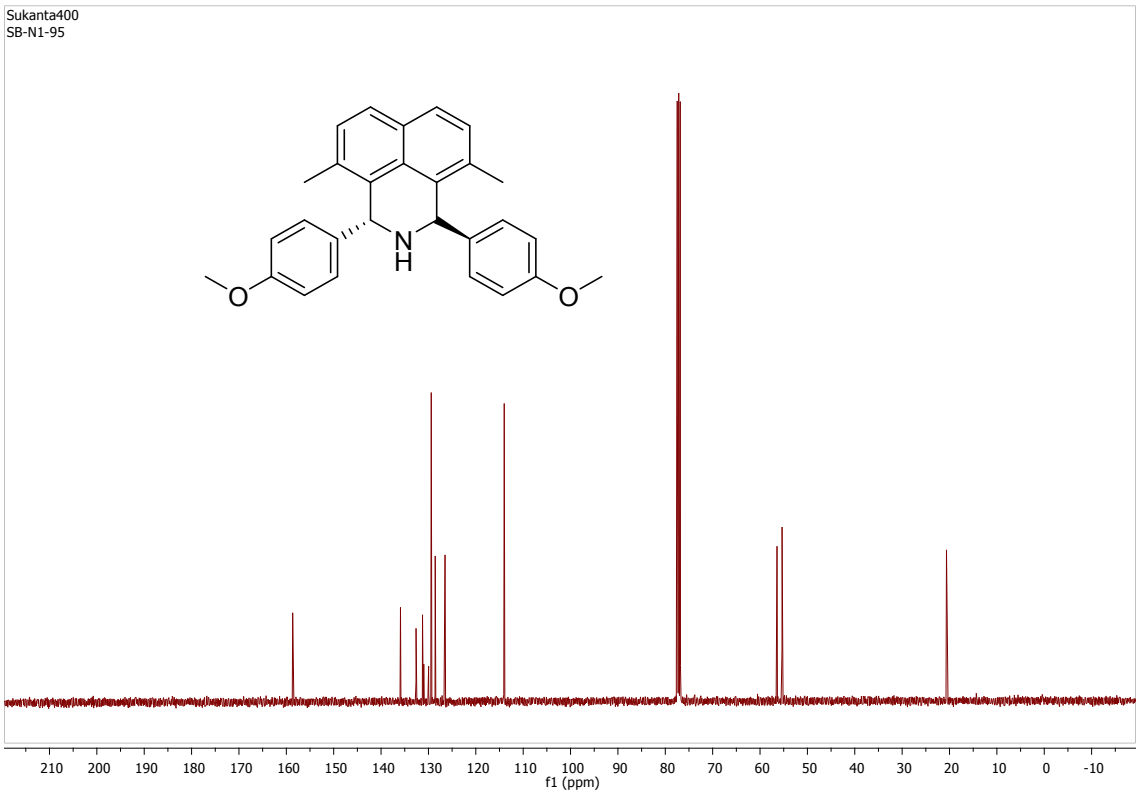
1,3-bis(4-methoxyphenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diyl bis(trifluoromethanesulfonate) (18b)



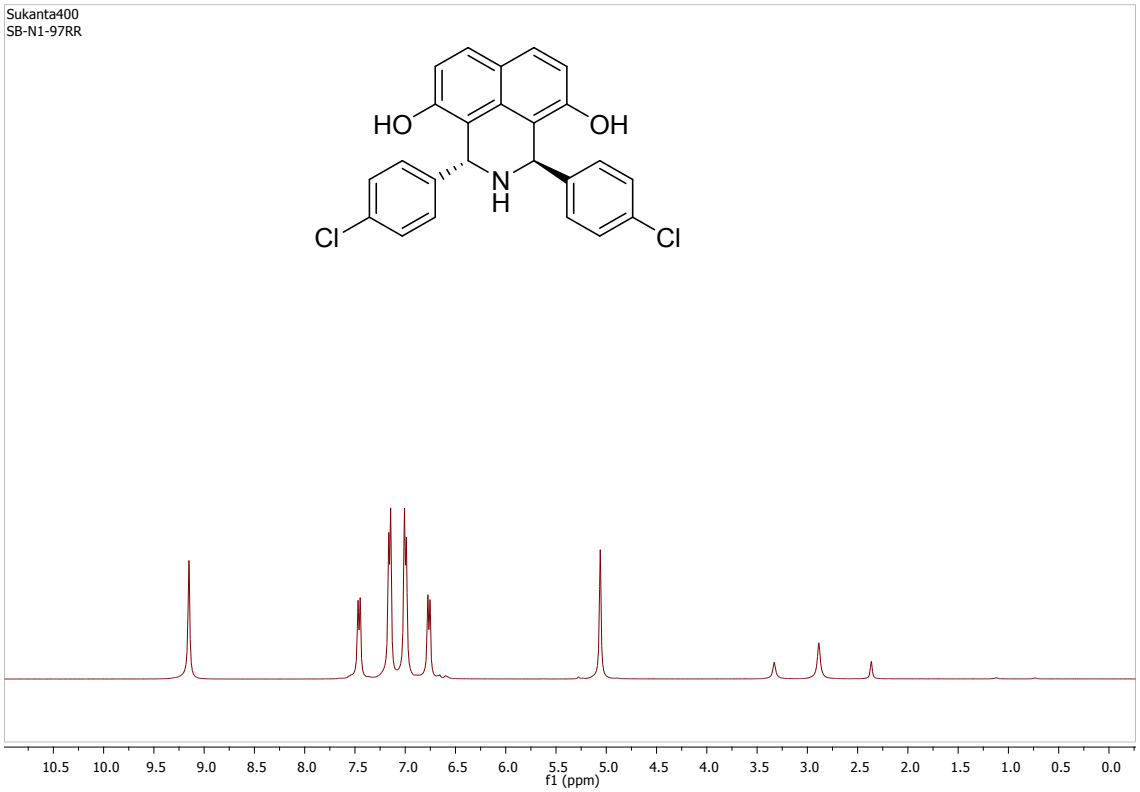


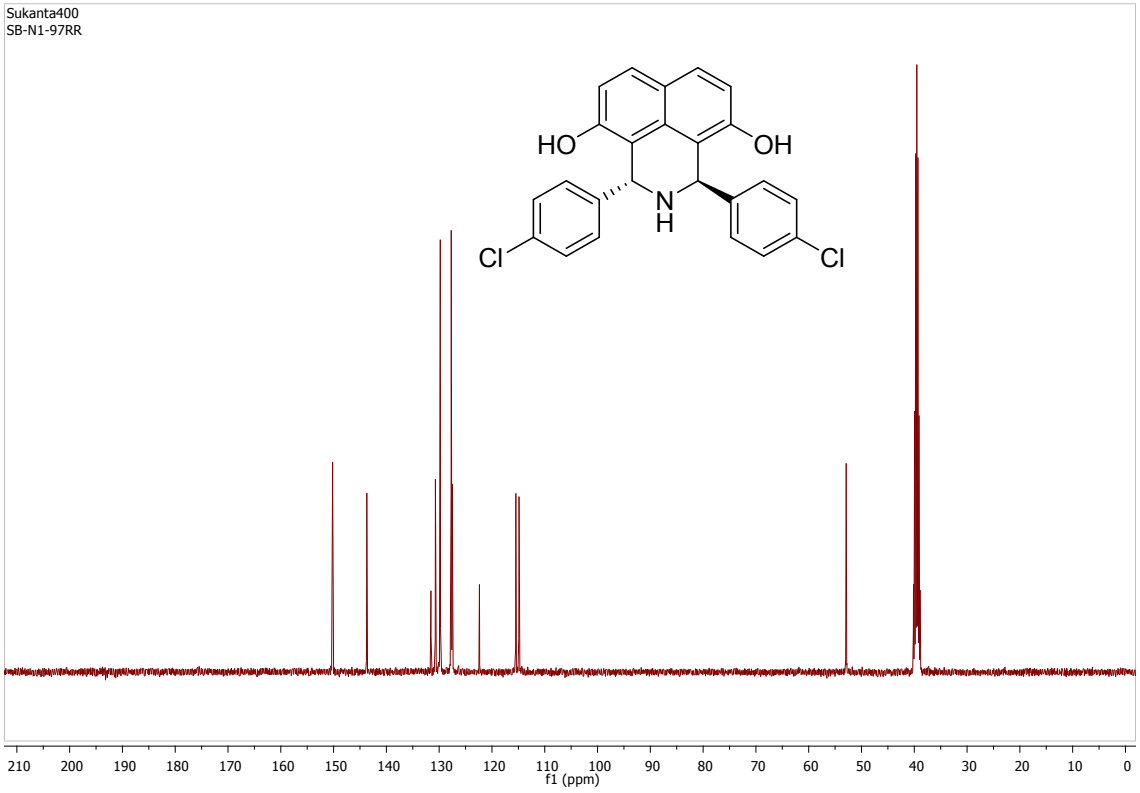
1,3-bis(4-methoxyphenyl)-4,9-dimethyl-2,3-dihydro-1H-benzo[de]isoquinoline (19b)



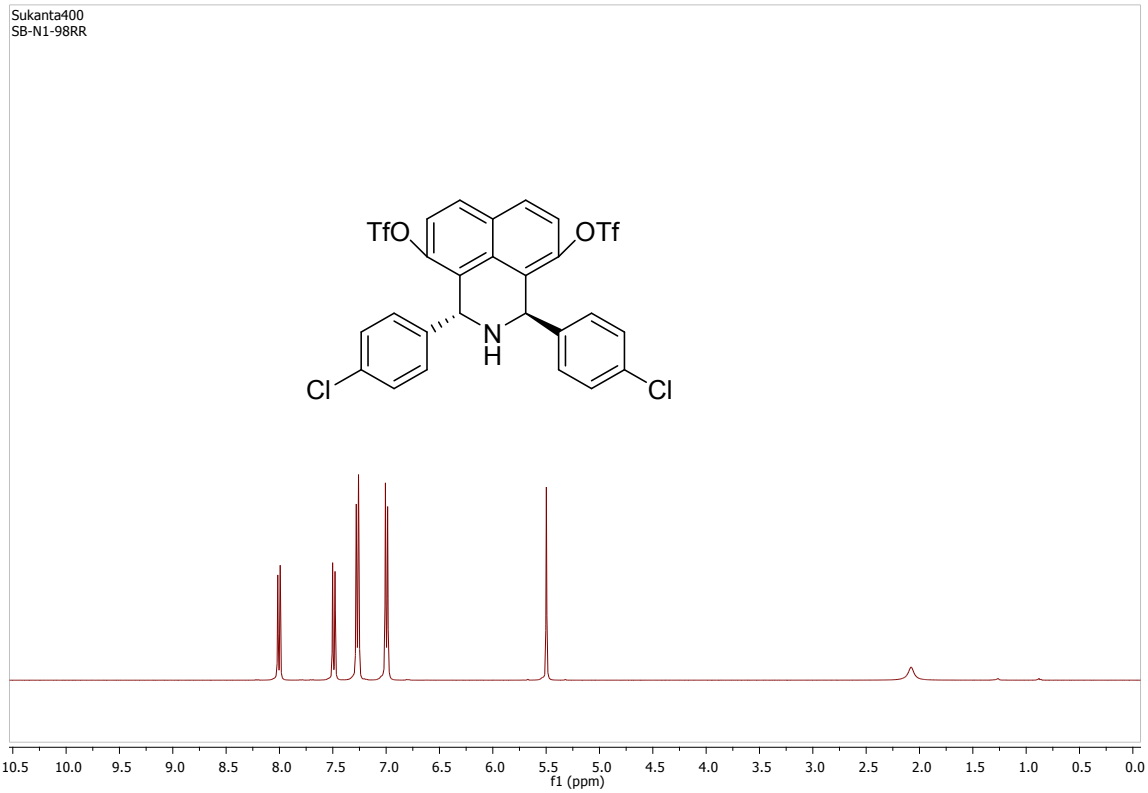


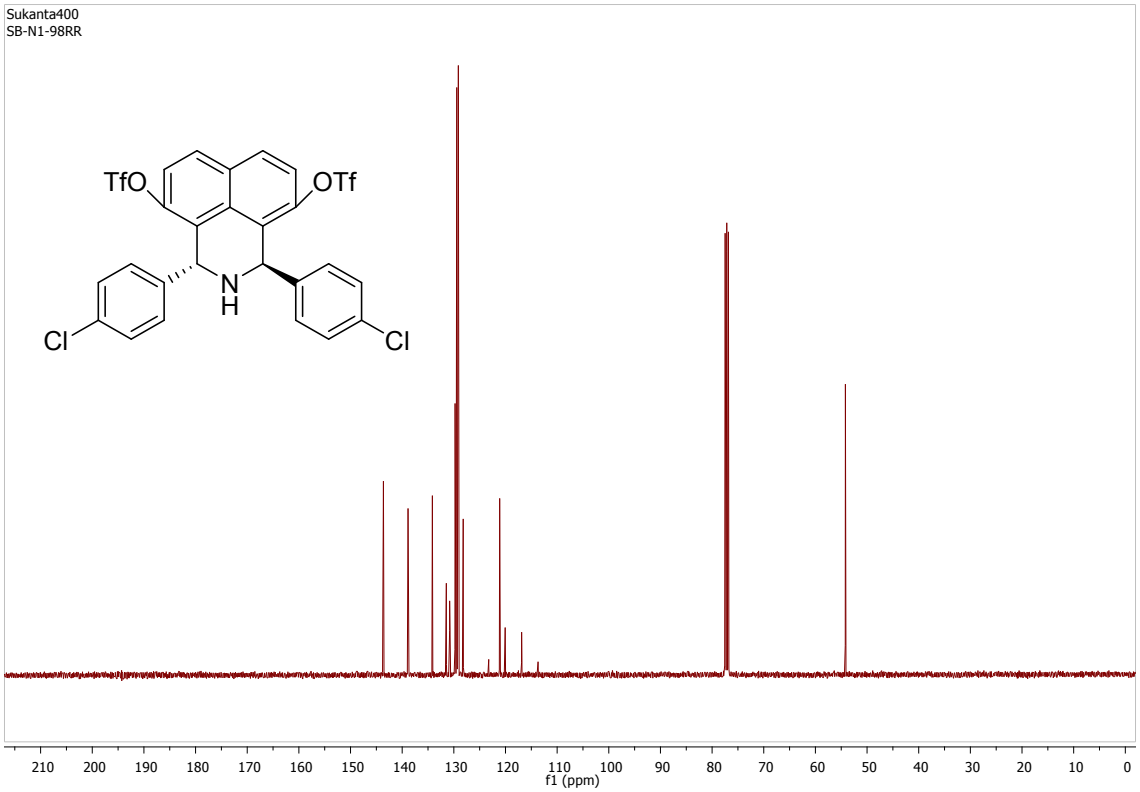
1,3-Bis-(4-chloro-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (17c)



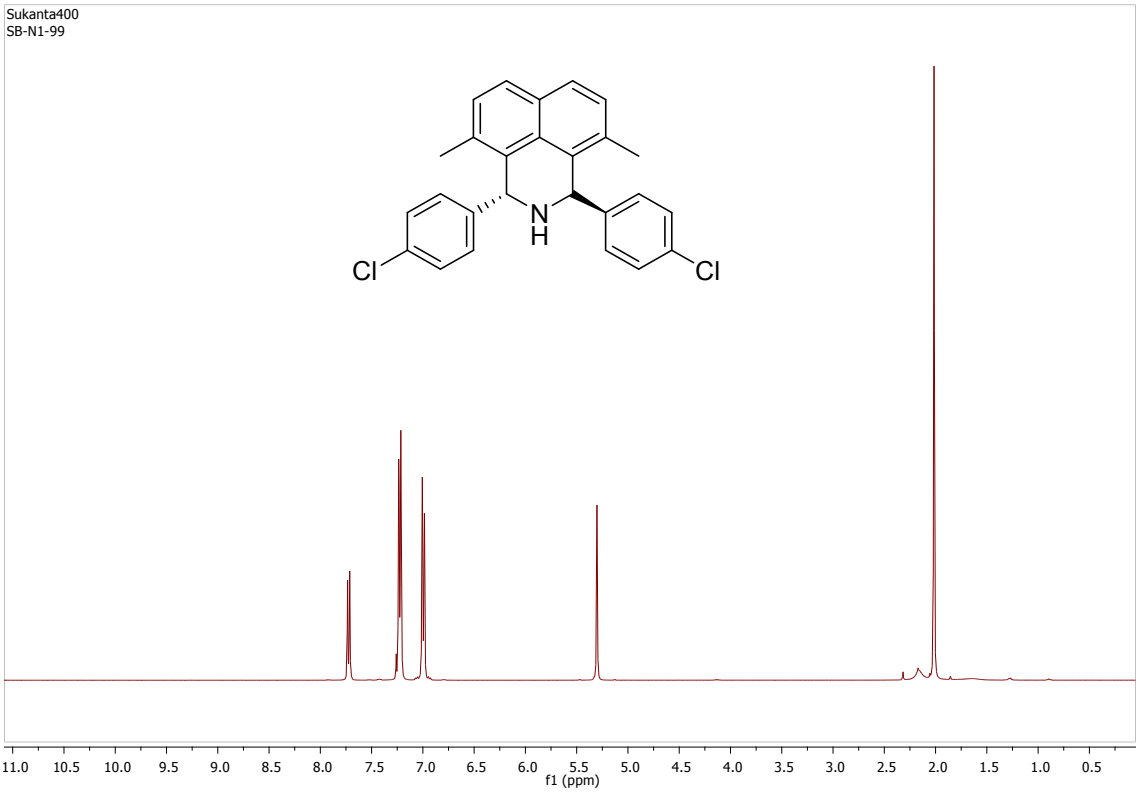


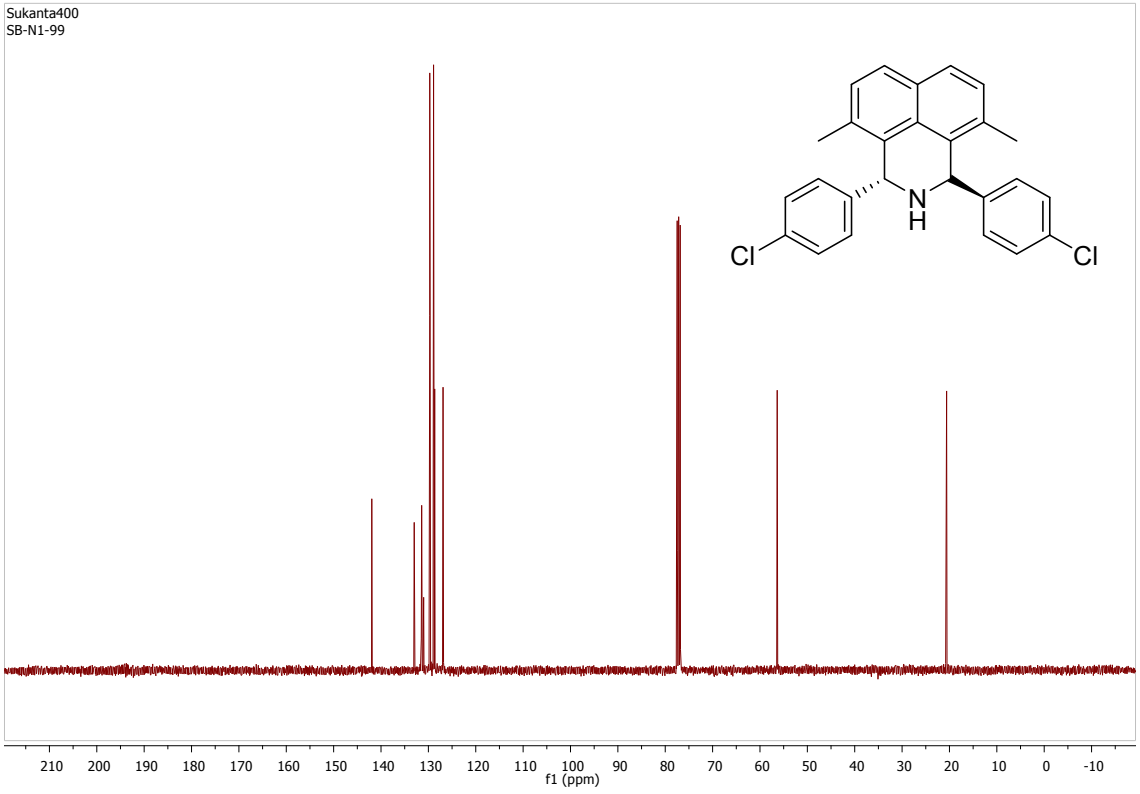
1,3-bis(4-chlorophenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diyl bis(trifluoromethanesulfonate) **(18c)**



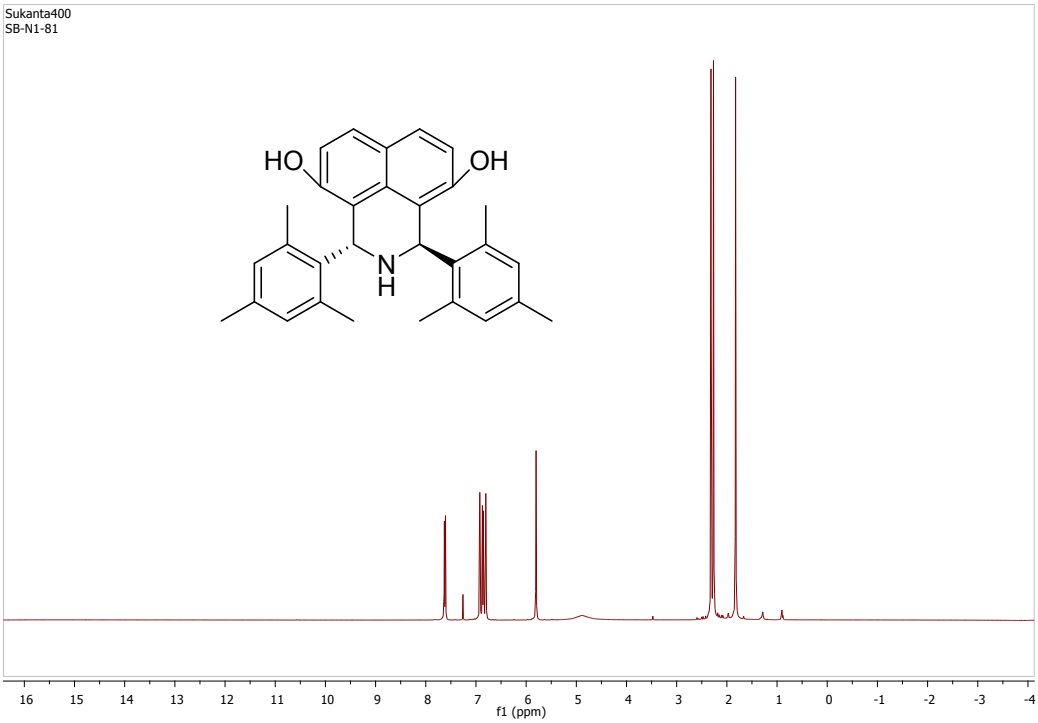


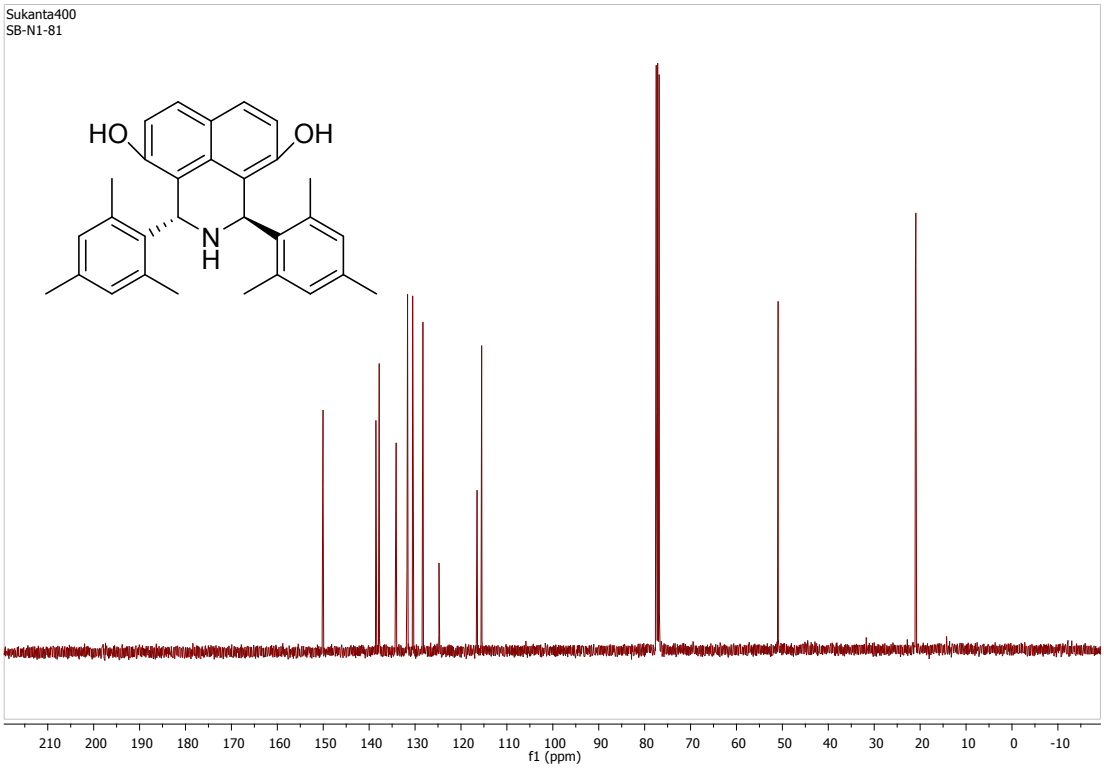
1,3-bis(4-chlorophenyl)-4,9-dimethyl-2,3-dihydro-1H-benzo[de]isoquinoline (19c)



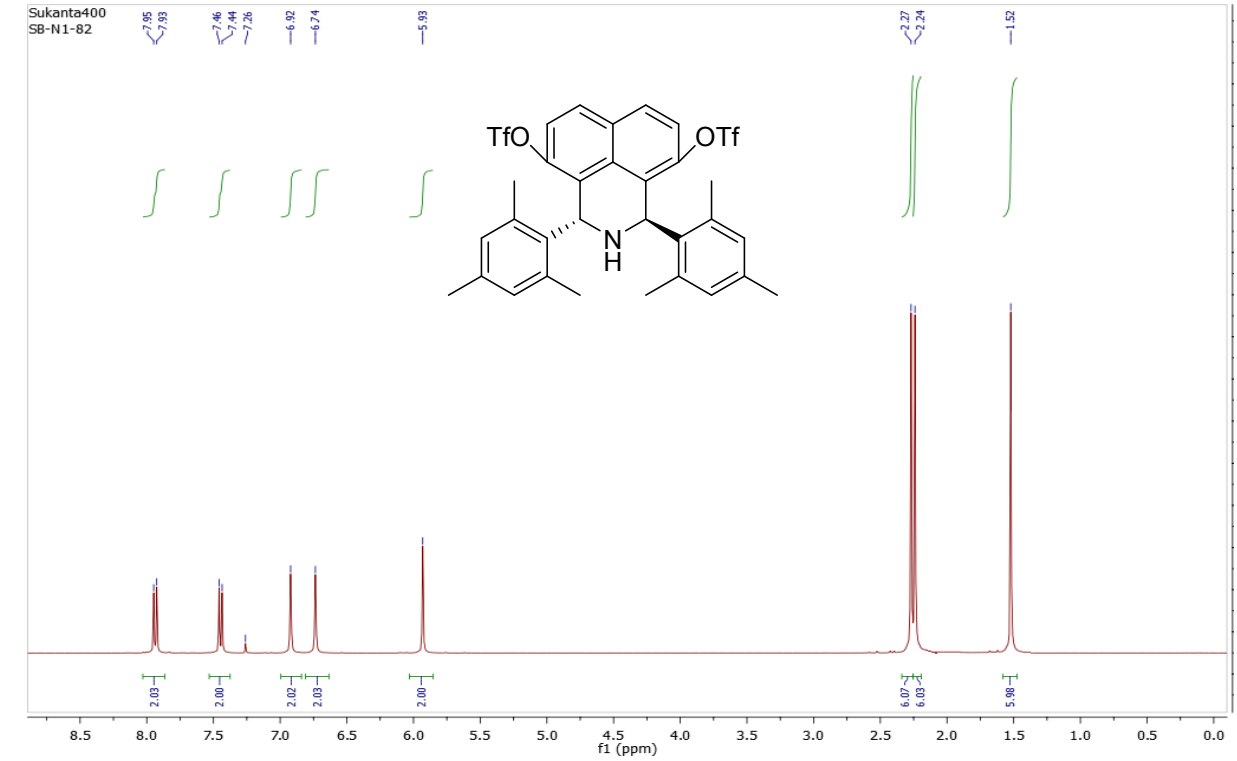


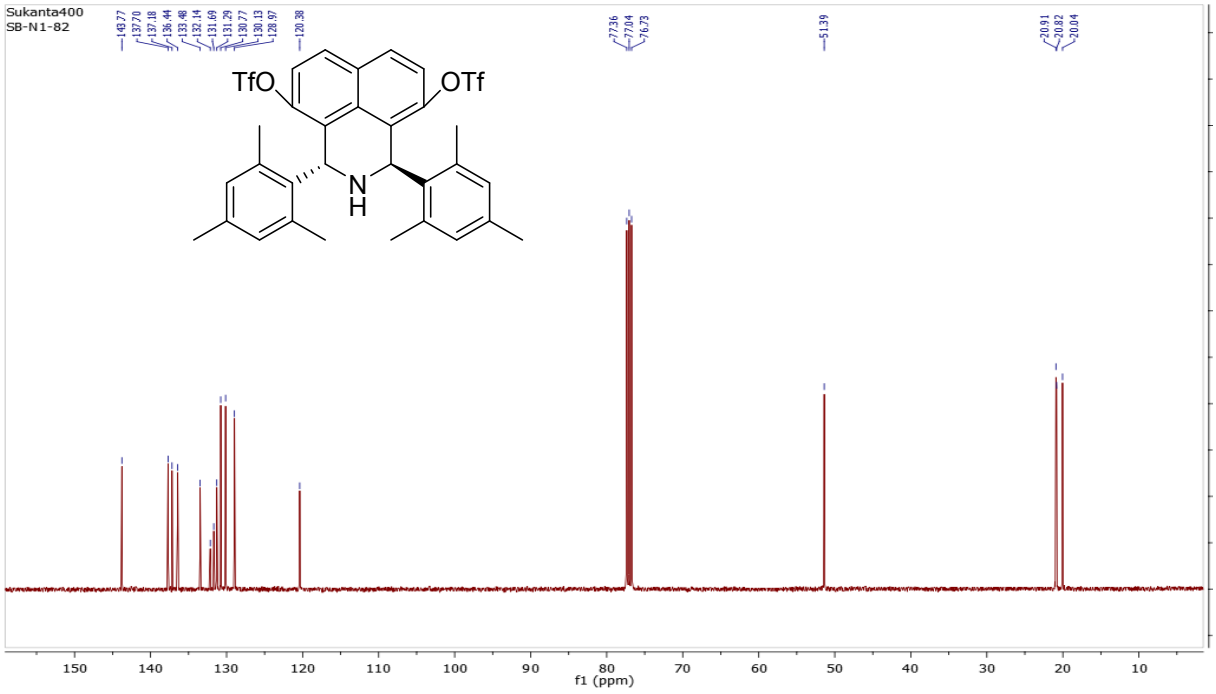
1,3-Bis-(2,4,6-trimethyl-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol (17d)



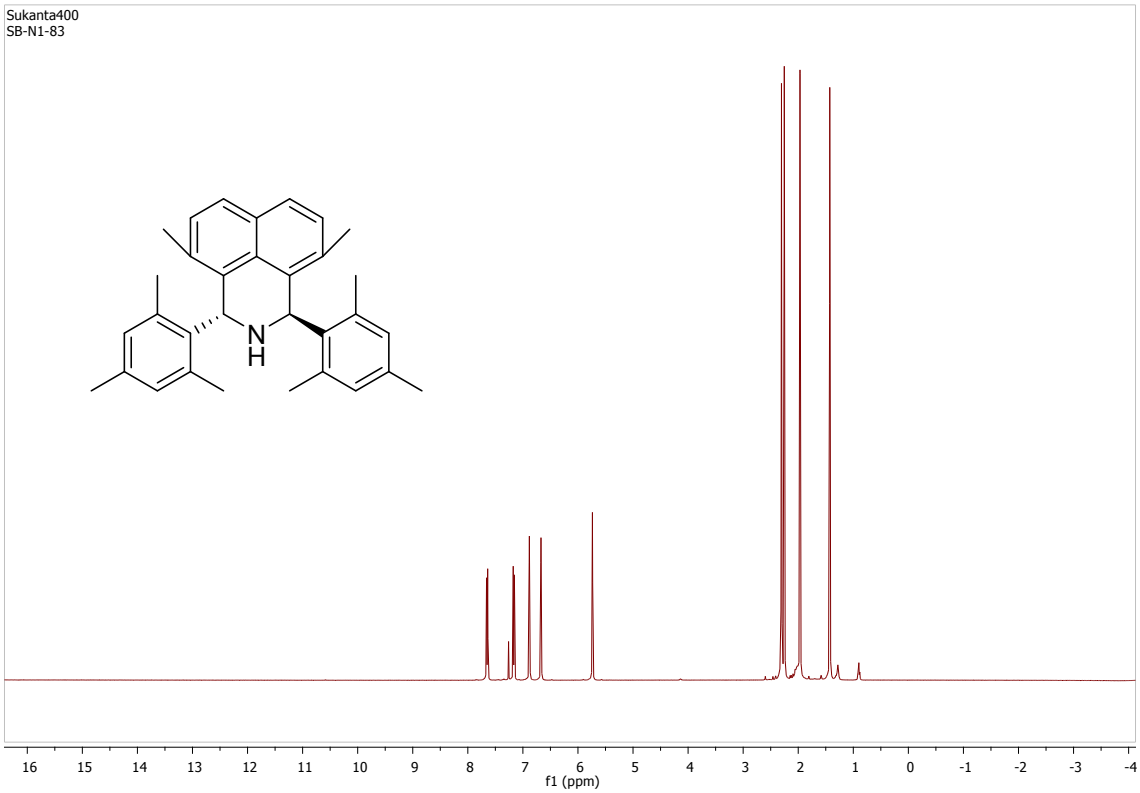


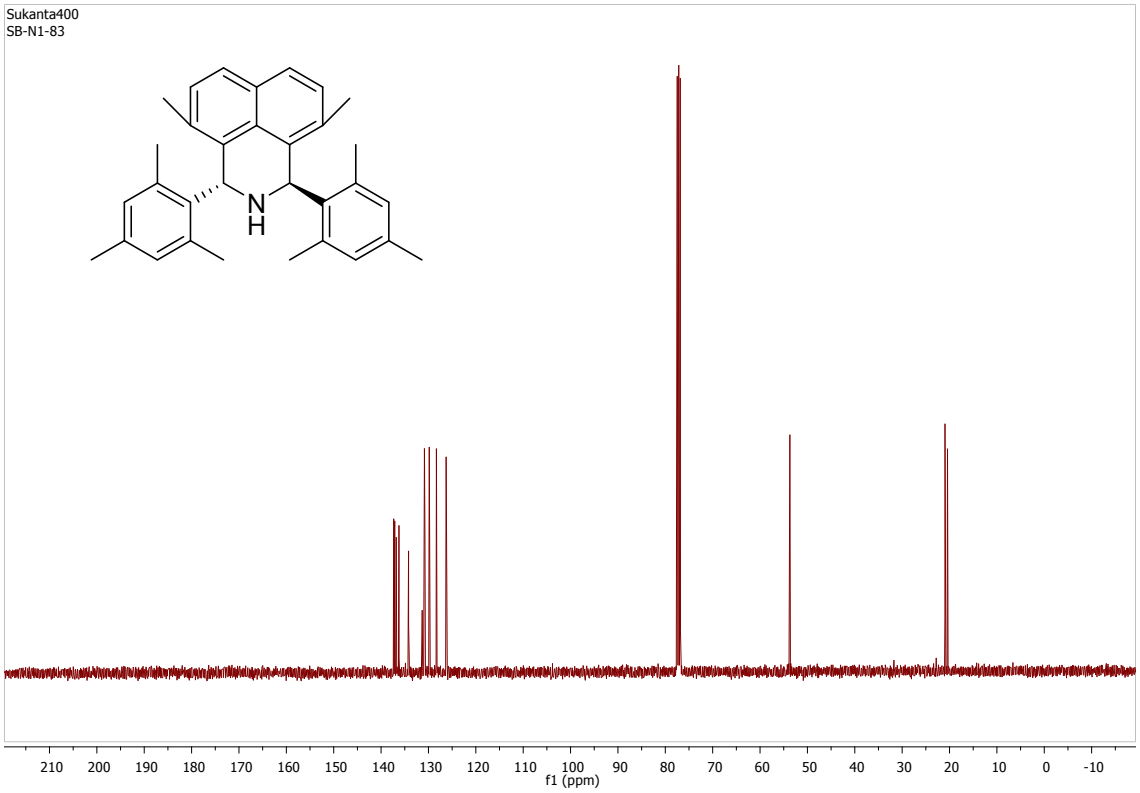
Trifluoro-methanesulfonicacid-9-trifluoromethanesulfonyloxy-1,3-bis-(2,4,6-trimethyl-phenyl)-2,3-dihydro-1H-benzo[de]isoquinolin-4-yl ester (18d)



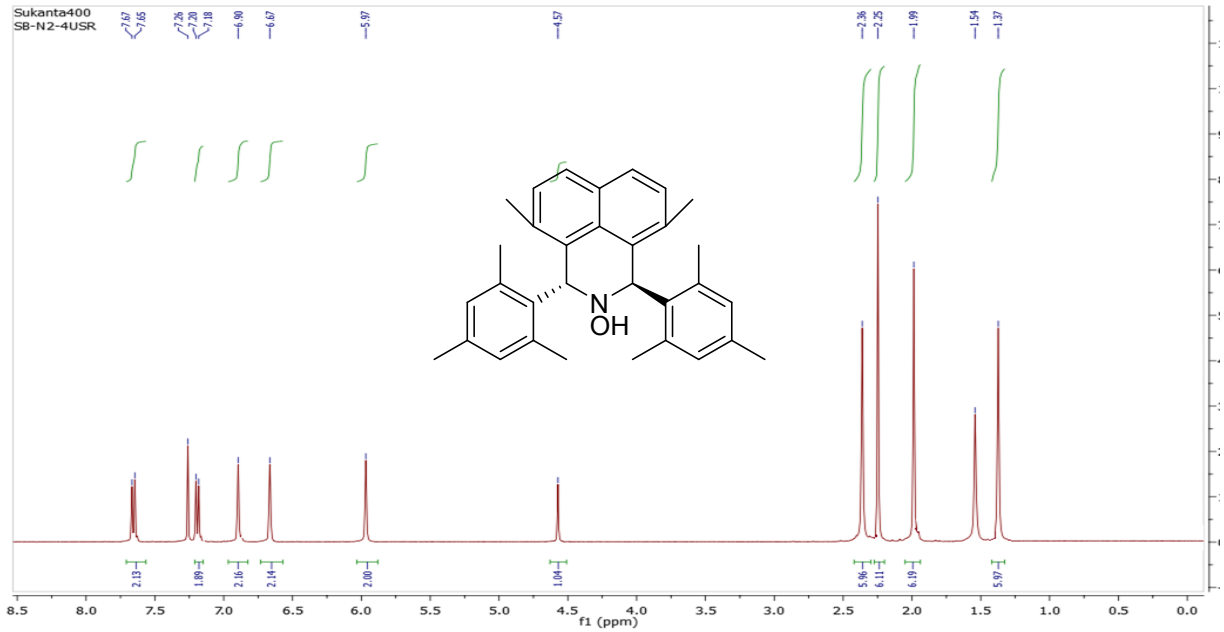


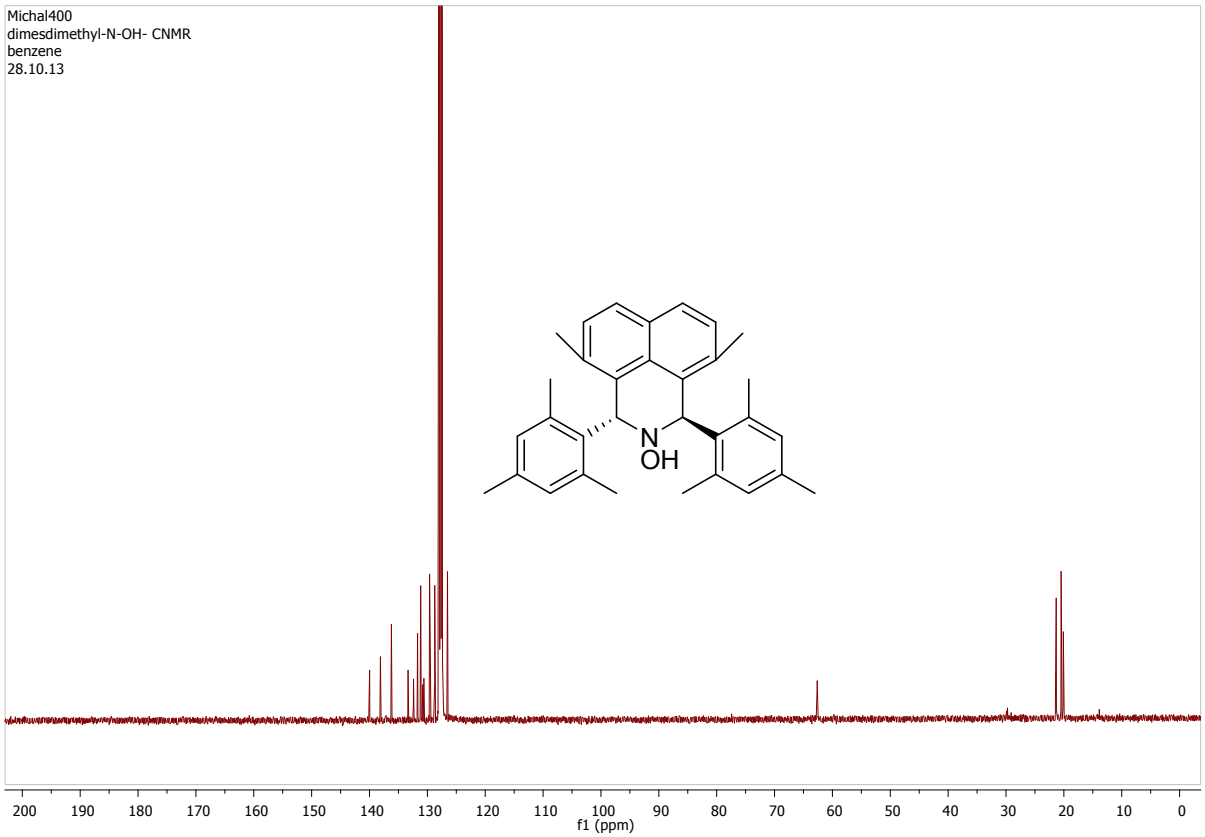
4,9-Dimethyl-1,3-bis-(2,4,6-trimethyl-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline (19d)



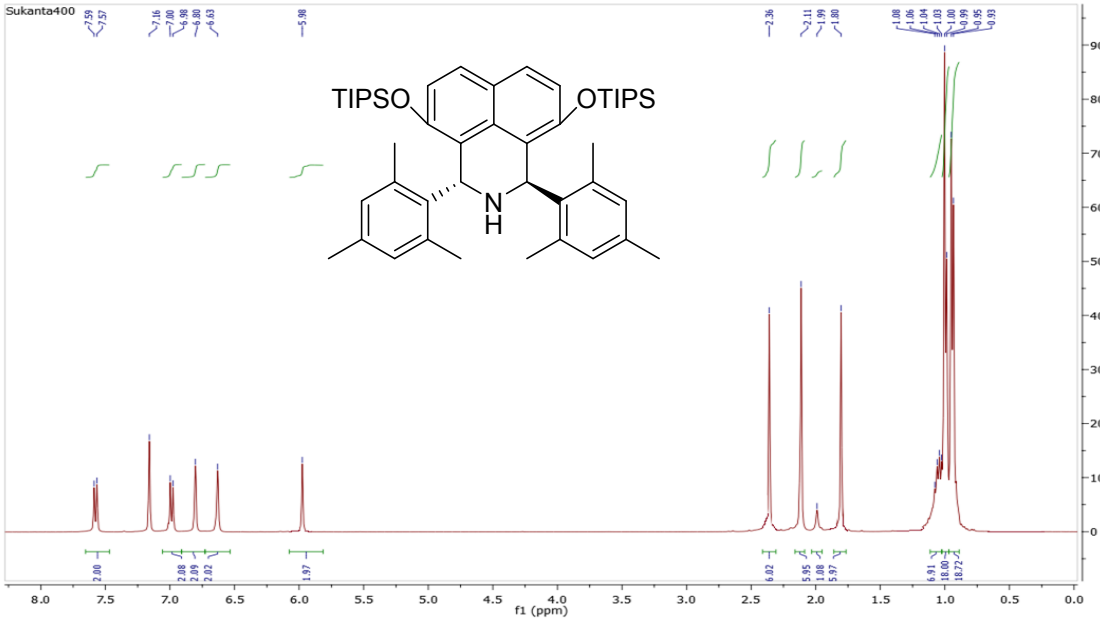


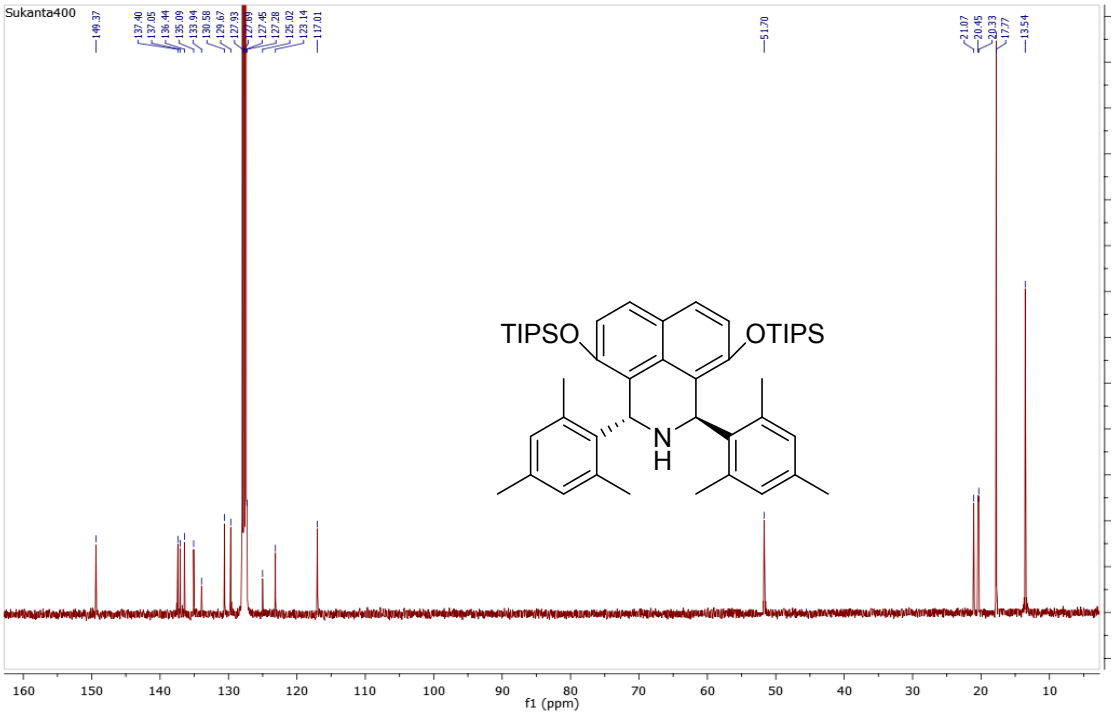
4,9-Dimethyl-1,3-bis-(2,4,6-trimethyl-phenyl)-1H,3H-benzo[de]isoquinolin-2-ol (20d)



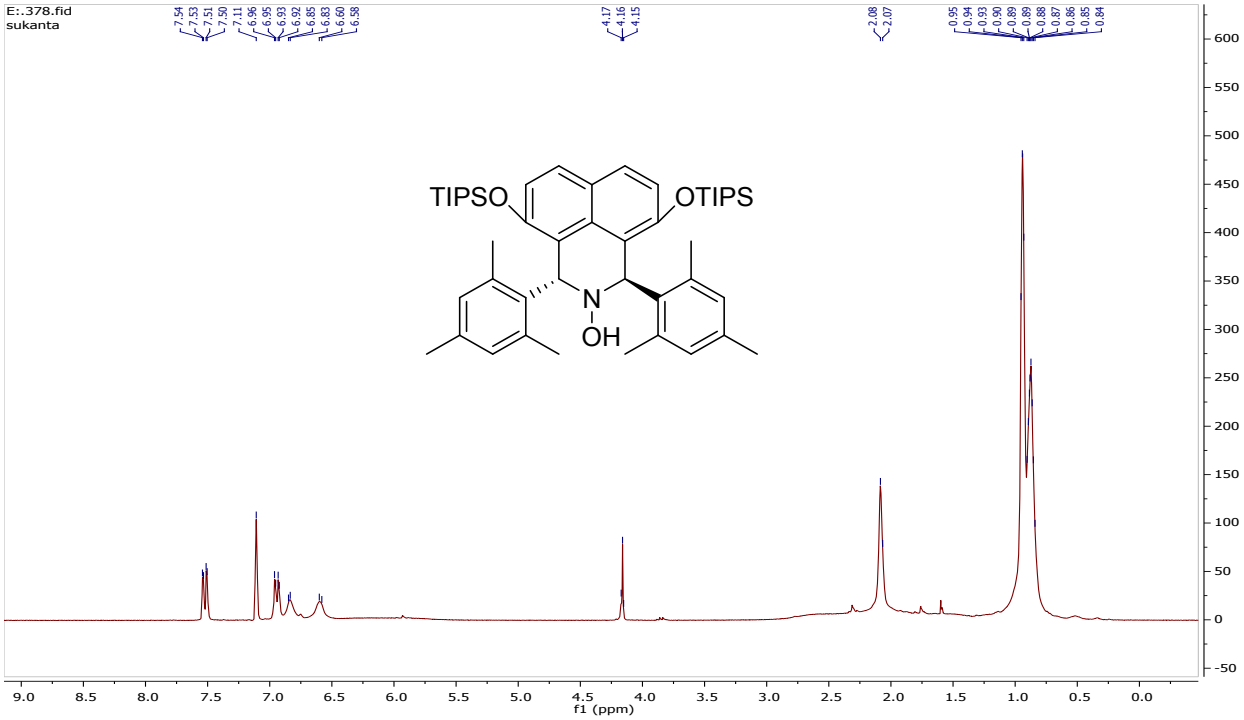


4,9-Bis-triisopropylsilanyloxy-1,3-bis-(2,4,6-trimethyl-phenyl)-2,3-dihydro-1H-benzo[de]isoquinoline (19e)

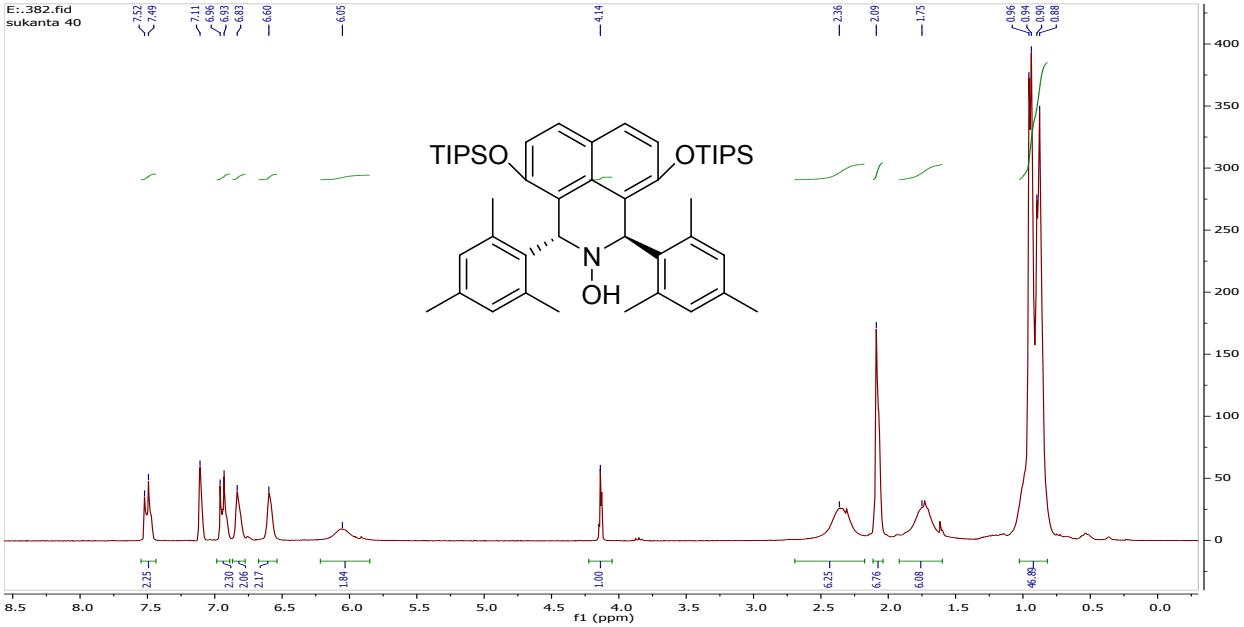




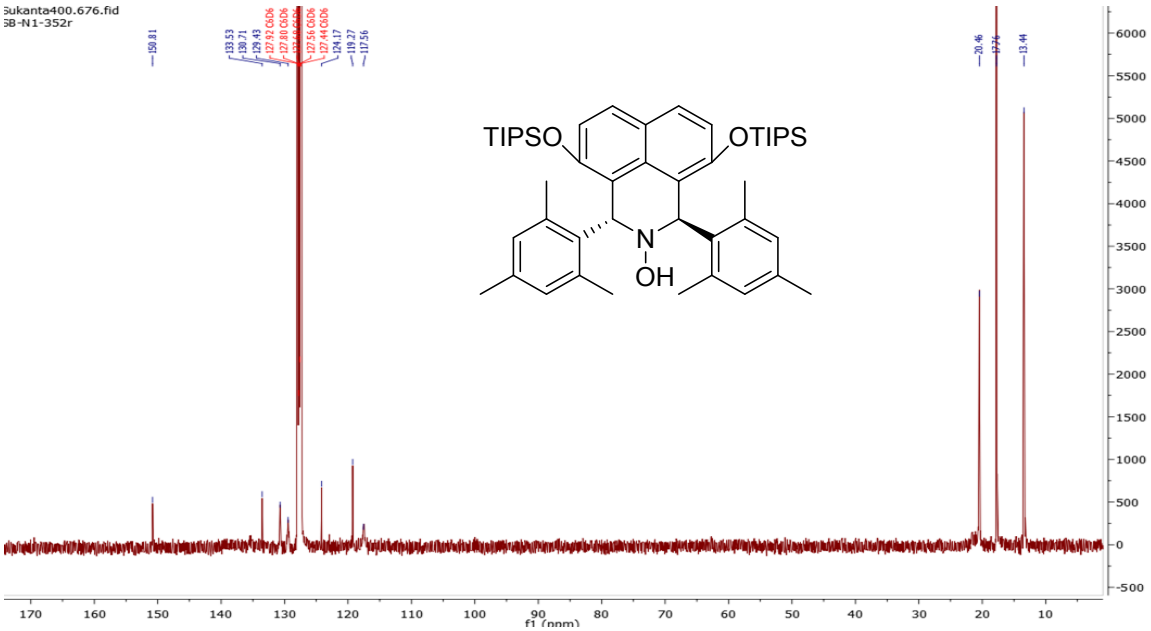
4,9-Bis-triisopropylsilanyloxy-1,3-bis-(2,4,6-trimethyl-phenyl)-1H,3H-benzo[de]isoquinolin-2-ol (20e)



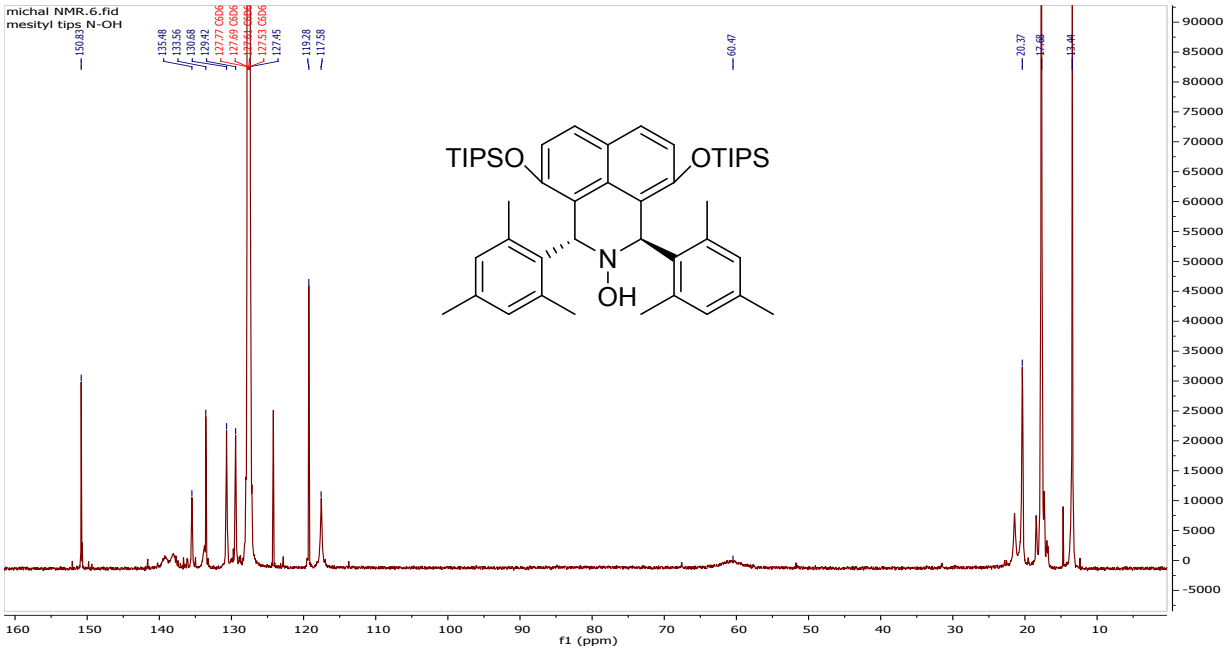
At 20°C



At 50°C

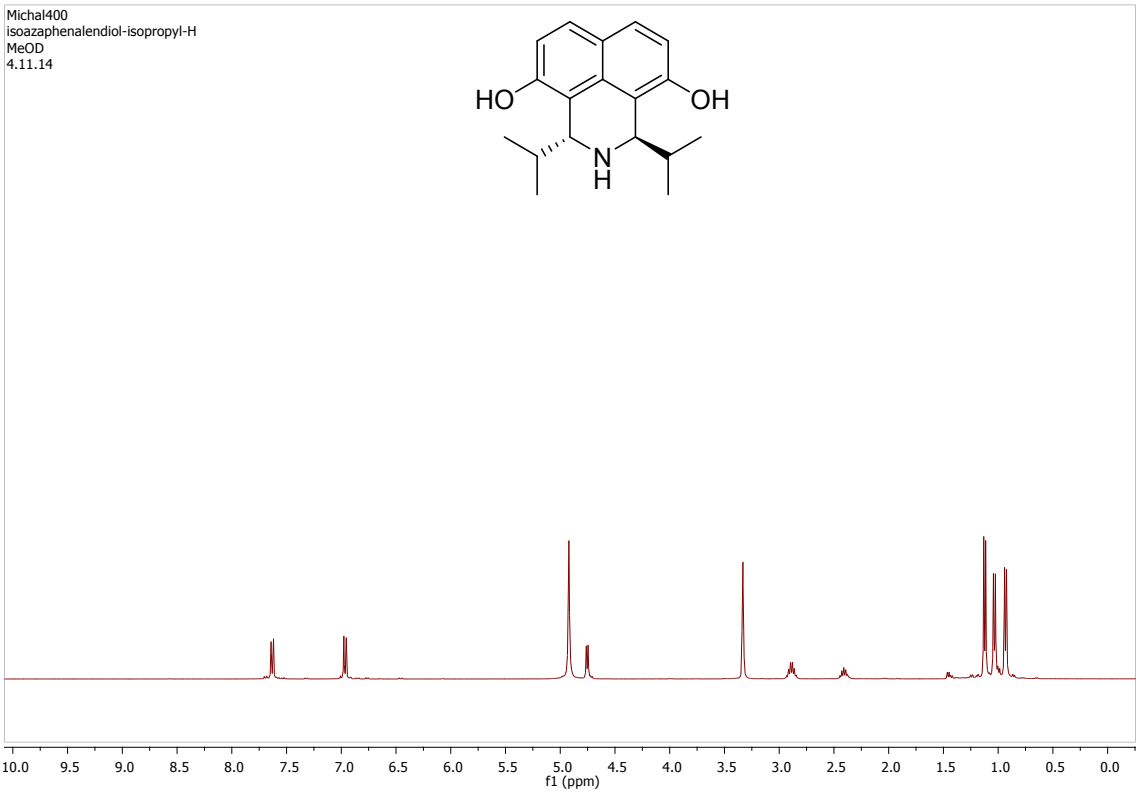

Sukanta400.676.fid
SB-N1-352r
TIPSO
OTIPS
N
OH
f1 (ppm)

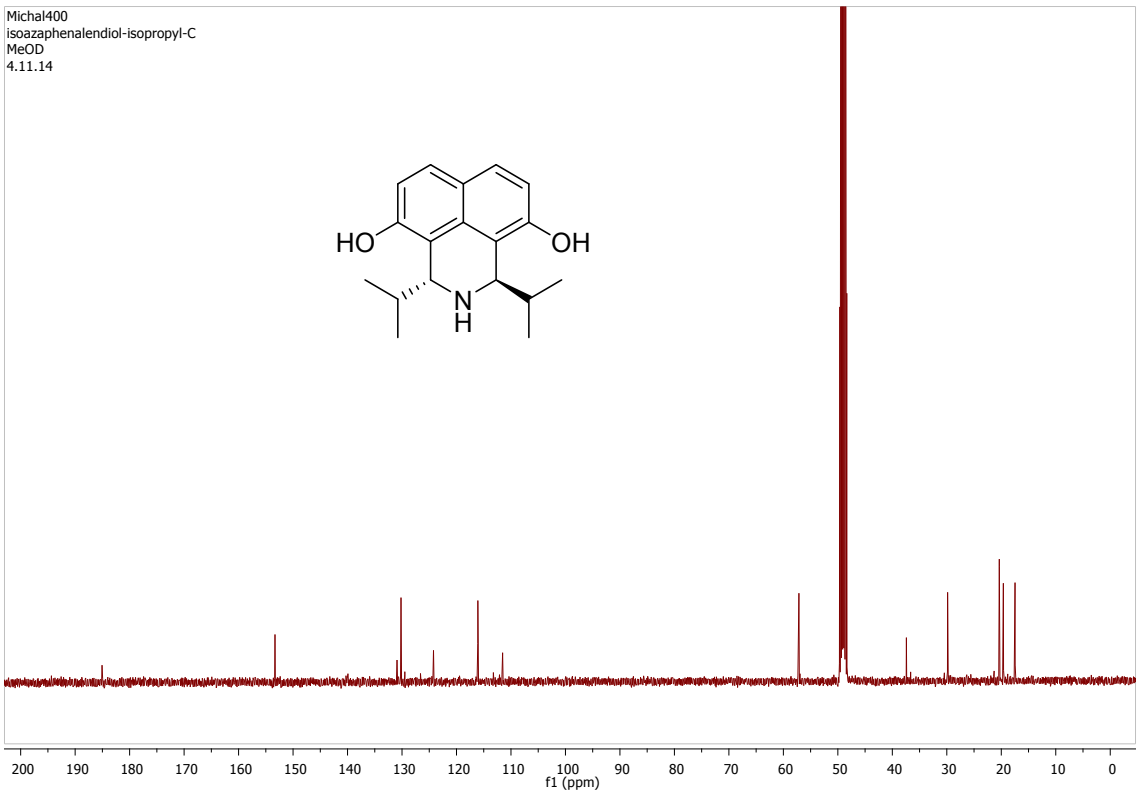
At 20°C


michal NMR.6.fid
mesityl tips N-OH
TIPSO
OTIPS
N
OH
f1 (ppm)

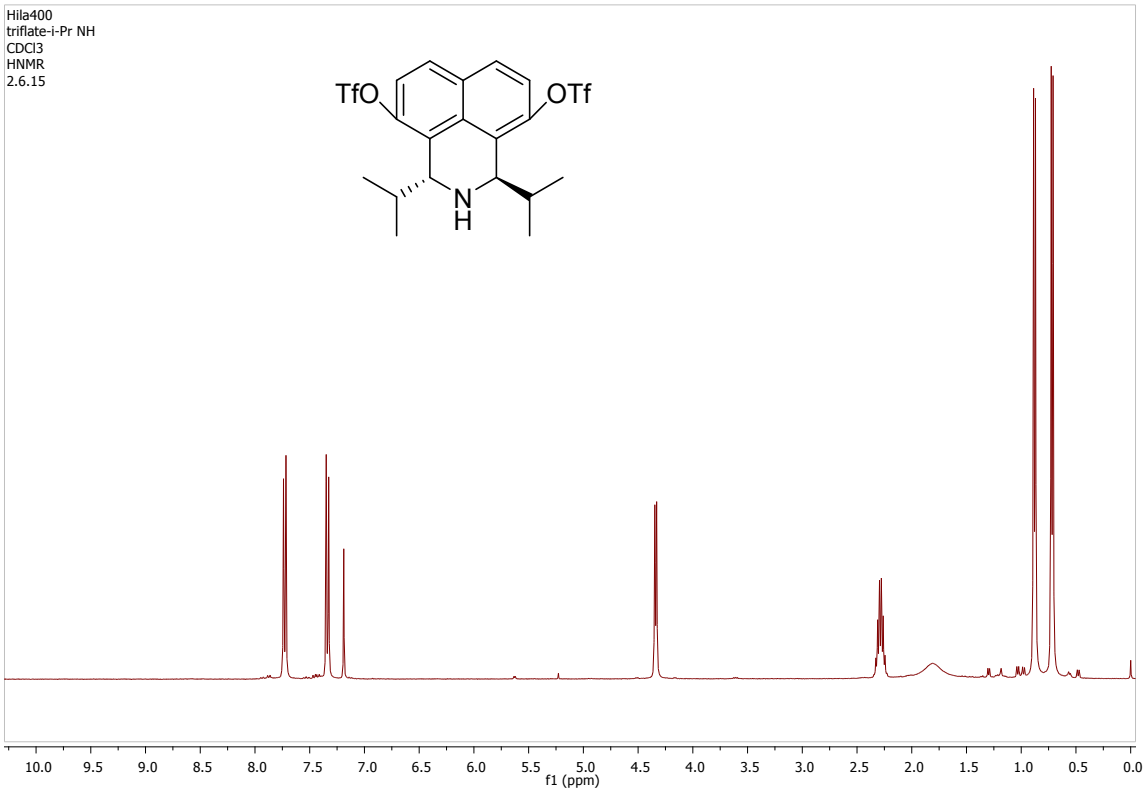
At 50°C

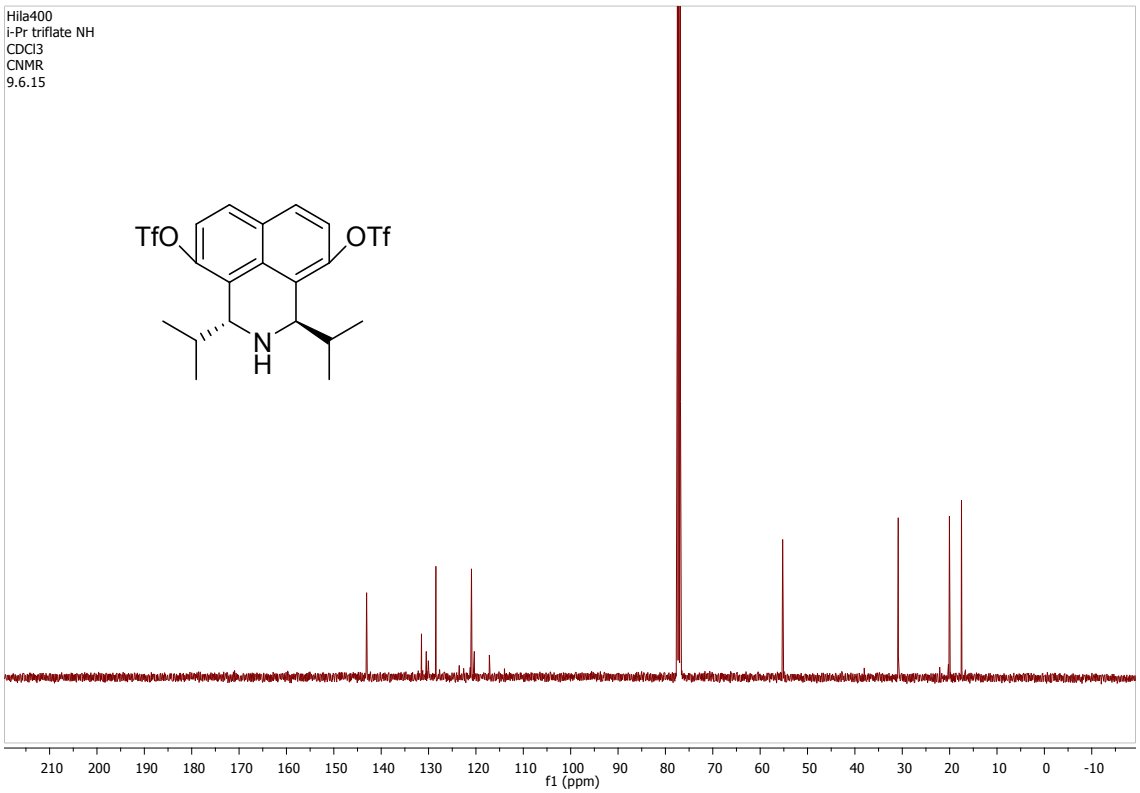
1,3-diisopropyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol **(17f)**



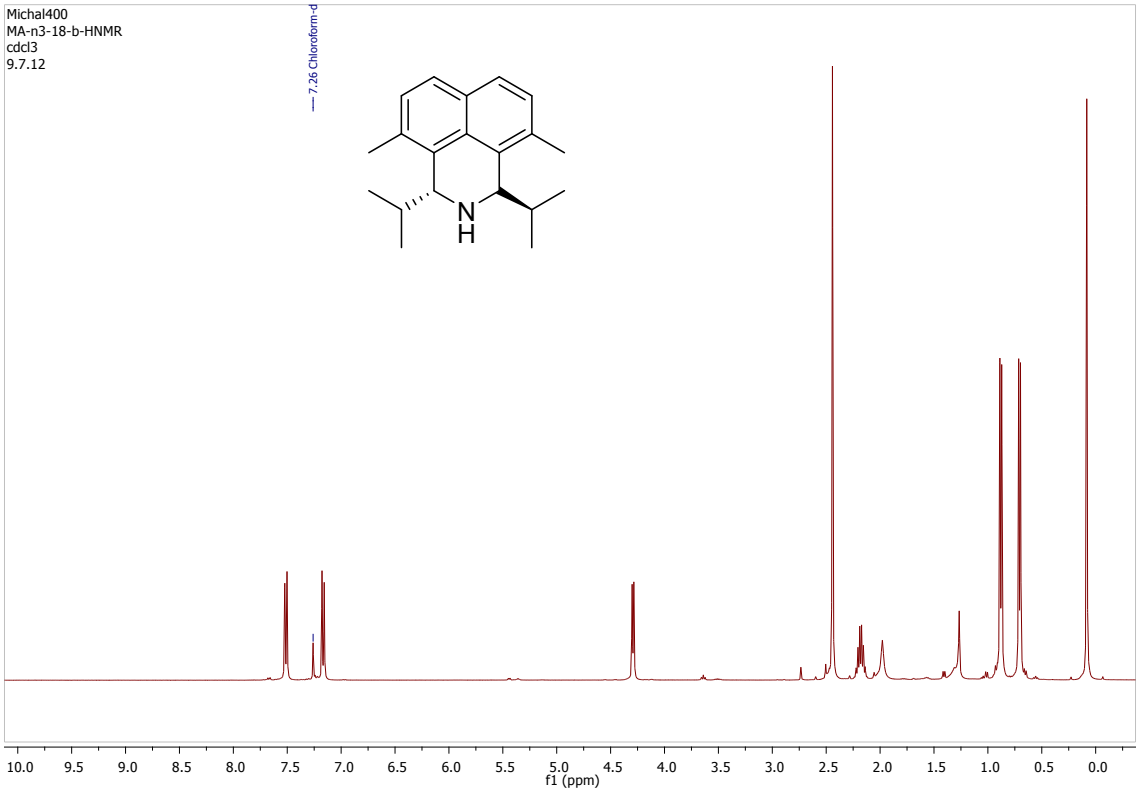


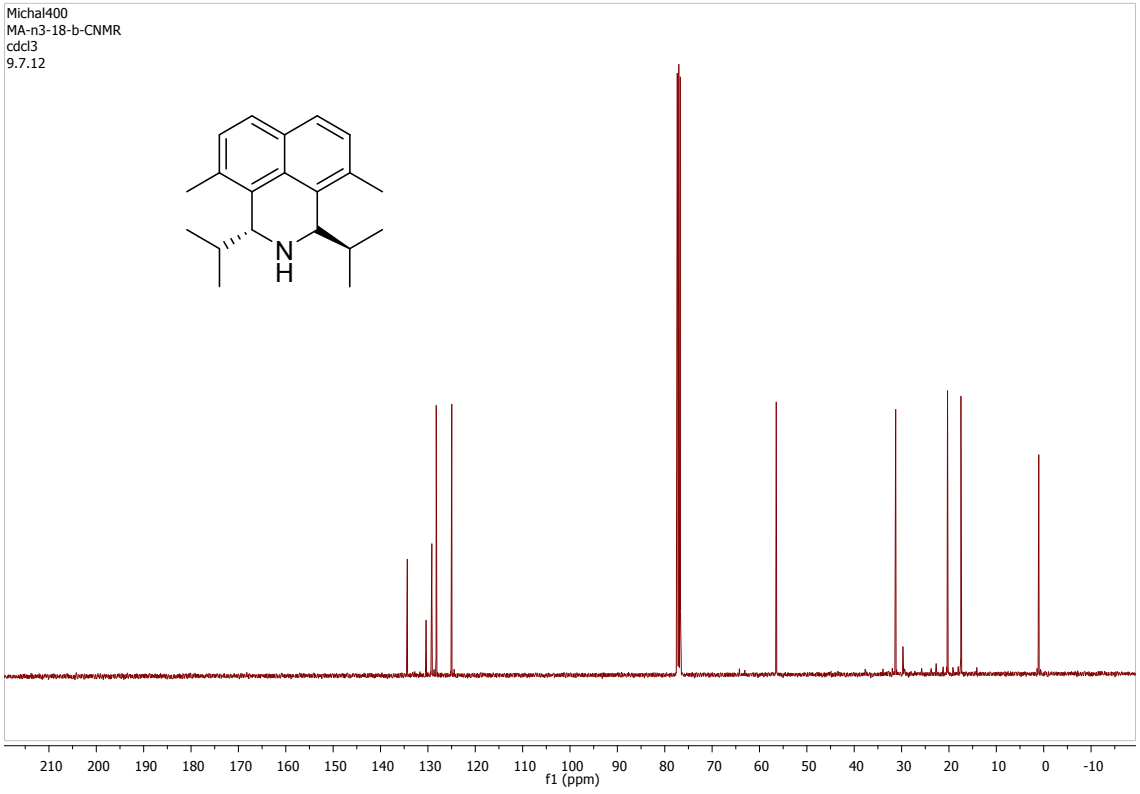
1,3-diisopropyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diyl bis(trifluoromethanesulfonate) **(18f)**



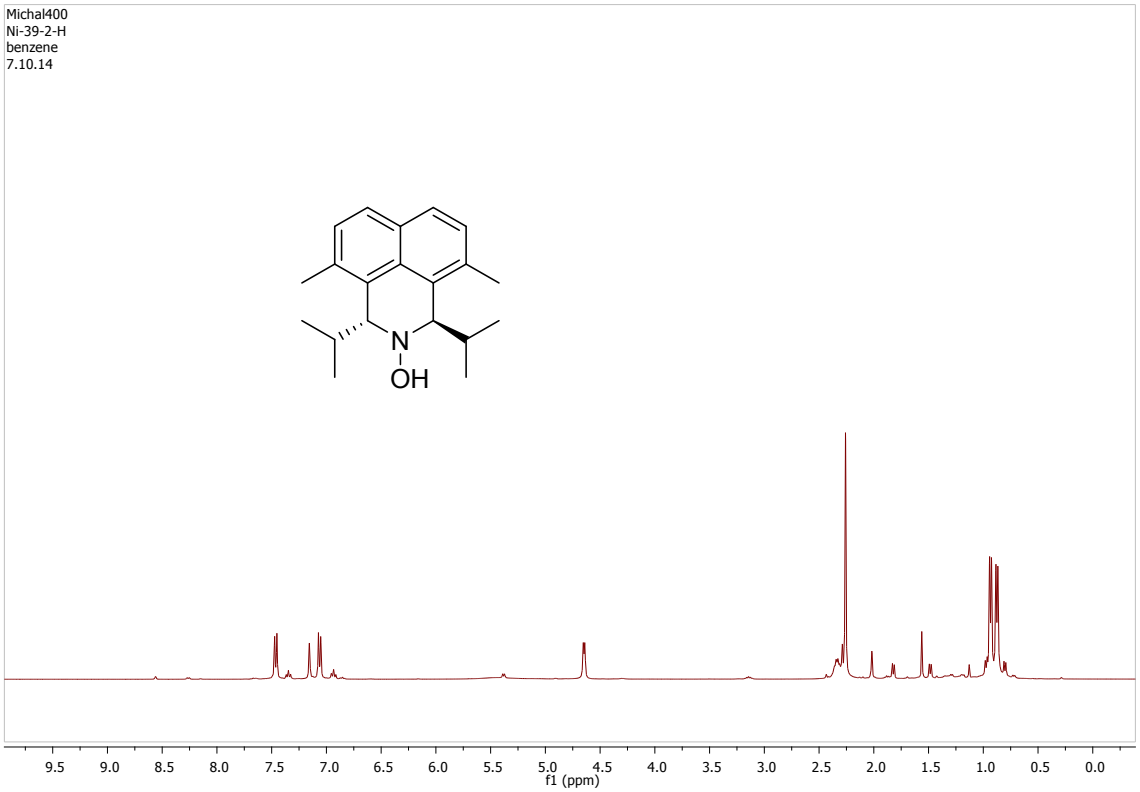


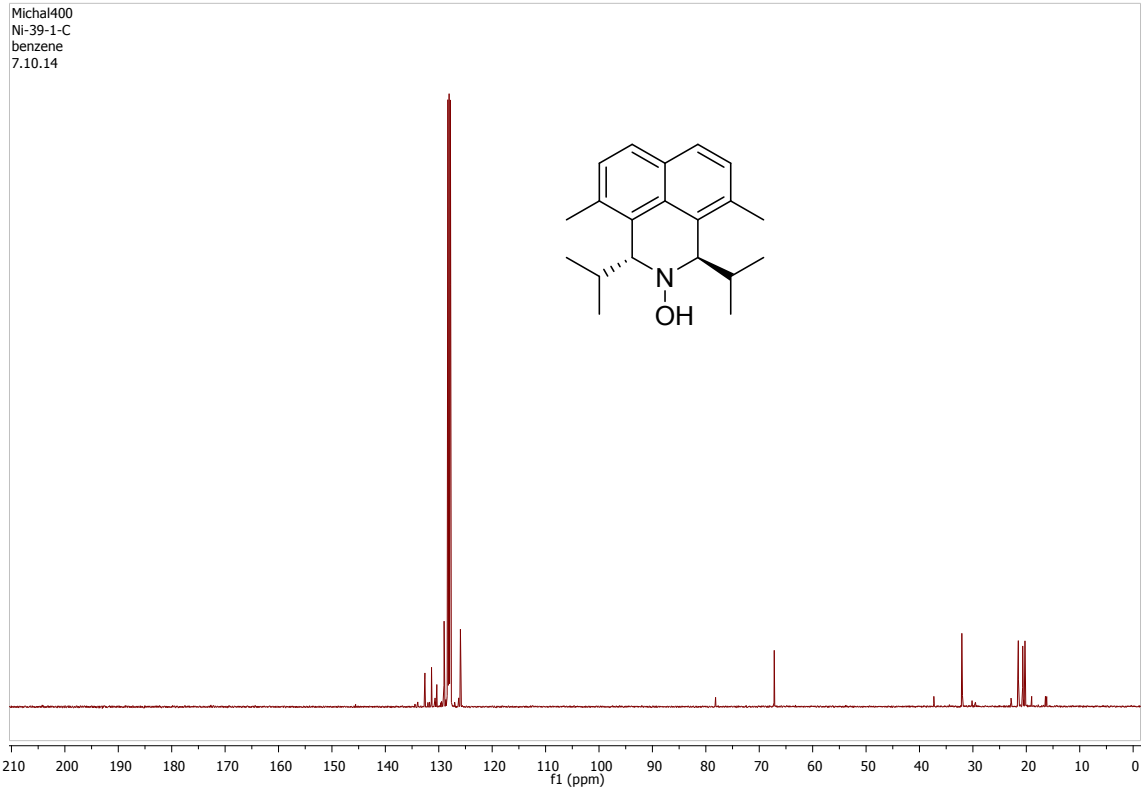
1,3-diisopropyl-4,9-dimethyl-2,3-dihydro-1H-benzo[de]isoquinoline (19f)



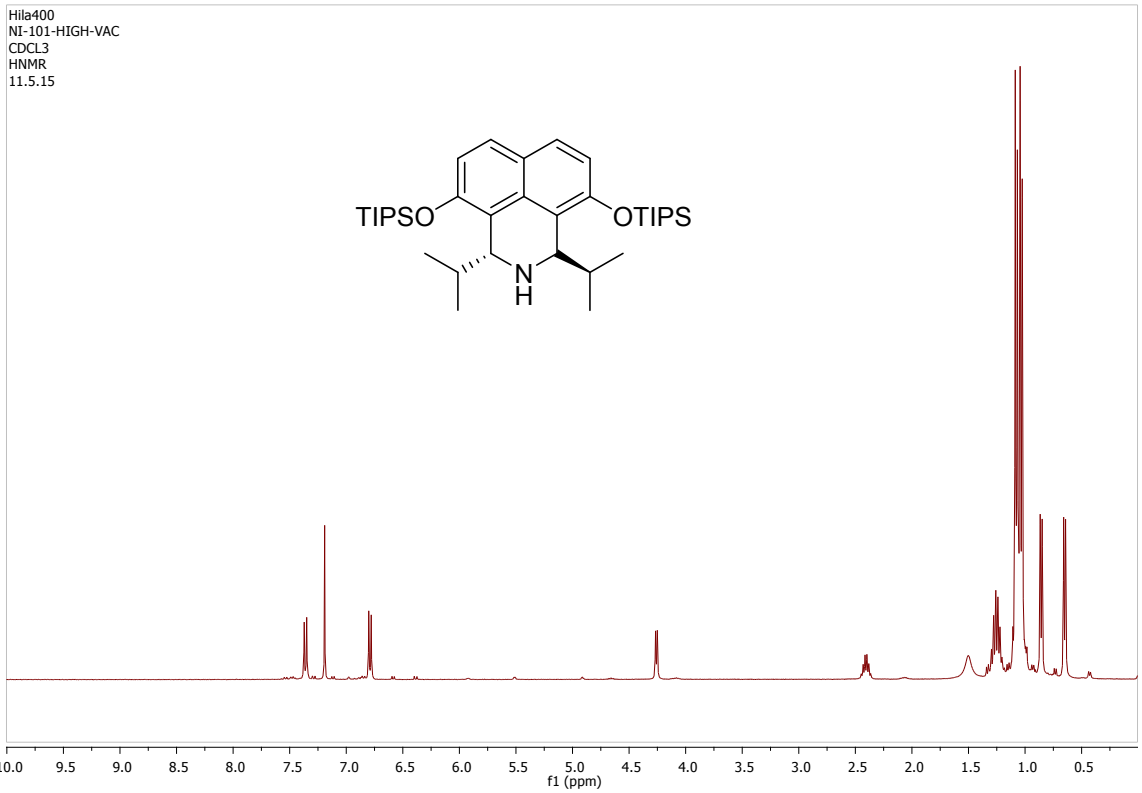


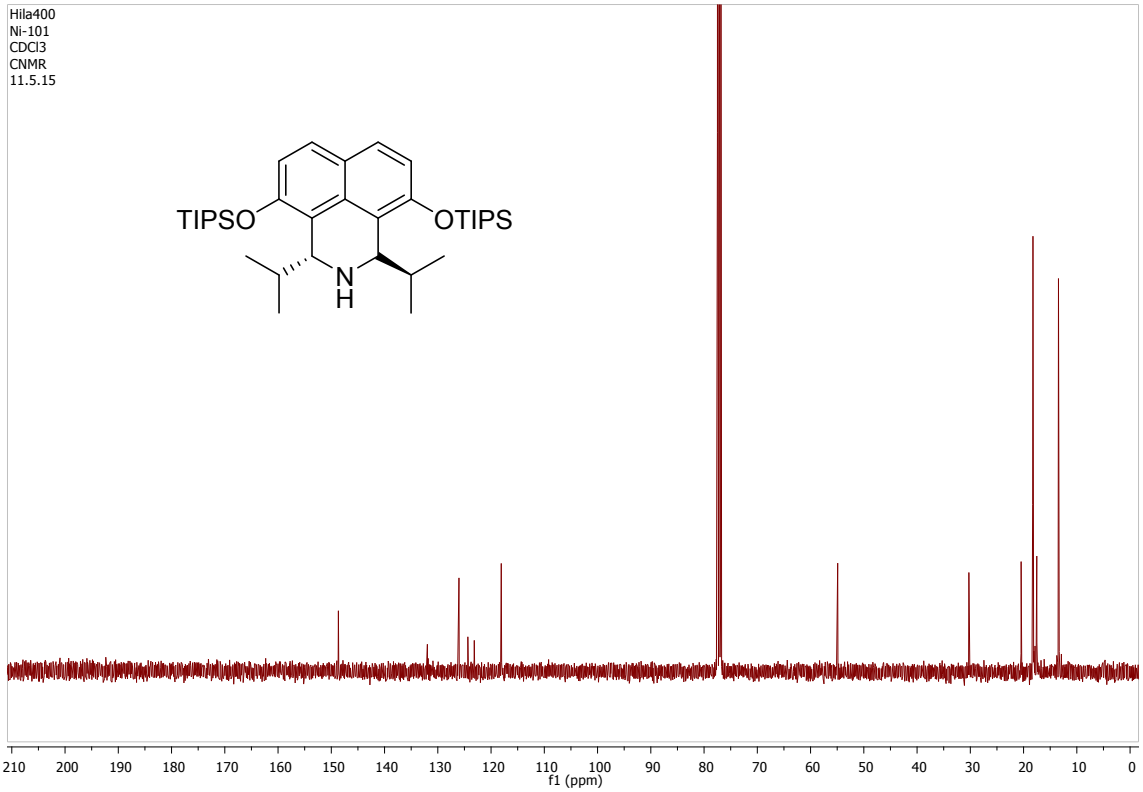
1,3-diisopropyl-4,9-dimethyl-1H-benzo[de]isoquinolin-2(3H)-ol **(20f)**



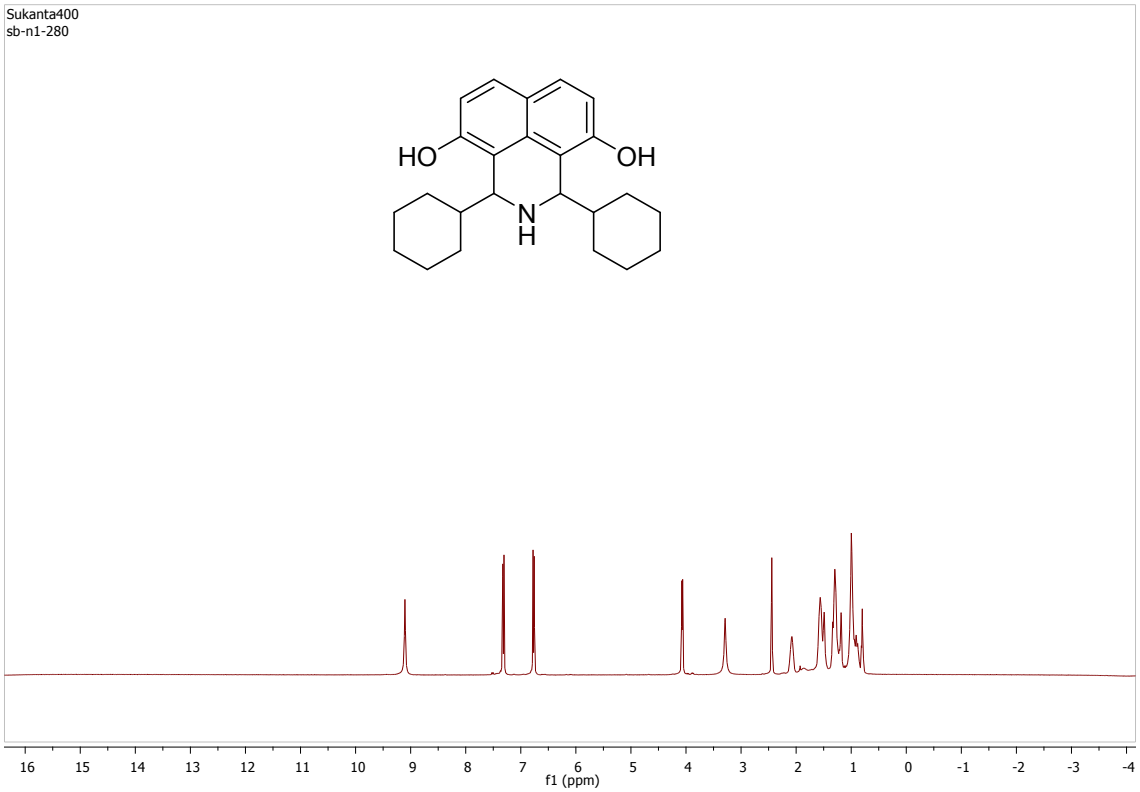


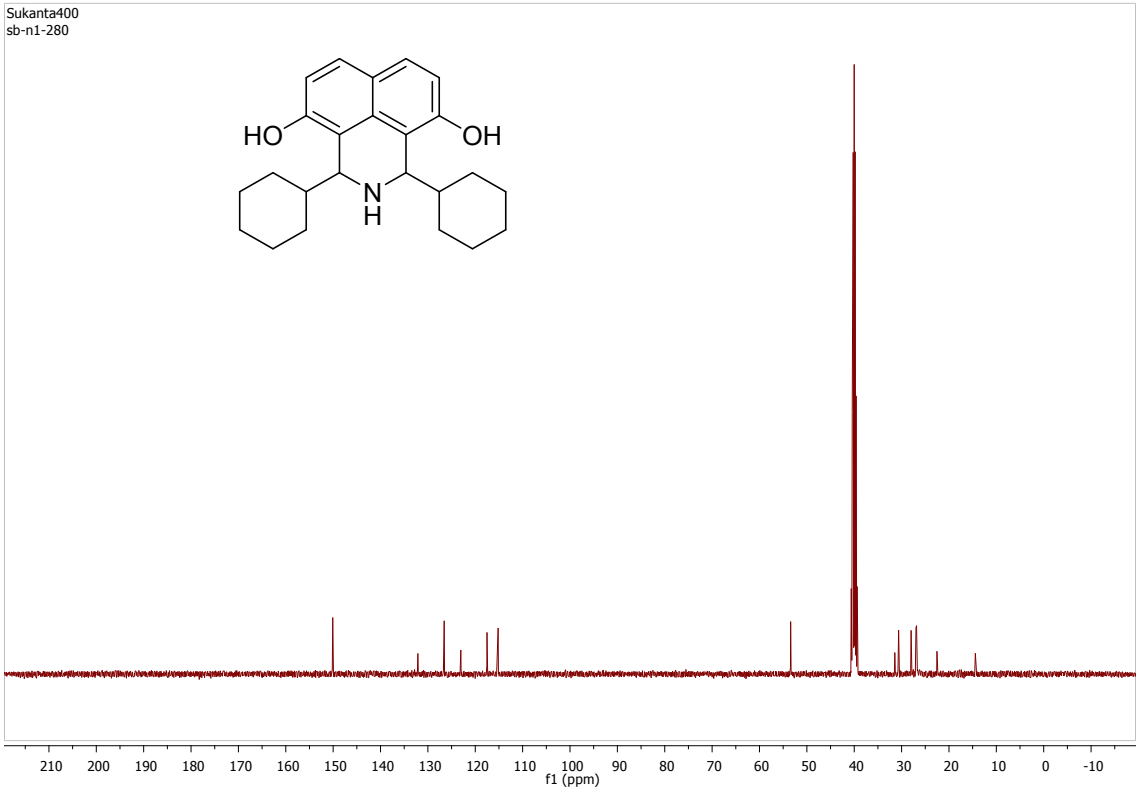
1,3-diisopropyl-4,9-bis((triisopropylsilyl)oxy)-2,3-dihydro-1H-benzo[de]isoquinoline (19g)



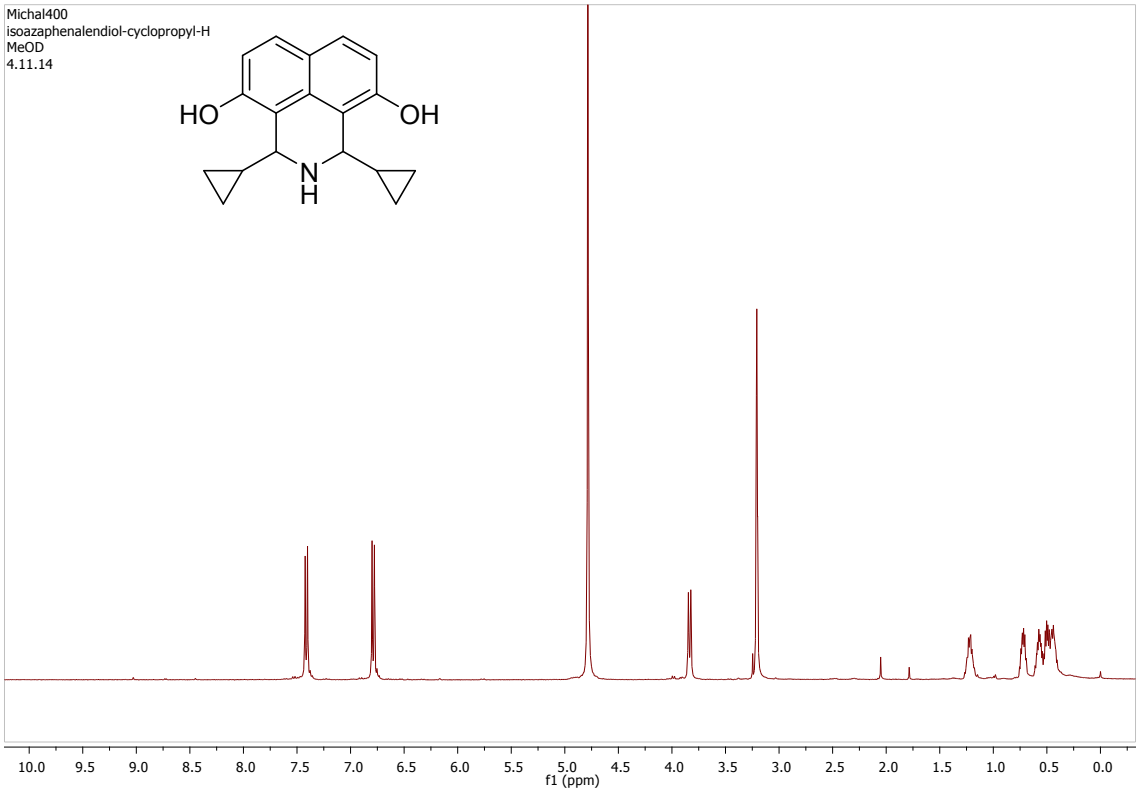


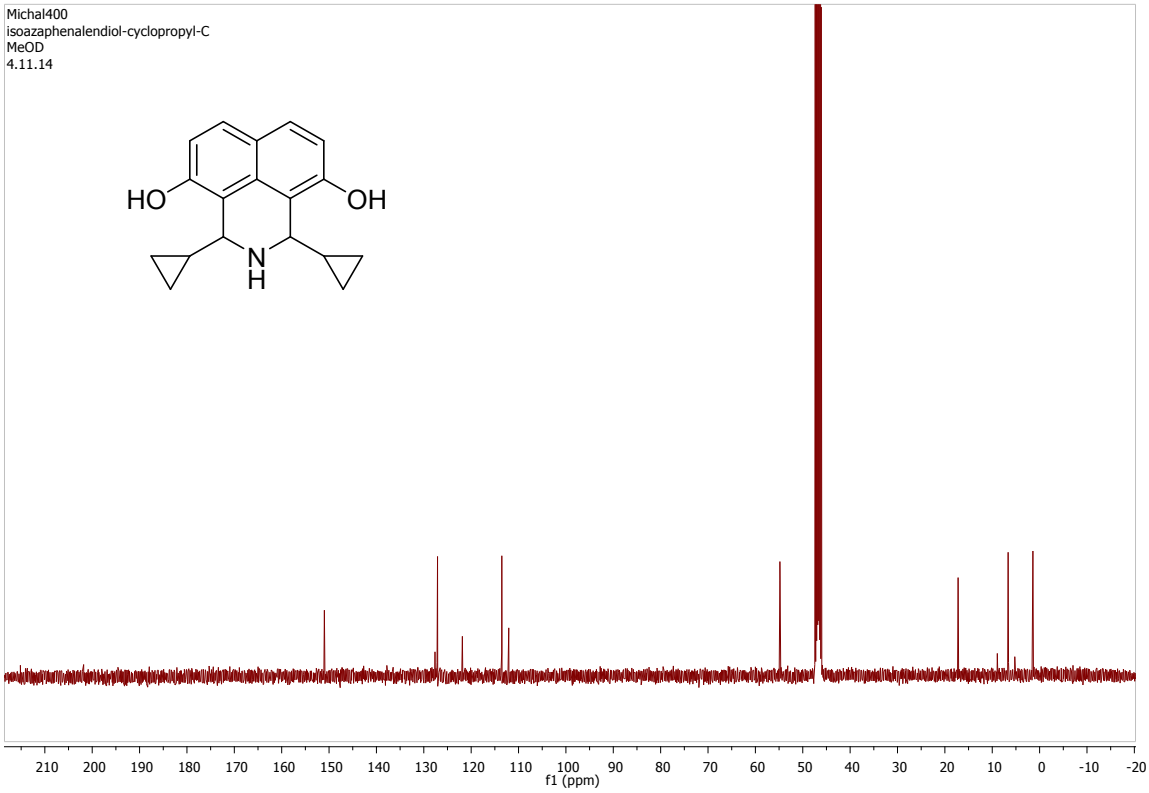
1,3-dicyclohexyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol **(I)**





1,3-dicyclopropyl-2,3-dihydro-1H-benzo[de]isoquinoline-4,9-diol **(II)**





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Computational Methods

All computations used either GAUSSIAN09 Revision D.01[1] or ORCA version 3.0.2.[2] Geometry optimizations were done with the former while the double-hybrid and CASSCF (vide infra) calculations were done with the latter. Geometries were optimized with the Perdew-Burke-Ernzerhof (PBE) exchange-correlation functional,[3,4] with an empirical dispersion correction[5-8] added, specifically the third version of Grimme's dispersion5,9 with Becke-Johnson dampening;[9-11] this combination is denoted as PBE_{D3BJ}. The def2-SVP double-ζ quality basis set[12,13] was used. When using a GGA functional, density fitting basis sets, specifically the fitting sets generated using the automatic generation algorithm implemented in GAUSSIAN09, were used in order to speed up the calculations.14,15 A few of the optimized structures had a small imaginary frequency (<6i cm-1), which were ignored as grid artefacts.

Energies were calculated using a Kozuch and Martin's dispersion corrected (D3BJ), spin component scaled (i.e., an SCS[16,17]-MP2[18]-like correlation contribution), double hybrid (DSD) functional, specifically DSD-PBEB95:[19] this functional incorporates the PBE exchange (i.e., PBE)3,4 and the Becke-95 (B95) correlation[20] functionals. The efficiency of the calculation was improved by using the resolution of identity–chain of spheres (RIJCOSX) approximation.21-25 Energies were calculated with the def2-TZVP basis set.[12,13] This class of DFT functionals has been shown to provide energies approaching that of the "Gold Standard" in computational chemistry, specifically CCSD(T). There are a number of reviews and benchmark studies of double-hybrid functionals. These studies clearly show that the use of this class of functionals is highly recommended.[6,19,26-34]

Bulk solvent effects were approximated by single point energy calculations using a polarizable continuum model (PCM),[35-38] specifically the integral equation formalism model (IEF-PCM)[35,36,39,40] with acetonitrile as the solvent as in the experiments. Specifically, Truhlar's empirically parameterized version Solvation Model Density (SMD) was used.41

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