Supporting Information

Nickel-catalyzed Suzuki–Miyaura type cross-coupling reactions of (2,2-difluorovinyl)benzene derivatives with arylboronic acids

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I. General information

All reagents were of analytical grade, and obtained from commercial suppliers and used without further purification. All reactions were carried out under argon with dry solvents under anhydrous conditions. The products were purified by column chromatography over silica gel (300–400 mesh size). Melting points were measured in an open capillary using Büchi melting point B-540 apparatus and are uncorrected. ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker AM-400 spectrometer (400 MHz and 100 MHz, respectively) using TMS as internal standard. The ^{19}F NMR was obtained using a Bruker AM-400 spectrometer (376 MHz) with $CDCl_3$ as the NMR solvent. The GC and GC-MS were recorded on HP 5973 MSD with 6890 GC. High resolution mass spectra (HRMS) were recorded under electron impact conditions using a MicroMass GCT CA 055 instrument and recorded on a MicroMass LCTTM spectrometer.

II. Preparation of 1,1-difluoroalkenes (1a–j)

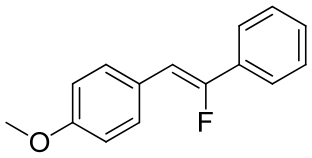
The 1,1-difluoroalkenes **(1a**–**j)** were prepared according to the reported procedure.[1]

III. General procedure for the synthesis of compounds 3aa–jf

To a stirred solution of 1,1-difluoroalkenes **1a**–**j** (1.0 mmol), K_3PO_4 (424 mg, 2.0 mmol) and $NiCl_2(PCy_3)_2$ (35 mg, 0.05 mmol) in 1 mL toluene, phenylboronic acid **2a**–**f** (1.5 mmol) in 1 mL toluene was added dropwise *via* syringe. The mixture was heated to 120 °C and stirred for 24**–**36 h (monitored by TLC) in a Schlenk tube. The reaction mixture was allowed to cool to room temperature, filtered and extracted with H_2O (20 mL) and CH_2Cl_2 (3 × 10 mL). The organic layer was separated and dried over $MgSO_4$, filtered, and evaporated under vacuum. The crude product was purified by column chromatography on silica gel using hexane/dichloromethane mixture (10/1 to 1/1) as eluent to afford the pure target compounds.

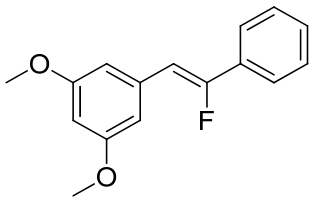
IV. Experimental date

(*Z*)-1-(2-fluoro-2-phenylvinyl)-4-methoxybenzene, **(*Z*)-3aa** (CAS: 174810-48-1)[2]



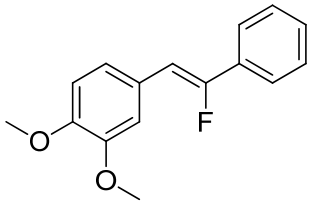
Yield：91 %, white solid, mp 94.2–95.1 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (dd, *J* = 12.0, 8.0 Hz, 4H), 7.40–7.30 (m, 3H), 6.90 (d, *J* = 8.0 Hz, 2H), 6.25 (d, *J* = 40.0 Hz, 1H), 3.81 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.9 (d, $^{4}J_{CF}$ = 3.0 Hz), 156.0 (d, $^{1}J_{CF}$ = 255.7 Hz), 133.2 (d, $^{2}J_{CF}$ = 28.0 Hz), 130.3 (d, $^{3}J_{CF}$ = 8.1 Hz), 128.6, 128.6 (d, $^{5}J_{CF}$ = 2.1 Hz), 126.4 (d, $^{4}J_{CF}$ = 3.0 Hz), 124.0 (d, $^{3}J_{CF}$ = 7.5 Hz), 114.1, 105.4 (d, $^{2}J_{CF}$ = 10.9 Hz), 55.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ –117.1 (d, *J* = 41.4 Hz).

(*Z*)-1-(2-fluoro-2-phenylvinyl)-3,5-dimethoxybenzene, **(*Z*)-3ba**



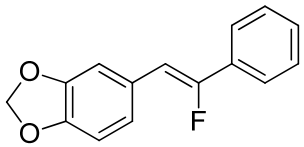
Yield：85 %, white solid, mp 118.4–119.7 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (d, *J* = 7.2 Hz, 2H), 7.35–7.28 (m, 3H), 6.74 (d, *J* = 2.0 Hz, 2H), 6.33 (d, *J* = 2.0 Hz, 1H), 6.17 (d, *J* = 38.8 Hz, 1H), 3.74 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.8, 157.5 (d, $^{1}J_{CF}$ = 259.4 Hz), 135.4, 132.8 (d, $^{2}J_{CF}$ = 27.9 Hz), 129.1, 128.6 (d, $^{4}J_{CF}$ = 2.1 Hz), 124.4 (d, $^{3}J_{CF}$ = 7.5 Hz), 107.0 (d, $^{3}J_{CF}$ = 8.2 Hz), 105.9 (d, $^{2}J_{CF}$ = 9.8 Hz), 100.0 (d, $^{4}J_{CF}$ = 1.8 Hz), 55.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ –112.8 (d, *J* = 37.6 Hz); HRMS (EI) calcd for $C_{16}H_{15}F$ $[M]^+$ 226.1158, found 226.1159.

(*Z*)-4-(2-fluoro-2-phenylvinyl)-1,2-dimethoxybenzene, **(*Z*)-3ca** (CAS: 259729-80-1)[3]



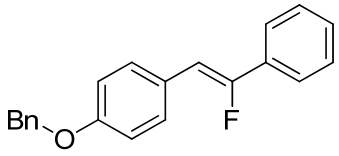
Yield：90 %, white solid, mp 120.6–121.0 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 7.3 Hz, 2H), 7.36–7.27 (m, 4H), 7.13 (dd, *J* = 8.4, 1.8 Hz, 1H), 6.83 (d, *J* = 8.4 Hz, 1H), 6.24 (d, *J* = 39.8 Hz, 1H), 3.90 (s, 3H), 3.86 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ –116.8 (d, *J* = 37.6 Hz).

(*Z*)-5-(2-fluoro-2-phenylvinyl)benzo[d][1,3]dioxole, **(*Z*)-3da**



Yield: 83 %, white solid, mp 131.6–132.4 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61–7.59 (m, 2H), 7.41–7.28 (m, 4H), 7.02 (d, *J* = 8.1 Hz, 1H), 6.81 (dd, *J* = 8.1, 1.3 Hz, 1H), 6.22 (d, *J* = 39.2 Hz, 1H), 5.96 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2 (d, $^{1}J_{CF}$ = 256.4 Hz), 147.9, 146.9 (d, $^{4}J_{CF}$ = 3.1 Hz), 133.0 (d, $^{2}J_{CF}$ = 27.9 Hz), 128.8, 128.6, 127.9 (d, $^{4}J_{CF}$ = 2.9 Hz), 124.1 (d, $^{3}J_{CF}$ = 7.5 Hz), 123.3 (d, $^{4}J_{CF}$ = 6.3 Hz), 109.0 (d, $^{3}J_{CF}$ = 10.7 Hz), 108.4, 105.7 (d, $^{2}J_{CF}$ = 10.4 Hz), 101.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ –116.2 (d, *J* = 39.2 Hz); HRMS (EI) calcd for $C_{15}H_{11}FO_2$ $[M]^+$ 242.0743, found 242.0744.

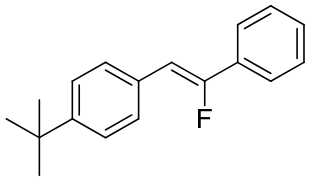
(*Z*)-1-(benzyloxy)-4-(2-fluoro-2-phenylvinyl)benzene, **(*Z*)-3ea**



Yield: 82 %, white solid, mp 155.4–156.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55–7.50 (m, 4H), 7.37–7.23

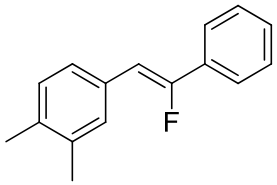
(m, 8H), 6.91 (d, J = 8.7 Hz, 2H), 6.18 (d, J = 39.8 Hz, 1H), 5.01 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.0 (d, $^4J_{CF}$ = 3.1 Hz), 156.1 (d, $^1J_{CF}$ = 255.8 Hz), 136.9, 133.1 (d, $^2J_{CF}$ = 27.9 Hz), 130.31 (d, $^3J_{CF}$ = 8.1 Hz), 128.6, 128.6, 128.5, 128.0, 127.5, 126.7 (d, $^4J_{CF}$ = 2.9 Hz), 124.0 (d, $^3J_{CF}$ = 7.4 Hz), 115.0, 105.4 (d, $^2J_{CF}$ = 10.8 Hz), 70.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ –116.9 (d, J = 39.8 Hz); HRMS (EI) calcd for $C_{21}H_{17}FO$ $[M]^+$304.1263, found 304.1265.

(*Z*)-1-(*tert*-butyl)-4-(2-fluoro-2-phenylvinyl)benzene, **(*Z*)-3fa**



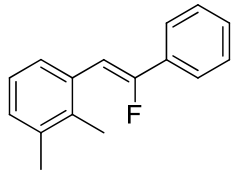
Yield: 90 %, white solid, mp 82.3–83.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69–7.64 (m, 4H), 7.47–7.39 (m, 5H), 6.37 (d, J = 40.0 Hz, 1H), 1.41 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.9 (d, $^1J_{CF}$= 257.5 Hz), 150.5 (d, $^4J_{CF}$ = 2.4 Hz), 133.1 (d, $^2J_{CF}$ = 27.9 Hz), 130.9 (d, $^4J_{CF}$ = 3.0 Hz), 128.8 (d, $^3J_{CF}$ = 4.4 Hz), 128.7, 128.6 (d, $^5J_{CF}$ = 2.1 Hz), 125.6, 124.2 (d, $^3J_{CF}$ = 7.5 Hz), 105.7 (d, $^2J_{CF}$ = 10.7 Hz), 34.7, 31.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ –115.2 (dd, J = 39.8, 4.8 Hz); HRMS (EI) calcd for $C_{18}H_{19}F$ $[M]^+$ 254.1471, found 254.1468.

(*Z*)-4-(2-fluoro-2-phenylvinyl)-1,2-dimethylbenzene, **(*Z*)-3ga**



Yield: 81 %, white solid, mp 79.3–80.8 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, J = 7.4 Hz, 2H), 7.42–7.31 (m, 5H), 7.13 (d, J = 7.8 Hz, 1H), 6.26 (d, J = 40.0 Hz, 1H), 2.28 (s, 3H), 2.27 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.6 (d, $^1J_{CF}$ = 257.1 Hz), 136.7, 136.0 (d, $^4J_{CF}$ = 2.5 Hz), 133.1 (d, $^2J_{CF}$= 28.0 Hz), 131.3 (d, $^4J_{CF}$ = 3.1 Hz), 130.2 (d, $^3J_{CF}$ = 7.6 Hz), 129.9, 128.7, 128.6 (d, $^5J_{CF}$ = 2.1 Hz), 126.5 (d, $^3J_{CF}$ = 8.1 Hz), 124.2 (d, $^4J_{CF}$ = 7.5 Hz), 105.9 (d, $^2J_{CF}$ = 10.6 Hz), 19.9, 19.6; ^{19}F NMR (376 MHz, $CDCl_3$) δ –115.3 (d, J = 40.0 Hz); HRMS (EI) calcd for $C_{16}H_{15}F$ $[M]^+$ 226.1158, found 226.1157.

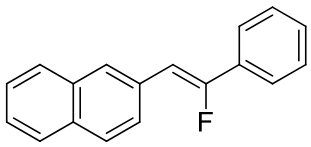
(*Z*)-1-(2-fluoro-2-phenylvinyl)-2,3-dimethylbenzene, **(*Z*)-3ha**



Yield: 76 %, white solid, mp 78.2–79.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, J = 7.2 Hz, 1H), 7.55 (d, J = 7.5 Hz, 1H), 7.43–7.35 (m, 3H), 7.15–7.09 (m, 2H), 6.51 (d, J = 37.7 Hz, 1H), 2.32 (s, 3H), 2.29 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.7 (d, $^1J_{CF}$ = 256.1 Hz), 136.8, 134.8, 133.1 (d, $^2J_{CF}$ = 28.5 Hz), 132.1, 129.2, 129.0, 128.6 (d, $^4J_{CF}$ = 2.0 Hz), 127.4 (d, $^3J_{CF}$ = 8.5 Hz), 125.4, 124.4 (d, $^3J_{CF}$ = 7.2 Hz), 104.4 (d, $^2J_{CF}$ = 12.4 Hz), 20.8,

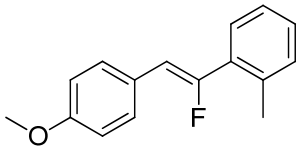
16.2; ^{19}F NMR (376 MHz, $CDCl_3$) δ –117.03 (d, J = 37.7 Hz); HRMS (EI) calcd for $C_{16}H_{15}F$ $[M]^+$ 226.1158, found 226.1159.

(*Z*)-2-(2-fluoro-2-phenylvinyl)naphthalene, **(*Z*)-3ia** (CAS: 886207-14-3) [4]



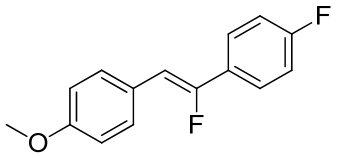
Yield: 88 %, white solid, mp 100.5–101.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, J = 8.0 Hz, 1H), 7.76 (d, J = 7.2 Hz, 1H), 7.67–7.53 (m, 4H), 7.33–7.17 (m, 6H), 6.78 (d, J = 36.9 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.0 (d, $^1J_{CF}$ = 257.8 Hz), 133.9, 133.1 (d, $^2J_{CF}$ = 28.2 Hz), 131.8, 129.8 (d, $^4J_{CF}$ = 1.8 Hz), 129.4, 128.9, 128.8 (d, $^4J_{CF}$ = 2.1 Hz), 128.2, 127.8 (d, $^3J_{CF}$ = 9.4 Hz), 126.9, 126.4, 125.8, 124.7 (d, $^3J_{CF}$ = 7.3 Hz), 124.2, 102.6 (d, $^2J_{CF}$ = 12.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ –114.7 (d, J = 36.9 Hz).

(*Z*)-1-(1-fluoro-2-(4-methoxyphenyl)vinyl)-2-methylbenzene, **(*Z*)-3ab**



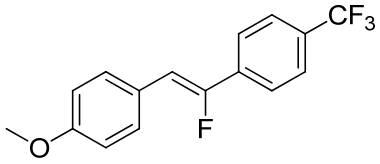
Yield: 89 %, white solid, mp 100.3–101.1 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, J = 8.8 Hz, 2H), 7.42 (d, J = 8.2 Hz, 2H), 7.11 (d, J = 8.1 Hz, 2H), 6.82 (d, J = 8.8 Hz, 2H), 6.12 (d, J = 40.0 Hz, 1H), 3.73 (s, 3H), 2.28 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.7 (d, $^3J_{CF}$ = 3.0 Hz), 156.2 (d, $^1J_{CF}$ = 255.5 Hz), 138.7, 130.5, 130.3 (d, $^3J_{CF}$ = 4.0 Hz), 130.2 (d, $^2J_{CF}$ = 18.0 Hz), 129.3 (d, $^4J_{CF}$ = 2.0 Hz), 126.7 (d, $^4J_{CF}$ = 2.9 Hz), 124.0 (d, $^3J_{CF}$ = 7.4 Hz), 116.4, 114.0, 104.6 (d, $^2J_{CF}$ = 11.0 Hz), 55.3, 21.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ –116.8 (d, J = 37.6 Hz); HRMS (EI) calcd for $C_{16}H_{15}FO$ $[M]^+$ 242.1107, found 242.1106.

(*Z*)-1-fluoro-4-(1-fluoro-2-(4-methoxyphenyl)vinyl)benzene, **(*Z*)-3ac**



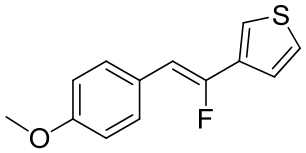
Yield: 78 %, white solid, mp 115.4–116.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51–7.46 (m, 4H), 7.01–6.94 (m, 2H), 6.82 (d, J = 8.7 Hz, 2H), 6.08 (d, J = 39.8 Hz, 1H), 3.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.0 (d, $^1J_{CF}$ = 249.0 Hz), 158.9 (d, $^4J_{CF}$ = 2.9 Hz), 155.2 (d, $^1J_{CF}$ = 255.4 Hz), 130.2 (d, $^3J_{CF}$ = 8.0 Hz), 126.3 (d, $^3J_{CF}$ = 3.0 Hz), 126.0 (d, $^2J_{CF}$ = 16.0 Hz), 125.9, 115.6 (dd, $^2J_{CF}$ = 22.0 Hz, $^4J_{CF}$ =1.8 Hz), 114.1, 105.3 (dd, $^2J_{CF}$ = 11.0 Hz, $^6J_{CF}$ =1.8 Hz), 55.2; ^{19}F NMR (376 MHz, $CDCl_3$) δ –112.4 to –112.5 (m), –116.3 (d, J = 37.6 Hz); HRMS (EI) calcd for $C_{15}H_{12}F_2O$ $[M]^+$ 246.0856, found 246.0855.

(*Z*)-1-(2-fluoro-2-(4-(trifluoromethyl)phenyl)vinyl)-4-methoxybenzene, **(*Z*)-3ad**



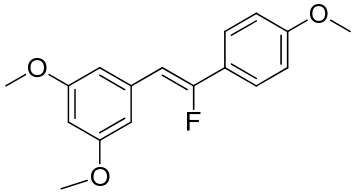
Yield: 66 %, white solid, mp 118.8–119.7 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (d, *J* = 8.4 Hz, 2H), 7.57–7.52 (m, 4H), 6.85 (d, *J* = 8.8 Hz, 2H), 6.28 (d, *J* = 39.5 Hz, 1H), 3.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.3, 154.5 (d, $^{1}J_{CF}$ = 255.7 Hz), 136.5 (d, $^{2}J_{CF}$ = 27.1 Hz), 130.6 (d, $^{3}J_{CF}$ = 8.2 Hz), 130.2 (q, $^{2}J_{CF}$ = 32.5 Hz), 125.7 (d, $^{4}J_{CF}$ = 3.0 Hz), 125.6–125.5 (m), 124.1 (d, $^{3}J_{CF}$ = 7.5 Hz), 124.0 (q, $^{1}J_{CF}$ = 270.3 Hz), 114.2, 107.6 (d, $^{2}J_{CF}$ = 10.4 Hz), 55.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ –62.6 (s, 3F), –118.2 (d, *J* = 39.5Hz, 1F); HRMS (EI) calcd for $C_{16}H_{12}F_4O$ $[M]^+$ 296.0824, found 296.0825.

(*Z*)-3-(1-fluoro-2-(4-methoxyphenyl)vinyl)thiophene, **(*Z*)-3ae**



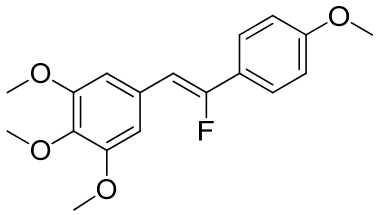
Yield: 77 %, white solid, mp 123.2–124.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 8.8 Hz, 2H), 7.46 (d, *J* = 2.8 Hz, 1H), 7.33–7.32 (m, 1H), 7.25 (s, 1H), 6.90 (d, *J* = 8.8 Hz, 2H), 6.08 (d, *J* = 39.9 Hz, 1H), 3.82 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.7 (d, $^{4}J_{CF}$ = 3.0 Hz), 153.2 (d, $^{1}J_{CF}$ = 253.2 Hz), 135.4 (d, $^{2}J_{CF}$ = 30.7 Hz), 130.1 (d, $^{3}J_{CF}$ = 7.8 Hz), 126.5 (d, $^{5}J_{CF}$ = 2.0 Hz), 126.3 (d, $^{4}J_{CF}$ = 3.0 Hz), 124.0 (d, $^{3}J_{CF}$ = 6.7 Hz), 121.0 (d, $^{3}J_{CF}$ = 5.2 Hz), 114.1, 105.2 (d, $^{2}J_{CF}$ = 9.9 Hz), 55.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ –113.6 (dd, *J* = 40.0, 2.4 Hz); HRMS (EI) calcd for $C_{13}H_{11}FOS$ $[M]^+$ 234.0515, found 234.0514.

(*Z*)-1-(2-fluoro-2-(4-methoxyphenyl)vinyl)-3,5-dimethoxybenzene, **(*Z*)-3bf** (CAS: 402490-65-7) [5]



Yield: 83 %, white solid, mp 127.6–128.4 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 8.8 Hz, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 6.78 (d, *J* = 1.6 Hz, 2H), 6.37 (s, 1H), 6.08 (d, *J* = 39.6 Hz, 1H), 3.77 (s, 6H), 3.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.8, 160.5, 157.7 (d, $^{1}J_{CF}$ = 258.5 Hz), 135.8 (d, $^{4}J_{CF}$ = 2.7 Hz), 125.9 (d, $^{3}J_{CF}$ = 7.6 Hz), 125.3 (d, $^{2}J_{CF}$ = 28.3 Hz), 114.1 (d, $^{4}J_{CF}$ = 1.8 Hz), 106.9 (d, $^{3}J_{CF}$ = 8.3 Hz), 104.2 (d, $^{2}J_{CF}$ = 10.0 Hz), 99.7 (d, $^{5}J_{CF}$ = 1.5 Hz), 55.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ –111.9 (d, *J* = 37.6 Hz).

(*Z*)-5-(2-fluoro-2-(4-methoxyphenyl)vinyl)-1,2,3-trimethoxybenzene, **(*Z*)-3jf**



Yield: 82 %, white solid, mp 142.5–143.7 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, J = 8.9 Hz, 2H), 6.90 (d, J = 8.7 Hz, 2H), 6.86 (s, 2H), 6.10 (d, J = 39.5 Hz, 1H), 3.87 (s, 9H), 3.80 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.3, 156.9 (d, $^{1}J_{CF}$ = 256.9 Hz), 153.1, 137.3 (d, $^{4}J_{CF}$ = 2.8 Hz), 129.7 (d, $^{4}J_{CF}$ = 2.8 Hz), 125.7 (d, $^{3}J_{CF}$ = 7.6 Hz), 125.3 (d, $^{2}J_{CF}$ = 28.3 Hz), 114.0 (d, $^{5}J_{CF}$ = 1.7 Hz), 106.0 (d, $^{3}J_{CF}$ = 8.5 Hz), 104.1 (d, $^{2}J_{CF}$ = 10.1 Hz), 60.9, 56.0, 55.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ –114.2 (d, J = 39.1 Hz); HRMS (EI) calcd for $C_{18}H_{19}FO_4$ $[M]^+$ 318.1267, found 318.1268.

V. References

1 C. S. Thomoson, H. Martinez and W. R. Dolbier Jr., *J. Fluorine Chem.,* 2013, **150**, 53–59.

2 W. Zhang, W. Huang and J. Hu, *Angew. Chem. Int. Ed.*, 2009, **48**, 9858–9861.

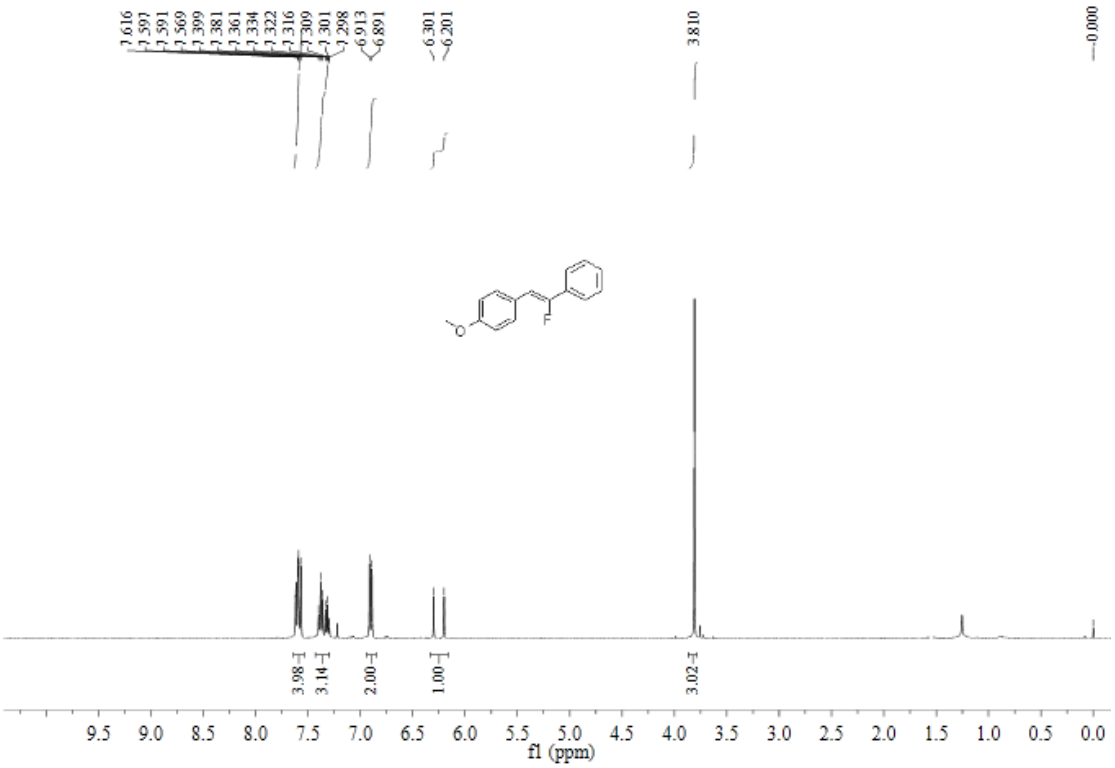
3 H.-J. Tsai, K.-W.Lin, T.-H. Ting and D. J. Burton, *Helv. Chim. Acta*, 1999, **82**, 2231–2239.

4 A. K. Ghosh and B. Zajc, *Org. Lett.*, 2006, **8**, 1553-1556.

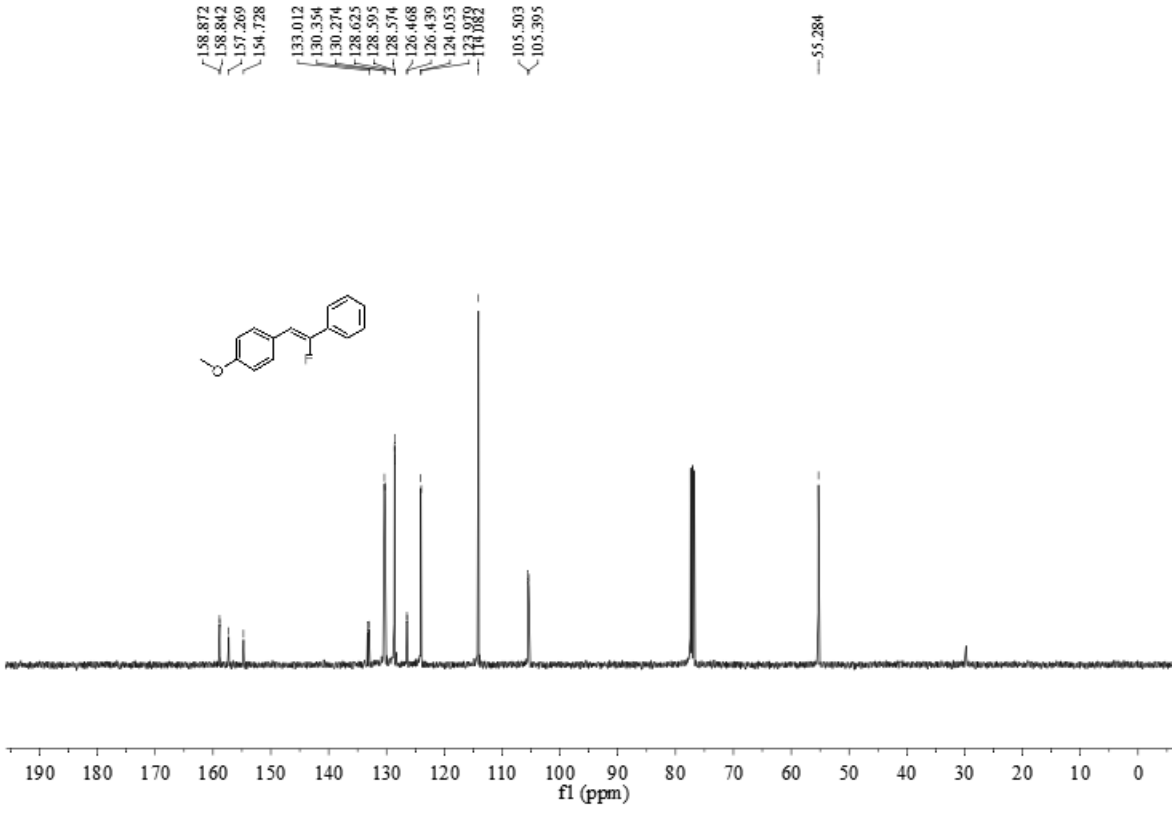
5 S. Eddarir, Z. Abdelhadi and C. Rolando, *Tetrahedron Lett.*, 2001, **42**, 9127–9130.

VI. ^{1}H, ^{13}C, ^{19}F NMR and HRMS(EI) spectra of compounds 3aa–jf

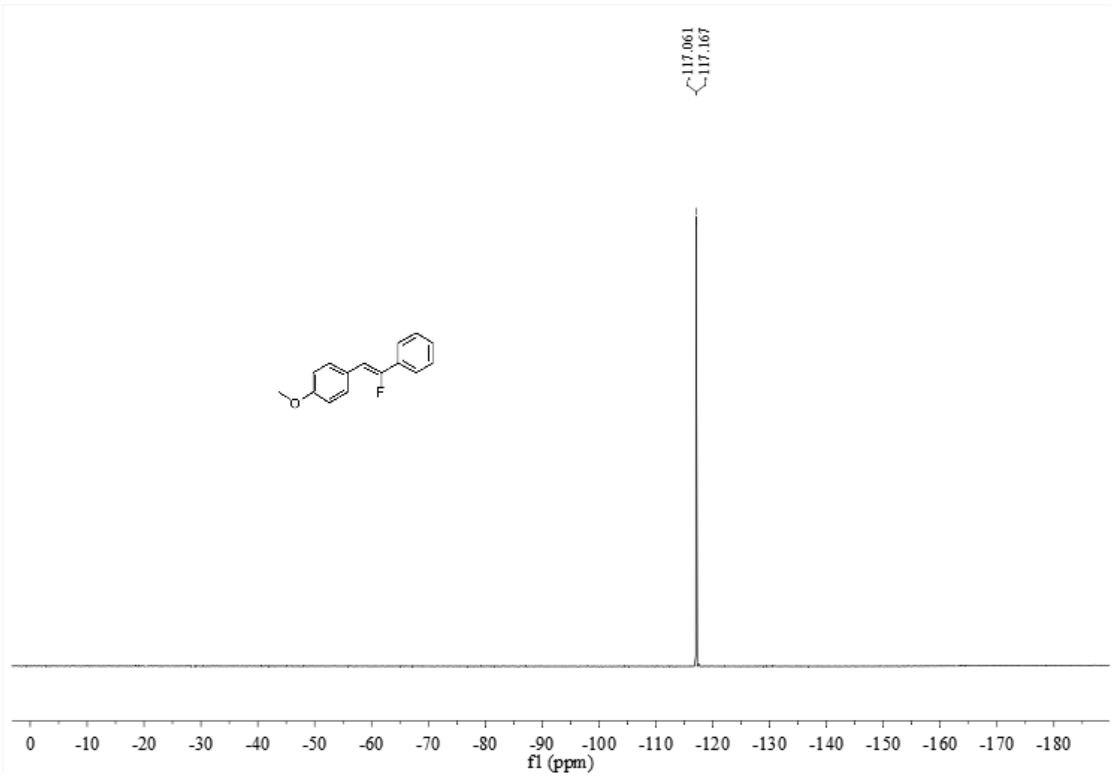
^{1}H NMR spectra of **(*Z*)-3aa**



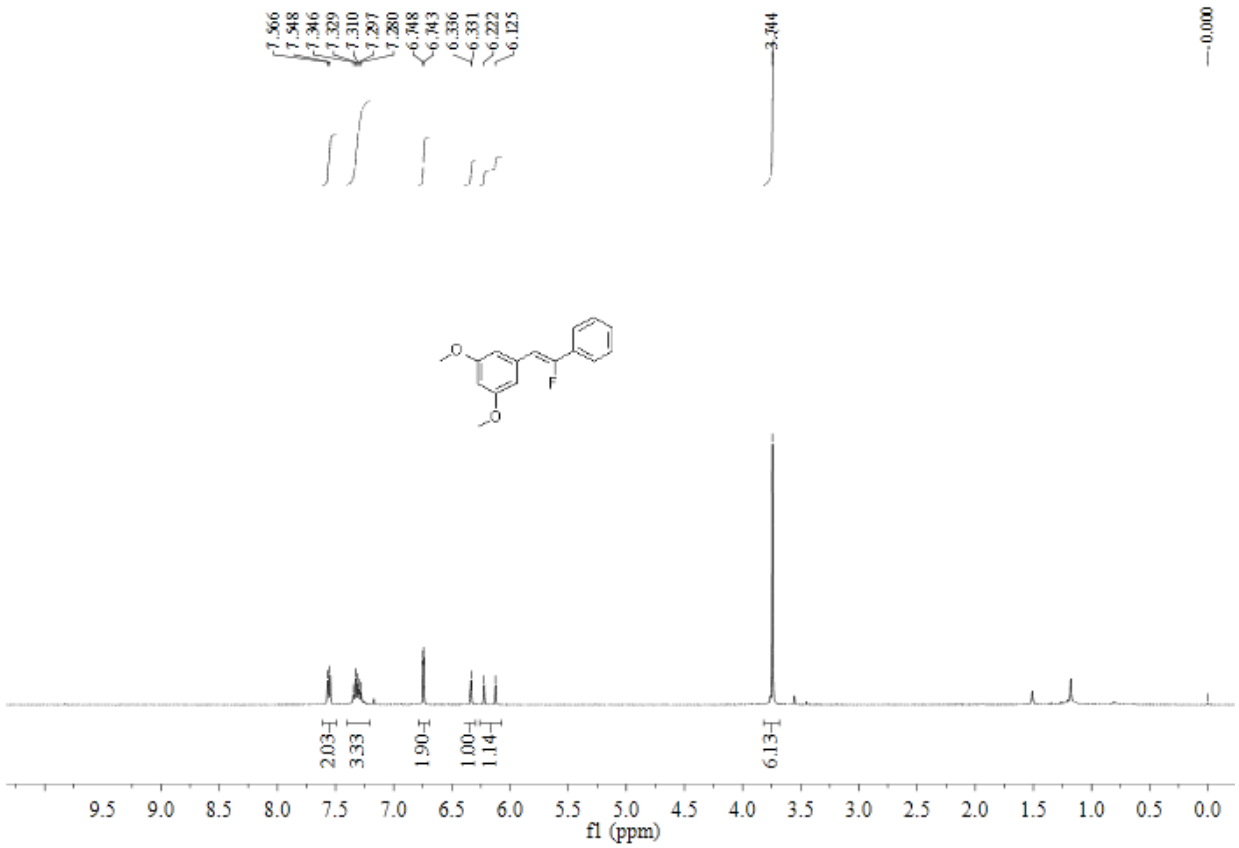
^{13}C NMR spectra of **(*Z*)-3aa**



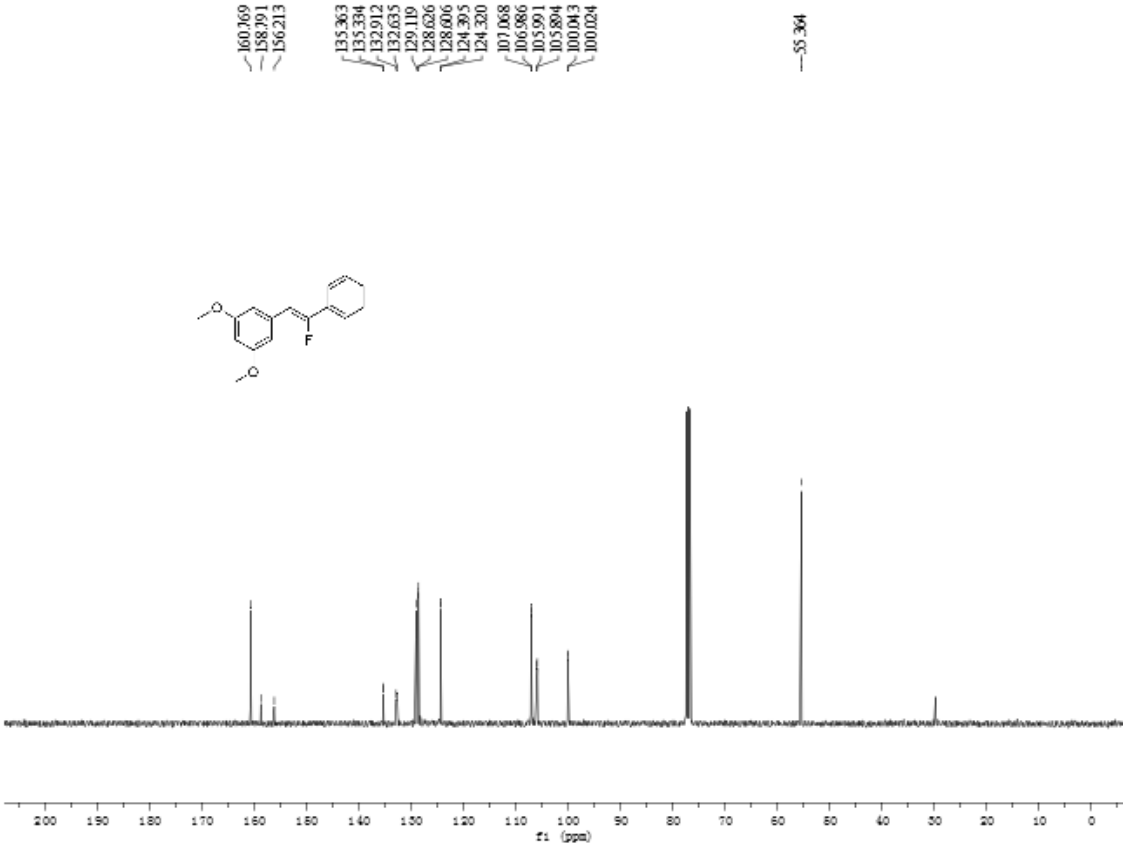
^{19}F NMR spectra of **(*Z*)-3aa**



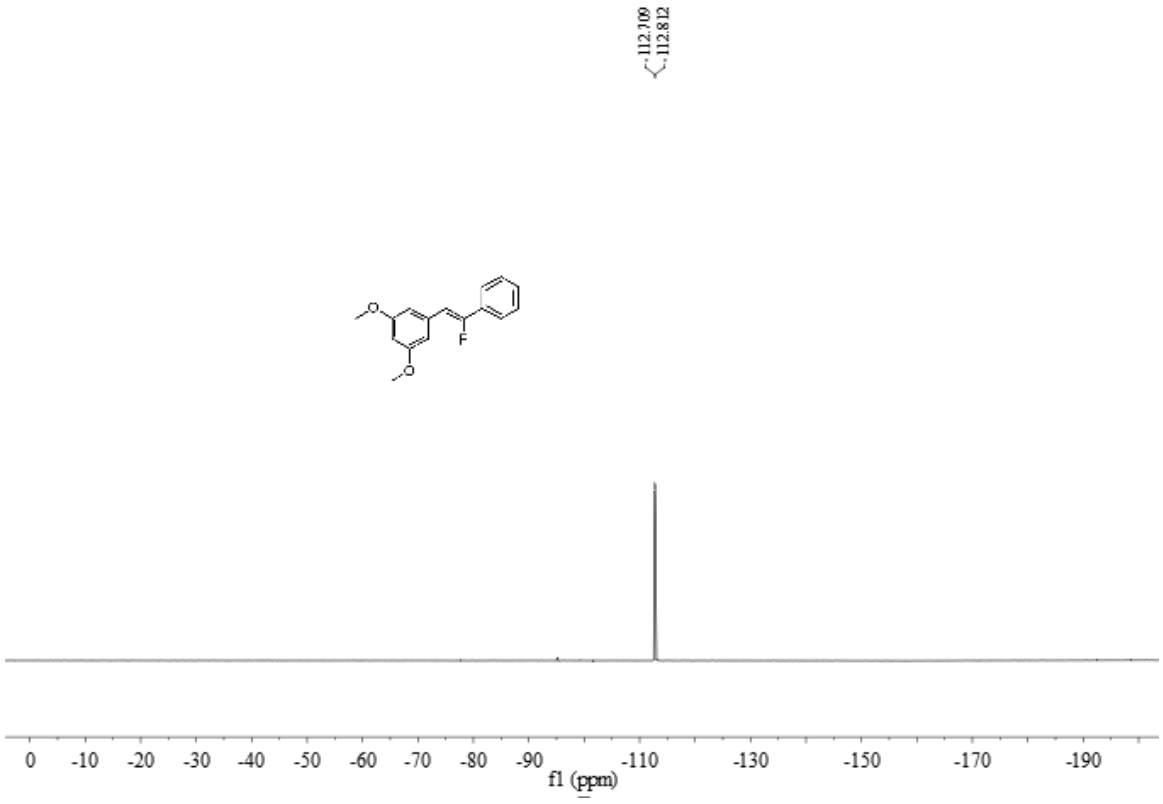
^{1}H NMR spectra of **(*Z*)-3ba**



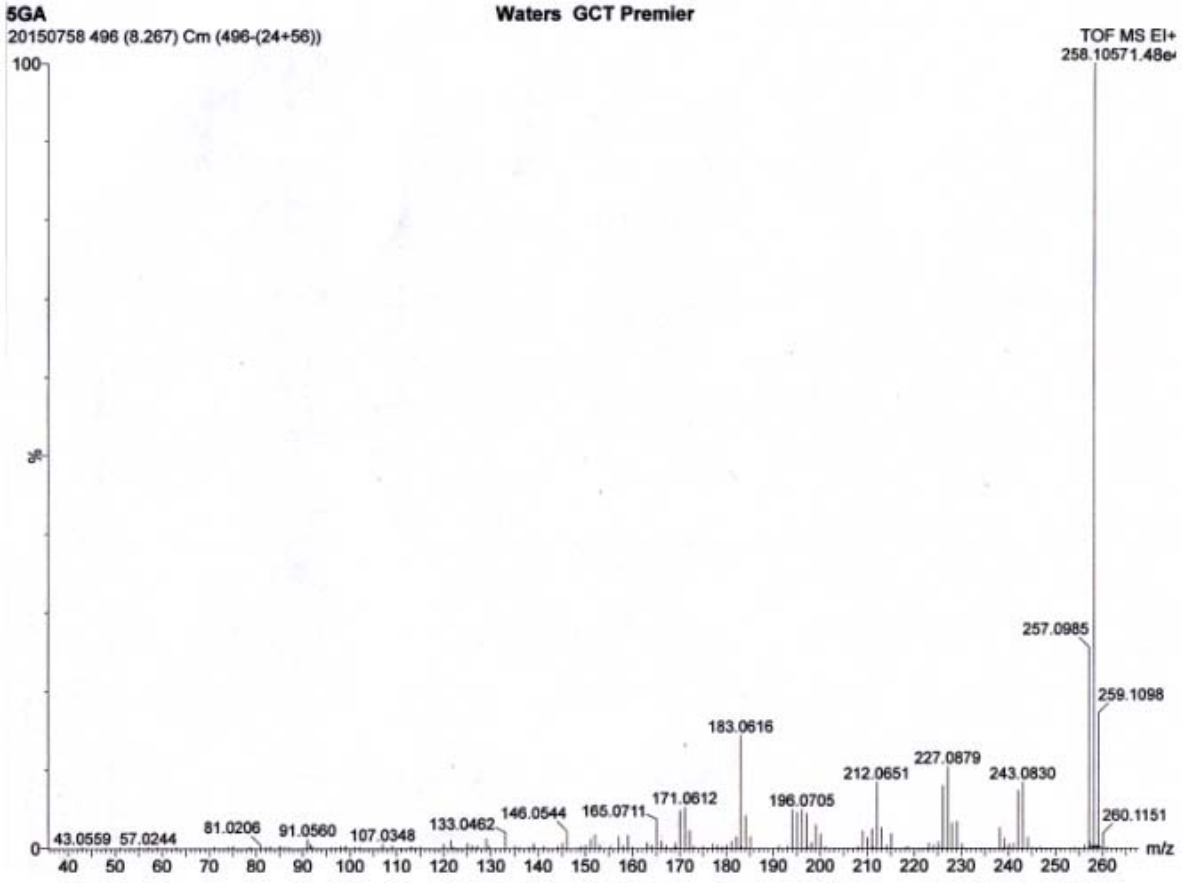
^{13}C NMR spectra of **(Z)-3ba**



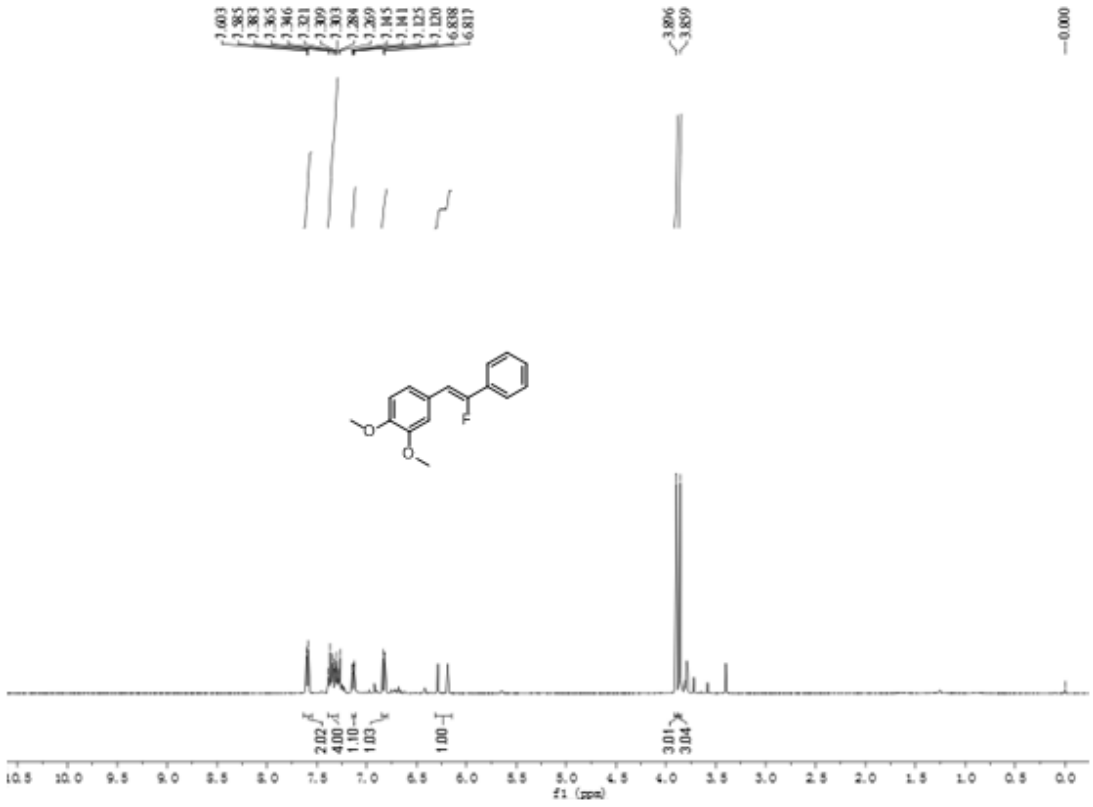
^{19}F NMR spectra of **(Z)-3ba**



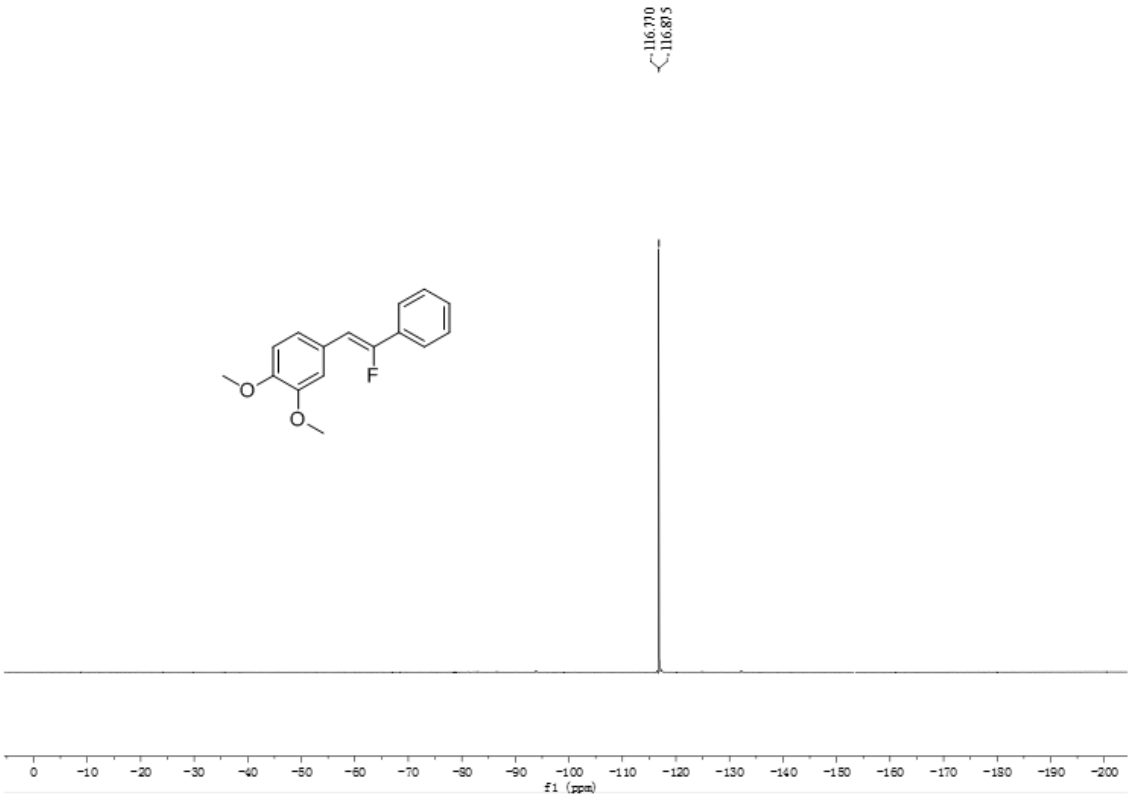
HRMS(EI) spectra of **(*Z*)-3ba**



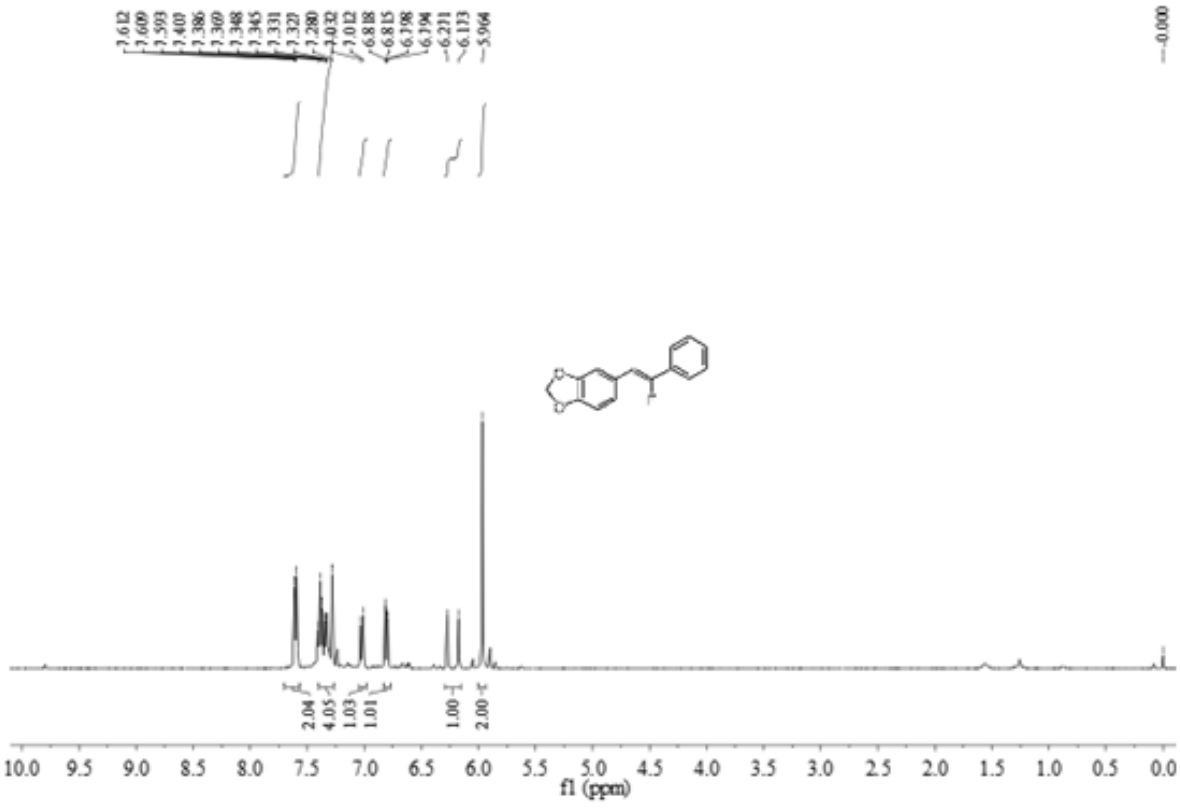
^{1}H NMR spectra of **(*Z*)-3ca**



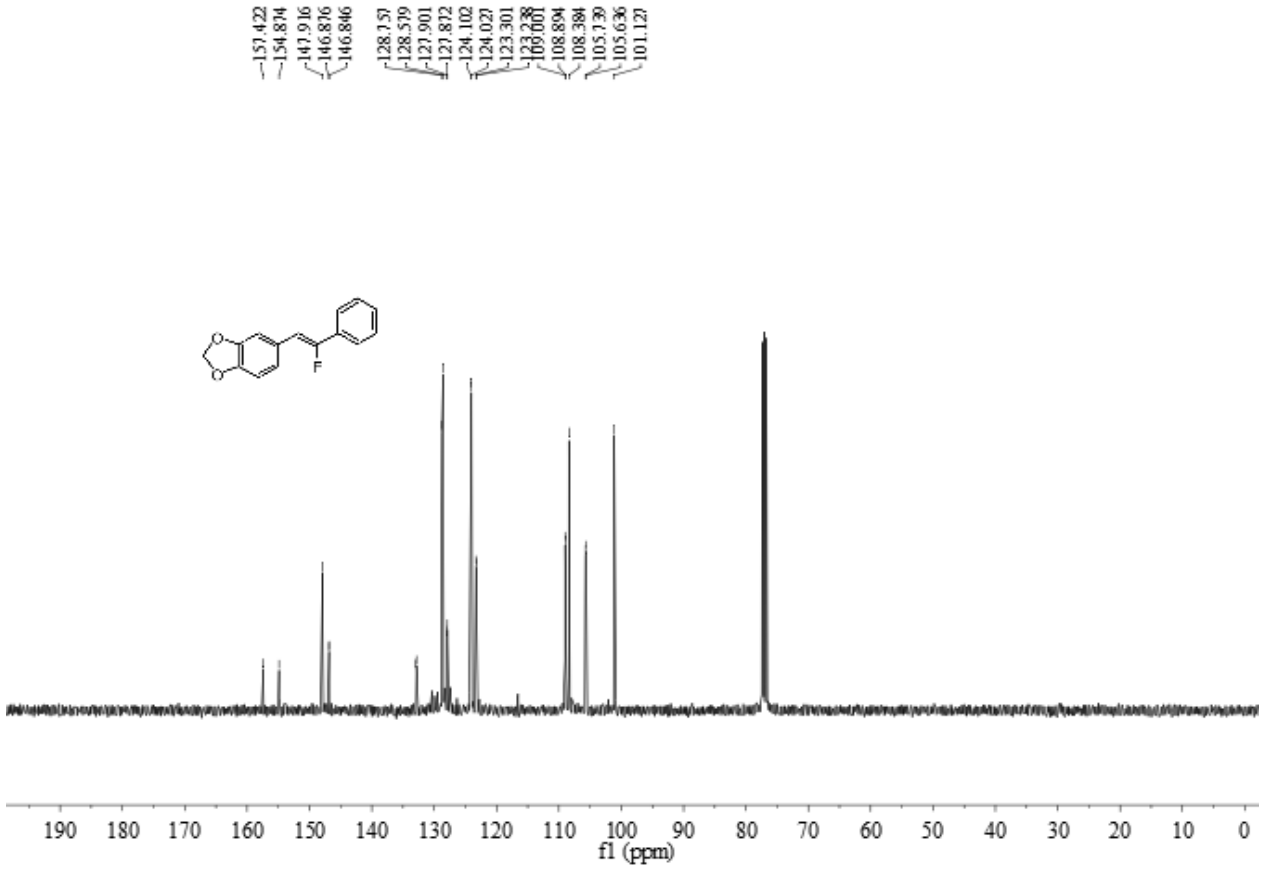
^{19}**F** NMR spectra of **(*Z*)-3ca**



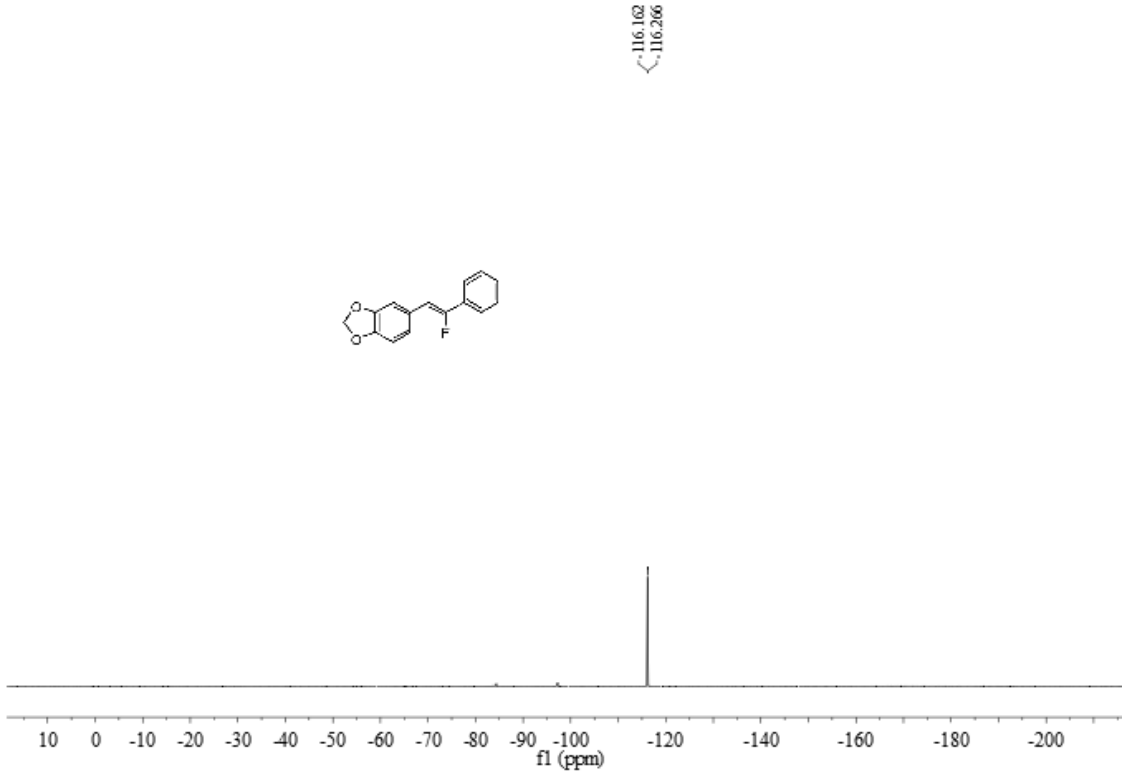
^{1}H NMR spectra of **(*Z*)-3da**



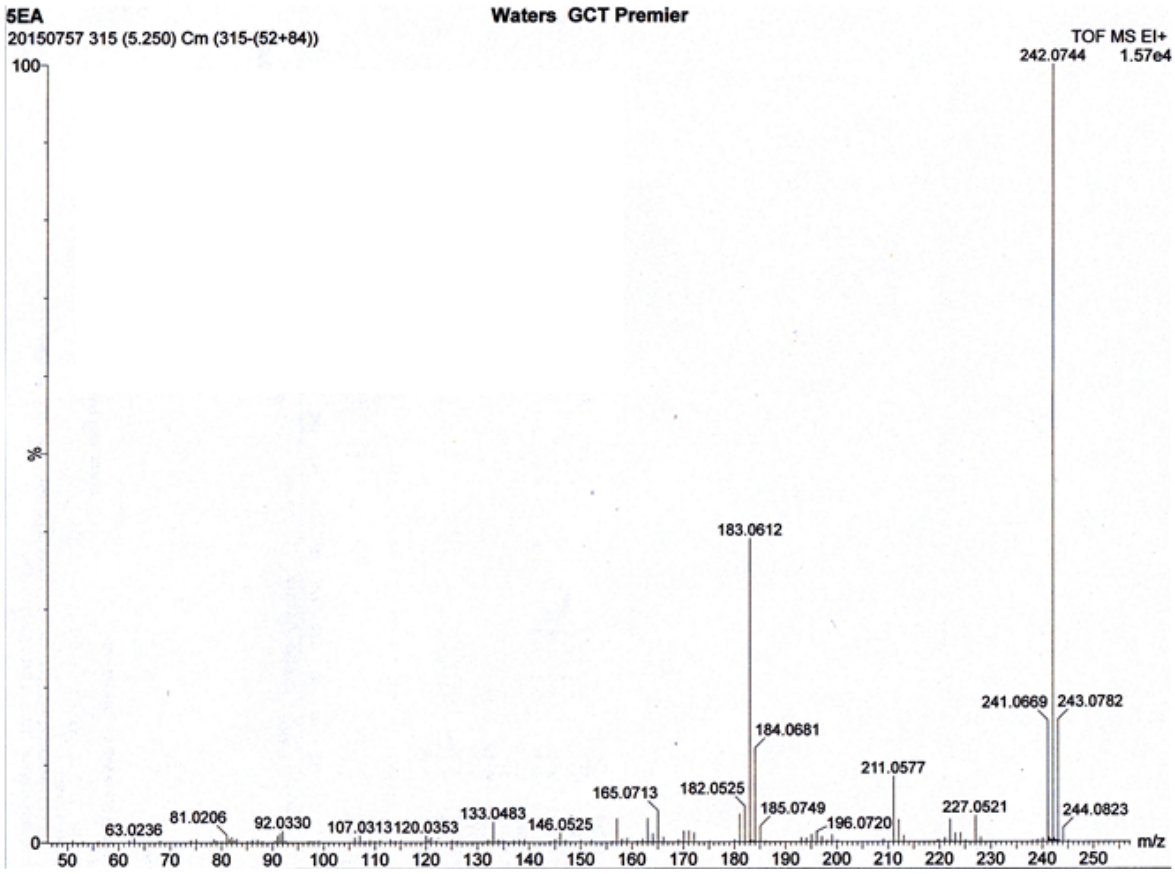
^{13}C NMR spectra of **(*Z*)-3da**



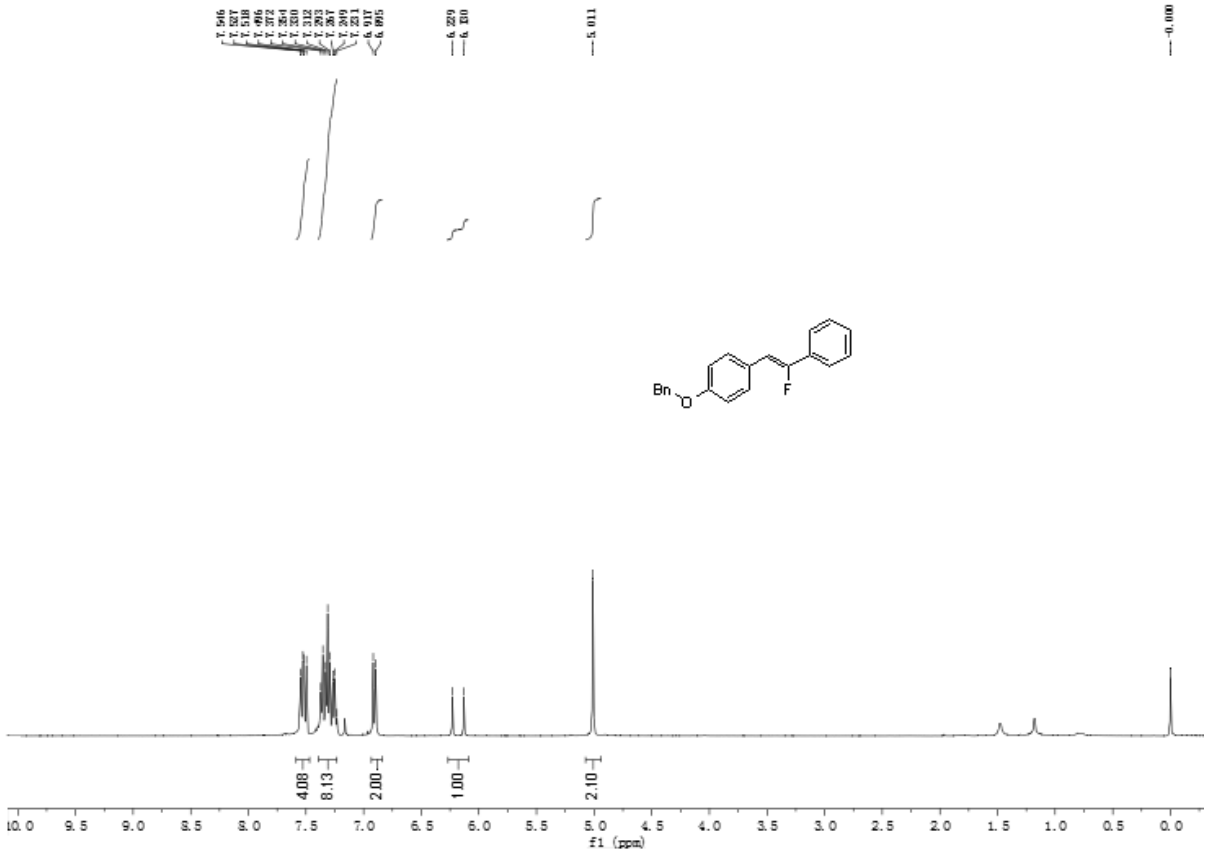
^{19}F NMR spectra of **(*Z*)-3da**



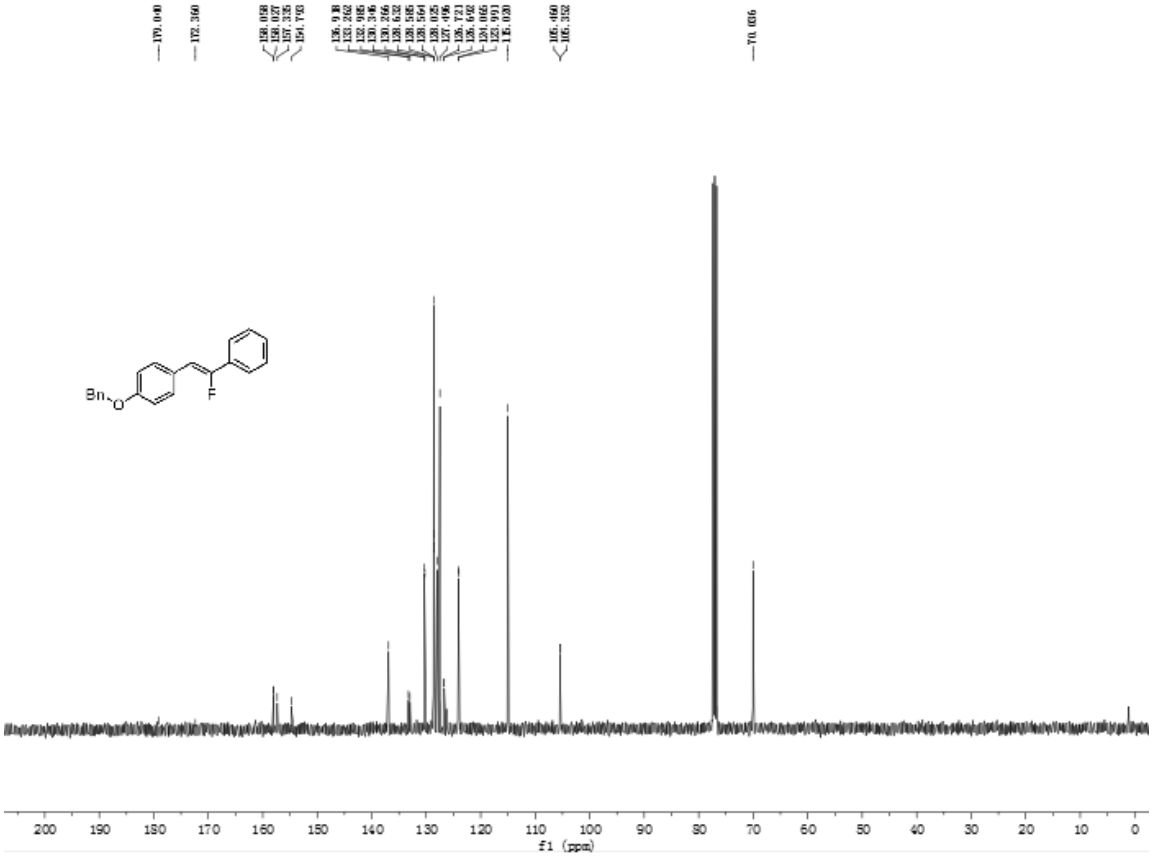
HRMS(EI) spectra of **(*Z*)-3da**



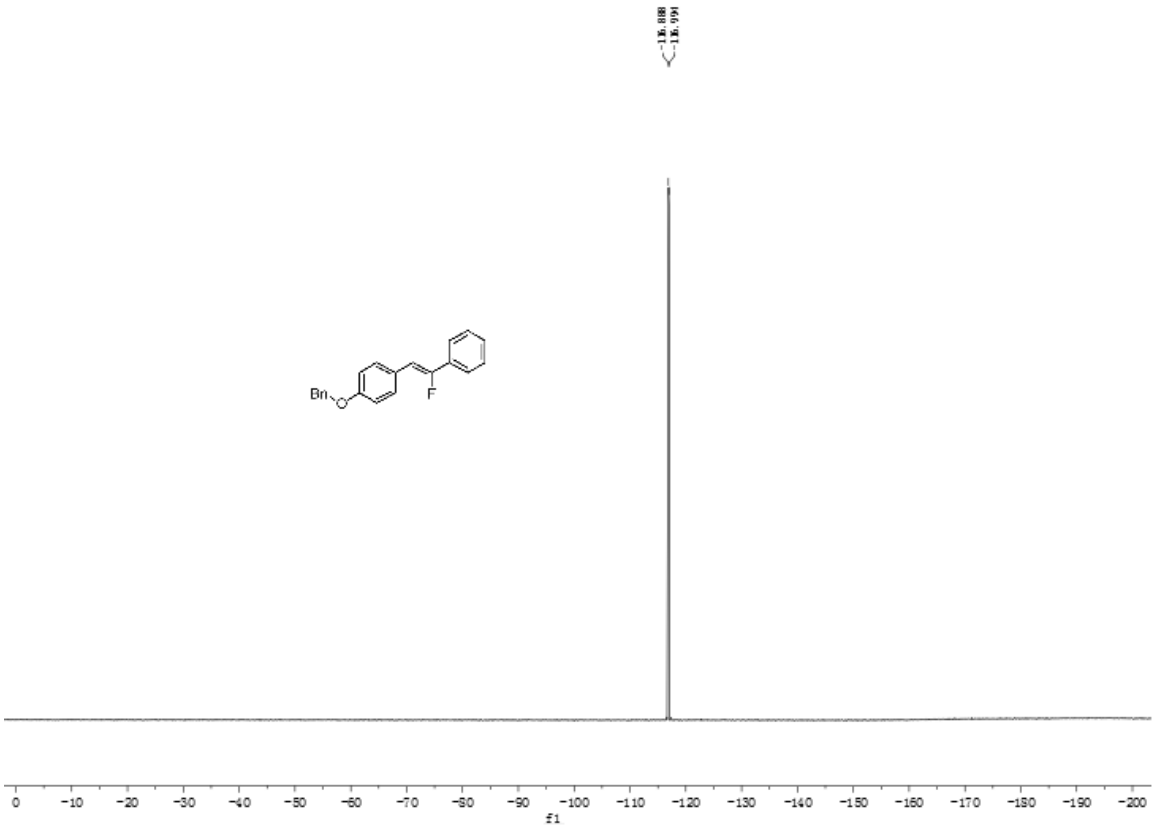
^{1}H NMR spectra of **(*Z*)-3ea**



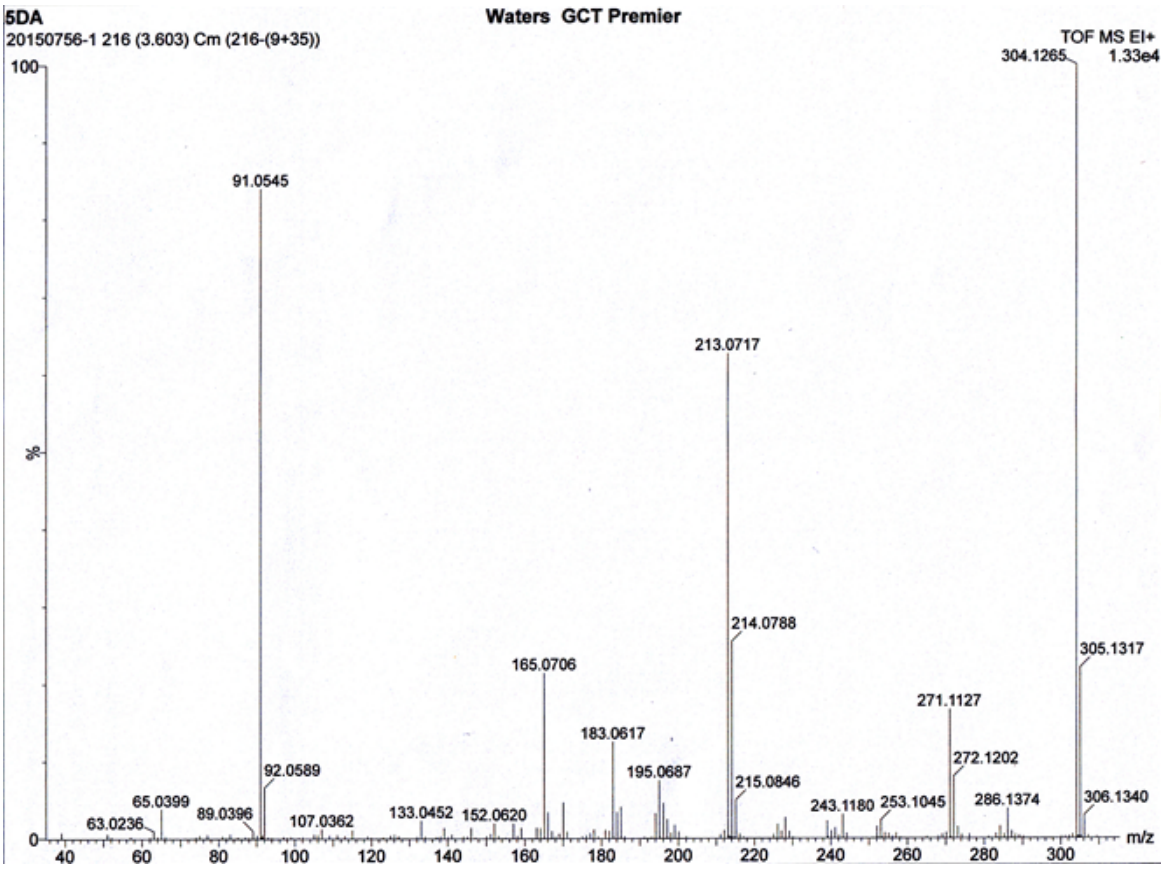
^{13}C NMR spectra of **(*Z*)-3ea**



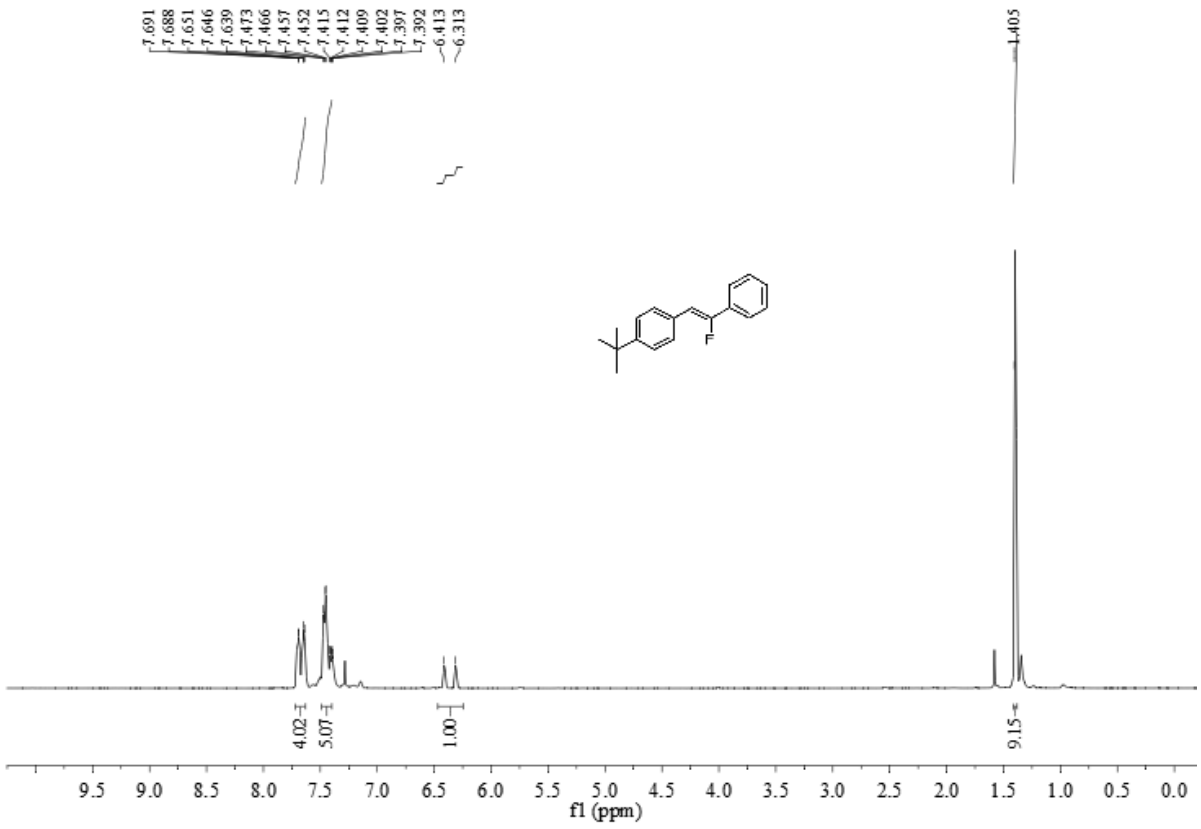
^{19}F NMR spectra of **(*Z*)-3ea**



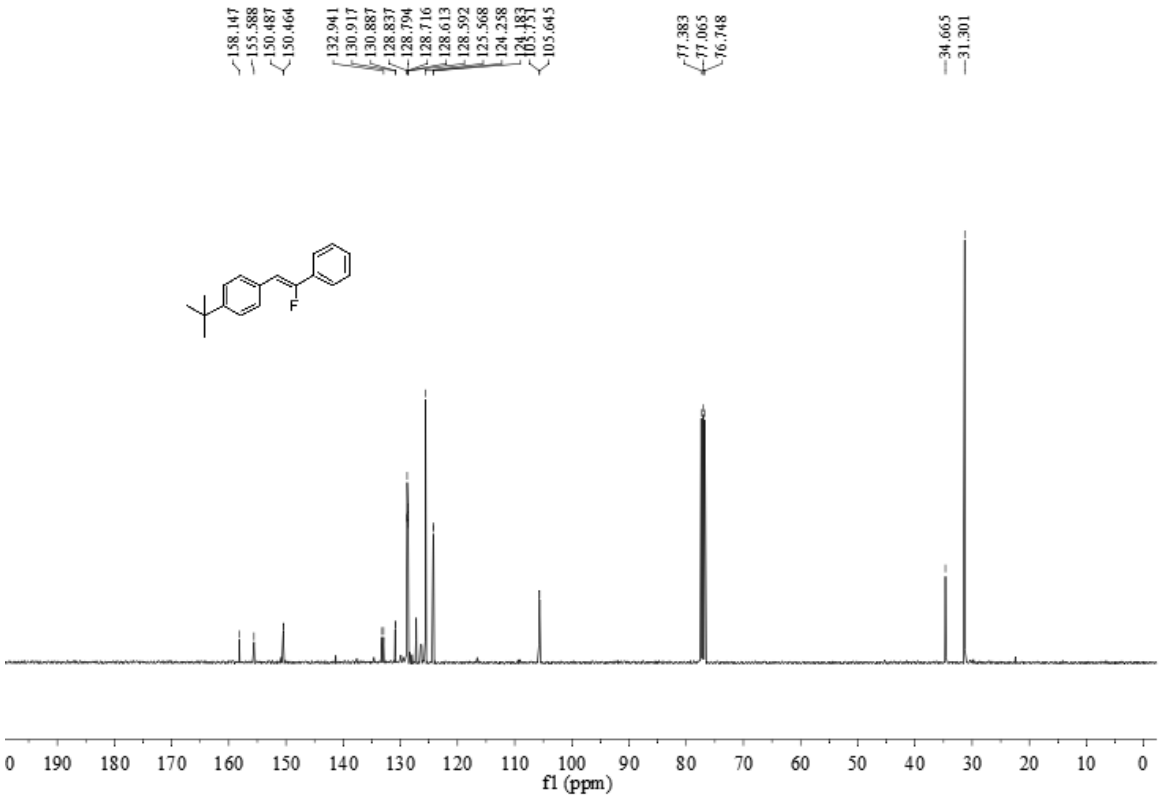
HRMS(EI) spectra of **(*Z*)-3ea**



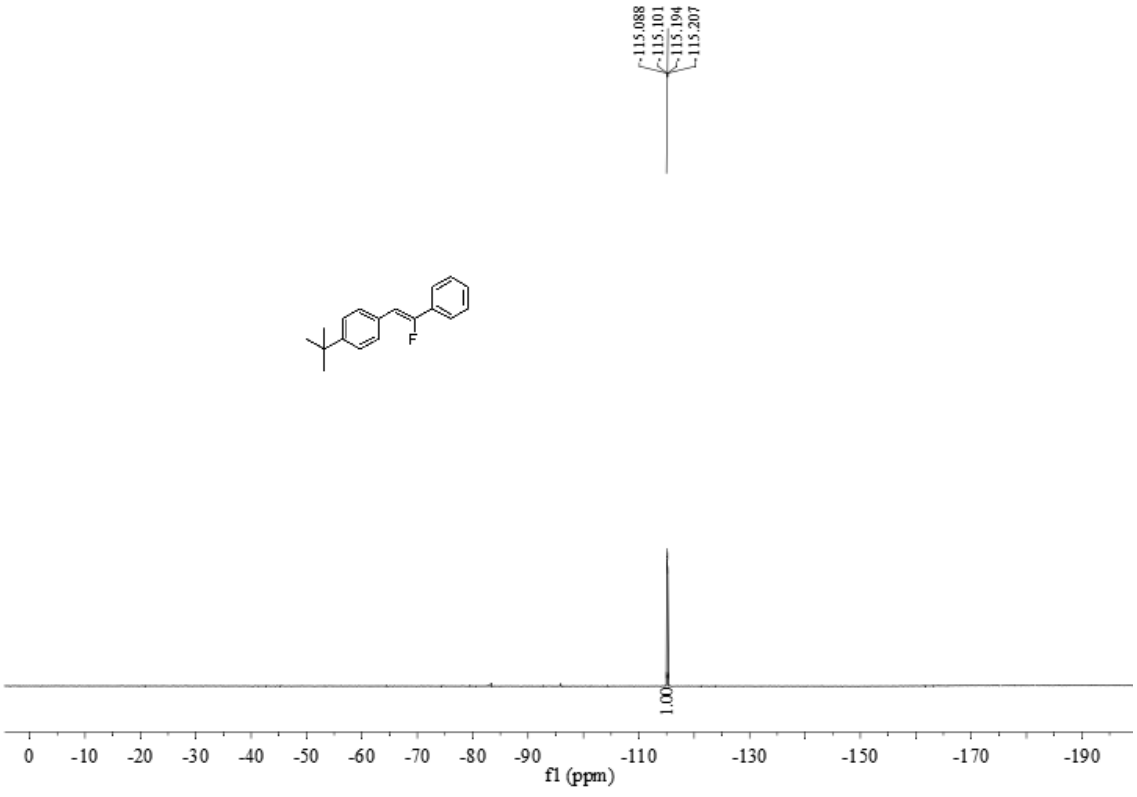
^{1}H NMR spectra of **(*Z*)-3fa**



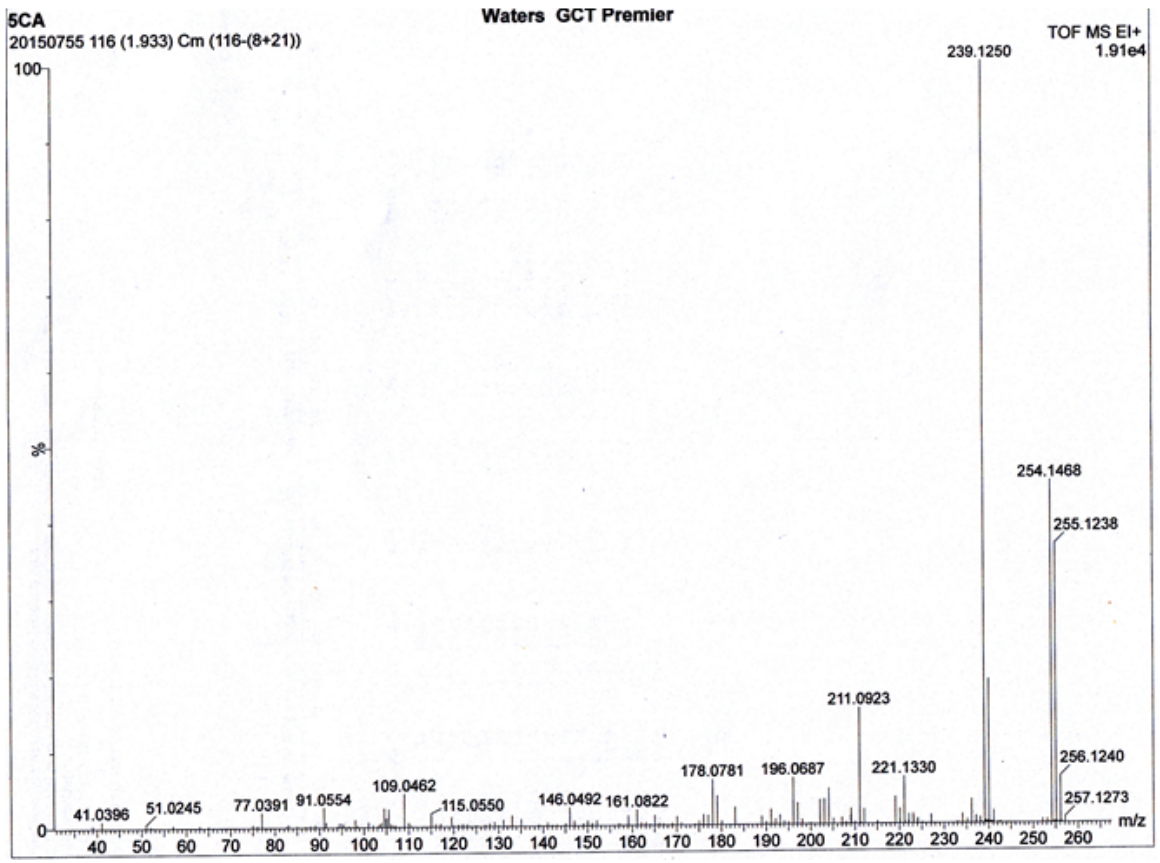
^{13}C NMR spectra of **(Z)-3fa**



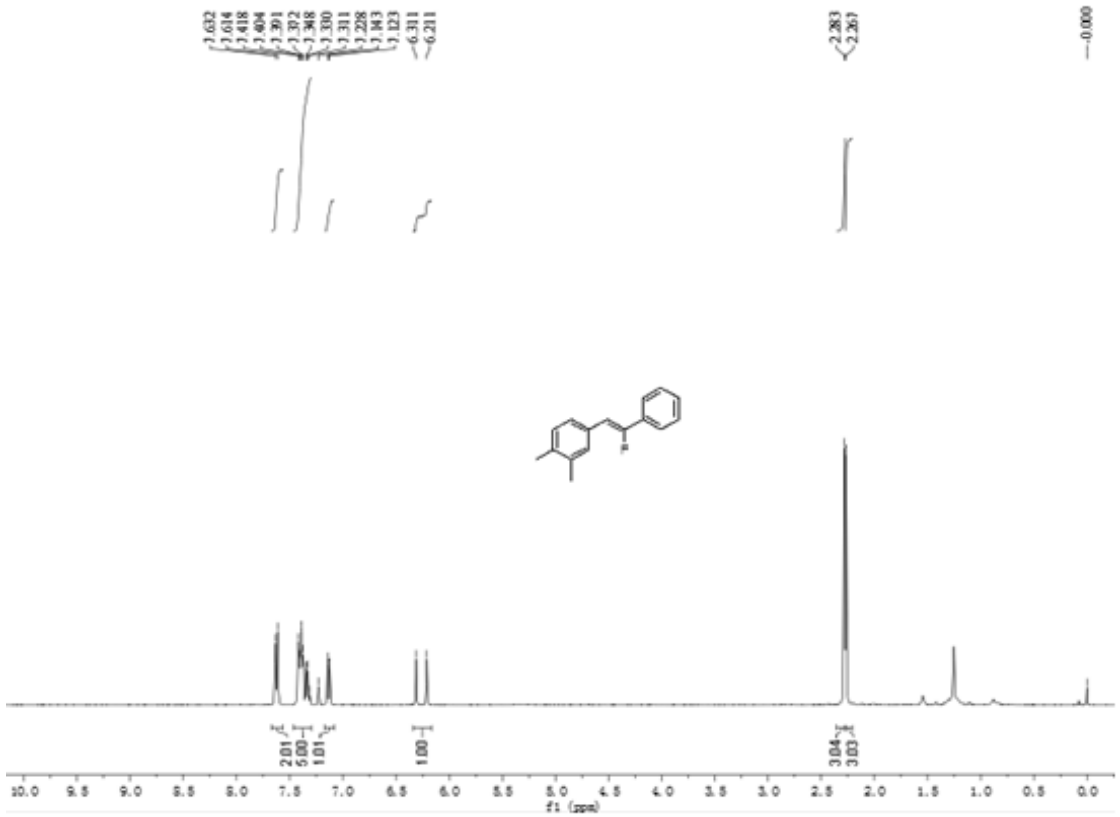
^{19}F NMR spectra of **(Z)-3fa**



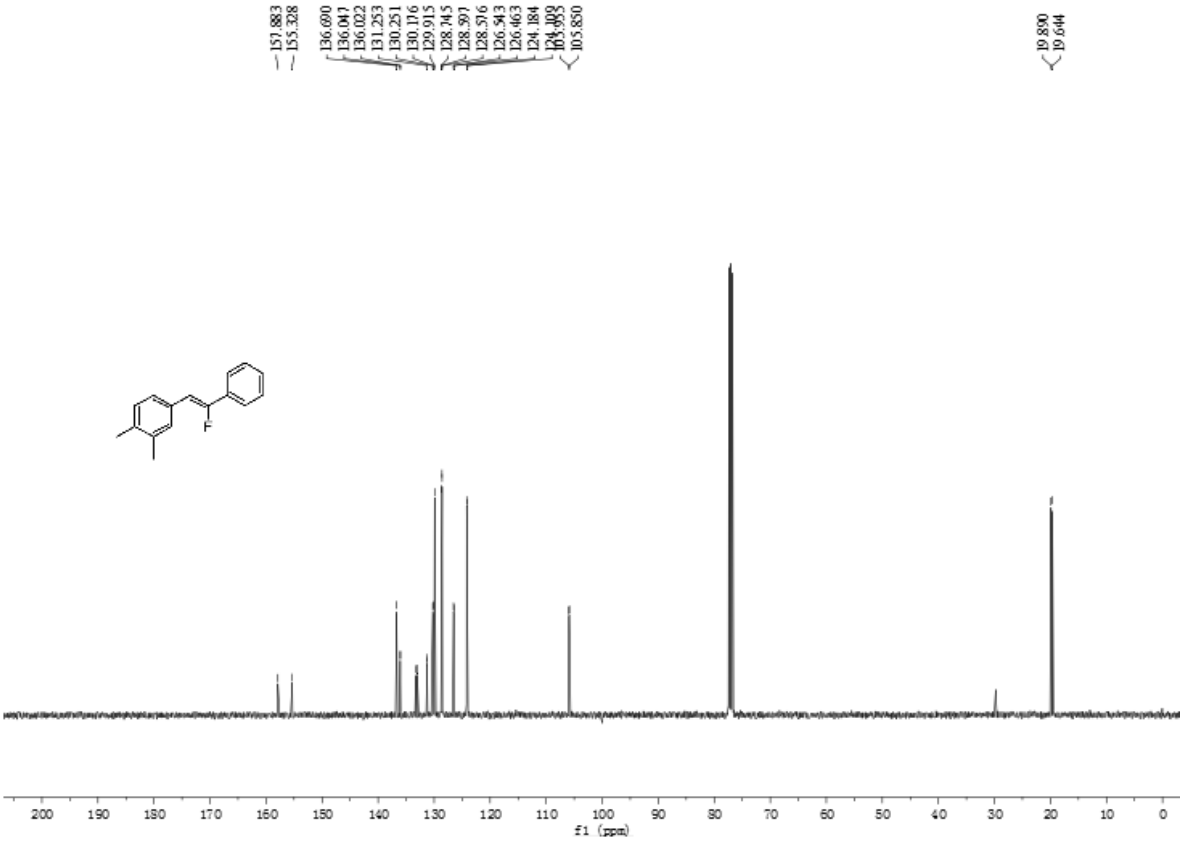
HRMS(EI) spectra of **(*Z*)-3fa**



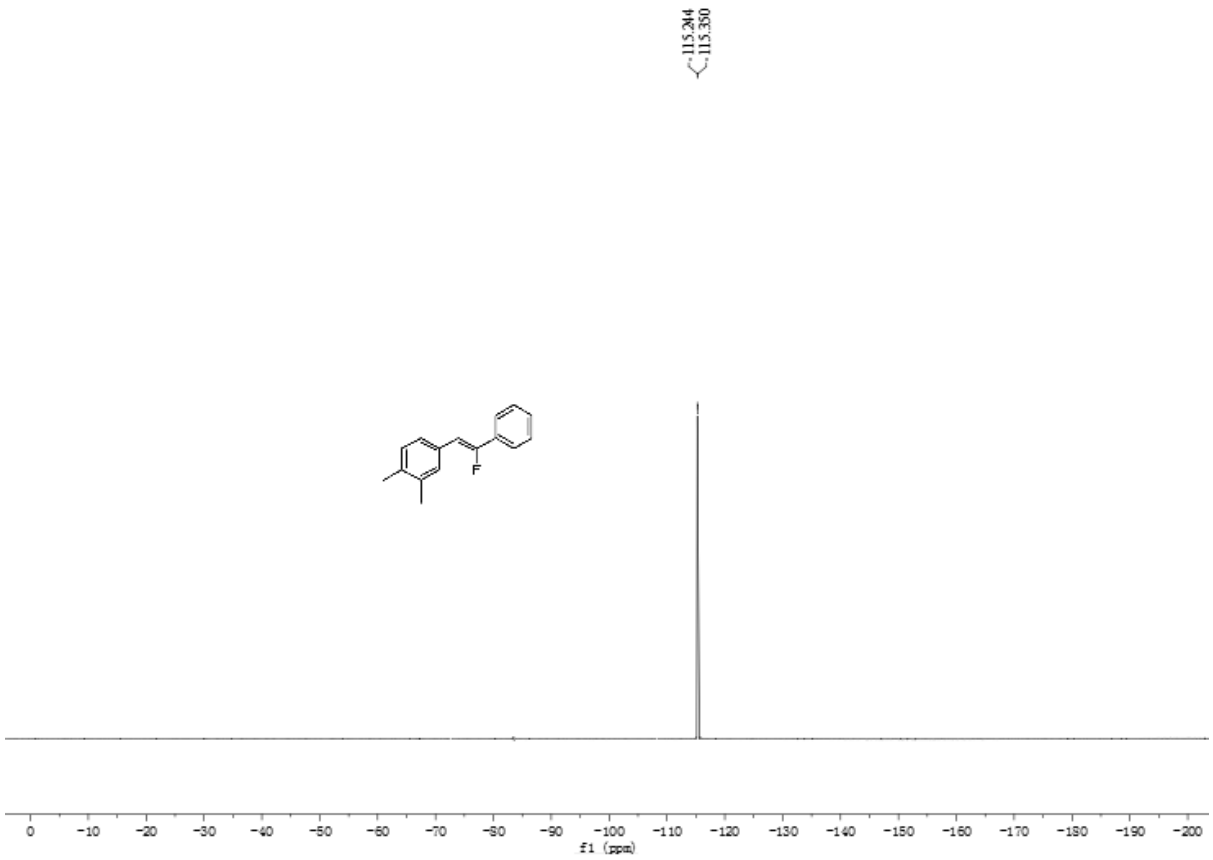
^{1}H NMR spectra of **(*Z*)-3ga**



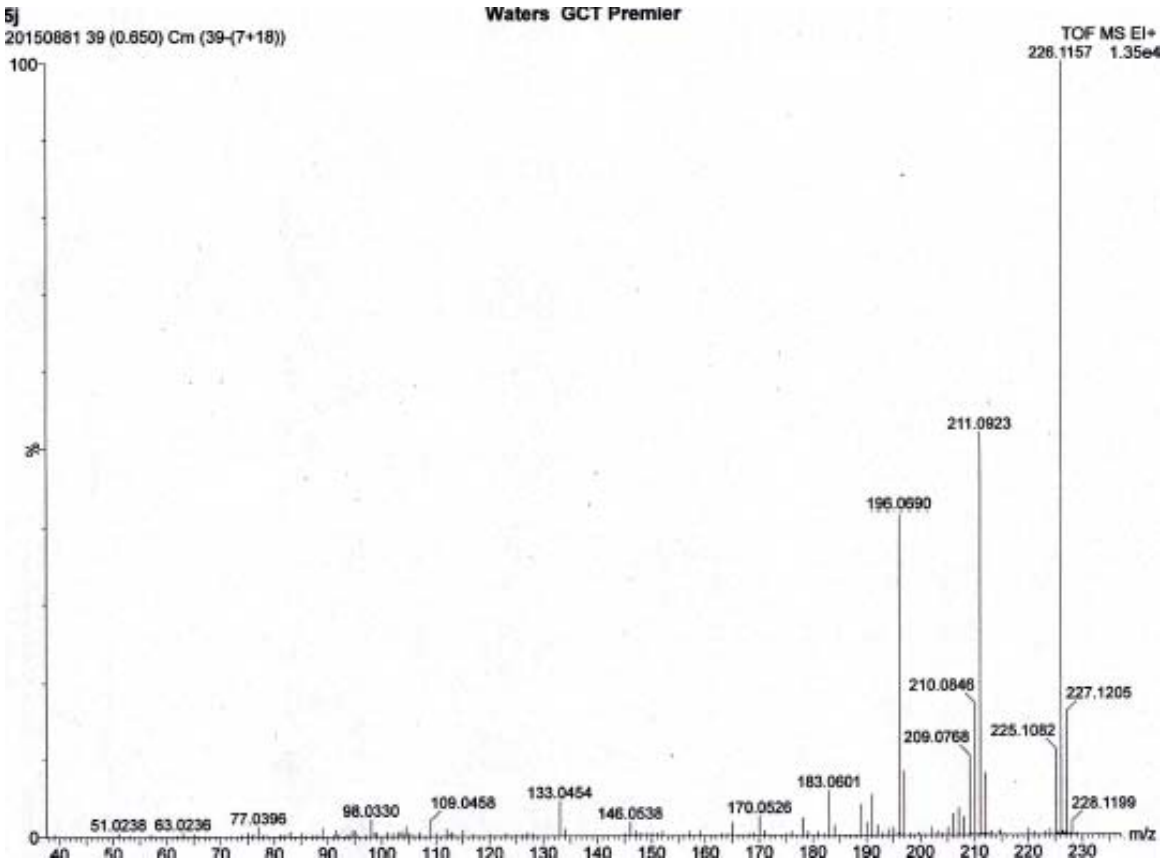
^{13}C NMR spectra of **(Z)-3ga**



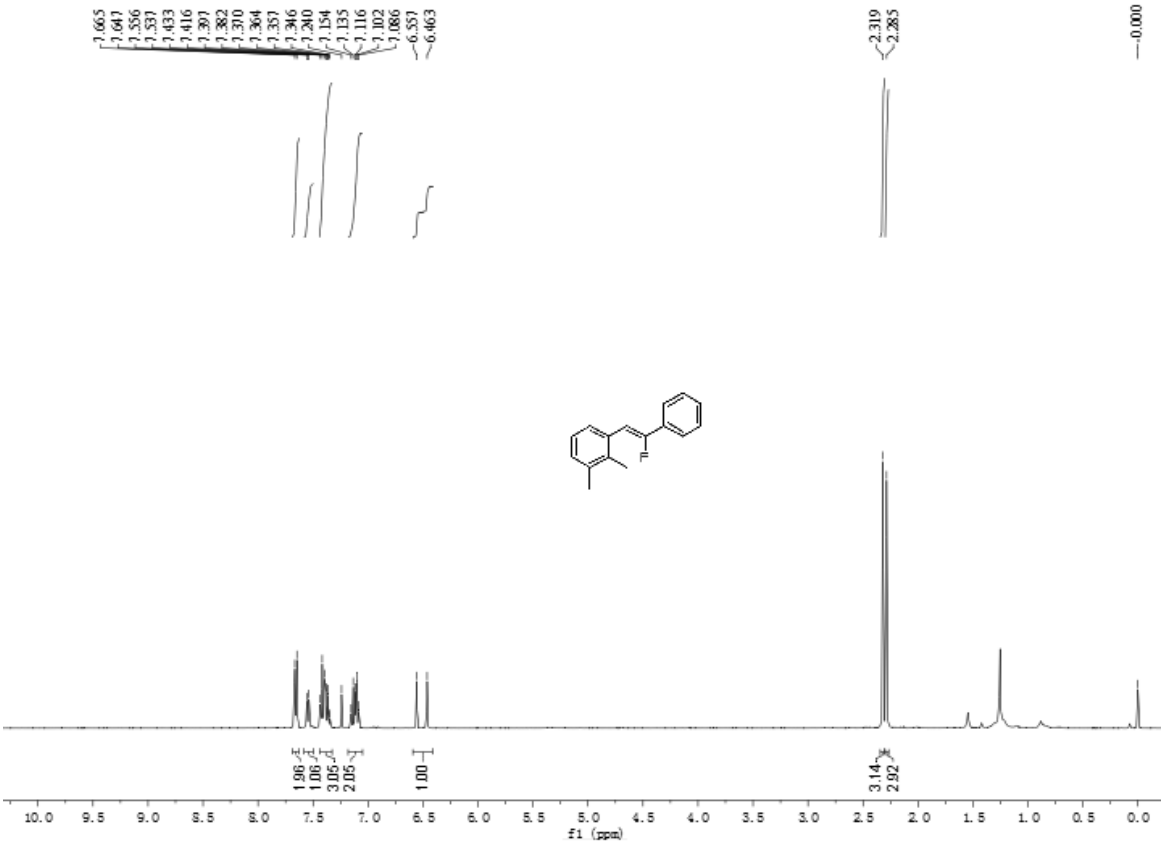
^{19}F NMR spectra of **(Z)-3ga**



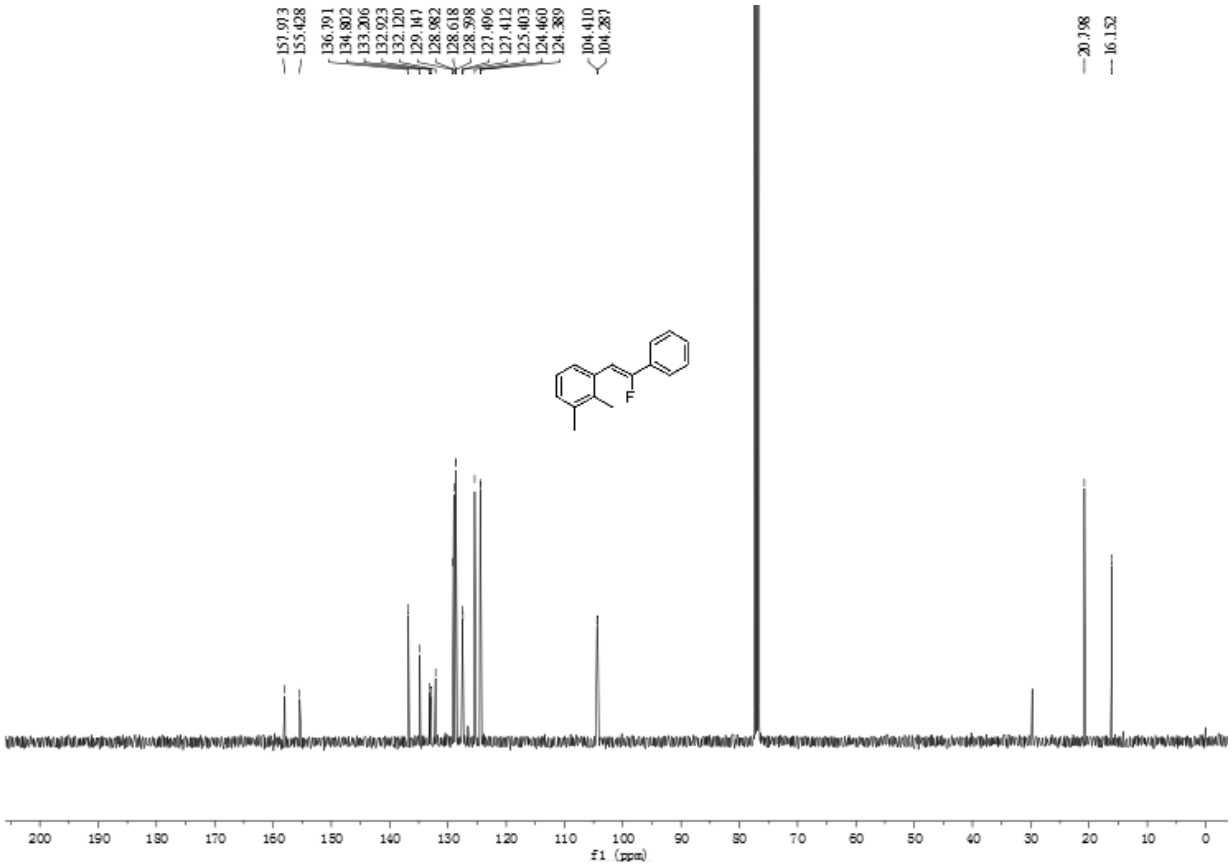
HRMS(EI) spectra of **(*Z*)-3ga**



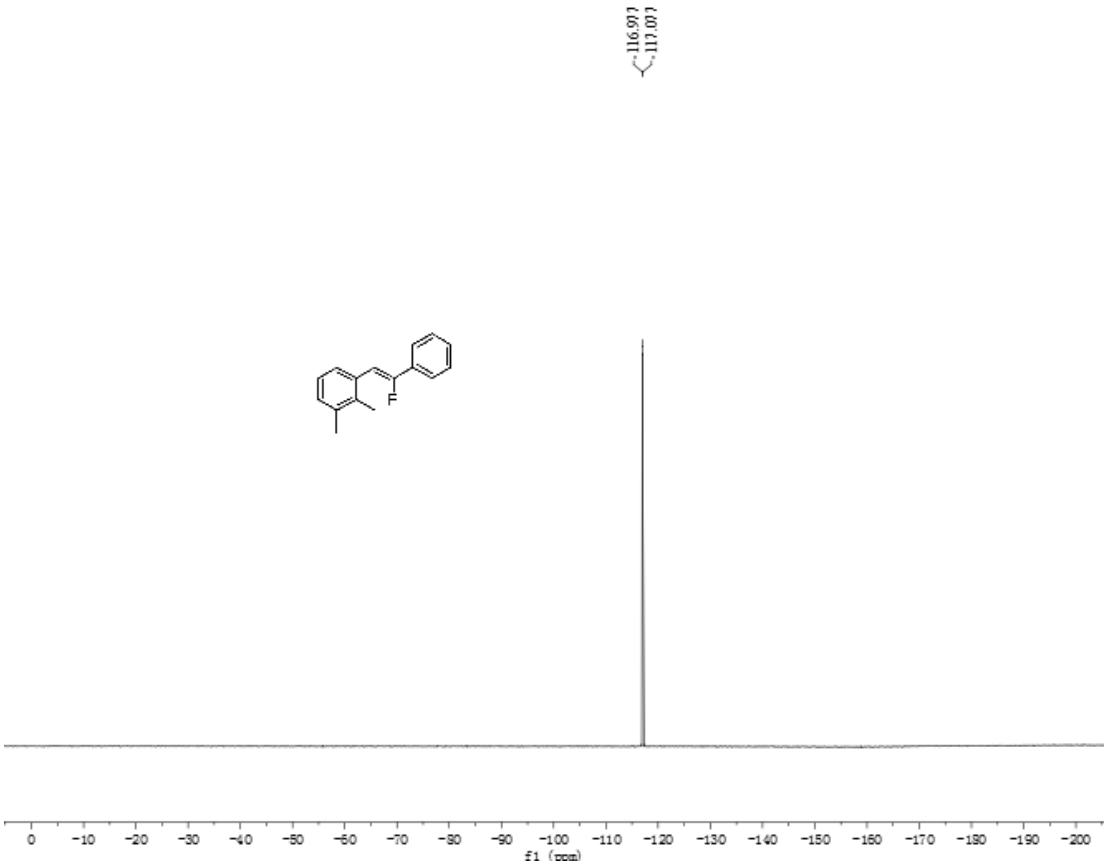
^{1}H NMR spectra of **(*Z*)-3ha**



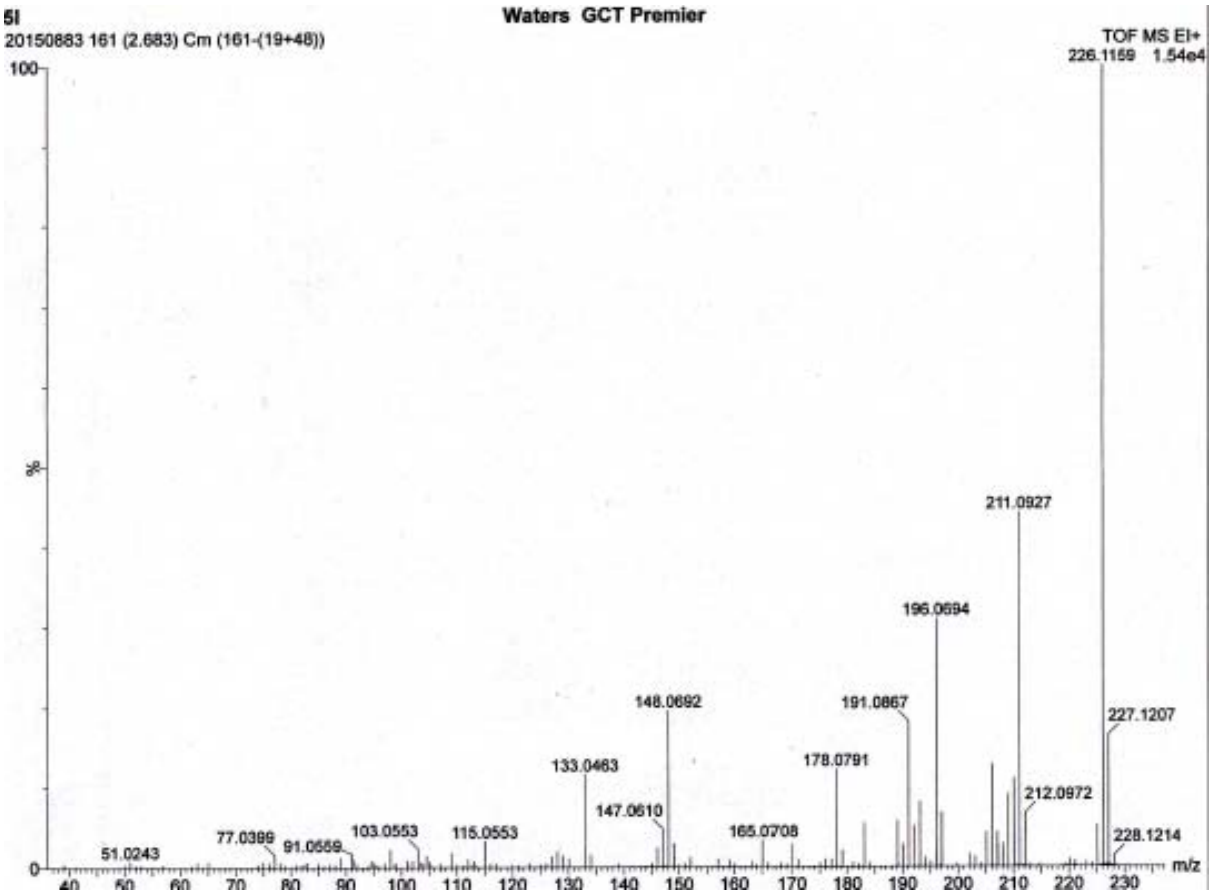
^{13}C NMR spectra of **(*Z*)-3ha**



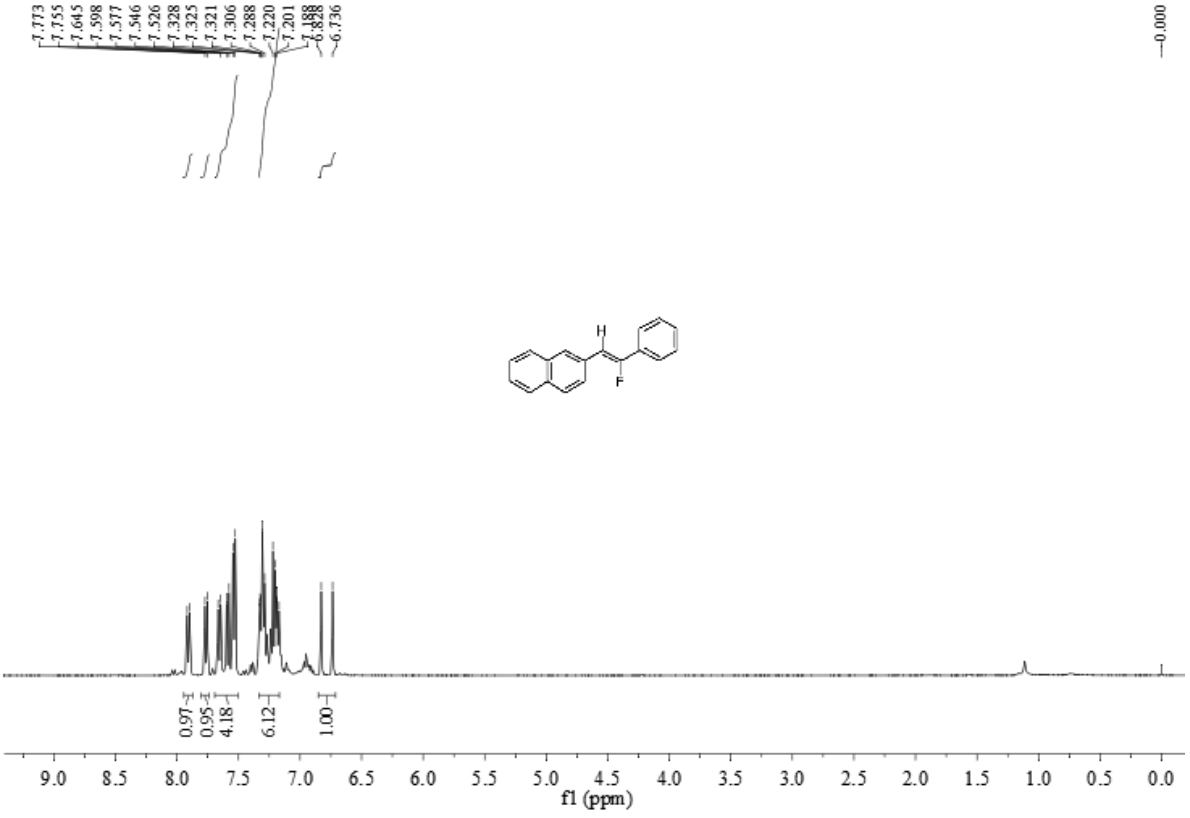
^{19}F NMR spectra of **(*Z*)-3ha**



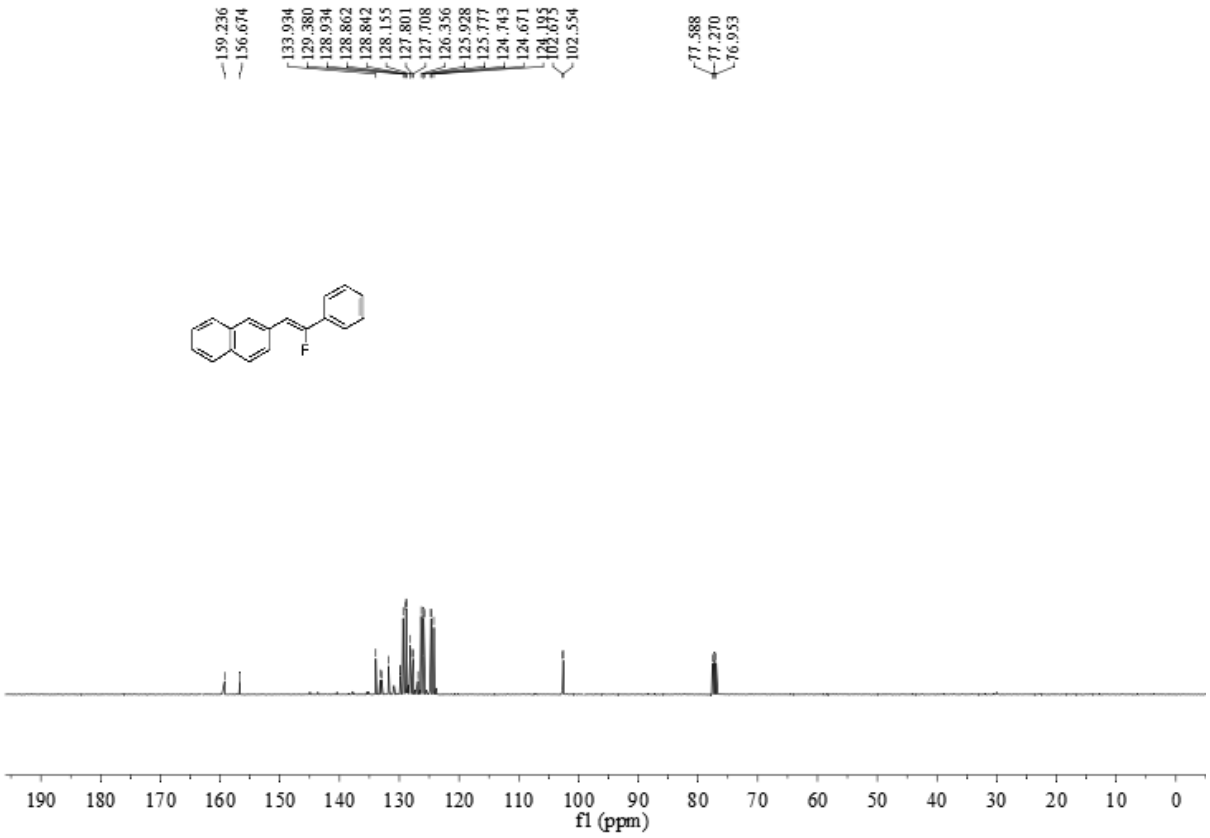
HRMS(EI) spectra of **(*Z*)-3ha**



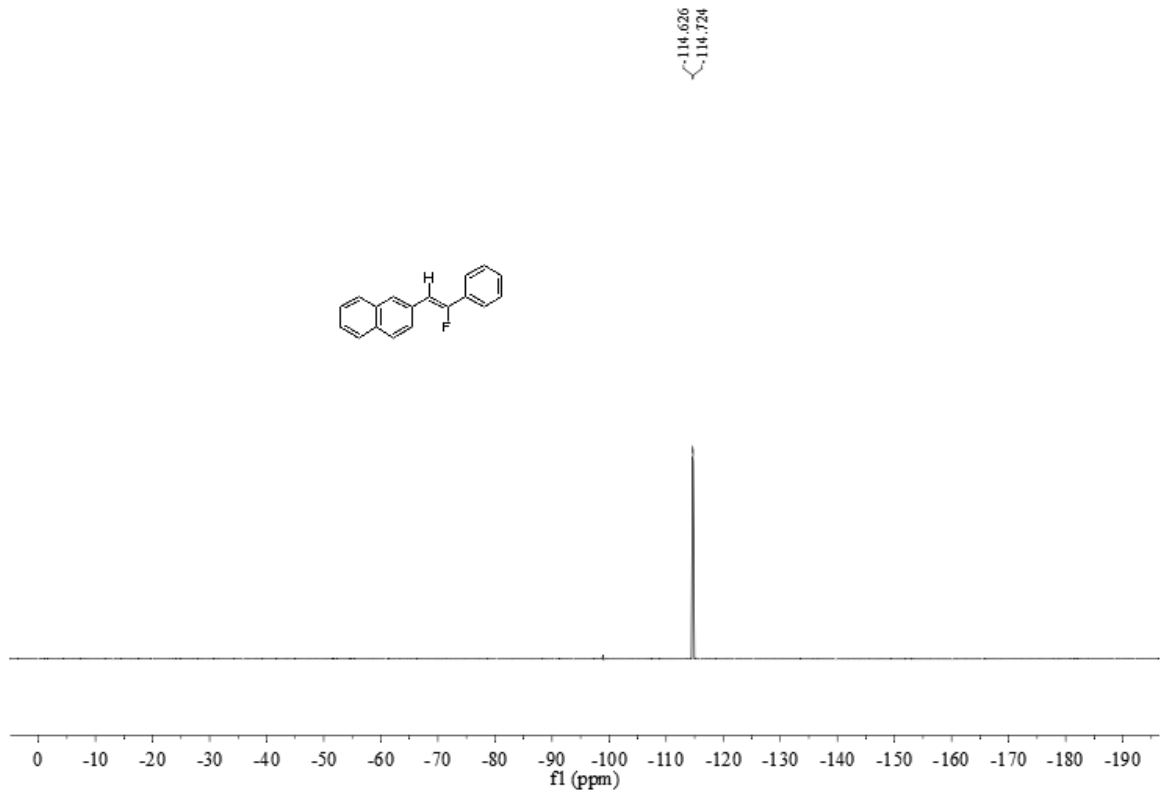
^{1}H NMR spectra of **(*Z*)-3ia**



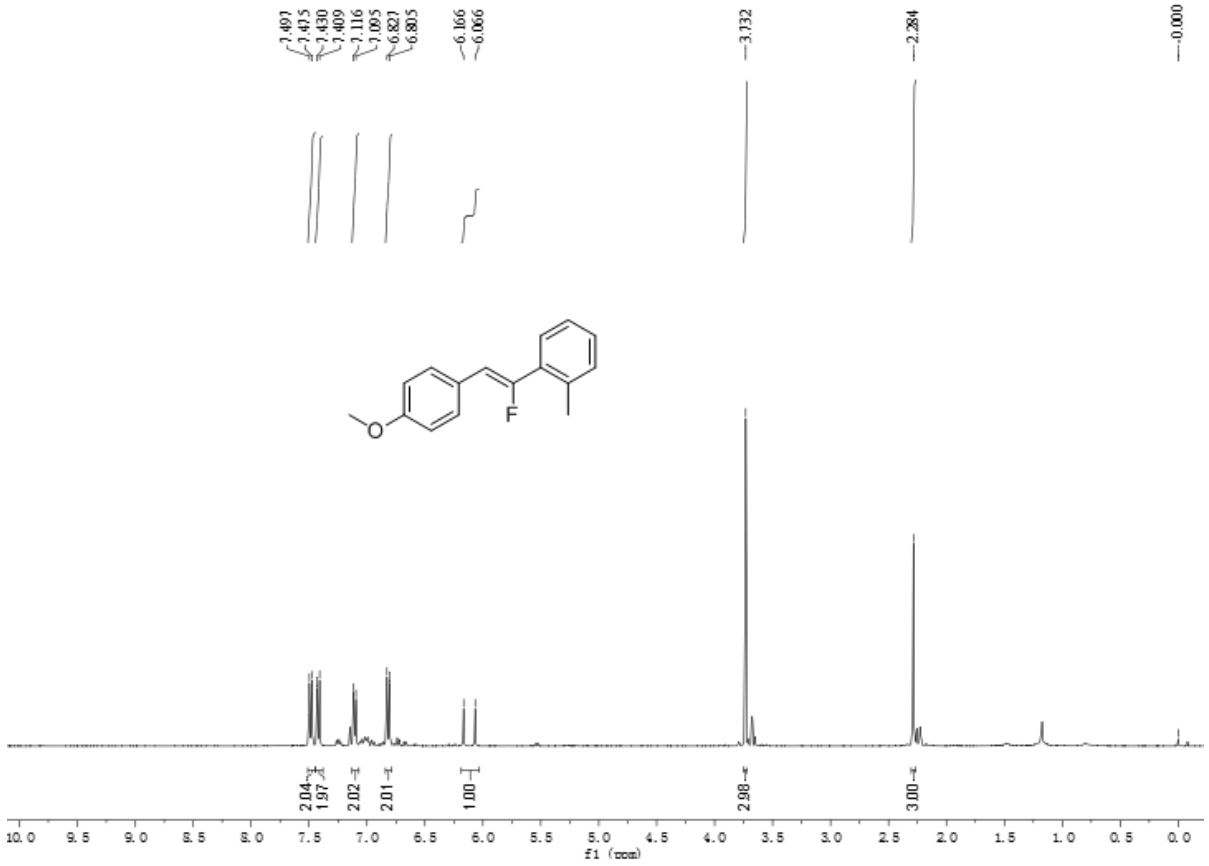
^{13}C NMR spectra of **(*Z*)-3ia**



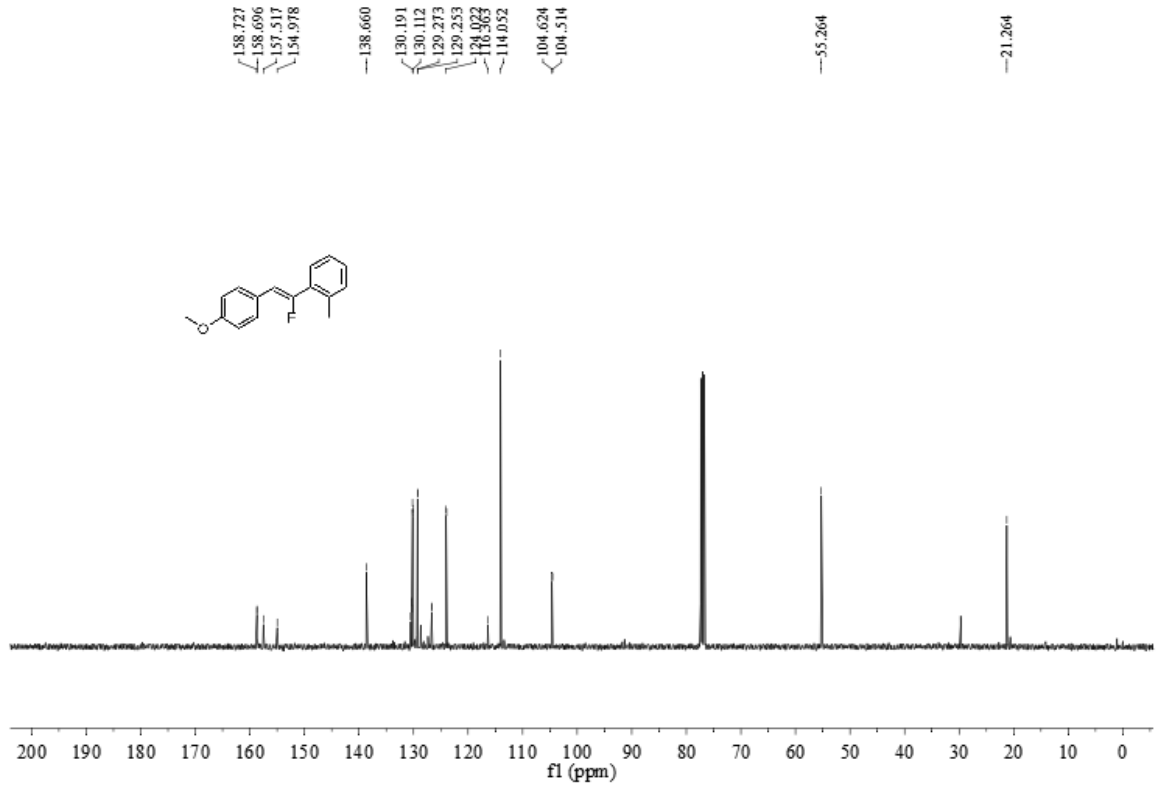
^{19}F NMR spectra of **(*Z*)-3ia**



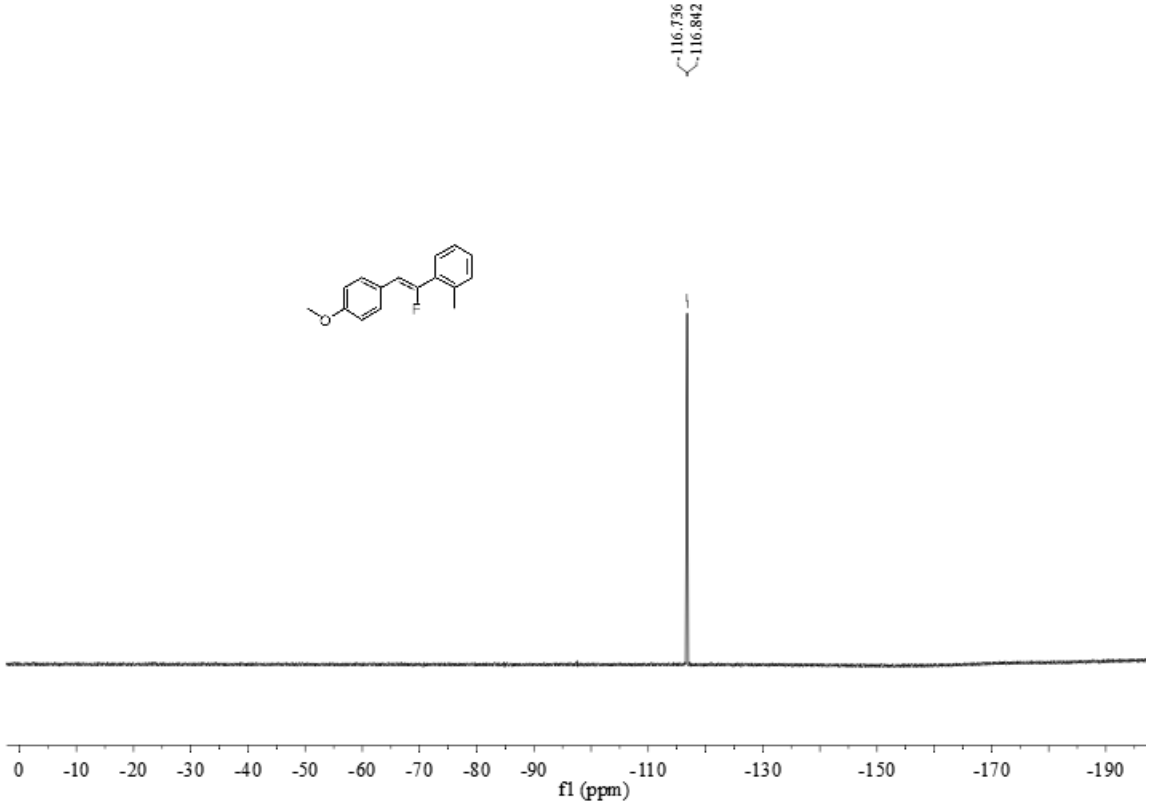
^{1}H NMR spectra of **(*Z*)-3ab**



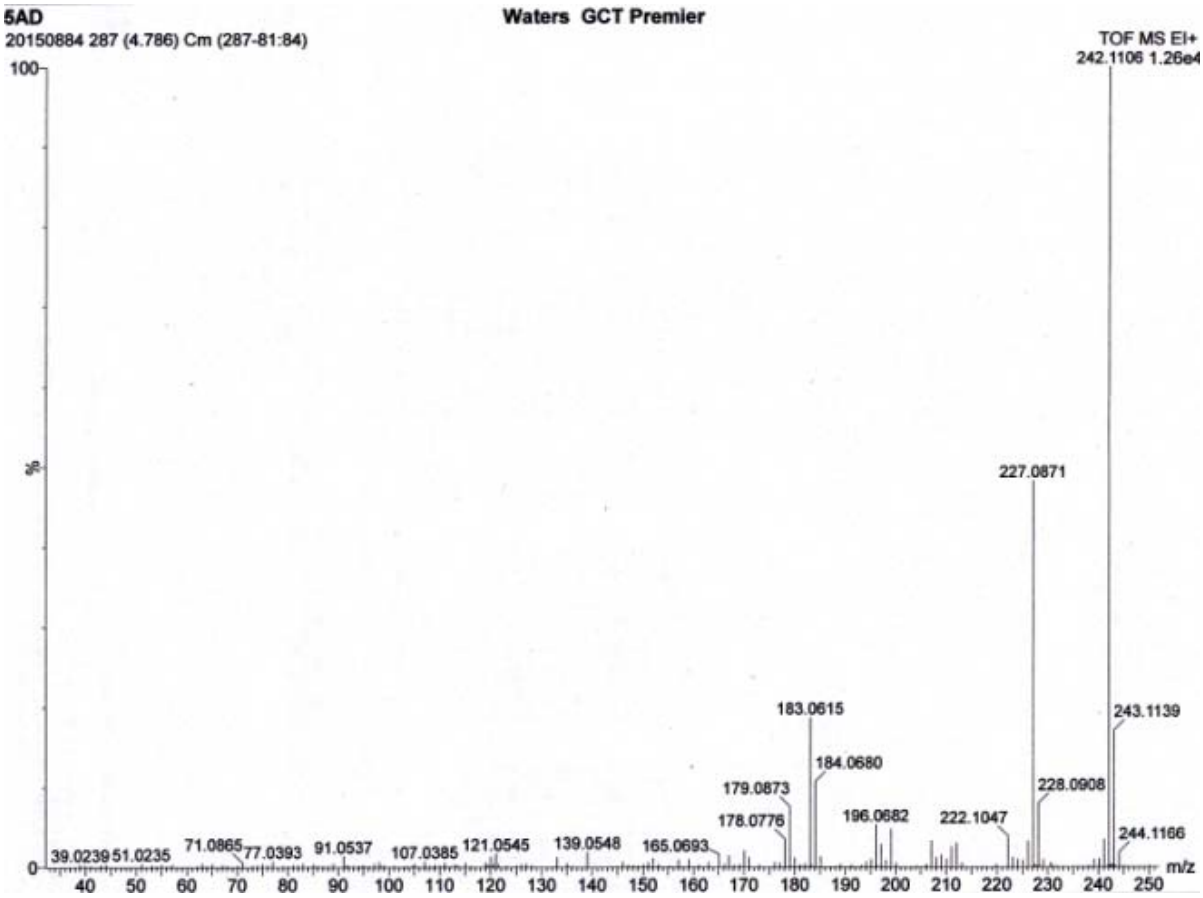
^{13}**C** NMR spectra of **(*Z*)-3ab**



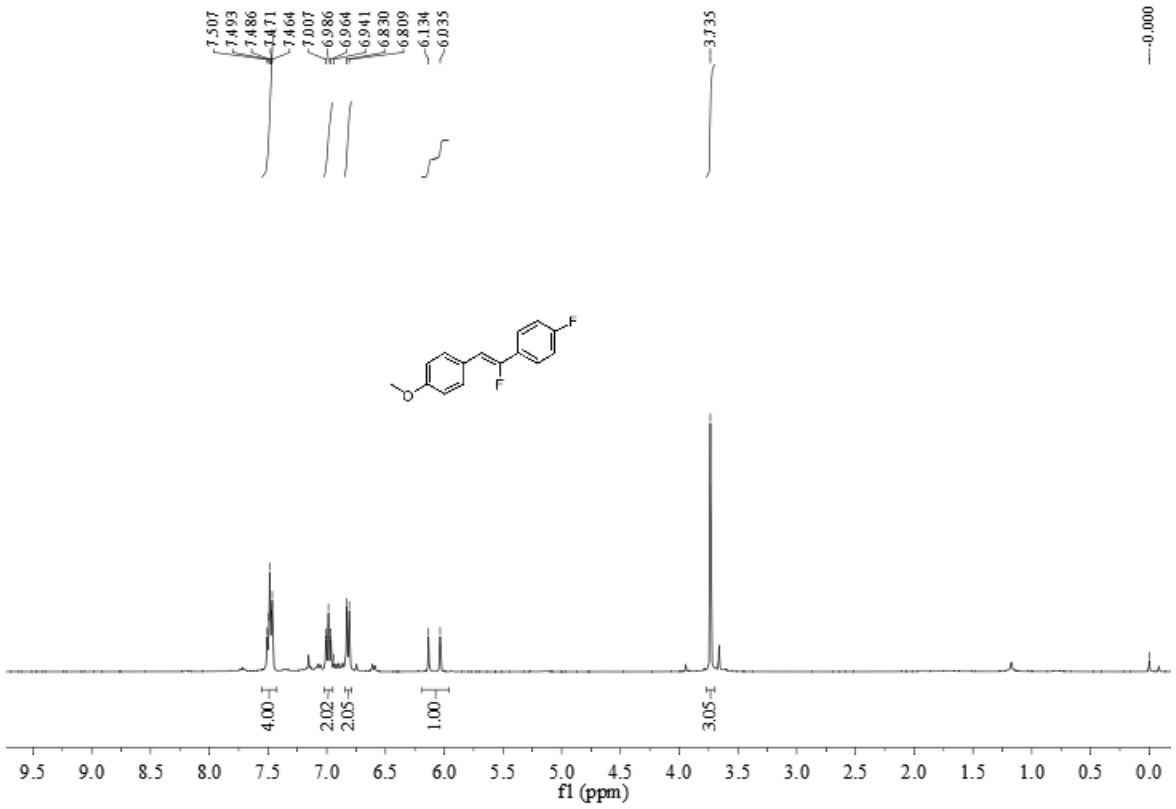
^{19}F NMR spectra of **(*Z*)-3ab**



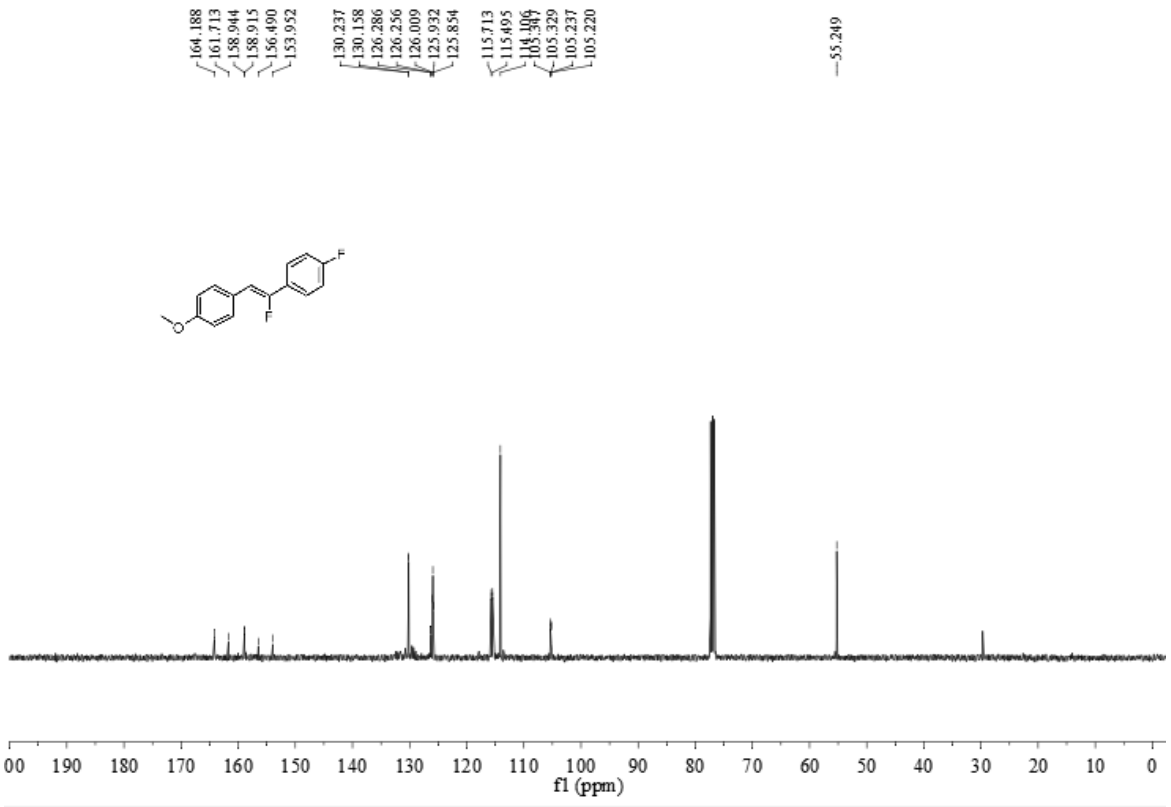
HRMS(EI) spectra of **(*Z*)-3ab**



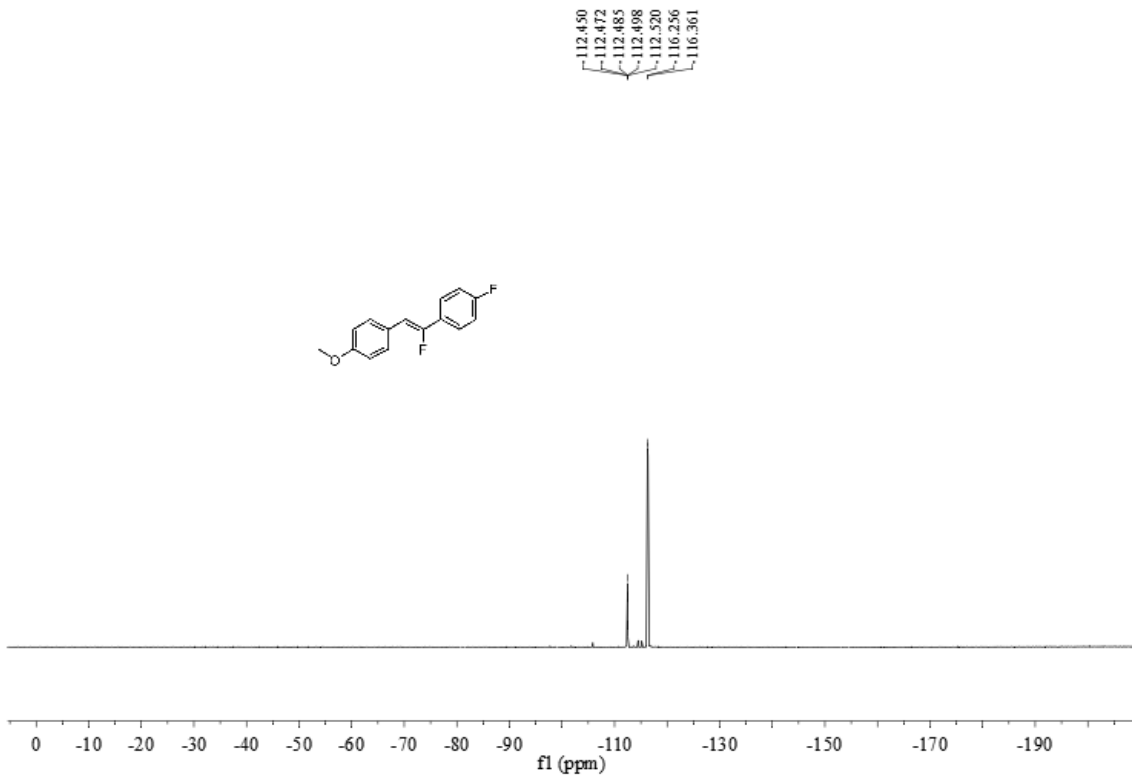
^{1}H NMR spectra of **(*Z*)-3ac**



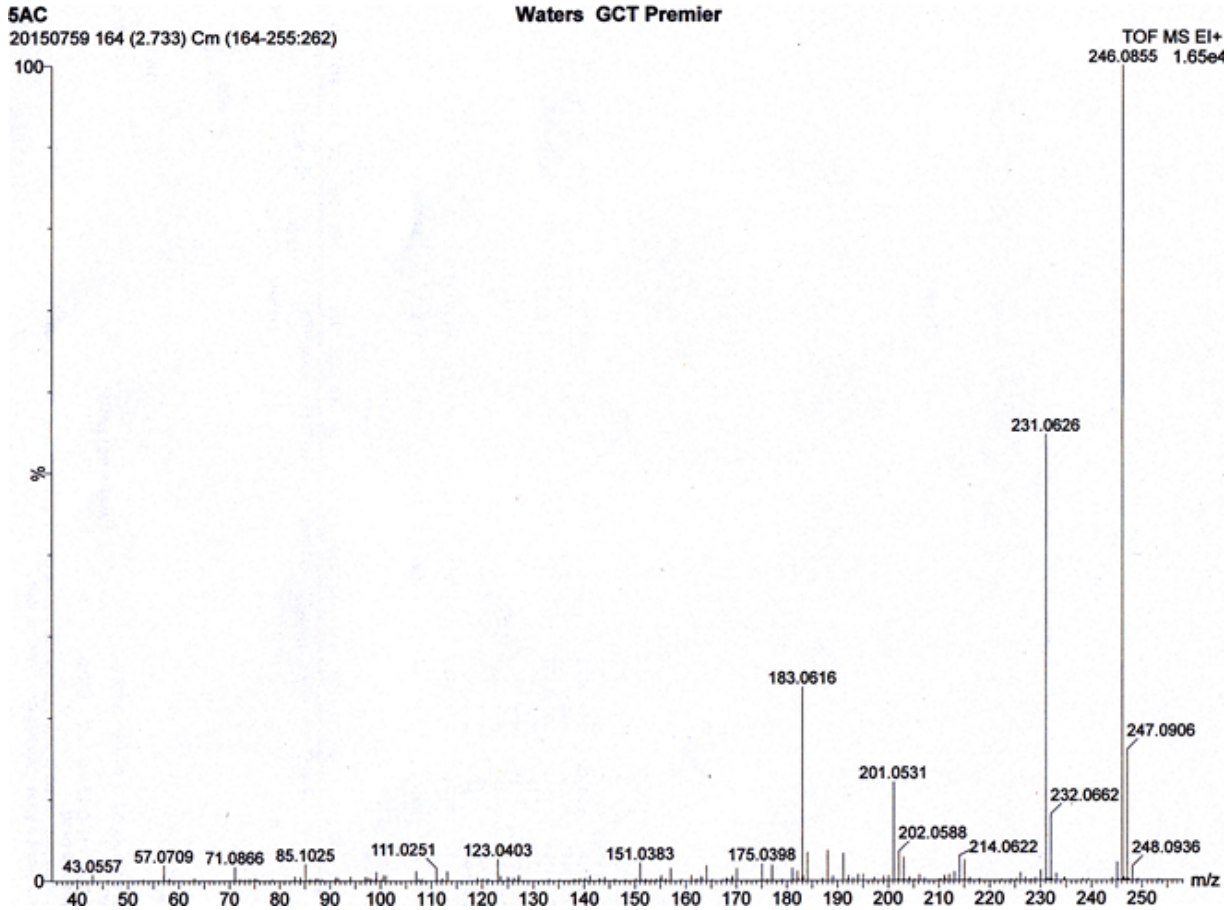
^{13}C NMR spectra of **(*Z*)-3ac**



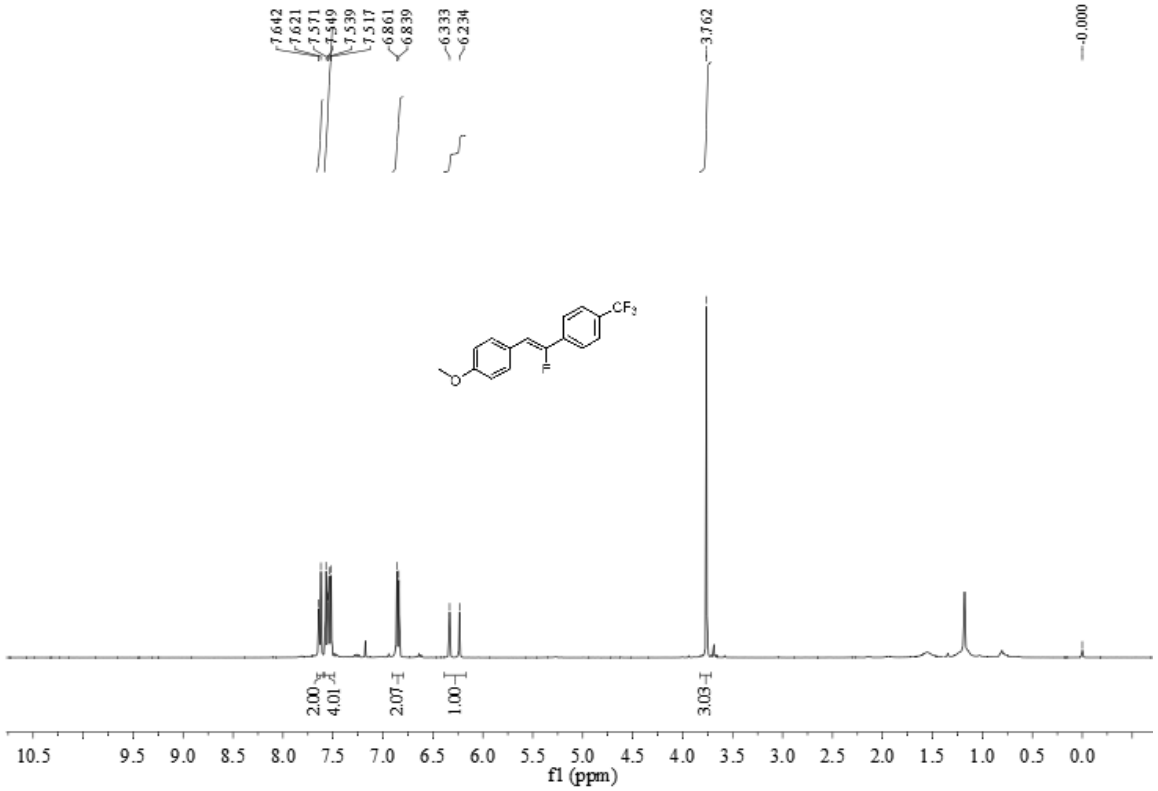
^{19}**F** NMR spectra of **(*Z*)-3ac**



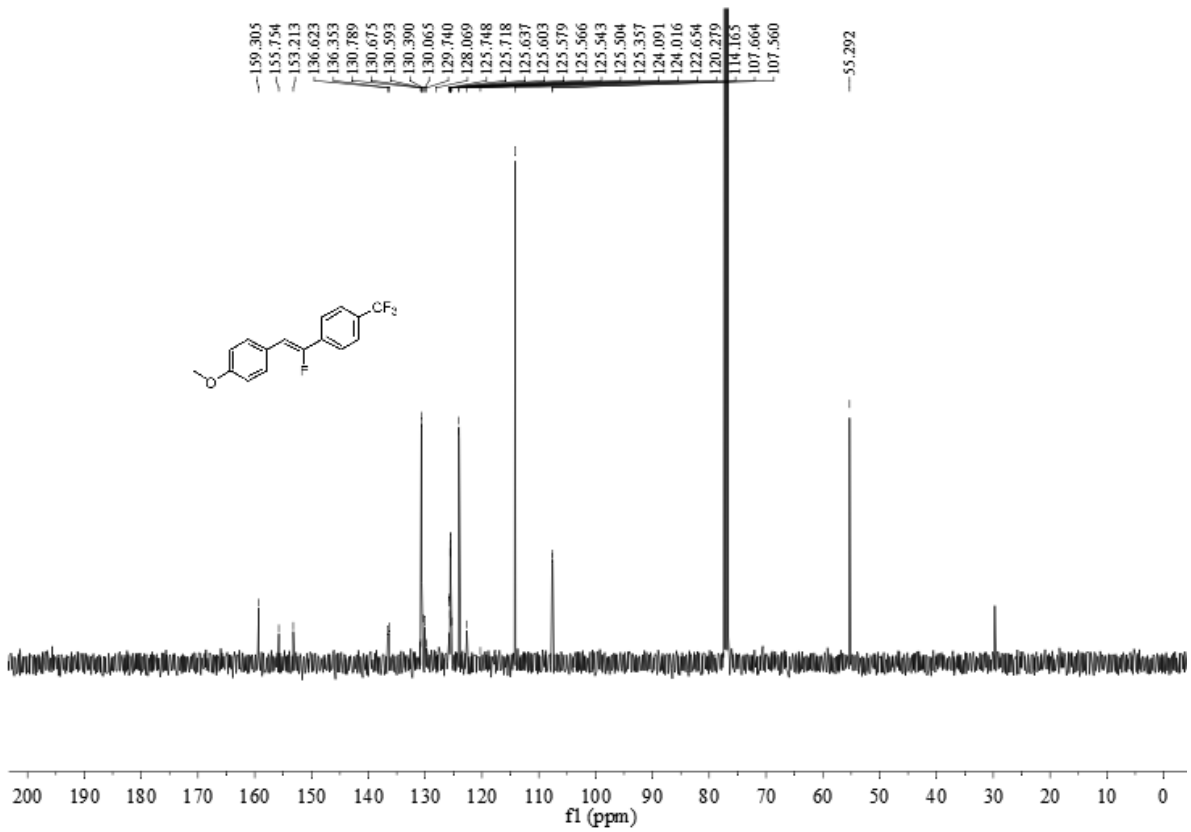
HRMS(EI) spectra of **(*Z*)-3ac**



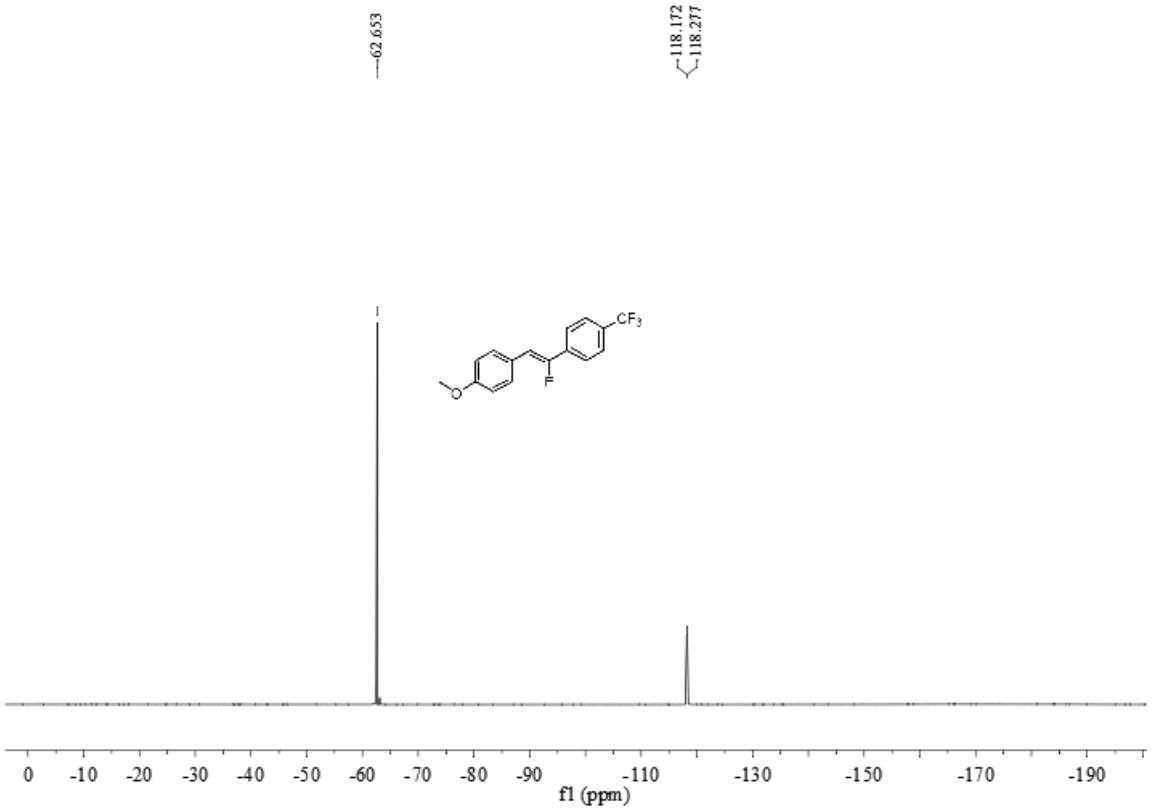
^{1}H NMR spectra of **(*Z*)-3ad**



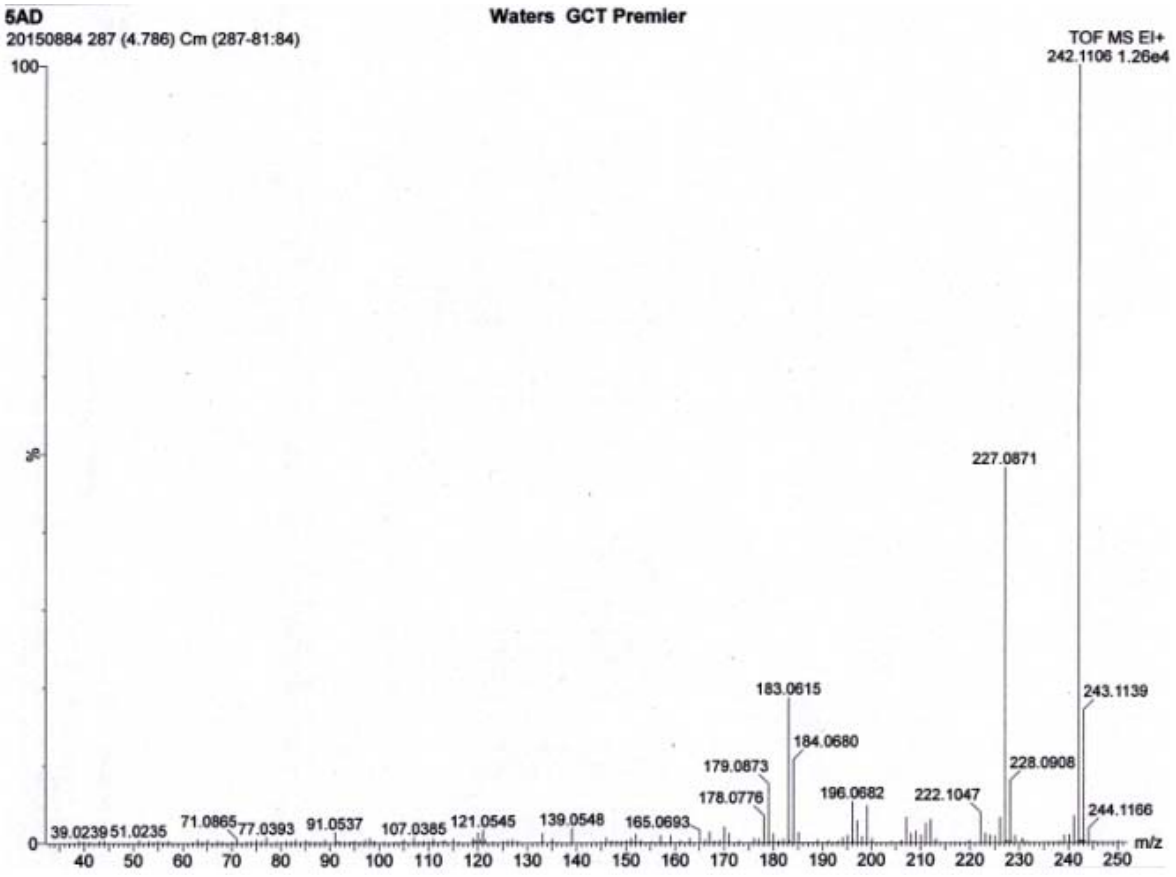
^{13}C NMR spectra of **(*Z*)-3ad**



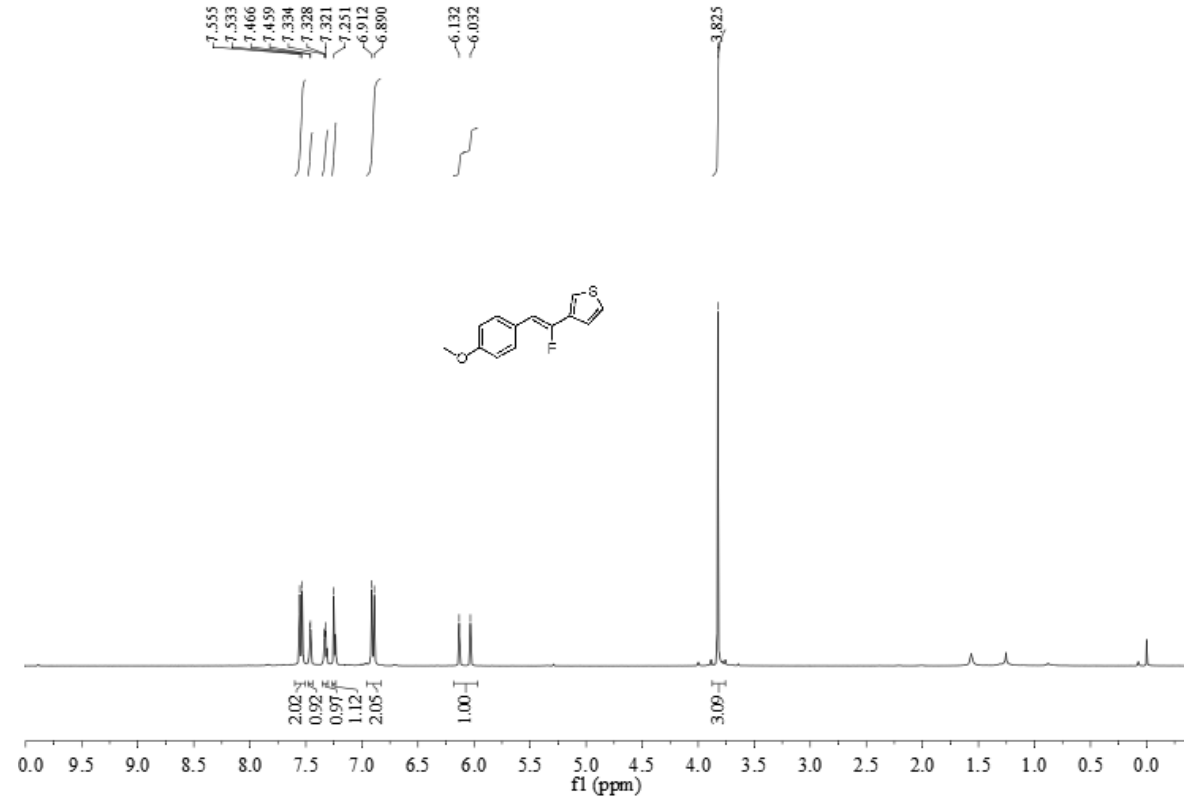
^{19}F NMR spectra of **(*Z*)-3ad**



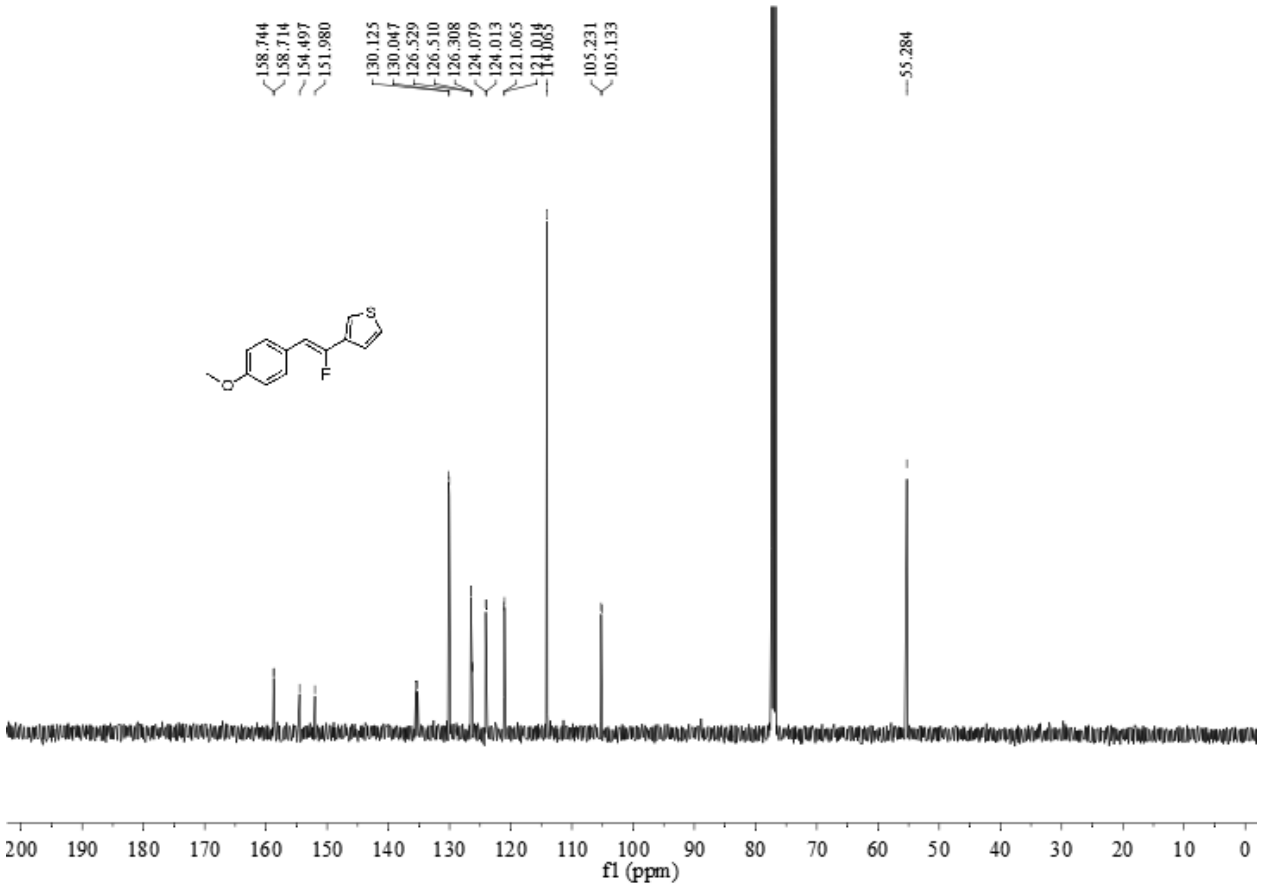
HRMS(EI) spectra of **(*Z*)-3ad**



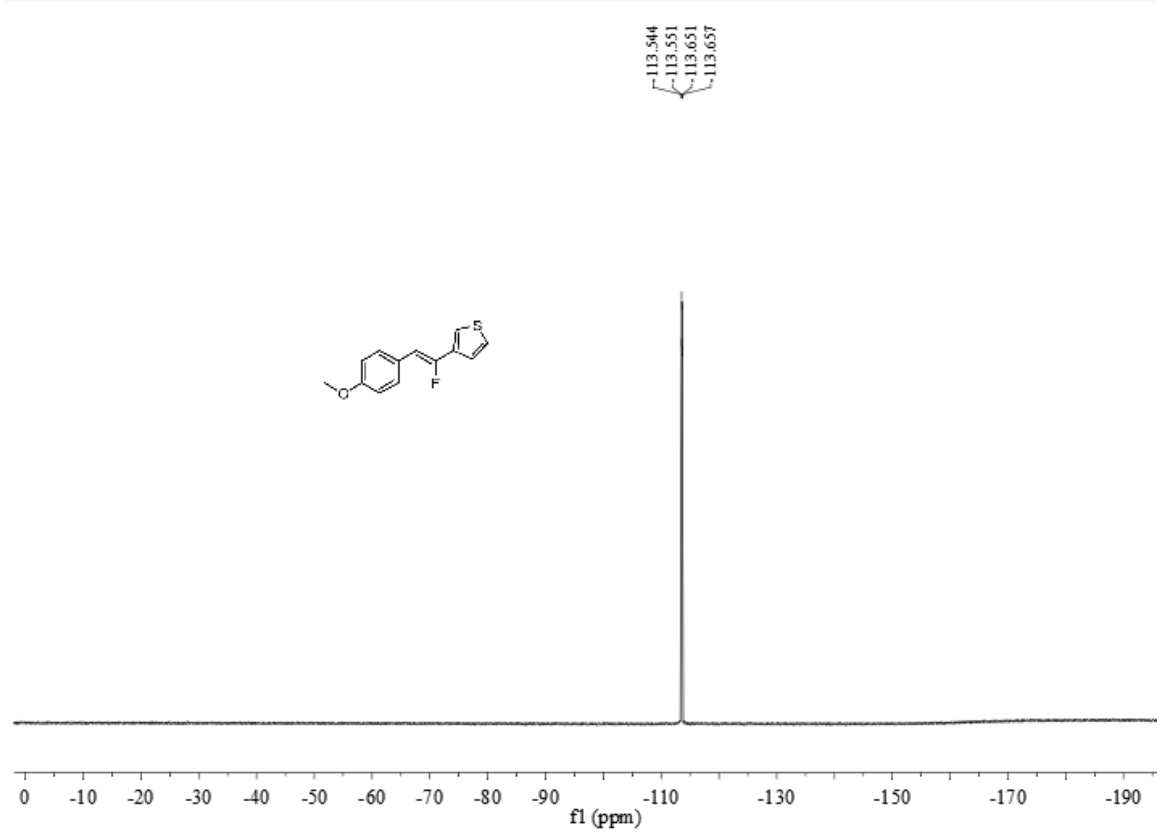
^{1}H NMR spectra of **(*Z*)-3ae**



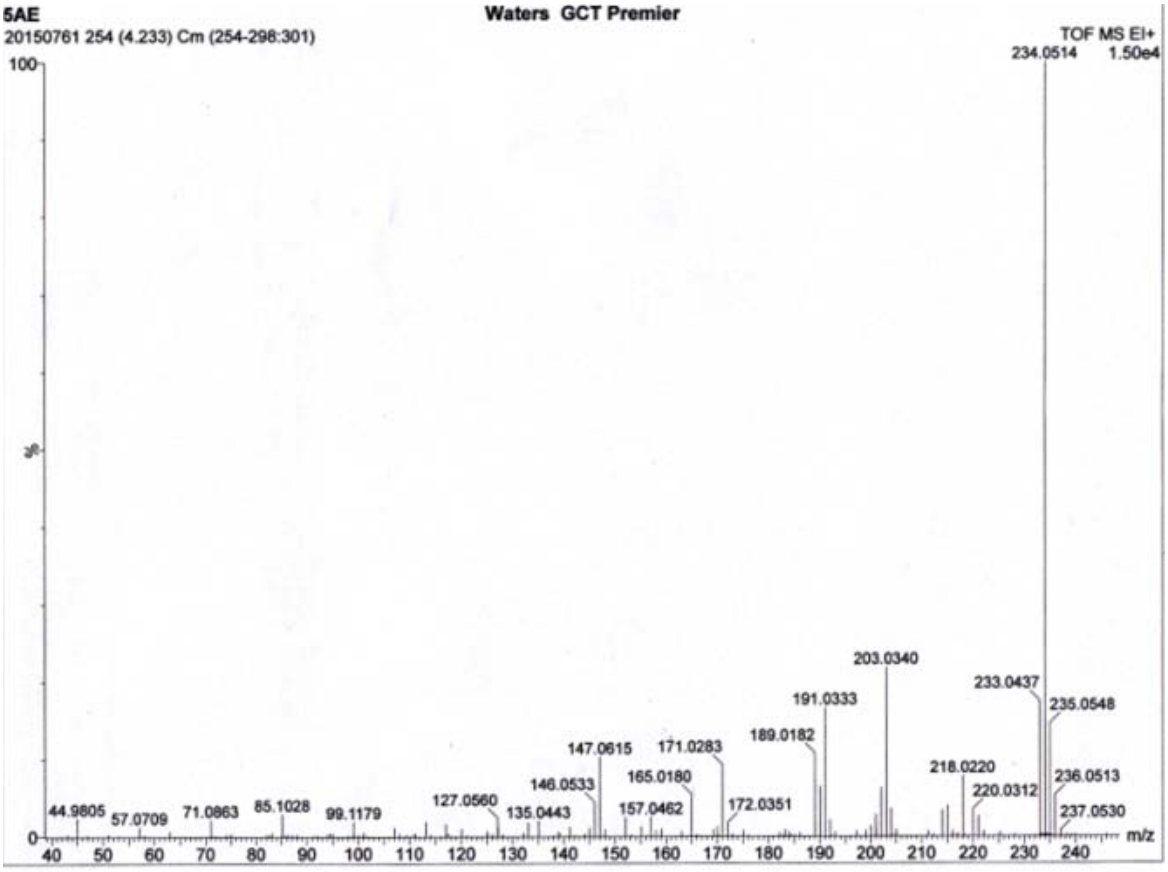
^{13}C NMR spectra of **(*Z*)-3ae**



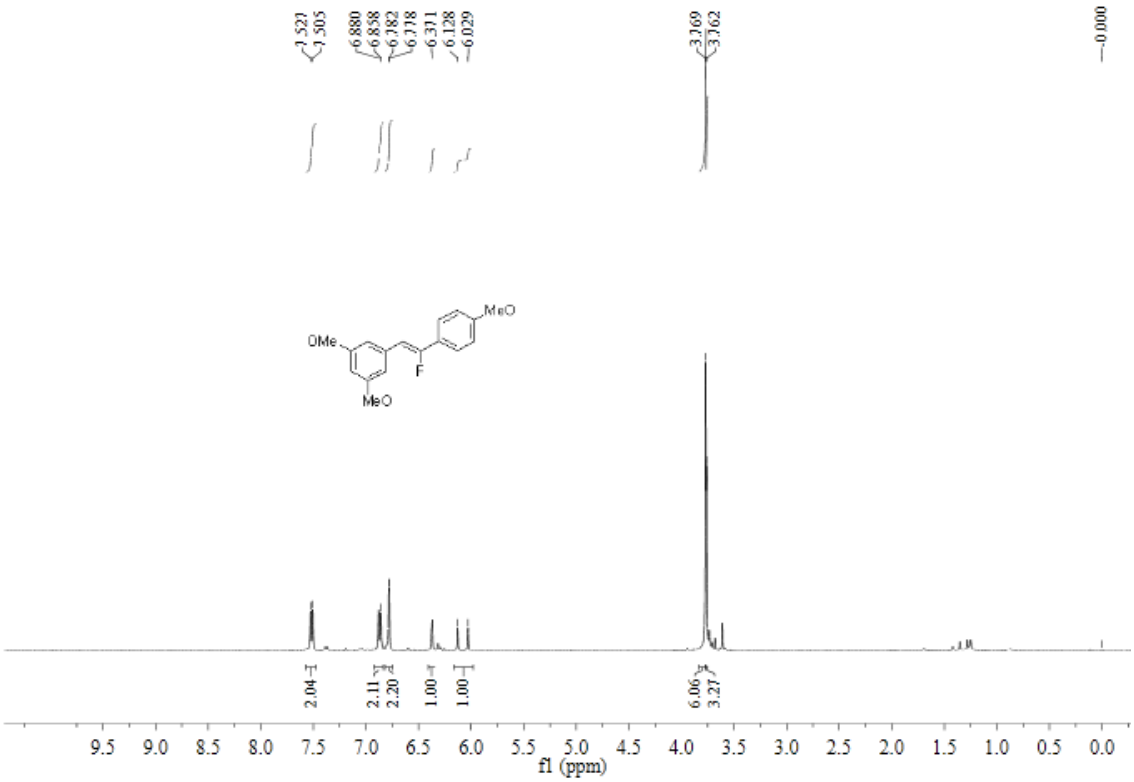
^{19}**F** NMR spectra of **(Z)-3ae**



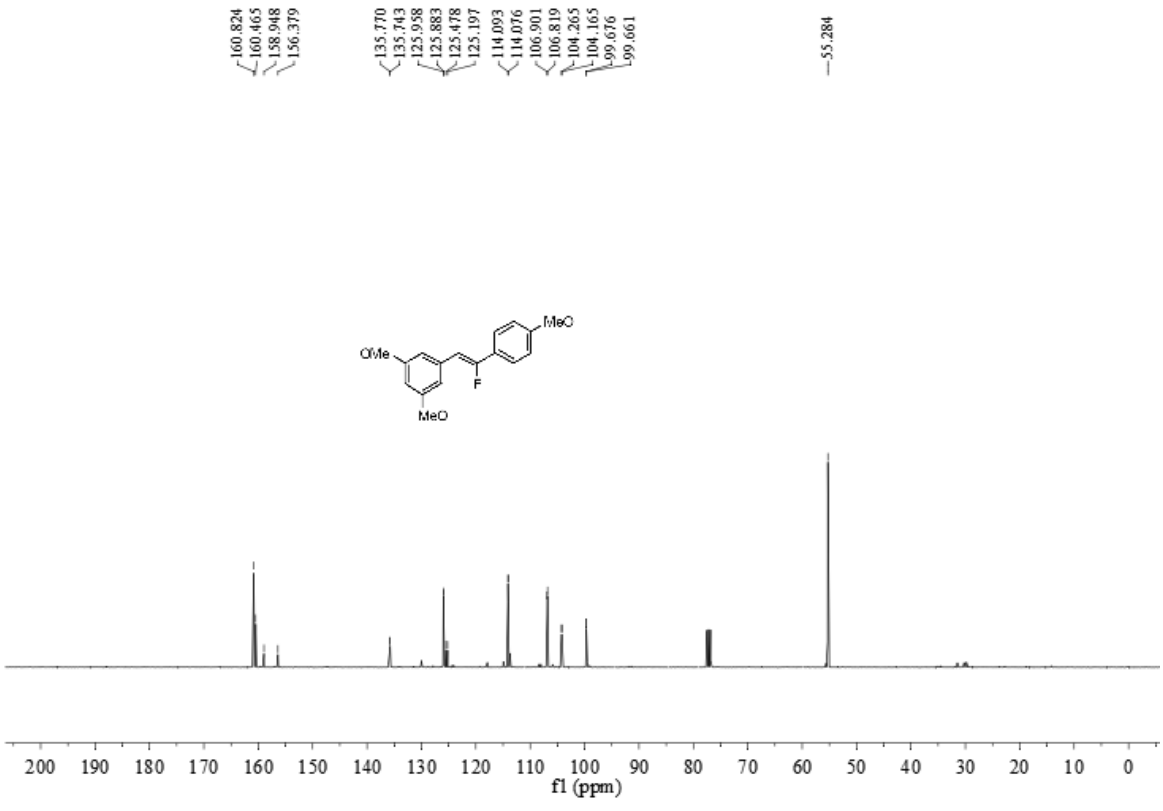
HRMS(EI) spectra of **(Z)-3ae**



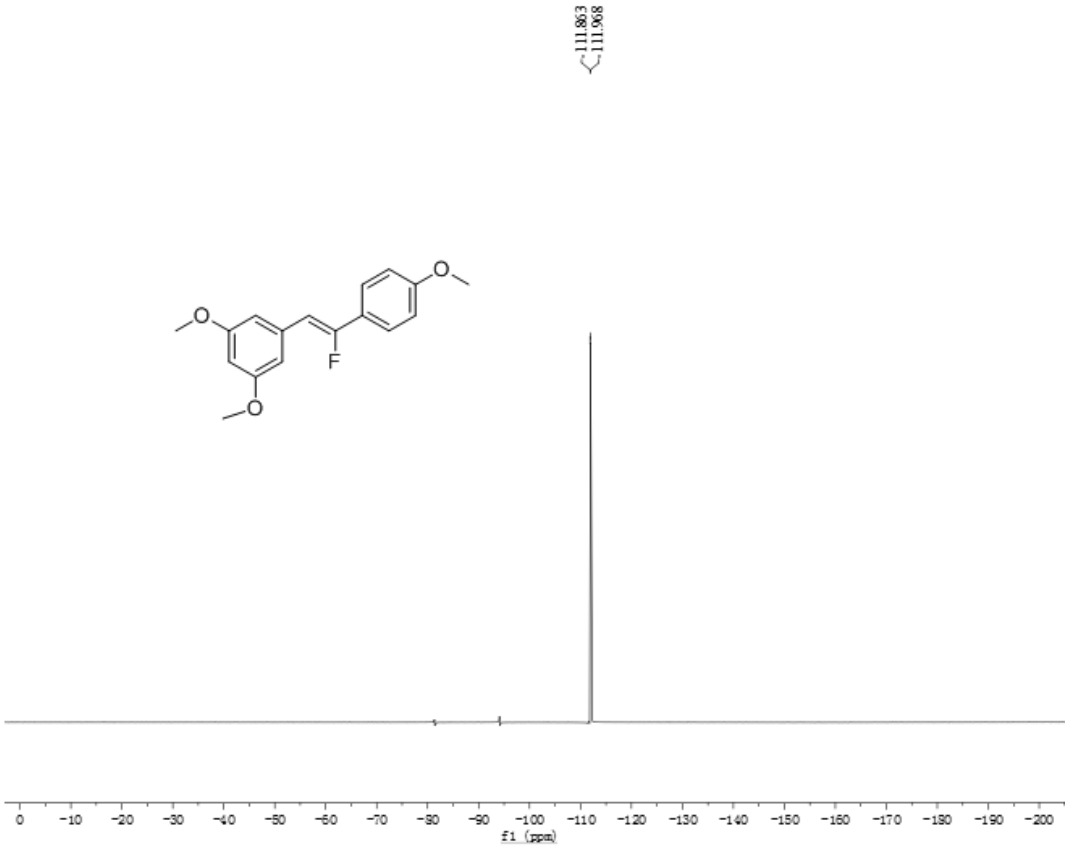
^{1}H NMR spectra of **(*Z*)-3bf**



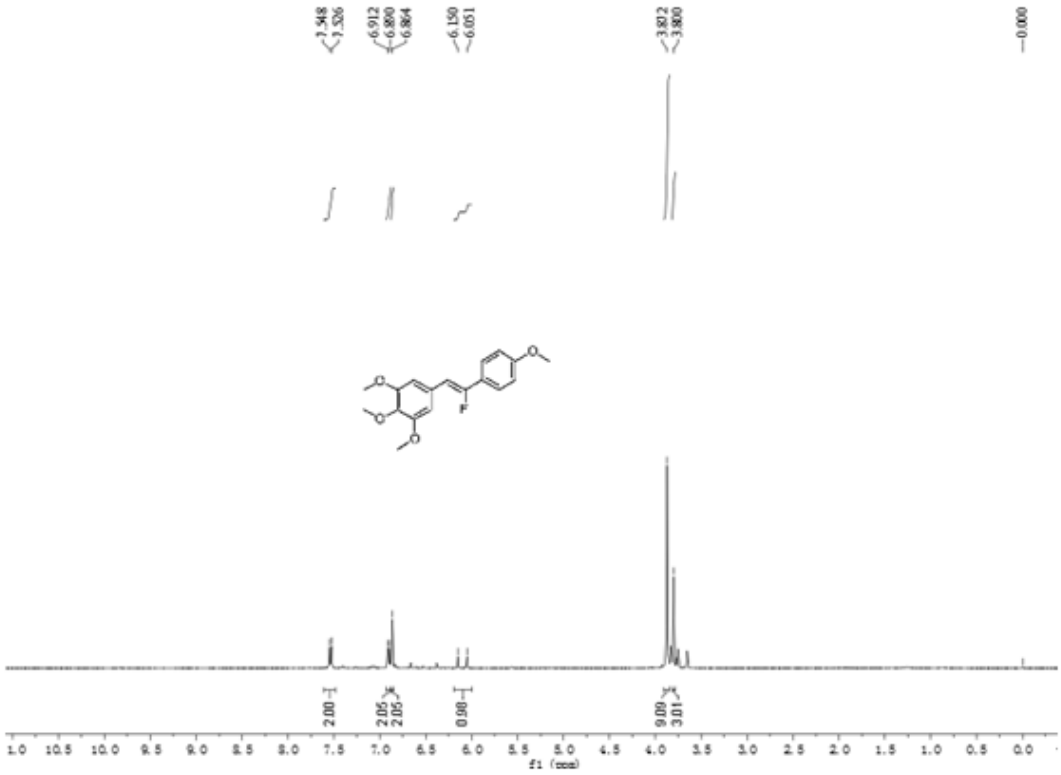
^{13}C NMR spectra of **(*Z*)-3bf**



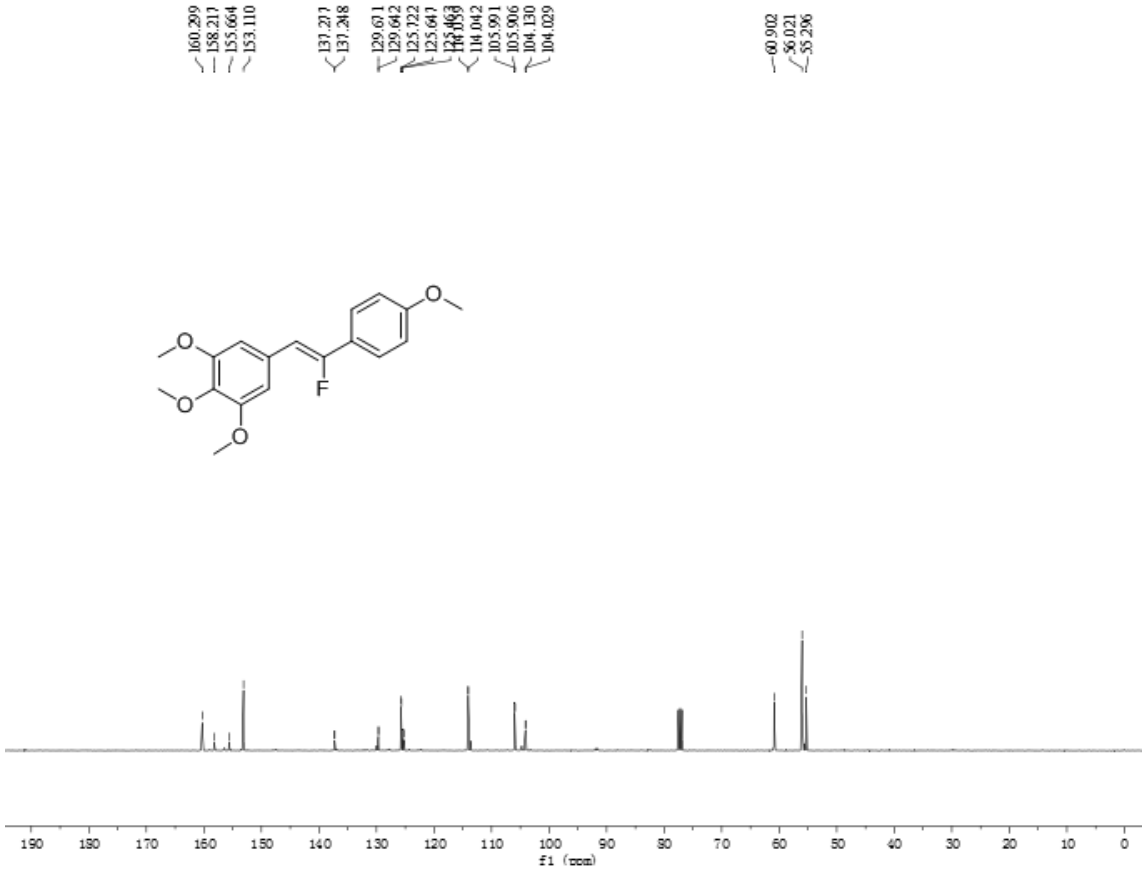
^{19}F NMR spectra of **(Z)-3bf**



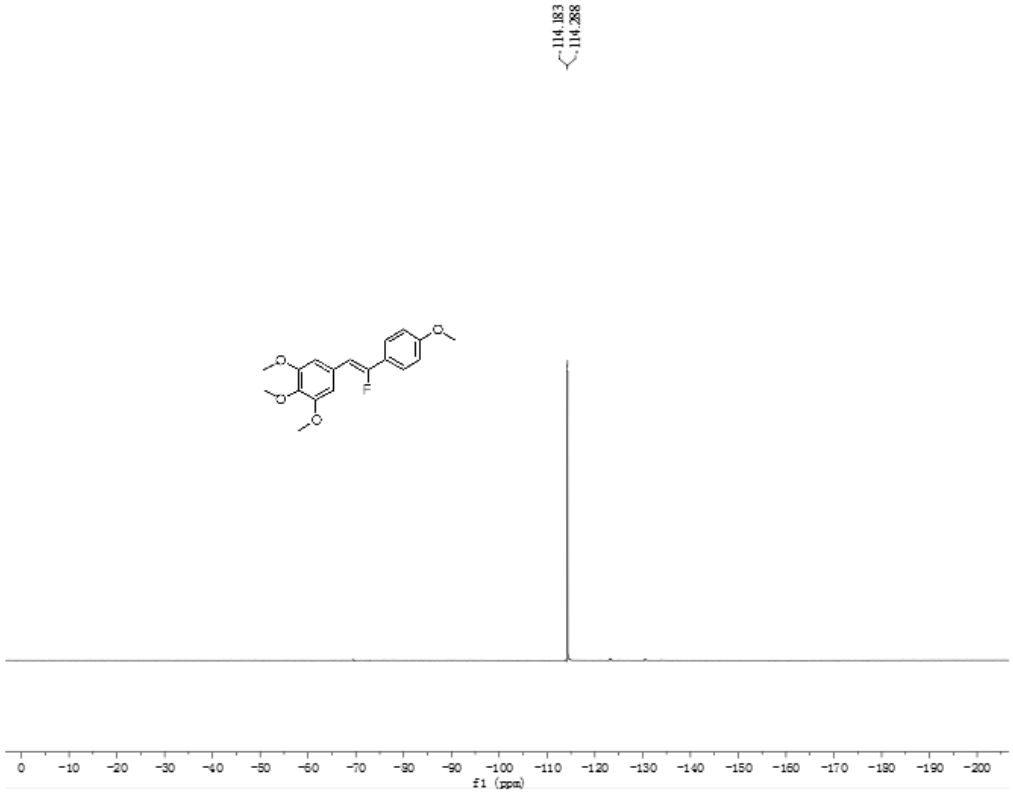
^{1}H NMR spectra of **(Z)-3jf**



^{13}C NMR spectra of **(Z)-3jf**



^{19}F NMR spectra of **(Z)-3jf**



HRMS(EI) spectra of **(Z)-3jf**