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Supporting Information

Silver-catalyzed one-pot cyclization/fluorination of 2-alkynylanilines: highly efficient synthesis of structurally diverse fluorinated indole derivatives

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Table of Contents

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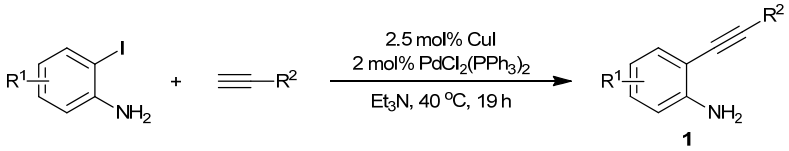
I. General remarks

NMR spectra were obtained on a Bruker AV II-400 MHz spectrometer (^{1}H NMR at 400 MHz, ^{13}C NMR at 100 MHz, and ^{19}F NMR at 376 MHz). The ^{1}H NMR chemical shifts were measured relative to $CDCl_3$ or DMSO-d_6 as the internal reference ($CDCl_3$: δ = 7.26 ppm; DMSO-d_6: δ = 2.50 ppm). The ^{13}C NMR chemical shifts were given using $CDCl_3$ or DMSO-d_6 as the internal standard ($CDCl_3$: δ = 77.16 ppm; DMSO-d_6: δ = 39.52 ppm). High-resolution mass spectra (HRMS) were obtained with a Waters-Q-TOF-Premier (ESI). Melting points were determined with Hanon MP300 and are uncorrected.

Unless otherwise noted, all reagents were obtained from commercial suppliers and used without further purification. $AgNO_3$ and Ag_2CO_3 were purchased from Chengdu Kelong Chemical Engineering Reagent (China) CO., Ltd and Tianjin Yingda Chemical Engineering Reagent (China) CO., Ltd, respectively. Selectfluor and NFSI were purchased from Beijing Innochem Science & Technology (China) CO., Ltd. 1,4-Dioxane (HPLC) was purchased from J & K Chemical Limited in China and used without further purification. CH_3CN was dried over CaH_2 and stored under N_2 over activated 4Å molecular sieves. Starting materials **1**[1] and **3**[2] were prepared according to the literature procedure. Starting materials **1a**[1], **1b-1d**[3], **1e**[4], **1f**[5], **1h**[6], **1j**[7], **1k**[8], **1l-1m**[3], **1n**[9], **3a**[10], **3b**[11], **3c**[12], and **3j**[10] are known compounds and were identified by comparison of their spectral data with those reported in the literature.

II. Synthesis and characterization of the starting materials

i. General procedure for the synthesis of *N*-unprotected 2-(1-alkynyl)anilines 1[1]



1

A mixture of 2-iodoaniline (2.0 mmol), terminal alkyne (2.4 mmol), CuI (9.6 mg, 2.5 mol%) and $PdCl_2(PPh_3)_2$ (28 mg, 2.0 mol%) in Et_3N (8 ml) was heated at 40 °C for 19 h under an nitrogen atmosphere. The volatile was then evaporated and the residue was partitioned between EtOAc (3 x 10 mL) and water (10 mL). The combined organic

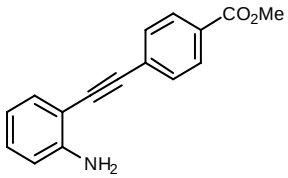
phases were washed with water (10 mL) and dried over anhydrous Na_2SO_4. The solvent was evaporated and the residue was purified by column chromatography on silica gel to afford the desired products.

ii. General procedure for the synthesis of *N*-substituted-2-(1-alkynyl)anilines 3[2]

3

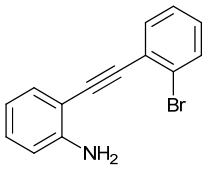
A mixture of *N*-substituted-2-iodoaniline (2.0 mmol), terminal alkyne (2.4 mmol), CuI (11 mg, 5.0 mol%) and $PdCl_2(PPh_3)_2$ (28 mg, 2.0 mol%) in Et_3N/THF (1:1, 10 ml) was heated at 40 °C under an nitrogen atmosphere for 2-19 h. The solvent was then evaporated and the residue was partitioned between EtOAc (3 x 10 mL) and water (10 mL). The combined organic phases were washed with water (10 mL) and dried over anhydrous Na_2SO_4. The volatile was evaporated and the residue was purified by column chromatography on neutral Al_2O_3 to afford the desired products.

iii. Characterization of the unknown starting materials



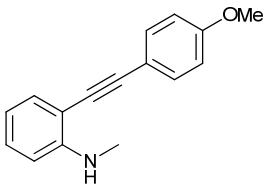
Methyl 4-((2-aminophenyl)ethynyl)benzoate (1g)

Compound **1g** was obtained as a white solid in 95% yield. M.p.: 97-99 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.93 (s, 3H), 4.26 (br. s, 2H), 6.71-6.74 (m, 2H), 7.16 (td, J = 7.6 Hz, 1.2 Hz, 1H), 7.37 (dd, J = 8.0 Hz, 1.6 Hz, 1H), 7.57 (d, J = 8.4 Hz, 2H), 8.02 (d, J = 8.0 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 52.3, 89.2, 94.1, 107.4, 114.6, 118.2, 128.2, 129.5, 129.7, 130.4, 131.4, 132.4, 148.1, 166.6 ppm. HRMS (ESI^+): calcd for $C_{16}H_{13}KNO_2$ $[M+K]^+$ 290.0583, found 290.0583.



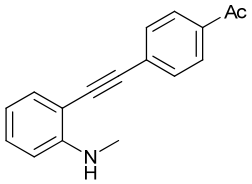
2-((2-Bromophenyl)ethynyl)aniline (1i)

Compound **1i** was obtained as a yellow solid in 82% yield. M.p.: 253-255 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 4.40 (br. s, 2H), 6.72-6.76 (m, 2H), 7.15-7.20 (m, 2H), 7.31 (td, J = 7.6 Hz, 0.8 Hz, 1H), 7.41 (dt, J = 7.6 Hz, 1.6 Hz, 1H), 7.58 (dd, J = 8.0 Hz, 1.6 Hz, 1H), 7.63 (dd, J = 8.0 Hz, 1.2 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 91.2, 93.5, 107.5, 114.5, 118.0, 125.2, 125.7, 127.3, 129.3, 130.3, 132.2, 132.5, 133.1, 148.5 ppm. HRMS (ESI^+): calcd for $C_{14}H_{10}BrNNa$ $[M+Na]^+$ 293.9894, found 293.9889.



2-((4-Methoxyphenyl)ethynyl)-*N*-methylaniline (3d)

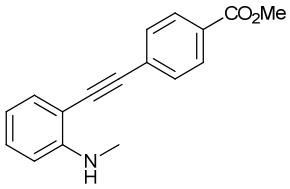
Compound **3d** was obtained as a white solid in 82% yield. M.p.: 103-104 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.94 (s, 3H), 3.84 (s, 3H), 4.70 (br. s, 1H), 6.62 (d, J = 8.0 Hz, 1H), 6.68 (t, J = 7.6 Hz, 1H), 6.88-6.91 (m, 2H), 7.23-7.27 (m, 1H), 7.38 (d, J = 7.6 Hz, 1H), 7.48 (d, J = 8.0 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 30.5, 55.4, 84.7, 95.0, 107.8, 109.1, 114.1, 115.6, 116.3, 129.9, 132.1, 133.0, 149.8, 159.7 ppm. HRMS (ESI^+): calcd for $C_{16}H_{15}KNO$ $[M+K]^+$ 276.0791, found 276.0782.



1-(4-((2-(Methylamino)phenyl)ethynyl)phenyl)ethanone (3e)

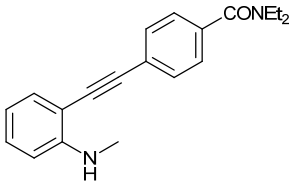
Compound **3e** was obtained as a yellow solid in 86% yield. M.p.: 103-105 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.60 (s, 3H), 2.94 (s, 3H), 4.70 (br. s, 1H), 6.63 (d, J =

8.4 Hz, 1H), 6.68 (td, J = 7.6 Hz, 0.8 Hz, 1H), 7.25-7.29 (m, 1H), 7.38 (dd, J = 7.6 Hz, 1.2 Hz, 1H), 7.59 (d, J = 8.4 Hz, 2H), 7.93 (d, J = 8.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 26.7, 30.4, 89.8, 94.4, 106.7, 109.3, 116.4, 128.36, 128.40, 130.8, 131.5, 132.4, 136.1, 150.1, 197.3 ppm. HRMS (ESI$^+$): calcd for $C_{17}H_{16}NO$ $[M+H]^+$ 250.1232, found 250.1230.



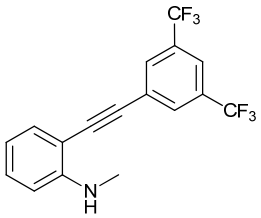
Methyl 4-((2-(methylamino)phenyl)ethynyl)benzoate (3f)

Compound **3f** was obtained as a yellow solid in 86% yield. M.p.: 179-181 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.94 (d, J = 5.2 Hz, 3H), 3.93 (s, 3H), 4.69 (d, J = 4.8 Hz, 1H), 6.63 (d, J = 8.4 Hz, 1H), 6.68 (td, J = 7.6 Hz, 0.8 Hz, 1H), 7.25-7.29 (m, 1H), 7.38 (dd, J= 7.6 Hz, 1.6 Hz, 1H), 7.58 (dd, J= 6.8 Hz, 2.0 Hz, 2H), 8.02 (dd, J= 6.8 Hz, 1.6 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 30.4, 52.3, 89.4, 94.4, 106.7, 109.2, 116.4, 128.2, 129.4, 129.6, 130.7, 131.4, 132.4, 150.0, 166.6 ppm. HRMS (ESI$^+$): calcd for $C_{17}H_{16}NO_2$ $[M+H]^+$ 266.1181, found 266.1178.



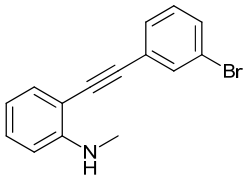
***N,N*-Diethyl-4-((2-(methylamino)phenyl)ethynyl)benzamide (3g)**

Compound **3g** was obtained as a white solid in 90% yield. M.p.: 116-118 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.12 (s, 3H), 1.24 (s, 3H), 2.93 (s, 3H), 3.26 (s, 2H), 3.54 (s, 2H), 4.73 (br. s, 1H), 6.62 (d, J = 8.4 Hz, 1H), 6.66 (t, J = 7.6 Hz, 1H), 7.23-7.27 (m, 1H), 7.35-7.38 (m, 3H), 7.54 (d, J = 8.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.0, 14.3, 30.5, 39.5, 43.4, 87.4, 94.4, 107.1, 109.2, 116.4, 124.4, 126.6, 130.4, 131.5, 132.3, 136.8, 149.9, 170.7 ppm. HRMS (ESI$^+$): calcd for $C_{20}H_{22}N_2NaO$ $[M+Na]^+$ 329.1630, found 329.1633.



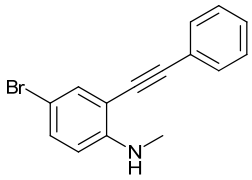
2-((3,5-Bis(trifluoromethyl)phenyl)ethynyl)-*N*-methylaniline (3h)

Compound **3h** was obtained as a yellow solid in 80% yield. M.p.: 141-142 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.97 (s, 3H), 4.67 (br. s, 1H), 6.66 (d, J = 8.4 Hz, 1H), 6.70 (t, J = 7.6 Hz, 1H), 7.29-7.33 (m, 1H), 7.40 (dd, J = 7.6 Hz, 1.2 Hz, 1H), 7.82 (s, 1H), 7.95 (s, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 30.4, 90.1, 92.1, 105.9, 109.5, 116.6, 121.4-121.5 (m), 123.1 (q, J = 271.2 Hz), 125.9, 131.29, 131.33, 132.1 (q, J = 33.5 Hz), 132.7, 150.3 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -63.1. HRMS (ESI^+): calcd for $C_{17}H_{12}F_6N$ $[M+H]^+$ 344.0874, found 344.0872.



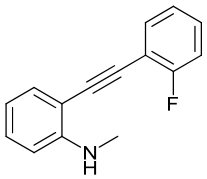
2-((3-Bromophenyl)ethynyl)-*N*-methylaniline (3i)

Compound **3i** was obtained as yellow liquid in 87% yield. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.95 (s, 3H), 4.66 (br. s, 1H), 6.63 (d, J = 8.0 Hz, 1H), 6.68 (td, J = 7.6 Hz, 0.8 Hz, 1H), 7.22 (t, J = 8.0 Hz, 1H), 7.25-7.29 (m, 1H), 7.37 (dd, J = 7.6 Hz, 1.6 Hz, 1H), 7.45-7.48 (m, 2H), 7.69 (t, J = 1.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 30.5, 87.6, 93.5, 106.8, 109.2, 116.4, 122.3, 125.5, 129.9, 130.1, 130.6, 131.3, 132.4, 134.2, 150.0 ppm. HRMS (ESI^+): calcd for $C_{15}H_{13}BrN$ $[M+H]^+$ 286.0231, found 286.0230.



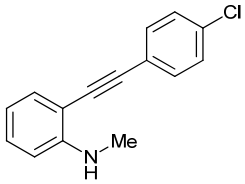
4-Bromo-*N*-methyl-2-(phenylethynyl)aniline (3k)

Compound **3k** was obtained as yellow liquid in 82% yield. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.91 (s, 3H), 4.71 (br. s, 1H), 6.49 (d, J = 8.8 Hz, 1H), 7.32 (dd, J = 8.8 Hz, 2.4 Hz, 1H), 7.36-7.41 (m, 3H), 7.49 (d, J = 2.4 Hz, 1H), 7.52-7.55 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 30.5, 84.7, 96.0, 107.4, 109.3, 110.6, 122.9, 128.5, 128.6, 131.6, 132.8, 134.2, 148.9 ppm. HRMS (ESI$^+$): calcd for $C_{15}H_{13}BrN$ $[M+H]^+$ 286.0231, found 286.0231.



2-((2-Fluorophenyl)ethynyl)-*N*-methylaniline (3l)

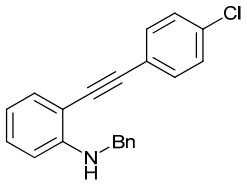
Compound **3l** was obtained as colorless liquid in 85% yield. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.96 (s, 3H), 4.86 (s, 1H), 6.64 (d, J = 8.4 Hz, 1H), 6.69 (t, J = 7.2 Hz, 1H), 7.11-7.17 (m, 2H), 7.26-7.35 (m, 2H), 7.41 (dd, J = 7.6 Hz, 1.2 Hz, 1H), 7.53 (td, J = 7.6 Hz, 1.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 30.4, 88.4, 91.7 (d, J = 3.3 Hz), 106.9, 109.1, 112.2 (d, J = 15.5 Hz), 115.5 (d, J = 20.9 Hz), 116.2, 124.2 (d, J = 3.6 Hz), 129.8 (d, J = 7.9 Hz), 130.5, 132.0, 132.9 (d, J = 0.9 Hz), 150.1, 162.4 (d, J = 248.8 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -110.3. HRMS (ESI$^+$): calcd for $C_{15}H_{13}FN$ $[M+H]^+$ 226.1032, found 226.1034.



2-((4-Chlorophenyl)ethynyl)-*N*-methylaniline (3m)

Compound **3m** was obtained as pale yellow liquid in 84% yield. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.94 (d, J = 1.6 Hz, 3H), 4.66 (br. s, 1H), 6.63 (d, J = 8.4 Hz, 1H), 6.68 (t, J = 7.6 Hz, 1H), 7.27 (td, J = 8.0 Hz, 1.6 Hz, 1H), 7.34 (td, J = 8.8 Hz, 2.0 Hz, 2H), 7.38 (dd, J = 7.6 Hz, 1.2 Hz, 1H), 7.46 (dd, J = 8.4 Hz, 2.0 Hz, 2H) ppm. ^{13}C NMR

(100 MHz, $CDCl_3$): δ = 30.5, 87.2, 93.9, 107.0, 109.2, 116.4, 122.0, 128.8, 130.4, 132.3, 132.8, 134.2, 149.9 ppm. HRMS (ESI^+): calcd for $C_{15}H_{13}ClN$ $[M+H]^+$ 242.0737, found 242.0742.



***N*-Benzyl-2-((4-chlorophenyl)ethynyl)aniline (3n)**

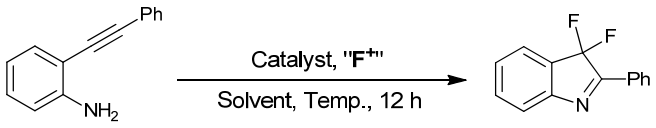
Compound **3n** was obtained as a pale yellow solid in 89% yield. M.p.: 64-66 °C. ^1H NMR (400 MHz, $CDCl_3$): δ = 4.48 (d, J = 4.8 Hz, 2H), 5.12 (br. s, 1H), 6.61 (d, J = 8.4 Hz, 1H), 6.70 (t, J = 7.6 Hz, 1H), 7.20 (td, J = 8.0 Hz, 1.2 Hz, 1H), 7.29-7.34 (m, 3H), 7.36-7.43 (m, 7H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 47.8, 87.1, 94.3, 107.3, 110.1, 116.8, 121.9, 127.2, 127.4, 128.8, 130.4, 132.3, 132.7, 134.3, 139.2, 148.8 ppm. HRMS (ESI^+): calcd for $C_{21}H_{16}ClNNa$ $[M+Na]^+$ 340.0869, found 340.0876.

III. Ag-catalyzed tandem cyclization/difluorination of *N*-unprotected 2-alkynylanilines

i. Optimization of the aminofluorination of 2-(phenylethynyl)aniline 1a

The mixture of 2-(phenylethynyl)aniline **1a** (58 mg, 0.3 mmol), catalyst, fluorinating reagent (0.6 mmol) and solvent (3.0 mL) was stirred at the indicated temperature for 12 h under air. The reaction was then cooled to ambient temperature. The solvent was evaporated and the residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80/1, v/v) to provide the desired product **2a**.

Table S1 Optimization of the aminofluorination of 2-(phenylethynyl)aniline **1a**[a,b]



1a **2a**

Entry	Catalyst (equiv)	"F^+" Source	Solvent	Temp. (^oC)	Yield (%)[b]
1	$NiCl_2·6H_2O$ (0.2)	NFSI	MeCN	80	0
2	CuCl (0.2)	NFSI	MeCN	80	0
3	$Cu(OAc)_2·H_2O$ (0.2)	NFSI	MeCN	80	0

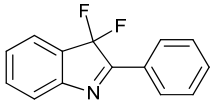
4	$FeCl_3·6H_2O$ (0.2)	NFSI	MeCN	80	0
5	Ag_2CO_3 (0.1)	NFSI	MeCN	80	7
6	Ag_2CO_3 (0.1)	NFSI	1,4-dioxane	80	81
7	Ag_2CO_3 (0.1)	NFSI	THF	80	71
8	Ag_2CO_3 (0.1)	NFSI	toluene	80	53
9	Ag_2CO_3 (0.1)	NFSI	DCE	80	69
10	Ag_2CO_3 (0.1)	NFSI	EtOH	80	30
11	Ag_2CO_3 (0.1)	NFSI	DMF	80	trace
12	Ag_2CO_3 (0.1)	NFSI	1,4-dioxane	60	81
13	Ag_2CO_3 (0.1)	NFSI	1,4-dioxane	r. t.	41
14[c]	Ag_2CO_3 (0.1)	NFSI	1,4-dioxane	60	68
15	Ag_2CO_3 (0.1)	Selectfluor	1,4-dioxane	60	N. D.[d]
16	Ag_2CO_3 (0.1)	None	1,4-dioxane	60	N. D.[e]
17	Ag_2CO_3 (0.05)	NFSI	1,4-dioxane	60	70
18	$AgNO_3$ (0.1)	NFSI	1,4-dioxane	60	67
19	AgOAc (0.1)	NFSI	1,4-dioxane	60	63
20	AgOTs (0.1)	NFSI	1,4-dioxane	60	62
21[f]	Ag_2CO_3 (0.1)	NFSI	1,4-dioxane	60	89

[a] Reaction conditions: **1a** (0.3 mmol, 1.0 equiv), catalyst, fluorinating reagent (2.0 equiv), and solvent (3.0 mL) at the indicated temperature for 12 h under air. [b] Isolated yield. [c] NFSI (3.0 equiv) was used. [d] 2-Phenyl-1*H*-indole was obtained in 49% NMR yield. [e] 2-Phenyl-1*H*-indole was obtained in 71% NMR yield. [f] 1.0 equiv of 2,6-di-*tert*-butyl-4-methylphenol was added. N. D. = not detected, NFSI = *N*-fluorobenzenesulfonimide, AgOTs = silver *p*-toluenesulfonate, THF = tetrahydrofuran, DCE = 1,2-dichloroethane, DMF = *N*,*N*-dimethylformamide.

ii. General procedure for the Ag-catalyzed tandem cyclization/fluorination of *N*-unprotected 2-alkynylanilines 1

A tube with a magnetic stir bar was charged with Ag_2CO_3 (8.3 mg, 0.03 mmol), 2-(1-alkynyl)anilines **1** (0.3 mmol), NFSI (189 mg, 0.6 mmol) and 1,4-dioxane (3.0 mL) under air. The resulting solution was stirred at 60 °C until the reaction was complete as monitored by TLC. The solution was then cooled to ambient temperature and the solvent was evaporated. The residue was purified by column chromatography on silica gel to afford the desired product **2**.

iii. Characterization of 3,3-difluoroindoles 2



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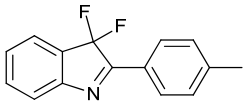
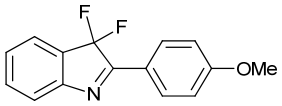
3,3-Difluoro-2-phenyl-3*H*-indole (2a)[13]

The reaction time was 12 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 80/1, v/v) afforded **2a** as an orange solid (56 mg, 81% yield). M.p.: 52-53 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.30 (t, J = 7.2 Hz, 1H), 7.49-7.60 (m, 6H), 8.23 (dd, J = 7.6 Hz, 0.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 122.1, 123.18, 123.22 (t, J = 254.7 Hz), 127.6 (t, J = 1.5 Hz), 128.7, 129.0, 129.1 (t, J = 24.0 Hz), 132.6, 133.4, 152.7 (t, J = 9.6 Hz), 169.3 (t, J = 24.6 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -116.4. HRMS (ESI$^+$): calcd for $C_{14}H_{10}F_2N$ $[M+H]^+$ 230.0781, found 230.0779.



3,3-Difluoro-2-(*p*-tolyl)-3*H*-indole (2b)[6]

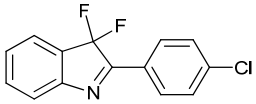
The reaction time was 6 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 75/1, v/v) afforded **2b** as an orange solid (59 mg, 81% yield). M.p.: 84-85 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.45 (s, 3H), 7.29 (t, J = 7.2 Hz, 1H), 7.34 (d, J = 8.0 Hz, 2H), 7.48-7.57 (m, 3H), 8.10 (d, J = 8.0 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 21.9, 121.9, 123.1, 123.3 (t, J = 254.6 Hz), 126.4 (t, J = 2.8 Hz), 127.4, 128.7, 129.1 (t, J = 24.1 Hz), 129.8, 133.4, 143.5, 152.9 (t, J = 9.7 Hz), 169.3 (t, J = 24.6 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -115.9. HRMS (ESI$^+$): calcd for $C_{15}H_{12}F_2N$ $[M+H]^+$ 244.0938, found 244.0937.



3,3-Difluoro-2-(4-methoxyphenyl)-3*H*-indole (2c)[6]

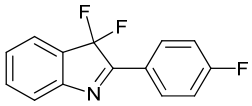
The reaction time was 6 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **2c** as an orange solid (47 mg, 60% yield). M.p.: 101-103 °C. ^{1}H NMR (400 MHz, DMSO-d_6): δ = 3.88 (s, 3H), 7.18 (d, J = 8.8 Hz, 2H), 7.36-7.39 (m, 1H), 7.57-7.64 (m, 2H), 7.74 (d, J = 6.8 Hz, 1H), 8.08 (d, J = 8.8 Hz, 2H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 55.6, 115.0, 120.5 (t, J =

2.4 Hz), 121.6, 123.0 (t, J = 254.7 Hz), 123.4, 127.5, 127.6 (t, J = 23.6 Hz), 130.2, 134.0, 152.2 (t, J = 10.0 Hz), 163.1, 167.5 (t, J = 24.4 Hz) ppm. ^{19}F NMR (376 MHz, DMSO): δ = -114.1. HRMS (ESI$^+$): calcd for $C_{15}H_{12}F_2NO$ $[M+H]^+$ 260.0887, found 260.0882.



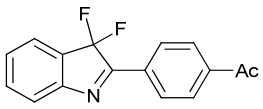
2-(4-Chlorophenyl)-3,3-difluoro-3*H*-indole (2d)[6]

The reaction time was 12 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 80/1, v/v) afforded **2d** as an orange solid (59 mg, 75% yield). M.p.: 82-83 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.31 (td, J = 7.2 Hz, 1.6 Hz, 1H), 7.49-7.53 (m, 4H), 7.57 (d, J = 8.0 Hz, 1H), 8.13 (d, J = 8.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 122.2, 123.1 (t, J = 254.6 Hz), 123.3, 127.5 (t, J = 2.8 Hz), 127.8, 128.9 (t, J = 23.9 Hz), 129.4, 129.9, 133.5, 139.0, 152.6 (t, J = 9.6 Hz), 168.3 (t, J = 24.8 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -116.7. HRMS (ESI$^+$): calcd for $C_{14}H_9ClF_2N$ $[M+H]^+$ 264.0392, found 264.0387.



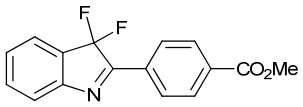
3,3-Difluoro-2-(4-fluorophenyl)-3*H*-indole (2e)

The reaction time was 12 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 80/1, v/v) afforded **2e** as an orange solid (50 mg, 67% yield). M.p.: 81-83 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.21 (t, J = 8.8 Hz, 2H), 7.30 (t, J = 7.2 Hz, 1H), 7.49-7.57 (m, 3H), 8.20-8.23 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 116.4 (d, J = 21.9 Hz), 122.1, 123.1 (t, J = 254.6 Hz), 123.2, 125.4 (q, J = 3.0 Hz), 127.6, 128.9 (t, J = 23.8 Hz), 131.1 (d, J = 8.9 Hz), 133.5, 152.7 (t, J = 9.7 Hz), 165.5 (d, J = 253.3 Hz), 168.2 (t, J = 25.0 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -105.4, -116.3. HRMS (ESI$^+$): calcd for $C_{14}H_9F_3N$ $[M+H]^+$ 248.0687, found 248.0686.



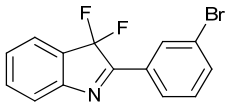
1-(4-(3,3-Difluoro-3*H*-indol-2-yl)phenyl)ethanone (2f)

The reaction time was 12 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **2f** as a pale yellow solid (61 mg, 75% yield). M.p.: 107-109 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.66 (s, 3H), 7.34 (t, J = 7.6 Hz, 1H), 7.53 (t, J = 7.6 Hz, 1H), 7.58 (d, J = 8.4 Hz, 2H), 8.09 (d, J = 8.4 Hz, 2H), 8.28 (d, J = 8.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 26.9, 122.6, 123.0 (t, J = 254.6 Hz), 123.3, 128.3, 128.8, 129.0 (t, J = 24.0 Hz), 132.8 (t, J = 2.8 Hz), 133.6, 139.6, 152.4 (t, J = 9.4 Hz), 168.4 (t, J = 24.8 Hz), 197.5 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -117.3. HRMS (ESI$^+$): calcd for $C_{16}H_{11}F_2NNaO$ $[M+Na]^+$ 294.0706, found 294.0712.



Methyl 4-(3,3-difluoro-3*H*-indol-2-yl)benzoate (2g)

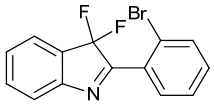
The reaction time was 12 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20/1, v/v) afforded **2g** as an orange solid (60 mg, 70% yield). M.p.: 109-110 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.96 (s, 3H), 7.34 (t, J = 7.2 Hz, 1H), 7.53 (t, J = 7.6 Hz, 1H), 7.57-7.59 (m, 2H), 8.17 (d, J = 8.8 Hz, 2H), 8.26 (d, J = 8.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 52.6, 122.5, 123.0 (t, J = 254.8 Hz), 123.3, 128.2, 128.5, 129.0 (t, J = 23.9 Hz), 130.1, 132.8 (t, J = 2.6 Hz), 133.3, 133.6, 152.4 (t, J = 9.5 Hz), 166.4, 168.5 (t, J = 24.9 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -117.3. HRMS (ESI$^+$): calcd for $C_{16}H_{11}F_2NNaO_2$ $[M+Na]^+$ 310.0656, found 310.0664.



2-(3-Bromophenyl)-3,3-difluoro-3*H*-indole (2h)[6]

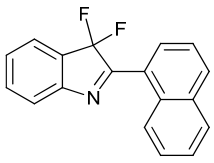
The reaction time was 12 h. Purification by column chromatography on silica gel

(petroleum ether/ethyl acetate = 80/1, v/v) afforded **2h** as a yellow solid (69 mg, 75% yield). M.p.: 157-158 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.32 (td, J = 7.2 Hz, 1.2 Hz, 1H), 7.39 (t, J = 8.0 Hz, 1H), 7.50-7.58 (m, 3H), 7.69 (dd, J = 8.0 Hz, 0.8 Hz, 1H), 8.10 (d, J = 8.0 Hz, 1H), 8.36 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 122.4, 122.9 (t, J = 254.8 Hz), 123.25, 123.29, 127.2 (t, J = 1.4 Hz), 128.1, 128.9 (t, J = 23.9 Hz), 130.5, 130.9 (t, J = 2.8 Hz), 131.3, 133.5, 135.4, 152.3 (t, J = 9.4 Hz), 168.0 (t, J = 24.9 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -117.0. HRMS (ESI^+): calcd for $C_{14}H_9BrF_2N$ $[M+H]^+$ 307.9886, found 307.9882.



2-(2-Bromophenyl)-3,3-difluoro-3*H*-indole (2i)

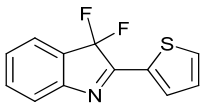
The reaction time was 6 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 80/1, v/v) afforded **2i** as yellow liquid (58 mg, 63% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.33-7.38 (m, 2H), 7.45 (td, J = 7.6 Hz, 1.2 Hz, 1H), 7.52-7.58 (m, 2H), 7.63 (d, J = 8.0 Hz, 1H), 7.78 (d, J = 8.0 Hz, 1H), 7.82 (d, J = 7.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 122.7, 122.87, 122.92 (t, J = 255.6 Hz), 123.3, 127.4, 128.1, 128.3, 128.4, 130.5 (t, J = 3.1 Hz), 132.0, 133.5, 134.8, 152.2 (t, J = 9.4 Hz), 169.2 (t, J = 24.8 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -119.9. HRMS (ESI^+): calcd for $C_{14}H_9BrF_2N$ $[M+H]^+$ 307.9886, found 307.9882.



3,3-Difluoro-2-(naphthalen-1-yl)-3*H*-indole (2j)[6]

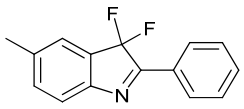
The reaction time was 12 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 80/1, v/v) afforded **2j** as an orange solid (60 mg, 72% yield). M.p.: 111-112 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.35 (t, J = 7.6 Hz, 1H), 7.55-7.65 (m, 4H), 7.70 (d, J = 7.6 Hz, 1H), 7.74 (dd, J = 7.2 Hz, 1.2 Hz, 1H), 7.94 (d, J = 8.0 Hz, 1H), 8.05 (d, J = 8.0 Hz, 1H), 8.40 (d, J = 7.6 Hz, 1H), 9.66 (d, J = 8.8 Hz,

1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 122.3, 123.0, 124.2 (t, J = 256.6 Hz), 124.9, 125.2 (t, J = 2.6 Hz), 126.6, 127.1, 127.7, 128.3 (t, J = 24.4 Hz), 128.4, 129.0, 130.7 (t, J = 4.9 Hz), 132.0, 133.4, 133.5, 134.4, 152.9 (t, J = 10.0 Hz), 169.6 (t, J = 23.2 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -112.7. HRMS (ESI^+): calcd for $C_{18}H_{12}F_2N$ $[M+H]^+$ 280.0938, found 280.0940.



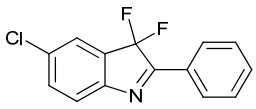
3,3-Difluoro-2-(thiophen-2-yl)-3*H*-indole (2k)

The reaction time was 12 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 80/1, v/v) afforded **2k** as a yellow solid (61 mg, 86% yield). M.p.: 122-124 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.22-7.25 (m, 1H), 7.27-7.31 (m, 1H), 7.48-7.52 (m, 2H), 7.56 (d, J = 7.2 Hz, 1H), 7.67 (d, J = 5.2 Hz, 1H), 7.87-7.88 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 121.9, 122.5 (t, J = 254.8 Hz), 123.3, 127.3, 128.4 (t, J = 23.6 Hz), 128.8, 132.7, 133.0 (t, J = 1.8 Hz), 133.2 (t, J = 3.0 Hz), 133.6, 153.2 (t, J = 9.5 Hz), 164.7 (t, J = 25.7 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -115.0. HRMS (ESI^+): calcd for $C_{12}H_8F_2NS$ $[M+H]^+$ 236.0346, found 236.0342.



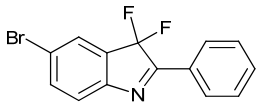
3,3-Difluoro-5-methyl-2-phenyl-3*H*-indole (2l)

The reaction time was 12 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 80/1, v/v) afforded **2l** as a pink solid (55 mg, 75% yield). M.p.: 139-140 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.42 (s, 3H), 7.30 (d, J = 7.6 Hz, 1H), 7.39 (s, 1H), 7.43 (d, J = 7.6 Hz, 1H), 7.50-7.58 (m, 3H), 8.19 (d, J = 7.2 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 21.5, 121.7, 123.3 (t, J = 254.7 Hz), 124.0, 128.5, 129.0, 129.18-129.24 (m), 132.4, 133.6, 138.0, 150.4 (t, J = 9.6 Hz), 168.6 (t, J = 24.6 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -116.1. HRMS (ESI^+): calcd for $C_{15}H_{12}F_2N$ $[M+H]^+$ 244.0938, found 244.0935.



5-Chloro-3,3-difluoro-2-phenyl-3*H*-indole (2m)

The reaction was stirred at 100 °C for 2 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 100/1, v/v) afforded **2m** as an orange solid (52 mg, 66% yield). M.p.: 71-72 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.45-7.61 (m, 6H), 8.18 (d, J = 7.2 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 122.7 (t, J = 256.2 Hz), 123.0, 123.9, 128.7, 129.1, 130.6 (t, J = 24.2 Hz), 132.9, 133.3, 133.5 (t, J = 1.6 Hz), 151.2 (t, J = 9.4 Hz), 169.5 (t, J = 24.4 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -116.0. HRMS (ESI^+): calcd for $C_{14}H_9ClF_2N$ $[M+H]^+$ 264.0392, found 264.0390.



5-Bromo-3,3-difluoro-2-phenyl-3*H*-indole (2n)

The reaction was stirred at 100 °C for 2 h. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 100/1, v/v) afforded **2n** as a yellow solid (65 mg, 70% yield). M.p.: 216-218 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.41 (d, J = 8.4 Hz, 1H), 7.53 (t, J = 7.2 Hz, 2H), 7.58-7.61 (m, 1H), 7.65 (d, J = 8.4 Hz, 1H), 7.70 (d, J = 1.6 Hz, 1H), 8.18 (d, J = 7.6 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 121.1 (t, J = 1.8 Hz), 122.7 (t, J = 256.3 Hz), 123.4, 126.7, 128.7, 128.8, 129.1, 130.9 (t, J = 24.2 Hz), 133.0, 136.3, 151.6 (t, J = 9.4 Hz), 169.4 (t, J = 24.3 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -115.9. HRMS (ESI^+): calcd for $C_{14}H_9BrF_2N$ $[M+H]^+$ 307.9886, found 307.9889.

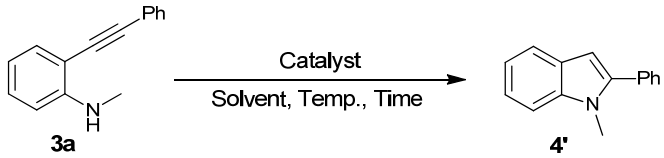
IV. Ag-catalyzed one-pot synthesis of 3,3-difluoroindolin-2-ols

i. Optimization of the Ag-catalyzed cycilzation of 2-alkynylanilines

A mixture of *N*-methyl-2-(phenylethynyl)aniline **3a** (41 mg, 0.2 mmol), catalyst, and solvent (1.0 mL) was stirred at the indicated temperature under an air atmosphere.

After the completion of the reaction as monitored by TLC, the solution was cooled to ambient temperature. The solvent was evaporated and the residue was analyzed by crude ^{1}H NMR with mesitylene as the internal standard.

Table S2 Optimization of the Ag-catalyzed cycilzation of *N*-methyl-2-(phenylethynyl)aniline **3a**[a]



3a **4'**

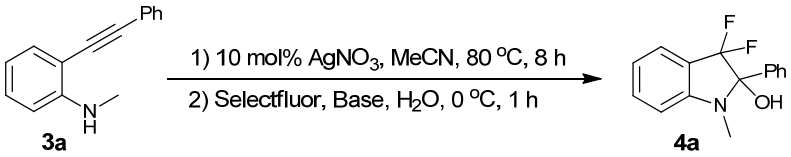
Entry	Catalyst (equiv)	Solvent	Temp. (^{o}C)	Time (h)	Yield (%)[b]
1	AgOTf (0.1)	toluene	110	2	67
2	AgOTf (0.1)	1,4-dioxane	110	2	34
3	AgOTf (0.1)	THF	110	2	63
4	AgOTf (0.1)	EtOH	110	2	68
5	AgOTf (0.1)	DCE	110	2	84
6	AgOTf (0.1)	MeCN	110	2	92
7	AgOAc (0.1)	MeCN	110	2	90
8	Ag_2CO_3 (0.05)	MeCN	110	2	22
9	$AgSbF_6$ (0.1)	MeCN	110	2	84
10	$AgNO_3$ (0.1)	MeCN	110	2	90 (97)[c]
11	$AgNO_3$ (0.1)	MeCN	80	8	90 (99)[c]

[a] Reaction conditions: **3a** (0.2 mmol), catalyst, and solvent (1.0 mL) under air. [b] NMR yield with mesitylene as the internal standard. [c] Isolated yields are given in the parentheses. AgOTf = silver trifluoromethanesulfonate, $AgSbF_6$ = silver hexafluoroantimonate, THF = tetrahydrofuran, DCE = 1,2-dichloroethane.

ii. Optimization of the Ag-catalyzed one-pot synthesis of 3,3-difluoroindolin-2-ols

A mixture of *N*-methyl-2-(phenylethynyl)aniline **3a** (62 mg, 0.3 mmol), $AgNO_3$ (5.1 mg, 0.03 mmol), and MeCN (1.5 mL) was stirred at 80 °C for 8 h under an air atmosphere. The reaction solution was then cooled to 0 ^{o}C, and successively added base (0.3 mmol), Selectfluor (212 mg, 0.6 mmol) and H_2O (16.2 μL, 0.9 mmol). After being stirred at 0 ^{o}C for 1 h, the reaction mixture was added Et_3N (0.5 mL). The solvent was then evaporated and the residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 10/1/0.03, v/v/v) to afford the desired products **4a**.

Table S3 Optimization of the Ag-catalyzed one-pot cyclization/difluorohydroxylation of *N*-methyl-2-(1-alkynyl)anilines **3a**

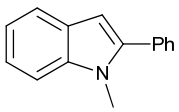


Entry	Base	Isolated Yield (%)
1	$NaHCO_3$	79
2	Na_2CO_3	73
3	K_2CO_3	52
4	K_3PO_4	61
5	None	91

iii. General procedure for the Ag-catalyzed one-pot synthesis of 3,3-difluoroindolin-2-ols

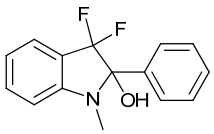
A mixture of *N*-substituted-2-(1-alkynyl)aniline **3** (0.3 mmol), $AgNO_3$ (5.1 mg, 0.03 mmol), and MeCN (1.5 mL) was stirred at 80 °C under an air atmosphere. After the completion of the reaction as monitored by TLC, the reaction solution was cooled to 0 ^oC, and successively added Selectfluor (212 mg, 0.6 mmol) and H_2O (16.2 μL, 0.9 mmol) under air. After being stirred at 0 ^oC for 0.5-2 h, the reaction mixture was added Et_3N (0.5 mL). The solvent was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product **4**.

iv. Characterization of products 4′ and 4



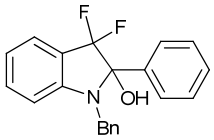
1-Methyl-2-phenyl-1*H*-indole (4′)

Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 50/1, v/v) afforded **4′** as a white solid in 99% yield. M.p.: 99-100 °C. ^1H NMR (400 MHz, $CDCl_3$): δ = 3.79 (s, 3H), 6.63 (t, J = 0.8 Hz, 1H), 7.19-7.23 (m, 1H), 7.31 (td, J = 7.6 Hz, 1.2 Hz, 1H), 7.42 (d, J = 8.4 Hz, 1H), 7.46 (d, J = 6.4 Hz, 1H), 7.50-7.58 (m, 4H), 7.70 (dd, J = 7.6 Hz, 0.8 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 31.3, 101.8, 109.7, 120.0, 120.6, 121.8, 128.0, 128.1, 128.6, 129.5, 133.0, 138.5, 141.7 ppm. HRMS (ESI^+): calcd for $C_{15}H_{14}N$ $[M+H]^+$ 208.1126, found 208.1125.



3,3-Difluoro-1-methyl-2-phenylindolin-2-ol (4a)[13]

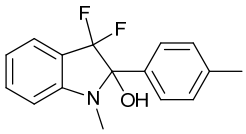
The reaction time of the cyclization and difluorohydroxylation was 8 h and 1 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 10/1/0.03, v/v/v) afforded **4a** as a yellow solid (71 mg, 91% yield). M.p.: >110 °C (dec.). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.72 (s, 3H), 3.15 (s, 1H), 6.68 (d, J = 8.0 Hz, 1H), 6.88 (t, J = 7.6 Hz, 1H), 7.40-7.46 (m, 5H), 7.55-7.56 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.4, 96.3 (dd, J = 31.0 Hz, 22.2 Hz), 107.9, 119.0, 119.8 (t, J = 25.1 Hz), 123.2 (t, J = 250.5 Hz), 124.6, 127.7, 128.4, 129.2, 133.7, 134.6 (d, J = 2.0 Hz), 151.4 (t, J = 6.8 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -111.0 (d, J = 250.0 Hz), -98.5 (d, J = 250.0 Hz). HRMS (ESI^+): calcd for $C_{15}H_{14}F_2NO$ $[M+H]^+$ 262.1043, found 262.1042.



1-Benzyl-3,3-difluoro-2-phenylindolin-2-ol (4b)[13]

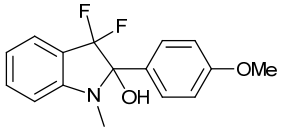
The reaction time of the cyclization and difluorohydroxylation was 12 h and 0.5 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 10/1/0.03, v/v/v) afforded **4b** as a yellow solid (81 mg, 80% yield). M.p.: 102-104 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.39 (s, 1H), 4.28 (d, J = 3.6 Hz, 2H), 6.46 (d, J = 8.0 Hz, 1H), 6.90 (t, J = 7.6 Hz, 1H), 7.29-7.42 (m, 9H), 7.50 (d, J = 7.2 Hz, 1H), 7.61-7.63 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 48.1, 97.0 (dd, J = 30.0 Hz, 22.3 Hz), 109.0, 119.4, 120.2 (t, J = 25.0 Hz), 123.1 (dd, J = 251.9 Hz, 249.2 Hz), 124.5, 126.8, 127.2, 127.6, 128.4, 128.8, 129.2, 133.5, 134.9 (d, J = 2.6 Hz), 138.1, 150.9 (t, J = 6.6 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -107.3 (dd, J = 248.9 Hz, 6.8 Hz), -101.9 (dd, J = 248.9 Hz, 13.9 Hz). HRMS (ESI^+):

calcd for $C_{21}H_{18}F_2NO$ $[M+H]^+$ 338.1356, found 338.1350.



3,3-Difluoro-1-methyl-2-(*p*-tolyl)indolin-2-ol (4c)[13]

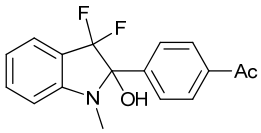
The reaction time of the cyclization and difluorohydroxylation was 8 h and 1 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 10/1/0.03, v/v/v) afforded **4c** as a yellow solid (69 mg, 84% yield). M.p.: 103-104 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.40 (s, 3H), 2.72 (s, 3H), 3.14 (s, 1H), 6.67 (d, J = 7.6 Hz, 1H), 6.88 (t, J = 7.6 Hz, 1H), 7.23 (d, J = 8.4 Hz, 2H), 7.41-7.46 (m, 4H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 21.3, 28.4, 96.3 (dd, J = 31.2 Hz, 22.1 Hz), 107.8, 118.9, 119.9 (t, J = 25.0 Hz), 123.2 (t, J = 250.4 Hz), 124.5, 127.6, 129.2, 131.6 (d, J = 2.5 Hz), 133.6, 139.0, 151.4 (t, J = 6.6 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -111.6 (d, J = 249.7 Hz), -98.4 (d, J = 249.7 Hz). HRMS (ESI^+): calcd for $C_{16}H_{15}F_2NNaO$ $[M+Na]^+$ 298.1019, found 298.1019.



3,3-Difluoro-2-(4-methoxyphenyl)-1-methylindolin-2-ol (4d)[13]

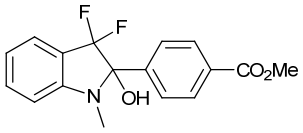
The reaction time of the cyclization and difluorohydroxylation was 8 h and 0.5 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 8/1/0.03, v/v/v) afforded **4d** as yellow liquid (67 mg, 77% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.70 (s, 3H), 3.13 (s, 1H), 3.82 (s, 3H), 6.65 (d, J = 8.0 Hz, 1H), 6.86 (t, J = 7.6 Hz, 1H), 6.90-6.94 (m, 2H), 7.39-7.46 (m, 4H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.3, 55.4, 96.2 (dd, J = 31.2 Hz, 22.0 Hz), 107.9, 113.8, 119.0 (d, J = 1.7 Hz), 119.9 (t, J = 25.0 Hz), 123.2 (t, J = 250.2 Hz), 124.6, 126.5 (d, J = 2.6 Hz), 129.0 (d, J = 1.0 Hz), 133.6, 151.4 (dd, J = 7.2 Hz, 5.9 Hz), 160.3 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -112.3 (d, J = 249.3 Hz), -98.1 (d,

J = 249.7 Hz). HRMS (ESI$^+$): calcd for $C_{16}H_{16}F_2NO_2$ $[M+H]^+$ 292.1149, found 292.1143.



1-(4-(3,3-Difluoro-2-hydroxy-1-methylindolin-2-yl)phenyl)ethanone (4e)

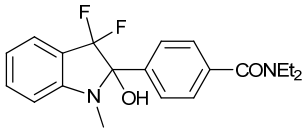
The reaction time of the cyclization and difluorohydroxylation was 16 h and 1 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 4/1/0.03, v/v/v) afforded **4e** as a pale yellow solid (71 mg, 78% yield). M.p.: >138 °C (dec.). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.59 (s, 3H), 2.69 (s, 3H), 3.44 (s, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 6.87 (t, *J* = 7.6 Hz, 1H), 7.40-7.44 (m, 2H), 7. 64 (d, *J* = 8.4 Hz, 2H), 7.95 (d, *J* = 8.8 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 26.8, 28.4, 96.0 (dd, *J* = 31.2 Hz, 22.2 Hz), 108.0, 119.3 (t, *J* = 1.7 Hz), 119.5 (t, *J* = 25.0 Hz), 123.2 (t, *J* = 251.2 Hz), 124.6, 128.1 (d, *J* = 1.4 Hz), 128.4, 133.8, 137.7, 140.0 (d, *J* = 2.6 Hz), 151.2 (dd, *J* = 7.3 Hz, 6.0 Hz), 198.1 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -109.9 (d, *J* = 250.8 Hz), -98.1 (d, *J* = 250.8 Hz). HRMS (ESI$^+$): calcd for $C_{17}H_{15}F_2NNaO_2$ $[M+Na]^+$ 326.0969, found 326.0969.



Methyl 4-(3,3-difluoro-2-hydroxy-1-methylindolin-2-yl)benzoate (4f)

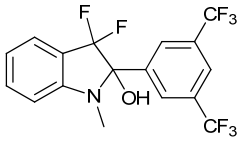
The reaction time of the cyclization and difluorohydroxylation was 12 h and 1 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 5/1/0.03, v/v/v) afforded **4f** as a pale yellow solid (79 mg, 82% yield). M.p.: >140 °C (dec.). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.69 (s, 3H), 3.42 (s, 1H), 3.90 (s, 3H), 6.66 (d, *J* = 8.0 Hz, 1H), 6.87 (t, *J* = 7.6 Hz, 1H), 7.40-7.44 (m, 2H), 7.61 (d, *J* = 8.4 Hz, 2H), 8.04 (d, *J* = 8.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.4, 52.3, 96.0 (dd, *J* = 31.2 Hz, 22.2 Hz), 108.0, 119.2 (d, *J* = 1.7 Hz),

119.5 (t, J = 25.0 Hz), 123.2 (t, J = 251.2 Hz), 124.6, 127.8 (d, J = 1.3 Hz), 129.6, 130.8, 133.8, 139.8 (d, J = 2.8 Hz), 151.2 (dd, J = 7.2 Hz, 6.2 Hz), 166.9 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -110.3 (d, J = 250.4 Hz), -97.7 (d, J = 250.8 Hz). HRMS (ESI$^+$): calcd for $C_{17}H_{15}F_2NNaO_3$ $[M+Na]^+$ 342.0918, found 342.0915.



4-(3,3-Difluoro-2-hydroxy-1-methylindolin-2-yl)-*N,N*-diethylbenzamide (4g)

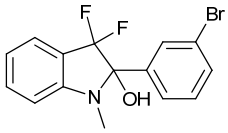
The reaction time of the cyclization and difluorohydroxylation was 12 h and 1 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 2/1/0.03, v/v/v) afforded **4g** as a pale yellow solid (79 mg, 73% yield). M.p.: >145 °C (dec.). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.08 (s, 3H), 1.20 (s, 3H), 2.61 (s, 3H), 3.23 (s, 2H), 3.50 (s, 2H), 4.25 (s, 1H), 6.62 (d, J = 8.0 Hz, 1H), 6.83 (t, J = 7.2 Hz, 1H), 7.30 (d, J = 8.4 Hz, 2H), 7.36-7.40 (m, 2H), 7.53 (d, J = 8.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 12.8, 14.2, 28.2, 39.3, 43.3, 95.9 (dd, J = 31.5 Hz, 21.8 Hz), 107.9, 118.8, 119.8 (t, J = 24.9 Hz), 123.1 (dd, J = 251.6 Hz, 250.2 Hz), 124.3, 126.2, 127.8, 133.4, 136.2 (d, J = 2.4 Hz), 137.4, 151.4 (t, J = 6.6 Hz), 171.0 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -111.4 (d, J = 249.7 Hz), -97.5 (d, J = 249.7 Hz). HRMS (ESI$^+$): calcd for $C_{20}H_{23}F_2N_2O_2$ $[M+H]^+$ 361.1728, found 361.1724.



2-(3,5-Bis(trifluoromethyl)phenyl)-3,3-difluoro-1-methylindolin-2-ol (4h)

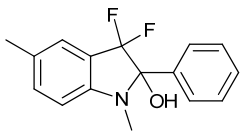
The reaction time of the cyclization and difluorohydroxylation was 16 h and 2 h, respectively. $NaHCO_3$ (25 mg, 0.3 mmol) was added to the reaction mixture after the cyzlization reaction. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 10/1/0.03, v/v/v) afforded **4h** as yellow liquid (93 mg, 78%

yield). Product **4h** was obtained in 57% yield in the absence of $NaHCO_3$**.** ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.72 (s, 3H), 3.47 (br. s, 1H), 6.75 (d, J = 8.0 Hz, 1H), 6.95 (t, J = 7.6 Hz, 1H), 7.47-7.50 (m, 2H), 7.96 (s, 1H), 8.09 (s, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.4, 95.7 (dd, J = 31.6 Hz, 22.4 Hz), 108.7, 119.1 (t, J = 24.9 Hz), 120.0, 122.1, 123.1 (t, J = 251.8 Hz), 123.3-123.5 (m), 124.8, 128.5, 132.0 (q, J = 33.3 Hz), 134.2, 138.0 (d, J = 2.6 Hz), 151.1 (dd, J = 7.6 Hz, 5.8 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -113.5 (d, J = 251.5 Hz), -94.3 (d, J = 251.9 Hz), -62.9. HRMS (ESI^+): calcd for $C_{17}H_{12}F_8NO$ $[M+H]^+$ 398.0791, found 398.0787.



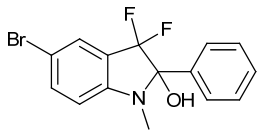
2-(3-Bromophenyl)-3,3-difluoro-1-methylindolin-2-ol (4i)

The reaction time of the cyclization and difluorohydroxylation was 8 h and 1.5 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 10/1/0.03, v/v/v) afforded **4i** as yellow liquid (84 mg, 82% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.73 (s, 3H), 3.19 (br. s, 1H), 6.70 (d, J = 8.0 Hz, 1H), 6.91 (t, J = 7.6 Hz, 1H), 7.28 (t, J = 8.0 Hz, 1H), 7.44-7.48 (m, 3H), 7.54-7.57 (m, 1H), 7.78 (t, J = 1.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.4, 95.7 (dd, J = 31.1 Hz, 22.2 Hz), 108.1, 119.3 (t, J = 1.6 Hz), 119.4 (t, J = 25.0 Hz), 122.7, 123.1 (t, J = 251.2 Hz), 124.7, 126.4 (d, J = 1.6 Hz), 129.9, 131.0 (d, J = 1.3 Hz), 132.3, 133.8 (t, J = 1.6 Hz), 137.1 (d, J = 2.7 Hz), 151.2 (dd, J = 7.4 Hz, 6.0 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -111.1 (d, J = 250.8 Hz), -97.3 (d, J = 250.8 Hz). HRMS (ESI^+): calcd for $C_{15}H_{13}BrF_2NO$ $[M+H]^+$ 340.0149, found 340.0150.



3,3-Difluoro-1,5-dimethyl-2-phenylindolin-2-ol (4j)

The reaction time of the cyclization and difluorohydroxylation was 8 h and 0.5 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 10/1/0.03, v/v/v) afforded **4j** as yellow liquid (56 mg, 68% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.35 (s, 3H), 2.70 (s, 3H), 3.19 (br. s, 1H), 6.61 (d, J = 8.0 Hz, 1H), 7.26 (d, J = 8.4 Hz, 1H), 7.30 (s, 1H), 7.42 (t, J = 3.2 Hz, 3H), 7.57-7.59 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 20.7, 28.5, 96.5 (dd, J = 31.4 Hz, 22.0 Hz), 107.9, 119.9 (t, J = 24.8 Hz), 123.3 (t, J = 250.7 Hz), 124.8, 127.7, 128.3, 128.6 (t, J = 1.8 Hz), 129.1, 134.1 (t, J = 1.6 Hz), 134.7 (d, J = 2.1 Hz), 149.4 (t, J = 6.8 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -111.8 (d, J = 249.7 Hz), -98.0 (dd, J = 249.7 Hz, 5.6 Hz). HRMS (ESI^+): calcd for $C_{16}H_{16}F_2NO$ $[M+H]^+$ 276.1200, found 276.1197.



5-Bromo-3,3-difluoro-1-methyl-2-phenylindolin-2-ol (4k)[13]

The reaction time of the cyclization and difluorohydroxylation was 12 h and 0.5 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 10/1/0.03, v/v/v) afforded **4k** as a yellow solid (65 mg, 64% yield). M.p.: 100-101 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.69 (s, 3H), 3.19 (br. s, 1H), 6.54 (d, J = 8.4 Hz, 1H), 7.39-7.42 (m, 3H), 7.48-7.54 (m, 4H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.4, 96.4 (dd, J = 30.8 Hz, 21.8 Hz), 109.4, 110.2 (t, J = 2.0 Hz), 121.7 (t, J = 25.2 Hz), 122.3 (t, J = 251.7 Hz), 127.5 (t, J = 1.3 Hz), 128.5, 129.4, 134.1 (d, J = 2.7 Hz), 136.3, 150.4 (dd, J = 6.9 Hz, 5.9 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -110.6 (d, J = 250.4 Hz), -99.0 (d, J = 250.4 Hz). HRMS (ESI^+): calcd for $C_{15}H_{13}BrF_2NO$ $[M+H]^+$ 340.0149, found 340.0151.

V. Ag-catalyzed one-pot synthesis of 2-alkoxy-3,3-difluoroindolines

i. General procedure for the Ag-catalyzed one-pot cyclization/ difluoroalkoxylation of 3a

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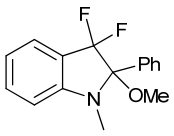
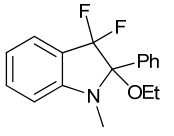
A flame-dried pressure tube with a magnetic stir bar was charged with $AgNO_3$ (5.1 mg, 0.03 mmol), *N*-methyl-2-(phenylethynyl)aniline **3a** (62 mg, 0.3 mmol) and MeCN (1.5 mL) under N_2. After being stirred at 80 °C for 8 h, the reaction solution was cooled to 0 ^oC. 4Å MS (150 mg), Selectfluor (212 mg, 0.6 mmol), and alcohol (1.5 mmol) were then added successively under N_2. The resulting mixture was stirred at 0 ^oC for 0.5-1 h and then added Et_3N (0.5 mL). The solution was diluted with 10 mL of CH_2Cl_2, filtered through a celite pad, and washed with 10-20 mL of CH_2Cl_2. The combined organic phases were concentrated and the residue was purified by column chromatography on silica gel to afford the desired products **5**.

ii. Characterization of products 5



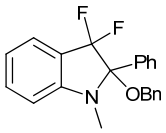
3,3-Difluoro-2-methoxy-1-methyl-2-phenylindoline (5a)[13]

The reaction time of the cyclization and difluoroalkoxylation was 8 h and 1 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 100/1/0.03, v/v/v) afforded **5a** as a white solid (61 mg, 74% yield). M.p.: 113-114 °C. ^1H NMR (400 MHz, $CDCl_3$): δ = 2.79 (s, 3H), 3.23 (s, 3H), 6.65 (d, J = 8.0 Hz, 1H), 6.84 (t, J = 7.2 Hz, 1H), 7.39-7.44 (m, 5H), 7.53-7.56 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.8, 52.8 (d, J = 5.0 Hz), 98.8 (dd, J = 32.1 Hz, 21.4 Hz), 105.8, 118.4 (t, J = 1.6 Hz), 120.3 (t, J = 24.6 Hz), 122.9 (dd, J = 255.8 Hz, 248.4 Hz), 123.7, 127.9 (d, J = 2.2 Hz), 128.2, 128.9, 133.7 (d, J = 1.5 Hz), 135.5 (d, J = 3.4 Hz), 151.8 (dd, J = 7.6 Hz, 5.6 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -115.3 (d, J = 256.1 Hz), -83.8 (d, J = 255.7 Hz). HRMS (ESI^+): calcd for $C_{16}H_{15}F_2NNaO$ $[M+Na]^+$ 298.1019, found 298.1020.



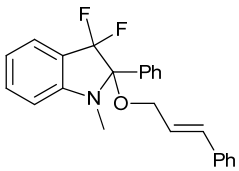
2-Ethoxy-3,3-difluoro-1-methyl-2-phenylindoline (5b)[13]

The reaction time of the cyclization and difluoroalkoxylation was 8 h and 1 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 100/1/0.03, v/v/v) afforded **5b** as a white solid (65 mg, 75% yield). M.p.: 122-124 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.24 (t, J = 6.8 Hz, 3H), 2.78 (s, 3H), 3.23-3.30 (m, 1H), 3.45-3.52 (m, 1H), 6.64 (d, J = 8.0 Hz, 1H), 6.84 (t, J = 7.6 Hz, 1H), 7.36-7.44 (m, 5H), 7.57-7.60 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 15.4, 28.8, 60.4 (d, J = 5.0 Hz), 98.6 (dd, J= 32.0 Hz, 21.3 Hz), 105.8, 118.3 (d, J = 1.4 Hz), 120.3 (t, J = 24.6 Hz), 122.9 (dd, J = 255.8 Hz, 248.1 Hz), 123.6, 127.9 (d, J = 2.1 Hz), 128.2, 128.8, 133.6 (d, J = 1.6 Hz), 135.8 (d, J = 3.4 Hz), 151.8 (dd, J = 7.7 Hz, 5.6 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -115.2 (d, J = 254.9 Hz), -83.9 (d, J = 255.3 Hz). HRMS (ESI^+): calcd for $C_{17}H_{17}F_2NNaO$ $[M+Na]^+$ 312.1176, found 312.1178.



2-(Benzyloxy)-3,3-difluoro-1-methyl-2-phenylindoline (5c)[13]

The reaction time of the cyclization and difluoroalkoxylation was 8 h and 1 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 100/1/0.03, v/v/v) afforded **5c** as a white solid (67 mg, 64% yield). M.p.: 111-113 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.81 (s, 3H), 4.33 (d, J = 11.6 Hz, 1H), 4.62 (d, J = 11.6 Hz, 1H), 6.69 (d, J = 7.6 Hz, 1H), 6.90 (t, J = 7.2 Hz, 1H), 7.29-7.50 (m, 10H), 7.63-7.64 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 29.0, 66.7 (d, J = 5.3 Hz), 98.9 (dd, J = 32.0 Hz, 21.3 Hz), 106.0, 118.6, 120.3 (t, J = 24.4 Hz), 123.0 (dd, J = 255.5 Hz, 248.9 Hz), 123.9, 127.4, 127.6, 128.0 (d, J = 1.9 Hz), 128.2, 128.4, 128.9, 133.8, 135.5 (d, J = 3.4 Hz), 138.2, 151.7 (dd, J = 7.4 Hz, 5.6 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -113.9 (d, J = 255.3 Hz), -83.9 (d, J = 255.7 Hz). HRMS (ESI^+): calcd for $C_{22}H_{19}F_2NNaO$ $[M+Na]^+$ 374.1332, found 374.1332.



2-(Cinnamyloxy)-3,3-difluoro-1-methyl-2-phenylindoline (5d)[13]

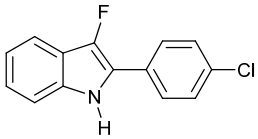
The reaction time of the cyclization and difluoroalkoxylation was 8 h and 0.5 h, respectively. $NaHCO_3$ (25 mg, 0.3 mmol) was added to the reaction mixture after the cyzlization reaction. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate/Et_3N = 100/1/0.03, v/v/v) afforded **5d** as a white solid (70 mg, 62% yield). M.p.: 98-100 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.82 (s, 3H), 3.97 (dd, J = 12.4 Hz, 6.0 Hz, 1H), 4.20 (dd, J = 12.4 Hz, 5.6 Hz, 1H), 6.30 (dt, J = 15.6 Hz, 5.6 Hz, 1H), 6.60 (d, J = 16.0 Hz, 1H), 6.67 (d, J = 8.0 Hz, 1H), 6.87 (t, J = 7.6 Hz, 1H), 7.23-7.26 (m, 1H), 7.32 (t, J = 7.6 Hz, 2H), 7.38-7.47 (m, 7H), 7.61-7.63 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 29.0, 65.5 (d, J = 5.2 Hz), 98.8 (dd, J = 32.1 Hz, 21.4 Hz), 106.0, 118.5, 120.2 (t, J = 24.6 Hz), 123.0 (dd, J = 255.5 Hz, 248.6 Hz), 123.9, 125.7, 126.6, 127.7, 127.9 (d, J = 2.0 Hz), 128.2, 128.7, 128.9, 131.7, 133.8 (d, J = 1.3 Hz), 135.5 (d, J = 3.5 Hz), 136.9, 151.7 (dd, J = 7.6 Hz, 5.7 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -113.4 (d, J = 255.3 Hz), -84.1 (d, J = 255.7 Hz). HRMS (ESI^+): calcd for $C_{24}H_{21}F_2NNaO$ $[M+Na]^+$ 400.1489, found 400.1496.

VI. Ag-catalyzed one-pot synthesis of 3-fluoroindoles

i. General procedure for the Ag-catalyzed one-pot synthesis of 3-fluoroindoles

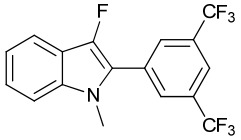
A mixture of 2-alkynylanilines **1** or **3** (0.3 mmol), $AgNO_3$ (5.1 mg, 0.03 mmol), and MeCN (1.5 mL) was stirred at 80 °C under an nitrogen atmosphere until the reaction was complete as monitored by TLC. The reaction solution was then cooled to room temperature, and added Selectfluor (127 mg, 0.36 mmol). After being stirred at room temperature for 6-15 h, the reaction mixture was added Et_3N (0.5 mL). The solvent was evaporated and the residue was purified by column chromatography on silica gel to afford the desired products **6**.

ii. Characterization of products 6



2-(4-Chlorophenyl)-3-fluoro-1*H*-indole (6a)[6]

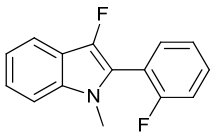
The reaction time of the cyclization and monofluorination was 30 h and 15 h, respectively. Selectfluor (138.2 mg, 0.39 mmol) was used. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 25/1, v/v) afforded **6a** as a yellow solid (42 mg, 57% yield). The difluorinated product **2d** was also obtained in 25% yield (20 mg). M.p.: 133-135 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.16 (td, J = 7.2 Hz, 0.8 Hz, 1H), 7. 23 (dd, J = 8.4 Hz, 1.2 Hz, 1H), 7.32 (dd, J = 8.4 Hz, 2.4 Hz, 1H), 7.44 (dt, J = 9.2 Hz, 2.4 Hz, 2H), 7.63-7.66 (m, 3H), 7.74 (br. s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 111.5 (d, J = 1.4 Hz), 117.2 (d, J = 2.6 Hz), 118.6 (d, J = 2.1 Hz), 118.7, 120.7, 123.9, 126.6 (d, J = 5.3 Hz), 128.6 (d, J = 4.7 Hz), 129.4, 132.7 (d, J = 6.5 Hz), 133.3 (d, J = 1.9 Hz), 142.8 (d, J = 247.8 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -169.5. HRMS (ESI$^-$): calcd for $C_{14}H_8ClFN$ $[M-H]^-$ 244.0329, found 244.0320.



2-(3,5-Bis(trifluoromethyl)phenyl)-3-fluoro-1-methyl-1*H*-indole (6b)

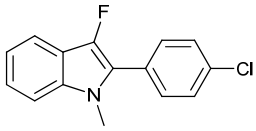
The reaction time of the cyclization and monofluorination was 16 h and 6 h, respectively. Purification by column chromatography on silica gel (petroleum ether) afforded **6b** as a white solid (62 mg, 57% yield). M.p.: 90-91 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.71 (s, 3H), 7.21 (td, J = 8.0 Hz, 1.6 Hz, 1H), 7.33-7.39 (m, 2H), 7.68 (d, J = 8.0 Hz, 1H), 7.91 (s, 1H), 7.98 (s, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 31.4, 110.1 (d, J = 1.6 Hz), 116.7 (d, J = 15.7 Hz), 117.5 (d, J = 2.6 Hz), 120.5, 120.7, 121.4-121.6 (m), 123.3 (q, J = 271.2 Hz), 124.3, 129.4 (d, J = 2.1 Hz), 131.3 (d, J =

3.6 Hz), 132.4 (q, J = 33.3 Hz), 135.1 (d, J = 5.8 Hz), 143.1 (d, J = 248.3 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -63.0, -172.5. HRMS (ESI^+): calcd for $C_{17}H_{11}F_7N$ $[M+H]^+$ 362.0780, found 362.0781.



3-Fluoro-2-(2-fluorophenyl)-1-methyl-1*H*-indole (6c)

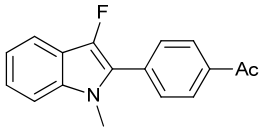
The reaction time of the cyclization and monofluorination was 16 h and 6 h, respectively. Purification by column chromatography on silica gel (petroleum ether) afforded **6c** as colorless liquid (38 mg, 52% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.62 (s, 3H), 7.17-7.21 (m, 1H), 7.23-7.38 (m, 4H), 7.44-7.52 (m, 2H), 7.69 (d, J = 8.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 30.8 (d, J = 3.6 Hz), 109.7 (d, J = 1.6 Hz), 116.3 (d, J = 21.8 Hz), 116.6 (d, J = 15.7 Hz), 116.9 (d, J = 3.3 Hz), 117.0 (d, J = 2.6 Hz), 117.9 (d, J = 22.0 Hz), 119.8, 123.0, 124.5 (d, J = 3.6 Hz), 130.9 (d, J = 8.1 Hz), 132.8 (t, J = 2.2 Hz), 134.0 (d, J = 5.6 Hz), 142.3 (d, J = 244.0 Hz), 160.3 (d, J = 247.7 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -112.6 (d, J = 1.6 Hz), -173.4 (d, J = 1.6 Hz). HRMS (ESI^+): calcd for $C_{15}H_{12}F_2N$ $[M+H]^+$ 244.0938, found 244.0940.



2-(4-Chlorophenyl)-3-fluoro-1-methyl-1*H*-indole (6d)

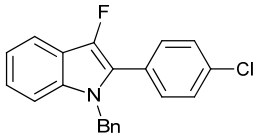
The reaction time of the cyclization and monofluorination was 12 h and 4 h, respectively. Purification by column chromatography on silica gel (petroleum ether) afforded **6d** as a white solid (45 mg, 58% yield). M.p.: 110-111 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.67 (s, 3H), 7.19 (t, J = 7.6 Hz, 1H), 7.30 (t, J = 8.0 Hz, 1H), 7.35 (d, J = 8.0 Hz, 1H), 7.47 (d, J = 8.8 Hz, 2H), 7.50 (d, J = 8.8 Hz, 2H), 7.66 (d, J = 8.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 31.2, 109.8 (d, J = 1.5 Hz), 116.8 (d, J = 15.9 Hz), 117.0 (d, J = 2.5 Hz), 120.1, 122.5 (d, J = 20.3 Hz), 123.2, 127.5 (d, J =

3.4 Hz), 129.1, 131.0 (d, J = 2.0 Hz), 134.2 (d, J = 4.3 Hz), 142.0 (d, J = 244.2 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -174.8. HRMS (ESI^+): calcd for $C_{15}H_{12}ClFN$ $[M+H]^+$ 260.0642, found 260.0641.



1-(4-(3-Fluoro-1-methyl-1*H*-indol-2-yl)phenyl)ethanone (6e)

The reaction time of the cyclization and monofluorination was 16 h and 4 h, respectively. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10/1, v/v) afforded **6e** as a pale yellow solid (24 mg, 30% yield). M.p.: 144-145 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.66 (s, 3H), 3.71 (s, 3H), 7.19 (t, J = 7.2 Hz, 1H), 7.29-7.37 (m, 2H), 7.64 (d, J = 8.4 Hz, 2H), 7.66 (d, J = 8.8 Hz, 1H), 8.09 (d, J = 8.0 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 26.8, 31.5, 109.9 (d, J = 1.5 Hz), 116.8 (d, J = 15.9 Hz), 117.2 (d, J = 2.5 Hz), 120.3, 122.6 (d, J = 19.6 Hz), 123.6, 128.8, 129.6 (d, J = 2.3 Hz), 133.8 (d, J = 3.6 Hz), 134.8 (d, J = 5.8 Hz), 136.1, 142.7 (d, J = 246.7 Hz), 197.7 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -172.9. HRMS (ESI^+): calcd for $C_{17}H_{14}FNNaO$ $[M+Na]^+$ 290.0957, found 290.0961.



1-Benzyl-2-(4-chlorophenyl)-3-fluoro-1*H*-indole (6f)

The reaction time of the cyclization and monofluorination was 16 h and 10 h, respectively. Purification by column chromatography on silica gel (petroleum ether) afforded **6f** as pale yellow liquid (45 mg, 45% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 5.28 (s, 2H), 7.01 (dd, J = 8.4 Hz, 1.6 Hz, 2H), 7.17-7.22 (m, 3H), 7.27-7.32 (m, 3H), 7.37-7.42 (m, 4H), 7.69-7.71 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 47.7, 110.6 (d, J = 1.5 Hz), 117.1 (d, J = 2.5 Hz), 117.4 (d, J = 16.1 Hz), 120.5, 122.6 (d, J = 20.3 Hz), 123.4, 126.0, 127.4 (d, J = 3.5 Hz), 127.6, 129.0, 129.1, 130.9 (d, J =

2.0 Hz), 134.0 (d, J = 5.8 Hz), 134.4, 137.8, 142.3 (d, J = 244.9 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = -174.0. HRMS (ESI^+): calcd for $C_{21}H_{15}ClFNNa$ $[M+Na]^+$ 358.0775, found 358.0772.

VII. References

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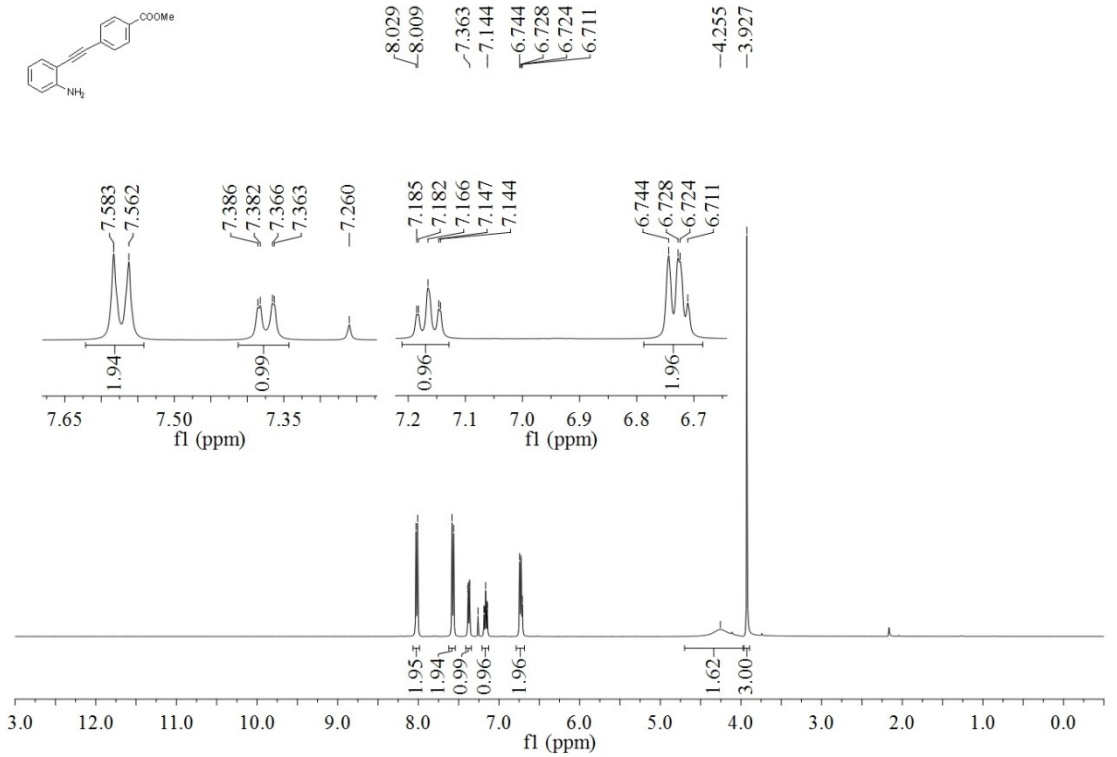
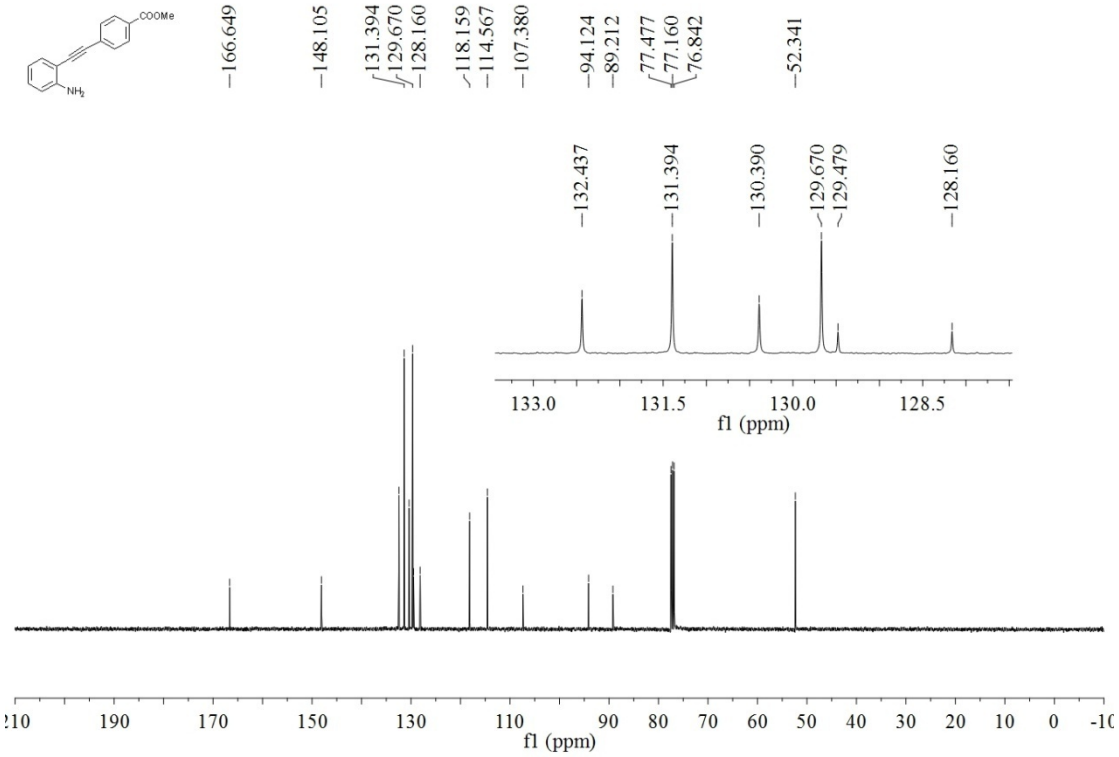
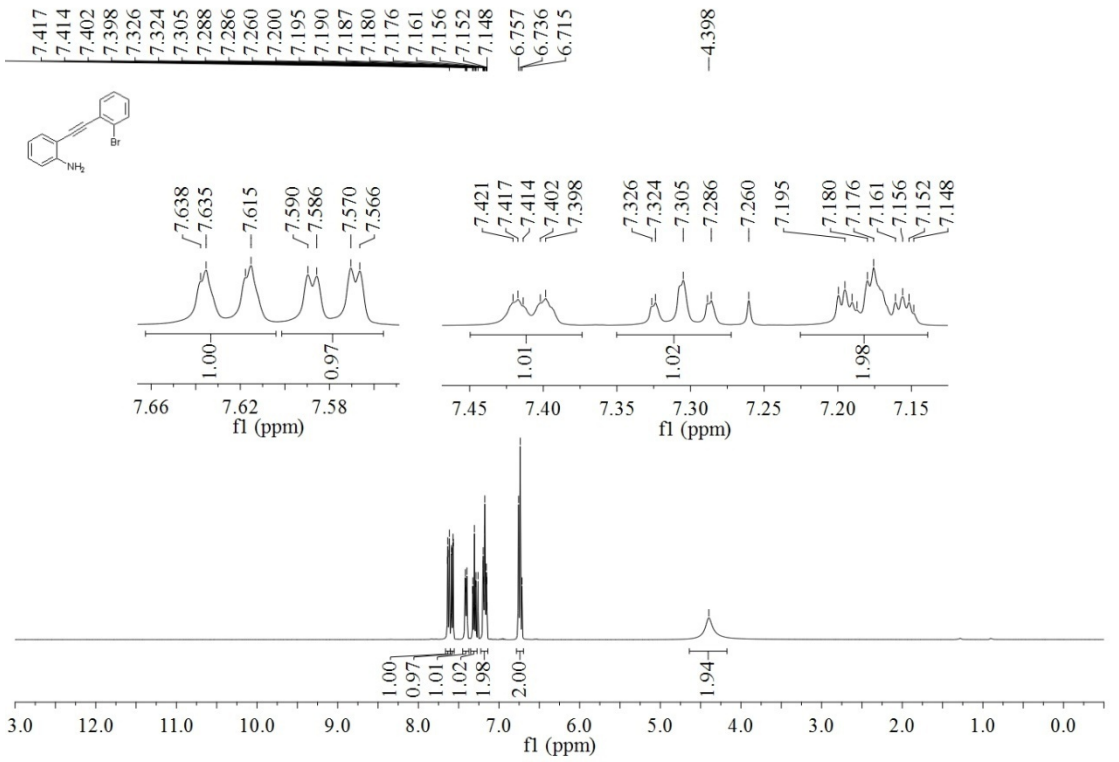
VIII. Copies of ^{1}H, ^{13}C and ^{19}F NMR spectra



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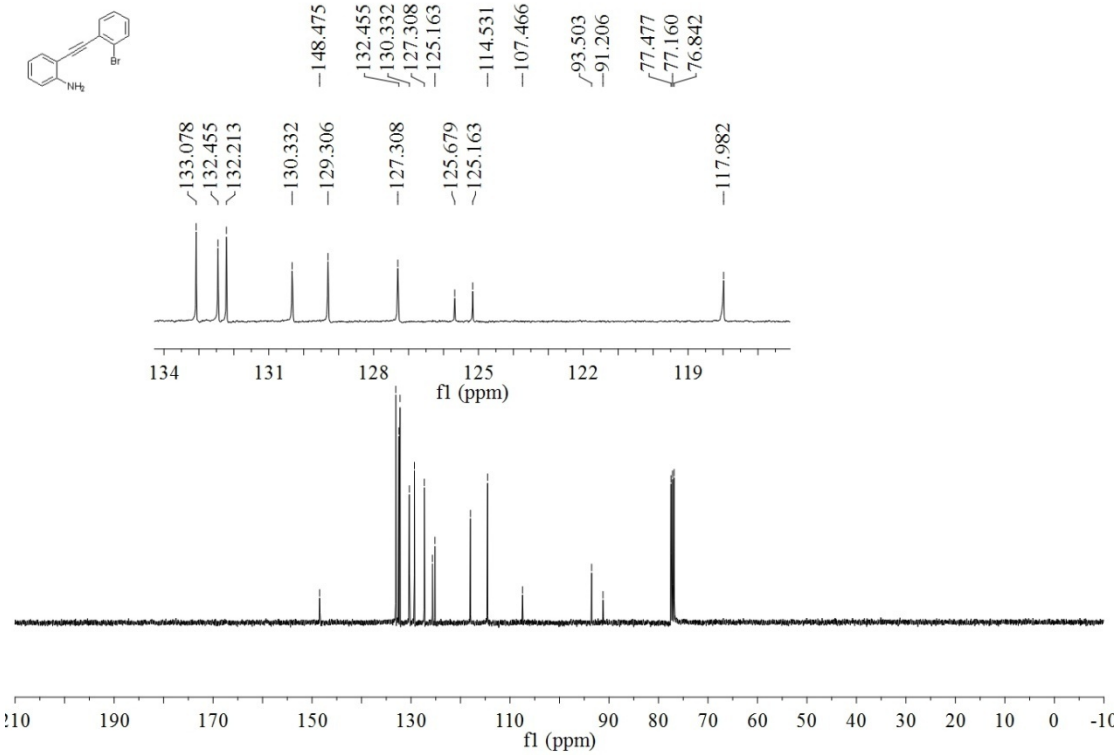
f1 (ppm)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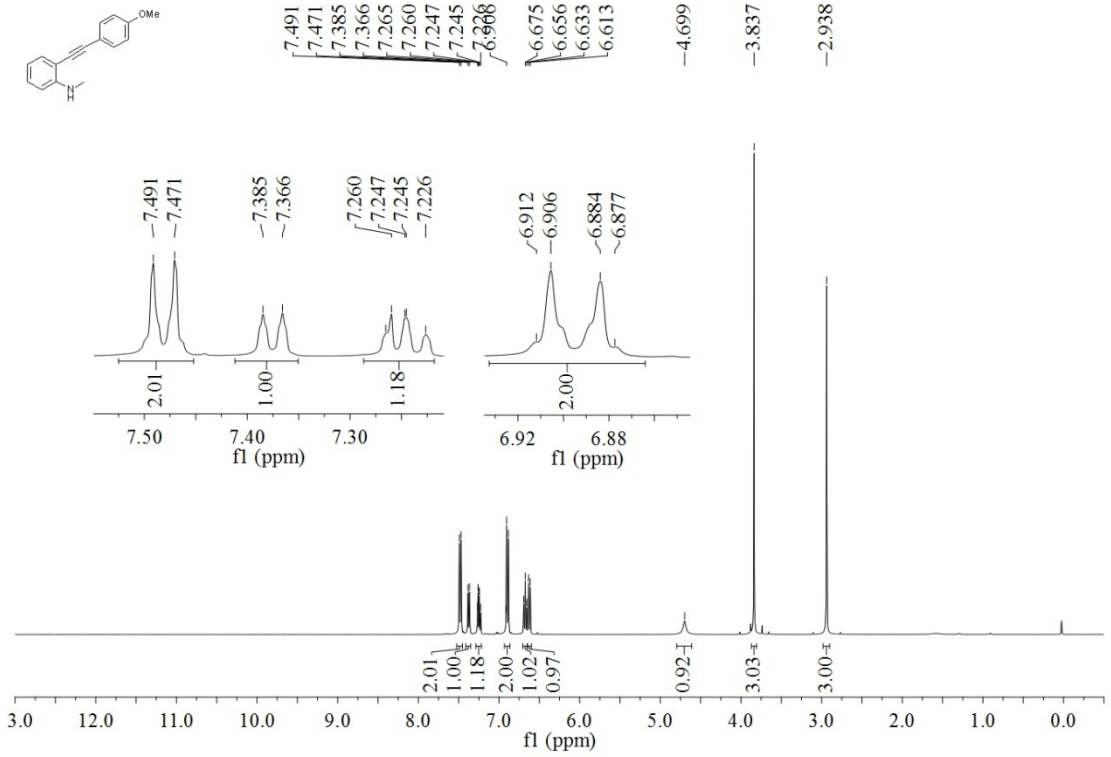
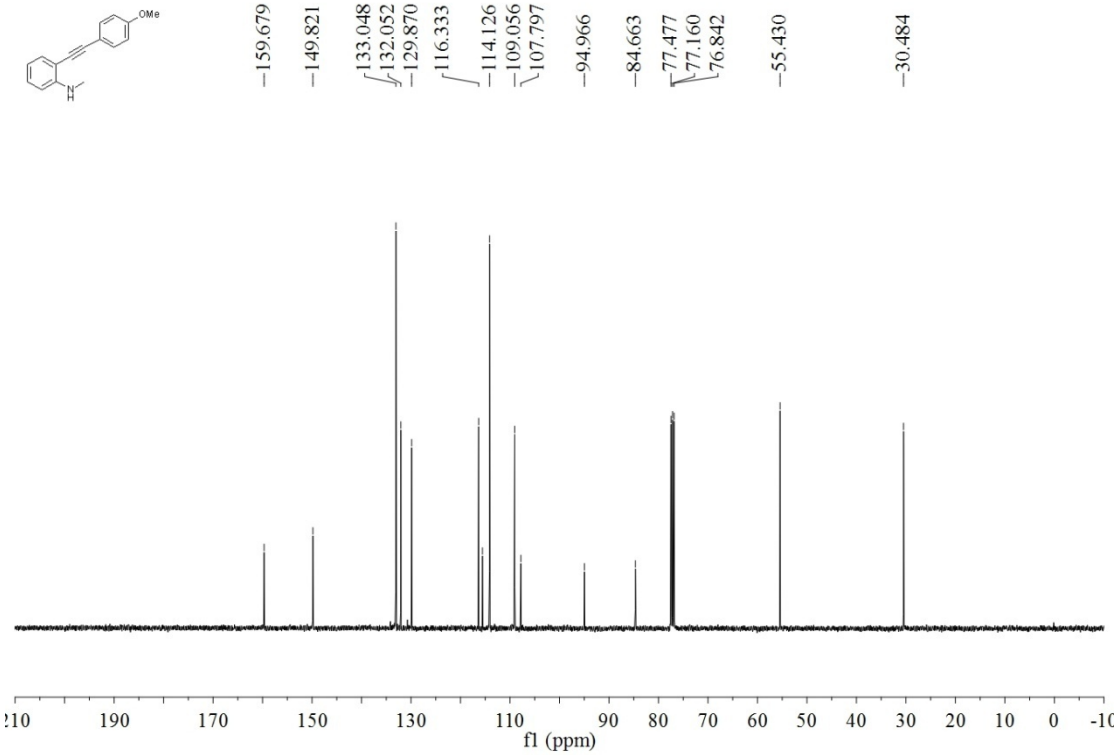
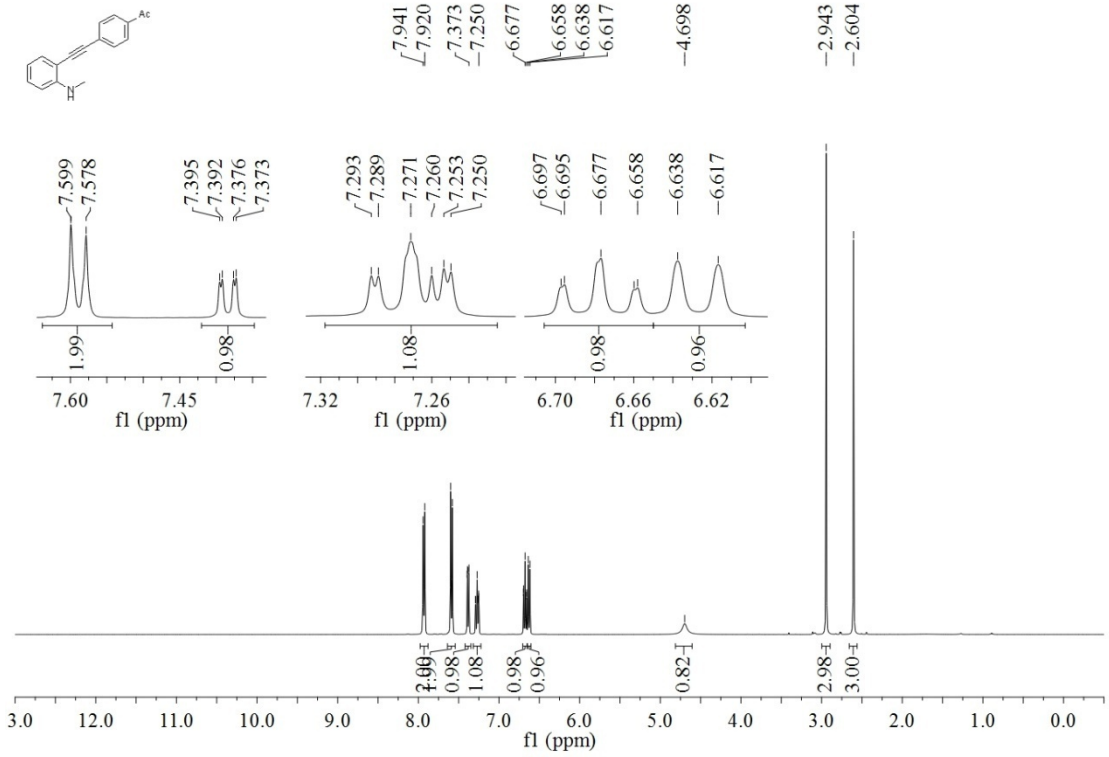
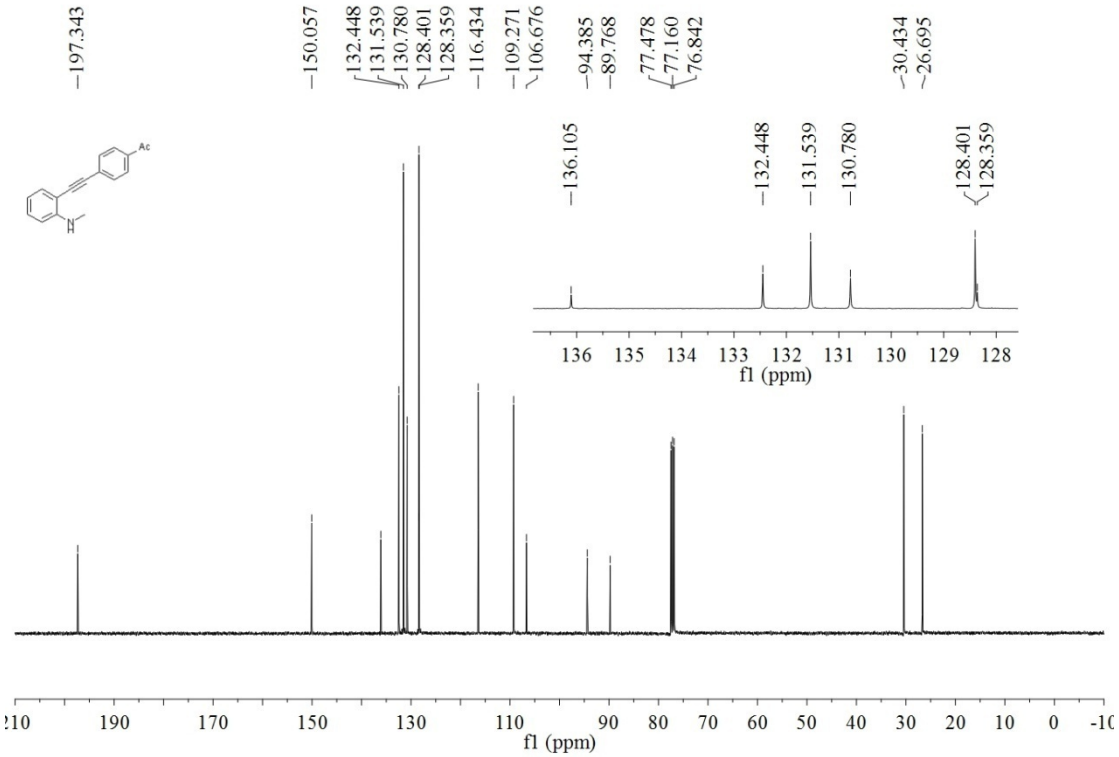
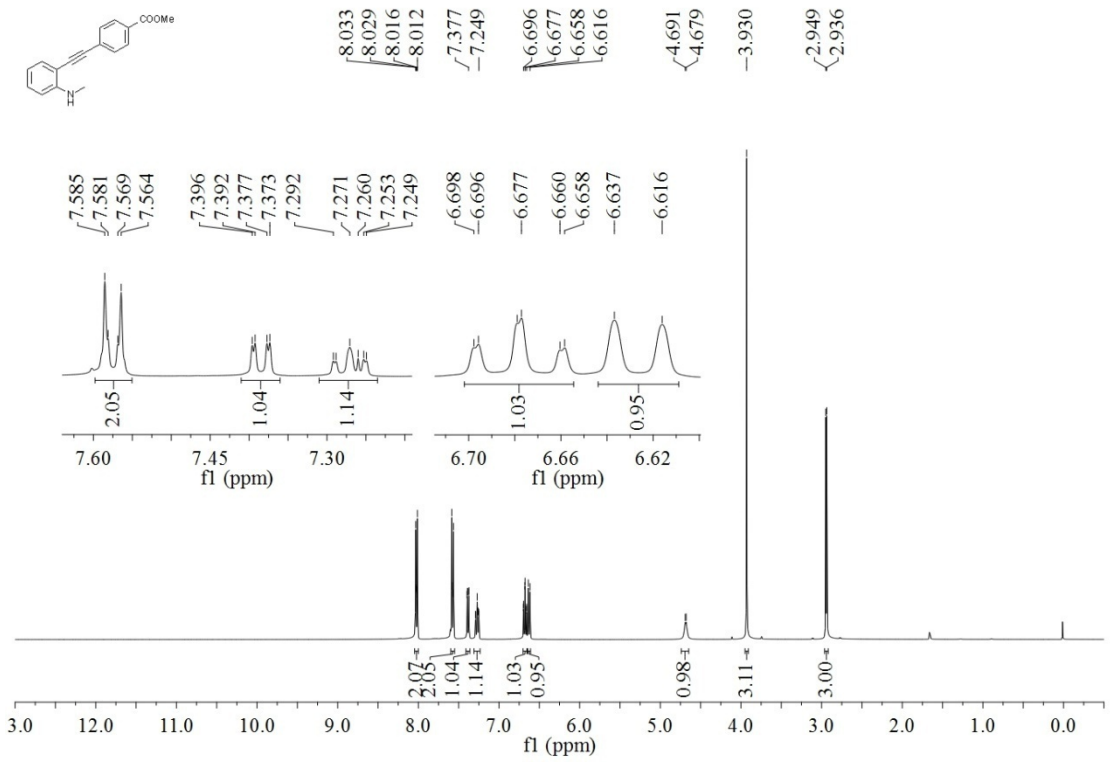
125.163
117.982
f1 (ppm)

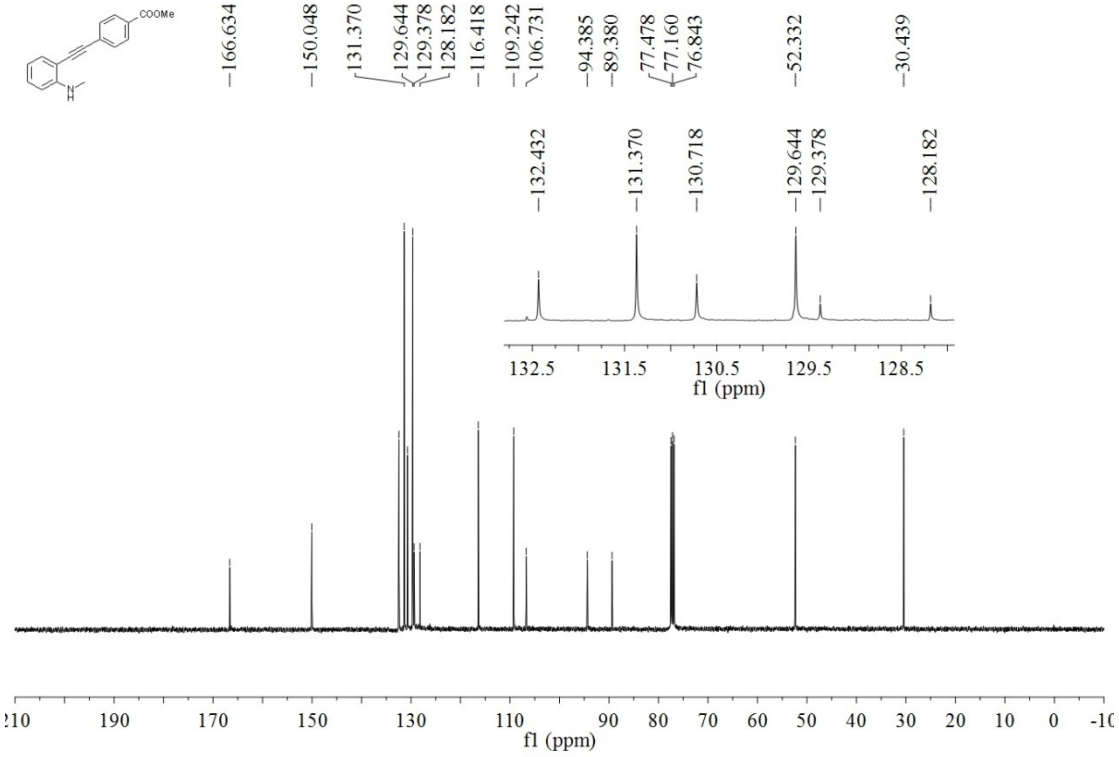

OMe
7.491
7.471
7.385
7.366
7.265
7.260
7.247
7.245
6.675
6.656
6.633
6.613
4.699
3.837
2.938
6.912
6.906
6.884
6.877
2.01
1.00
1.18
2.00
7.50
7.40
7.30
6.92
6.88
fl (ppm)
0.92
3.03
3.00
0.97
1.02
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0

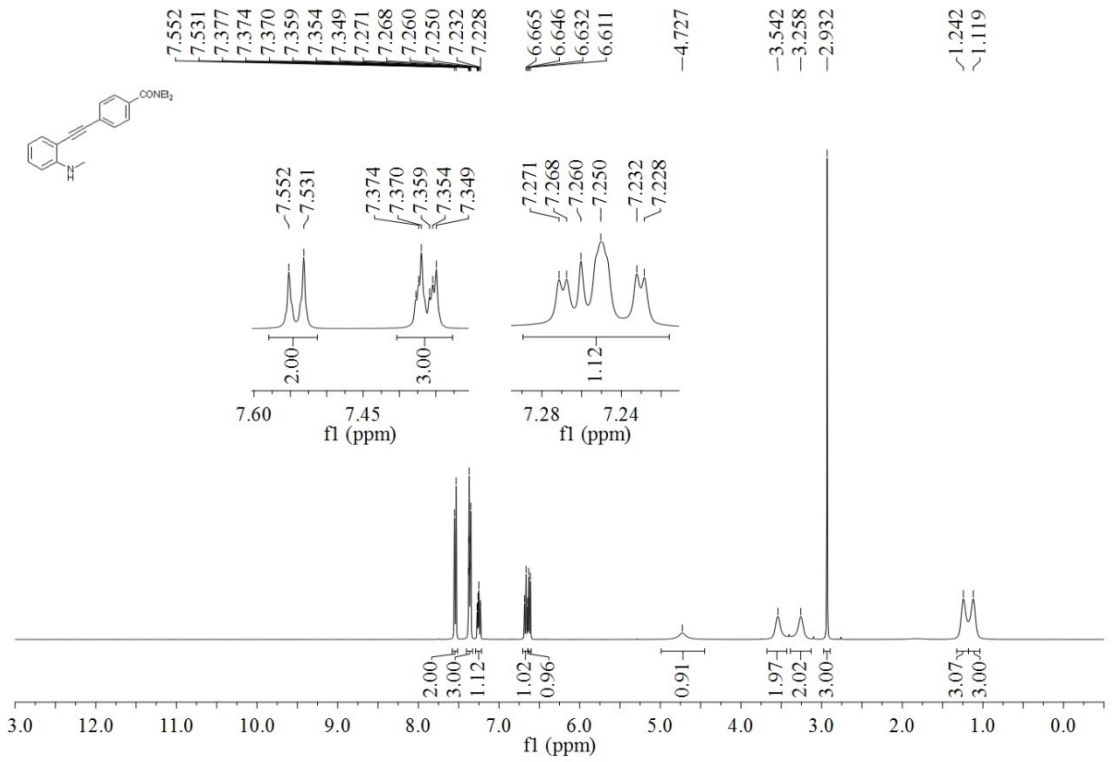

OMe
159.679
149.821
133.048
132.052
129.870
116.333
114.126
109.056
107.797
94.966
84.663
77.477
77.160
76.842
55.430
30.484
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)

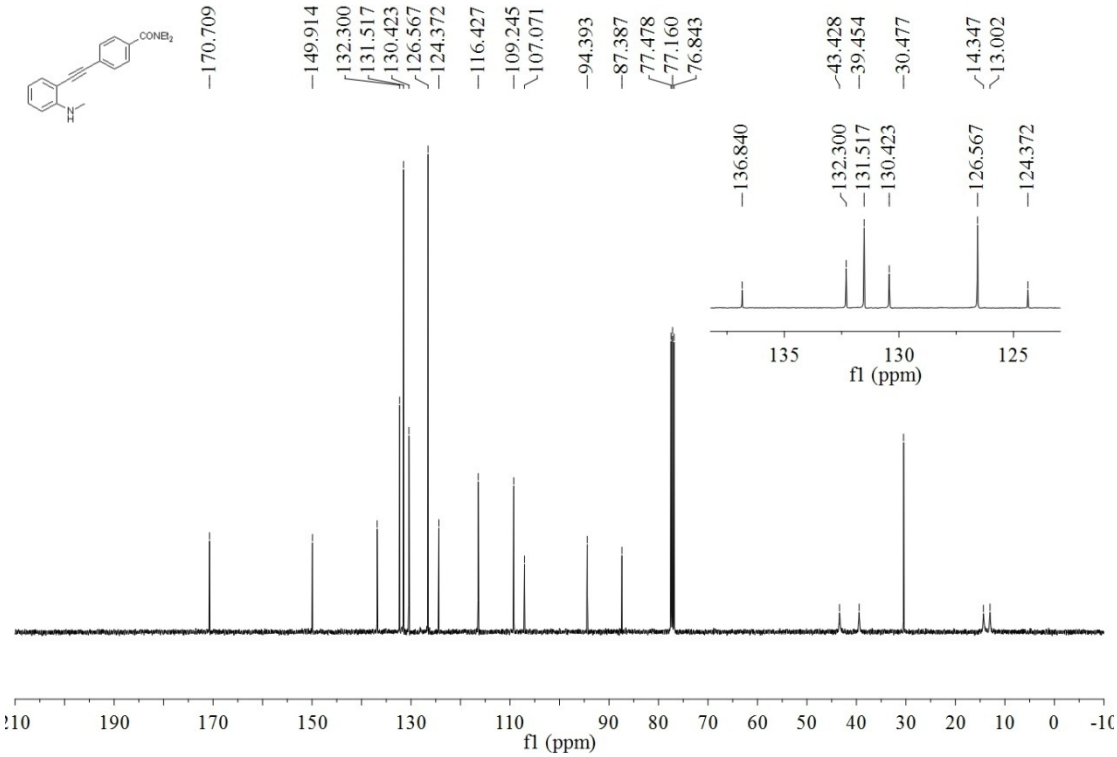

7.941
7.920
7.373
7.250
6.677
6.658
6.638
6.617
4.698
2.943
2.604
7.599
7.578
7.395
7.392
7.376
7.373
7.293
7.289
7.271
7.260
7.253
7.250
6.697
6.695
6.677
6.658
6.638
6.617
1.99
0.98
1.08
0.98
0.96
7.60
7.45
7.32
7.26
6.70
6.66
6.62
f1 (ppm)
2.00
0.98
1.08
0.98
0.96
0.82
2.98
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

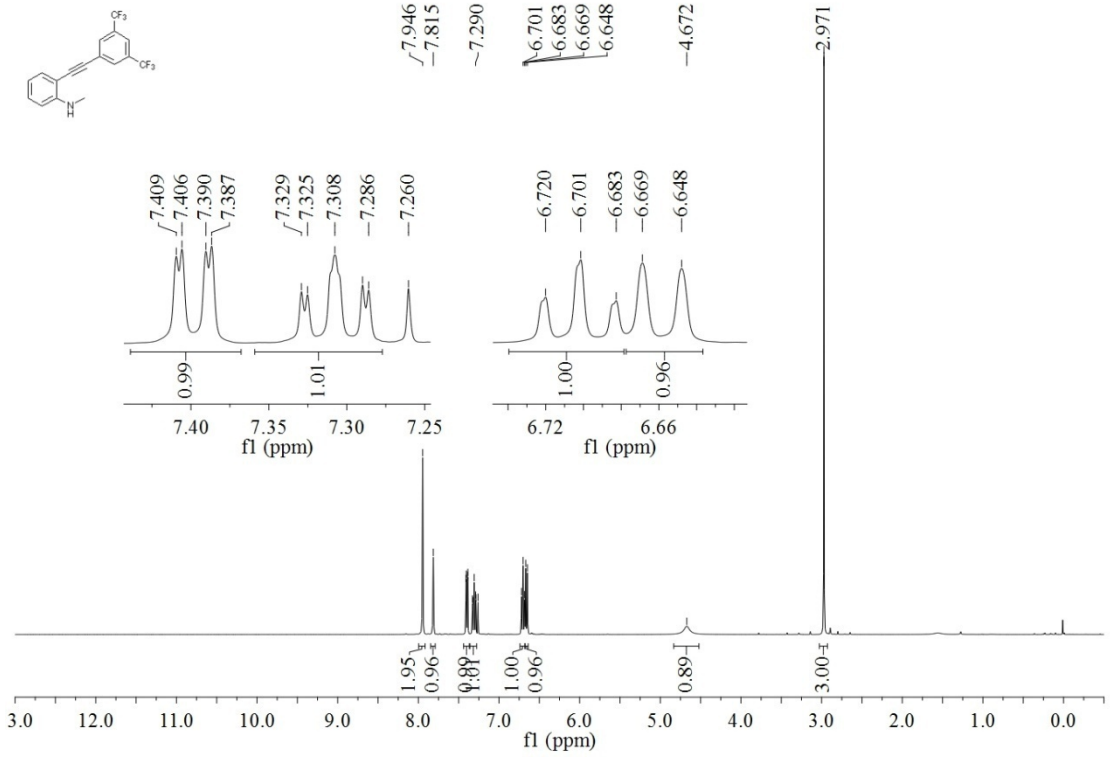

197.343
150.057
132.448
131.539
130.780
128.401
128.359
116.434
109.271
106.676
94.385
89.768
77.478
77.160
76.842
30.434
26.695
136.105
132.448
131.539
130.780
128.401
128.359
136
135
134
133
132
131
130
129
128
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

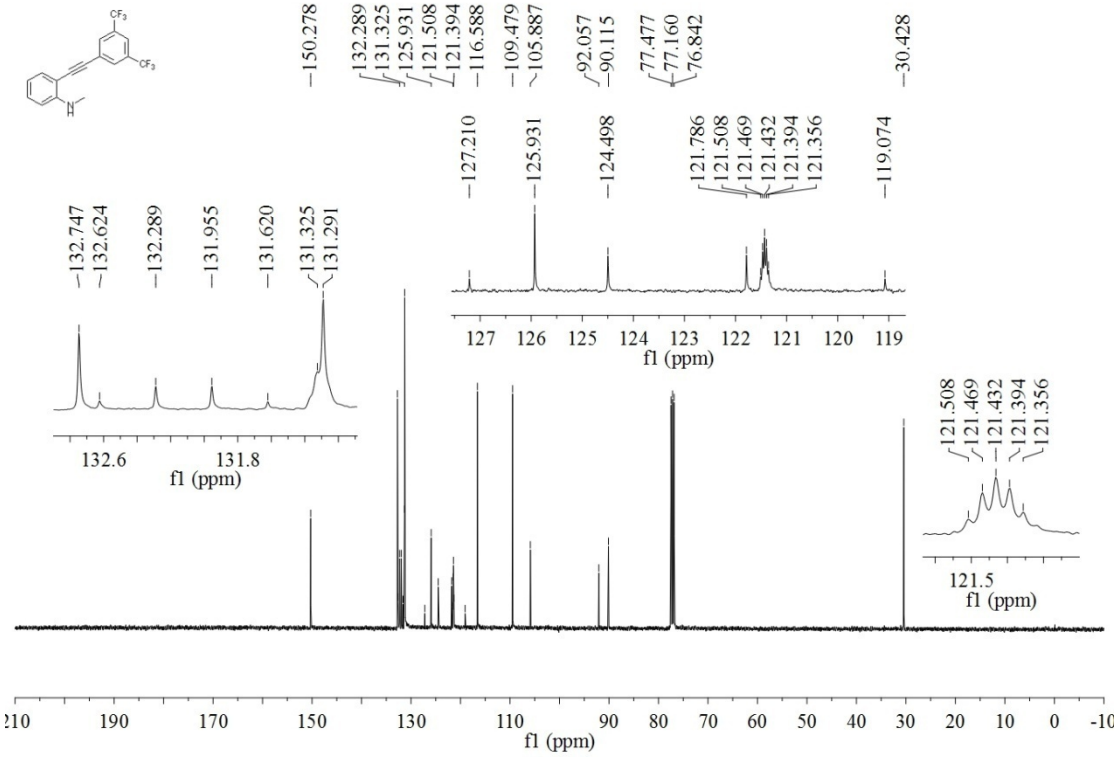

COOMe
8.033
8.029
8.016
8.012
7.377
7.249
6.696
6.677
6.658
6.616
4.691
4.679
3.930
2.949
2.936
7.585
7.581
7.569
7.564
7.396
7.392
7.377
7.373
7.292
7.271
7.260
7.253
7.249
6.698
6.696
6.677
6.660
6.658
6.637
6.616
2.05
1.04
1.14
1.03
0.95
7.60
7.45
7.30
6.70
6.66
6.62
f1 (ppm)
2.07
2.05
1.04
1.14
1.03
0.95
0.98
3.11
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

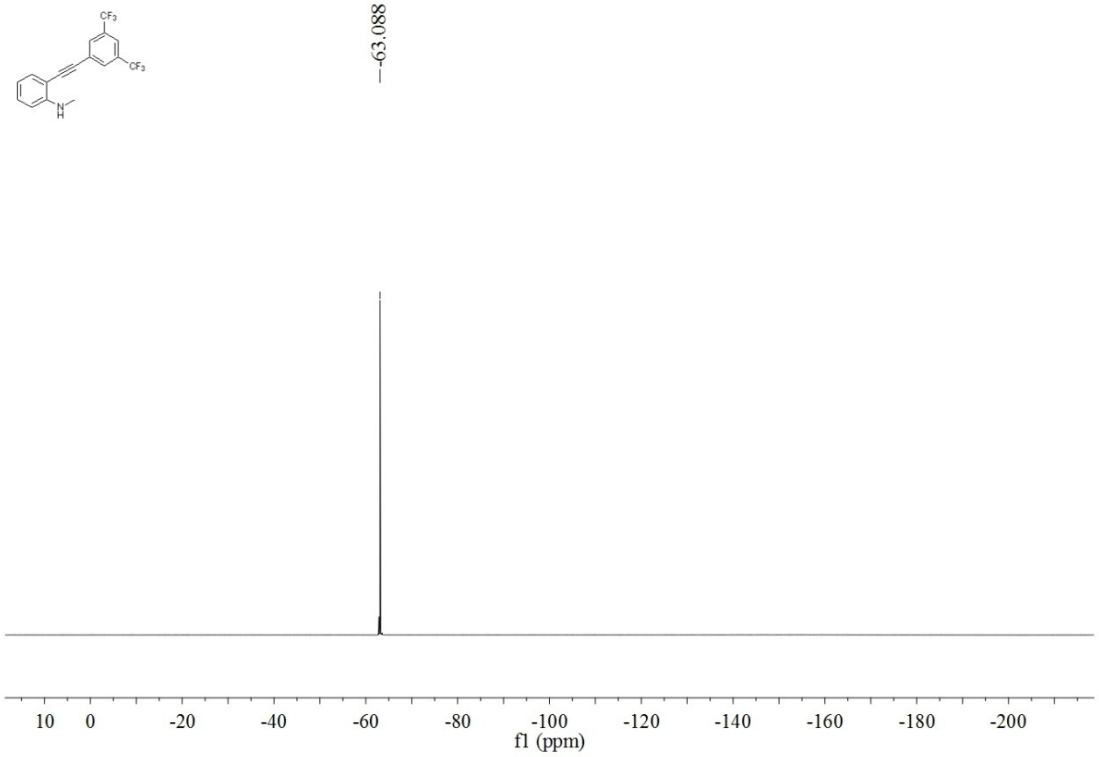

COOMe
166.634
150.048
131.370
129.644
129.378
128.182
116.418
109.242
106.731
94.385
89.380
77.478
77.160
76.843
52.332
30.439
132.432
131.370
130.718
129.644
129.378
128.182
132.5
131.5
130.5
129.5
128.5
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

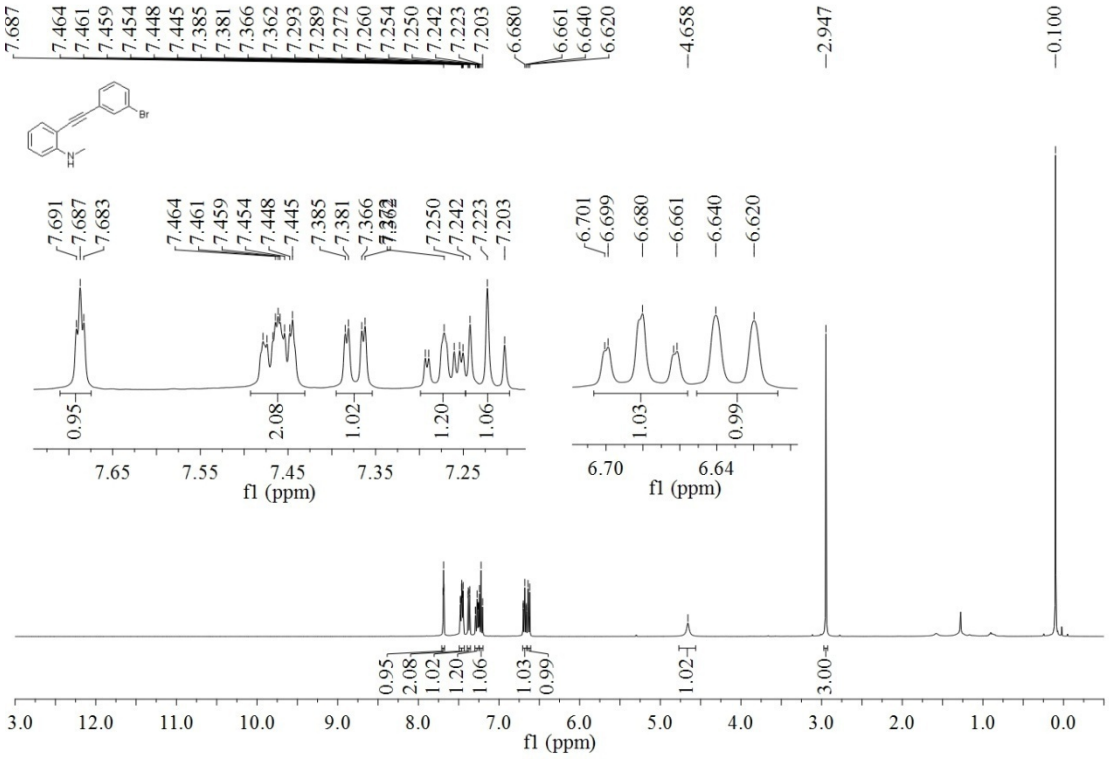

7.552
7.531
7.377
7.374
7.370
7.359
7.354
7.349
7.271
7.268
7.260
7.250
7.232
7.228
6.665
6.646
6.632
6.611
4.727
3.542
3.258
2.932
1.242
1.119
CONEt2
2.00
3.00
1.12
1.02
0.96
0.91
1.97
2.02
3.00
3.07
3.00
fl (ppm)

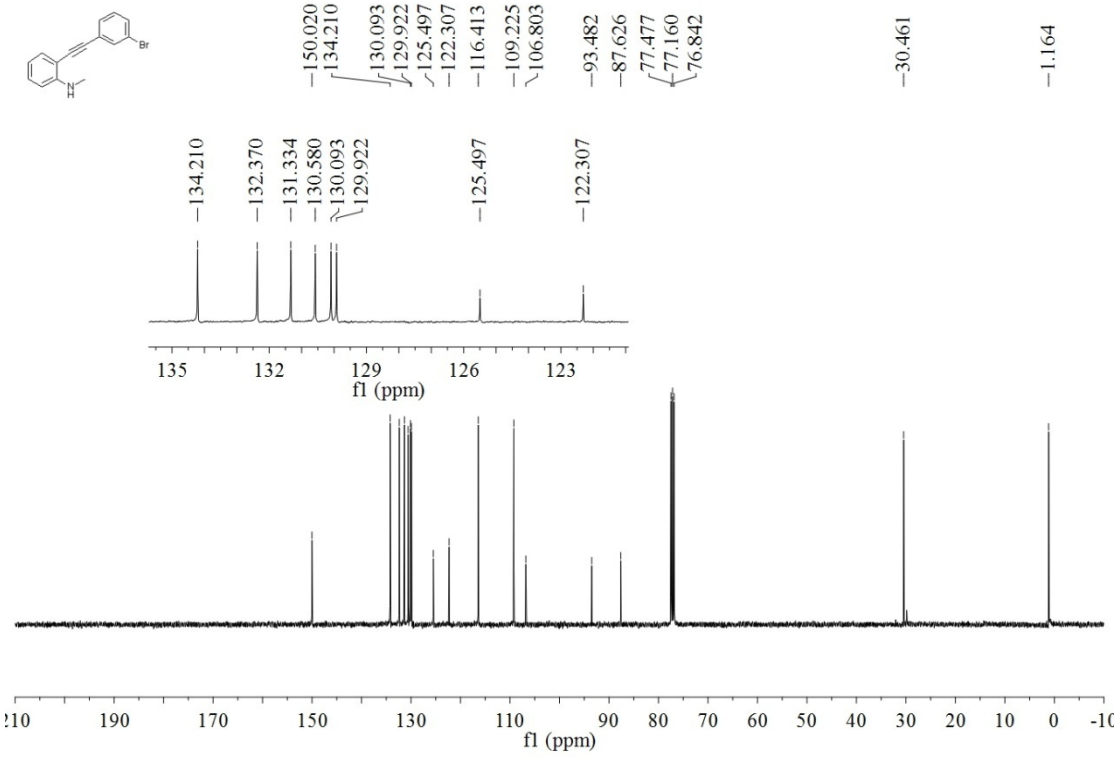

170.709
149.914
132.300
131.517
130.423
126.567
124.372
116.427
109.245
107.071
94.393
87.387
77.478
77.160
76.843
43.428
39.454
30.477
14.347
13.002
136.840
CONEt2
fl (ppm)

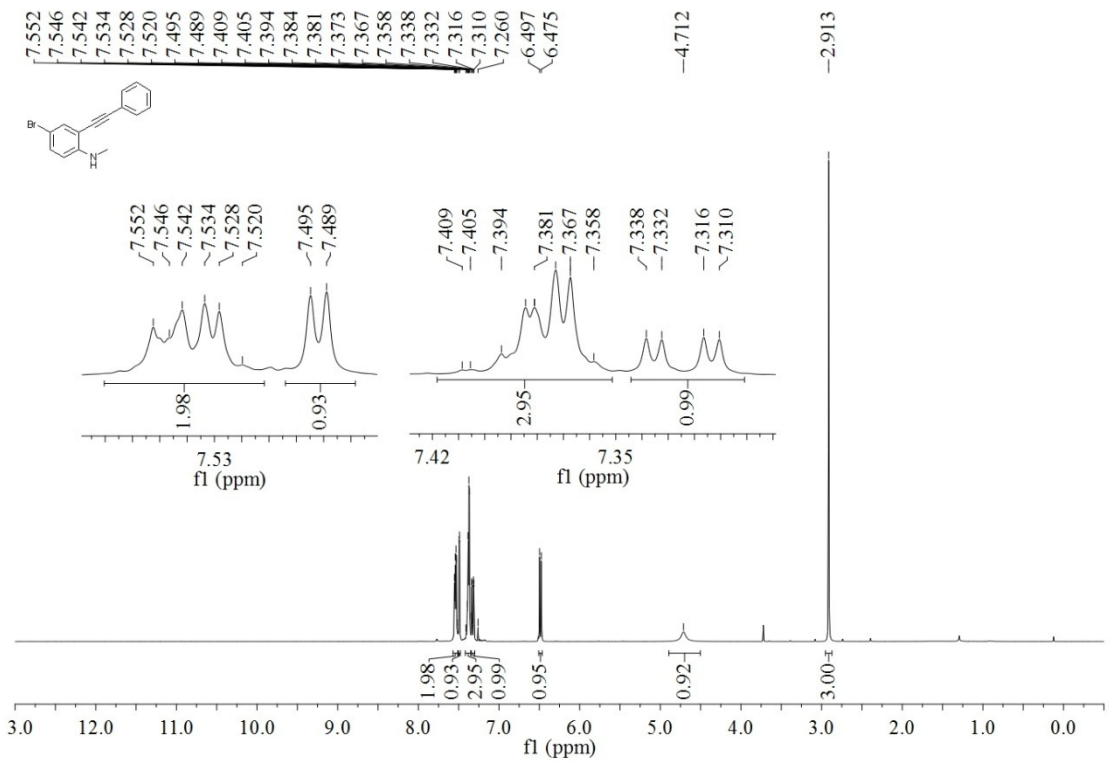

7.946
7.815
7.290
6.701
6.683
6.669
6.648
4.672
2.971
7.409
7.406
7.390
7.387
7.329
7.325
7.308
7.286
7.260
6.720
6.701
6.683
6.669
6.648
0.99
1.01
1.00
0.96
7.40
7.35
7.30
7.25
fl (ppm)
6.72
6.66
fl (ppm)
1.95
0.96
1.00
0.96
0.89
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
fl (ppm)

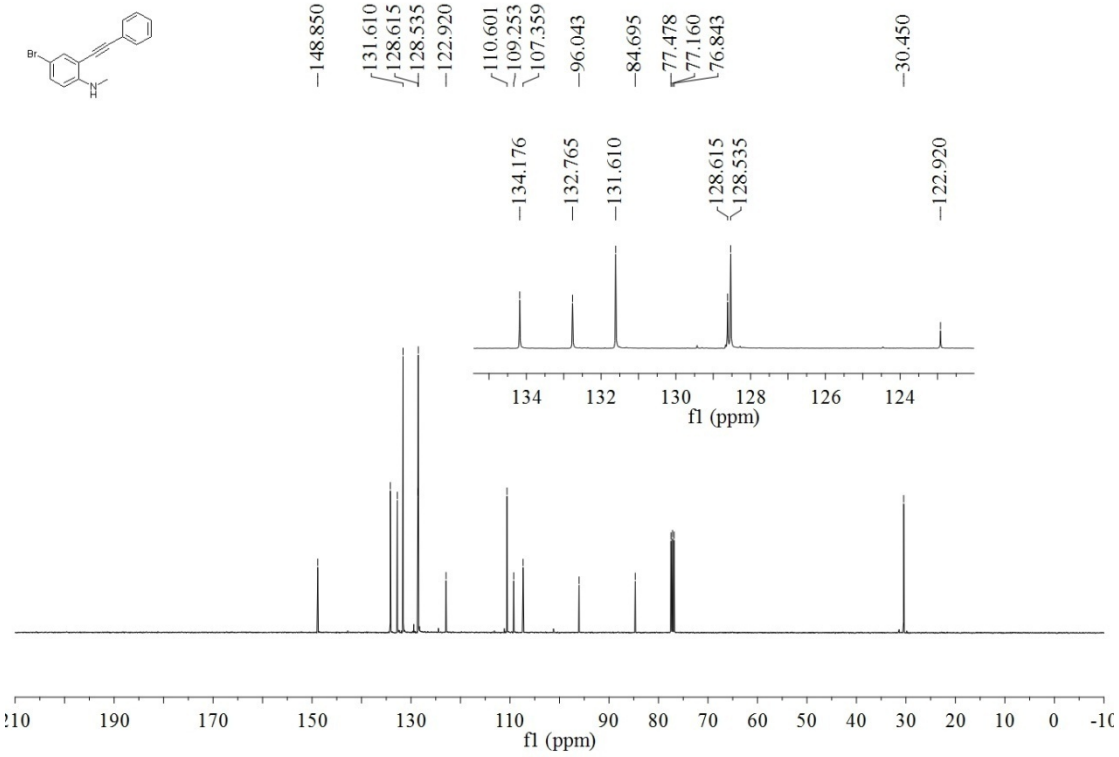

150.278
132.289
131.325
125.931
121.508
121.394
116.588
109.479
105.887
92.057
90.115
77.477
77.160
76.842
30.428
127.210
125.931
124.498
121.786
121.508
121.469
121.432
121.394
121.356
119.074
132.747
132.624
132.289
131.955
131.620
131.325
131.291
127
126
125
124
123
122
121
120
119
fl (ppm)
132.6
131.8
fl (ppm)
121.508
121.469
121.432
121.394
121.356
121.5
fl (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)

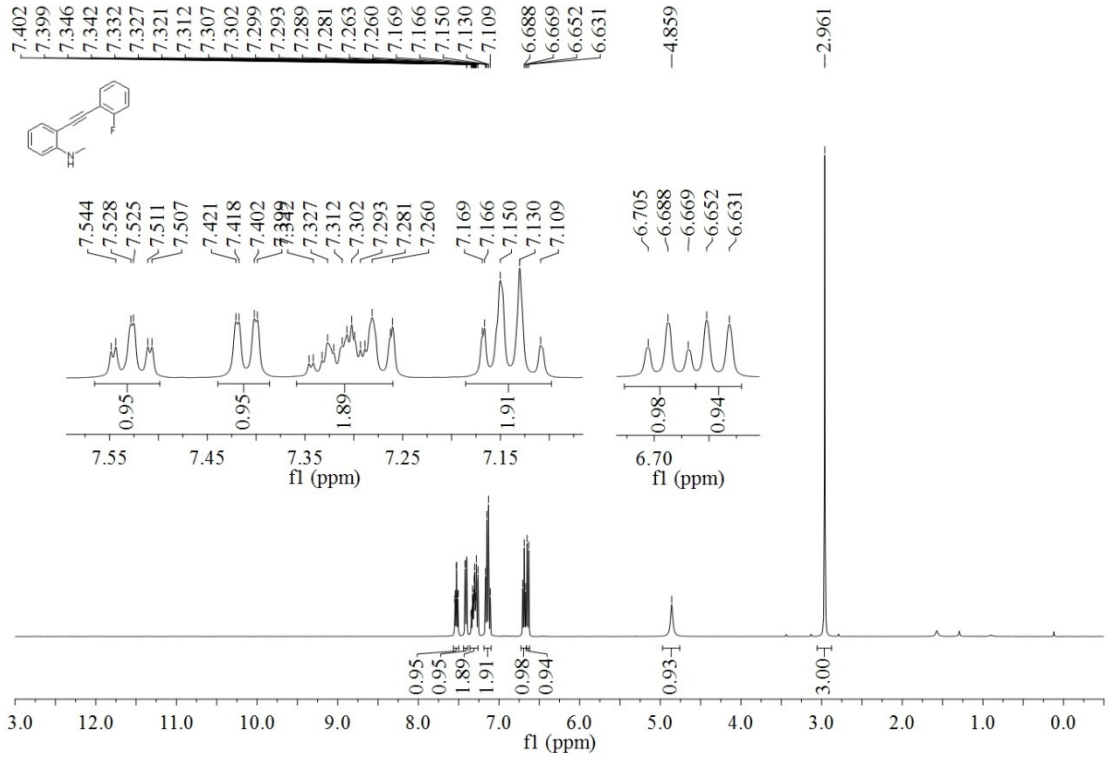

CF3
CF3
NH
-63.088
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

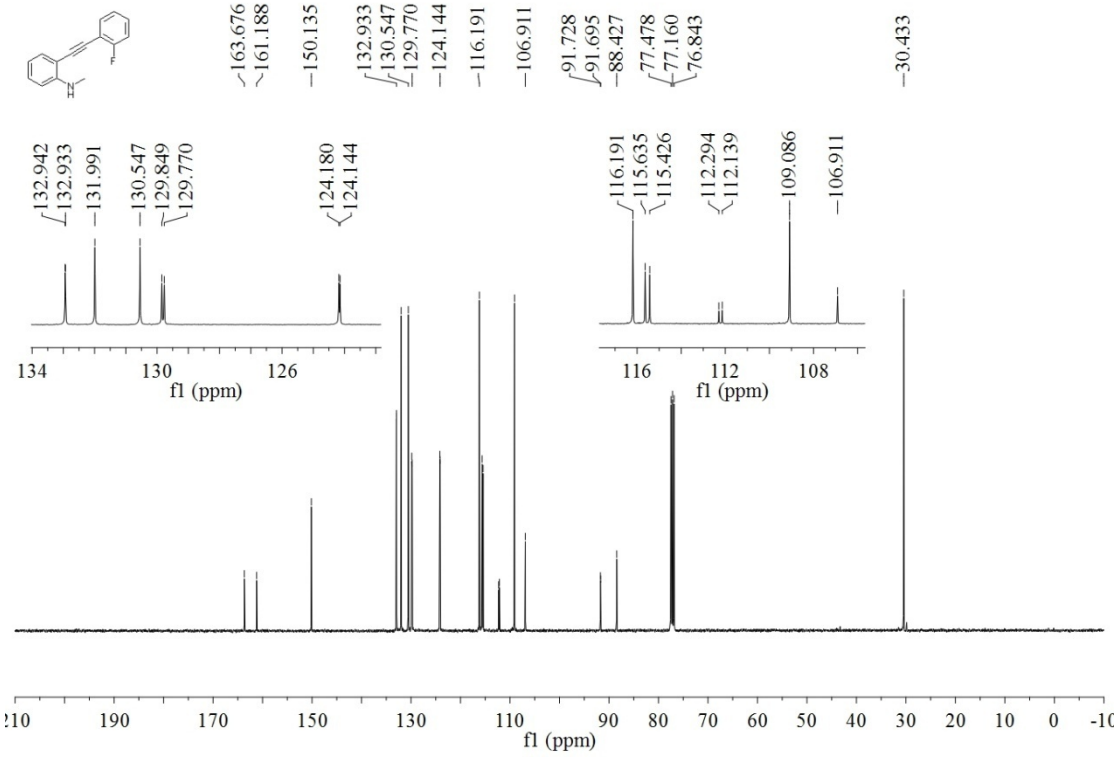

7.687 7.464 7.461 7.459 7.454 7.448 7.445 7.385 7.381 7.366 7.362 7.293 7.289 7.272 7.260 7.254 7.250 7.242 7.223 7.203 6.680 6.661 6.640 6.620 4.658 2.947 0.100
Br
NH
0.95 2.08 1.02 1.20 1.06 1.03 0.99 1.02 3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

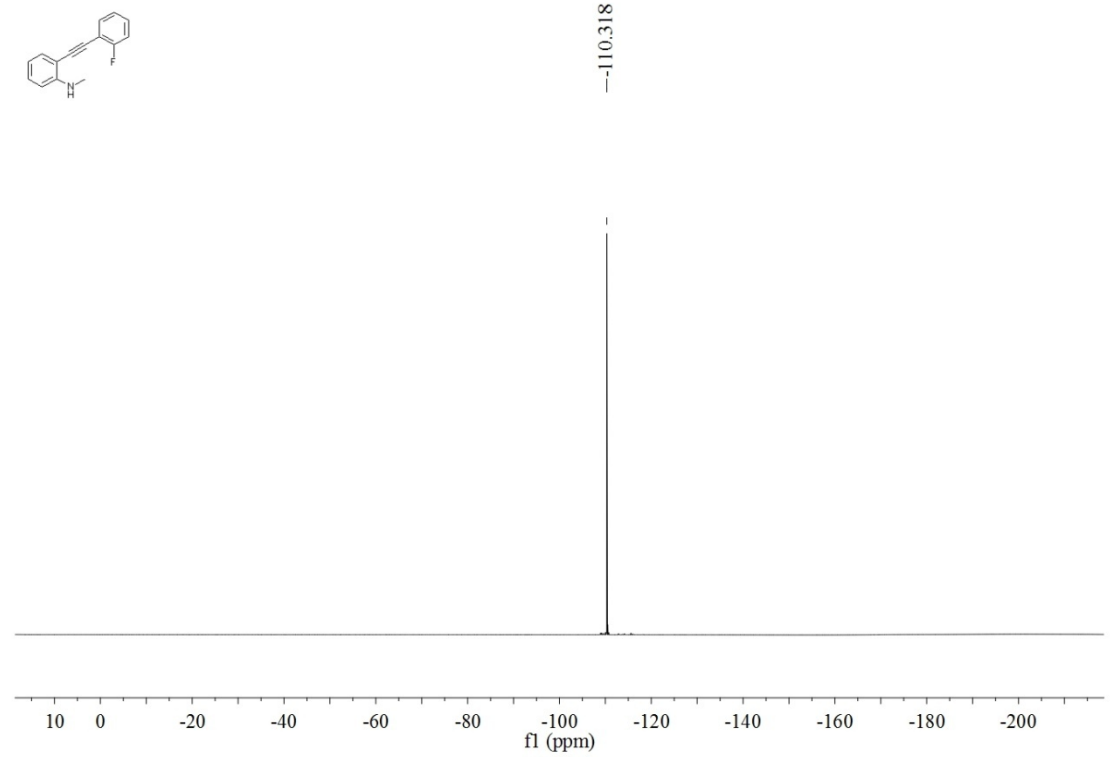

150.020
134.210
130.093
129.922
125.497
122.307
116.413
109.225
106.803
93.482
87.626
77.477
77.160
76.842
30.461
1.164
134.210
132.370
131.334
130.580
130.093
129.922
125.497
122.307
135
132
129
126
123
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

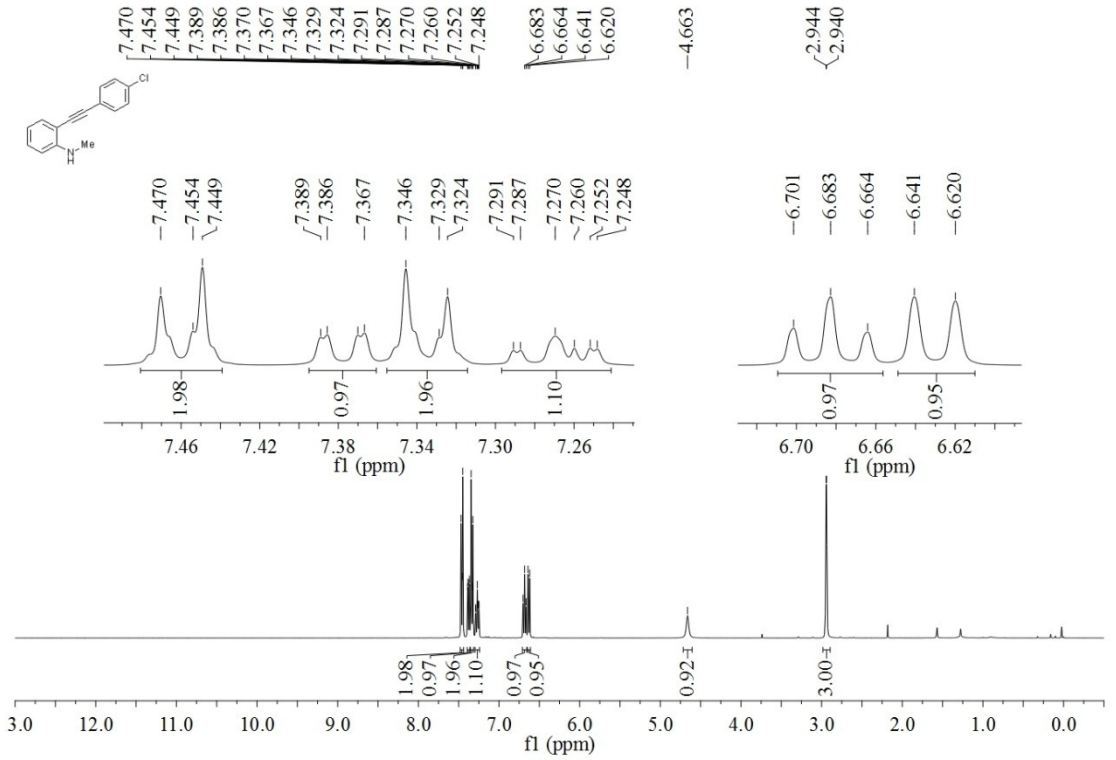

7.552
7.546
7.542
7.534
7.528
7.520
7.495
7.489
7.409
7.405
7.394
7.384
7.381
7.373
7.367
7.358
7.338
7.332
7.316
7.310
7.260
6.497
6.475
4.712
2.913
1.98
0.93
2.95
0.99
7.53
f1 (ppm)
7.42
7.35
f1 (ppm)
1.98
0.93
2.95
0.99
0.95
0.92
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


148.850
131.610
128.615
128.535
122.920
110.601
109.253
107.359
96.043
84.695
77.478
77.160
76.843
30.450
134.176
132.765
131.610
128.615
128.535
122.920
134
132
130
128
126
124
fl (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)


7.402
7.399
7.346
7.342
7.332
7.327
7.321
7.312
7.307
7.302
7.299
7.293
7.289
7.281
7.263
7.260
7.169
7.166
7.150
7.130
7.109
6.688
6.669
6.652
6.631
4.859
2.961
7.544
7.528
7.525
7.511
7.507
7.421
7.418
7.402
7.327
7.312
7.302
7.293
7.281
7.260
7.169
7.166
7.150
7.130
7.109
6.705
6.688
6.669
6.652
6.631
0.95
0.95
1.89
1.91
0.98
0.94
7.55
7.45
7.35
7.25
7.15
fl (ppm)
6.70
fl (ppm)
0.95
0.95
1.89
1.91
0.98
0.94
0.93
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
fl (ppm)


163.676
161.188
150.135
132.933
130.547
129.770
124.144
116.191
106.911
91.728
91.695
88.427
77.478
77.160
76.843
30.433
132.942
132.933
131.991
130.547
129.849
129.770
124.180
124.144
116.191
115.635
115.426
112.294
112.139
109.086
106.911
134
130
126
f1 (ppm)
116
112
108
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


-110.318
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


7.470
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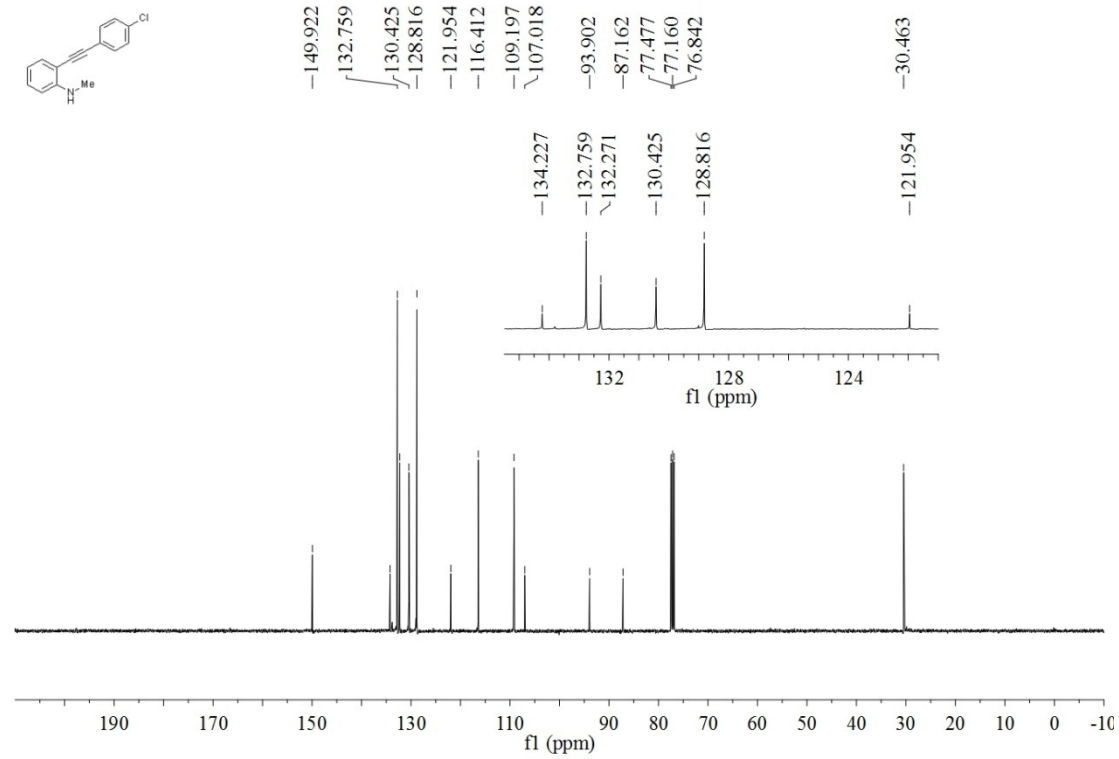
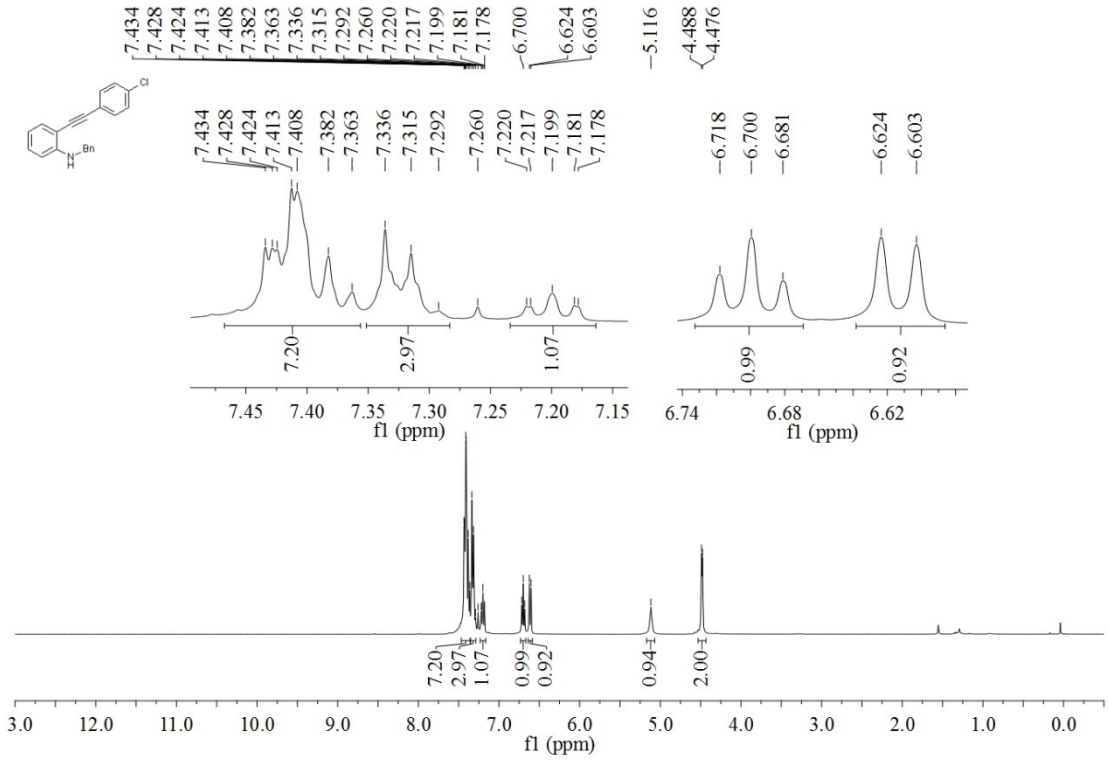
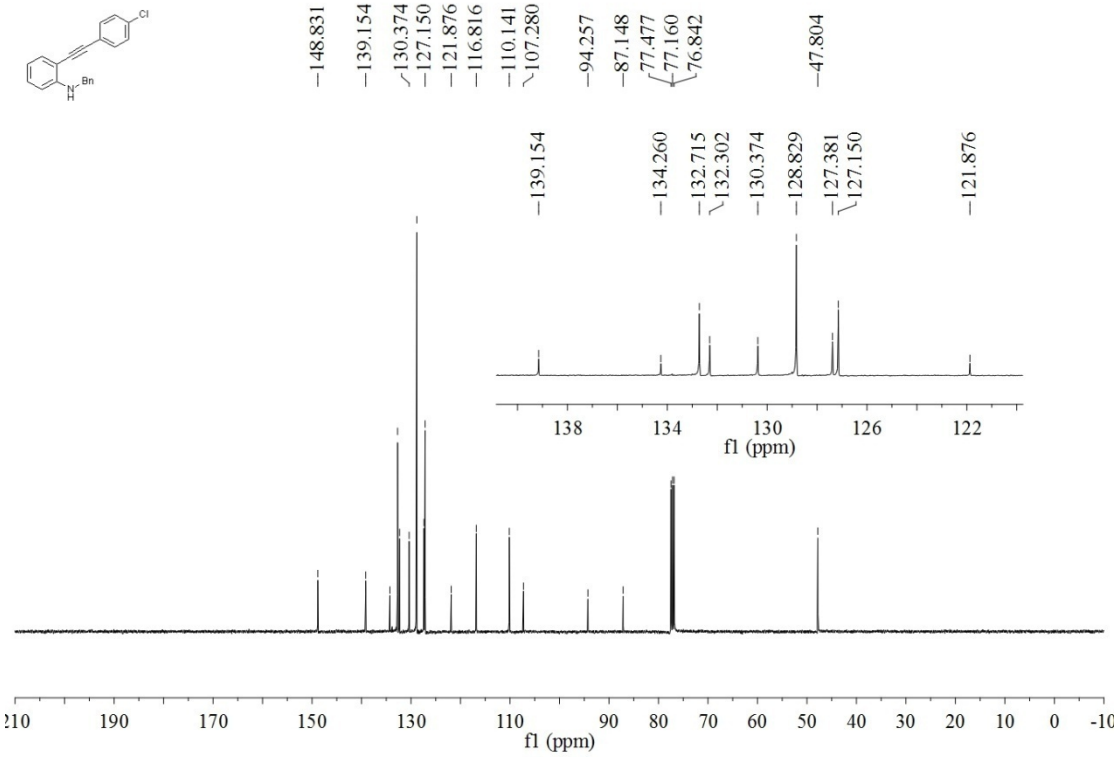
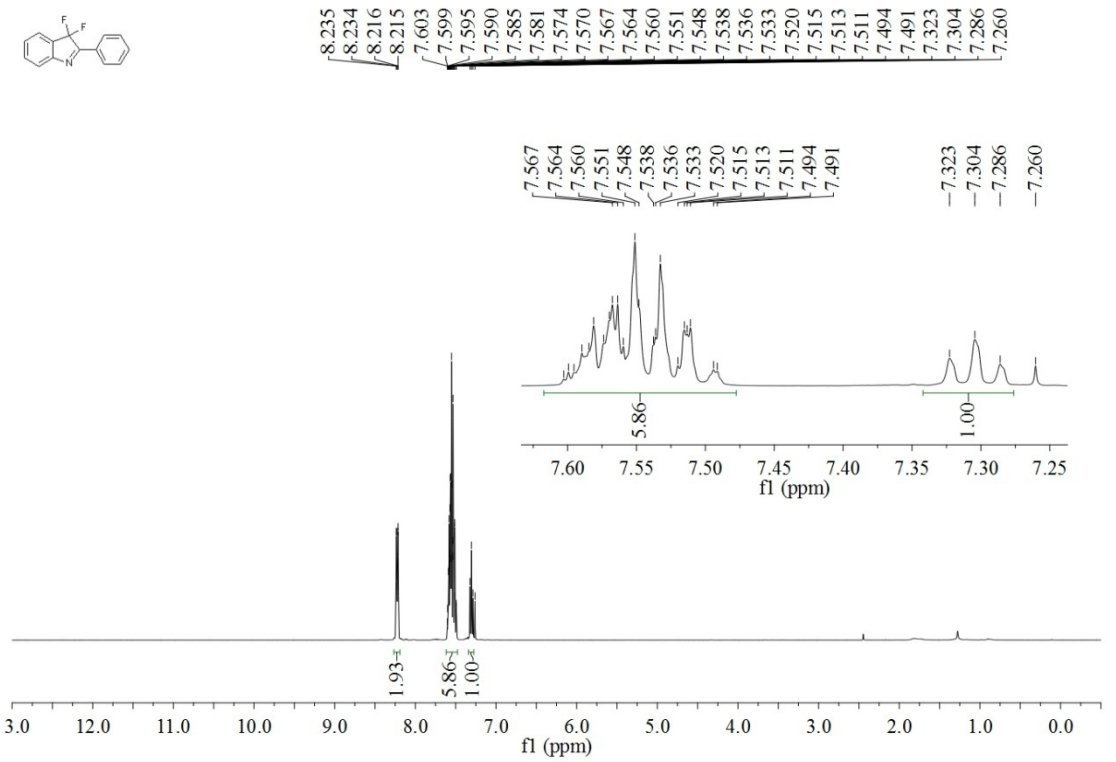
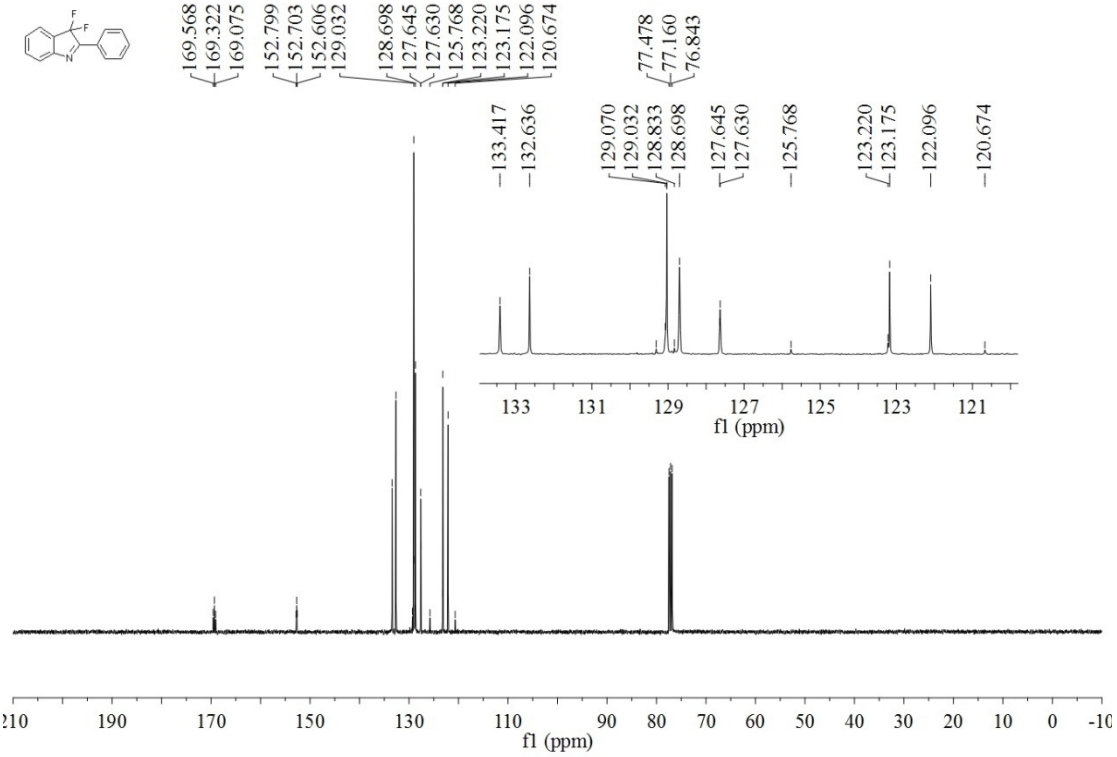
7.449
7.389
7.386
7.370
7.367
7.346
7.329
7.324
7.291
7.287
7.270
7.260
7.252
7.248
6.683
6.664
6.641
6.620
4.663
2.944
2.940
Cl
Me
H
N
1.98
0.97
1.96
1.10
0.97
0.95
0.92
3.00
fl (ppm)

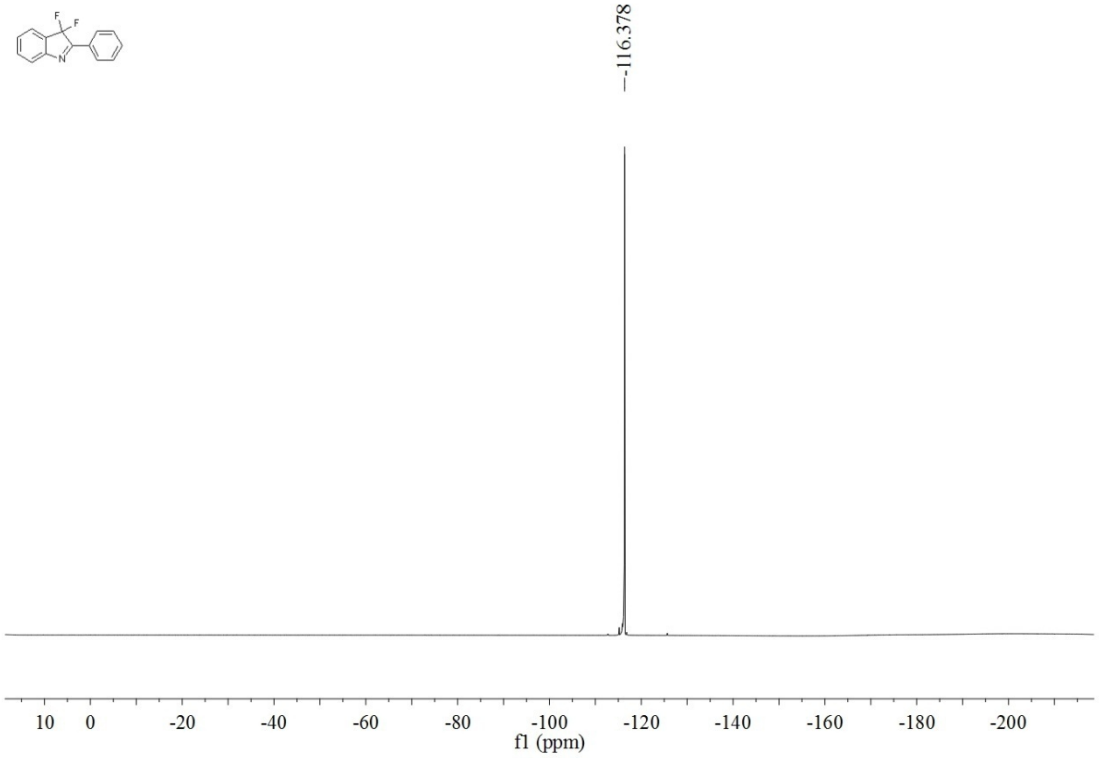

149.922
132.759
130.425
128.816
121.954
116.412
109.197
107.018
93.902
87.162
77.477
77.160
76.842
30.463
134.227
132.759
132.271
130.425
128.816
121.954
Cl
Me
H
N
fl (ppm)

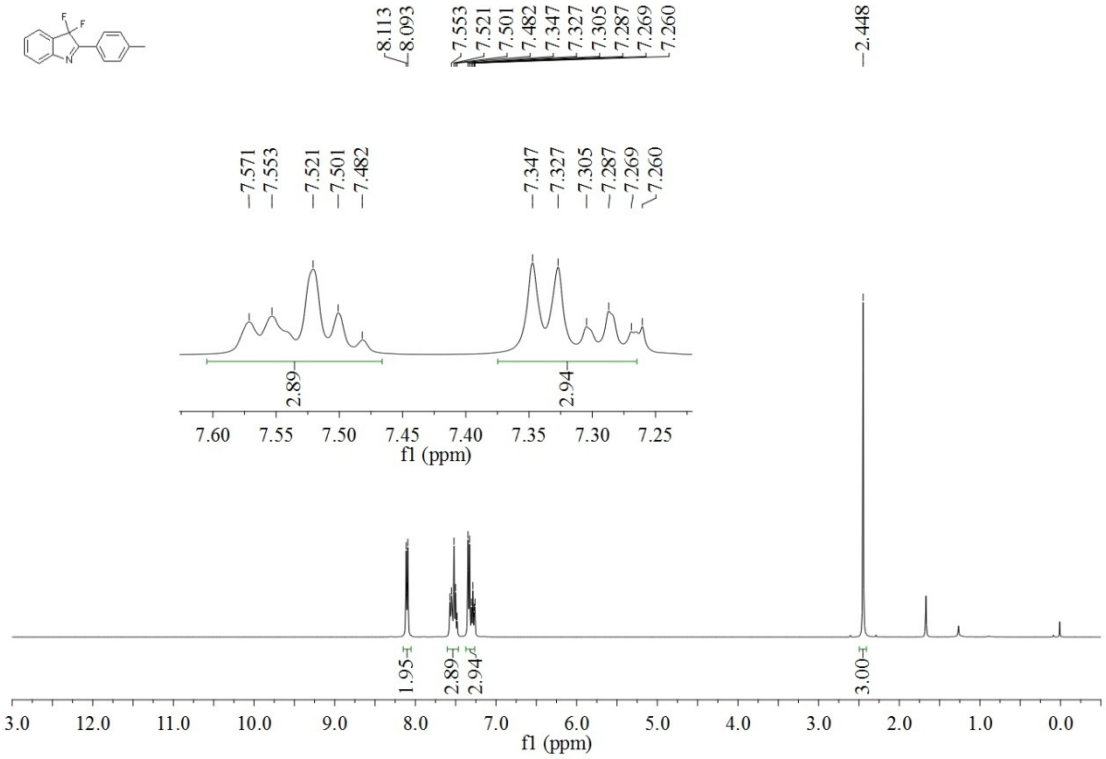

7.434
7.428
7.424
7.413
7.408
7.382
7.363
7.336
7.315
7.292
7.260
7.220
7.217
7.199
7.181
7.178
6.700
6.624
6.603
5.116
4.488
4.476
6.718
6.681
7.20
2.97
1.07
0.99
0.92
0.94
2.00
fl (ppm)

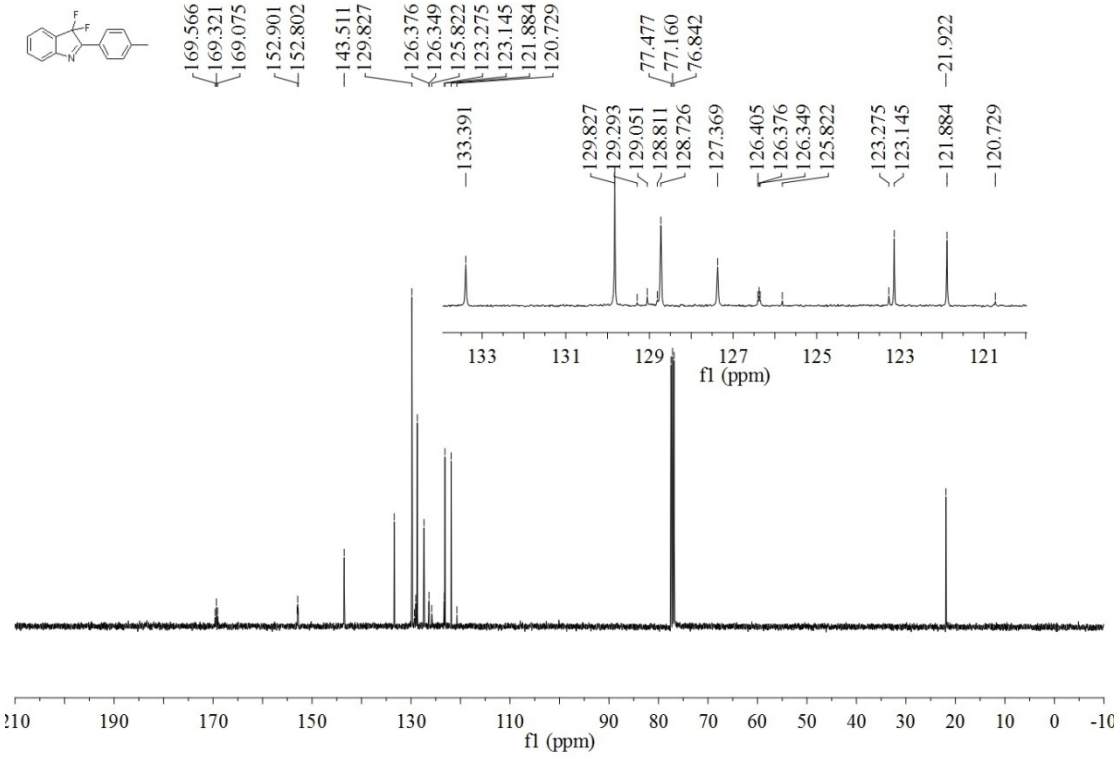

148.831
139.154
130.374
127.150
121.876
116.816
110.141
107.280
94.257
87.148
77.477
77.160
76.842
47.804
134.260
132.715
132.302
128.829
127.381
127.150
fl (ppm)

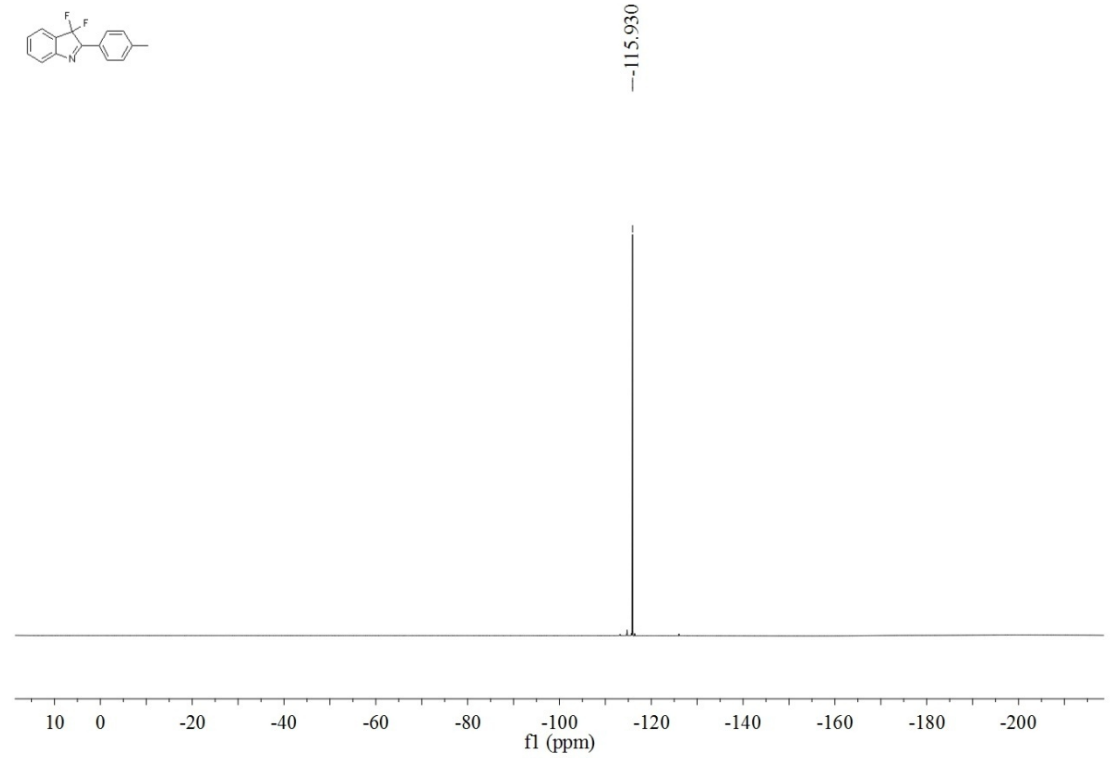

8.235
8.234
8.216
8.215
7.603
7.599
7.595
7.590
7.585
7.581
7.574
7.570
7.567
7.564
7.560
7.551
7.548
7.538
7.536
7.533
7.520
7.515
7.513
7.511
7.494
7.491
7.323
7.304
7.286
7.260
5.86
1.00
7.60 7.55 7.50 7.45 7.40 7.35 7.30 7.25
f1 (ppm)
1.93
5.86
1.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)


169.568
169.322
169.075
152.799
152.703
152.606
129.032
128.698
127.645
127.630
125.768
123.220
123.175
122.096
120.674
77.478
77.160
76.843
133.417
132.636
129.070
129.032
128.833
128.698
127.645
127.630
125.768
123.220
123.175
122.096
120.674
133 131 129 127 125 123 121
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-116.378
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)


8.113
8.093
7.553
7.521
7.501
7.482
7.347
7.327
7.305
7.287
7.269
7.260
2.448
2.89
2.94
1.95
2.89
2.94
3.00
f1 (ppm)


169.566
169.321
169.075
152.901
152.802
143.511
129.827
126.376
126.349
125.822
123.275
123.145
121.884
120.729
77.477
77.160
76.842
21.922
133.391
129.827
129.293
129.051
128.811
128.726
127.369
126.405
126.376
126.349
125.822
123.275
123.145
121.884
120.729
133
131
129
127
125
123
121
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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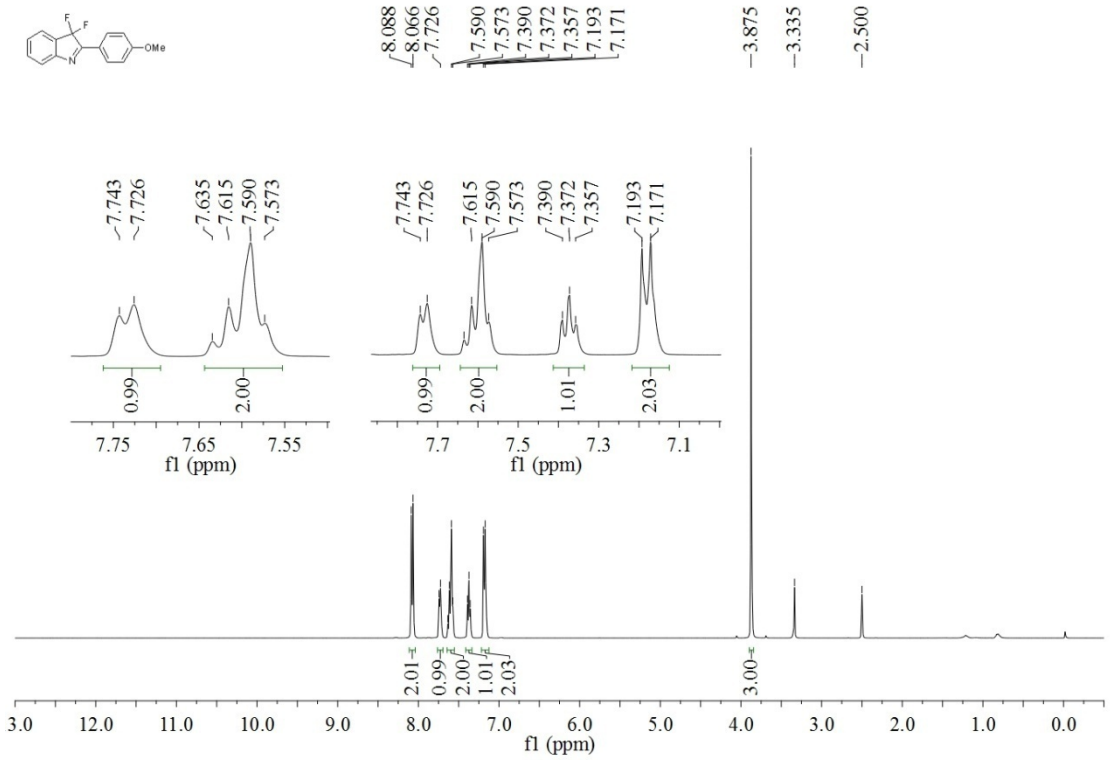
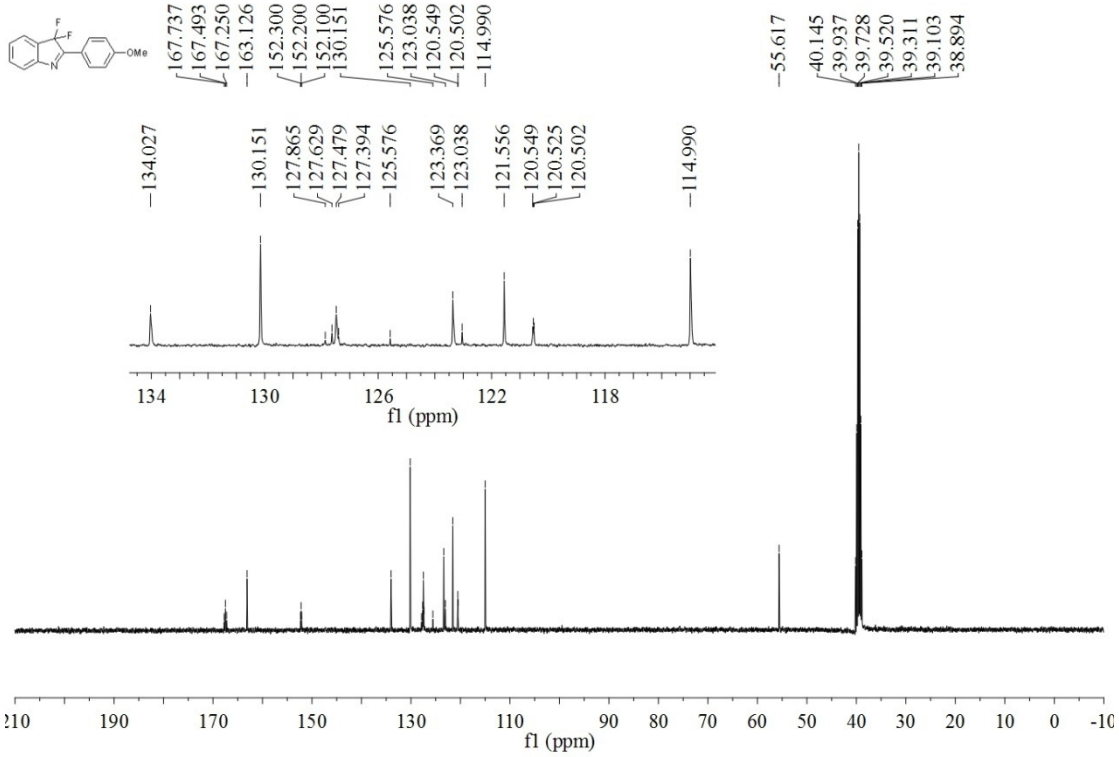
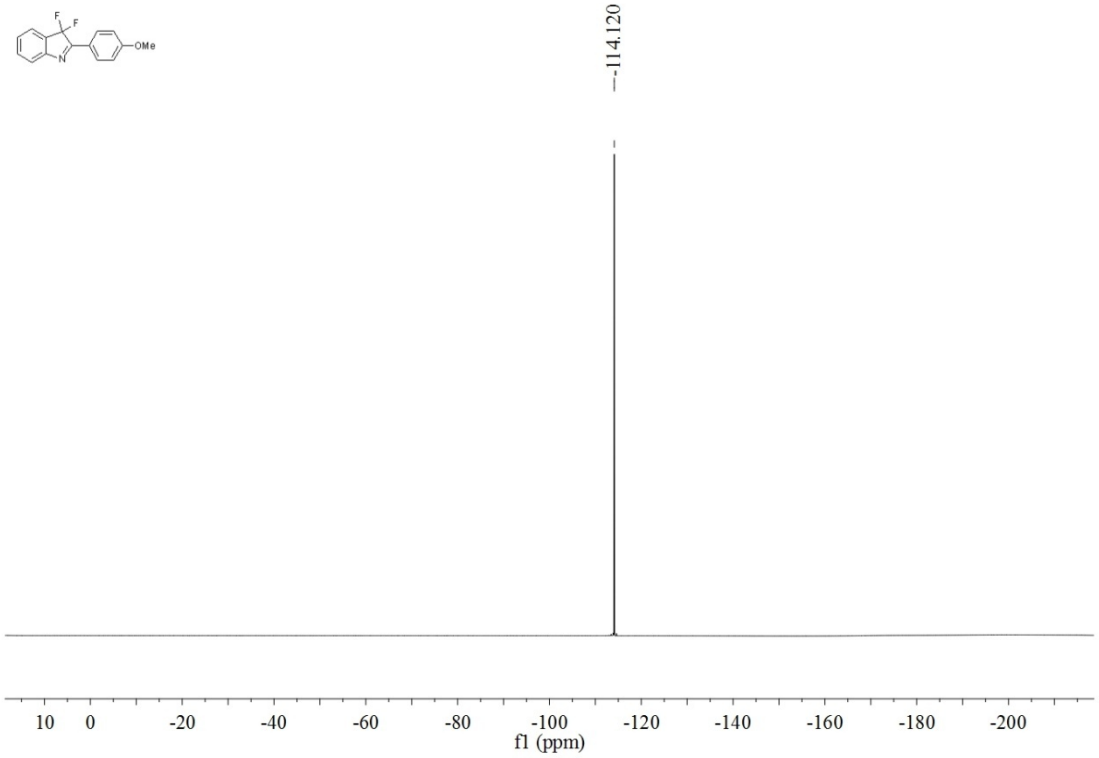
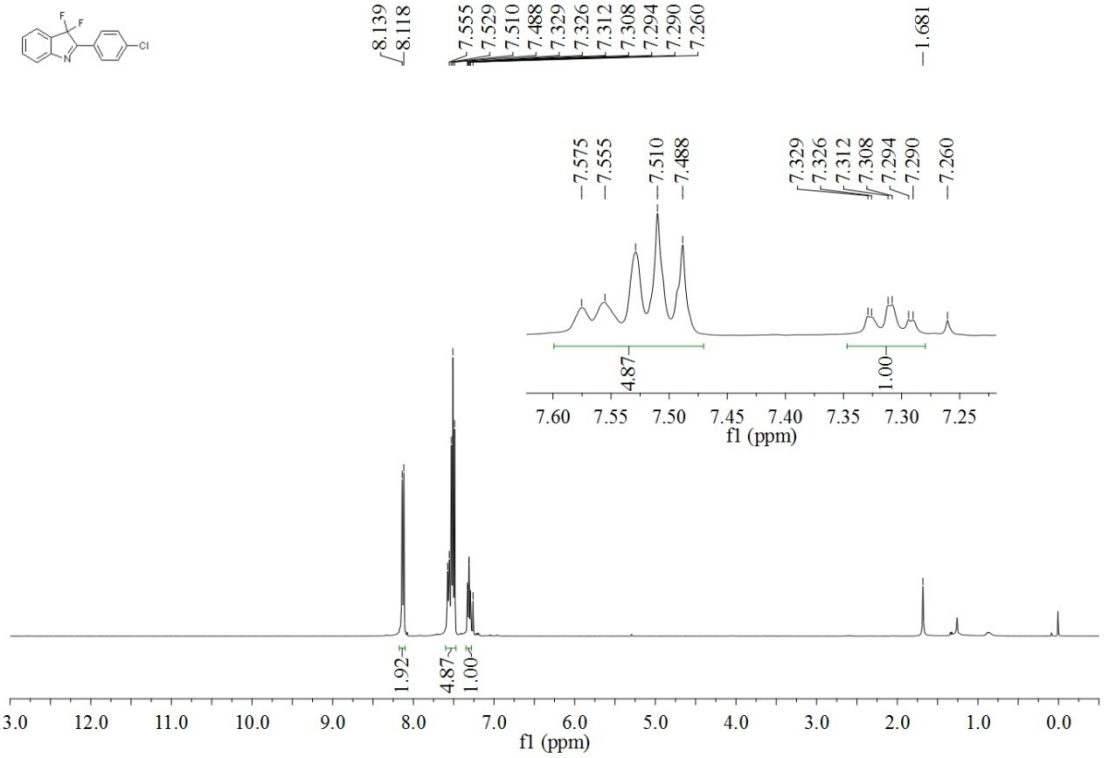
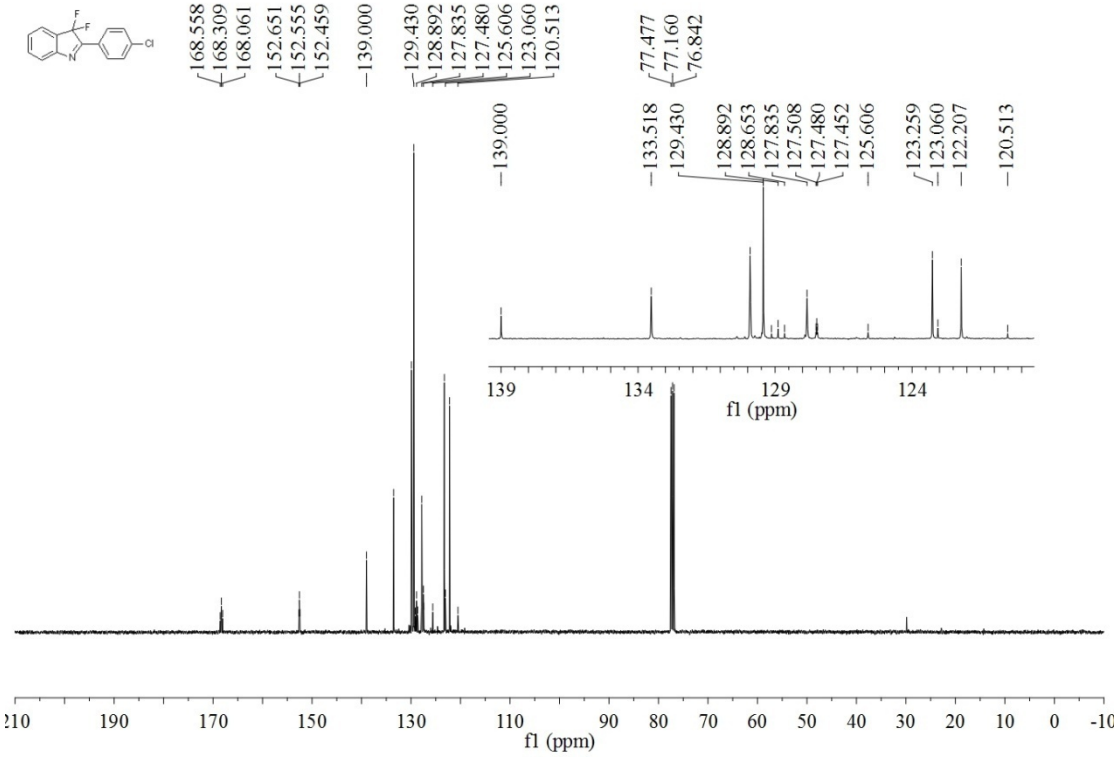
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

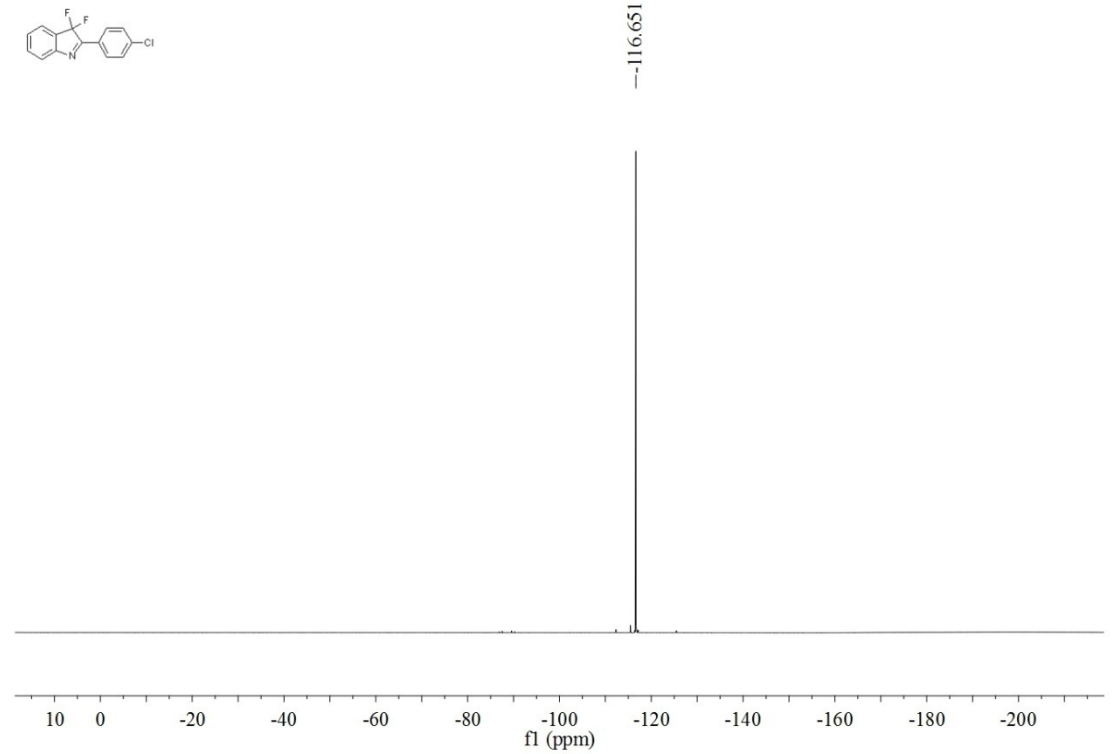

8.088
8.066
7.726
7.590
7.573
7.390
7.372
7.357
7.193
7.171
3.875
3.335
2.500
7.743
7.726
7.635
7.615
7.590
7.573
0.99
2.00
7.75
7.65
7.55
fl (ppm)
7.743
7.726
7.615
7.590
7.573
7.390
7.372
7.357
7.193
7.171
0.99
2.00
1.01
2.03
7.7
7.5
7.3
7.1
fl (ppm)
2.01
0.99
2.00
1.01
2.03
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
fl (ppm)

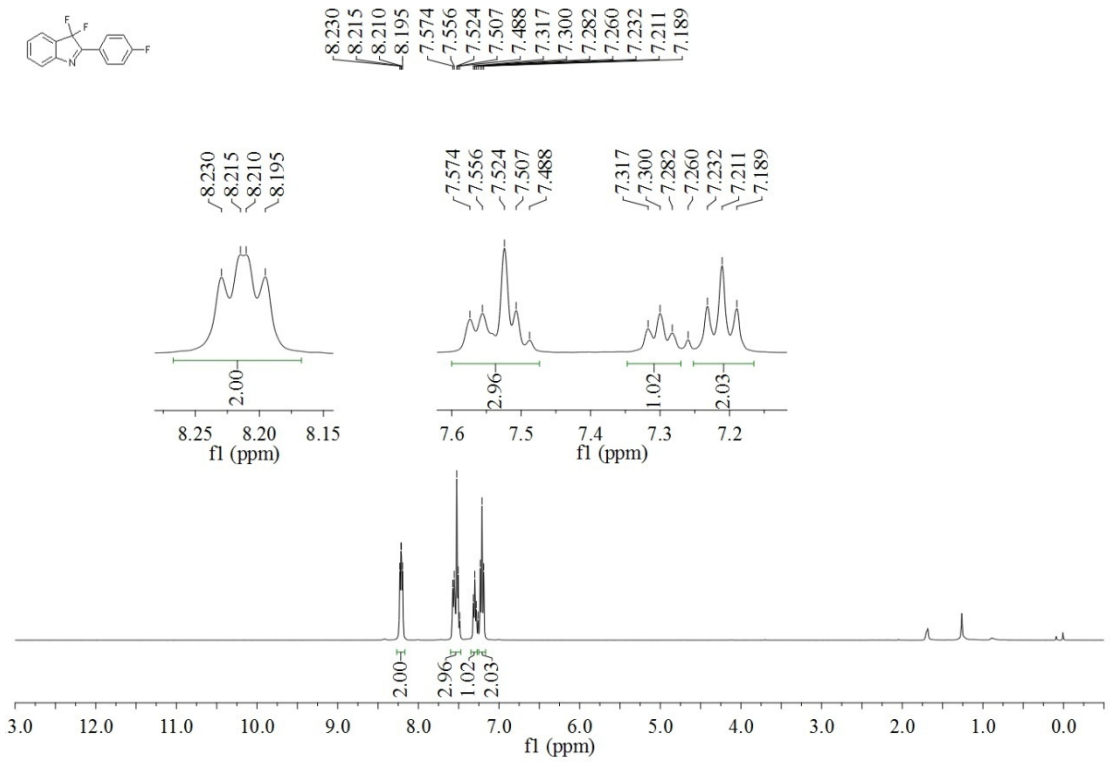

167.737
167.493
167.250
163.126
152.300
152.200
152.100
130.151
125.576
123.038
120.549
120.502
114.990
55.617
40.145
39.937
39.728
39.520
39.311
39.103
38.894
134.027
130.151
127.865
127.629
127.479
127.394
125.576
123.369
123.038
121.556
120.549
120.525
120.502
114.990
134
130
126
122
118
fl (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)

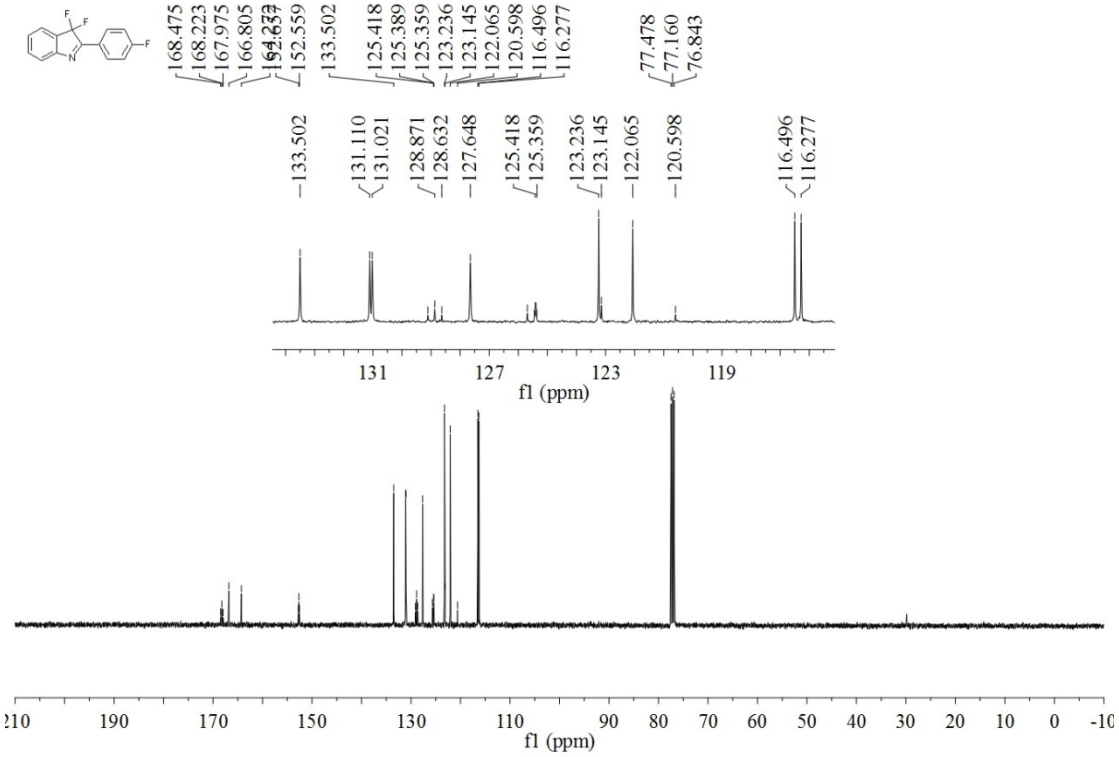

F
F
OMe
-114.120
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

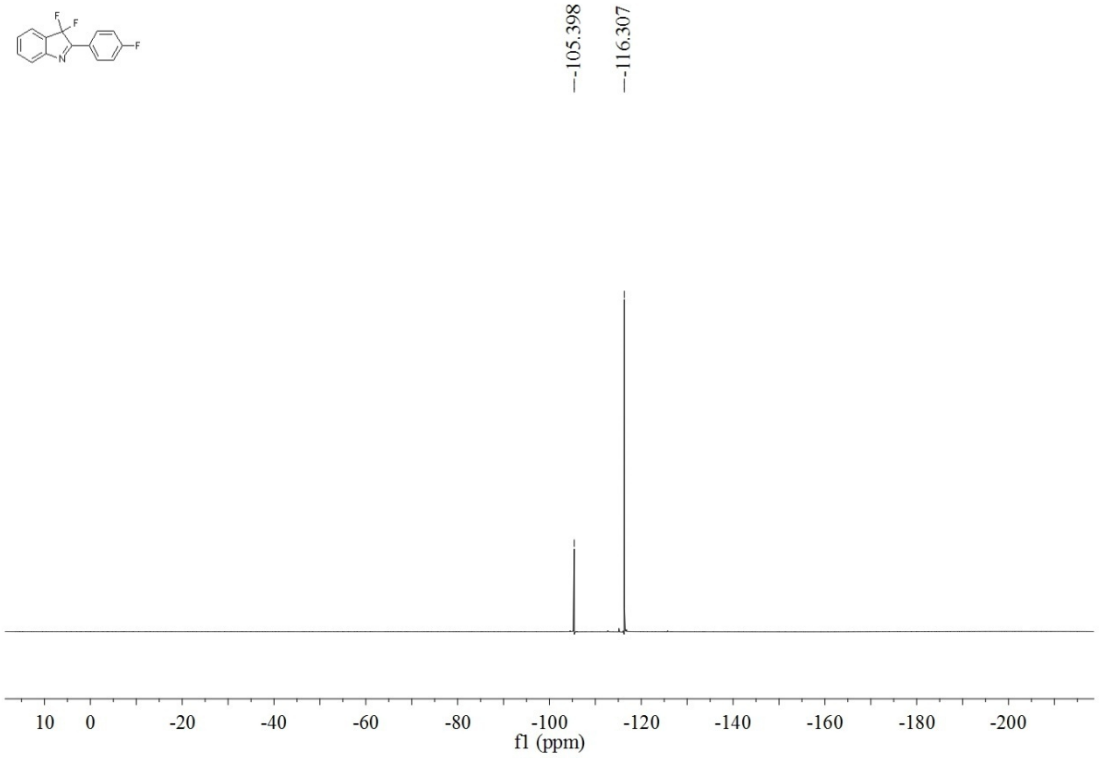

F
F
Cl
8.139
8.118
7.555
7.529
7.510
7.488
7.329
7.326
7.312
7.308
7.294
7.290
7.260
1.681
7.575
7.555
7.510
7.488
7.329
7.326
7.312
7.308
7.294
7.290
7.260
4.87
1.00
7.60 7.55 7.50 7.45 7.40 7.35 7.30 7.25
f1 (ppm)
1.92
4.87
1.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

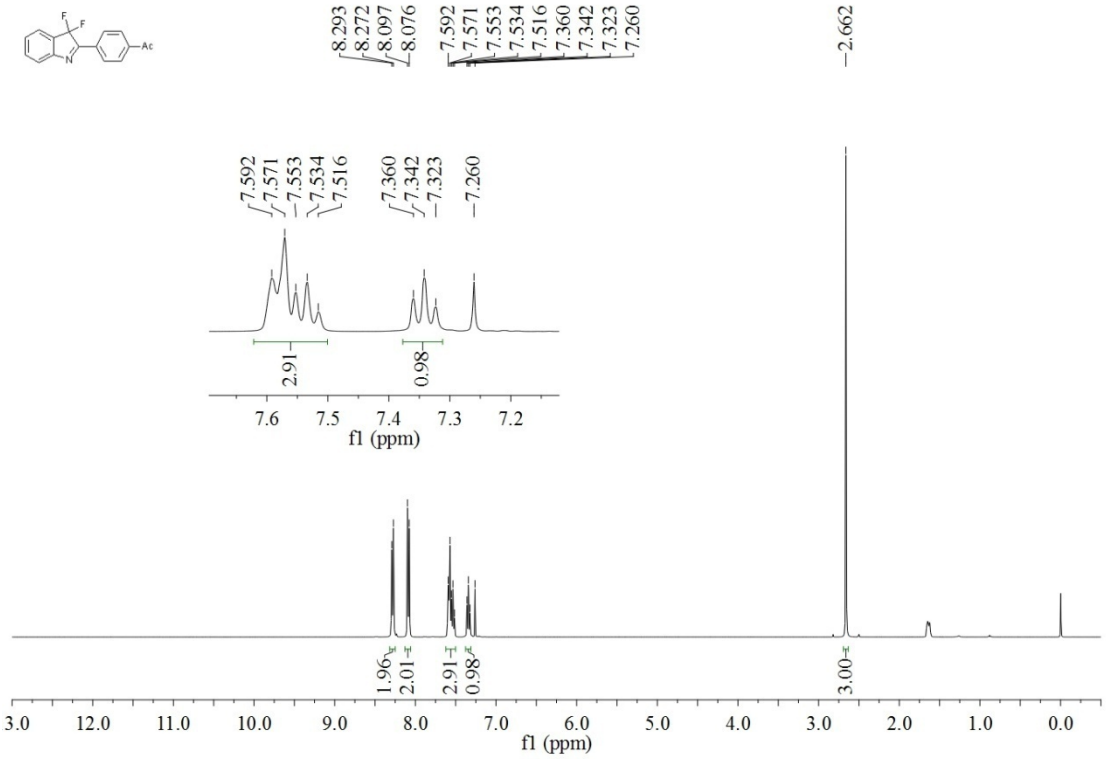

168.558
168.309
168.061
152.651
152.555
152.459
139.000
129.430
128.892
127.835
127.480
125.606
123.060
120.513
77.477
77.160
76.842
139.000
133.518
129.430
128.892
128.653
127.835
127.508
127.480
127.452
125.606
123.259
123.060
122.207
120.513
139
134
129
124
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

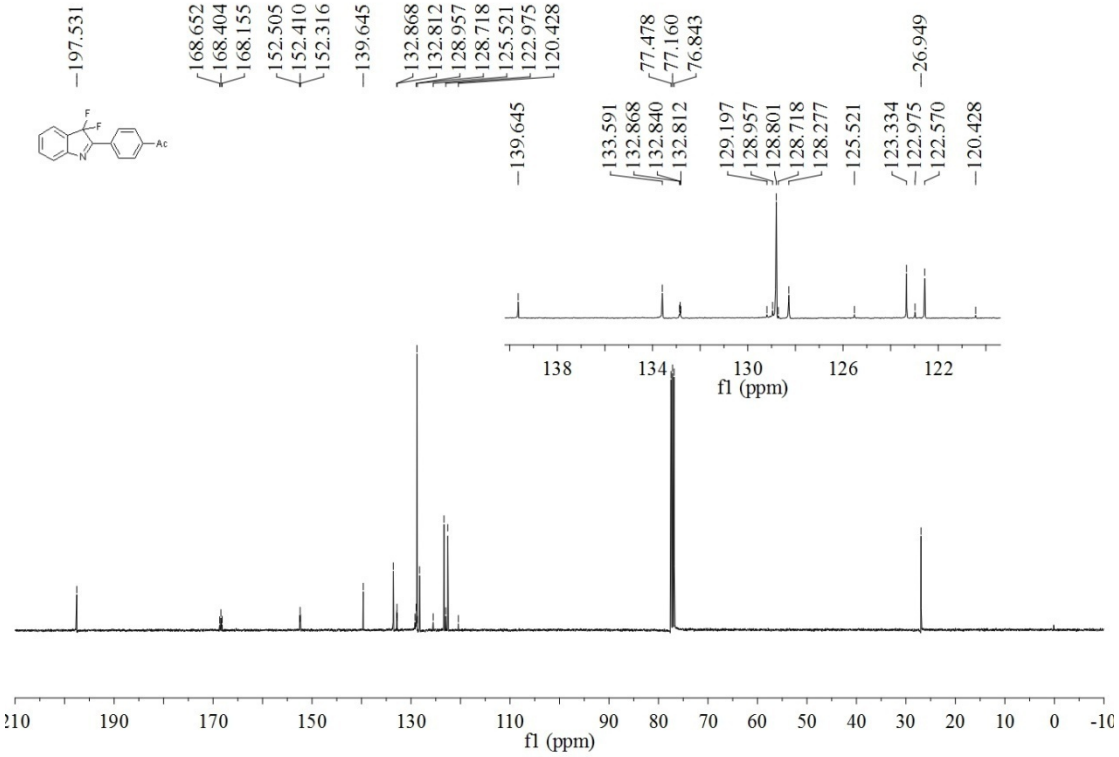

-116.651
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

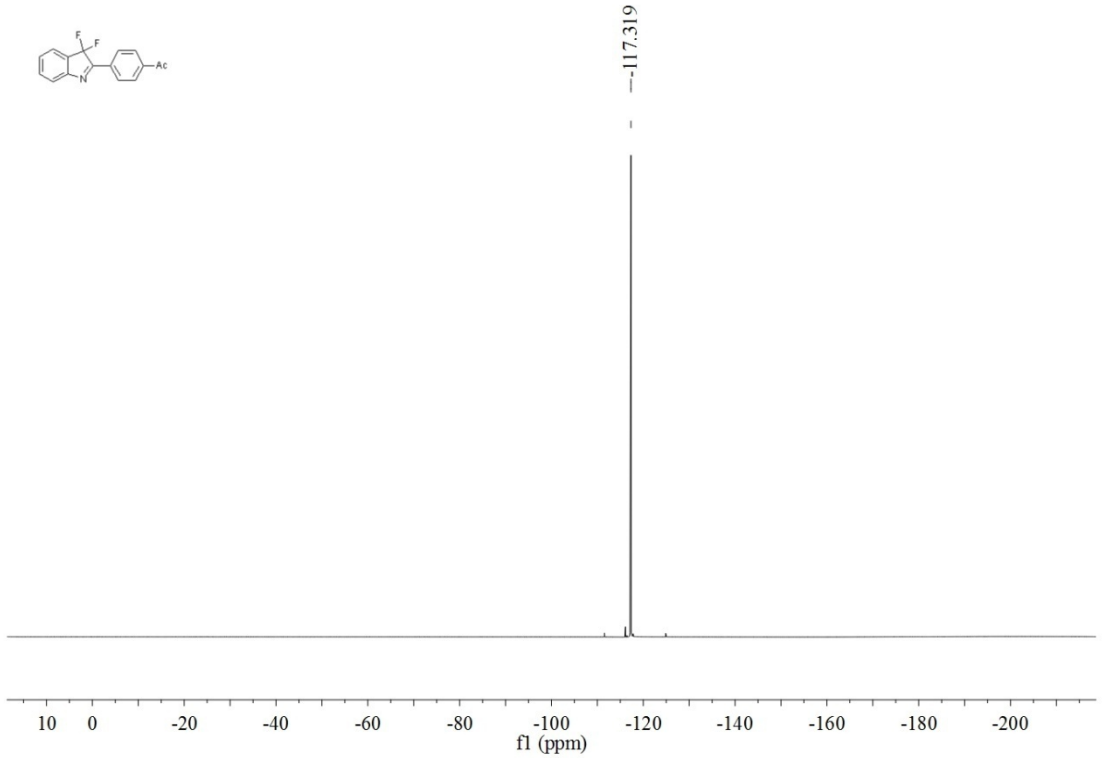

8.230
8.215
8.210
8.195
7.574
7.556
7.524
7.507
7.488
7.317
7.300
7.282
7.260
7.232
7.211
7.189
2.00
2.96
1.02
2.03
f1 (ppm)

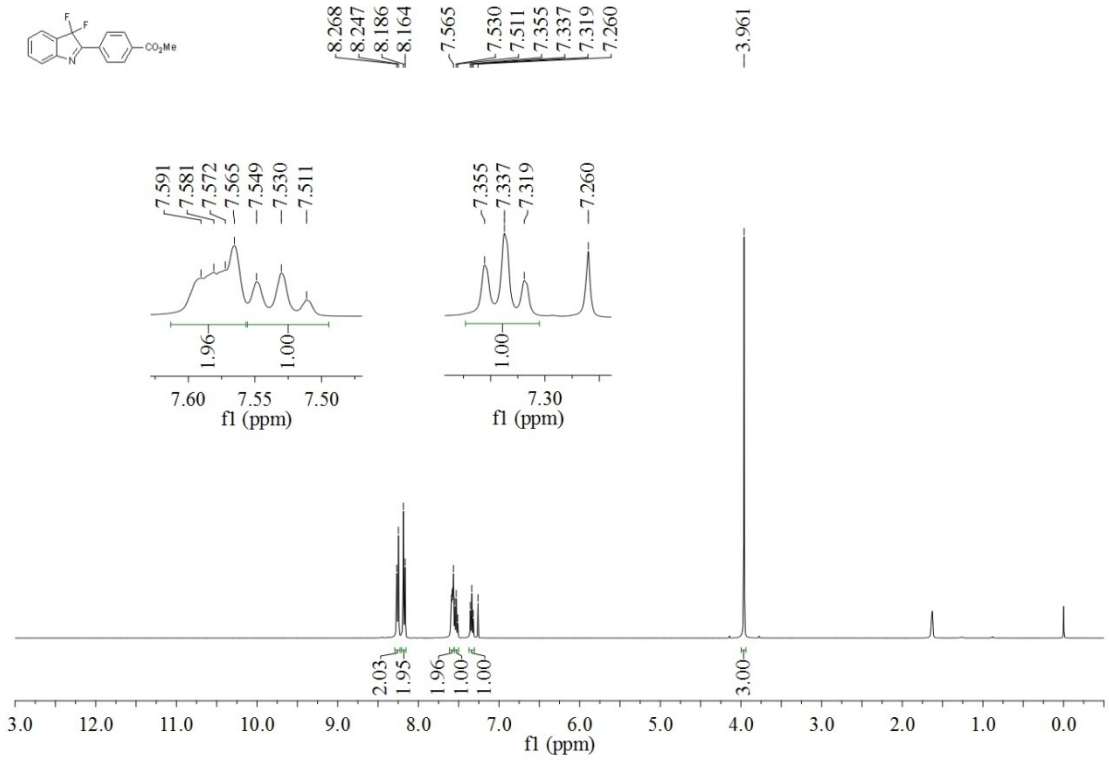

168.475
168.223
167.975
166.805
152.559
133.502
125.418
125.389
125.359
123.236
123.145
122.065
120.598
116.496
116.277
77.478
77.160
76.843
131.110
131.021
128.871
128.632
127.648
125.418
125.359
123.236
123.145
122.065
120.598
116.496
116.277
f1 (ppm)

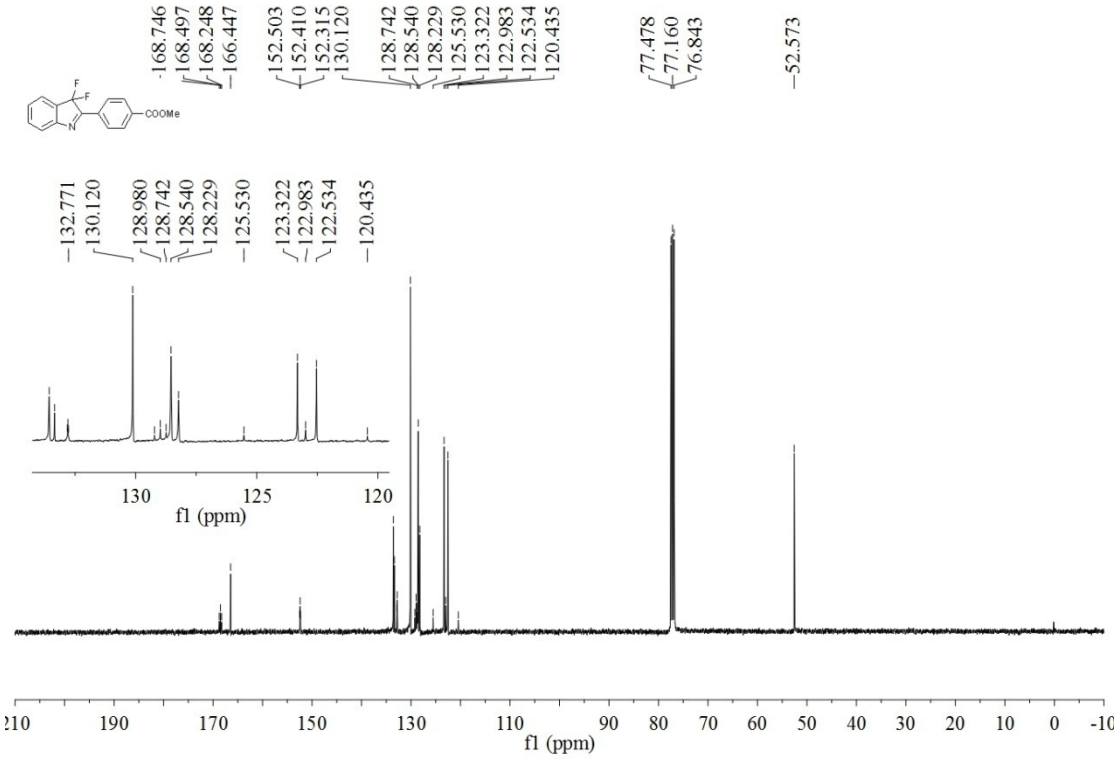

-105.398
-116.307
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

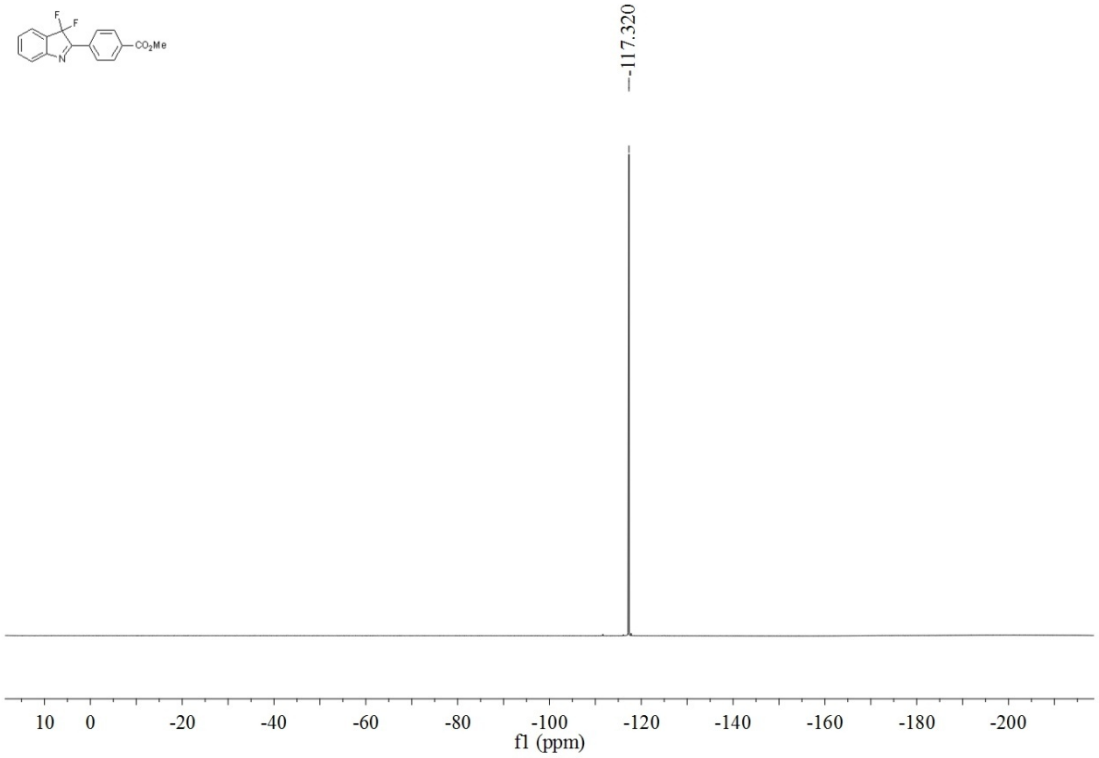

8.293
8.272
8.097
8.076
7.592
7.571
7.553
7.534
7.516
7.360
7.342
7.323
7.260
2.662
2.91
0.98
7.6 7.5 7.4 7.3 7.2
f1 (ppm)
1.96
2.01
2.91
0.98
3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

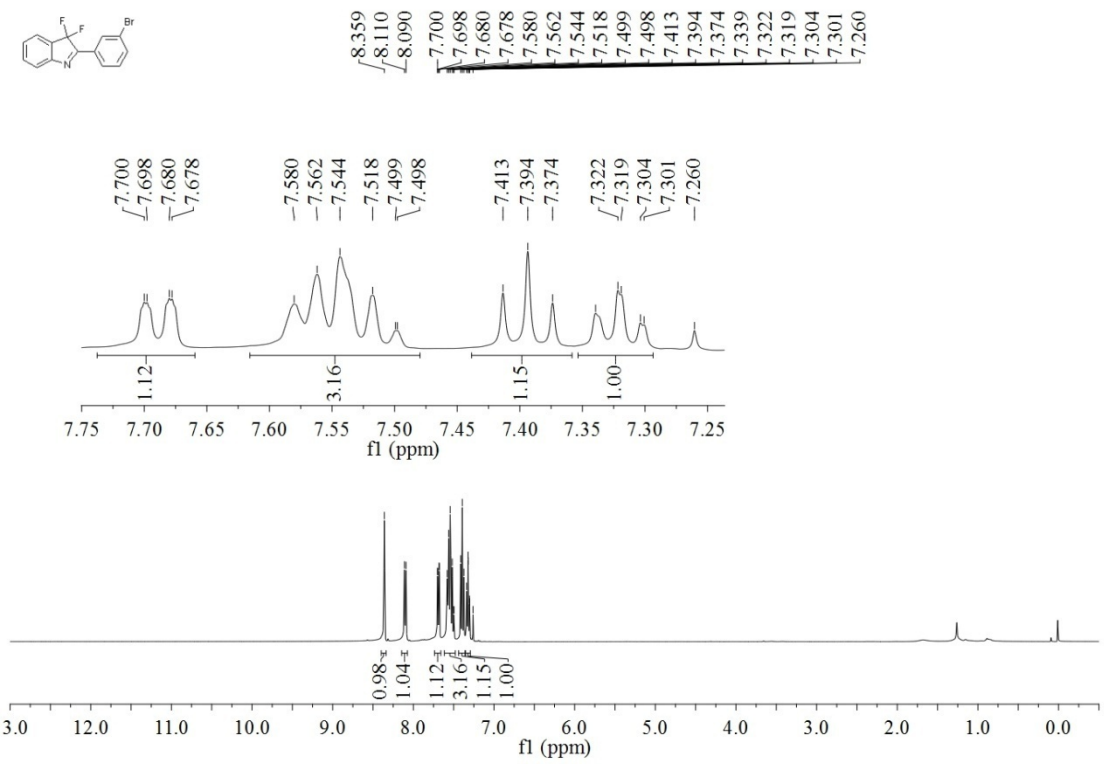

197.531
168.652
168.404
168.155
152.505
152.410
152.316
139.645
132.868
132.812
128.957
128.718
125.521
122.975
120.428
77.478
77.160
76.843
26.949
F
F
N
Ac
139.645
133.591
132.868
132.840
132.812
129.197
128.957
128.801
128.718
128.277
125.521
123.334
122.975
122.570
120.428
138
134
130
126
122
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

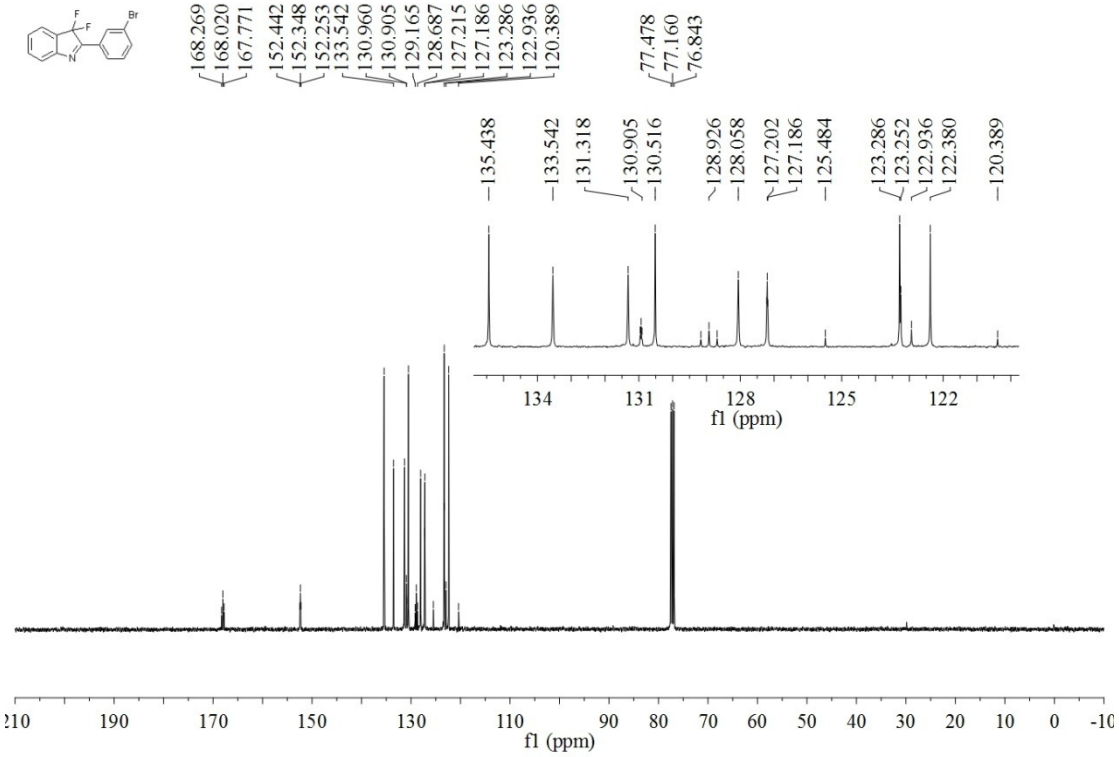

F
F
N
Ac
-117.319
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

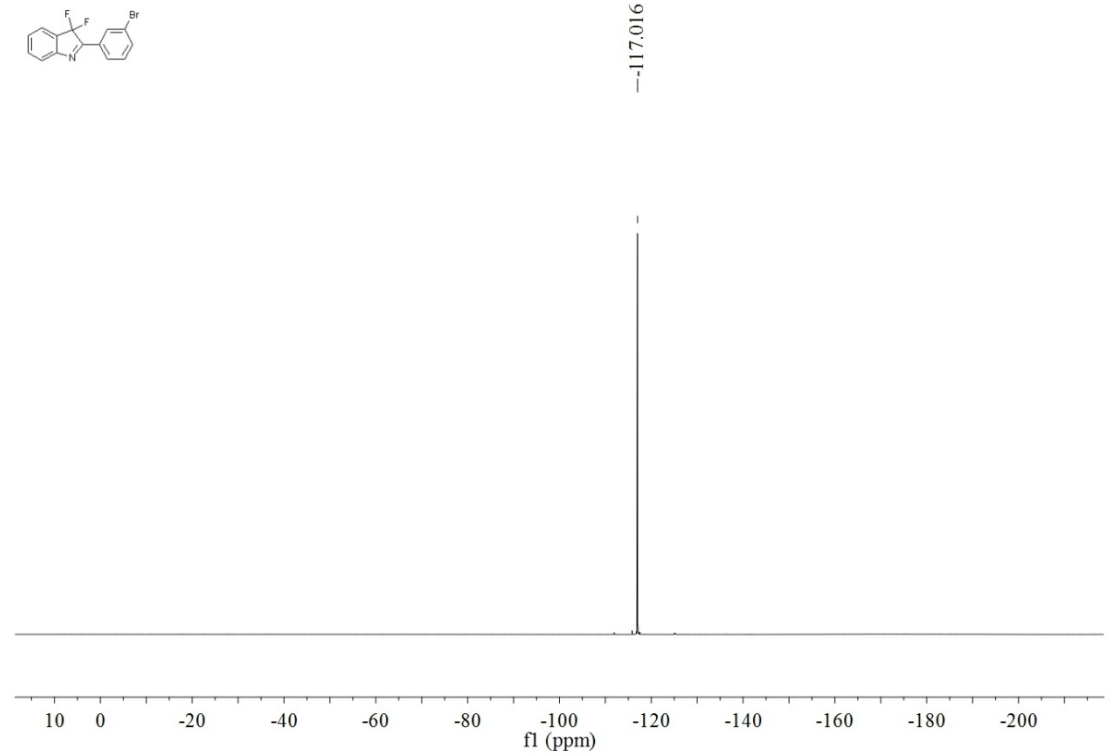

8.268
8.247
8.186
8.164
7.565
7.530
7.511
7.355
7.337
7.319
7.260
3.961
7.591
7.581
7.572
7.565
7.549
7.530
7.511
1.96
1.00
7.60
7.55
7.50
f1 (ppm)
7.355
7.337
7.319
7.260
1.00
7.30
f1 (ppm)
2.03
1.95
1.96
1.00
1.00
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


168.746
168.497
168.248
166.447
152.503
152.410
152.315
130.120
128.742
128.540
128.229
125.530
123.322
122.983
122.534
120.435
77.478
77.160
76.843
52.573
132.771
130.120
128.980
128.742
128.540
128.229
125.530
123.322
122.983
122.534
120.435
130
125
120
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


F
F
CO2Me
-117.320
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


F
F
Br
8.359
8.110
8.090
7.700
7.698
7.680
7.678
7.580
7.562
7.544
7.518
7.499
7.498
7.413
7.394
7.374
7.339
7.322
7.319
7.304
7.301
7.260
1.12
3.16
1.15
1.00
7.75
7.70
7.65
7.60
7.55
7.50
7.45
7.40
7.35
7.30
7.25
f1 (ppm)
0.98
1.04
1.12
3.16
1.15
1.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


168.269
168.020
167.771
152.442
152.348
152.253
133.542
130.960
130.905
129.165
128.687
127.215
127.186
123.286
122.936
120.389
77.478
77.160
76.843
135.438
133.542
131.318
130.905
130.516
128.926
128.058
127.202
127.186
125.484
123.286
123.252
122.936
122.380
120.389
134
131
128
125
122
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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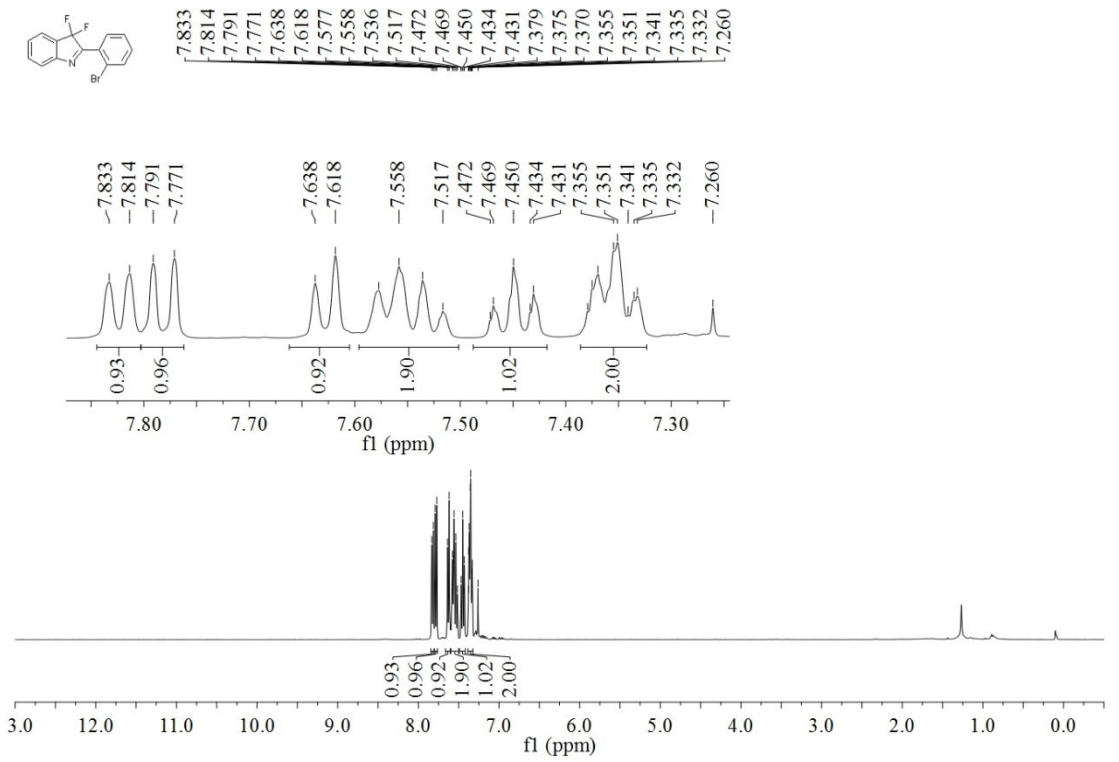
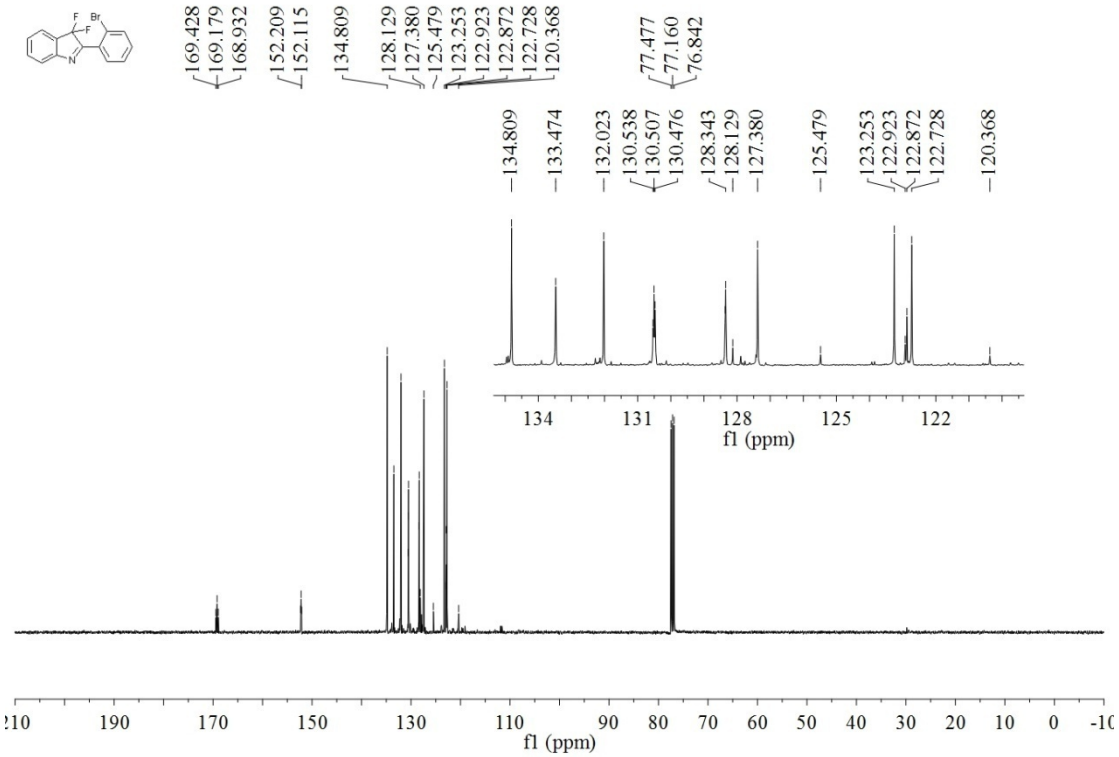
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


7.833
7.814
7.791
7.771
7.638
7.618
7.577
7.558
7.536
7.517
7.472
7.469
7.450
7.434
7.431
7.379
7.375
7.370
7.355
7.351
7.341
7.335
7.332
7.260
0.93
0.96
0.92
1.90
1.02
2.00
fl (ppm)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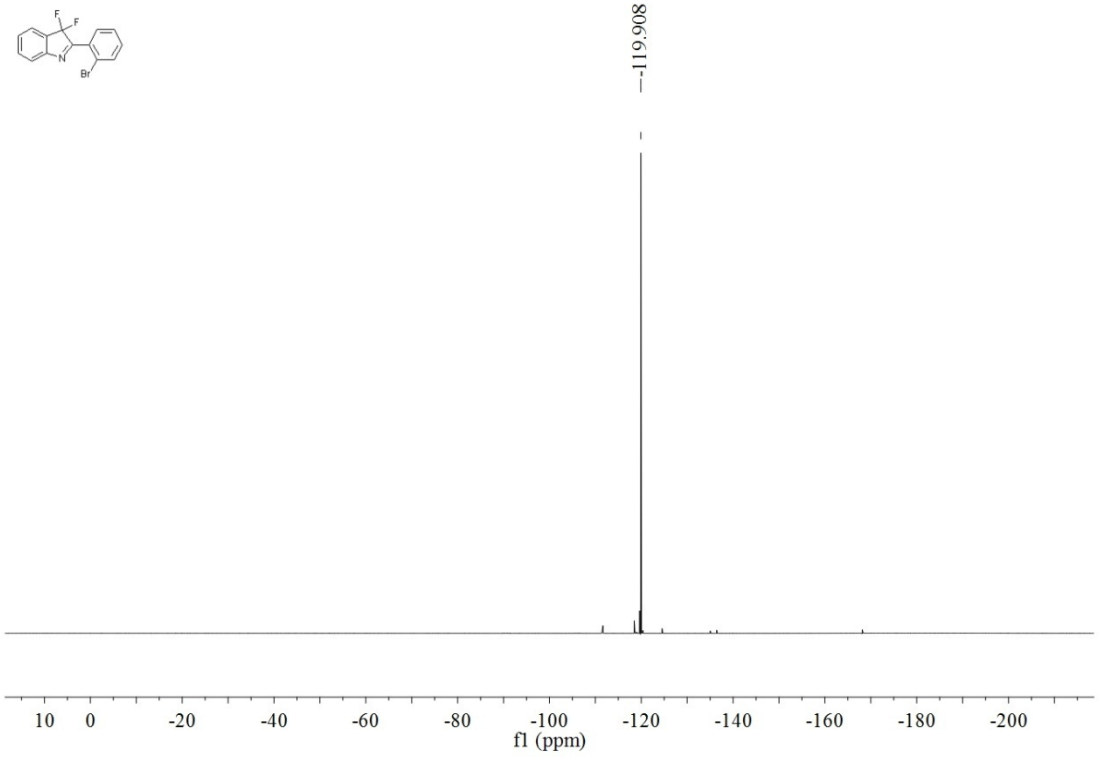
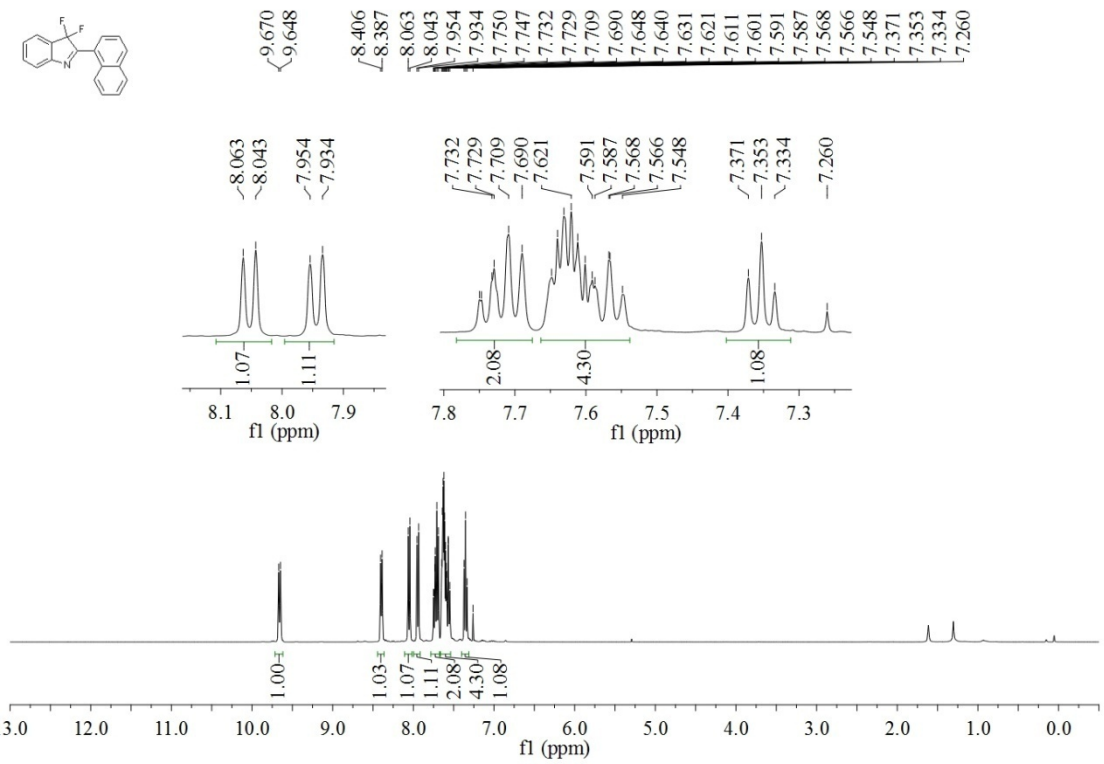
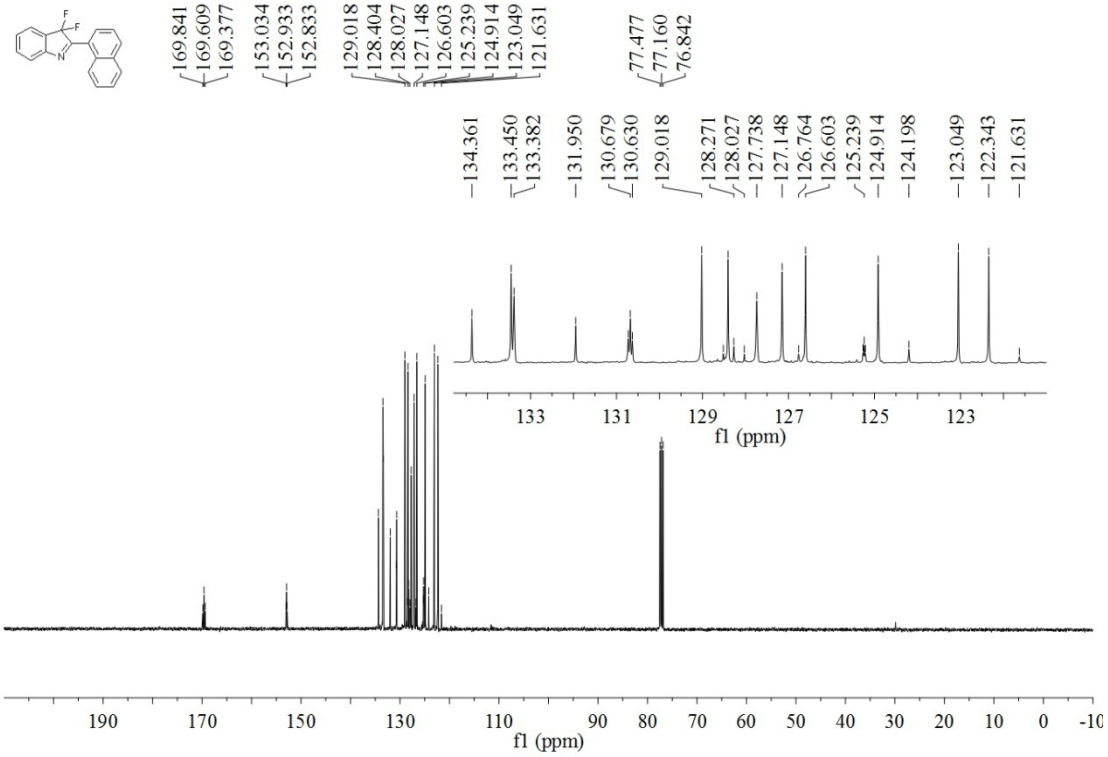
169.179
168.932
152.209
152.115
134.809
128.129
127.380
125.479
123.253
122.923
122.872
122.728
120.368
77.477
77.160
76.842
134.809
133.474
132.023
130.538
130.507
130.476
128.343
128.129
127.380
125.479
123.253
122.923
122.872
122.728
120.368
fl (ppm)


-119.908
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)


9.670
9.648
8.406
8.387
8.063
8.043
7.954
7.934
7.750
7.747
7.732
7.729
7.709
7.690
7.648
7.640
7.631
7.621
7.611
7.601
7.591
7.587
7.568
7.566
7.548
7.371
7.353
7.334
7.260
1.07
1.11
2.08
4.30
1.08
1.00
1.03
f1 (ppm)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169.609
169.377
153.034
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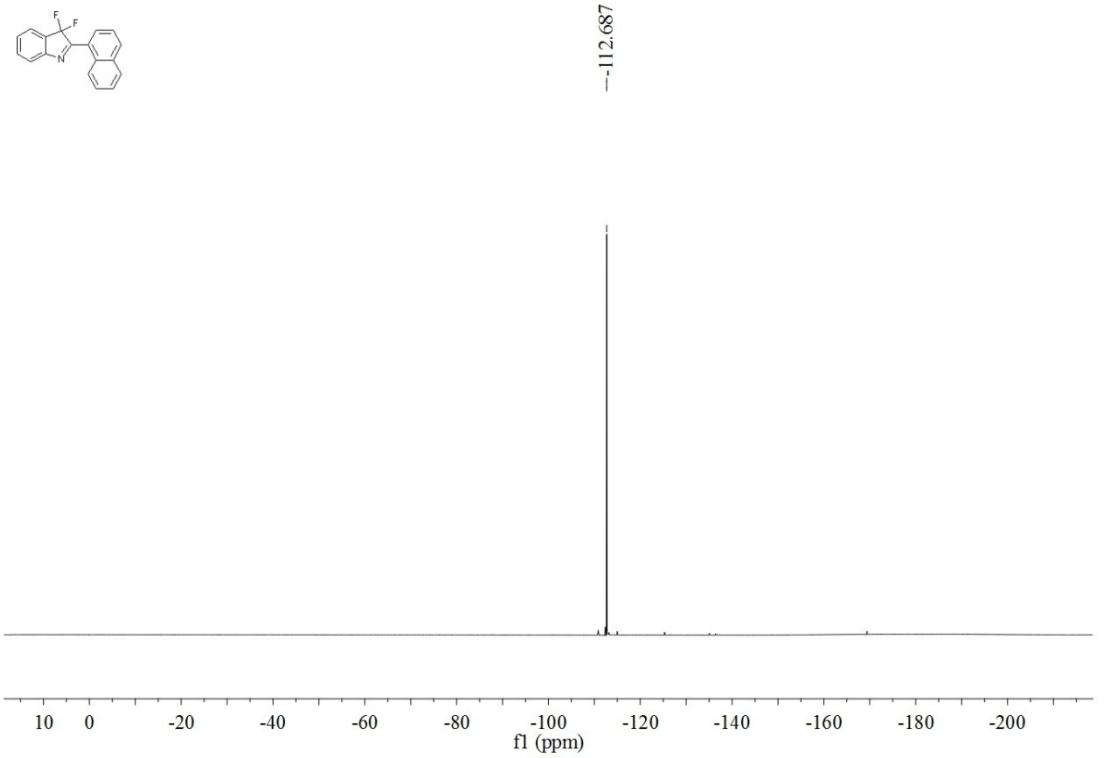
152.833
129.018
128.404
128.027
127.148
126.603
125.239
124.914
123.049
121.631
77.477
77.160
76.842
134.361
133.450
133.382
131.950
130.679
130.630
129.018
128.271
128.027
127.738
127.148
126.764
126.603
125.239
124.914
124.198
123.049
122.343
121.631
133
131
129
127
125
123
f1 (ppm)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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10
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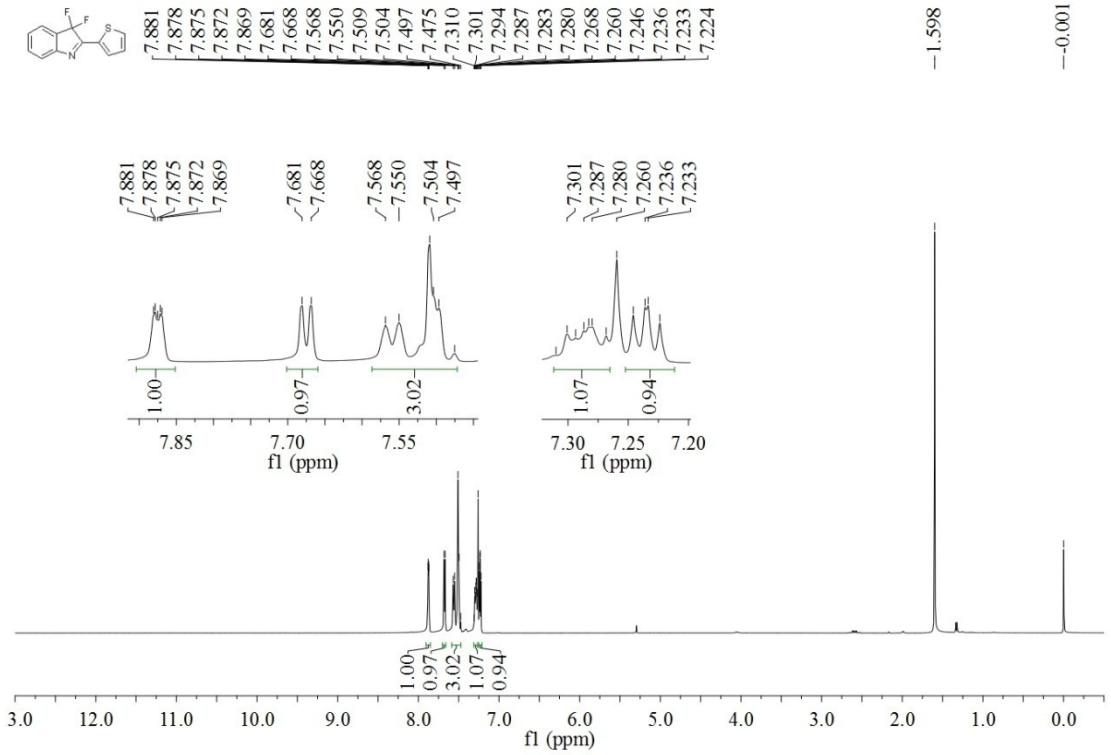
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)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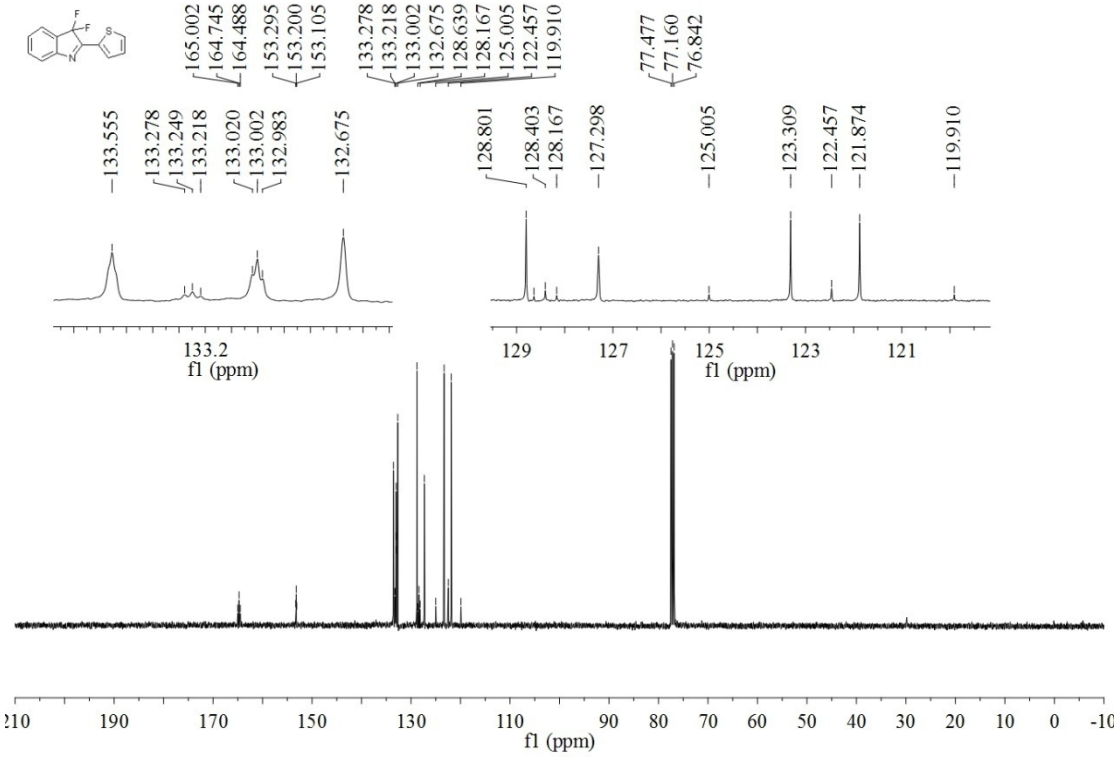
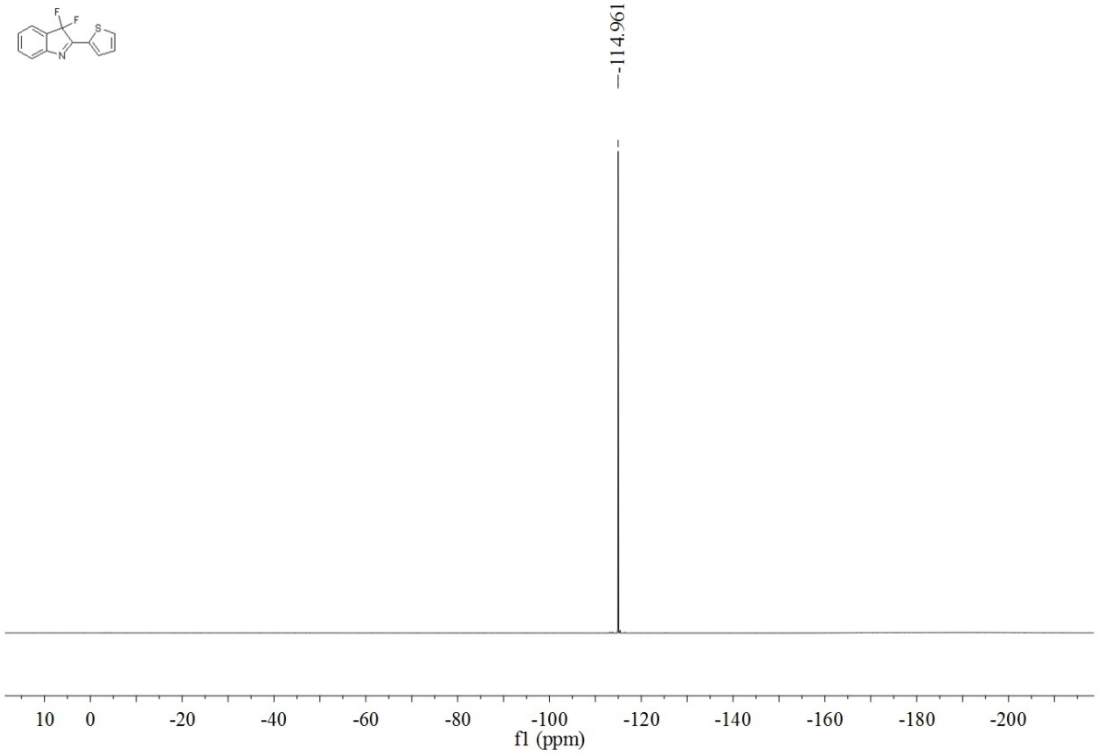
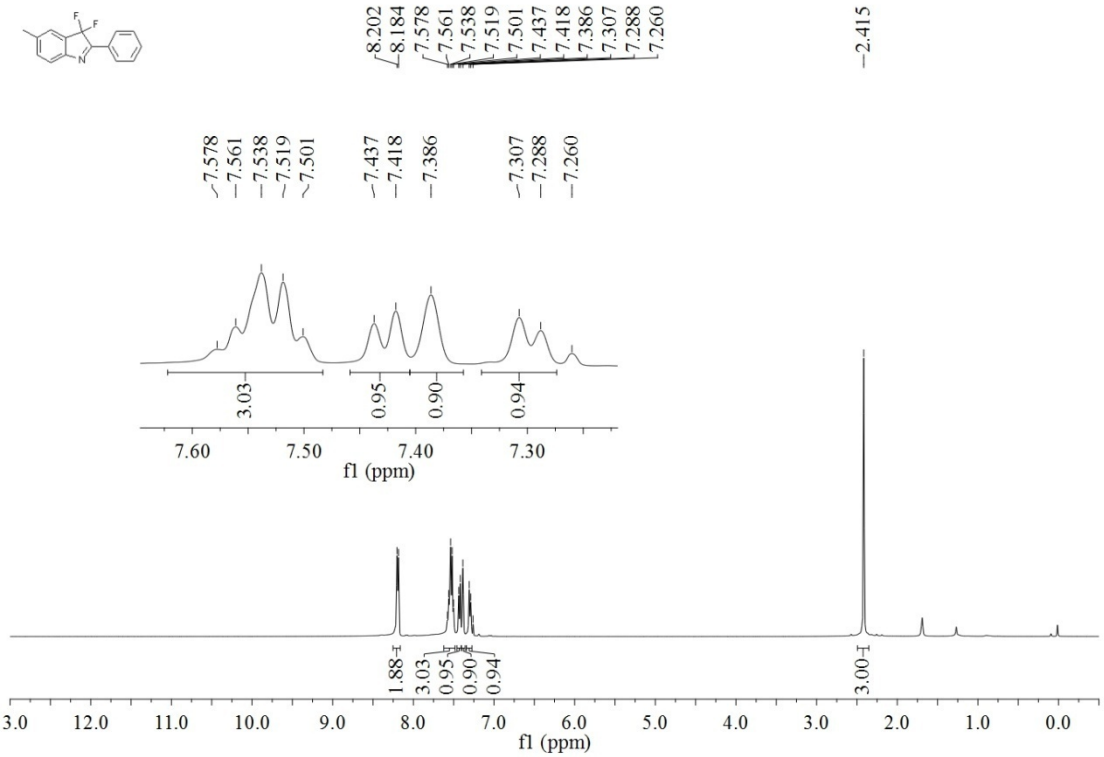
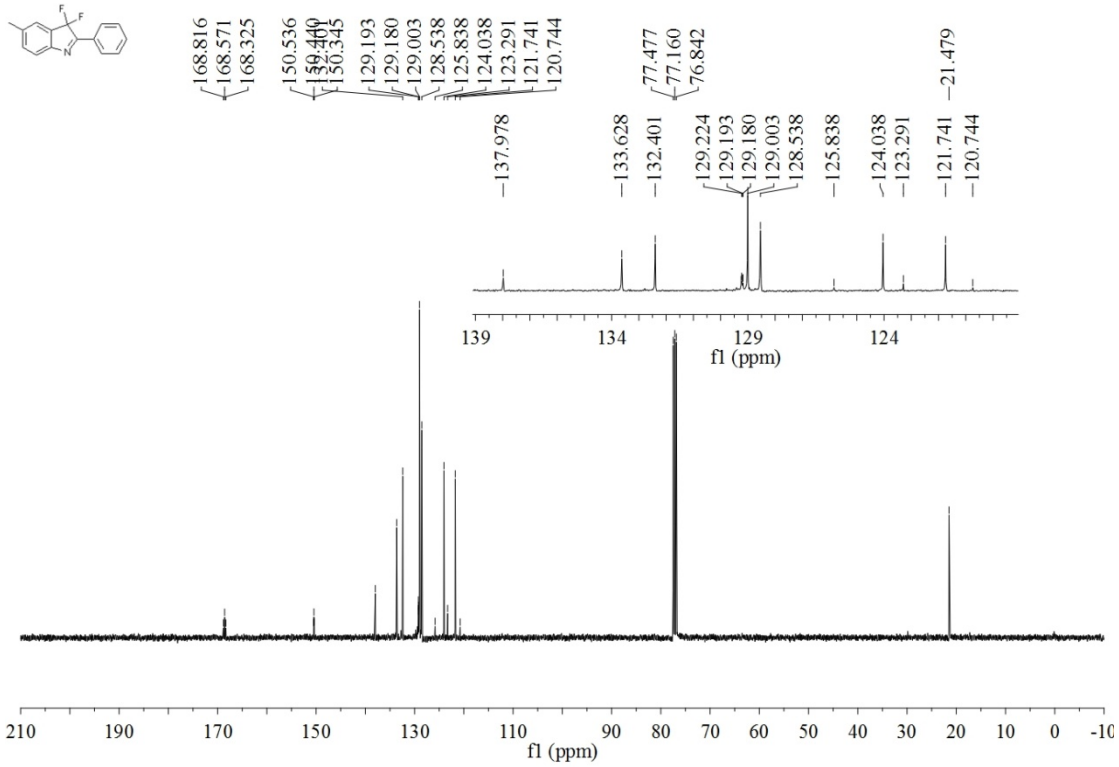
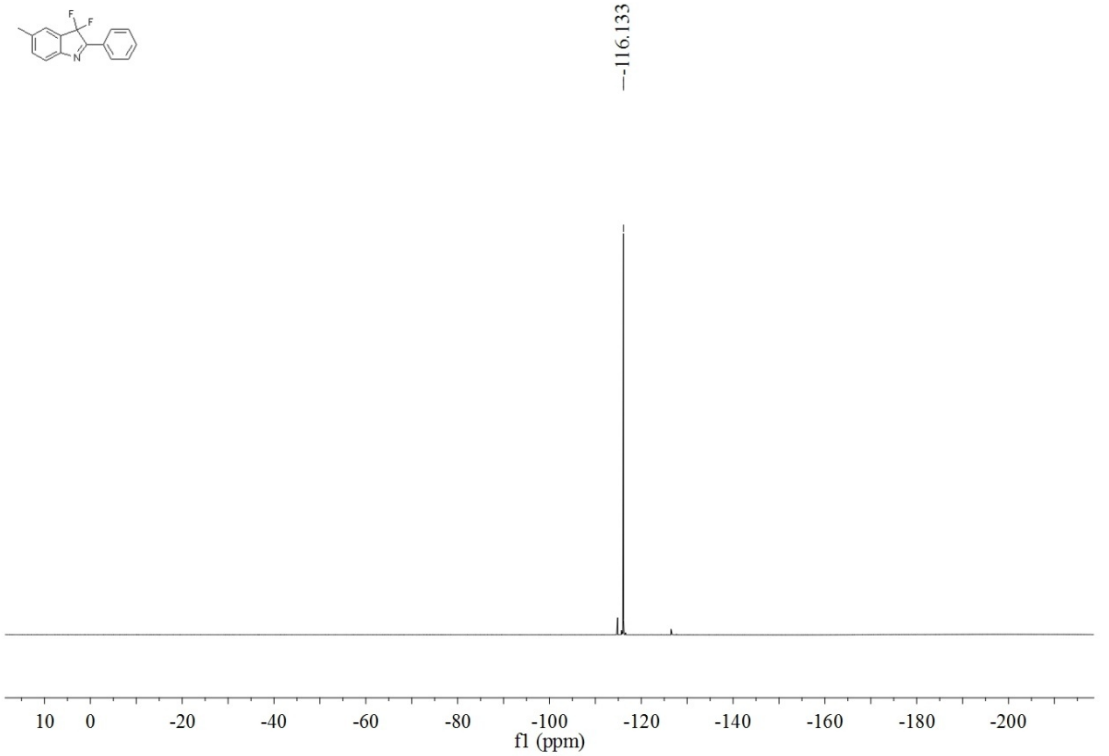
7.878
7.875
7.872
7.869
7.681
7.668
7.568
7.550
7.509
7.504
7.497
7.475
7.310
7.301
7.294
7.287
7.283
7.280
7.268
7.260
7.246
7.236
7.233
7.224
1.598
-0.001
1.00
0.97
3.02
1.07
0.94
7.85
7.70
7.55
7.30
7.25
7.20
f1 (ppm)
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0

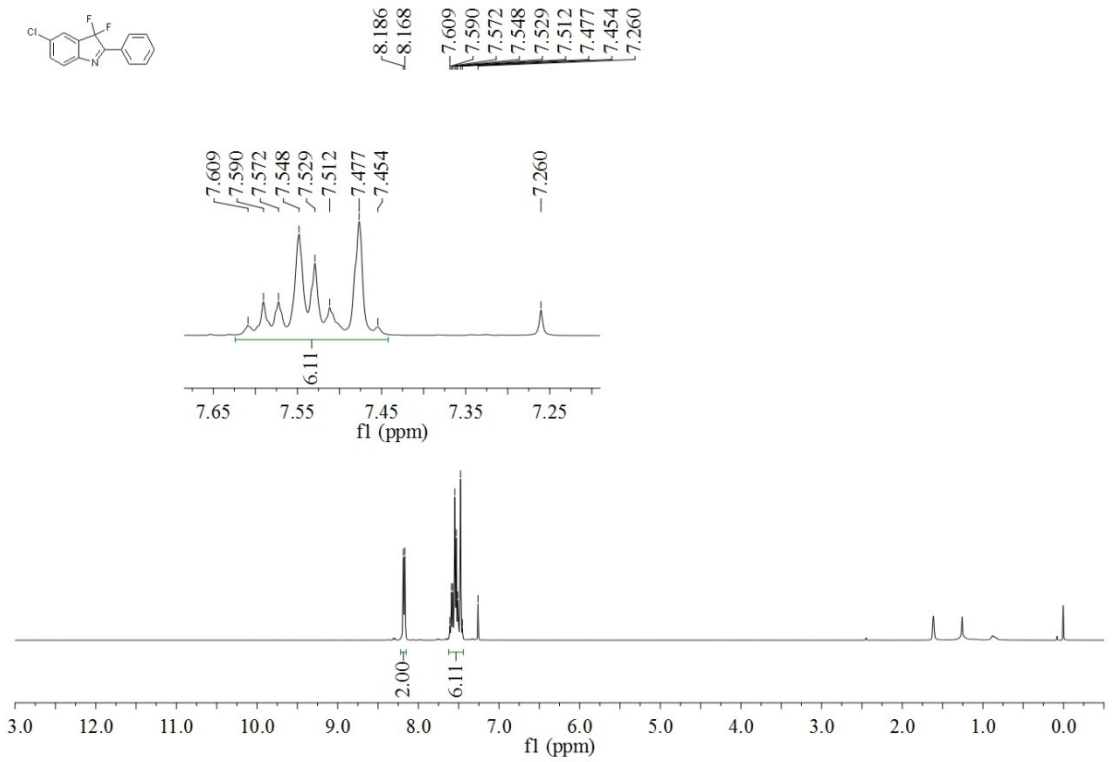

165.002
164.745
164.488
153.295
153.200
153.105
133.278
133.218
133.002
132.675
128.639
128.167
125.005
122.457
119.910
77.477
77.160
76.842
133.555
133.278
133.249
133.218
133.020
133.002
132.983
132.675
128.801
128.403
128.167
127.298
125.005
123.309
122.457
121.874
119.910
133.2
129
127
125
123
121
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10

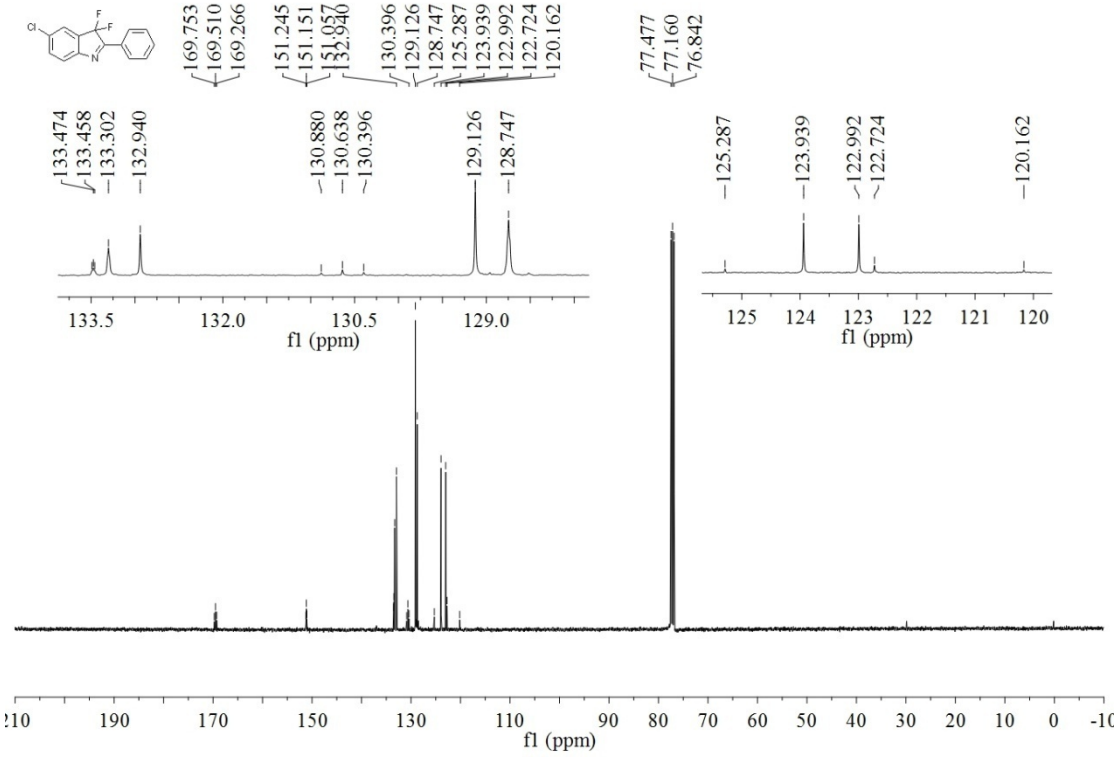

-114.961
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

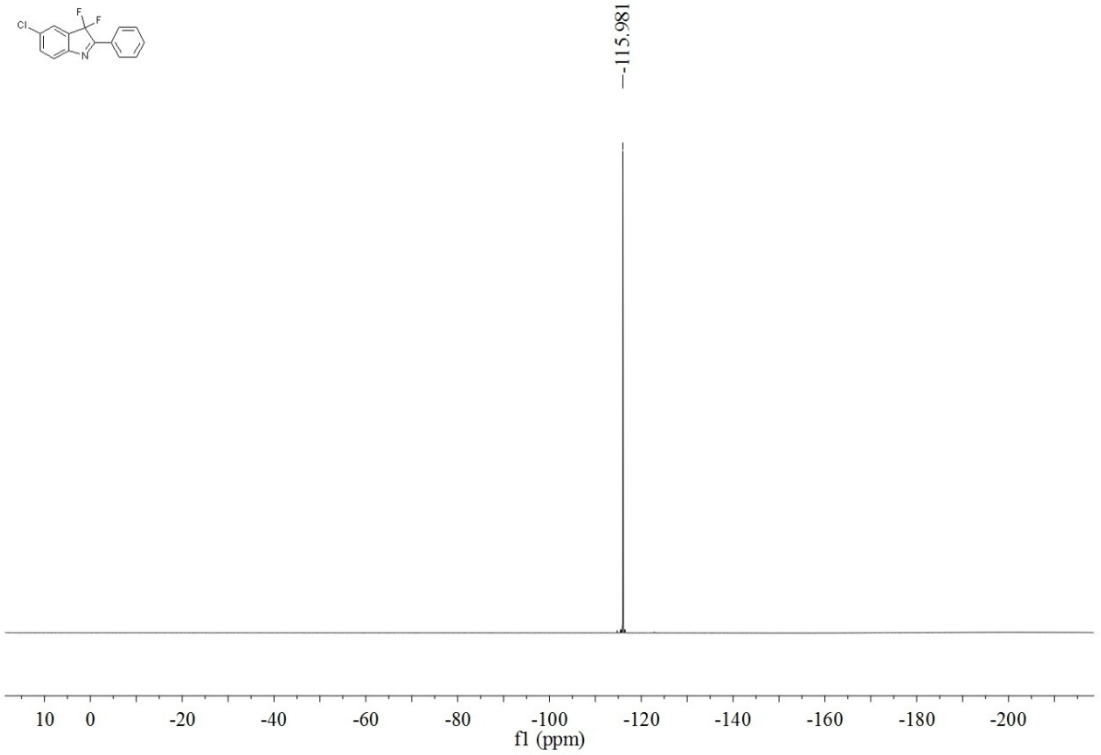

8.202
8.184
7.578
7.561
7.538
7.519
7.501
7.437
7.418
7.386
7.307
7.288
7.260
2.415
3.03
0.95
0.90
0.94
7.60 7.50 7.40 7.30
f1 (ppm)
1.88
3.03
0.95
0.90
0.94
3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

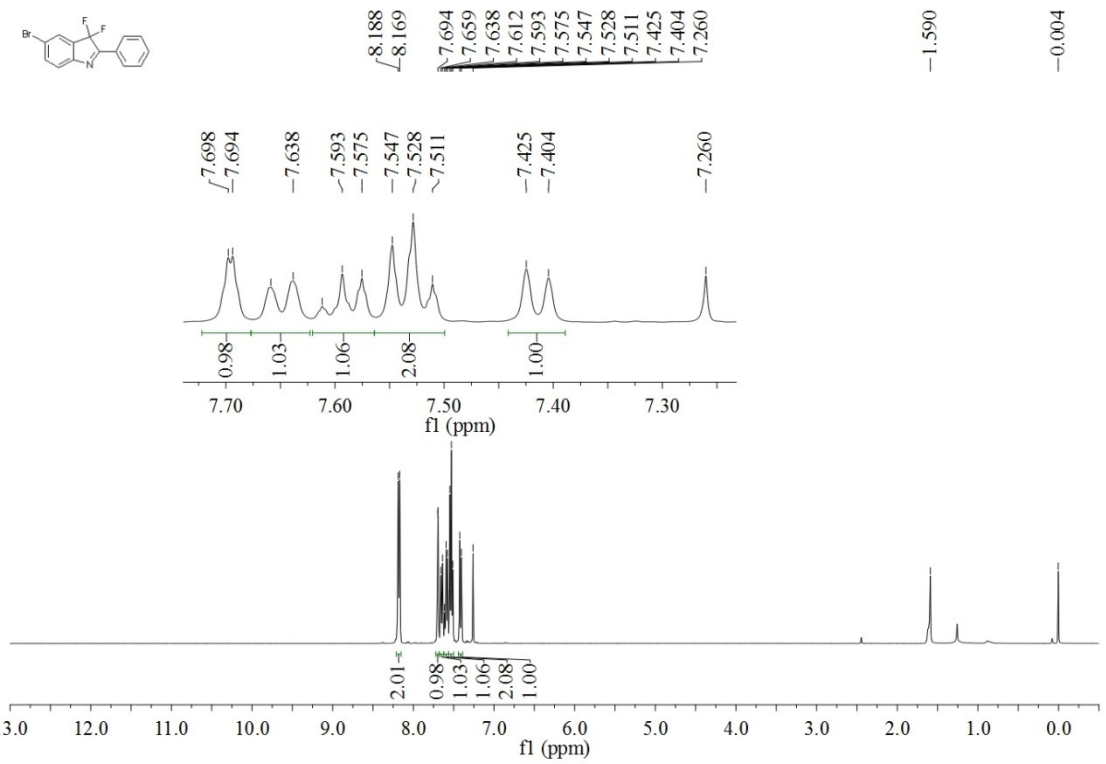

168.816
168.571
168.325
150.536
150.345
129.193
129.180
129.003
128.538
125.838
124.038
123.291
121.741
120.744
77.477
77.160
76.842
21.479
137.978
133.628
132.401
129.224
129.193
129.180
129.003
128.538
125.838
124.038
123.291
121.741
120.744
139
134
129
124
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

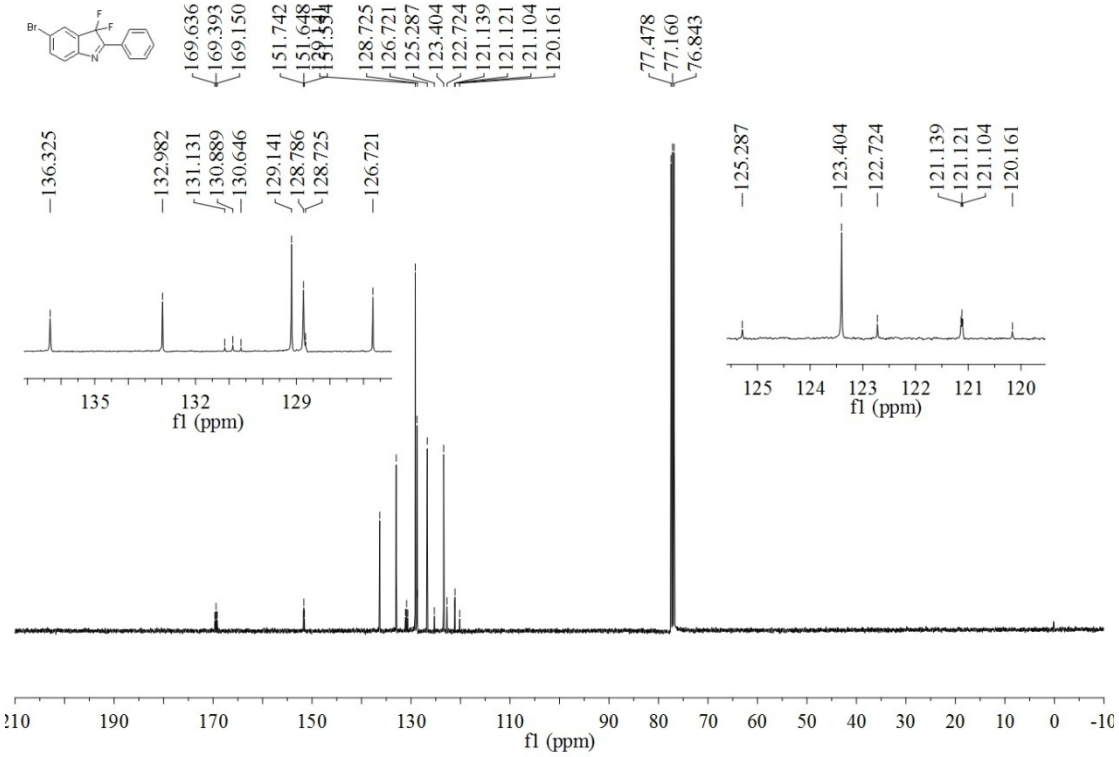

-116.133
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

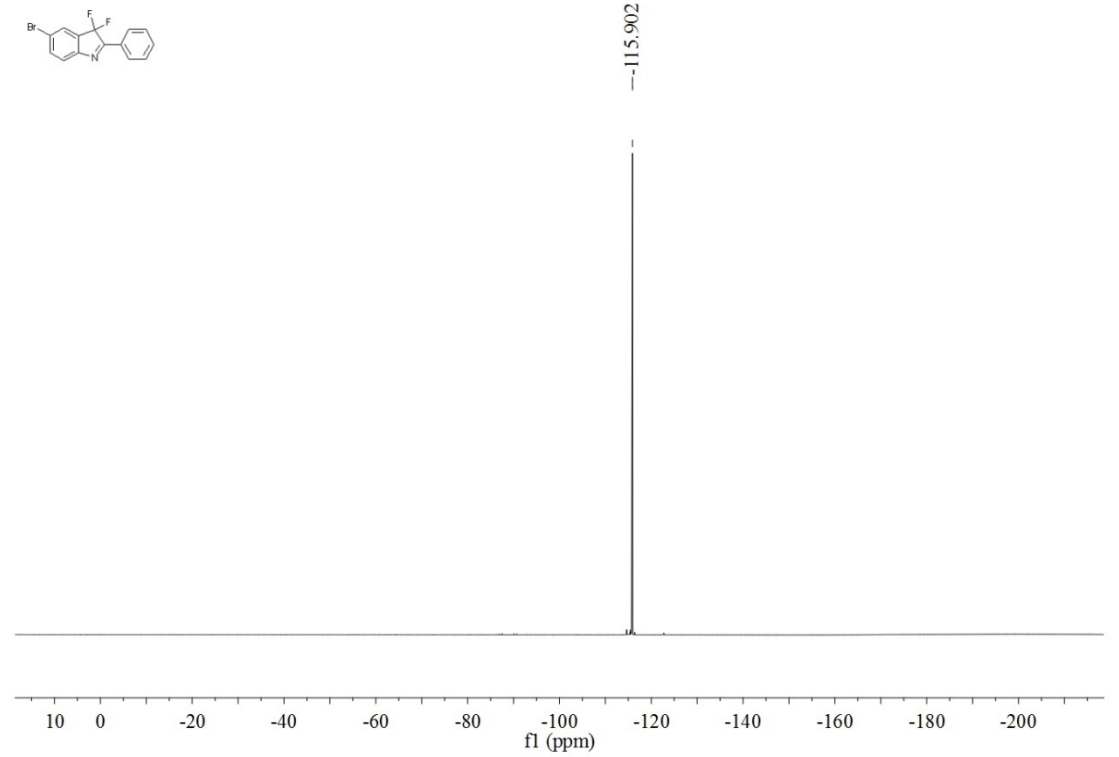

8.186
8.168
7.609
7.590
7.572
7.548
7.529
7.512
7.477
7.454
7.260
6.11
7.65
7.55
7.45
7.35
7.25
f1 (ppm)
2.00
6.11
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

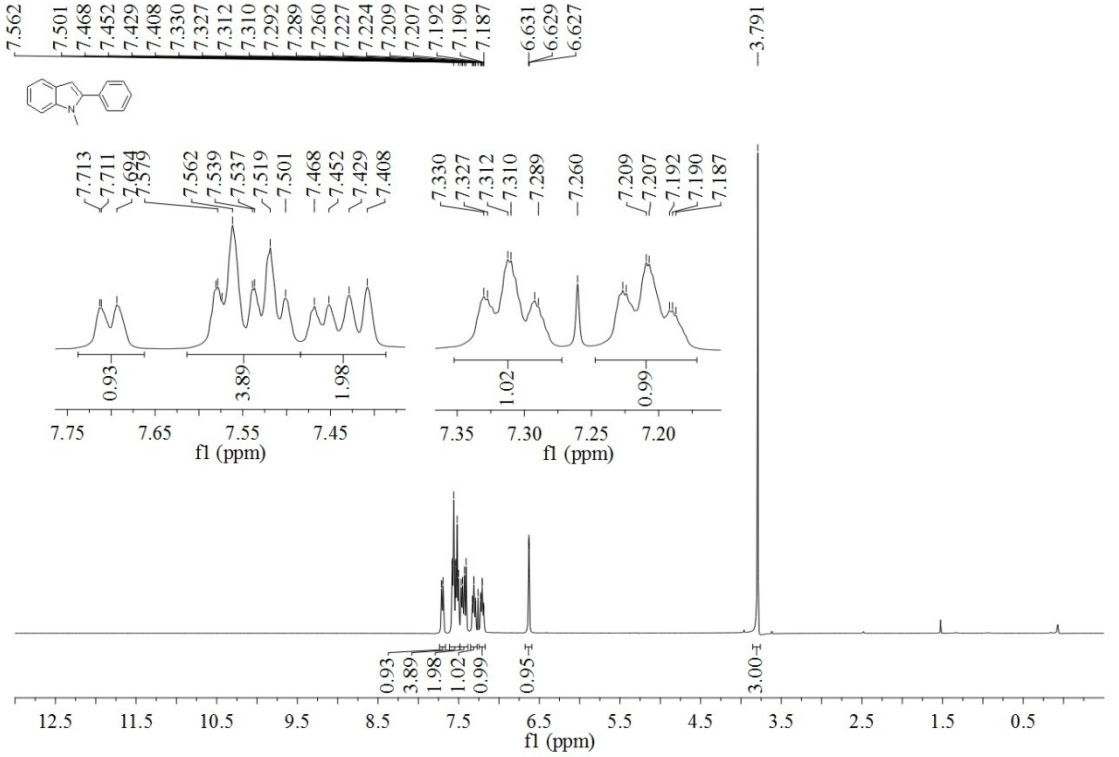

169.753
169.510
169.266
151.245
151.151
132.940
130.396
129.126
128.747
125.287
123.939
122.992
122.724
120.162
77.477
77.160
76.842
133.474
133.458
133.302
132.940
130.880
130.638
130.396
129.126
128.747
125.287
123.939
122.992
122.724
120.162
133.5
132.0
130.5
129.0
f1 (ppm)
125
124
123
122
121
120
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

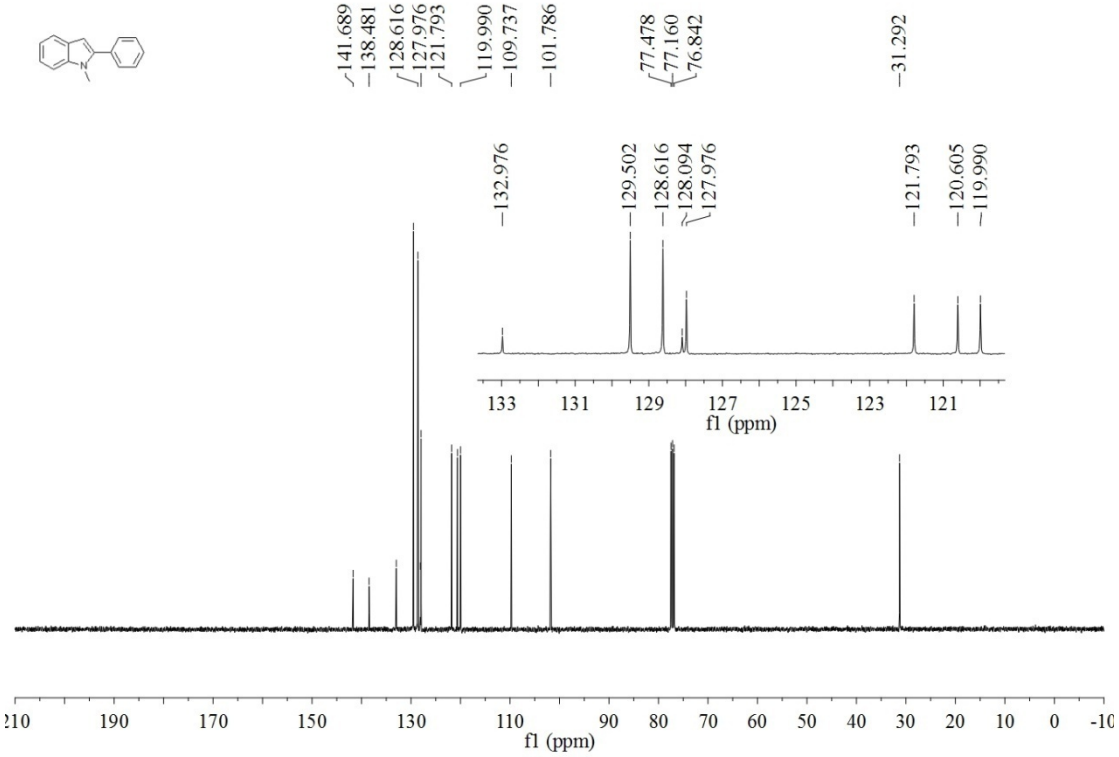

-115.981
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

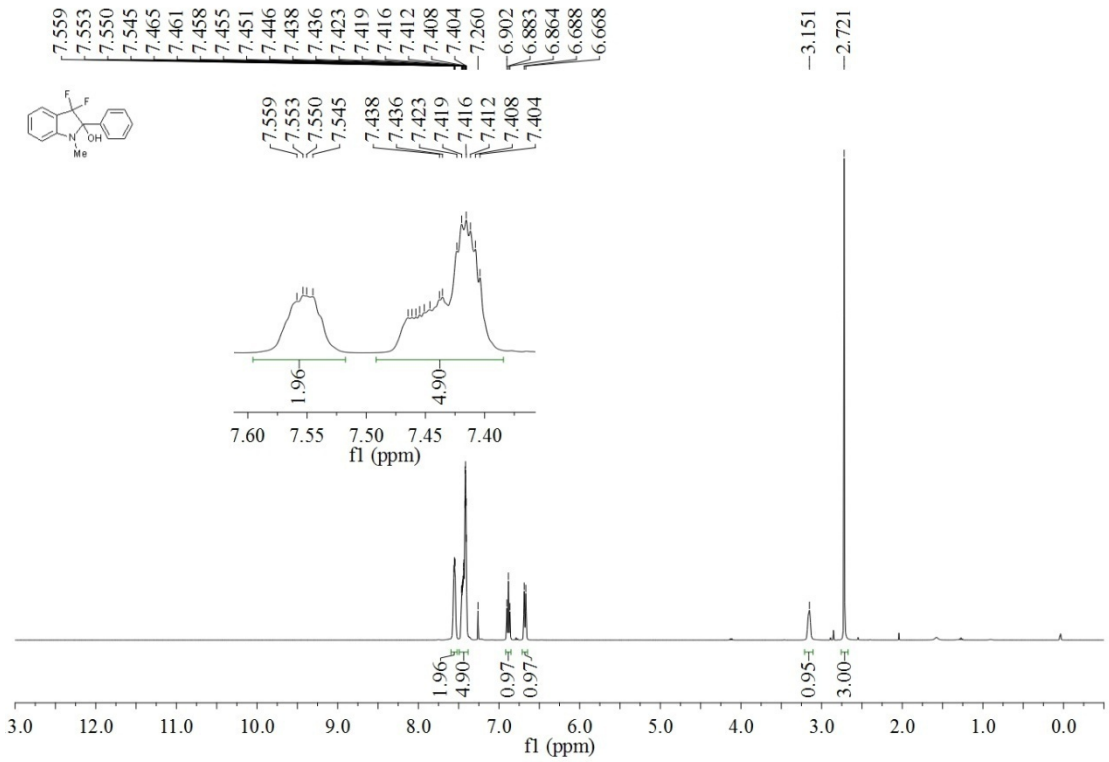

8.188
8.169
7.694
7.659
7.638
7.612
7.593
7.575
7.547
7.528
7.511
7.425
7.404
7.260
1.590
0.004
0.98
1.03
1.06
2.08
1.00
7.70 7.60 7.50 7.40 7.30
f1 (ppm)
2.01
0.98
1.03
1.06
2.08
1.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

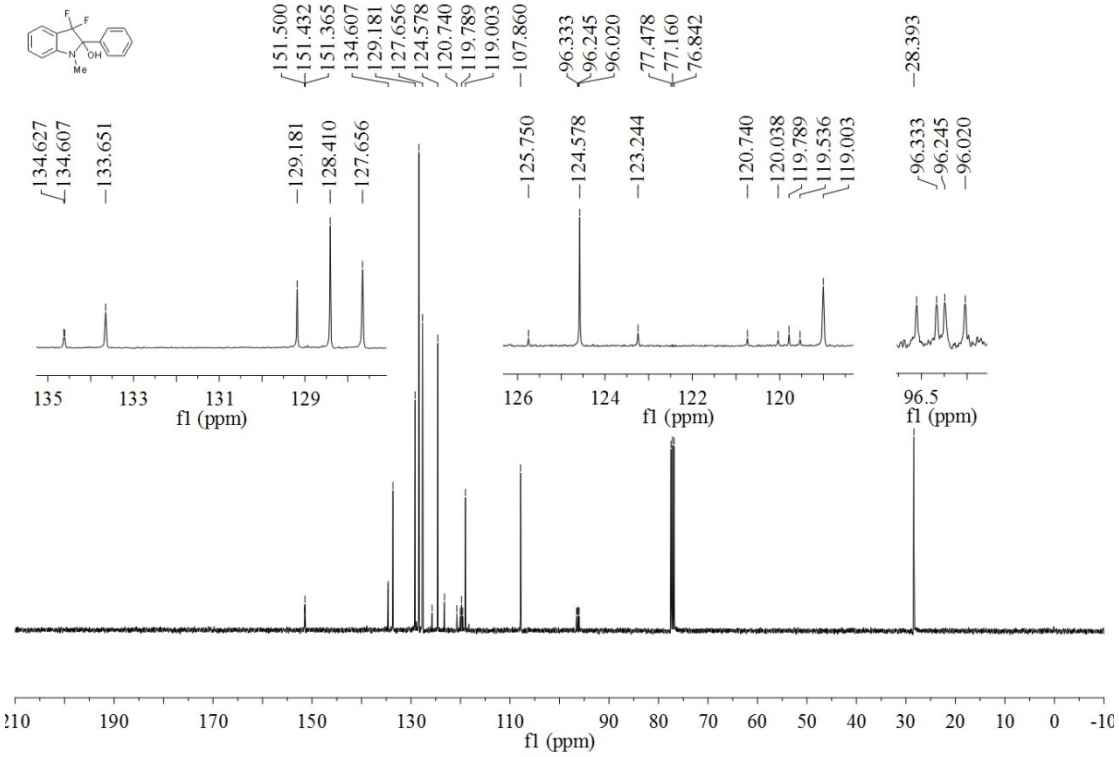

169.636
169.393
169.150
151.742
128.725
126.721
125.287
123.404
122.724
121.139
121.121
121.104
120.161
77.478
77.160
76.843
136.325
132.982
131.131
130.889
130.646
129.141
128.786
128.725
126.721
125.287
123.404
122.724
121.139
121.121
121.104
120.161
135
132
129
f1 (ppm)
125
124
123
122
121
120
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

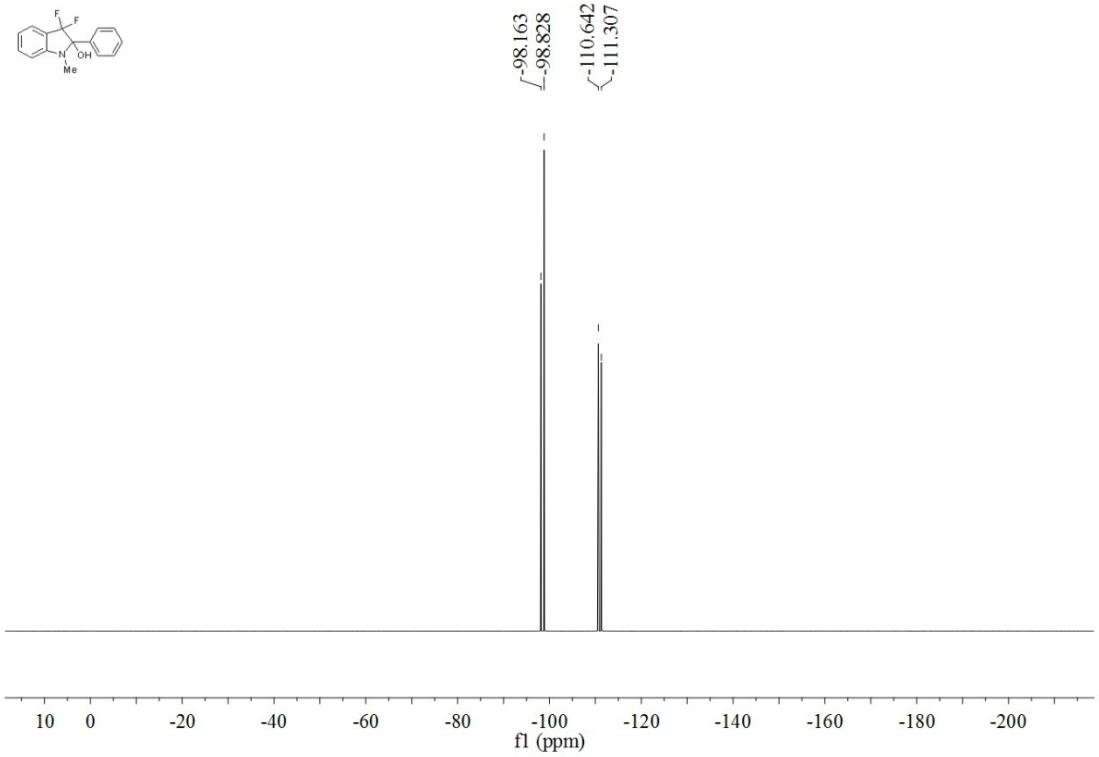

-115.902
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

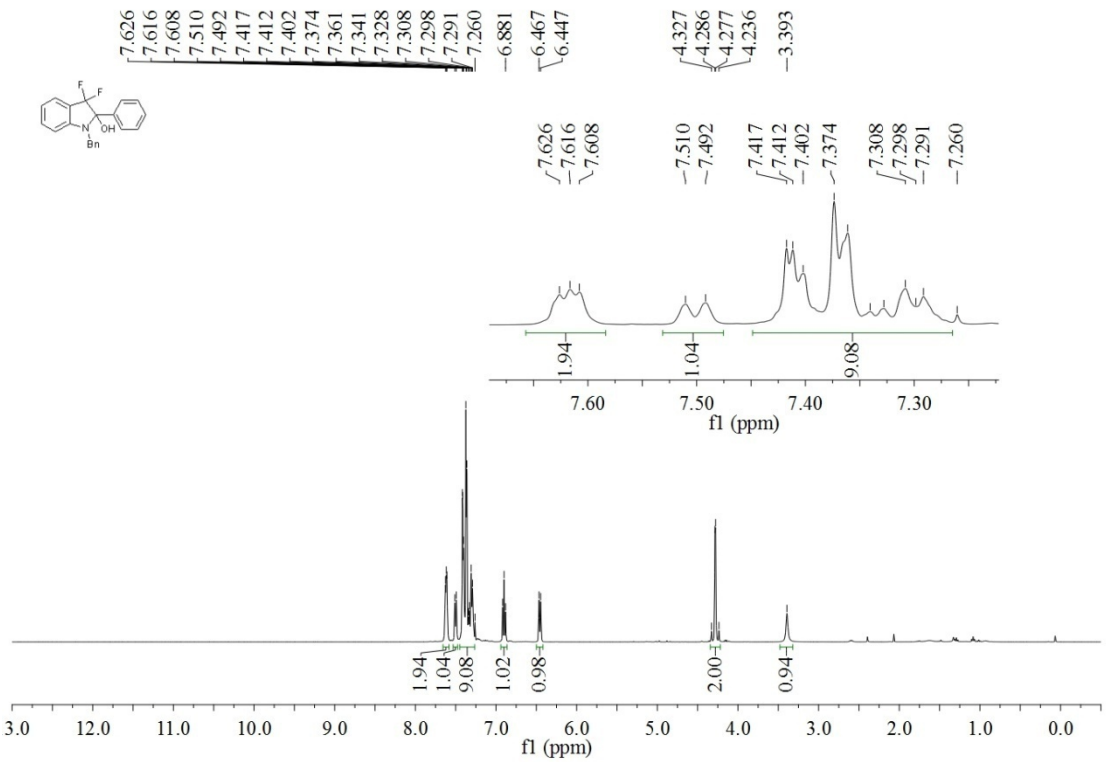

7.562
7.501
7.468
7.452
7.429
7.408
7.330
7.327
7.312
7.310
7.292
7.289
7.260
7.227
7.224
7.209
7.207
7.192
7.190
7.187
6.631
6.629
6.627
3.791
0.93
3.89
1.98
1.02
0.99
0.95
3.00
fl (ppm)

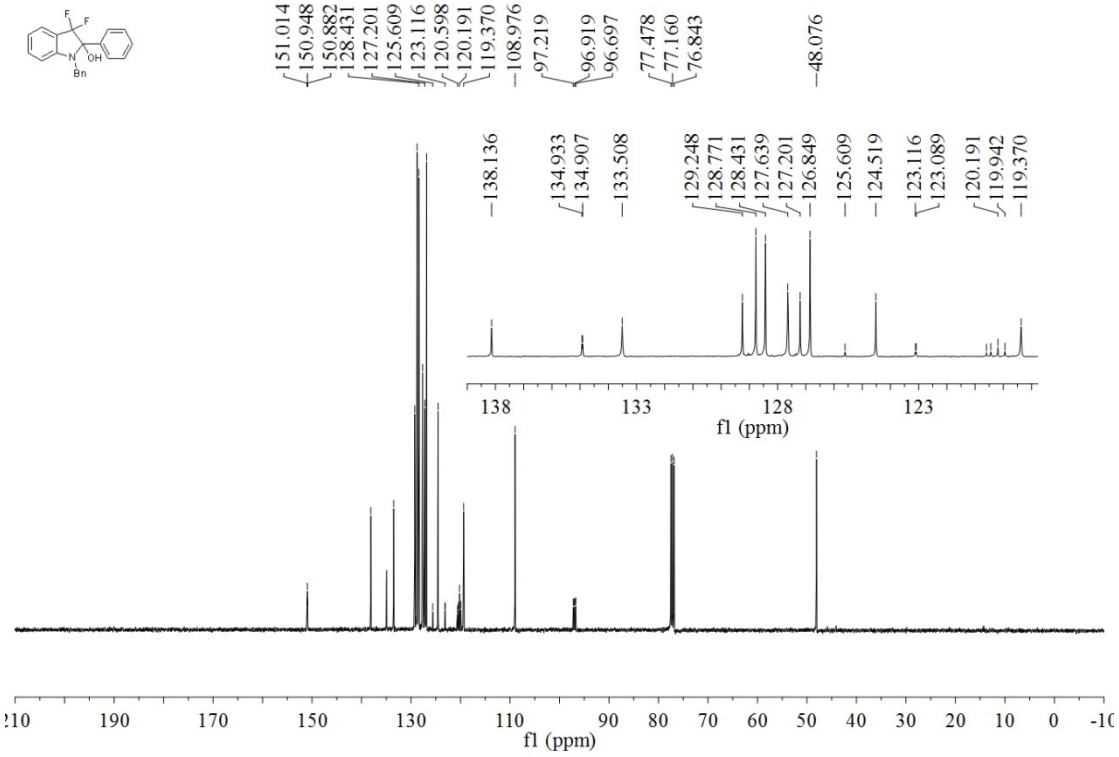

141.689
138.481
128.616
127.976
121.793
119.990
109.737
101.786
77.478
77.160
76.842
31.292
132.976
129.502
128.616
128.094
127.976
121.793
120.605
119.990
fl (ppm)


7.559
7.553
7.550
7.545
7.465
7.461
7.458
7.455
7.451
7.446
7.438
7.436
7.423
7.419
7.416
7.412
7.408
7.404
7.260
6.902
6.883
6.864
6.688
6.668
3.151
2.721
F
F
OH
N
Me
1.96
4.90
7.60 7.55 7.50 7.45 7.40
f1 (ppm)
0.97
0.95
3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)


151.500
151.432
151.365
134.607
129.181
127.656
124.578
120.740
119.789
119.003
107.860
96.333
96.245
96.020
77.478
77.160
76.842
28.393
134.627
134.607
133.651
129.181
128.410
127.656
125.750
124.578
123.244
120.740
120.038
119.789
119.536
119.003
96.333
96.245
96.020
135 133 131 129
f1 (ppm)
126 124 122 120
f1 (ppm)
96.5
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-98.163
-98.828
-110.642
-111.307
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)


7.626
7.616
7.608
7.510
7.492
7.417
7.412
7.402
7.374
7.361
7.341
7.328
7.308
7.298
7.291
7.260
6.881
6.467
6.447
4.327
4.286
4.277
4.236
3.393
1.94
1.04
9.08
7.60
7.50
7.40
7.30
f1 (ppm)
1.94
1.04
9.08
1.02
0.98
2.00
0.94
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)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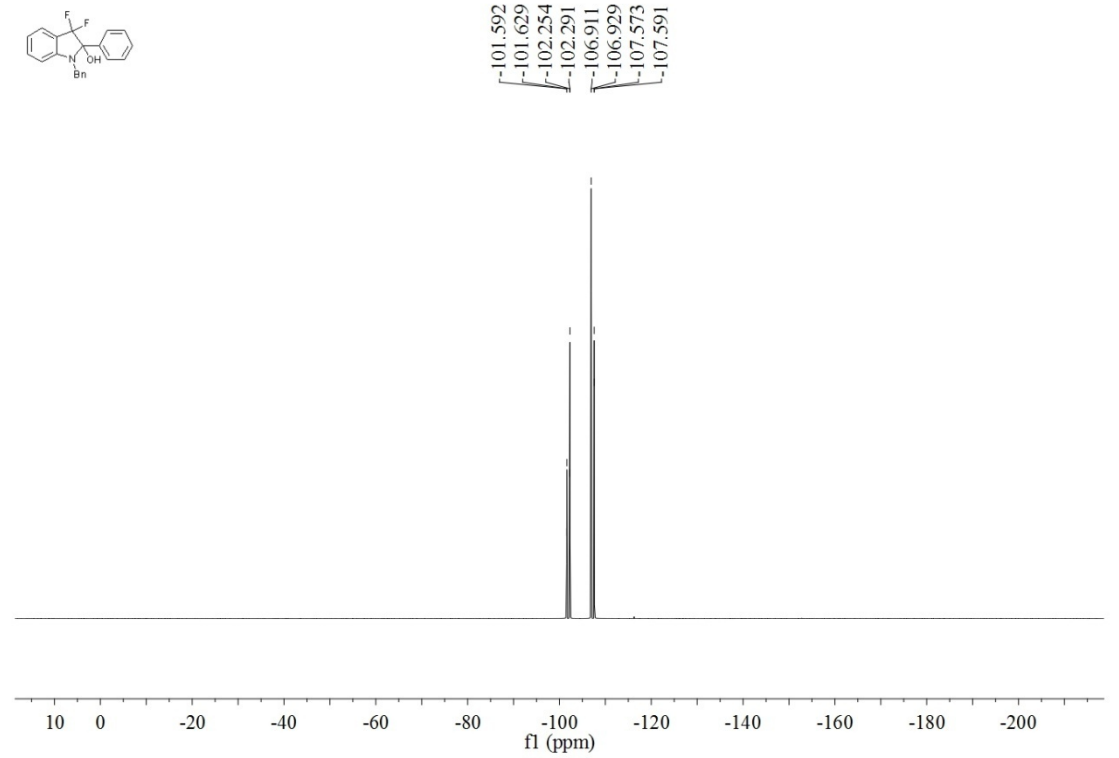
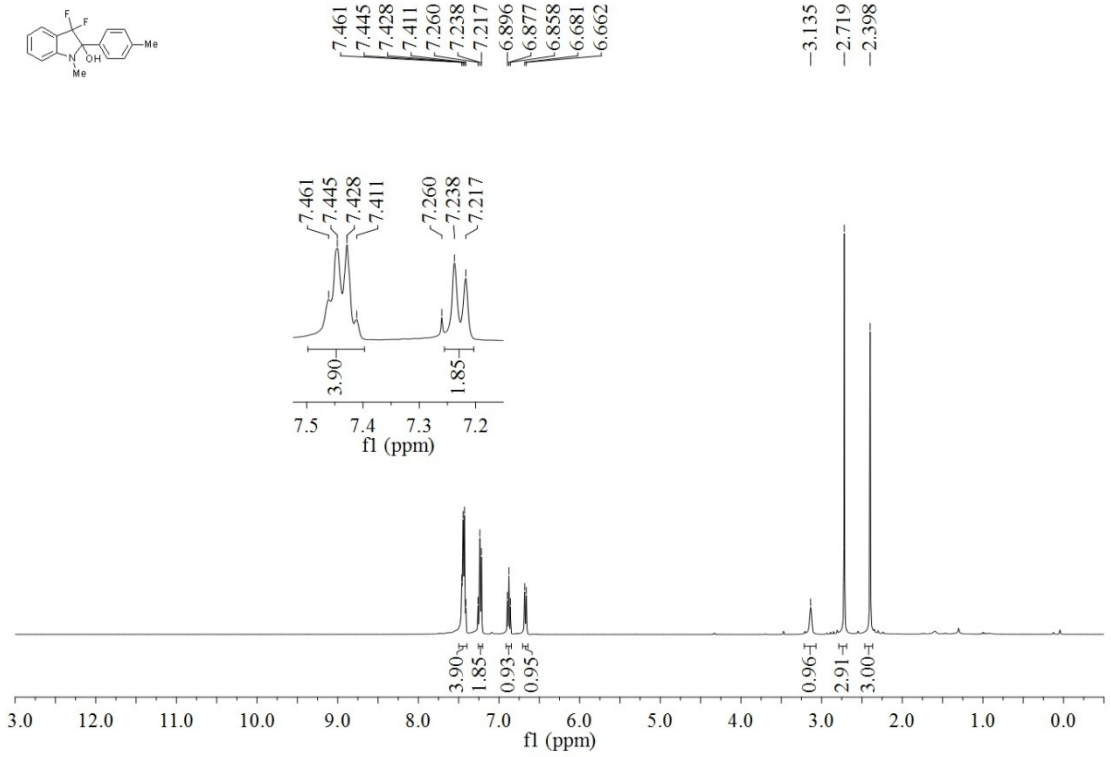
150.948
150.882
128.431
127.201
125.609
123.116
120.598
120.191
119.370
108.976
97.219
96.919
96.697
77.478
77.160
76.843
48.076
138.136
134.933
134.907
133.508
129.248
128.771
128.431
127.639
127.201
126.849
125.609
124.519
123.116
123.089
120.191
119.942
119.370
138
133
128
123
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


-101.592
-101.629
-102.254
-102.291
-106.911
-106.929
-107.573
-107.591
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)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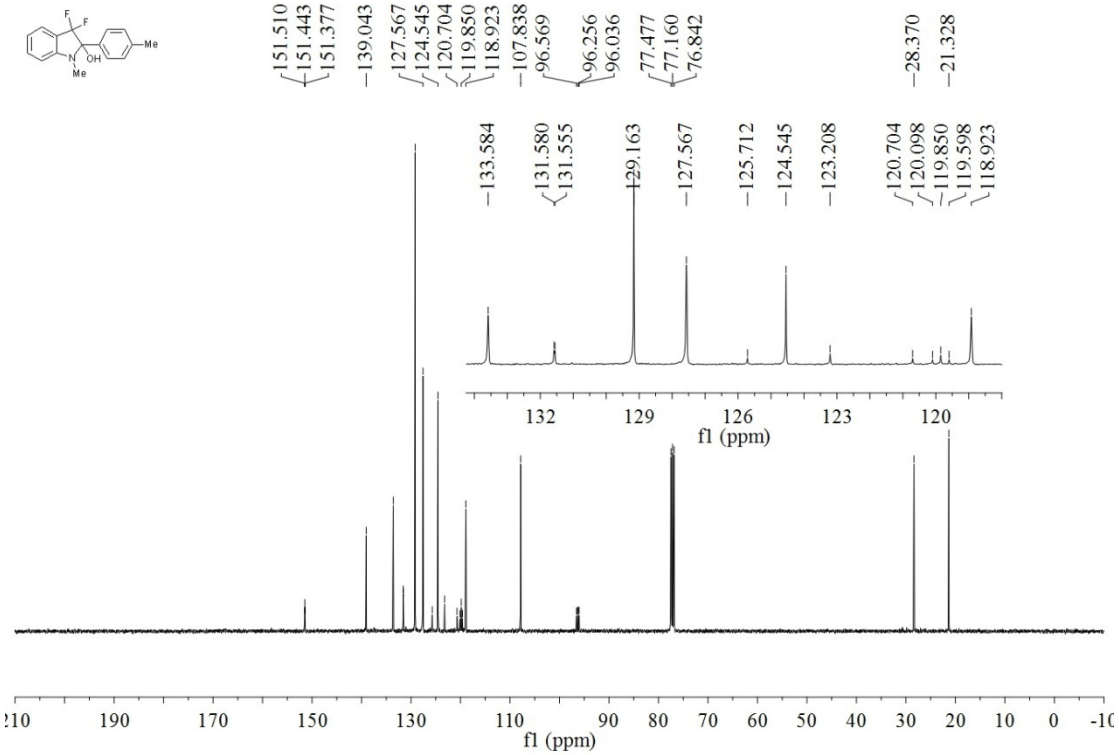
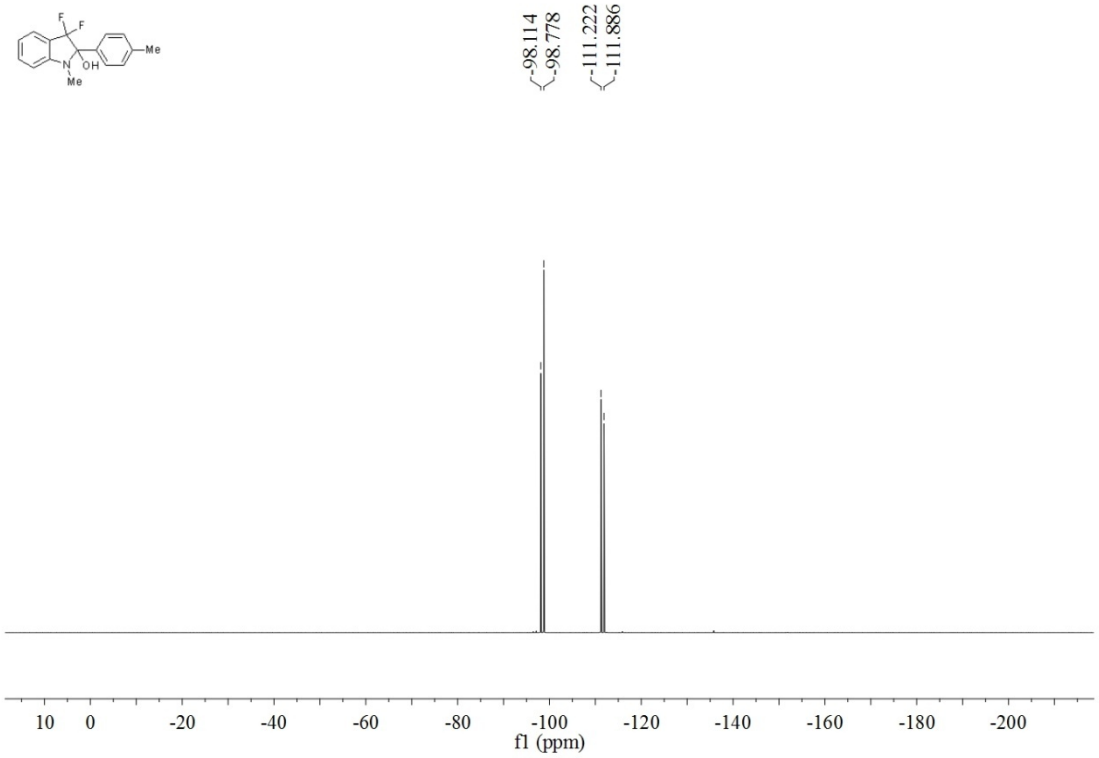
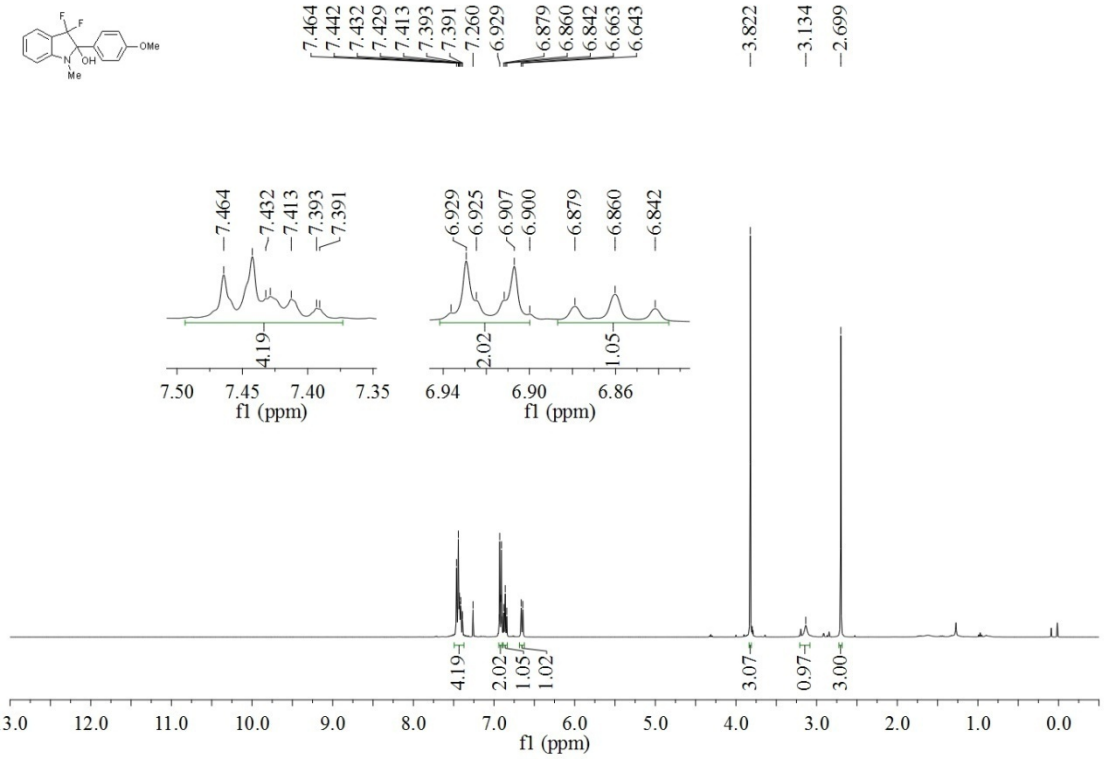
7.445
7.428
7.411
7.260
7.238
7.217
6.896
6.877
6.858
6.681
6.662
3.135
2.719
2.398
3.90
1.85
7.5 7.4 7.3 7.2
f1 (ppm)
3.90
1.85
0.93
0.95
0.96
2.91
3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)


151.510
151.443
151.377
139.043
127.567
124.545
120.704
119.850
118.923
107.838
96.569
96.256
96.036
77.477
77.160
76.842
28.370
21.328
133.584
131.580
131.555
129.163
127.567
125.712
124.545
123.208
120.704
120.098
119.850
119.598
118.923
132 129 126 123 120
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-98.114
-98.778
-111.222
-111.886
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)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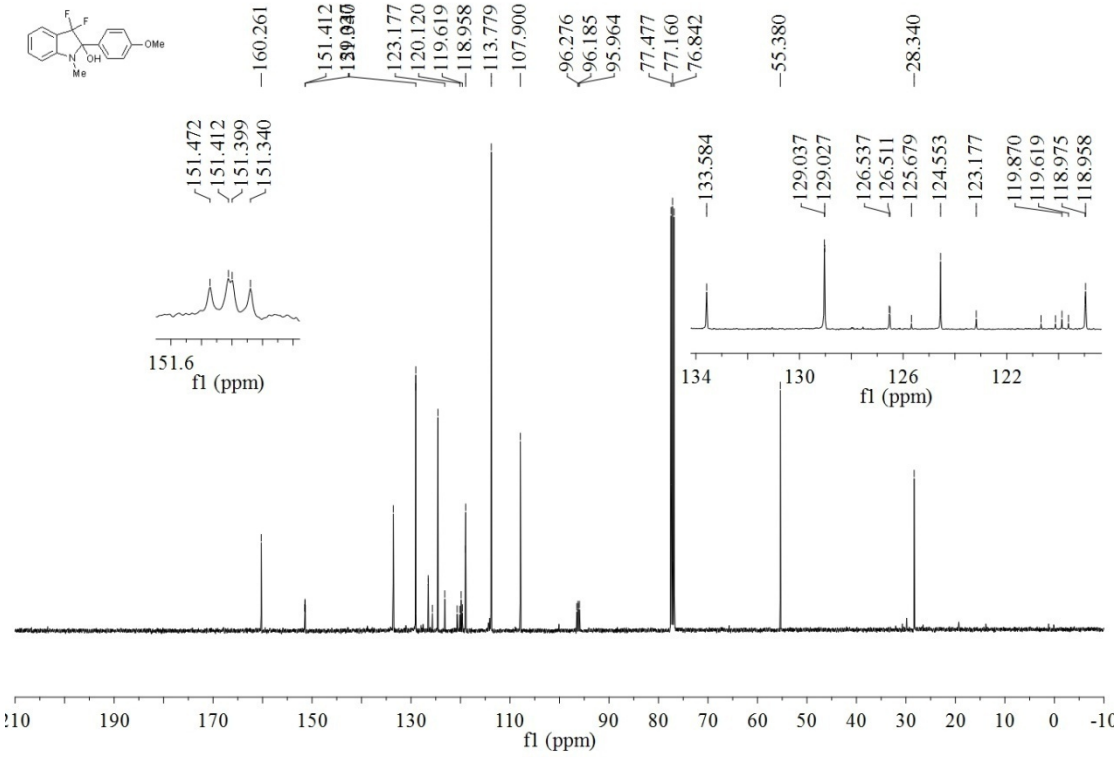
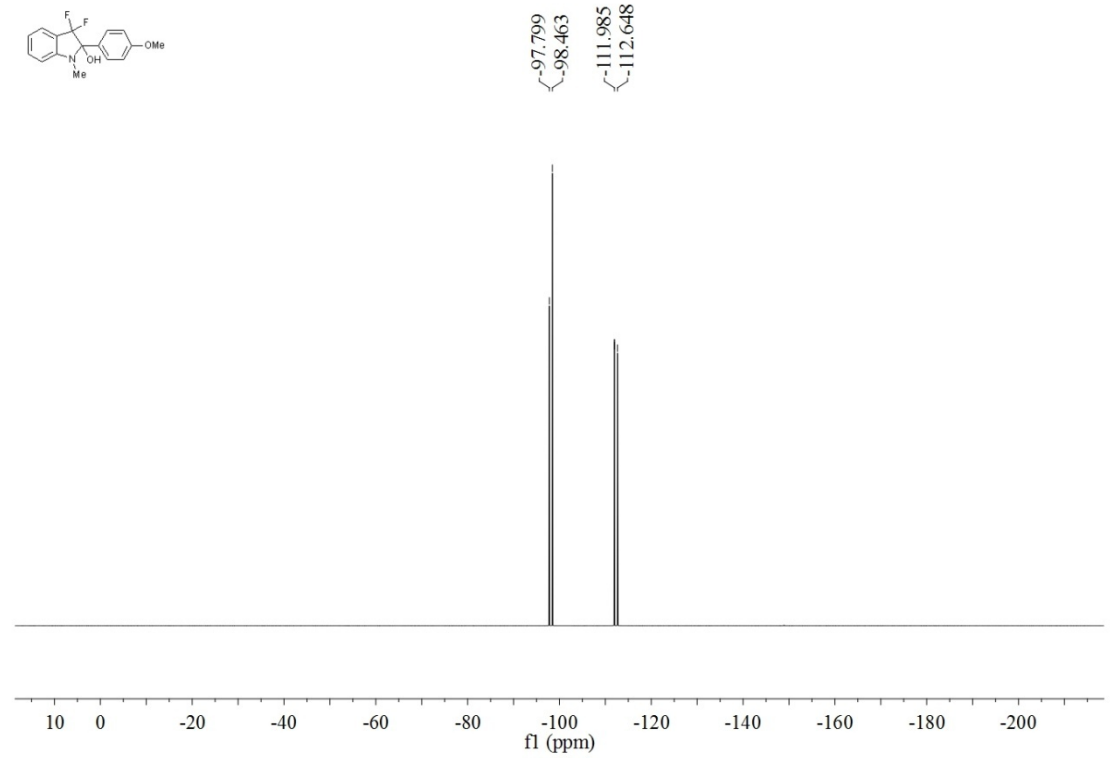
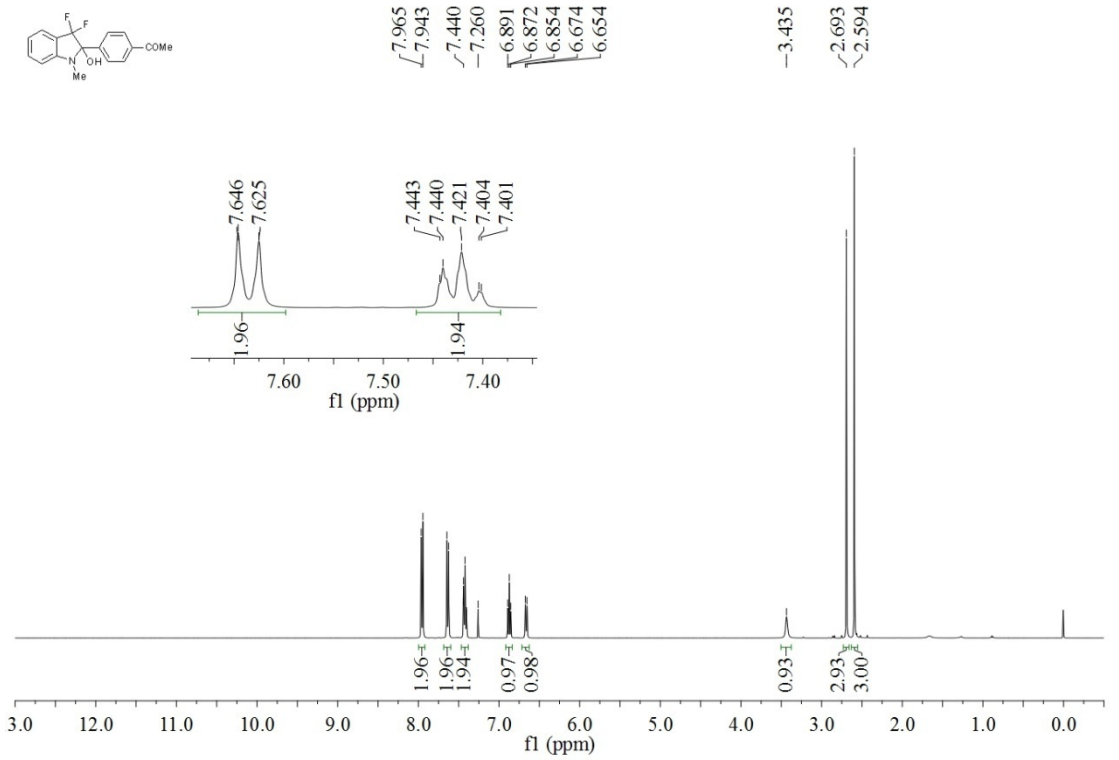
7.442
7.432
7.429
7.413
7.393
7.391
7.260
6.929
6.879
6.860
6.842
6.663
6.643
3.822
3.134
2.699
4.19
2.02
1.05
1.02
3.07
0.97
3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)


160.261
151.412
123.177
120.120
119.619
118.958
113.779
107.900
96.276
96.185
95.964
77.477
77.160
76.842
55.380
28.340
151.472
151.412
151.399
151.340
133.584
129.037
129.027
126.537
126.511
125.679
124.553
123.177
119.870
119.619
118.975
118.958
151.6
f1 (ppm)
134
130
126
122
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


97.799
98.463
111.985
112.648
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)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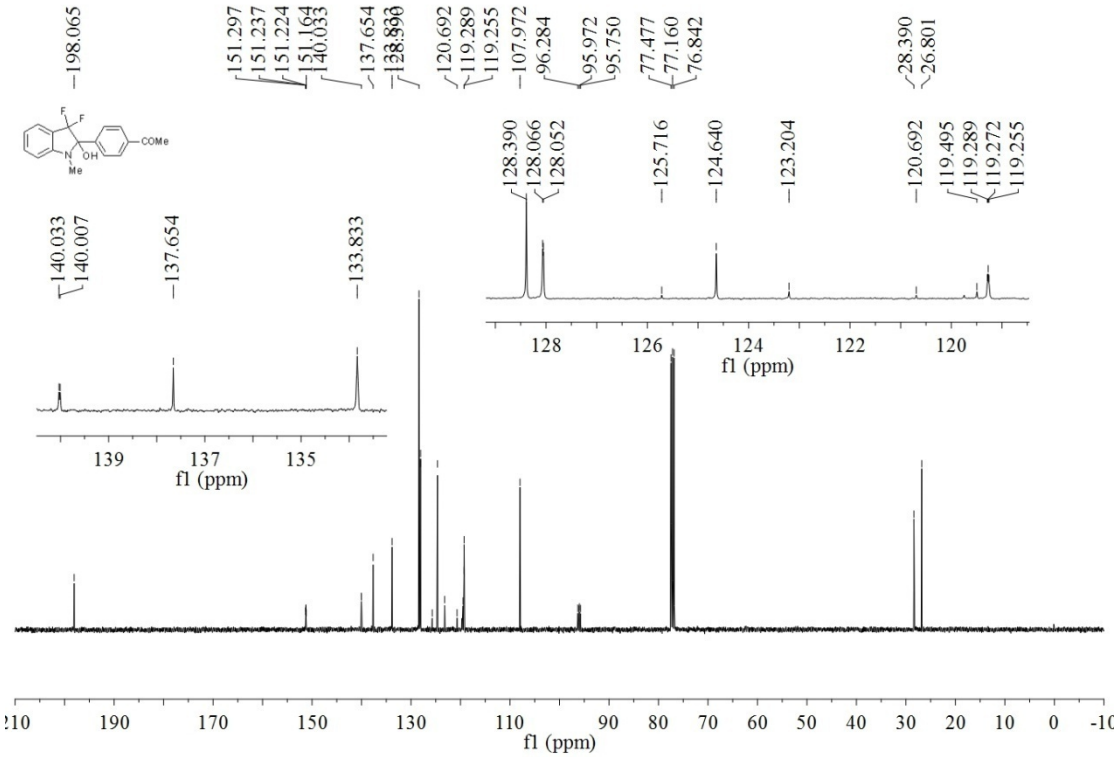
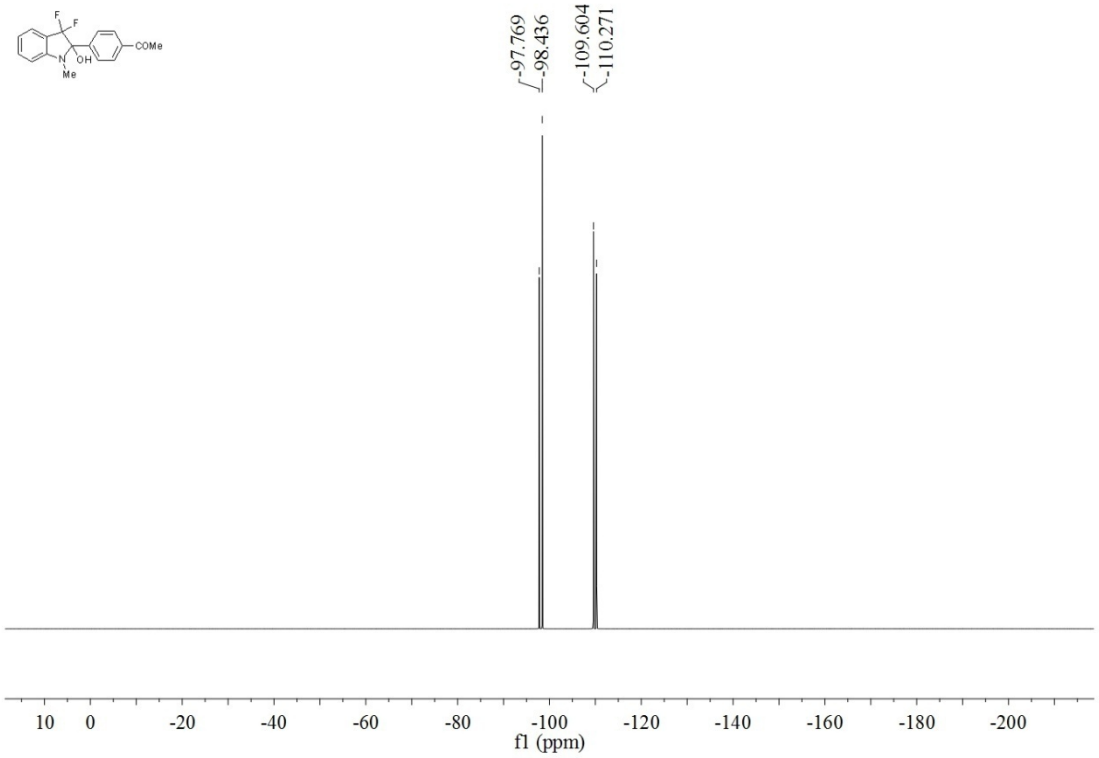
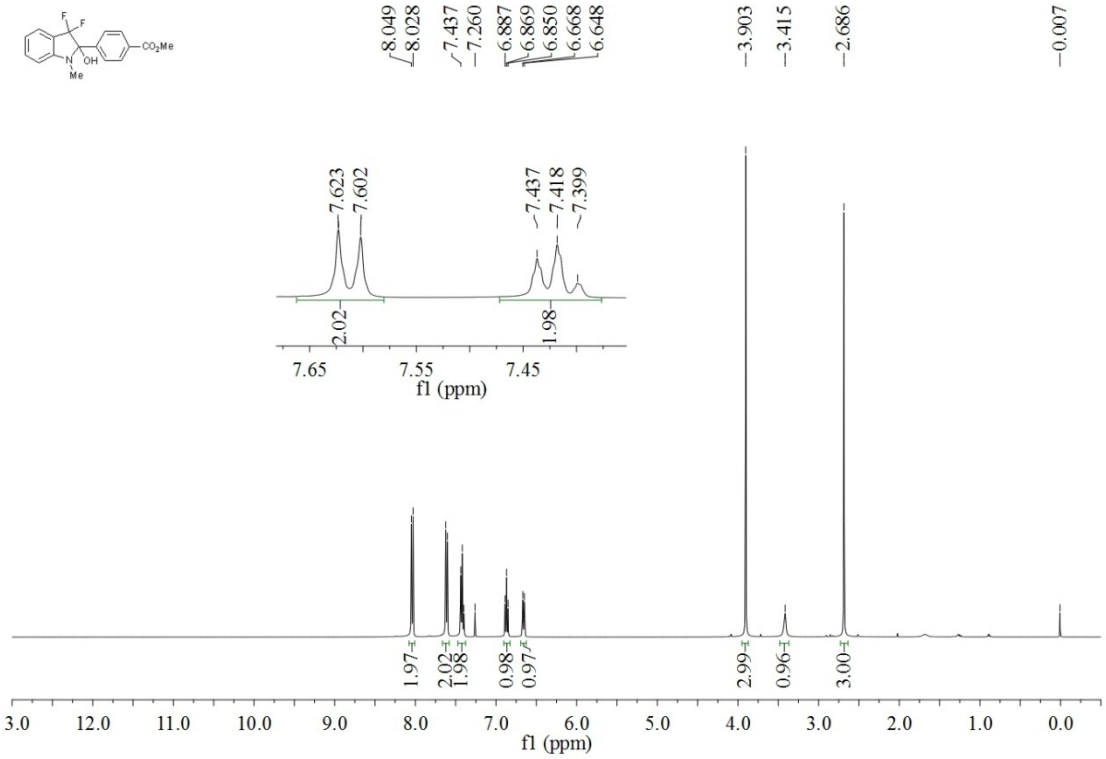
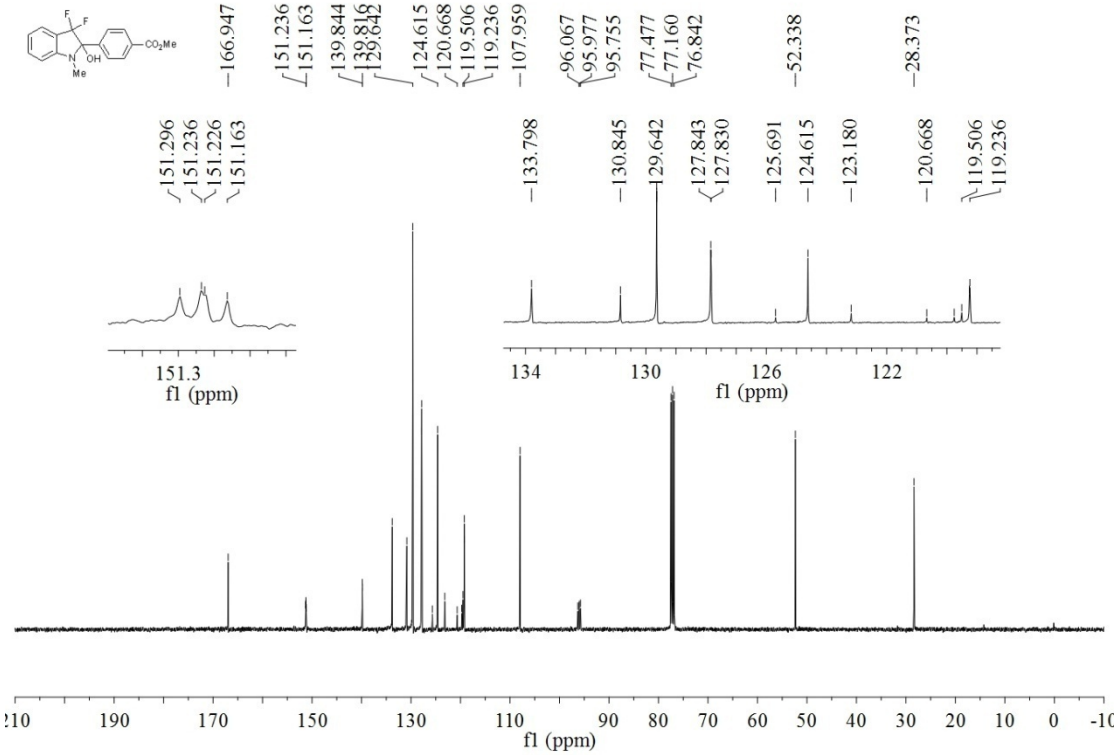
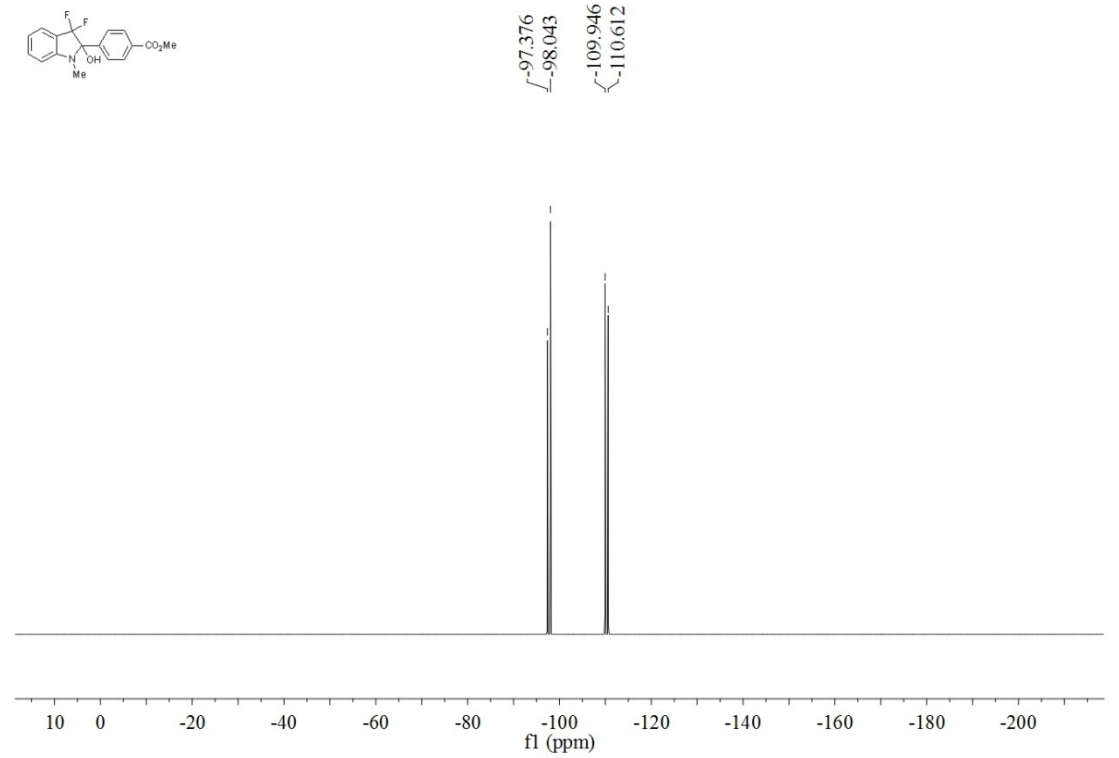
7.943
7.440
7.260
6.891
6.872
6.854
6.674
6.654
3.435
2.693
2.594
7.646
7.625
7.443
7.440
7.421
7.404
7.401
1.96
1.94
7.60
7.50
7.40
f1 (ppm)
1.96
1.96
1.94
0.97
0.98
0.93
2.93
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

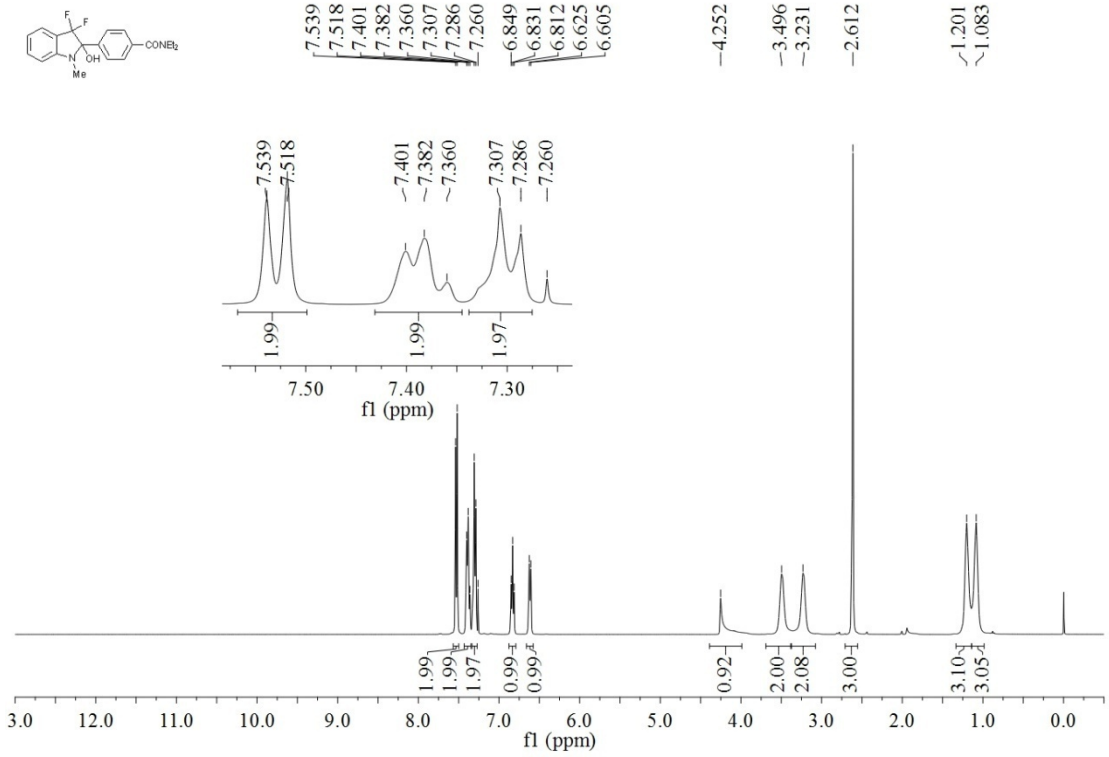

198.065
151.297
151.237
151.224
151.164
140.033
137.654
120.692
119.289
119.255
107.972
96.284
95.972
95.750
77.477
77.160
76.842
28.390
26.801
128.390
128.066
128.052
125.716
124.640
123.204
120.692
119.495
119.289
119.272
119.255
140.033
140.007
137.654
133.833
139
137
135
f1 (ppm)
128
126
124
122
120
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

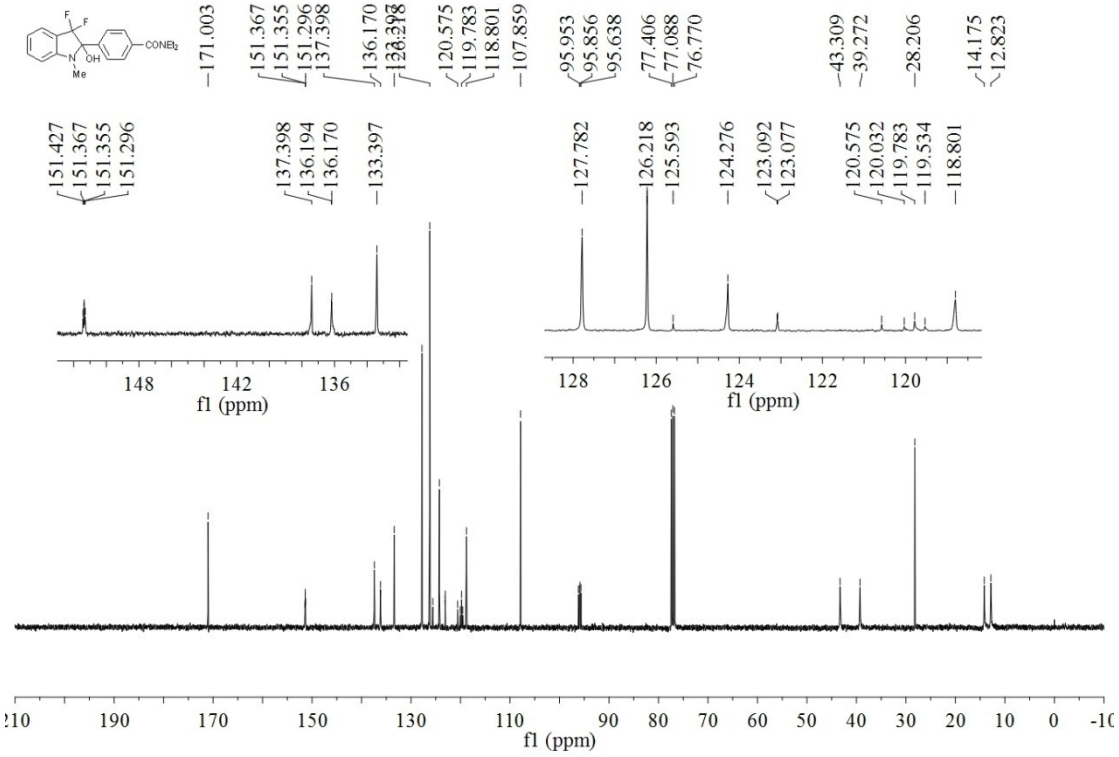

F
F
OH
N
Me
COMe
-97.769
-98.436
-109.604
-110.271
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


F
F
OH
N
Me
CO2Me
8.049
8.028
7.437
7.260
6.887
6.869
6.850
6.668
6.648
3.903
3.415
2.686
0.007
7.623
7.602
7.437
7.418
7.399
2.02
1.98
7.65
7.55
7.45
f1 (ppm)
1.97
2.02
1.98
0.98
0.97
2.99
0.96
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


166.947
151.236
151.163
139.844
139.816
129.842
124.615
120.668
119.506
119.236
107.959
96.067
95.977
95.755
77.477
77.160
76.842
52.338
28.373
151.296
151.236
151.226
151.163
133.798
130.845
129.642
127.843
127.830
125.691
124.615
123.180
120.668
119.506
119.236
151.3
f1 (ppm)
134
130
126
122
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


97.376
98.043
109.946
110.612
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


7.539
7.518
7.401
7.382
7.360
7.307
7.286
7.260
6.849
6.831
6.812
6.625
6.605
4.252
3.496
3.231
2.612
1.201
1.083
1.99
1.99
1.97
7.50
7.40
7.30
fl (ppm)
0.99
0.99
0.92
2.00
2.08
3.00
3.10
3.05
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
fl (ppm)


171.003
151.367
151.355
151.296
137.398
136.170
133.397
120.575
119.783
118.801
107.859
95.953
95.856
95.638
77.406
77.088
76.770
43.309
39.272
28.206
14.175
12.823
151.427
151.367
151.355
151.296
137.398
136.194
136.170
133.397
127.782
126.218
125.593
124.276
123.092
123.077
120.575
120.032
119.783
119.534
118.801
148
142
136
fl (ppm)
128
126
124
122
120
fl (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)

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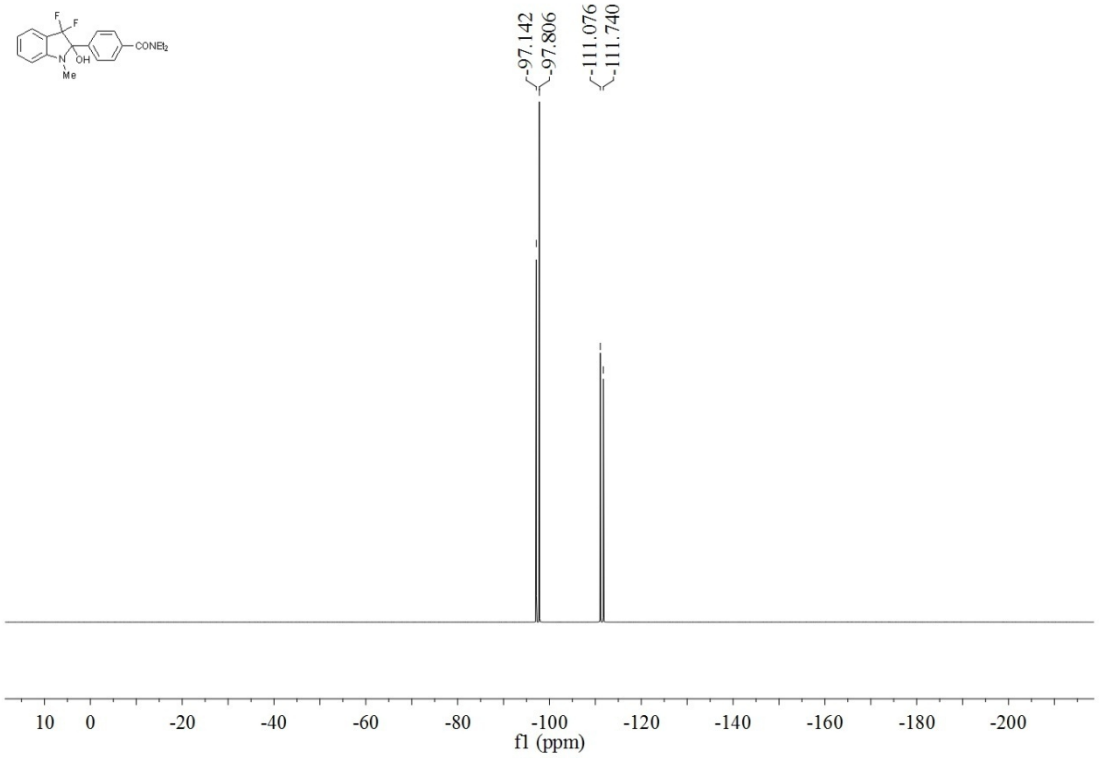

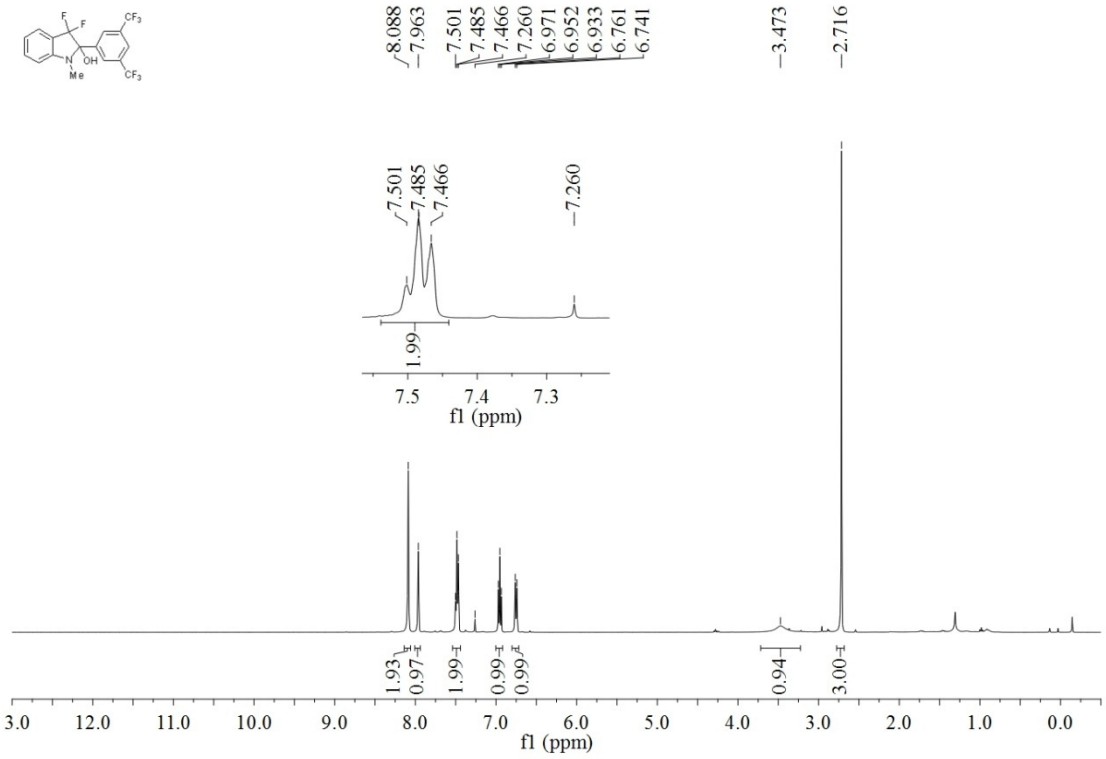

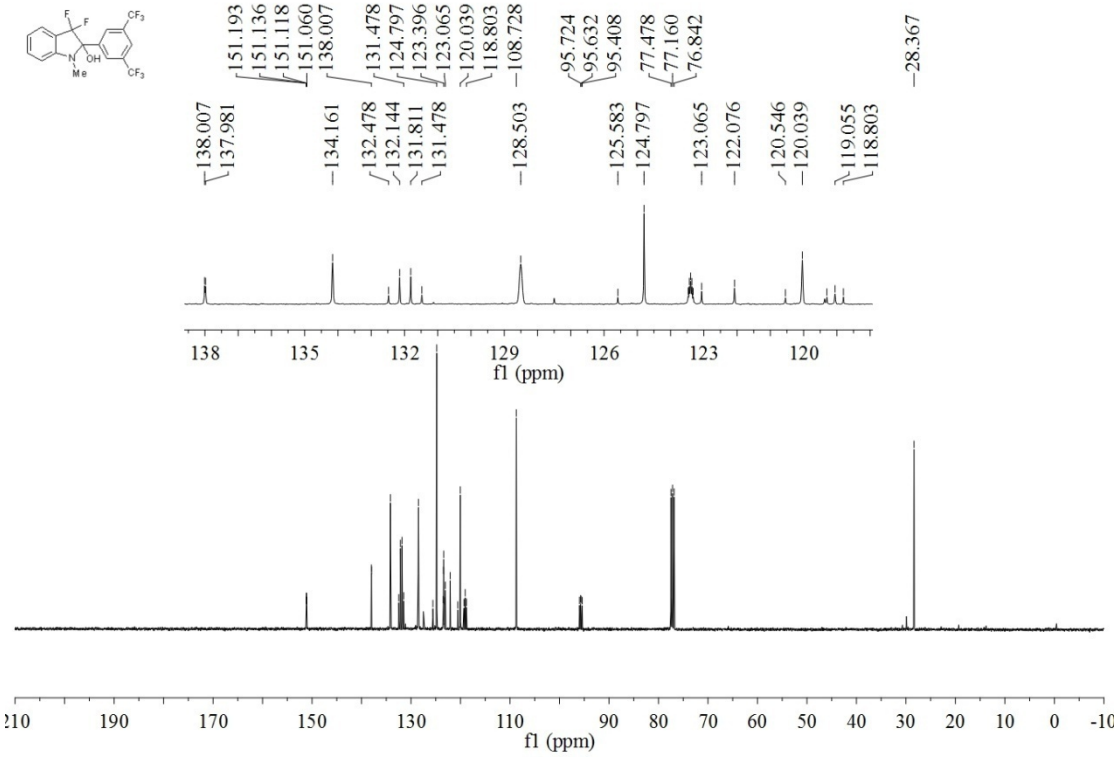
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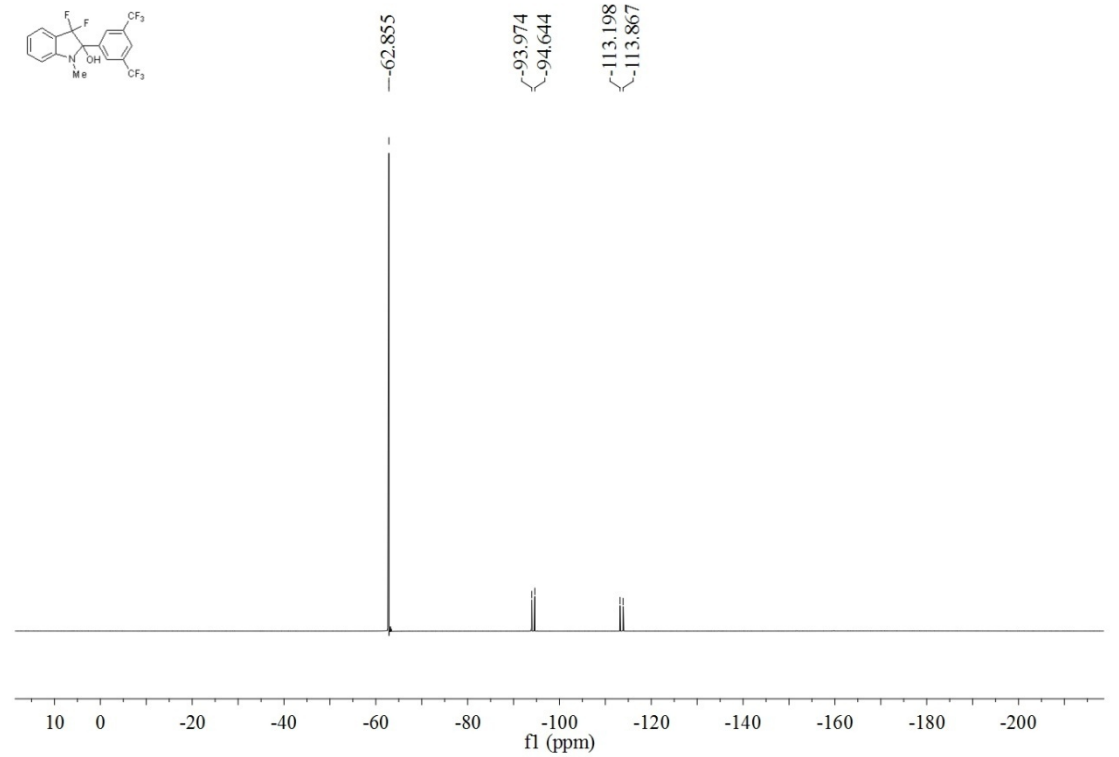
151.060
138.007
131.478
124.797
123.396
123.065
120.039
118.803
108.728
95.724
95.632
95.408
77.478
77.160
76.842
28.367
138.007
137.981
134.161
132.478
132.144
131.811
131.478
128.503
125.583
124.797
123.065
122.076
120.546
120.039
119.055
118.803
fl (ppm)
fl (ppm)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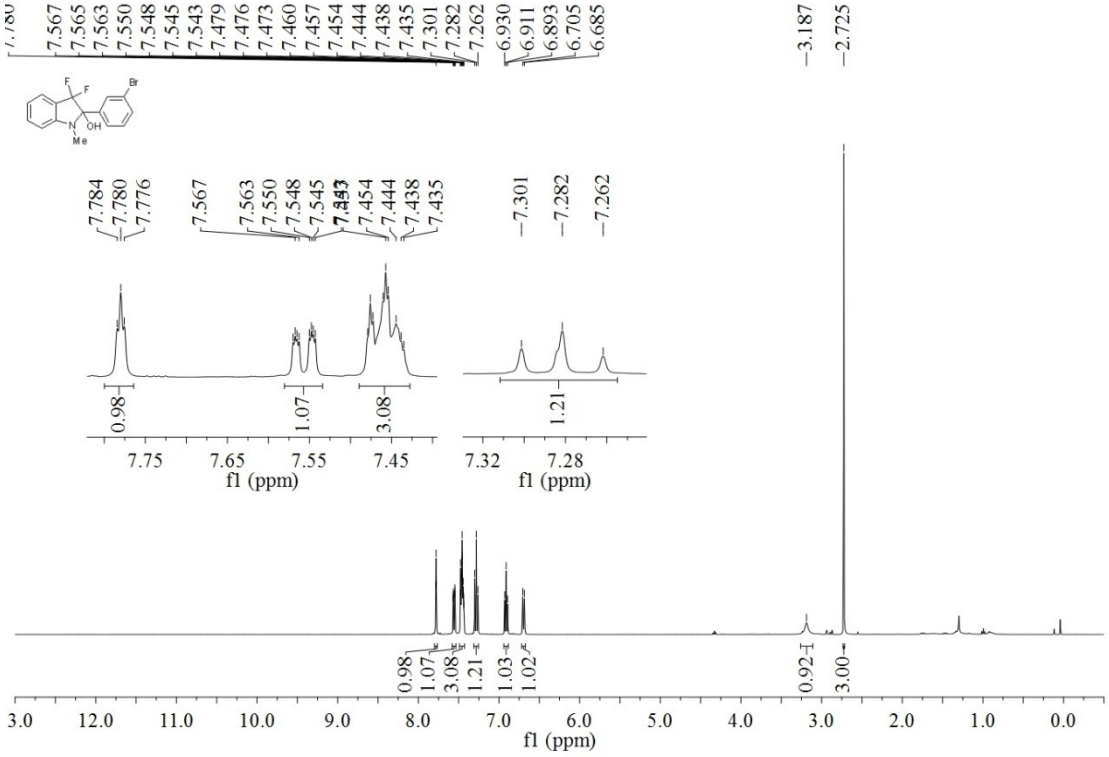
-93.974
-94.644
-113.198
-113.867
fl (ppm)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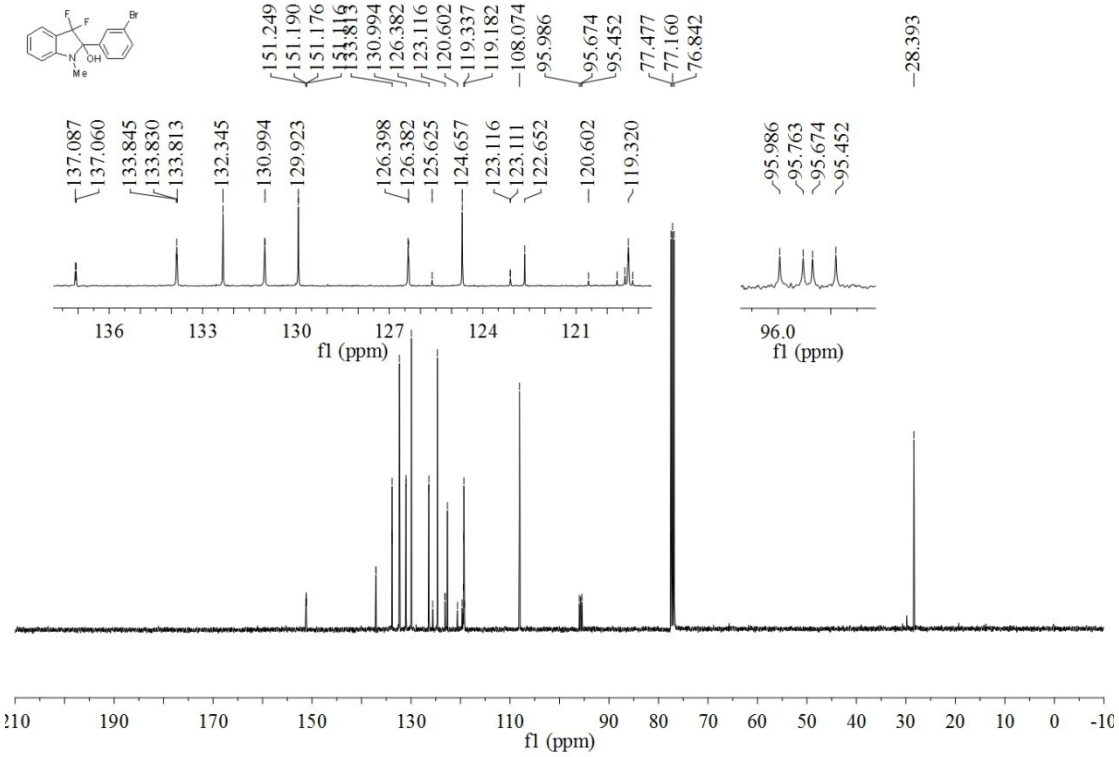
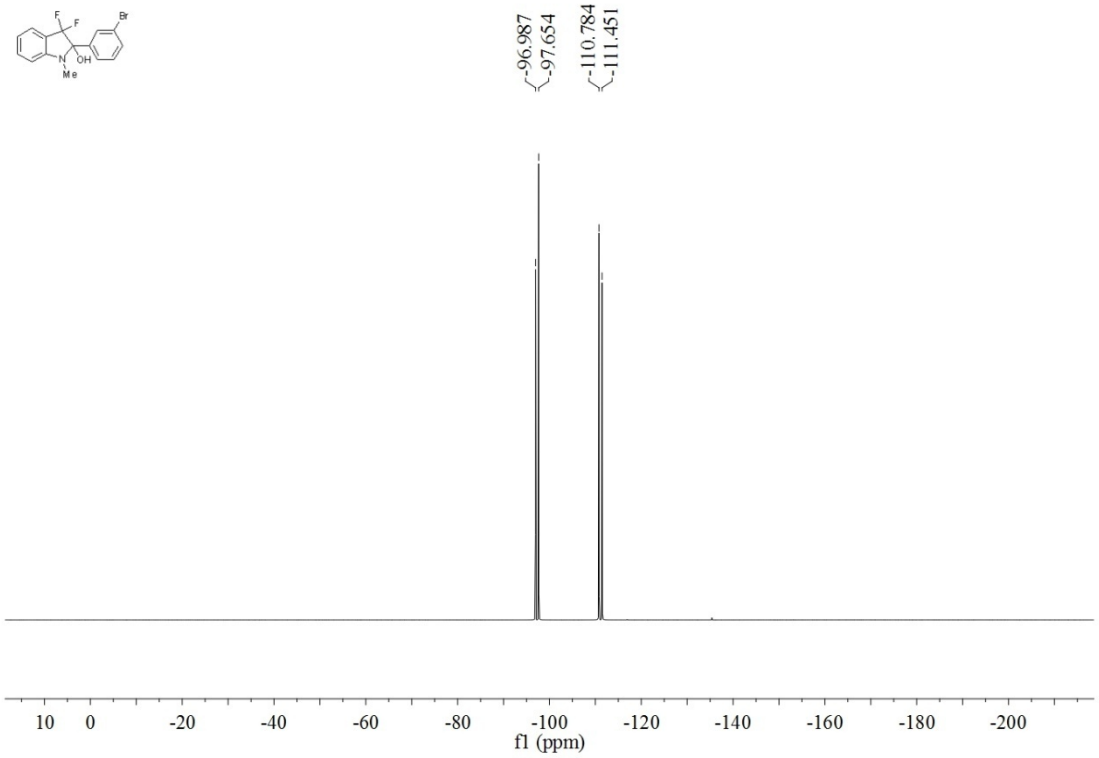
7.565
7.563
7.550
7.548
7.545
7.543
7.479
7.476
7.473
7.460
7.457
7.454
7.444
7.438
7.435
7.301
7.282
7.262
6.930
6.911
6.893
6.705
6.685
3.187
2.725
F
F
Br
N
OH
Me
7.784
7.780
7.776
7.567
7.563
7.550
7.548
7.545
7.454
7.444
7.438
7.435
7.301
7.282
7.262
0.98
1.07
3.08
1.21
7.75
7.65
7.55
7.45
7.32
7.28
f1 (ppm)
0.98
1.07
3.08
1.21
1.03
1.02
0.92
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


F
F
Br
N
OH
Me
151.249
151.190
151.176
130.994
126.382
123.116
120.602
119.337
119.182
108.074
95.986
95.674
95.452
77.477
77.160
76.842
28.393
137.087
137.060
133.845
133.830
133.813
132.345
130.994
129.923
126.398
126.382
125.625
124.657
123.116
123.111
122.652
120.602
119.320
95.986
95.763
95.674
95.452
136
133
130
127
124
121
f1 (ppm)
96.0
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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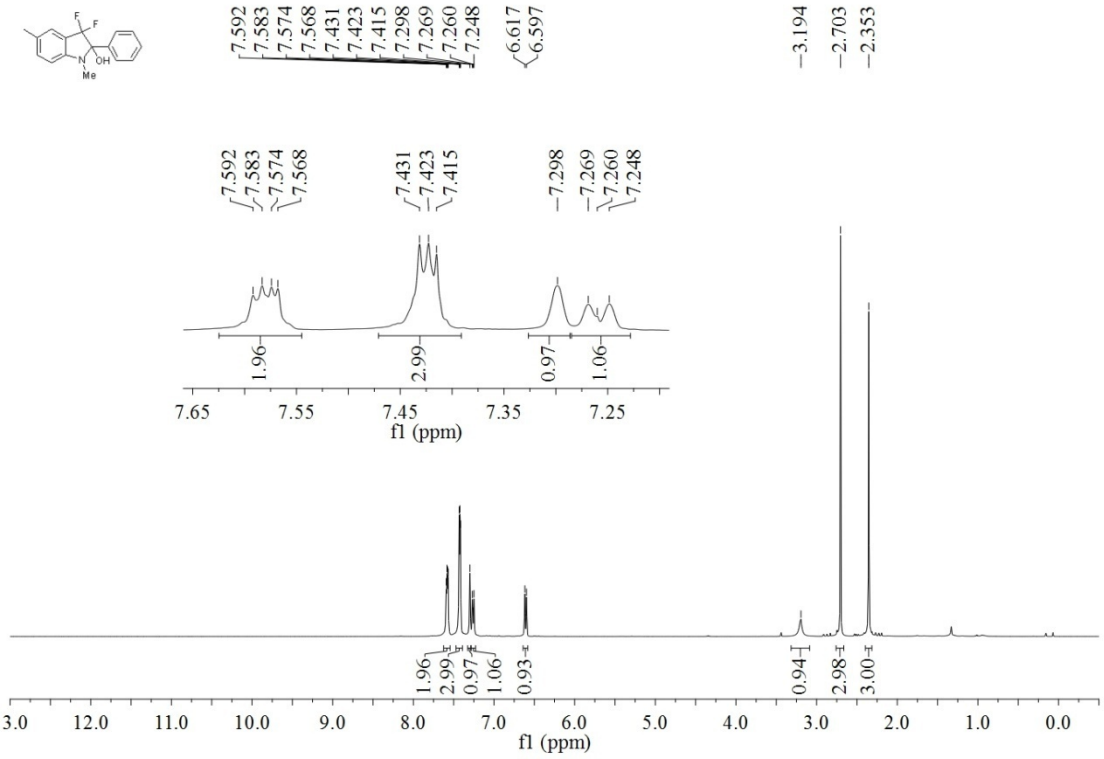
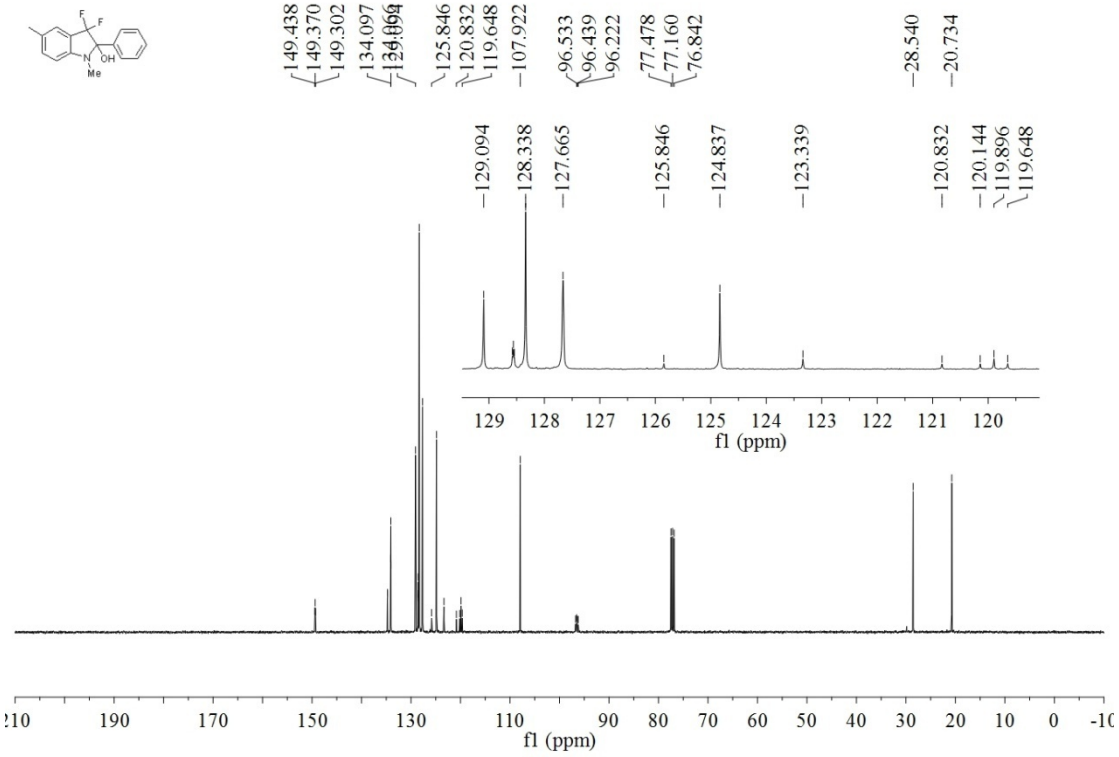
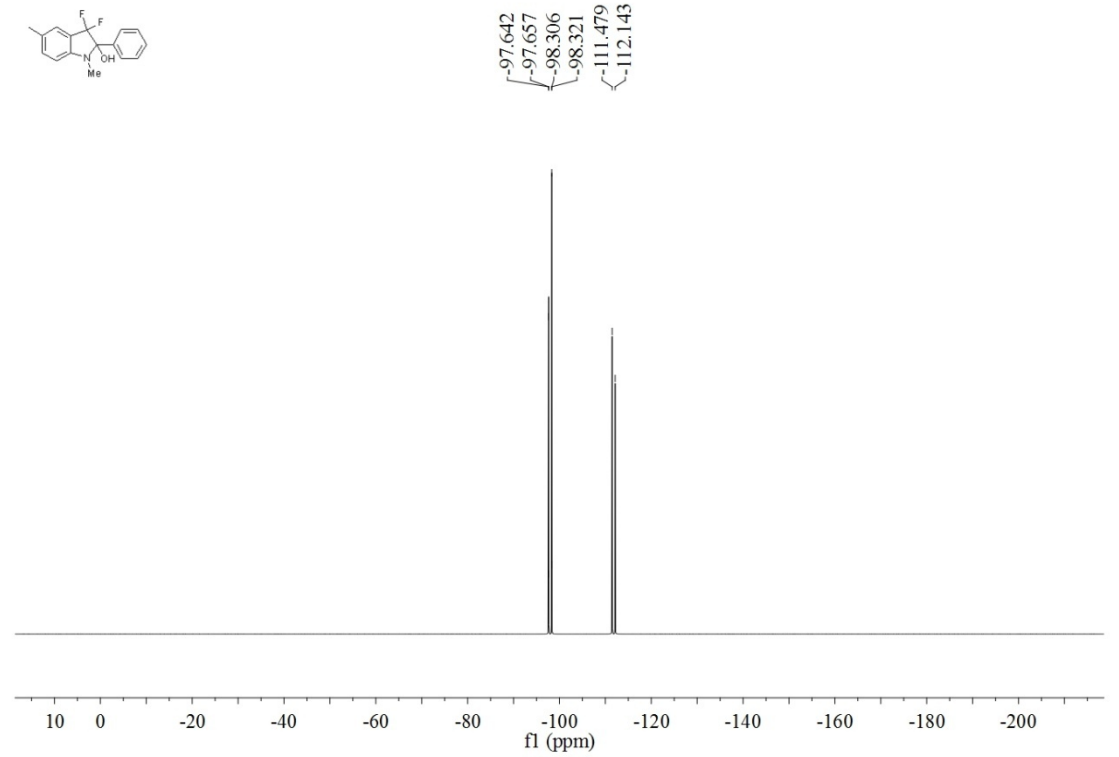
-97.654
-110.784
-111.451
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)


7.592
7.583
7.574
7.568
7.431
7.423
7.415
7.298
7.269
7.260
7.248
6.617
6.597
3.194
2.703
2.353
1.96
2.99
0.97
1.06
7.65 7.55 7.45 7.35 7.25
f1 (ppm)
0.93
0.94
2.98
3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)


149.438
149.370
149.302
134.097
125.846
120.832
119.648
107.922
96.533
96.439
96.222
77.478
77.160
76.842
28.540
20.734
129.094
128.338
127.665
125.846
124.837
123.339
120.832
120.144
119.896
119.648
129 128 127 126 125 124 123 122 121 120
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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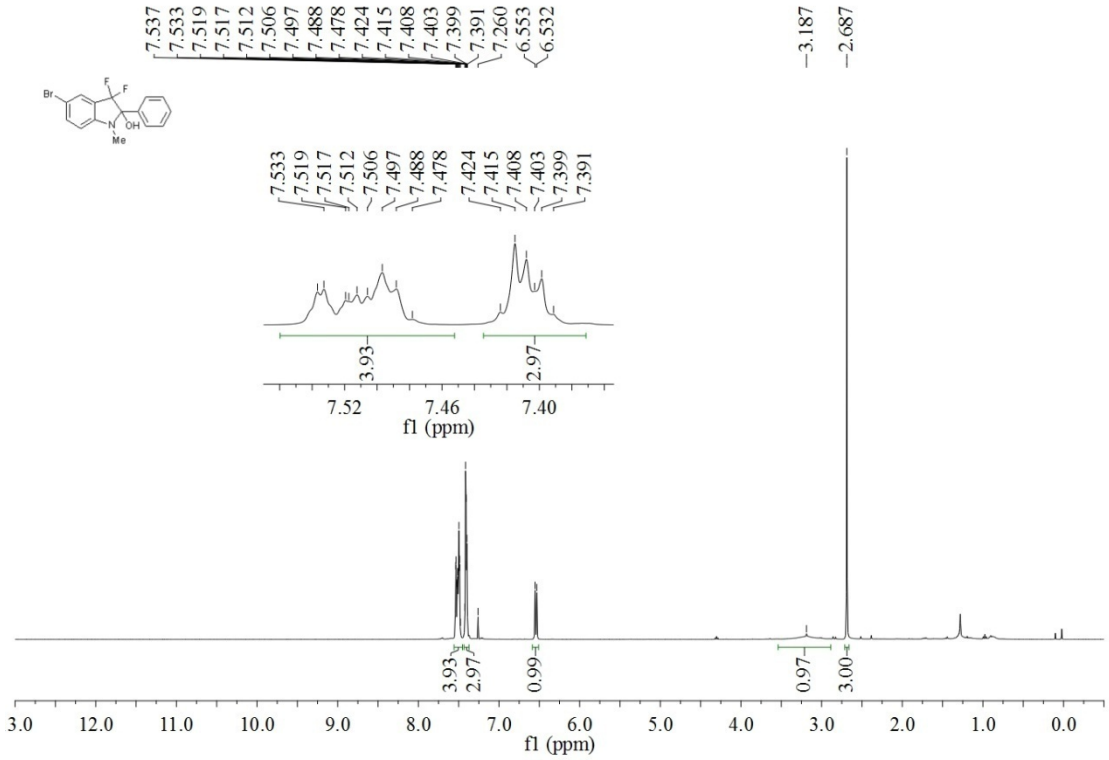
-97.657
-98.306
-98.321
-111.479
-112.143
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)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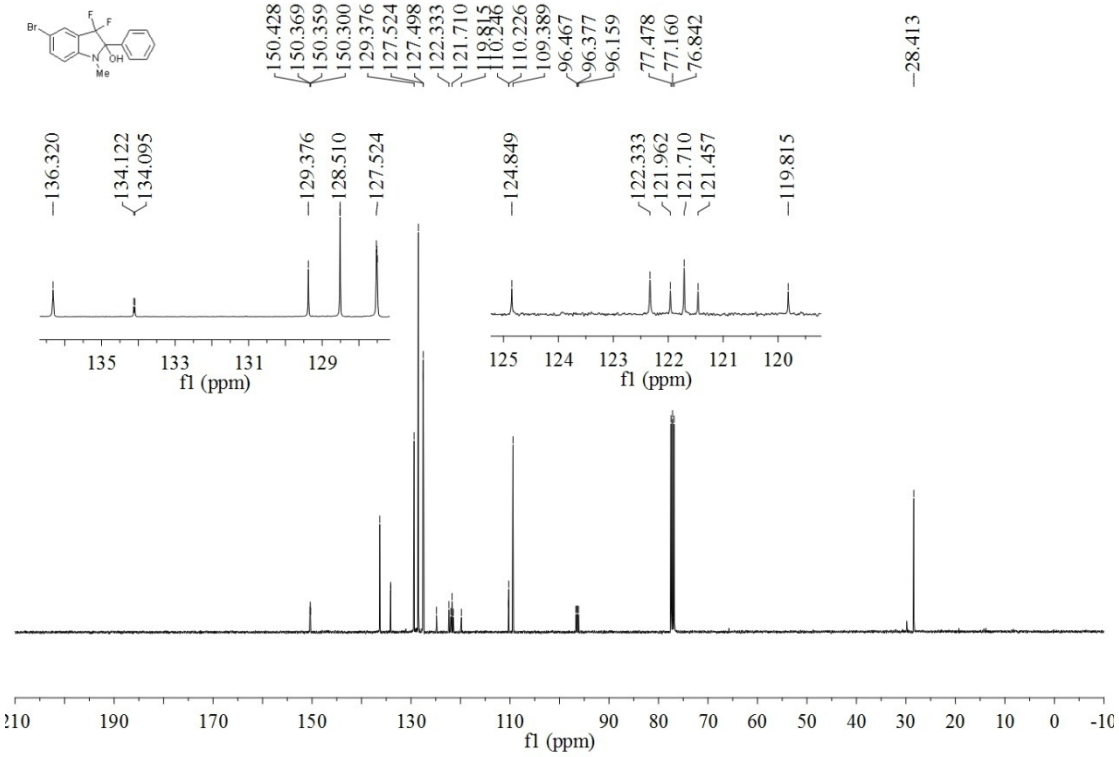
7.512
7.506
7.497
7.488
7.478
7.424
7.415
7.408
7.403
7.399
7.391
7.260
6.553
6.532
3.187
2.687
3.93
2.97
7.52
7.46
7.40
f1 (ppm)
0.99
0.97
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


150.428
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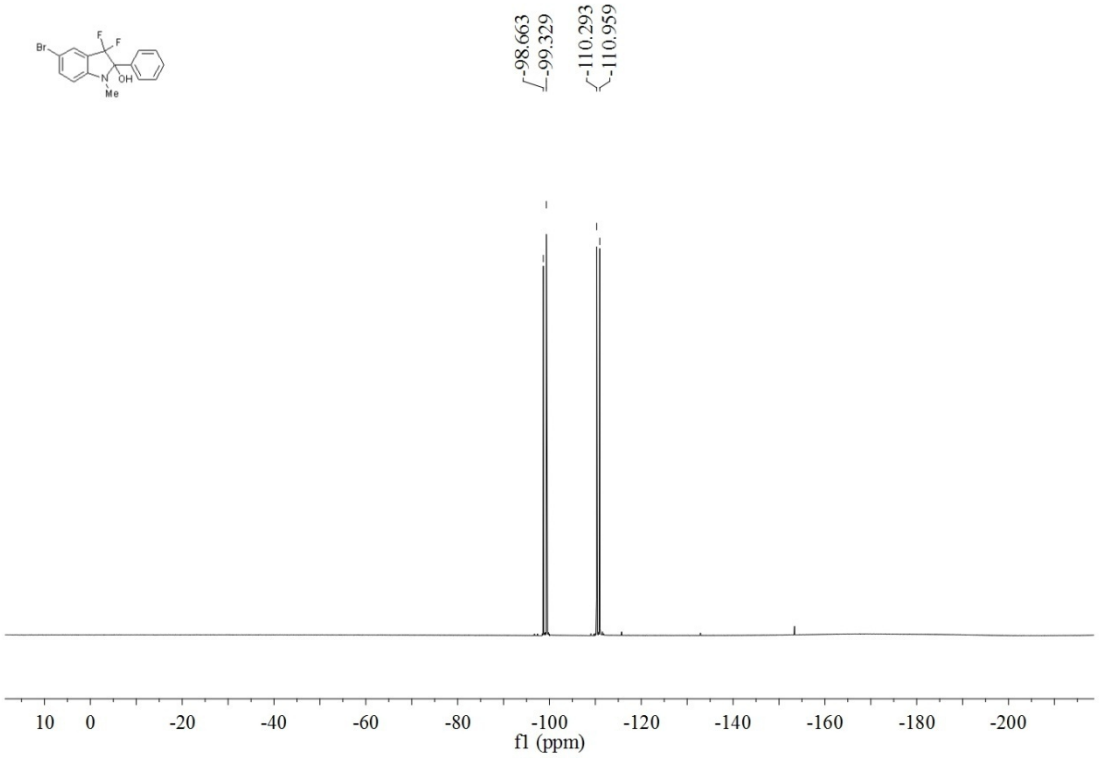
122.333
121.710
119.815
110.246
110.226
109.389
96.467
96.377
96.159
77.478
77.160
76.842
28.413
136.320
134.122
134.095
129.376
128.510
127.524
124.849
122.333
121.962
121.710
121.457
119.815
135
133
131
129
f1 (ppm)
125
124
123
122
121
120
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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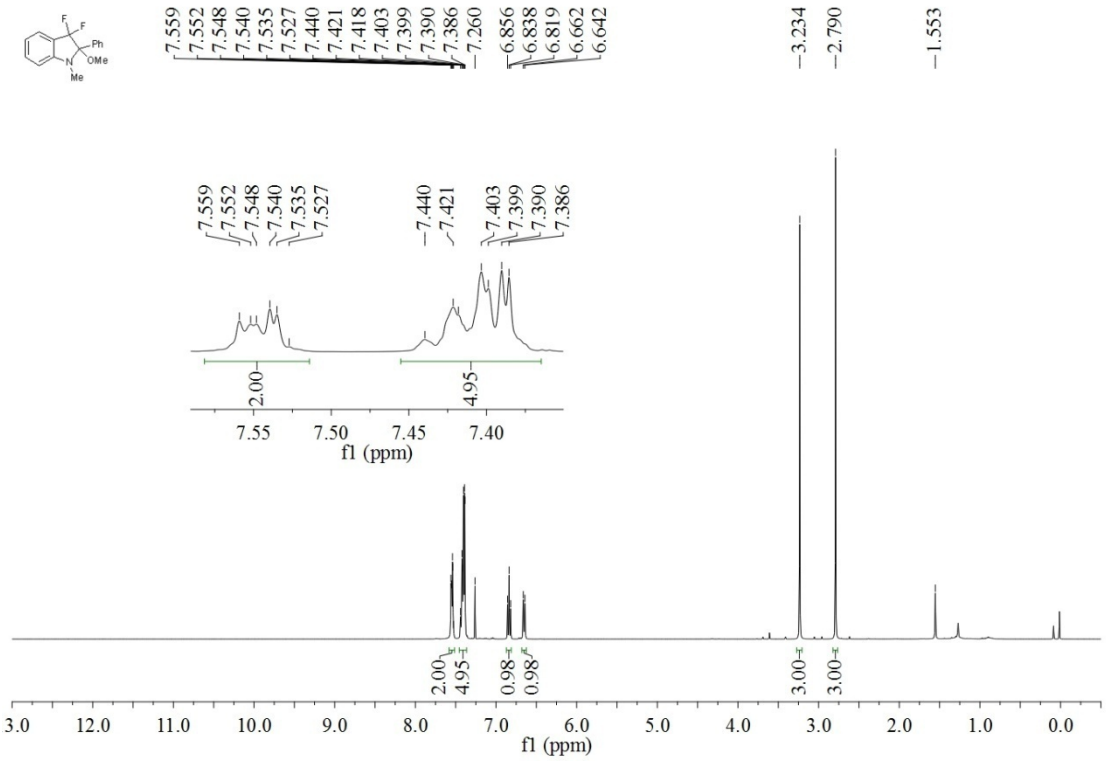
-99.329
-110.293
-110.959
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)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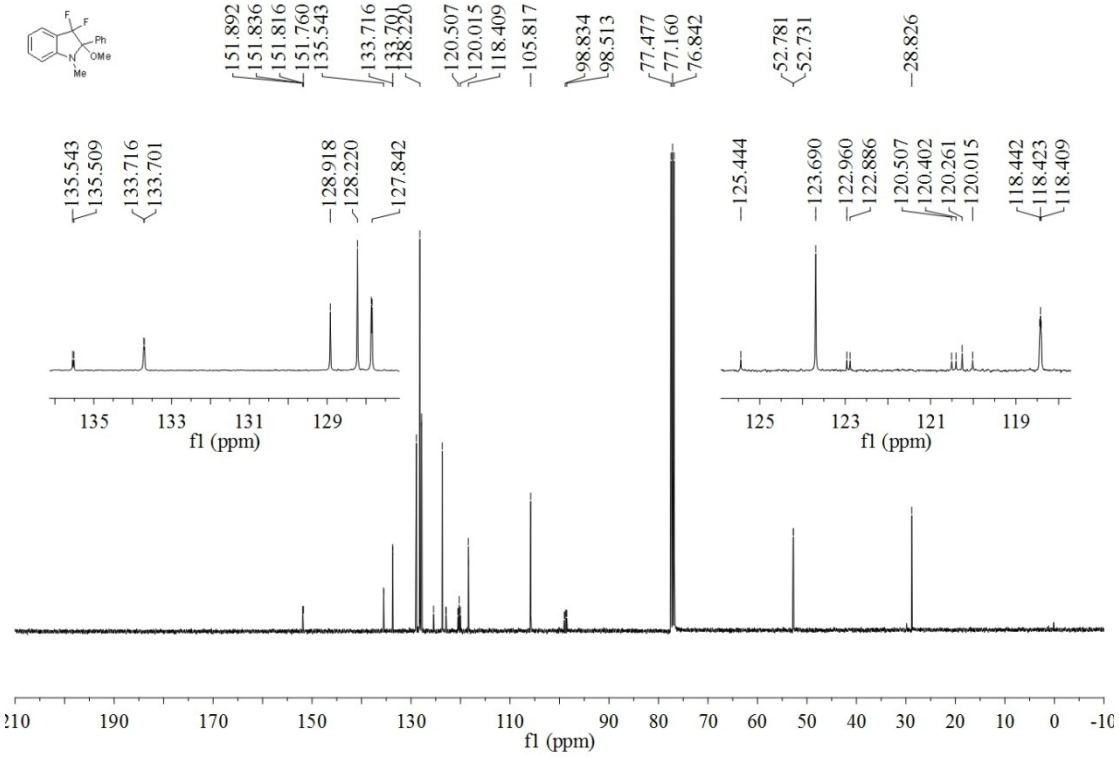
7.552
7.548
7.540
7.535
7.527
7.440
7.421
7.418
7.403
7.399
7.390
7.386
7.260
6.856
6.838
6.819
6.662
6.642
3.234
2.790
1.553
2.00
4.95
7.55 7.50 7.45 7.40
f1 (ppm)
2.00
4.95
0.98
0.98
3.00
3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)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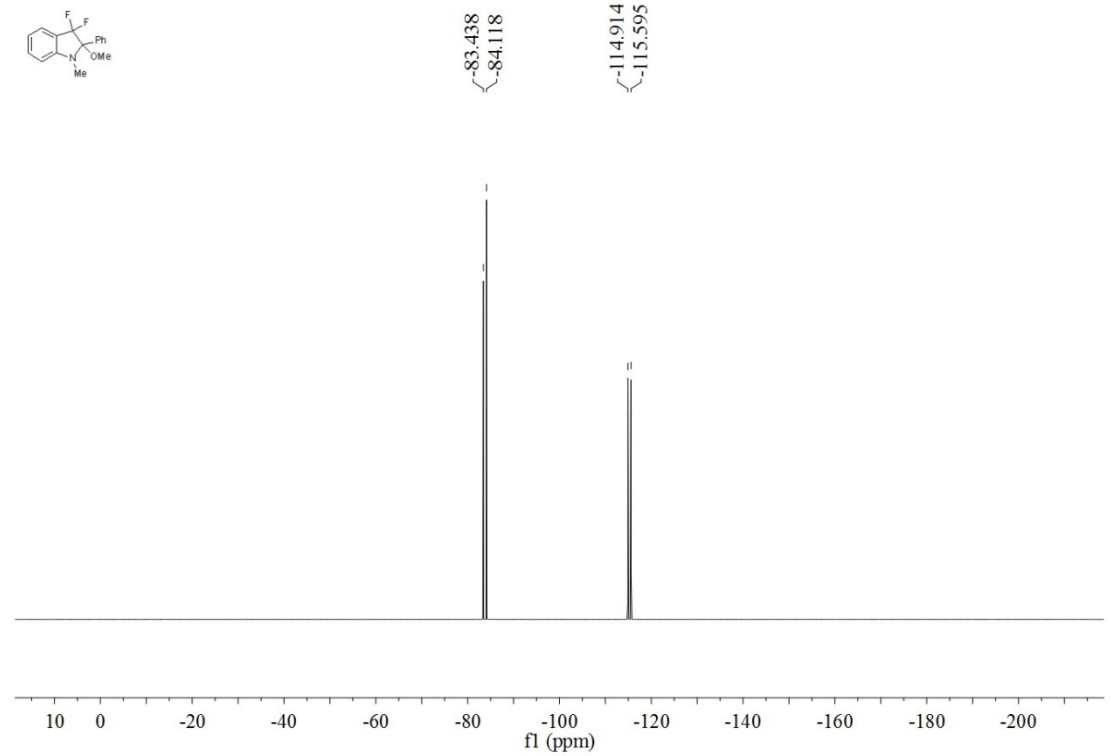
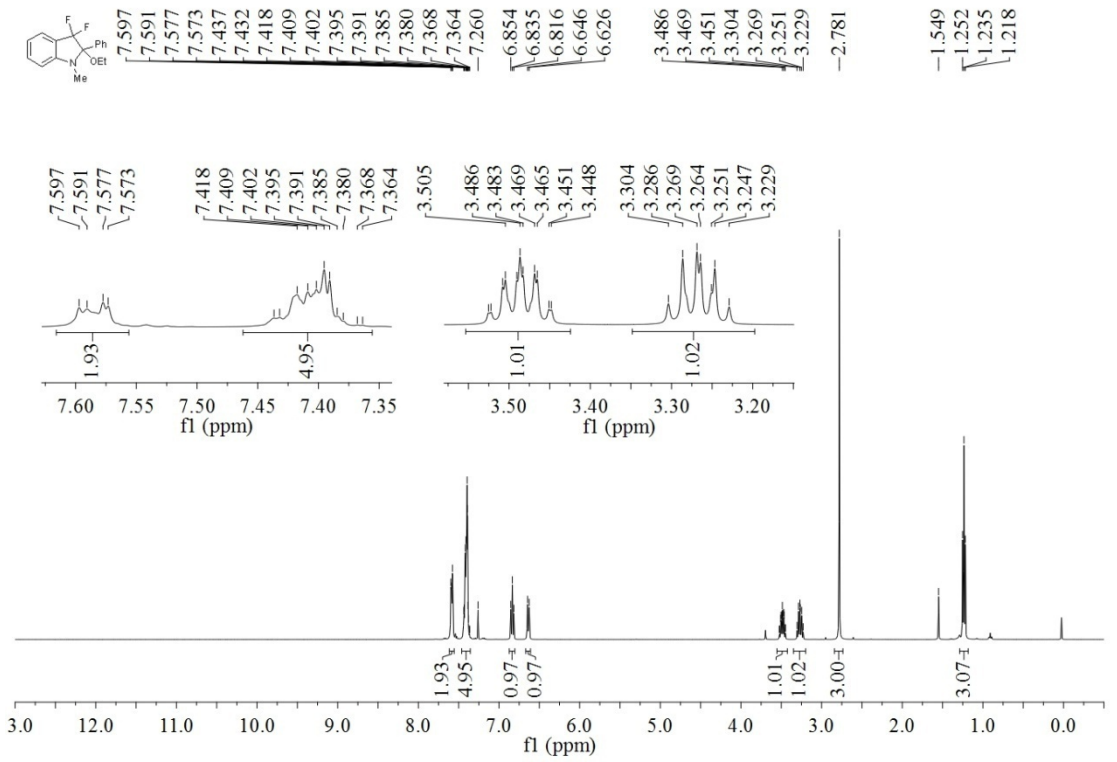
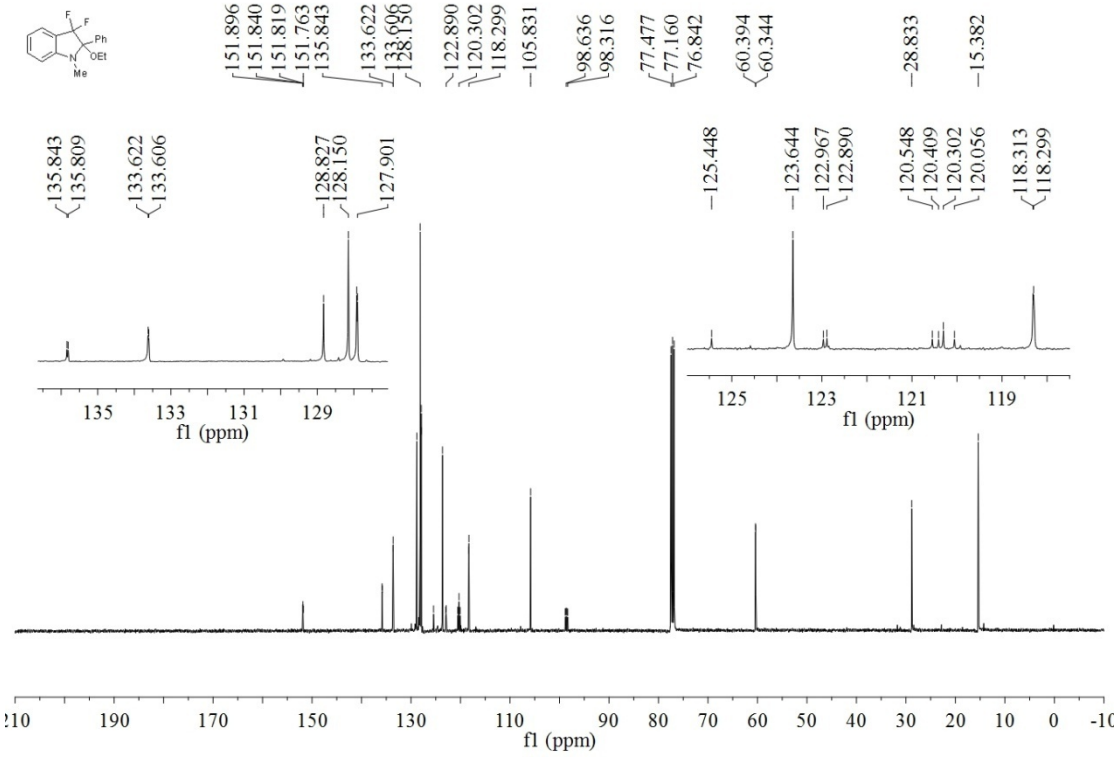
133.701
128.918
128.220
127.842
120.507
120.015
118.409
105.817
98.834
98.513
77.477
77.160
76.842
52.781
52.731
28.826
125.444
123.690
122.960
122.886
120.507
120.402
120.261
120.015
118.442
118.423
118.409
f1 (ppm)


83.438
84.118
114.914
115.595
f1 (ppm)


7.597
7.591
7.577
7.573
7.437
7.432
7.418
7.409
7.402
7.395
7.391
7.385
7.380
7.368
7.364
7.260
6.854
6.835
6.816
6.646
6.626
3.486
3.469
3.451
3.304
3.269
3.251
3.229
2.781
1.549
1.252
1.235
1.218
1.93
4.95
1.01
1.02
fl (ppm)
0.97
0.97
3.00
3.07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151.819
151.763
135.843
133.622
133.606
128.150
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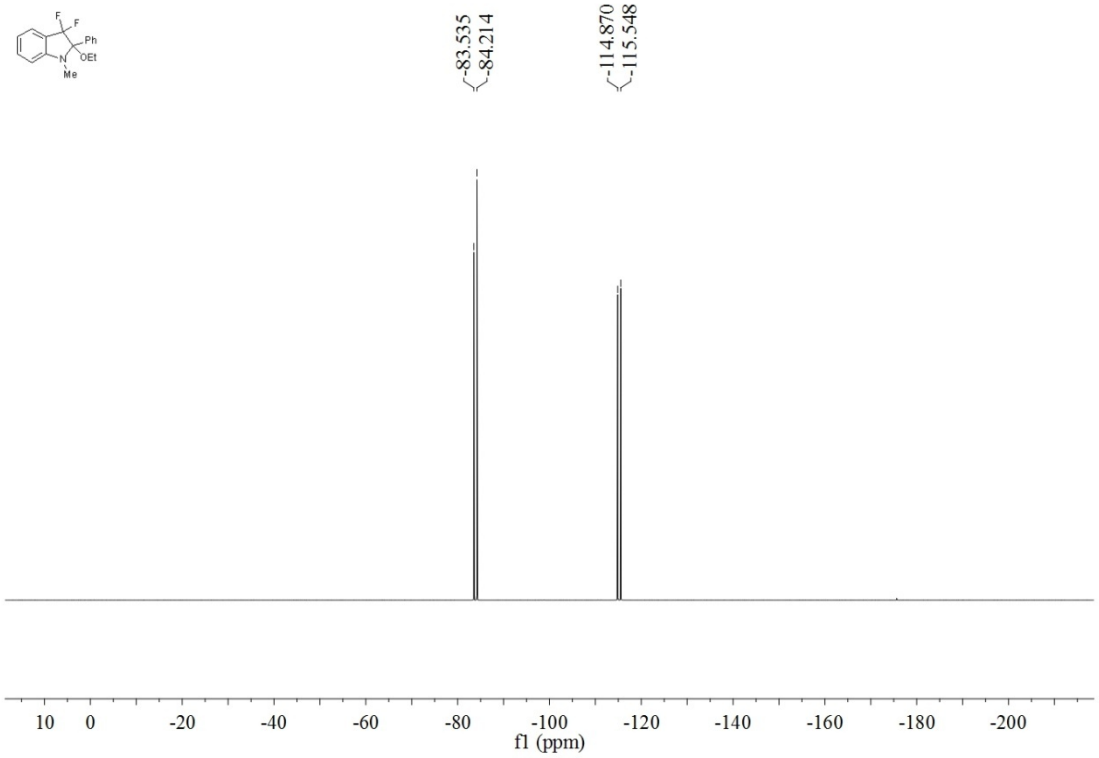
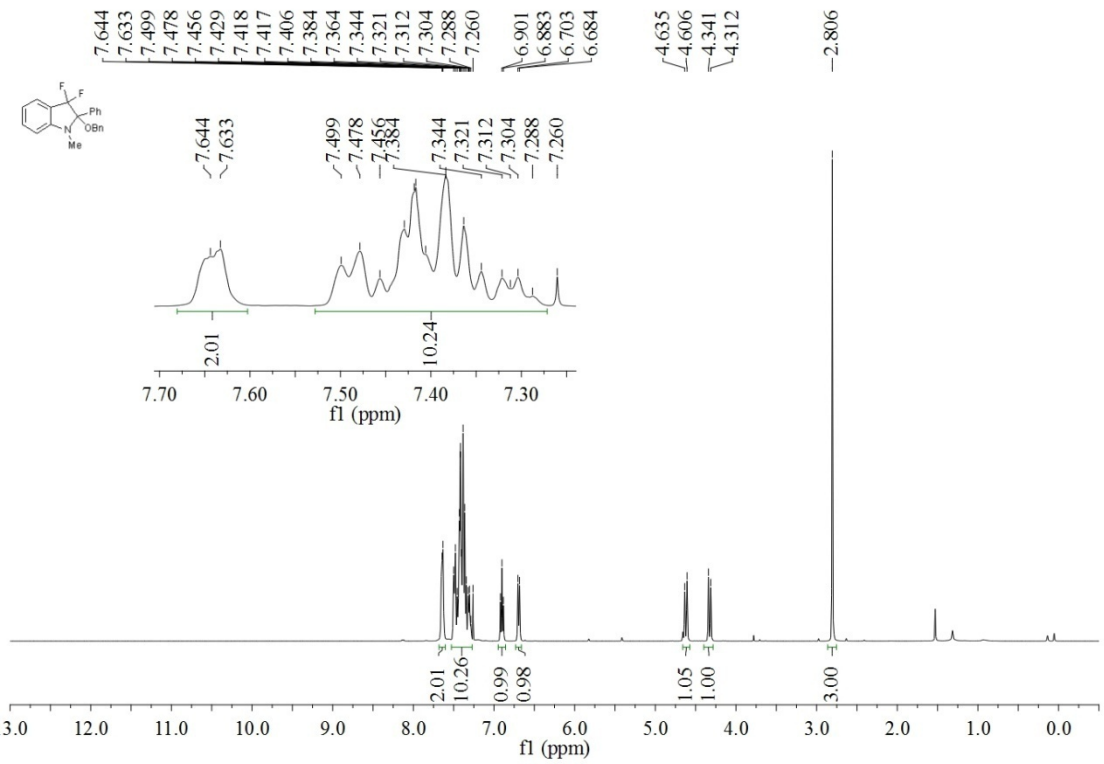
120.302
118.299
105.831
98.636
98.316
77.477
77.160
76.842
60.394
60.344
28.833
15.382
135.843
135.809
133.622
133.606
128.827
128.150
127.901
125.448
123.644
122.967
122.890
120.548
120.409
120.302
120.056
118.313
118.299
fl (ppm)


F
F
Ph
OEt
N
Me
-83.535
-84.214
-114.870
-115.548
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)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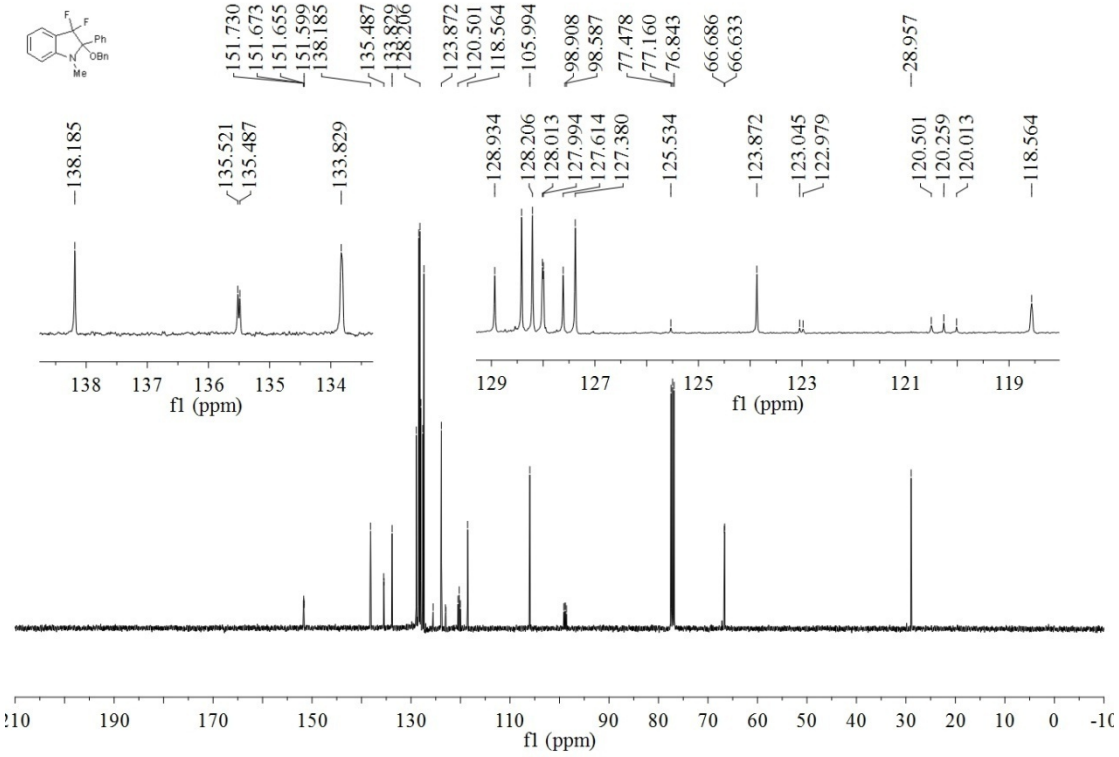
7.633
7.499
7.478
7.456
7.429
7.418
7.417
7.406
7.384
7.364
7.344
7.321
7.312
7.304
7.288
7.260
6.901
6.883
6.703
6.684
4.635
4.606
4.341
4.312
2.806
F
F
Ph
OBn
N
Me
2.01
10.24
7.70
7.60
7.50
7.40
7.30
f1 (ppm)
2.01
10.26
0.99
0.98
1.05
1.00
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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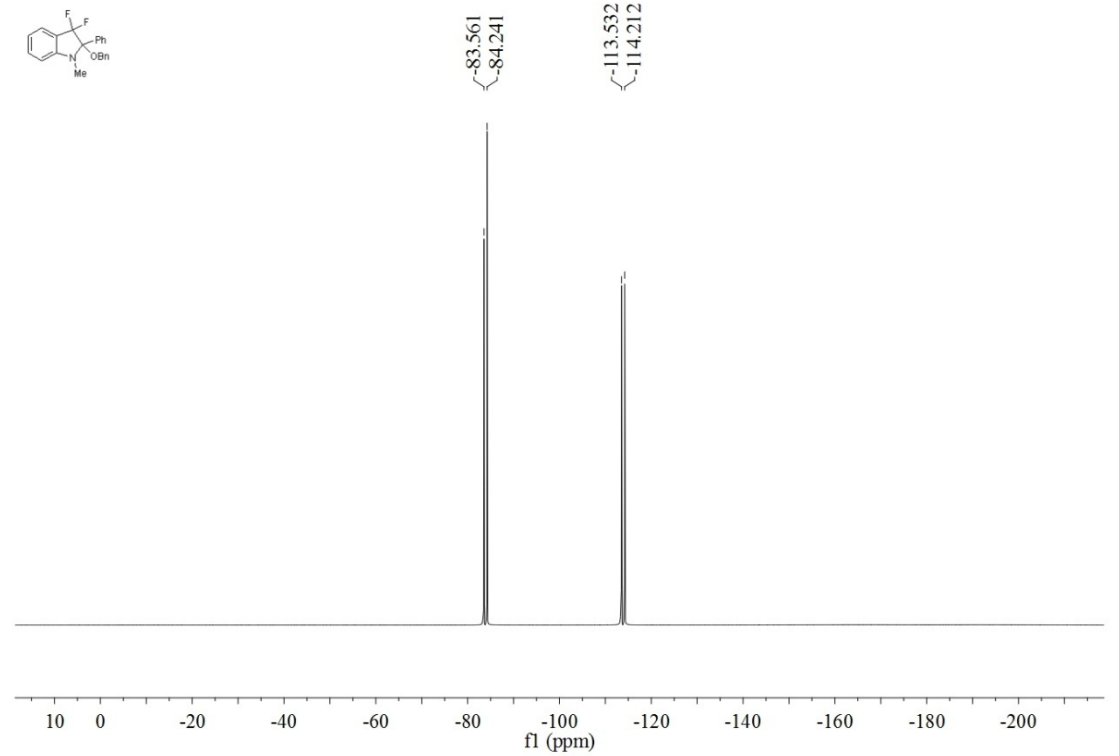
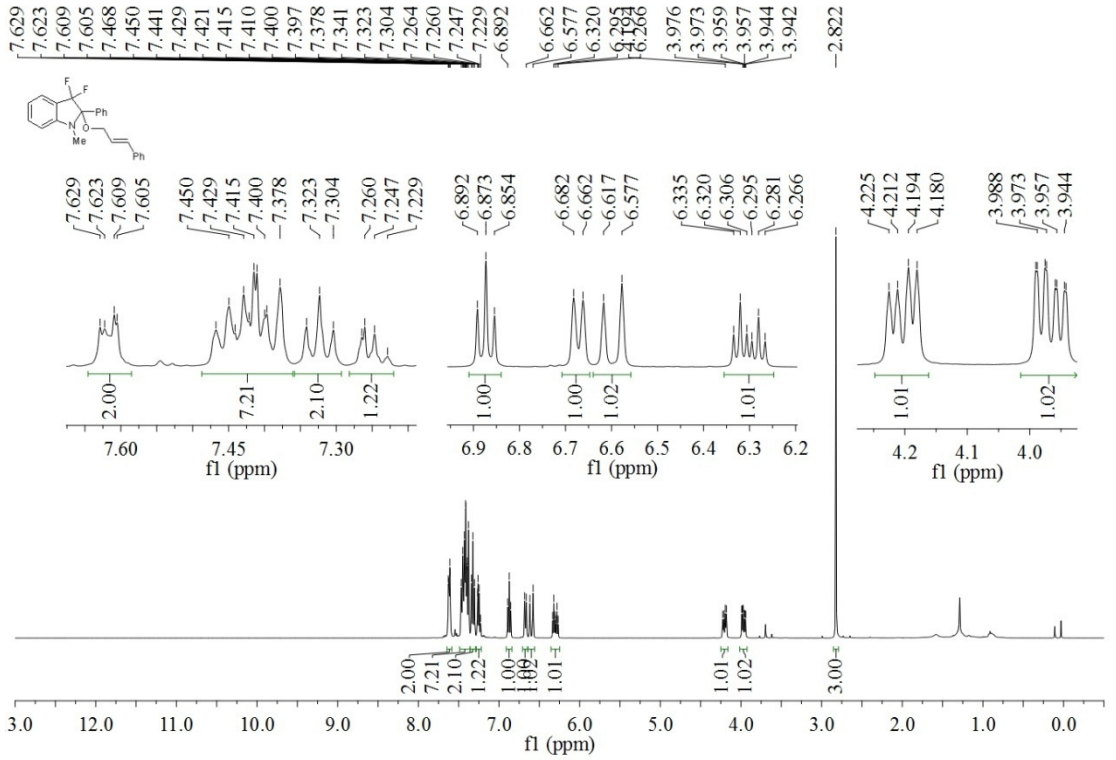
151.673
151.655
151.599
138.185
135.487
133.829
128.206
123.872
120.501
118.564
105.994
98.908
98.587
77.478
77.160
76.843
66.686
66.633
28.957
138.185
135.521
135.487
133.829
128.934
128.206
128.013
127.994
127.614
127.380
125.534
123.872
123.045
122.979
120.501
120.259
120.013
118.564
f1 (ppm)
f1 (ppm)
f1 (ppm)


-83.561
-84.241
-113.532
-114.212
f1 (ppm)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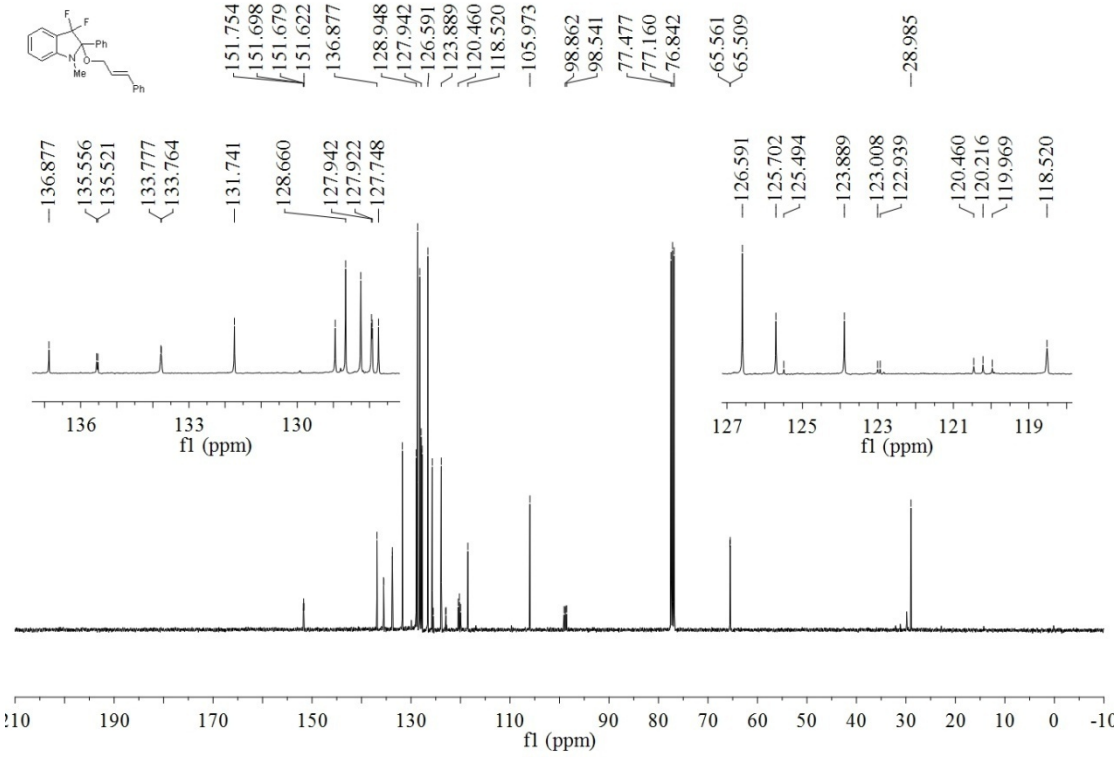
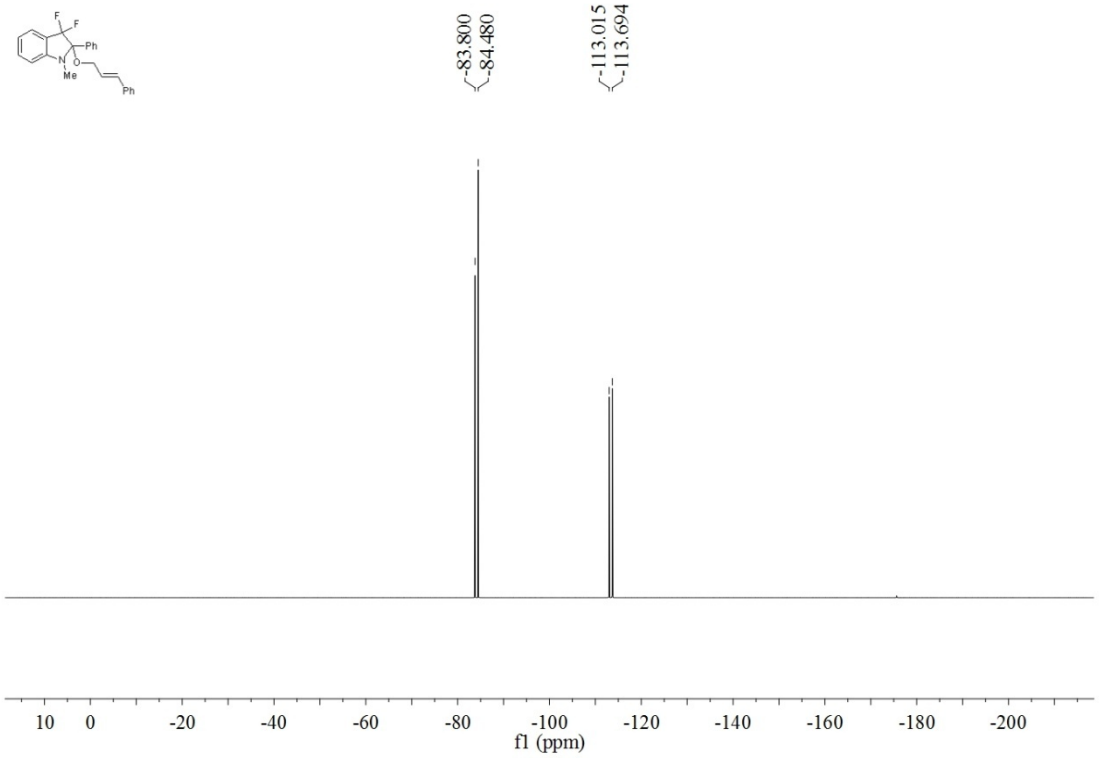
7.623
7.609
7.605
7.468
7.450
7.441
7.429
7.421
7.415
7.410
7.400
7.397
7.378
7.341
7.323
7.304
7.264
7.260
7.247
7.229
6.892
6.662
6.577
6.320
3.976
3.973
3.959
3.957
3.944
3.942
2.822
F
F
Ph
N
O
Me
Ph
6.892
6.873
6.854
6.682
6.662
6.617
6.577
6.335
6.320
6.306
6.295
6.281
6.266
4.225
4.212
4.194
4.180
3.988
3.973
3.957
3.944
2.00
7.21
2.10
1.22
1.00
1.00
1.02
1.01
1.01
1.02
7.60
7.45
7.30
fl (ppm)
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
fl (ppm)
4.2
4.1
4.0
fl (ppm)
2.00
7.21
2.10
1.22
1.00
1.00
1.02
1.01
1.01
1.02
3.00
3.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
fl (ppm)


F
F
Ph
N
O
Me
Ph
151.754
151.698
151.679
151.622
136.877
128.948
127.942
126.591
123.889
120.460
118.520
105.973
98.862
98.541
77.477
77.160
76.842
65.561
65.509
28.985
136.877
135.556
135.521
133.777
133.764
131.741
128.660
127.942
127.922
127.748
126.591
125.702
125.494
123.889
123.008
122.939
120.460
120.216
119.969
118.520
136
133
130
fl (ppm)
127
125
123
121
119
fl (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)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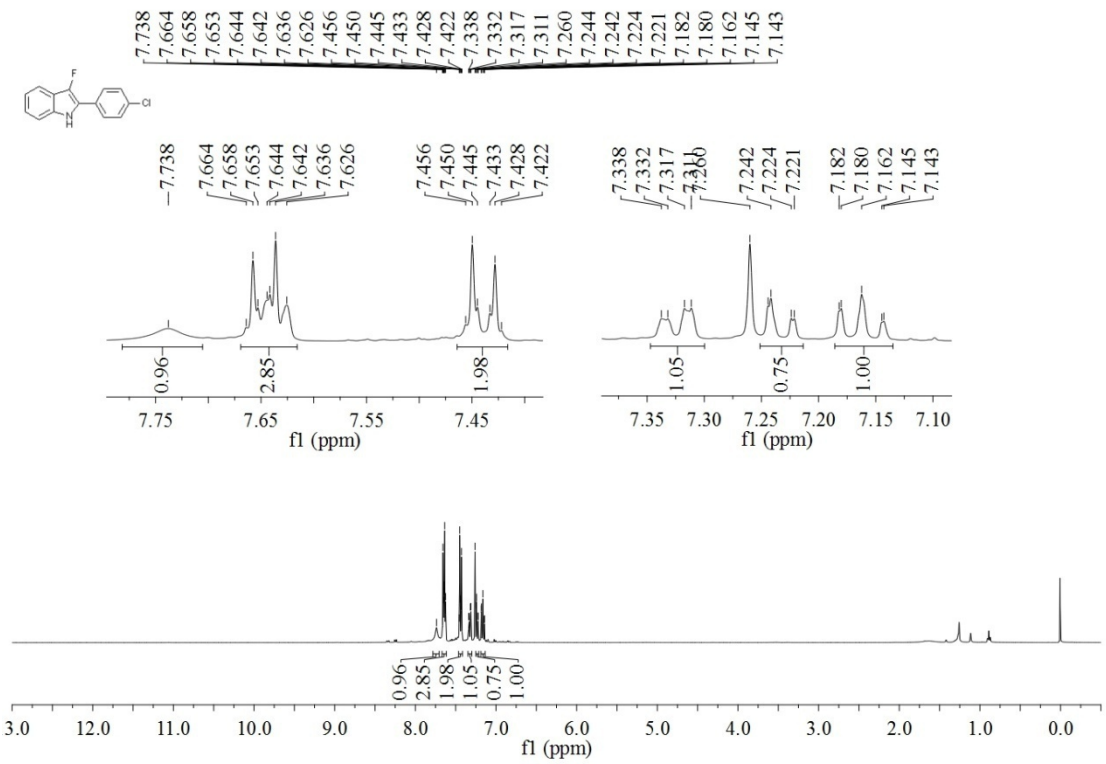
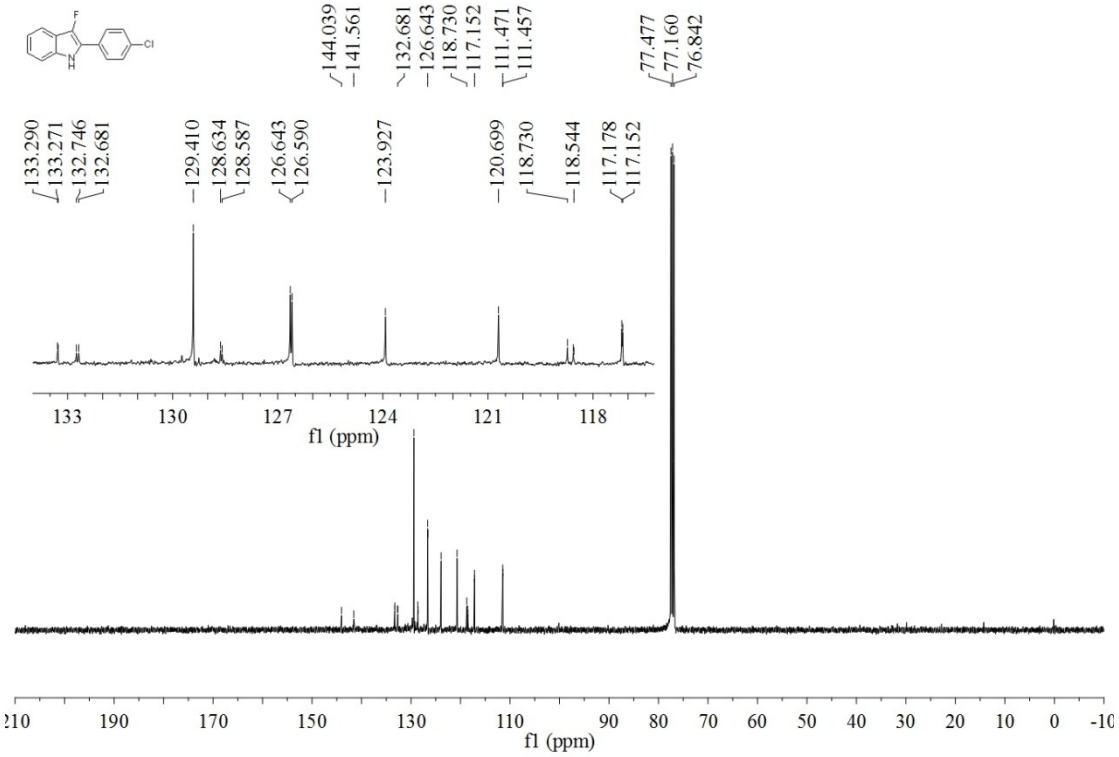
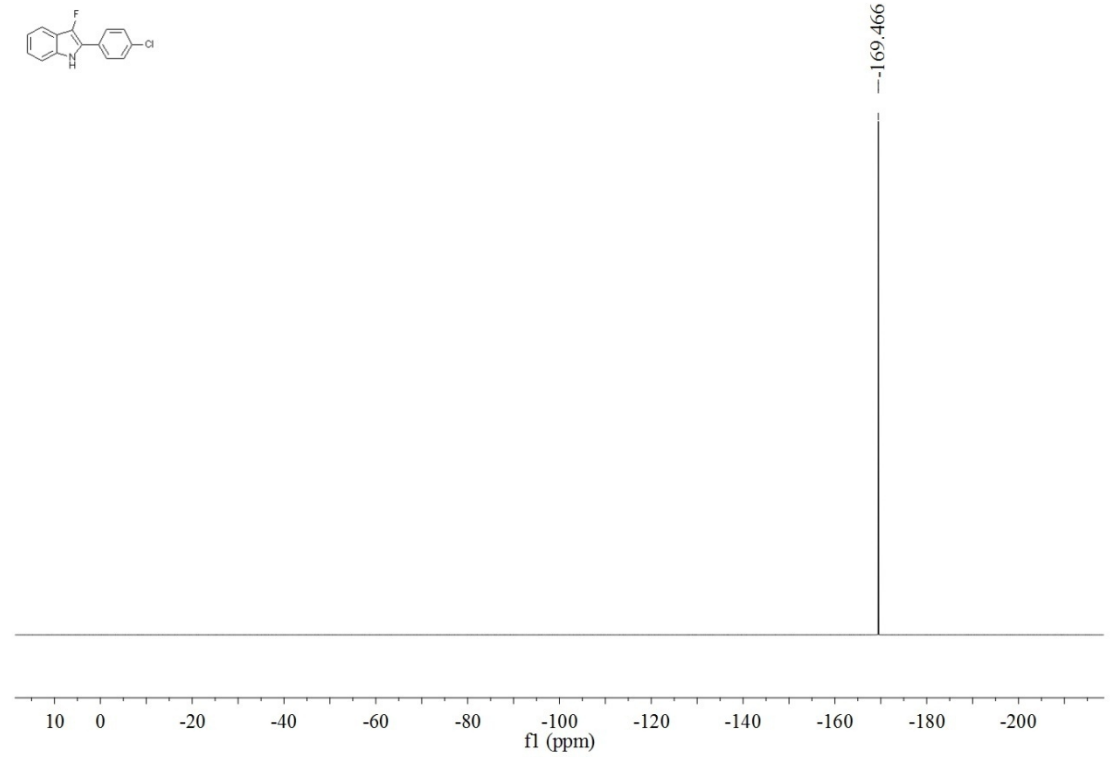
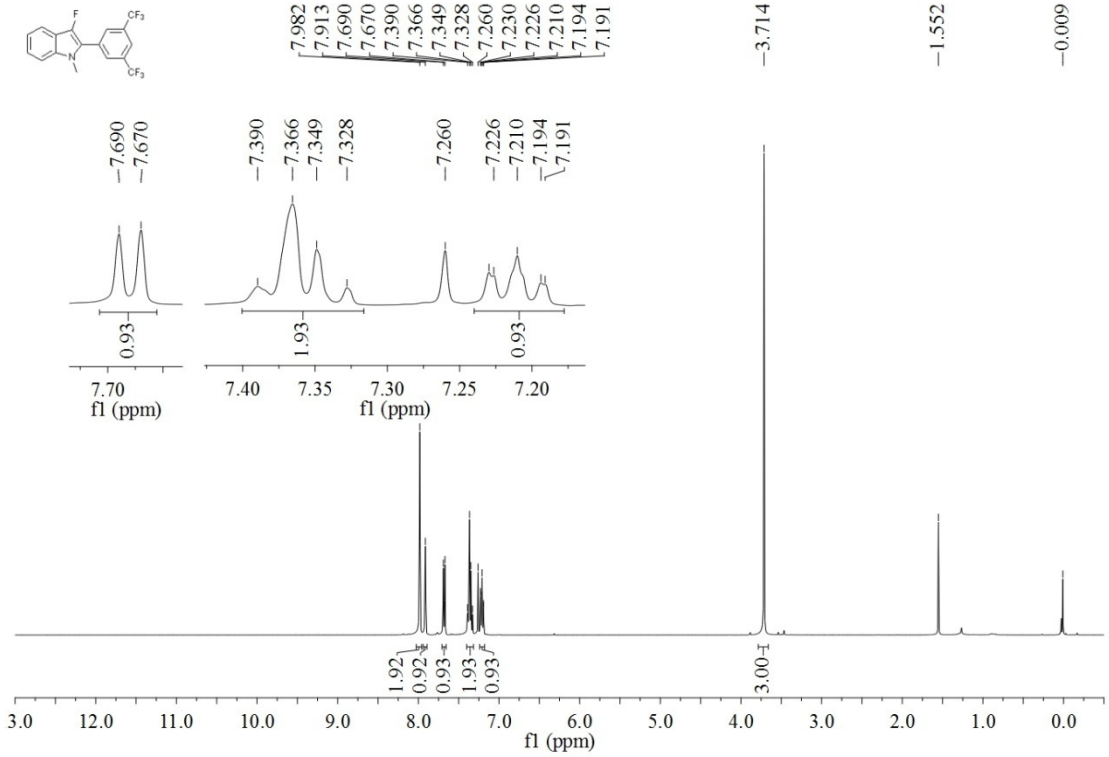
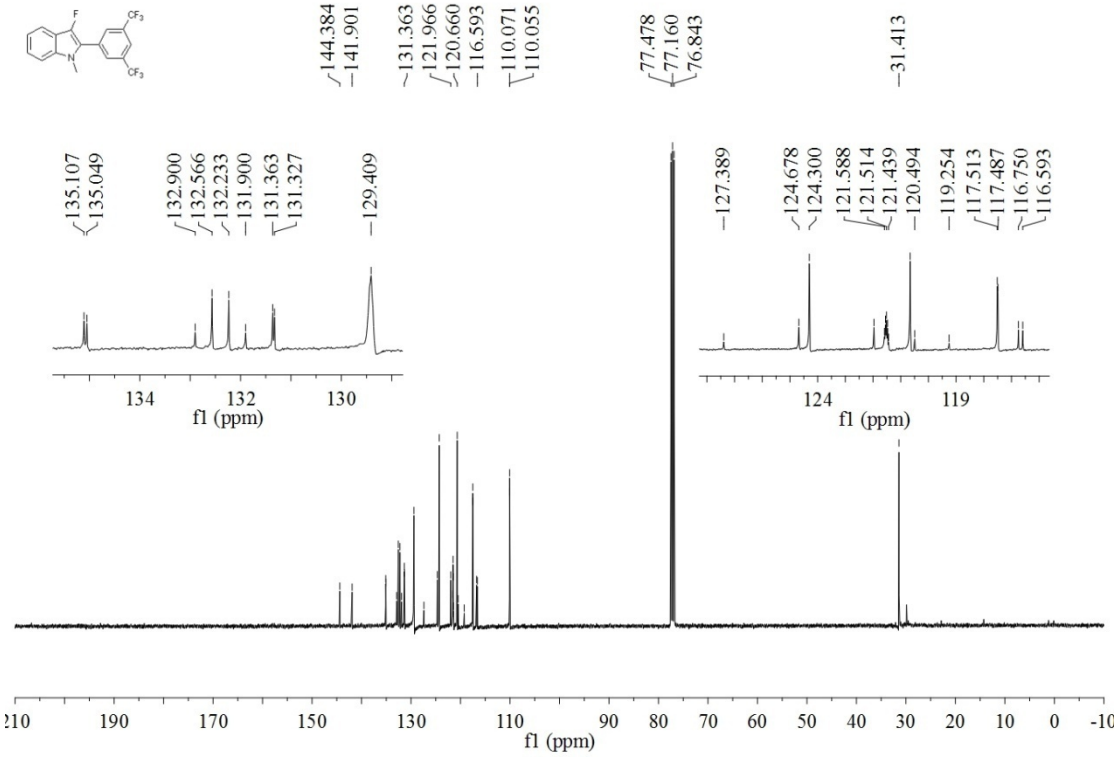
-84.480
-113.015
-113.694
f1 (ppm)

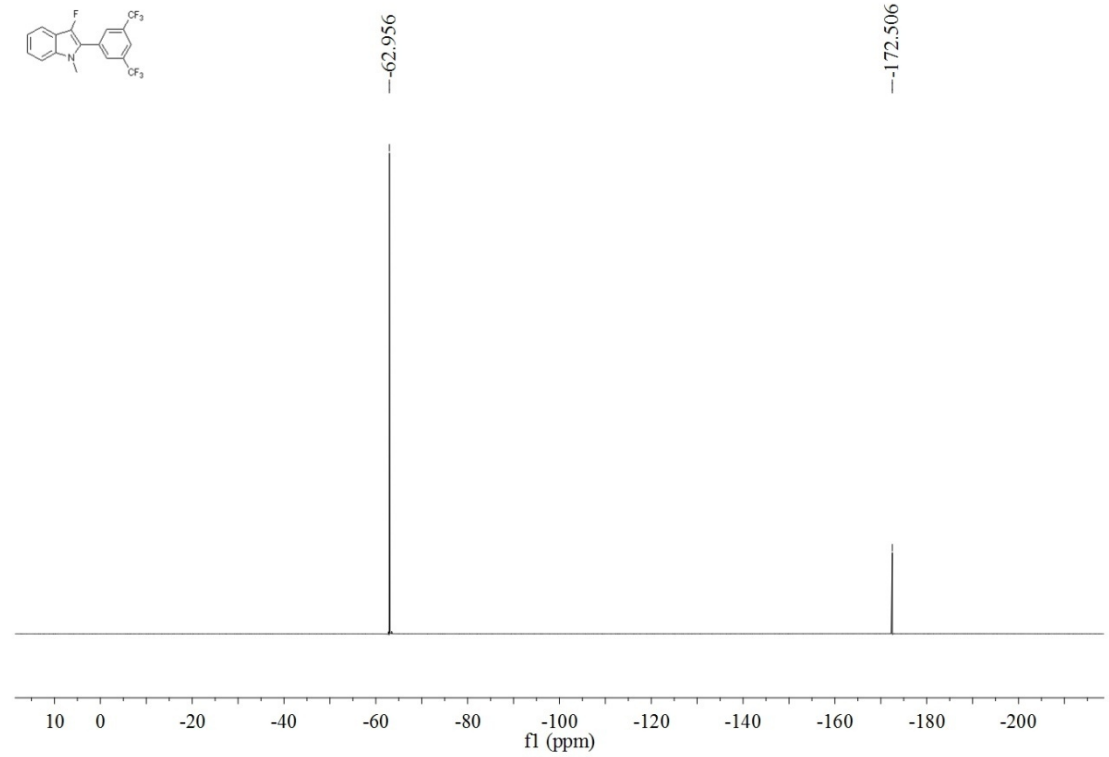

7.738
7.664
7.658
7.653
7.644
7.642
7.636
7.626
7.456
7.450
7.445
7.433
7.428
7.422
7.338
7.332
7.317
7.311
7.260
7.244
7.242
7.224
7.221
7.182
7.180
7.162
7.145
7.143
0.96
2.85
1.98
1.05
0.75
1.00
f1 (ppm)

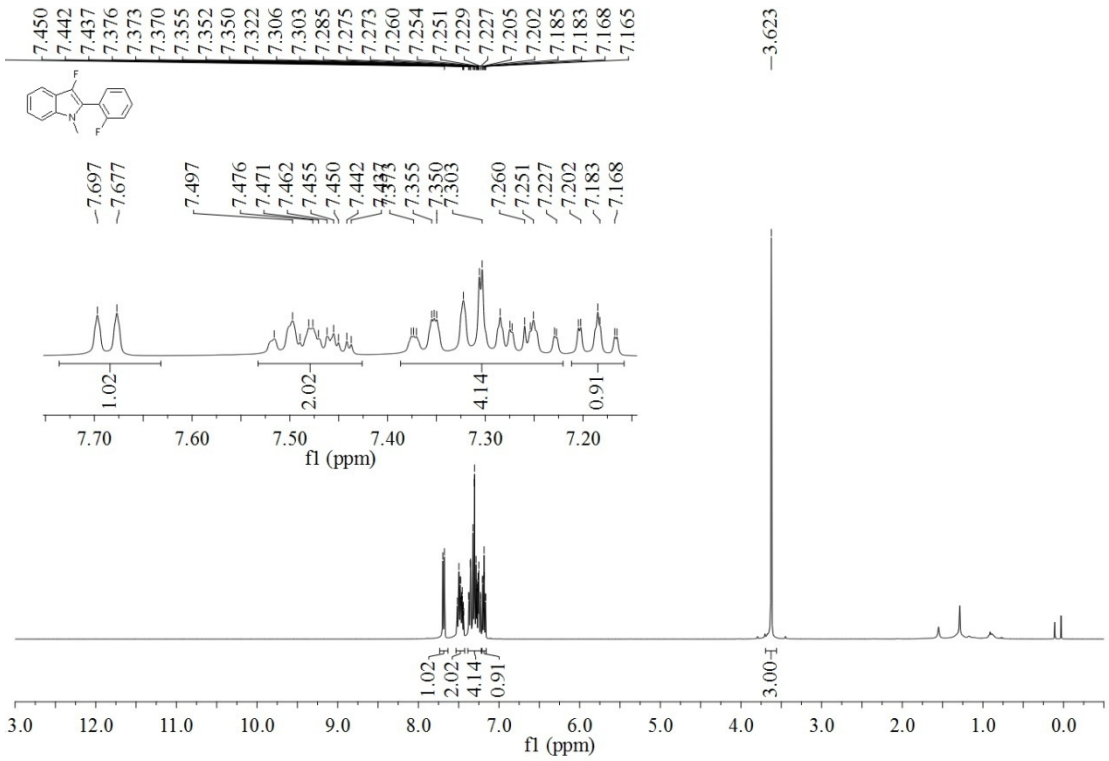

144.039
141.561
132.681
126.643
118.730
117.152
111.471
111.457
77.477
77.160
76.842
133.290
133.271
132.746
132.681
129.410
128.634
128.587
126.643
126.590
123.927
120.699
118.730
118.544
117.178
117.152
133
130
127
124
121
118
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

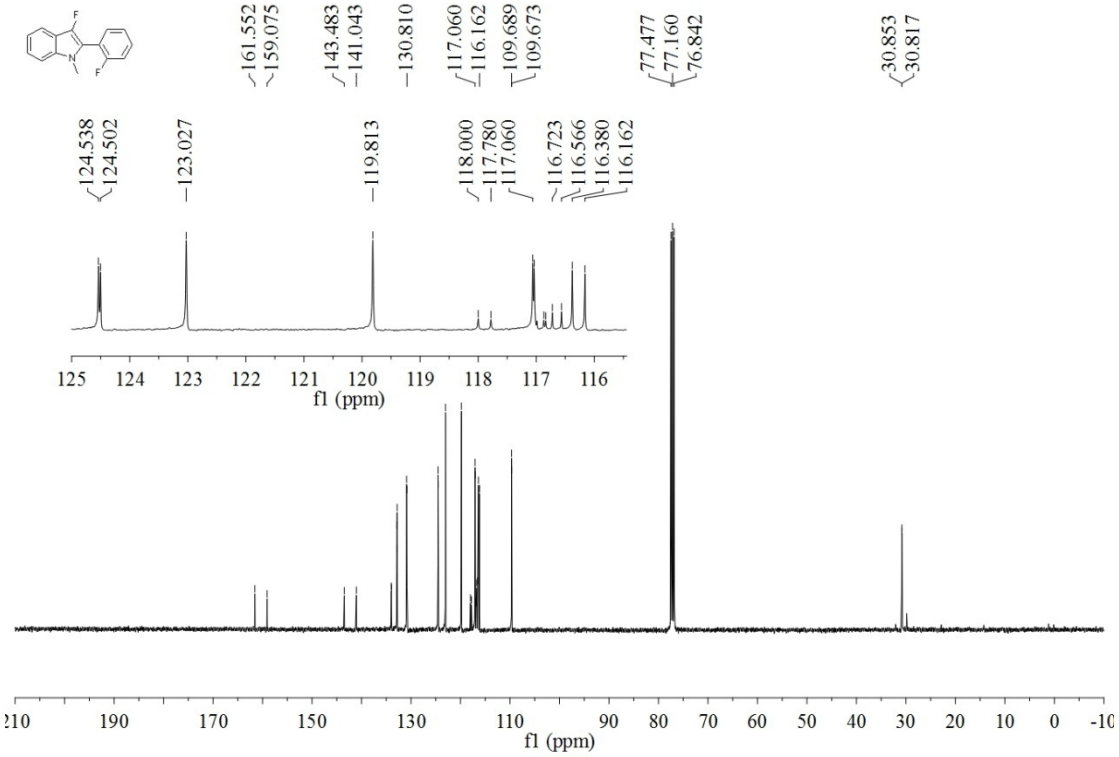

-169.466
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

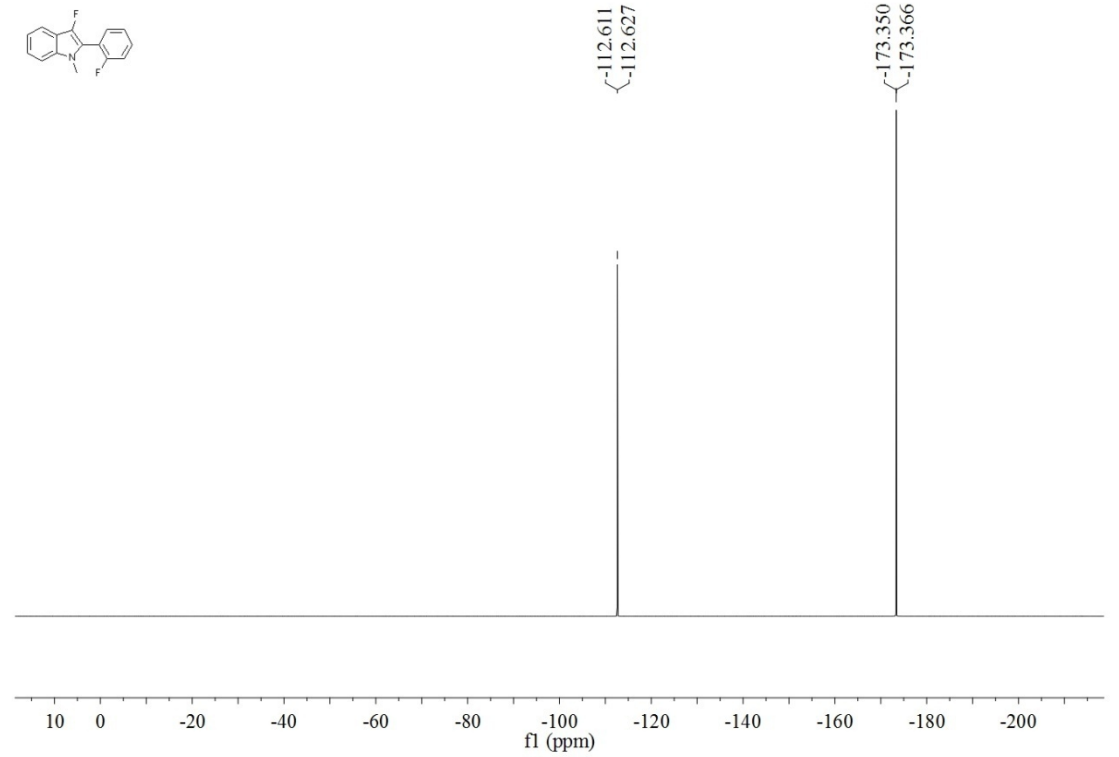

7.982
7.913
7.690
7.670
7.390
7.366
7.349
7.328
7.260
7.230
7.226
7.210
7.194
7.191
3.714
1.552
0.009
0.93
1.93
0.93
1.92
0.92
0.93
1.93
0.93
3.00
fl (ppm)

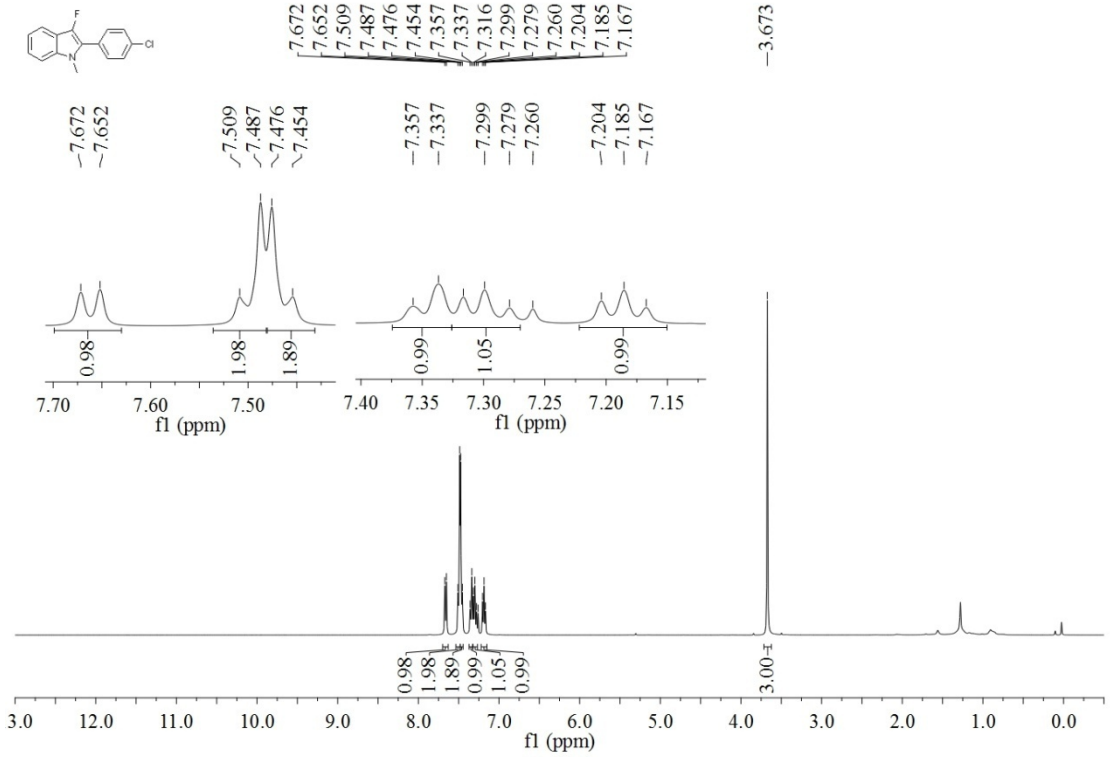

144.384
141.901
131.363
121.966
120.660
116.593
110.071
110.055
77.478
77.160
76.843
31.413
135.107
135.049
132.900
132.566
132.233
131.900
131.363
131.327
129.409
127.389
124.678
124.300
121.588
121.514
121.439
120.494
119.254
117.513
117.487
116.750
116.593
fl (ppm)

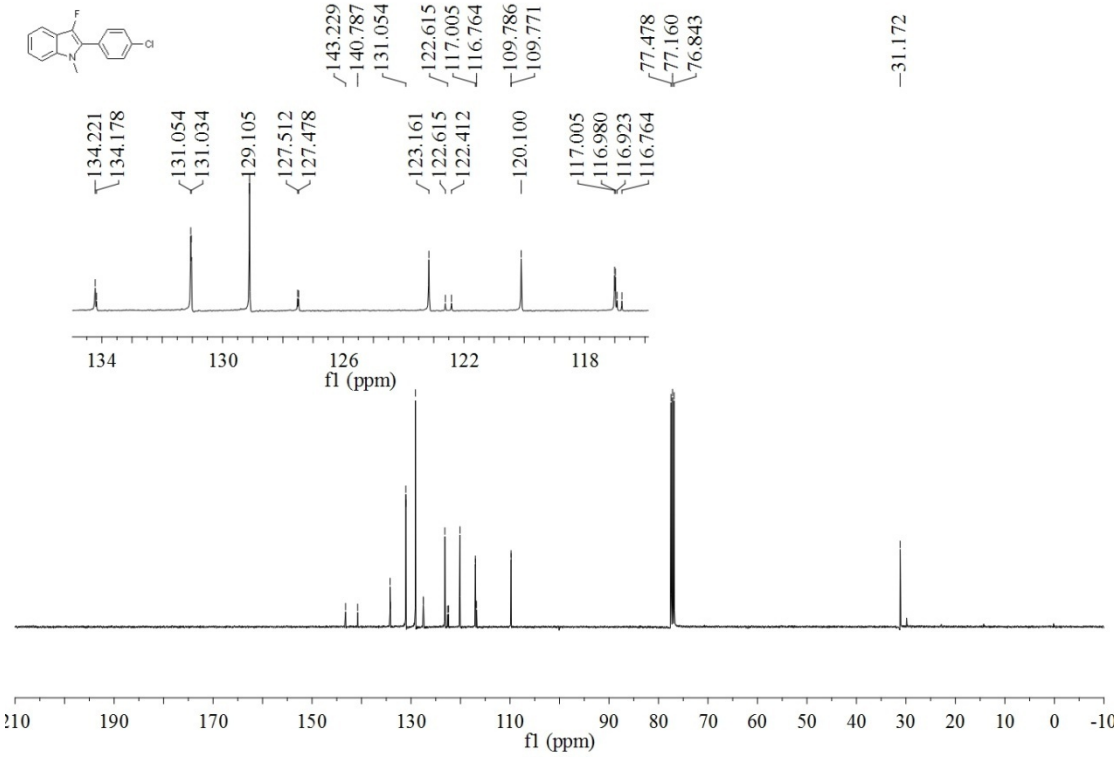

-62.956
-172.506
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

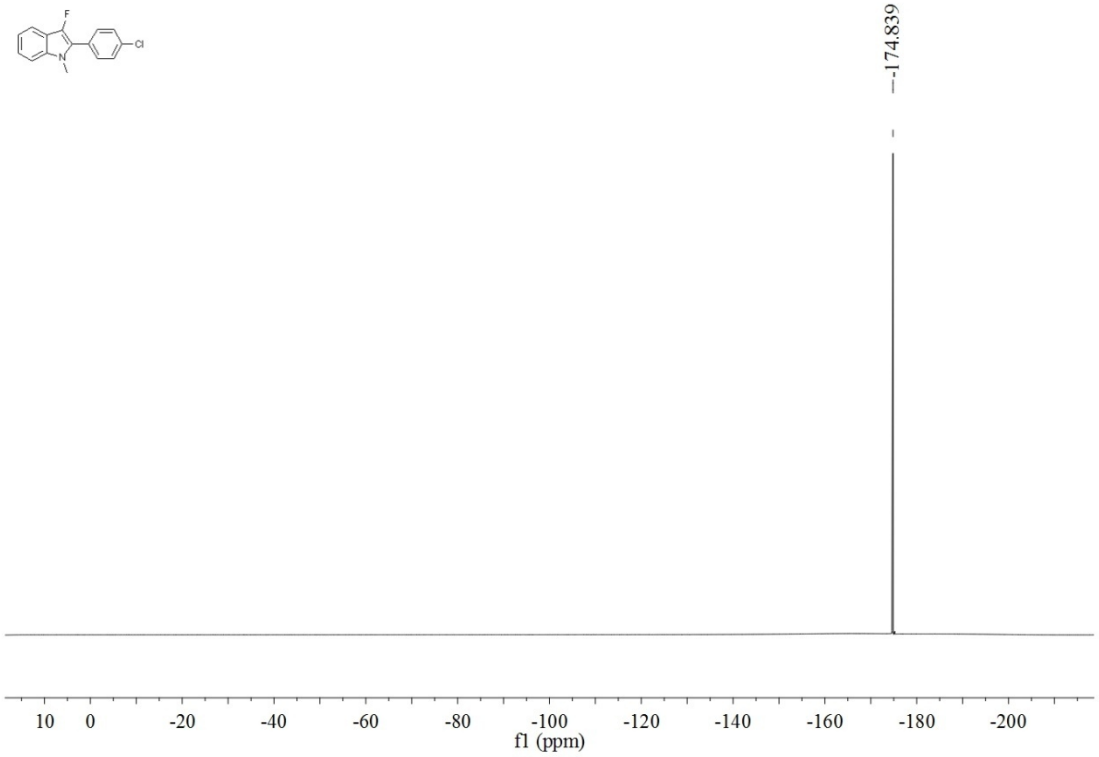

7.450 7.442 7.437 7.376 7.373 7.370 7.355 7.352 7.350 7.322 7.306 7.303 7.285 7.275 7.273 7.260 7.254 7.251 7.229 7.227 7.205 7.202 7.185 7.183 7.168 7.165
3.623
7.697 7.677 7.497 7.476 7.471 7.462 7.455 7.450 7.442 7.355 7.350 7.303 7.260 7.251 7.227 7.202 7.183 7.168
1.02 2.02 4.14 0.91
7.70 7.60 7.50 7.40 7.30 7.20
f1 (ppm)
1.02 2.02 4.14 0.91 3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

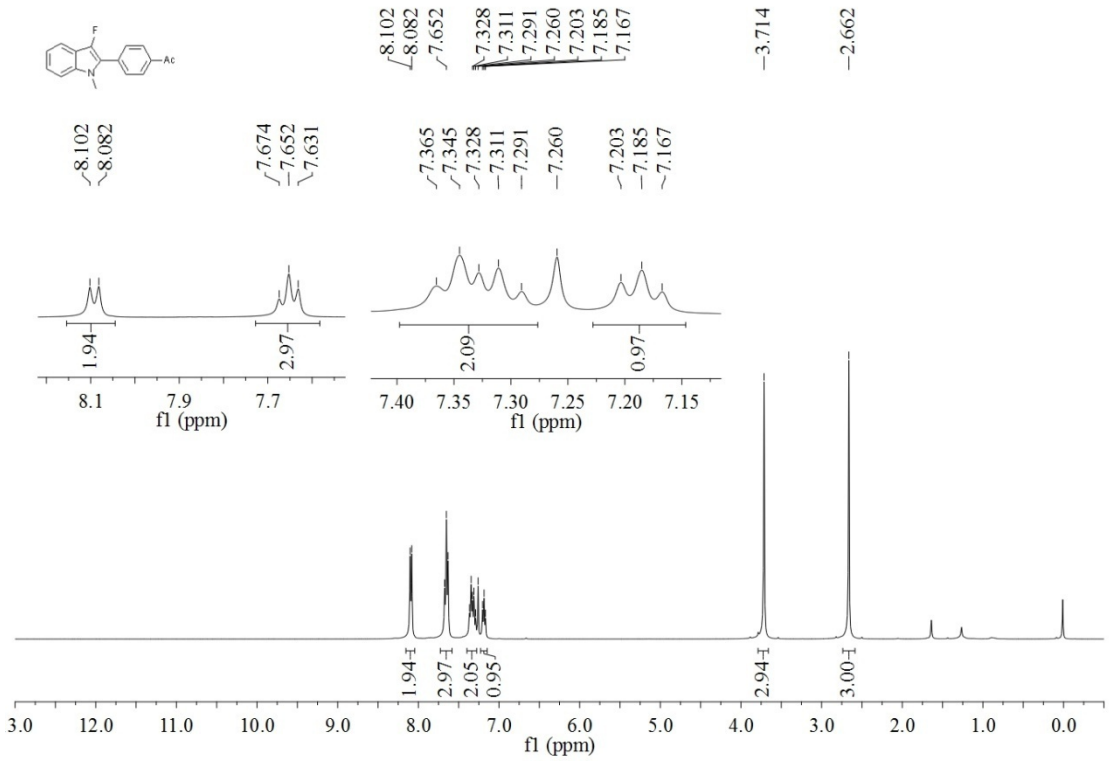

161.552
159.075
143.483
141.043
130.810
117.060
116.162
109.689
109.673
77.477
77.160
76.842
30.853
30.817
124.538
124.502
123.027
119.813
118.000
117.780
117.060
116.723
116.566
116.380
116.162
f1 (ppm)
f1 (ppm)

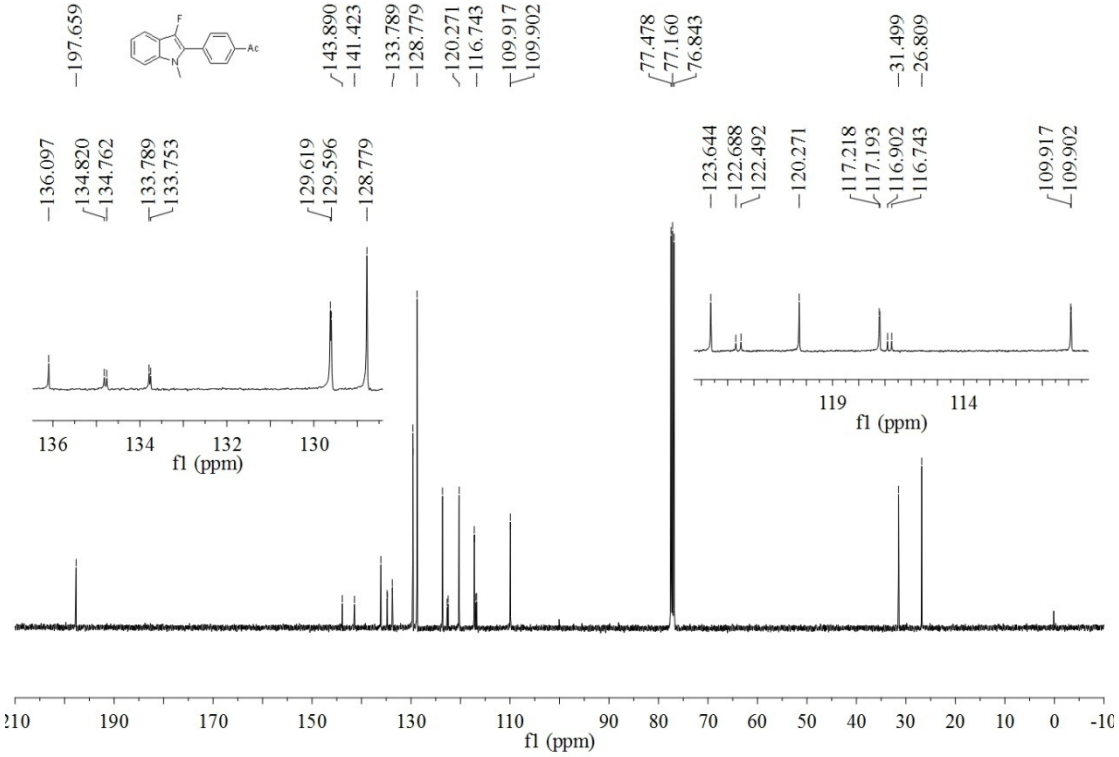

-112.611
-112.627
-173.350
-173.366
f1 (ppm)

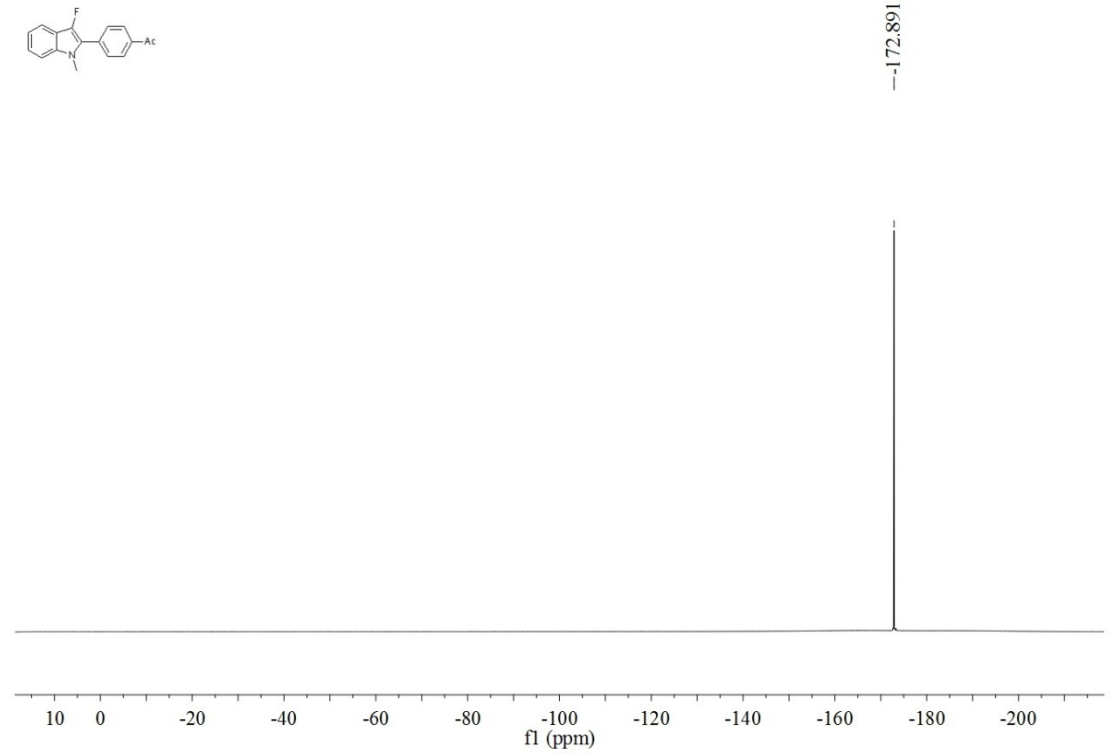

7.672
7.652
7.509
7.487
7.476
7.454
7.357
7.337
7.316
7.299
7.279
7.260
7.204
7.185
7.167
3.673
0.98
1.98
1.89
0.99
1.05
0.99
3.00
f1 (ppm)

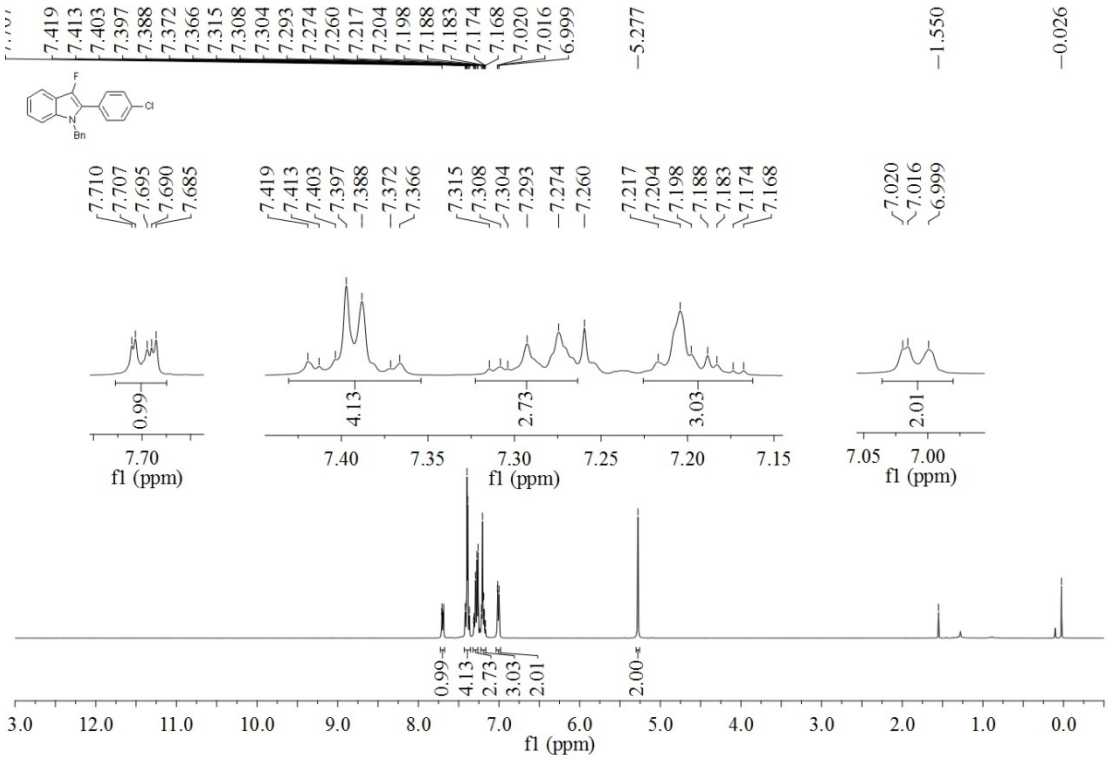

143.229
140.787
131.054
122.615
117.005
116.764
109.786
109.771
77.478
77.160
76.843
31.172
134.221
134.178
131.054
131.034
129.105
127.512
127.478
123.161
122.615
122.412
120.100
117.005
116.980
116.923
116.764
f1 (ppm)

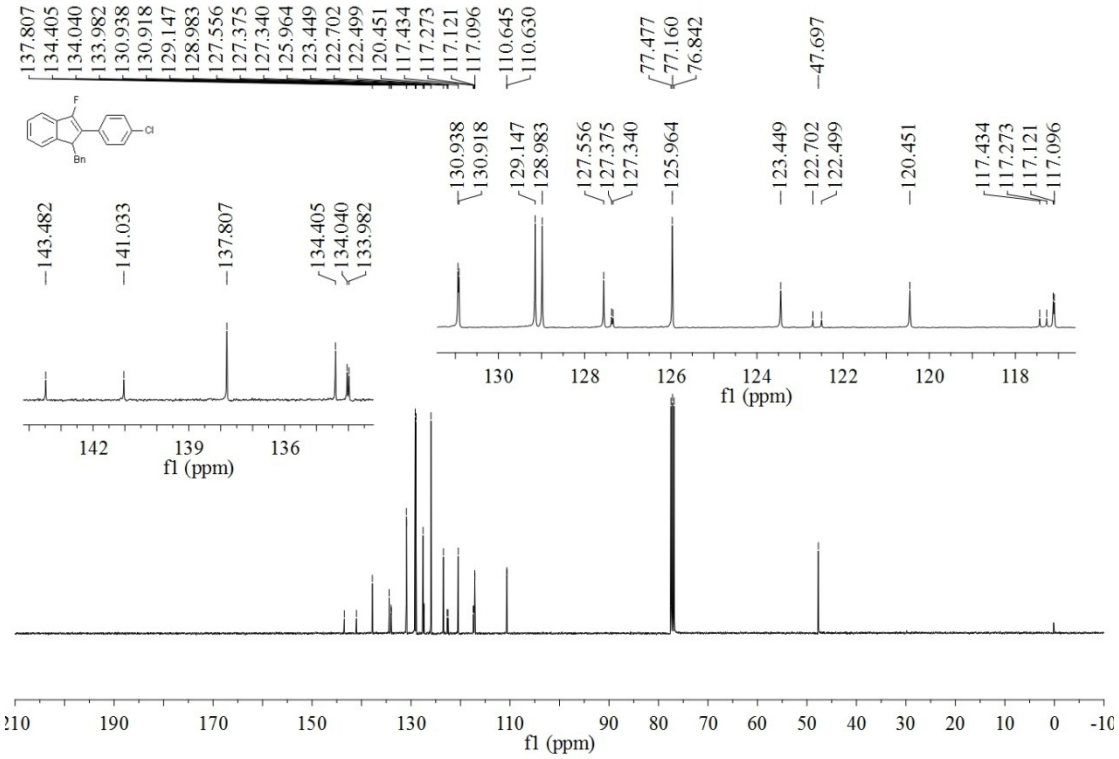

F
Cl
-174.839
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

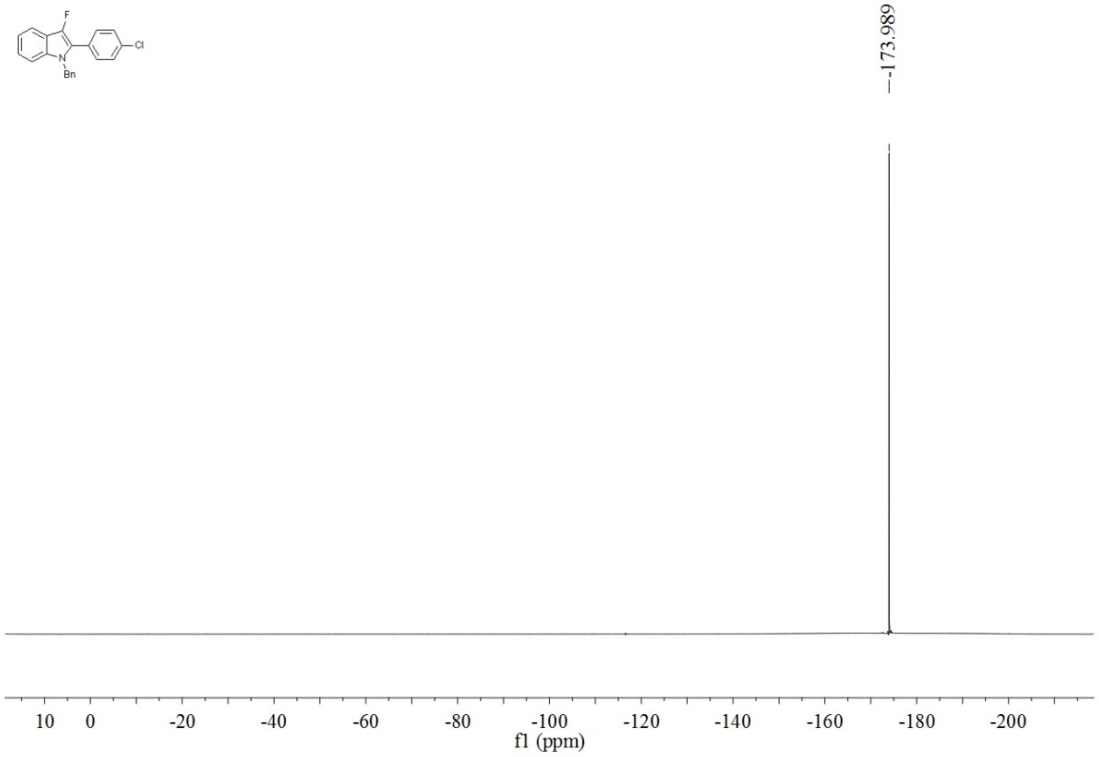

F
Ac
8.102
8.082
7.652
7.328
7.311
7.291
7.260
7.203
7.185
7.167
3.714
2.662
7.674
7.652
7.631
7.365
7.345
7.328
7.311
7.291
7.260
7.203
7.185
7.167
1.94
2.97
2.09
0.97
8.1 7.9 7.7
7.40 7.35 7.30 7.25 7.20 7.15
f1 (ppm)
1.94
2.97
2.05
0.95
2.94
3.00
3.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)


197.659
143.890
141.423
133.789
128.779
120.271
116.743
109.917
109.902
77.478
77.160
76.843
31.499
26.809
136.097
134.820
134.762
133.789
133.753
129.619
129.596
128.779
123.644
122.688
122.492
120.271
117.218
117.193
116.902
116.743
109.917
109.902
136
134
132
130
f1 (ppm)
119
114
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


172.891
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


7.419
7.413
7.403
7.397
7.388
7.372
7.366
7.315
7.308
7.304
7.293
7.274
7.260
7.217
7.204
7.198
7.188
7.183
7.174
7.168
7.020
7.016
6.999
5.277
1.550
0.026
0.99
4.13
2.73
3.03
2.01
2.00
fl (ppm)


137.807
134.405
134.040
133.982
130.938
130.918
129.147
128.983
127.556
127.375
127.340
125.964
123.449
122.702
122.499
120.451
117.434
117.273
117.121
117.096
110.645
110.630
77.477
77.160
76.842
47.697
143.482
141.033
fl (ppm)


F
Cl
N
Bn
-173.989
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)