Supplementary Information for

Facile access to boryltetralins and borylnaphthalenes via a cycloaddition using *o*-quinodimethanes

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^{1}H and ^{13}C NMR Spectra of New Compounds

General remarks.

All manipulations of oxygen- and moisture-sensitive materials were conducted with a standard Schlenk technique under a purified argon atmosphere. Nuclear magnetic resonance spectra were taken on a JEOL EX-270 (^{1}H, 270 MHz; ^{13}C, 67.8 MHz) spectrometer or a JEOL Lambda-400 (^{1}H, 400 MHz; ^{13}C, 99.5 MHz) spectrometer using residual chloroform (^{1}H, δ = 7.26), or $CDCl_3$ (^{13}C, δ = 77.0) as an internal standard. ^{1}H NMR data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, quint = quintet, sext = sextet, br = broad, m = multiplet), coupling constants (Hz), integration. High-resolution mass spectra were obtained with a JEOL JMS-SX102A spectrometer. Preparative recycling gel permeation chromatography was performed with GL Science PU 614 equipped with Shodex GPC H-2001L and -2002L columns (chloroform or toluene as an eluent). Unless otherwise noted, commercially available reagents were used without purification. 18-Crown-6 was recrystallized from distilled MeCN. KF (spray-dried) was vacuum dried at 100 °C for 12 h. Dioxane was distilled from sodium/benzophenone ketyl. MeCN was distilled from phosphorus pentoxide.

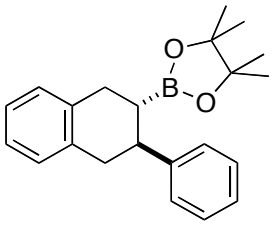
Materials.

o-Quinodimethane precursors (**1a**–**1e**)[1] and borylalkenes (**2a**–**2l**)[2] were prepared according to literature procedures. Other borylalkenes (**2m** and **2n**) were purchased from Aldrich.

[4+2] Cycloaddition between *o*-QDMs and borylalkenes: a general procedure.

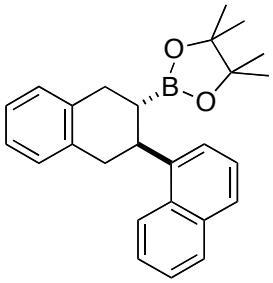
A dioxane solution (1 mL) of **1** (0.30 mmol), **2** (0.20 mmol), 18-crown-6 (0.33 mmol) and KF (0.33 mmol) was stirred at 100 °C for the period as specified in Table 1, Scheme 4 and eqn. 1. The mixture was diluted with ethyl acetate and washed with cold brine. The organic layer was dried over $MgSO_4$ and concentrated in vacuo. Preparative recycling gel permeation chromatography (chloroform as an eluent) gave the corresponding product.

4,4,5,5-Tetramethyl-2-(3-phenyl-1,2,3,4-tetrahydro-naphthalen-2-yl)-[1,3,2]dioxaborolane (3aa)



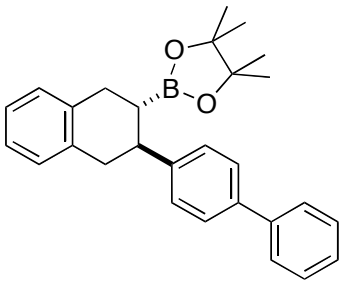
A pale yellow solid: ^{1}H NMR ($CDCl_3$): δ 0.97 (s, 6H, C*H*$_3$), 0.99 (s, 6H, C*H*$_3$), 1.74 (td, *J* = 10.9, 6.3 Hz, 1H, BC*H*), 2.88-3.06 (m, 5H, ArC*H*$_2$ and ArC*H*), 7.06-7.13 (m, 4H, Ar*H*), 7.16-7.24 (m, 1H, Ar*H*), 7.29-7.31 (m, 4H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.35, 24.43, 31.6, 39.1, 42.9, 76.5, 125.4, 125.6, 126.2, 127.6, 128.2, 128.6, 128.9, 136.4, 136.8, 146.4.

4,4,5,5-Tetramethyl-2-[3-(1-naphthyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3ab)



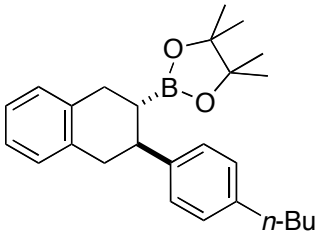
A yellow solid: ^{1}H NMR ($CDCl_3$): δ 0.74 (s, 6H, C*H*$_3$), 0.86 (s, 6H, C*H*$_3$), 1.97 (td, *J* = 11.5, 5.3 Hz, 1H, BC*H*), 1.91-2.02 (m, 4H, ArC*H*$_2$), 3.93 (td, *J* = 11.2, 4.6 Hz, 1H, ArC*H*), 7.03-7.17 (m, 4H, Ar*H*), 7.41-7.52 (m, 4H, Ar*H*), 7.70 (dd, *J* = 6.9, 2.3 Hz, 1H, Ar*H*), 7.84 (dd, *J* = 6.3, 2.6 Hz, 1H, Ar*H*), 8.23 (dd, *J* = 8.2, 2.0 Hz, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.19, 24.21, 29.7, 31.8, 39.0, 82.9, 123.6, 125.3, 125.5, 125.56, 125.59, 125.7, 126.5, 128.65, 128.70, 128.9, 131.7, 133.8, 136.5, 136.9, 143.0.

4,4,5,5-Tetramethyl-2-[3-(biphenyl-4-yl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3ac)



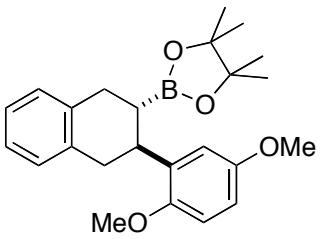
A white solid: ^{1}H NMR ($CDCl_3$): δ 0.98 (s, 6H, C*H*$_3$), 1.02 (s, 6H, C*H*$_3$), 1.76 (td, *J* = 10.9, 6.3 Hz, 1H, BC*H*), 2.94-3.12 (m, 5H, ArC*H*$_2$ and ArC*H*), 7.12-7.16 (m 4H, Ar*H*), 7.33-7.57 (m, 9H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.3, 24.4, 31.6, 39.0, 42.5, 83.0, 125.5, 125.6, 127.0, 128.1, 128.6, 128.7, 129.0. 136.4, 136.7, 139.2, 141.2, 145.6.

4,4,5,5-Tetramethyl-2-[3-(4-*n*-butylphenyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3ad)



A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.93 (t, *J* = 6.8 Hz, 3H, C*H*$_3$CH$_2$), 0.96 (s, 6H, C*H*$_3$), 1.00 (s, 6H, C*H*$_3$), 1.35 (sext, *J* = 7.8 Hz, 2H, C*H*$_2$), 1.57 (quint, *J* = 7.7 Hz, 2H, C*H*$_2$), 1.71 (td, *J* = 11.6, 5.8 Hz, 1H, BC*H*), 2.59 (t, *J* = 7.7 Hz, 2H, ArC*H*$_2$CH$_2$), 2.90-3.03 (m, 5H, ArC*H*$_2$ and ArC*H*), 7.06-7.13 (m, 6H, Ar*H*), 7.21 (d, *J* = 8.7 Hz, 2H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 13.9, 22.2, 24.3, 24.4, 31.7, 33.8, 35.2, 39.1, 42.5, 82.9, 125.4, 125.5, 127.5, 128.3, 128.6, 129.0, 136.4, 136.9, 140.7, 143.5.

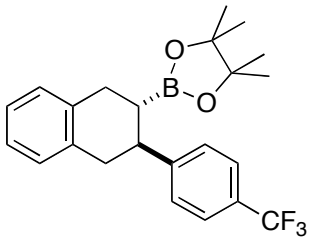
4,4,5,5-Tetramethyl-2-[3-(2,5-dimethoxyphenyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3ae)



A yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.99 (s, 6H, C*H*$_3$), 1.02 (s, 6H, C*H*$_3$), 1.83 (td, *J* = 11.2, 5.6 Hz, 1H, BC*H*), 2.77-3.06 (m, 4H, ArC*H*$_2$), 3.46 (td, *J* = 11.5, 4.9 Hz, 1H, ArC*H*), 3.77 (s, 3H, OC*H*$_3$), 3.79 (s, 3H, OC*H*$_3$), 6.68-6.84 (m, 3H, Ar*H*), 7.07-7.11 (m 4H, Ar*H*); ^{13}C

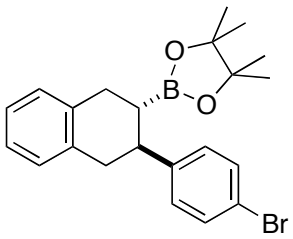
NMR ($CDCl_3$): δ 24.3, 24.4, 31.7, 36.0, 53.5, 55.7, 56.4, 82.8, 111.5, 112.1, 114.0, 125.3, 125.4, 128.6, 128.9, 136.1, 136.5, 137.1, 151.6, 153.7.

4,4,5,5-Tetramethyl-2-[3-(4-trifluoromethylphenyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3af)



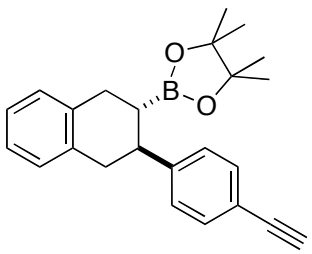
A white solid: ^{1}H NMR ($CDCl_3$): δ 0.98 (s, 6H, C*H*$_3$), 1.00 (s, 6H, C*H*$_3$), 1.73 (td, *J* = 10.9, 6.6 Hz, 1H, BC*H*), 2.83-3.15 (m, 5H, ArC*H*$_2$ and ArC*H*), 7.05-7.14 (m, 4H, Ar*H*), 7.41 (d, *J* = 8.4 Hz, 2H, Ar*H*), 7.57 (d, *J* = 8.4 Hz, 2H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.30, 24.34, 31.4, 38.7, 42.8, 83.1, 125.06, 125.11, 125.17, 125.22, 125.6, 125.8, 128.0, 128.3, 128.6, 128.9, 136.1, 136.2, 150.66, 150.68.

4,4,5,5-Tetramethyl-2-[3-(4-bromophenyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3ag)



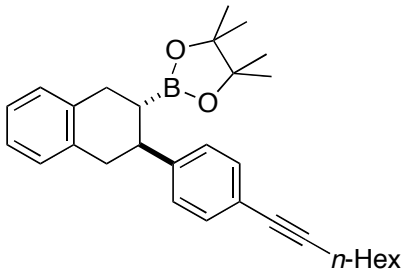
A white solid: ^{1}H NMR ($CDCl_3$): δ 1.01 (s, 6H, C*H*$_3$), 1.02 (s, 6H, C*H*$_3$), 1.65-1.72 (m, 1H, BC*H*), 2.79-3.01 (m, 5H, ArC*H*$_2$ and ArC*H*), 7.06-7.13 (m, 4H, Ar*H*), 7.18 (d, *J* = 8.7 Hz, 2H, Ar*H*), 7.43 (d, *J* = 7.7 Hz, 2H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.39, 24.41, 31.4, 38.9, 42.3, 83.0, 119.8, 125.5, 125.7, 128.6, 128.9, 129.4, 131.2, 136.2, 136.3.

4,4,5,5-Tetramethyl-2-[3-(4-ethynylphenyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3ah)



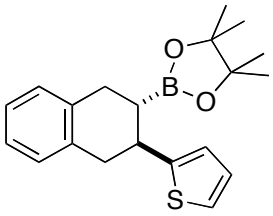
A white solid: ^{1}H NMR ($CDCl_3$): δ1.00 (s, 6H, CH_3), 1.01 (s, 6H, CH_3), 1.71 (td, J = 11.6, 6.8 Hz, 1H, BCH), 2.85-3.06 (m, 6H, CH, ArCH_2 and ArCH), 7.07-7.13 (m, 4H, ArH), 7.26 (d, J = 7.8 Hz, 2H, ArH), 7.45 (d, J = 7.8 Hz, 2H, ArH); ^{13}C NMR ($CDCl_3$): δ 24.39, 24.40, 31.4, 38.8, 42.7, 76.5, 83.0, 83.9, 119.8, 125.5, 125.7, 127.6, 128.6, 128.9, 132.0, 136.2, 136.4, 147.5.

4,4,5,5-Tetramethyl-2-[3-(1-octynylphenyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3ai)



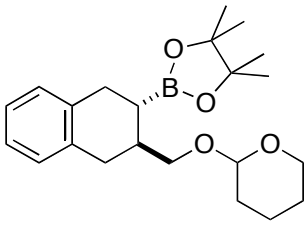
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.92 (t, J = 6.7 Hz, 3H, CH_3CH$_2$), 1.00 (s, 6H, CH_3), 1.01 (s, 6H, CH_3), 1.34-1.71 (m, 9H, BCH and CH_2), 2.41 (t, J = 6.7 Hz, 2H, C≡CCH_2), 2.80-3.00 (m, 5H, ArCH_2 and ArCH), 7.06-7.12 (m, 4H, ArH), 7.21 (d, J = 7.7 Hz, 2H, ArH), 7.34 (d, J = 7.7 Hz, 2H, ArH); ^{13}C NMR ($CDCl_3$): δ 14.0, 19.4, 22.5, 24.4, 25.1, 28.6, 28.8, 31.3, 31.5, 38.9, 42.6, 80.7, 83.0, 89.6, 121.8, 125.5, 125.6, 127.5, 128.5, 128.9, 131.4, 136.3, 136.5, 146.0.

4,4,5,5-Tetramethyl-2-[3-(2-thienyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3aj)



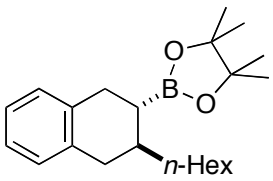
A colorless oil: ^{1}H NMR ($CDCl_3$): δ 1.07 (s, 6H, CH_3), 1.09 (s, 6H, CH_3), 1.70 (td, J = 11.1, 6.1 Hz, 1H, BCH), 2.89-3.02 (m, 3H, ArCH_2), 3.14 (dd, J = 16.4, 5.1 Hz, 1H, ArCH_2), 3.38 (td, J = 11.1, 5.1 Hz, 1H, (thiphene)CH), 6.91-6.93 (m, 2H, ArH), 7.06-7.14 (m, 5H, ArH); ^{13}C NMR ($CDCl_3$): δ 24.4, 24.5, 31.2, 37.7, 39.5, 83.1, 122.6, 123.4, 125.5, 125.7, 126.3, 128.5, 128.8, 136.0, 136.1, 150.3.

4,4,5,5-Tetramethyl-2-[3-((tetrahydro-*2H*-pyran-2-yloxy)methyl)-1,2,3,4-tetrahydro-naphthalen-2-yl]-[1,3,2]dioxaborolane (3ak)



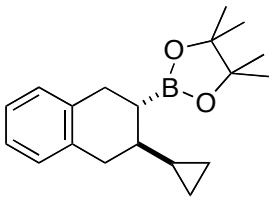
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.20-1.29 (m, 2H, CH_2), 1.24 (s, 12H, CH_3), 1.52-1.85 (m, 6H, BC*H* and CH_2), 2.15-2.27 (m, 1H, C*H*CH_2O), 2.62-2.68 (m, 1H, ArCH_2), 2.80-2.83 (m, 2H, ArCH_2), 2.98 (td, *J* = 16.4, 5.8 Hz, 1H, ArCH_2), 3.31 (dd, *J* = 9.8, 7.2 Hz, 1H, OCH_2), 3.49 (dd, *J* = 9.7, 4.9 Hz, 1H, OCH_2), 3.62 (t, *J* = 9.7 Hz, 1H, OCH_2), 3.81-3.89 (m, 1H, OCH_2), 4.61 (dt, *J* = 10.6, 3.8 Hz, 1H, OC*H*O), 7.07 (brs, 4H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 19.4, 20.8, 24.6, 24.71, 24.74, 24.8, 25.5, 30.20, 30.24, 30.3, 30.6, 30.65, 32.70, 32.9, 33.1, 33.2, 35.1, 35.2, 35.4, 35.5, 61.5, 61.8, 71.6, 71.9, 83.08, 83.12, 97.7, 98.25, 98.33, 99.1, 99.7, 124.5, 125.2, 125.5, 128.0, 128.1, 128.3, 128.8, 129.1, 136.5, 136.6, 137.0, 137.1.

4,4,5,5-Tetramethyl-2-(3-*n*-hexyl-1,2,3,4-tetrahydro-naphthalen-2-yl)-[1,3,2]dioxaborolane (3al)



A colorless oil: ^{1}H NMR ($CDCl_3$): δ 0.89 (t, *J* = 6.8, 3H, C$H_3$$CH_2$), 1.13-1.51 (m, 23H, C$H_3$, C$H_2$ and C*H*), 1.83-1.92 (m, 1H, BC*H*), 2.39 (dd, *J* = 16.4, 9.7 Hz, 1H, ArCH_2), 2.79-2.82 (m, 2H, ArCH_2), 2.90 (dd, *J* = 16.4, 4.8 Hz, 1H, ArCH_2), 7.06 (brs, 4H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 14.1, 22.7, 24.7, 24.8, 26.5, 29.5, 30.8, 31.8, 34.9, 35.0, 36.4, 83.0, 125.2, 125.3, 128.2, 128.9, 136.9, 137.1.

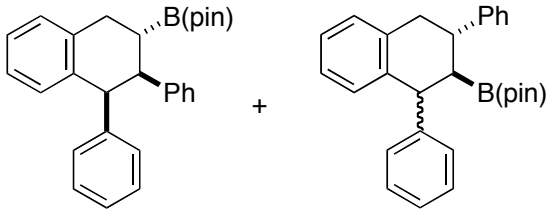
4,4,5,5-Tetramethyl-2-(3-cyclopropyl-1,2,3,4-tetrahydro-naphthalen-2-yl)-[1,3,2]dioxaborolane (3am)



A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.13-0.18 (m, 1H), 0.29-0.38 (m, 1H), 0.42-0.50 (m, 2H), 0.65-0.74 (m, 1H), 1.01-1.23 (m 1H), 1.24-1.38 (m, 1H, BC*H*), 1.29 (s, 12H, CH_3), 2.60 (dd, *J* = 16.4, 10.6 Hz, 1H, ArCH_2), 2.82 (d, 7.7 Hz, 2H, ArCH_2), 2.90 (dd, *J* =

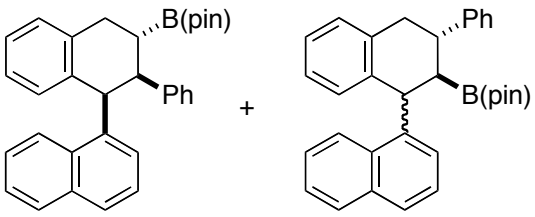
16.4, 4.8 Hz, 1H, ArCH_2), 7.07 (brs, 4H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 3.4, 5.3, 17.3, 24.8, 25.1, 31.2, 36.2, 40.9, 83.0, 125.3, 128.3, 128.9, 136.8, 136.9.

A mixture of 2-(3,4-diphenyl-1,2,3,4-tetrahydronaphthalen-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (3ba) and 2-(1,3-diphenyl-1,2,3,4-tetrahydronaphthalen-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (3'ba) (3ba:3'ba = 93:7)



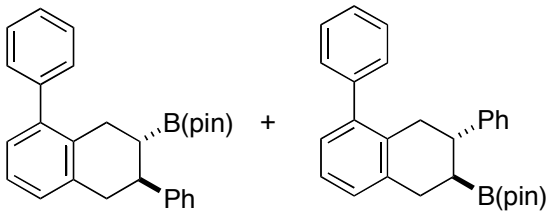
A yellow solid: ^{1}H NMR ($CDCl_3$): δ 0.67-0.97 (m, CH_3), 1.99-2.11 (m, BC*H*), 3.00-3.09 (m, ArCH_2), 3.47 (dd, *J* = 12.5, 4.8 Hz, PhC*H*), 4.07-4.27 (m, ArC*H*Ph), 6.47 (d, *J* = 6.8 Hz, Ar*H*), 6.71-7.36 (m, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.08, 24.11, 24.15, 24.23, 24.3, 31.4, 32.3, 40.2, 43.9, 47.0, 51.3, 51.9, 55.0, 82.8, 82.88, 82.92, 125.6, 125.7, 125.9, 126.0, 126.1, 126.5, 126.9, 127.3, 127.71, 127.73, 128.2, 128.3, 128.4, 129.0, 129.4, 129.5, 130.3, 130.7, 130.8, 136.4, 136.8, 137.1, 139.6, 140.3, 140.4, 142.5, 143.5, 144.2, 145.4, 145.5.

A mixture of 4,4,5,5-tetramethyl-2-(2-phenyl-1,2,3,4-tetrahydro-1,1'-binaphthyl-3-yl)-1,3,2-dioxaborolane (3ca) and 4,4,5,5-tetramethyl-2-(3-phenyl-1,2,3,4-tetrahydro-1,1'-binaphthyl-2-yl)-1,3,2-dioxaborolane (3'ca) (3ca:3'ca = 89:11)



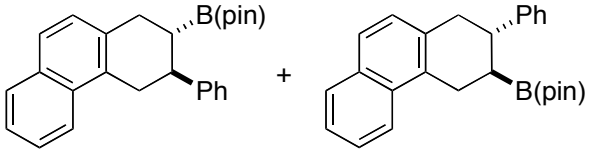
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.84-0.97 (m, CH_3), 2.13-2.33 (m, BC*H*), 3.21 (d, *J* = 8.77 Hz, ArCH_2), 3.64 (dd, *J* = 12.6, 5.8 Hz, PhC*H*), 5.33 (d, *J* = 5.8 Hz, ArC*H*Ar), 6.57-7.78 (m, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 17.6, 24.0, 24.07, 24.14, 24.2, 24.26, 24.33, 24.4, 31.4, 32.3, 44.0, 44.1, 44.3, 47.3, 82.7, 82.8, 82.9, 123.5, 124.3, 124.56, 124.61, 124.63, 125.1, 125.5, 125.8, 125.9, 126.0, 126.4, 126.5, 127.0, 127.6, 127.7, 127.8, 127.9, 128.3, 128.5, 128.9, 129.5, 129.6, 130.8, 132.7, 133.2, 136.6, 139.6, 140.7, 143.0, 145.5.

A mixture of 2-(3,8-diphenyl-1,2,3,4-tetrahydronaphthalen-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (3da) and 2-(3,5-diphenyl-1,2,3,4-tetrahydronaphthalen-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (3'da) (3da:3'da = 68:32)



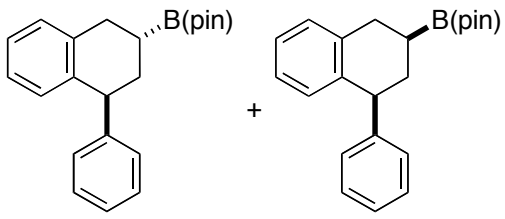
A yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.92-0.94 (m, CH_3), 0.98-1.01 (m, CH_3), 1.64 (td, J = 11.6, 3.8 Hz, BCH), 1.78 (td, J = 10.6, 6.7 Hz, BCH), 2.71-3.18 (m, ArCH_2 and PhCH), 7.07-7.46 (m, ArH); ^{13}C NMR ($CDCl_3$): δ 24.31, 24.34, 24.4, 30.2, 32.3, 37.7, 39.7, 42.7, 43.3, 77.2, 82.88, 82.89, 125.28, 125.33, 126.1, 126.2, 126.6, 126.7, 127.3, 127.4, 127.6, 127.7, 127.8, 127.88, 127.94, 128.0, 128.1, 128.2, 128.3, 129.1, 129.2, 134.0, 134.3, 136.7, 137.2, 141.7, 141.8, 141.9, 142.1, 146.4.

A mixture of 4,4,5,5-tetramethyl-2-(3-phenyl-1,2,3,4-tetrahydrophenanthren-2-yl)-1,3,2-dioxaborolane (3ea) and 4,4,5,5-tetramethyl-2-(2-phenyl-1,2,3,4-tetrahydrophenanthren-3-yl)-1,3,2-dioxaborolane (3'ea) (3ea:3'ea = 50:50)



A yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.98-1.02 (m, CH_3), 1.82 (td, J = 11.6, 4.8 Hz, BCH), 3.01-3.20 (m), 3.43 (dd, J = 17.4, 4.8 Hz), 3.54 (dd, J = 15.5, 2.9 Hz), 7.18-7.51 (m, ArH), 7.63 (d, J = 3.9 Hz, ArH), 7.65 (d, J = 2.9 Hz, ArH), 7.79-7.82 (m, ArH), 7.89 (d, J = 7.7 Hz, ArH), 8.01 (d, J = 8.7 Hz, ArH); ^{13}C NMR ($CDCl_3$): δ 24.37, 24.43, 24.5, 28.0, 32.6, 35.7, 40.0, 42.5, 43.0, 82.99, 83.03, 122.7, 123.0, 124.7, 125.7, 125.79, 125.82, 126.27, 126.32, 127.66, 127.71, 127.8, 128.0, 128.25, 128.33, 128.36, 128.38, 130.9, 131.2, 132.0, 132.1, 132.2, 132.3, 133.8, 134.1, 146.3, 146.6.

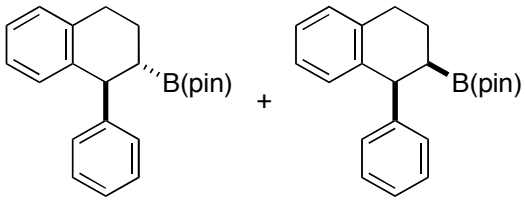
A mixture of *anti*- and *syn*-4,4,5,5-tetramethyl-2-(4-phenyl-1,2,3,4-tetrahydronaphthalen-2-yl)-1,3,2-dioxaborolane (3bo) (*anti*:*syn* = 62:38)



A colorless oil: ^{1}H NMR ($CDCl_3$): δ 1.21 (s, CH_3), 1,22 (s, CH_3), 1.43-1.58 (m), 1.70-2.31 (m), 2.80-3.00 (m, ArCH_2), 4.05 (dd, J = 11.9, 4.0 Hz, ArCHPh), 4.25 (dd, J = 5.8, 2.9 Hz, ArCHPh), 6.77-7.31 (m, ArH); ^{13}C NMR ($CDCl_3$): δ 24.67, 24.74, 24.8, 30.6, 31.4, 33.2,

36.1, 44.0, 47.6, 83.1, 83.2, 125.48, 125.54, 125.6, 125.9, 126.0, 128.0, 128.3, 128.6, 128.76, 128.83, 129.0, 129.8, 130.6, 137.8, 138.0, 138.4, 140.0, 147.4, 147.7.

A mixture of *anti-* and *syn*-4,4,5,5-tetramethyl-2-(1-phenyl-1,2,3,4-tetrahydronaphthalen-2-yl)-1,3,2-dioxaborolane (3'bo) (*anti*:*syn* = 84:16)



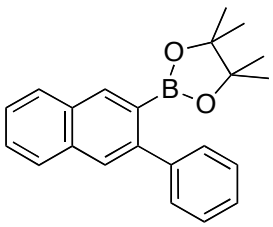
A colorless oil: ^{1}H NMR ($CDCl_3$): δ 1.02-1.12 (m, CH_3), 1.58 (td, J = 10.6, 2.9 Hz, BCH), 1.79-1.87 (m, CH_2), 1.96-2.02 (m, CH_2), 2.88-2.95 (m, ArCH_2), 4.16 (d, J = 10.6 Hz, ArCHPh), 4.41 (d, J = 4.0 Hz, ArCHPh) 6.75 (d, J = 7.8 Hz, ArH), 6.93-7.27 (m, ArH); ^{13}C NMR ($CDCl_3$): δ 14.1, 19.1, 23.0, 23.5, 24.0, 24.5, 24.6, 24.7, 25.1, 25.8, 29.6, 30.0, 37.7, 45.1, 47.3, 83.0, 83.1, 121.3, 125.4, 125.5, 125.6, 125.7, 125.86, 125.91, 127.6, 128.1, 128.8, 129.0, 129.3, 129.7, 129.9, 137.15, 137.19, 140.5, 147.0.

Aromatization of boryltetralins: a general procedure.

Method A: A benzene (6 mL) solution of **3** (0.10 mmol), NBS (0.50 mmol), sodium methoxide (0.30 mmol) and AIBN (5.0 μmol) was stirred at reflux temperature in the dark for the period as specified in Schemes 3 and 4. The mixture was diluted with hexane before filtration with Celite pad. Preparative recycling gel permeation chromatography (chloroform as an eluent) gave the corresponding product.

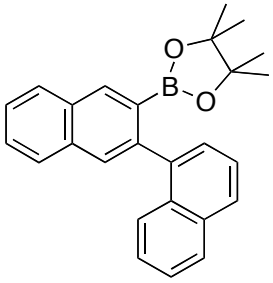
Method B: A toluene (0.5 mL) solution of **3** (0.10 mmol) and DDQ (0.25 mmol) was stirred at 100 °C for the period as specified in Scheme 3. The mixture was diluted with benzene before filtration with Celite pad. Preparative recycling gel permeation chromatography (chloroform as an eluent) gave the corresponding product.

4,4,5,5-Tetramethyl-2-(3-phenyl-naphthalen-2-yl)-[1,3,2]dioxaborolane (4aa)



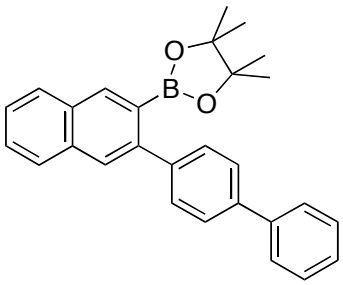
A yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.26 (s, 12H, C*H*$_3$), 7.37-7.53 (m, 7H, Ar*H*), 7.83-7.92 (m, 3H, Ar*H*), 8.29 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 23.7, 83.8, 125.8, 126.8, 127.1, 127.5, 127.8, 128.1, 129.3, 131.6, 134.2, 135.8, 143.1, 143.6; HRMS Calcd for $C_{22}H_{23}BO_2$: M^+, 330.1791. Found: *m*/*z* 330.1776.

4,4,5,5-Tetramethyl-2-[3-(1-naphthyl)-naphthalen-2-yl]-[1,3,2]dioxaborolane (4ab)



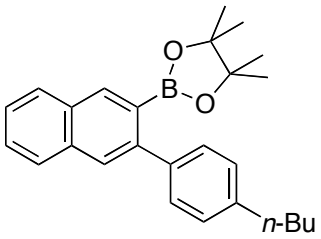
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.69 (s, 6H, C*H*$_3$), 0.97 (s, 6H, C*H*$_3$), 7.34 (t, *J* = 6.8 Hz, 1H, Ar*H*), 7.44 (t, *J* = 6.8 Hz, 1H, Ar*H*), 7.51-7.61 (m, 5H, Ar*H*), 7.79-7.90 (m, 4H, Ar*H*), 7.97 (d, *J* = 7.7 Hz, 1H, Ar*H*), 8.37 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.0, 24.4, 83.3, 84.1, 124.9, 125.2, 125.3, 125.7, 125.8, 125.9, 126.3, 126.7, 127.0, 127.09, 127.14, 127.4, 127.7, 127.76, 127.79, 128.0, 128.2, 128.3, 128.4, 131.9, 133.2, 133.4, 134.5, 135.3, 141.5, 142.3; HRMS Calcd for $C_{26}H_{25}BO_2$: M^+, 380.1948. Found: *m*/*z* 380.1942.

4,4,5,5-Tetramethyl-2-[3-(biphenyl-4-yl)-naphthalen-2-yl]-[1,3,2]dioxaborolane (4ac)



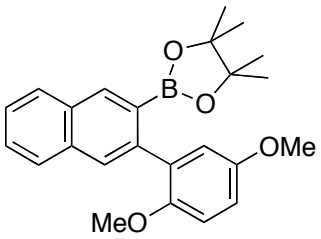
A white solid: ^{1}H NMR ($CDCl_3$): δ 1.28 (s, 12H, C*H*$_3$), 7.38 (t, *J* = 8.7 Hz, 1H, Ar*H*), 7.47-7.70 (m, 10H, Ar*H*), 7.85-7.92 (m, 3H, Ar*H*), 8.31 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.6, 83.9, 125.9, 126.6, 127.10, 127.12, 127.2, 127.5, 127.8, 128.1, 128.8, 129.75, 129.83, 131.7, 134.3, 136.0, 139.6, 141.1, 142.2, 143.2; HRMS Calcd for $C_{28}H_{27}BO_2$: M^+, 406.2104. Found: *m*/*z* 406.2089.

4,4,5,5-Tetramethyl-2-[3-(4-*n*-butylphenyl)-naphthalen-2-yl]-[1,3,2]dioxaborolane (4ad)



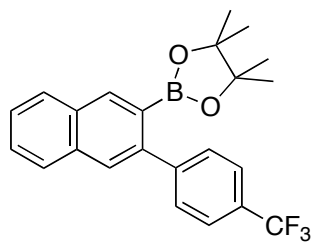
A yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.96 (t, *J* = 7.7 Hz, 3H, C*H*$_3$CH$_2$), 1.26 (s, 12H, C*H*$_3$), 1.40 (sext, *J* = 7.7 Hz, 2H, C*H*$_2$), 1.66 (quint, *J* = 7.7 Hz, 2H, C*H*$_2$), 2.69 (t, *J* = 7.7 Hz, 2H, ArC*H*$_2$), 7.23 (d, *J* = 7.7 Hz, 2H, Ar*H*), 7.41 (d, *J* = 7.7 Hz, 2H, Ar*H*) 7.47 (t, *J* = 7.7 Hz, 3H, Ar*H*), 7.51 (t, *J* = 6.8 Hz, 1H, Ar*H*), 7.82 (s, 1H, Ar*H*), 7.83 (d, *J* = 8.7 Hz, 1H, Ar*H*), 7.89 (d, *J* = 6.8 Hz, 1H, Ar*H*), 8.26 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 14.0, 22.2, 24.6, 33.8, 35.3, 83.8, 127.2, 127.3, 127.8, 127.9, 128.1, 129.0, 129.2, 131.6, 134.2, 135.6, 135.7, 140.5, 141.4, 143.6; HRMS Calcd for $C_{26}H_{31}BO_2$: M^+, 386.2417. Found: *m*/*z* 386.2415.

4,4,5,5-Tetramethyl-2-[3-(2,5-dimethoxyphenyl)-naphthalen-2-yl]-[1,3,2]dioxaborolane (4ae)



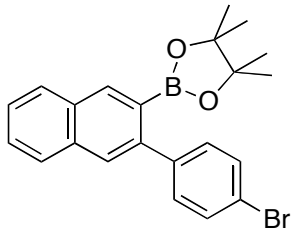
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.23 (s, 12H, C*H*$_3$), 3.62 (s, 3H, OC*H*$_3$), 3.83 (s, 3H, OC*H*$_3$), 6.82-6.97 (m, 3H, Ar*H*), 7.45-7.51 (m, 2H, Ar*H*), 7.76 (s, 1H, Ar*H*) 7.82 (d, *J* = 7.7 Hz, 1H, Ar*H*), 7.89 (d, *J* = 8.7 Hz 1H, Ar*H*), 8.39 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.7, 55.7, 56.5, 83.4, 112.6, 113.0, 116.6, 125.7, 126.3, 126.7, 127.8, 128.0, 128.1, 131.8, 133.7, 134.4, 135.0, 140.0, 151.4, 153.7; HRMS Calcd for $C_{24}H_{27}BO_4$: M^+, 390.2002. Found: *m*/*z* 390.2000.

4,4,5,5-Tetramethyl-2-[3-(4-trifluoromethylphenyl)-naphthalen-2-yl]-[1,3,2]dioxaborolane (4af)



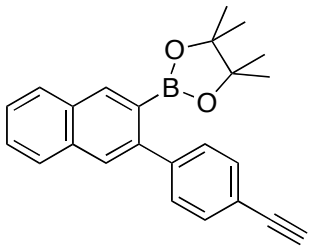
A yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.27 (s, 12H, C*H*$_3$), 7.50-7.68 (m, 6H, Ar*H*), 7.79-7.93 (m, 3H, Ar*H*), 8.34 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.6, 84.0, 124.5, 124.6, 126.3, 126.9, 127.4, 127.7, 127.9, 128.3, 129.1, 129.7, 130.2, 131.4, 131.9, 134.1, 136.5, 136.9, 142.4, 146.8; HRMS Calcd for $C_{23}H_{22}BF_3O_2$: M^+, 398.1665. Found: *m*/*z* 398.1654.

4,4,5,5-Tetramethyl-2-[3-(4-bromophenyl)-naphthalen-2-yl]-[1,3,2]dioxaborolane (4ag)



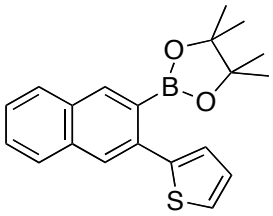
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.27 (s, 12H, C*H*$_3$), 7.36 (d, *J* = 8.7 Hz, 2H, Ar*H*), 7.47-7.57 (m, 4H, Ar*H*), 7.77 (s, 1H, Ar*H*), 7.83 (d, *J* = 7.7 Hz, 1H, Ar*H*), 7.90 (d, *J* = 7.7 Hz, 1H, Ar*H*), 8.31 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.6, 83.9, 121.0, 126.1, 127.3, 127.5, 127.8, 128.1, 130.7, 131.0, 131.8, 134.2, 136.4, 142.1, 142.5; HRMS Calcd for $C_{22}H_{22}BBrO_2$: M^+, 408.0896. Found: *m*/*z* 408.0901.

4,4,5,5-Tetramethyl-2-[3-(4-ethynylphenyl)-naphthalen-2-yl]-[1,3,2]dioxaborolane (4ah)



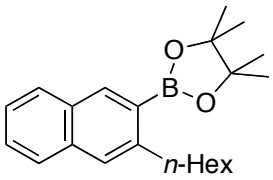
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.26 (s, 12H, C*H*$_3$), 3.14 (s, 1H, C*H*), 7.45-7.55 (m, 6H, Ar*H*), 7.79 (s, 1H, Ar*H*), 7.84 (d, *J* = 7.7 Hz, 1H, Ar*H*), 7.90 (d, *J* = 8.7 Hz, 1H, Ar*H*), 8.30 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.6, 77.2, 84.0, 120.4, 126.1, 127.28, 127.31, 127.6, 127.8, 128.1, 129.4, 131.6, 131.8, 132.5, 134.2, 136.3, 142.8, 143.8; HRMS Calcd for $C_{24}H_{23}BO_2$: M^+, 354.1791. Found: *m*/*z* 354.1798.

4,4,5,5-Tetramethyl-2-[3-(2-thienyl)-naphthalen-2-yl]-[1,3,2]dioxaborolane (4aj)



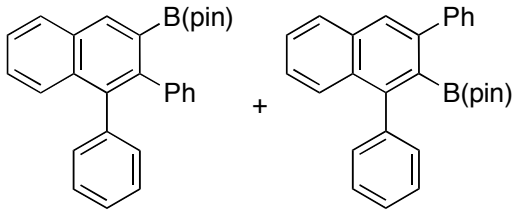
A yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.31 (s, 12H, C*H*$_3$), 7.08 (t, *J* = 3.9 Hz, 1H, Ar*H*-thiophene), 7.18 (d, *J* = 4.8 Hz, 1H, Ar*H*-thiophene), 7.33 (d, *J* = 3.9 Hz, 1H, Ar*H*-thiophene), 7.46-7.53 (m, 2H, Ar*H*), 7.84 (dd, *J* = 18.3, 7.7 Hz, 2H, Ar*H*), 7.91 (s, 1H, Ar*H*), 8.21 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.7, 84.0, 125.1, 126.1, 126.4, 127.0, 127.2, 127.8, 128.07, 128.14, 132.0, 134.1, 135.6, 135.8, 145.0; HRMS Calcd for $C_{20}H_{21}BO_2S$: M^+, 336.1355. Found: *m*/*z* 336.1353.

4,4,5,5-Tetramethyl-2-(3-*n*-hexyl-naphthalen-2-yl)-[1,3,2]dioxaborolane (4al)



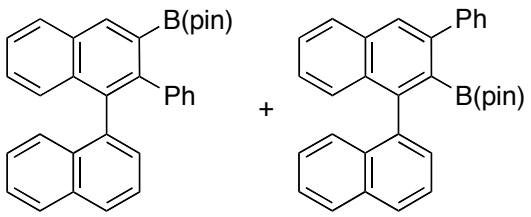
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 0.89 (t, *J* = 7.7 Hz, 3H, C*H*$_3$CH$_2$), 1.27-1.39 (m, 18H, C*H*$_3$ and C*H*$_2$), 1.61 (quint, *J* = 7.8 Hz, 2H, C*H*$_2$), 3.00 (t, *J* = 7.8 Hz, 2H, ArC*H*$_2$), 7.38 (t, *J* = 7.7 Hz, 1H, Ar*H*), 7.46 (t, *J* = 7.7 Hz, 1H, Ar*H*), 7.58 (s, 1H, Ar*H*), 7.74 (d, *J* = 7.7 Hz, 1H, Ar*H*), 7.83 (d, *J* = 7.7 Hz, 1H, Ar*H*), 8.32 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 14.1, 22.7, 24.9, 29.5, 31.9, 33.4, 36.1, 83.5, 124.8, 126.7, 126.9, 127.0, 128.2, 131.1, 134.9, 137.5, 145.6; HRMS Calcd for $C_{22}H_{31}BO_2$: M^+, 338.2417. Found: *m*/*z* 338.2415.

A mixture of 2-(3,4-diphenylnaphthalen-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (4ba) and 2-(1,3-diphenylnaphthalen-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (4'ba) (4ba:4'ba = 93:7)



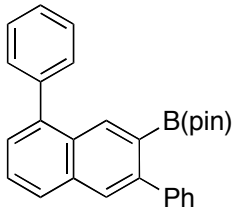
A yellow solid: ^{1}H NMR ($CDCl_3$): δ 1.14 (s, C*H*$_3$), 7.11-7.28 (m, Ar*H*), 7.37-7.55 (m, Ar*H*), 7.68 (d, *J* = 8.6 Hz, Ar*H*), 7.94 (d, *J* = 7.6 Hz, Ar*H*), 8.19 (s, Ar*H*), 8.26 (s, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.5, 24.9, 83.6, 83.8, 125.5, 125.8, 126.3, 126.7, 126.9, 127.5, 127.7, 128.2, 130.1, 130.5, 131.2, 131.9, 133.4, 134.3, 137.6, 139.1, 141.9, 142.5; HRMS Calcd for $C_{28}H_{27}BO_2$: M^+, 406.2104. Found: *m*/*z* 406.2107.

A mixture of 4,4,5,5-tetramethyl-2-(2-phenyl-1,1'-binaphthyl-3-yl)-1,3,2-dioxaborolane (4ca) and 4,4,5,5-tetramethyl-2-(3-phenyl-1,1'-binaphthyl-2-yl)-1,3,2-dioxaborolane (4'ca) (4ca:4'ca = 89:11)



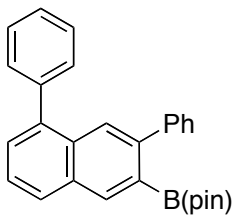
A pale yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.07-1.17 (m, C*H*$_3$), 6.96-7.48 (m, Ar*H*), 7.71-7.86 (m, Ar*H*), 7.99 (d, *J* = 7.8 Hz, Ar*H*), 8.27 (s, Ar*H*), 8.35 (s, Ar*H*), 8.40 (d, *J* = 7.8 Hz, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.3, 24.4, 24.5, 24.7, 83.7, 83.9, 125.0, 125.4, 125.56, 125.62, 125.8, 126.7, 126.8, 126.9, 127.0, 127.2, 127.9, 128.2, 128.3, 129.0, 131.7, 133.0, 133.4, 133.9, 134.6, 134.7, 135.6, 136.9, 142.4, 142.9; HRMS Calcd for $C_{32}H_{29}BO_2$: M^+, 456.2261. Found: *m*/*z* 456.2247.

2-(3,8-Diphenylnaphthalen-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (4da)



A yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.27 (s, 12H, C*H*$_3$), 7.32-7.54 (m, 12H, Ar*H*), 7.92 (s, 1H, Ar*H*), 7.93 (d, *J* = 8.7 Hz, 1H, Ar*H*), 8.36 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.6, 83.8, 125.3, 125.5, 126.7, 127.2, 127.7, 127.8, 128.2, 128.3, 129.3, 130.0, 132.0, 132.3, 136.3, 140.2, 140.5, 143.3, 143.8; HRMS Calcd for $C_{28}H_{27}BO_2$: M^+, 406.2104. Found: *m*/*z* 406.2095.

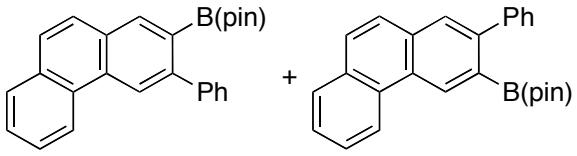
2-(3,5-Diphenylnaphthalen-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (4'da)



A yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.17 (s, 12H, C*H*$_3$), 7.37-7.57 (m, 12H, Ar*H*), 7.86 (d, *J* = 7.7 Hz, 1H, Ar*H*), 7.89 (s, 1H, Ar*H*), 8.32 (s, 1H, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.5, 83.8, 126.5, 126.8, 127.1, 127.2, 127.6, 127.7, 127.9, 128.2, 129.2, 129.7, 130.2, 133.3, 134.6,

140.5, 140.6, 143.0, 143.3; HRMS Calcd for $C_{28}H_{27}BO_2$: M^+, 406.2104. Found: *m/z* 406.2119.

A mixture of 4,4,5,5-tetramethyl-2-(3-phenylphenanthren-2-yl)-1,3,2-dioxaborolane (4ea) and 4,4,5,5-tetramethyl-2-(2-phenylphenanthren-3-yl)-1,3,2-dioxaborolane (4'ea) (4ea:4'ea = 50:50)

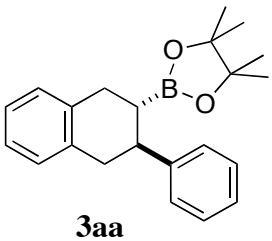


A yellow oil: ^{1}H NMR ($CDCl_3$): δ 1.27 (s, C*H*$_3$), 1.29 (s, C*H*$_3$), 7.38-7.91 (m, Ar*H*), 8.30 (s, Ar*H*), 8.65 (s, Ar*H*), 8.72 (d, *J* = 6.7 Hz, Ar*H*), 8.82 (d, *J* = 7.8 Hz, Ar*H*), 9.09 (s, Ar*H*); ^{13}C NMR ($CDCl_3$): δ 24.6, 24.7, 83.91, 83.92, 122.90, 122.91, 126.46, 126.50, 126.7, 126.82, 126.84, 126.88, 126.89, 126.93, 127.8, 127.9, 128.16, 128.22, 128.3, 128.4, 128.5, 128.6, 129.4, 129.5, 130.0, 130.1, 130.2, 131.4, 132.0, 132.7, 133.2, 136.0, 143.0, 143.5, 144.97, 145.01; HRMS Calcd for $C_{26}H_{25}BO_2$: M^+, 380.1948. Found: *m/z* 380.1950.

References

1 H. Yoshida, S. Nakano, Y. Yamaryo, J. Ohshita and A. Kunai, *Org. Lett.*, 2006, **8**, 4157.

2 S. Pereira and M. Srebnik, *Organometallics*, 1995, **14**, 3127.



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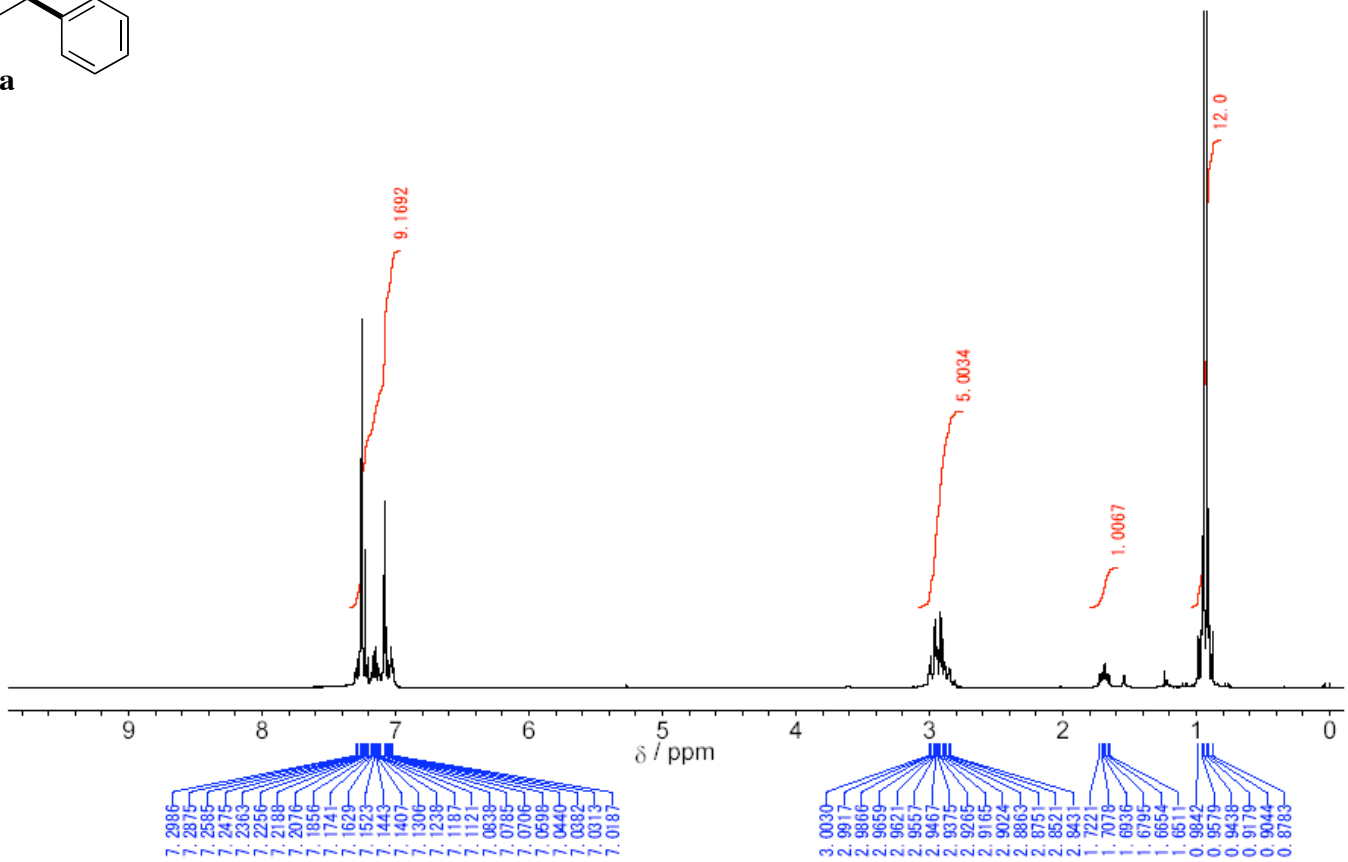

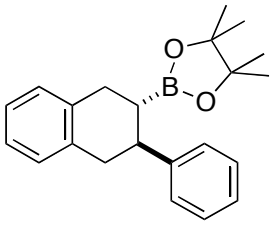

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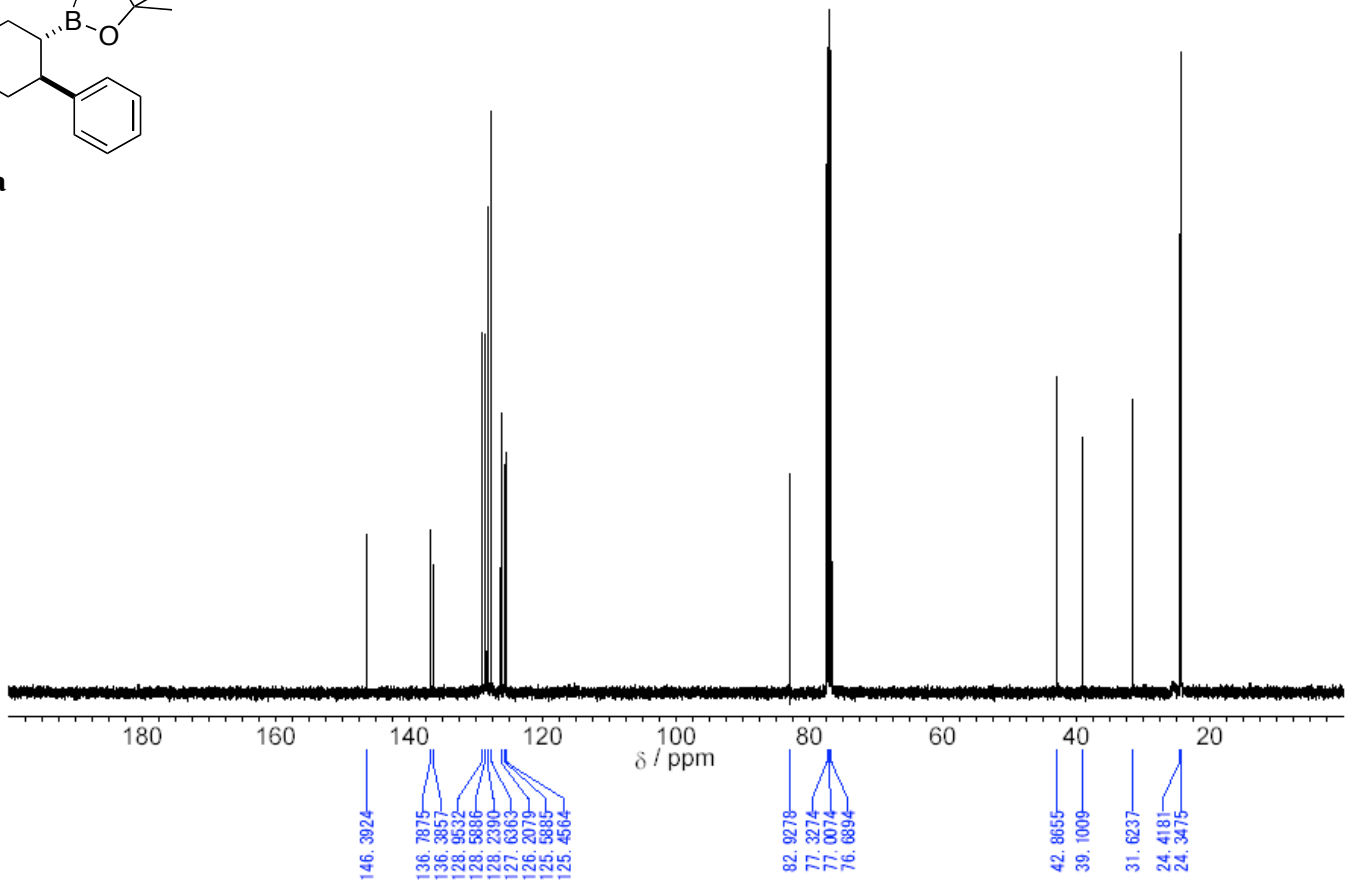

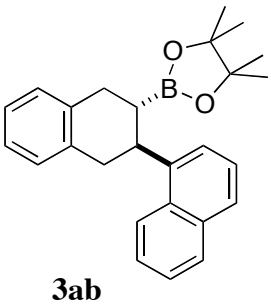

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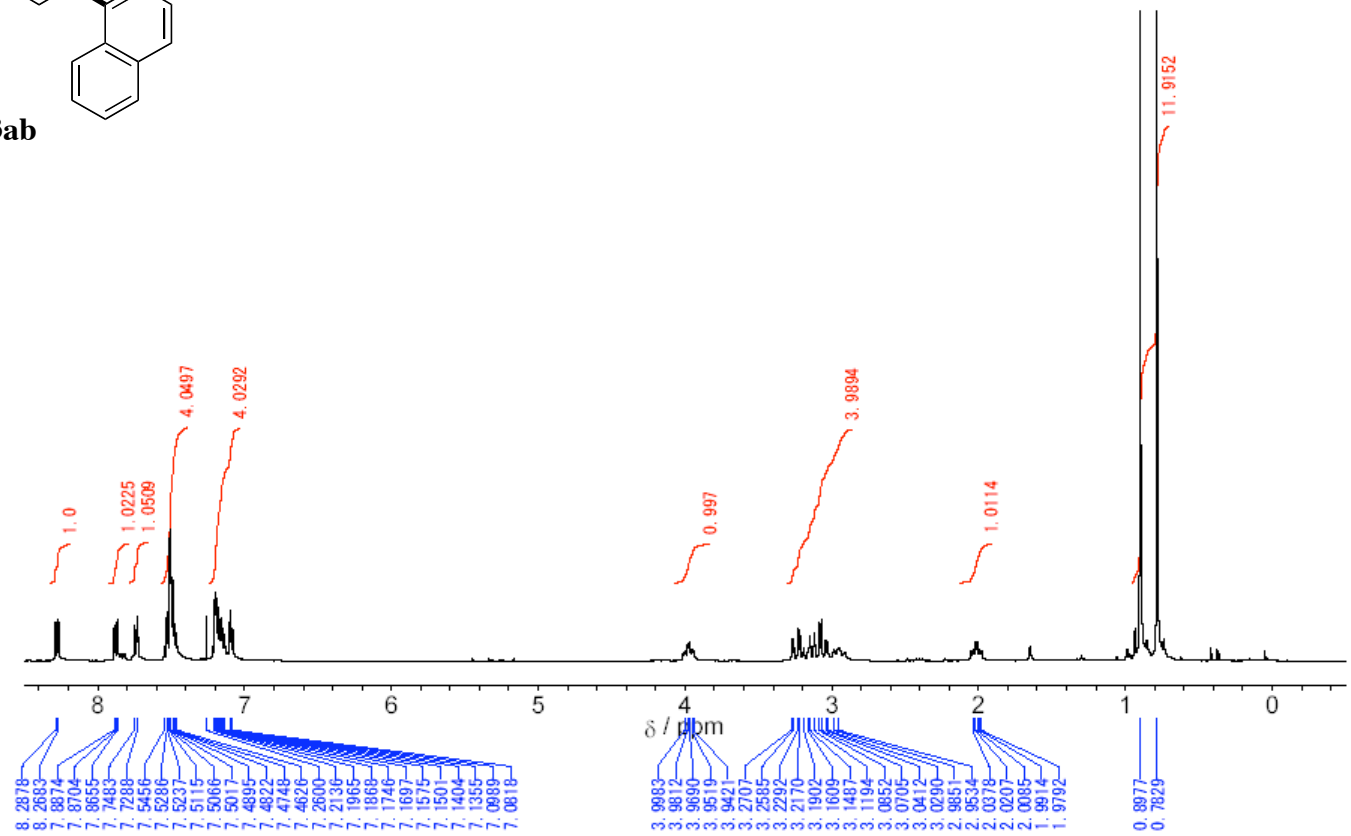

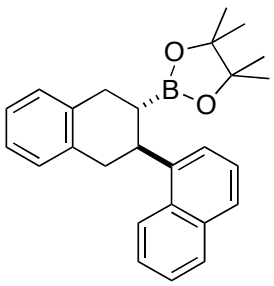

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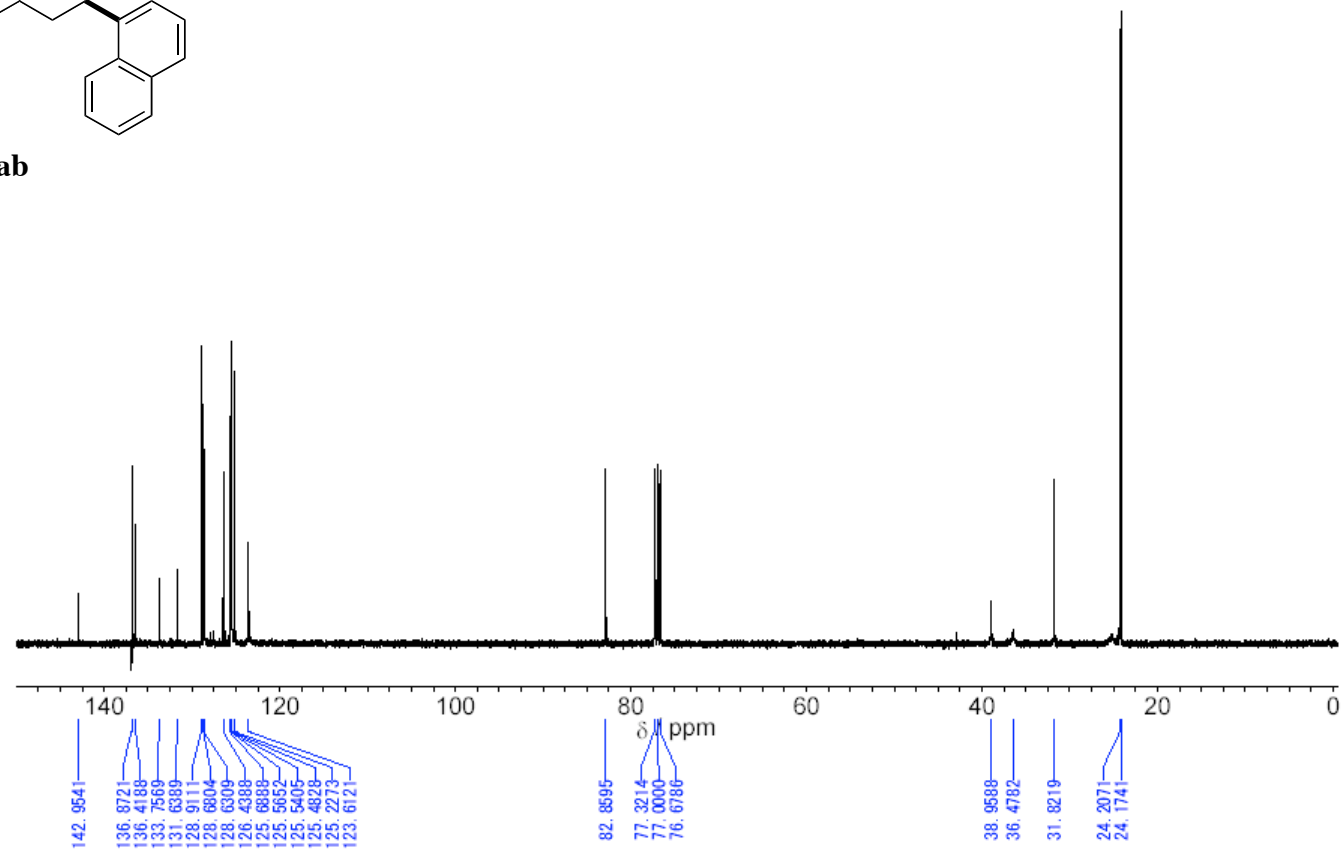

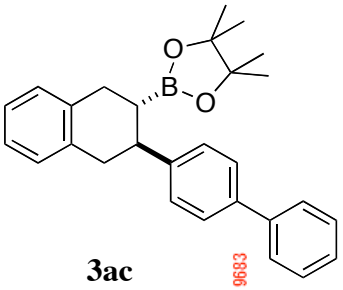

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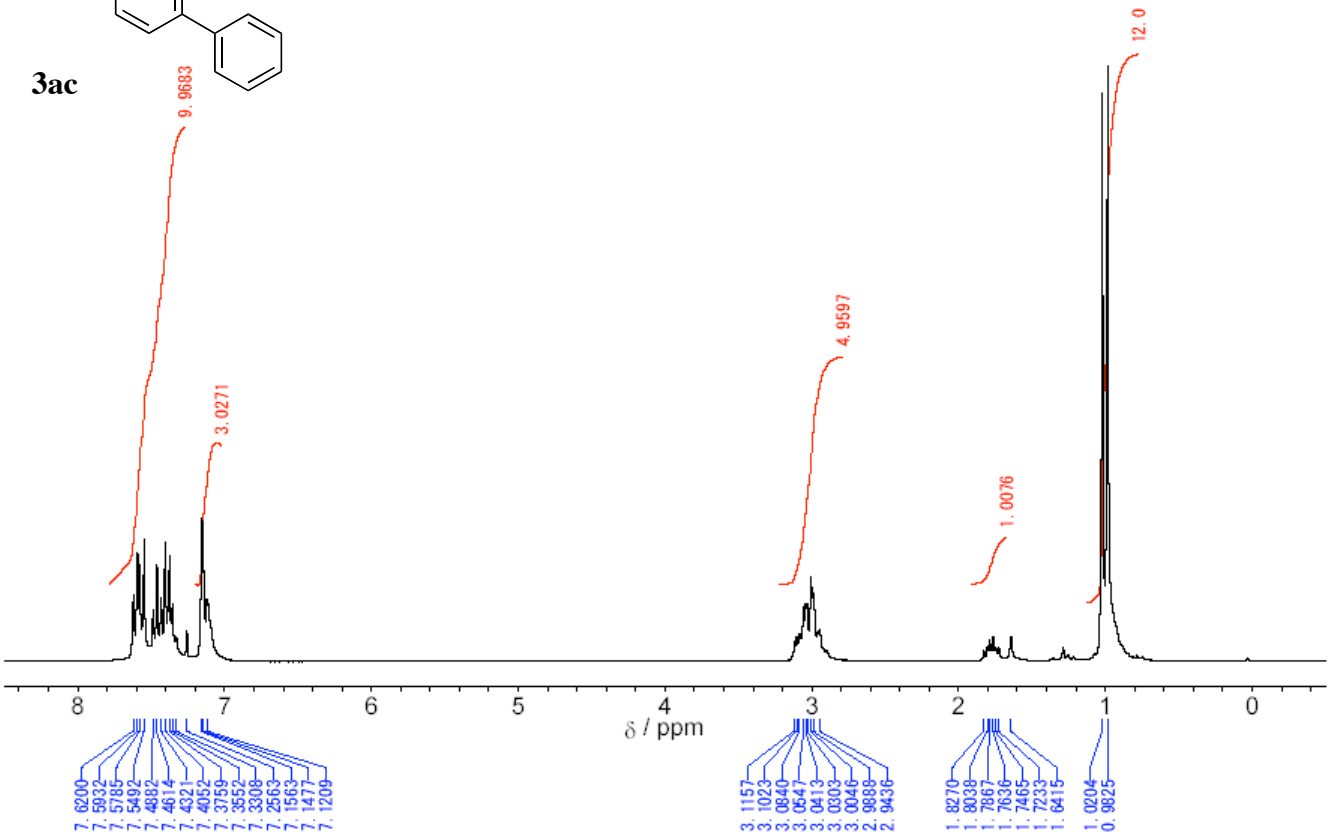

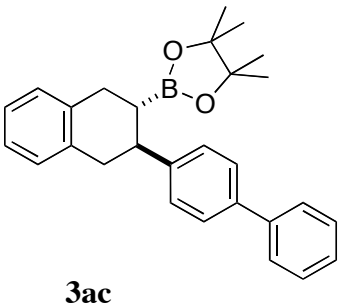

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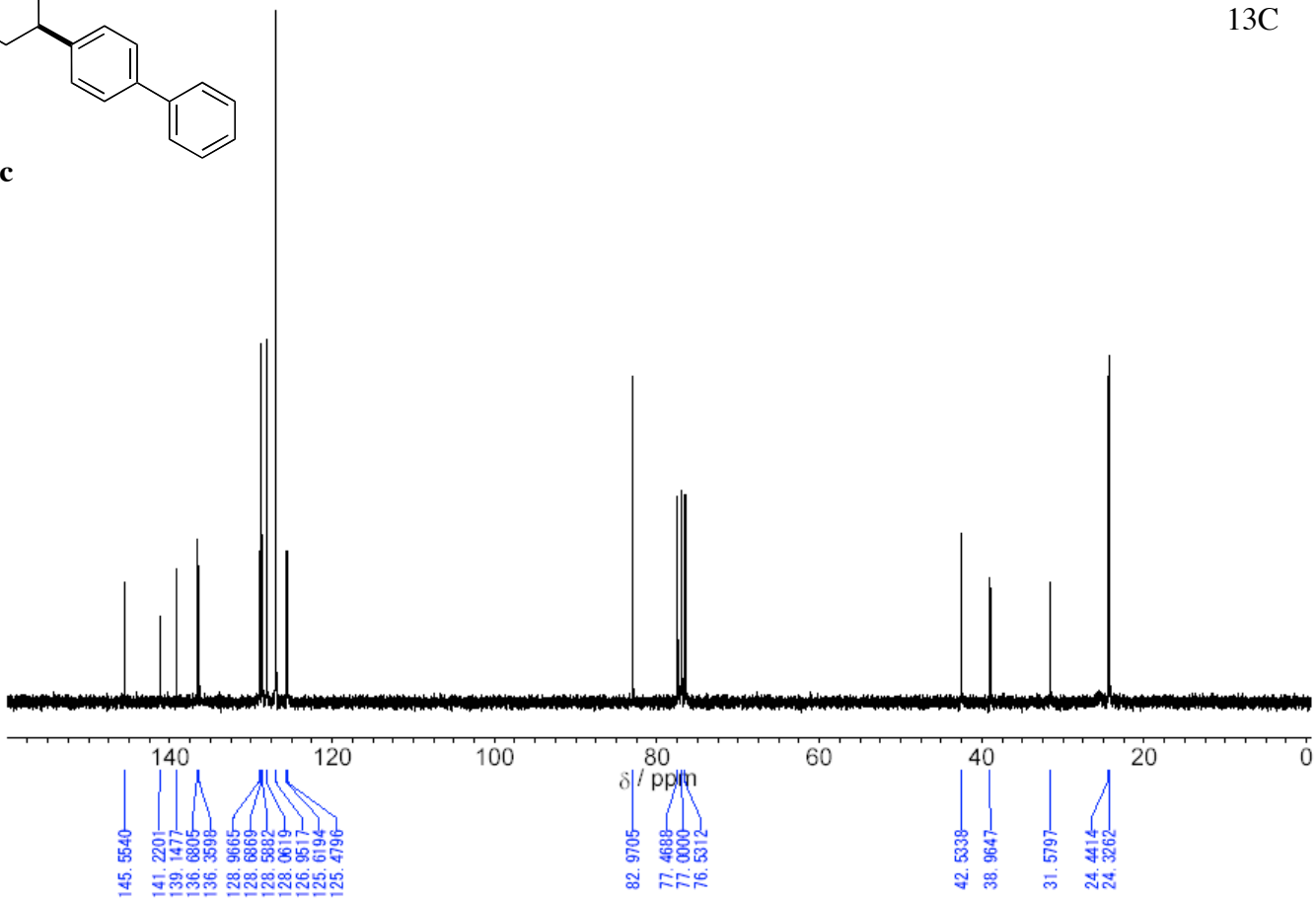

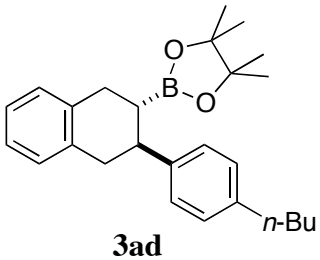

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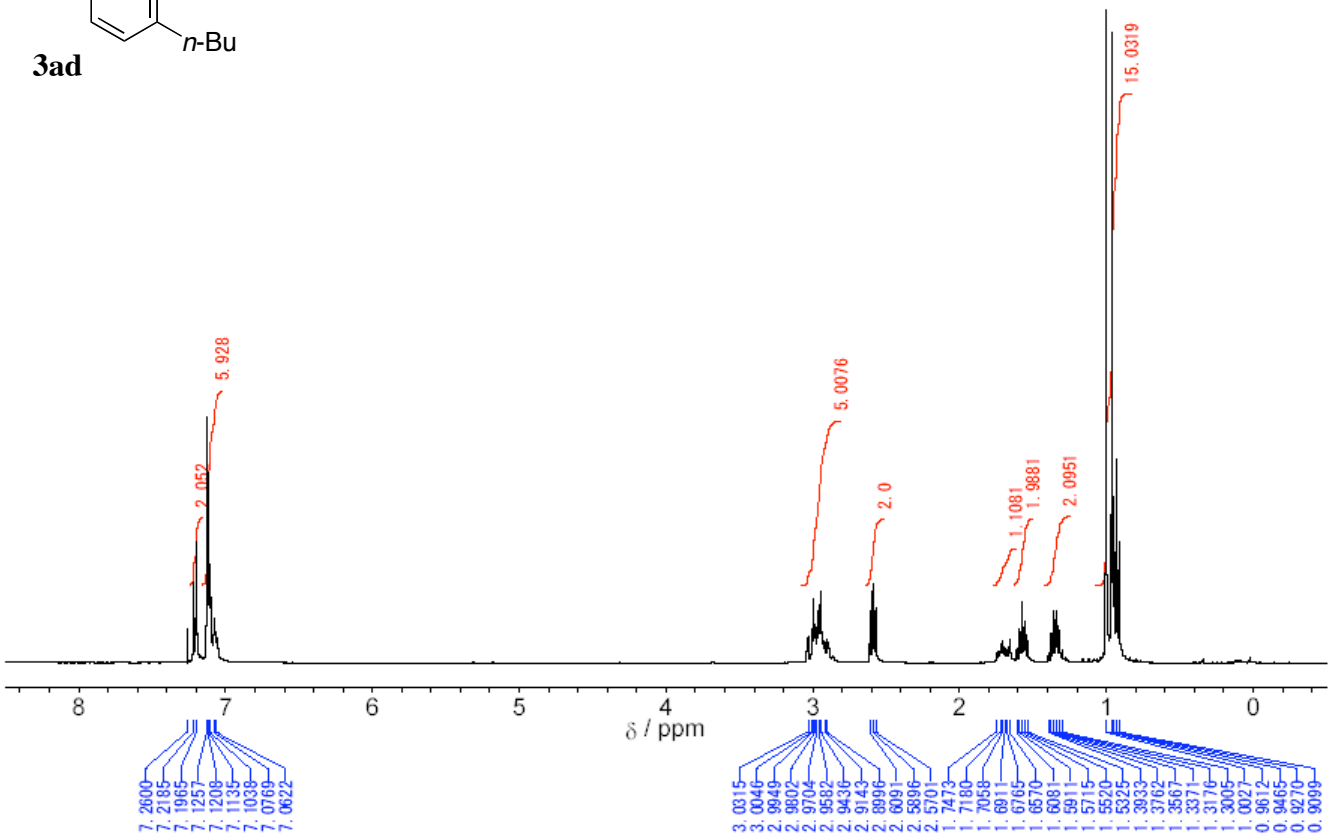

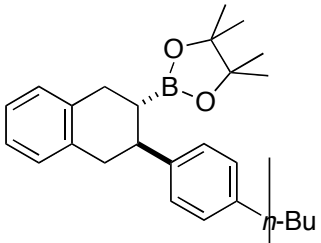

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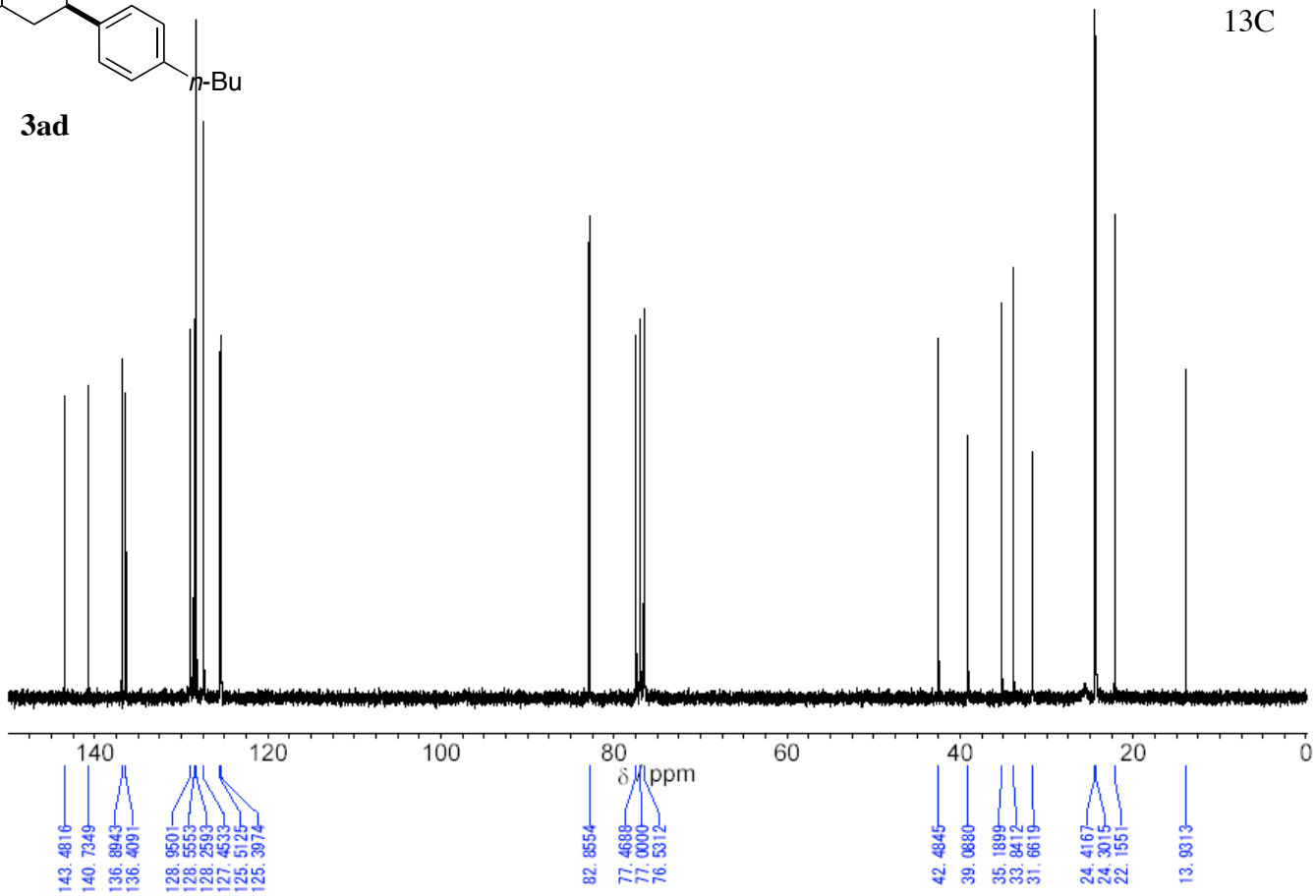

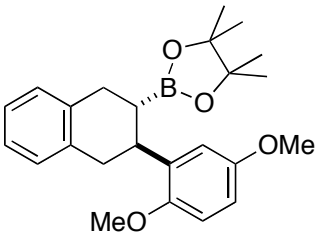

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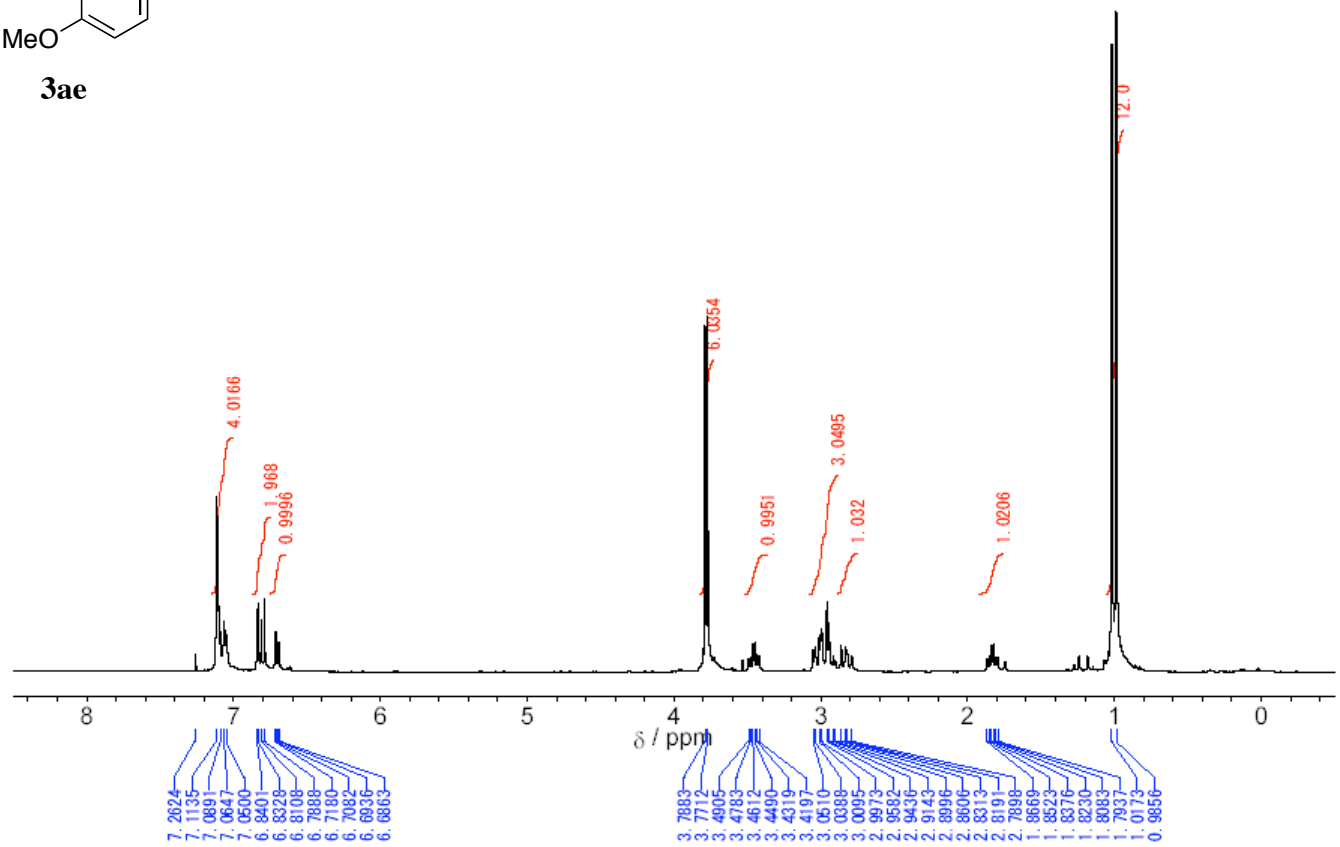

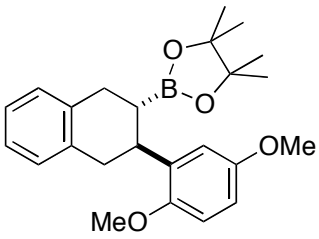

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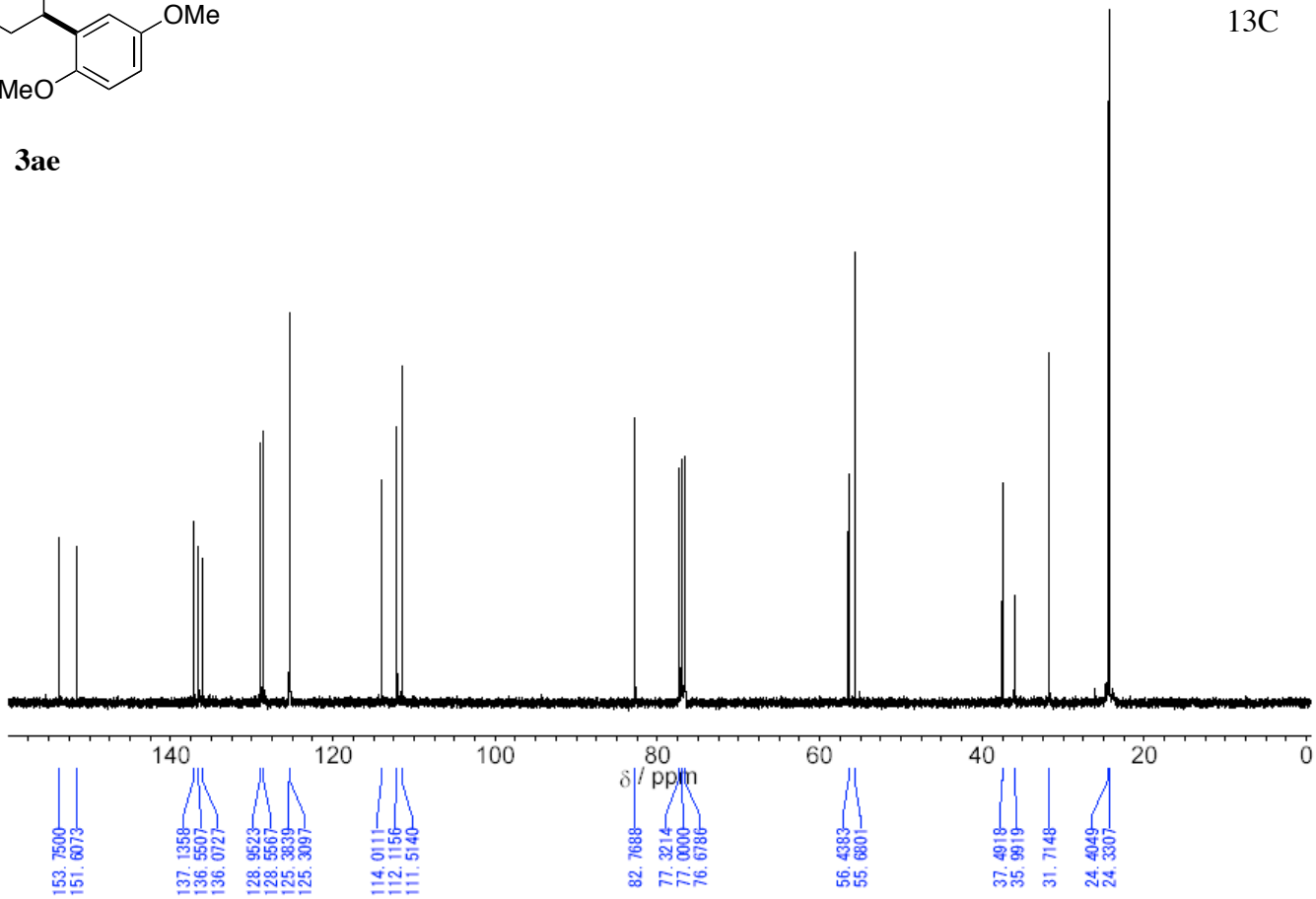

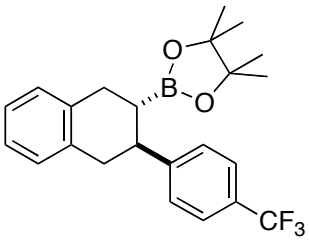

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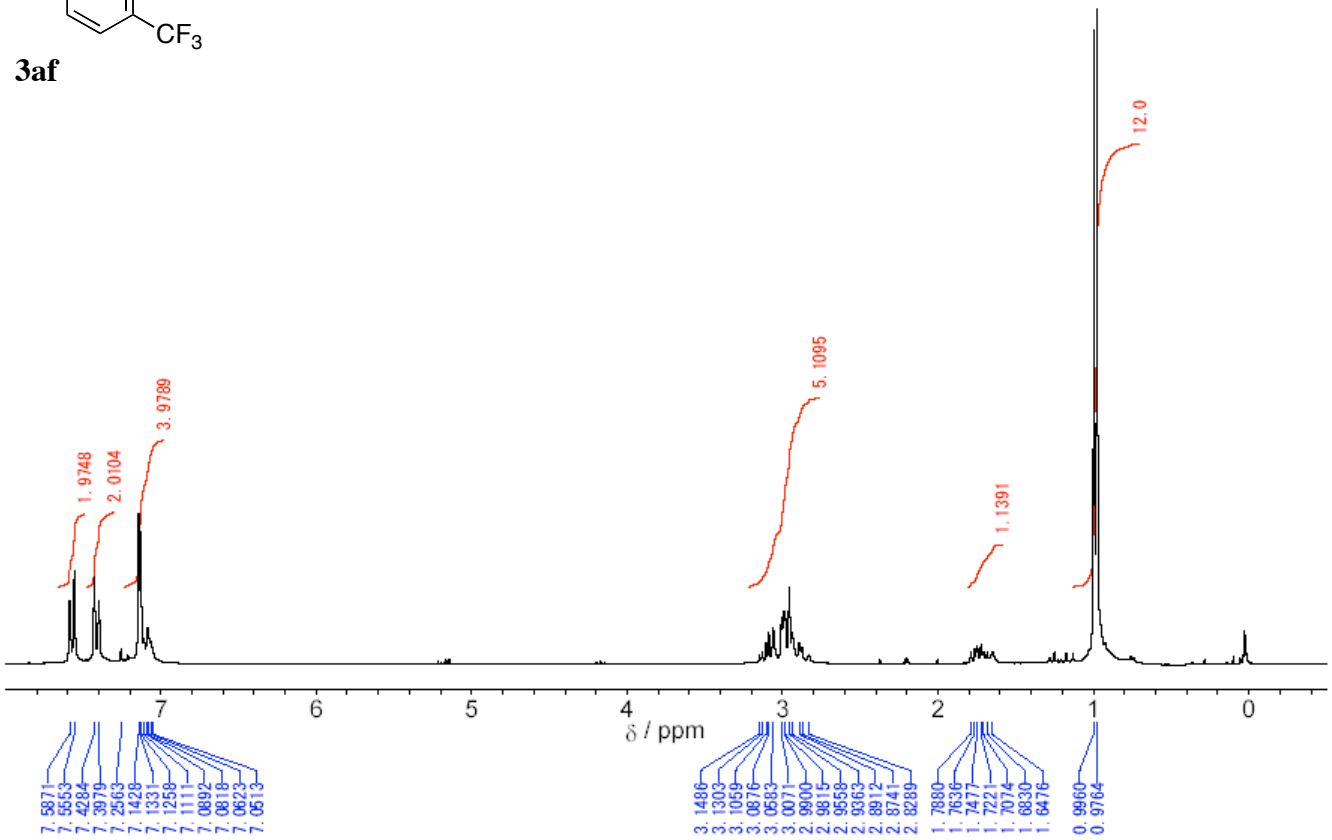

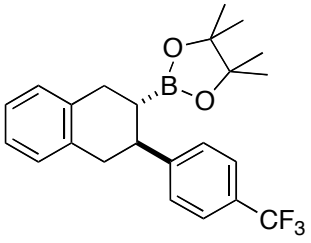

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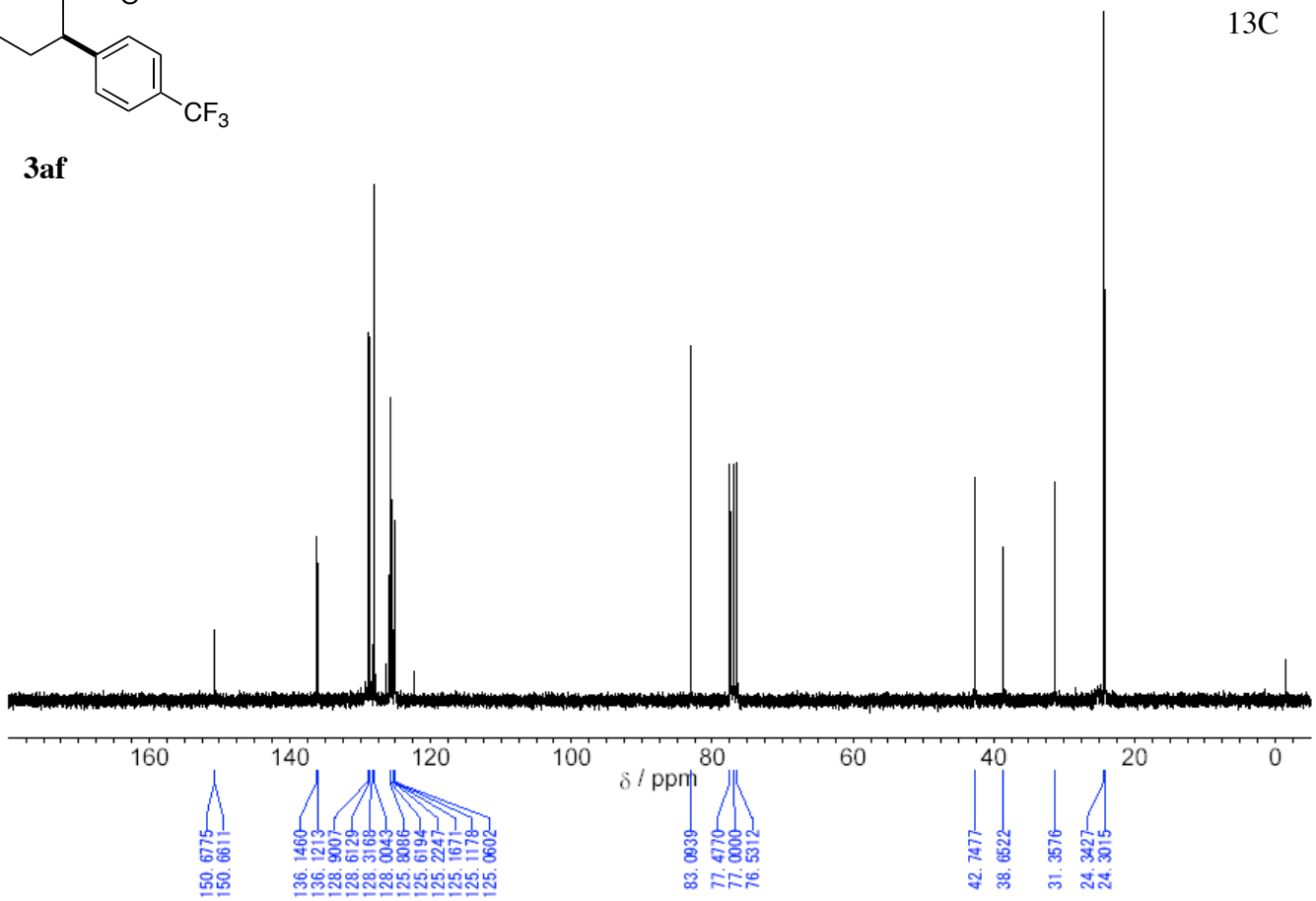

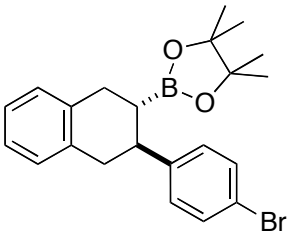

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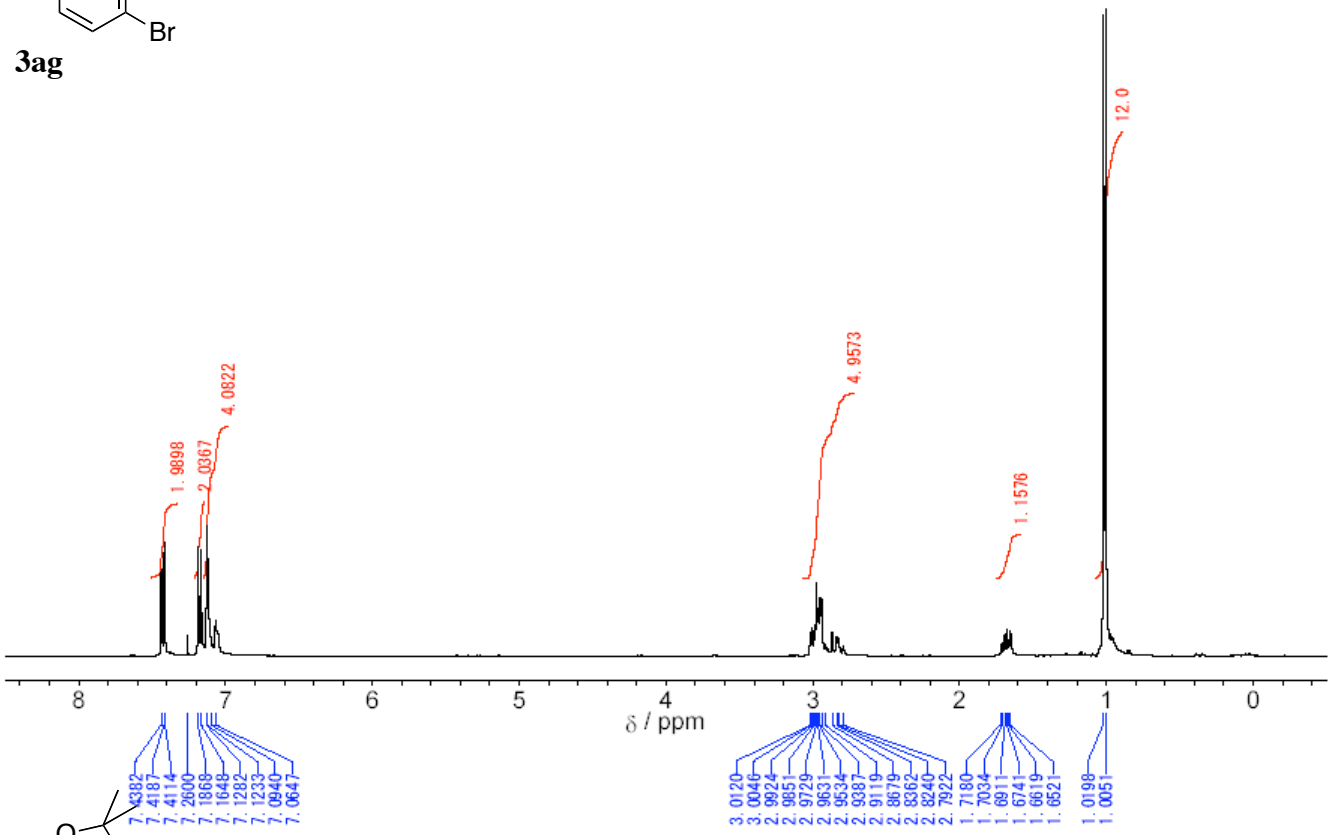

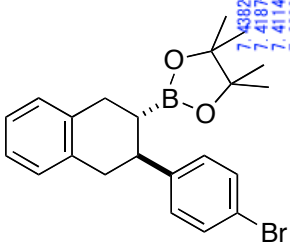

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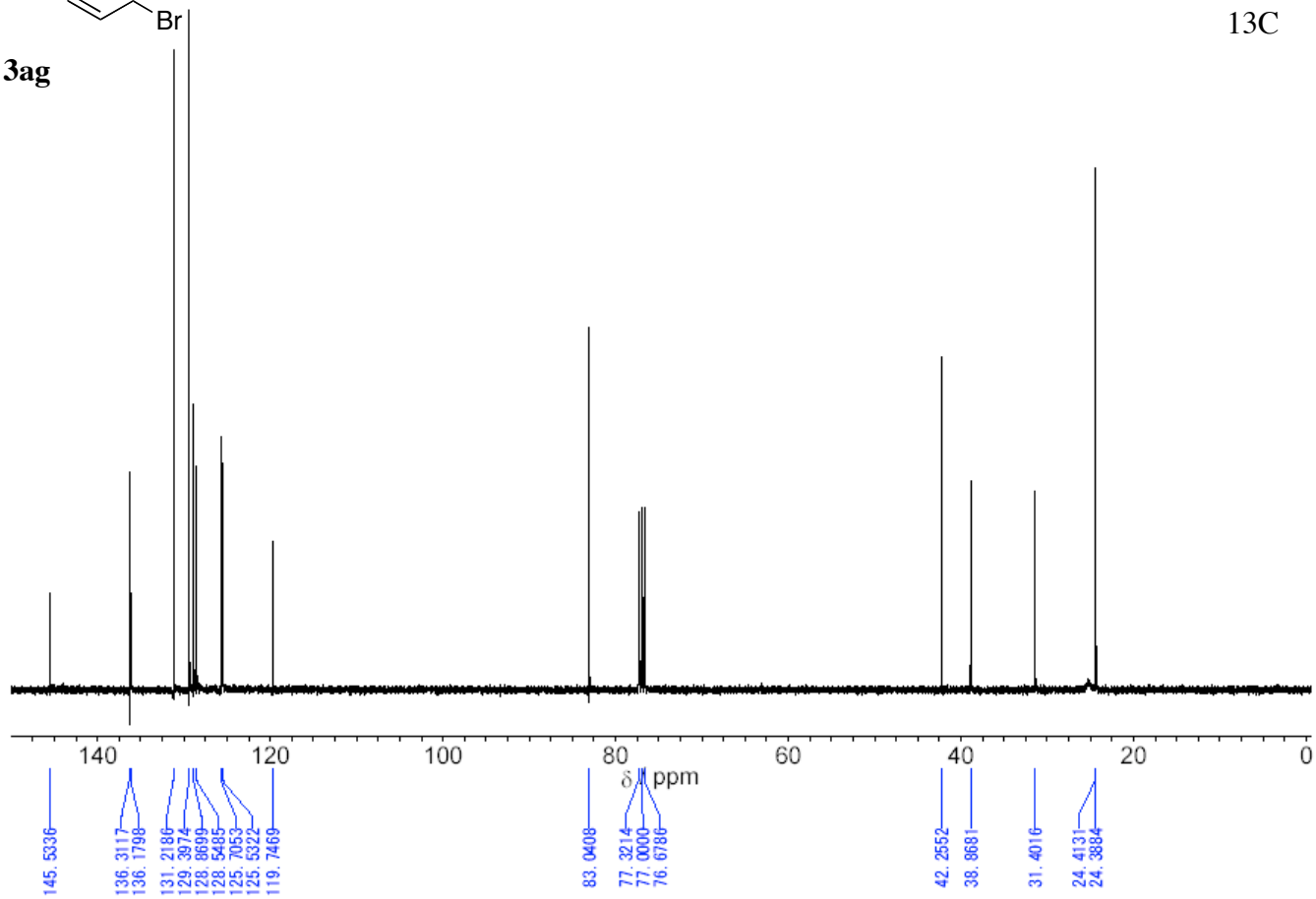

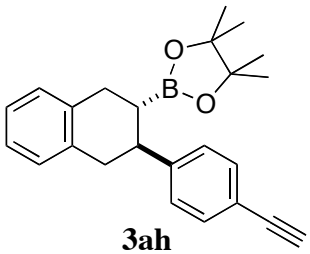

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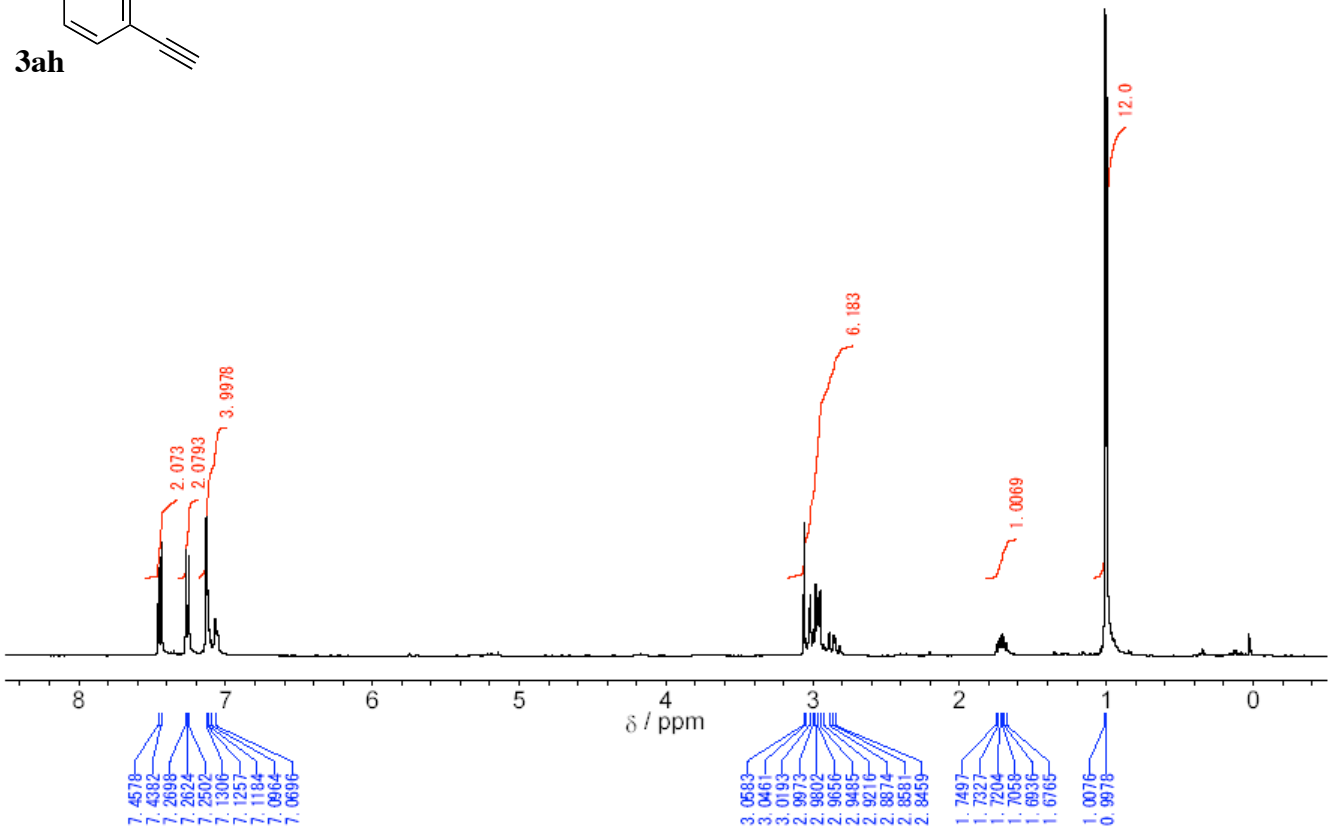

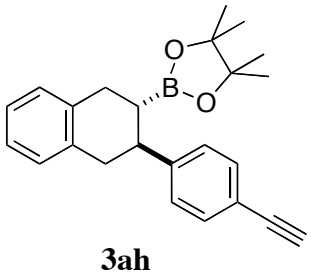

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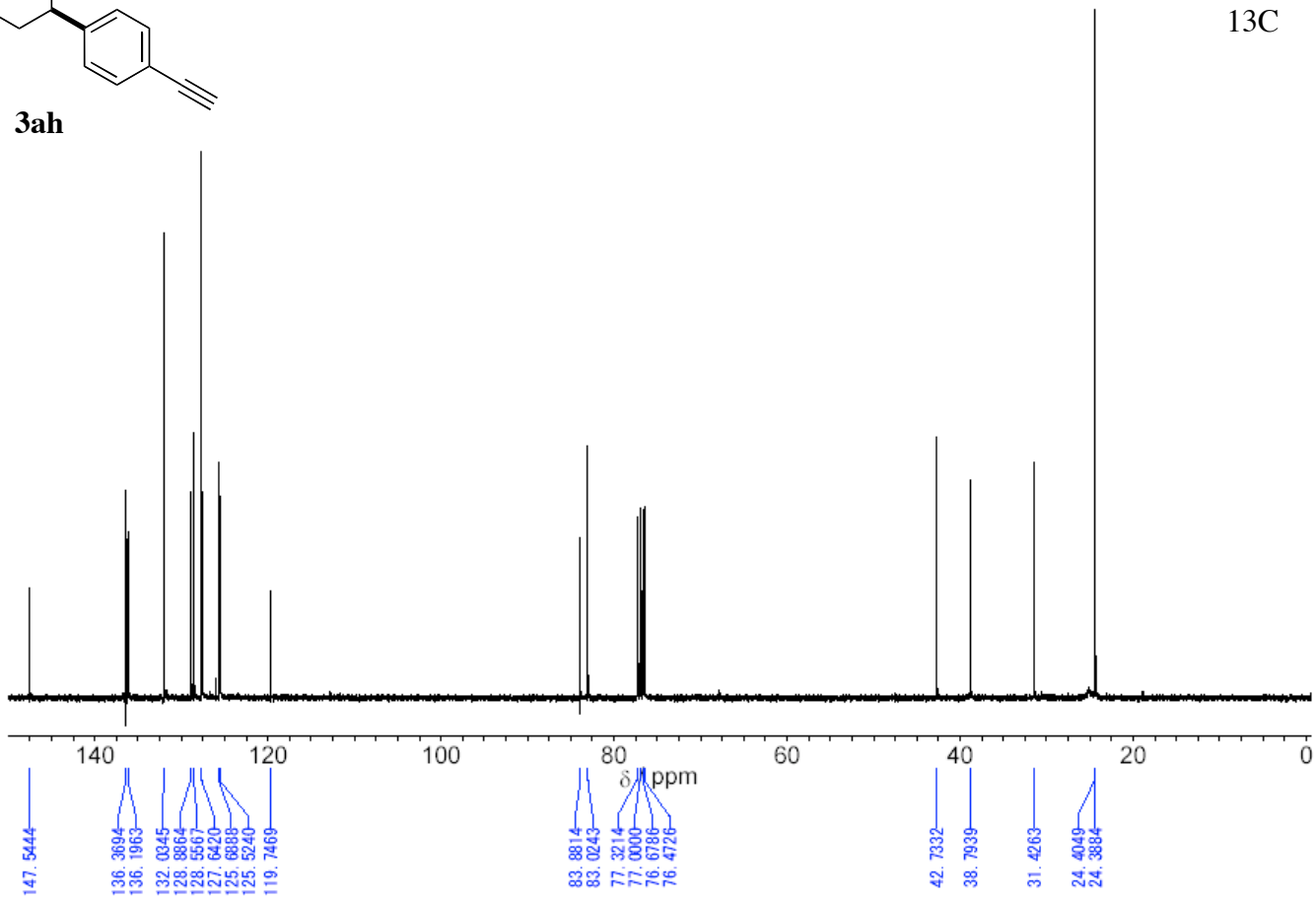

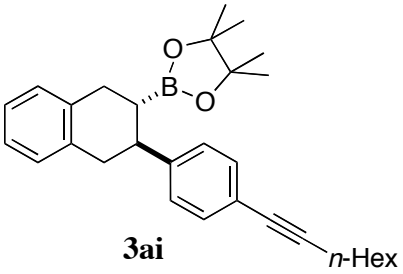

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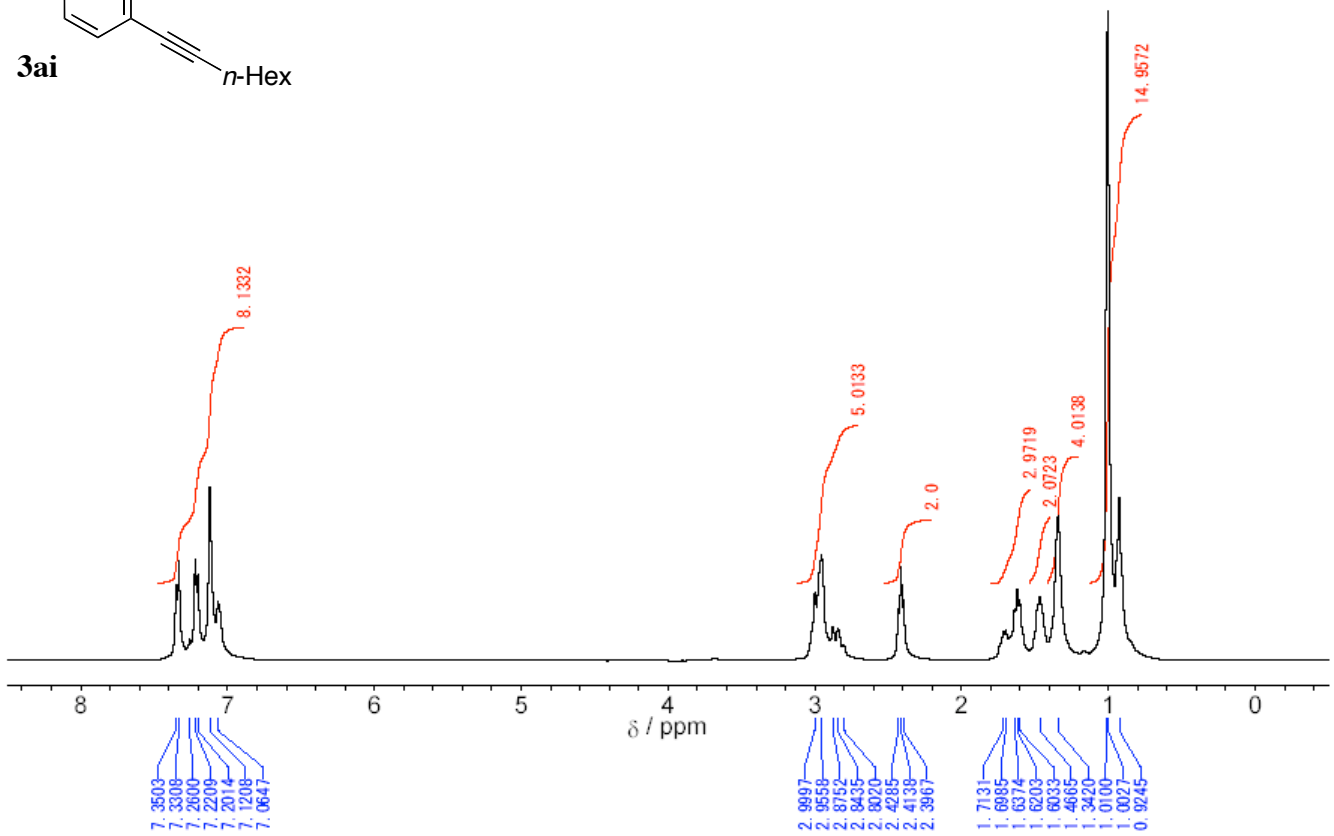

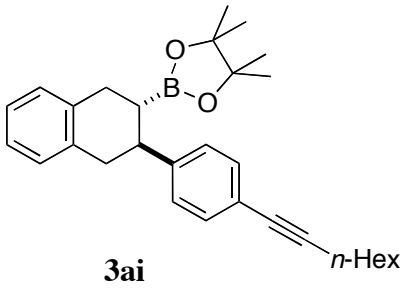

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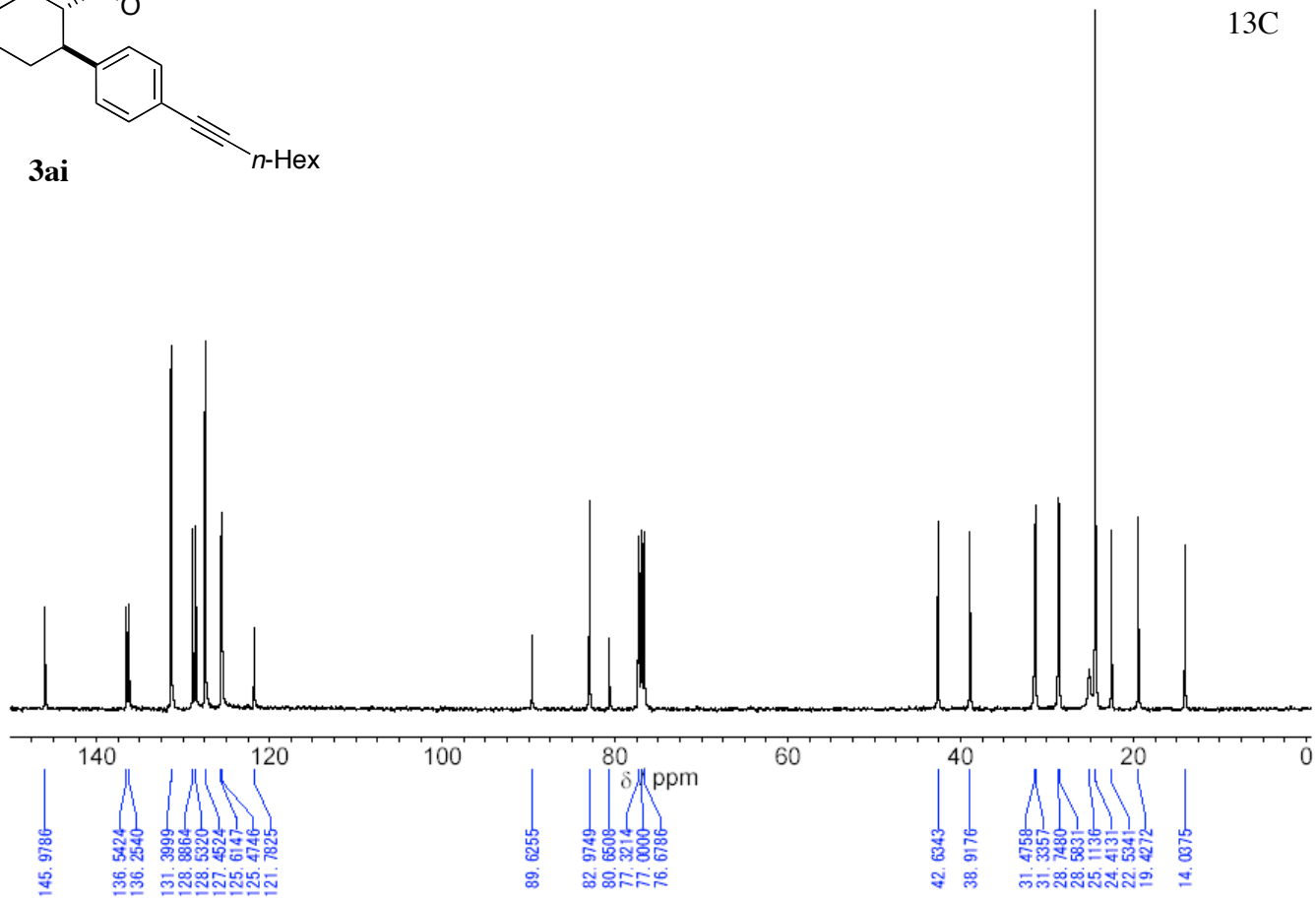

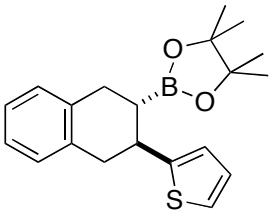

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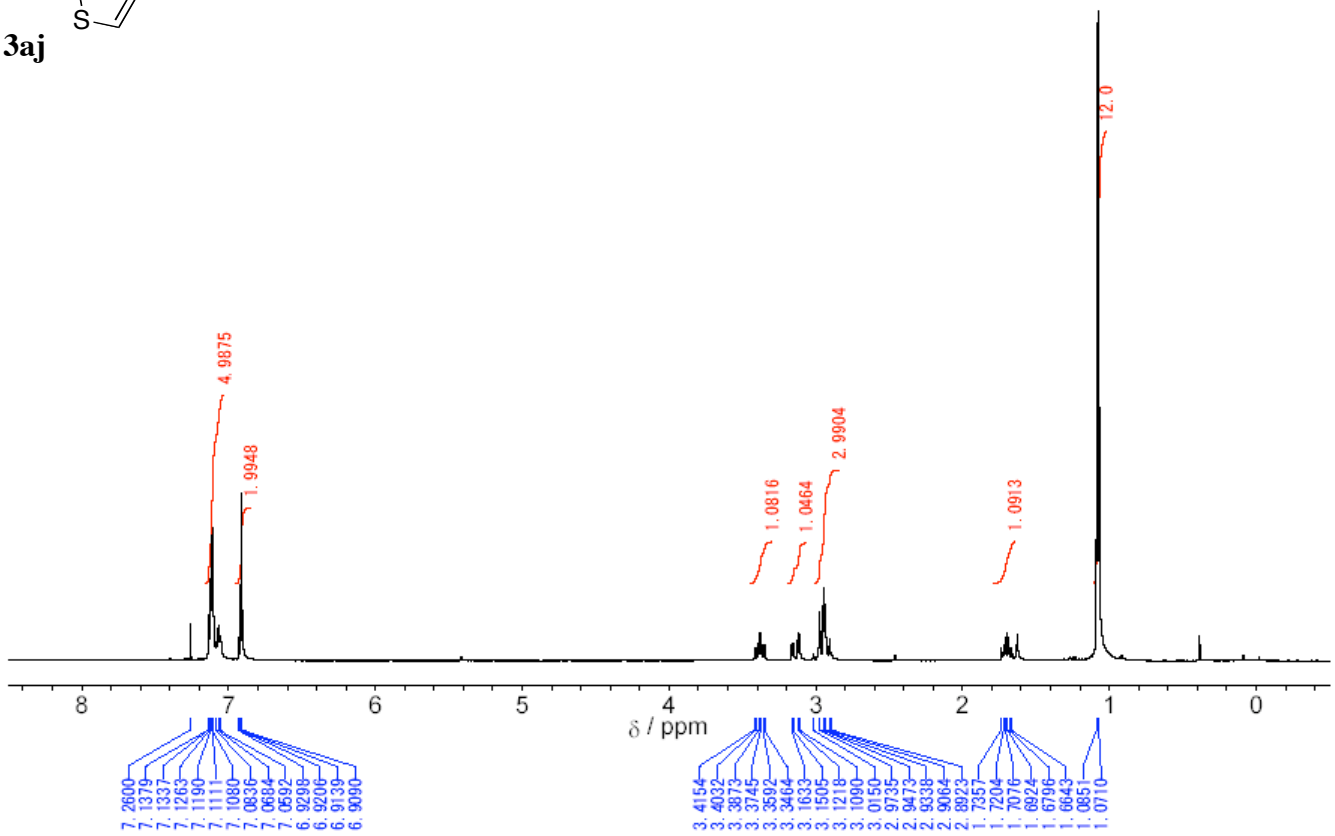

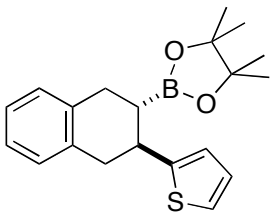

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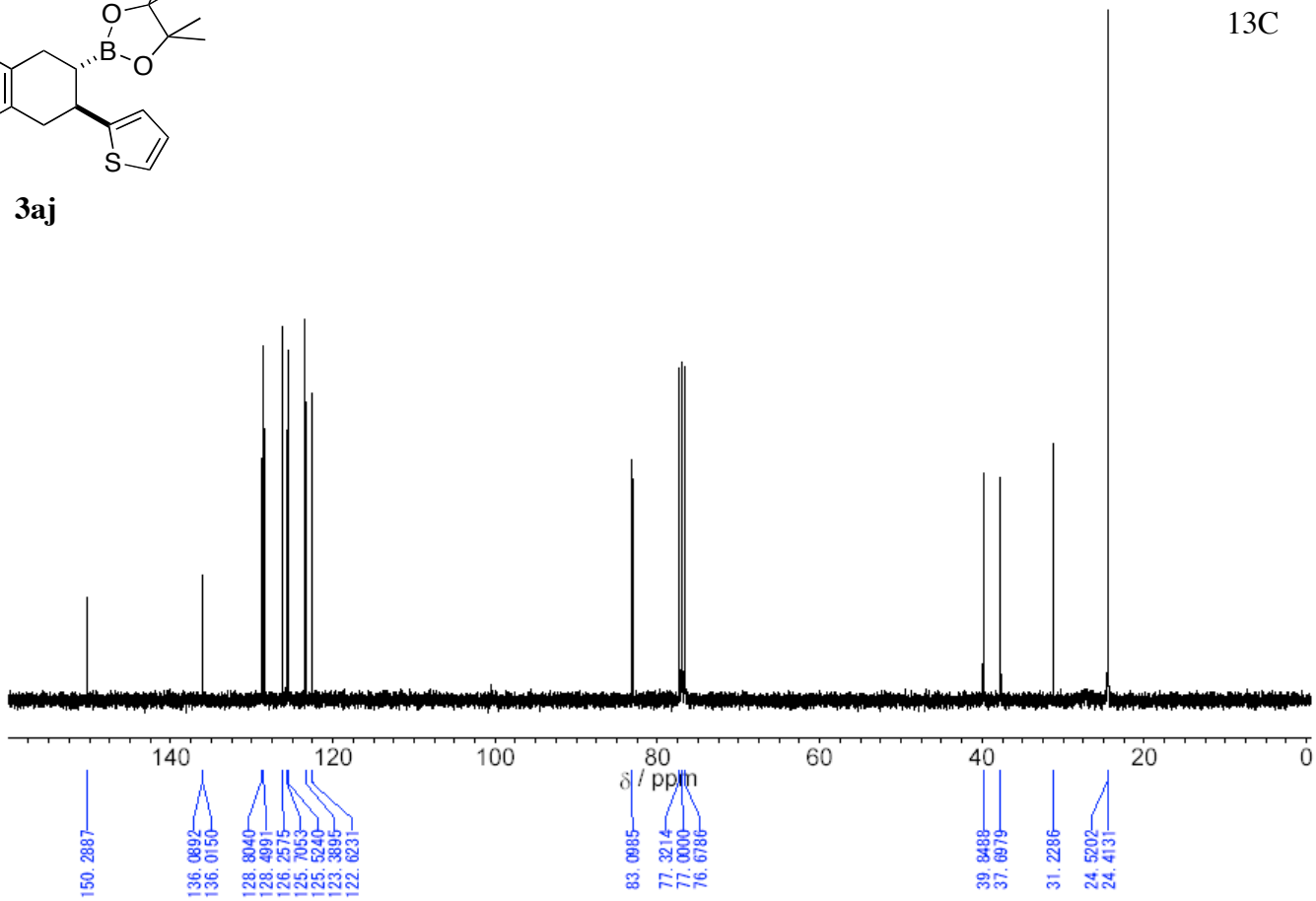

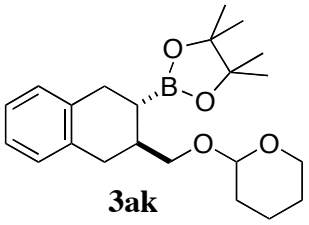

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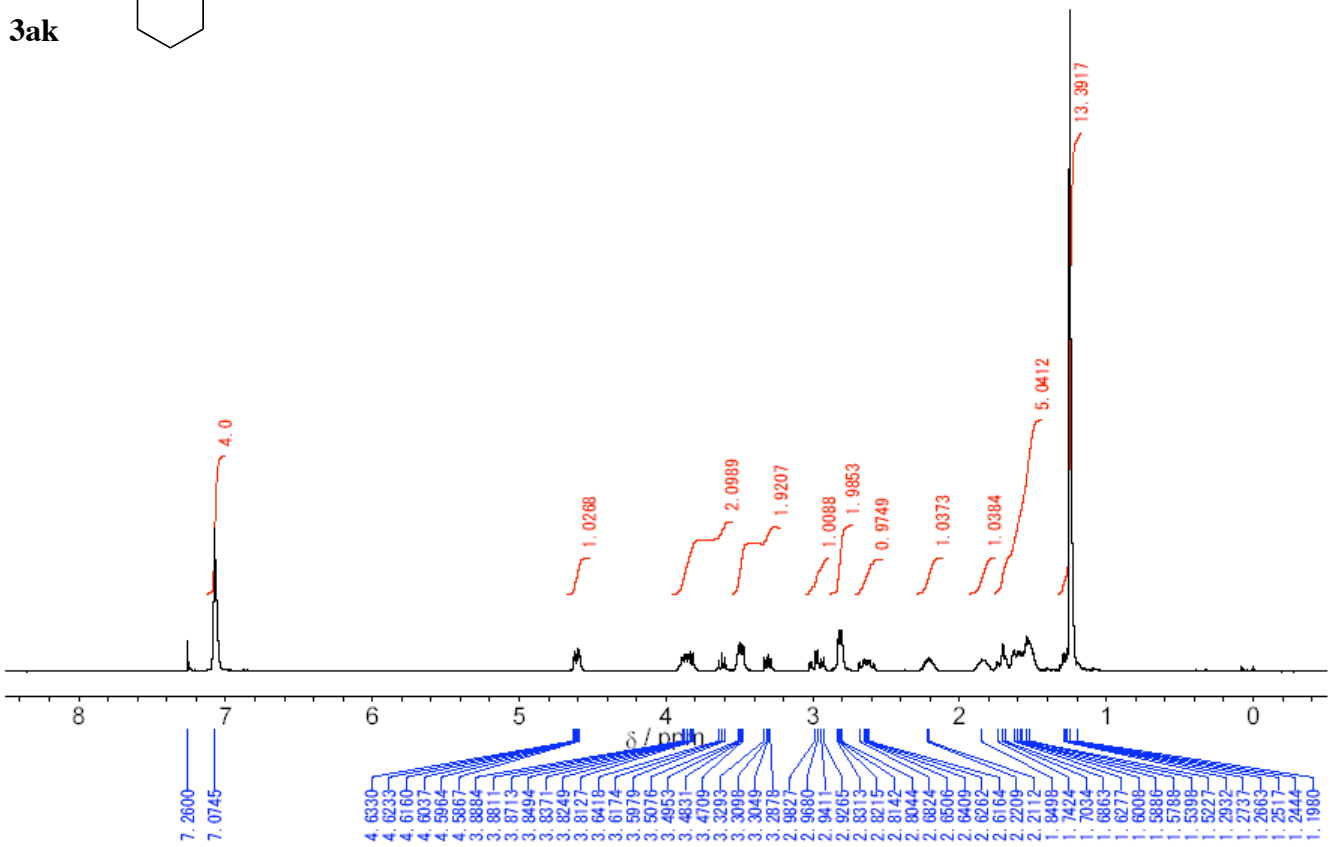
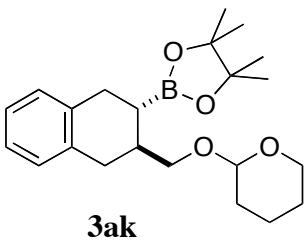
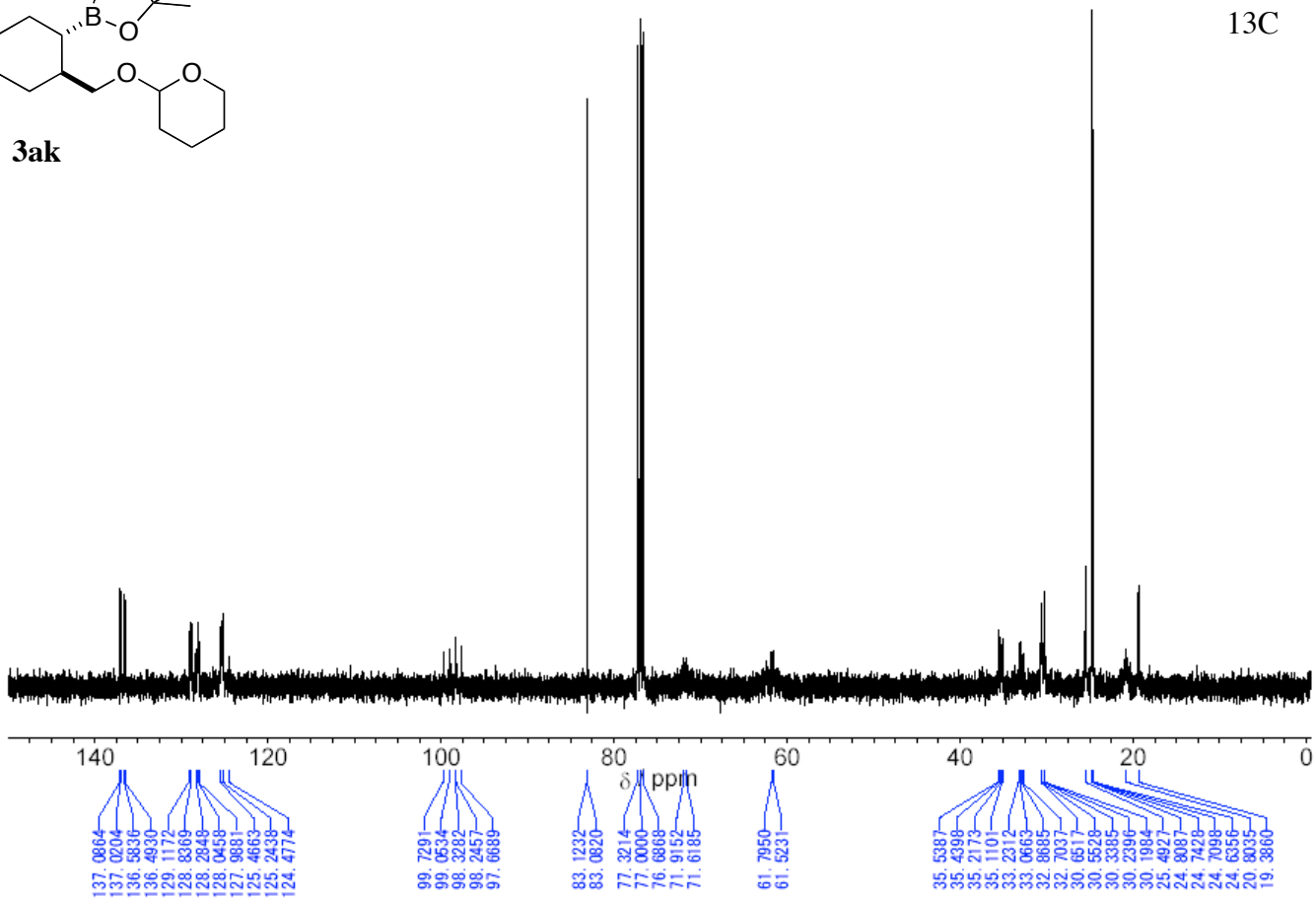
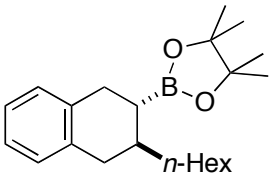




3ak

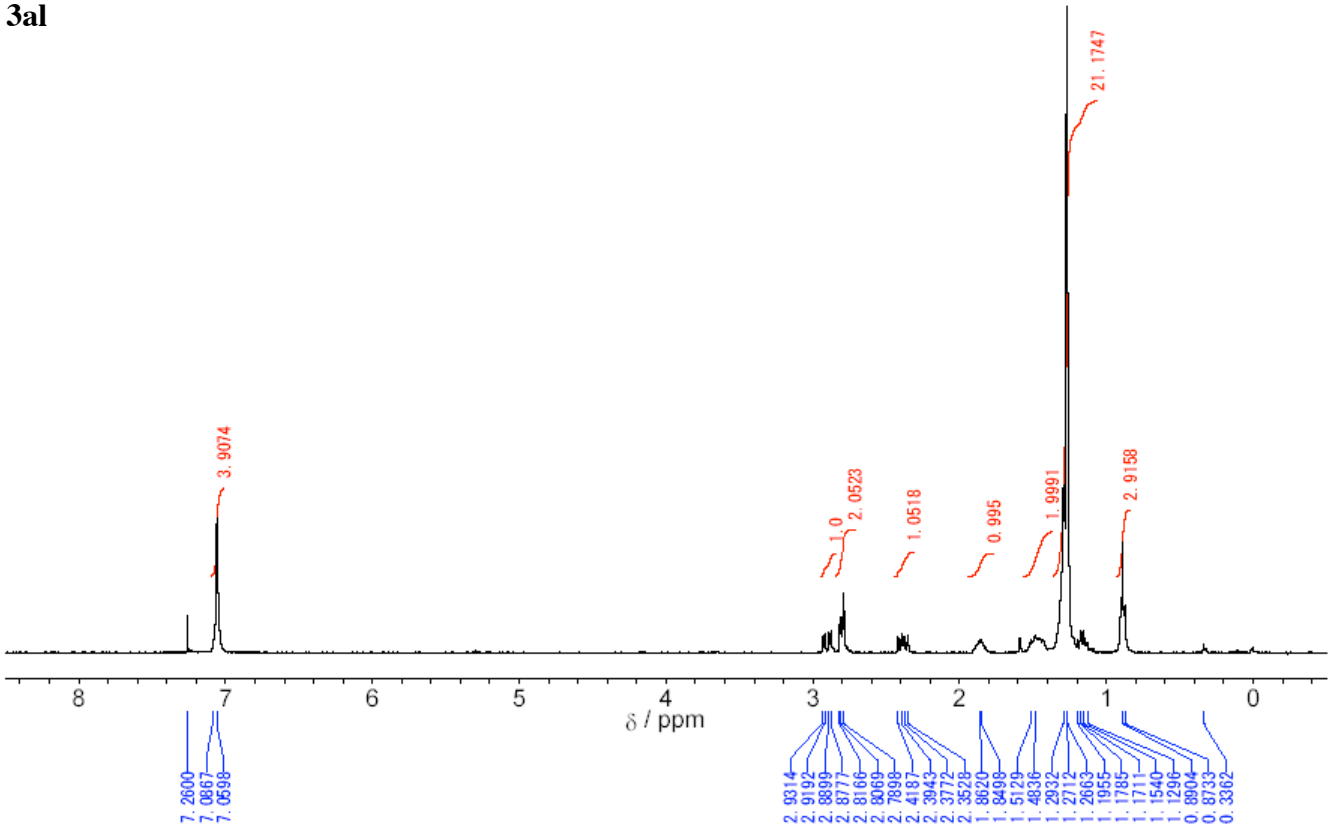
13C

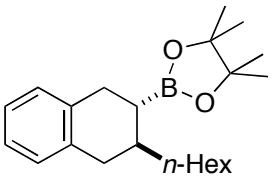




3al

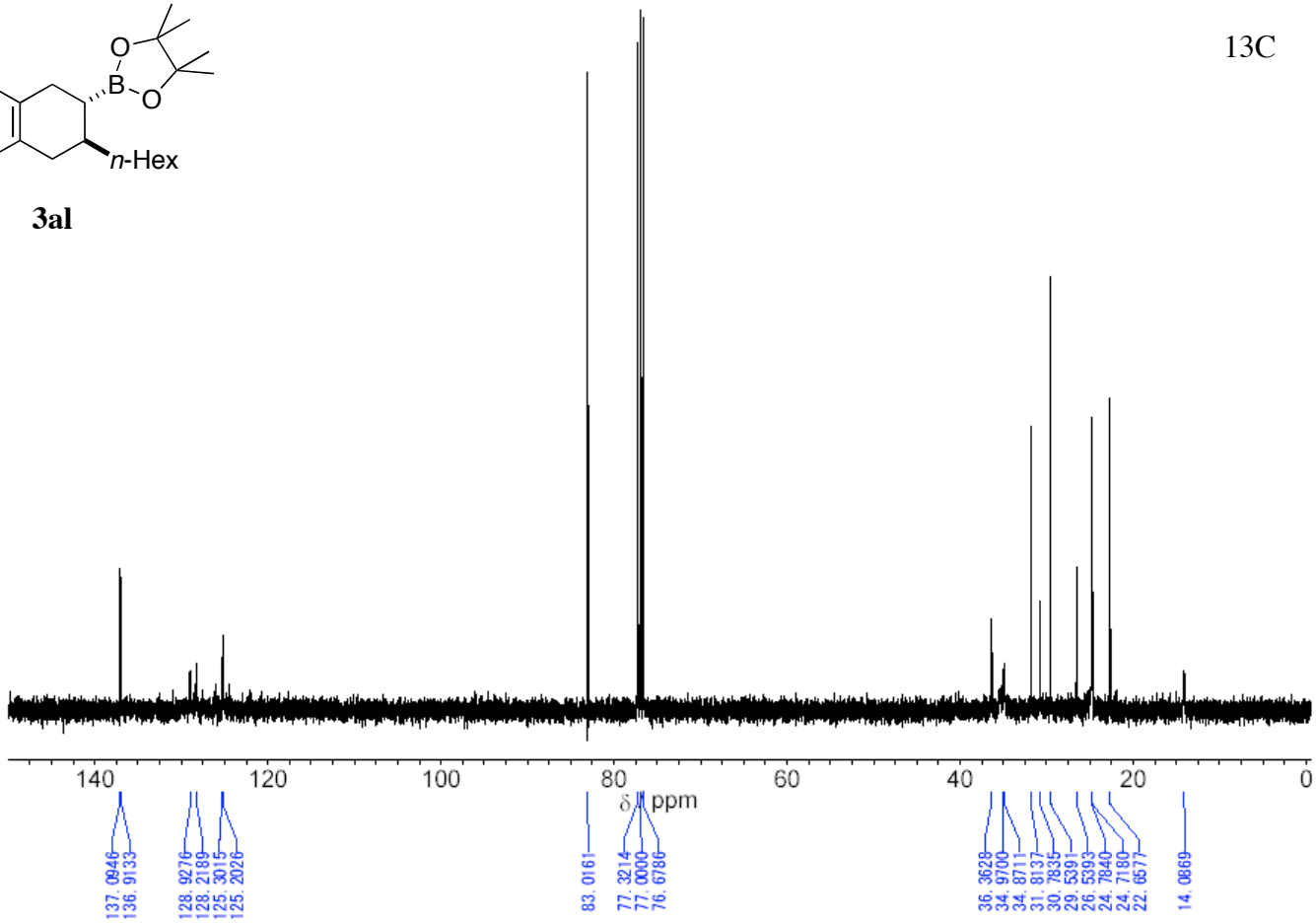
1H

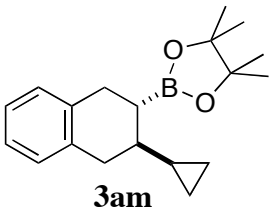




3al

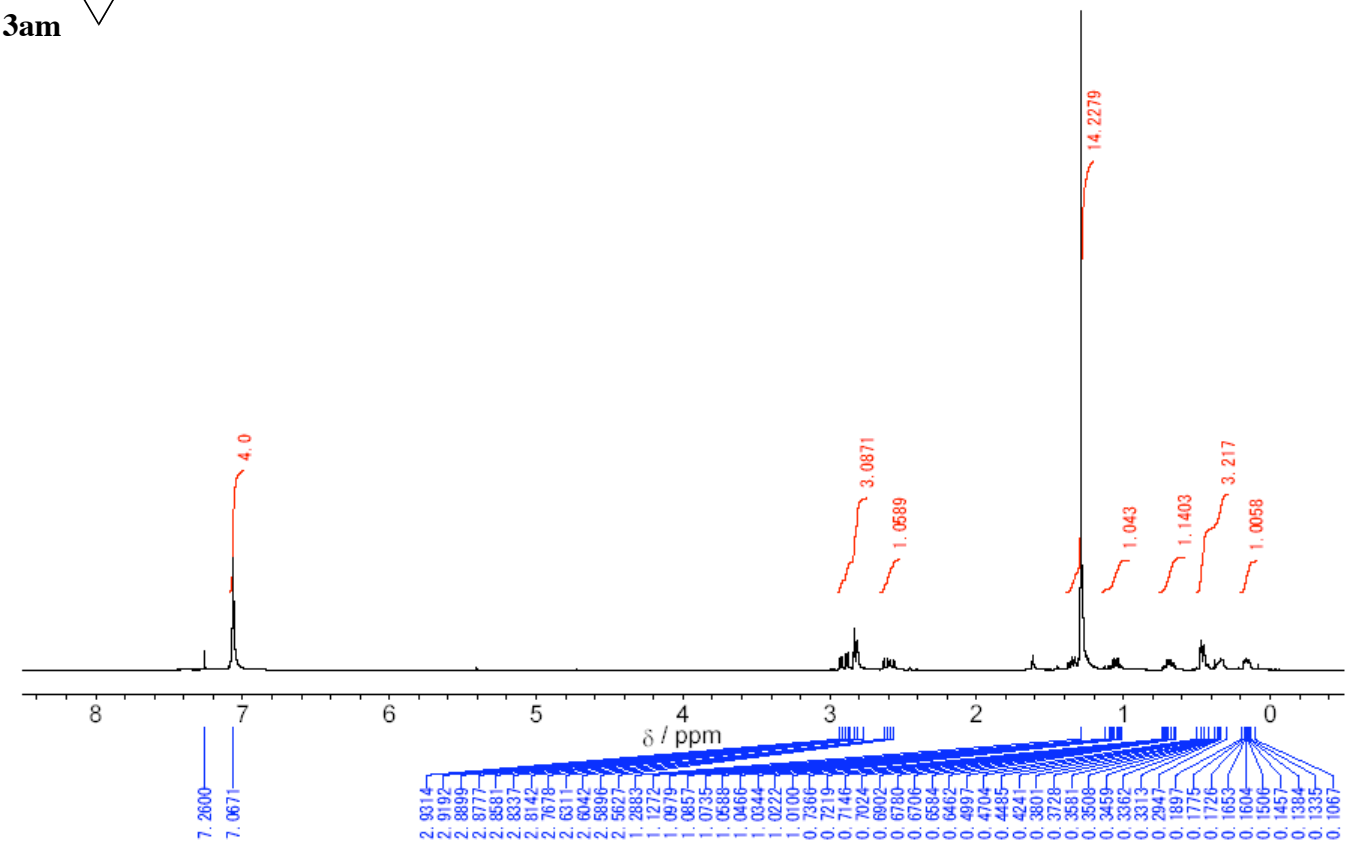
13C

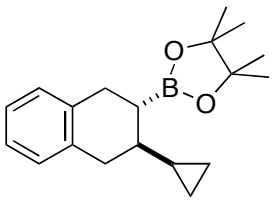




3am

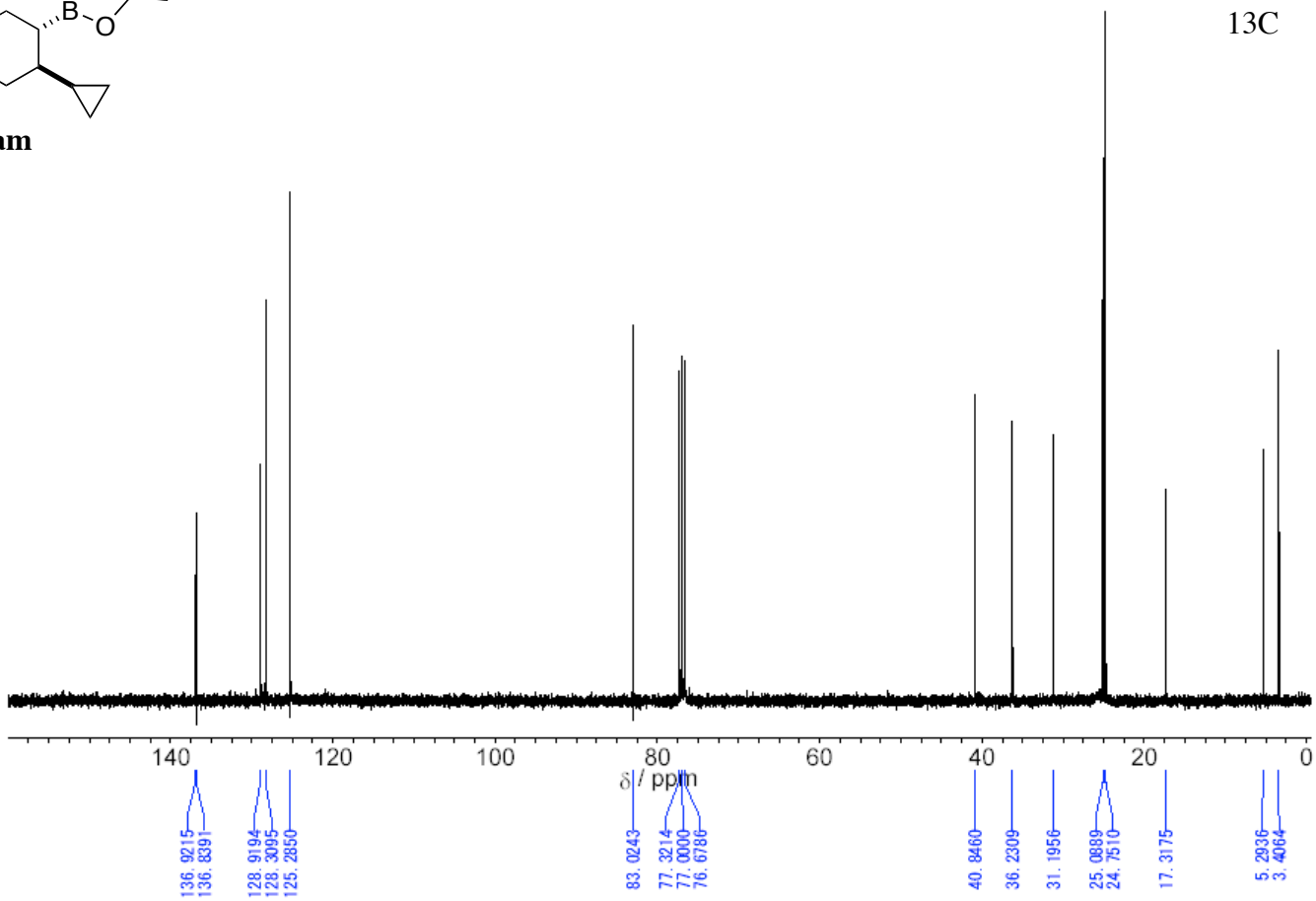
1H

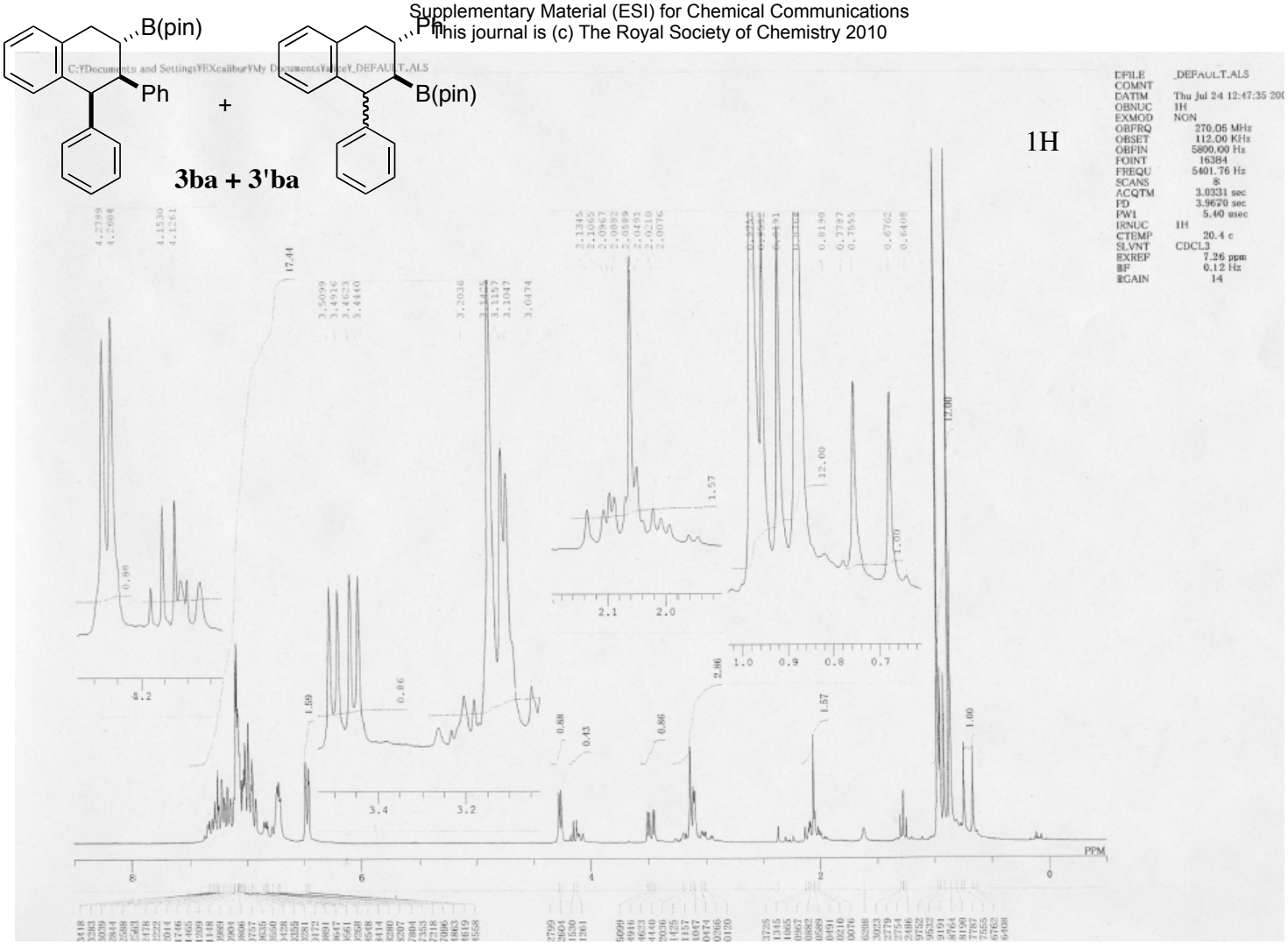


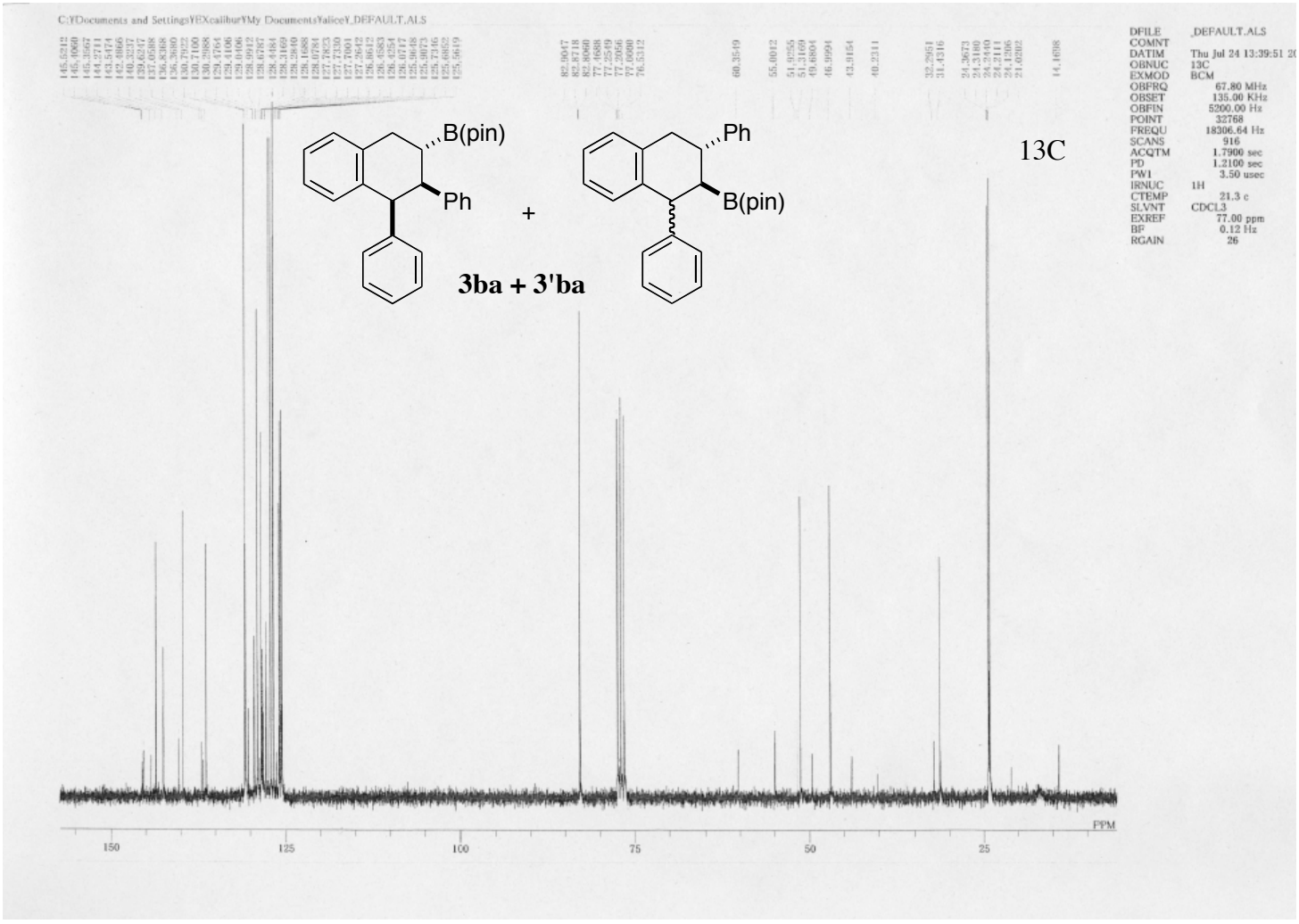


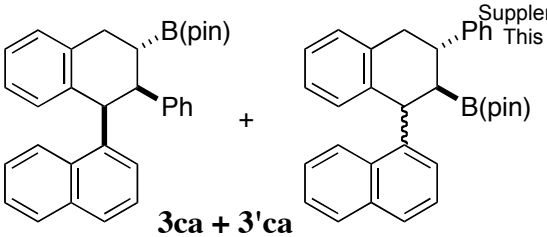
3am

13C



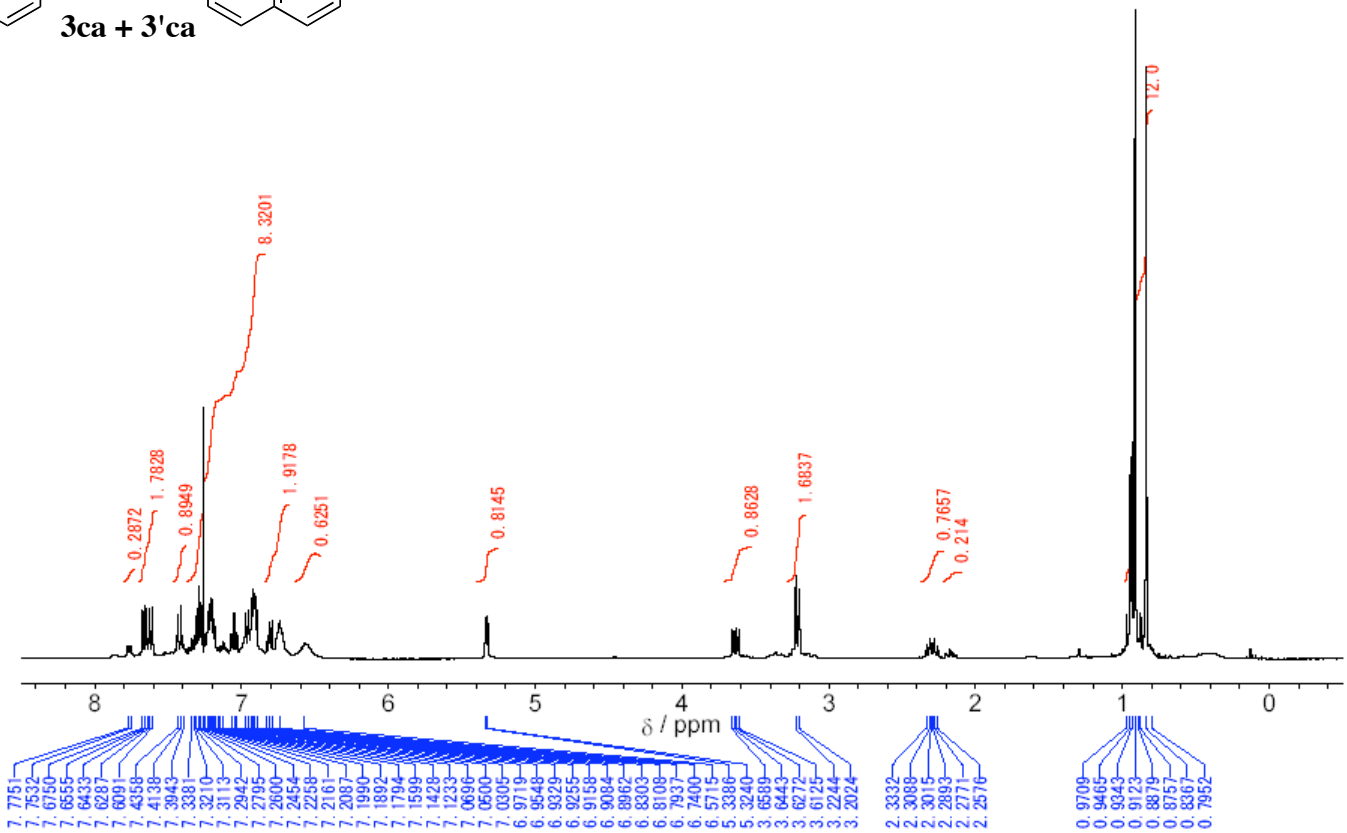

B(pin)
Ph
+
Ph
B(pin)
3ba + 3'ba
1H
PPM

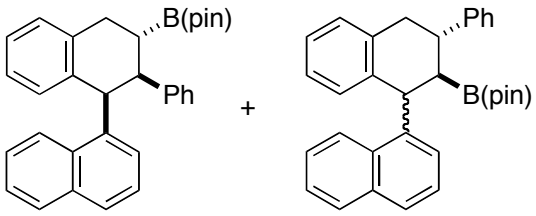

B(pin)
Ph
+
Ph
B(pin)
3ba + 3'ba
13C
PPM



3ca + 3'ca

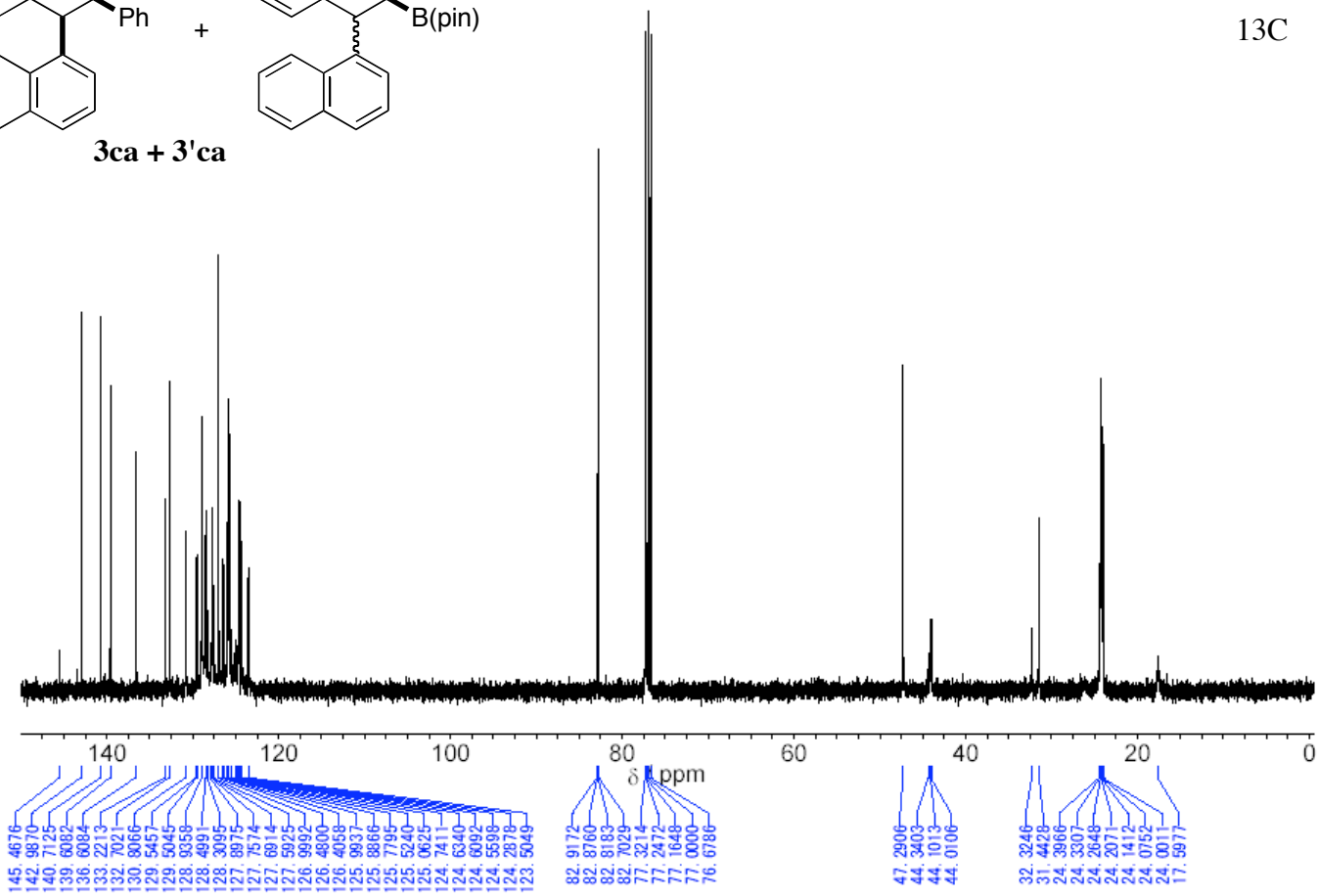
1H

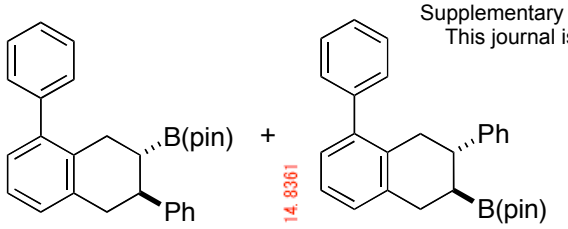




3ca + 3'ca

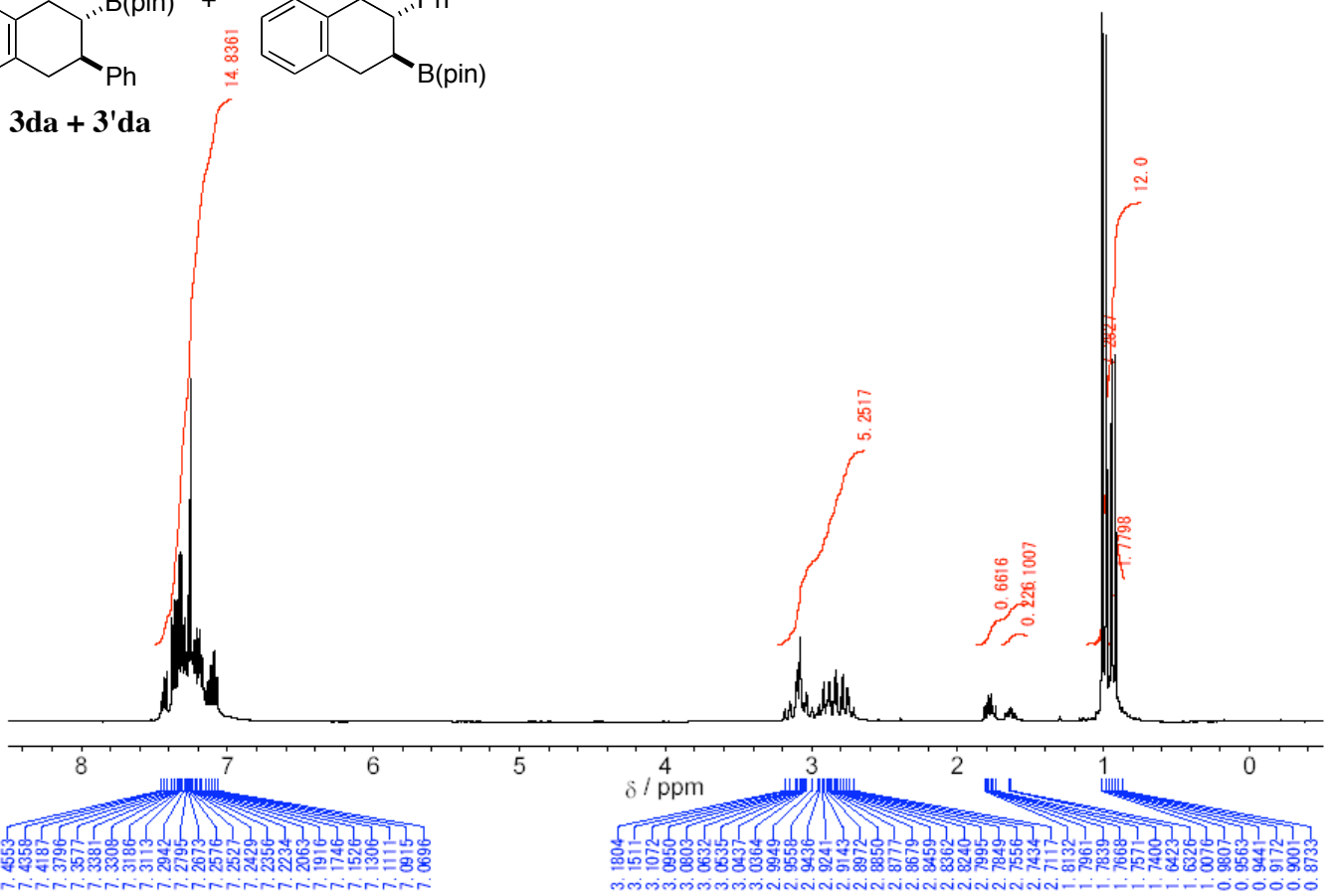
13C

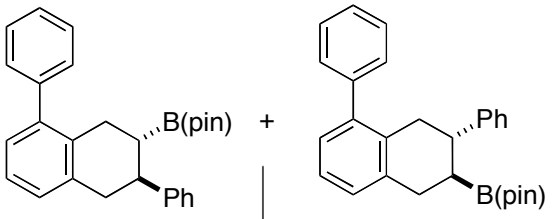




3da + 3'da

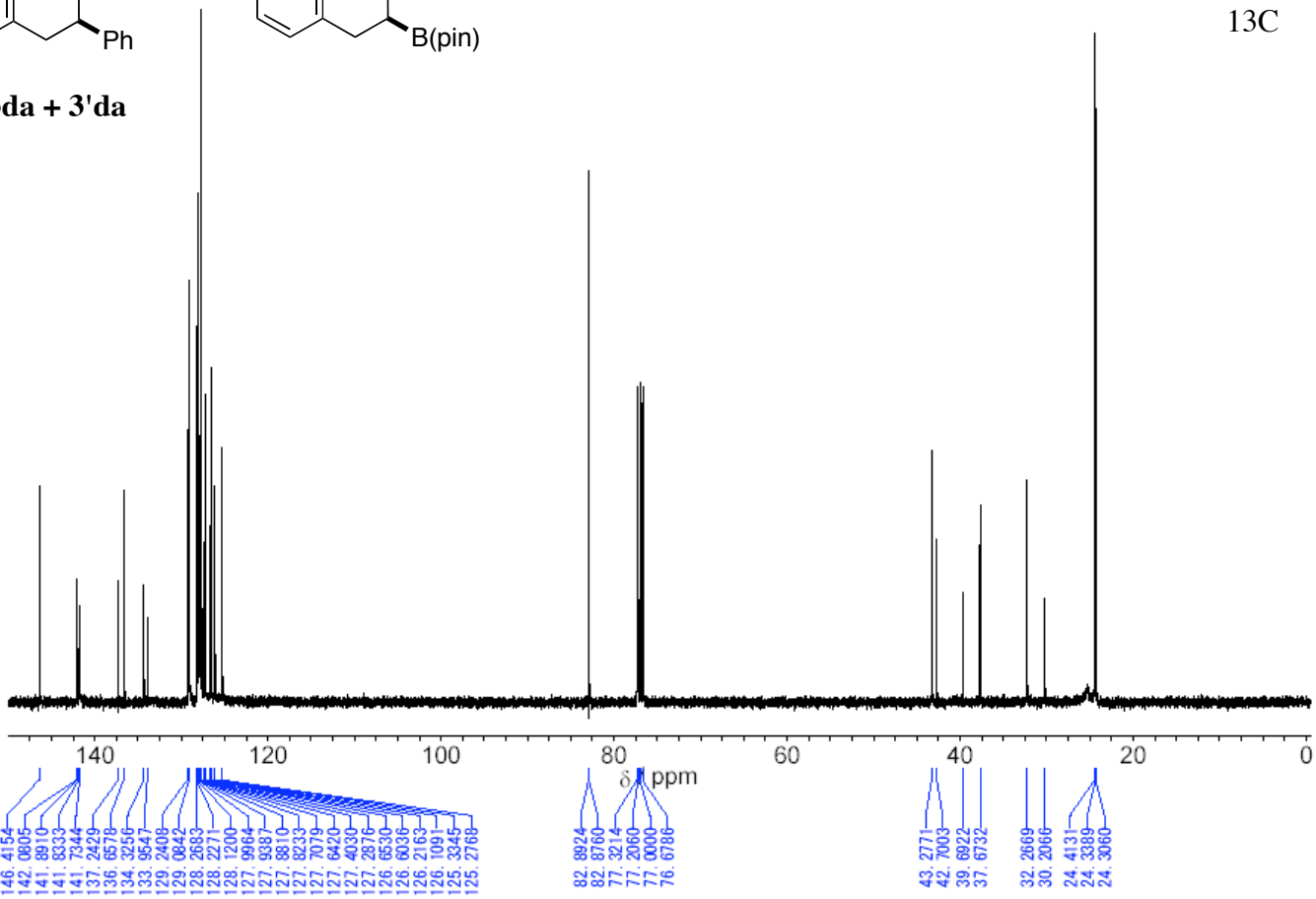
1H

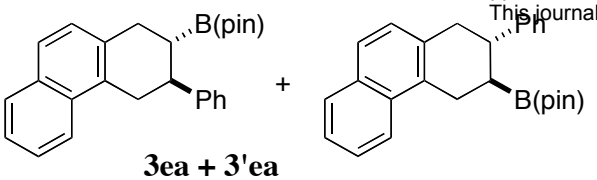




3da + 3'da

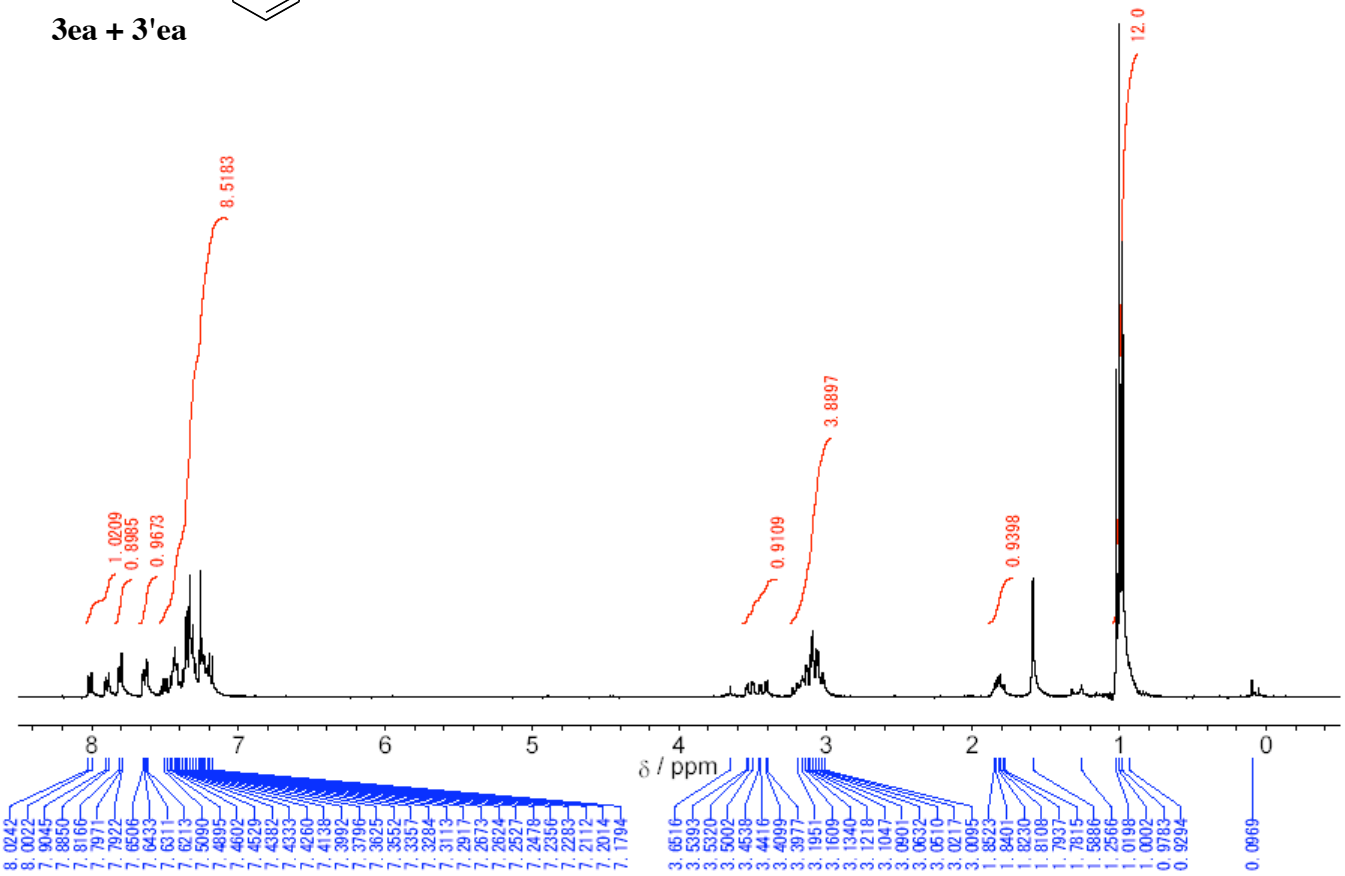
13C





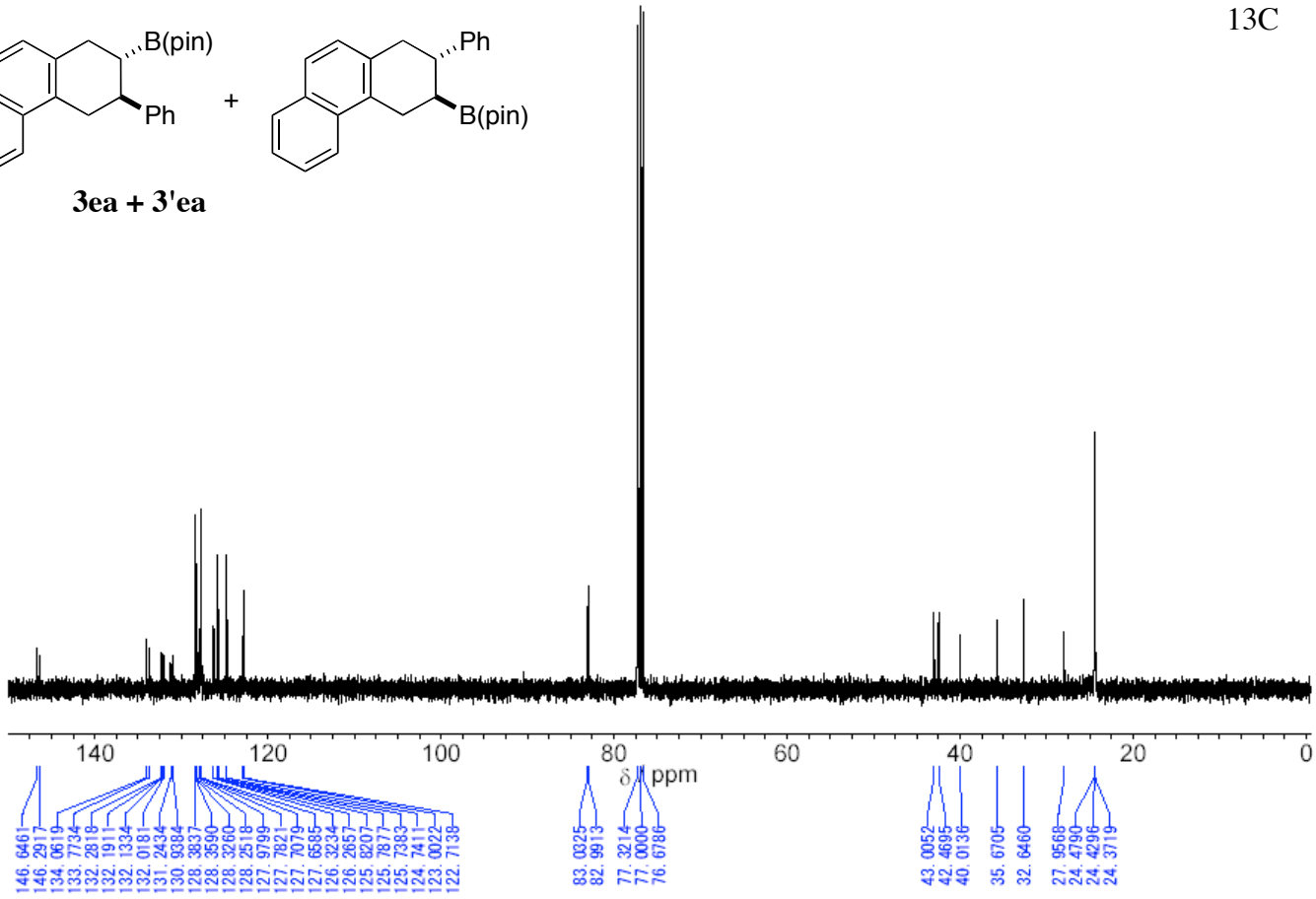
3ea + 3'ea

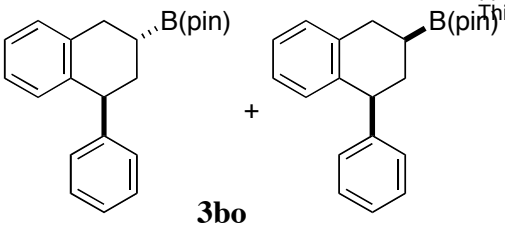
1H



3ea + 3'ea

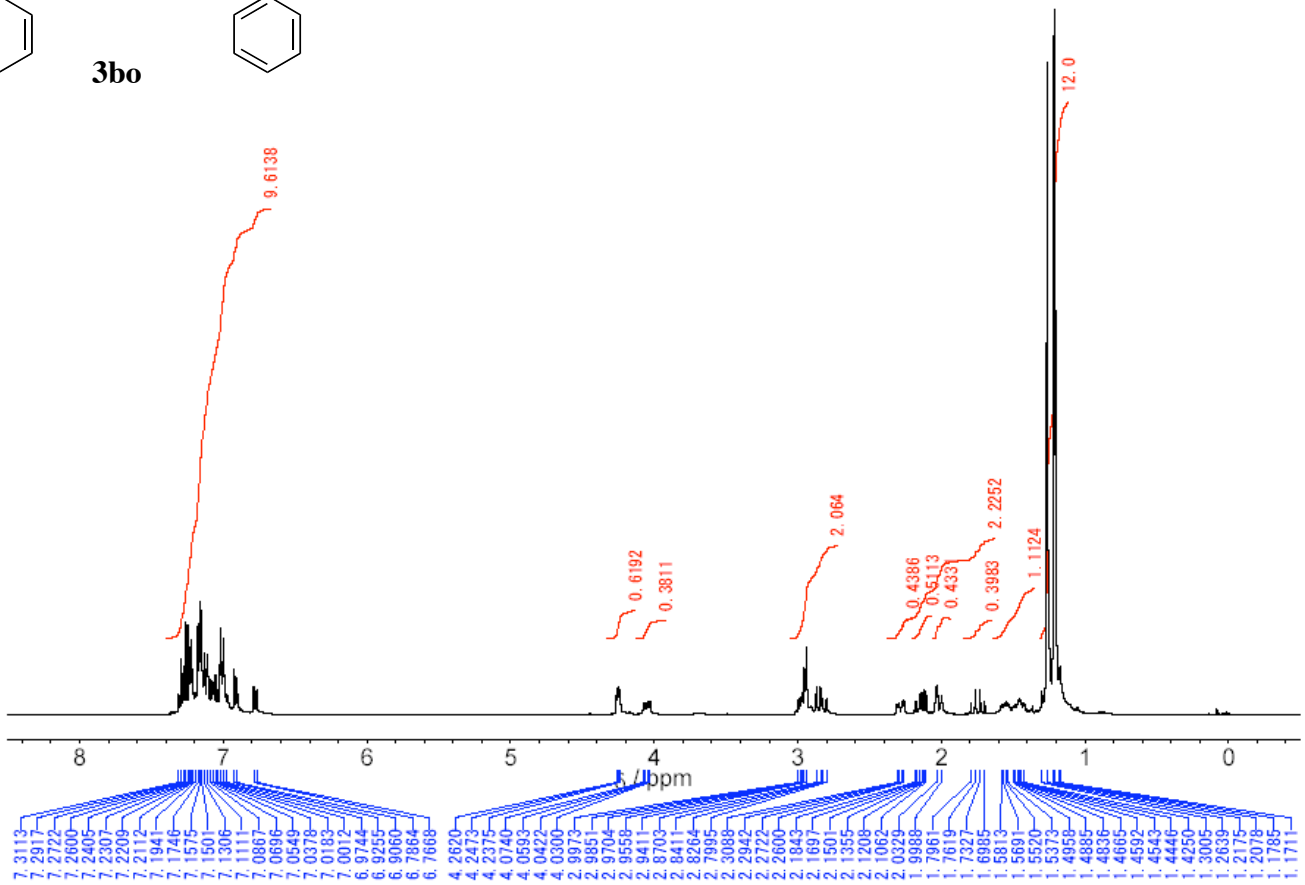
13C

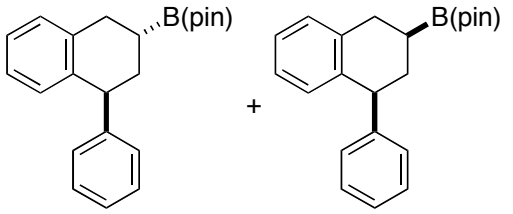




3bo

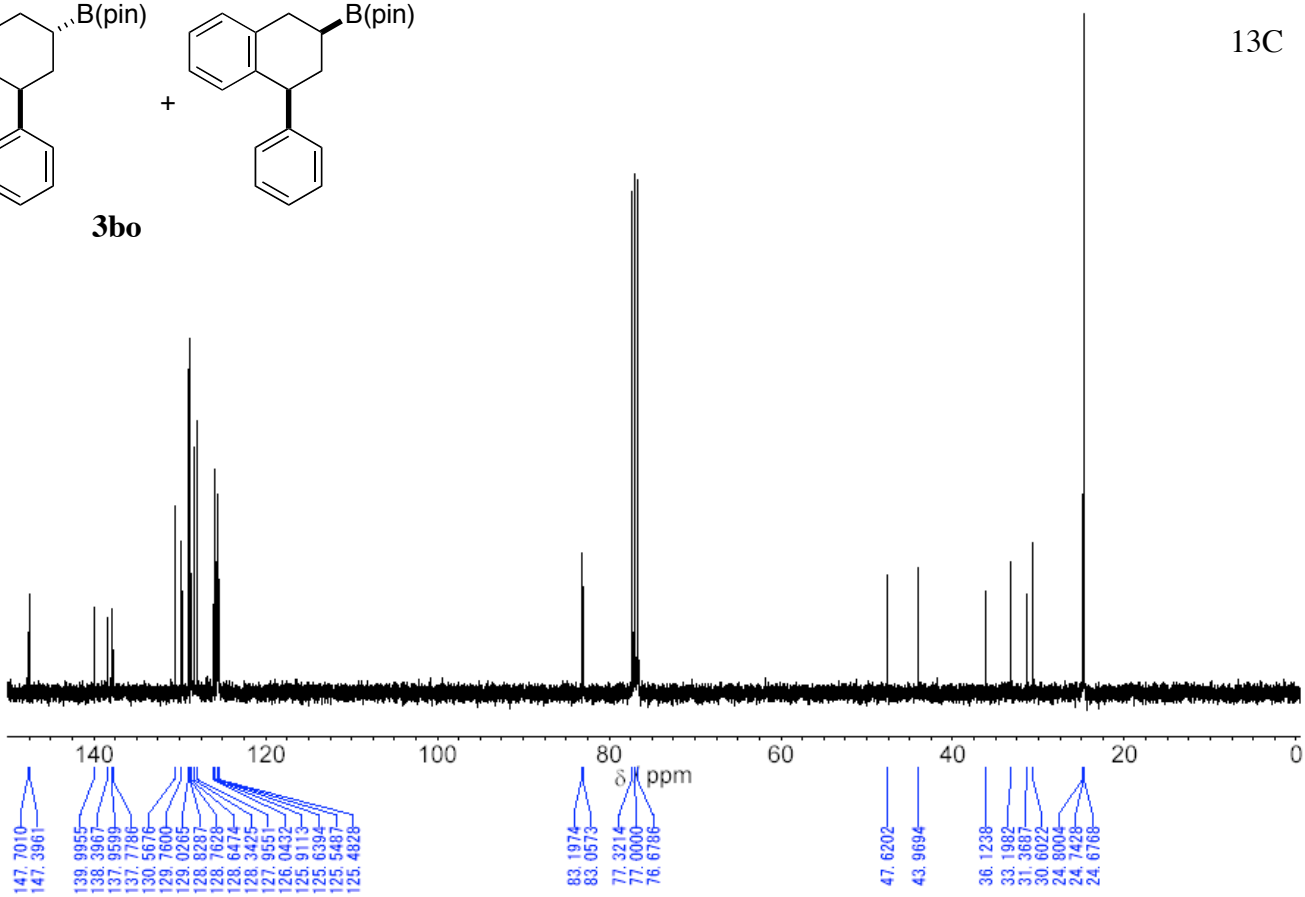
1H

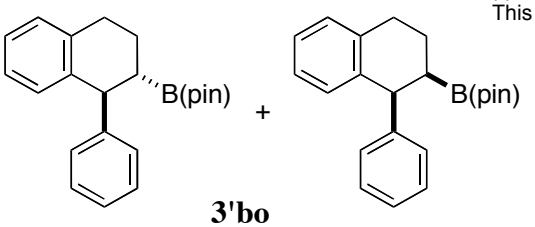




3bo

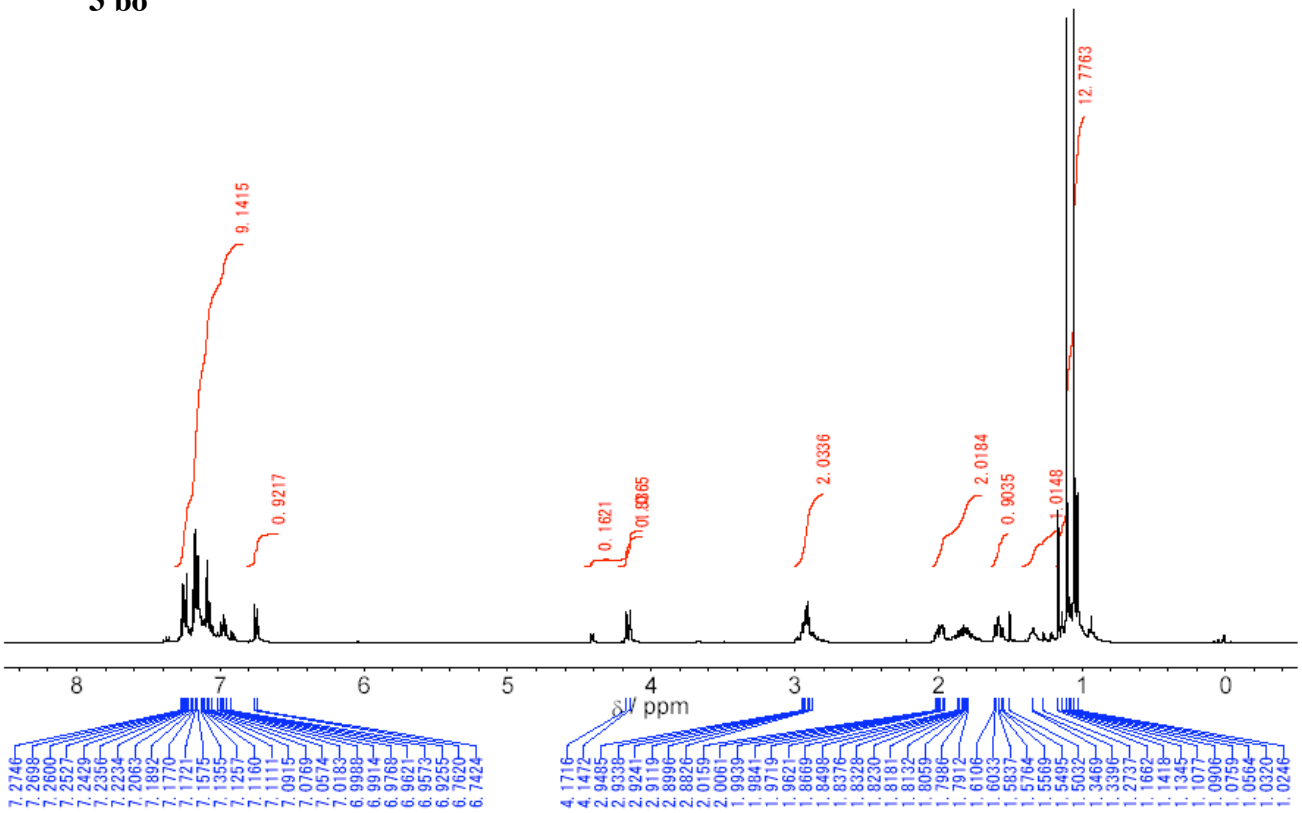
13C

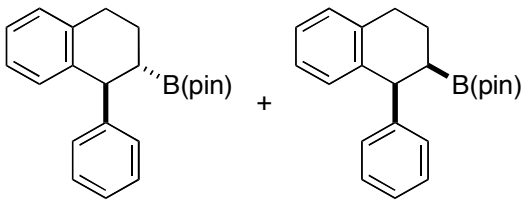




3'bo

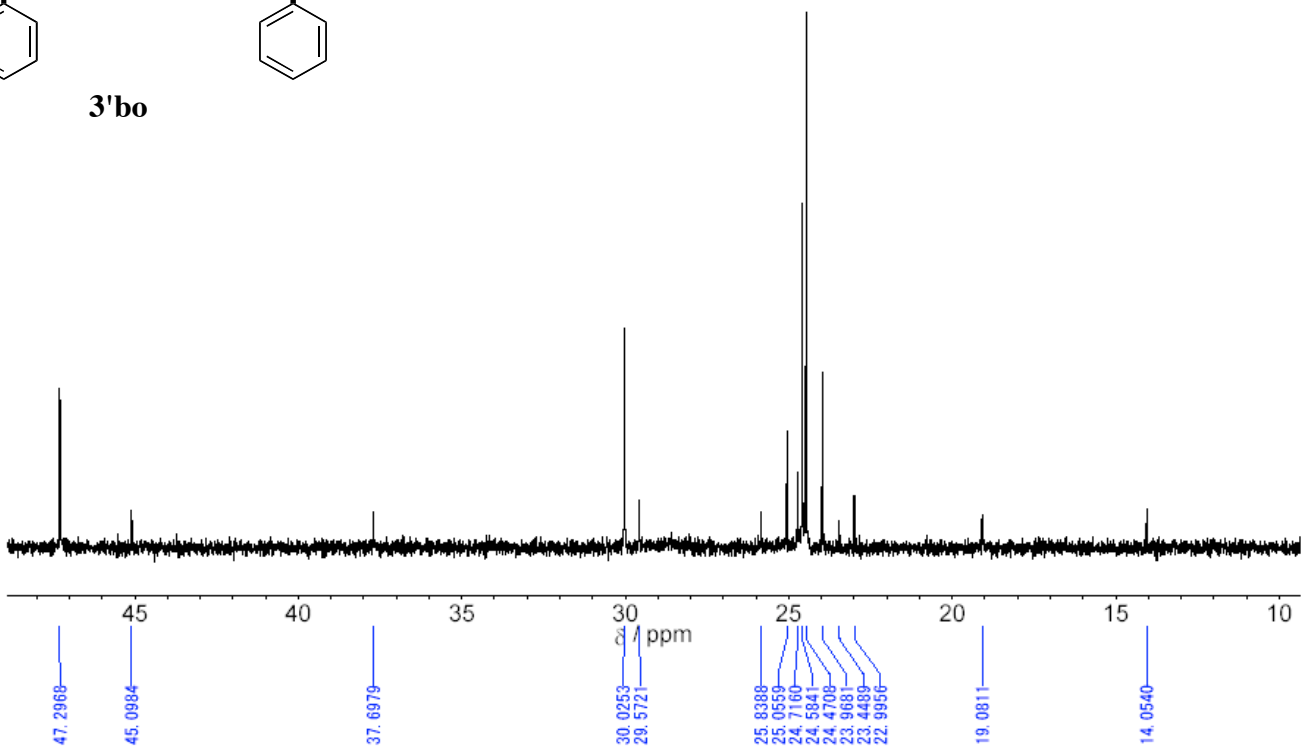
1H

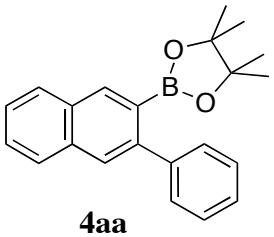




3'bo

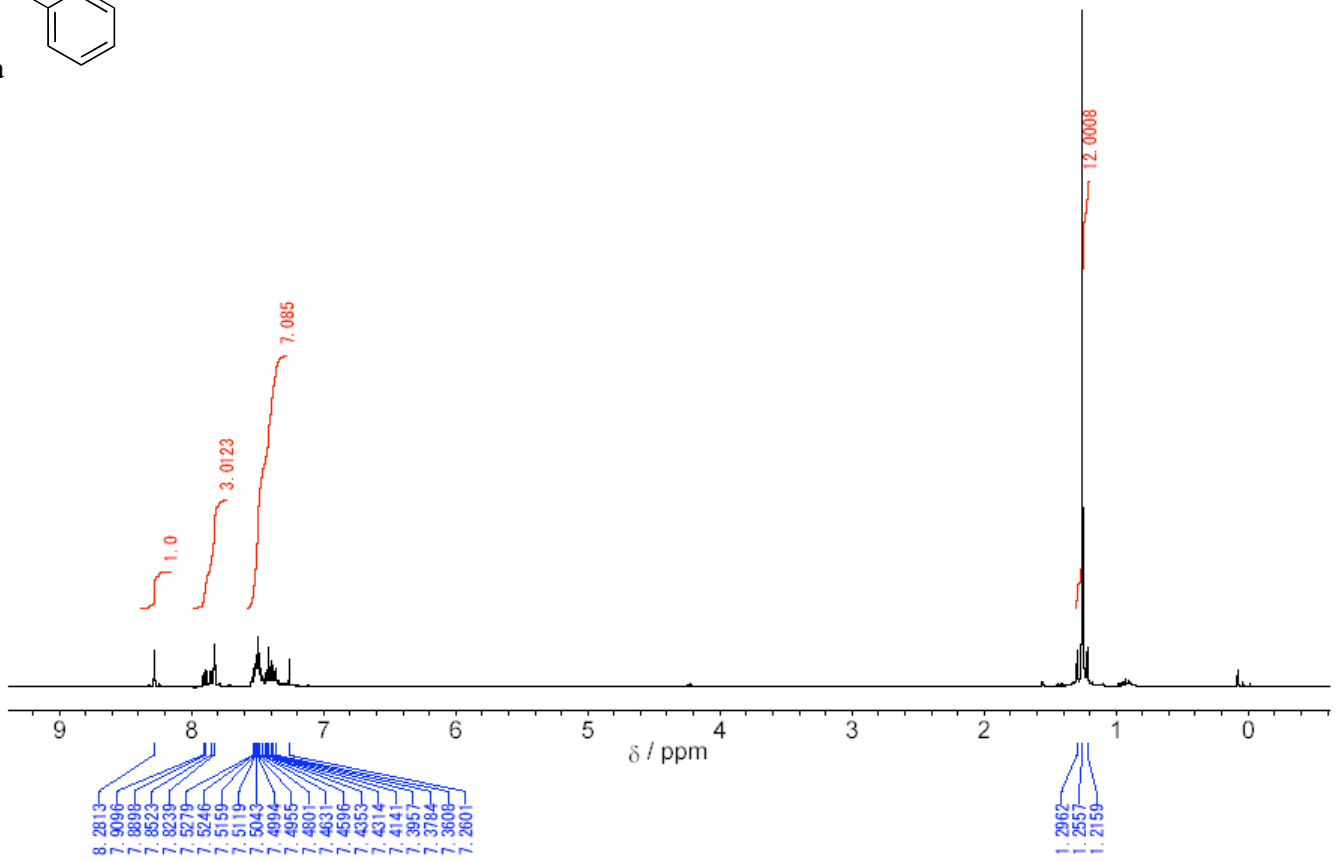
13C

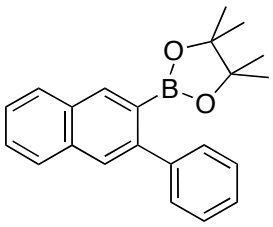




4aa

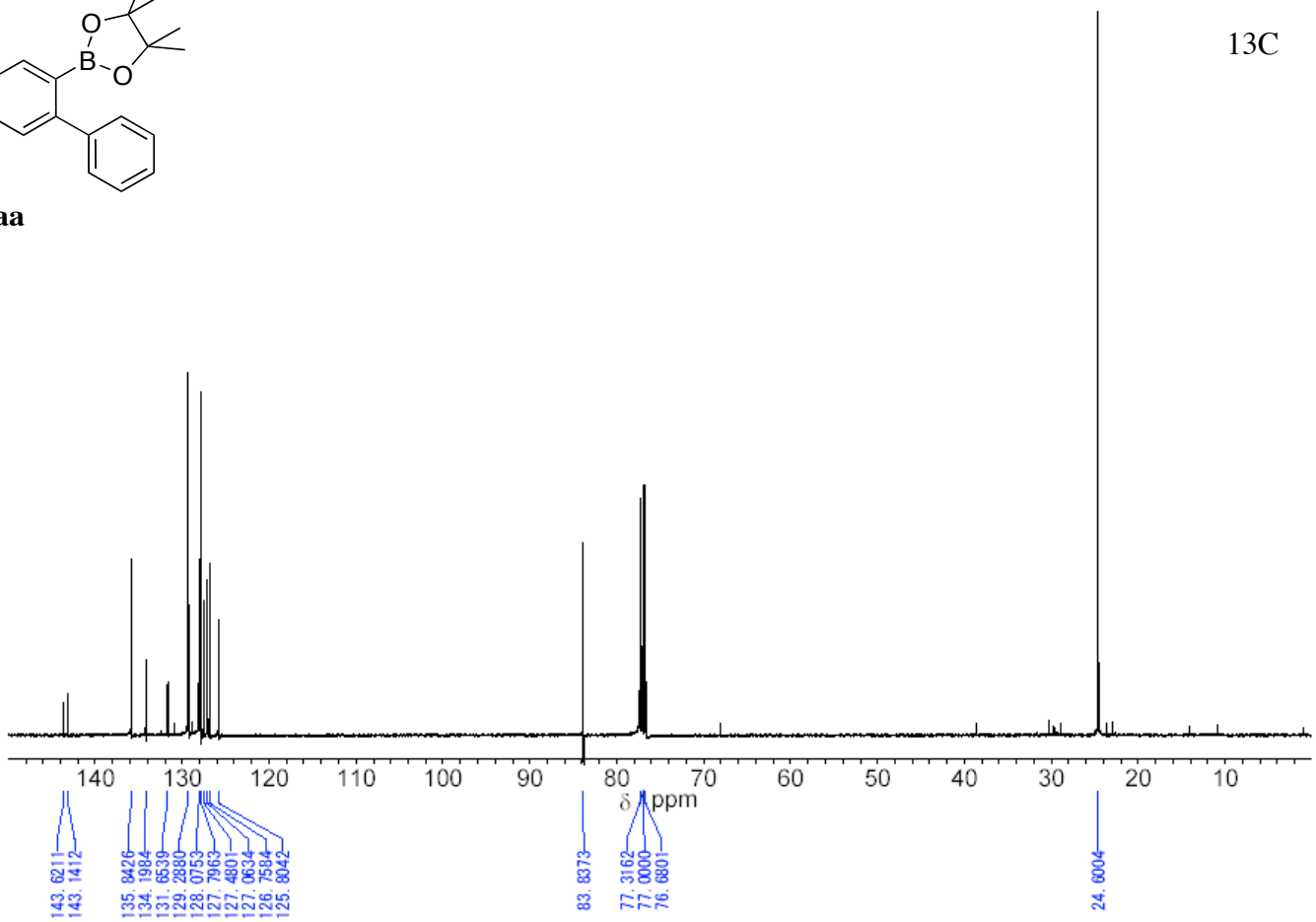
1H

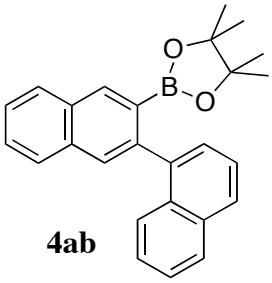




4aa

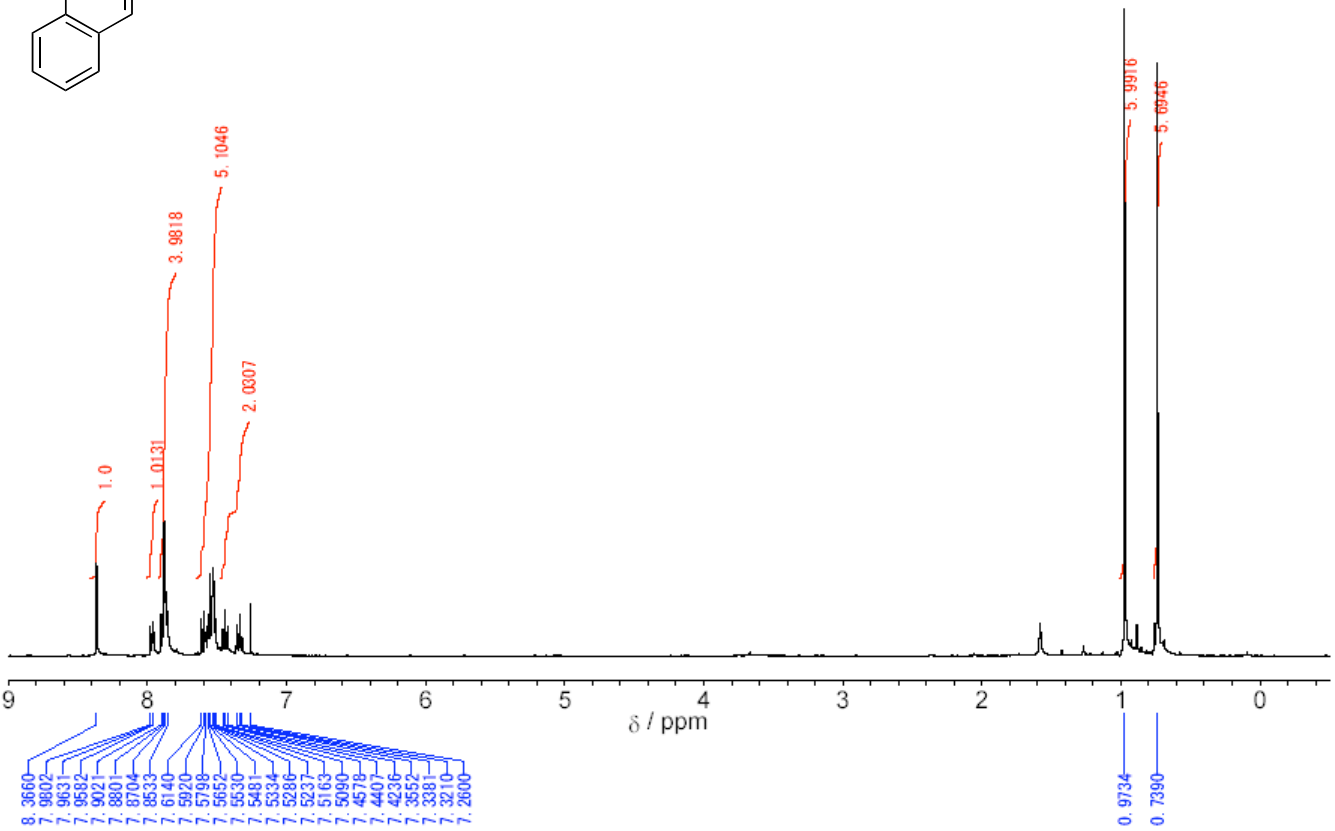
13C

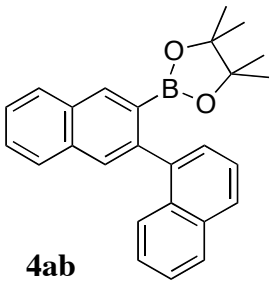




4ab

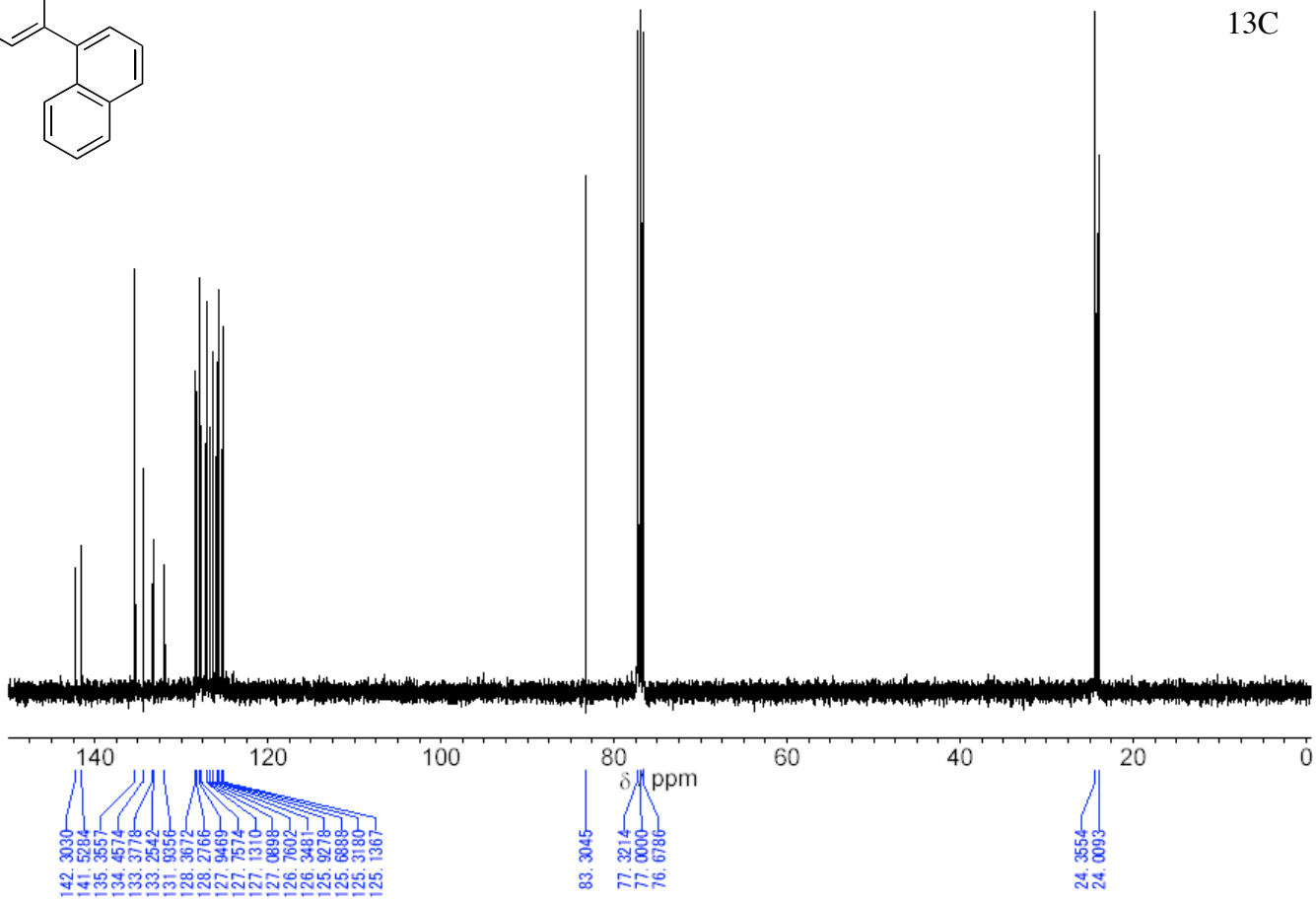
1H

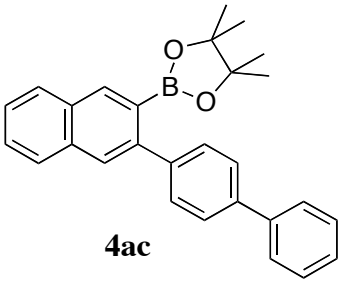




4ab

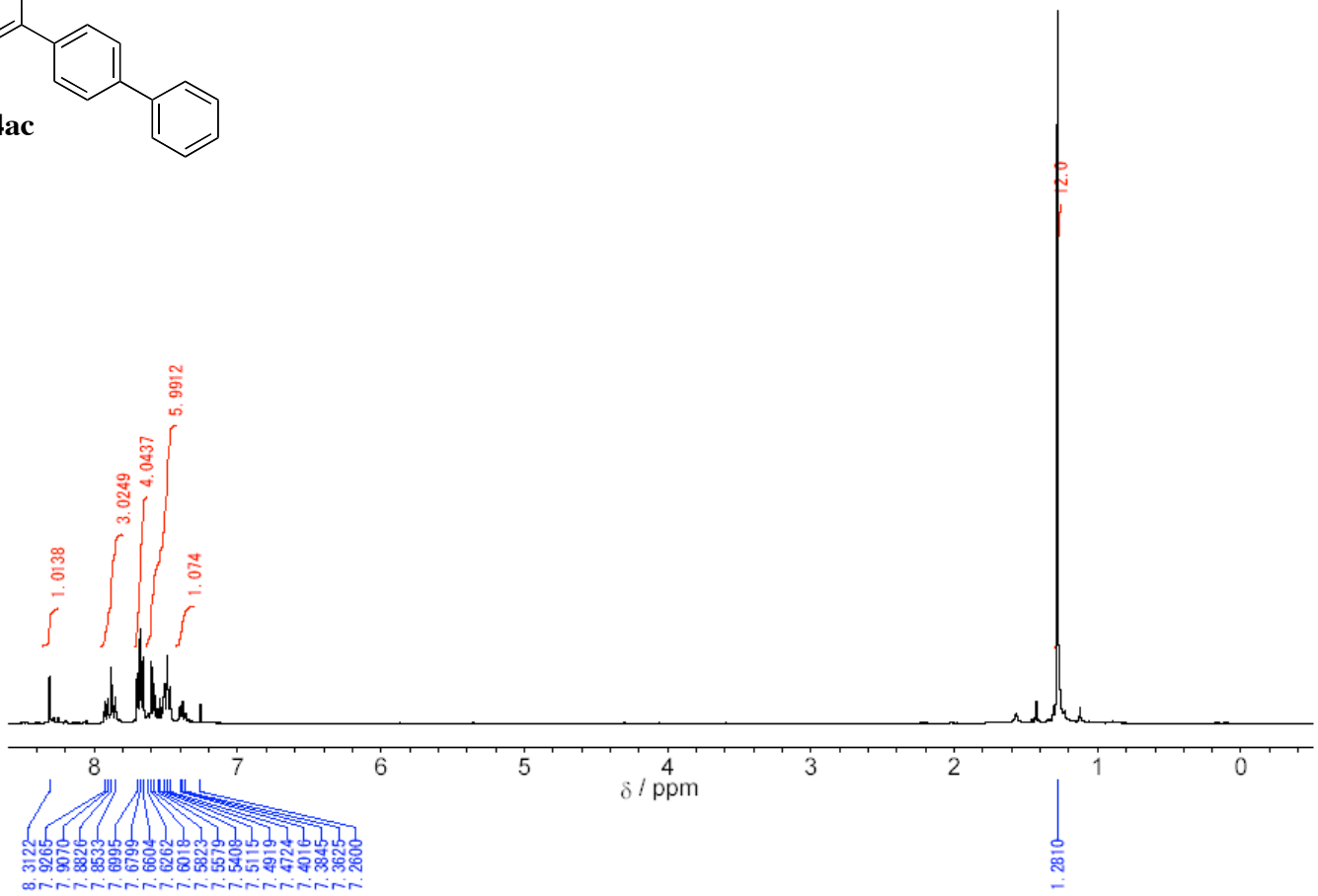
13C

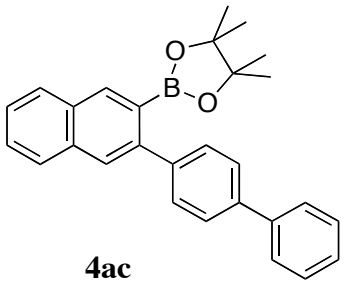




4ac

1H





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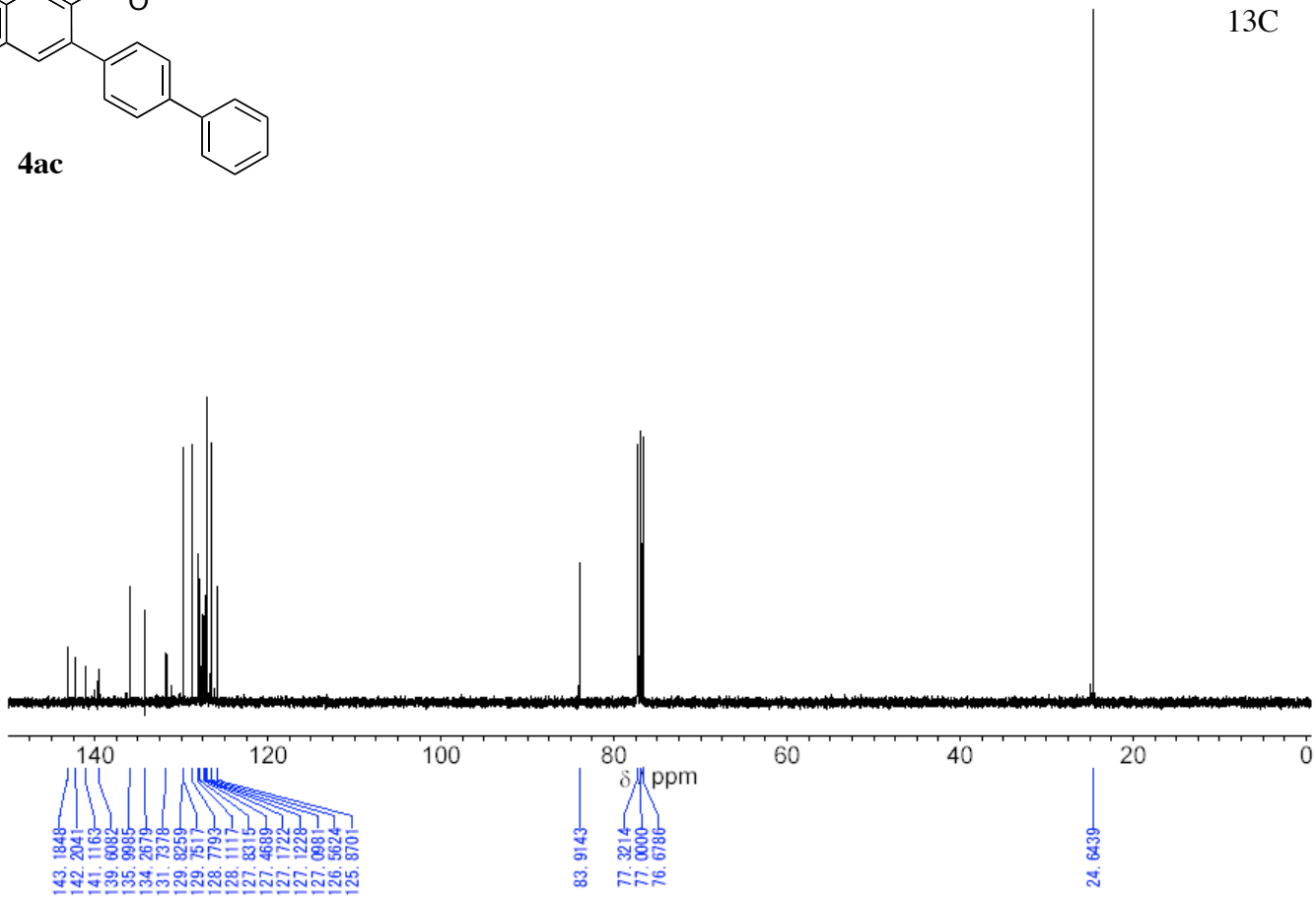
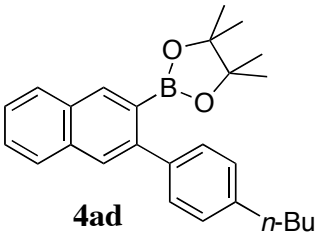
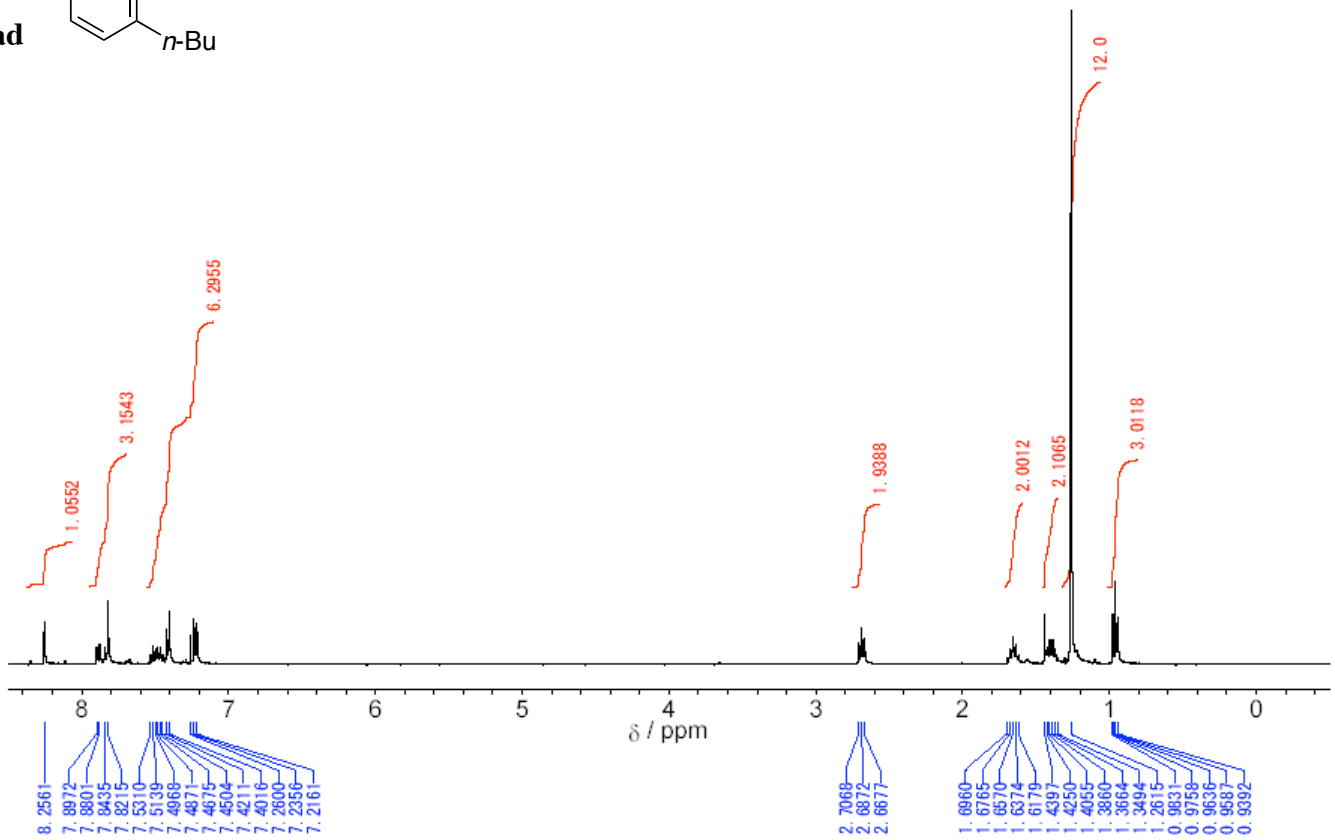
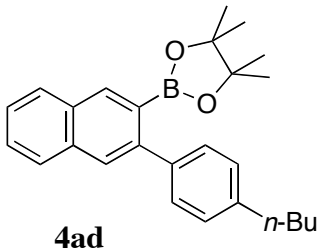




4ad

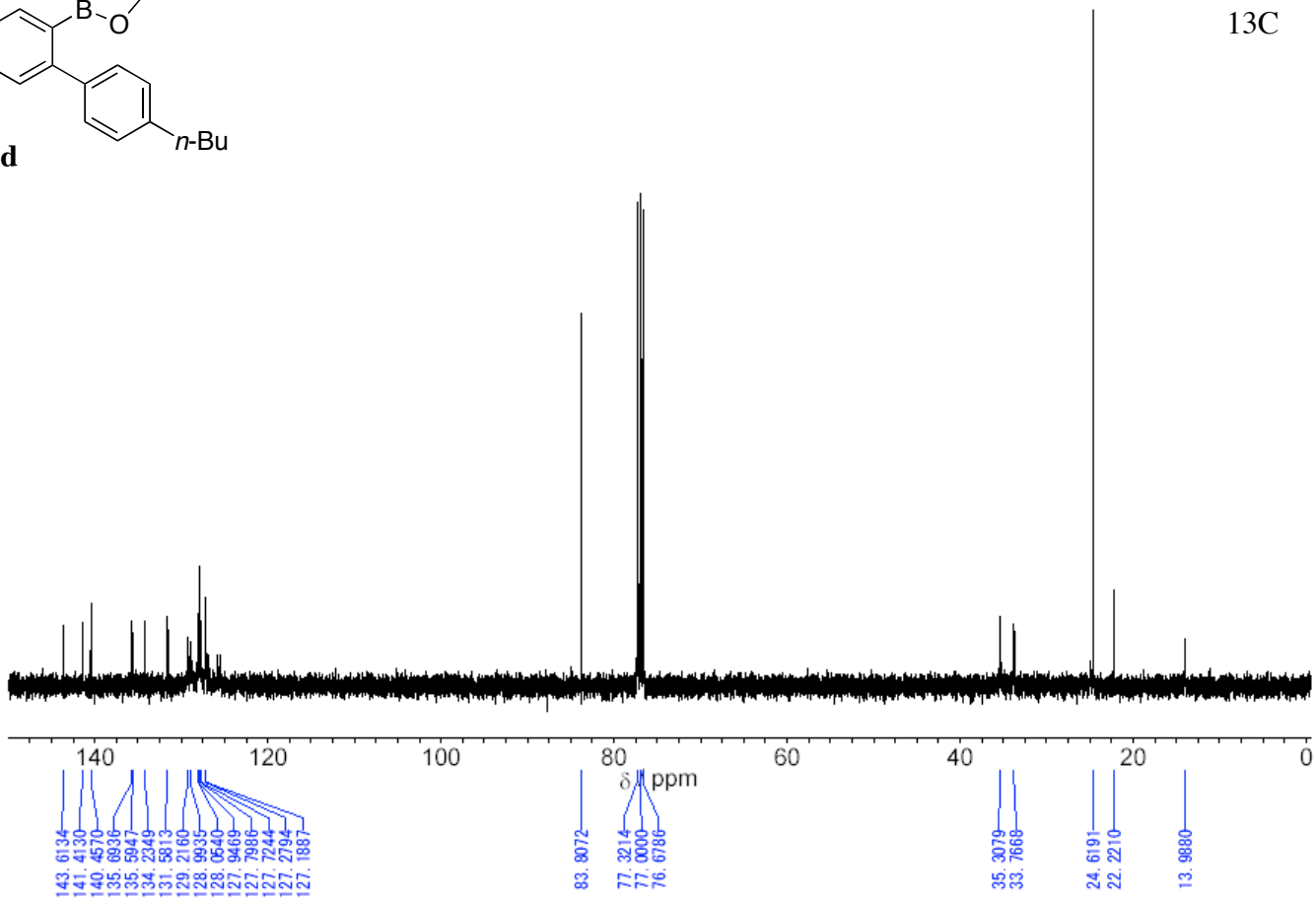
1H

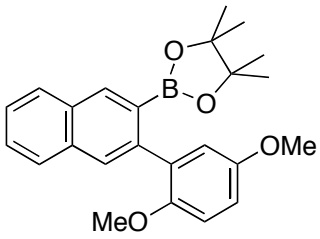




4ad

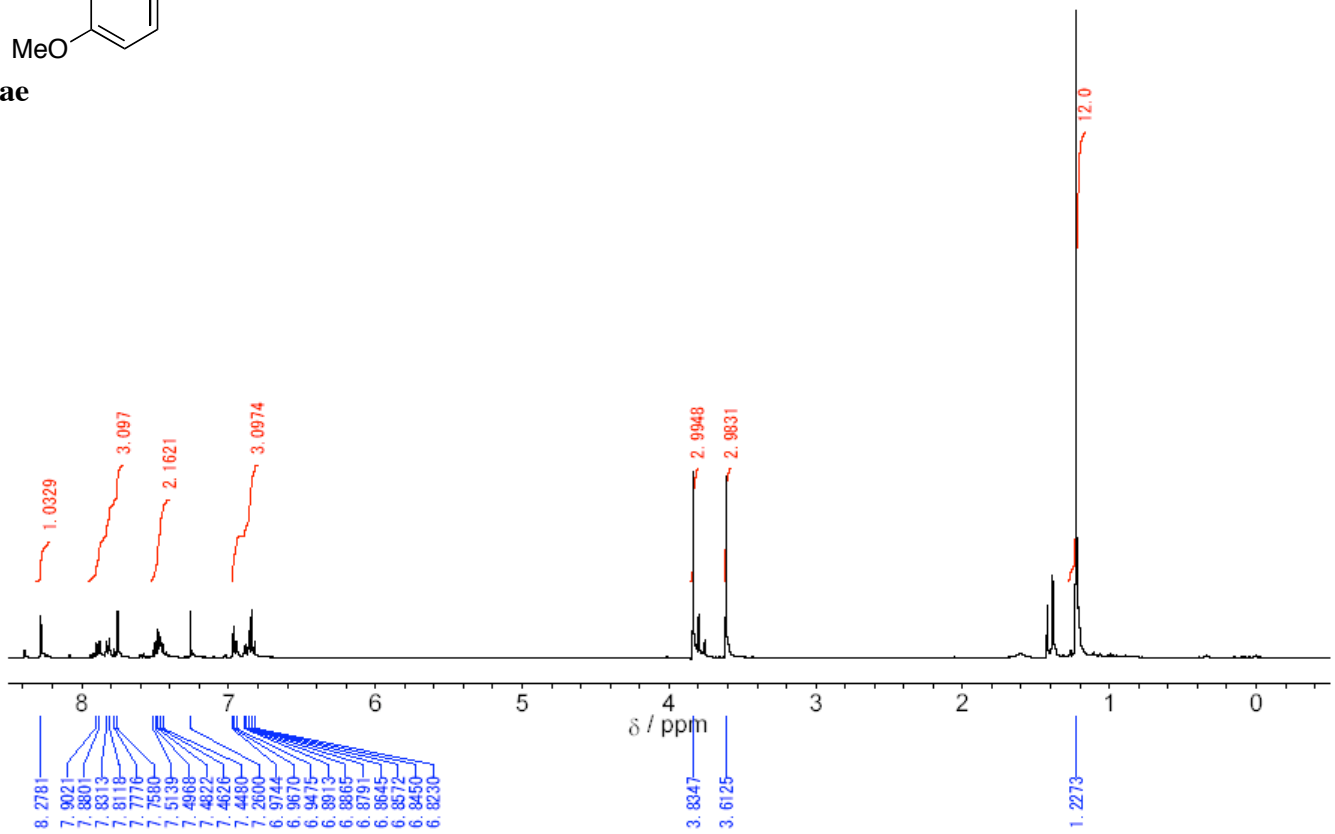
13C

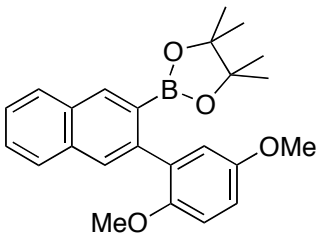




4ae

1H





4ae

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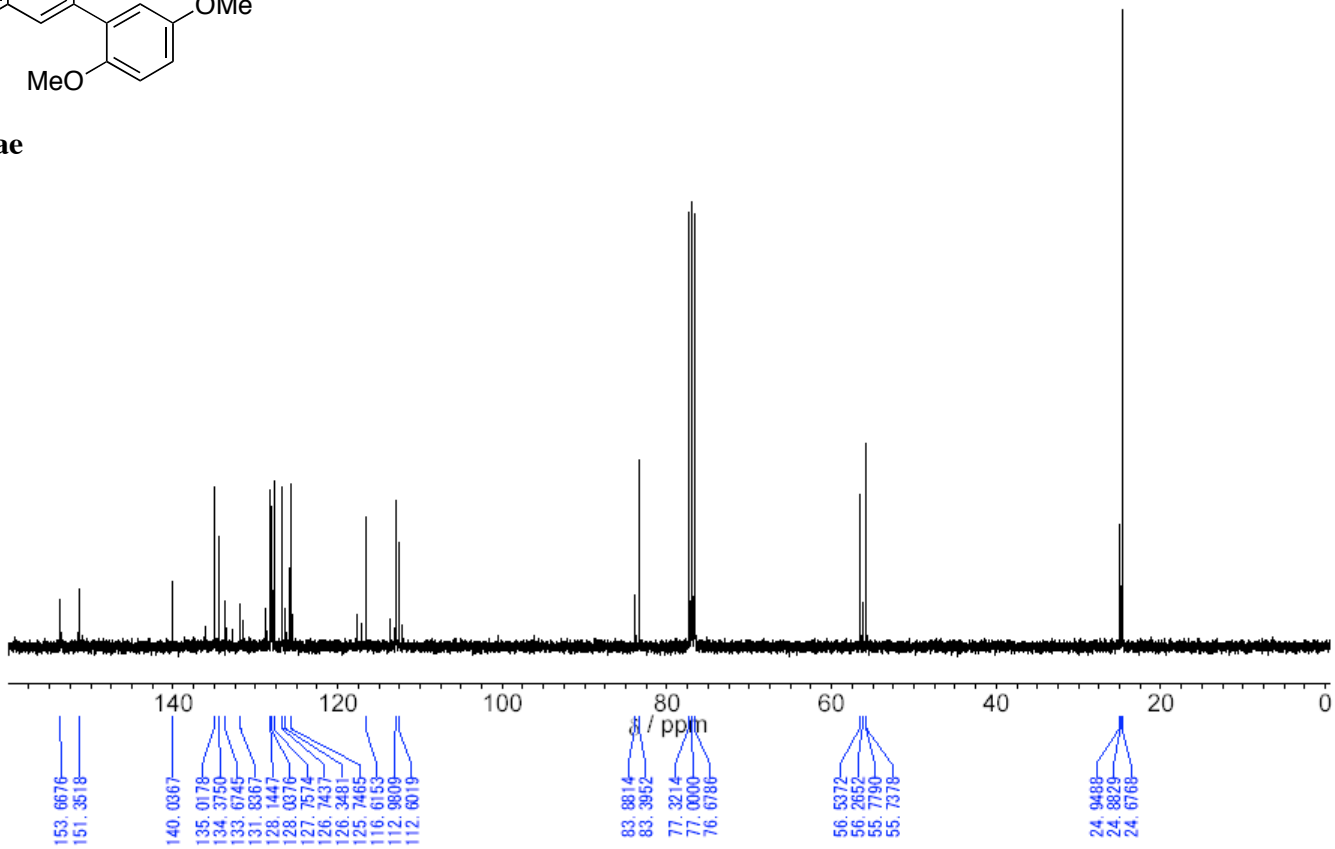
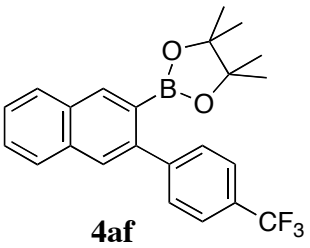
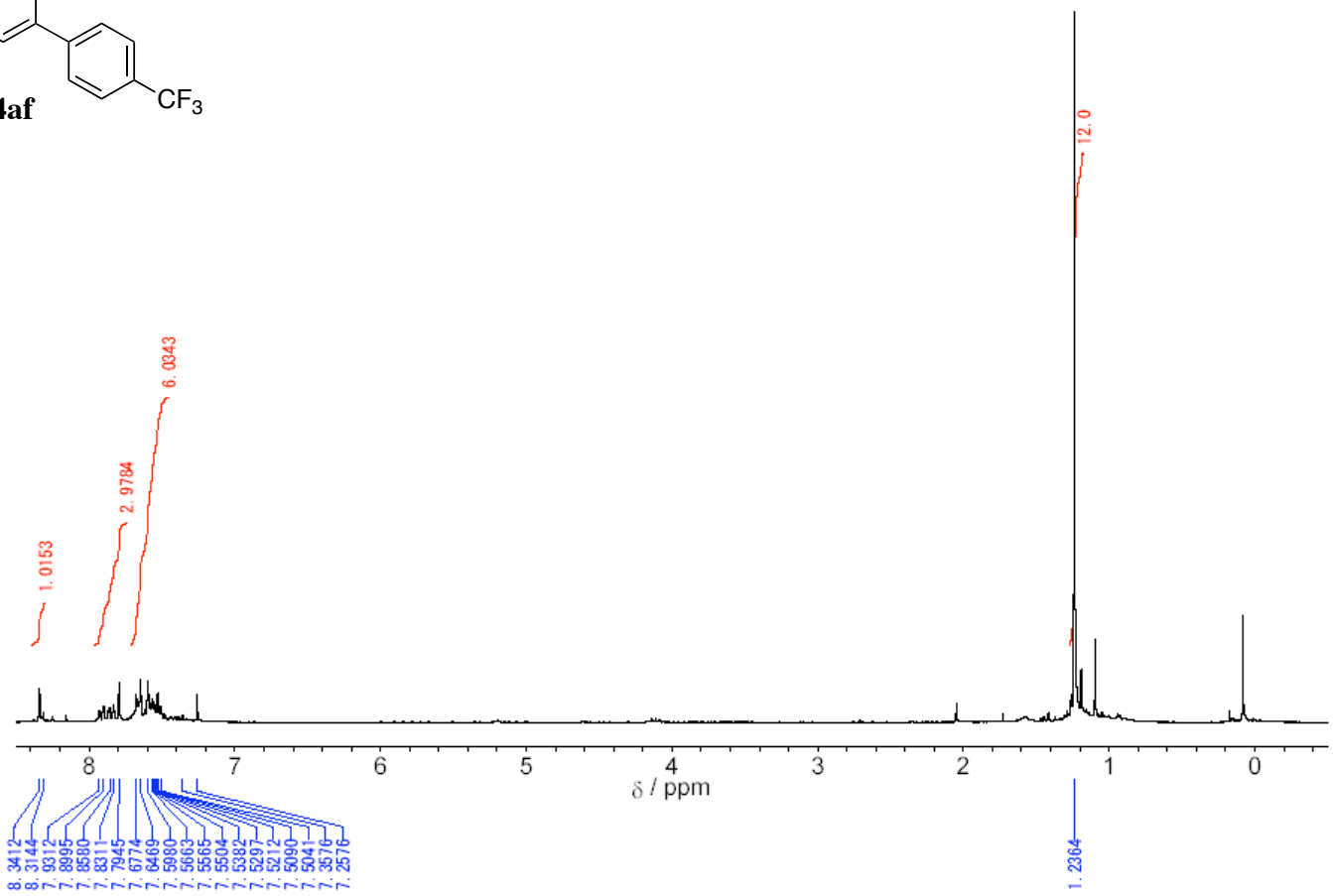
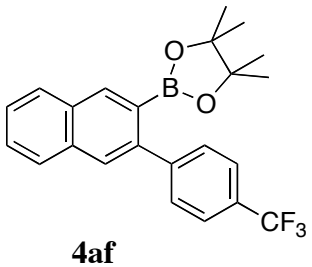




4af

1H





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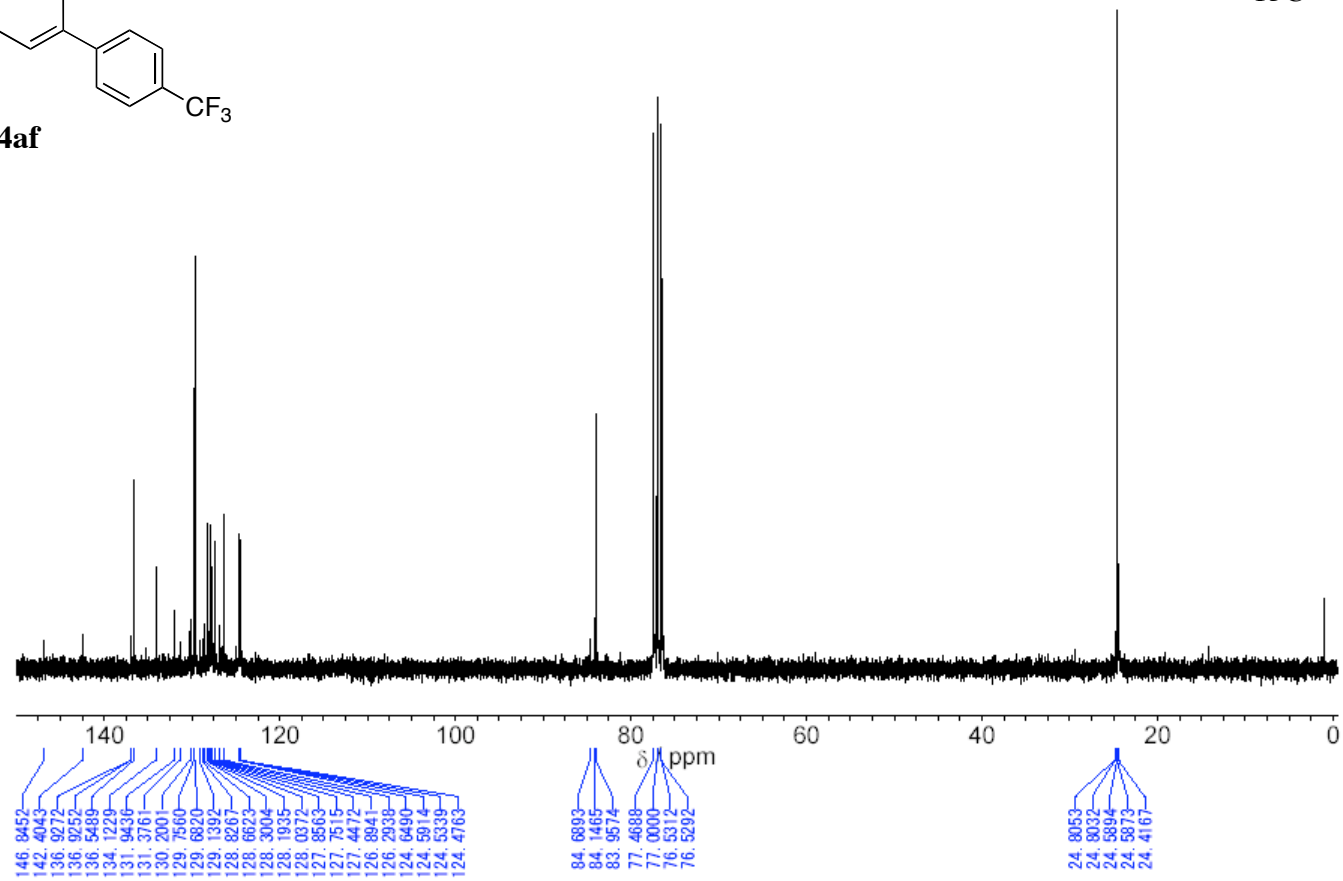
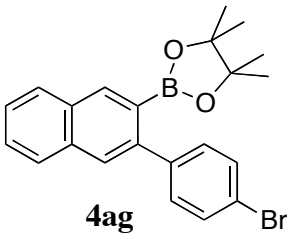
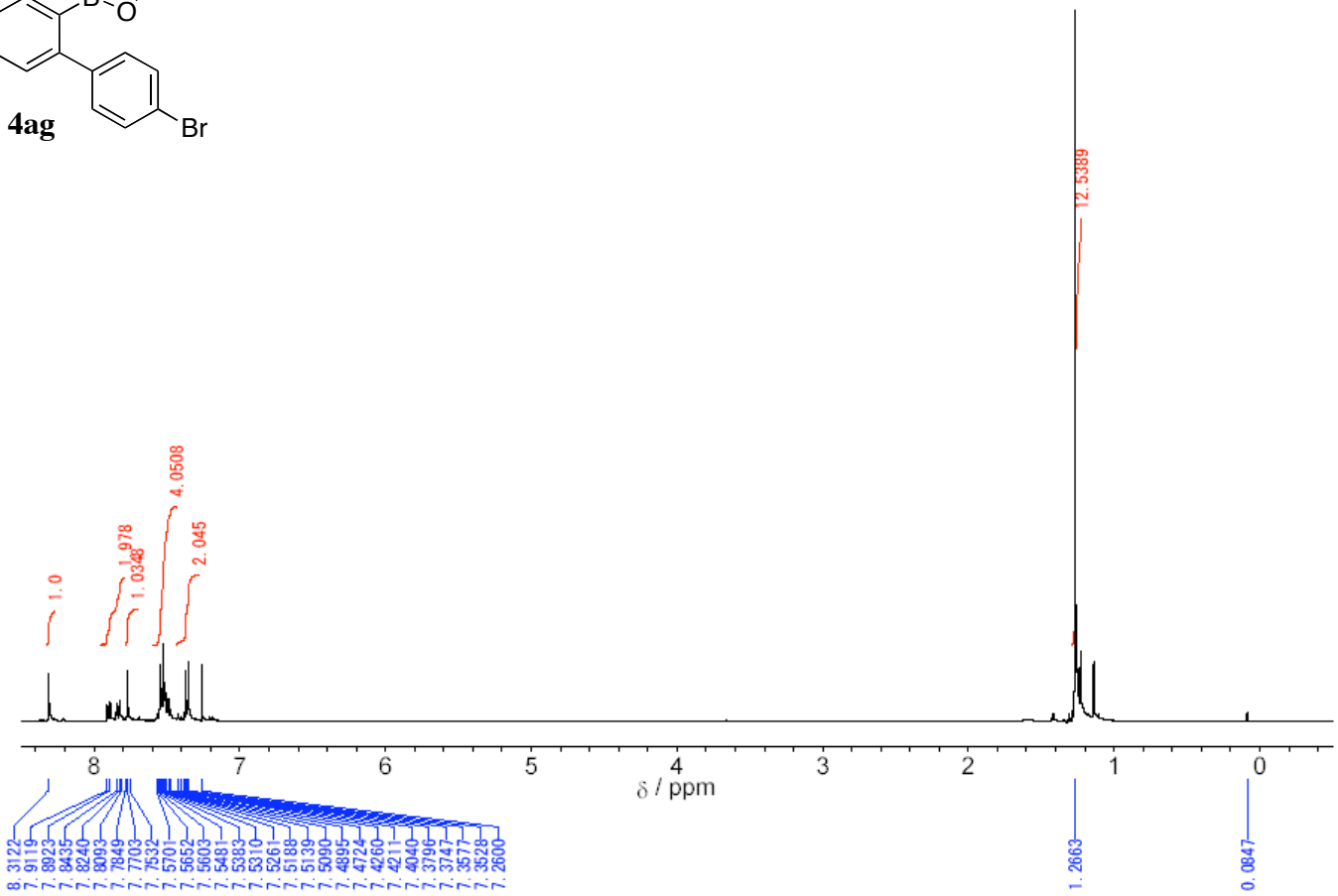
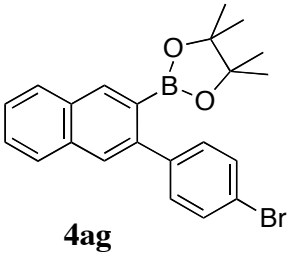




4ag

1H





4ag

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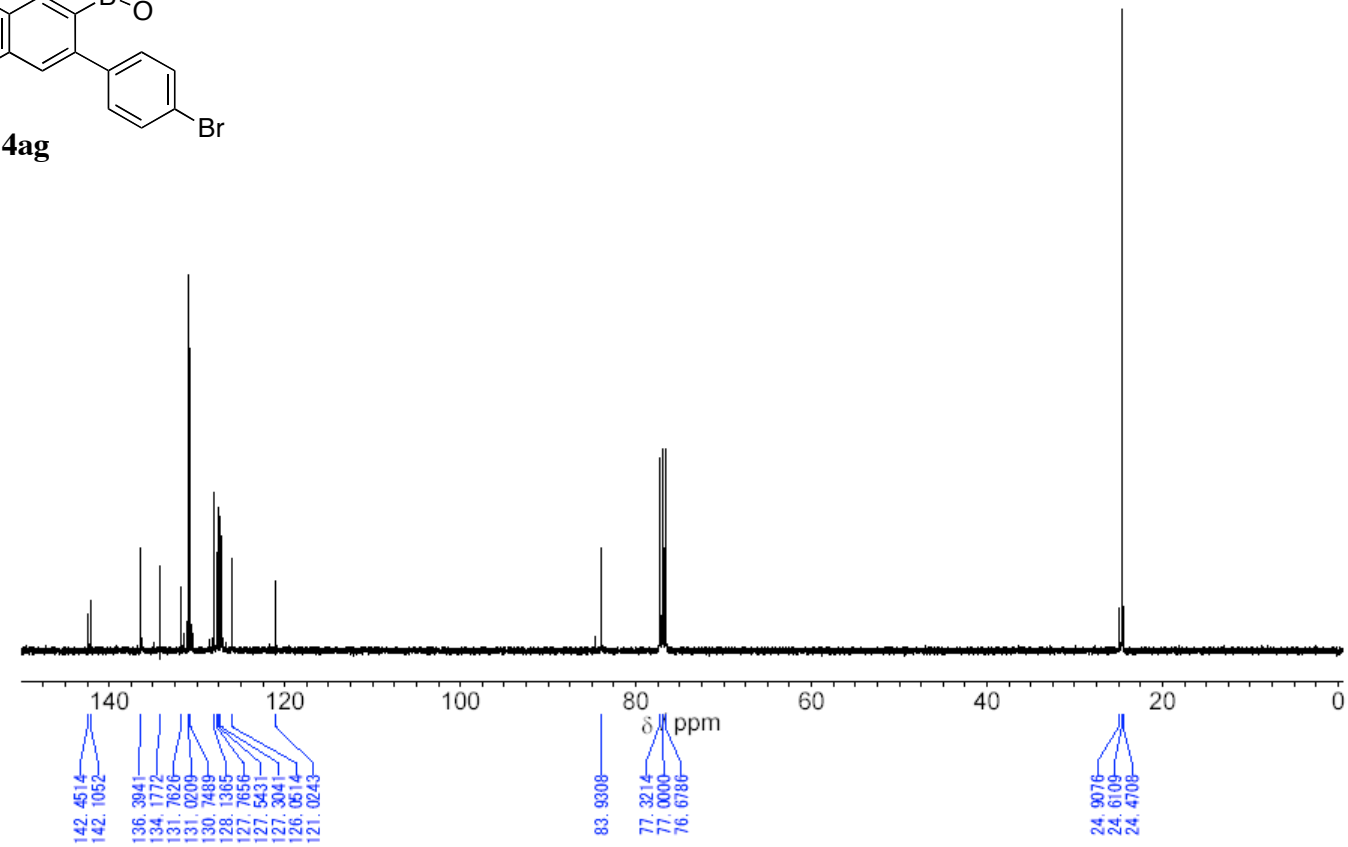
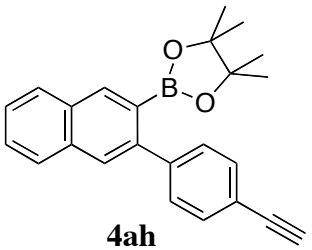
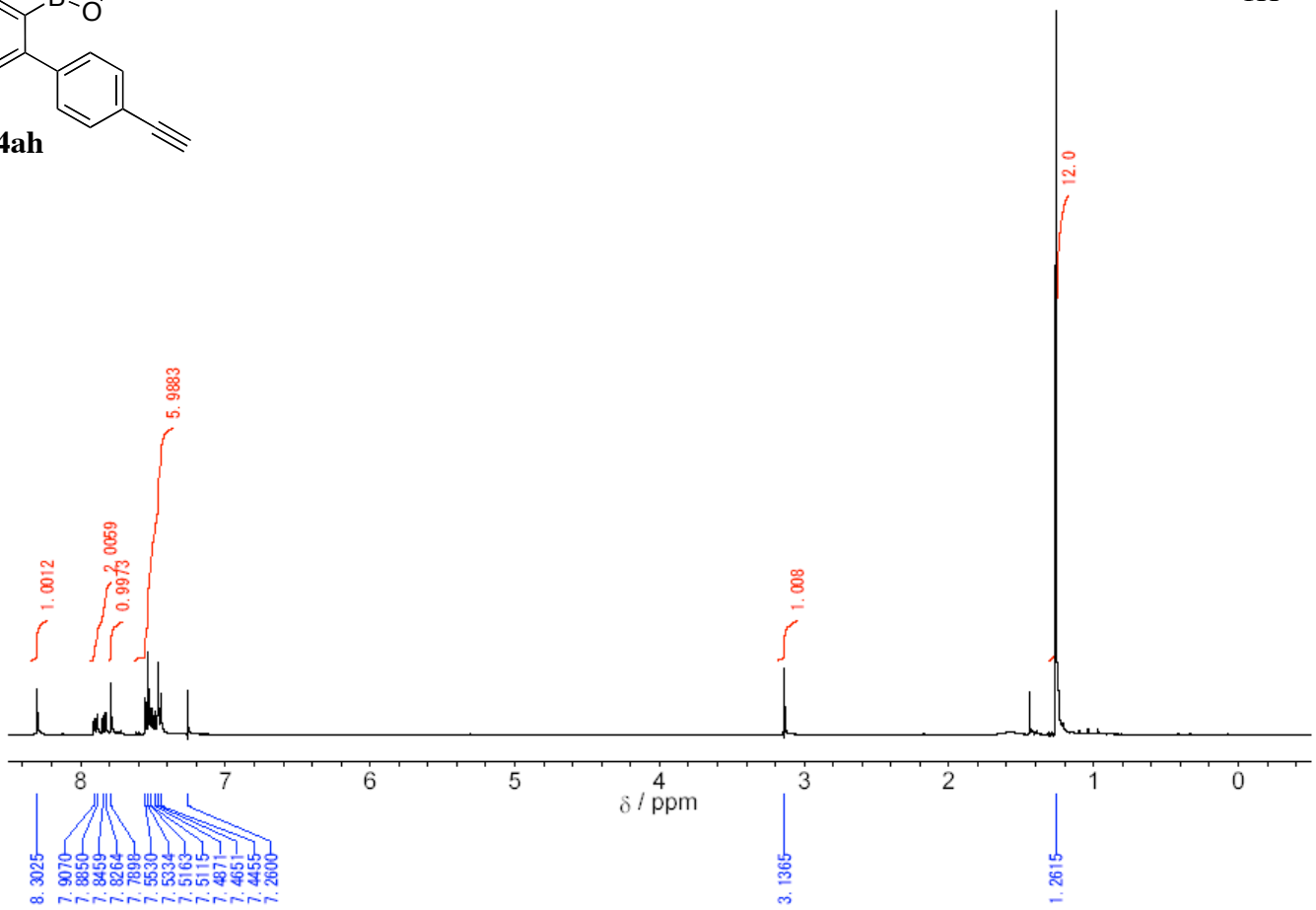
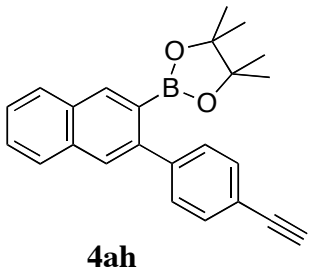




4ah

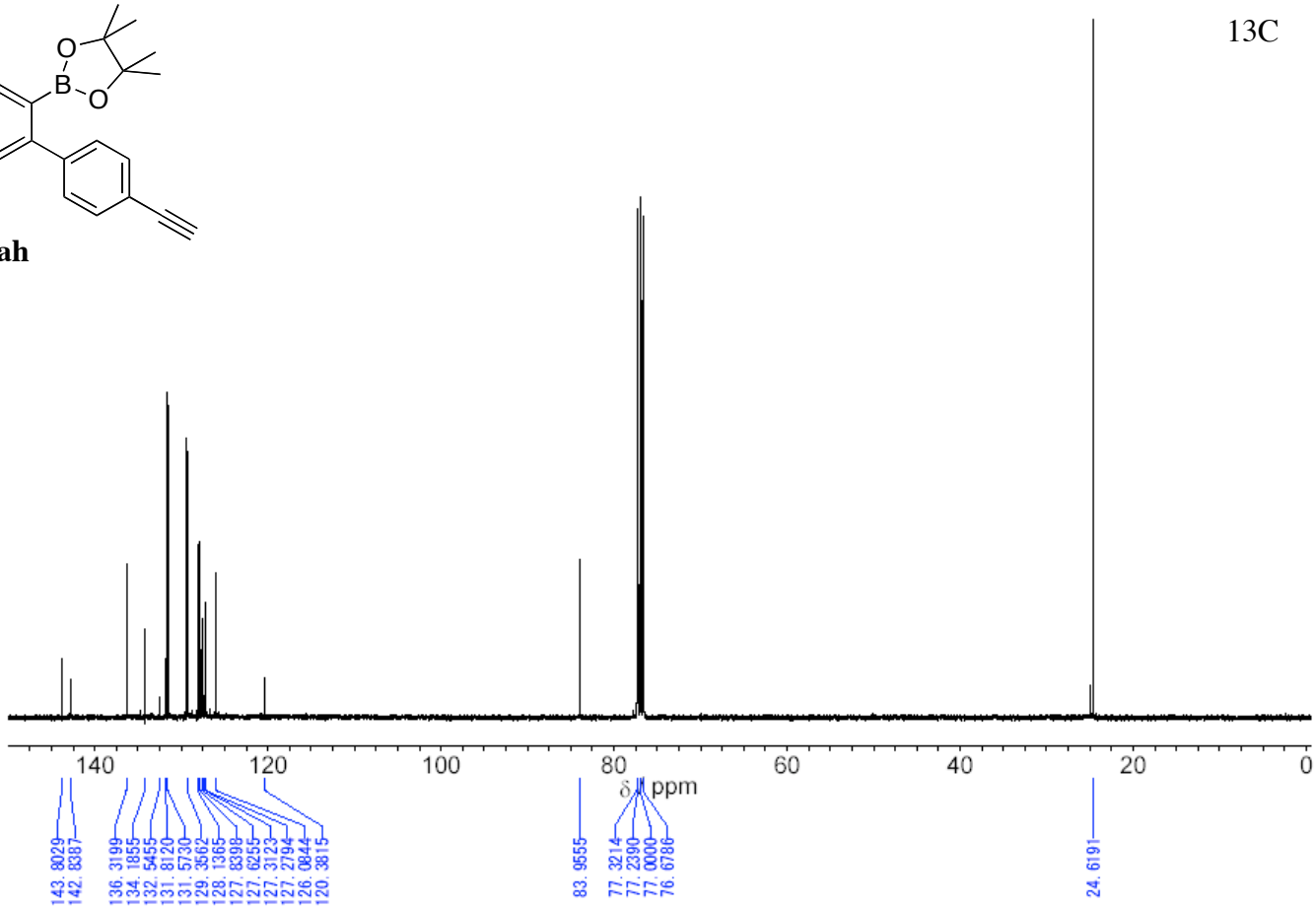
1H

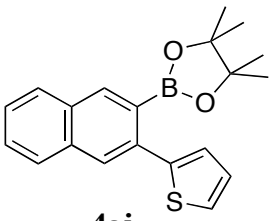




4ah

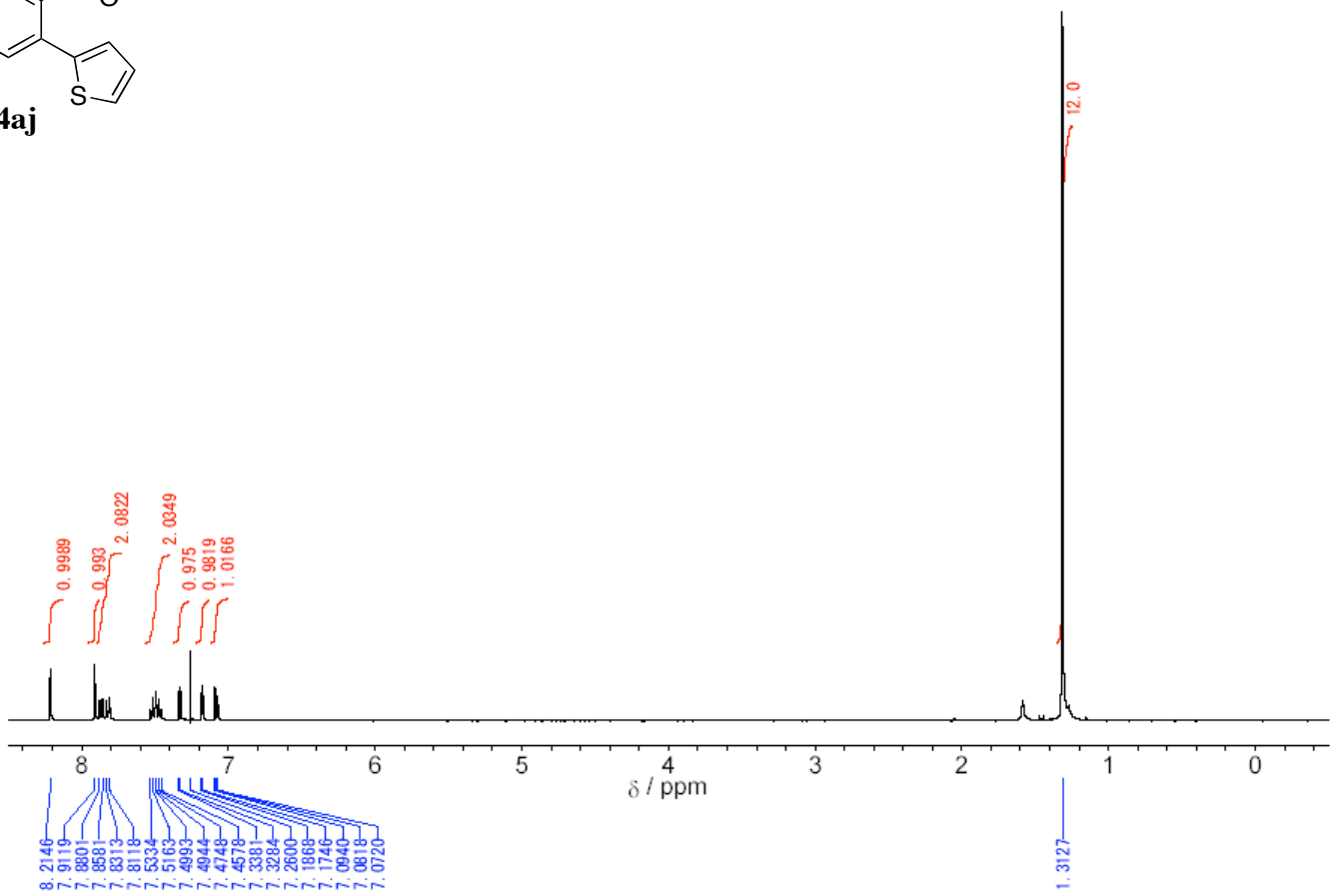
13C

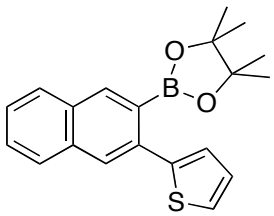




4aj

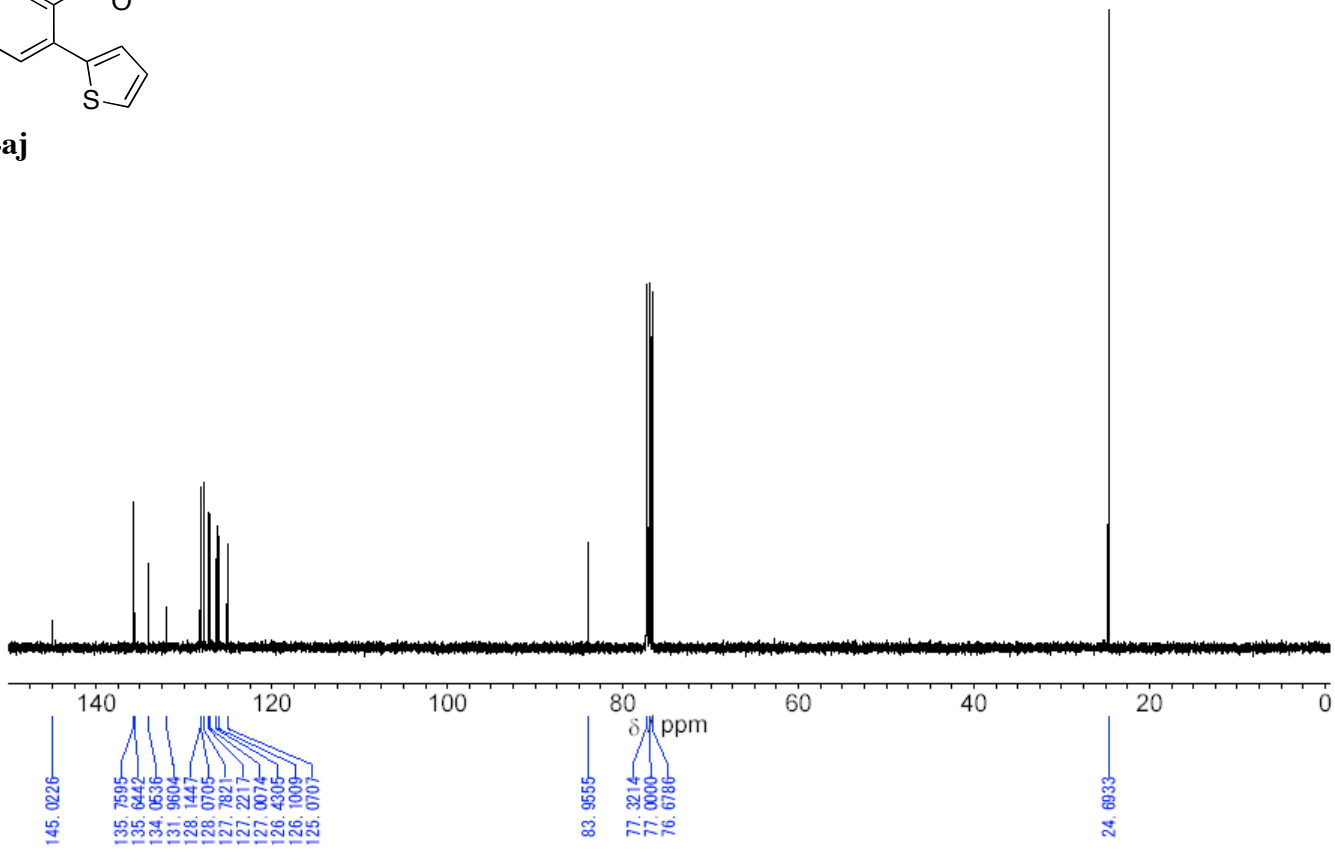
1H

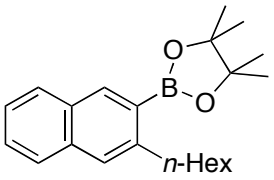




4aj

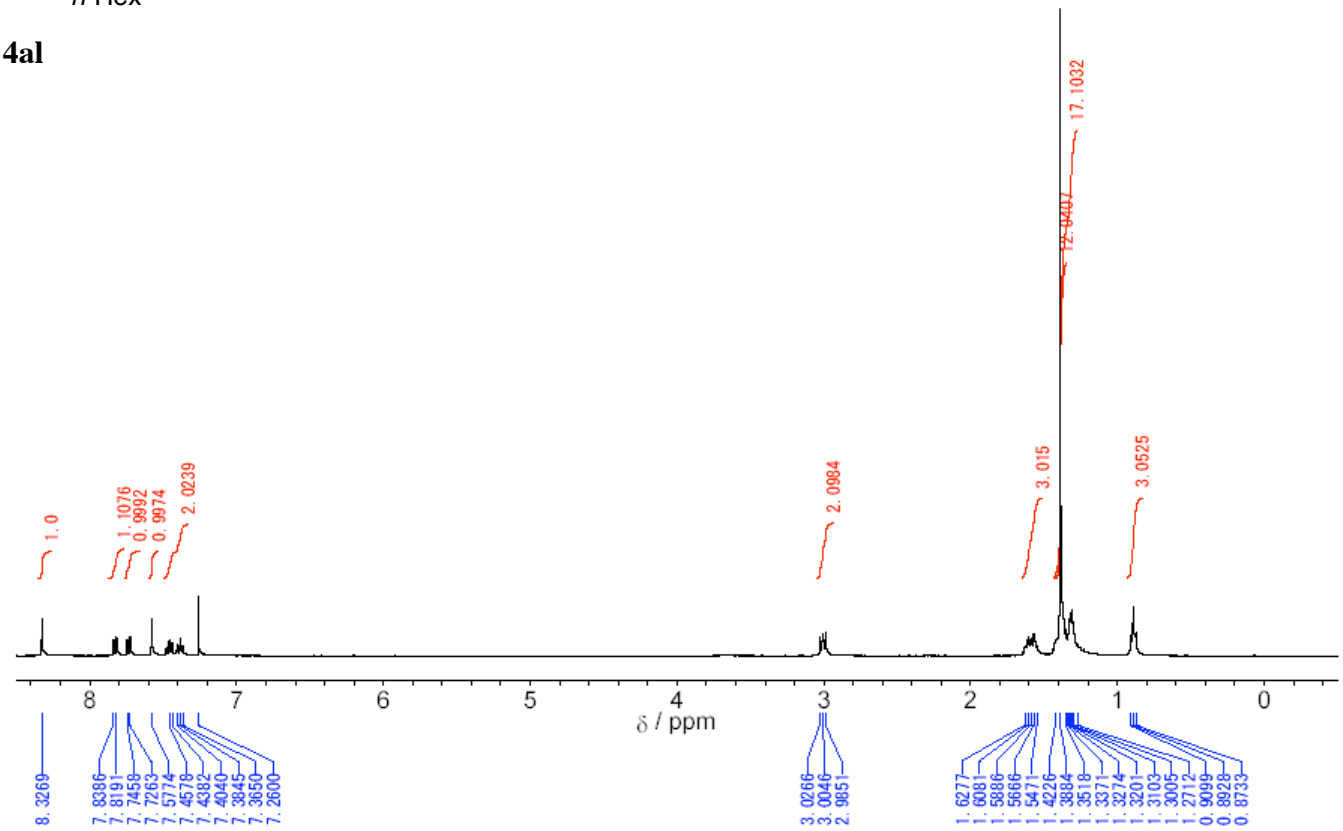
13C



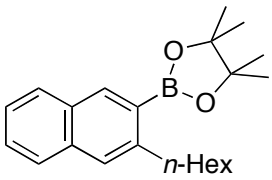


4al

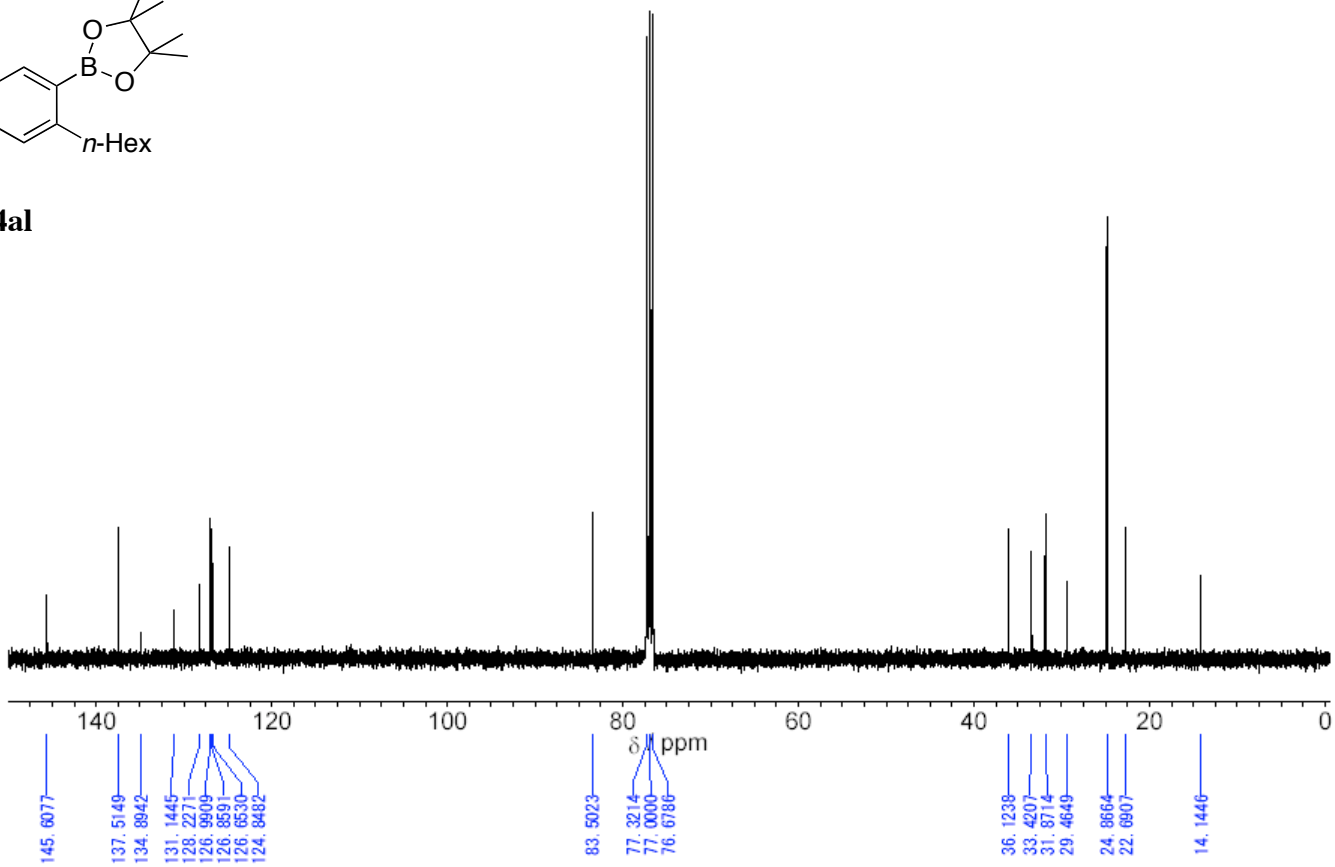
1H

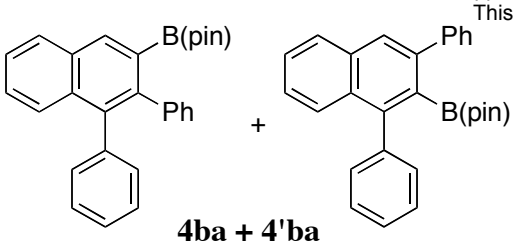


13C



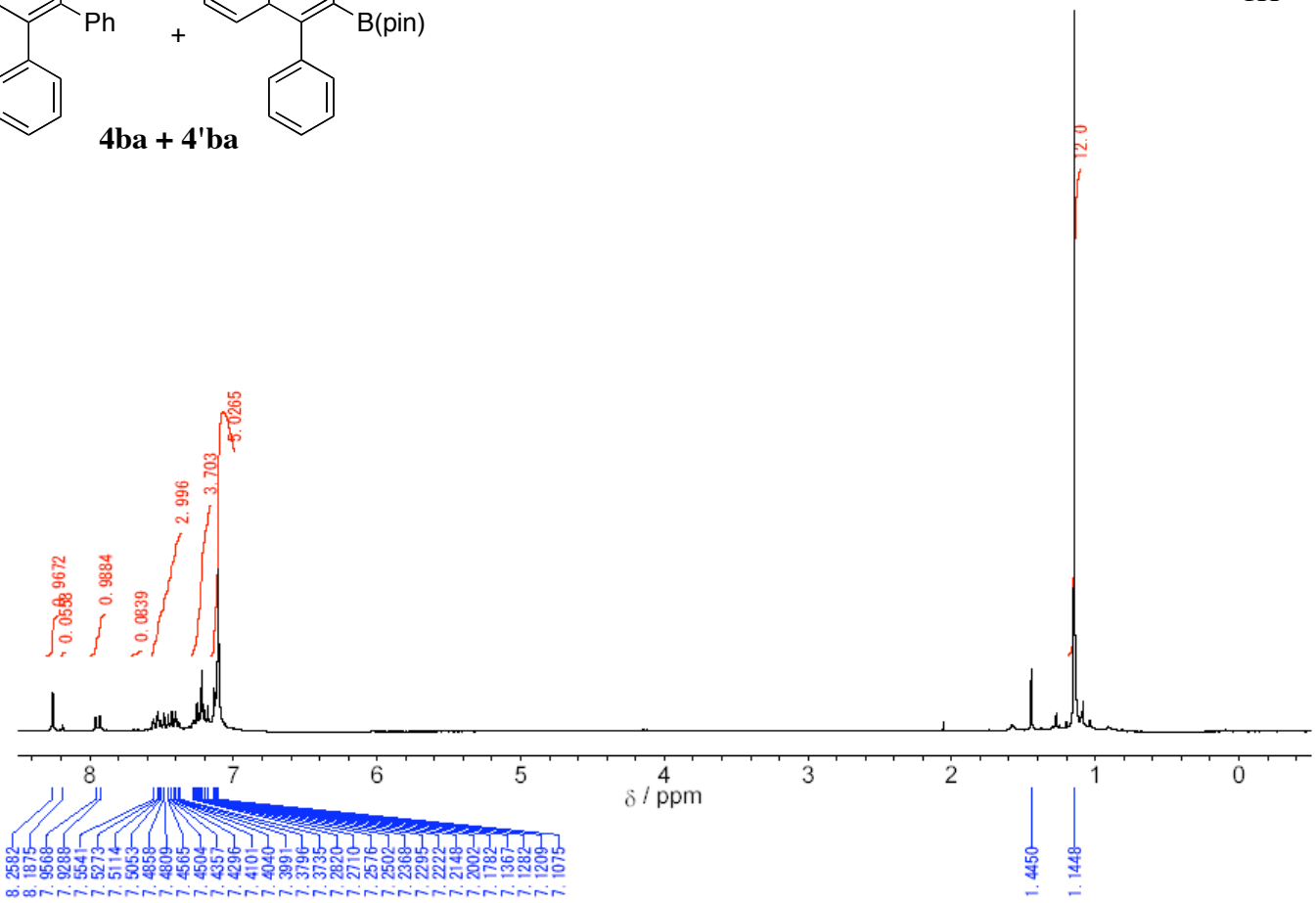
4al

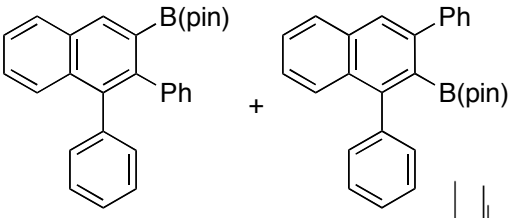




4ba + 4'ba

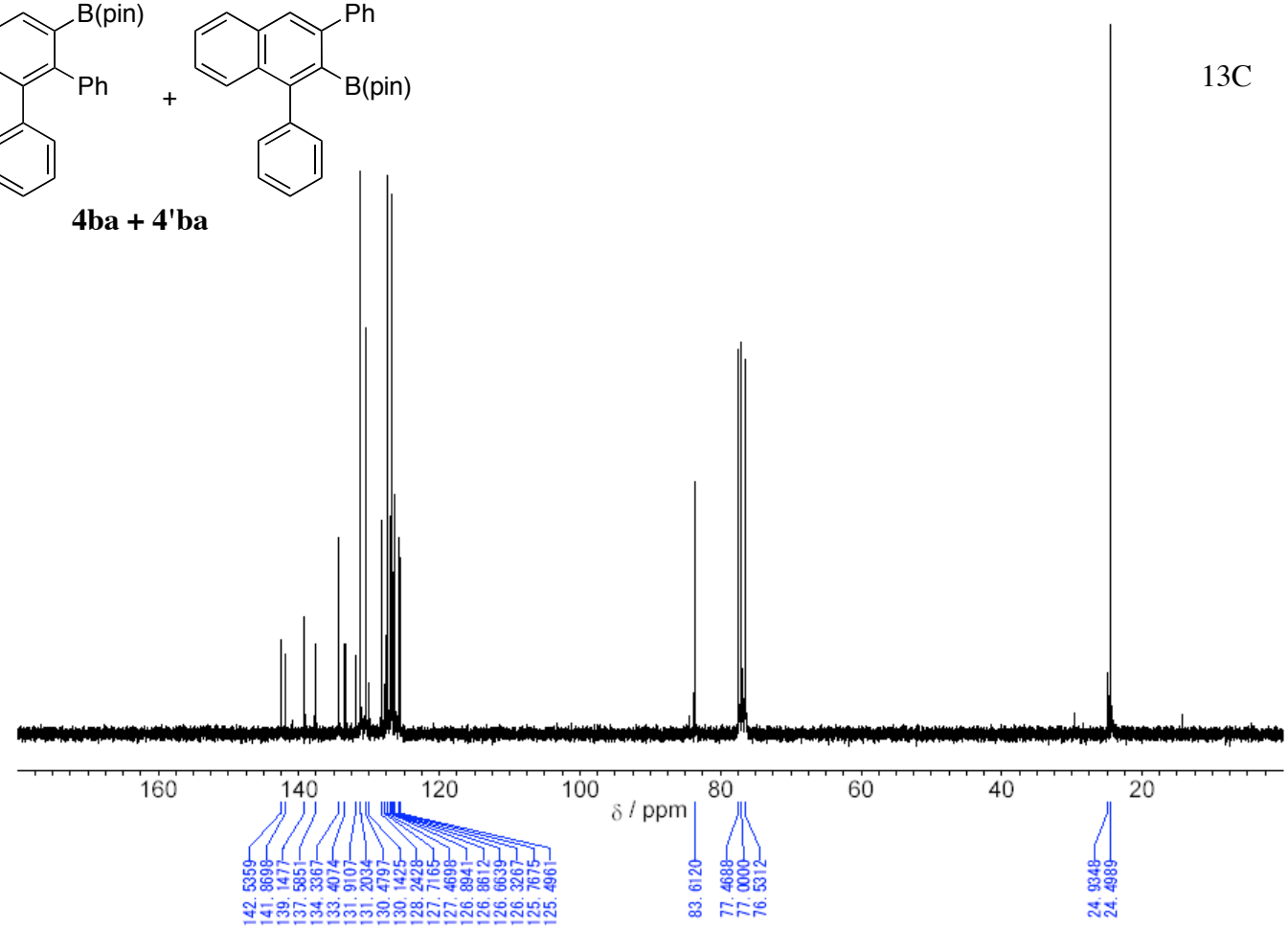
1H

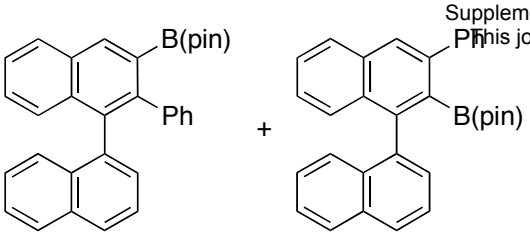




4ba + 4'ba

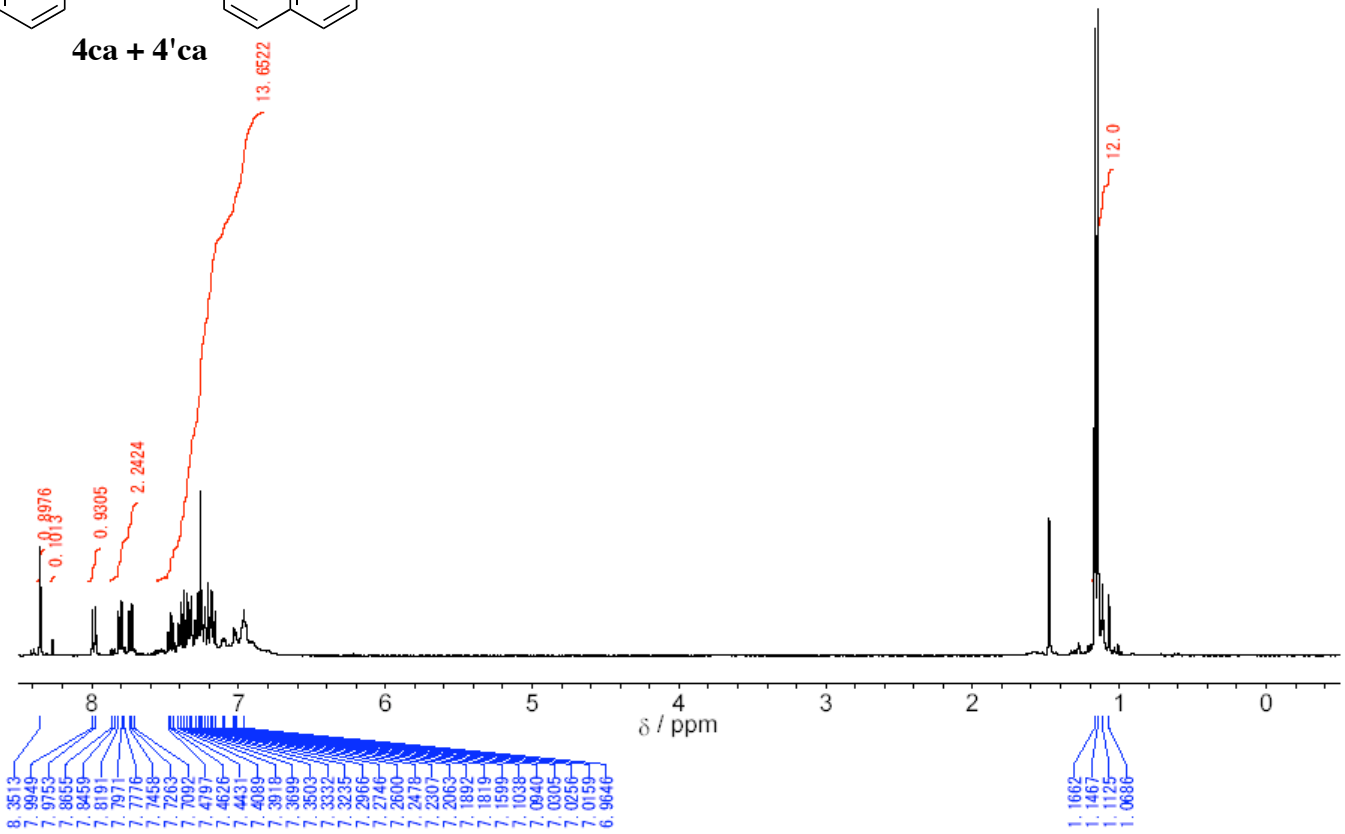
13C

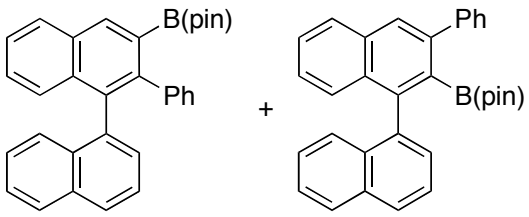




4ca + 4'ca

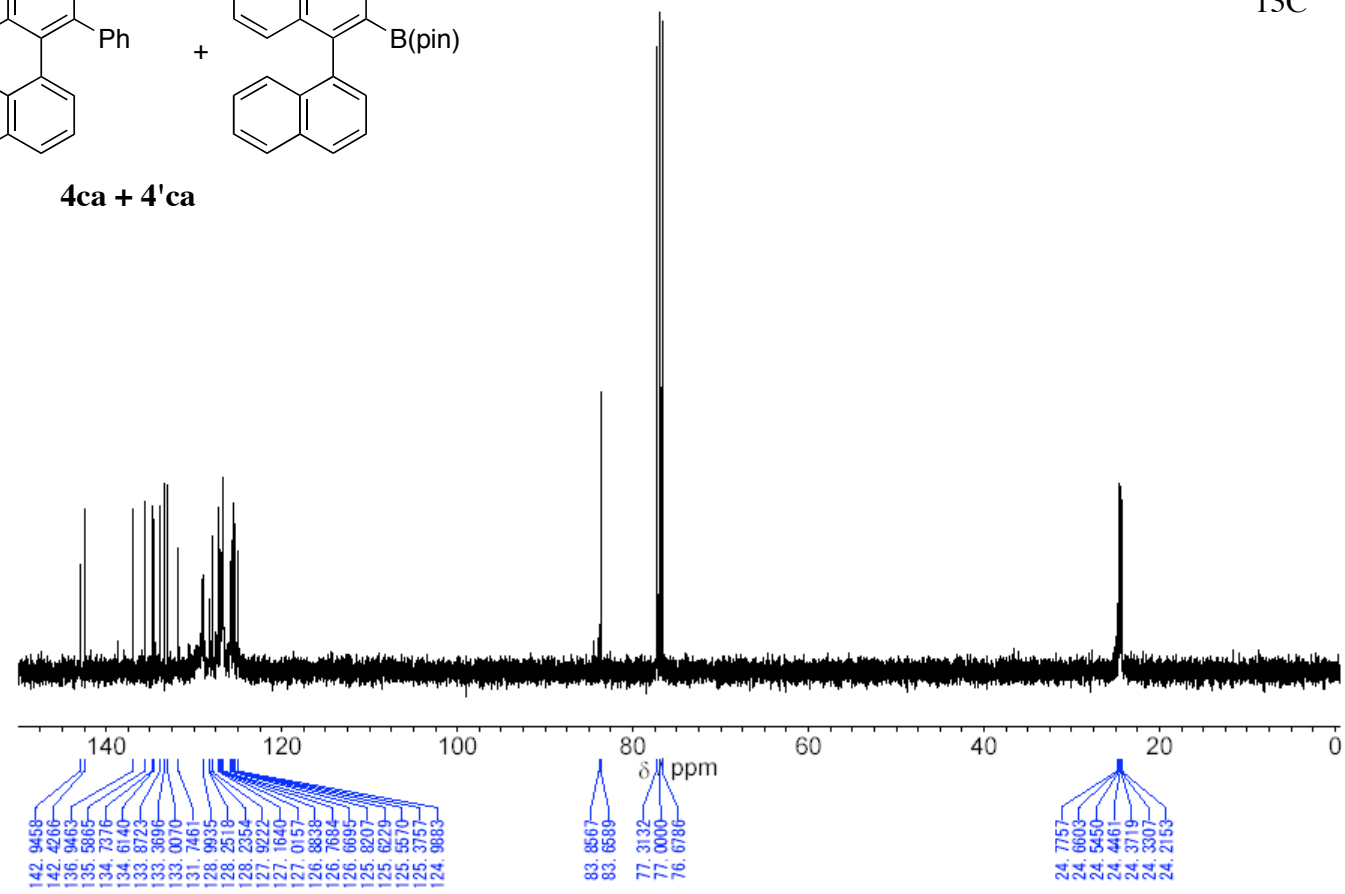
1H

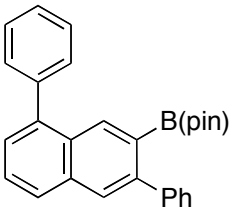




4ca + 4'ca

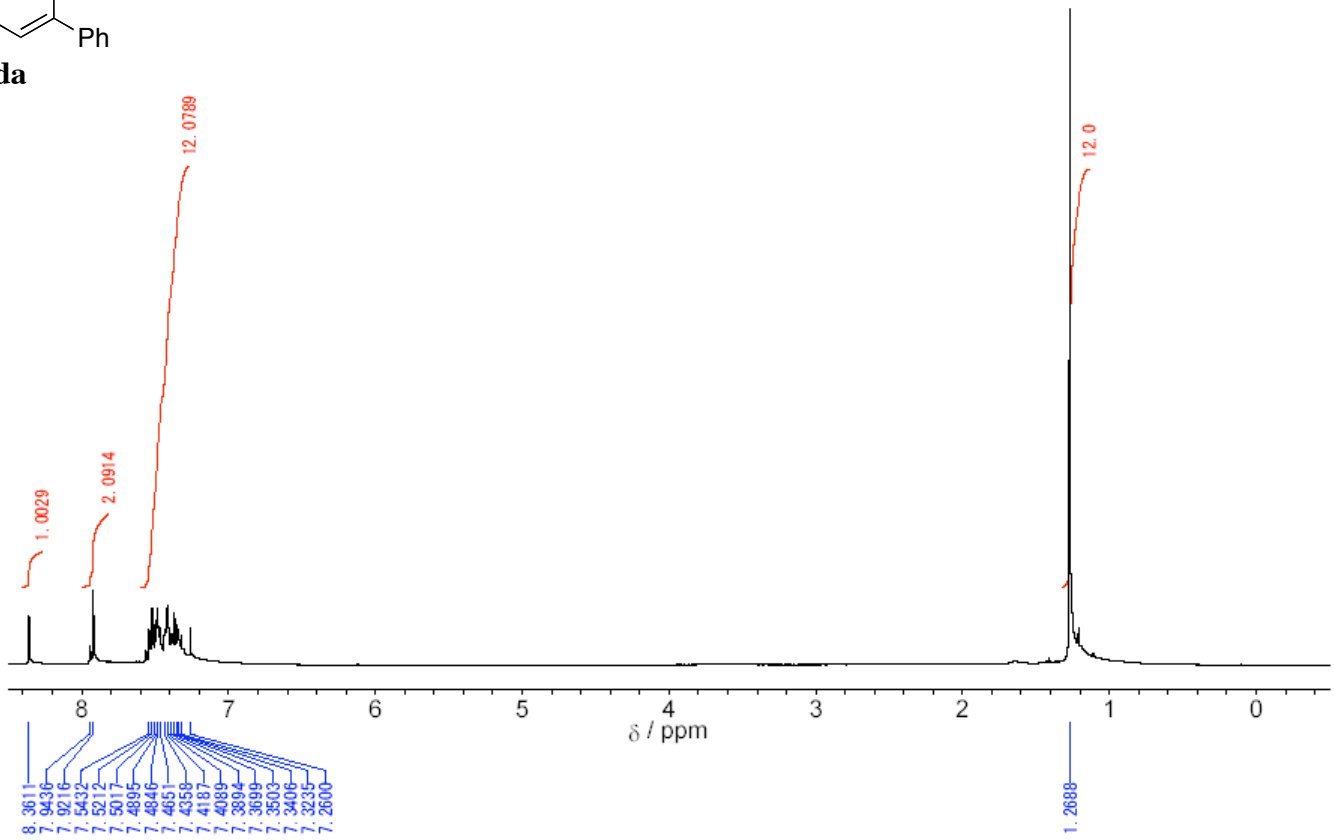
13C

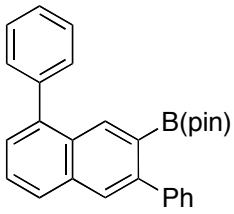




4da

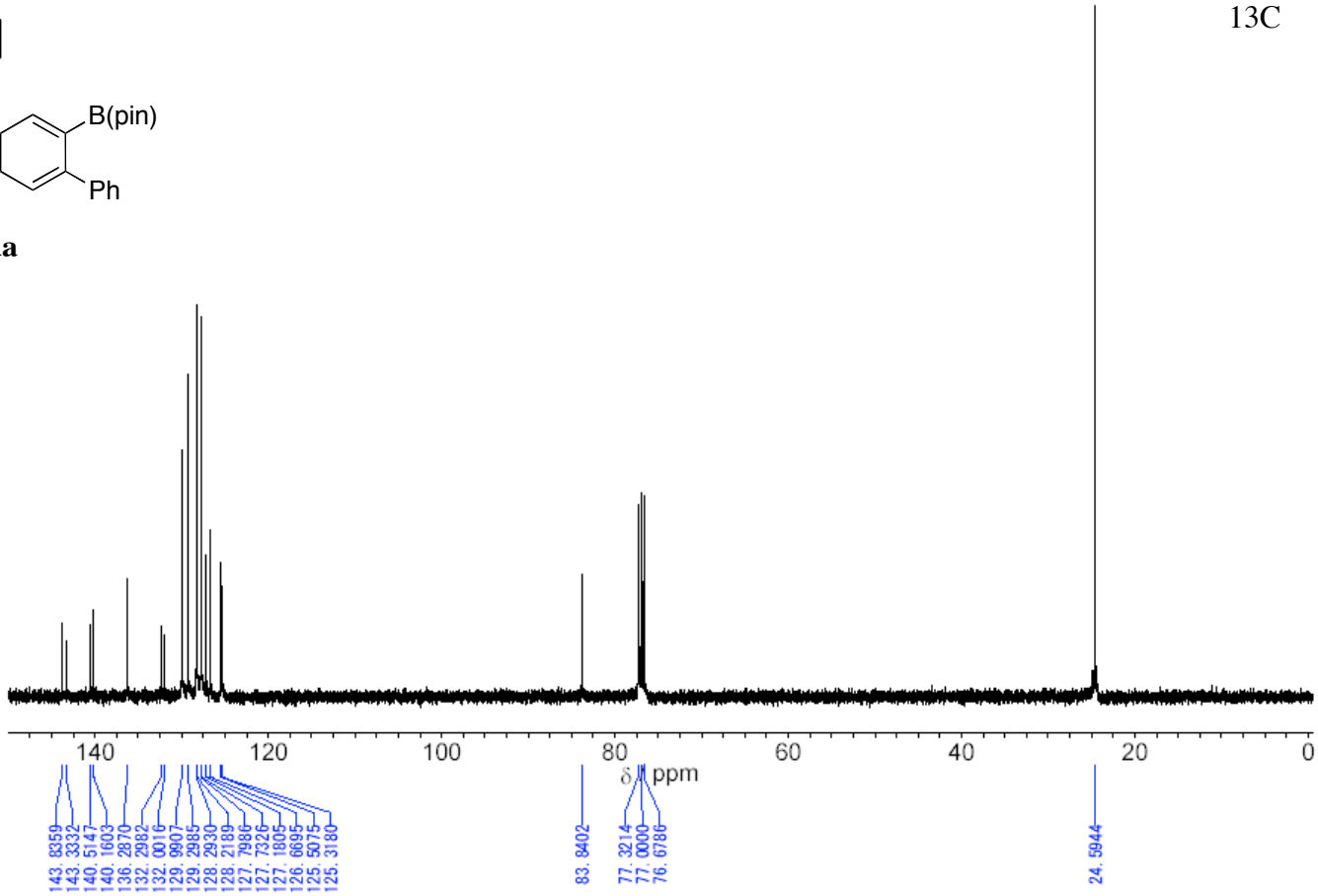
1H

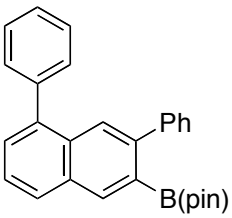




4da

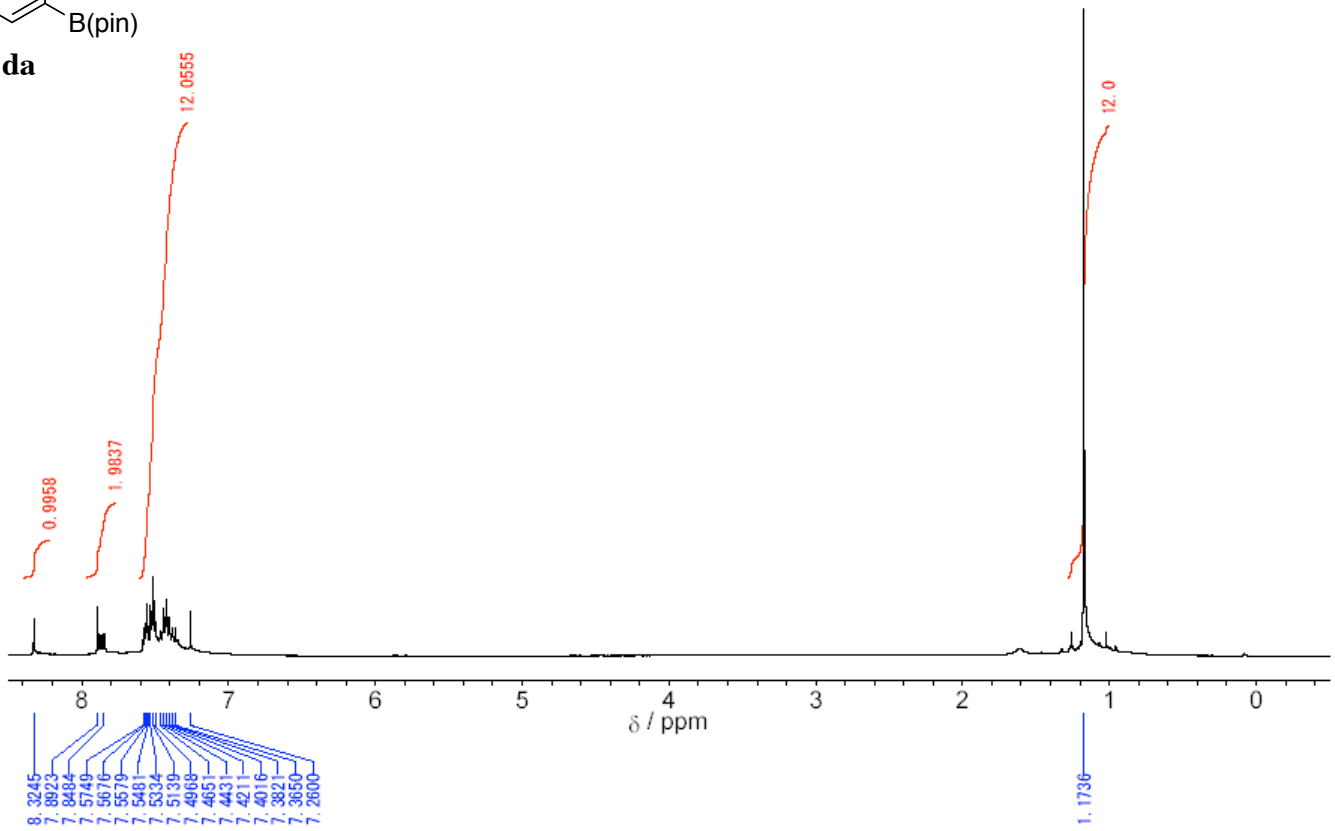
13C

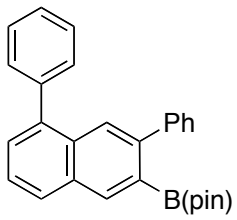




4'da

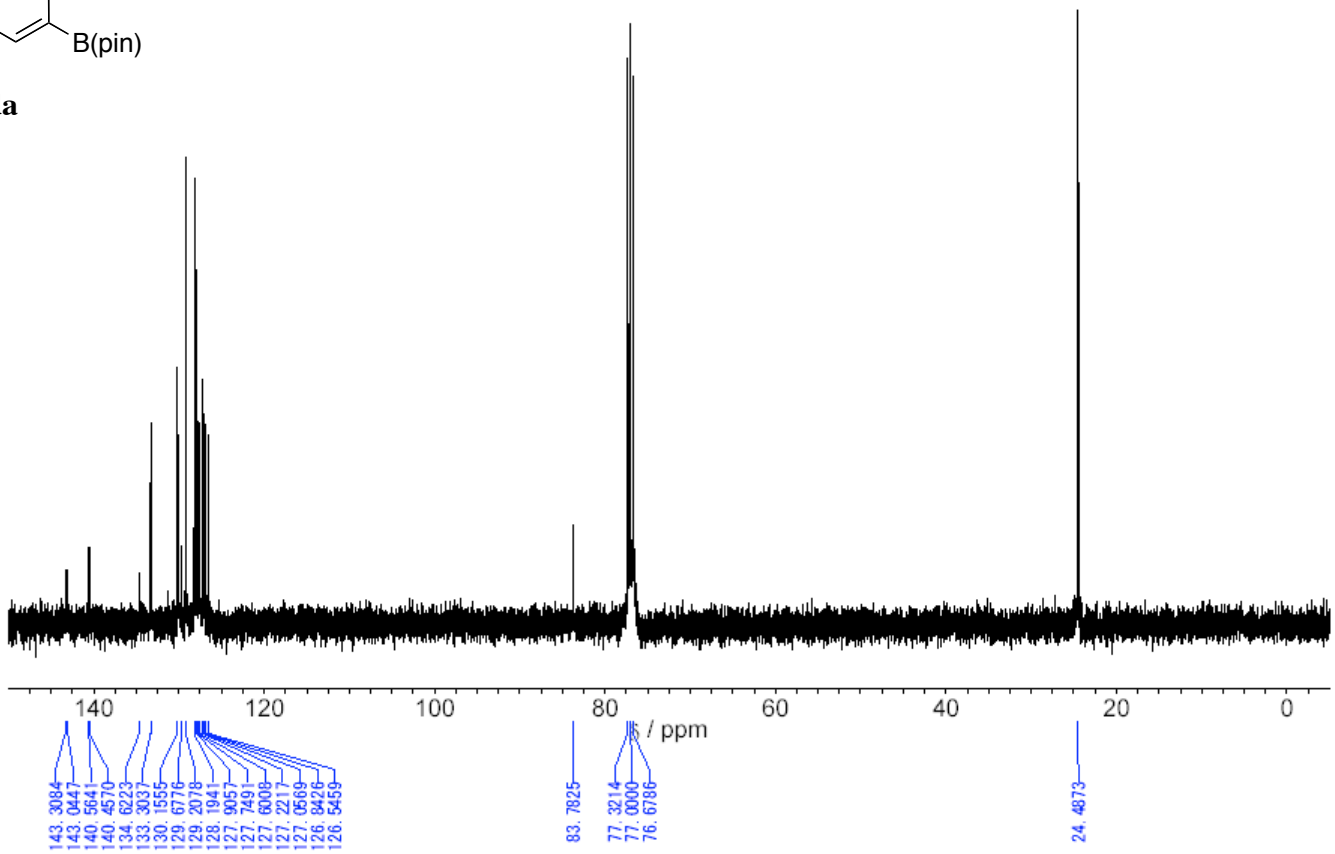
1H

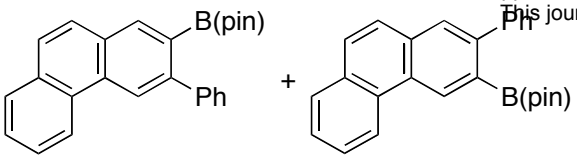




4'da

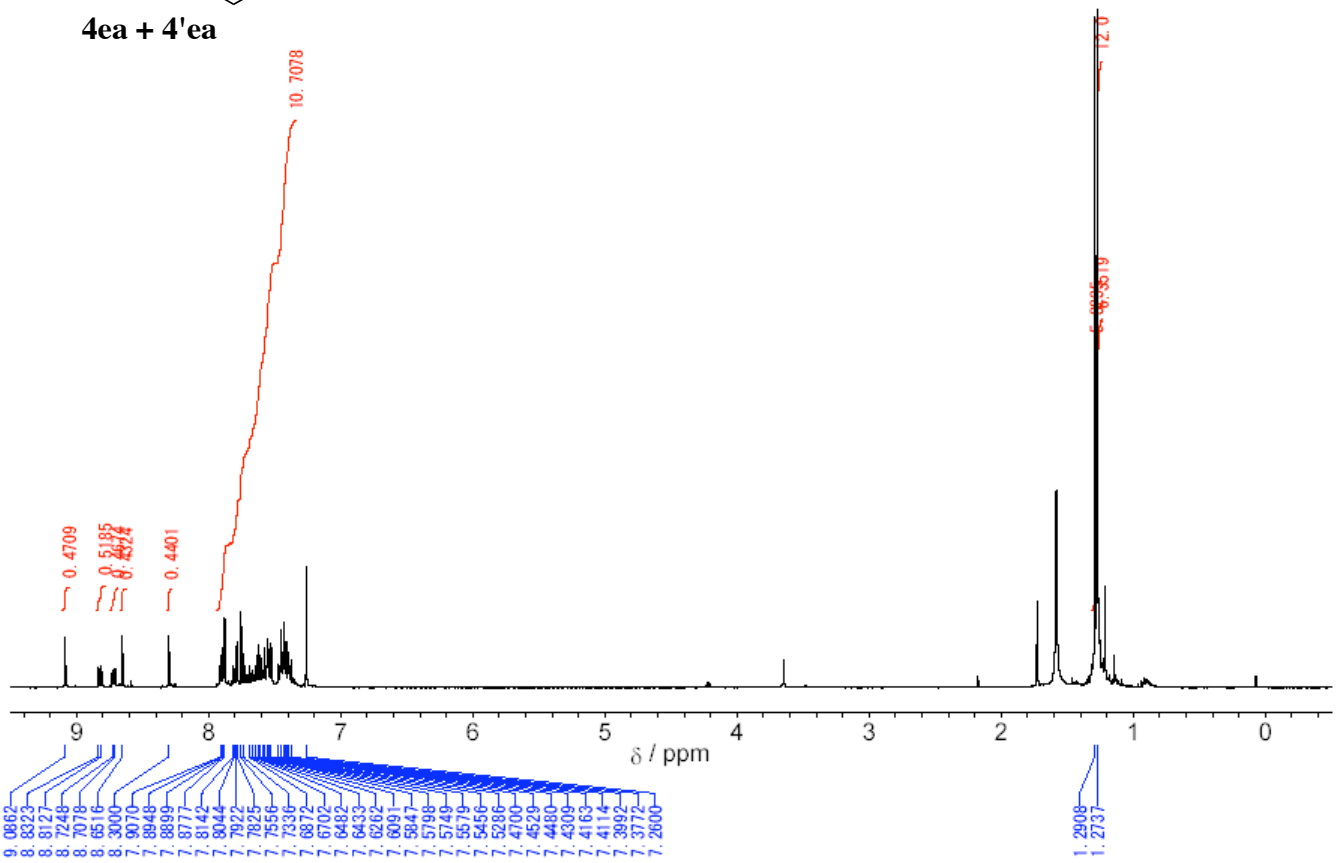
13C

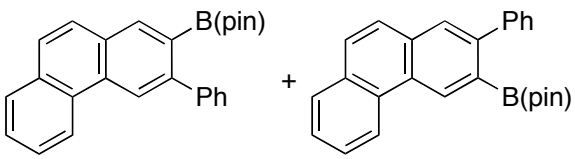




4ea + 4'ea

1H





4ea + 4'ea

13C