Electronic Supplementary Material (ESI) for Chemical Communications

Supporting Information

Aerobic Ru-catalyzed direct C2-olefination of *N*-heteroarenes with alkenes directed by a removable *N*-dimethylcarbamoyl group

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I. General remarks

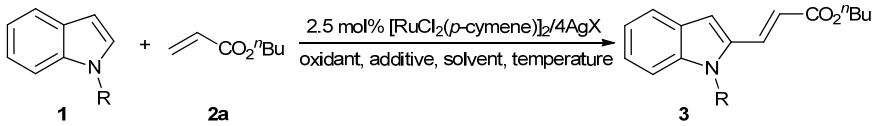
NMR spectra were obtained on a Bruker AV II-400 MHz spectrometer. The ^{1}H NMR (400 MHz) chemical shifts were measured relative to $CDCl_3$ or DMSO-d_6 as the internal reference ($CDCl_3$: δ = 7.26 ppm, DMSO-d_6: δ = 2.50 ppm). The ^{13}C NMR (100 MHz) chemical shifts were given using $CDCl_3$ or DMSO-d_6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

Unless otherwise noted, all reagents were obtained from commercial suppliers and used without further purification. *N*-Dimethylcarbamoyl indoles, pyrrole and carbazole were prepared according to the literature procedures.[1,2] 1,2-Dichloroethane was dried over CaH_2 and distilled prior to use.

II. Optimization of the Ru-catalyzed C2-olefination of indoles with alkenes

A sealable tube with a magnetic stir bar was charged with $Cu(OAc)_2$, additive (if required), indole **1** (0.25 mmol), $[RuCl_2(p\text{-cymene})]_2$ (4.0 mg, 6.25 μmol, 2.5 mol%), and silver salt (*25* μmol, 10 mol%) under an N_2 atmosphere. The system was evacuated and backfilled with O_2 for three times. Then butyl acrylate **2a** (53.5 μL, 0.375 mmol, 1.5 equiv) and DCE (1.0 mL) were added through syringes and the tube was sealed with a teflon-coated screw cap. The reaction mixture was first stirred at room temperature for 15 min and then heated at the indicated temperature for 15 or 24 h. The resulting solution was subsequently diluted with 5 mL of dichloromethane, filtered through a celite pad and washed with 10-20 mL of dichloromethane. The combined organic phases were evaporated, and the resulting residue was purified by column chromatography on silica gel to provide the desired product.

Table S1: Optimization of the reaction of **1** with butyl acrylate **2a**.[a]



Entry	R	Silver salt	$Cu(OAc)_2$ (mol%)	Atmos-phere	Additive	Solvent	Tempera-ture (°C)	Yield (%)[b]
1	Dmc	$AgSbF_6$	150	N_2	-	Toluene	130	87
2[c]	Dmc	$AgBF_4$	150	N_2	-	Toluene	130	52
3	Dmc	AgOAc	150	N_2	-	Toluene	130	32
4	Dmc	-	150	N_2	-	Toluene	130	23
5	Dmc	$AgSbF_6$	-	O_2	-	Toluene	130	36
6	Dmc	$AgSbF_6$	20	O_2	-	Toluene	130	63
7	Dmc	$AgSbF_6$	20	O_2	-	*t*-AmylOH	130	68
8	Dmc	$AgSbF_6$	20	O_2	-	THF	130	45
9	Dmc	$AgSbF_6$	20	O_2	-	DCE	130	73
10	Dmc	$AgSbF_6$	20	O_2	NaOAc	DCE	130	82
11	Dmc	$AgSbF_6$	20	O_2	$MesCO_2H$	DCE	130	78
12	Dmc	$AgSbF_6$	20	O_2	PivOH	DCE	130	75
13	Dmc	$AgSbF_6$	20	O_2	NaOAc	DCE	100	90
14[c]	Dmc	$AgSbF_6$	20	O_2	NaOAc	DCE	100	93
15[c,d]	Dmc	$AgSbF_6$	20	O_2	NaOAc	DCE	100	28
16[c]	Dmc	$AgSbF_6$	20	O_2	NaOAc	DCE	80	63
17[c]	Ac	$AgSbF_6$	20	O_2	NaOAc	DCE	100	trace
18[c]	PhCO	$AgSbF_6$	20	O_2	NaOAc	DCE	100	trace
19[c]	Pym	$AgSbF_6$	20	O_2	NaOAc	DCE	100	trace
20[c]	Ts	$AgSbF_6$	20	O_2	NaOAc	DCE	100	trace

[a] Reaction conditions: **1a** (0.25 mmol, 1.0 equiv), **2a** (1.5 equiv), $[RuCl_2(p\text{-cymene})]_2$ (2.5 mol%,), silver salt (10 mol%), oxidant, additive (30 mol%), and solvent (1.0 mL) at 130 °C. [b] Isolated yields. [c] 15 h. [d] $[RuCl_2(p\text{-cymene})]_2$ (1 mol%) and $AgSbF_6$ (4 mol%) were used. Dmc = dimethylcarbamoyl, Ac = acetyl, Pym = 2-pyrimidyl, Ts = 4-toluenesulfonyl, PivOH = pivalic acid, $MesCO_2H$ = 2,4,6-trimethylbenzoic acid, THF = tetrahydrofuran, DCE = 1,2-dichloroethane.

III. General procedure for the Ru-catalyzed olefination of *N*-heteroarenes

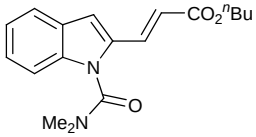
A sealable tube with a magnetic stir bar was charged with $Cu(OAc)_2$ (9.1 mg, 50 μmol, 20 mol%), NaOAc (6.2 mg, 75 μmol, 30 mol%), *N*-heteroarenes **1** (0.25 mmol), $[RuCl_2(p\text{-cymene})]_2$ (4.0 mg, 6.25 μmol, 2.5 mol%), and $AgSbF_6$ (8.6 mg, 25 μmol,

10 mol%) under an N_2 atmosphere. The system was evacuated and backfilled with O_2 for three times. Then alkenes **2** (0.375 mmol, 1.5 equiv) and DCE (1.0 mL) were added through syringes and the tube was capped with a teflon-coated screw cap. The reaction mixture was first stirred at room temperature for 15 min and then heated at 100 ºC for 15 h. The resulting solution was subsequently diluted with 5 mL of dichloromethane, filtered through a celite pad, and washed with 10-20 mL of dichloromethane. The combined organic phases were evaporated, and the resulting residue was purified by column chromatography on silica gel to provide the desired product.

IV. General procedure for the deprotection of the *N*-dimethylcarbamoyl group[3]

A sealable tube with a magnetic stir bar was charged with 2-alkenylated indoles (0.25 mmol), EtOH (2.8 mL) and saturated aqueous KOH solution (0.9 mL). The tube was then capped and the mixture was stirred at 80 °C. After the completion of the reaction as monitored by TLC, the solution was cooled to ambient temperature, diluted with water, acidified to pH = 5 using 1N HCl, and extracted with ethyl acetate for 5-6 times. The combined organic phases were dried over anhydrous Na_2SO_4. The solvent was concentrated and the residue was purified by column chromatography on silica gel to provide the desired products.

V. Experimental data for the described substances

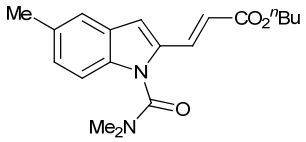


(*E*)-Butyl 3-(1-(dimethylcarbamoyl)-1*H*-indol-2-yl)acrylate (3a)

Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/CH_2Cl_2/Et_2O = 5/2/1, v/v/v) afforded **3a** as yellow oil (73 mg, 93% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.97 (t, J = 7.2 Hz, 3H), 1.39-1.48 (m, 2H), 1.65-1.72 (m, 2H), 3.04 (br. s, 6H), 4.21 (t, J =

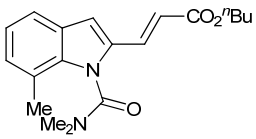
6.8 Hz, 2H), 6.36 (d, J = 16.0 Hz, 1H), 7.00 (s, 1H), 7.19 (t, J = 8.0 Hz, 1H), 7.29-7.34 (m, 2H), 7.61 (d, J = 8.0 Hz, 1H), 7.69 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.8, 19.2, 30.8, 37.7, 64.6, 108.4, 111.6, 118.7, 121.7, 122.1, 125.3, 128.0, 133.0, 134.0, 137.2, 153.4, 166.9 ppm. HRMS (ESI): calcd for $C_{18}H_{22}N_2NaO_3$ $[M+Na]^+$ 337.1528, found 337.1527.

The structure of **3a** was further confirmed by ^{1}H-^{1}H NOESY spectrum.



(*E*)-Butyl 3-(1-(dimethylcarbamoyl)-5-methyl-1*H*-indol-2-yl)acrylate (3b)

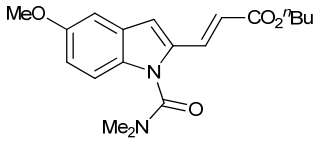
Following the general procedure. 5-Methyl-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide **1b** (50.5 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3b** as yellow oil (70 mg, 86% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.97 (t, J = 7.2 Hz, 3H), 1.39-1.48 (m, 2H), 1.65-1.72 (m, 2H), 2.43 (s, 3H), 3.01 (br. s, 6H), 4.20 (t, J = 6.8 Hz, 2H), 6.34 (d, J = 16.0 Hz 1H), 6.91 (s, 1H), 7.13 (dd, J = 8.8 Hz, 0.8 Hz, 1H), 7.22 (d, J = 8.8 Hz, 1H), 7.39 (s, 1H), 7.67 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.8, 19.3, 21.4, 30.9, 37.7, 64.6, 108.1, 111.3, 118.4, 121.2, 127.0, 128.2, 131.6, 133.1, 134.1, 135.7, 153.6, 166.9 ppm. HRMS (ESI): calcd for $C_{19}H_{24}N_2NaO_3$ $[M+Na]^+$ 351.1685, found 351.1680.



(*E*)-Butyl 3-(1-(dimethylcarbamoyl)-7-methyl-1*H*-indol-2-yl)acrylate (3c)

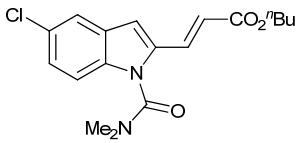
Following the general procedure. 7-Methyl-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide **1c** (50.5 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3c** as brown oil (63 mg, 77% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ =

0.97 (t, J = 7.2 Hz, 3H), 1.39-1.48 (m, 2H), 1.65-1.73 (m, 2H), 2.43 (s, 3H), 2.62 (s, 3H), 3.25 (s, 3H), 4.21 (td, J = 6.8 Hz, 0.8 Hz, 2H), 6.40 (d, J = 16.0 Hz, 1H), 6.98 (s, 1H), 7.04-7.10 (m, 2H), 7.47 (dd, J = 7.2 Hz, 1.2 Hz, 1H), 7.57 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.8, 17.5, 19.3, 30.8, 36.8, 37.9, 64.6, 107.6, 118.4, 119.6, 121.5, 122.0, 127.1, 128.2, 132.2, 132.9, 136.1, 154.3, 166.9 ppm. HRMS (ESI): calcd for $C_{19}H_{24}N_2NaO_3$ $[M+Na]^+$ 351.1685, found 351.1690.



(*E*)-Butyl 3-(1-(dimethylcarbamoyl)-5-methoxy-1*H*-indol-2-yl)acrylate (3d)

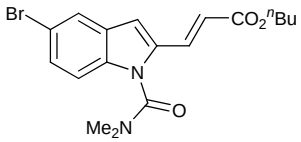
Following the general procedure. 5-Methoxy-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide **1d** (54.5 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3d** as yellow oil (76 mg, 88% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.96 (t, J = 7.2 Hz, 3H), 1.39-1.48 (m, 2H), 1.65-1.72 (m, 2H), 3.01 (br. s, 6H), 3.84 (s, 3H), 4.20 (t, J = 6.8 Hz, 2H), 6.34 (d, J = 16.0 Hz, 1H), 6.92 (s, 1H), 6.95 (dd, J = 8.8 Hz, 2.4 Hz, 1H), 7.02 (d, J = 2.4 Hz, 1H), 7.23 (d, J = 8.8 Hz, 1H), 7.66 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.7, 19.3, 30.8, 37.8, 55.8, 64.6, 102.6, 107.9, 112.5, 115.8, 118.4, 128.6, 132.4, 133.0, 134.5, 153.5, 155.6, 166.9 ppm. HRMS (ESI): calcd for $C_{19}H_{24}N_2NaO_4$ $[M+Na]^+$ 367.1634, found 367.1627.



(*E*)-Butyl 3-(5-chloro-1-(dimethylcarbamoyl)-1*H*-indol-2-yl)acrylate (3e)

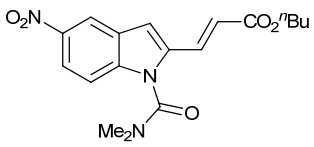
Following the general procedure. 5-Chloro-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide **1e** (56 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3e** as a yellow solid (71 mg, 82% yield). M.p.: 80-81 °C. ^{1}H NMR (400

MHz, $CDCl_3$): δ = 0.97 (t, J = 7.2 Hz, 3H), 1.39-1.48 (m, 2H), 1.65-1.73 (m, 2H), 3.02 (br. s, 6H), 4.21 (t, J = 6.8 Hz, 2H), 6.39 (d, J = 16.0 Hz, 1H), 6.92 (s, 1H), 7.23-7.28 (m, 2H), 7.58 (s, 1H), 7.64 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.8, 19.2, 30.8, 37.7, 64.7, 107.1, 112.7, 119.7, 120.9, 125.4, 127.7, 128.9, 132.4, 135.2, 135.4, 152.9, 166.5 ppm. HRMS (ESI): calcd for $C_{18}H_{21}ClN_2NaO_3$ $[M+Na]^+$ 371.1138, found 371.1141.



(*E*)-Butyl 3-(5-bromo-1-(dimethylcarbamoyl)-1*H*-indol-2-yl)acrylate (3f)

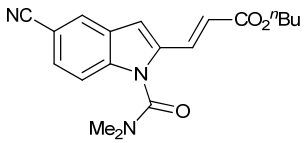
Following the general procedure. 5-Bromo-*N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1f** (67 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3f** as a yellow solid (73 mg, 74% yield). M.p.: 98-99 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.97 (t, J = 7.2 Hz, 3H), 1.38-1.48 (m, 2H), 1.65-1.72 (m, 2H), 3.01 (br. s, 6H), 4.21 (t, J = 6.8 Hz, 2H), 6.39 (d, J = 16.0 Hz, 1H), 6.91 (s, 1H), 7.21 (d, J = 8.8 Hz, 1H), 7.38 (dd, J = 8.8 Hz, 1.6 Hz, 1H), 7.64 (d, J = 16.0 Hz, 1H), 7.74 (d, J = 1.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.8, 19.3, 30.8, 37.8, 64.8, 107.0, 113.1, 115.3, 119.9, 124.1, 128.0, 129.6, 132.4, 135.1, 135.7, 152.9, 166.6 ppm. HRMS (ESI): calcd for $C_{18}H_{21}BrN_2NaO_3$ $[M+Na]^+$ 415.0633, found 415.0634.



(*E*)-Butyl 3-(1-(dimethylcarbamoyl)-5-nitro-1*H*-indol-2-yl)acrylate (3g)

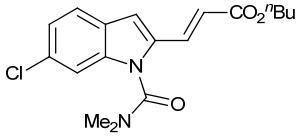
Following the general procedure. *N*,*N*-Dimethyl-5-nitro-1*H*-indole-1-carboxamide **1g** (58.3 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 3/1,

v/v) afforded **3g** as a yellow solid (57 mg, 63% yield). M.p.: 80-81 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.97 (t, J = 7.2 Hz, 3H), 1.39-1.48 (m, 2H), 1.66-1.73 (m, 2H), 3.02 (br. s, 6H), 4.23 (t, J = 6.8 Hz, 2H), 6.47 (d, J = 16.0 Hz, 1H), 7.13 (s, 1H), 7.41 (d, J = 9.2 Hz, 1H), 7.64 (d, J = 16.0 Hz, 1H), 8.20 (dd, J = 9.2 Hz, 2.4 Hz, 1H), 8.57 (d, J = 2.4 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.8, 19.3, 30.8, 37.9, 65.0, 108.5, 111.8, 118.5, 120.2, 121.4, 127.3, 131.6, 137.1, 139.6, 143.5, 152.2, 166.3 ppm. HRMS (ESI): calcd for $C_{18}H_{21}N_3NaO_5$ $[M+Na]^+$ 382.1379, found 382.1382.



(*E*)-Butyl 3-(5-cyano-1-(dimethylcarbamoyl)-1*H*-indol-2-yl)acrylate (3h)

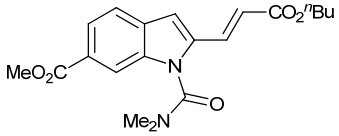
Following the general procedure. 5-Cyano-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide **1h** (53.3 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 3/1, v/v) afforded **3h** as a white solid (45 mg, 54% yield). M.p.: 87-88 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.97 (t, J = 7.2 Hz, 3H), 1.39-1.48 (m, 2H), 1.65-1.73 (m, 2H), 3.02 (br. s, 6H), 4.22 (t, J = 6.8 Hz, 2H), 6.44 (d, J = 16.0 Hz 1H), 7.03 (s, 1H), 7.41 (d, J = 8.4 Hz, 1H), 7.52 (dd, J = 8.4 Hz, 1.2 Hz, 1H), 7.63 (d, J = 16.0 Hz, 1H), 7.97 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.9, 19.3, 30.8, 37.9, 65.0, 105.7, 107.4, 112.6, 119.7, 127.0, 121.1, 127.0, 127.68, 127.74, 136.2, 138.4, 152.3, 166.3 ppm. HRMS (ESI): calcd for $C_{19}H_{21}N_3NaO_3$ $[M+Na]^+$ 362.1481, found 362.1476.



(*E*)-Butyl 3-(6-chloro-1-(dimethylcarbamoyl)-1*H*-indol-2-yl)acrylate (3i)

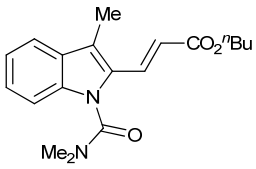
Following the general procedure. 6-Chloro-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide **1i** (56 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used.

Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3i** as yellow oil (78 mg, 90% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.97 (t, J = 7.2 Hz, 3H), 1.38-1.48 (m, 2H), 1.65-1.72 (m, 2H), 3.02 (br. s, 6H), 4.21 (t, J = 6.8 Hz, 2H), 6.35 (d, J = 16.0 Hz 1H), 6.95 (s, 1H), 7.16 (dd, J = 8.4 Hz, 2.0 Hz, 1H), 7.35 (s, 1H), 7.52 (d, J = 8.4 Hz, 1H), 7.63 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.9, 19.3, 30.9, 37.8, 64.8, 108.0, 111.7, 119.3, 122.6, 123.1, 126.5, 131.2, 132.5, 134.7, 137.5, 152.9, 166.7 ppm. HRMS (ESI): calcd for $C_{18}H_{21}ClN_2NaO_3$ $[M+Na]^+$ 371.1138, found 371.1141.



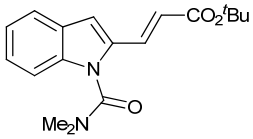
(*E*)-Methyl 2-(3-butoxy-3-oxoprop-1-en-1-yl)-1-(dimethylcarbamoyl)-1*H*-indole-6-carboxylate (3j)

Following the general procedure. Methyl 1-(dimethylcarbamoyl)-1*H*-indole-6-carboxylate **1j** (47 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3j** as yellow oil (89 mg, 96% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.96 (t, J = 7.2 Hz, 3H), 1.38-1.48 (m, 2H), 1.65-1.72 (m, 2H), 3.05 (br. s, 6H), 3.94 (s, 3H), 4.21 (t, J = 6.8 Hz, 2H), 6.44 (d, J = 16.0 Hz, 1H), 7.01 (s, 1H), 7.64 (d, J = 9.2 Hz, 1H), 7.67 (d, J = 16.8 Hz, 1H), 7.87 (d, J = 8.4 Hz, 1H), 8.04 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.8, 19.3, 30.8, 37.9, 52.3, 64.8, 107.5, 113.6, 120.6, 121.3, 123.1, 126.7, 131.4, 132.3, 136.5, 136.9 152.8, 166.5, 167.4 ppm. HRMS (ESI): calcd for $C_{20}H_{24}N_2NaO_5$ $[M+Na]^+$ 395.1583, found 395.1582.



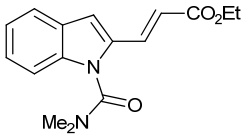
(*E*)-Butyl 3-(1-(dimethylcarbamoyl)-3-methyl-1*H*-indol-2-yl)acrylate (3k)

Following the general procedure. 3-Methyl-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide **1k** (50.5 mg, 0.25 mmol) and *n*-butyl acrylate 2**a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 10/1, v/v) afforded the desired product **3k** as yellow oil (54 mg, 66% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.97 (t, J = 7.2 Hz, 3H), 1.39-1.48 (m, 2H), 1.66-1.73 (m, 2H), 2.46 (s, 3H), 3.02 (s, 3H), 3.06 (s, 3H), 4.21 (t, J = 6.8 Hz, 2H), 6.09 (d, J = 16.4 Hz, 1H), 7.20 (t, J = 7.2 Hz, 1H), 7.28-7.35 (m, 2H), 7.59 (d, J = 8.0 Hz, 1H), 7.80 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 10.0, 13.9, 19.4, 31.0, 37.8, 64.6, 111.3, 117.5, 120.1, 120.8, 121.6, 126.0, 129.1, 130.1, 131.9, 137.0, 154.1, 167.3 ppm. HRMS (ESI): calcd for $C_{19}H_{24}N_2NaO_3$ $[M+Na]^+$ 351.1685, found 351.1686.



(*E*)-*tert*-Butyl 3-(1-(dimethylcarbamoyl)-1*H*-indol-2-yl)acrylate (3l)

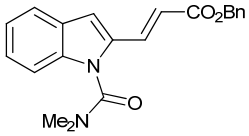
Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and *tert*-butyl acrylate **2b** (54.4 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/CH_2Cl_2/Et_2O = 5/2/1, v/v/v) afforded **3l** as yellow oil (68 mg, 87% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.53 (s, 9H), 3.03 (br. s, 6H), 6.30 (d, J = 16.0 Hz, 1H), 6.96 (s, 1H), 7.18 (td, J = 7.6 Hz, 1.2 Hz, 1H), 7.27-7.34 (m, 2H), 7.59 (d, J = 16.0 Hz, 1H), 7.60 (d, J = 7.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.3, 37.8, 80.8, 107.9, 111.6, 120.7, 121.6, 122.1, 125.1, 128.0, 132.0, 134.2, 137.1, 153.5, 166.1 ppm. HRMS (ESI): calcd for $C_{18}H_{22}N_2NaO_3$ $[M+Na]^+$ 337.1528, found 337.1533.



(*E*)-Ethyl 3-(1-(dimethylcarbamoyl)-1*H*-indol-2-yl)acrylate (3m)

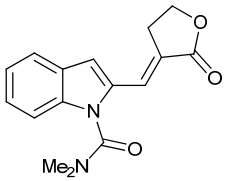
Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg,

0.25 mmol) and ethyl acrylate **2c** (40.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/CH_2Cl_2/Et_2O = 5/2/1, v/v/v) afforded the desired product **3m** as yellow oil (64 mg, 89% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.34 (t, J = 7.2 Hz, 3H), 3.02 (br. s, 6H), 4.26 (q, J = 7.2 Hz, 2H), 6.36 (d, J = 16.0 Hz, 1H), 6.99 (s, 1H), 7.19 (t, J = 6.8 Hz, 1H), 7.28-7.34 (m, 2H), 7.61 (d, J = 8.0 Hz, 1H), 7.69 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 14.5, 37.9, 60.8, 108.5, 111.6, 118.7, 121.8, 122.2, 125.3, 128.0, 133.0, 134.1, 137.3, 153.5, 166.8 ppm. HRMS (ESI): calcd for $C_{16}H_{18}N_2NaO_3$ $[M+Na]^+$ 309.1215, found 309.1214.



(*E*)-Benzyl 3-(1-(dimethylcarbamoyl)-1*H*-indol-2-yl)acrylate (3n)

Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and benzylacrylate **2d** (57.7 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3n** as yellow oil (79 mg, 91% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.02 (br. s, 6H), 5.25 (s, 2H), 6.41 (d, J = 16.0 Hz, 1H), 7.00 (s, 1H), 7.17-7.21 (m, 1H), 7.29-7.43 (m, 7H), 7.61 (d, J = 8.0 Hz, 1H), 7.74 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 37.4, 66.6, 108.8, 111.7, 118.2, 121.8, 122.2, 125.4, 128.0, 128.40, 128.45, 128.7, 133.6, 134.0, 136.1, 137.3, 153.4, 166.6 ppm. HRMS (ESI): calcd for $C_{21}H_{20}N_2NaO_3$ $[M+Na]^+$ 371.1372, found 371.1371.

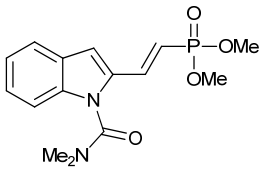


(*E*)-*N*,*N*-Dimethyl-2-((2-oxodihydrofuran-3(2*H*)-ylidene)methyl)-1*H*-indole-1-carboxamide (3o)

Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg,

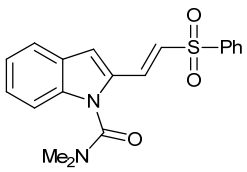
0.25 mmol) and 3-methylenedihydro-2(3*H*)-furanone **2e** (32.8 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 2/1, v/v) afforded **3o** as a yellow solid (40 mg, 56% yield). M.p.: 162-163 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.95 (br. s, 6H), 3.23 (td, J = 7.2 Hz, 2.8 Hz, 2H), 4.53 (t, J = 7.2 Hz, 2H), 6.88 (s, 1H), 7.19-7.23 (m, 1H), 7.32-7.37 (m, 2H), 7.59 (t, J = 2.8 Hz, 1H), 7.65 (d, J = 8.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.2, 38.0, 65.5, 109.5, 111.7, 121.8, 122.2, 124.4, 124.6, 125.6, 128.2, 133.7, 136.2, 153.0, 171.9 ppm. HRMS (ESI): calcd for $C_{16}H_{16}N_2NaO_3$ $[M+Na]^+$ 307.1059, found 307.1057.

The configuration of **3o** was confirmed by ^{1}H-^{1}H NOESY spectrum.



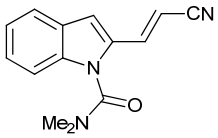
(*E*)-Dimethyl (2-(1-(dimethylcarbamoyl)-1*H*-indol-2-yl)vinyl)phosphonate (3p)

Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and dimethyl vinylphosphonate **2f** (44.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/2, v/v) afforded **3p** as a white solid (71 mg, 88% yield). M.p.: 81-83 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.00 (br. s, 6H), 3.76 (s, 3H), 3.79 (s, 3H), 6.12 (t, J = 17.6 Hz, 1H), 6.96 (s, 1H), 7.17-7.21 (m, 1H), 7.28-7.31 (m, 2H), 7.52 (dd, J = 23.2 Hz, 17.6 Hz, 1H), 7.61 (d, J = 7.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 37.8, 52.59, 52.65, 108.3, 111.6, 112.0, 114.0, 121.8, 122.2, 125.3, 127.8, 134.2, 134.5, 137.1, 137.9, 138.0, 153.3 ppm. HRMS (ESI): calcd for $C_{15}H_{19}N_2NaO_4P$ $[M+Na]^+$ 345.0980, found 345.0982.



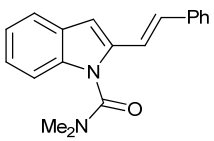
(*E*)-*N*,*N*-Dimethyl-2-(2-(phenylsulfonyl)vinyl)-1*H*-indole-1-carboxamide (3q)

Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and phenyl vinyl sulfone **2g** (63mg, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 3/1, v/v) afforded the desired product **3q** as a yellow solid (80 mg, 87% yield). M.p.: 48-49 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.99 (br. s, 6H), 6.77 (d, J = 15.6 Hz, 1H), 6.99 (s, 1H), 7.17-7.21 (m, 1H), 7.31-7.36 (m, 2H), 7.55 (t, J = 7.6 Hz, 2H), 7.59-7.64 (m, 2H), 7.73 (d, J = 15.6 Hz, 1H), 7.95 (d, J = 8.0 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 37.7, 110.5, 111.7, 122.0, 122.4, 126.0, 126.9, 127.63, 127.68, 129.5, 131.3, 131.6, 133.5, 137.5, 140.7, 153.1 ppm. HRMS (ESI): calcd for $C_{19}H_{18}N_2NaO_3S$ $[M+Na]^+$ 377.0936, found 377.0936.



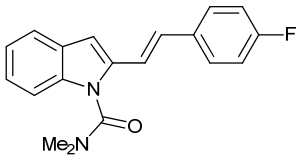
(*E*)-2-(2-Cyanovinyl)-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide (3r)

Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and vinyl cyanide **2h** (49.2 μL, 0.75 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/2, v/v) afforded **3r** as a white solid (39 mg, 65% yield). M.p.: 83-86 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.04 (br. s, 6H), 5.83 (d, J = 16.8 Hz, 1H), 7.01 (s, 1H), 7.21 (t, J = 8.0 Hz, 1H), 7.29 (d, J = 7.6 Hz, 1H), 7.35 (t, J = 8.0 Hz, 1H), 7.45 (d, J = 16.8 Hz, 1H), 7.63 (d, J = 8.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 38.0, 96.3, 108.8, 111.8, 118.2, 122.2, 122.6, 126.1, 127.7, 133.2, 137.3, 138.9, 153.2 ppm. HRMS (ESI): calcd for $C_{14}H_{13}N_3NaO$ $[M+Na]^+$ 262.0956, found 262.0951.



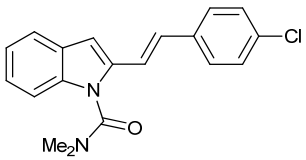
(*E*)-*N*,*N*-Dimethyl-2-styryl-1*H*-indole-1-carboxamide (3s)

Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and styrene **2i** (43 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtO_2 = 10/1, v/v) afforded **3s** as yellow oil (49 mg, 68% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.02 (br. s, 6H), 6.86 (s, 1H), 7.14 (d, J = 2.0 Hz, 2H), 7.18 (d, J = 7.2 Hz, 1H), 7.23 (d, J = 7.2 Hz, 1H), 7.28-7.39 (m, 4H), 7.51 (d, J = 7.6 Hz, 2H), 7.59 (d, J = 7.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 37.6, 103.1, 111.3, 117.5, 120.8, 121.7, 123.5, 126.6, 128.1, 128.6, 128.8 130.8, 136.3, 136.9, 137.2, 154.1 ppm. HRMS (ESI): calcd for $C_{19}H_{18}N_2NaO$ $[M+Na]^+$ 313.1317, found 313.1323.



(*E*)-2-(4-Fluorostyryl)-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide (3t)

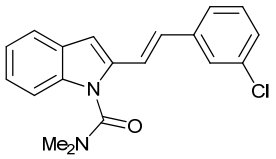
Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and 4-fluorostyrene **2j** (30.2 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3t** as a yellow solid (56 mg, 73% yield). M.p.: 120-121 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.04 (br. s, 6H), 6.85 (s, 1H), 7.05 (t, J = 8.4 Hz, 2H), 7.08 (s, 2H), 7.17 (t, J =7.2 Hz, 1H), 7.23 (d, J = 8.0 Hz, 1H), 7.30 (d, J = 8.0 Hz, 1H), 7.46 (d, J = 8.8 Hz, 1H), 7.47 (d, J = 8.4 Hz, 1H), 7.58 (d, J = 8.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 37.9, 103.1, 111.3, 115.7, 115.9, 117.3, 117.4, 120.8, 121.8, 123.5, 128.2, 128.3, 128.6, 129.6, 133.17, 133.21, 136.2, 137.2, 154.1, 161.4, 163.9 ppm. HRMS (ESI): calcd for $C_{19}H_{17}FN_2NaO$ $[M+Na]^+$ 331.1223, found 331.1223.



(*E*)-2-(4-Chlorostyryl)-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide (3u)

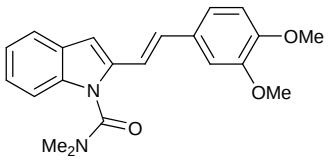
Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg,

0.25 mmol) and 4-chlorostyrene **2k** (45 μL, 0.375 mmol), were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3u** as a white solid (53 mg, 65% yield). M.p.: 121-123 °C. ^{1}H NMR (400 MHz, DMSO-d_6): δ = 3.03 (br. s, 6H), 6.87 (s, 1H), 7.06 (d, J = 16.4 Hz, 1H), 7.13 (d, J = 16.0 Hz, 1H), 7.18 (d, J = 7.2 Hz, 1H), 7.24 (d, J = 8.0 Hz, 1H), 7.29 (s, 1H), 7.32 (d, J = 8.4 Hz, 2H), 7.42 (d, J = 8.4 Hz, 2H), 7.58 (d, J = 7.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 37.7, 103.5, 111.4, 118.1, 120.9, 121.8, 123.7, 127.8, 128.5, 129.0, 129.4, 133.6, 135.5, 136.3, 137.0, 154.1 ppm. HRMS (ESI): calcd for $C_{19}H_{17}ClN_2NaO$ $[M+Na]^+$ 347.0927, found 347.0930.



(*E*)-2-(3-Chlorostyryl)-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide (3v)

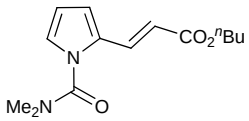
Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and 3-chlorostyrene **2l** (45 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **3v** as a yellow solid (75 mg, 93% yield). M.p.: 96-98 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.03 (br. s, 6H), 6.87 (s, 1H), 7.04 (d, J = 16.4 Hz, 1H), 7.13-7.19 (m, 2H), 7.22-7.31 (m, 4H), 7.35 (d, J = 7.6 Hz, 1H), 7.48 (s, 1H), 7.58 (d, J = 7.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 37.8, 103.8, 111.4, 119.0, 121.0, 121.9, 123.8, 124.9, 126.4, 128.0, 128.5, 129.2, 130.1, 134.8, 136.4, 136.8, 138.9, 154.1 ppm. HRMS (ESI): calcd for $C_{19}H_{17}ClN_2NaO$ $[M+Na]^+$ 347.0927, found 347.0933.



(*E*)-2-(3,4-Dimethoxystyryl)-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide (3w)

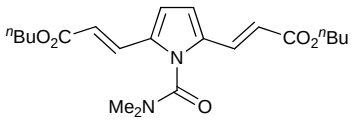
Following the general procedure. *N*,*N*-Dimethyl-1*H*-indole-1-carboxamide **1a** (47 mg, 0.25 mmol) and 3,4-dimethoxystyrene **2m** (111.0 μL, 0.75 mmol) were used.

Purification via column chromatography on silica gel (petroleum ether/EtOAc = 10/1, v/v) afforded **3w** as a yellow solid (44 mg, 50% yield). M.p.: 43-45 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.02 (br. s, 6H), 3.91 (s, 3H), 3.95 (s, 3H), 6.81 (s, 1H), 6.86 (d, J = 8.4 Hz, 1H), 6.98-7.09 (m, 4H), 7.16 (t, J = 7.6 Hz, 1H), 7.23 (t, J = 7.6 Hz, 1H), 7.31 (d, J = 8.4 Hz, 1H), 7.57 (d, J = 7.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 37.7, 56.10, 56.12, 102.7, 109.1, 111.3, 111.4, 115.7, 120.2, 120.7, 121.7, 123.3, 128.7, 130.2, 130.9, 136.2, 137.6, 149.3, 149.5, 154.2 ppm. HRMS (ESI): calcd for $C_{21}H_{22}N_2NaO_3$ $[M+Na]^+$ 373.1528, found 373.1523.



(*E*)-Butyl 3-(1-(dimethylcarbamoyl)-1*H*-pyrrol-2-yl)acrylate (4a)

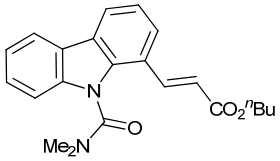
Following the general procedure. *N*,*N*-Dimethyl-1*H*-pyrrole-1-carboxamide **1l** (34.5 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) afforded **4a** as yellow oil (58 mg, 87% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.95 (t, J = 7.2 Hz, 3H), 1.37-1.46 (m, 2H), 1.62-1.70 (m, 2H), 2.97 (s, 6H), 4.17 (t, J = 6.8 Hz, 2H), 6.13 (d, J = 16.0 Hz, 1H), 6.28 (t, J = 3.2 Hz, 1H), 6.68 (dd, J = 3.6 Hz, 0.9 Hz, 1H), 6.96 (q, J = 0.9 Hz, 1H), 7.56 (d, J = 16.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.9, 19.3, 30.9, 37.9, 64.4, 111.3, 113.8, 115.0, 124.0, 129.3, 132.7, 153.8, 167.5 ppm. HRMS (ESI): calcd for $C_{14}H_{20}N_2NaO_3$ $[M+Na]^+$ 287.1372, found 287.1374.



(2*E*,2'*E*)-Dibutyl 3,3'-(1-(dimethylcarbamoyl)-1*H*-pyrrole-2,5-diyl)diacrylate (4b)

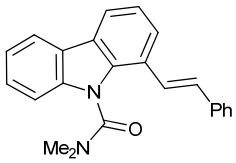
A sealable tube with a magnetic stir bar was charged with Ag_2CO_3 (172 mg, 0.625 mmol), NaOAc (12.4 mg, 0.15 mmol), *N*,*N*-dimethyl-1*H*-pyrrole-1-carboxamide **1l** (34.5 mg, 0.25 mmol), $[RuCl_2(p\text{-cymene})]_2$ (8.0 mg, 12.5 μmol), $AgSbF_6$ (17.2 mg, 50 μmol), butyl acrylate **2a** (53.5 μL, 0.375 mmol, 1.5 equiv) and DCE (1.0 mL) under

an N_2 atmosphere. The tube was then sealed with a teflon-coated screw cap. The reaction mixture was first stirred at room temperature for 15 min and then heated at 100 ^oC for 15 h. The resulting solution was subsequently diluted with 5 mL of dichloromethane, filtered through a celite pad and washed with 10-20 mL of dichloromethane. The combined organic phases were evaporated, and the resulting residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1, v/v) to afford product **4b** as yellow oil (50 mg, 51% yield). ^1H NMR (400 MHz, $CDCl_3$): δ = 0.95 (t, J = 7.2 Hz, 6H), 1.37-1.46 (m, 4H), 1.63-1.70 (m, 4H), 2.61 (s, 3H), 3.23 (s, 3H), 4.17 (t, J = 7.2 Hz, 4H), 6.20 (d, J = 16.0 Hz, 2H), 6.69 (s, 2H), 7.39 (d, J = 16.0 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.9, 19.3, 30.9, 37.2, 37.9, 64.6, 114.1, 117.0, 131.0, 131.6, 152.1, 167.0 ppm. HRMS (ESI): calcd for $C_{21}H_{30}N_2NaO_5$ $[M+Na]^+$ 413.2052, found 413.2051.



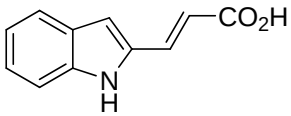
(*E*)-Butyl 3-(9-(dimethylcarbamoyl)-9*H*-carbazol-1-yl)acrylate (5a)

Following the general procedure. 9-(Dimethylcarbamoy1)carbazole **1m** (59.5 mg, 0.25 mmol) and *n*-butyl acrylate **2a** (53.5 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 15/1, v/v) afforded **5a** as light yellow oil (64 mg, 70% yield). ^1H NMR (400 MHz, $CDCl_3$): δ = 0.99 (t, J = 7.2 Hz, 3H), 1.43-1.52 (m, 2H), 1.69-1.76 (m, 2H), 2.82 (s, 3H), 3.29 (s, 3H), 4.24 (t, J = 6.4 Hz, 2H), 6.46 (d, J = 15.6 Hz, 1H), 7.33 (t, J = 7.2 Hz, 2H), 7.46-7.51 (m, 2H), 7.64 (d, J = 7.6 Hz, 1H), 8.01-8.09 (m, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.9, 19.3, 30.9, 36.7, 38.2, 64.6, 111.1, 119.6, 120.3, 120.5, 121.65, 121.71, 122.2, 123.7, 125.3, 125.6, 127.2, 137.2, 139.3, 140.0, 154.8, 166.8 ppm. HRMS (ESI): calcd for $C_{22}H_{24}N_2NaO_3$ $[M+Na]^+$ 387.1685, found 387.1685.



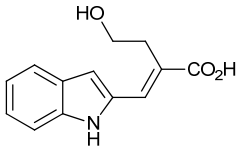
(*E*)-*N*,*N*-dimethyl-1-styryl-9*H*-carbazole-9-carboxamide (5b)

Following the general procedure. 9-(Dimethylcarbamoy1)carbazole **1m** (59.5 mg, 0.25 mmol) and styrene **2i** (43 μL, 0.375 mmol) were used. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 15/1, v/v) afforded the desired product **5b** as yellow oil (29 mg, 35% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.60 (s, 3H), 3.12 (s, 3H), 7.08 (d, J = 16.0 Hz, 1H), 7.27-7.36 (m, 3H), 7.39 (t, J = 7.2 Hz, 2H), 7.46-7.57 (m, 5H), 7.64 (d, J = 7.2 Hz, 1H), 8.01 (d, J = 7.6 Hz, 1H), 8.06 (d, J = 7.6 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 36.9, 37.9, 111.1, 119.9, 120.4, 121.4, 121.7, 123.6, 123.8, 124.2, 124.8, 124.9, 126.7, 126.9, 128.0, 128.9, 130.8, 136.6, 137.3, 139.2, 155.1 ppm. HRMS (ESI): calcd for $C_{23}H_{20}N_2NaO$ $[M+Na]^+$ 363.1473, found 363.1472.



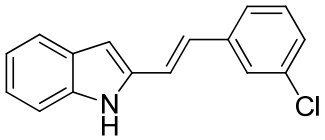
(*E*)-3-(1*H*-indol-2-yl)acrylic acid (6a)[4]

(*E*)-Butyl 3-(1-(dimethylcarbamoyl)-1*H*-indol-2-yl) acrylate **3a** (79 mg, 0.25 mmol) was used as the starting material and the reaction time was 5 h. Purification via column chromatography on silica gel (CH_2Cl_2/MeOH = 5/1, v/v) afforded **6a** as a brown solid (43 mg, 91% yield). ^{1}H NMR (400 MHz, DMSO-d_6): δ = 6.46 (d, J = 16 Hz, 1H), 6.86 (d, J = 1.2 Hz, 1H), 7.01 (t, J = 7.2 Hz, 1H), 7.18 (td, J = 7.6 Hz, 0.8 Hz, 1H), 7.37 (d, J = 8.0 Hz, 1H), 7.55-7.59 (m, 2H), 11.54 (s, 1H), 12.33 (br. s, 1H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 107.9, 111.5, 116.9, 119.8, 121.1, 123.8, 127.9, 133.9, 134.4, 138.0, 167.8 ppm. HRMS (ESI): calcd for $C_{11}H_9NNaO_2$ $[M+Na]^+$ 210.0531, found 210.0532.



(*E*)-2-((1*H*-indol-2-yl)methylene)-4-hydroxybutanoic acid (6b)

(*E*)-*N*,*N*-Dimethyl-2-((2-oxodihydrofuran-3(2*H*)-ylidene)methyl)-1*H*-indole-1-carbox amide **3o** (71 mg, 0.25 mmol) was used as the starting material and the reaction time was 5 h. Purification via column chromatography on silica gel (CH_2Cl_2/MeOH = 5/1, v/v) afforded **6b** as a yellow solid (52 mg, 89% yield). M.p.: 244-245 °C. ^{1}H NMR (400 MHz, DMSO-d_6): δ = 2.84 (t, J = 7.2 Hz, 2H), 3.61 (t, J = 7.2 Hz, 2H), 5.00 (br. s, 1H), 6.92 (s, 1H), 7.03 (td, J = 7.6 Hz, 0.8 Hz, 1H), 7.15 (td, J = 7.6 Hz, 0.8 Hz, 1H), 7.38 (d, J = 8.0 Hz, 1H), 7.59 (d, J = 8.0 Hz, 1H), 7.67 (s, 1H), 11.38 (s, 1H), 12.45 (br. s, 1H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 31.8, 59.3, 104.8, 111.4, 119.7, 120.7, 122.9, 128.2, 128.4, 129.8, 133.3, 136.6, 169.0 ppm. HRMS (ESI): calcd for $C_{13}H_{13}NNaO_3$ $[M+Na]^+$ 254.0793, found 254.0795.



(*E*)-2-(3-chlorostyryl)-1*H*-indole (6c)

(*E*)-2-(3-Chlorostyryl)-*N*,*N*-dimethyl-1*H*-indole-1-carboxamide **3v** (81 mg, 0.25 mmol) was used as the starting material and the reaction time was 20 h. THF (1.0 mL) was added to the reaction system due to the low solubility of **3v** in EtOH/H_2O. Purification via column chromatography on silica gel (petroleum ether/EtOAc = 10/1, v/v) afforded **6c** as a yellow solid (48 mg, 77% yield). M.p.: 151-153 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 6.65 (d, J = 1.2 Hz, 1H), 6.81 (d, J = 16.4 Hz, 1H), 7.09-7.14 (m, 2H), 7.20-7.25 (m, 2H), 7.30 (t, J = 7.6 Hz, 1H), 7.35 (d, J = 8.0 Hz, 2H), 7.49 (m, 1H), 7.60 (d, J = 8.0 Hz, 1H), 8.20 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 104.8, 110.8, 120.49, 120.52, 120.9, 123.3, 124.6, 125.6, 126.2, 127.7, 129.0, 130.1, 134.9, 135.9, 137.2, 138.9 ppm. HRMS (ESI): calcd for $C_{16}H_{13}ClN$ $[M+H]^+$ 254.0737, found 254.0734.

VI. References

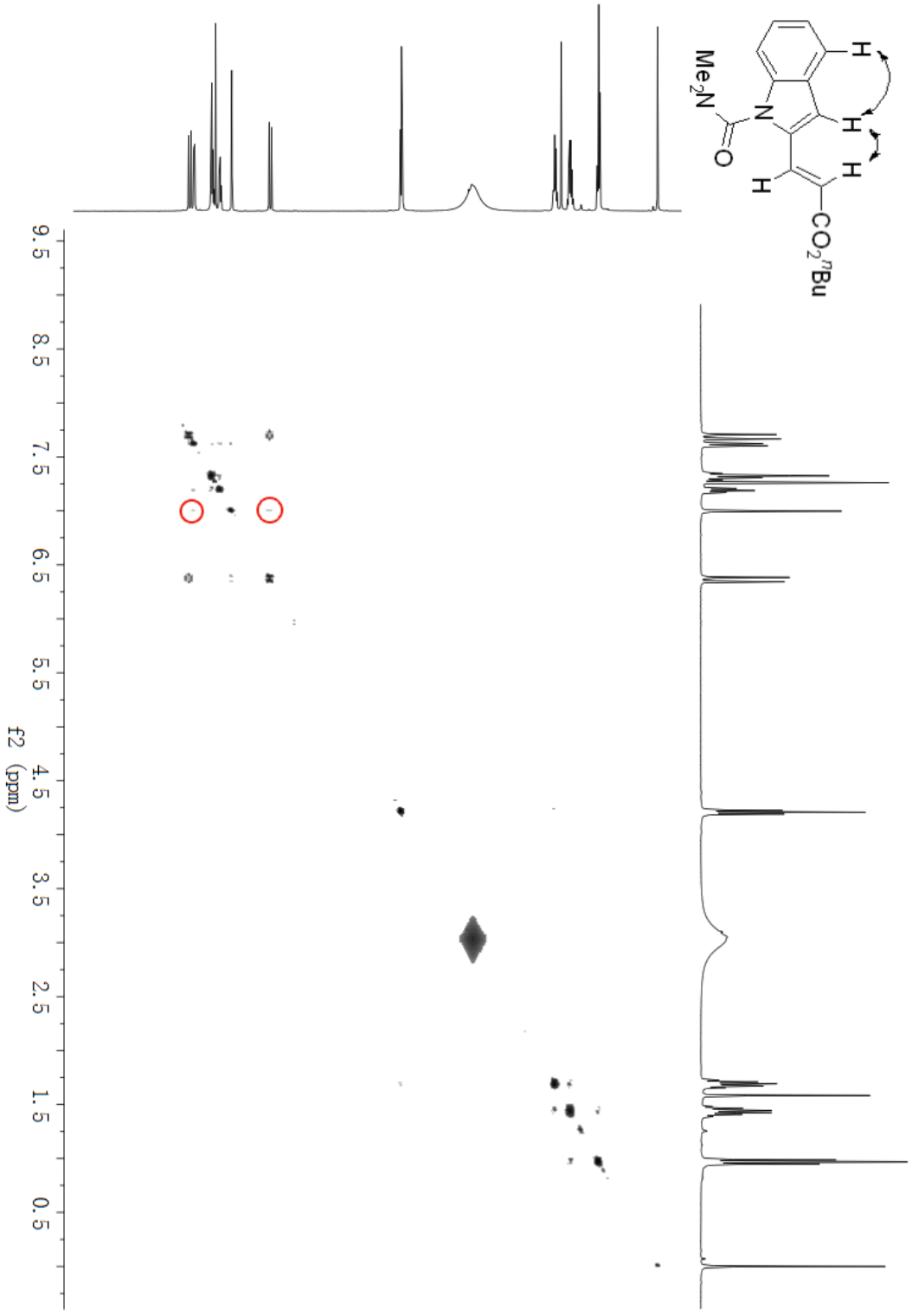
1 D. J. Schipper, M. Hutchinson and K. Fagnou, *J. Am. Chem. Soc.*, 2010, **132**, 6910.

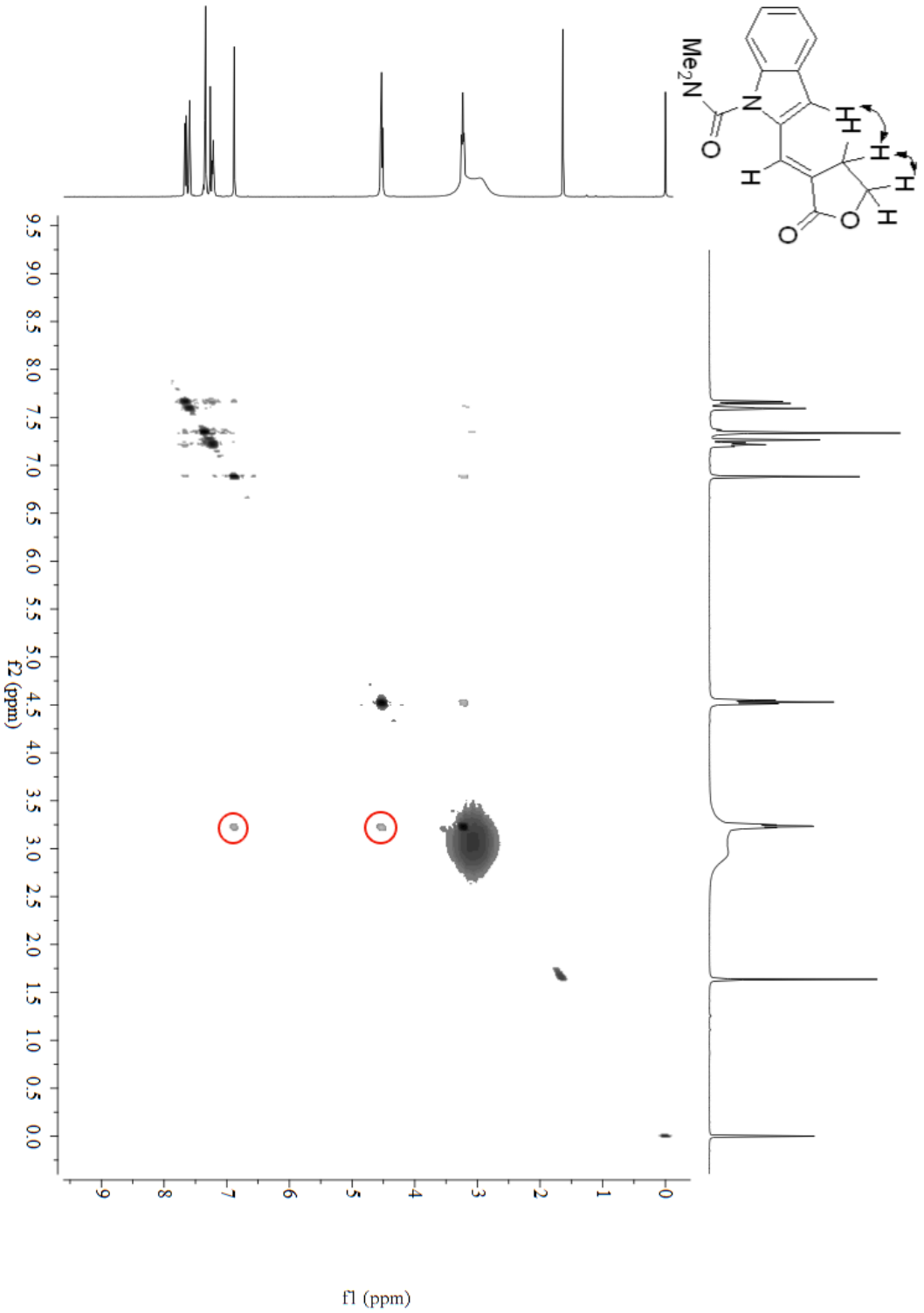
2 B. Zhou, Y. Yang, S. Lin and Y. Li, *Adv. Synth. Catal.*, 2013, **355**, 360.

3 (*a*) B. Zhou, Y. Yang, S. Lin and Y. Li, *Adv. Synth. Catal.*, 2013, **355**, 360; (*b*) D. J. Schipper, M. Hutchinson and K. Fagnou, *J. Am. Chem. Soc.*, 2010, **132**, 6910; (*c*) C. G. Hartung, A. Fecher, B. Chapell and V. Snieckus, *Org. Lett*., 2003, **5**, 1899.

4 V. Lanke and K. R. Prabhu, *Org. Lett.*, 2013, **15**, 2818.

VII. ^{1}H-^{1}H NOESY spectra of compounds 3a and 3o




Me2N
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H
H
H
H
O
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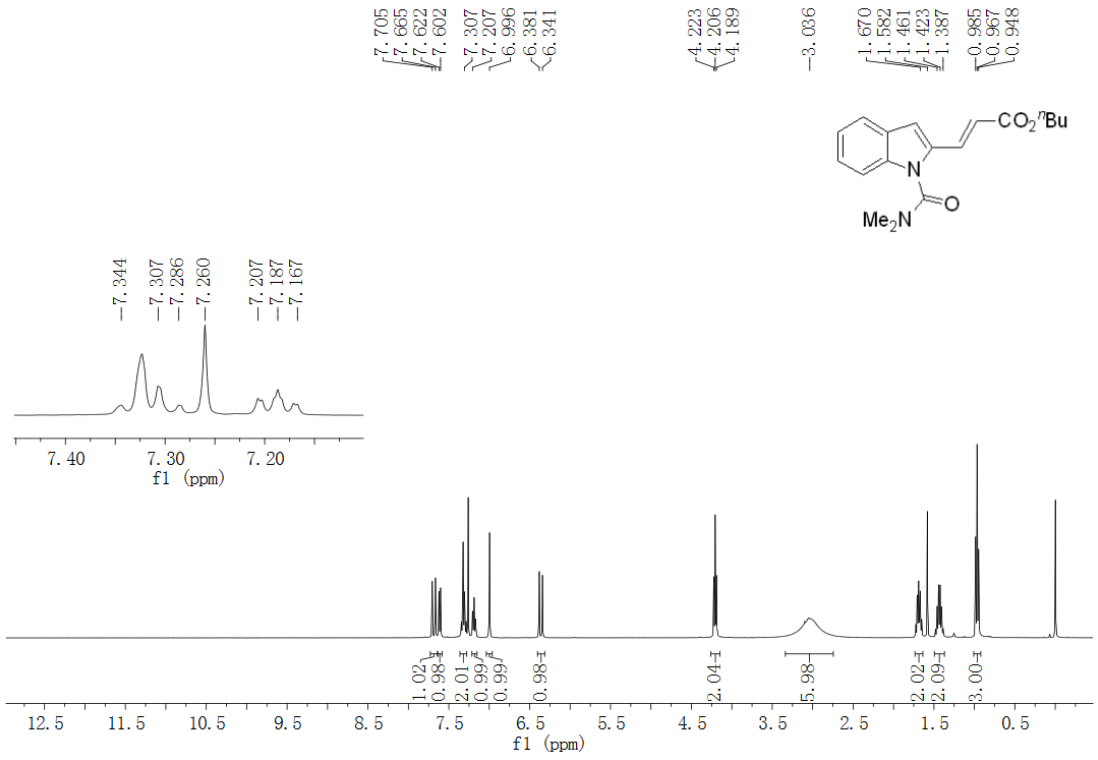
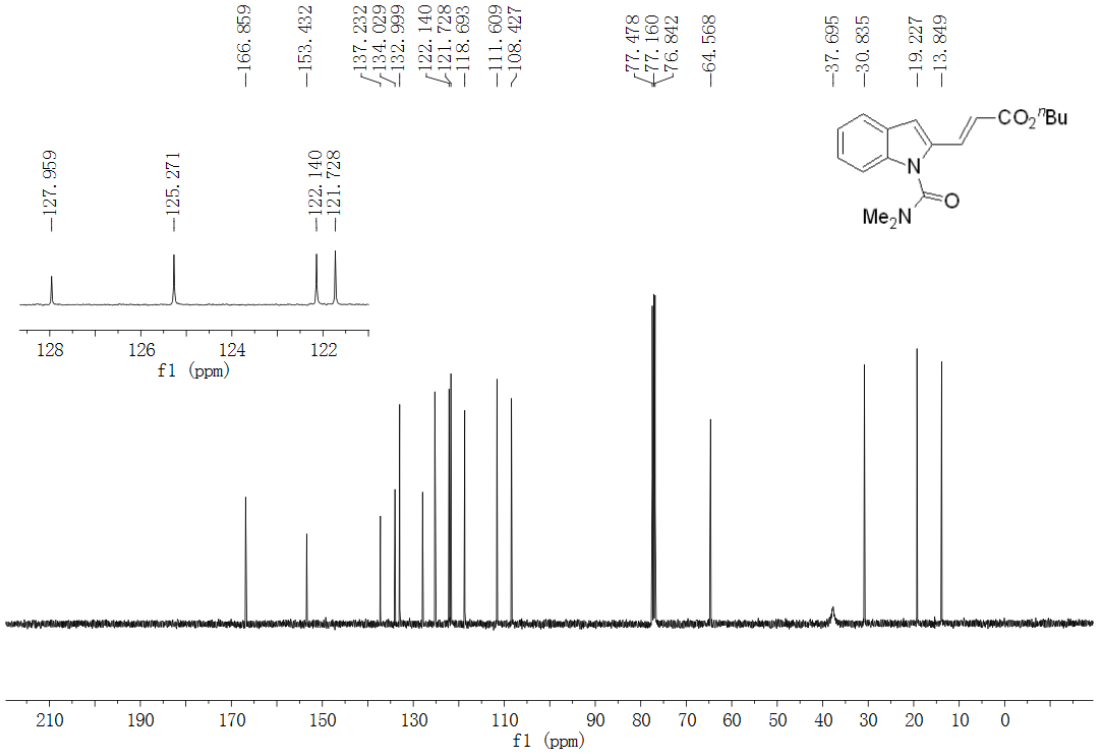
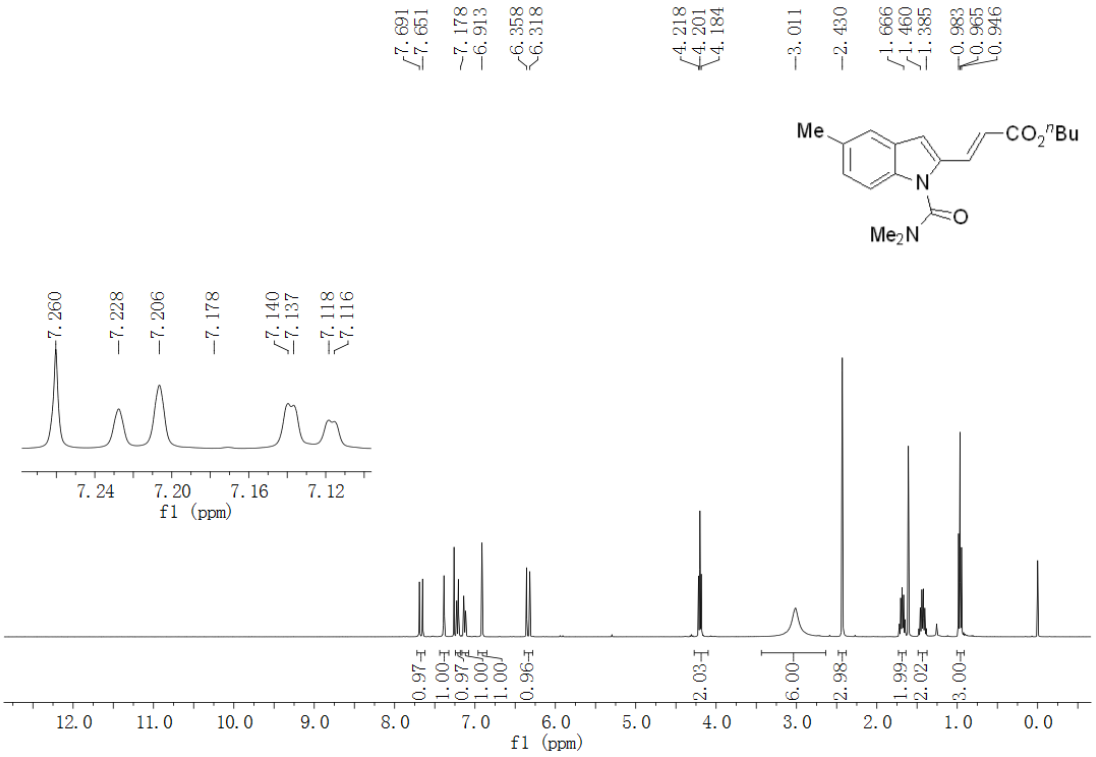
f2 (ppm)
f1 (ppm)

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



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0.983
0.965
0.946
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CO2nBu
N
O
Me2N
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7.116
7.24
7.20
7.16
7.12
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0.97
1.00
1.00
0.96
2.03
6.00
2.98
1.99
2.02
3.00
12.0
11.0
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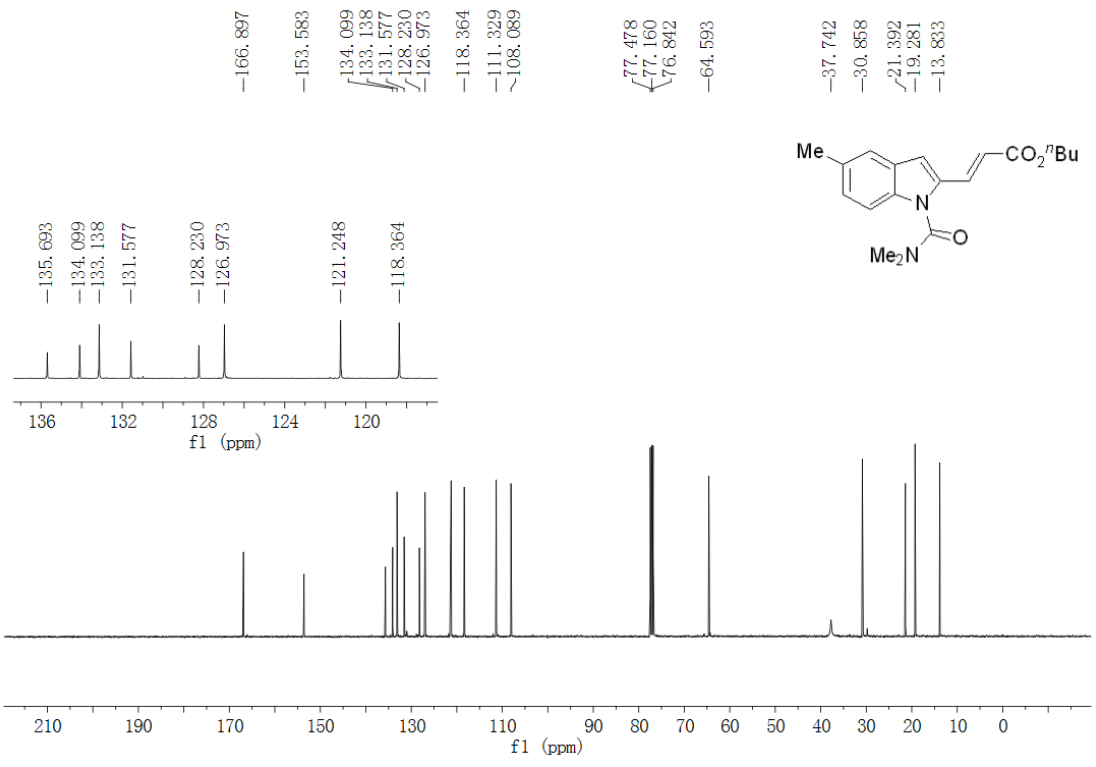
f1 (ppm)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76.842
64.593
37.742
30.858
21.392
19.281
13.833
Me
CO2nBu
N
O
Me2N
135.693
134.099
133.138
131.577
128.230
126.973
121.248
118.364
136
132
128
124
120
f1 (ppm)
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150
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50
40
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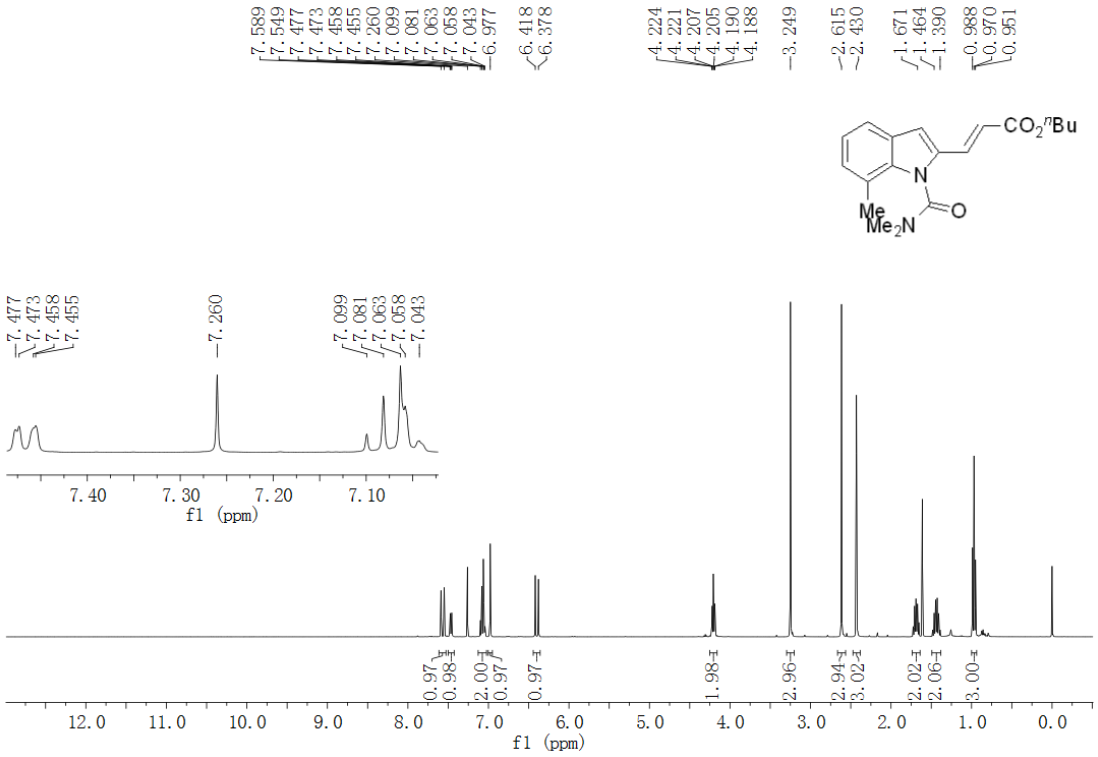
20
10
0
f1 (ppm)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4.205
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0.970
0.951
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N
O
Me
Me2N
f1 (ppm)
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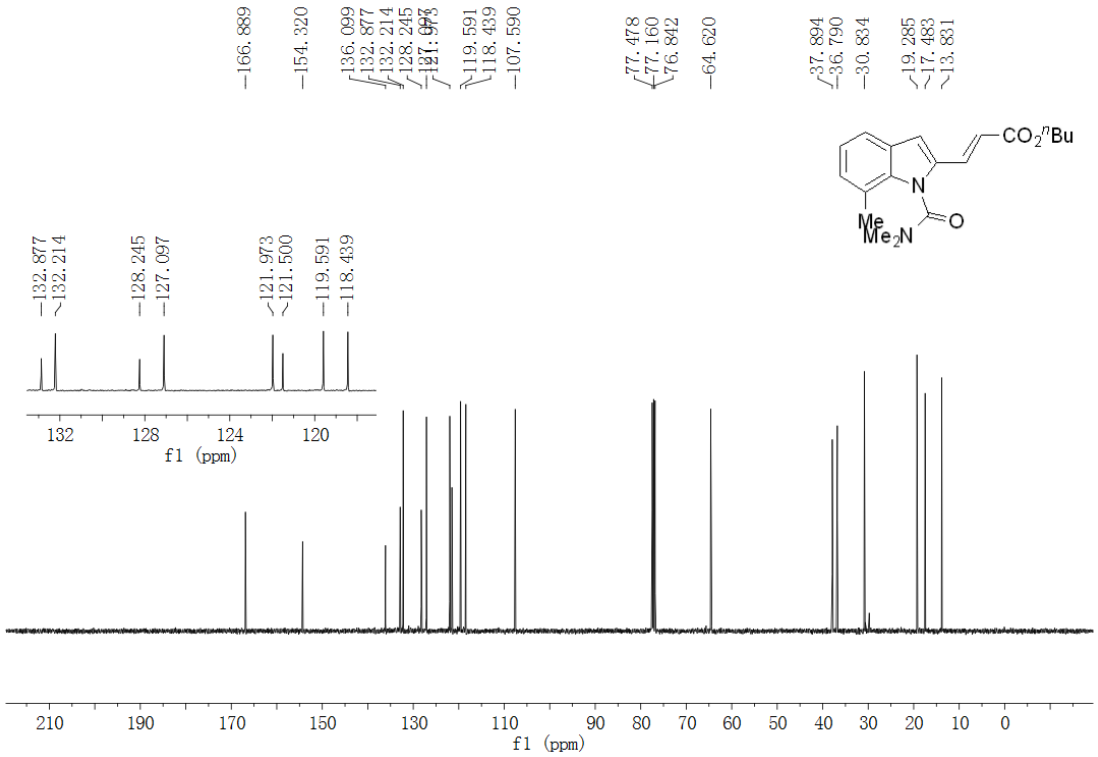
2.94
3.02
2.02
2.06
3.00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64.620
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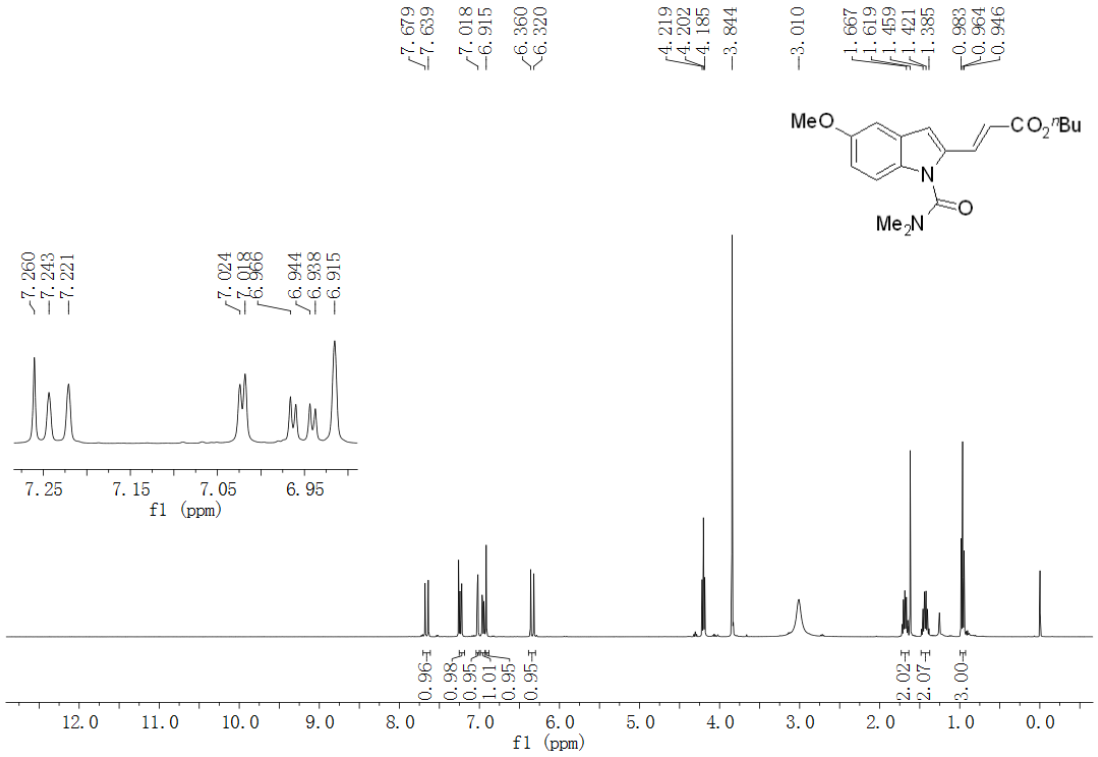
f1 (ppm)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MeO
CO2nBu
N
O
Me2N
7.260
7.243
7.221
7.024
7.018
6.966
6.944
6.938
6.915
7.25
7.15
7.05
6.95
f1 (ppm)
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0.98
0.95
1.01
0.95
0.95
2.02
2.07
3.00
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11.0
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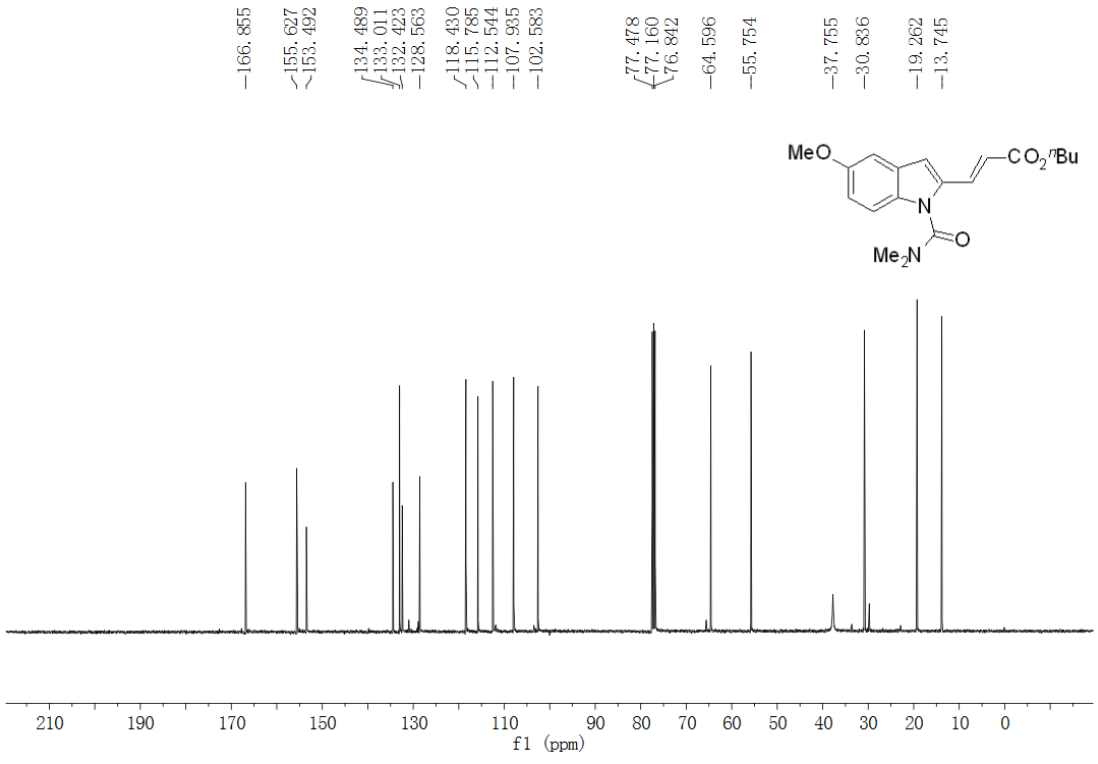
f1 (ppm)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13.745
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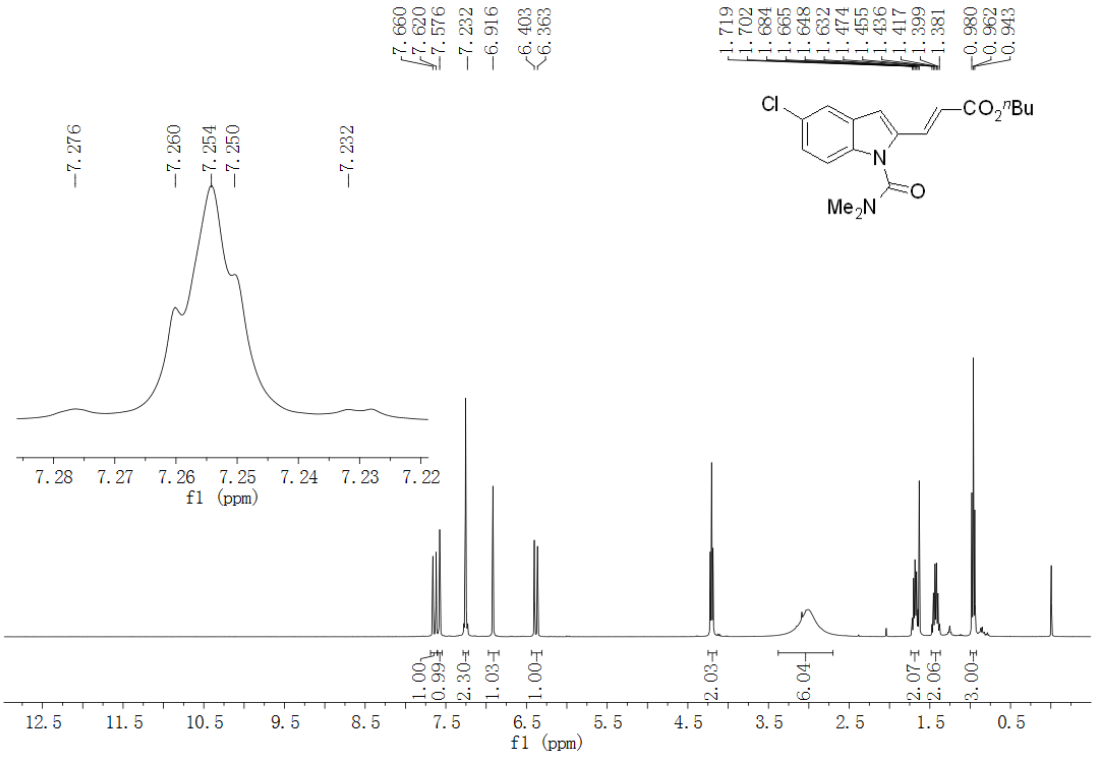
f1 (ppm)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0.962
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7.254
7.250
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Cl
CO2nBu
N
O
Me2N
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1.03
1.00
2.03
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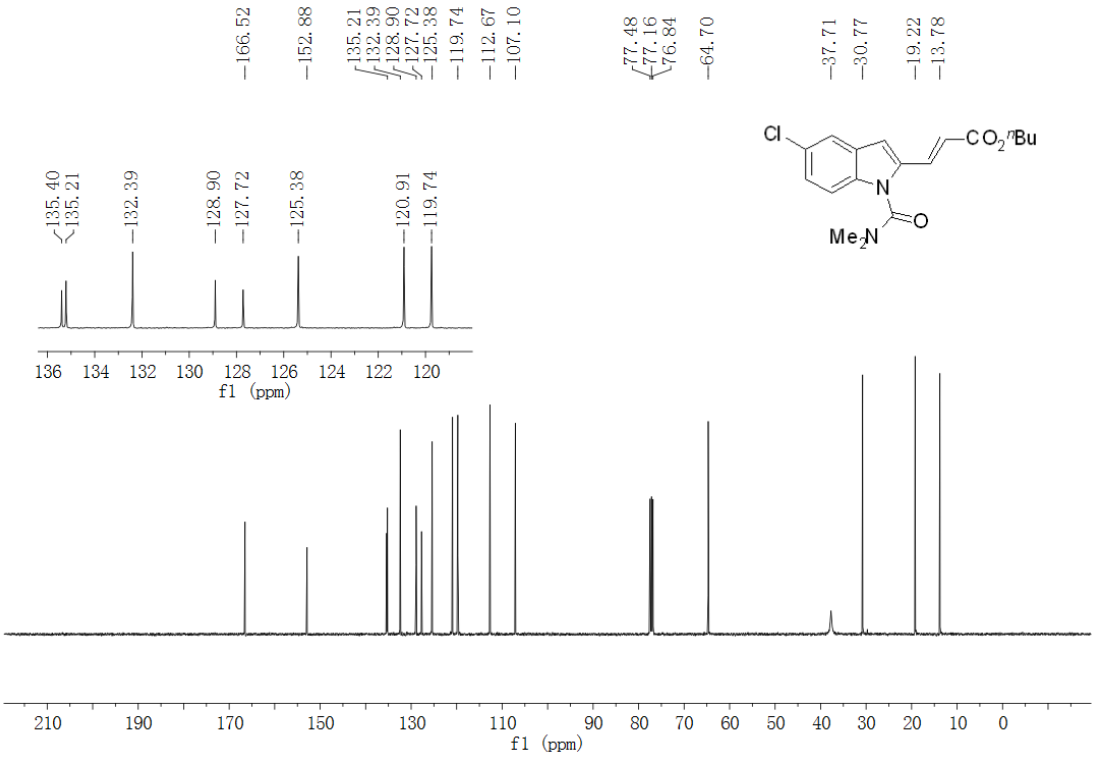
f1 (ppm)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19.22
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135.40
135.21
132.39
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127.72
125.38
120.91
119.74
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Me2N
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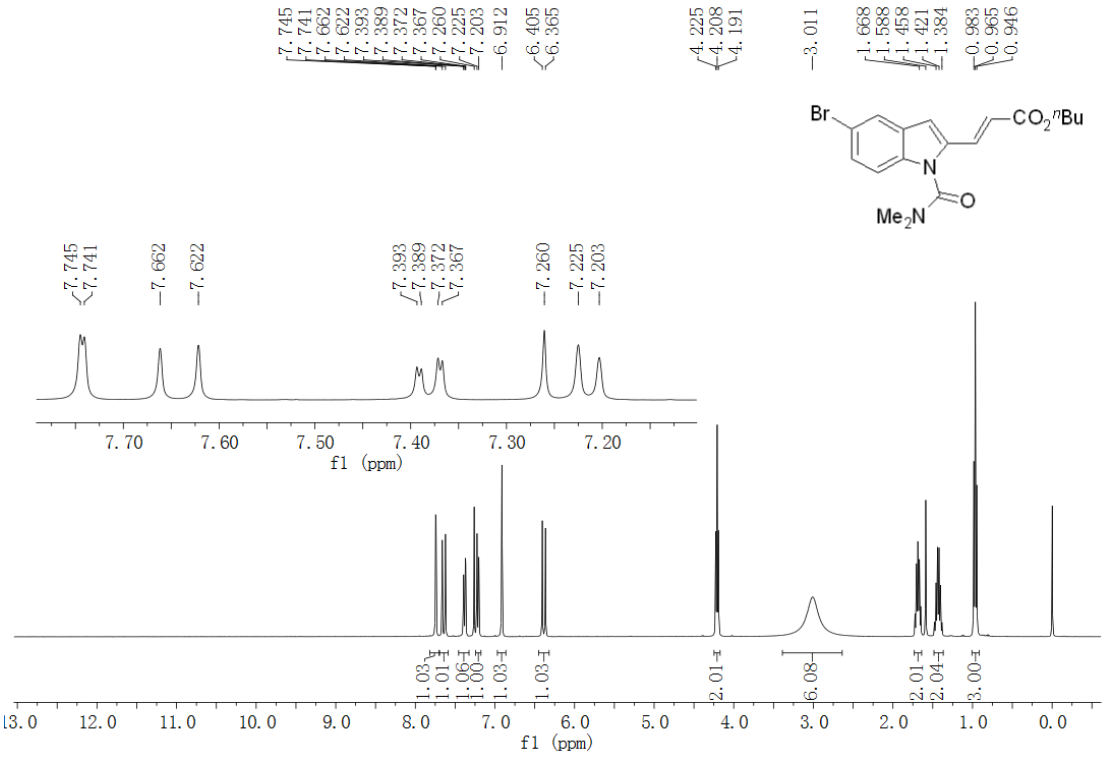
f1 (ppm)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CO2nBu
N
O
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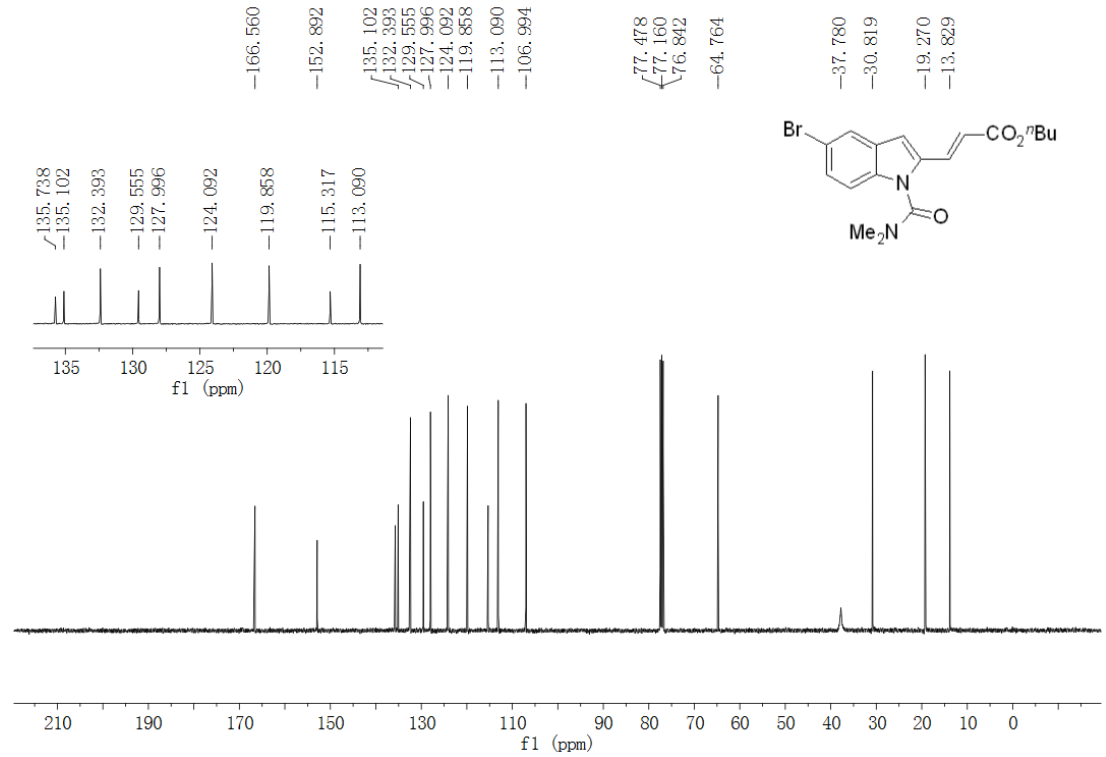
1.06
1.00
1.03
1.03
2.01
6.08
2.01
2.04
3.00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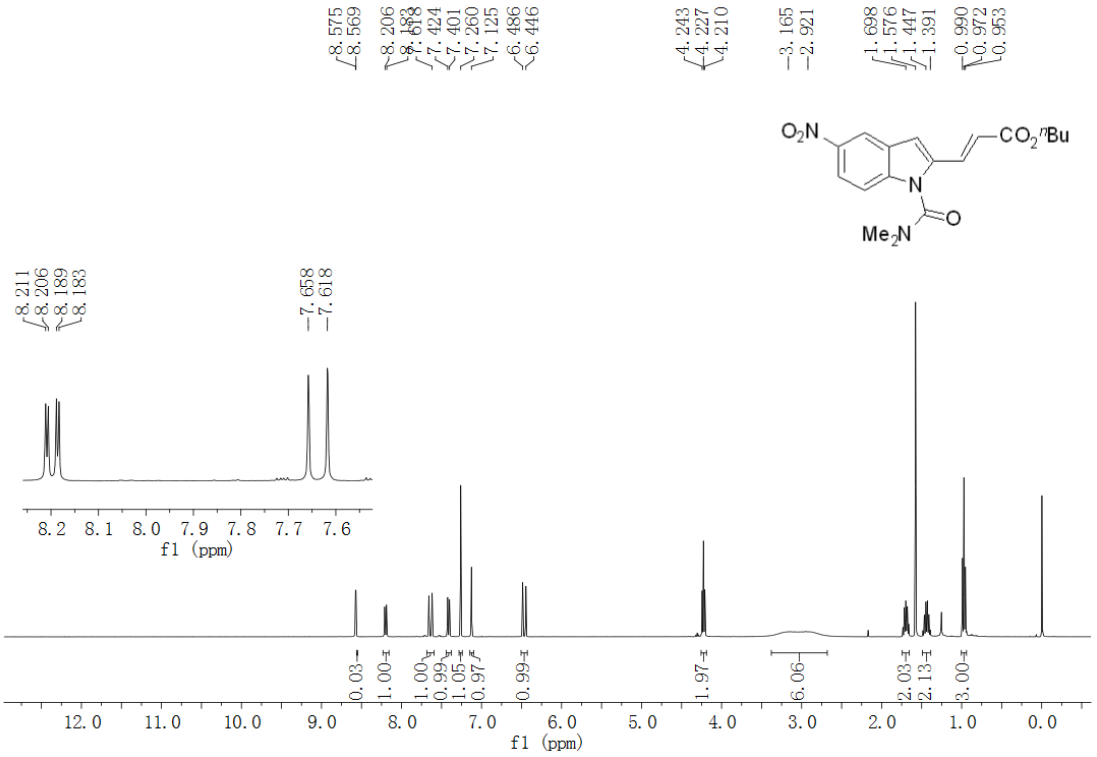
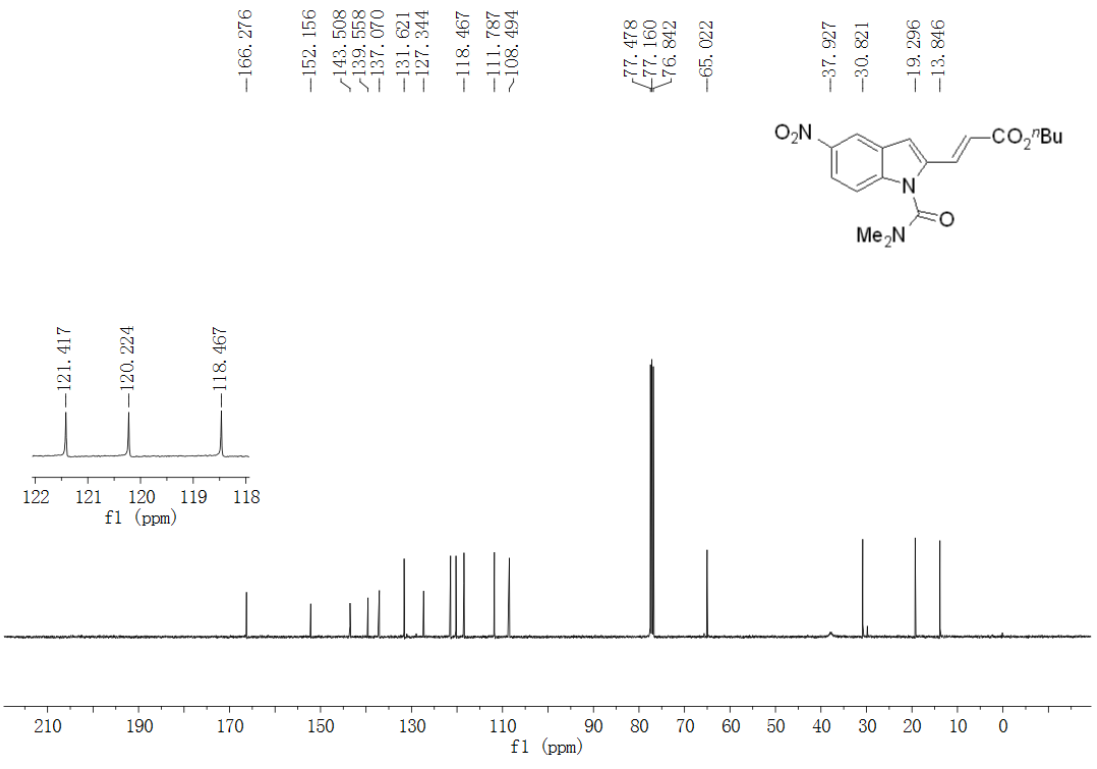
152.892
135.102
132.393
129.555
127.996
124.092
119.858
113.090
106.994
77.478
77.160
76.842
64.764
37.780
30.819
19.270
13.829
135.738
135.102
132.393
129.555
127.996
124.092
119.858
115.317
113.090
Br
CO2nBu
N
O
Me2N
f1 (ppm)


8.575
8.569
8.206
8.183
7.424
7.401
7.260
7.125
6.486
6.446
4.243
4.227
4.210
3.165
2.921
1.698
1.576
1.447
1.391
0.990
0.972
0.953
O2N
CO2nBu
N
Me2N
O
8.211
8.206
8.189
8.183
7.658
7.618
8.2 8.1 8.0 7.9 7.8 7.7 7.6
f1 (ppm)
0.03
1.00
1.00
0.99
1.05
0.97
0.99
1.97
6.06
2.03
2.13
3.00
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)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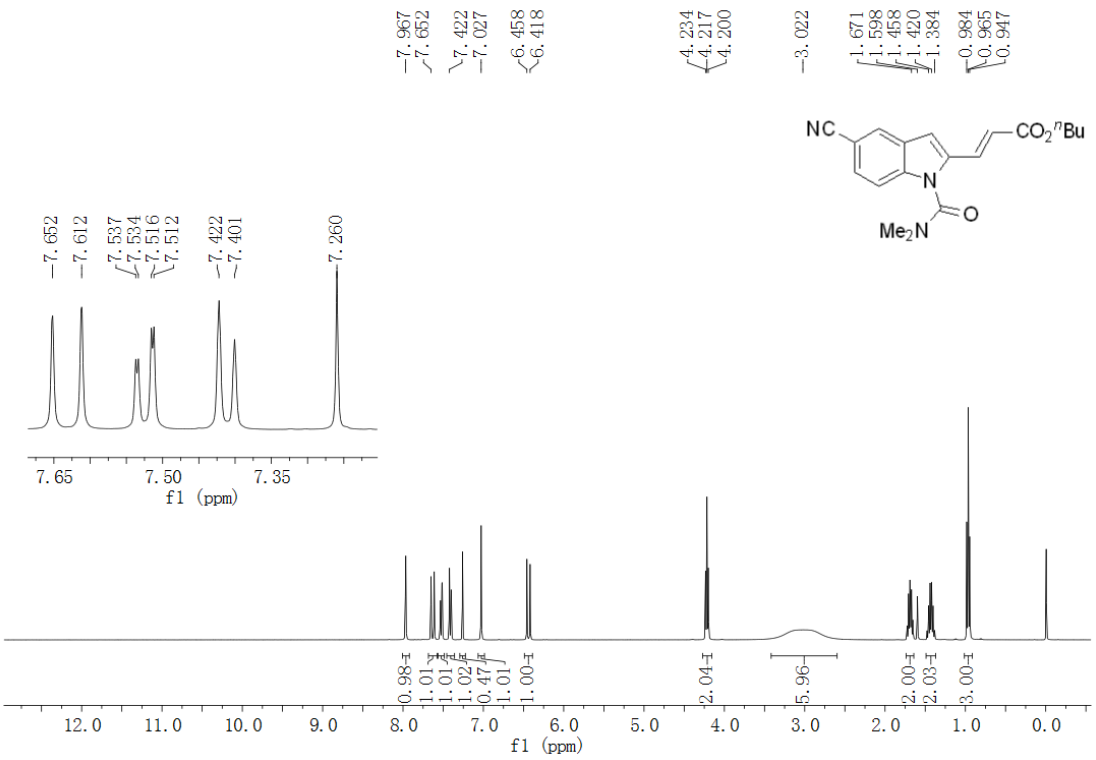
152.156
143.508
139.558
137.070
131.621
127.344
118.467
111.787
108.494
77.478
77.160
76.842
65.022
37.927
30.821
19.296
13.846
O2N
CO2nBu
N
Me2N
O
121.417
120.224
118.467
122 121 120 119 118
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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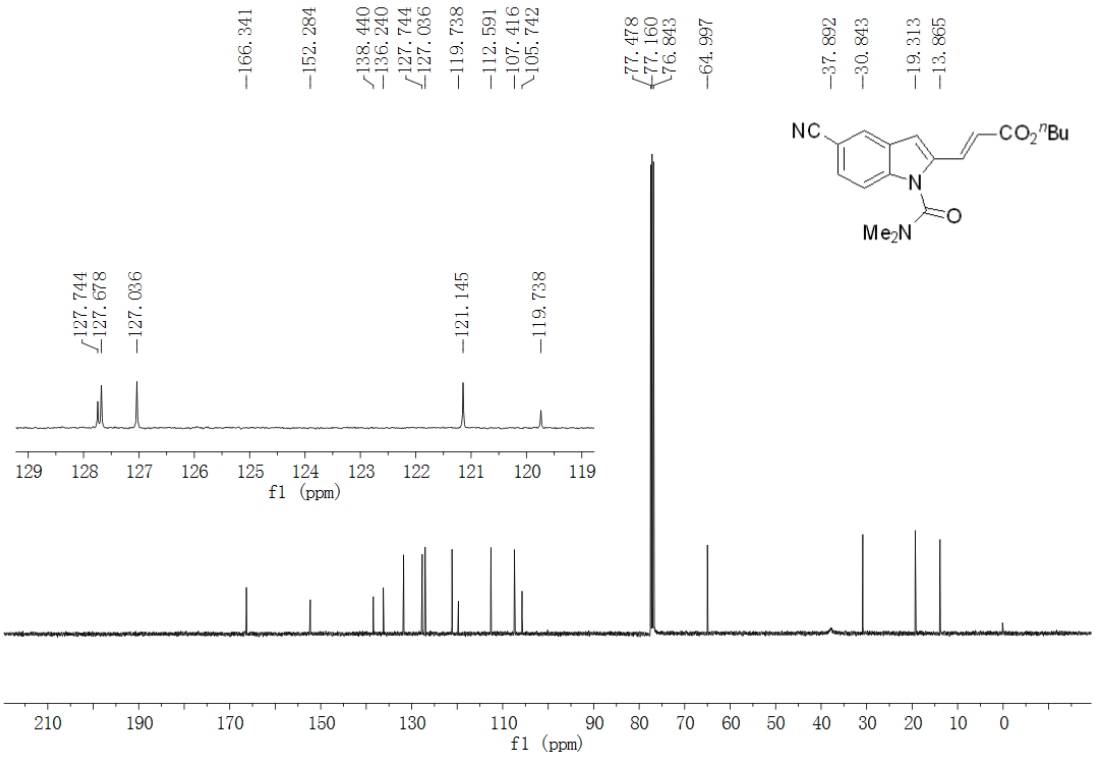
7.652
7.422
7.027
6.458
6.418
4.234
4.217
4.200
3.022
1.671
1.598
1.458
1.420
1.384
0.984
0.965
0.947
NC
CO2nBu
N
O
Me2N
7.652
7.612
7.537
7.534
7.516
7.512
7.422
7.401
7.260
7.65
7.50
7.35
f1 (ppm)
0.98
1.01
1.01
1.02
0.47
1.01
1.00
2.04
5.96
2.00
2.03
3.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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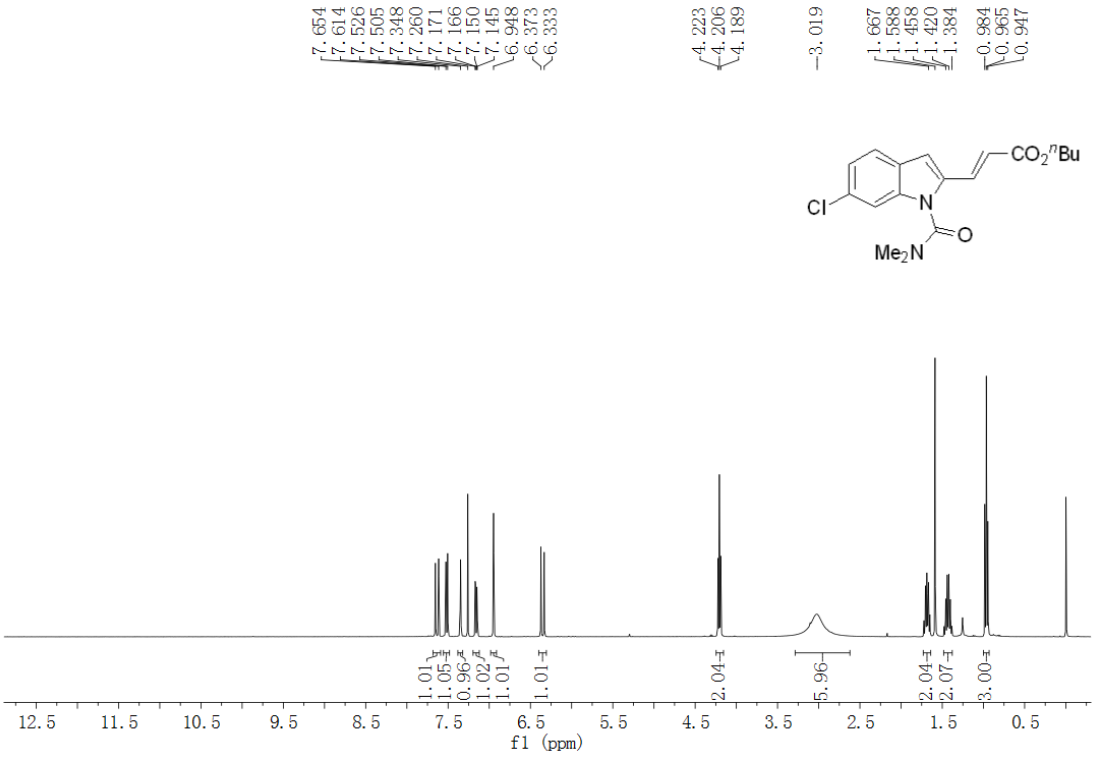
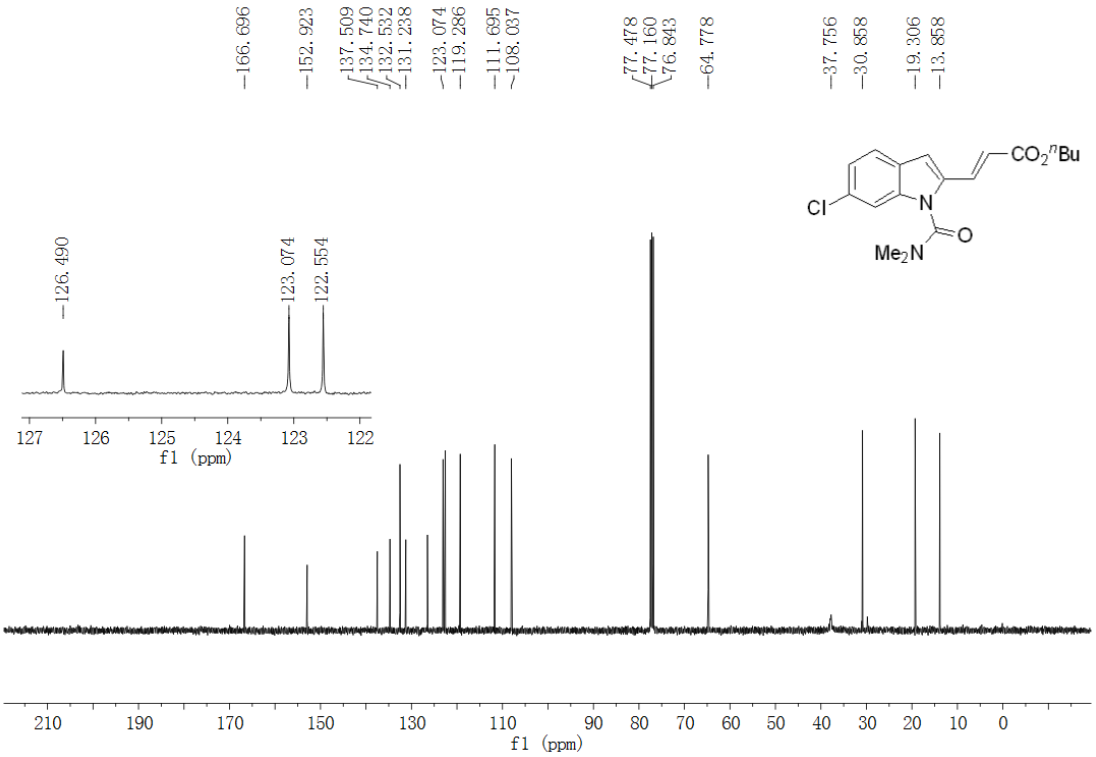
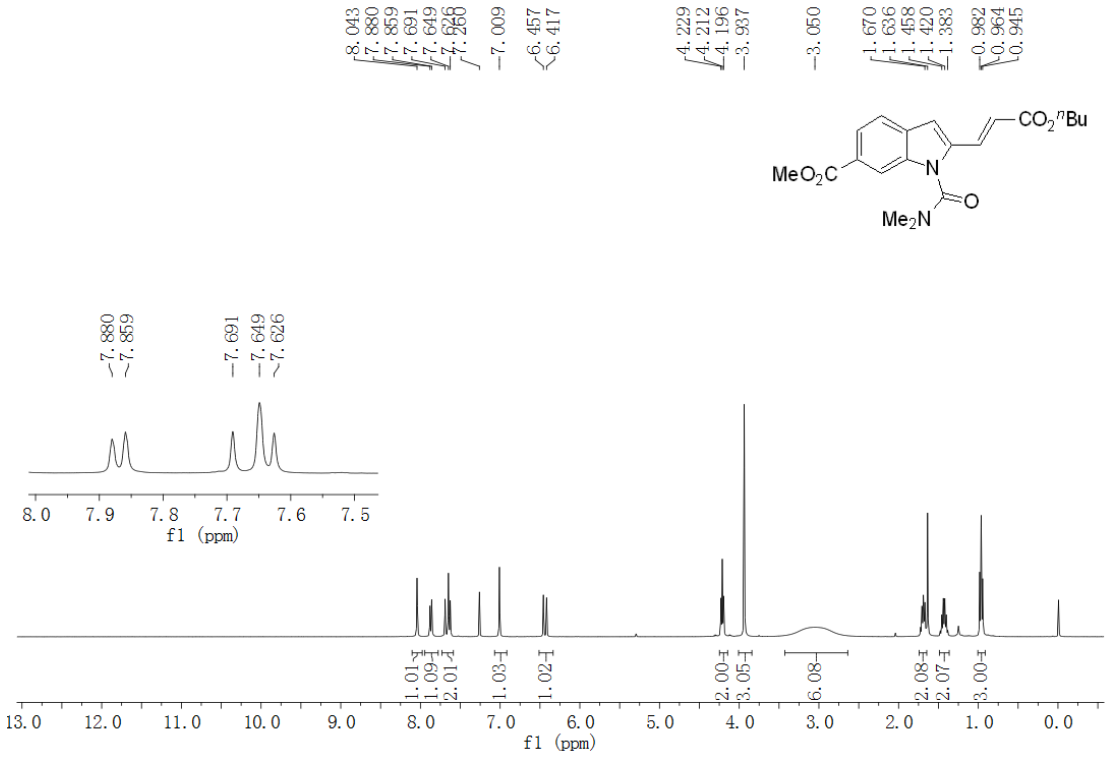
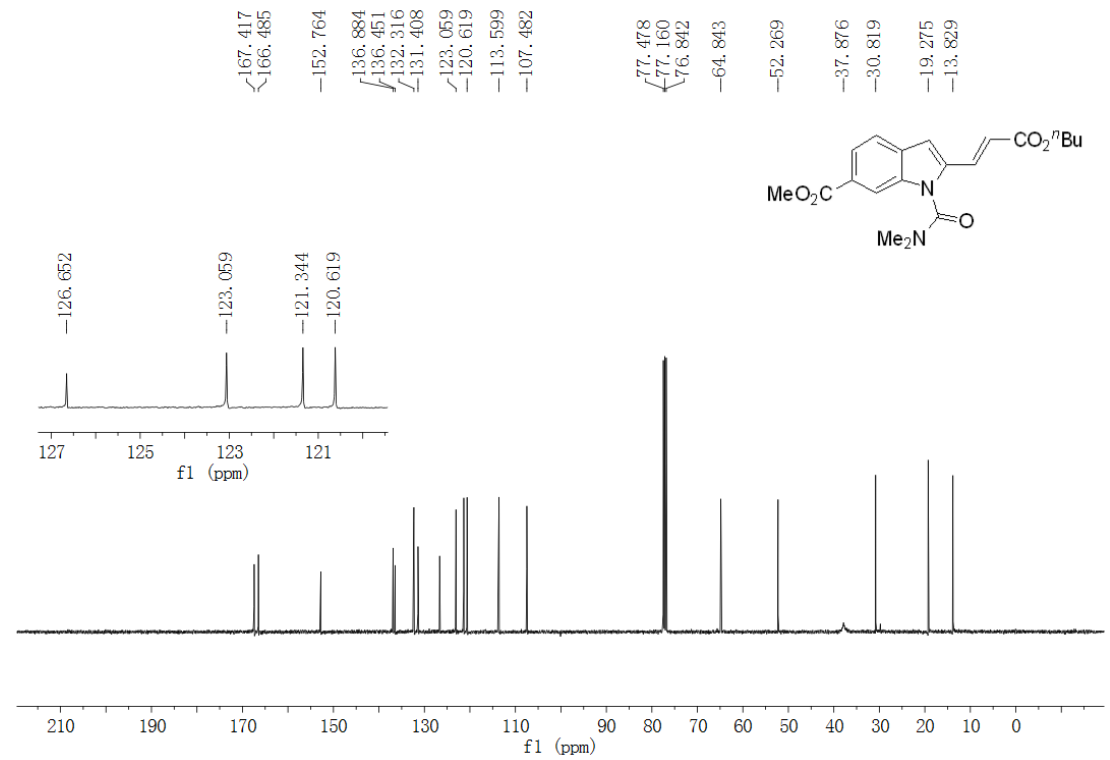
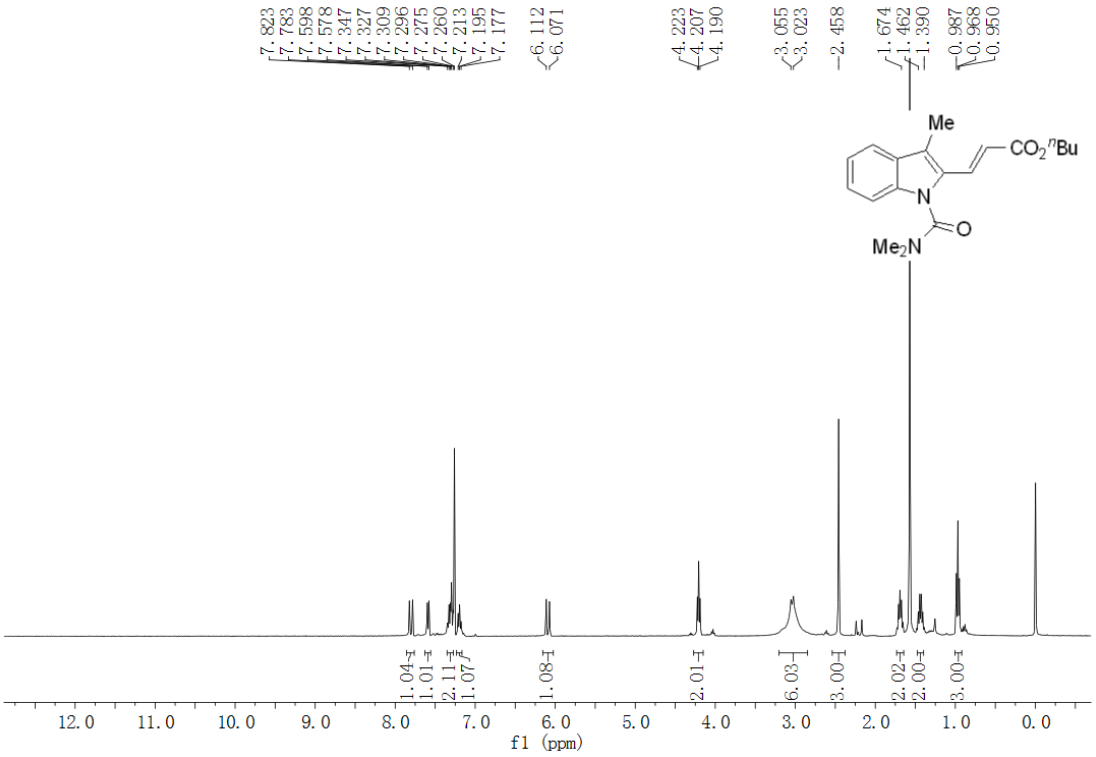
152.284
138.440
136.240
127.744
127.036
119.738
112.591
107.416
105.742
77.478
77.160
76.843
64.997
37.892
30.843
19.313
13.865
NC
CO2nBu
N
O
Me2N
127.744
127.678
127.036
121.145
119.738
129
128
127
126
125
124
123
122
121
120
119
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

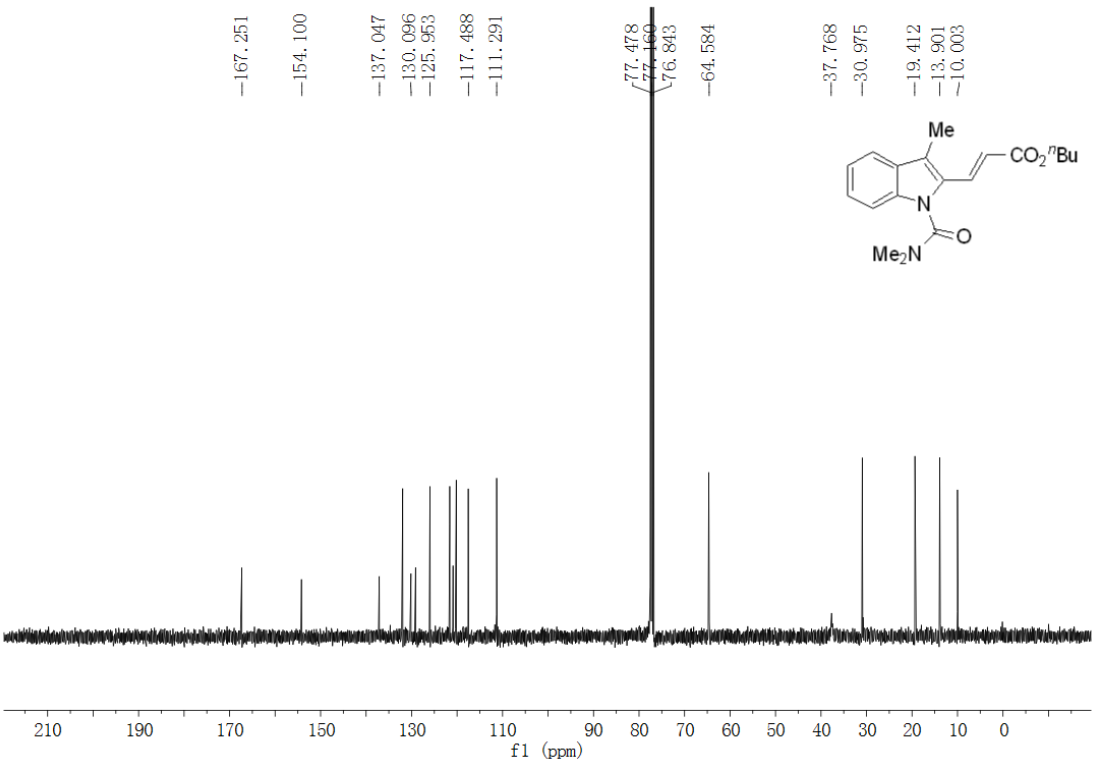

7.654
7.614
7.526
7.505
7.348
7.260
7.171
7.166
7.150
7.145
6.948
6.373
6.333
4.223
4.206
4.189
3.019
1.667
1.588
1.458
1.420
1.384
0.984
0.965
0.947
CO2nBu
Cl
N
O
Me2N
1.01
1.05
0.96
1.02
1.01
1.01
2.04
5.96
2.04
2.07
3.00
f1 (ppm)

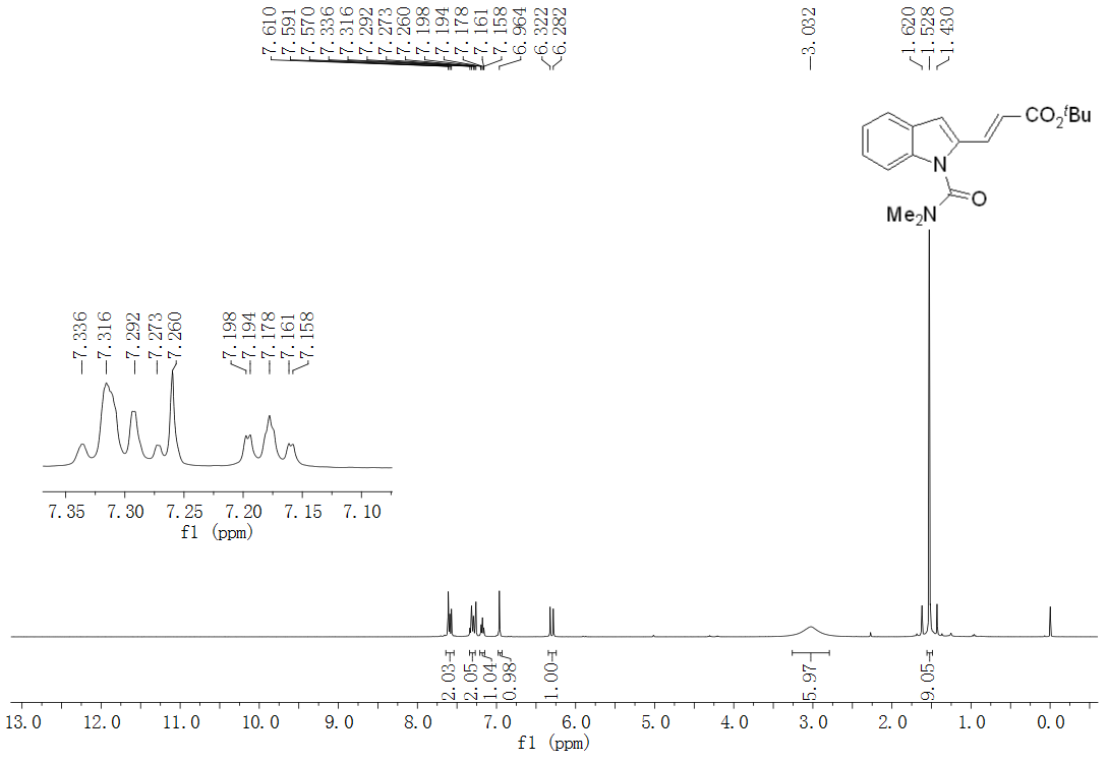

166.696
152.923
137.509
134.740
132.532
131.238
123.074
119.286
111.695
108.037
77.478
77.160
76.843
64.778
37.756
30.858
19.306
13.858
126.490
123.074
122.554
CO2nBu
Cl
N
O
Me2N
f1 (ppm)
f1 (ppm)

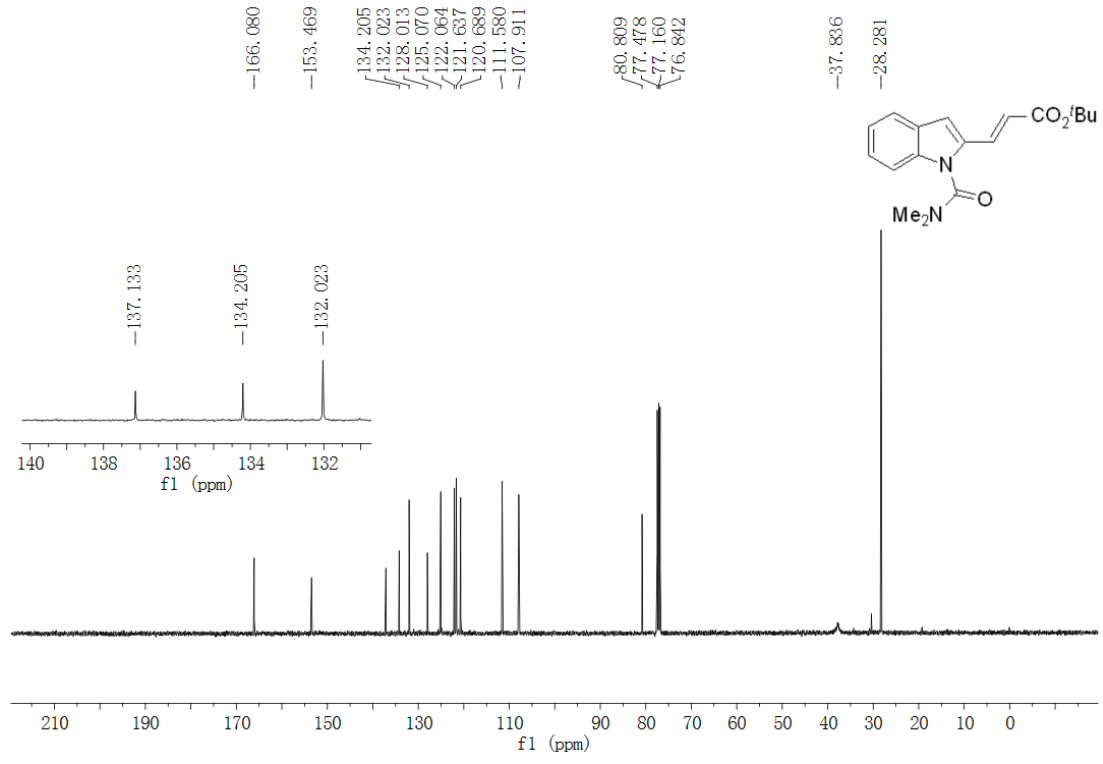

8.043
7.880
7.859
7.691
7.649
7.626
7.260
7.009
6.457
6.417
4.229
4.212
4.196
3.937
3.050
1.670
1.636
1.458
1.420
1.383
0.982
0.964
0.945
CO2nBu
MeO2C
N
O
Me2N
f1 (ppm)
1.01
1.09
2.01
1.03
1.02
2.00
3.05
6.08
2.08
2.07
3.00

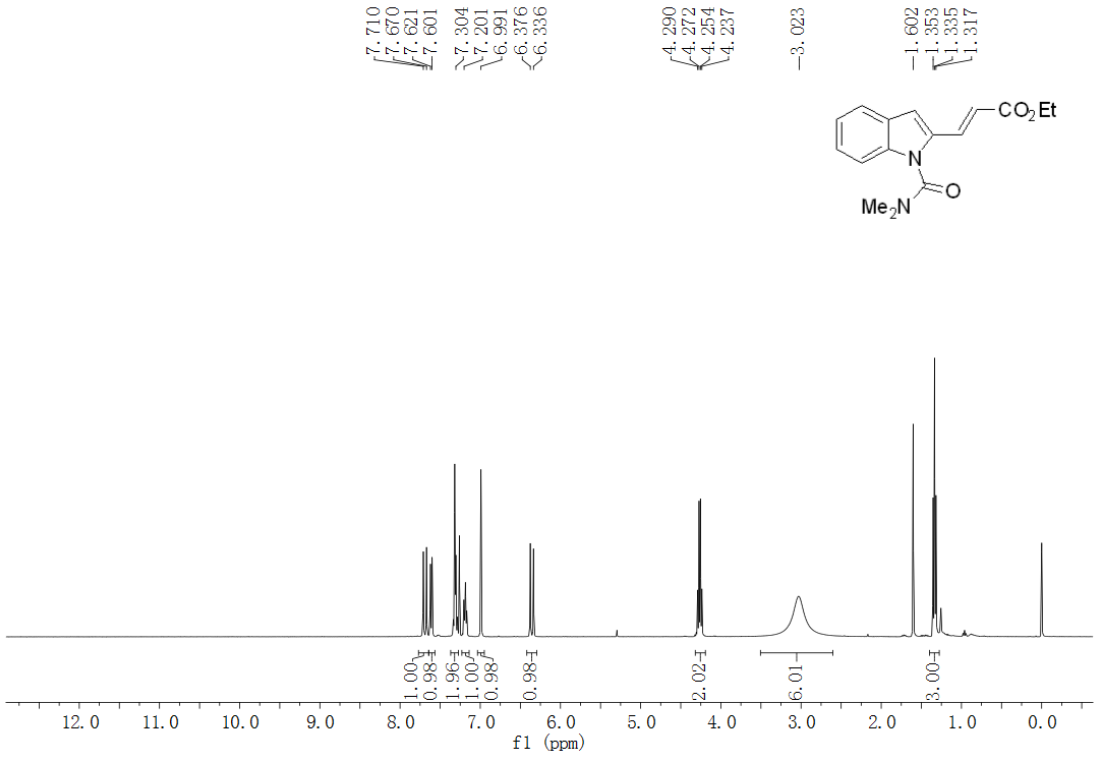

167.417
166.485
152.764
136.884
136.451
132.316
131.408
123.059
120.619
113.599
107.482
77.478
77.160
76.842
64.843
52.269
37.876
30.819
19.275
13.829
126.652
123.059
121.344
120.619
CO2nBu
MeO2C
N
O
Me2N
f1 (ppm)

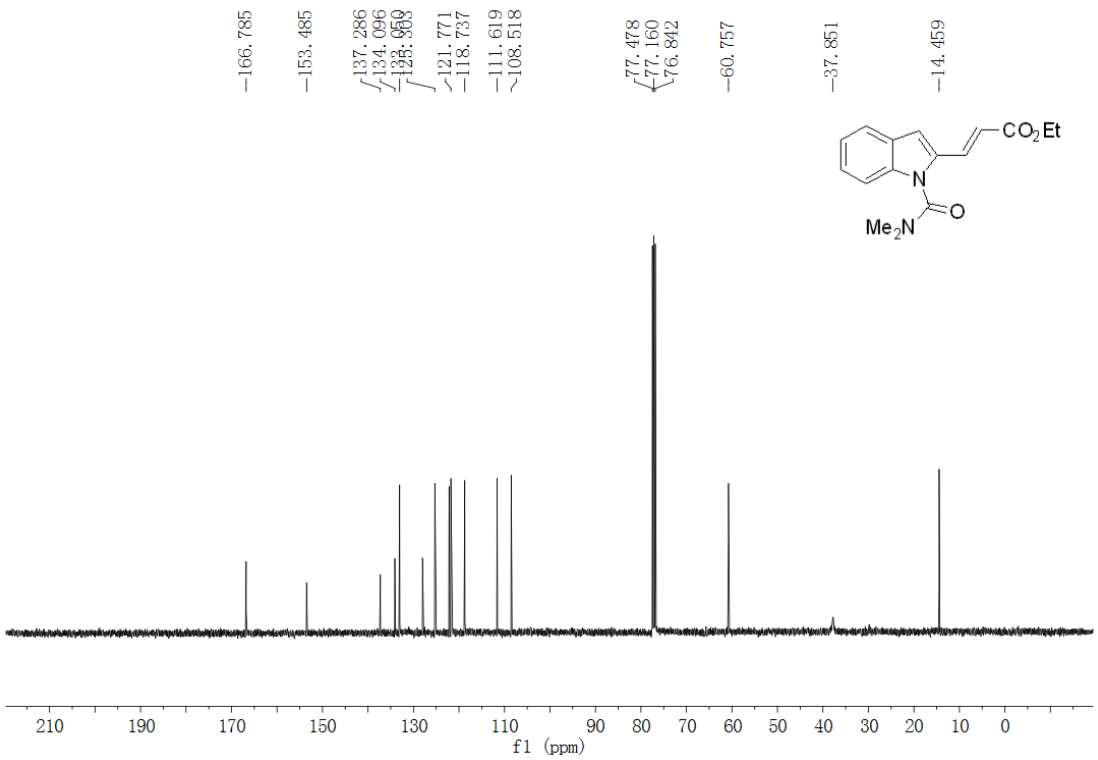

7.823
7.783
7.598
7.578
7.347
7.327
7.309
7.296
7.275
7.260
7.213
7.195
7.177
6.112
6.071
4.223
4.207
4.190
3.055
3.023
2.458
1.674
1.462
1.390
0.987
0.968
0.950
Me
CO2nBu
N
O
Me2N
1.04
1.01
2.11
1.07
1.08
2.01
6.03
3.00
2.02
2.00
3.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


167.251
154.100
137.047
130.096
125.953
117.488
111.291
77.478
77.160
76.843
64.584
37.768
30.975
19.412
13.901
10.003
Me
CO2nBu
N
O
Me2N
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.610
7.591
7.570
7.336
7.316
7.292
7.273
7.260
7.198
7.194
7.178
7.161
7.158
6.964
6.322
6.282
3.032
1.620
1.528
1.430
CO2tBu
N
O
Me2N
2.03
2.05
1.04
0.98
1.00
5.97
9.05
f1 (ppm)


166.080
153.469
134.205
132.023
128.013
125.070
122.064
121.637
120.689
111.580
107.911
80.809
77.478
77.160
76.842
37.836
28.281
137.133
134.205
132.023
CO2tBu
N
O
Me2N
f1 (ppm)


7.710
7.670
7.621
7.601
7.304
7.201
6.991
6.376
6.336
4.290
4.272
4.254
4.237
3.023
1.602
1.353
1.335
1.317
CO2Et
N
O
Me2N
1.00
0.98
1.96
1.00
0.98
0.98
2.02
6.01
3.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)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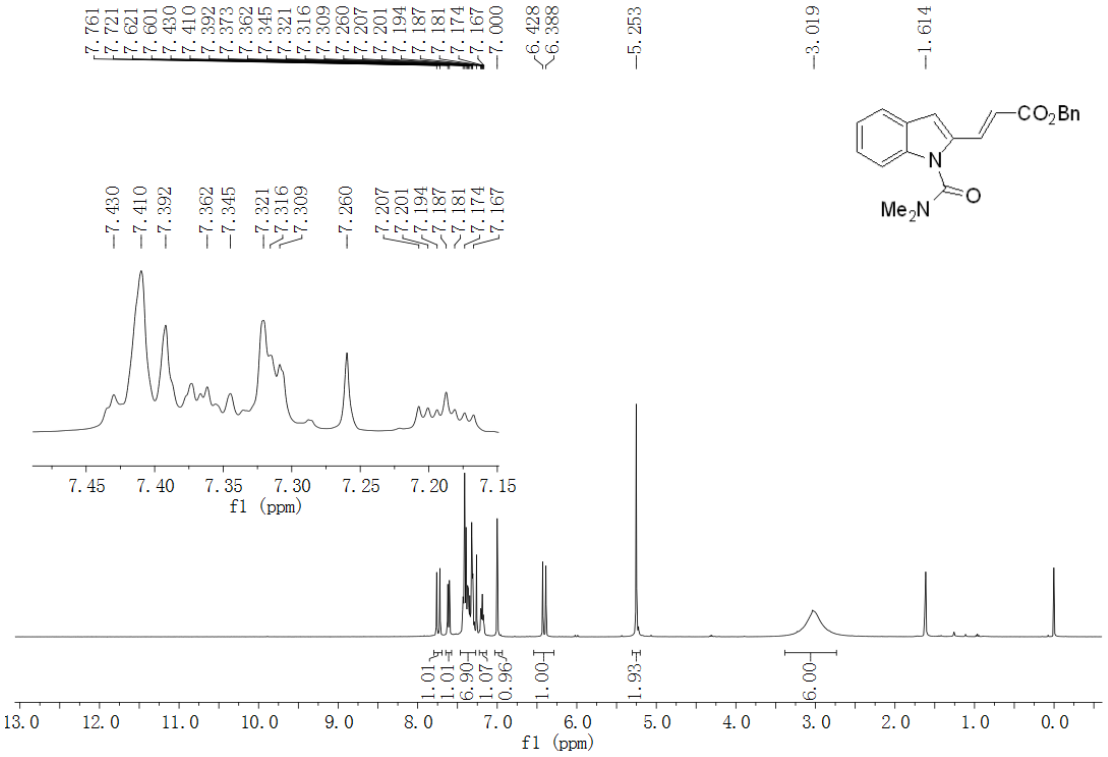
153.485
137.286
134.096
133.050
128.303
121.771
118.737
111.619
108.518
77.478
77.160
76.842
60.757
37.851
14.459
CO2Et
N
O
Me2N
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.761
7.721
7.621
7.601
7.430
7.410
7.392
7.373
7.362
7.345
7.321
7.316
7.309
7.260
7.207
7.201
7.194
7.187
7.181
7.174
7.167
7.000
6.428
6.388
5.253
3.019
1.614
CO2Bn
N
O
Me2N
f1 (ppm)
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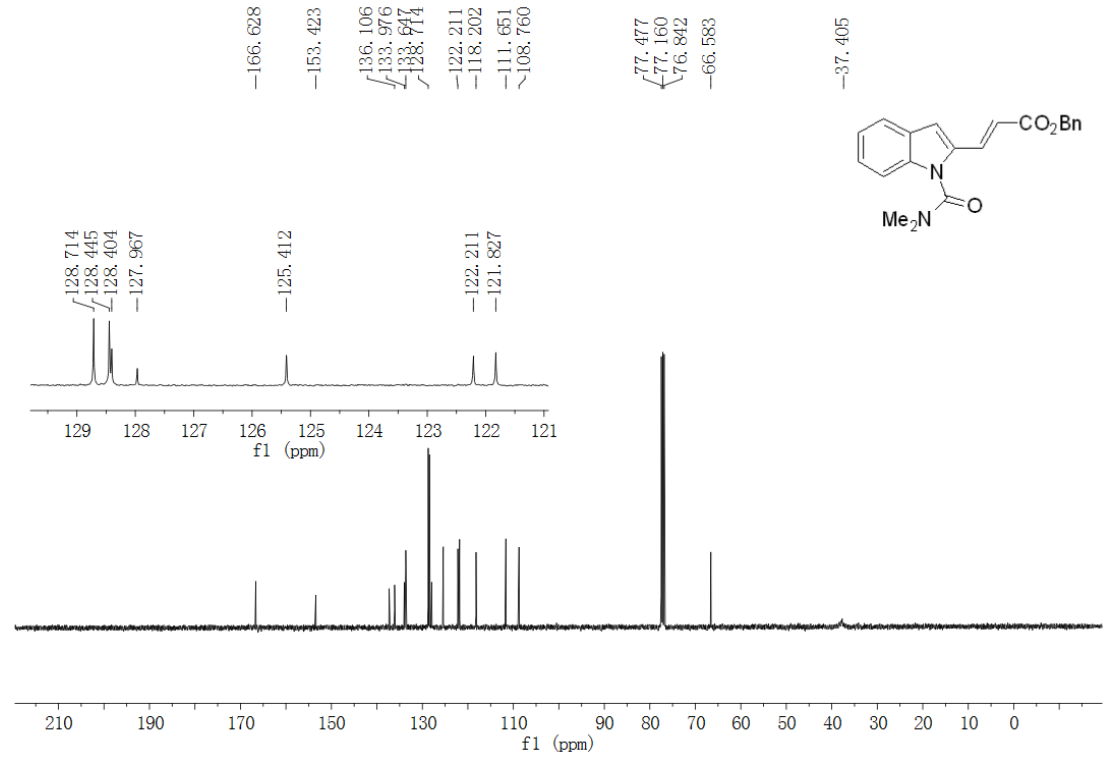
1.01
6.90
1.07
0.96
1.00
1.93
6.00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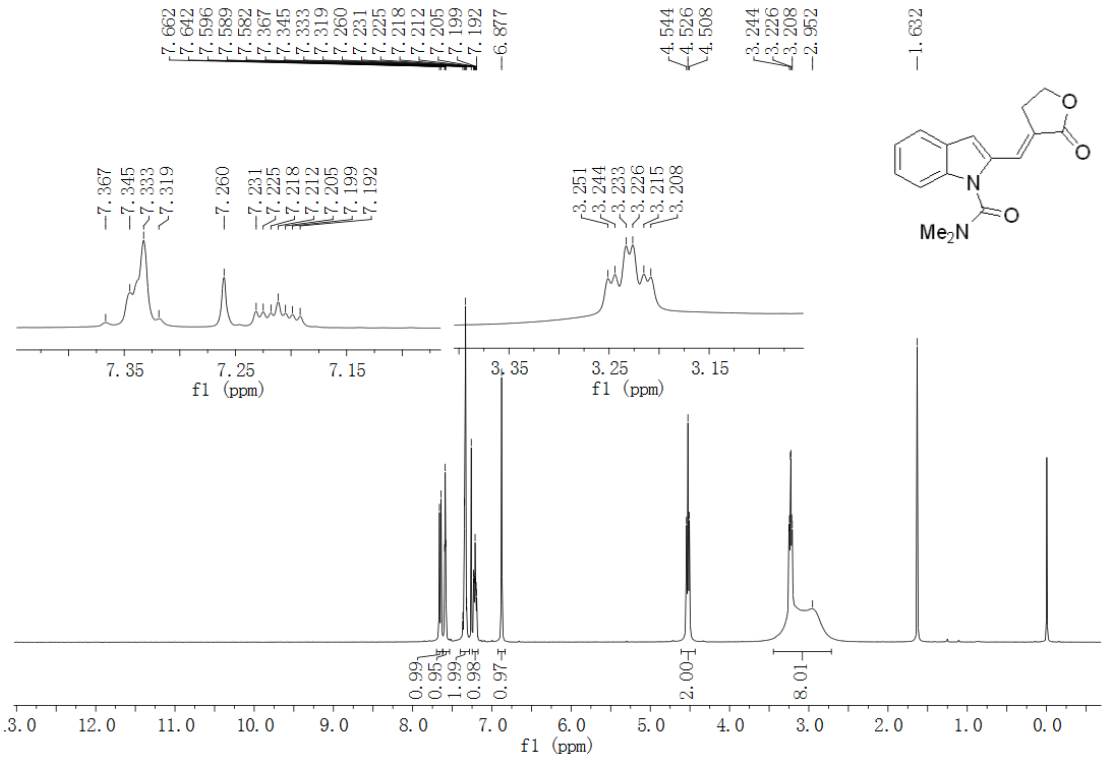
136.106
133.976
133.647
128.714
122.211
118.202
111.651
108.760
77.477
77.160
76.842
66.583
37.405
CO2Bn
N
O
Me2N
128.714
128.445
128.404
127.967
125.412
122.211
121.827
f1 (ppm)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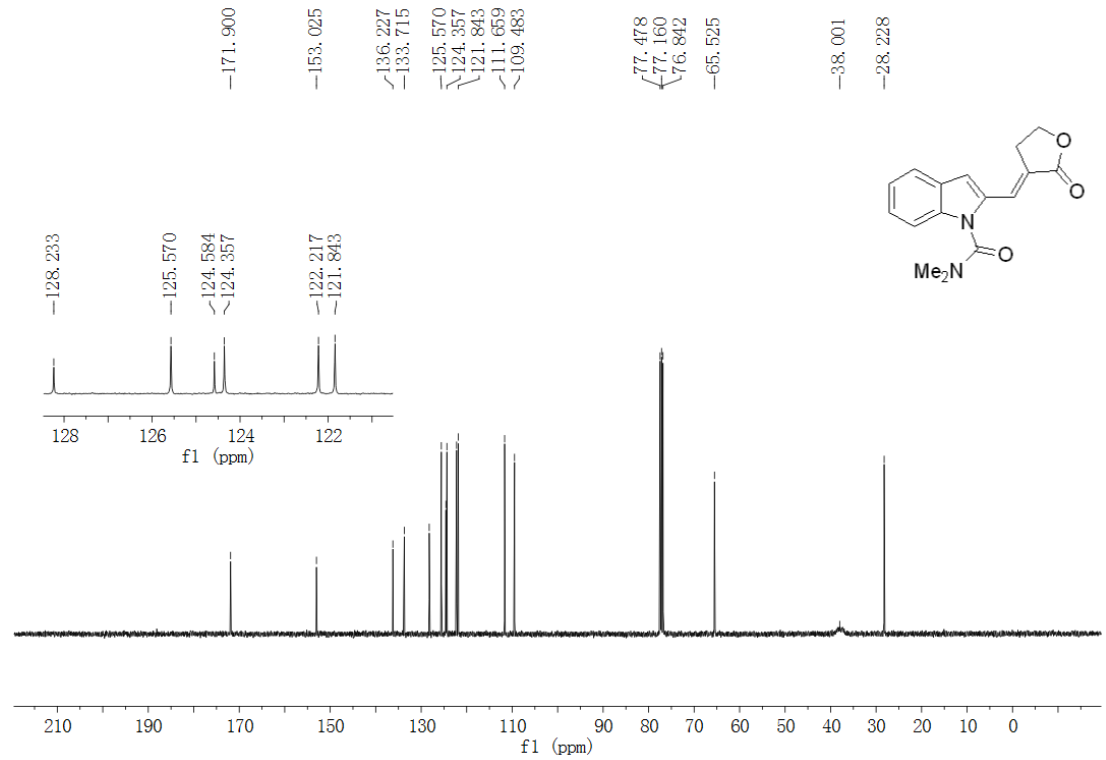
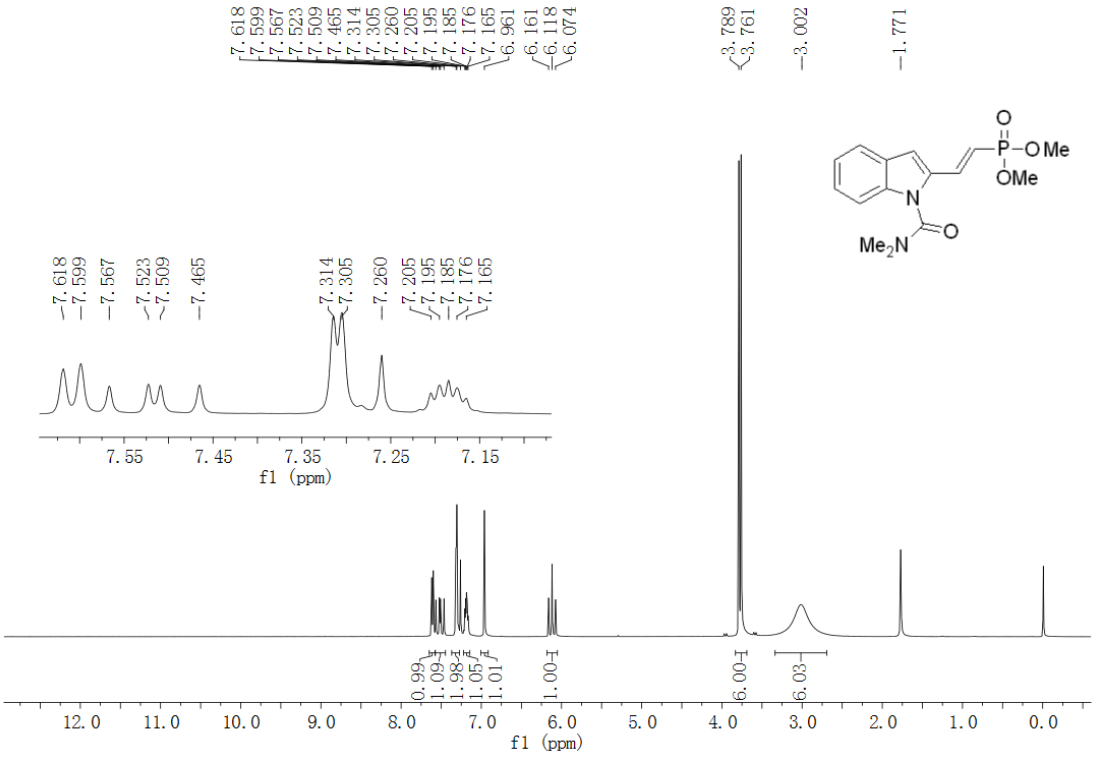
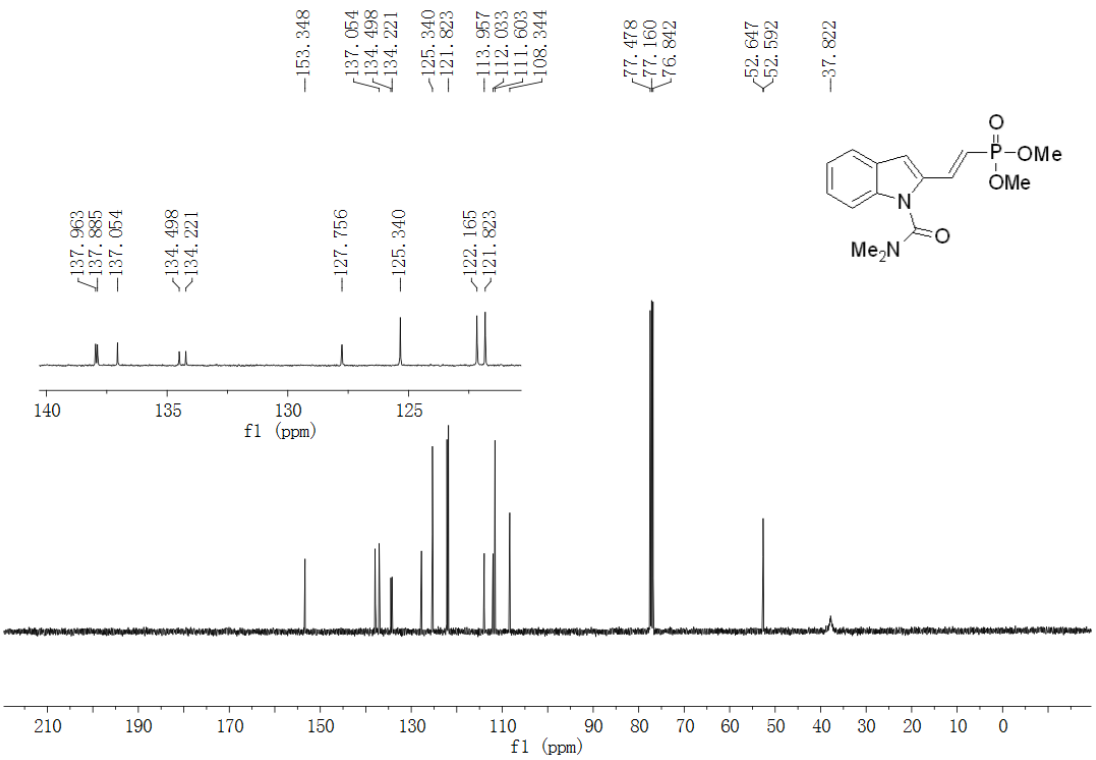
7.642
7.596
7.589
7.582
7.367
7.345
7.333
7.319
7.260
7.231
7.225
7.218
7.212
7.205
7.199
7.192
6.877
4.544
4.526
4.508
3.244
3.226
3.208
2.952
1.632
3.251
3.244
3.233
3.226
3.215
3.208
Me2N
f1 (ppm)
0.99
0.95
1.99
0.98
0.97
2.00
8.01


171.900
153.025
136.227
133.715
125.570
124.357
121.843
111.659
109.483
77.478
77.160
76.842
65.525
38.001
28.228
128.233
125.570
124.584
124.357
122.217
121.843
Me2N
f1 (ppm)


7.618
7.599
7.567
7.523
7.509
7.465
7.314
7.305
7.260
7.205
7.195
7.185
7.176
7.165
6.961
6.161
6.118
6.074
3.789
3.761
3.002
1.771
O
P–OMe
OMe
N
Me2N
O
0.99
1.09
1.98
1.05
1.01
1.00
6.00
6.03
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)
7.55
7.45
7.35
7.25
7.15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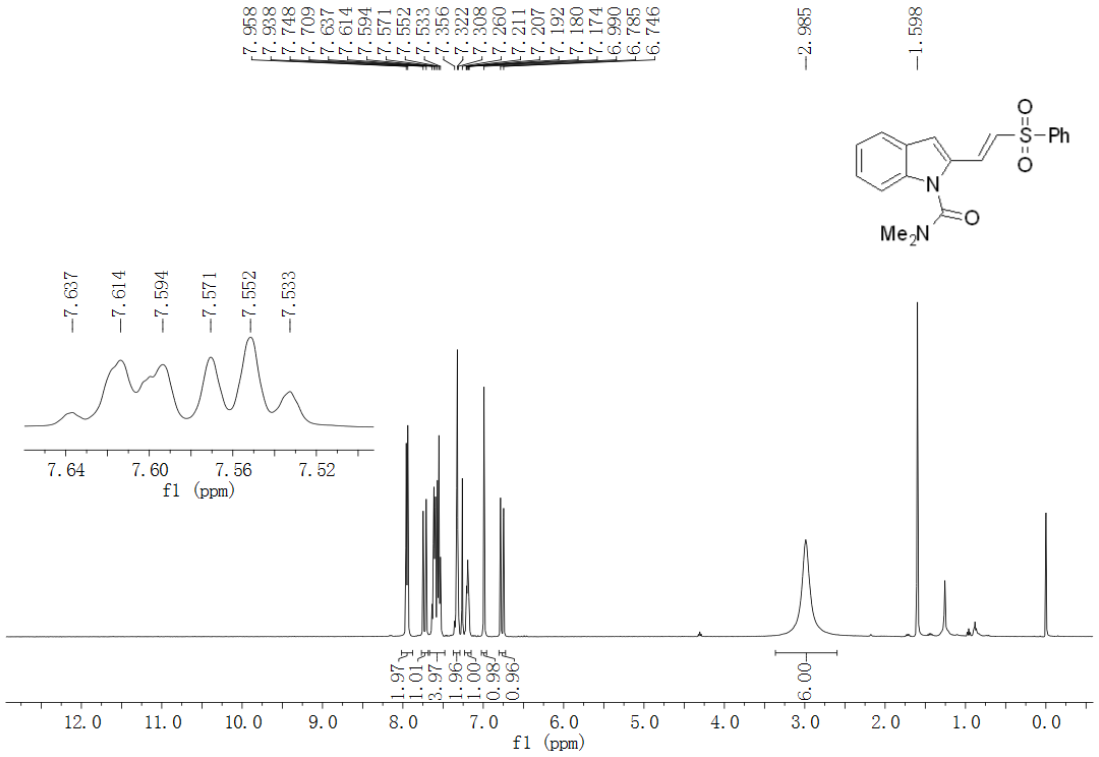
137.054
134.498
134.221
125.340
121.823
113.957
112.033
111.603
108.344
77.478
77.160
76.842
52.647
52.592
37.822
O
P–OMe
OMe
N
Me2N
O
137.963
137.885
137.054
134.498
134.221
127.756
125.340
122.165
121.823
140
135
130
125
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0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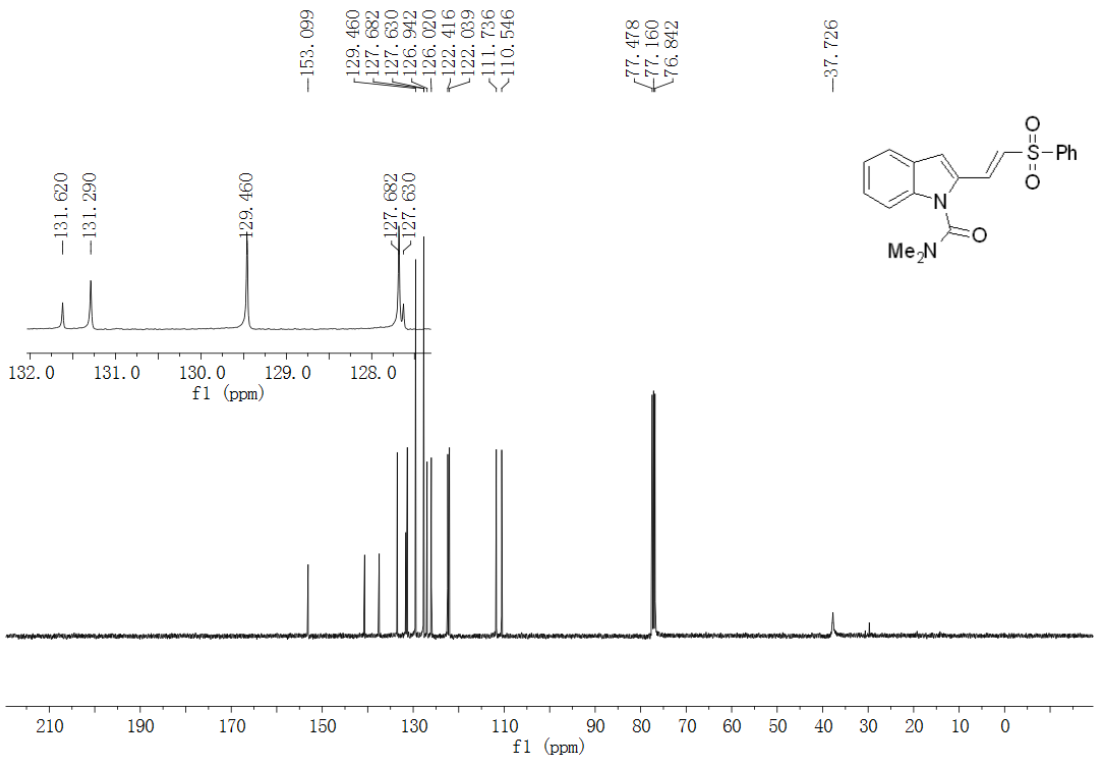
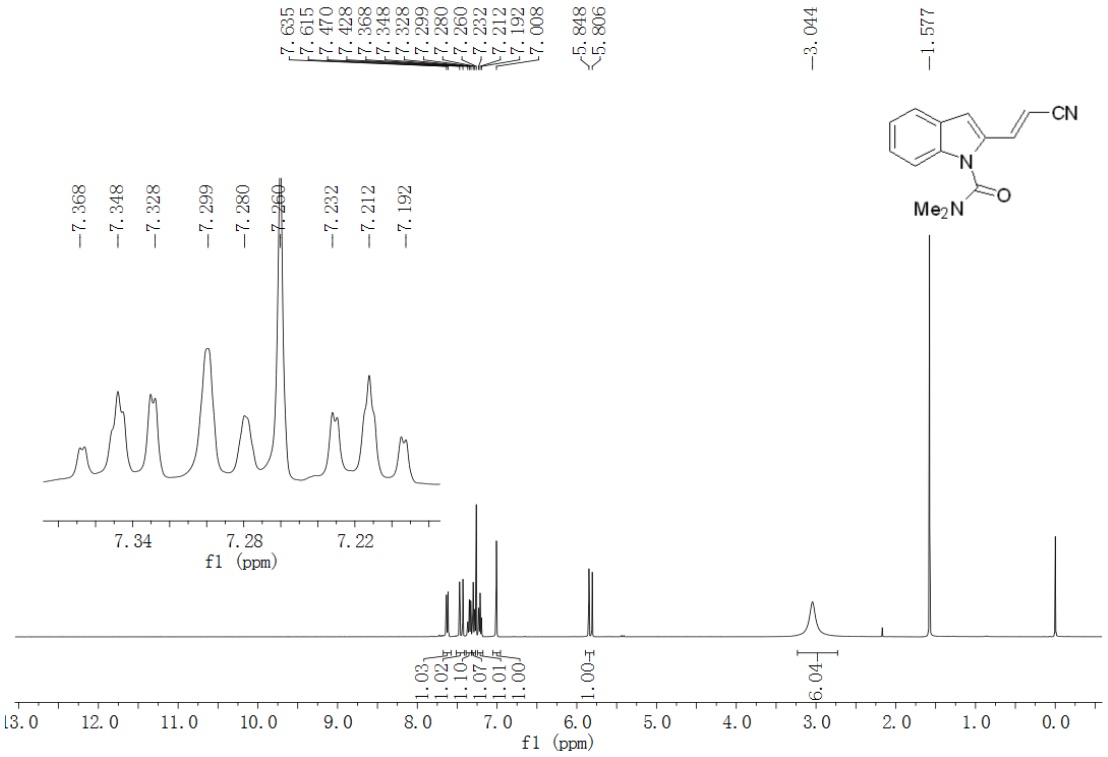
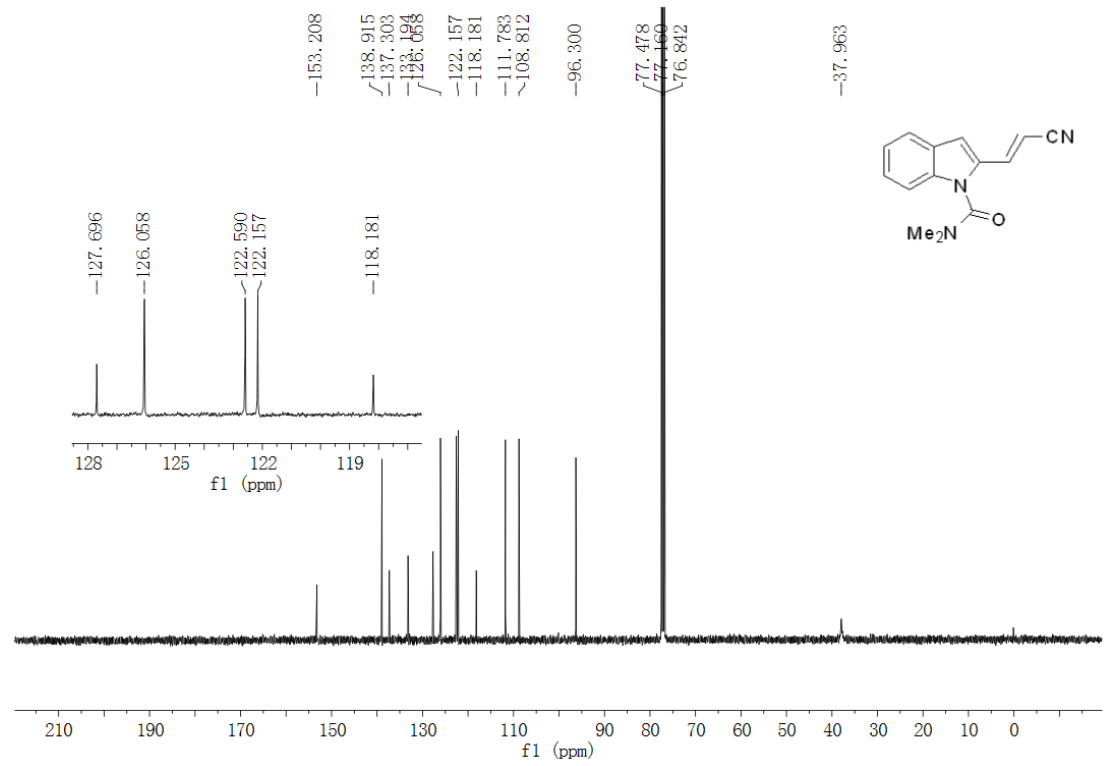
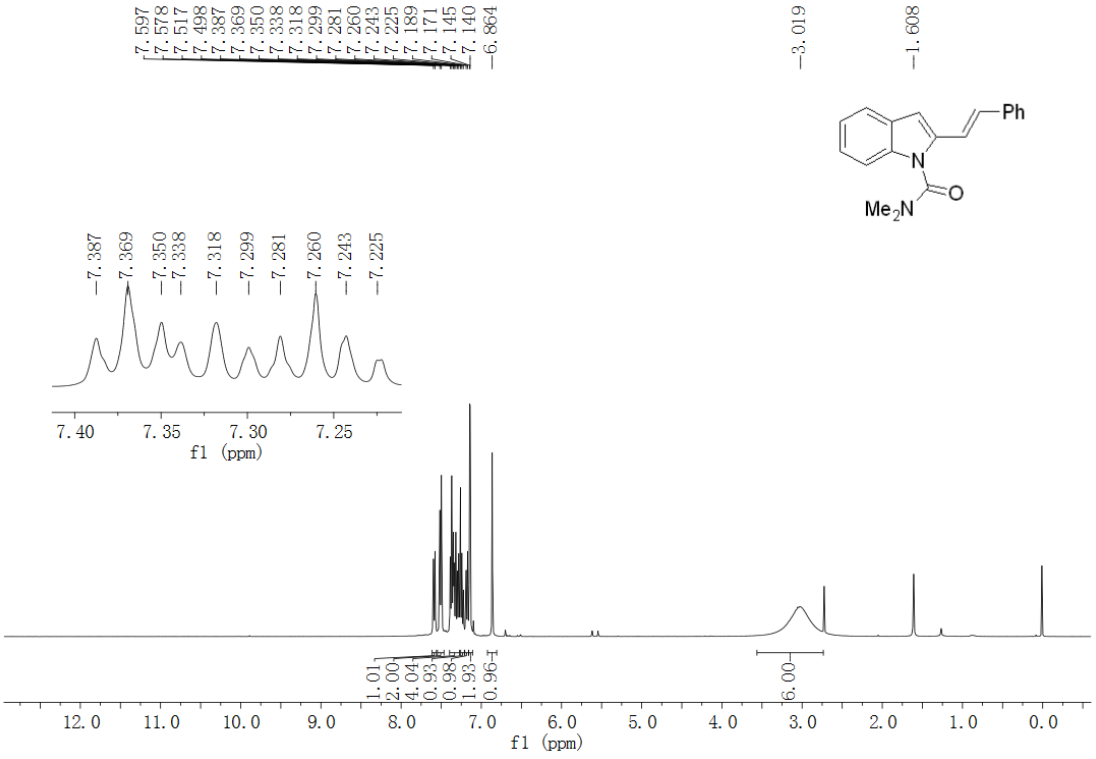
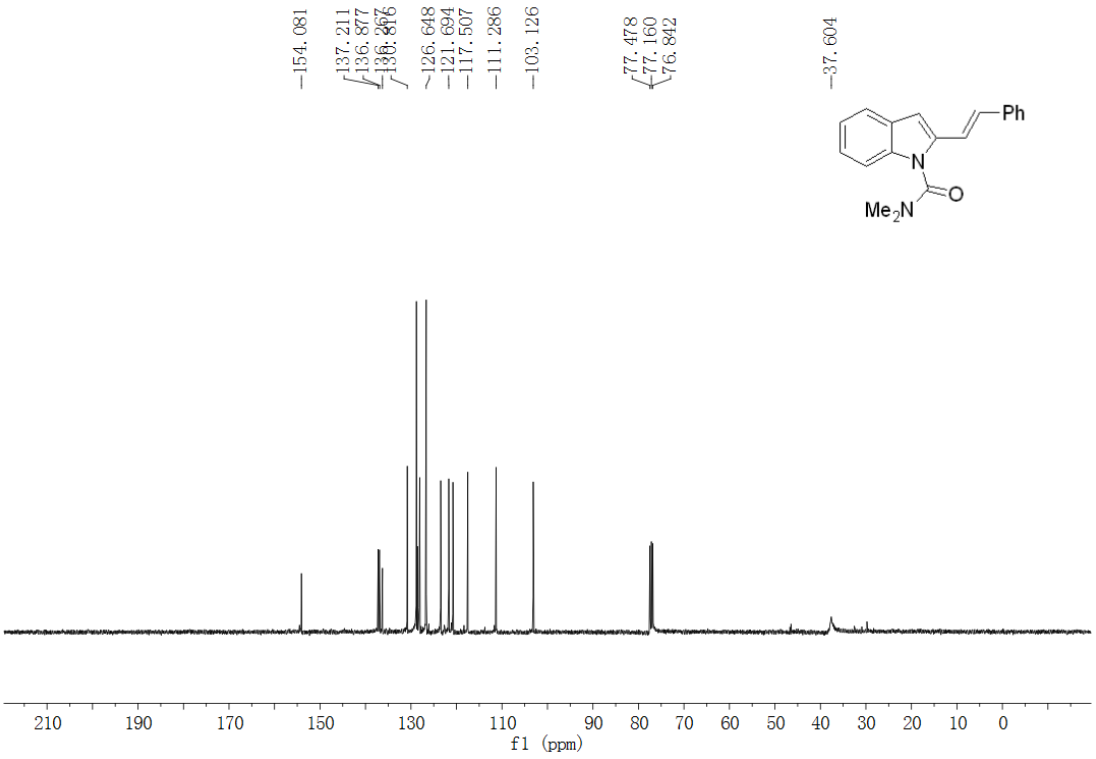
7.938
7.748
7.709
7.637
7.614
7.594
7.571
7.552
7.533
7.356
7.322
7.308
7.260
7.211
7.207
7.192
7.180
7.174
6.990
6.785
6.746
2.985
1.598
O
S
Ph
O
N
O
Me2N
7.637
7.614
7.594
7.571
7.552
7.533
7.64
7.60
7.56
7.52
f1 (ppm)
1.97
1.01
3.97
1.96
1.00
0.98
0.96
6.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

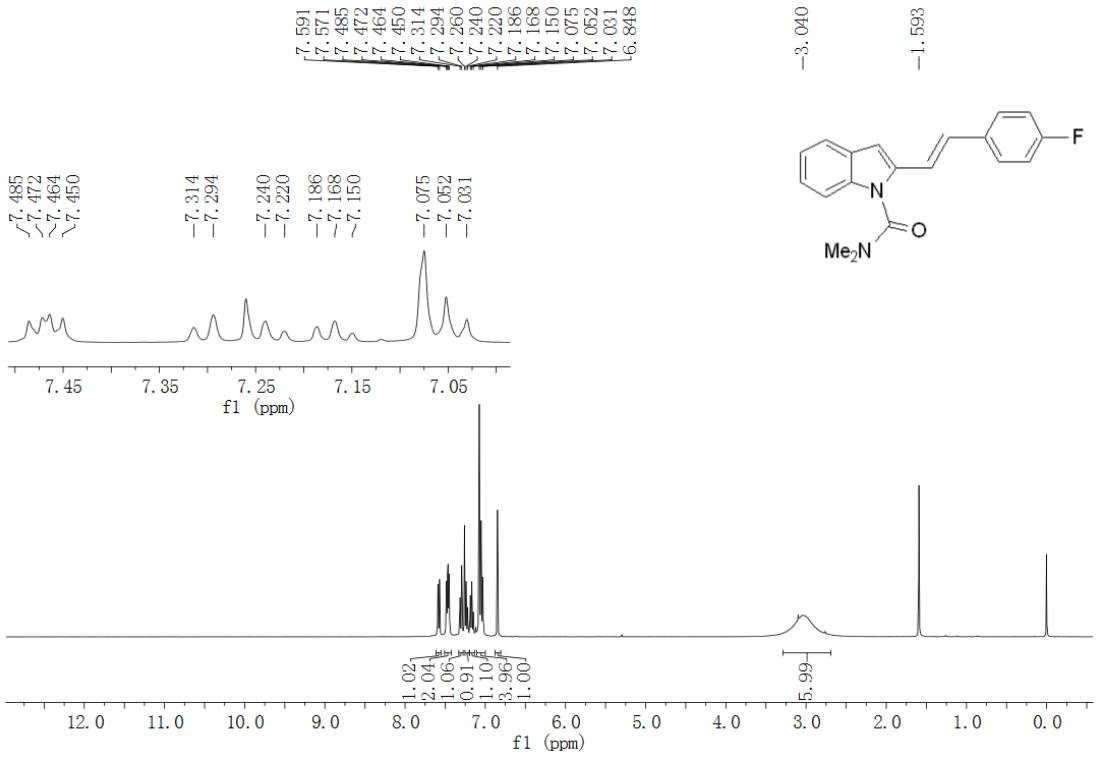

153.099
129.460
127.682
127.630
126.942
126.020
122.416
122.039
111.736
110.546
77.478
77.160
76.842
37.726
O
S
Ph
O
N
O
Me2N
131.620
131.290
129.460
127.682
127.630
132.0
131.0
130.0
129.0
128.0
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

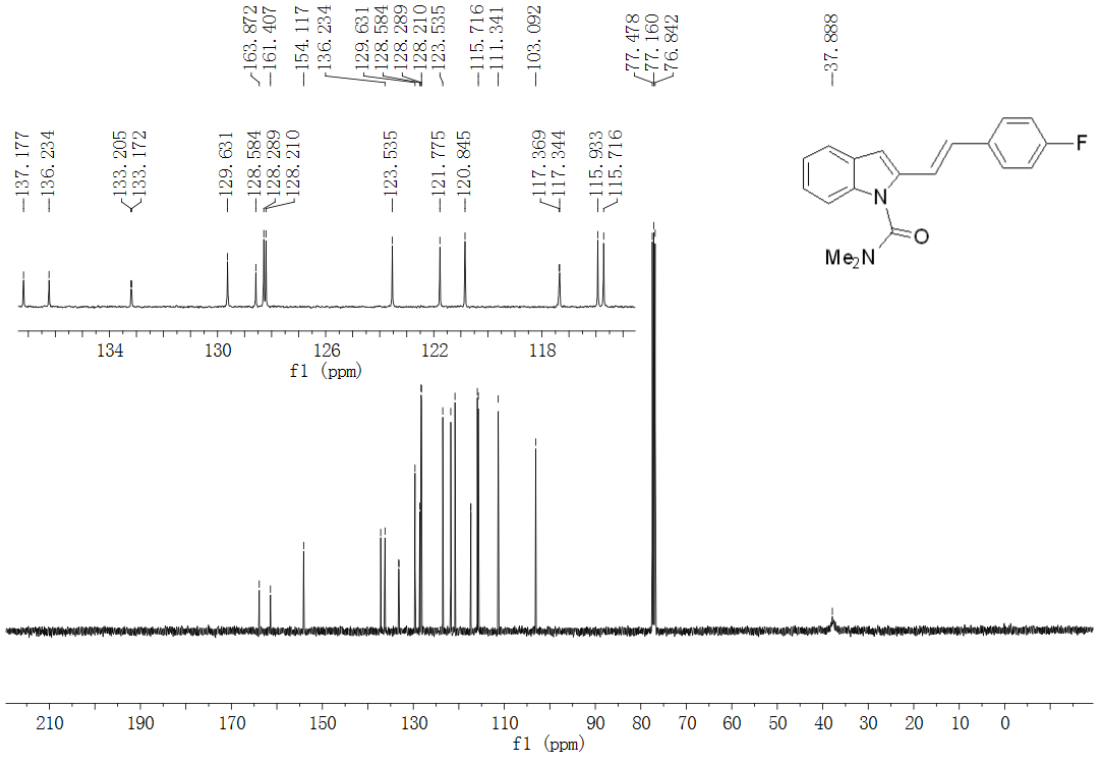

7.635
7.615
7.470
7.428
7.368
7.348
7.328
7.299
7.280
7.260
7.232
7.212
7.192
7.008
5.848
5.806
3.044
1.577
CN
N
O
Me2N
7.34
7.28
7.22
f1 (ppm)
1.03
1.02
1.10
1.07
1.01
1.00
1.00
6.04
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

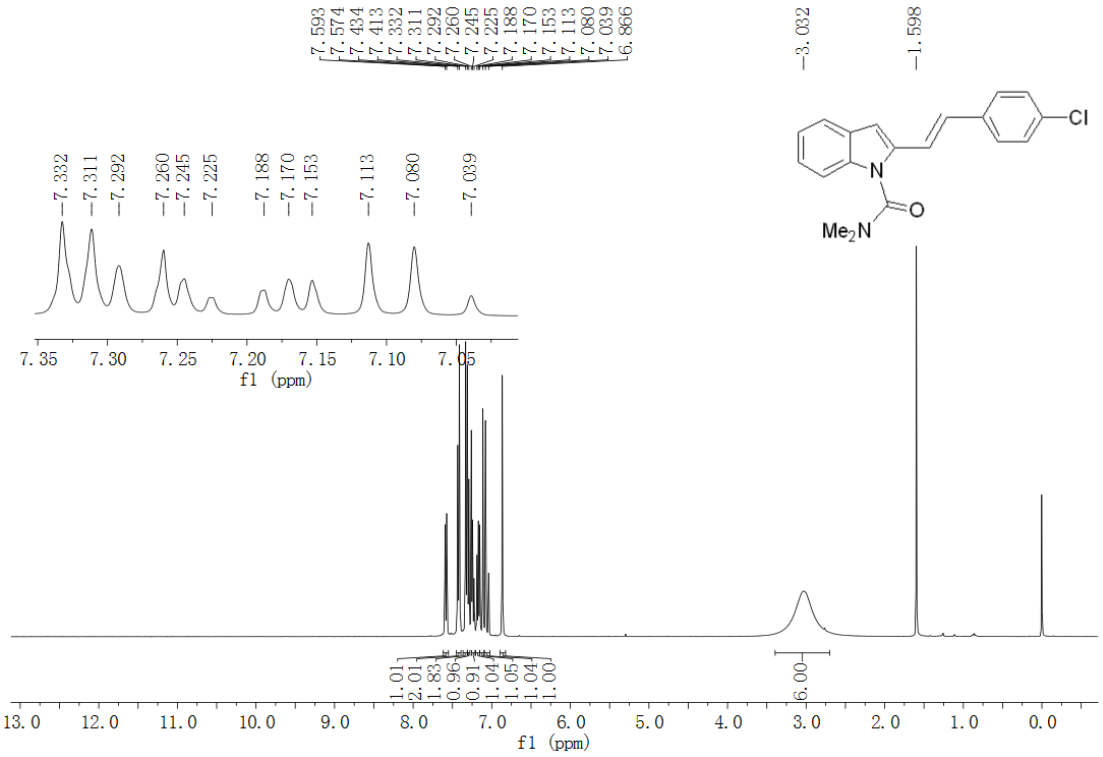

153.208
138.915
137.303
133.194
126.058
122.157
118.181
111.783
108.812
96.300
77.478
77.160
76.842
37.963
CN
N
O
Me2N
127.696
126.058
122.590
122.157
118.181
128
125
122
119
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

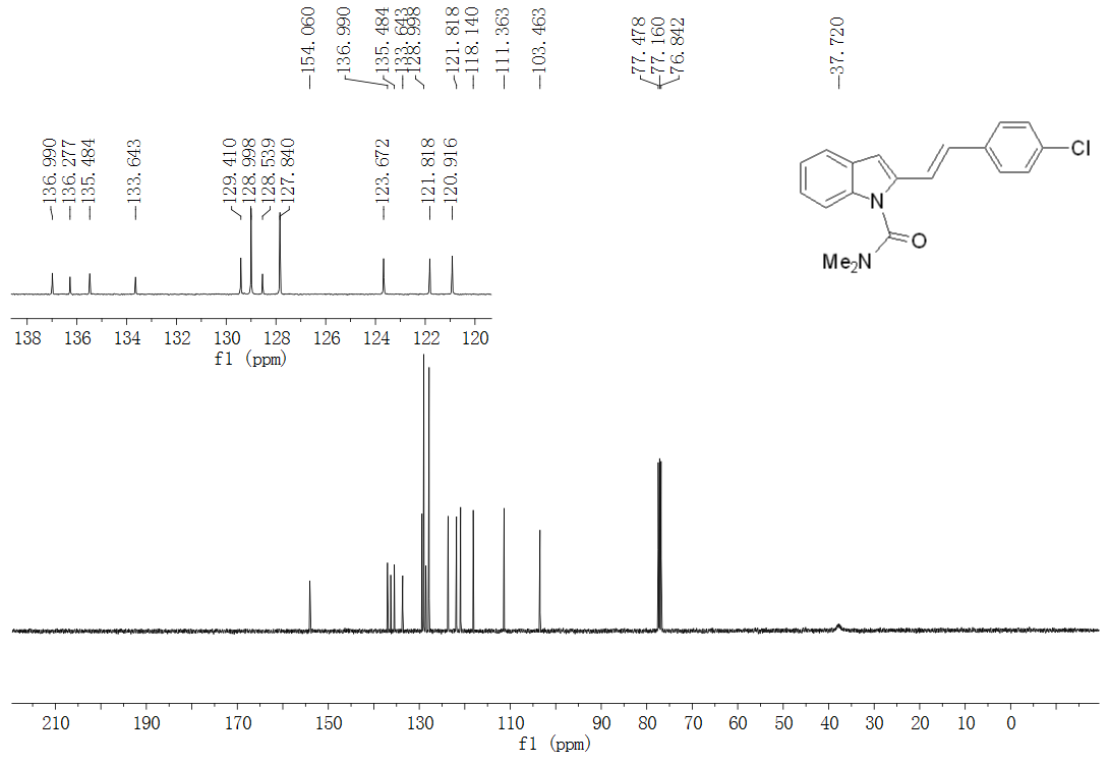

7.597
7.578
7.517
7.498
7.387
7.369
7.350
7.338
7.318
7.299
7.281
7.260
7.243
7.225
7.189
7.171
7.145
7.140
6.864
3.019
1.608
Ph
N
O
Me2N
7.40
7.35
7.30
7.25
f1 (ppm)
1.01
2.00
4.04
0.93
0.98
1.93
0.96
6.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

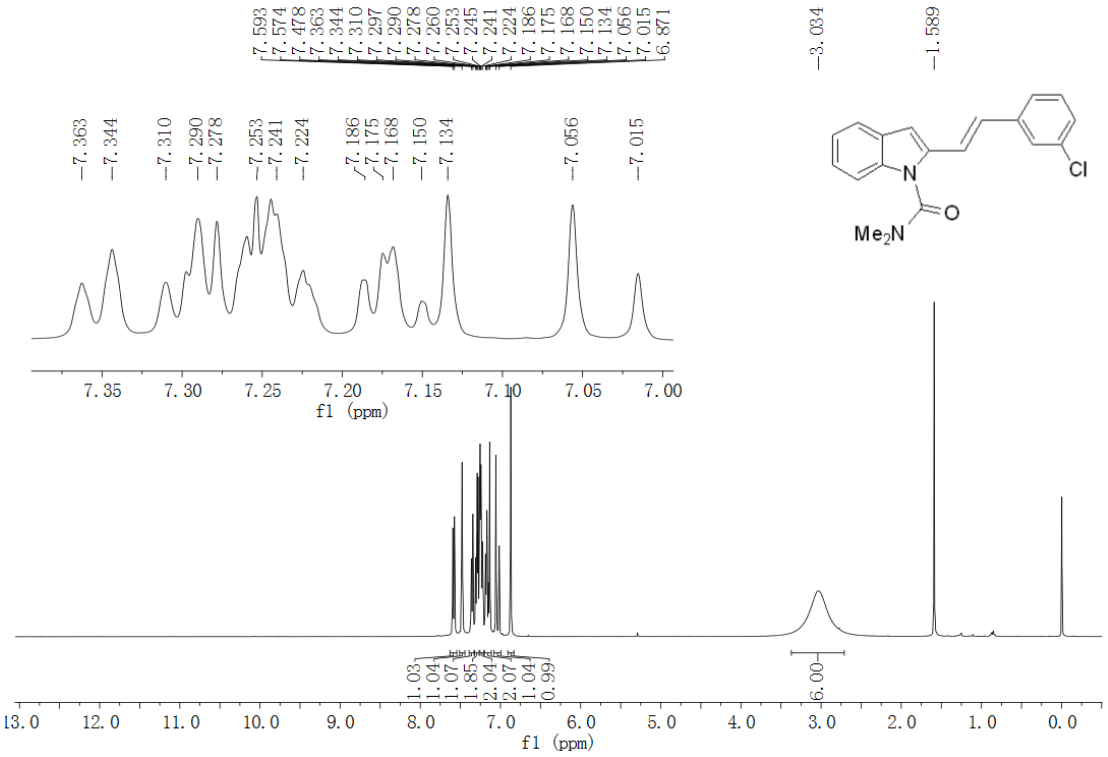

154.081
137.211
136.877
136.267
130.816
126.648
121.694
117.507
111.286
103.126
77.478
77.160
76.842
37.604
Ph
N
O
Me2N
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

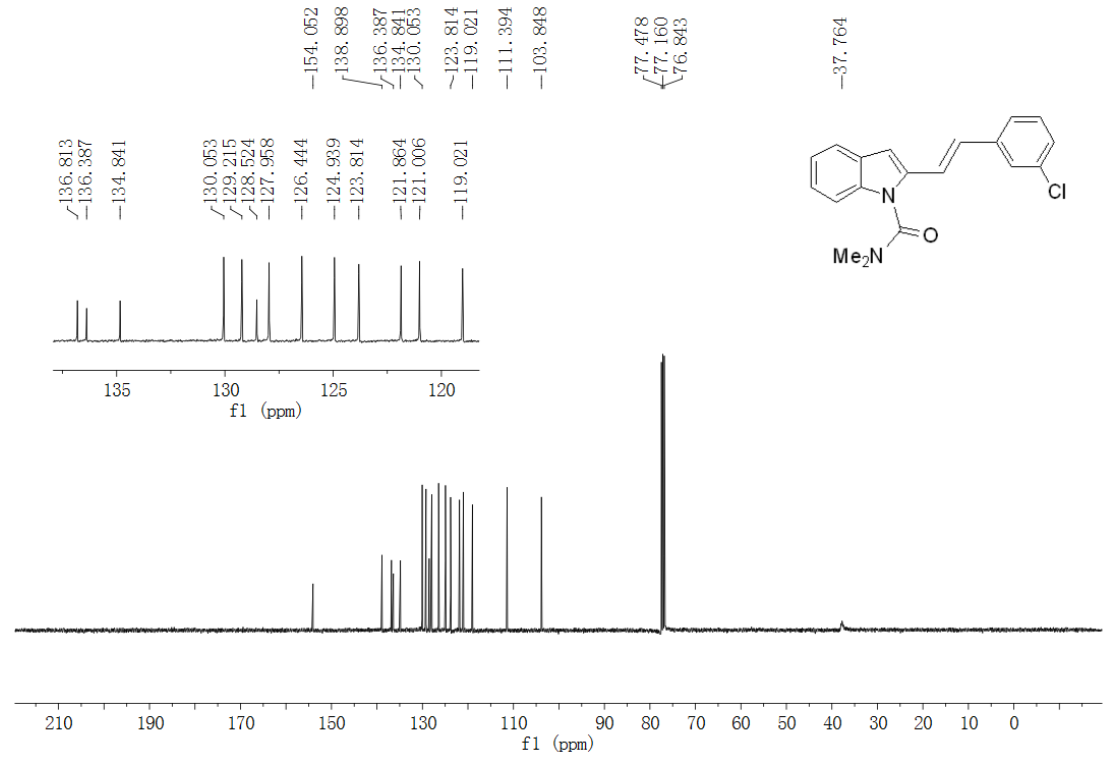

7.591
7.571
7.485
7.472
7.464
7.450
7.314
7.294
7.260
7.240
7.220
7.186
7.168
7.150
7.075
7.052
7.031
6.848
3.040
1.593
F
N
O
Me2N
7.45
7.35
7.25
7.15
7.05
f1 (ppm)
1.02
2.04
1.06
0.91
1.10
3.96
1.00
5.99
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

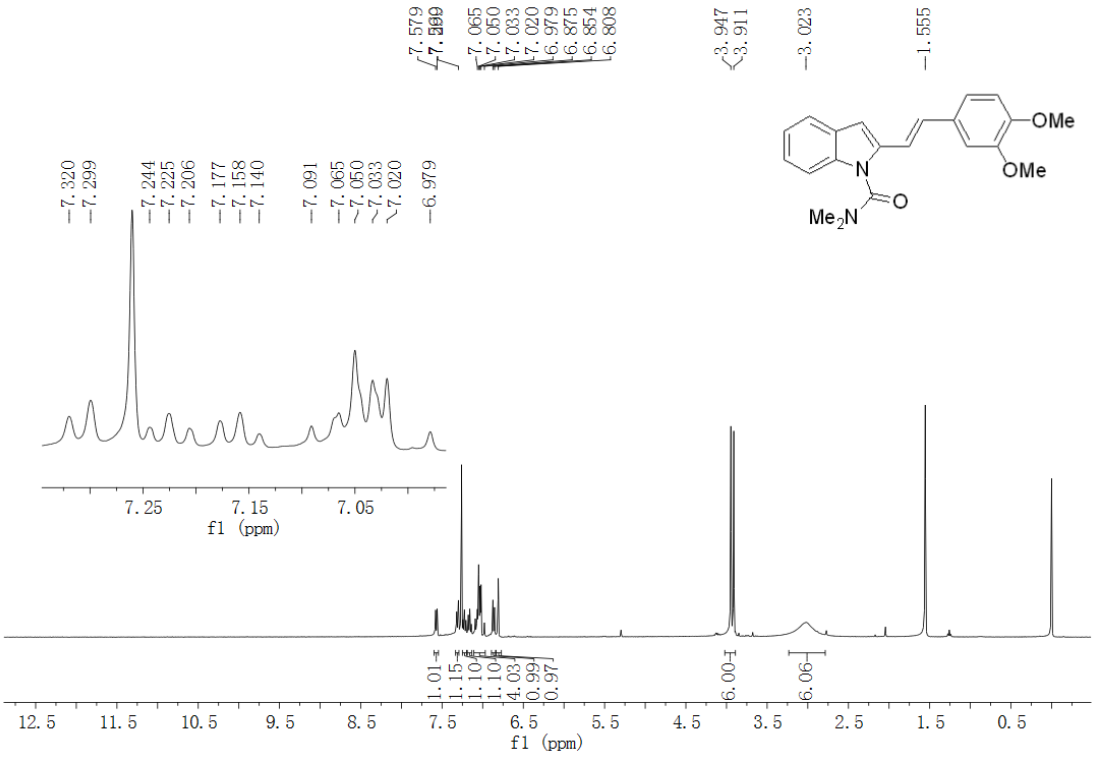

163.872
161.407
154.117
136.234
129.631
128.584
128.289
128.210
123.535
115.716
111.341
103.092
77.478
77.160
76.842
37.888
137.177
136.234
133.205
133.172
129.631
128.584
128.289
128.210
123.535
121.775
120.845
117.369
117.344
115.933
115.716
F
N
O
Me2N
134
130
126
122
118
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

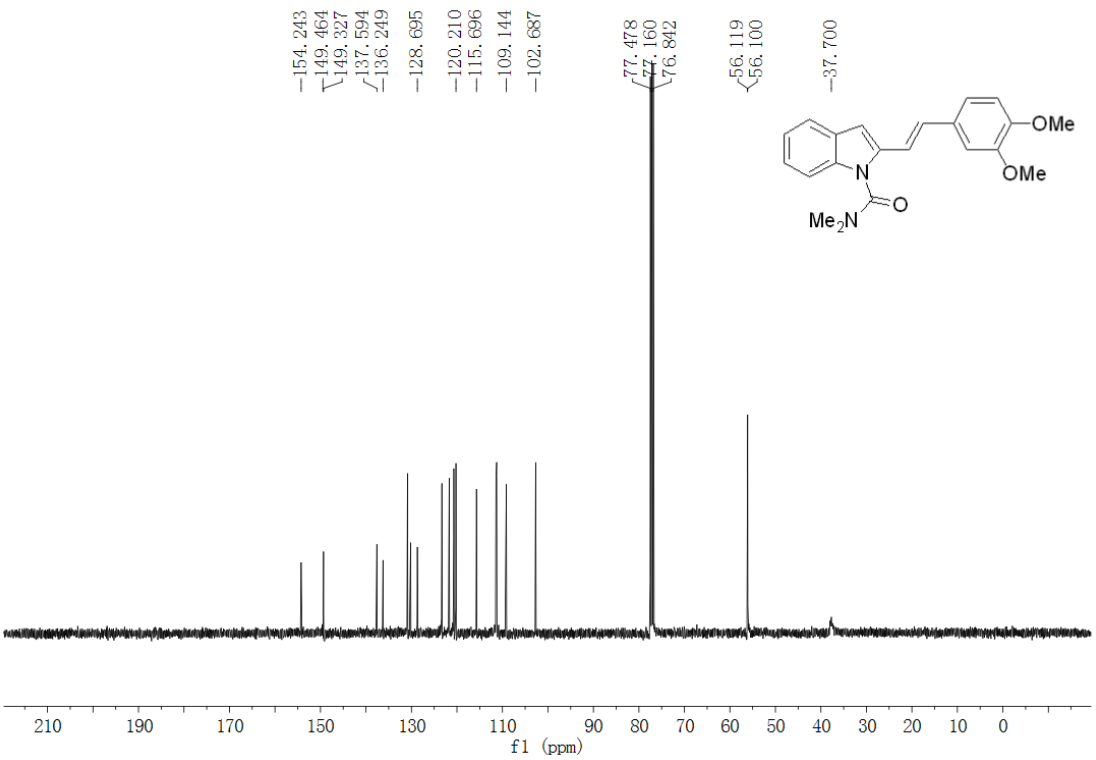

7.593
7.574
7.434
7.413
7.332
7.311
7.292
7.260
7.245
7.225
7.188
7.170
7.153
7.113
7.080
7.039
6.866
3.032
1.598
Cl
N
O
Me2N
1.01
2.01
1.83
0.96
0.91
1.04
1.05
1.04
1.00
6.00
f1 (ppm)

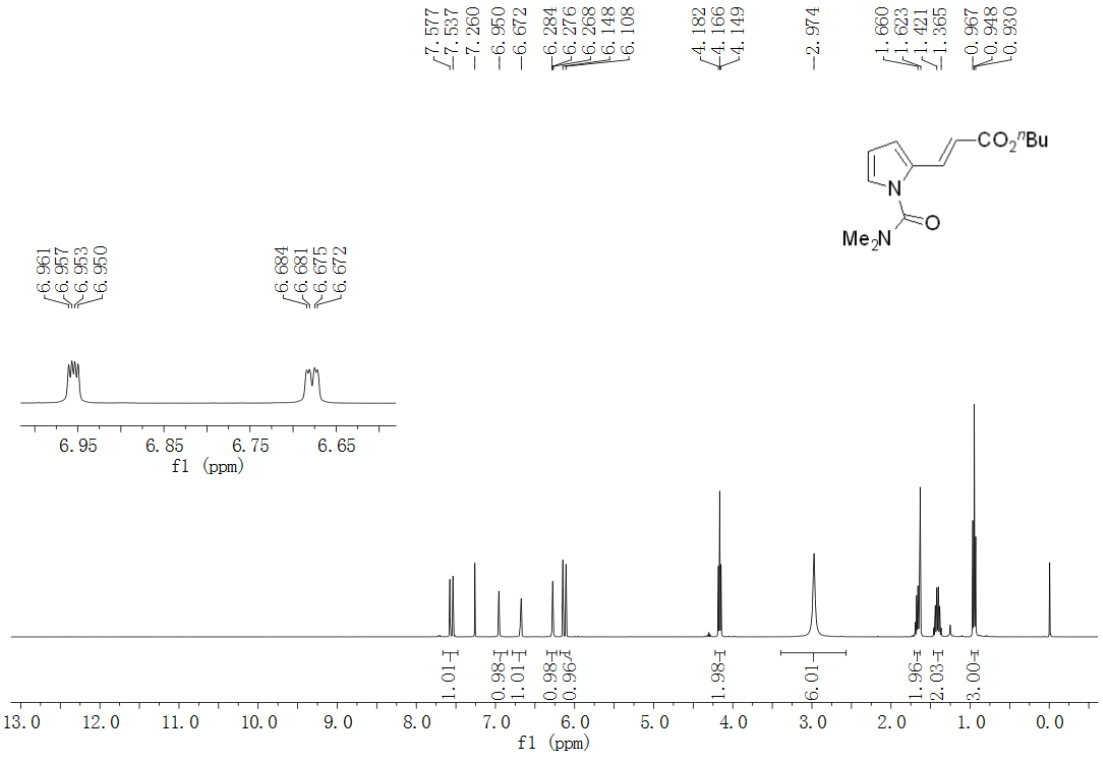

154.060
136.990
135.484
133.643
128.998
121.818
118.140
111.363
103.463
77.478
77.160
76.842
37.720
Cl
N
O
Me2N
f1 (ppm)

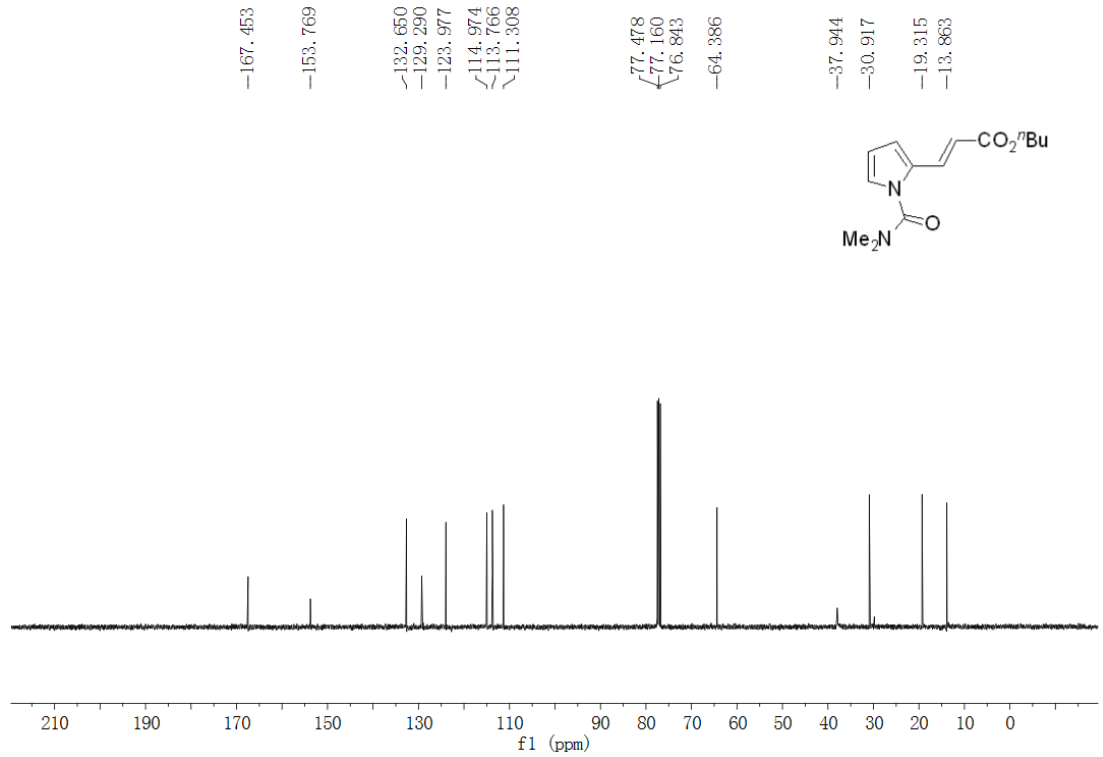

7.593
7.574
7.478
7.363
7.344
7.310
7.297
7.290
7.278
7.260
7.253
7.245
7.241
7.224
7.186
7.175
7.168
7.150
7.134
7.056
7.015
6.871
3.034
1.589
Cl
N
O
Me2N
f1 (ppm)
1.03
1.04
1.07
1.85
2.04
2.07
1.04
0.99
6.00

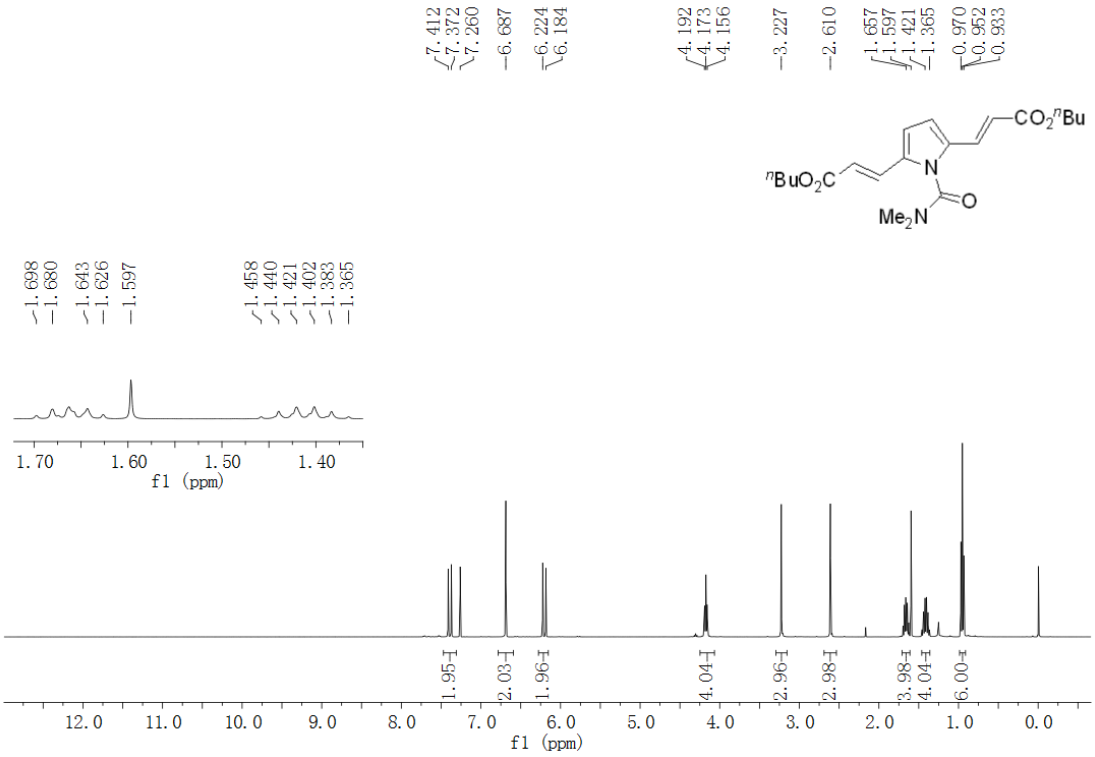

154.052
138.898
136.387
134.841
130.053
123.814
119.021
111.394
103.848
77.478
77.160
76.843
37.764
Cl
N
O
Me2N
f1 (ppm)

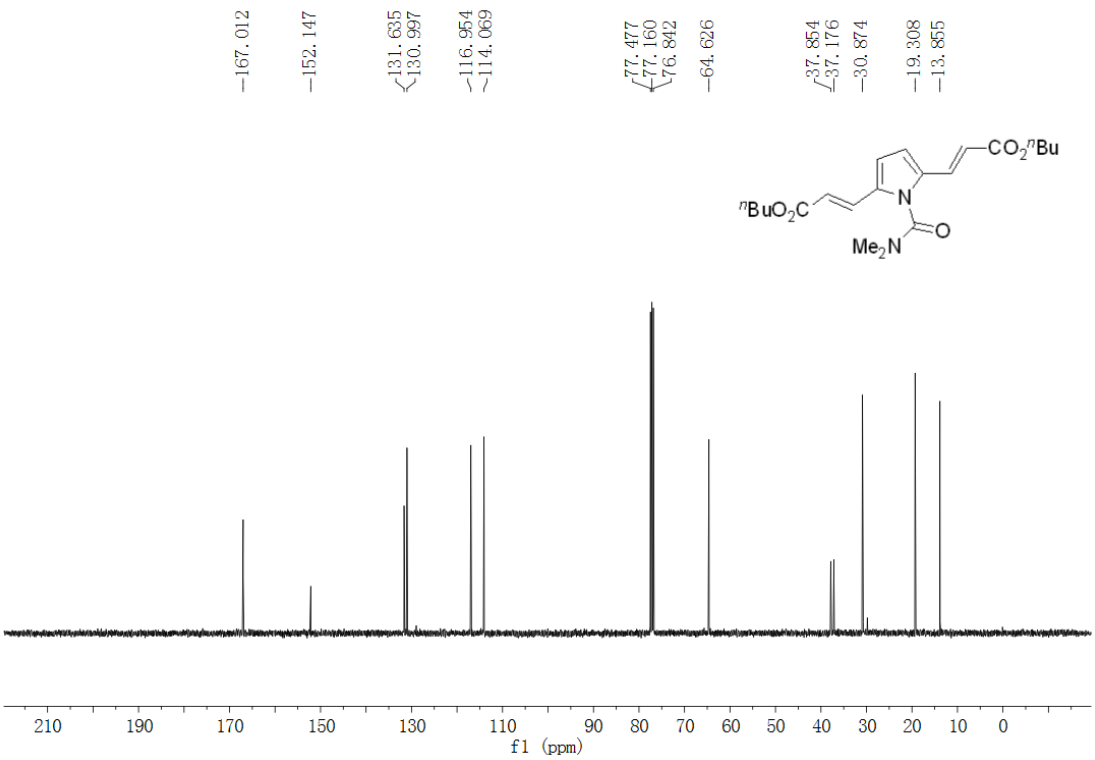

7.579
7.065
7.050
7.033
7.020
6.979
6.875
6.854
6.808
3.947
3.911
3.023
1.555
7.320
7.299
7.244
7.225
7.206
7.177
7.158
7.140
7.091
7.065
7.050
7.033
7.020
6.979
OMe
OMe
N
O
Me2N
7.25
7.15
7.05
f1 (ppm)
1.01
1.15
1.10
1.10
4.03
0.99
0.97
6.00
6.06
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

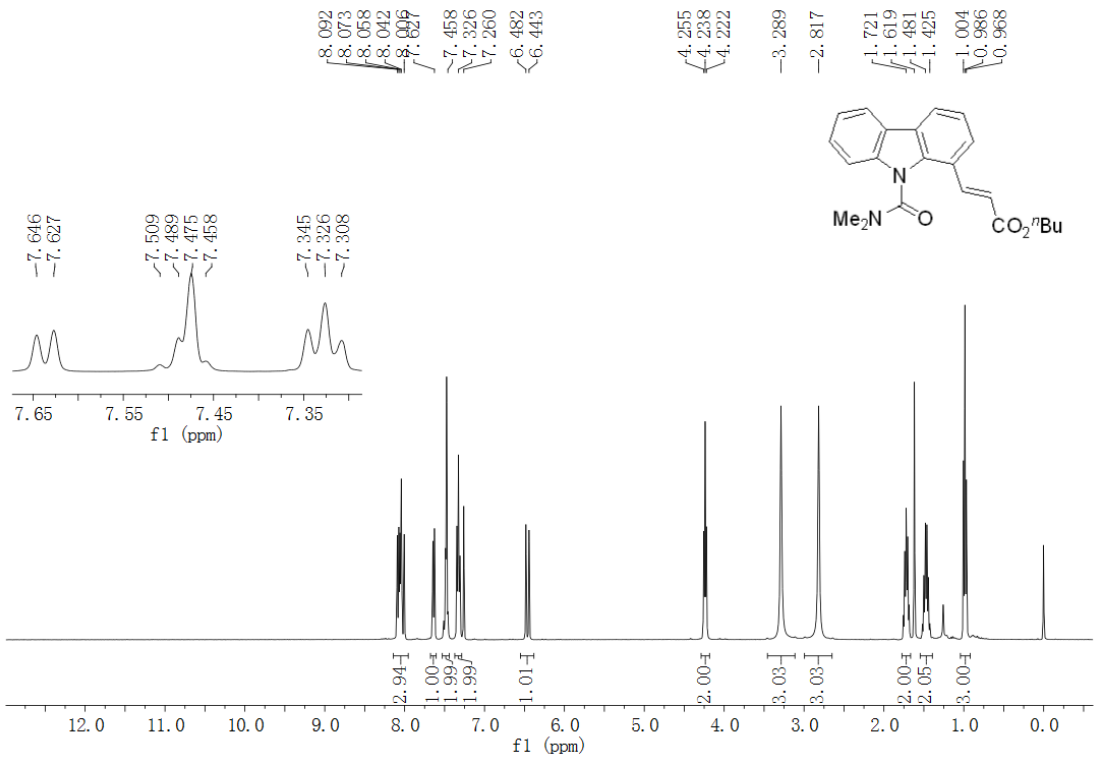

154.243
149.464
149.327
137.594
136.249
128.695
120.210
115.696
109.144
102.687
77.478
77.160
76.842
56.119
56.100
37.700
OMe
OMe
N
O
Me2N
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

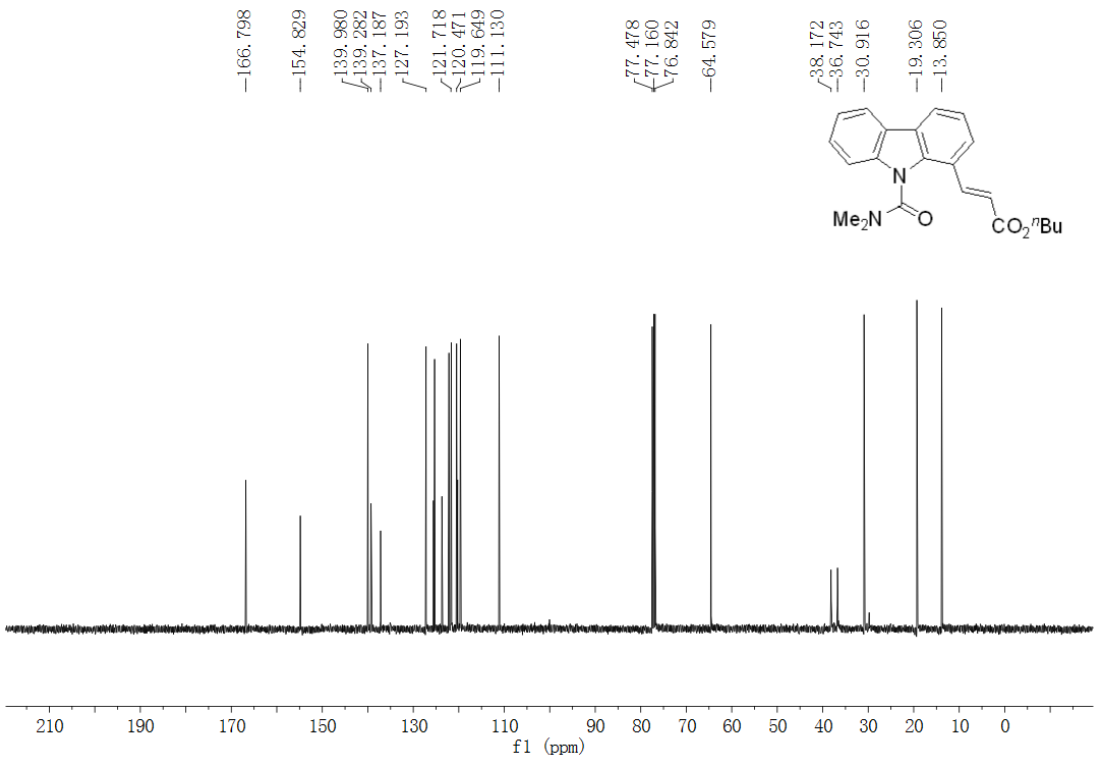

7.577
7.537
7.260
6.950
6.672
6.284
6.276
6.268
6.148
6.108
4.182
4.166
4.149
2.974
1.660
1.623
1.421
1.365
0.967
0.948
0.930
CO2nBu
N
O
Me2N
6.961
6.957
6.953
6.950
6.684
6.681
6.675
6.672
6.95
6.85
6.75
6.65
f1 (ppm)
1.01
0.98
1.01
0.98
0.96
1.98
6.01
1.96
2.03
3.00
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

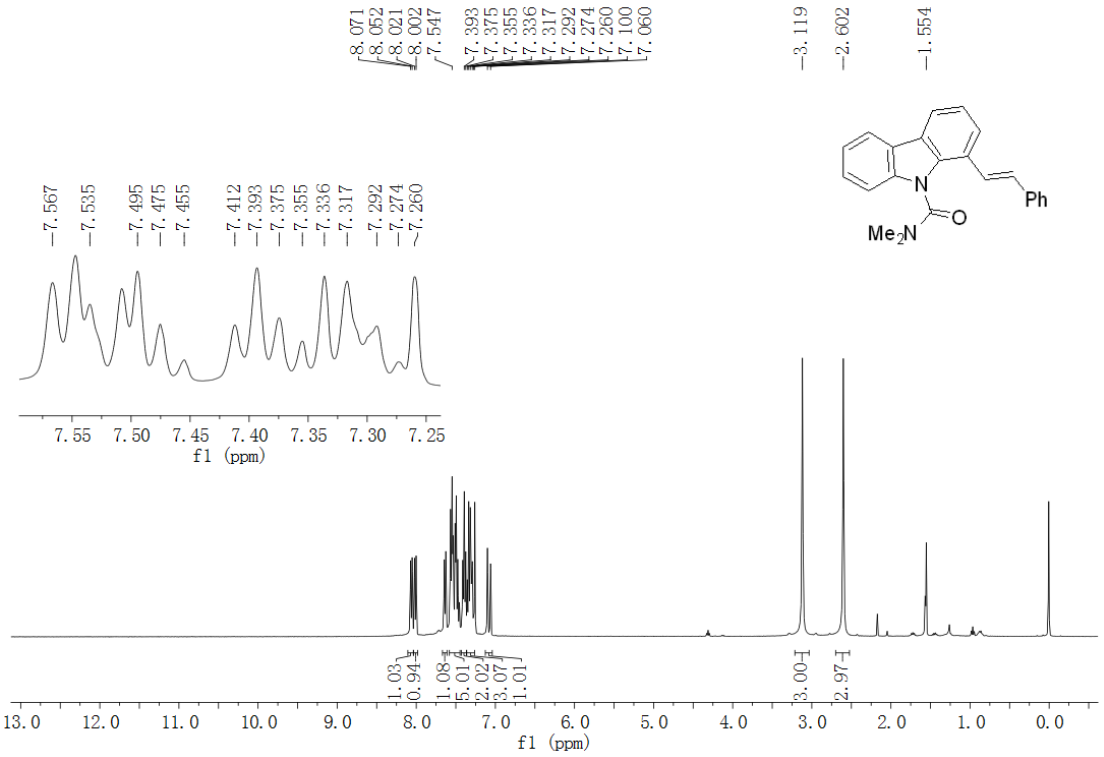

167.453
153.769
132.650
129.290
123.977
114.974
113.766
111.308
77.478
77.160
76.843
64.386
37.944
30.917
19.315
13.863
CO2nBu
N
O
Me2N
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

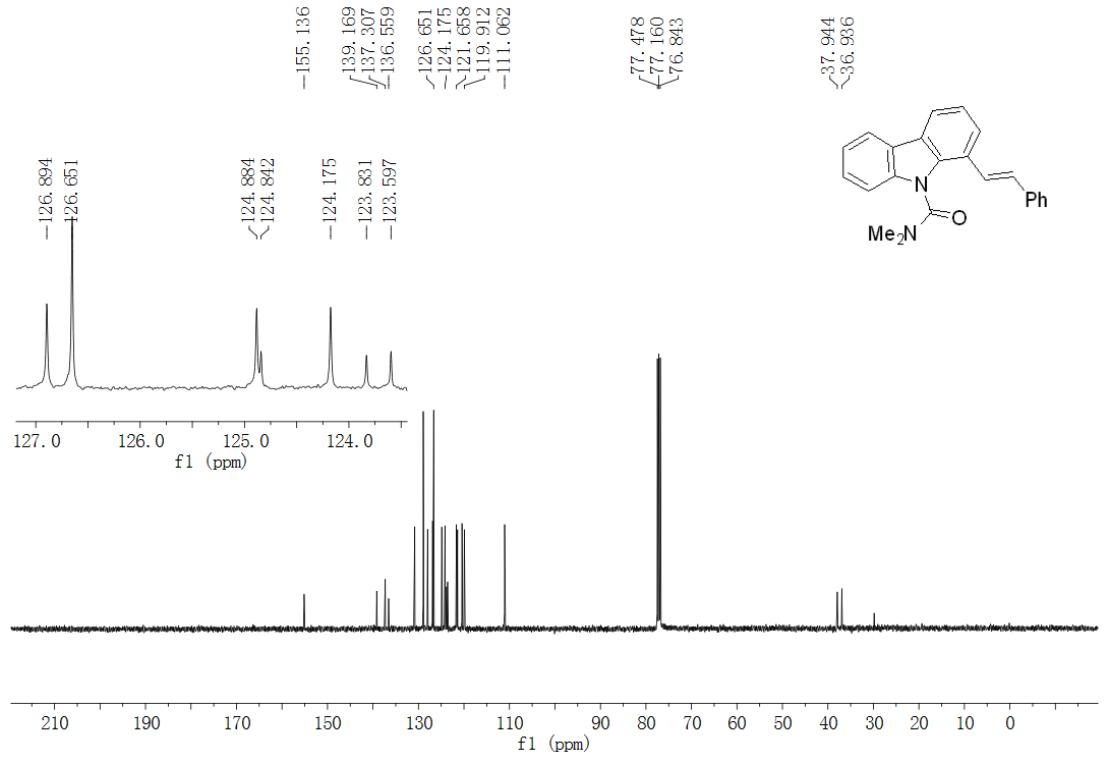

7.412
7.372
7.260
6.687
6.224
6.184
4.192
4.173
4.156
3.227
2.610
1.657
1.597
1.421
1.365
0.970
0.952
0.933
CO2nBu
nBuO2C
N
O
Me2N
1.698
1.680
1.643
1.626
1.597
1.458
1.440
1.421
1.402
1.383
1.365
1.70
1.60
1.50
1.40
f1 (ppm)
1.95
2.03
1.96
4.04
2.96
2.98
3.98
4.04
6.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

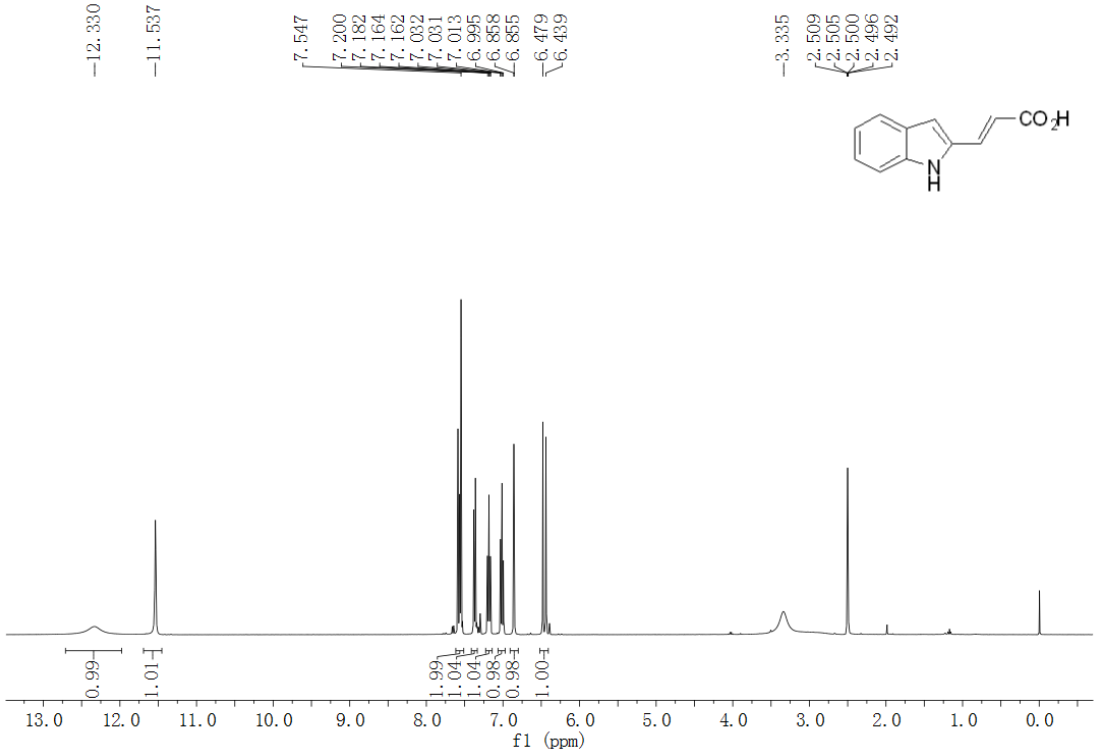

167.012
152.147
131.635
130.997
116.954
114.069
77.477
77.160
76.842
64.626
37.854
37.176
30.874
19.308
13.855
CO2nBu
nBuO2C
N
O
Me2N
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

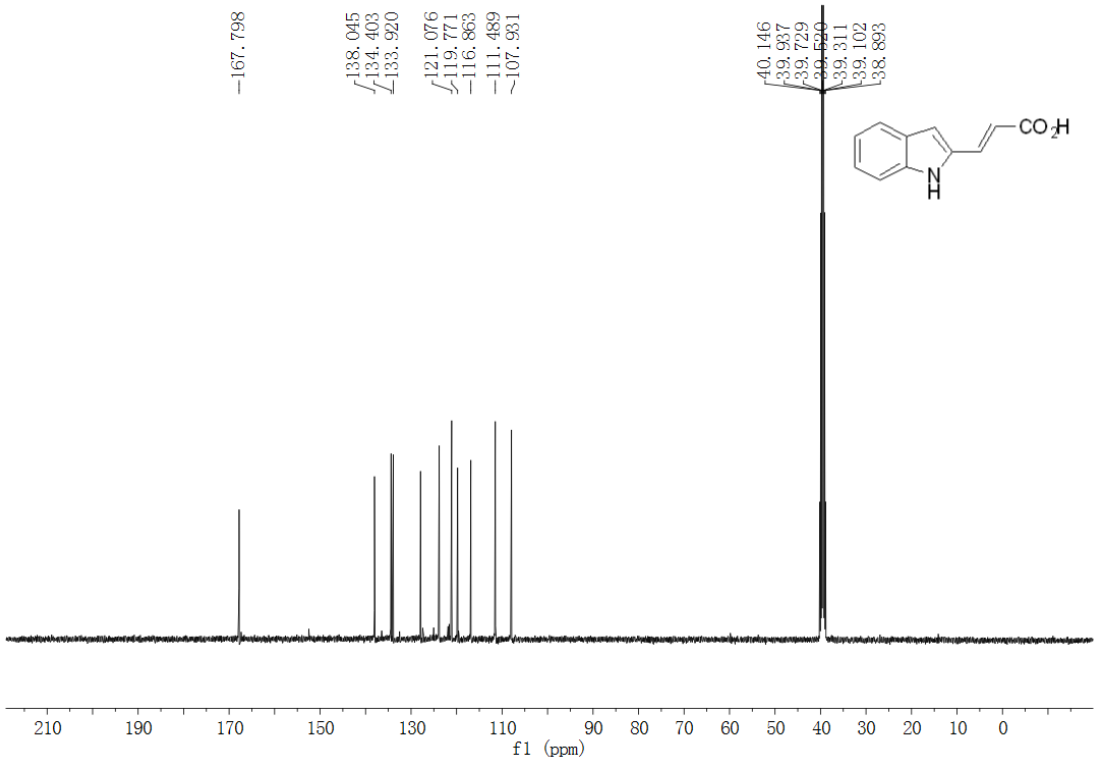

8.092
8.073
8.058
8.042
7.627
7.458
7.326
7.260
6.482
6.443
4.255
4.238
4.222
3.289
2.817
1.721
1.619
1.481
1.425
1.004
0.986
0.968
7.646
7.627
7.509
7.489
7.475
7.458
7.345
7.326
7.308
7.65
7.55
7.45
7.35
f1 (ppm)
Me2N
O
N
CO2nBu
2.94
1.00
1.99
1.99
1.01
2.00
3.03
3.03
2.00
2.05
3.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

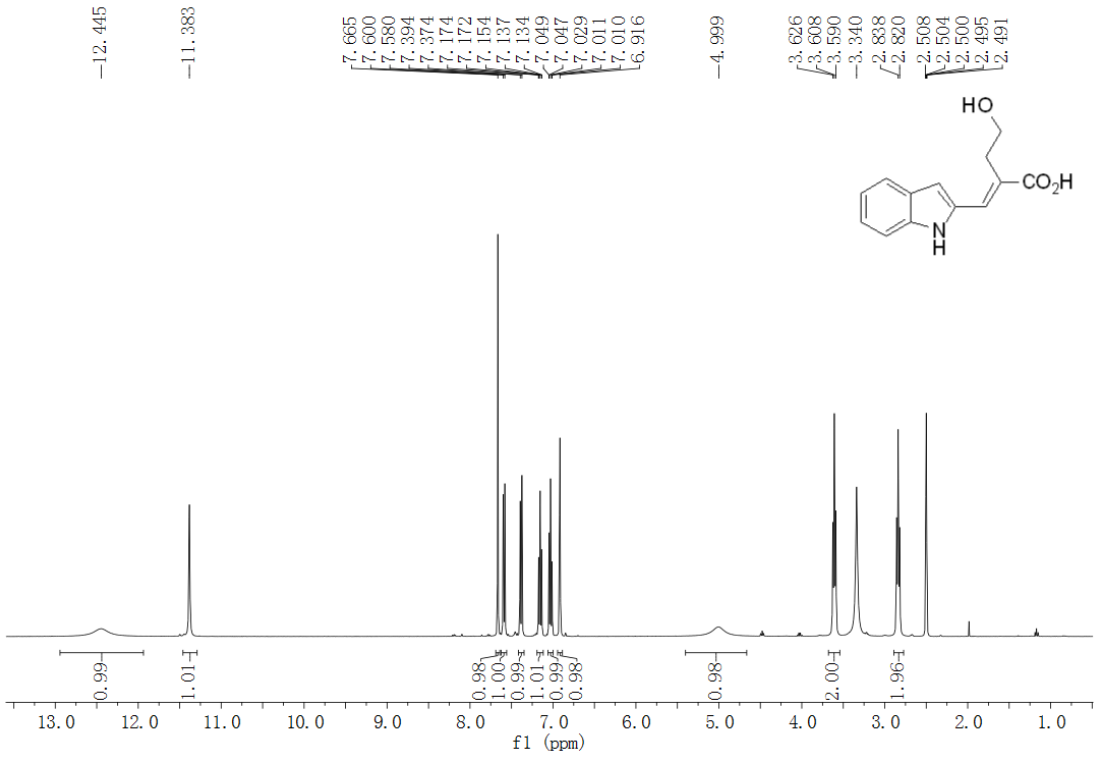

166.798
154.829
139.980
139.282
137.187
127.193
121.718
120.471
119.649
111.130
77.478
77.160
76.842
64.579
38.172
36.743
30.916
19.306
13.850
Me2N
O
N
CO2nBu
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

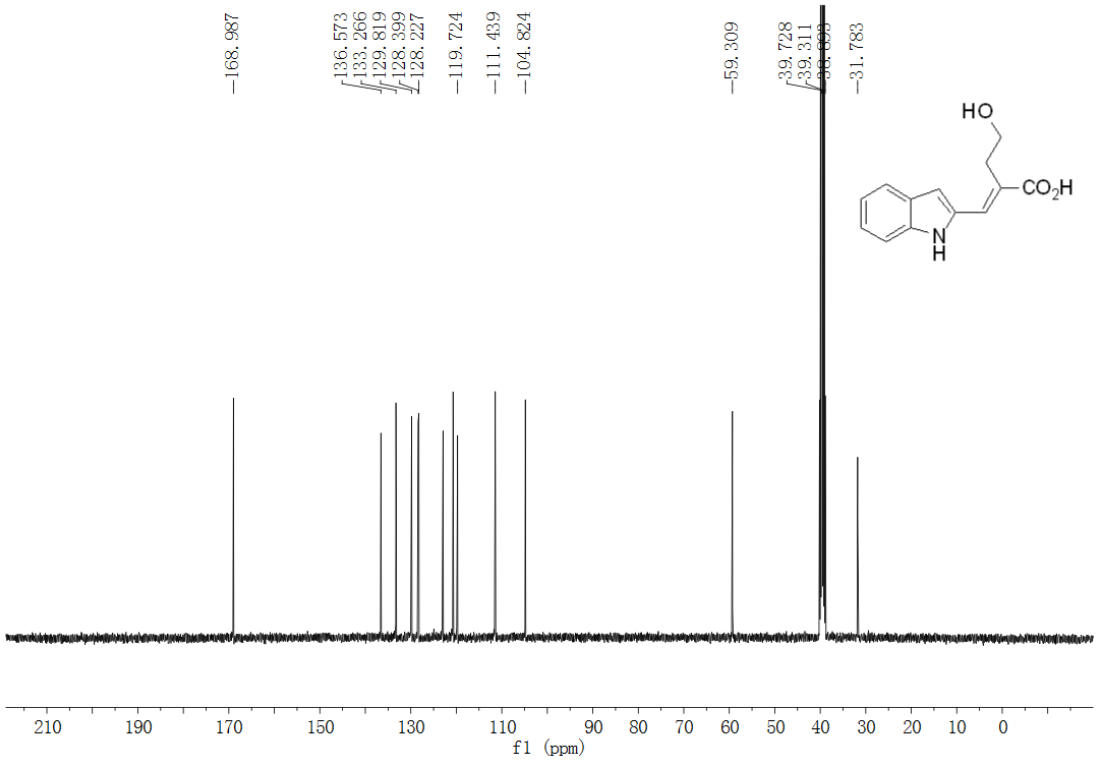

8.071
8.052
8.021
8.002
7.547
7.393
7.375
7.355
7.336
7.317
7.292
7.274
7.260
7.100
7.060
3.119
2.602
1.554
7.567
7.535
7.495
7.475
7.455
7.412
7.393
7.375
7.355
7.336
7.317
7.292
7.274
7.260
7.55 7.50 7.45 7.40 7.35 7.30 7.25
f1 (ppm)
Ph
N
O
Me2N
1.03
0.94
1.08
5.01
2.02
3.07
1.01
3.00
2.97
13.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

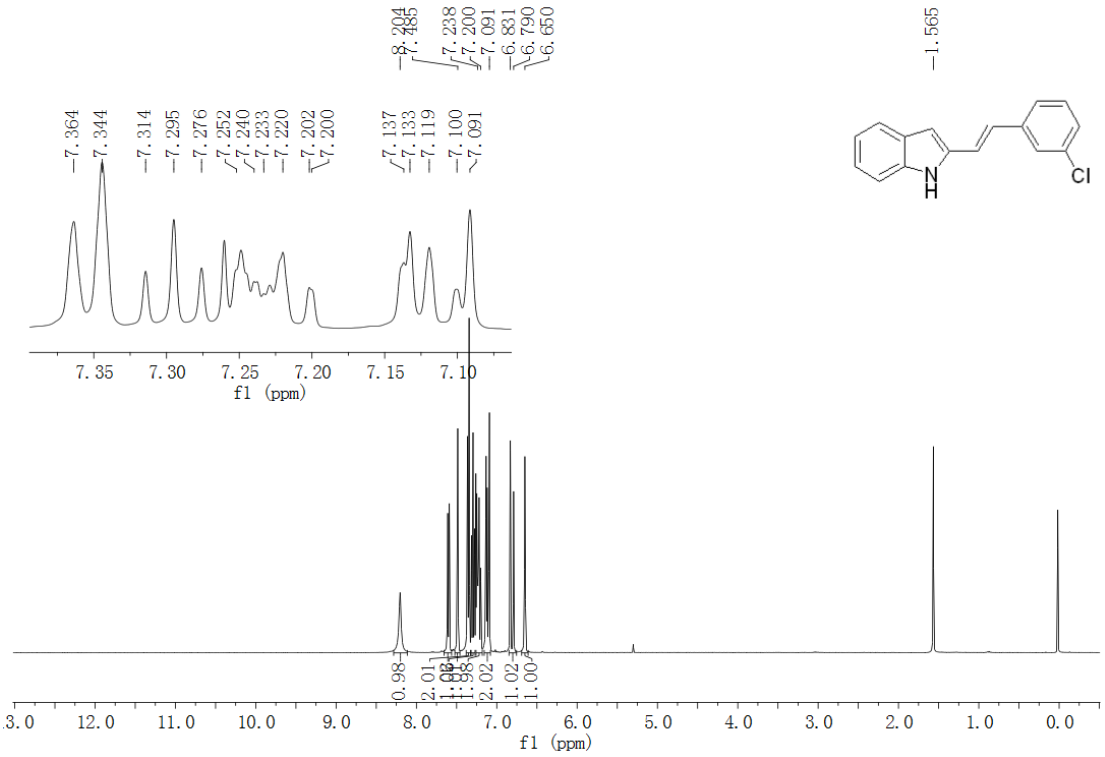

155.136
139.169
137.307
136.559
126.651
124.175
121.658
119.912
111.062
77.478
77.160
76.843
37.944
36.936
126.894
126.651
124.884
124.842
124.175
123.831
123.597
127.0 126.0 125.0 124.0
f1 (ppm)
Ph
N
O
Me2N
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

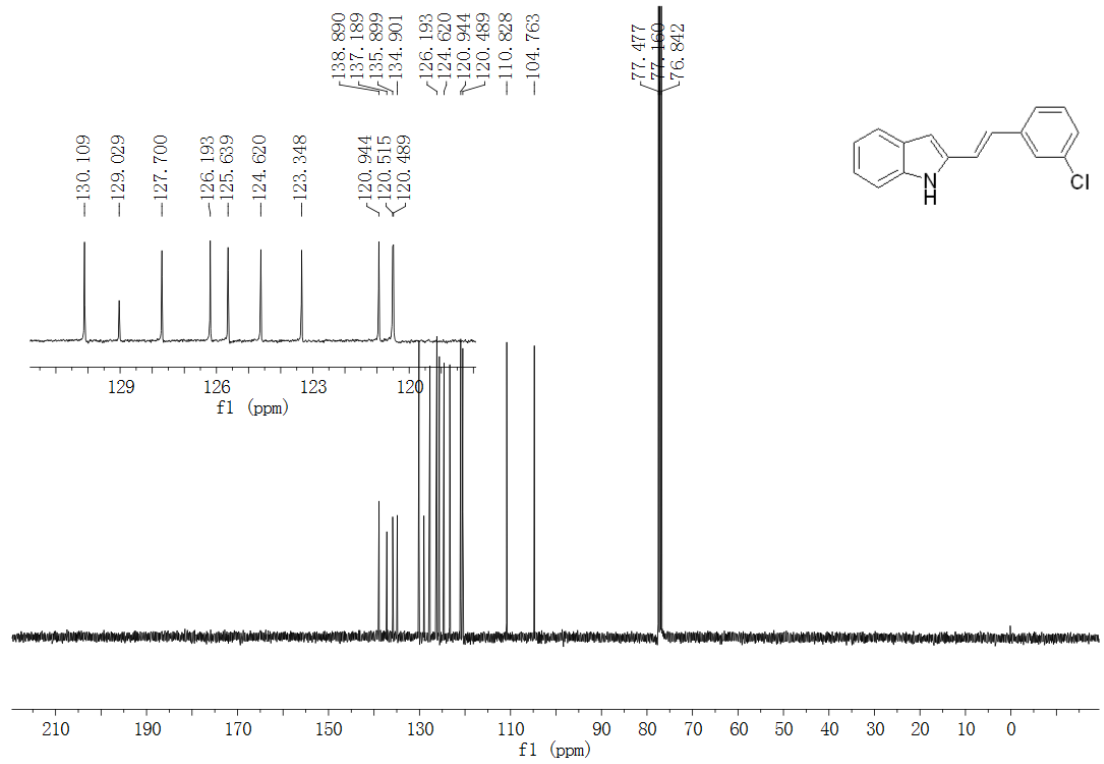

12.330
11.537
7.547
7.200
7.182
7.164
7.162
7.032
7.031
7.013
6.995
6.858
6.855
6.479
6.439
3.335
2.509
2.505
2.500
2.496
2.492
CO2H
N
H
0.99
1.01
1.99
1.04
1.04
0.98
0.98
1.00
13.0 12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)


167.798
138.045
134.403
133.920
121.076
119.771
116.863
111.489
107.931
40.146
39.937
39.729
39.520
39.311
39.102
38.893
CO2H
N
H
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


12.445
11.383
7.665
7.600
7.580
7.394
7.374
7.174
7.172
7.154
7.137
7.134
7.049
7.047
7.029
7.011
7.010
6.916
4.999
3.626
3.608
3.590
3.340
2.838
2.820
2.508
2.504
2.500
2.495
2.491
HO
CO2H
N
H
0.99
1.01
0.98
1.00
0.99
1.01
0.99
0.98
0.98
2.00
1.96
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
f1 (ppm)


168.987
136.573
133.266
129.819
128.399
128.227
119.724
111.439
104.824
59.309
39.728
39.311
31.783
HO
CO2H
N
H
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.204
8.485
7.238
7.200
7.091
6.831
6.790
6.650
1.565
7.364
7.344
7.314
7.295
7.276
7.252
7.240
7.233
7.220
7.202
7.200
7.137
7.133
7.119
7.100
7.091
N
H
Cl
7.35
7.30
7.25
7.20
7.15
7.10
f1 (ppm)
0.98
2.01
1.08
1.98
2.02
1.02
1.00
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


138.890
137.189
135.899
134.901
126.193
124.620
120.944
120.489
110.828
104.763
77.477
77.160
76.842
130.109
129.029
127.700
126.193
125.639
124.620
123.348
120.944
120.515
120.489
N
H
Cl
129
126
123
120
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)