Supporting Information

Copper-Catalyzed/Mediated Borylation Reactions of Epoxides with Diboron Reagents: Access to *β*-Hydroxyl Boronic Esters

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I. General Information

a). Materials

All the reactions were carried out in oven-dried schlenk tubes under argon atmosphere (purity ≥ 99.999%). Copper(I) iodide was purchased from Sinopharm Chemical Reagent Co., Ltd as a offwhite powder. Diboron reagents bis(pinacolato)diboron (B_2pin_2) and neopentylglycolatediboron (B_2neop_2) were purchased from Ally Chemical Co., Ltd and recrystallized in EtOAc and petroleum ether for further purification (as white solid). The following chemicals were purchased and used as received: LiO-*t*Bu (J & K, 99.9%), KO-*t*Bu (Acros), NaO-*t*Bu (Acros), 2-(phenoxymethyl)oxirane (adamas, 98%), (S)-2-((benzyloxy)methyl)oxirane (adamas, 98%), 2-((benzyloxy)methyl)oxirane (adamas, 98%).

Anhydrous solvents (DME, DMF, Diglyme, EtOAc, 1, 3-dioxane, THF) were purchased from Acros and used without further purification. Anhydrous THF (Acros) was stored over 4 Å molecular sieves under an argon atmosphere in a septum-capped bottle.

All the other reagents and solvents mentioned in this text were purchased from commercial sources and used without purification.

b). Analytical Methods

^{1}H-NMR, ^{13}C-NMR and ^{19}F-NMR spectra were recorded on a Bruker Avance 400 spectrometer at ambient temperature in $CDCl_3$ unless otherwise noted; Data for ^{1}H-NMR arereported as follows: chemical shift (δ ppm), multiplicity, integration, and coupling constant (Hz). Data for ^{13}C-NMR are reported in terms of chemical shift (δ ppm), multiplicity, and coupling constant (Hz). Gas chromatography (GC) analysis was acquired on a Shimadzu GC-2014 Series GC System equipped with a flame-ionization detector. GC-MS analysis was performed on Thermo Scientific AS 3000 Series GC-MS System. HRMS analysis was performed on FinniganLCQ advantage Max Series MS System. HPLC analysis was performed on Waters-Breeze (2487 Dual Absorbance Detector and 1525 Binary HPLC Pump). Chiralpak IC, OD, AS, KM columns were purchased from Daicel Chemical Industries, LTD. Organic solutions were concentrated under reduced pressure on a Buchi rotary evaporator. Flash column chromatographic purification of products was accomplished using forced-flow chromatography on Silica Gel (200-300 mesh).

II. Preparation of Substrates

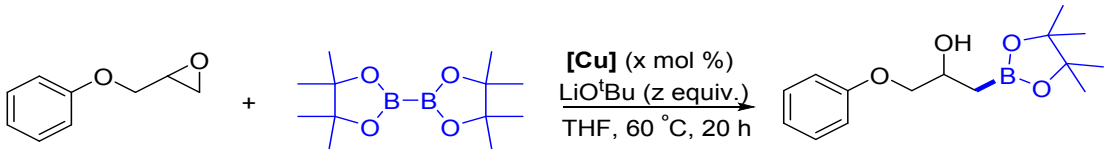
Synthesis and characterization of epoxides

Epoxide substrates were prepared according to literature procedure, and NMR data have reported there.[1-2]

III. General Experimental Procedures of Copper-Catalyzed Borylation Reactions of Epoxides with Diboron Reagents, Spectral Data and HPLC Analysis

Experimental Procedures for Examples Described in Table 1.

In air, schlenk tube was charged with Cu catalyst (0.03 mmol), base (0.6 mmol, 3 equiv.), and diboron reagent (0.6 mmol, 3 equiv.) which equipped with a stirring bar. The vessel was evacuated and refilled with argon three times. Under inert gas, 2-(phenoxymethyl)oxirane substrate (0.2 mmol, 1 equiv.) and 1.0 mL of solvent were added. The resulting suspension was stirred for 20 h at 60 °C up to completion of reaction. Then 4 mL of H_2O was added for reaction mixture, and extracted by EtOAc (3 x 5 mL). The combined organic layers were dried over anhydrous Na_2SO_4, filtered, concentrated and purified by thin layer chromatography plate over silic gel using petroleum ether/EtOAc (5/1, v/v) as eluent to obtain the *β*-hydroxyl boronic ester product.



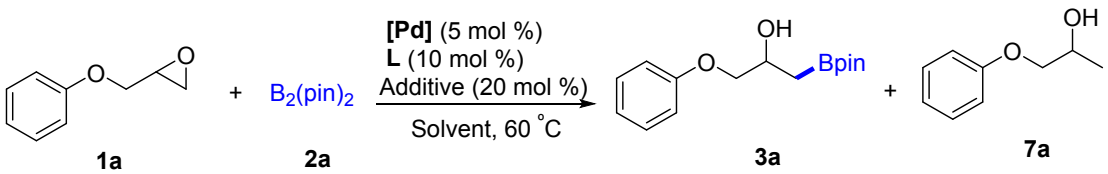
1a, (2.0 mmol) + **2a**, (y equiv.) → **3a**

Entry	[Cu] (x mol %)	B_2pin_2 (y equiv.)	LiO^{t}Bu (z equiv.)	Yield (%)[a]
1	(15)	(1.5)	(2.0)	43
2	(15)	(2.0)	(2.0)	54
3	**(15)**	**(3.0)**	**(3.0)**	**85**
4	(10)	(3.0)	(3.0)	60
5	(5)	(3.0)	(3.0)	26
6	-	(3.0)	(3.0)	0

[a] Standard reaction conditions: epoxide (0.2 mmol), $B_2(pin)_2$ reagent (y equiv.), CuI (x mol %), base (z equiv.), in 1 mL of THF at 60 °C for 20 h under Ar atmosphere. The yield was determined by GC (average of two GC runs) using diphenyl methanol as internal standard.

Experimental Procedures for Palladium-Catalyzed Borylation Reactions of Epoxides with Bis(pinacolato)diboron[a]

The reaction of epoxide **1a** with B_2pin_2 **2a** was conducted accoding to procedure described in previous literature.[3]



1a + **2a** → **3a** + **7a**

Entry	[Pd]	Ligand	Solvent	Additive	Yield (%)[a] 3a	Yield (%)[b] 7a
1[c]	$Pd(OAc)_2$	P(*t*-Bu)$_2$Me	MTBE/H_2O	-	0	0
2	$Pd_2(dba)_3$	P(*t*-Bu)$_2$Me	THF/H_2O	bpy	0	0
3	$Pd_2(dba)_3$	P(*t*-Bu)$_2$Me	THF	bpy	0	0
4[d]	$Pd_2(dba)_3$	P(*t*-Bu)$_2$Me	THF	-	0	50
5[d]	$Pd_2(dba)_3$	P(*t*-Bu)$_2$Me	THF	bpy	0	57
6[d, e]	$Pd_2(dba)_3$	P(*t*-Bu)$_2$Me	THF	-	0	Trace

[a] Standard reaction conditions: epoxide (0.1 mmol), $B_2(pin)_2$ reagent (2.0 equiv.), Pd cat. (5 mol %), Ligand (10 mol %) in 0.6 mL of solvent (solvent/H_2O = 12/1 v/v) at 60 ^oC from 3 up to 20 hrs under Ar atmosphere. [b] Yield represents isolated yield after purification by silica gel chromatography. [c] $Pd_2(dba)_3$ was used instead of $Pd(OAc)_2$, and same results were obtained. [d] (3 equiv.) of *t*-BuOLi was used. [e] (2 mol %/1 mol % of $Pd_2(dba)_3$/P(t-Bu)$_2$Me was used. The yield was determined by GC using diphenyl methanol as internal standard. In entries (1, 2, 3) the recovery of substrate 1a was 80%. dba = dibenzylideneacetone, bpy = 2,2'-bipyridine.

Experimental Procedures for Examples Described in Table 2.

In air, schlenk tube was charged with CuI (0.03 mmol), LiO^tBu (0.6 mmol, 3 equiv.), and diboron reagents (B_2pin_2, B_2neop_2) (0.6 mmol, 3 equiv.) which equipped with a stirring bar. The vessel was evacuated and refilled with argon three times. Oxirane substrate (0.2 mmol, 1 equiv.) and 1.0 mL of THF were added under inert gas.The reaction mixture was stirred for 20 hrs at 60 ^oC. After completing of reaction, 4 mL of H_2O was added, and extracted by EtOAc (3 x 5 mL). The combined organic layers were dried over anhydrous Na_2SO_4, filtered, concentrated and purified by thin layer chromatography plate using petroleum ether/EtOAc (10/1 to 2/1, v/v) as eluent to afford the desired *β*-hydroxyl boronic ester products.

Experimental Procedures for Examples Described in Scheme 2.

In air, the arylation reaction of *β*-hydroxyl boronic ester was performed according to previous literatures procedure with some modefications;[4-7] in schlenk tube which charged with $Pd_2(dba)_3$ (0.005 mmol, 5 mol %), RuPhos (0.0075 mmol, 7.5 mol %), and KO^tBu (0.3 mmol, 3 equiv.). The vessel was evacuated and refilled with argon three times. Then THF (0.4 mL), toluene (0.5 mL) were added and the resulting mixture was stirred at room temperature for 10 min. Afterward, *β*-hydroxyl boronic ester (0.13 mmol) and haloaryls (0.1 mmol), and 0.1 mL of deionized H_2O were added. The reaction mixture was stirred for 24 h at 70 ^oC up to end of reaction. 2 mL of H_2O was added for reaction mixture which extracted by EtOAc (3 x 5 mL), dried over anhydrous Na_2SO_4, filtered, concentrated and purified by thin layer chromatography plate using petroleum ether/EtOAc (10/1 to 5/1, v/v) as eluent to afford the desired products.

Experimental Procedures for Examples Described in Scheme 3.

In air, schlenk tube was charged with CuI (0.03 mmol), LiO^tBu (0.6 mmol, 3 equiv.), and bis(pinacolato)diboron (B_2pin_2) (0.6 mmol, 3 equiv.) which equipped with a stirring bar. The vessel was evacuated and refilled with argon three times. Under inert gas, benzyl epoxides (0.2 mmol, 1 equiv.) and 1.0 mL of THF were added. The reaction mixture was stirred for 20 hrs at 60 ^oC. After completing of reaction, the previously work-up was carried out and *β*-hydroxyl boronic ester was obtained as pure products using petroleum ether/EtOAc (5/1, v/v) as eluent.

(I) The oxidation step of pinacolboronate alcohols (**3ba** & **3bb**) was performed for (0.2 mmol) scale according to previous literatures,[2,8] to afford 1,2-diol products which were purified by thin layer chromatography plate using petroleum ether/EtOAc (1/1, v/v).

(II) The arylation reaction of pinacolboronate alcohols (**3ba** & **3bb**) was performed as followed; in 10 mL schlenk tube which charged with $Pd_2(dba)_3$ (0.005 mmol, 5 mol %), RuPhos (0.0075 mmol, 7.5 mol %), and KO^{t}Bu (0.3 mmol, 3 equiv.). The tube was evacuated and refilled with argon three times. THF (0.4 mL), toluene (0.5 mL) were added and the resulting mixture was stirred at room temperature for 10 min. Then borylated alcohol (0.13 mmol) and bromophenyl (0.1 mmol), and 0.1 mL of deionized H_2O were added. The reaction mixture was stirred for 24 h at 70 ^{o}C up to end of reaction. Then the previous work-up was performed and the concentrated crude product was purified by thin layer chromatography plate using petroleum ether/EtOAc (5/1, v/v) as eluent to afford the desired products which subjected for HPLC analysis.

(III) The enantiomeric purity of (S)-4-(benzyloxy)butane-1,3-diol and (S)-1-(benzyloxy)-3-phenylpropan-2-ol were determined by HPLC analysis (Chiralcel OD-H column, 90:10 hexanes/*i*-PrOH, 1.5 mL/min and 97:3 hexanes/*i*-PrOH, 1.0 mL/min respectively, $\lambda = 210$ nm).

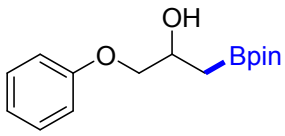
Experimental Procedures for Example Described in Scheme 4.

The Chan-Lam-Evans amination of *β*-hydroxyl boronic ester with N-methylaniline was conducted accoding to procedure described in previous literatures with some modeficattions. [9-10] 10 mL schlenk tube was charged by $Cu(OAc)_2$ (10 mol %, 0.02 mmol). The tube was evacuated and refilled with argon three times. Then *β*-hydroxyl boronic ester (1 equiv., 0.2 mmol), *N*-methylaniline (1.3 equiv. 0.26 mmol), and 0.5 mL of *m*-xylene were added. Under inert gas, di-*tert*-butyl peroxide (2 equiv., 0.4 mmol) was added to the mixture. The reaction mixture was stirred for 24 hrs at 100 ^{o}C up to end of reaction. Then the mixture was diluted with EtOAc and filtered through a pad of Celite and washed with EtOAc. Then concentrated under vacuo and purified by column chromatography using petroleum ether/EtOAc (5/1, v/v) to afford the desired product (25.4 mg, 49% yield) as brown oil.

Experimental Procedures for Example Described in Scheme 5.

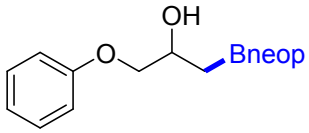
A gram-scale borylation reaction was performed in three-necked around-bottom flask which equipped with a stirring bar, CuI (0.15 mmol, 0.3 g), B_2pin_2 (30 mmol, 7.6 g) LiO^{t}Bu (30 mmol, 2.4 g), were put. The vessel was evacuated and refilled with argon three times. Under inert gas, epoxide substrate (10 mmol, 1 equiv.) and 50 mL of freshly distilled THF were added respectively. The resulting suspension was stirred for 20 h at 60 ^{o}C up to end of reaction. Thereafter, the work-up steps were conducted for the resulting reaction mixture, and the filtered crude product was concentrated under reduced pressure and then purified by flash column chromatography using petroleum ether/EtOAc (5/1, v/v) as eluent to afford the desired product (2.35 g, 85% yield).

Scope of Epoxides



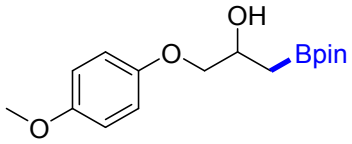
1-phenoxy-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3a)

Following general procedure, (45.5 mg, 82% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (t, *J* = 7.8 Hz, 2H), 6.90 – 6.80 (m, 3H), 4.27 – 4.14 (m, 1H), 3.90 (dd, *J* = 9.4, 3.4 Hz, 1H), 3.84 – 3.75 (m, 1H), 2.57 (br, 1H), 1.18 (s, 12H), 1.16 – 1.10 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.80, 129.54, 121.00, 114.75, 83.64, 73.31, 67.67, 24.91 (d, *J* = 3.7 Hz), 16.55; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.28; HRMS calcd for $C_{15}H_{23}BO_4[H]^+$: 279.1762; found: 279.1750.



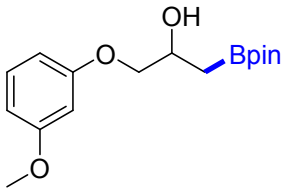
1-(5,5-dimethyl-1,3,2-dioxaborinan-2-yl)-3-phenoxypropan-2-ol (3b)

Following general procedure, (34.5 mg, 65% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.24 (m, 2H), 6.98 – 6.89 (m, 3H), 4.33 – 4.20 (m, 1H), 3.96 (dd, *J* = 9.4, 3.5 Hz, 1H), 3.90 – 3.83 (m, 1H), 3.62 (s, 4H), 2.66 (br, 1H), 1.13 (d, *J* = 6.7 Hz, 2H), 0.98 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.88, 129.53, 120.93, 114.73, 73.51, 72.16, 67.96, 31.82, 21.93, 19.78; ^{11}B NMR (128 MHz, $CDCl_3$) δ 29.74; HRMS calcd for $C_{14}H_{21}BO_4[H]^+$: 265.1606; found: 265.15912.



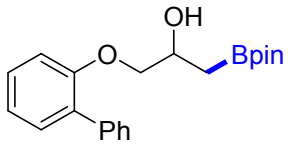
1-(4-methoxyphenoxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3c)

Following general procedure, (33.8 mg, 55% yield) as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 6.91 – 6.78 (m, 4H), 4.30 – 4.17 (m, 1H), 3.92 (dd, *J* = 9.4, 3.5 Hz, 1H), 3.86 – 3.78 (m, 1H), 3.76 (s, 3H), 2.38 (br, 1H), 1.26 (s, 12H), 1.23 – 1.15 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 154.08, 153.04, 115.81, 114.74, 83.63, 74.26, 67.76, 55.84, 24.93 (d, *J* = 2.3 Hz), 16.70; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.30; HRMS calcd for $C_{16}H_{25}BO_5[H]^+$: 309.1868; found: 309.18601.



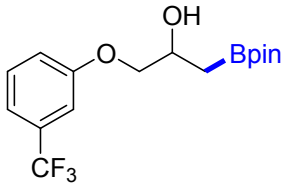
1-(3-methoxyphenoxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3d)

Following general procedure, (40 mg, 65% yield) as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.17 (t, *J* = 8.1 Hz, 1H), 6.56 – 6.46 (m, 3H), 4.33 – 4.18 (m, 1H), 3.96 (dd, *J* = 9.4, 3.4 Hz, 1H), 3.89 – 3.81 (m, 1H), 3.78 (s, 3H), 2.61 (br, 1H), 1.27 (s, 12H), 1.20 (d, *J* = 6.9 Hz, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 160.93, 160.10, 129.98, 106.91, 106.66, 101.28, 83.66, 73.42, 67.65, 55.38, 24.93 (d, *J* = 3.0 Hz), 16.64; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.30; HRMS calcd for $C_{16}H_{25}BO_5[H]^+$: 309.1868; found: 309.18603.



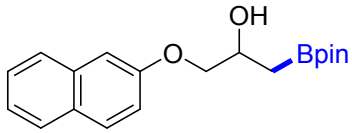
1-([1,1'-biphenyl]-2-yloxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3e)

Following general procedure, (51.5 mg, 73% yield) as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.55 – 7.48 (m, 2H), 7.40 (t, *J* = 7.4 Hz, 2H), 7.35 – 7.24 (m, 3H), 7.09 – 6.94 (m, 2H), 4.22 – 4.08 (m, 1H), 4.07 – 3.91 (m, 1H), 3.88 – 3.74 (m, 1H), 2.41 (br, 1H), 1.25 (s, 12H), 1.16 – 1.05 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 155.61, 138.56, 131.46, 131.01, 129.55, 128.73, 128.17, 127.07, 121.51, 113.39, 83.56, 74.31, 67.56, 24.90 (d, *J* = 4.8 Hz), 16.47; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.34; HRMS calcd for $C_{21}H_{27}BO_4[H]^+$: 355.2075; found: 355.2068.



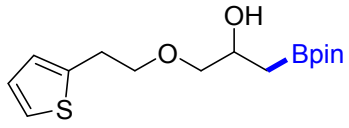
1-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-3-(3-(trifluoromethyl)phenoxy)propan-2-ol (3f)

Following general procedure, (47 mg, 68% yield) as light brown oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.43 – 7.34 (m, 1H), 7.24 – 7.18 (m, 1H), 7.18 – 7.06 (m, 2H), 4.35 – 4.21 (m, 1H), 4.02 (dd, *J* = 9.5, 3.4 Hz, 1H), 3.96 – 3.84 (m, 1H), 2.47 (br, 1H), 1.27 (s, 12H), 1.24 – 1.20 (m, 2H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.68 (s); ^{13}C NMR (75 MHz, $CDCl_3$) δ 159.00, 131.95 (q, *J* = 32.2 Hz), 130.09, 124.07 (d, *J* = 272.3 Hz), 118.33 (d, *J* = 0.8 Hz), 117.72 (q, *J* = 3.8 Hz), 111.56 (t, *J* = 3.8 Hz), 83.77, 73.67, 67.53, 24.92 (d, *J* = 3.1 Hz), 16.63; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.24; HRMS calcd for $C_{16}H_{22}BF_3O_4[H]^+$: 347.1636; found: 347.1626.



1-(naphthalen-2-yloxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3g)

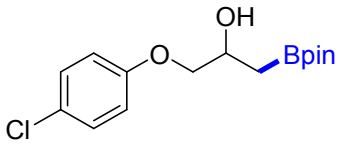
Following general procedure, (47.1 mg, 72% yield) as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.82 – 7.67 (m, 3H), 7.43 (t, *J* = 7.4 Hz, 1H), 7.38 – 7.28 (m, 1H), 7.26 – 7.11 (m, 2H), 4.47 – 4.26 (m, 1H), 4.09 (dd, *J* = 9.5, 3.4 Hz, 1H), 4.04 – 3.94 (m, 1H), 2.48 (br, 1H), 1.27 (s, 12H), 1.25 – 1.21 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 156.72, 134.56, 129.44, 129.10, 127.68, 126.81, 126.40, 123.71, 118.96, 106.99, 83.62, 73.41, 67.58, 24.87 (d, *J* = 3.6 Hz), 16.86; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.28; HRMS calcd for $C_{19}H_{25}BO_4[H]^+$: 329.1919; found: 329.1912.



1-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-3-(2-(thiophen-2-yl)ethoxy)propan-2-ol (3h)

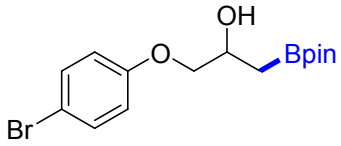
Following general procedure, (34.5 mg, 55% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.13 (d, *J* = 4.7 Hz, 1H), 6.96 – 6.89 (m, 1H), 6.87 – 6.80 (m, 1H), 4.13 – 3.99 (m, 1H), 3.78 – 3.63 (m, 2H), 3.49 (dd, *J* = 9.5, 3.2 Hz, 1H), 3.37 – 3.29 (m, 1H), 3.10 (t, *J* = 6.7 Hz, 2H), 2.63 (br, 1H), 1.25 (s, 12H), 1.14 – 0.99 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.33, 126.79, 125.26, 123.82, 83.50,

76.62, 71.82, 67.89, 30.52, 24.91 (d, J = 5.5 Hz), 16.60; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.21; HRMS calcd for $C_{15}H_{25}BO_4S[H]^+$: 313.1639; found: 313.1634.



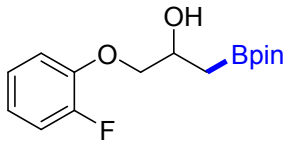
1-(4-chlorophenoxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3i)

Following general procedure, (49.8 mg, 80% yield) as pale yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 – 7.18 (m, 2H), 6.90 – 6.78 (m, 2H), 4.31 – 4.20 (m, 1H), 3.98 – 3.90 (m, 1H), 3.88 – 3.81 (m, 1H), 2.72 (br, 1H), 1.26 (s, 12H), 1.22 – 1.17 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.47, 129.41, 125.86, 116.05, 83.71, 73.73, 67.57, 24.92 (d, J = 4.1 Hz), 16.64; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.25; HRMS calcd for $C_{15}H_{22}BClO_4[H]^+$: 313.1372; found: 313.1365.



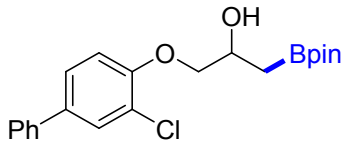
1-(4-bromophenoxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3j)

Following general procedure, (42.6 mg, 60% yield) as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.42 – 7.32 (m, 2H), 6.87 – 6.75 (m, 2H), 4.32 – 4.20 (m, 1H), 3.94 (dd, J = 9.4, 3.5 Hz, 1H), 3.88 – 3.80 (m, 1H), 2.01 (br, 1H), 1.27 (s, 12H), 1.23 – 1.17 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 158.03, 132.39, 116.64, 113.23, 83.75, 73.72, 67.62, 24.96 (d, J = 2.9 Hz); ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.53; HRMS calcd for $C_{15}H_{22}BBrO_4[H]^+$: 357.0867; found: 357.0848.



1-(2-fluorophenoxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3k)

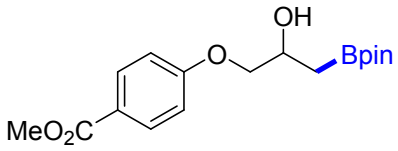
Following general procedure, (37 mg, 63% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.12 – 6.96 (m, 3H), 6.95 – 6.85 (m, 1H), 4.35 – 4.23 (m, 1H), 4.04 (dd, J = 9.2, 2.6 Hz, 1H), 3.98 – 3.89 (m, 1H), 2.71 (br, 1H), 1.26 (s, 12H), 1.21 (d, J = 6.4 Hz, 2H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -134.14 – -134.39 (m); ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.96 (d, J = 245.7 Hz), 146.96 (d, J = 10.6 Hz), 124.38 (d, J = 3.9 Hz), 121.56 (d, J = 6.8 Hz), 116.38 (d, J = 18.2 Hz), 115.60 (d, J = 1.5 Hz), 83.68, 74.97, 67.62, 24.93 (d, J = 4.3 Hz), 16.55; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.22; HRMS calcd for $C_{15}H_{22}BFO_4[H]^+$: 297.1668; found: 297.1660.



1-((3-chloro-[1,1'-biphenyl]-4-yl)oxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3l)

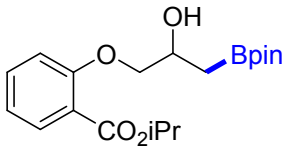
Following general procedure, (58.4 mg, 75% yield) as light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.58 (m, 1H), 7.56 – 7.50 (m, 2H), 7.46 – 7.39 (m, 3H), 7.37 – 7.29 (m, 1H), 7.04 – 6.99 (m, 1H), 4.40 – 4.27 (m, 1H), 4.09 (dd, J = 9.3, 3.4 Hz, 1H), 4.00 – 3.92 (m, 1H), 2.81 (br, 1H), 1.27 (s, 12H), 1.25 – 1.21 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 153.64, 139.54, 135.13, 128.85, 128.84,

127.25, 126.74, 126.23, 123.53, 114.18, 83.58, 74.75, 67.47, 24.83 (d, J = 3.7 Hz), 16.43; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.68; HRMS calcd for $C_{21}H_{26}BClO_4[H]^+$: 389.1685 found: 389.1657.



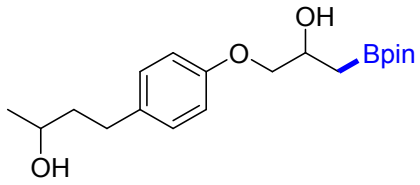
Methyl 4-(2-hydroxy-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propoxy)benzoate (3m)

Following general procedure, (39 mg, 58% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 – 7.95 (m, 2H), 6.99 – 6.90 (m, 2H), 4.34 – 4.24 (m, 1H), 4.03 (dd, J = 9.5, 3.4 Hz, 1H), 3.97 – 3.91 (m, 1H), 3.88 (s, 3H), 2.70 (br, 1H), 1.27 (s, 12H), 1.24 – 1.20 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.98, 162.62, 131.70, 122.87, 114.35, 83.77, 73.48, 67.53, 52.01, 24.93 (d, J = 4.4 Hz), 16.68; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.40; HRMS calcd for $C_{17}H_{25}BO_6[H]^+$: 337.1817; found: 337.1817.



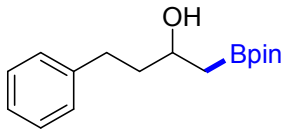
Isopropyl 2-(2-hydroxy-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propoxy)benzoate (3n)

Following general procedure, (29.3 mg, 40% yield) as pale green oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 – 7.75 (m, 1H), 7.48 – 7.40 (m, 1H), 7.04 – 6.94 (m, 2H), 5.32 – 5.19 (m, 1H), 4.32 – 4.17 (m, 2H), 3.89 – 3.78 (m, 1H), 2.88 (br, 1H), 1.36 (d, J = 6.3 Hz, 6H), 1.26 (s, 12H), 1.18 – 1.06 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.04, 158.85, 133.53, 131.73, 121.32, 120.93, 114.93, 83.53, 75.57, 68.52, 67.28, 24.93 (d, J = 5.6 Hz), 22.04 (d, J = 1.7 Hz), 16.23; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.23; HRMS calcd for $C_{19}H_{29}BO_6[H]^+$: 365.2130; found: 365.2127.



4-(4-(2-hydroxy-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propoxy)phenyl)butan-2-ol (3o)

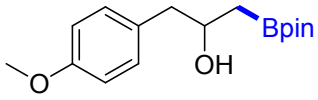
Following general procedure, (34.8 mg, 50% yield) as a colorless oil; ^{1}H NMR (300 MHz, CDCl3) δ 7.17 – 7.04 (m, 2H), 6.92 – 6.79 (m, 2H), 4.33 – 4.12 (m, 1H), 4.00 – 3.89 (m, 1H), 3.88 – 3.72 (m, 2H), 2.77 – 2.53 (m, 2H), 1.88 (br 2H), 1.79 – 1.68 (m, 2H), 1.27 (s, 12H), 1.24 – 1.15 (m, 5H); ^{13}C NMR (75 MHz, CDCl3) δ 157.06, 134.50, 129.38, 114.77, 83.66, 73.52, 67.73, 67.60, 41.16, 31.33, 24.94 (d, J = 2.4 Hz), 23.73, 16.69; ^{11}B NMR (128 MHz, CDCl3) δ 33.35; HRMS calcd for C19H31BO5[H]+: 351.2337; found: 351.2328.



4-phenyl-1-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)butan-2-ol (3p)

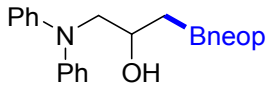
Following general procedure, (36 mg, 65% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.25 (m, 2H), 7.23 – 7.13 (m, 3H), 3.95 – 3.82 (m, 1H), 2.85 – 2.74 (m, 1H), 2.72 – 2.61 (m, 1H), 2.00 (br, 1H), 2.00 (br, 1H), 1.85 – 1.70 (m, 2H), 1.26 (s, 12H), 1.18 (dd, J = 16.1, 4.8 Hz, 1H), 1.12 – 1.04 (m, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.51, 128.57, 128.46, 125.80, 83.58, 68.64, 41.31,

32.39, 24.96 (d, J = 2.2 Hz), 21.27; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.60; HRMS calcd for $C_{16}H_{25}BO_3[H]^+$: 277.1970; found: 277.1958.



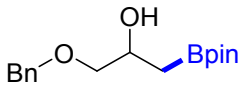
1-(4-methoxyphenyl)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3q)

Following general procedure, (40.9 mg, 70% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.16 – 7.10 (m, 2H), 6.87 – 6.80 (m, 2H), 4.04 (ddd, J = 13.1, 7.1, 5.6 Hz, 1H), 3.79 (s, 3H), 2.80 – 2.64 (m, 2H), 2.23 (br, 1H), 1.26 (s, 12H), 1.16 – 1.04 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.27, 131.07, 130.55, 113.95, 83.53, 70.43, 55.39, 45.09, 24.96 (d, J = 4.5 Hz); ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.55; HRMS calcd for $C_{16}H_{25}BO_4[H]^+$: 293.1919; found: 293.1919.



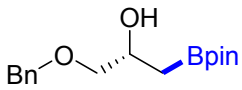
1-(5,5-dimethyl-1,3,2-dioxaborinan-2-yl)-3-(diphenylamino)propan-2-ol (3r)

Following general procedure, (60.2 mg, 89% yield) as light brown oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.21 (m, 4H), 7.11 – 7.04 (m, 4H), 6.94 (t, J = 7.3 Hz, 2H), 4.24 – 4.15 (m, 1H), 3.83 (dd, J = 14.8, 3.9 Hz, 1H), 3.69 – 3.64 (m, 1H), 3.60 (s, 4H), 2.59 (br, 1H), 1.09 – 1.01 (m, 2H), 0.96 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 148.72, 129.35, 121.57, 121.44, 72.15, 66.96, 60.69, 31.83, 21.96; ^{11}B NMR (128 MHz, $CDCl_3$) δ 29.66; HRMS calcd for $C_{20}H_{26}BNO_3[H]^+$: 340.2079; found: 340.2074.



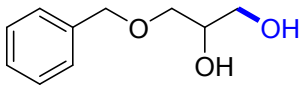
1-(benzyloxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3ba)

Following general procedure, (42.5 mg, 73% yield) as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.39 – 7.25 (m, 5H), 4.56 (s, 2H), 4.20 – 4.00 (m, 1H), 3.53 – 3.44 (m, 1H), 3.40 – 3.28 (m, 1H), 2.67 (br, 1H), 1.23 (s, 12H), 1.13 – 1.02 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 138.33, 128.49, 127.81, 127.74, 83.47, 75.80, 73.23, 68.07, 24.88 (d, J = 2.3 Hz), 16.88; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.32; HRMS calcd for $C_{16}H_{25}BO_4[H]^+$: 293.1919; found: 293.1917.



(S)-1-(benzyloxy)-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-ol (3bb)

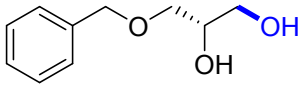
Following general procedure, (44.2 mg, 76% yield) as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.40 – 7.26 (m, 5H), 4.56 (s, 2H), 4.18 – 4.01 (m, 1H), 3.54 – 3.42 (m, 1H), 3.40 – 3.27 (m, 1H), 2.65 (br, 1H), 1.25 (s, 12H), 1.14 – 1.02 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 138.35, 128.52, 127.83, 127.76, 83.49, 75.83, 73.26, 68.10, 24.90 (d, J = 2.3 Hz), 16.85; ^{11}B NMR (128 MHz, $CDCl_3$) δ 33.20; HRMS calcd for $C_{16}H_{25}BO_4[H]^+$: 293.1919; found: 293.1912.



3-(benzyloxy)propane-1,2-diol (3bc)

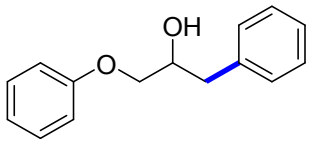
Following general procedure, (26.5 mg, 73% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.27 (m, 5H), 4.54 (s, 2H), 3.93 – 3.84 (m, 1H), 3.68 (dd, J = 11.5, 3.7 Hz, 1H), 3.64 – 3.57 (m,

1H), 3.57 – 3.48 (m, 2H), 2.93 (br, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.77, 128.62, 128.03, 127.93, 73.67, 71.84, 70.80, 64.12; HRMS calcd for $C_{10}H_{14}O_3[H]^+$: 183.1016; found: 183.1007.



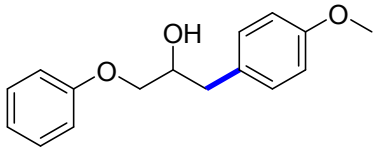
(S)-3-(benzyloxy)propane-1,2-diol (3bd)

Following general procedure, (29 mg, 80% yield) as a colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.27 (m, 5H), 4.55 (s, 2H), 3.95 – 3.86 (m, 1H), 3.70 (dd, *J* = 11.4, 3.8 Hz, 1H), 3.66 – 3.59 (m, 1H), 3.59 – 3.50 (m, 2H), 2.39 (br, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.76, 128.65, 128.07, 127.94, 73.72, 71.92, 70.74, 64.18; HRMS calcd for $C_{10}H_{14}O_3[H]^+$: 183.1016; found: 183.1008.



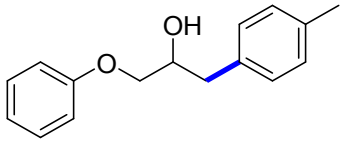
1-phenoxy-3-phenylpropan-2-ol (4a)

Following general procedure, (14.5 mg, 64% yield) as pale yellow solid; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.37 – 7.18 (m, 7H), 7.01 – 6.84 (m, 3H), 4.29 – 4.15 (m, 1H), 3.95 (dd, *J* = 9.4, 3.7 Hz, 1H), 3.87 (dd, *J* = 9.3, 6.6 Hz, 1H), 2.98 – 2.87 (m, 2H), 2.21 (br, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 158.63, 137.68, 129.63, 129.50, 128.72, 126.74, 121.27, 114.71, 71.19, 71.04, 39.97; HRMS calcd for $C_{15}H_{16}O_2[H]^+$: 229.1223; found: 229.1227.



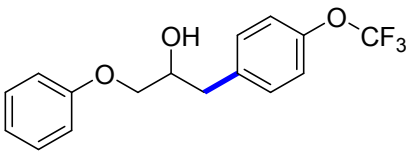
1-(4-methoxyphenyl)-3-phenoxypropan-2-ol (4b)

Following general procedure, (17.6 mg, 68% yield) as pale white solid; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.34 – 7.25 (m, 2H), 7.22 – 7.15 (m, 2H), 7.02 – 6.83 (m, 5H), 4.26 – 4.15 (m, 1H), 3.97 (dd, *J* = 9.4, 3.6 Hz, 1H), 3.93 – 3.85 (m, 1H), 3.80 (s, 3H), 2.96 – 2.82 (m, 2H), 1.92 (br, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 158.69, 158.53, 130.48, 129.65, 129.59, 121.28, 114.75, 114.20, 71.33, 71.06, 55.40, 39.06; HRMS calcd for $C_{16}H_{18}O_3[H]^+$: 259.1329; found: 259.1323.



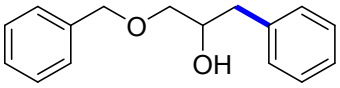
1-phenoxy-3-(p-tolyl)propan-2-ol (4c)

Following general procedure, (13.2 mg, 55% yield) as pale yellow solid; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.33 – 7.23 (m, 2H), 7.19 – 7.09 (m, 4H), 7.00 – 6.86 (m, 3H), 4.27 – 4.16 (m, 1H), 3.97 (dd, *J* = 9.4, 3.6 Hz, 1H), 3.93 – 3.85 (m, 1H), 2.96 – 2.86 (m, 2H), 2.33 (s, 3H), 1.88 (br, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 158.69, 136.34, 134.48, 129.64, 129.46, 129.39, 121.27, 114.75, 71.29, 71.09, 39.55, 21.17; HRMS calcd for $C_{16}H_{18}O_2[H]^+$: 243.1380; found: 243.1377.



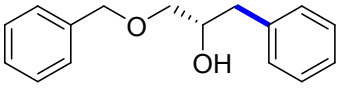
1-phenoxy-3-(4-(trifluoromethoxy)phenyl)propan-2-ol (4d)

Following general procedure, (13.8 mg, 44% yield) as offwhite solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.24 (m, 4H), 7.20 – 7.13 (m, 2H), 6.98 (t, *J* = 7.3 Hz, 1H), 6.93 – 6.87 (m, 2H), 4.29 – 4.16 (m, 1H), 3.98 (dd, *J* = 9.3, 3.5 Hz, 1H), 3.93 – 3.85 (m, 1H), 3.01 – 2.88 (m, 2H), 1.63 (br, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -57.88 (s); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.52, 148.14, 148.13, 136.57, 130.83, 129.72, 121.46, 121.25, 114.71, 71.04, 70.99, 39.19; HRMS calcd for $C_{16}H_{15}F_3O_3[H]^+$: 313.1046; found: 313.1041.



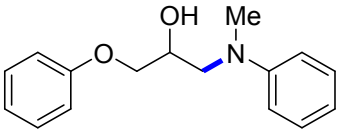
1-(benzyloxy)-3-phenylpropan-2-ol (5a)

Following general procedure, (13.5 mg, 56% yield) as pale yellow oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.40 – 7.26 (m, 7H), 7.25 – 7.17 (m, 3H), 4.60 – 4.50 (m, 2H), 4.12 – 4.00 (m, 1H), 3.52 (dd, *J* = 9.5, 3.5 Hz, 1H), 3.45 – 3.34 (m, 1H), 2.86 – 2.76 (m, 2H), 1.88 (br, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 138.09, 138.08, 129.48, 128.62, 128.61, 127.95, 127.92, 126.59, 73.67, 73.55, 71.56, 40.03; HRMS calcd for $C_{16}H_{18}O_2[H]^+$: 243.1380; found: 243.1380.



(S)-1-(benzyloxy)-3-phenylpropan-2-ol (5b)

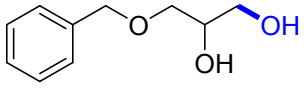
Following general procedure, (13.8 mg, 57% yield) as pale yellow oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.40 – 7.26 (m, 7H), 7.25 – 7.16 (m, 3H), 4.60 – 4.48 (m, 2H), 4.11 – 3.98 (m, 1H), 3.51 (dd, *J* = 9.5, 3.5 Hz, 1H), 3.45 – 3.34 (m, 1H), 2.87 – 2.75 (m, 2H), 2.05 (br, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 138.09, 138.08, 129.47, 128.61, 128.60, 127.94, 127.92, 126.58, 73.66, 73.53, 71.56, 40.03; HRMS calcd for $C_{16}H_{18}O_2[H]^+$: 243.1380; found: 243.1366.

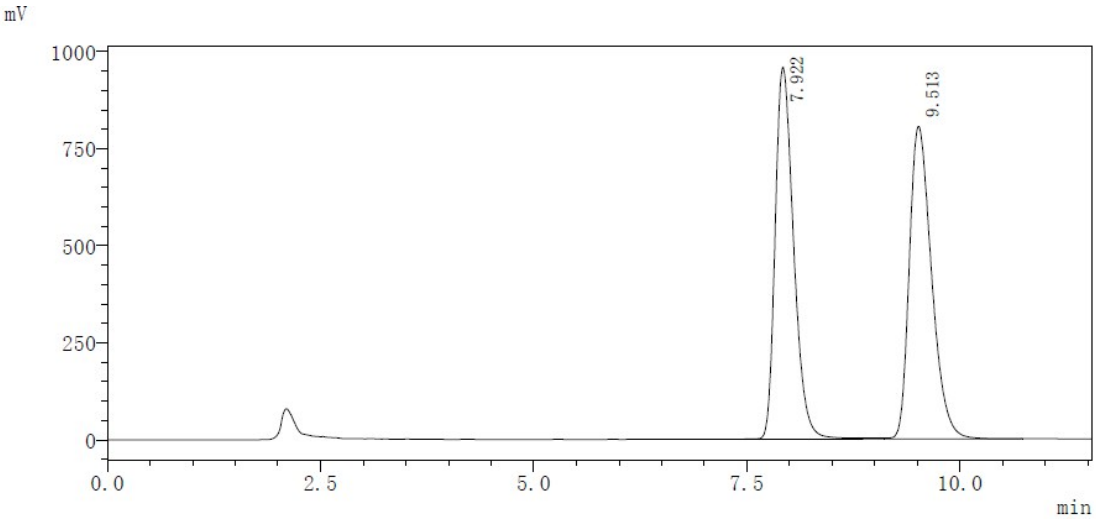


1-(methyl(phenyl)amino)-3-phenoxypropan-2-ol (6a)

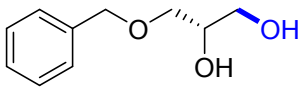
Following general procedure, ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.34 – 7.19 (m, 4H), 7.02 – 6.94 (m, 1H), 6.94 – 6.89 (m, 2H), 6.84 – 6.78 (m, 2H), 6.78 – 6.71 (m, 1H), 4.35 – 4.24 (m, 1H), 4.05 (dd, *J* = 9.5, 4.0 Hz, 1H), 3.99 (dd, *J* = 9.5, 5.4 Hz, 1H), 3.57 – 3.49 (m, 2H), 2.99 (s, 3H), 2.52 (br, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 158.57, 149.83, 129.69, 129.41, 121.41, 117.43, 114.72, 112.98, 69.72, 68.32, 56.17, 39.64; HRMS calcd for $C_{16}H_{19}NO_2[H]^+$: 258.1489; found: 258.1481.

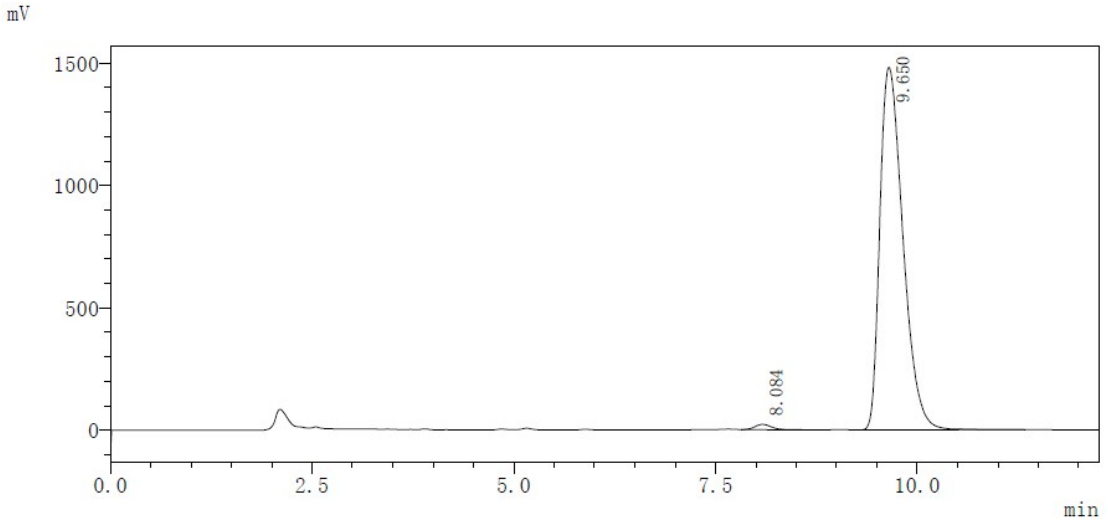
HPLC Analysis



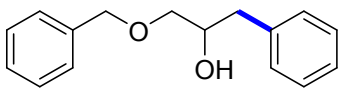


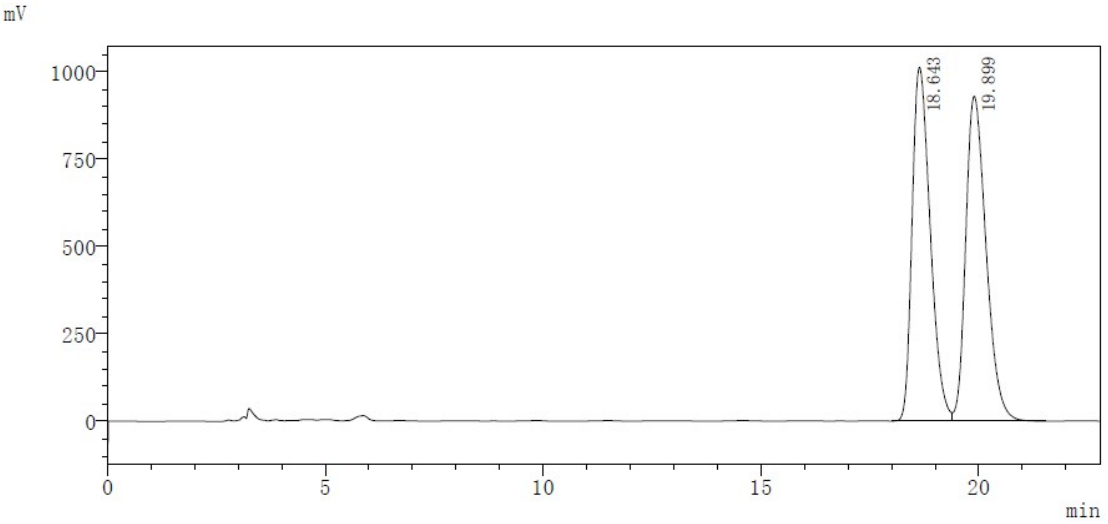
Peak	Ret. Time (min)	Area ((mAu*s)	Height (mAU)	Area %
1	7.922	14497776	958168	49.710
2	9.513	14666930	805137	50.290



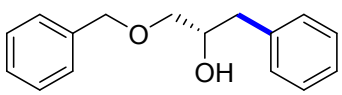


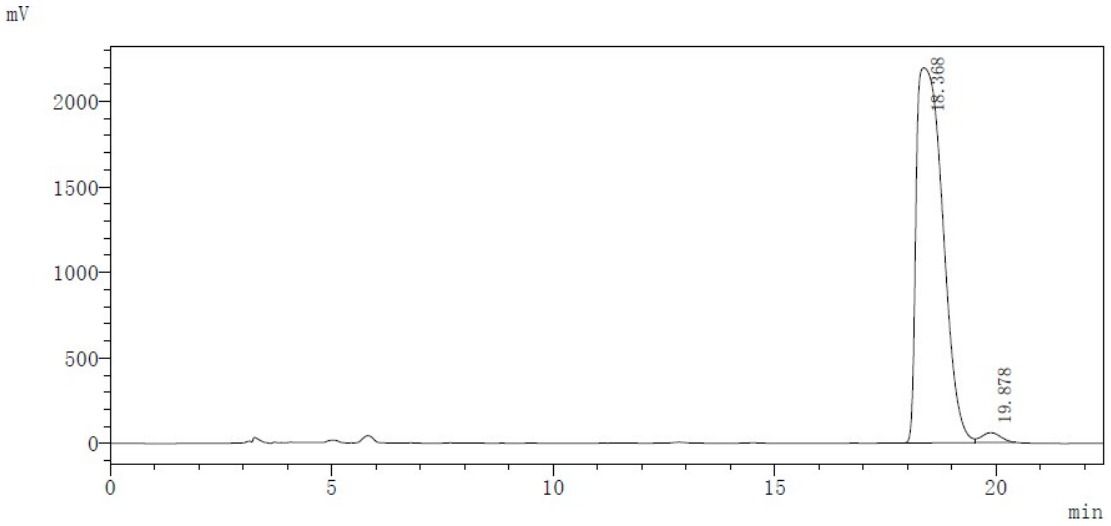
Peak	Ret. Time (min)	Area ((mAu*s)	Height (mAU)	Area %
1	8.084	311669	21517	1.046
2	9.650	29498319	1481655	98.954





Peak	Ret. Time (min)	Area ((mAu*s)	Height (mAU)	Area %
1	18.643	29323333	1012177	49.190
2	19.899	30288865	929767	50.810





Peak	Ret. Time (min)	Area ((mAu*s)	Height (mAU)	Area %
1	18.368	90180088	2185906	99.037
2	19.878	877158	38687	0.963

IV. References

(1) X. Lu, C. Yang*, J. Liu, Z.* Zhang, X. Lu, X. Lou, B. Xiao and Y. Fu *Chem. Commun.*, 2015, **51**, 2388.
(2) E. A. Ahmed, Z. Zhang, T. Gong, W. Su, X. Lu, B. Xiao and Y. Fu, *Chem. Commun.,* 2016, **52**, 4891 and references therein.
(3) Y. Takeda, A. Kuroda, W. M. C. Sameera, K. Morokuma, and S. Minakata, *Chem. Sci*., 2016, **7**, 6141.
(4) C.T. Yang, Z. Q. Zhang, H. Tajuddin, C. C. Wu, J. Liang, J. H. Liu, Y. Fu, M. Czyzewska, P. G. Steel,T. B. Marder, and L. Liu, *Angew. Chem. Int. Ed*., 2012, **51**, 528.
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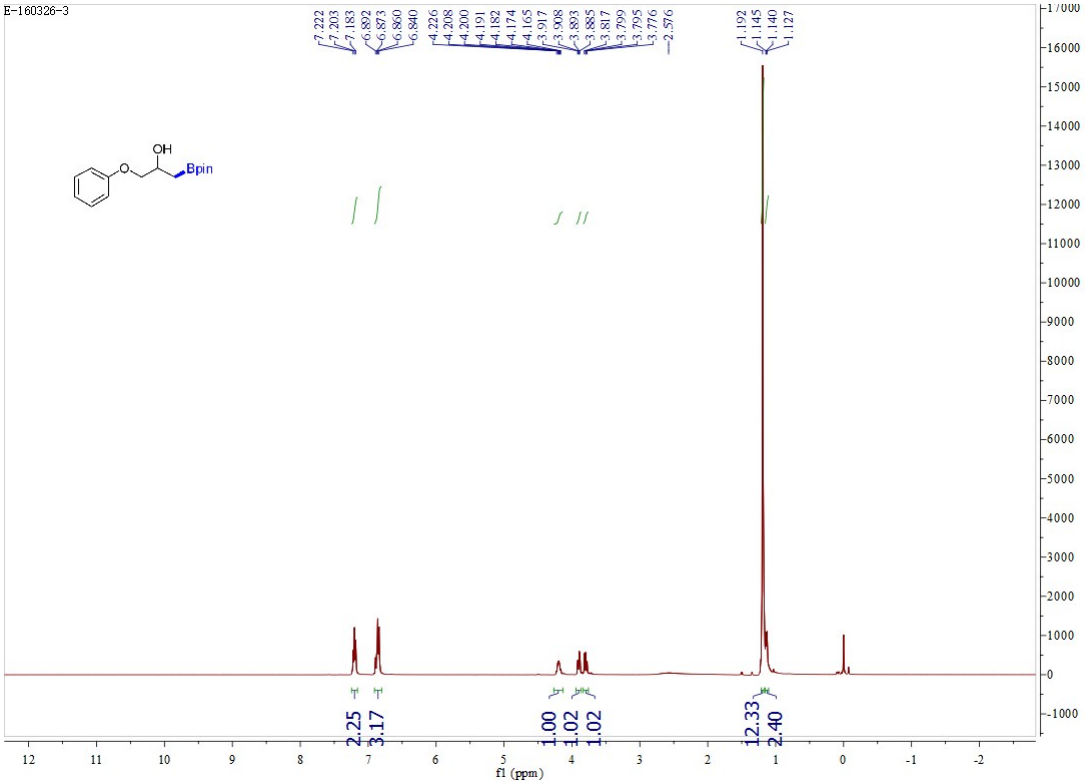
(6) T. P. Blaisdell and J. P. Morken, *J. Am. Chem. Soc*., 2015, **137**, 8712.
(7) Y. Takeda, A. Kuroda, W. M. C. Sameera, K. Morokuma, and S. Minakata, *Chem. Sci*., 2016, **7**, 6141.
(8) T. P. Blaisdell, T. C. Caya, L. Zhang, A. Sanz-Marco, and J. P. Morken, *J. Am. Chem. Soc*., 2014, **136**, 9264.
(9) S. Sueki and Y. Kuninobu, *Org. Lett*., 2013, **15**, 1544.
(10) J. C. Vantourout, R. P. Law, A. Isidro-Llobet, S. J. Atkinson, and A. J. B. Watson, *J. Org. Chem*., 2016, **81**, 3942.

NMR Spectra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4.200
4.191
4.182
4.174
4.165
3.917
3.908
3.893
3.885
3.817
3.799
3.795
3.776
2.576
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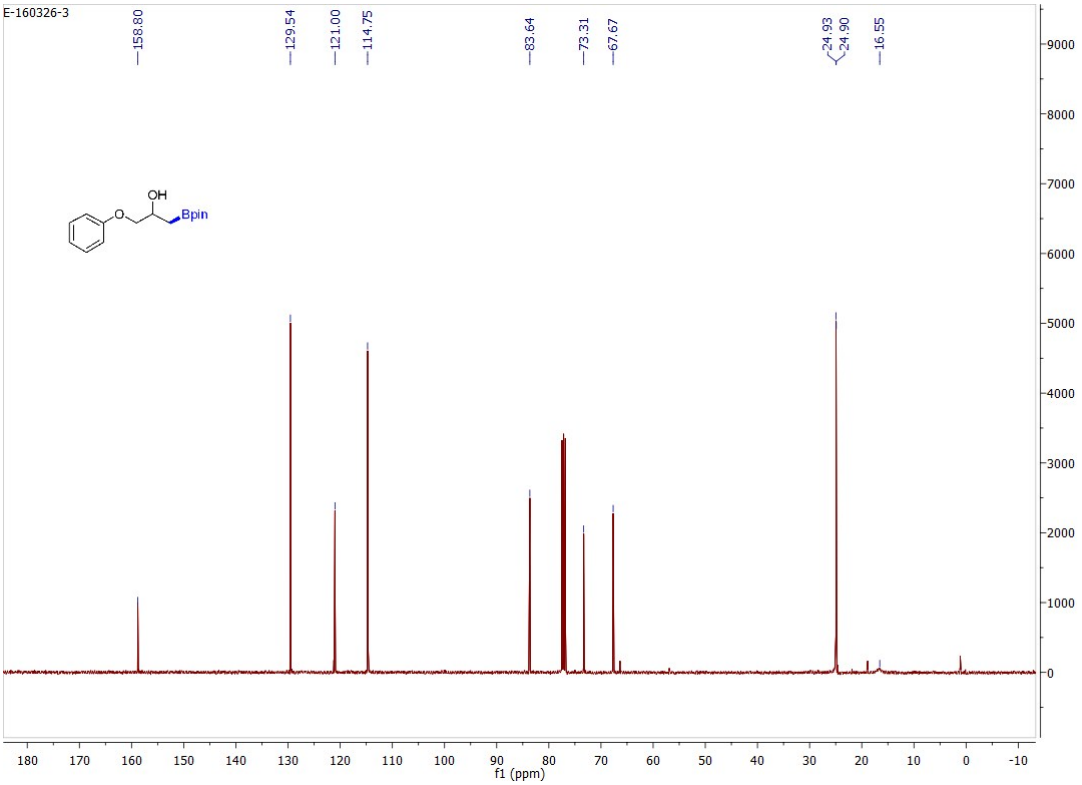
1.145
1.140
1.127
2.25
3.17
1.00
1.02
1.02
12.33
2.40
f1 (ppm)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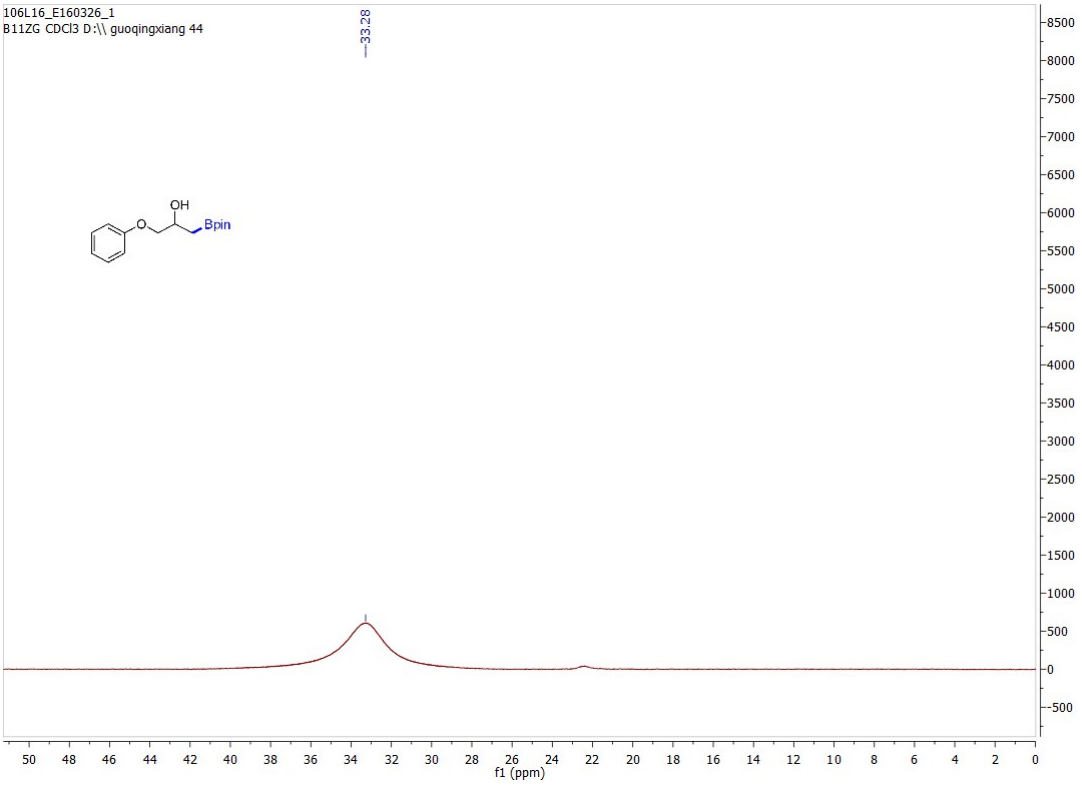
OH
Bpin
f1 (ppm)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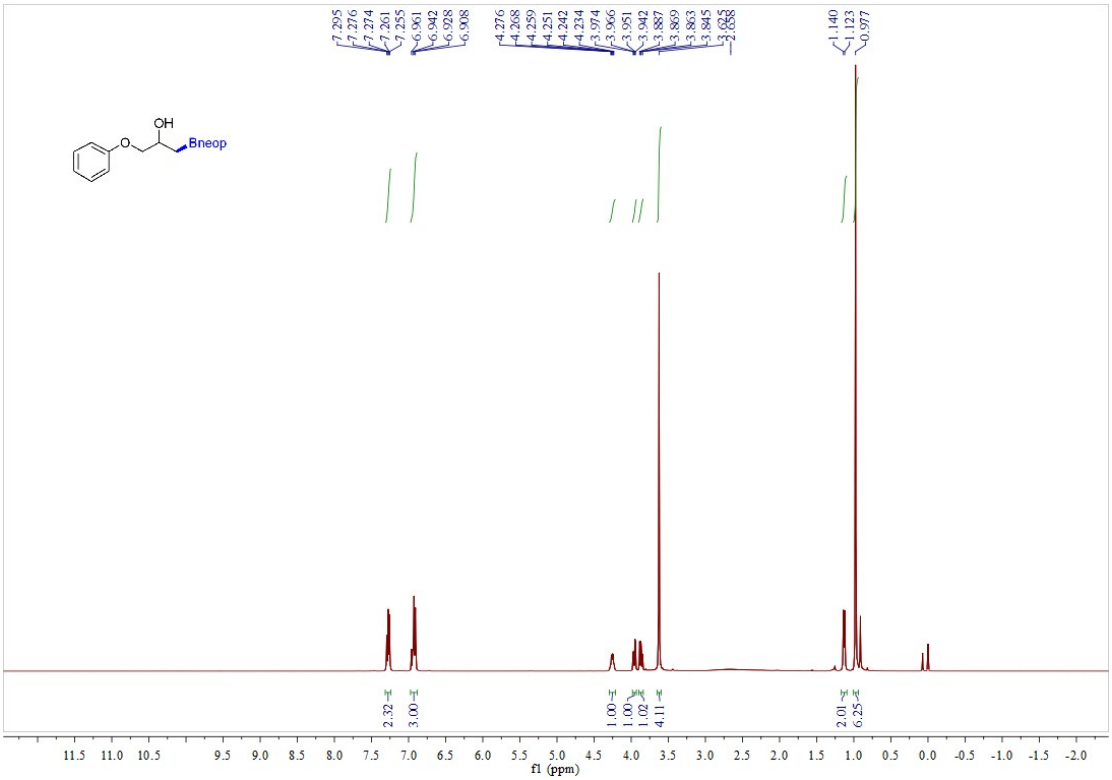
OH
Bpin
f1 (ppm)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7.274
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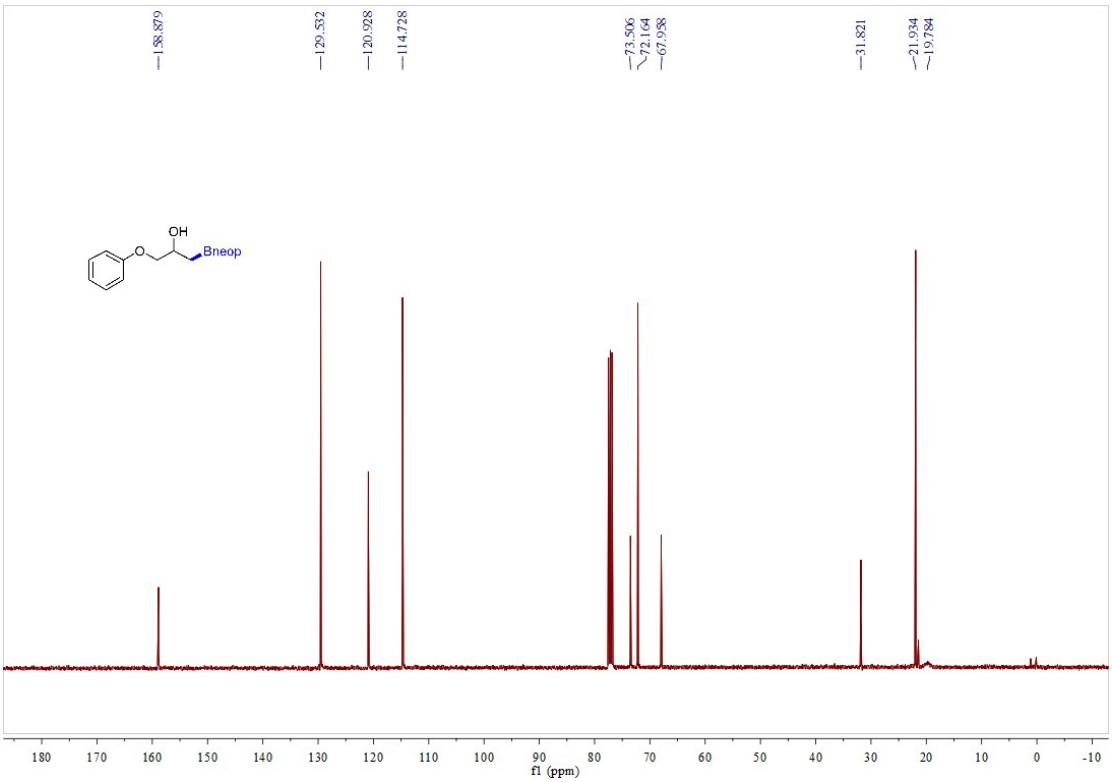
4.259
4.251
4.242
4.234
3.974
3.966
3.951
3.942
3.887
3.869
3.863
3.845
3.625
2.038
1.140
1.123
0.977
OH
Bneop
2.32
3.00
1.00
1.00
1.02
4.11
2.01
6.25
f1 (ppm)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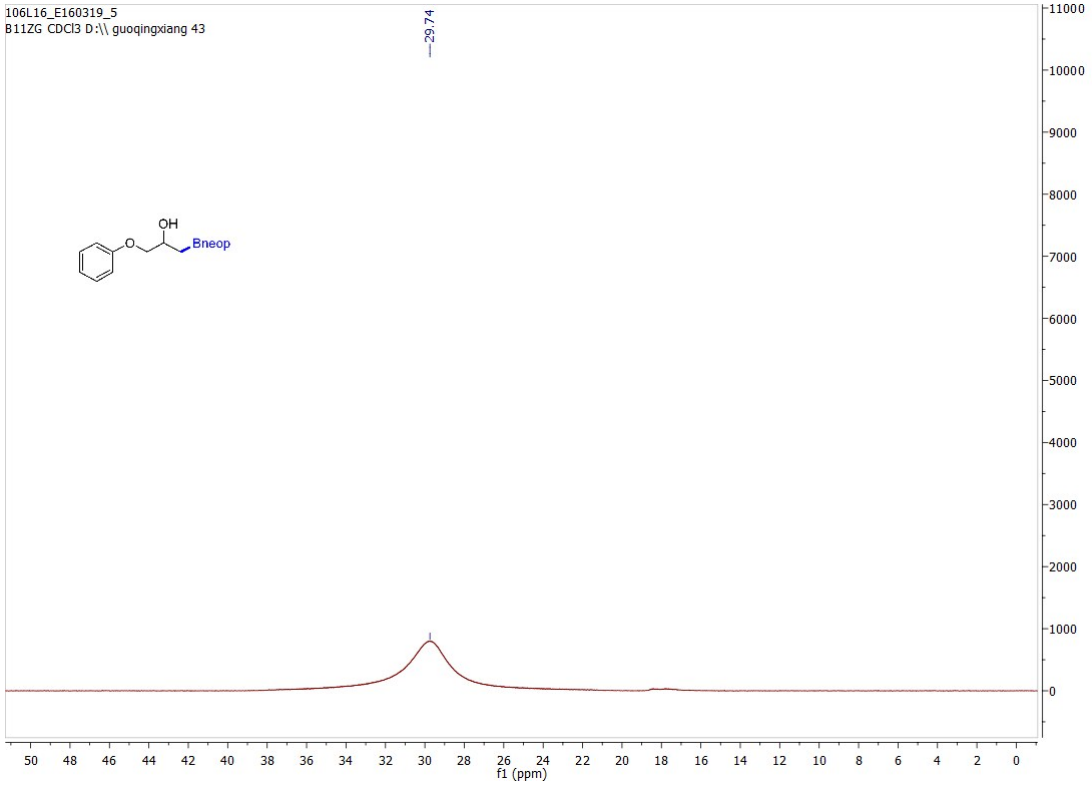
OH
Bneop
f1 (ppm)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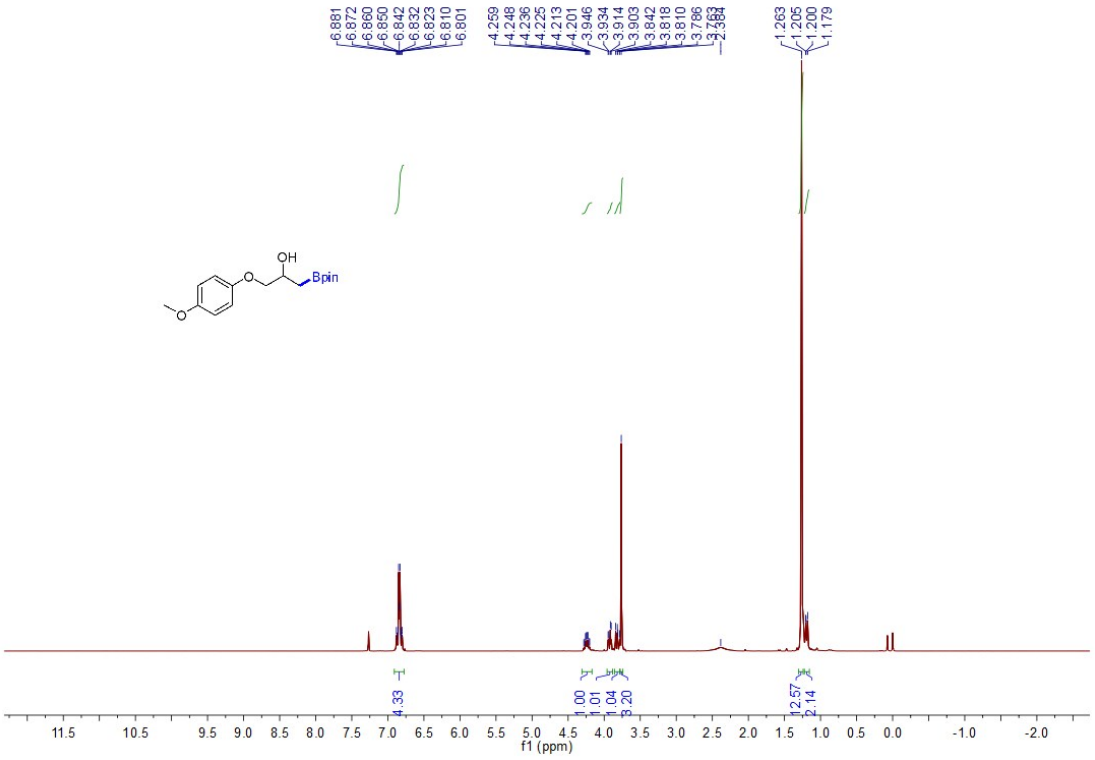
OH
O
Bneop
f1 (ppm)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4.225
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3.946
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3.914
3.903
3.842
3.818
3.810
3.786
3.763
2.384
1.263
1.205
1.200
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Bpin
O
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1.00
1.01
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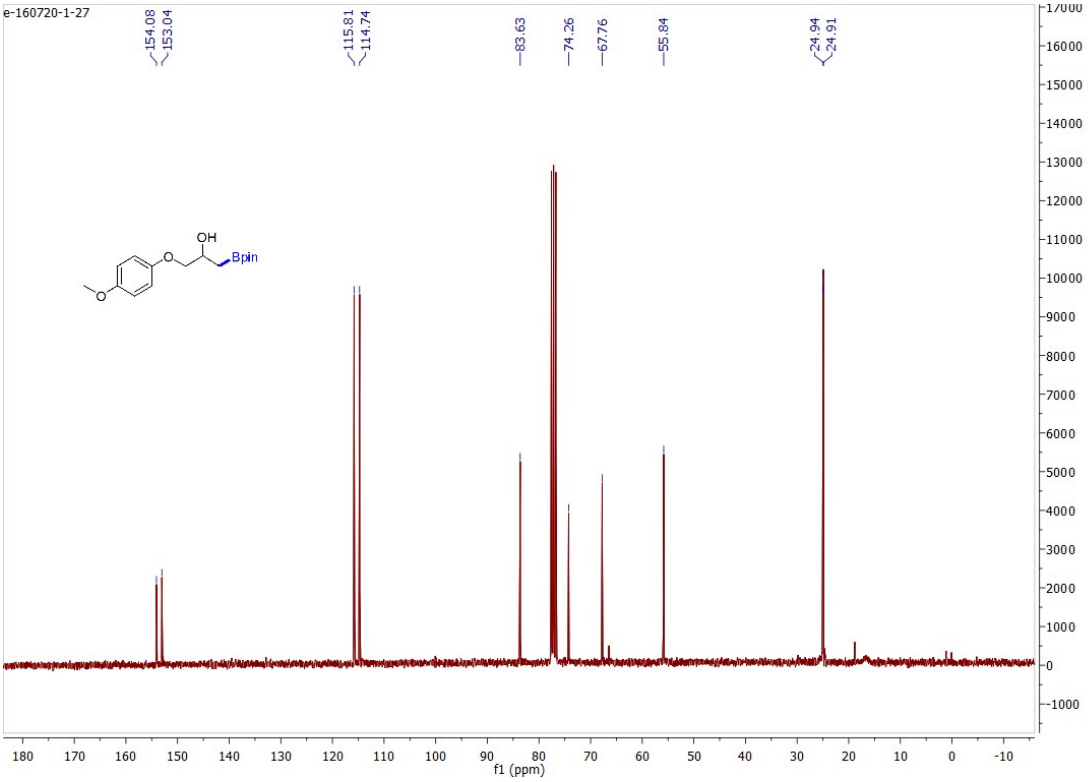
3.20
12.57
2.14
f1 (ppm)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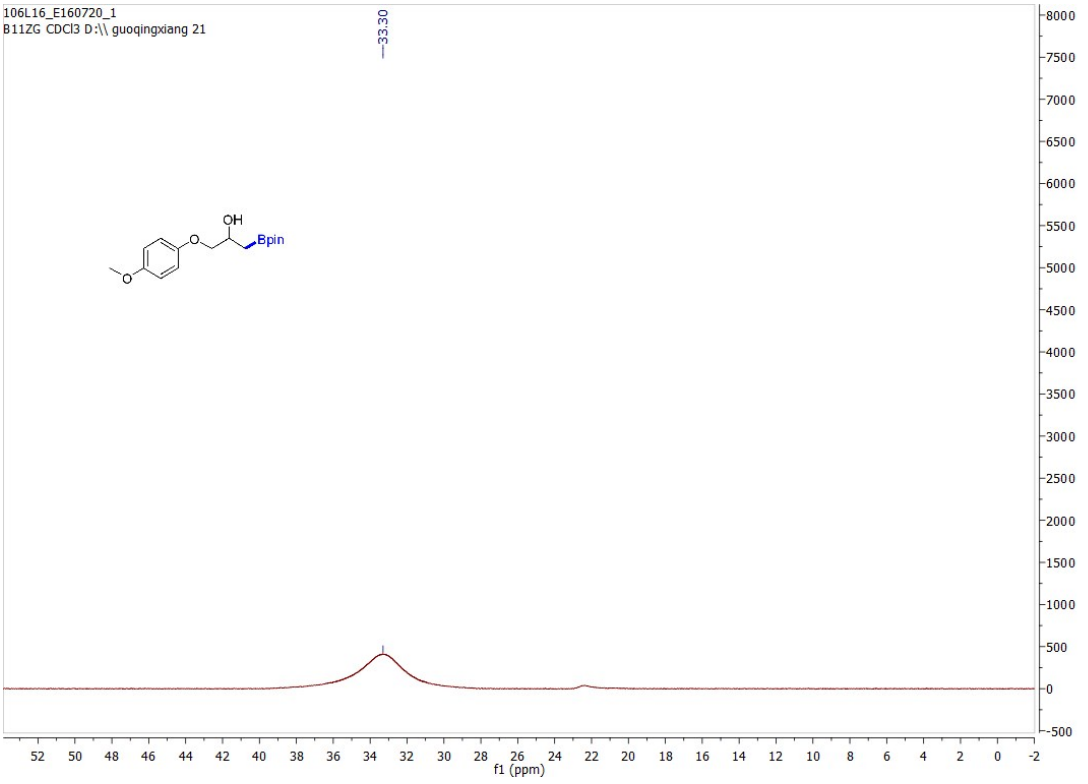
OH
Bpin
f1 (ppm)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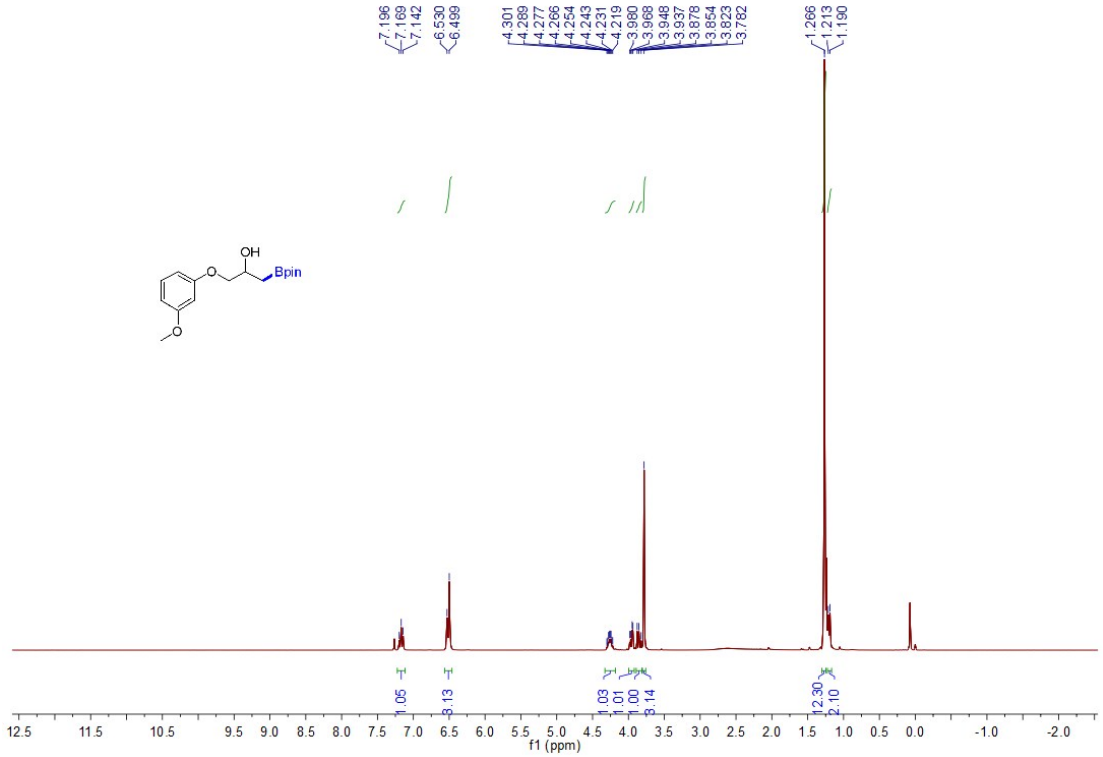
OH
Bpin
f1 (ppm)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6.499
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4.277
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4.254
4.243
4.231
4.219
3.980
3.968
3.948
3.937
3.878
3.854
3.823
3.782
1.266
1.213
1.190
OH
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O
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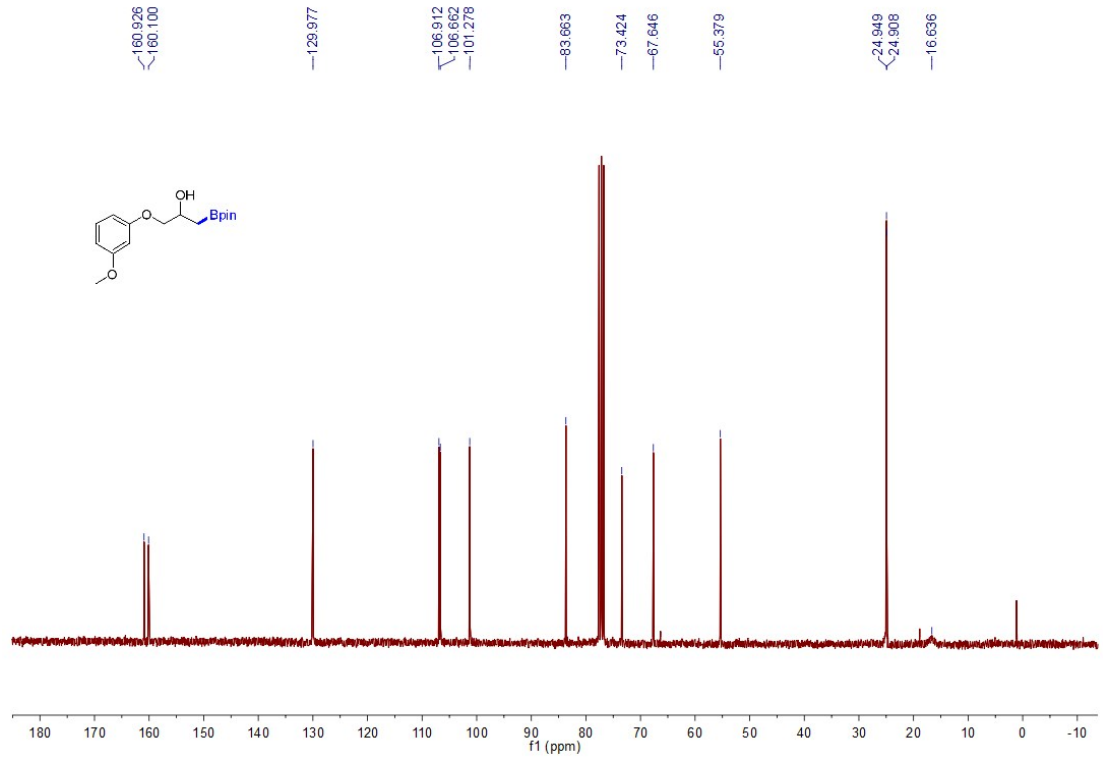
3.13
1.03
1.01
1.00
3.14
12.30
2.10
f1 (ppm)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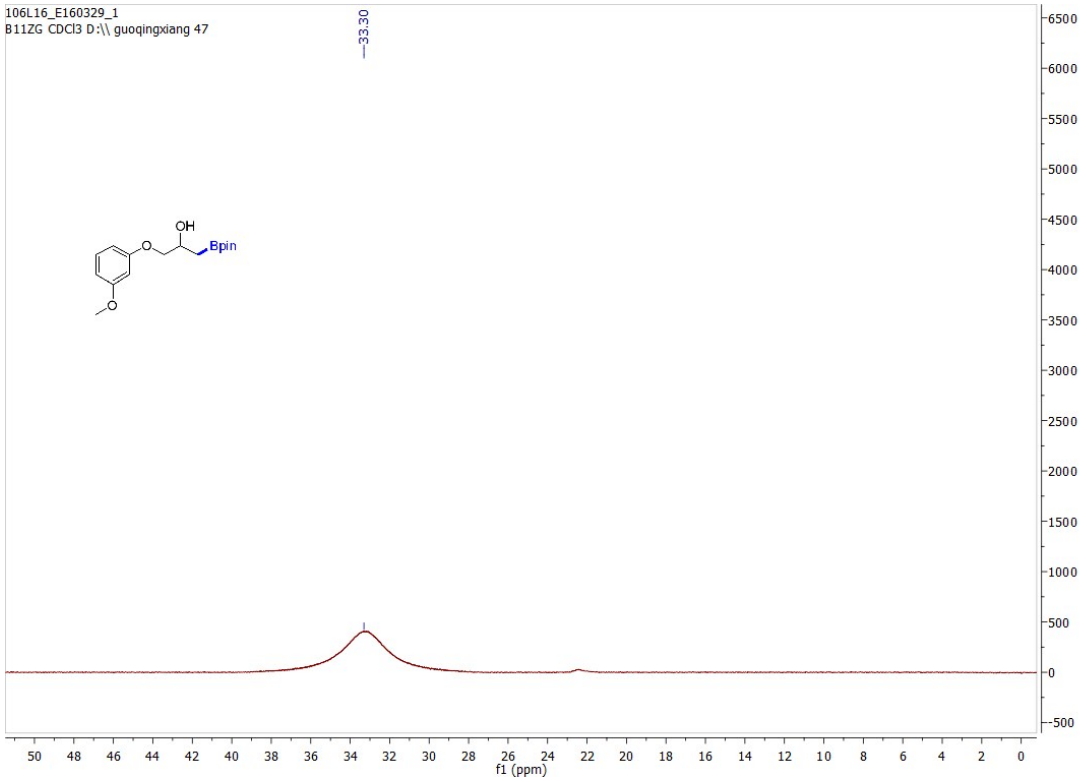
24.908
16.636
OH
Bpin
O
f1 (ppm)


106L16_E160329_1
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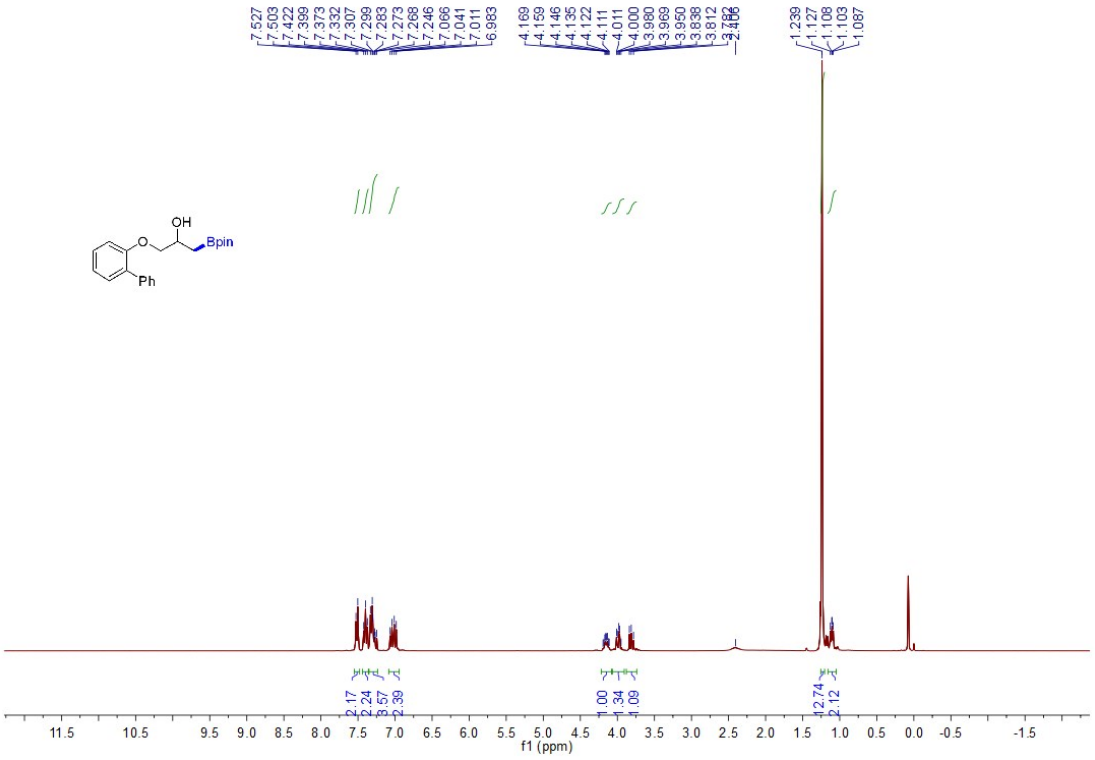
33.30
OH
Bpin
O
O
f1 (ppm)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6.983
4.169
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4.135
4.122
4.111
4.011
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3.950
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1.127
1.106
1.103
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Bpin
Ph
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2.39
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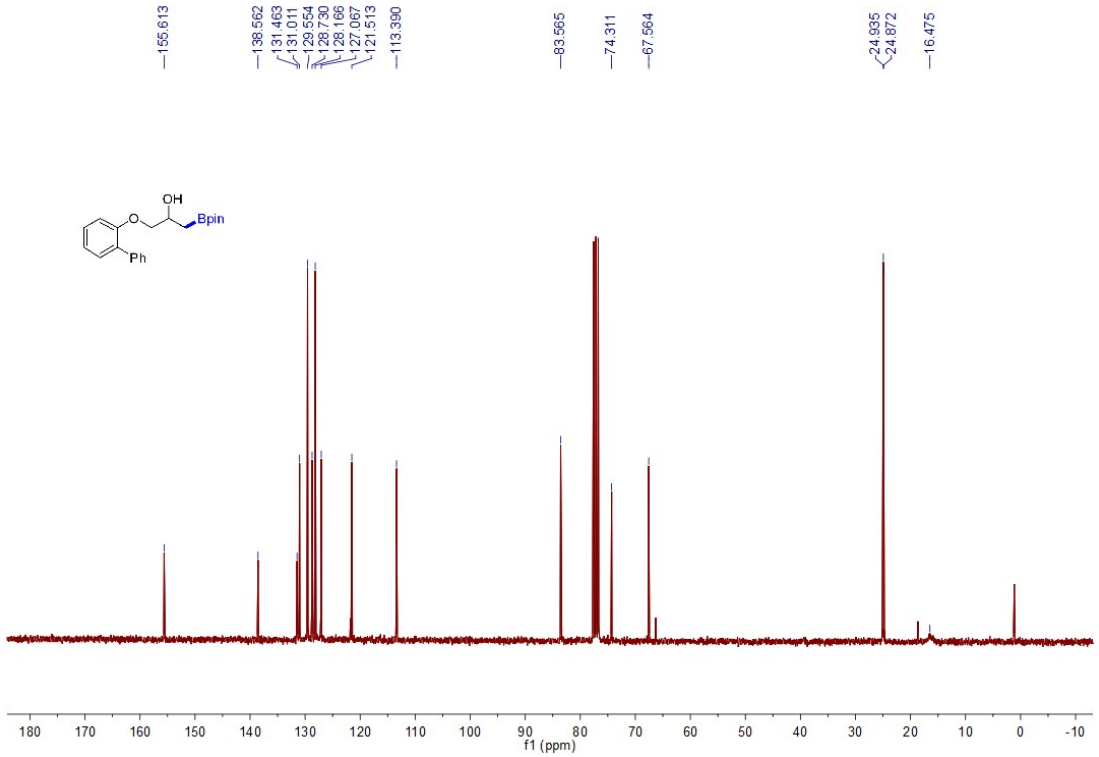
12.74
2.12
f1 (ppm)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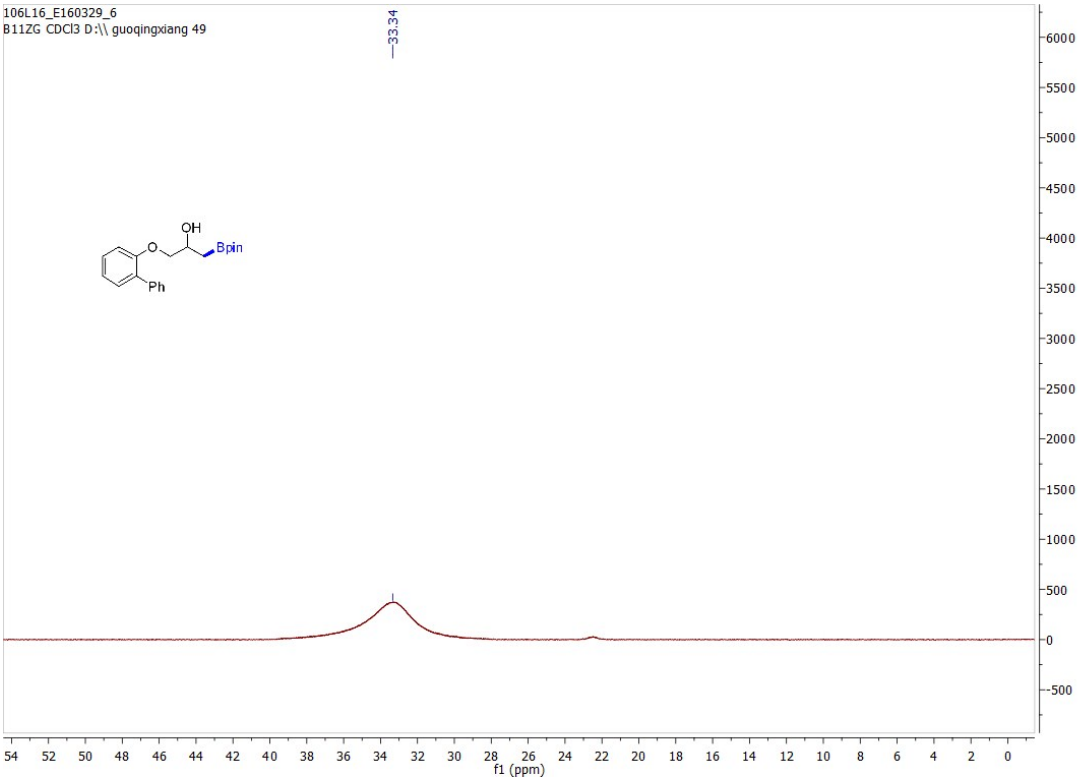
OH
Bpin
Ph
f1 (ppm)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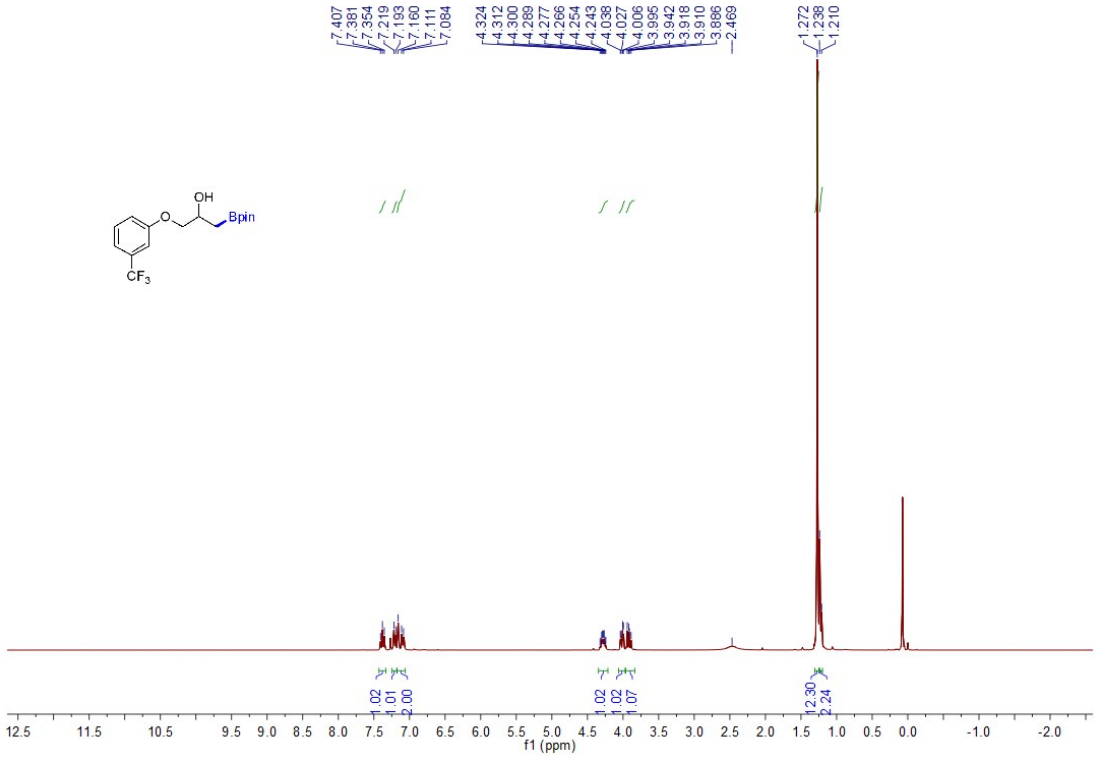
Bpin
Ph
f1 (ppm)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4.266
4.254
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4.038
4.027
4.006
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3.942
3.918
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3.886
2.469
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1.238
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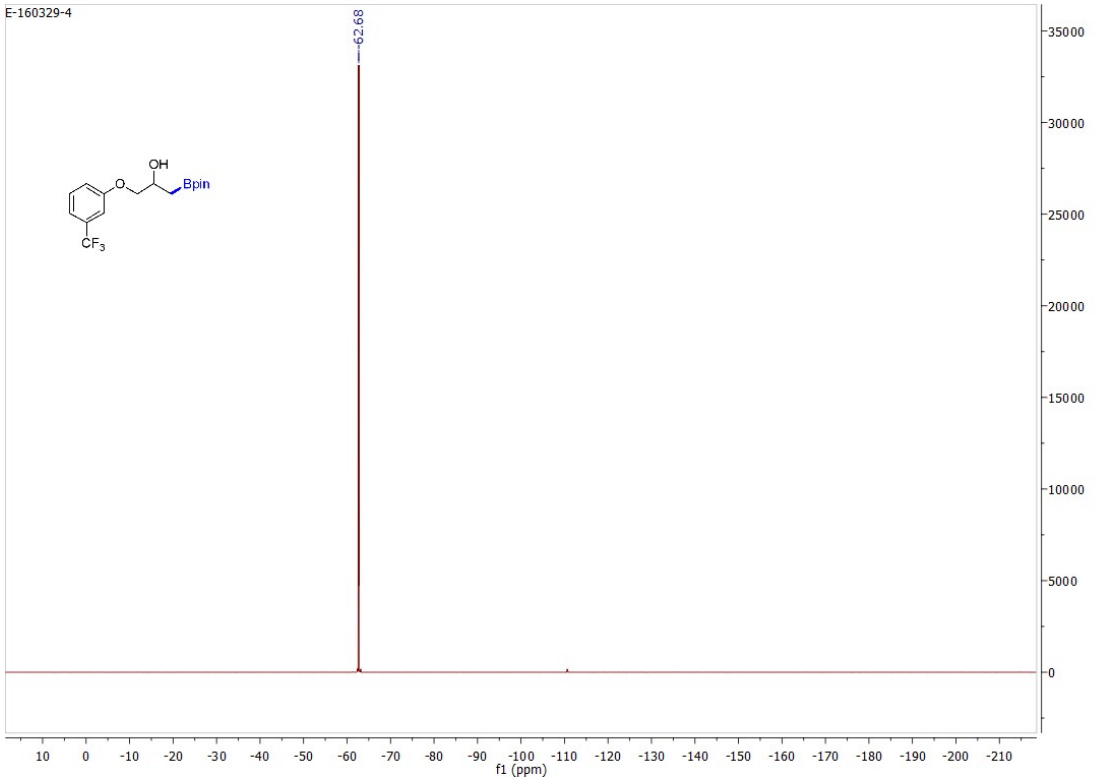
2.24
f1 (ppm)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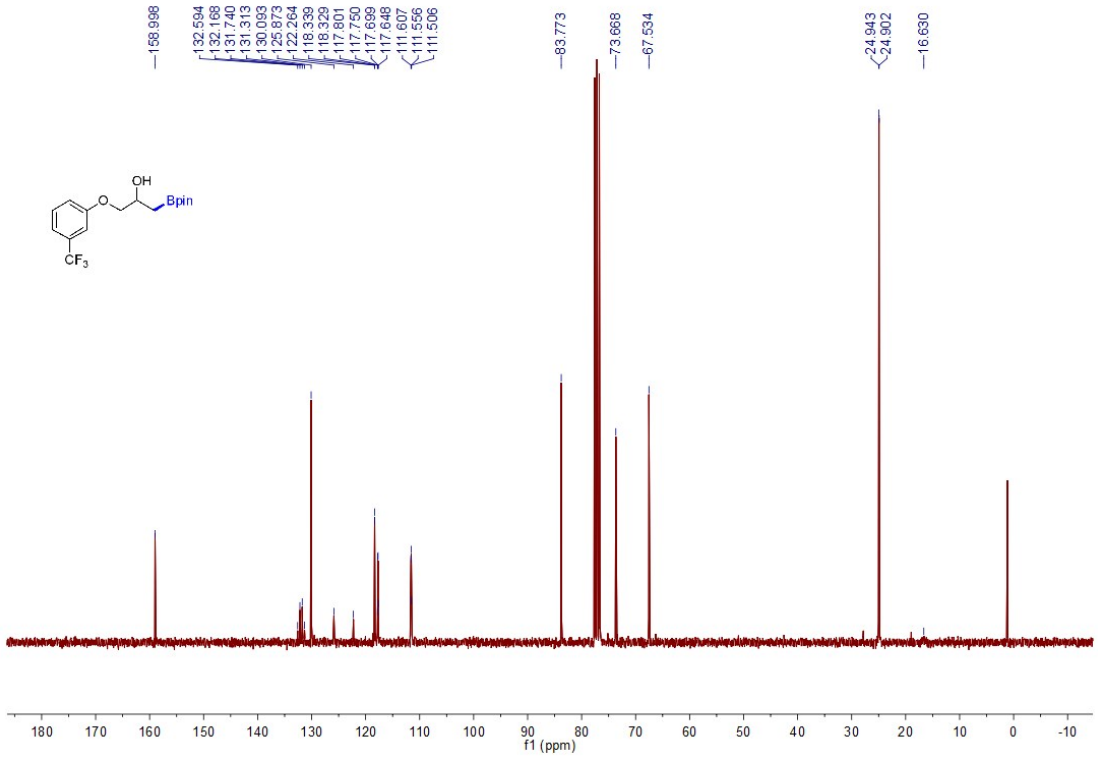
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117.699
117.648
111.607
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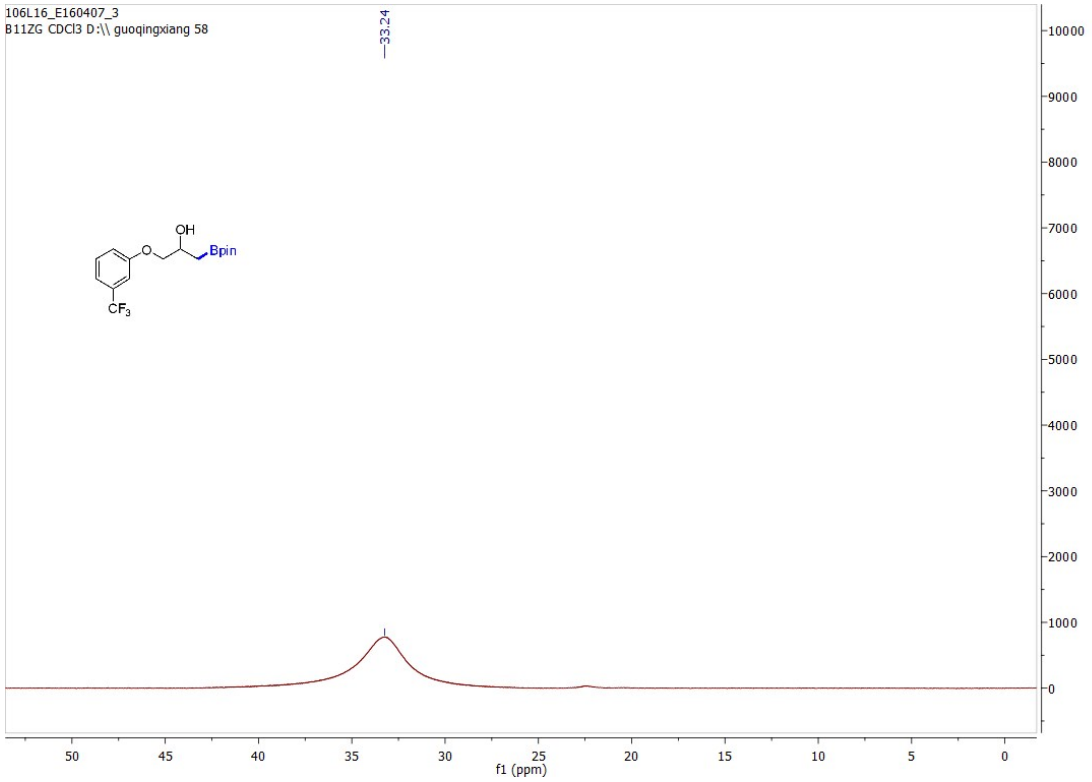
Bpin
CF3
f1 (ppm)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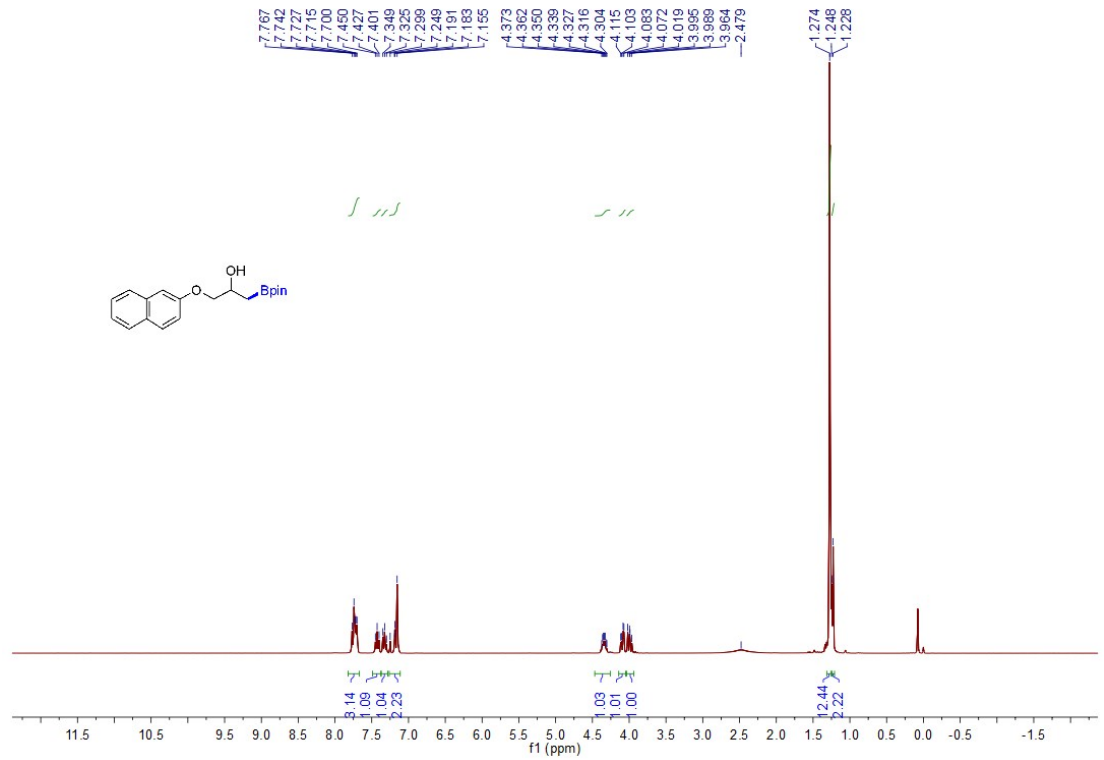
CF3
f1 (ppm)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7.191
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1.248
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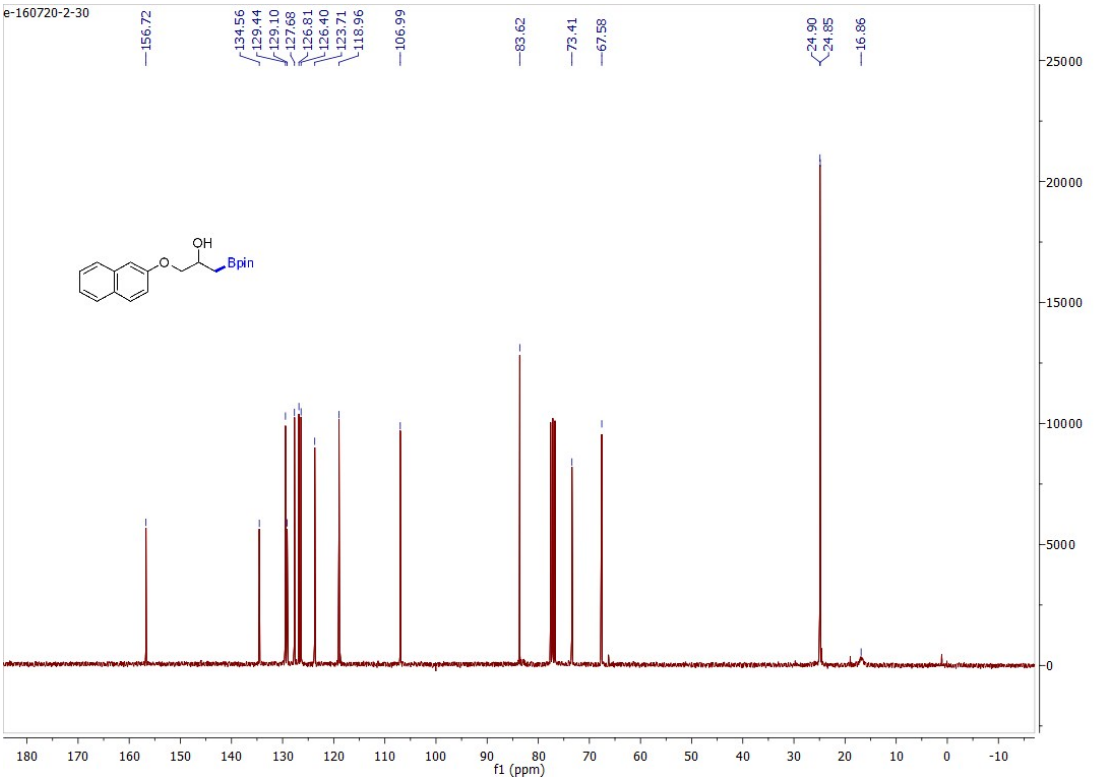
f1 (ppm)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20000
15000
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5000
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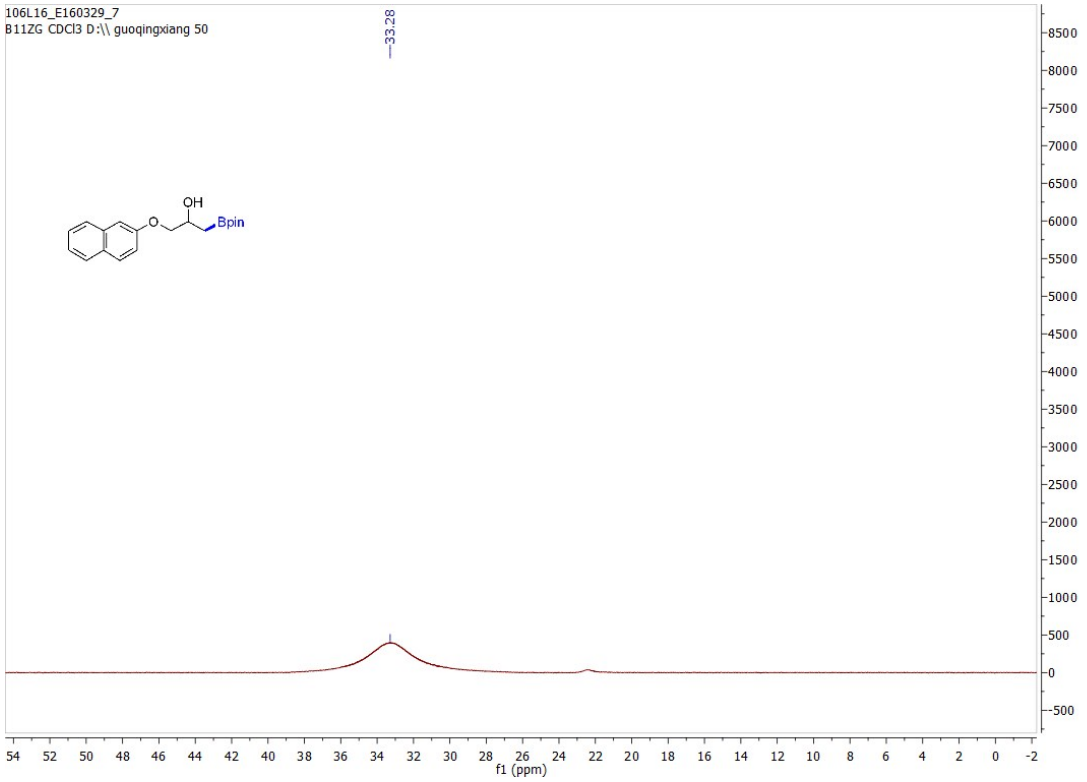
f1 (ppm)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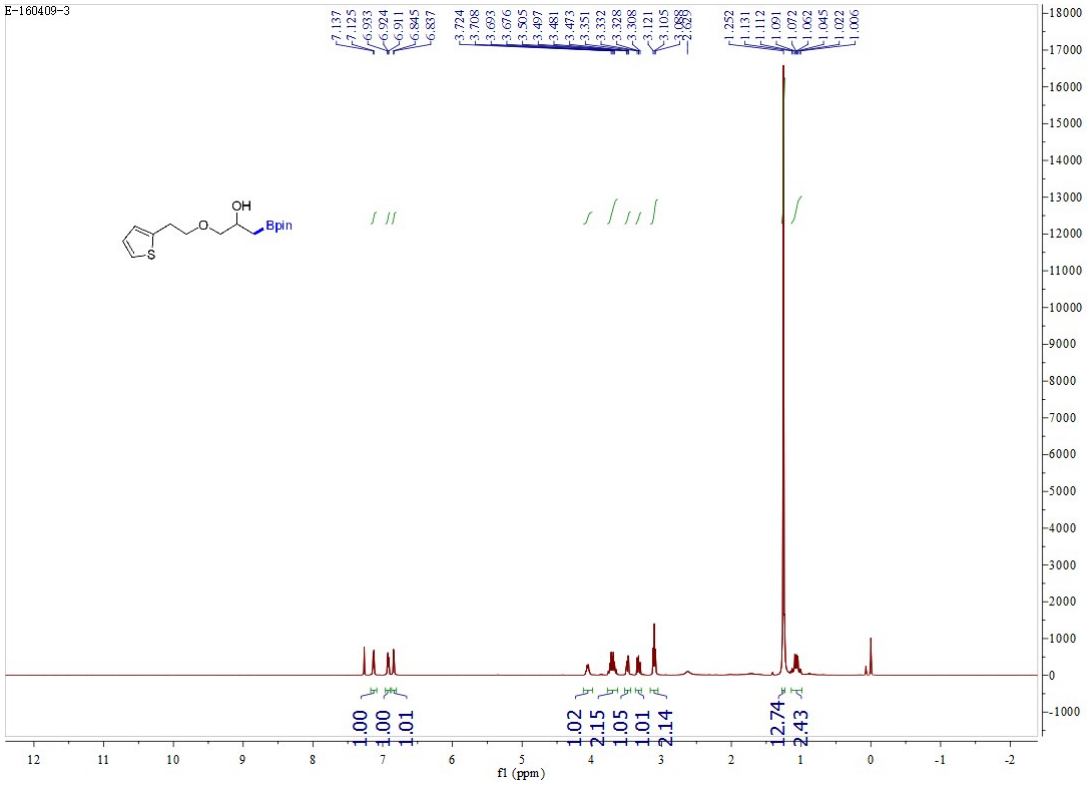
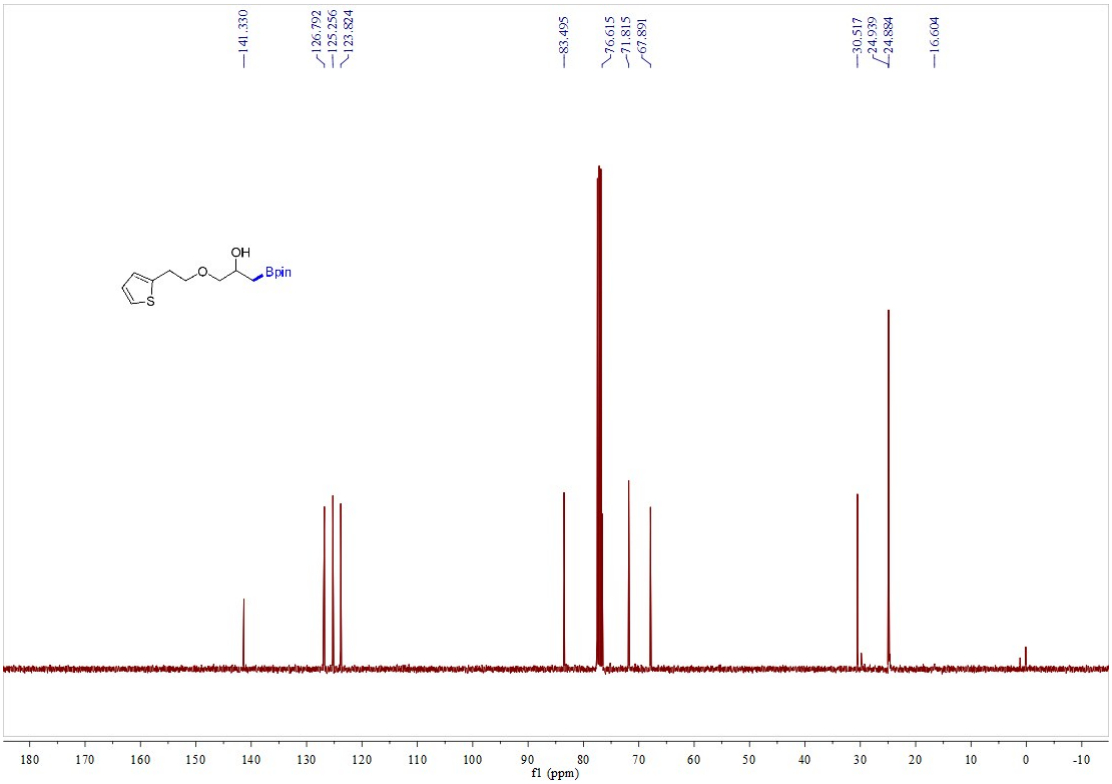
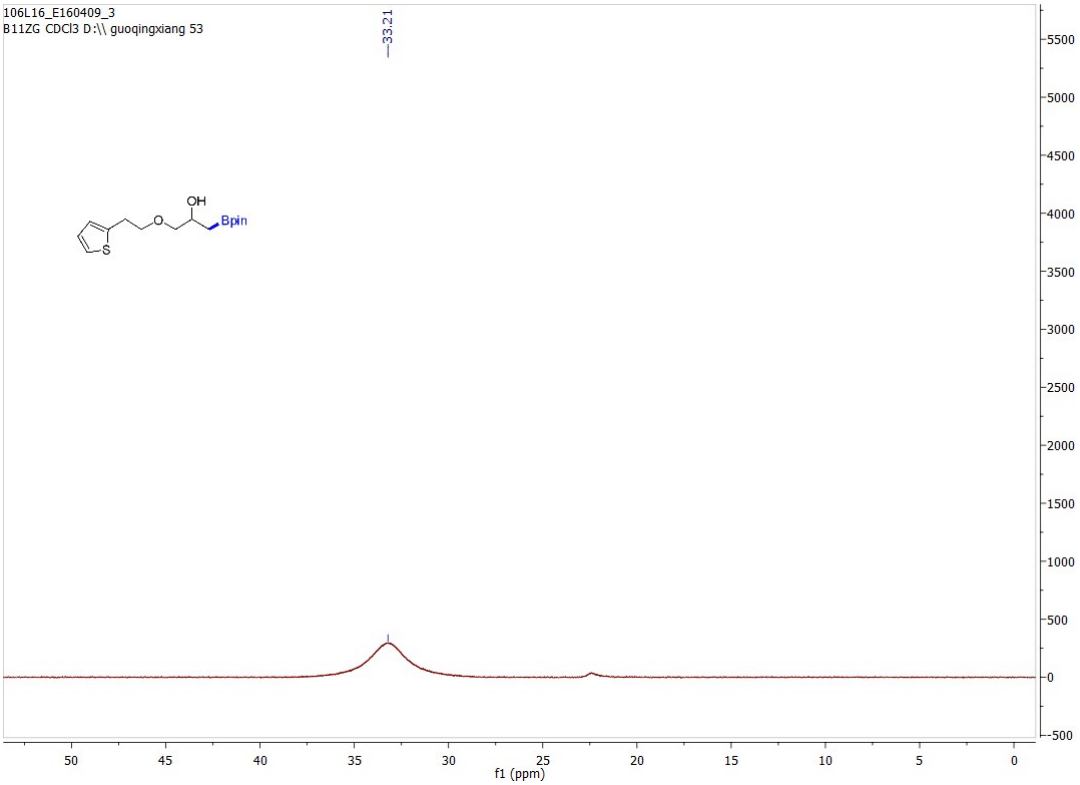
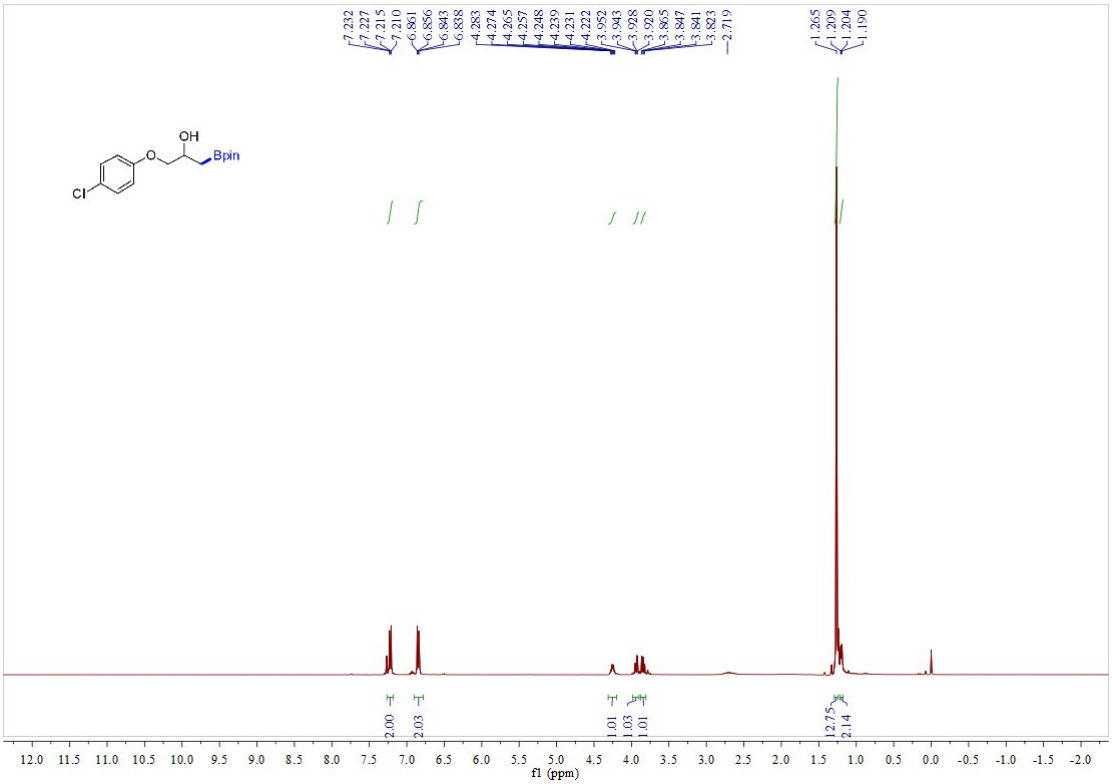
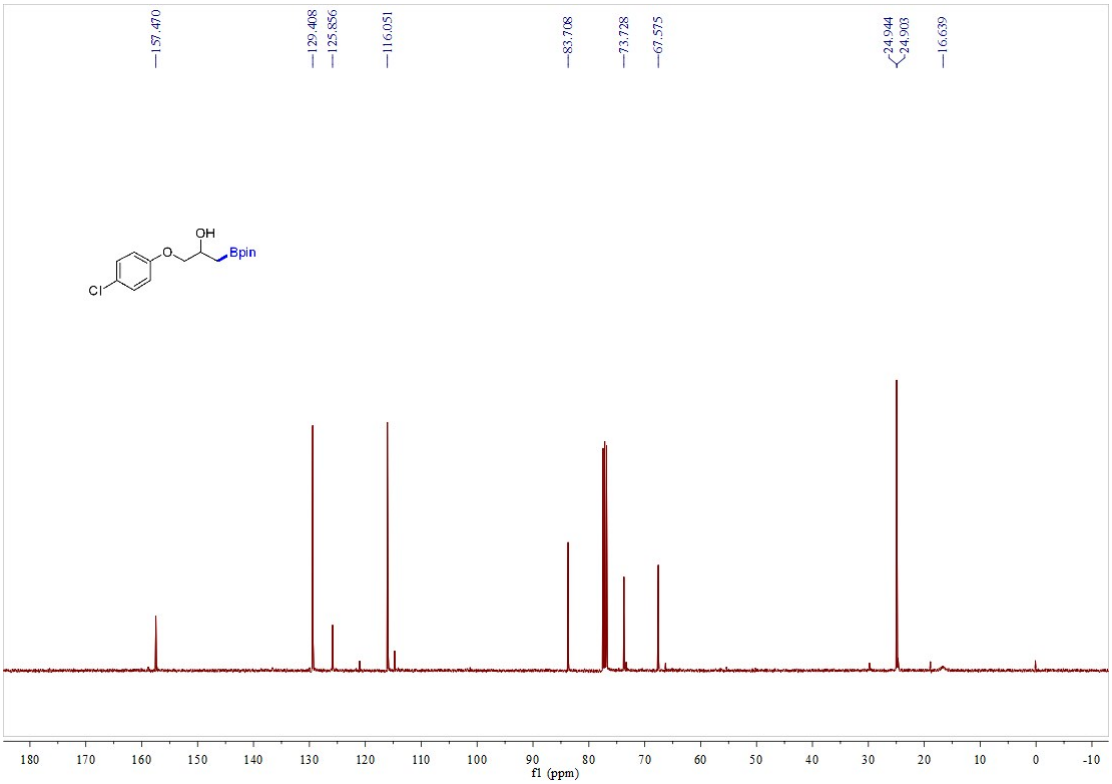
Bpin
f1 (ppm)

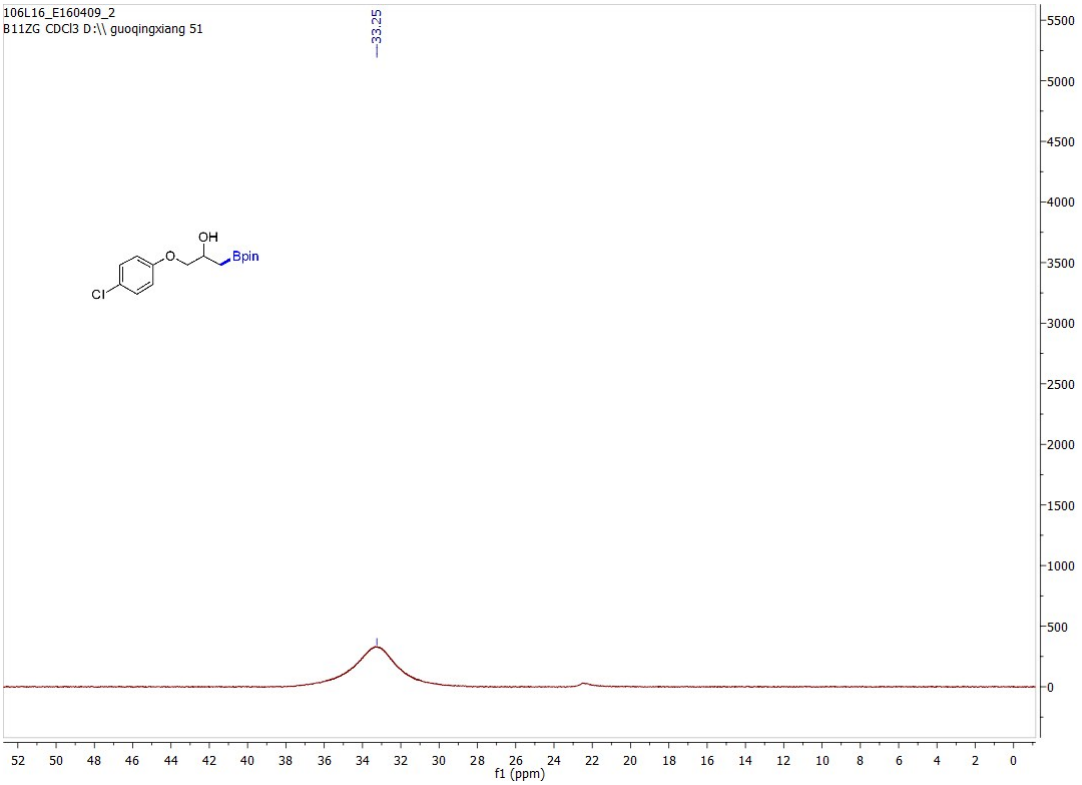

E-160409-3
7.137
7.125
6.933
6.924
6.911
6.845
6.837
3.724
3.708
3.693
3.676
3.505
3.497
3.481
3.473
3.351
3.332
3.328
3.308
3.121
3.105
2.089
1.252
1.131
1.112
1.091
1.072
1.062
1.045
1.022
1.006
OH
Bpin
S
1.00
1.00
1.01
1.02
2.15
1.05
1.01
2.14
12.74
2.43
f1 (ppm)

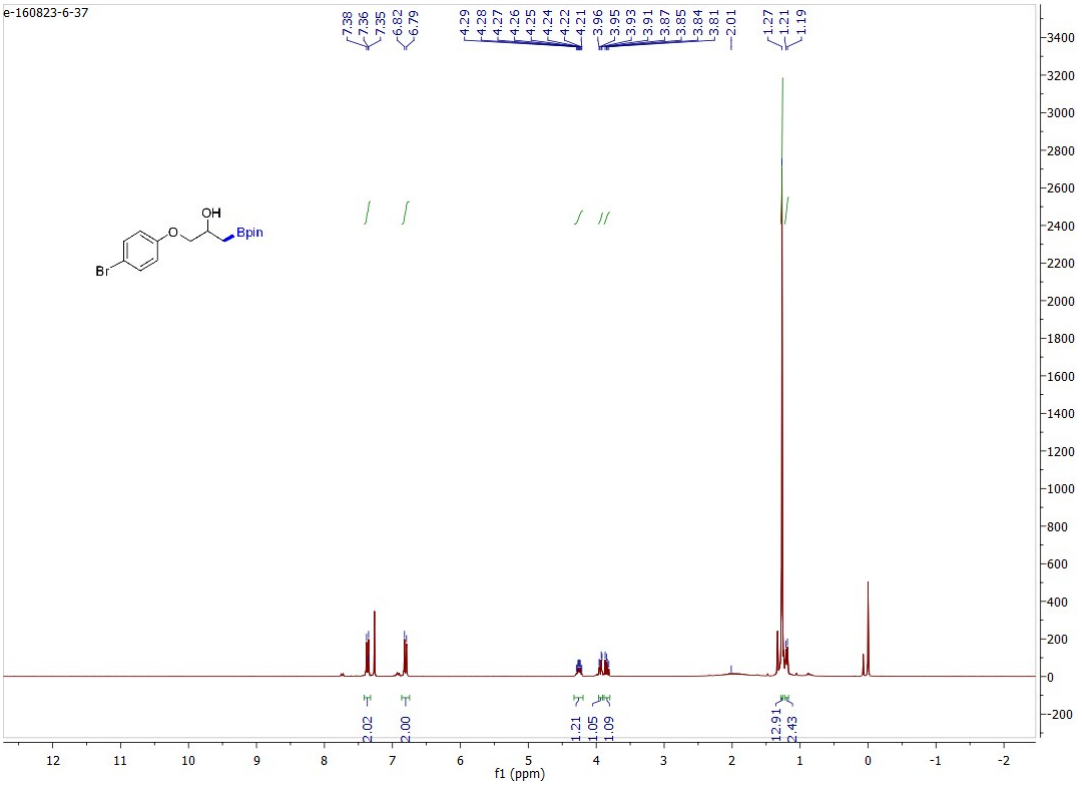

141.330
126.792
125.256
123.824
83.495
76.615
71.815
67.891
30.517
24.939
24.884
16.604
OH
Bpin
S
O
f1 (ppm)

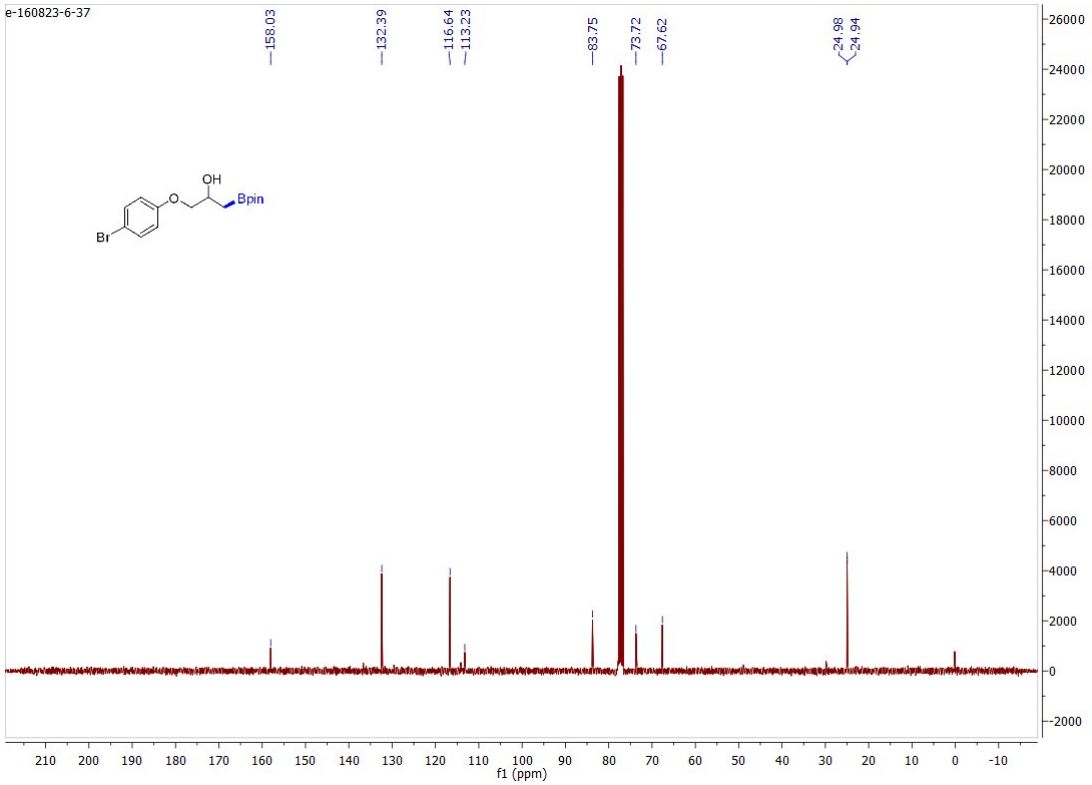

106L16_E160409_3
B11ZG CDCl3 D:\\ guoqingxiang 53
33.21
OH
Bpin
S
O
f1 (ppm)

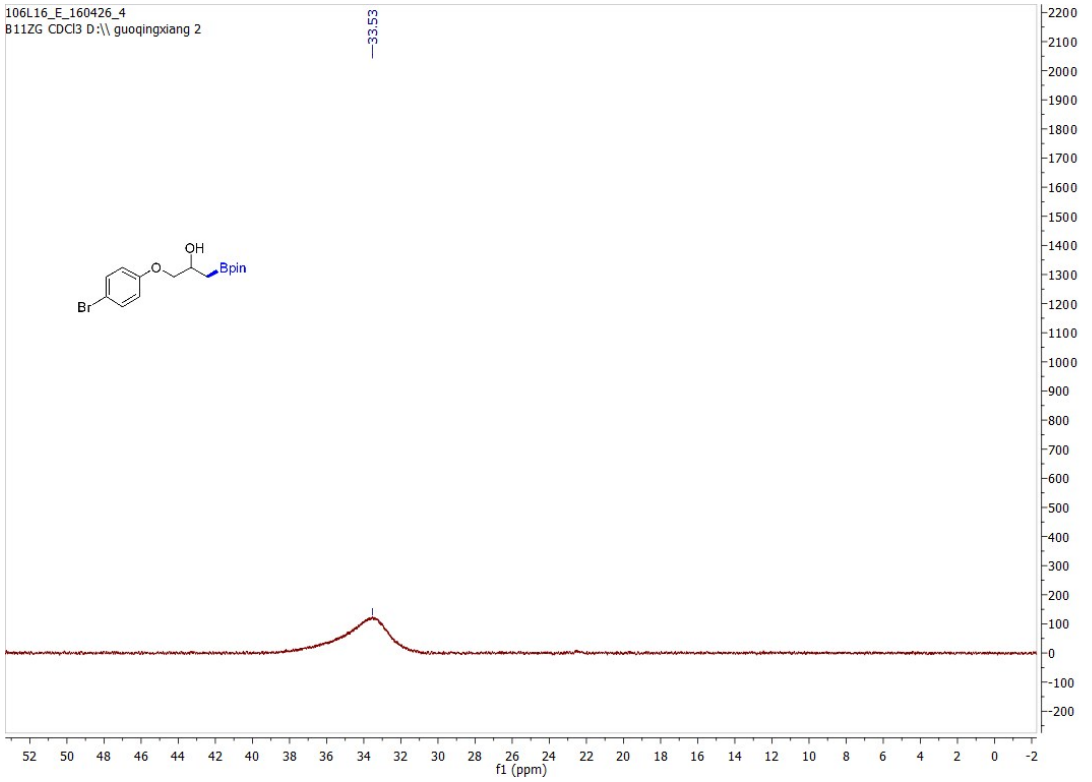

7.232
7.227
7.215
7.210
6.861
6.856
6.843
6.838
4.283
4.274
4.265
4.257
4.248
4.239
4.231
4.222
3.952
3.943
3.928
3.920
3.865
3.847
3.841
3.823
2.719
1.265
1.209
1.204
1.190
OH
Bpin
Cl
2.00
2.03
1.01
1.03
1.01
12.75
2.14
f1 (ppm)

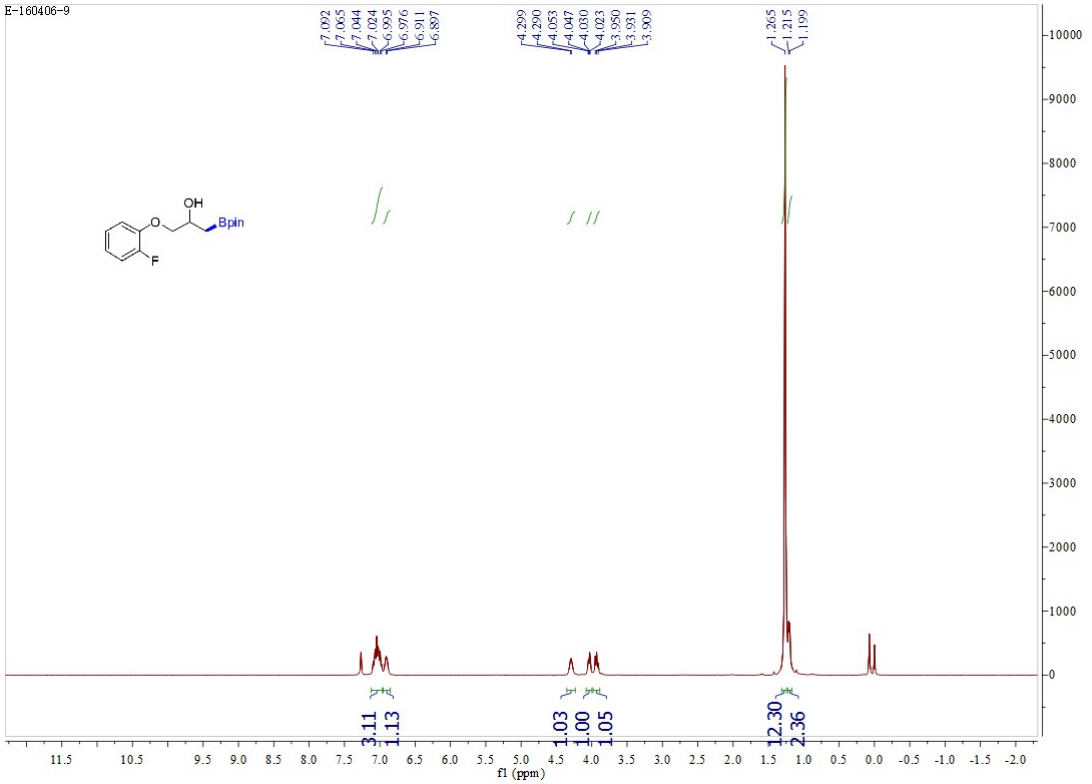

157.470
129.408
125.856
116.051
83.708
73.728
67.575
24.944
24.903
16.639
OH
Bpin
Cl
f1 (ppm)

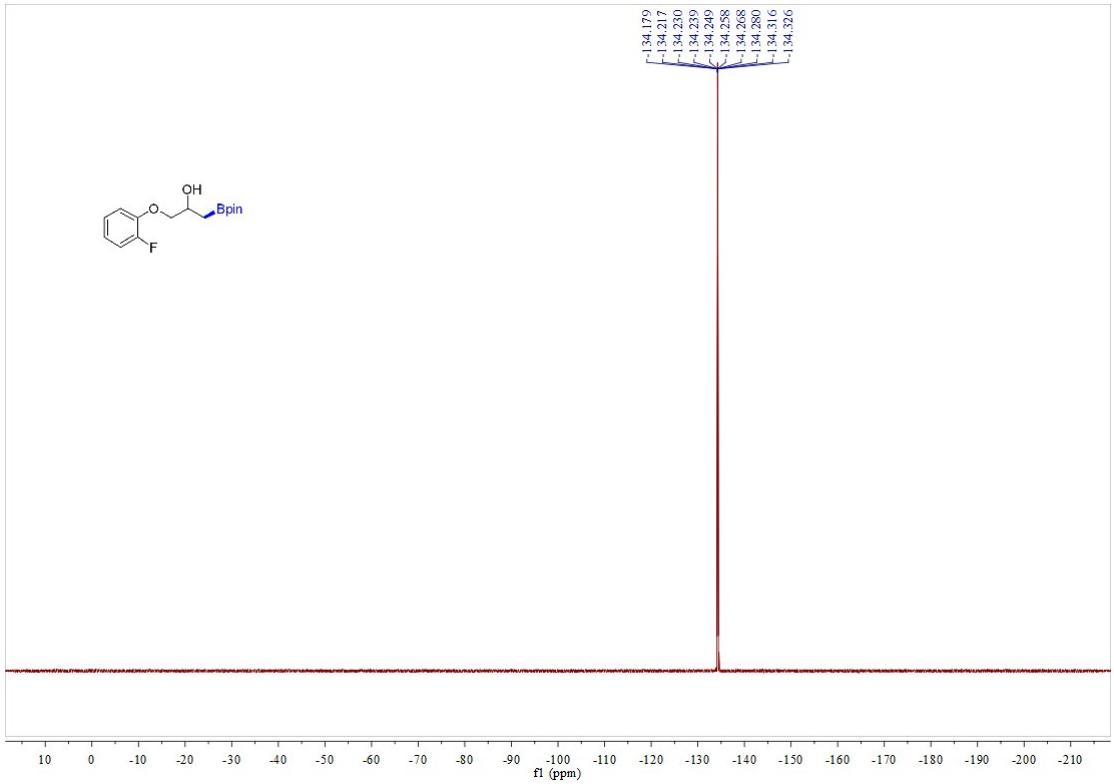

106L16_E160409_2
B11ZG CDCl3 D:\\ guoqingxiang 51
33.25
OH
O
Bpin
Cl
f1 (ppm)

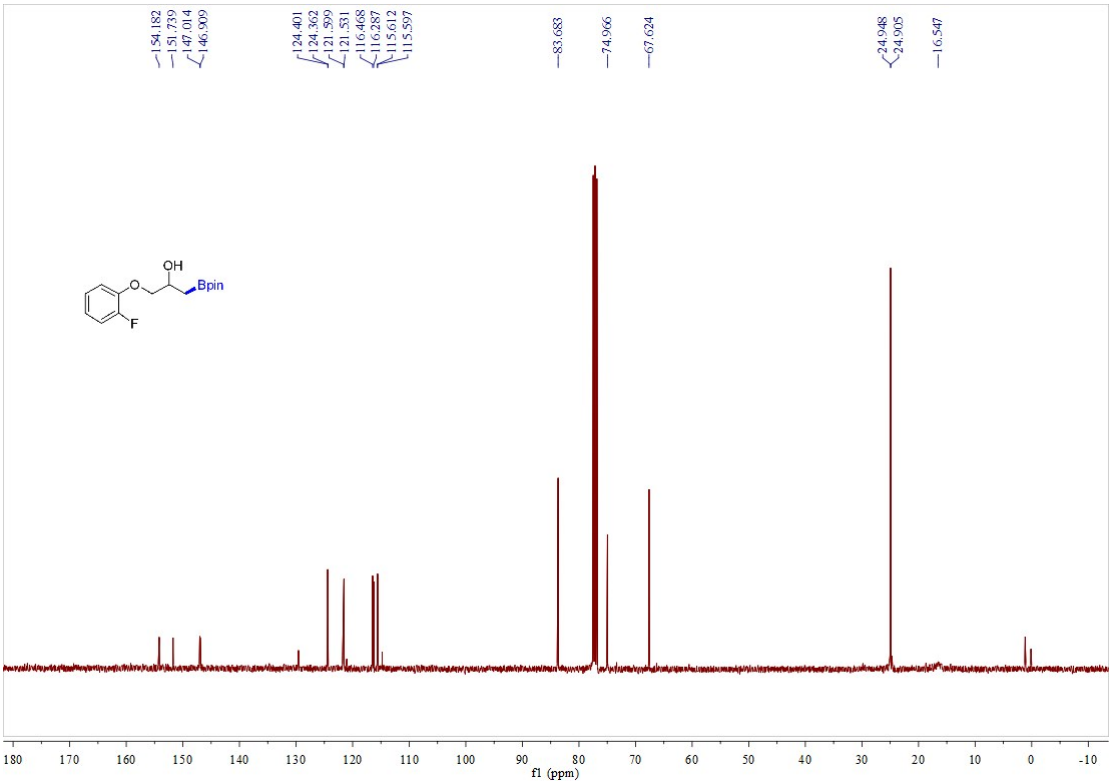

e-160823-6-37
7.38
7.36
7.35
6.82
6.79
4.29
4.28
4.27
4.26
4.25
4.24
4.22
4.21
3.96
3.95
3.93
3.91
3.87
3.85
3.84
3.81
2.01
1.27
1.21
1.19
OH
O
Bpin
Br
2.02
2.00
1.21
1.05
1.09
12.91
2.43
f1 (ppm)

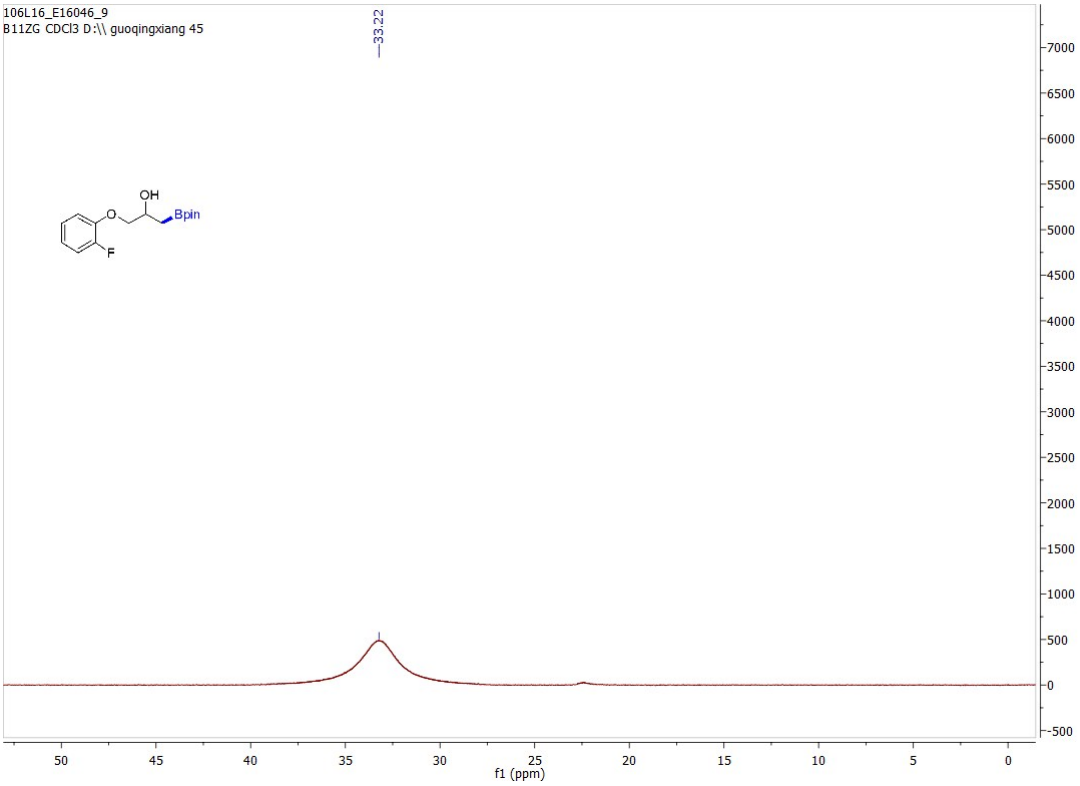

e-160823-6-37
158.03
132.39
116.64
113.23
83.75
73.72
67.62
24.98
24.94
OH
Bpin
Br
f1 (ppm)

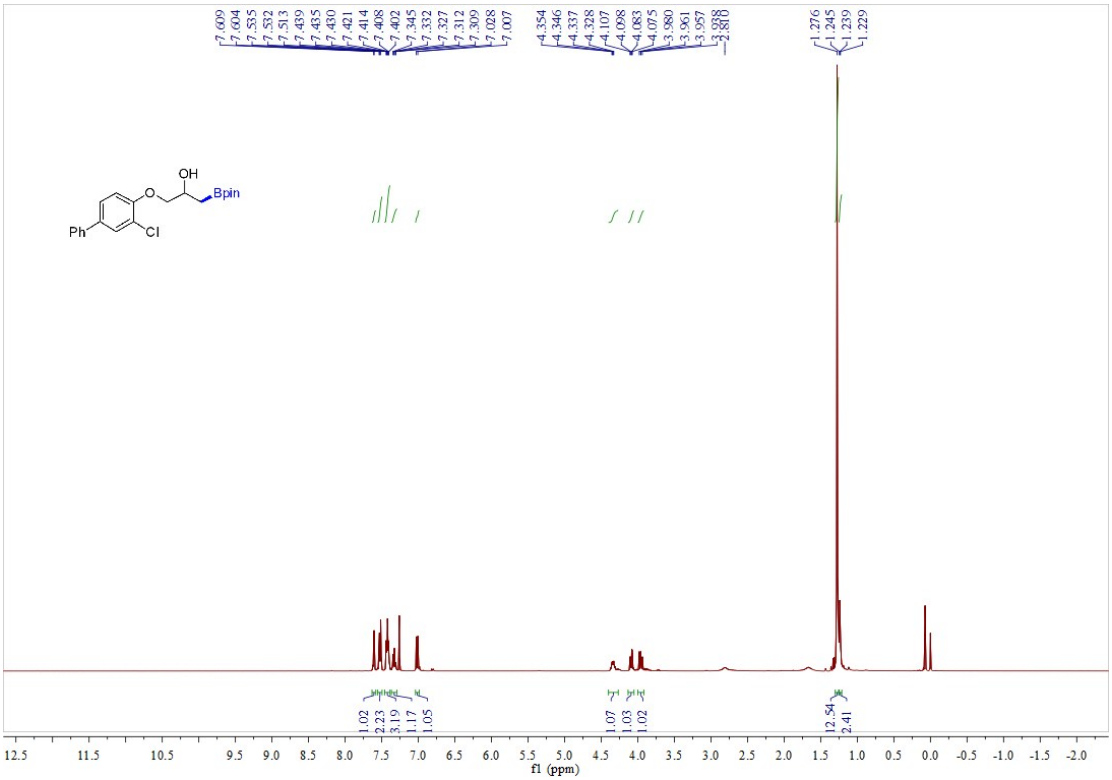

106L16_E_160426_4
B11ZG CDCl3 D:\\ guoqingxiang 2
33.53
OH
Bpin
Br
f1 (ppm)

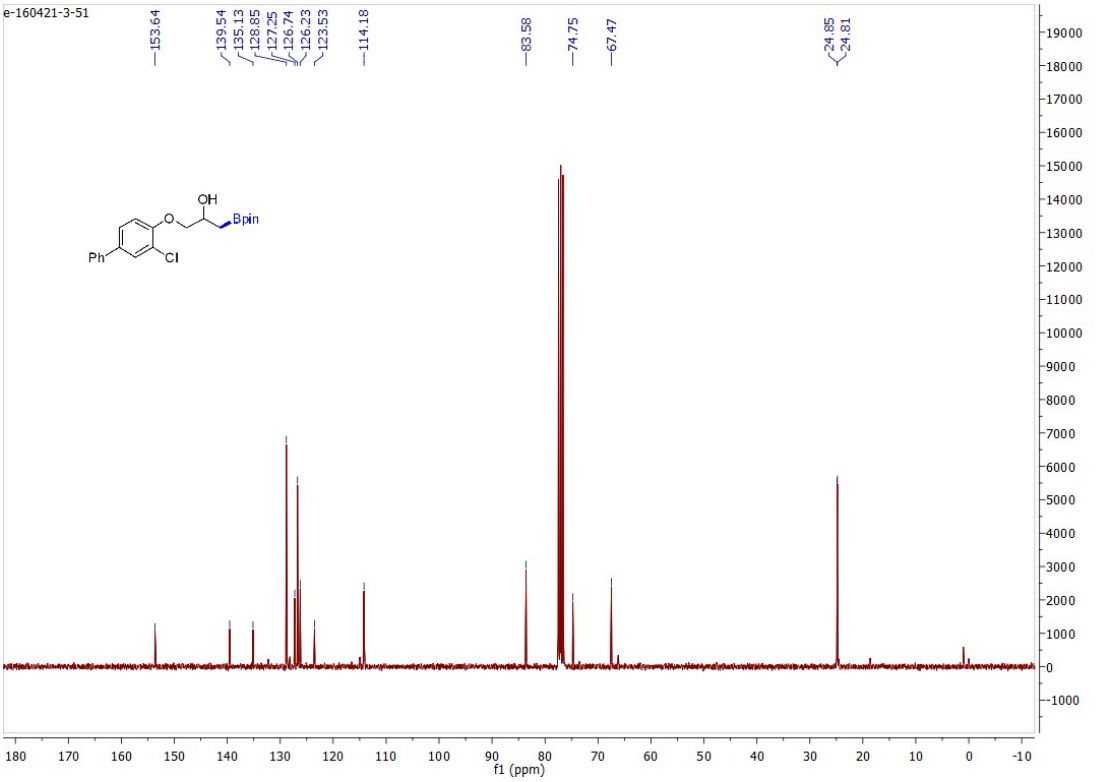

E-160406-9
7.092
7.065
7.044
7.024
6.995
6.976
6.911
6.897
4.299
4.290
4.053
4.047
4.030
4.023
3.950
3.931
3.309
1.265
1.215
1.199
OH
Bpin
F
3.11
1.13
1.03
1.00
1.05
12.30
2.36
f1 (ppm)

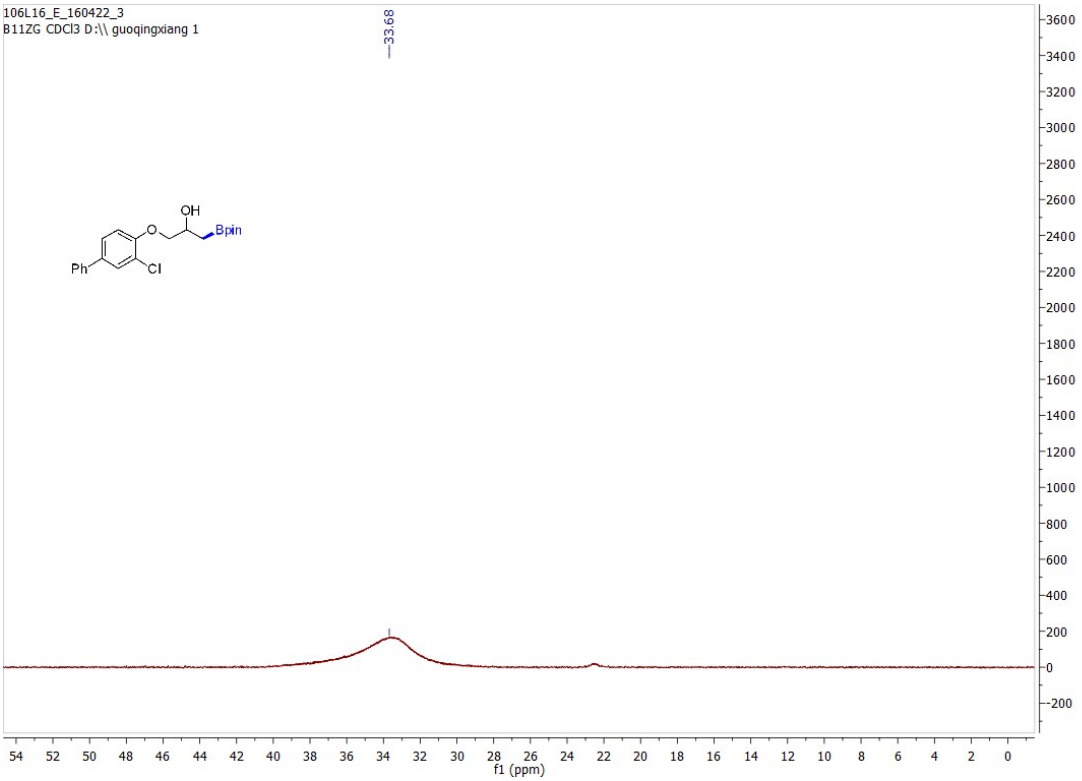

134.179
134.217
134.230
134.239
134.249
134.258
134.268
134.280
134.316
134.326
OH
Bpin
F
f1 (ppm)

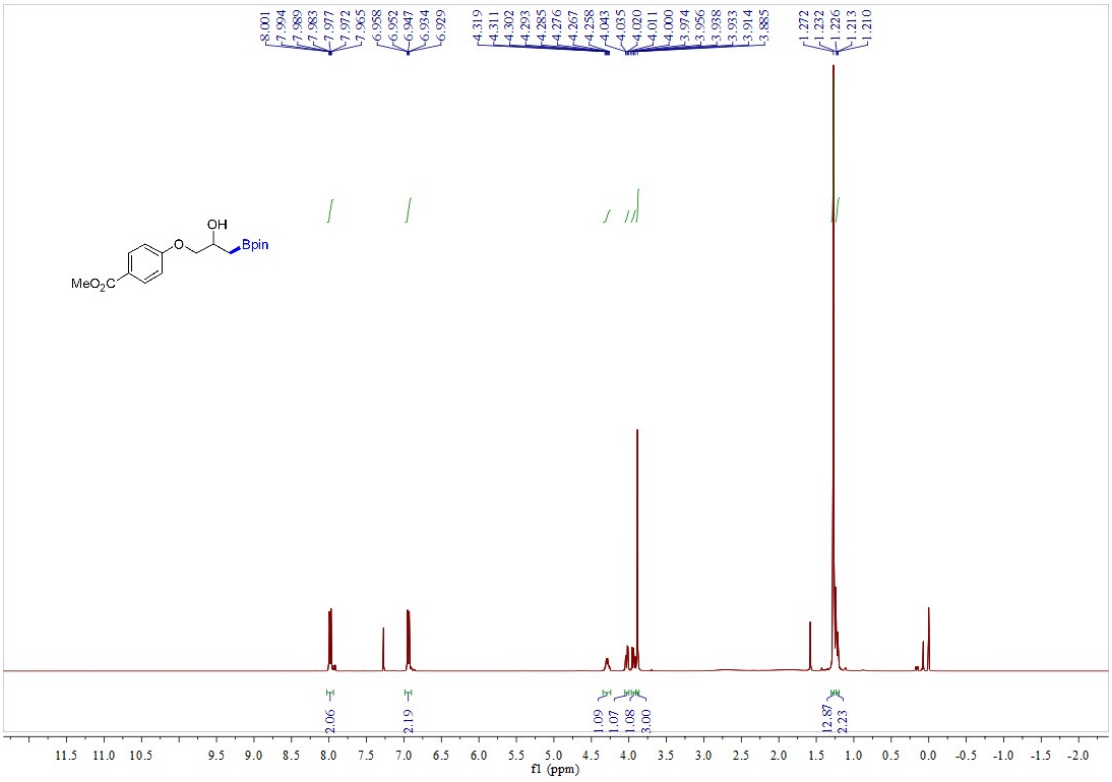

154.182
151.739
147.014
146.909
124.401
124.362
121.599
121.531
116.468
116.287
115.612
115.597
83.683
74.966
67.624
24.948
24.905
16.547
OH
Bpin
F
f1 (ppm)

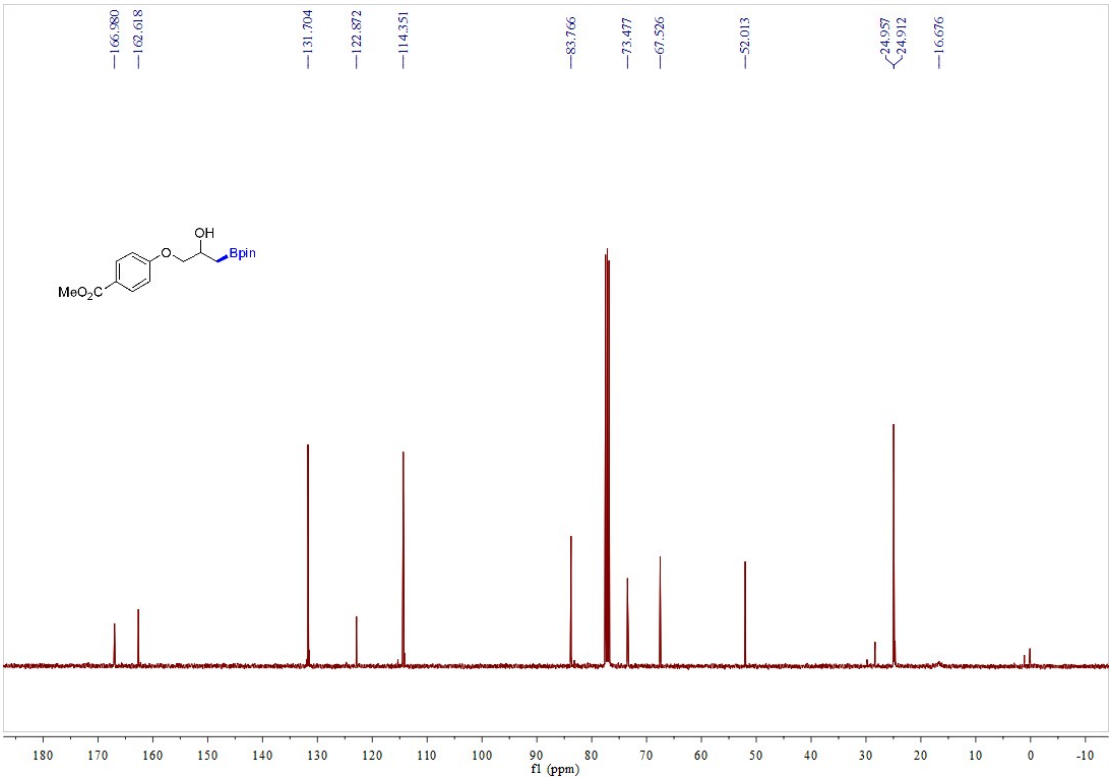

106L16_E16046_9
B11ZG CDCl3 D:\\ guoqingxiang 45
33.22
OH
Bpin
F
f1 (ppm)

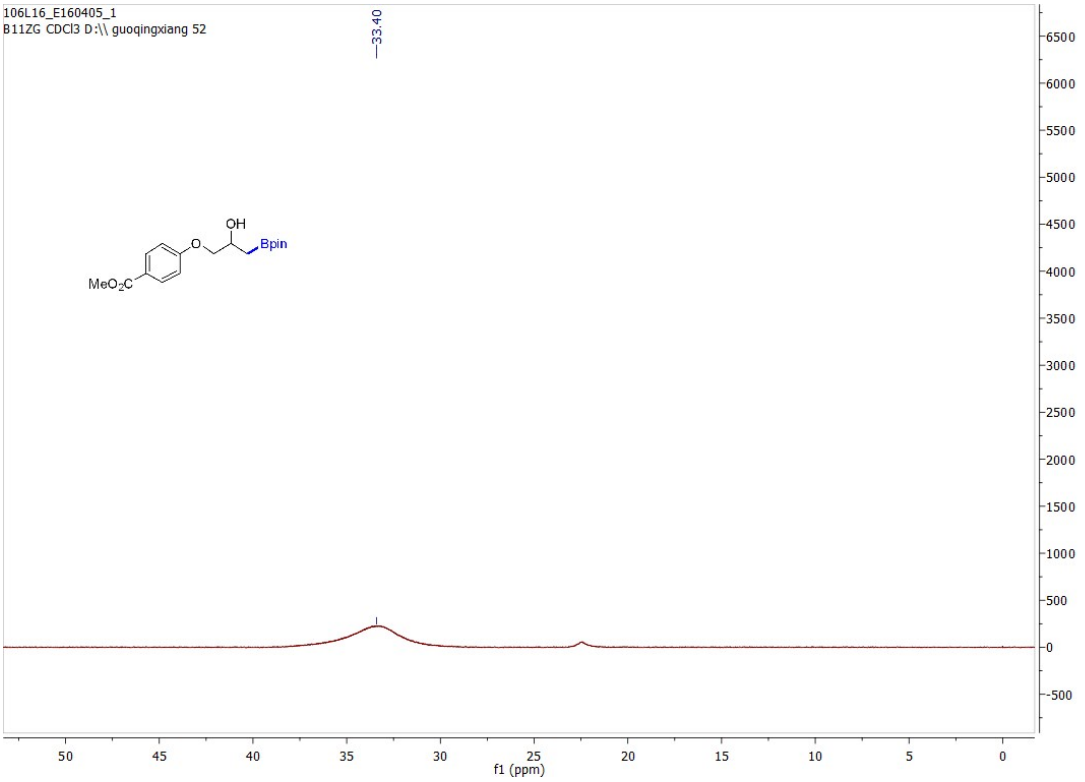

7.609
7.604
7.535
7.532
7.513
7.439
7.435
7.430
7.421
7.414
7.408
7.402
7.345
7.332
7.327
7.312
7.309
7.028
7.007
4.354
4.346
4.337
4.328
4.107
4.098
4.083
4.075
3.980
3.961
3.957
3.888
3.880
1.276
1.245
1.239
1.229
OH
Bpin
Ph
Cl
1.02
2.23
3.19
1.17
1.05
1.07
1.03
1.02
12.54
2.41
f1 (ppm)

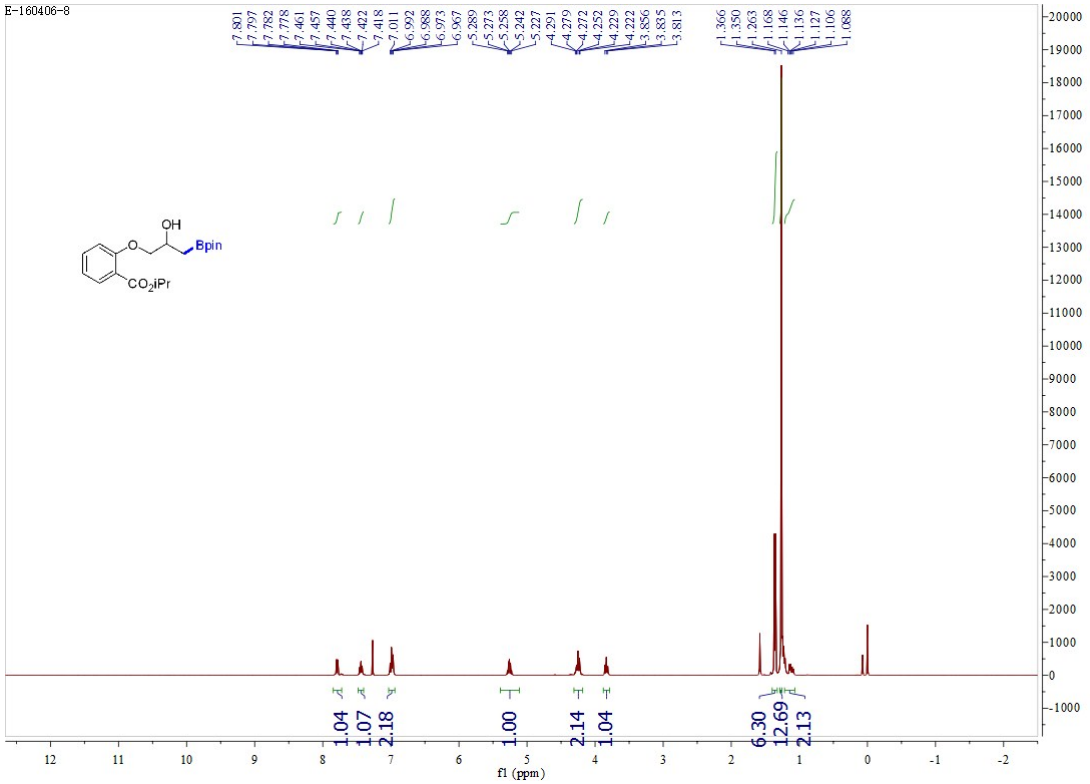

e-160421-3-51
153.64
139.54
135.13
128.85
127.25
126.74
126.23
123.53
114.18
83.58
74.75
67.47
24.85
24.81
OH
Bpin
Ph
Cl
f1 (ppm)

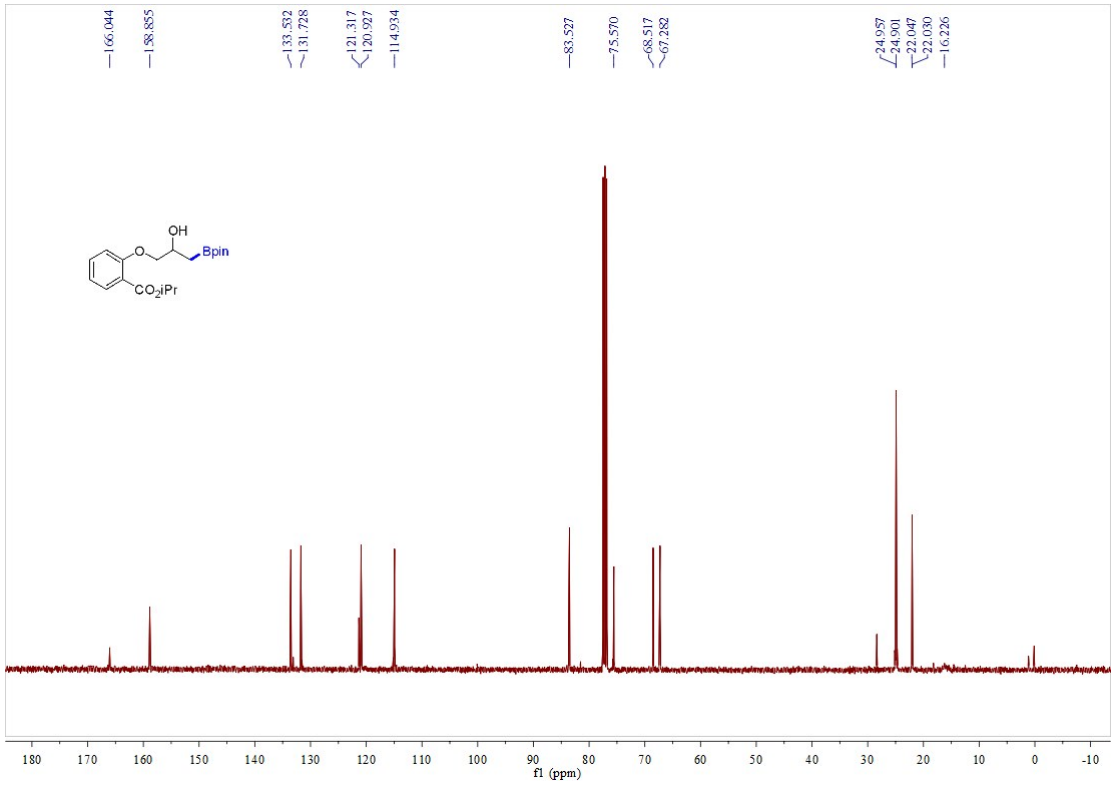

106L16_E_160422_3
B11ZG CDCl3 D:\\ guoqingxiang 1
33.68
OH
Bpin
Ph
Cl
f1 (ppm)

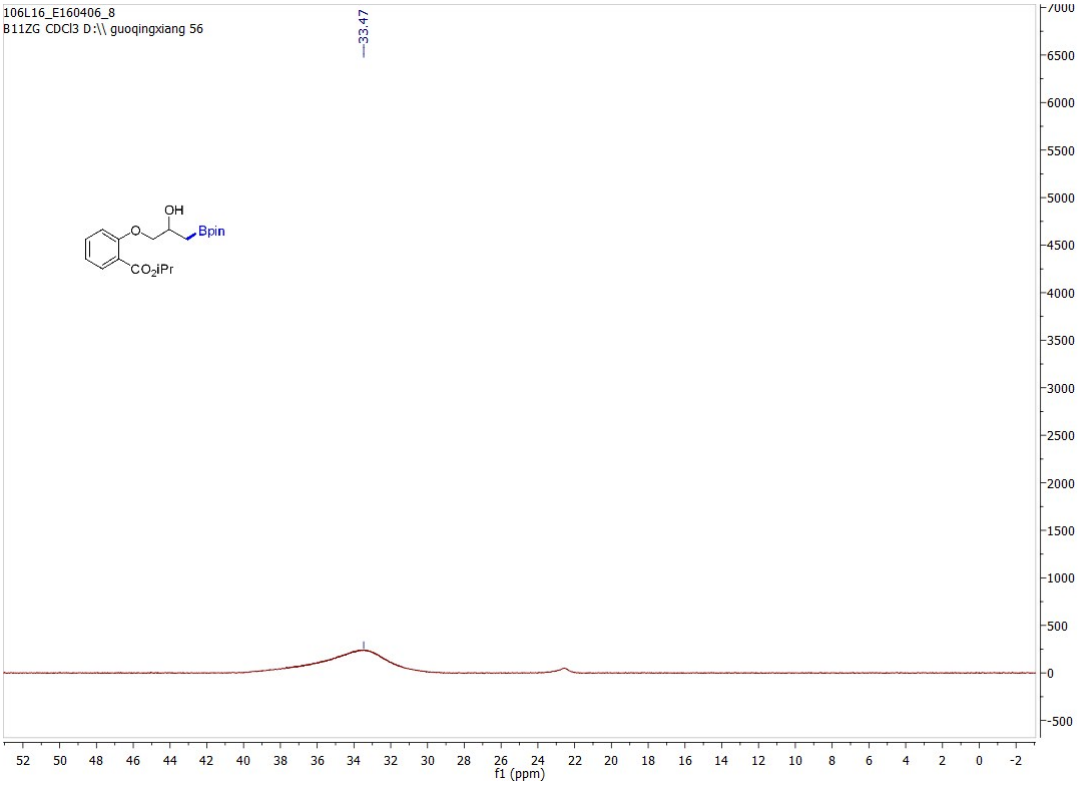

OH
Bpin
MeO2C
f1 (ppm)

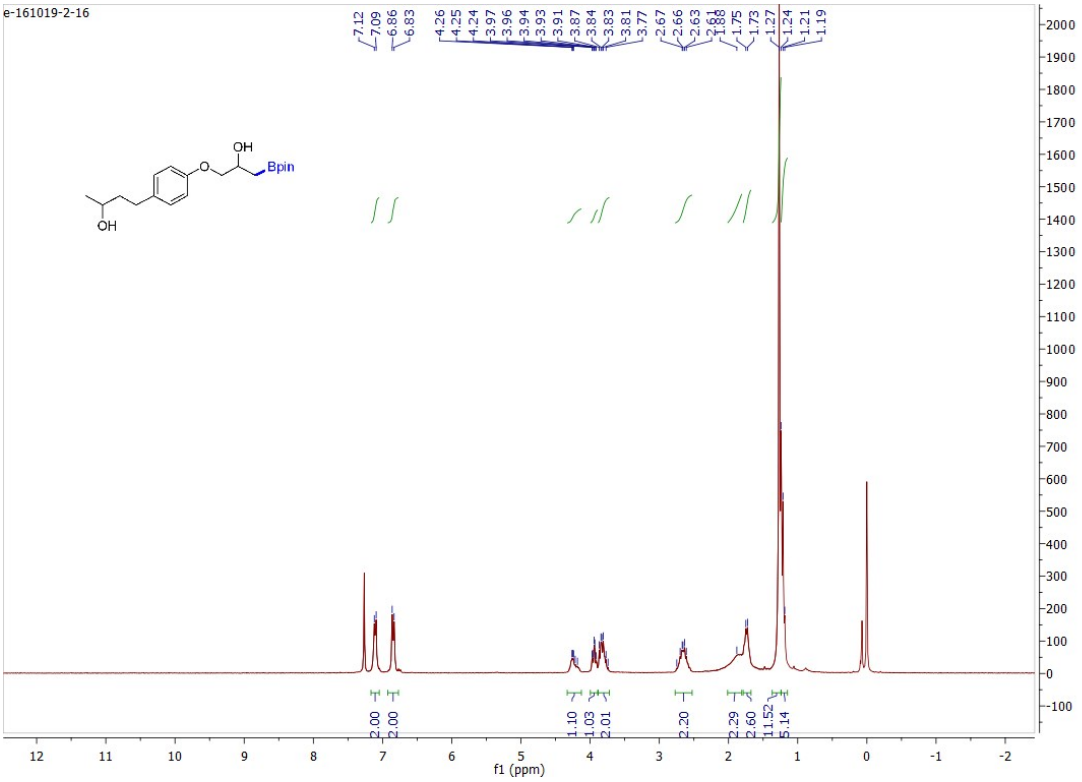

166.380
162.618
131.704
122.872
114.351
83.766
73.477
67.526
52.013
24.957
24.912
16.676
OH
Bpin
MeO2C
f1 (ppm)

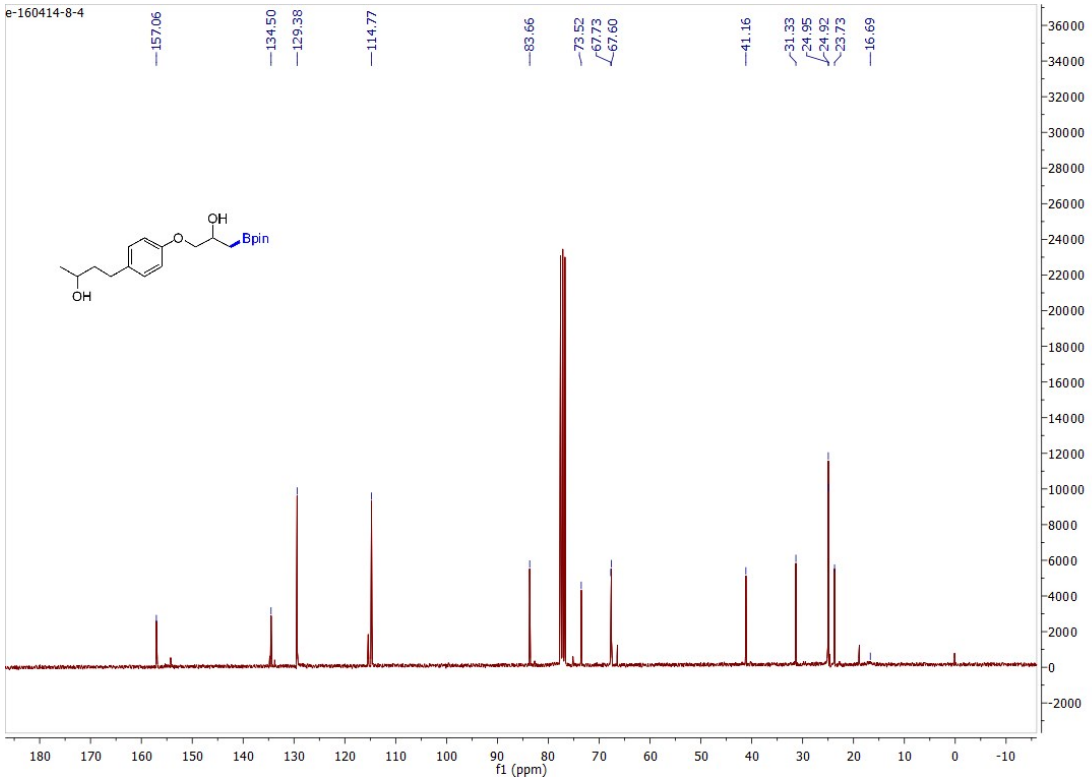

106L16_E160405_1
B11ZG CDCl3 D:\\ guoqingxiang 52
33.40
OH
Bpin
MeO2C
f1 (ppm)

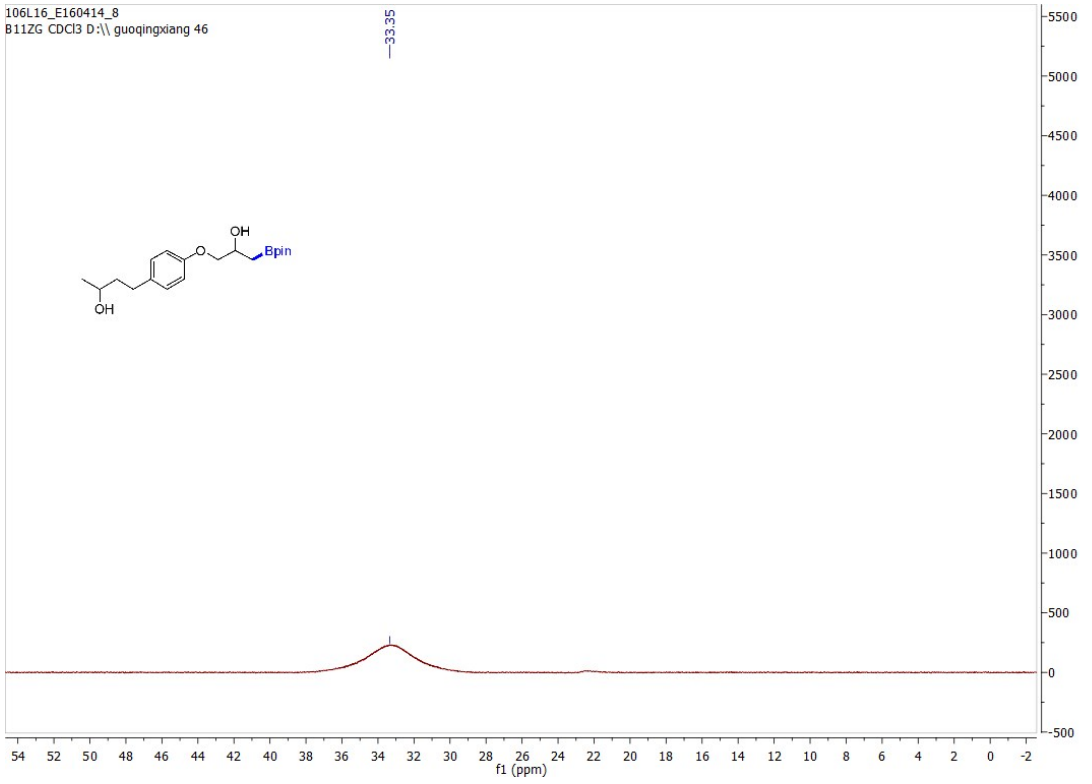

E-160406-8
7.801
7.797
7.782
7.778
7.461
7.457
7.440
7.438
7.422
7.418
7.011
6.992
6.988
6.973
6.967
5.289
5.273
5.258
5.242
5.227
4.291
4.279
4.272
4.252
4.229
4.222
3.856
3.835
3.813
1.366
1.350
1.263
1.168
1.146
1.136
1.127
1.106
1.088
OH
Bpin
CO2iPr
1.04
1.07
2.18
1.00
2.14
1.04
6.30
12.69
2.13
f1 (ppm)

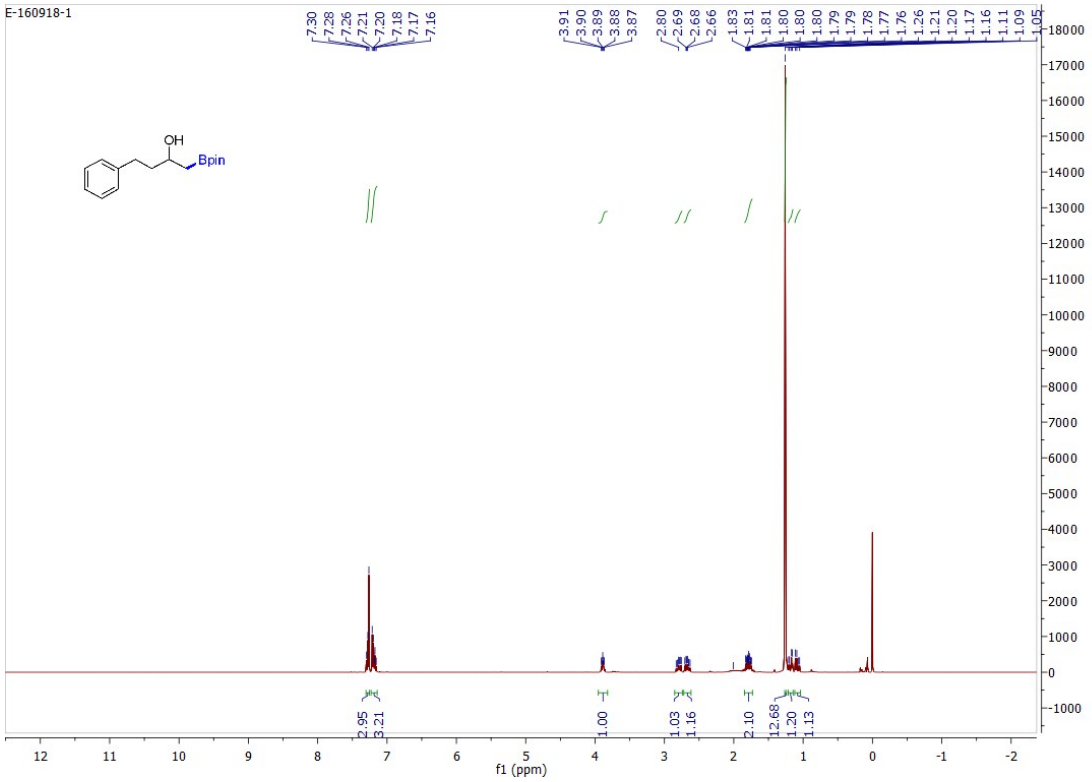

166.044
138.855
133.532
131.728
121.317
120.927
114.934
83.527
75.570
68.517
67.282
24.957
24.901
22.047
22.030
16.226
OH
Bpin
CO2iPr
f1 (ppm)

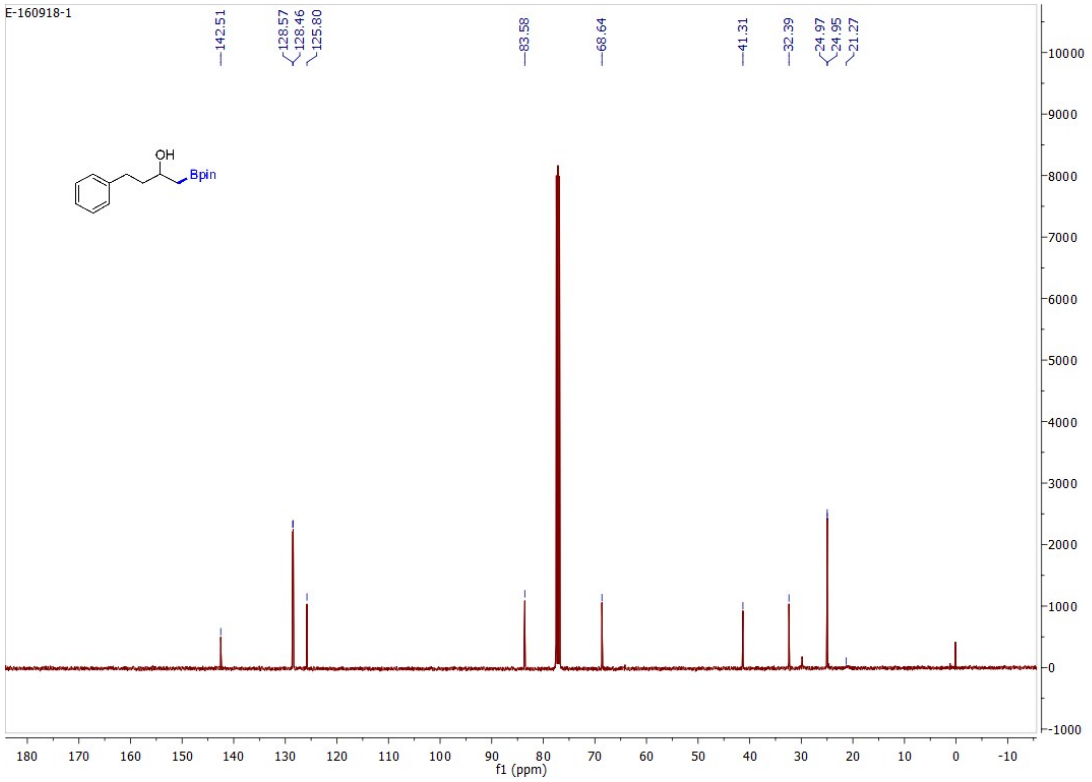

106L16_E160406_8
B11ZG CDCl3 D:\\ guoqingxiang 56
33.47
OH
Bpin
CO2iPr
f1 (ppm)

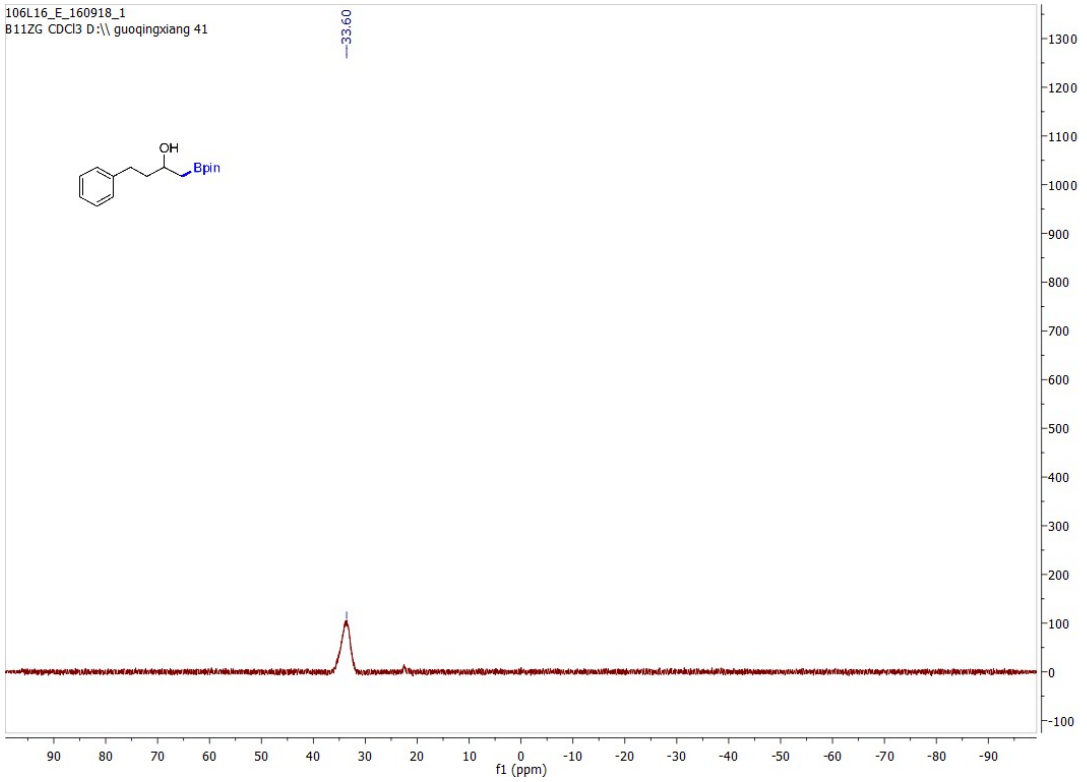

e-161019-2-16
7.12
7.09
6.86
6.83
4.26
4.25
4.24
3.97
3.96
3.94
3.93
3.91
3.87
3.84
3.83
3.81
3.77
2.67
2.66
2.63
2.61
1.88
1.75
1.73
1.27
1.24
1.21
1.19
OH
Bpin
OH
2.00
2.00
1.10
1.03
2.01
2.20
2.29
2.60
11.52
5.14
f1 (ppm)

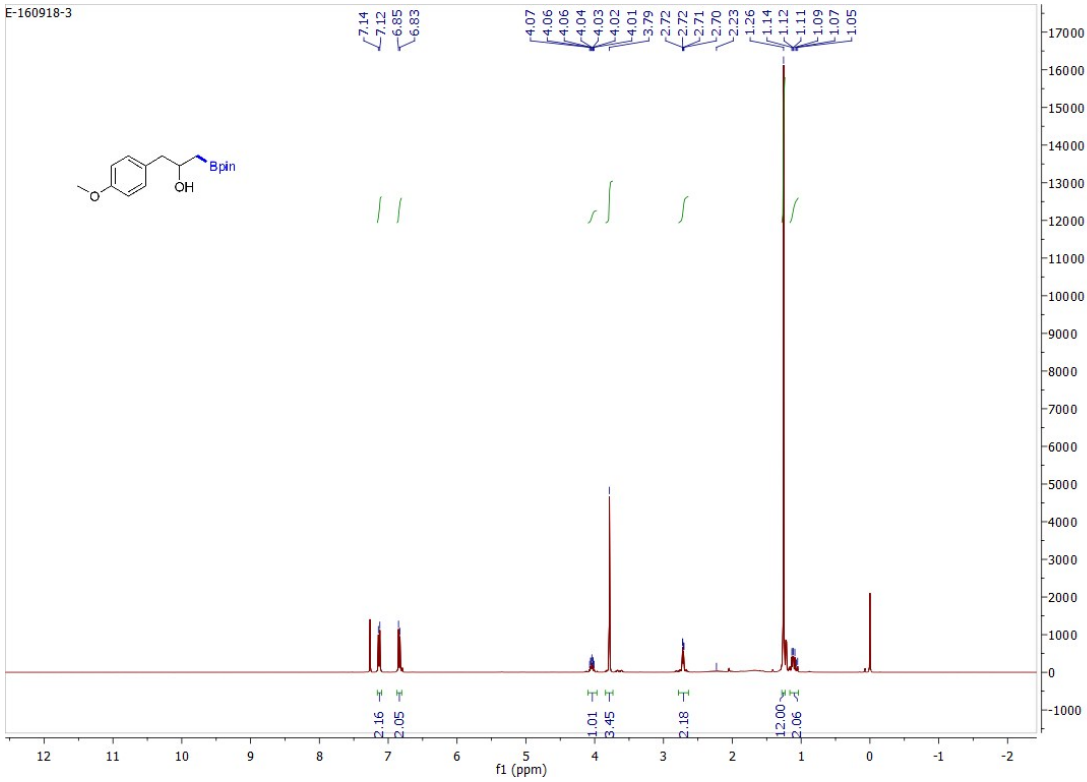

e-160414-8-4
157.06
134.50
129.38
114.77
83.66
73.52
67.73
67.60
41.16
31.33
24.95
24.92
23.73
16.69
OH
Bpin
OH
f1 (ppm)

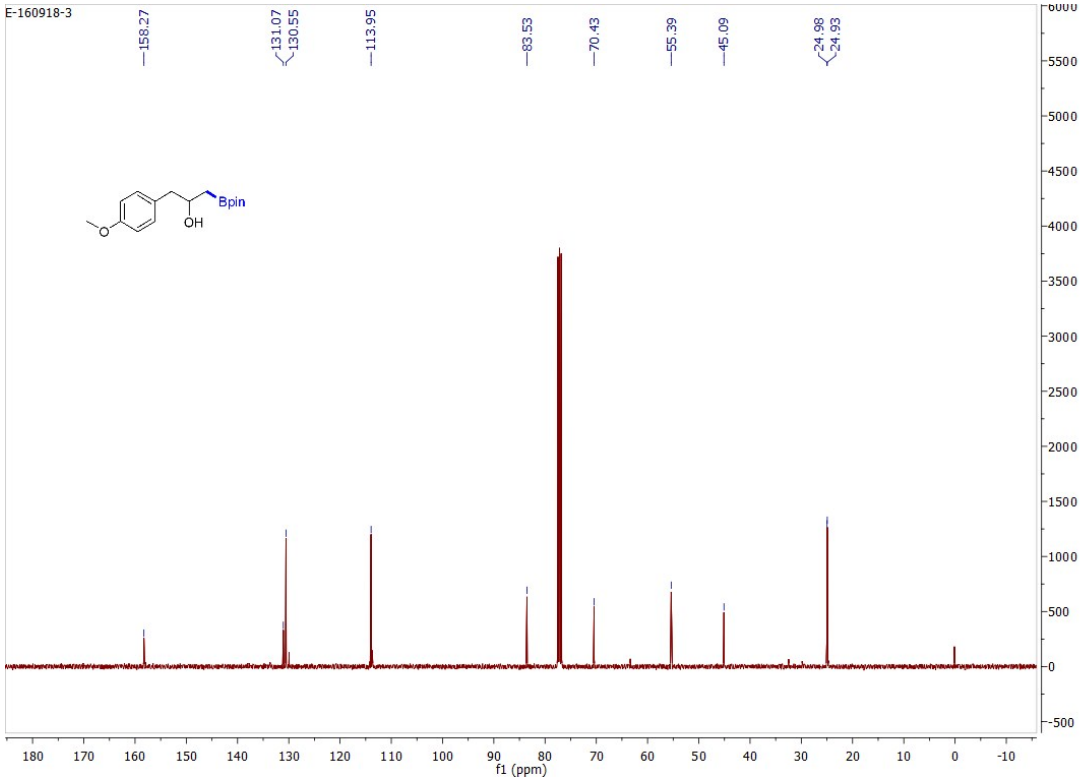

106L16_E160414_8
B11ZG CDCl3 D:\\ guoqingxiang 46
33.35
OH
Bpin
OH
f1 (ppm)

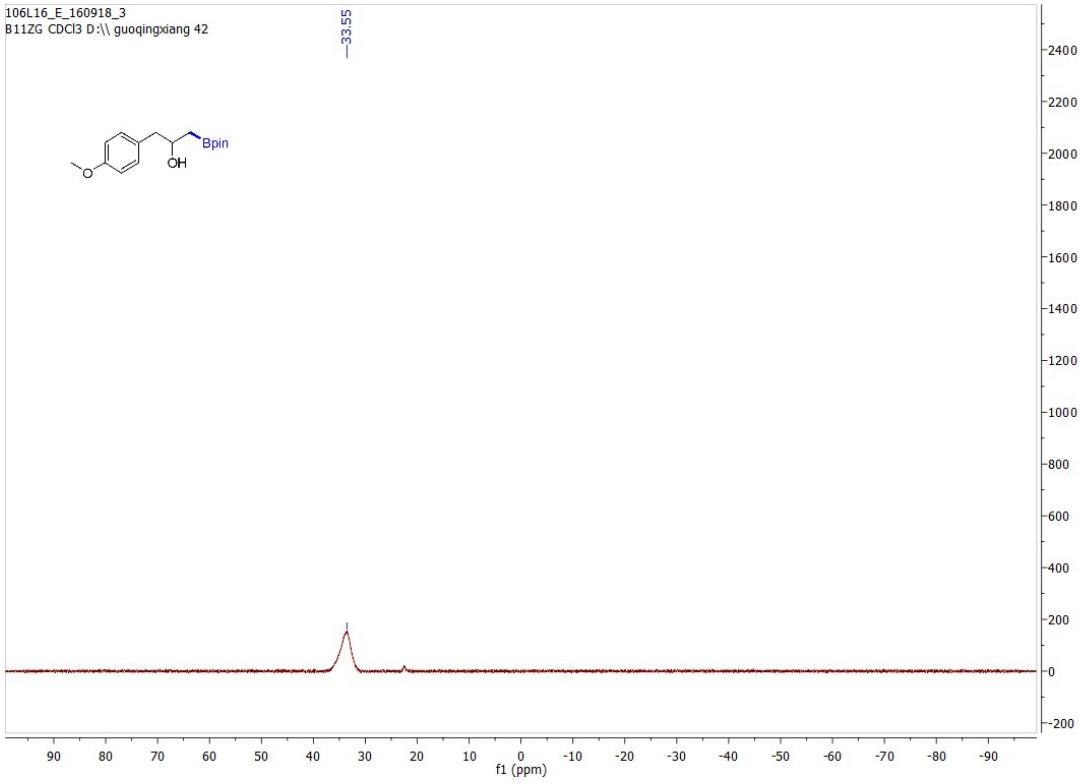

E-160918-1
OH
Bpin
f1 (ppm)

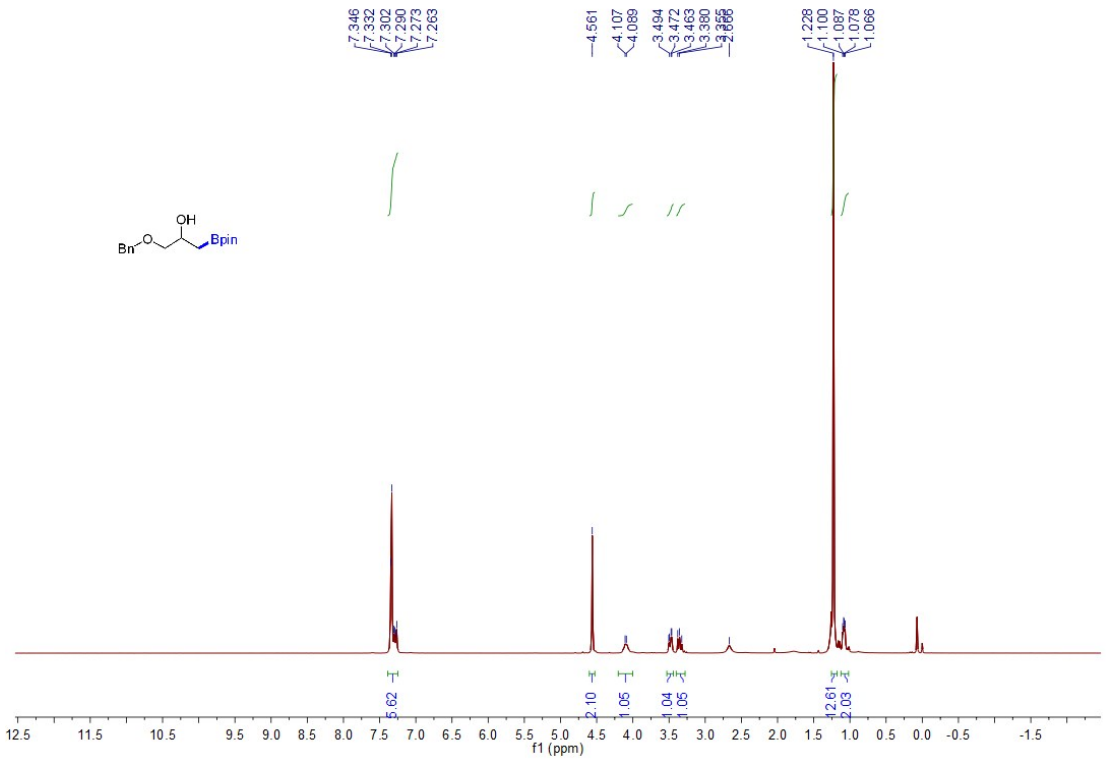

E-160918-1
OH
Bpin
f1 (ppm)

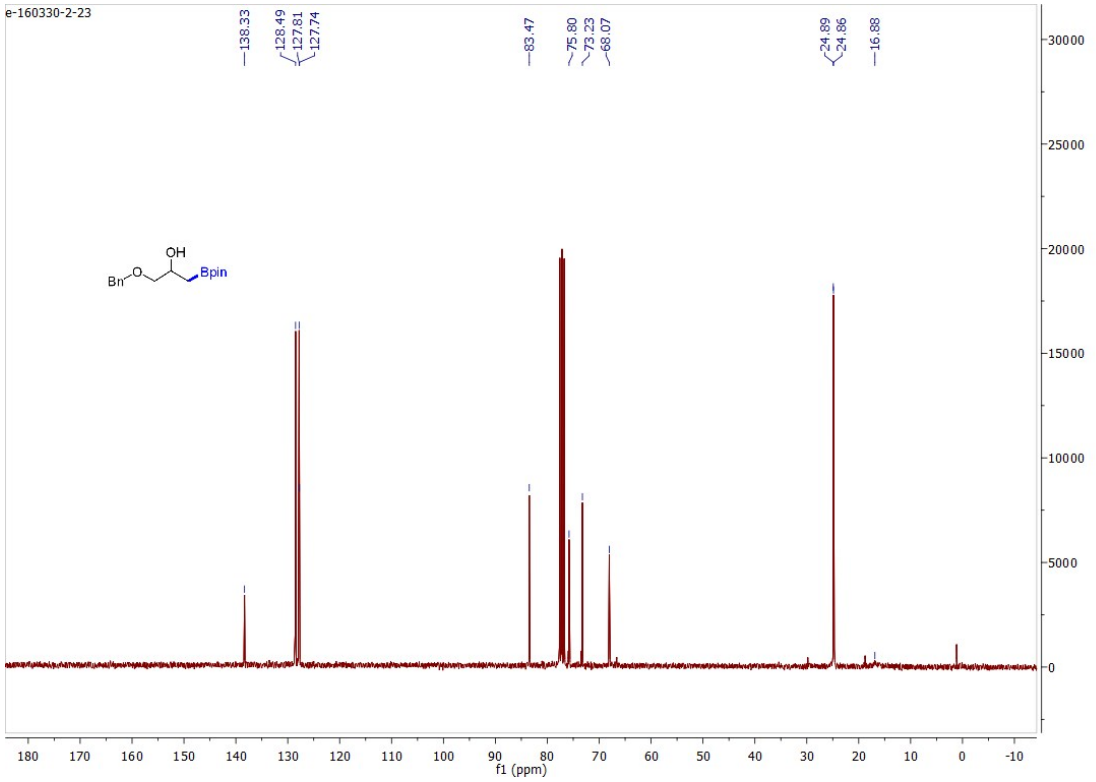

106L16_E_160918_1
B11ZG CDCl3 D:\\ guoqingxiang 41
33.60
OH
Bpin
f1 (ppm)

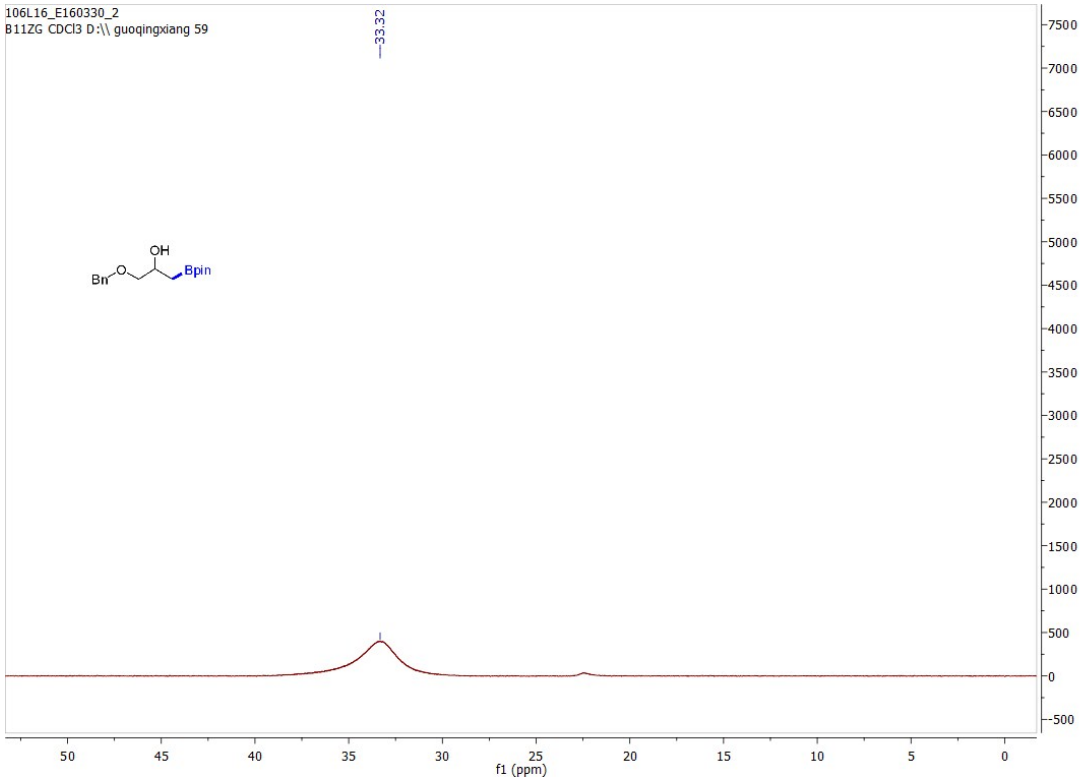

E-160918-3
7.14
7.12
6.85
6.83
4.07
4.06
4.06
4.04
4.03
4.02
4.01
3.79
2.72
2.72
2.71
2.70
2.23
1.26
1.14
1.12
1.11
1.09
1.07
1.05
Bpin
OH
2.16
2.05
1.01
3.45
2.18
12.00
2.06
f1 (ppm)

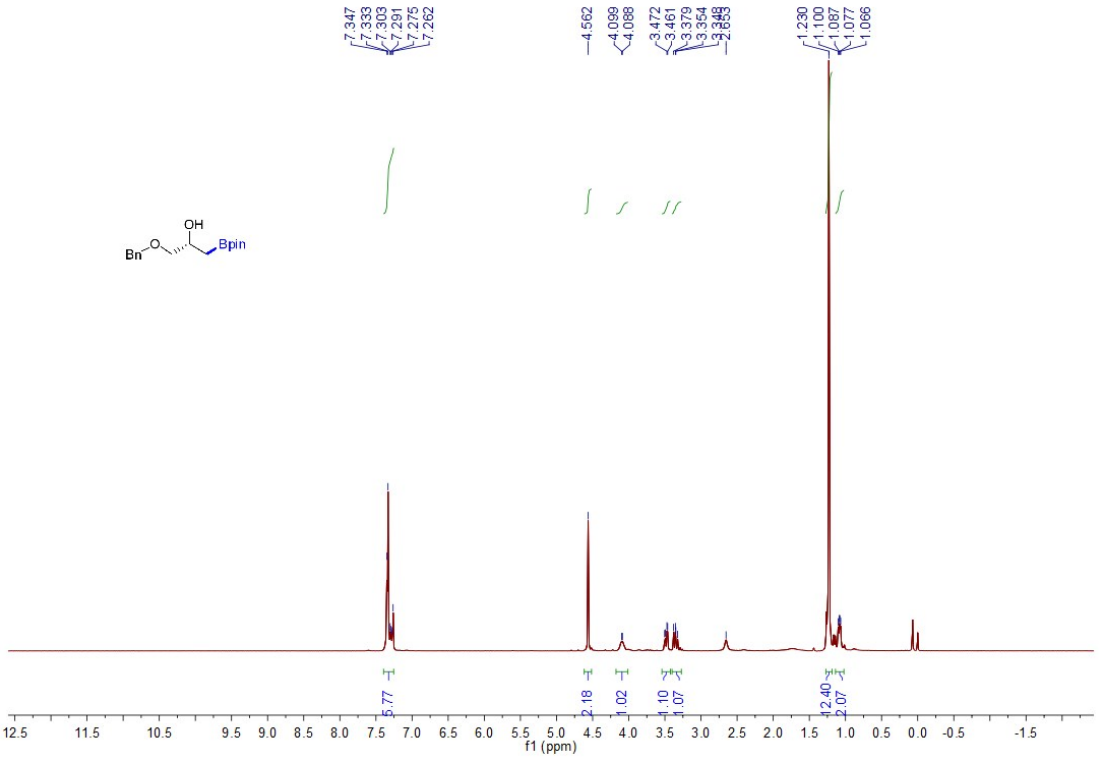

E-160918-3
158.27
131.07
130.55
113.95
83.53
70.43
55.39
45.09
24.98
24.93
Bpin
OH
f1 (ppm)

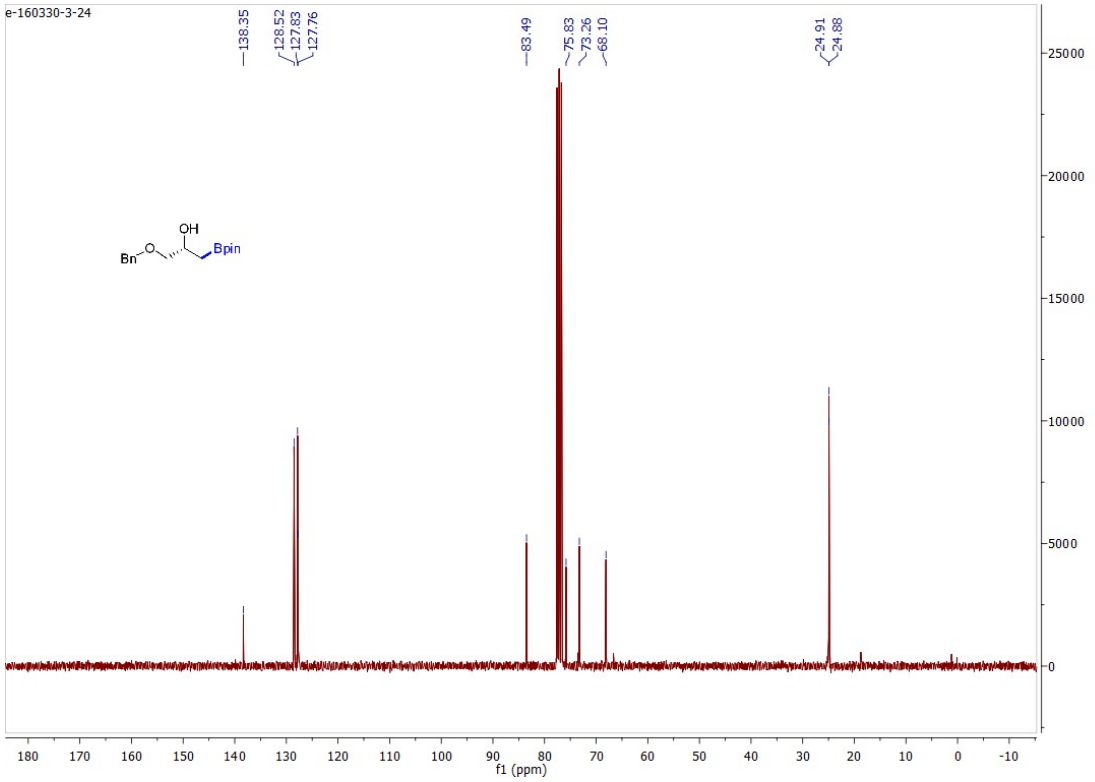

106L16_E_160918_3
B11ZG CDCl3 D:\\ guoqingxiang 42
33.55
Bpin
OH
f1 (ppm)

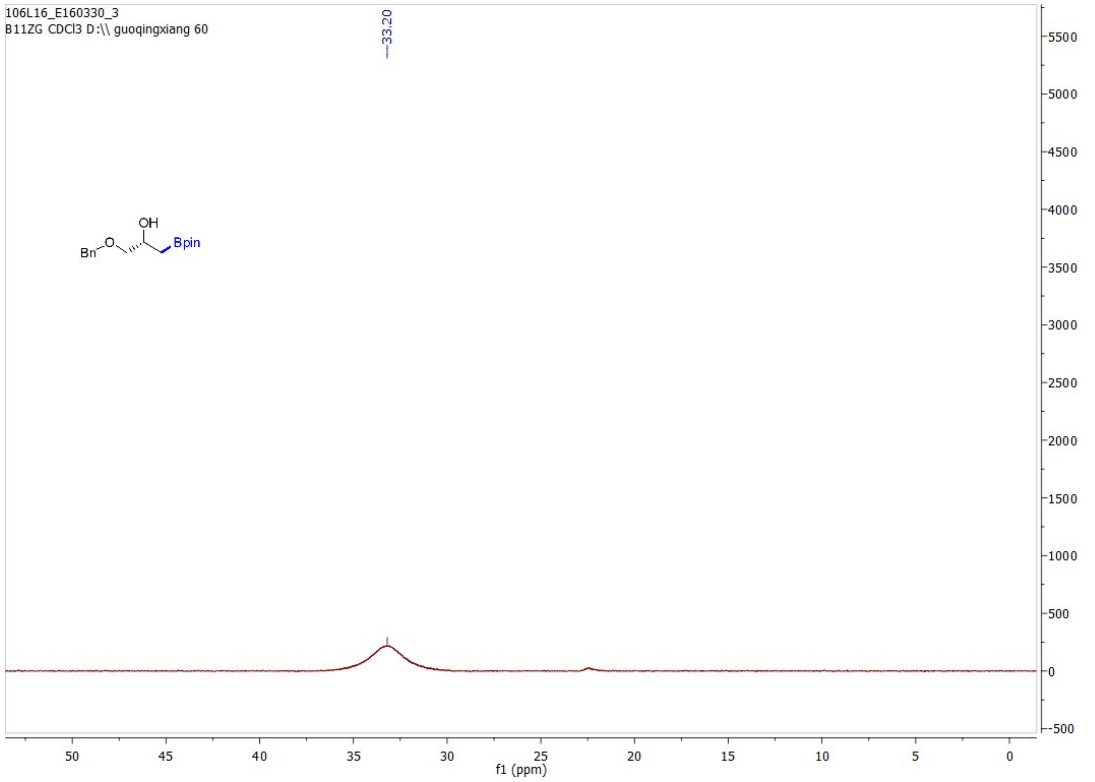

7.346
7.332
7.302
7.290
7.273
7.263
4.561
4.107
4.089
3.494
3.472
3.463
3.380
2.066
1.228
1.100
1.087
1.078
1.066
OH
Bn
O
Bpin
5.62
2.10
1.05
1.04
1.05
12.61
2.03
f1 (ppm)

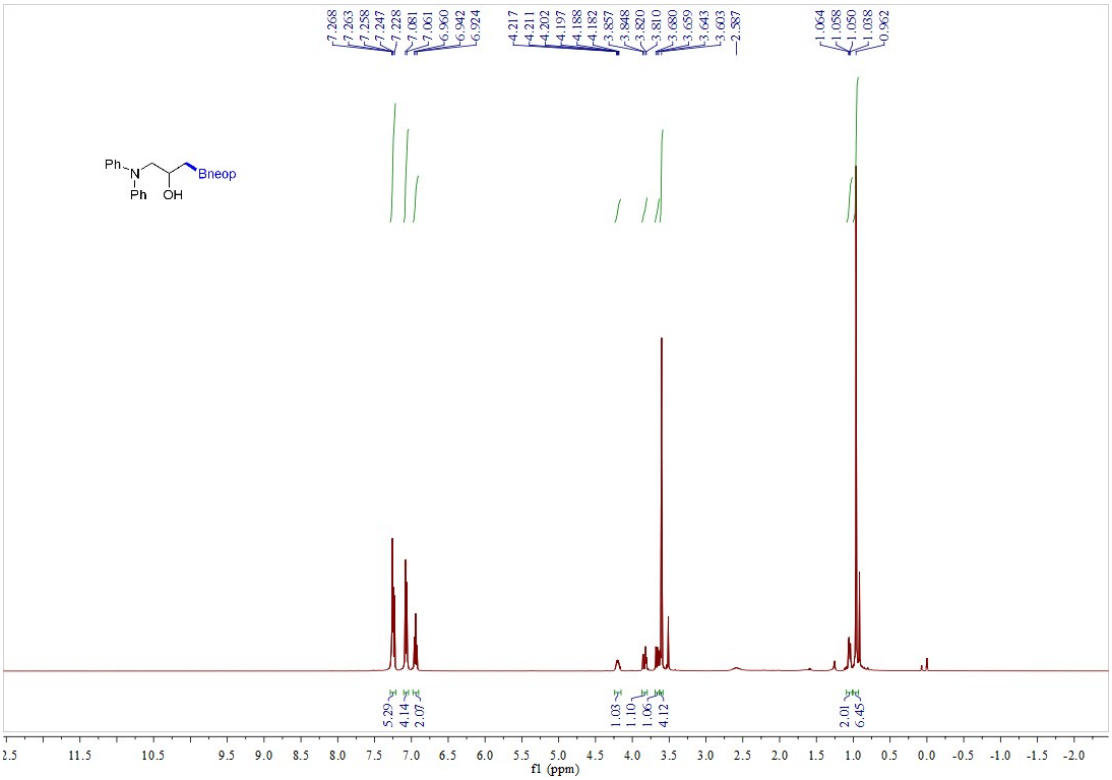

e-160330-2-23
138.33
128.49
127.81
127.74
83.47
75.80
73.23
68.07
24.89
24.86
16.88
OH
Bn
O
Bpin
f1 (ppm)


106L16_E160330_2
B11ZG CDCl3 D:\\ guoqingxiang 59
33.32
OH
Bn
O
Bpin
f1 (ppm)


7.347
7.333
7.303
7.291
7.275
7.262
4.562
4.099
4.088
3.472
3.461
3.379
3.354
2.653
1.230
1.100
1.087
1.077
1.066
OH
Bn
O
Bpin
5.77
2.18
1.02
1.10
1.07
12.40
2.07
f1 (ppm)


e-160330-3-24
138.35
128.52
127.83
127.76
83.49
75.83
73.26
68.10
24.91
24.88
OH
Bn
O
Bpin
f1 (ppm)


106L16_E160330_3
B11ZG CDCl3 D:\\ guoqingxiang 60
33.20
OH
Bn
O
Bpin
f1 (ppm)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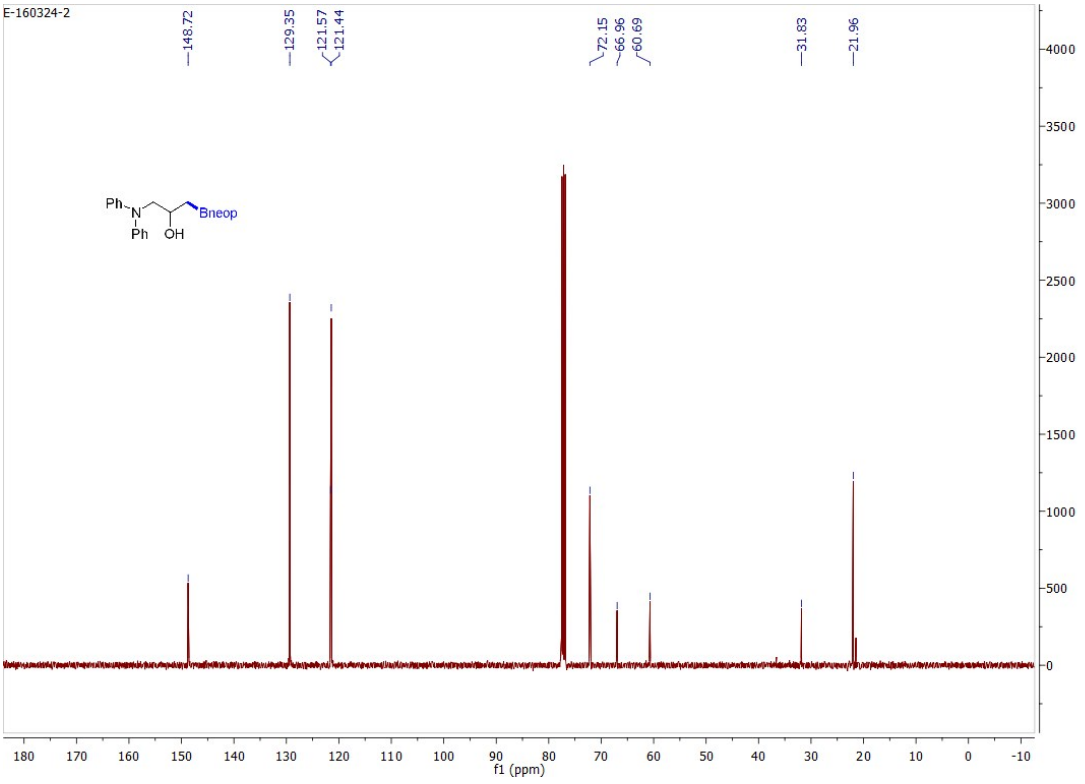
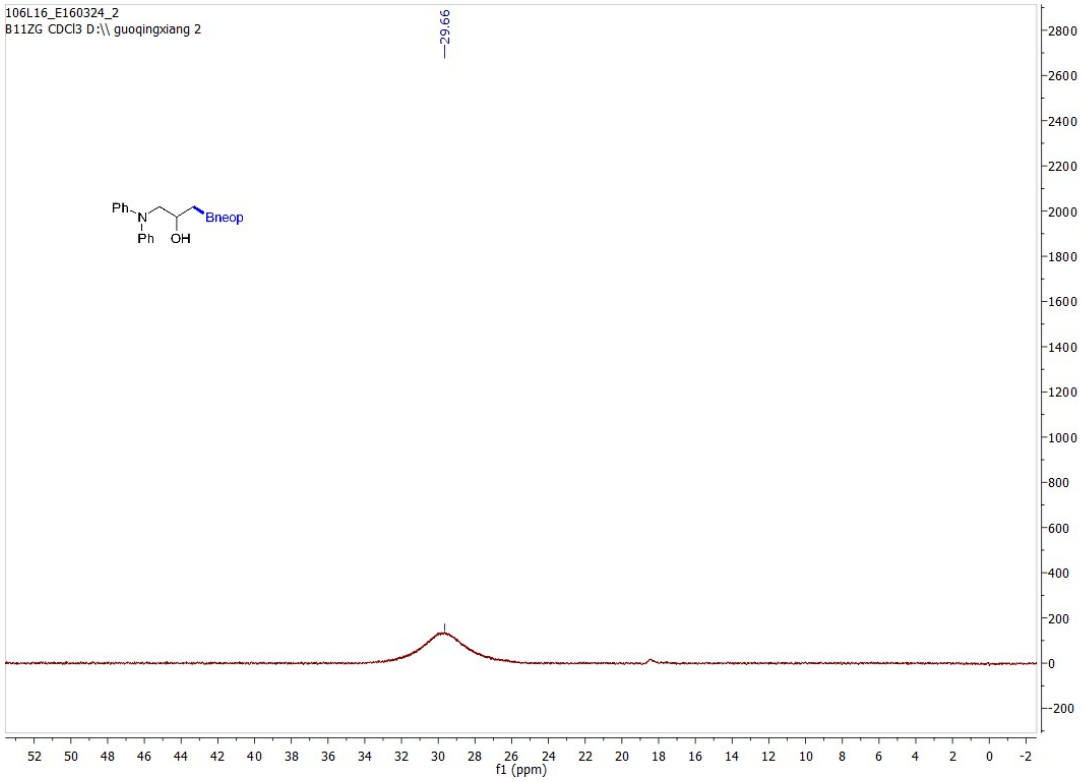
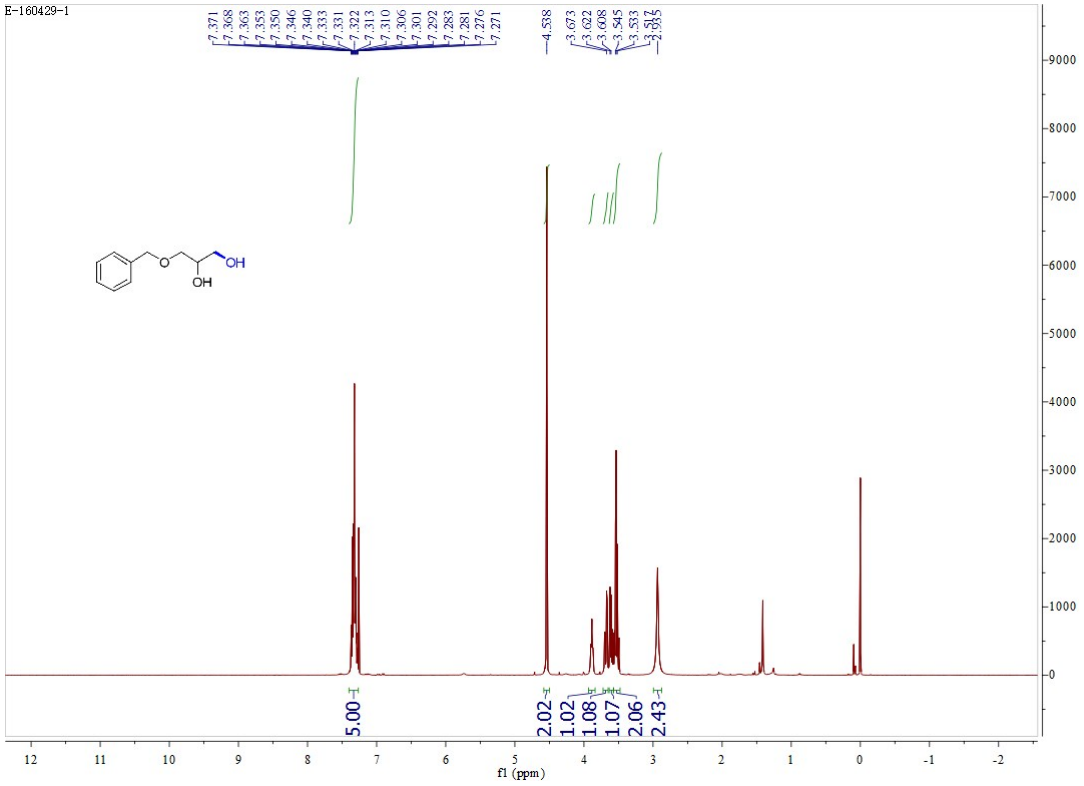
7.263
7.258
7.247
7.228
7.081
7.061
6.960
6.942
6.924
4.217
4.211
4.202
4.197
4.188
4.182
3.857
3.848
3.820
3.810
3.680
3.659
3.643
3.603
2.387
1.064
1.058
1.050
1.038
0.962
Ph
N
Ph
OH
Bneop
5.29
4.14
2.07
1.03
1.10
1.06
4.12
2.01
6.45
f1 (ppm)


E-160324-2
148.72
129.35
121.57
121.44
72.15
66.96
60.69
31.83
21.96
Ph
N
Ph
OH
Bneop
f1 (ppm)


106L16_E160324_2
B11ZG CDCl3 D:\\ guoqingxiang 2
29.66
Ph
N
Ph
OH
Bneop
f1 (ppm)


E-160429-1
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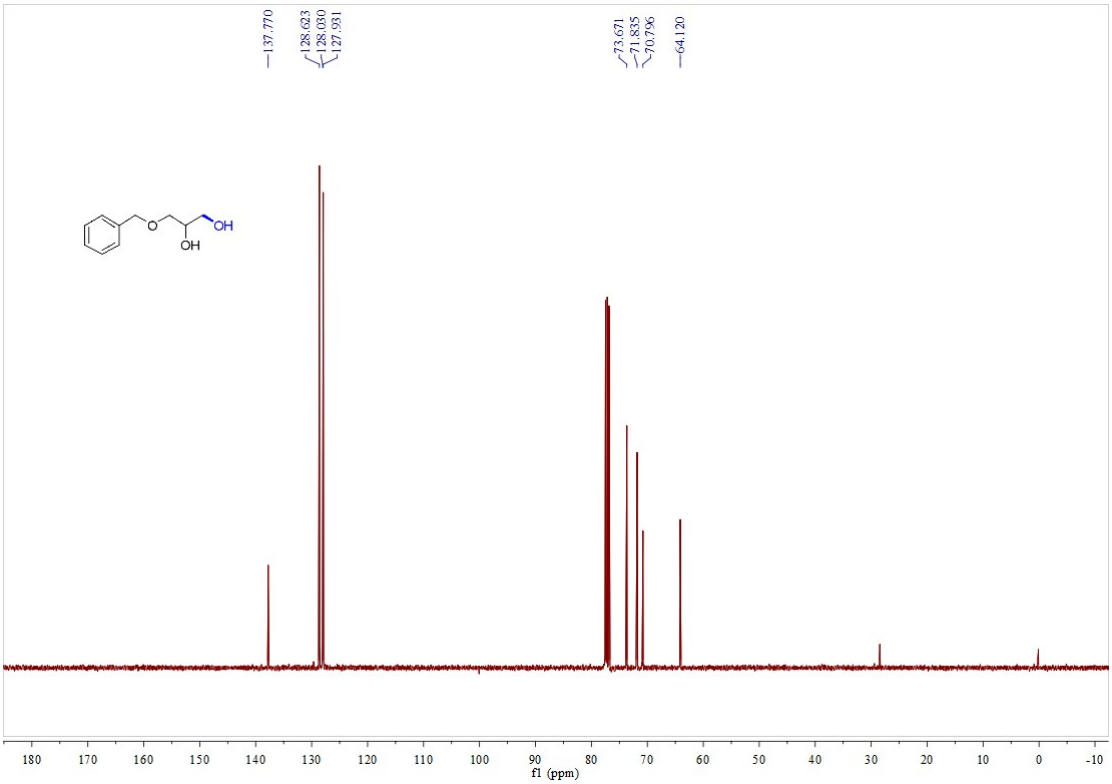
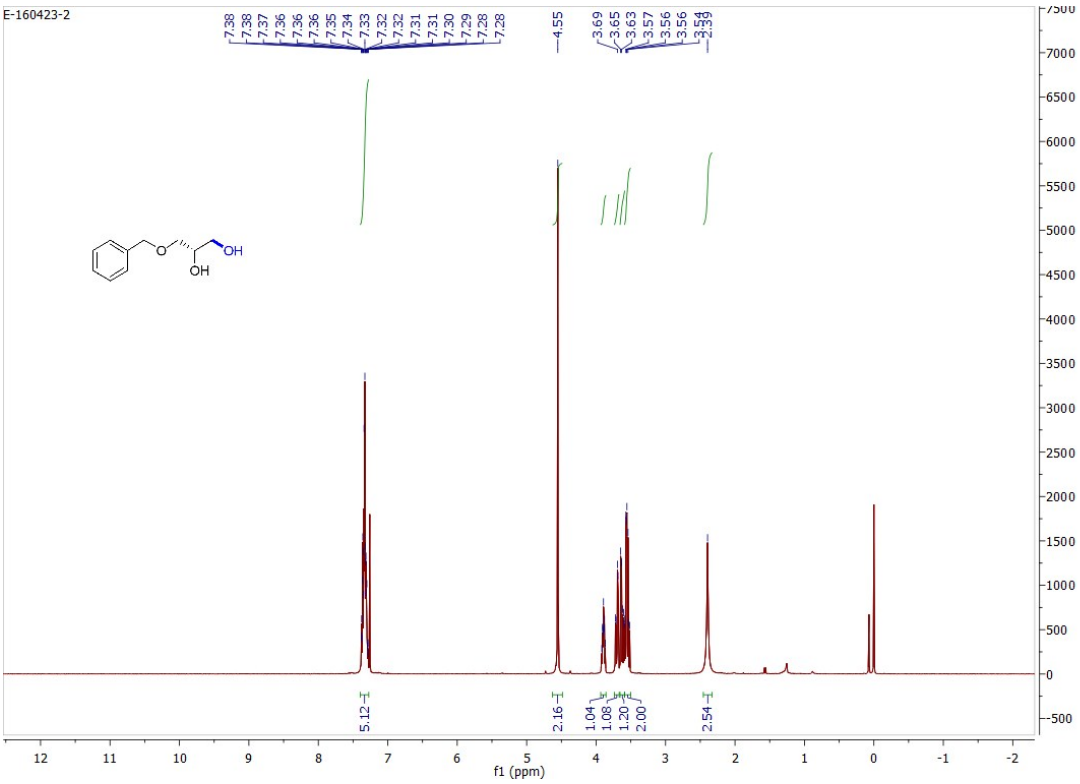
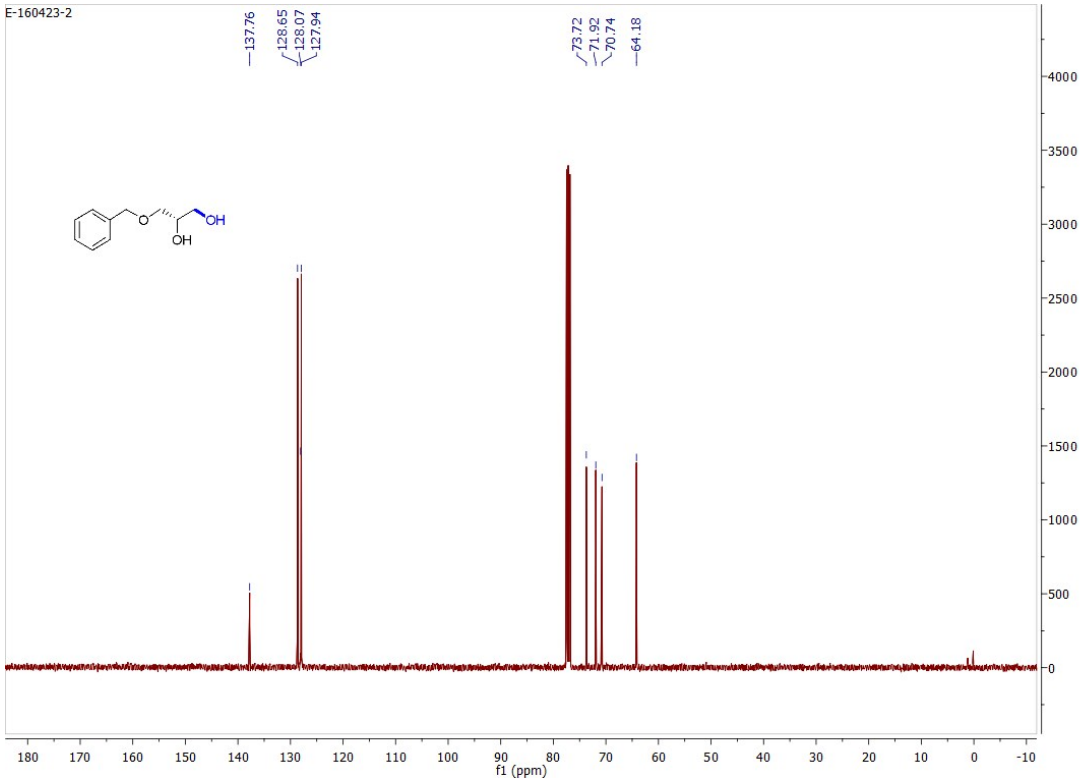
7.368
7.363
7.353
7.350
7.346
7.340
7.333
7.331
7.322
7.313
7.310
7.306
7.301
7.292
7.283
7.281
7.276
7.271
4.538
3.673
3.622
3.608
3.545
3.533
3.515
2.935
O
OH
OH
5.00
2.02
1.02
1.08
1.07
2.06
2.43
f1 (ppm)


137.770
128.623
128.030
127.931
73.671
71.835
70.796
64.120
OH
OH
f1 (ppm)


E-160423-2
7.38
7.38
7.37
7.36
7.36
7.36
7.35
7.34
7.33
7.32
7.32
7.31
7.31
7.30
7.29
7.28
7.28
4.55
3.69
3.65
3.63
3.57
3.56
3.56
3.54
3.39
OH
OH
5.12
2.16
1.04
1.08
1.20
2.00
2.54
f1 (ppm)


E-160423-2
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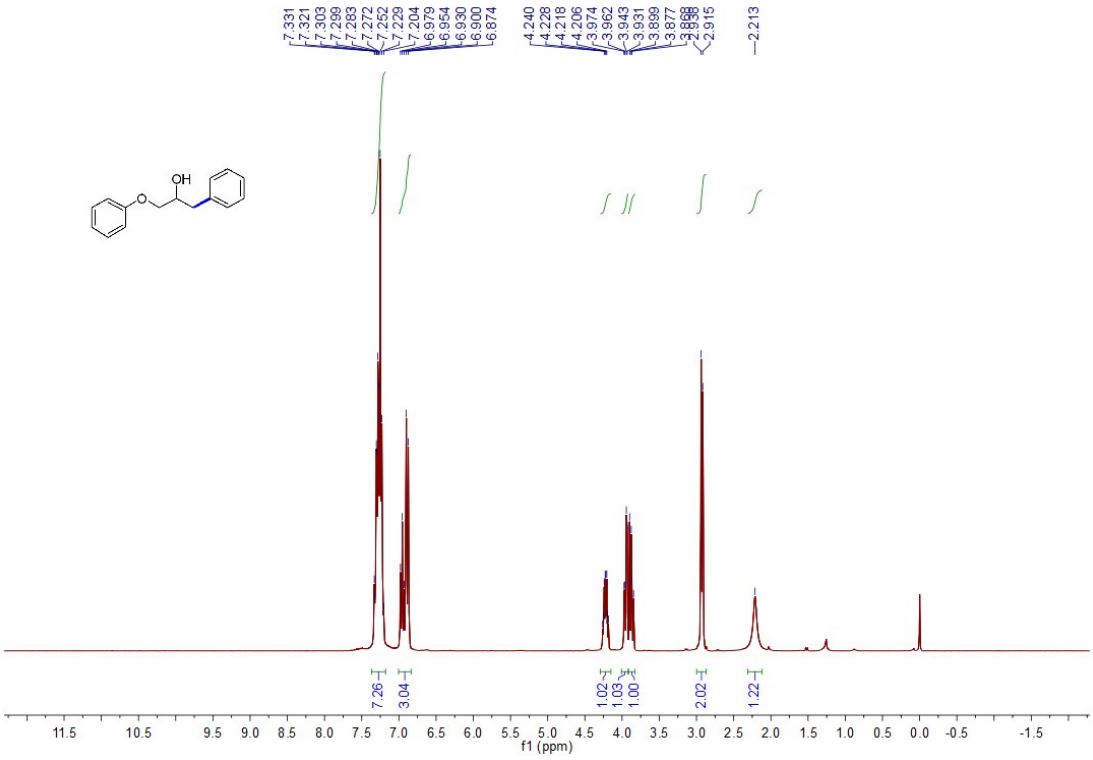
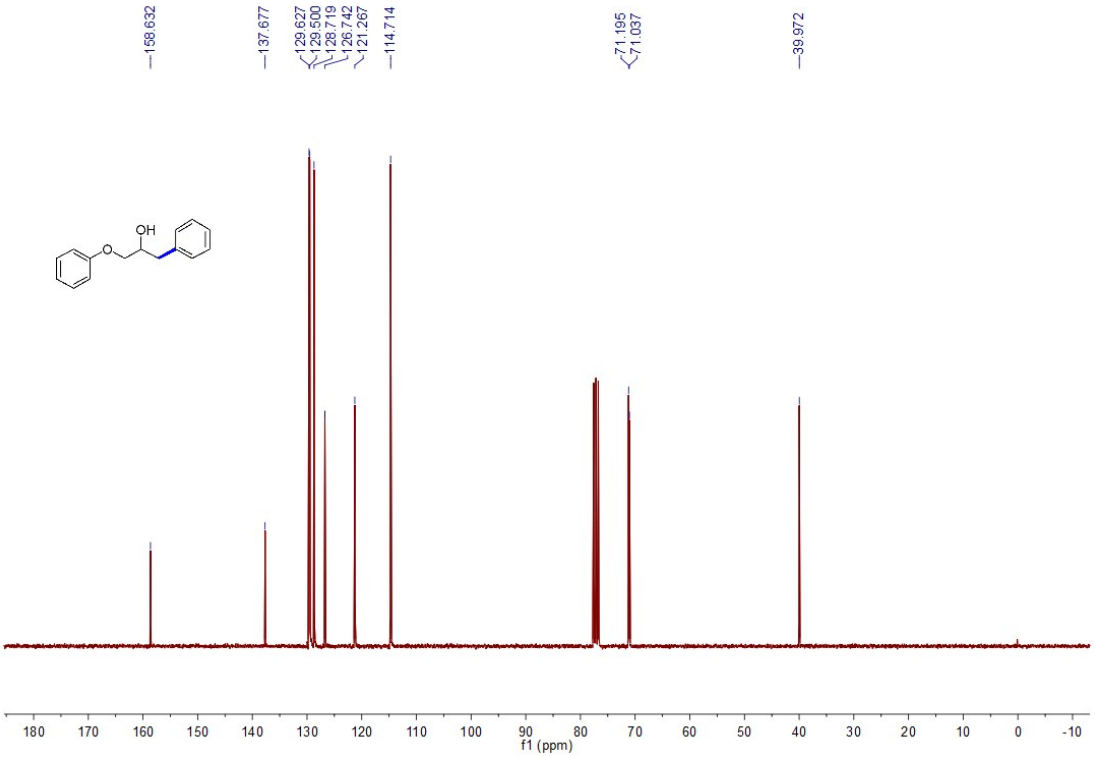
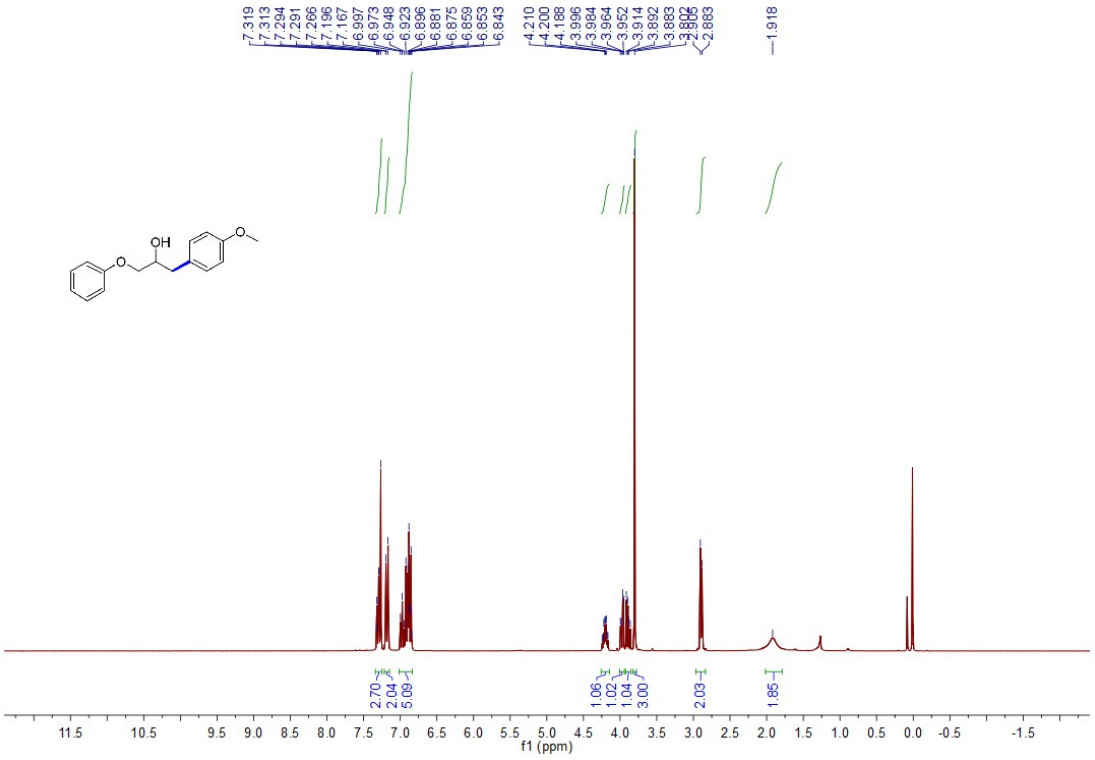
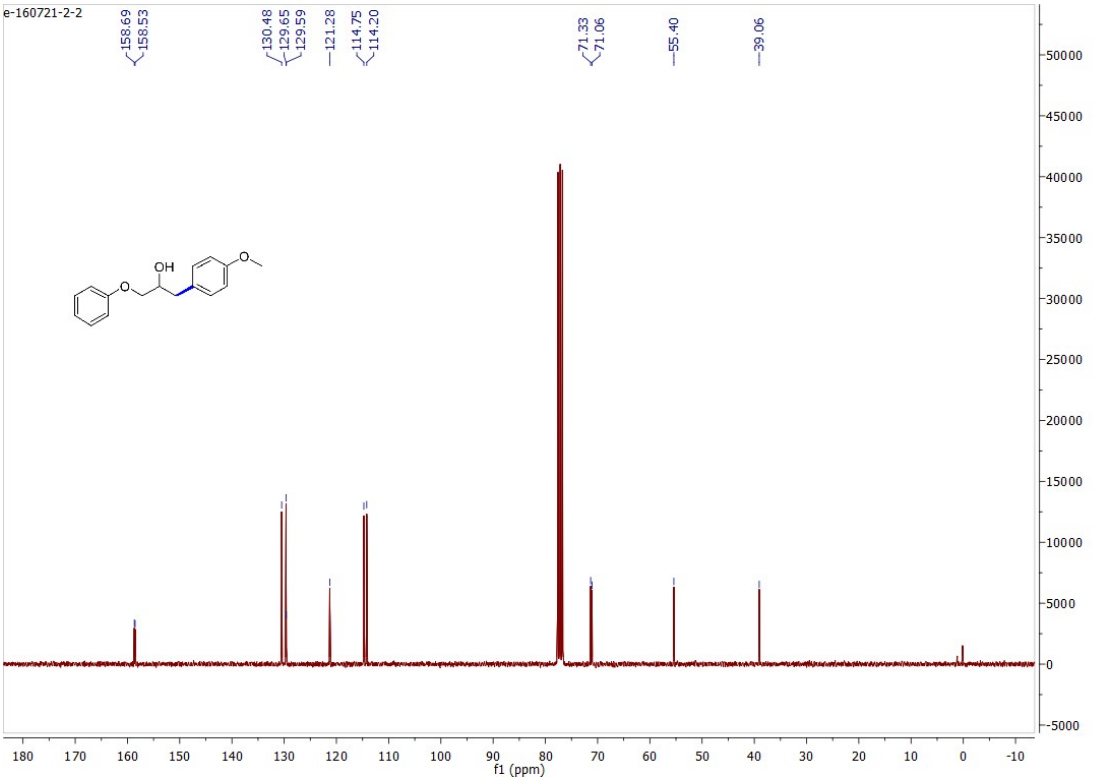
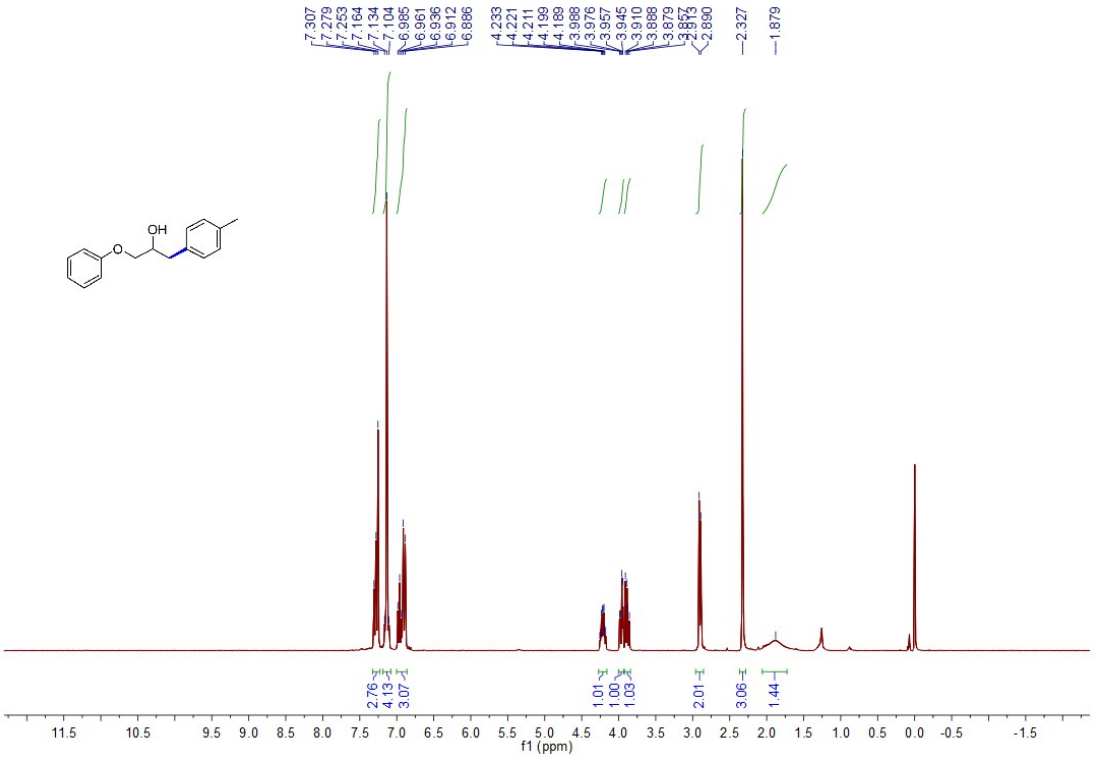
128.07
127.94
73.72
71.92
70.74
64.18
OH
OH
f1 (ppm)

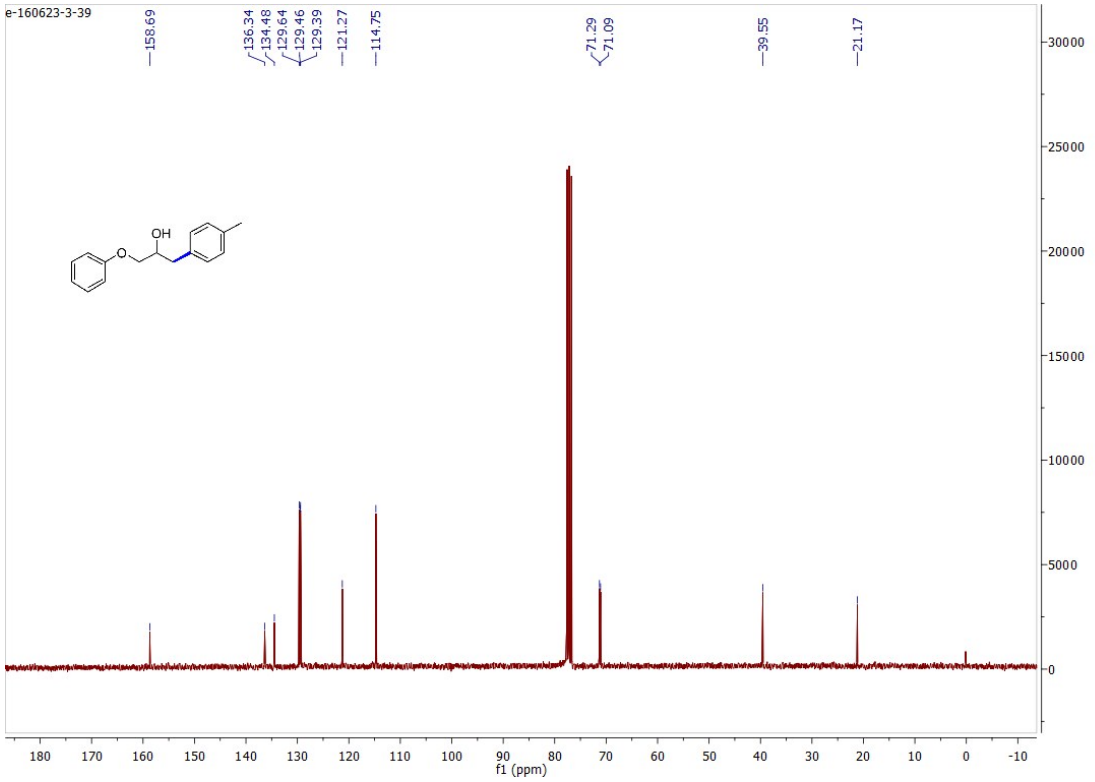

7.331
7.321
7.303
7.299
7.283
7.272
7.252
7.229
7.204
6.979
6.954
6.930
6.900
6.874
4.240
4.228
4.218
4.206
3.974
3.962
3.943
3.931
3.899
3.877
2.915
2.213
OH
7.26
3.04
1.02
1.03
1.00
2.02
1.22
f1 (ppm)

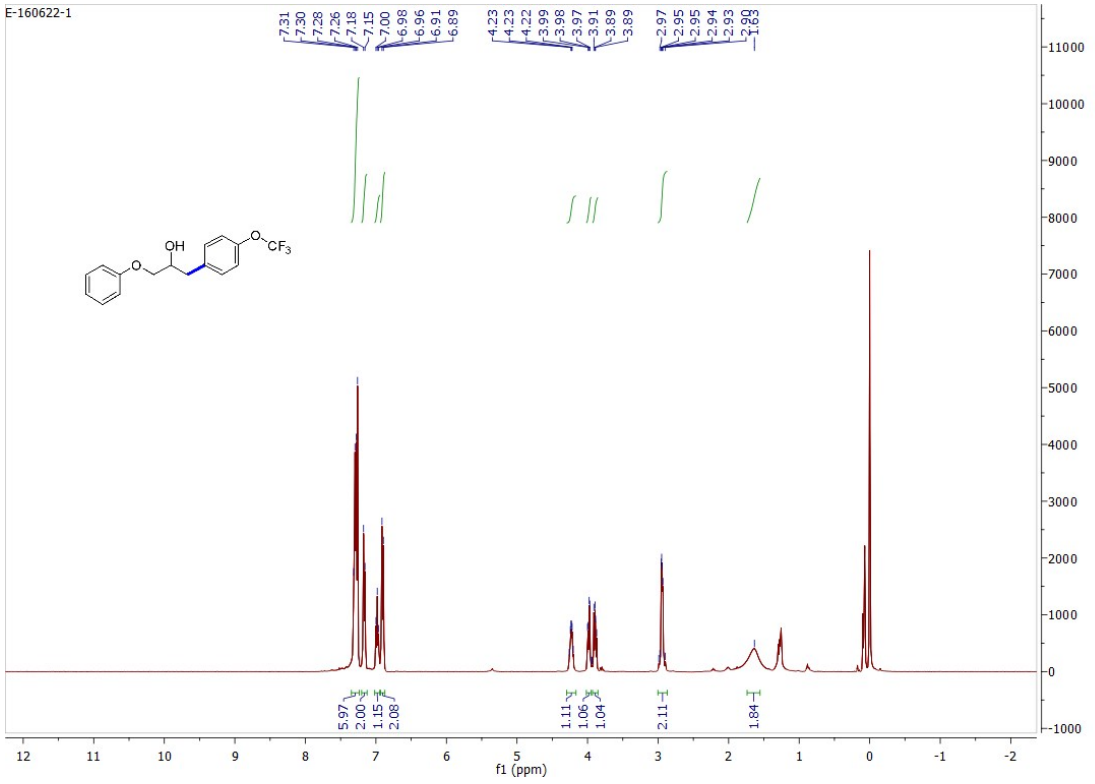

158.632
137.677
129.627
129.500
128.719
126.742
121.267
114.714
71.195
71.037
39.972
OH
f1 (ppm)

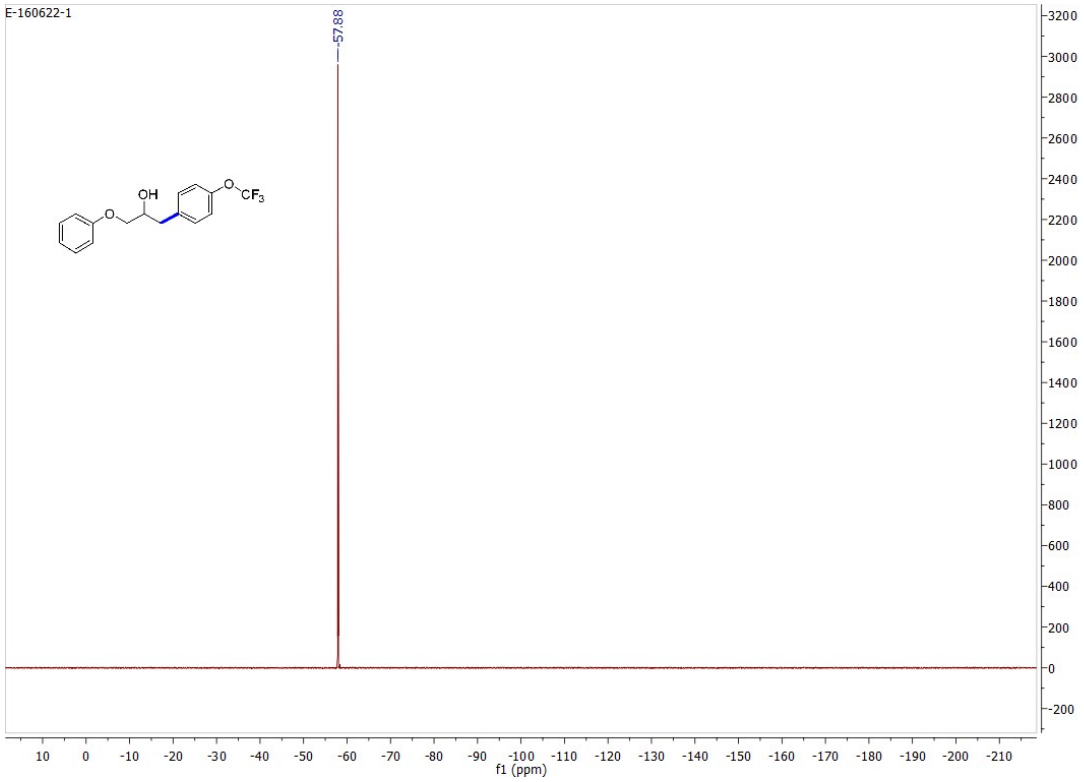

7.319
7.313
7.294
7.291
7.266
7.196
7.167
6.997
6.973
6.948
6.923
6.896
6.881
6.875
6.859
6.853
6.843
4.210
4.200
4.188
3.996
3.984
3.964
3.952
3.914
3.892
3.883
2.905
2.883
1.918
OH
2.70
2.04
5.09
1.06
1.02
1.04
3.00
2.03
1.85
f1 (ppm)

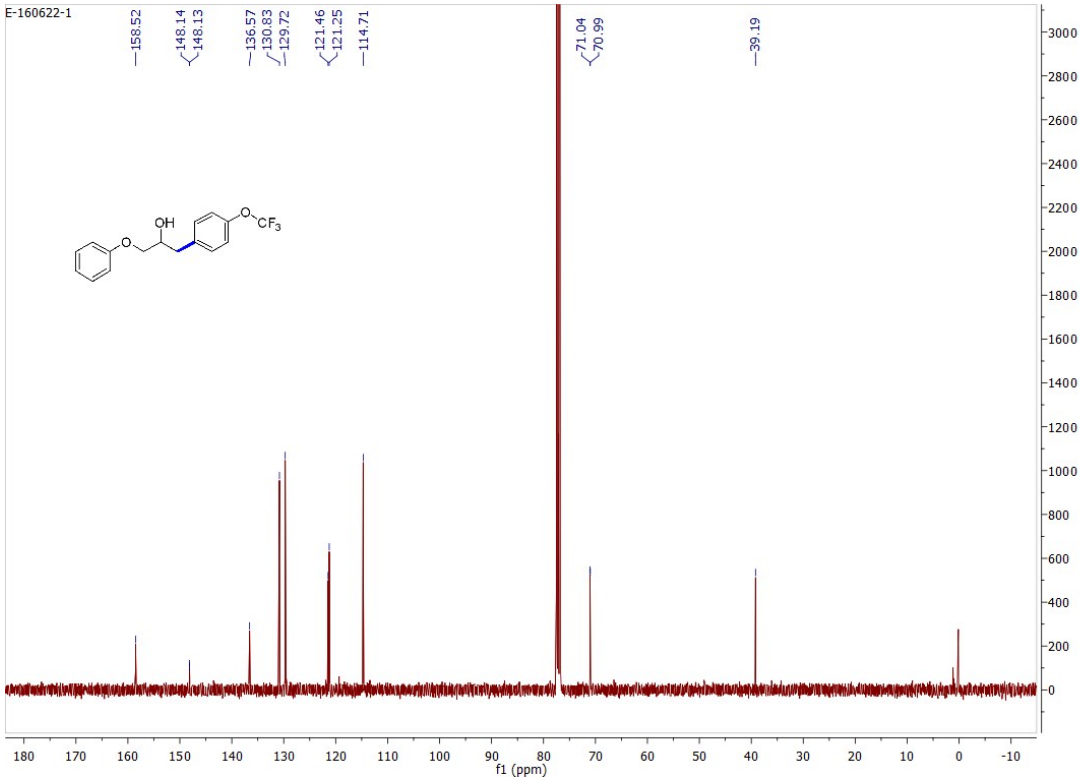

e-160721-2-2
158.69
158.53
130.48
129.65
129.59
121.28
114.75
114.20
71.33
71.06
55.40
39.06
OH
O
O
f1 (ppm)


7.307
7.279
7.253
7.164
7.134
7.104
6.985
6.961
6.936
6.912
6.886
4.233
4.221
4.211
4.199
4.189
3.988
3.976
3.957
3.945
3.910
3.888
3.879
2.913
2.890
2.327
1.879
OH
O
2.76
4.13
3.07
1.01
1.00
1.03
2.01
3.06
1.44
f1 (ppm)


e-160623-3-39
158.69
136.34
134.48
129.64
129.46
129.39
121.27
114.75
71.29
71.09
39.55
21.17
OH
O
f1 (ppm)


E-160622-1
7.31
7.30
7.28
7.26
7.18
7.15
7.00
6.98
6.96
6.91
6.89
4.23
4.23
4.22
3.99
3.98
3.97
3.91
3.89
3.89
2.97
2.95
2.95
2.94
2.93
1.93
1.93
OH
O
CF3
5.97
2.00
1.15
2.08
1.11
1.06
1.04
2.11
1.84
f1 (ppm)


E-160622-1
-57.88
OH
O
O
CF3
f1 (ppm)


E-160622-1
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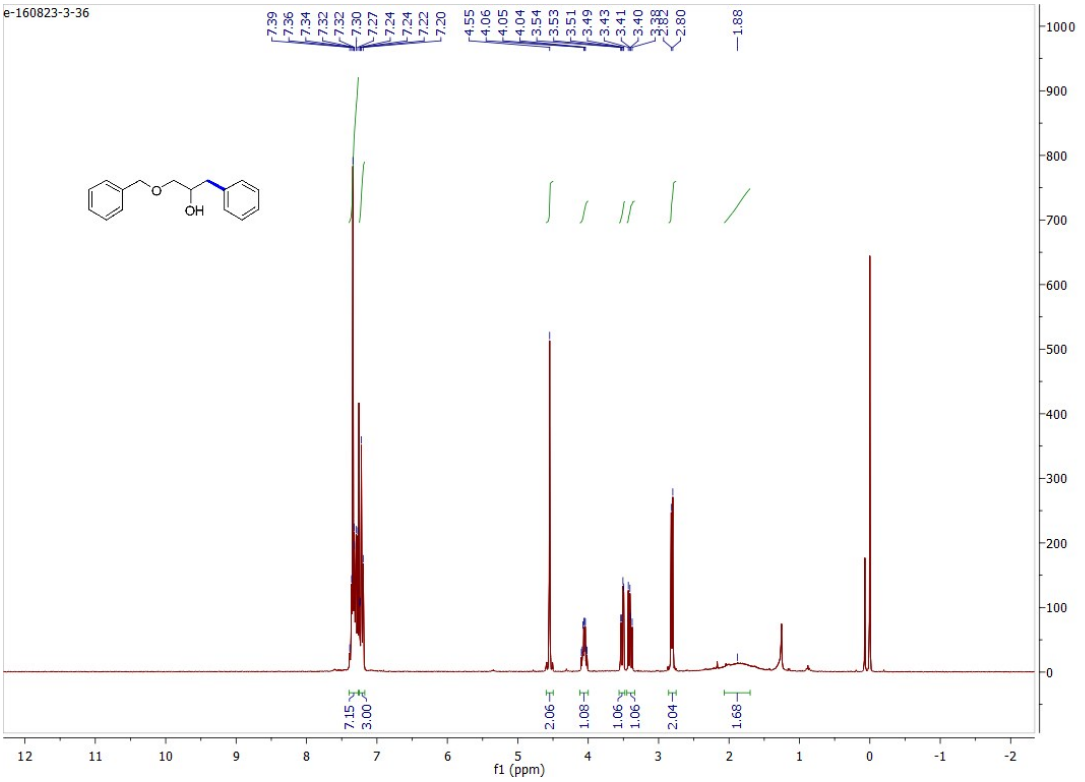
148.14
148.13
136.57
130.83
129.72
121.46
121.25
114.71
71.04
70.99
39.19
OH
O
O
CF3
f1 (ppm)


e-160823-3-36
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7.36
7.34
7.32
7.32
7.30
7.27
7.24
7.24
7.22
7.20
4.55
4.06
4.05
4.04
3.54
3.53
3.51
3.49
3.43
3.41
3.40
3.38
2.82
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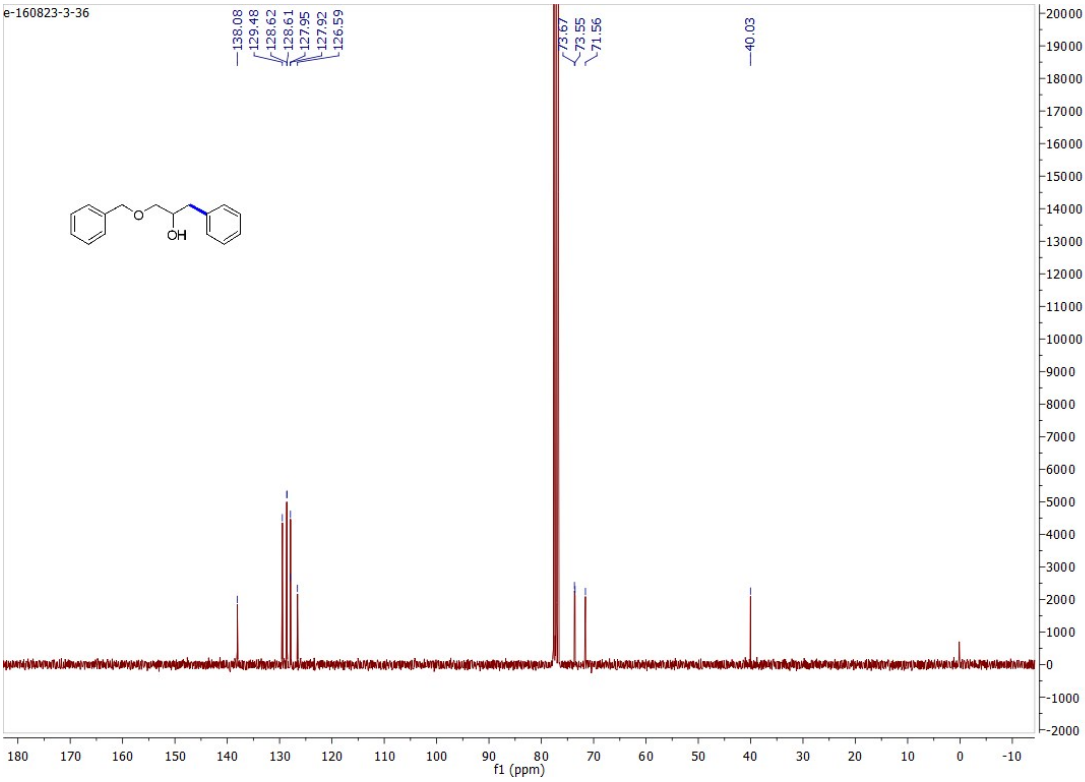
OH
7.15
3.00
2.06
1.08
1.06
1.06
2.04
1.68
f1 (ppm)


e-160823-3-36
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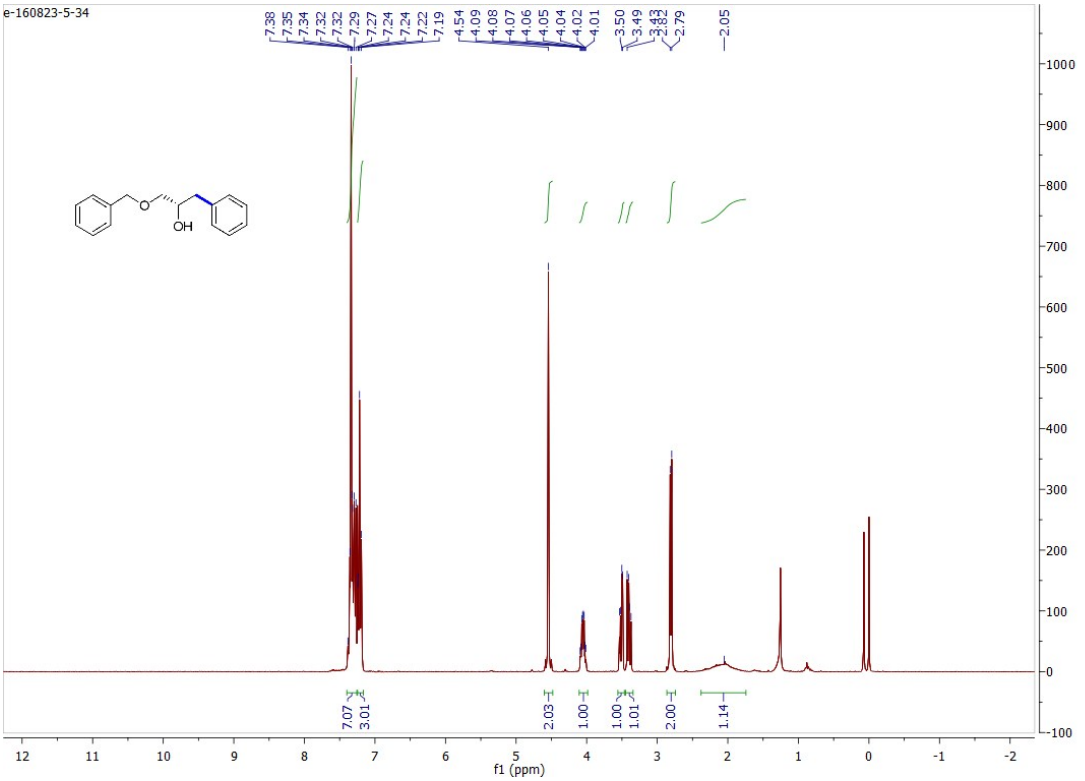
127.92
126.59
73.67
73.55
71.56
40.03
OH
f1 (ppm)


e-160823-5-34
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7.35
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7.32
7.29
7.27
7.24
7.24
7.22
7.19
4.54
4.09
4.08
4.07
4.06
4.05
4.04
4.02
4.01
3.50
3.49
3.43
2.82
2.79
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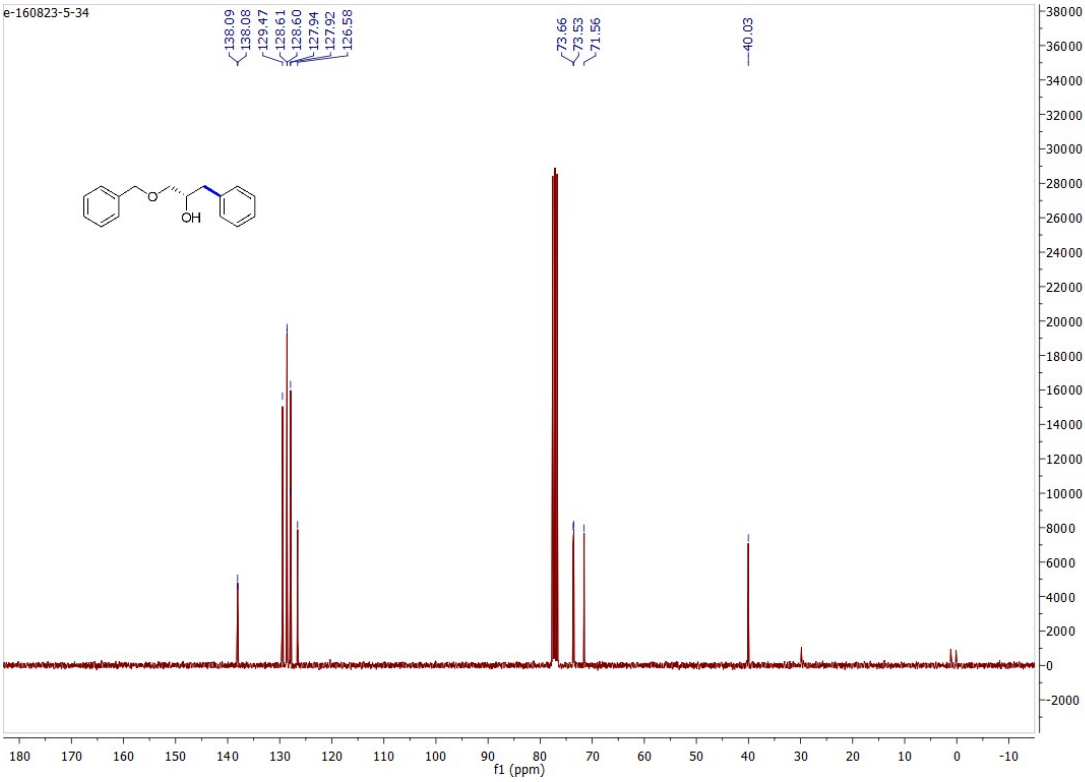
OH
7.07
3.01
2.03
1.00
1.00
1.01
2.00
1.14
f1 (ppm)


e-160823-5-34
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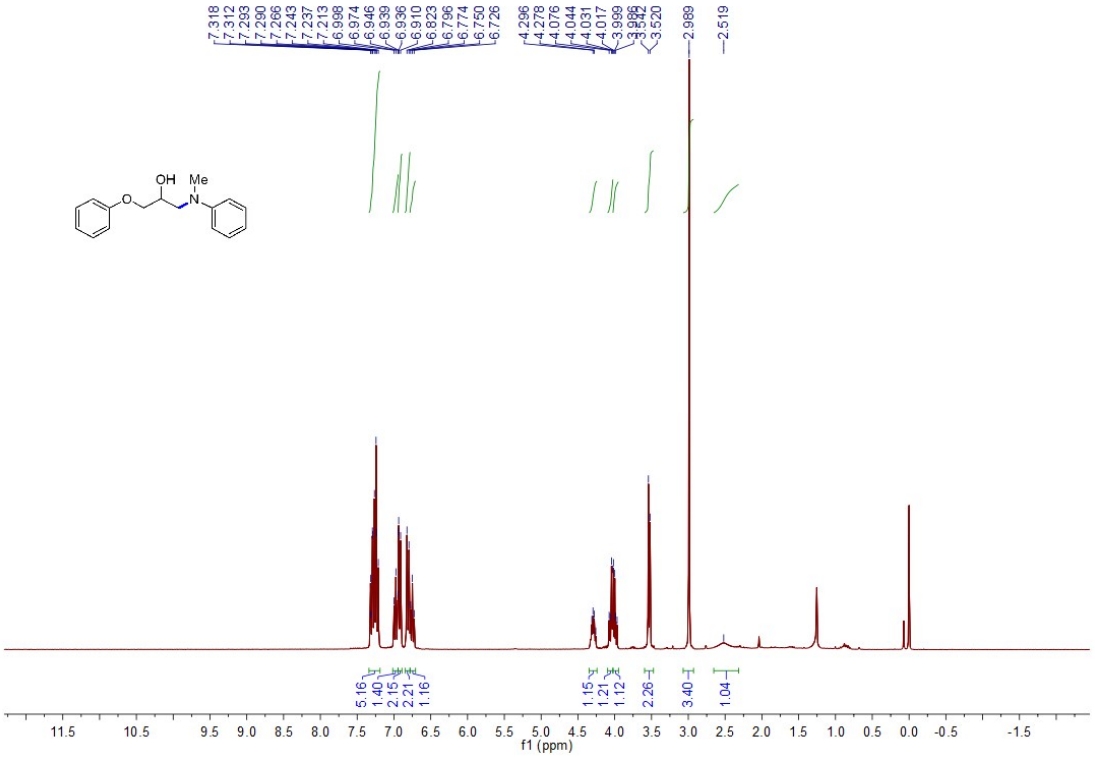
127.92
126.58
73.66
73.53
71.56
40.03
OH
f1 (ppm)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7.237
7.213
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6.974
6.946
6.939
6.936
6.910
6.823
6.796
6.774
6.750
6.726
4.296
4.278
4.076
4.044
4.031
4.017
3.999
3.986
3.942
3.520
2.989
2.519
OH
Me
N
O
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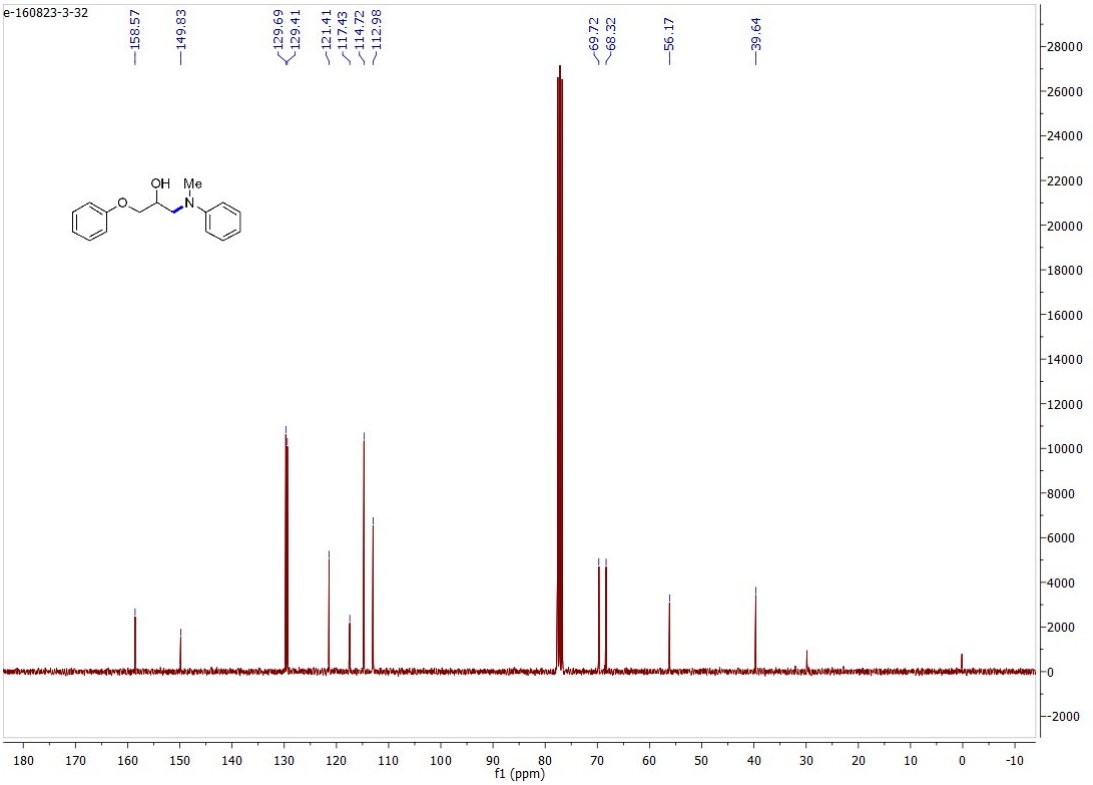
2.15
2.21
1.16
1.15
1.21
1.12
2.26
3.40
1.04
f1 (ppm)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129.69
129.41
121.41
117.43
114.72
112.98
69.72
68.32
56.17
39.64
OH
Me
N
O
f1 (ppm)