Supporting Information

Nickel-Catalyzed Direct Arylation of Azoles with Aryl Bromides

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Contents

Instrumentation and Chemicals

^{1}H and ^{13}C NMR spectra were recorded at 400 MHz and 100 MHz, respectively, for $CDCl_3$ solutions. MS data were obtained by EI. GC analysis was carried out using a silicon OV-17 column (i. d. 2.6 mm x 1.5 m) or a CBP-1 capillary column (i. d. 0.5 mm x 25 m). TLC analyses were performed on commercial glass plates bearing 0.25-mm layer of Merck Silica gel $60F_{254}$. Silica gel (Wakogel 200 mesh) was used for column chromatography.

Unless otherwise noted, materials obtained from commercial suppliers were used without further purification. Diglyme and *o*-xylene were freshly distilled from CaH_2 prior to use. $NiBr_2$ and 2,9-dimethyl-1,10-phenanthroline hydrate were purchased from Wako Pure Chemical Co. $NiBr_2$•diglyme and 1,10-phenanthroline were obtained from Aldrich. Zn powder was available from Kanto Chemical Co. 5-Aryloxazoles **6a** and **6b** were prepared by the van Lausen reaction with TosMIC and the corresponding aldehydes.[1] All reactions were carried out under nitrogen atmosphere.

[1] van Leusen, A. M.; Hoogenboom, B. E.; Sinderius, H. *Tetrahedron Lett*. **1972**, *13*, 2369.

Typical Procedure for the Nickel-Catalyzed Direct Arylation of Azoles with Aryl Bromides

Synthesis of 2a (Table 2, entry 1): $NiBr_2$ (11 mg, 0.050 mmol), 1,10-phenanthroline (11 mg, 0.060 mmol), LiO*t*-Bu (160 mg, 2.0 mmol), benzothiazole (**1**, 68 mg, 0.50 mmol), 4-bromotoluene (**2a**, 103 mg, 0.60 mmol), diglyme (3.0 mL), and dibenzyl (ca. 50 mg, internal standard) were placed in a 20 mL two-necked reaction flask equipped with a reflux condenser. After being stirred for 10 min at room temperature, the solution was heated at 150 ˚C for 4 h. The consumption of **1** was confirmed by GC analysis, and the resulting mixture was then quenched with water. The mixture was extracted with diethyl ether, and the combined organic layer was dried over sodium sulfate. Concentration in vacuo followed by silica gel column purification gave 2-(4-methylphenyl)benzothiazole (**3a**, 74 mg, 0.33 mmol) in 67% yield.

Synthesis of 5c (Table 4, entry 1): $NiBr_2$•diglyme (18 mg, 0.050 mmol), 2,9-dimethyl-1,10-phenanthroline hydrate (13 mg, 0.060 mmol), LiO*t*-Bu (160 mg, 2.0 mmol), benzoxazole (**4**, 119 mg, 1.0 mmol), 2-bromotoluene (**2c**, 86 mg, 0.50 mmol), Zn powder (16 mg, 0.25 mmol), *o*-xylene (3.0 mL), and 1-methylnaphthalene (ca. 50 mg, internal standard) were placed in a 20 mL two-necked reaction flask equipped with a reflux condenser. The solution was stirred for 10 min at room temperature and then heated at 150 ˚C. After the consumption of **2c** was checked by GC analysis, the resulting mixture was allowed to cool to room temperature and quenched with water. Extraction with diethyl ether, evaporation, and purification by column chromatography on silica gel afforded 2-(2-methylphenyl)benzoxazole (**5c**, 55 mg, 0.27 mmol) in 53% yield.

Characterization Data for Compounds

^{1}H and ^{13}C NMR spectra for all compounds are attached in the last part. Compounds **3a**,[2] **3b**,[3] **3c**,[4] **3e**,[5] **3f**,[6] **3g**,[7] **3h**,[6] **3i**,[8] **3j**,[9] **3a'**,[10] **5c**,[11] and **5e**[12] are found in the literature.

2-(4-Methylphenyl)benzothiazole (3a) m.p. 80-82 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) 2.44 (s, 3H), 7.31 (d, *J* = 8.1 Hz, 2H), 7.36-7.40 (m, 1H), 7.47-7.52 (m, 1H), 7.90 (d, *J* = 8.1 Hz, 1H), 8.00 (dt, *J* = 8.1 Hz, 1.8 Hz, 2H), 8.07 (d, *J* = 8.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 21.71, 121.77, 123.27, 125.20, 126.44, 127.70, 129.92, 131.20, 135.18, 141.62, 154.41, 168.44; HRMS *m/z* (M^+) calcd for $C_{14}H_{11}NS$: 225.0612, found: 225.0607.

2-(3-Methylphenyl)benzothiazole (3b) m.p. 63-66 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) 2.47 (s, 3H), 7.32 (d, *J* = 7.7 Hz, 1H), 7.39 (t, *J* = 7.7 Hz, 2H), 7.48-7.53 (m, 1H), 7.87-7.92 (m, 2H), 7.96 (s, 1H), 8.09 (d, *J* = 8.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 21.55, 121.80, 123.40, 125.08, 125.32, 126.48, 128.22, 129.12, 132.00, 133.78, 135.27, 139.07, 154.38, 168.52; HRMS *m/z* (M^+) calcd for $C_{14}H_{11}NS$: 225.0612, found: 225.0605.

2-(2-Methylphenyl)benzothiazole (3c) m.p. 51-53 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) 2.69 (s, 3H), 7.31-7.45 (m, 4H), 7.51-7.55 (m, 1H), 7.78 (d, *J* = 7.7 Hz, 1H), 7.95 (d, *J* = 7.3 Hz, 1H), 8.13 (d, *J* = 8.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 21.53, 121.55, 123.60, 125.28, 126.30, 126.32, 130.19, 130.74, 131.74, 133.33, 135.83, 137.48, 154.04, 168.18; HRMS *m/z* (M^+) calcd for $C_{14}H_{11}NS$: 225.0612, found: 225.0603.

2-(2,5-Dimethylphenyl)benzothiazole (3d) oil; ^{1}H NMR (400 MHz, $CDCl_3$) 2.38 (s, 3H), 2.61 (s, 3H), 7.17-7.24 (m, 2H), 7.37-7.41 (m, 1H), 7.48-7.52 (m, 1H), 7.59 (s, 1H), 7.92 (d, *J* = 8.4 Hz, 1H), 8.10 (d, *J* = 8.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 21.07 (Two signals merged.), 121.53, 123.55, 125.21, 126.28, 131.02, 131.22, 131.69, 133.11, 134.29, 135.84, 135.87, 153.98, 168.36; HRMS *m/z*

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[11] Derridj, F.; Djebbar, S.; Benali-Baitich, O.; Doucet, H. *J. Organomet. Chem.* **2008**, *693*, 135.

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(M^+) calcd for $C_{15}H_{13}NS$: 239.0769, found: 239.0772.

2-(1-Naphthyl)benzothiazole (3e) m.p. 78-80 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45-7.49 (m, 1H), 7.55-7.67 (m, 4H), 7.94-8.02 (m, 4H), 8.22 (d, *J* = 8.1 Hz, 1H), 8.96 (d, *J* = 8.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 121.61, 123.80, 125.20, 125.51, 126.13, 126.48, 126.72, 127.84, 128.62, 129.59, 130.91, 131.09, 131.28, 134.26, 135.70, 154.40, 167.80; HRMS *m/z* (M^+) calcd for $C_{17}H_{11}NS$: 261.0612, found: 225.0619.

2-(4-Methoxyphenyl)benzothiazole (3f) m.p. 115-116 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.88 (s, 3H), 7.01 (d, *J* = 8.8 Hz, 2H), 7.36 (t, *J* = 7.7 Hz, 1H), 7.48 (t, *J* = 8.1 Hz, 1H), 7.88 (d, *J* = 8.4 Hz, 1H), 8.05 (d, *J* = 8.8 Hz, 2H), 8.03-8.06 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 55.65, 114.58, 121.69, 123.05, 124.98, 126.38, 126.70, 129.32, 135.10, 154.48, 162.15, 168.03; HRMS *m/z* (M^+) calcd for $C_{14}H_{11}NOS$: 241.0561, found: 241.0549.

2-(4-Fluorophenyl)benzothiazole (3g) m.p. 100-102 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (dd, *J* = 8.6 Hz, 8.4 Hz, 2H), 7.37-7.41 (m, 1H), 7.47-7.52 (m, 1H), 7.90 (d, *J* = 8.1 Hz, 1H), 8.05-8.11 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 116.38 (d, *J* = 22.2 Hz), 121.84, 123.44, 125.48, 126.64, 129.77 (d, *J* = 9.1 Hz), 130.24 (d, *J* = 3.1 Hz), 135.31,154.37, 164.71 (d, *J* = 251.8 Hz), 166.96; HRMS *m/z* (M^+) calcd for $C_{13}H_8FNS$: 229.0361, found: 229.0359.

2-(4-Trifluoromethylphenyl)benzothiazole (3h) m.p. 161-162 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.45 (m, 1H), 7.51-7.55 (m, 1H), 7.75 (d, *J* = 8.1 Hz, 2H), 7.93 (d, *J* = 7.7 Hz, 1H), 8.11 (d, *J* = 7.7 Hz, 1H), 8.21 (d, *J* = 8.1 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 121.74, 123.65, 123.83 (q, *J* = 272.4 Hz), 125.79, 126.01 (q, *J* = 3.8 Hz), 126.66, 127.78, 132.48 (q, *J* = 32.8 Hz), 135.23, 136.79, 154.07, 166.04; HRMS *m/z* (M^+) calcd for $C_{14}H_8F_3NS$: 279.0330, found: 279.0331.

4-(2-Benzothiazolyl)benzonitrile (3i) m.p. 169-170 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43-7.48 (m, 1H), 7.53-7.57 (m, 1H), 7.78 (dt, *J* = 8.4 Hz, 1.5Hz, 2H), 7.95 (d, *J* = 8.1 Hz, 1H), 8.11 (d, *J* = 7.7 Hz, 1H), 8.20 (dt, *J* = 8.4 Hz, 1.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 114.36, 118.46, 122.00, 124.03, 126.28, 127.02, 128.13, 132.96, 135.53, 137.70, 154.26, 165.52; HRMS *m/z* (M^+) calcd for $C_{14}H_{18}N_2S$: 236.0408, found: 236.0405.

1-{4-(2-Benzothiazolyl)phenyl}ethanone (3j) m.p. 187-188 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.66 (s, 3H), 7.41-7.45 (m, 1H), 7.51-7.55 (m, 1H), 7.94 (d, *J* = 7.7 Hz, 1H), 8.07 (dt, *J* = 8.4 Hz, 1.8 Hz, 2H), 8.11 (d, *J* = 8.1 Hz, 1H), 8.19 (dt, *J* = 8.4 Hz, 1.8Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 26.93, 121.94, 123.85, 125.95, 126.83, 127.87, 129.17, 135.53, 137.74, 138.81, 154.37, 166.63, 197.46; HRMS *m/z* (M^+) calcd for $C_{15}H_{11}NOS$: 253.0561, found: 253.0560.

2-(4-Methylphenyl)thiazole (3a') oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.40 (s, 3H), 7.26 (d, *J* =

8.4 Hz, 2H), 7.30 (d, *J* = 3.3 Hz, 1H), 7.84-7.88 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) 21.59, 118.50, 126.73, 129.85, 131.24, 140.43, 143.74, 168.83; HRMS *m/z* (M^+) calcd for $C_{10}H_9NS$: 175.0456, found:175.0454.

2-(2-Methylphenyl)benzoxazole (5c) m.p. 64-66 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) 2.84 (s, 3H), 7.35-7.45 (m, 5H), 7.59-7.63 (m, 1H), 7.80-7.85 (m, 1H), 8.18-8.21 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 22.38, 110.68, 120.37, 124.57, 125.20, 126.26, 126.49, 130.16, 131.09, 131.99, 139.08, 142.39, 150.54, 163.63; HRMS *m/z* (M^+) calcd for $C_{14}H_{11}NO$: 209.0841, found: 209.0831.

2-(2,5-Dimethylphenyl)benzoxazole (5d) m.p. 40-42 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) 2.43 (s, 3H), 2.78 (s, 3H), 7.22-7.27 (m, 2H), 7.35-7.39 (m, 2H), 7.58-7.62 (m, 1H), 7.80-7.84 (m, 1H), 8.02 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 21.04, 21.86, 110.65, 120.30, 124.54, 125.12, 126.21, 130.62, 131.95, 131.97, 135.82, 135.95, 142.36, 150.58, 163.92; HRMS *m/z* (M^+) calcd for $C_{15}H_{13}NO$: 223.0997, found: 223.0999.

2-(1-Naphthyl)benzoxazole (5e) m.p. 101-104 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) 7.40-7.44 (m, 2H), 7.59-7.69 (m, 3H), 7.71-7.75 (m, 1H), 7.89-7.93 (m, 1H), 7.96 (d, *J* = 8.4 Hz, 1H), 8.05 (d, *J* = 8.1 Hz, 1H), 8.45 (dd, *J* = 7.3 Hz, 1.1 Hz, 1H), 9.50 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 110.72, 120.53, 123.91, 124.71, 125.15, 125.49, 126.55, 126.68, 128.13, 128.88, 129.54, 130.97, 132.51, 134.23, 142.59, 150.45, 163.06; HRMS *m/z* (M^+) calcd for $C_{17}H_{11}NO$: 245.0841, found: 245.0838.

2-(4-Methoxy-2-methylphenyl)benzoxazole (5k) m.p. 73-75 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) 2.82 (s, 3H), 3.88 (s, 3H), 6.87-9.89 (m, 2H), 7.31-7.37 (m, 2H), 7.55-7.59 (m, 1H), 7.77-7.79 (m, 1H), 8.15 (dd, *J* = 7.0 Hz, 2.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 22.73, 55.50, 110.45, 111.78, 117.25, 119.14, 120.00, 124.39, 124.73, 131.90, 141.20, 142.55, 150.40, 161.70, 163.74; HRMS *m/z* (M^+) calcd for $C_{15}H_{13}NO_2$: 239.0946, found: 239.0951.

2-(9-Phenanthrenyl)benzoxazole (5l) m.p. 169-170 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) 7.41-7.46 (m, 2H), 7.65-7.72 (m, 2H), 7.75-7.82 (m, 3H), 7.91-7.95 (m, 1H), 8.04 (d, *J* = 7.7 Hz, 1H), 8.73 (d, *J* = 8.1 Hz, 2H), 8.80 (d, *J* = 8.6 Hz, 1H), 9.55-9.57 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 110.71, 110.72, 120.56, 122.78, 122.92, 123.15, 124.76, 125.60, 127.34, 127.36, 127.83, 128.88, 128.95, 130.01, 130.77, 131.03, 131.82, 131.97, 142.54, 150.43, 162.94; HRMS *m/z* (M^+) calcd for $C_{21}H_{13}NO$: 295.0997, found: 295.1007.

2-(2-Biphenylyl)benzoxazole (5m) oil; ^{1}H NMR (400 MHz, $CDCl_3$) 7.23-7.34 (m, 8H), 7.47-7.53 (m, 2H), 7.56-7.61 (m, 1H), 7.69-7.73 (m, 1H), 8.11 (d, *J* = 7.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 110.72, 120.30, 124.50, 125.10, 126.55, 127.47, 127.73, 128.31, 129.02, 131.17, 131.18,

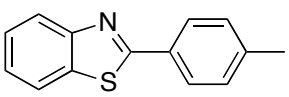
131.35, 141.22, 141.95, 142.70, 150.97, 164.08; HRMS *m/z* (M^+) calcd for $C_{19}H_{13}NO$: 271.0997, found: 271.0990.

2-(9-Anthracenyl)benzoxazole (5n) m.p. 164-166 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48-7.56 (m, 6H), 7.71-7.75 (m, 1H), 7.99-8.03 (m, 1H), 8.07-8.12 (m, 4H), 8.68 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 111.14, 120.79, 121.58, 124.88, 125.68, 125.75, 125.79, 127.58, 128.90, 131.02, 131.34, 131.61, 142.12, 151.40, 162.29; HRMS *m/z* (M^+) calcd for $C_{21}H_{13}NO$: 295.0997, found: 295.1007.

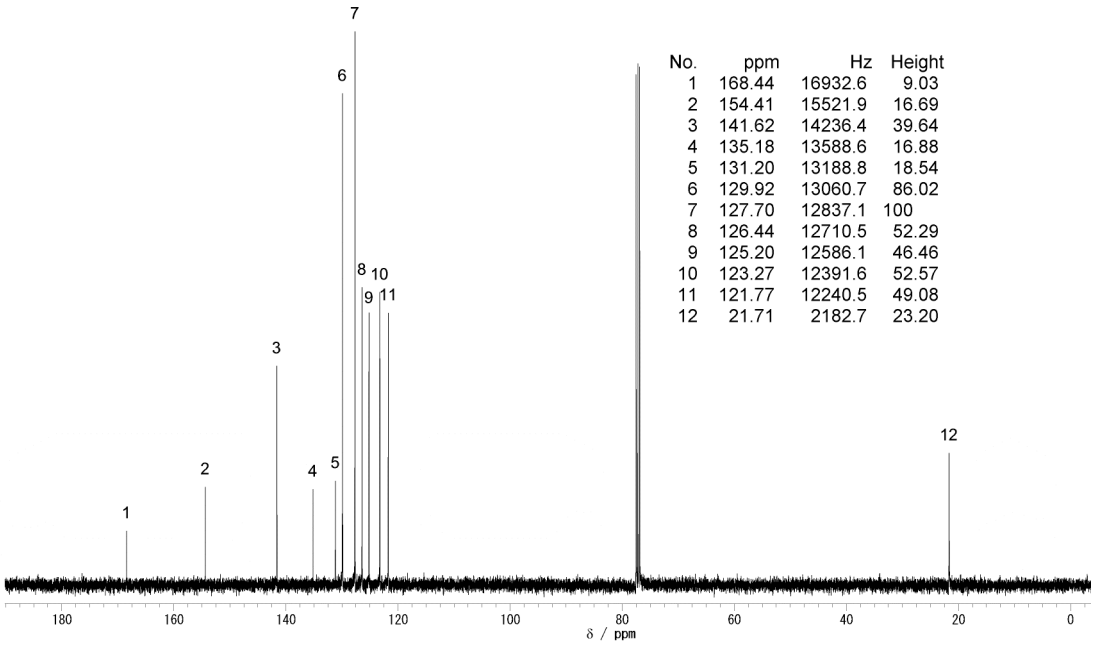
2-(9-Phenanthrenyl)-5-phenyloxazole (7al) m.p. 180-182 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (t, *J* = 7.3 Hz, 1H), 7.51 (t, *J* = 7.3 Hz, 2H), 7.63 (s, 1H), 7.64-7.68 (m, 1H), 7.72-7.79 (m, 3H), 7.82-7.85 (m, 2H), 8.01-8.03 (dd, *J* = 7.2 Hz, 1.1 Hz, 1H), 8.57 (s, 1H), 8.71 (d, *J* = 8.4 Hz, 1H), 8.77-8.80 (m, 1H), 9.41-9.45 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 122.87, 123.06, 123.11, 123.65, 124.63, 127.19, 127.23, 127.25, 127.65, 128.26, 128.35, 128.78, 128.80, 129.22, 129.73, 129.86, 130.95, 131.02, 131.51, 151.32, 161.16; HRMS *m/z* (M^+) calcd for $C_{23}H_{15}NO$: 321.1154, found: 321.1151.

2-(9-Phenanthrenyl)-5-(4-trifluoromethylphenyl)oxazole (7bl) m.p. 165-167 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64-7.78 (m, 7H), 7.87 (d, *J* = 8.4 Hz, 2H), 8.01 (d, *J* = 7.7 Hz, 1H), 8.54 (s, 1H), 8.70 (d, *J* = 8.1 Hz, 1H), 8.75-8.78 (m, 1H), 9.37-9.41 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 122.65, 122.90, 123.16, 124.19 (q, *J* = 271.6 Hz), 124.60, 125.35, 126.23 (q, *J* = 3.8 Hz), 127.10, 127.31, 127.34, 127.72, 128.60, 128.66, 129.78, 130.20, 130.40 (q, *J* = 32.8 Hz), 130.81, 131.02, 131.39, 131.64, 149.82, 161.96; HRMS *m/z* (M^+) calcd for $C_{24}H_{14}F_3NO$: 389.1027, found: 389.1022.

[^{1}H and ^{13}C NMR Spectra of **3a**]

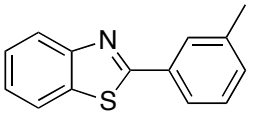


3a

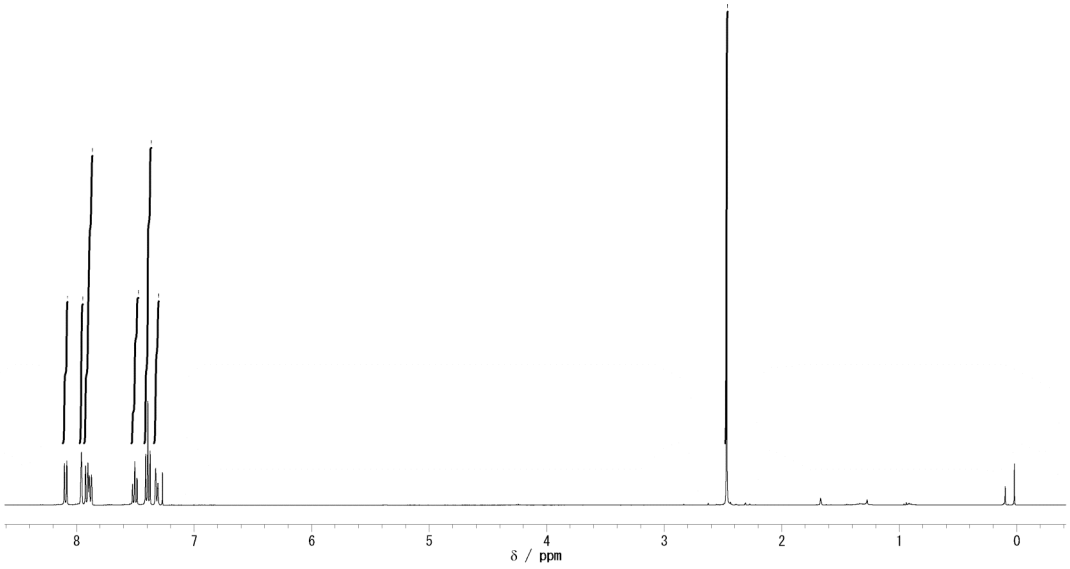


No.	ppm	Hz	Height
1	168.44	16932.6	9.03
2	154.41	15521.9	16.69
3	141.62	14236.4	39.64
4	135.18	13588.6	16.88
5	131.20	13188.8	18.54
6	129.92	13060.7	86.02
7	127.70	12837.1	100
8	126.44	12710.5	52.29
9	125.20	12586.1	46.46
10	123.27	12391.6	52.57
11	121.77	12240.5	49.08
12	21.71	2182.7	23.20

[^{1}H and ^{13}C NMR Spectra of **3b**]



3b



No.	ppm	Hz	Height
1	168.52	16941.0	15.88
2	154.38	15518.9	12.07
3	139.07	13980.0	39.11
4	135.27	13598.5	13.35
5	133.78	13448.2	13.02
6	132.00	13269.7	85.76
7	129.12	12979.8	100
8	128.22	12889.0	96.71
9	126.48	12714.3	99.73
10	125.32	12597.6	95.14
11	125.08	12573.9	86.97
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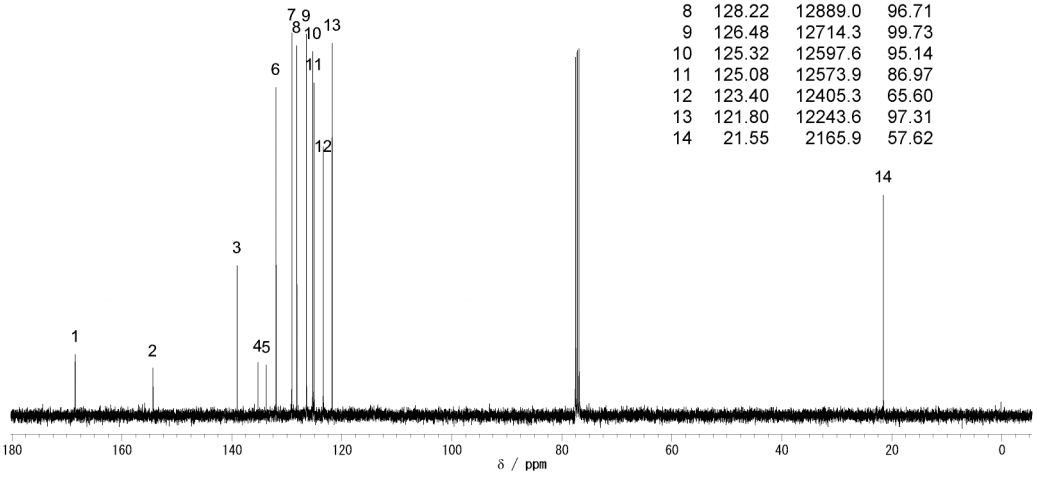
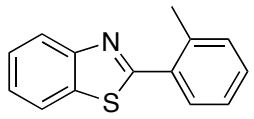
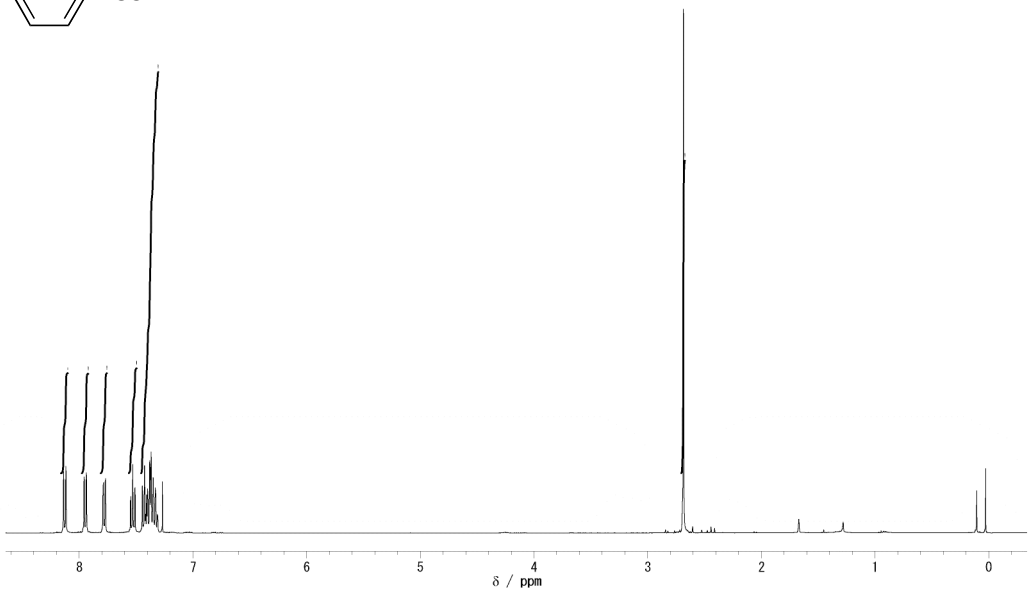
14	21.55	2165.9	57.62



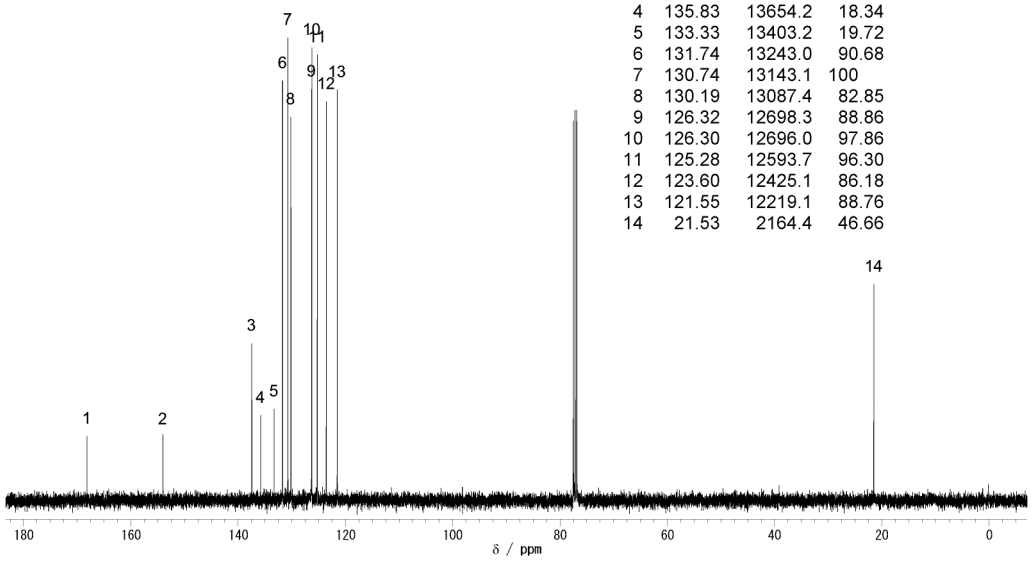
[^{1}H and ^{13}C NMR Spectra of **3c**]



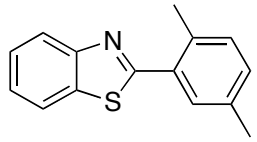
3c



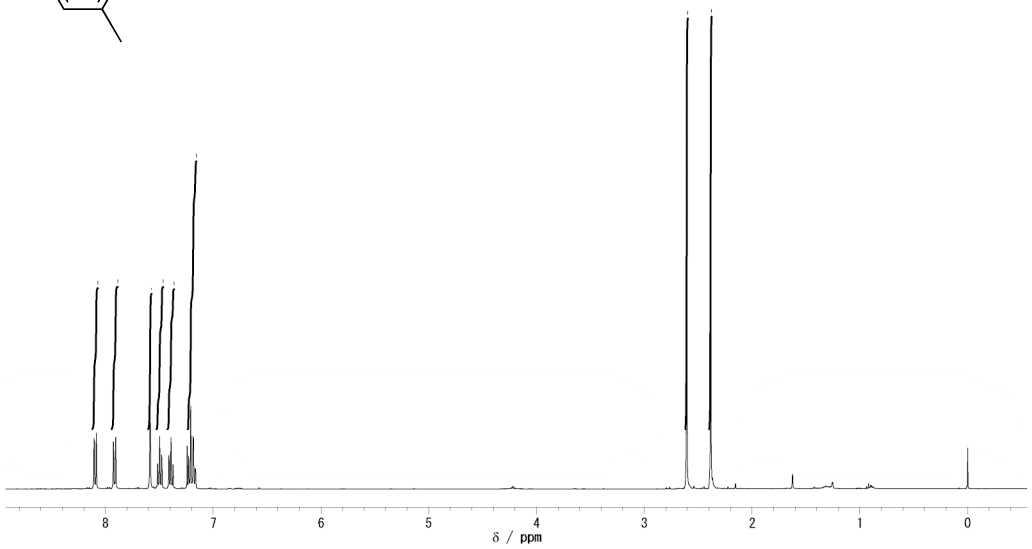
No.	ppm	Hz	Height
1	168.18	16906.6	13.83
2	154.04	15485.3	13.69
3	137.48	13819.8	33.89
4	135.83	13654.2	18.34
5	133.33	13403.2	19.72
6	131.74	13243.0	90.68
7	130.74	13143.1	100
8	130.19	13087.4	82.85
9	126.32	12698.3	88.86
10	126.30	12696.0	97.86
11	125.28	12593.7	96.30
12	123.60	12425.1	86.18
13	121.55	12219.1	88.76
14	21.53	2164.4	46.66



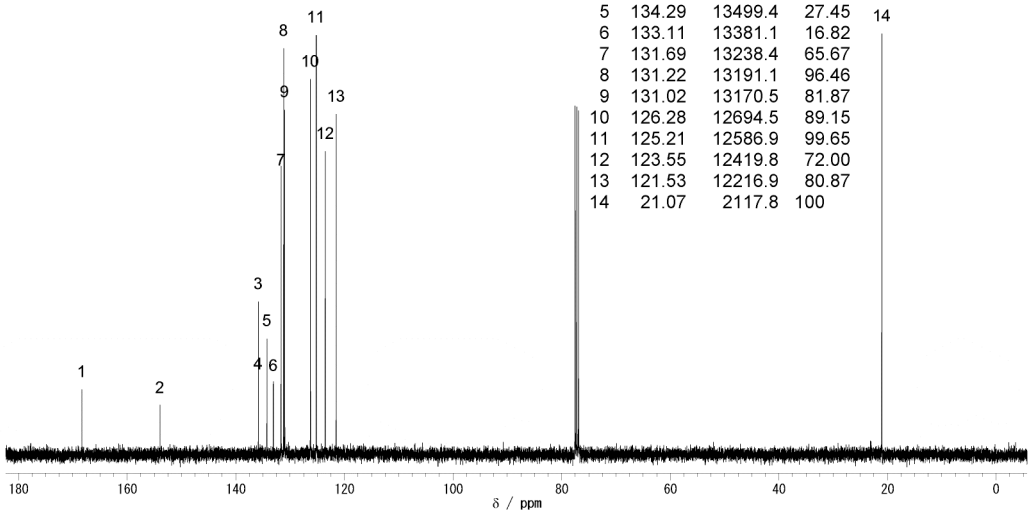
[^{1}H and ^{13}C NMR Spectra of **3d**]



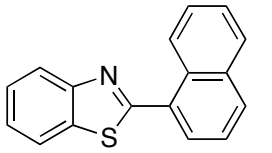
3d



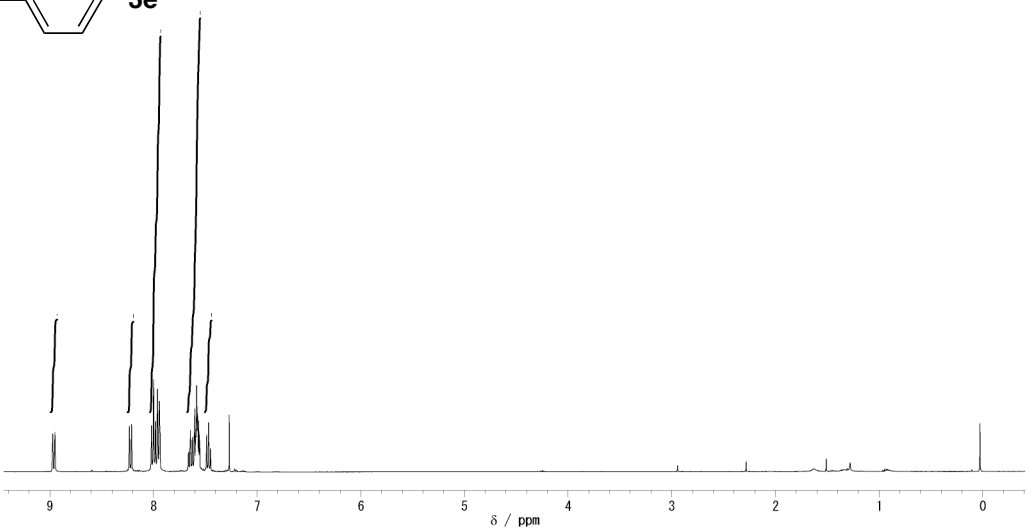
No.	ppm	Hz	Height
1	168.36	16924.2	15.36
2	153.98	15479.2	11.51
3	135.87	13658.8	36.24
4	135.84	13655.8	17.15
5	134.29	13499.4	27.45
6	133.11	13381.1	16.82
7	131.69	13238.4	65.67
8	131.22	13191.1	96.46
9	131.02	13170.5	81.87
10	126.28	12694.5	89.15
11	125.21	12586.9	99.65
12	123.55	12419.8	72.00
13	121.53	12216.9	80.87
14	21.07	2117.8	100

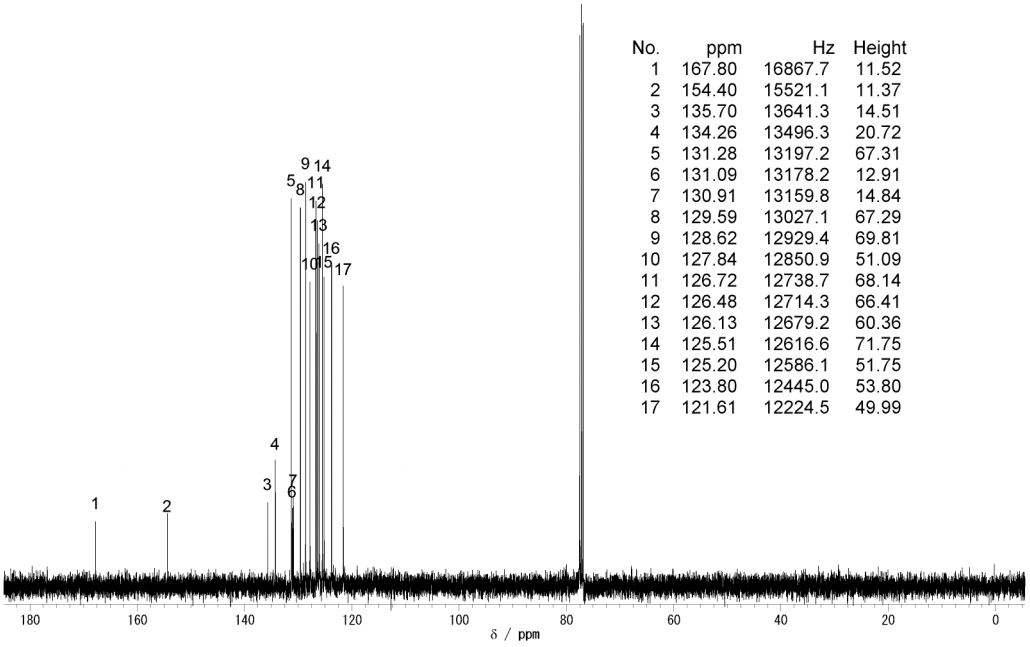


[^{1}H and ^{13}C NMR Spectra of **3e**]



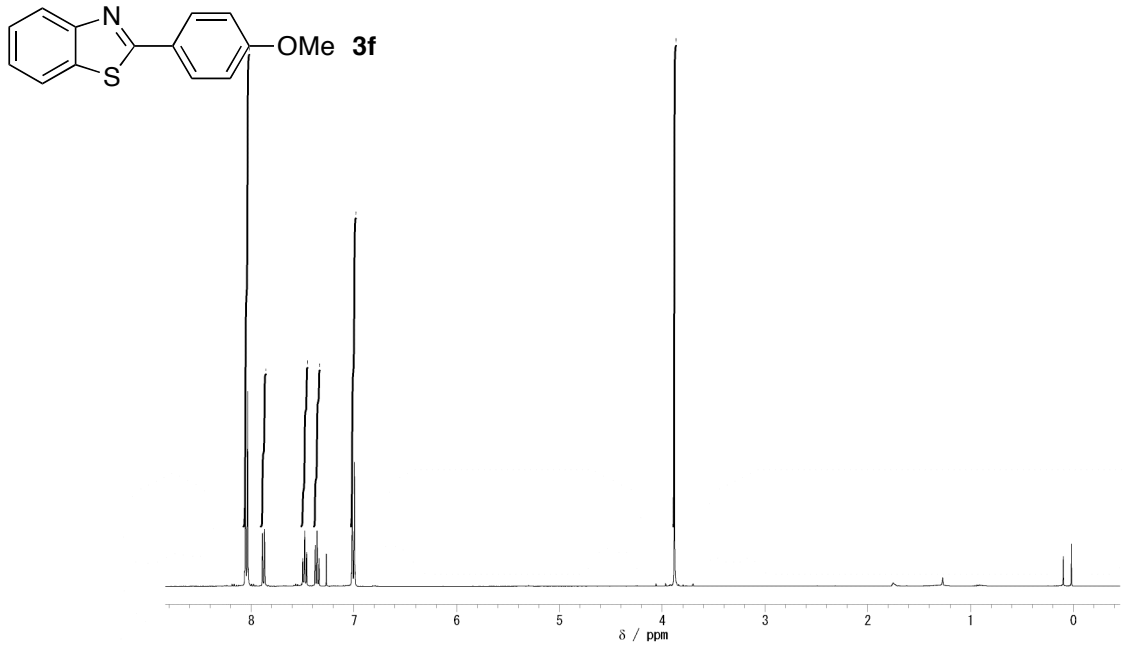
3e

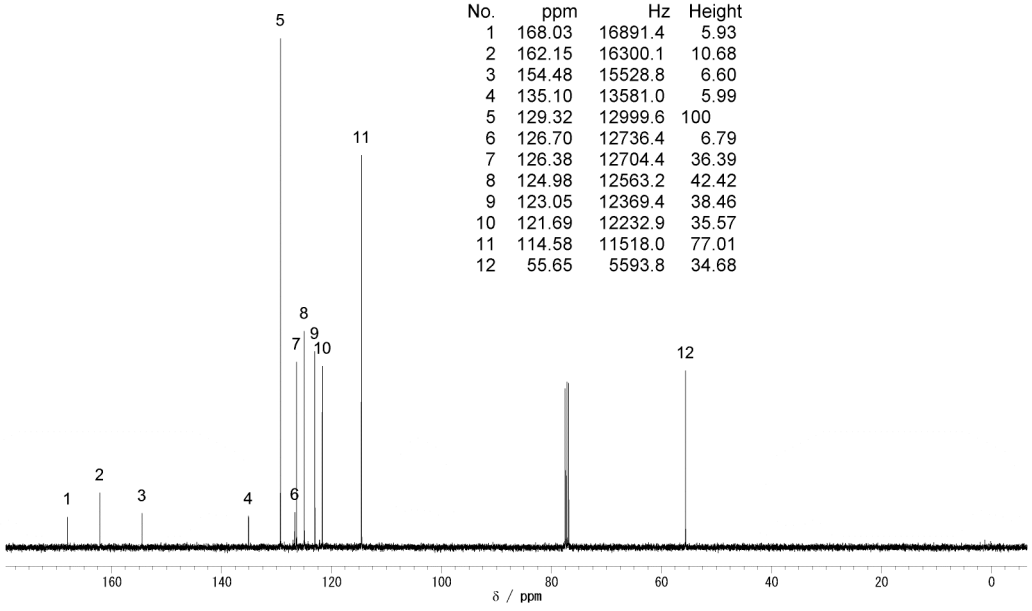




No.	ppm	Hz	Height
1	167.80	16867.7	11.52
2	154.40	15521.1	11.37
3	135.70	13641.3	14.51
4	134.26	13496.3	20.72
5	131.28	13197.2	67.31
6	131.09	13178.2	12.91
7	130.91	13159.8	14.84
8	129.59	13027.1	67.29
9	128.62	12929.4	69.81
10	127.84	12850.9	51.09
11	126.72	12738.7	68.14
12	126.48	12714.3	66.41
13	126.13	12679.2	60.36
14	125.51	12616.6	71.75
15	125.20	12586.1	51.75
16	123.80	12445.0	53.80
17	121.61	12224.5	49.99

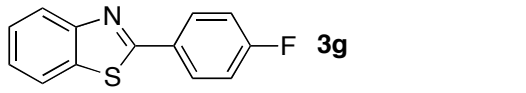
[^{1}H and ^{13}C NMR Spectra of **3f**]



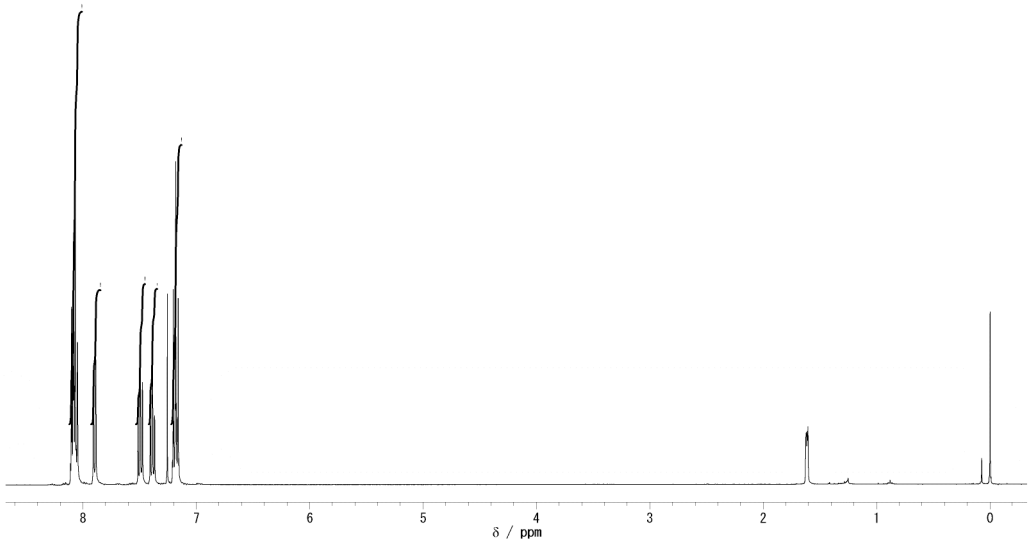


No.	ppm	Hz	Height
1	168.03	16891.4	5.93
2	162.15	16300.1	10.68
3	154.48	15528.8	6.60
4	135.10	13581.0	5.99
5	129.32	12999.6	100
6	126.70	12736.4	6.79
7	126.38	12704.4	36.39
8	124.98	12563.2	42.42
9	123.05	12369.4	38.46
10	121.69	12232.9	35.57
11	114.58	11518.0	77.01
12	55.65	5593.8	34.68

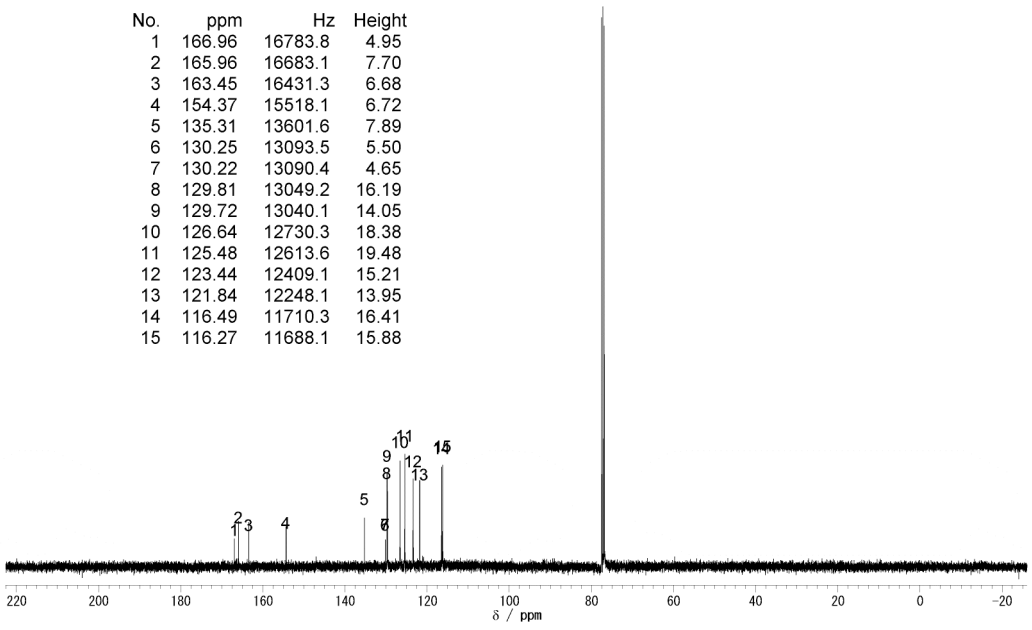
[^{1}H and ^{13}C NMR Spectra of **3g**]



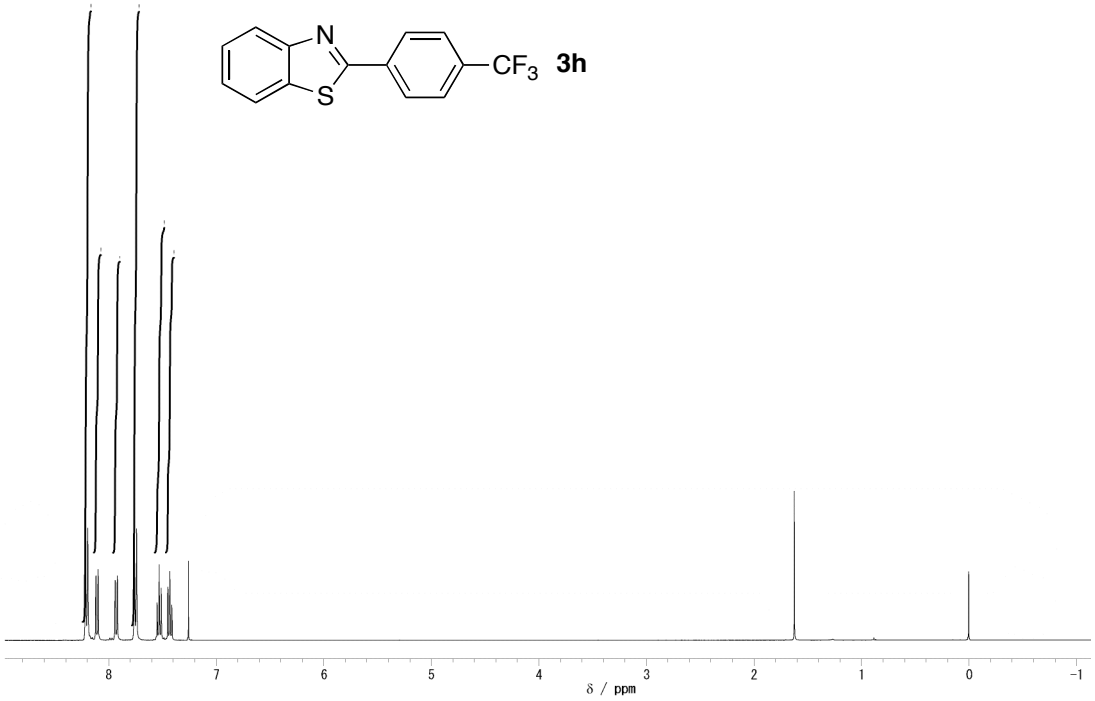
3g

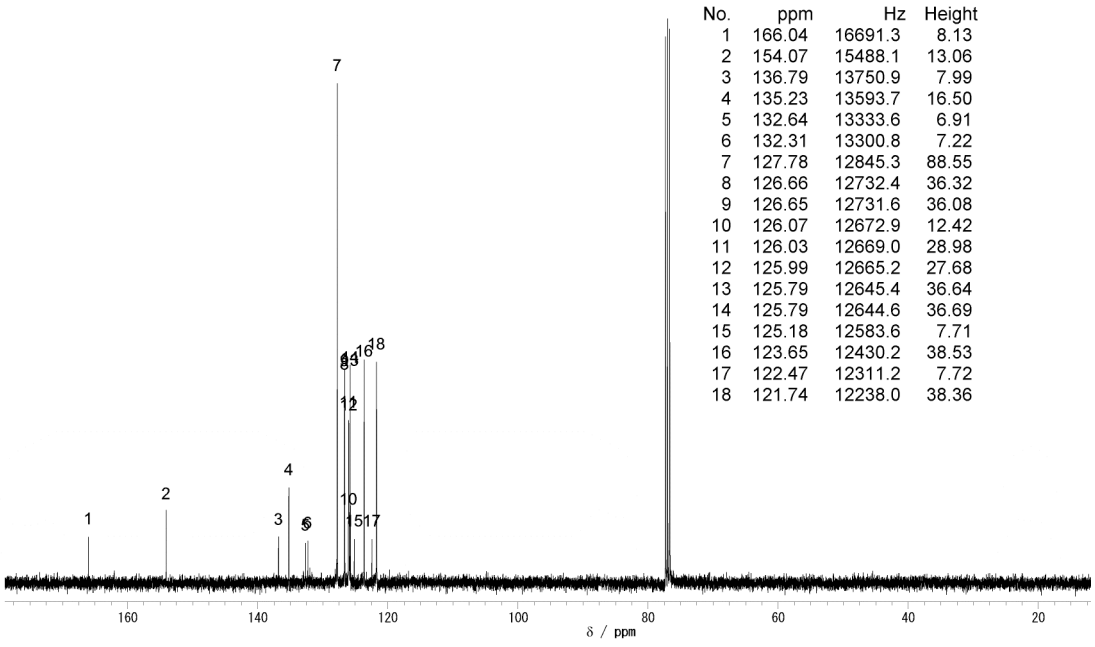


No.	ppm	Hz	Height
1	166.96	16783.8	4.95
2	165.96	16683.1	7.70
3	163.45	16431.3	6.68
4	154.37	15518.1	6.72
5	135.31	13601.6	7.89
6	130.25	13093.5	5.50
7	130.22	13090.4	4.65
8	129.81	13049.2	16.19
9	129.72	13040.1	14.05
10	126.64	12730.3	18.38
11	125.48	12613.6	19.48
12	123.44	12409.1	15.21
13	121.84	12248.1	13.95
14	116.49	11710.3	16.41
15	116.27	11688.1	15.88



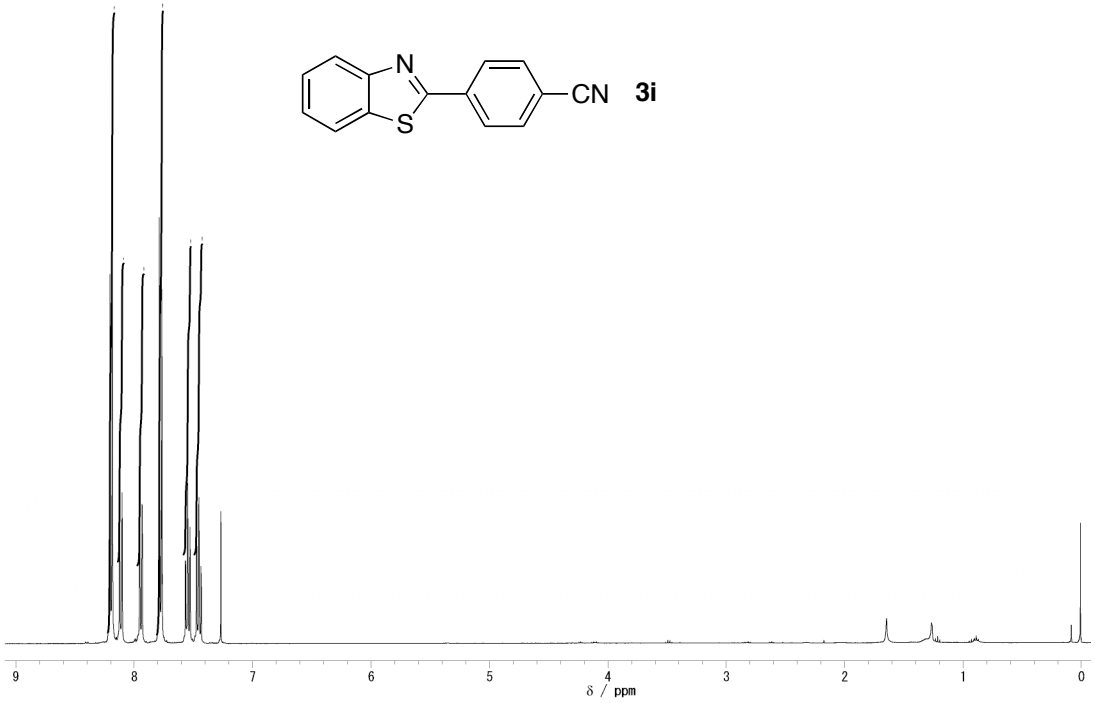
[^{1}H and ^{13}C NMR Spectra of **3h**]

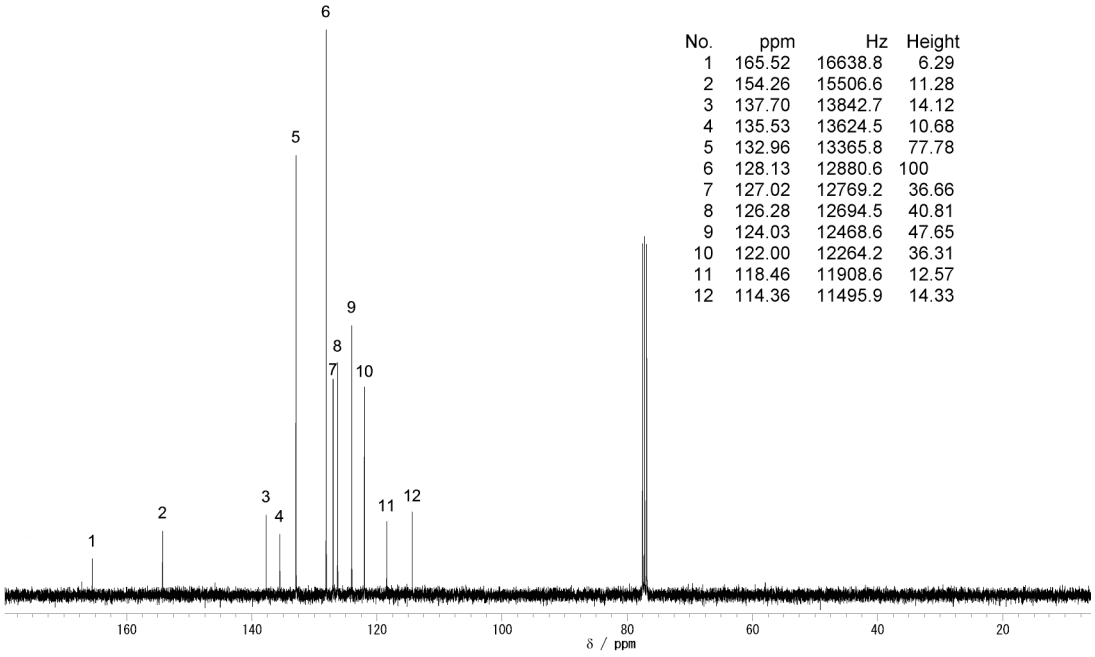




No.	ppm	Hz	Height
1	166.04	16691.3	8.13
2	154.07	15488.1	13.06
3	136.79	13750.9	7.99
4	135.23	13593.7	16.50
5	132.64	13333.6	6.91
6	132.31	13300.8	7.22
7	127.78	12845.3	88.55
8	126.66	12732.4	36.32
9	126.65	12731.6	36.08
10	126.07	12672.9	12.42
11	126.03	12669.0	28.98
12	125.99	12665.2	27.68
13	125.79	12645.4	36.64
14	125.79	12644.6	36.69
15	125.18	12583.6	7.71
16	123.65	12430.2	38.53
17	122.47	12311.2	7.72
18	121.74	12238.0	38.36

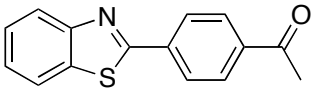
[^{1}H and ^{13}C NMR Spectra of **3i**]



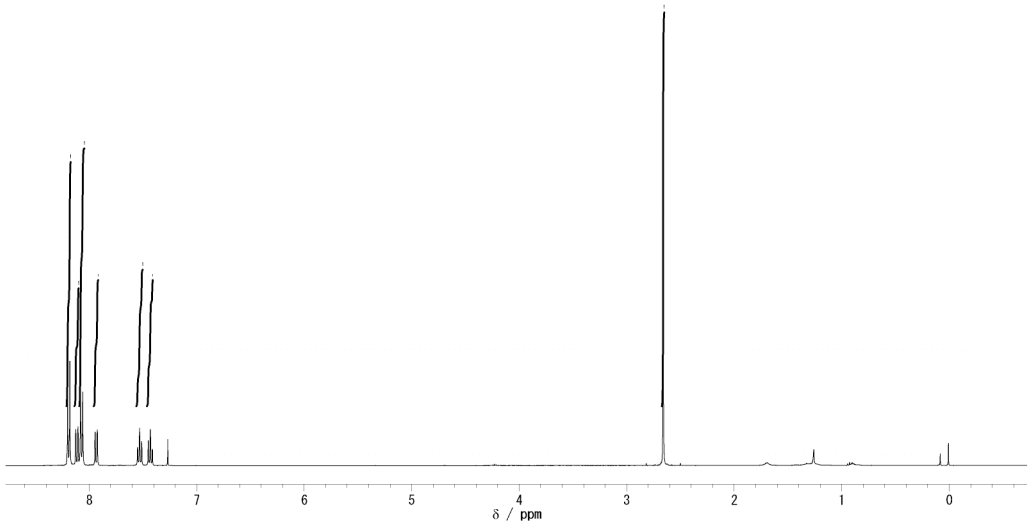


No.	ppm	Hz	Height
1	165.52	16638.8	6.29
2	154.26	15506.6	11.28
3	137.70	13842.7	14.12
4	135.53	13624.5	10.68
5	132.96	13365.8	77.78
6	128.13	12880.6	100
7	127.02	12769.2	36.66
8	126.28	12694.5	40.81
9	124.03	12468.6	47.65
10	122.00	12264.2	36.31
11	118.46	11908.6	12.57
12	114.36	11495.9	14.33

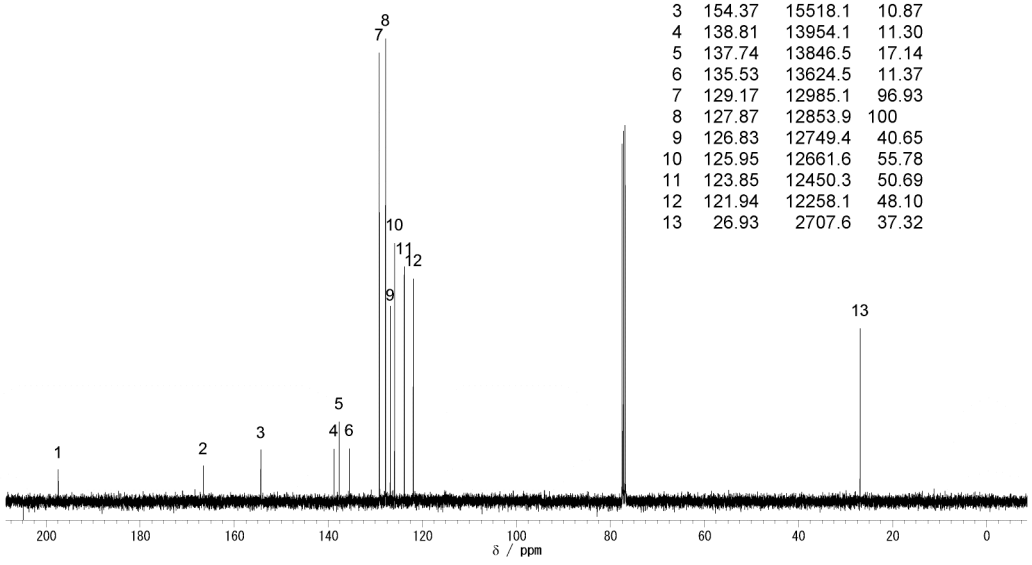
[^{1}H and ^{13}C NMR Spectra of **3j**]



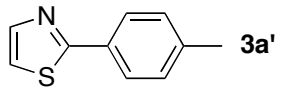
3j

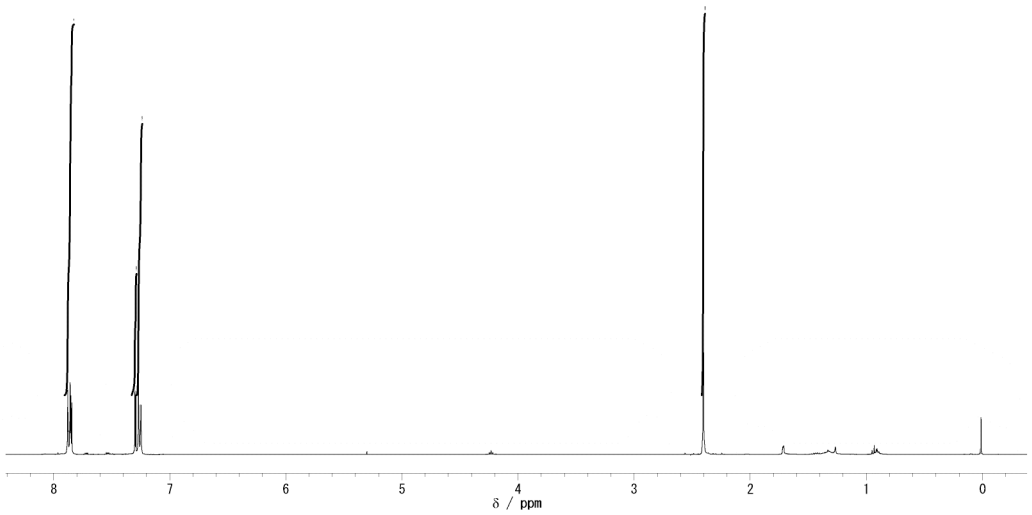


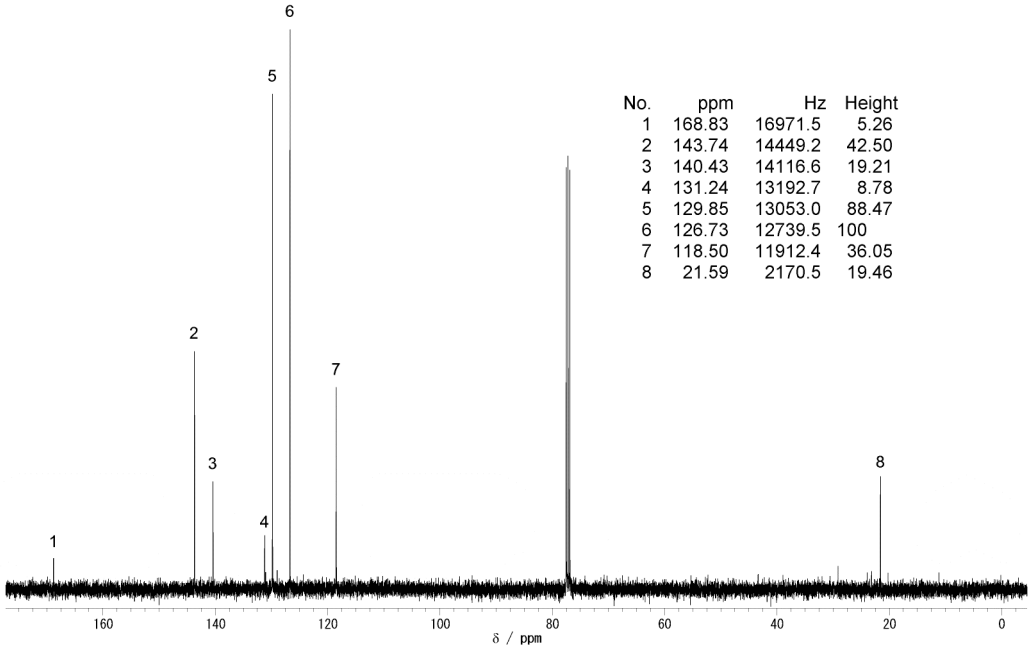
No.	ppm	Hz	Height
1	197.46	19849.3	6.63
2	166.63	16750.2	7.44
3	154.37	15518.1	10.87
4	138.81	13954.1	11.30
5	137.74	13846.5	17.14
6	135.53	13624.5	11.37
7	129.17	12985.1	96.93
8	127.87	12853.9	100
9	126.83	12749.4	40.65
10	125.95	12661.6	55.78
11	123.85	12450.3	50.69
12	121.94	12258.1	48.10
13	26.93	2707.6	37.32



[^{1}H and ^{13}C NMR Spectra of **3a'**]

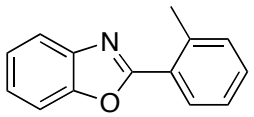




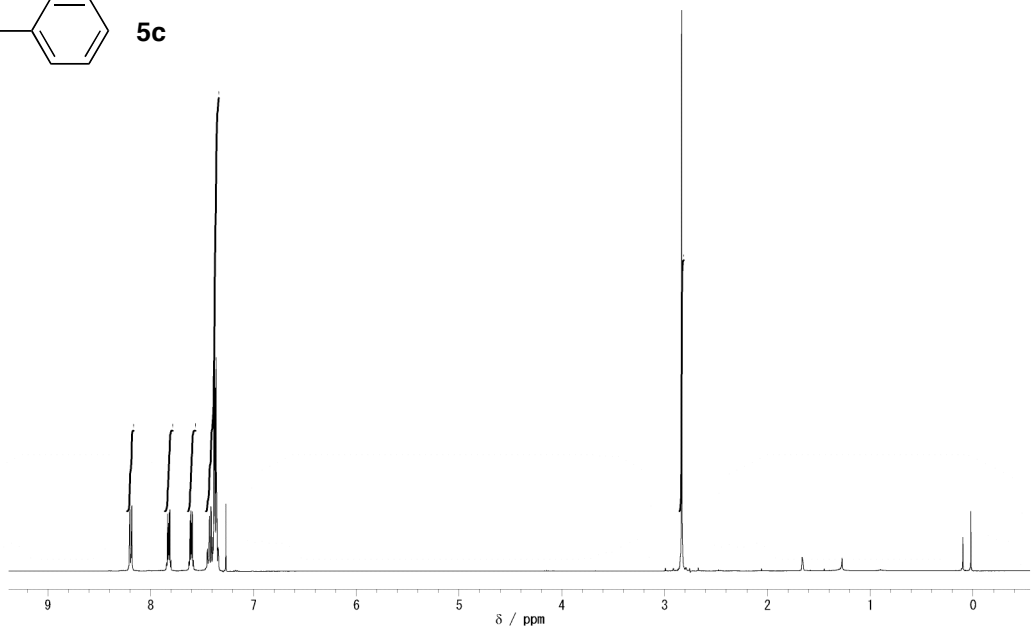


No.	ppm	Hz	Height
1	168.83	16971.5	5.26
2	143.74	14449.2	42.50
3	140.43	14116.6	19.21
4	131.24	13192.7	8.78
5	129.85	13053.0	88.47
6	126.73	12739.5	100
7	118.50	11912.4	36.05
8	21.59	2170.5	19.46

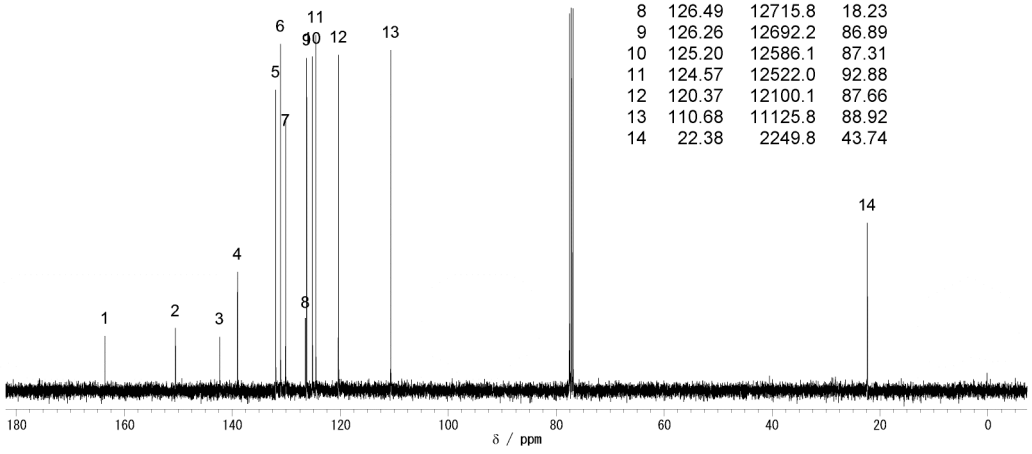
[^{1}H and ^{13}C NMR Spectra of **5c**]



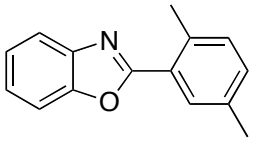
5c



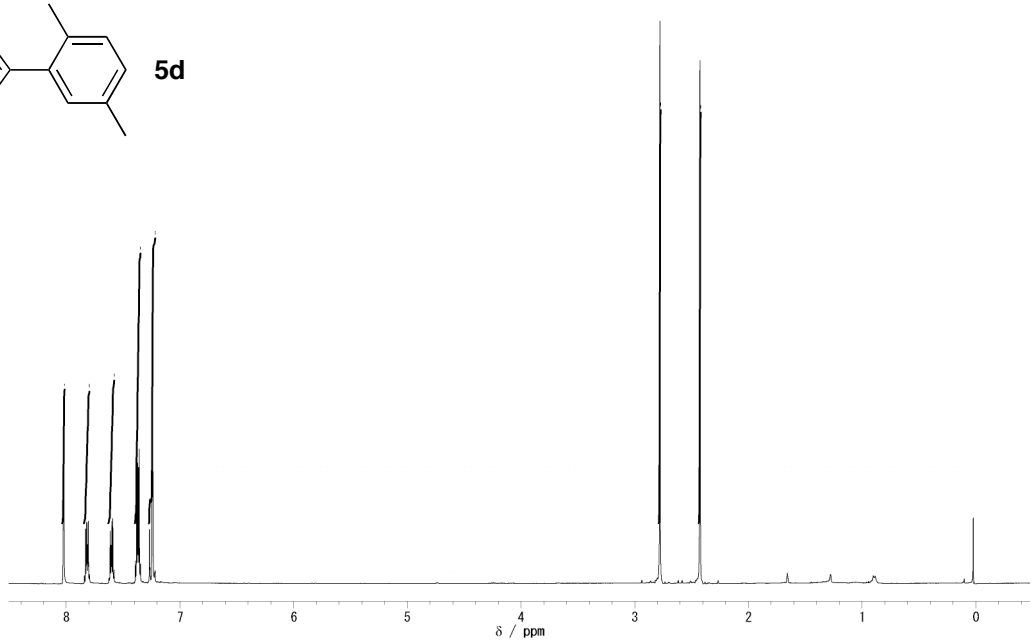
No.	ppm	Hz	Height
1	163.63	16448.9	14.12
2	150.54	15133.6	16.05
3	142.39	14313.4	13.92
4	139.08	13980.8	30.90
5	131.99	13268.2	78.54
6	131.09	13178.2	90.55
7	130.16	13084.3	65.85
8	126.49	12715.8	18.23
9	126.26	12692.2	86.89
10	125.20	12586.1	87.31
11	124.57	12522.0	92.88
12	120.37	12100.1	87.66
13	110.68	11125.8	88.92
14	22.38	2249.8	43.74



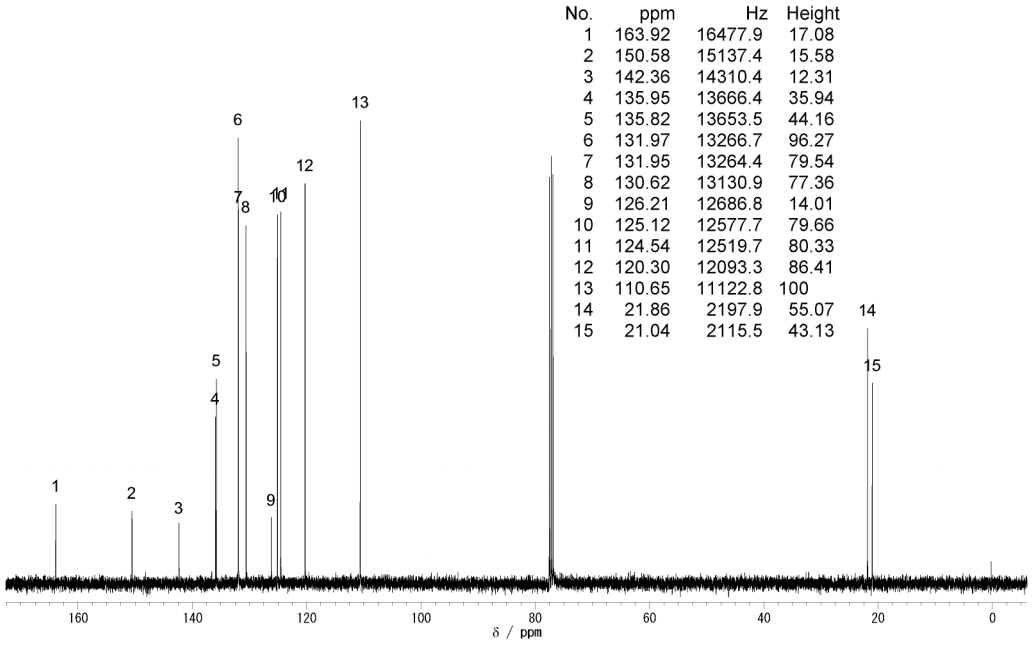
[^{1}H and ^{13}C NMR Spectra of **5d**]



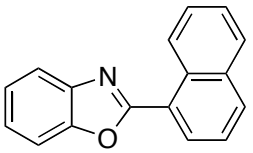
5d



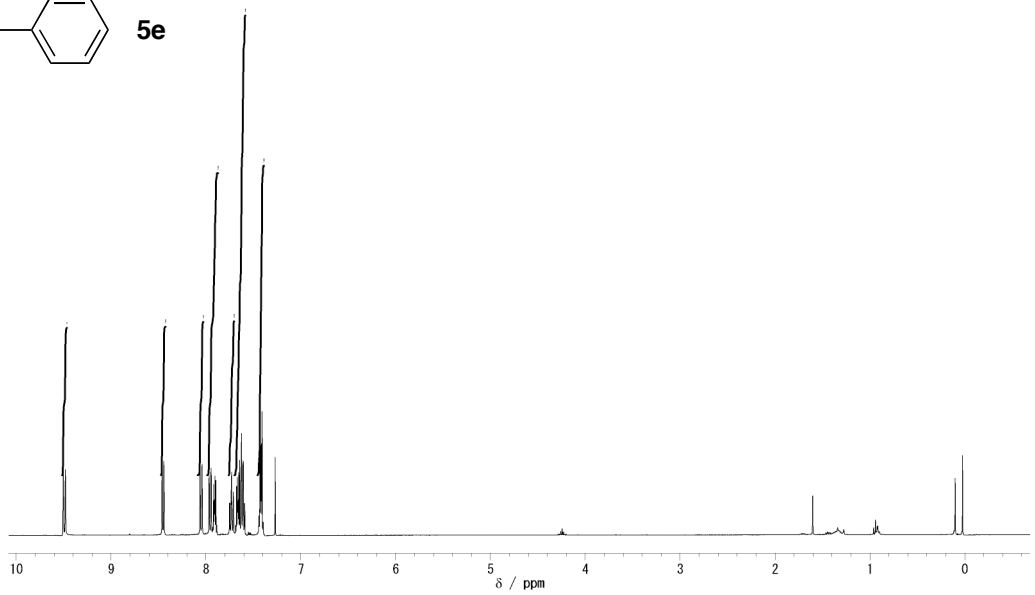
No.	ppm	Hz	Height
1	163.92	16477.9	17.08
2	150.58	15137.4	15.58
3	142.36	14310.4	12.31
4	135.95	13666.4	35.94
5	135.82	13653.5	44.16
6	131.97	13266.7	96.27
7	131.95	13264.4	79.54
8	130.62	13130.9	77.36
9	126.21	12686.8	14.01
10	125.12	12577.7	79.66
11	124.54	12519.7	80.33
12	120.30	12093.3	86.41
13	110.65	11122.8	100
14	21.86	2197.9	55.07
15	21.04	2115.5	43.13



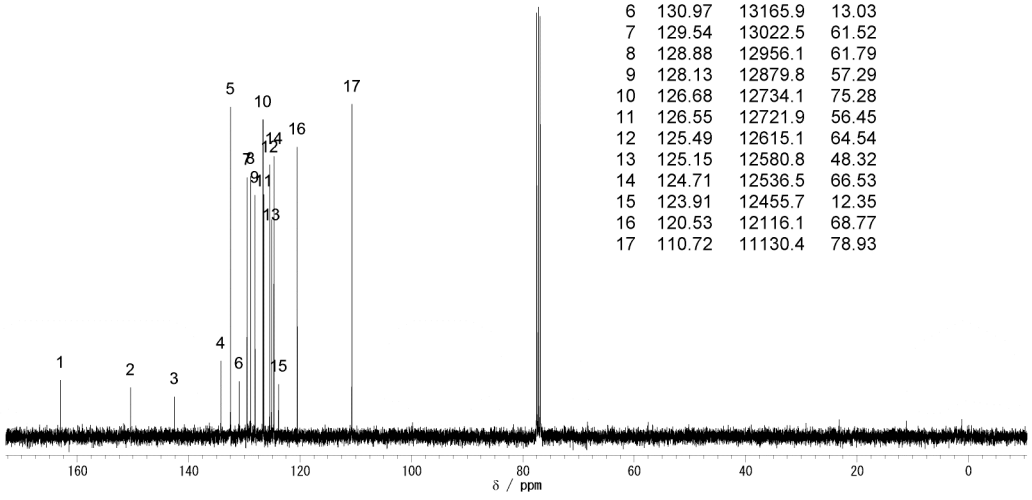
[^{1}H and ^{13}C NMR Spectra of **5e**]



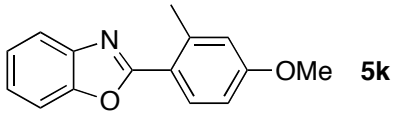
5e



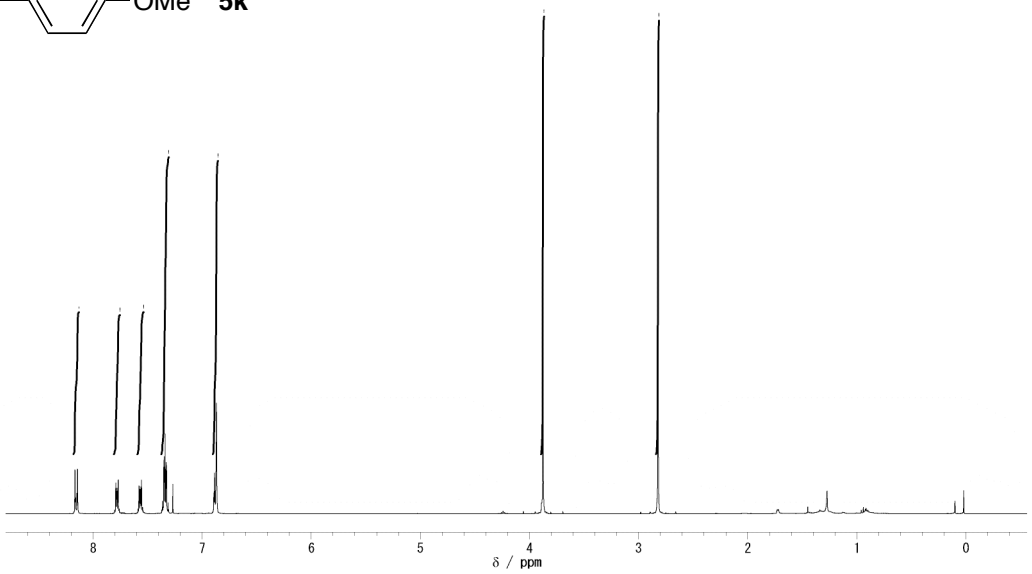
No.	ppm	Hz	Height
1	163.06	16391.7	13.28
2	150.45	15124.4	11.55
3	142.59	14334.0	9.37
4	134.23	13493.2	17.90
5	132.51	13320.8	78.31
6	130.97	13165.9	13.03
7	129.54	13022.5	61.52
8	128.88	12956.1	61.79
9	128.13	12879.8	57.29
10	126.68	12734.1	75.28
11	126.55	12721.9	56.45
12	125.49	12615.1	64.54
13	125.15	12580.8	48.32
14	124.71	12536.5	66.53
15	123.91	12455.7	12.35
16	120.53	12116.1	68.77
17	110.72	11130.4	78.93



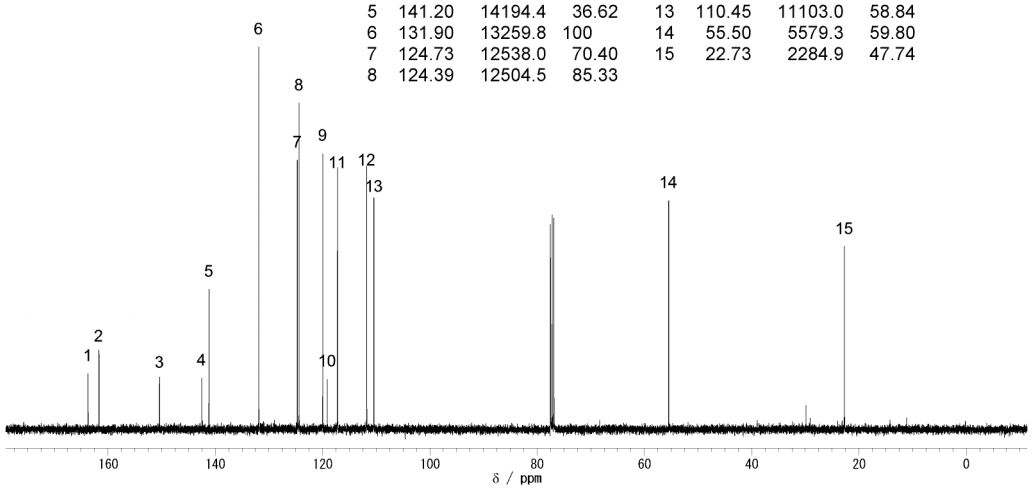
[^{1}H and ^{13}C NMR Spectra of **5k**]



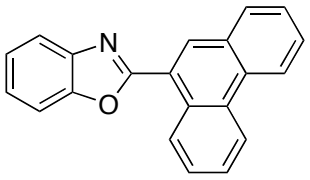
5k



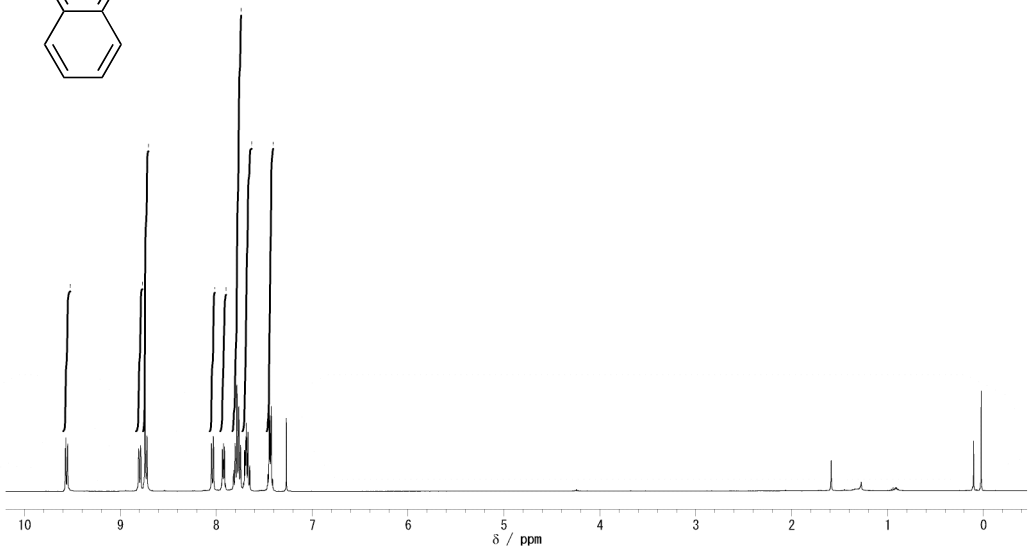
No.	ppm	Hz	Height	No.	ppm	Hz	Height
1	163.74	16459.6	14.53	9	120.00	12062.7	72.11
2	161.70	16255.1	19.64	10	119.14	11976.5	13.09
3	150.40	15119.1	12.79	11	117.25	11786.6	65.05
4	142.55	14329.4	13.40	12	111.78	11236.5	65.68
5	141.20	14194.4	36.62	13	110.45	11103.0	58.84
6	131.90	13259.8	100	14	55.50	5579.3	59.80
7	124.73	12538.0	70.40	15	22.73	2284.9	47.74
8	124.39	12504.5	85.33				

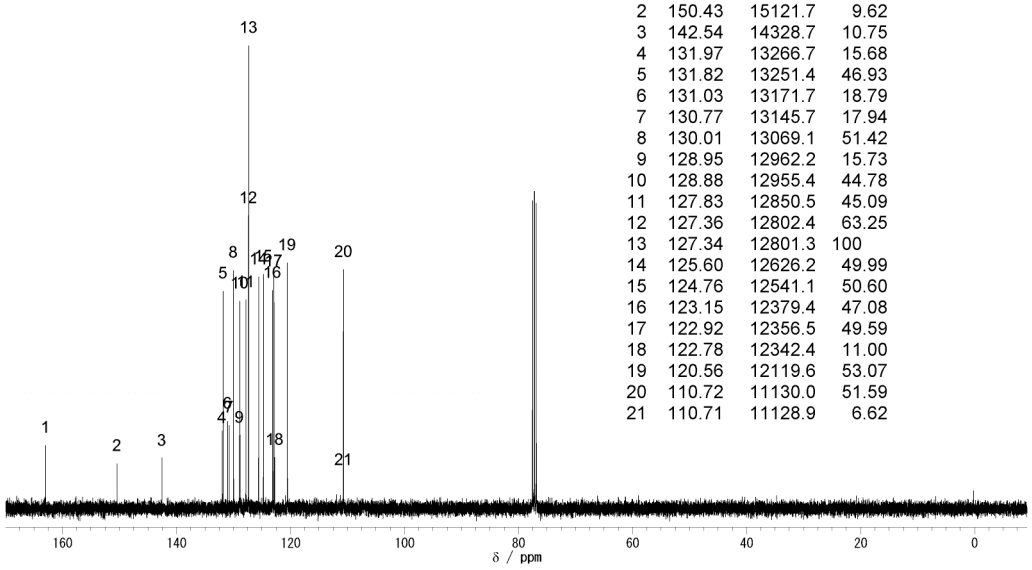


[^{1}H and ^{13}C NMR Spectra of **5l**]



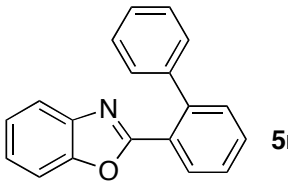
5l



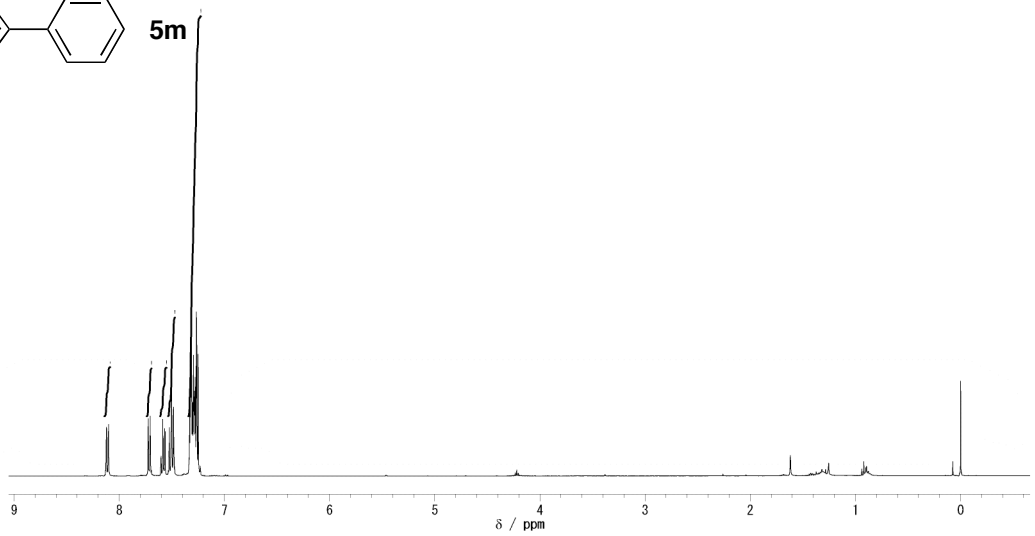


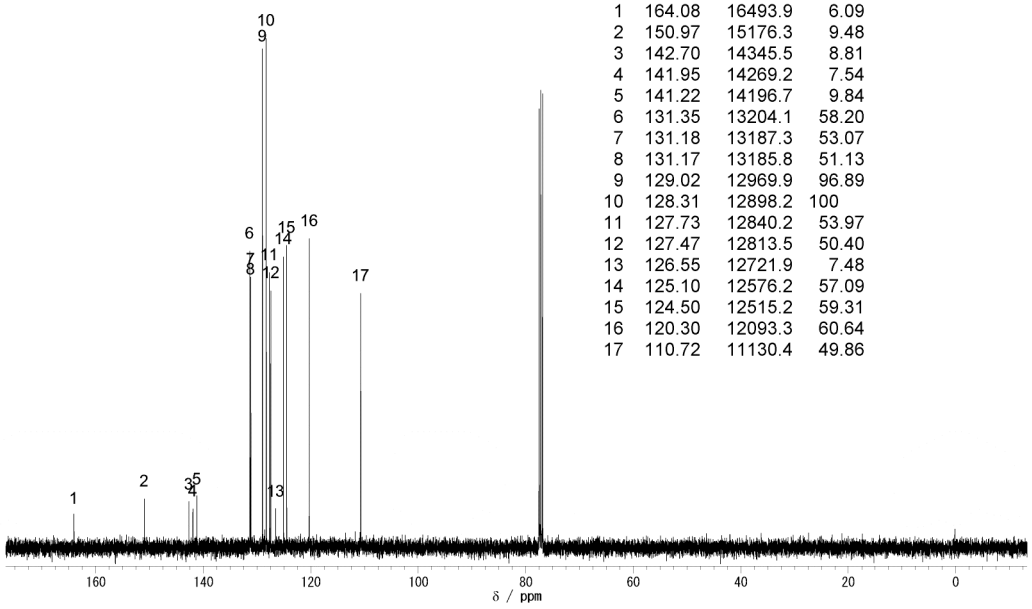
No.	ppm	Hz	Height
1	162.94	16379.8	13.57
2	150.43	15121.7	9.62
3	142.54	14328.7	10.75
4	131.97	13266.7	15.68
5	131.82	13251.4	46.93
6	131.03	13171.7	18.79
7	130.77	13145.7	17.94
8	130.01	13069.1	51.42
9	128.95	12962.2	15.73
10	128.88	12955.4	44.78
11	127.83	12850.5	45.09
12	127.36	12802.4	63.25
13	127.34	12801.3	100
14	125.60	12626.2	49.99
15	124.76	12541.1	50.60
16	123.15	12379.4	47.08
17	122.92	12356.5	49.59
18	122.78	12342.4	11.00
19	120.56	12119.6	53.07
20	110.72	11130.0	51.59
21	110.71	11128.9	6.62

[^{1}H and ^{13}C NMR Spectra of **5m**]



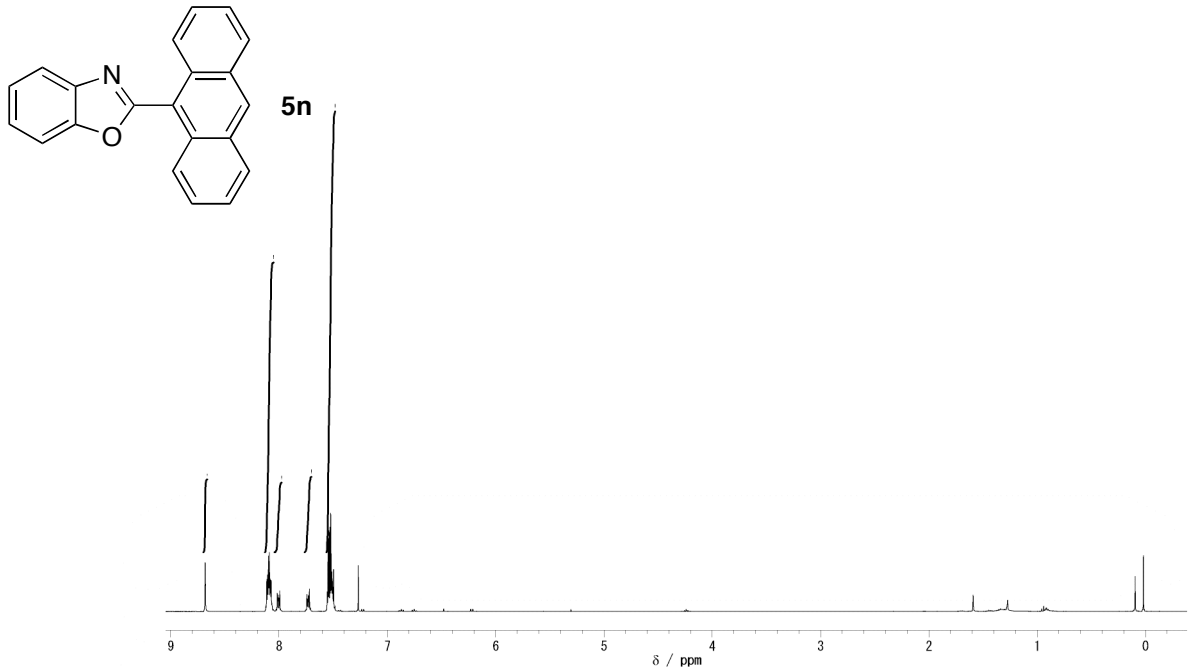
5m

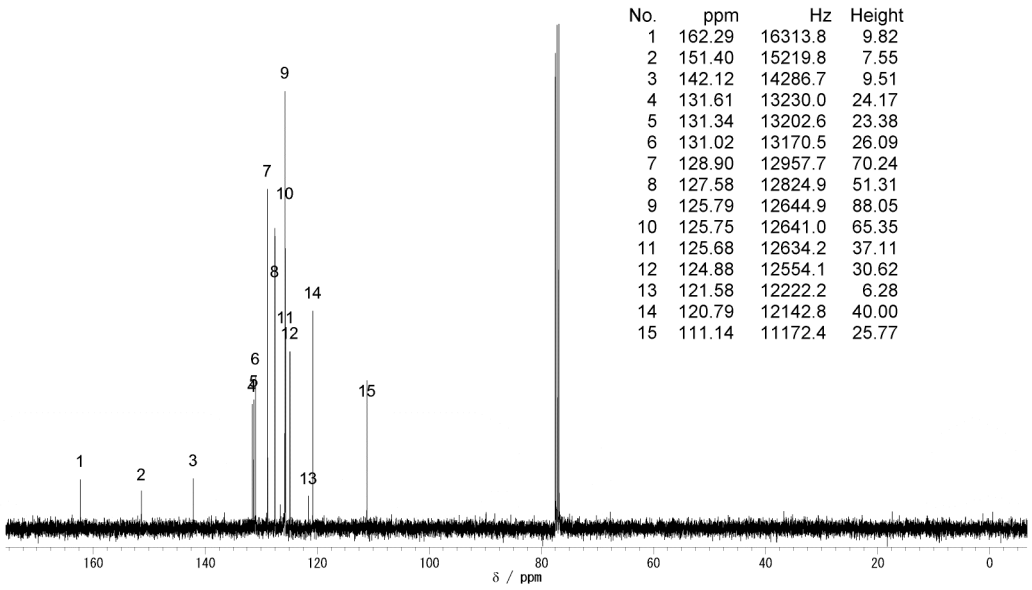




No.	ppm	Hz	Height
1	164.08	16493.9	6.09
2	150.97	15176.3	9.48
3	142.70	14345.5	8.81
4	141.95	14269.2	7.54
5	141.22	14196.7	9.84
6	131.35	13204.1	58.20
7	131.18	13187.3	53.07
8	131.17	13185.8	51.13
9	129.02	12969.9	96.89
10	128.31	12898.2	100
11	127.73	12840.2	53.97
12	127.47	12813.5	50.40
13	126.55	12721.9	7.48
14	125.10	12576.2	57.09
15	124.50	12515.2	59.31
16	120.30	12093.3	60.64
17	110.72	11130.4	49.86

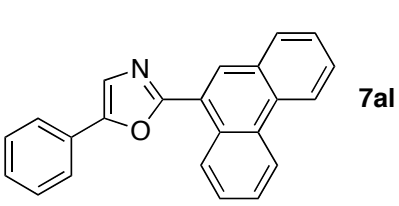
[^{1}H and ^{13}C NMR Spectra of **5n**]



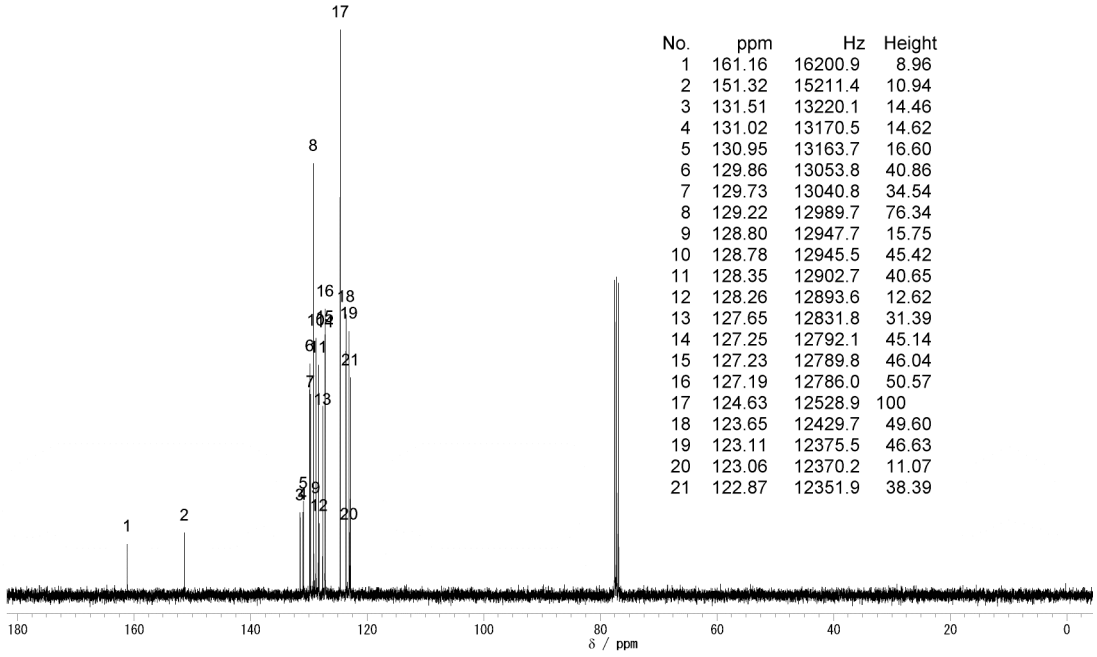


No.	ppm	Hz	Height
1	162.29	16313.8	9.82
2	151.40	15219.8	7.55
3	142.12	14286.7	9.51
4	131.61	13230.0	24.17
5	131.34	13202.6	23.38
6	131.02	13170.5	26.09
7	128.90	12957.7	70.24
8	127.58	12824.9	51.31
9	125.79	12644.9	88.05
10	125.75	12641.0	65.35
11	125.68	12634.2	37.11
12	124.88	12554.1	30.62
13	121.58	12222.2	6.28
14	120.79	12142.8	40.00
15	111.14	11172.4	25.77

[^{1}H and ^{13}C NMR Spectra of **7al**]

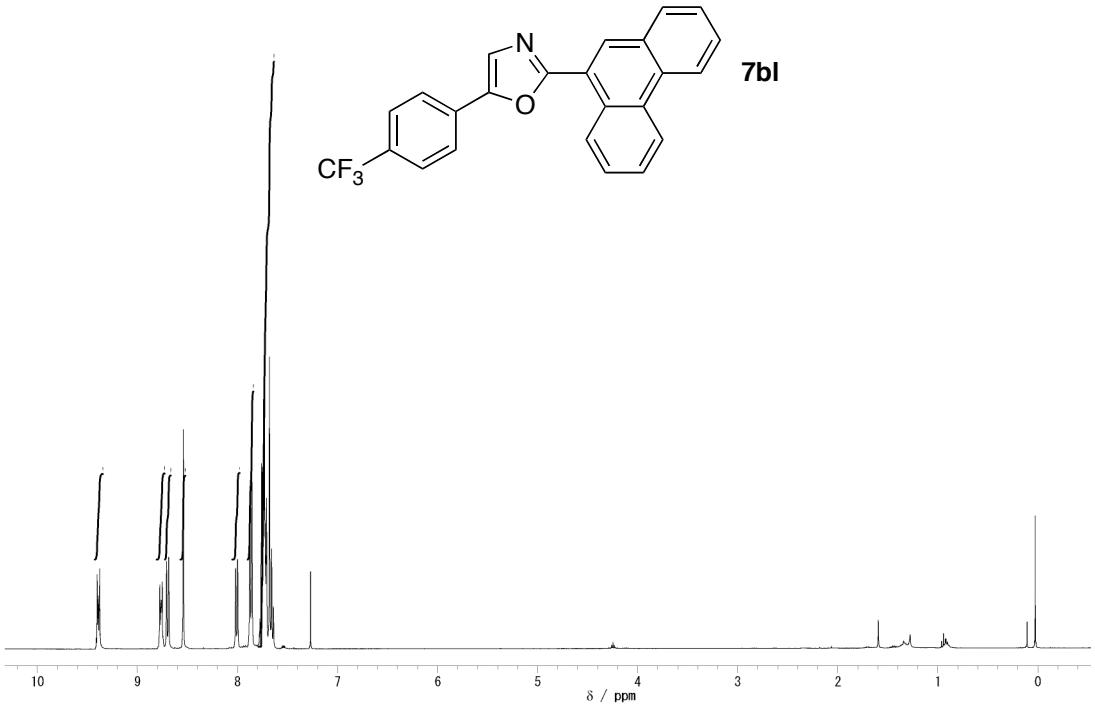


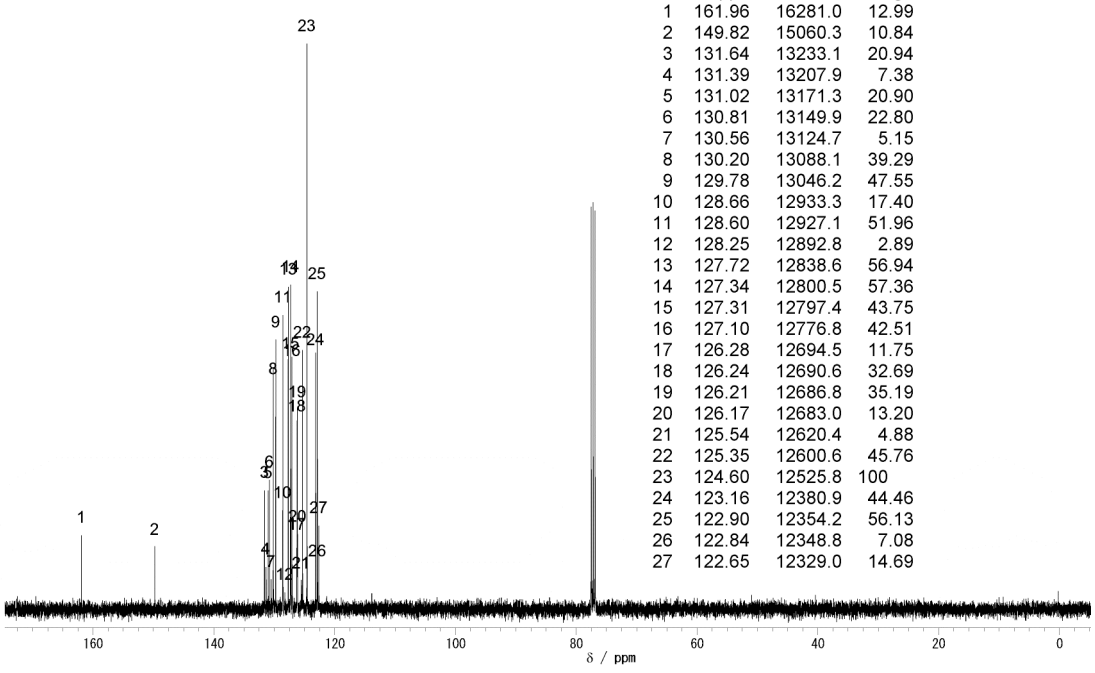
7al



No.	ppm	Hz	Height
1	161.16	16200.9	8.96
2	151.32	15211.4	10.94
3	131.51	13220.1	14.46
4	131.02	13170.5	14.62
5	130.95	13163.7	16.60
6	129.86	13053.8	40.86
7	129.73	13040.8	34.54
8	129.22	12989.7	76.34
9	128.80	12947.7	15.75
10	128.78	12945.5	45.42
11	128.35	12902.7	40.65
12	128.26	12893.6	12.62
13	127.65	12831.8	31.39
14	127.25	12792.1	45.14
15	127.23	12789.8	46.04
16	127.19	12786.0	50.57
17	124.63	12528.9	100
18	123.65	12429.7	49.60
19	123.11	12375.5	46.63
20	123.06	12370.2	11.07
21	122.87	12351.9	38.39

[^{1}H and ^{13}C NMR Spectra of **7bl**]





No.	ppm	Hz	Height
1	161.96	16281.0	12.99
2	149.82	15060.3	10.84
3	131.64	13233.1	20.94
4	131.39	13207.9	7.38
5	131.02	13171.3	20.90
6	130.81	13149.9	22.80
7	130.56	13124.7	5.15
8	130.20	13088.1	39.29
9	129.78	13046.2	47.55
10	128.66	12933.3	17.40
11	128.60	12927.1	51.96
12	128.25	12892.8	2.89
13	127.72	12838.6	56.94
14	127.34	12800.5	57.36
15	127.31	12797.4	43.75
16	127.10	12776.8	42.51
17	126.28	12694.5	11.75
18	126.24	12690.6	32.69
19	126.21	12686.8	35.19
20	126.17	12683.0	13.20
21	125.54	12620.4	4.88
22	125.35	12600.6	45.76
23	124.60	12525.8	100
24	123.16	12380.9	44.46
25	122.90	12354.2	56.13
26	122.84	12348.8	7.08
27	122.65	12329.0	14.69