Benzyloxycalix[8]arene supported Pd-NHC cinnamyl complexes for Buchwald-Hartwig C-N cross-couplings

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Supporting Information

I. General Information

Solvents and reagents were purchased from Acros Organics, Carlo Erba Reagents, VWR Chemicals, Sigma Aldrich, Alfa Aesar, TCI, ABCR, Strem Chemicals and Fluorochem. Cyclopentyl methyl ether (CPME), methylcyclohexane (MeCy) and 2-methyltetrahydrofuran (MeTHF) were used as received from Sigma Aldrich and Alfa Aesar. Redistilled morpholine (99.5+ %) was purchased from Sigma Aldrich. Acetone (99.8 %, extra dry, AcroSeal) and 1,4-dioxane (99.8 %, extra dry, stabilised, AcroSeal) were purchased from Acros Organics. Nitric Acid (69 %, TraceMetal™ Grade) was purchased from Fisher Scientific. All commercially available reagents were used as received. Toluene and acetonitrile were routinely distilled prior to use. Dicalite™ was purchased from Carlo Erba Reagents.

^{1}H NMR, ^{19}F NMR and ^{13}C NMR spectra were recorded on either a Bruker DPX 250, Bruker 300, Bruker Avance 360, Bruker 400 or Bruker DRX 400 instrument and data are reported in ppm with the solvent signal as reference. Chemical shifts (δ) are reported in parts per million (ppm). The following abbreviations are used for the proton spectra multiplicities: s: singlet, d: doublet, t: triplet, q: quadruplet, quint: quintuplet, hex: hexuplet, m: multiplet, br.: broad.

The HR-MS analyses were performed with a Bruker MicroTOF-Q 2009 (direct injection QTOF). Gas chromatography (GC) analyses were performed on a Shimadzu GC 2010 plus (ZB-5-MS Phenomenex, 15mx025mmx0.25µm), with the following temperature program: 60 °C (1 min) to 250 °C (10 °C/min). Melting points were measured in capillary tubes on a STUART apparatus (SMP30).

Infrared spectra were recorded on a FT-IR spectrometer Vertex 70, Bruker.

High Performance Liquid Chromatography (HPLC) analyses were performed using a JASCO pump-PU 2089 associated to an UV detector (UV 100) from TSP. The enantioselectivity values of compounds **20** and **23** were determined on a Chiralpak IA column (250x4.6mm, 5µm) using Hexane/EtOH = 98:2 as eluent (0.5 ml/min, 254 nm, 20 ˚C) for **20** and Hexane/EtOH = 9:1 (0.8 ml/min, 254 nm, 20 ˚C) for **23**.

Optical rotation was determined on an Anton Paar, MCP150 polarimeter with a sodium lamp (589 nm, D line).

XPS analyses were performed using a Thermofisher Scientific K-Alpha spectrometer.

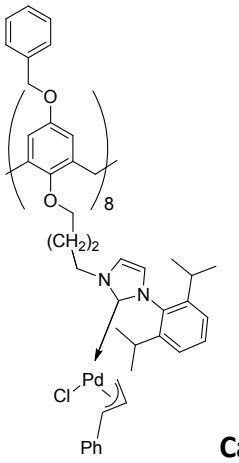
ICP-MS analyses were performed by IRAMIS (CEA-Saclay).

TEM images were recorded on a MET-STEM JEOL 1400 TEM microscope, operating at an accelerating voltage of 120 KV. Copper-made TEM grids (CF400-U, carbon film, 400 mesh) were obtained from Electron Microscopy Sciences. MEB analyses were performed on a MEB-FEG ZEISS Supra 55 VP apparatus.

II. General procedure for the synthesis of Cat 1-5

Prepared according to a slightly modified synthetic procedure described in the literature:[1]
In a Schlenk tube equipped with a magnetic stirring bar and a septum were introduced the supported imidazolium precursor (**3a**, **3b**, **4a**, **4b** or the precursor of **Cat 1**, 1 equiv.), palladium (π-cinnamyl) chloride dimer (4.25 equiv.) and potassium carbonate (10 equiv.). The solids were dried under vacuum for 5 minutes, then the Schlenk tube was evacuated and backfilled with argon 3 times. Anhydrous acetone was then added under argon and the reaction mixture was stirred for 5 hours at 60 °C. The mixture was allowed to cool under argon and the solvent was evaporated. DCM was added, the mixture was centrifuged (20 min, 20 °C, 9000 rpm). The supernatant was then filtered on a Dicalite™ pad, and the pad was washed with DCM. The solvent was evaporated, then the residue was dissolved in a minimum of DCM and precipitated by a dropwise addition at room temperature in a flask containing diethyl ether, under vigorous stirring. The heterogeneous solution was stirred under argon 15 min at room temperature, then 15 min at 0 °C. In the case of **Cat 1**, **Cat 2** and **Cat 3**, the product precipitated as a fine powder, which was filtered on a fritted glass filter, washed 3 times with diethyl ether and dried under vacuum overnight. In the case of **Cat 4** and **Cat 5**, the product precipitated as a sticky residue which stayed on the sides of the flask. The supernatant was slowly removed, and the sticky residue was washed 2 times with diethyl ether, each time removing the supernatant slowly while keeping the sticky solid inside the flask. The solid was then dried under vacuum overnight. In each of the two cases, the procedure allowed to obtain the expected product as a pure solid in good yield.

III. Procedure for the synthesis of Cat 1



Cat 1

[1] C. M. Zinser, F. Nahra, M. Brill, R. E. Meadows, D. B. Cordes, A. M. Z. Slawin, S. P. Nolan and C. S. J. Cazin, *Chem. Commun.* 2017, **53**, 7990.

This compound was synthesised according to the general procedure described in part II, using the corresponding imidazolium chloride (795 mg, 0.187 mmol), palladium (π-cinnamyl) chloride dimer (412 mg, 0.795 mmol), potassium carbonate (258 mg, 1.87 mmol) and 6 mL of anhydrous acetone. The product was precipitated using 2 mL DCM in 150 mL of diethyl ether. **Cat 1** was obtained as a yellow solid in 56 % yield (630 mg).

^{1}H NMR (360 MHz; DMSO-d_6): δ for one repeating unit: 7.66-7.34 (m, 5H), 7.34-7.21 (m, 3H), 7.21-7.01 (m, 6H), 7.01-6.92 (m, 3H), 6.55 (br. s, 2H), 5.35-5.20 (m, 1H), 4.53 (br. s, 2H), 4.44-4.28 (m, 3H), 3.92 (br. s, 2H), 3.82 (br. s, 2H), 2.61 (br. s, 2H), 2.01 (br. s, 2H), 1.68 (br. s, 2H), 1.14 (d, *J* = 6.8 Hz, 6H), 0.96 (d, *J* = 6.8 Hz, 6H).

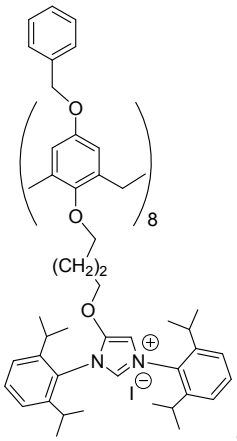
^{13}C NMR (90 MHz; DMSO-d_6): δ for one repeating unit: 179.0, 154.2, 148.1, 145.7 (2C), 138.1, 136.7, 136.0, 135.0, 129.6 (2C), 128.7, 128.1, 128.0 (2C), 127.4, 127.2, 127.1 (2C), 126.3, 124.8, 123.4 (2C), 121.8, 114.1 (2C), 112.9, 108.9, 89.5, 73.1, 68.8, 49.6, 44.8, 29.4, 27.7 (2C), 26.9, 26.4, 25.7 (2C), 22.6 (2C).

XPS: Calculated (%) for $C_{336}Cl_8N_{16}Pd_8$. C: 91.3; Cl: 2.2; N: 4.3; Pd: 2.2. Found (%): C: 90.5; Cl: 2.1; N: 4.6; Pd: 2.6. Only residual traces of bromide anions were detected (less than 0.2 %).

IR (ATR-GE): $\bar{\upsilon}$ (cm^{-1}) = 2977, 2940, 2879, 1719, 1642, 1602, 1462, 1415, 1389, 1389, 1254, 1212, 1147, 1059, 1031, 980, 940, 854, 803, 761.

IV. Procedure for the synthesis of imidazolium iodides 3a and 3b

In a three-necked round bottom flask equipped with a magnetic stirring bar, a reflux condenser and an argon inlet were introduced compound **2a** (12 equiv.), **1** (1 equiv.), sodium iodide (32 equiv.) and potassium carbonate (32 equiv.). The solids were dried under vacuum for 5 minutes, then the flask was evacuated and backfilled with argon 3 times. Distilled acetonitrile (C= 0.02 M) was added under argon and the reaction mixture was stirred for 5 days at 80 °C. The mixture was allowed to cool to room temperature under argon, then DCM was added, and the suspension was filtered on a Dicalite™ pad and washed with DCM. The filtrate was evaporated, and the resulting residue was dissolved in a minimum of DCM and precipitated in diethyl ether at room temperature under vigorous stirring. The heterogeneous solution was then stirred under argon for 15 minutes at room temperature, then for 15 minutes at 0 ˚C. The solid was then filtered on a fritted glass filter, washed 3 times with diethyl ether and dried under vacuum overnight. The resulting yellow powder was dissolved in a minimum of DCM and precipitated in ethyl acetate following the procedure described above, to ensure an important removal of the impurities. This time the product precipitated as a sticky residue which stayed on the sides of the flask. The supernatant was slowly removed, and the sticky residue was washed 2 times with ethyl acetate and 2 times with diethyl ether, each time removing the supernatant slowly while keeping the sticky solid inside the flask. The solid was then dried under vacuum for 1 hour, then dissolved in a minimum of DCM and precipitated in diethyl ether following the procedure described previously, in order to obtain the product in a powdery form. This powder was filtered over a fritted glass filter, washed 3 times with diethyl ether and dried under vacuum overnight, to afford the expected product as a pure solid.



3a

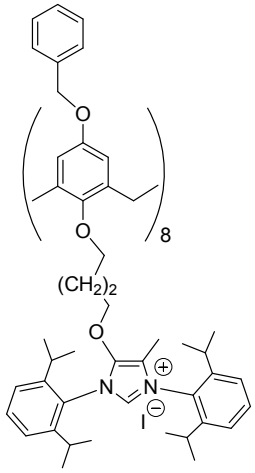
This compound was synthesised according to the general procedure described in part IV, using potassium carbonate (132.1 mmol, 18.26 g), sodium iodide (132.1 mmol, 19.8 g), **1** (4.13 mmol, 10 g), **2a** (49.5 mmol, 24.05 g) and 200 mL of distilled acetonitrile. The product was precipitated using 50 mL of DCM, and 600 mL of diethyl ether or 700 mL of ethyl acetate for each precipitation described in the general procedure, respectively. The target compound **3a** was obtained as a light yellow solid in 86 % yield (22.7 g).

^{1}H NMR (400 MHz; 60 ˚C; DMSO-d_6): δ for one repeating unit: 9.79 (s, 1H), 8.09 (s, 1H), 7.69 (dd, *J* = 6.4 Hz and 6.4 Hz, 1H), 7.53-7.46 (m, 3H), 7.39-7.33 (m, 2H), 7.03-6.86 (m, 5H), 6.41 (s, 2H), 4.48 (br. s, 2H), 4.33-4.21 (m, 2H), 3.71 (br. s, 2H), 3.66-3.54 (m, 2H), 2.49-2.35 (m, 4H), 1.86-1.75 (m, 2H), 1.73-1.60 (m, 2H), 1.28 (d, *J* = 7.1 Hz, 6H), 1.19 (d, *J* = 7.1 Hz, 6H), 1.15 (d, *J* = 7.1 Hz, 6H), 1.13 (d, *J* = 7.1 Hz, 6H).

^{13}C NMR (100 MHz, DMSO-d_6): δ for one repeating unit: 154.0, 147.9, 147.5, 145.2 (2C), 144.7 (2C), 136.8, 134.8 (2C), 133.2, 131.9, 130.4, 128.1, 127.9 (2C), 127.3, 127.0 (2C), 126.1, 124.6 (2C), 124.5 (2C), 114.2 (2C), 103.3, 73.7, 73.1, 68.6, 29.2, 28.8 (2C), 28.5 (2C), 26.0, 24.9, 24.3 (2C), 23.8 (2C), 23.2 (2C), 22.7 (2C).

HRMS [ESI(+)]: *m/z* $[M-4I]^{+4}/4$ calculated for $[C_{360}H_{440}I_4N_{16}O_{24}]^{+4}/4$: 1469.7465, found: 1469.7407.

IR (ATR-GE): ῡ (cm^{-1}) = 2966, 2931, 2872, 1617, 1543, 1463, 1387, 1330, 1308, 1279, 1213, 1199, 1145, 1048, 945, 857, 803, 754, 698, 667, 646, 606.



3b

This compound was synthesised according to the general procedure described in part IV, using potassium carbonate (58.9 mmol, 8.12 g), sodium iodide (58.9 mmol, 8.81 g), **1** (1.84 mmol, 4.45 g), **2b** (22 mmol, 11 g) and 90 mL of distilled acetonitrile. The product was precipitated using 20 mL of DCM, and 200 mL of diethyl ether or 200 mL of ethyl acetate for each precipitation described in the general procedure, respectively. The target compound **3b** was obtained as a beige solid in 92 % yield (11.0 g).

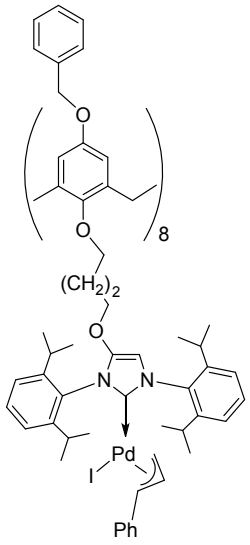
^{1}H NMR (400 MHz; 40 ˚C; DMSO-d_6): δ for one repeating unit: 9.80 (s, 1H), 7.71 (dd, *J* = 8.1 Hz and 8.1 Hz, 1H), 7.58-7.53 (m, 2H), 7.48 (dd, *J* = 8.1 Hz and 8.1 Hz, 1H), 7.40-7.32 (m, 2H), 7.13-6.82 (m, 5H), 6.43 (br. s, 2H), 4.50 (br. s, 2H), 4.33-4.16 (m, 2H), 3.70 (br. s, 2H), 3.64-3.45 (m, 2H), 2.48-2.41 (m, 2H), 2.40-2.33 (m, 2H), 2.07 (s, 3H), 1.76-1.64 (m, 2H), 1.63-1.51 (m, 2H), 1.25 (d, *J* = 6.5 Hz, 6H), 1.19 (d, *J* = 6.5 Hz, 6H), 1.14 (d, *J* = 6.5 Hz, 6H), 1.10 (d, *J* = 6.5 Hz, 6H).

^{13}C NMR (100 MHz, DMSO-d_6): δ for one repeating unit: 154.0, 147.9, 145.3 (2C), 145.2 (2C), 142.7, 136.7, 134.9 (2C), 132.2, 132.1, 131.9, 128.1, 127.9 (2C), 127.7, 127.3, 127.1, 126.5, 125.0 (2C), 124.5 (2C), 115.1 (2C), 114.2, 75.7, 73.0, 68.7, 29.3, 28.6 (2C), 28.4 (2C), 26.0, 25.9, 24.7 (2C), 24.6 (2C), 22.7 (2C), 22.5 (2C), 7.8.

HRMS [ESI(+)]: *m/z* $[M-4I]^{+4}/4$ calculated for $[C_{368}H_{456}I_4N_{16}O_{24}:]^{+4}/4$: 1497.7778, found: 1497.7834.

IR (ATR-GE): ῡ (cm^{-1}) = 2964, 2929, 2871, 1639, 1598, 1537, 1462, 1387, 1367, 1329, 1211, 1143, 1048, 1030, 993, 940, 859, 805, 741, 698.

V. Procedure for the synthesis of Cat 2 and Cat 4



Cat 2

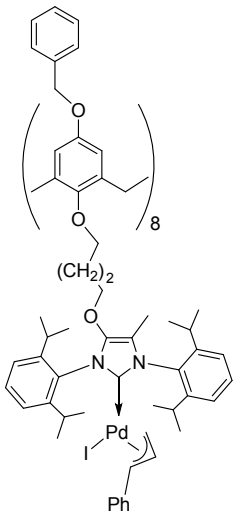
This compound was synthesised according to the general procedure described in part II, using **3a** (0.047 mmol, 300 mg), palladium (π-cinnamyl) chloride dimer (0.2 mmol, 103.5 mg), potassium carbonate (0.47 mmol, 65 mg) and 2.5 mL of anhydrous acetone. The product was precipitated using 1 mL of DCM in 50 mL of diethyl ether. **Cat 2** was obtained as a yellow solid in 84 % yield (321 mg).

^{1}H NMR (400 MHz; 40 ˚C; $CDCl_3$): *δ* for one repeating unit: 7.42 (dd, *J* = 7.9 Hz and 7.9 Hz, 1H), 7.34 (dd, *J* = 7.9 Hz and 7.9 Hz, 1H), 7.25-7.24 (m, 1H), 7.23-7.12 (m, 5H), 7.11-7.03 (m, 3H), 7.02-6.91 (m, 2H), 6.90-6.76 (m, 3H), 6.43 (br. s, 1H), 6.38 (br. s, 2H), 5.19-5.03 (m, 1H), 4.38 (br. s, 2H), 4.18 (d, *J* = 11.5 Hz, 1H), 3.93-3.82 (m, 2H), 3.72 (br. s, 2H), 3.64-3.50 (m, 2H), 3.47 (d, *J* = 7.4 Hz, 1H), 3.37-3.28 (m, 1H), 3.27-3.21 (m, 1H), 3.20-3.11 (m, 1H), 2.99-2.86 (m, 1H), 1.88 (d, *J* = 11.5 Hz, 1H), 1.83-1.72 (m, 2H), 1.71-1.53 (m, 2H), 1.43-1.28 (m, 12H), 1.18-1.03 (m, 12H).

^{13}C NMR (400 MHz; $CDCl_3$): *δ* for one repeating unit: 180.9, 154.9, 149.9, 148.2, 147.2, 147.0, 145.9, 145.8, 138.6, 136.9, 136.6, 135.2 (2C), 132.7, 130.1, 129.9, 129.2, 128.3, 128.2, 128.1, 127.8, 127.6, 127.5, 127.4, 127.3, 126.8, 124.3, 124.1, 123.9, 123.8, 115.0 (2C), 108.5, 102.2, 87.8, 73.5, 71.5, 69.5, 53.1, 29.7, 28.8 (2C), 26.9 (2C), 26.3, 25.8 (2C), 25.4, 25.3, 23.8 (2C), 23.6, 23.3 (2C).

XPS: Calculated (%) for $C_{432}I_8N_{16}Pd_8$. C: 93.1; I: 1.72; N: 3.45; Pd: 1.72. Found (%): C: 92; I: 2; N: 3; Pd: 2.

IR (ATR-GE): ῡ (cm^{-1}) = 2964, 2931, 2869, 1631, 1598, 1462, 1384, 1362, 1315, 1204, 1143, 1049, 956, 858, 802, 755, 696, 663.



Cat 4

This compound was synthesised according to the general procedure described in part II, using **3b** (0.0925 mmol, 602 mg), palladium (π-cinnamyl) chloride dimer (0.393 mmol, 203.7 mg), potassium carbonate (0.925 mmol, 127.9 mg) and 3.7 mL of anhydrous acetone. The product was precipitated using 0.3 mL of DCM in 200 mL of diethyl ether. **Cat 4** was obtained as an orange solid in 73 % yield (560 mg).

^{1}H NMR (400 MHz; 55 ˚C; $CDCl_3$): δ for one repeating unit: 7.46 (dd, *J* = 8.1 Hz and 8.1 Hz, 1H), 7.33-7.27 (m, 3H), 7.20-7.14 (m, 4H), 7.13-7.06 (m, 3H), 7.02-6.91 (m, 2H), 7.90-6.74 (m, 3H), 6.44 (br. s, 2H), 5.17-5.06 (m, 1H), 4.36 (br. s, 2H), 4.23 (d, *J* = 12.4 Hz, 1H), 3.91-3.82 (m, 2H), 3.75 (br. s, 2H), 3.67-3.52 (m, 2H), 3.28-2.84 (m, 5H), 1.98 (br. s, 3H), 1.80-1.64 (m, 3H), 1.63-1.52 (m, 2H), 1.40 (d, *J* = 7.4 Hz, 6H), 1.38 (d, *J* = 7.4 Hz, 6H), 1.16 (d, *J* = 7.4 Hz, 6H), 1.14 (d, *J* = 7.4 Hz, 6H).

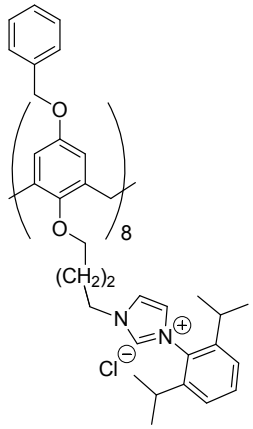
^{13}C NMR (400 MHz; $CDCl_3$): δ for one repeating unit: 178.5, 155.0, 148.3, 146.7 (4C), 145.9, 138.5, 137.0, 135.4 (2C), 135.1, 133.0, 130.1, 129.7, 128.9, 128.6, 128.4, 128.3, 128.1 (2C), 128.0 (2C), 127.6, 127.5, 127.4, 126.8, 124.6, 124.3, 114.9 (2C), 114.1, 108.1, 88.9, 74.5, 73.9, 69.5, 53.0, 29.9, 28.7 (2C), 28.4 (2C), 26.8 (2C), 25.3 (4C), 25.1 (2C), 24.9 (2C), 10.5.

IR (ATR-GE): ῡ (cm^{-1}) = 2969, 2932, 2871, 1663, 1599, 1460, 1382, 1363, 1306, 1206, 1143, 1049, 996, 959, 853, 806, 750, 695.

VI. Procedure for the synthesis of imidazolium chlorides 4a and 4b

In a one-necked round bottom flask, NMe_4Cl (650 equiv.) was dissolved in MeOH ($C_{[NMe_4Cl]}$ = 2.5 M) using manual stirring. Compound **3a** or **3b** (1 equiv., C = $3.8.10^{-3}$ M) was then added to the homogeneous solution, leading to the precipitation of a solid. The solvent was concentrated under reduced pressure at 40 °C until dryness. Then a limpid solution of NMe_4Cl (650 equiv.) dissolved in MeOH ($C_{[NMe_4Cl]}$ = 2.5 M) was added to the residual solid, and the heterogeneous solution was concentrated under reduced pressure at 40 °C until dryness. Chloroform was then added to dissolve the product, and the ammonium salts were filtered on a Dicalite™ pad and washed with chloroform. The filtrate was concentrated under

reduced pressure, and chloroform was added to the residue. After a second filtration on a Dicalite™ pad (washed with chloroform), the filtrate was transferred into an extraction funnel, and cold water was added. The organic layer was collected, and the aqueous phase was extracted two times with chloroform. The combined organic layers were washed with cold water, dried over $MgSO_4$ and filtered over a Dicalite™ pad (washed with chloroform) to obtain efficient removal of $MgSO_4$ salts. The solvent was evaporated, then the residue was dissolved in a minimum of DCM and precipitated by a dropwise addition at room temperature in a flask containing diethyl ether, under vigorous stirring. The heterogeneous solution was stirred under argon 15 min at room temperature, then 15 min at 0 °C. The solid was then filtered on a fritted glass filter, washed 3 times with diethyl ether and finally dried under vacuum overnight, to afford the desired product as a pure powder.



This compound was synthesised according to the general procedure described in part VI, using the corresponding imidazolium bromide[2] (1 equiv., 0.217 mmol, 1.00 g), NMe_4Cl (650 equiv., 141 mol, 15.47 g) and 57 mL of MeOH (C = $3.8.10^{-3}$ M). The residue was washed with 75 mL of cold water and extracted with 3x70 mL of chloroform, then combined organic layers were washed with 75 mL of cold water. The product was precipitated using 4 mL of DCM in 200 mL of diethyl ether. The expected product, precursor of **Cat 1**, was obtained as an off-white solid in 90 % yield (833 mg).

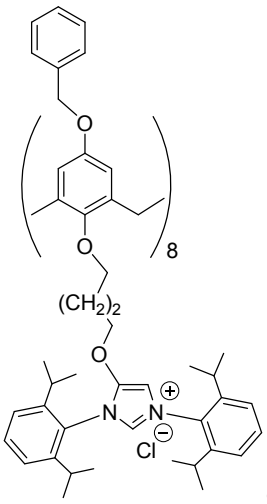
^{1}H NMR (300 MHz; DMSO-d_6): δ for one repeating unit: 10.22 (s, 1H), 8.30 (br. s, 1H), 8.11 (s, 1H), 7.61 (dd, *J* = 7.8 Hz and 7.8 Hz, 1H), 7.41 (d, *J* = 7.5 Hz, 2H), 7.04 (br. s, 5H), 6.50 (br. s, 2H), 4.59 (br. s, 2H), 4.45 (br. s, 2H), 3.90 (br. s, 2H), 3.78 (br. s, 2H), 2.19 (quint, *J* = 6.9 Hz, 2H), 2.07 (br. s, 2H), 1.69 (br. s, 2H), 1.08 (d, *J* = 6.9 Hz, 6H), 1.05 (d, *J* = 6.9 Hz, 6H).

^{13}C NMR (75 MHz; DMSO-d_6): δ for one repeating unit: 154.1, 148.2, 144.9 (2C), 138.0, 136.7, 134.9, 131.4 (2C), 130.4, 128.0 (2C), 127.4, 127.3 (2C), 125.0, 124.3 (2C), 123.3, 114.3 (2C), 72.7, 68.8, 48.8, 29.4, 28.1 (2C), 26.2, 26.1, 23.8 (2C), 23.4 (2C).

HRMS [ESI(+)]: *m/z* [M-6Cl]$^{+6}$/6 calculated for $[C_{264}H_{312}Cl_2N_{16}O_{16}]^{+6}$/6: 672.0573, found: 672.0601.

IR (ATR-GE): ῡ (cm^{-1}) = 2966, 2933, 2871, 2362, 2337, 1596, 1542, 1459, 1386, 1315, 1198, 1144, 1048, 958, 758.

[2] Prepared following a procedure described in the following publication: I. Abdellah, P. Kasongo, A. Labattut, R. Guillot, E. Schulz, C. Martini and V. Huc, *Dalton Trans.* 2018, **47**, 13843.



4a

This compound was synthesised according to the general procedure described in part VI, using **3a** (1 equiv., 1.7 mmol, 10.92 g), NMe_4Cl (650 equiv., 1.11 mol, 121.73 g) and 450 mL of MeOH (C = $3.8.10^{-3}$ M). The residue was washed with 600 mL of cold water and extracted with 3x400 mL of chloroform, then combined organic layers were washed with 600 mL of cold water. The organic residue was precipitated using 30 mL of DCM in 320 mL of diethyl ether. The target compound **4a** was obtained as an off-white solid in 87 % yield (8.44 g).

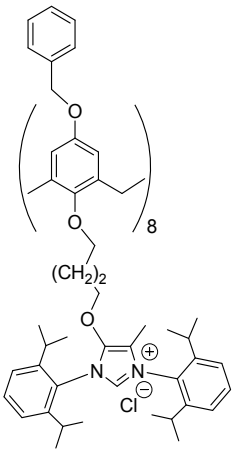
^{1}H NMR (400 MHz, 40 °C, DMSO-d_6): δ for one repeating unit: 9.92 (br. s, 1H), 8.16 (br. s, 1H), 7.68 (dd, *J* = 7.6 Hz and 7.6 Hz, 1H), 7.54-7.47 (m, 3H), 7.38-7.31 (m, 2H), 7.08-6.84 (m, 5H), 6.40 (s, 2H), 4.48 (br. s, 2H), 4.36-4.21 (m, 2H), 3.01 (br. s, 2H), 3.65-3.48 (m, 2H), 2.49-2.43 (m, 2H), 2.42-2.35 (m, 2H), 1.81-1.71 (m, 2H), 1.70-1.56 (m, 2H), 1.26 (d, *J* = 6.7 Hz, 6H), 1.17 (d, *J* = 6.7 Hz, 6H), 1.14 (d, *J* = 6.7 Hz, 6H), 1.12 (d, *J* = 6.7 Hz, 6H).

^{13}C NMR (100 MHz, DMSO-d_6): δ for one repeating unit: 154.0, 147.9, 147.5, 145.2 (2C), 144.7 (2C), 136.8, 134.8 (2C), 133.4, 131.9, 130.5, 128.1, 127.9 (2C), 127.3, 127.1, 127.0, 126.1, 124.6 (2C), 124.5 (2C), 114.2 (2C), 103.5, 73.7, 73.0, 68.6, 29.2, 28.8 (2C), 28.6 (2C), 26.0, 24.9, 24.3 (2C), 23.8 (2C), 23.2 (2C), 22.7 (2C).

HRMS [ESI(+)]: *m/z* $[M\text{-}3Cl]^{+3}/3$ calculated for $[C_{360}H_{440}Cl_5N_{16}O_{24}]^{+3}/3$: 1848.7376, found: 1848.7913.

IR (ATR-GE): ū (cm^{-1}) = 2965, 2930, 2870, 1617, 1542, 1462, 1387, 1367, 1330, 1308, 1256, 1049, 959, 861, 803, 754, 697.

XPS: Calculated (%) for $C_{360}Cl_8N_{16}O_{24}$. C: 88.2; Cl: 1.96; N: 3.92; O: 5.88. Found (%): C: 87; Cl: 2; N: 4; O: 7. Only residual traces of iodide anions were detected (less than 0.1 %).



4b

This compound was synthesised according to the general procedure described in part VI, using **3b** (1 equiv., 1.57 mmol, 10.17 g), NMe_4Cl (650 equiv., 1.02 mol, 111.41 g) and 410 mL of MeOH (C = $3.8.10^{-3}$ M). The residue was washed with 600 mL of cold water and extracted with 3x400 mL of chloroform, then combined organic layers were washed with 600 mL of cold water. The organic residue was precipitated using 30 mL of DCM in 320 mL of diethyl ether. The target compound **4b** was obtained as a beige solid in 80 % yield (7.21 g).

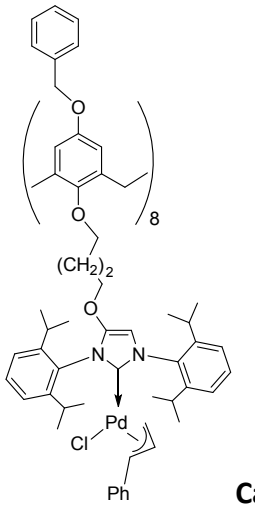
^{1}H NMR (400 MHz; DMSO-d_6): δ for one repeating unit: 9.94 (br. s, 1H), 7.71 (dd, *J* = 8.4 Hz and 8.4 Hz, 1H), 7.59-7.52 (m, 2H), 7.47 (dd, *J* = 8.4 Hz and 8.4 Hz, 1H), 7.39-7.31 (m, 2H), 7.11-6.80 (m, 5H), 6.44 (br. s, 2H), 4.50 (br. s, 2H), 4.32-4.11 (m, 2H), 3.68 (br. s, 2H), 3.64-3.46 (m, 2H), 2.47-2.39 (m, 2H), 2.38-2.30 (m, 2H), 2.05 (s, 3H), 1.71-1.62 (m, 2H), 1.60-1.48 (m, 2H), 1.25 (d, *J* = 6.5 Hz, 6H), 1.19 (d, *J* = 6.5 Hz, 6H), 1.14 (d, *J* = 6.5 Hz, 6H), 1.10 (d, *J* = 6.5 Hz, 6H).

^{13}C NMR (100 MHz, DMSO-d_6): δ for one repeating unit: 154.1, 148.0, 145.3 (4C), 142.7, 136.7, 134.8 (2C), 132.3, 132.2, 131.8, 128.2, 127.9 (2C), 127.7, 127.3, 127.1, 126.5, 125.0 (2C), 124.4 (2C), 115.2 (2C), 114.2, 75.7, 73.0, 68.7, 29.4, 28.6 (2C), 28.5 (2C), 26.0, 25.9, 24.7 (2C), 24.6 (2C), 22.6 (2C), 22.4 (2C), 7.7.

HRMS [ESI(+)]: *m/z* $[M\text{-}5Cl]^{+5}/5$ calculated for $[C_{368}H_{456}Cl_3N_{16}O_{24}:]^{+5}/5$: 1118.6820, found: 1118.6866.

IR (ATR-GE): 2966, 2931, 2871, 1639, 1598, 1536, 1462, 1330, 1300, 1257, 1214, 1143, 1049, 1030, 941, 858, 805, 744, 698.

VII. Procedure for the synthesis of Cat 3 and Cat 5



Cat 3

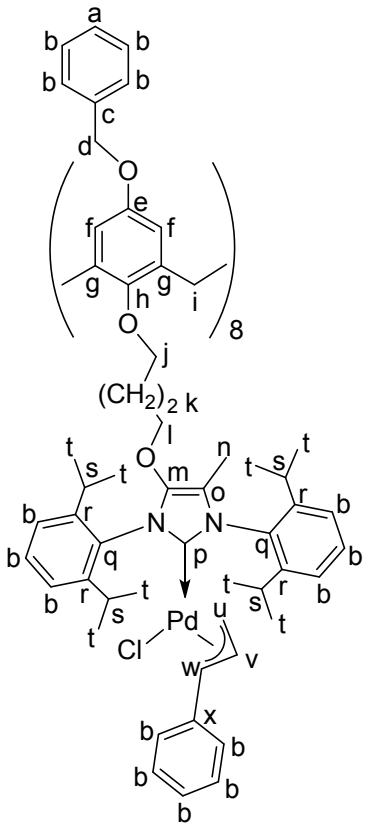
This compound was synthesised according to the general procedure described in part II, using **4a** (0.143 mmol, 810 mg), palladium (π-cinnamyl) chloride dimer (0.608 mmol, 315.2 mg), potassium carbonate (1.43 mmol, 197.8 mg) and 5.7 mL of anhydrous acetone. The product was precipitated using 1.6 mL of DCM in 150 mL of diethyl ether. **Cat 3** was obtained as a yellow solid in 74 % yield (790 mg).

^{1}H NMR (400 MHz; 55 ˚C; $CDCl_3$): *δ* for one repeating unit: 7.42 (dd, *J* = 8.1 Hz and 8.1 Hz, 1H), 7.33 (dd, *J* = 8.1 Hz and 8.1 Hz, 1H), 7.28-7.27 (m, 1H), 7.25-7.24 (m, 1H), 7.21-7.18 (m, 2H), 7.15-7.09 (m, 5H), 6.98-6.91 (m, 2H), 6.90-6.81 (m, 3H), 6.49-6.31 (m, 3H), 5.08-4.98 (m, 1H), 4.37 (br. s, 2H), 4.31 (d, *J* = 12.1 Hz, 1H), 3.91-3.83 (m, 2H), 3.71 (br. s, 2H), 3.61-3.46 (m, 2H), 3.20-3.09 (m, 2H), 3.08-2.85 (m, 3H), 1.87-1.70 (m, 3H), 1.68-1.58 (m, 2H), 1.37 (d, *J* = 7.1 Hz, 6H), 1.35-1.31 (m, 6H), 1.13 (d, *J* = 7.1 Hz, 6H), 1.08 (d, *J* = 7.1 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$): *δ* for one repeating unit: 180.8, 154.9, 149.7, 148.2, 147.0 (2C), 146.0 (2C), 138.0, 137.0, 136.5, 135.2 (2C), 132.5, 130.1, 129.9, 128.7, 128.5, 128.3, 128.2, 127.9, 127.8, 127.6, 127.5, 127.3, 126.8, 124.0 (2C), 123.7 (2C), 114.9 (2C), 108.8, 101.7, 90.2, 73.5, 71.7, 69.5, 46.7, 29.8, 28.8 (2C), 28.7 (2C), 27.0, 26.8, 26.4 (2C), 26.0, 25.8, 25.2 (2C), 23.3 (2C).

XPS: Calculated (%) for $C_{432}Cl_8N_{16}Pd_8$. C: 93.1; Cl: 1.72; N: 3.45; Pd: 1.72. Found (%): C: 93.6; Cl: 1.5; N: 3; Pd: 1.6. Residual traces of iodide anions were detected (0.3 %).

IR (ATR-GE): 2964, 2931, 2869, 1629, 1598, 1463, 1362, 1316, 1204, 1049, 1002, 957, 856, 802, 756, 696.



Cat 5

This compound was synthesised according to the general procedure described in part II, using **4b** (1.2 mmol, 6.92 g), palladium (π-cinnamyl) chloride dimer (5.1 mmol, 2.64 g), potassium carbonate (12 mmol, 1.66 g) and 60 mL of anhydrous acetone. The product was precipitated using 0.5 mL of DCM in 200 mL of diethyl ether. **Cat 5** was obtained as a yellow solid in 87 % yield (7.9 g).

^{1}H NMR (360 MHz; $CDCl_3$): δ for one repeating unit: 7.46 (dd, J = 7.6 Hz and 7.6 Hz, $1H_a$), 7.33-7.27 (m, $3H_b$), 7.20-7.09 (m, $7H_b$), 7.02-6.72 (m, $5H_b$), 6.43 (br. s, $2H_f$), 5.14-5.01 (m, $1H_v$), 4.50-4.21 (m, $3H_{d+w}$), 3.85-3.77 (m, $2H_l$), 3.73 (br. s, $2H_i$), 3.67-3.50 (m, $2H_j$), 3.11-2.77 (m, $5H_{s+u}$), 1.94 (br. s, $3H_n$), 1.81-1.55 (m, $5H_{k+u}$), 1.38 (d, J = 6.6 Hz, $6H_t$), 1.35 (d, J = 6.6 Hz, $6H_t$), 1.20-1.07 (m, $12H_t$).

^{13}C NMR (100 MHz, $CDCl_3$): δ for one repeating unit: 178.1 (C_e), 155.0 (C_p), 148.3 (C_h), 146.7 ($4C_r$), 145.4 (C_m), 137.8 (C_x), 136.9 (C_c), 135.4 ($2C_g$), 134.9 (C_q), 132.8 (C_q), 130.1 (C_a), 129.7 (C_b), 128.6 (C_b), 128.4 ($2C_b$), 128.3 (C_b), 128.2 (C_b), 128.0 (C_b), 127.6 ($2C_b$), 127.5 (C_b), 127.4 (C_b), 126.9 (C_b), 126.8 (C_b), 124.3 (C_b), 124.1 (C_b), 114.9 ($2C_f$), 114.1 (C_o), 108.4 (C_v), 91.3 (C_w), 74.9 (C_l), 73.9 (C_j), 69.4 (C_d), 46.7 (C_u), 29.5 (C_i), 28.8 ($2C_s$), 28.5 ($2C_s$), 26.8 ($2C_k$), 25.2 ($2C_t$), 24.9 ($4C_t$), 24.4 ($2C_t$), 10.0 (C_n).

XPS: Calculated (%) for $C_{440}Cl_8N_{16}Pd_8$. C: 93.22; Cl: 1.69; N: 3.39; Pd: 1.69. Found (%): C: 93.1; Cl: 2; N: 3.1; Pd: 1.9. Only residual traces of iodide anions were detected (less than 0.1 %).

IR (ATR-GE): ῡ (cm^{-1}) = 2966, 2932, 2870, 1664, 1599, 1460, 1382, 1363, 1307, 1206, 1142, 1049, 1031, 960, 857, 806, 750, 695.

VIII. General procedure for the catalytic cross-coupling reactions

A Schlenk tube equipped with a magnetic stirring bar and a septum was charged with all the solids: the catalyst (x mol% Pd), the base (1.5 equiv.), the aryl halide (1 equiv., if solid) and the amine (1.2 equiv., if solid). The solids were dried under vacuum for 10 minutes. The Schlenk tube was evacuated and backfilled with argon 3 times. Then the solvent and the rest of the reagents (the aryl halide and/or the amine, if liquids) were introduced under argon. The Schlenk tube was then immersed in a pre-heated oil bath (at the desired temperature) and the reaction mixture was stirred under warming during x hours. At the end of the reaction, the mixture was allowed to cool to room temperature under argon, then the crude was filtered on a Dicalite™ pad and rinsed with ethyl acetate. The solvents were evaporated under reduced pressure, and the crude residue was purified by silica gel column chromatography (or in one case by preparative TLC), leading to the expected product in pure form.

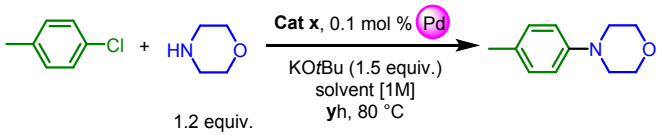
IX. General procedure for the leaching tests

Caution: all the glassware used for the reactions, for the storage of the solutions and for the filtration operations were thoroughly washed with aqua regia, rinsed with distilled water and oven-dried before their use for the determination tests of residual palladium content.

A Schlenk tube equipped with a magnetic stirring bar and a septum was charged with all the solids: the catalyst (x mol% Pd), KO*t*Bu (1.5 equiv., 1.5 mmol), the aryl halide (1 equiv., if solid) and the amine (1.2 equiv., if solid). The mixture was dried under vacuum for 10 minutes. The Schlenk tube was evacuated and backfilled with argon 3 times. Then the solvent (C = 0.5 or 1 M, V = 1 or 2 mL, depending on the coupling) and the rest of the reagents (the aryl halide and/or the amine, if liquids) were introduced under argon. The Schlenk tube was then immersed in a pre-heated oil bath (at the desired temperature) and the reaction mixture was stirred under warming during x hours. At the end of the reaction, the mixture was allowed to cool to room temperature under argon for at least 30 minutes, then the crude was filtered on a Dicalite™ pad and rinsed with diethyl ether. The filtrate was transferred into an extraction funnel, washed with distilled water (20 mL), and the organic phase was collected. The aqueous phase was extracted with diethyl ether (2x20 mL). The combined organic phases were evaporated under reduced pressure. The crude residue was heated with a heat gun under high vacuum (10^{-1} mm Hg) for 5-10 minutes, and the remaining solid was mineralised in nitric acid (69 %, TraceMetal™ Grade, 3 mL) at 140 °C for 2 to 3 h, until obtaining a homogeneous light-yellow solution which was used to perform the ICP-MS analyses.

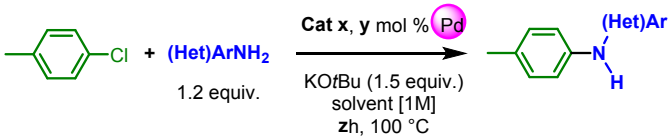
X. Supplementary material for the catalytic activity evaluation of Cat 2-5

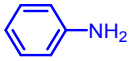
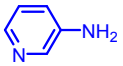
The activity of **Cat 2**, **Cat 3**, **Cat 4** and **Cat 5** was evaluated in various solvents for the coupling between 4-chlorotoluene and morpholine, and the results are shown in the Table below. Among all four catalysts, **Cat 5** always displayed the best activity when tested under identical conditions, since none of the other catalysts could surpass **Cat 5** in terms of yield and selectivity.



Solvent	Cat x	Time (h)	GC conv. (%)	GC yield (%)
MeCy	**Cat 5**	20	38	30
MeCy + 1 % H_2O	**Cat 5**	20	74	73
CPME	**Cat 2**	16	13	13
	Cat 3	16	94	92
	Cat 5	20	> 99	93
	Cat 5	2	26	19
CPME + 1 % H_2O	**Cat 5**	2	65	62
Toluene	**Cat 2**	20	27	19
	Cat 3	20	29	21
	Cat 5	20	85	82
Toluene + 1 % H_2O	**Cat 5**	20	72	68
MeTHF	**Cat 2**	20	71	57
	Cat 3	20	97	97
	Cat 5	20	> 99	> 99
1,4-Dioxane	**Cat 2**	20	55	55
	Cat 3	20	53	53
	Cat 4	2	56	51
	Cat 4	20	> 99	> 99
	Cat 5	2	80	79
	Cat 5	20	> 99	> 99
1,4-Dioxane + 1 % H_2O	**Cat 5**	20	> 99	> 99

The activity of **Cat 2**, **Cat 3** and **Cat 5** was also evaluated for the coupling between 4-chlorotoluene and aniline or 3-aminopyridine in various solvents (see Table below). For both substrates, among all solvents tested 1,4-dioxane systematically led to the best results, in terms of yield and selectivity.

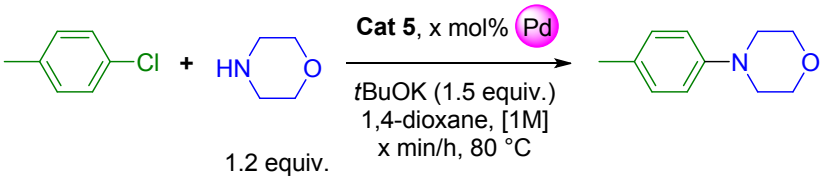


(Het)ArNH$_2$	Solvent	Cat x	Pd (mol%)	Time (h)	GC conv. (%)	GC yield (%)
	**1,4-Dioxane**	**Cat 5**	0.1	2	97	93
	"	"	0.05	20	66	65
	CPME	**Cat 2**	0.1	20	54	45
	"	**Cat 3**	0.1	20	54	45
	"	**Cat 5**	0.1	20	92	86
	MeTHF	**Cat 5**	0.1	20	46	35
	**1,4-Dioxane**	**Cat 4**	0.3	5	60	57
	1,4-Dioxane	**Cat 5**	0.3	5	97	93
	CPME	**Cat 5**	1	15	99	85
	MeTHF	**Cat 5**	1	2	99	94

XI. General procedure for the recycling tests

A Schlenk tube equipped with a magnetic stirring bar was charged with solids: catalyst (x mol% Pd), *t*BuOK (1.5 equiv., 1.5 mmol), aryl halide (1 equiv., 1 mmol) and amine (1.2 equiv., 1.2 mmol) derivatives (if solids). The mixture was dried under vacuum for 10 minutes. The Schlenk tube was evacuated and backfilled with argon 3 times. Then the solvent (C = 1 M, V = 1 mL) and the rest of the reactants (if liquids) were introduced under argon. The reaction mixture was heated and stirred for x minutes/hours. Once cooled at rt under argon for 30 minutes, an internal standard was added and the crude was diluted with diethyl ether (10 mL). Then the supernatant was collected with a fritted glass tube connected to vacuum. The Schlenk tube was rinsed two more times with diethyl ether (10 mL), and the supernatant was collected in the same way as above. The supernatant was analyzed by GC, and the residual brown cake which remained in the Schlenk tube was dried under vacuum for 1 hour. After evacuating and backfilling the Schlenk tube with argon, a second reaction can be performed in the same conditions without addition of new amount of catalyst.

Recycling studies of **Cat 5** for the Buchwald--Hartwig coupling between 4-chlorotoluene and morpholine

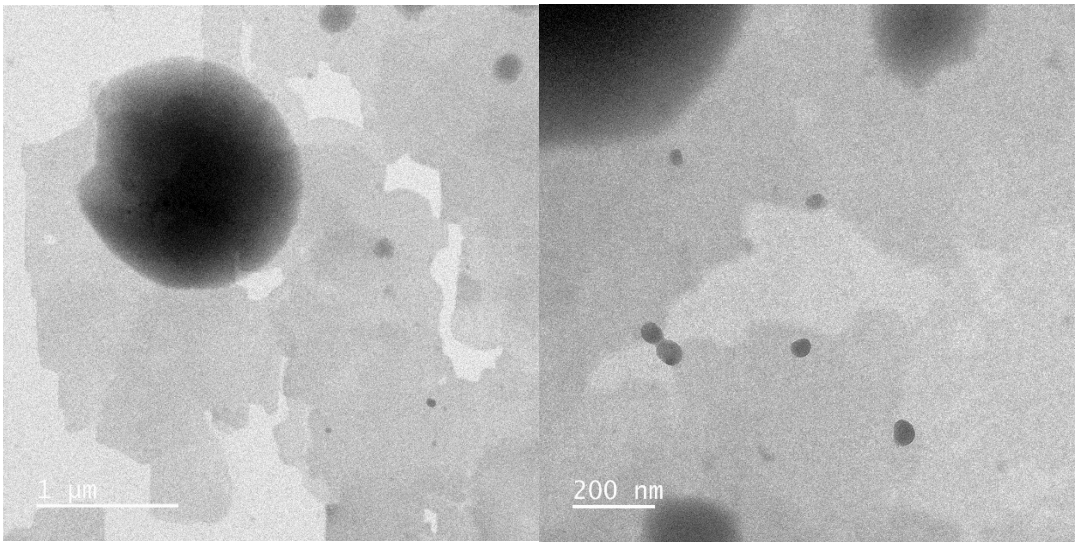


Entry	Pd loading (mol % Pd)	Time	N° of runs	GC conv. (%)[a]
1	0.1	20 h	1 [b]	> 99
2	0.1	20 h	2	56
3	1	20 min	1 [b]	> 99
4	1	20 min	2	57
5	1	20 min	1 [b]	> 99
6	1	8 h	2	> 99
7	1	16 h	3	94
8	1	16 h	4	93
9	1	16 h	5	76

[a] Determined using hexadecane as internal standard. [b] Initial run, with a new catalyst batch.

XII. TEM/MEB analyses of the spent catalyst

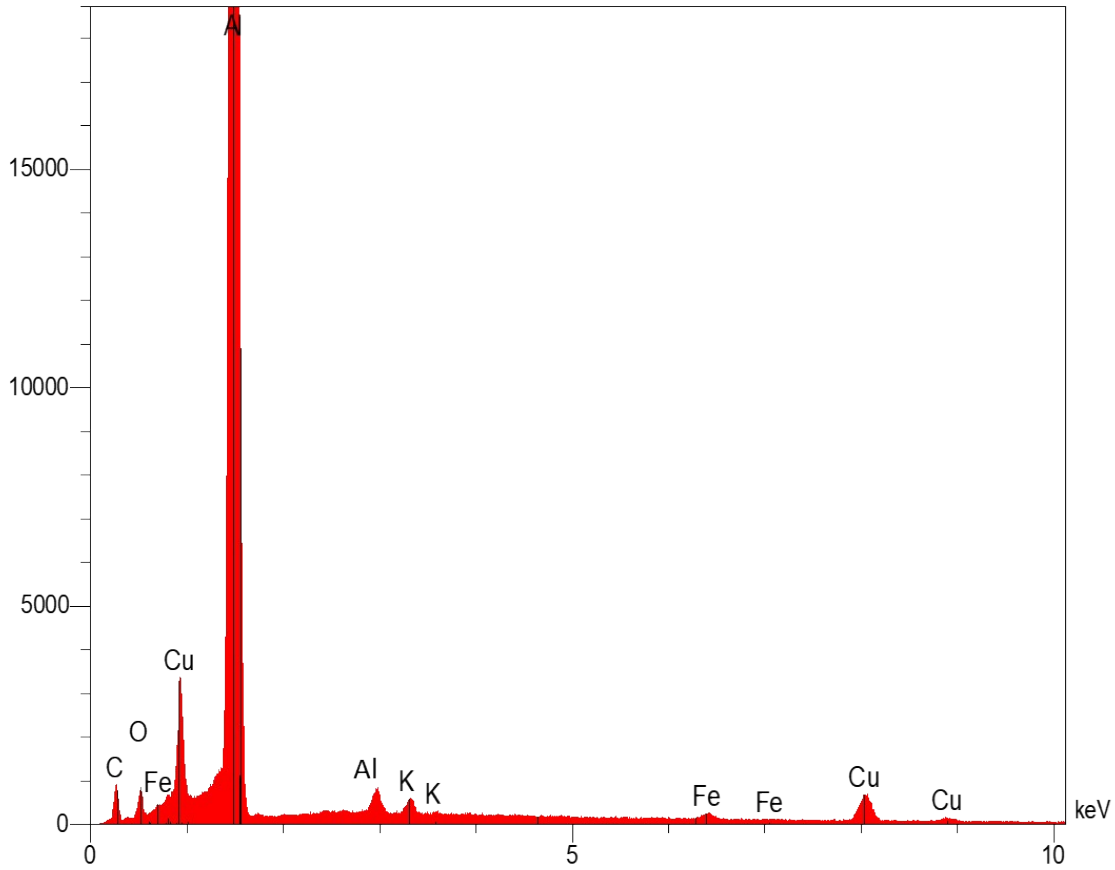
The sample was prepared by directly taking an aliquot of the yellow-brown crude reaction media (once cooled down to ambient temperature, without any filtration) and diluting this sample in ethanol (corresponding to a dilution factor of 2). One droplet of this diluted EtOH solution was then deposited onto a carbon coated TEM grid, previously cleaned using a plasma cleaner. Excess solution was removed using an absorbing paper. The grid was then introduced into the microscope. Two representative TEM micrographs are shown below.



The presence of large, faint, diversely shaped objects is evidenced, resulting from the precipitation of organic molecules or salts during the evaporation of the solution.

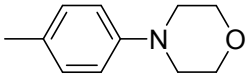
Considering the large size of these objects, their contrast is too low to be Pd nanoparticles. At an accelerating voltage of 120KV, Pd nanoparticles larger than 3 nm should completely shut the electron beam, and should thus appear as black spots. No such black nano-objects were observed, even after zooming on different areas of the TEM grid.
The presence of Pd nanoparticles (regardless of their size) can thus be ruled out in the supernatant solution.
These experiments have benefited from Imagerie-Gif core facility supported by l'Agence Nationale de la Recherche (ANR-11-EQPX-0029/Morphoscope, ANR-10-INBS-04/FranceBioImaging ; ANR-11-IDEX-0003-02/ Saclay Plant Sciences).

As shown below, MEB-EDX analyses did not show any presence of Pd in the crude reaction filtrate.



XIII. Description of the Buchwald-Hartwig coupling products

The products used for the optimisation steps have been prepared following procedures already described in the literature, and isolated in their pure form in order to determine accurately their GC response factors with hexadecane, then allowing to calculate GC yields for later experiments.



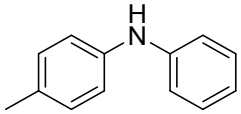
***N*-(4-Tolyl)morpholine:** In a Schlenk tube equipped with a magnetic stirring bar and a septum were introduced 4-iodotoluene (1.09 g, 5 mmol, 1 equiv.), CuBr (140 mg, 1 mmol, 0.2 equiv.), racemic BINOL ligand (285 mg, 1 mmol, 0.2 equiv.) and K_3PO_4 (2.12 g, 10 mmol, 2 equiv.). The tube was evacuated and backfilled with argon 3 times, then anhydrous DMF (5 mL, C = 1 M) and morpholine (0.66 mL, 7.5 mmol, 1.5 equiv.) were added. The tube was sealed with a screw cap and the mixture was stirred at 40 ˚C for 8 hours. After allowing the reaction mixture to cool to room temperature, the mixture was filtered on a Dicalite™ pad and rinsed with ethyl acetate. The solvent was evaporated and the crude residue was purified by silica gel column chromatography using petroleum ether/ethyl acetate (9:1 to 7:3) as eluent. The product was obtained as an off-white solid in 75 % yield (667 mg).

^{1}H NMR (360 MHz, $CDCl_3$): 7.11 (d, *J* = 8.3 Hz, 2H), 6.85 (d, *J* = 8.4 Hz, 2H), 3.87 (t, *J* = 8.4 Hz, 4H), 3.12 (t, *J* = 8.4 Hz, 4H), 2.29 (s, 3H).

^{13}C NMR (90 MHz, $CDCl_3$): 149.3, 129.8 (2C), 129.6, 116.1 (2C), 67.0 (2C), 50.0 (2C), 20.5.

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{11}H_{16}NO]^+$: 178.1226, found: 178.1218.

The spectral data are in accordance with those reported in the literature.[3]



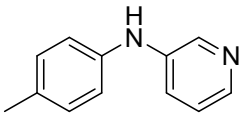
***N*-(4-Tolyl)aniline:** In a Schlenk tube equipped with a magnetic stirring bar and a septum were introduced $Pd_2(dba)_3$ (45.8 mg, 0.05 mmol, 0.0125 equiv.), XPhos (95.3 mg, 0.2 mmol, 0.05 equiv.), NaO*t*Bu (576.6 mg, 6 mmol, 1.5 equiv.) and 4-bromotoluene (687.3 mg, 4 mmol, 1 equiv.). The Schlenk tube was evacuated and backfilled with argon 3 times, then distilled toluene (15 mL, C = 0.27 M) and aniline (0.44 mL, 4.8 mmol, 1.2 equiv.) were added. The Schlenk tube was sealed with a screw cap and the mixture was stirred at 95 ˚C for 4 hours. After allowing the reaction mixture to cool to room temperature, the mixture was filtered on a silica pad and rinsed with ethyl acetate. The solvent was evaporated and the crude residue was purified by silica gel column chromatography using pentane/diethyl ether (95:5 to 90:10) as eluent. The product was obtained as a beige solid in 89 % yield (653 mg).

^{1}H NMR (300 MHz, $CDCl_3$): 7.25-7.19 (m, 2H), 7.11-7.05 (m, 2H), 7.04-6.96 (m, 4H), 6.92-6.83 (m, 1H), 5.75 (br. s, 1H), 2.29 (s, 3H).

^{13}C NMR (90 MHz, $CDCl_3$): 144.0, 140.4, 131.0, 129.9 (2C), 129.4 (2C), 120.4, 119.0 (2C), 117.0 (2C), 20.8.

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{13}H_{14}N]^+$: 184.1120, found: 184.1114.

The spectral data are in accordance with those reported in the literature.[4,5]



[3] D. Jiang, H. Fu, Y. Jiang and Y. Zhao, *J. Org. Chem.*, 2007, **72**, 672.

[4] Z. Shi, G. B. Hammond and B. Xu, *ACS Omega,* 2018, **3**, 6748.

[5] S-E. Park, S. B. Kang, K-J. Jung, J-E. Won, S-G. Lee and Y-J. Yoon, *Synthesis,* 2009, 815.

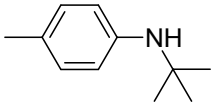
***N*-(3-Pyridyl)-4-methylaniline:** The product has been prepared following a slightly modified procedure described in the literature:[6] In a microwave vial equipped with a magnetic stirring bar were introduced $Pd(OAc)_2$ (11.2 mg, 0.05 mmol, 0.01 equiv.), JohnPhos (29.8 mg, 0.1 mmol, 0.02 equiv.) and NaO*t*Bu (768.8 mg, 8 mmol, 1.6 equiv.). Under argon, distilled toluene (V = 5 mL, C = 1 M), *p*-toluidine (0.83 ml, 7.5 mmol, 1.5 equiv.), 3-chloropyridine (0.47 ml, 5 mmol, 1 equiv.) and some drops of DMF were added. The mixture was heated in the microwave at 200 ˚C for 10 minutes. After allowing the reaction mixture to cool to room temperature, the mixture was filtered on a Dicalite™ pad and rinsed with DCM. The solvent was evaporated and the crude residue was purified by silica gel column chromatography using dichloromethane/acetonitrile (8:2 to 2:8) as eluent. The product was obtained as a yellow solid in 74 % yield (683 mg).

^{1}H NMR (360 MHz, $CDCl_3$): 8.34 (s, 1H), 8.10 (s, 1H), 7.34 (dd, *J* = 8.2 Hz and 1.9 Hz, 1H), 7.16-7.06 (m, 3H), 7.01 (d, *J* = 8.2 Hz, 2H), 6.24 (br. s, 1H), 2.31 (s, 3H).

^{13}C NMR (90 MHz, $CDCl_3$): 140.9 (2C), 139.2 (2C), 131.1, 130.1 (2C), 123.8, 122.3, 119.3 (2C), 20.8.

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{12}H_{13}N_2]^+$: 185.1073, found: 185.1071.

The spectral data are in accordance with those reported in the literature.[7]



***N*-*tert*-Butyl-4-methylaniline:** In a Schlenk tube equipped with a magnetic stirring bar and a septum were introduced $Pd(OAc)_2$ (26.9 mg, 0.12 mmol, 0.03 equiv.), XPhos (114.4 mg, 0.24 mmol, 0.06 equiv.), NaO*t*Bu (576.6 mg, 6 mmol, 1.5 equiv.) and 4-bromotoluene (687.3 mg, 4 mmol, 1 equiv.) . The Schlenk tube was evacuated and backfilled with argon 3 times, then distilled toluene (12 mL, C = 0.33 M) and *tert*-butylamine (0.5 mL, 4.8 mmol, 1.2 equiv.) were added. The Schlenk was sealed with a screw cap and the mixture was stirred at 100 ˚C for 20 hours. After allowing the reaction mixture to cool to room temperature, the mixture was filtered on a silica pad and rinsed with ethyl acetate. The solvent was evaporated and the crude residue was purified by silica gel column chromatography using pentane/diethyl ether (95:5 to 70:30) as eluent. The product was obtained as an orange oil in 50 % yield (324 mg).

^{1}H NMR (360 MHz, $CDCl_3$): 6.98 (d, *J* = 8.4 Hz, 2H), 6.71 (d, *J* = 8.4 Hz, 2H), 3.14 (br. s, 1H), 2.26 (s, 3H), 1.30 (s, 9H).

^{13}C NMR (90 MHz, $CDCl_3$): 144.2, 129.3 (2C), 128.3, 119.0 (2C), 51.6, 30.1 (3C), 20.5.

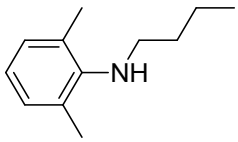
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{11}H_{18}N]^+$: 164.1433, found: 164.1429.

IR (ATR-GE): ῡ (cm^{-1}) = 3407.1, 2974, 2869, 1617, 1515, 1457, 1390, 1364, 1318, 1306, 1257, 1219, 1184, 1045, 1029, 958, 809, 696.

All the other products described Schemes 2 and 3 of the publication (compounds **5**-**29**) were prepared following the general procedure described in part VIII.

[6] B. U. W. Maes, K. T. J. Loones, G. L. F. Lemière and R. A. Dommisse, *Synlett,* 2003, 1822.

[7] Q. Shen, T. Ogata and J. F. Hartwig, *J. Am. Chem. Soc.,* 2008, **130**, 6586.



***N*-*n*-Butyl-*N*-(2,6-dimethylphenyl)-amine (5):** obtained as a yellow oil, in 70 % (124 mg, 0.70 mmol) isolated yield, after purification through a silica pad using ethyl acetate as eluent. Prepared from 2-chloro-1,3-dimethylbenzene (1 equiv.), *n*-butylamine (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.3 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 20h.

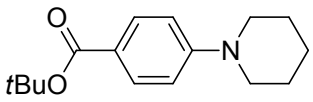
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.08 (d, *J* = 7.4 Hz, 2H), 6.89 (dd, *J* = 7.4 Hz and 7.4 Hz, 1H), 3.12-2.99 (m, 3H), 2.38 (s, 6H), 1.66 (quint, *J* = 7.3 Hz, 2H), 1.51 (hex, *J* = 7.3 Hz, 2H), 1.04 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 146.5, 129.1 (2C), 128.8 (2C), 121.6, 48.5, 33.4, 20.4, 18.6 (2C), 14.1.

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{12}H_{20}N]^+$: 178.1590, found: 178.1584.

The spectral data are in accordance with those reported in the literature.[8]

[8] L. Ackermann, J. H. Spatz, C. J. Gschrei, R. Born and A. Althammer, *Angew. Chem. Int. Ed.*, 2006, **45**, 7627.



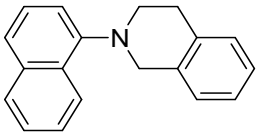
***N*-[4-(*tert*-Butylcarbonyl)phenyl]-piperidine (6):** white solid, 86 % (225 mg, 0.86 mmol) isolated yield, after purification by silica gel column chromatography (pentane/ethyl acetate = 98:2 to 95:5). Prepared from *tert*-butyl-4-chlorobenzoate (1 equiv.), piperidine (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.5 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 80 °C for 4 h.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.85 (d, *J* = 8.7 Hz, 2H), 6.84 (d, *J* = 8.7 Hz, 2H), 3.35-3.26 (m, 4H), 1.74-1.60 (m, 6H), 1.57 (s, 9H).

^{13}C NMR (90 MHz, $CDCl_3$): δ 166.0, 154.3, 131.0 (2C), 120.7, 113.7 (2C), 79.8, 49.0 (2C), 28.3 (3C), 25.4 (2C), 24.4.

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{16}H_{24}NO_2]^+$: 262.1802, found: 262.1797.

The spectral data are in accordance with those reported in the literature.[9]



***N*-(1-Naphthyl)-1,2,3,4-tetrahydroisoquinoline (7):** yellow solid, 79 % (410 mg, 1.58 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 98:2 to 90:10). Prepared from 1-chloronaphthalene (1 equiv.), 1,2,3,4-tetraisoquinoline (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (0.2 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 20 h.

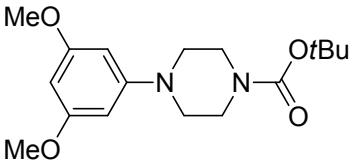
^{1}H NMR (360 MHz, $CDCl_3$): δ 8.34 (m, 1H), 7.90 (m, 1H), 7.63 (d, *J* = 8.2 Hz, 1H), 7.56-7.50 (m, 2H), 7.47 (dd, *J* = 8.2 Hz and 7.3 Hz, 1H), 7.30-7.23 (m, 3H), 7.21 (dd, *J* = 7.4 Hz and 0.9 Hz, 1H), 7.17-7.12 (m, 1H), 4.36 (s, 2H), 3.48 (br. s, 2H), 3.18 (br. s, 2H).

^{13}C NMR (90 MHz, $CDCl_3$): δ 149.7, 135.4, 134.9, 134.6, 129.2, 129.1, 128.5, 126.5, 126.4, 126.0 (2C), 125.9, 125.5, 123.8, 123.6, 115.0, 55.4, 51.6, 29.8.

HR-MS [ESI(+)]: *m/z* $[M+Na]^+$ calculated for $[C_{19}H_{18}N]^+$: 260.1434, found: 260.1421.

IR (ATR-GE): $\bar{\upsilon}$ (cm^{-1}) = 3064, 2971, 2823, 2805, 1592, 1576, 1506, 1498, 1457, 1446, 1399, 1374, 1276, 1223, 1139, 1093, 1049, 1020, 935, 802, 777, 752, 741, 721.

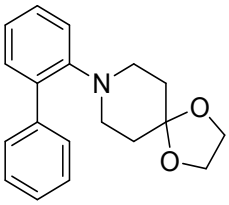
mp: 74.8 ˚C.



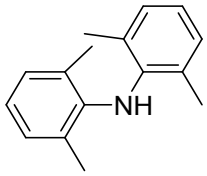
***N*-Boc-*N'*-(3,5-dimethoxyphenyl)piperazine (8):** white solid, 88 % (847 mg, 2.63 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 7:3 to 5:5). Prepared from 5-chloro-1,3-dimethoxybenzene (1 equiv.), *N*-boc-piperazine (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (0.03 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 20 h.

[9] V. Bavetsias and E. A. Henderson, *J. Chem. Research (S)*, 2000, 418.

^{1}H NMR (360 MHz, $CDCl_3$): δ 6.1-6.07 (m, 2H), 6.04 (dd, *J* = 2.1 Hz and 2.1 Hz, 1H), 3.77 (s, 6H), 3.56 (t, *J* = 5.6 Hz, 4H), 3.12 (t, *J* = 5.6 Hz, 4H), 1.48 (s, 9H).
^{13}C NMR (90 MHz, $CDCl_3$): δ 161.5 (2C), 154.7, 153.2, 95.5 (2C), 92.1, 79.9, 55.2 (2C), 49.3 (2C), 43.4 (br. s, 2C), 28.4 (3C).
HR-MS [ESI(+)]: *m/z* $[M+Na]^+$ calculated for $[C_{17}H_{26}N_2NaO_4]^+$: 345.1785, found: 345.1776.
IR (ATR-GE): ῡ (cm^{-1}) = 3001.23, 2978, 2933, 2845, 1688, 1614, 1589, 1487, 1454, 1430, 1392, 1287, 1251, 1203, 1173, 1150, 1084, 1064, 1005, 996, 926, 868, 813, 769, 686.
mp: 75.7 ˚C.

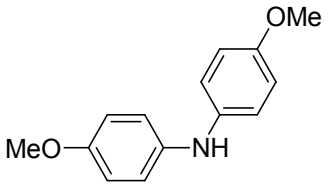


***N*-(2-Biphenylyl)-4-piperidone ethylene ketal (9):** light yellow solid, 77 % (228 mg, 0.77 mmol) isolated yield, after purification on preparative TLC (pentane/diethyl ether = 8:2). Prepared from 2-chlorobiphenyle (1 equiv.), 4-piperidone ethylene ketal (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (1 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 8 h.
^{1}H NMR (360 MHz, $CDCl_3$): 7.67-7.61 (m, 2H), 7.44-7.34 (m, 2H), 7.31-7.22 (m, 3H), 7.12-7.00 (m, 2H), 3.93 (s, 4H), 2.92 (t, *J* = 5.4 Hz, 4H), 1.62 (t, *J* = 5.4 Hz, 4H).
^{13}C NMR (90 MHz, $CDCl_3$): 150.6, 141.3, 135.2, 131.4, 128.8 (2C), 128.3 (3C), 126.8, 122.7, 118.8, 107.2, 64.3 (2C), 49.5 (2C), 35.2 (2C).
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{19}H_{21}NNaO_2]^+$: 318.1465, found: 318.1452.
IR (ATR-GE): ῡ (cm^{-1}) = 2956, 2927, 2887, 2828, 1725, 1594, 1479, 1433, 1365, 1334, 1230, 1141, 1096, 1057, 1037, 951, 933, 897, 807, 756, 740, 703.
mp: 108.7 ˚C.



***N*,*N*-Bis-(2,6-dimethylphenyl)amine (10):** white solid, 87 % (1.17 g, 5.20 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 100:0 to 97:3). Prepared from 2-chloro-1,3-xylene (1 equiv.), 2,6-dimethylaniline (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.05 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 20 h.
^{1}H NMR (360 MHz, $CDCl_3$): δ 7.12 (d, *J* = 7.7 Hz, 4H), 6.98 (dd, *J* = 7.4 Hz and 7.4 Hz, 2H), 4.93 (br. s, 1H), 2.15 (s, 12H).
^{13}C NMR (90 MHz, $CDCl_3$): δ 141.8 (2C), 129.6 (4C), 128.8 (4C), 121.8 (2C), 19.3 (4C).
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{16}H_{20}N]^+$: 226.1590, found: 226.1583.
The spectral data are in accordance with those reported in the literature.[10]

[10] J. Li, M. Cui, A. Yu and Y. Wu, *J. Organomet. Chem.*, 2007, **692**, 3732.



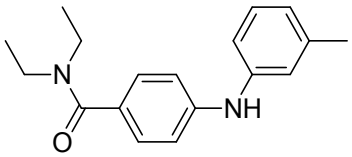
***N,N*-Bis-(4-methoxyphenyl)amine (11):** beige solid, 72 % (330 mg, 1.44 mmol) isolated yield, after purification by silica gel column chromatography (pentane/ethyl acetate = 95:5 to 93:7). Prepared from 4-chloroanisole (1 equiv.), 4-anisidine (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.2 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 20 h.

^{1}H NMR (360 MHz, $CDCl_3$): δ 6.98 (d, *J* = 8.4 Hz, 4H), 6.87 (d, *J* = 9.1 Hz, 4H), 5.38 (br. s, 1H), 3.81 (s, 6H).

^{13}C NMR (90 MHz, $CDCl_3$): δ 154.2 (2C), 138.0 (2C), 119.5. (4C), 114.7 (4C), 55.6 (2C).

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{14}H_{16}NO_2]^+$: 230.1176, found: 230.1167.

The spectral data are in accordance with those reported in the literature.[11]



***N*-[4-(*N*',*N*'-Diethylbenzamido)]-*N*-(3-tolyl)amine (12):** white solid, 84 % (237 mg, 0.84 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 5:5 to 0:10). Prepared from 4-chloro-*N*,*N*-diethylbenzamide (1 equiv.), 3-toluidine (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.5 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 4 h.

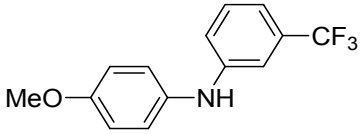
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.30 (d, *J* = 8.7 Hz, 2H), 7.18 (dd, *J* = 8.7 Hz and 7.5 Hz, 1H), 7.01 (d, *J* = 8.7 Hz, 2H), 6.95-6.90 (m, 2H), 6.81 (d, *J* = 7.5 Hz, 1H), 5.85 (s, 1H), 3.52-3.37 (m, 4H), 2.32 (s, 3H), 1.19 (t, *J* = 6.9 Hz, 6H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 171.5, 144.9, 142.2, 139.0, 129.0, 128.0 (3C), 122.3, 119.5, 115.82 (2C), 115.80, 41.5 (br. s, 2C), 21.4, 13.6 (2C).

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{18}H_{23}N_2O]^+$: 283.1803, found: 283.1798.

IR (ATR-GE): ῡ (cm^{-1}) = 3297, 2972, 2928, 2363, 2336, 1602, 1536, 1489, 1430, 1330, 1168, 1102, 844, 763.

mp: 125.5-126.5 °C.

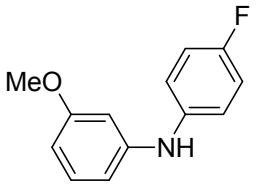


***N*-(4-Methoxyphenyl)-3-(trifluoromethyl)aniline (13):** white solid, 95 % (254 mg, 0.95 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 90:10 to 85:15). Prepared from 4-chloroanisole (1 equiv.), 3-(trifluoromethyl)aniline (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.8 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 20 h.

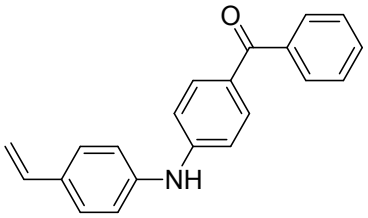
^{1}H NMR (360 MHz, $CDCl_3$): δ 7.25 (dd, *J* = 8.1 Hz and 8.1 Hz, 1H), 7.09-7.05 (m, 3H), 7.04-6.95 (m, 2H), 6.91-6.86 (m, 2H), 5.62 (br. s, 1H), 3.79 (s, 3H).

[11] J. McNulty, S. Cheekoori, T. P. Bender and J. A. Coggan, *Eur. J. Org. Chem.*, 2007, 1423.

^{13}C NMR (90 MHz, $CDCl_3$): δ 156.2, 146.1, 134.4, 131.3 (q, *J* = 31.9 Hz, 1C), 129.9, 124.2 (q, *J* = 272.3 Hz, 1C), 123.6, 117.9, 115.6 (q, *J* = 3.6 Hz, 1C), 115.0, 111.3 (q, *J* = 3.6 Hz, 1C), 55.6.
^{19}F NMR (235 MHz, $CDCl_3$): δ -62.9 (s).
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{14}H_{13}F_3NO]^+$: 268.0944, found: 268.0936.
The spectral data are in accordance with those reported in the literature.[12]



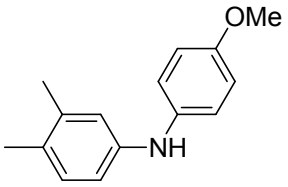
***N*-(4-Fluorophenyl)-*N*-(3-methoxyphenyl)amine (14):** pale white solid, 97 % (421 mg, 1.94 mmol) isolated yield, after purification by silica gel column chromatography (pentane/ethyl acetate = 97:3 to 93:7). Prepared from 3-chloroanisole (1 equiv.), 4-fluoroaniline (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.2 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.
^{1}H NMR (360 MHz, $CDCl_3$): δ 7.16 (dd, *J* = 8.2 Hz and 8.2 Hz, 1H), 7.10-7.04 (m, 2H), 7.02-6.95 (m, 2H), 6.56 (dd, *J* = 8.2 Hz and 2.2 Hz, 1H), 6.53 (dd, *J* = 2.2 Hz and 2.2 Hz, 1H), 6.46 (dd, *J* = 8.2 Hz and 2.2 Hz, 1H), 5.59 (s, 1H), 3.78 (s, 3H).
^{13}C NMR (62.5 MHz, $CDCl_3$): δ 160.8, 158.1 (d, J = 239 Hz, 1C), 145.5, 138.7, 130.2, 121.1 (d, J = 8.2 Hz, 2C), 115.9 (d, J = 22.6 Hz, 2C), 109.3, 105.6, 102.4, 55.1.
^{19}F NMR (235 MHz, $CDCl_3$): δ -121.6 (tt, *J* = 8.2 Hz and 4.9 Hz, 1F).
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{13}H_{13}FNO]^+$: 218.0976, found: 218.0968.
The spectral data are in accordance with those reported in the literature.[13]



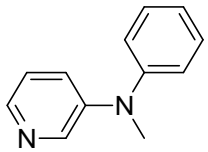
***N*-(4-Styryl)-*N*-(4-(benzoyl)-phenyl)amine (15):** yellow solid, 96 % (575 mg, 1.92 mmol) isolated yield, after purification by silica gel column chromatography (petroleum ether/ethyl acetate = 9:1 to 8:2). Prepared from 4-chlorostyrene (1 equiv.), 4-aminobenzophenone (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.2 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.79-7.72 (m, 4H), 7.56-7.51 (m, 1H), 7.48-7.42 (m, 2H), 7.38 (d, *J* = 8.4 Hz, 2H), 7.13 (d, *J* = 8.7 Hz, 2H), 7.01 (d, *J* = 8.7 Hz, 2H), 6.67 (dd, *J* = 17.7 Hz and 10.8 Hz, 1H), 6.17 (br. s, 1H), 5.66 (d, *J* = 17.7 Hz, 1H), 5.18 (d, *J* = 10.8 Hz, 1H).
^{13}C NMR (75 MHz, $CDCl_3$): δ 195.4, 148.0, 140.5, 138.8, 136.3, 132.9 (2C), 131.8, 129.8 (2C), 129.0, 128.3 (2C), 127.9, 127.6 (2C), 121.3, 120.4, 114.8, 114.2, 112.7.

[12] A. Correa, M. Carril and C. Bolm, *Chem. Eur. J.*, 2008, **14**, 10919.
[13] S. Rivara, F. Vacondio, A. Fioni, C. Silva, C. Carmi, M. Mor, V. Lucini, M. Pannacci, A. Caronno, F. Scaglione, G. Gobbi, G. Spadoni, A. Bedini, P. Orlando, S. Lucarini and G. Tarzia, *ChemMedChem*, 2009, **4**, 1746.

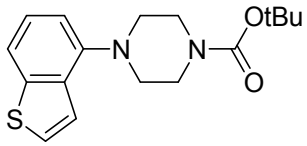
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{21}H_{18}NO]^+$: 300.1383, found: 300.1372.
IR (ATR-GE): ῡ (cm^{-1}) = 3315, 3184, 3087, 2929, 2854, 1714, 1635, 1583, 1561, 1524, 1501, 1445, 1403, 1344, 1321, 1287, 1255, 1218, 1191, 1175, 1149, 1076, 996, 940, 923, 908, 840, 816.
mp: 147.8-150 ˚C.



***N*-3,4-Dimethylphenyl-4-methoxyaniline (16):** light yellow solid, 92 % (626 mg, 2.75 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 95:5 to 90:10). Prepared from 4-chloro-1,2-dimethylbenzene (1 equiv.), 4-anisidine (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (0.3 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.
^{1}H NMR (360 MHz, $CDCl_3$): *δ* 7.09-6.95 (m, 3H), 6.85 (d, *J* = 8.7 Hz, 2H), 6.76 (s, 1H), 6.74-6.69 (m, 1H), 5.36 (br. s, 1H), 3.80 (s, 3H), 2.21 (s, 3H), 2.20 (s, 3H).
^{13}C NMR (90 MHz, $CDCl_3$): *δ* 154.8, 142.8, 137.6, 136.8, 130.4, 128.1, 121.2 (2C), 118.1, 114.7 (2C), 114.0, 55.7, 20.1, 19.0.
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{15}H_{18}NO]^+$: 228.1383, found: 228.1378.
The spectral data are in accordance with those reported in the literature.[14]



***N*-Methyl-*N*-(3-pyridyl)aniline (17):** yellow oil, 96 % (177 mg, 0.96 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether/methanol = 50:50:0 to 49:49:2). Prepared from 3-chloropyridine (1 equiv.), *N*-methylaniline (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (0.3 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 20 h.
^{1}H NMR (300 MHz, $CDCl_3$): *δ* 8.33 (d, *J* = 2.2 Hz, 1H), 8.15 (d, *J* = 4.0 Hz, 1H), 7.38-7.29 (m, 2H), 7.25-7.18 (m, 1H), 7.17-7.02 (m, 4H), 3.34 (s, 3H).
^{13}C NMR (90 MHz, $CDCl_3$): *δ* 147.8, 145.0, 141.1, 140.5, 129.5 (2C), 124.6, 123.4, 123.2, 122.3 (2C), 39.9.
HR-MS [ESI(+)]: *m/z* $[M+Na]^+$ calculated for $[C_{12}H_{13}N_2]^+$: 185.1073, found: 185.1068.
The spectral data are in accordance with those reported in the literature.[15]



[14] Y. Monguchi, K. Kitamoto, T. Ikawa, T. Maegawa and H. Sajiki, *Adv. Synth. Catal.*, 2008, **350**, 2764.
[15] F. Rataboul, A. Zapf, R. Jackstell, S. Harkal, T. Riermeier, A. Monsees, U. Dingerdissen and M. Beller, *Chem. Eur. J.*, 2004, **10**, 2983.

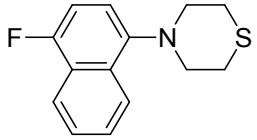
***N*'-Boc-*N*-(4-benzothiophenyl)piperazine (18):** white solid, 96 % (306 mg, 0.96 mmol) isolated yield, after purification by silica gel column chromatography (petroleum ether/ethyl acetate = 95:5 to 90:10). Prepared from 4-bromobenzothiophene (1 equiv.), *N*-Boc-piperazine (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (0.2 mol% Pd) in CPME (C = 0.5 M) at 100 °C for 4 h.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.55 (d, *J* = 8.1 Hz, 1H), 7.38 (s, 2H), 7.25 (dd, *J* = 8.1 Hz and 7.5 Hz, 1H), 6.84 (d, *J* = 7.5 Hz, 1H), 3.65 (t, *J* = 5.1 Hz, 4H), 3.07 (t, *J* = 5.1 Hz, 4H), 1.51 (s, 9H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 154.9, 148.3, 141.3, 134.3, 125.4, 125.1, 121.7, 117.5, 112.5, 79.9, 52.2 (2C), 44.2 (2C), 28.6 (3C).

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{17}H_{22}N_2NaO_2S]^+$: 341.1294, found: 341.1288.

The spectral data are in accordance with those reported in the literature.[16]



***N*-[1-(4-Fluoronaphthyl)]-thiomorpholine (19):** red solid, 80 % (198 mg, 0.80 mmol) isolated yield, after purification by silica gel column chromatography (petroleum ether/diethyl ether = 98:2). Prepared from 1-bromo-4-fluoro-naphthalene (1 equiv.), thiomorpholine (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (0.5 mol% Pd) in 1,4-dioxane (C = 1 M) at 100 °C for 20 h.

^{1}H NMR (360 MHz, $CDCl_3$): δ 8.24-8.15 (m, 1H), 8.14-8.04 (m, 1H), 7.64-7.48 (m, 2H), 7.12-6.95 (m, 2H), 3.30 (br. s, 4H), 2.93 (br. s, 4H).

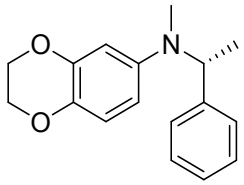
^{13}C NMR (90 MHz, $CDCl_3$): δ 155.6 (d, *J* = 248.8 Hz, 1C), 146.9 (d, *J* = 3.6 Hz, 1C), 130.4 (d, *J* = 4.7 Hz, 1C), 126.6, 126.4, 124.7 (d, *J* = 16.9 Hz, 1C), 123.4, 121.1 (d, *J* = 5.3 Hz, 1C), 115.6 (d, *J* = 8.2 Hz, 1C), 109.0 (d, *J* = 20.8 Hz, 1C), 55.7 (2C), 28.7 (2C).

^{19}F NMR (235 MHz, $CDCl_3$, 27 ˚C): δ -128.1 (s).

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{14}H_{15}FNS]^+$: 248.0904, found: 248.0902.

IR (ATR-GE): ῡ (cm^{-1}) = 2960, 2948, 2903, 2837, 1634, 1599, 1465, 1452, 1397, 1373, 1282, 1257, 1221, 1074, 1040, 1020, 961, 863, 825, 771, 713.

mp: 48.4 ˚C.

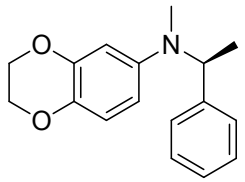


(*R*)-*N*-[3-(1,4-Benzodioxyl)]-*N*-methyl-*N*-(1-phenylethyl)amine ((*R*)-20): colourless oil, 72 % (388 mg, 1.44 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 10:0 to 8:2). Prepared from 4-bromobenzodioxane (1 equiv.), (*R*)-*N*,α-dimethylbenzylamine (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (0.5 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.

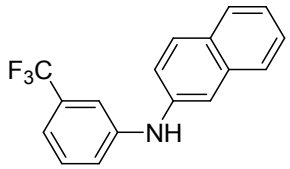
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.43-7.37 (m, 4H), 7.35-7.28 (m, 1H), 6.88-6.84 (m, 1H), 6.52-6.47 (m, 2H), 5.02 (q, *J* = 6.6 Hz, 1H), 4.31-4.24 (m, 4H), 2.67 (s, 3H), 1.54 (d, *J* = 6.6 Hz, 3H).

[16] C. Wu, W. Chen, D. Jiang, X. Jiang and J. Shen, *Org. Process Res. Dev.,* 2015, **19**, 555.

^{13}C NMR (75 MHz, $CDCl_3$): δ 145.8, 143.9, 142.9, 135.6, 128.4 (2C), 127.1 (2C), 126.9, 117.5, 108.0, 103.3, 64.8, 64.3, 58.0, 32.6, 16.2.
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{17}H_{20}NO_2]^+$: 270,1489, found: 270.1478.
IR (ATR-GE): ῡ (cm^{-1}) = 2976, 2936, 2875, 2806, 1713, 1626, 1584, 1510, 1450, 1383, 1301, 1282, 1244, 1180, 1150, 1105, 1070, 1050, 1027, 994, 957, 925, 889, 856.

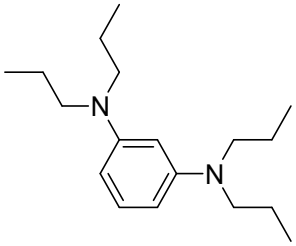


(*S*)-*N*-[3-(1,4-Benzodioxyl)]-*N*-methyl-*N*-(1-phenylethyl)amine ((*S*)-20): colourless oil, 76 % (409 mg, 1.52 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 10:0 to 8:2). Prepared from 4-bromobenzodioxane (1 equiv.), (*S*)-*N*,α-dimethylbenzylamine (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (0.5 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.43-7.37 (m, 4H), 7.34-7.28 (m, 1H), 6.88-6.84 (m, 1H), 6.51-6.47 (m, 2H), 5.02 (q, *J* = 6.9 Hz, 1H), 4.31-4.24 (m, 4H), 2.67 (s, 3H), 1.57 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (75 MHz, $CDCl_3$): δ 145.8, 143.9, 142.9, 135.6, 128.4 (2C), 127.1 (2C), 126.9, 117.5, 108.0, 103.3, 64.8, 64.3, 58.0, 32.6, 16.2.
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{17}H_{20}NO_2]^+$: 270,1489, found: 270.1480.
IR (ATR-GE): ῡ (cm^{-1}) = 2976, 2936, 2876, 2805, 1715, 1626, 1605, 1584, 1510, 1450, 1383, 1301, 1282, 1244, 1181, 1150, 1132, 1105, 1070, 1050, 1027, 994, 957, 925, 890, 856.



***N*-(3-Trifluoromethylphenyl)-2-naphthylamine (21):** beige solid, 88 % (506 mg, 1.76 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 10:0 to 9:1). Prepared 3-bromo-1-trifluorobenzene (1 equiv.), 2-naphthylamine (1.2 equiv.), KO*t*Bu (1.5 equiv.), and **Cat 5** (0.5 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.96 (d, *J* = 7.8 Hz, 1H), 7.92 (d, *J* = 8.7 Hz, 1H), 7.85 (d, *J* = 7.8 Hz, 1H), 7.64 (td, *J* = 7.8 Hz and 1.5 Hz, 1H), 7.59-7.54 (m, 2H), 7.51-7.44 (m, 2H), 7.42-7.31 (m, 3H), 5.88 (s, 1H).
^{13}C NMR (75 MHz, $CDCl_3$): δ 144.0, 139.7, 134.7, 132.0 (q, *J* = 31.8 Hz), 130.1, 130.0, 129.6, 128.0, 127.0, 126.9, 124.5 (q, *J* = 270.8 Hz), 124.4, 120.6, 120.2, 117.4 (q, *J* = 3.8 Hz), 113.9 (q, *J* = 3.8 Hz), 113.7.
^{19}F NMR (235 MHz, $CDCl_3$): δ -62.8 (s).
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{17}H_{13}F_3N]^+$: 288.0995, found: 288.0988.
The spectral data are in accordance with those reported in the literature.[17]

[17] L. Ackermann, R. Sandmann and W. Song, *Org. Lett.,* 2011, **13**, 1784.



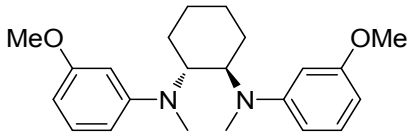
***N*,*N*,*N'*,*N'*-Tetrapropyl-1,3-phenylenediamine (22):** yellow oil, 89 % (245 mg, 0.89 mmol) isolated yield, after purification by silica gel column chromatography (pentane/diethyl ether = 99:1 to 9:1). Prepared from 1,3-dichlorobenzene (1 equiv.), dipropylamine (2.4 equiv.), KO*t*Bu (3 equiv.), and **Cat 5** (1 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.

^{1}H NMR (360 MHz, $CDCl_3$): δ 7.04 (dd, *J* = 8.2 and 8.2 Hz, 1H), 6.01 (dd, *J* = 8.2 and 2.3 Hz, 2H), 5.90 (dd, *J* = 2.3 and 2.3 Hz, 1H), 3.22 (t, *J* = 7.5 Hz, 8H), 1.63 (hex, *J* = 7.4 Hz, 8H), 0.93 (t, *J* = 7.4 Hz, 12H).

^{13}C NMR (90 MHz, $CDCl_3$): δ 149.4 (2C), 129.7, 100.2 (2C), 95.5, 53.3 (4C), 20.8 (4C), 11.6 (4C).

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{18}H_{33}N_2]^+$: 277.2638, found: 277.2629.

IR (ATR-GE): ῡ (cm^{-1}) = 2958, 2933, 2872, 1602, 1570, 1504, 1466, 1364, 1291, 1245, 1217, 1182, 1142, 1102, 1015, 883, 805, 740, 688.



(1*R*,2*R*)-*N*,*N'*-Bis-(3-methoxyphenyl)-*N*,*N'*-dimethyl-1,2-cyclohexanediamine (23): light yellow oil, 71 % (328 mg, 0.925 mmol) isolated yield, after purification on by silica gel column chromatography (pentane/diethyl ether = 95:5 to 80:20). Prepared from (*R,R*)-(-)-*N,N'*-dimethyl-1,2-cyclohexanediamine (1 equiv.), 3-chloroanisole (2.4 equiv.), KO*t*Bu (3 equiv.), and **Cat 5** (0.2 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.

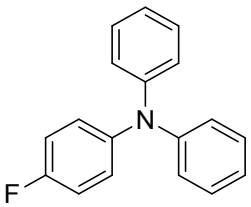
^{1}H NMR (360 MHz, $CDCl_3$): 7.67-7.61 (m, 2H), 6.4-6.36 (m, 2H), 6.31-6.25 (m, 4H), 3.81 (s, 6H), 3.79-3.72 (m, 2H), 2.57 (s, 6H), 1.98-1.83 (m, 4H), 1.62-1.36 (m, 4H).

^{13}C NMR (90 MHz, $CDCl_3$): 160.9 (2C), 151.4 (2C), 129.9 (2C), 105.9 (2C), 100.6 (2C), 99.3 (2C), 60.0 (2C), 55.2 (2C), 31.3 (2C), 29.4 (2C), 25.6 (2C).

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{22}H_{31}N_2O_2]^+$: 355.2380, found: 355.2368.

IR (ATR-GE): ῡ (cm^{-1}) = 2992, 2930, 2856, 2833, 1607, 1573, 1497, 1452, 1432, 1381, 1302, 1240, 1216, 1171, 1136, 1099, 1051, 1010, 823, 749, 687.

$(\alpha)^{20}_{D}$ (DCM, C= 10 mg/mL, Cell length = 1 cm): + 86.0˚.



***N*-(4-Fluorophenyl)-*N*,*N*-diphenylamine (24):** white solid, 96 % (253 mg, 0.96 mmol) isolated yield, after purification by silica gel column chromatography (pentane/ethyl acetate = 99:1 to 95:5). Prepared from 1-chloro-4-fluorobenzene (1 equiv.), diphenylamine (1.2 equiv.), KO*t*Bu (1.5 equiv.) and **Cat 5** (1 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.

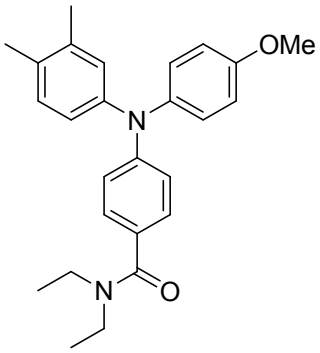
^{1}H NMR (360 MHz, $CDCl_3$): 7.30 (d, *J* = 8.7 Hz, 2H), 7.28 (d, *J* = 8.7 Hz, 2H), 7.15-6.98 (m, 10H).

^{13}C NMR (75 MHz, $CDCl_3$): *δ* 159.0 (d, *J* = 244 Hz, 1C), 148.0 (2C), 144.0 (d, *J* = 2.6 Hz, 1C), 129.4 (4C), 126.5 (d, *J* = 8.3 Hz, 2C), 123.7 (4C), 122.6 (2C), 116.2 (d, *J* = 22.6 Hz, 2C).

^{19}F NMR (235 MHz, $CDCl_3$, 27 ˚C): *δ* -119.7 (tt, *J* = 8.2 and 4.9 Hz, 1F).

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{18}H_{15}FN]^+$: 264.1183, found: 264.1176.

The spectral data are in accordance with those reported in the literature.[18]



***N*-[4-(*N*',*N*'-Diethylbenzamido)]-*N*-(3,4-dimethylphenyl)-*N*-(4-methoxyphenyl)amine (26):** light brown oil, 84 % (135 mg, 0.335 mmol) isolated yield, after purification by two consecutive elutions on preparative TLC (pentane/acetone = 9:1). Prepared from *N*-(3,4-dimethylphenyl)-*N*-(4-methoxyphenyl)-amine (1 equiv.), 4-chloro-*N*,*N*-diethylbenzamide (1.2 equiv.), KO*t*Bu (1.25 equiv.), and **Cat 5** (1 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 8 h.

^{1}H NMR (360 MHz, $CDCl_3$): 7.21 (d, *J* = 8.7 Hz, 2H), 7.07 (d, *J* = 8.7 Hz, 2H), 7.03 (d, *J* = 8.4 Hz, 1H), 6.95-6.88 (m, 3H), 6.87-6.80 (m, 3H), 3.80 (s, 3H), 3.44 (br. s, 4H), 2.22 (s, 3H), 2.18 (s, 3H), 1.19 (t, *J* = 6.5 Hz, 6H).

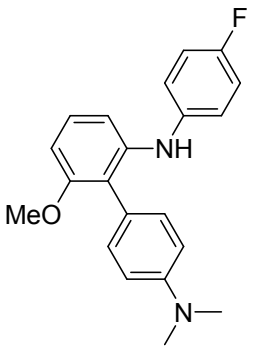
^{13}C NMR (100 MHz, $CDCl_3$): 171.6, 156.5, 149.7, 145.2, 140.5, 137.8, 132.0, 130.6, 128.7, 127.9 (2C), 127.5 (2C), 126.3, 122.6, 119.9 (2C), 114.9 (2C), 55.6, 29.8 (2C), 20.0, 19.3, 13.8 (br. s, 2C).

HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{26}H_{31}N_2O_2]^+$: 403.2380, found: 403.2367.

IR (ATR-GE): ῡ (cm^{-1}) = 2970, 2931, 2872, 1623, 1602, 1505, 1455, 1422, 1314, 1282, 1242, 1178, 1094, 1034, 824, 762.

[18] C. J. Smith, M. W. S. Tsang, A. B. Holmes, R. L. Danheiser and J. W. Tester, *Org. Biomol. Chem.,* 2005, **3**, 3767.

Description of the C-H activation product



***N*-(4-Fluorophenyl)-*N*-[2-(4-*N*',*N*'-dimethylaminophenyl)-3-(methoxy)-phenyl]amine (29):** white solid, 91 % (306 mg, 0.91 mmol) isolated yield, after purification by silica gel column chromatography (pentane/ethyl acetate = 97:3 to 95:5). Prepared from 4-bromo-*N*,*N*-dimethylaniline (1.2 equiv.), *N*-(4-fluorophenyl)-*N*-(3-methoxyphenyl)amine (1 equiv.), KO*t*Bu (1.3 equiv.) and **Cat 5** (1 mol% Pd) in 1,4-dioxane (C = 0.5 M) at 100 °C for 20 h.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.21 (d, *J* = 8.7 Hz, 2H), 7.15 (dd, *J* = 8.2 Hz and 8.2 Hz, 1H), 7.04-6.89 (m, 4H), 6.82 (d, *J* = 8.7 Hz, 2H), 6.81 (dd, *J* = 8.2 Hz and 0.9 Hz, 1H), 6.53 (dd, *J* = 8.2 Hz and 0.9 Hz, 1H), 5.42 (s, 1H), 3.74 (s, 3H), 3.00 (s, 6H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 158.3 (d, *J* = 240 Hz, 1C), 158.2, 149.8, 143.4, 139.3 (d, *J* = 2.2 Hz, 1C), 131.5 (2C), 128.1, 121.8 (d, *J* = 8.0 Hz, 2C), 121.7, 119.1, 115.8 (d, *J* = 22.3 Hz, 2C), 112.9 (2C), 108.2, 102.9, 55.9, 40.5 (2C).

^{19}F NMR (235 MHz, $CDCl_3$): δ -121.8 (tt, *J* = 8.2 Hz and 4.9 Hz, 1F).

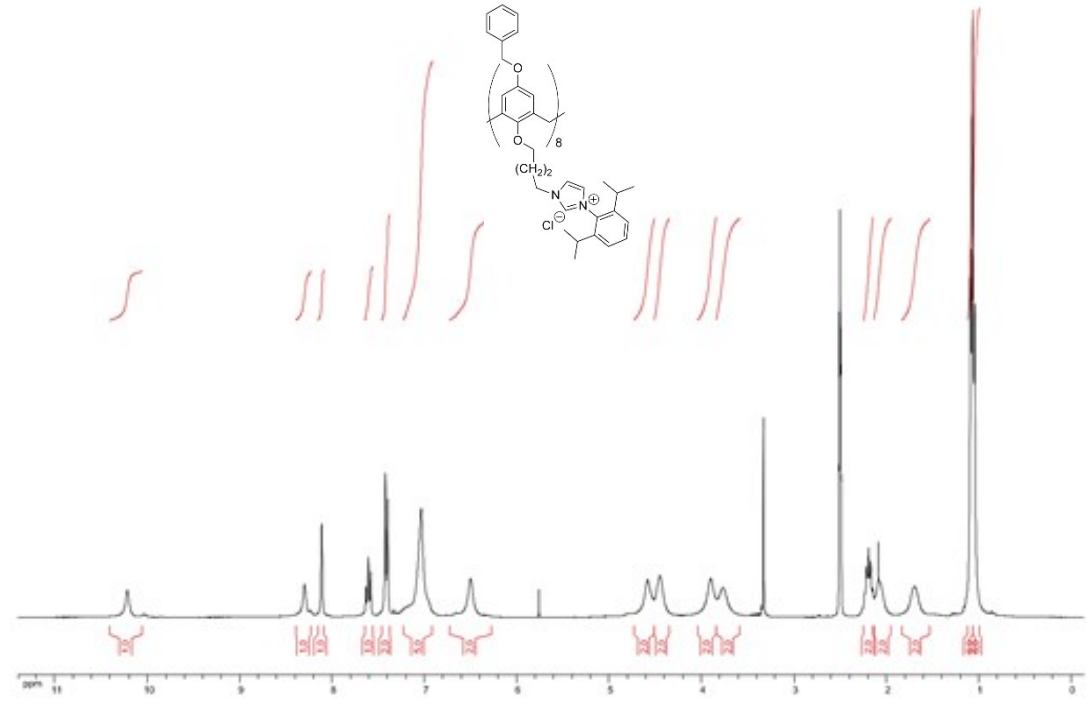
HR-MS [ESI(+)]: *m/z* $[M+H]^+$ calculated for $[C_{21}H_{22}FN_2O]^+$: 337.1711, found: 337.1703.

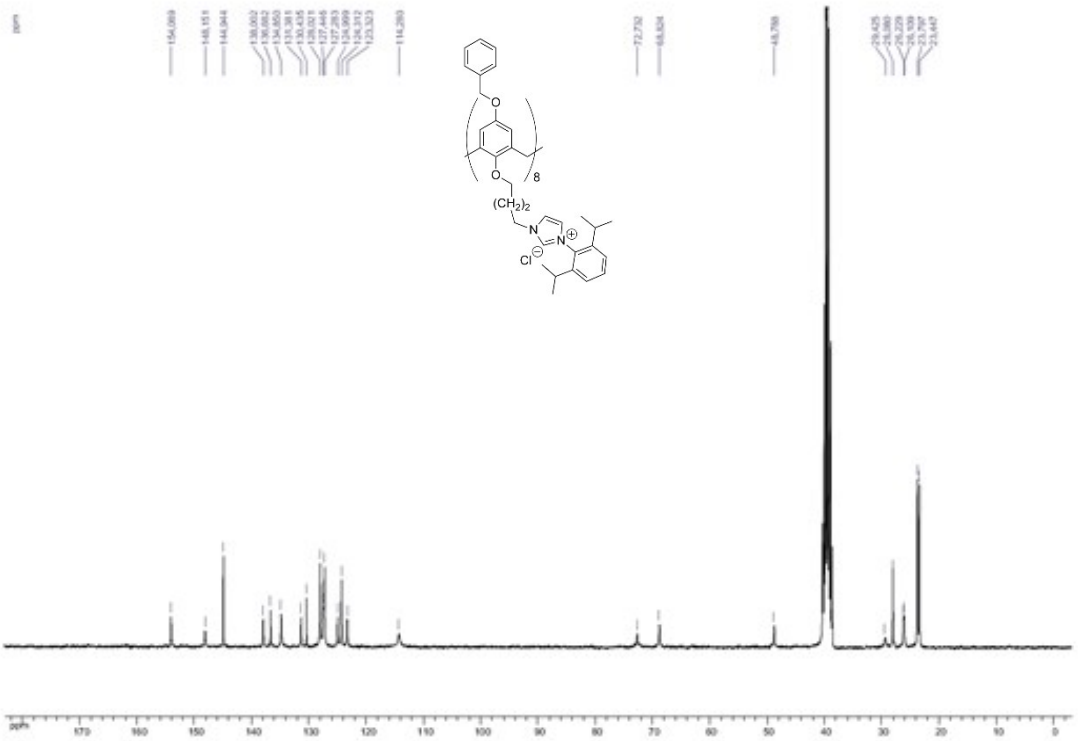
IR (ATR-GE): ū (cm^{-1}) = 3376, 2958, 2927, 2855, 2804, 1588, 1506, 1468, 1254, 1211, 1080, 807, 778.

mp: 133.5-135.5 °C.

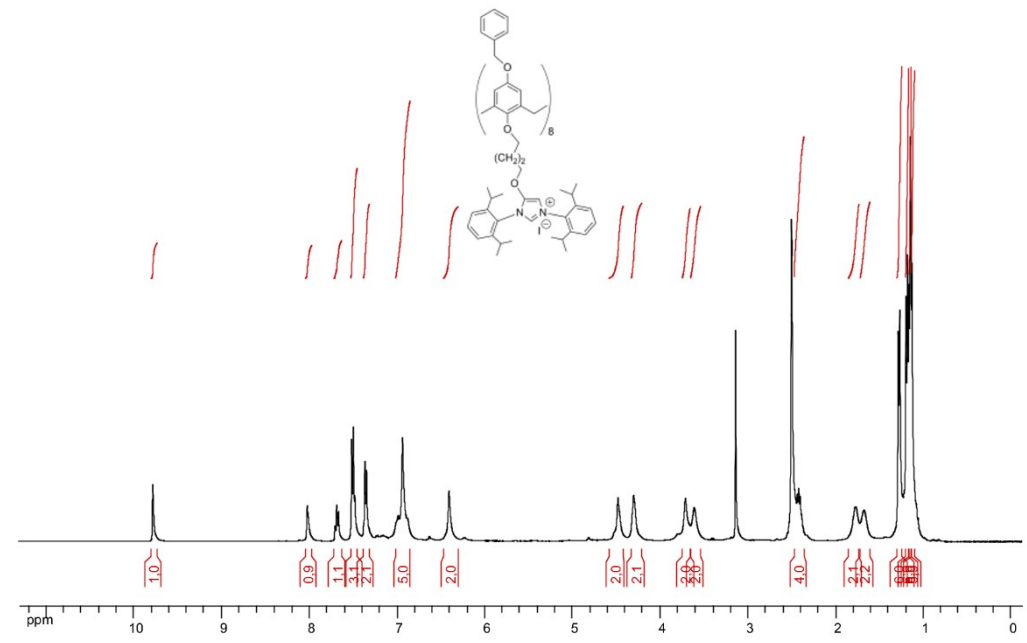
XIV. NMR spectra of Cat 1 precursor, 3a-b, 4a-b and Cat 1-5

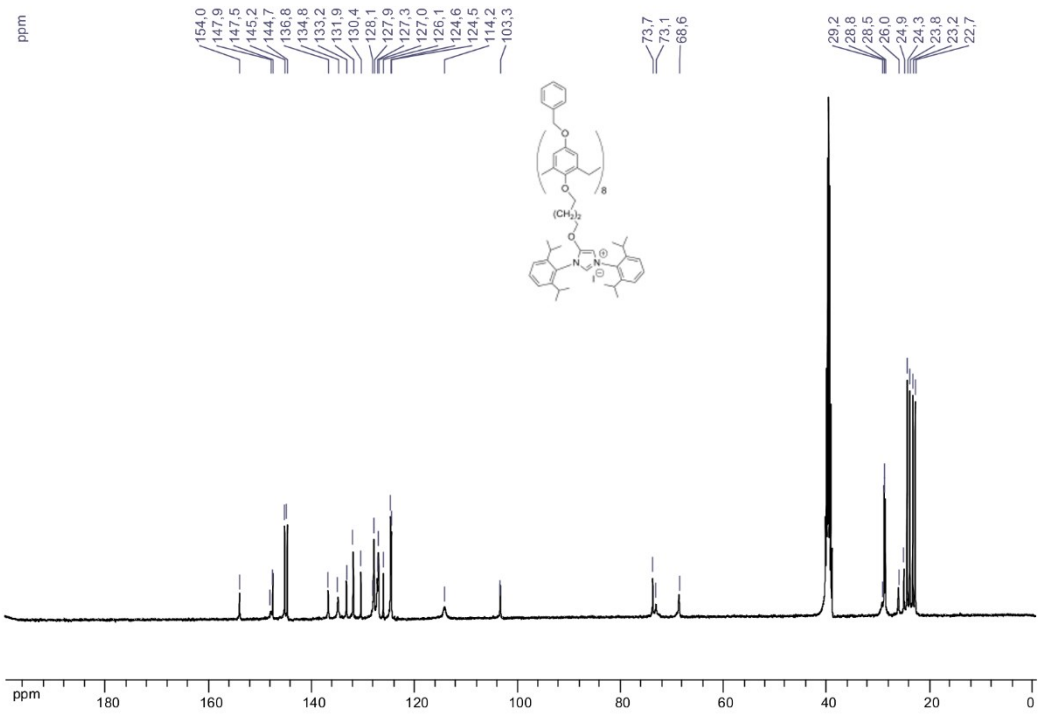
Cat 1 precursor



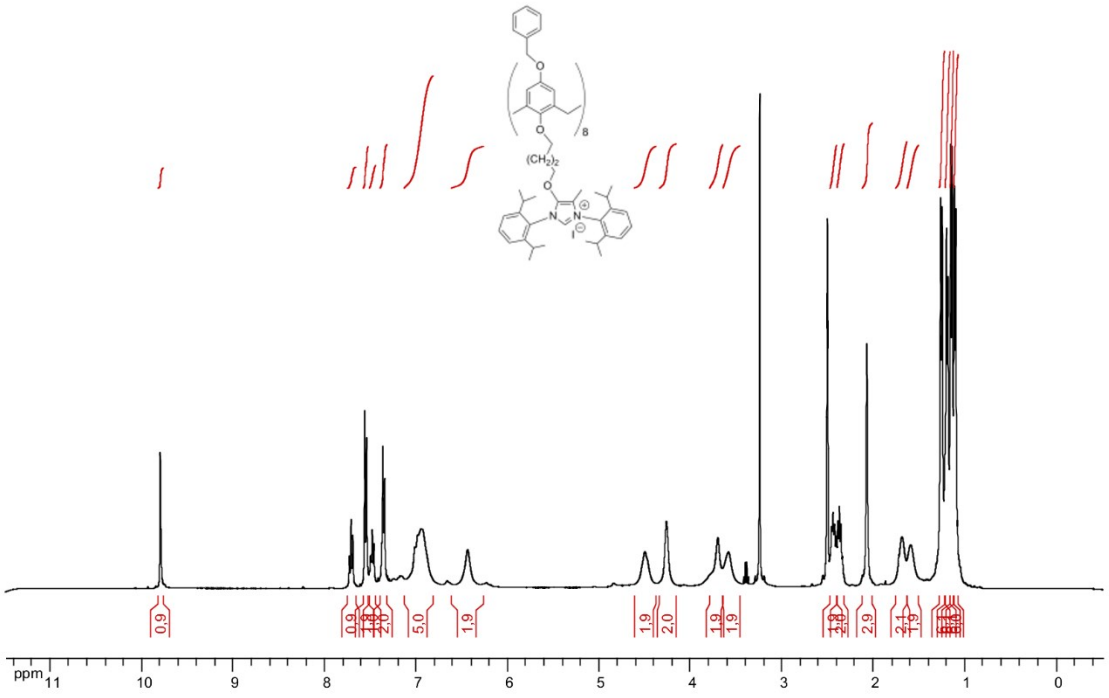


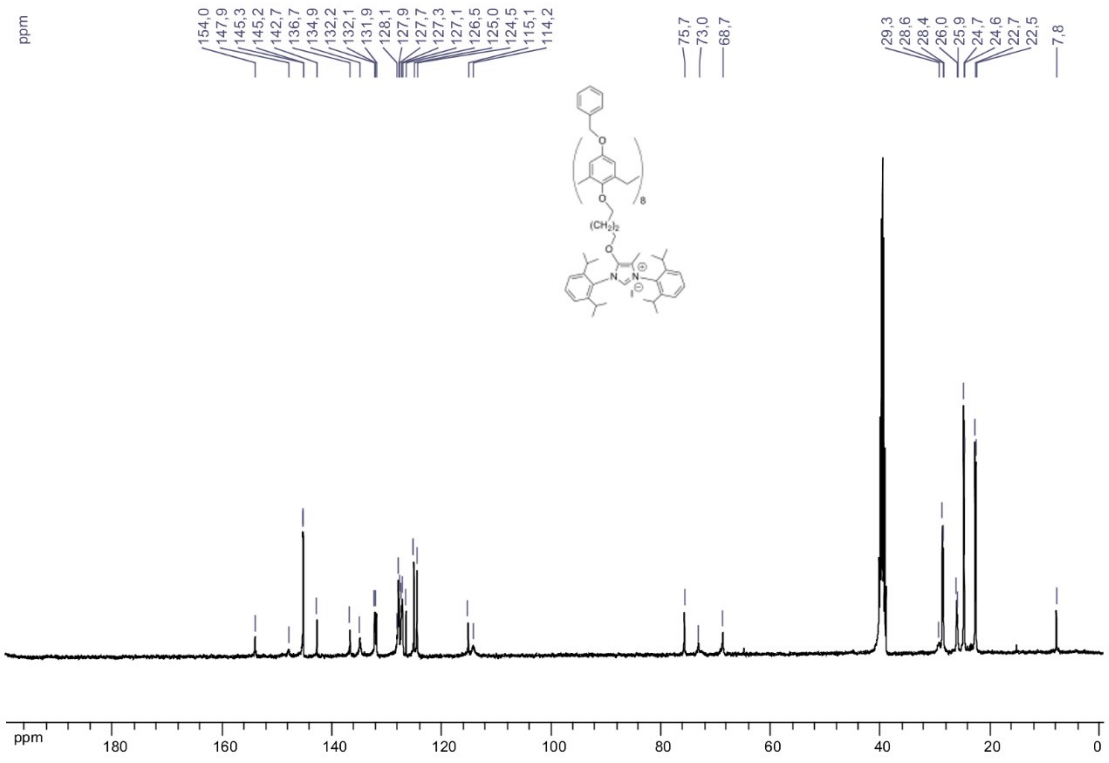
Compound 3a: ^{1}H NMR spectrum recorded at 60 ˚C



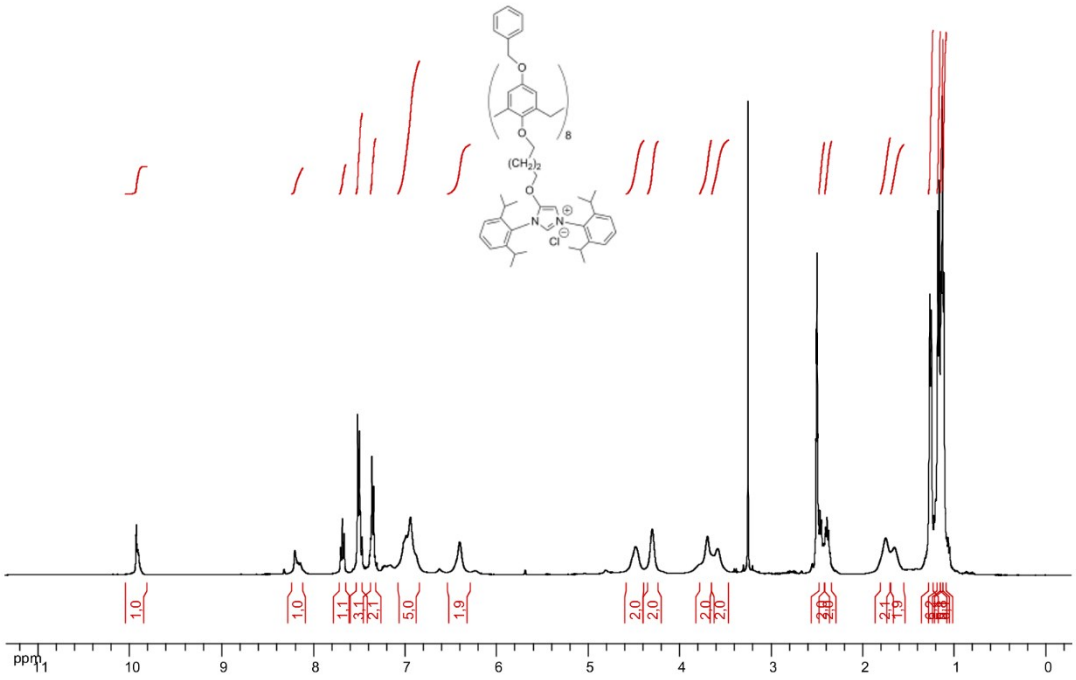


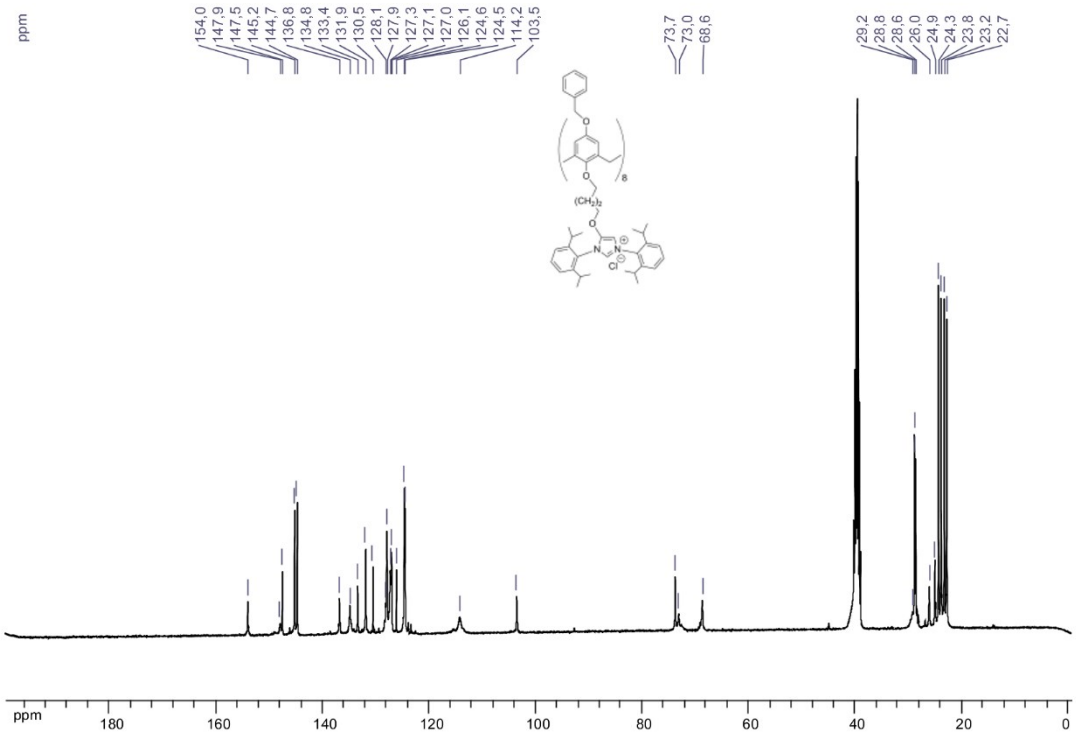
Compound 3b: ^{1}H NMR spectrum recorded at 40 ˚C



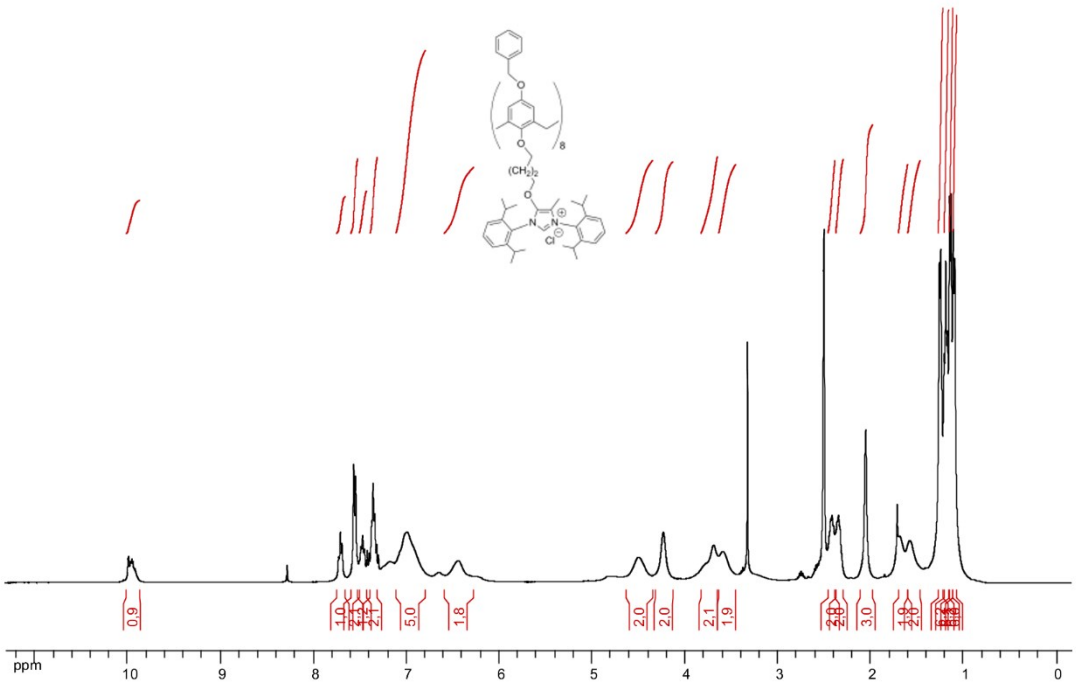


Compound 4a: ^{1}H NMR spectrum recorded at 40 ˚C





Compound 4b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1,0
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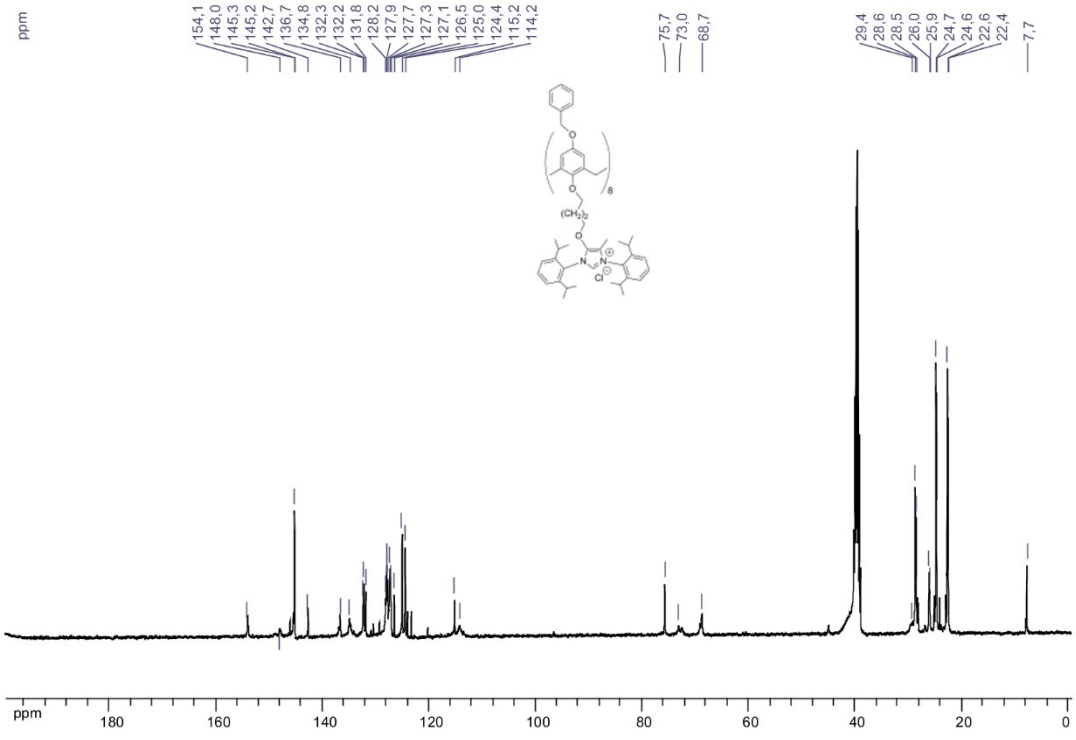
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127,1
126,5
125,0
124,4
115,2
114,2
75,7
73,0
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28,6
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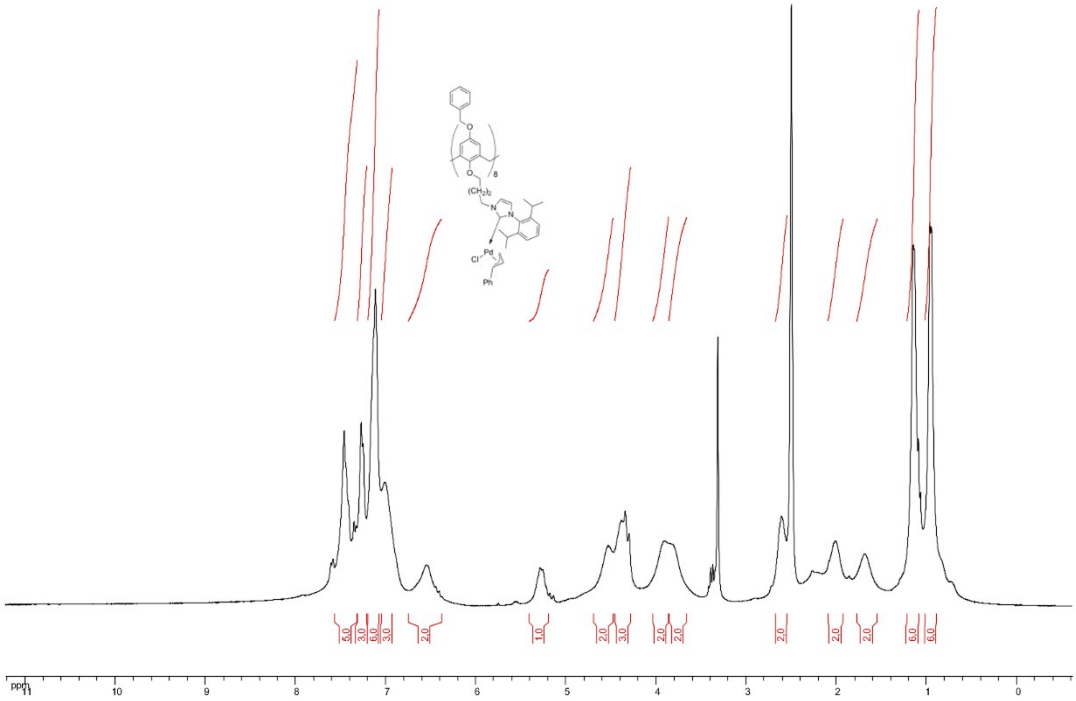
Cat 1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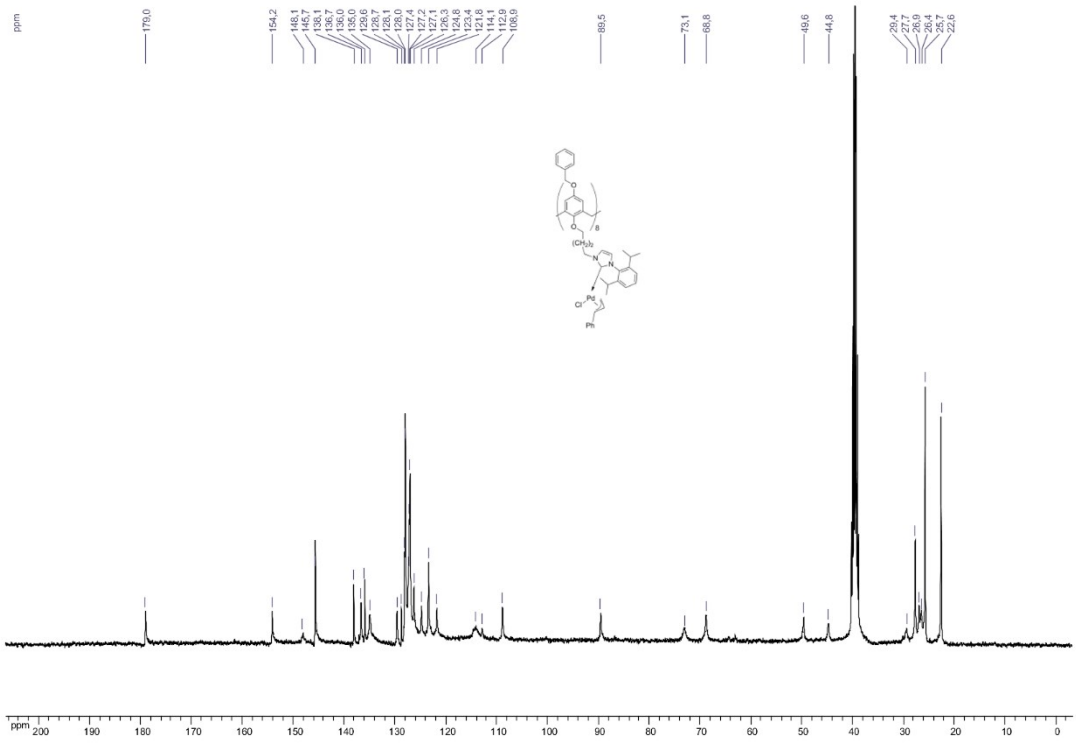
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127.2
127.1
126.3
124.8
123.4
121.6
114.1
112.9
108.9
89.5
73.1
68.8
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22.6
ppm
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190
180
170
160
150
140
130
120
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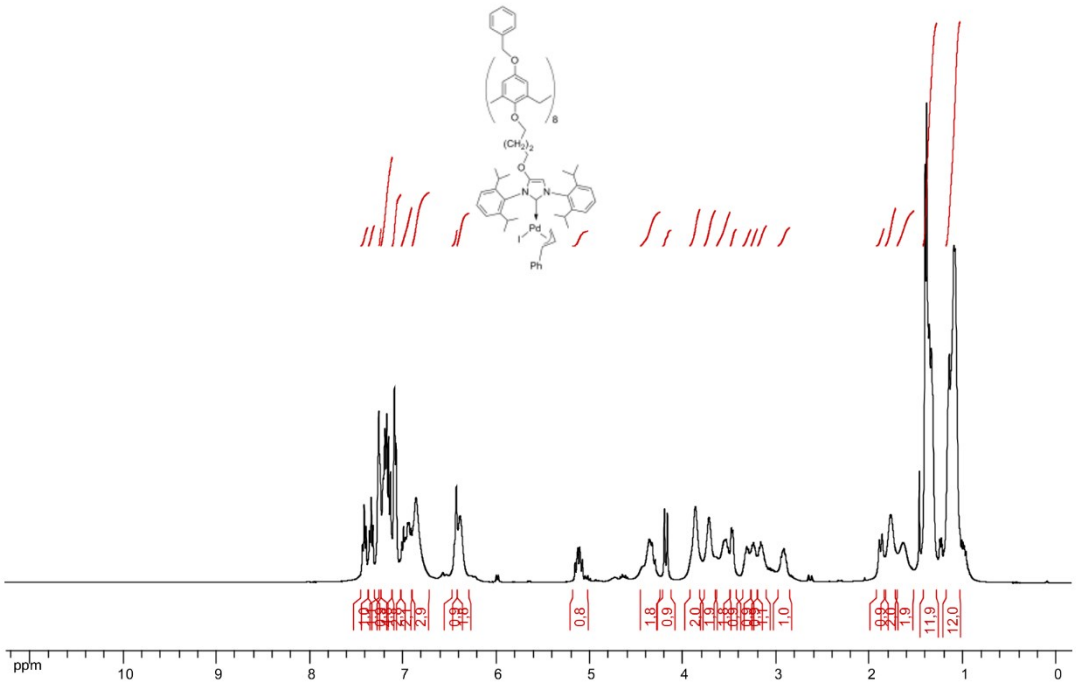
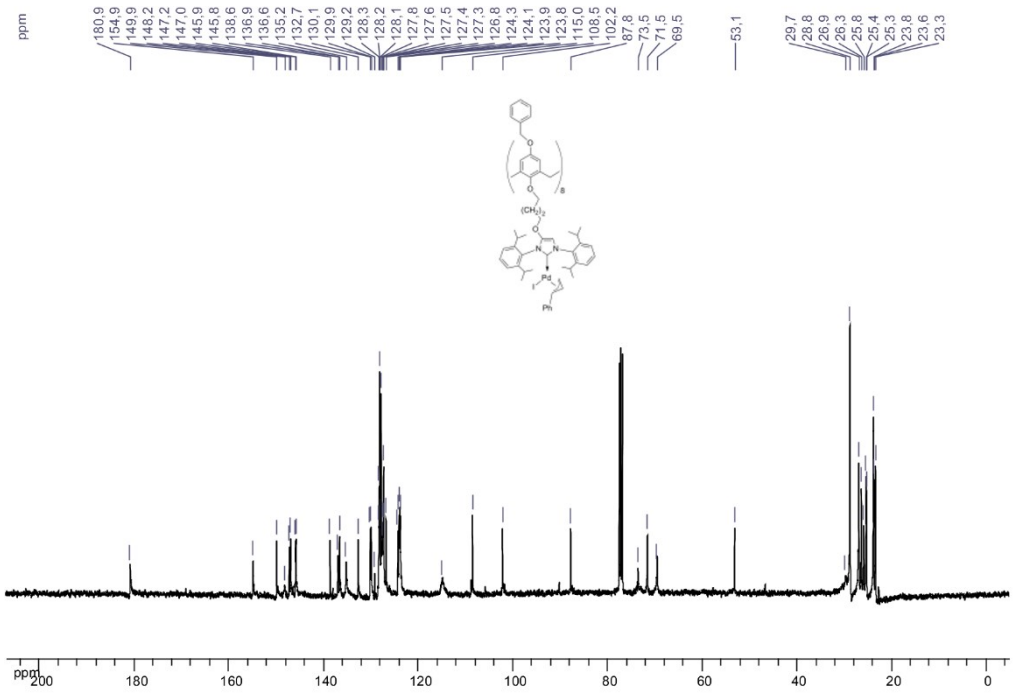
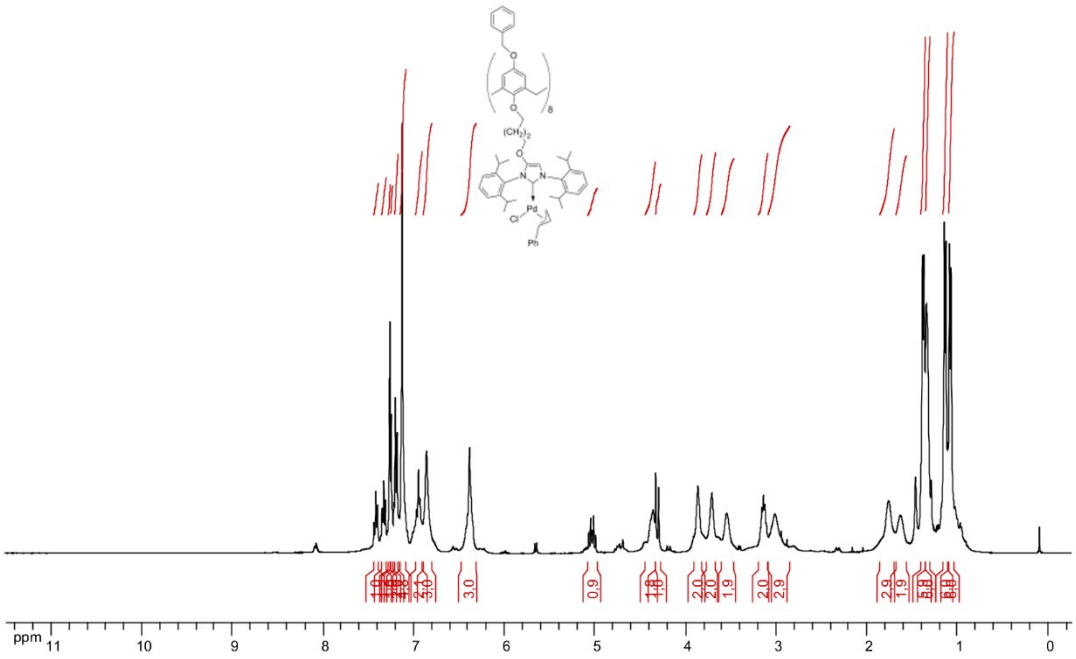
100
90
80
70
60
50
40
30
20
10
0

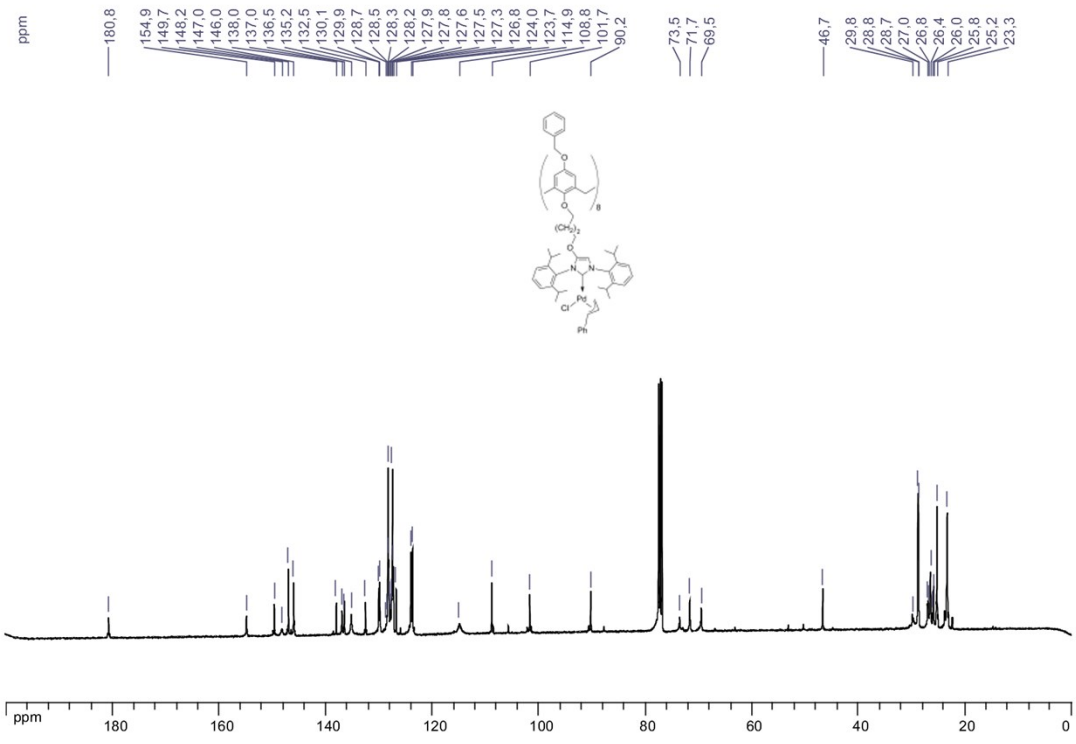
Cat 2: ^{1}H NMR spectrum recorded at 40 ˚C



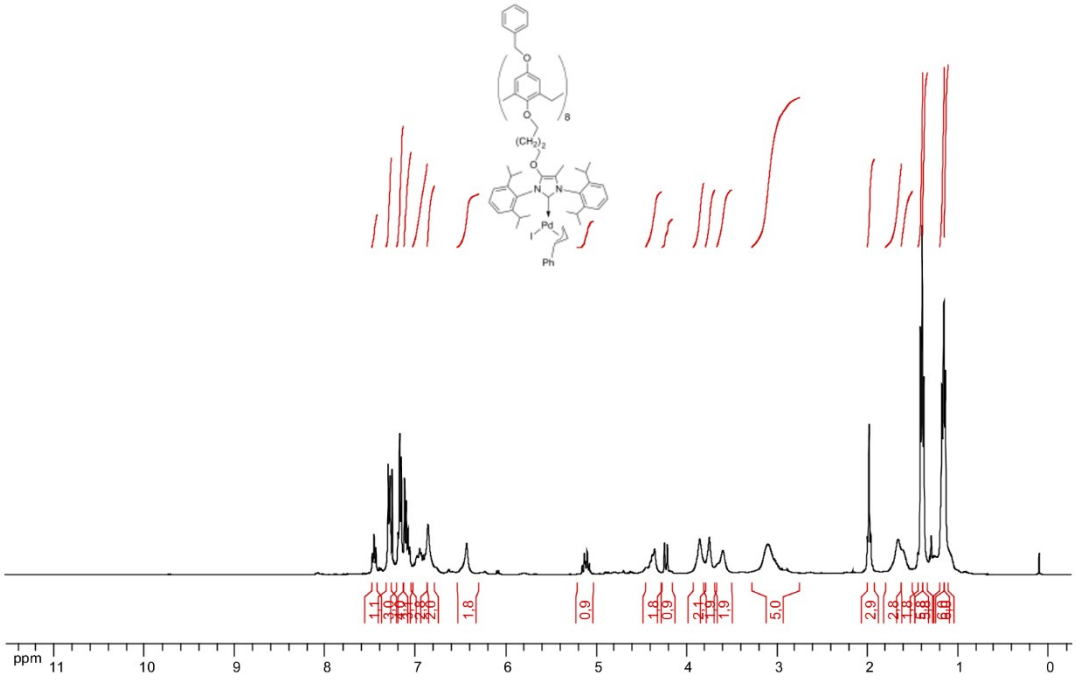


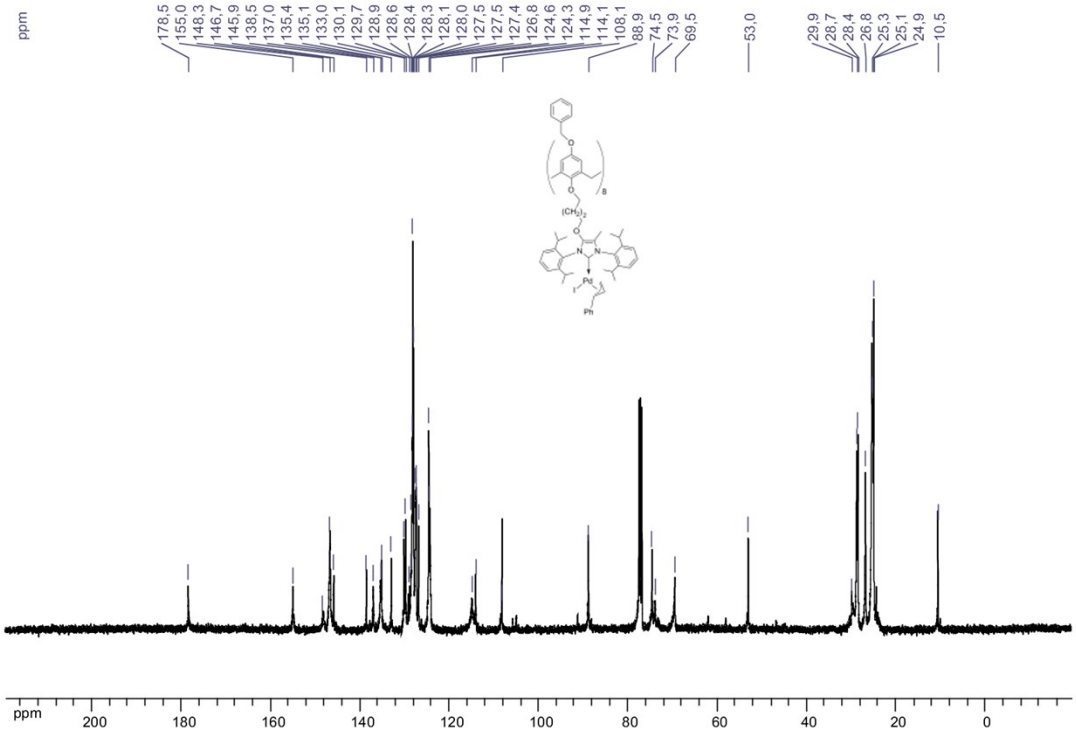
Cat 3: ^{1}H NMR spectrum recorded at 55 ˚C



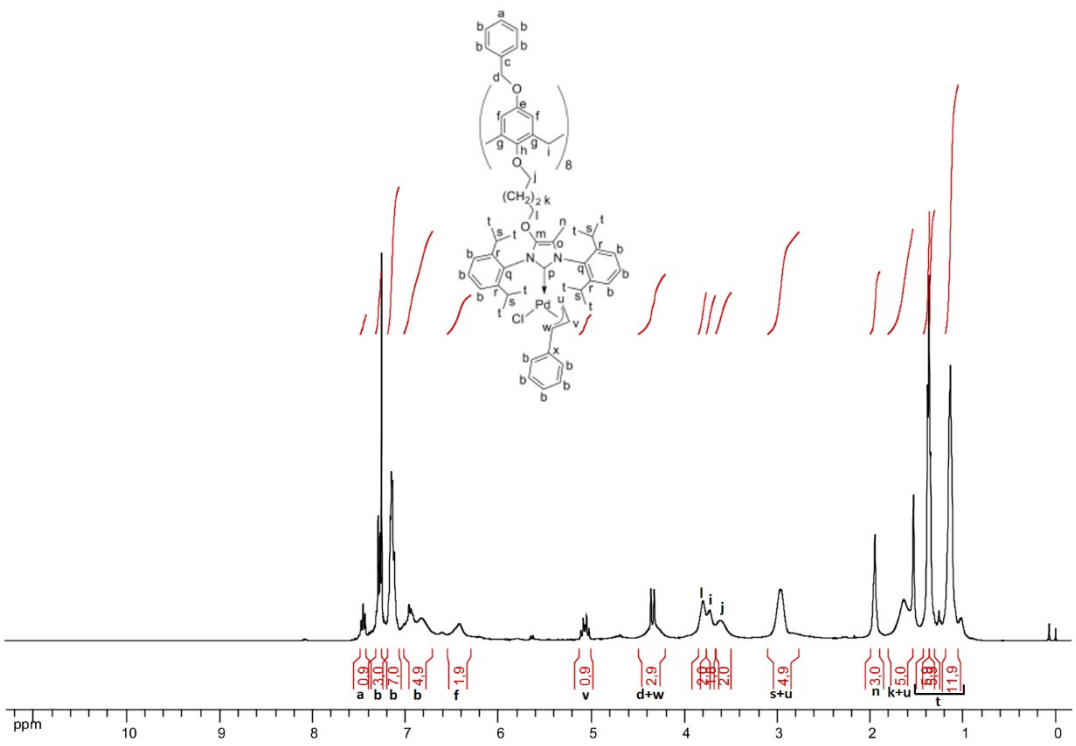


Cat 4: ^{1}H NMR spectrum recorded at 55 ˚C





Cat 5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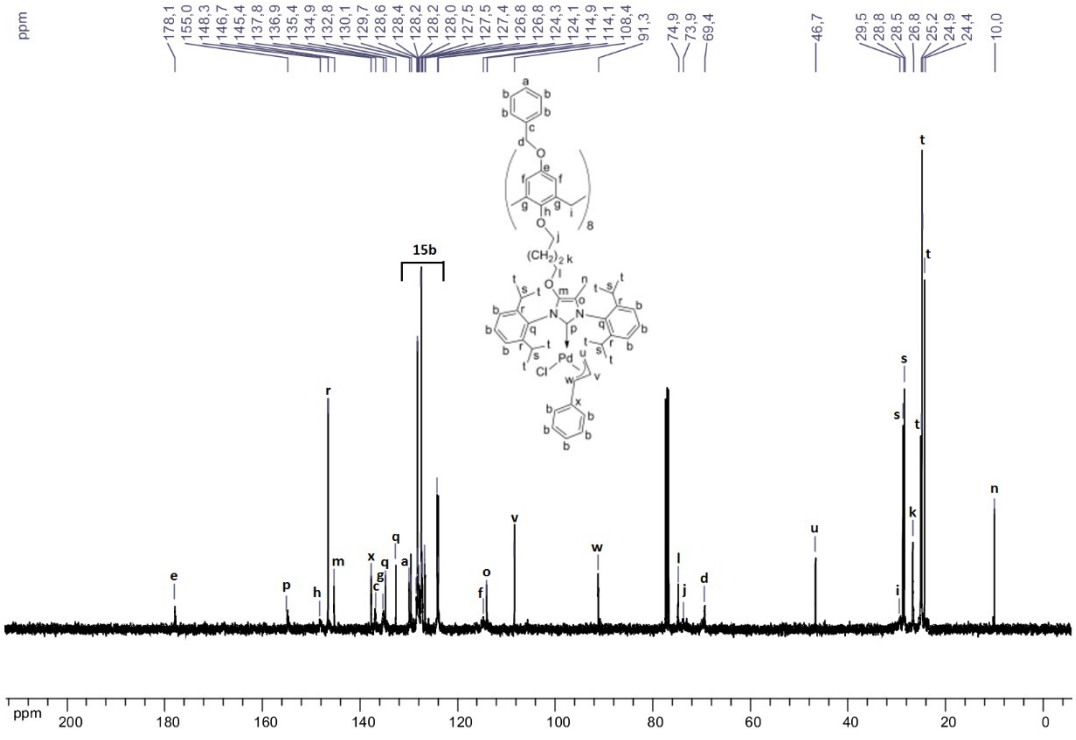
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124,3
124,1
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108,4
91,3
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73,9
69,4
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26,8
25,2
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15b
ppm
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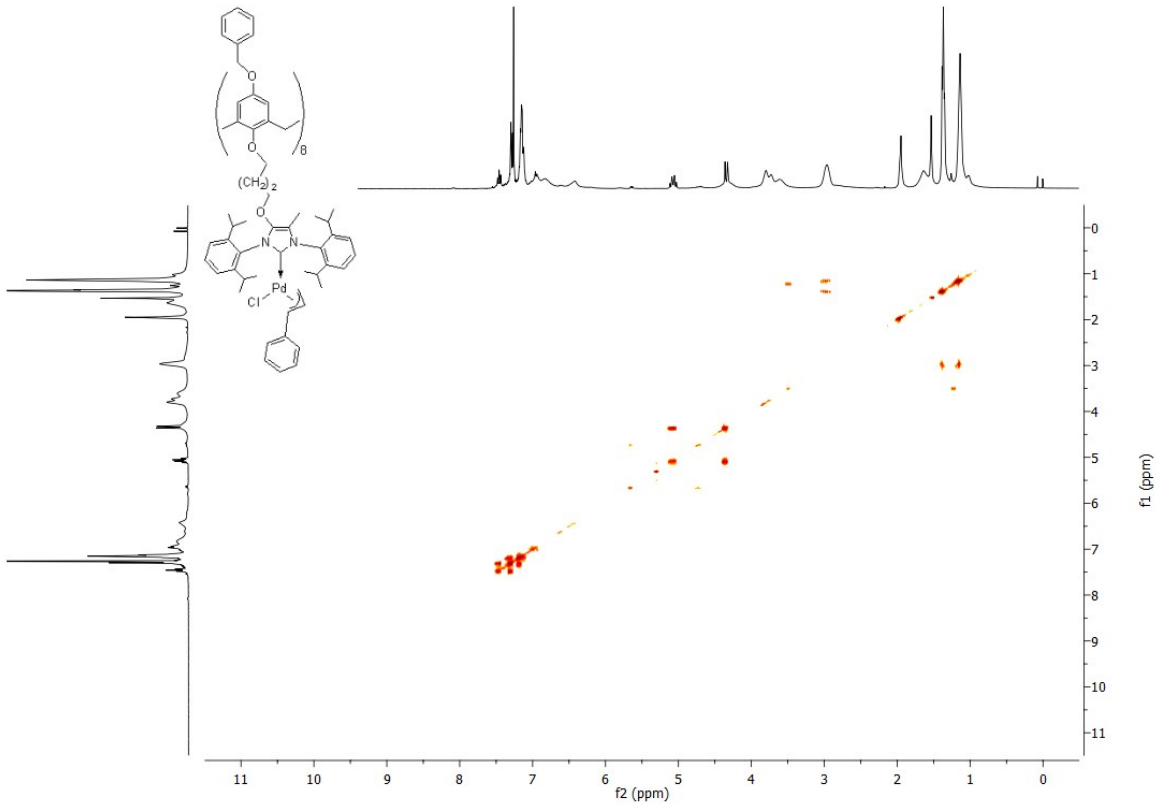
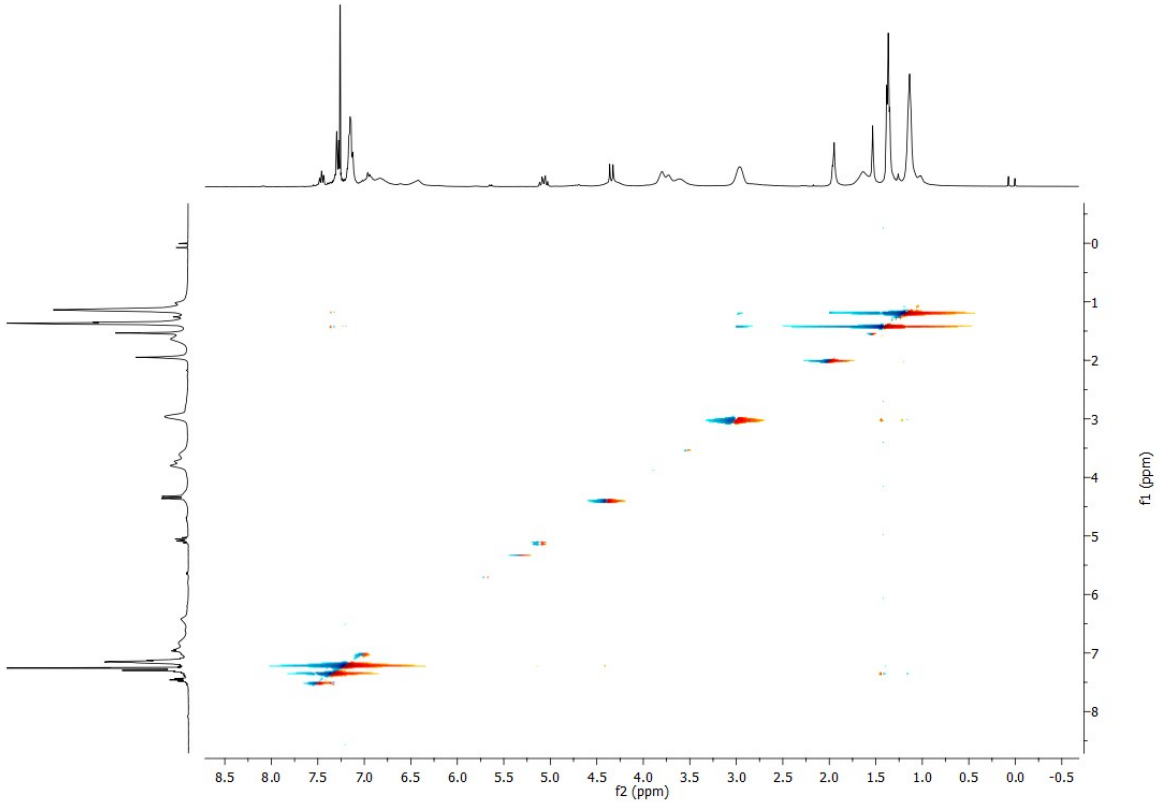
80
60
40
20
0

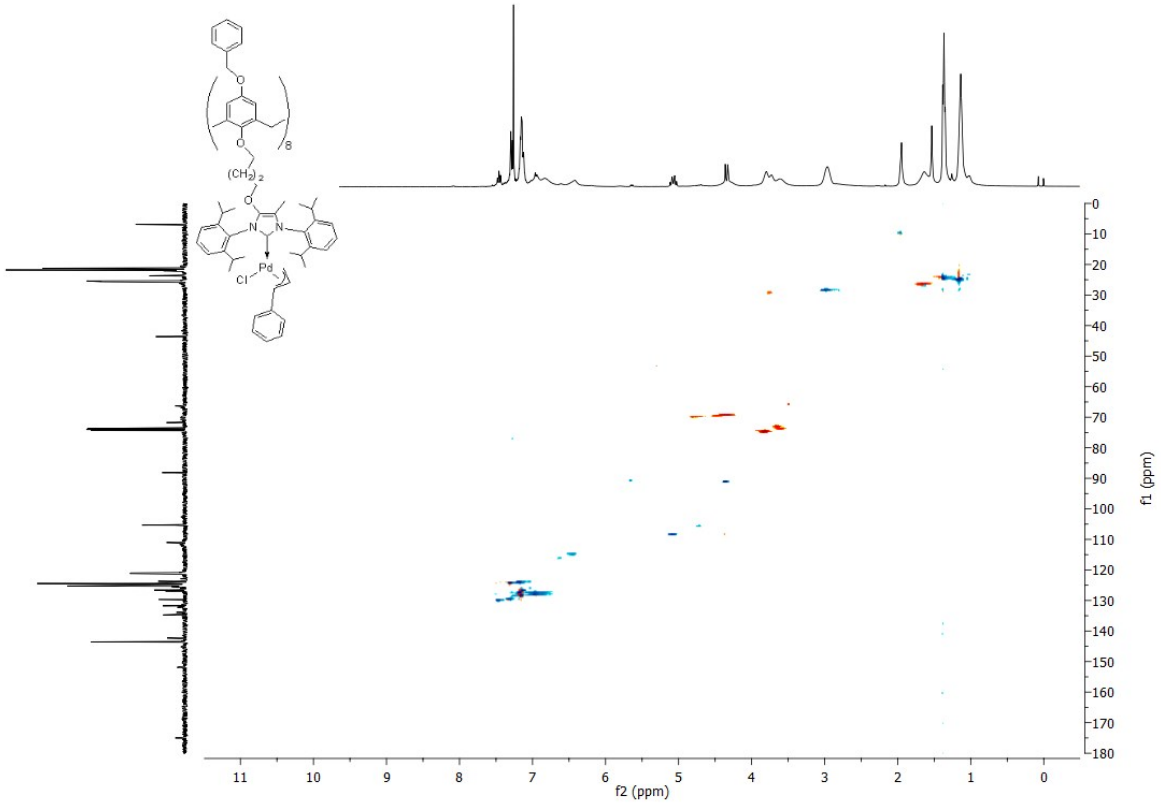
Cat 5: Cosy 2D NMR spectrum



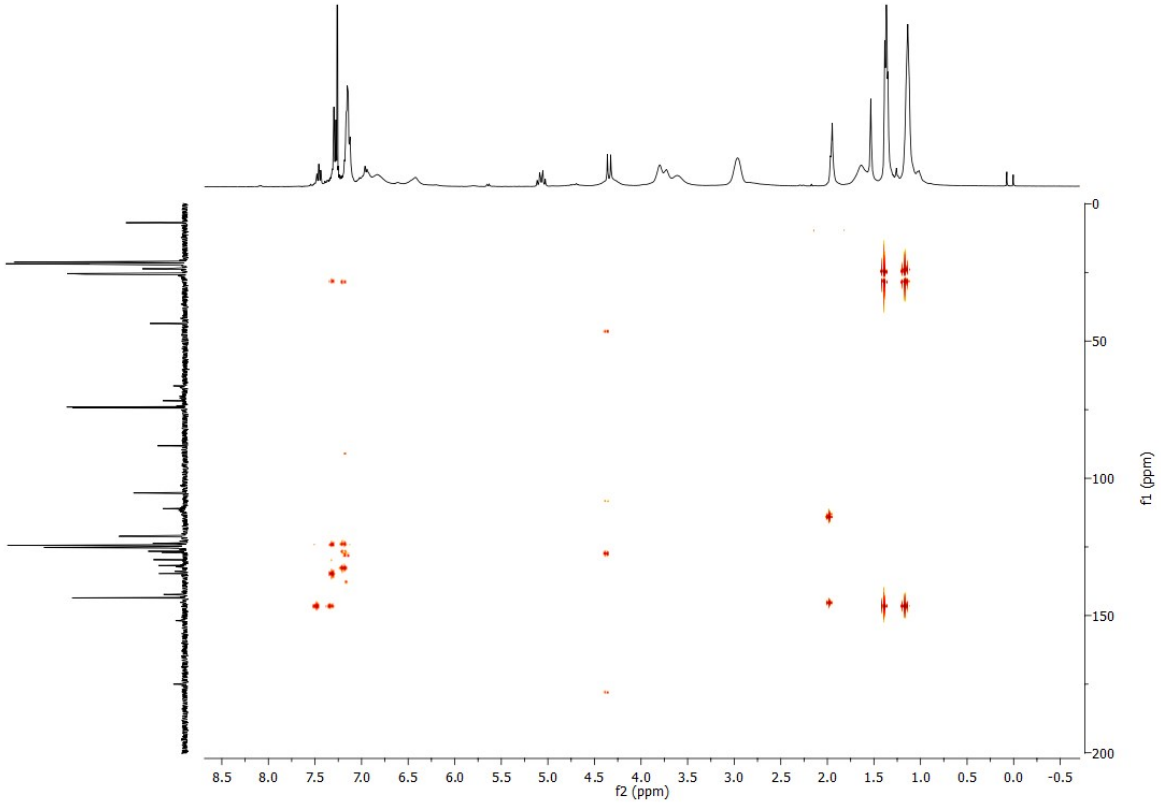
Cat 5: Roesy 2D NMR spectrum



Cat 5: HSQC 2D NMR spectrum

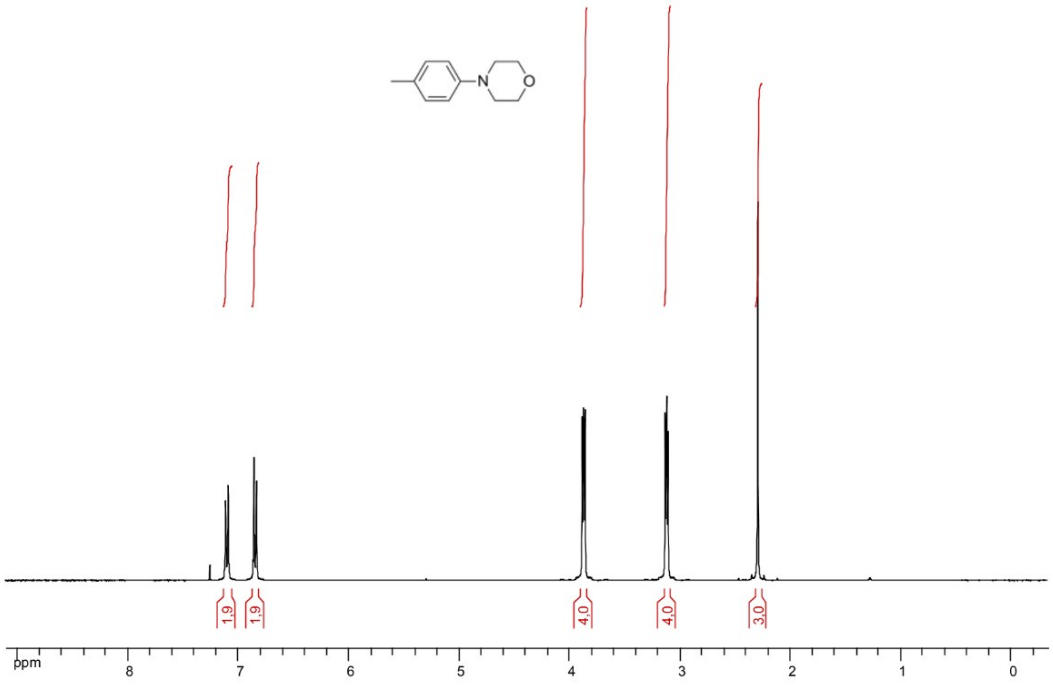


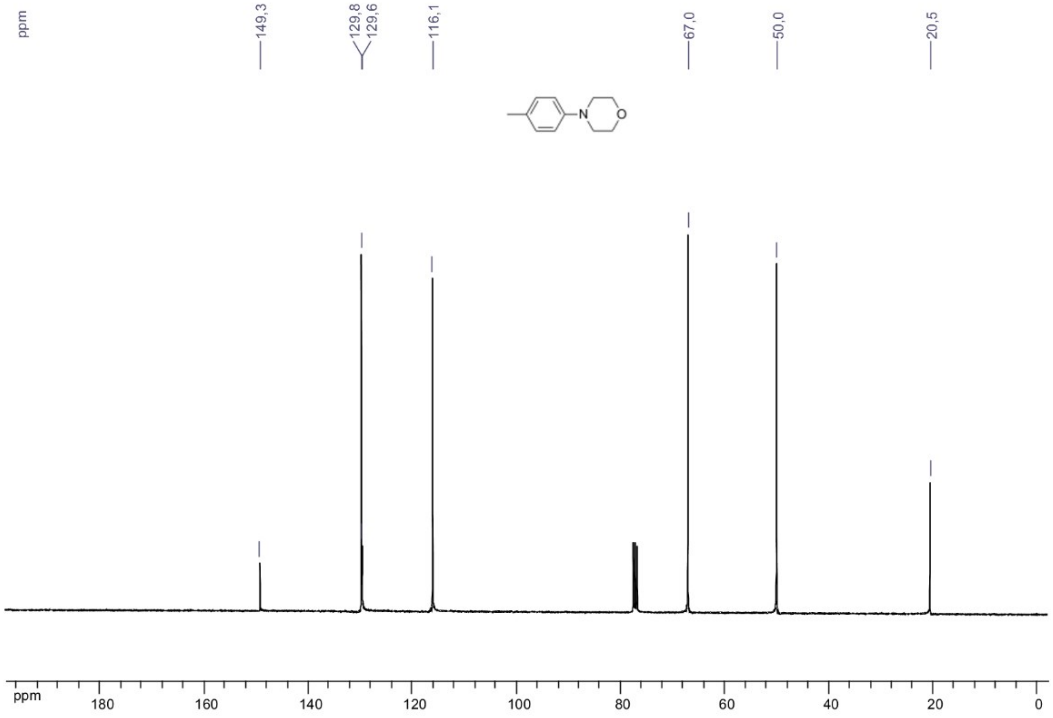
Cat 5: HMBC 2D NMR spectrum



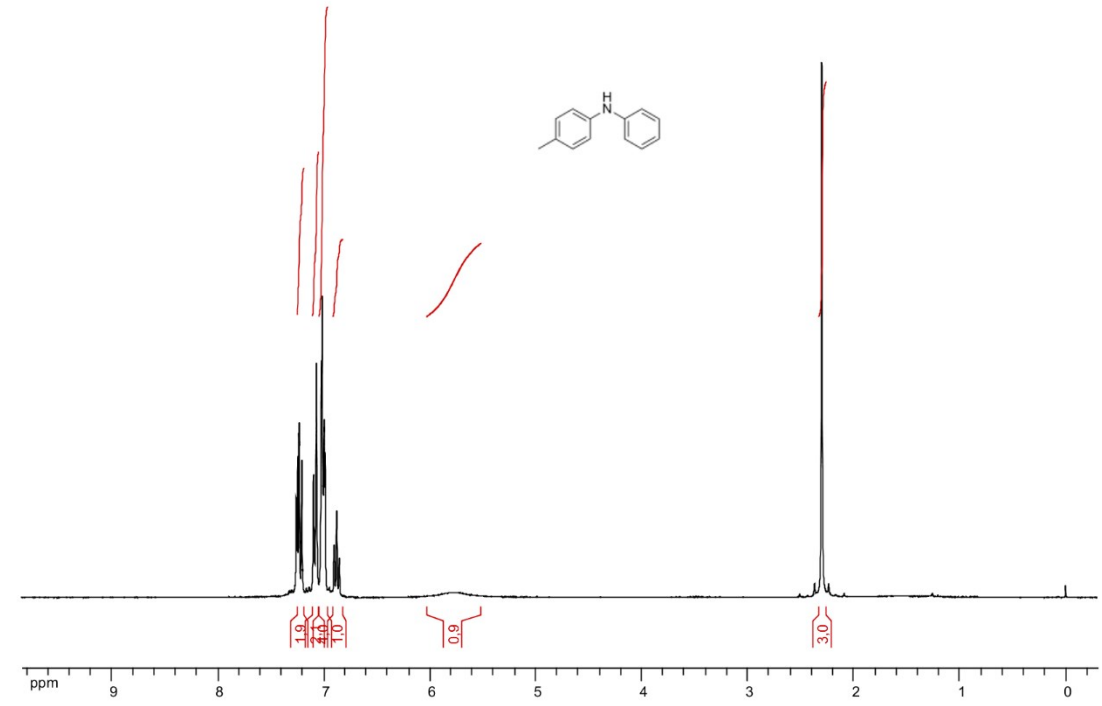
XV. NMR spectra of the Buchwald-Hartwig coupling products

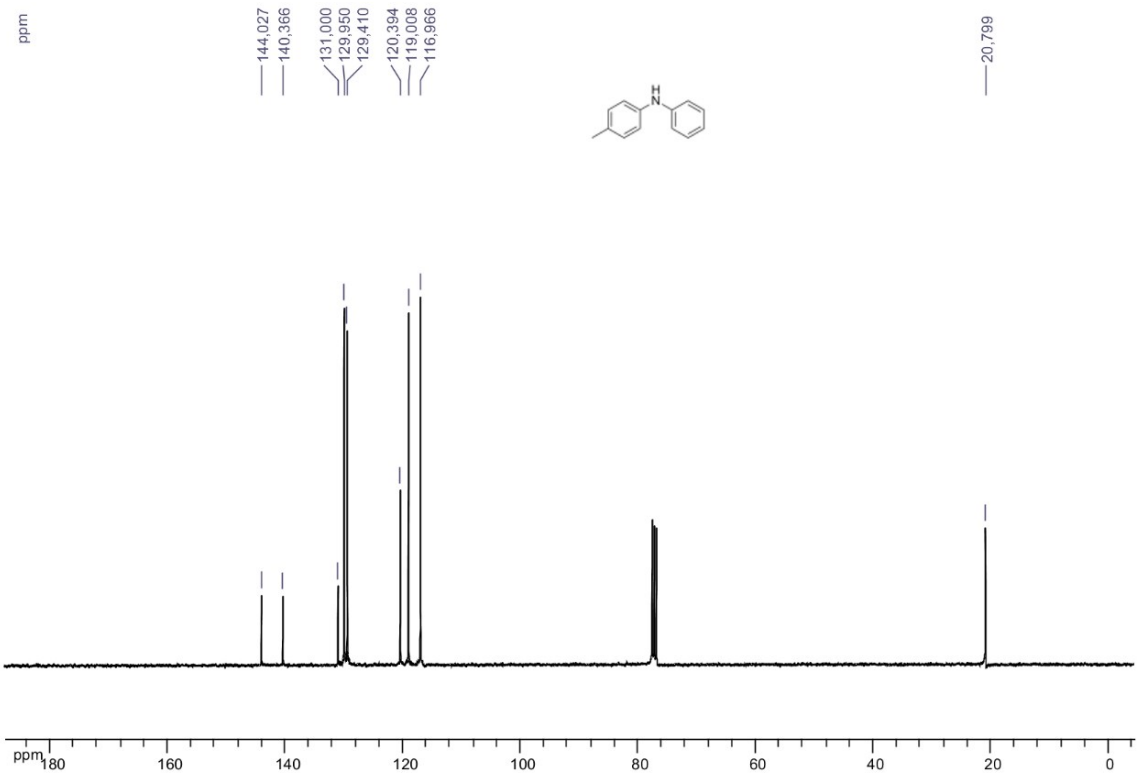
N-(4-Tolyl)morpholine



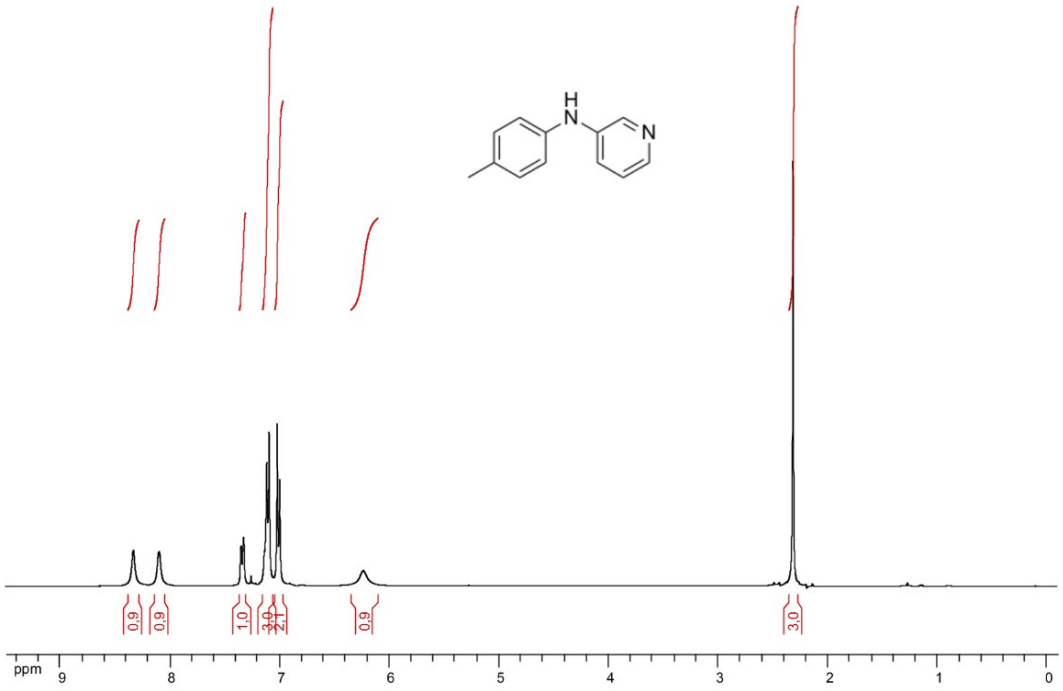


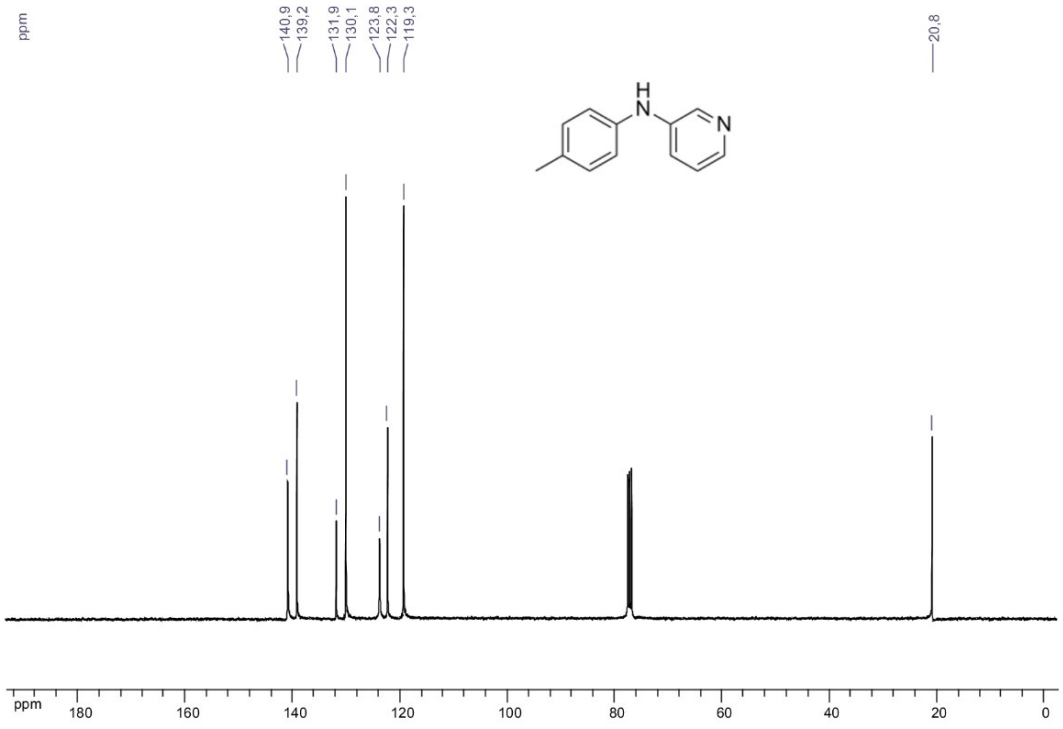
***N*-(4-Tolyl)aniline**



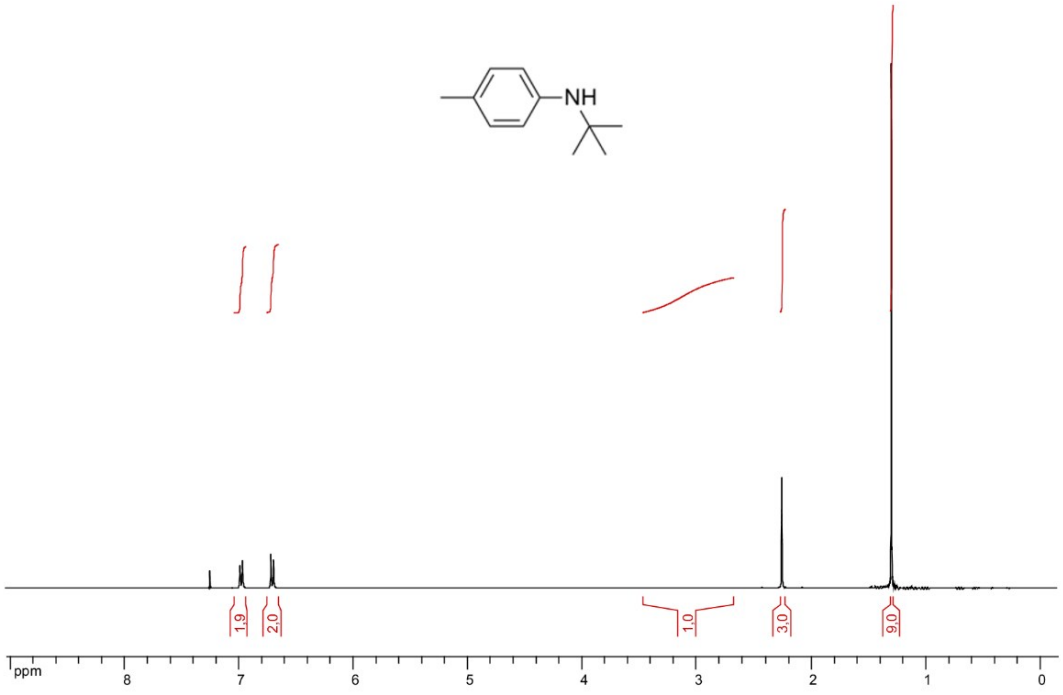


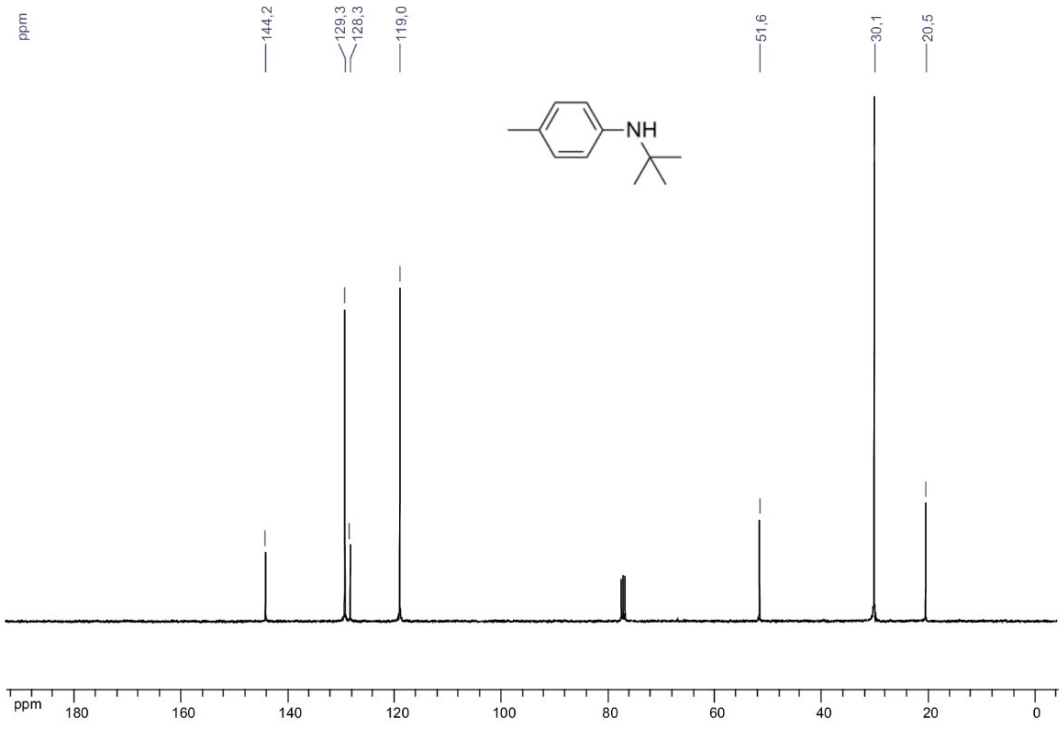
***N*-(3-Pyridyl)-4-methylaniline**



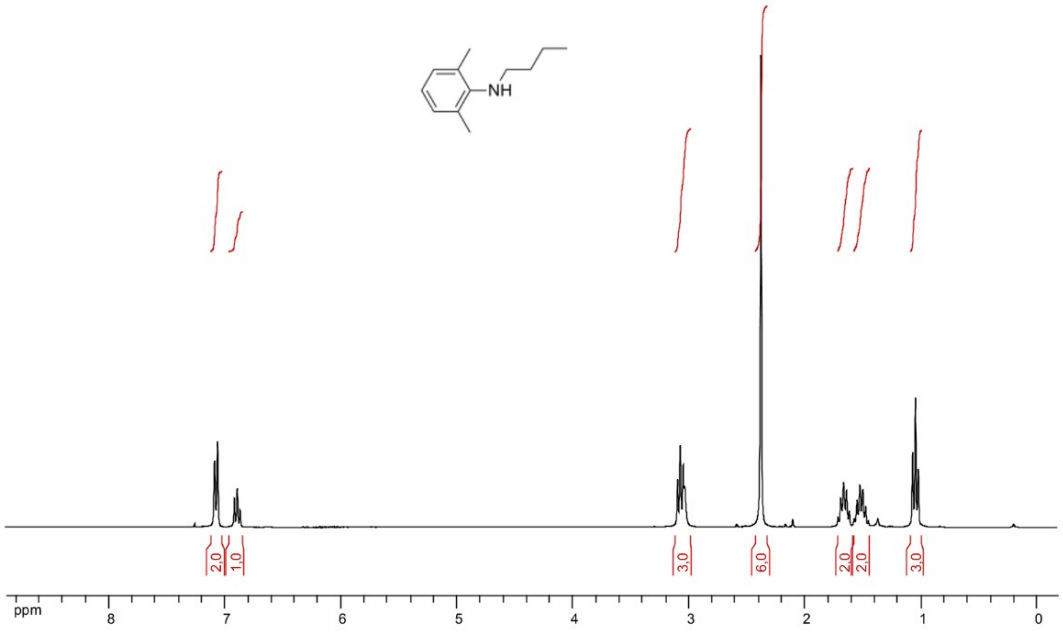


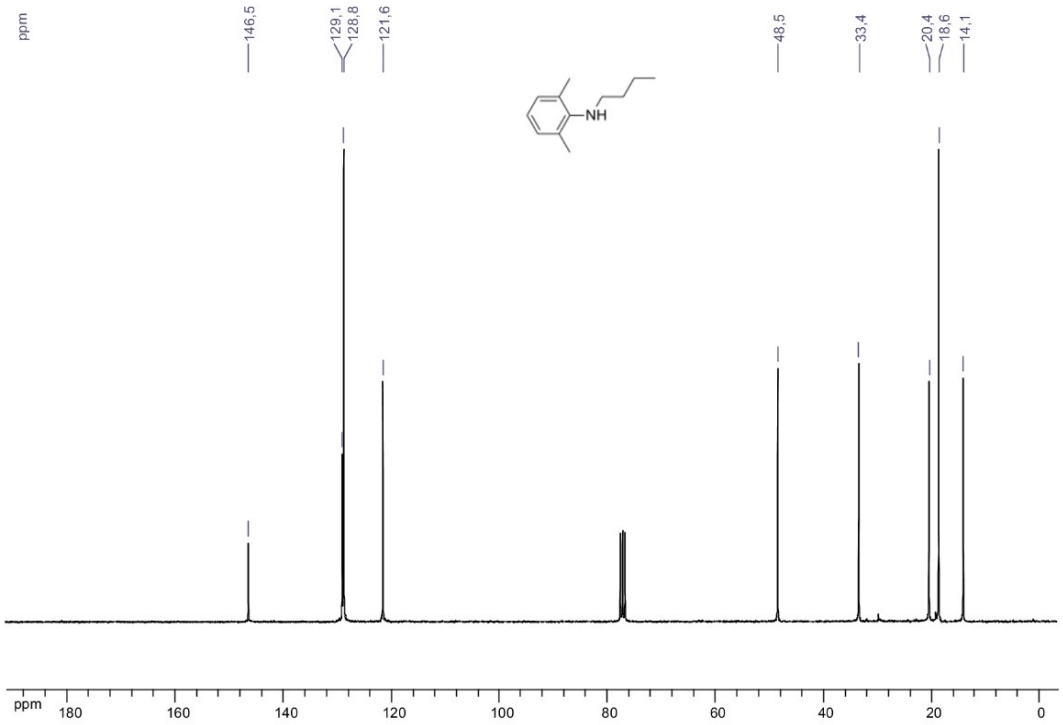
***N-tert*-Butyl-4-methylaniline**



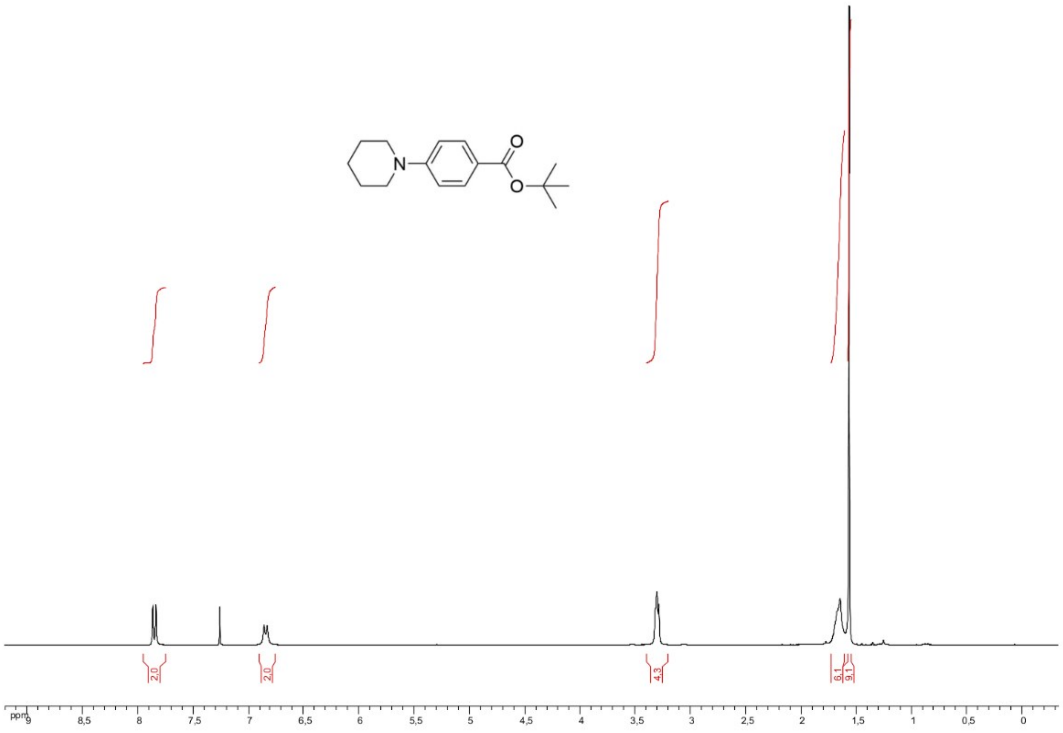


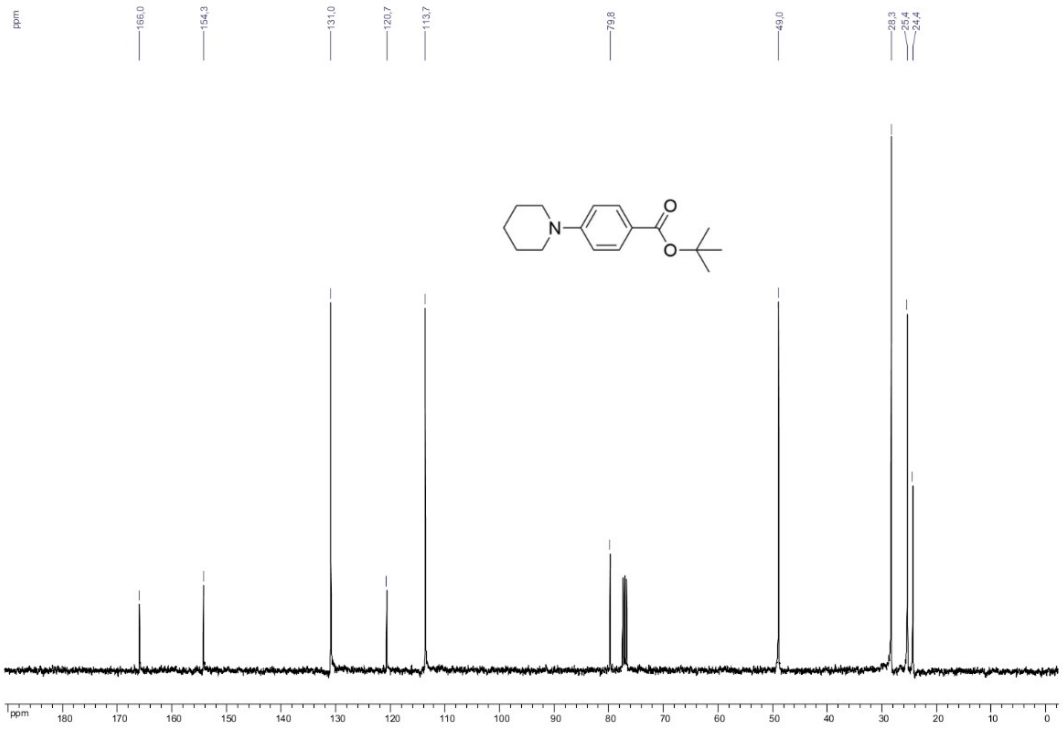
***N*-*n*-Butyl-*N*-(2,6-dimethylphenyl)-amine (5)**



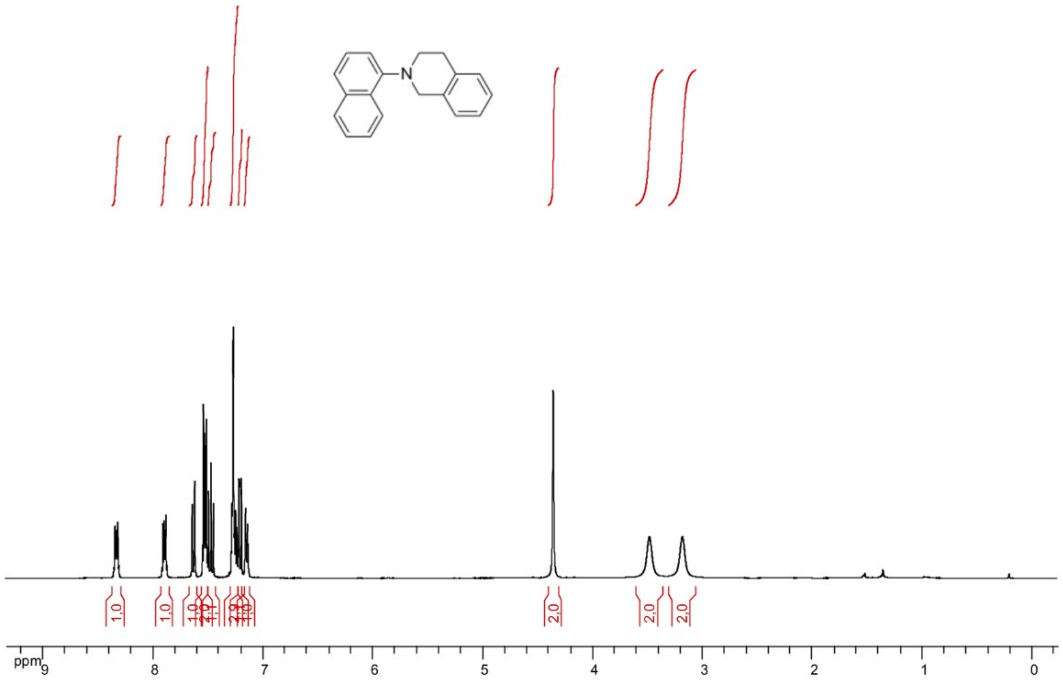


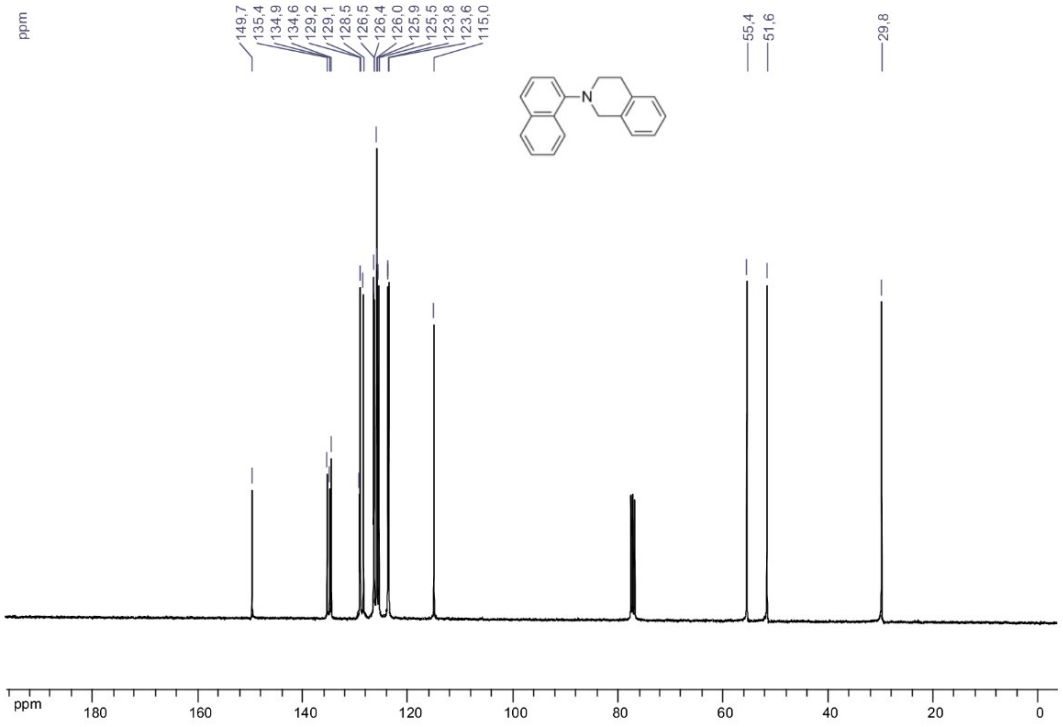
***N*-[4-(*tert*-Butylcarbonyl)phenyl]-piperidine (6)**



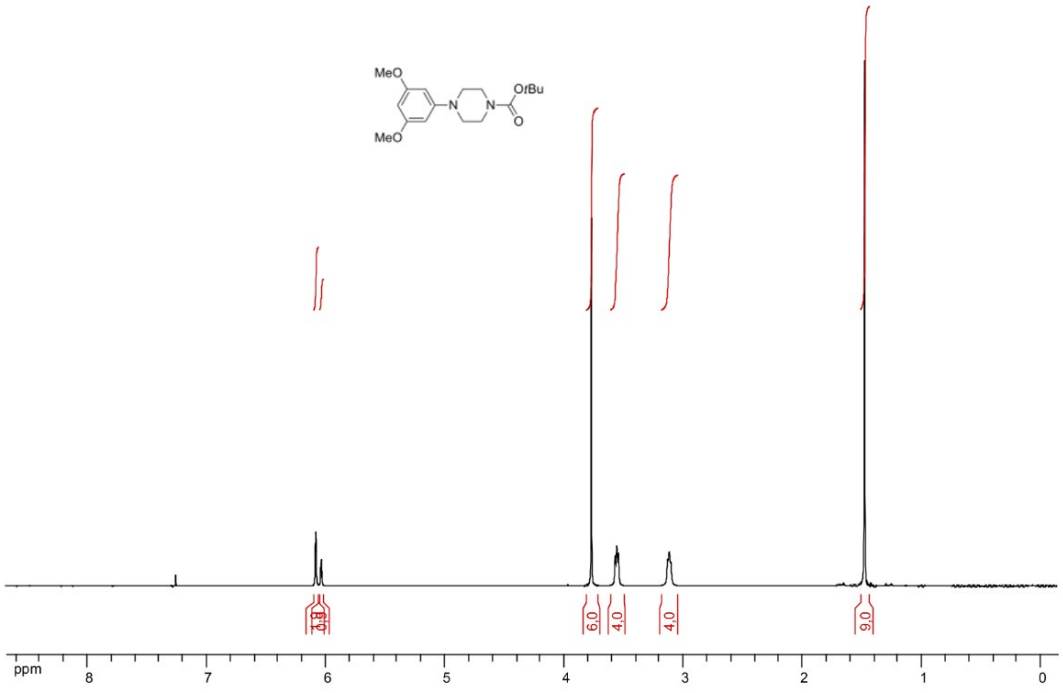


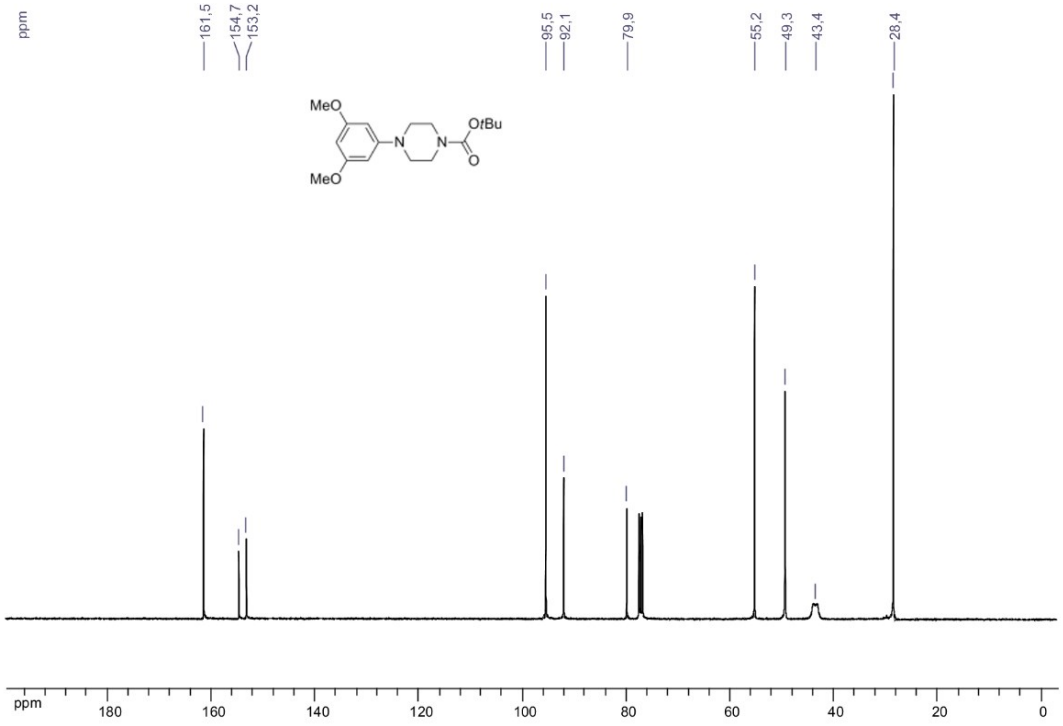
***N*-(1-Naphthyl)-1,2,3,4-tetrahydroisoquinoline (7)**



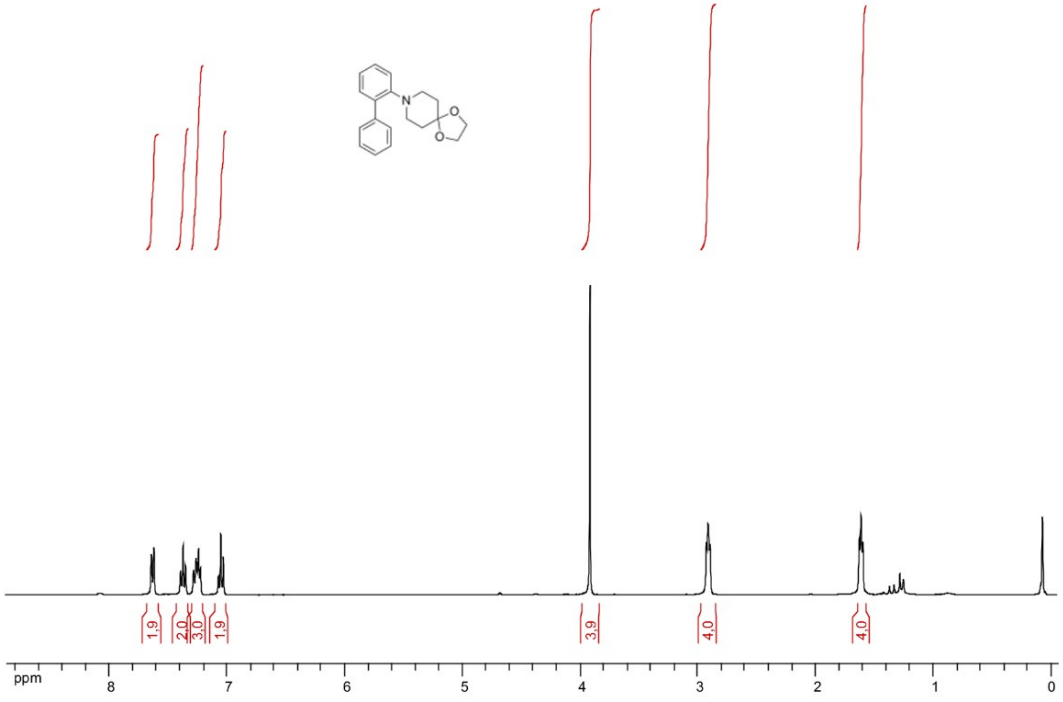


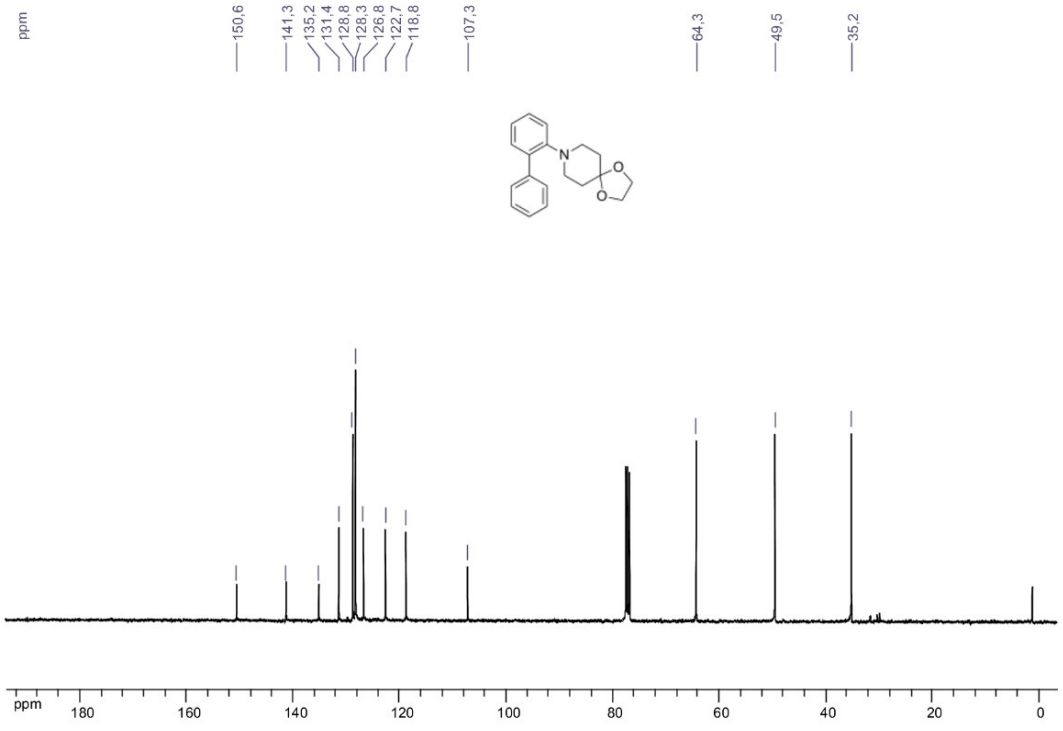
***N*-Boc-*N'*-(3,5-dimethoxyphenyl)piperazine (8)**



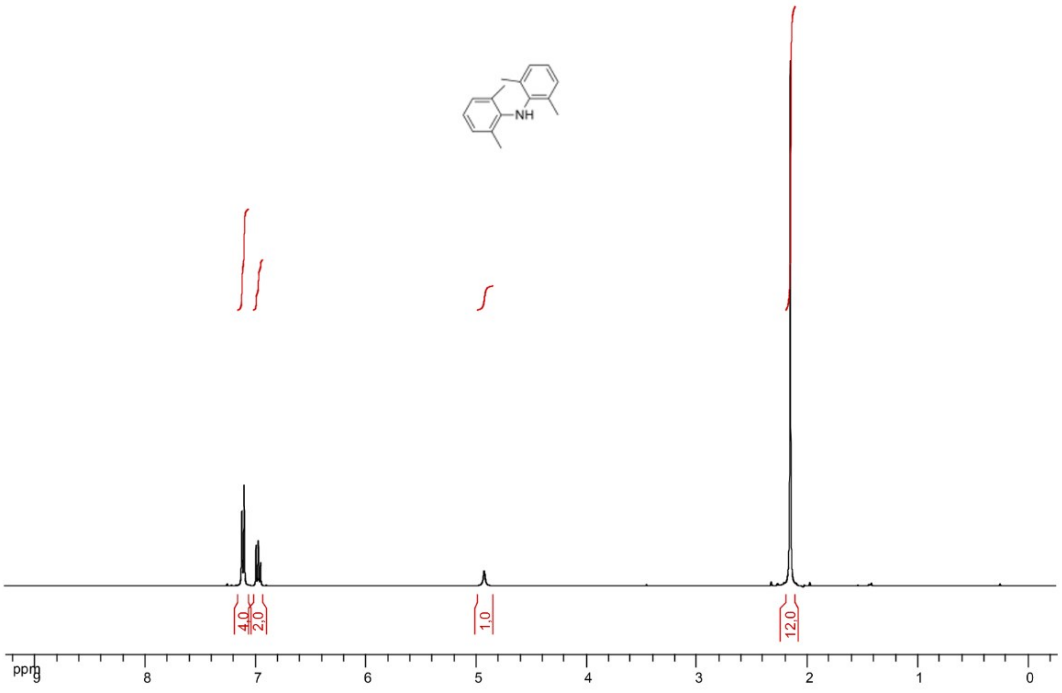


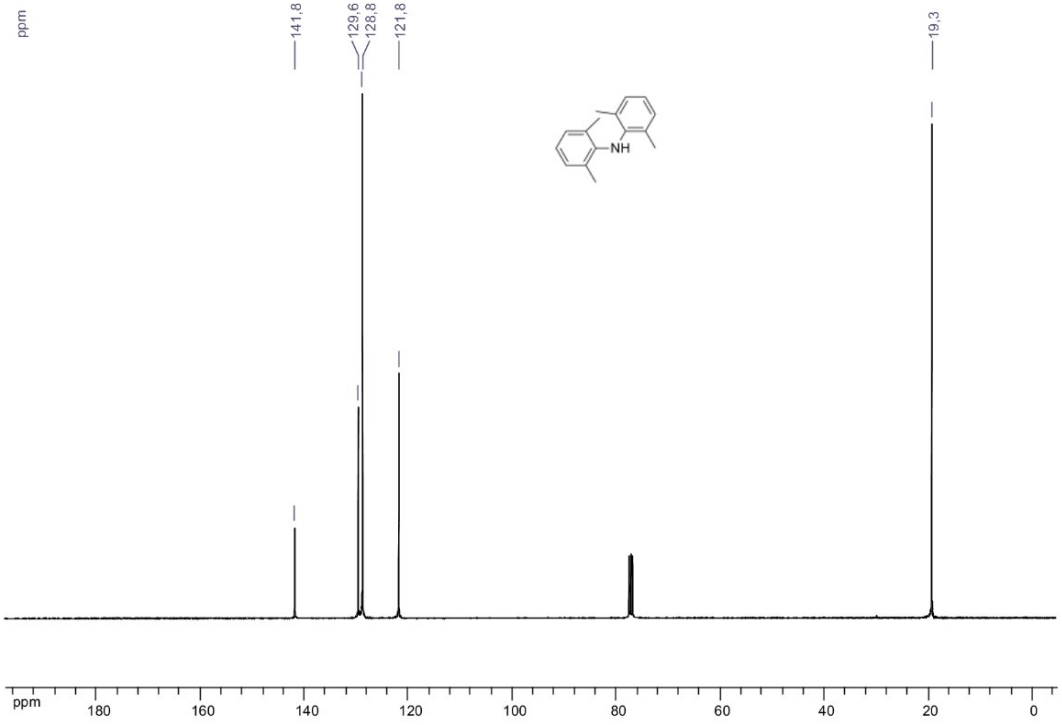
***N*-(2-Biphenylyl)-4-piperidone ethylene ketal (9)**



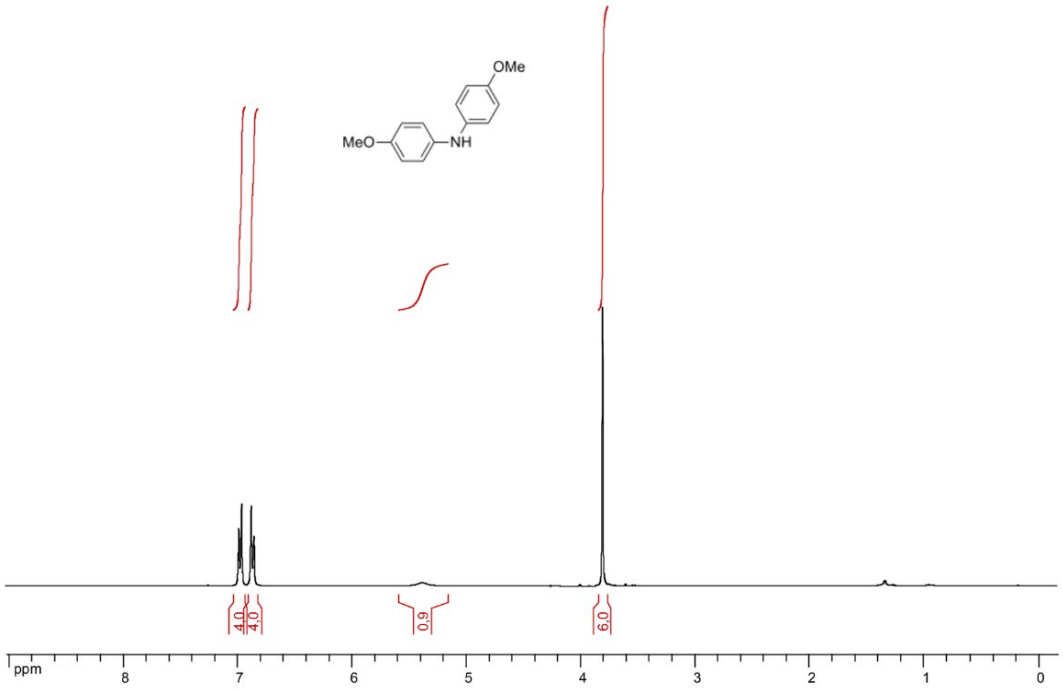


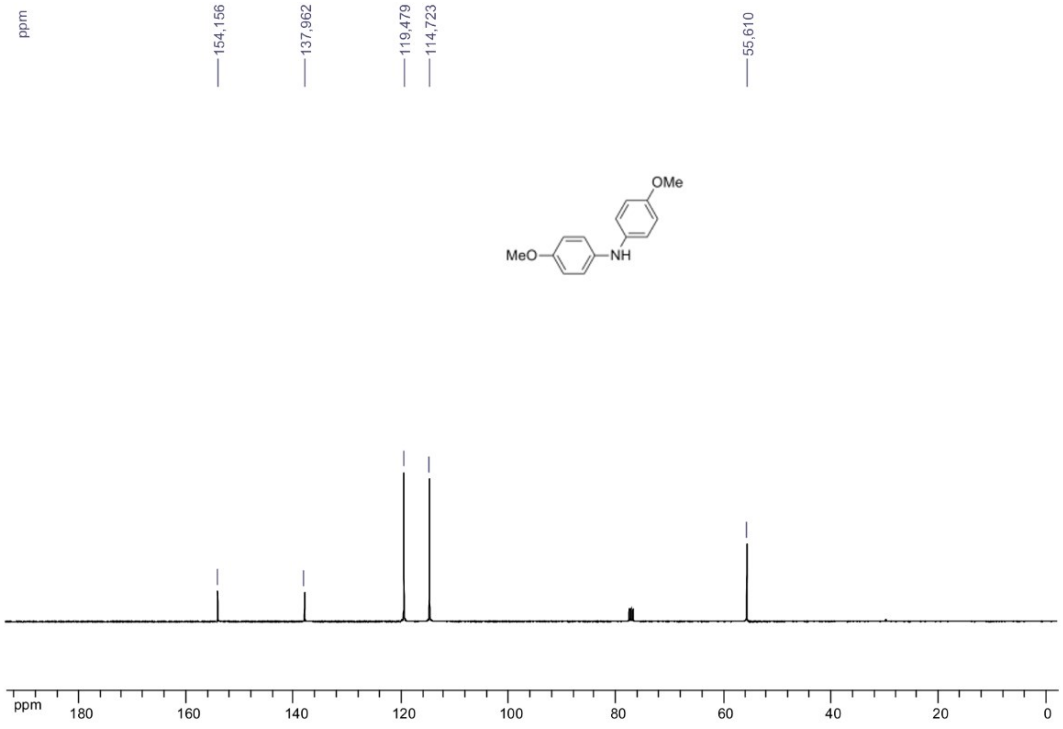
***N*,*N*-Bis-(2,6-dimethylphenyl)amine (10)**



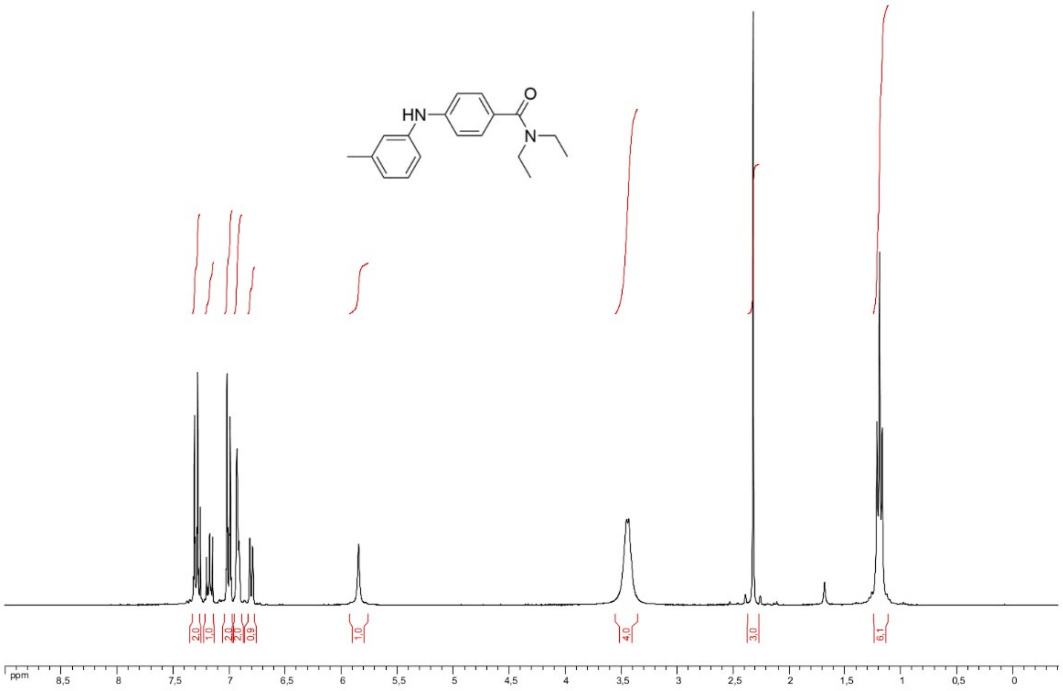


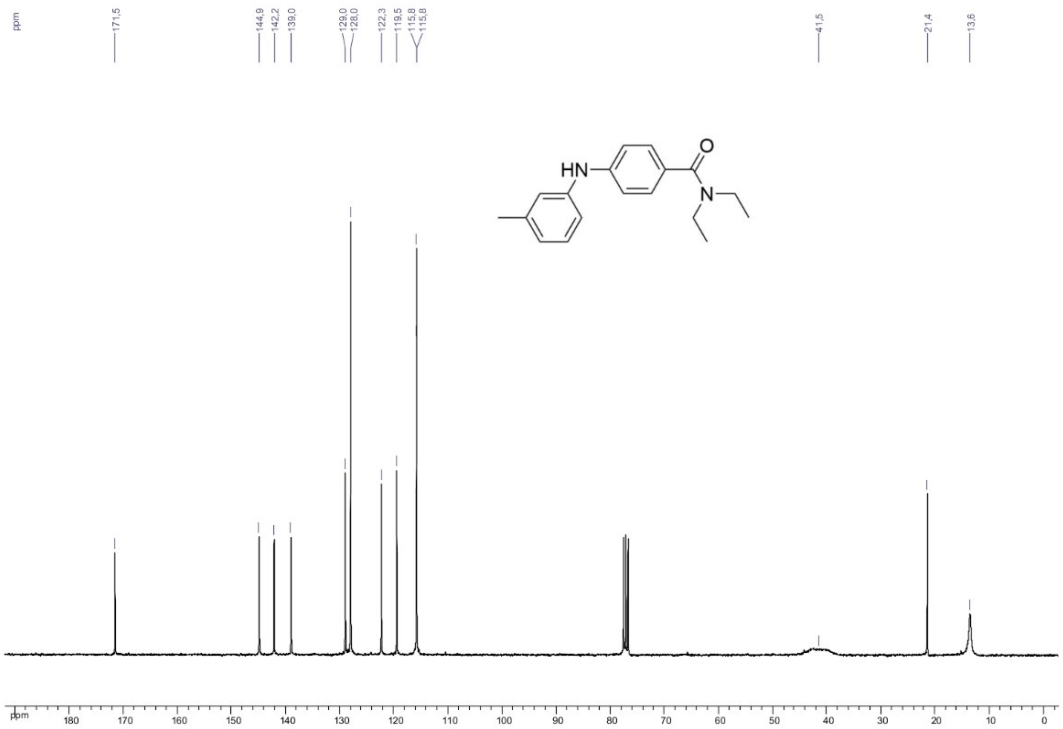
***N,N*-Bis-(4-methoxyphenyl)amine (11)**



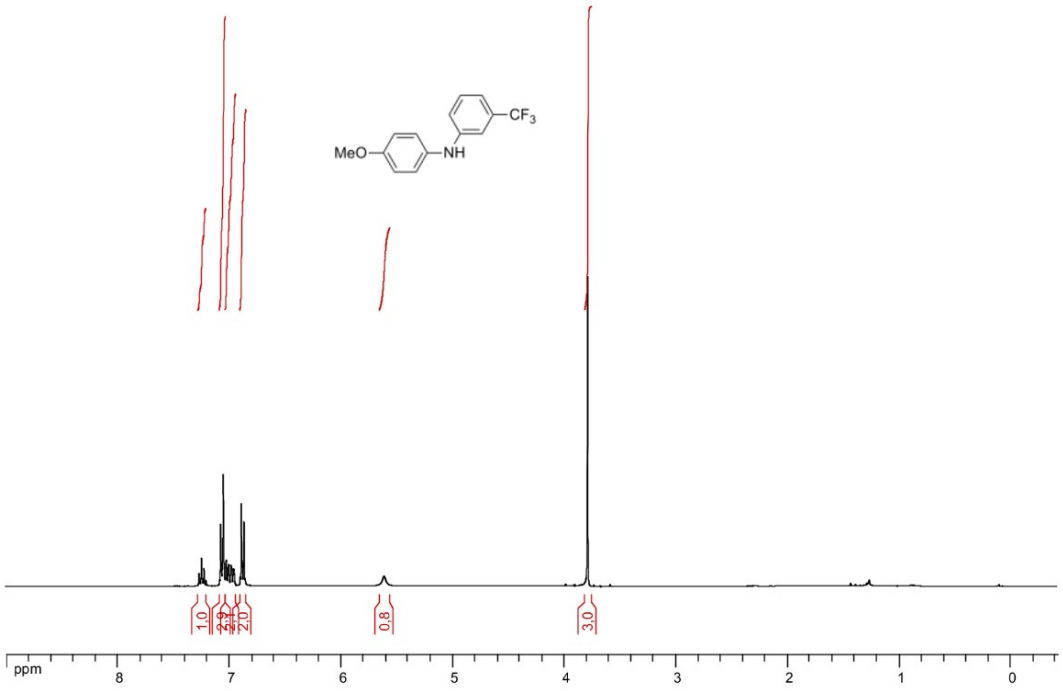


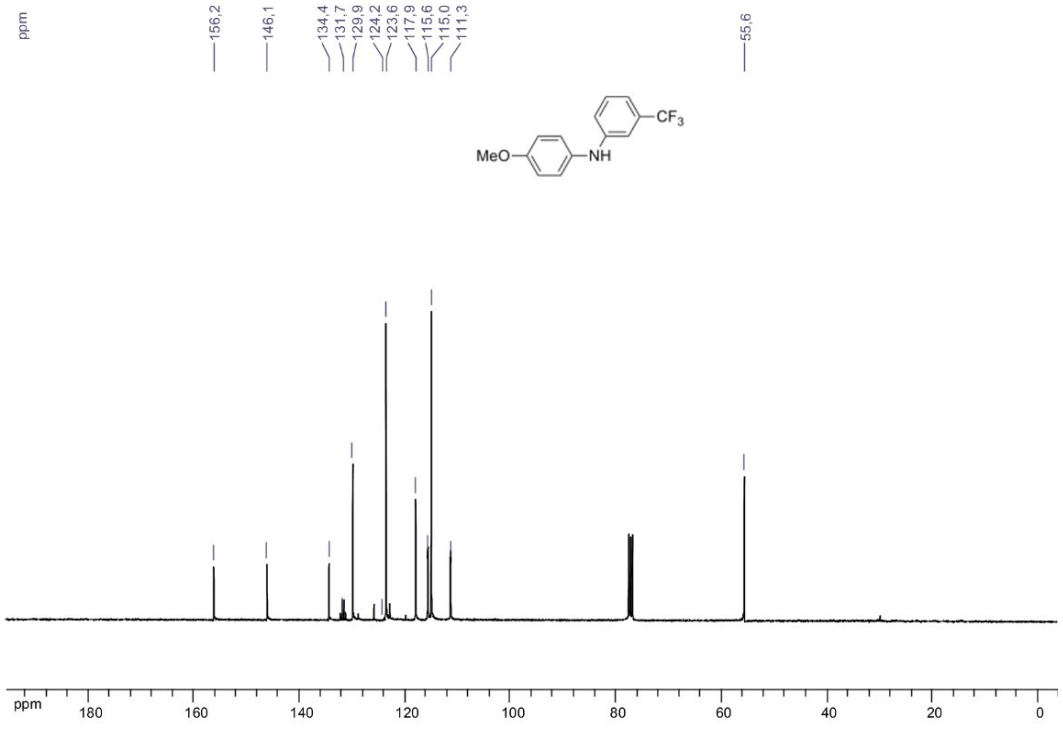
***N*-[4-(*N*',*N*'-Diethylbenzamido)]-*N*-(3-tolyl)amine (12)**

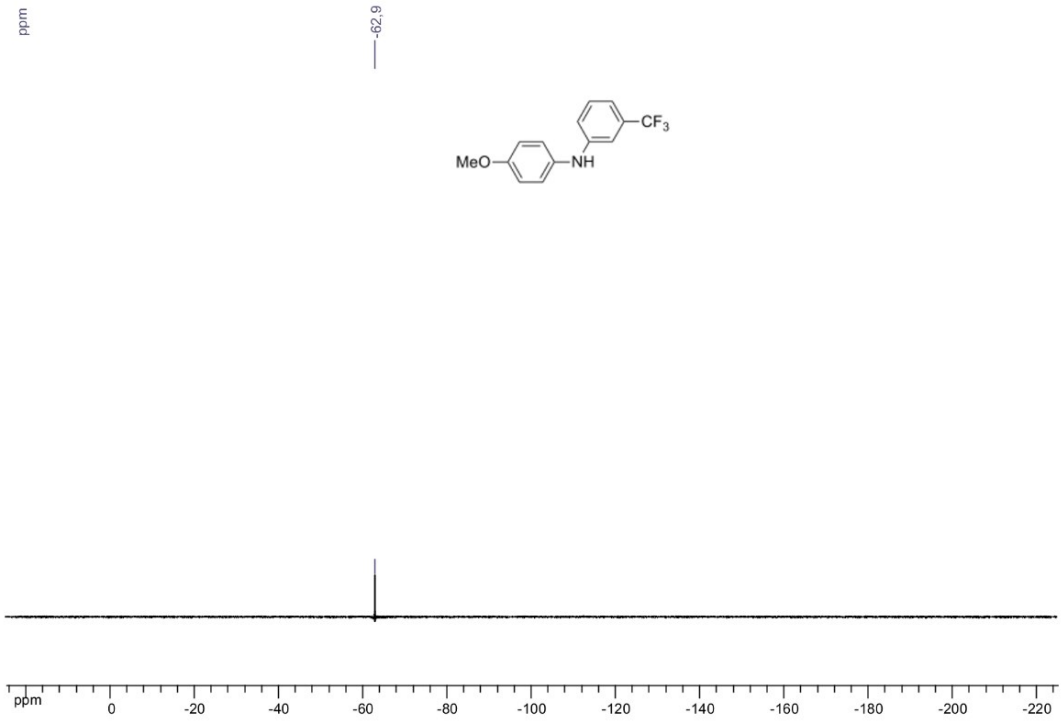




***N*-(4-Methoxyphenyl)-3-(trifluoromethyl)aniline (13)**



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NH
ppm
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-40
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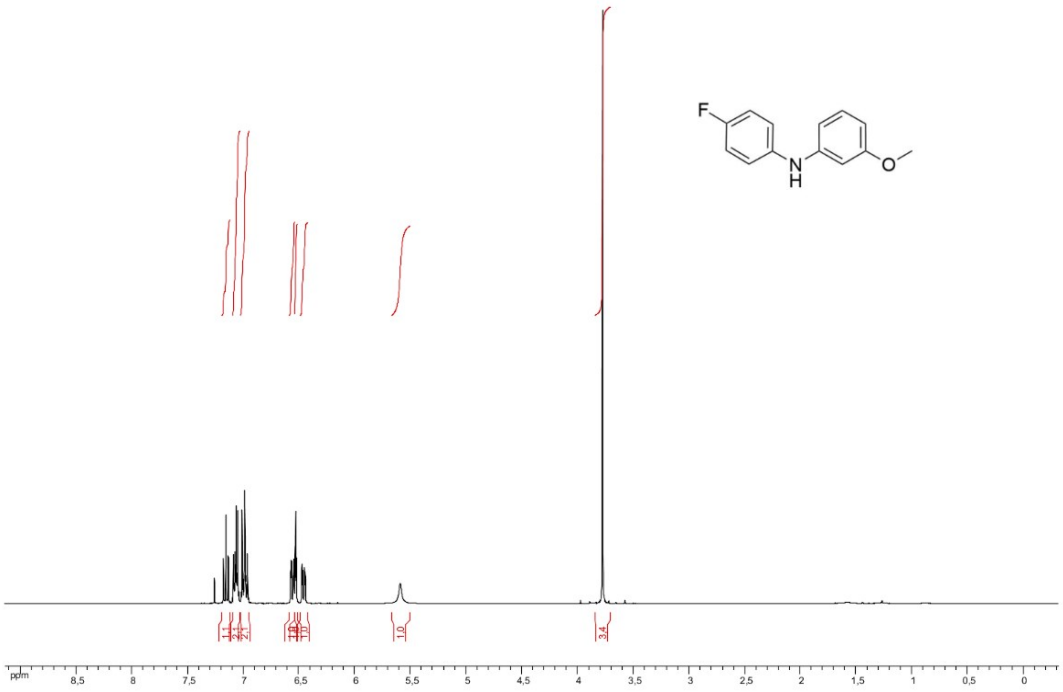
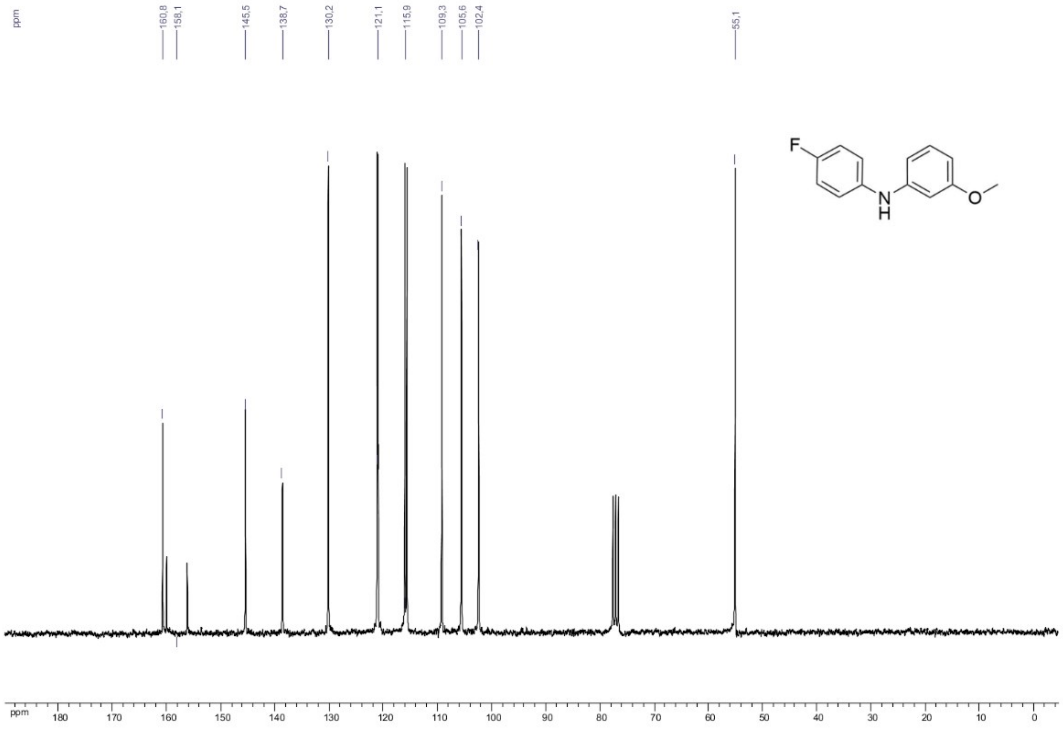
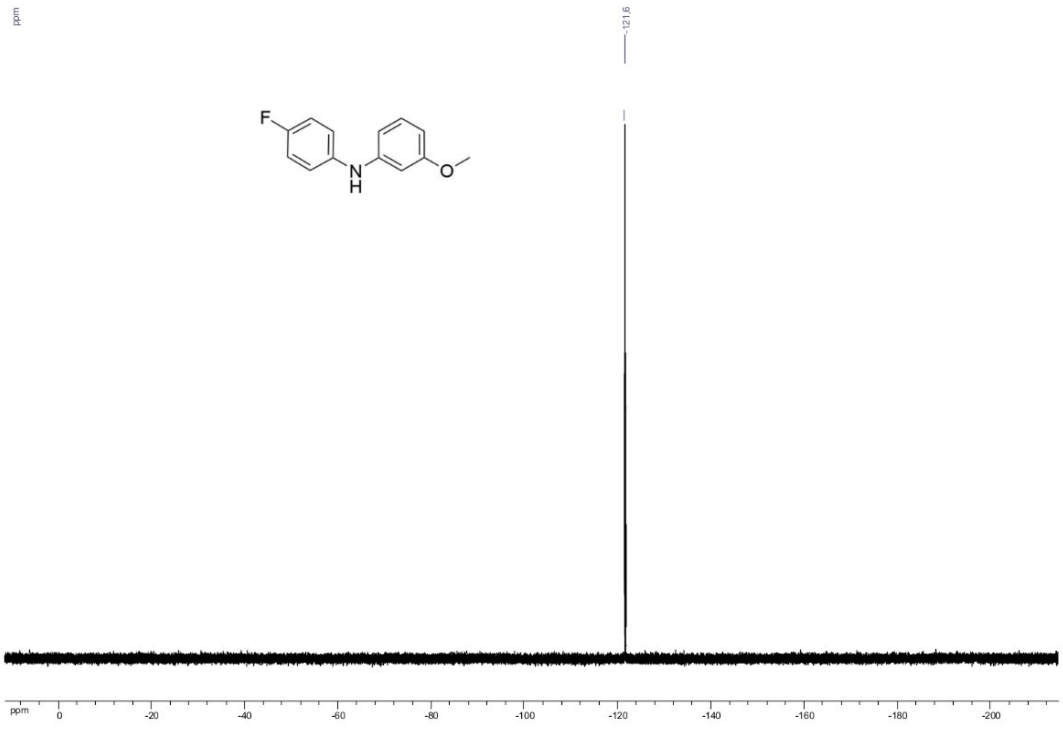
-160
-180
-200
-220

***N*-(4-Fluorophenyl)-*N*-(3-methoxyphenyl)amine (14)**



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N
H
O
ppm
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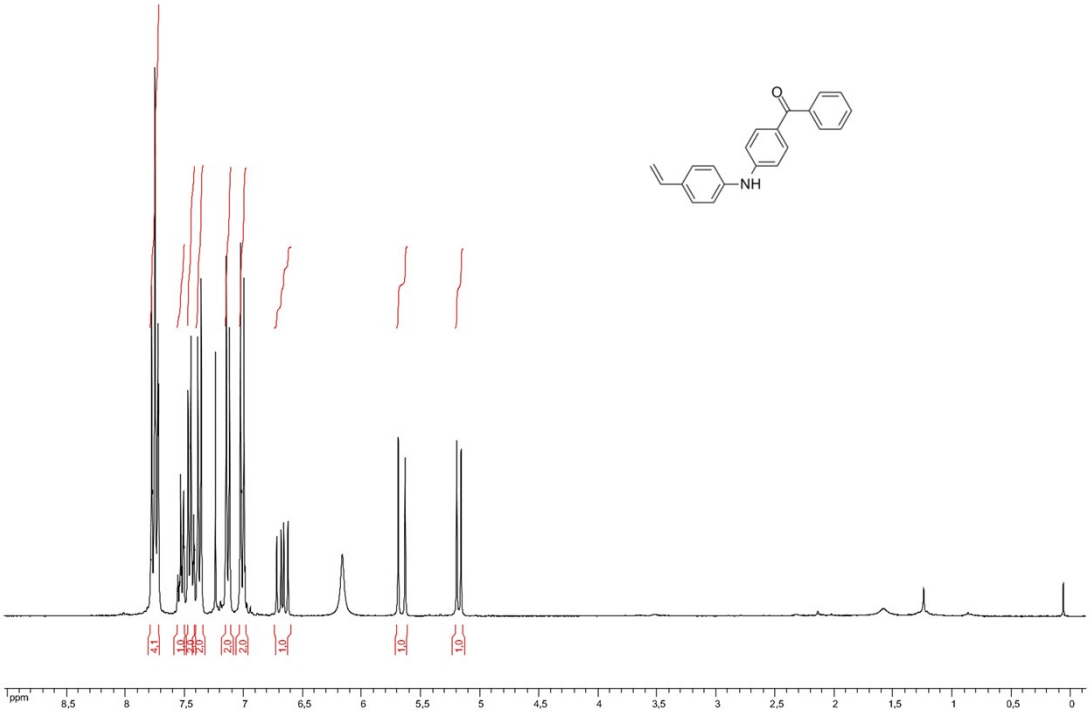
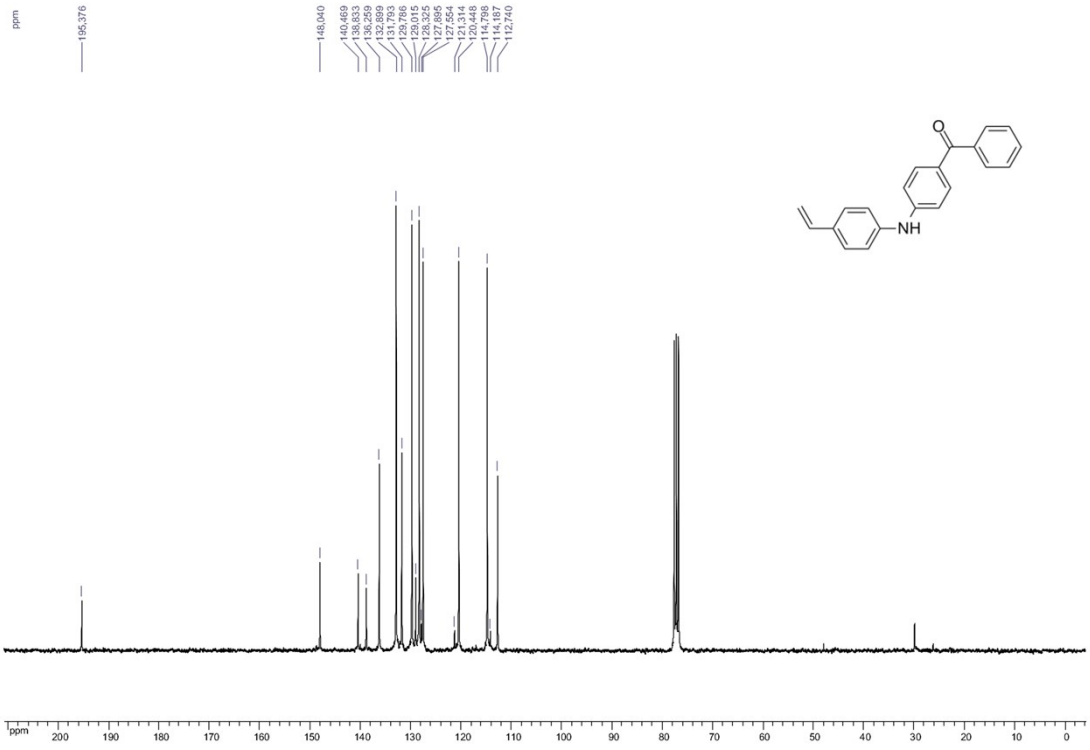
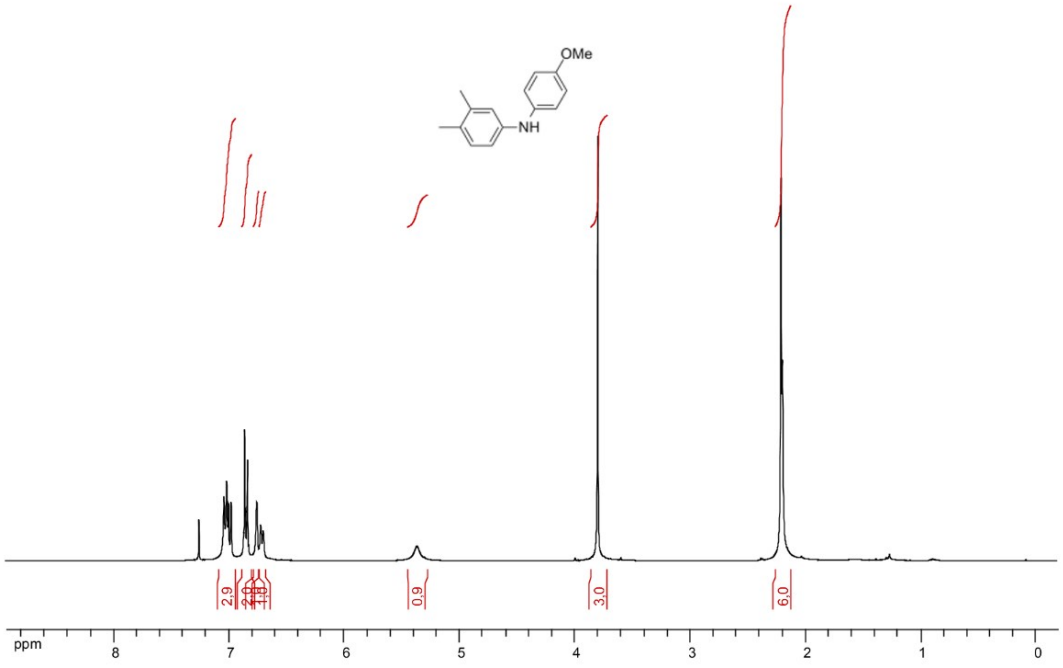
-60
-80
-100
-120
-140
-160
-180
-200

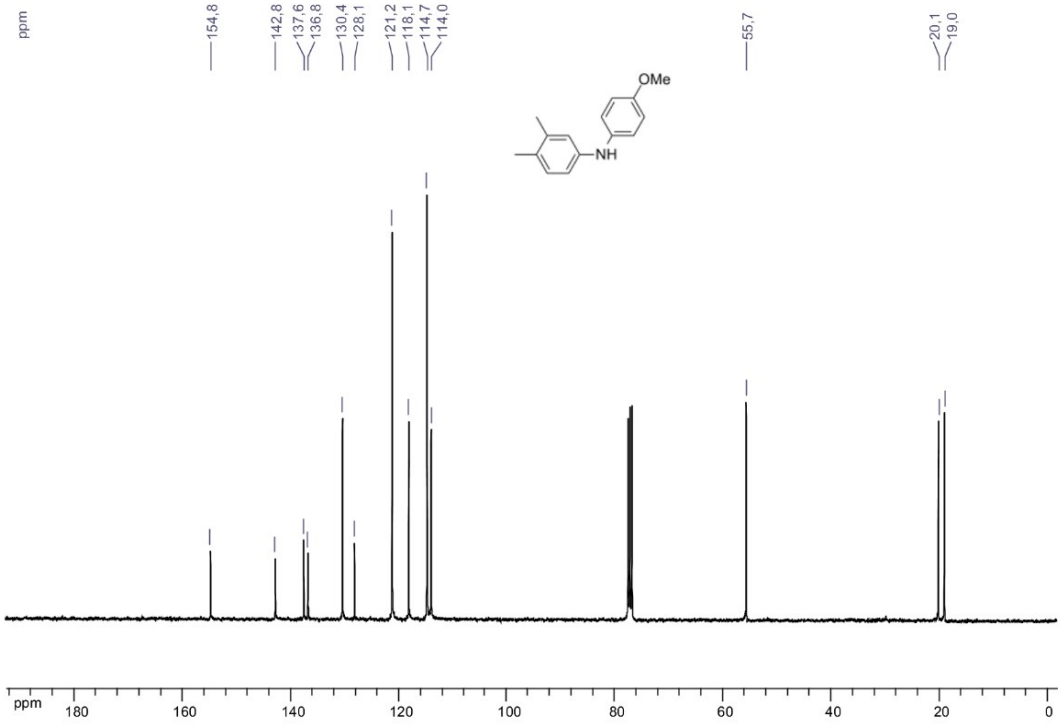
***N*-(4-Styryl)-*N*-(4-(benzoyl)-phenyl)amine (15)**



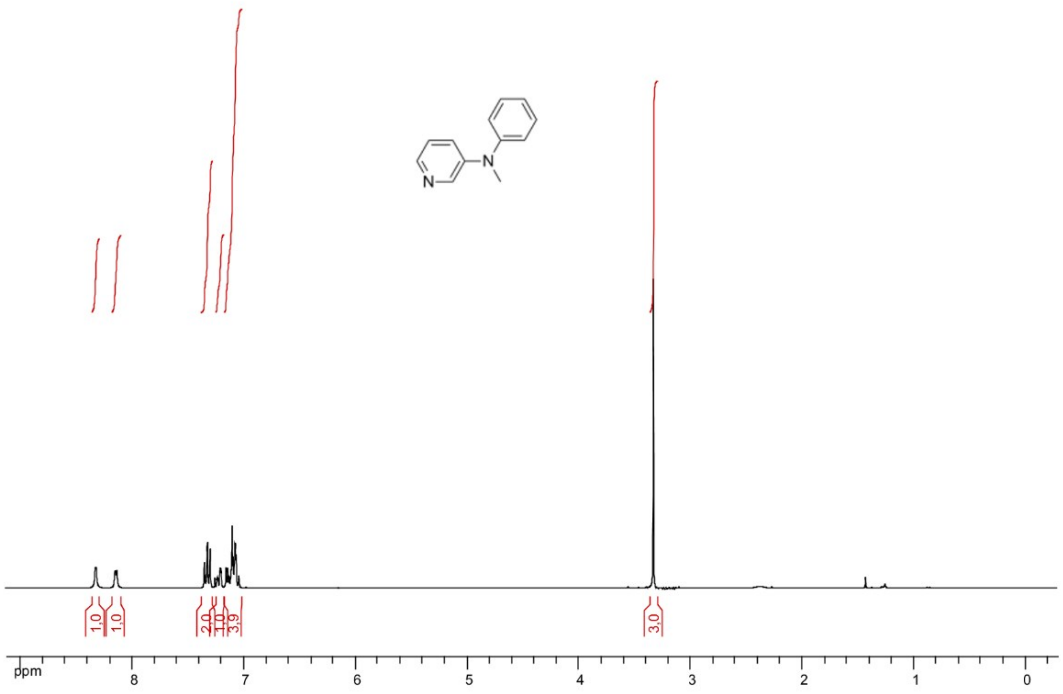


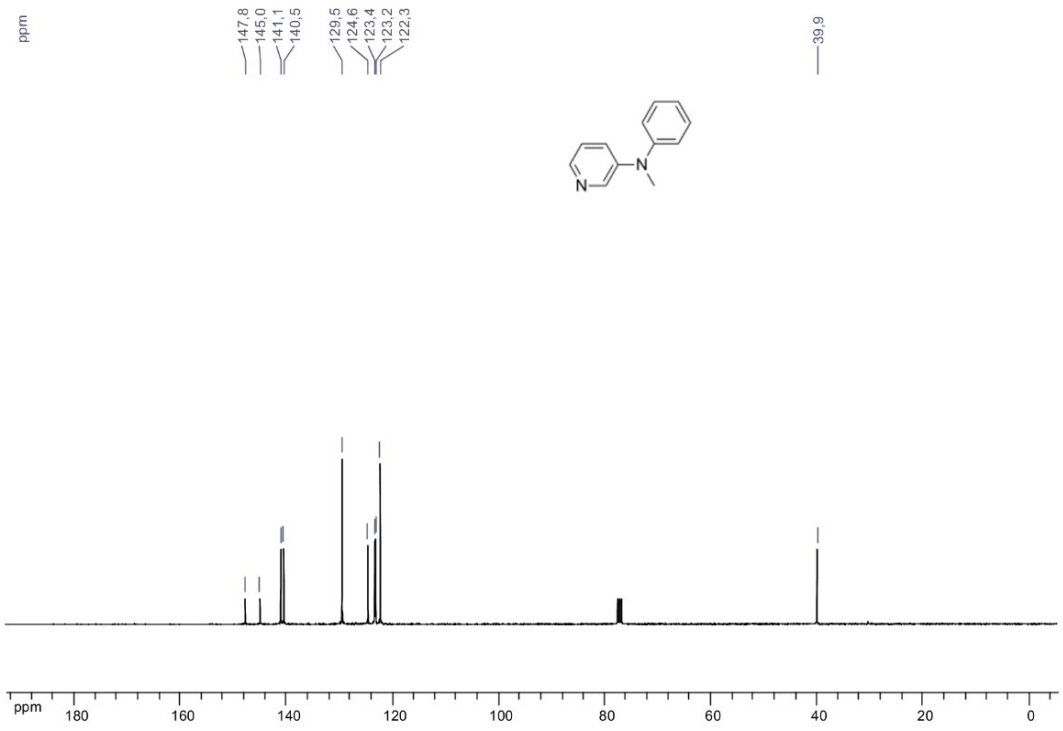
3,4-Dimethylphenyl-4’-methoxyphenylamine (16)



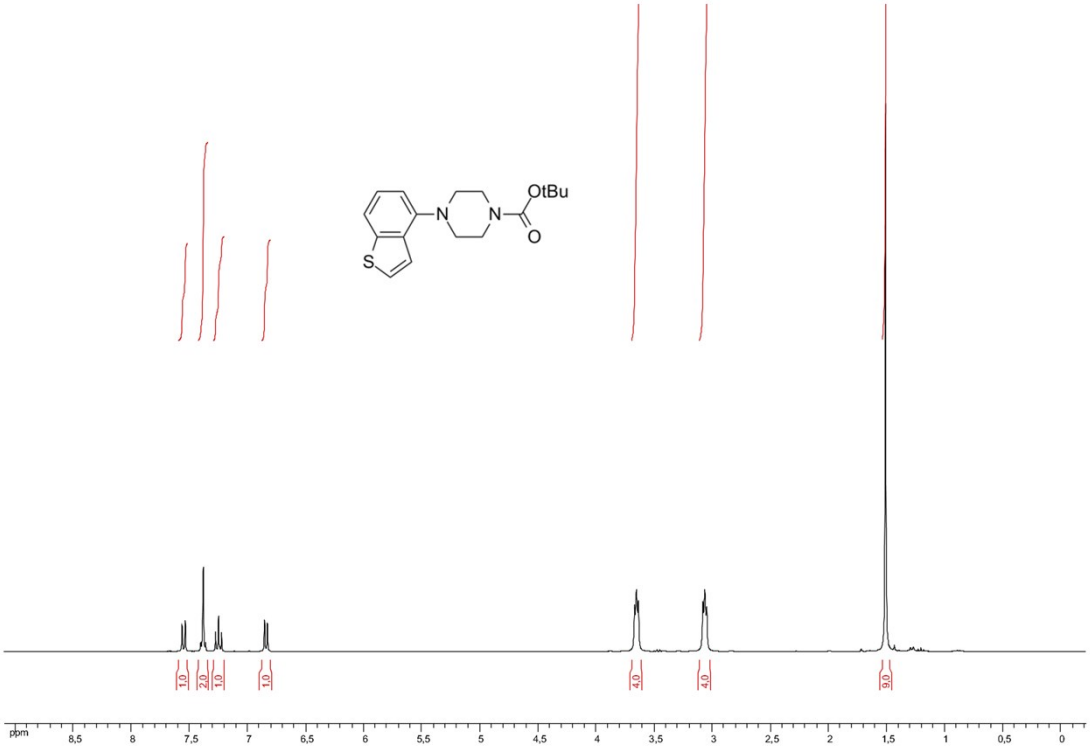


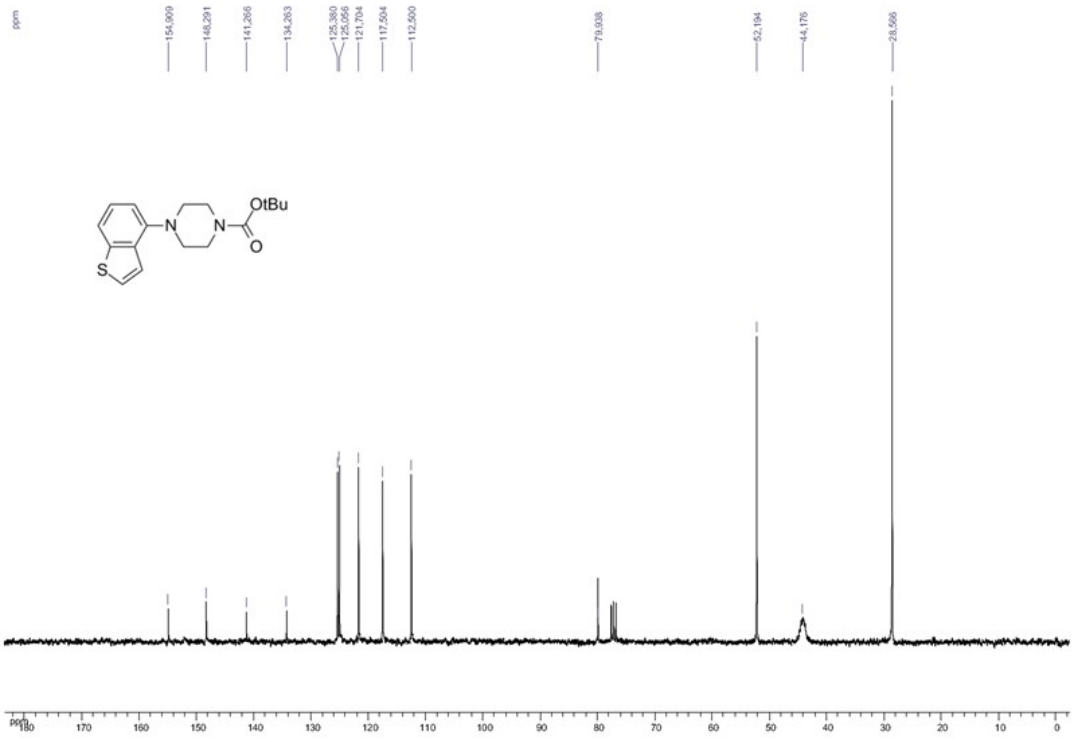
***N*-Methyl-*N*-(3-pyridyl)aniline (17)**



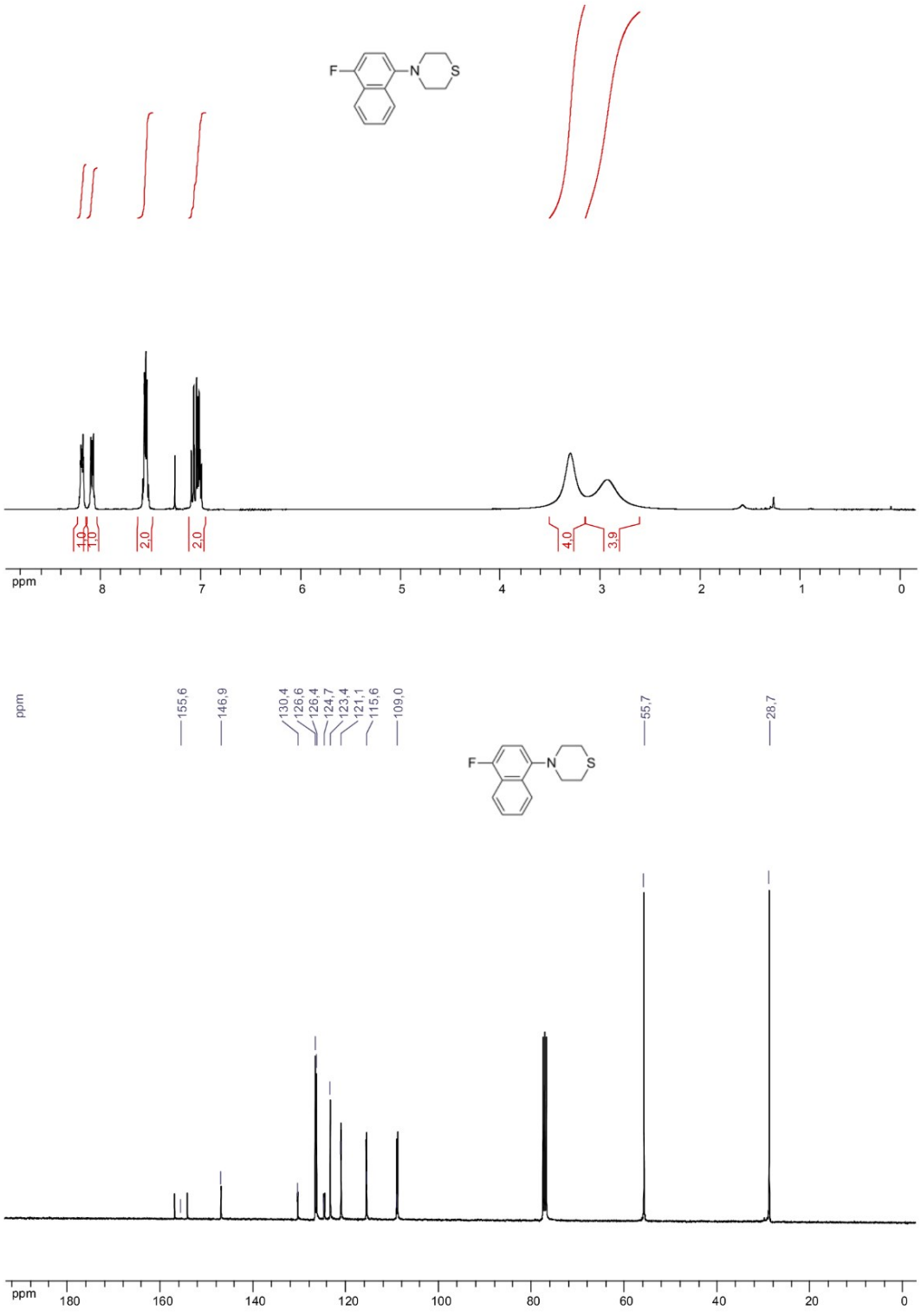


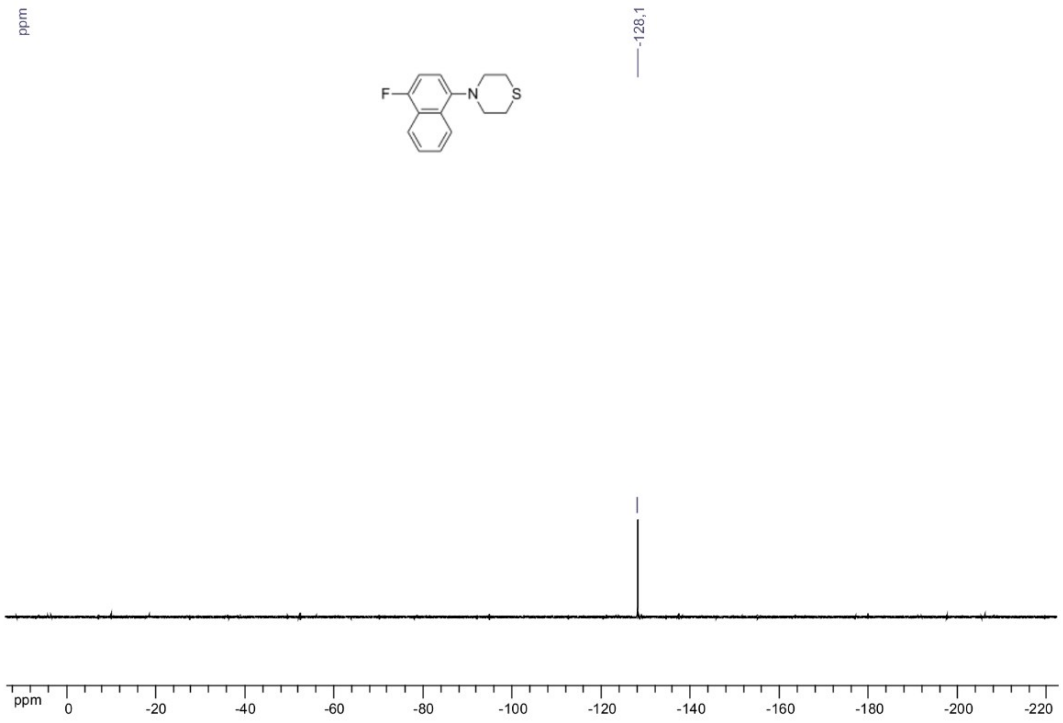
***N*'-Boc-*N*-(4-benzothiophenyl)piperazine (18)**





***N*-[1-(4-Fluoronaphthyl)]-thiomorpholine (19)**

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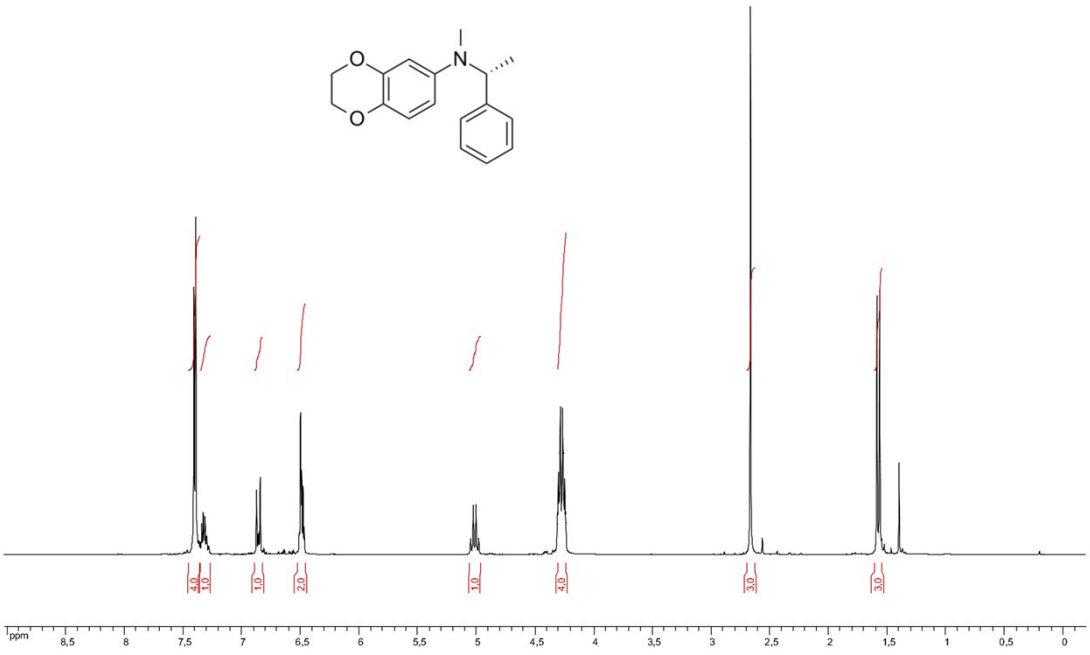
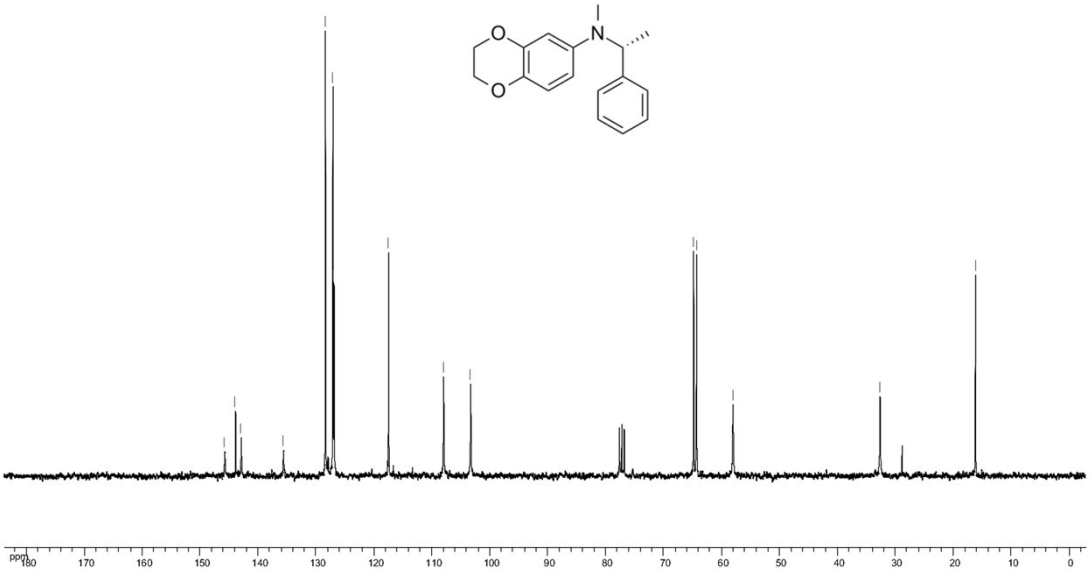
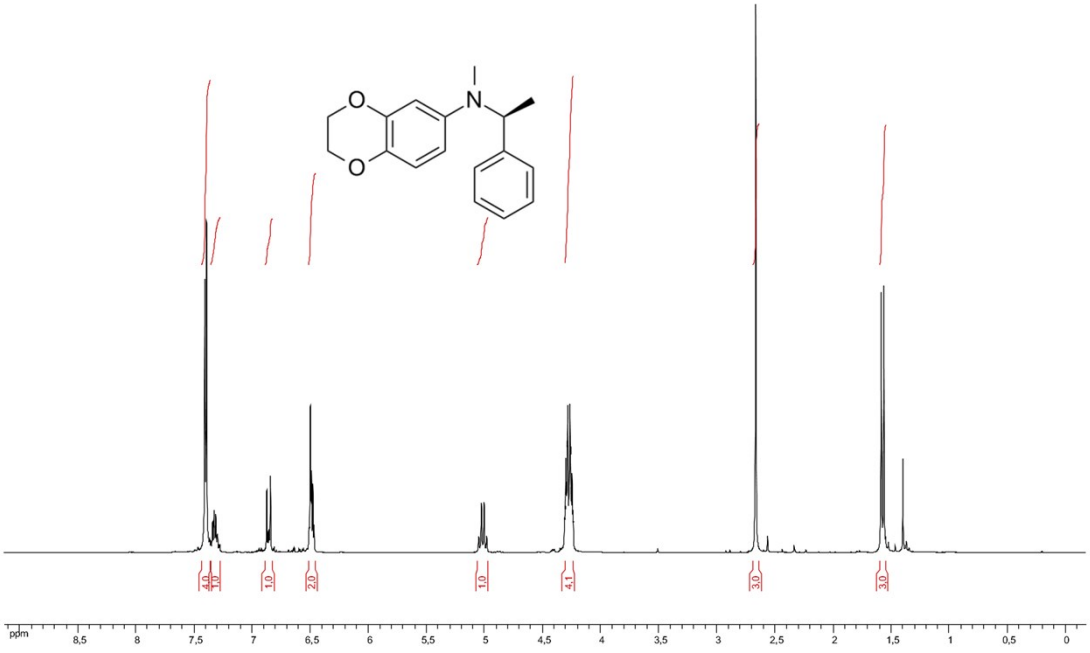
N
S
ppm
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220

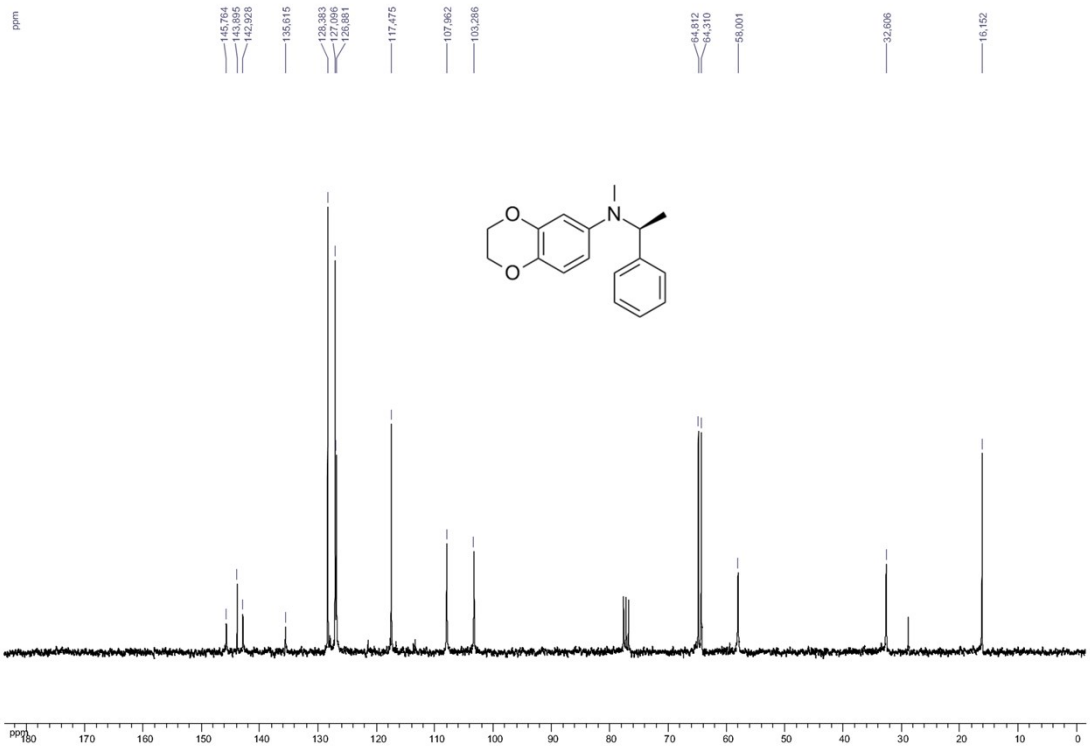
(R)-*N*-[3-(1,4-Benzodioxyl)]-*N*-methyl-*N*-(1-phenylethyl)amine ((*R*)-20)



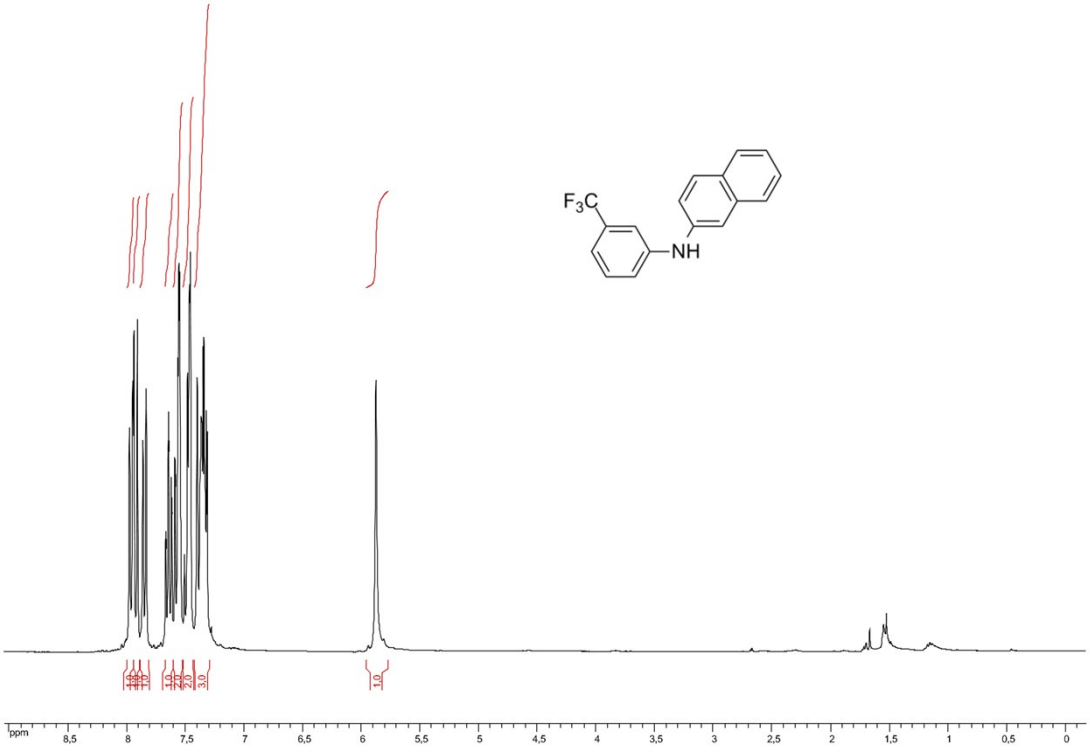


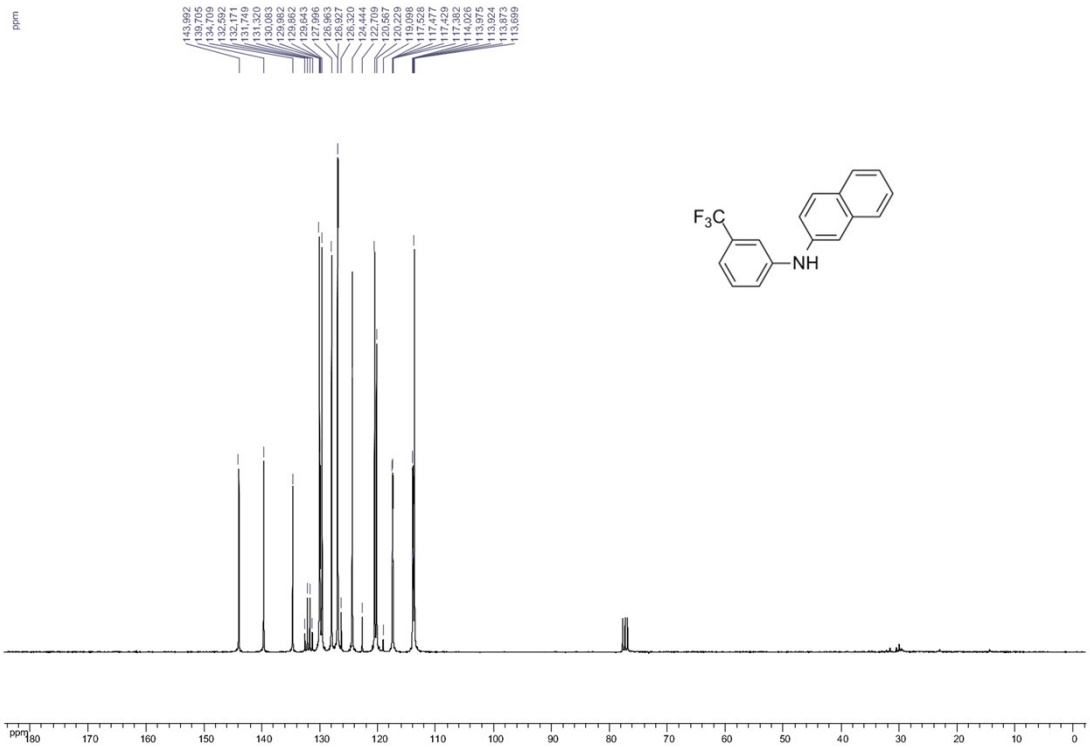
(S)-*N*-[3-(1,4-Benzodioxyl)]-*N*-methyl-*N*-(1-phenylethyl)amine ((*S*)-20)

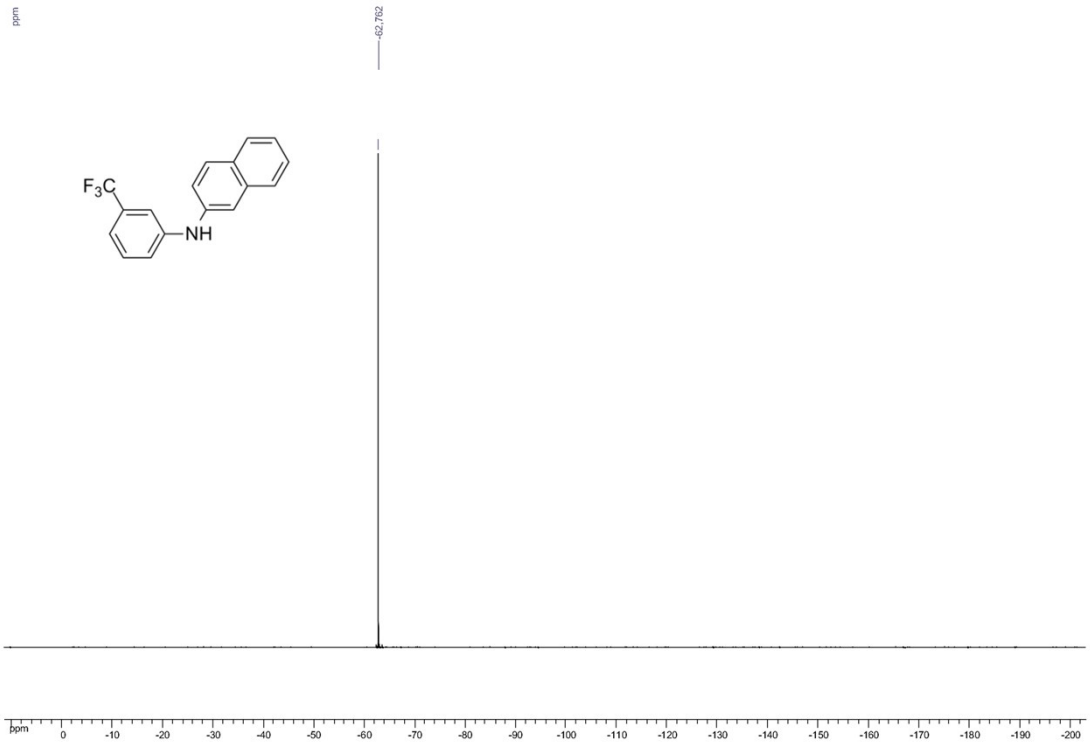




***N*-(3-Trifluoromethylphenyl)-2-naphthylamine (21)**



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ppm
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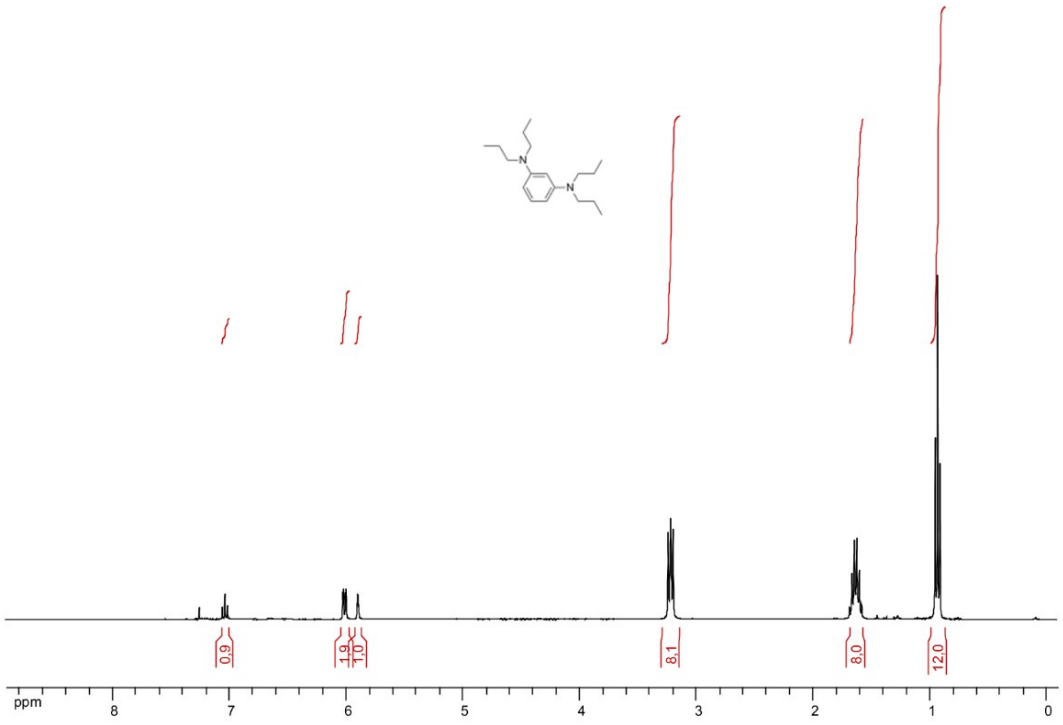
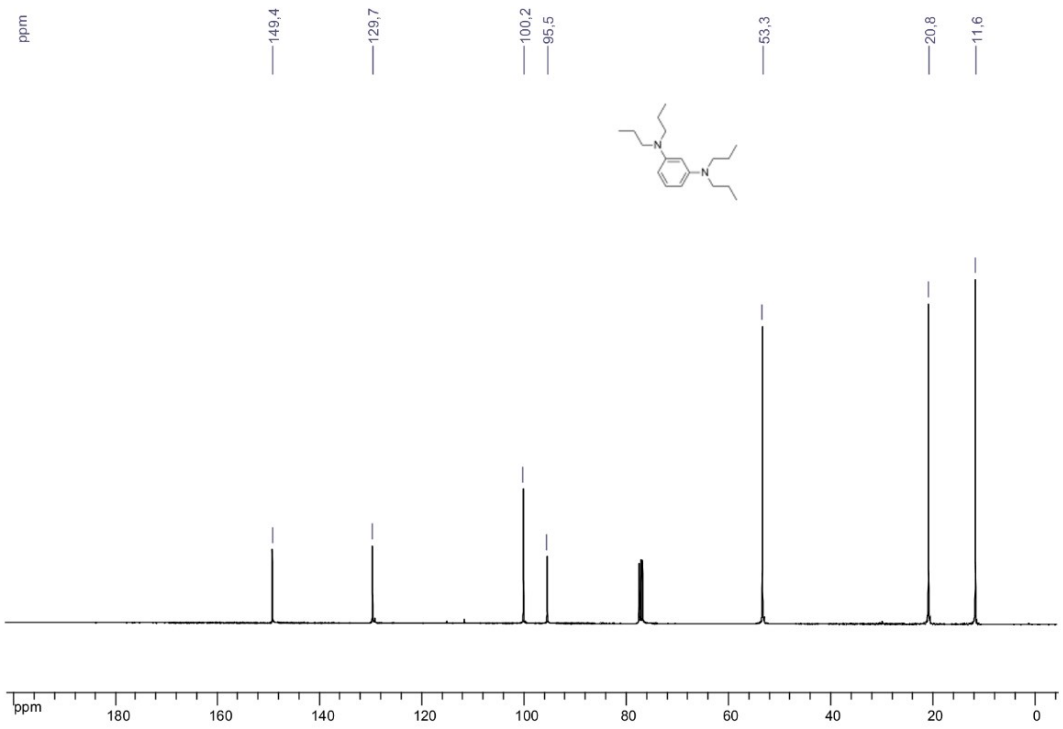
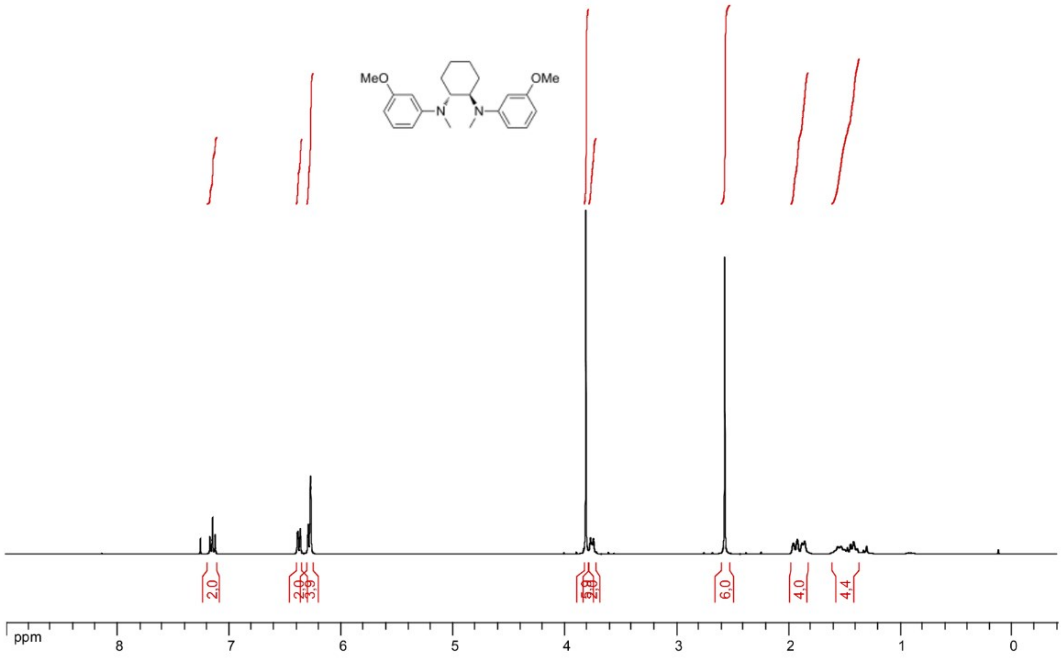
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200

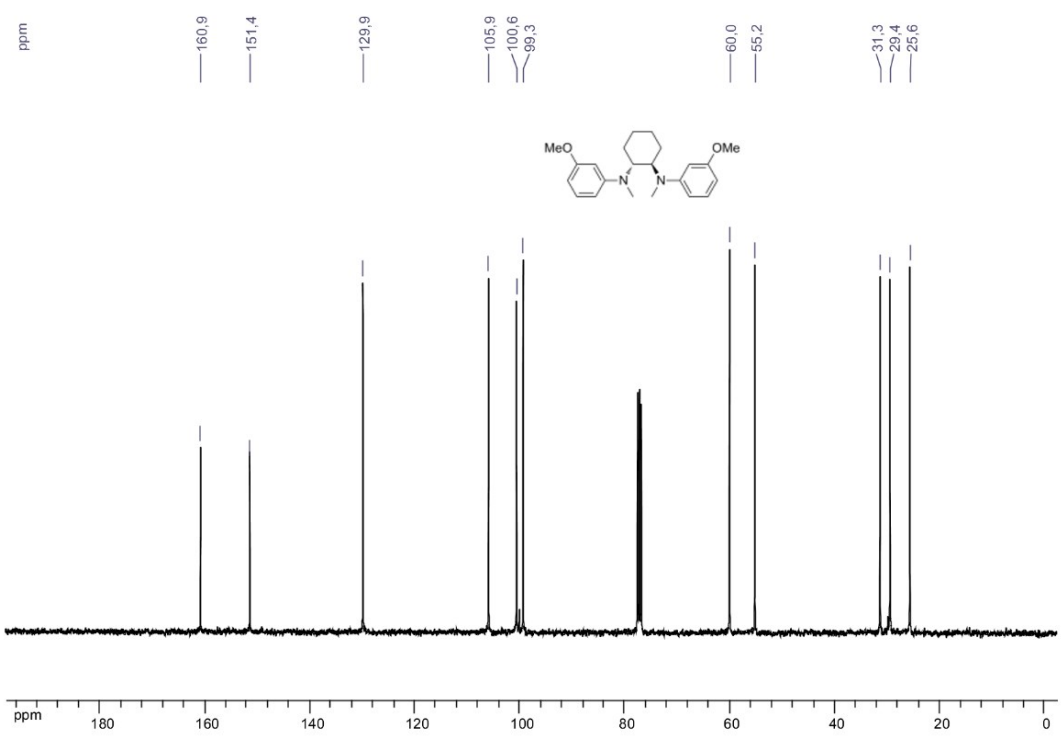
***N*,*N*,*N*',*N*'-Tetrapropyl-1,3-phenylenediamine (22)**



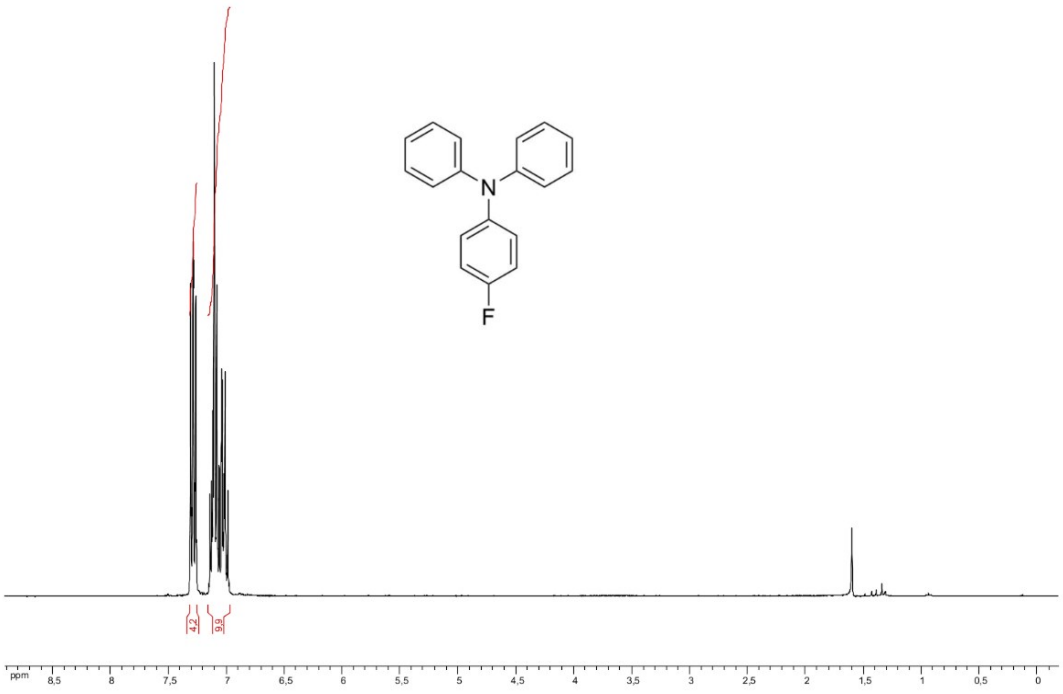


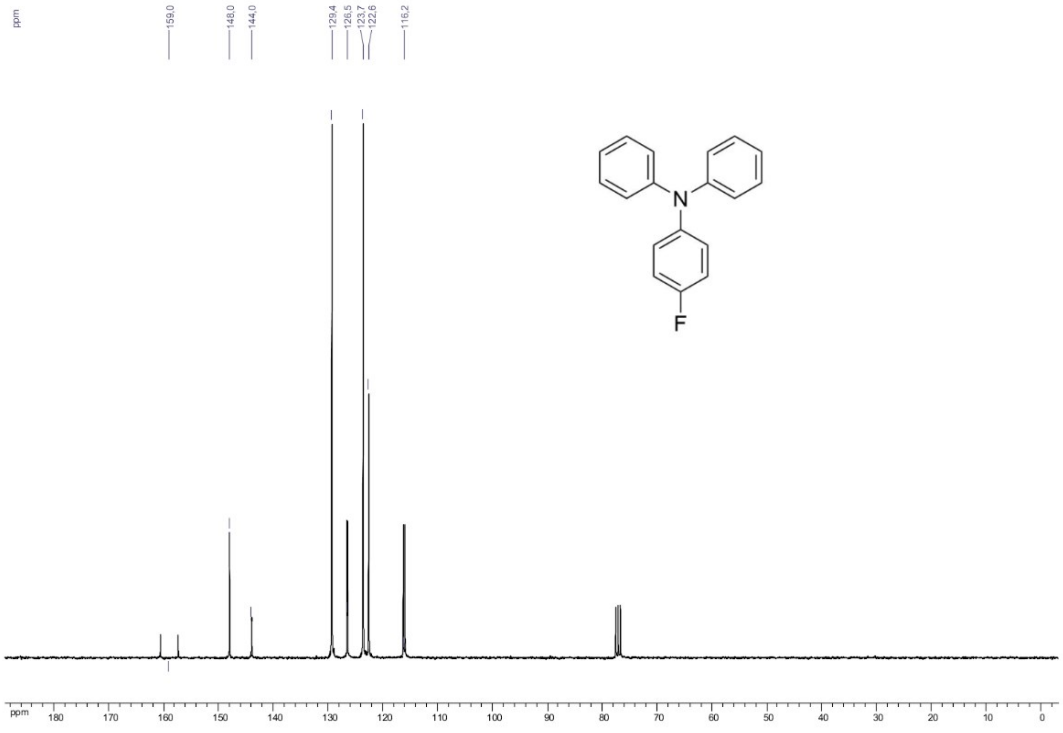
(1R,2R)-*N*,*N'*-Bis-(3-methoxyphenyl)-*N*,*N'*-dimethyl-1,2-cyclohexanediamine (23)

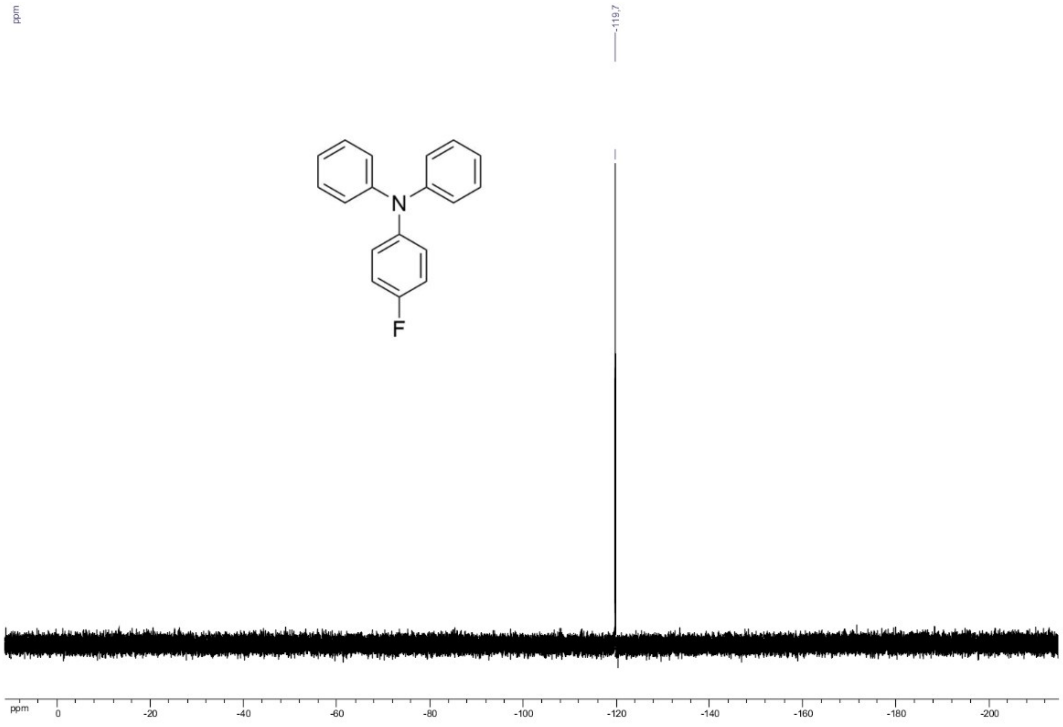




***N*-(4-Fluorophenyl)-*N*,*N*-diphenylamine (24)**



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N
F
ppm
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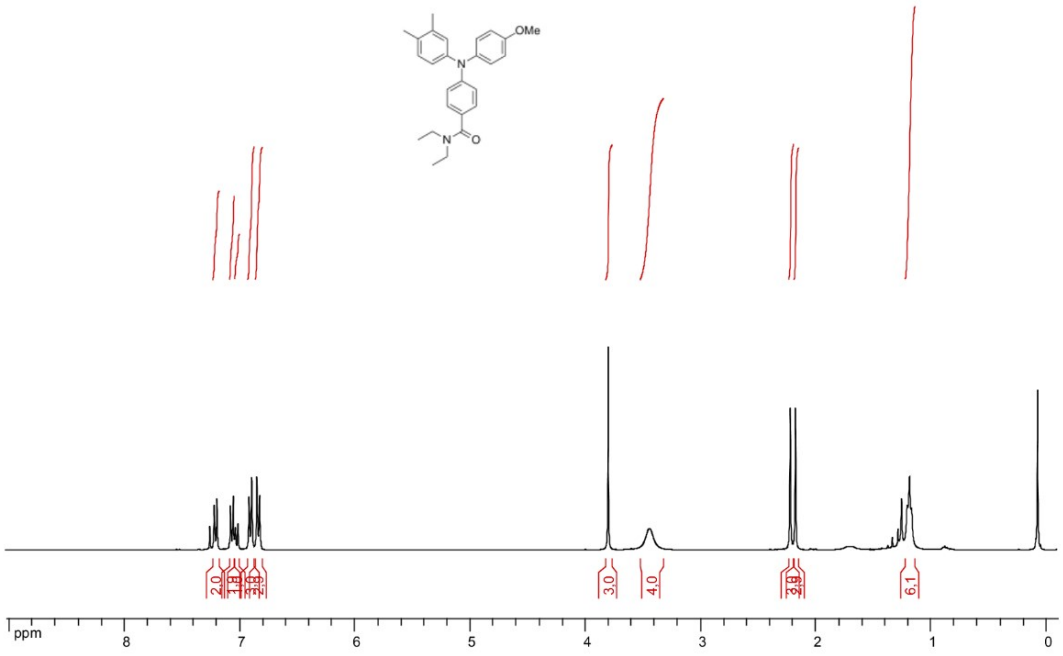
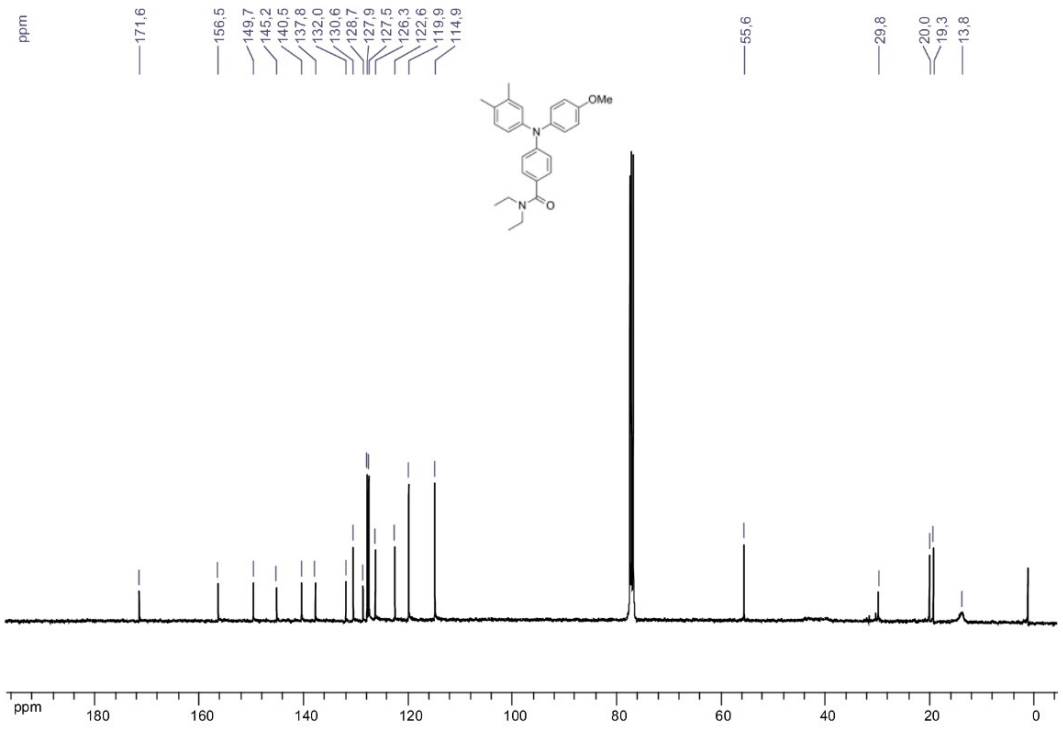
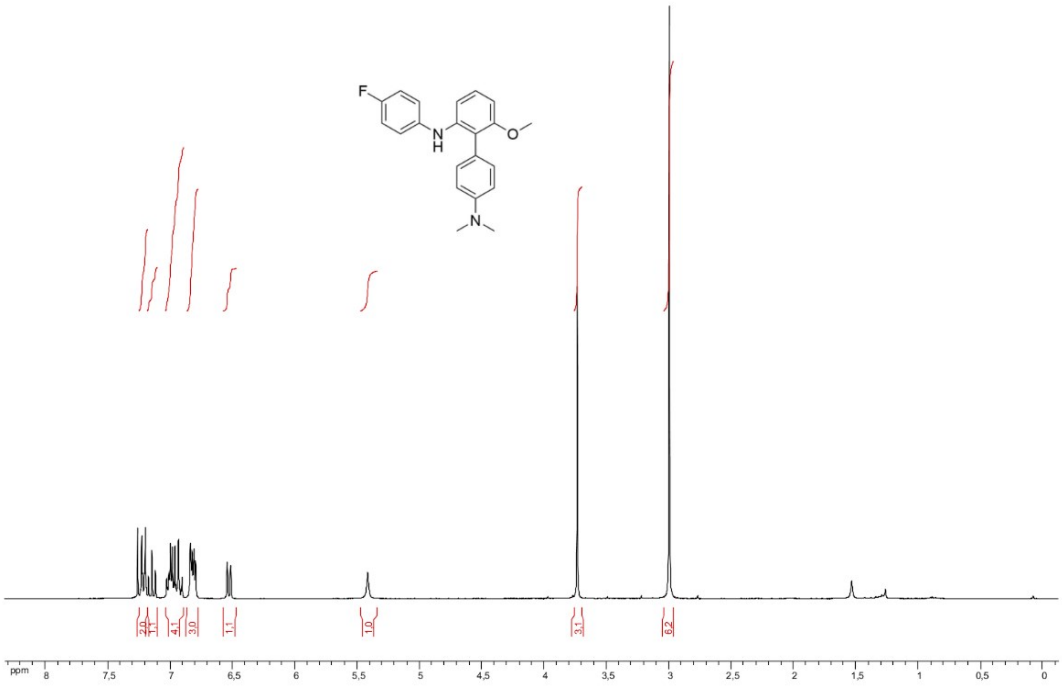
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200

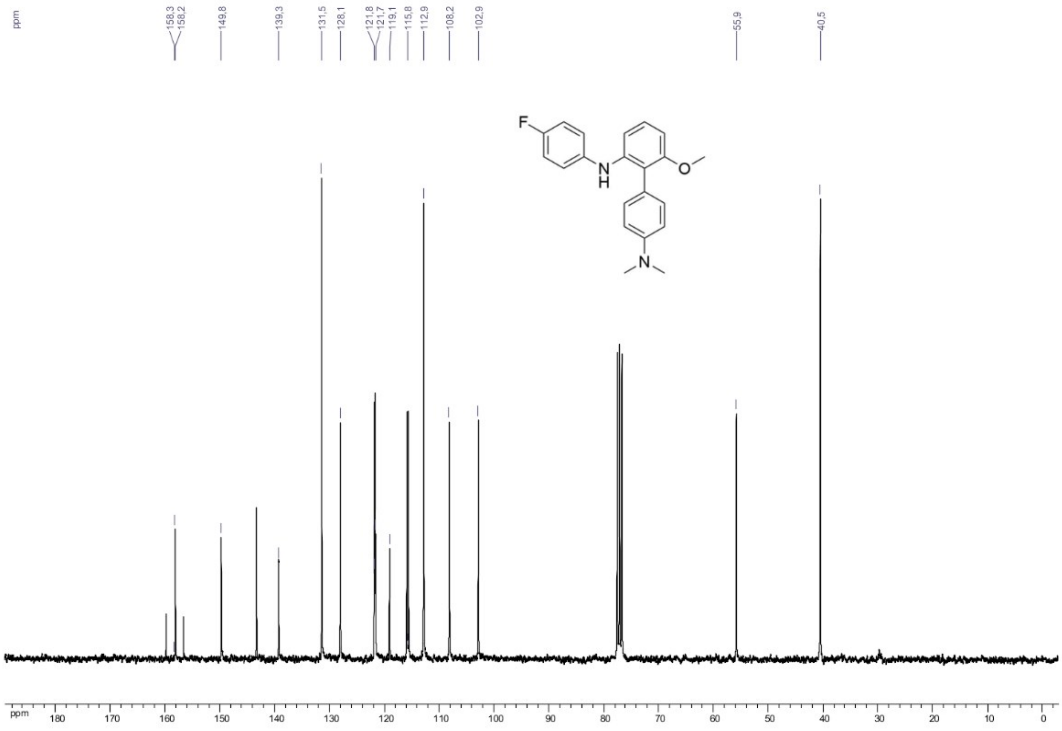
***N*-[4-(*N*',*N*'-Diethylbenzamido)]-*N*-(3,4-dimethylphenyl)-*N*-(4-methoxyphenyl)amine (26)**

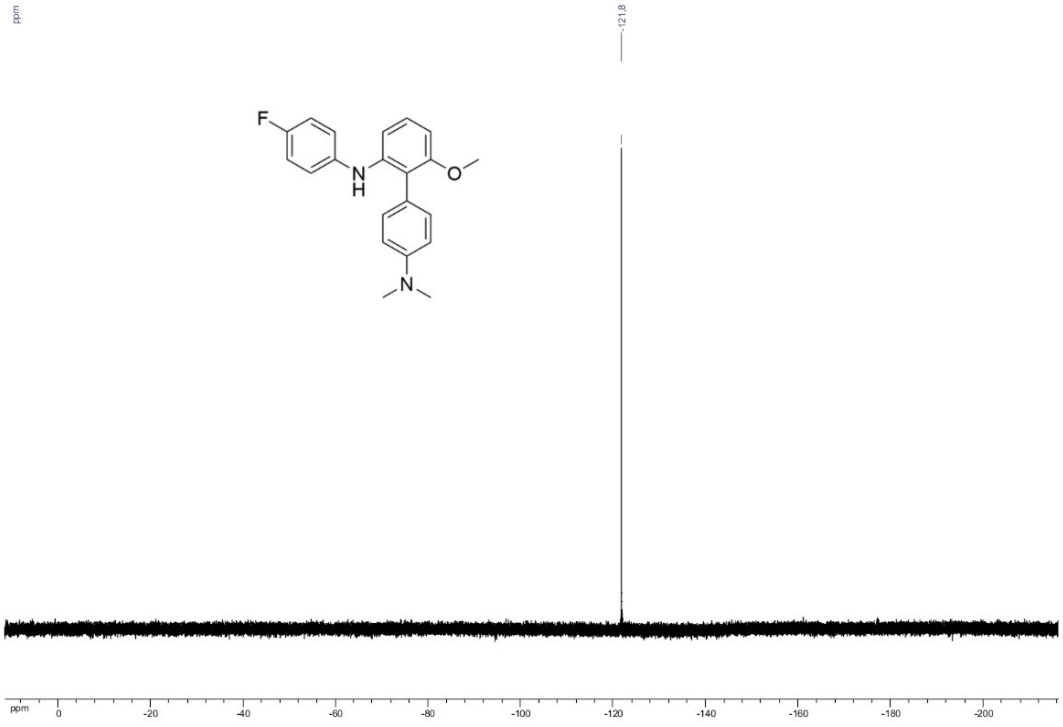




***N*-(4-Fluorophenyl)-*N*-[2-(4-*N*',*N*'-dimethylaminophenyl)-3-(methoxy)-phenyl]amine (29)**



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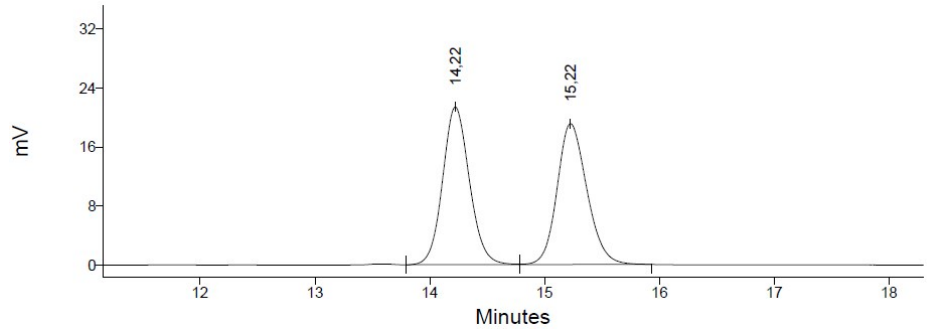
O
N
ppm
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200

XVI. HPLC chromatograms of the Buchwald-Hartwig coupling products 20 and 23

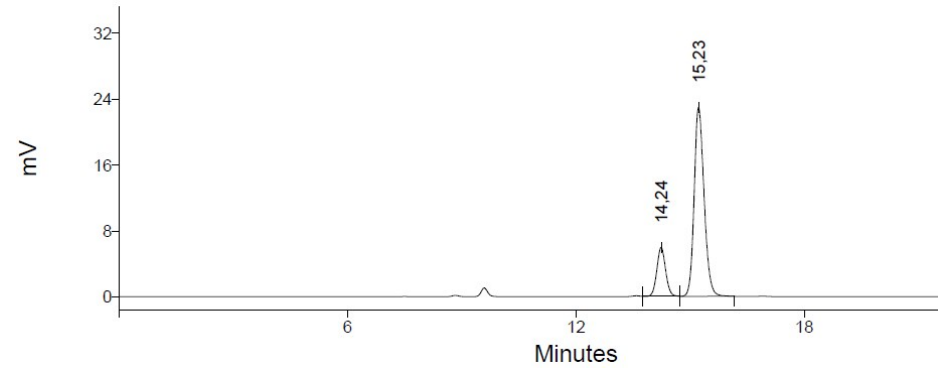
_N_-[3-(1,4-Benzodioxyl)]-_N_-methyl-_N_-(1-phenylethyl)amine (racemic-20)



Résultats d'intégration

#	Nom du pic	Tr.	Aire	% Aire	Asymétrie (USP, EP)	Plateaux (EP)
1		14,22	346,33	**50,21**	1,10	18276,46
2		15,22	343,46	**49,79**	1,17	17069,19
SOMME			**689,79**	**100,00**		

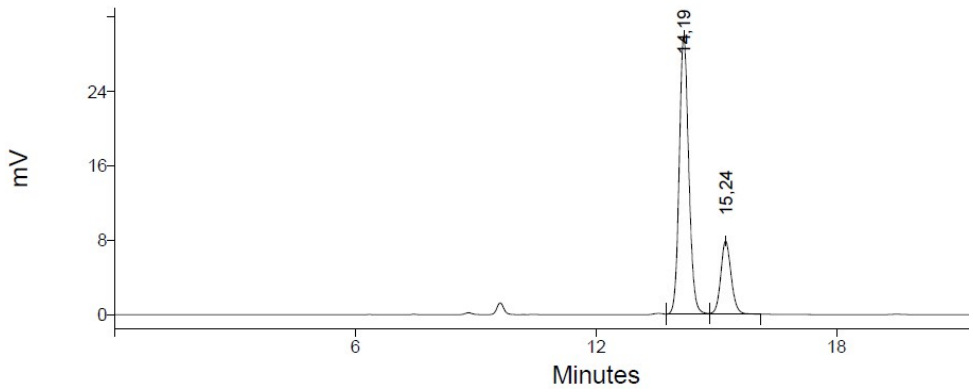
(_R_)-_N_-[3-(1,4-Benzodioxyl)]-_N_-methyl-_N_-(1-phenylethyl)amine ((_R_)-20): *ee* = 63 %



Résultats d'intégration

#	Nom du pic	Tr.	Aire	% Aire	Asymétrie (USP, EP)	Plateaux (EP)
1		14,24	95,39	**18,65**	1,07	18687,26
2		15,23	416,24	**81,35**	1,19	16885,96
SOMME			**511,63**	**100,00**		

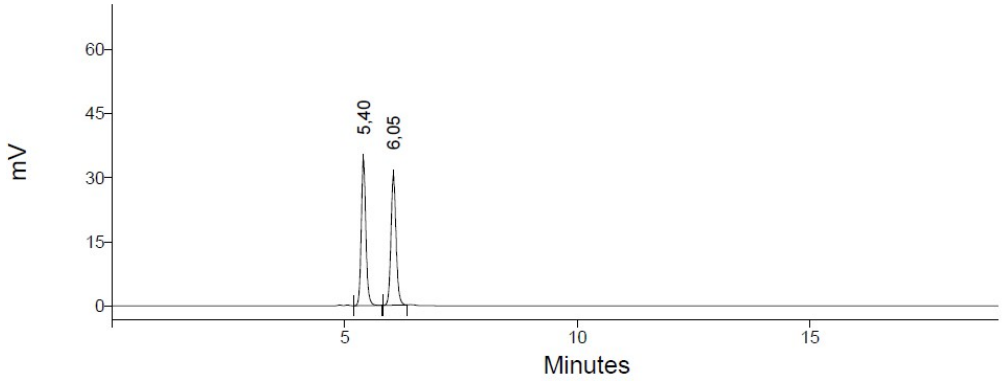
(*S*)-*N*-[3-(1,4-Benzodioxyl)]-*N*-methyl-*N*-(1-phenylethyl)amine ((*S*)-20): *ee* = 55 %



Résultats d'intégration

#	Nom du pic	Tr.	Aire	% Aire	Asymétrie (USP, EP)	Plateaux (EP)
1		14,19	492,67	**77,58**	1,13	17685,03
2		15,24	142,37	**22,42**	1,11	17227,45
SOMME			**635,04**	**100,00**		

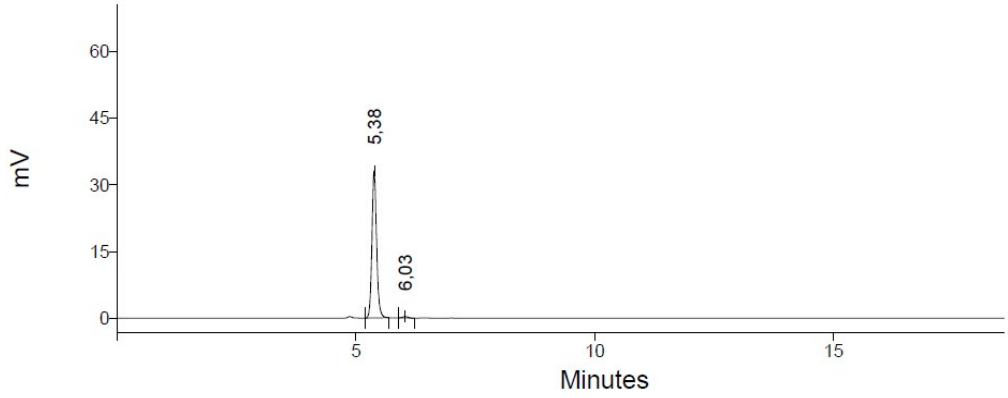
***N*,*N'*-Bis-(3-methoxyphenyl)-*N*,*N'*-dimethyl-1,2-cyclohexanediamine (racemic-23)**



Résultats d'intégration

#	Nom du pic	Tr.	Aire	% Aire	Asymétrie (USP, EP)	Plateaux (EP)
1		5,40	235,50	**50,21**	1,16	15263,42
2		6,05	233,56	**49,79**	1,12	15109,32
SOMME			**469,05**	**100,00**		

(1*R*,2*R*)-*N*,*N'*-Bis-(3-methoxyphenyl)-*N*,*N'*-dimethyl-1,2-cyclohexanediamine (23): *ee* = 98 %



Résultats d'intégration

#	Nom du pic	Tr.	Aire	% Aire	Asymétrie (USP, EP)	Plateaux (EP)
1		5,38	223,57	**98,88**	1,13	15730,65
2		6,03	2,54	**1,12**	#	14623,61
SOMME			**226,11**	**100,00**		

XVII. X-ray structure analysis of compound 18

A crystal suitable for X-ray diffraction of compound **18** was obtained by slow evaporation of diethyl ether solution at ambient temperature.

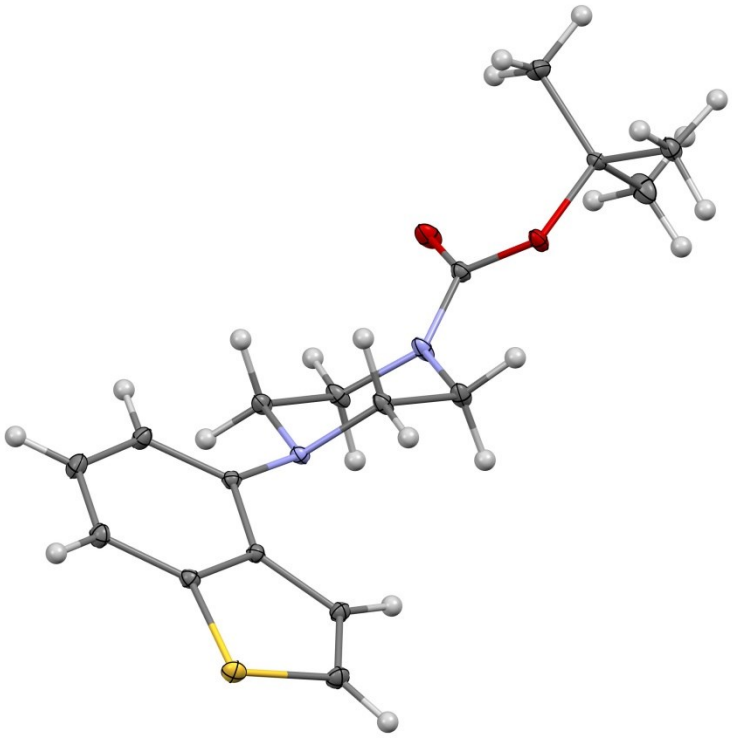


Figure S1. ORTEP drawing of compound **18**. Thermal ellipsoids are shown at the 30 % level.

X-ray diffraction data for compound **18** were collected by using a Kappa X8 APPEX II Bruker diffractometer with graphite-monochromated MoK_α radiation. Crystal was mounted on a CryoLoop (Hampton Research) with Paratone-N (Hampton Research) as cryoprotectant and then flashfrozen in a nitrogen-gas stream at 100 K. The temperature of the crystal was maintained at the selected value by means of a 700 series Cryostream 700 cooling device within an accuracy of ±1K. The data were corrected for Lorentz polarisation, and absorption effects. The structures were solved by direct methods using SHELXS-9719 and refined against F2 by full-matrix least-squares techniques using SHELXL-201820 with anisotropic displacement parameters for all non-hydrogen atoms. Hydrogen atoms were located on a difference Fourier map and introduced into the calculations as a riding model with isotropic thermal parameters. All calculations were performed by using the Crystal Structure crystallographic software package WINGX.21

[19] G. M. Sheldrick, SHELXS-97, Program for Crystal Structure Solution, University of Göttingen, Göttingen, Germany, 1997.
[20] G. M. Sheldrick, *Acta Crystallogr. A,* 2008, **64**, 112.
[21] L. J. Farrugia, *J. Appl. Cryst*., 1999, **32**, 837.

The crystal data collection and refinement parameters are given in **Table S1**.

Table S1. Crystallographic data and structure refinement details for **18**.

Compound	**18**
CCDC	2074275
Empirical Formula	$C_{17}\ H_{22}\ N_2\ O_2\ S$
M_r	318.42
Crystal size, mm^3	0.31 x 0.28 x 0.21
Crystal system	triclinic
Space group	$P\ 2_1/n$
a, Å	10.3118(3)
b, Å	9.8749(3)
c, Å	16.4567(5)
α, °	90
β, °	105.3960(10)
γ, °	90
Cell volume, $Å^3$	1615.62(8)
Z ; Z'	4 ; 1
T, K	100(1)
Radiation type ; wavelength Å	MoKα ; 0.71073
F_{000}	680
μ, mm^{-1}	0.209
θ range, °	2.109 - 33.226
Reflection collected	57 631
Reflections unique	6 152
R_{int}	0.0251
GOF	1.039
Refl. obs. (I>2σ(I))	5 567
Parameters	202
wR_2 (all data)	0.0834
R value (I>2σ(I))	0.0294
Largest diff. peak and hole ($e^-.Å^{-3}$)	0.479 ; -0.285

CCDC 2074275 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from the Cambridge Crystallographic Data Centre via http://www.ccdc.cam.ac.uk/Community/Requestastructure.