Supporting Information

Atroposelective Haloamidation of Indoles with Amino Acid Derivatives and Hypohalides

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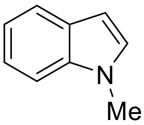
1. General methods.

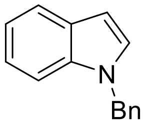
NaClO (Sodium hypochlorite solution reagent grade, available chlorine 4.00 - 4.99 %) was purchased from Sigma Aldrich. Freshly prepared *NaBrO* (1.25 M) aqueous solution (0.375 mol of NaOH and 0.125 mol of Br_2 formulated into 100 mL aqueous solution at -5 ºC). Benzotrifluoride, Toluene, Anisole, THF, DCM, 1,4-Dioxane, CH_3CN and DMF were dried according to *Purification of Common Laboratory Chemicals*. Other reagents were used without further purification. Thin layer chromatography (TLC) was performed on EMD precoated plates (silica gel 60 F254, Art 5715) and visualized by fluorescence quenching under UV light and by staining with phosphomolybdic acid or potassium permanganate, respectively. Column chromatography was performed on EMD Silica Gel 60 (300–400 Mesh) using a forced flow of 0.5–1.0 bar. ^{1}H NMR (400 MHz), ^{13}C NMR (100 MHz) and ^{19}F (376 MHz) were measured on a Bruker AVANCE III-400 spectrometer. Chemical shifts are expressed in parts per million (ppm) with respect to the residual solvent peak. Coupling constants are reported as Hertz (Hz), signal shapes and splitting patterns are indicated as follows: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet.

2. Starting materials and products

(1a-1i, 2b-2g are known compounds and **2a** were synthesized according to the literature.[1]**)**



1a



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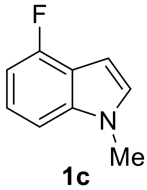

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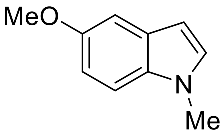

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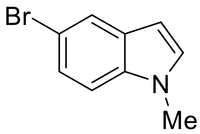

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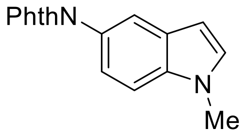

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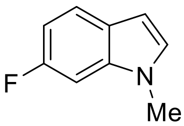

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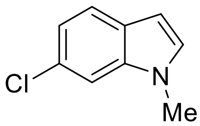

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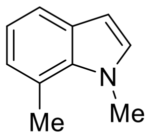

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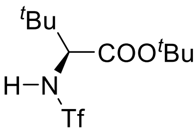

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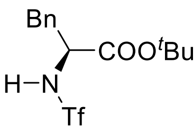

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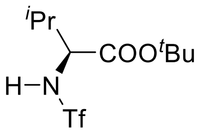

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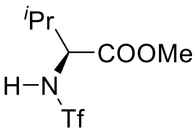

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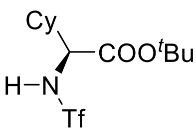

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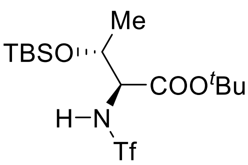

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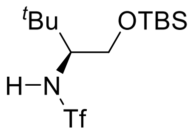

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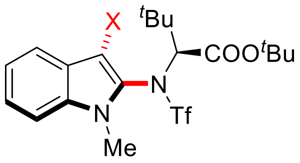
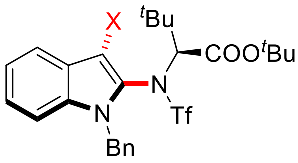
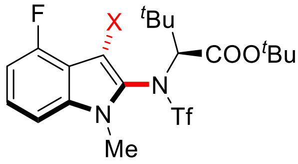


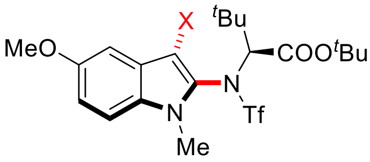
X = Br, **3a**
X = Cl, **4a**



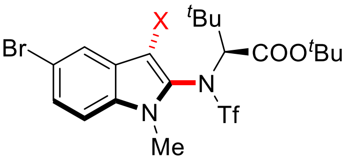
X = Br, **3b**
X = Cl, **4b**



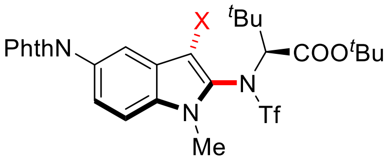
X = Br, **3c**
X = Cl, **4c**



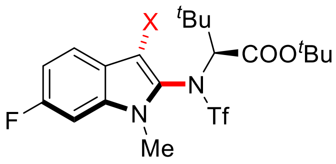
X = Br, **3d**
X = Cl, **4d**



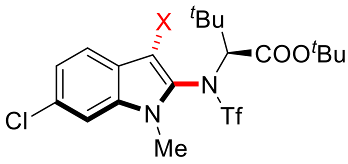
X = Br, **3e**
X = Cl, **4e**



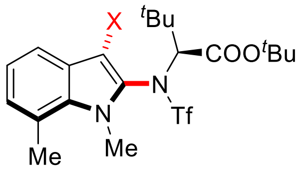
X = Br, **3f**
X = Cl, **4f**



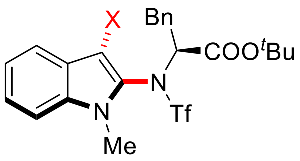
X = Br, **3g**
X = Cl, **4g**



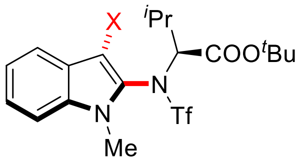
X = Br, **3h**
X = Cl, **4h**



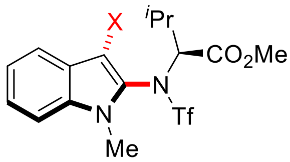
X = Br, **3i**
X = Cl, **4i**



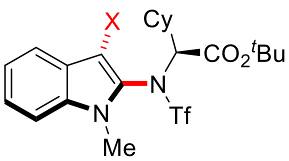
X = Br, **3j**
X = Cl, **4j**



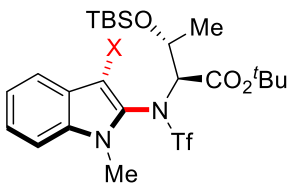
X = Br, **3k**
X = Cl, **4k**



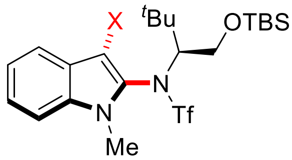
X = Br, **3l**
X = Cl, **4l**



X = Br, 3m
X = Cl, 4m

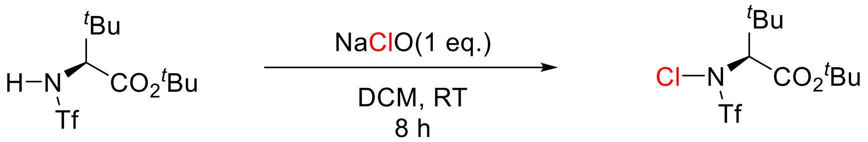


X = Br, 3n
X = Cl, 4n



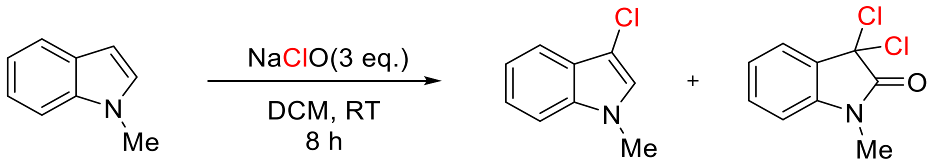
X = Br, **3o**
X = Cl, **4o**

3. Mechanism studies



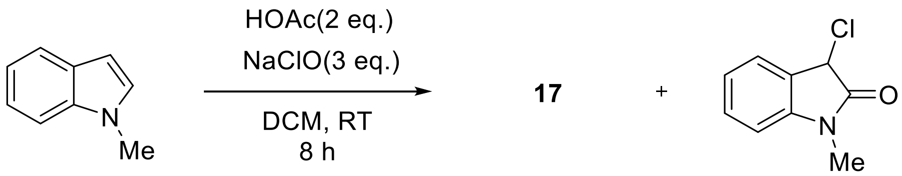
2a **15** (trace)

A 10 mL round bottom flask was equipped with a rubber septum and magnetic stir bar and was charged with **2a** (0.1mmol, 31.9 mg), NaClO (0.1 mmol, 129 uL) in DCM (2 mL) at room temperature for 8 h. **15** was not observed based on TLC and NMR analysis.



1a **16** (8%) **17** (6%)

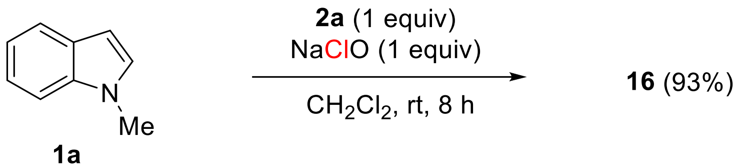
A 10 mL round bottom flask was equipped with a rubber septum and magnetic stir bar and was charged with **1a** (0.1mmol, 13.1 mg), NaClO (0.3 mmol, 388 uL) in DCM (2 mL) at room temperature for 8 h. **16** (8%) and **17** (6%) was obtained. **Substrate 16**: ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.62 (d, J = 8.0 Hz, 1H), 7.37-7.22 (m, 2H), 7.21-7.14 (m, 1H), 7.02 (s, 1H), 3.76 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 125.24, 122.60, 119.89, 118.38, 109.48, 32.97. **Substrate 17**: ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.64 (dd, J = 7.6, 0.8 Hz, 1H), 7.42 (td, J = 7.8, 1.3 Hz, 1H), 7.20 (td, J = 7.6, 0.9 Hz, 1H), 6.87 (d, J = 7.9 Hz, 1H), 3.27 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.94, 140.69, 131.91, 129.32, 124.83, 124.24, 109.12, 27.07.



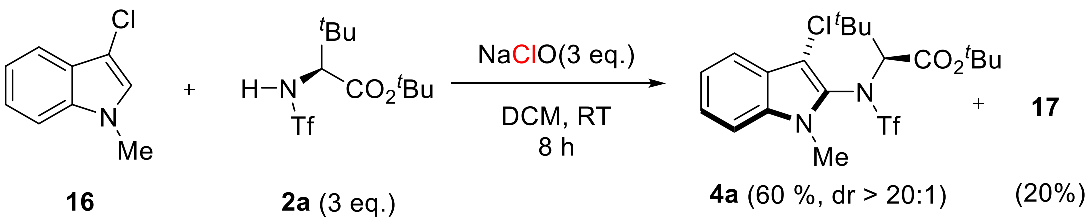
1a (72%) **18** (17%)

A 10 mL round bottom flask was equipped with a rubber septum and magnetic stir bar and was charged with **1a** (0.1 mmol, 13.1 mg), HOAc (0.2 mmol, 11.4 uL), NaClO (0.3 mmol, 388 uL) in DCM (2 mL) at room temperature for 8 h. **17** (72%) and **18** (17%)

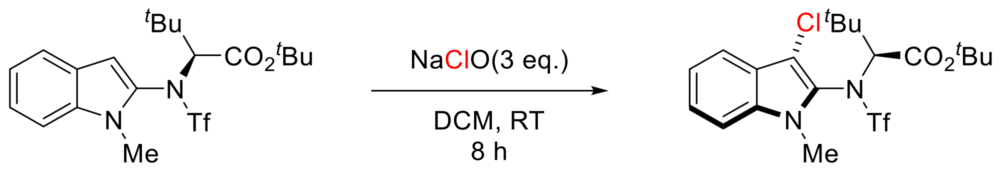
was obtained. Substrate **18**: ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.43 (d, J = 7.4 Hz, 1H), 7.37 (t, J = 7.8 Hz, 1H), 7.17-7.08 (m, 1H), 6.85 (d, J = 7.8 Hz, 1H), 5.13 (s, 1H), 3.23 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 172.08, 143.85, 130.53, 125.71, 125.64, 123.42, 108.72, 51.51, 26.70.



A 10 mL round bottom flask was equipped with a rubber septum and magnetic stir bar and was charged with **1a** (0.1mmol, 13.1 mg), **2a** (0.1 mmol, 31.9 mg), NaClO (0.1 mmol, 129 uL) in DCM (2 mL) at room temperature for 8 h. **16** (93%) was obtained.

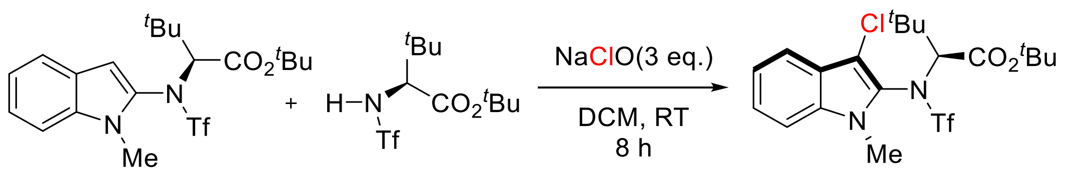


A 10 mL round bottom flask was equipped with a rubber septum and magnetic stir bar and was charged with **16** (0.1mmol, 16.5 mg), **2a** (0.3 mmol, 95.7 mg), NaClO (0.3 mmol, 388 uL) in DCM (2 mL) at room temperature for 8 h. **4a** (60%) and **17** (20%) was obtained. Substrate **4a**: m.p. 109-110 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.69-7.57 (m, 1H), 7.41-7.28 (m, 2H), 7.25-7.18 (m, 1H), 4.51 (s, 1H), 3.61 (s, 3H), 1.54 (s, 9H), 1.12 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.62. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.48, 134.63, 125.20, 124.91, 123.63, 120.98, 119.30, 119.52 (q, J = 323 Hz), 110.39, 107.90, 82.94, 72.68, 36.06, 32.61, 27.99, 27.15. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{20}H_{26}ClF_3N_2NaO_4S^+$: 505.1152; found: 505.1142.



19 (dr = 4.5 : 1) **4a** (trace)

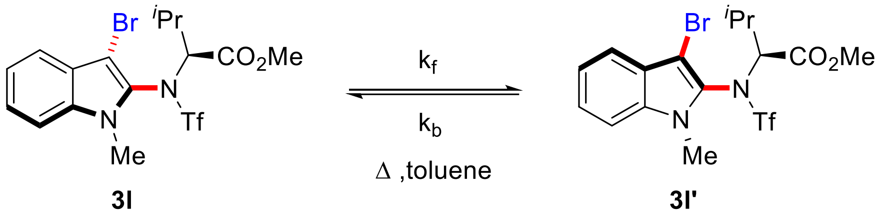
A 10 mL round bottom flask was equipped with a rubber septum and magnetic stir bar and was charged with **19** (0.1mmol, 44.8 mg), NaClO (0.3 mmol, 388 uL) in DCM (2 mL) at room temperature for 8 h. trace of **4a** was obtained. Substrate **19**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 8.0 Hz, 1H), 7.32-7.29 (m, 2H), 7.16-7.13 (m, 1H), 6.79 (s, 1H), 4.53 (s, 1H), 3.79 (s, 3H), 1.56 (s, 10H), 0.99 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -69.71. ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.90, 135.85, 128.80, 125.23, 123.49, 121.69, 120.31, 120.26, 110.40, 109.90, 105.14, 82.98, 72.03, 35.50, 31.29, 27.90, 27.24, 27.15. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{20}H_{27}F_3N_2NaO_4S^+$: 471.1541; found: 471.1556.



19 (dr = 4.5 : 1) **2a** (3 eq.) **4a'** (90 %, dr = 9:1)

A 10 mL round bottom flask was equipped with a rubber septum and magnetic stir bar and was charged with **19** (0.1mmol, 44.8 mg), **2a** (0.3 mmol, 95.7 mg), NaClO (0.3 mmol, 388 uL) in DCM (2 mL) at room temperature for 8 h. **4a'** (90%, dr = 9:1) was obtained. Substrate **4a'**: ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.64 (d, *J* = 8.0 Hz, 1H), 7.38-7.28 (m, 2H), 7.25-7.16 (m, 1H), 4.53 (s, 1H), 3.82 (s, 3H), 1.53 (s, 9H), 1.09 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$) *δ* -72.12 (s). ^{13}C NMR (101 MHz, $CDCl_3$) *δ* 165.31, 134.69, 125.03, 120.95, 119.59, 119.60, 110.11, 82.84, 71.77, 28.07, 26.90. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{20}H_{26}ClF_3N_2NaO_4S^{+}$: 505.1152; found: 505.1148.

4. Epimerization studies



Thermal epimerization of **3l**: A solution of **3l** (50 mg, dr > 100:1) in toluene (5 mL) was heated at the indicated temperatures (**Table S1**). At intervals, small samples (0.2 mL) were taken and the solvent was removed by evaporation. The dr value was determined by ^{19}F NMR. The rates and energy barrier for the isomerization of **3l** in toluene was calculated as shown in **Table S2** and **Table S3**.

Table S1. Thermal Epimerization of **3l.**

50 ºC	Time/ h	0 h	2 h	5 h	7 h	10 h	13 h	29 h	37 h
	dr	>100:1	42.5:1	28.6:1	18.1:1	15.9:1	13.9:1	13.9:1	13.9:1
70 ºC	Time/ min	0 min	10 min	20 min	30 min	50 min	70 min	120 min	-
	dr	>100:1	29.6:1	16.3:1	15.4:1	11.3:1	11.5:1	11.4:1	-

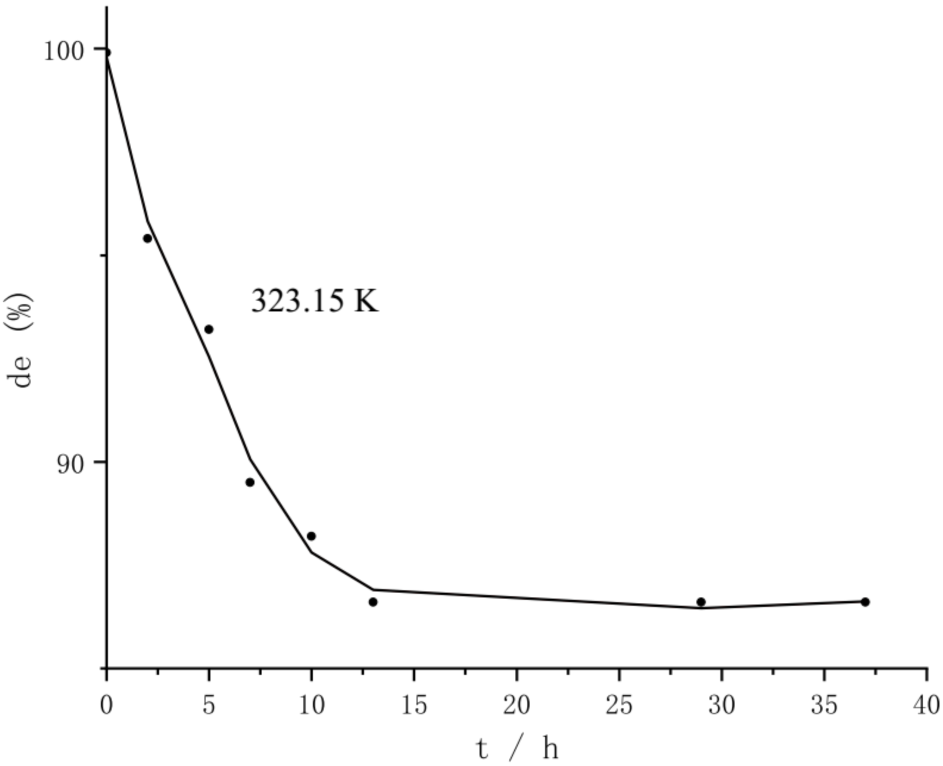


Figure S1.1. The epimerization plot of **3l** at 323.15 K

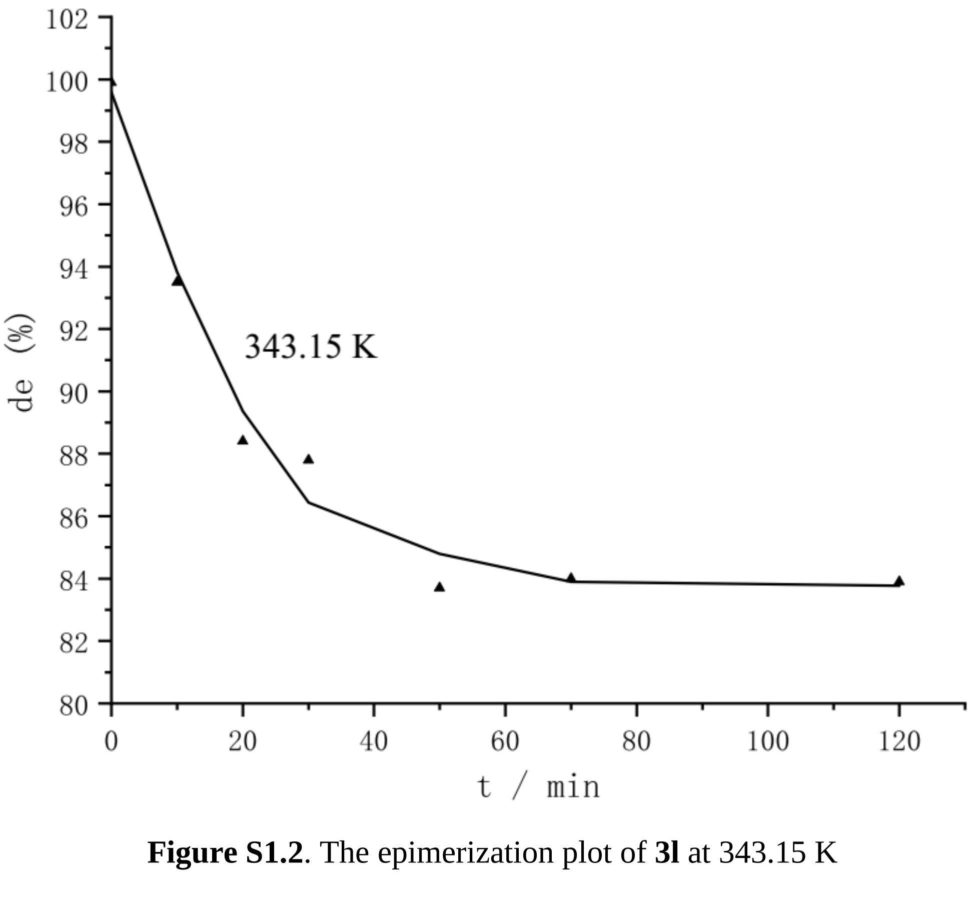


Figure S1.2. The epimerization plot of **3l** at 343.15 K

At 323.15 K: For reversible first order kinetics, the rate law is: ν= $\frac{d[3l]}{dt}$ = $k_f[3l]$- $k_b[3l']$

And since K_{eq} = $\frac{k_f}{k_b}$ = $\frac{[3l']_{eq}}{[3l]_{eq}}$ = $\frac{[3l]_0-[3l]_{eq}}{[3l]_{eq}}$ and K_{eq} = $\frac{1}{13.9}$, It can be used to eliminate [3l`], integration of the rate law gives ln($\frac{[3l]_t-[3l]_{eq}}{[3l]_0-[3l]_{eq}}$) = -$(k_f + k_b)t$

By plotting ln($\frac{[3l]_t-[3l]_{eq}}{[3l]_0-[3l]_{eq}}$) against t, a linear equation is obtained, with the slope = -$(k_f + k_b)$.

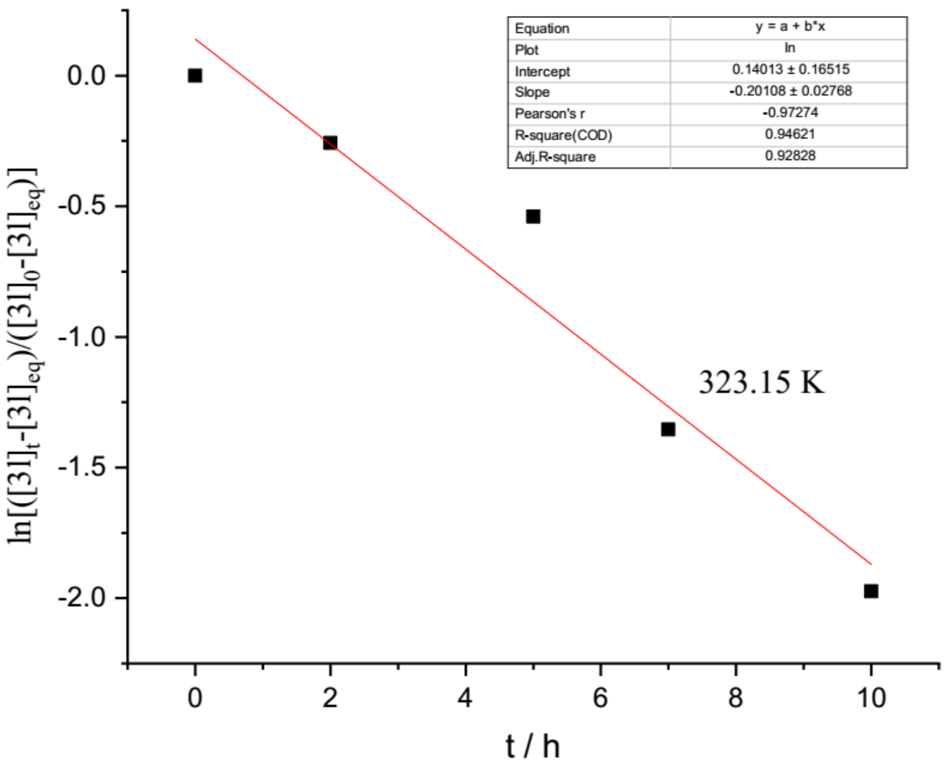


Figure S2.1. The plot of ln($\frac{[3l]_t-[3l]_{eq}}{[3l]_0-[3l]_{eq}}$) vesus time t at 323.15 K

At 343.15 K: For reversible first order kinetics, the rate law is: ν= $\frac{d[3l]}{dt}$ = $k_f[3l]$- $k_b[3l']$

And since K_{eq} = $\frac{k_f}{k_b}$ = $\frac{[3l']_{eq}}{[3l]_{eq}}$ = $\frac{[3l]_0-[3l]_{eq}}{[3l]_{eq}}$ and K_{eq} = $\frac{1}{11.4}$, It can be used to eliminate [3l`], integration of the rate law gives ln($\frac{[3l]_t-[3l]_{eq}}{[3l]_0-[3l]_{eq}}$) = -$(k_f + k_b)t$

By plotting ln($\frac{[3l]_t-[3l]_{eq}}{[3l]_0-[3l]_{eq}}$) against t, a linear equation is obtained, with the slope = -$(k_f + k_b)$.

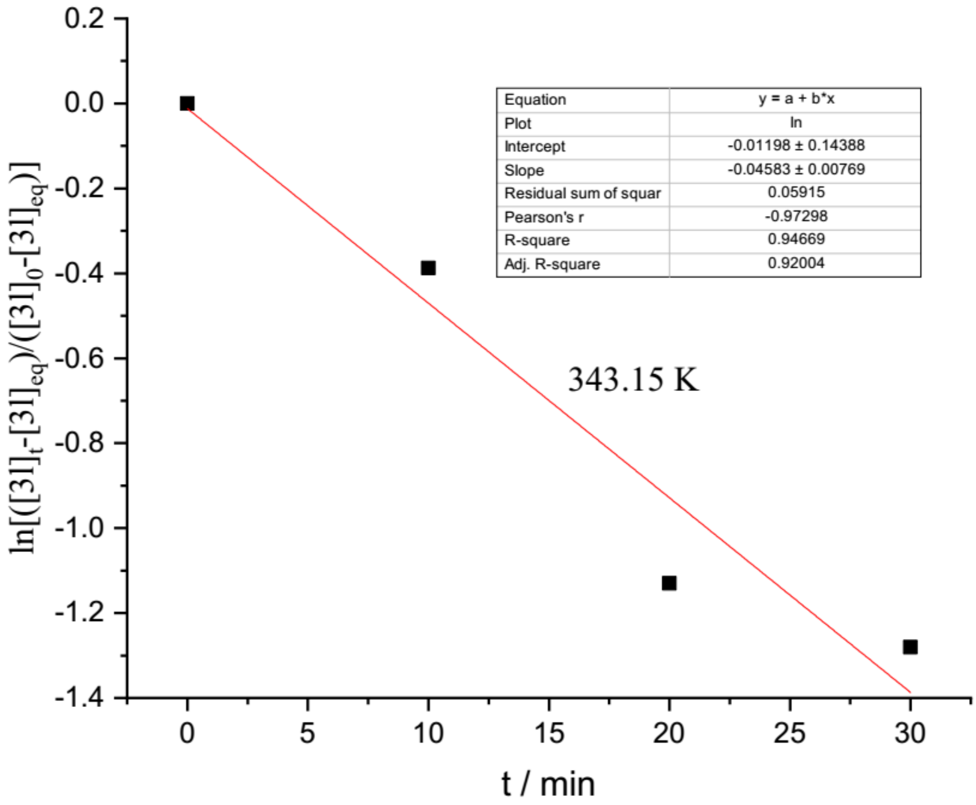


Figure S2.2. The plot of $\ln(\frac{[3l]_t-[3l]_{eq}}{[3l]_0-[3l]_{eq}})$ vesus time t at 343.15 K

Table S2. Rates for the Epimerization of **3l**

T (K)	k_{obs}/h^{-1}	k_f/h^{-1}	k_b/h^{-1}
323.15 K	0.2011	0.0135	0.1876
343.15 K	2.7480	0.2216	2.5264

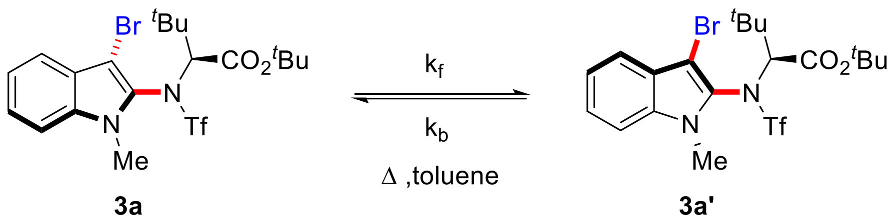
The calculation of energy barrier $\Delta^{\neq}{}_r\, G^{\theta}{}_m$ for epimerization:

Insertion of k_f and k_b into the eyring equation $\Delta G^{‡} = RT * \ln(\frac{k_B*T}{k*h})$ give $\Delta G^{‡}_{k_f}$ and $\Delta G^{‡}_{k_b}$.

The half-life of epimerization of **3l** $\tau_{1/2rac} = \frac{ln2}{k_{obs}}$

Table S3. Rates, half-life and energy barrier for the epimerization of **3l**.

T (K)	$\tau_{1/2rac}$	$\Delta G^{‡}_{k_f}$ (kcal·mol^{-1})	$\Delta G^{‡}_{k_b}$ (kcal·mol^{-1})
323.15 K	3.45 h	26.98	25.29
343.15 K	0.25 h	26.78	25.12



Thermal epimerization of **3a**: A solution of **3a** (50 mg, dr > 100:1) in toluene (5 mL) was heated at the indicated temperatures (**Table S4**). At intervals, small samples (0.2 mL) were taken and the solvent was removed by evaporation. The dr value was determined by ^{1}H NMR. The rates and energy barrier for the isomerization of **3a** in toluene was calculated as shown in **Table S5** and **Table S6**.

Table S4. Thermal Epimerization of **3a.**

50 ºC	time/h	0 h	3 h	6 h	9 h	17 h	25 h	49 h	69 h	90 h
	dr	>20:1	9.3:1	8.2:1	6.6:1	5.6:1	4.3:1	3.4:1	3.4:1	3.4:1

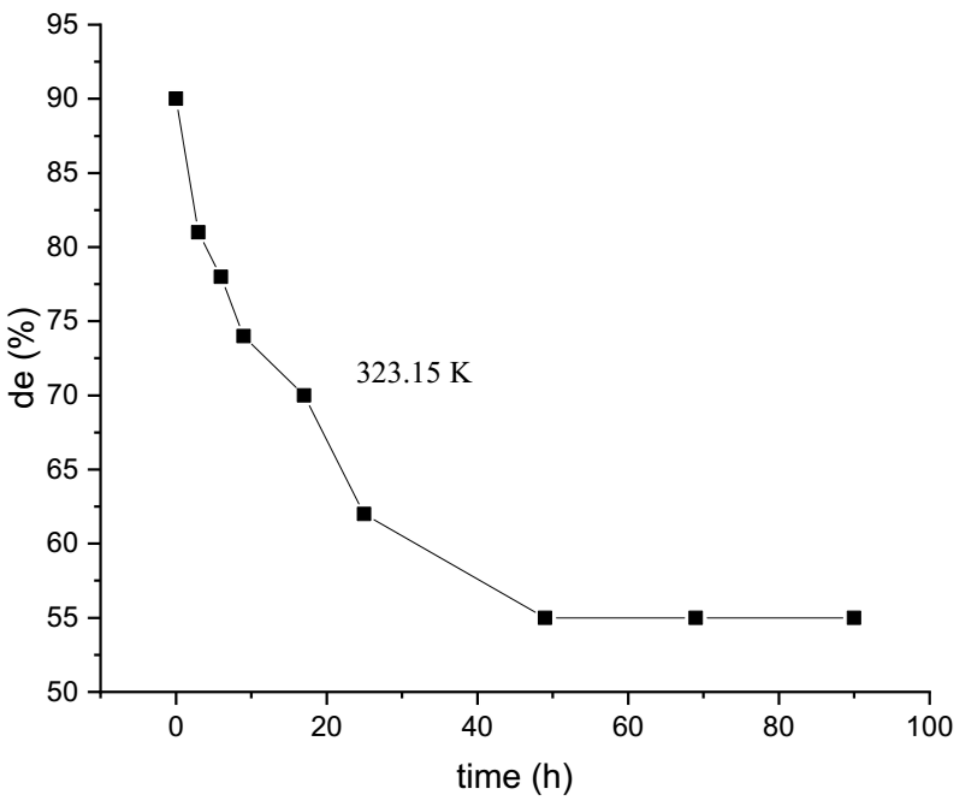


Figure S4.1. The epimerization plot of **3a** at 323.15 K

At 323.15 K: for reversible first order kinetics, the rate law is: ν= $\frac{d[3a]}{dt}$ = $k_f[3a]$-$k_b[3a`]$ And since $K_{eq}$ = $\frac{k_f}{k_b}$ = $\frac{[3a`]_{eq}}{[3a]_{eq}}$ = $\frac{[3a]_0-[3a]_{eq}}{[3a]_{eq}}$ and K_{eq} = $\frac{1}{3.4}$, It can be used to eliminate [3a`], integration of the rate law gives $\ln(\frac{[3a]_t-[3a]_{eq}}{[3a]_0-[3a]_{eq}}) = -(k_f + k_b)t$

By plotting $\ln(\frac{[3a]_t-[3a]_{eq}}{[3a]_0-[3a]_{eq}})$ against t, a linear equation is obtained, with the slope = -$(k_f + k_b)$.

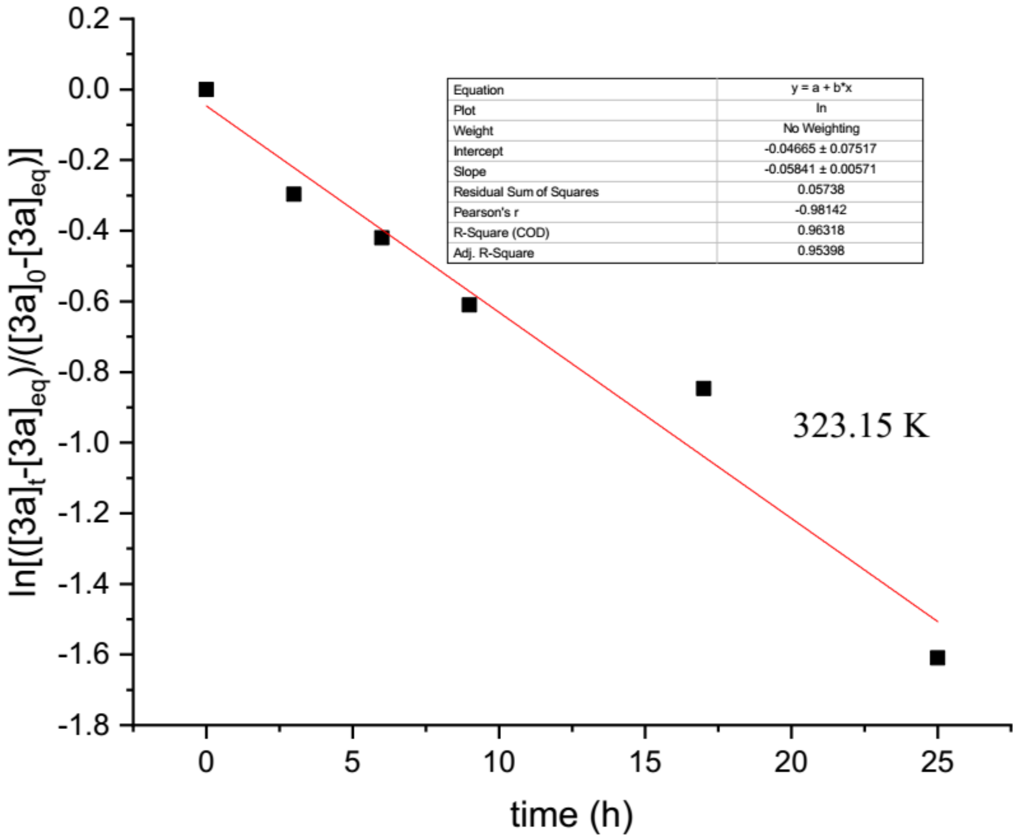


Figure S4.2. The plot of $\ln(\frac{[3a]_t-[3a]_{eq}}{[3a]_0-[3a]_{eq}})$ vesus time t at 323.15 K

Table S5. Rates for the Epimerization of **3a**

T (K)	k_{obs}/h^{-1}	k_f/h^{-1}	k_b/h^{-1}
323.15 K	0.0584	0.0133	0.0452

The calculation of energy barrier $\Delta^{\neq}{}_r\, G^{\theta}{}_m$ for epimerization:

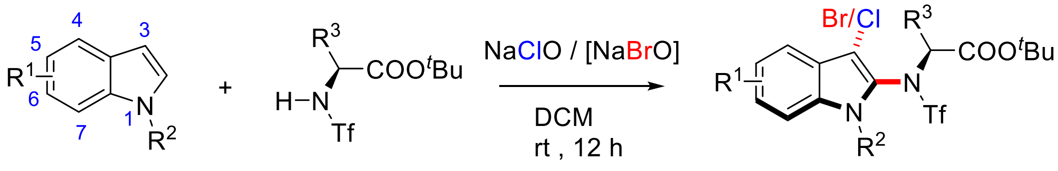
Insertion of k_f and k_b into the eyring equation $\Delta G^{\ddagger}$= RT ∗ $\ln(\frac{k_B * T}{k * h})$ give $\Delta G^{\ddagger}_{k_f}$ and $\Delta G^{\ddagger}_{k_b}$.

The half-life of epimerization of **3a** $\tau_{1/2rac} = \frac{ln2}{k_{obs}}$

Table S6. Rates, half-life and energy barrier for the epimerization of **3a**.

T (K)	$\tau_{1/2rac}$	$\Delta G^{\ddagger}_{k_f}$ (kcal·mol^{-1})	$\Delta G^{\ddagger}_{k_b}$ (kcal·mol^{-1})
323.15 K	11.87 h	26.98	26.20

6. General procedure



A 10 mL round bottom flask was equipped with a rubber septum and magnetic stir bar. It was charged with indole **1** (0.1 mmol, 1.0 eq.) and amino acid derivative **2** (0.3 mmol, 3.0 eq.). DCM (2.0 mL, 0.05 M) and NaClO or [NaBrO] (0.3 mmol, 3.0 eq.) was added *via* syringe. The mixture was then stirred for 12 h. After the reaction was complete (as judged by TLC analysis), the mixture was poured into a separatory funnel containing 10 mL of H_2O and 10 mL of DCM. The layers were separated and the aqueous layer was extracted with DCM (2 × 10 mL). The combined organic layers were dried over Na_2SO_4 and concentrated under reduced pressure after filtration. The residue was purified by flash chromatography on silica gel to afford the desired product **3** or **4**.

Notes:

NaClO (Sodium hypochlorite solution reagent grade, available chlorine 4.00-4.99 %) was purchased from Sigma-Aldrich.

Product Number: 239305

CAS Number: 7681-52-9

MDL: MFCD00011120

Formula: NaClO

Formula Weight: 74.44 g/mol

Composition available chlorine, 4.00 - 4.99%

Density 1.097 g/mL at 25 °C

Storage Temperature: 2 - 8 °C

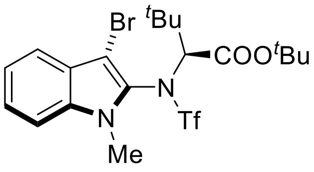
M [ClO-] = available chlorine * d / 0.070906

M [ClO-] = 0.05* 1.097 / 0.070906 = 0.775 M

(The above data was provided by Sigma-Aldrich)

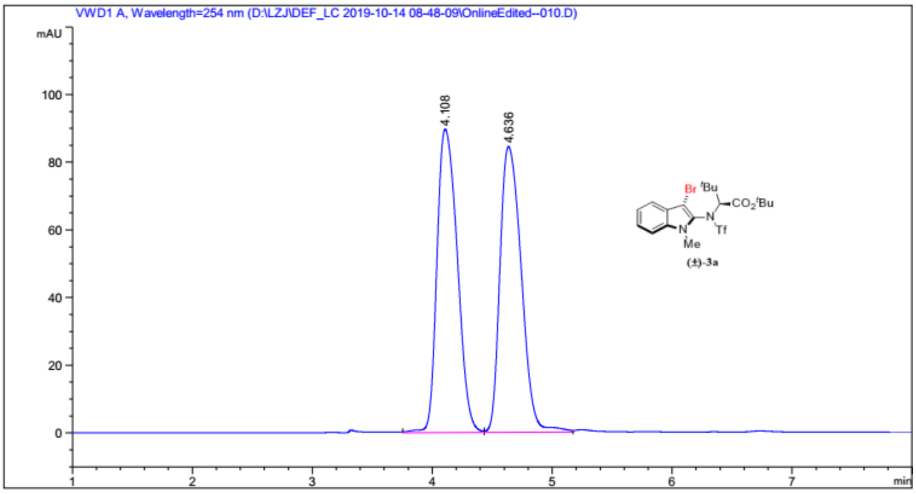
Freshly prepared NaBrO (1.25 M) aqueous solution (0.375 mol of NaOH and 0.125 mol of Br_2 formulated into 100 mL aqueous solution at -5 °C).

7. Date for products



3a

(*S*)-*tert*-butyl-2-((*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (3a). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3a** (34.2 mg, 65%, > 20:1 dr) was obtained as a white solid from **1a**, **2a** and NaBrO. m.p. 121-122 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.60 (d, J = 8.0 Hz, 1H), 7.41-7.33 (m, 1H), 7.30 (d, J = 8.3 Hz, 1H), 7.26-7.20 (m, 1H), 4.52 (s, 1H), 3.61 (s, 3H), 1.54 (s, 9H), 1.16 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.29. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.26, 135.28, 126.98, 125.48, 124.93 , 121.19, 119.51（q, J = 323 Hz）, 120.50, 110.38, 95.96, 83.00, 72.65, 36.31, 33.07, 33.05, 28.01, 27.35. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{20}H_{26}BrF_3N_2NaO_4S^+$: 549.0646; found: 549.0644. Enantiomeric ratio: > 99:1, determined by HPLC (Daicel Chiralpak AD, hexane / isopropanol = 98/2, flow rate 1 mL/min, T = 25 °C, 254 nm): t_R = 4.166 min (major), t_R = 4.636 min (minor). (dr > 20:1, two stereoisomers were resolved on HPLC column) According to general procedure, (±)-**3a** was obtained from **1a**, (±)-**2a** and NaBrO.



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面积百分比报告

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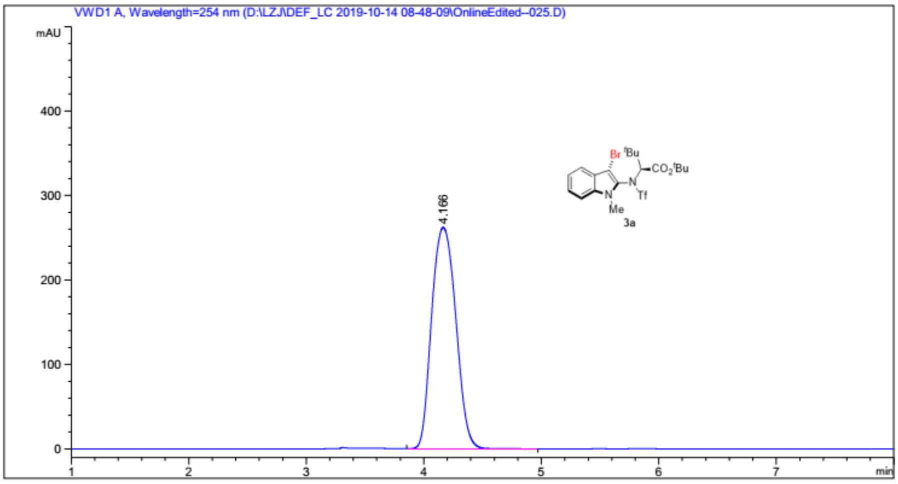
排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	4.108	BV	0.1912	1054.51025	89.69972	50.2406
2	4.636	VV	0.2012	1044.40845	84.48083	49.7594



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面积百分比报告

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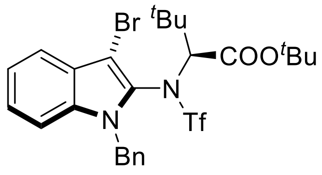
排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

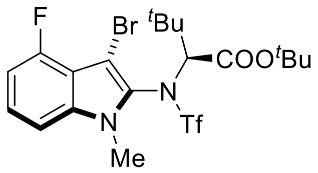
信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	4.166	VB	0.2353	3758.59204	262.17438	100.0000



3b

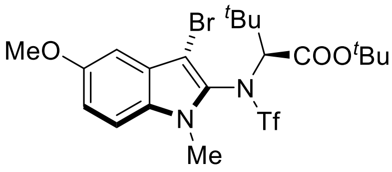
(*S*)-*tert*-butyl-2-((*N*-(1-benzyl-3-bromo-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (3b). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3b** (25.3 mg, 42%, > 20:1 dr) was obtained as a white solid from **1b**, **2a** and NaBrO. m.p. 128-129 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.60 (d, J = 7.8 Hz, 1H), 7.20 (d, J = 1.8 Hz, 3H), 7.17-7.13 (m, 1H), 7.12-7.06 (m, 1H), 6.95-6.88 (m, 2H), 6.78 (d, J = 8.3 Hz, 1H), 5.26 (dd, J = 64.5, 16.9 Hz, 2H), 4.43 (s, 1H), 1.54 (s, 9H), 1.15 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -71.30. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.28, 136.49, 134.23, 128.40, 127.81, 127.66, 127.29, 126.63, 125.80, 124.65, 121.08, 120.36, 119.55 (q, J = 323 Hz), 112.77, 97.37, 83.00, 72.83, 50.37, 36.32, 27.98, 27.45. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{26}H_{30}BrF_3N_2NaO_4S^+$: 625.0959; found: 625.0985.



3c

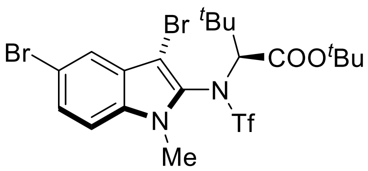
(*S*)-*tert*-butyl-2-((*N*-(3-bromo-4-fluoro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (3c). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3c** (28.8 mg, 53%, > 20:1 dr) was obtained as a white solid from **1c**, **2a** and NaBrO. m.p. 122-123 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28-7.19 (m, 1H), 7.08 (d, J = 8.0 Hz, 1H), 6.85 (dd, J = 10.9, 7.9 Hz, 1H), 4.50 (s, 1H), 3.58 (s, 3H), 1.54 (s, 9H), 1.17 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.14 (s), -124.09--124.19 (m). ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.25, 156.36 (d, J = 251 Hz), 137.47 (d , J = 8.0 Hz), 127.60, 125.02 (d , J = 8.0 Hz), 119.46 (q, J = 322 Hz), 114.43 (d, J = 17 Hz), 106.60 (d , J = 4.0 Hz), 106.40 (d , J =

19.0 Hz), 91.74, 83.15, 72.75, 36.39, 33.61, 28.00, 27.37. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{20}H_{25}BrF_4N_2NaO_4S^+$: 567.0552; found: 567.0539.



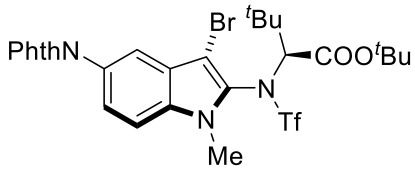
3d

(S)-*tert*-butyl-2-((*N*-(3-bromo-5-methoxy-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoro methyl)sulfonamido)-3,3-dimethylbutanoate(3d). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 10:90), **3d** (35.6 mg, 64%, > 20:1 dr) was obtained as a white solid from **1d**, **2a** and NaBrO. m.p. 138-140 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.20 (d, J = 8.9 Hz, 1H), 7.04-6.96 (m, 2H), 4.50 (s, 1H), 3.88 (s, 3H), 3.57 (s, 3H), 1.53 (s, 9H), 1.15 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -72.32. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.28, 155.28, 130.42, 126.87, 125.69, 119.51(q, J = 323 Hz), 116.31, 111.61, 100.72, 95.25, 82.97, 72.60, 55.79, 36.28, 33.12, 28.00, 27.34. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{21}H_{28}BrF_3N_2NaO_5S^+$: 579.0752; found: 579.0719.



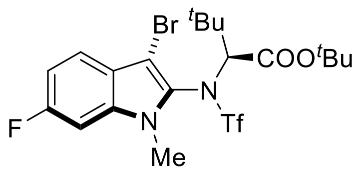
3e

(*S*)-*tert*-butyl-2-((*N*-(3,5-dibromo-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)s ulfonamido)-3,3-dimethylbutanoate (3e). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3e** (39.9 mg, 66%, > 20:1 dr) was obtained as a white solid from **1e**, **2a** and NaBrO. m.p. 147-149 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.74 (d, J = 1.7 Hz, 1H), 7.44 (dd, J = 8.8, 1.9 Hz, 1H), 7.18 (d, J = 8.8 Hz, 1H), 4.50 (s, 1H), 3.58 (s, 3H), 1.53 (s, 9H), 1.14 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.28. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.26, 133.88, 128.10, 128.01, 126.93, 123.00, 119.44 (q, J = 323 Hz), 114.60, 112.08, 95.09, 83.16, 72.72, 36.29, 33.21, 28.00, 27.31. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{20}H_{25}Br_2F_3N_2NaO_4S^+$: 626.9752; found: 626.9783.



3f

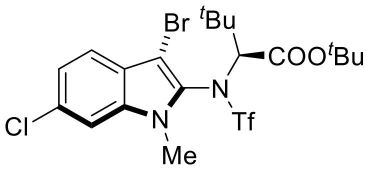
(*S*)-*tert*-butyl-2-((*N*-(3-bromo-5-(1,3-dioxoisoindolin-2-yl)-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (3f). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 15:85), **3f** (40.3 mg, 60%, > 20:1 dr) was obtained as a white solid from **1f**, **2a** and NaBrO. m.p. 108-109 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.97 (dd, J = 5.5, 3.0 Hz, 2H), 7.79 (dd, J = 5.4, 3.1 Hz, 2H), 7.66 (d, J = 1.8 Hz, 1H), 7.44 (d, J = 8.7 Hz, 1H), 7.37 (dd, J = 8.8, 1.9 Hz, 1H), 4.52 (s, 1H), 3.65 (s, 3H), 1.55 (s, 9H), 1.16 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -72.25. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.80, 167.22, 134.71, 134.38, 131.88, 128.42, 125.76, 125.19, 124.06, 123.75, 119.61, 119.48 (q, J = 323 Hz), 111.32, 96.40, 83.06, 72.82, 36.31, 33.29, 28.01, 27.40. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{28}H_{29}BrF_3N_3NaO_6S^+$: 694.0810; found: 694.0822.



3g

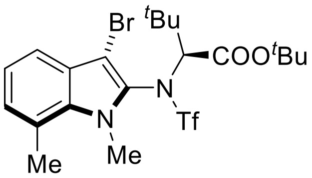
(*S*)-*tert*-butyl-2-((*N*-(3-bromo-6-fluoro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (3g). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3g** (38.1 mg, 70%, > 20:1 dr) was obtained as a white solid from **1g**, **2a** and NaBrO. m.p. 115-117 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.59-7.48 (m, 1H), 7.04-6.91 (m, 2H), 4.50 (s, 1H), 3.54

(s, 3H), 1.53 (s, 9H), 1.15 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.32 (s), -115.51- -115.67 (m). ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.29, 161.55 (d, J = 241 Hz), 135.25 (d, J = 12 Hz), 127.30 (d, J = 4 Hz), 122.03 (d, J = 10 Hz), 121.98, 119.47 (q, J = 323 Hz), 110.50 (d, J = 25 Hz), 96.63 (d, J = 27 Hz), 96.19, 83.12, 72.59, 36.28, 33.19, 28.00, 27.32. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{20}H_{25}BrF_4N_2NaO_4S^+$: 567.0552; found: 567.0588.



3h

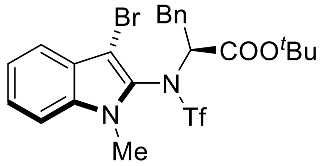
(*S*)-*tert*-butyl-2-((*N*-(3-bromo-6-chloro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (3h). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3h** (35.3 mg, 63%, > 20:1 dr) was obtained as a white solid from **1h**, **2a** and NaBrO. m.p. 73-74 ºC. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.51 (d, J = 8.5 Hz, 1H), 7.31 (d, J = 1.6 Hz, 1H), 7.19 (dd, J = 8.5, 1.7 Hz, 1H), 4.50 (s, 1H), 3.56 (s, 3H), 1.53 (s, 9H), 1.14 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.30. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.23, 135.45, 131.11, 127.68, 123.98, 122.10, 121.69, 119.44 (q, J = 323 Hz), 110.35, 96.15, 83.15, 72.65, 36.29, 33.17, 28.00, 27.31. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{20}H_{25}BrClF_3N_2NaO_4S^+$: 583.0257; found: 583.0278.



3i

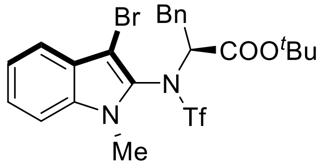
(*S*)-*tert*-butyl-2-((*N*-(3-bromo-1,7-dimethyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl) sulfonamido)-3,3-dimethylbutanoate (3i). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3i** (34.0 mg, 63%, >

20:1 dr) was obtained as a white solid from **1i**, **2a** and NaBrO. m.p. 91-92 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.44 (dd, J = 7.0, 2.0 Hz, 1H), 7.12-7.00 (m, 2H), 4.49 (s, 1H), 3.80 (s, 3H), 2.77 (s, 3H), 1.54 (s, 9H), 1.14 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -71.89. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.21, 134.62, 127.77, 127.49, 126.40, 122.21, 121.12, 118.65, 119.55 (q, J = 323 Hz), 96.46, 82.89, 72.71, 36.26, 36.09, 28.00, 27.36, 20.38. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{21}H_{28}BrF_3N_2NaO_4S^+$: 563.0803; found: 563.0832.



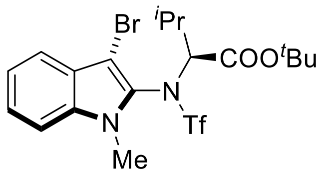
3j

***Tert*-butyl-*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-phenylalaninate (3j).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3j** (33.1 mg, 76%, 3.5:1 dr) was obtained as a colourless oil from **1a**, **2b** and NaBrO. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.61 (d, J = 8.0 Hz, 1H), 7.43-7.34 (m, 2H), 7.29-7.20 (m, 4H), 7.10 (dd, J = 7.3, 1.9 Hz, 2H), 4.86 (dd, J = 12.2, 4.7 Hz, 1H), 3.92 (s, 3H), 3.46 (dd, J = 12.8, 4.7 Hz, 1H), 2.56 (t, J = 12.5 Hz, 1H), 1.15 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -73.12. ^{13}C NMR (101 MHz, $CDCl_3$): δ 168.85， 135.11, 134.13, 129.66, 128.49, 127.36, 126.27, 125.07, 124.93, 121.27, 120.25, 119.73(q, J = 323 Hz), 110.55, 93.89, 82.90, 66.32, 37.43, 31.08, 27.43. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{23}H_{24}BrF_3N_2NaO_4S^+$: 583.0490; found: 583.0513.



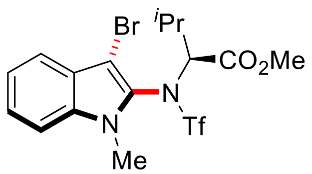
3j`

***Tert*-butyl-*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-phenylalaninate (3j`).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3j`** was obtained as a colourless oil from **1a**, **2b** and NaBrO. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63-7.58 (m, 1H), 7.42-7.30 (m, 2H), 7.27-7.18 (m, 6H), 4.77 (dd, J = 11.7, 4.1 Hz, 1H), 3.81 (s, 3H), 3.60 (dd, J = 12.8, 4.1 Hz, 1H), 3.36-3.25 (m, 1H), 1.13 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -73.36. ^{13}C NMR (101 MHz, $CDCl_3$): δ 166.50, 145.33, 135.33, 134.96, 130.94, 129.51, 128.50, 127.23, 125.22, 124.94, 121.24, 120.33, 119.34 (q, J = 323 Hz) 110.35, 83.19, 69.47, 38.36, 31.12, 27.46. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{23}H_{24}BrF_3N_2NaO_4S^+$: 583.0490; found: 583.0513.



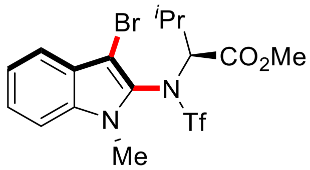
3k

***Tert*-butyl-*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-valinate (3k).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3k** (42 mg, 82%, 10.2:1 dr) was obtained as a colourless oil from **1a**, **2c** and NaBrO. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.61-7.56 (m, 1H), 7.40-7.35 (m, 2H), 7.26-7.22 (m, 1H), 4.57 (d, J = 2.0 Hz, 1H), 4.06 (s, 3H), 2.56-2.40 (m, 1H), 1.55 (s, 9H), 1.17 (d, J = 7.1 Hz, 3H), 0.34 (d, J = 6.8 Hz, 3H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -72.64. ^{13}C NMR (101 MHz, $CDCl_3$): δ 168.30, 134.91, 124.82, 121.16, 120.09, 119.84 (q, J = 323 Hz), 110.54, 94.01, 83.07, 70.18, 31.10, 28.27, 28.08, 22.04, 16.50. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{19}H_{24}BrF_3N_2NaO_4S^+$: 535.0490; found: 535.0498.



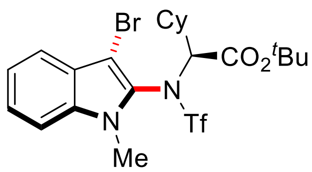
3l

Methyl-*N*-(3-bromo-1-methyl-1H-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-valinate (3l). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3l** (35.8 mg, 76%, 3:1 dr) was obtained as a white solid from **1a**, **2d** and NaBrO. m.p. 102-104 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (dd, J = 7.2, 0.8 Hz, 1H), 7.43-7.34 (m, 2H), 7.29-7.22 (m, 1H), 4.71 (d, J = 2.6 Hz, 1H), 4.01 (s, 3H), 3.85 (s, 3H), 2.60-2.43 (m, 1H), 1.15 (d, J = 7.1 Hz, 3H), 0.33 (d, J = 6.7 Hz, 3H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -72.61. ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.94, 134.99, 126.08, 125.00, 124.98, 121.29, 120.18, 119.82 (q, J = 323 Hz), 110.57, 94.07, 69.82, 52.40, 31.00, 28.38, 21.79, 16.65. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{16}H_{18}BrF_3N_2NaO_4S^+$: 493.0020; found: 493.0040.



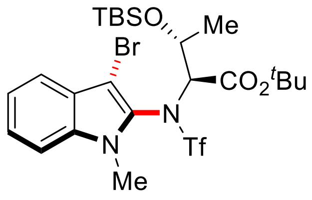
3l`

Methyl-*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-valinate (3l`).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3l` was obtained as a white solid from **1a**, **2d** and NaBrO. m.p. 97-98 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, J = 8.0 Hz, 1H), 7.41-7.30 (m, 2H), 7.25-7.19 (m, 1H), 4.62 (d, J = 6.6 Hz, 1H), 3.79 (s, 3H), 3.73 (s, 3H), 2.26-2.15 (m, 1H), 1.24 (d, J = 6.8 Hz, 3H), 0.91 (d, J = 6.7 Hz, 3H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -72.54 (s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.22, 135.05, 126.93, 125.35, 125.04, 121.21, 120.50, 119.49 (q, J = 323 Hz), 110.23, 94.16, 71.34, 52.46, 30.97, 29.99, 21.52, 18.21. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{16}H_{18}BrF_3N_2NaO_4S^+$: 493.0020; found: 493.0040.



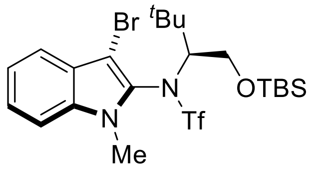
3m

***tert*-butyl-(S)-2-((*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl) sulf onamido)-2-cyclohexylacetate (3m).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3m** (35.9 mg, 65%, 13:1 dr) was obtained as a white solid from **1a**, **2e** and NaBrO. m.p. 125-127 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, J = 8.0 Hz, 1H), 7.39-7.36 (m, 2H), 7.25-7.21 (m, 1H), 4.49 (d, J = 2.3 Hz, 1H), 4.03 (s, 3H), 2.23-2.09 (m, 1H), 1.89 (d, J = 12.6 Hz, 1H), 1.78 (d, J = 14.1 Hz, 1H), 1.56 (s, 9H), 1.45-1.36 (m, 1H), 1.33-1.19 (m, 3H), 1.00-0.86 (m, 1H), 0.81-0.50 (m, 3H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -72.78 (s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.49, 134.96, 124.78, 121.10, 120.11, 119.81 (q, J = 323 Hz), 110.52, 82.98, 70.41, 38.17, 32.40, 31.24, 28.12, 26.97, 26.02, 25.94. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{22}H_{28}BrF_3N_2NaO_4S^+$: 575.0803; found: 575.0821.



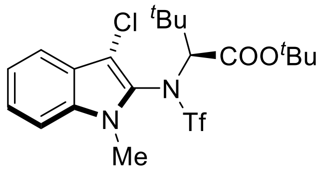
3n

***tert*-butyl-*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-*O*-(tert-butyldimethylsilyl)-*N*-((trifluoromethyl)sulfonyl)-*L*-threoninate (3n).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3n** (47.9 mg, 76%, 5.6:1 dr) was obtained as a colourless oil from **1a**, **2f** and NaBrO. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, J = 8.0 Hz, 1H), 7.33-7.27 (m, 2H), 7.20-7.15 (m, 1H), 4.60 (d, J = 3.5 Hz, 1H), 4.50-4.41 (m, 1H), 3.97 (s, 3H), 1.46 (s, 9H), 0.83 (d, J = 4.1 Hz, 10H), 0.45 (d, J = 6.1 Hz, 3H), 0.10 (s, 3H), 0.00 (s, 3H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -72.64 (s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.27, 134.84, 126.58, 125.05, 121.28, 120.24, 119.83 (q, J = 323 Hz), 110.65, 110.13, 93.33, 82.71, 68.88, 66.87, 31.21, 27.93, 25.76, 25.67, 18.70, -4.75, -4.95. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{24}H_{36}BrF_3N_2NaO_5SSi^+$: 651.1147; found: 651.1157.



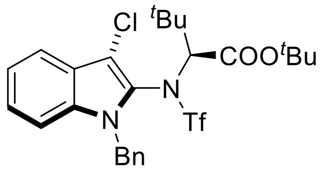
3o

(*S*)-*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-*N*-(1-((tert-butyldimethylsilyl)oxy)-3,3-dimethylbutan-2-yl)-1,1,1-trifluoromethanesulfonamide (3o). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **3o** (51.3 mg, 90%, 10.6:1 dr) was obtained as a white solid from **1a**, **2g** and NaBrO. m.p. 111-112 ^{o}C. ^{1}H NMR (400 MHz, CDCl$_3$): δ 7.62 (d, J = 8.0 Hz, 1H), 7.42-7.32 (m, 2H), 7.26-7.23 (m, 1H), 4.16-4.12 (m, 1H), 4.03 (dd, J = 12.6, 2.7 Hz, 1H), 3.93 (s, 3H), 3.90-3.86 (m, 1H), 1.14 (s, 9H), 0.96 (s, 9H), 0.15 (d, J = 7.2 Hz, 6H). ^{19}F NMR (376 MHz, CDCl$_3$): δ -71.96. ^{13}C NMR (101 MHz, CDCl$_3$): δ 134.40, 127.22, 124.81, 123.85, 122.29, 120.20, 119.46, 118.65 (q, J = 323 Hz), 109.32, 78.50, 59.73, 34.95, 31.26, 27.15, 24.76, 17.15, -0.00, -6.16, -6.32. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{22}H_{34}BrF_3N_2NaO_3SSi^+$: 593.1093; found: 593.1118.



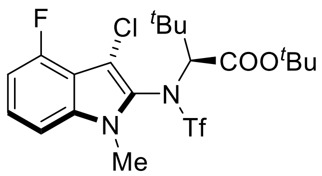
4a

(*S*)-*tert*-butyl-2-((*N*-(3-chloro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (4a). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4a** (36.6 mg, 76%, > 20:1 dr) was obtained as a white solid from **1a**, **2a** and NaClO. m.p. 109-110 ^{o}C. ^{1}H NMR (400 MHz, CDCl$_3$): δ 7.69-7.57 (m, 1H), 7.41-7.28 (m, 2H), 7.25-7.18 (m, 1H), 4.51 (s, 1H), 3.61 (s, 3H), 1.54 (s, 9H), 1.12 (s, 9H). ^{19}F NMR (377 MHz, CDCl$_3$): δ -72.62. ^{13}C NMR (101 MHz, CDCl$_3$): δ 167.48, 134.63, 125.20, 124.91, 123.63, 120.98, 119.30, 119.52 (q, J = 323 Hz), 110.39, 107.90, 82.94, 72.68, 36.06, 32.61, 27.99, 27.15. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{20}H_{26}ClF_3N_2NaO_4S^+$: 505.1152; found: 505.1142.



4b

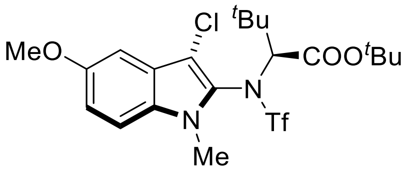
(*S*)-*tert*-butyl-2-((*N*-(1-benzyl-3-chloro-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (4b). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4b** (14.5 mg, 26%, > 20:1 dr) was obtained as a white solid from **1b**, **2a** and NaClO. m.p. 125-126 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, J = 7.5 Hz, 1H), 7.38-7.36 (m, 1H), 7.25-7.20 (m, 3H), 7.18-7.05 (m, 2H), 6.99-6.93 (m, 2H), 6.79 (d, J = 8.2 Hz, 1H), 5.28 (dd, J = 75.6, 16.8 Hz, 2H), 4.45 (s, 1H), 1.53 (s, 9H), 1.13 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -71.68. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.51, 136.50, 133.70, 128.37, 127.80, 127.65, 127.27, 126.77, 125.90, 124.65, 124.00, 120.90, 119.18, 119.58 (q, J = 323 Hz), 112.77, 82.93, 72.95, 72.13, 49.99, 36.06, 27.95, 27.27. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{26}H_{30}ClF_3N_2NaO_4S^+$: 581.1465; found: 581.1471.



4c

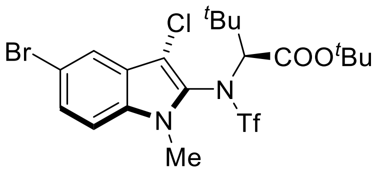
(*S*)-*tert*-butyl-2-((*N*-(3-chloro-4-fluoro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (4c). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4c** (32.0 mg, 64%, > 20:1 dr) was obtained as a white solid from **1c**, **2a** and NaClO. m.p. 98-99 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.31-7.17 (m, 1H), 7.07 (d, J = 8.4 Hz, 1H), 6.88-6.74 (m, 1H), 4.49 (s, 1H), 3.58 (s, 3H), 1.54 (s, 9H), 1.13 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -72.50, -124.25. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.47, 156.25 (d, J = 251 Hz), 136.80 (d, J = 9 Hz), 125.78, 125.13(d, J = 8.0 Hz), 119.47 (q, J = 323 Hz), 112.80 (d, J = 18

Hz), 106.56 (d, J = 4.0 Hz), 106.25 (d, J = 18.0 Hz), 105.69, 83.07, 72.79, 36.11, 33.14, 27.98, 27.16. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{20}H_{25}ClF_4N_2NaO_4S^+$: 523.1057; found: 523.1052.



4d

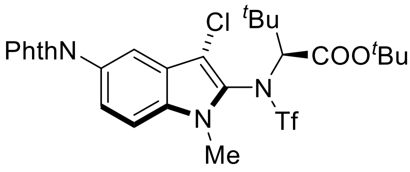
(*S*)-*tert*-butyl-2-((*N*-(3-chloro-5-methoxy-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoro methyl)sulfonamido)-3,3-dimethylbutanoate (4d). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 10:90), **4d** (29.7 mg, 58%, > 20:1 dr) was obtained as a white solid from **1d**, **2a** and NaClO. m.p. 109-110 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.23-7.18 (m, 1H), 7.04-6.97 (m, 2H), 4.49 (s, 1H), 3.87 (s, 3H), 3.58 (s, 3H), 1.53 (s, 9H), 1.12 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.64. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.50, 155.11, 129.84, 125.16, 123.83, 119.53 (q, J = 323 Hz), 116.31,111.61, 107.20, 99.53, 82.89, 72.67, 55.77, 36.02, 32.65, 27.98, 27.14. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{21}H_{28}ClF_3N_2NaO_5S^+$: 535.1257; found: 535.1264.



4e

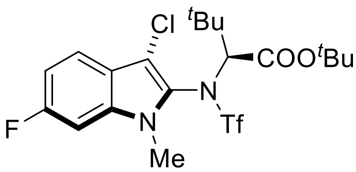
(*S*)-*tert*-butyl-2-((*N*-(5-bromo-3-chloro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluorome thyl)sulfonamido)-3,3-dimethylbutanoate (4e). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4e** (30.8 mg, 55%, > 20:1 dr) was obtained as a white solid from **1e**, **2a** and NaClO. m.p. 124-125 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.78 (d, J = 1.7 Hz, 1H), 7.44 (dd, J = 8.8, 1.9 Hz, 1H), 7.19 (d, J = 8.8 Hz, 1H), 4.49 (s, 1H), 3.59 (s, 3H), 1.53 (s, 9H), 1.11 (s, 9H). ^{19}F NMR

(377 MHz, $CDCl_3$) δ -72.60. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.48, 133.20, 128.01, 126.31, 125.04, 121.83, 119.44 (q, J = 323 Hz), 114.40, 112.08, 107.26, 83.10, 72.75, 36.05, 32.79, 27.98, 27.10. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{20}H_{25}BrClF_3N_2NaO_4S^+$: 583.0257; found: 583.0247.



4f

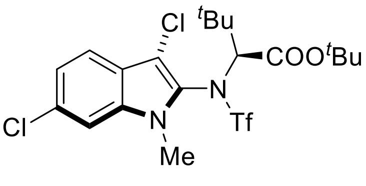
(*S*)-*tert*-butyl-2-((*N*-(3-chloro-5-(1,3-dioxoisoindolin-2-yl)-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (4f). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 15:85), **4f** (32.6 mg, 52%, > 20:1 dr) was obtained as a white solid from **1f**, **2a** and NaClO. m.p. 98-99 °C. ^1H NMR (400 MHz, $CDCl_3$): δ 7.97 (dd, J = 5.4, 3.0 Hz, 2H), 7.80 (dd, J = 5.4, 3.1 Hz, 2H), 7.70 (d, J = 1.6 Hz, 1H), 7.45 (d, J = 8.8 Hz, 1H), 7.37 (dd, J = 8.8, 1.9 Hz, 1H), 4.51 (s, 1H), 3.66 (s, 3H), 1.55 (s, 9H), 1.13 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -72.57. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.81, 167.44, 134.39, 134.01, 131.86, 126.63, 124.99, 124.03, 123.87, 123.76, 118.41, 119.48 (q, J = 323 Hz), 111.31, 108.49, 83.01, 72.85, 36.06, 32.85, 27.99, 27.19. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{28}H_{29}ClF_3N_3O_6S^+$: 627.1418; found: 627.1427.



4g

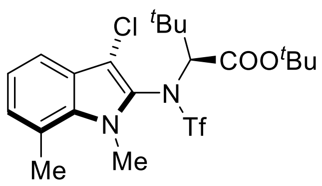
(*S*)-*tert*-butyl-2-((*N*-(3-chloro-6-fluoro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (4g). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4g** (22.0 mg, 44%, > 20:1 dr) was obtained as a white solid from **1g**, **2a** and NaClO. m.p. 110-111 °C. ^1H

NMR (400 MHz, $CDCl_3$): δ 7.57 (dd, J = 9.4, 5.2 Hz, 1H), 7.03 – 6.88 (m, 2H), 4.49 (s, 1H), 3.55 (s, 3H), 1.54 (s, 9H), 1.12 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.63 (s), -115.50 (td, J = 9.5, 5.2 Hz).^{13}C NMR (101 MHz, $CDCl_3$): δ 167.50, 161.54 (d, J = 241 Hz), 134.71 (d, J = 12 Hz), 121.09, 120.84 (d, J = 11.0 Hz), 119.48 (q, J = 323 Hz), 110.33 (d, J = 15.0 Hz), 108.28, 96.66 (d, J =27.0 Hz), 83.04, 72.66, 36.02, 32.74, 27.98, 27.12. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{20}H_{25}ClF_4N_2NaO_4S^+$: 523.1057; found: 523.1078.



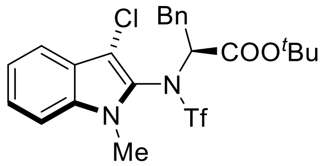
4h

(*S*)-*tert*-butyl-2-((*N*-(3,6-dichloro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl) sulfonamido)-3,3-dimethylbutanoate (4h). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4h** (22.7 mg, 44%, > 20:1 dr) was obtained as a white solid from **1h**, **2a** and NaClO. m.p. 79-80 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, J = 8.5 Hz, 1H), 7.32 (d, J = 1.5 Hz, 1H), 7.18 (dd, J = 8.5, 1.7 Hz, 1H), 4.49 (s, 1H), 3.57 (s, 3H), 1.54 (s, 9H), 1.11 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.62. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.44, 134.84, 131.10, 125.88, 122.11, 121.93, 120.50, 119.45 (q, J = 323 Hz), 110.38, 108.24, 83.09, 72.68, 36.05, 32.74, 27.98, 27.11. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{20}H_{25}Cl_2F_3N_2NaO_4S^+$: 539.0762; found: 539.0759.



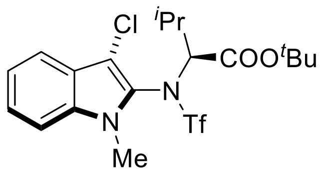
4i

(*S*)-*tert*-butyl-2-((*N*-(3-chloro-1,7-dimethyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl) sulfonamido)-3,3-dimethylbutanoate (4i). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4i** (17.9 mg, 36%, > 20:1 dr) was obtained as a white solid from **1i**, **2a** and NaClO. m.p. 94-95 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.50-7.42 (m, 1H), 7.11-6.99 (m, 2H), 4.47 (s, 1H), 3.80 (s, 3H), 2.77 (s, 3H), 1.54 (s, 9H), 1.10 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$): δ -72.28. ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.40, 134.03, 127.71, 125.63, 124.62,122.25, 120.93, 119.49 (q, J = 323 Hz), 117.32, 108.13, 82.83, 72.72, 36.02, 35.65, 27.98, 27.16, 20.41. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{21}H_{28}ClF_3N_2NaO_4S^+$: 519.1308; found: 519.1279.



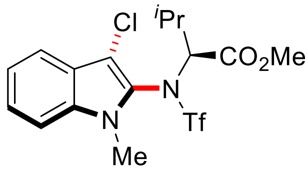
4j

***Tert*-butyl-*N*-(3-chloro-1-methyl-1*H*-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-phenylalaninate (4j).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4j** (48.5 mg, 94%, 3.7:1 dr) was obtained as a white solid from **1a**, **2b** and NaClO. m.p. 110-112 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.66 (d, J = 8.0 Hz, 1H), 7.41-7.37 (m, 2H), 7.25-7.20 (m, 4H), 7.12-7.07 (m, 2H), 4.87 (dd, J = 12.2, 4.7 Hz, 1H), 3.88 (s, 3H), 3.43 (dd, J = 12.8, 4.7 Hz, 1H), 2.60 (t, J = 12.5 Hz, 1H), 1.15 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -73.65. ^{13}C NMR (101 MHz, $CDCl_3$): δ 168.81, 134.14, 129.66, 128.50, 127.36, 124.92, 121.07, 119.17, 119.77 (q, J = 323 Hz), 110.51, 82.88, 66.36, 37.05, 30.80, 27.43. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{23}H_{24}ClF_3N_2NaO_4S^+$: 539.0995; found: 539.0985.



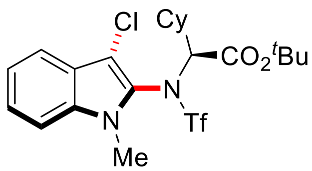
4k

***Tert*-butyl-*N*-(3-chloro-1-methyl-1*H*-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-valinate (4k).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4k** (37.4 mg, 80%, 17.3:1 dr) was obtained as a colourless oil from **1a**, **2c** and NaClO. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 8.0 Hz, 1H), 7.41-7.34 (m, 2H), 7.27-7.19 (m, 1H), 4.57 (d, J = 2.3 Hz, 1H), 4.03 (s, 3H), 2.59-2.34 (m, 1H), 1.56 (s, 10H), 1.19 (d, J = 7.1 Hz, 3H), 0.36 (d, J = 6.8 Hz, 3H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -73.26. ^{13}C NMR (101 MHz, $CDCl_3$): δ 168.34, 134.27, 124.82, 124.30, 123.17, 120.97, 119.02, 119.89 (q, J = 323 Hz), 110.51, 106.48, 83.07, 70.28, 30.83, 28.13, 28.08, 22.08, 16.58. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{19}H_{24}ClF_3N_2NaO_4S^+$: 491.0995; found: 491.0986.



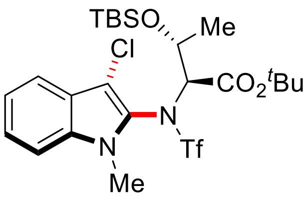
4l

Methyl-*N*-(3-chloro-1-methyl-1*H*-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-valinate (4l). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4l** (26 mg, 61%, 5.8:1 dr) was obtained as a white solid from **1a**, **2d** and NaClO. m.p. 89-91 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66-7.62 (m, 1H), 7.39-7.37 (m, 2H), 7.26-7.22 (m, 1H), 4.70 (d, J = 2.6 Hz, 1H), 3.98 (s, 3H), 3.85 (s, 3H), 2.54-2.38 (m, 1H), 1.17 (d, J = 7.0 Hz, 3H), 0.34 (d, J = 6.7 Hz, 3H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -73.21 (s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.96, 134.34, 124.97, 121.07, 119.10, 118.22 (q, J = 323 Hz), 110.51, 69.91, 52.40, 30.72, 28.23, 21.81, 16.77. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{16}H_{18}ClF_3N_2NaO_4S^+$: 449.0526; found: 449.0533.



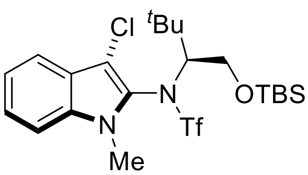
4m

***Tert*-butyl-(S)-2-((*N*-(3-chloro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl) sulfonamido)-2-cyclohexylacetate (4m).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4m** (50.9 mg, 87%, 14.6:1 dr) was obtained as a white solid from **1a**, **2e** and NaClO. m.p. 83-84 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 8.0 Hz, 1H), 7.39-7.34 (m, 2H), 7.24-7.19 (m, 1H), 4.48 (d, J = 2.7 Hz, 1H), 3.98 (s, 3H), 2.14-2.01 (m, 1H), 1.91 (d, J = 12.6 Hz, 1H), 1.78 (d, J = 13.2 Hz, 1H), 1.55 (s, 9H), 1.42 (dd, J = 12.4, 3.3 Hz, 1H), 1.36-1.20 (m, 3H), 1.03-0.88 (m, 1H), 0.80 (d, J = 12.1 Hz, 1H), 0.73-0.57 (m, 2H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -73.38 (s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.50, 134.32, 124.77, 123.17, 120.91, 119.03, 119.84 (q, J = 323 Hz), 110.48, 106.45, 82.99, 70.46, 38.12, 32.38, 30.99, 28.18, 28.12, 26.91, 26.02, 25.94. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{22}H_{28}ClF_3N_2NaO_4S^+$: 531.1308; found: 531.1333.



4n

***Tert*-butyl-*O*-(*tert*-butyldimethylsilyl)-*N*-(3-chloro-1-methyl-1*H*-indol-2-yl)-*N*-((trifluoromethyl)sulfonyl)-*L*-threoninate (4n).** According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4n** (40.4 mg, 69%, 13.1:1 dr) was obtained as a colourless oil from **1a**, **2f** and NaClO. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, J = 8.0 Hz, 1H), 7.34-7.29 (m, 2H), 7.21-7.16 (m, 1H), 4.61 (d, J = 3.3 Hz, 1H), 4.44-4.35 (m, 1H), 3.96 (s, 3H), 1.47 (s, 9H), 0.84 (s, 9H), 0.47 (d, J = 6.1 Hz, 3H), 0.10 (s, 3H), 0.00 (s, 3H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -73.21 (s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.29, 134.15, 125.03, 121.09, 119.14, 119.88 (q, J = 323 Hz), 110.61, 82.72, 69.06, 66.63, 30.88, 27.94, 25.64, 18.81, -4.94, -5.10. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{24}H_{36}ClF_3N_2NaO_5SSi^+$: 607.1653; found: 607.1645.

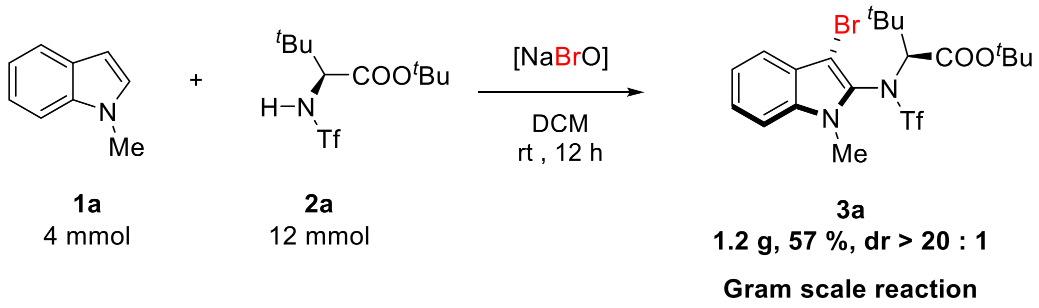


4o

(*S*)-*N*-(1-((tert-butyldimethylsilyl)oxy)-3,3-dimethylbutan-2-yl)-*N*-(3-chloro-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethanesulfonamide (4o). According to the general procedure, Purification by flash chromatography (EtOAc/*n*-Hexane 5:95), **4o** (35.8 mg, 68%, 10.4:1 dr) was obtained as a colourless oil from **1a**, **2g** and NaClO. ^{1}H NMR (400 MHz, CDCl3): δ 7.52 (d, J = 8.0 Hz, 1H), 7.31-7.17 (m, 2H), 7.14-7.03 (m, 1H), 4.04 (dd, J = 8.1, 1.9 Hz, 1H), 3.87 (dd, J = 12.8, 1.9 Hz, 1H), 3.78 (s, 3H), 3.62 (dd, J = 12.8, 8.1 Hz, 1H), 0.98 (s, 9H), 0.83 (s, 9H), 0.01 (d, J = 11.5 Hz, 6H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -72.46. ^{13}C NMR (101 MHz, $CDCl_3$): δ 134.95, 125.82, 124.93, 124.08, 121.04, 119.36, 119.66 (q, J = 323 Hz), 110.37, 78.60, 60.31, 35.70, 31.81, 28.01, 27.95, 25.80, 18.21, -5.05, -5.26. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{22}H_{34}ClF_3N_2NaO_3SSi^+$: 549.1598; found: 549.1576.

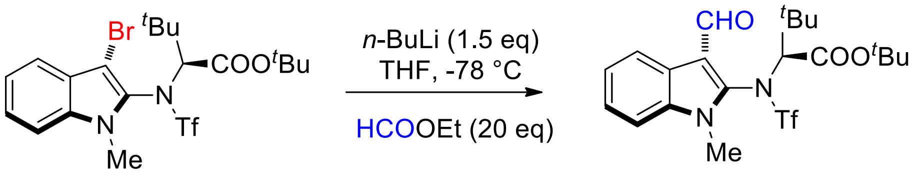
5. Large scale reaction and synthetic application

Gram scale synthesis of 3a



A 100 mL round bottom flask was equipped with a rubber septum and magnetic stir bar. It was charged with indole **1a** (4 mmol, 524.3 mg, 1.0 eq.) and amino acid derivative **2a** (12 mmol, 3.83 g, 3.0 eq.). DCM (80 mL, 0.05 M) and NaBrO (12 mmol, 9.6 mL, 3.0 eq.) was added *via* syringe. The mixture was then stirred for 12 h. After the reaction was complete (as judged by TLC analysis), the mixture was poured into a separatory funnel containing 50 mL of H_2O and 50 mL of DCM. The layers were separated and the aqueous layer was extracted with DCM (2 × 30 mL). The combined organic layers were dried over Na_2SO_4 and concentrated under reduced pressure after filtration. The residue was purified by flash chromatography on silica gel to afford the desired product **3b** (1.2 g, 57%, > 20:1 dr) as a white solid.

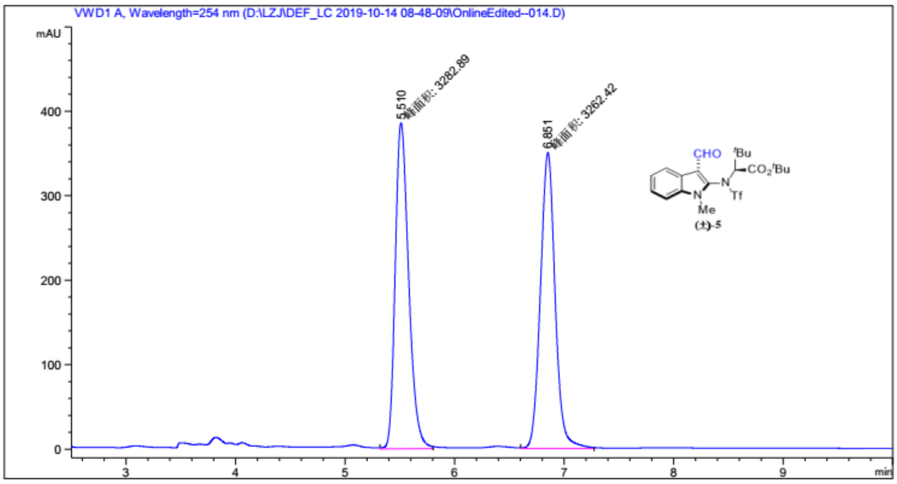
Synthetic application of axially chiral 3-bromoindole derivatives



3a

5
58 %, dr > 20:1

To a solution of (*S*)-*tert*-butyl-2-((*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (**3a**) (1 eq., 105 mg, 0.2 mmol) in THF (2 mL) at -78 °C was added dropwise *n*-BuLi (1.5 eq., 2.5 M, 120 µL, 0.3 mmol). The mixture was stirred 5 min. at -78 °C, then, HCOOEt (20 eq., 0.33 mL, 4 mmol) was added. The resulting mixture was stirred for 30 mim. And then allowed to come back to rt for another 2 h. It was then quenched by a MeOH solution in Et_2O (1mL, MeOH/Et_2O 1 : 10 v/v), diluted with further Et_2O and filtrated on a silica gel plug. Volatiles were removed under reduced pressure and flash chromatography (PE/EA/Et_3N = 100:1:1) afforded *tert*-butyl (*S*)-3,3-dimethyl-2-((1,1,1-trifluoro-*N*-(3-formyl-1-methyl-1*H*-indol-2-yl)methyl)sulfonamido)butanoate **5** (55.2 mg, 0.116 mmol, 58 %) as a white powder with a > 20:1 dr. m.p. = 101-103 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 10.32 (s, 1H), 8.42 (d, J = 7.4 Hz, 1H), 7.55-7.32 (m, 3H), 4.60 (s, 1H), 3.82 (s, 3H), 1.55 (s, 9H), 1.03 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -71.70 (s). ^{13}C NMR (101 MHz, $CDCl_3$): δ 185.15, 167.75, 135.51, 125.48, 124.06, 123.63, 122.67, 119.78(q, J = 323 Hz), 115.89, 110.52, 83.60, 74.19, 36.14, 32.38, 27.91, 27.72. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{21}H_{27}F_3N_2NaO_5S^+$: 499.1490; found: 499.1502. Enantiomeric ratio: > 99:1, determined by HPLC (Daicel Chiralpak AD, hexane / isopropanol = 90/10, flow rate 1 mL/min, T = 25 ^{o}C, 254 nm): t_R = 5.544 min (major), t_R = 6.886 min (minor). (dr >20:1, two stereoisomers were resolved on HPLC column) According to above procedure, (±)-**5** was obtained from (±)-**3a** *n*-BuLi and HCOOEt.



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面积百分比报告

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排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

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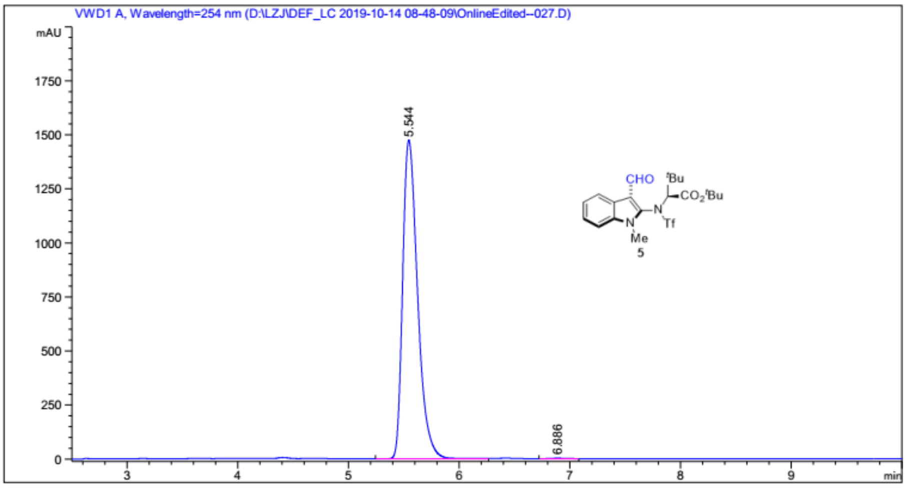
2	6.851	MF	0.1552	3262.42139	350.25558	49.8436



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面积百分比报告

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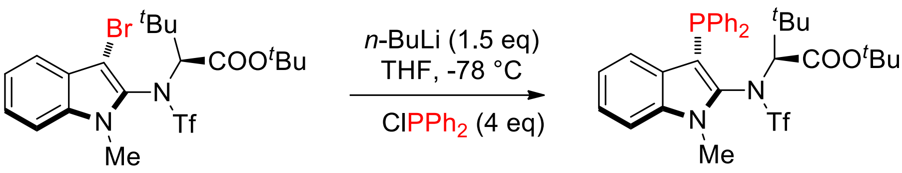
排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	5.544	VV	0.1453	1.38163e4	1474.32629	99.7556
2	6.886	VV	0.1839	33.84718	2.78288	0.2444

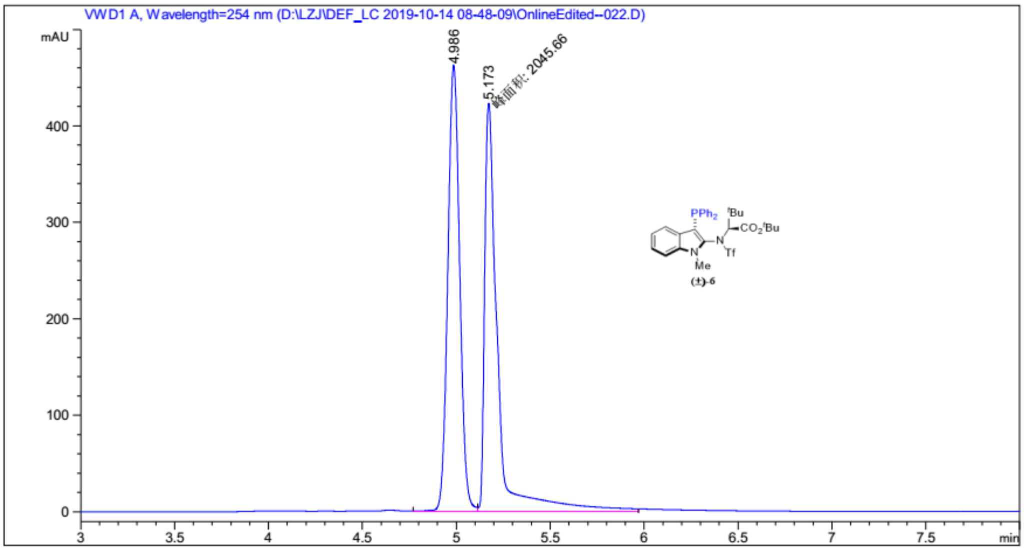


3a

6

52 %, dr > 20:1

To a solution of (*S*)-*tert*-butyl-2-((*N*-(3-bromo-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate (**3a**) (1 eq., 105 mg, 0.2 mmol) in THF (2 mL) at -78 °C was added dropwise *n*-BuLi (1.5 eq., 2.5 M, 120 μL, 0.3 mmol). The mixture was stirred 5 min. at -78 °C, then, freshly distilled $ClPPh_2$ was added. The resulting mixture was stirred for 30 mim. And then allowed to come back to rt for another 2 h. It was then quenched by a MeOH solution in Et_2O (1mL, MeOH/Et_2O 1 : 10 v/v), diluted with further Et_2O and filtrated on a silica gel plug. Volatiles were removed under reduced pressure and flash chromatography (PE/EA/Et_3N = 100:1:1) afforded *tert*-butyl (*S*)-2-((*N*-(3-(diphenylphosphanyl)-1-methyl-1*H*-indol-2-yl)-1,1,1-trifluoromethyl)sulfonamido)-3,3-dimethylbutanoate **6** (65.7 mg, 0.104 mmol, 52 %) as a white powder with a >20:1 dr. m.p. = 125-126 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.65-7.55 (m, 2H), 7.36-7.28 (m, 4H), 7.25-7.19 (m, 3H), 7.17-7.10 (m, 3H), 7.01 (d, J = 8.1 Hz, 1H), 6.93-6.86 (m, 1H), 4.58 (s, 1H), 3.65 (s, 3H), 1.54 (s, 9H), 1.00 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -71.25. ^{31}P NMR (162 MHz, $CDCl_3$): δ -30.48 (q, J = 12.7 Hz). ^{13}C NMR (101 MHz, $CDCl_3$): δ 167.08, 138.41, 138.32, 137.20, 135.48, 135.39, 134.04, 133.85, 131.81, 131.64, 128.25, 128.19, 127.94, 127.89, 127.24, 123.69, 123.41, 120.84, 119.92 (q, J = 323 Hz), 110.68, 82.94, 72.99, 36.57, 33.31, 28.03, 27.52. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{32}H_{36}F_3N_2NaO_4PS^+$: 655.1983; found: 655.1996. Enantiomeric ratio: > 99:1, determined by HPLC (Daicel Chiralpak AD, hexane / isopropanol = 99.3/0.7, flow rate 0.8 mL/min, T = 25 ^{o}C, 254 nm): t_R = 4.642 min (major), t_R = 4.919 min (minor). (dr >20:1, two stereoisomers were resolved on HPLC column). According to above procedure, (±)-**6** was obtained from (±)-**3a** *n*-BuLi and $ClPPh_2$.



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面积百分比报告

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排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
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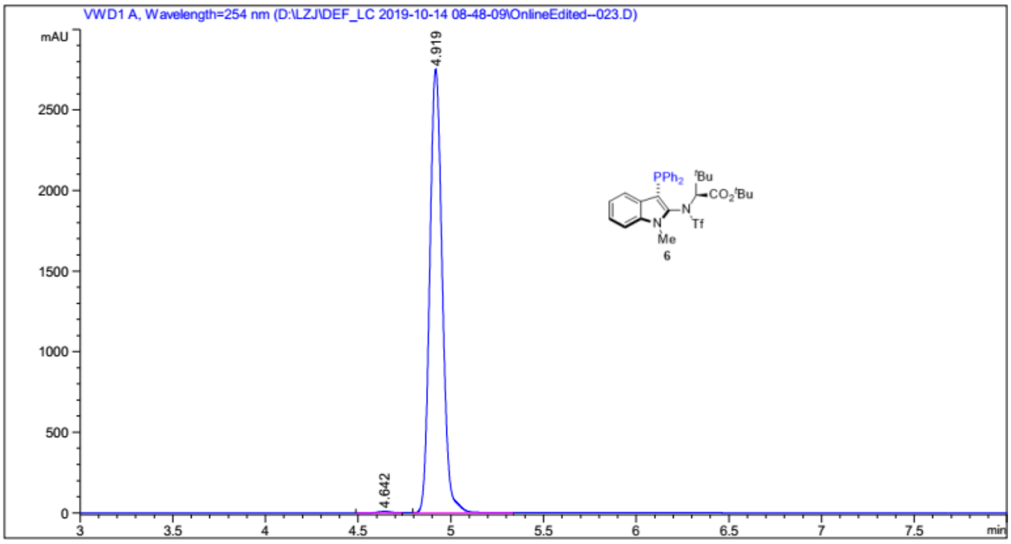
2	5.173	MF	0.0805	2045.66003	423.64609	50.1157

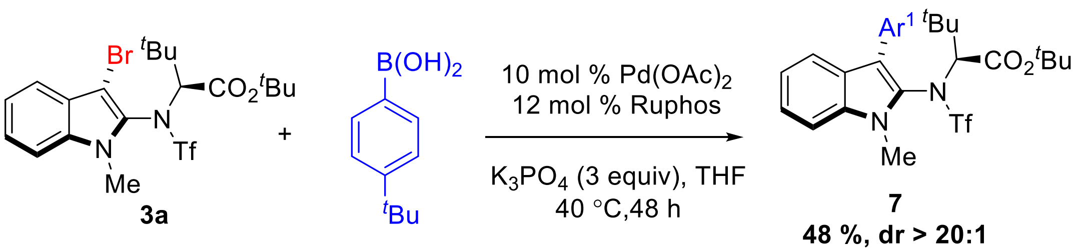


面积百分比报告

排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	4.642	BV	0.0714	43.11052	9.08346	0.3334
2	4.919	VB	0.0737	1.28884e4	2751.06372	99.6666



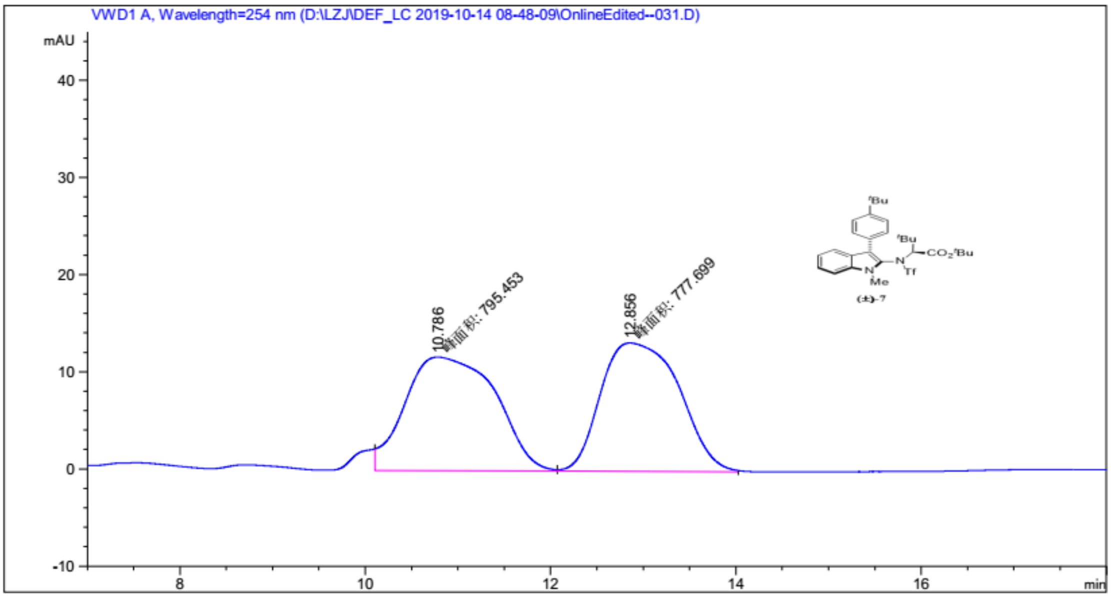
3a

7

48 %, dr > 20:1

Ar^1 = 4-^{t}BuC_6H_5

An oven-dried resealable Schlenk tube was charged with the $Pd(OAc)_2$ (10 mol %), RuPhos (12 mol %), **3a** (0.1 mmol, 1.0 equiv), (4-(*tert*-butyl)phenyl)boronic acid (0.2 mmol, 2.0 equiv), and K_3PO_4 (3 equiv). The Schlenk tube was capped with a rubber septum and twice evacuated and backfilled with argon. THF (1 mL) was injected into the Schlenk tube. The septum was replaced with a Teflon screwcap. The Schlenk tube was sealed, and the mixture was stirred vigorously at the 40 °C for 48 h. The reaction was monitored by TLC analysis. The reaction mixture was then cooled to room temperature, diluted with ethyl acetate and water, extracted, the combined organic layers was dried over androus Na_2SO_4 and concentrated. The crude material was purified by flash chromatography on silica gel. **7** (27.8 mg, 48 %) was afforded as a a colorless liquid with a > 20:1dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, J = 7.5 Hz, 1H), 7.47-7.41 (m, 4H), 7.20 (d, J = 7.7 Hz, 1H), 7.14-7.08 (m, 1H), 7.07-7.03 (m, 1H), 3.70 (s, 3H), 3.50 (d, J = 11.2 Hz, 1H), 1.37 (s, 9H), 1.19 (s, 9H), 0.97 (s, 9H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -78.28. ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.42, 141.28, 139.46, 134.83, 128.97, 127.64, 125.48, 124.37, 123.93, 119.66, 119.60, 119.89 (q, J = 324 Hz), 117.48, 116.14, 108.22, 69.07, 34.58, 31.46, 29.56, 27.77, 26.57. HRMS (ESI) ($[M+Na]^+$) Calcd. for $C_{30}H_{39}F_3N_2NaO_4S^+$: 603.2480; found: 603.2496. Enantiomeric ratio: > 99:1, determined by HPLC (Daicel Chiralpak AD, hexane / isopropanol = 99.3/0.7, flow rate 0.8 mL/min, T = 25 °C, 254 nm): t_R = 12.824 min (major), t_R = 10.786 min (minor). (dr >20:1, two stereoisomers were resolved on HPLC column). According to above procedure, (±)-**7** was obtained from (±)-**3a** and (4-(*tert*-butyl)phenyl)boronic acid.



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面积百分比报告

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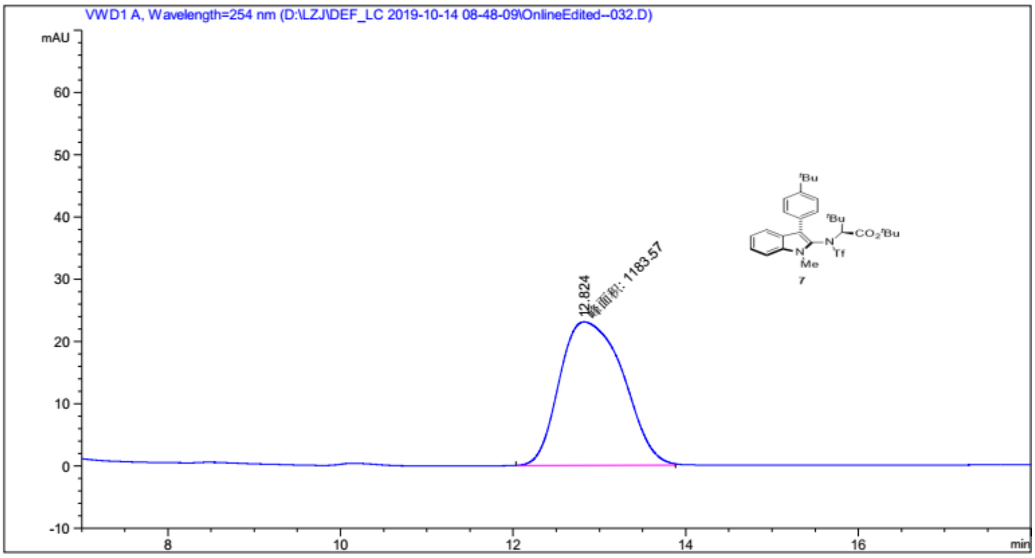
排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	10.786	FM	1.1347	795.45343	11.68365	50.5643
2	12.856	MF	0.9811	777.69861	13.21107	49.4357

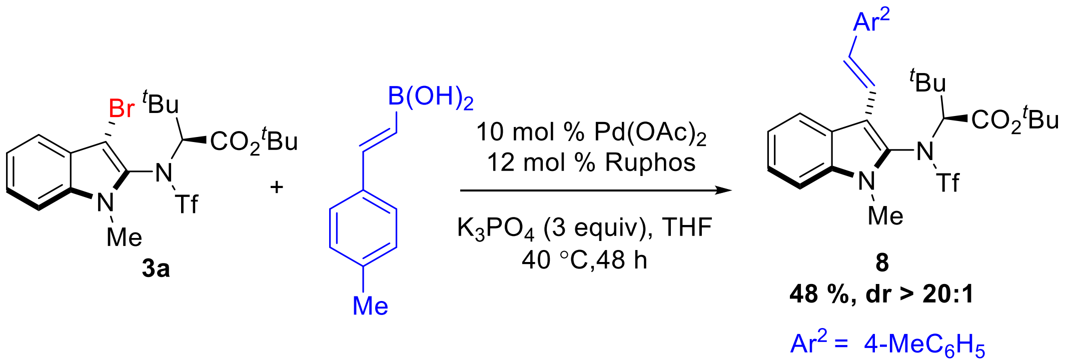


面积百分比报告

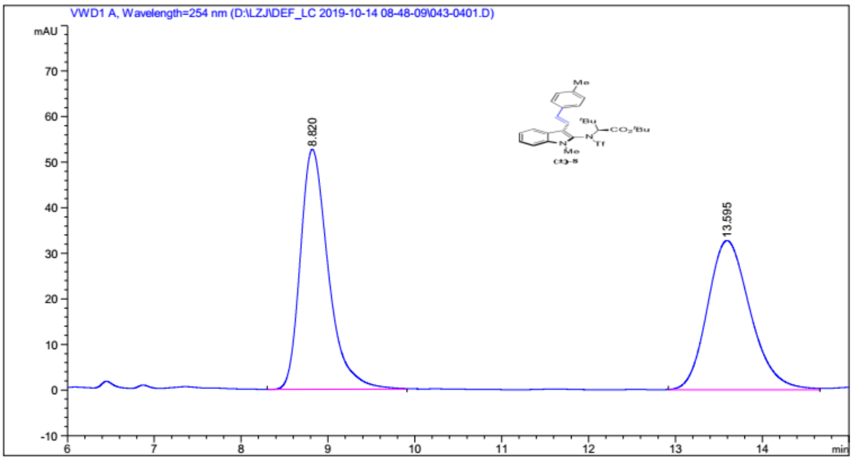
排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	12.824	MF	0.8552	1183.57275	23.06584	100.0000



An oven-dried resealable Schlenk tube was charged with the $Pd(OAc)_2$ (10 mol %), RuPhos (12 mol %), **3a** (0.1 mmol, 1.0 equiv), (*E*)-(4-methylstyryl)boronic acid (0.2 mmol, 2.0 equiv), and K_3PO_4 (3 equiv). The Schlenk tube was capped with a rubber septum and twice evacuated and backfilled with argon. THF (1 mL) was injected into the Schlenk tube. The septum was replaced with a Teflon screwcap. The Schlenk tube was sealed, and the mixture was stirred vigorously at the 40 °C for 48 h. The reaction was monitored by TLC analysis. The reaction mixture was then cooled to room temperature, diluted with ethyl acetate and water, extracted, the combined organic layers was dried over androus Na_2SO_4 and concentrated. The crude material was purified by flash chromatography on silica gel. **8** (29.9 mg, 53 %) was afforded as a colorless liquid with a > 20:1 dr. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88-7.78 (m, 1H), 7.36 (d, J = 8.1 Hz, 2H), 7.20 (d, J = 16.0 Hz, 1H), 7.16-7.12 (m, 1H), 7.11-7.06 (m, 4H), 6.92 (d, J = 16.3 Hz, 1H), 3.59 (s, 3H), 3.42 (s, 1H), 2.28 (s, 3H), 1.24 (s, 9H), 1.10 (s, 9H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -44.99 (s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.94, 143.46, 136.70, 135.58, 135.37, 129.31, 125.60, 125.38, 123.54, 120.59, 120.51, 120.17, 119.41, 119.16 (q, J = 321 Hz), 108.74, 101.33, 81.84, 70.66, 34.87, 29.28, 28.00, 26.79, 21.19. HRMS (ESI) ([M+Na]$^+$) Calcd. for $C_{29}H_{35}F_3N_2NaO_4S$ $^+$: 587.2167; found: 587.2185. Enantiomeric ratio: > 99:1, determined by HPLC (Daicel Chiralpak OD, hexane / isopropanol = 95/5, flow rate 1 mL/min, T = 25 °C, 254 nm): t_R = 8.789 min (major), t_R = 13.595 min (minor). (dr >20:1, two stereoisomers were resolved on HPLC column). According to above procedure, (±)-**7** was obtained from (±)-**3a** and (*E*)-(4-methylstyryl)boronic acid.



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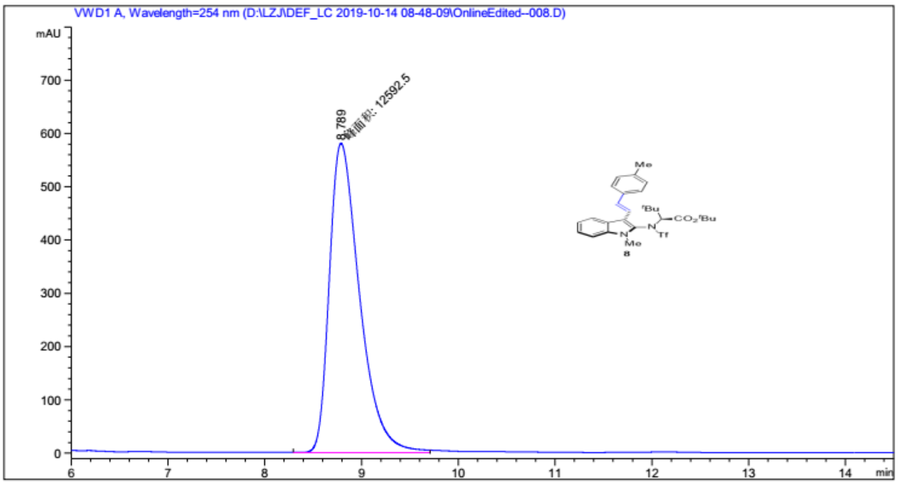
面积百分比报告

===

排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	8.820	VB	0.3408	1177.48096	52.67784	51.1991
2	13.595	BB	0.5279	1122.32837	32.74673	48.8009



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面积百分比报告

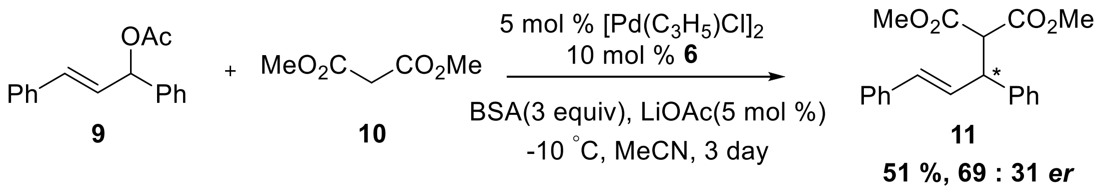
==

排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

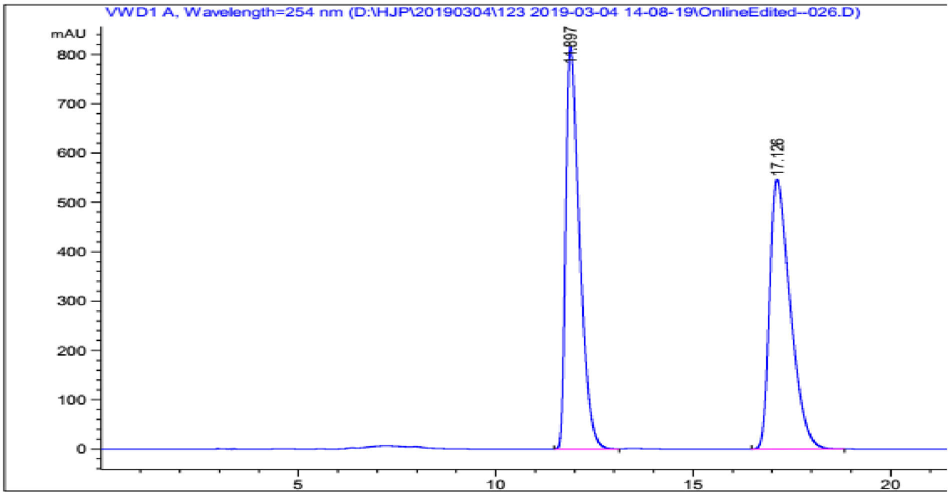
信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	8.789	MF	0.3614	1.25925e4	580.70032	100.0000

Asymmetric allylic substitution reactions



Lithium acetate (0.3 mg, 5%), N,O-bistrimethylsilyl acetamide (BSA, 36.8 uL, 0.15 mmol, 3 equiv), dimethyl malonate **10** (17 uL, 0.15 mmol, 3 equiv), and (*E*)-1,3-diphenylallyl acetate **9** (12.6 mg, 0.05 mmol, 1 equiv) were added to a solution of allylpalladium dichloride dimer (0.9 mg, 10 mol % Pd) and phosphine **6** (3.2 mg, 10 mol %) in MeCN (1 mL) under nitrogen. The mixture was stirred at -10 °C for 72 h, poured into water, extracted into dichloromethane, dried over magnesium sulfate, and concentrated under reduced pressure to give the crude product oil. The crude product was purified by column chromatography (eluting with PE/EA 9:1) to give the substitution product **11** (8.6 mg, 51%, 31:69 *er*), with data matching that described in the literature.[2] ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.35-7.26 (m, 7H), 7.25-7.15 (m, 2H), 6.48 (d, J = 15.8 Hz, 1H), 6.37-6.26 (m, 1H), 4.27 (dd, J = 10.8, 8.6 Hz, 1H), 3.95 (d, J = 10.9 Hz, 1H), 3.70 (s, 3H), 3.52 (s, 3H). ^{13}C NMR (101 MHz, CDCl$_3$): δ 168.22, 167.80, 140.18, 136.84, 131.85, 129.13, 128.74, 128.50, 127.89, 127.59, 127.19, 126.41, 57.67, 52.66, 52.48, 49.21. Enantiomeric ratio: 31:69, determined by HPLC (Daicel Chiralpak AD, hexane/ethanol = 90/10, flow rate 1 mL/min, T = 25 °C, 254 nm): t_R = 14.81 min (major), t_R = 10.84 min (minor).

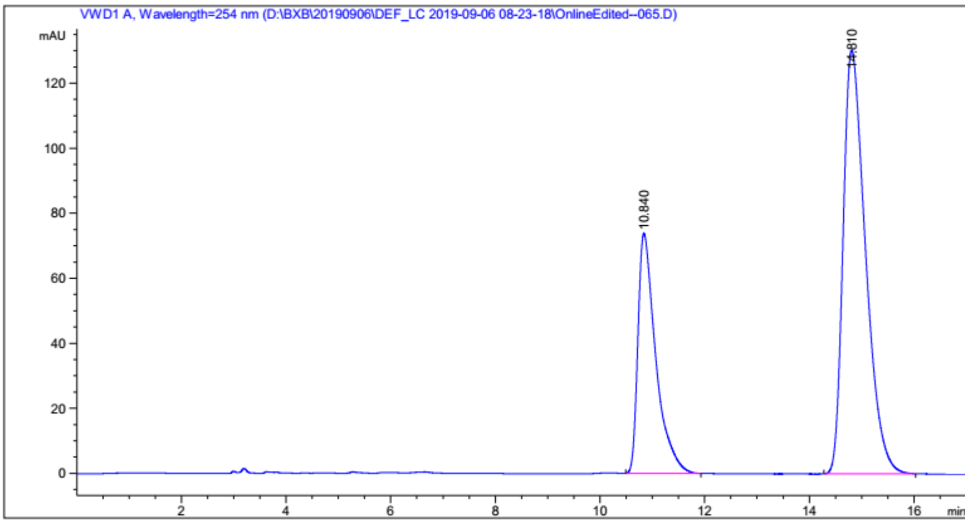


面积百分比报告

排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	11.897	BB	0.3628	1.98499e4	815.98450	50.0029
2	17.126	BB	0.5445	1.98476e4	546.80811	49.9971



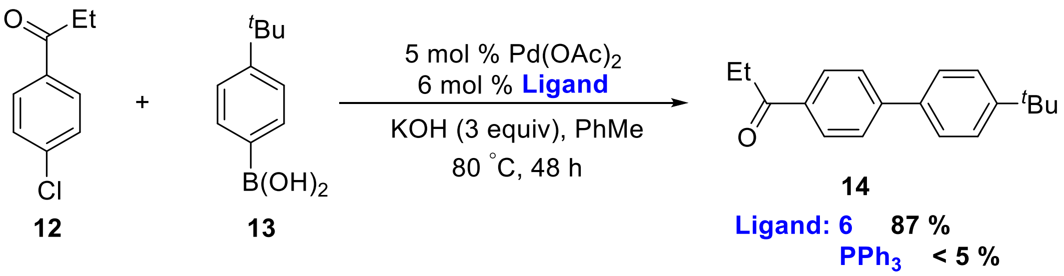
面积百分比报告

排序 : 信号
乘积因子 : 1.0000
稀释因子 : 1.0000
内标使用乘积因子和稀释因子

信号 1: VWD1 A, Wavelength=254 nm

峰 #	保留时间 [min]	类型	峰宽 [min]	峰面积 [mAU*s]	峰高 [mAU]	峰面积 %
1	10.840	BB	0.3489	1745.73706	73.80879	31.0676
2	14.810	BB	0.4505	3873.42554	130.42743	68.9324

Suzuki-Miyaura coupling reaction of less reactive aryl chloride



An oven-dried resealable Schlenk tube was charged with the $Pd(OAc)_2$ (5 mol %), ligand (6 mol %), aryl chloride **12** (0.1 mmol, 1.0 equiv), boronic acid **13** (0.2 mmol, 2.0 equiv), and KOH (3 equiv). The Schlenk tube was capped with a rubber septum and twice evacuated and backfilled with argon. toluene (1 mL) was injected into the Schlenk tube. The septum was replaced with a Teflon screwcap. The Schlenk tube was sealed, and the mixture was stirred vigorously at the 80 °C for 48 h. The reaction was monitored by TLC analysis. The reaction mixture was then cooled to room temperature, diluted with ethyl acetate and water, extracted, the combined organic layers was dried over androus Na_2SO_4 and concentrated. The crude material was purified by flash chromatography on silica gel. to give the product **14** (65.7 mg, 0.104 mmol, 87 %) as a white powder, with data matching that described in the literature.[3] ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06-8.00 (m, 2H), 7.71-7.65 (m, 2H), 7.61-7.55 (m, 2H), 7.53-7.45 (m, 2H), 3.04 (q, *J* = 7.2 Hz, 2H), 1.38 (s, 9H), 1.26 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) *δ* 200.51, 151.40, 145.41, 137.00, 135.39, 128.59, 127.00, 126.93, 125.94, 34.65, 31.83, 31.33, 8.36.

References:

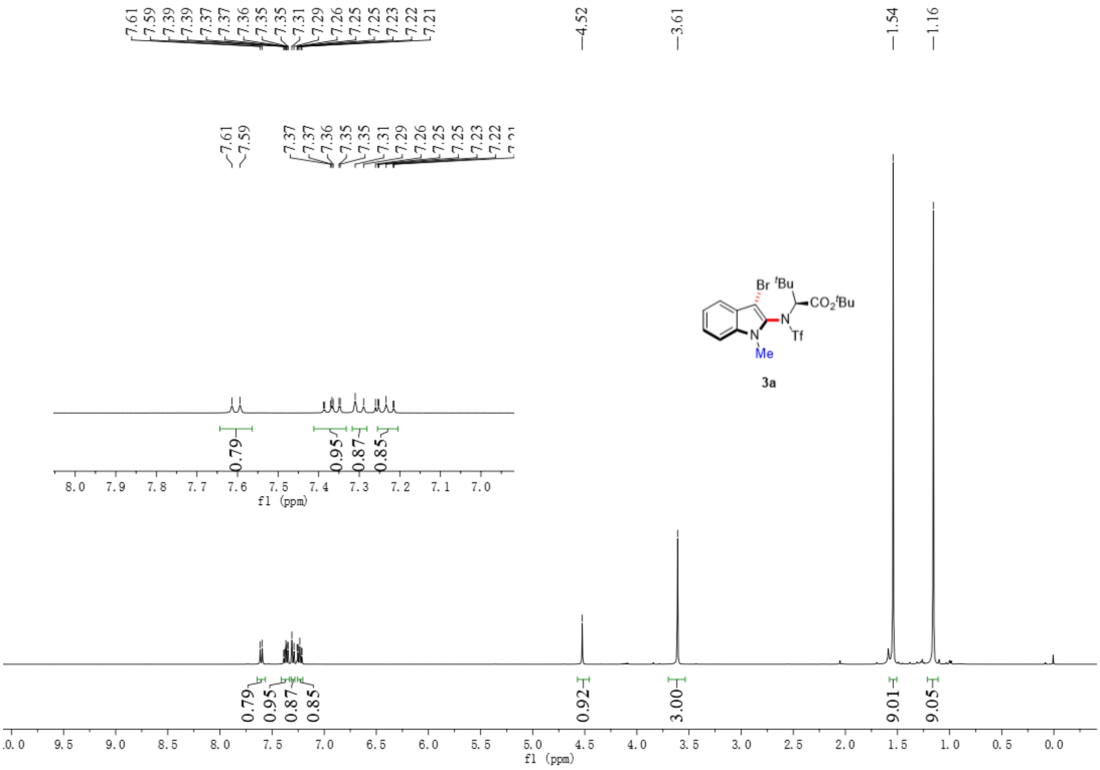
1. Fukumoto, K.; Ohno, H. *Angew. Chem. Int. Ed.* **2007**, *46*, 1852-1855.

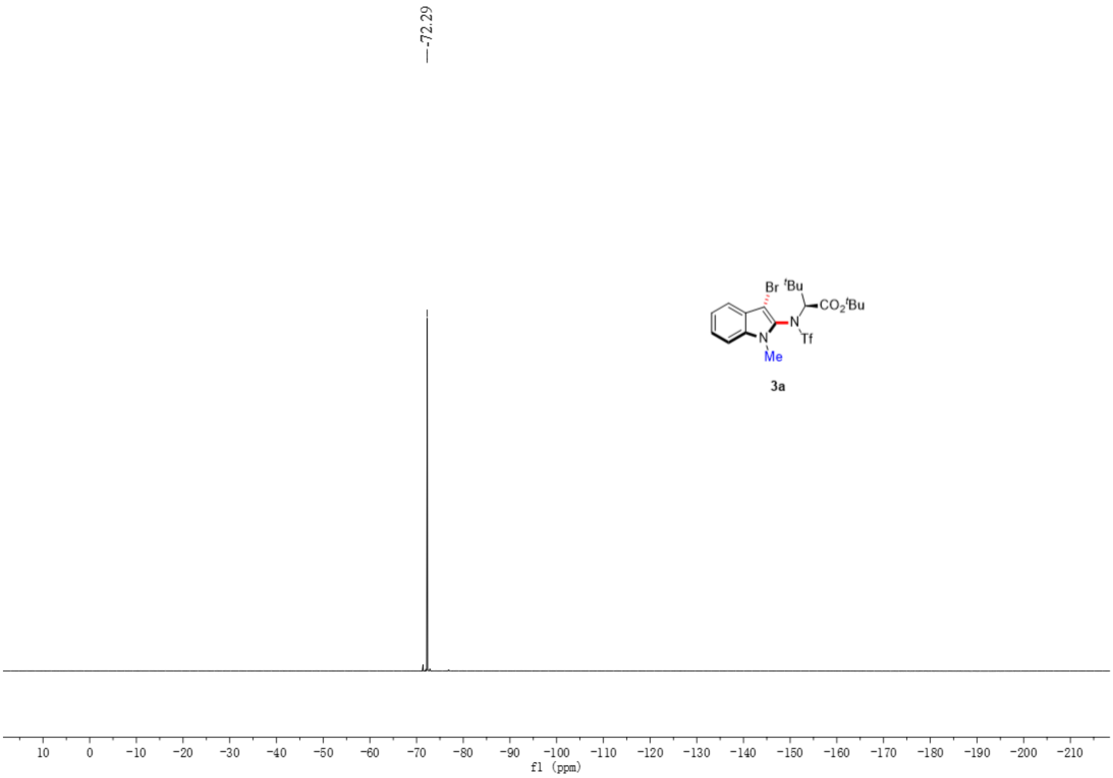
2. Breeden, S.; Wills, M. *J. Org. Chem.* **1999**, *64*, 9735-9738.

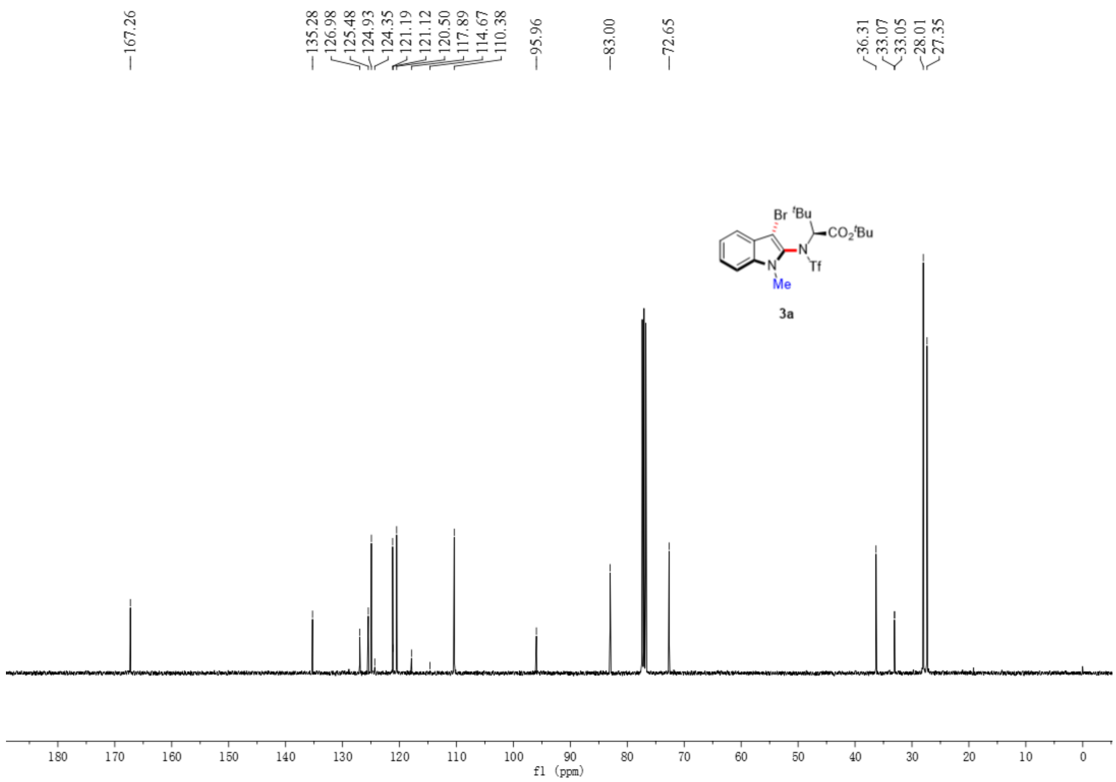
3. Guo, B.; Li, H.-X.; Zha, C.-H.; Young, D. J.; Li, H.-Y.; Lang, J.-P. *ChemSusChem*. **2019**, *12*, 1421-1427.

8. NMR spectra for all compounds

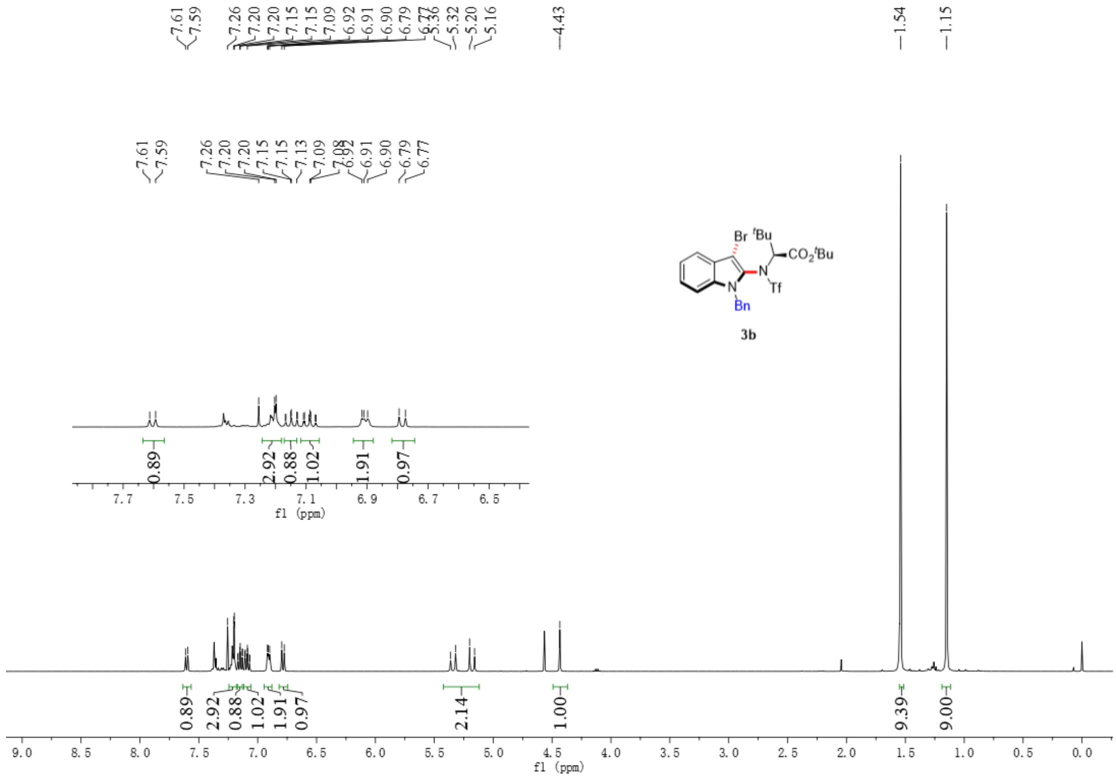
All of the ^1H NMR (400 MHz), ^{13}C NMR (101 MHz) and ^{19}F (376 MHz) were measured on a Bruker AVANCE III-400 spectrometer. $CDCl_3$ was used as the solvent.



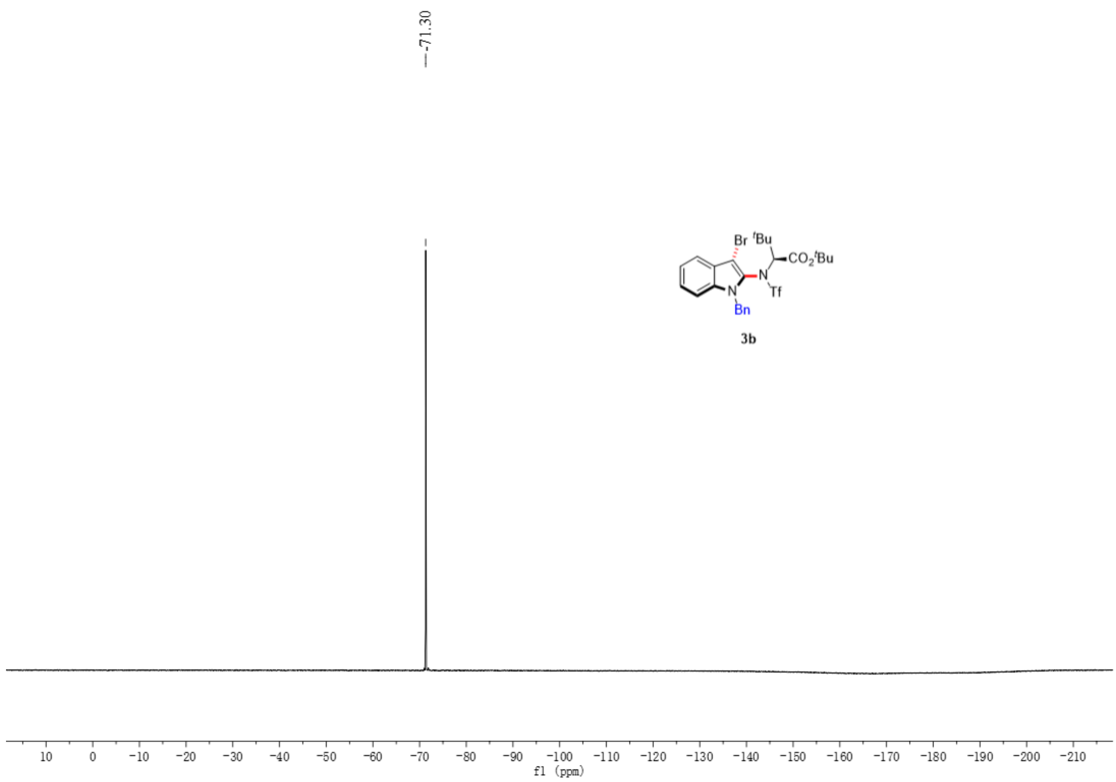




167.26
135.28
126.98
125.48
124.93
124.35
121.19
121.12
120.50
117.89
114.67
110.38
95.96
83.00
72.65
36.31
33.07
33.05
28.01
27.35
Br
tBu
CO2tBu
N
Tf
Me
3a
fl (ppm)



7.61
7.59
7.26
7.20
7.20
7.15
7.15
7.13
7.09
7.08
6.92
6.91
6.90
6.79
6.77
5.36
5.32
5.20
5.16
4.43
1.54
1.15
Br
tBu
CO2tBu
N
Tf
Bn
3b
0.89
2.92
0.88
1.02
1.91
0.97
2.14
1.00
9.39
9.00
fl (ppm)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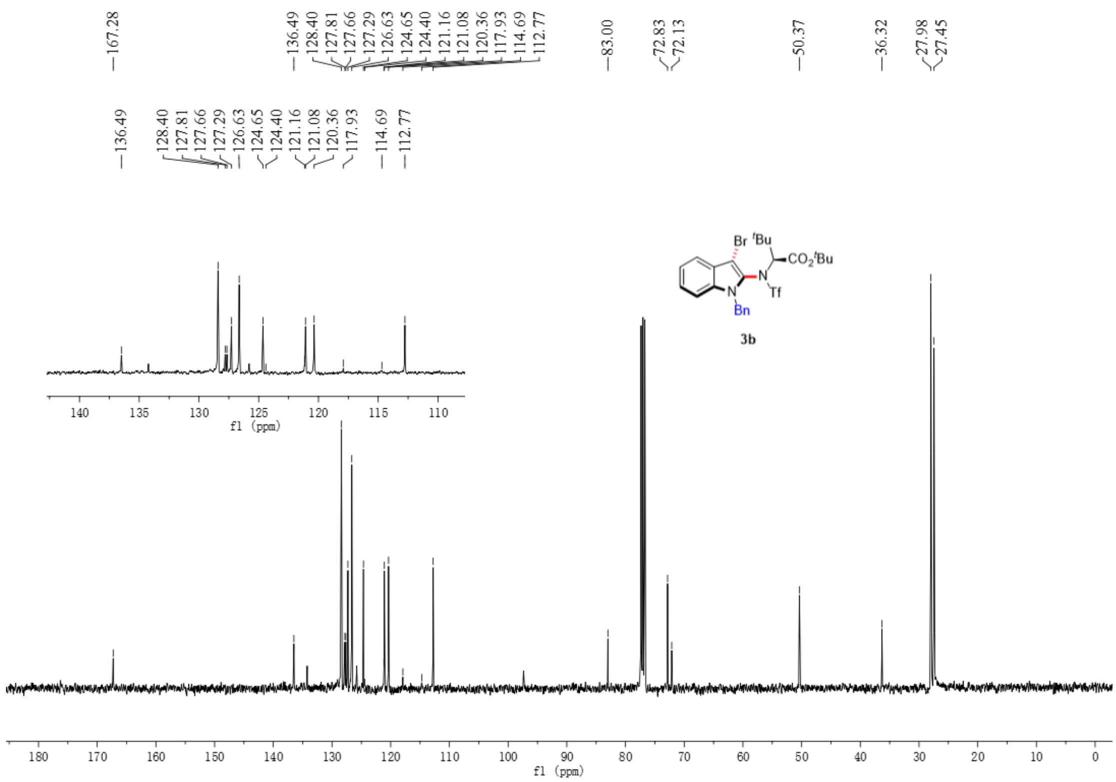
Br
tBu
CO2tBu
N
Tf
N
Bn
3b
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)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127.81
127.66
127.29
126.63
124.65
124.40
121.16
121.08
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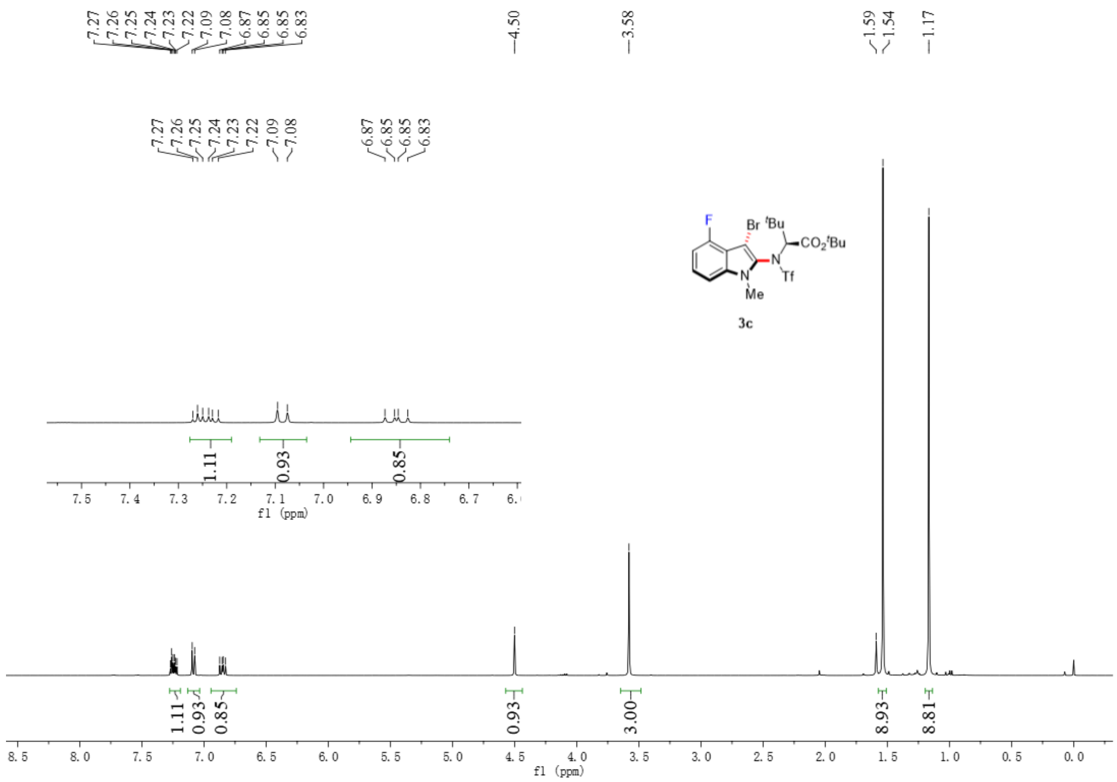
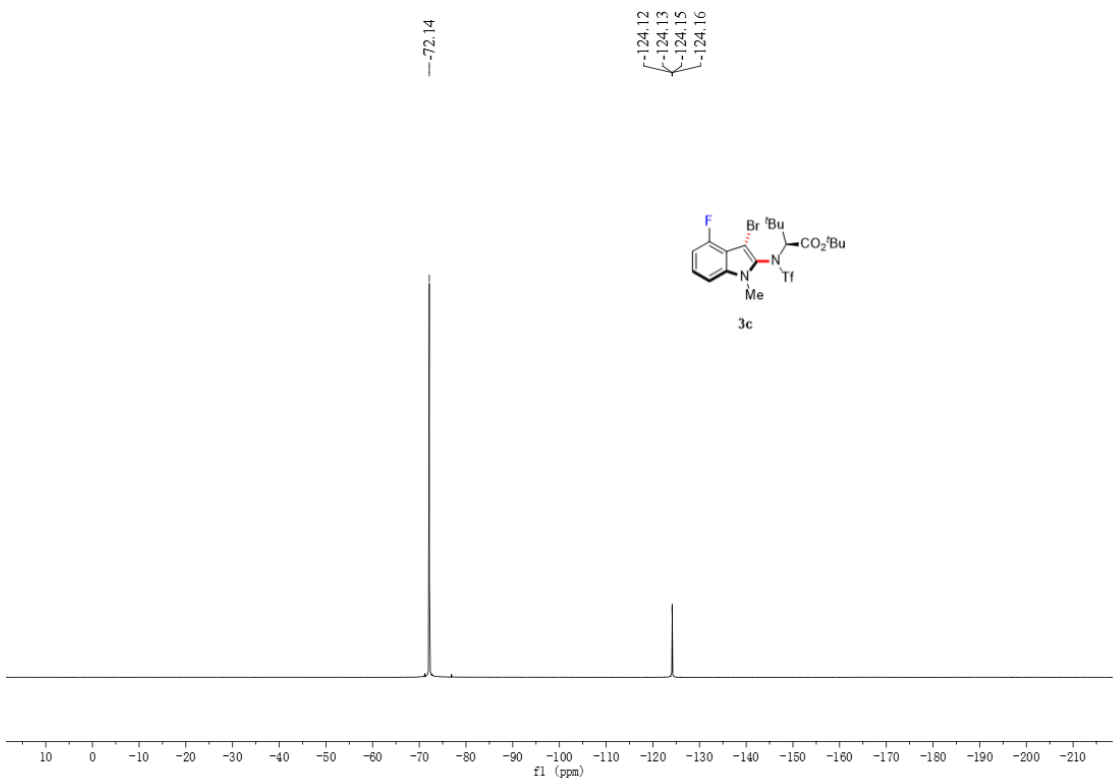
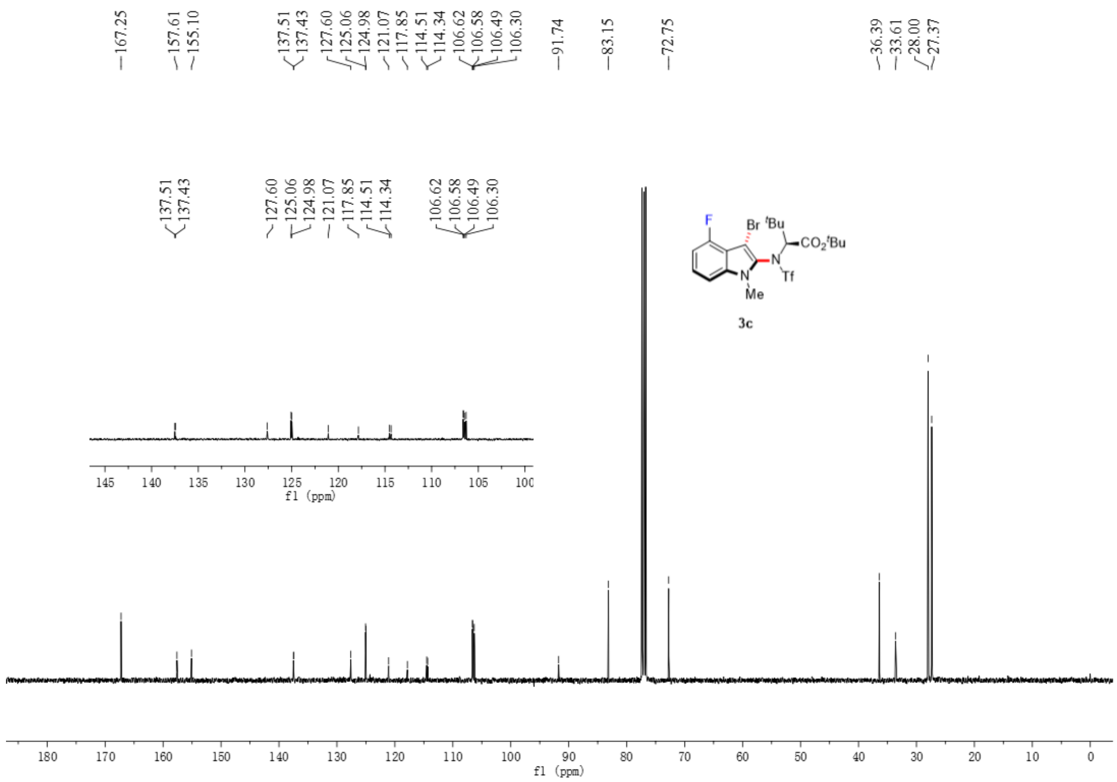
114.69
112.77
83.00
72.83
72.13
50.37
36.32
27.98
27.45
Br
tBu
CO2tBu
N
Tf
N
Bn
3b
140 135 130 125 120 115 110
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



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157.61
155.10
137.51
137.43
127.60
125.06
124.98
121.07
117.85
114.51
114.34
106.62
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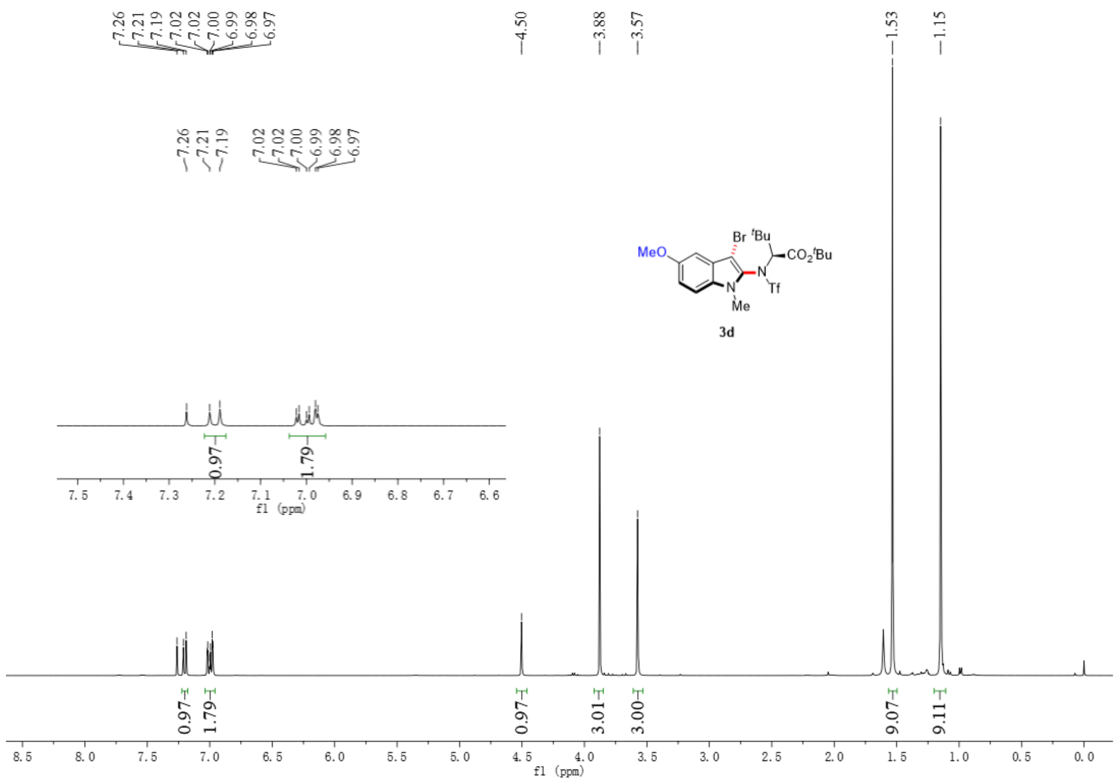
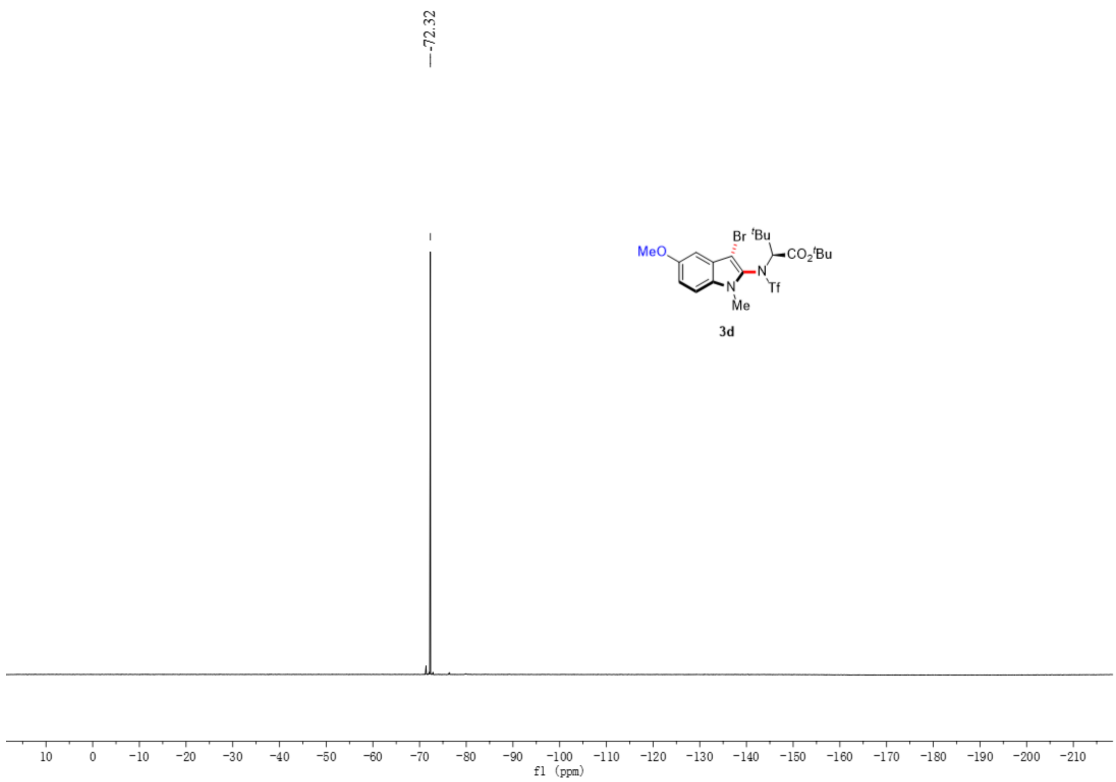
27.37
3c
f1 (ppm)


7.26
7.21
7.19
7.02
7.02
7.00
6.99
6.98
6.97
4.50
3.88
3.57
1.53
1.15
3d
0.97
1.79
0.97
3.01
3.00
9.07
9.11
f1 (ppm)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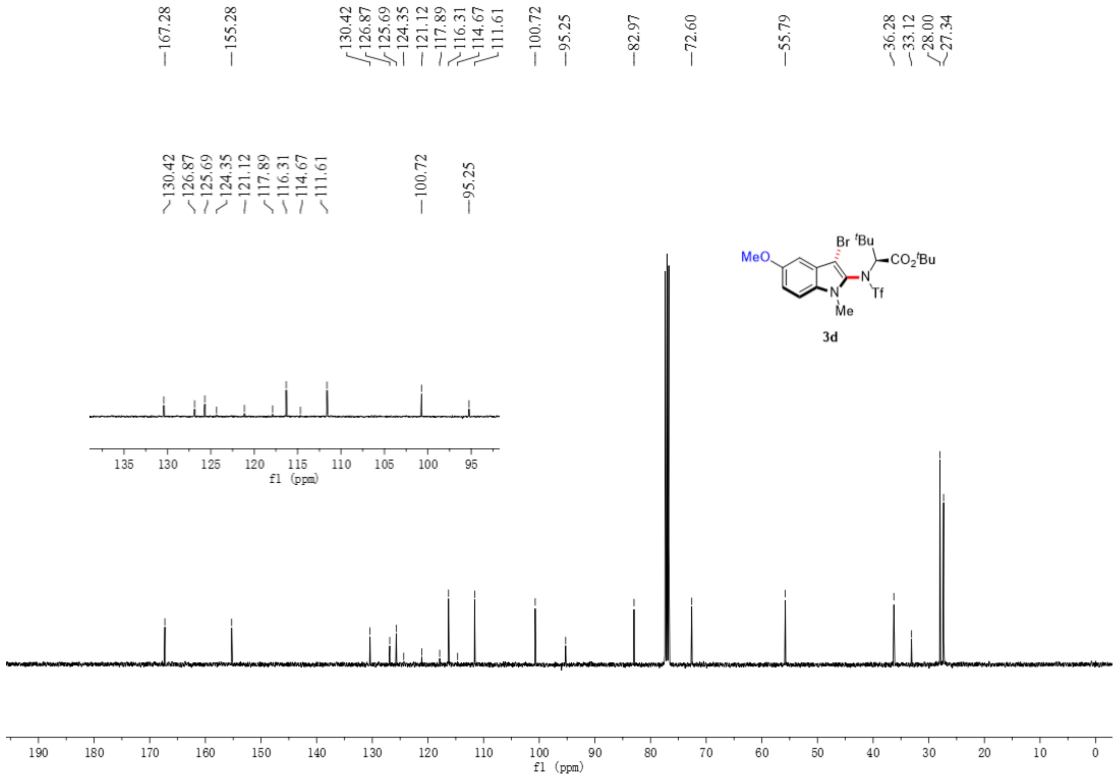
Tf
Me
3d
f1 (ppm)


167.28
155.28
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121.12
117.89
116.31
114.67
111.61
100.72
95.25
82.97
72.60
55.79
36.28
33.12
28.00
27.34
MeO
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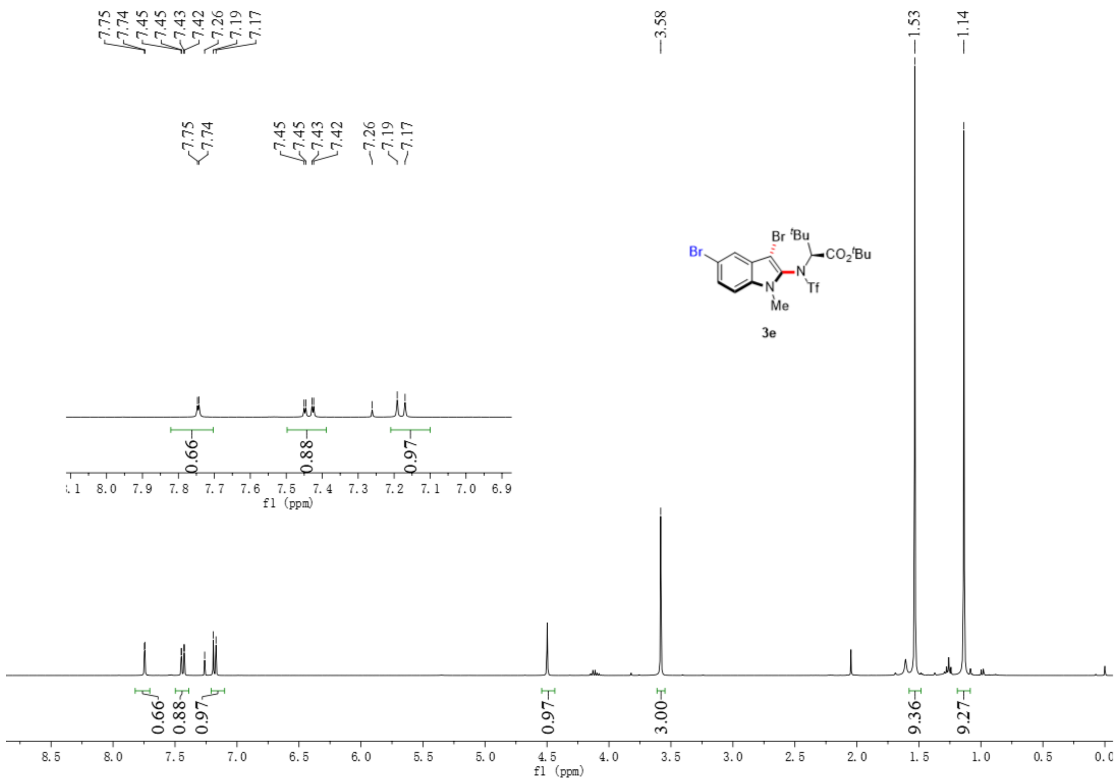
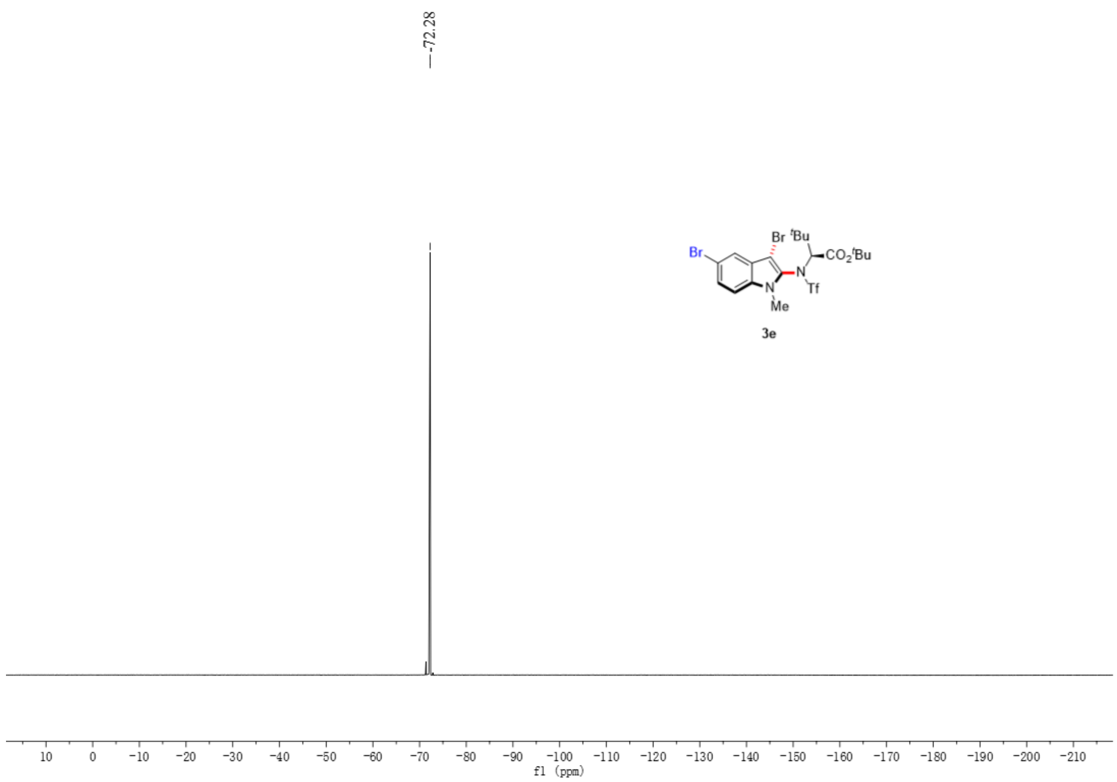
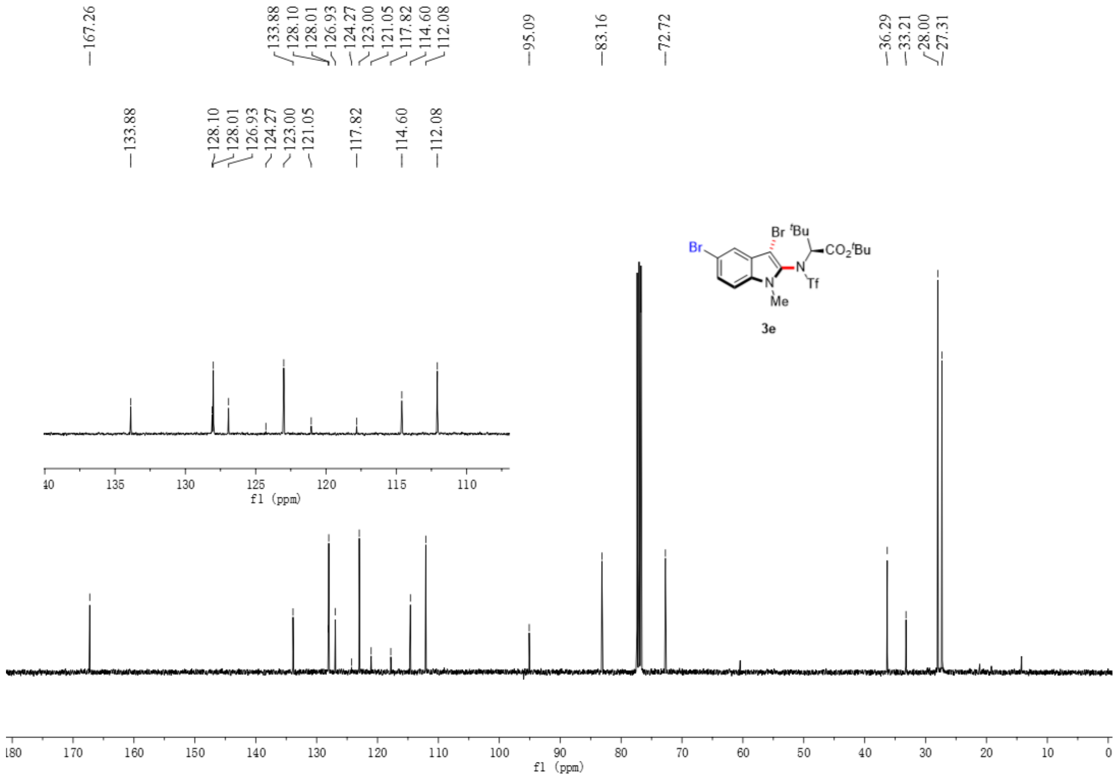
tBu
CO2tBu
N
Tf
Me
3d
f1 (ppm)



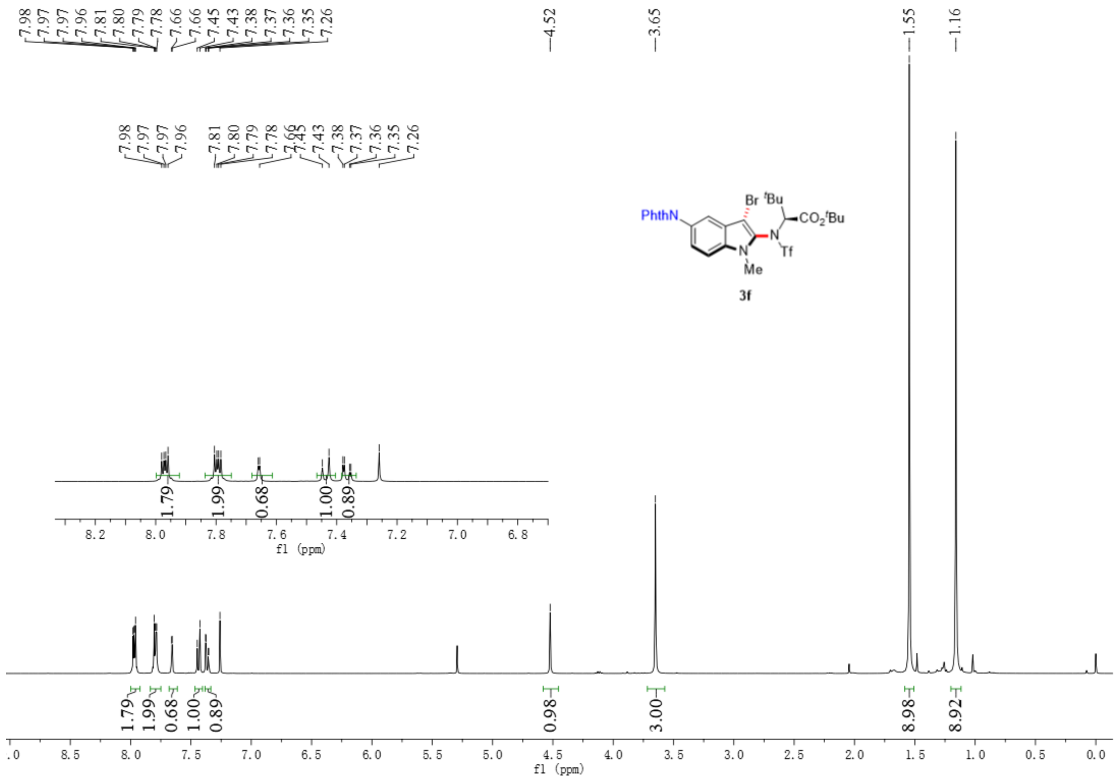
3e



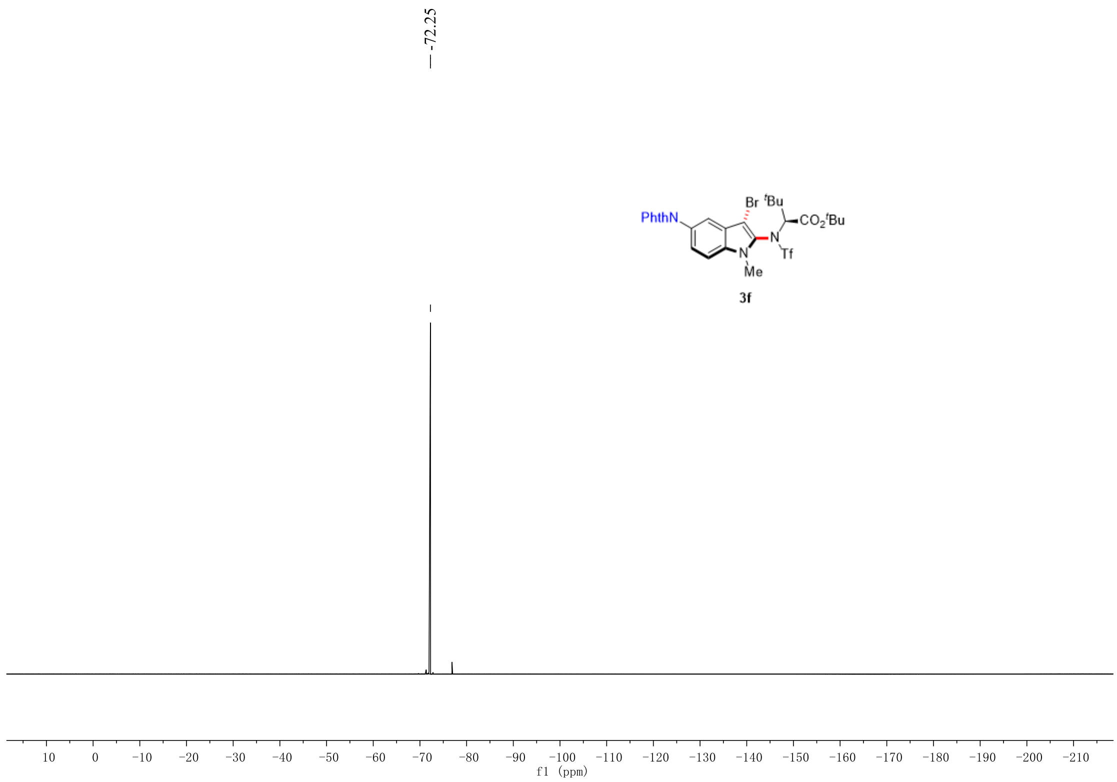
3e



167.26
133.88
128.10
128.01
126.93
124.27
123.00
121.05
117.82
114.60
112.08
95.09
83.16
72.72
36.29
33.21
28.00
27.31
Br
Br
tBu
CO2tBu
N
Tf
N
Me
3e
f1 (ppm)



7.98
7.97
7.97
7.96
7.81
7.80
7.79
7.78
7.66
7.66
7.45
7.43
7.38
7.37
7.36
7.35
7.26
4.52
3.65
1.55
1.16
PhthN
Br
tBu
CO2tBu
N
Tf
N
Me
3f
1.79
1.99
0.68
1.00
0.89
0.98
3.00
8.98
8.92
f1 (ppm)



-72.25
PhthN
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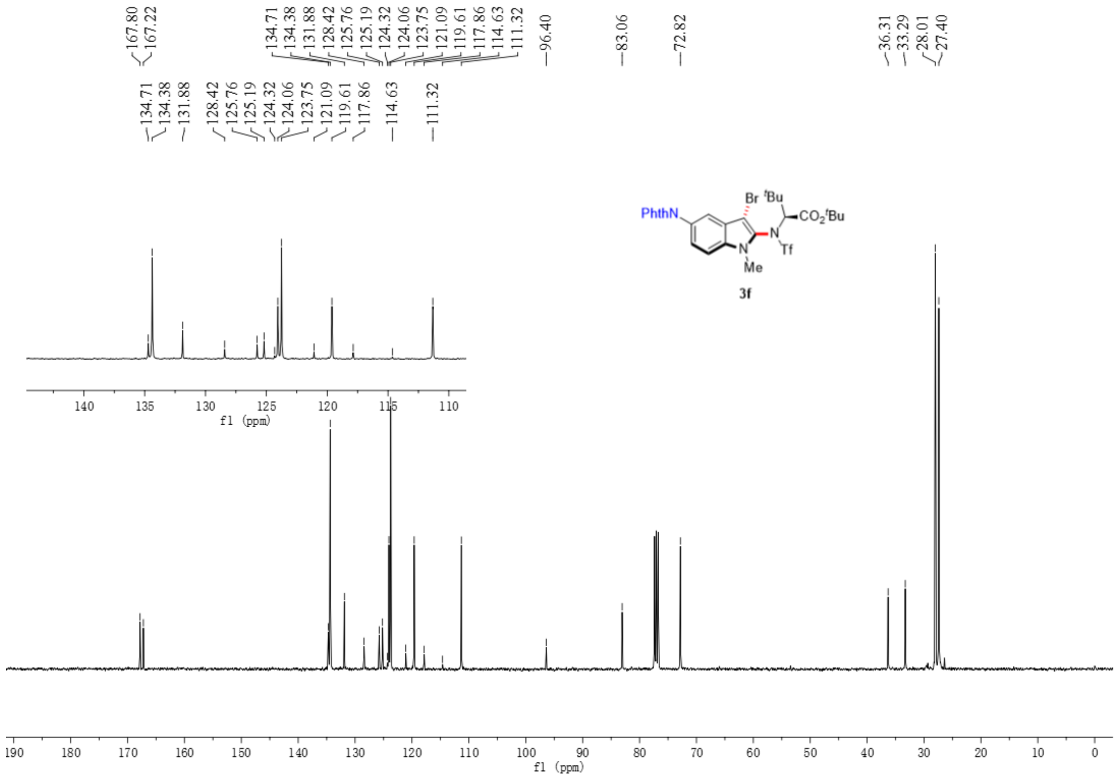
Tf
Me
3f
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)



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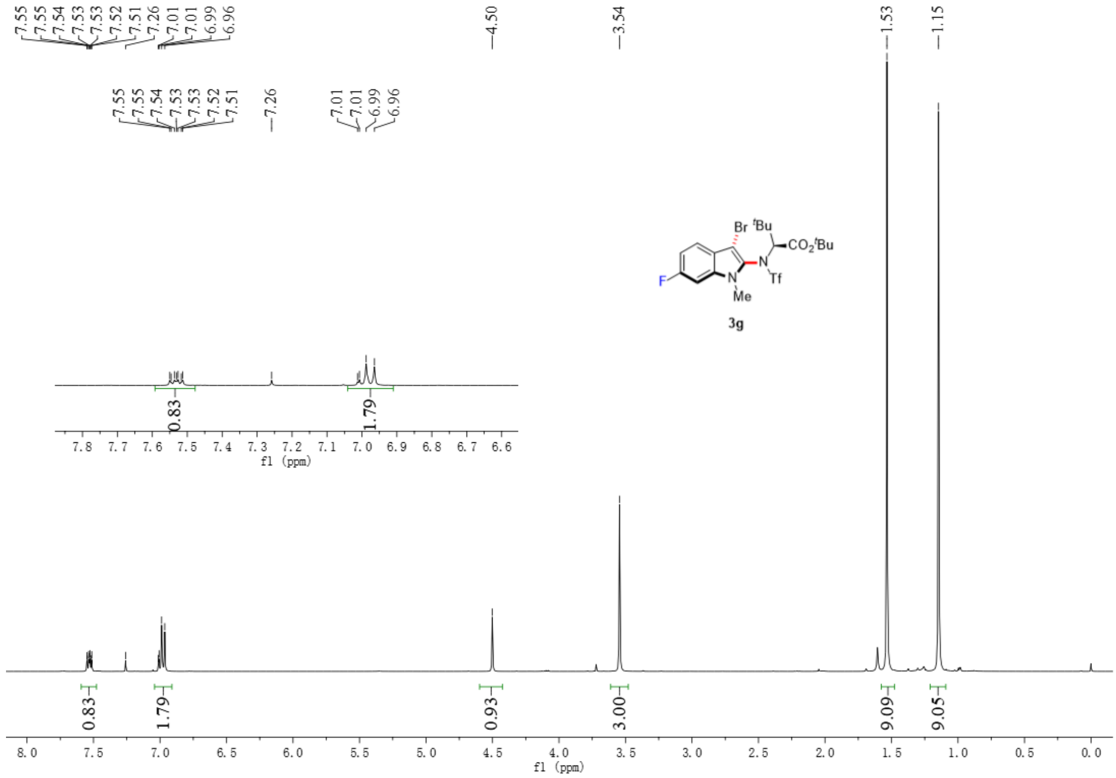
125.19
124.32
124.06
123.75
121.09
119.61
117.86
114.63
111.32
96.40
83.06
72.82
36.31
33.29
28.01
27.40
PhthN
Br
tBu
CO2tBu
N
Tf
Me
3f
140 135 130 125 120 115 110
f1 (ppm)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.01
6.99
6.96
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3.54
1.53
1.15
Br
tBu
CO2tBu
N
Tf
F
N
Me
3g
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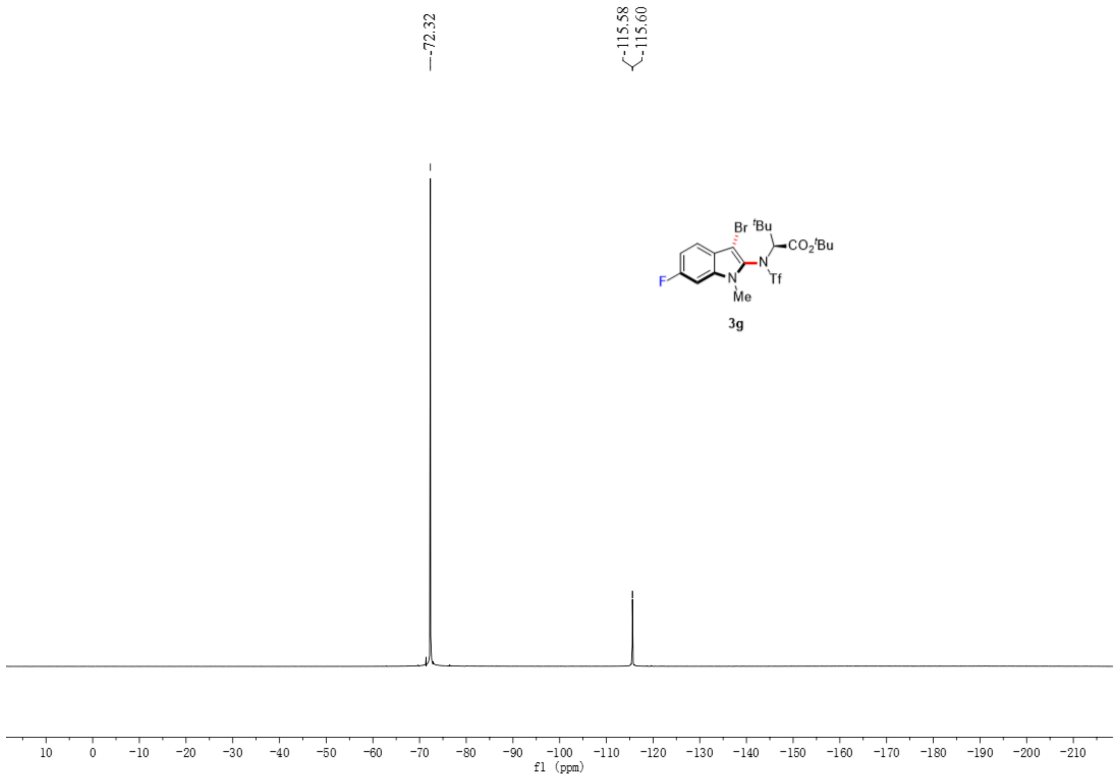
1.79
0.93
3.00
9.09
9.05
fl (ppm)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-115.60
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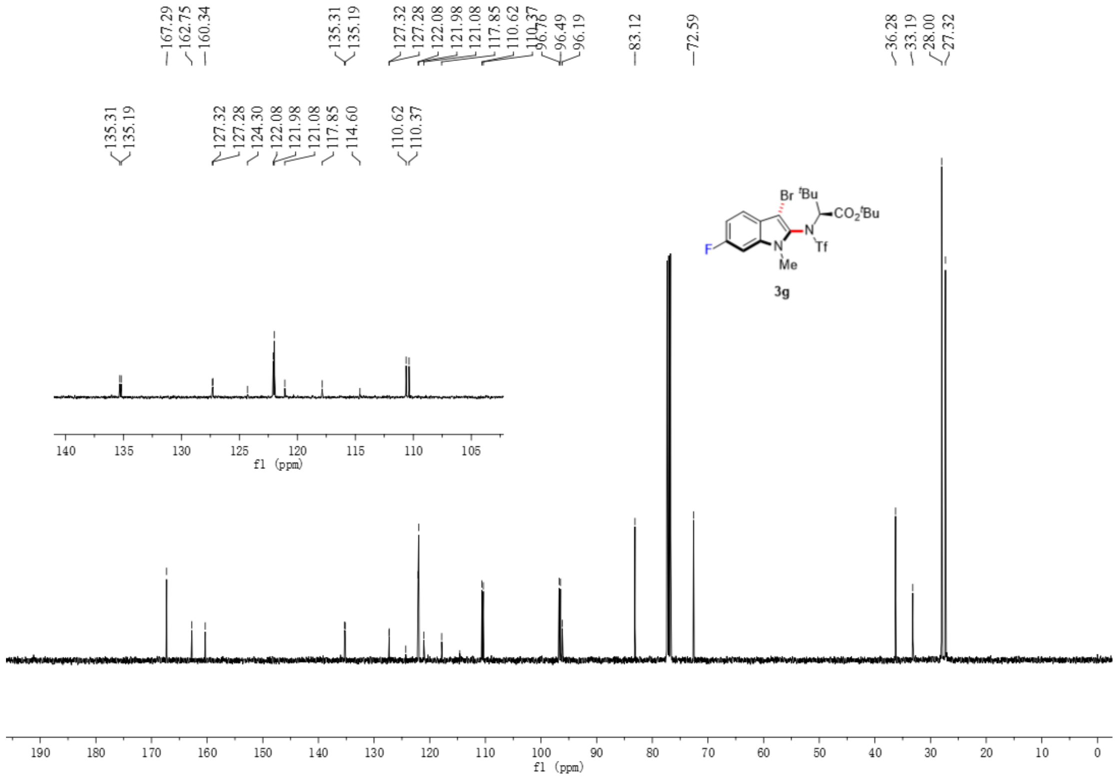
tBu
CO2tBu
N
Tf
F
N
Me
3g
fl (ppm)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122.08
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121.08
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110.37
96.76
96.49
96.19
83.12
72.59
36.28
33.19
28.00
27.32
135.31
135.19
127.32
127.28
124.30
122.08
121.98
121.08
117.85
114.60
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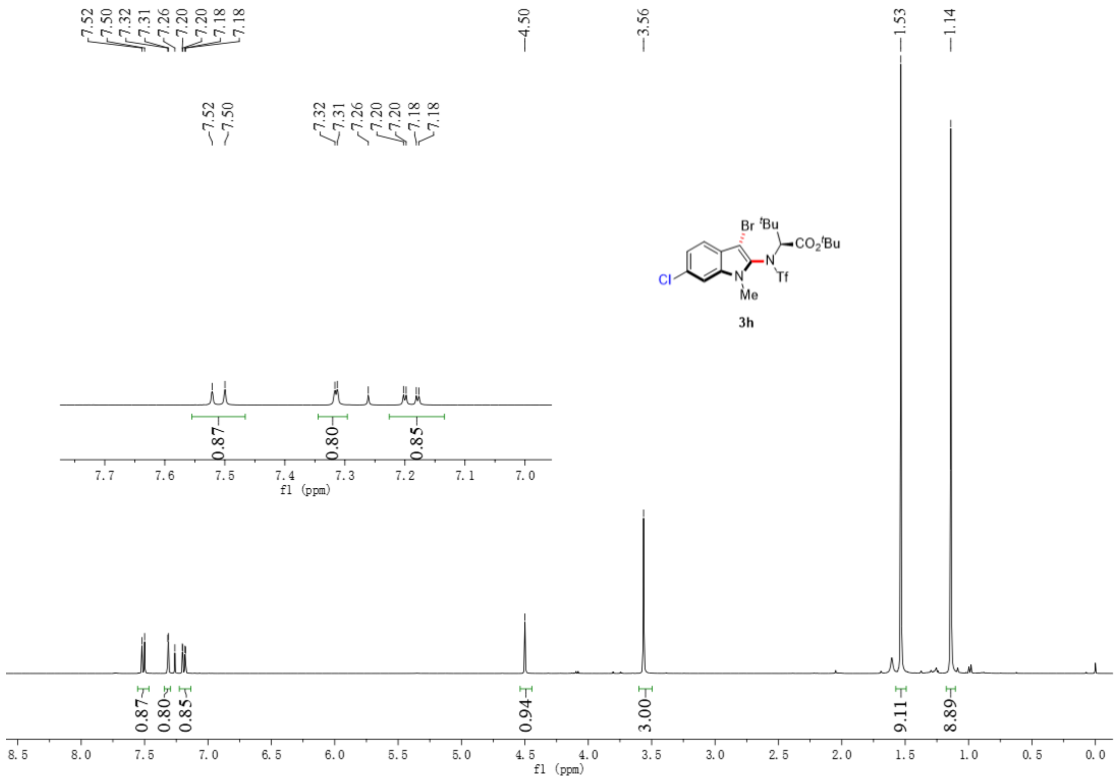
Br
^{t}Bu
$CO_2{}^t$Bu
F
N
N
Tf
Me
3g
f1 (ppm)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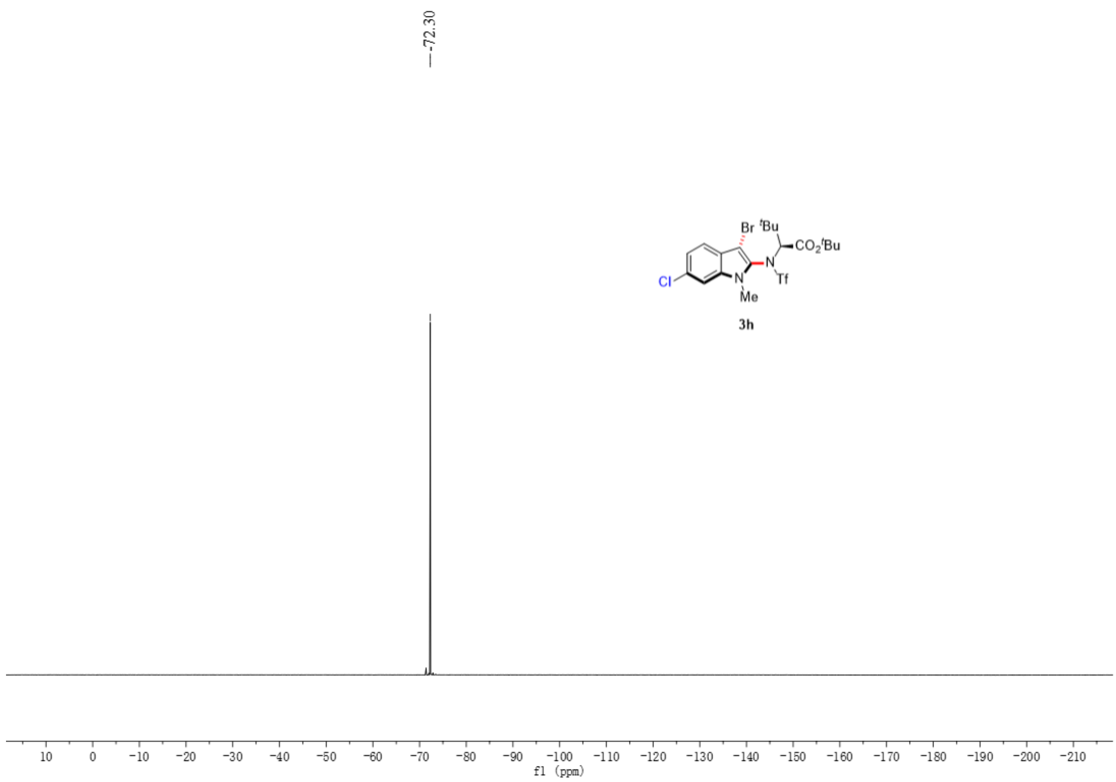
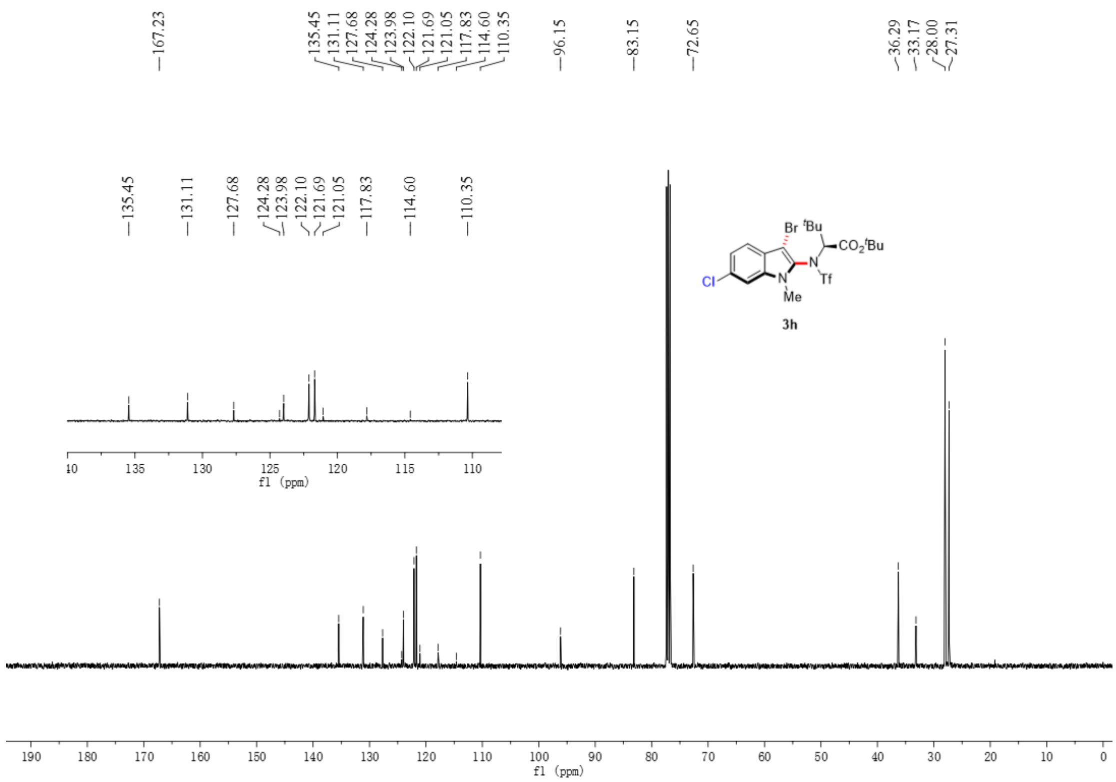
7.18
7.18
4.50
3.56
1.53
1.14
Br
^{t}Bu
$CO_2{}^t$Bu
Cl
N
N
Tf
Me
3h
0.87
0.80
0.85
0.94
3.00
9.11
8.89
f1 (ppm)



-72.30
Br
tBu
CO2tBu
N
Tf
Cl
N
Me
3h
f1 (ppm)



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135.45
131.11
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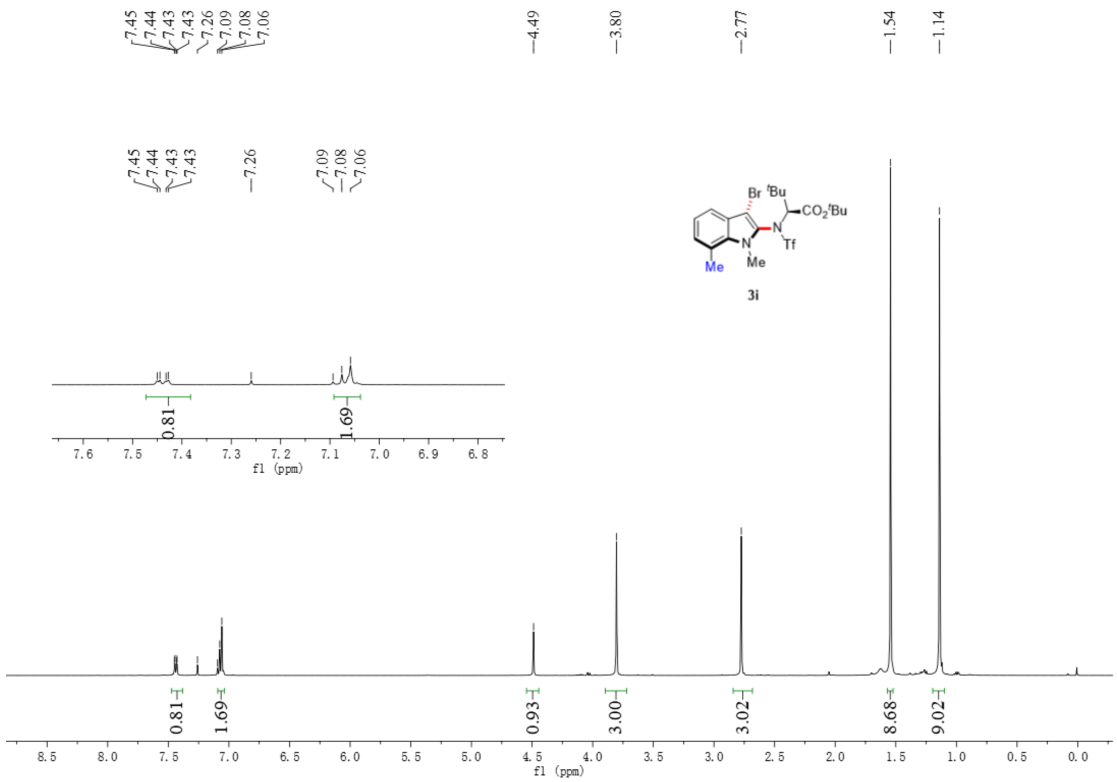
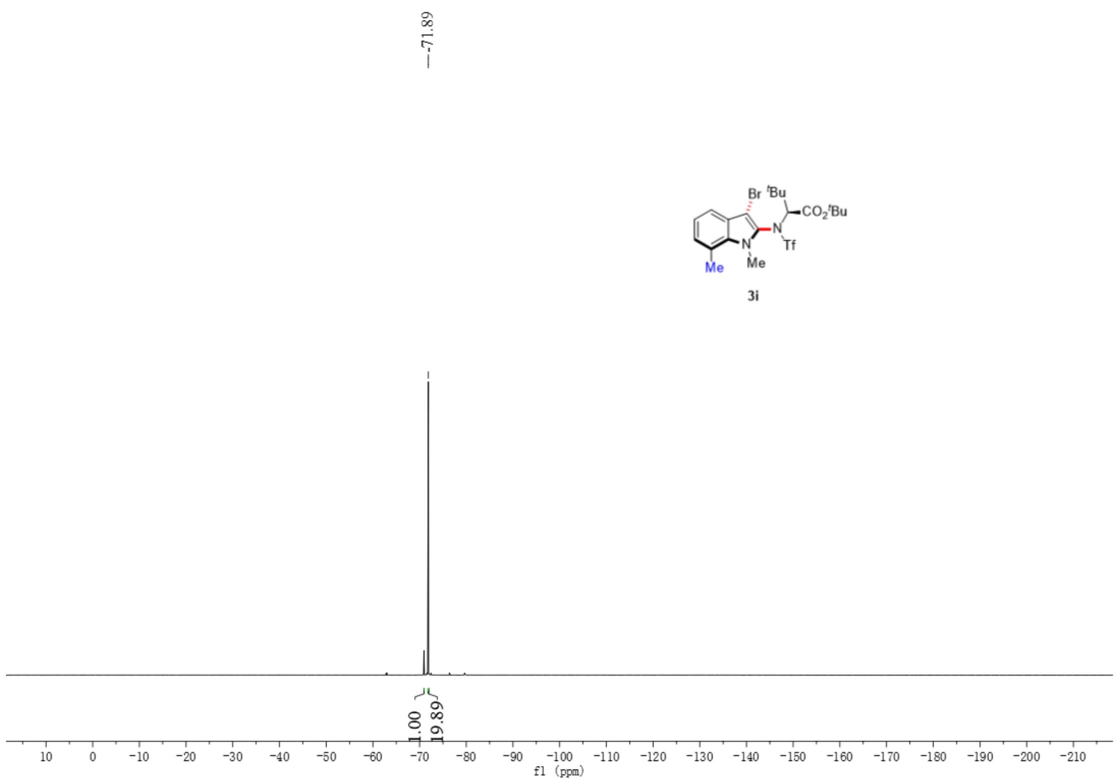
123.98
122.10
121.69
121.05
117.83
114.60
110.35
96.15
83.15
72.65
36.29
33.17
28.00
27.31
Br
tBu
CO2tBu
N
Tf
Cl
N
Me
3h
f1 (ppm)


7.45 7.44 7.43 7.43 7.26 7.09 7.08 7.06
4.49
3.80
2.77
1.54
1.14
Br
tBu
CO2tBu
N
Tf
N
Me
Me
3i
0.81
1.69
7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8
f1 (ppm)
0.81
1.69
0.93
3.00
3.02
8.68
9.02
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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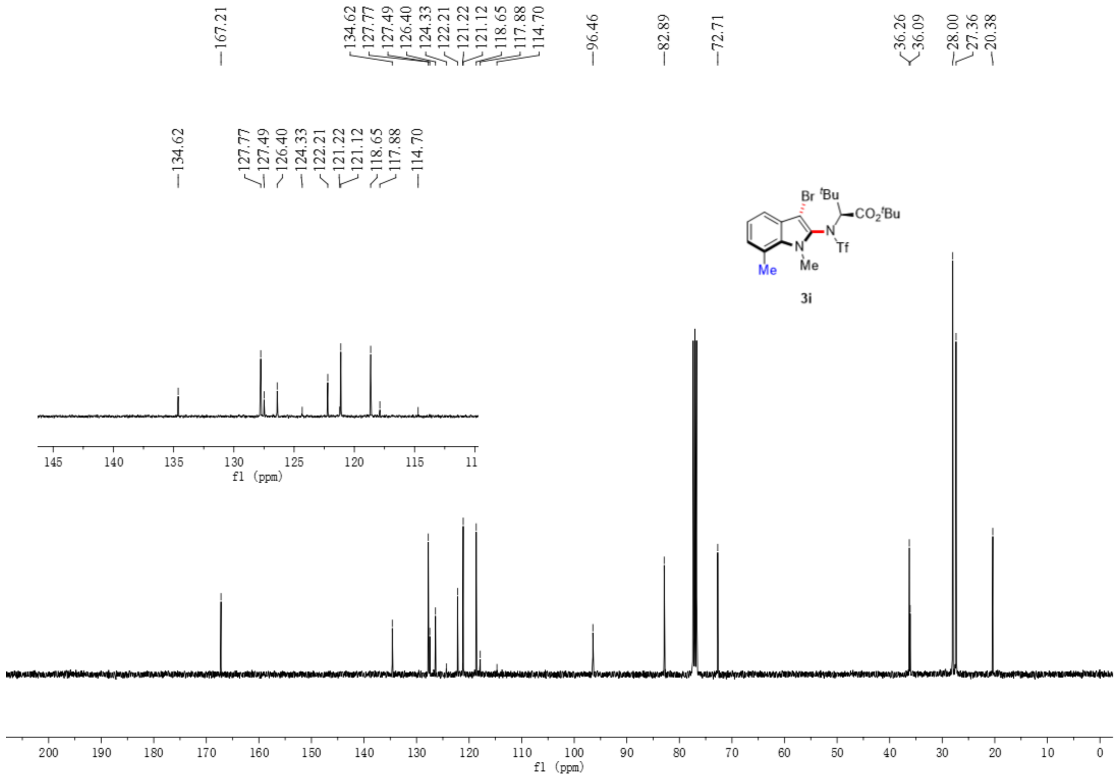
tBu
CO2tBu
N
Tf
N
Me
Me
3i
1.00
19.89
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)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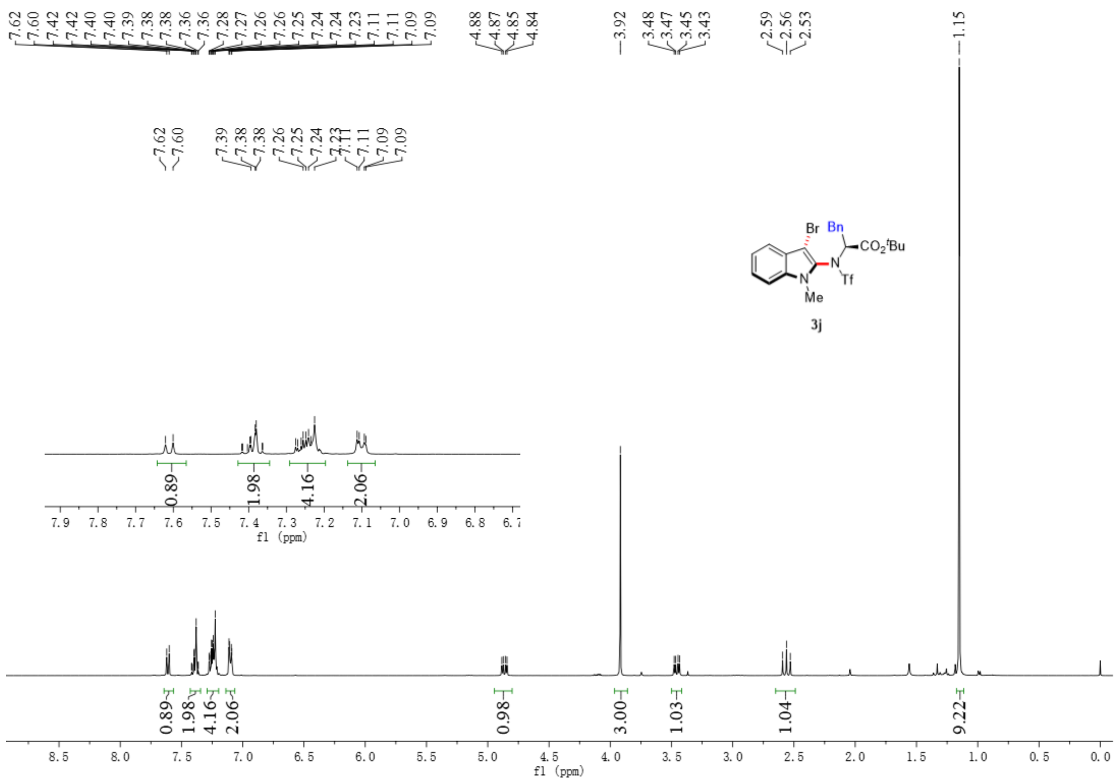
127.77
127.49
126.40
124.33
122.21
121.22
121.12
118.65
117.88
114.70
96.46
82.89
72.71
36.26
36.09
28.00
27.36
20.38
Br
^{t}Bu
$CO_2{}^tBu$
N
Tf
Me
Me
3i
f1 (ppm)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7.60
7.42
7.42
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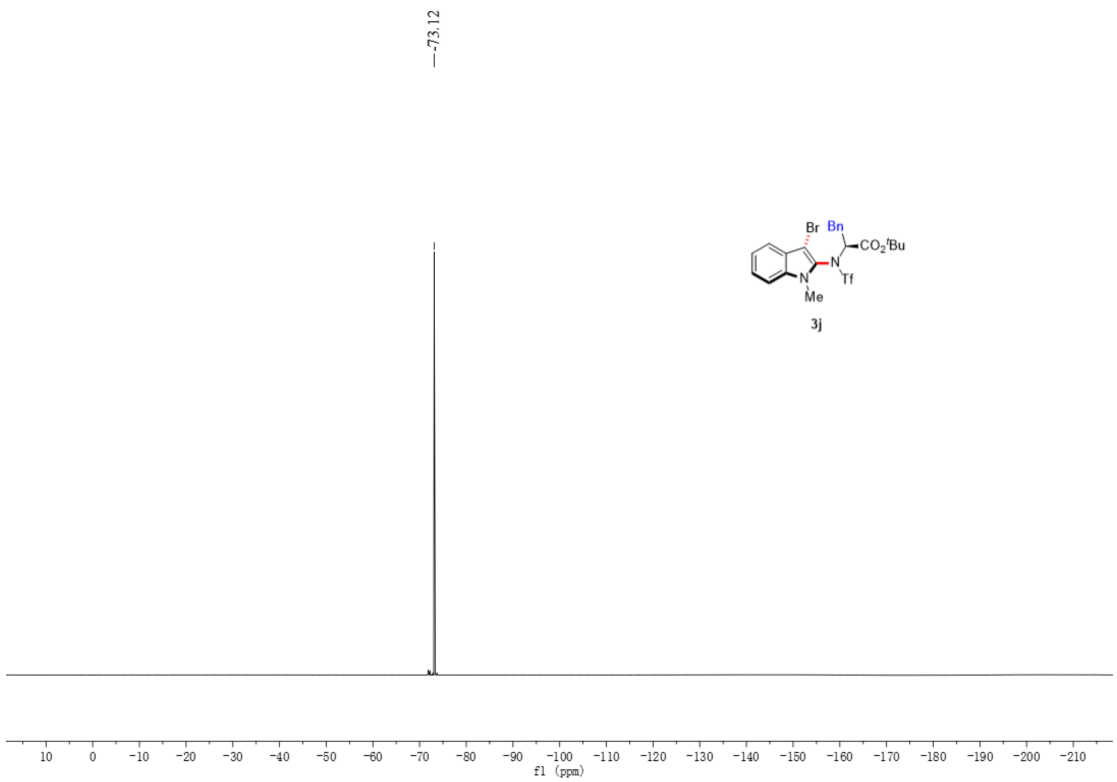
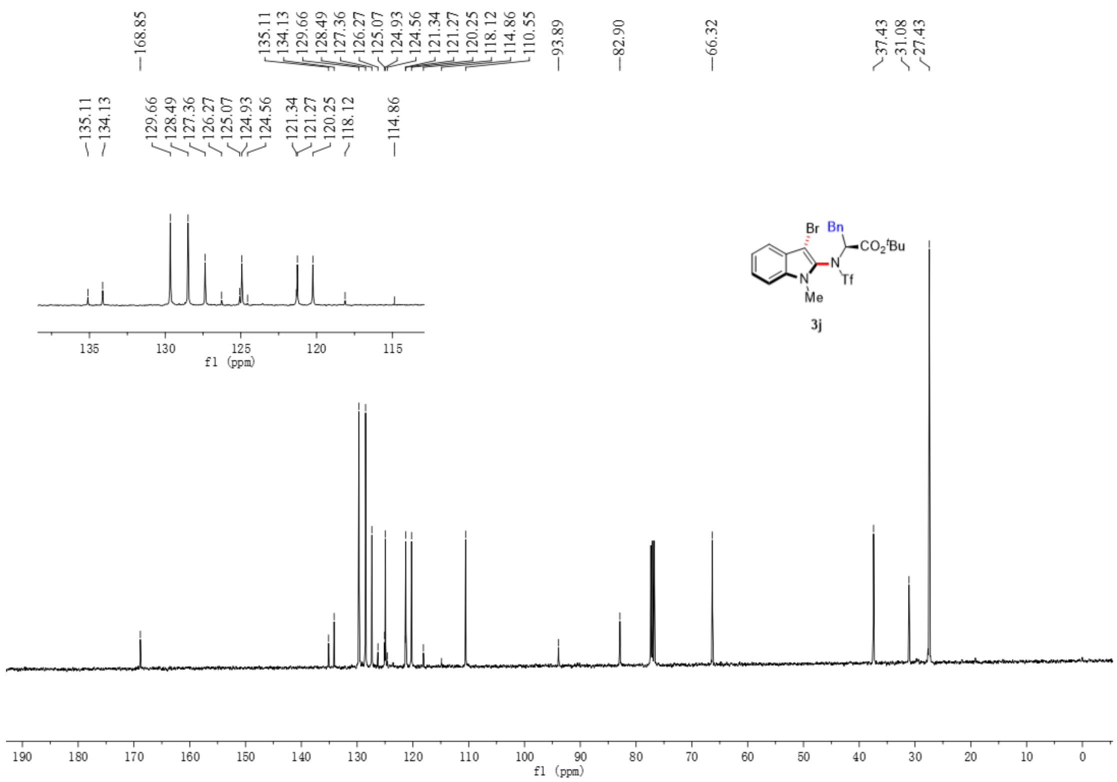
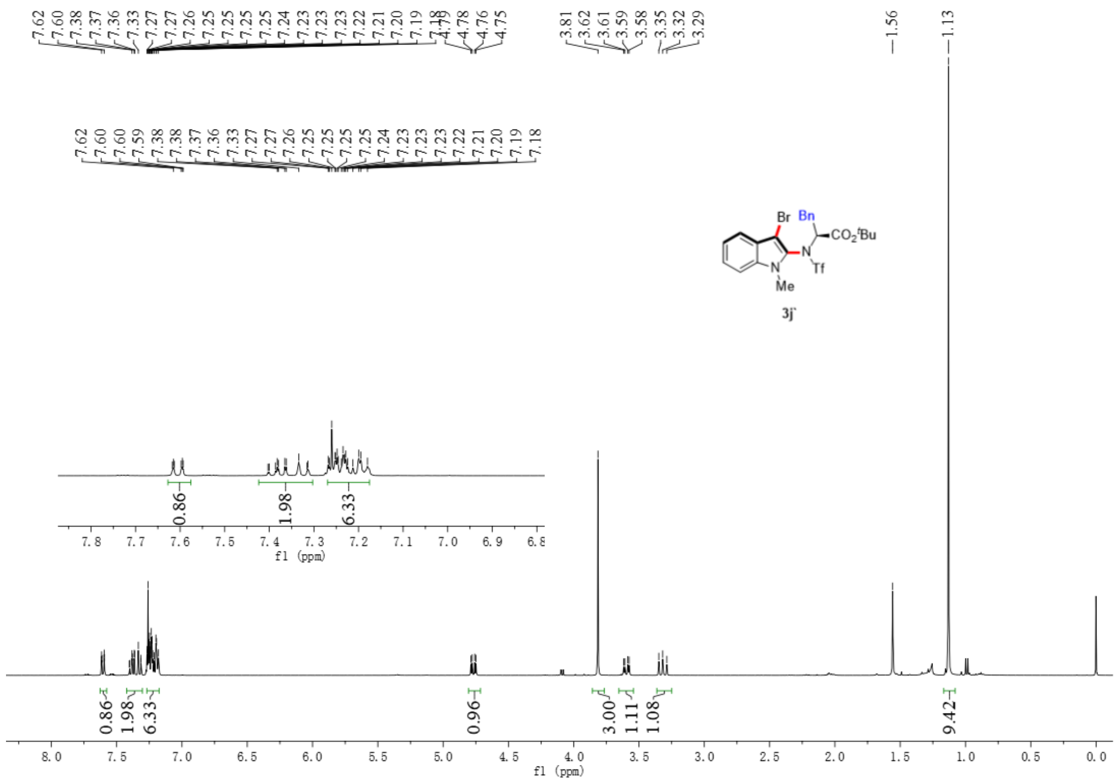
7.38
7.38
7.36
7.36
7.28
7.27
7.26
7.26
7.25
7.25
7.24
7.24
7.23
7.11
7.11
7.09
7.09
4.88
4.87
4.85
4.84
3.92
3.48
3.47
3.45
3.43
2.59
2.56
2.53
1.15
Br
Bn
$CO_2{}^tBu$
N
Tf
Me
3j
0.89
1.98
4.16
2.06
0.98
3.00
1.03
1.04
9.22
f1 (ppm)



-73.12
Br
Bn
$CO_2{}^tBu$
N
Tf
N
Me
3j
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)



168.85
135.11 134.13 129.66 128.49 127.36 126.27 125.07 124.93 124.56 121.34 121.27 120.25 118.12 114.86 110.55
93.89
82.90
66.32
37.43 31.08 27.43
135.11 134.13 129.66 128.49 127.36 126.27 125.07 124.93 124.56 121.34 121.27 120.25 118.12 114.86
135 130 125 120 115
f1 (ppm)
Br
Bn
$CO_2{}^tBu$
N
Tf
N
Me
3j
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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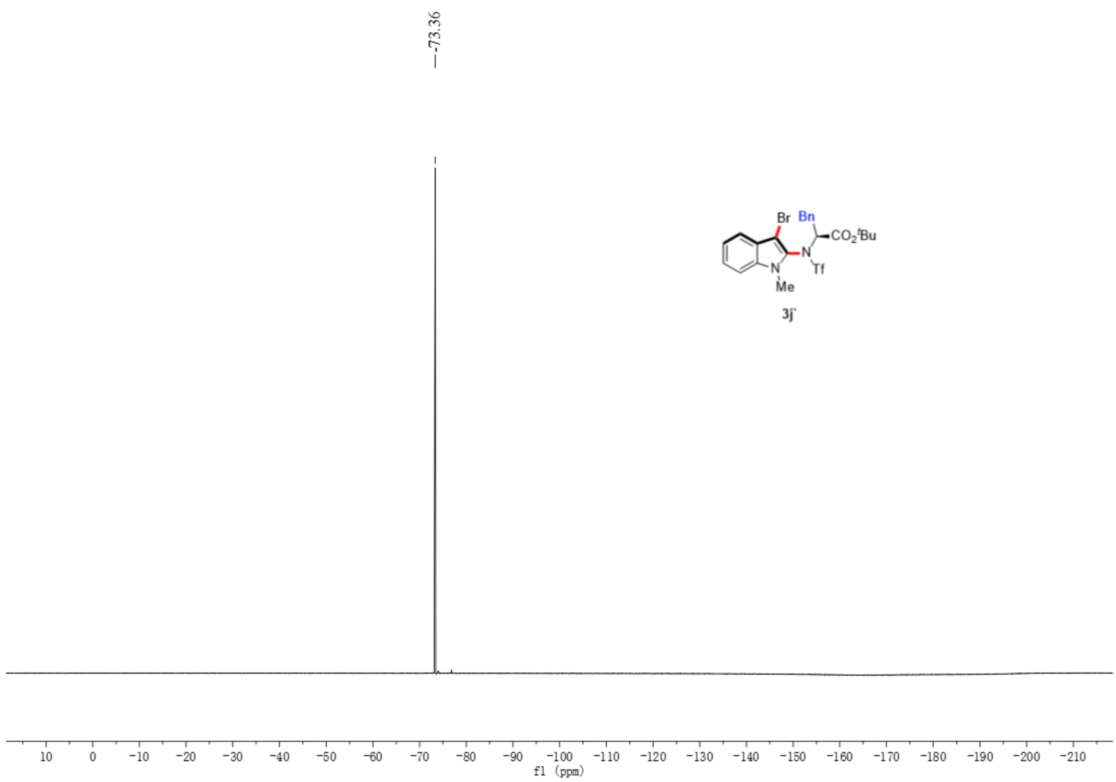
7.60
7.38
7.37
7.36
7.33
7.27
7.26
7.25
7.24
7.23
7.22
7.21
7.20
7.19
7.18
4.79
4.78
4.76
4.75
3.81
3.62
3.61
3.59
3.58
3.35
3.32
3.29
1.56
1.13
Br
Bn
$CO_2{}^tBu$
N
Tf
Me
3j'
0.86
1.98
6.33
0.96
3.00
1.11
1.08
9.42
f1 (ppm)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$CO_2{}^tBu$
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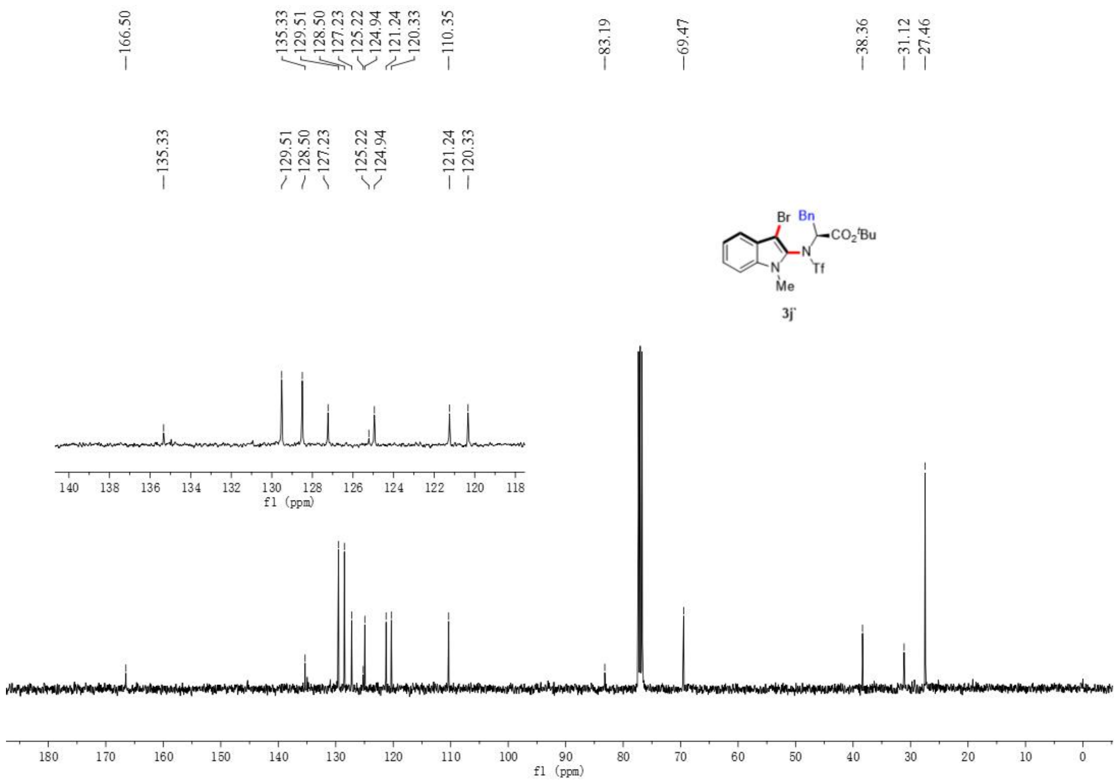
Me
3j'
f1 (ppm)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121.24
120.33
110.35
83.19
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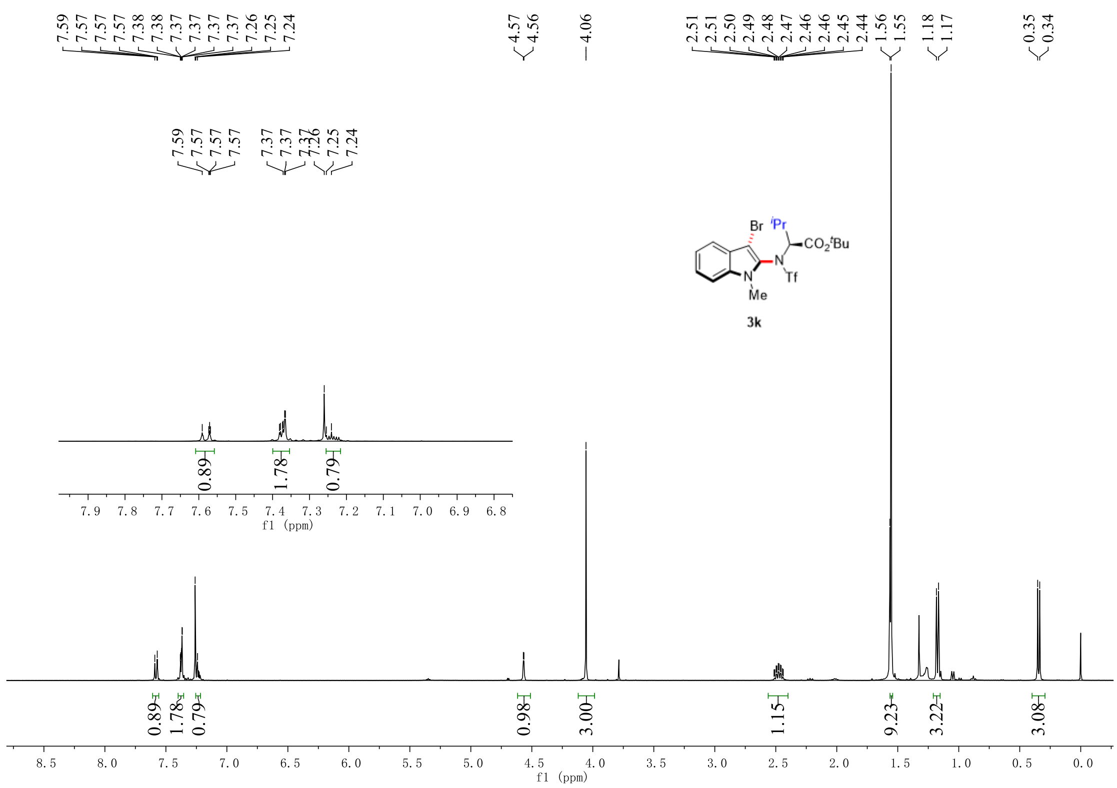
31.12
27.46
Br
Bn
$CO_2{}^tBu$
N
Tf
Me
3j
f1 (ppm)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7.37
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7.26
7.25
7.24
4.57
4.56
4.06
2.51
2.51
2.50
2.49
2.48
2.47
2.46
2.46
2.45
2.44
1.56
1.55
1.18
1.17
0.35
0.34
Br
^{i}Pr
$CO_2{}^tBu$
N
Tf
Me
3k
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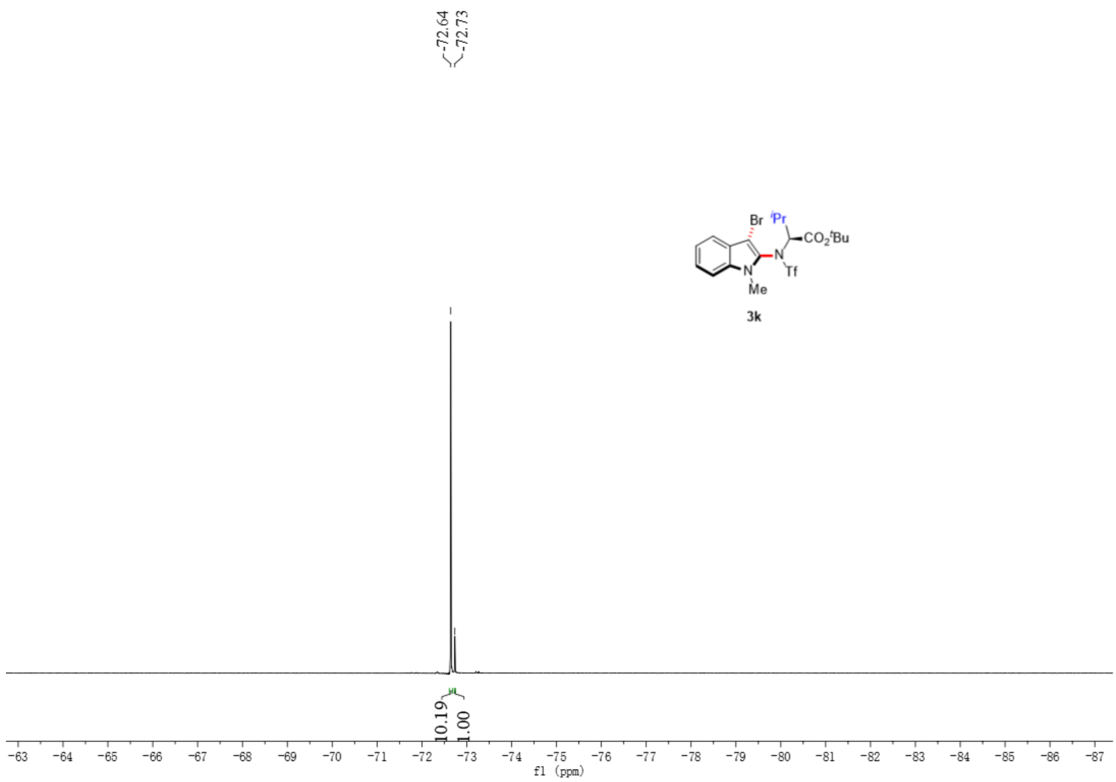
1.78
0.79
0.98
3.00
1.15
9.23
3.22
3.08
f1 (ppm)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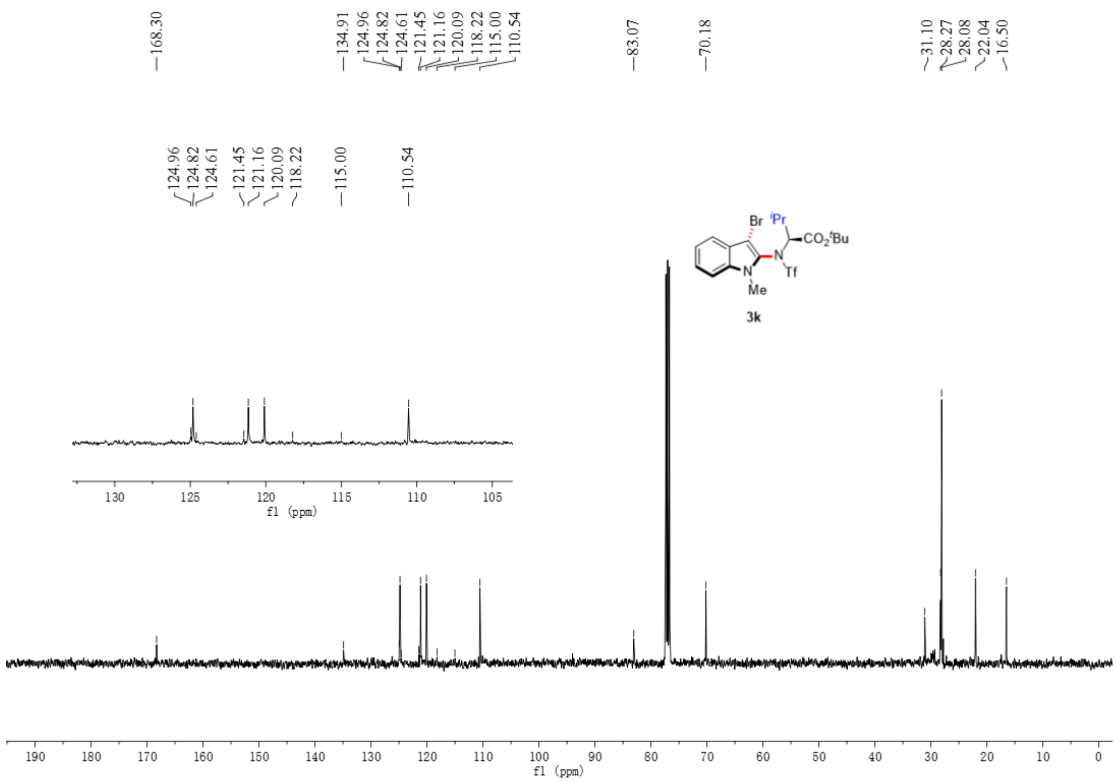
-72.73
Br
iPr
CO2tBu
N
Tf
N
Me
3k
10.19
1.00
−63 −64 −65 −66 −67 −68 −69 −70 −71 −72 −73 −74 −75 −76 −77 −78 −79 −80 −81 −82 −83 −84 −85 −86 −87
f1 (ppm)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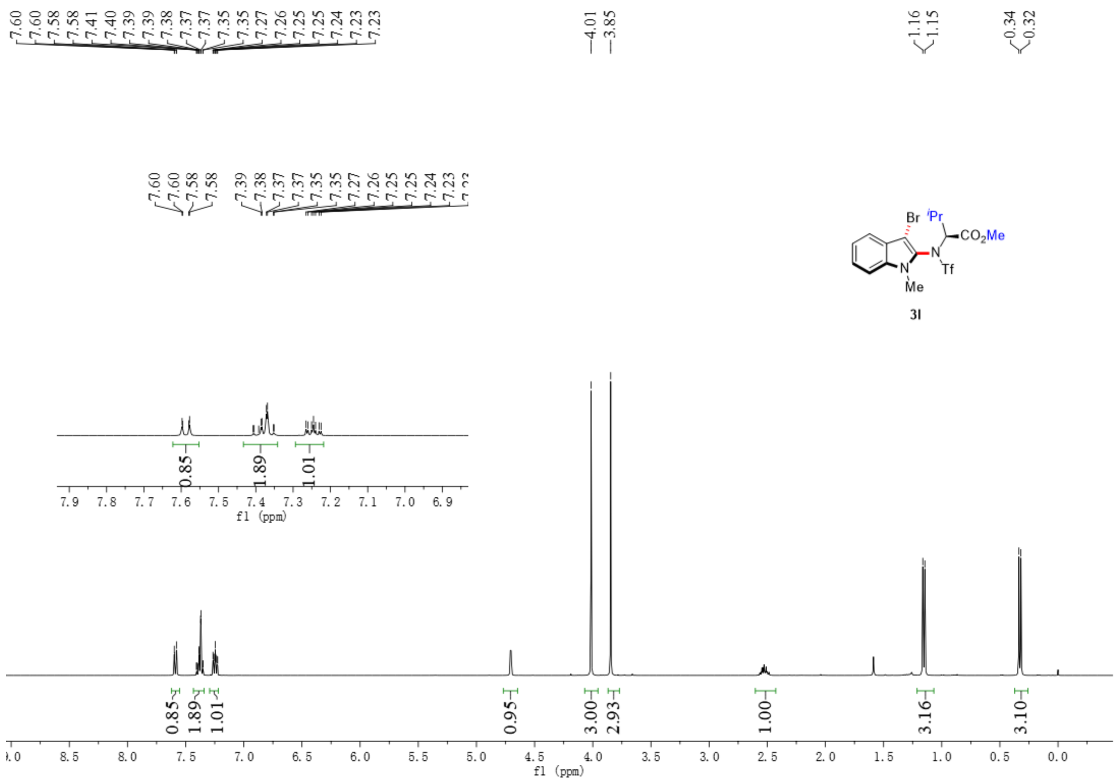
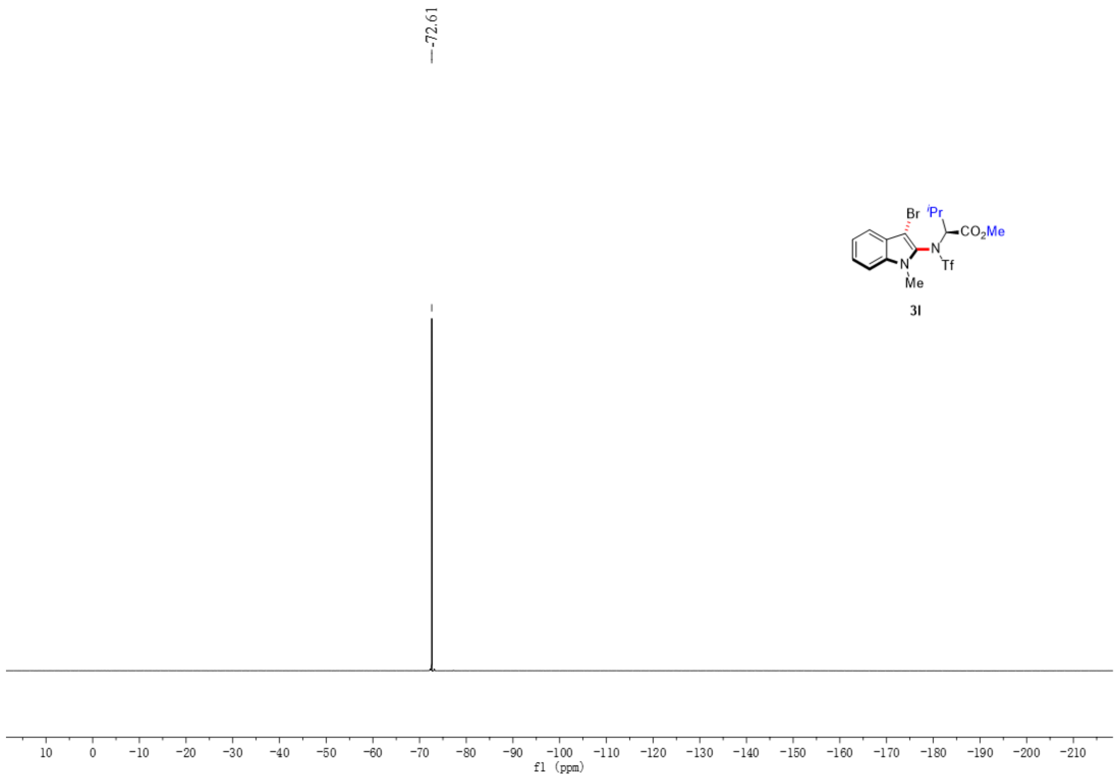
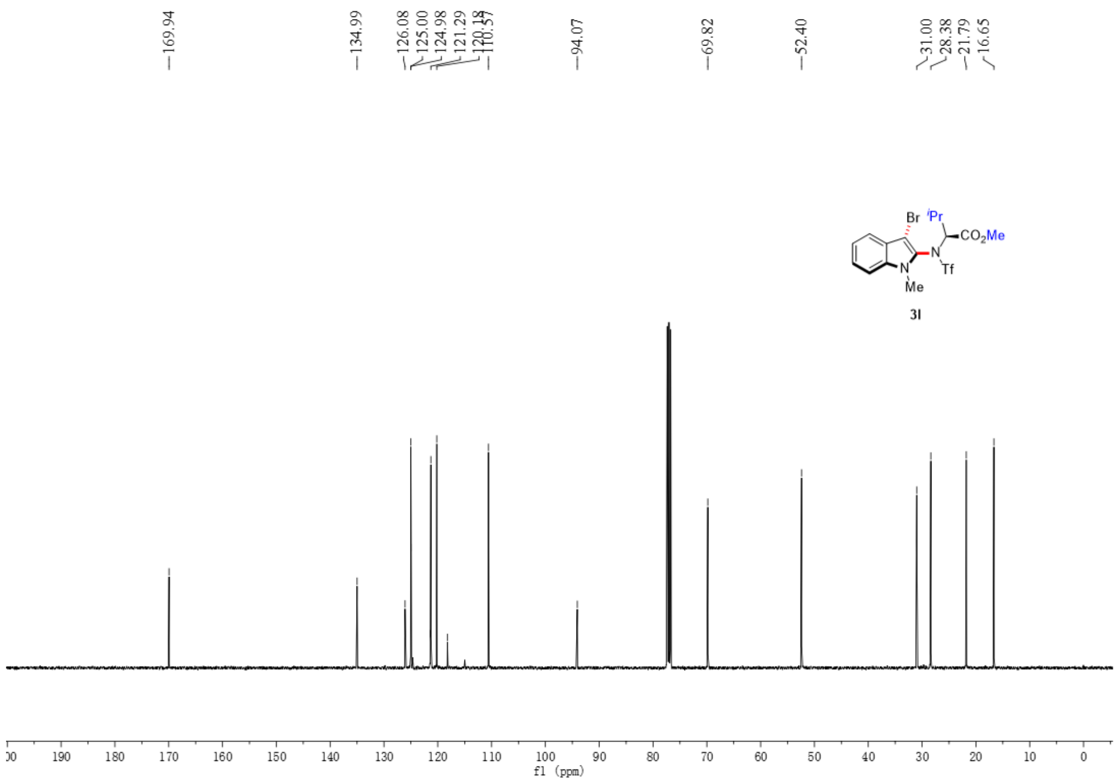
124.82
124.61
121.45
121.16
120.09
118.22
115.00
110.54
83.07
70.18
31.10
28.27
28.08
22.04
16.50
124.96
124.82
124.61
121.45
121.16
120.09
118.22
115.00
110.54
Br
iPr
CO2tBu
N
Tf
N
Me
3k
130 125 120 115 110 105
f1 (ppm)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



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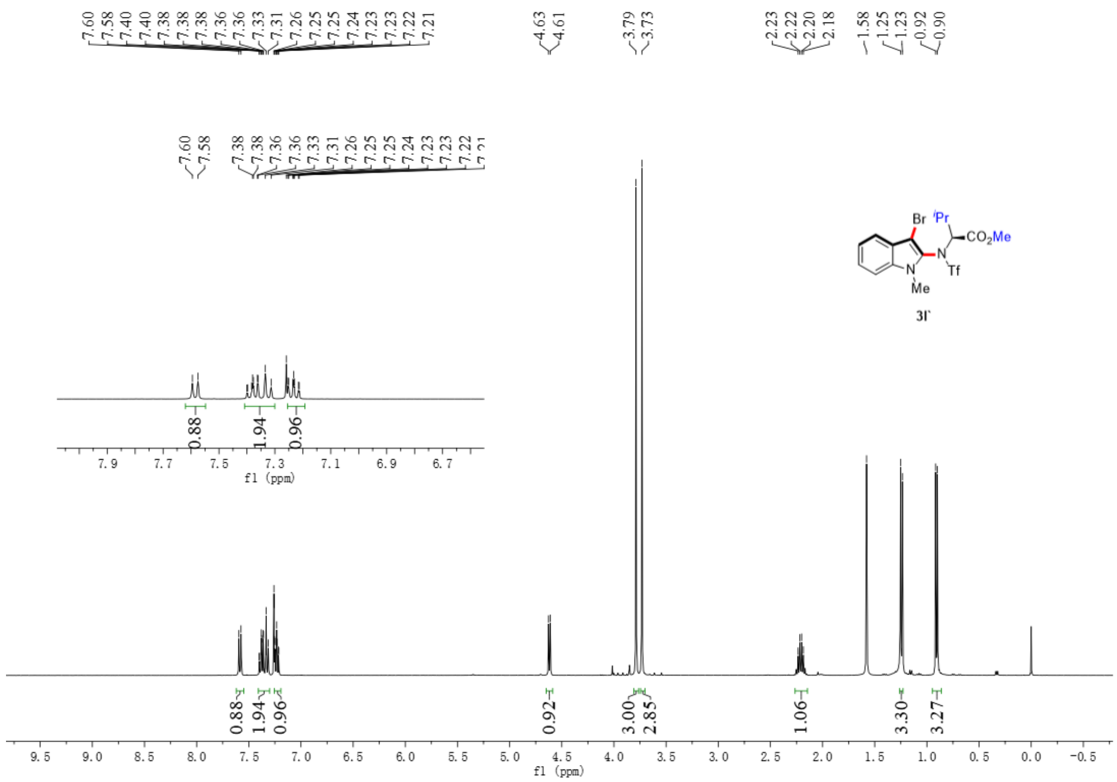
iPr
CO2Me
N
Tf
N
Me
3l
f1 (ppm)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7.25
7.24
7.23
7.23
7.22
7.21
4.63
4.61
3.79
3.73
2.23
2.22
2.20
2.18
1.58
1.25
1.23
0.92
0.90
Br
iPr
CO2Me
N
Tf
N
Me
3l'
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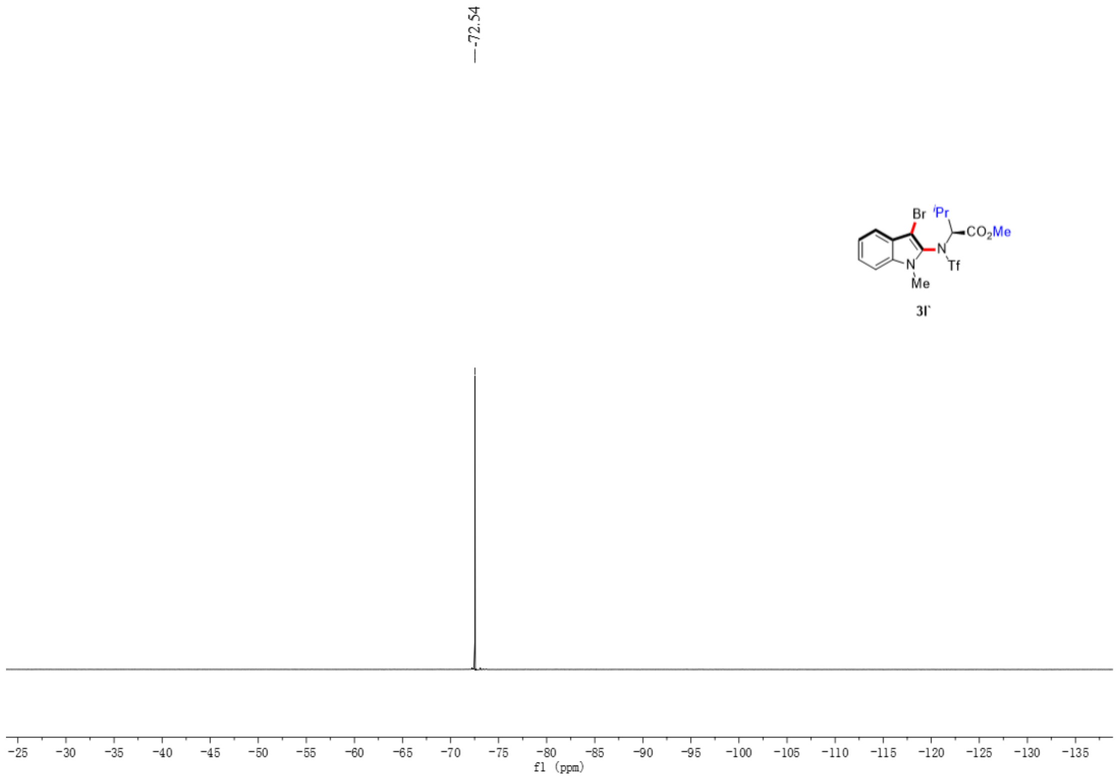
1.94
0.96
0.92
3.00
2.85
1.06
3.30
3.27
f1 (ppm)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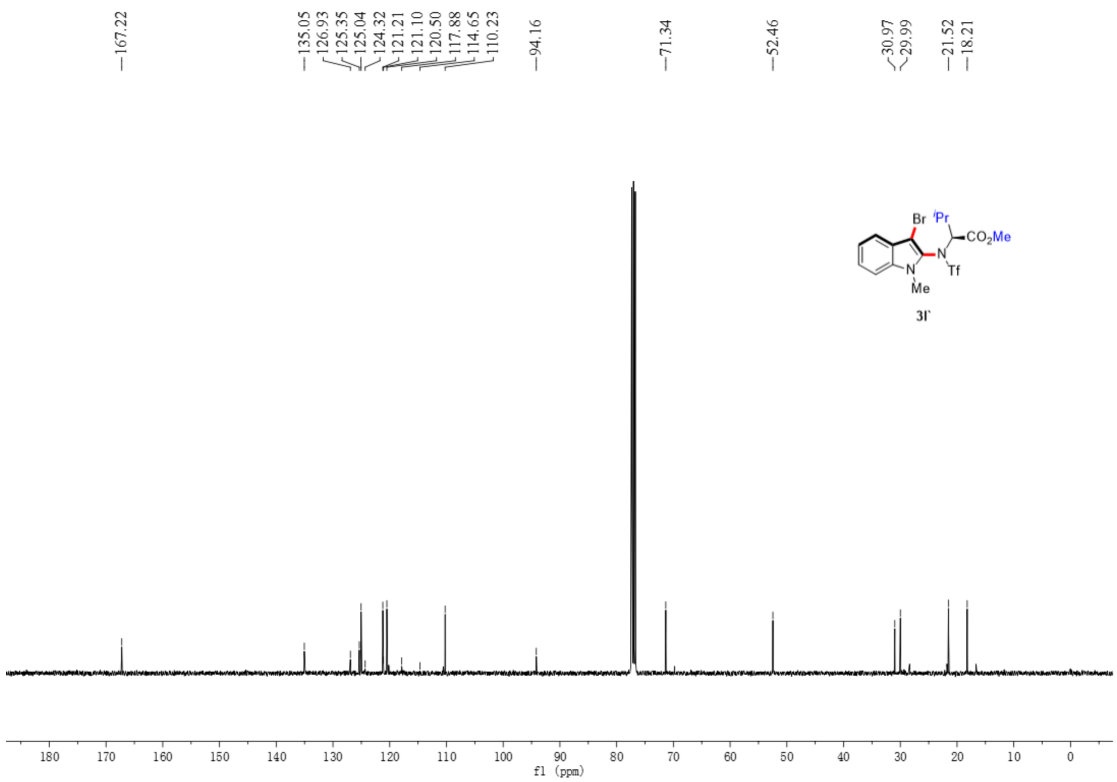
Tf
N
Me
3l'
-25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105 -110 -115 -120 -125 -130 -135
f1 (ppm)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121.10
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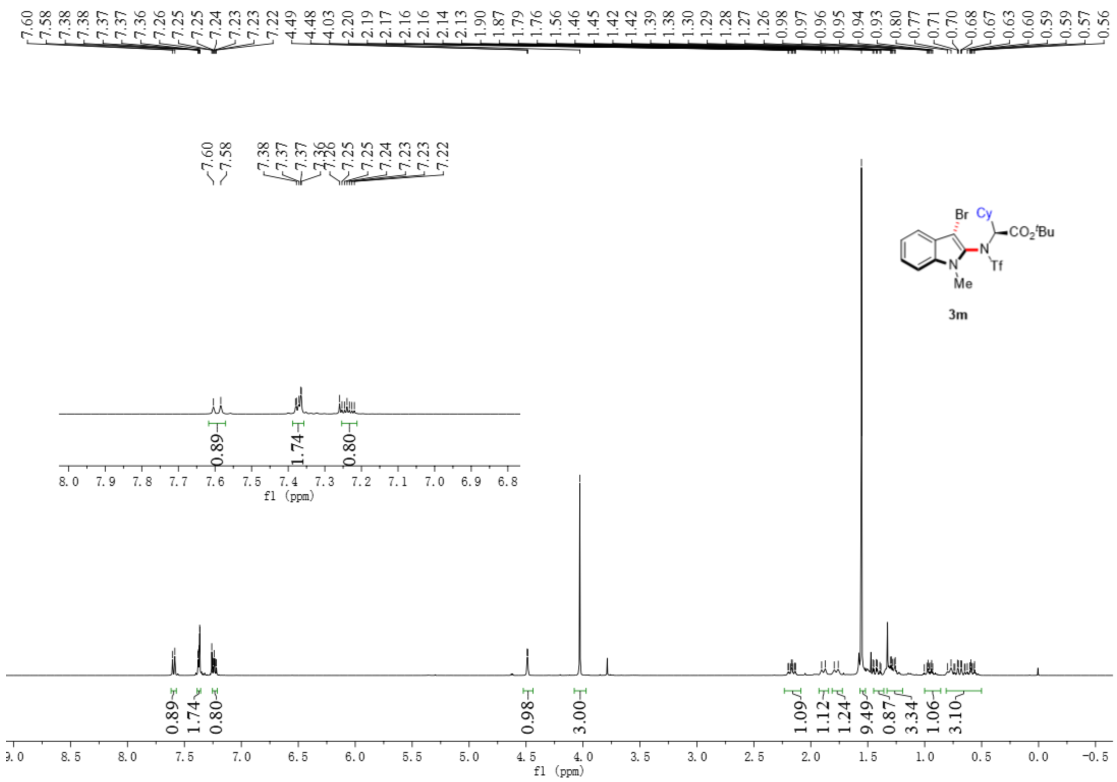
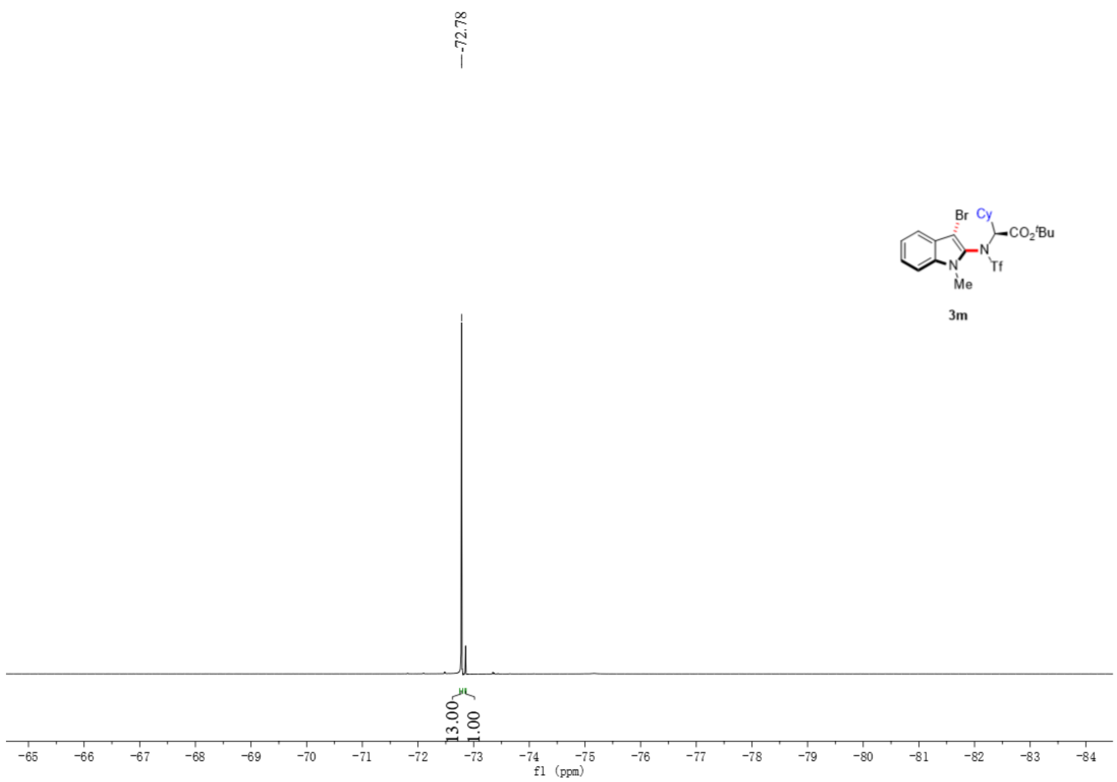
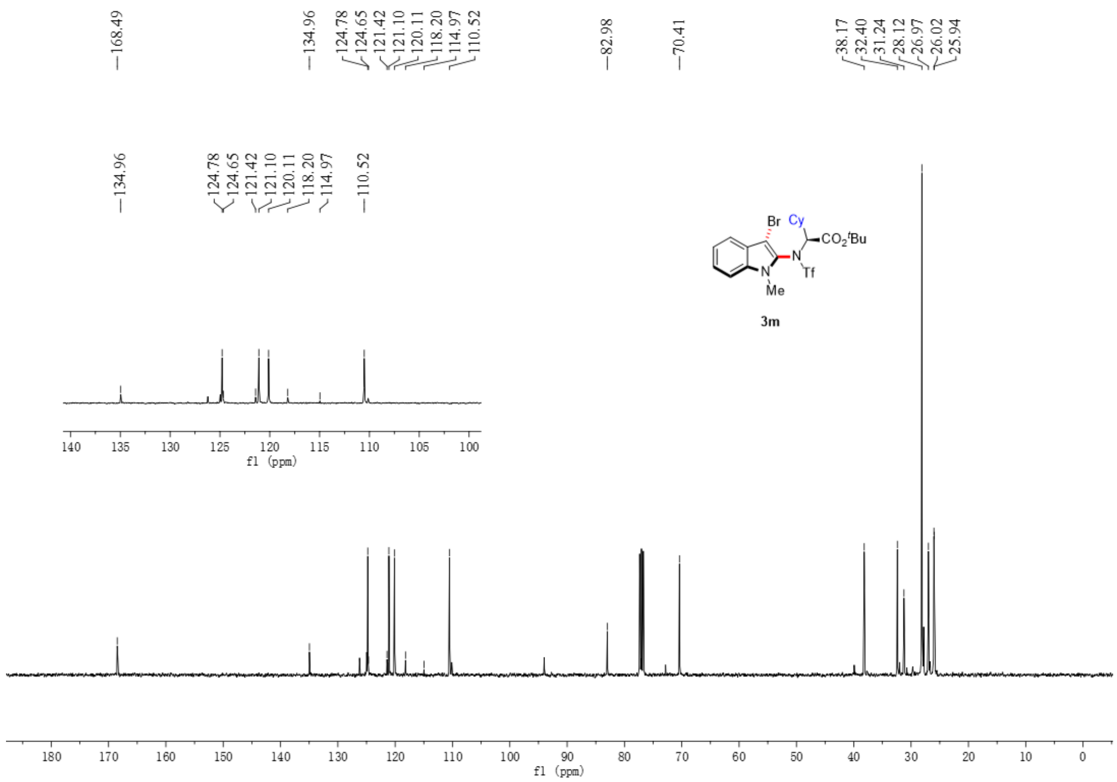
117.88
114.65
110.23
94.16
71.34
52.46
30.97
29.99
21.52
18.21
Br
iPr
CO2Me
N
Tf
N
Me
3l'
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



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70.41
38.17
32.40
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28.12
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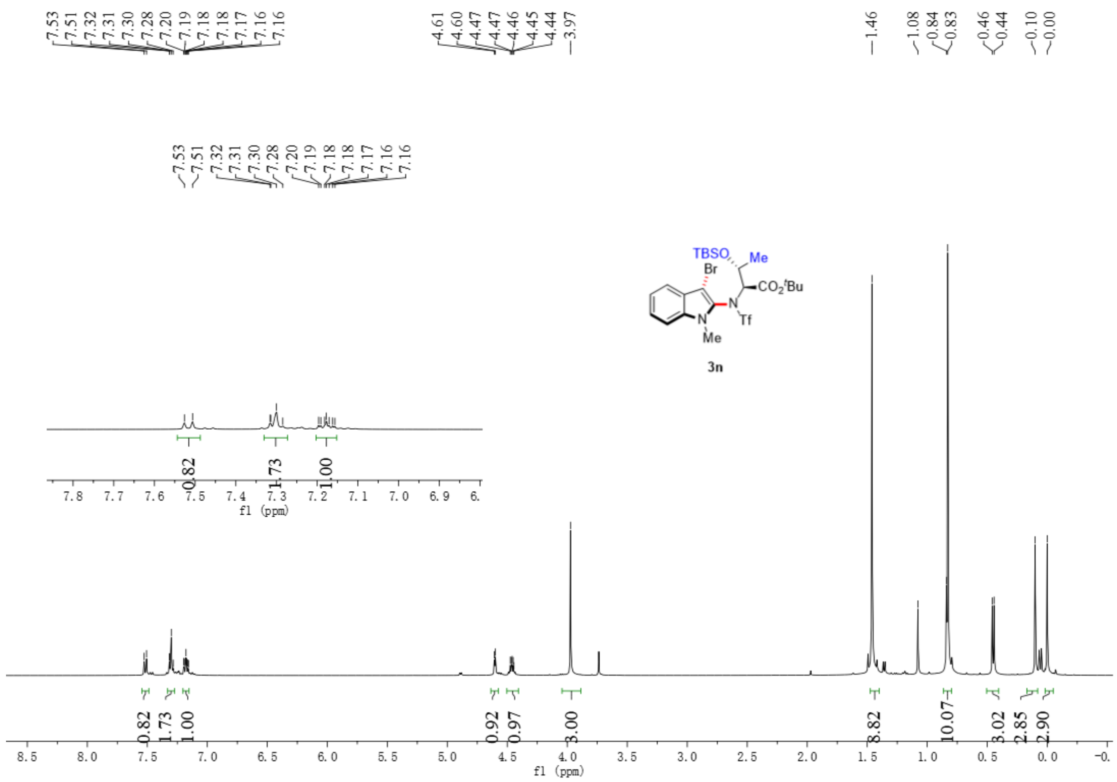
26.02
25.94
Br
Cy
$CO_2{}^tBu$
N
Tf
Me
3m
fl (ppm)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4.61
4.60
4.47
4.47
4.46
4.45
4.44
3.97
1.46
1.08
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0.83
0.46
0.44
0.10
0.00
TBSO
Me
Br
$CO_2{}^tBu$
N
Tf
Me
3n
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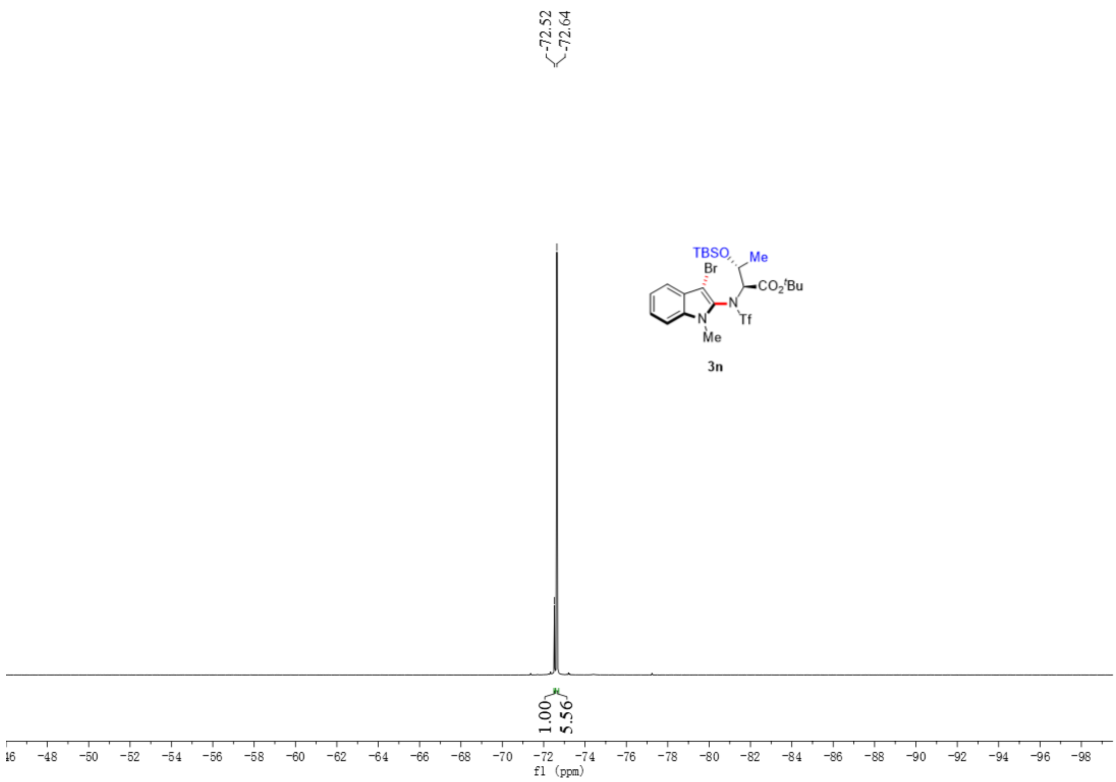
1.00
0.92
0.97
3.00
8.82
10.07
3.02
2.85
2.90
fl (ppm)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N
Tf
N
Me
3n
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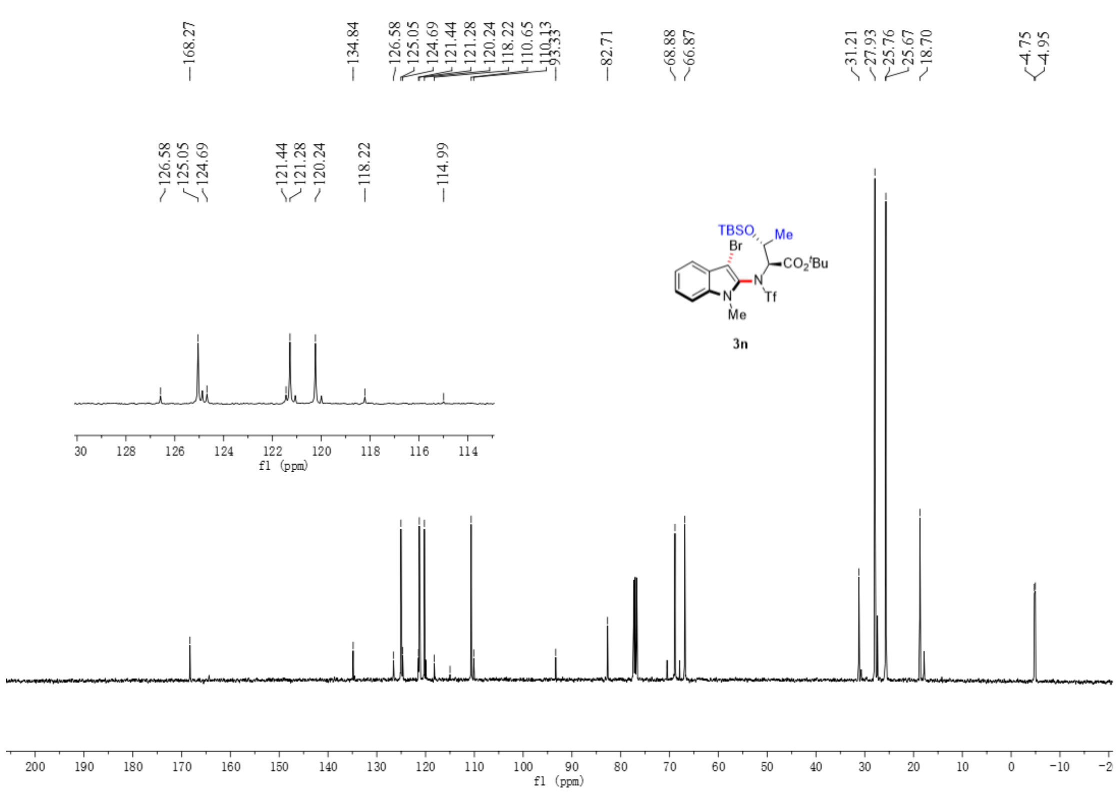
5.56
f1 (ppm)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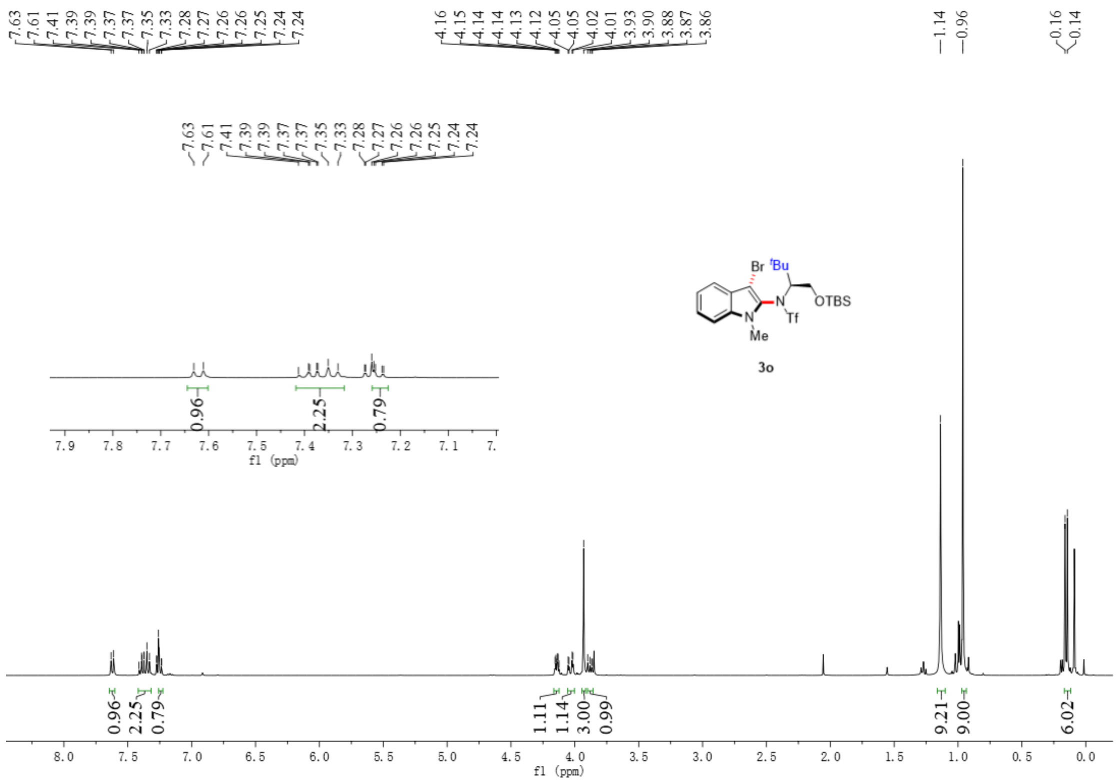
68.88
66.87
31.21
27.93
25.76
25.67
18.70
-4.75
-4.95
126.58
125.05
124.69
121.44
121.28
120.24
118.22
114.99
TBSO
Me
Br
CO2tBu
N
Tf
N
Me
3n
f1 (ppm)
f1 (ppm)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7.25
7.24
7.24
4.16
4.15
4.14
4.14
4.13
4.12
4.05
4.05
4.02
4.01
3.93
3.90
3.88
3.87
3.86
1.14
0.96
0.16
0.14
Br
tBu
N
Tf
OTBS
N
Me
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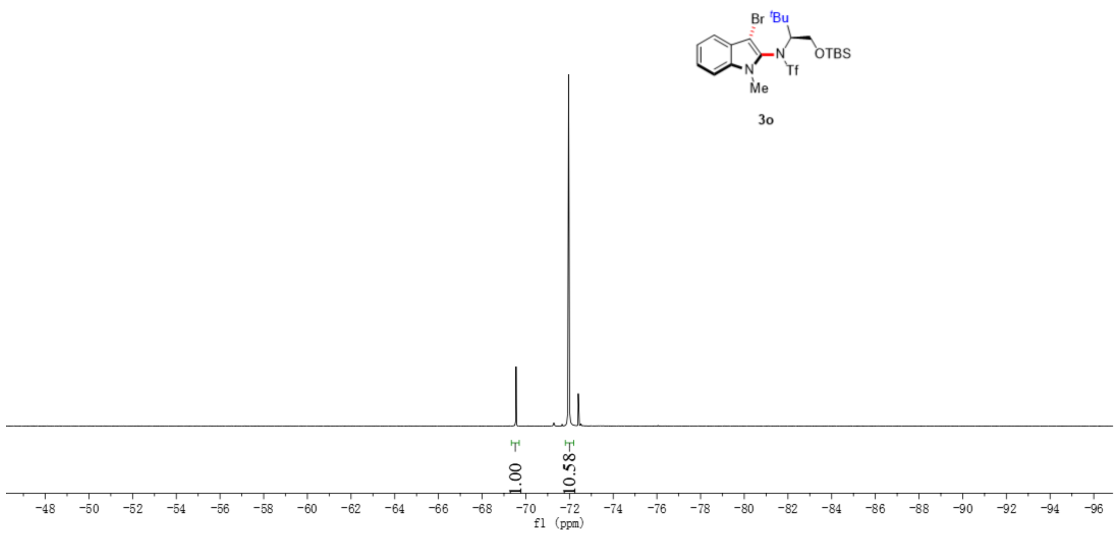
1.11
1.14
3.00
0.99
9.21
9.00
6.02
f1 (ppm)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OTBS
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Me
3o
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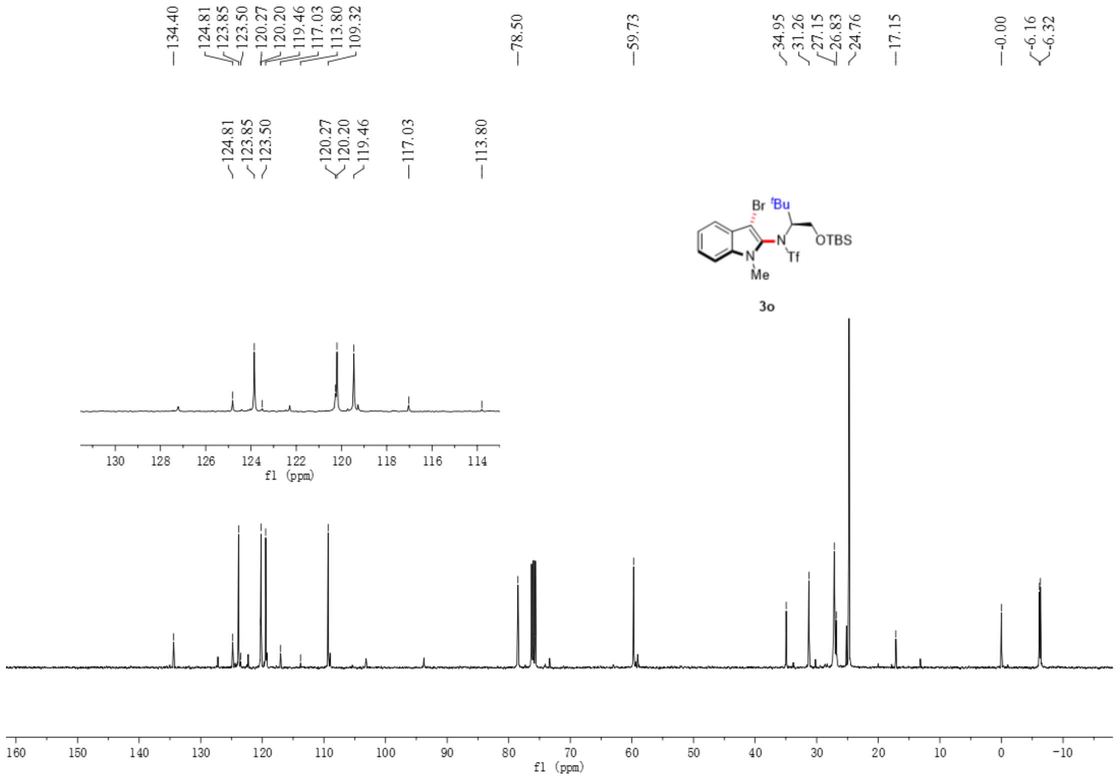
10.58
f1 (ppm)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109.32
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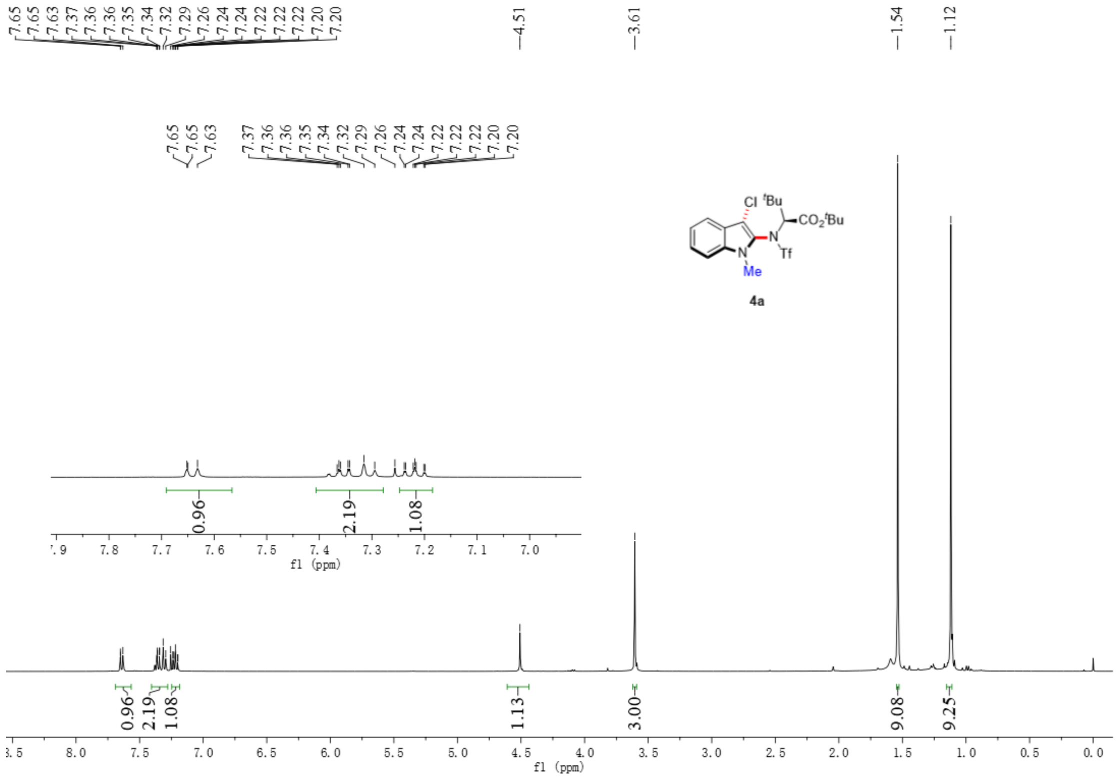
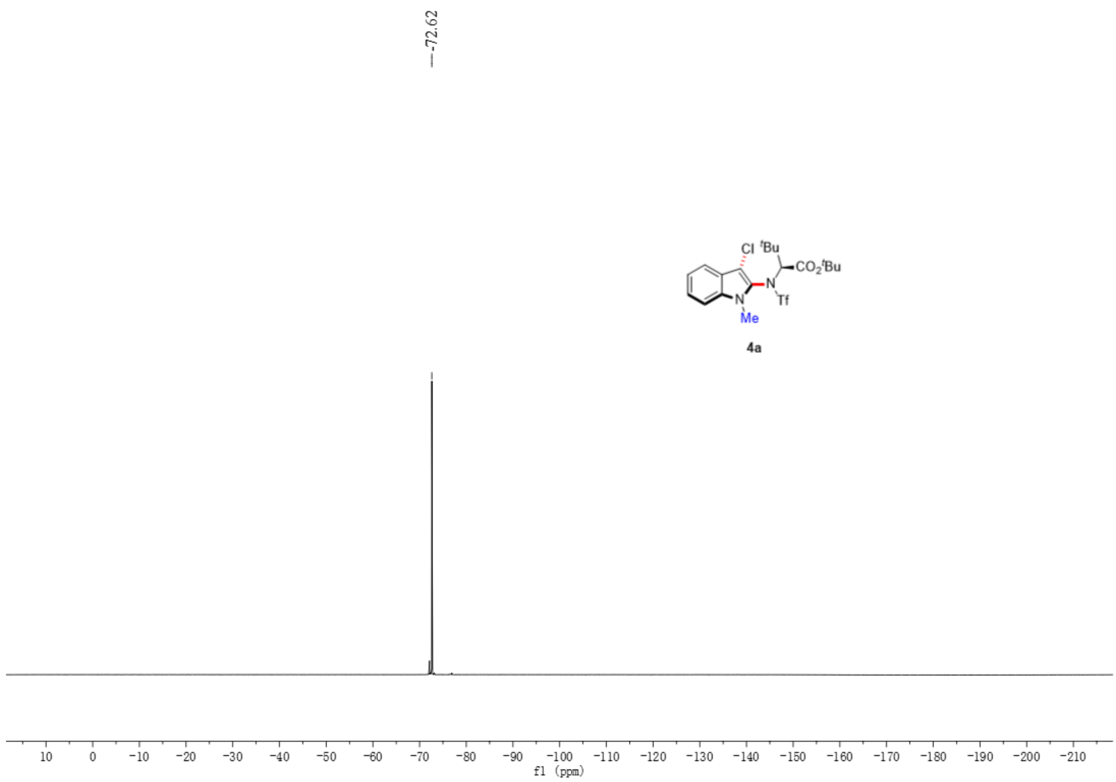
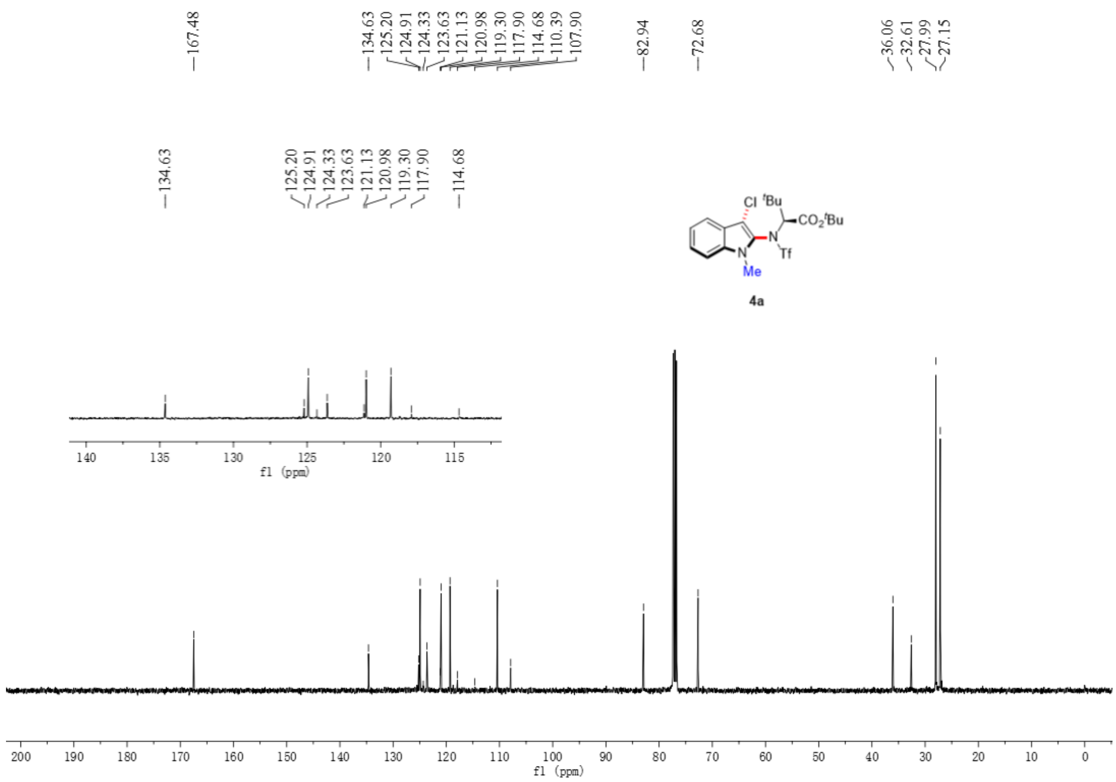
59.73
34.95
31.26
27.15
26.83
24.76
17.15
-0.00
-6.16
-6.32
Br
^{t}Bu
OTBS
N
Tf
Me
f1 (ppm)

3o


7.65
7.65
7.63
7.37
7.36
7.36
7.35
7.34
7.32
7.29
7.26
7.24
7.24
7.22
7.22
7.22
7.20
7.20
4.51
3.61
1.54
1.12
Cl
^{t}Bu
$CO_2{}^t$Bu
N
Tf
Me
0.96
2.19
1.08
1.13
3.00
9.08
9.25
f1 (ppm)

4a


-72.62
Cl
tBu
CO2tBu
N
Tf
N
Me
4a
f1 (ppm)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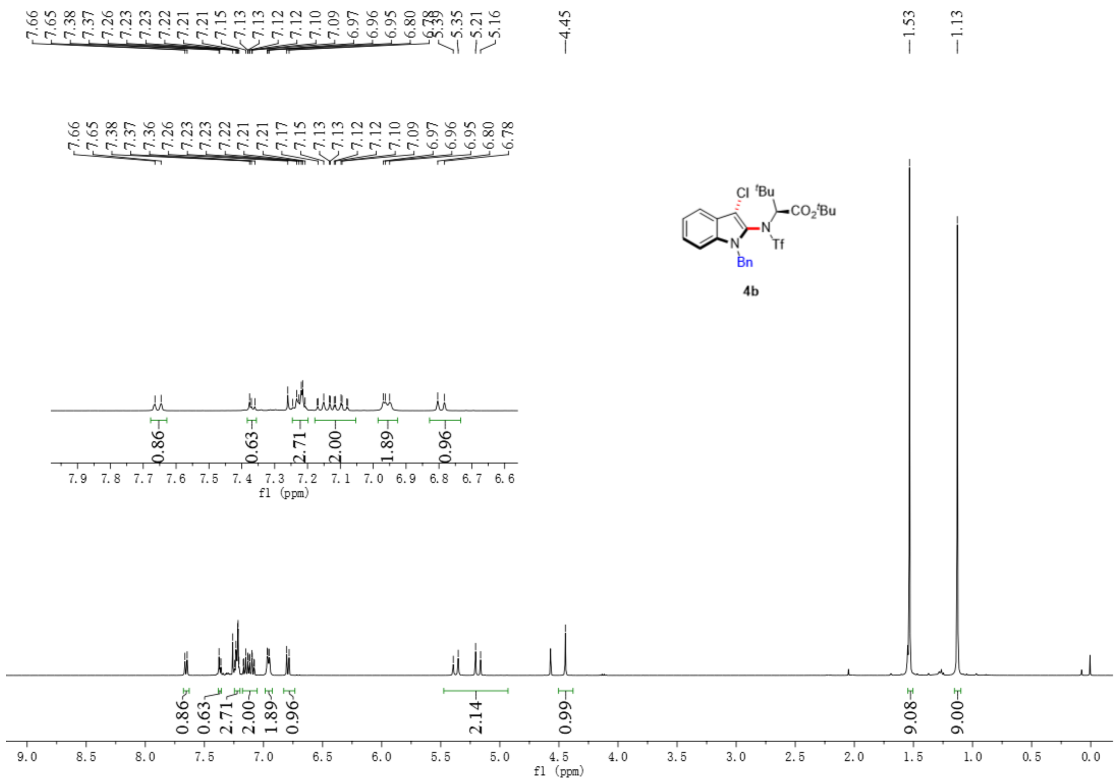
134.63
125.20
124.91
124.33
123.63
121.13
120.98
119.30
117.90
114.68
110.39
107.90
82.94
72.68
36.06
32.61
27.99
27.15
Cl
tBu
CO2tBu
N
Tf
N
Me
4a
f1 (ppm)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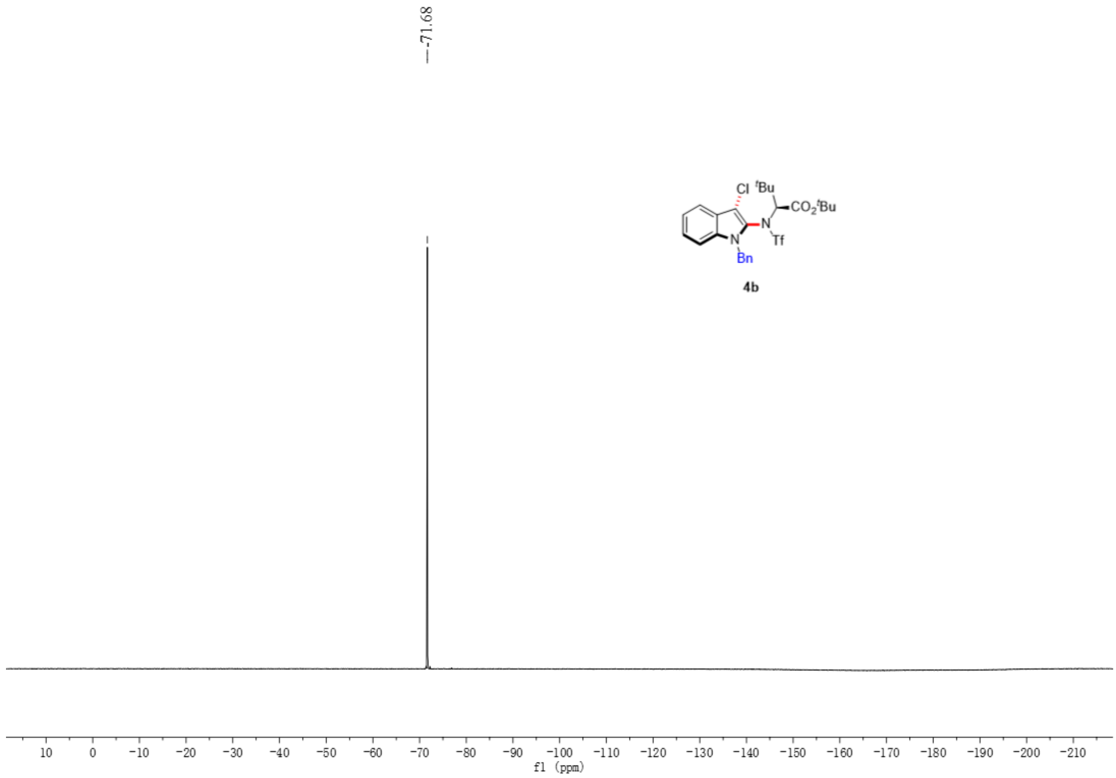
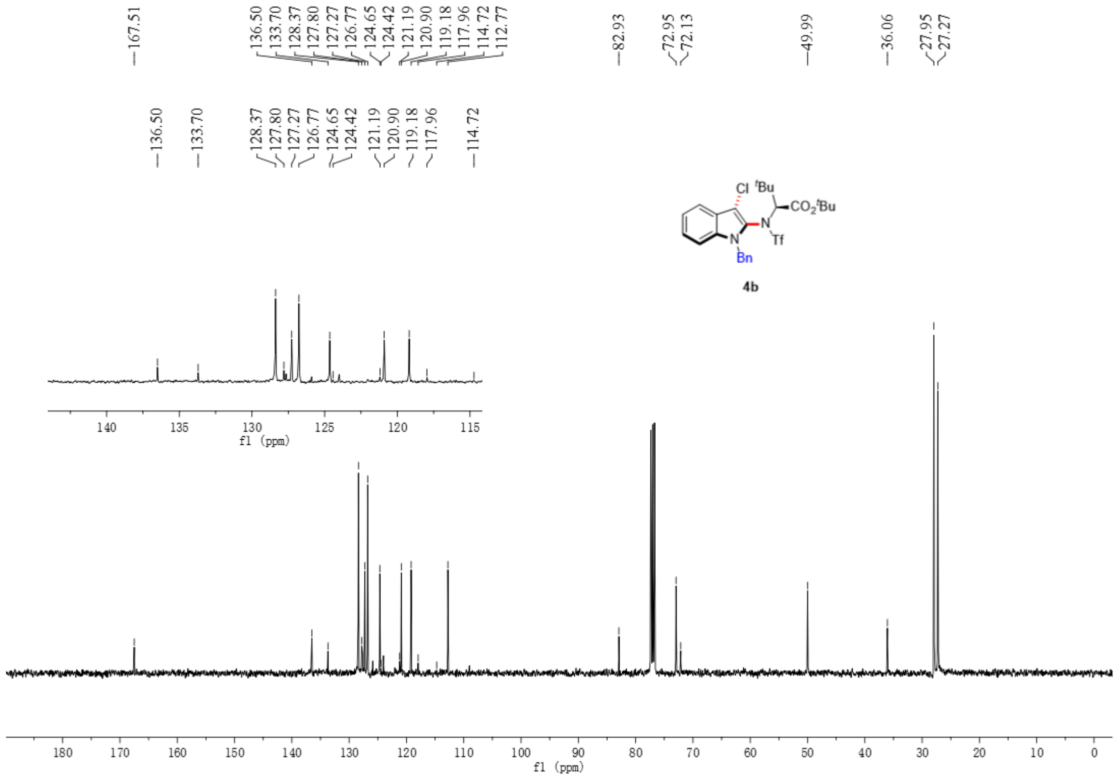
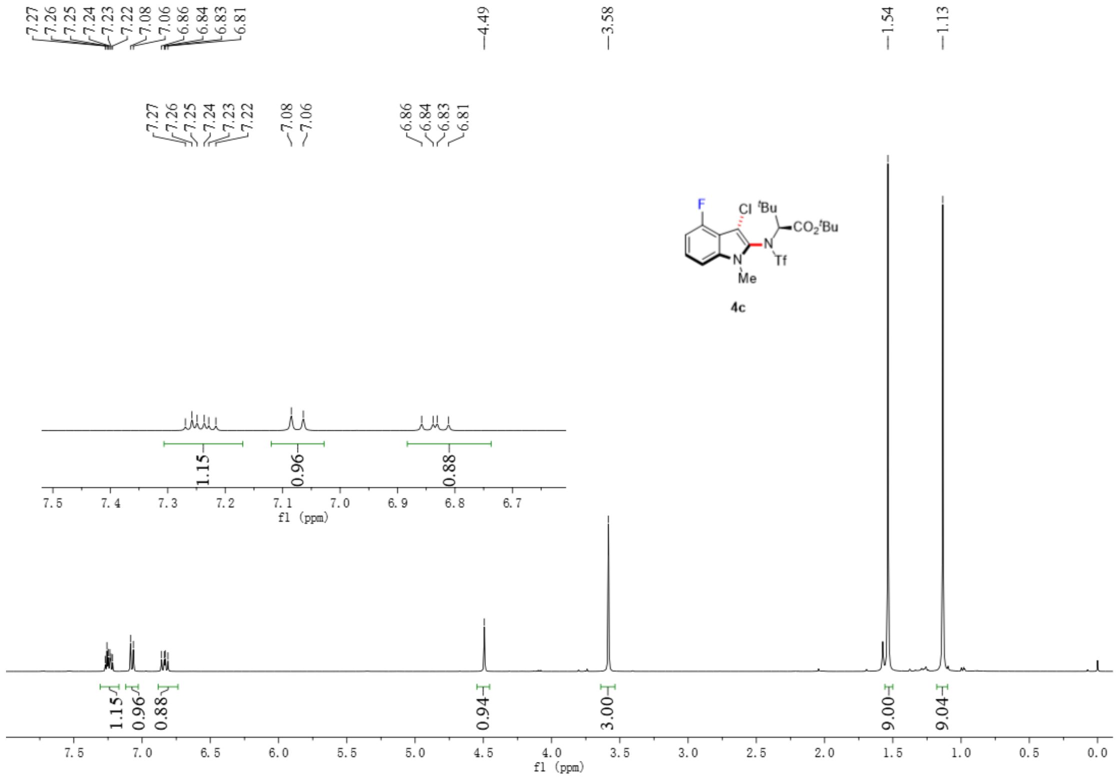
4.45
1.53
1.13
7.66 7.65 7.38 7.37 7.36 7.26 7.23 7.23 7.22 7.21 7.21 7.17 7.15 7.13 7.13 7.12 7.12 7.10 7.09 6.97 6.96 6.95 6.80 6.78
Cl
tBu
CO2tBu
N
Tf
N
Bn
4b
0.86 0.63 2.71 2.00 1.89 0.96
f1 (ppm)
0.86 0.63 2.71 2.00 1.89 0.96 2.14 0.99 9.08 9.00
f1 (ppm)

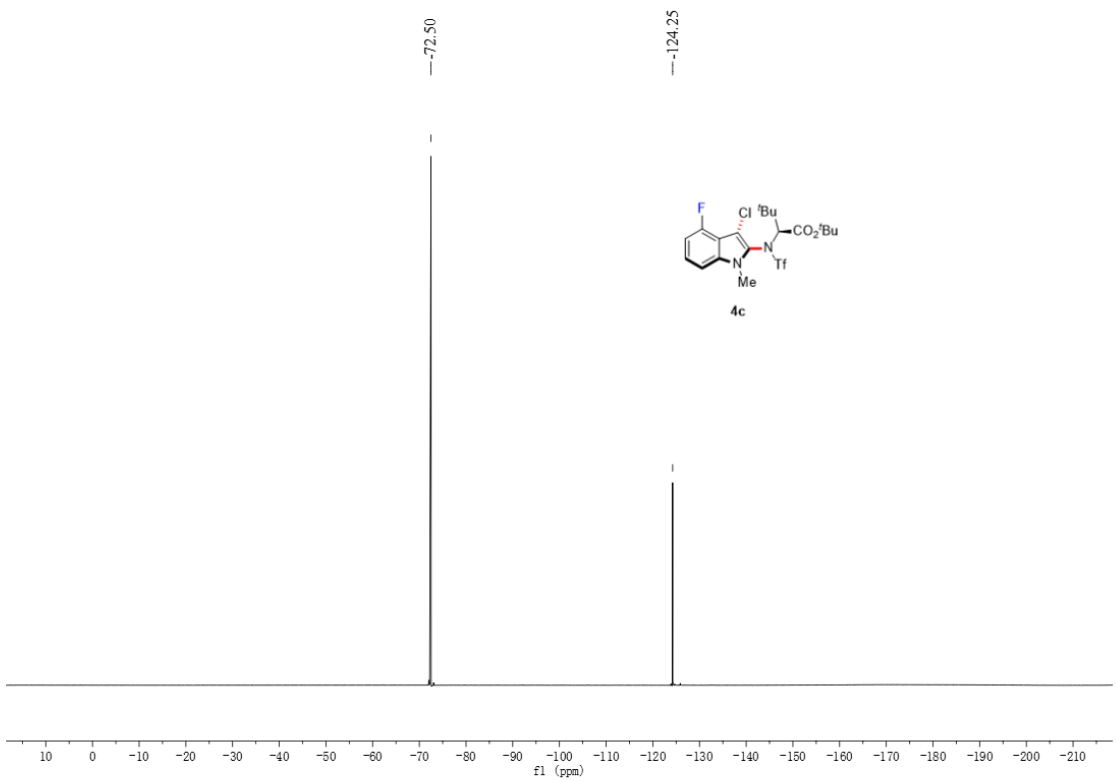

-71.68
Cl
tBu
CO2tBu
N
Tf
N
Bn
4b
f1 (ppm)



167.51
136.50
133.70
128.37
127.80
127.27
126.77
124.65
124.42
121.19
120.90
119.18
117.96
114.72
112.77
82.93
72.95
72.13
49.99
36.06
27.95
27.27
Cl
^{t}Bu
$CO_2{}^t$Bu
N
Tf
Bn
4b
f1 (ppm)



7.27
7.26
7.25
7.24
7.23
7.22
7.08
7.06
6.86
6.84
6.83
6.81
4.49
3.58
1.54
1.13
F
Cl
^{t}Bu
$CO_2{}^t$Bu
N
Tf
Me
4c
1.15
0.96
0.88
0.94
3.00
9.00
9.04
f1 (ppm)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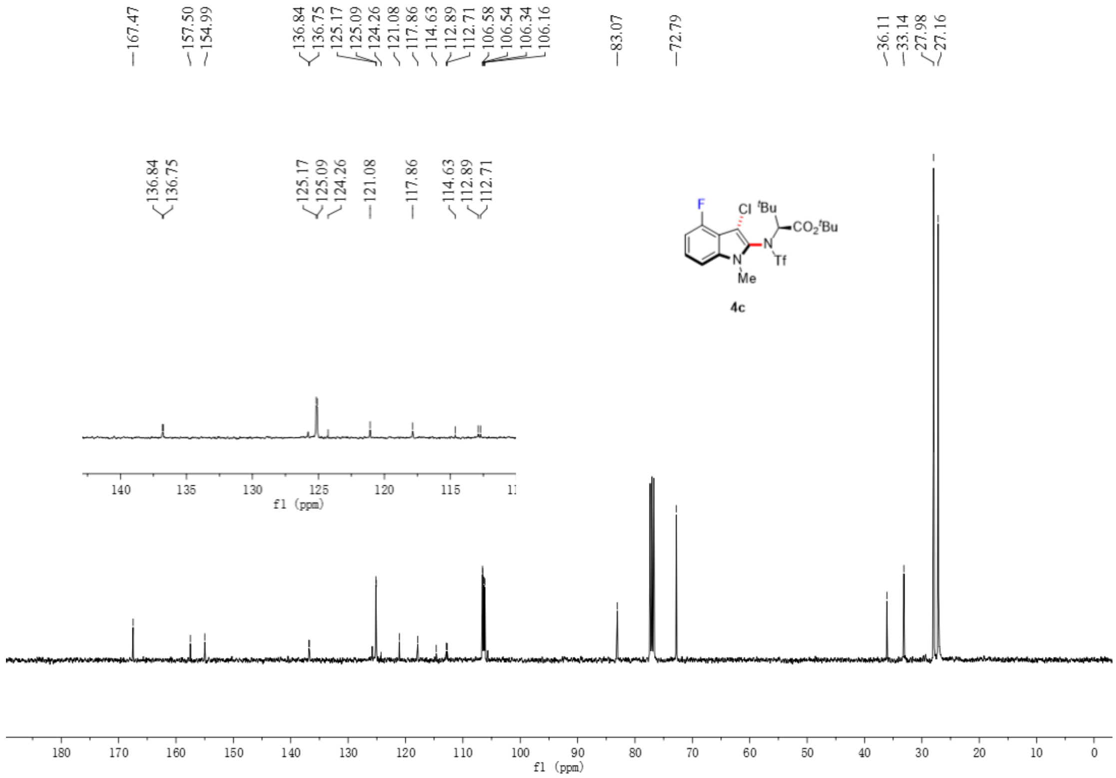
-124.25
F
Cl
tBu
CO2tBu
N
Tf
N
Me
4c
f1 (ppm)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157.50
154.99
136.84
136.75
125.17
125.09
124.26
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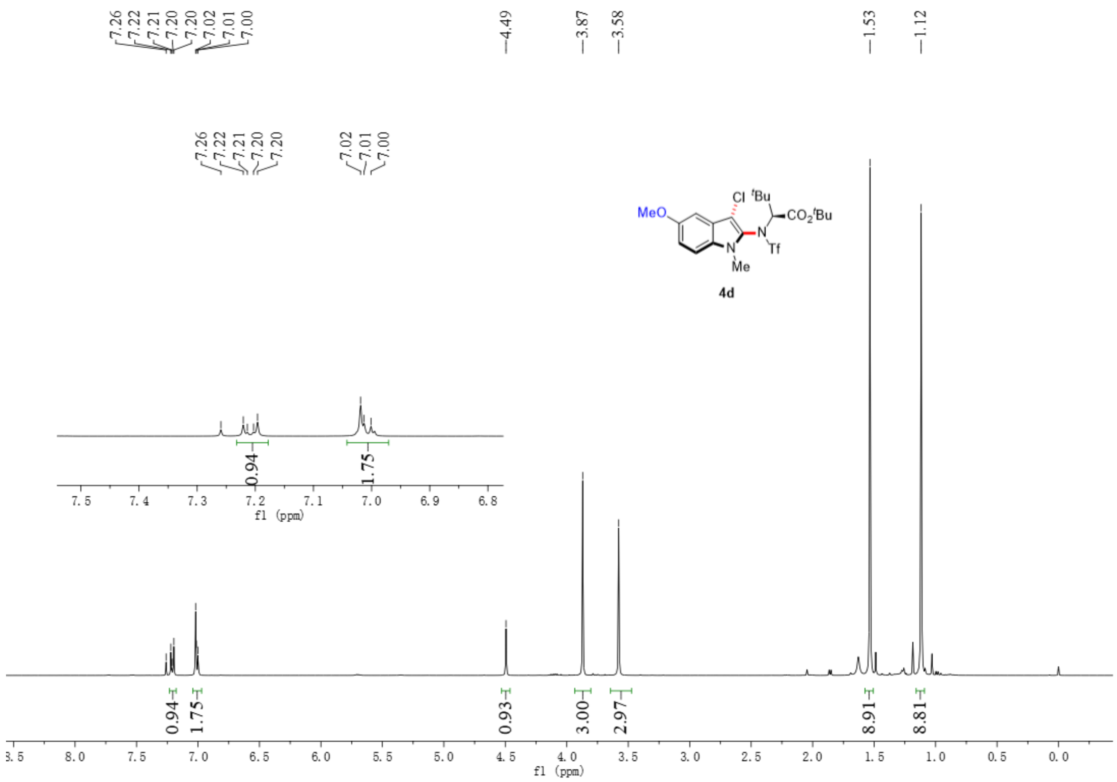
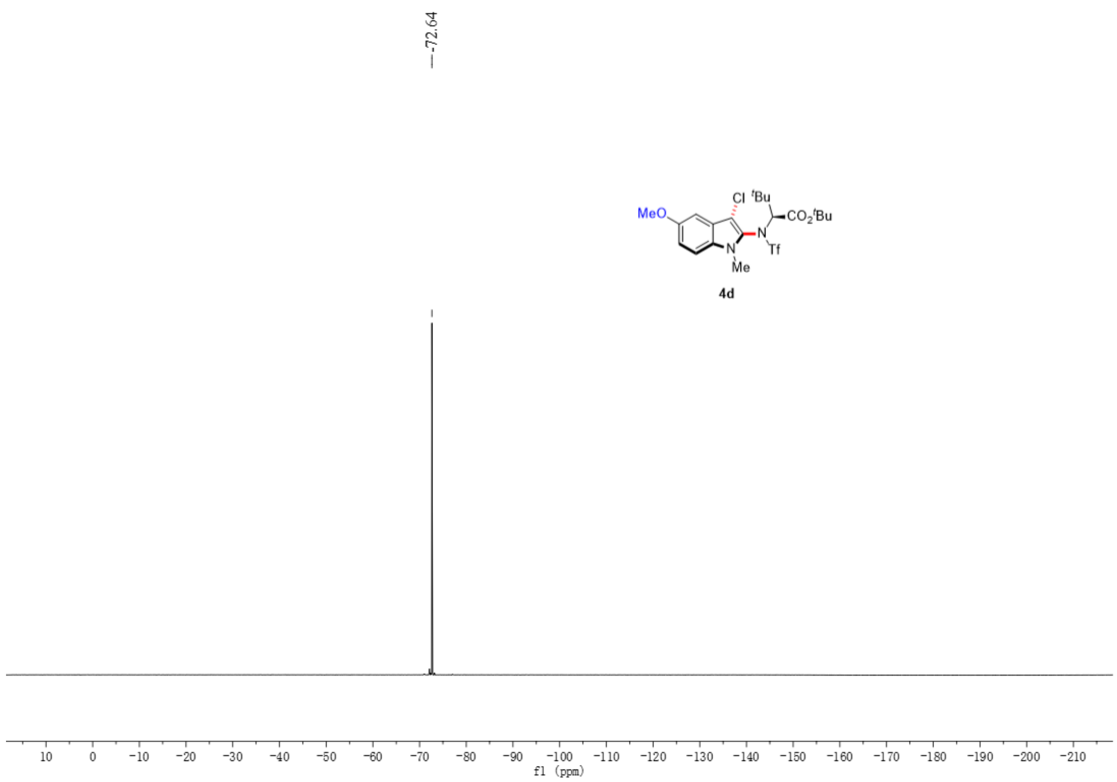
117.86
114.63
112.89
112.71
106.58
106.54
106.34
106.16
83.07
72.79
36.11
33.14
27.98
27.16
4c
f1 (ppm)


7.26
7.22
7.21
7.20
7.20
7.02
7.01
7.00
4.49
3.87
3.58
1.53
1.12
MeO
Cl
tBu
CO2tBu
N
Tf
Me
4d
0.94
1.75
0.93
3.00
2.97
8.91
8.81
f1 (ppm)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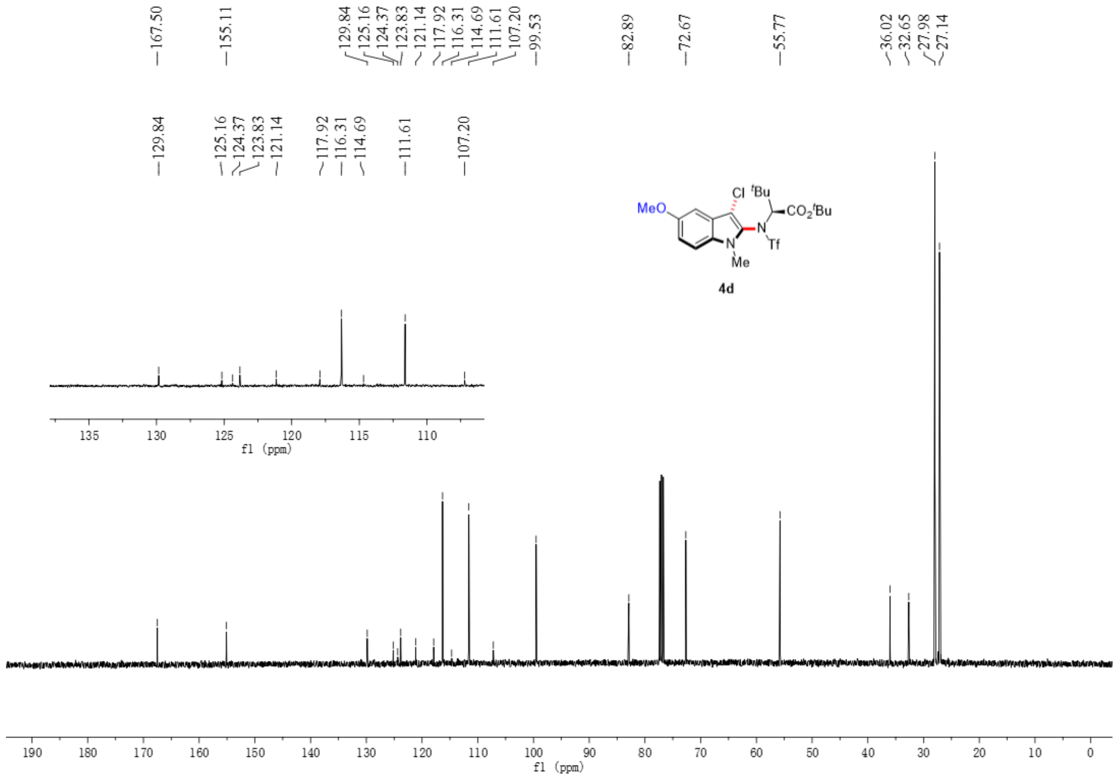
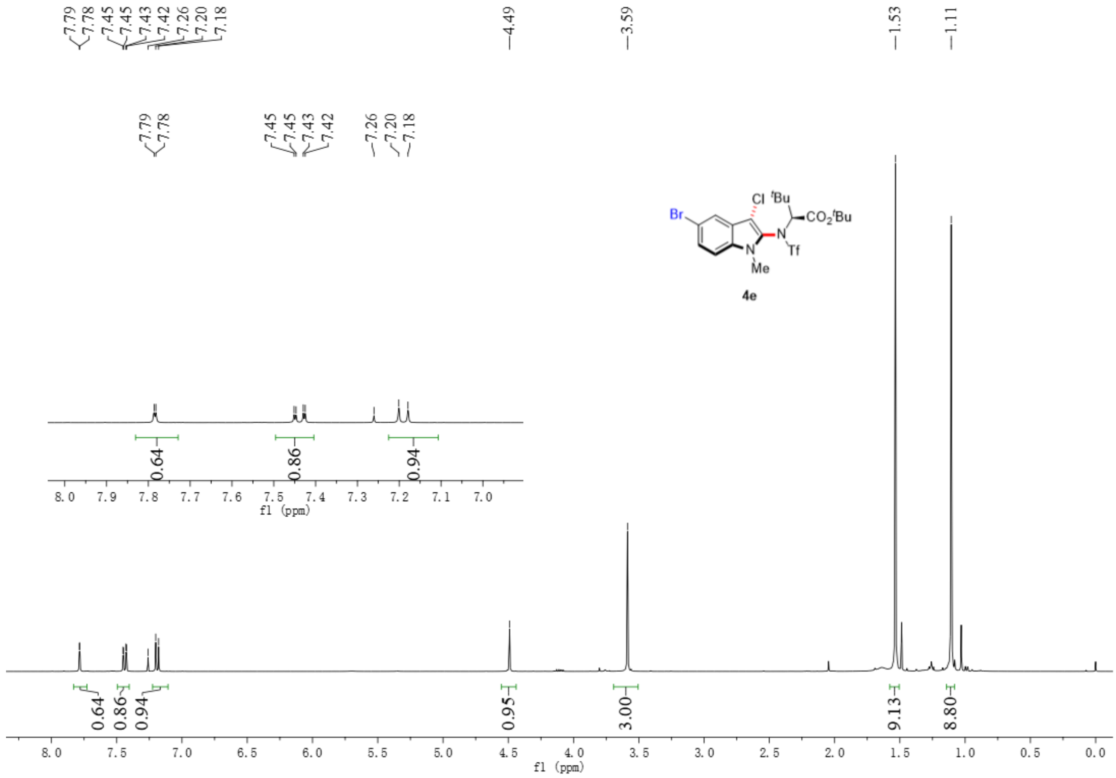
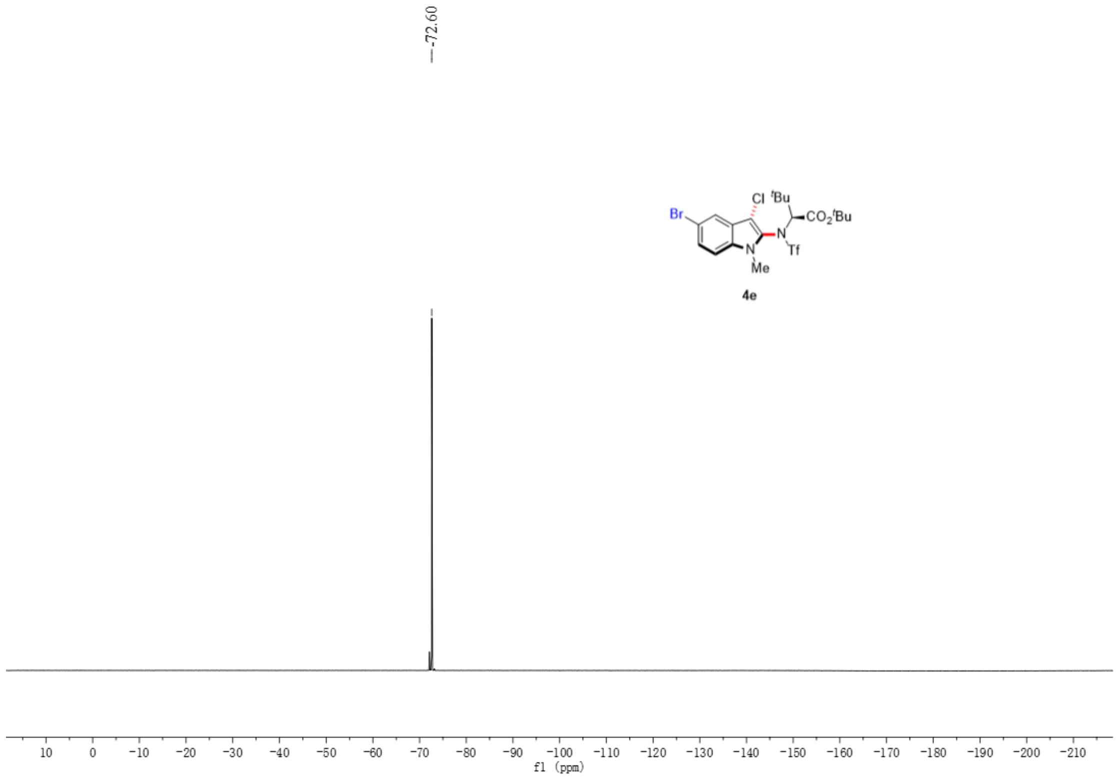
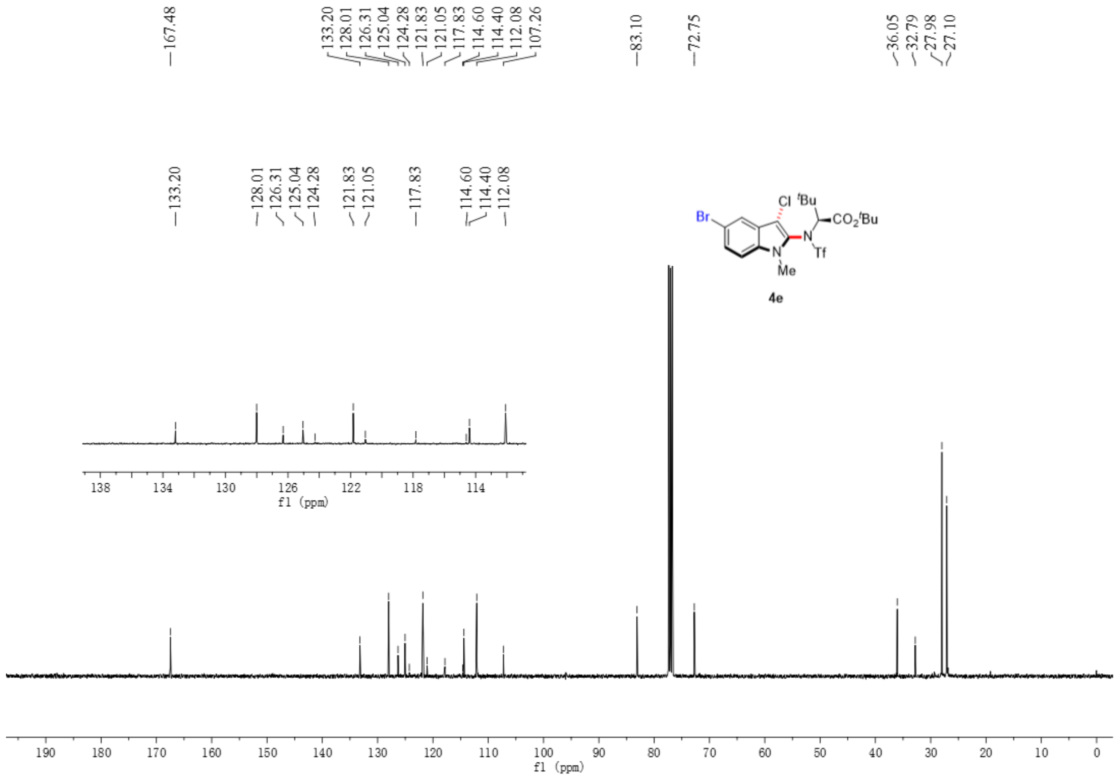
MeO
Cl
tBu
CO2tBu
N
Tf
Me
4d
f1 (ppm)


167.50
155.11
129.84
125.16
124.37
123.83
121.14
117.92
116.31
114.69
111.61
107.20
99.53
82.89
72.67
55.77
36.02
32.65
27.98
27.14
MeO
Cl
tBu
CO2tBu
N
Tf
Me
4d
fl (ppm)

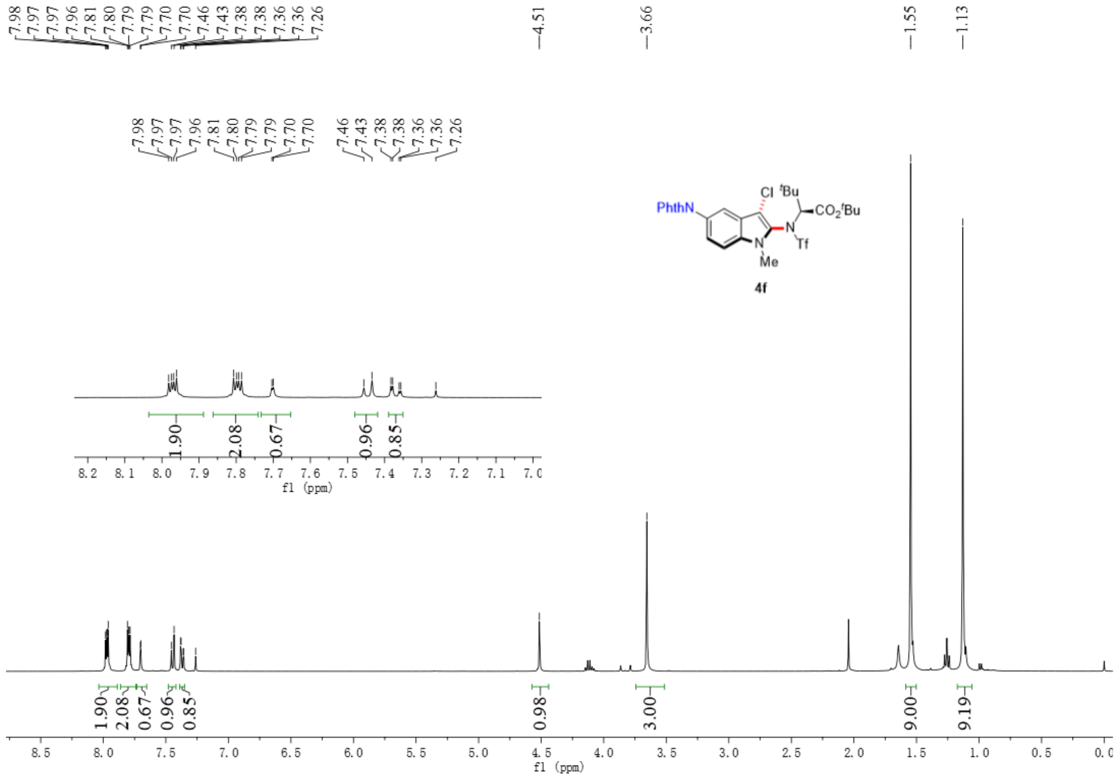

7.79
7.78
7.45
7.45
7.43
7.42
7.26
7.20
7.18
4.49
3.59
1.53
1.11
Br
Cl
tBu
CO2tBu
N
Tf
Me
4e
0.64
0.86
0.94
0.95
3.00
9.13
8.80
fl (ppm)

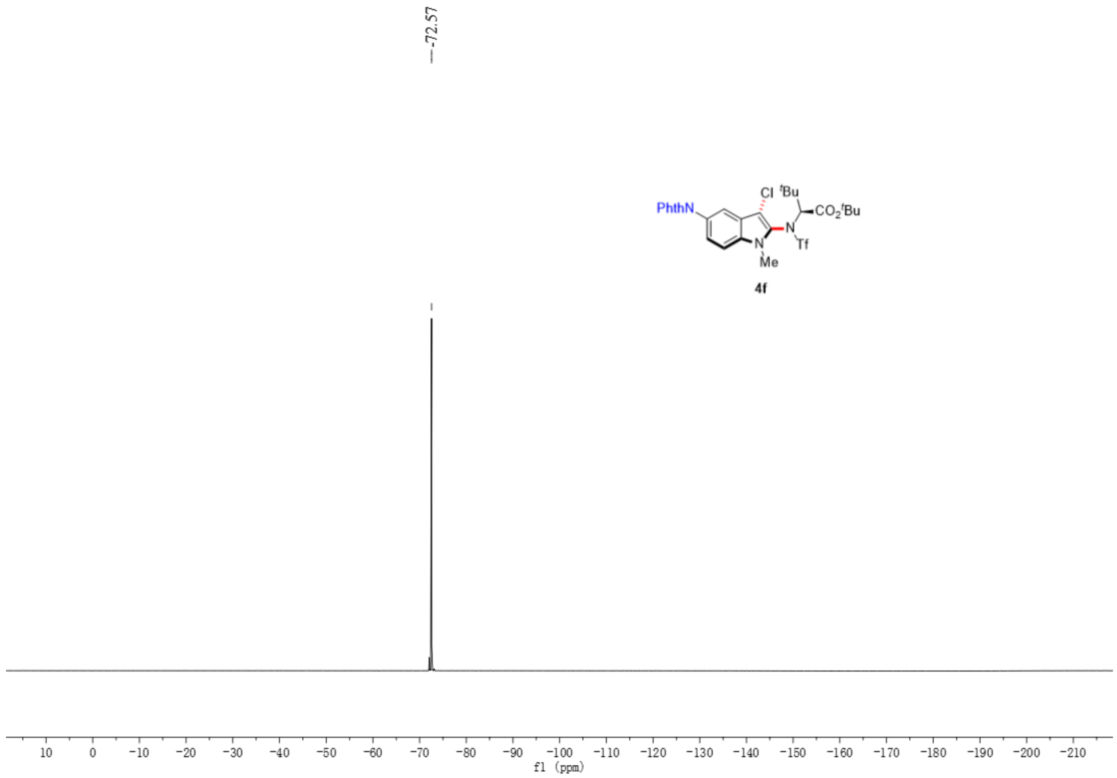


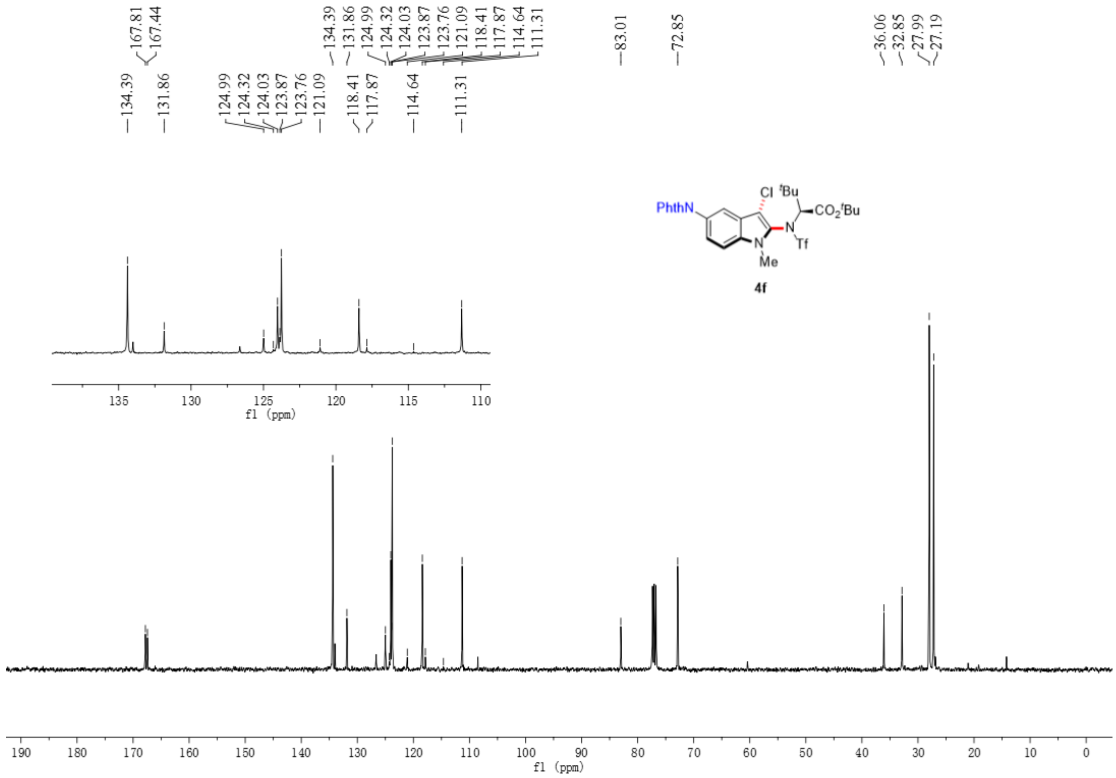
-72.60
Br
Cl
^{t}Bu
$CO_2{}^t$Bu
N
Tf
N
Me
4e
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)

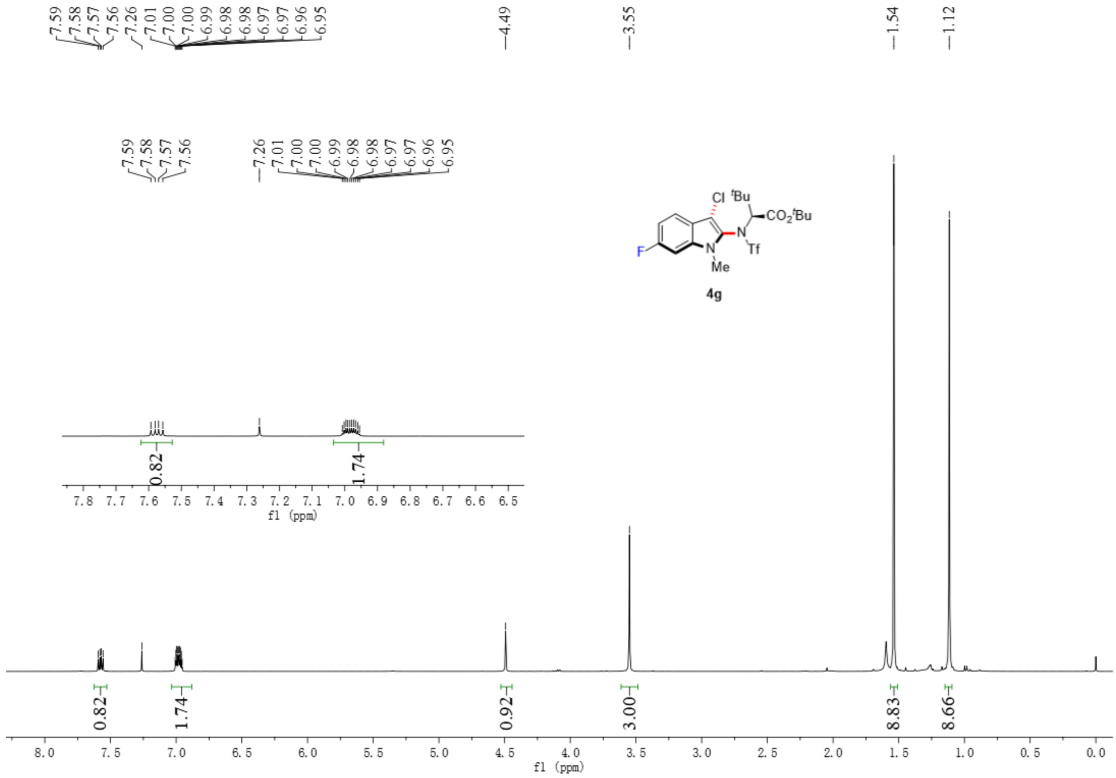


167.48
133.20
128.01
126.31
125.04
124.28
121.83
121.05
117.83
114.60
114.40
112.08
107.26
83.10
72.75
36.05
32.79
27.98
27.10
133.20
128.01
126.31
125.04
124.28
121.83
121.05
117.83
114.60
114.40
112.08
Br
Cl
^{t}Bu
$CO_2{}^t$Bu
N
Tf
N
Me
4e
138 134 130 126 122 118 114
f1 (ppm)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)






167.81
167.44
134.39
131.86
124.99
124.32
124.03
123.87
123.76
121.09
118.41
117.87
114.64
111.31
83.01
72.85
36.06
32.85
27.99
27.19
PhthN
Cl
tBu
CO2tBu
N
Tf
N
Me
4f
f1 (ppm)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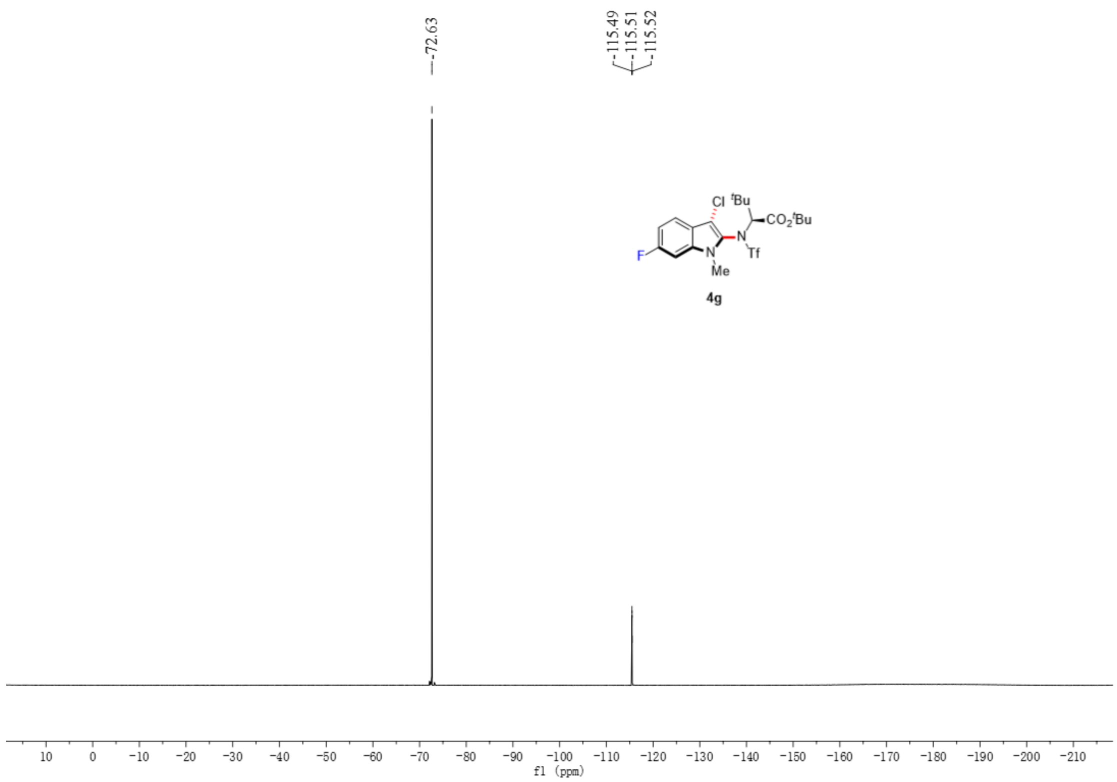
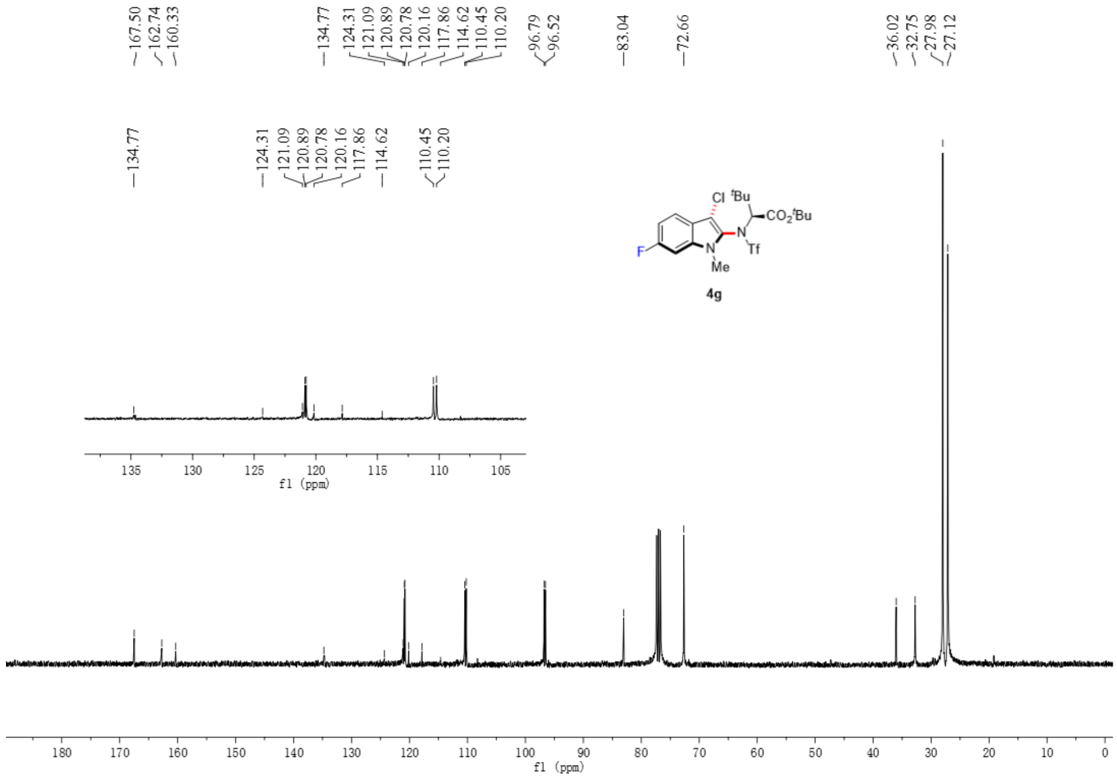
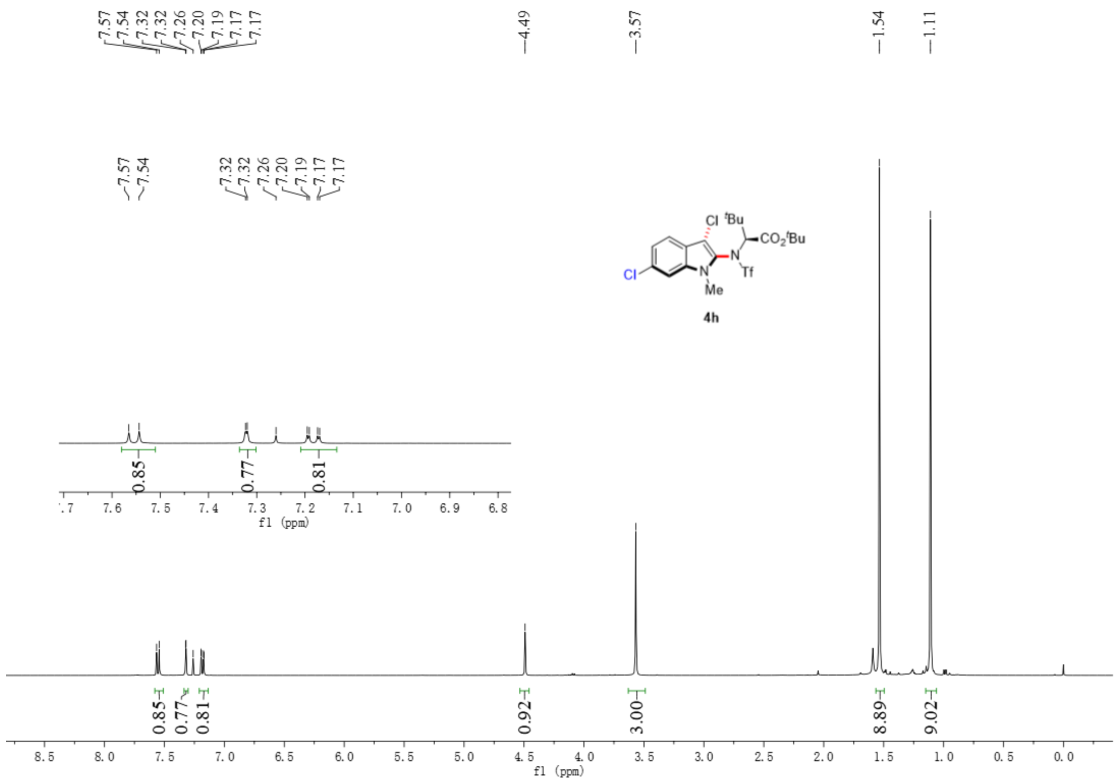
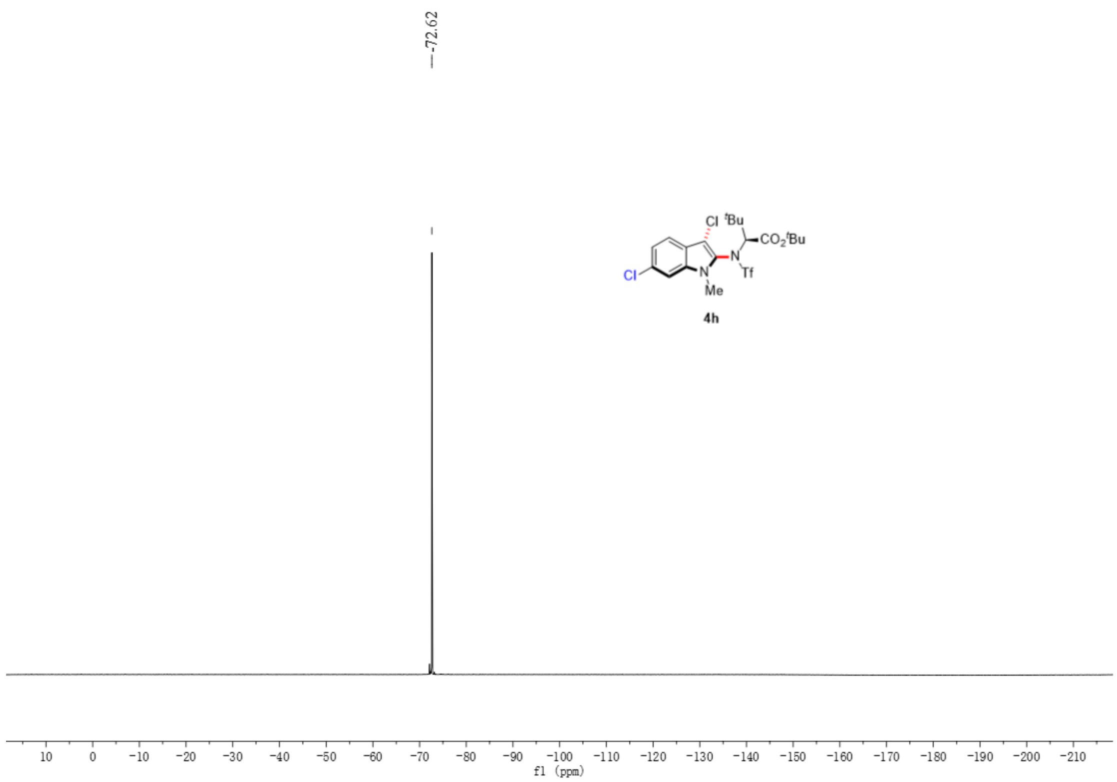
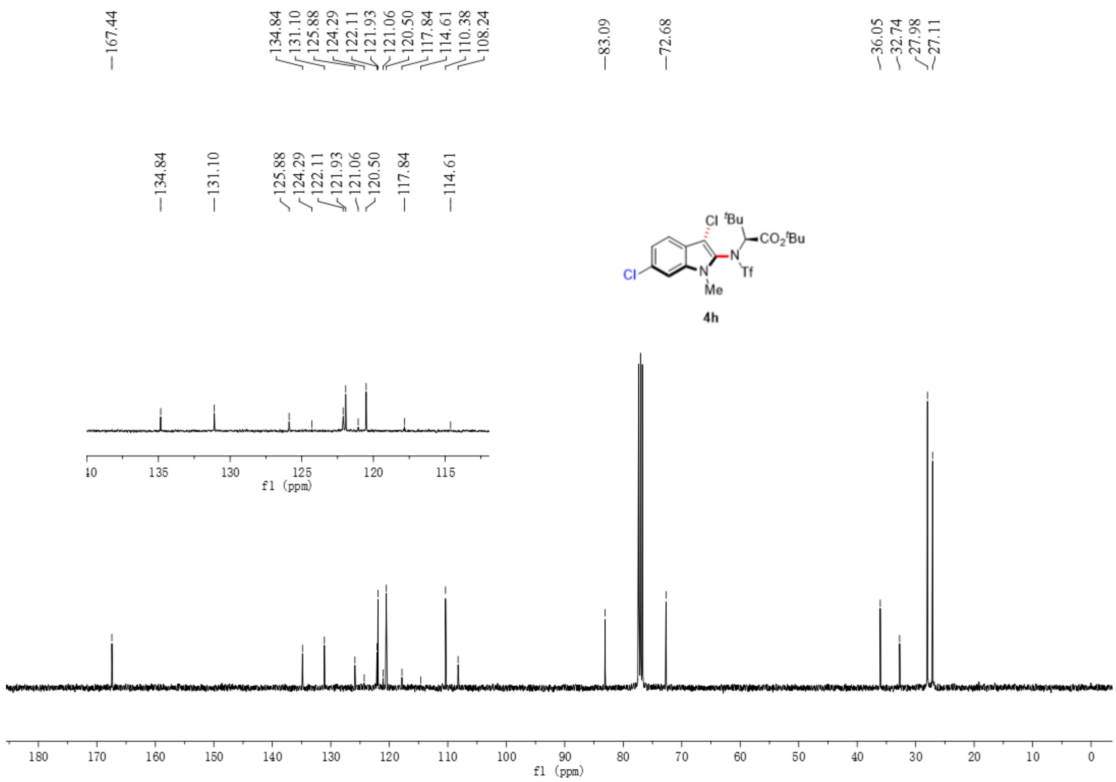
7.58
7.57
7.56
7.26
7.01
7.00
6.99
6.98
6.98
6.97
6.97
6.96
6.95
4.49
3.55
1.54
1.12
Cl
tBu
CO2tBu
N
Tf
F
N
Me
4g
0.82
1.74
0.92
3.00
8.83
8.66
f1 (ppm)







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125.88
124.29
122.11
121.93
121.06
120.50
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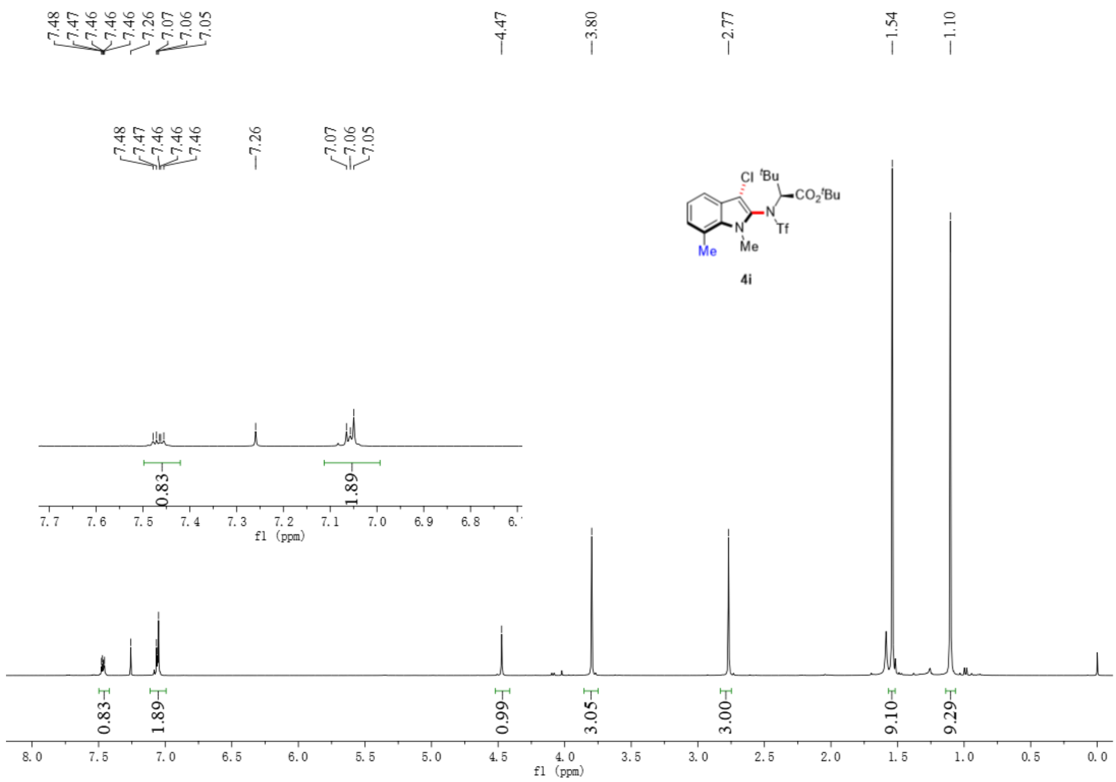
114.61
110.38
108.24
83.09
72.68
36.05
32.74
27.98
27.11
4h
f1 (ppm)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7.47
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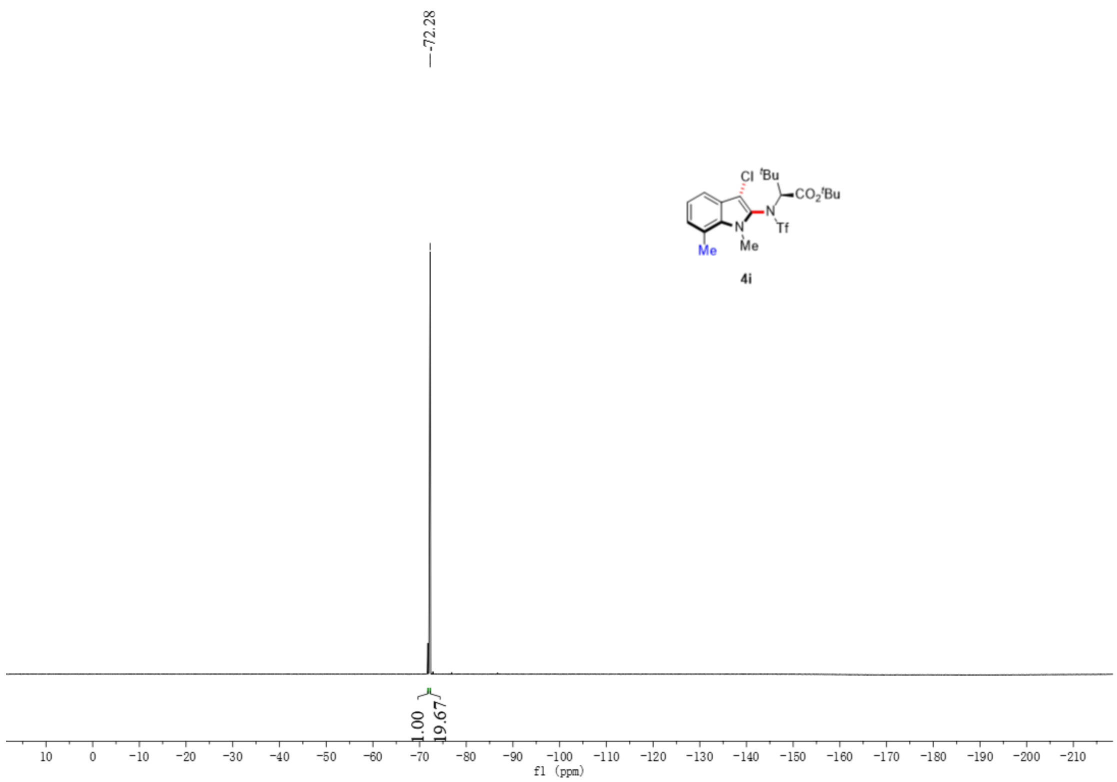
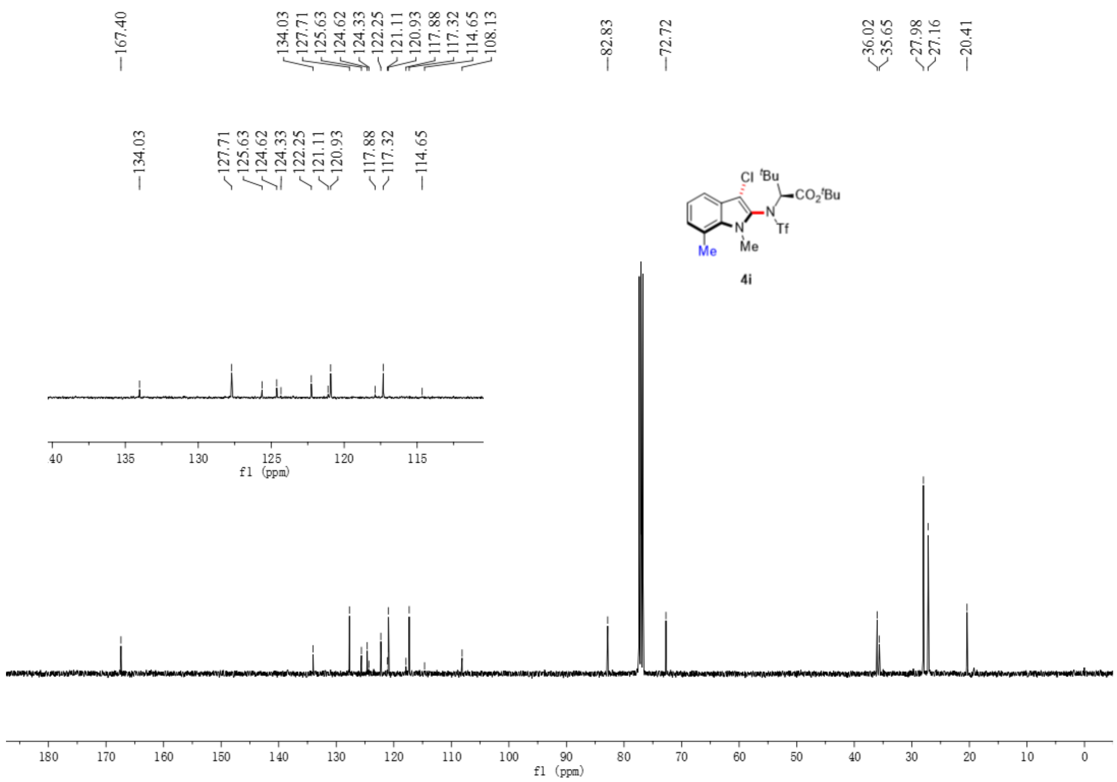
7.46
7.46
7.26
7.07
7.06
7.05
4.47
3.80
2.77
1.54
1.10
4i
0.83
1.89
0.99
3.05
3.00
9.10
9.29
f1 (ppm)


-72.28
Cl
tBu
CO2tBu
N
Tf
N
Me
Me
4i
1.00
19.67
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)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121.11
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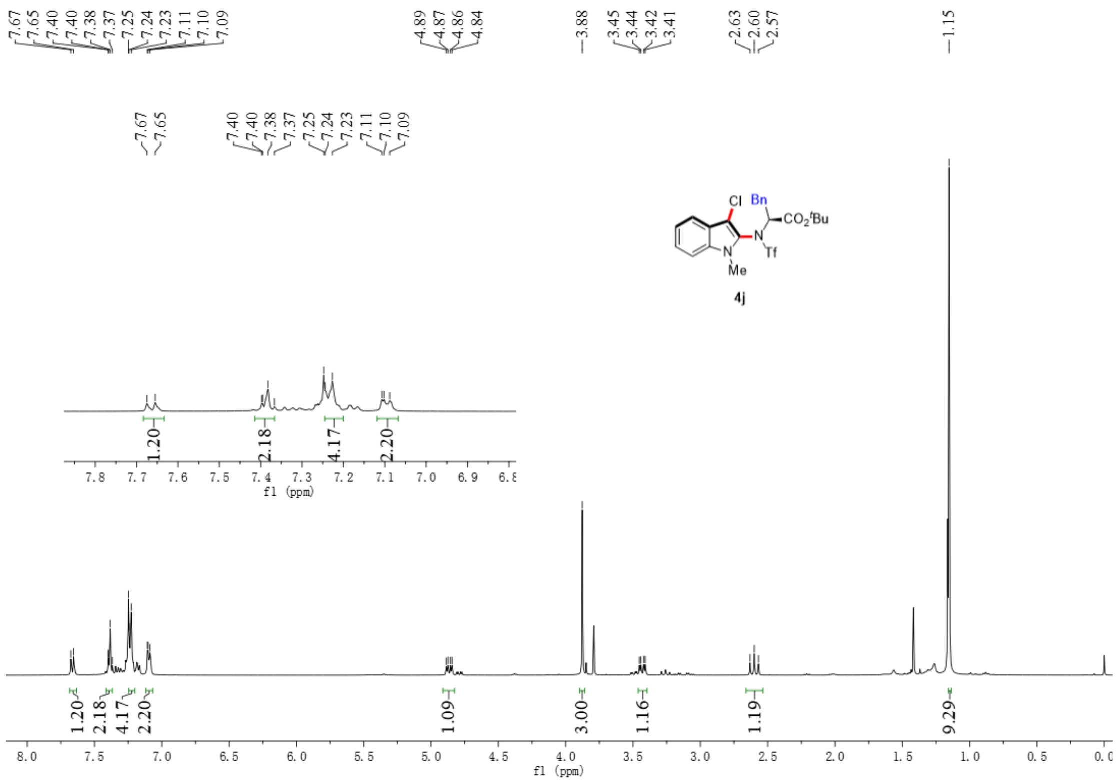
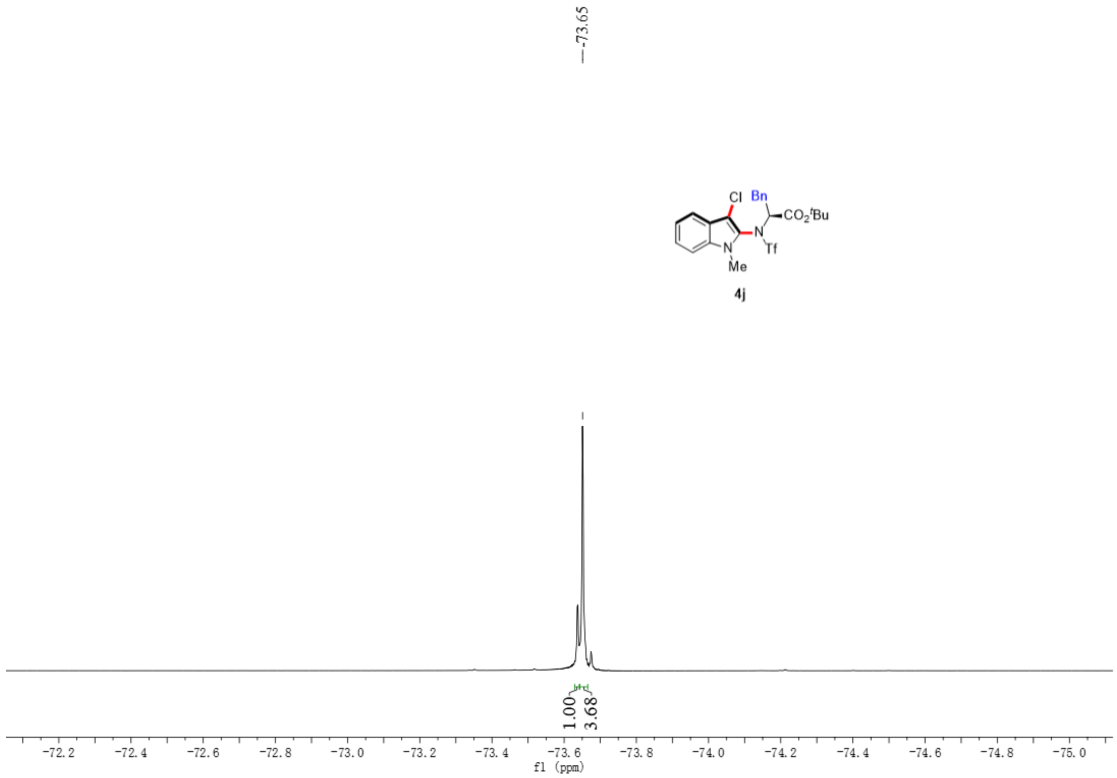
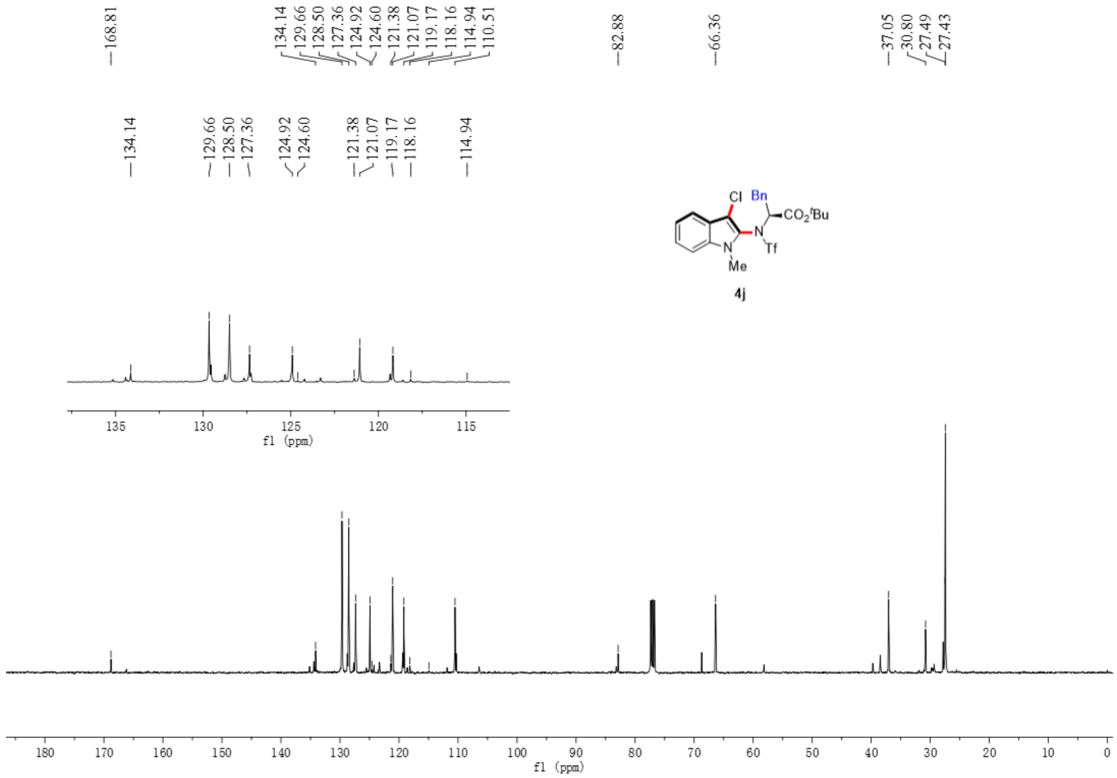
117.88
117.32
114.65
108.13
82.83
72.72
36.02
35.65
27.98
27.16
20.41
134.03
127.71
125.63
124.62
124.33
122.25
121.11
120.93
117.88
117.32
114.65
Cl
tBu
CO2tBu
N
Tf
N
Me
Me
4i
40 135 130 125 120 115
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



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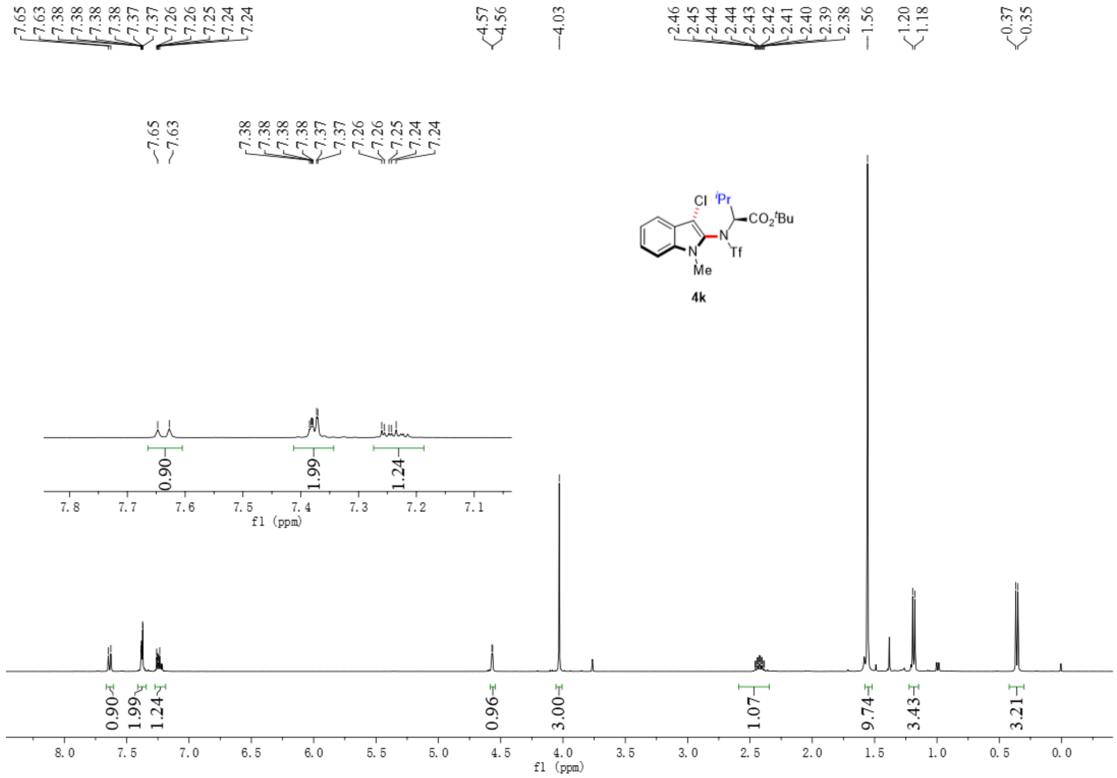
124.92
124.60
121.38
121.07
119.17
118.16
114.94
110.51
82.88
66.36
37.05
30.80
27.49
27.43
Cl
Bn
$CO_2{}^tBu$
N
Tf
Me
4j
f1 (ppm)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7.37
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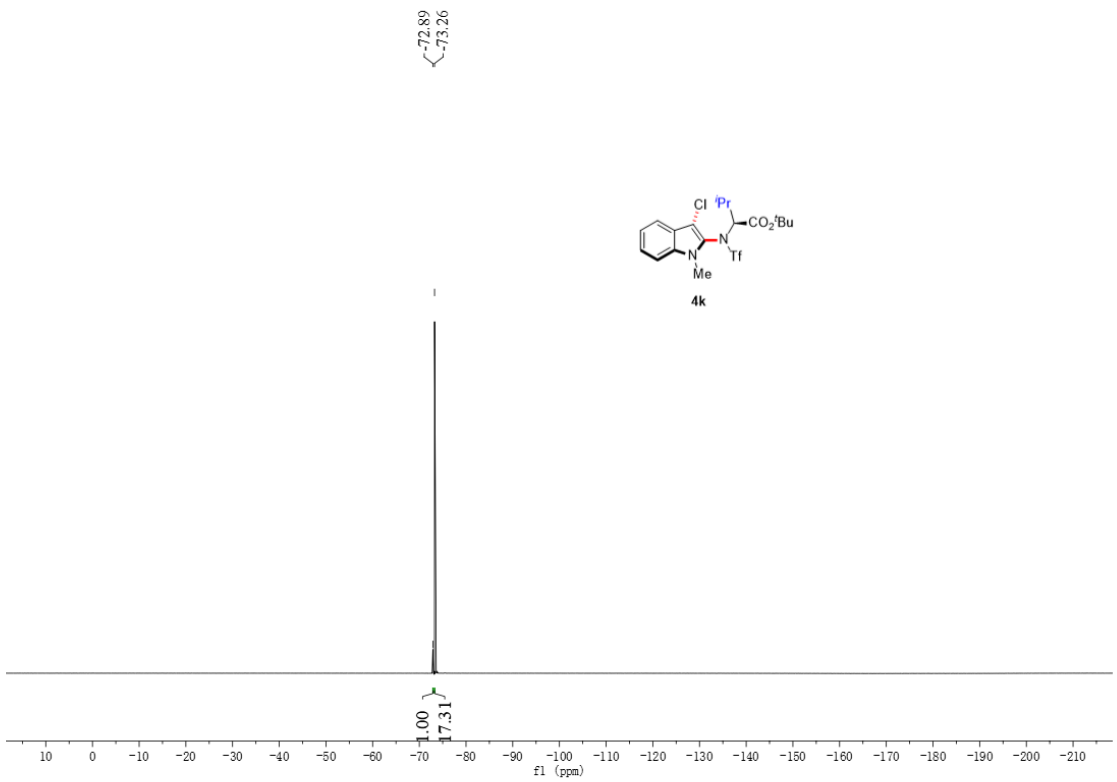
7.26
7.25
7.24
7.24
4.57
4.56
4.03
2.46
2.45
2.44
2.44
2.43
2.42
2.41
2.40
2.39
2.38
1.56
1.20
1.18
0.37
0.35
Cl
^{i}Pr
$CO_2{}^tBu$
N
Tf
Me
4k
0.90
1.99
1.24
0.96
3.00
1.07
9.74
3.43
3.21
f1 (ppm)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iPr
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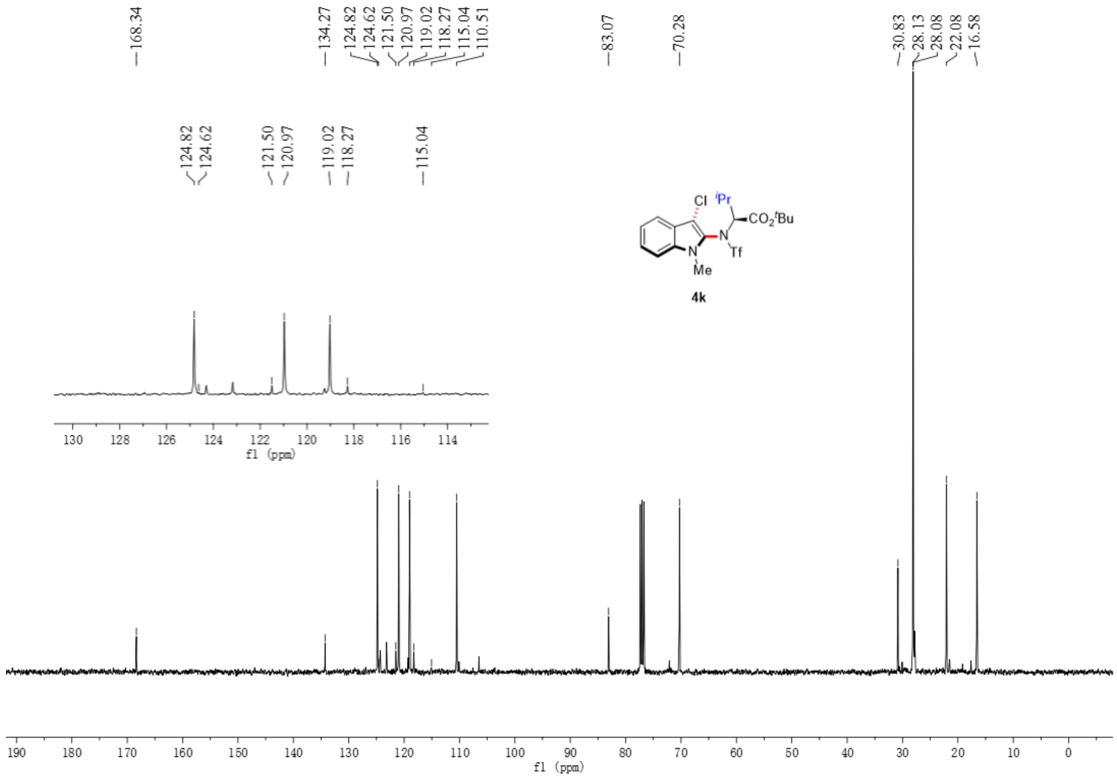
N
Tf
N
Me
4k
1.00
17.31
f1 (ppm)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118.27
115.04
110.51
83.07
70.28
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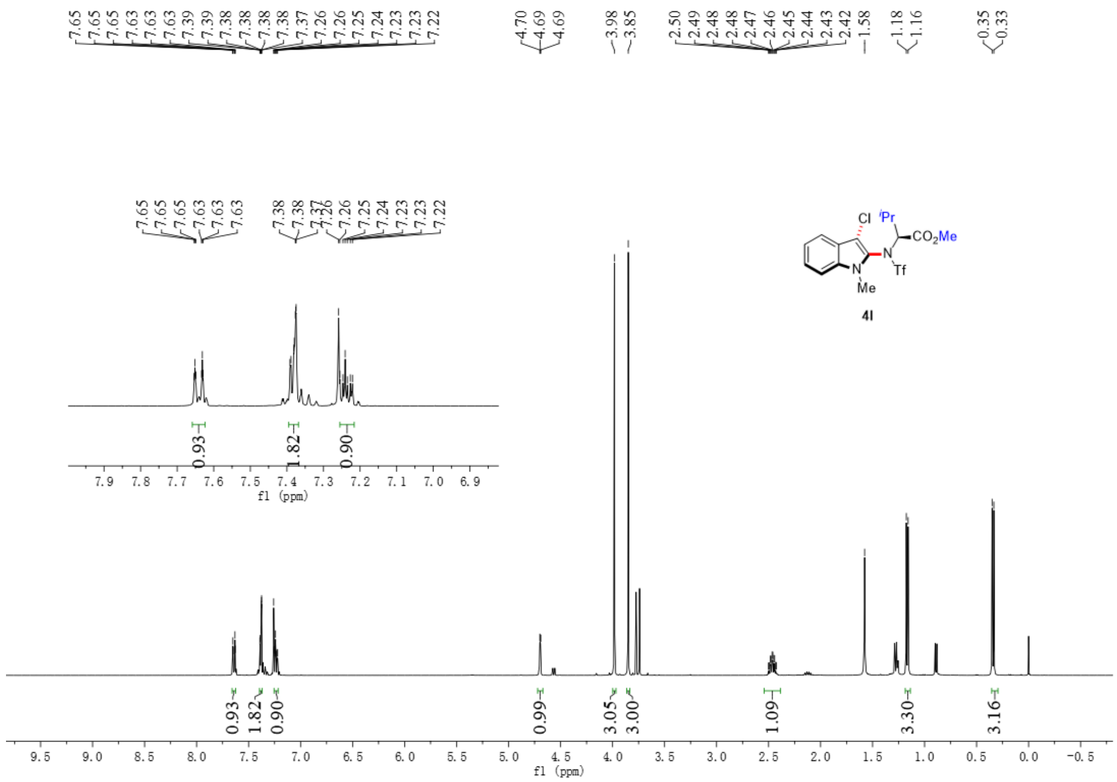
28.13
28.08
22.08
16.58
Cl
iPr
CO2tBu
N
Tf
N
Me
4k
f1 (ppm)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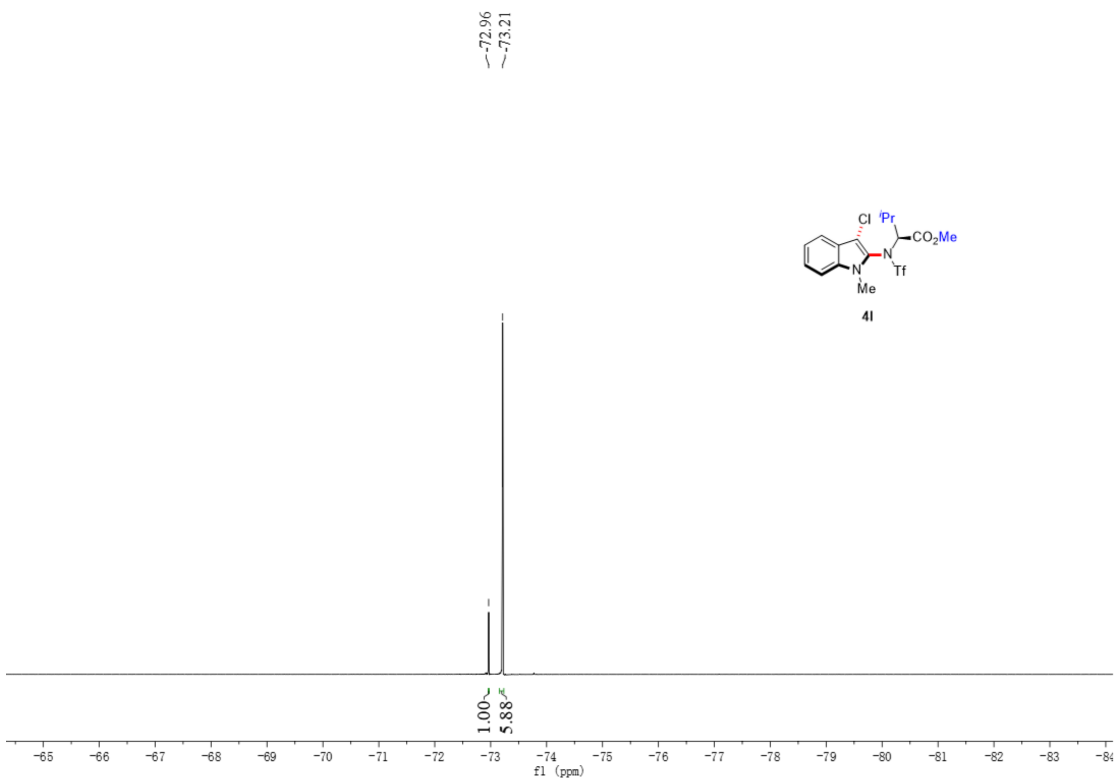
7.26
7.26
7.25
7.24
7.23
7.23
7.22
4.70
4.69
4.69
3.98
3.85
2.50
2.49
2.48
2.48
2.47
2.46
2.45
2.44
2.43
2.42
1.58
1.18
1.16
0.35
0.33
Cl
iPr
CO2Me
N
N
Tf
Me
4l
0.93
1.82
0.90
f1 (ppm)
0.93
1.82
0.90
0.99
3.05
3.00
1.09
3.30
3.16
f1 (ppm)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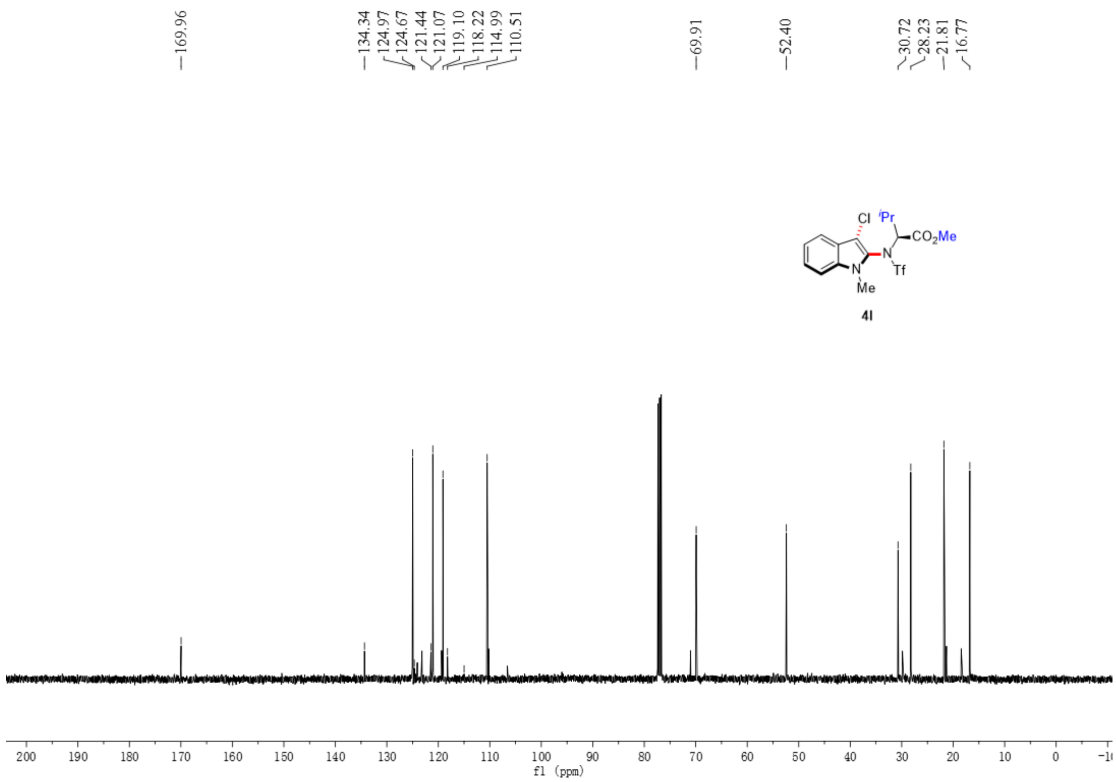
-73.21
Cl
iPr
CO2Me
N
N
Tf
Me
4l
1.00
5.88
f1 (ppm)



169.96
134.34
124.97
124.67
121.44
121.07
119.10
118.22
114.99
110.51
69.91
52.40
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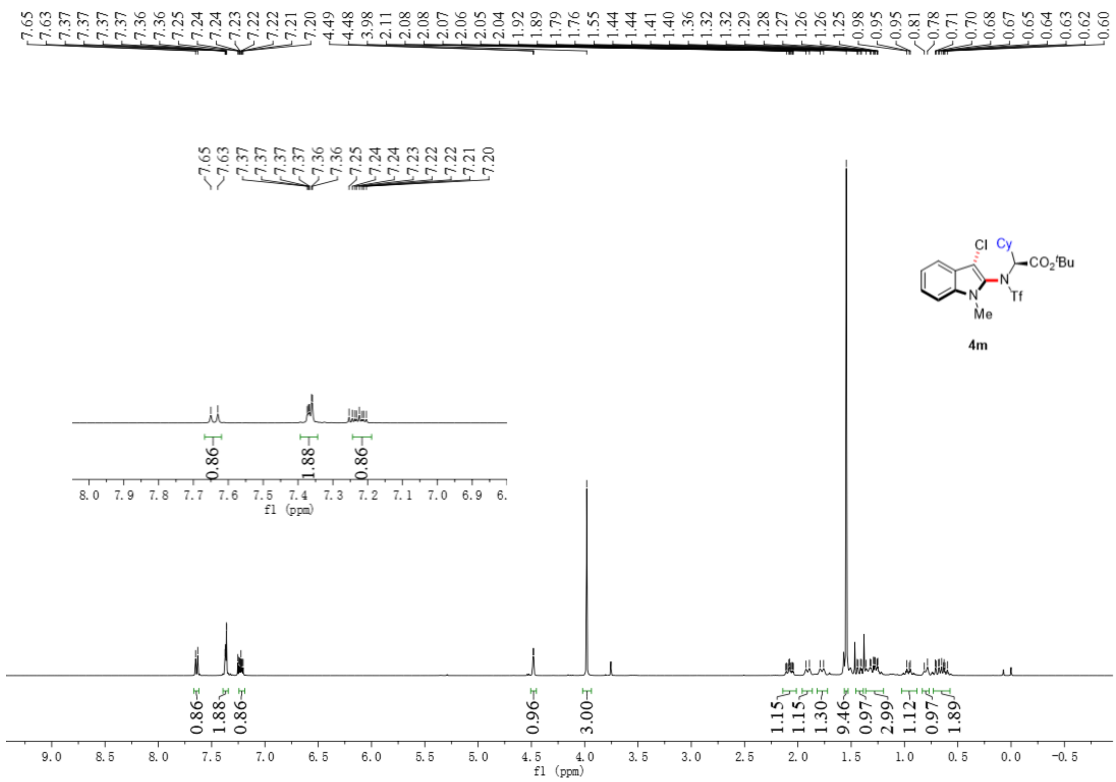
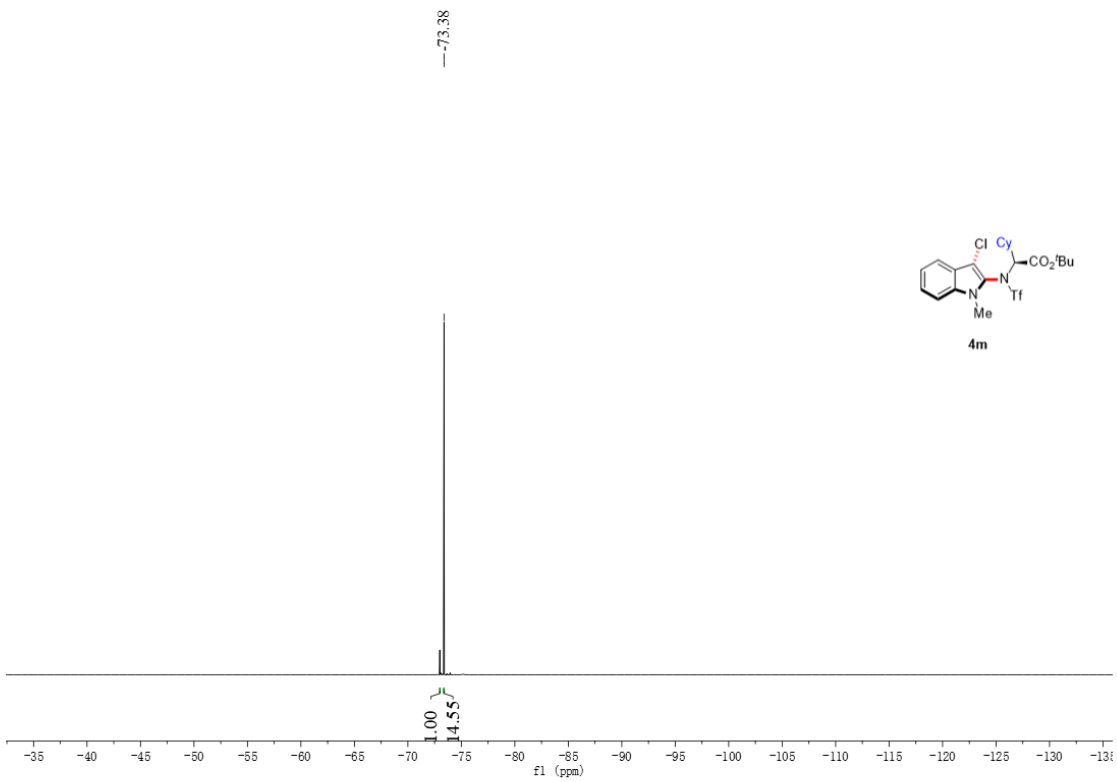
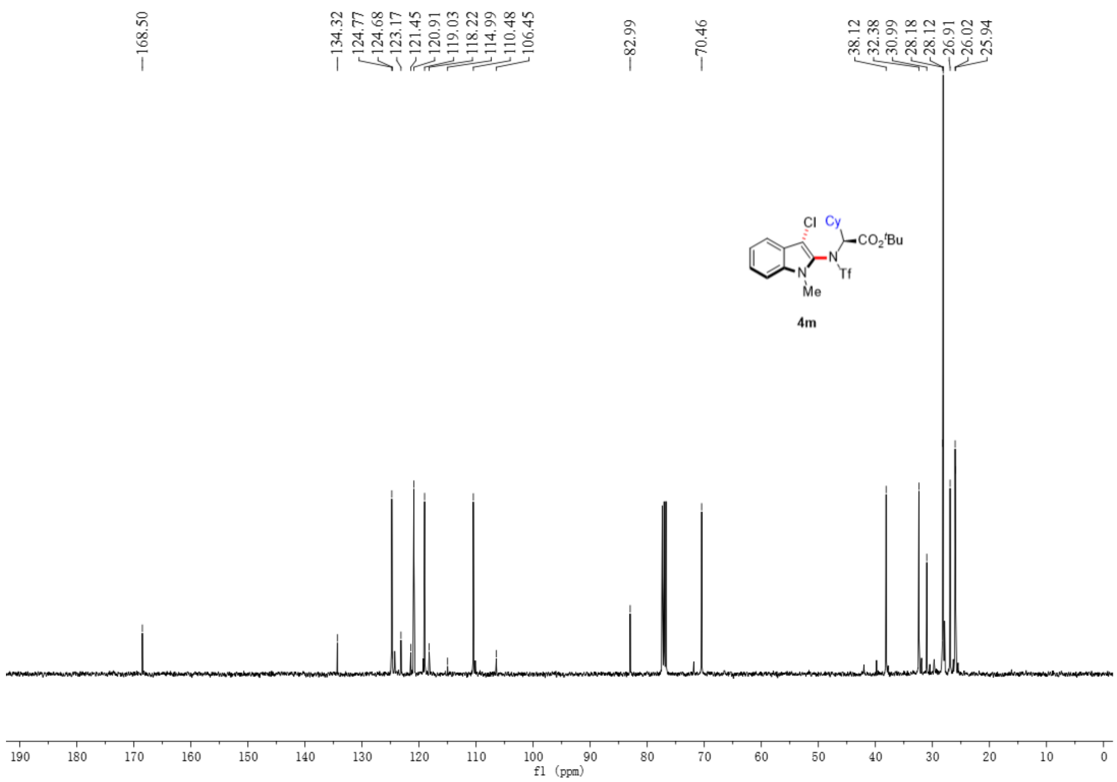
Tf
Me
4l
f1 (ppm)



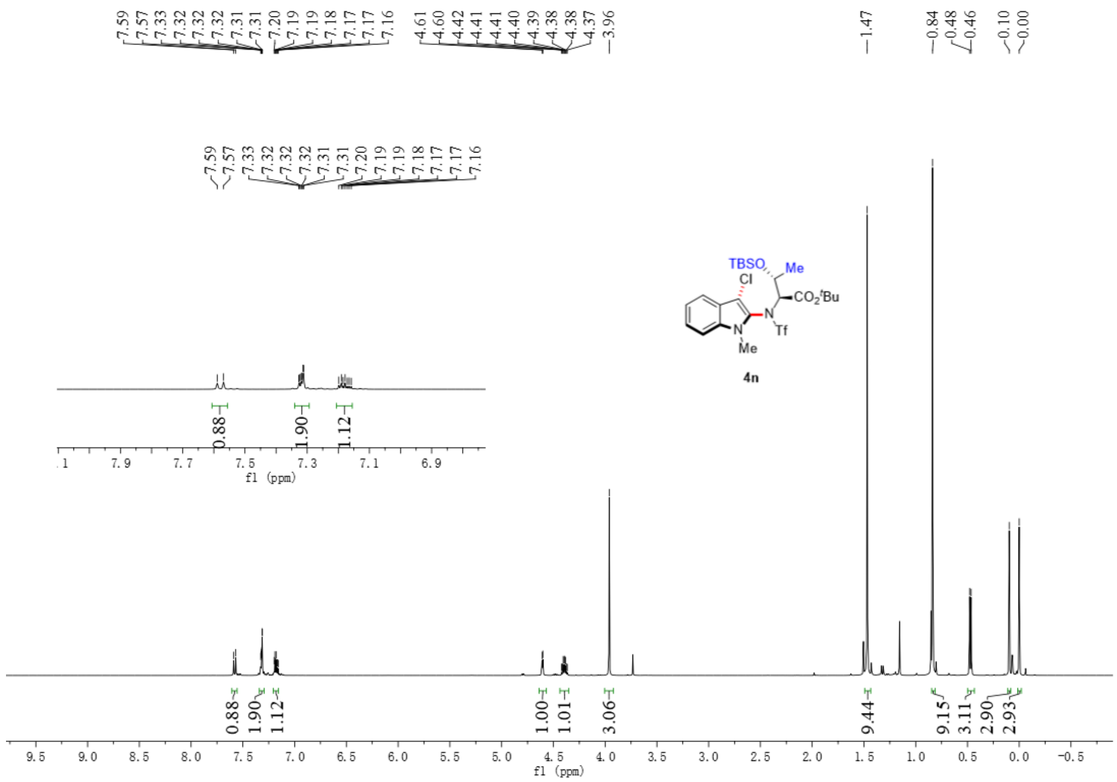
7.65 7.63 7.37 7.37 7.37 7.37 7.36 7.25 7.24 7.24 7.23 7.22 7.22 7.21 7.20 4.49 4.48 3.98 2.11 2.08 2.08 2.07 2.06 2.05 2.04 1.92 1.89 1.79 1.76 1.55 1.44 1.44 1.41 1.40 1.36 1.32 1.32 1.29 1.28 1.27 1.26 1.26 1.25 0.98 0.95 0.95 0.81 0.78 0.71 0.70 0.68 0.67 0.65 0.64 0.63 0.62 0.60
Cl
Cy
$CO_2{}^{t}Bu$
N
Tf
Me
4m
0.86 1.88 0.86
f1 (ppm)
0.86 1.88 0.86 0.96 3.00 1.15 1.15 1.30 9.46 0.97 2.99 1.12 0.97 1.89
f1 (ppm)

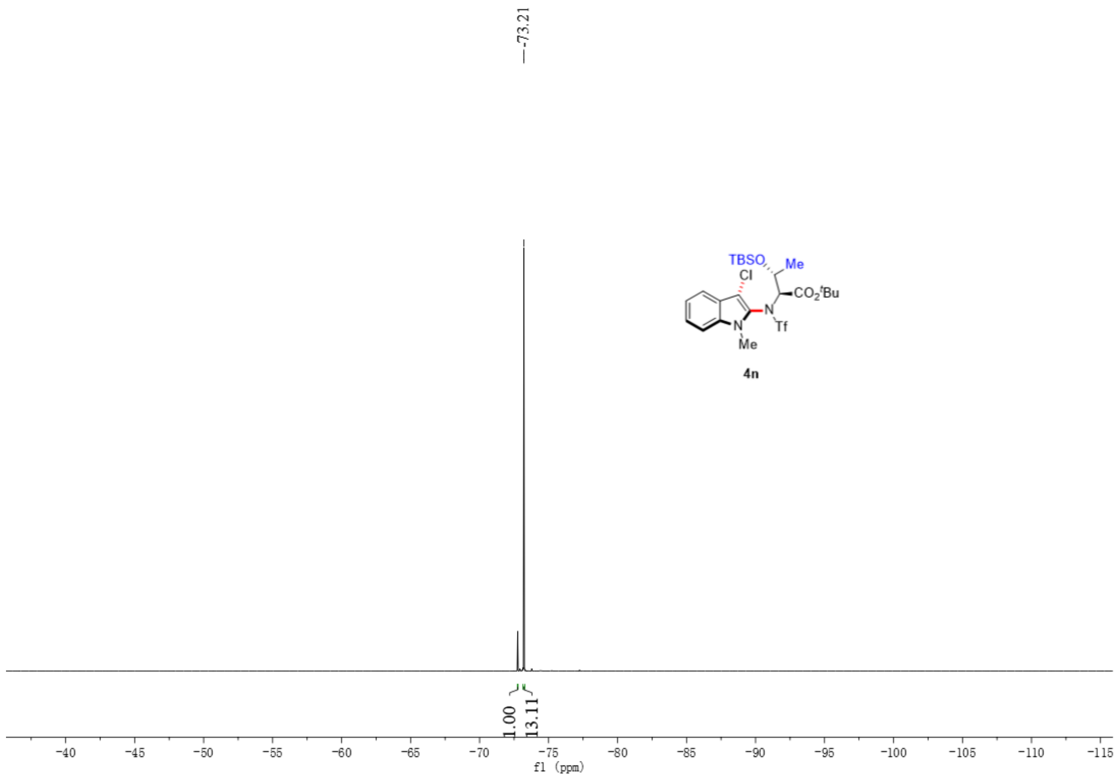


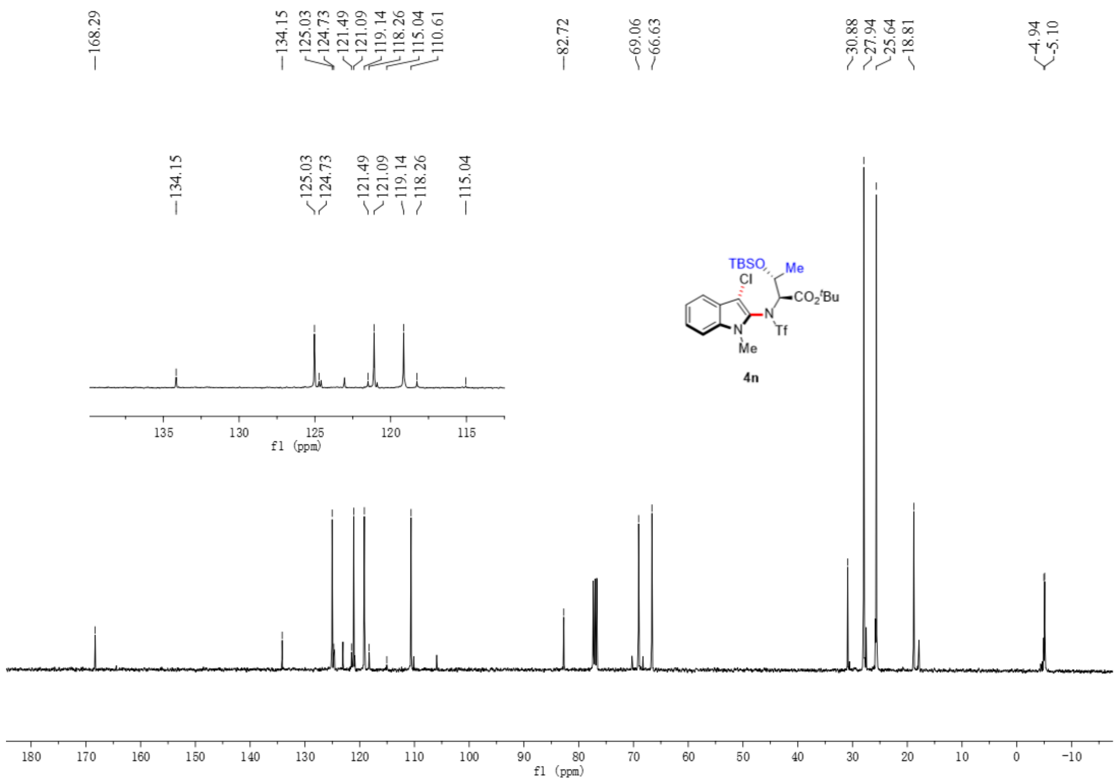
—73.38
Cl
Cy
$CO_2{}^tBu$
N
N
Tf
Me
4m
1.00
14.55
f1 (ppm)

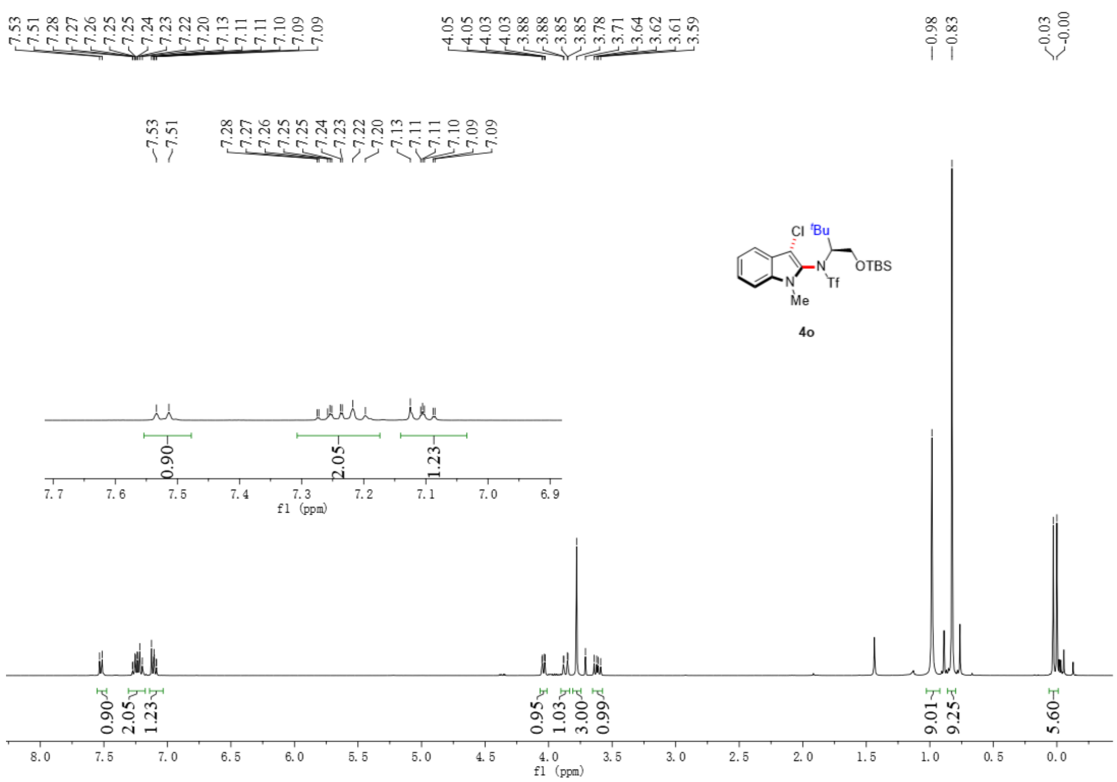


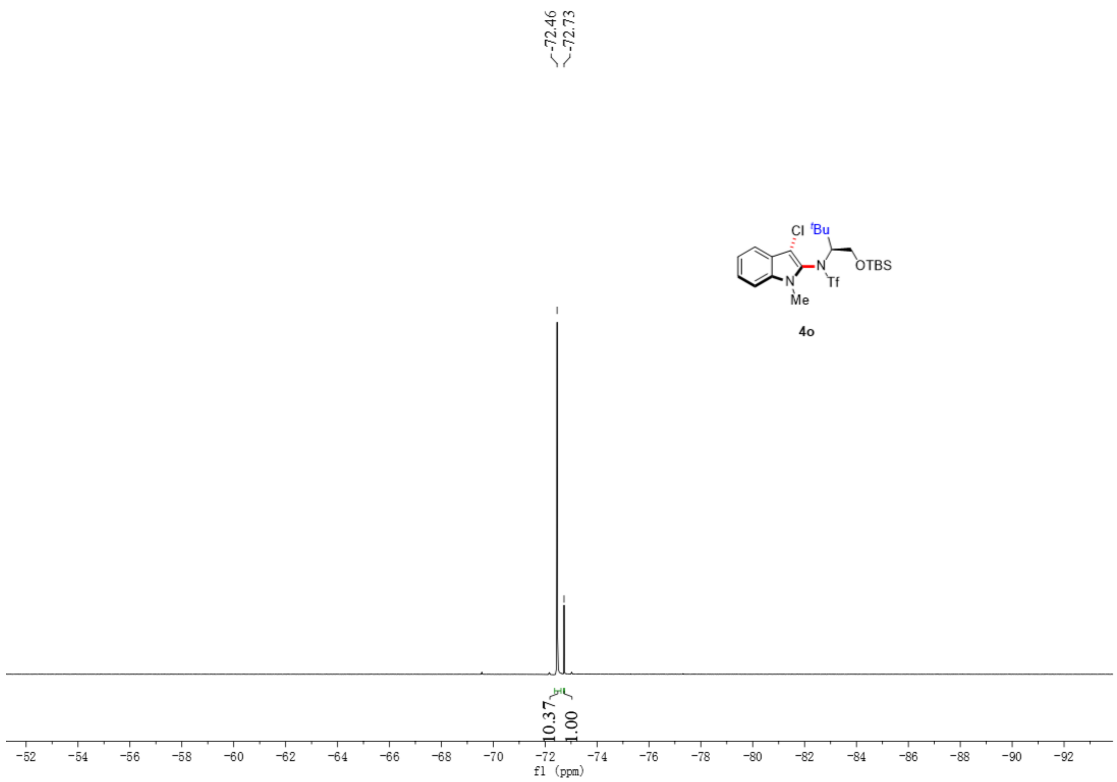
—168.50
134.32
124.77
124.68
123.17
121.45
120.91
119.03
118.22
114.99
110.48
106.45
—82.99
—70.46
38.12
32.38
30.99
28.18
28.12
26.91
26.02
25.94
Cl
Cy
$CO_2{}^tBu$
N
N
Tf
Me
4m
f1 (ppm)

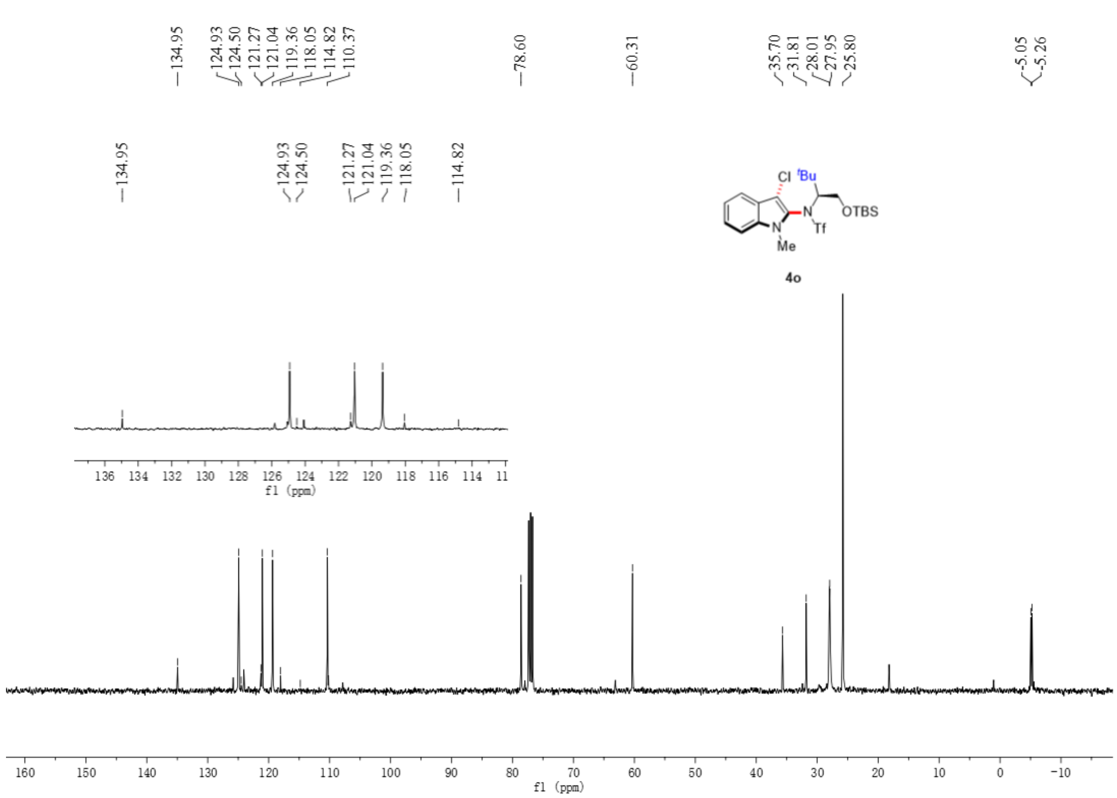


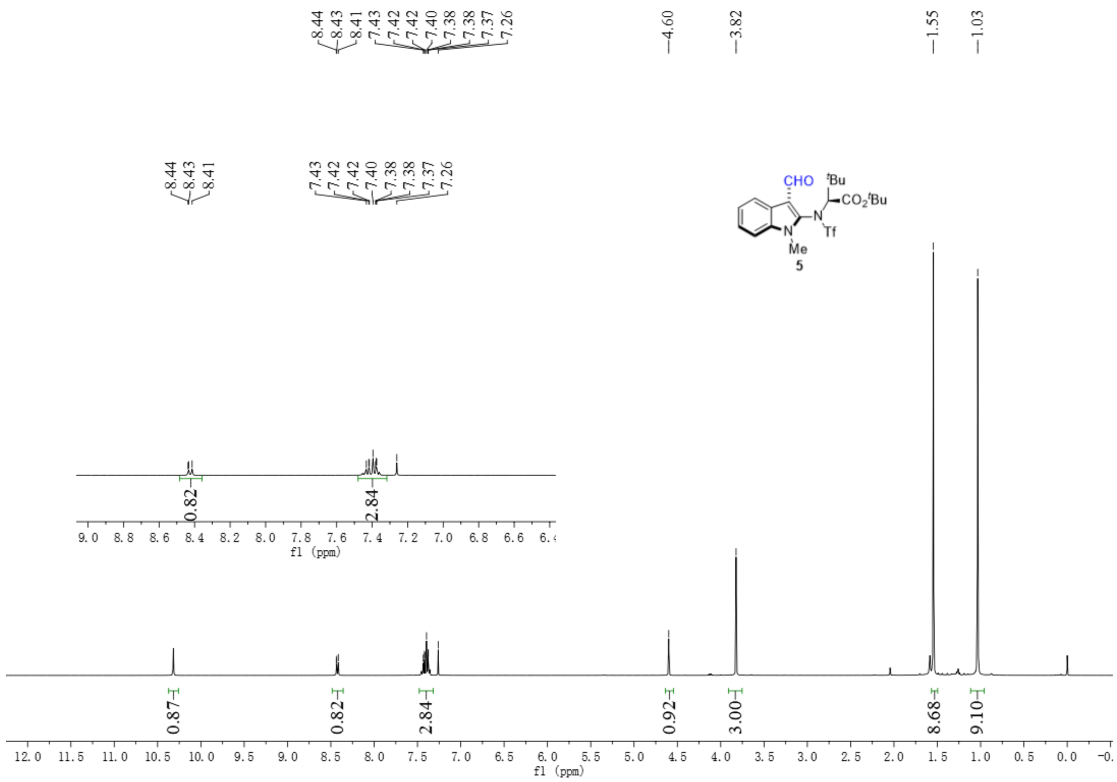


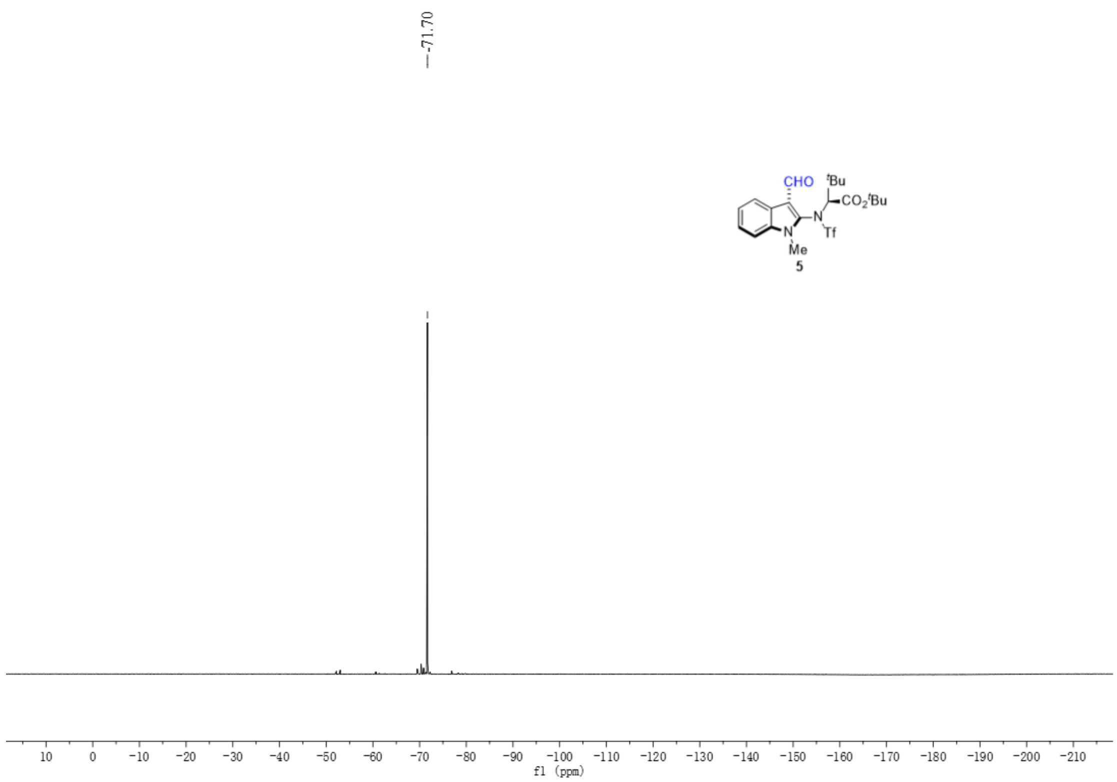

TBSO
Me
Cl
$CO_2{}^tBu$
N
Tf
Me
4n
f1 (ppm)

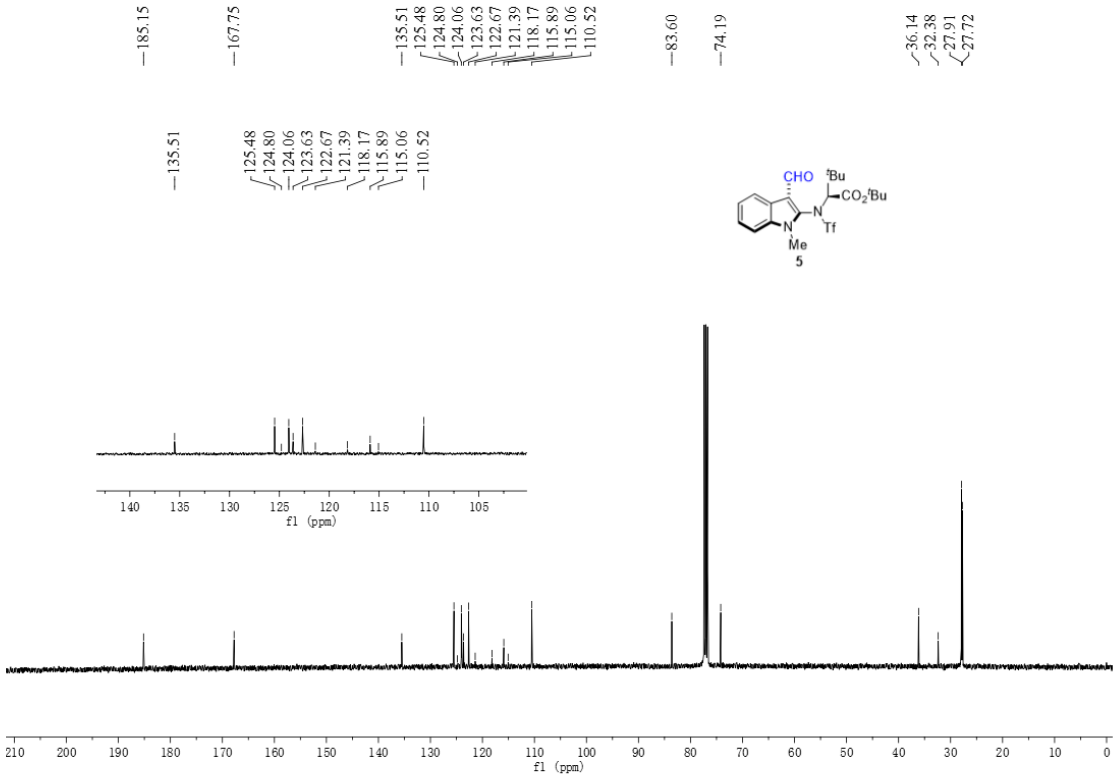

Cl
^{t}Bu
OTBS
N
Tf
Me
4o
f1 (ppm)



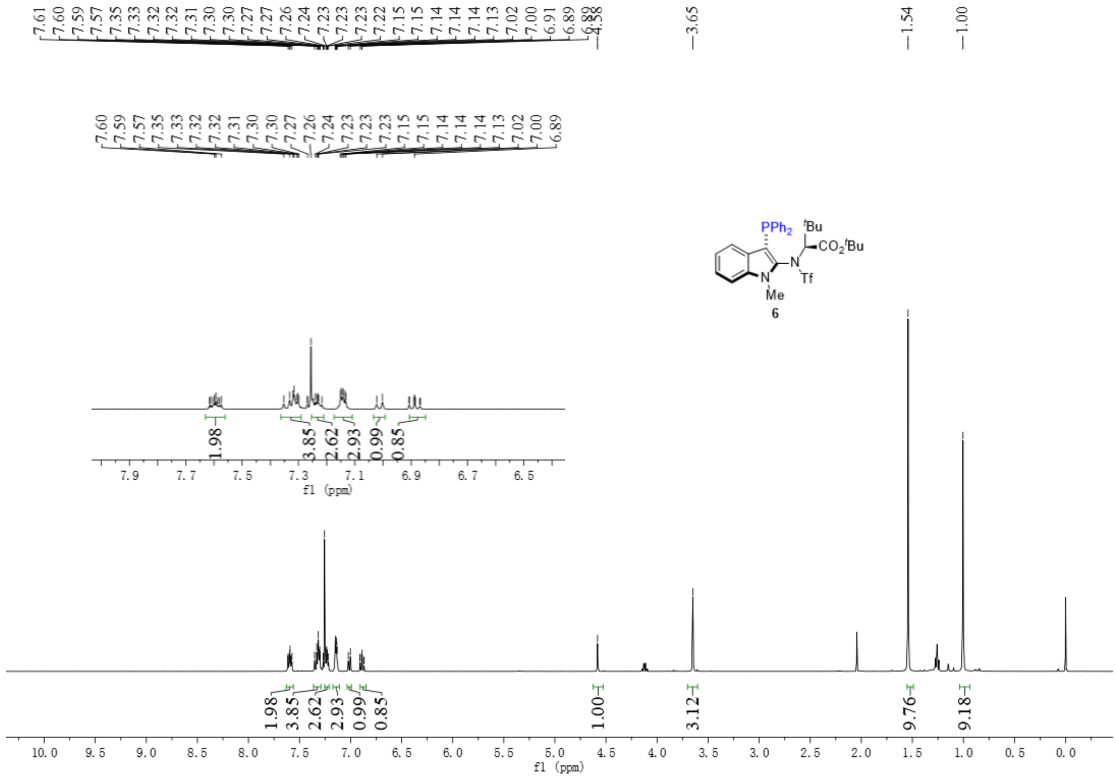




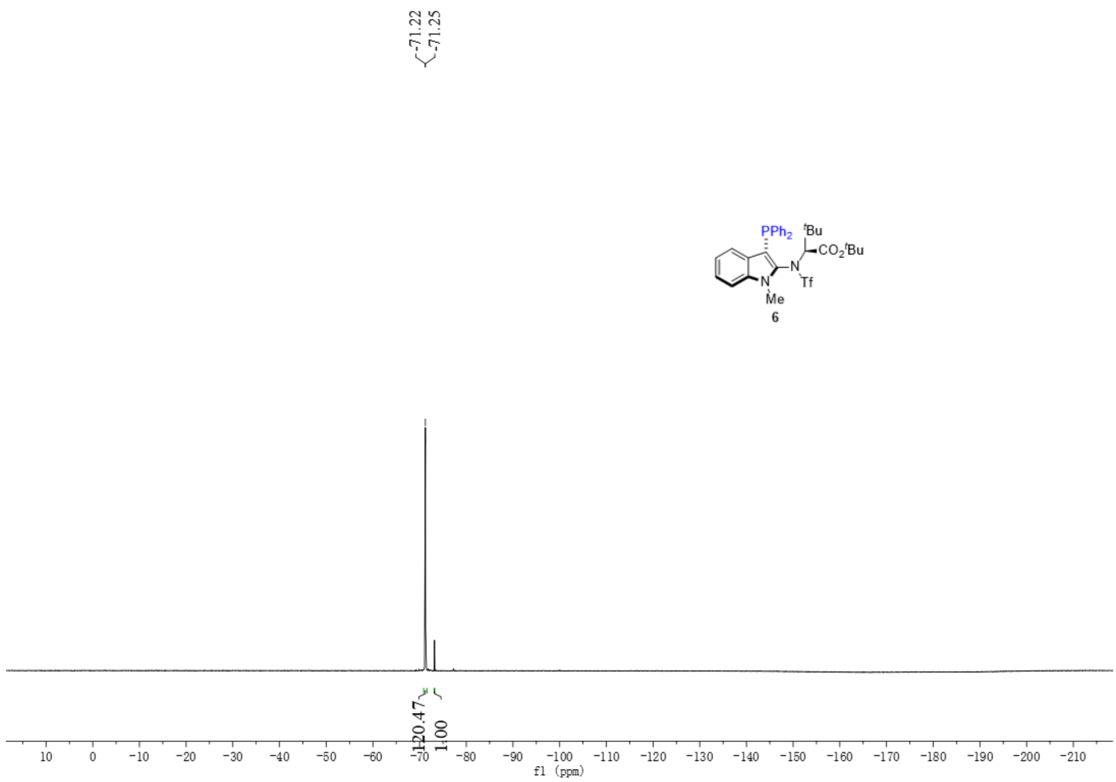


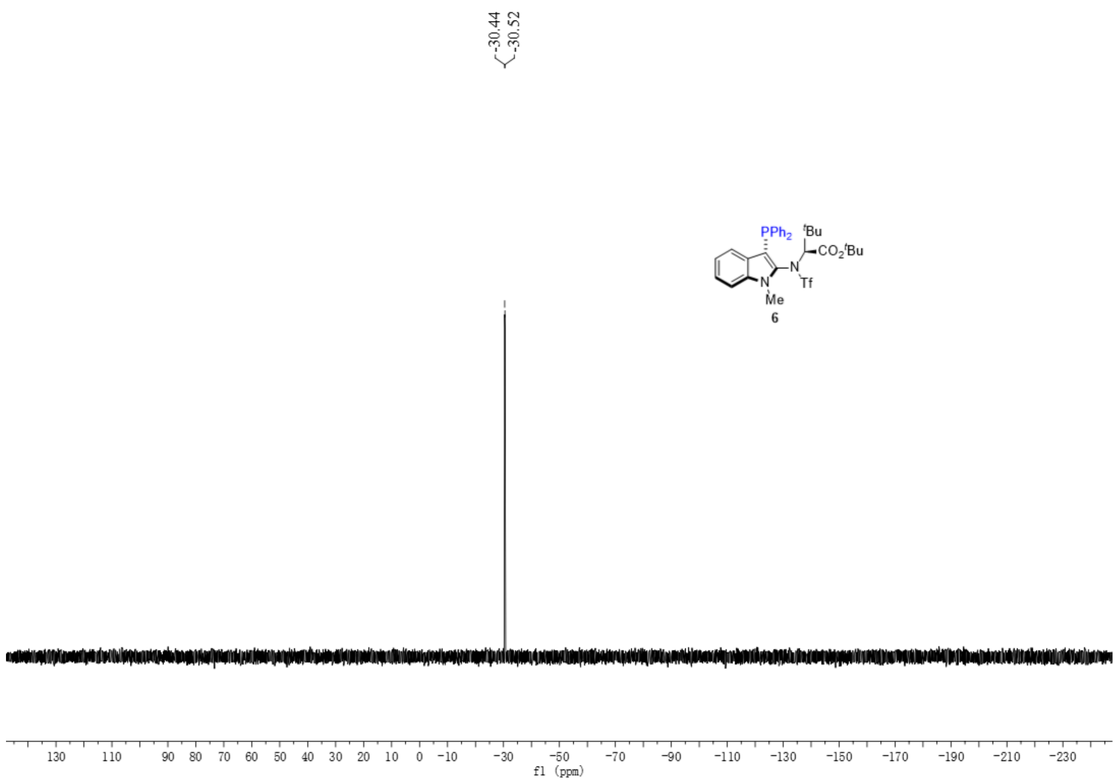


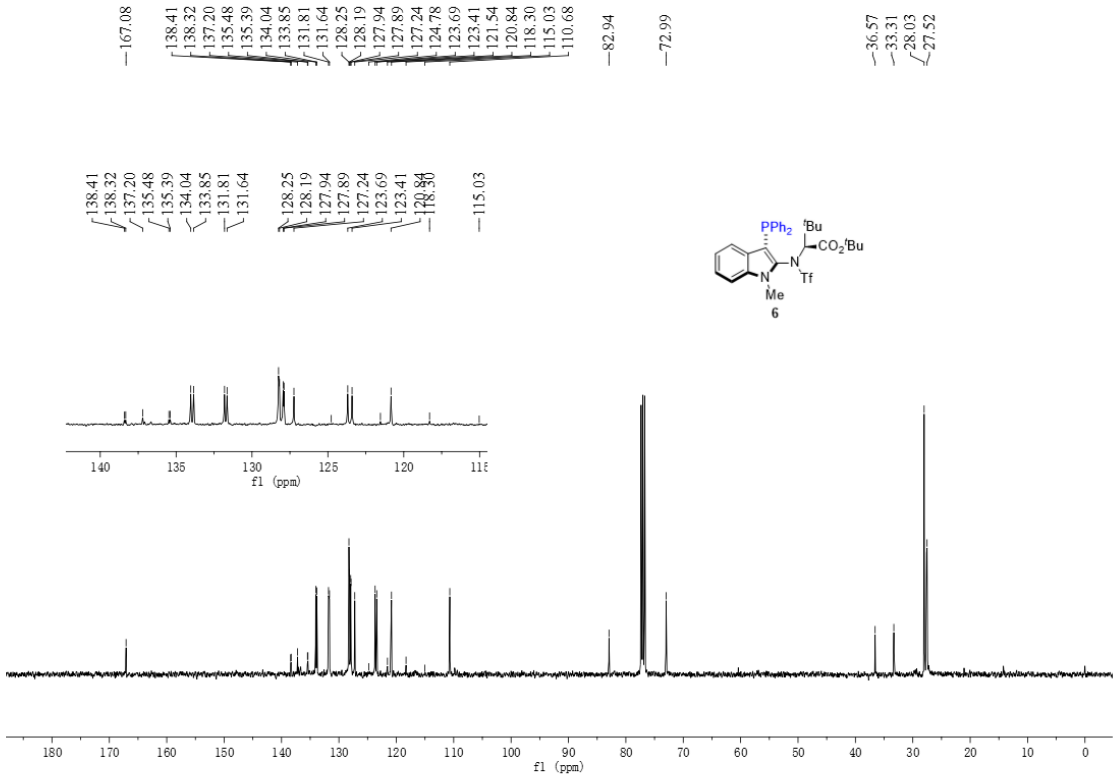
5

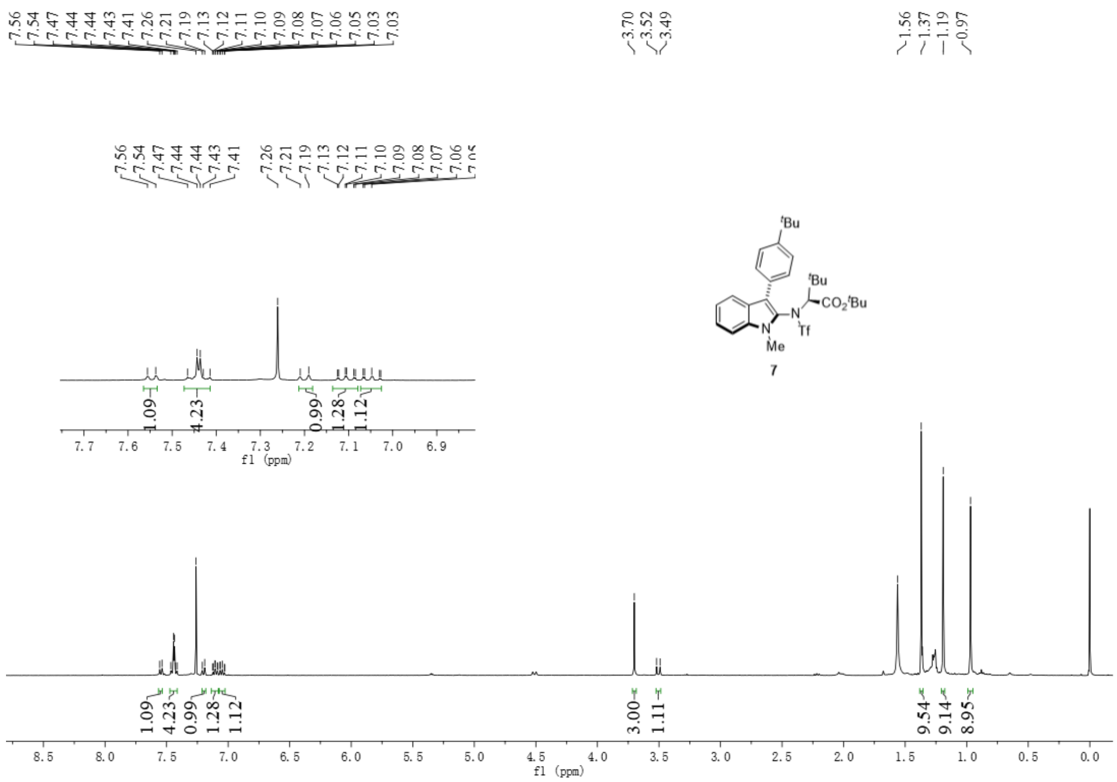


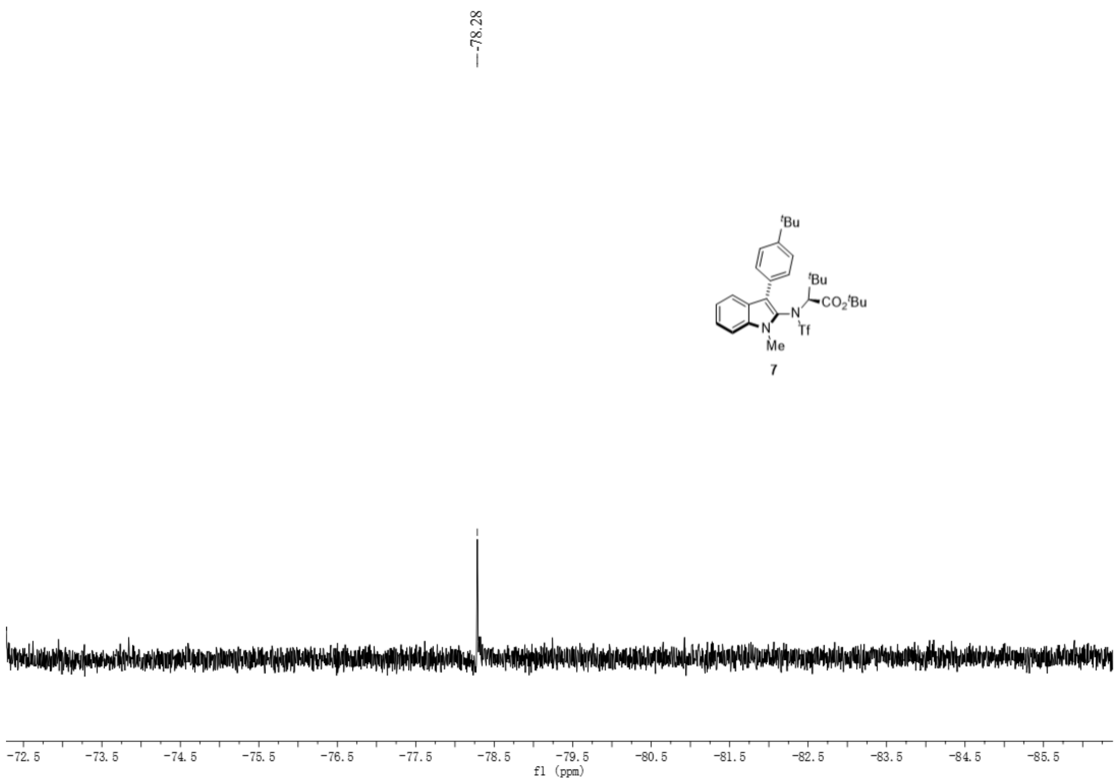
6

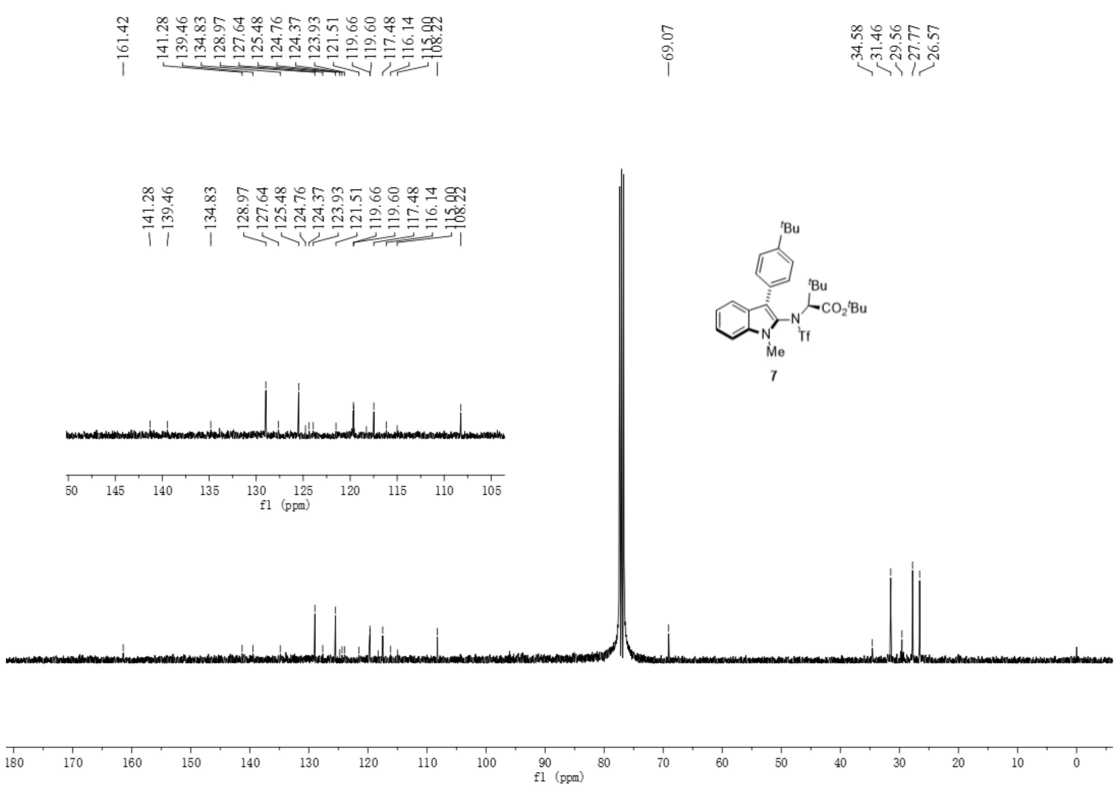

-71.22
-71.25
PPh2
tBu
CO2tBu
N
Tf
N
Me
6
120.47
1.00
f1 (ppm)

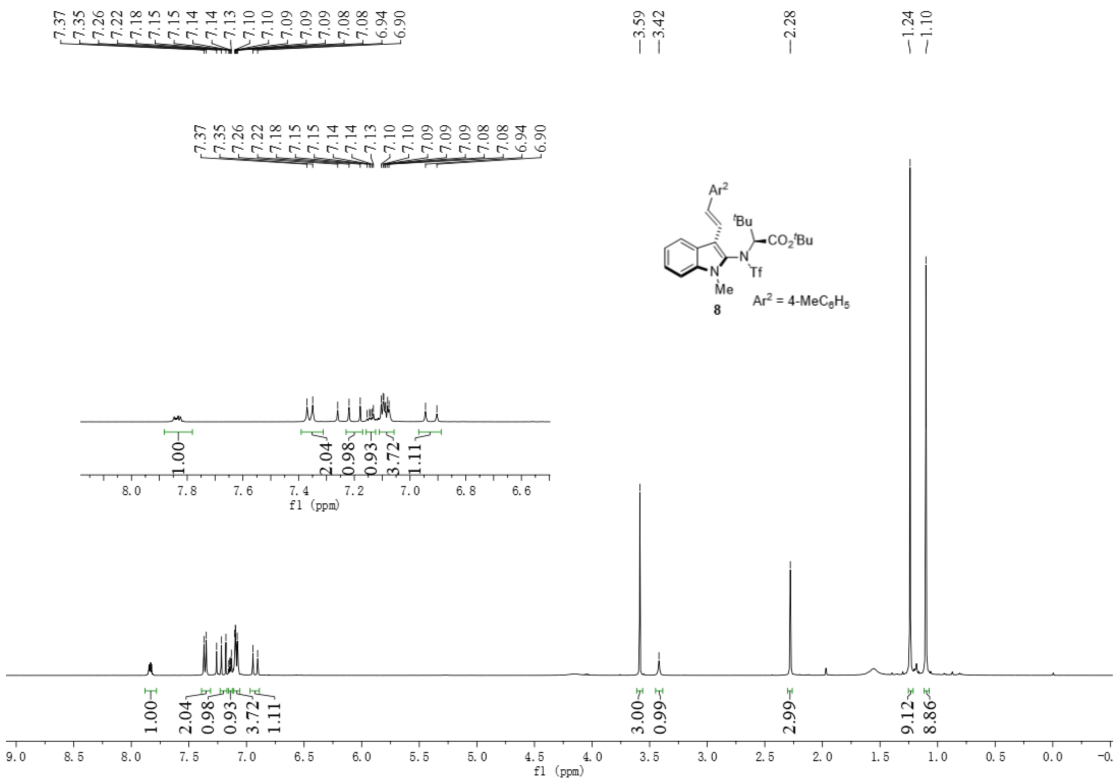

-30.44
-30.52
PPh2
tBu
CO2tBu
N
Tf
N
Me
6
f1 (ppm)

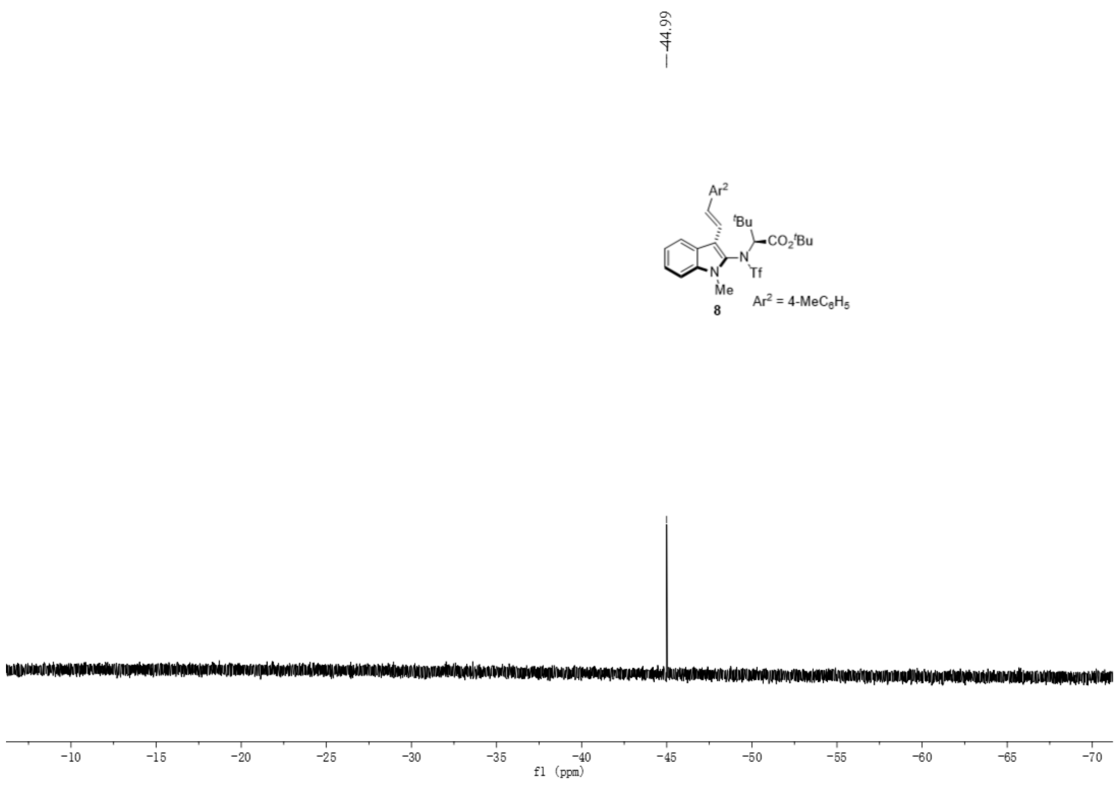

167.08
138.41 138.32 137.20 135.48 135.39 134.04 133.85 131.81 131.64 128.25 128.19 127.94 127.89 127.24 124.78 123.69 123.41 121.54 120.84 118.30 115.03 110.68
82.94
72.99
36.57 33.31 28.03 27.52
PPh2
tBu
CO2tBu
N
Tf
Me
6
f1 (ppm)

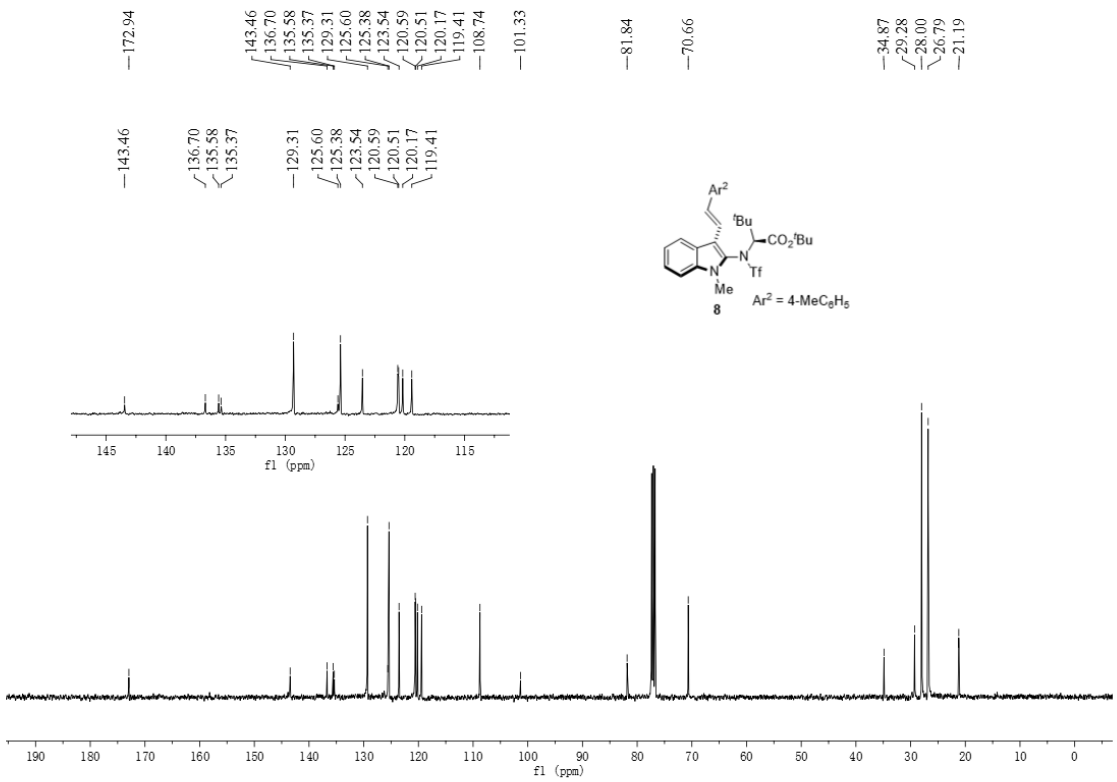

7.56 7.54 7.47 7.44 7.44 7.43 7.41 7.26 7.21 7.19 7.13 7.12 7.11 7.10 7.09 7.08 7.07 7.06 7.05 7.03 7.03
3.70 3.52 3.49
1.56 1.37 1.19 0.97
tBu
tBu
CO2tBu
N
Tf
Me
7
1.09 4.23 0.99 1.28 1.12
3.00 1.11
9.54 9.14 8.95
f1 (ppm)


-78.28
tBu
tBu
N
CO2tBu
N
Tf
Me
7
-72.5 -73.5 -74.5 -75.5 -76.5 -77.5 -78.5 -79.5 -80.5 -81.5 -82.5 -83.5 -84.5 -85.5
f1 (ppm)

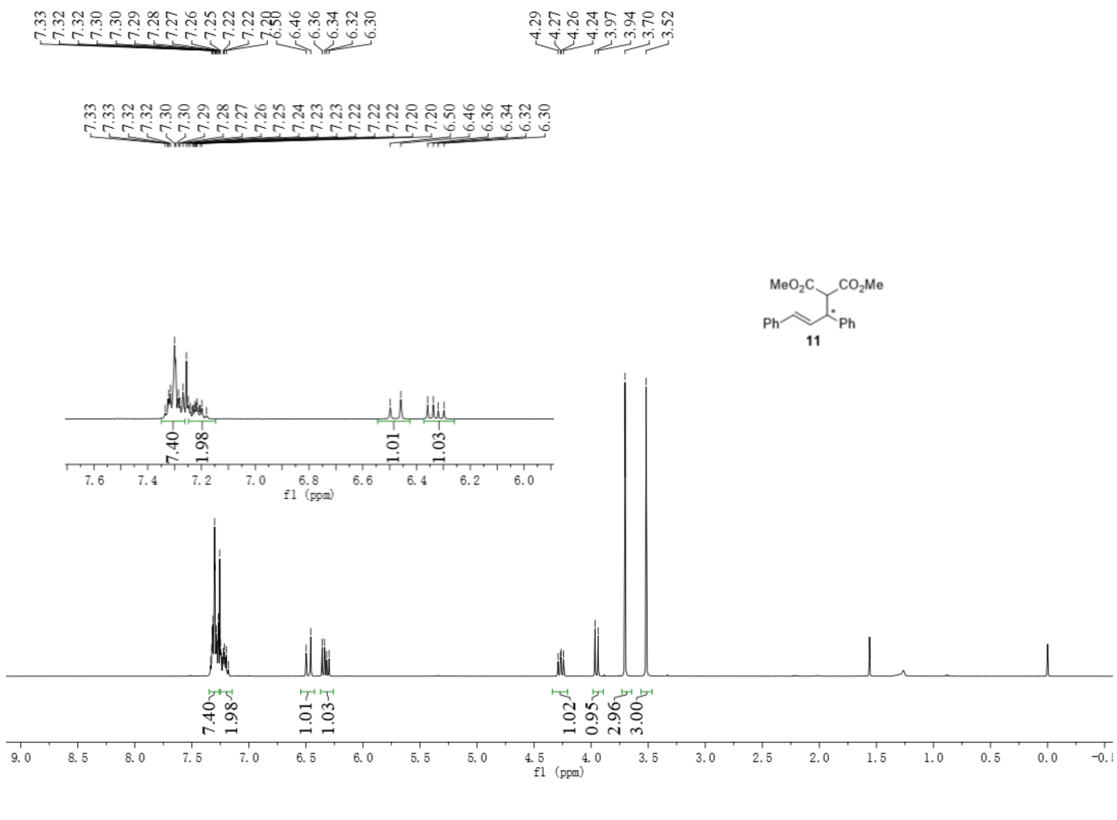

161.42
141.28 139.46 134.83 128.97 127.64 125.48 124.76 124.37 123.93 121.51 119.66 119.60 117.48 116.14 115.00 108.22
69.07
34.58 31.46 29.56 27.77 26.57
tBu
tBu
N
CO2tBu
N
Tf
Me
7
150 145 140 135 130 125 120 115 110 105
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



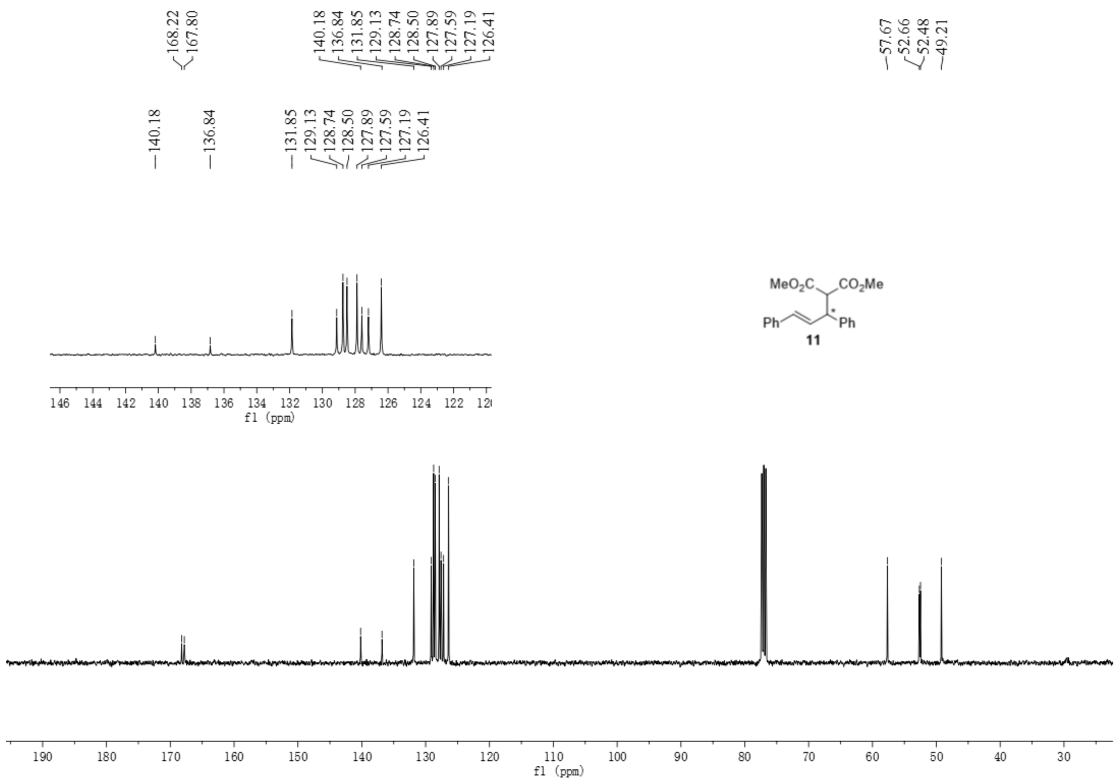


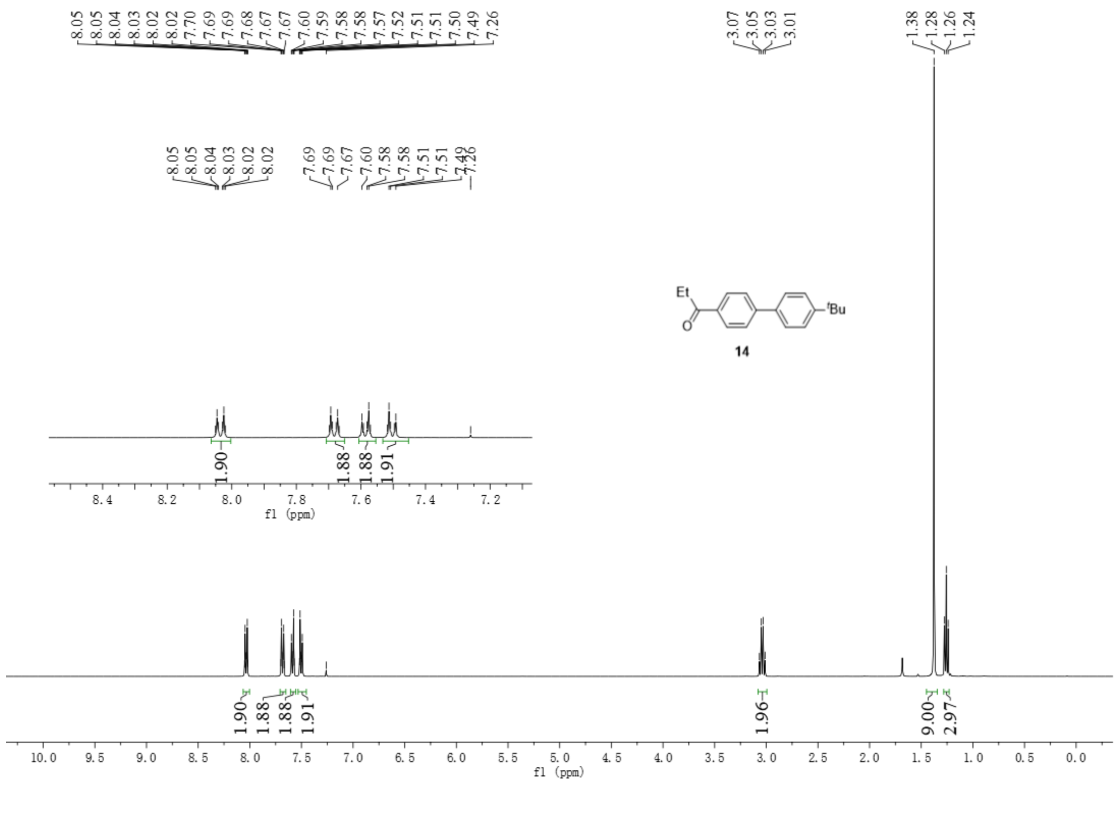


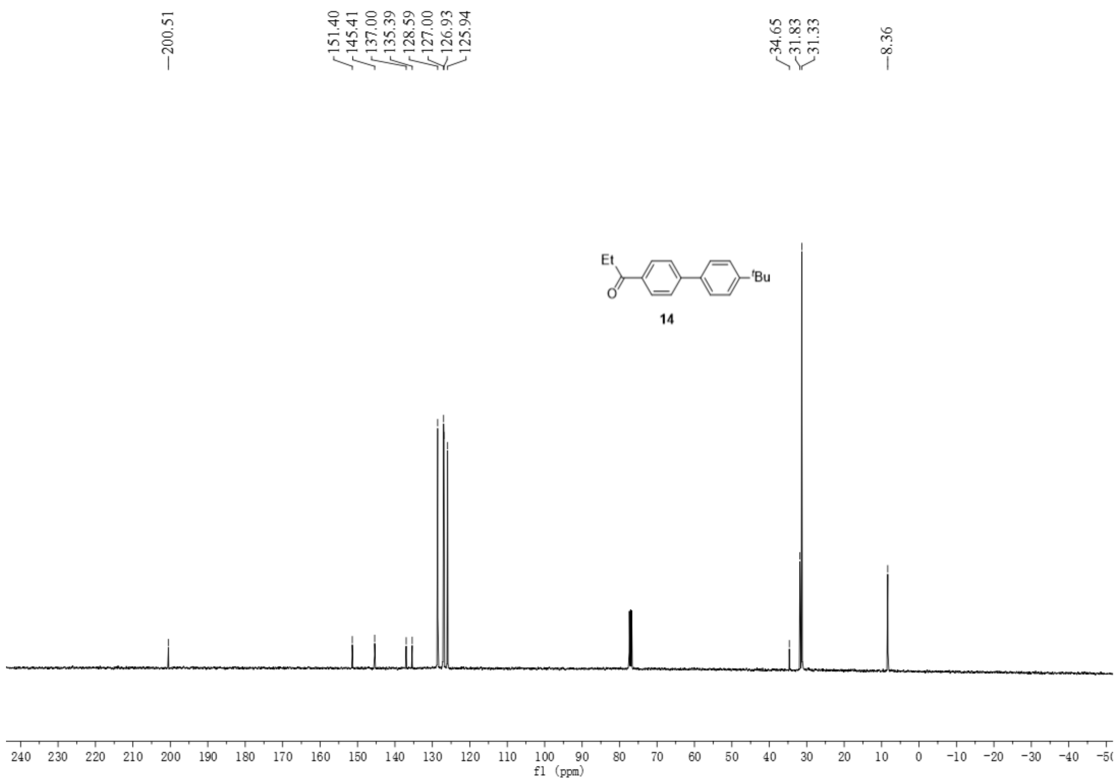
172.94
143.46 136.70 135.58 135.37 129.31 125.60 125.38 123.54 120.59 120.51 120.17 119.41 108.74
101.33
81.84
70.66
34.87 29.28 28.00 26.79 21.19
143.46
136.70 135.58 135.37
129.31 125.60 125.38 123.54 120.59 120.51 120.17 119.41
Ar2
tBu
CO2tBu
N
Tf
N
Me
8
Ar2 = 4-MeC6H5
145 140 135 130 125 120 115
f1 (ppm)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

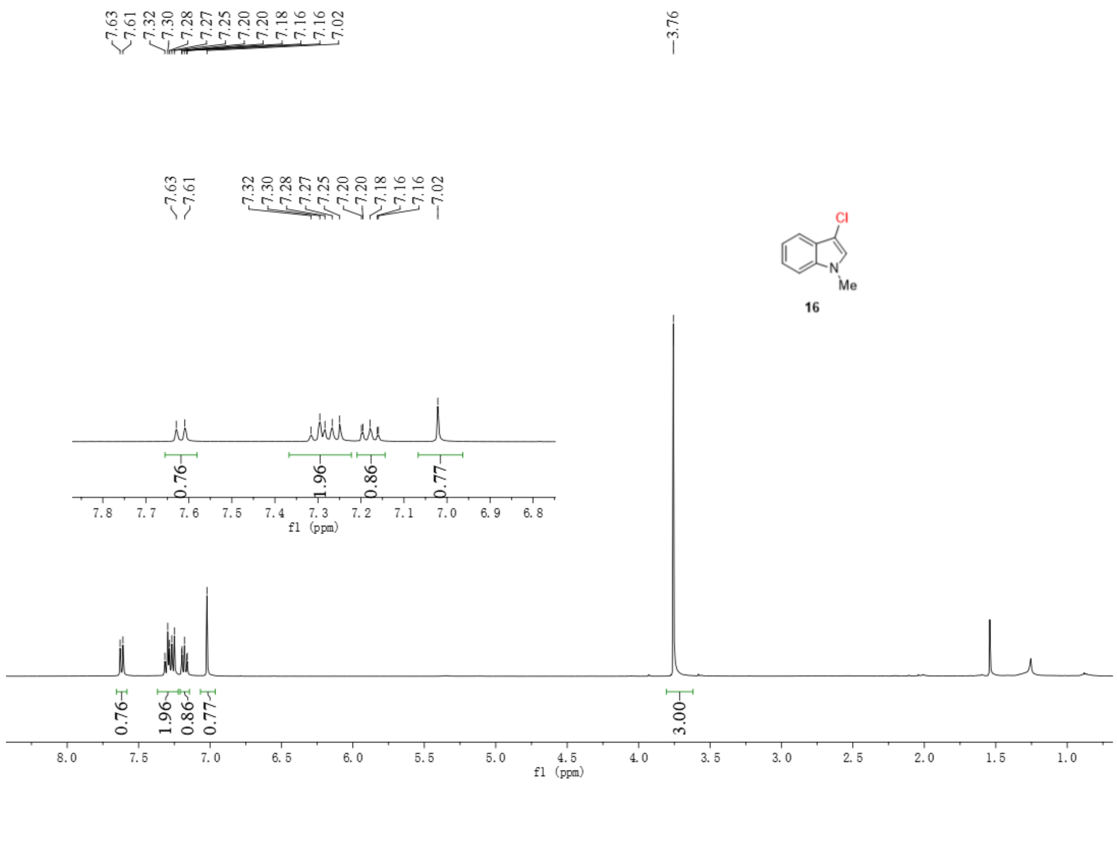


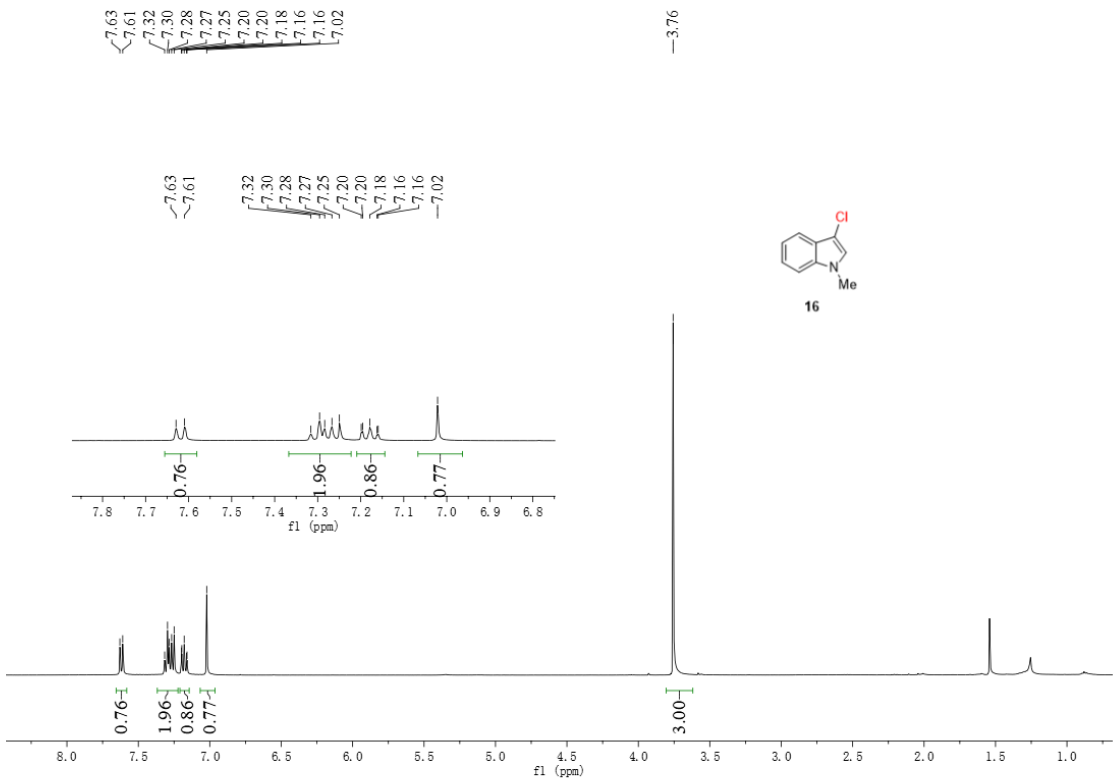
7.33 7.32 7.32 7.30 7.29 7.28 7.27 7.26 7.25 7.22 7.22 7.20 6.50 6.46 6.36 6.34 6.32 6.30
4.29 4.27 4.26 4.24 3.97 3.94 3.70 3.52
7.33 7.33 7.32 7.32 7.30 7.30 7.29 7.28 7.27 7.26 7.25 7.24 7.23 7.23 7.22 7.22 7.22 7.20 7.20 6.50 6.46 6.36 6.34 6.32 6.30
MeO2C
CO2Me
Ph
Ph
11
7.40
1.98
1.01
1.03
7.6 7.4 7.2 7.0 6.8 6.6 6.4 6.2 6.0
f1 (ppm)
7.40
1.98
1.01
1.03
1.02
0.95
2.96
3.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


168.22
167.80
140.18
136.84
131.85
129.13
128.74
128.50
127.89
127.59
127.19
126.41
57.67
52.66
52.48
49.21
MeO2C CO2Me
Ph Ph
11
f1 (ppm)

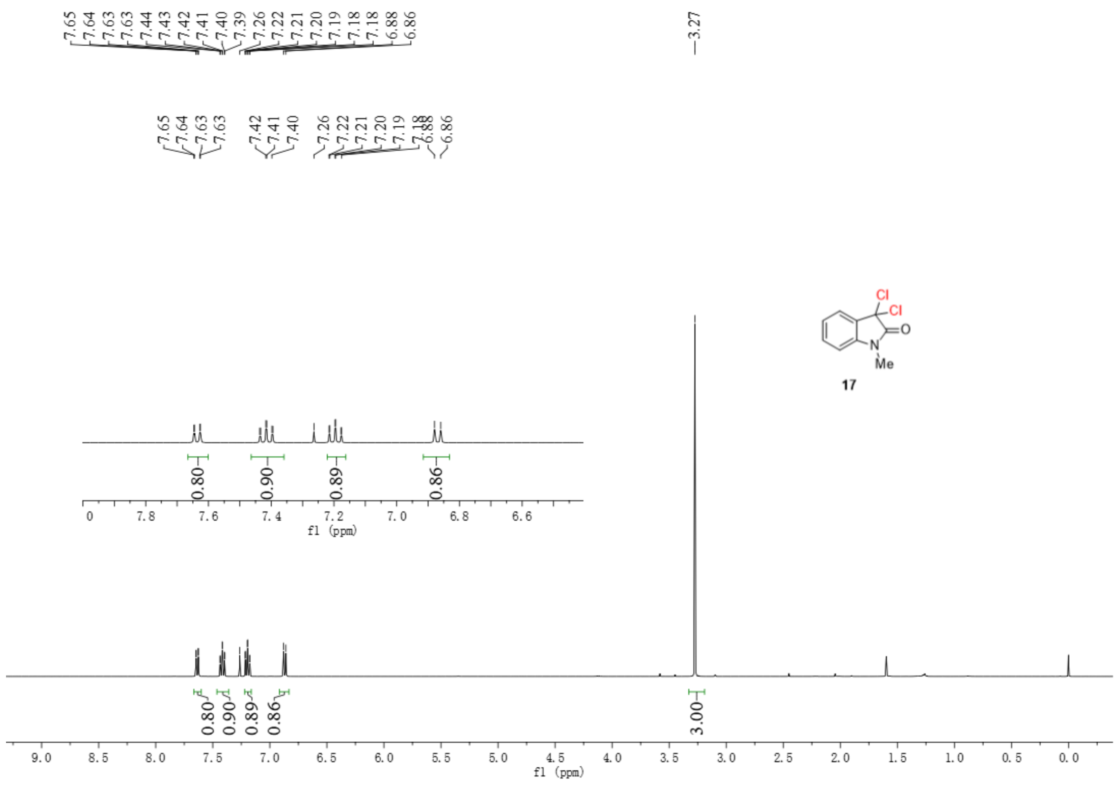

8.05
8.05
8.04
8.03
8.02
8.02
7.70
7.69
7.69
7.68
7.67
7.67
7.60
7.59
7.58
7.58
7.57
7.52
7.51
7.51
7.50
7.49
7.26
3.07
3.05
3.03
3.01
1.38
1.28
1.26
1.24
Et
O
tBu
14
1.90
1.88
1.88
1.91
1.96
9.00
2.97
f1 (ppm)


200.51
151.40
145.41
137.00
135.39
128.59
127.00
126.93
125.94
34.65
31.83
31.33
8.36
Et
O
tBu
14
f1 (ppm)

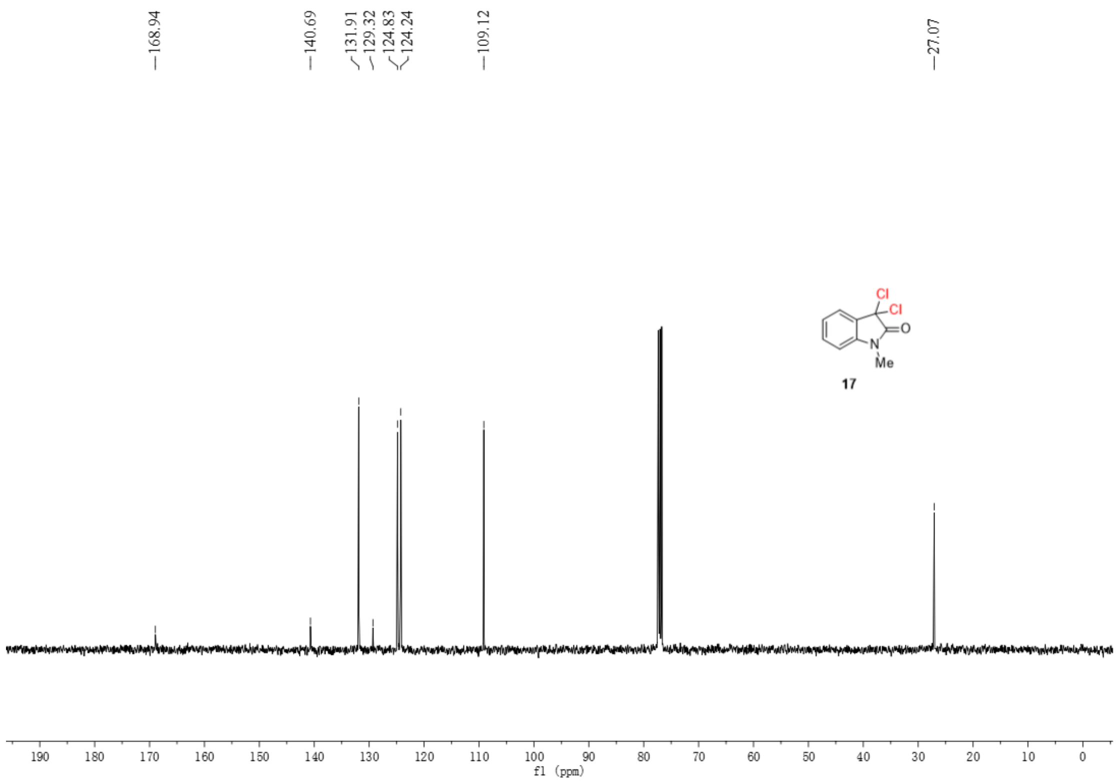

7.63
7.61
7.32
7.30
7.28
7.27
7.25
7.20
7.20
7.18
7.16
7.16
7.02
3.76
Cl
N
Me
16
0.76
1.96
0.86
0.77
3.00
f1 (ppm)

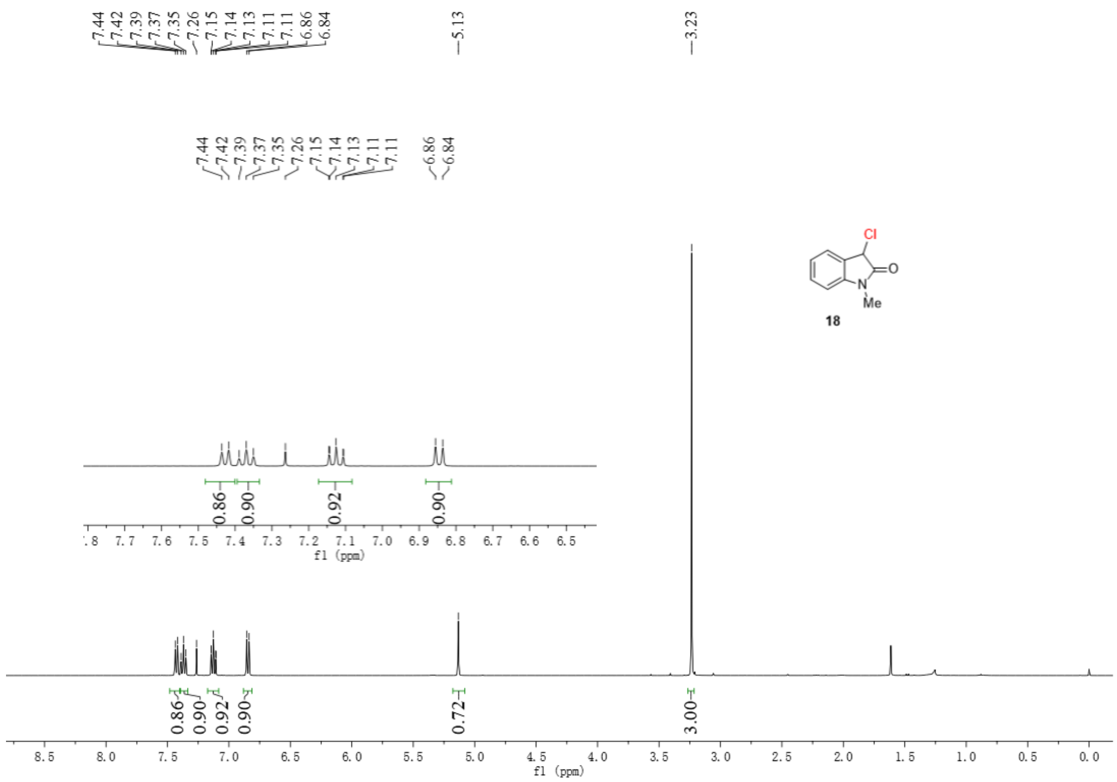


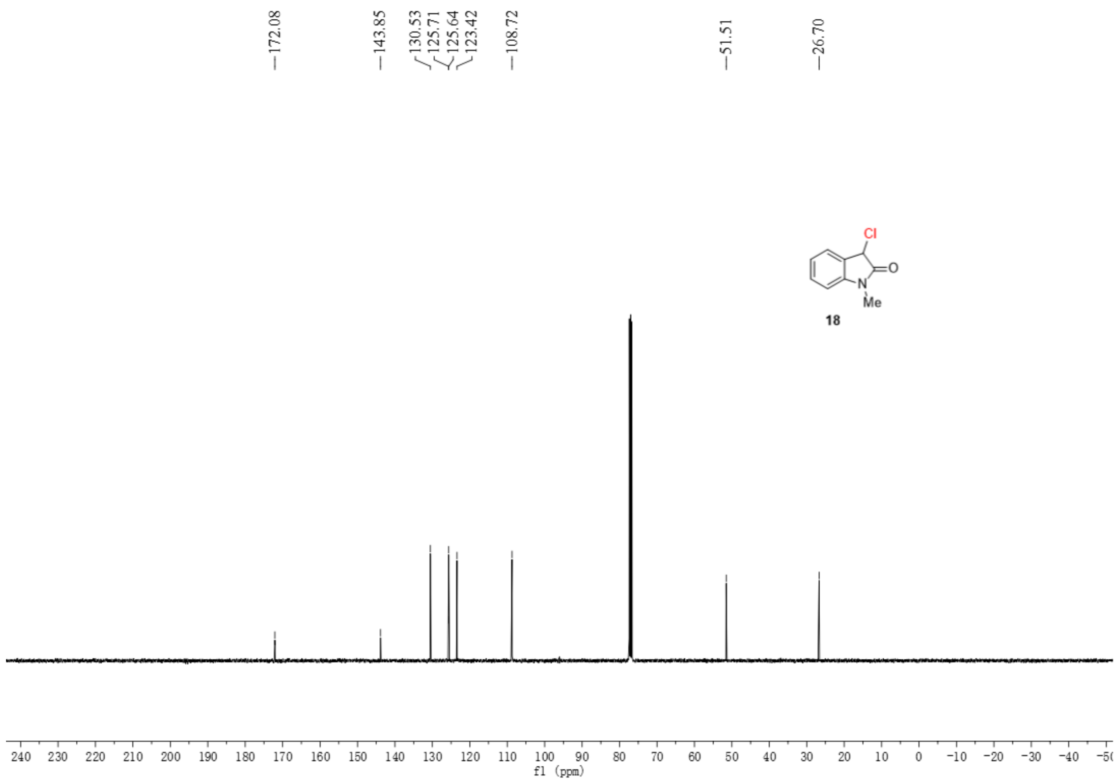
16



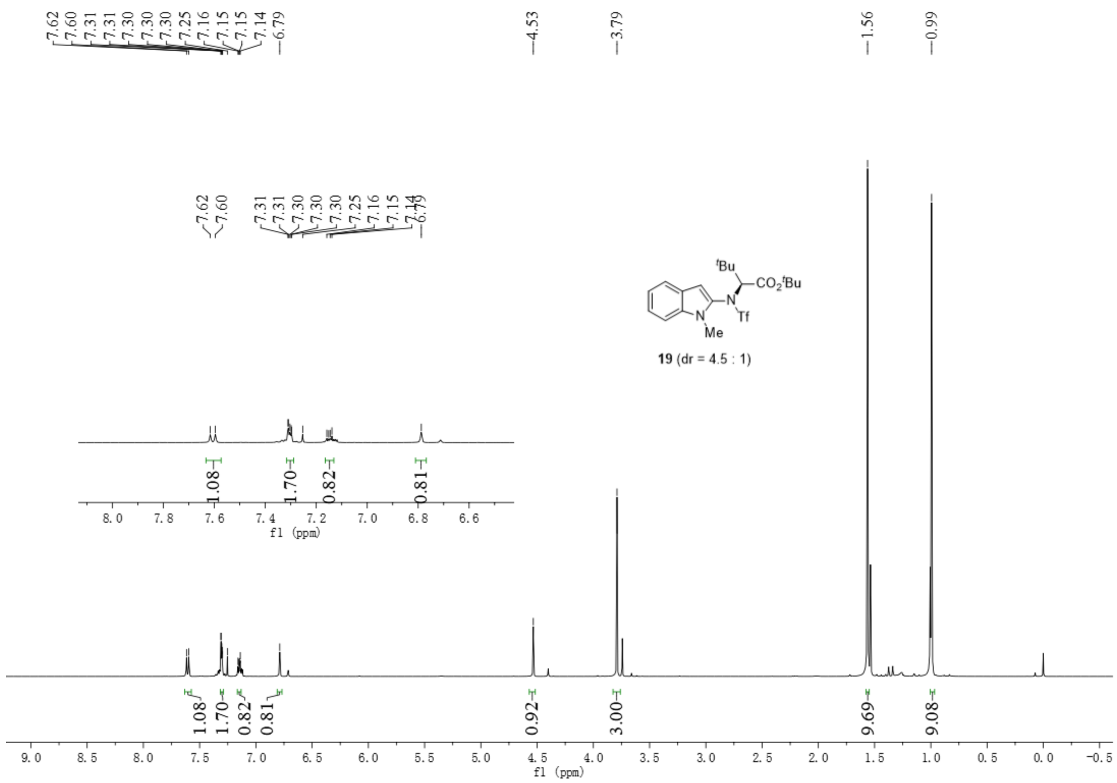
17


168.94
140.69
131.91
129.32
124.83
124.24
109.12
27.07
Cl
Cl
O
N
Me
17
f1 (ppm)

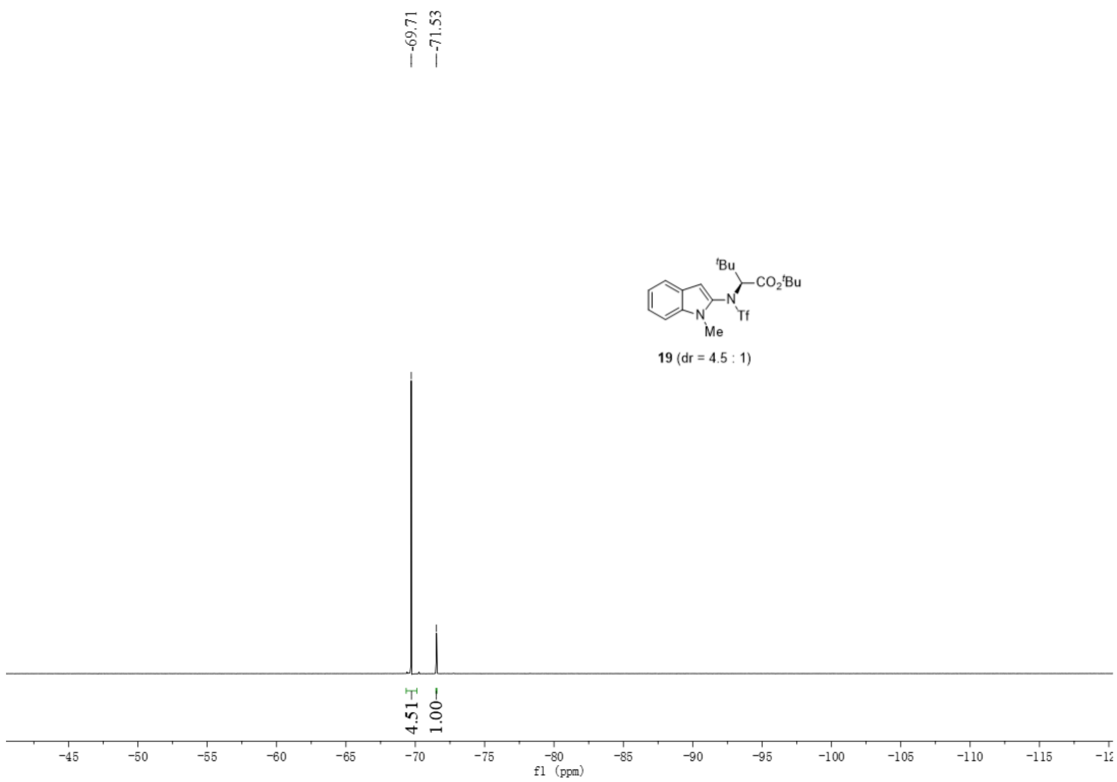

7.44
7.42
7.39
7.37
7.35
7.26
7.15
7.14
7.13
7.11
7.11
6.86
6.84
5.13
3.23
Cl
O
N
Me
18
0.86
0.90
0.92
0.90
0.72
3.00
f1 (ppm)

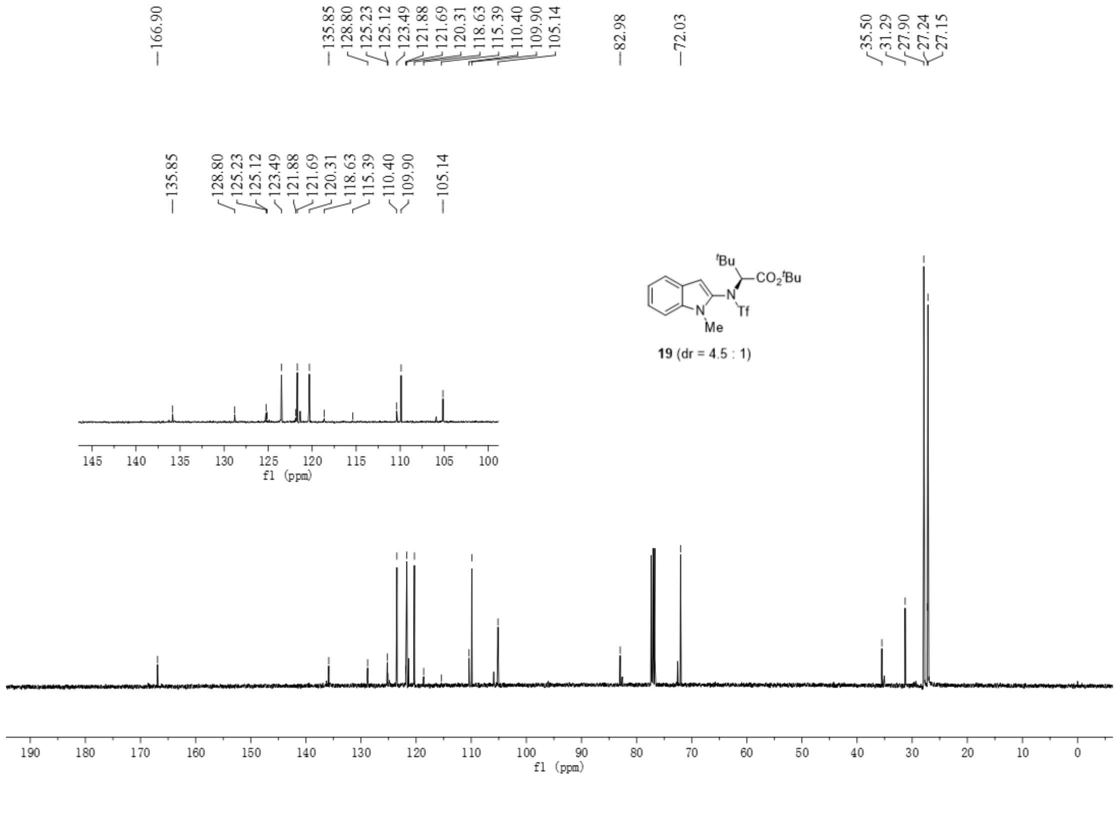


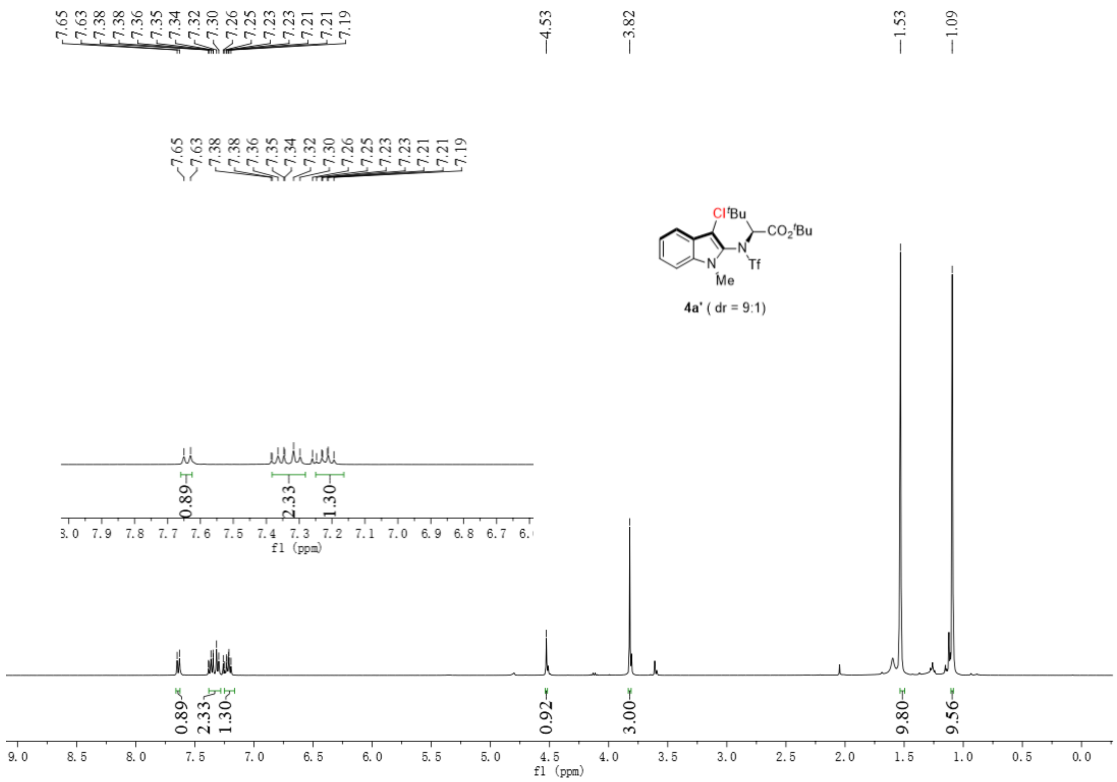
—172.08
—143.85
130.53
125.71
125.64
123.42
—108.72
—51.51
—26.70
Cl
O
N
Me
18
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10 −20 −30 −40 −50
f1 (ppm)

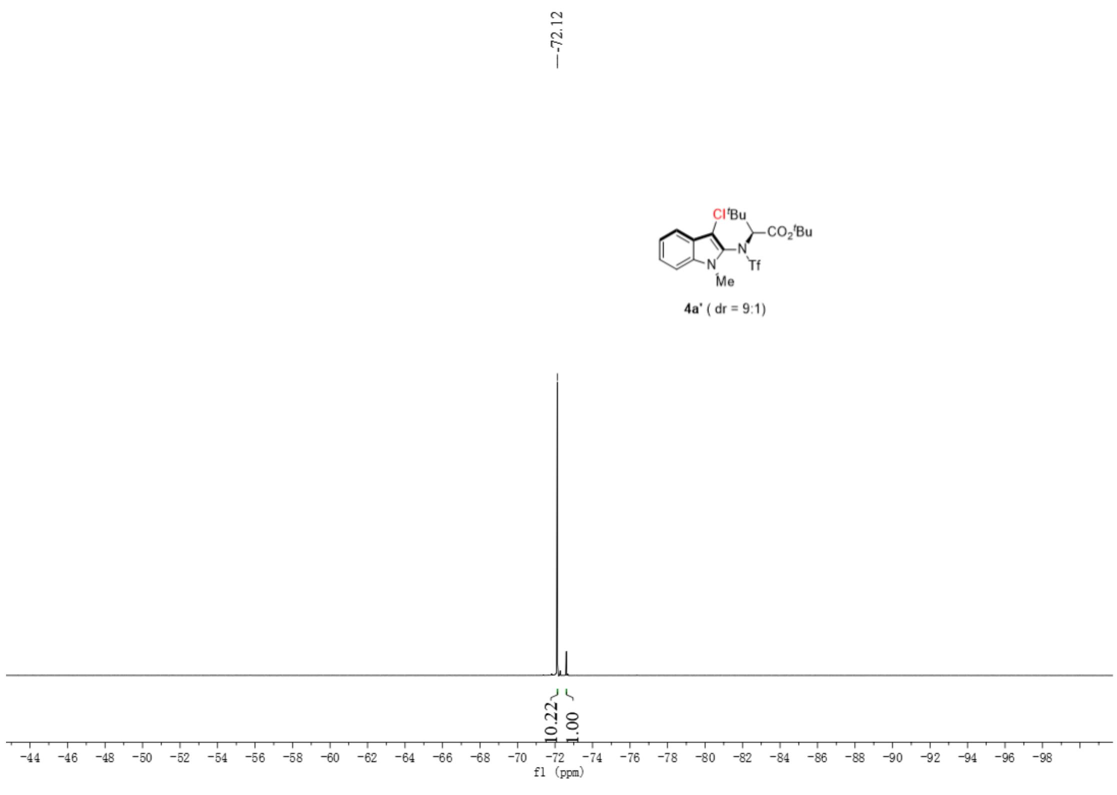


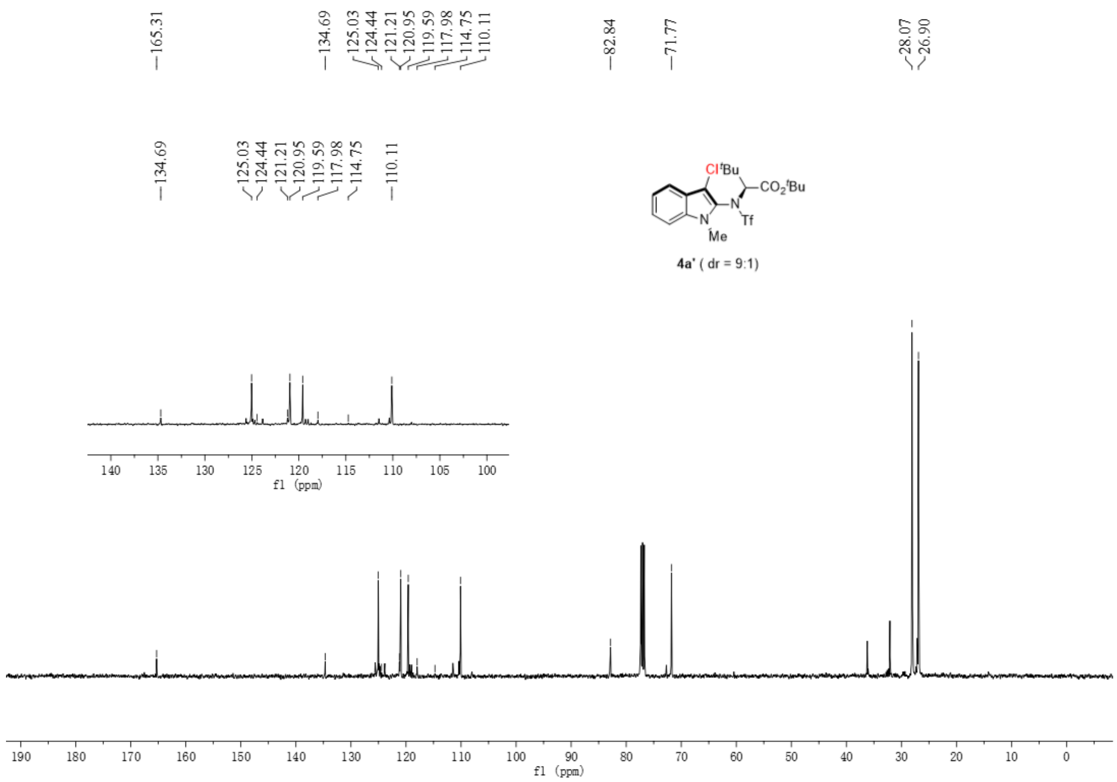
7.62
7.60
7.31
7.31
7.30
7.30
7.30
7.25
7.16
7.15
7.15
7.14
—6.79
—4.53
—3.79
—1.56
—0.99
tBu
CO2tBu
N
Tf
N
Me
19 (dr = 4.5 : 1)
1.08
1.70
0.82
0.81
8.0 7.8 7.6 7.4 7.2 7.0 6.8 6.6
f1 (ppm)
1.08
1.70
0.82
0.81
0.92
3.00
9.69
9.08
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5
f1 (ppm)


-69.71
-71.53
4.51
1.00
f1 (ppm)
19 (dr = 4.5 : 1)


166.90
135.85
128.80
125.23
125.12
123.49
121.88
121.69
120.31
118.63
115.39
110.40
109.90
105.14
82.98
72.03
35.50
31.29
27.90
27.24
27.15
f1 (ppm)
19 (dr = 4.5 : 1)

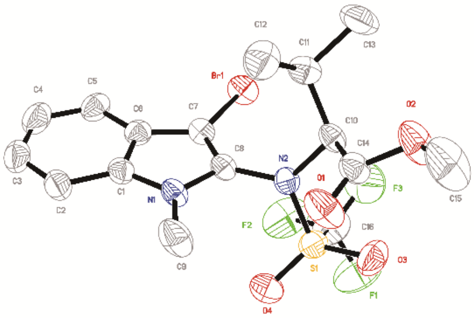





165.31
134.69
125.03
124.44
121.21
120.95
119.59
117.98
114.75
110.11
82.84
71.77
28.07
26.90
Cl
tBu
CO2tBu
N
Tf
N
Me
f1 (ppm)

4a' (dr = 9:1)

9. X-ray single crystal data for compounds 3l and 3l’



3l (CCDC 1955748)

Table S4. Crystal data and structure refinement for mo_d8v18848_0m.

Identification code	mo_d8v18848_0m	
Empirical formula	C16 H18 Br F3 N2 O4 S	
Formula weight	471.29	
Temperature	190(2) K	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	P 21 21 21	
Unit cell dimensions	a = 10.1681(8) Å	α= 90°.
	b = 11.3748(11) Å	β= 90°.
	c = 17.2446(16) Å	γ = 90°.
Volume	1994.5(3) $Å^3$	
Z	4	
Density (calculated)	1.570 Mg/m^3	
Absorption coefficient	2.216 mm^{-1}	
F(000)	952	
Crystal size	0.180 x 0.140 x 0.110 mm^3	
Theta range for data collection	2.935 to 25.999°.	
Index ranges	-11<=h<=12, -14<=k<=13, -21<=l<=18	
Reflections collected	16603	
Independent reflections	3913 [R(int) = 0.0541]	
Completeness to theta = 25.242°	99.6 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7456 and 0.4267	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3913 / 0 / 249	
Goodness-of-fit on F^2	1.036	
Final R indices [I>2sigma(I)]	R1 = 0.0319, wR2 = 0.0680	
R indices (all data)	R1 = 0.0428, wR2 = 0.0726	

Absolute structure parameter	0.031(7)
Extinction coefficient	0.0122(13)
Largest diff. peak and hole	0.281 and -0.376 e.Å^{-3}

Table S7. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters (Å^{2}x 10^3) for mo_d8v18848_0m. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Br(1)	5633(1)	5835(1)	4985(1)	45(1)
S(1)	8905(1)	3953(1)	3973(1)	43(1)
F(1)	9353(4)	2868(3)	5250(2)	107(1)
F(2)	8387(4)	4531(3)	5406(2)	90(1)
F(3)	7297(3)	3054(3)	4985(2)	90(1)
N(1)	8321(3)	6696(3)	3330(2)	34(1)
N(2)	7672(3)	4662(3)	3602(2)	33(1)
O(1)	8218(3)	3987(3)	2070(2)	58(1)
O(2)	6671(3)	2608(3)	2133(2)	61(1)
O(3)	8984(3)	2838(3)	3605(2)	58(1)
O(4)	10011(3)	4703(3)	4048(2)	63(1)
C(1)	8033(4)	7800(4)	3611(3)	36(1)
C(2)	8558(4)	8891(4)	3387(3)	45(1)
C(3)	8081(5)	9864(4)	3774(3)	57(1)
C(4)	7134(5)	9787(4)	4353(3)	59(1)
C(5)	6640(4)	8711(4)	4577(3)	46(1)
C(6)	7099(4)	7704(3)	4198(2)	37(1)
C(7)	6834(4)	6476(3)	4282(2)	34(1)
C(8)	7587(3)	5895(4)	3749(2)	32(1)
C(9)	9236(4)	6468(4)	2695(3)	56(1)
C(10)	6679(3)	3970(4)	3148(2)	34(1)
C(11)	5428(4)	4677(4)	2972(3)	41(1)
C(12)	5532(5)	5457(4)	2263(3)	62(1)
C(13)	4237(4)	3847(5)	2909(3)	63(1)
C(14)	7314(4)	3556(4)	2394(3)	40(1)
C(15)	7085(6)	2182(6)	1368(3)	79(2)
C(16)	8450(5)	3587(5)	4965(4)	68(1)

Table S8. Bond lengths [Å] and angles [°] for mo_d8v18848_0m.

Br(1)-C(7)	1.869(4)
S(1)-O(4)	1.417(3)
S(1)-O(3)	1.420(3)
S(1)-N(2)	1.623(3)
S(1)-C(16)	1.820(6)
F(1)-C(16)	1.325(5)
F(2)-C(16)	1.317(6)
F(3)-C(16)	1.321(6)
N(1)-C(1)	1.378(5)
N(1)-C(8)	1.382(5)
N(1)-C(9)	1.460(5)
N(2)-C(8)	1.428(5)
N(2)-C(10)	1.500(5)
O(1)-C(14)	1.182(5)
O(2)-C(14)	1.339(5)
O(2)-C(15)	1.466(6)
C(1)-C(6)	1.394(6)
C(1)-C(2)	1.405(6)
C(2)-C(3)	1.380(7)
C(2)-H(2)	0.9500
C(3)-C(4)	1.390(8)
C(3)-H(3)	0.9500
C(4)-C(5)	1.377(7)
C(4)-H(4)	0.9500
C(5)-C(6)	1.398(5)
C(5)-H(5)	0.9500
C(6)-C(7)	1.430(5)
C(7)-C(8)	1.367(5)
C(9)-H(9A)	0.9800
C(9)-H(9B)	0.9800
C(9)-H(9C)	0.9800
C(10)-C(14)	1.526(5)
C(10)-C(11)	1.535(6)
C(10)-H(10)	1.0000
C(11)-C(12)	1.515(6)
C(11)-C(13)	1.539(6)

C(11)-H(11)	1.0000
C(12)-H(12A)	0.9800
C(12)-H(12B)	0.9800
C(12)-H(12C)	0.9800
C(13)-H(13A)	0.9800
C(13)-H(13B)	0.9800
C(13)-H(13C)	0.9800
C(15)-H(15A)	0.9800
C(15)-H(15B)	0.9800
C(15)-H(15C)	0.9800
O(4)-S(1)-O(3)	122.3(2)
O(4)-S(1)-N(2)	110.47(18)
O(3)-S(1)-N(2)	108.14(18)
O(4)-S(1)-C(16)	104.7(3)
O(3)-S(1)-C(16)	103.3(2)
N(2)-S(1)-C(16)	106.7(2)
C(1)-N(1)-C(8)	107.7(3)
C(1)-N(1)-C(9)	124.1(3)
C(8)-N(1)-C(9)	128.2(3)
C(8)-N(2)-C(10)	124.5(3)
C(8)-N(2)-S(1)	117.7(3)
C(10)-N(2)-S(1)	117.7(3)
C(14)-O(2)-C(15)	115.4(4)
N(1)-C(1)-C(6)	109.2(4)
N(1)-C(1)-C(2)	128.9(4)
C(6)-C(1)-C(2)	121.9(4)
C(3)-C(2)-C(1)	116.2(4)
C(3)-C(2)-H(2)	121.9
C(1)-C(2)-H(2)	121.9
C(2)-C(3)-C(4)	122.7(4)
C(2)-C(3)-H(3)	118.7
C(4)-C(3)-H(3)	118.6
C(5)-C(4)-C(3)	120.7(5)
C(5)-C(4)-H(4)	119.7
C(3)-C(4)-H(4)	119.7
C(4)-C(5)-C(6)	118.4(5)
C(4)-C(5)-H(5)	120.8
C(6)-C(5)-H(5)	120.8

C(1)-C(6)-C(5)	120.2(4)
C(1)-C(6)-C(7)	106.1(4)
C(5)-C(6)-C(7)	133.7(4)
C(8)-C(7)-C(6)	107.4(3)
C(8)-C(7)-Br(1)	127.9(3)
C(6)-C(7)-Br(1)	124.7(3)
C(7)-C(8)-N(1)	109.6(3)
C(7)-C(8)-N(2)	129.0(3)
N(1)-C(8)-N(2)	121.5(3)
N(1)-C(9)-H(9A)	109.5
N(1)-C(9)-H(9B)	109.5
H(9A)-C(9)-H(9B)	109.5
N(1)-C(9)-H(9C)	109.5
H(9A)-C(9)-H(9C)	109.5
H(9B)-C(9)-H(9C)	109.5
N(2)-C(10)-C(14)	108.8(3)
N(2)-C(10)-C(11)	112.7(3)
C(14)-C(10)-C(11)	110.1(3)
N(2)-C(10)-H(10)	108.4
C(14)-C(10)-H(10)	108.4
C(11)-C(10)-H(10)	108.4
C(12)-C(11)-C(10)	114.1(4)
C(12)-C(11)-C(13)	110.9(4)
C(10)-C(11)-C(13)	110.2(4)
C(12)-C(11)-H(11)	107.1
C(10)-C(11)-H(11)	107.1
C(13)-C(11)-H(11)	107.1
C(11)-C(12)-H(12A)	109.5
C(11)-C(12)-H(12B)	109.5
H(12A)-C(12)-H(12B)	109.5
C(11)-C(12)-H(12C)	109.5
H(12A)-C(12)-H(12C)	109.5
H(12B)-C(12)-H(12C)	109.5
C(11)-C(13)-H(13A)	109.5
C(11)-C(13)-H(13B)	109.5
H(13A)-C(13)-H(13B)	109.5
C(11)-C(13)-H(13C)	109.5
H(13A)-C(13)-H(13C)	109.5

H(13B)-C(13)-H(13C)	109.5
O(1)-C(14)-O(2)	123.6(4)
O(1)-C(14)-C(10)	127.1(4)
O(2)-C(14)-C(10)	109.2(3)
O(2)-C(15)-H(15A)	109.5
O(2)-C(15)-H(15B)	109.5
H(15A)-C(15)-H(15B)	109.5
O(2)-C(15)-H(15C)	109.5
H(15A)-C(15)-H(15C)	109.5
H(15B)-C(15)-H(15C)	109.5
F(2)-C(16)-F(3)	108.5(5)
F(2)-C(16)-F(1)	108.8(5)
F(3)-C(16)-F(1)	108.8(5)
F(2)-C(16)-S(1)	111.6(4)
F(3)-C(16)-S(1)	110.8(4)
F(1)-C(16)-S(1)	108.3(4)

Symmetry transformations used to generate equivalent atoms:

Table S9. Anisotropic displacement parameters ($Å^2$x 10^3) for mo_d8v18848_0m. The anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2 a^{*2}U^{11} + ... + 2 h k a^* b^* U^{12}]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Br(1)	46(1)	57(1)	33(1)	-1(1)	13(1)	-4(1)
S(1)	41(1)	43(1)	46(1)	-8(1)	-6(1)	3(1)
F(1)	119(3)	123(3)	77(3)	32(2)	-15(2)	53(2)
F(2)	109(3)	119(3)	43(2)	-21(2)	-24(2)	31(2)
F(3)	99(2)	96(2)	77(2)	31(2)	11(2)	-9(2)
N(1)	34(2)	37(2)	33(2)	-4(2)	6(2)	-8(1)
N(2)	36(2)	33(2)	31(2)	-6(2)	-3(1)	-2(1)
O(1)	53(2)	73(2)	47(2)	-22(2)	21(2)	-22(2)
O(2)	67(2)	67(2)	47(2)	-31(2)	15(2)	-27(2)
O(3)	66(2)	44(2)	64(2)	-17(2)	-10(2)	14(2)
O(4)	41(2)	60(2)	87(3)	-5(2)	-20(2)	-6(1)
C(1)	35(2)	36(2)	38(3)	1(2)	-6(2)	-3(2)
C(2)	43(2)	41(3)	52(3)	8(2)	-9(2)	-8(2)
C(3)	58(3)	35(3)	78(4)	5(3)	-28(3)	-5(2)

C(4)	62(3)	37(3)	77(4)	-12(3)	-16(3)	10(2)
C(5)	49(2)	43(3)	46(3)	-9(2)	-8(2)	9(2)
C(6)	35(2)	39(2)	36(3)	-2(2)	-6(2)	2(2)
C(7)	36(2)	38(2)	28(2)	1(2)	1(2)	-3(2)
C(8)	34(2)	36(2)	27(2)	-3(2)	0(2)	-6(2)
C(9)	58(3)	59(3)	50(3)	-6(2)	21(2)	-19(2)
C(10)	35(2)	38(2)	28(2)	-7(2)	1(2)	-10(2)
C(11)	36(2)	52(3)	35(2)	-7(2)	0(2)	-2(2)
C(12)	68(3)	56(3)	62(4)	2(3)	-3(3)	3(3)
C(13)	38(3)	73(3)	76(4)	3(3)	-13(2)	-13(2)
C(14)	39(2)	44(2)	38(3)	-10(2)	0(2)	-6(2)
C(15)	91(4)	97(4)	50(4)	-43(4)	14(3)	-32(4)
C(16)	81(4)	78(4)	45(3)	4(3)	-12(3)	17(3)

Table S10. Hydrogen coordinates (x 10^4) and isotropic displacement parameters (Å^{2}x 10 ^{3}) for mo_d8v18848_0m.

	x	y	z	U(eq)
H(2)	9205	8955	2992	55
H(3)	8414	10617	3639	68
H(4)	6825	10482	4597	70
H(5)	6003	8655	4978	55
H(9A)	9043	7001	2263	83
H(9B)	9139	5652	2521	83
H(9C)	10139	6598	2874	83
H(10)	6428	3263	3459	41
H(11)	5267	5203	3427	49
H(12A)	6344	5920	2291	93
H(12B)	4774	5988	2244	93
H(12C)	5546	4968	1795	93
H(13A)	4292	3403	2423	94
H(13B)	3424	4310	2915	94
H(13C)	4238	3301	3348	94
H(15A)	6638	2636	964	119
H(15B)	6855	1349	1316	119
H(15C)	8039	2276	1314	119

Table S11. Torsion angles [°] for mo_d8v18848_0m.

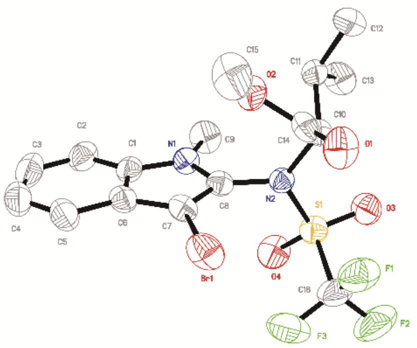
O(4)-S(1)-N(2)-C(8)	-29.5(4)
O(3)-S(1)-N(2)-C(8)	-165.7(3)
C(16)-S(1)-N(2)-C(8)	83.7(3)
O(4)-S(1)-N(2)-C(10)	152.4(3)
O(3)-S(1)-N(2)-C(10)	16.2(3)
C(16)-S(1)-N(2)-C(10)	-94.4(3)
C(8)-N(1)-C(1)-C(6)	-1.0(5)
C(9)-N(1)-C(1)-C(6)	178.2(4)
C(8)-N(1)-C(1)-C(2)	178.0(4)
C(9)-N(1)-C(1)-C(2)	-2.8(7)
N(1)-C(1)-C(2)-C(3)	-179.9(4)
C(6)-C(1)-C(2)-C(3)	-1.0(6)
C(1)-C(2)-C(3)-C(4)	-0.1(7)
C(2)-C(3)-C(4)-C(5)	1.1(8)
C(3)-C(4)-C(5)-C(6)	-1.0(7)
N(1)-C(1)-C(6)-C(5)	-179.9(4)
C(2)-C(1)-C(6)-C(5)	1.0(6)
N(1)-C(1)-C(6)-C(7)	1.0(5)
C(2)-C(1)-C(6)-C(7)	-178.1(4)
C(4)-C(5)-C(6)-C(1)	0.0(6)
C(4)-C(5)-C(6)-C(7)	178.8(5)
C(1)-C(6)-C(7)-C(8)	-0.7(4)
C(5)-C(6)-C(7)-C(8)	-179.6(4)
C(1)-C(6)-C(7)-Br(1)	-179.3(3)
C(5)-C(6)-C(7)-Br(1)	1.8(7)
C(6)-C(7)-C(8)-N(1)	0.1(4)
Br(1)-C(7)-C(8)-N(1)	178.7(3)
C(6)-C(7)-C(8)-N(2)	-179.9(4)
Br(1)-C(7)-C(8)-N(2)	-1.4(6)
C(1)-N(1)-C(8)-C(7)	0.5(4)
C(9)-N(1)-C(8)-C(7)	-178.6(4)
C(1)-N(1)-C(8)-N(2)	-179.4(3)
C(9)-N(1)-C(8)-N(2)	1.4(6)
C(10)-N(2)-C(8)-C(7)	78.4(5)
S(1)-N(2)-C(8)-C(7)	-99.6(4)
C(10)-N(2)-C(8)-N(1)	-101.7(4)

S(1)-N(2)-C(8)-N(1)	80.3(4)
C(8)-N(2)-C(10)-C(14)	112.5(4)
S(1)-N(2)-C(10)-C(14)	-69.5(4)
C(8)-N(2)-C(10)-C(11)	-9.9(5)
S(1)-N(2)-C(10)-C(11)	168.1(3)
N(2)-C(10)-C(11)-C(12)	83.8(4)
C(14)-C(10)-C(11)-C(12)	-37.9(5)
N(2)-C(10)-C(11)-C(13)	-150.7(4)
C(14)-C(10)-C(11)-C(13)	87.6(4)
C(15)-O(2)-C(14)-O(1)	-5.3(7)
C(15)-O(2)-C(14)-C(10)	173.9(4)
N(2)-C(10)-C(14)-O(1)	-24.2(6)
C(11)-C(10)-C(14)-O(1)	99.7(5)
N(2)-C(10)-C(14)-O(2)	156.6(3)
C(11)-C(10)-C(14)-O(2)	-79.5(4)
O(4)-S(1)-C(16)-F(2)	48.3(4)
O(3)-S(1)-C(16)-F(2)	177.3(3)
N(2)-S(1)-C(16)-F(2)	-68.8(4)
O(4)-S(1)-C(16)-F(3)	169.3(3)
O(3)-S(1)-C(16)-F(3)	-61.8(4)
N(2)-S(1)-C(16)-F(3)	52.1(4)
O(4)-S(1)-C(16)-F(1)	-71.5(4)
O(3)-S(1)-C(16)-F(1)	57.5(4)
N(2)-S(1)-C(16)-F(1)	171.4(4)

Symmetry transformations used to generate equivalent atoms:

Table S12. Hydrogen bonds for mo_d8v18848_0m [Å and °].

D-H...A	d(D-H)	d(H...A)	d(D...A)	<(DHA)
C(11)-H(11)...Br(1)	1.00	2.81	3.719(4)	151.9
C(9)-H(9B)...O(1)	0.98	2.25	3.193(5)	160.7
C(2)-H(2)...O(1)#1	0.95	2.62	3.373(5)	136.2



3l` (CCDC 1955748)

Table S13. Crystal data and structure refinement for mo_d8v18849_0m.

Identification code	mo_d8v18849_0m	
Empirical formula	C16 H18 Br F3 N2 O4 S	
Formula weight	471.29	
Temperature	191(2) K	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	P 21 21 21	
Unit cell dimensions	a = 8.4627(2) Å	α= 90°.
	b = 14.6178(3) Å	β= 90°.
	c = 15.3653(4) Å	γ = 90°.
Volume	1900.78(8) $Å^3$	
Z	4	
Density (calculated)	1.647 Mg/m^3	
Absorption coefficient	2.326 mm^{-1}	
F(000)	952	
Crystal size	0.170 x 0.150 x 0.110 mm^3	
Theta range for data collection	2.748 to 25.999°.	
Index ranges	-8<=h<=10, -17<=k<=18, -18<=l<=18	
Reflections collected	9507	
Independent reflections	3710 [R(int) = 0.0375]	
Completeness to theta = 25.242°	99.8 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7456 and 0.5062	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3710 / 0 / 249	
Goodness-of-fit on F^2	0.981	
Final R indices [I>2sigma(I)]	R1 = 0.0298, wR2 = 0.0636	

R indices (all data)	R1 = 0.0410, wR2 = 0.0681
Absolute structure parameter	0.027(7)
Extinction coefficient	0.0476(19)
Largest diff. peak and hole	0.245 and -0.260 e.Å^{-3}

Table S14. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters (Å^{2}x 10^3) for mo_d8v18849_0m. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Br(1)	2672(1)	2990(1)	4974(1)	57(1)
S(1)	4733(1)	5644(1)	4926(1)	43(1)
F(1)	5849(4)	4261(2)	5809(2)	72(1)
F(2)	7562(3)	4992(2)	5046(2)	96(1)
F(3)	5934(4)	4073(2)	4425(2)	82(1)
O(1)	2880(4)	4002(2)	7038(2)	57(1)
O(2)	558(3)	4315(2)	6392(2)	47(1)
O(3)	5342(3)	6313(2)	5499(2)	58(1)
O(4)	4647(4)	5787(2)	4016(2)	60(1)
N(1)	989(4)	5435(2)	4135(2)	38(1)
N(2)	3005(3)	5308(2)	5268(2)	34(1)
C(1)	113(5)	4858(2)	3621(2)	40(1)
C(2)	-995(5)	5059(3)	2981(3)	54(1)
C(3)	-1688(5)	4344(4)	2555(3)	65(1)
C(4)	-1306(6)	3445(4)	2748(3)	64(1)
C(5)	-210(6)	3234(3)	3374(2)	54(1)
C(6)	524(5)	3950(2)	3820(2)	40(1)
C(7)	1700(5)	4011(2)	4471(2)	38(1)
C(8)	1961(4)	4906(2)	4663(2)	36(1)
C(9)	939(6)	6429(2)	4075(3)	57(1)
C(10)	2612(4)	5400(2)	6225(2)	34(1)
C(11)	1432(4)	6166(2)	6419(2)	40(1)
C(12)	954(5)	6127(3)	7386(3)	55(1)
C(13)	2138(6)	7111(2)	6232(3)	58(1)
C(14)	2069(5)	4479(2)	6593(2)	39(1)
C(15)	-126(7)	3499(3)	6779(3)	71(2)
C(16)	6090(5)	4674(3)	5062(3)	57(1)

Table S15. Bond lengths [Å] and angles [°] for mo_d8v18849_0m.

Br(1)-C(7)	1.872(3)
S(1)-O(3)	1.414(3)
S(1)-O(4)	1.416(3)
S(1)-N(2)	1.630(3)
S(1)-C(16)	1.836(4)
F(1)-C(16)	1.314(5)
F(2)-C(16)	1.329(5)
F(3)-C(16)	1.321(5)
O(1)-C(14)	1.193(4)
O(2)-C(14)	1.337(5)
O(2)-C(15)	1.454(4)
N(1)-C(1)	1.373(4)
N(1)-C(8)	1.390(4)
N(1)-C(9)	1.456(4)
N(2)-C(8)	1.412(4)
N(2)-C(10)	1.513(4)
C(1)-C(2)	1.390(5)
C(1)-C(6)	1.406(5)
C(2)-C(3)	1.365(6)
C(2)-H(2)	0.9500
C(3)-C(4)	1.384(7)
C(3)-H(3)	0.9500
C(4)-C(5)	1.372(6)
C(4)-H(4)	0.9500
C(5)-C(6)	1.397(5)
C(5)-H(5)	0.9500
C(6)-C(7)	1.414(5)
C(7)-C(8)	1.359(4)
C(9)-H(9A)	0.9800
C(9)-H(9B)	0.9800
C(9)-H(9C)	0.9800
C(10)-C(11)	1.530(5)
C(10)-C(14)	1.530(5)
C(10)-H(10)	1.0000
C(11)-C(13)	1.532(5)
C(11)-C(12)	1.541(5)

C(11)-H(11)	1.0000
C(12)-H(12A)	0.9800
C(12)-H(12B)	0.9800
C(12)-H(12C)	0.9800
C(13)-H(13A)	0.9800
C(13)-H(13B)	0.9800
C(13)-H(13C)	0.9800
C(15)-H(15A)	0.9800
C(15)-H(15B)	0.9800
C(15)-H(15C)	0.9800
O(3)-S(1)-O(4)	122.10(17)
O(3)-S(1)-N(2)	109.54(16)
O(4)-S(1)-N(2)	108.51(17)
O(3)-S(1)-C(16)	103.6(2)
O(4)-S(1)-C(16)	105.0(2)
N(2)-S(1)-C(16)	107.01(17)
C(14)-O(2)-C(15)	115.7(4)
C(1)-N(1)-C(8)	108.2(3)
C(1)-N(1)-C(9)	124.1(3)
C(8)-N(1)-C(9)	127.5(3)
C(8)-N(2)-C(10)	122.7(3)
C(8)-N(2)-S(1)	118.3(2)
C(10)-N(2)-S(1)	119.0(2)
N(1)-C(1)-C(2)	129.9(4)
N(1)-C(1)-C(6)	108.7(3)
C(2)-C(1)-C(6)	121.4(4)
C(3)-C(2)-C(1)	117.8(4)
C(3)-C(2)-H(2)	121.1
C(1)-C(2)-H(2)	121.1
C(2)-C(3)-C(4)	121.6(4)
C(2)-C(3)-H(3)	119.2
C(4)-C(3)-H(3)	119.2
C(5)-C(4)-C(3)	121.4(4)
C(5)-C(4)-H(4)	119.3
C(3)-C(4)-H(4)	119.3
C(4)-C(5)-C(6)	118.4(4)
C(4)-C(5)-H(5)	120.8
C(6)-C(5)-H(5)	120.8

C(5)-C(6)-C(1)	119.4(4)
C(5)-C(6)-C(7)	135.0(4)
C(1)-C(6)-C(7)	105.6(3)
C(8)-C(7)-C(6)	109.2(3)
C(8)-C(7)-Br(1)	127.4(3)
C(6)-C(7)-Br(1)	123.4(3)
C(7)-C(8)-N(1)	108.3(3)
C(7)-C(8)-N(2)	130.2(3)
N(1)-C(8)-N(2)	121.5(3)
N(1)-C(9)-H(9A)	109.5
N(1)-C(9)-H(9B)	109.5
H(9A)-C(9)-H(9B)	109.5
N(1)-C(9)-H(9C)	109.5
H(9A)-C(9)-H(9C)	109.5
H(9B)-C(9)-H(9C)	109.5
N(2)-C(10)-C(11)	113.4(3)
N(2)-C(10)-C(14)	110.3(3)
C(11)-C(10)-C(14)	112.2(3)
N(2)-C(10)-H(10)	106.9
C(11)-C(10)-H(10)	106.9
C(14)-C(10)-H(10)	106.9
C(10)-C(11)-C(13)	111.7(3)
C(10)-C(11)-C(12)	109.3(3)
C(13)-C(11)-C(12)	108.5(3)
C(10)-C(11)-H(11)	109.1
C(13)-C(11)-H(11)	109.1
C(12)-C(11)-H(11)	109.1
C(11)-C(12)-H(12A)	109.5
C(11)-C(12)-H(12B)	109.5
H(12A)-C(12)-H(12B)	109.5
C(11)-C(12)-H(12C)	109.5
H(12A)-C(12)-H(12C)	109.5
H(12B)-C(12)-H(12C)	109.5
C(11)-C(13)-H(13A)	109.5
C(11)-C(13)-H(13B)	109.5
H(13A)-C(13)-H(13B)	109.5
C(11)-C(13)-H(13C)	109.5
H(13A)-C(13)-H(13C)	109.5

H(13B)-C(13)-H(13C)	109.5
O(1)-C(14)-O(2)	125.3(4)
O(1)-C(14)-C(10)	123.6(4)
O(2)-C(14)-C(10)	111.0(3)
O(2)-C(15)-H(15A)	109.5
O(2)-C(15)-H(15B)	109.5
H(15A)-C(15)-H(15B)	109.5
O(2)-C(15)-H(15C)	109.5
H(15A)-C(15)-H(15C)	109.5
H(15B)-C(15)-H(15C)	109.5
F(1)-C(16)-F(3)	109.0(3)
F(1)-C(16)-F(2)	108.8(4)
F(3)-C(16)-F(2)	108.2(4)
F(1)-C(16)-S(1)	110.9(3)
F(3)-C(16)-S(1)	111.5(3)
F(2)-C(16)-S(1)	108.3(3)

Symmetry transformations used to generate equivalent atoms:

Table S16. Anisotropic displacement parameters ($Å^2 x 10^3$) for mo_d8v18849_0m. The anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2 a^{*2}U^{11} + ... + 2 h k a^* b^* U^{12}]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Br(1)	79(1)	33(1)	60(1)	-1(1)	-4(1)	10(1)
S(1)	41(1)	47(1)	42(1)	5(1)	6(1)	-6(1)
F(1)	67(2)	88(2)	60(2)	20(1)	7(1)	26(2)
F(2)	39(2)	133(3)	116(2)	6(2)	13(2)	6(1)
F(3)	92(2)	82(2)	72(2)	-15(2)	18(2)	26(2)
O(1)	69(2)	48(2)	54(2)	16(1)	-13(2)	2(2)
O(2)	45(2)	51(2)	44(2)	6(1)	1(1)	-17(1)
O(3)	51(2)	58(2)	64(2)	-10(1)	7(2)	-19(2)
O(4)	58(2)	77(2)	46(2)	18(1)	9(2)	-11(2)
N(1)	41(2)	35(2)	38(2)	4(1)	-2(1)	3(1)
N(2)	33(2)	35(1)	34(2)	1(1)	0(1)	0(1)
C(1)	34(2)	53(2)	34(2)	2(2)	4(2)	-4(2)
C(2)	43(2)	74(3)	45(2)	6(2)	0(2)	-3(2)
C(3)	46(3)	102(4)	46(3)	2(2)	-5(2)	-16(3)

C(4)	55(3)	89(3)	47(3)	-17(3)	7(2)	-27(3)
C(5)	56(3)	58(2)	48(2)	-13(2)	9(2)	-16(2)
C(6)	42(2)	44(2)	35(2)	-2(2)	9(2)	-8(2)
C(7)	46(2)	33(2)	34(2)	1(2)	5(2)	0(2)
C(8)	40(2)	36(2)	33(2)	2(1)	3(2)	3(2)
C(9)	71(3)	37(2)	62(3)	9(2)	-9(2)	8(2)
C(10)	35(2)	35(2)	31(2)	2(1)	0(2)	-3(2)
C(11)	37(2)	40(2)	42(2)	-4(2)	-2(2)	3(2)
C(12)	53(3)	63(3)	49(3)	-14(2)	9(2)	2(2)
C(13)	75(3)	34(2)	65(3)	-4(2)	-3(2)	5(2)
C(14)	49(3)	41(2)	28(2)	-2(2)	2(2)	-5(2)
C(15)	85(4)	60(3)	67(3)	7(2)	7(3)	-37(3)
C(16)	44(2)	76(3)	51(3)	3(3)	13(3)	8(2)

Table S17. Hydrogen coordinates (x 10^4) and isotropic displacement parameters (Å^{2}x 10 ^{3}) for mo_d8v18849_0m.

	x	y	z	U(eq)
H(2)	-1262	5674	2844	65
H(3)	-2450	4466	2116	78
H(4)	-1815	2965	2440	76
H(5)	43	2615	3502	65
H(9A)	188	6669	4504	85
H(9B)	604	6608	3489	85
H(9C)	1993	6678	4193	85
H(10)	3617	5561	6531	40
H(11)	470	6079	6050	48
H(12A)	478	5531	7513	82
H(12B)	187	6613	7509	82
H(12C)	1893	6213	7750	82
H(13A)	3061	7210	6606	87
H(13B)	1345	7583	6351	87
H(13C)	2460	7145	5620	87
H(15A)	457	2959	6579	106
H(15B)	-1236	3446	6603	106
H(15C)	-60	3540	7414	106

Table S18. Torsion angles [°] for mo_d8v18849_0m.

O(3)-S(1)-N(2)-C(8)	157.9(3)
O(4)-S(1)-N(2)-C(8)	22.4(3)
C(16)-S(1)-N(2)-C(8)	-90.4(3)
O(3)-S(1)-N(2)-C(10)	-24.9(3)
O(4)-S(1)-N(2)-C(10)	-160.4(2)
C(16)-S(1)-N(2)-C(10)	86.8(3)
C(8)-N(1)-C(1)-C(2)	-178.6(4)
C(9)-N(1)-C(1)-C(2)	-2.1(6)
C(8)-N(1)-C(1)-C(6)	0.1(4)
C(9)-N(1)-C(1)-C(6)	176.5(3)
N(1)-C(1)-C(2)-C(3)	179.2(4)
C(6)-C(1)-C(2)-C(3)	0.7(6)
C(1)-C(2)-C(3)-C(4)	-0.1(7)
C(2)-C(3)-C(4)-C(5)	-0.2(7)
C(3)-C(4)-C(5)-C(6)	0.0(7)
C(4)-C(5)-C(6)-C(1)	0.5(6)
C(4)-C(5)-C(6)-C(7)	-178.2(4)
N(1)-C(1)-C(6)-C(5)	-179.7(4)
C(2)-C(1)-C(6)-C(5)	-0.9(6)
N(1)-C(1)-C(6)-C(7)	-0.6(4)
C(2)-C(1)-C(6)-C(7)	178.2(4)
C(5)-C(6)-C(7)-C(8)	179.8(4)
C(1)-C(6)-C(7)-C(8)	1.0(4)
C(5)-C(6)-C(7)-Br(1)	-1.1(7)
C(1)-C(6)-C(7)-Br(1)	-179.9(3)
C(6)-C(7)-C(8)-N(1)	-0.9(4)
Br(1)-C(7)-C(8)-N(1)	180.0(3)
C(6)-C(7)-C(8)-N(2)	179.5(4)
Br(1)-C(7)-C(8)-N(2)	0.4(6)
C(1)-N(1)-C(8)-C(7)	0.5(4)
C(9)-N(1)-C(8)-C(7)	-175.7(4)
C(1)-N(1)-C(8)-N(2)	-179.8(3)
C(9)-N(1)-C(8)-N(2)	3.9(6)
C(10)-N(2)-C(8)-C(7)	-82.1(5)
S(1)-N(2)-C(8)-C(7)	95.1(4)
C(10)-N(2)-C(8)-N(1)	98.4(4)

S(1)-N(2)-C(8)-N(1)	-84.5(4)
C(8)-N(2)-C(10)-C(11)	-75.8(4)
S(1)-N(2)-C(10)-C(11)	107.1(3)
C(8)-N(2)-C(10)-C(14)	50.9(4)
S(1)-N(2)-C(10)-C(14)	-126.2(3)
N(2)-C(10)-C(11)-C(13)	-66.9(4)
C(14)-C(10)-C(11)-C(13)	167.4(3)
N(2)-C(10)-C(11)-C(12)	173.0(3)
C(14)-C(10)-C(11)-C(12)	47.3(4)
C(15)-O(2)-C(14)-O(1)	1.9(5)
C(15)-O(2)-C(14)-C(10)	-174.4(3)
N(2)-C(10)-C(14)-O(1)	103.8(4)
C(11)-C(10)-C(14)-O(1)	-128.8(4)
N(2)-C(10)-C(14)-O(2)	-79.9(4)
C(11)-C(10)-C(14)-O(2)	47.5(4)
O(3)-S(1)-C(16)-F(1)	73.8(3)
O(4)-S(1)-C(16)-F(1)	-157.1(3)
N(2)-S(1)-C(16)-F(1)	-41.9(4)
O(3)-S(1)-C(16)-F(3)	-164.5(3)
O(4)-S(1)-C(16)-F(3)	-35.4(3)
N(2)-S(1)-C(16)-F(3)	79.8(3)
O(3)-S(1)-C(16)-F(2)	-45.5(4)
O(4)-S(1)-C(16)-F(2)	83.6(4)
N(2)-S(1)-C(16)-F(2)	-161.2(3)

Symmetry transformations used to generate equivalent atoms:

Table S19. Hydrogen bonds for mo_d8v18849_0m [Å and °].

D-H...A	d(D-H)	d(H...A)	d(D...A)	<(DHA)
C(9)-H(9C)...S(1)	0.98	2.99	3.651(5)	125.9
C(9)-H(9C)...O(4)	0.98	2.61	3.277(6)	125.3
C(15)-H(15A)...Br(1)	0.98	3.10	3.722(5)	122.8