Supporting Information

Regioselective synthesis of polycyclic sulfones *via* radical-induced three-component bicyclization cascades

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Context

Experimental

General Information

^{1}H NMR (^{13}C NMR) spectra were measured on a Bruker DPX 400 MHz spectrometer in $CDCl_3$ (DMSO-d_6) with chemical shift (δ) given in ppm relative to TMS as internal standard [(s = singlet, d = doublet, t = triplet, brs = broad singlet, m = multiplet), coupling constant (Hz)]. HRMS (ESI) was determined by using microTOF-QII HRMS/MS instrument (BRUKER). X-Ray crystallographic analysis was performed with a Siemens SMART CCD and a Siemens P4 diffractometer.

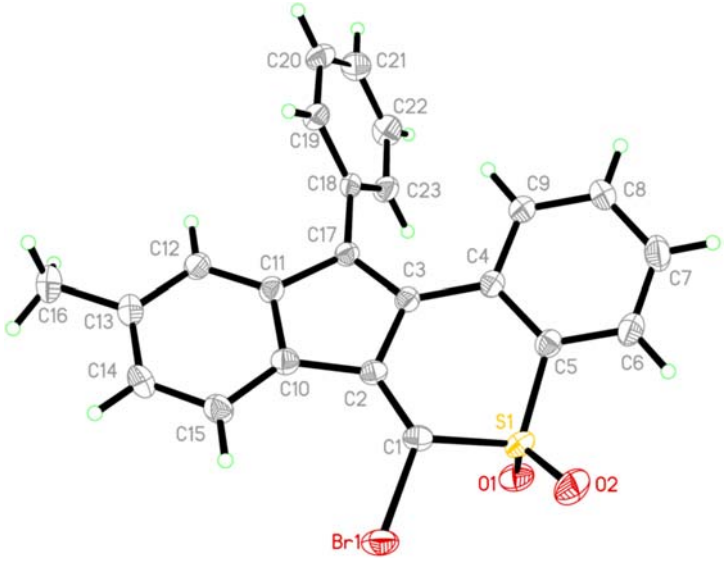
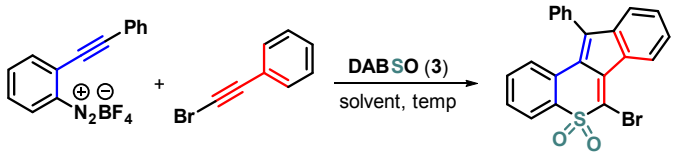


Figure S1 The ORTEP Drawing of **4g** (The ellipsoid contour 30% probability levels)

Table S1 Optimization of the reaction conditions for **4a**



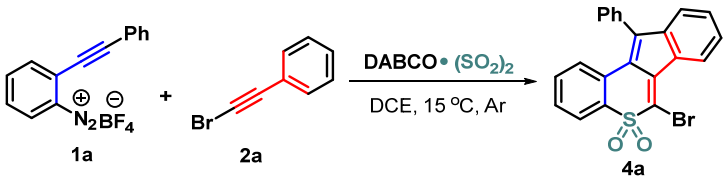
1a **2a** **4a**

Entry	Ratio (**1a**:**2a**:**3**)	Solvent	*t* (°C)	Yield[b] (%)
1	1:1:1	DCE	rt	48
2	1.1:1:1.1	DCE	rt	52
3	1.2:1:1.2	DCE	rt	45
4	1.5:1:1.5	DCE	rt	41
5	1.1:1:1.1	DCM	rt	45
6	1.1:1:1.1	CH_3CN	rt	trace
7	1.1:1:1.1	THF	rt	trace
8	1.1:1:1.1	1,4-dioxane	rt	trace
9	1.1:1:1.1	DCE	30	46
10	1.1:1:1.1	DCE	15	60
11	1.1:1:1.1	DCE	10	52
12	1.1:1:1.1	DCE	15	65[c]

[a]Reaction conditions: **1a** (x equiv), **2a** (0.2 mmol), DABSO (**3**, x equiv); solvent (2.5 mL); 0.5 h. [b]Isolated yield based on **2a**. [c]Under Ar conditions.

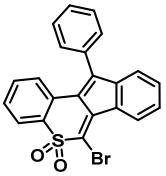
General Procedure for the Synthesis of Products 4.

Example for the synthesis of **4a**:



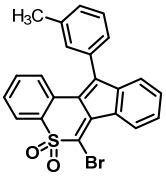
To a 10 mL Schlenk tube under Ar conditions, 2-(phenylethynyl)benzenediazonium tetrafluoroborate (**1a**, 0.22 mmol, 64.2 mg, 1.1 equiv), 1,4-diazabicyclo[2.2.2]octane-bis(sulfur dioxide) adduct (0.22 mmol, 48.4 mg, 1.1 equiv), (bromoethynyl)benzene (**2a**, 0.2 mmol, 36 mg, 1 equiv) and 1,2-dichloroethane (2.5 mL) were successively added. Then, the tube was stirred at 15 °C for 0.5 h until complete consumption of **2a**, as monitored by TLC analysis. After the reaction was completed, the reaction mixture was concentrated in vacuum and the resulting residue was purified by column chromatography on silica gel (eluent, petroleum ether/ethyl acetate = 5:1) to afford the desired product **4a** as a red solid.

6-Bromo-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4a)



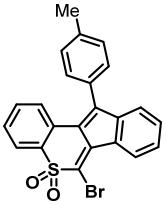
red solid; 54.7 mg, 65% yield; mp: 273-274 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.41-8.38 (m, 1H), 8.04 (d, J = 8.4 Hz, 1H), 7.60-7.55 (m, 3H), 7.45-7.43 (m, 2H), 7.3-7.31 (m, 3H), 7.19 (d, J = 3.6 Hz, 2H), 7.02-7.00 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 148.0, 145.3, 143.2, 134.4, 134.1, 133.8, 132.0, 131.2, 129.7, 129.5, 128.7, 128.5, 128.3, 128.2, 127.2, 125.5, 124.9, 124.4, 122.8, 120.8; IR (KBr, *v*, cm^{-1}): 3049, 1599, 1540, 1451, 1301, 818, 701; HRMS (APCI) m/z calcd for $C_{22}H_{14}BrO_2S$ $[M+H]^+$420.9898, found 420.9914.

6-Bromo-11-(m-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4b)



red solid; 58.3 mg, 67% yield; mp: 203-204 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) : 8.40-8.38 (m, 1H), 8.04 (d, J=8.0 Hz, 1H), 7.48-7.44 (m, 1H), 7.40-7.32 (m, 4H), 7.24-7.20 (m, 4H), 7.02-7.00 (m, 1H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 148.3, 145.4, 143.3, 139.6, 134.5, 134.0, 133.7, 132.0, 131.2, 130.2, 129.6, 128.8, 128.5, 128.5, 128.3, 127.3, 125.4, 125.2, 124.9, 124.2, 122.8, 120.6, 77.3, 77.2, 77.0, 76.7, 21.5; IR (KBr, *v*, cm^{-1}): 3065, 1558, 1507, 1450, 1302, 791, 708; HRMS (APCI) m/z calcd for $C_{23}H_{16}BrO_2S$ $[M+H]^+$435.0054, found 435.0050.

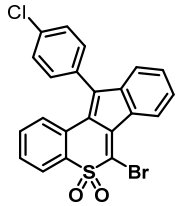
6-Bromo-11-(p-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4c)



red solid; 61.8 mg, 71% yield; mp: 199-200 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.24 (d, *J* = 8.4 Hz, 1H), 7.99 (d, *J* = 2.0, 1H), 7.60-7.56 (m, 3H), 7.42-7.40 (m, 2H), 7.27(s,1H), 7.14-7.07 (m, 3H), 6.79 (s, 1H), 2.32 (s, 3H); ^{13}C NMR

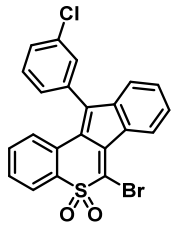
(100 MHz, $CDCl_3$) (δ, ppm) : 148.3, 145.3, 143.3, 139.6, 134.5, 134.0, 132.0, 131.1, 130.6, 130.4, 128.9, 128.5, 128.2, 128.2, 127.2, 125.39, 124.9, 124.2, 122.8, 120.4, 21.6; IR (KBr, *v*, cm^{-1}): 3064, 1558, 1506, 1457, 1302, 757; HRMS (APCI) m/z calcd for $C_{23}H_{16}BrO_2S$ $[M+H]^+$ 435.0054, found 435.0051.

6-Bromo-11-(4-chlorophenyl)indeno[1,2-c]thiochromene 5,5-dioxide (4d)



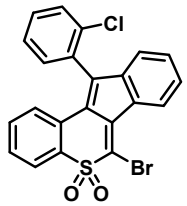
red solid; 64.1 mg, 55% yield; mp: 198-200 °C; ^1H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.40-7.38 (m, 1H), 8.04 (d, *J* = 8.0 Hz, 1H), 7.46-7.43 (m, 2H), 7.41-7.34 (m, 3H), 7.31-7.28 (m, 1H), 7.27-7.22 (m, 2H), 7.19-7.17 (m, 1H), 7.01-6.99 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) : 164.6, 162.1, 146.8, 145.1, 143.1, 134.4, 134.2, 132.2, 131.3, 130.4, 130.3, 129.6, 129.6, 128.7, 128.6, 128.5, 127.1, 125.5, 125.1, 124.7, 122.6, 121.1, 117.2, 117.0; IR (KBr, *v*, cm^{-1}): 3065, 1558, 1508, 1457, 1303, 757; HRMS (APCI) m/z calcd for $C_{22}H_{13}BrClO_2S$ $[M+H]^+$ 454.9508, found 454.9512.

6-Bromo-11-(3-chlorophenyl)indeno[1,2-c]thiochromene 5,5-dioxide (4e)



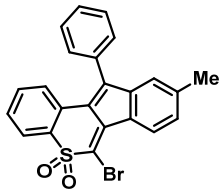
red solid; 43.7 mg, 48% yield; mp: 197-199 °C; ^1H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.41-8.38 (m, 1H), 8.05 (d, *J* = 8.0 Hz, 1H), 7.54-7.50 (m, 2H), 7.45-7.39 (m, 2H), 7.37-7.32 (m, 3H), 7.26-7.24 (m, 1H), 7.17 (d, *J* = 8.4 Hz, 1H), 7.00-6.98 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) : 146.0, 144.9, 143.0, 135.8, 135.7, 134.3, 132.3, 131.4, 131.2, 129.7, 128.8, 128.7, 128.3, 128.2, 127.2, 126.6, 125.6, 125.1, 124.9, 122.6, 121.6; IR (KBr, *v*, cm^{-1}): 3064, 1557, 1506, 1455, 1303, 757; HRMS (APCI) m/z calcd for $C_{22}H_{13}BrClO_2S$ $[M+H]^+$ 454.9508, found 454.9510.

6-Bromo-11-(2-chlorophenyl)indeno[1,2-c]thiochromene 5,5-dioxide (4f)



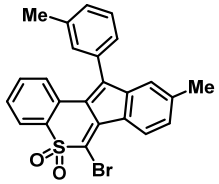
red solid; 31.9 mg, 35% yield; mp: 197-198 °C; ^1H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.43-8.41 (m, 1H), 8.05 (d, *J* = 8.0 Hz, 1H), 7.66-7.64 (m, 1H), 7.53-7.48 (m, 2H), 7.43-7.39 (m, 1H), 7.36-7.31 (m, 3H), 7.26-7.23 (m, 1H), 7.06 (d, *J* = 8.4 Hz, 1H), 6.63-6.61 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) : 144.8, 144.7, 142.6, 134.2, 134.0, 133.3, 133.0, 132.6, 131.4, 130.8, 129.8, 128.7, 128.6, 128.3, 128.1, 126.4, 125.6, 125.3, 125.0, 122.5, 121.6; IR (KBr, *v*, cm^{-1}): 3066, 1557, 1506, 1456, 1303, 757; HRMS (APCI) m/z calcd for $C_{22}H_{13}BrClO_2S$ $[M+H]^+$ 454.9508, found 454.9509.

6-Bromo-9-methyl-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4g)



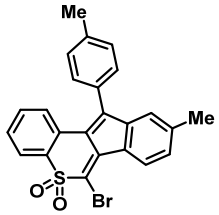
red solid; 62.3 mg, 73% yield; mp: 173-174 °C;^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.26-8.24 (m, 1H), 8.03 (d, *J* = 8.0 Hz, 1H), 7.61-7.55 (m, 3H), 7.44-7.42 (m, 2H), 7.38-7.34 (m, 1H), 7.20-7.12 (m, 3H), 6.79 (s, 1H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 148.0, 145.6, 143.2, 141.9, 134.1, 133.9, 132.0, 131.7, 129.7, 129.4, 129.0, 128.6, 128.2, 128.2, 127.1, 125.4, 124.9, 124.6, 123.8, 119.7, 21.8; IR (KBr, *v*, cm^{-1}): 3060, 1594, 1490, 1442, 1361, 818, 698; HRMS (APCI) m/z calcd for $C_{23}H_{16}BrO_2S$ $[M+H]^+$ 435.0054, found 435.0064.

6-Bromo-9-methyl-11-(m-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4h)



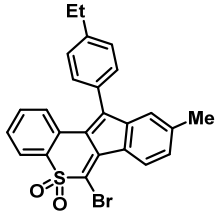
red solid; 67.4 mg, 75% yield; mp: 288-289 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) : 8.25 (d, J = 8.0 Hz, 1H), 8.03 (d, J = 8.0 Hz, 1H), 7.46 (d, J = 7.6 Hz, 1H), 7.37-7.35 (m, 2H), 7.23-7.18 (m, 4H), 7.12 (d, J = 7.6 Hz, 1H), 6.79 (s, 1H), 2.45 (s, 3H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) :148.3, 145.7, 143.2, 141.9, 139.6, 134.1, 133.9, 132.0, 131.7, 130.2, 129.6, 129.0, 128.9, 128.5, 128.17, 127.2, 125. 3, 125.2, 124.8, 124.5, 123.8, 119.6, 21.8, 21.6; IR (KBr, *v*, cm^{-1}): 2965, 1595, 1506, 1456, 1308, 820, 711; HRMS (APCI) m/z calcd for $C_{24}H_{18}BrO_2S$ $[M+H]^+$ 449.0211, found 449.0213.

6-Bromo-9-methyl-11-(p-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4i)



red solid; 69.1 mg, 77% yield; mp: 236-237 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.40-8.37 (m, 1H), 7.91 (d, J = 8.0 Hz, 1H), 7.38 (d, J = 8.0 Hz, 2H), 7.34-7.31 (m, 4H), 7.17 (d, J = 8.4 Hz, 1H), 7.05-7.02 (m, 2H), 2.49 (s, 3H), 2.07 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 148.3, 145.6, 143.3, 141.8, 139.5, 134.1, 131.9, 131.6, 130.8, 130.4, 128.9, 128.9, 128.1, 127.1, 125.3, 124.8, 124.4, 123.8, 119.4, 21.8, 21.6; IR (KBr, *v*, cm^{-1}): 3026, 1593, 1504, 1458, 1298, 815, 728; HRMS (APCI) m/z calcd for $C_{24}H_{18}BrO_2S$ $[M+H]^+$ 449.0211, found 449.0235.

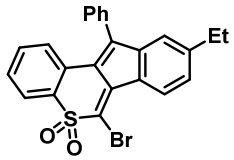
6-Bromo-11-(4-ethylphenyl)-9-methylindeno[1,2-c]thiochromene 5,5-dioxide (4j)



red solid; 72.2 mg, 78% yield; mp: 204-205 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.24 (d, *J* = 8.0 Hz, 1H), 8.04-8.01 (m, 1H), 7.41-7.33 (m, 5H), 7.24-7.17 (m, 2H), 7.13-7.11 (m, 1H), 6.83 (s, 1H), 2.83-2.77 (m, 2H), 2.32 (s,

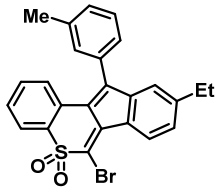
3H), 1.38-1.34 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 148.3, 145.8, 145.6, 143.4, 141.8, 134.1, 132.0, 131.8, 131.0, 129.16, 129.0, 128.9, 128.2, 128.1, 127.2, 125.3, 124.8, 124.4, 123.8, 119.3, 28.8, 21.8, 15.3; IR (KBr, *v*, cm^{-1}): 2964, 1595, 1506, 1456, 1313, 818, 725; HRMS (APCI) m/z calcd for $C_{25}H_{20}BrO_2S$ $[M+H]^+$ 463.0367, found 463.0349.

6-Bromo-9-ethyl-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4k)



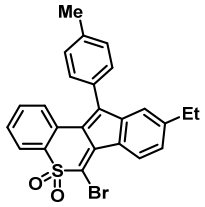
red solid; 67.4 mg, 75% yield; mp: 210-215 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.29 (d, *J* = 8 Hz, 1H), 8.04-8.02 (m, 1H), 7.60-7.56 (m, 3H), 7.45-7.43 (m, 2H), 7.36 (d, *J* = 0.8 Hz, 1H), 7.18-7.15 (m, 3H), 6.81 (d, *J* = 1.2 Hz, 1H), 2.64-2.58 (m, 2H), 1.22-1.18 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 148.3, 148.1, 145.6, 143.2, 134.2, 133.9, 132.0, 132.0, 129.7, 129.4, 128.8, 128.2, 127.8, 127.1, 125.5, 124.9, 124.6, 122.7, 119.7, 29.1, 15.4; IR (KBr, *v*, cm^{-1}): 2966, 1593, 1489, 1443, 1310, 823, 700; HRMS (APCI) m/z calcd for $C_{24}H_{18}BrO_2S$ $[M+H]^+$ 449.0211, found 449.0237.

6-Bromo-9-ethyl-11-(m-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4l)



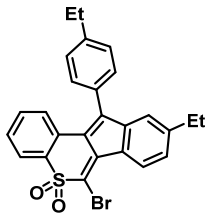
red solid; 71.3 mg, 77% yield; mp: 241-242 °C;^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.28 (d, *J* = 8.0 Hz, 1H), 8.03 (d, *J* = 8.0 Hz, 1H), 7.49-7.46 (m, 1H), 7.37-7.34 (m, 2H), 7.24-7.14 (m, 5H), 6.81 (s, 1H), 2.64-2.58 (m, 2H), 2.45 (s, 3H), 1.22-1.18 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm):148.4, 148.3, 145.7, 143.3, 139.6, 134.1, 133.9, 132.0, 130.2, 129.62, 128.9, 128.6, 128.2, 127.8, 127.2, 125.5, 125.2, 124.8, 124.5, 122.7, 119. 6, 29.1, 21.6, 15.4; IR (KBr, *v*, cm^{-1}): 2963, 1596, 1506, 1422, 1307, 821, 707; HRMS (APCI) m/z calcd for $C_{25}H_{20}BrO_2S$ $[M+H]^+$ 463.0367, found 463.0363.

6-Bromo-9-ethyl-11-(p-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4m)



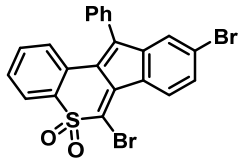
red solid; 64.8 mg, 79% yield; mp: 236-237 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.27 (d, *J* = 8.0 Hz, 1H), 8.04-8.01 (m, 1H), 7.40-7.32 (m, 8.0, 5H), 7.24-7.14 (m, 3H), 6.84 (d, *J* = 1.2 Hz, 1H), 2.64-2.58 (m, 2H), 2.50 (s, 3H), 1.22-1.18 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 148.3, 148.3, 145.7, 143.4, 139.5, 134.1, 132.0, 131.9, 130.8, 130.4, 129.0, 128.2, 128.1, 127.8, 127.1, 125.5, 124.8, 124.4, 122.7, 119.4, 29.1, 21.6, 15.4; IR (KBr, *v*, cm^{-1}): 2964, 1595, 1506, 1436, 1303, 832, 718; HRMS (APCI) m/z calcd for $C_{25}H_{20}BrO_2S$ $[M+H]^+$ 463.0367, found 463.0357.

6-Bromo-9-ethyl-11-(4-ethylphenyl)indeno[1,2-c]thiochromene 5,5-dioxide (4n)



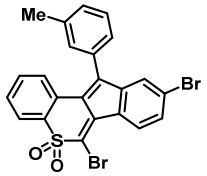
red solid; 78.2 mg, 82% yield; mp: 280-283 °C;^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.25 (d, *J* = 8.4 Hz, 1H), 8.05-8.03 (m, 1H), 7.47 (d, *J* = 1.6 Hz, 1H), 7.45 (d, *J* = 2.0 Hz, 1H), 7.43-7.37 (m, 2H), 7.35-7.33(m, 2H), 7.25-7.20 (m, 2H), 7.15 (d, *J* = 0.8 Hz, 1H), 2.83-2.77 (m, 4H), 1.38-1.34 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.2, 146.8, 146.2, 142.4, 134.2, 133.0, 132.1, 131.0, 130.2, 129.4, 128.6, 128.4, 128.1, 127.4, 126.3, 125.9, 125.8, 125.2, 124.9, 121.5, 28.8, 15.3; IR (KBr, *v*, cm^{-1}): 2965, 1569, 1508, 1447, 1302, 832, 689; HRMS (APCI) m/z calcd for $C_{26}H_{22}BrO_2S$ $[M+H]^+$ 477.0524, found 477.0529.

6,9-Dibromo-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4o)



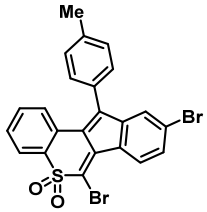
red solid; 59.0 mg, 59% yield; mp: 248-249 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.41-8.38 (m, 1H), 8.04 (d, *J* = 8.4 Hz, 1H), 7.60-7.53 (m, 3H), 7.45-7.43 (m, 2H), 7.39-7.31 (m, 2H), 7.20-7.19 (m, 2H), 7.02-7.00 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.1, 146.5, 142.2, 137.5, 134.3, 133.2, 132.5, 132.2, 130.0, 129.8, 128.8, 128.2, 128.1(0), 128.1(8), 127.3, 126.2, 125.5, 125.0, 123.0, 121.8; IR (KBr, *v*, cm^{-1}): 3070, 1594, 1490, 1441, 1311, 830, 711; HRMS (APCI) m/z calcd for $C_{22}H_{13}Br_2O_2S$ $[M+H]^+$ 500.8983, found 500.8990.

6,9-Dibromo-11-(m-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4p)



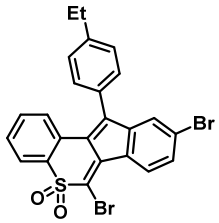
red solid; 62.7 mg, 61% yield; mp: 189-191 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.25 (d, *J* = 8.0 Hz, 1H), 8.04 (d, *J* = 8.4 Hz, 1H), 7.48-7.45 (m, 2H), 7.40-7.36 (m, 2H), 7.23-7.20 (m, 4H), 7.11 (d, *J* = 0.8 Hz, 1H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.3, 146.8, 142.3, 139.9, 134.2, 133.1, 132.9, 132.2, 131.0, 130.5, 129.9, 128.7, 128.4, 128.3, 127.4, 126.3, 125.9, 125.81, 125.2, 125.0, 124.9, 121.7, 21.6; IR (KBr, *v*, cm^{-1}): 3065, 1558, 1507, 1450, 1302, 791, 708; HRMS (APCI) m/z calcd for $C_{23}H_{15}Br_2O_2S$ $[M+H]^+$ 514.9139, found 514.9130.

6,9-Dibromo-11-(p-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4q)



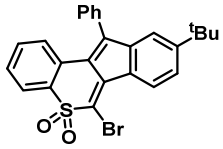
red solid; 64.8 mg, 63% yield; mp: 263-264 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.24 (d, *J* = 8.0 Hz, 1H), 8.05-8.03 (m, 1H), 7.47-7.45 (m, 1H), 7.41-7.37 (m, 3H), 7.31 (d, *J* = 8.0 Hz, 2H), 7.26-7.22 (m, 2H), 7.14 (d, *J* = 0.8 Hz, 1H), 2.50 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.2, 146.8, 142.4, 140.0, 134.2, 133.0, 132.1, 131.0, 130.6, 130.0, 128.7, 128.4, 128.0, 127.3, 126.3, 125.9, 125.8, 125.2, 124.9, 121.5, 21.6; IR (KBr, *v*, cm^{-1}): 3026, 1593, 1504 1458, 1298, 815, 728; HRMS (APCI) m/z calcd for $C_{23}H_{15}Br_2O_2S$ $[M+H]^+$ 514.9139, found 514.9142.

6,9-Dibromo-11-(4-ethylphenyl)indeno[1,2-c]thiochromene 5,5-dioxide (4r)



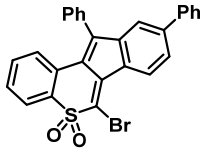
red solid; 67.6 mg, 64% yield; mp: 244-245 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.25 (d, *J* = 8.4 Hz, 1H), 8.04 (d, *J* = 8.0 Hz, 1H), 7.47-7.33 (m, 7H), 7.22 (s, 1H), 7.15 (s, 1H), 2.83-2.77 (m, 2H), 1.36-1.34 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.2, 146.8, 146.2, 142.4, 134.2, 133.0, 132.6, 131.0, 130.2, 129.4, 128.7, 128.4, 128.1, 127.4, 126.3, 125.9, 125.8, 125.2, 125.0, 121.5, 28.8, 15.3; IR (KBr, *v*, cm^{-1}): 2970, 1587, 1506, 1456, 1308, 830, 691; HRMS (APCI) m/z calcd for $C_{24}H_{17}Br_2O_2S$ $[M+H]^+$ 528.9296, found 528.9280.

6-Bromo-9-(tert-butyl)-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4s)



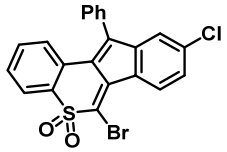
red solid; 66.8 mg, 79% yield; mp: 273-274 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.30 (d, *J* = 8.0 Hz, 1H), 8.04-8.02 (m, 1H), 7.60-7.56 (m, 3H), 7.46-7.44 (m, 2H), 7.38-7.33 (m, 2H), 7.187.15 (m, 2H), 7.01 (d, *J* = 0.8 Hz, 1H), 1.28 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 155.2, 148.3, 145.3, 143.2, 134.2, 133.8, 132.0, 131.8, 129.7, 129.5, 128.8, 128.2, 128.2, 127.1, 125.4, 125.3, 124.9, 124.6, 120.1, 119.7, 35.2, 31.1; IR (KBr, *v*, cm^{-1}): 3070, 1594, 1490, 1441, 1311, 830, 711; HRMS (APCI) m/z calcd for $C_{26}H_{22}BrO_2S$ $[M+H]^+$ 477.0524, found 477.0557.

6-Bromo-9,11-diphenylindeno[1,2-c]thiochromene 5,5-dioxide (4t)



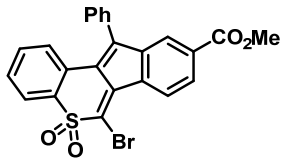
red solid; 70.6 mg, 71% yield; mp: 191-192 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.42 (d, *J*=8.0 Hz, 1H), 8.05 (d, *J* = 8.0 Hz, 1H), 7.60-7.58 (m, 3H), 7.54-7.52 (m, 3H), 7.50-7.46 (m, 2H), 7.44-7.36 (m, 4H), 7.20-7.19 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.9, 146.1, 144.4, 143.1, 140.1, 134.23, 133.8, 133.2, 132.2, 130.0(9), 130.0(8), 130.0(7), 130.0(5), 129.9(2), 129.9(8), 129.7, 129.0(2), 129.0(7), 128.7, 128.5, 128.3(4), 128.3(9), 128.2, 127.4, 127.2(0), 127.2(8), 127.2(5), 127.1, 125.9, 125.1, 125.0, 121.6, 120.7; IR (KBr, *v*, cm^{-1}): 3060, 1593, 1490, 1445, 1306, 832, 697; HRMS (APCI) m/z calcd for $C_{28}H_{18}BrO_2S$ $[M+H]^+$ 497.0211, found 497.0241.

6-Bromo-9-chloro-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4u)



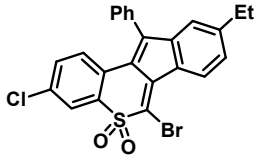
red solid; 52.7 mg, 58% yield; mp: 217-218 °C;^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.32 (d, *J* = 8.0 Hz, 1H), 8.06-8.03 (m, 1H), 7.62-7.57 (m, 3H), 7.44-7.38 (m, 3H), 7.32-7.29 (m, 1H), 7.22-7.20 (m, 2H), 6.97 (d, *J* = 1.6Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.1, 146.5, 142.2, 137.5, 134.3, 133.2, 132.5, 132.2, 130.0, 129.8, 128.8, 128.2, 128.1(0), 128.1(8), 127.3, 126.2, 125.5, 125.0, 123.0, 121.8; IR (KBr, *v*, cm^{-1}): 3079, 1562, 1489, 1449, 1306, 833, 711; HRMS (APCI) m/z calcd for $C_{22}H_{13}BrClO_2S$ $[M+H]^+$ 454.9508, found 454.9512 .

Methyl 6-bromo-11-phenylindeno[1,2-c]thiochromene-9-carboxylate 5,5-dioxide (4v)



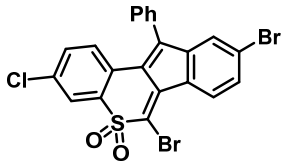
red solid; 52.5 mg, 55% yield; mp: 239-240 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.46 (d, *J* = 8.0, 1H), 8.05-8.01 (m, 2H), 7.62-7.58 (m, 4H), 7.46-7.43 (m, 2H), 7.41-7.37 (m, 1H), 7.22-7.20 (m, 2H), 3.89 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 166.3, 147.4, 145.5, 142.4, 138.4, 134.1, 133.3, 132.6, 132.3, 130.2, 130.1(8), 130.1(7), 130.1(5), 130.0(3), 130.0(2), 123.0(9), 130.0(8), 128.8, 128.4, 128.3, 127.5, 125.3, 125.1(8), 125.1(6), 123.2, 123.0, 52.6. IR (KBr, *v*, cm^{-1}): 2970, 1700, 1506, 1456, 1308, 830, 691; HRMS (APCI) m/z calcd for $C_{24}H_{16}BrO_4S$ $[M+H]^+$ 478.9953, found 478.9960.

6-Bromo-3-chloro-9-ethyl-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4w)



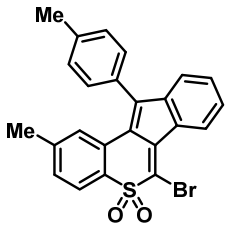
red solid; 53.0 mg, 55% yield; mp: 272-274 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.28 (d, *J* = 8.0 Hz, 1H), 7.99 (d, *J* = 2.0 Hz, 1H), 7.59 (d, *J* = 7.2 Hz, 3H), 7.43-7.41 (m, 2H), 7.18-7.06 (m, 3H), 6.81 (s, 1H), 2.64-2.58 (m, 2H), 1.22-1.18 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm):148.6, 148.6, 145.5, 143.2, 135.2, 134.3, 133.6, 132.4, 131.9, 129.9, 129.6, 128.4, 128.1(3), 128.1(8), 127.2, 125.6, 124.8, 123.9, 122.8, 119.3, 29.1, 15.4; IR (KBr, *v*, cm^{-1}): 2971, 1558, 1506, 1457, 1305, 824, 698; HRMS (APCI) m/z calcd for $C_{24}H_{17}BrClO_2S$ $[M+H]^+$ 482.9821, found 482.9817.

6,9-Dibromo-3-chloro-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4x)



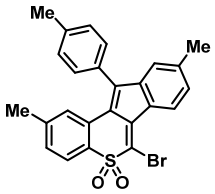
red solid; 53.4 mg, 50% yield; mp: 199-200 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.25 (d, *J* = 8.0 Hz, 1H), 8.00 (d, *J* = 2.0 Hz, 1H), 7.61-7.59 (m, 3H), 7.50-7.47 (m, 1H), 7.42-7.39 (m, 2H), 7.18-7.16 (m, 1H), 7.11 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.0, 146.9, 142.2, 135.3, 134.9, 132.8, 132.8, 132.6, 131.3, 130.1, 130.0, 128.6, 128.0, 126.6, 126.5, 126.0, 126.0, 124.9, 124.6, 121.4; IR (KBr, *v*, cm^{-1}): 3065, 1558, 1470, 1311, 828, 705; HRMS (APCI) m/z calcd for $C_{22}H_{12}Br_2ClO_2S$ $[M+H]^+$ 534.8593, found 534.8599.

6-Bromo-2-methyl-11-(p-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4y)



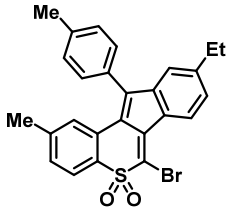
red solid; 63.8 mg, 71% yield; mp: 241-242 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.39-8.37 (m, 1H), 7.91 (d, *J* = 8.0 Hz, 1H), 7.39-7.27 (m, 6H), 7.17 (d, *J* = 8.4 Hz, 1H), 7.05-7.02 (m, 2H), 2.49 (s, 3H), 2.07 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.9, 145.4, 143.2, 142.5, 139.5, 134.5, 131.3, 131.1, 130.8, 130.2, 129.1, 128.7, 128.4, 128.2, 127.6, 125.4, 124.8, 124.3, 122.7, 120.6, 21.7, 21.6; IR (KBr, *v*, cm^{-1}): 2918, 1599, 1506, 1447, 1298, 813, 699; HRMS (APCI) m/z calcd for $C_{24}H_{18}BrO_2S$ $[M+H]^+$ 449.0211, found 449.0220.

6-Bromo-2,9-dimethyl-11-(p-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4z)



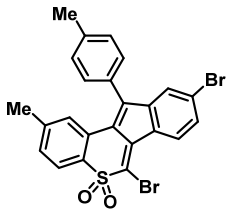
red solid; 69.5 mg, 75% yield; mp: 266-267 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm):8.24 (d, *J* = 8.0 Hz, 1H), 7.90 (d, *J* = 8.4 Hz, 1H), 7.39 (d, *J* = 8.0 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.17-7.10 (m, 2H), 6.99 (s, 1H), 6.82 (s, 1H), 2.50 (s, 3H), 2.32 (s, 3H), 2.06 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.9, 145.7, 143.2, 142.4, 141.8, 139.4, 131.8, 131.4, 130.9, 130.2, 129.0, 128.8, 128.7, 128.2, 127.6, 125.3, 124.8, 124.6, 123.7, 119.7, 21.8, 21.7, 21.5; IR (KBr, *v*, cm^{-1}): 3065, 1558, 1470, 1311, 828, 705; HRMS (APCI) m/z calcd for $C_{25}H_{20}BrO_2S$ $[M+H]^+$ 463.0367, found 463.0376.

6-Bromo-9-ethyl-2-methyl-11-(p-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4aa)



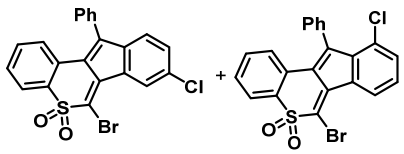
red solid; 72.5 mg, 76% yield; mp: 259-260 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm):8.27 (d, *J* = 7.6 Hz, 1H), 7.90 (d, *J* = 8.0 Hz, 1H), 7.39 (d, *J* = 8.0 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.16 (d, *J* = 7.2 Hz, 2H), 6.99 (s, 1H), 6.84 (s, 1H), 2.64-2.58 (m, 2H), 2.50 (s, 3H), 2.06 (s, 3H), 1.22-1.18 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) : 148.2, 148.0, 145.7, 143.21, 142.4, 139.4, 132.1, 131.4, 130.9, 130.2, 129.0, 128.8, 128.2, 127.6, 127.6, 125.4, 124.8, 124.6, 122.6, 119.7, 29.1, 21.7, 21.5, 15.4; IR (KBr, *v*, cm^{-1}): 2963, 1593, 1506, 1456, 1307, 811, 668; HRMS (APCI) m/z calcd for $C_{26}H_{22}BrO_2S$ $[M+H]^+$ 477.0524, found 477.0530.

6,9-Dibromo-2-methyl-11-(p-tolyl)indeno[1,2-c]thiochromene 5,5-dioxide (4bb)



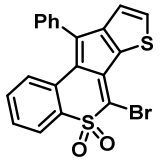
red solid; 83.4 mg, 79% yield; mp: 263-264 °C;^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.24 (d, *J* = 8.0 Hz, 1H), 7.91 (d, *J* = 8.0 Hz, 1H), 7.46-7.44 (m, 1H), 7.40 (d, *J* = 7.6 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 1H), 7.14 (d, *J* = 2 Hz, 1H), 7.02 (s, 1H), 2.50 (s, 3H), 2.07 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 147.2, 146.4, 142.7, 142.3, 139.9, 133.0, 131.5, 130.9, 130.5, 130.1, 129.5, 128.2, 128.1, 127.8, 126.3, 125.8, 125.7, 125.4, 124.9, 121.8, 21.7, 21.6; IR (KBr, *v*, cm^{-1}): 3073, 1598, 1505, 1448, 1299, 814, 681; HRMS (APCI) m/z calcd for $C_{24}H_{17}Br_2O_2S$ $[M+H]^+$ 528.9296, found 528.9294.

Compound 4cc



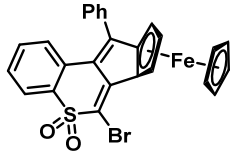
red solid; 36.4 mg, isomers 1:1 ratio, 40% yield; mp: 197-199 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.42-8.37 (m, 1H), 8.04-8.01 (m, 1H), 7.59-7.53 (m, 3H), 7.43-7.40 (m, 1H), 7.39-7.30 (m, 2H), 7.27-7.13 (m, 3H), 6.986.92 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) : 147.7, 147.2, 143.6, 142.2, 141.8, 139.8, 136.6, 135.8, 135.3, 134.6, 134.1, 134.0, 133.9, 133.4, 132.3, 132.2, 130.9, 130.1, 129.9, 129.8, 129.7, 129.2(3), 129.2(0), 128.7, 128.6, 128.4, 128.3, 128.2, 128.1, 127.4, 127.2, 125.9, 125.7, 125.0, 125.0, 124.5, 123.9, 123.4, 122.3, 122.2; IR (KBr, *v*, cm^{-1}): 3064, 1557, 1506, 1455, 1303, 757; HRMS (APCI) m/z calcd for $C_{22}H_{13}BrClO_2S$ $[M+H]^+$ 454.9508, found 454.9510.

6-Bromo-10-phenylthieno[3',2':4,5]cyclopenta[1,2-c]thiochromene 5,5-dioxide (4ee)



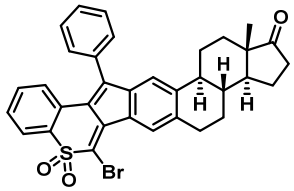
A red solid; 48.4 mg, 55% yield mp: 270-271 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.00-7.98 (m, 1H), 7.58-7.51 (m, 5H), 7.48 (d, *J* = 4.8 Hz, 1H), 7.30-7.29 (m, 2H), 7.21-7.17 (m, 1H), 6.85 (d, *J* = 4.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 154.1, 144.2, 142.1, 134.6, 134.2, 133.8, 133.4, 132.1, 129.8, 129.5, 129.3, 128.1, 127.7, 125.9, 125.0, 123.2, 121.2, 120.8; IR (KBr, *v*, cm^{-1}): 2963, 1593, 1506, 1456, 1307, 811, 668; HRMS (APCI) m/z calcd for $C_{20}H_{12}BrO_2S_2$ $[M+H]^+$ 425.9384, found 425.9390.

Compound 4ff



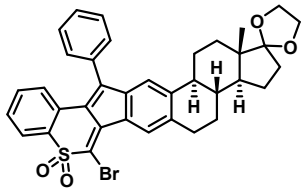
red solid; 66.5 mg, 63% yield; mp: 255-256 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.18 (d, *J* = 8 Hz, 1H), 7.75-7.73 (m, 3H), 7.65-7.61 (m, 1H), 7.54-7.45 (m, 4H), 4.30 (d, *J* = 13.2 Hz, 3H), 4.07 (s, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) : 142.8, 134.0, 133.4, 132.1, 129.5, 128.7, 128.4, 128.2, 122.8, 122.6,100.0, 96.4, 85.7, 81.4, 73.0, 71.0, 70.5; IR (KBr, *v*, cm^{-1}): 3049, 1587, 1490,1437, 1304, 795, 704; HRMS (APCI) m/z calcd for $C_{26}H_{18}BrFeO_2S$ $[M+H]^+$ 528.9560, found 528.9660.

(2aS,5aS,5bR,16bS)-9-Bromo-2a-methyl-15-phenyl-1,2,2a,4,5,5a,5b,6,7,16b-decahydro-3H-cyclopenta[5',6']naphtho[1',2':5,6]indeno[1,2-c]thiochromen-3-one 10,10-dioxide (4gg)



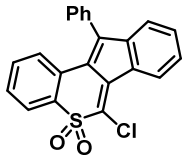
red solid; 83.6 mg, 70% yield; mp: 264-265 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.30 (d, *J* = 8.4 Hz, 1H), 8.02-8.00 (m, 1H), 7.60-7.54 (m, 3H), 7.39-7.41 (m, 4H), 7.11-7.06 (m, 1H), 6.77 (d, *J* = 8.0 Hz, 1H), 2.46 (s, 1H), 2.24-2.14 (m, 4H), 1.99-1.95 (m, 2H), 1.72-1.67 (m, 1H), 1.61-1.54 (m, 3H), 1.48-1.43 (m, 3H), 1.16-1.11 (m, 1H), 0.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 150.3, 145.1, 143.2, 142.5, 141.1, 138.1, 137.6, 134.6, 134.1, 132.9, 132.0, 131.7, 130.1, 130.1, 129.8, 129.5, 129.0, 128.9, 128.7, 128.2, 128.1, 127.6, 127.5, 127.1, 126.8, 126.8, 126.6, 126.2, 125.8, 125.7, 125.2, 125.0, 124.9, 124.1, 123.2, 120.0, 119.6, 119.4, 118.7, 50.5(1), 50.5(6), 47.9, 47.8, 45.0, 36.9, 35.9, 31.6, 27.0, 26.3, 26.2, 26.1, 21.5, 13.9, 13.8; IR (KBr, *v*, cm^{-1}): 2928, 1701, 1490, 1449, 1307, 823, 702; HRMS (APCI) m/z calcd for $C_{34}H_{30}BrO_3S$ $[M+H]^+$ 597.1099, found 597.1100.

(2aS,5aS,5bR,16bS)-9-Bromo-2a-methyl-15-phenyl-1,2,2a,4,5,5a,5b,6,7,16b-decahydrospiro[cyclopenta[5',6']naphtho [1',2':5,6]indeno[1,2-c]thiochromene-3,2'-[1,3]dioxolane] 10,10-dioxide (4hh)



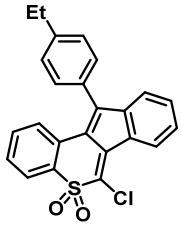
red solid; 93.6 mg, 73% yield; mp: 267-268 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.29 (d, *J* = 8.0 Hz, 1H), 8.02-8.00 (m, 1H), 7.59-7.54 (m, 3H), 7.39-7.31 (m, 4H), 7.11-7.06 (m, 1H), 6.77 (d, *J* = 8.4 Hz, 1H), 2.51-2.40 (m, 2H), 2.24-2.06 (m, 6H), 1.99-1.95 (m, 2H), 1.70-1.44 (m, 9H), 0.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 220.6, 150.4, 145.2, 142.6, 141.2, 138.1, 134.7, 134.2, 132.9, 132.1, 130.2, 130.3, 129.9, 129.1, 128.9, 128.2, 128.1, 127.7, 127.5, 126.9, 125.8, 125.2, 125.0, 123.3, 119.6, 50.5(4), 50.5(0), 48.0, 47.8, 45.1, 36.9, 35.9, 31.6, 27.1, 26.2(2), 26.2(8), 21.6, 13.9, 13.8; IR (KBr, *v*, cm^{-1}): 2928, 1594, 1490, 1449, 1307, 823, 702; HRMS (APCI) m/z calcd for $C_{36}H_{34}BrO_4S$ $[M+H]^+$ 641.1361, found 641.1360.

6-Chloro-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4ii)



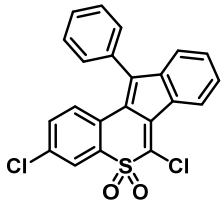
red solid; 41.5 mg, 55% yield; mp: 268-269 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.02-7.99 (m, 1H), 7.61-7.55 (m, 4H), 7.46-7.44 (m, 2H), 7.41-7.36 (m, 1H), 7.30-7.27 (m, 3H), 7.21-7.17 (m, 1H), 6.99-6.97 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 149.6, 145.3, 144.9, 136.1, 133.9, 133.9, 131.7, 131.2, 129.7, 129.5, 128.6, 128.5, 128.4, 128.1, 126.5, 124.1, 122.4, 121.2, 120.7; IR (KBr, *v*, cm^{-1}): 3027, 1575, 1506, 1456, 1299, 760, 668; HRMS (APCI) m/z calcd for $C_{22}H_{14}ClO_2S$ $[M+H]^+$ 377.0403, found 377.0404.

6-Chloro-11-(4-ethylphenyl)indeno[1,2-c]thiochromene 5,5-dioxide (4jj)



red solid; 46.2 mg, 57% yield; mp: 230-232 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.01-7.99 (m, 1H), 7.56-7.54 (m, 1H), 7.42-7.34 (m, 6H), 7.31-7.27 (m, 2H), 7.24-7.22 (m, 1H), 7.03-7.01 (m, 1H), 2.82-2.77 (m, 2H), 1.37-1.33 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 150.0, 145.8, 145.5, 145.0, 136.0, 134.0, 131.7, 131.1, 131.0, 129.1, 128.8, 128.4, 128.3, 128.1, 126.5, 124.0, 122.5, 122.1, 121.1, 120.3, 28.8, 15.3; IR (KBr, *v*, cm^{-1}): 3037, 1585, 1506, 1456, 1299, 770, 668; HRMS (APCI) m/z calcd for $C_{24}H_{18}ClO_2S$ $[M+H]^+$ 405.0716, found 405.0726.

3,6-Dichloro-11-phenylindeno[1,2-c]thiochromene 5,5-dioxide (4kk)

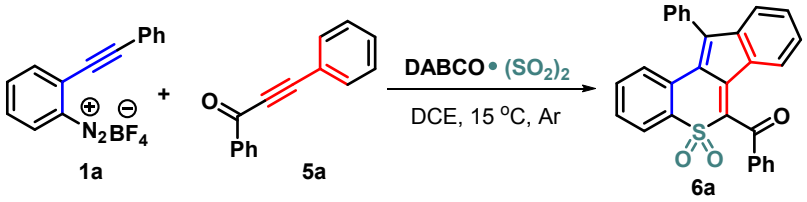


red solid; 40.3 mg, 49% yield mp: 273-274 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 7.97 (d, *J* = 2.0 Hz, 1H), 7.62-7.55 (m, 3H), 7.45-7.43 (m, 2H), 7.32-7.30 (m, 2H), 7.25 (s, 1H), 7.21-7013 (m, 2H), 7.00-6.98(m, 1H); ^{13}C NMR (100 MHz,

$CDCl_3$) (δ, ppm): 150.2, 145.3, 144.7, 137.3, 134.6, 133.8, 133.6, 132.0, 131.3, 129.8, 129.7, 128.7, 128.0, 127.9, 127.0, 124.1, 122.5, 121.3, 120.3; IR (KBr, *v*, cm^{-1}): 3030, 1579, 1506, 1456, 1299, 760, 668; HRMS (APCI) m/z calcd for $C_{22}H_{13}Cl_2O_2S$ $[M+H]^+$ 411.0013, found 411.0015.

General Procedure for the Synthesis of Products 6.

Example for the synthesis of **6a**:

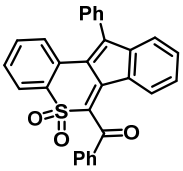


To a 10 mL Schlenk tube under Ar conditions, 2-(phenylethynyl)benzenediazonium tetrafluoroborate (**1a**, 0.22 mmol, 64.2 mg, 1.1 equiv), 1,4-diazabicyclo[2.2.2]octane-bis(sulfur dioxide) adduct (0.22 mmol, 48.4 mg, 1.1 equiv), 1,3-diphenylprop-2-yn-1-one (**5a**, 0.2 mmol, 41.2 mg, 1 equiv) and 1,2-dichloroethane (2.5 mL) were successively added. Then, the tube was stirred at 15 °C for 0.5 h until complete consumption of **5a**, as monitored by TLC analysis. After the reaction was completed, the reaction mixture was concentrated in vacuum and the resulting residue was purified by column chromatography on silica gel (eluent, petroleum ether/ethyl acetate = 5:1) to afford the desired product **6a** as a red solid.

Amplification Reaction for the Synthesis of 6a

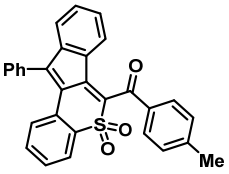
To a 25 mL Schlenk tube under Ar conditions, 2-(phenylethynyl)benzenediazonium tetrafluoroborate (**1a**, 2.2 mmol, 642 mg, 1.1 equiv), 1,4-diazabicyclo[2.2.2]octane-bis(sulfur dioxide) adduct (2.2 mmol, 484 mg, 1.1 equiv), 1,3-diphenylprop-2-yn-1-one (**5a**, 2 mmol, 412 mg, 1.0 equiv) and 1,2-dichloroethane (8 mL) were successively added. Then, the tube was stirred at 15 °C for 0.5 h until complete consumption of **5a**, as monitored by TLC analysis. After the reaction was completed, the reaction mixture was concentrated in vacuum and the resulting residue was purified by column chromatography on silica gel (eluent, petroleum ether/ethyl acetate = 5:1) to afford the desired product **6a** as a red solid (535 mg, 60% yield).

(5,5-Dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)(phenyl)methanone (6a)



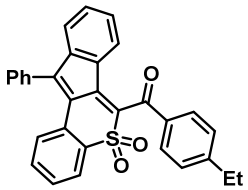
red solid; 59.0 mg, 66% yield; mp: 269-270 °C; ^1H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.28-8.26 (m, 2H), 8.00 (d, J = 7.6 Hz, 1H), 7.72-7.68 (m, 1H), 7.63-7.54 (m, 5H), 7.51-7.49 (m, 2H), 7.41-7.37 (m, 1H), 7.25-7.16 (m, 3H), 7.03-6.96 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 188.3, 150.2, 145.0, 143.3, 136.1, 135.6, 135.4, 135.3, 133.8, 132.9, 132.1, 131.0, 130.9(4), 130.9(9), 130.9(8), 129.9(0), 129.9(6), 129.9(5), 129.8(4), 129.8(9), 129.3, 129.0, 128.7, 128.5, 128.4, 128.3(3), 128.3(1), 128.3(0), 128.3(9), 128.3(6), 128.2, 127.0, 124.8, 124.0, 122.8(8), 122.8(7); IR (KBr, *v*, cm^{-1}): 3064, 1771, 1592, 1506, 1456, 785, 701; HRMS (APCI) m/z calcd for $C_{29}H_{19}O_3S$ $[M+H]^+$ 447.1055, found 447.1059.

(5,5-Dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)(p-tolyl)methanone (6b)



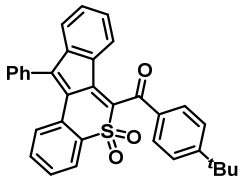
red solid; 64.5 mg, 70% yield; mp: 268-269 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.27-8.25 (m, 2H), 7.99 (d, *J* = 8.0 Hz, 1H), 7.68 (d, *J* = 7.2 Hz, 1H), 7.61-7.48 (m, 7H), 7.38-7.35 (m, 1H), 7.21-7.20 (m, 2H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.77 (d, *J* = 9.2 Hz, 2H), 2.22 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 187.7, 150.0, 146.8, 144.9, 143.0, 135.7, 135.5, 133.9, 133.8, 133.0(9), 132.0(2), 131.1, 130.9, 130.0, 129.8, 129.4, 129.0, 128.6, 128.5, 128.3, 127.0, 124.8, 124.0, 122.8, 122.7, 22.1; IR (KBr, *v*, cm^{-1}): 3063, 1733, 1601, 1506, 1456, 818, 705; HRMS (APCI) m/z calcd for $C_{30}H_{21}O_3S$ $[M+H]^+$ 461.1211, found 461.1235.

(5,5-Dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)(4-ethylphenyl)methanone (6c)



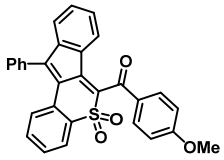
red solid; 69.4 mg, 73% yield; mp: 267-268 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.18 (d, *J* = 8.4 Hz, 2H), 7.99 (d, *J* = 8.0 Hz, 1H), 7.62-7.56 (m, 3H), 7.51-7.49 (m, 2H), 7.40-7.36 (m, 3H), 7.24-7.16 (m, 3H), 7.06-6.97 (m, 3H), 2.78-2.72 (m, 2H), 1.30-1.23 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 187.7, 152.8, 150.0, 145.0, 143.0, 135.7, 133.9, 133.9, 133.0, 132.0, 131.2, 130.9, 129.8, 129.7, 129.0, 128.8, 128.7, 128.5, 128.3, 127.0, 124.8, 124.0, 122.8, 122.7, 29.3, 15.0; IR (KBr, *v*, cm^{-1}): 3055, 1771, 1602, 1506, 1456, 824, 699; HRMS (APCI) m/z calcd for $C_{31}H_{23}O_3S$ $[M+H]^+$ 475.1368, found 475.1373.

(4-(tert-Butyl)phenyl)(5,5-dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)methanone (6d)



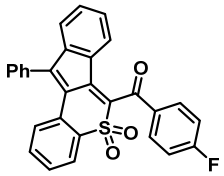
red solid; 80.5 mg, 80% yield; mp: 223-224 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.20-8.18 (m, 2H), 7.99 (d, *J* = 7.6 Hz, 1H), 7.60-7.55 (m, 4H), 7.51-7.49 (m, 2H), 7.38 (s, 2H), 7.23-7.16 (m, 4H), 7.06-7.00 (m, 2H), 1.35 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 187.7, 159.5, 150.0, 145.0, 133.9, 133.6, 133.0, 132.0, 130.9, 130.9, 129.8, 129.7, 129.0, 128.7, 128.5, 128.3, 127.0, 126.3, 124.8, 124.0, 122.8, 122.7, 35.6, 31.1; IR (KBr, *v*, cm^{-1}): 3064, 1771, 1601, 1506, 1456, 826, 701; HRMS (APCI) m/z calcd for $C_{33}H_{27}O_3S$ $[M+H]^+$ 503.1681, found 503.1685.

(5,5-Dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)(4-methoxyphenyl)methanone (6e)



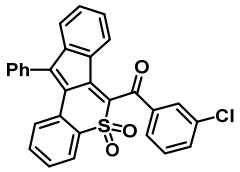
red solid; 60.1 mg, 63% yield; mp: 223-224 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.26-8.22(m, 2H), 8.00 (d, *J* = 8.0 Hz, 1H), 7.62-7.54 (m, 3H), 7.50-7.48 (m, 2H), 7.40-7.35 (m, 1H), 7.27-7.16 (m, 3H), 7.09-6.96 (m, 5H), 3.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 186.2, 165.5, 149.9, 144.9, 142.8, 135.7, 135.6, 133.9, 133.5, 133.0, 132.0, 130.9, 129.8, 129.7, 129.4, 129.0, 128.6, 128.5, 128.3, 126.9, 124.8, 124.0, 122.8, 122.7, 114.6, 55.8; IR (KBr, *v*, cm^{-1}): 3064, 1771, 1601, 1506, 1456, 826, 701; HRMS (APCI) m/z calcd for $C_{30}H_{21}O_4S$ $[M+H]^+$ 477.1161, found 477.1159.

(5,5-Dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)(4-fluorophenyl)methanone (6f)



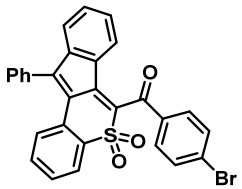
red solid; 65.1 mg, 70% yield; mp: 293-294 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.33-8.29 (m, 2H), 7.99 (d, *J*=7.6, 1H), 7.62-7.57 (m, 3H), 7.51-7.48 (m, 2H), 7.41-7.37 (m, 1H), 7.25-7.18 (m, 5H), 7.01-7.00 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 186.7, 168.5, 165.9 ($^1J_{CF}$ = 257.6 Hz), 150.4, 145.0(9), 145.0(7), 145.0(6), 143.4, 135.6, 135.5, 134.9, 133.9, 133.8 ($^3J_{CF}$ = 10.0 Hz), 133.7, 133.7, 132.8, 132.8, 132.7, 132.6 ($^4J_{CF}$ = 2.9 Hz), 132.2, 131.2, 129.9, 129.9, 129.8, 128.9, 128.9, 128.7, 128.6, 128.3, 128.3, 128.3(8), 128.3(6), 128.3(5), 128.2(4), 128.2(3), 128.2(2), 127.0, 124.6, 123.9, 122.9, 122.7, 122.7, 116.8, 116.6($^2J_{CF}$ = 22.2 Hz); IR (KBr, *v*, cm^{-1}): 2925, 1748, 1593, 1507, 1456, 823, 707; HRMS (APCI) m/z calcd for$C_{29}H_{18}FO_3S$ $[M+H]^+$ 465.0961, found 465.0966.

(3-Chlorophenyl)(5,5-dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)methanone (6g)



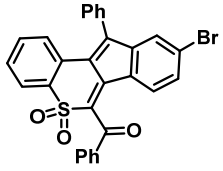
red solid; 62.5 mg, 65% yield; mp: 240-241 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.25-8.24 (m, 1H), 8.15-8.13 (m, 1H), 7.99 (d, *J* = 8.0 Hz, 1H), 7.68-7.65 (m, 1H), 7.63-7.57 (m, 3H), 7.52-7.48 (m, 3H), 7.41-7.37 (m, 1H), 7.24– 7.18 (m, 3H), 7.02-6.97 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 180.9, 138.0, 136.3, 134.8, 133.7, 132.7, 132.2(1), 132.2(6), 131.3(7), 131.3(3), 129.9, 128.8, 128.6, 128.4, 128.3, 126.7, 126.5, 124.6, 124.3, 123.4, 122.9, 122.7; IR (KBr, *v*, cm^{-1}): 2967, 1771, 1602, 1506, 1456, 833, 702; HRMS (APCI) m/z calcd for $C_{29}H_{18}ClO_3S$ $[M+H]^+$ 481.0665, found 481.0670.

(4-Bromophenyl)(5,5-dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)methanone (6h)



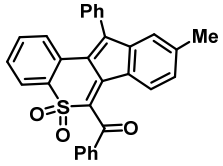
red solid; 70.2 mg, 67% yield; mp: 242-243 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.25-8.24 (m, 1H), 8.15-8.13 (m, 1H), 7.99 (d, *J* = 8.0 Hz, 1H), 7.68-7.65 (m, 1H), 7.63-7.57 (m, 3H), 7.52-7.48 (m, 3H), 7.41-7.37 (m, 1H), 7.24-7.18 (m, 3H), 7.02-6.97 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 187.5, 150.5, 145.0, 143.5, 135.5, 135.5, 134.8, 134.7, 134.7, 133.7, 132.7, 132.7, 132.2, 132.2, 131.3, 129.9(9), 129.9(7), 128.9(4), 128.9(3), 128.9(1), 128.9(9), 128.8, 128.6, 128.3(3), 128.2, 127.0, 124.6, 123.9, 122.9, 122.7; IR (KBr, *v*, cm^{-1}): 2967, 1770, 1619, 1506, 1456, 833, 702; HRMS (APCI) m/z calcd for $C_{29}H_{18}BrO_3S$ $[M+H]^+$ 525.0160, found 525.0170

(9-Bromo-5,5-dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)(phenyl)methanone (6i)



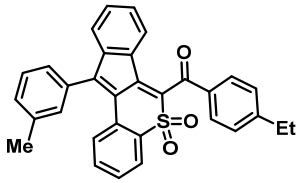
red solid; 78.8 mg, 75% yield; mp: 223-224 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.25-8.23 (m, 2H), 8.00 (d, *J* = 8.0 Hz, 1H), 7.70 (d, *J* = 7.2 Hz, 1H), 7.63-7.55 (m, 5H), 7.49-7.47 (m, 2H), 7.41 (s, 1H), 7.27-7.23 (m, 2H), 7.13-7.08 (m, 2H), 6.86 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 188.0, 148., 146.8, 142.1, 136.1, 135.9, 135.9, 135.8, 135.6, 133.2, 132.2, 131.5, 131.4, 131.2, 130.9, 130.1, 130.1, 129.4, 129.0, 128.5, 128.2(1), 128.2(8), 127.1, 125.9, 125.7(0), 125.7(8), 124.1, 123.9; IR (KBr, *v*, cm^{-1}): 3062, 1733, 1622, 1506, 1450, 789, 702; HRMS (APCI) m/z calcd for $C_{29}H_{18}BrO_3S$ $[M+H]^+$ 525.0160, found 525.0171

(9-Methyl-5,5-dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)(phenyl)methanone (6j)



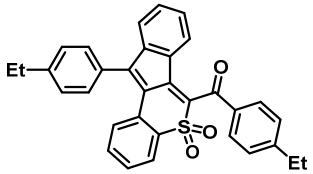
red solid; 73.8 mg, 80% yield; mp: 250-251 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.27-8.25 (m, 2H), 7.99 (d, *J* = 8.0 Hz, 1H), 7.68 (d, *J* = 7.2 Hz, 1H), 7.61-7.53 (m, 5H), 7.50-7.48 (m, 2H), 7.38-7.35 (m, 1H), 7.21-7.20 (m, 2H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.77 (d, *J* = 9.2 Hz, 2H), 2.22 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 192.1, 150.2, 141.8, 136.1, 135.7, 135.3, 133.9, 132.0, 130.9, 130.1, 129.8, 129.7, 129.2, 129.1, 129.0, 128.4, 128.3, 126.9, 124.7, 123.93, 123.74, 21.7; IR (KBr, *v*, cm^{-1}): 3063, 1771, 1576, 1506, 1457, 770, 703; HRMS (APCI) m/z calcd for $C_{30}H_{21}O_3S$ $[M+H]^+$ 461.1211, found 461.1208.

(5,5-Dioxido-11-(m-tolyl)indeno[1,2-c]thiochromen-6-yl)(4-ethylphenyl)methanone (6k)



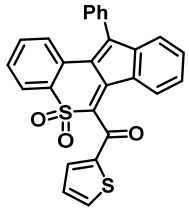
red solid; 68.5 mg, 70% yield; mp: 261-262 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.18 (d, *J* = 8.4 Hz, 2H), 8.00-7.98 (m, 1H), 7.50-7.46 (m, 1H), 7.40-7.36 (m, 4H), 7.29 (d, *J* = 9.6 Hz, 2H), 7.25-7.15 (m, 3H), 7.05-7.04 (m, 3H), 2.77-2.72 (m, 2H), 2.45 (s, 3H), 1.30-1.26 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 187.8, 152.8, 150.3, 145.0, 143.1, 139.7, 135.7, 135.4, 134.0, 133.8, 133.0, 132.0, 131.2, 130.9, 130.5, 129.7, 129.1, 128.8, 128.7, 128.6, 128.4, 127.0, 125.3, 124.8, 123.9, 122.8, 122.6, 29.3, 21.7, 15.0; IR (KBr, *v*, cm^{-1}): 3065, 1733, 1590, 1506, 1456, 797, 701; HRMS (APCI) m/z calcd for $C_{32}H_{25}O_3S$ $[M+H]^+$ 489.1254, found 489.1254.

(4-Ethylphenyl)(11-(4-ethylphenyl)-5,5-dioxidoindeno[1,2-c]thiochromen-6-yl)methanone (6l)

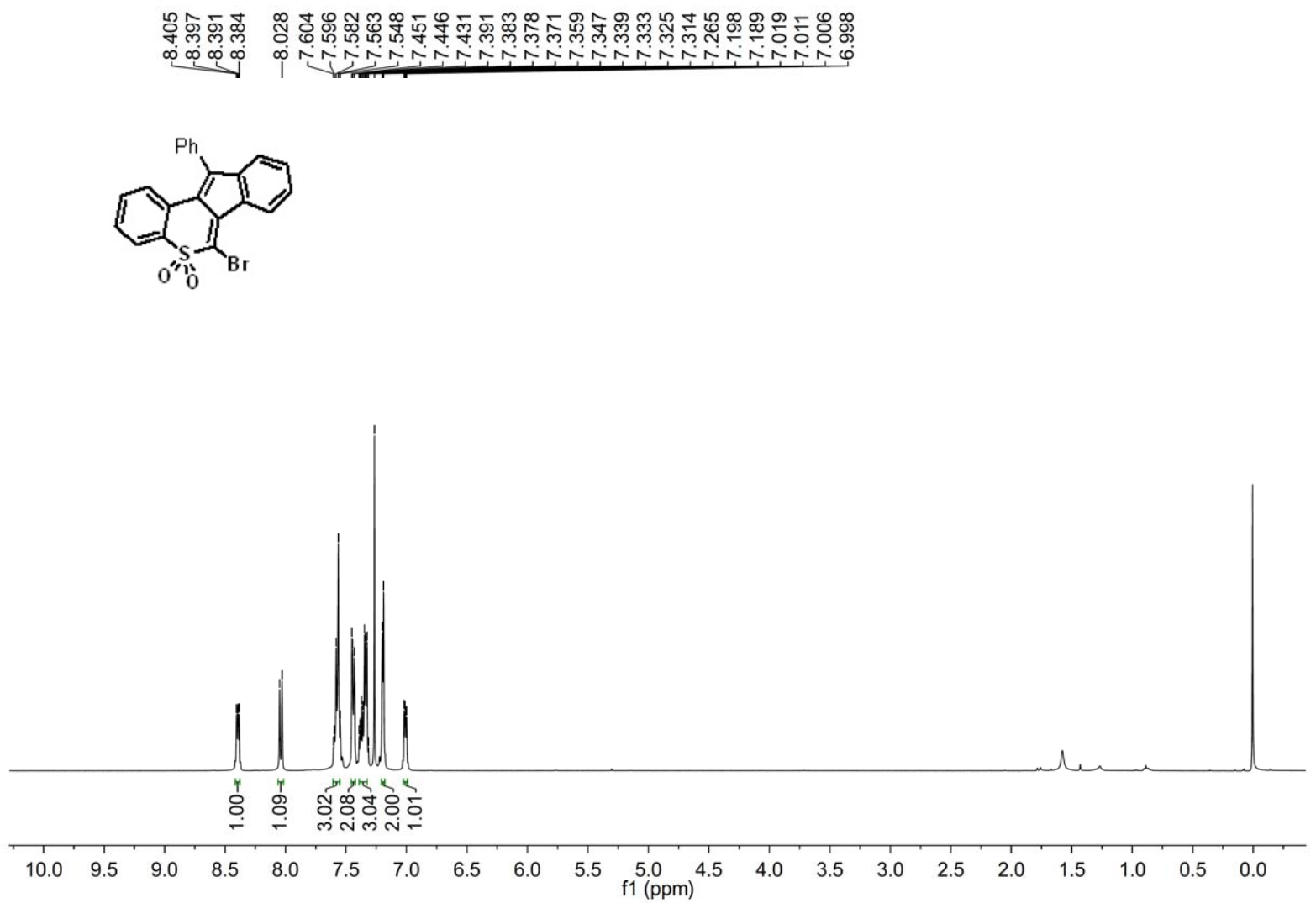


red solid; 71.4 mg, 71% yield; mp: 280-281 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.18 (d, *J* = 8.4 Hz, 2H), 7.99 (d, *J* = 8.0 Hz, 1H), 7.42-7.36 (m, 7H), 7.30 (d, *J* = 7.6 Hz, 1H), 7.27-7.15 (m, 2H), 7.05-6.96 (m, 3H), 2.83-2.71 (m, 4H), 1.38-1.26 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 187.8, 152.8, 150.4, 146.2, 145.0, 143.2, 135.6, 135.2, 134.0, 133.1, 132.0, 131.2, 130.9, 130.9, 129.3, 128.8, 128.6, 128.4, 127.0, 124.7, 123.9, 122.8, 122.6, 29.3, 28.9, 15.4, 15.0; IR (KBr, *v*, cm^{-1}): 2967, 1771, 1602, 1506, 1456, 833, 702; HRMS (APCI) m/z calcd for $C_{33}H_{27}O_3S$ $[M+H]^+$ 503.1681, found 503.1680.

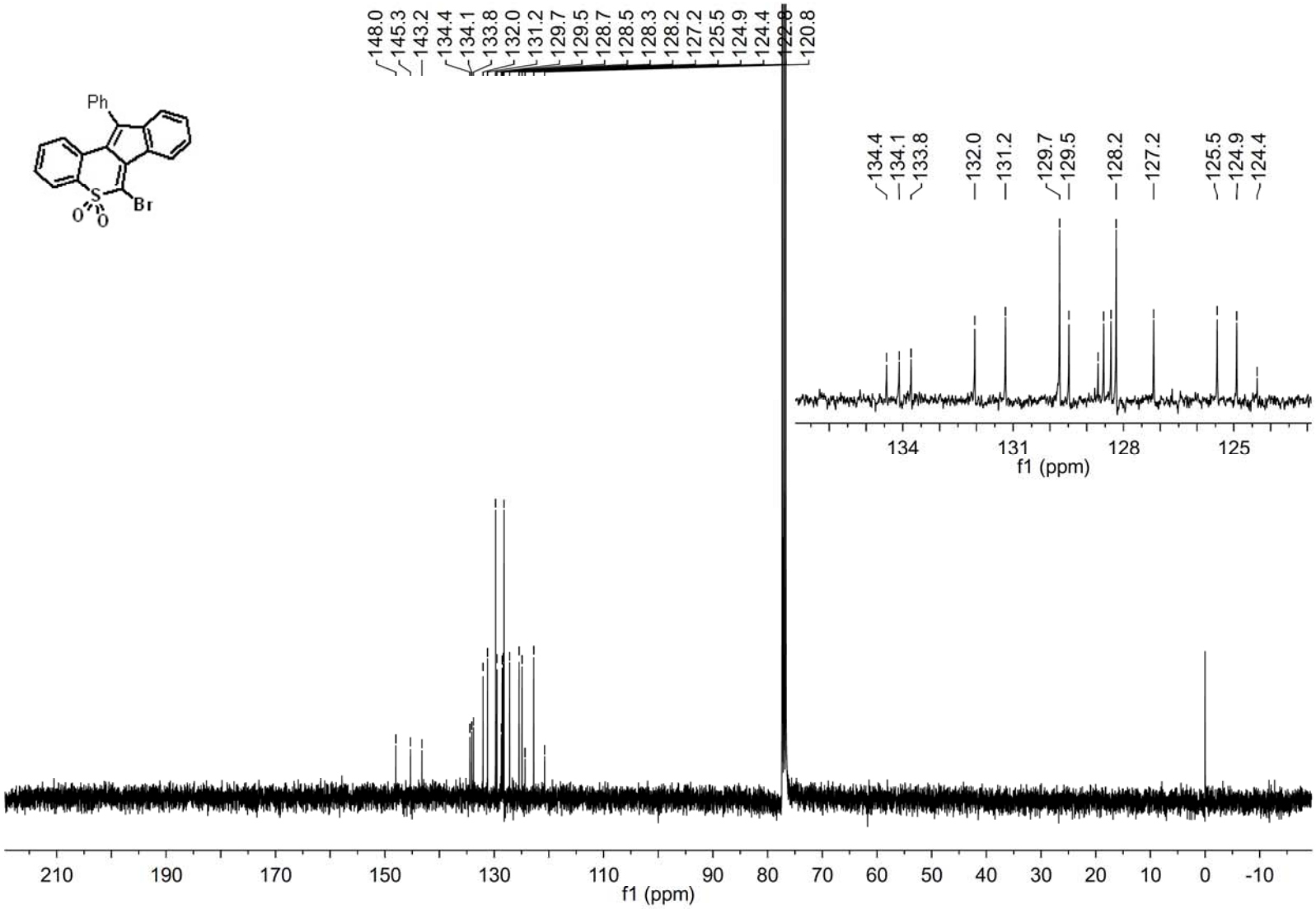
(5,5-dioxido-11-phenylindeno[1,2-c]thiochromen-6-yl)(thiophen-2-yl)methanone (6m)



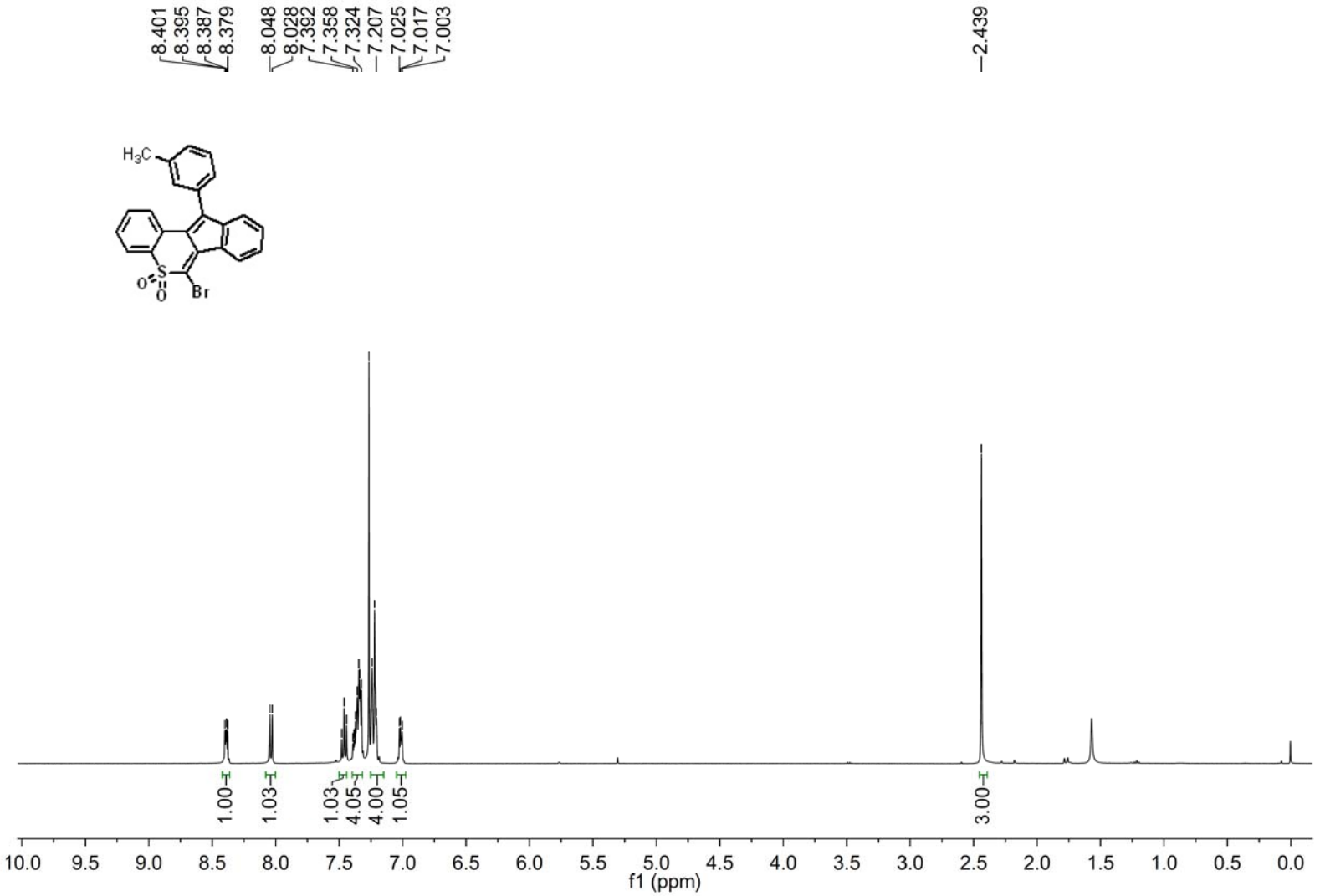
red solid; 65.1 mg, 72% yield; mp: 282-283 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm): 8.08-8.07 (m, 1H), 8.01 (d, J = 8.0, 1H), 7.91-7.89 (m, 1H), 7.62-7.56 (m, 3H), 7.50-7.48 (m, 2H), 7.41-7.37 (m, 1H), 7.22-7.18 (m, 5H), 7.06-6.97 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm): 179.5, 150.4, 144.9, 143.5, 138.9, 138.0, 135.6, 134.8, 133.7, 132.9, 132.1, 131.1, 129.8(3), 129.8(2), 129.3, 128.9, 128.8, 128.6, 128.3, 127.0, 124.8, 124.0, 122.9, 122.8; IR (KBr, v, cm^{-1}): 2967, 1771, 1600, 1506, 1456, 843, 702; HRMS (APCI) m/z calcd for $C_{27}H_{17}O_3S_2$ $[M+H]^+$453.0619, found 453.0620.



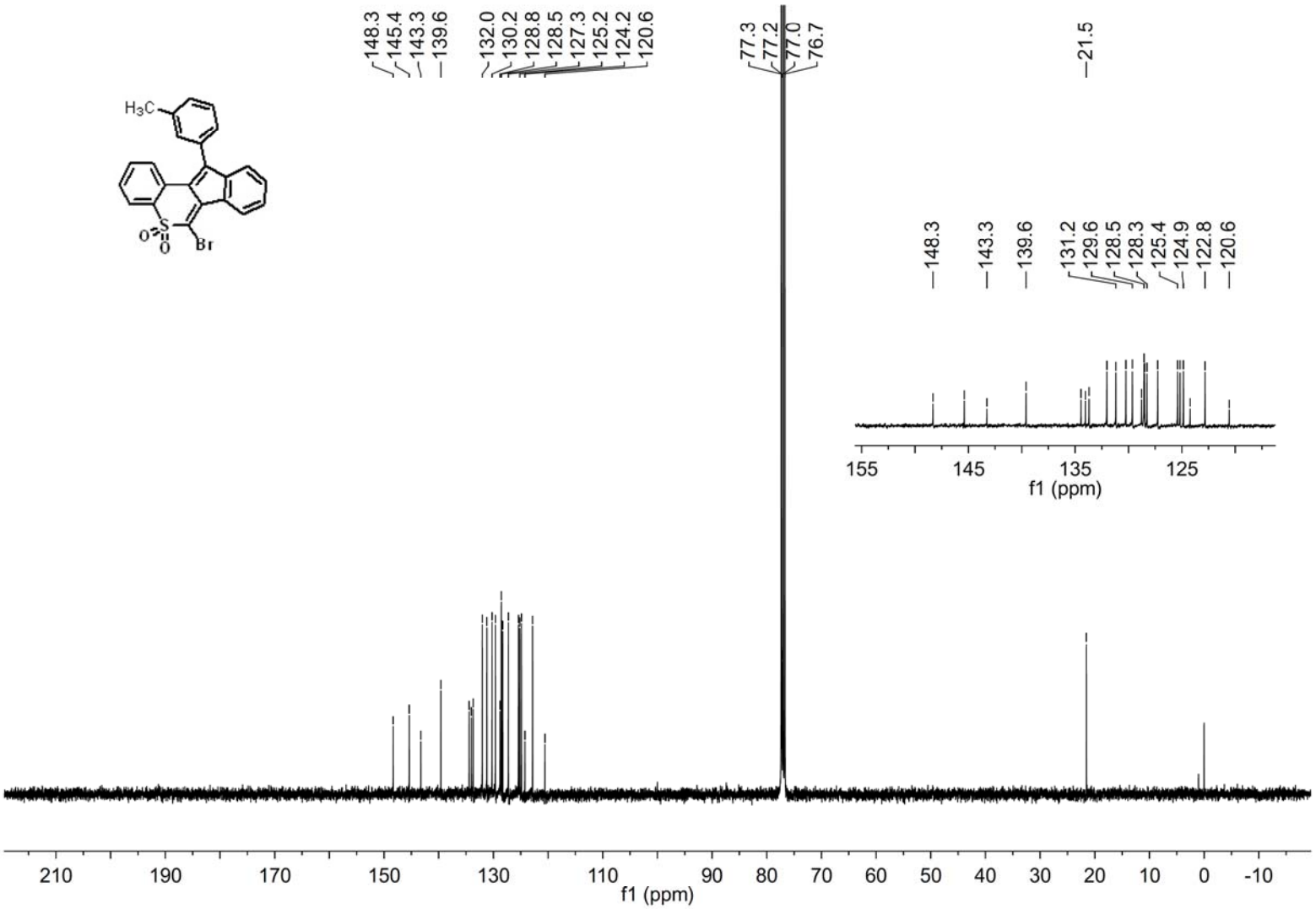
^{1}H NMR Spectrum of Compound 4a



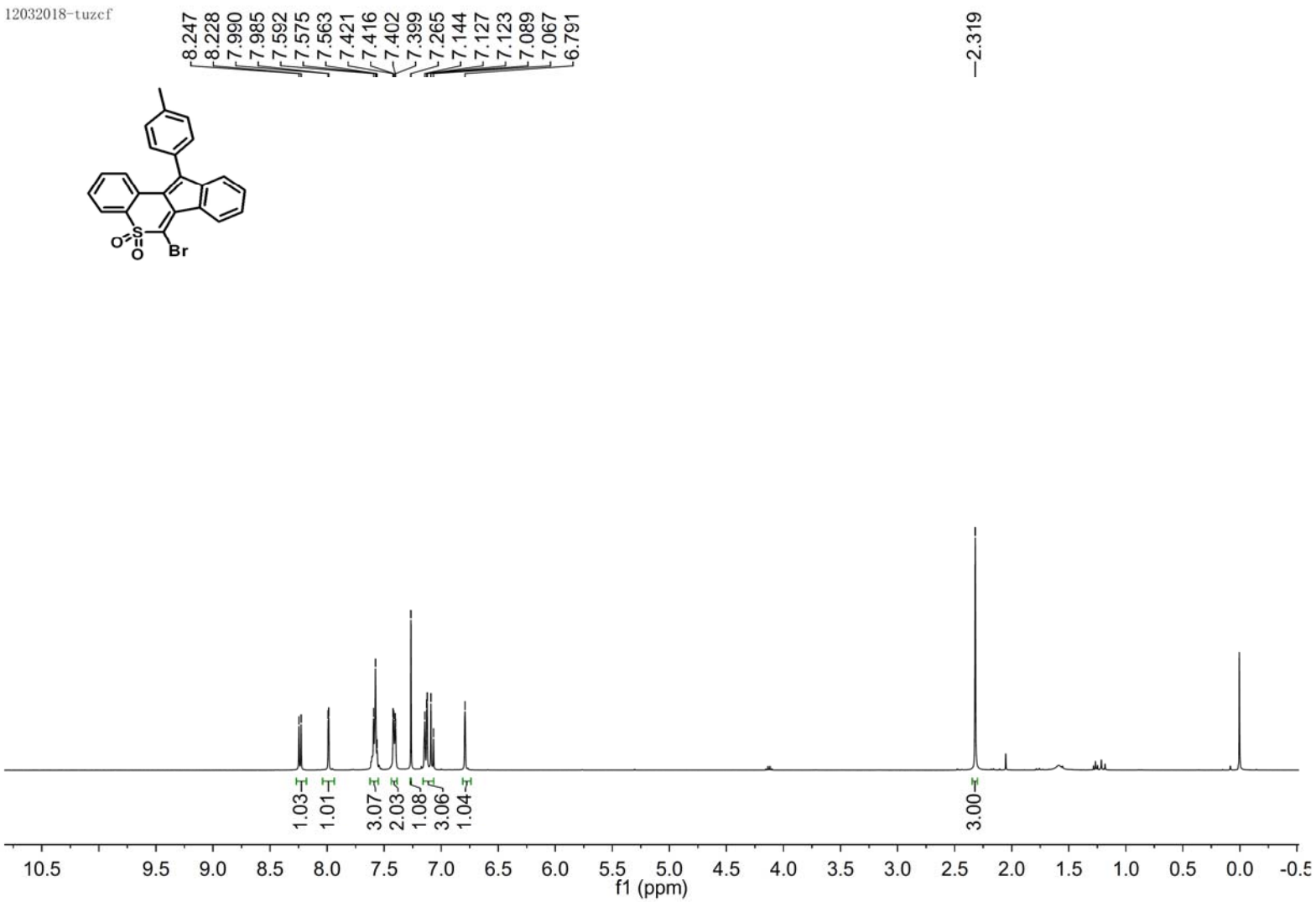
^{13}C NMR Spectrum of Compound 4a



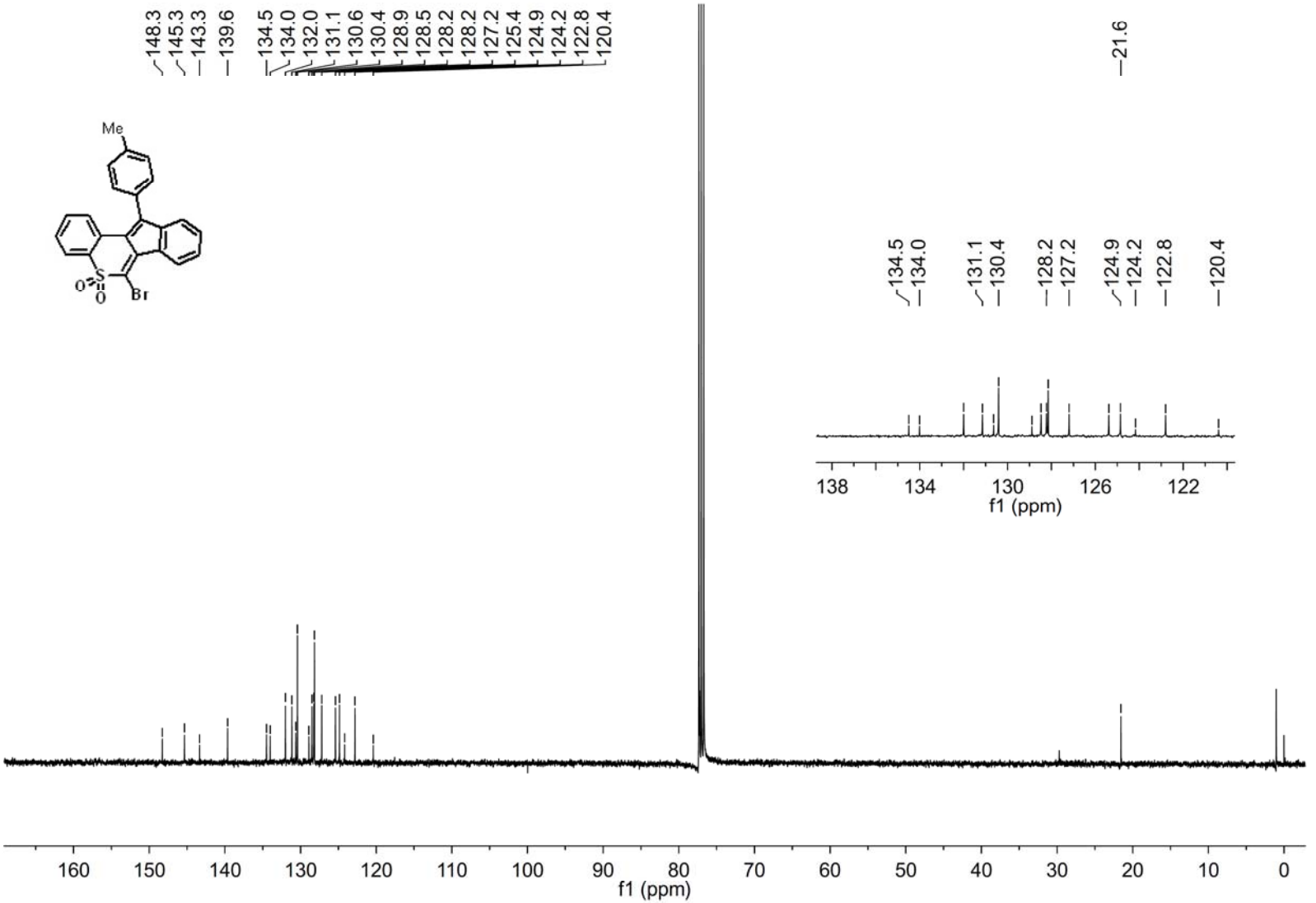
^{1}H NMR Spectrum of Compound 4b



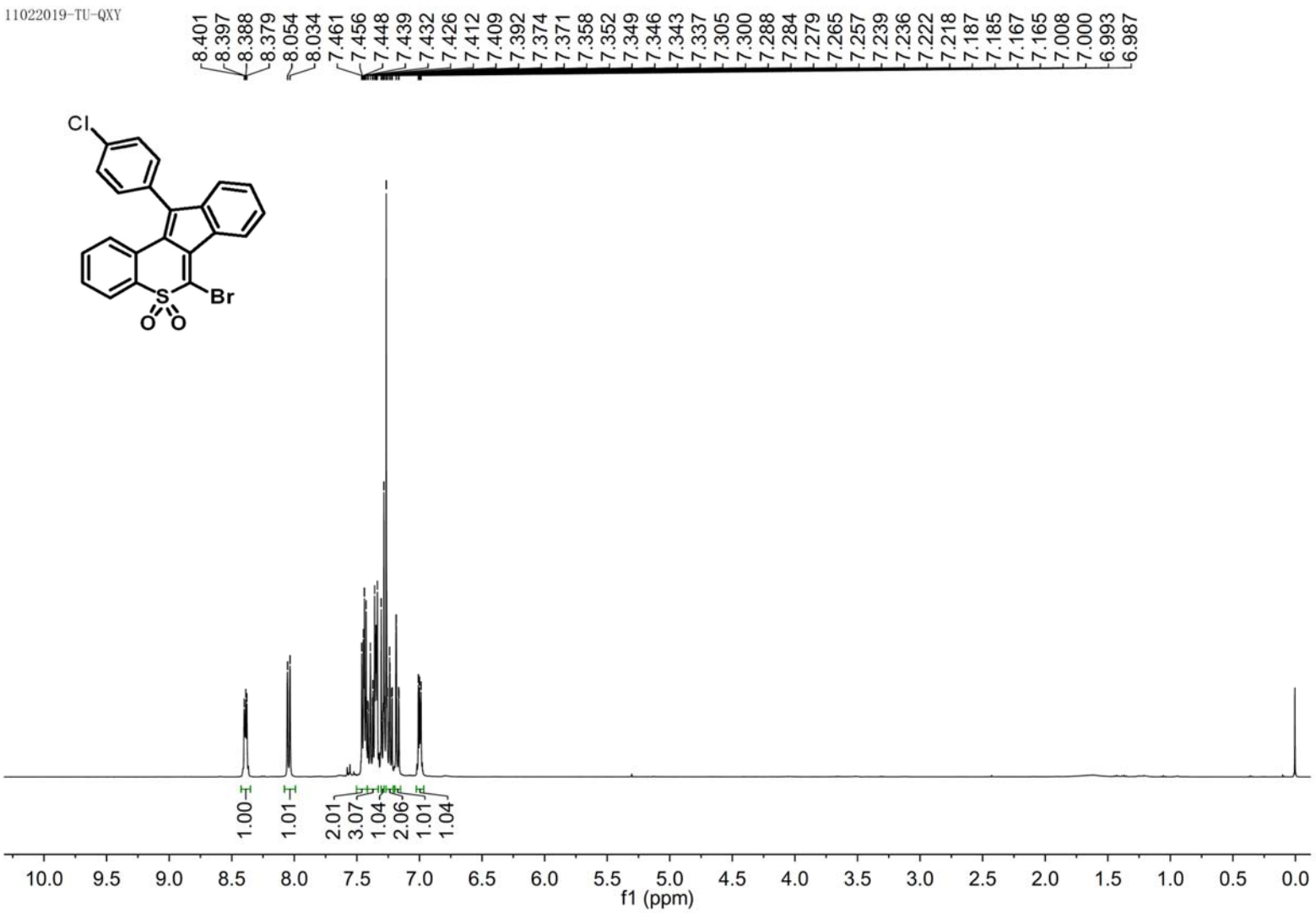
^{13}C NMR Spectrum of Compound 4b



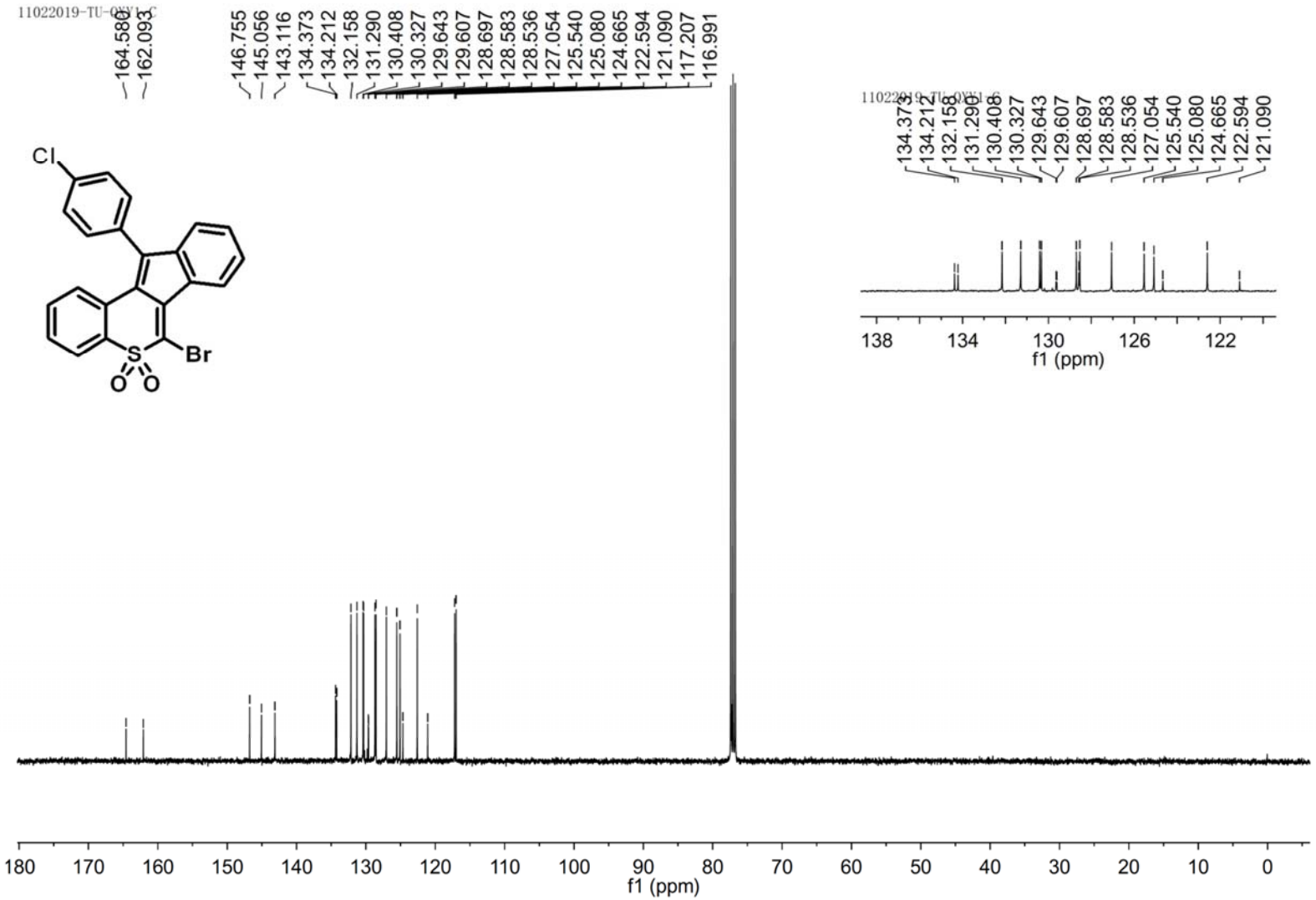
^{1}H NMR Spectrum of Compound 4c



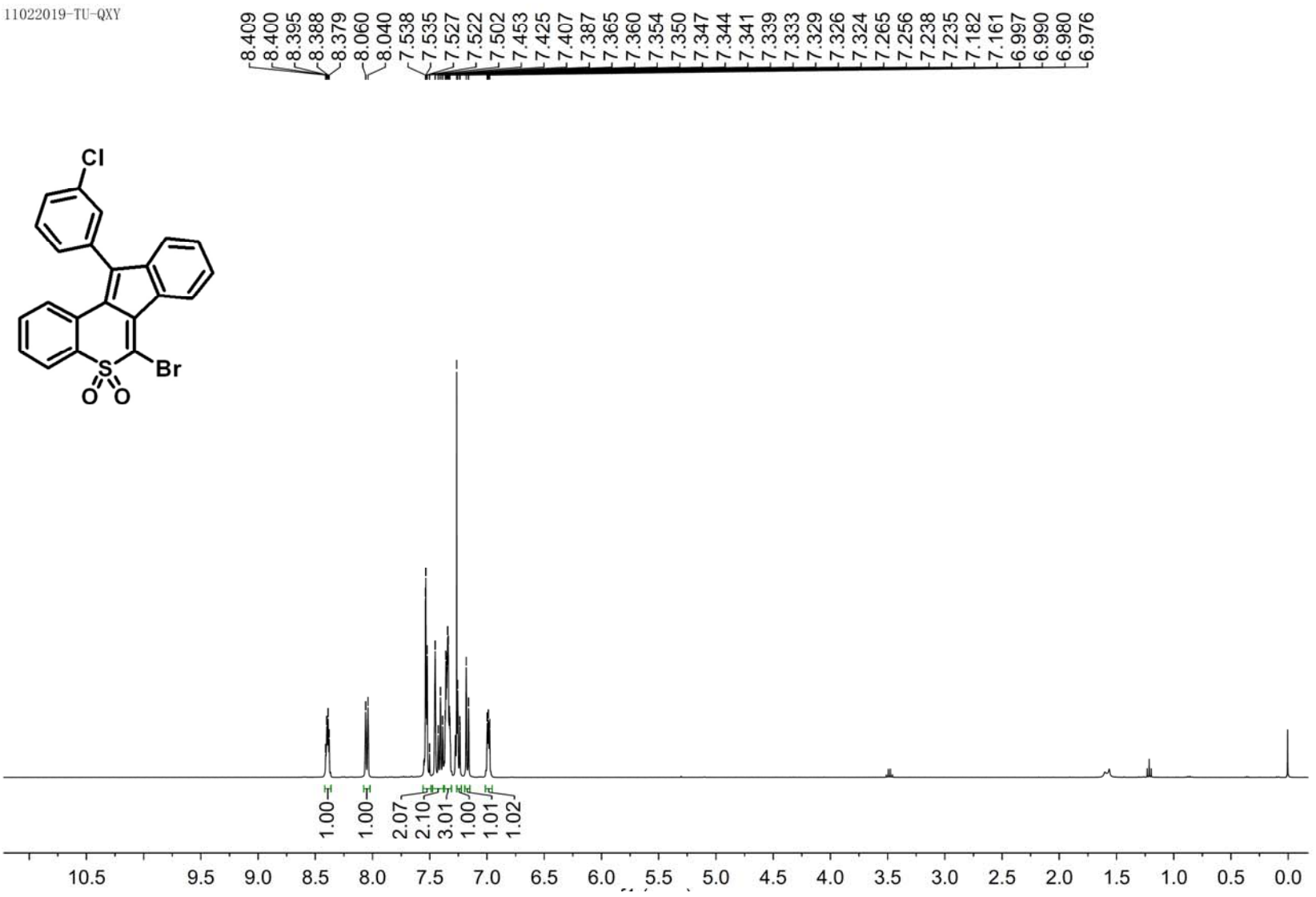
^{13}C NMR Spectrum of Compound 4c



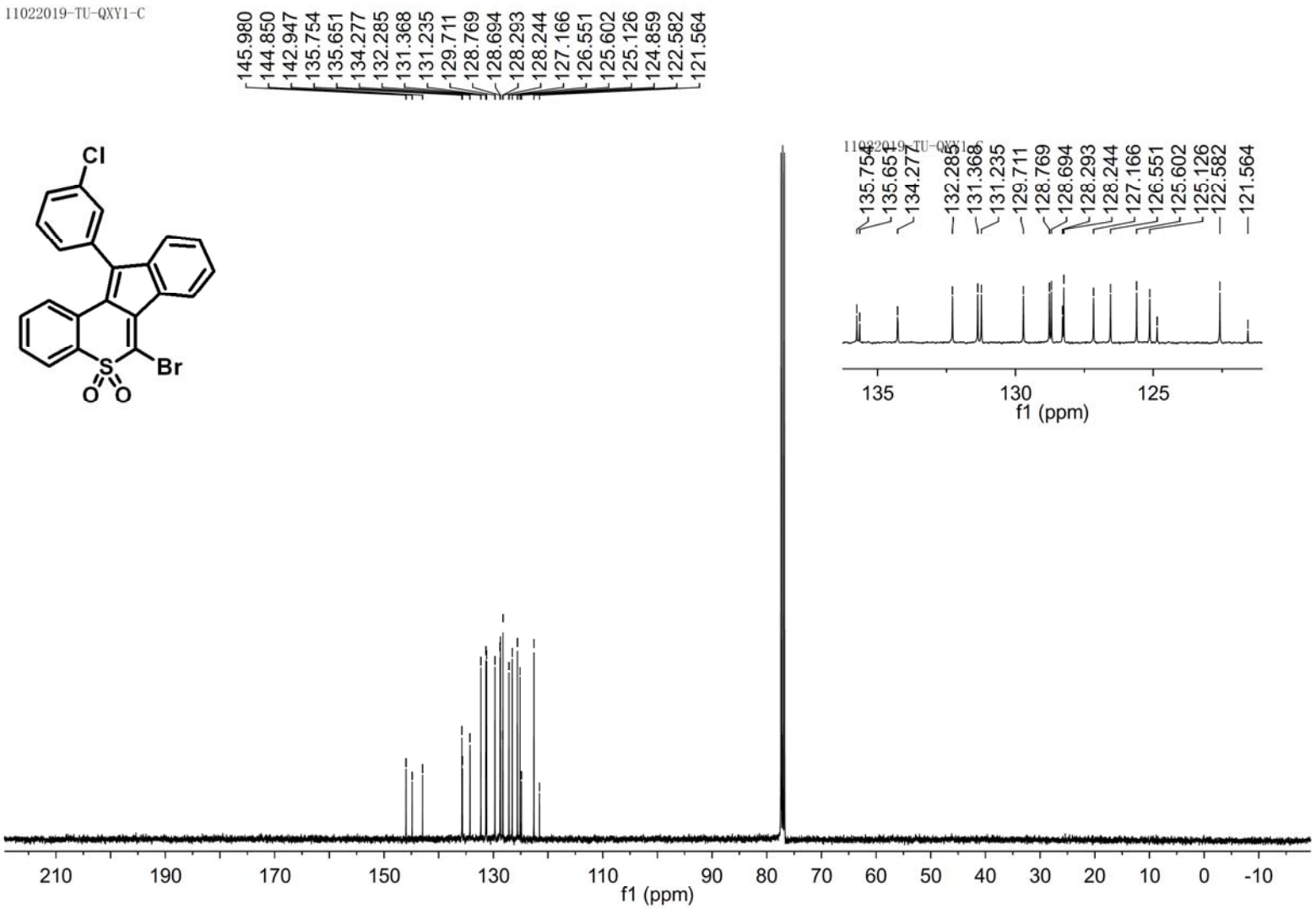
^{1}H NMR Spectrum of Compound 4d



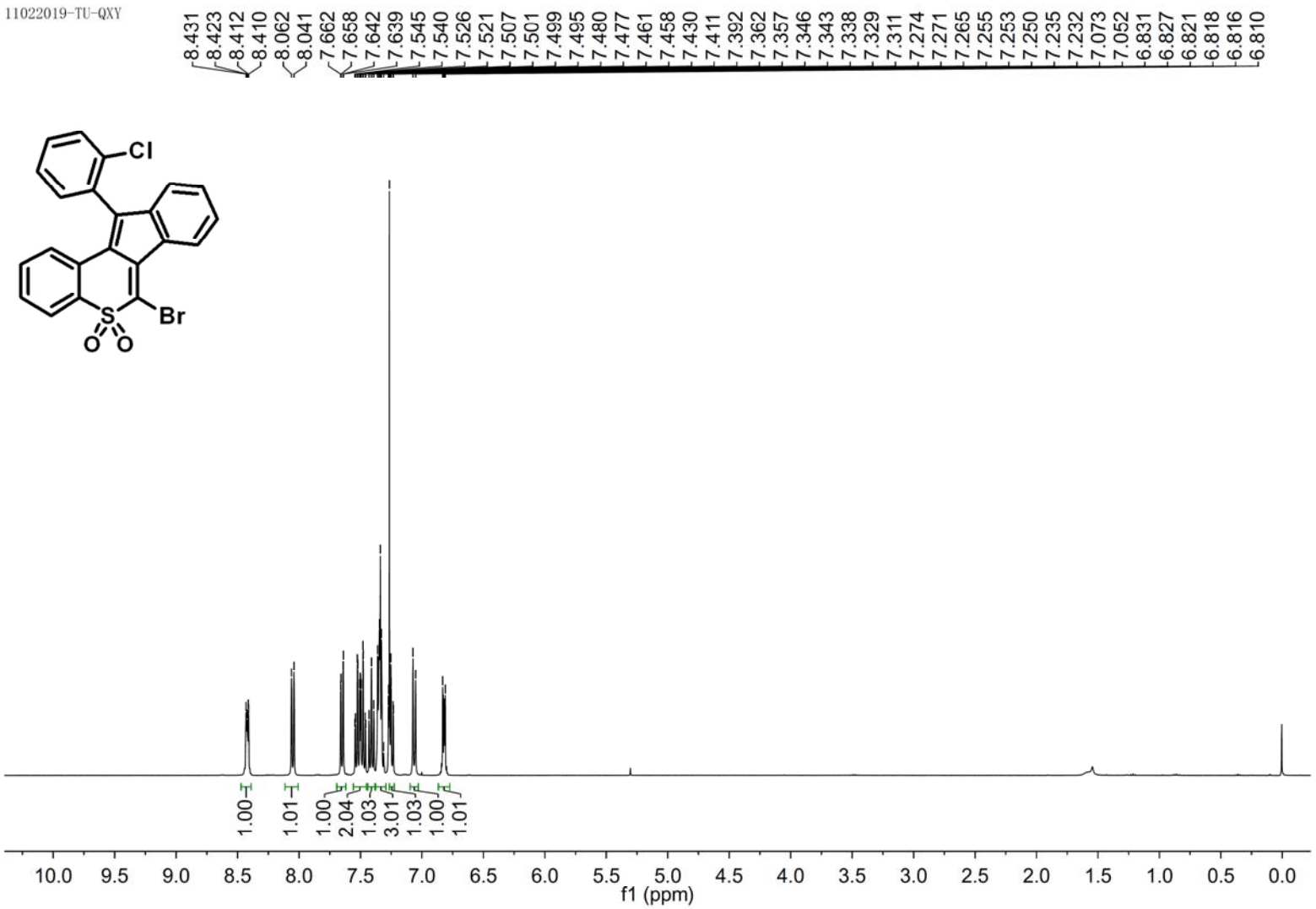
^{13}C NMR Spectrum of Compound 4d



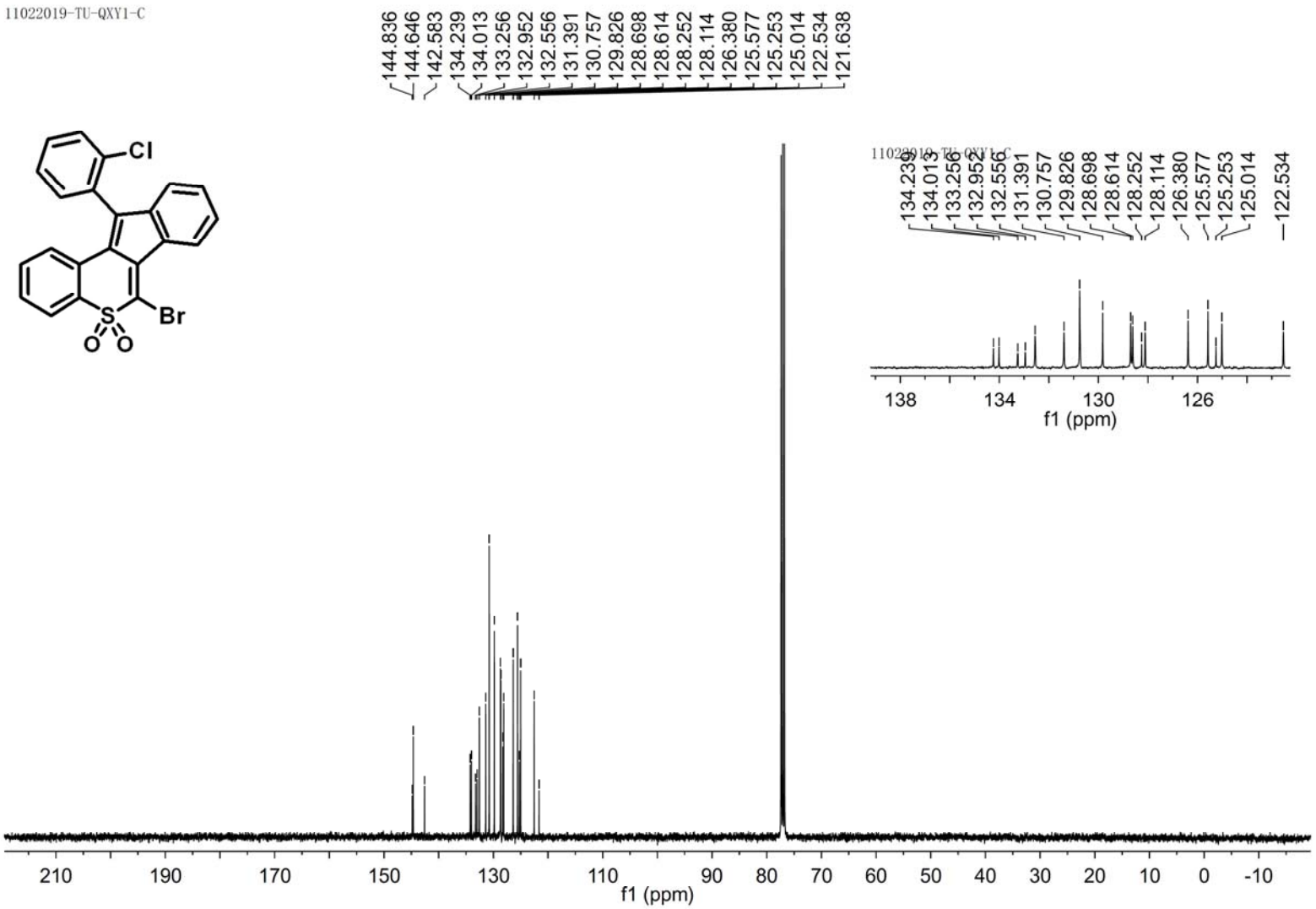
^{1}H NMR Spectrum of Compound 4e



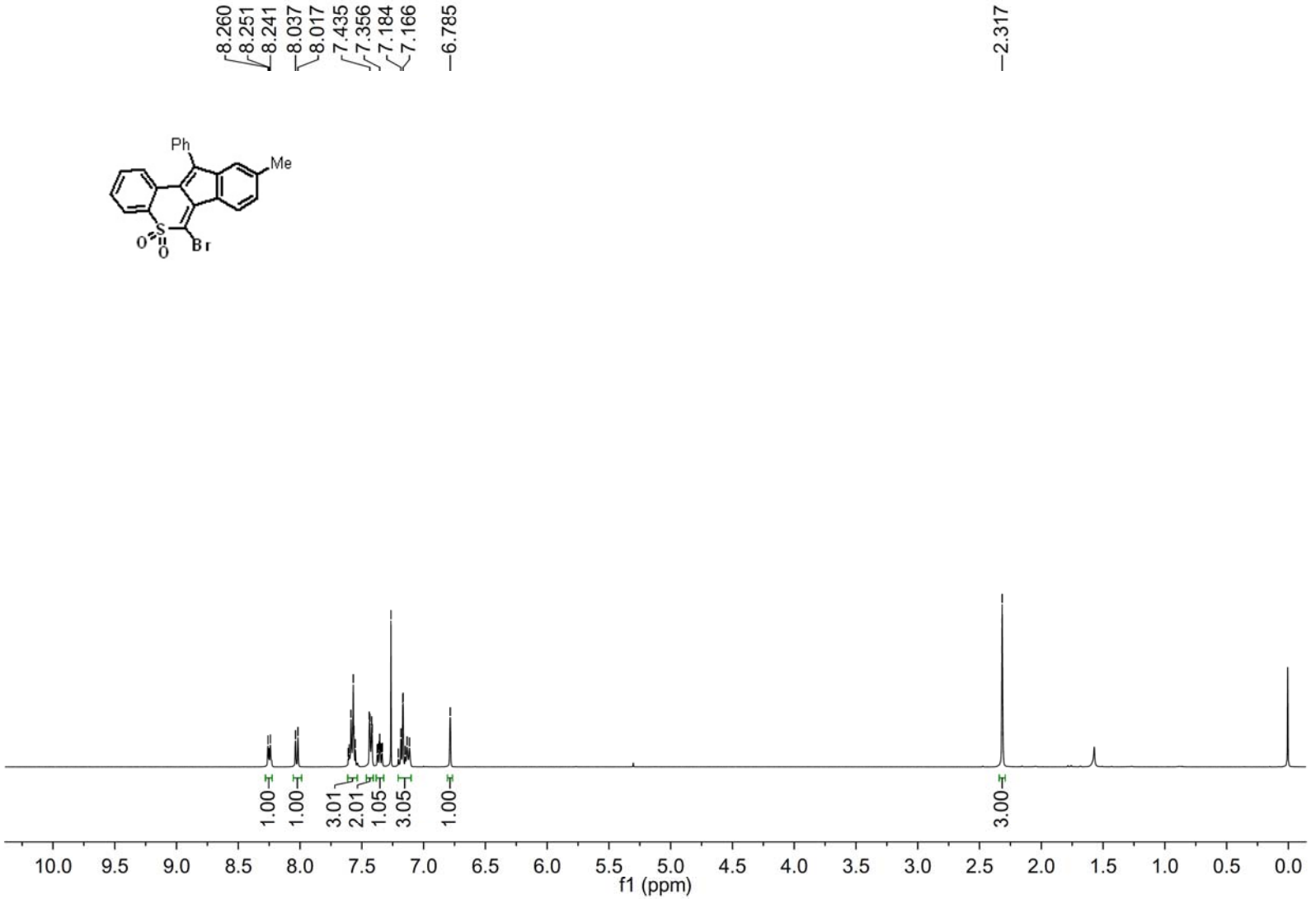
^{13}C NMR Spectrum of Compound 4e



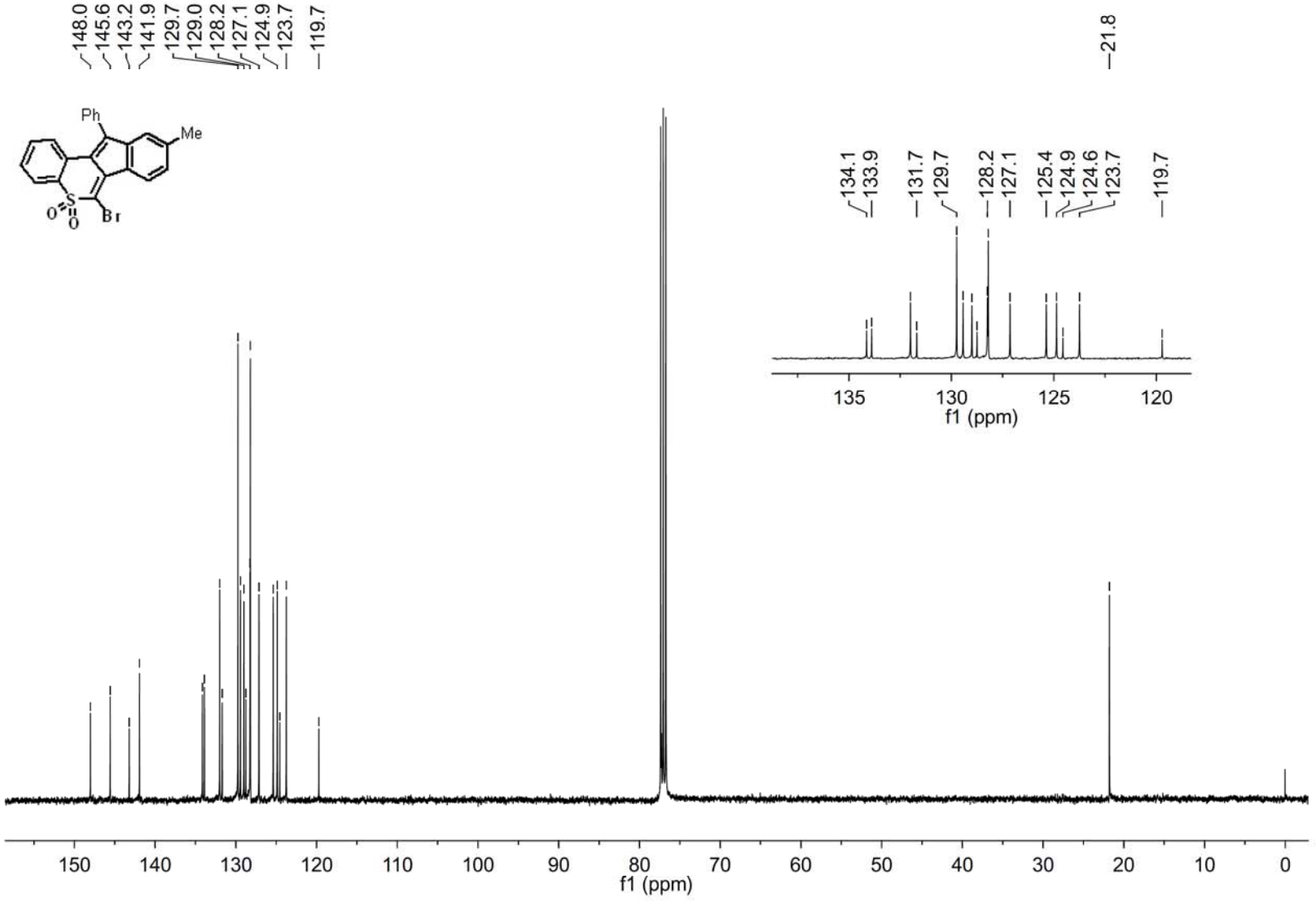
^{1}H NMR Spectrum of Compound 4f



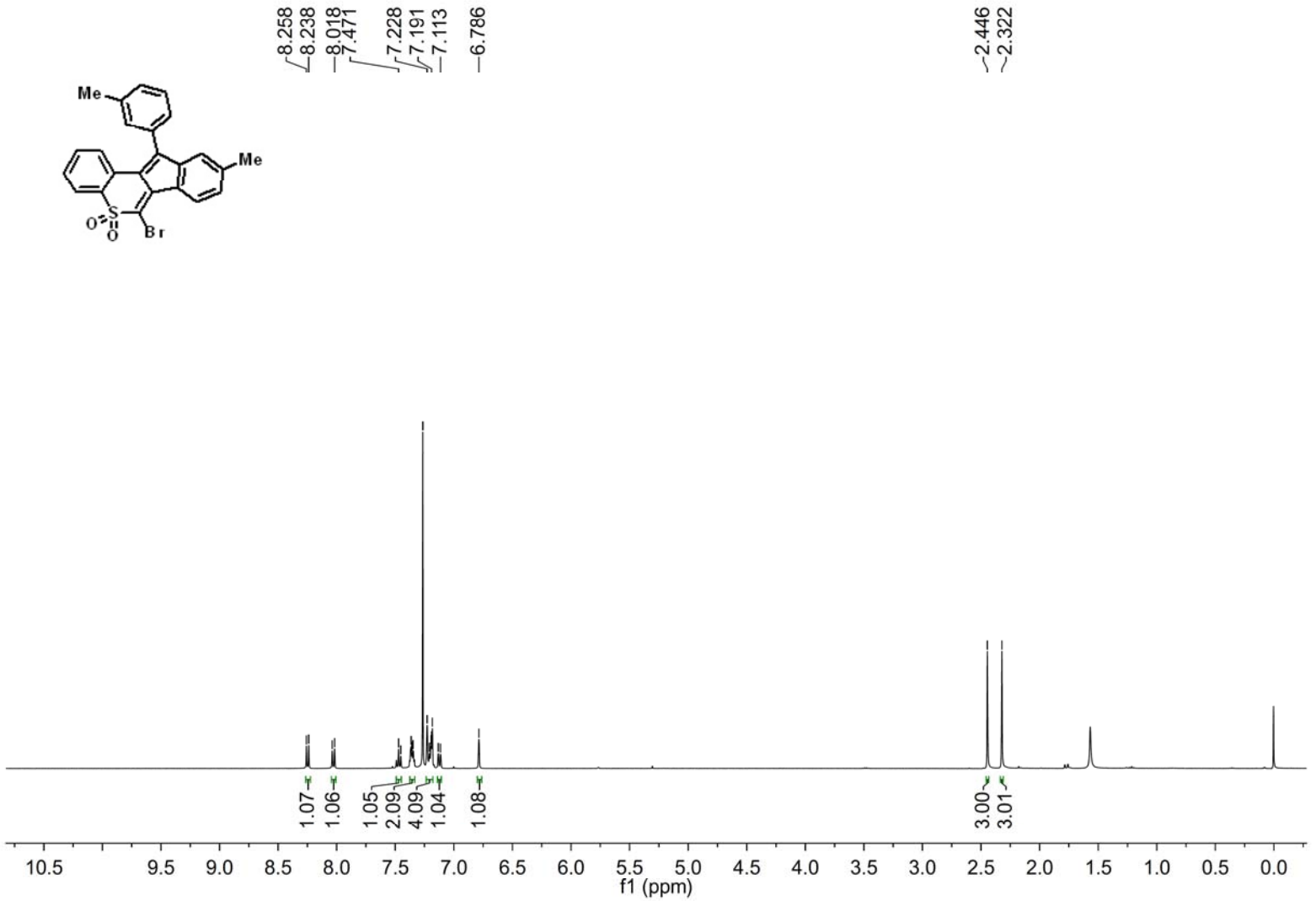
^{13}C NMR Spectrum of Compound 4f



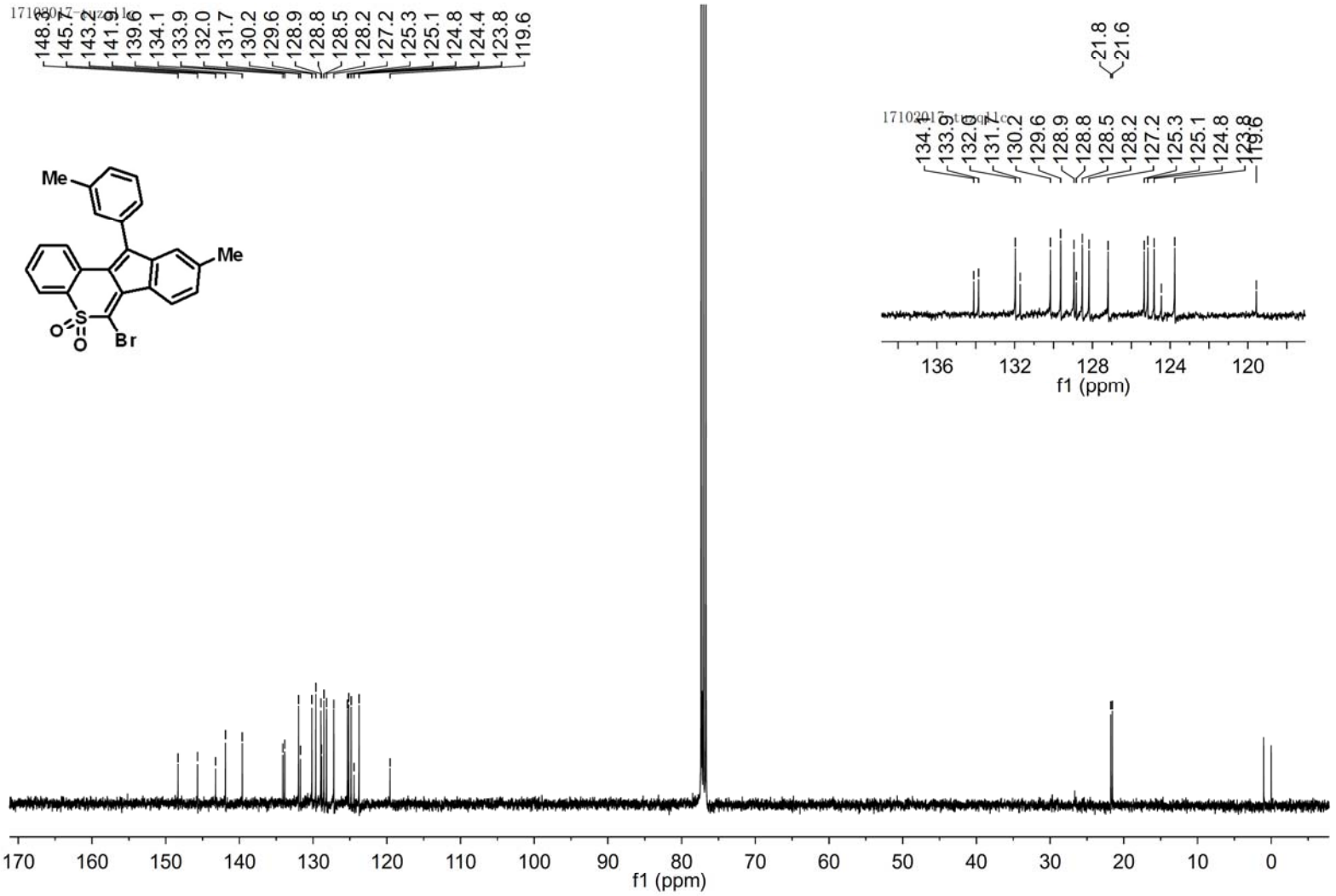
^{1}H NMR Spectrum of Compound 4g



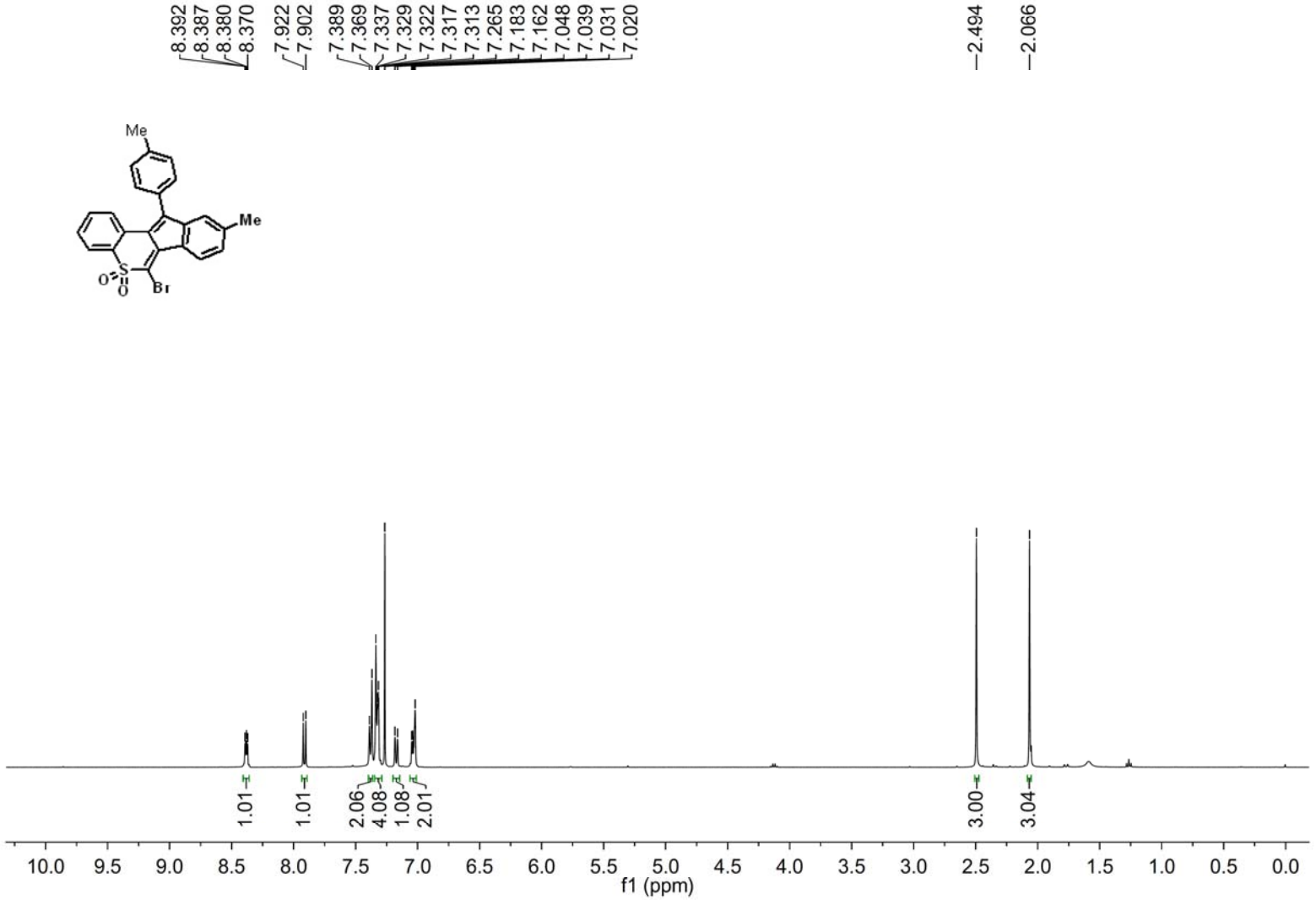
^{13}C NMR Spectrum of Compound 4g



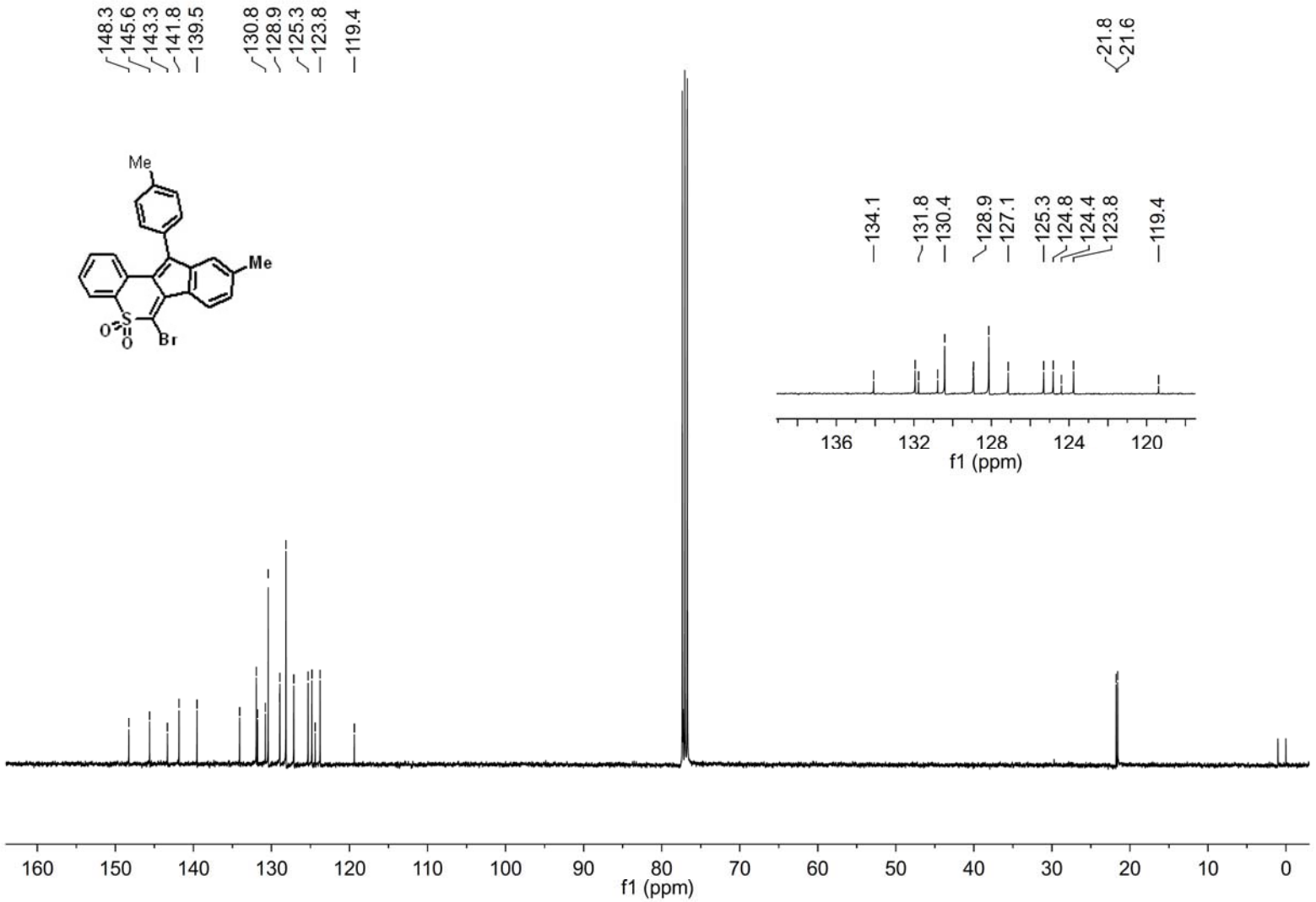
^{1}H NMR Spectrum of Compound 4h



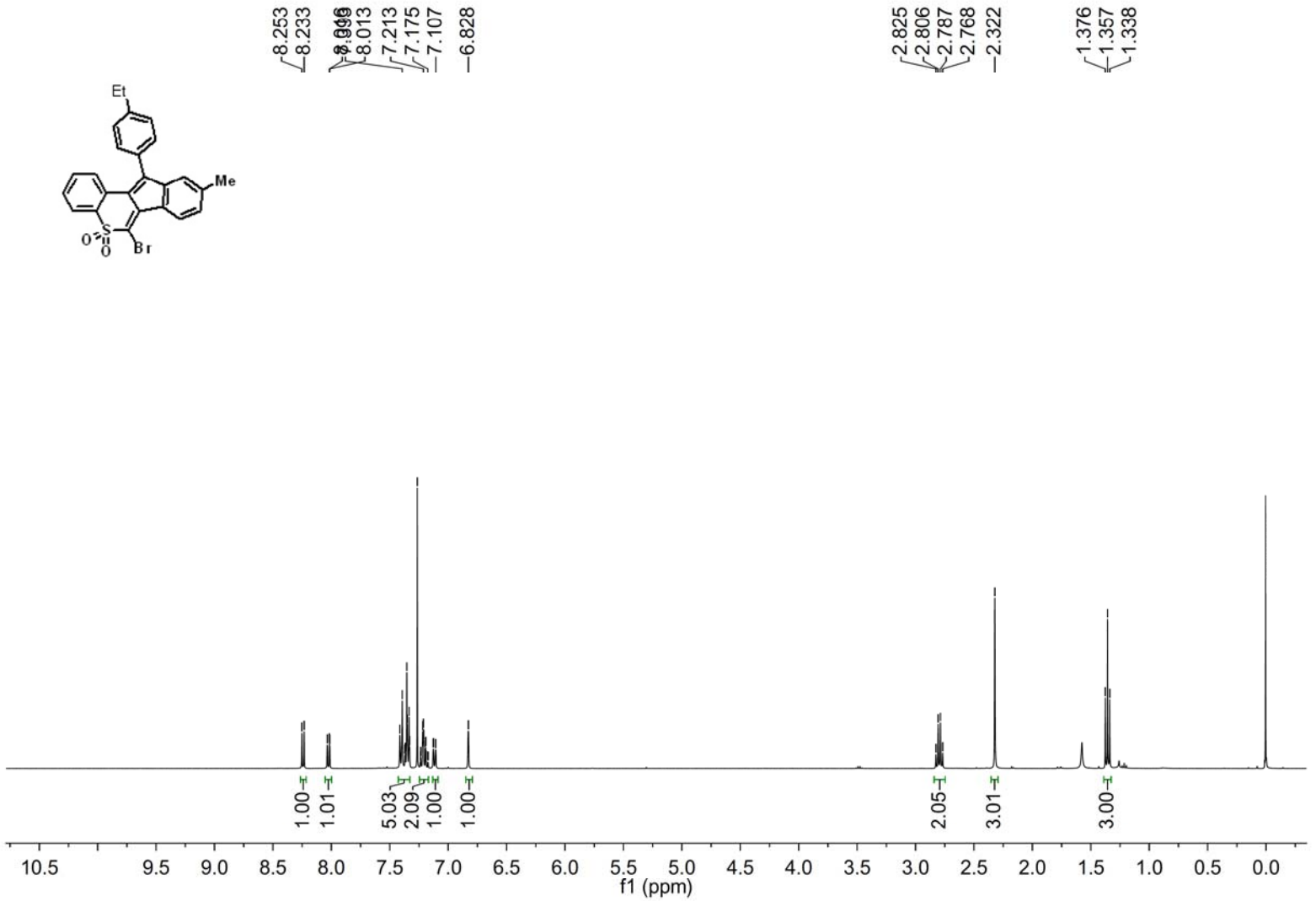
^{13}C NMR Spectrum of Compound 4h



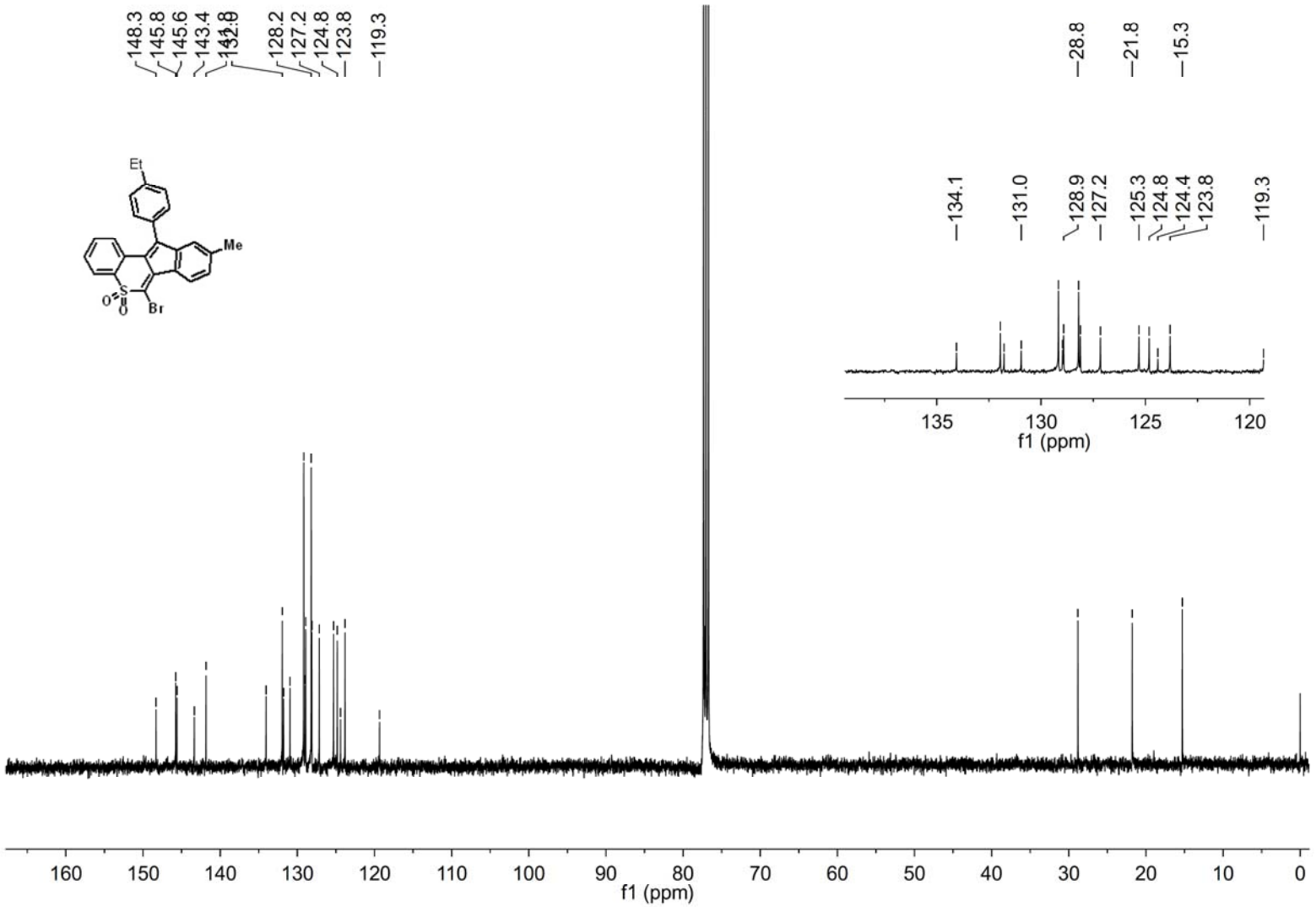
^{1}H NMR Spectrum of Compound 4i



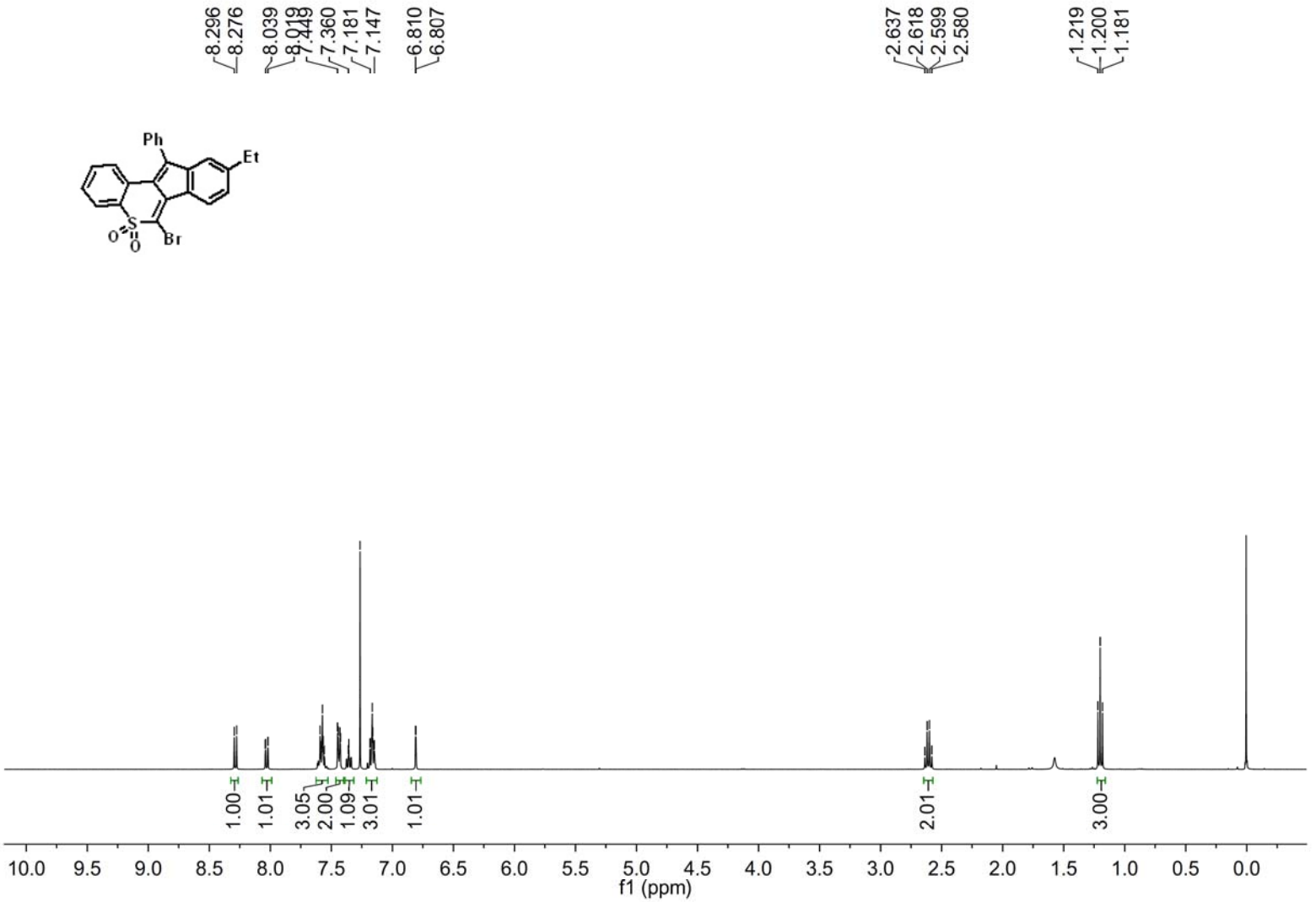
^{13}C NMR Spectrum of Compound 4i



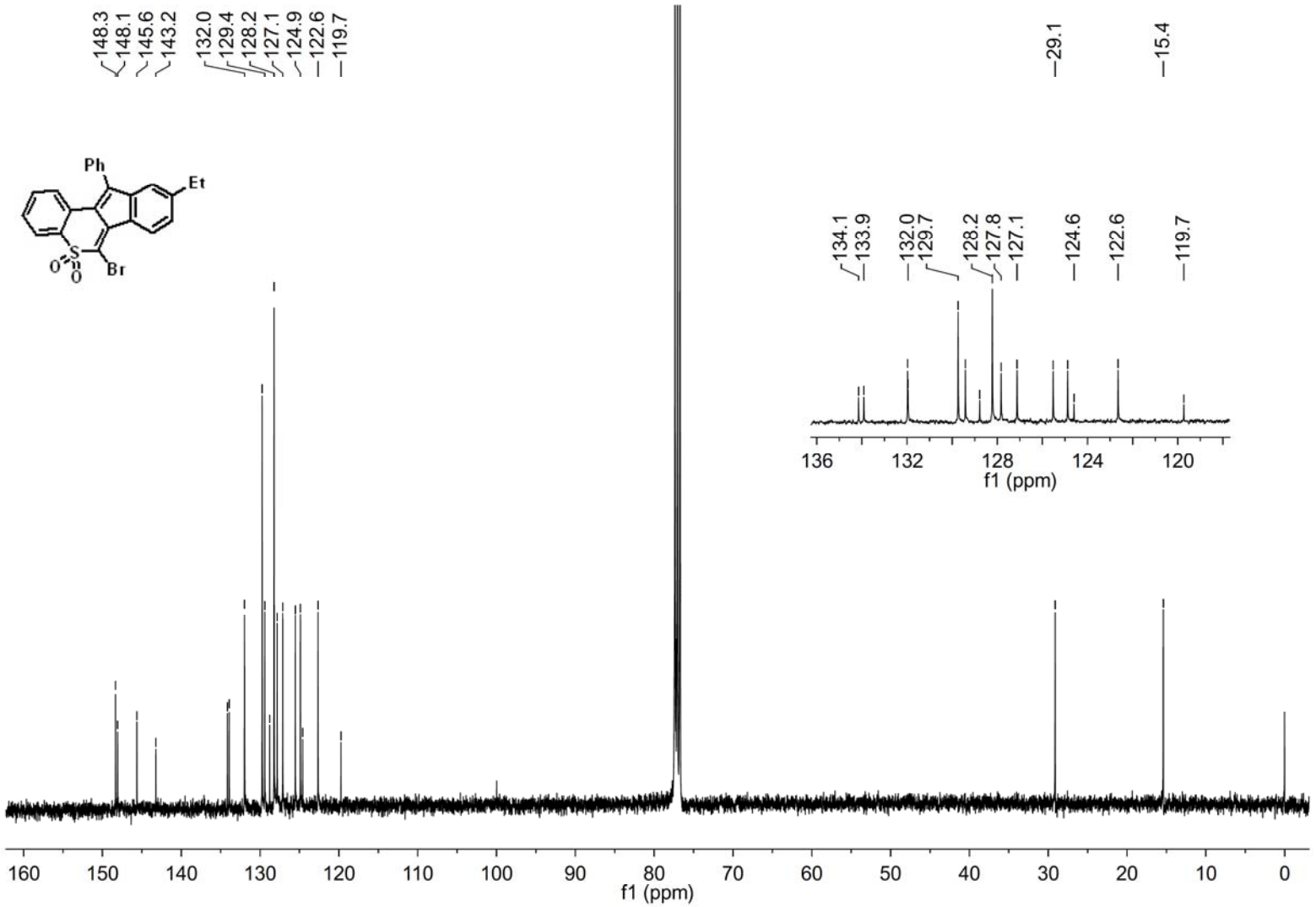
^{1}H NMR Spectrum of Compound 4j



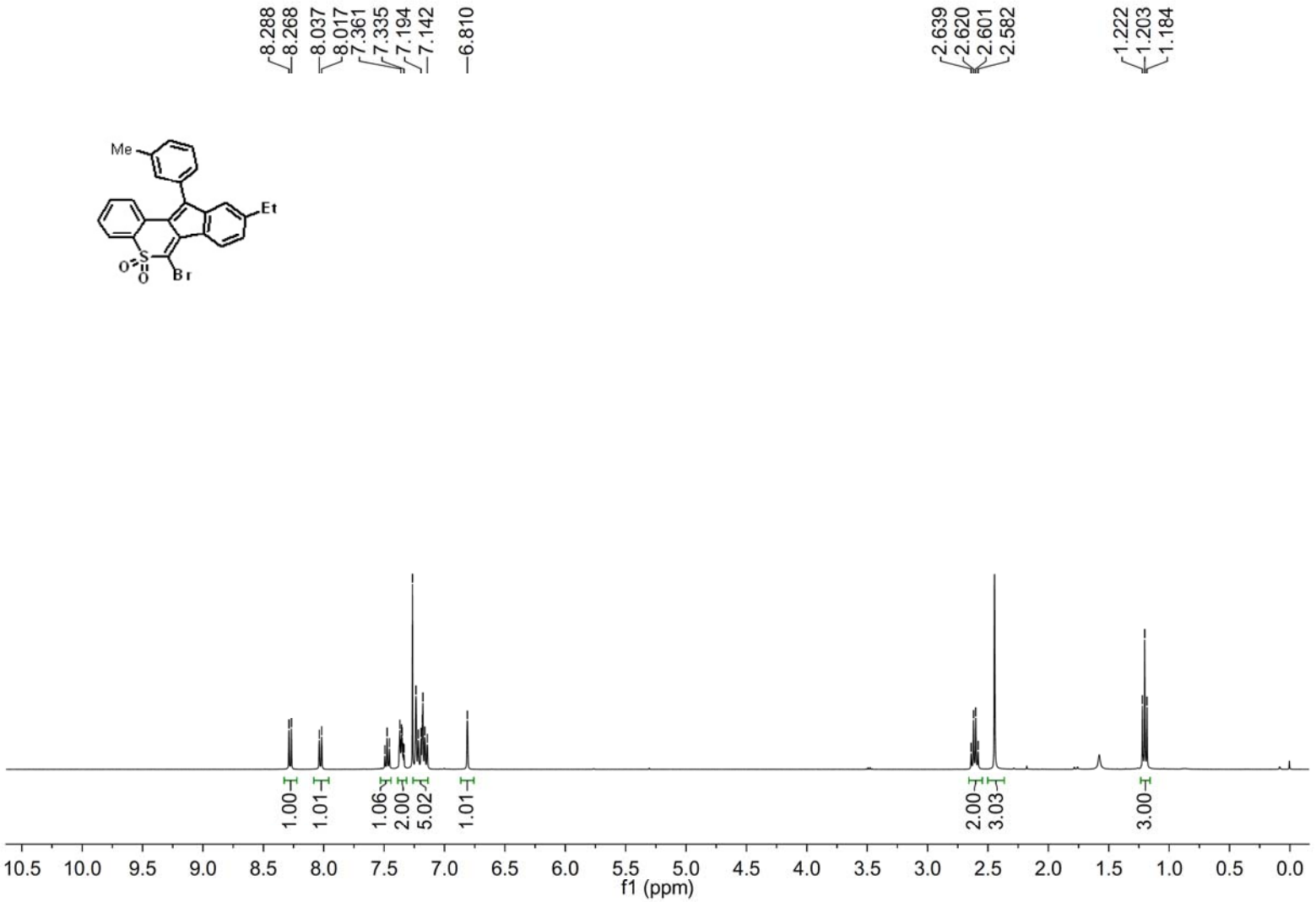
^{13}C NMR Spectrum of Compound 4j



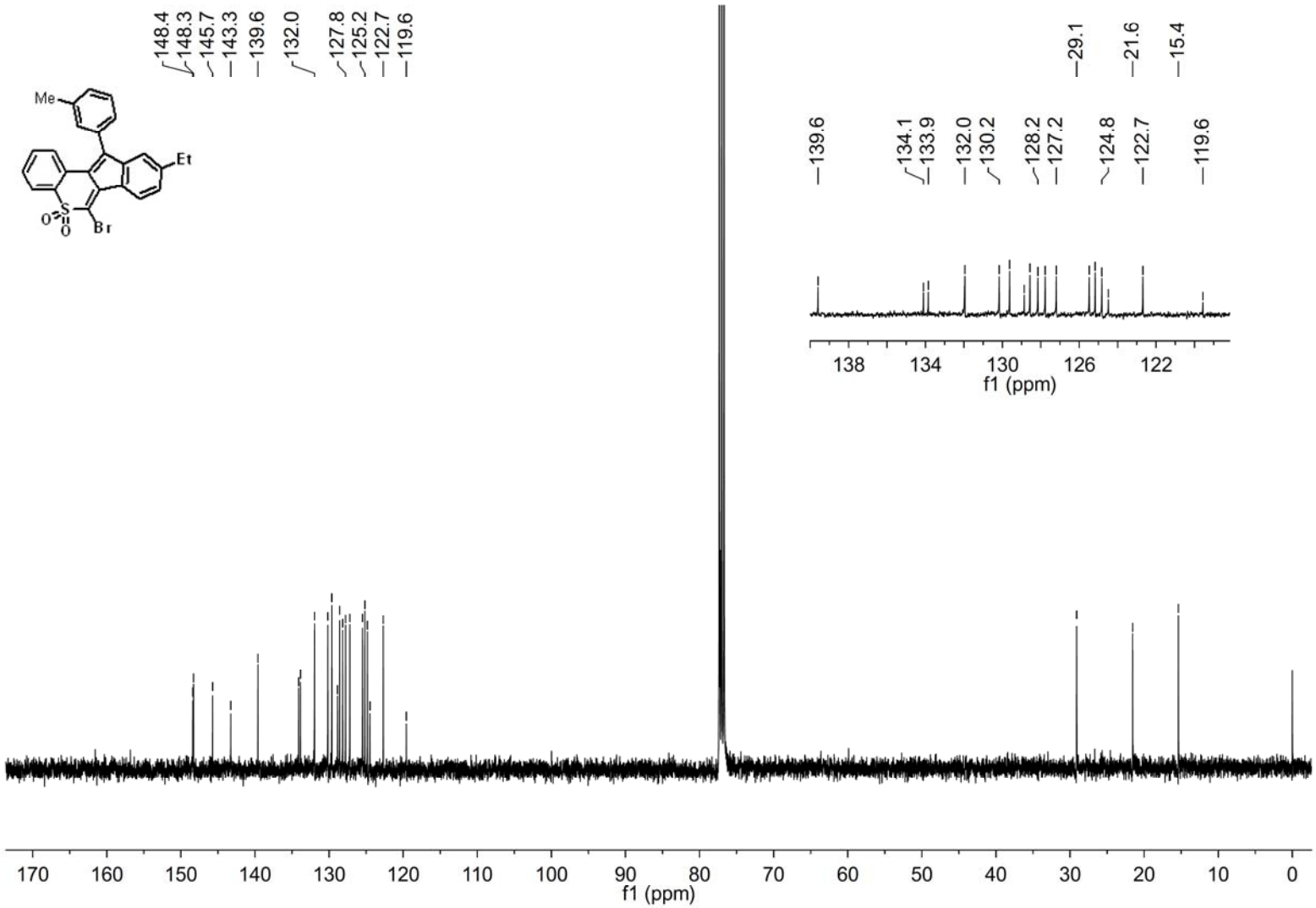
^{1}H NMR Spectrum of Compound 4k



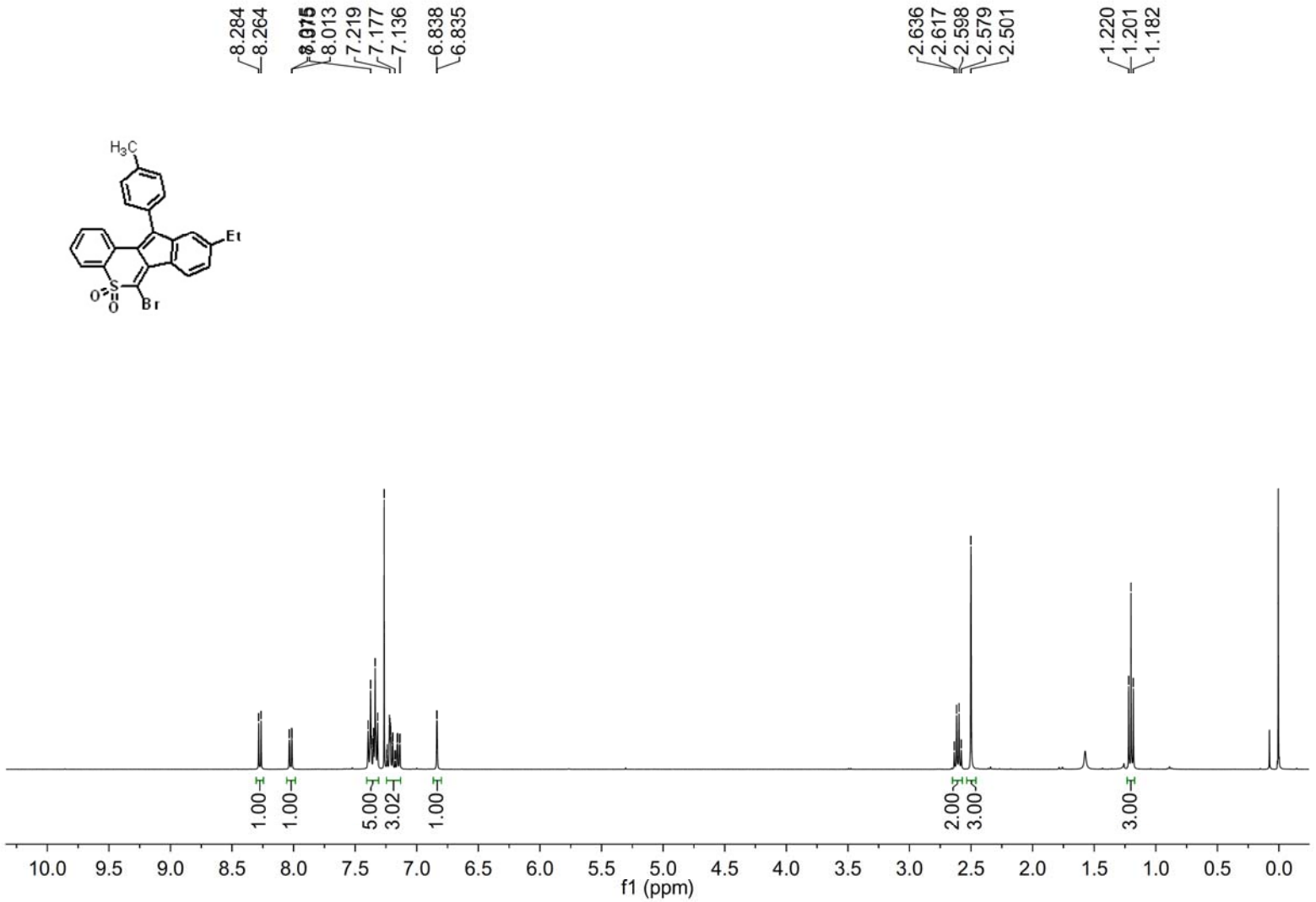
^{13}C NMR Spectrum of Compound 4k



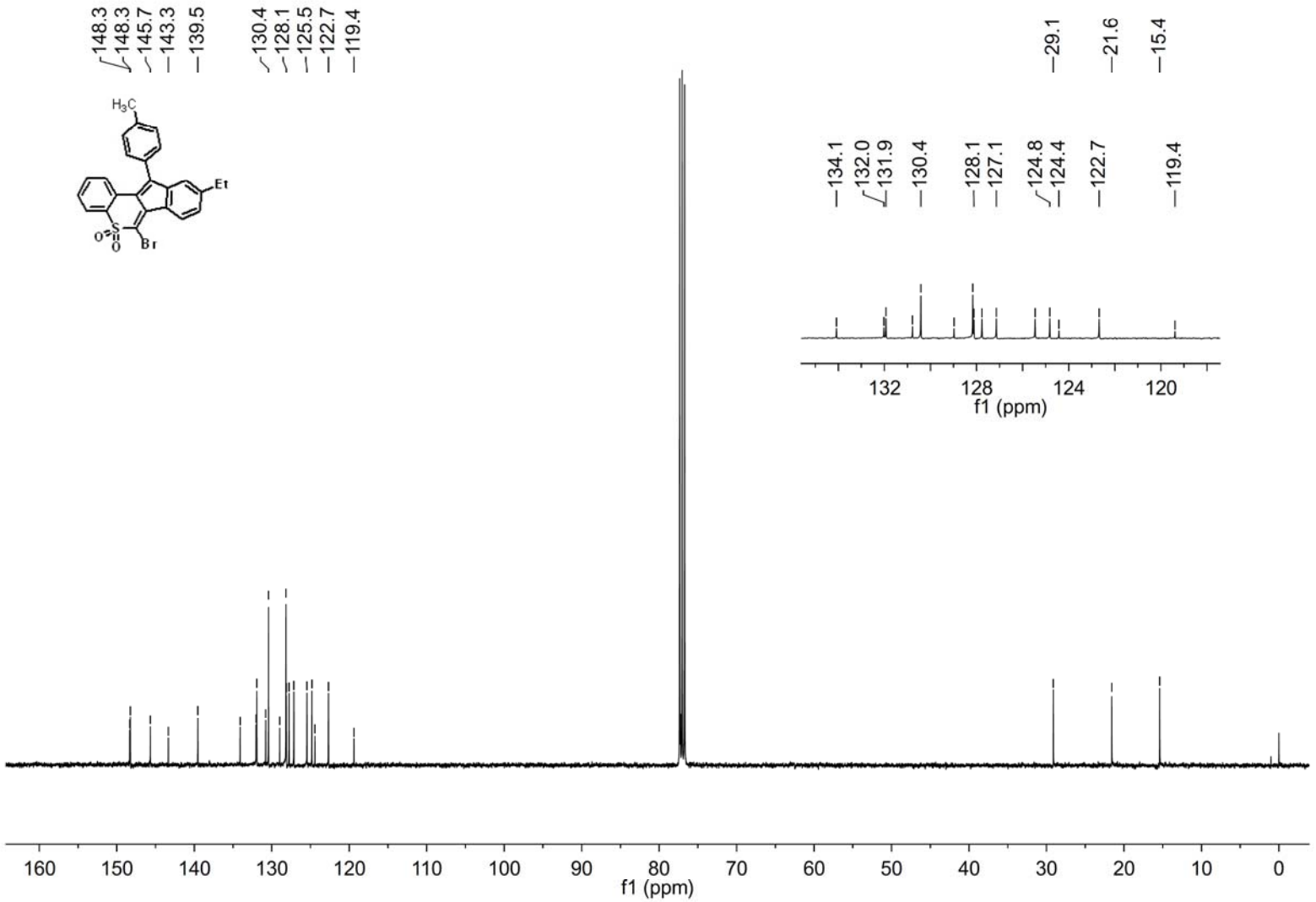
^{1}H NMR Spectrum of Compound 4l



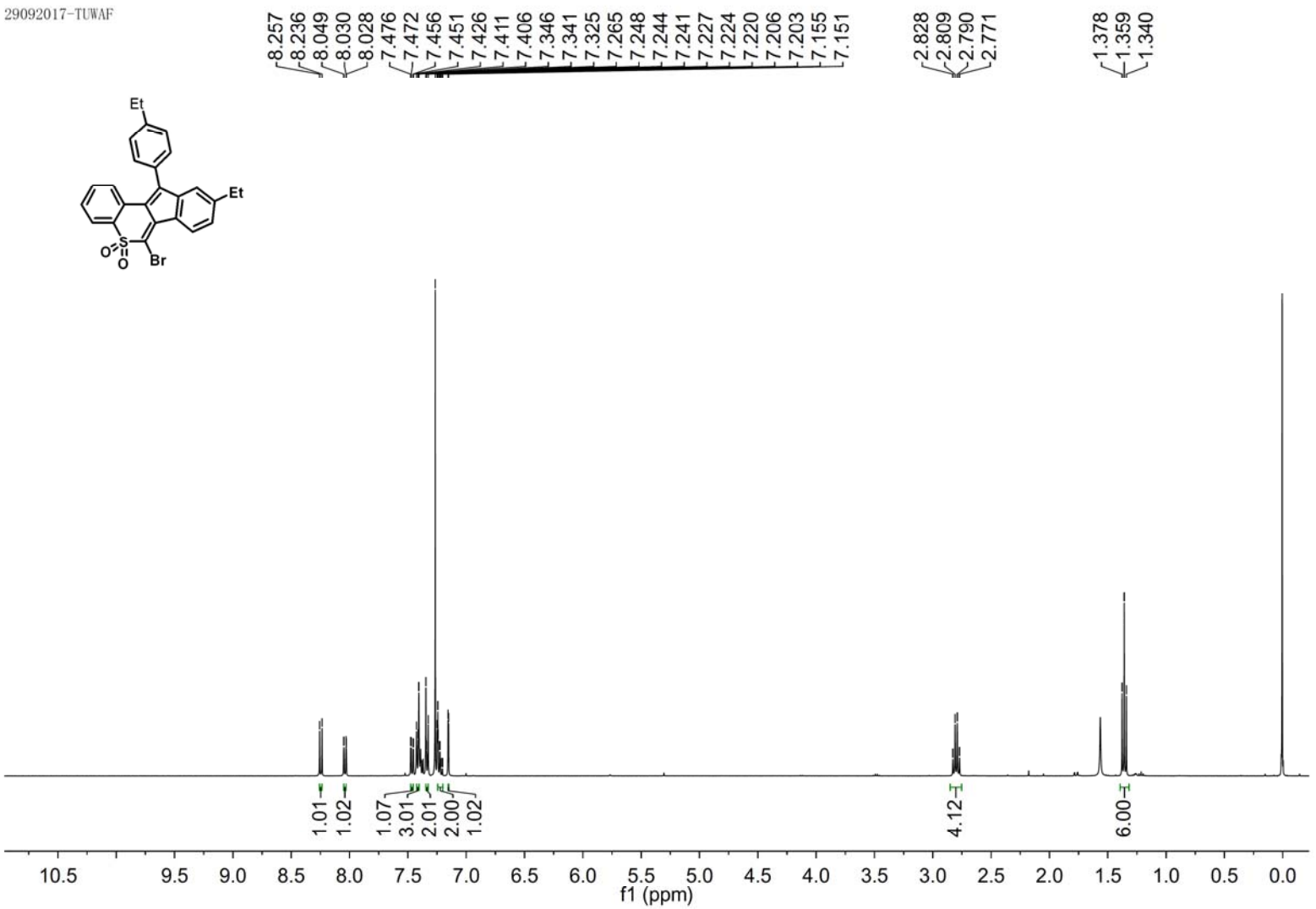
^{13}C NMR Spectrum of Compound 4l



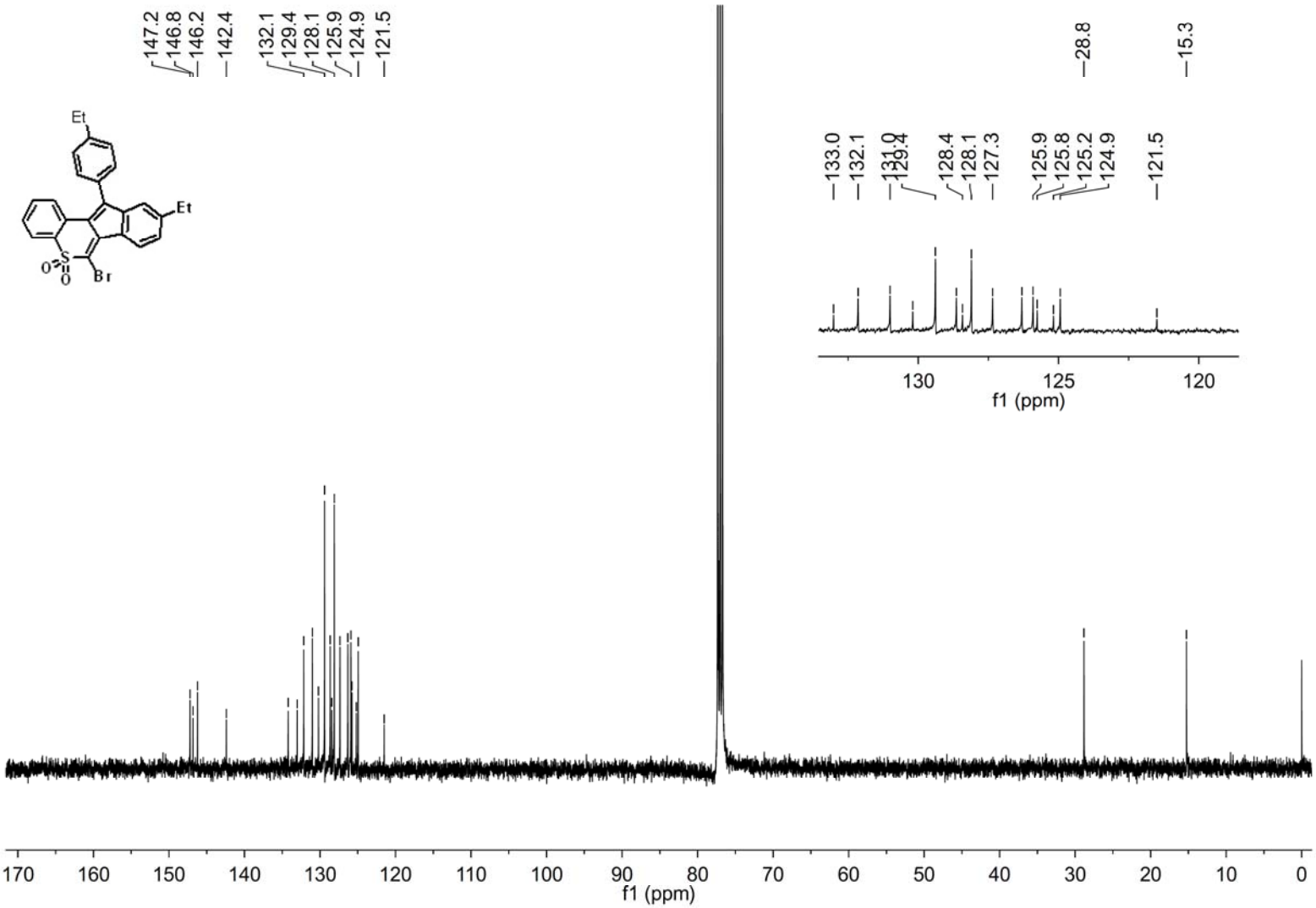
^{1}H NMR Spectrum of Compound 4m



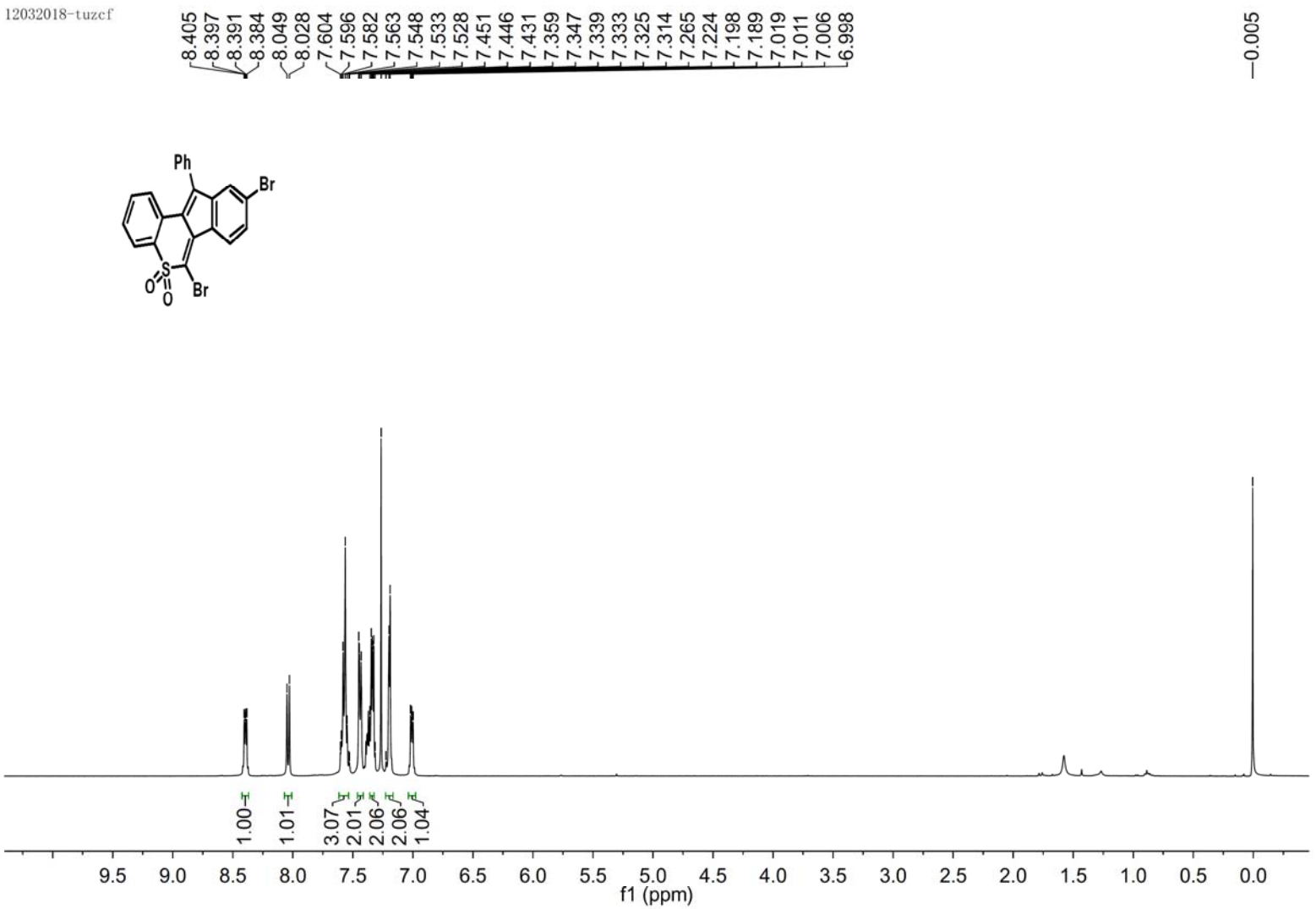
^{13}C NMR Spectrum of Compound 4m



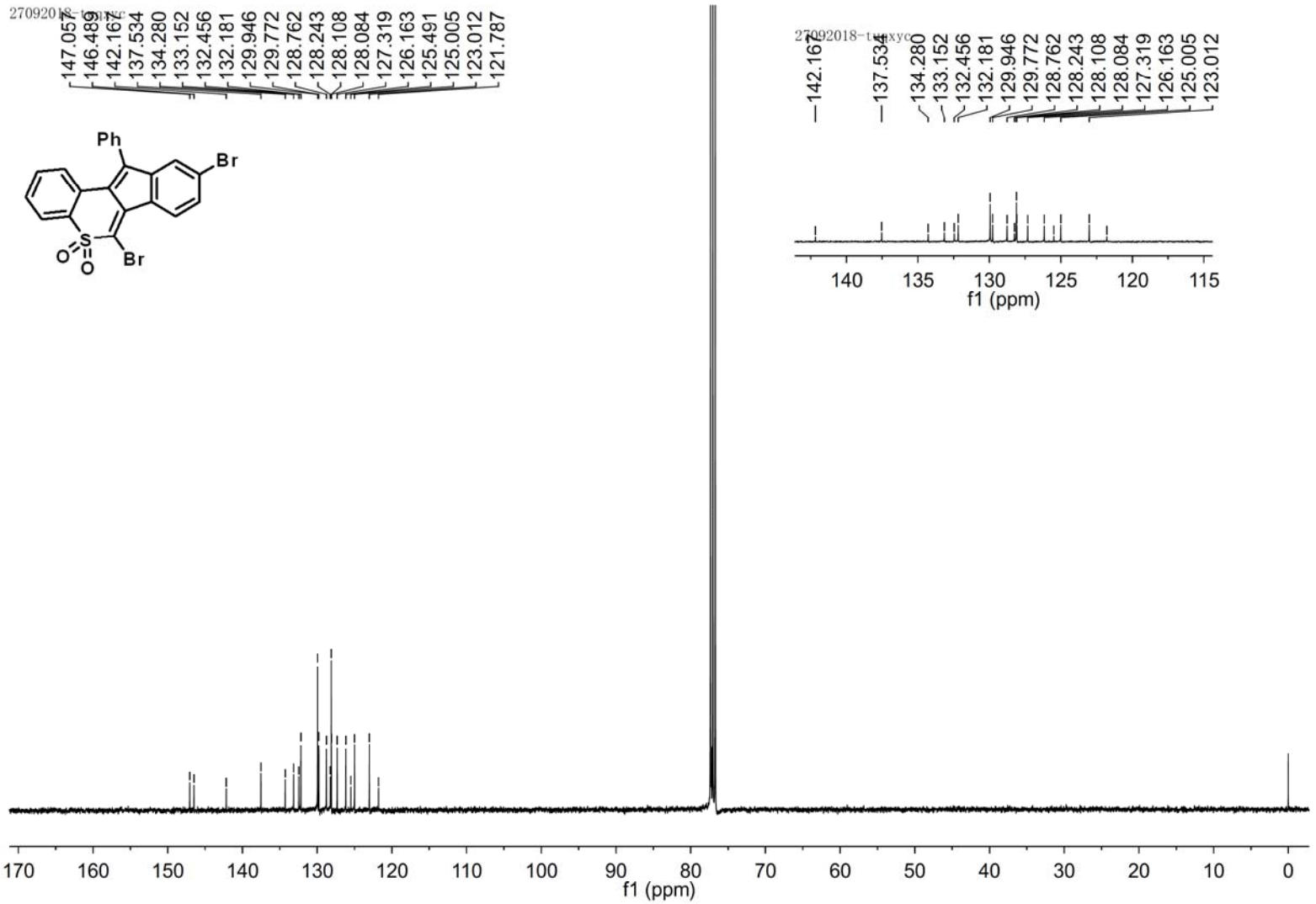
^{1}H NMR Spectrum of Compound 4n



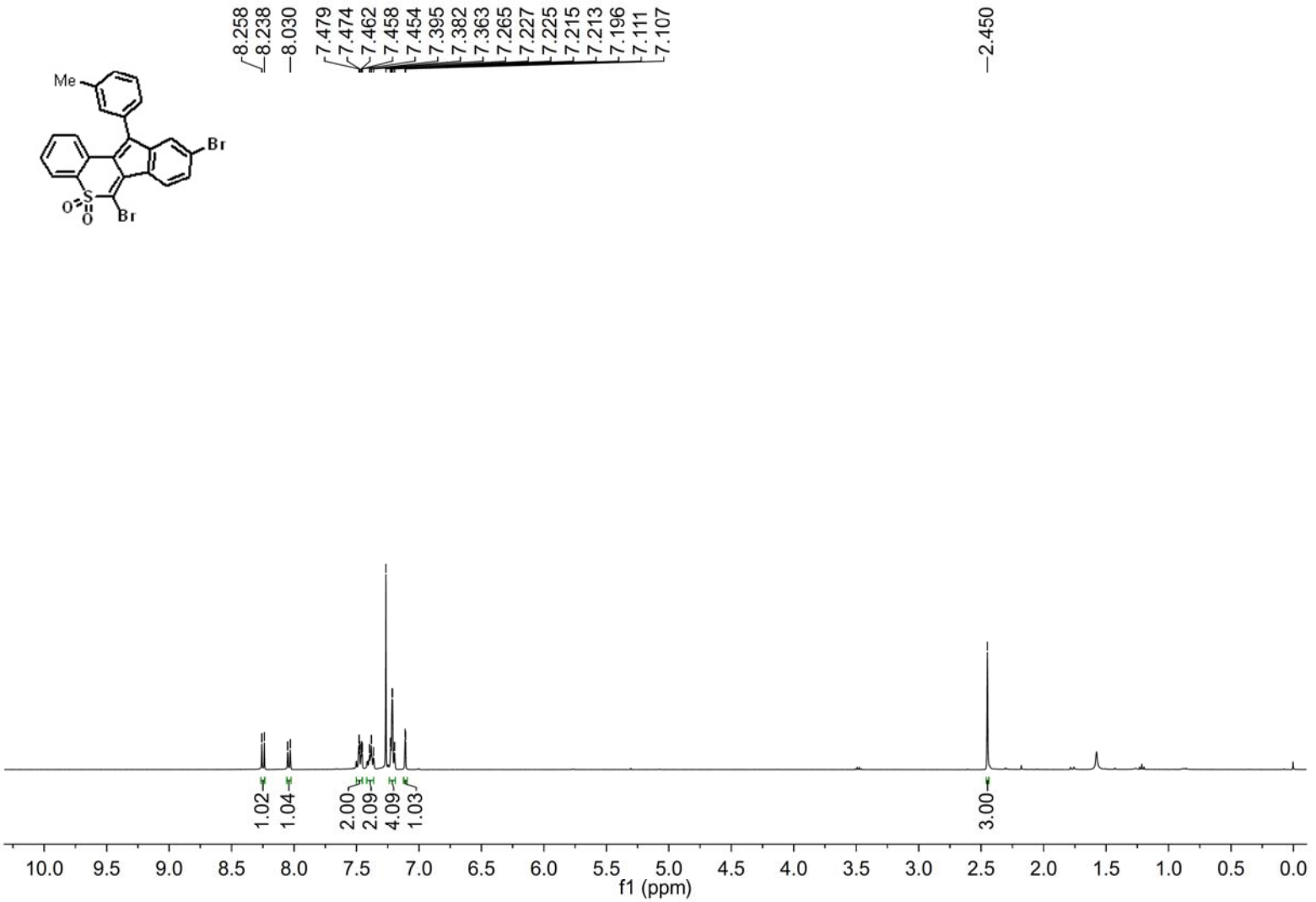
^{13}C NMR Spectrum of Compound 4n



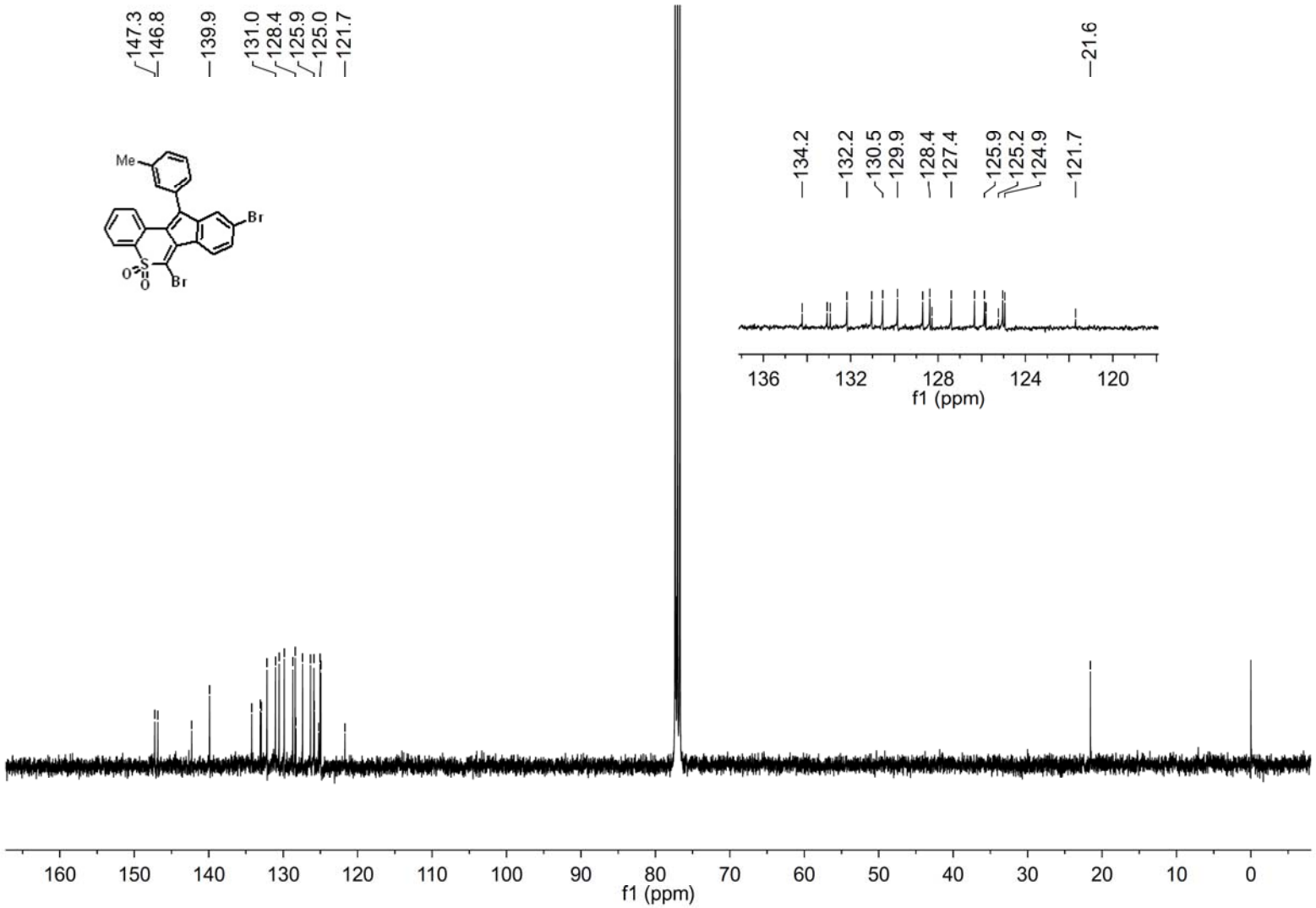
^{1}H NMR Spectrum of Compound 4o



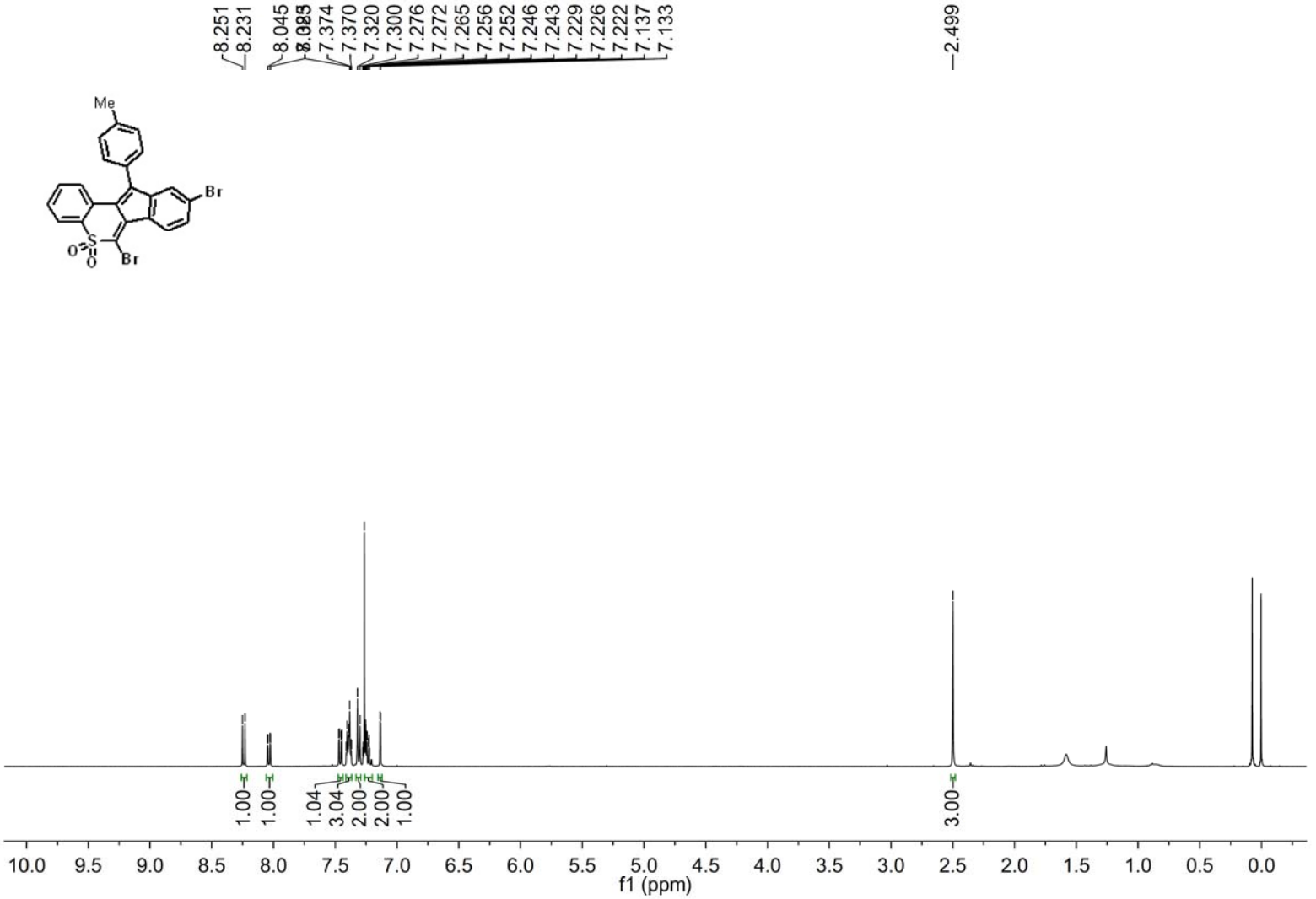
^{13}C NMR Spectrum of Compound 4o



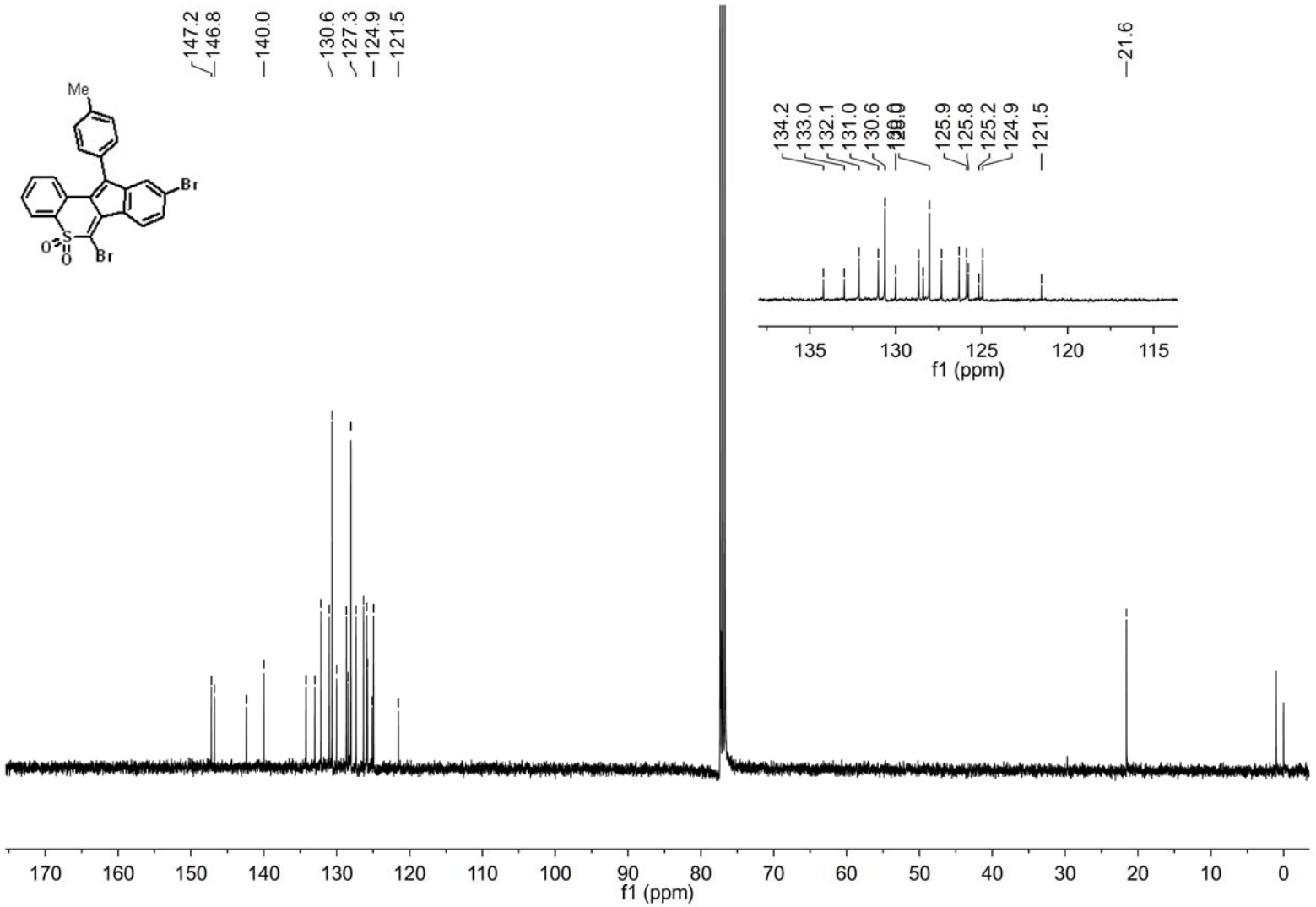
^{1}H NMR Spectrum of Compound 4p



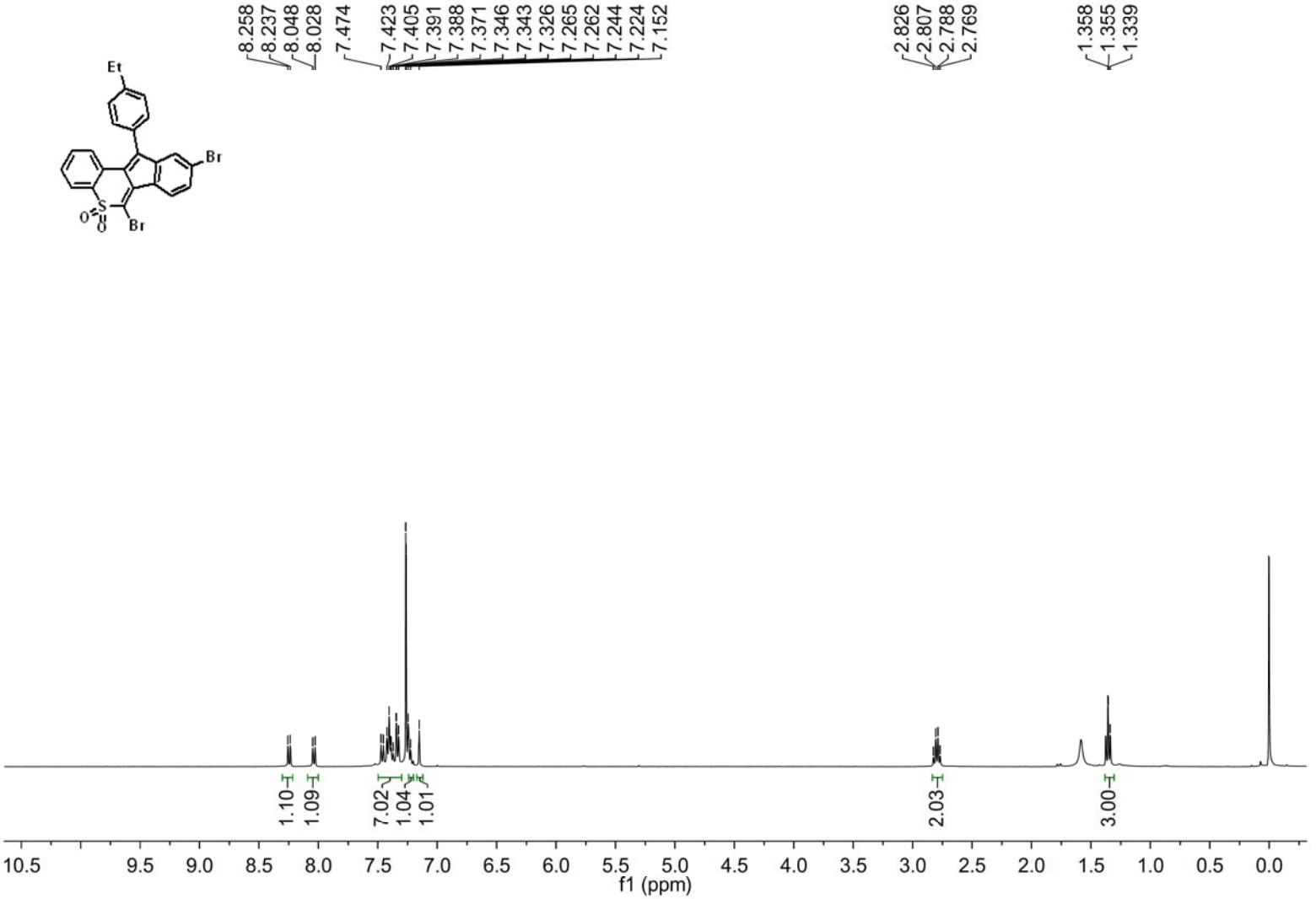
^{13}C NMR Spectrum of Compound 4p



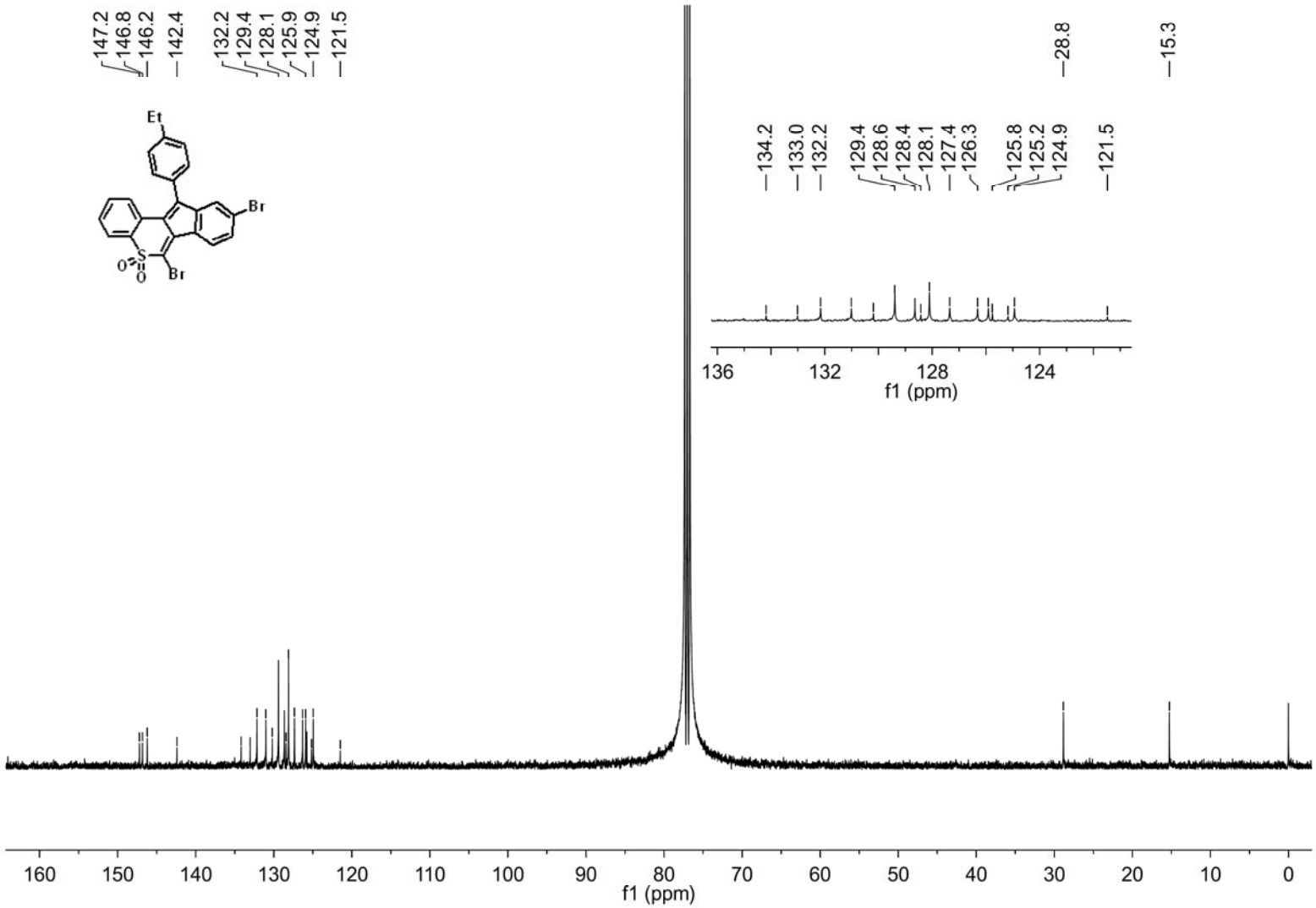
^{1}H NMR Spectrum of Compound 4q



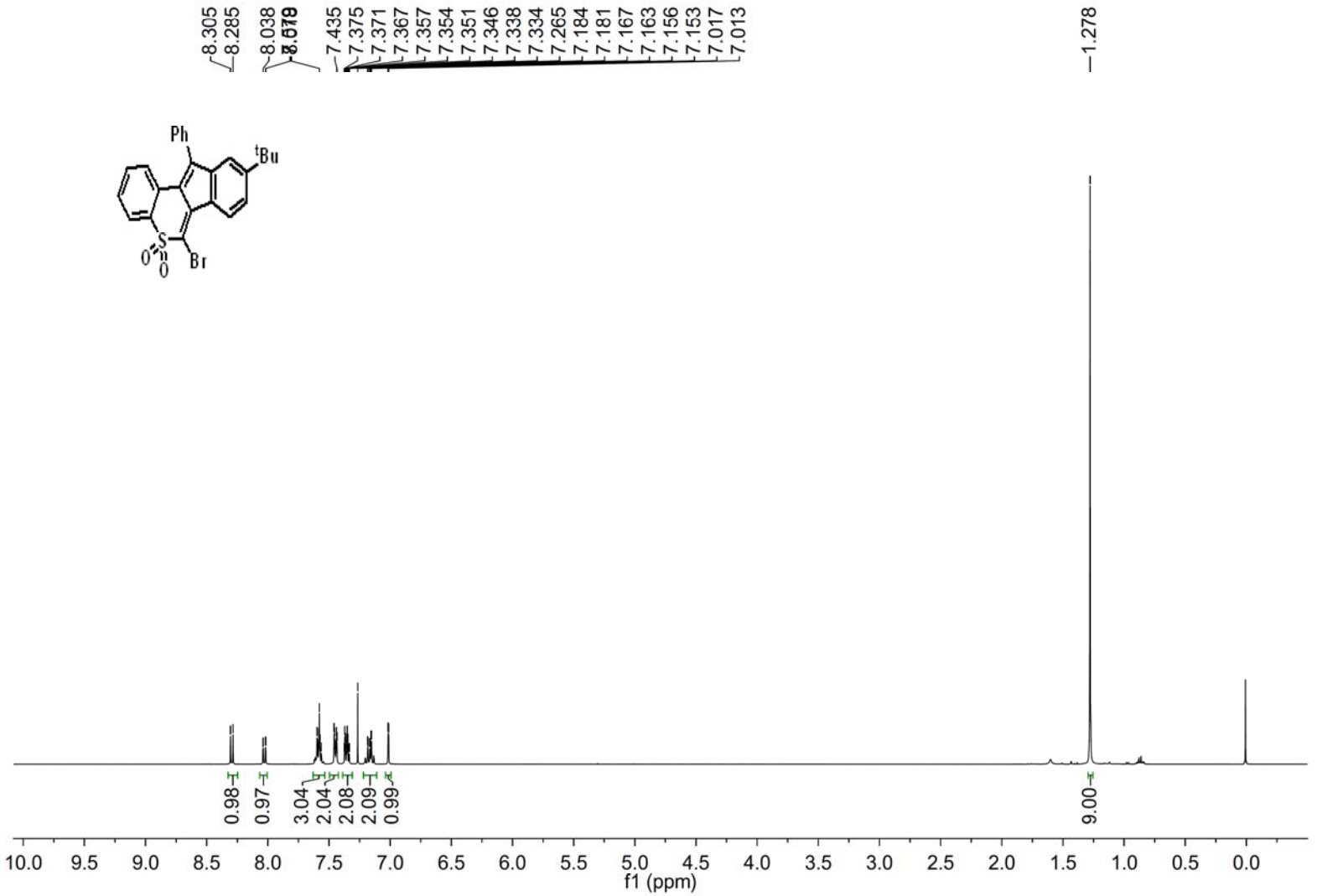
^{13}C NMR Spectrum of Compound 4q



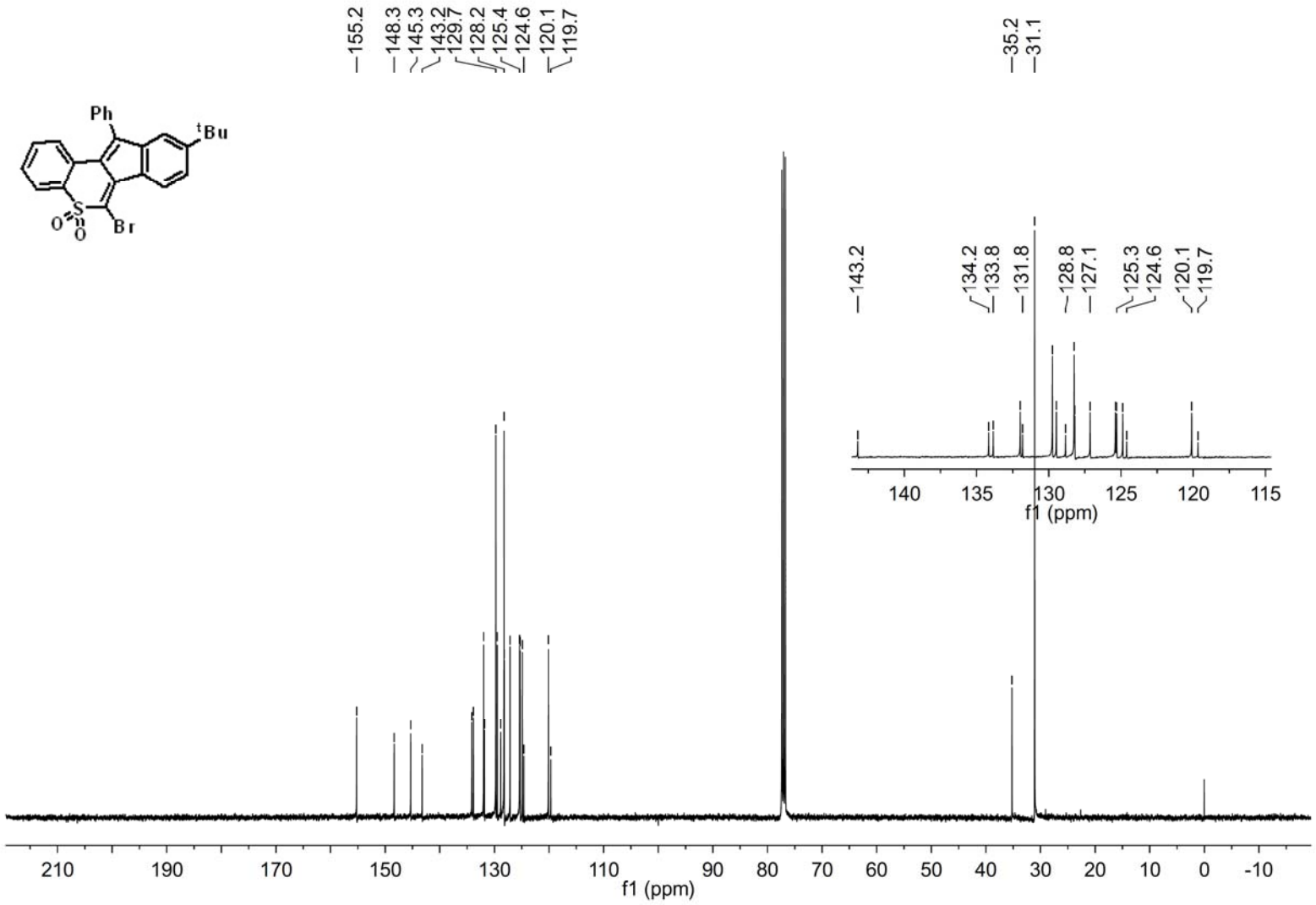
^{1}H NMR Spectrum of Compound 4r



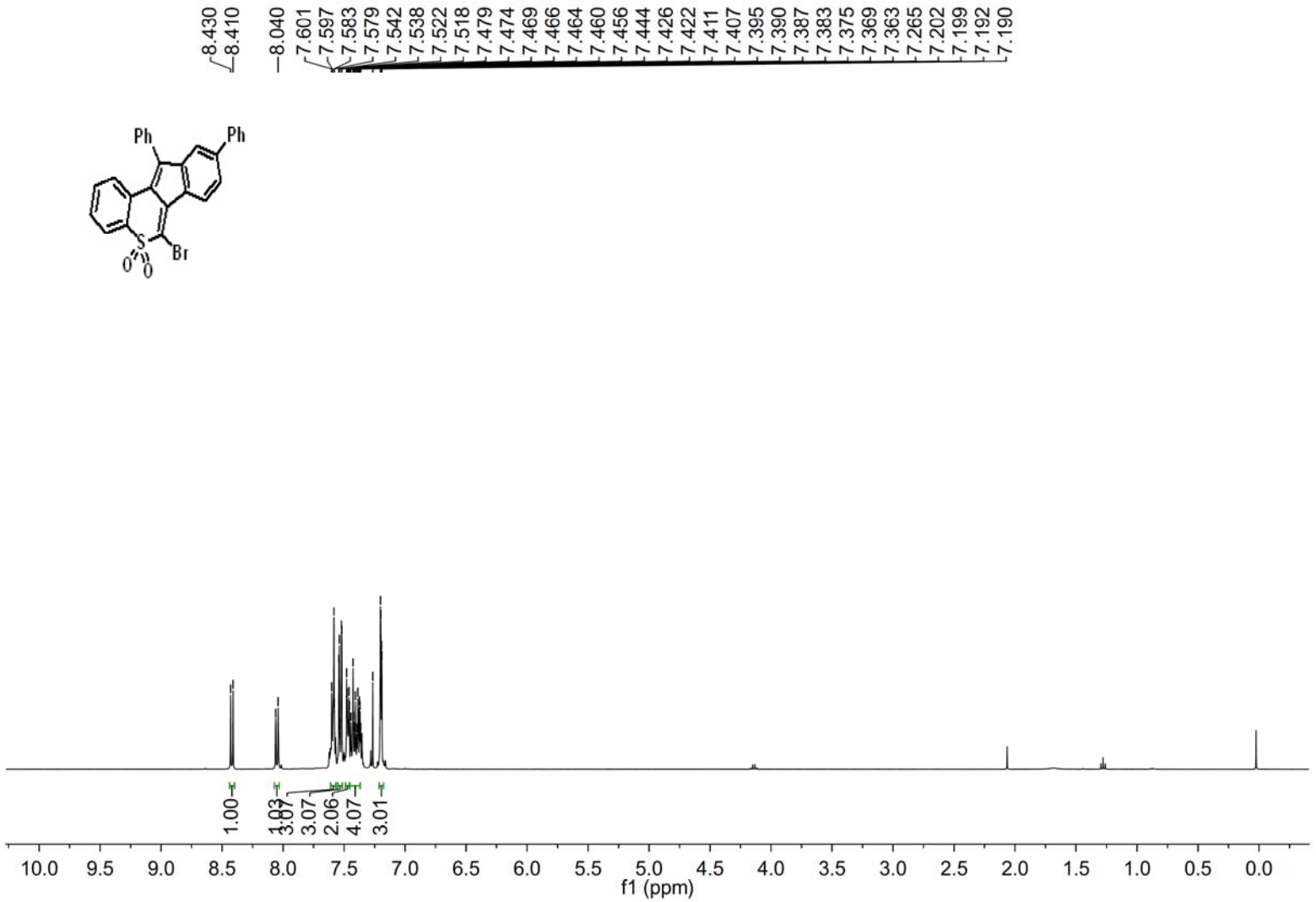
^{13}C NMR Spectrum of Compound 4r



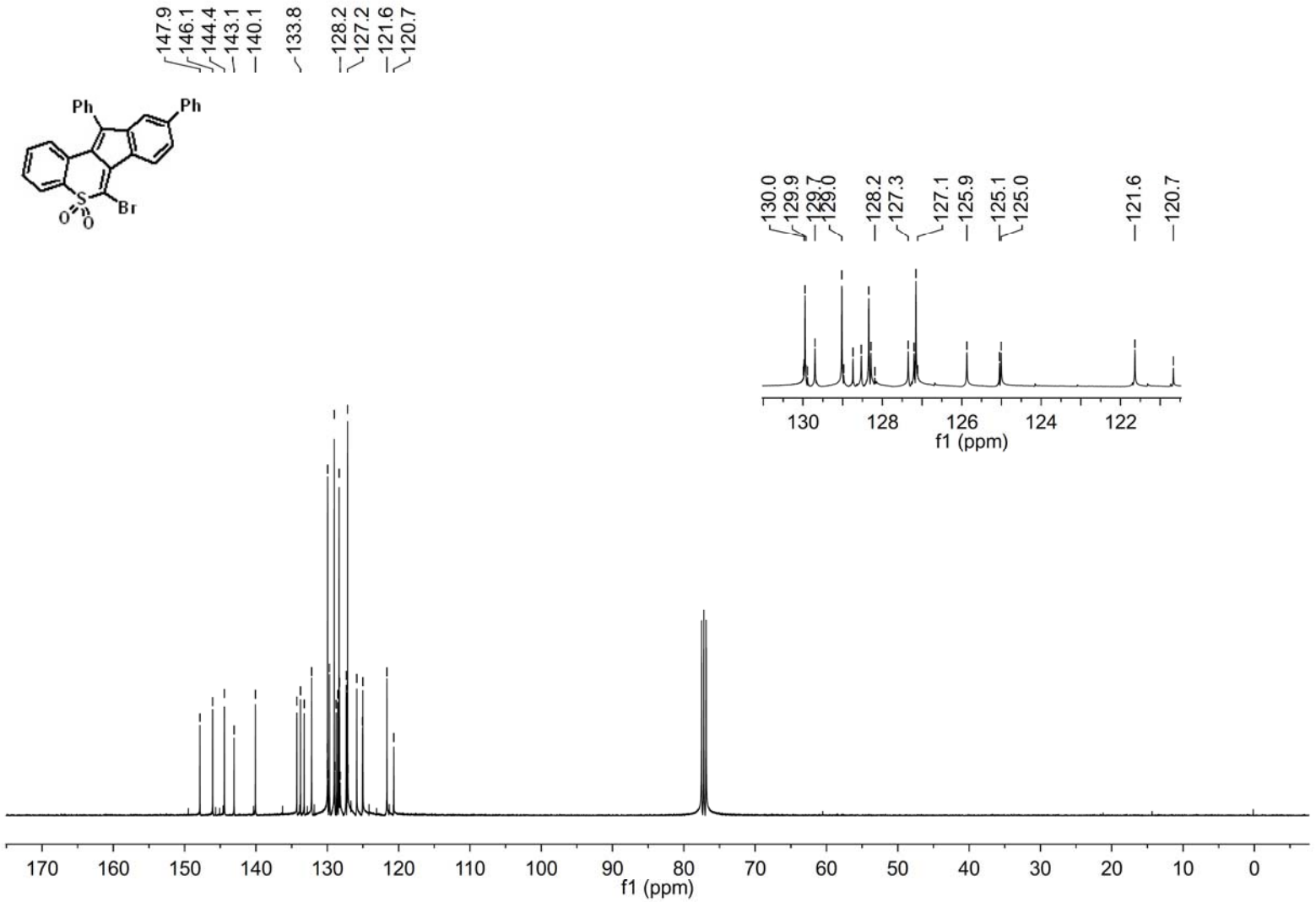
^{1}H NMR Spectrum of Compound 4s



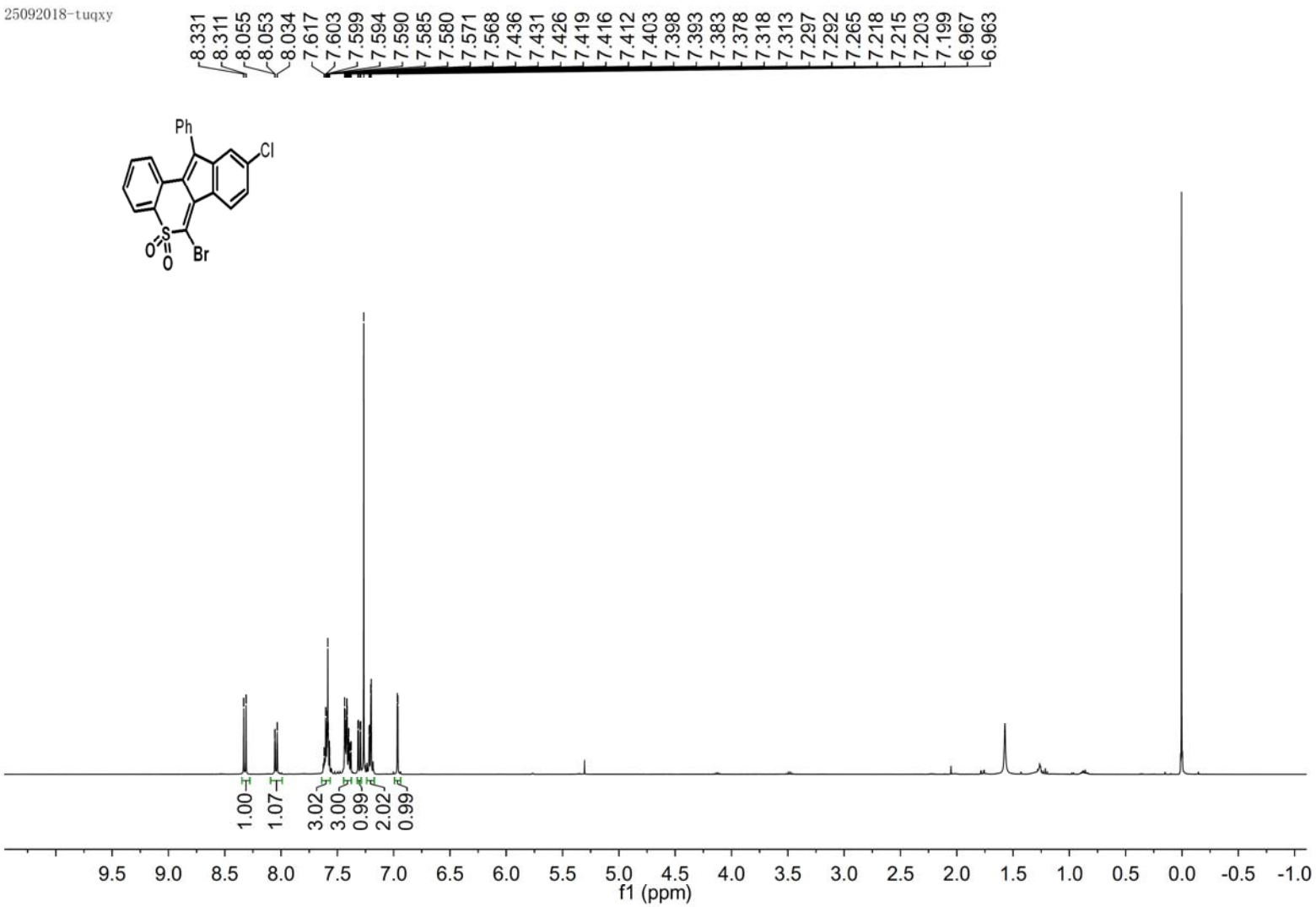
^{13}C NMR Spectrum of Compound 4s



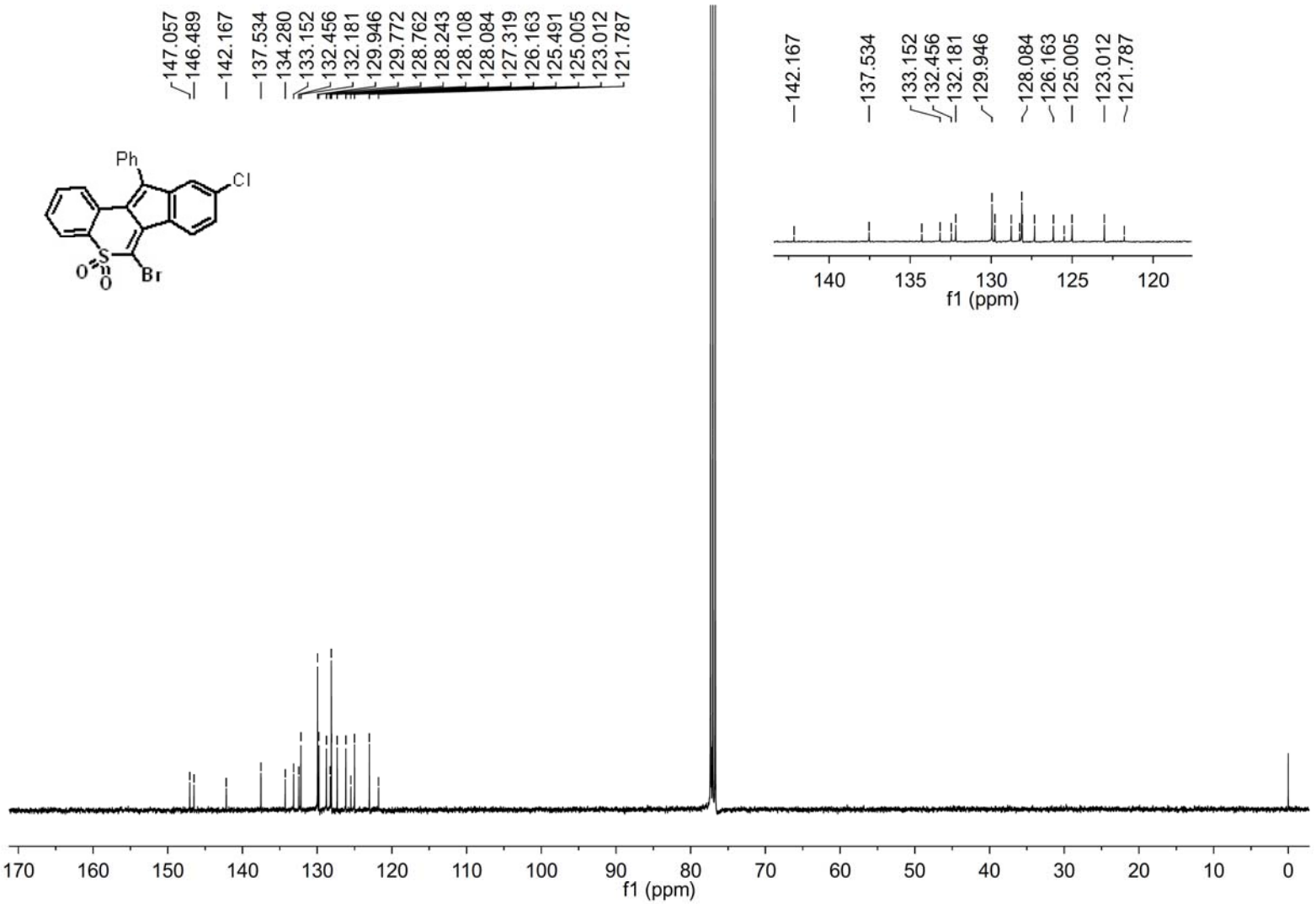
^{1}H NMR Spectrum of Compound 4t



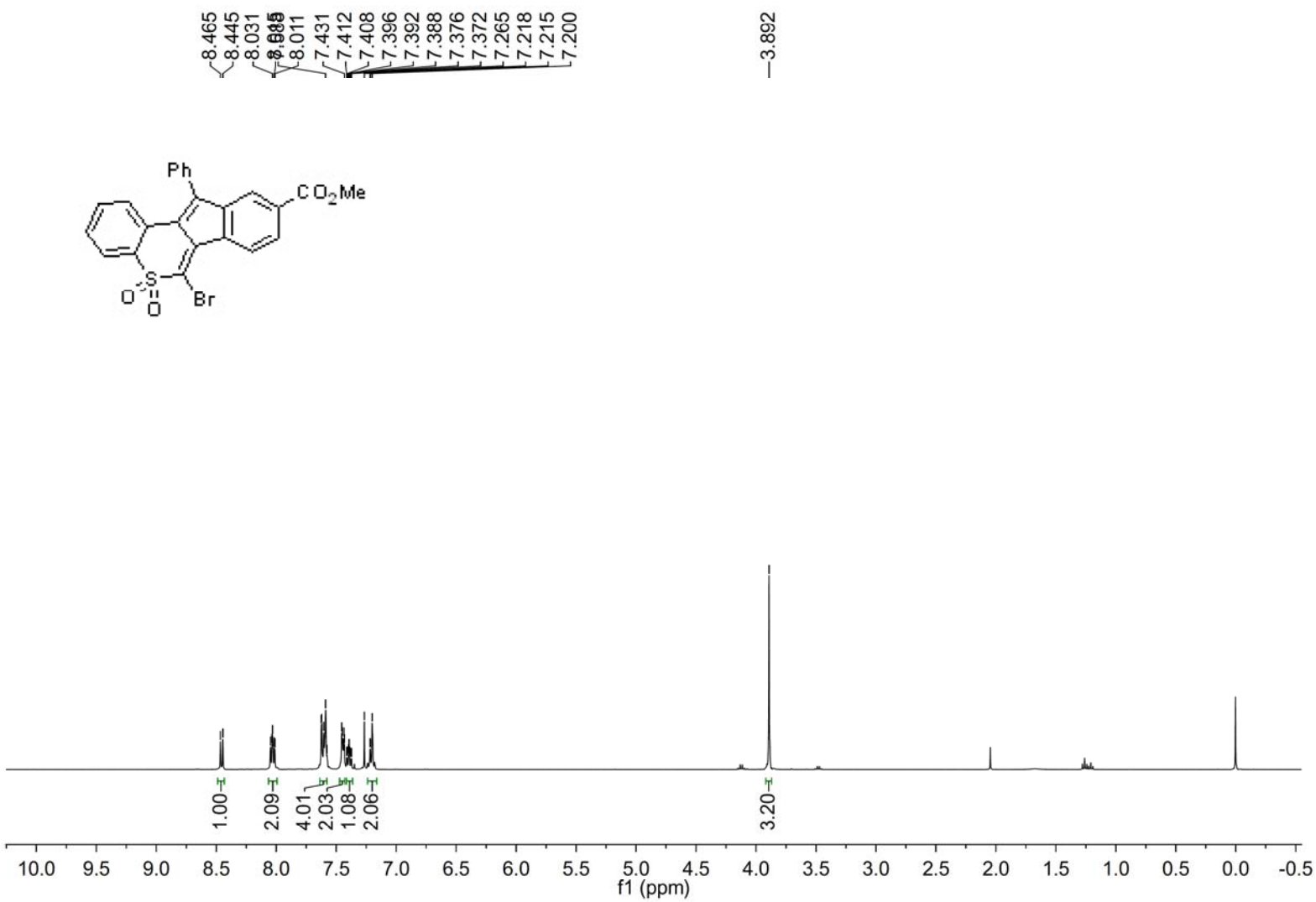
^{13}C NMR Spectrum of Compound 4t



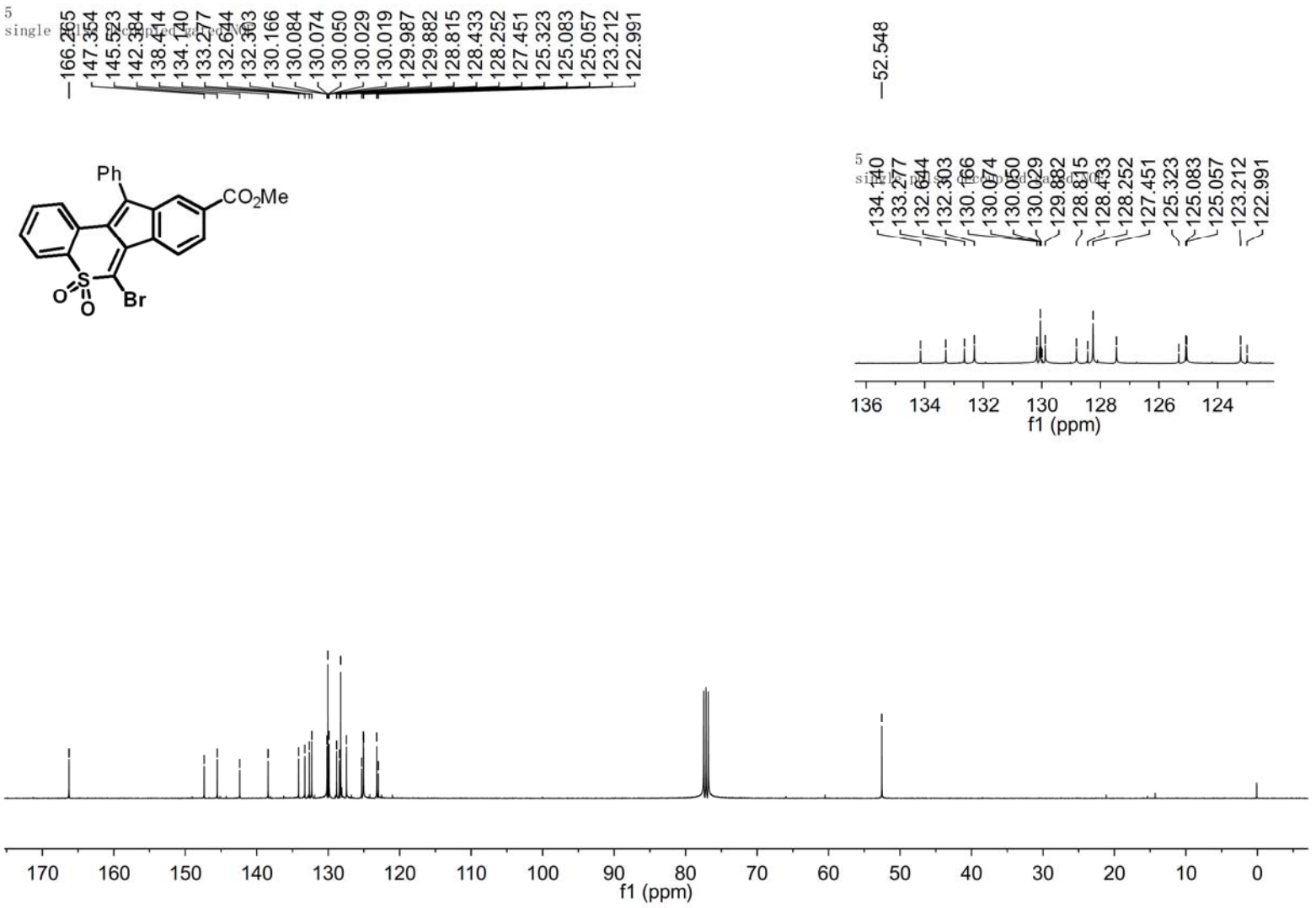
^{1}H NMR Spectrum of Compound 4u



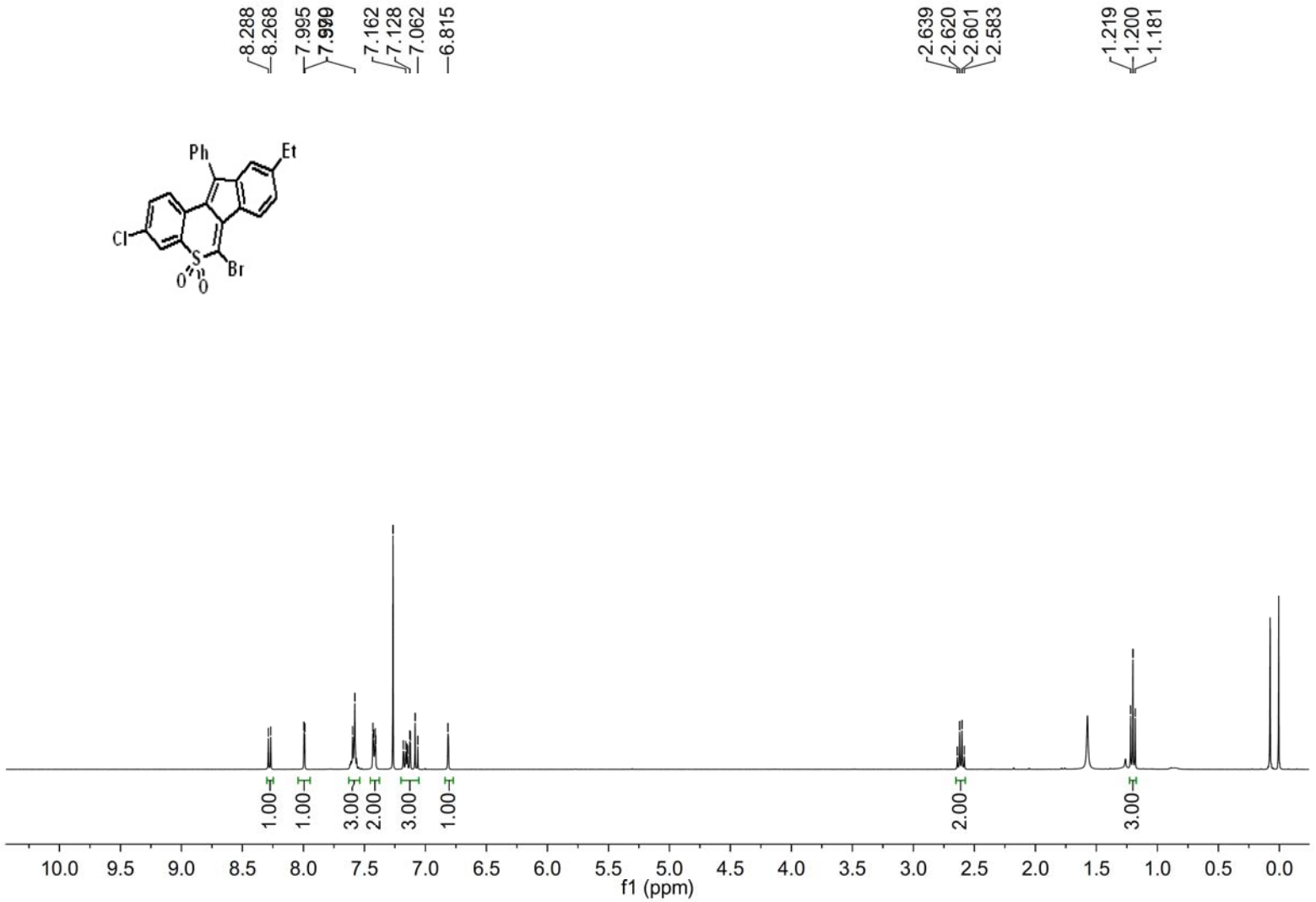
^{13}C NMR Spectrum of Compound 4u



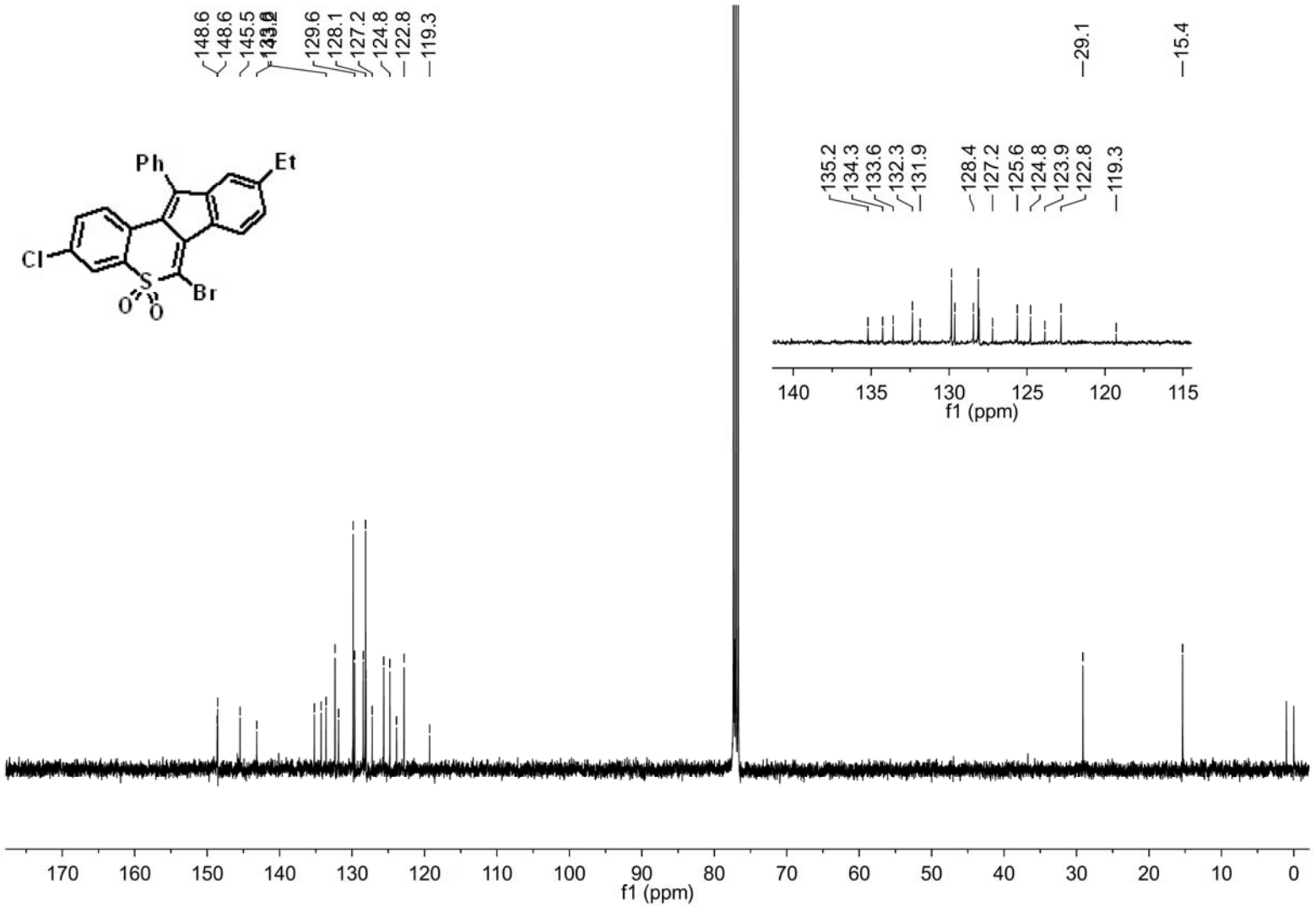
^{1}H NMR Spectrum of Compound 4v



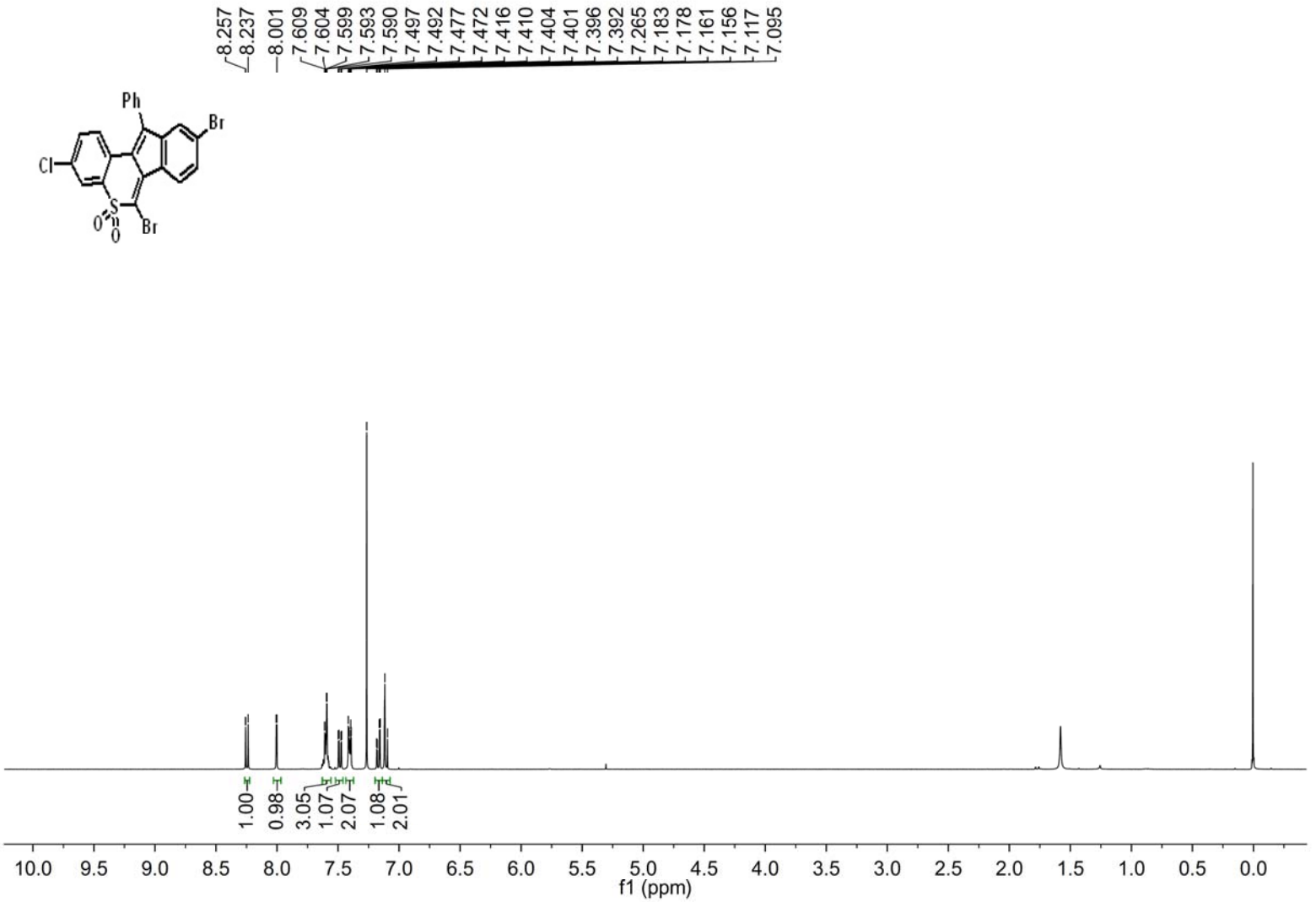
^{13}C NMR Spectrum of Compound 4v



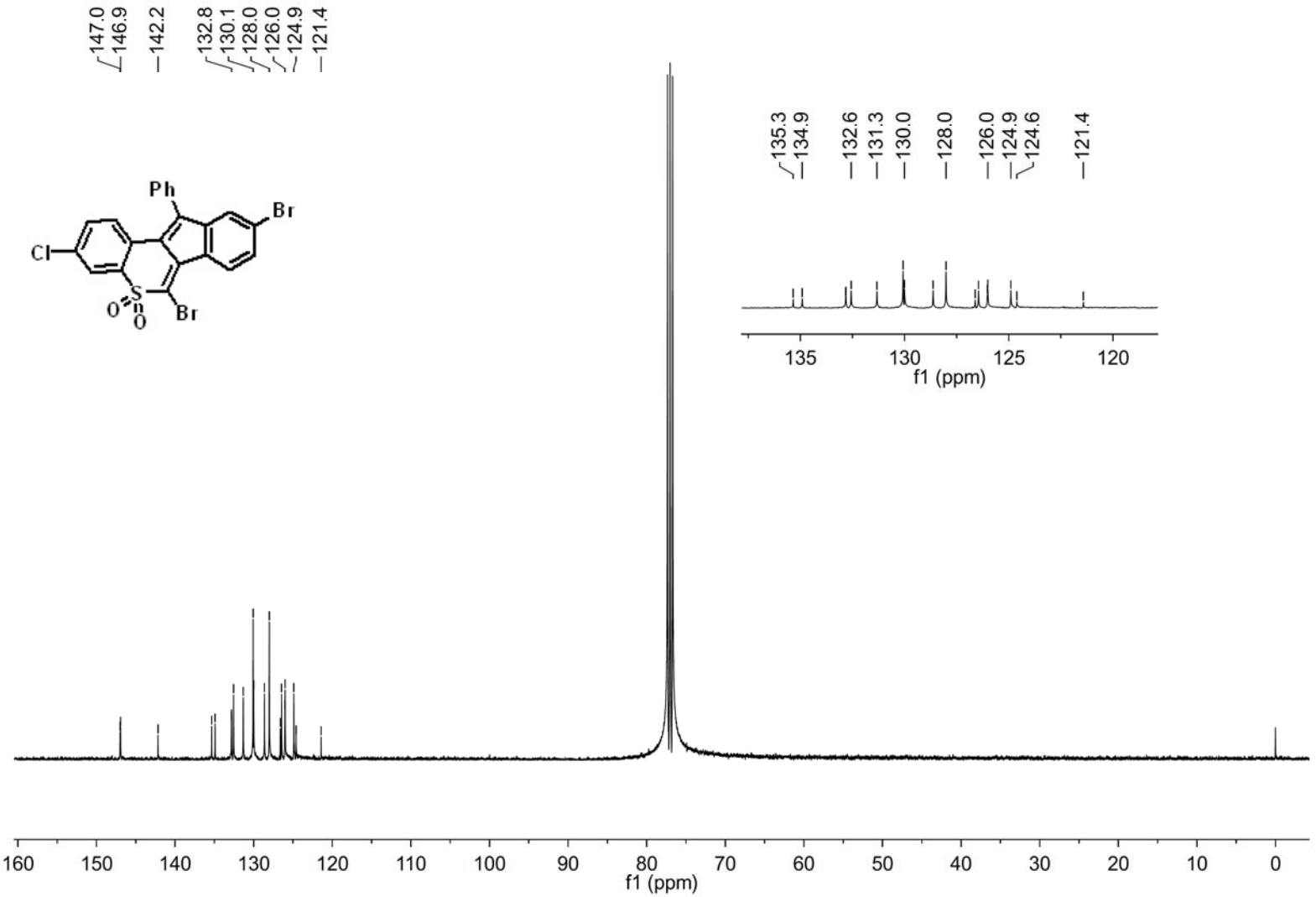
^{1}H NMR Spectrum of Compound 4w



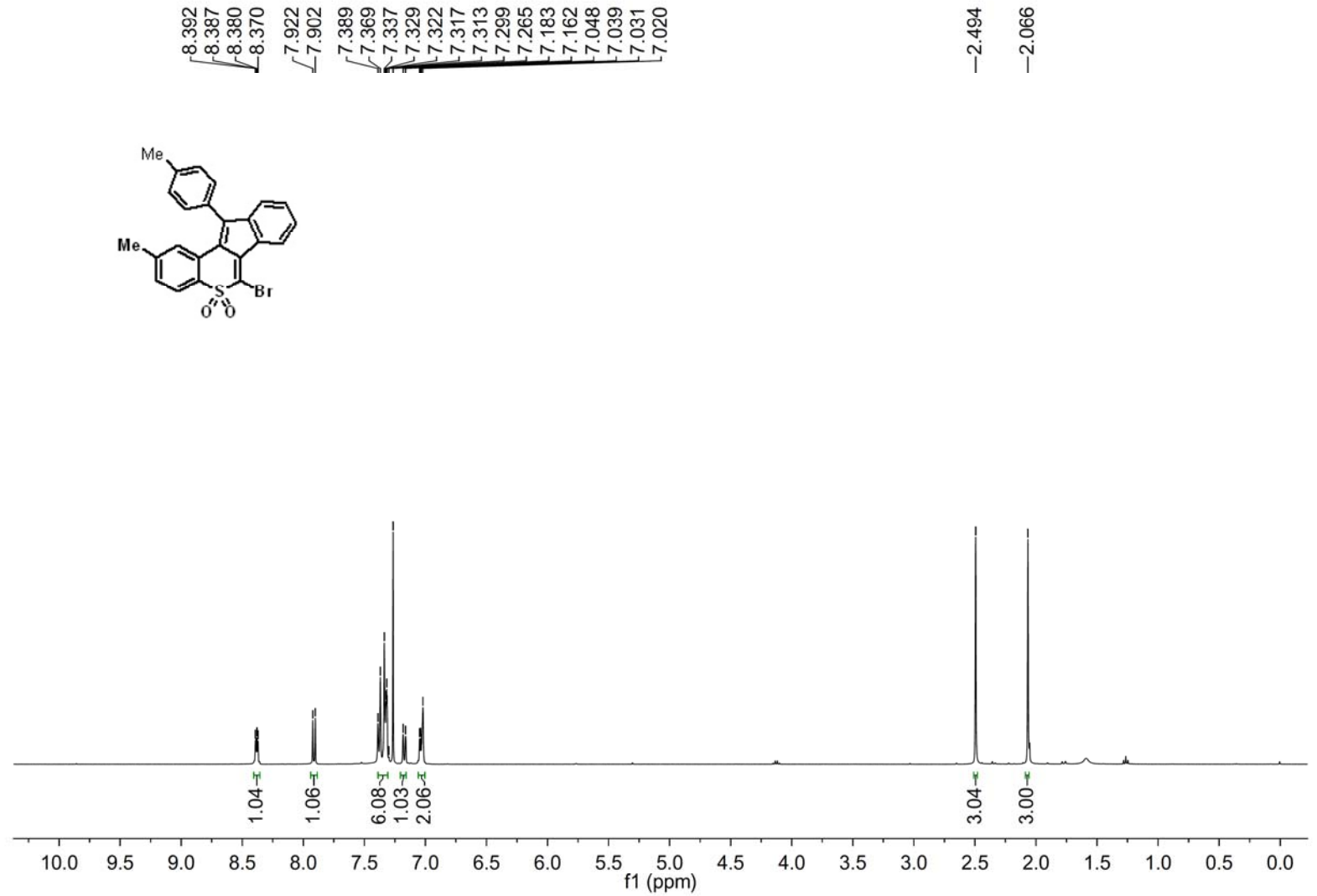
^{13}C NMR Spectrum of Compound 4w



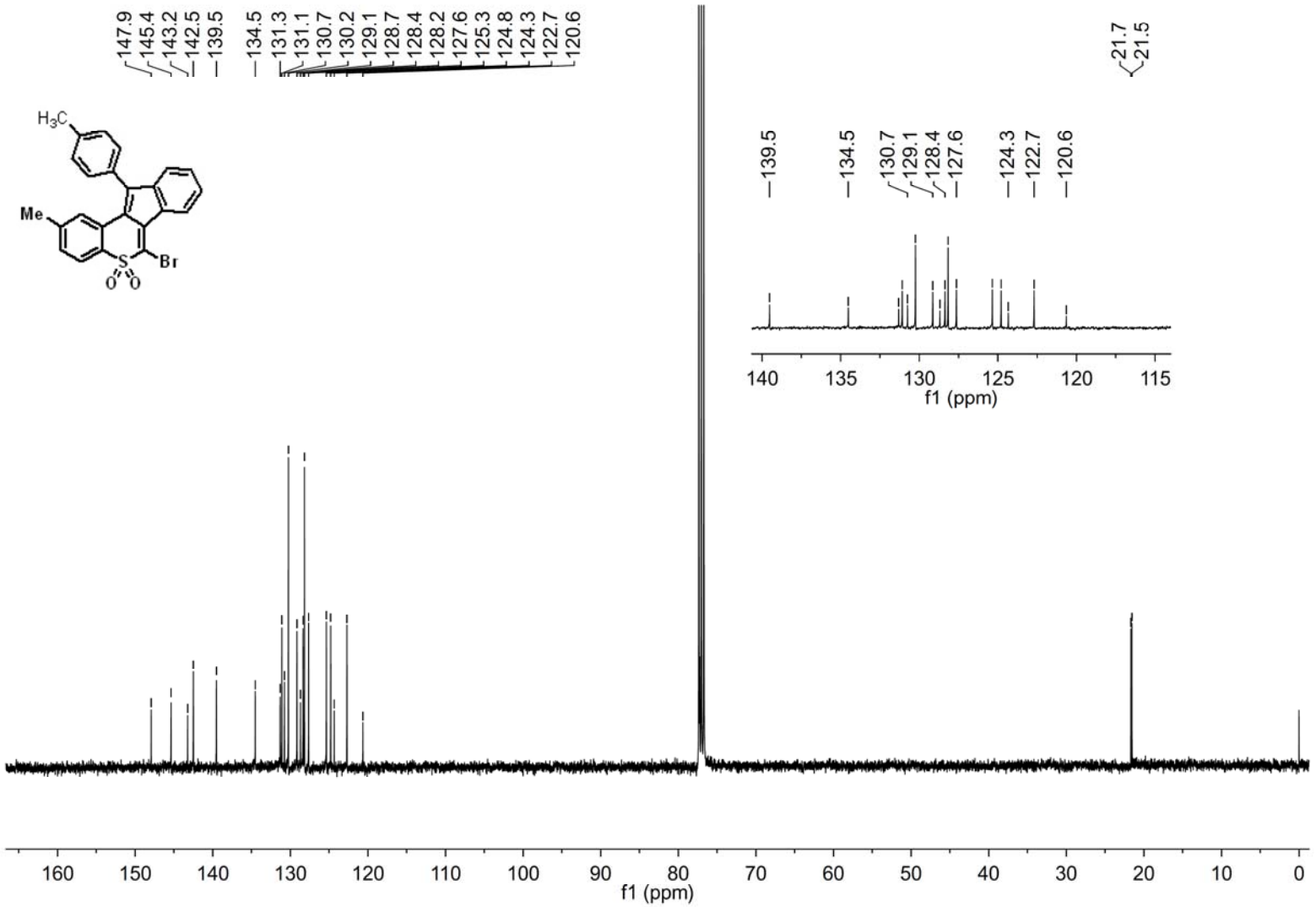
^{1}H NMR Spectrum of Compound 4x



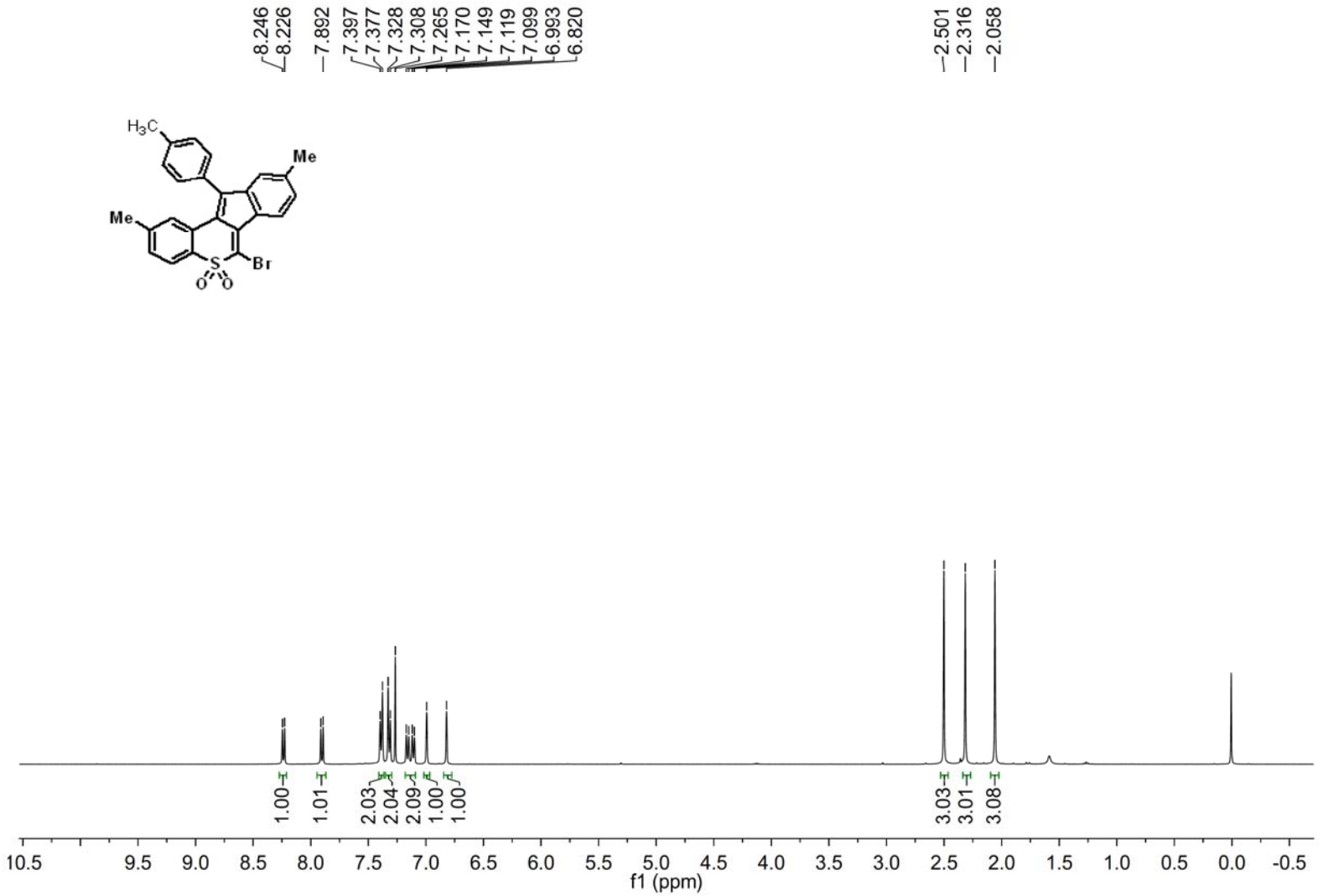
^{13}C NMR Spectrum of Compound 4x



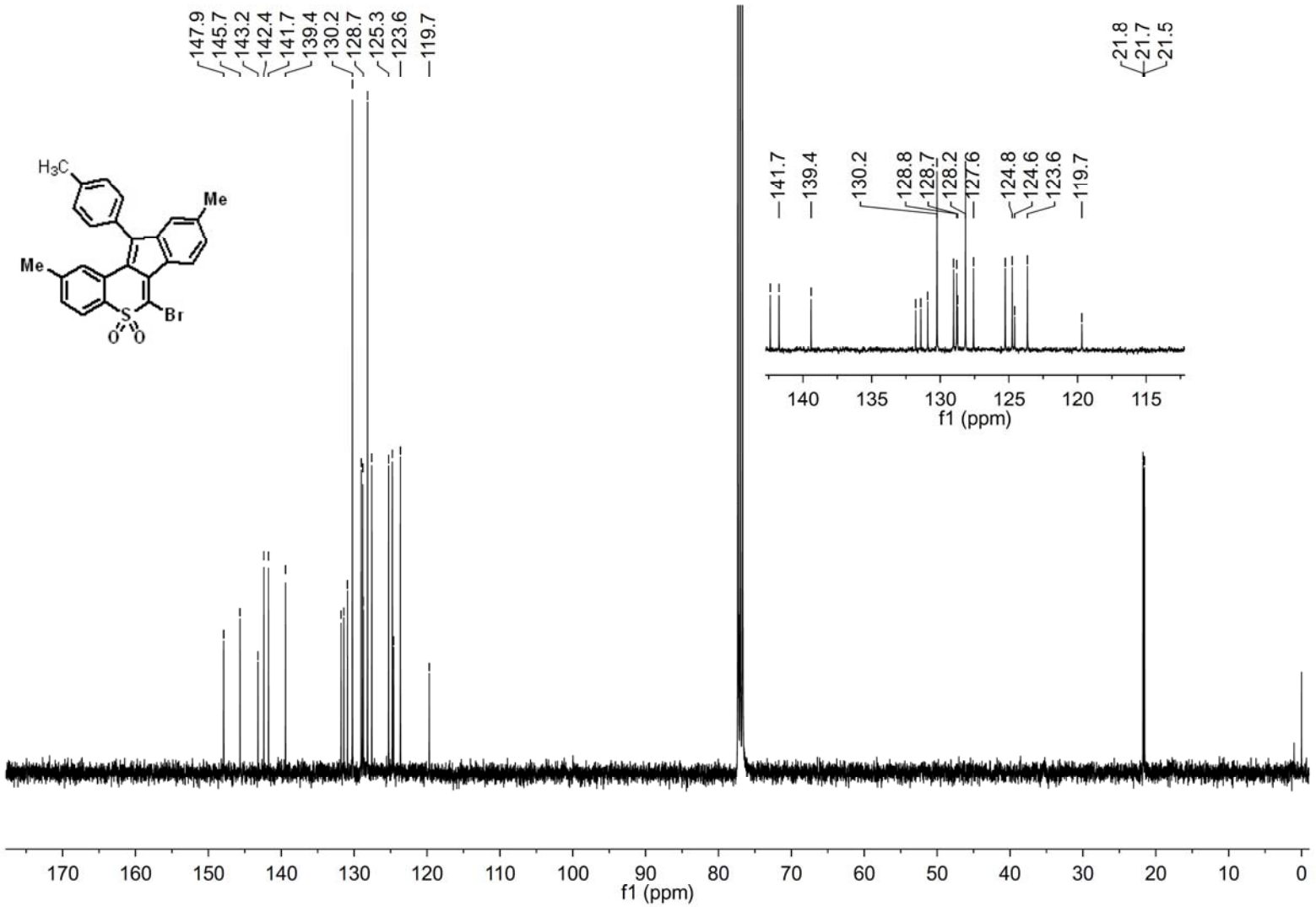
^{1}H NMR Spectrum of Compound 4y



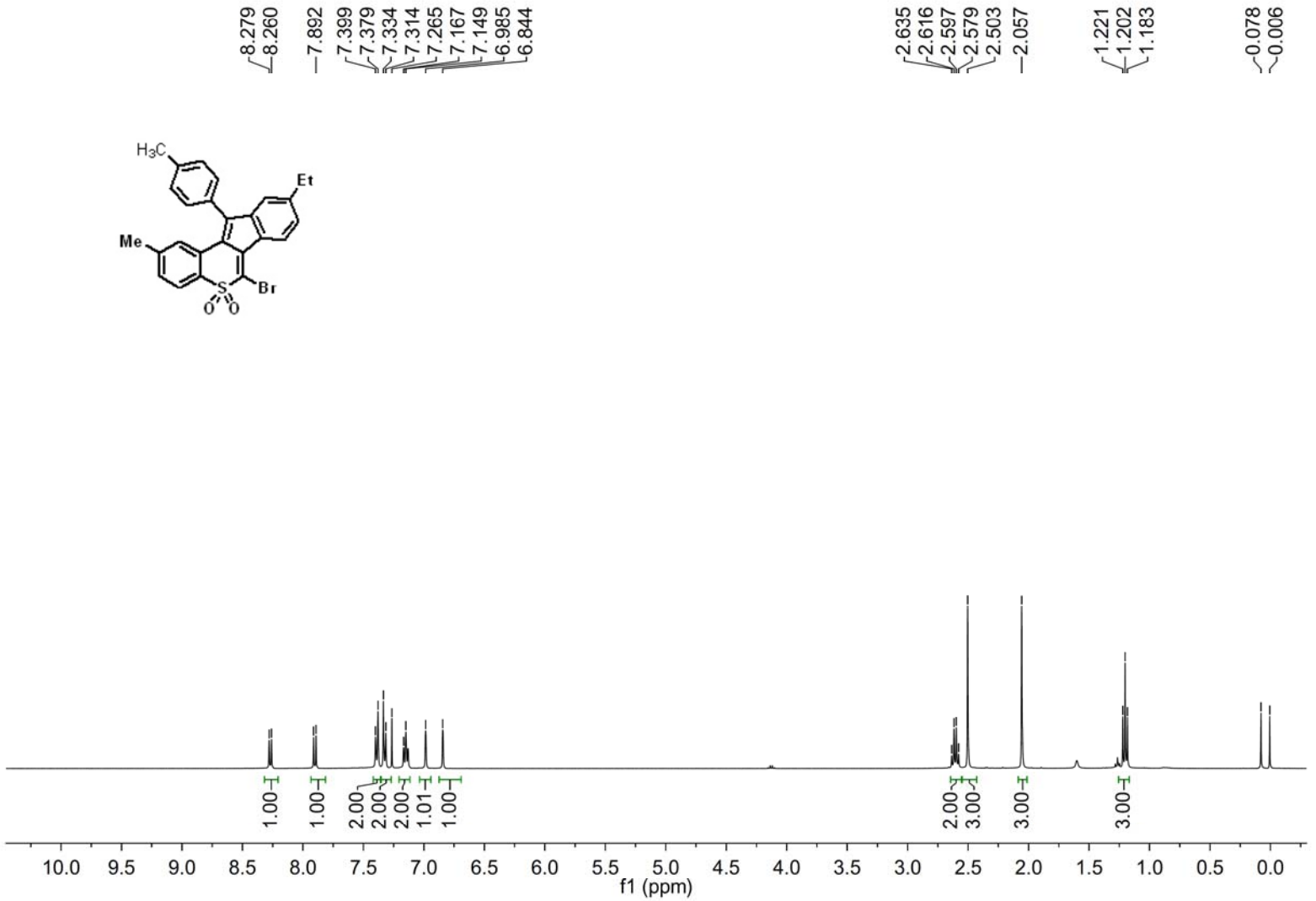
^{13}C NMR Spectrum of Compound 4y



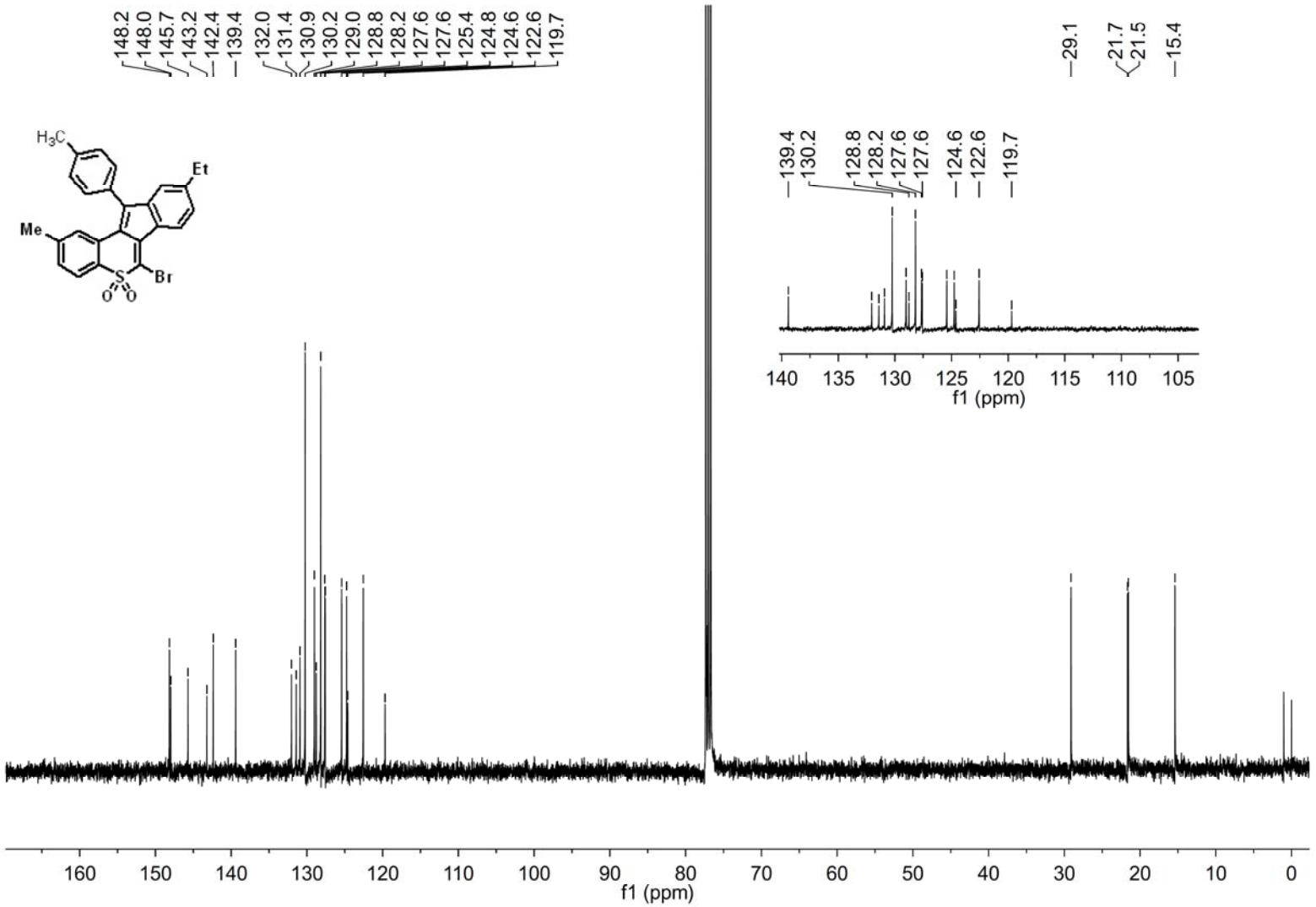
^{1}H NMR Spectrum of Compound 4z



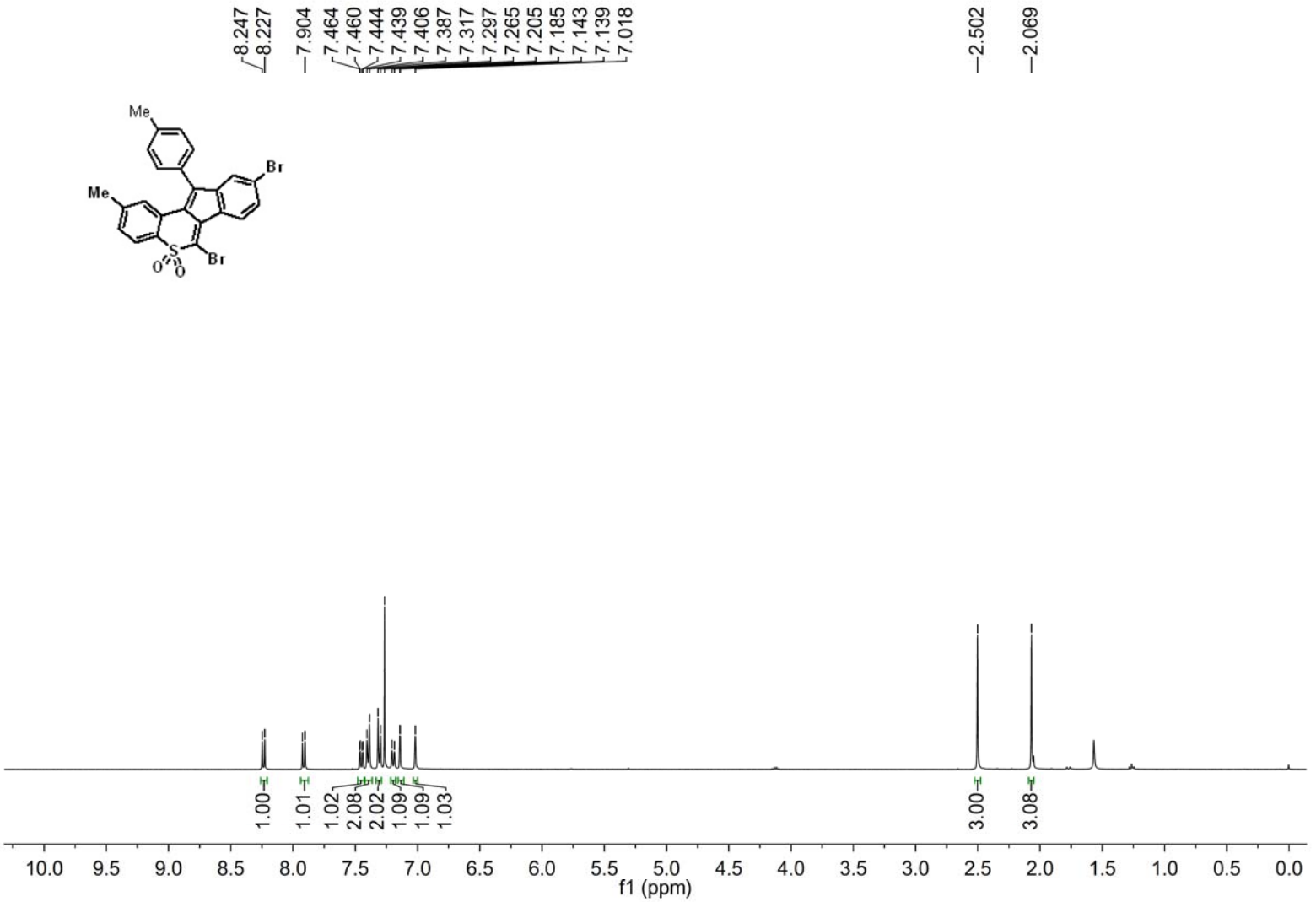
^{13}C NMR Spectrum of Compound 4z



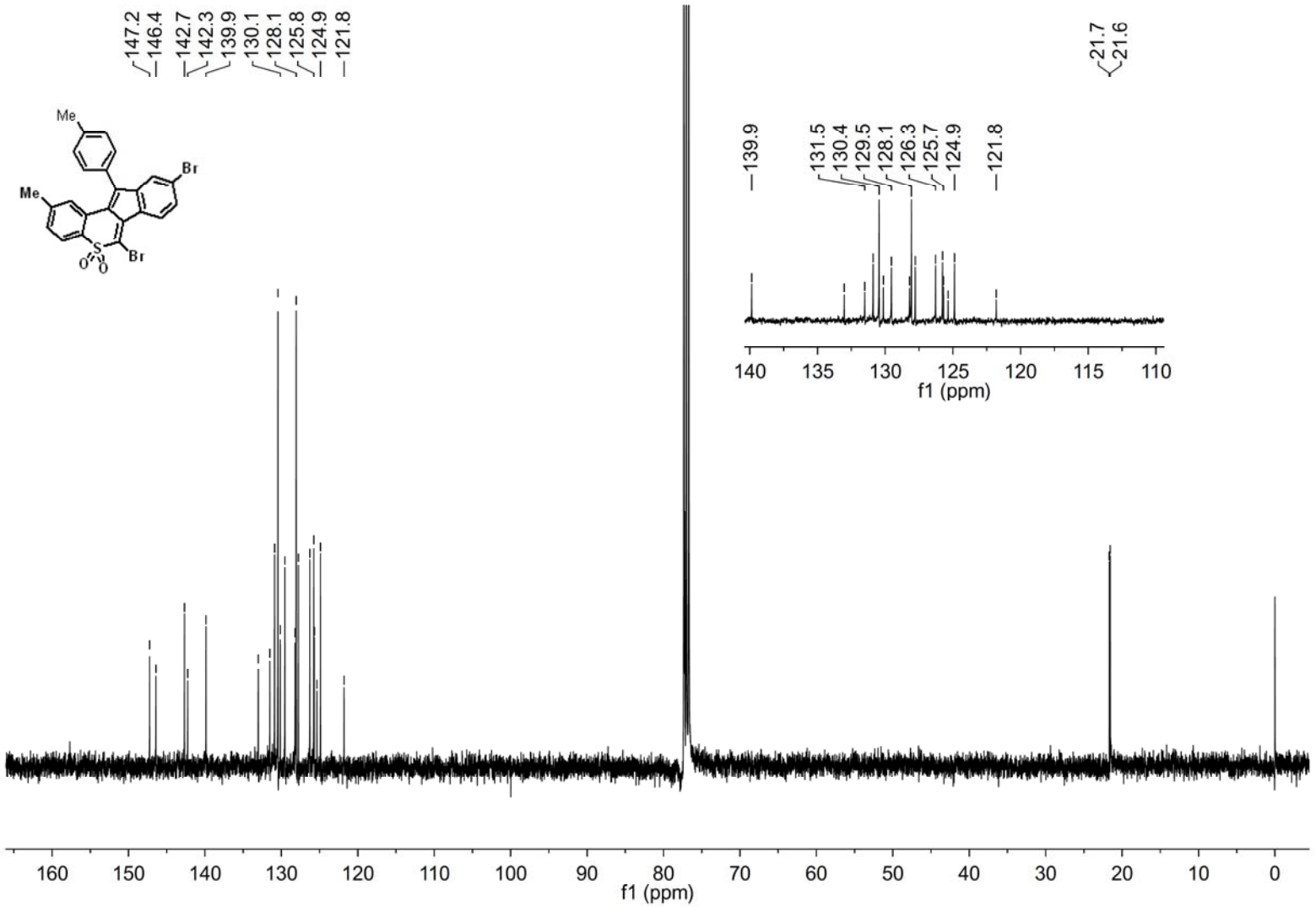
^{1}H NMR Spectrum of Compound 4aa



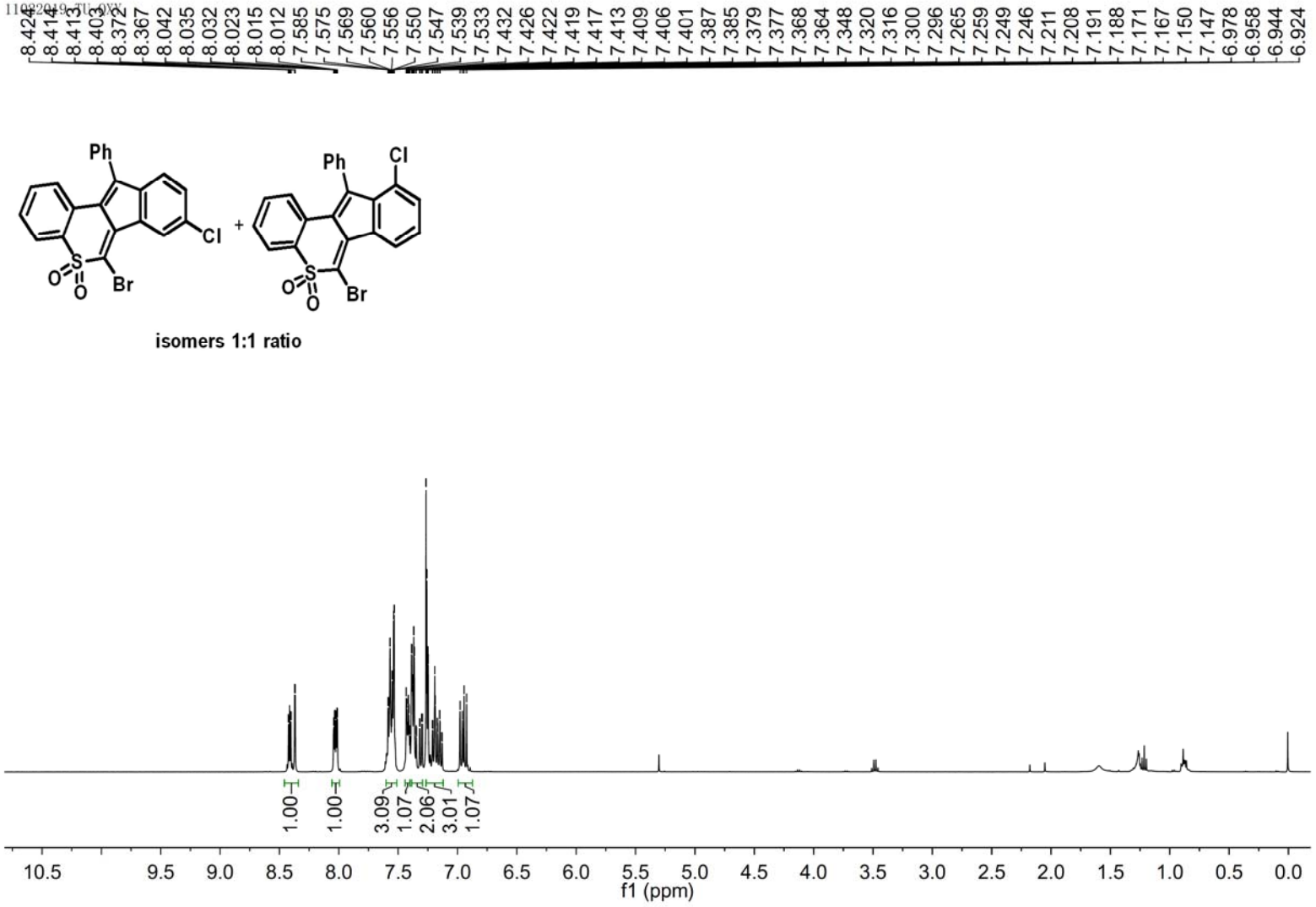
^{13}C NMR Spectrum of Compound 4aa



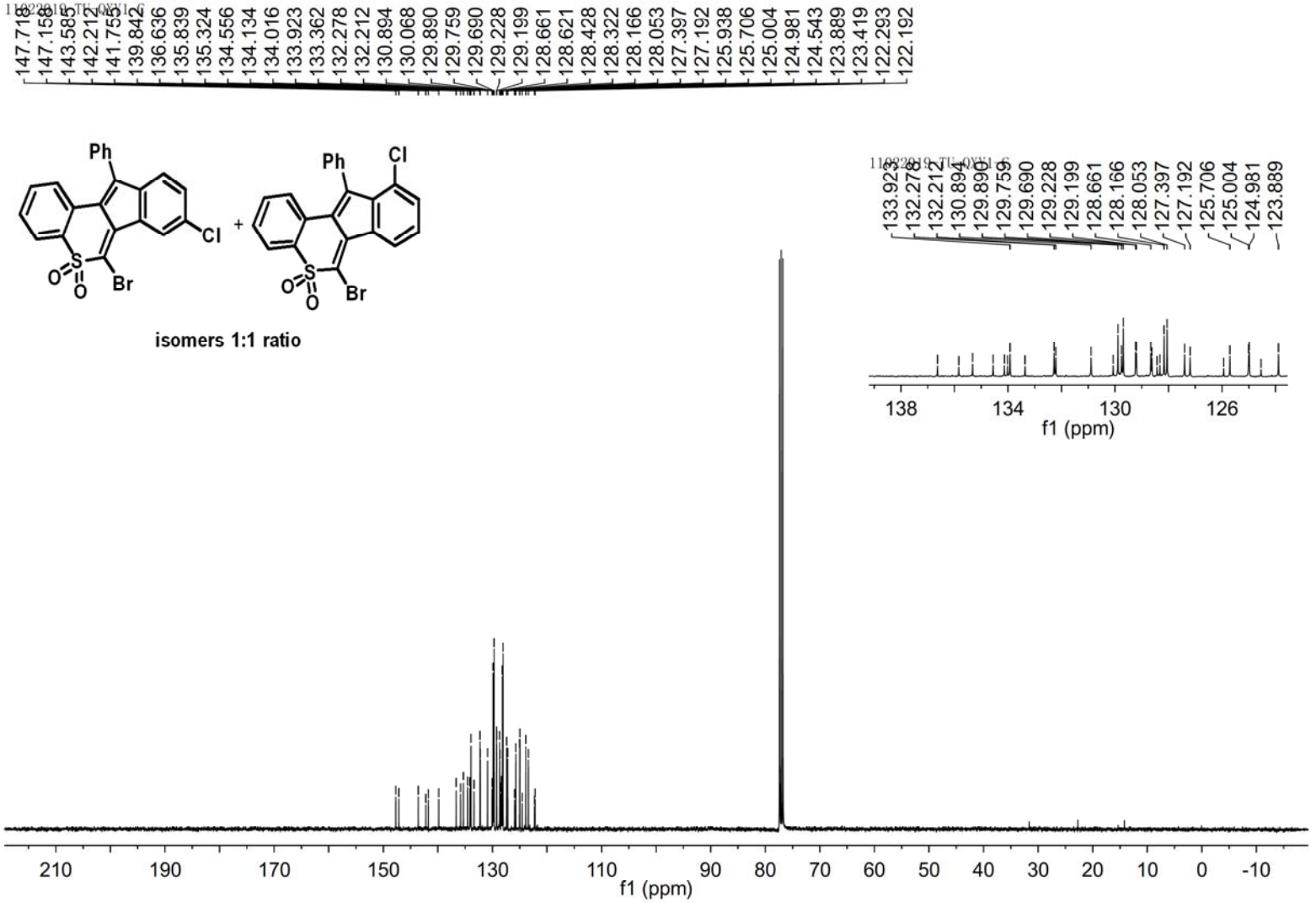
^{1}H NMR Spectrum of Compound 4bb



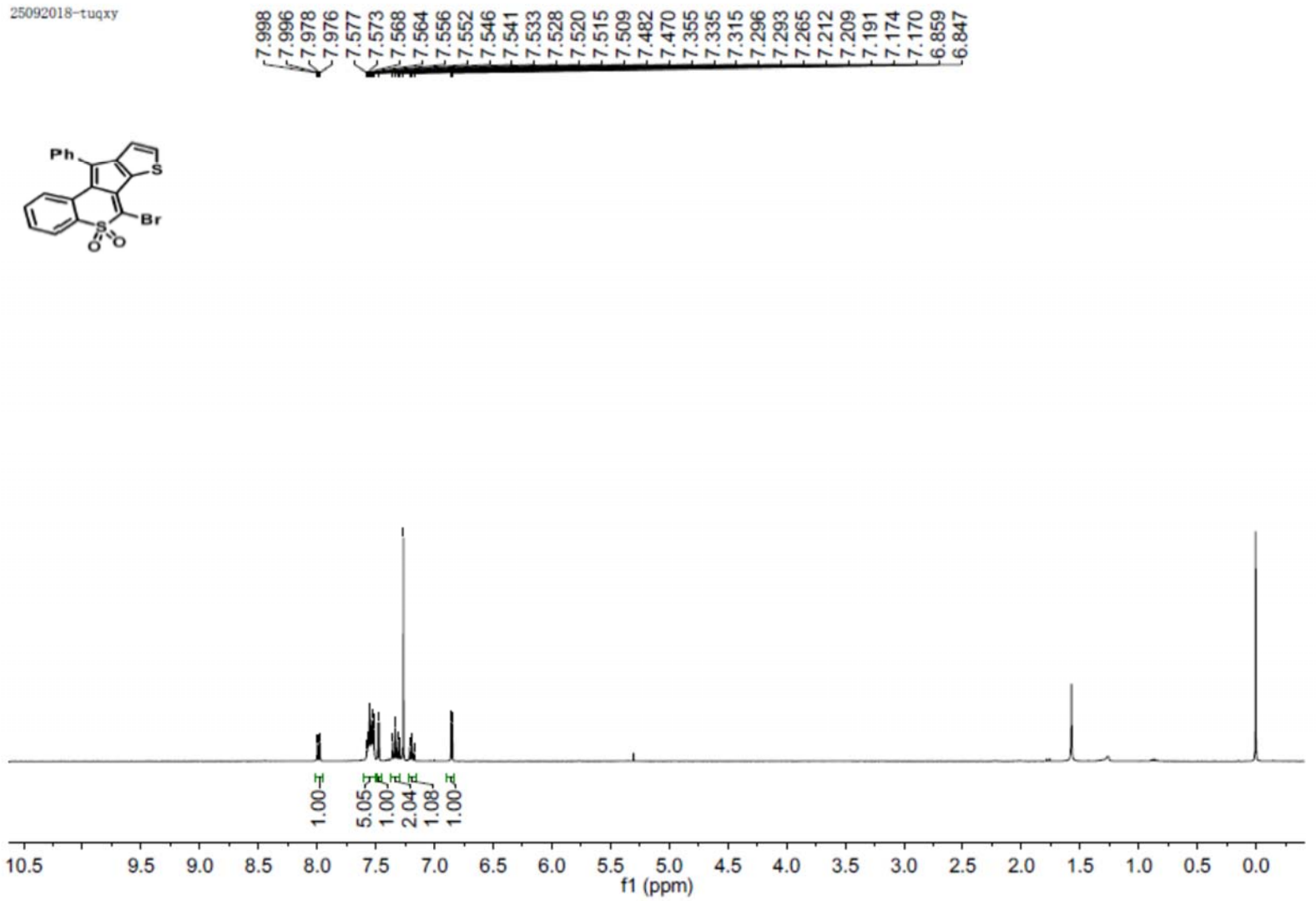
^{13}C NMR Spectrum of Compound 4bb



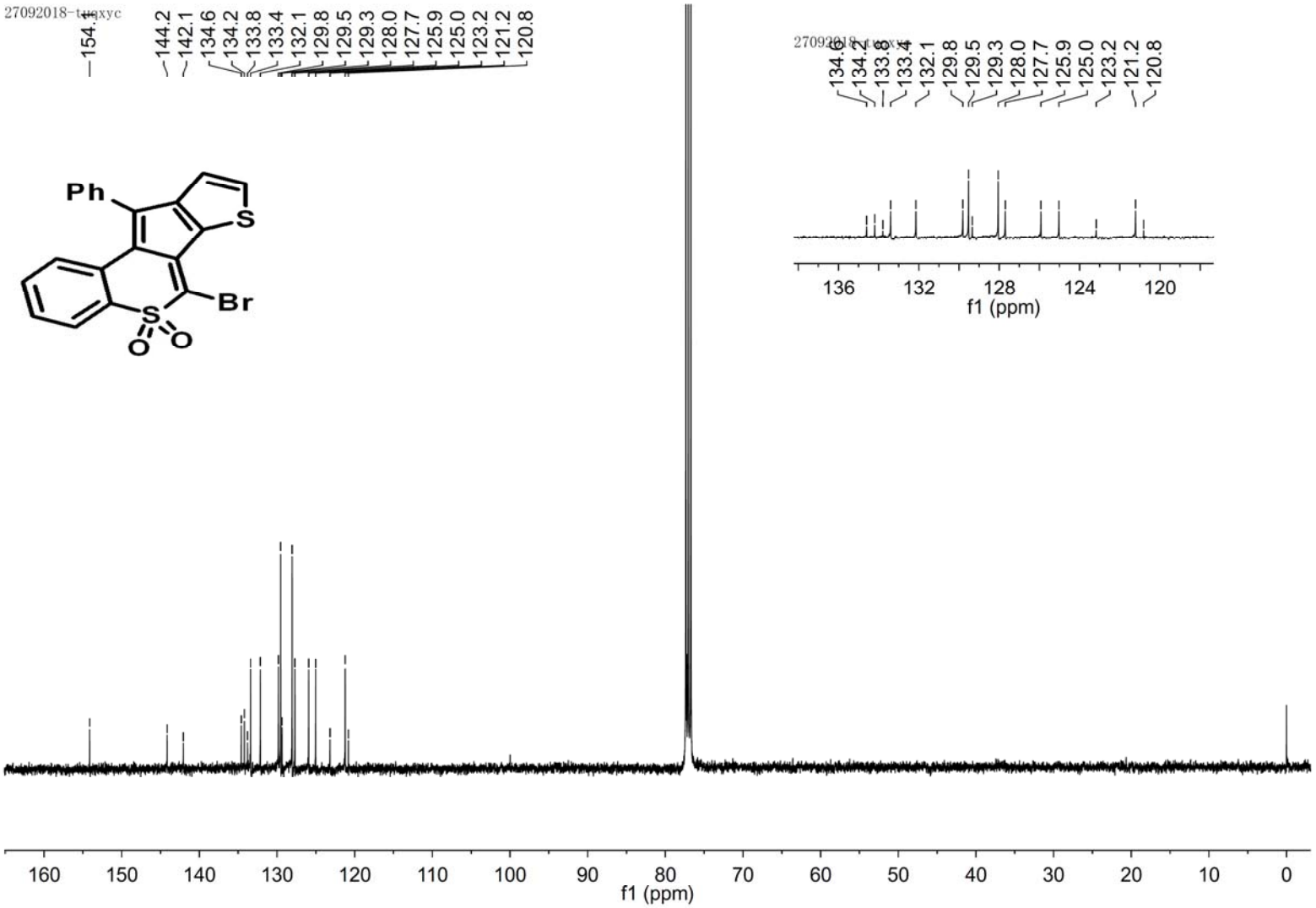
^{1}H NMR Spectrum of Compound 4cc



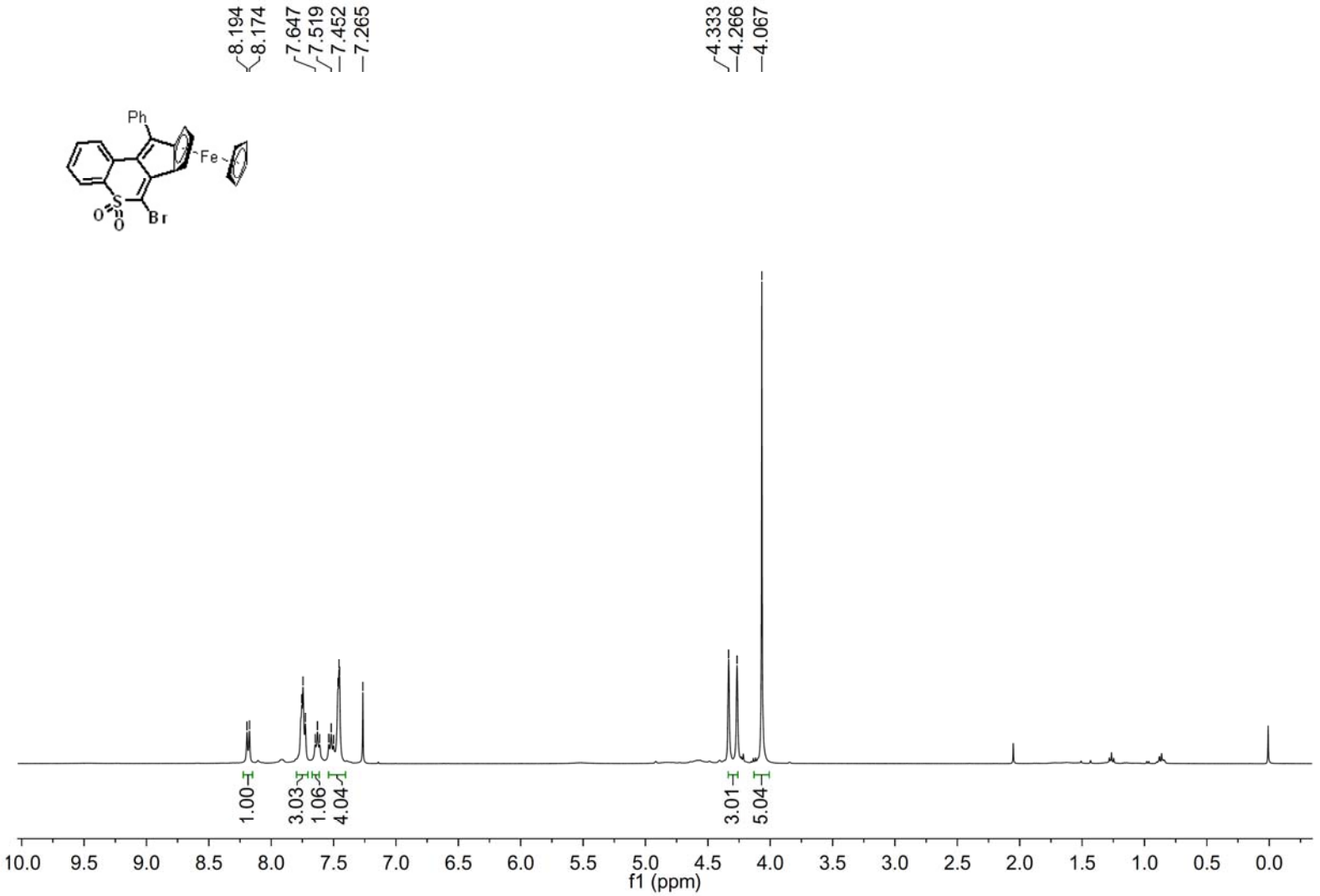
^{13}C NMR Spectrum of Compound 4cc



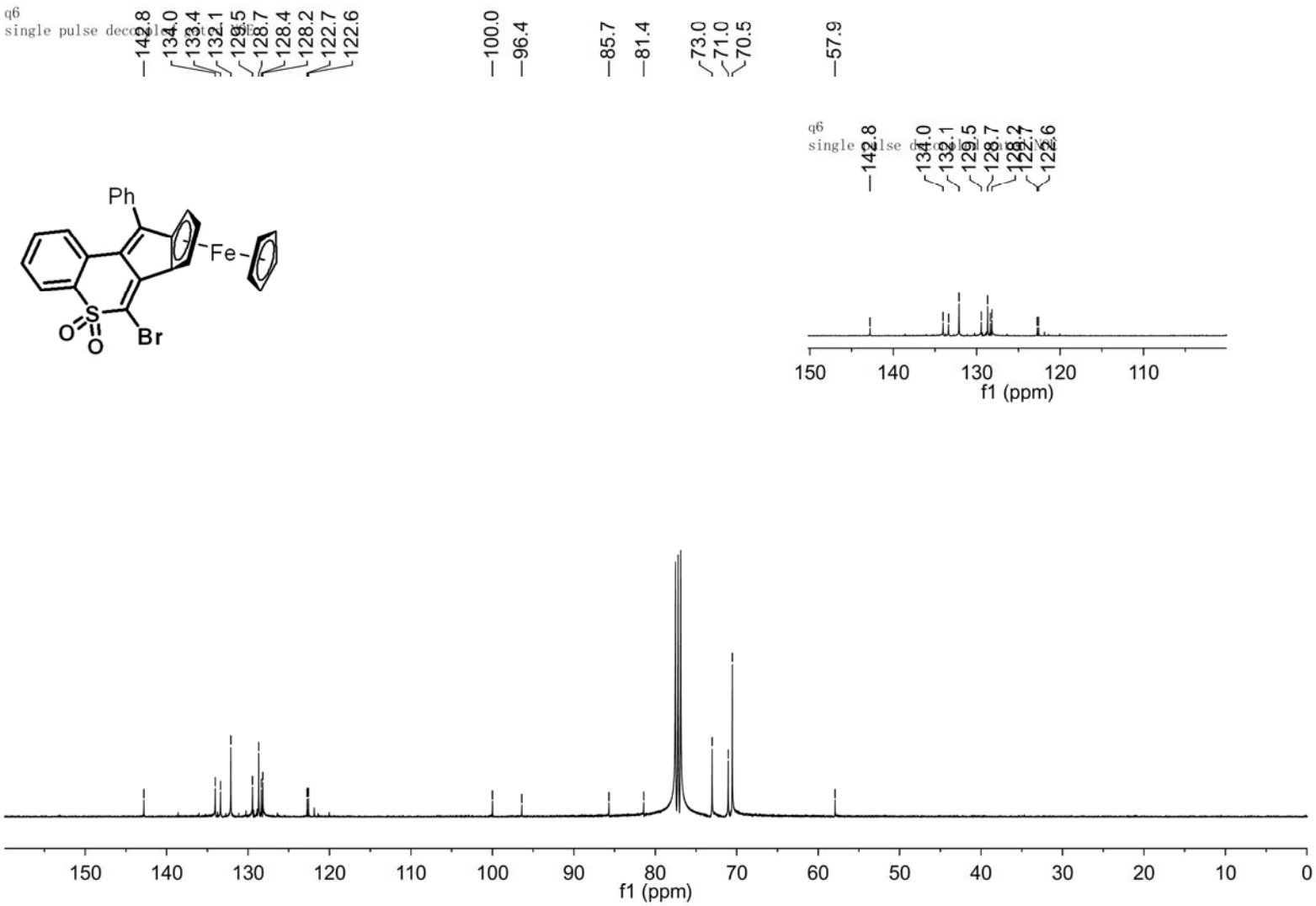
^{1}H NMR Spectrum of Compound 4ee



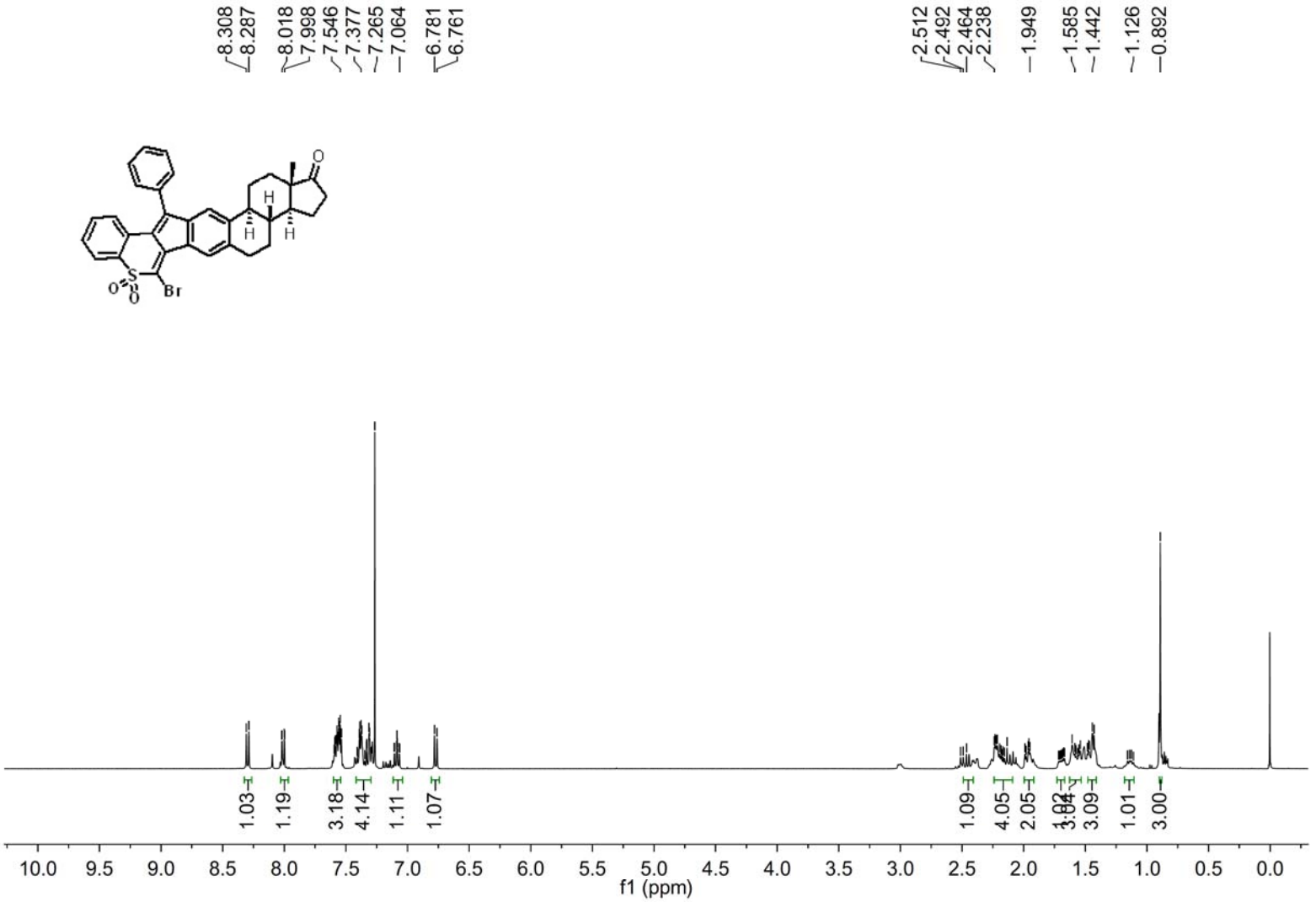
^{13}C NMR Spectrum of Compound 4ee



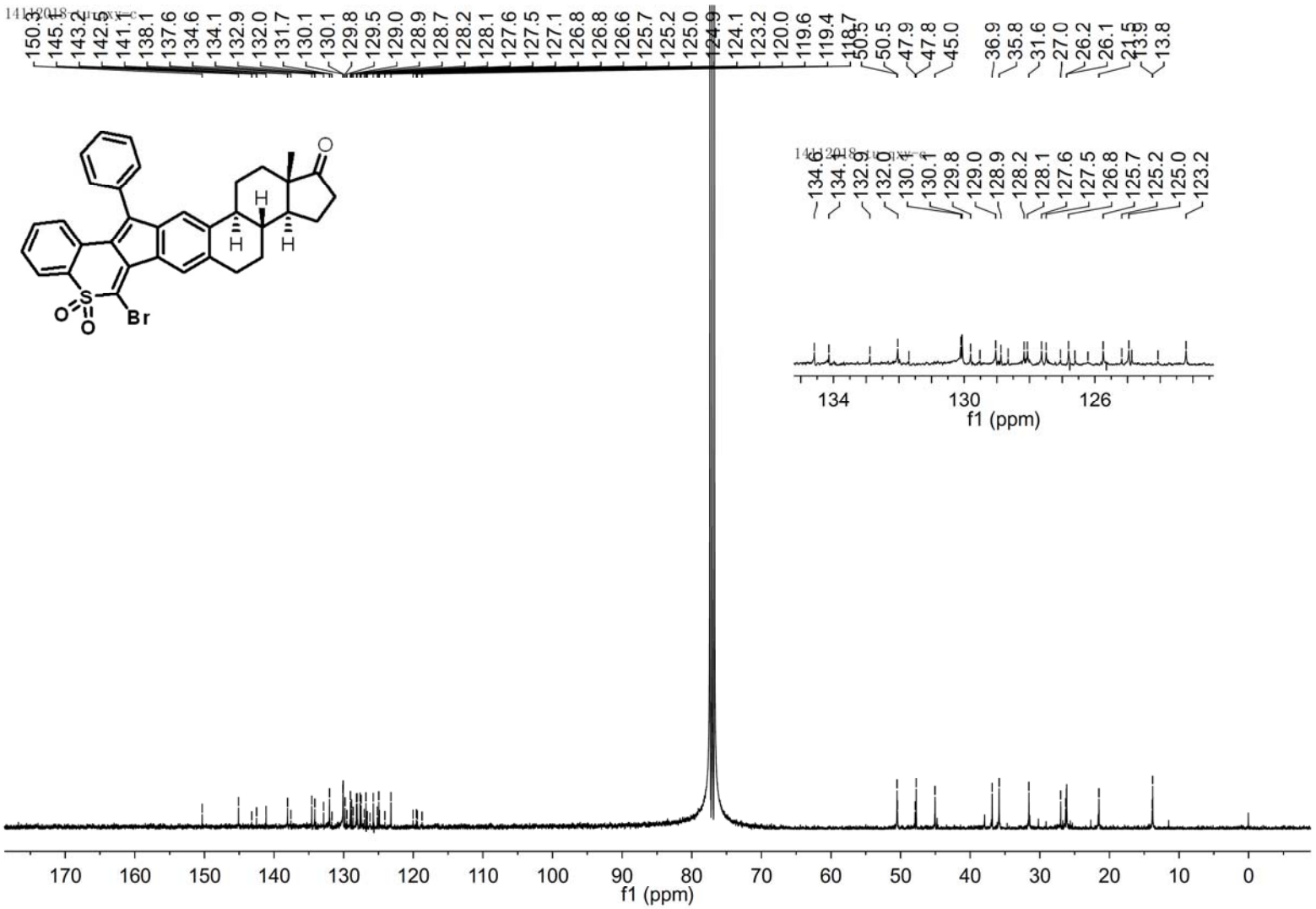
^{1}H NMR Spectrum of Compound 4ff



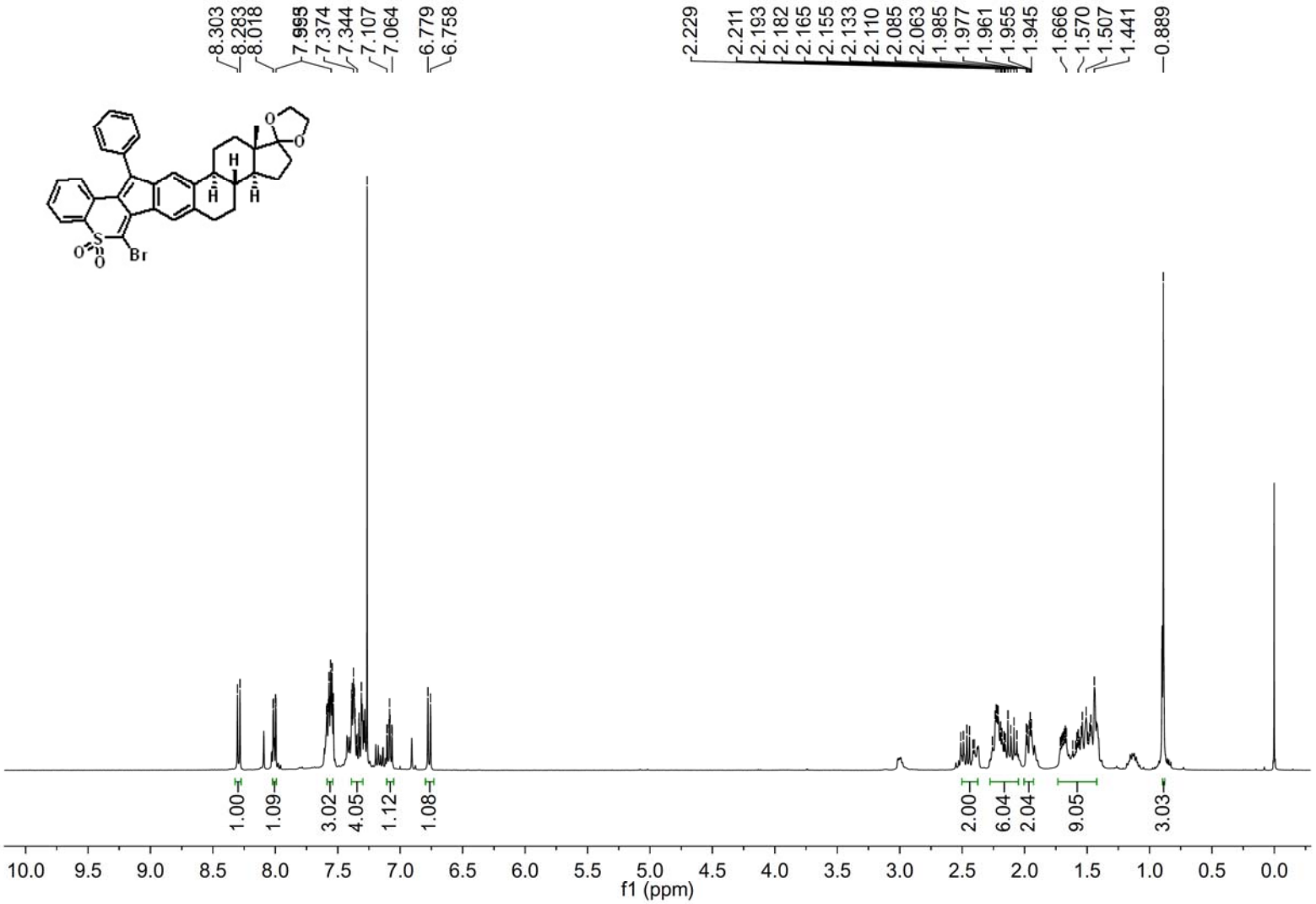
^{13}C NMR Spectrum of Compound 4ff



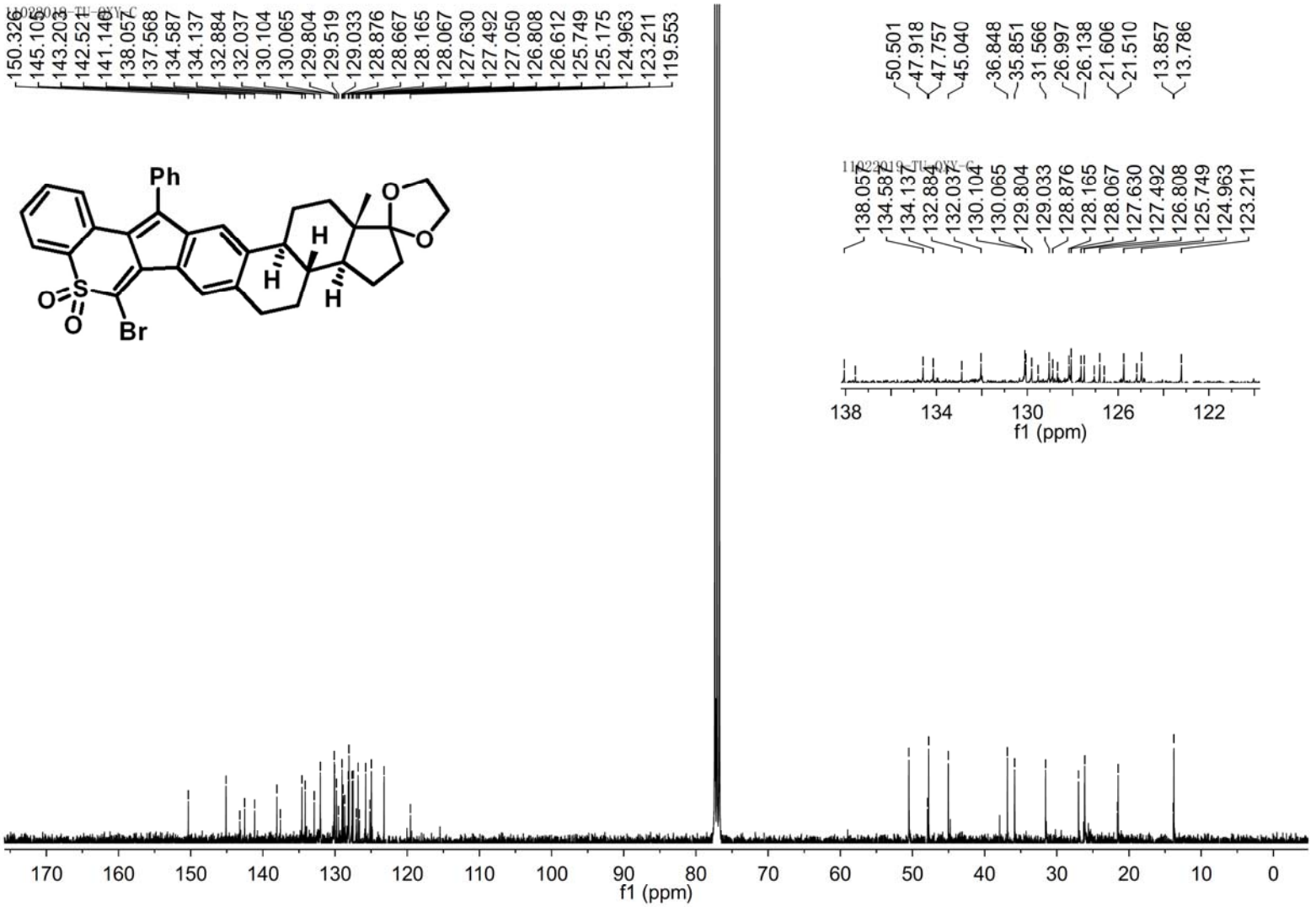
^{1}H NMR Spectrum of Compound 4gg



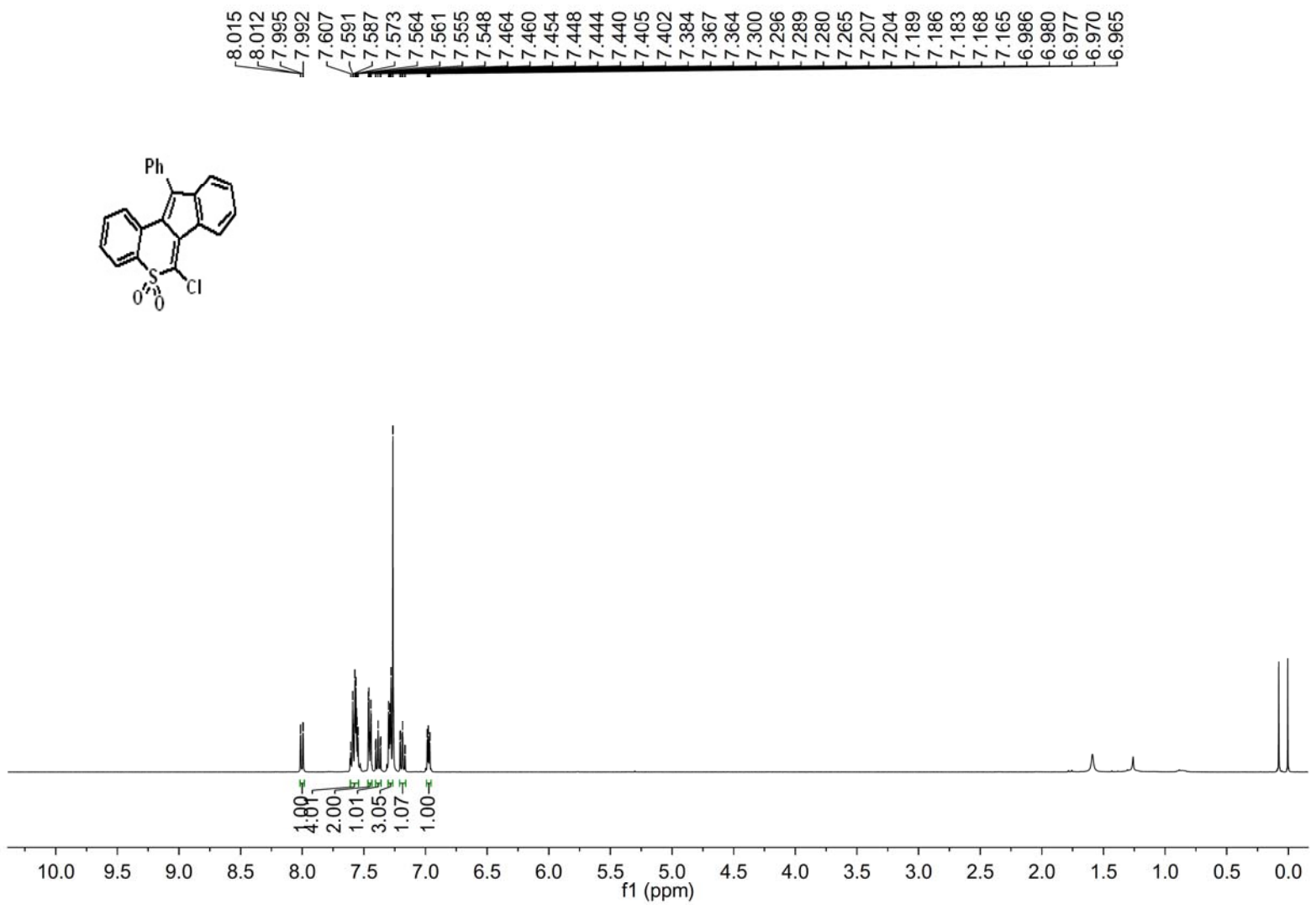
^{13}C NMR Spectrum of Compound 4gg



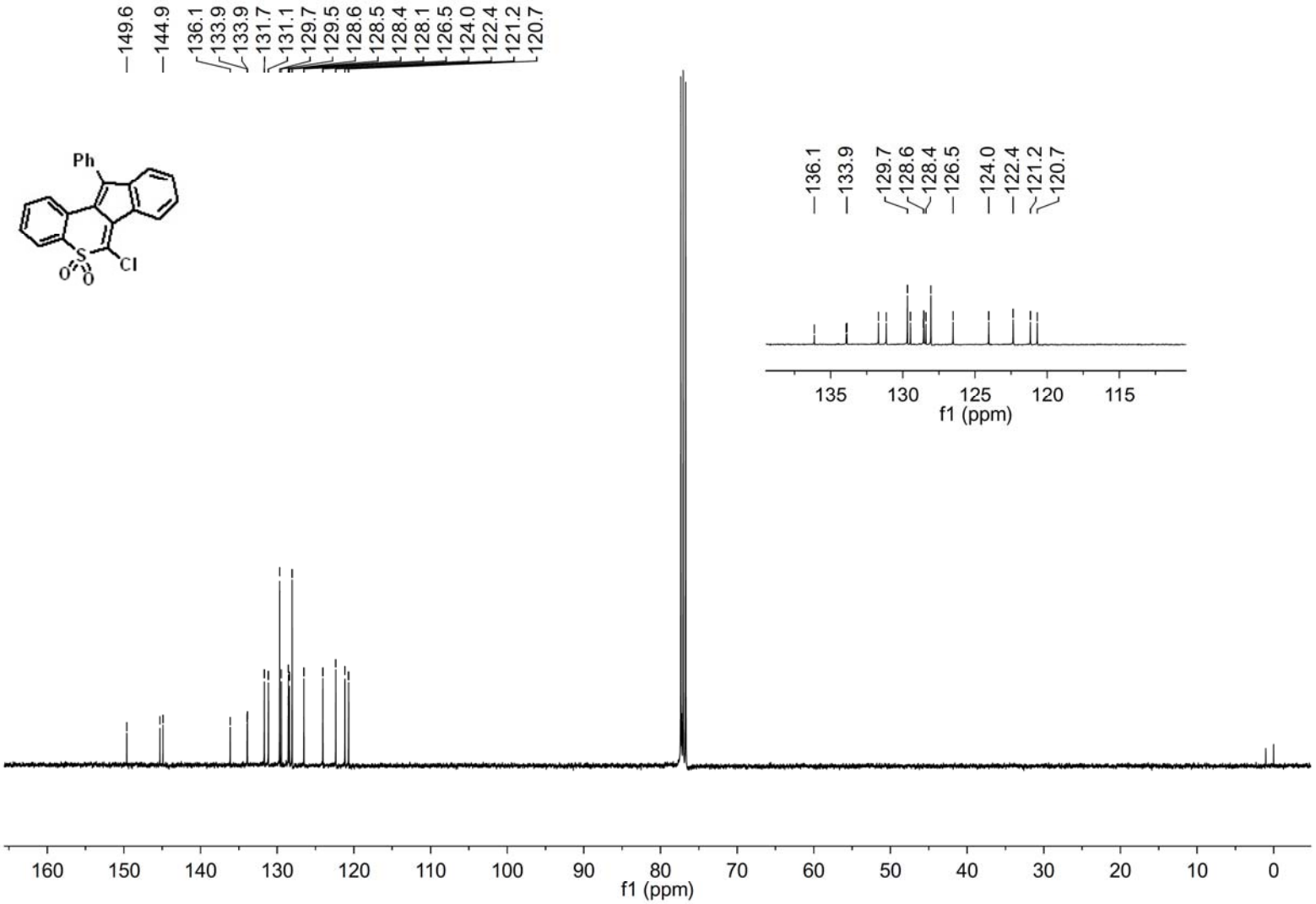
^{1}H NMR Spectrum of Compound 4hh



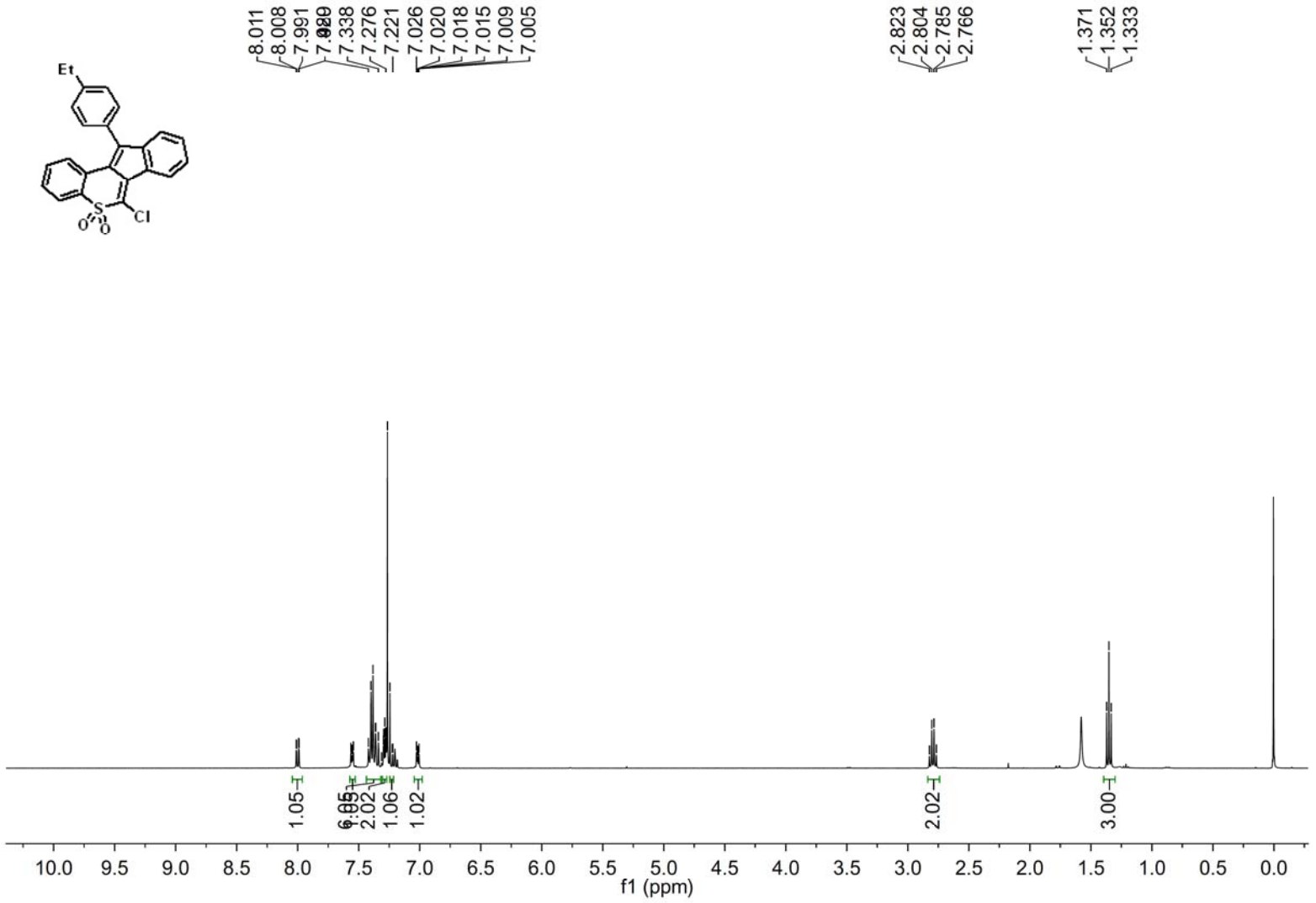
^{13}C NMR Spectrum of Compound 4hh



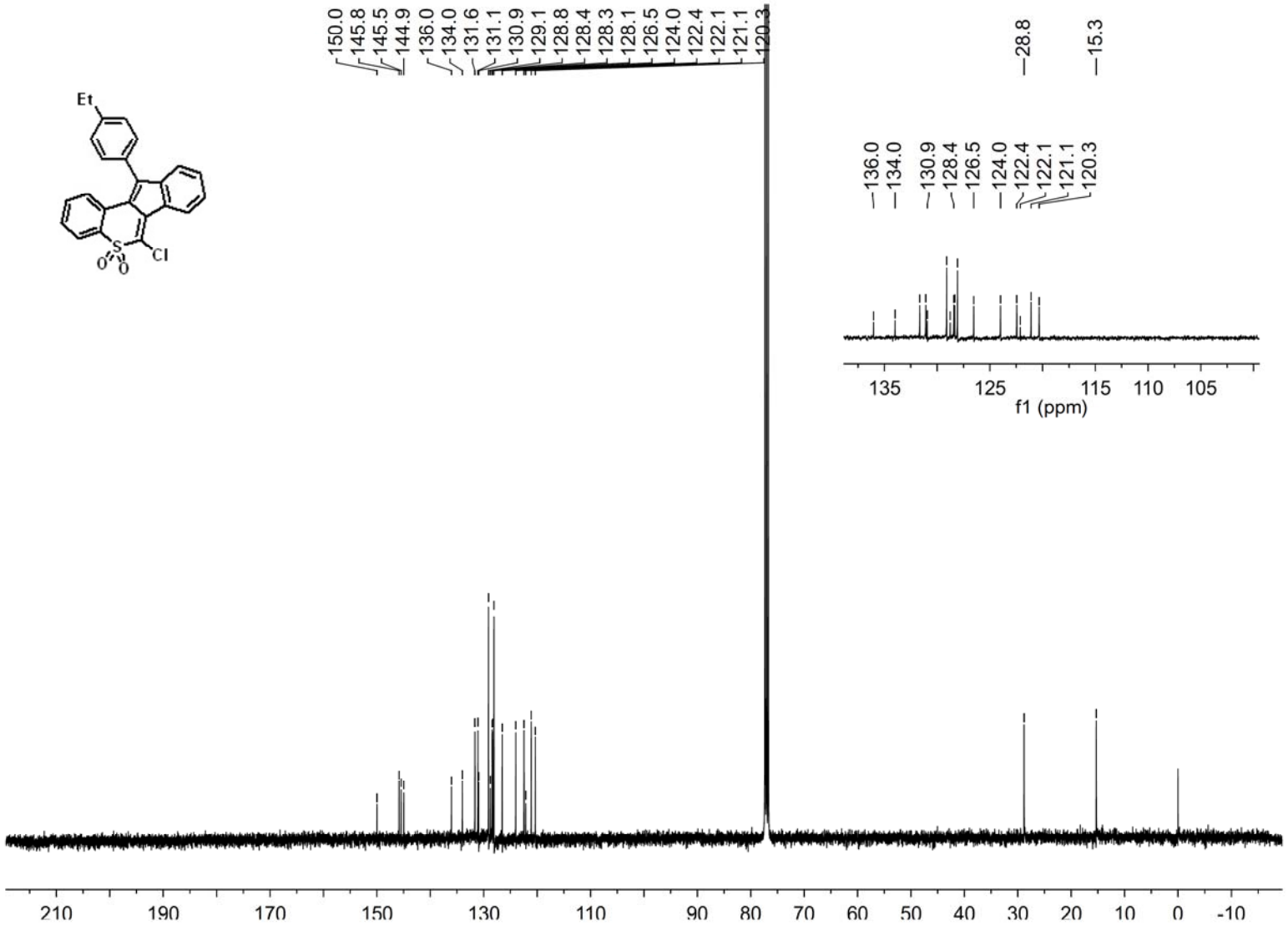
^{1}H NMR Spectrum of Compound 4ii



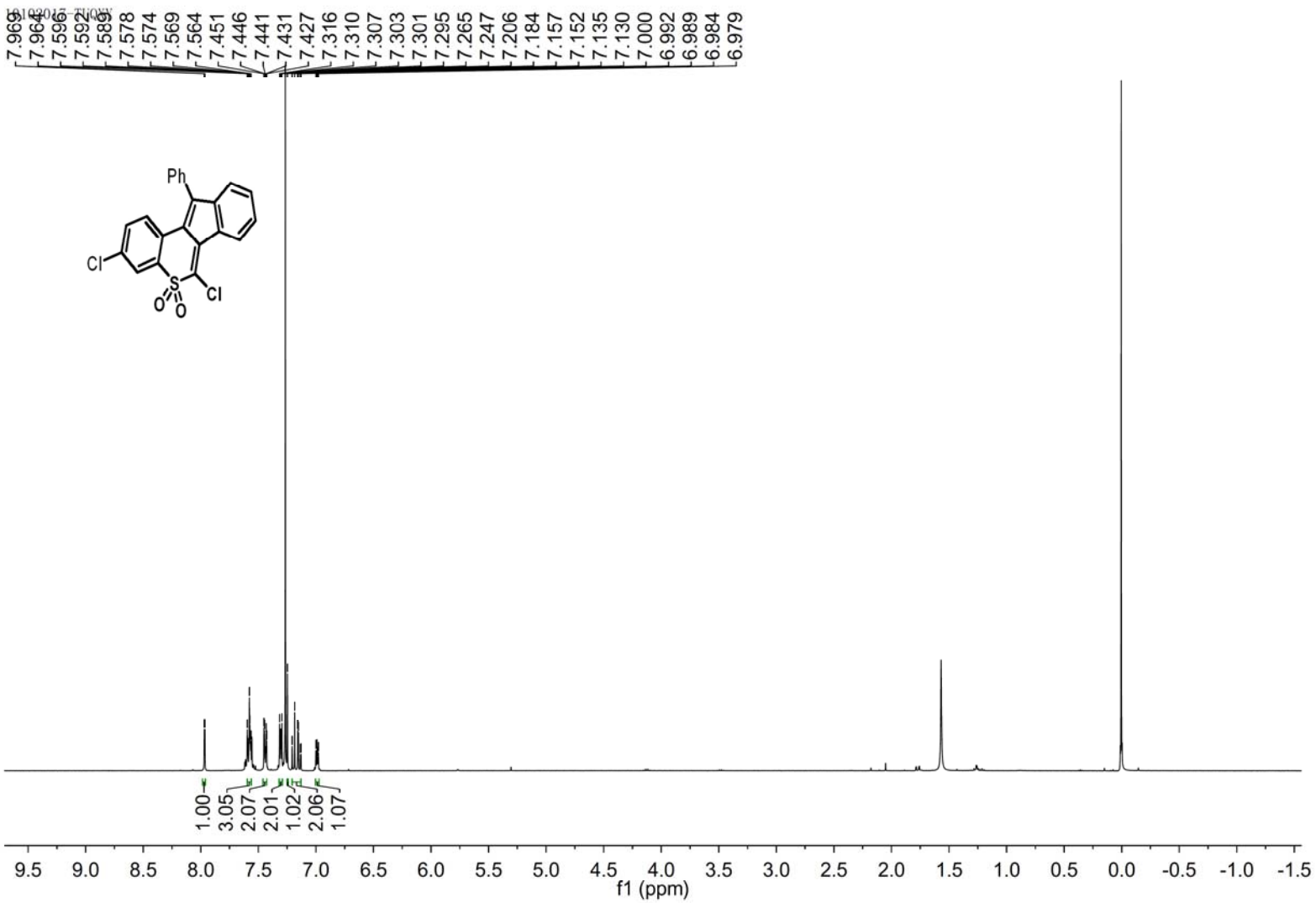
^{13}C NMR Spectrum of Compound 4ii



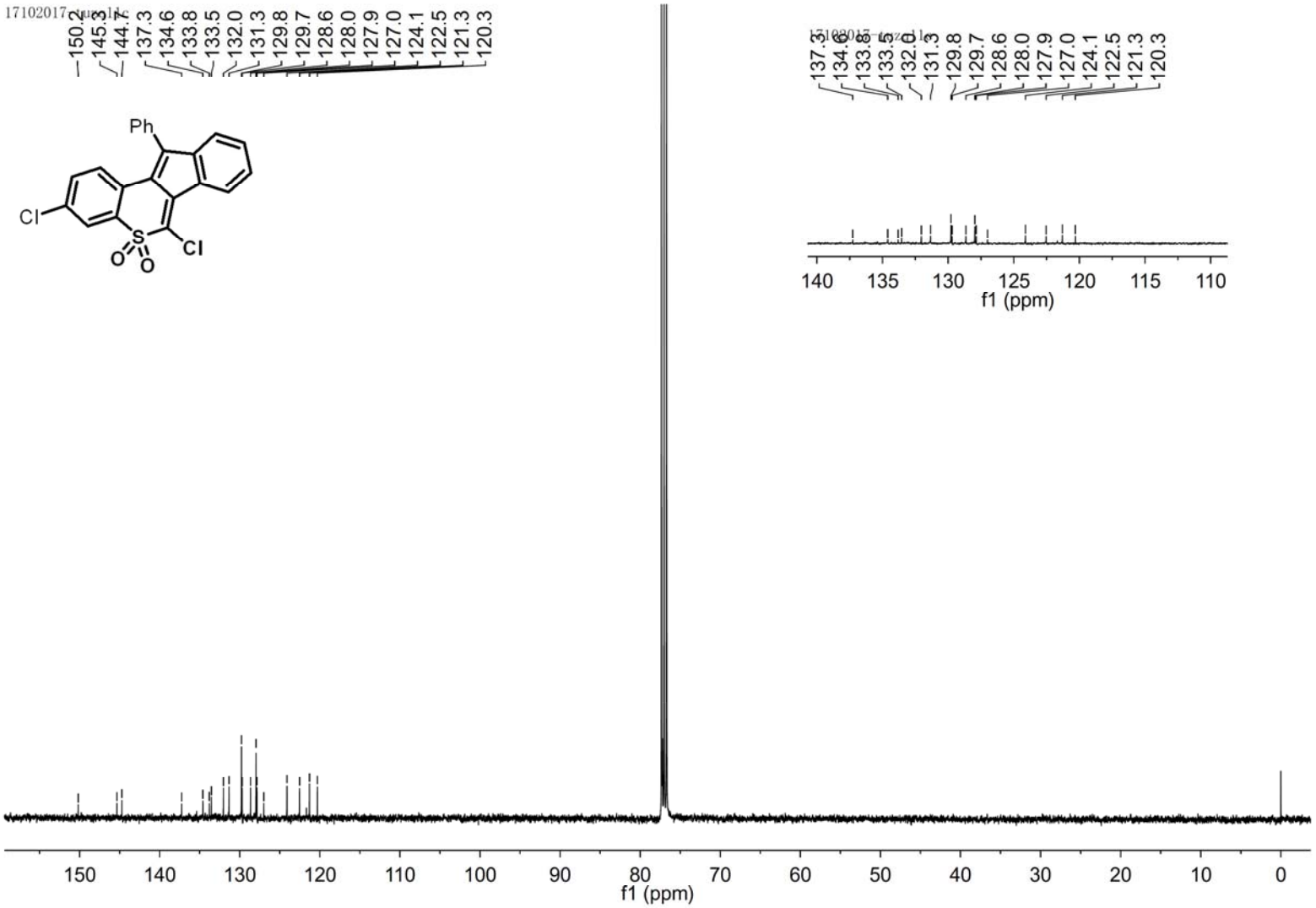
^{1}H NMR Spectrum of Compound 4jj



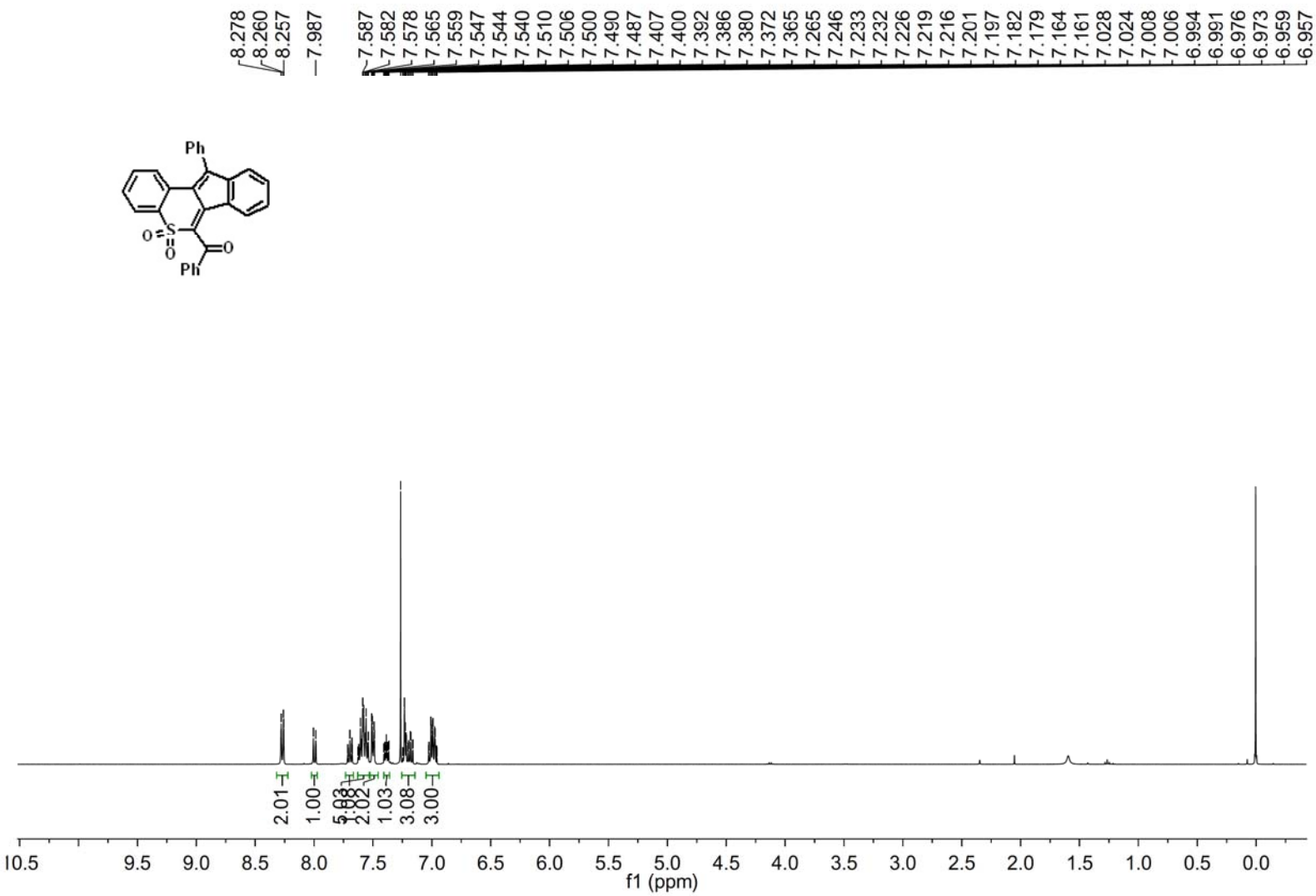
^{13}C NMR Spectrum of Compound 4jj



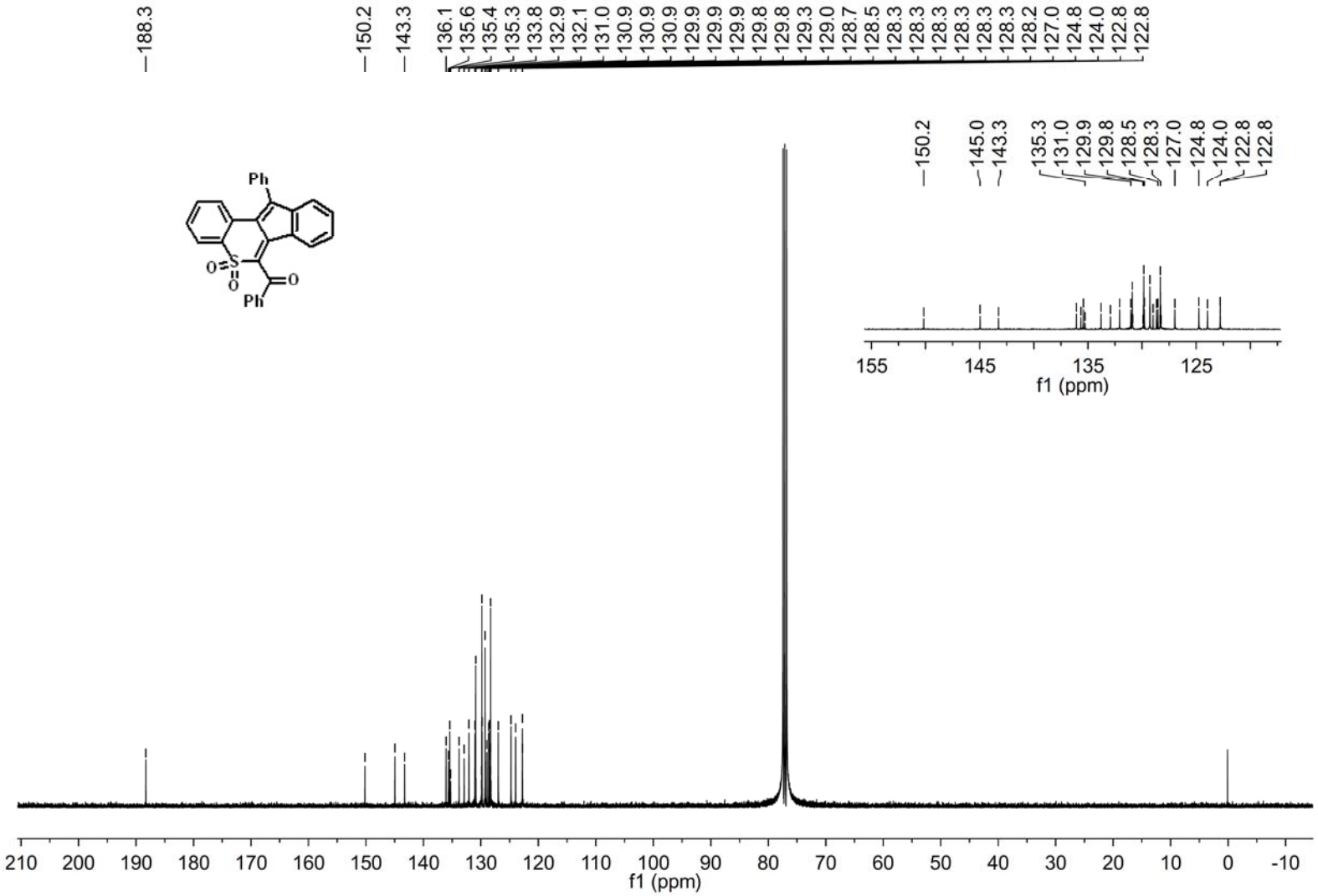
^{1}H NMR Spectrum of Compound 4kk



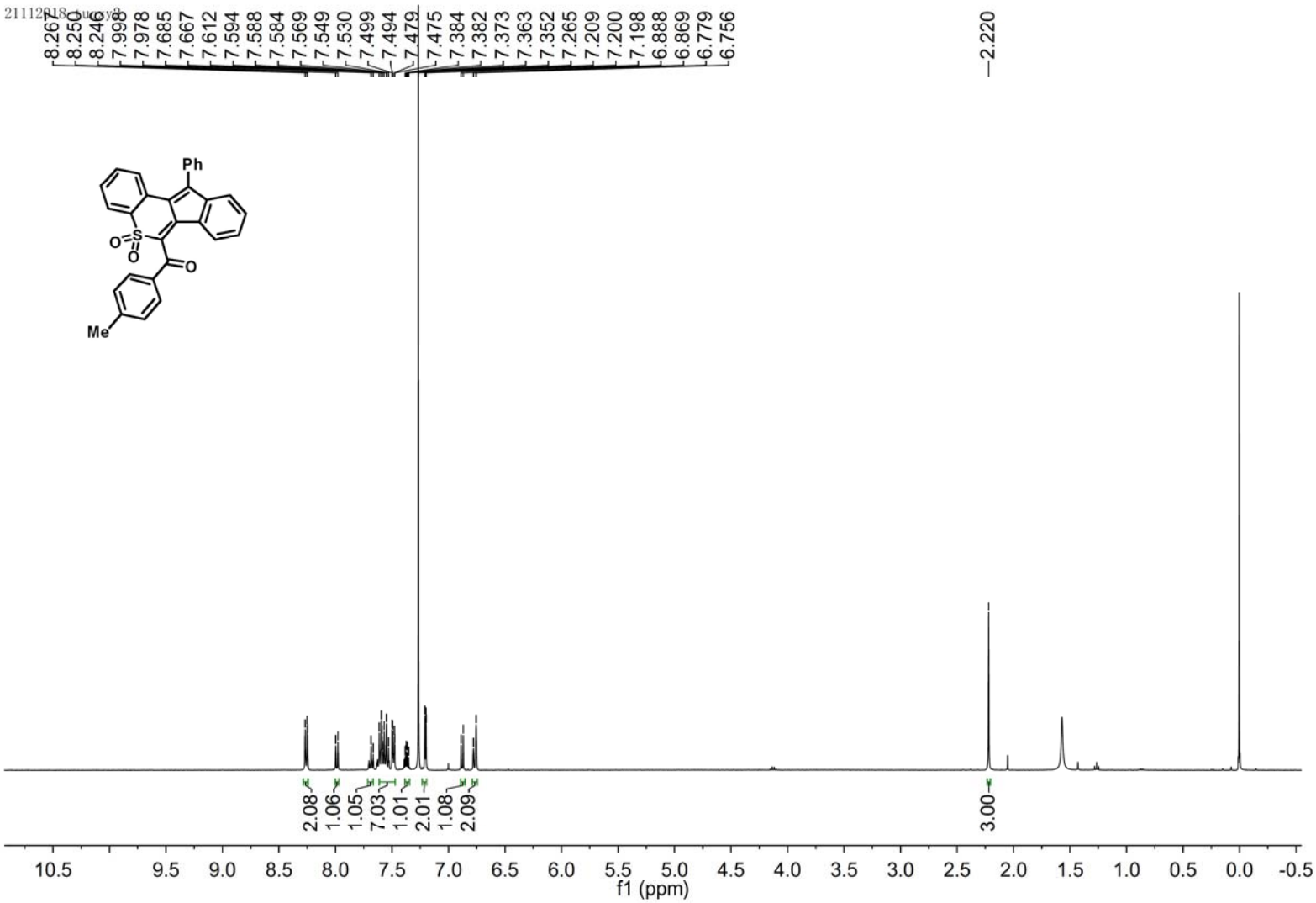
^{13}C NMR Spectrum of Compound 4kk



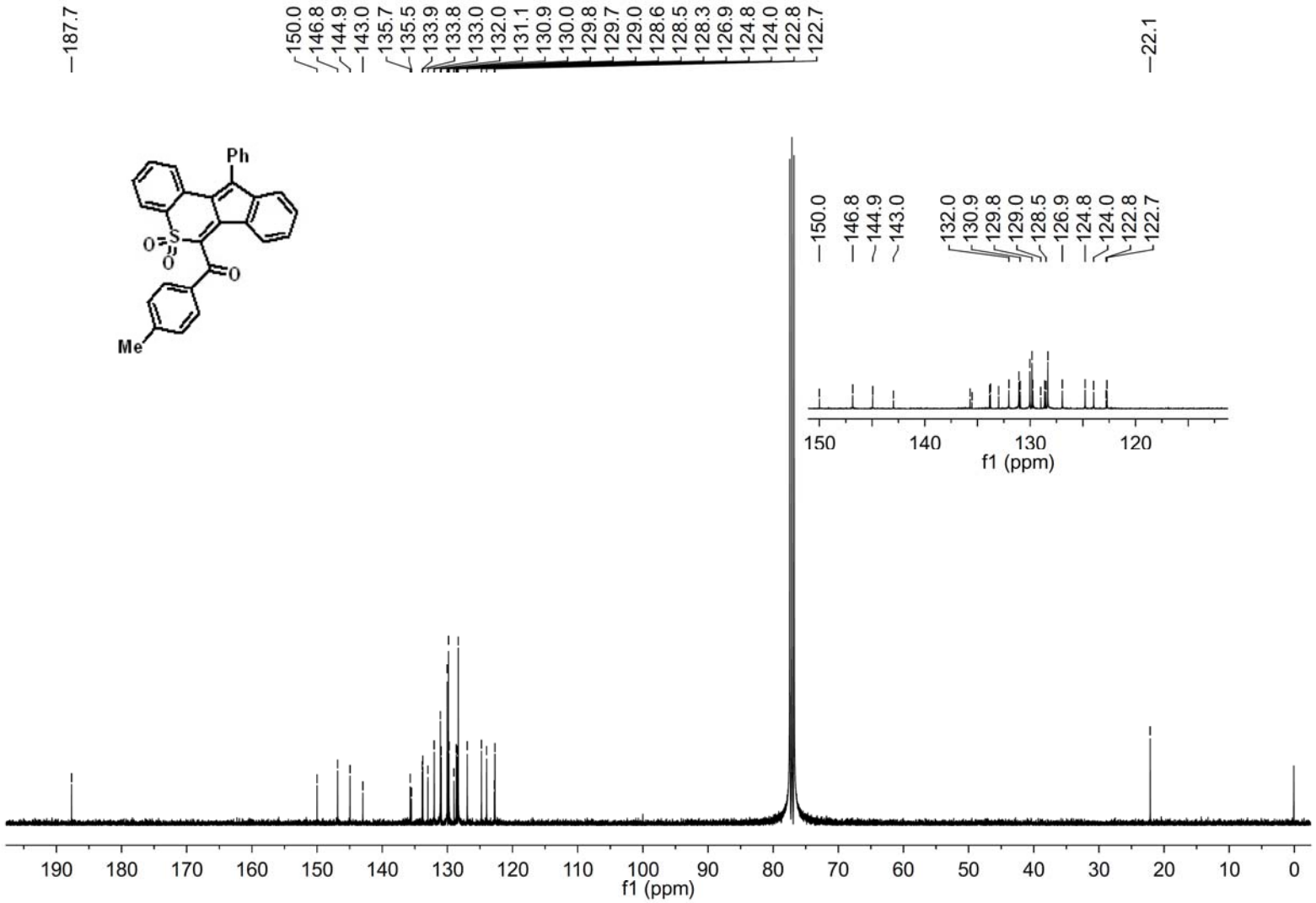
^{1}H NMR Spectrum of Compound 6a



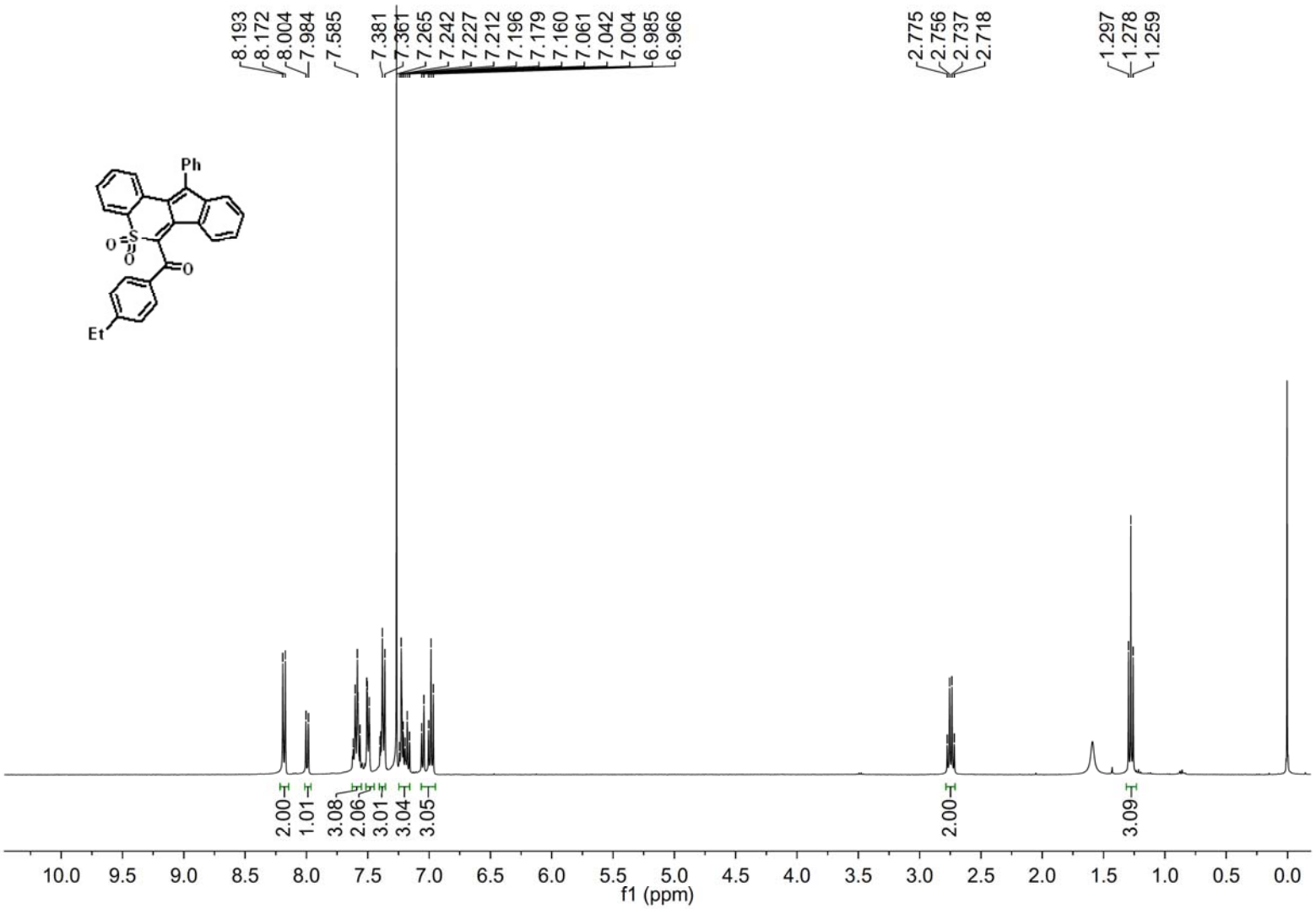
^{13}C NMR Spectrum of Compound 6a



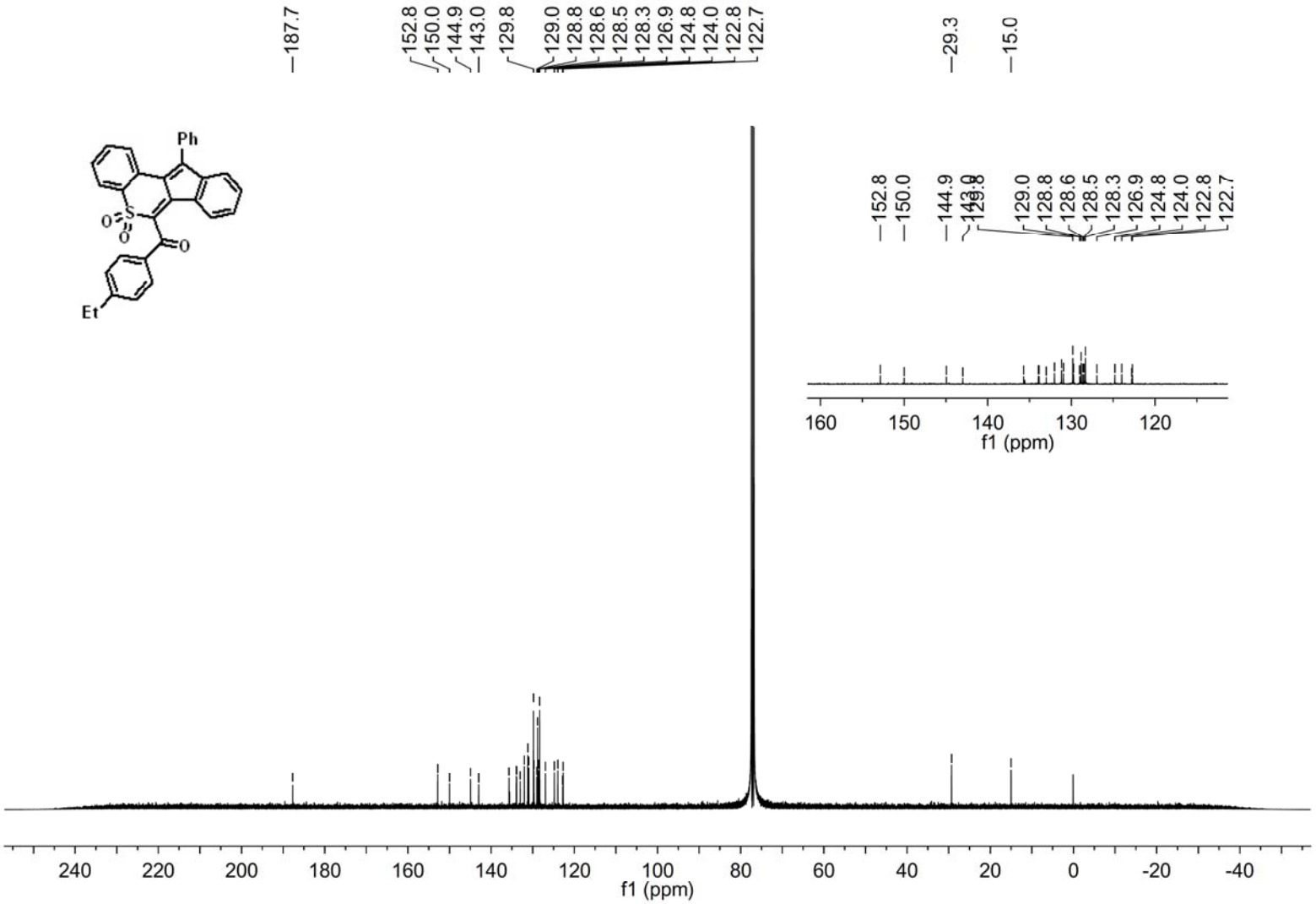
^{1}H NMR Spectrum of Compound 6b



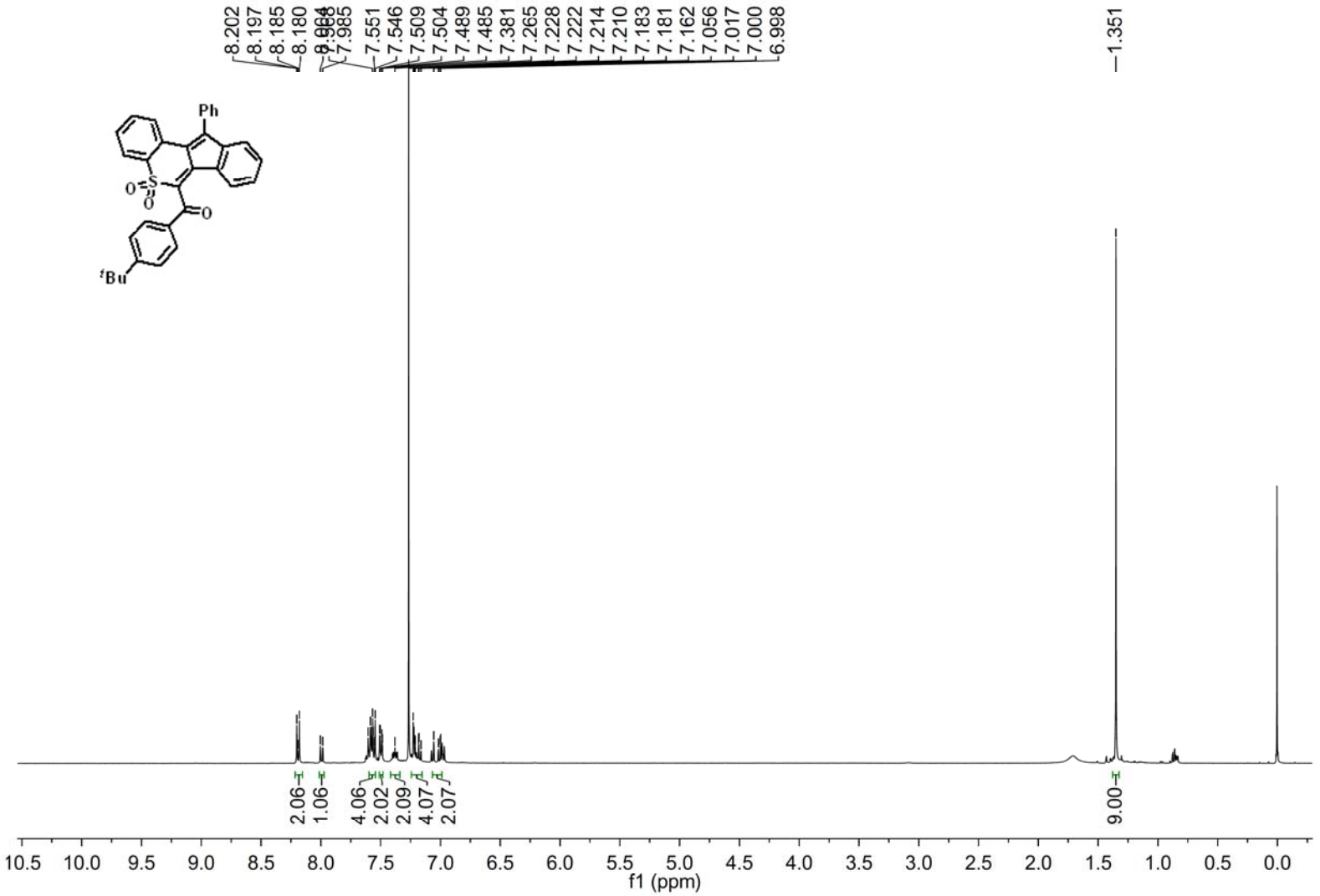
^{13}C NMR Spectrum of Compound 6b



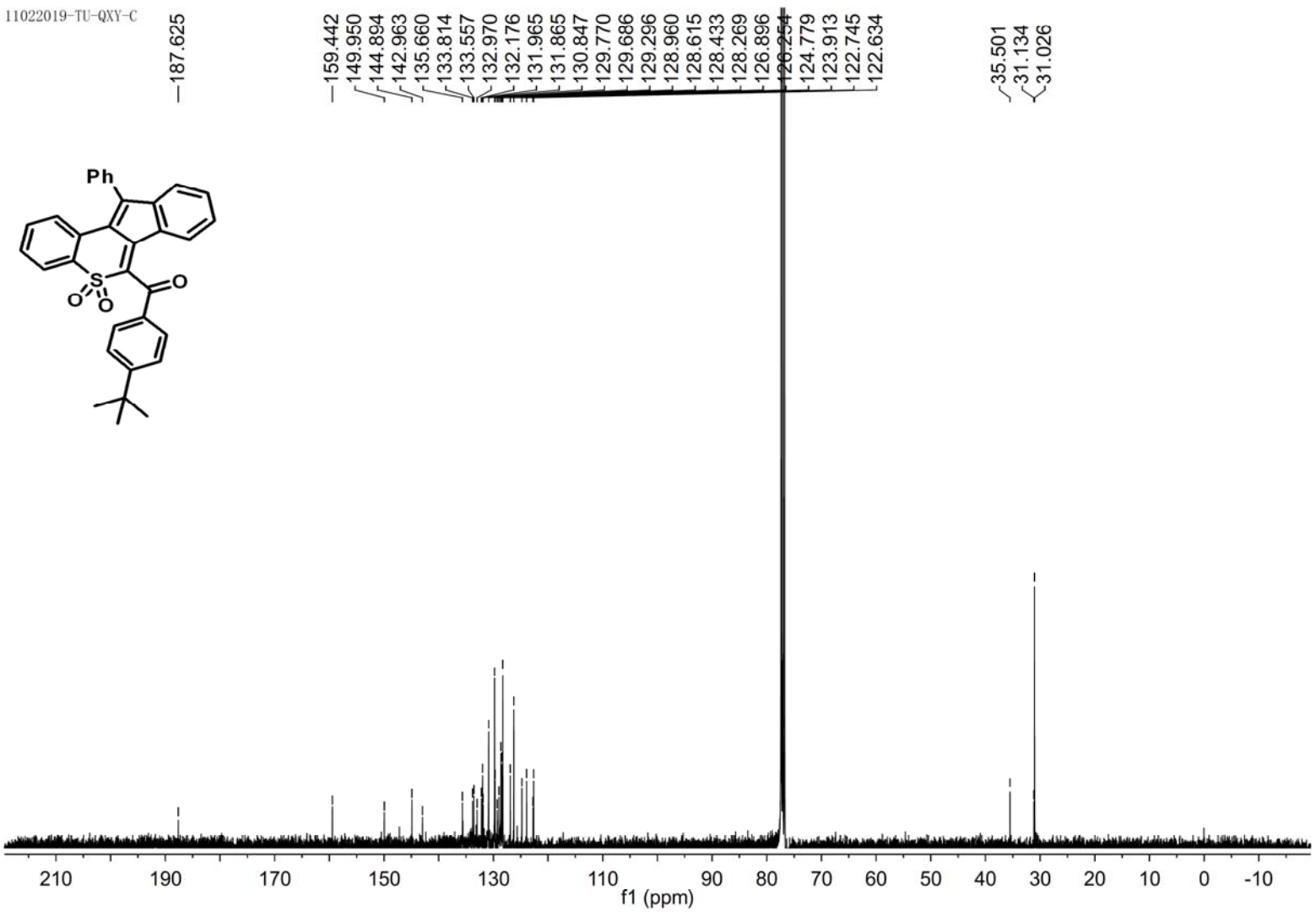
^{1}H NMR Spectrum of Compound 6c



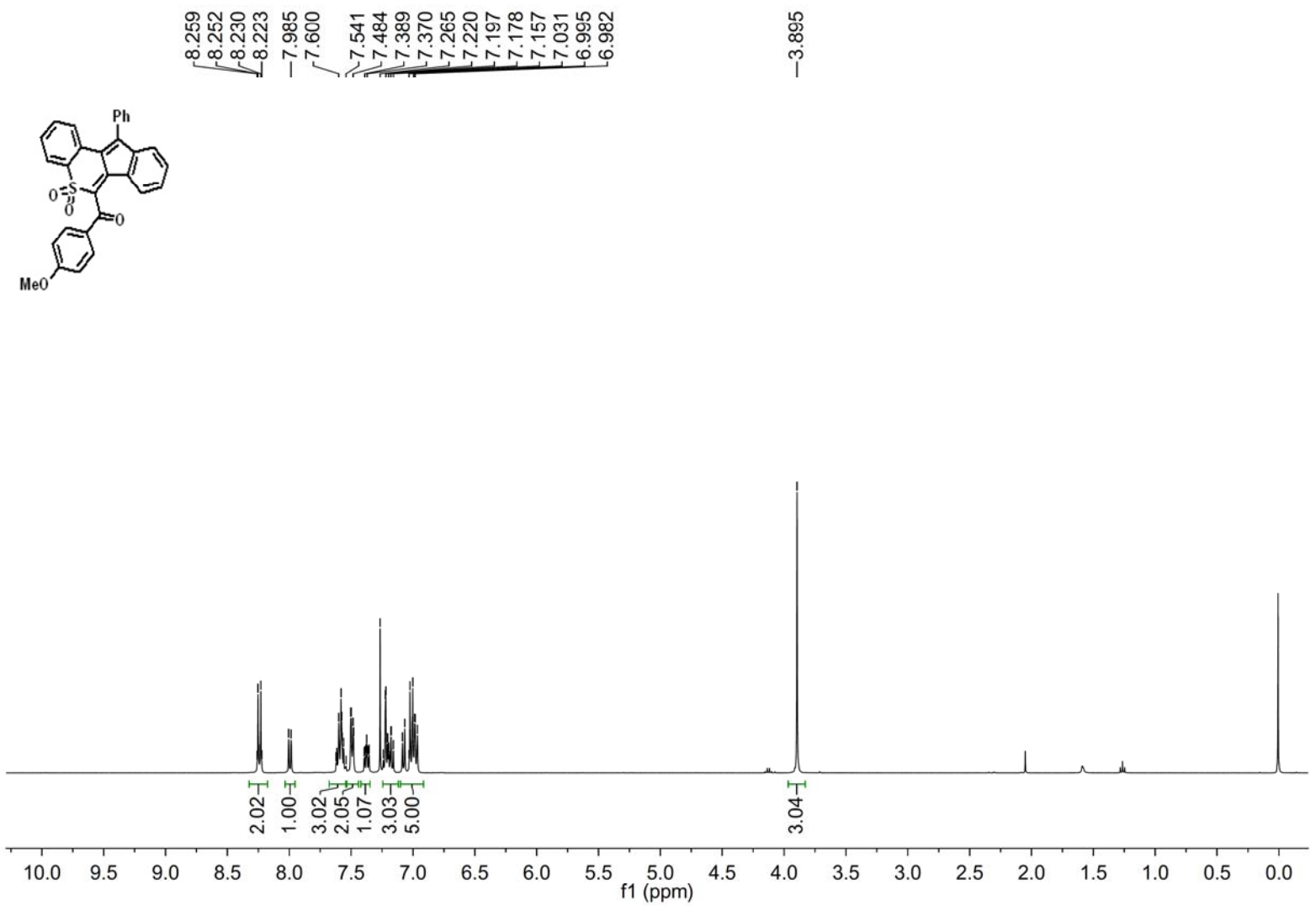
^{13}C NMR Spectrum of Compound 6c



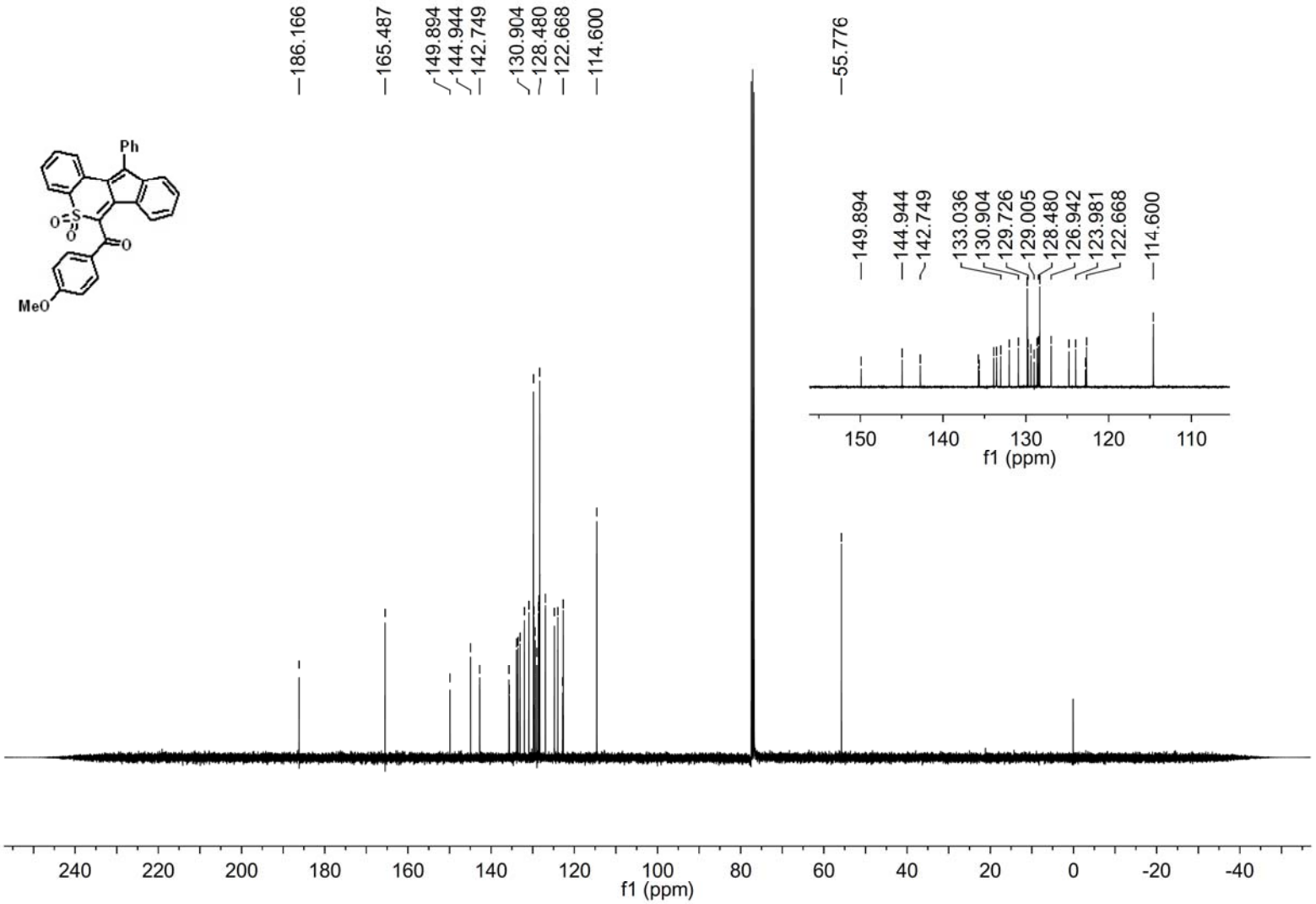
^{1}H NMR Spectrum of Compound 6d



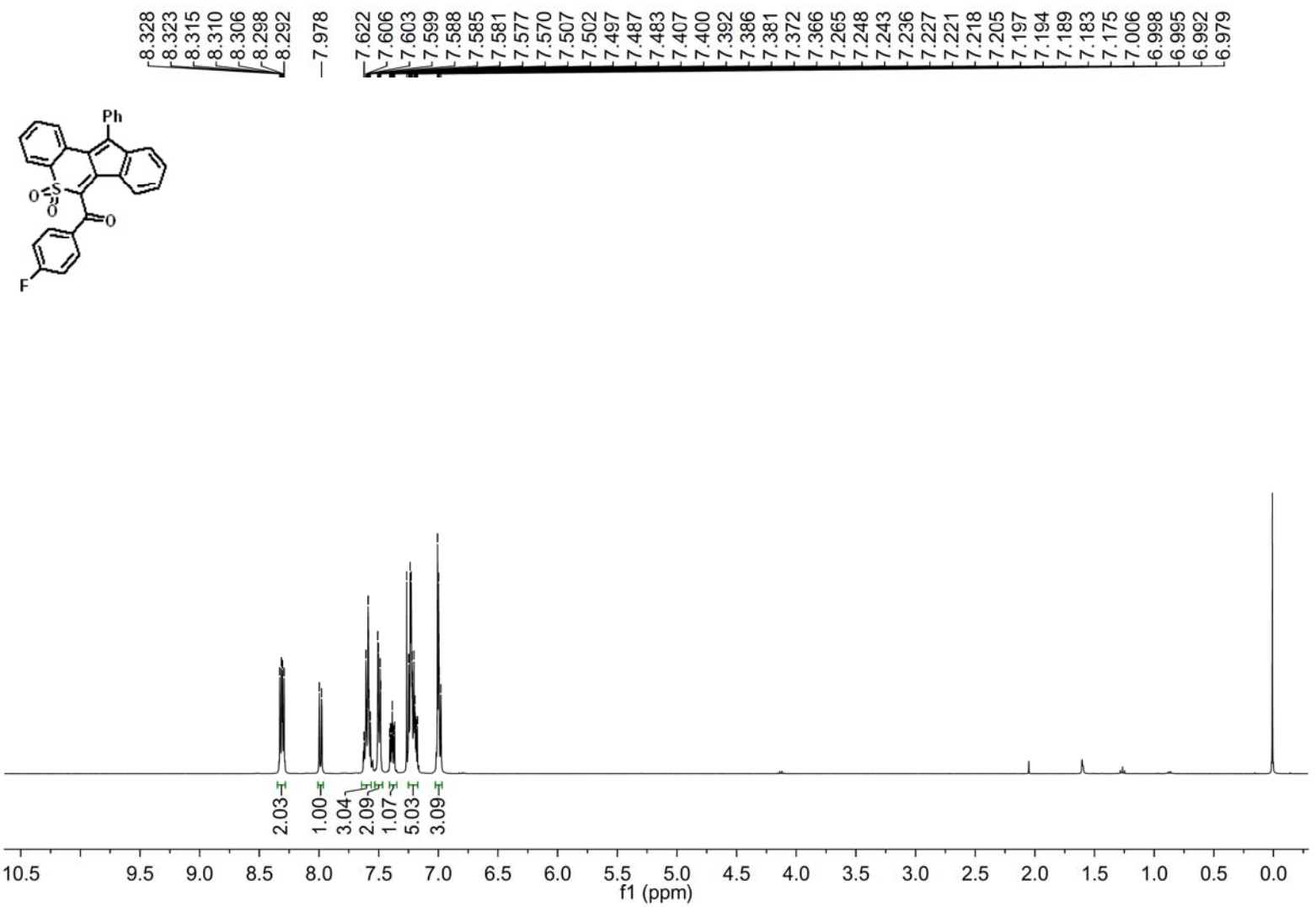
^{13}C NMR Spectrum of Compound 6d



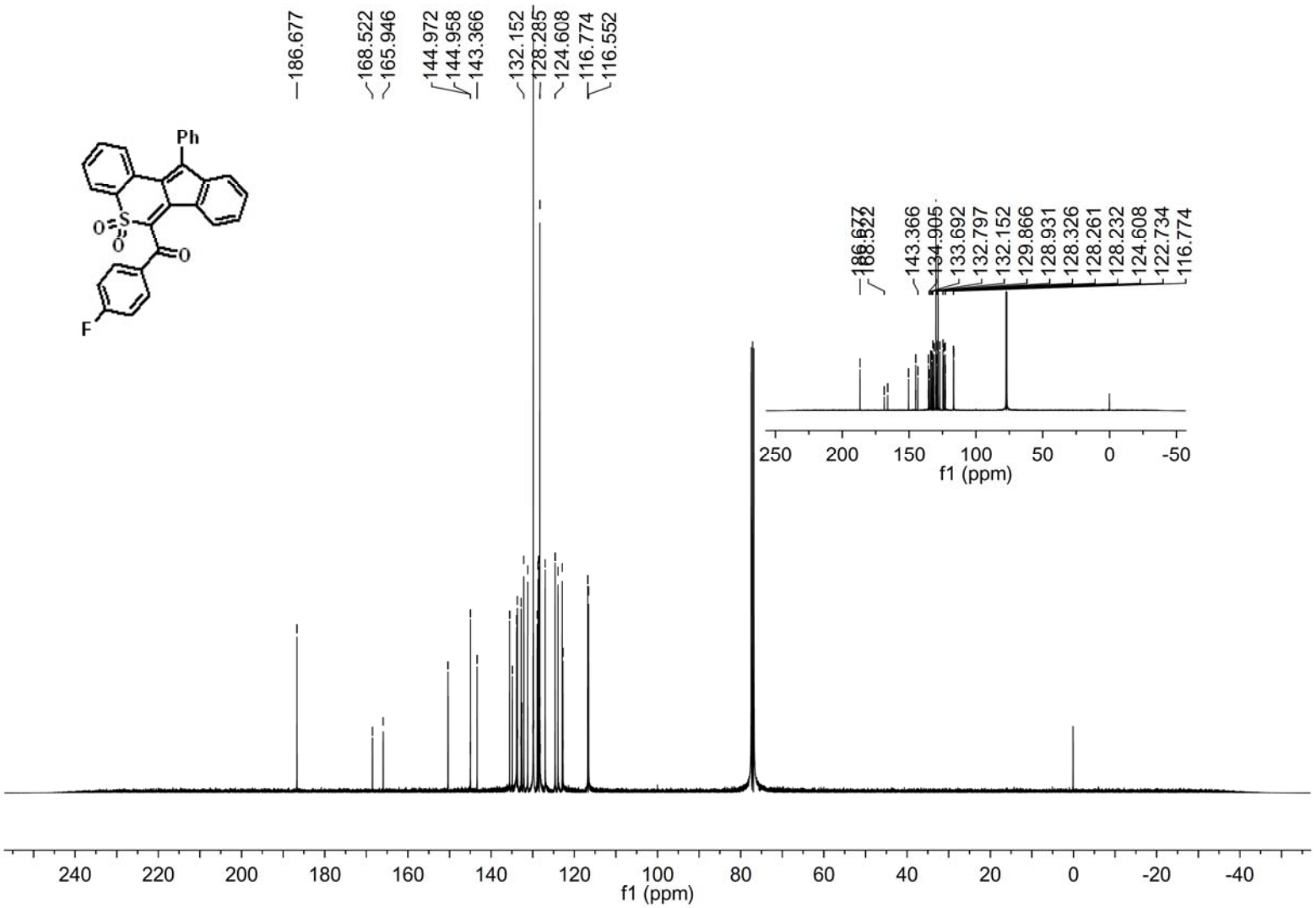
^{1}H NMR Spectrum of Compound 6e



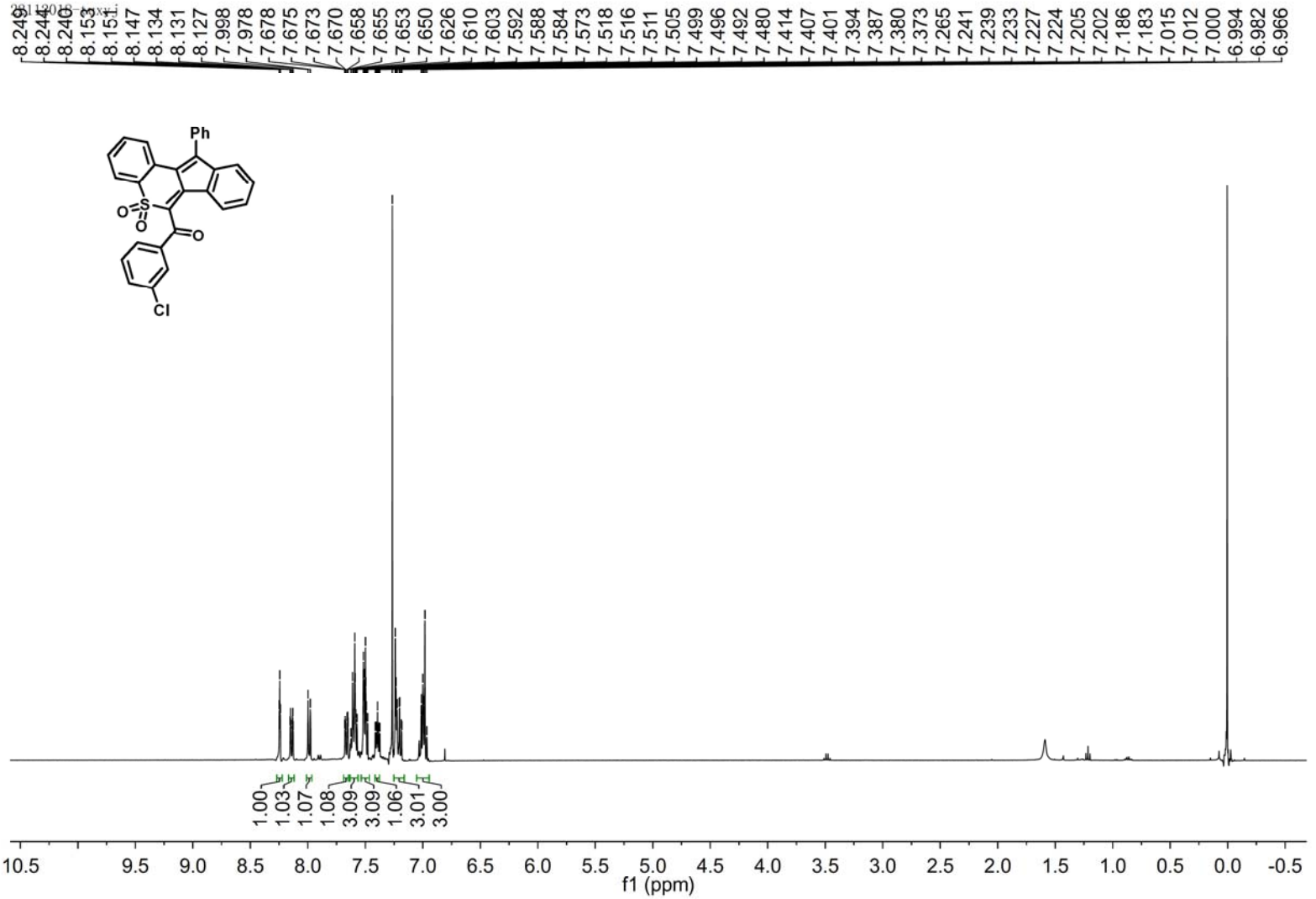
^{13}C NMR Spectrum of Compound 6e



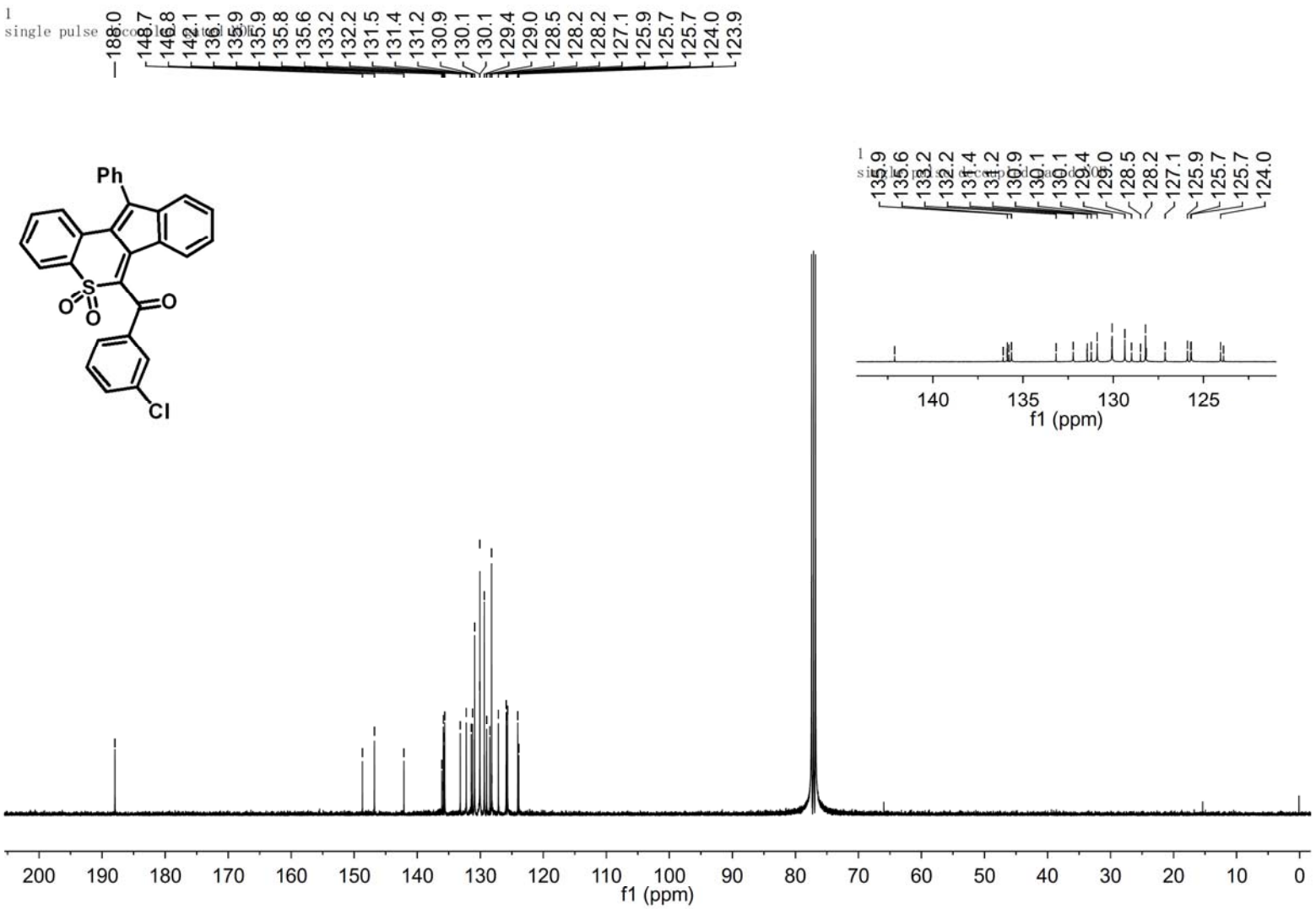
^{1}H NMR Spectrum of Compound 6f



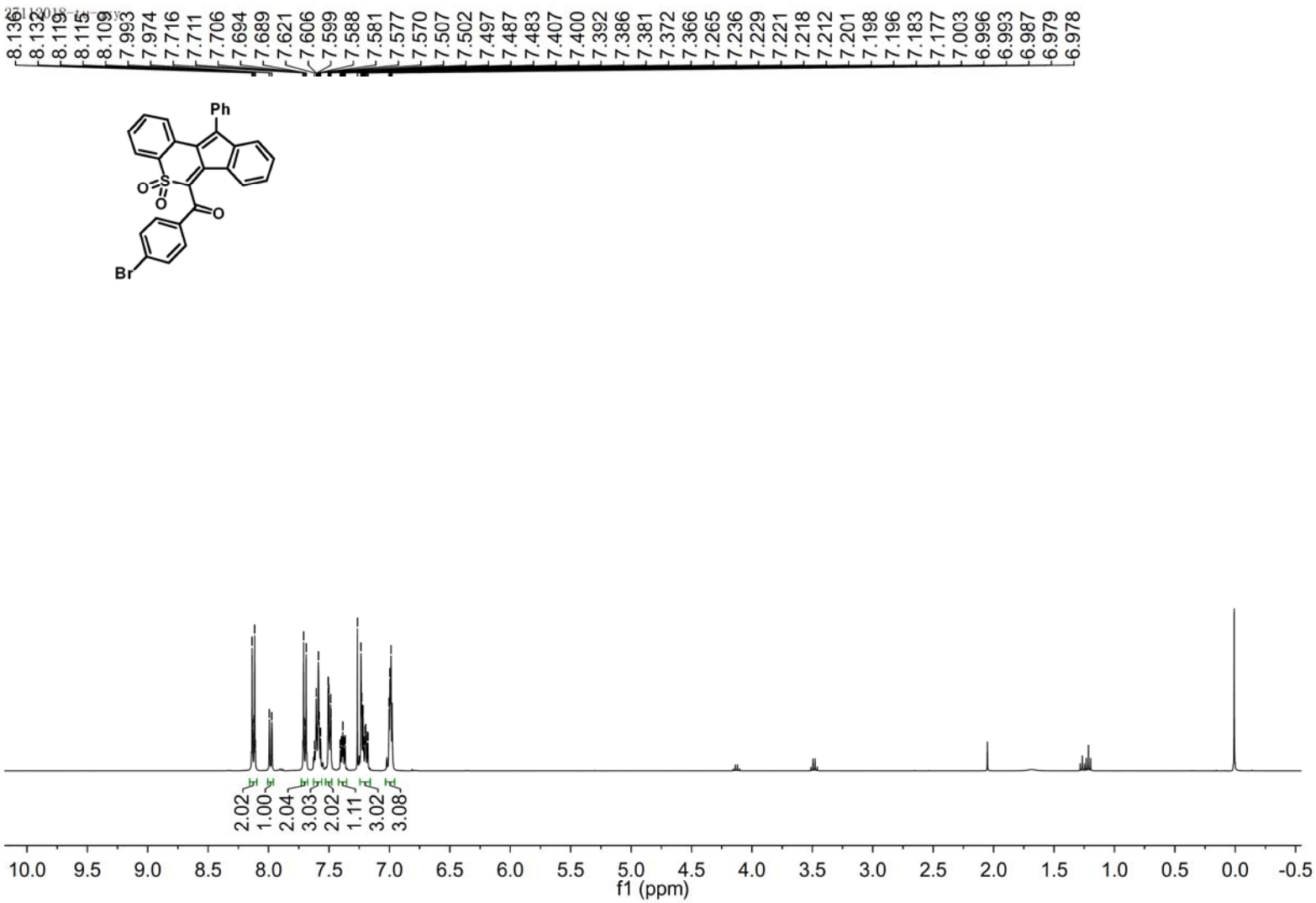
^{13}C NMR Spectrum of Compound 6f



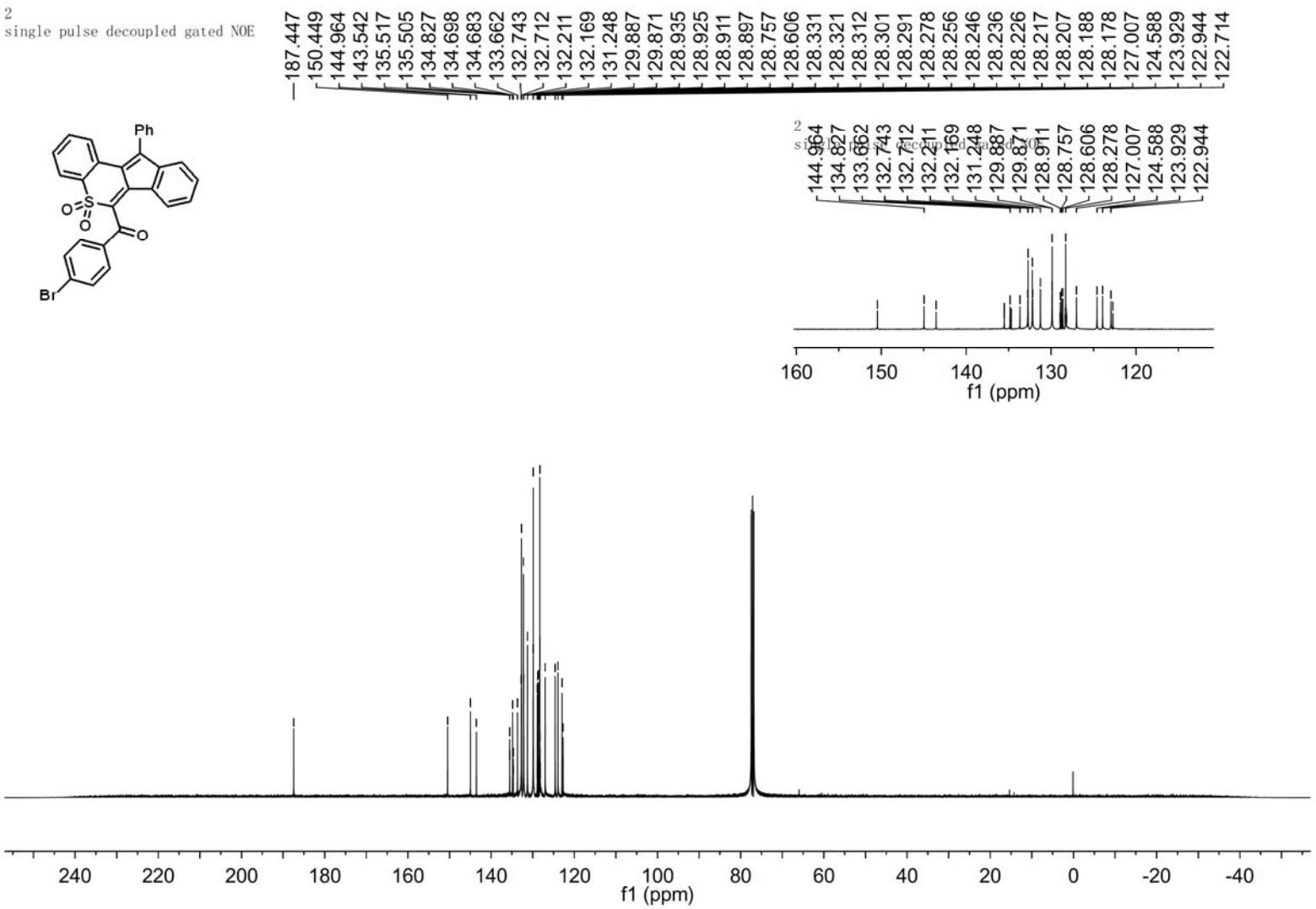
^{1}H NMR Spectrum of Compound 6g



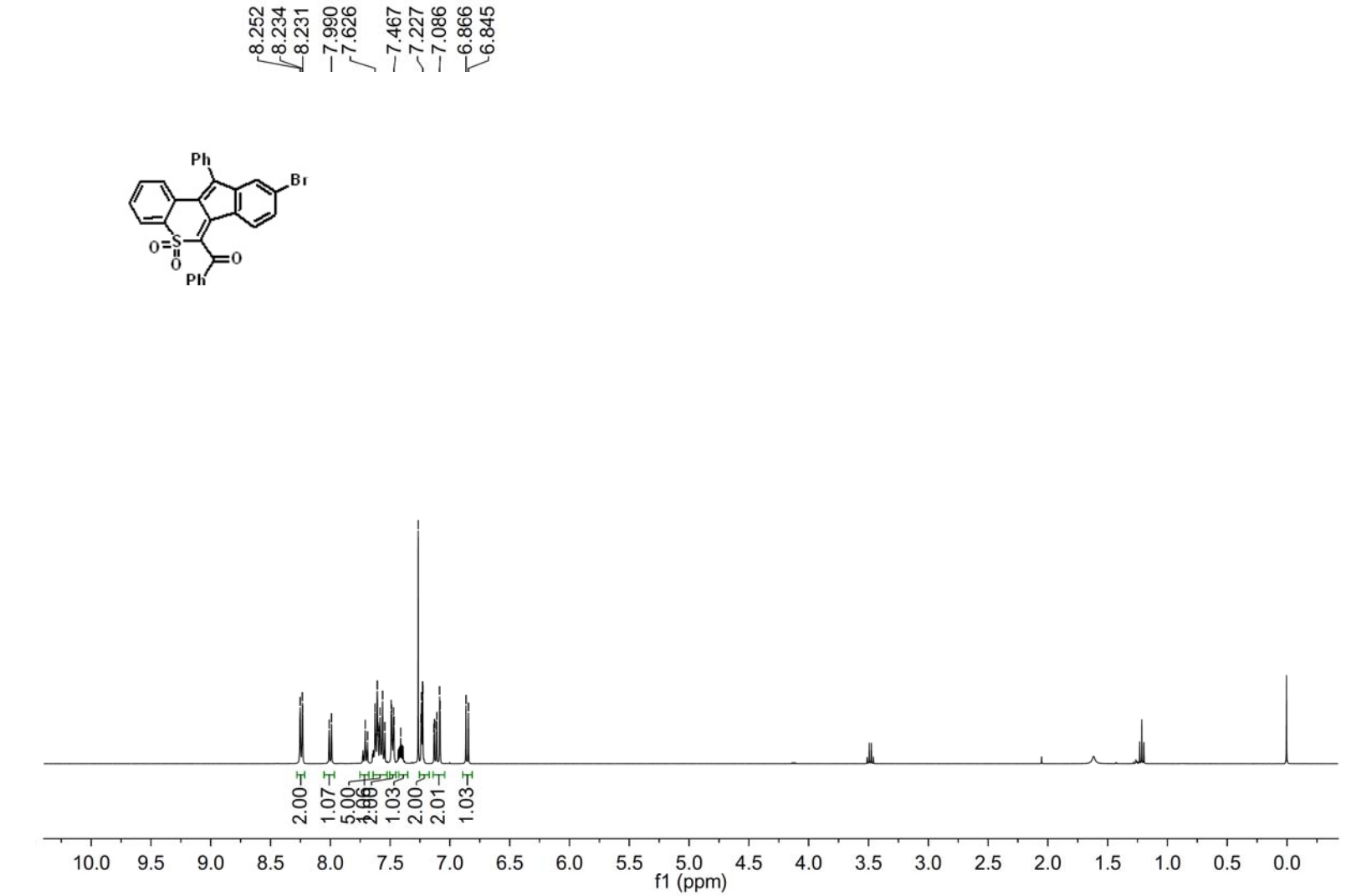
^{13}C NMR Spectrum of Compound 6g



^{1}H NMR Spectrum of Compound 6h

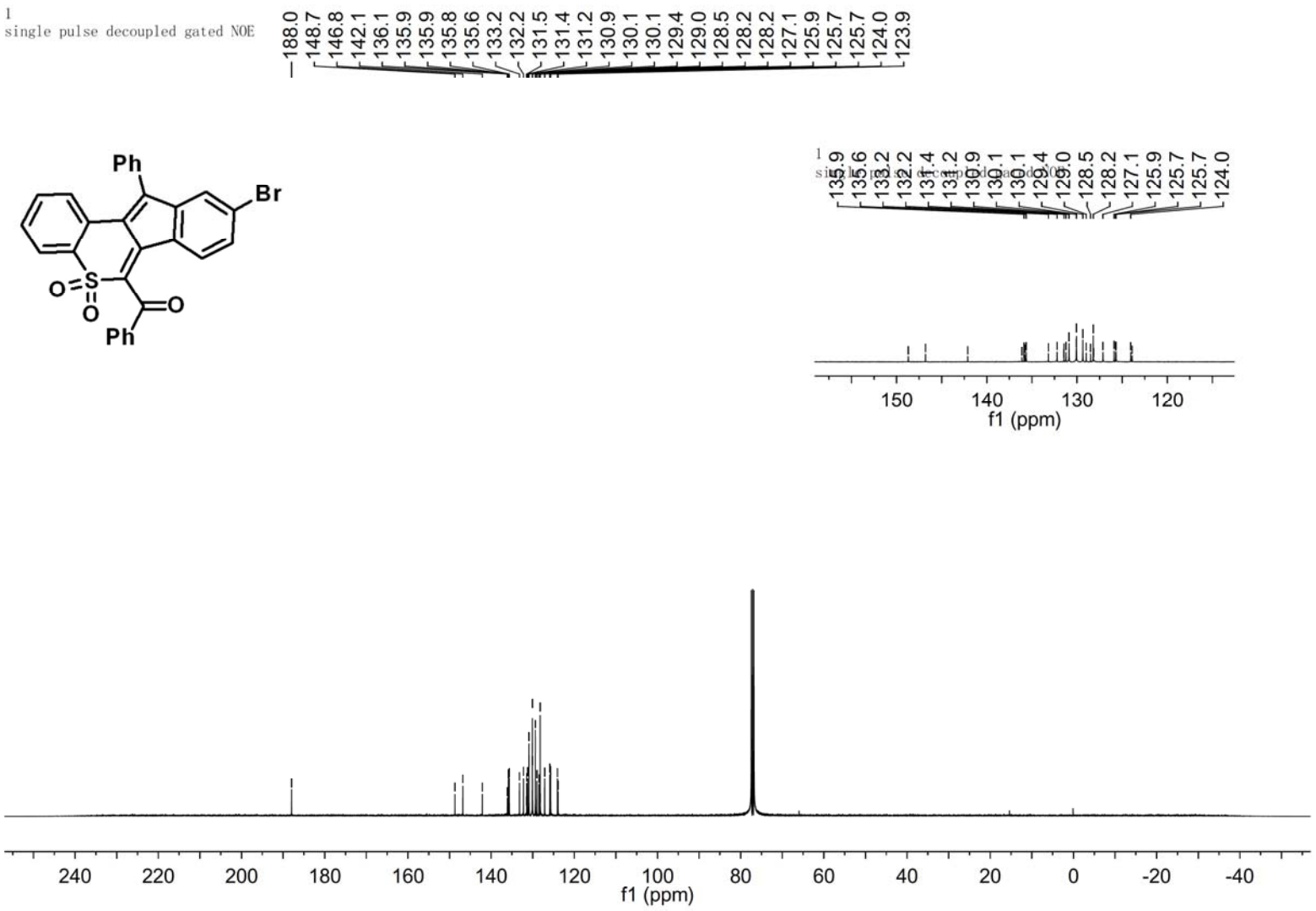


^{13}C NMR Spectrum of Compound 6h

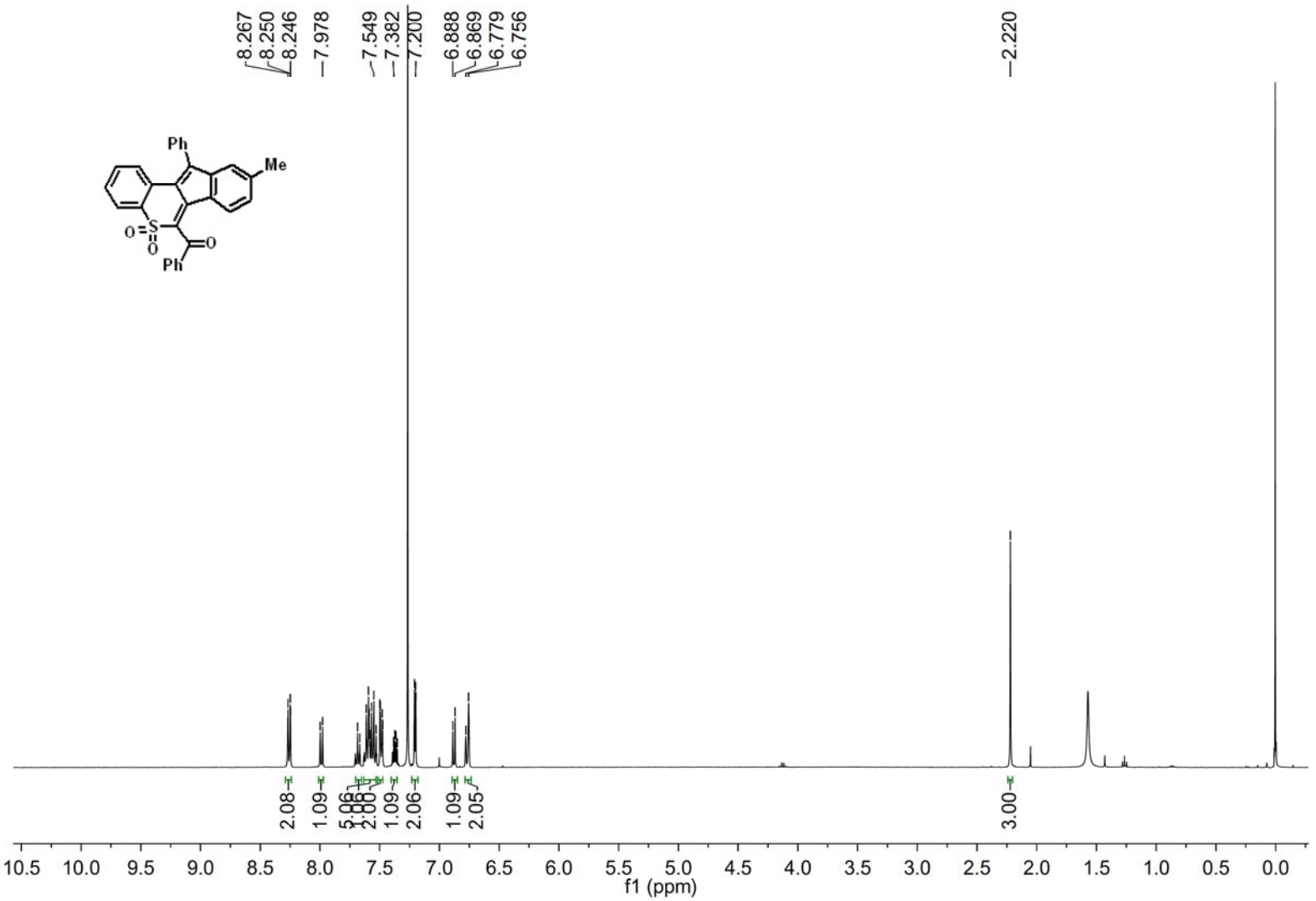


^{1}H NMR Spectrum of Compound 6i

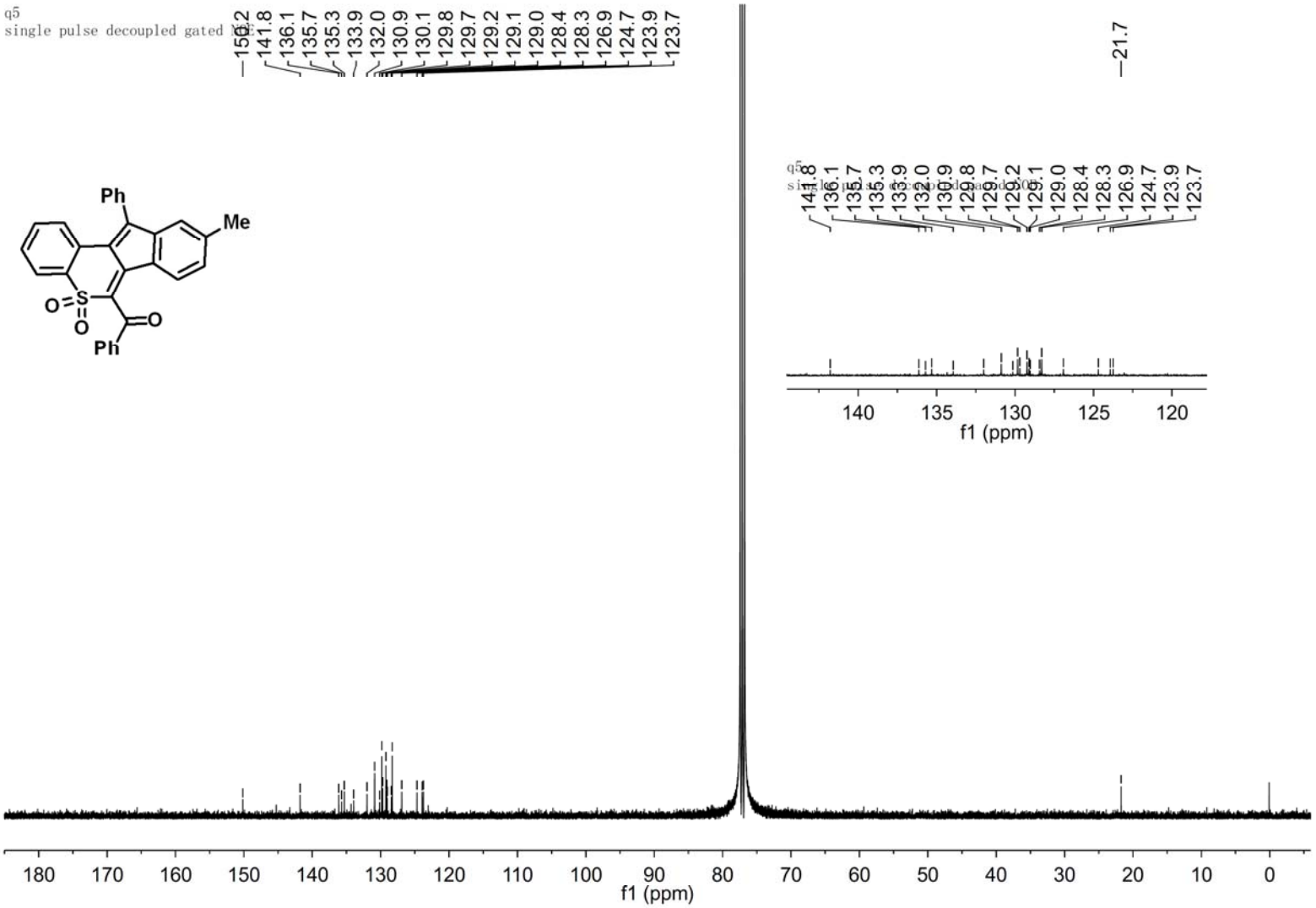
.19



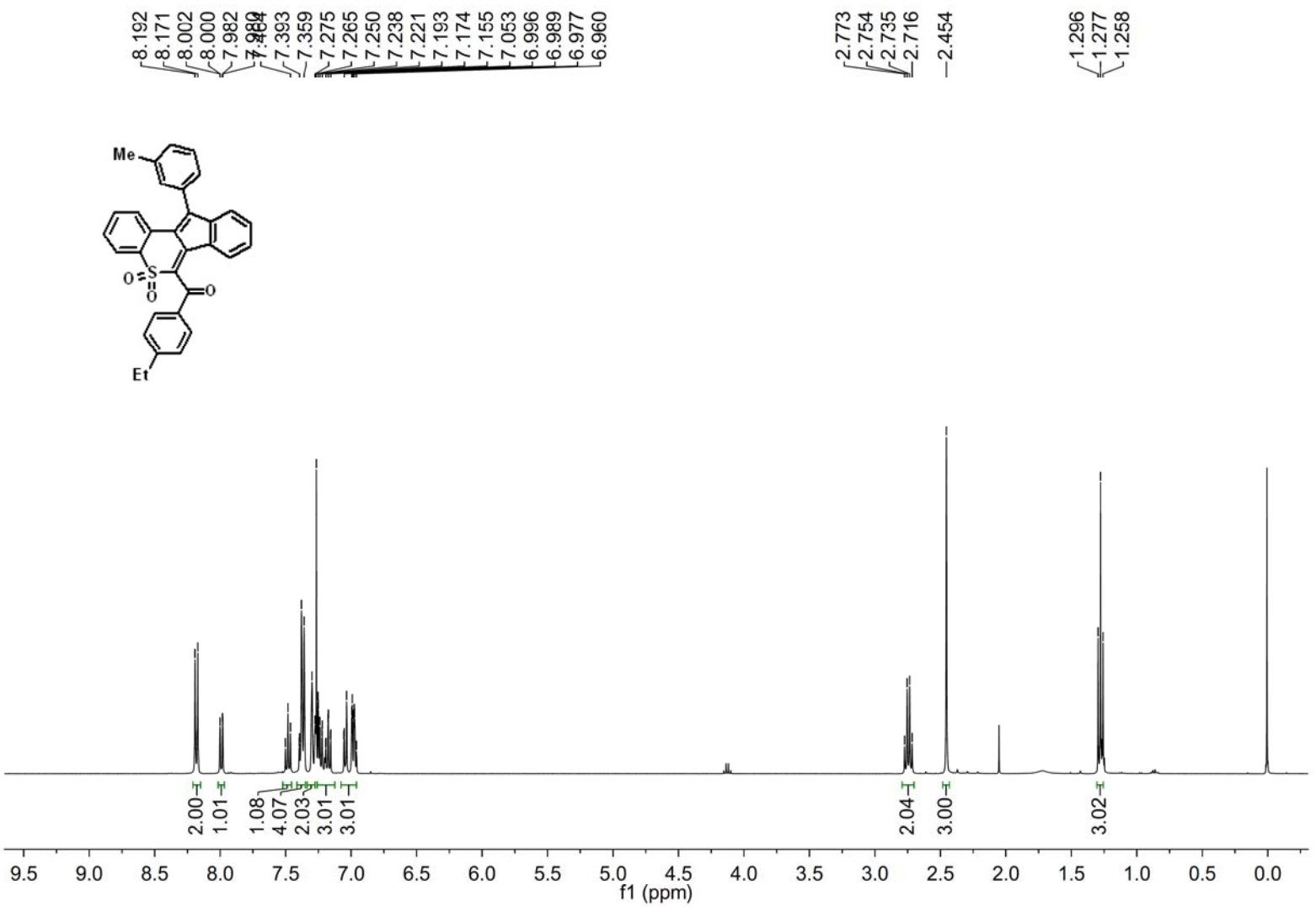
^{13}C NMR Spectrum of Compound 6i



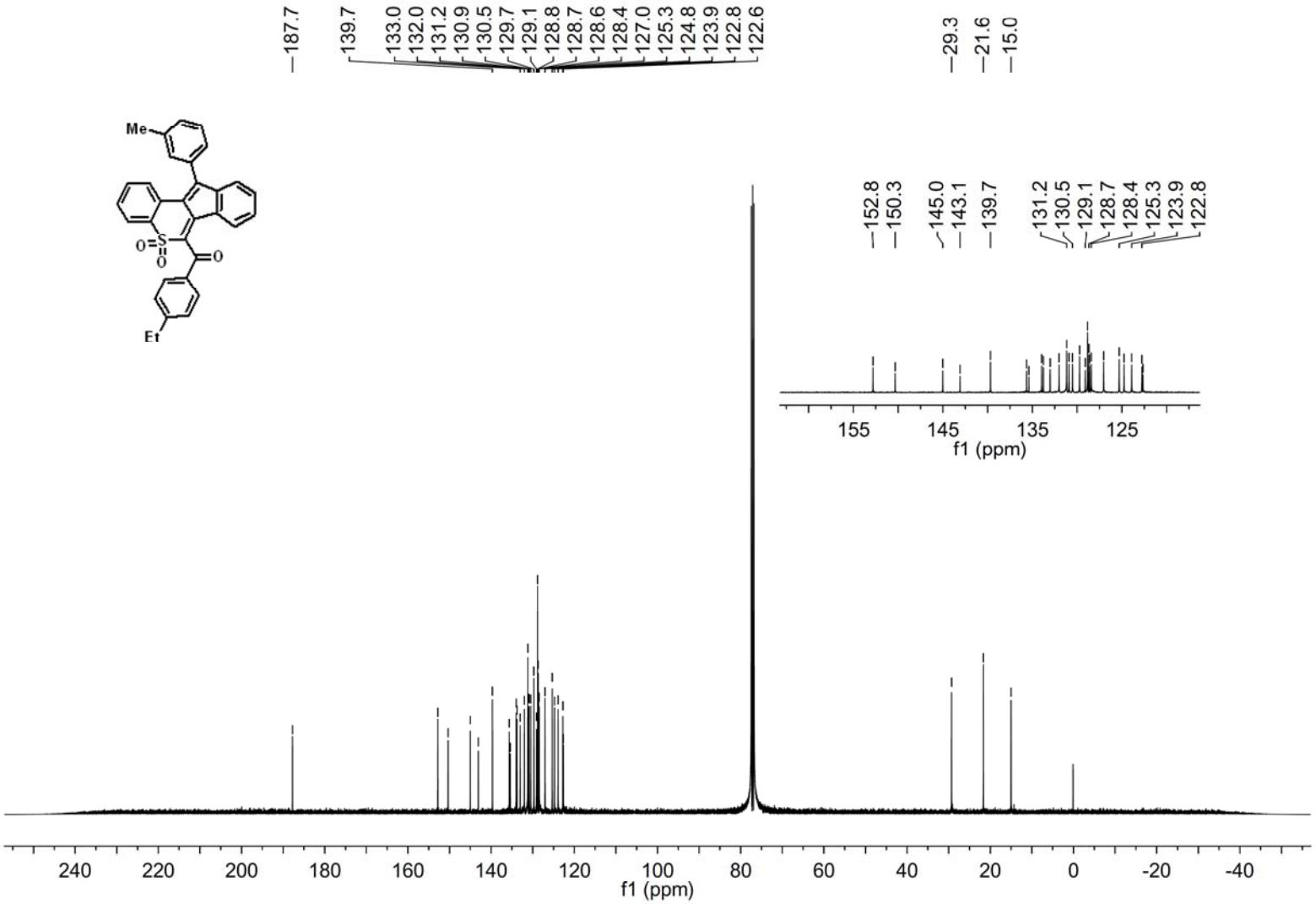
^{1}H NMR Spectrum of Compound 6j



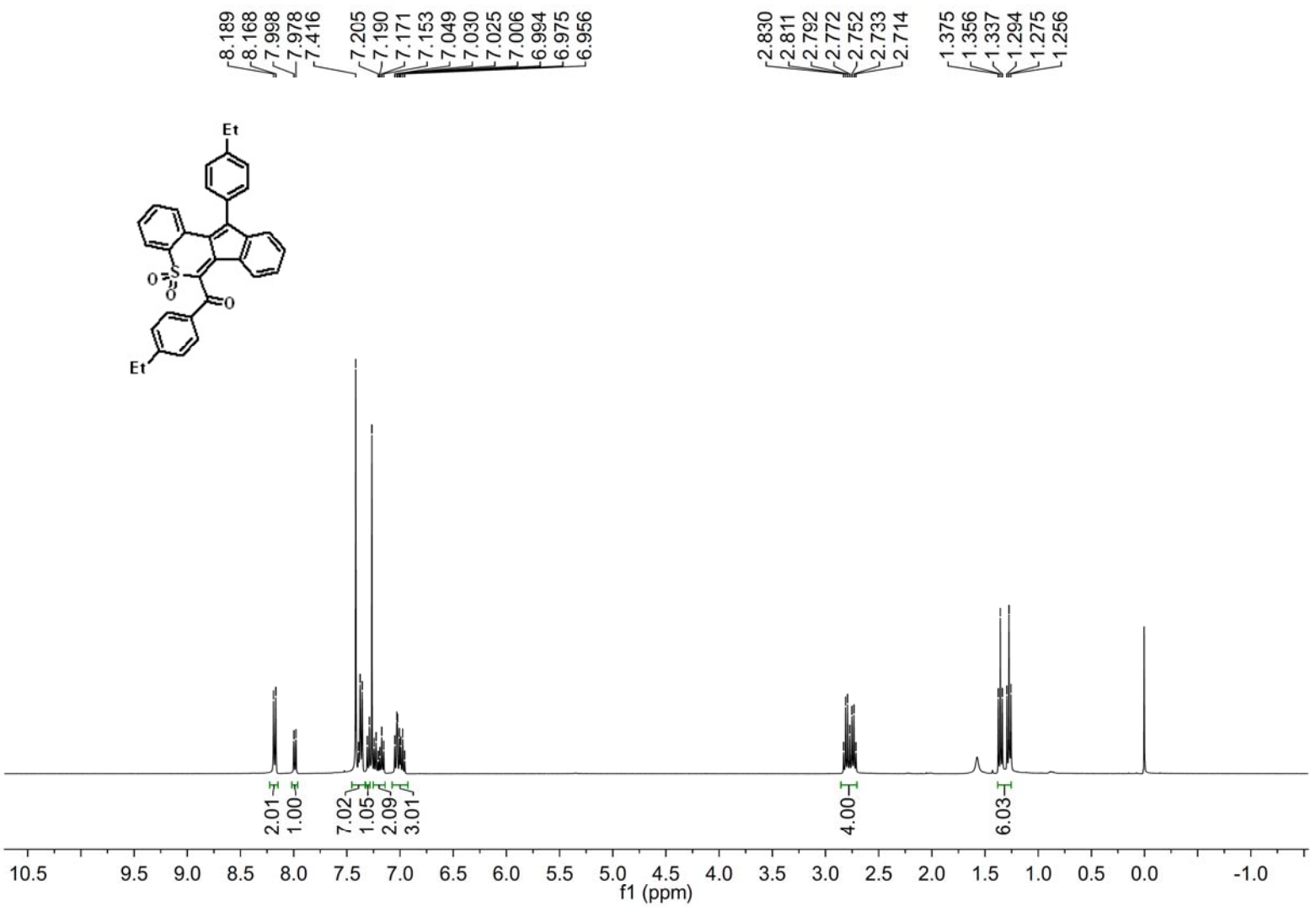
^{13}C NMR Spectrum of Compound 6j



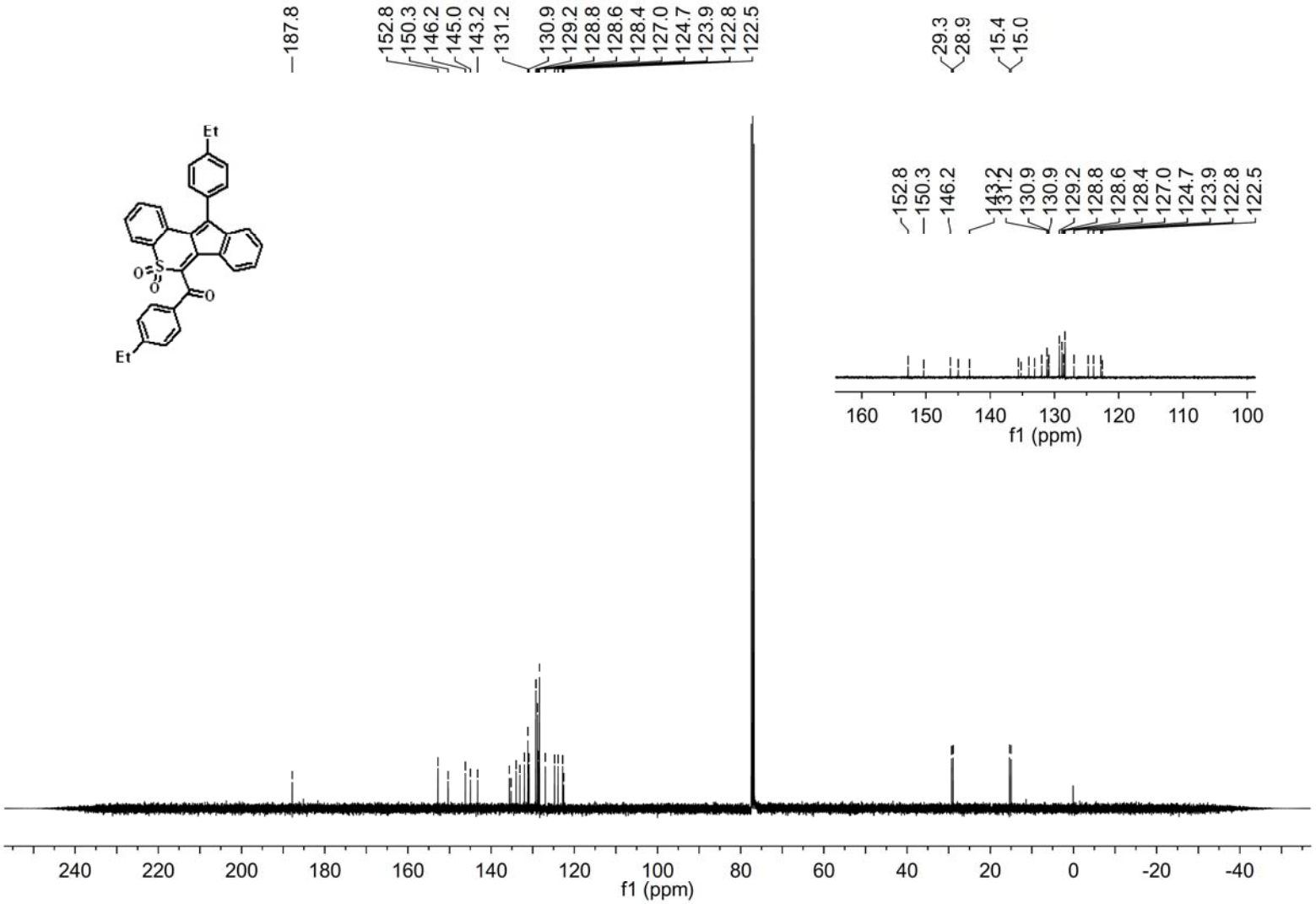
^{1}H NMR Spectrum of Compound 6k



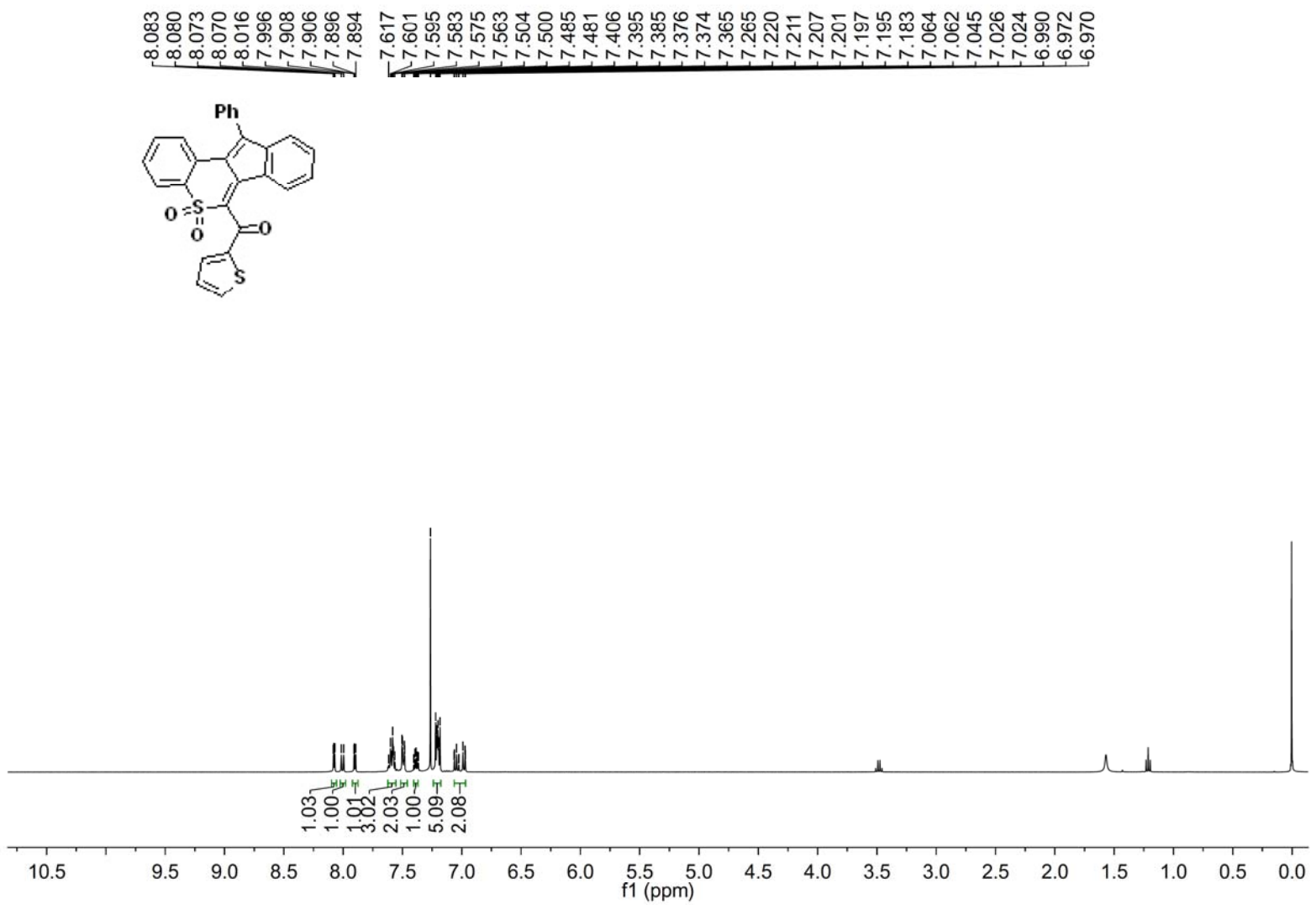
^{13}C NMR Spectrum of Compound 6k



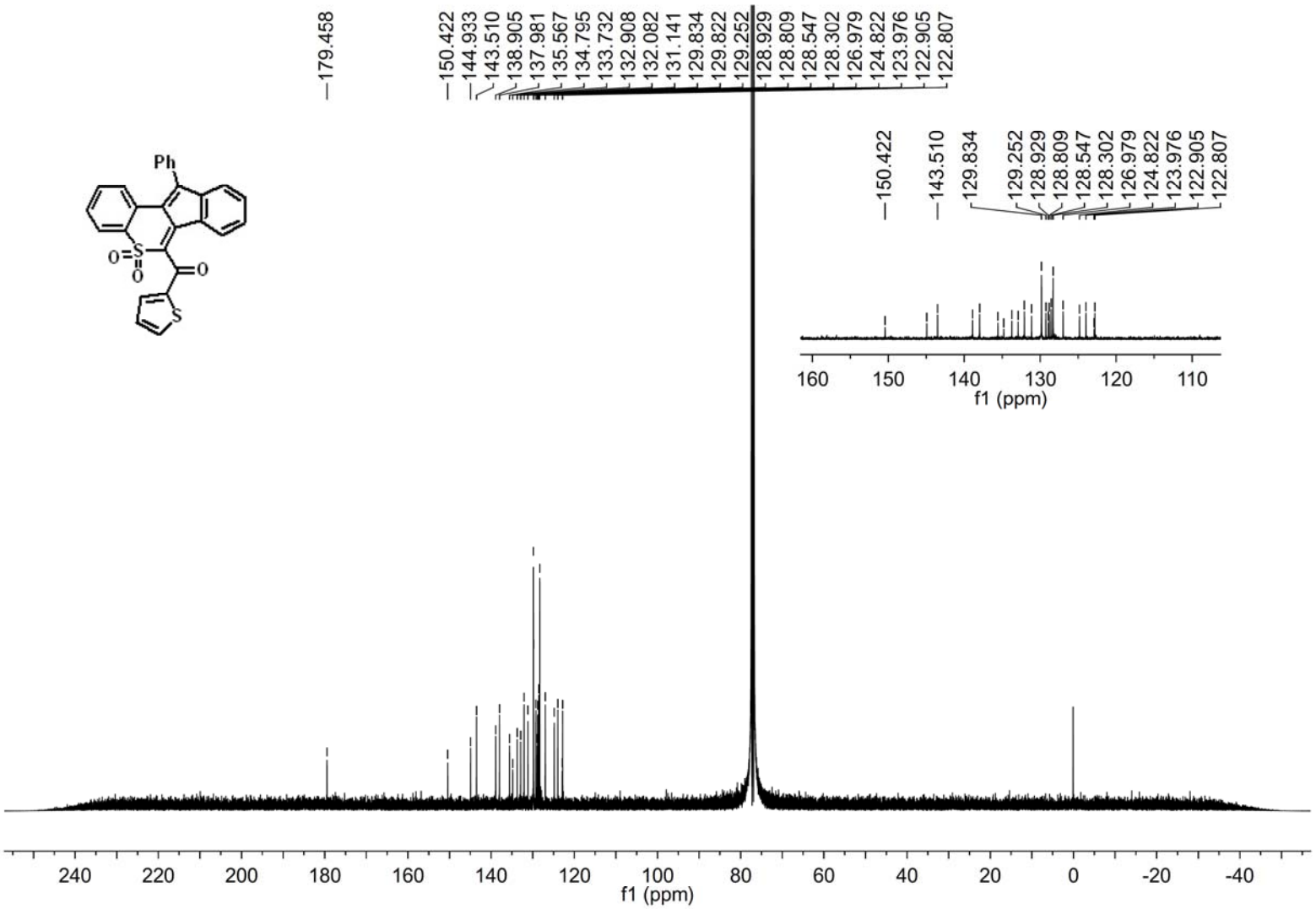
^{1}H NMR Spectrum of Compound 6l



^{13}C NMR Spectrum of Compound 6l



^{1}H NMR Spectrum of Compound 6m



^{13}C NMR Spectrum of Compound 6m