Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Supplememtary Information

For

UV Light-Mediated Difunctionalization of Alkenes with CF_3SO_2Na: Synthesis of Trifluoromethyl Phenanthrene and Antrone Derivatives

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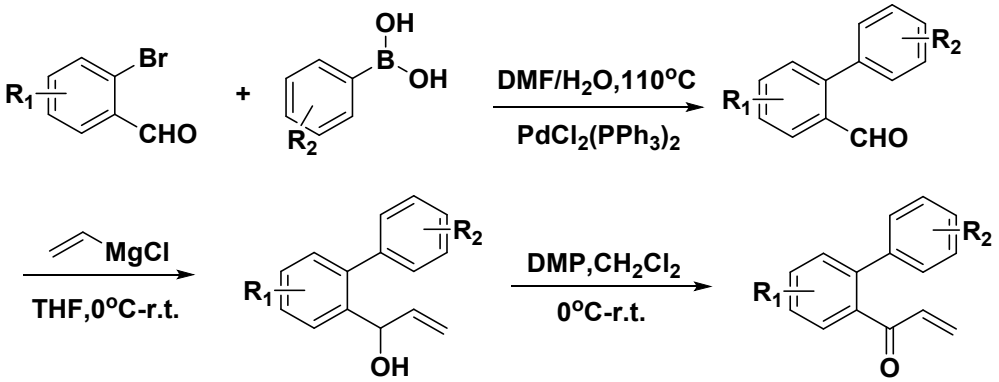
Contents

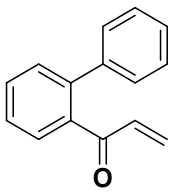
1. General information

^{1}H NMR, ^{13}C NMR ^{19}F NMR(decoupled) spectra were obtained on Bruker AV-400 or AV-600 instrument(400M or 600M) in $CDCl_3$ (7.26 for ^{1}H, 77.01 for ^{13}C) or DMSO-d_6 (2.50 for ^{1}H, 39.51 for ^{13}C) with TMS as internal standard. HRMS (ESI) spectra were recorded on a 1200-6520 Q-TOF/Agilent mass spectrometer using electrospray ionization. GC-MS analysis was performed on a 7890A-5975C/Agilent. The starting materials were purchased from Aladdin, Energy Chemicals used without further purification. Flash column chromatography was performed using 200-300 mesh silica gel. Solvent were dried and purified according to the procedure from "Purification of Laboratory Chemicals book".

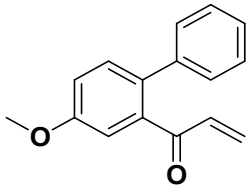
2. Preparation and Characterization of Substrates

(1) The aromatic α, β- unsaturated ketones (1a-1q) were synthesized according to ref. *Org. Lett.*, 2013, **15**, 928, [1]*Angew. Chem. Int. Ed.*, 2008, **47**, 9284, [2] and *Angew. Chem. Int. Ed.,* 2007, **46**, 4136.[3]

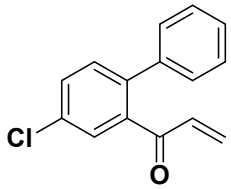




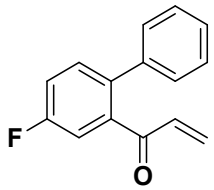
1-([1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1a): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.54 (t, J = 7.4 Hz, 2H), 7.44 (d, J = 7.6 Hz, 2H), 7.38-7.34 (m, 3H), 7.32-7.29 (m, 2H), 6.19 (dd, J = 17.2, 10.4 Hz, 1H), 5.96 (d, J = 17.2 Hz, 1H), 5.56 (d, J = 10.4 Hz, 1H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.4, 140.9, 140.4, 139.1, 136.2, 130.8, 130.1, 129.4, 129.1, 128.8, 128.6, 127.8, 127.4; GC-MS (EI): 207.1, 181.1, 152.1, 126.1, 103.1, 76.1, 55.1, 27.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{15}H_{12}NaO^+$: 231.0780, found: 231.0786.



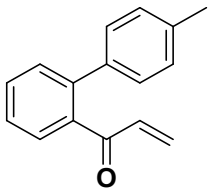
1-(4-methoxy-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1b): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40-7.33 (m, 4H), 7.30-7.28 (m, 2H), 7.11-7.09 (m, 2H), 6.18 (dd, J = 17.2, 10.4 Hz, 1H), 6.00 (d, J = 17.2 Hz, 1H), 5.57 (d, J = 10.4 Hz, 1H), 3.89 (s, 3H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.1, 158.9, 140.1, 140.0, 136.1, 133.5, 131.4, 129.4, 129.2, 128.6, 127.4, 117.2, 113.3, 55.6; GC-MS (EI): 238.1, 211.1, 195.1, 183.1, 168.1, 152.1, 139.1, 55.2; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{16}H_{14}NaO_2^+$: 261.0886, found: 261.0886.



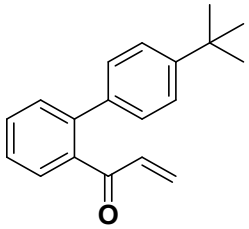
1-(4-chloro-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1c): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, J = 2.0 Hz, 1H), 7.52 (d, J = 2.4 Hz, 1H), 7.41 (s, 1H), 7.41 – 7.36 (m, 3H), 7.32 – 7.27 (m, 2H), 6.18 (dd, J = 17.2, 10.4 Hz, 1H), 5.99 (d, J = 17.4 Hz, 1H), 5.63 (d, J = 10.4 Hz, 1H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 195.8, 140.3, 139.3, 139.2, 135.7, 133.6, 131.5, 130.7, 130.2, 129.0, 128.7, 128.6, 128.1; GC-MS (EI): 241.0, 215.0, 206.1, 179.1, 152.1, 76.1, 55.1; HRMS (ESI):$[M+H]^+$ calcd. for $C_{15}H_{12}ClO^+$: 243.0571, found: 243.0571.



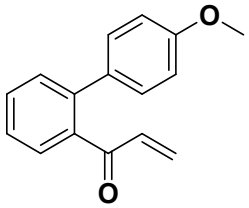
1-(4-fluoro-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1d): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.44 (dd, J = 8.0, 5.6 Hz, 1H), 7.40-7.38 (m, 3H), 7.30-7.28 (m, 4H), 6.18 (dd, J = 17.2, 10.3 Hz, 1H), 6.00 (d, J = 17.2 Hz, 1H), 5.62 (d, J = 10.4 Hz, 1H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 195.8, 161.9 (d, J = 248.9 Hz), 140.5 (d, J = 6.2 Hz), 139.3, 139.9 (d, J = 3.3 Hz), 135.7, 131.9 (d, J = 7.7 Hz), 130.0, 129.1, 128.7, 127.9, 117.7 (d, J = 21.3 Hz), 115.6 (d, J = 23.0 Hz); GC-MS (EI): 226.1, 199.0, 170.1, 151.0, 85.1, 55.1; HRMS (ESI): $[M+K]^+$ calcd. for $C_{15}H_{11}FKO^+$: 265.0426, found: 265.0434.



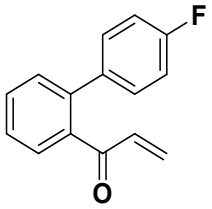
1-(4'-methyl-[1,1'-biphenyl]-2-yl)prop-2-en-1-one (1e): Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.52 (d, J = 7.8 Hz, 1H), 7.49 (t, J = 7.5 Hz, 1H), 7.40 (d, J = 8.4 Hz, 1H), 7.38 (t, J = 8.1 Hz, 1H), 7.19-7.15 (m, 4H), 6.19 (dd, J = 17.2, 10.4 Hz, 1H), 5.96 (d, J = 17.2 Hz, 1H), 5.53 (d, J = 10.4 Hz, 1H), 2.35 (s, 3H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.4, 140.9, 139.1, 137.7, 137.5, 136.3, 130.8, 130.1, 129.4, 129.3, 129.0, 128.8, 127.2, 21.3; GC-MS (EI): 222.1, 207.1, 195.1, 179.1, 165.1, 152.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{16}H_{14}NaO^+$: 245.0937, found: 245.0942.



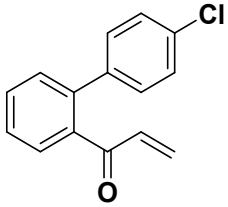
1-(4'-(*tert*-butyl)-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1f): Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.55-7.52 (m, 2H), 7.44 (d, J = 7.2 Hz, 1H), 7.42 (t, J = 7.5 Hz, 1H), 7.39 (d, J = 8.4 Hz, 2H), 7.23 (d, J = 8.4 Hz, 2H), 6.19 (dd, J = 17.2, 10.4 Hz, 1H), 5.97 (d, J = 17.2 Hz, 1H), 5.56 (d, J =10.4 Hz, 1H), 1.34 (s, 9H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.5, 150.9, 140.9, 139.1, 137.3, 136.3, 130.7, 130.1, 129.1, 128.8, 128.7, 127.1, 125.5, 31.4； GC-MS (EI): 264.1, 249.2, 207.1, 178.1, 152.1, 97.1, 82.2, 55.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{19}H_{21}O^+$: 265.1587, found: 265.1587.



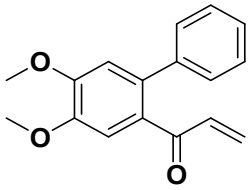
1-(4'-methoxy-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1g): Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.54-7.50 (m, 2H), 7.43-7.38 (m, 2H), 7.24-7.20 (m, 2H), 6.92-6.90 (m, 2H), 6.19 (dd, J = 17.2, 10.4 Hz, 1H), 5.98 (d, J = 17.2 Hz, 1H), 5.56 (d, J = 10.4 Hz, 1H), 3.83 (s, 3H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.5, 159.5, 140.5, 139.0, 136.2, 132.7, 130.8, 130.3, 130.0, 129.1, 128.8, 127.0, 114.0, 55.3; GC-MS (EI): 238.1, 211.1, 195.1, 168.1, 139.1, 55.1, 27.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{16}H_{14}NaO_2^+$: 261.0886, found: 261.0886.



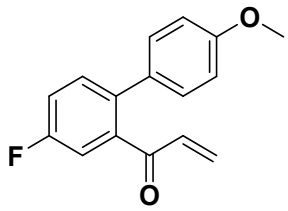
1-(4'-fluoro-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1h): Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.53 – 7.49 (m, 2H), 7.41 (td, J = 7.5, 0.6 Hz, 1H), 7.38 (d, J = 8.4 Hz, 1H), 7.27 – 7.23 (m, 2H), 7.06 – 7.01 (m, 2H), 6.22 (dd, J = 17.2, 10.4 Hz, 1H), 5.97 (dd, J = 17.2 Hz, 1H), 5.61 (dd, J = 10.4 Hz, 1H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.0, 163.4, 161.8 (d, J = 247.6 Hz), 139.8, 139.0, 136.4 (d, J = 3.0 Hz), 136.3, 130.8, 130.8, 130.7 (d, J = 8.2 Hz), 130.1, 129.9, 128.8, 127.5, 115.5 (d, J = 21.4 Hz); GC-MS (EI): 226.1, 199.0, 170.1, 151.0, 85.1, 55.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{15}H_{11}FNaO^+$: 249.0686, found: 249.0687.



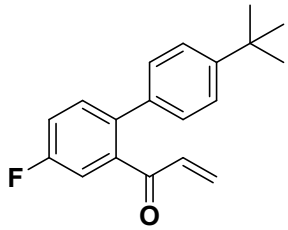
1-(4'-chloro-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1i): Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.54 – 7.51 (m, 2H), 7.43 (td, J = 7.5, 1.1 Hz, 1H), 7.38 (d, J = 7.8 Hz, 1H), 7.33 (dt, J = 8.4, 1.8 Hz, 2H), 7.22 (dt, J = 8.4, 1.8 Hz, 2H), 6.25 (dd, J = 17.2, 10.4 Hz, 1H), 5.98 (d, J = 17.2 Hz, 1H), 5.65 (d, J = 10.4 Hz, 1H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.0, 139.6, 138.9, 138.8, 136.3, 134.0, 130.9, 130.4, 130.2, 130.1, 128.9, 128.8, 127.7; GC-MS (EI): 241.1, 215.0, 206.1, 179.1, 152.1, 76.1, 55.1, 27.2; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{15}H_{11}ClNaO^+$: 265.0391, found: 265.0392.



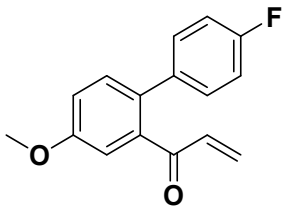
1-(4, 5-dimethoxy-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1j): White solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40 – 7.37 (m, 3H), 7.32-7.30 (m, 2H), 7.20 (s, 1H), 6.90 (s, 1H), 6.10 (dd, J = 16.8, 9.6 Hz, 1H), 6.02 (d, J = 16.8 Hz, 1H), 5.42 (d, J = 9.6 Hz, 1H), 3.97 (s, 6H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 195.4, 151.0, 148.3, 140.5, 135.9, 135.4, 131.4, 129.3, 128.6, 127.8, 127.7, 112.7, 112.0, 56.1; GC-MS (EI): 268.1, 241.1, 210.1, 152.1, 139.1, 127.1, 77.1, 55.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{17}H_{17}O_3^+$: 269.1172, found: 269.1180.



1-(4-fluoro-4'-methoxy-[1,1'-biphenyl]-2-yl)prop-2-en-1-one (1k): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40 (dd, J = 8.4, 5.3 Hz, 1H), 7.27-7.23 (m, 2H), 7.20 (d, J = 8.4 Hz, 2H), 6.92 (d, J = 8.4 Hz, 2H), 6.18 (dd, J = 17.2, 10.4 Hz, 1H), 6.01 (dd, J = 17.2, 1.4 Hz, 1H), 5.62 (dd, J = 10.4, 1.4 Hz, 1H), 3.85 (s, 3H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 195.9, 161.7 (d, J = 248.4 Hz), 159.5, 140.4 (d, J = 6.3 Hz), 136.6 (d, J = 3.5 Hz), 135.6, 131.8 (d, J = 7.6 Hz), 131.7, 130.3, 129.7, 117.7 (d, J = 21.4 Hz), 115.5 (d, J = 22.8 Hz), 114.1, 55.31; GC-MS (EI): 256.1, 241.1, 225.1, 213.1, 186.1, 170.0, 157.1, 55.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{16}H_{14}FO_2^+$: 257.0972, found: 257.0973.

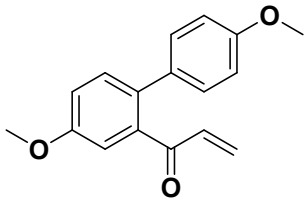


1-(4'-(*tert*-butyl)-4-fluoro-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1l): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45 – 7.39 (m, 3H), 7.28 – 7.21 (m, 4H), 6.18 (dd, J = 17.2, 10.4 Hz, 1H), 6.01 (d, J = 17.2 Hz, 1H), 5.60 (d, J = 10.4 Hz, 1H), 1.36 (s, 9H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 195.8, 161.7 (d, J = 248.5 Hz), 151.1, 140.5 (d, J = 6.2 Hz), 136.9 (d, J = 3.5 Hz), 136.3 , 135.7, 131.9 (d, J = 7.6 Hz), 129.7, 128.8, 125.6, 117.7 (d, J = 21.3 Hz), 115.5 (d, J = 22.8 Hz), 34.6, 31.4; GC-MS (EI): 282.1, 267.1, 225.1, 209.1, 196.1, 183.1, 170.1, 106.1, 55.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{19}H_{19}FNaO^+$: 305.1312, found: 305.1312.

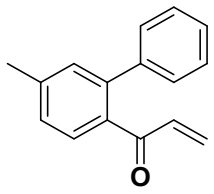


1-(4'-fluoro-4-methoxy-[1,1'-biphenyl]-2-yl)prop-2-en-1-one (1m): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.33 (d, J = 7.6 Hz, 1H), 7.25-7.22 (m, 2H), 7.10 – 7.02 (m, 4H), 6.20 (dd, J = 17.2, 10.4 Hz, 1H), 6.00 (d, J = 17.2 Hz, 1H), 5.62 (d, J = 10.4 Hz, 1H), 3.88 (s, 3H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 196.9, 162.4 (d, J = 247.0 Hz), 158.9, 139.9, 136.1 (d, J = 3.2 Hz), 132.3, 131.4, 130.6 (d, J = 8.2 Hz), 129.9, 117.1,

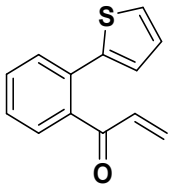
115.5 (d, J = 21.4 Hz), 113.3, 55.5; GC-MS (EI): 256.1, 241.1, 225.1, 213.1, 186.1, 157.1, 55.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{16}H_{14}FO_2^+$: 257.0972, found: 257.0970.



1-(4, 4'-dimethoxy-[1, 1'-biphenyl]-2-yl) prop-2-en-1-one (1n): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.35 (dd, J = 8.8, 1.6 Hz, 1H), 7.20 (dt, J = 8.8, 2.4 Hz, 2H), 7.10-7.08 (m, 2H), 6.91 (dt, J = 8.8, 1.6 Hz, 2H), 6.18 (dd, J = 17.2, 10.4 Hz, 1H), 6.01 (dd, J = 17.2, 1.5 Hz, 1H), 5.57 (dd, J = 10.4, 1.5 Hz, 1H), 3.88 (s, 3H), 3.84 (s, 3H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.2, 159.2, 158.6, 139.9, 136.0, 133.2, 132.5, 131.3, 130.3, 129.1, 117.3, 114.0, 113.1, 55.6, 55.3; GC-MS (EI): 268.1, 241.1, 225.1, 198.1, 182.1, 155.1, 127.1, 55.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{17}H_{17}O_3^+$: 269.1172, found: 269.1172

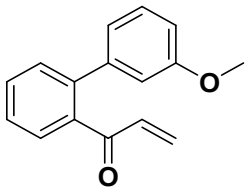


1-(4-methyl-[1,1'-biphenyl]-2-yl)prop-2-en-1-one (1o): Yellow oil.^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, J = 8.4 Hz, 1H), 7.39-7.36 (m, 3H), 7.34 (d, J = 2.4 Hz, 1H), 7.32 (d, J = 1.6 Hz, 1H), 7.28 (s, 1H), 7.27 (d, J = 7.2 Hz, 1H), 6.22 (dd, J = 17.2, 10.4 Hz, 1H), 6.01 (dd, J = 17.2, 1.6 Hz, 1H), 5.54 (dd, J = 10.4, 1.2 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 196.8, 141.2, 141.1, 140.6, 136.5, 136.3, 130.9, 129.1, 128.8, 128.6, 128.1, 127.7, 21.5; GC-MS (EI): 221.1, 195.1, 179.1, 165.1, 152.1, 28.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{16}H_{14}NaO^+$: 245.0937, found: 245.0930.

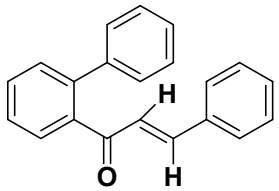


1-(2-(thiophen-2-yl)phenyl)prop-2-en-1-one (1p): Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.52 – 7.47 (m, 3H), 7.42 (t, J = 8.4 Hz, 1H), 7.34 (d, J = 4.8 Hz, 1H), 7.02 (t, J = 4.2 Hz, 1H), 6.95 (d, J = 3.6 Hz, 1H), 6.30 (dd, J = 17.2, 10.4 Hz, 1H), 5.95 (d, J = 17.2 Hz, 1H), 5.67 (d, J = 10.4 Hz, 1H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 197.6, 141.5, 139.2, 136.1, 132.9, 130.6, 130.2, 129.6, 128.6, 128.0, 127.9, 126.7; GC-MS

(EI): 214.1, 185.1, 159.1, 115.1, 89.1, 55.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{13}H_{10}NaSO^+$: 237.0345, found: 237.0349.



1-(3'-methoxy-[1,1'-biphenyl]-2-yl)prop-2-en-1-one (1q): Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.55-7.51 (m, 2H), 7.45-7.41 (m, 2H), 7.27 (t, J = 7.8 Hz, 1H), 6.88 (d, J = 7.8 Hz, 2H), 6.85 (s, 1H), 6.21 (dd, J = 17.2, 10.4 Hz, 1H), 5.96 (d, J = 17.2 Hz, 1H), 5.57 (d, J = 10.4 Hz, 1H), 3.79 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$): δ 197.2, 159.7, 141.8, 140.7, 139.1, 136.2, 130.7, 129.9, 129.6, 129.2, 128.7, 127.5, 121.7, 114.6, 113.5, 55.3; GC-MS(EI): 238.1, 223.1, 211.1, 195.1, 179.1, 168.1, 152.1, 139.1, 55.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{16}H_{14}NaO_2^+$: 261.0886, found: 261.0888.



(E)-1-([1,1'-biphenyl]-2-yl)-3-phenylprop-2-en-1-one (1r): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.69 (dd, J = 7.6, 0.8 Hz, 1H), 7.60 (td, J = 8.0, 1.6 Hz, 1H), 7.53 – 7.47 (m, 2H), 7.43 – 7.27 (m, overlapping $CDCl_3$, 10H), 7.25 (d, J = 1.2 Hz, 1H), 7.23 (d, J = 2.0 Hz, 1H), 6.57 (d, J = 16.0 Hz, 1H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 196.3, 143.6, 141.0, 140.5, 139.9, 134.7, 130.8, 130.3, 130.2, 129.2, 128.9, 128.8, 128.6, 128.2, 127.9, 127.5, 126.8; GC-MS (EI): 284.1, 255.2, 206.2, 178.2, 165.1, 152.1, 131.1.

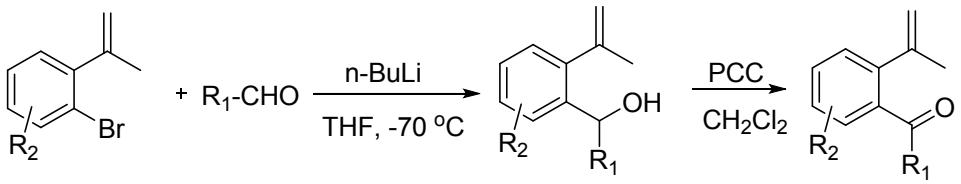
Reference:

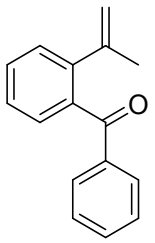
1) Sebastian Wertz, Dirk Leifert, and Armido Studer. *Org. Lett.*, 2013, **15**, 928.

2) Sascha Jautze and Rene Peters. *Angew. Chem. Int. Ed.* 2008, **47**, 9284.

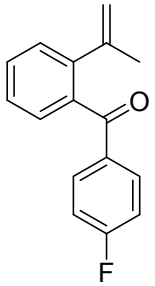
3) Jose Barluenga, Hugo Fanlo Salome Lopez, and Josefa Florez. *Angew. Chem. Int. Ed.* 2007, **26**, 4136

(2) The aromatic γ, δ- unsaturatedketones (4a-4r) were synthesized according to ref *synlett.* 2015, 26, 1997-2000.

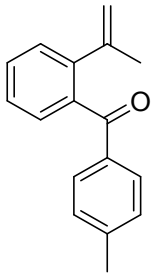




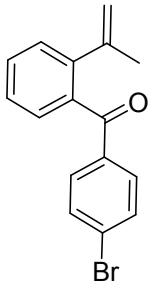
Phenyl(2-(prop-1-en-2-yl)phenyl)methanone(4a). Colorless oil. Yield 94 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, 2H, *J* = 7.4 Hz), 7.61 – 7.30 (m, 7H), 4.96 (s, 1H), 4.85 (s, 1H), 1.94 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 198.91, 143.90, 142.85, 138.23, 137.83, 132.95, 130.02, 129.84, 128.46, 128.27, 127.88, 126.86, 117.41, 23.70. LRMS (EI): 222, 207, 178, 115, 77. HRMS (ESI): calcd.. for $C_{16}H_{15}O^+$ 223.1117 $[M+H]^+$, found 223.1115.



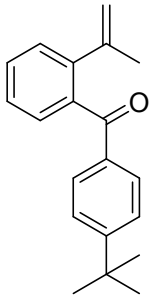
(4-fluorophenyl)(2-(prop-1-en-2-yl)phenyl)methanone(4b). Colorless oil. Yield 76 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (dd, 2H, *J* = 8.9, 5.5 Hz), 7.51 – 7.44 (m, 1H), 7.37 (d, 3H, *J* = 7.2 Hz), 7.08 (t, 2H, *J* = 8.6 Hz), 4.96 (d, 1H, *J* = 1.4 Hz), 4.84 (s, 1H), 1.95 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.33, 166.94, 164.41, 143.79, 142.69, 137.93, 134.27, 134.24, 132.41, 132.32, 130.12, 128.31, 127.93, 126.97, 117.49, 115.53, 115.31, 23.68. LRMS (EI):240, 225, 175, 115, 77. HRMS (ESI): calcd.. for $C_{16}H_{14}FO^+$ 241.1023 $[M+H]^+$, found 241.1020.



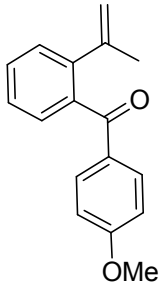
(2-(prop-1-en-2-yl)phenyl)(p-tolyl)methanone(4c). Colorless oil. Yield 75 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, 2H, *J* = 8.1 Hz), 7.50 – 7.42 (m, 1H), 7.35 (t, 3H, *J* = 6.2 Hz), 7.21 (d, 2H, *J* = 8.0 Hz), 4.96 (s, 1H), 4.86 (s, 1H), 2.40 (s, 3H), 1.95 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.49, 143.95, 143.82, 142.71, 138.47, 135.27, 130.04, 129.79, 129.00, 128.29, 127.88, 126.78, 117.14, 23.76, 21.71. LRMS (EI):236, 221, 178, 115, 91, 28. HRMS (ESI): calcd. for $C_{17}H_{17}O^+$ 237.1274 $[M+H]^+$, found 237.1277.



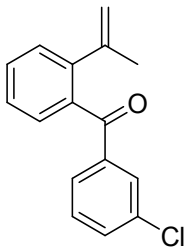
(4-bromophenyl)(2-(prop-1-en-2-yl)phenyl)methanone(4d). Colorless oil. Yield 79 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (td, *J* = 8.7, 6.6 Hz, 4H), 7.51 – 7.45 (m, 1H), 7.41 – 7.31 (m, 3H), 5.02 – 4.93 (m, 1H), 4.83 (s, 1H), 1.94 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.87, 143.70, 142.74, 137.68, 136.63, 131.61, 131.34, 131.21, 130.29, 128.43, 128.14, 127.89, 127.06, 117.79, 23.66.
LRMS (EI):236, 221, 178, 115, 91, 28. HRMS (ESI): calcd. for $C_{16}H_{14}BrO^{+}$ 301.0223 $[M+H]^{+}$, found 301.0220.



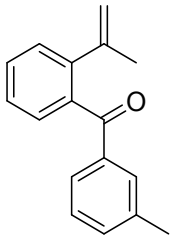
(4-tert-butylphenyl)(2-(prop-1-en-2-yl)phenyl)methanone(4e). Colorless oil. Yield 80 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, 2H, *J* = 8.4 Hz), 7.43 (t, 3H, *J* = 7.0 Hz), 7.35 (t, 3H, *J* = 8.7 Hz), 4.98 (s, 1H), 4.87 (s, 1H), 1.97 (s, 3H), 1.34 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.37, 156.75, 144.05, 142.86, 138.46, 135.11, 129.93, 129.75, 129.70, 128.29, 127.99, 126.64, 126.00, 125.22, 116.95, 35.14, 31.11, 23.81. LRMS (EI): 278, 177, 115, 77. HRMS (ESI): calcd. for $C_{20}H_{23}O^{+}$ 279.1743 $[M+H]^{+}$, found 279.1748.



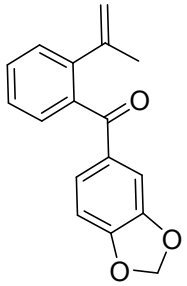
(4-methoxyphenyl)(2-(prop-1-en-2-yl)phenyl)methanone(4f). Colorless oil. Yield 80 %. ^{1}H NMR (400 MHz,) δ 7.77 – 7.71 (m), 7.35 (dd, *J* = 7.0, 4.8 Hz), 6.89 (d, *J* = 8.9 Hz), 5.01 – 4.95 (m), 4.87 (s), 3.87 (s), 1.96 (s).^{13}C NMR (151 MHz,) δ 197.53, 163.52, 143.97, 142.54, 138.52, 132.26, 130.73, 129.66, 128.14, 127.92, 126.78, 116.98, 113.52, 55.49, 23.81. LRMS (EI): 252, 175, 115, 77. HRMS (ESI): calcd. for $C_{17}H_{17}O_2^{+}$ 253.1223 $[M+H]^{+}$, found 253.1238.



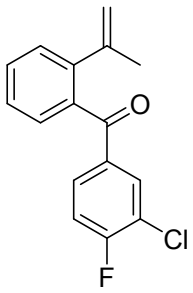
(3-chlorophenyl)(2-(prop-1-en-2-yl)phenyl)methanone(4g). Colorless oil. Yield 94 %.^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (t, 1H, *J* = 1.8 Hz), 7.59 (d, 1H, *J* = 7.7 Hz), 7.49 (dd, 2H, *J* = 11.9, 4.6 Hz), 7.45 – 7.32 (m, 4H), 4.97 (d, 1H, *J* = 1.4 Hz), 4.83 (s, 1H), 1.95 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.44, 143.72, 142.89, 139.54, 137.54, 134.57, 132.78, 130.41, 129.61, 129.57, 128.57, 127.87, 127.77, 127.08, 117.87, 23.55. LRMS (EI): 256, 203, 176, 115, 91, 65. HRMS (ESI): calcd. for $C_{16}H_{14}ClO^+$ 257.0728 $[M+H]^+$, found 257.0731.



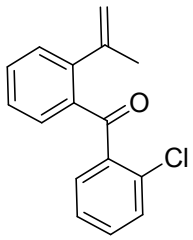
(2-(prop-1-en-2-yl)phenyl)(m-tolyl)methanone(4h). Colorless oil. Yield 75 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (s, 1H), 7.49 (dd, 1H, *J* = 9.2, 4.7 Hz), 7.48 – 7.43 (m, 1H), 7.41 – 7.32 (m, 4H), 7.28 (dd, 1H, *J* = 12.9, 5.3 Hz), 5.00 – 4.93 (m, 1H), 4.85 (s, 1H), 2.37 (s, 3H), 1.95 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.98, 143.93, 142.85, 138.38, 138.05, 137.79, 133.75, 130.21, 129.91, 128.44, 128.11, 127.86, 127.28, 126.80, 117.24, 23.70, 21.30. LRMS (EI):236, 221, 178, 115, 91, 65. HRMS (ESI): calcd. for $C_{17}H_{17}O^+$ 237.1274 $[M+H]^+$, found 237.1275.



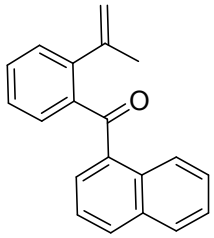
benzo[d][1,3]dioxol-5-yl(2-(prop-1-en-2-yl)phenyl)methanone(4i) Colorless oil. Yield 82 %. ^{1}H NMR (400 MHz,) δ 7.48 – 7.39 (m), 7.34 (dd, *J* = 4.9, 4.0 Hz), 7.23 (dd, *J* = 8.1, 1.7 Hz), 6.77 (d, *J* = 8.1 Hz), 6.05 (s), 5.00 – 4.96 (m), 4.86 (s), 1.97 (s). ^{13}C NMR (101 MHz,) δ 197.03, 151.83, 148.06, 143.90, 142.53, 138.37, 132.65, 129.73, 128.12, 127.89, 126.95, 126.77, 117.04, 109.09, 107.59, 101.87, 23.79. LRMS (EI):266, 237, 177, 119, 77. HRMS (ESI): calcd. for $C_{17}H_{15}O_3^+$ 267.1016 $[M+H]^+$, found 267.1015.



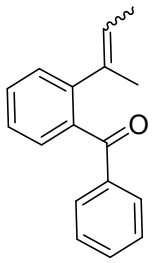
(3-chloro-4-fluorophenyl)(2-(prop-1-en-2-yl)phenyl)methanone(4j). Colorless oil. Yield 85 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (dd, 1H, *J* = 7.1, 2.1 Hz), 7.62 (ddd, 1H, *J* = 8.5, 4.7, 2.1 Hz), 7.55 – 7.45 (m, 1H), 7.45 – 7.33 (m, 3H), 7.17 (t, 1H, *J* = 8.5 Hz), 5.01 – 4.95 (m, 1H), 4.83 (s, 1H), 1.95 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.19, 162.18, 159.63, 143.63, 142.74, 137.23, 135.10, 135.06, 132.37, 130.50, 130.04, 129.96, 128.45, 127.93, 127.19, 121.65, 121.47, 117.93, 116.63, 116.42, 23.58. LRMS (EI): 274, 167, 115, 77. HRMS (ESI): calcd. for $C_{16}H_{13}ClFO^+$ 275.0633 $[M+H]^+$, found 275.0634.



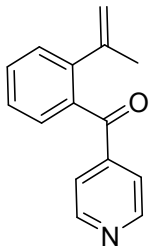
(2-chlorophenyl)(2-(prop-1-en-2-yl)phenyl)methanone(4k). Colorless oil. Yield 85 %. ^{1}H NMR (400 MHz,) δ 7.68 (dd, *J* = 4.9, 1.1 Hz), 7.38 (ddd, *J* = 20.3, 9.4, 6.7 Hz), 7.07 (dd, *J* = 4.8, 3.8 Hz), 5.06 – 5.01 (m), 4.92 (s), 2.03 (s). ^{13}C NMR (151 MHz,) δ 190.79, 143.93, 142.54, 138.06, 134.88, 134.55, 130.11, 128.20, 128.04, 127.94, 126.78, 116.96, 23.88. LRMS (EI):256, 228, 138, 105, 77. HRMS (ESI): calcd. for $C_{16}H_{14}ClO^+$ 257.0728 $[M+H]^+$, found 257.0737.



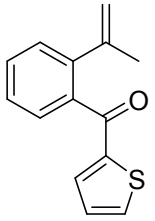
naphthalen-1-yl(2-(prop-1-en-2-yl)phenyl)methanone(4l). White solid. Yield 85 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, *J* = 8.5 Hz, 1H), 7.99 (d, *J* = 8.0 Hz, 1H), 7.91 (d, *J* = 7.6 Hz, 1H), 7.69 – 7.48 (m, 4H), 7.48 – 7.32 (m, 4H), 4.91 (s, 1H), 4.86 – 4.78 (m, 1H), 1.79 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 200.36, 144.33, 143.83, 140.00, 136.35, 133.78, 132.83, 131.34, 130.61, 130.26, 129.66, 128.32, 128.01, 127.99, 126.94, 126.46, 126.07, 123.84, 117.17, 23.39. LRMS (EI): 272, 253, 228, 128, 115. HRMS (ESI): calcd. for $C_{20}H_{17}O^+$ 273.1274 $[M+H]^+$, found 273.1279.



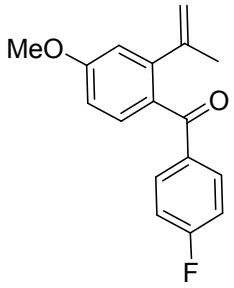
(2-(but-2-en-2-yl)phenyl)(phenyl)methanone(4m). Colorless oil. Yield 89 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (dd, *J* = 33.3, 7.5 Hz, 2H), 7.58 – 7.16 (m, 8H), 5.40 – 5.25 (m, 1H), 1.84 (s, 3H), 1.74 (s, 1H), 1.43 (d, *J* = 6.7 Hz, 1H), 1.34 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 198.34, 141.51, 138.68, 137.76, 135.85, 132.85, 132.51, 130.36, 130.11, 129.81, 129.33, 129.25, 128.74, 128.50, 128.09, 127.89, 127.81, 126.37, 126.31, 123.54, 25.87, 15.13. LRMS (EI): 236, 221, 178, 115, 77. HRMS (ESI): calcd. for $C_{17}H_{17}O^+$ 237.1274 $[M+H]^+$, found 237.1269.



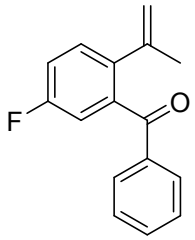
(2-(prop-1-en-2-yl)phenyl)(pyridin-4-yl)methanone(4n). Colorless oil. Yield 92 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.74 (d, *J* = 6.0 Hz, 2H), 7.52 (dd, *J* = 7.4, 1.6 Hz, 1H), 7.49 – 7.44 (m, 3H), 7.41 (dd, *J* = 11.6, 4.3 Hz, 2H), 5.02 – 4.90 (m, 1H), 4.81 (s, 1H), 1.93 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.98, 150.48, 144.26, 143.55, 143.08, 136.83, 130.98, 128.96, 127.79, 127.34, 122.36, 118.83, 23.41. LRMS (EI): 236, 221, 178, 115, 77. HRMS (ESI): calcd for $C_{15}H_{14}NO^+$ 224.1070 $[M+H]^+$, found 224.1070.



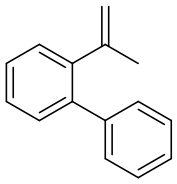
(2-(prop-1-en-2-yl)phenyl)(thiophen-2-yl)methanone(4o). Colorless oil. Yield 72 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, 1H, *J* = 4.9 Hz), 7.46 (t, 2H, *J* = 7.4 Hz), 7.40 – 7.31 (m, 3H), 7.10 – 7.05 (m, 1H), 5.04 (s, 1H), 4.92 (s, 1H), 2.03 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$) δ 190.72, 145.11, 143.93, 142.56, 138.09, 134.81, 134.47, 130.07, 128.19, 128.02, 127.89, 126.74, 116.93, 23.85. LRMS (EI): 228, 178, 165, 115, 77. HRMS (ESI): calcd. for $C_{14}H_{13}OS^+$ 229.0682 $[M+H]^+$, found 229.0680.



(4-fluorophenyl)(4-methoxy-2-(prop-1-en-2-yl)phenyl)methanone(4p). Colorless oil. Yield 77 %. ^{1}H NMR (400 MHz,) δ 7.79 – 7.70 (m), 7.44 – 7.35 (m), 7.12 – 7.03 (m), 6.90 – 6.83 (m), 4.96 (d, *J* = 1.4 Hz), 4.85 (s), 3.88 (s), 1.94 (s). ^{13}C NMR (151 MHz,) δ 196.65, 161.10, 145.51, 144.13, 134.91, 132.57, 132.32, 132.26, 131.16, 130.98, 130.46, 129.80, 128.16, 117.13, 116.95, 115.37, 115.22, 113.80, 111.97, 111.83, 55.45, 23.61. LRMS (EI): 252, 175, 115, 77. HRMS (ESI): calcd. for $C_{17}H_{16}FO_2^+$ 271.1129 $[M+H]^+$, found 271.1138.



(5-fluoro-2-(prop-1-en-2-yl)phenyl)(phenyl)methanone(4q). Colorless oil. Yield 70 %. ^{1}H NMR (400 MHz, $CDCl_3$) ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.96 (d, 1H, *J* = 8.0 Hz), 7.73 (d, 2H, *J* = 8.0 Hz), 7.56 (t, 1H, *J* = 7.3 Hz), 7.43 (t, 2H, *J* = 7.6 Hz), 7.34 (dd, 1H., *J* = 8.5, 5.4 Hz), 7.16 (dd, 1H, *J* = 9.5, 7.3 Hz), 7.10 (dd,1H, *J* = 8.6, 2.3 Hz), 4.95 (s, 1H), 4.83 (s, 1H), 1.91 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 200.65, 197.33, 162.10, 160.45, 142.83, 139.90, 139.86, 138.79, 138.77, 137.17, 133.30, 132.89, 129.84, 129.80, 129.75, 129.70, 128.57, 128.51, 128.40, 128.08, 117.81, 116.98, 116.84, 115.34, 115.19, 23.79. LRMS (EI): 240, 178, 165, 115, 77. HRMS (ESI): calcd. for $C_{16}H_{14}FO^+$ 241.1023 $[M+H]^+$, found 241.1035.



2-(prop-1-en-2-yl)biphenyl(4r). Colorless oil. Yield 90 %. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (d, *J* = 7.1 Hz, 2H), 7.39 – 7.27 (m, 7H), 5.06 (s, 1H), 4.99 (s, 1H), 1.65 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 146.60, 142.82, 142.03, 139.59, 130.13, 129.13, 128.93, 128.05, 127.24, 127.19, 126.83, 116.26, 23.53. LRMS (EI): 194, 179, 165, 152, 115. 89. HRMS (ESI): calcd. for $C_{16}H_{14}O^+$ 195.1168 $[M+H]^+$, found 195.1175.

Reference:

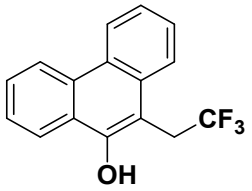
B. Li, C. Yang, W.-T. Xia, W.-J. Xia, *synlett.* 2015, 26, 1997-2000.

3. General Procedures and Characterization of products

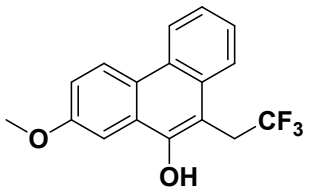
1) General Procedures of products

In a Pyrex filter, the magnetic stir bar was added. Then it was charged with substrate **1** (0.2 mmol), CF_3SO_2Na (0.4 mmol), dried CH_3CN (10 mL) and sensitizer BP (0.04 mmol). The mixture was charged with N_2 for 30 minutes under room temperature and then was irradiated by UV lamp (280 nm). After the substrate was consumed (monitored by TLC), the mixture was filtered and concentrated in vacuo. The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate) to afford the desired product **3**.

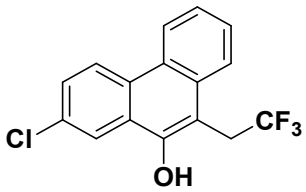
2) Characterization of products



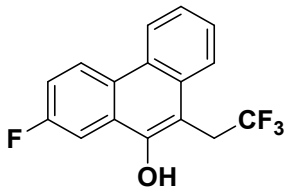
10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3a): White solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.71 (d, J = 8.4 Hz, 1H), 8.68 (d, J = 8.4 Hz, 1H), 8.17 (d, J = 7.6 Hz, 1H), 7.96 (d, J = 8.4 Hz, 1H), 7.74-7.63 (m, 3H), 7.57 (t, J = 7.6 Hz, 1H), 5.47 (s, 1H, -O*H*), 4.02 (q, J = 10.8 Hz, 2H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 148.8, 131.8, 131.4, 127.7, 127.5, 127.1, 126.9, 126.7 (q, J = 278.7 Hz), 125.2, 124.7, 123.6, 123.1, 123.0, 121.4, 106.7, 30.4 (q, J = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.2 (s, 3F); GC-MS (EI): 276.1, 256.1, 236.1, 207.1, 179.1, 152.1, 118.1, 89.0, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{16}H_{12}F_3O^+$: 277.0835, found: 277.0835.



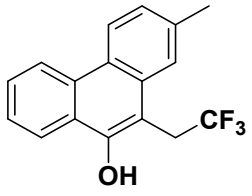
7-methoxy-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3b): Pale Yellow solid. ^{1}H NMR (400 MHz, DMSO): δ 9.72 (s, 1H, -O*H*), 8.74 (d, J = 9.2 Hz, 1H), 8.67 (d, J = 7.6 Hz, 1H), 8.03 (d, J = 8.4 Hz, 1H), 7.83 (d, J = 2.8 Hz, 1H), 7.56 (t, J = 7.6 Hz, 1H), 7.50 (t, J = 7.6 Hz, 1H), 7.35 (d, J = 8.8 Hz, 1H), 4.24 (q, J = 11.2 Hz, 2H), 3.95 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 158.1, 149.8, 130.7, 127.1, 127.0 (q, J = 279.2 Hz), 126.1, 126.0, 124.9, 124.8, 124.0, 123.8, 122.4, 117.6, 106.8, 103.7, 55.3, 29.1 (q, J = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.3 (s, 3F); GC-MS (EI): 306.1, 286.1, 243.1, 209.1, 165.1, 143.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{17}H_{13}F_3NaO_2^+$: 329.0760, found: 329.0748.



7-chloro-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3c): Pale Yellow solid. ^{1}H NMR (400 MHz, DMSO): δ 9.97 (s, 1H, -O*H*), 8.88 (d, *J* = 8.8 Hz, 1H), 8.77 (d, *J* = 8.0 Hz, 1H), 8.39 (d, *J* = 2.4 Hz, 1H), 8.09 (d, *J* = 8.4 Hz, 1H), 7.75 (dd, *J* = 8.8, 2.4 Hz, 1H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.56 (t, *J* = 7.4 Hz, 1H), 4.26 (q, *J* = 11.2 Hz, 2H); ^{13}C NMR (151 MHz, DMSO): δ 149.3, 131.9, 131.7, 129.3, 127.6, 127.5, 127.1, 126.9 (q, *J* = 279.7 Hz), 125.5, 125.4, 124.5, 124.0, 123.2, 122.1, 108.0, 29.0 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.3 (s, 3F); GC-MS (EI): 310.0, 290.0, 255.0, 241.0, 213.0, 178.0, 88.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{16}H_{11}ClF_3O^+$: 311.0445, found: 311.0440.

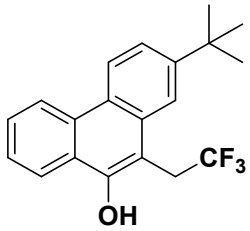


7-fluoro-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3d): Yellow solid. ^{1}H NMR (400 MHz, DMSO): δ 8.89 (dd, *J* = 9.2, 5.6 Hz, 1H), 8.73 (d, *J* = 8.4 Hz, 1H), 8.15 (dd, *J* = 11.2, 2.6 Hz, 1H), 8.04 (d, *J* = 8.0 Hz, 1H), 7.63 – 7.56 (m, 2H), 7.52 (t, *J* = 7.6 Hz, 1H), 4.26 (q, *J* = 11.2 Hz, 2H); ^{13}C NMR (151 MHz, DMSO): δ 160.9 (d, *J* = 243.7 Hz), 150.6, 131.7, 128.6 (d, *J* = 24.9 Hz), 127.9 (d, *J* = 8.6 Hz), 127.7, 127.6, 127.1 (q, *J* = 279.0 Hz), 126.9, 126.0 (d, *J* = 8.6 Hz), 125.3, 124.0, 123.9, 123.8, 123.0, 116.0 (d, *J* = 23.6 Hz), 107.8 (d, *J* = 22.5 Hz), 107.3, 29.4, 29.1 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.2 (s, 3F), -114.2 (s, 1F); GC-MS (EI): 294.1, 274.1, 245.1, 225.1, 196.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{16}H_{11}F_4O^+$: 295.0741, found: 295.0739.

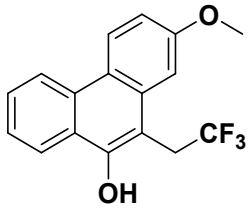


2-methyl-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3e): Pale Yellow solid. ^{1}H NMR (400 MHz, DMSO): δ 9.72 (s, 1H, -O*H*), 8.78 (d, *J* = 8.0 Hz, 1H), 8.66 (d, *J* = 8.4 Hz, 1H), 8.35 (d, *J* = 7.6 Hz, 1H), 7.85 (s, 1H), 7.71 (t, *J* = 8.2 Hz, 1H), 7.66 (t, *J* = 7.0 Hz, 1H), 7.37 (d, *J* = 8.0 Hz, 1H), 4.22 (q, *J* = 11.2 Hz, 2H), 2.53 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 150.3, 136.4, 132.0, 130.8, 127.4, 127.1 (q, *J* = 279.2

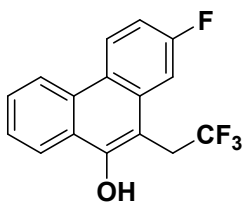
Hz), 126.2, 125.4, 123.8, 123.4, 123.0, 122.9, 122.7, 106.1, 29.1 (q, *J* =30.2 Hz), 21.5; ^{19}F NMR (376 MHz, DMSO): δ -62.1 (s, 3F); GC-MS (EI): 290.1, 270.1, 255.1, 221.1, 193.1, 178.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{17}H_{14}F_3O^+$: 291.0991, found: 291.0980.



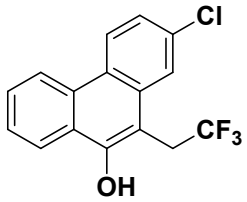
2-(*tert*-butyl)-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3f): Yellow oil. ^{1}H NMR (400 MHz, DMSO): *δ* 9.72 (s, 1H, -O*H*), 8.78 (d, *J* = 8.0 Hz, 1H), 8.68 (d, *J* = 8.8 Hz, 1H), 8.37 (d, *J* = 8.0 Hz, 1H), 7.96 (s, 1H), 7.72 (t, *J* = 7.0 Hz, 1H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.60 (d, *J* = 8.4 Hz, 1H), 4.27 (q, *J* = 11.2 Hz, 2H), 1.42 (s, 9H); ^{13}C NMR (151 MHz, DMSO): δ 150.2, 149.2, 131.5, 130.6, 127.4, 127.2 (q, *J* = 279.4 Hz), 126.2, 125.5, 123.8, 122.9, 122.8, 122.1, 119.7, 106.3, 34.7, 31.1, 29.0 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): *δ* -62.1 (s, 3F); GC-MS (EI): 332.3, 317.2, 289.1, 234.2, 178.1, 165.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{20}H_{20}F_3O^+$: 333.1461, found: 333.1455.



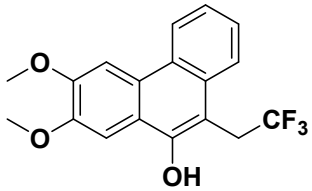
2-methoxy-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3g): Yellow oil. ^{1}H NMR (400 MHz, DMSO): *δ* 9.77 (s, 1H, -O*H*), 8.71 (d, *J* = 10.0 Hz, 1H), 8.69 (d, *J* = 9.2 Hz, 1H), 8.34 (d, *J* = 8.0 Hz, 1H), 7.69 (t, *J* = 7.2 Hz, 1H), 7.61 (t, *J* = 7.2 Hz, 1H), 7.44 (s, 1H), 7.17 (d, *J* = 9.2 Hz, 1H), 4.24 (q, *J* = 11.2 Hz, 2H), 3.93 (s, 3H); ^{13}C NMR (151 MHz, DMSO): *δ* 158.4, 150.9, 133.6, 130.9, 127.5, 127.2 (q, *J* = 279.4 Hz), 125.5, 124.7, 124.6, 122.9, 122.5, 120.1, 113.5, 106.1, 105.6, 55.2, 29.1 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.1 (s, 3F); GC-MS (EI): 306.1, 286.1, 243.1, 209.1, 181.1, 165.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{17}H_{14}F_3O_2^+$: 307.0940, found: 307.0948.



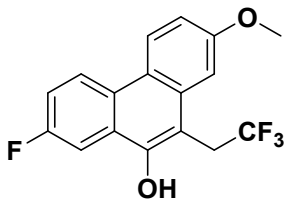
2-fluoro-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3h): Pale Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.66 (d, J = 10.4 Hz, 1H), 8.64 (d, J = 9.2 Hz, 1H), 8.18 (d, J = 7.6 Hz, 1H), 7.75 (t, J = 7.4 Hz, 1H), 7.69 (t, J = 7.4 Hz, 1H), 7.60 (d, J = 11.2 Hz, 1H), 7.33 (t, J = 8.4 Hz, 1H), 5.63 (s, 1H, -O*H*), 3.97 (q, J = 10.8 Hz, 2H); ^{13}C NMR (151 MHz, $CDCl_3$): δ 162.2 (d, J = 246.3 Hz), 149.9, 133.7 (d, J = 8.9 Hz), 131.1, 128.1, 126.7, 126.5 (q, J = 278.7 Hz), 125.4 (d, J = 9.2 Hz), 124.5, 123.6, 122.9, 121.4, 113.4 (d, J = 23.6 Hz), 108.6 (d, J = 22.2 Hz), 30.6 (q, J = 30.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): δ -63.5 (s, 3F), -113.1 (s, 1F); GC-MS (EI): 294.1, 274.1, 225.1, 196.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{16}H_{11}F_4O^+$: 295.0741, found: 295.0748.



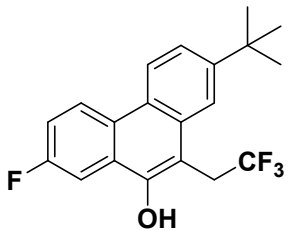
2-chloro-10-(2, 2, 2-trifluoroethyl)phenanthren-9-ol (3i): Yellow solid. ^{1}H NMR (400 MHz, DMSO): δ 10.05 (s, 1H, -O*H*), 8.80 (d, J = 8.4 Hz, 2H), 8.39 (d, J = 7.2 Hz, 1H), 8.11 (s, 1H), 7.74 (t, J = 7.5 Hz, 2H), 7.54 (d, J = 8.4 Hz, 1H), 4.27 (q, J = 11.2 Hz, 2H); ^{13}C NMR (151 MHz, DMSO): δ 151.5, 133.4, 132.2, 130.3, 128.0, 127.1 (q, J = 279.2 Hz), 127.0, 125.7, 125.3, 124.5, 124.0, 123.1, 123.0, 122.9, 105.5, 28.9 (q, J = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.4 (s, 3F); GC-MS (EI): 310.0, 290.0, 255.0, 241.0, 213.0, 178.0, 88.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{16}H_{11}ClF_3O^+$: 311.0445, found: 311.0448.



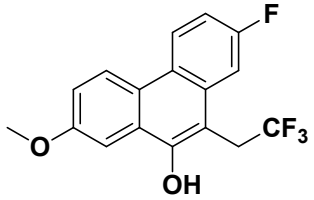
6, 7-dimethoxy-10-(2,2,2-trifluoroethyl)phenanthren-9-ol (3j): White solid. ^{1}H NMR (400 MHz, DMSO): δ 9.62 (s, 1H, -O*H*), 8.72 (d, J = 8.4 Hz, 1H), 8.16 (s, 1H), 8.00 (d, J = 8.0 Hz, 1H), 7.80 (s, 1H), 7.55 (t, J = 7.4 Hz, 1H), 7.48 (t, J = 7.4 Hz, 1H), 4.20 (q, J = 11.2 Hz, 2H), 4.04 (s, 3H), 3.95 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 149.8, 149.7, 149.0, 131.2, 127.2 (q, J = 279.7 Hz), 126.0, 125.7, 123.7, 123.4, 123.0, 120.3, 104.5, 104.0, 130.5, 55.8, 55.5, 129.9, 128.1, 29.0 (q, J = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.4 (s, 3F); GC-MS (EI): 336.2, 307.1, 267.1, 239.1, 210.1, 181.1, 152.1; HRMS (ESI): $[M+Na]^+$ calcd. for $C_{18}H_{15}F_3NaO_3^+$: 359.0866, found: 359.0858.



7-fluoro-2-methoxy-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3k): Yellow oil. ^{1}H NMR (400 MHz, DMSO): δ 9.82 (s, 1H, -O*H*), 8.79 (dd, *J* = 9.2, 5.6 Hz, 1H), 8.66 (d, *J* = 9.2 Hz, 1H), 8.03 (dd, *J* = 11.2, 2.8 Hz, 1H), 7.56 (td, *J* = 8.8, 2.4 Hz, 1H), 7.44 (s, 1H), 7.19 (dd, *J* = 8.8, 2.4 Hz, 1H), 4.25 (q, *J* = 11.2 Hz, 2H), 3.92 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 161.0 (d, *J* = 242.7 Hz), 158.3, 150.2, 133.1, 127.8, 127.1 (d, J = 278.9 Hz), 126.0 (d, *J* = 8.2 Hz), 125.6 (d, *J* = 8.5 Hz), 124.7, 119.9, 116.4 (d, *J* = 23.4 Hz), 114.0, 107.6 (d, *J* = 6.0 Hz), 107.5 (d, *J* = 22.5 Hz), 105.7, 55.2, 29.1 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.1 (s, 3F), -115.5 (s, 1F); GC-MS (EI): 324.1, 304.1, 261.1, 227.1, 212.1, 183.1, 152.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{17}H_{13}F_4O_2^+$: 325.0846, found: 325.0855.

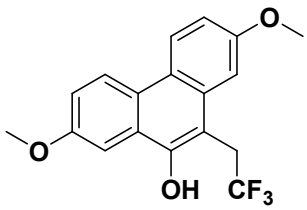


2-(tert-butyl)-7-fluoro-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3l): Yellow oil.^{1}H NMR (400 MHz, DMSO): δ 9.82 (s, 1H, -O*H*), 8.85 (dd, *J* = 9.2, 5.6 Hz, 1H), 8.66 (d, *J* = 8.8 Hz, 1H), 8.06 (dd, *J* = 10.8, 2.6 Hz, 1H), 7.96 (s, 1H), 7.63 – 7.56 (m, 2H), 4.29 (q, *J* = 11.2 Hz, 2H), 1.41 (s, 9H); ^{13}C NMR (151 MHz, DMSO): δ 160.7 (d, *J* = 243.4 Hz), 149.5 (d, *J* = 3.5 Hz), 149.2, 131.0, 127.5, 127.1 (d, *J* = 8.5 Hz), 127.0 (q, *J* = 279.2 Hz), 125.9 (d, *J* = 8.6 Hz), 123.5, 122.8, 122.5, 119.8, 116.1 (d, *J* = 23.6 Hz), 108.1, 107.5 (d, *J* = 22.7 Hz), 34.7, 31.1, 29.1 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.1 (s, 3F), -115.5 (s, 1F); GC-MS (EI): 350.2, 335.2, 307.1, 252.1, 196.1, 143.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{20}H_{19}F_4O^+$: 351.1367, found: 351.1378.

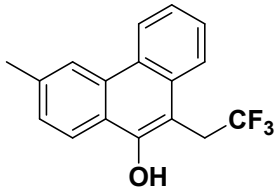


2-fluoro-7-methoxy-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3m): Pale yellow oil. ^{1}H NMR (400 MHz, DMSO): δ 9.93 (s, 1H, -O*H*), 8.74 – 8.68 (m, 2H), 7.83 – 7.80 (m, 2H), 7.35 (td, *J* = 8.8, 2.4 Hz, 2H), 4.23 (q, *J* = 11.2 Hz, 2H), 3.95 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 160.8 (d, *J* = 241.6 Hz), 158.0, 151.1, 132.6 (d, *J* =

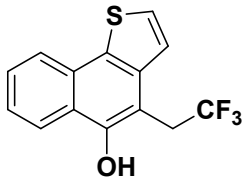
8.9 Hz), 128.6, 127.0 (q, J = 279.5 Hz), 126.5, 125.2 (d, J = 8.9 Hz), 124.9, 124.8 (d, J = 16.9 Hz), 122.8, 118.0, 112.4 (d, J = 23.4 Hz), 108.5 (d, J = 23.1 Hz), 106.4, 103.7, 55.3, 29.1 (q, J = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.4 (s, 3F), -115.30 (s, 1F); GC-MS (EI): 324.1, 304.1, 261.1, 227.1, 212.1, 183.1, 152.1; HRMS (ESI):$[M+H]^+$ calcd. for $C_{17}H_{13}F_4O_2^+$: 325.0846, found: 325.0840.



2, 7-dimethoxy-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3n): Yellow solid. ^{1}H NMR (400 MHz, DMSO): δ 9.68 (s, 1H, -O*H*), 8.63 (d, J = 9.2 Hz, 1H), 8.58 (d, J = 9.2 Hz, 1H), 7.77 (d, J = 2.4 Hz, 1H), 7.40 (s, 1H), 7.31 (dd, J = 9.2, 2.4 Hz, 1H), 7.14 (dd, J = 9.2, 2.4 Hz, 1H), 4.23 (q, J = 11.2 Hz, 2H), 3.93 (s, 3H), 3.91 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 157.6, 157.3, 150.4, 132.3, 127.2 (q, J = 279.4 Hz), 125.7, 125.2, 124.3, 124.1, 120.3, 117.7, 113.6, 106.6, 105.5, 103.6, 55.3, 55.2, 29.2 (q, J = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.1 (s, 3F); GC-MS (EI): 336.1, 293.1, 273.1, 230.1, 207.1, 181.1, 152.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{18}H_{16}F_3O_3^+$: 337.1046, found: 337.1045.

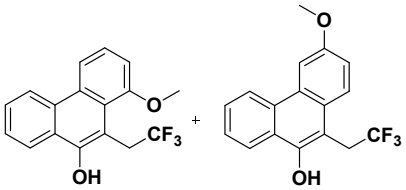


6-methyl-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3o): Yellow oil.^{1}H NMR (400 MHz, DMSO): δ 9.71 (s, 1H, -O*H*), 8.77 (d, J = 8.4 Hz, 1H), 8.64 (s, 1H), 8.27 (d, J = 8.4 Hz, 1H), 8.03 (d, J = 8.0 Hz, 1H), 7.60 (t, J = 7.2 Hz, 1H), 7.55 – 7.49 (m, 2H), 4.21 (q, J =11.2 Hz, 2H), 2.60 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 150.3, 137.0, 132.1, 130.9, 128.2, 127.1 (q, J = 279.2 Hz), 127.0, 125.7, 123.8, 123.7, 123.6, 123.0, 122.9, 122.6, 105.3, 28.9 (q, J = 30.2 Hz), 21.5; ^{19}F NMR (376 MHz, DMSO): δ -62.3 (s, 3F); GC-MS (EI): 290.1, 270.1, 255.1, 221.1, 193.1, 178.1, 28.1; HRMS (ESI):$[M+H]^+$ calcd. for $C_{17}H_{14}F_3O^+$: 291.0991, found: 291.0997.



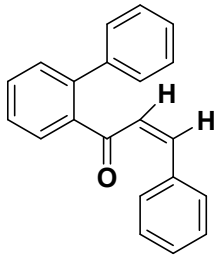
4-(2, 2, 2-trifluoroethyl) naphtha [1, 2-*b*] thiophen-5-ol (3p): Pale yellow solid. ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.14 (d, J = 7.8 Hz, 1H), 8.12 (d, J = 7.8 Hz, 1H), 7.62 (t,

J = 7.6 Hz, 1H), 7.58 (t, *J* = 7.8 Hz, 1H), 7.56 (d, *J* = 5.4 Hz, 1H), 7.46 (d, *J* = 5.4 Hz, 1H), 5.34 (s, 1H, -O*H*), 3.92 (q, *J* = 10.8 Hz, 2H); ^{13}C NMR (151 MHz, $CDCl_3$) δ 148.1, 137.6, 131.5, 129.3, 127.4, 126.7 (q, *J* = 278.8 Hz), 125.9, 125.8, 124.1, 123.6, 123.1, 122.1, 107.1, 32.4 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): *δ* -62.2 (s, 3F); GC-MS (EI): 282.0, 262.0, 233.0, 213.0, 184.0, 139.0, 92.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{14}H_{10}F_3OS^+$: 283.0399, found: 283.0401.

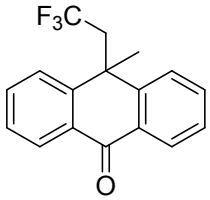


1-methoxy-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3q-1): Yellow oil.^{1}H NMR (400 MHz, DMSO): *δ* 9.63 (s, 1H, -O*H*), 8.80 (d, *J* = 9.2 Hz, 1H), 8.41 (d, *J* = 8.4 Hz, 1H), 8.33 (d, *J* = 5.2 Hz, 1H), 7.74 – 7.66 (m, 2H), 7.47 (t, *J* = 8.6 Hz, 1H), 7.19 (d, *J* = 7.6 Hz, 1H), 4.63 (q, *J* = 11.2 Hz, 2H), 3.94 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 156.4, 150.3, 130.5, 128.1, 127.5, 127.4 (q, *J* = 279.4 Hz), 126.8, 125.7, 124.5, 123.6, 122.8, 122.6, 115.8, 109.0, 106.6, 55.52, 31.3 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): *δ* -62.5 (s, 3F); GC-MS (EI): 306.1, 286.1, 243.1, 209.1, 181.1, 165.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{17}H_{14}F_3O_2^+$: 307.0940, found: 307.0948.

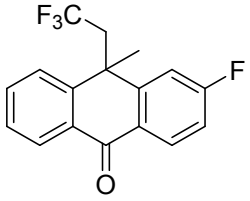
3-methoxy-10-(2, 2, 2-trifluoroethyl) phenanthren-9-ol (3q-2): Yellow oil. ^{1}H NMR (400 MHz, DMSO): *δ* 9.77 (s, 1H, -O*H*), 8.71 (d, *J* = 10.0 Hz, 1H), 8.69 (d, *J* = 9.2 Hz, 1H), 8.34 (d, *J* = 8.0 Hz, 1H), 7.69 (t, *J* = 7.2 Hz, 1H), 7.61 (t, *J* = 7.2 Hz, 1H), 7.44 (s, 1H), 7.17 (d, *J* = 9.2 Hz, 1H), 4.24 (q, *J* = 11.2 Hz, 2H), 3.93 (s, 3H); ^{13}C NMR (151 MHz, DMSO): δ 158.4, 150.9, 133.6, 130.9, 127.5, 127.2 (q, *J* = 279.4 Hz), 125.5, 124.7, 124.6, 122.9, 122.5, 120.1, 113.5, 106.1, 105.6, 55.2, 29.1 (q, *J* = 30.2 Hz); ^{19}F NMR (376 MHz, DMSO): δ -62.1 (s, 3F); GC-MS (EI): 306.1, 286.1, 243.1, 209.1, 181.1, 165.1, 28.1; HRMS (ESI): $[M+H]^+$ calcd. for $C_{17}H_{14}F_3O_2^+$: 307.0940, found: 307.0950.



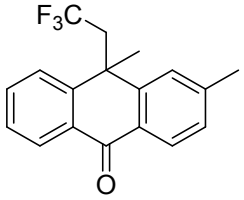
(Z)-1-([1,1'-biphenyl]-2-yl)-3-phenylprop-2-en-1-one (3r): Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.70 (dd, *J* = 7.6, 1.1 Hz, 1H), 7.48 (td, *J* = 7.5, 1.4 Hz, 1H), 7.43 – 7.25 (m, overlapping $CDCl_3$, 13H), 6.46 (d, *J* = 12.8 Hz, 1H), 5.94 (d, *J* = 12.8 Hz, 1H); GC-MS (EI): 284.1, 255.2, 181.2, 165.2, 152.2, 131.1.



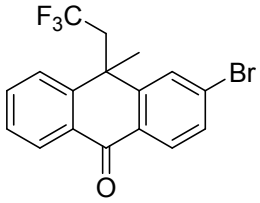
10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5a). Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$) ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.41 (d, *J* = 7.8 Hz, 2H), 7.69 (t, *J* = 7.4 Hz, 2H), 7.64 (d, *J* = 7.9 Hz, 2H), 7.49 (t, *J* = 7.4 Hz, 2H), 3.13 (q, *J* = 9.8 Hz, 2H), 1.81 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 183.1, 145.9, 133.5, 130.7, 127.9, 127.8, 127.5, 126.5, 125.1(q, *J* = 279.7 Hz), 47.4 (q, *J* = 26.0 Hz), 38.2, 33.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.6. (s, 3F). LRMS (EI): 290, 221, 207, 115, 77. HRMS (ESI): calcd. for $C_{17}H_{14}F_3O^+$ 291.0997 $[M+H]^+$, found 291.0998.



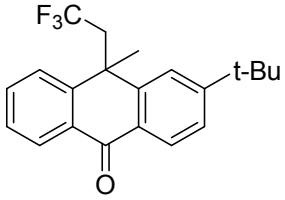
3-fluoro-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5b). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 – 8.28 (m, 2H), 7.61 (t, *J* = 7.6 Hz, 1H), 7.54 (d, *J* = 7.8 Hz, 1H), 7.42 (t, *J* = 7.5 Hz, 1H), 7.21 (m, 1H), 7.10 (m, 1H), 3.01 (m, 2H), 1.73 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 181.9, 166.9, 165.2, 149.1, 149.0, 145.5, 133.6, 131.2, 131.2, 130.4, 128.0, 127.7, 126.5, 124.9 (q, *J* = 279.7 Hz), 115.7, 115.5, 113.2, 113.0, 60.4, 47.5 (q, *J* = 26.3 Hz), 33.7. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.7 (s, 3F), -104.0 (s, 1F). LRMS (EI): 308, 228, 178, 152, 115. HRMS (ESI): calcd. for $C_{17}H_{13}F_4O^+$ 309.0903 $[M+H]^+$, found 309.0895.



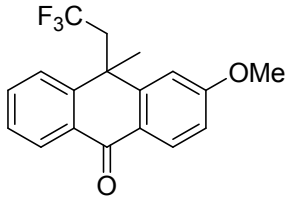
3,10-dimethyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5c). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (dd, *J* = 7.9, 1.3 Hz, 1H), 8.30 (d, *J* = 8.0 Hz, 1H), 7.65 (m, 2H), 7.51 – 7.43 (m, 1H), 7.40 (s, 1H), 7.29 (d, *J* = 8.1 Hz, 1H), 3.11 (q, *J* = 9.9 Hz, 2H), 2.49 (s, 3H), 1.79 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.9, 146.1, 145.9, 144.2, 133.3, 130.8, 128.7, 128.4, 128.0, 127.8, 127.4, 126.8, 126.5, 125.1 (q, *J* = 279.7 Hz), 47.4 (q, *J* = 26.1 Hz), 38.1, 33.8, 22.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.6 (s, 3F). LRMS (EI): 304, 289, 221, 191, 152, 115. HRMS (ESI): calcd. for $C_{18}H_{16}F_3O^+$ 305.1153 $[M+H]^+$, found 305.1124.



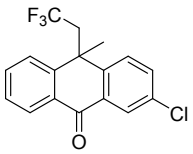
3-bromo-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5d). Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.39 (d, *J* = 7.8 Hz, 1H), 8.26 (d, *J* = 8.4 Hz, 1H), 7.78 (s, 1H), 7.70 (t, *J* = 7.6 Hz, 1H), 7.62 (t, *J* = 7.1 Hz, 2H), 7.50 (t, *J* = 7.5 Hz, 1H), 3.10 (m, 2H), 1.81 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.3, 147.7, 145.4, 133.8, 131.1, 130.3, 129.7, 129.7, 129.6, 128.9, 128.0, 127.7, 126.5, 124.9 (q, *J* = 279.9 Hz), 47.5 (q, *J* = 26.4 Hz), 38.2, 33.6. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.6 (s, 3F). LRMS (EI): 368, 353, 285, 225, 178. HRMS (ESI): calcd. for $C_{17}H_{13}BrF_3O^+$ 369.0102 $[M+H]^+$, found 369.0096.



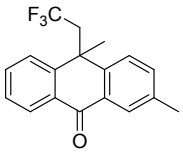
3-tert-butyl-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5e). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (dd, *J* = 7.9, 1.2 Hz, 1H), 8.35 – 8.30 (m, 1H), 7.81 (dd, *J* = 5.8, 3.3 Hz, 1H), 7.70 – 7.45 (m, 6H), 7.42 – 7.30 (m, 1H), 3.13 (q, *J* = 9.9 Hz, 2H), 1.81 (s, 3H), 1.40 (s, 8H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.9, 157.0, 146.3, 145.5, 134.2, 133.3, 130.8, 128.4, 127.8, 127.8, 127.3, 127.3, 126.4, 125.1 (q, *J* = 279.5 Hz), 124.9, 123.1, 47.4 (q, *J* = 26.1 Hz), 38.4, 31.1. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.6 (s, 3F). LRMS (EI): 346, 330, 315, 209, 152, 105. HRMS (ESI): calcd. for $C_{21}H_{22}F_3O^+$ 347.1623 $[M+H]^+$, found 347.1606.



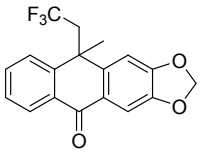
3-methoxy-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5f). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 (d, *J* = 8.4 Hz, 2H), 7.66 (dt, *J* = 17.8, 8.0 Hz, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.11 – 7.01 (m, 2H), 3.96 (s, 3H), 3.11 (qd, *J* = 9.8, 6.8 Hz, 2H), 1.81 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.1, 163.7, 148.3, 145.7, 133.1, 130.8, 130.6, 127.8, 127.4, 126.4, 124.5, 125.1 (q, *J* = 25.2 Hz), 113.1, 111.9, 55.6, 47.5 (q, *J* = 26.3 Hz), 38.3, 33.9. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.6 (s, 3F). LRMS (EI): 320, 287, 228, 189, 145. HRMS (ESI): calcd. for $C_{18}H_{16}F_3O_2^+$ 321.1102 $[M+H]^+$, found 321.1110.



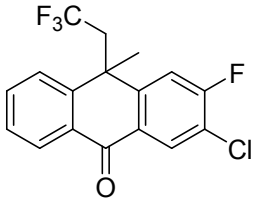
2-chloro-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5g). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.41 (dd, *J* = 7.9, 1.2 Hz, 1H), 8.39 (d, *J* = 2.4 Hz, 1H), 7.77 – 7.69 (m, 1H), 7.69 – 7.62 (m, 2H), 7.60 (d, *J* = 8.6 Hz, 1H), 7.53 (t, *J* = 7.5 Hz, 1H), 3.22 – 3.03 (m, 2H), 1.82 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.0, 145.7, 144.2, 133.9, 133.8, 133.5, 132.1, 130.3, 128.3, 128.1, 127.7, 127.6, 126.5, 124.9 (q, *J* = 279.8 Hz), 47.3 (q, *J* = 26.3 Hz), 38.1, 33.7. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.6 (s, 3F). LRMS (EI): 324, 223, 178, 118, 91. HRMS (ESI): calcd. for $C_{17}H_{13}ClF_3O^+$ 325.0607 $[M+H]^+$, found 325.0625



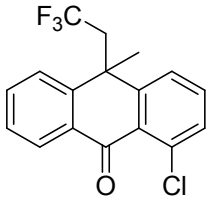
3,10-dimethyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5h). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.43 (dd, *J* = 7.9, 1.2 Hz, 1H), 8.23 (s, 1H), 7.68 (m, 2H), 7.58 – 7.46 (m, 3H), 3.13 (q, *J* = 9.9 Hz, 2H), 2.48 (s, 3H), 1.81 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 183.3, 146.1, 143.2, 137.3, 134.6, 133.4, 130.8, 130.4, 127.9, 127.4, 126.5, 125.2 (q, *J* = 279.7 Hz), 47.3 (q, *J* = 24.5 Hz), 37.9, 33.8, 21.0. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.6 (s, 3F). LRMS (EI): 304, 242, 189, 164, 115. HRMS (ESI): calcd. for $C_{18}H_{16}F_3O^+$ 305.1153 $[M+H]^+$, found 305.1048.



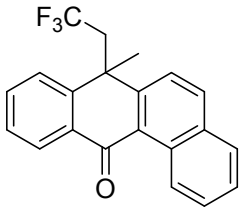
10-methyl-10-(2,2,2-trifluoroethyl)anthra[2,3-d][1,3]dioxol-5(10H)-one(5i).
Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.82 (s, 1H), 7.72 – 7.64 (m, 1H), 7.61 (d, *J* = 7.3 Hz, 1H), 7.54 – 7.44 (m, 1H), 7.03 (s, 1H), 6.11 (dd, *J* = 3.0, 1.2 Hz, 2H), 3.20 – 2.97 (m, 2H), 1.78 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 181.7, 152.6, 147.6, 145.7, 142.7, 133.0, 130.5, 127.8, 127.4, 126.3, 125.0 (q, *J* = 279.7 Hz), 106.4, 105.7, 102.0, 47.3 (q, *J* = 26.1 Hz), 38.5, 33.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.8 (s, 3F). LRMS (EI): 334, 319, 251, 193, 165, 115. HRMS (ESI): calcd. for $C_{18}H_{14}F_3O_3^+$ 335.0895 $[M+H]^+$, found 335.0887.



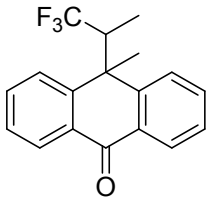
2-chloro-3-fluoro-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5j). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (d, *J* = 7.9 Hz, 1H), 8.40 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.76 – 7.69 (m, 1H), 7.64 (d, *J* = 7.8 Hz, 1H), 7.56 – 7.49 (m, 1H), 7.41 (d, *J* = 10.2 Hz, 1H), 3.23 – 2.97 (m, 2H), 1.82 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 180.9, 162.1, 160.4, 147.0, 147.0, 145.4, 133.9, 130.9, 130.0, 129.8, 129.1, 128.7, 128.3, 128.2, 128.1, 127.8, 126.5, 124.8 (q, *J* = 279.7 Hz), 123.2, 121.7, 121.6, 114.7, 114.6, 47.4 (q, *J* = 26.4 Hz), 38.2, 33.7. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.7 (s, 3F), -106.9 (s, 1F). LRMS (EI): 342, 265, 207, 165, 115. HRMS (ESI): calcd. for $C_{17}H_{12}ClF_4O^+$ 343.0513 $[M+H]^+$, found 343.0519.



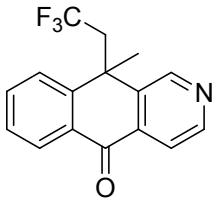
1-chloro-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one (5k). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.71 – 7.65 (m, 1H), 7.64 – 7.59 (m, 2H), 7.58 – 7.47 (m, 3H), 3.06 (q, *J* = 9.9 Hz, 2H), 1.87 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.6, 148.8, 144.1, 135.2, 133.3, 132.7, 132.2, 131.4, 128.2, 128.1, 127.7, 125.8, 125.6, 125.0 (q, *J* = 279.5 Hz), 48.2 (q, *J* = 26.3 Hz), 38.9, 38.8, 33.0. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.5 (s, 3F). LRMS (EI): 324, 214, 195, 152, 115. HRMS (ESI): calcd. for $C_{17}H_{13}ClF_3O^+$ 325.0607 $[M+H]^+$, found 325.0609.



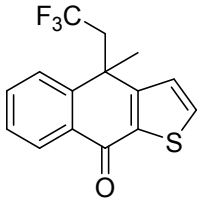
7-methyl-7-(2,2,2-trifluoroethyl)tetraphen-12(7H)-one (5l). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.81 (d, *J* = 8.8 Hz, 1H), 8.45 (dd, *J* = 7.9, 0.9 Hz, 1H), 8.15 (d, *J* = 8.8 Hz, 1H), 7.91 (d, *J* = 8.2 Hz, 1H), 7.80 – 7.51 (m, 6H), 3.33 – 3.12 (m, 2H), 1.89 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 185.6, 147.5, 144.5, 134.6, 132.9, 132.7, 132.7, 131.5, 129.1, 128.3, 127.9, 127.9, 127.6, 126.9, 126.2, 125.8, 125.1(q, *J* = 279.5 Hz), 123.6, 46.9 (q, *J* = 26.3 Hz), 39.2, 33.3. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.7 (s, 3F). LRMS (EI): 340, 274, 245, 189, 178, 115. HRMS (ESI): calcd. for $C_{21}H_{16}F_3O^+$ 341.1153 $[M+H]^+$, found 341.1149.



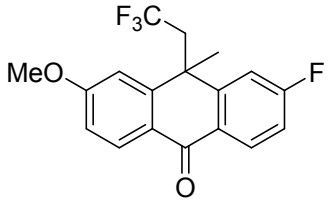
10-methyl-10-(1,1,1-trifluoropropan-2-yl)anthracen-9(10H)-one (5m). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (d, *J* = 7.3 Hz, 2H), 7.68 (m, 4H), 7.53 – 7.46 (m, 2H), 2.88 – 2.74 (m, 1H), 2.04 (s, 3H), 0.87 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 184.0, 146.6, 145.2, 133.3, 133.0, 132.3, 131.9, 127.8, 127.6, 127.5, 127.3, 126.7, 51.2 (q, *J* = 23.9 Hz), 42.4, 27.0, 10.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -64.2 (s, 3F). LRMS (EI): 304, 242, 215, 189, 155, 91. HRMS (ESI): calcd. for $C_{18}H_{16}F_3O^+$ 305.1153 $[M+H]^+$, found 305.1074



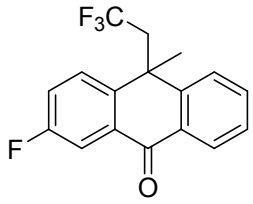
10-methyl-10-(2,2,2-trifluoroethyl)benzo[g]isoquinolin-5(10H)-one (5n). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.07 (s, 1H), 8.78 (d, *J* = 5.1 Hz, 1H), 8.39 (dd, *J* = 7.9, 1.4 Hz, 1H), 8.14 (d, *J* = 5.0 Hz, 1H), 7.81 – 7.72 (m, 1H), 7.66 (d, *J* = 7.8 Hz, 1H), 7.58 – 7.49 (m, 1H), 3.20 (qd, *J* = 9.8, 4.0 Hz, 2H), 1.90 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.4, 149.9, 148.6, 145.6, 139.4, 135.9, 134.5, 130.2, 128.1, 127.9, 126.5, 124.9 (q, *J* = 279.4 Hz), 119.5, 47.1 (q, *J* = 26.4 Hz), 36.9, 33.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.6 (s, 3F). LRMS (EI): 291, 275, 207, 171, 145, 115. HRMS (ESI): calcd. for $C_{16}H_{13}F_3NO^+$ 292.0949 $[M+H]^+$, found 292.0932.



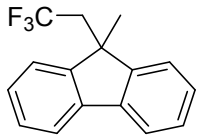
4-methyl-4-(2,2,2-trifluoroethyl)naphtho[2,3-b]thiophen-9(4H)-one (5o). Yellow oil. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.31 (d, *J* = 7.8 Hz, 1H), 7.66 (dd, *J* = 11.1, 4.0 Hz, 1H), 7.59 (d, *J* = 7.9 Hz, 2H), 7.51 (m, 3H), 3.04 (qd, *J* = 9.9, 2.4 Hz, 2H), 1.85 (s, 3H).^{13}C NMR (151 MHz, $CDCl_3$) δ 182.6, 148.8, 144.1, 135.3, 133.3, 132.7, 132.2, 131.4, 128.2, 128.1, 127.7, 125.9, 125.8, 125.5, 124.9 (q, *J* = 279.3 Hz), 48.2 (q, *J* = 26.4 Hz), 38.9, 33.0. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.5 (s, 3F). LRMS (EI): 296, 212, 176, 151, 115. HRMS (ESI): calcd. for $C_{16}H_{15}O^+$ 297.0561 $[M+H]^+$, found 297.0555.



3-fluoro-6-methoxy-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one(5p). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (m, 2H), 7.69 – 7.58 (m, 1H), 7.52 – 7.45 (m, 1H), 7.28 – 7.23 (m, 2H), 7.20 – 7.14 (m, 1H), 7.06 – 7.00 (m, 2H), 3.94 (s, 3H), 3.13 – 2.97 (m, 2H), 1.79 (s, 1H), 1.78 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.1, 180.9, 166.7, 165.0, 163.8, 163.7, 148.8, 148.7, 148.3, 147.9, 145.7, 133.1, 131.0, 131.0, 130.8, 130.7, 130.6, 127.8, 127.5, 127.4, 126.4, 124.5, 124.9 (q, J = 279.7 Hz), 124.1, 115.5, 115.4, 113.2, 113.1, 113.1, 113.0, 111.9, 111.9, 55.6, 47.6 (q, J = 26.1 Hz), 38.5, 38.3, 33.9, 33.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.7 (s, 3F), -104.8 (s, 1F). LRMS (EI): 338, 244, 178, 152, 115. HRMS (ESI): calcd. for $C_{18}H_{15}F_4O_2^+$ 339.0997 $[M+H]^+$, found 339.0992.



3-fluoro-10-methyl-10-(2,2,2-trifluoroethyl)anthracen-9(10H)-one (5q). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 (dd, J = 7.9, 1.3 Hz, 1H), 8.04 (dd, J = 9.1, 2.9 Hz, 1H), 7.70 (m, 1H), 7.63 (dd, J = 8.7, 4.7 Hz, 2H), 7.54 – 7.46 (m, 1H), 7.39 (m, 1H), 3.18 – 3.02 (m, 2H), 1.80 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 182.2, 162.6, 160.9, 145.9, 141.7, 141.7, 133.8, 132.8, 132.7, 130.3, 128.9, 128.9, 128.5, 128.0, 127.6, 126.5, 125.0 (q, J = 279.4 Hz), 121.2, 121.1, 113.6, 113.4, 47.4 (q, J = 25.8 Hz), 38.1, 33.7. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.7 (s, 3F), -113.8 (s, 1F). LRMS (EI): 308, 251, 165, 115. HRMS (ESI): calcd. for $C_{17}H_{13}F_4O^+$ 309.0903 $[M+H]^+$, found 309.0985.

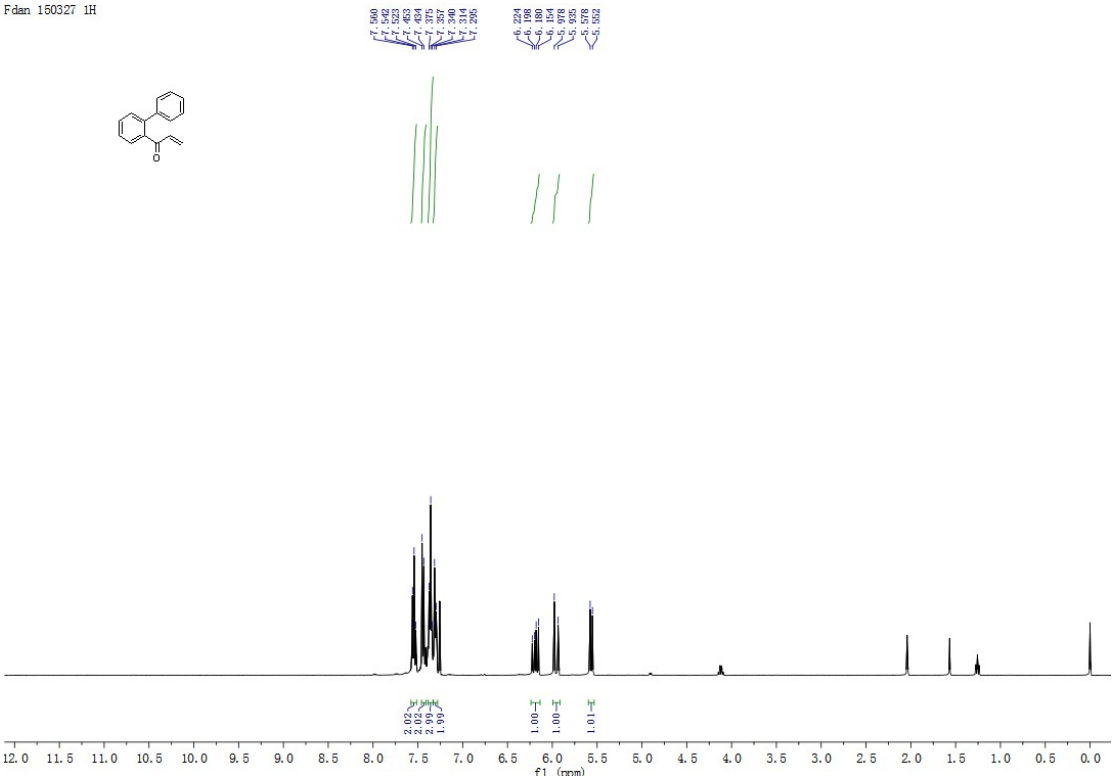


9-methyl-9-(2,2,2-trifluoroethyl)-9H-fluorene(5r). Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (dd, J = 6.8, 3.7 Hz, 2H), 7.37 (m, 3H), 7.29 – 7.27 (m, 1H), 7.12 – 6.95 (m, 2H), 2.57 (m, 2H), 1.96 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 151.4, 136.7, 129.88, 128.6, 128.4, 128.2, 125.3 (q, J = 278.7 Hz), 123.8, 122.9, 122.5, 122.3, 121.9, 118.4, 75.9, 41.6 (q, J = 27.2 Hz), 29.7, 24.9. ^{19}F NMR (376 MHz, $CDCl_3$) δ -60.2 (s, 3F). LRMS (EI):262, 223, 209, 151, 105.

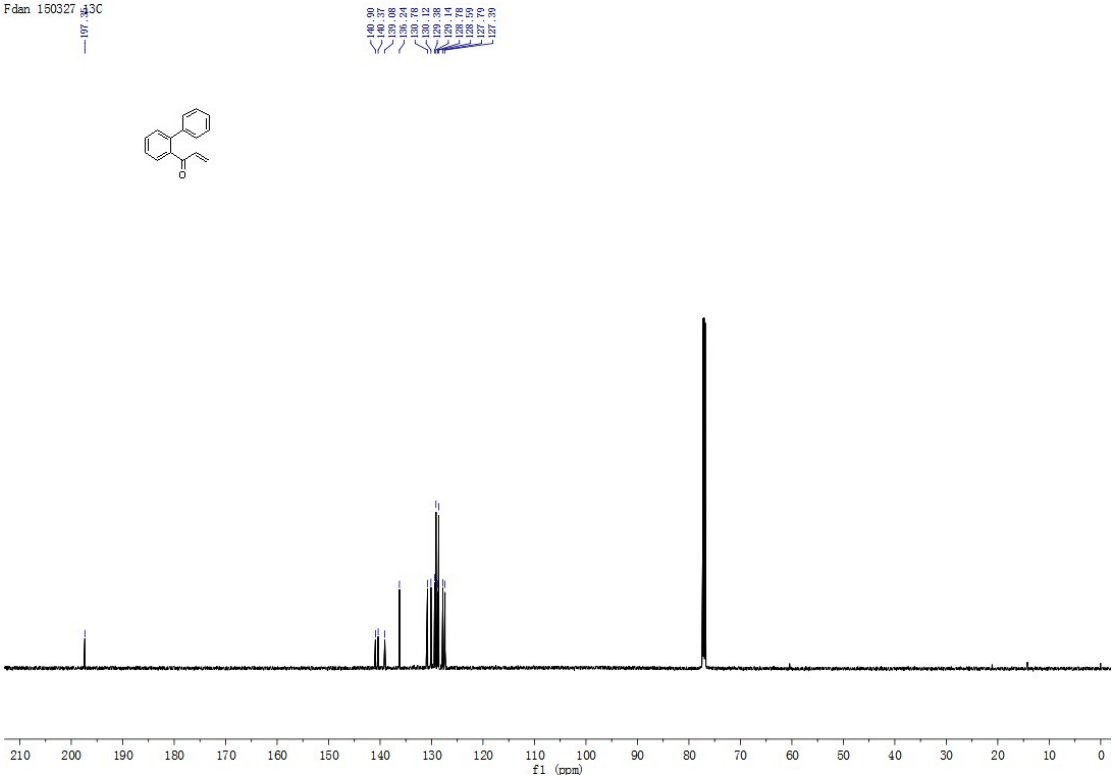
4. ^{1}H NMR and ^{13}C NMR for substrates and products

NMR for substrates:

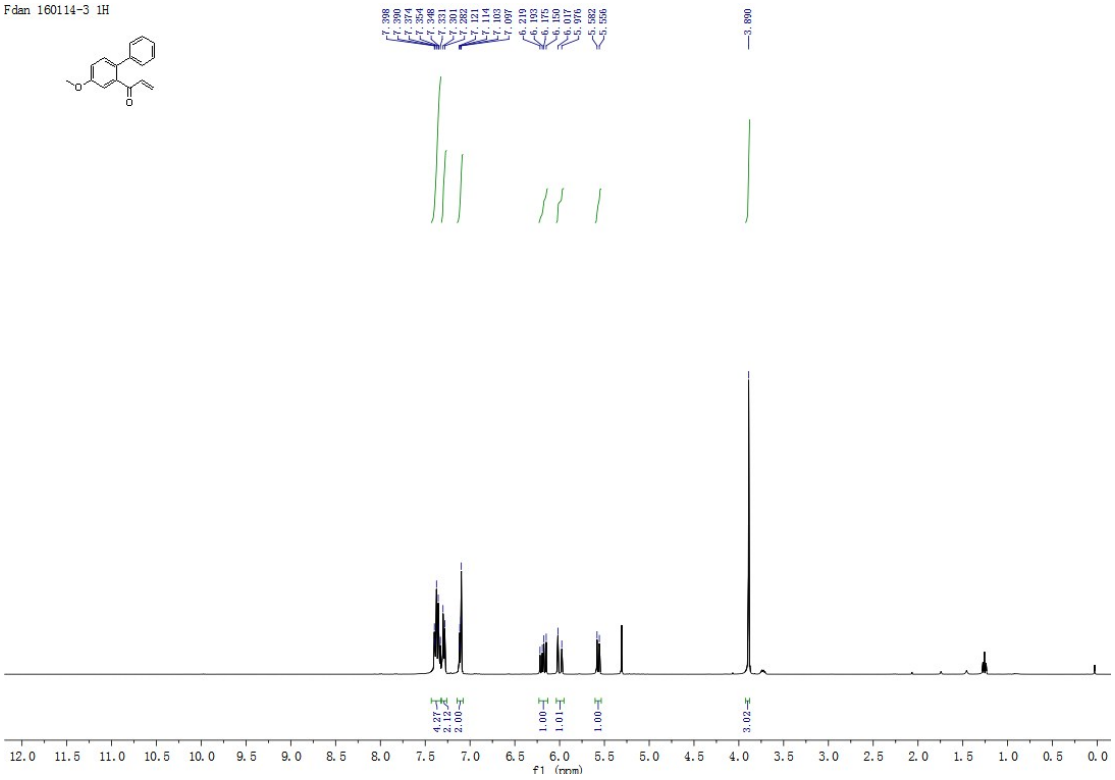
1a ^{1}H NMR



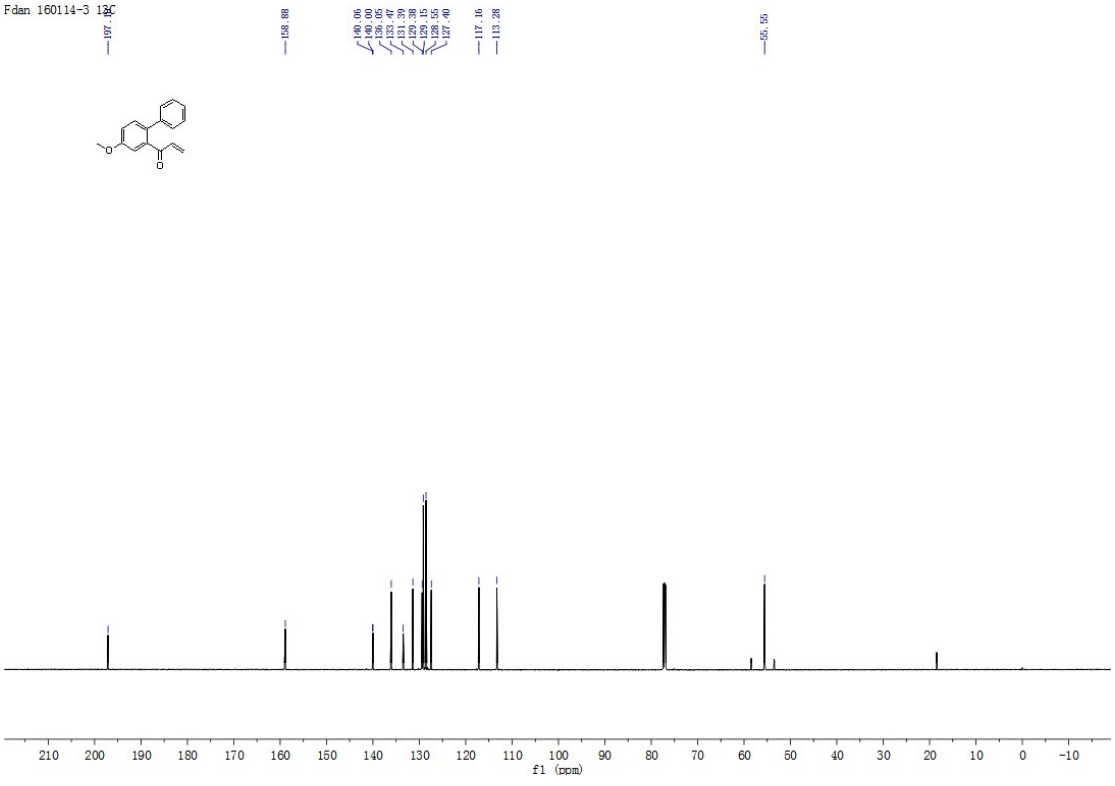
1a ^{13}C NMR



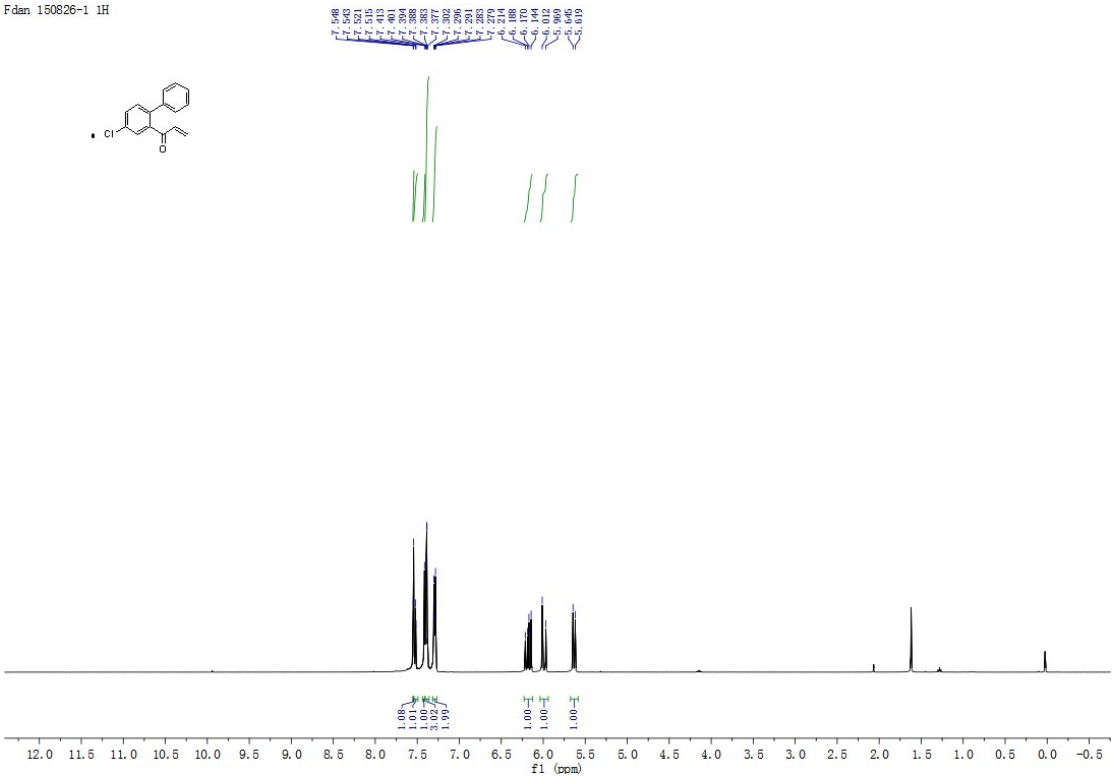
1b ^{1}H NMR



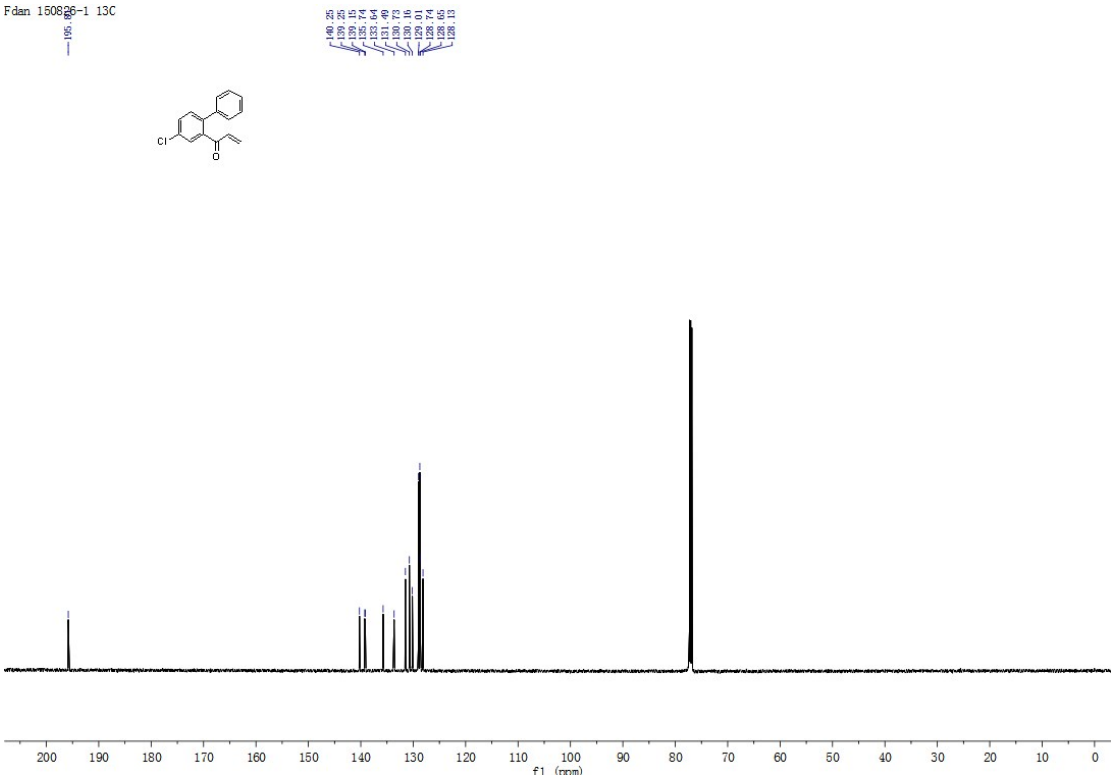
1b ^{13}C NMR



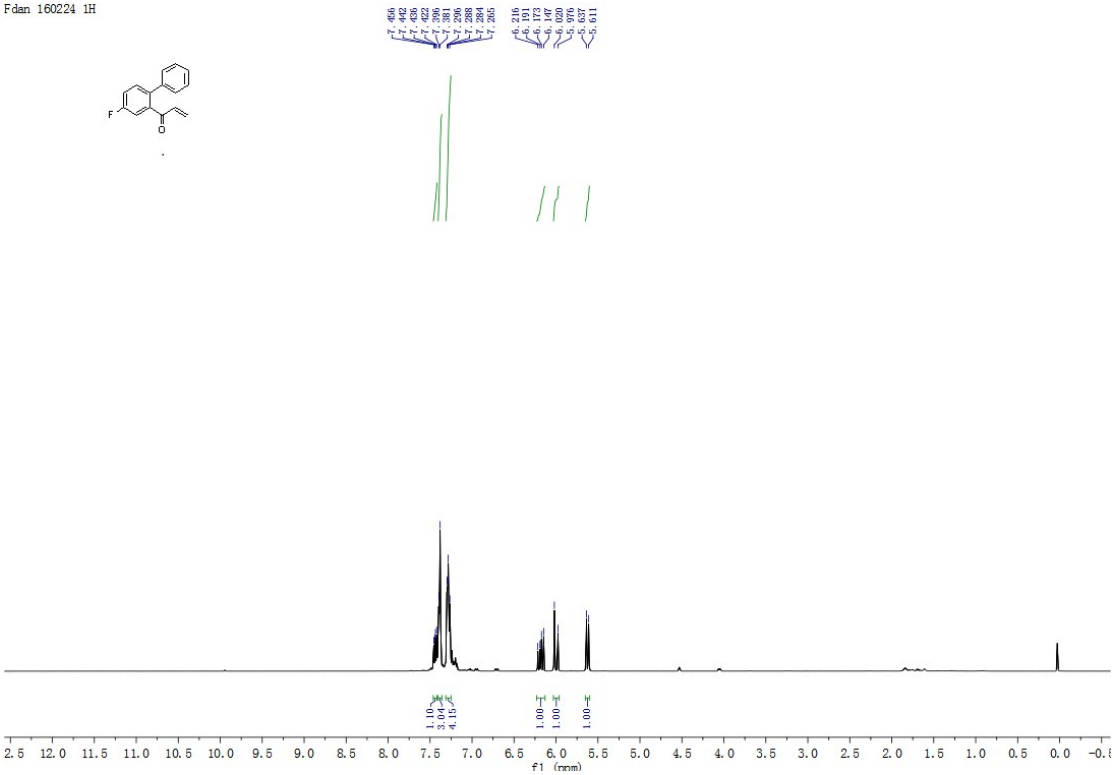
1c ^{1}H NMR



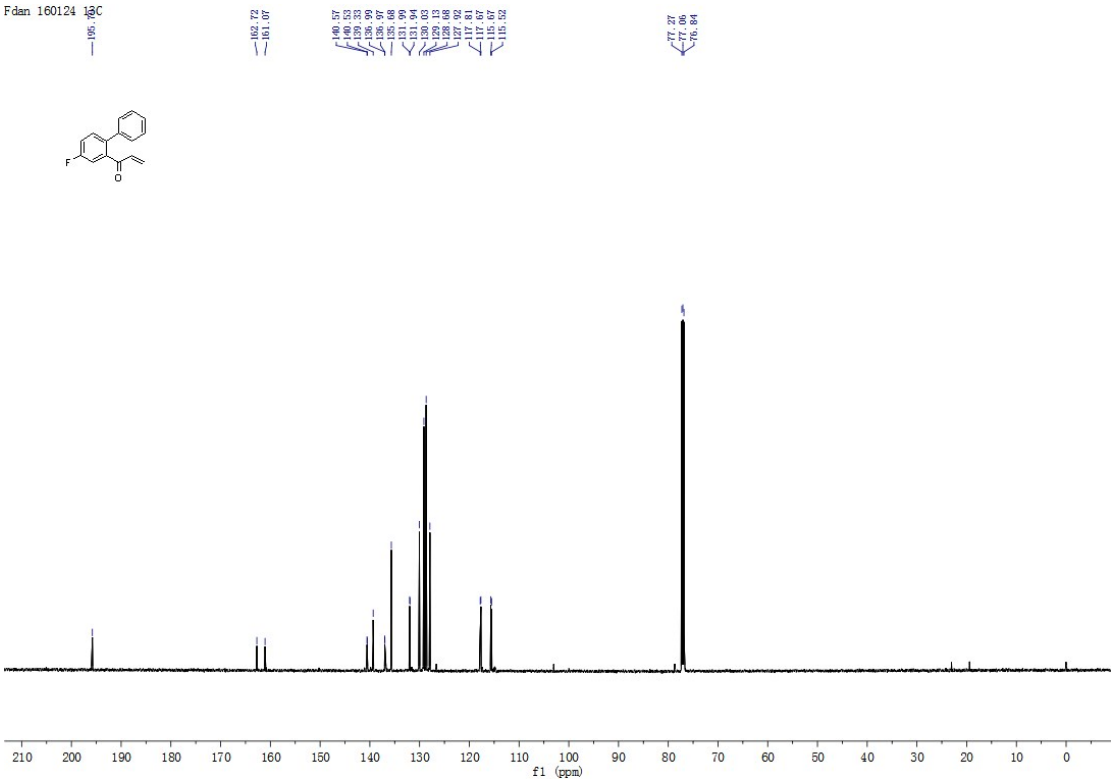
1c^{13}C NMR



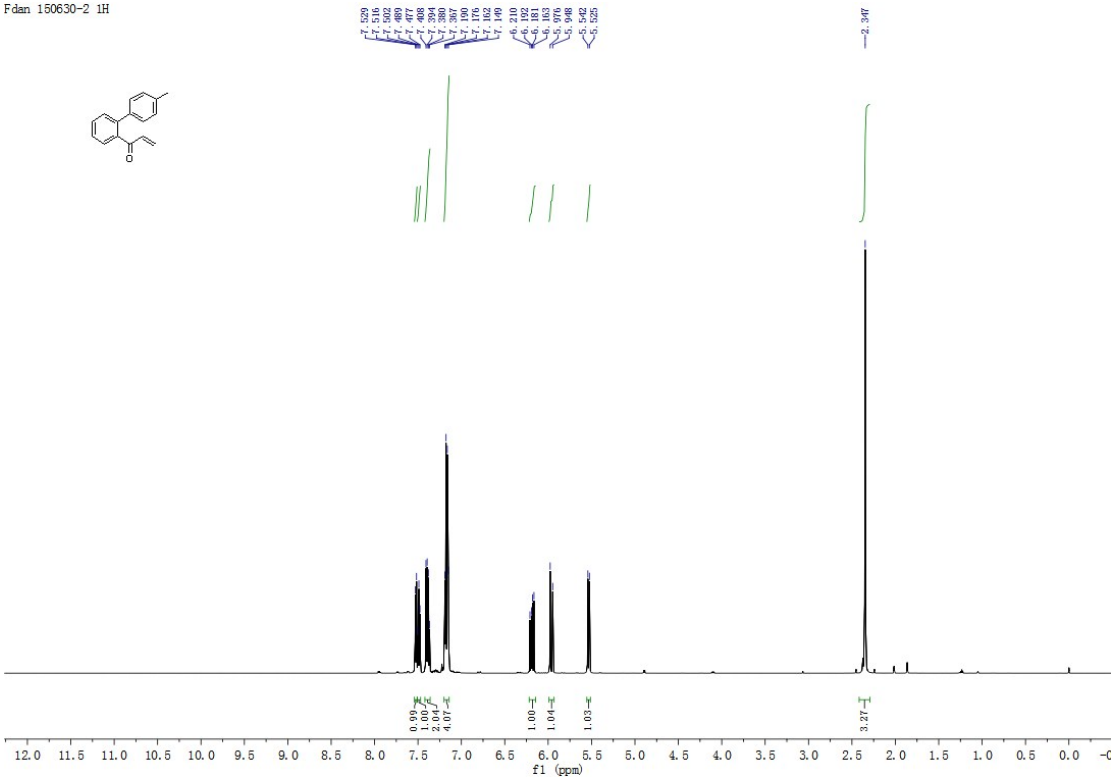
1d^{1}H NMR



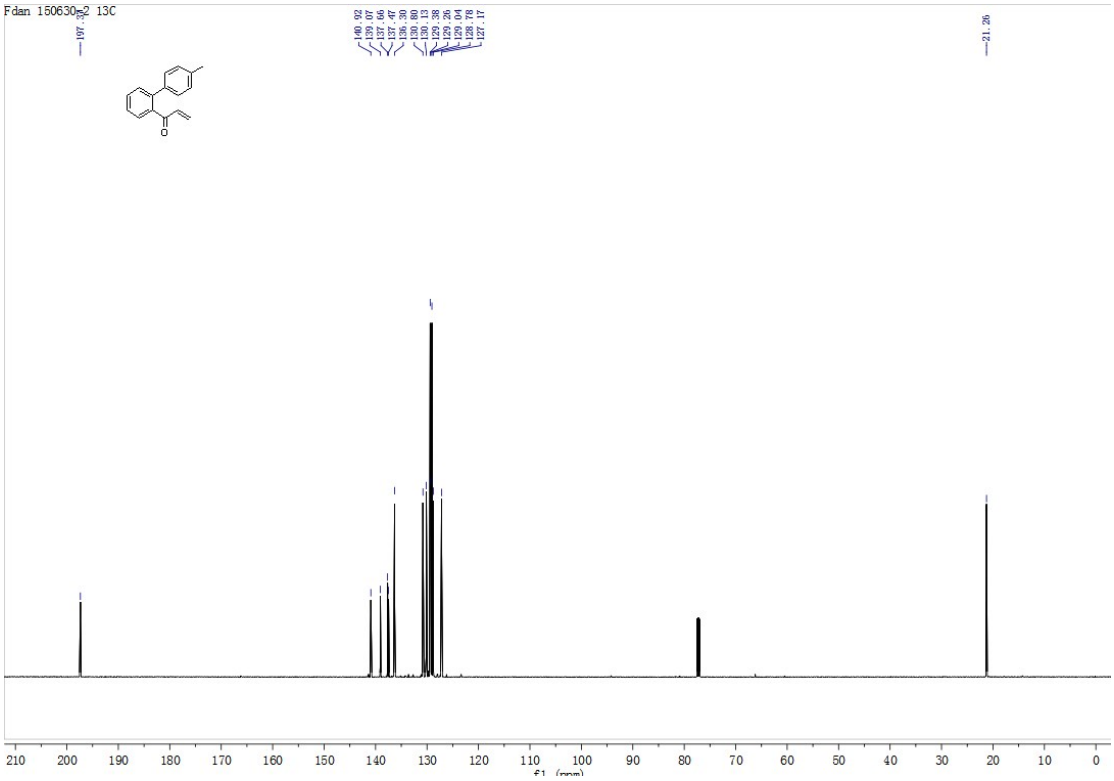
1d^{13}H NMR



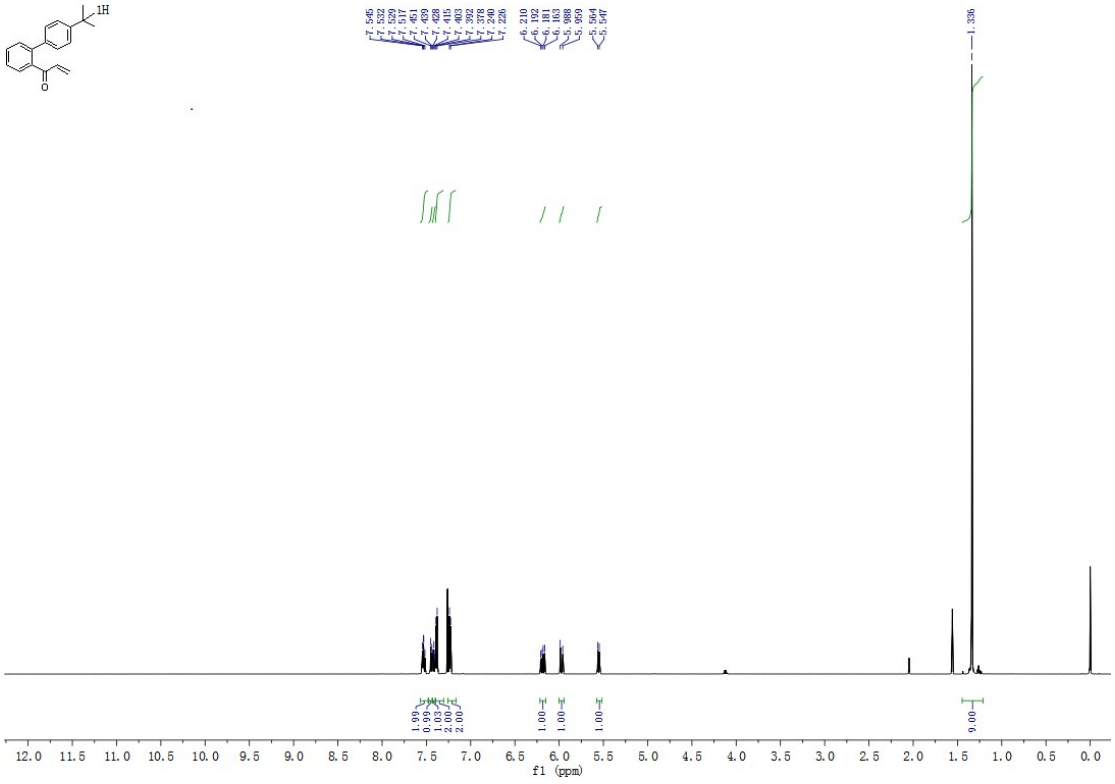
1e[1]H NMR



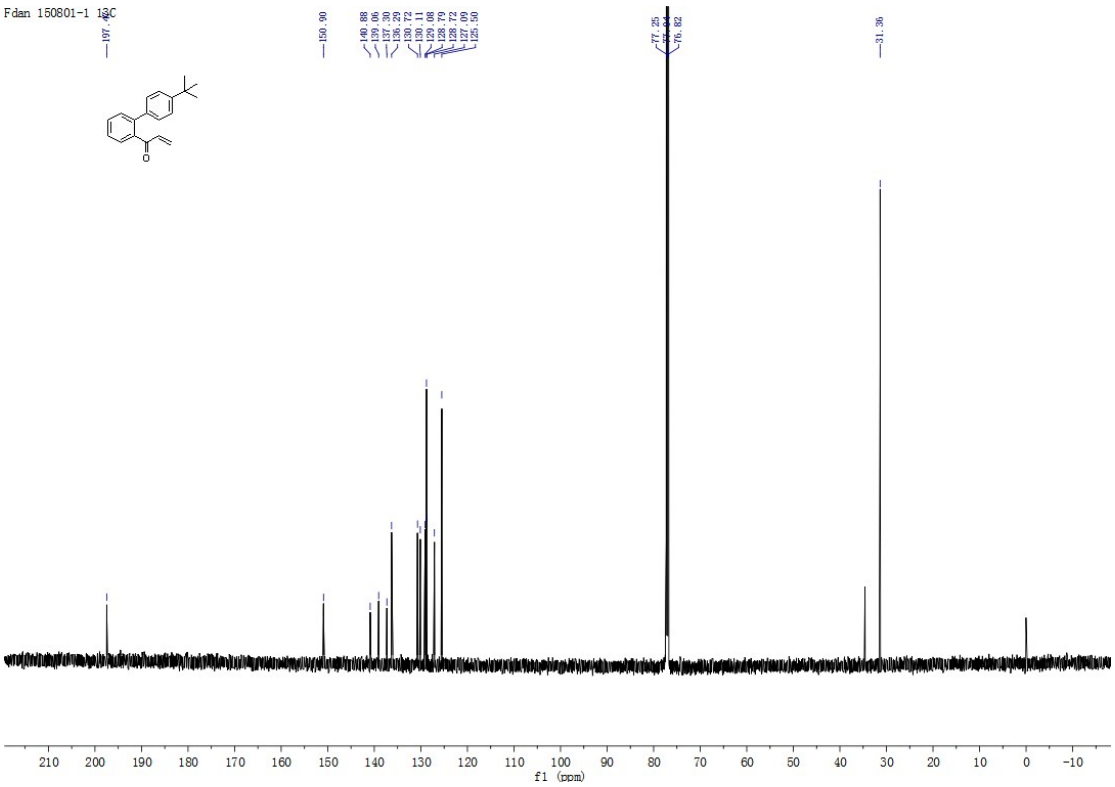
1e[13]C NMR



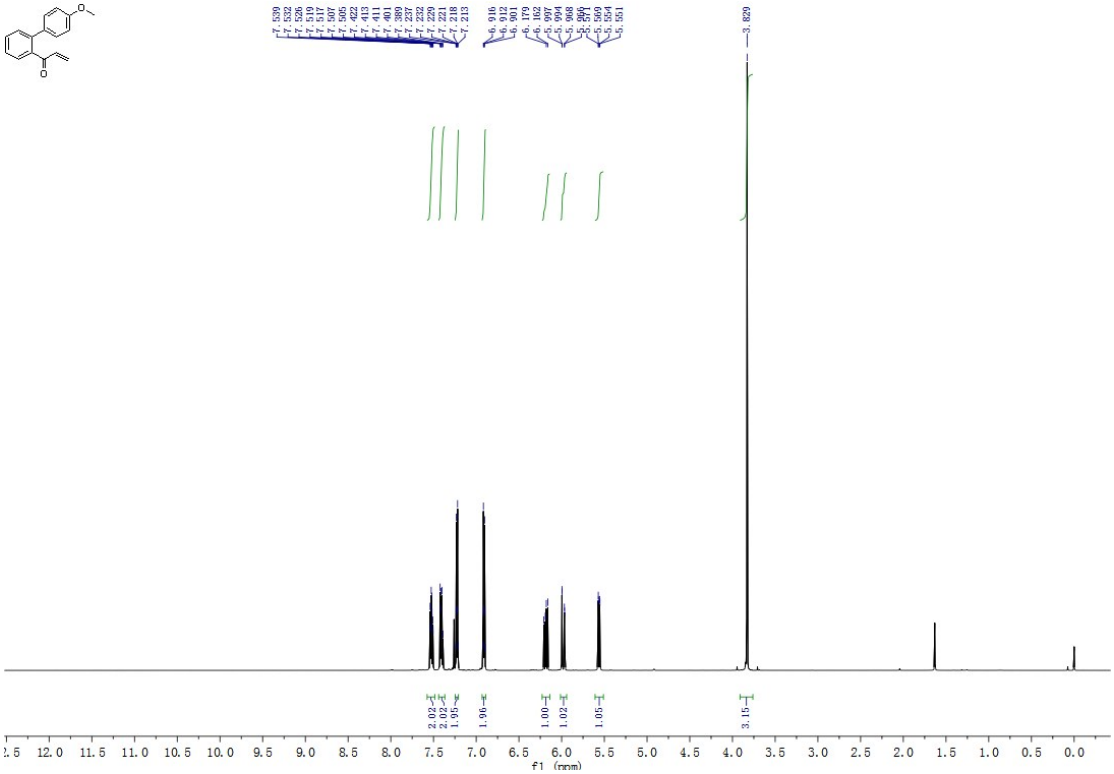
1f[1]H NMR



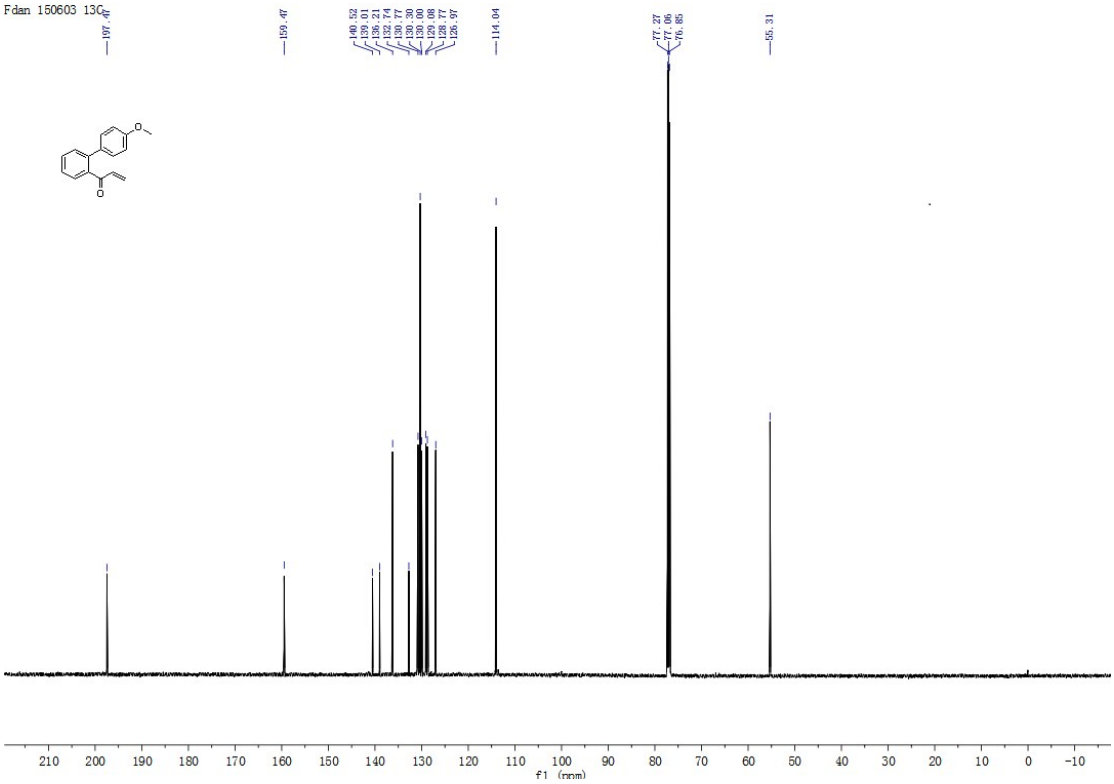
1f[13]C NMR



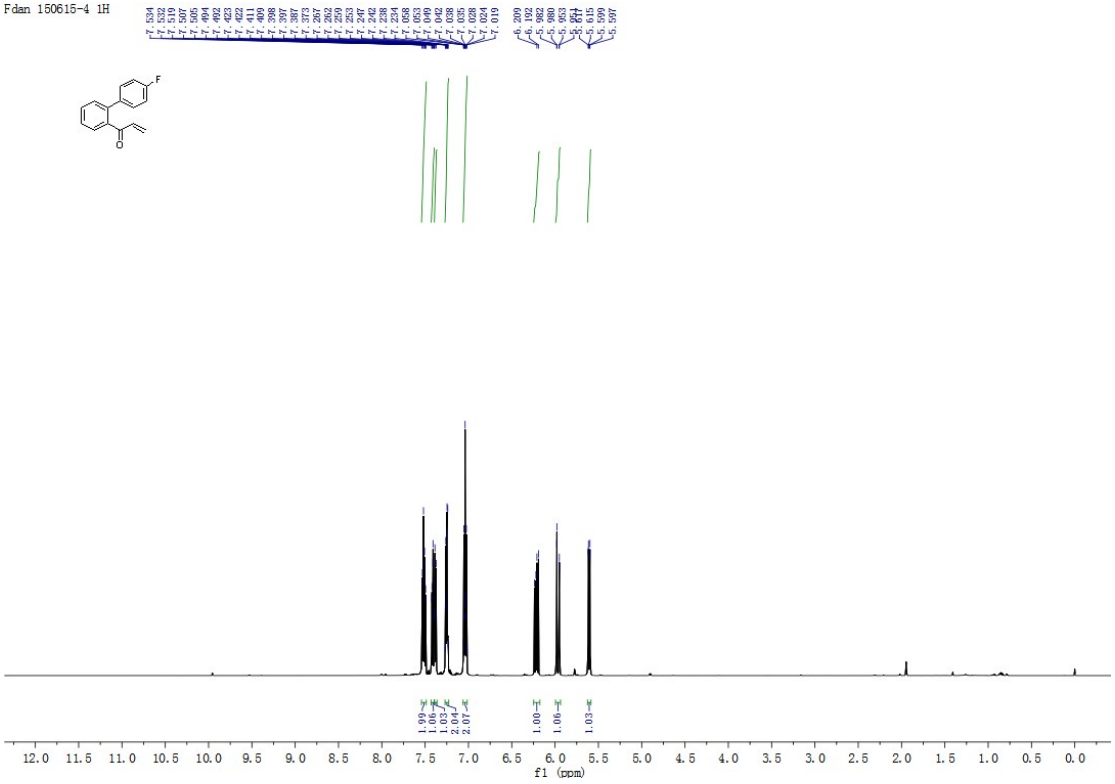
1g[1]H NMR



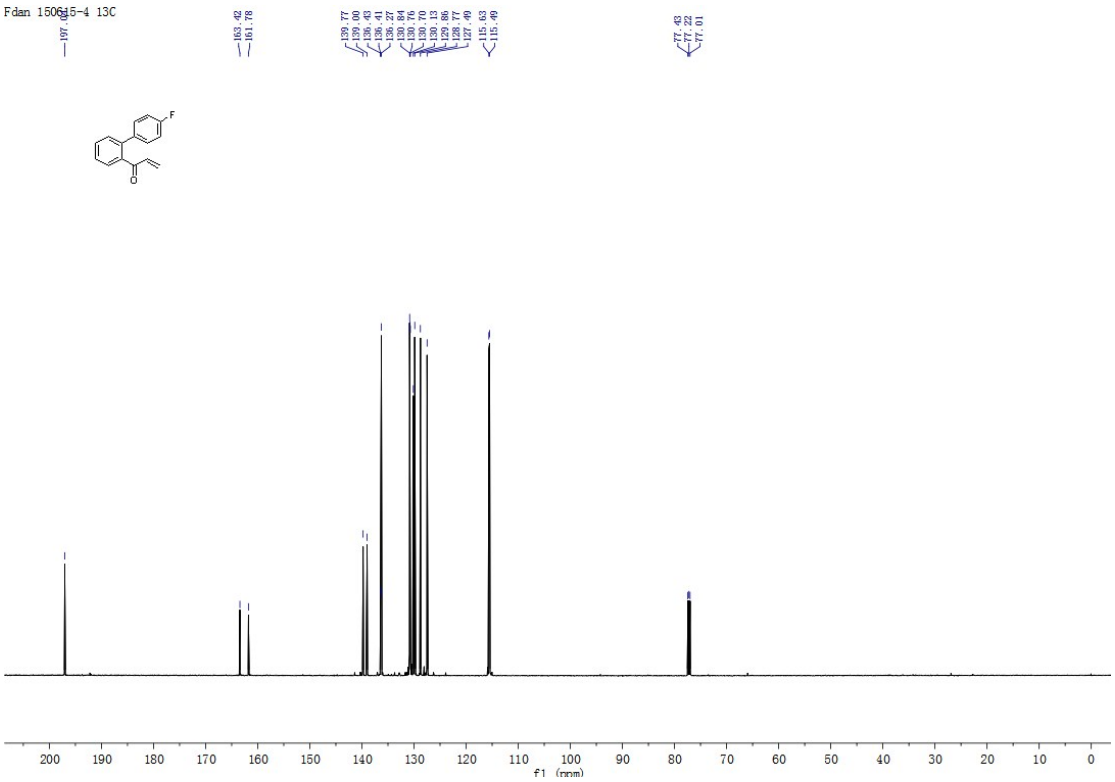
1g[13]C NMR



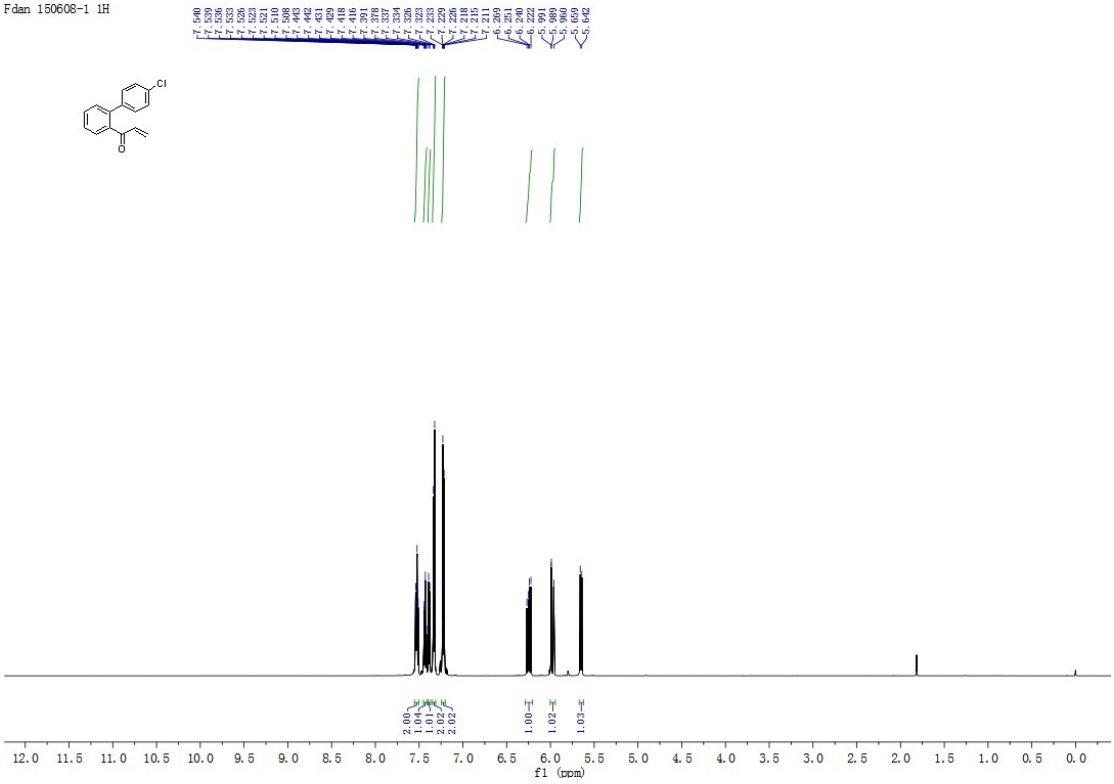
1h ^{1}H NMR



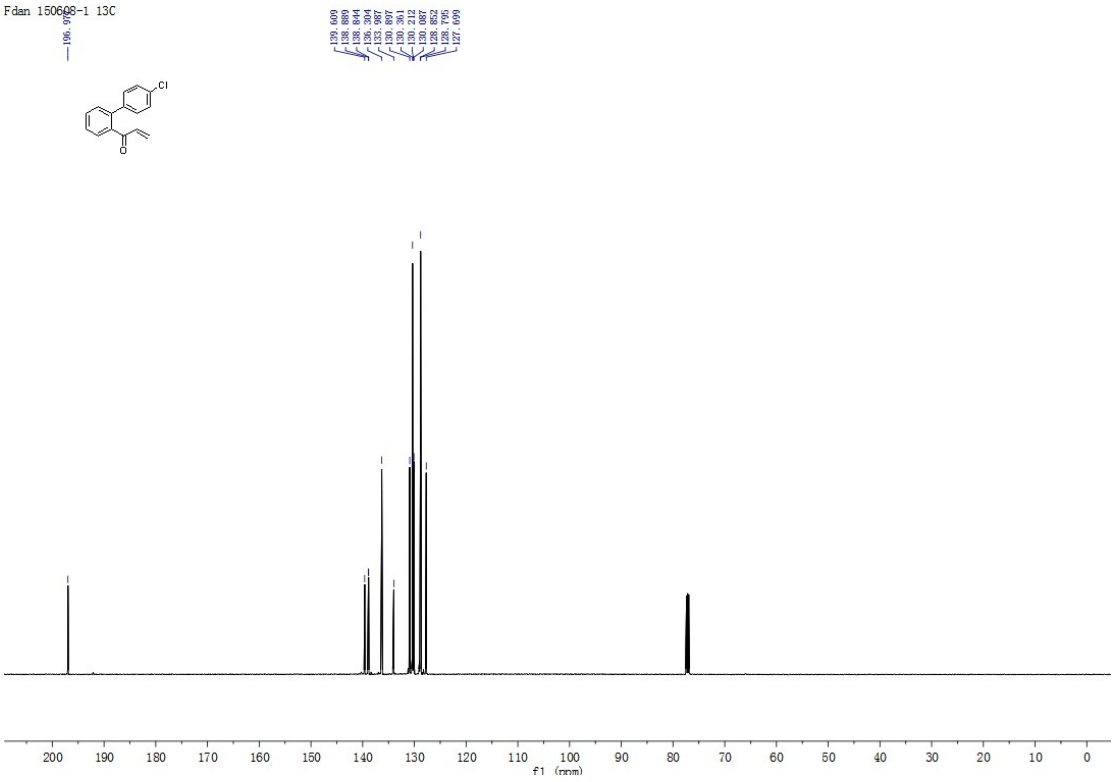
1h ^{13}C NMR



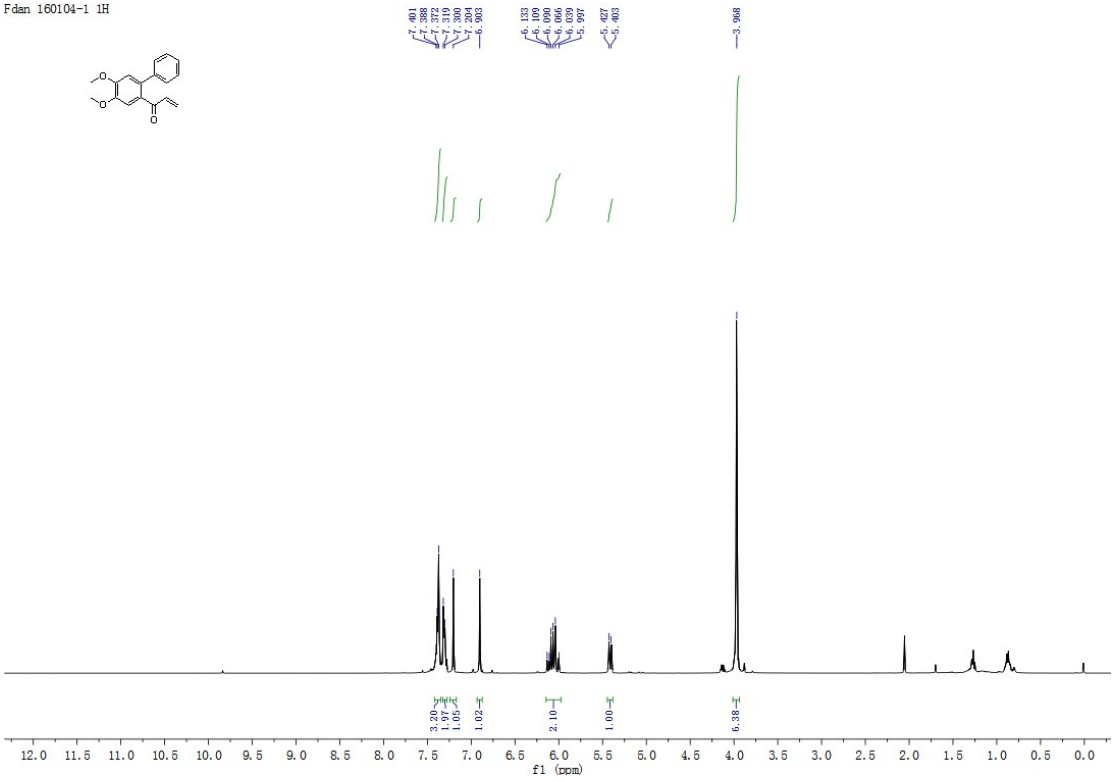
1i^{1}H NMR



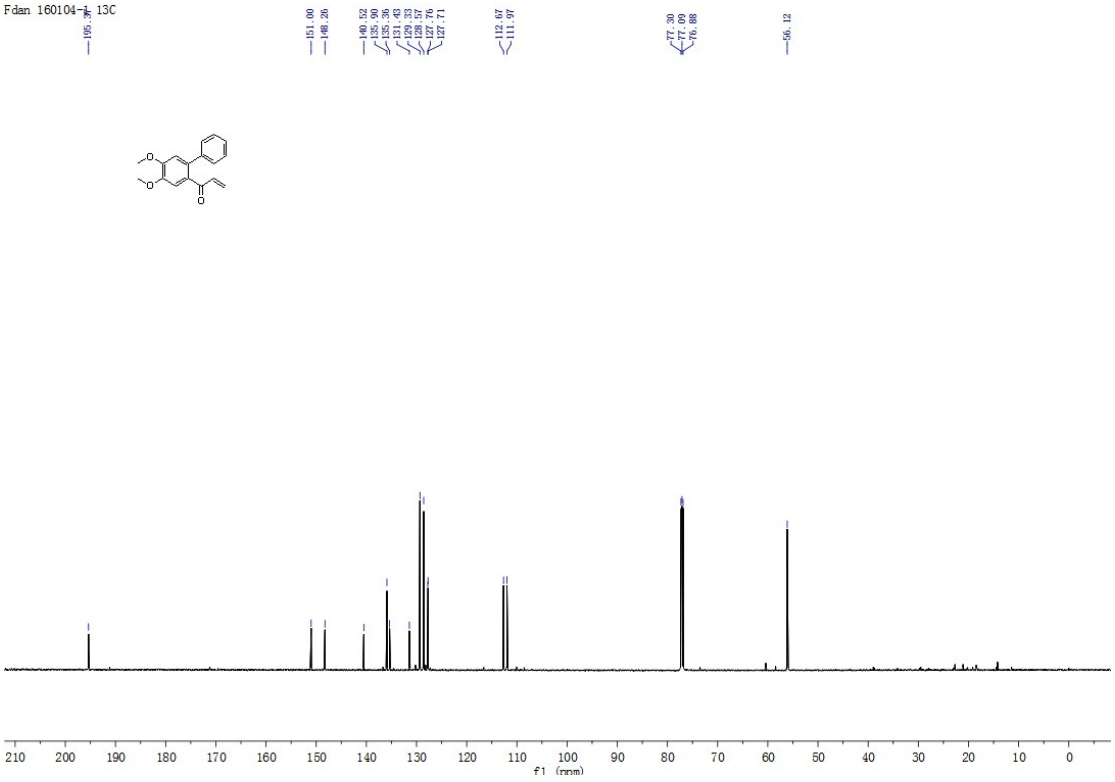
1i^{13}C NMR



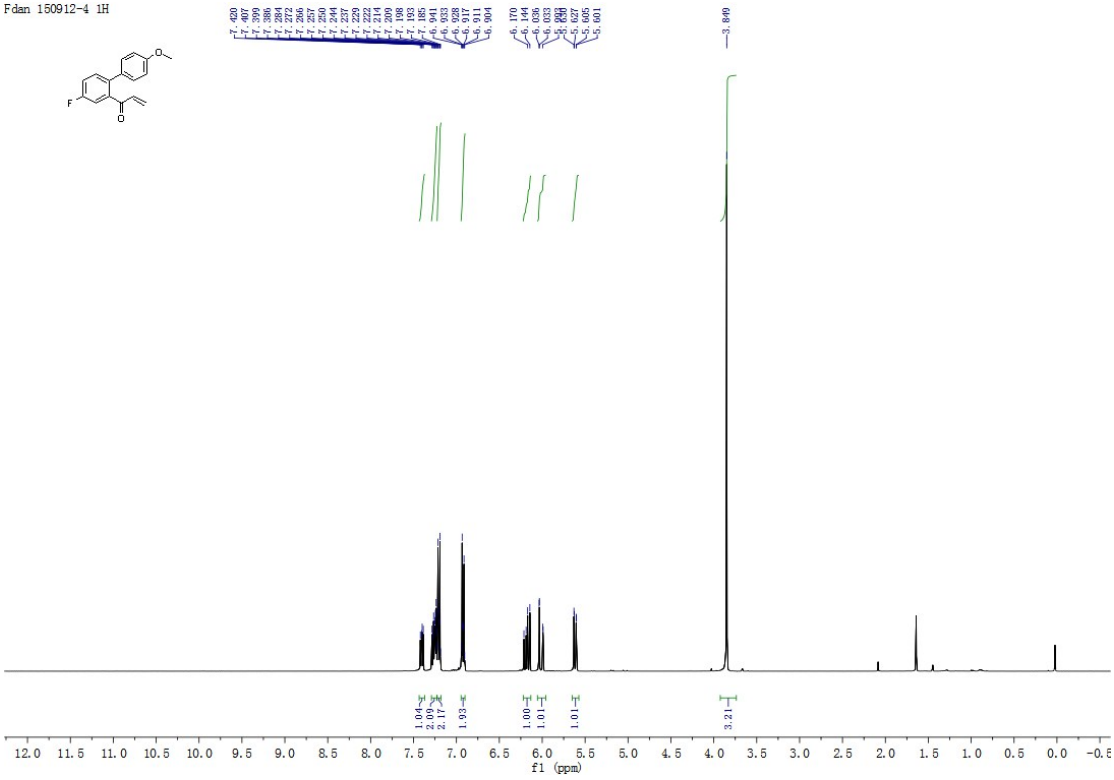
1j^{1}H NMR



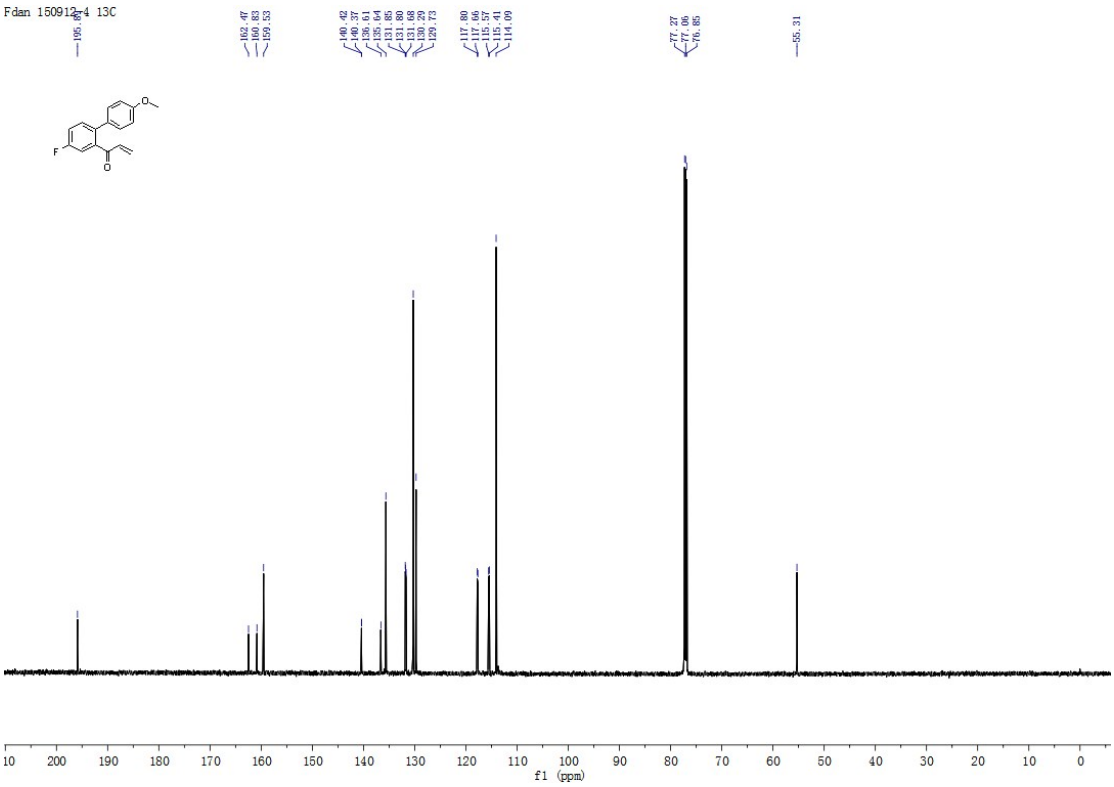
1j^{13}C NMR



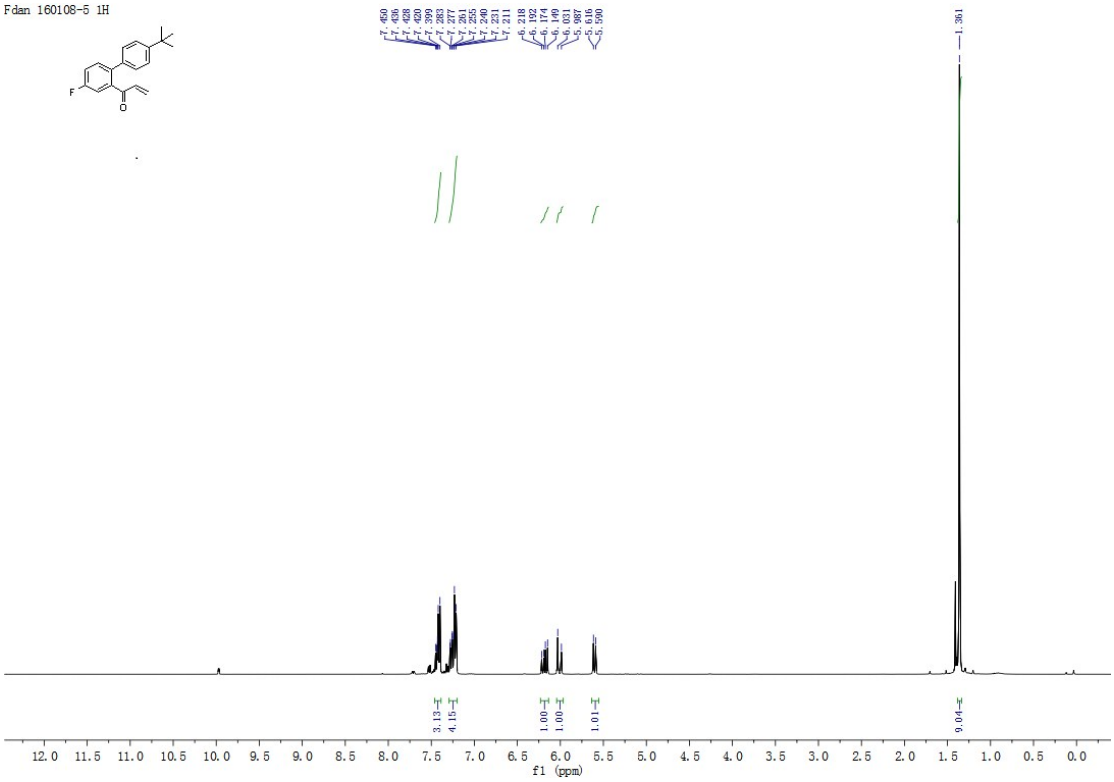
1k^{1}H NMR



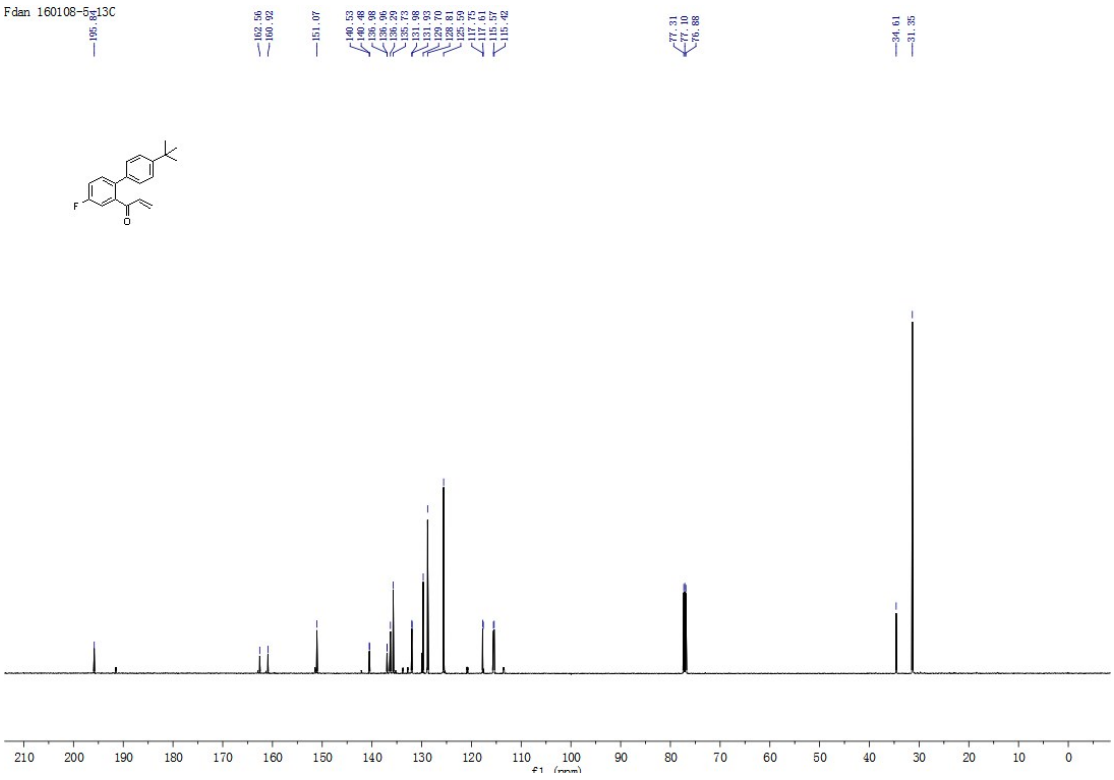
1k^{13}C NMR



1l ^{1}H NMR



1l ^{13}C NMR



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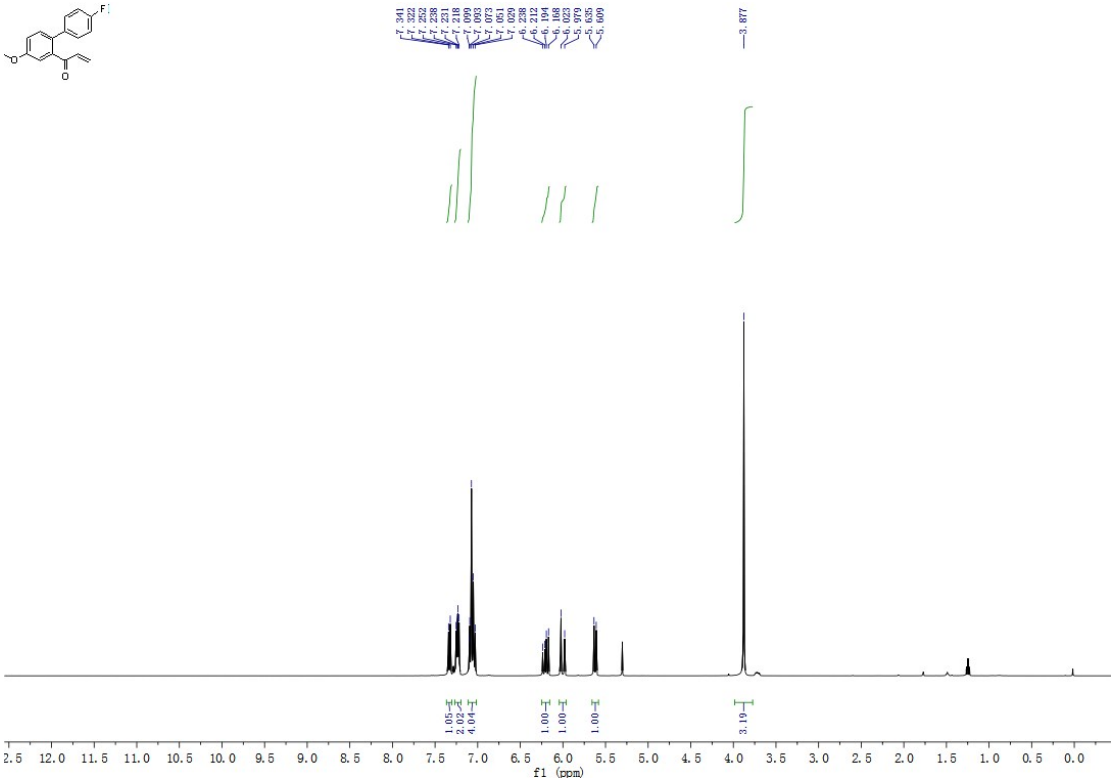

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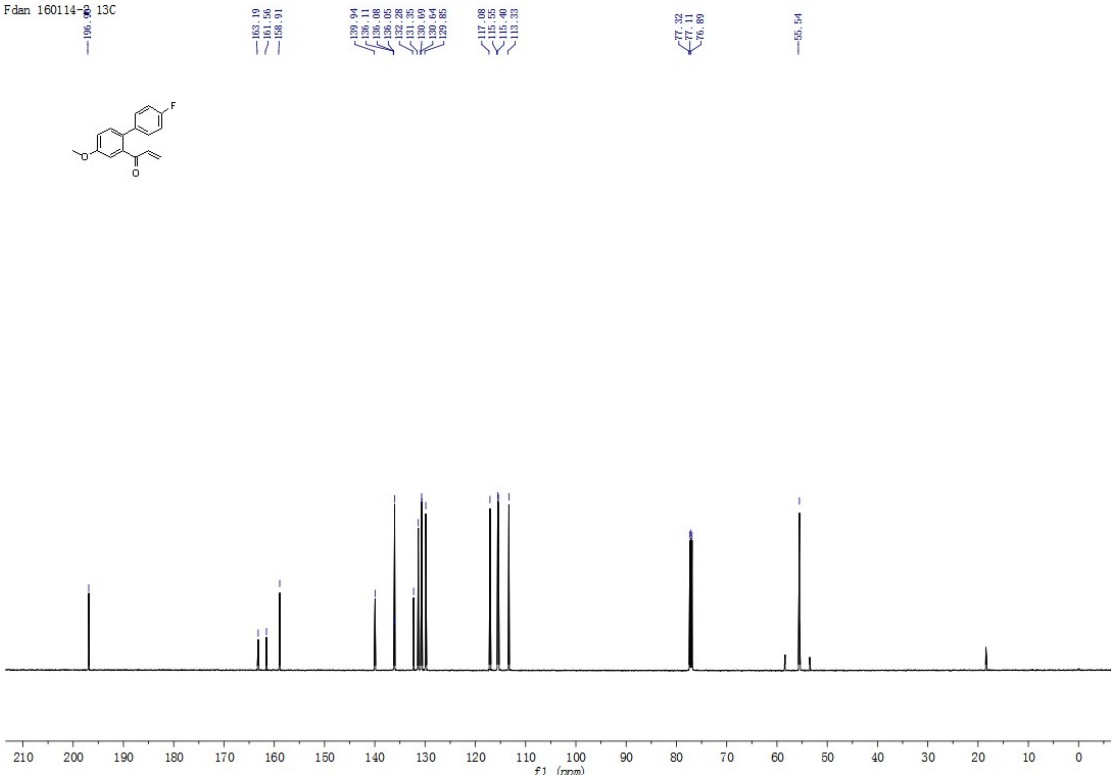
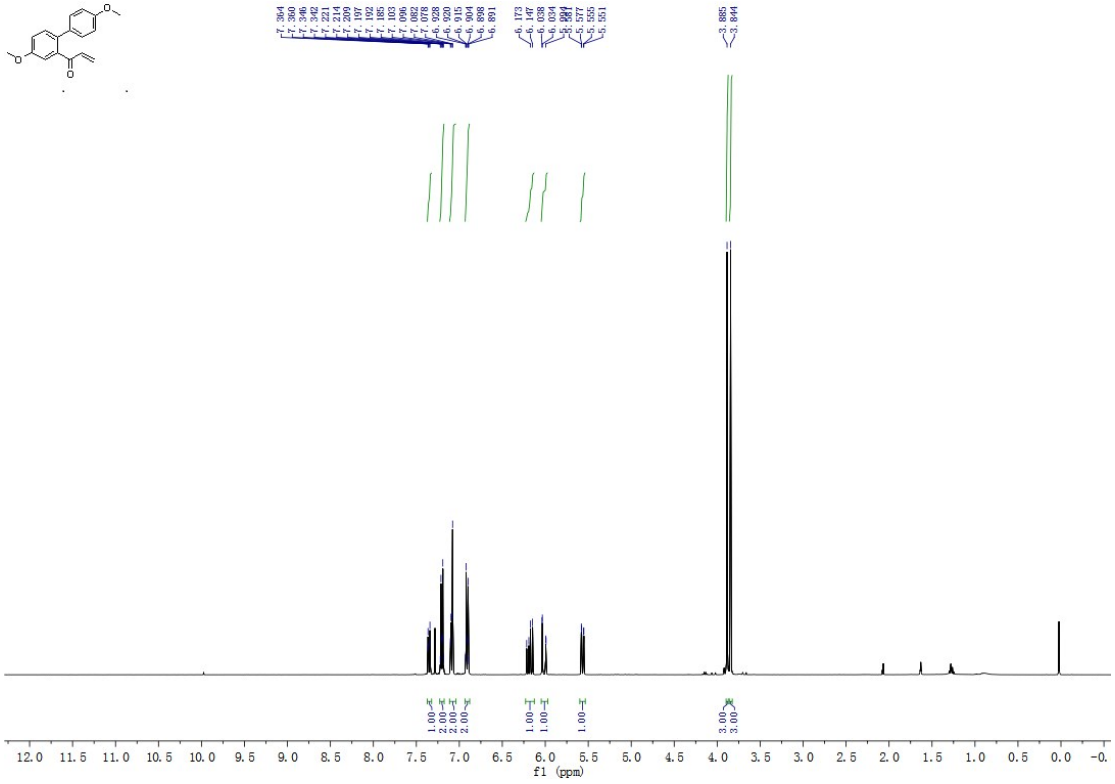


1n ^{1}H NMR



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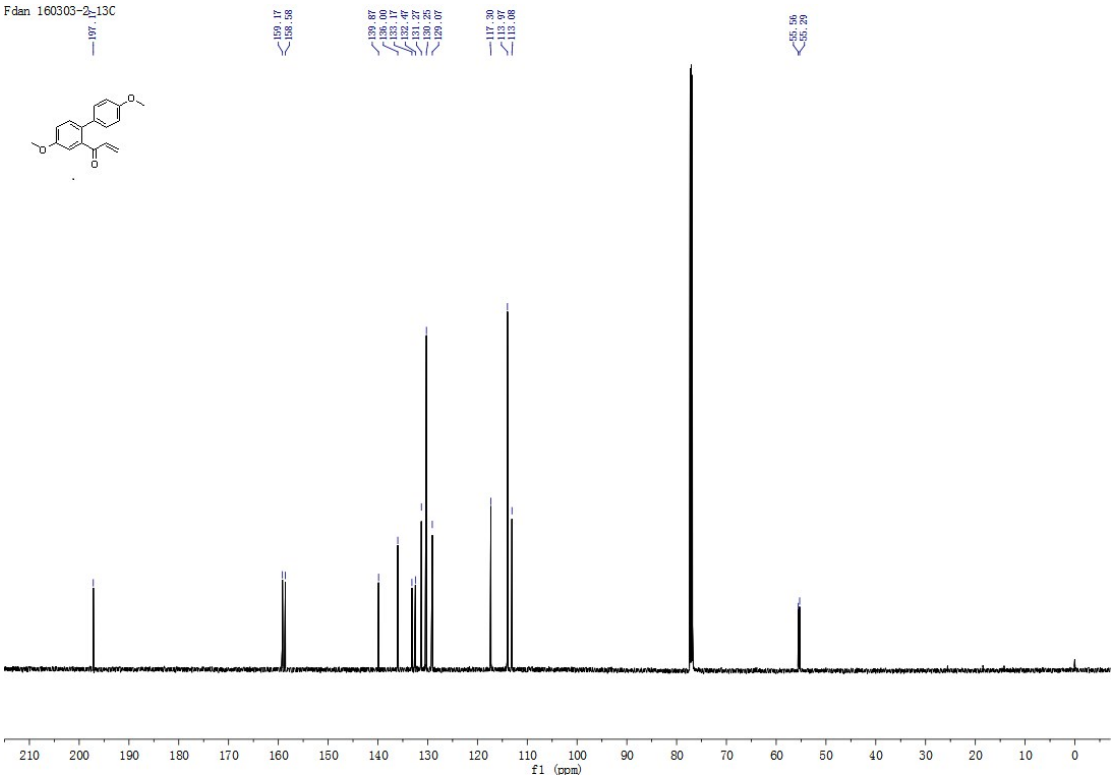

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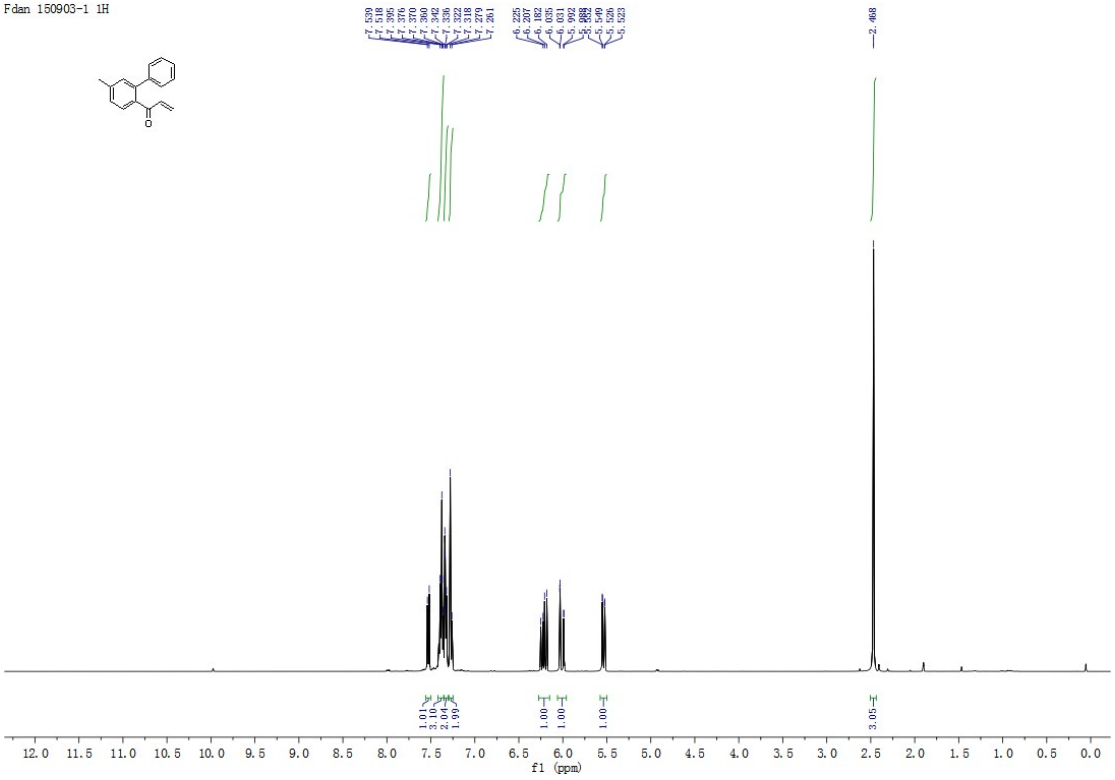

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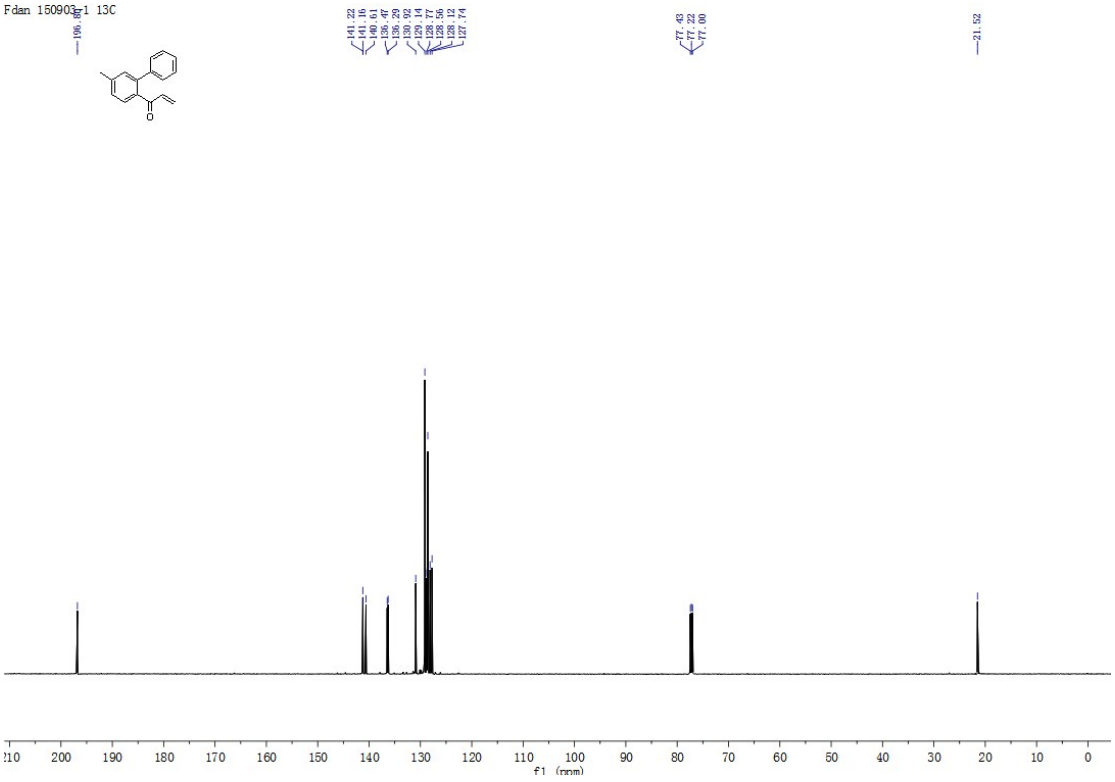

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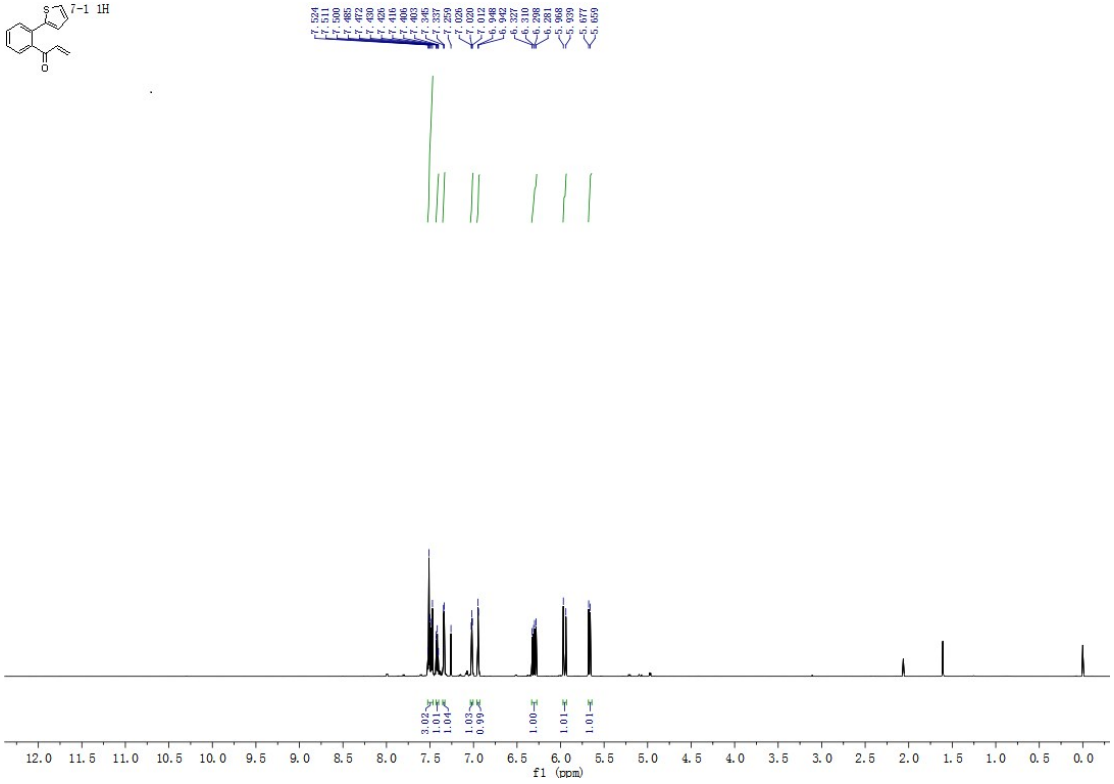

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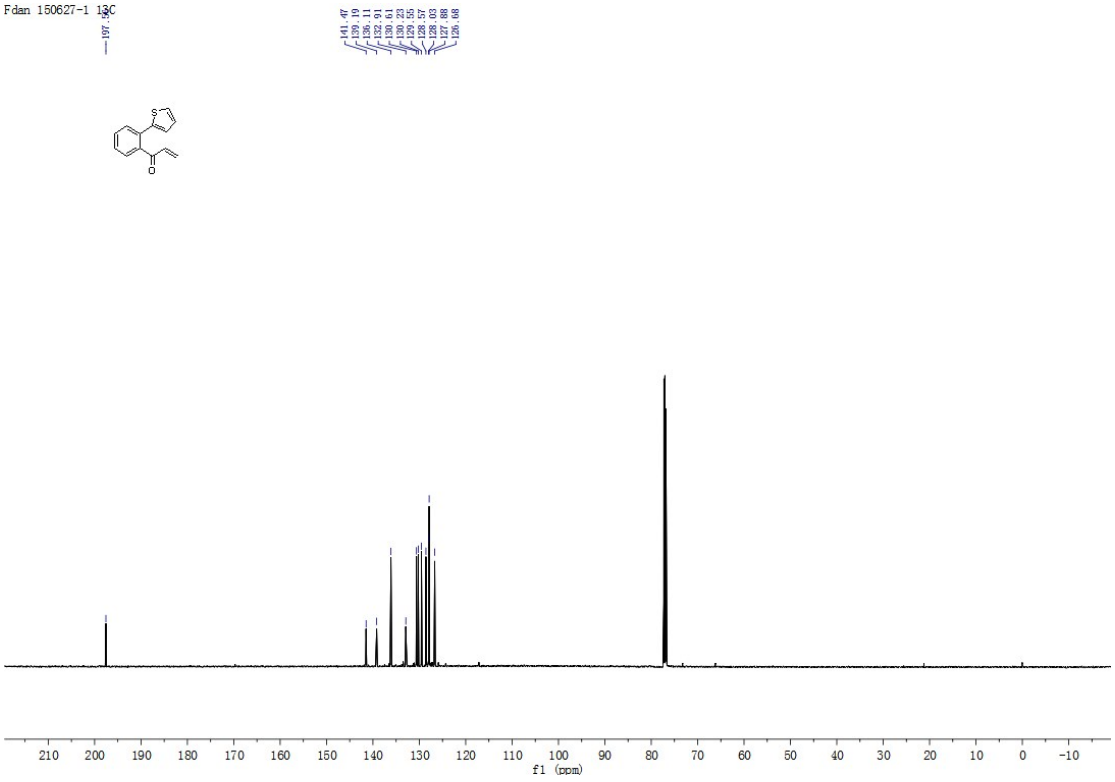

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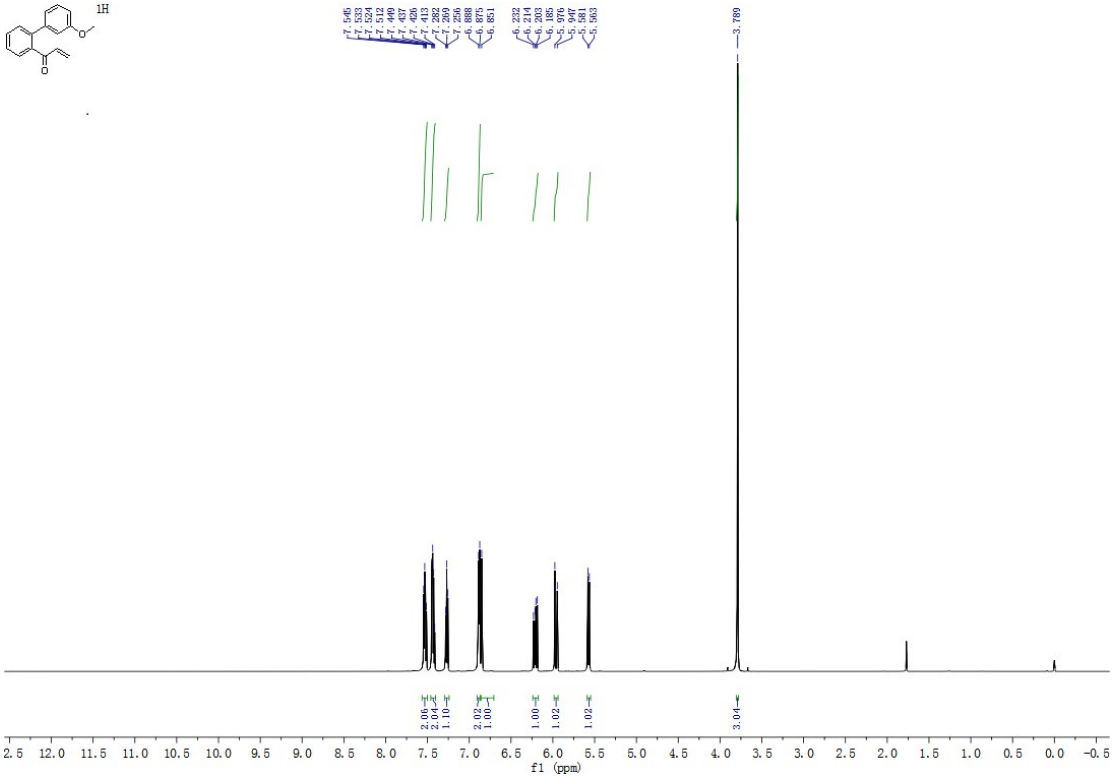

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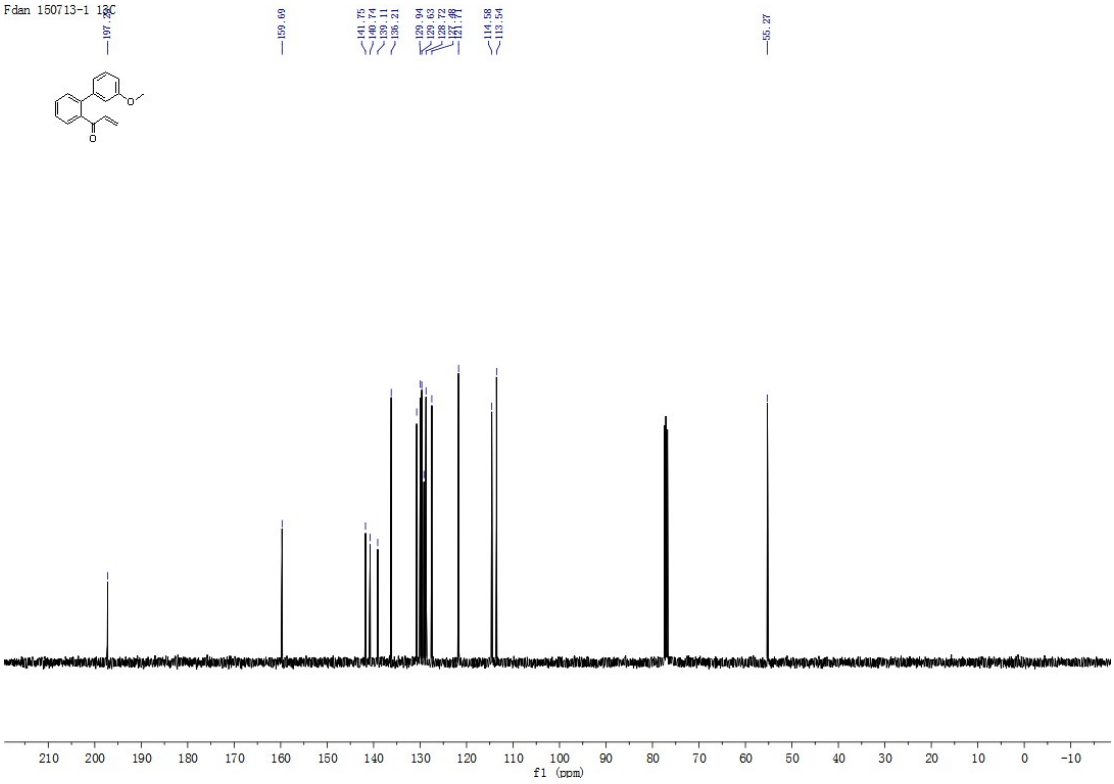
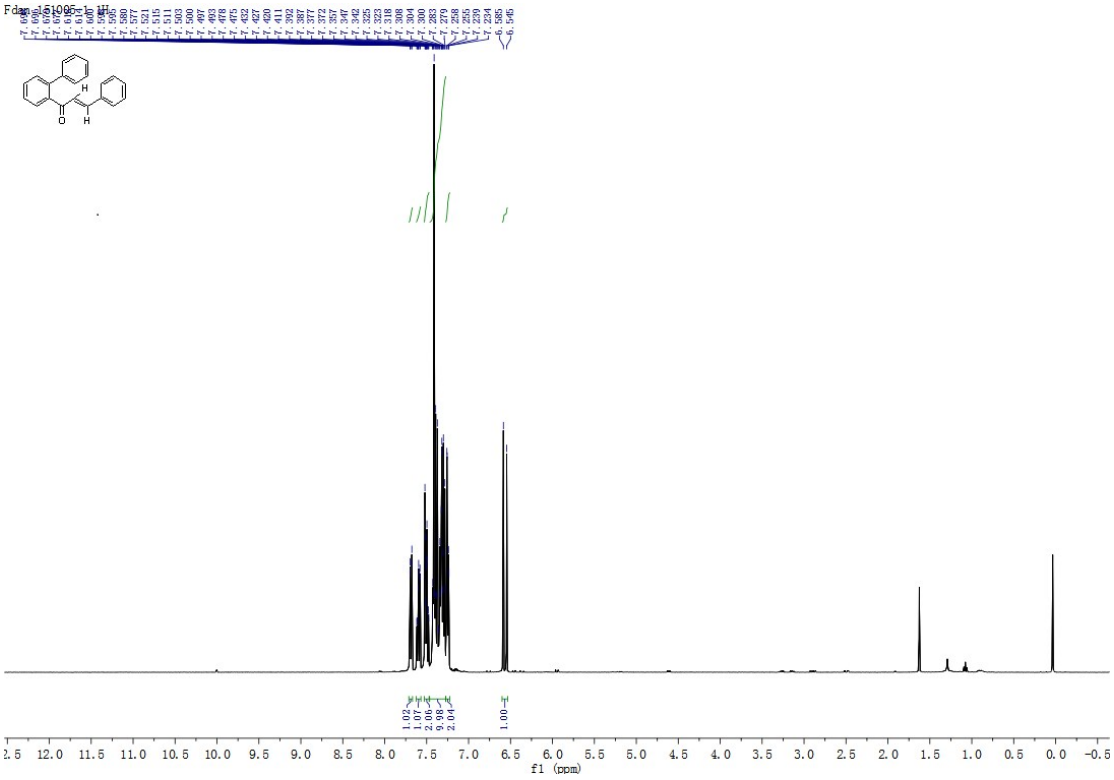


1r ^{1}H NMR



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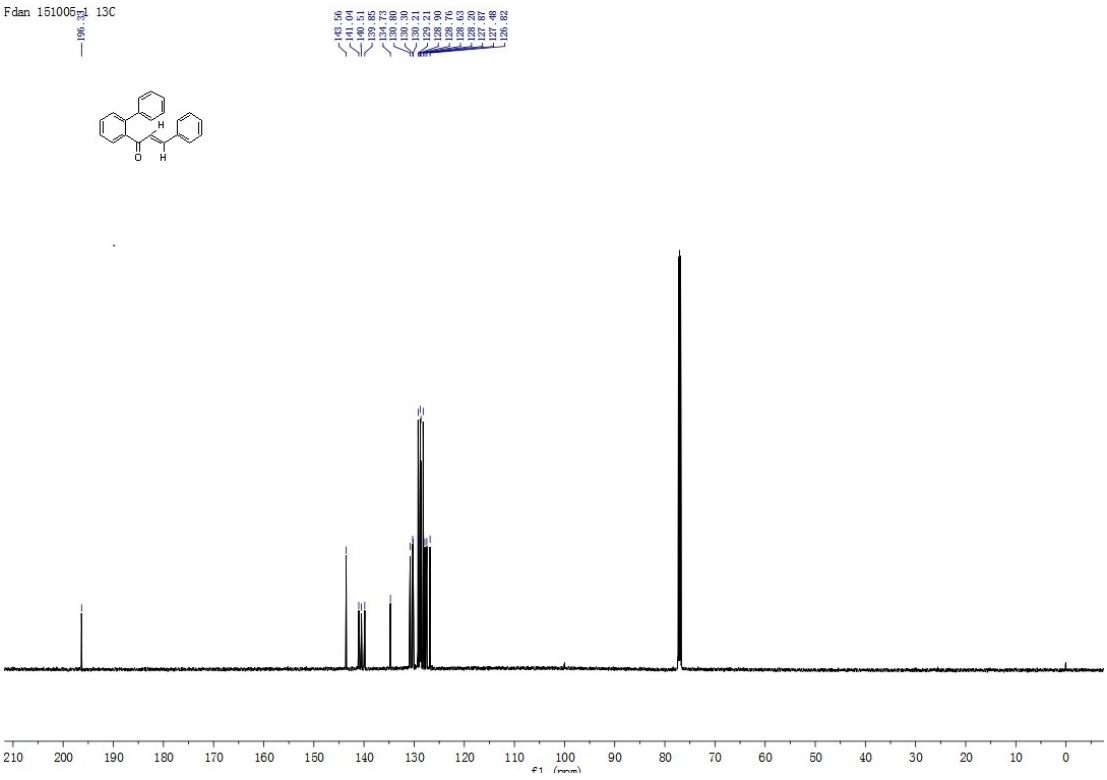
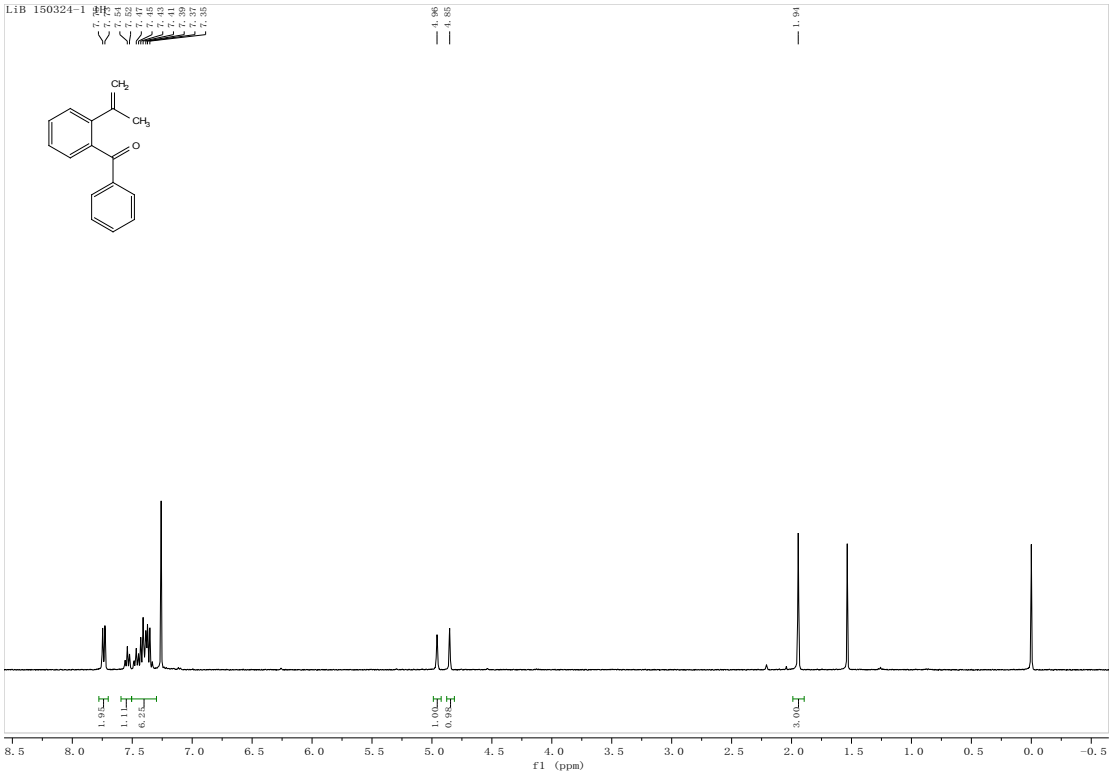
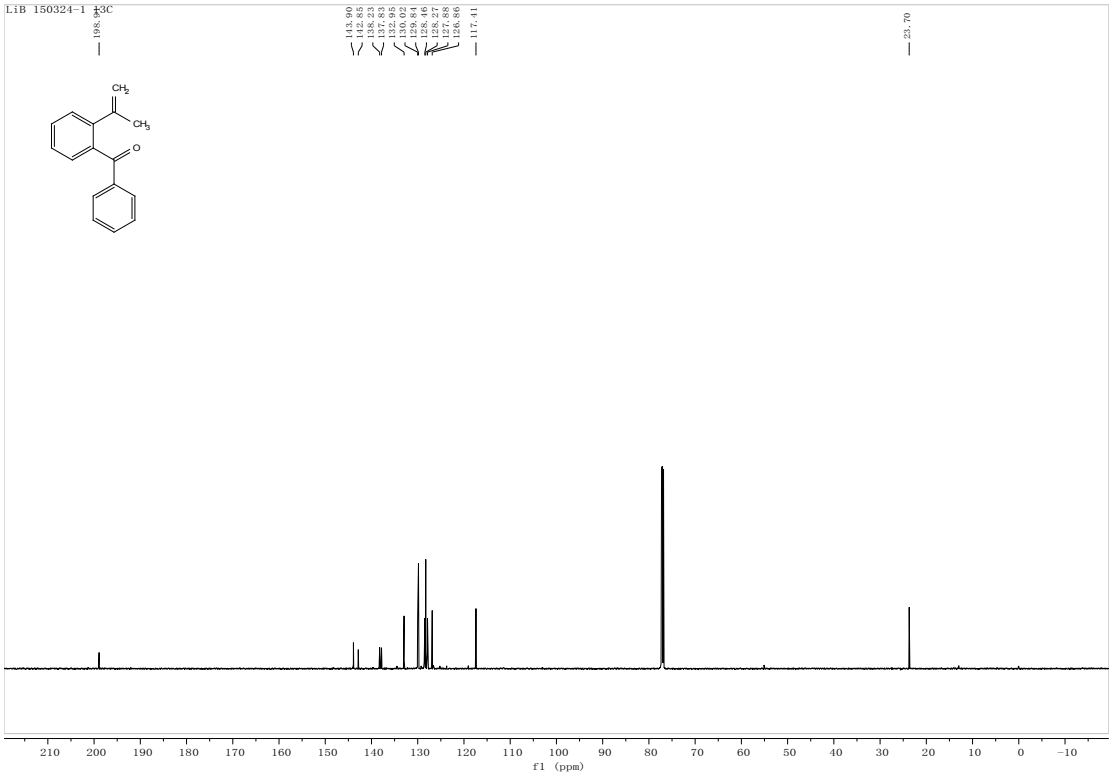


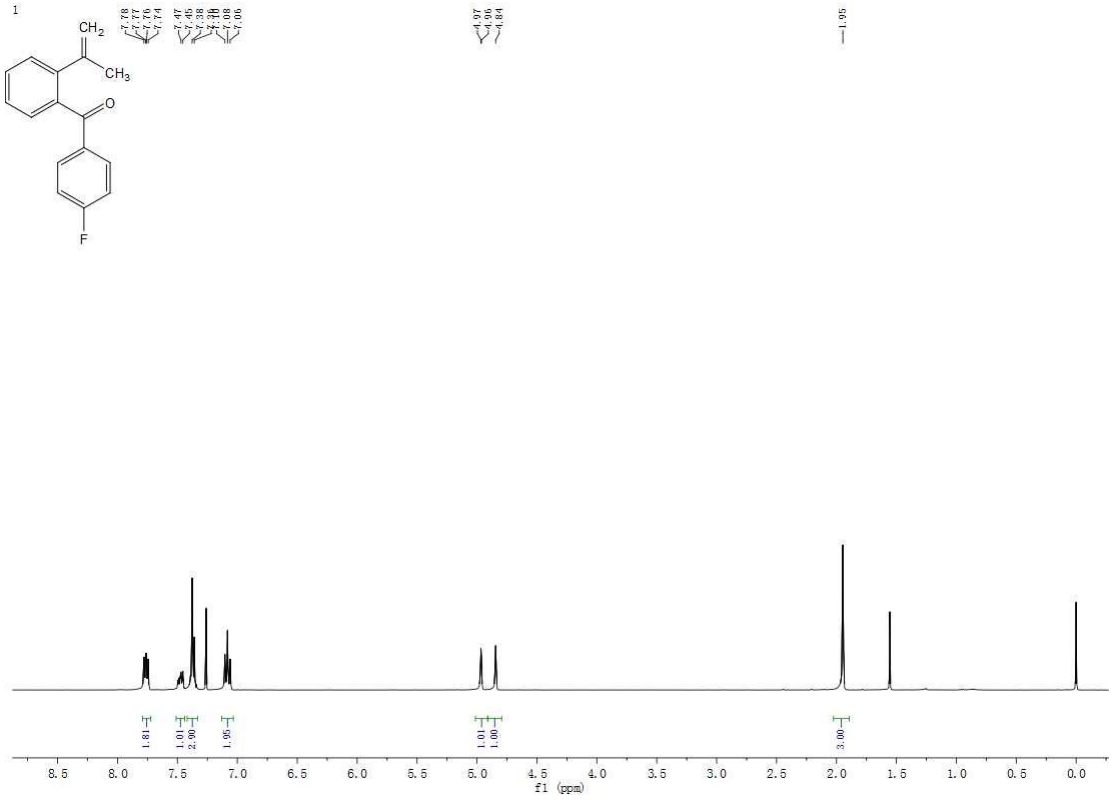
4a ^{1}H NMR



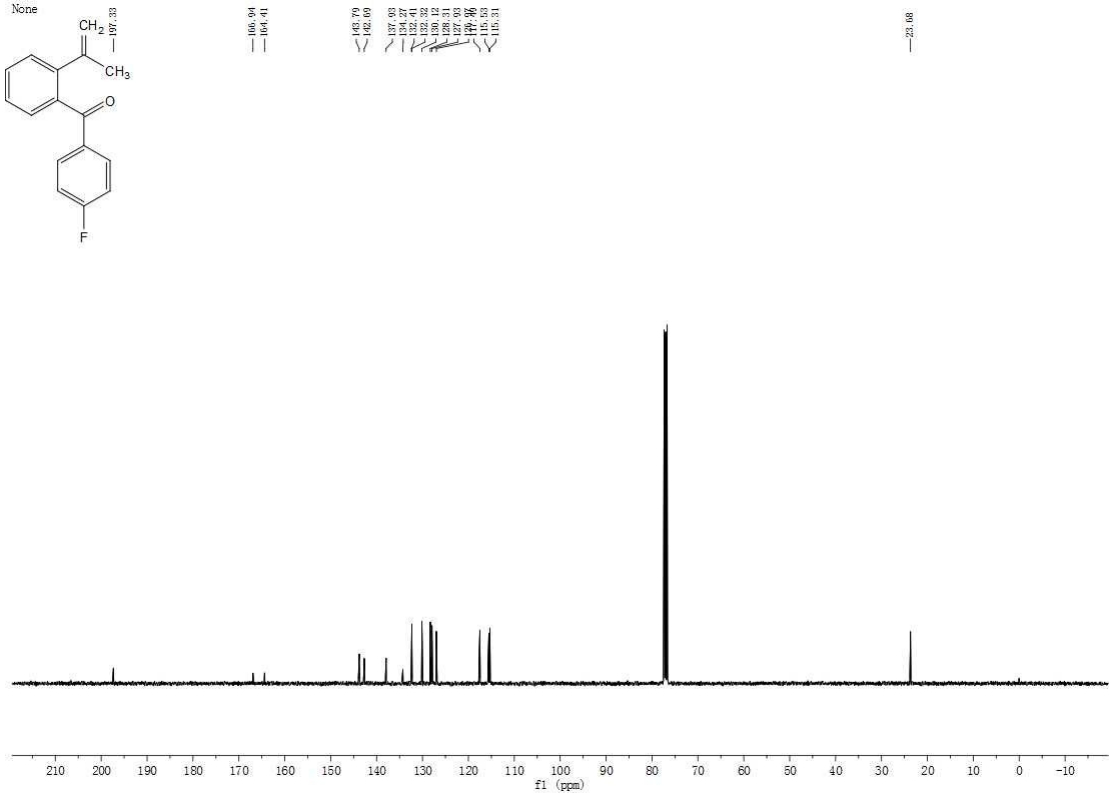
4a ^{13}C NMR



4b ^{1}H NMR



4b ^{13}C NMR



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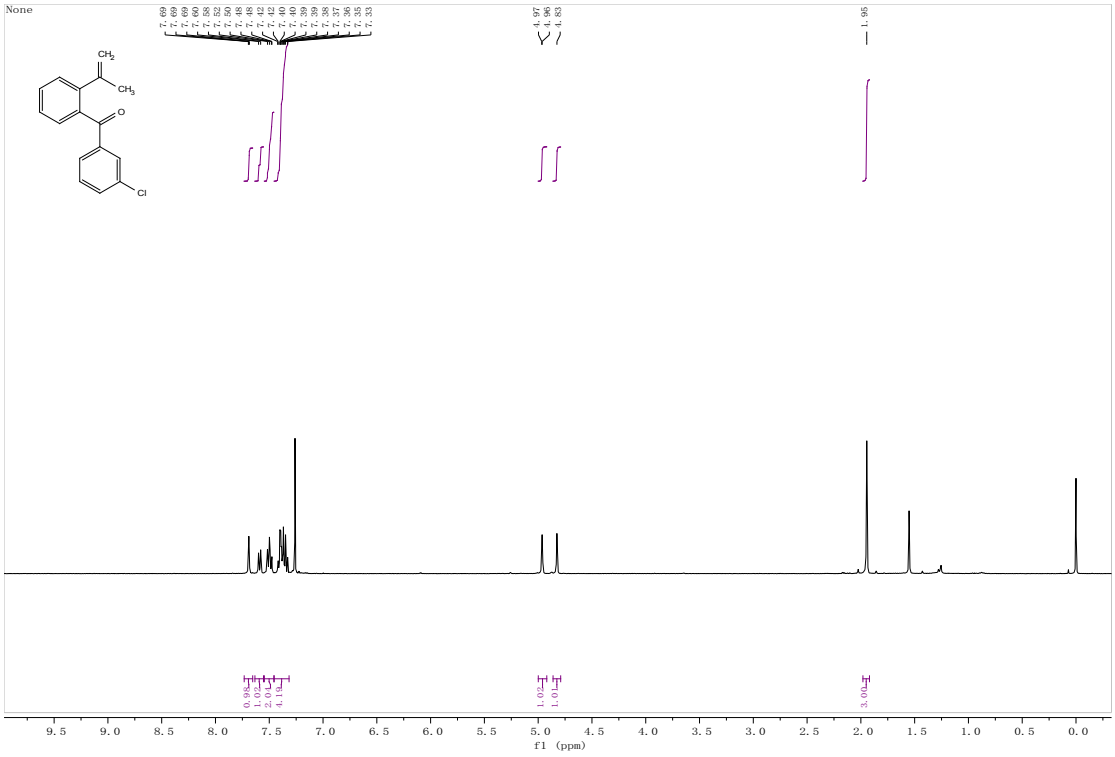

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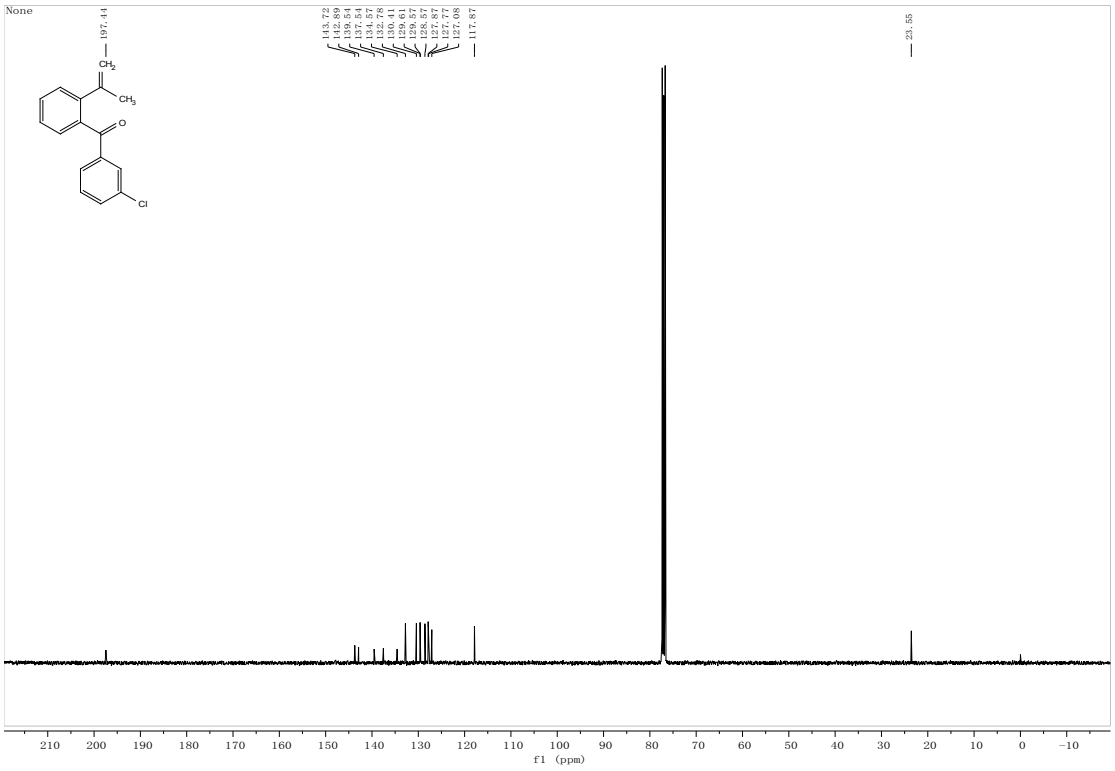

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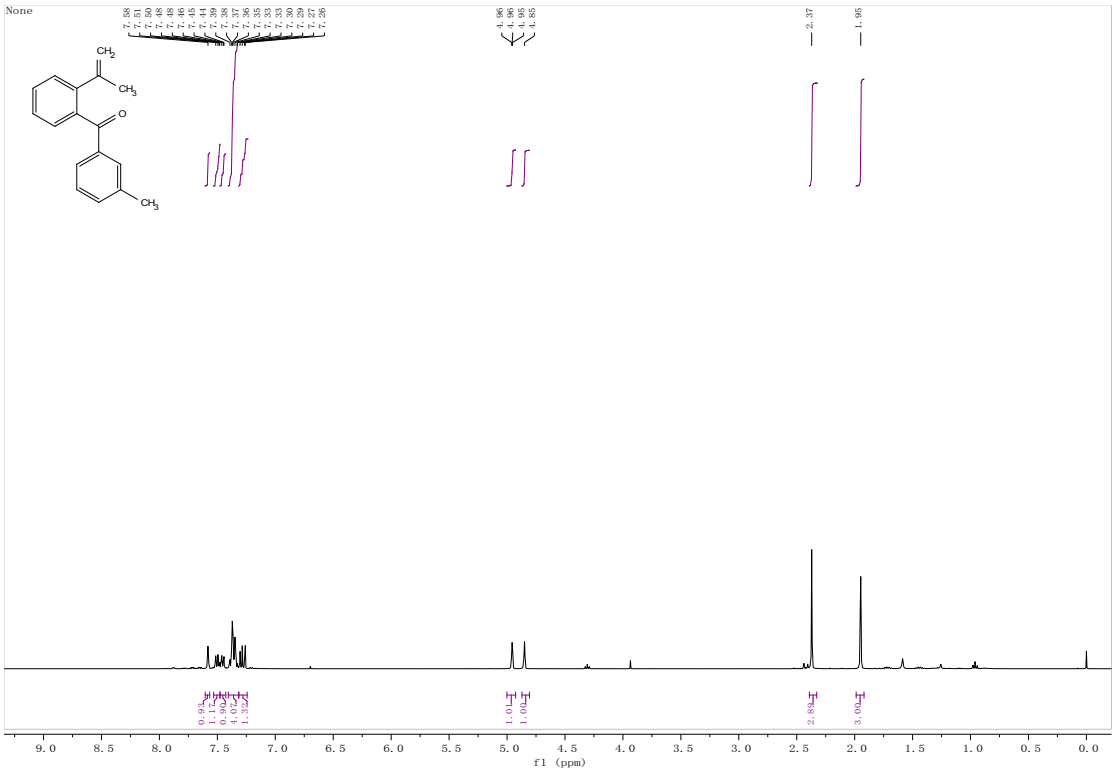

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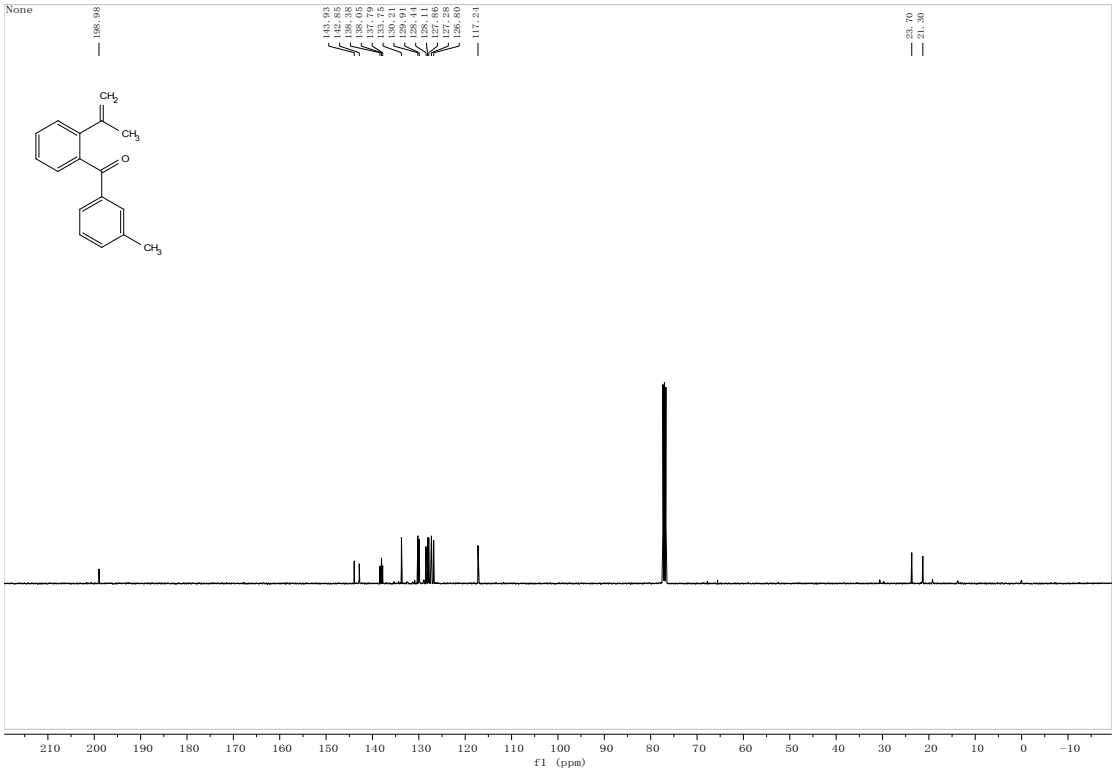
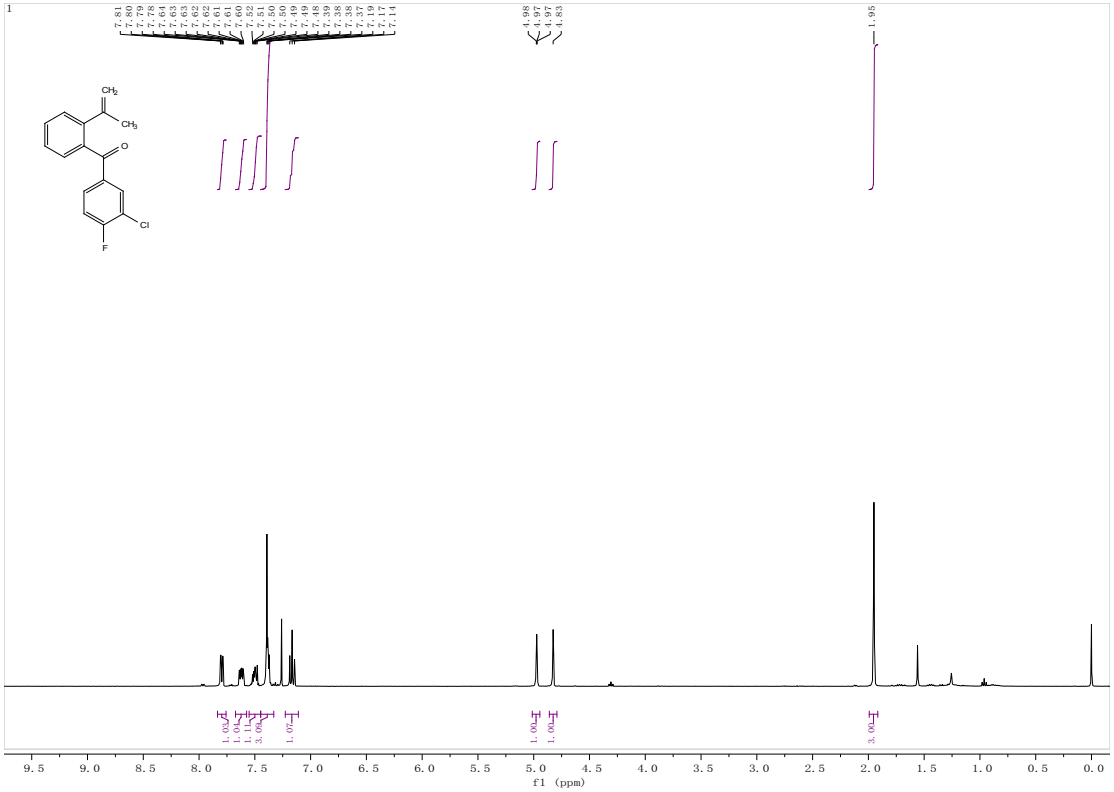
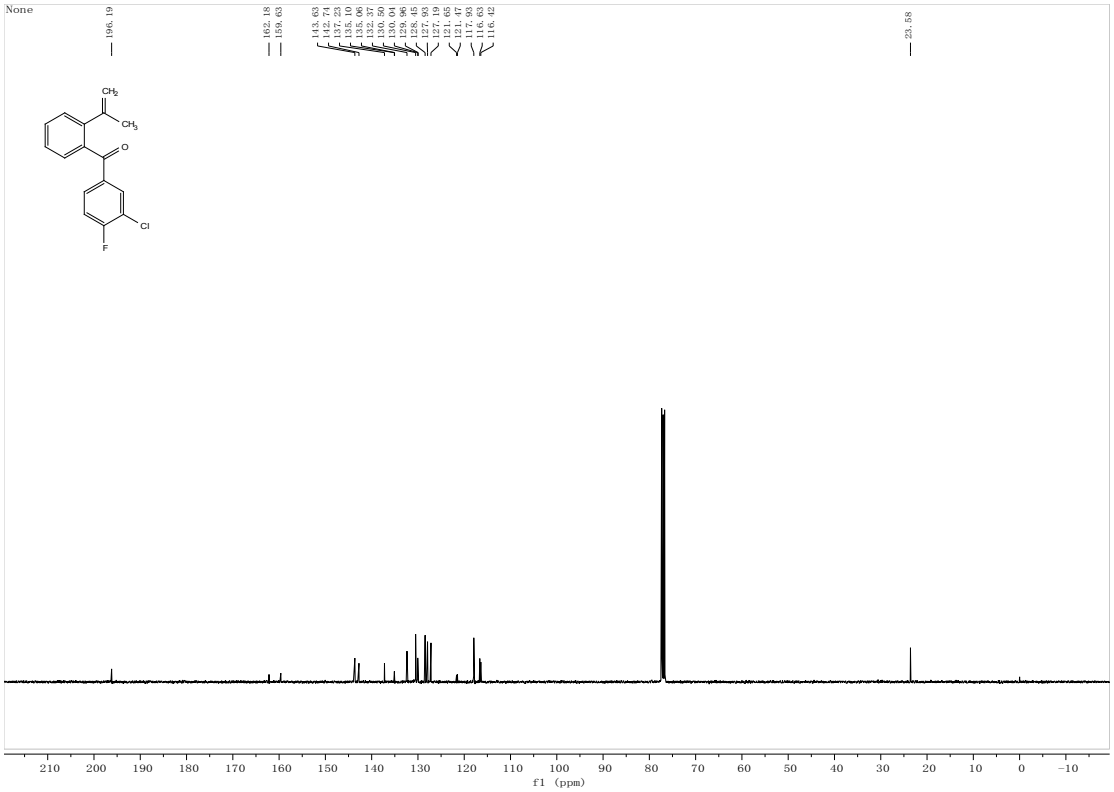


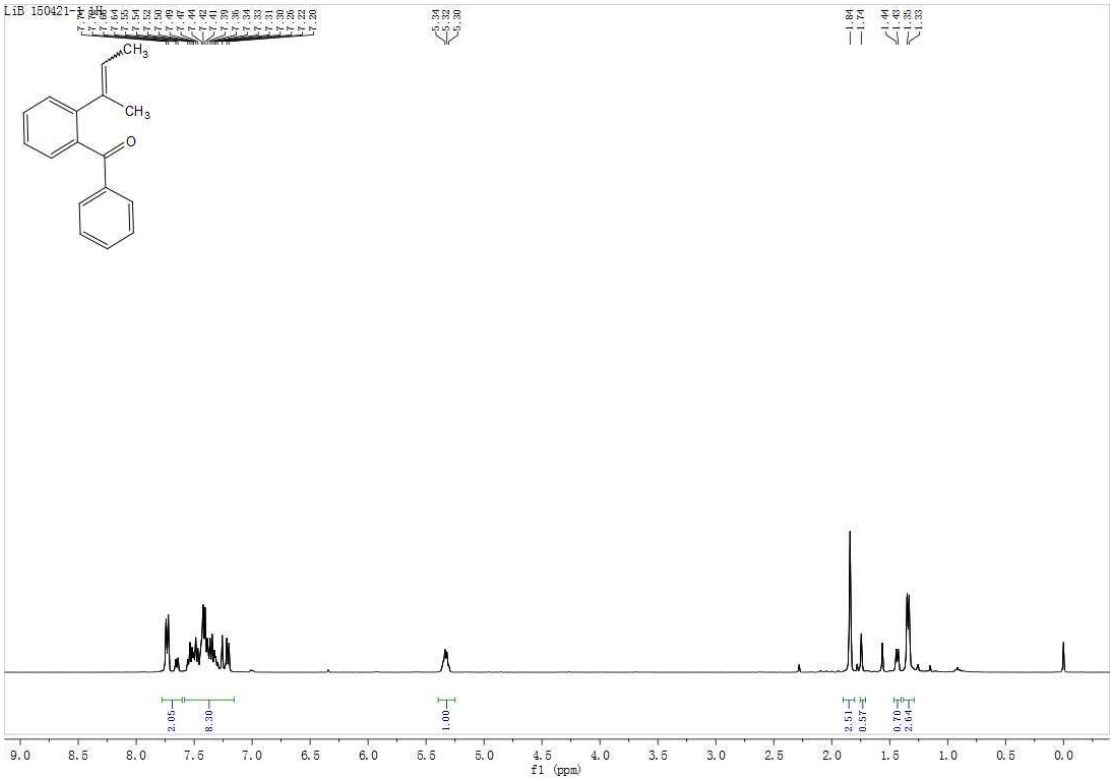
4i ^{1}H NMR



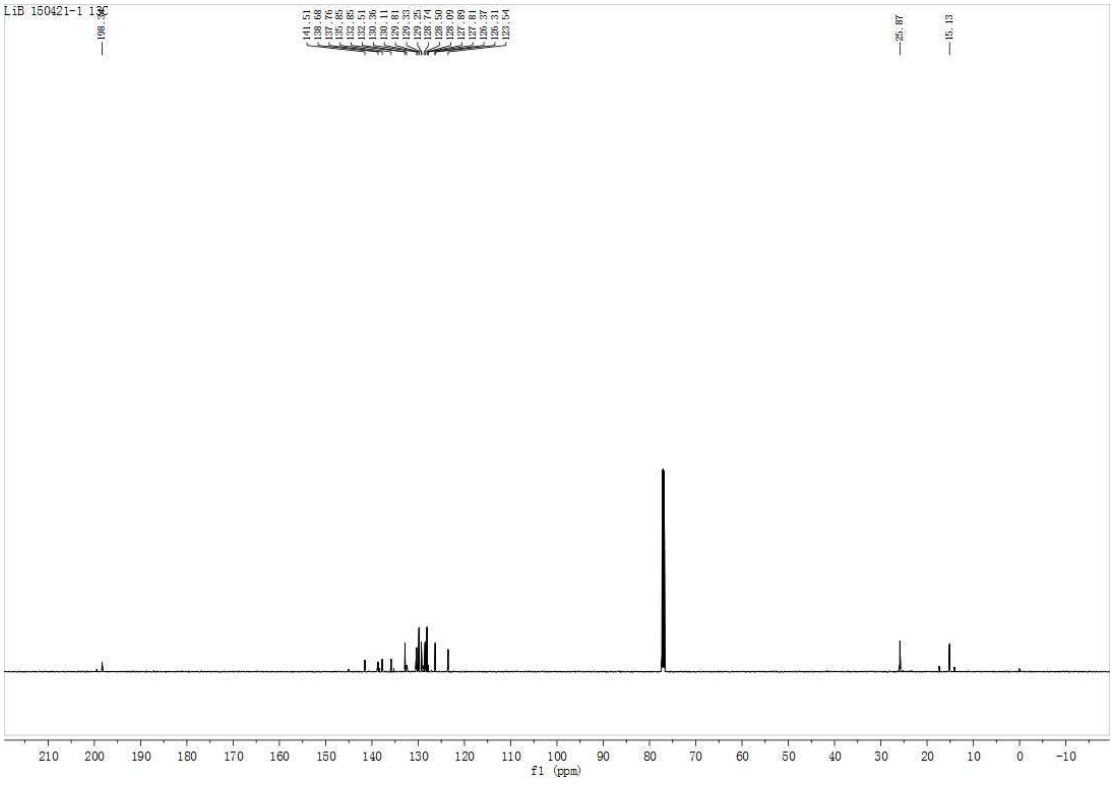
4i ^{13}C NMR



4m 1H NMR



4m ^{13}C NMR



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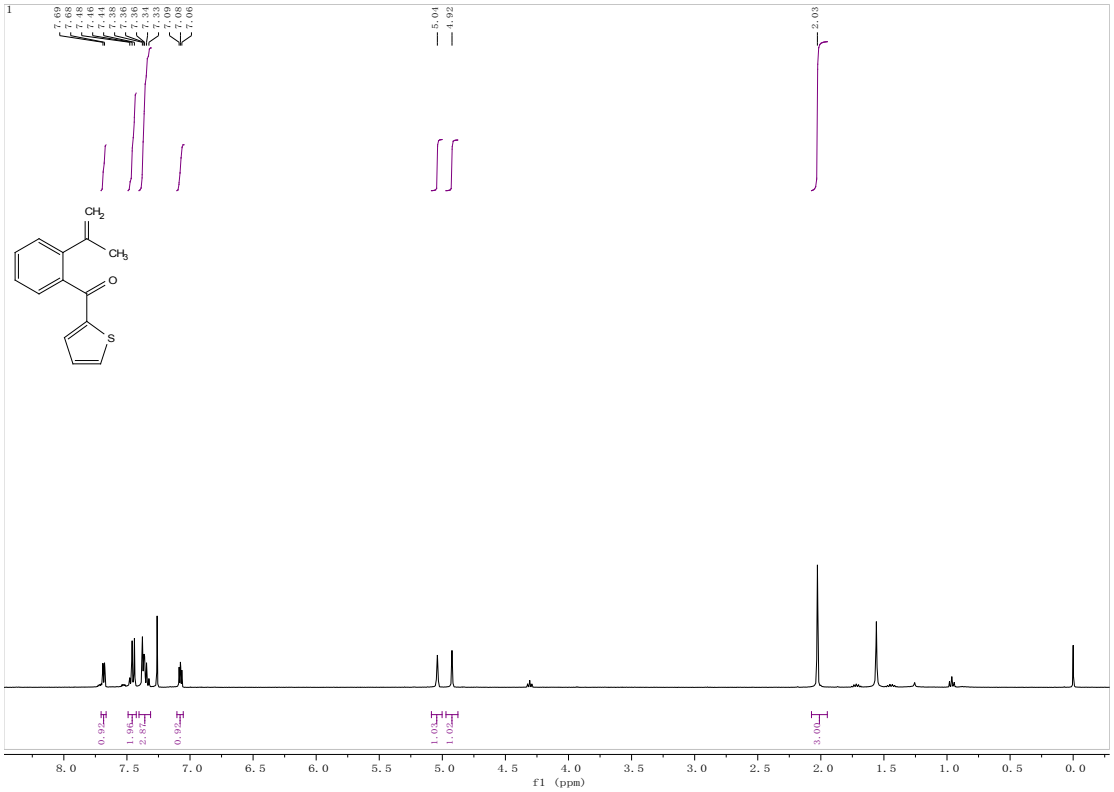

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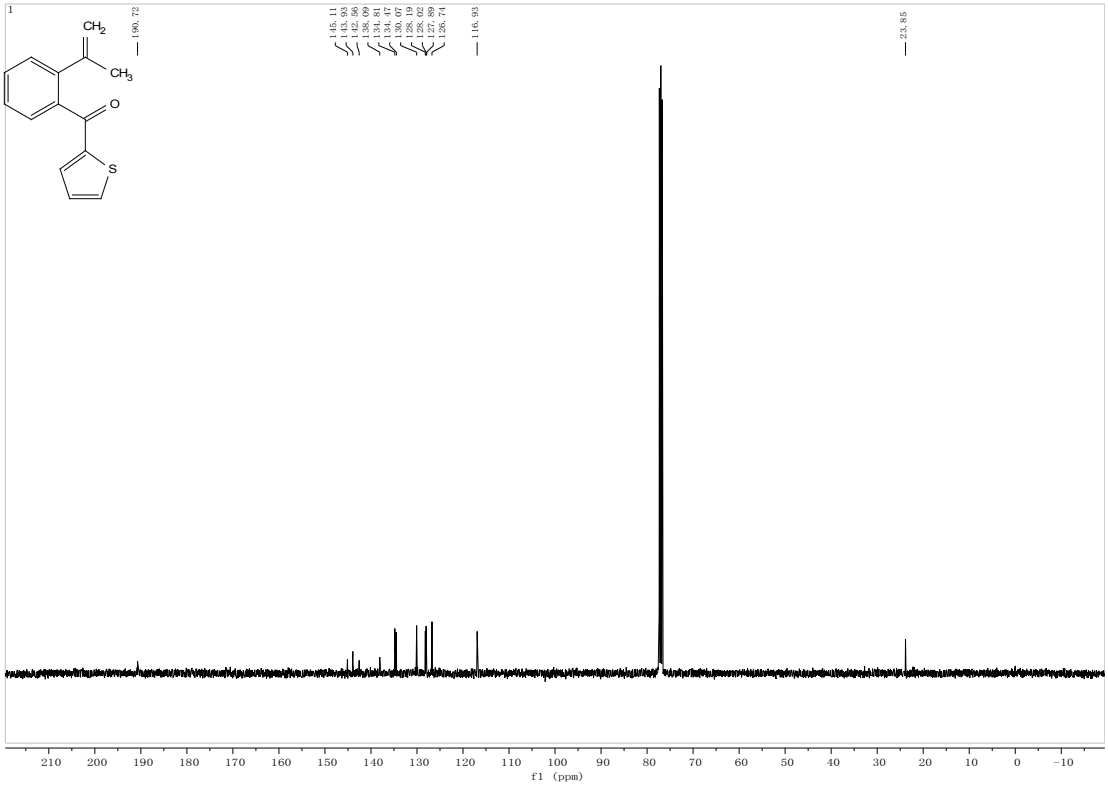

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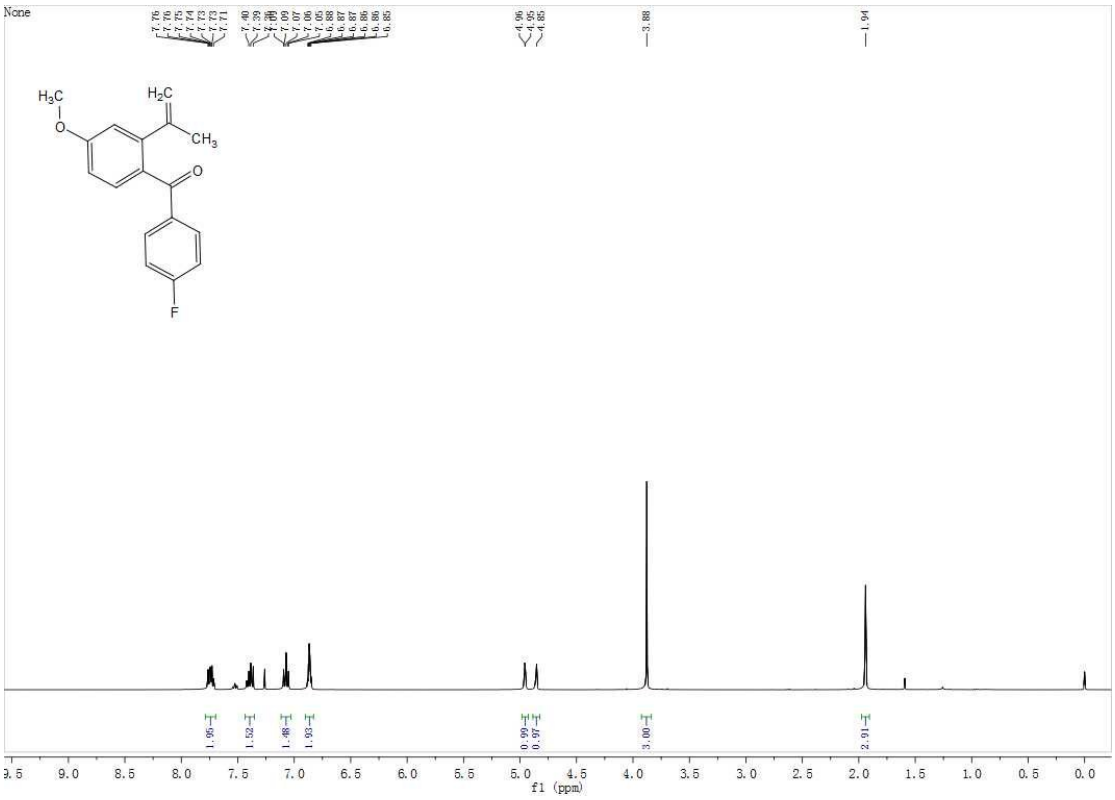

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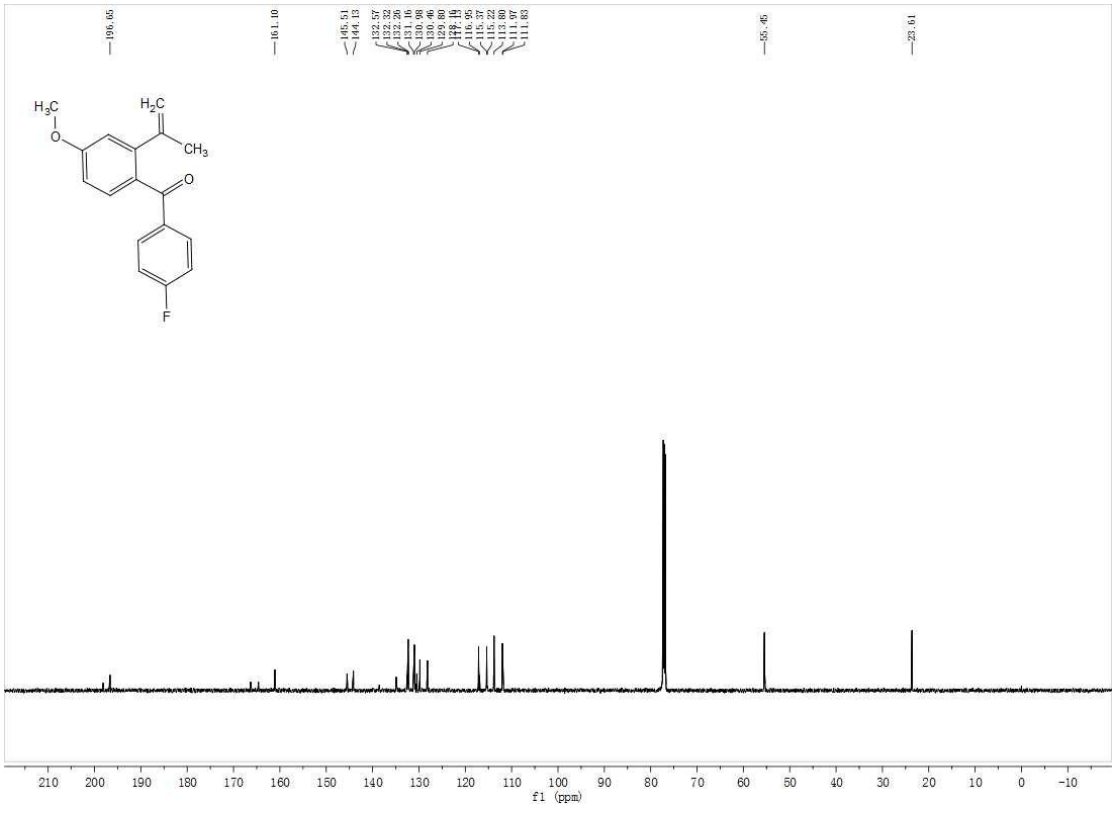

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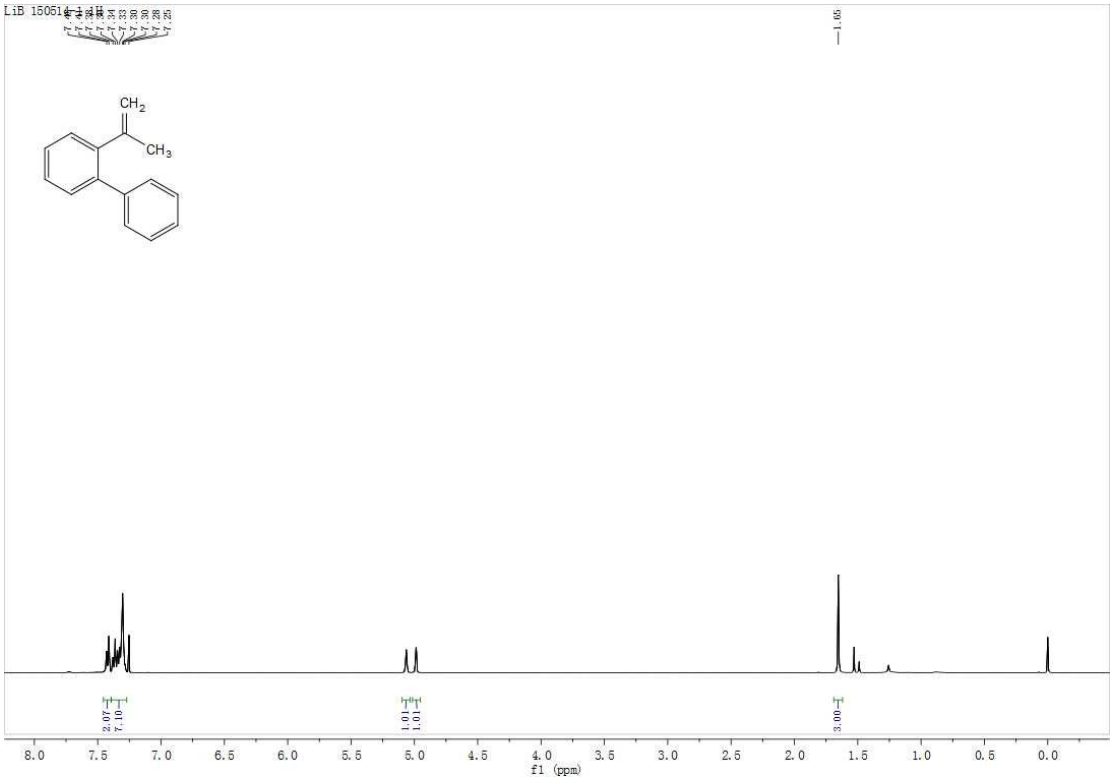

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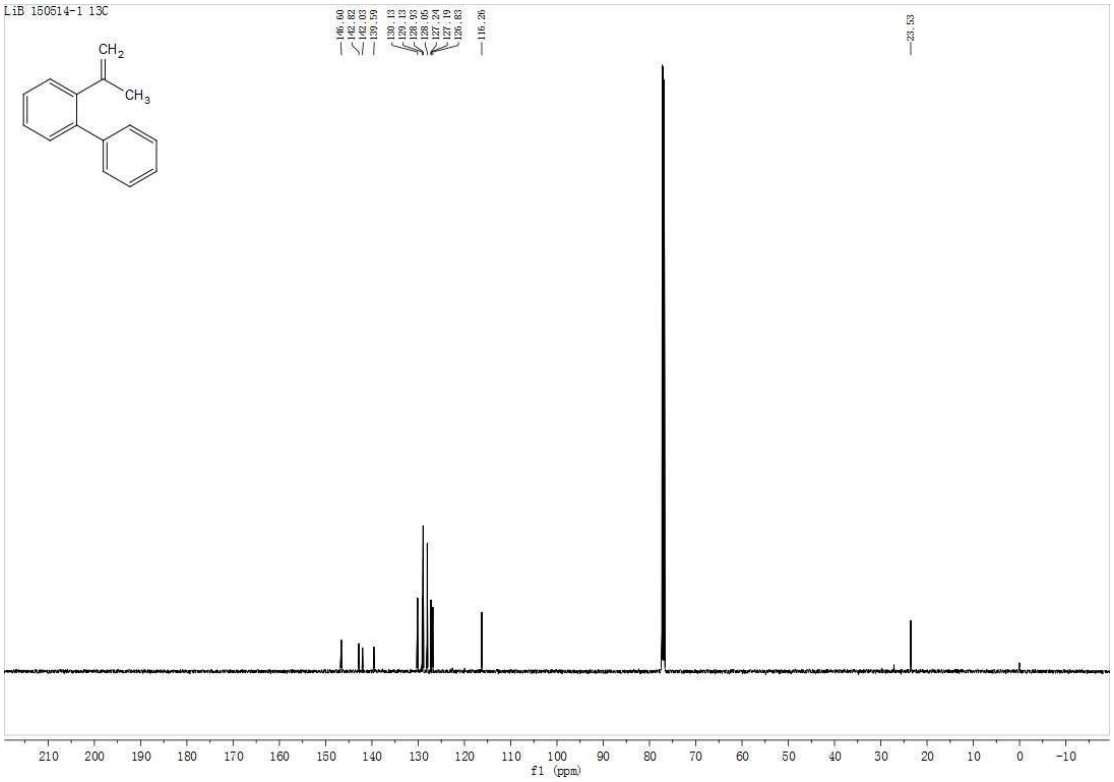
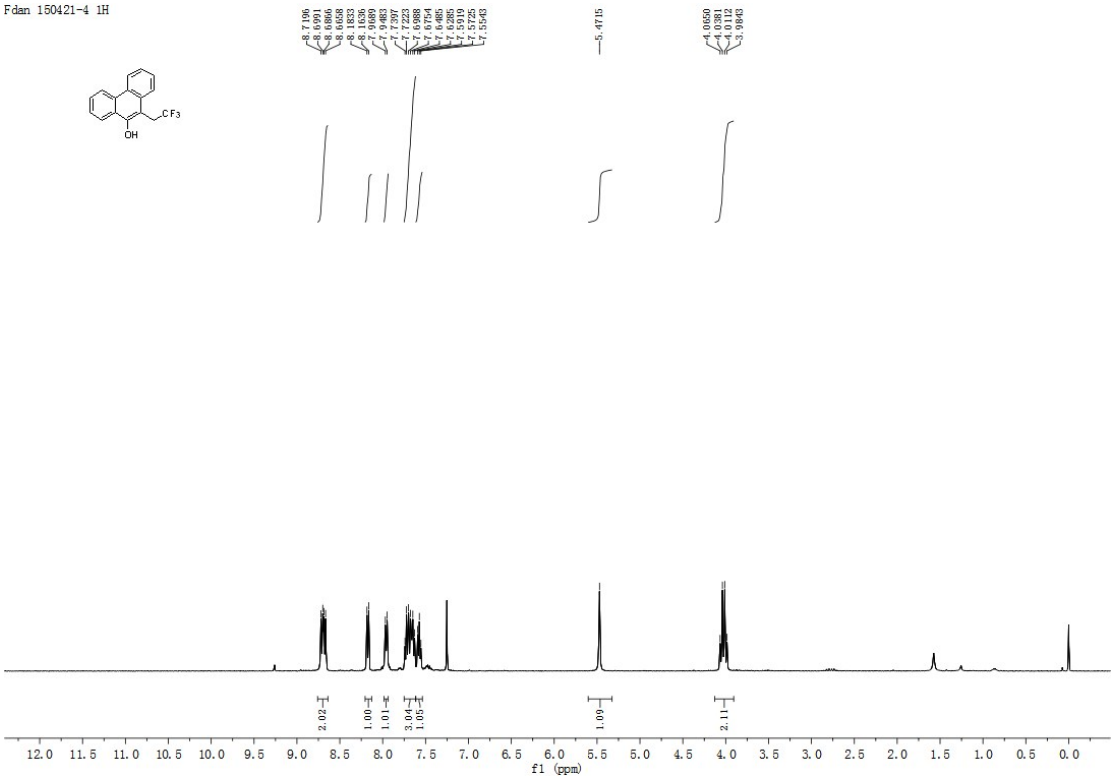
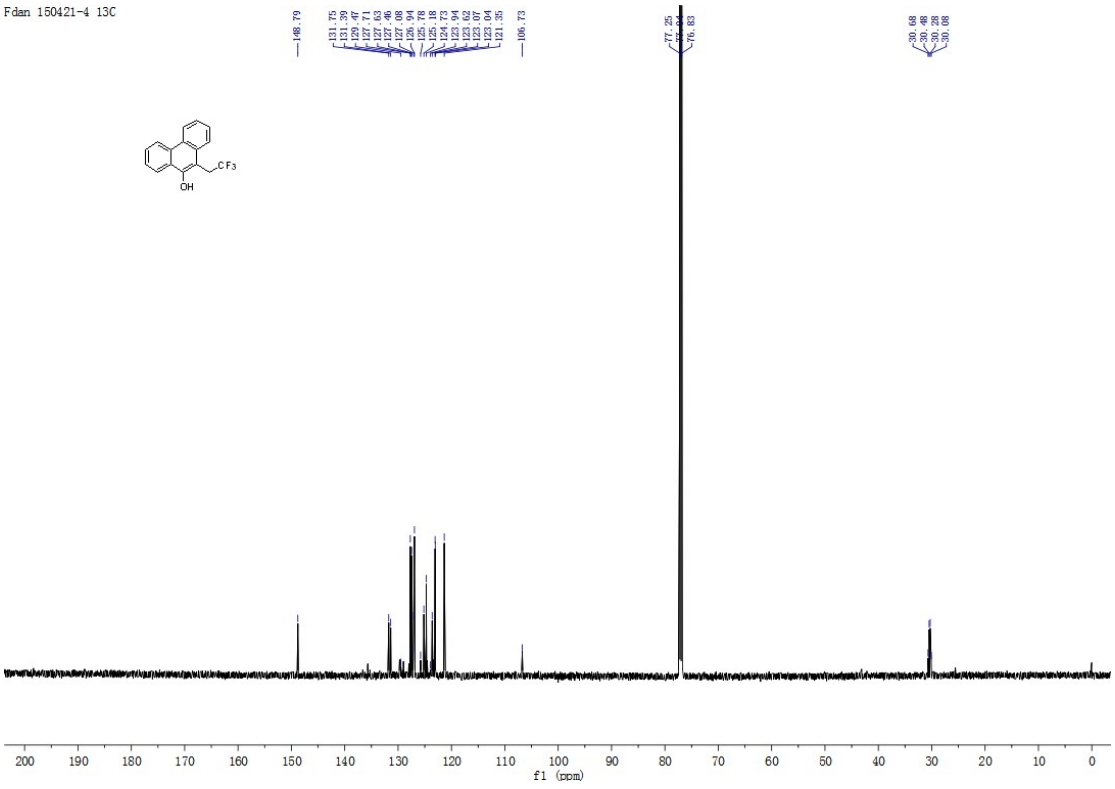


NMR for products:

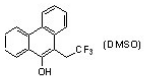
3a ^{1}H NMR



3a ^{13}C NMR



3a ^{19}F NMR



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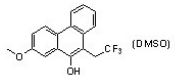
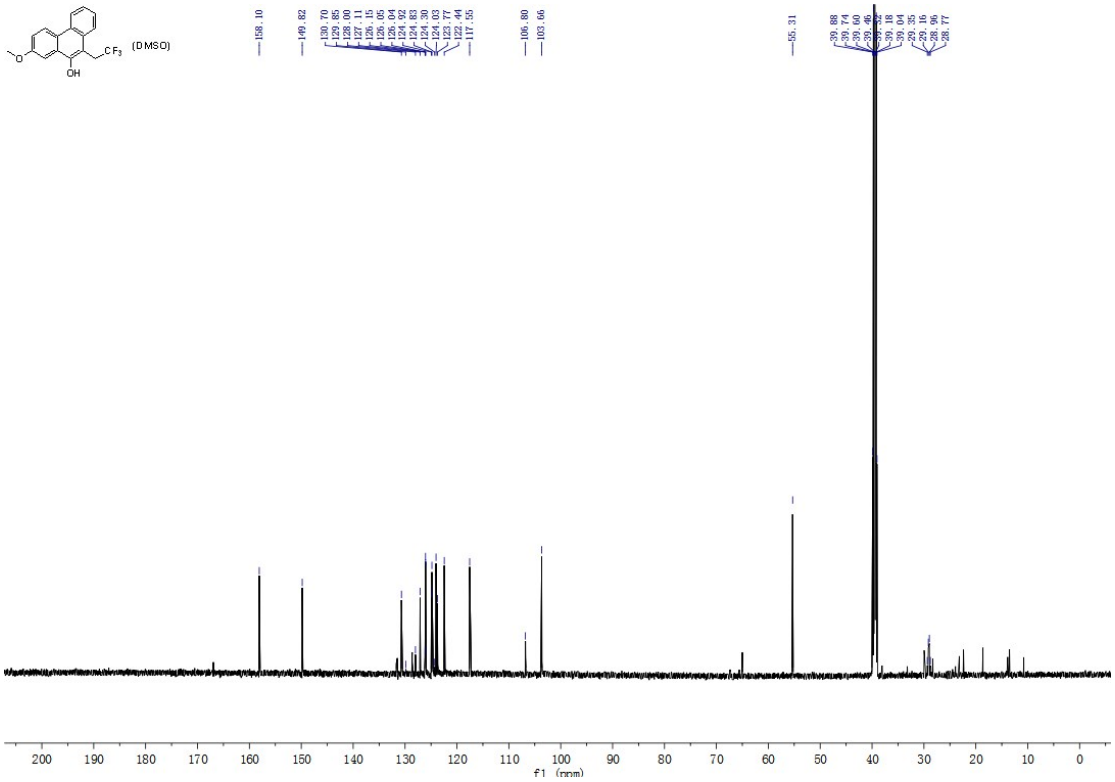
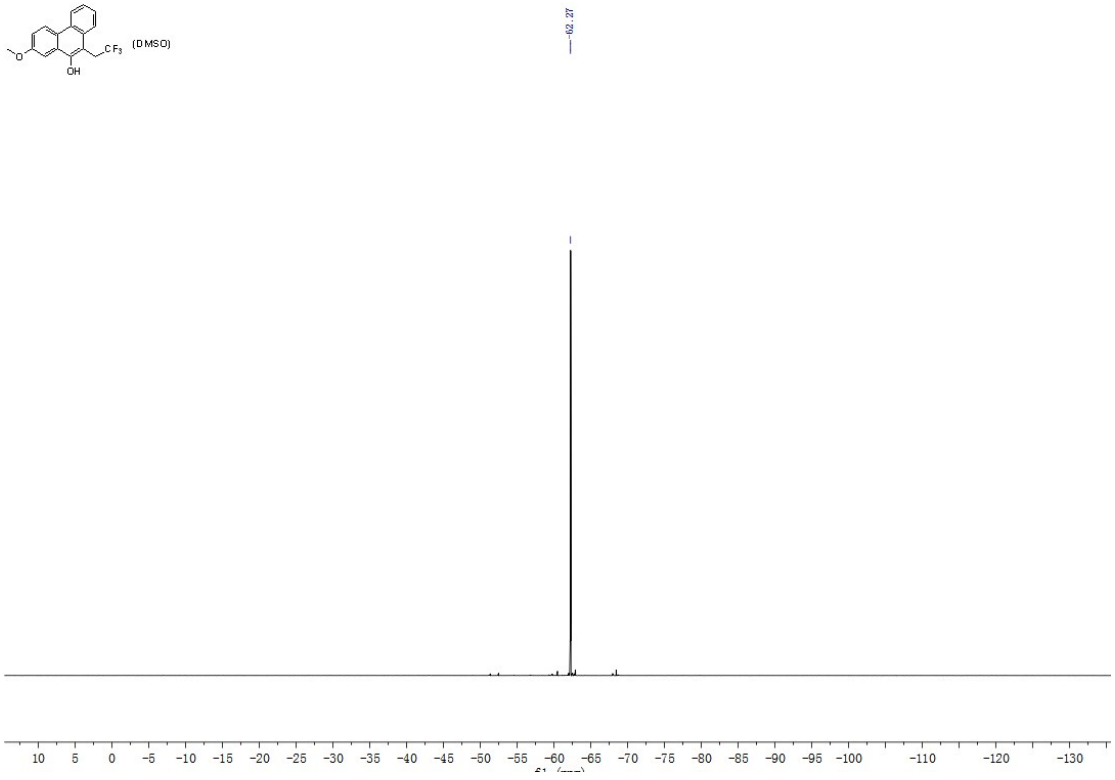


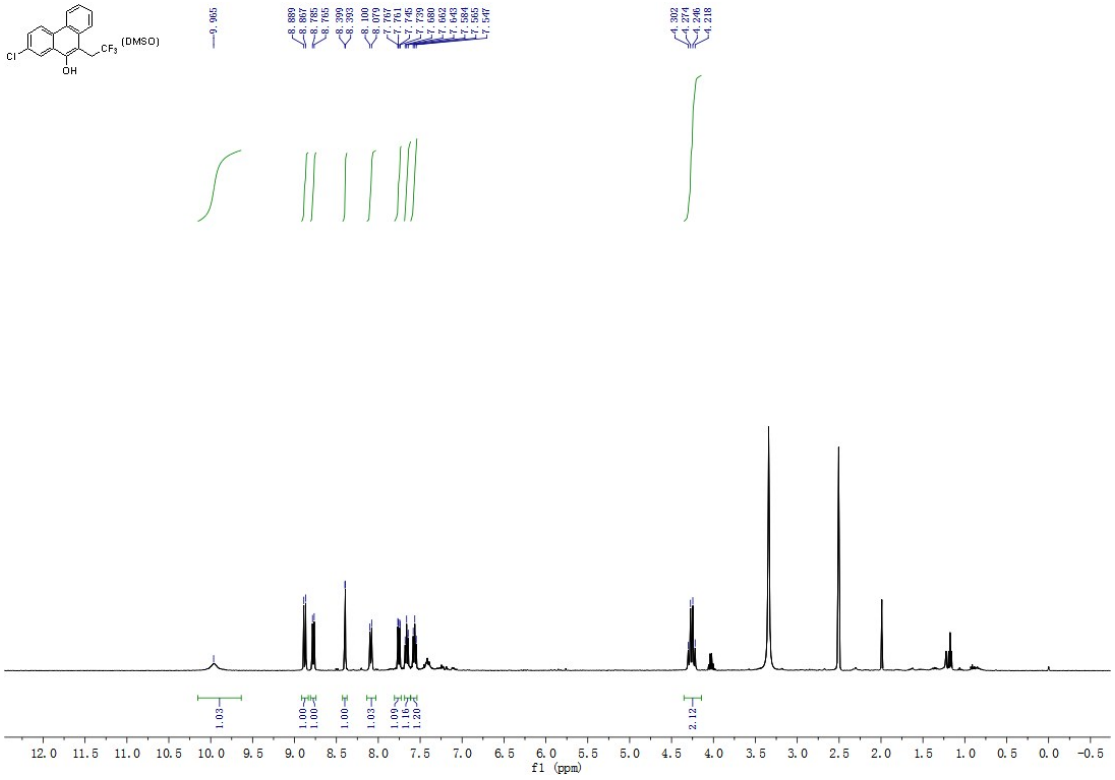
3b^{13}C NMR



3b ^{19}F NMR



3c[1]H NMR



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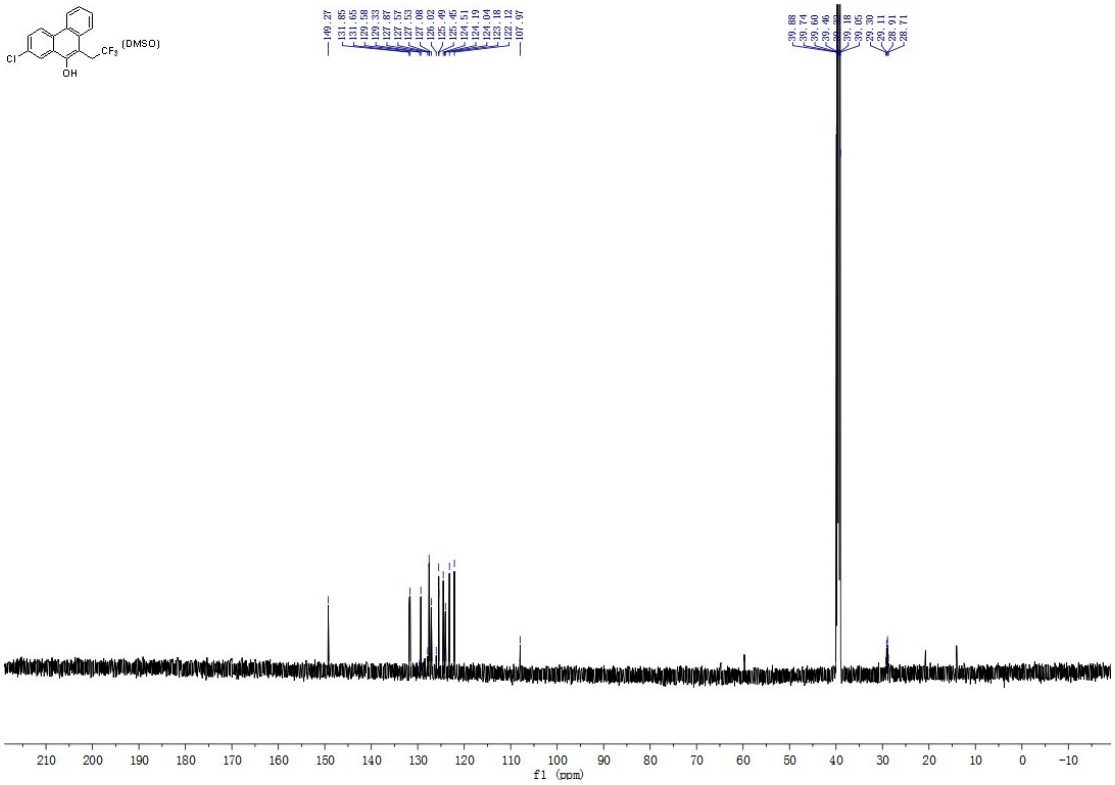
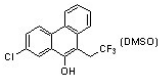


3c^{19}F NMR



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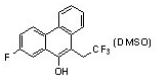

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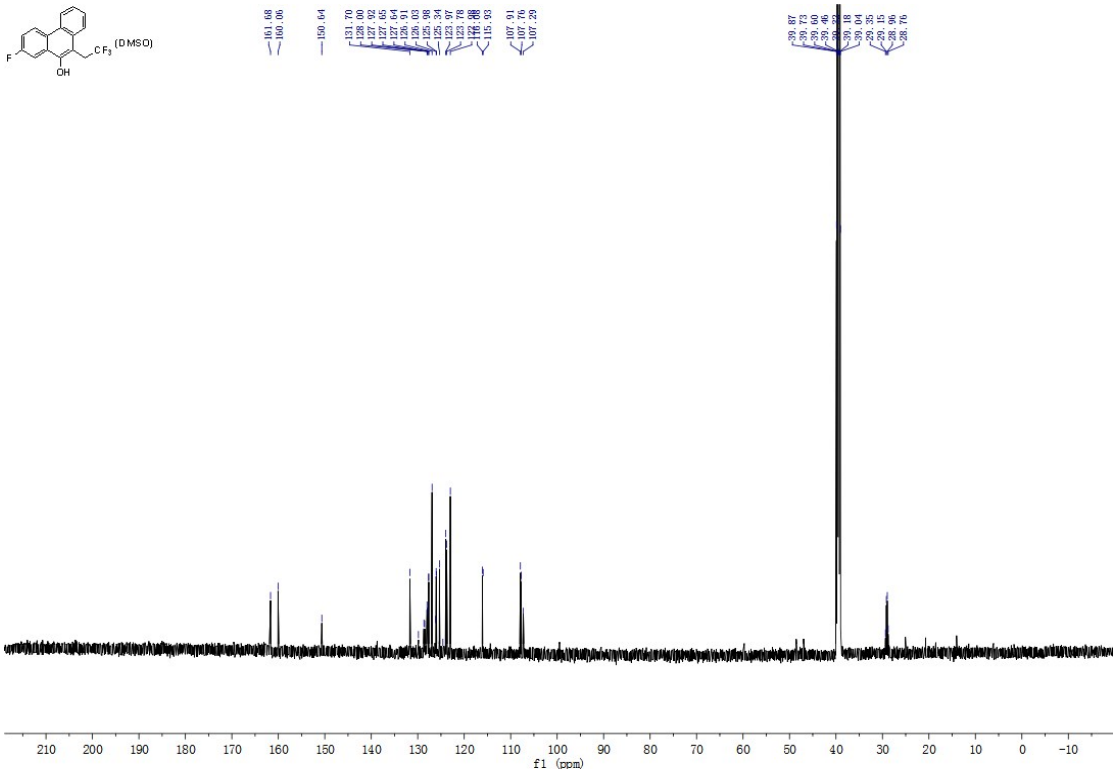
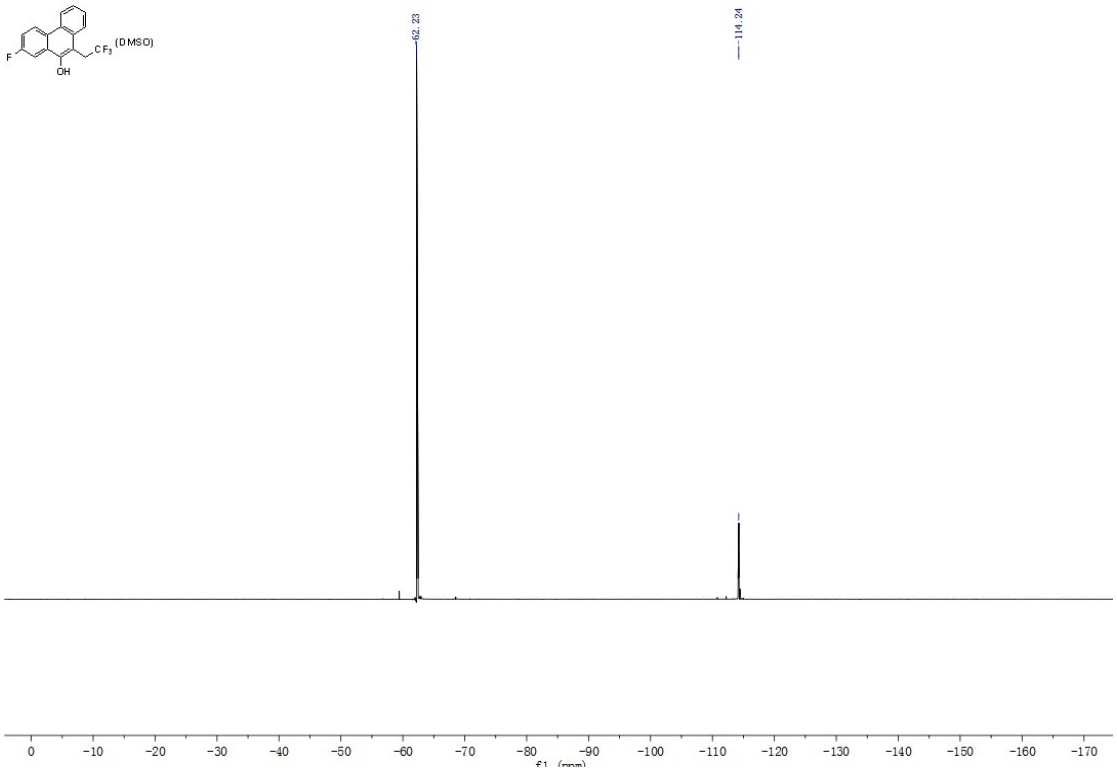
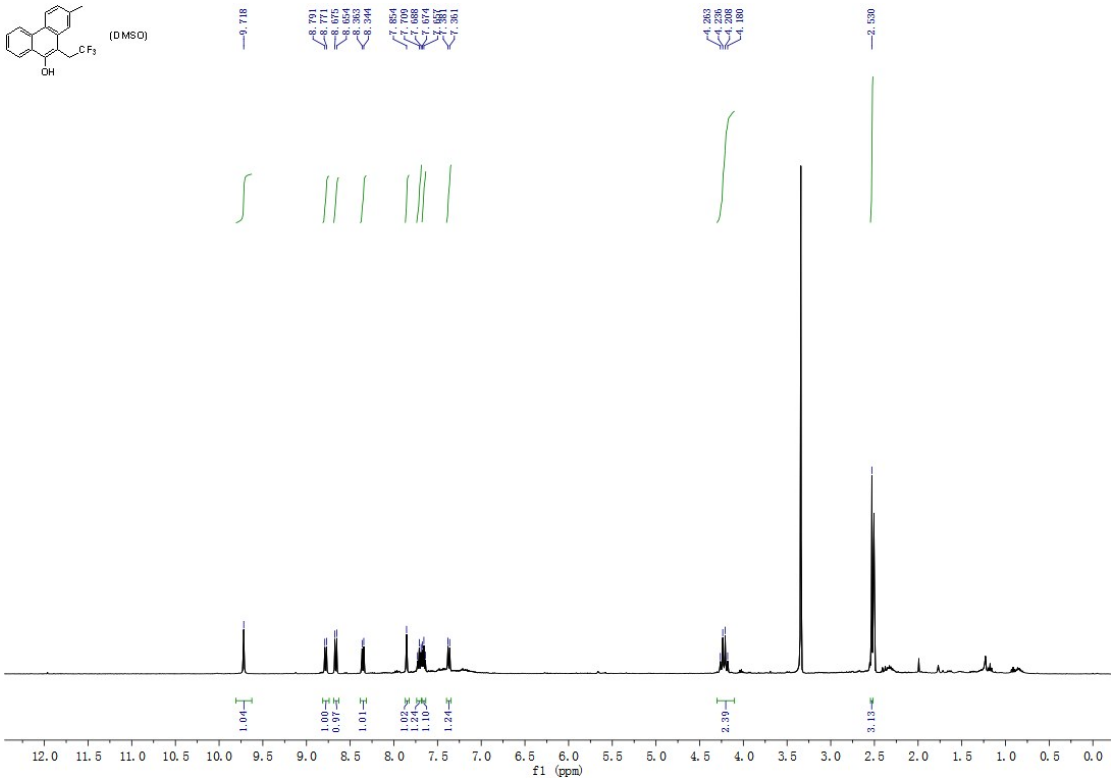


3d^{19}F NMR



3e[1]H NMR



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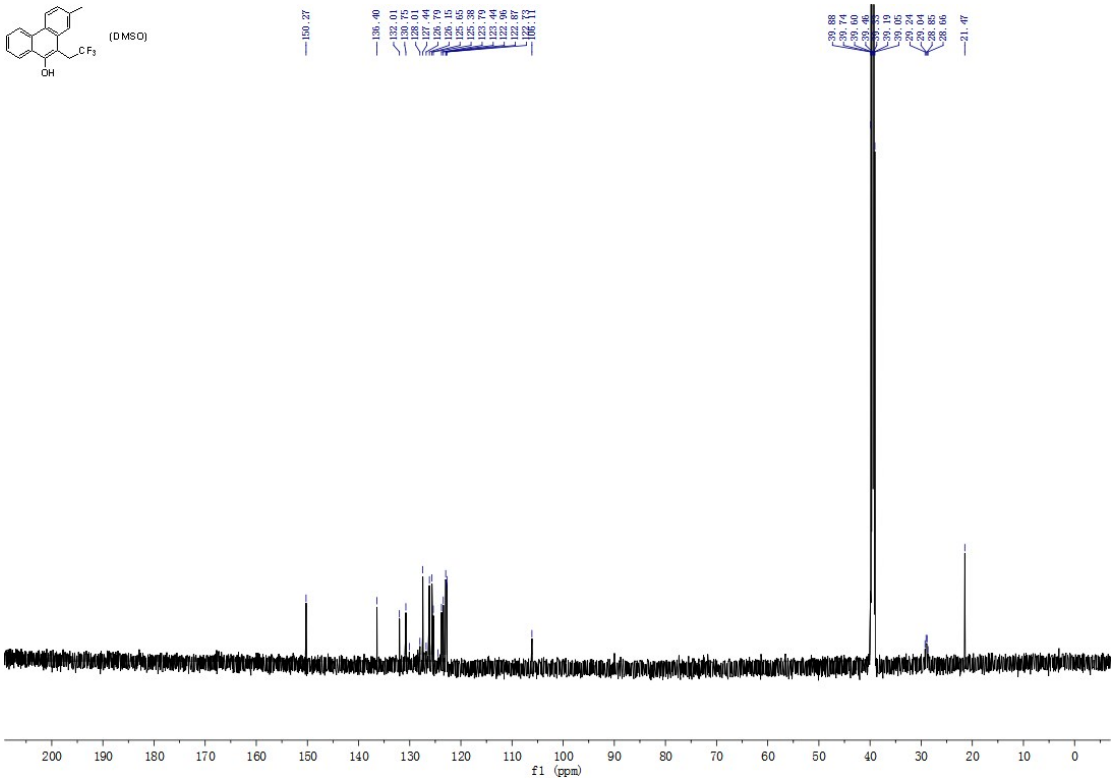

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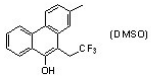

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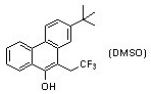

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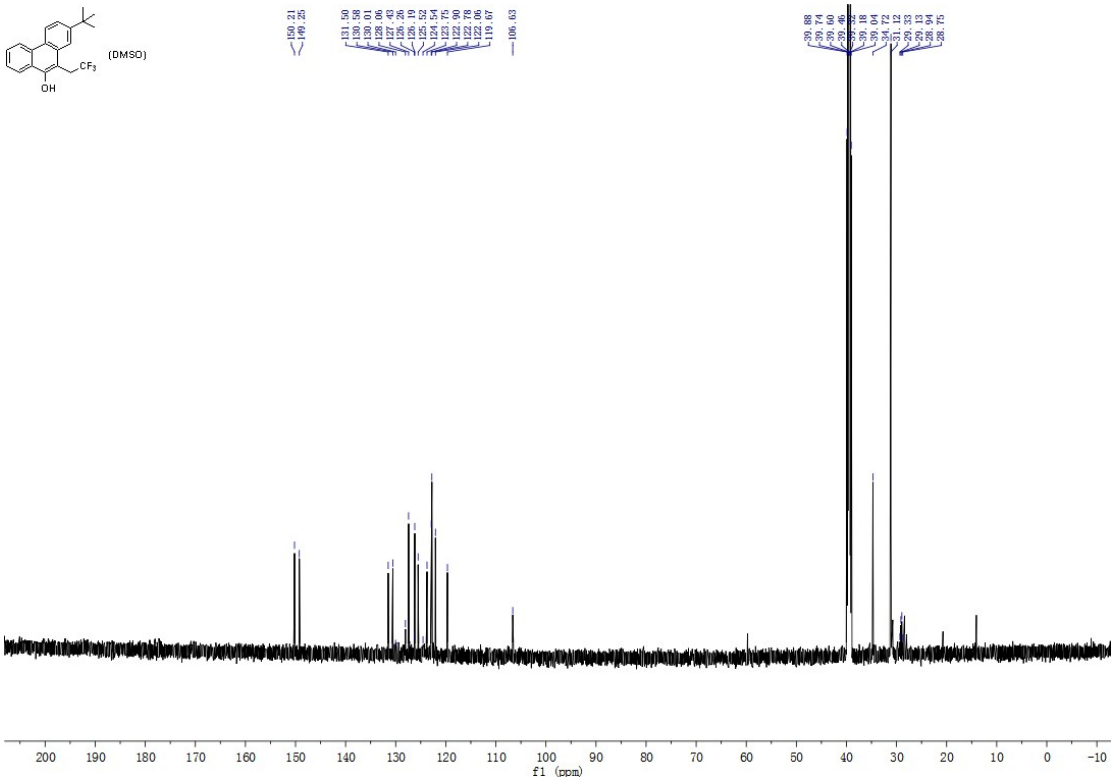
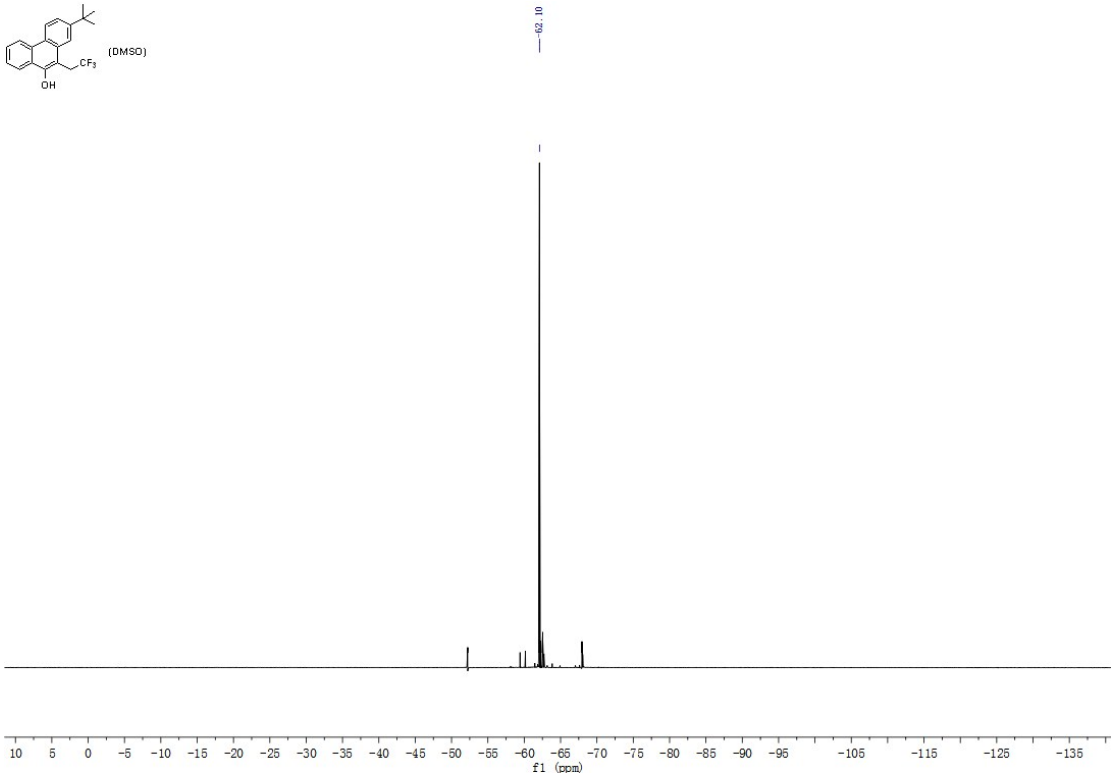


3f^{19}F NMR



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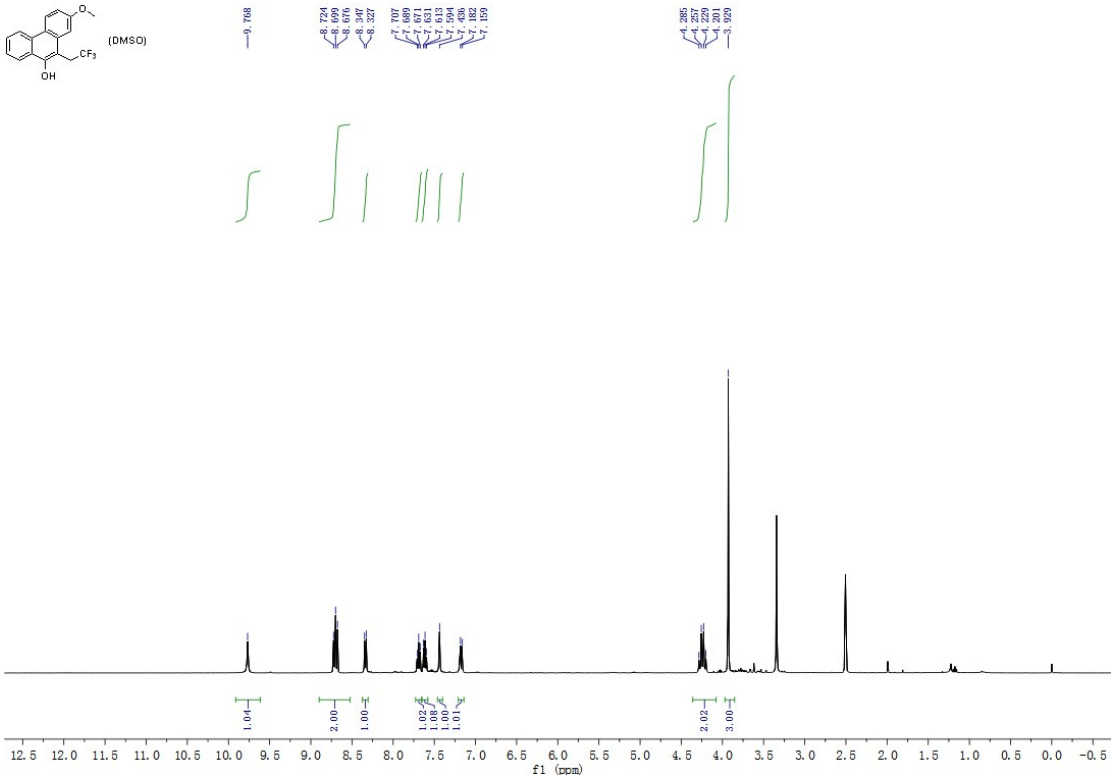

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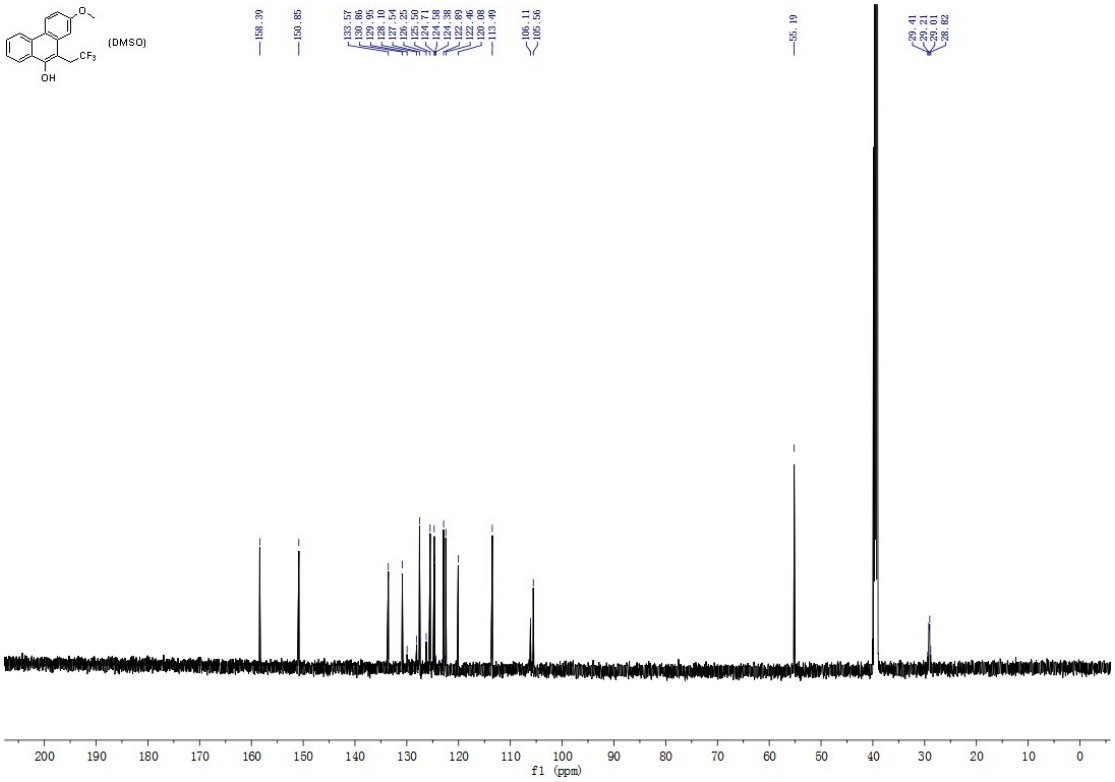

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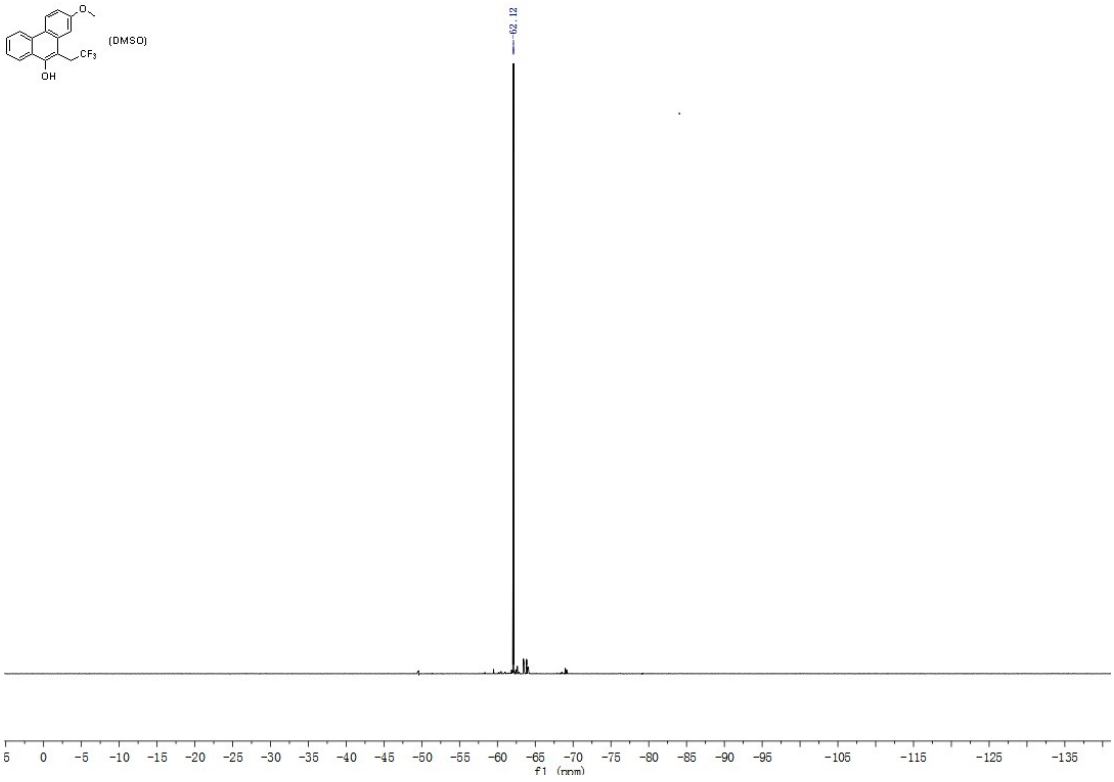

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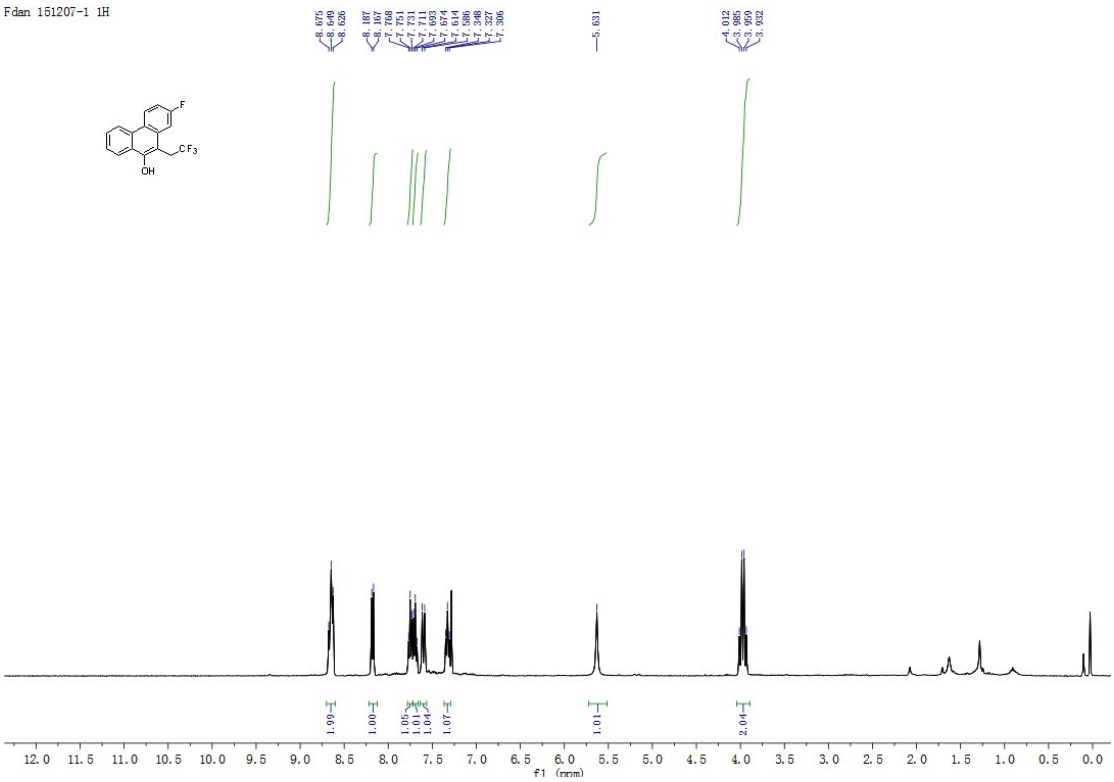

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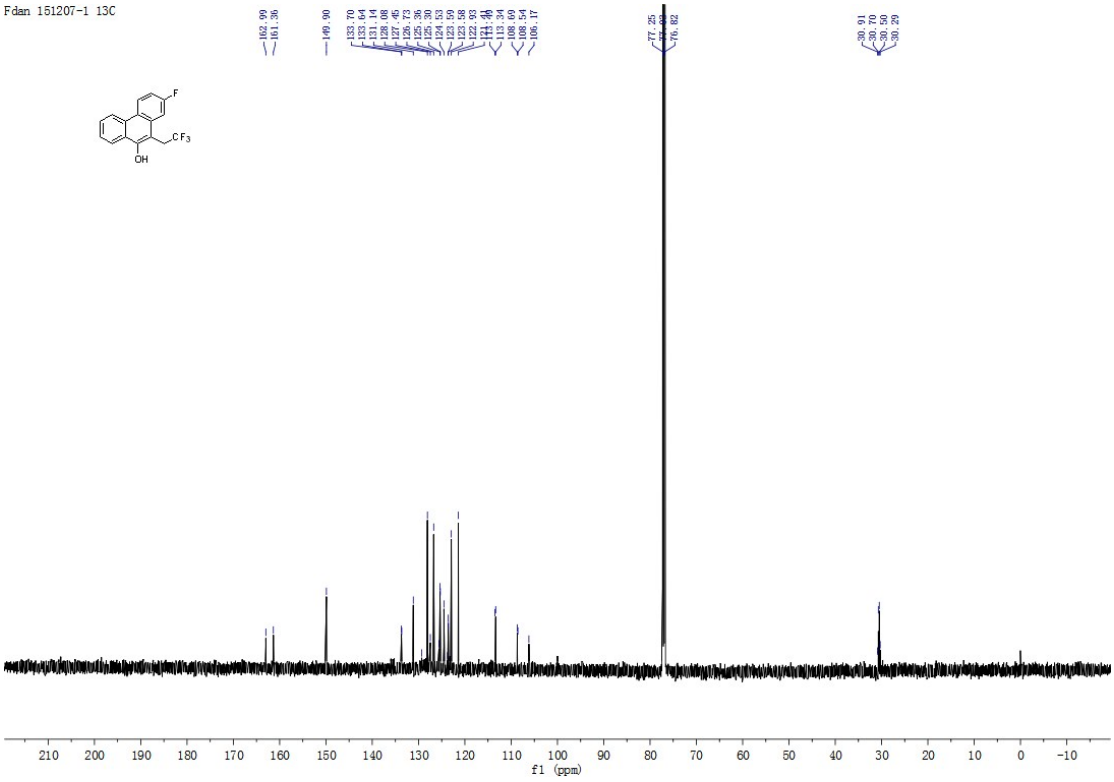

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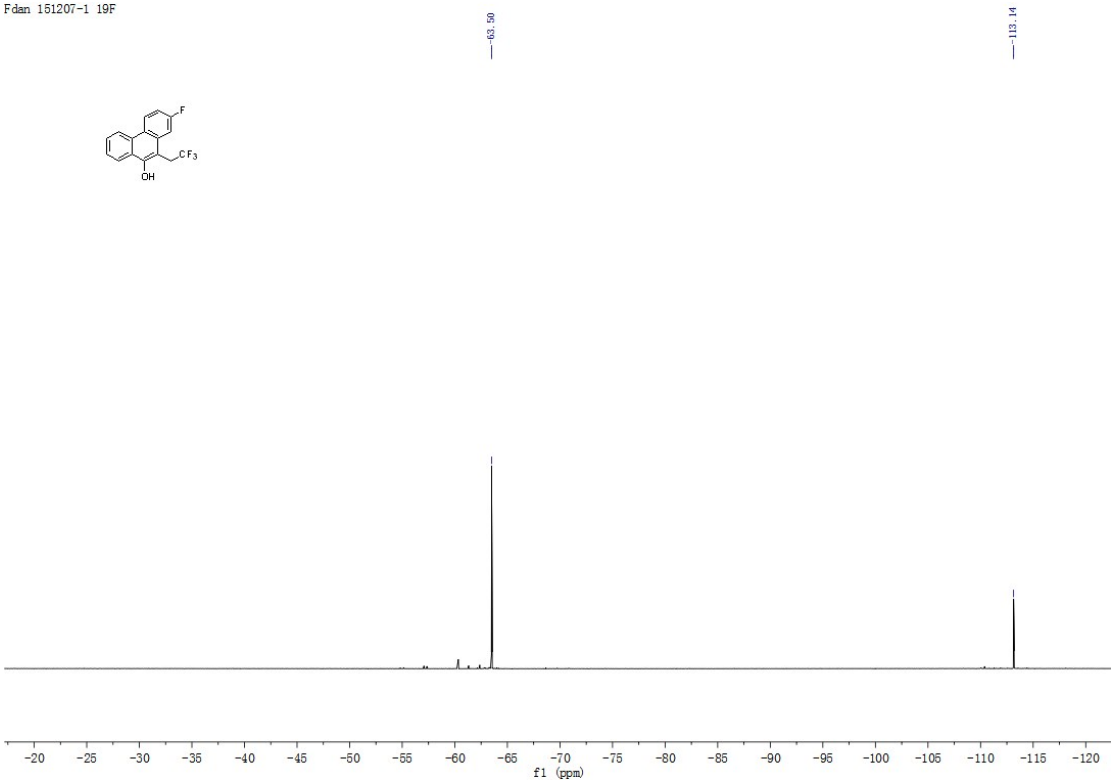

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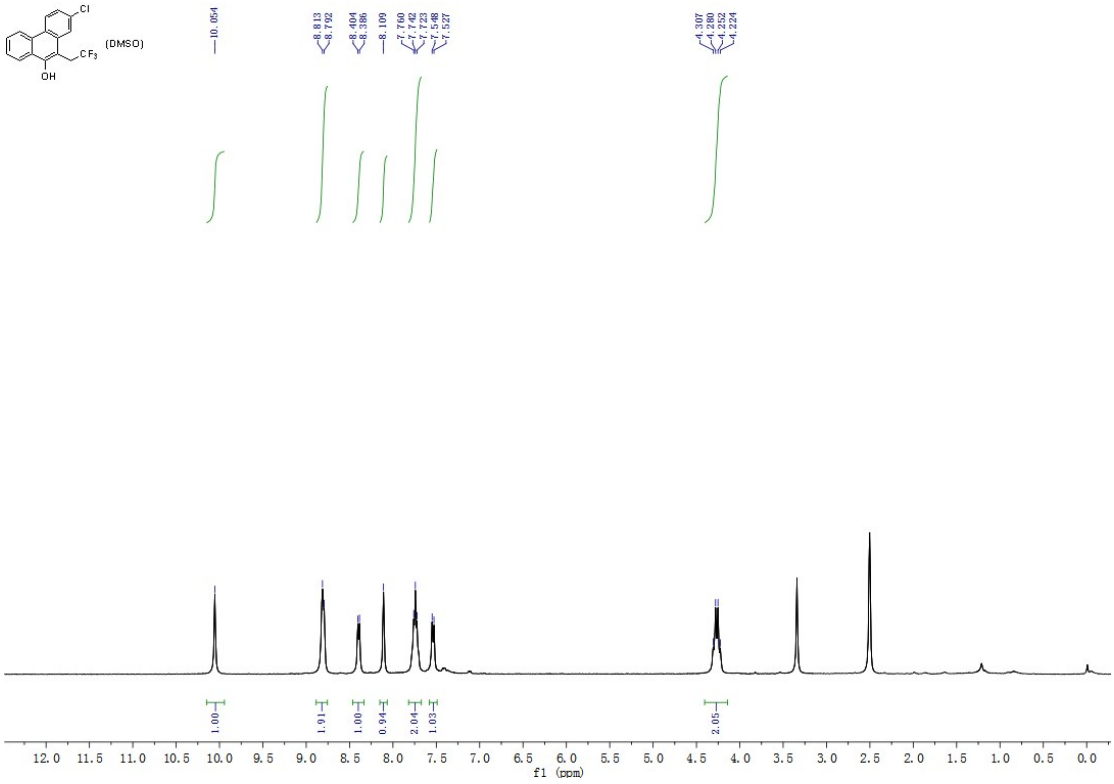
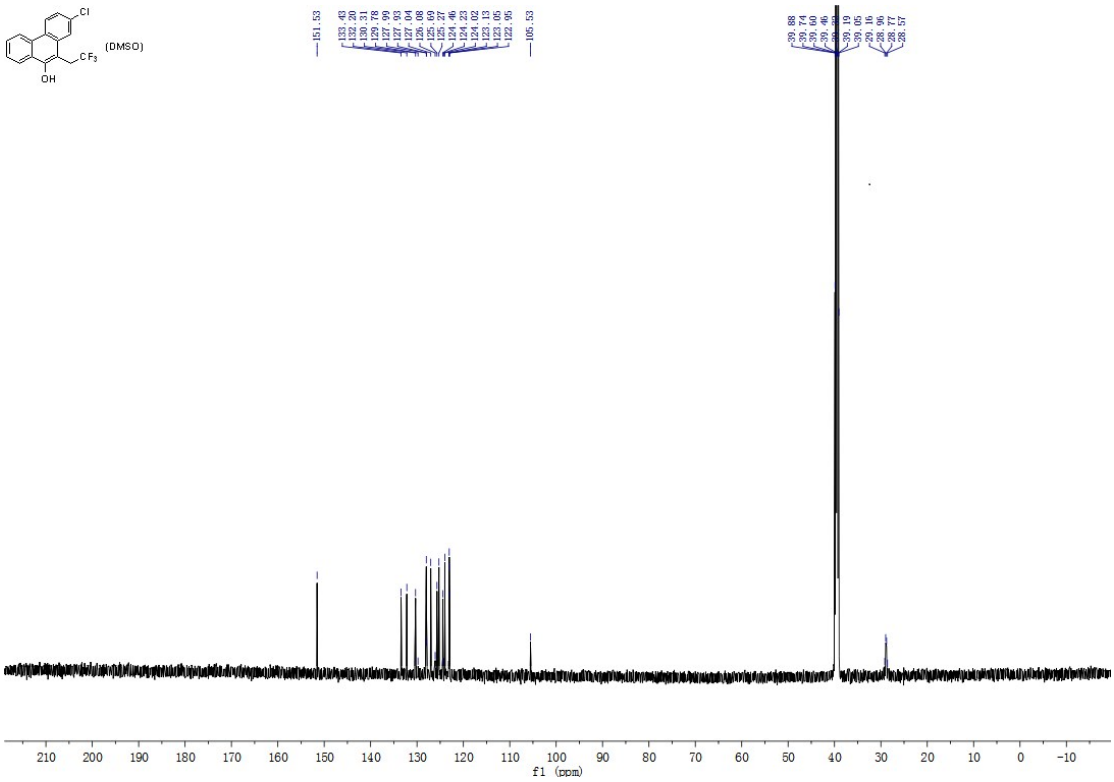
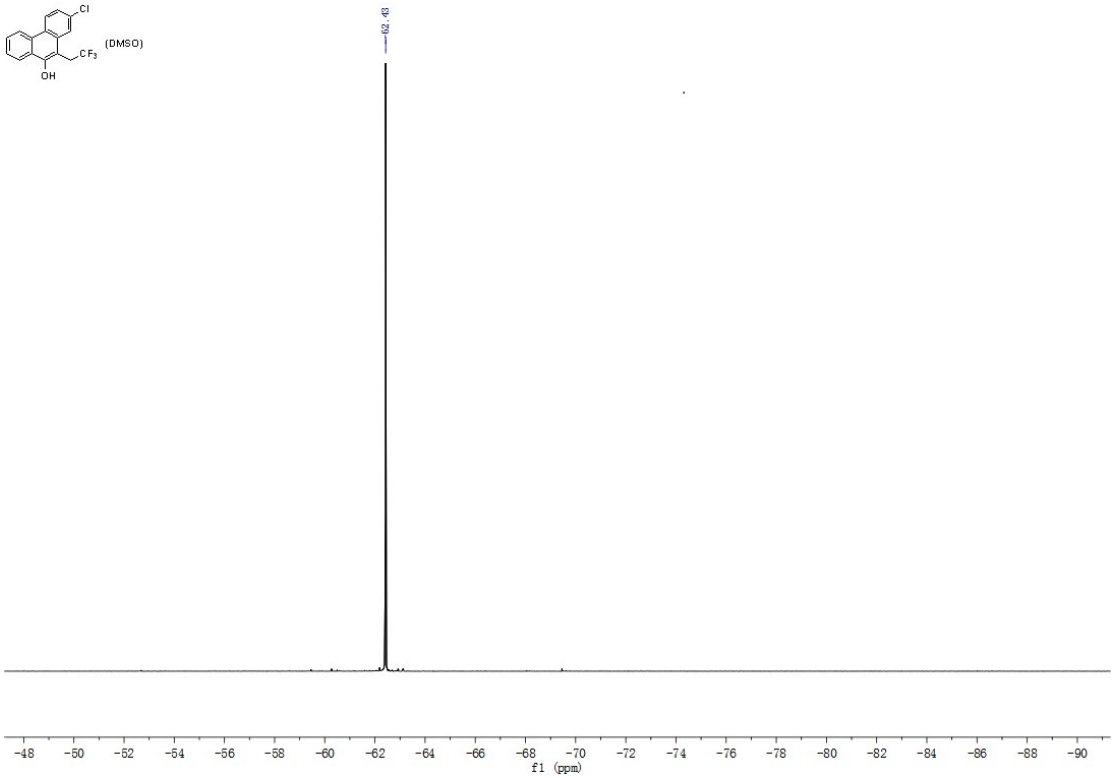


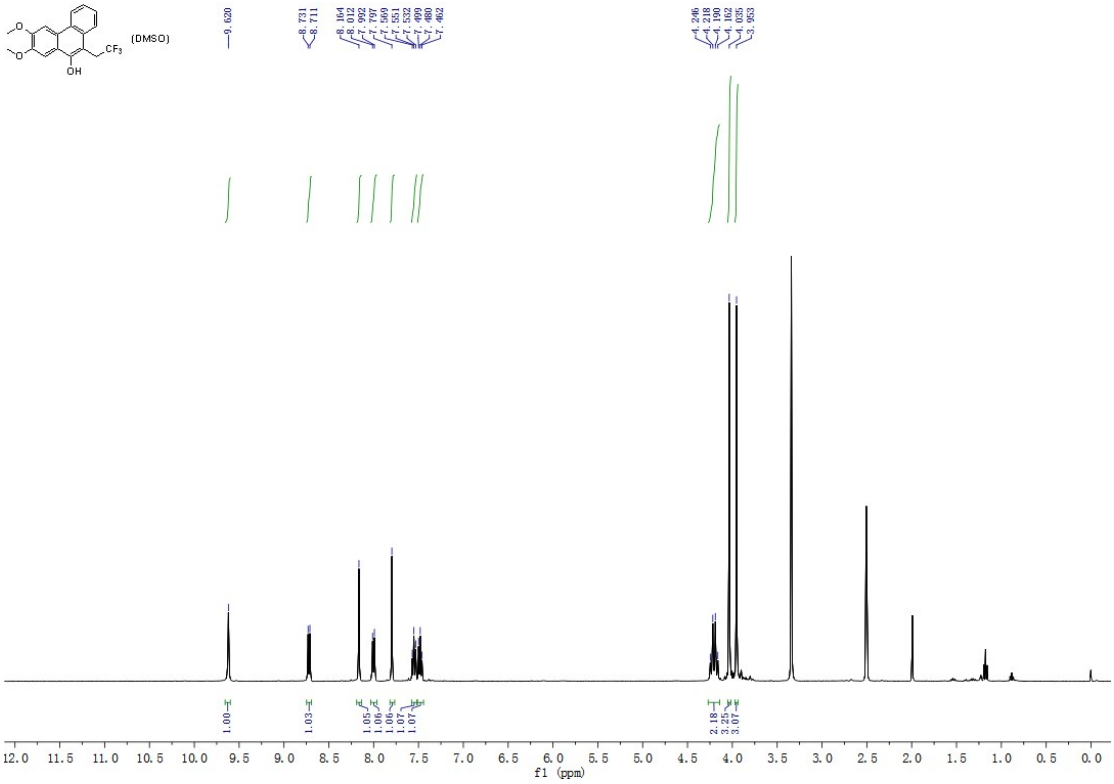
3i[13]C NMR



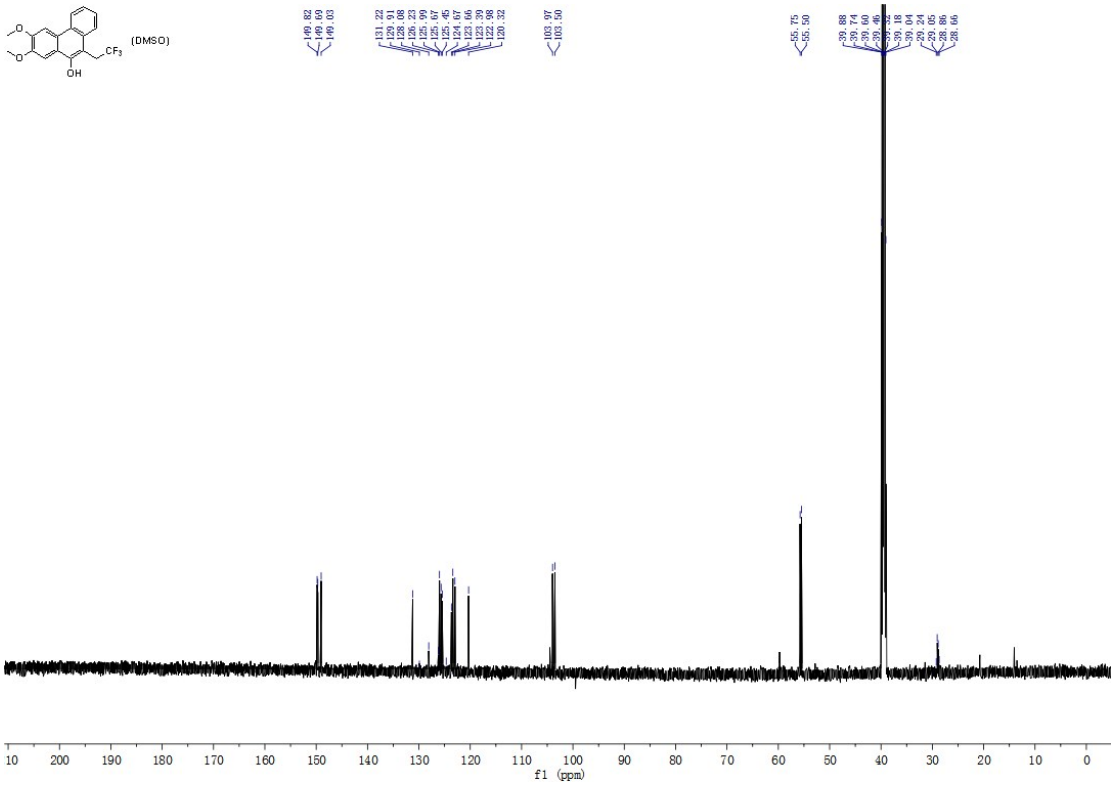
3i^{19}F NMR



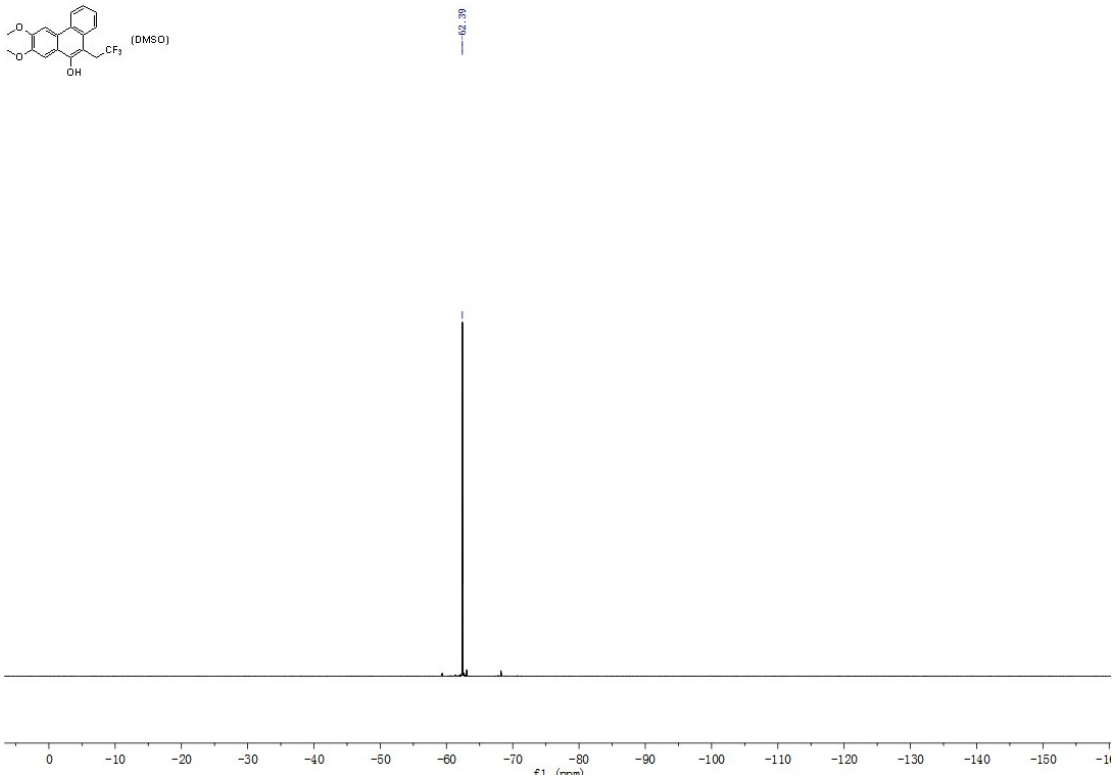
3j^{1}H NMR



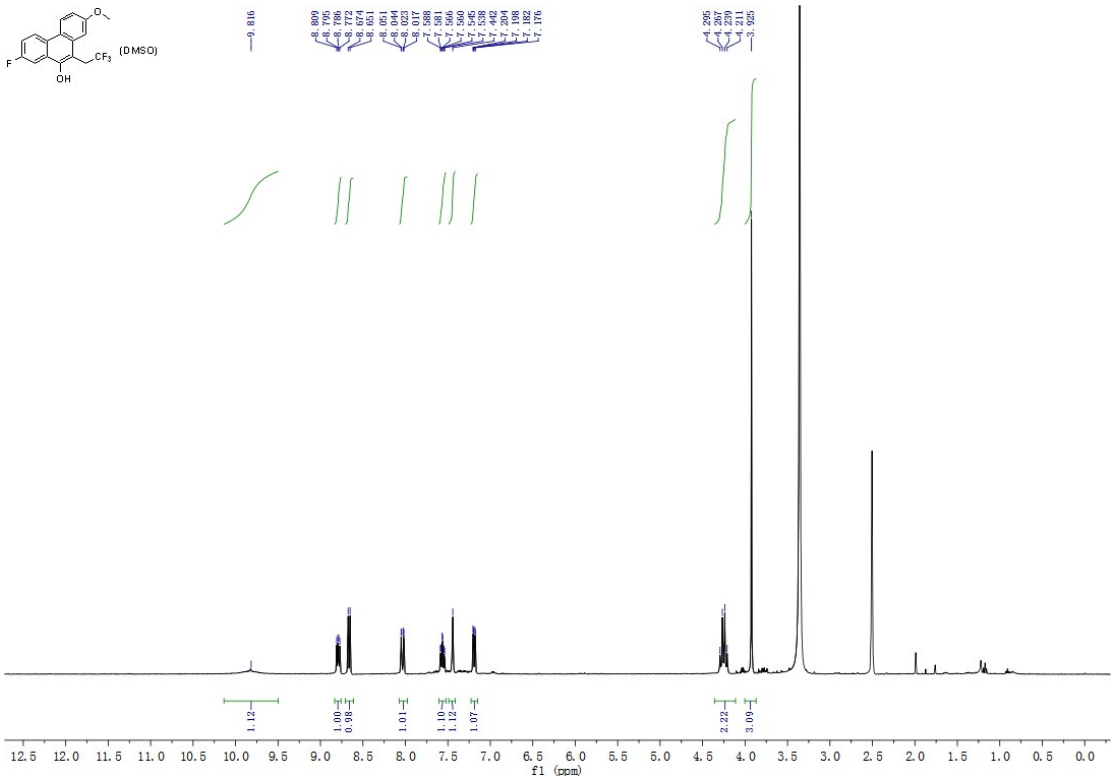
3j^{13}C NMR



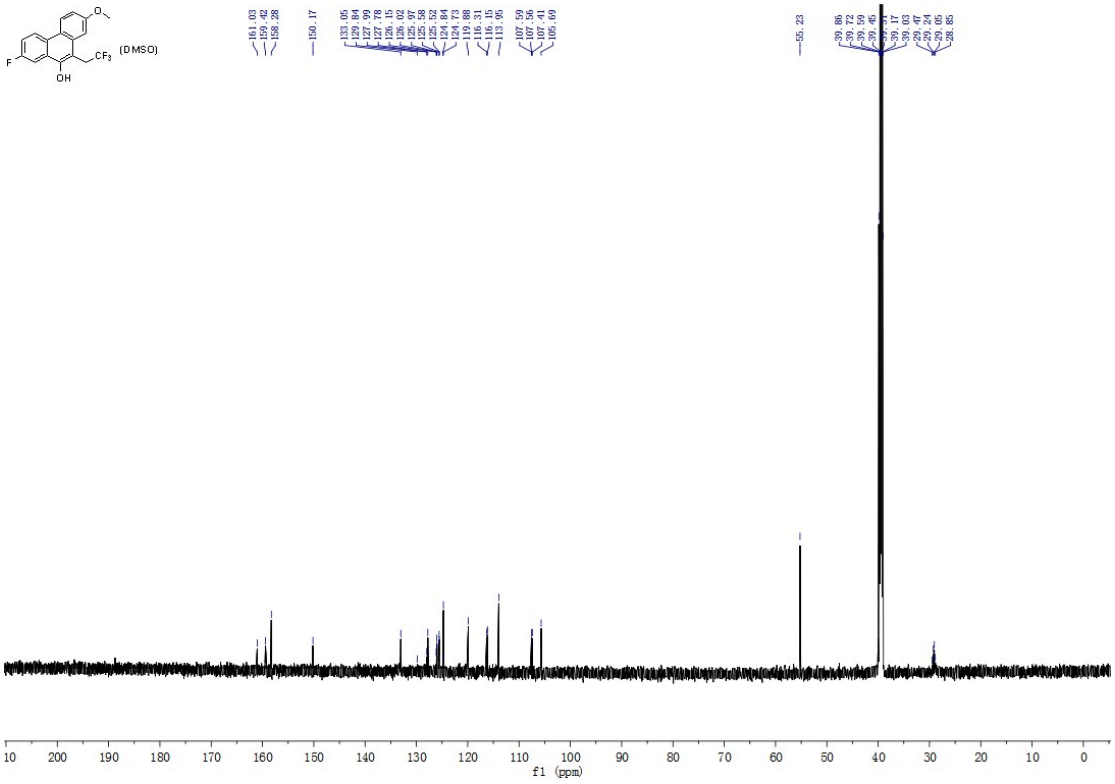
3j^{19}F NMR



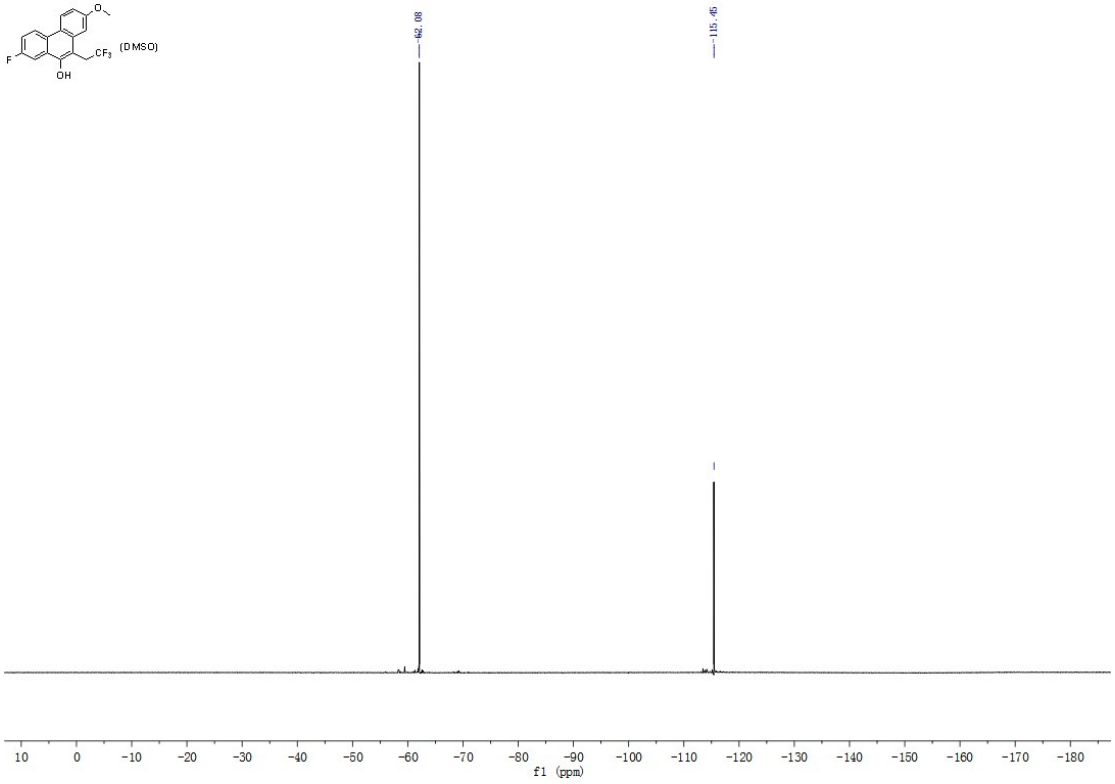
3k[1]H NMR



3k[13]C NMR



3k^{19}F NMR



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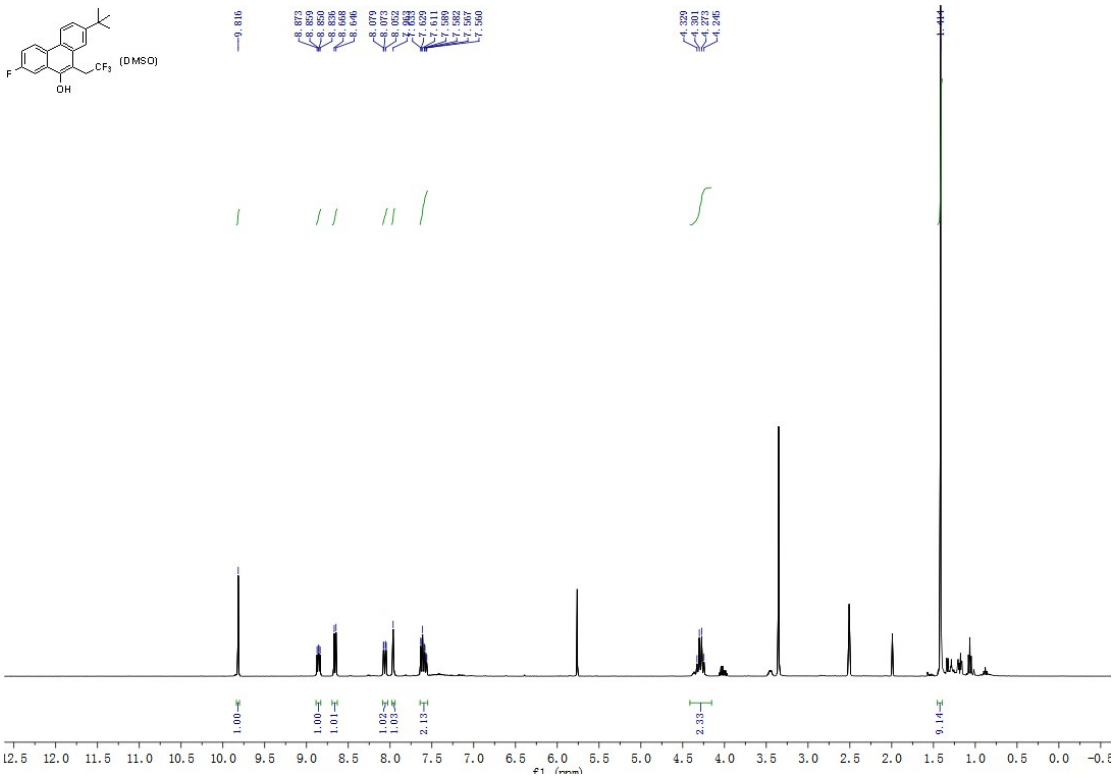

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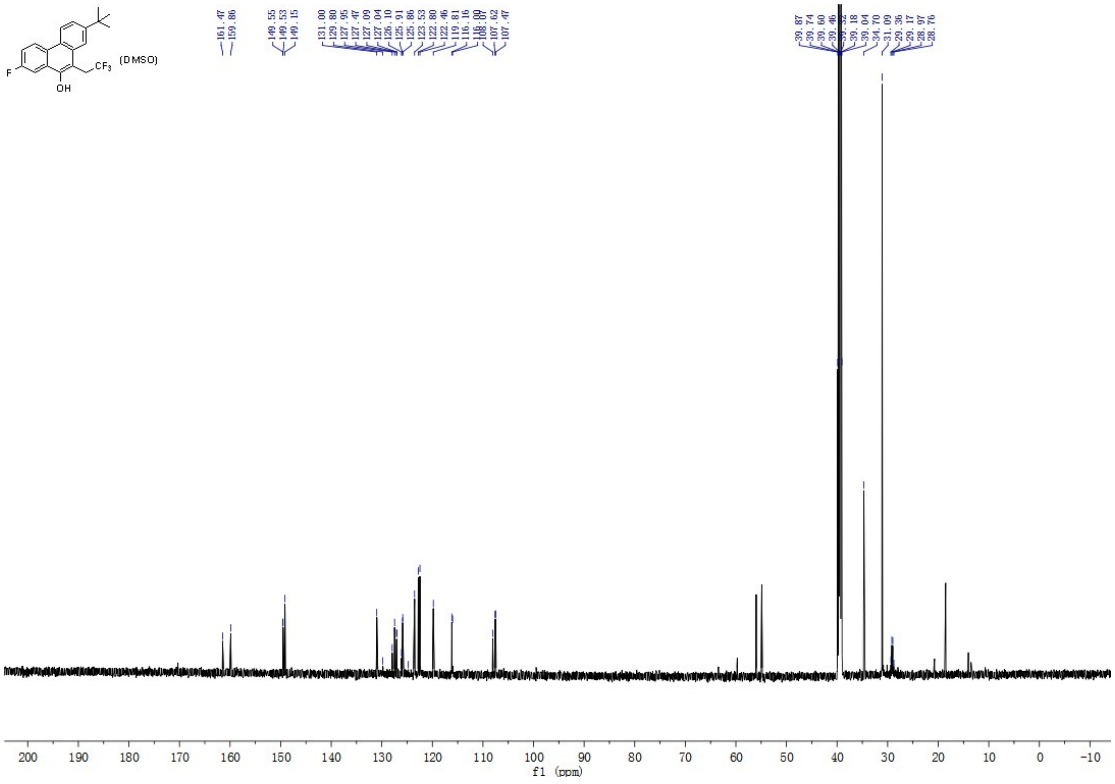
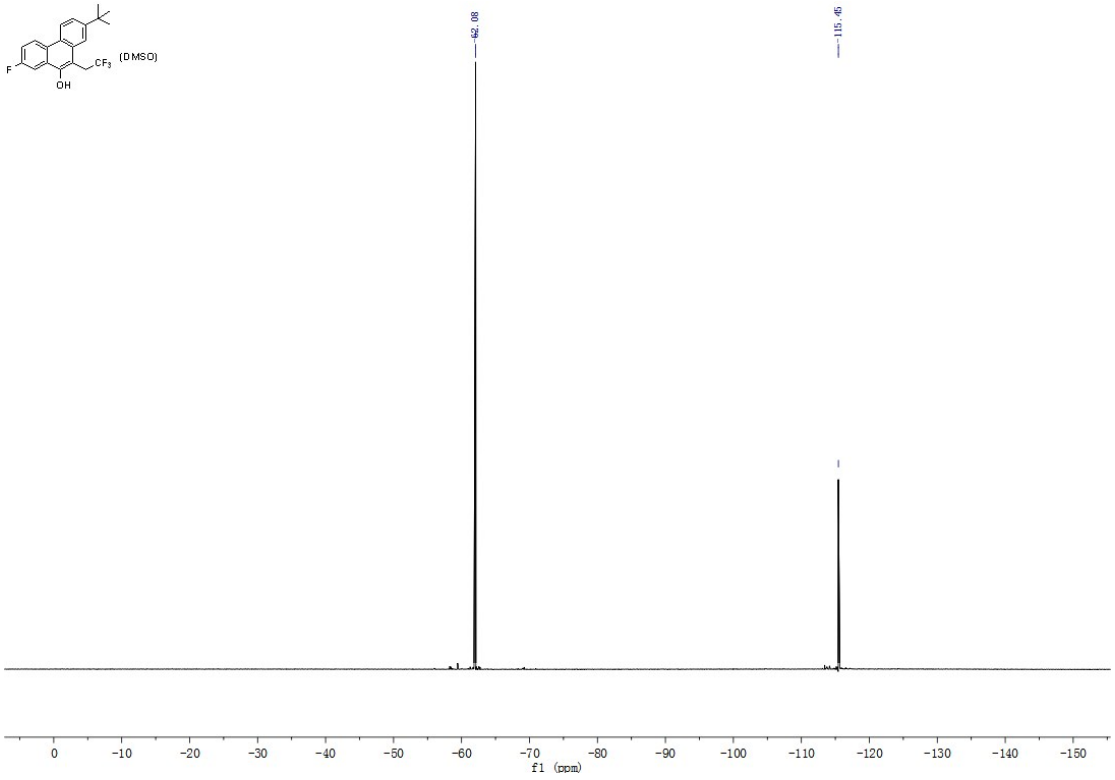
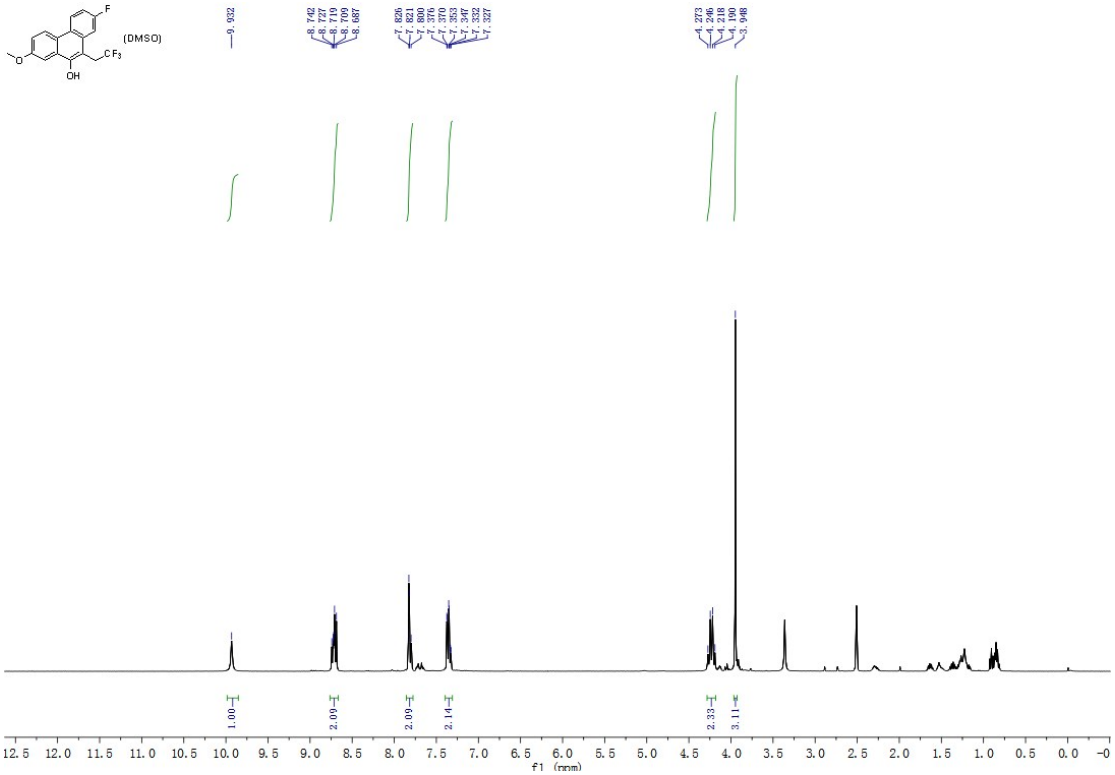


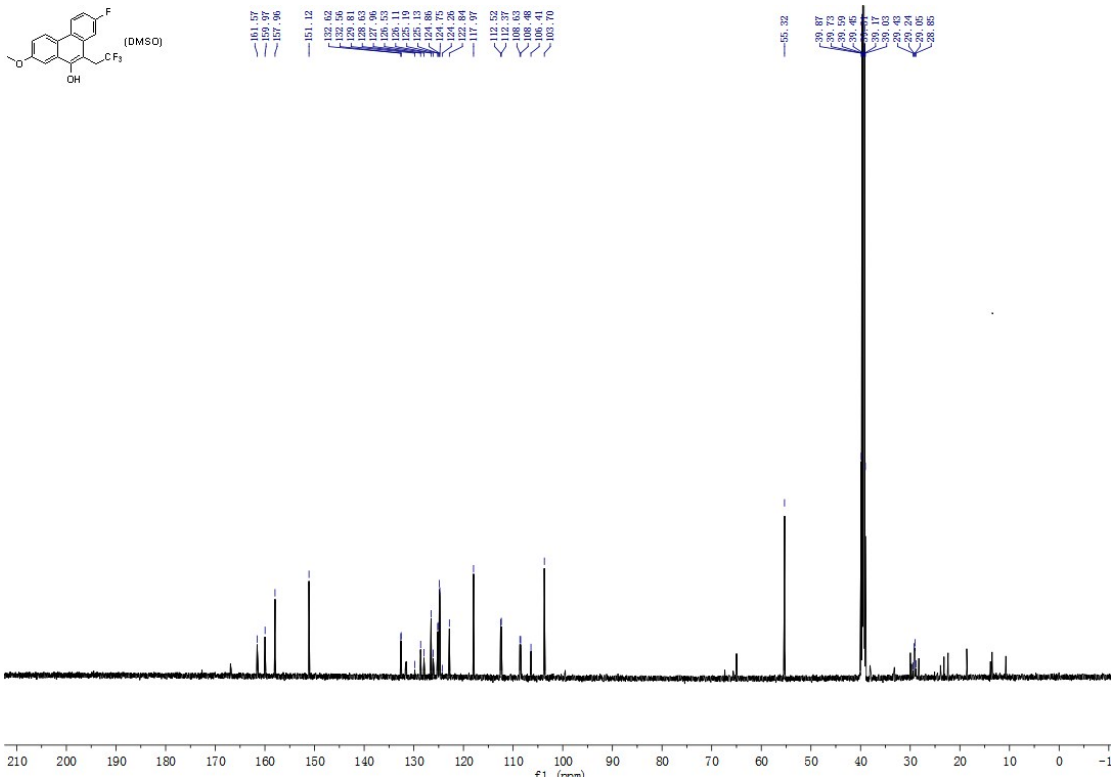
3l^{19}F NMR



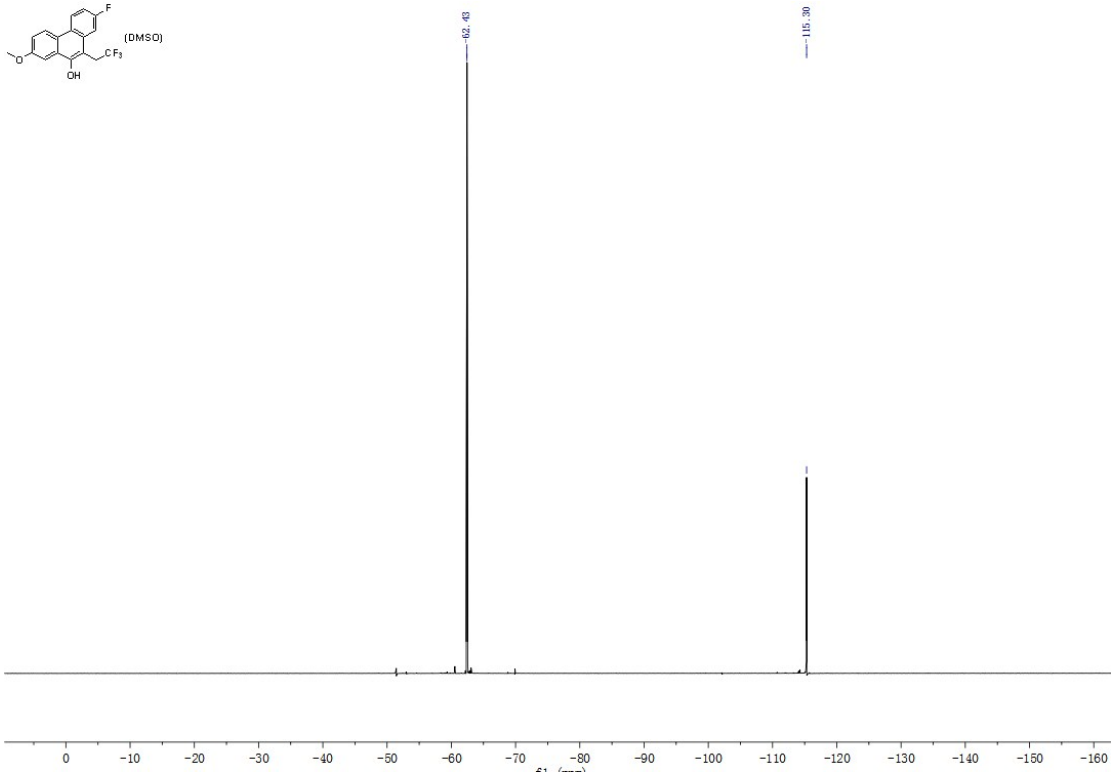
3m[1]H NMR



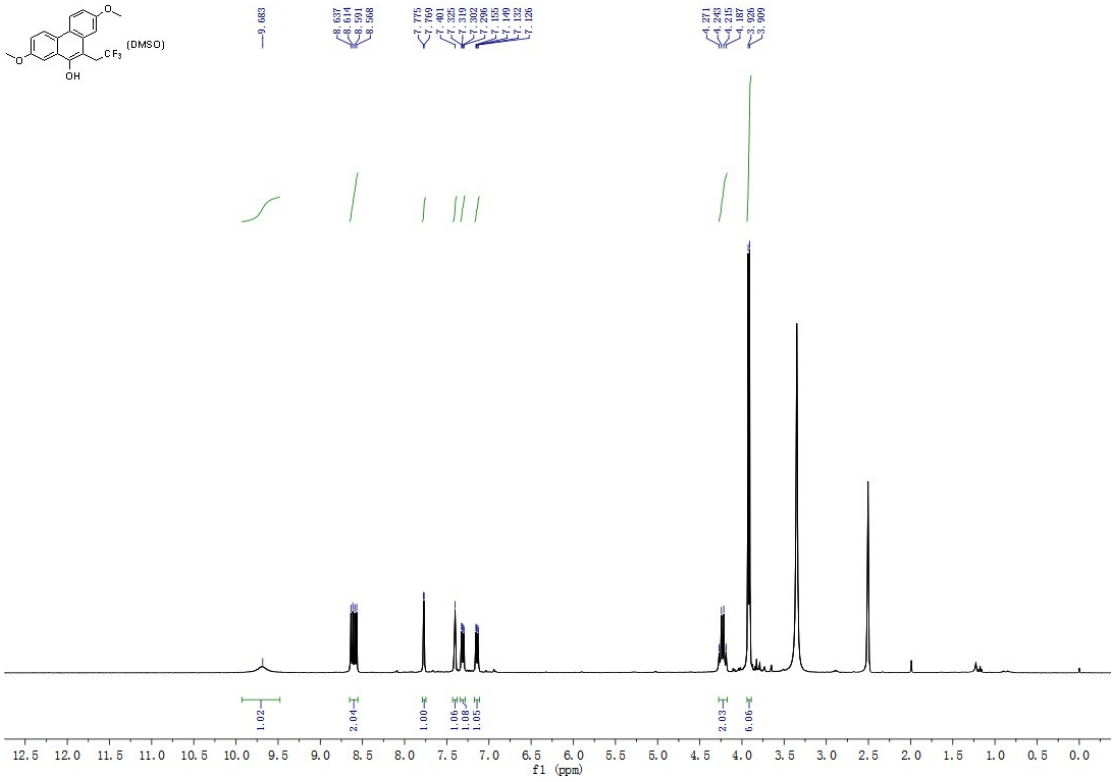
3m[13]C NMR



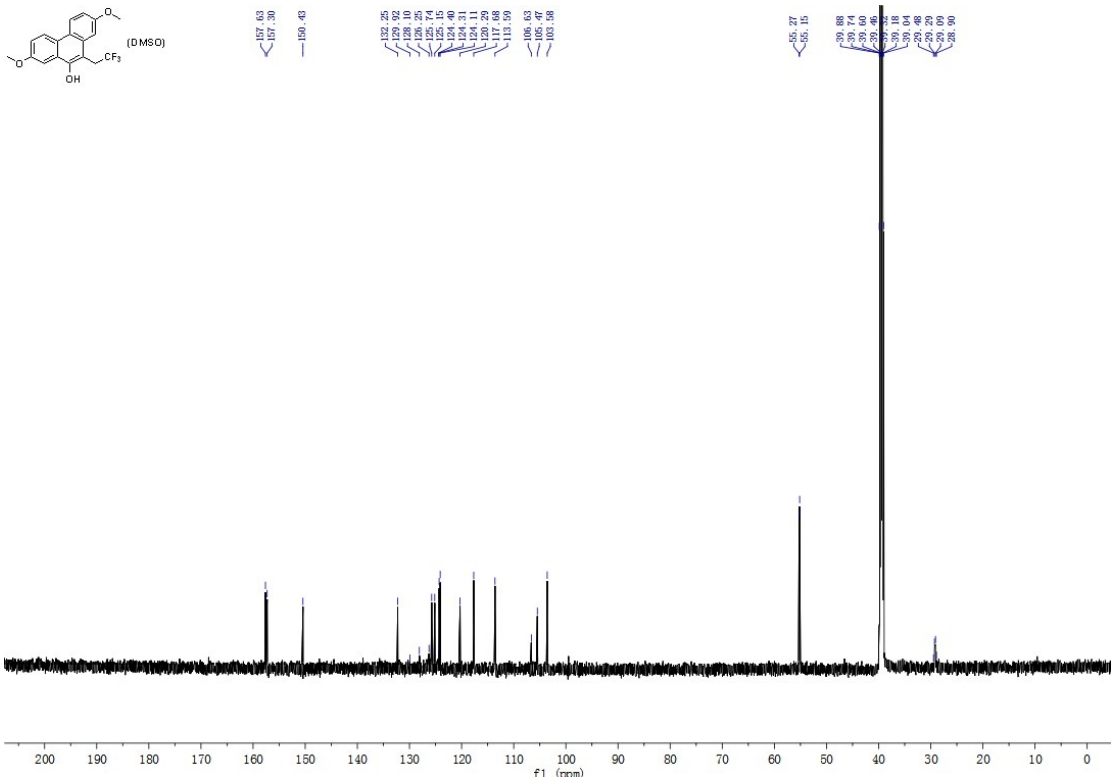
3m ^{19}F NMR



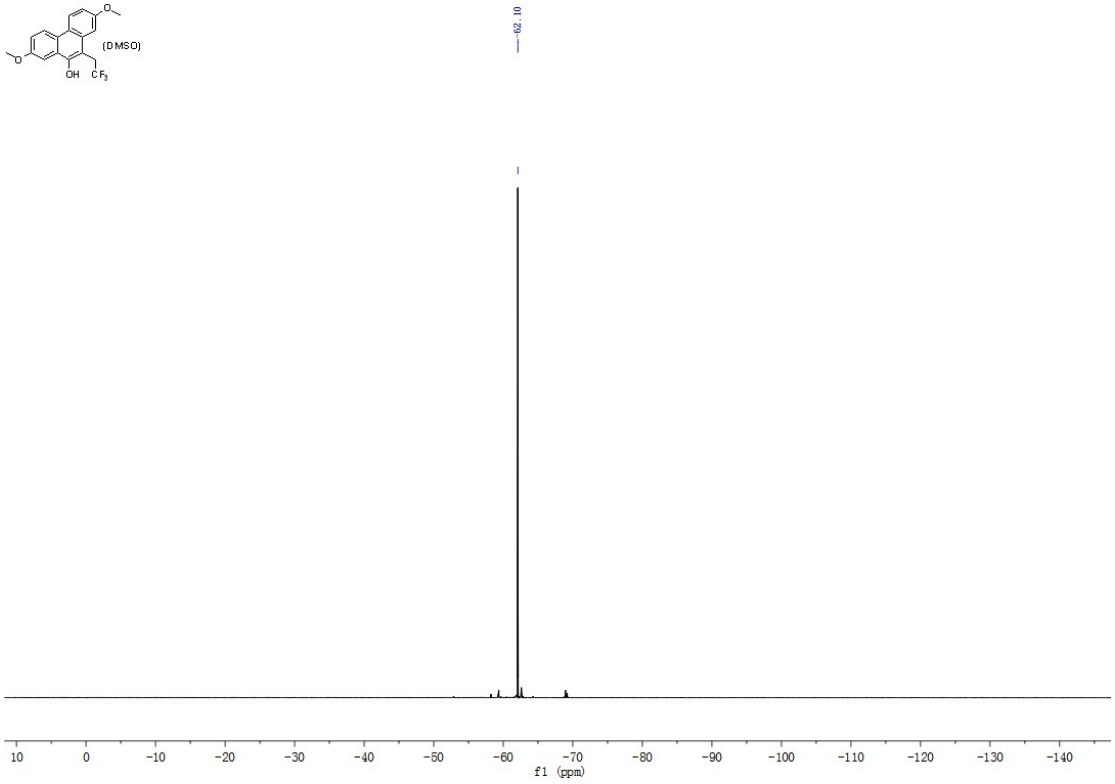
3n ^{1}H NMR



3n ^{13}C NMR



3n ^{19}F NMR



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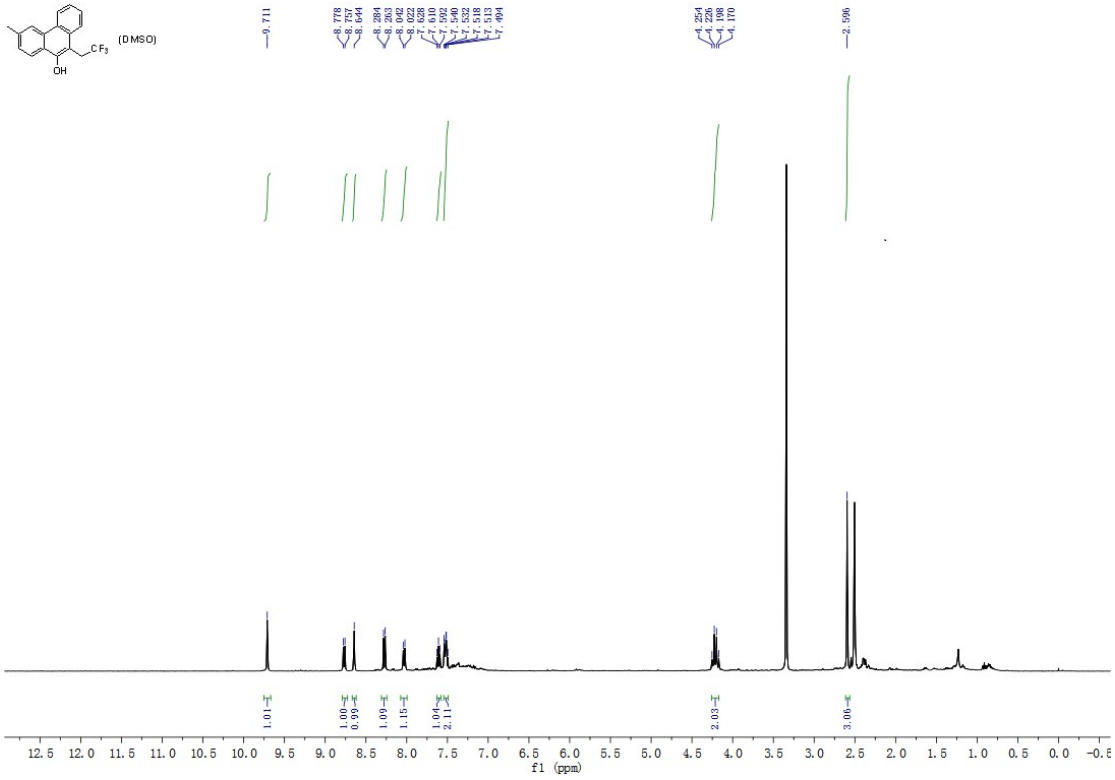
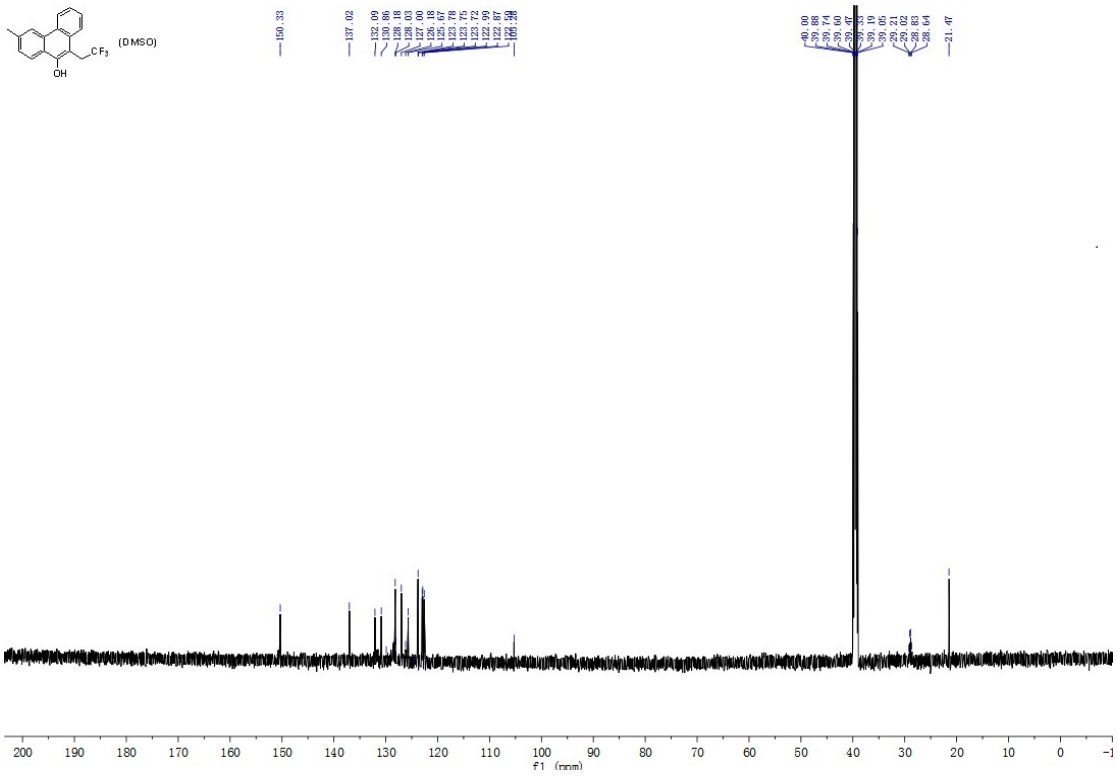
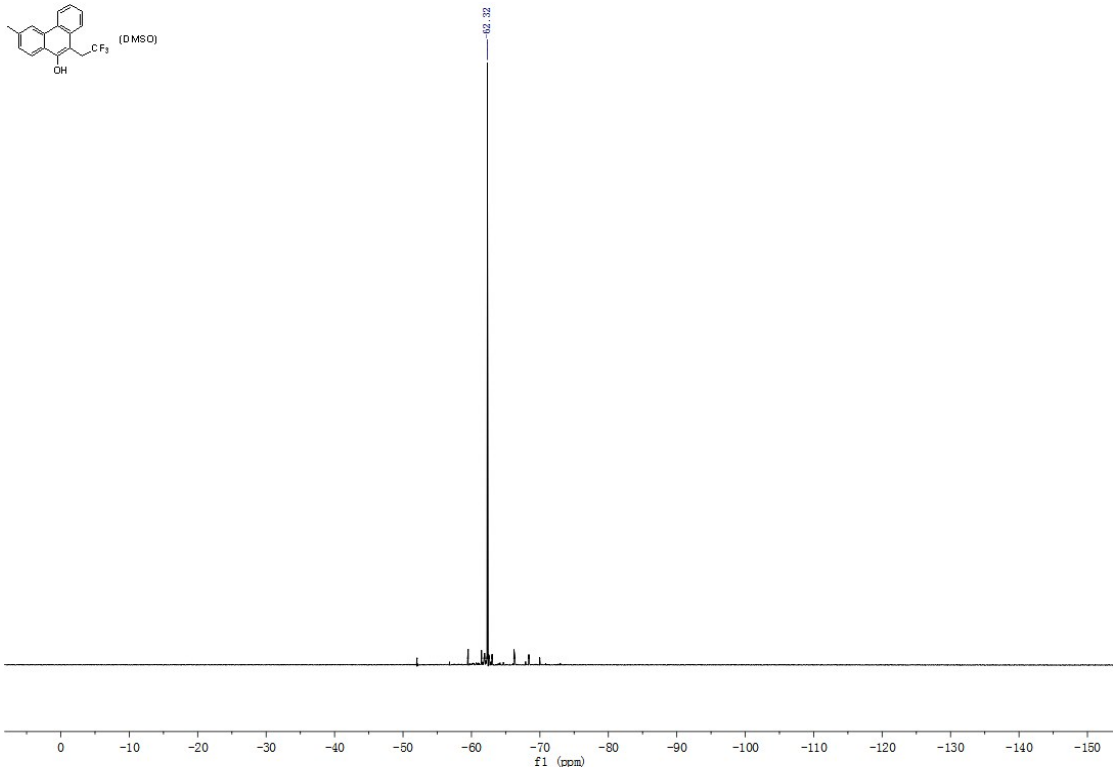


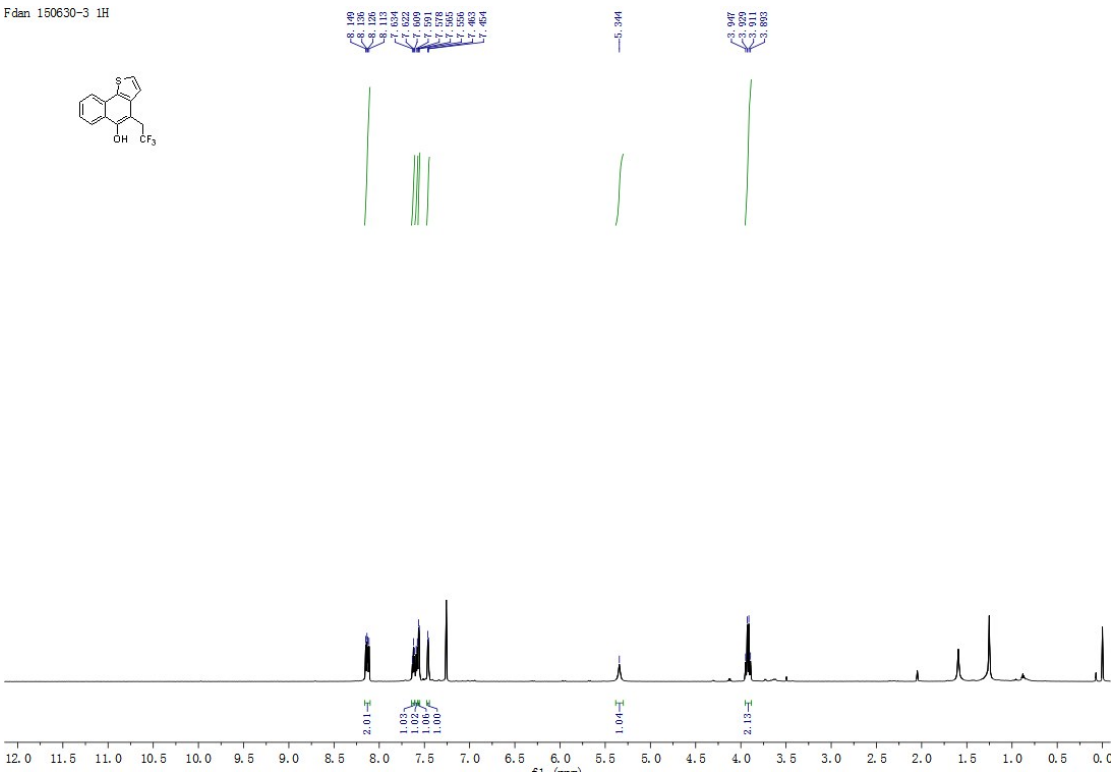
3o[13]C NMR



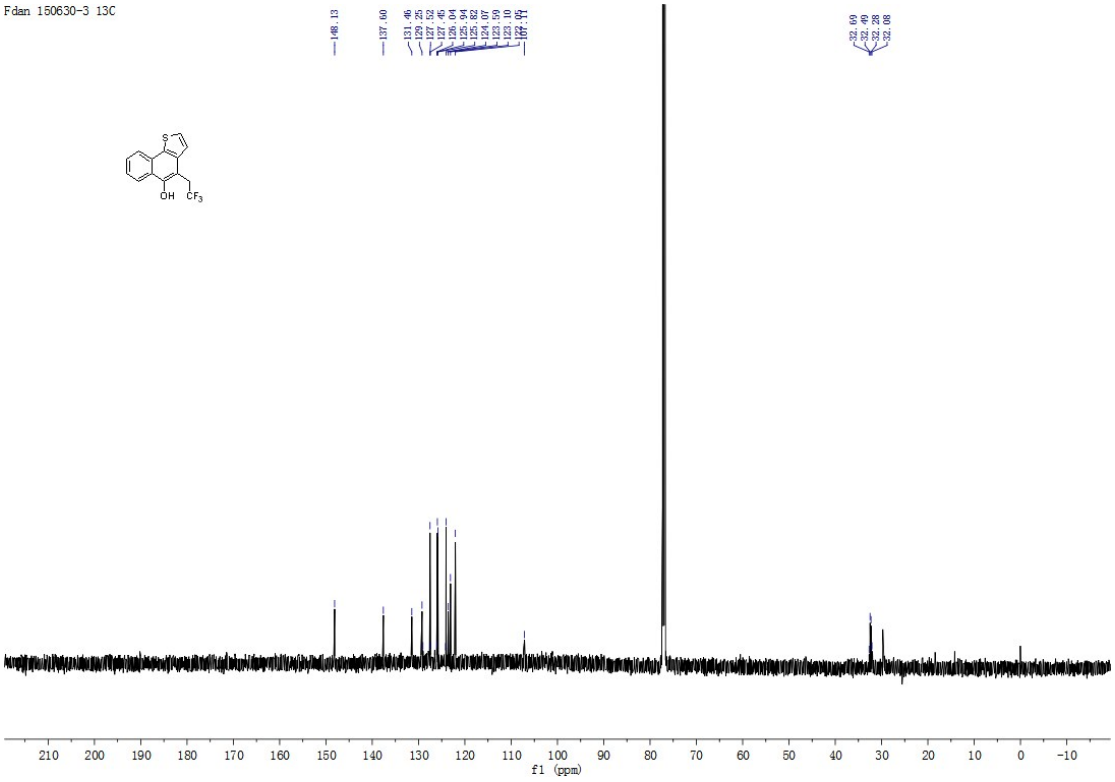
3o^{19}F NMR



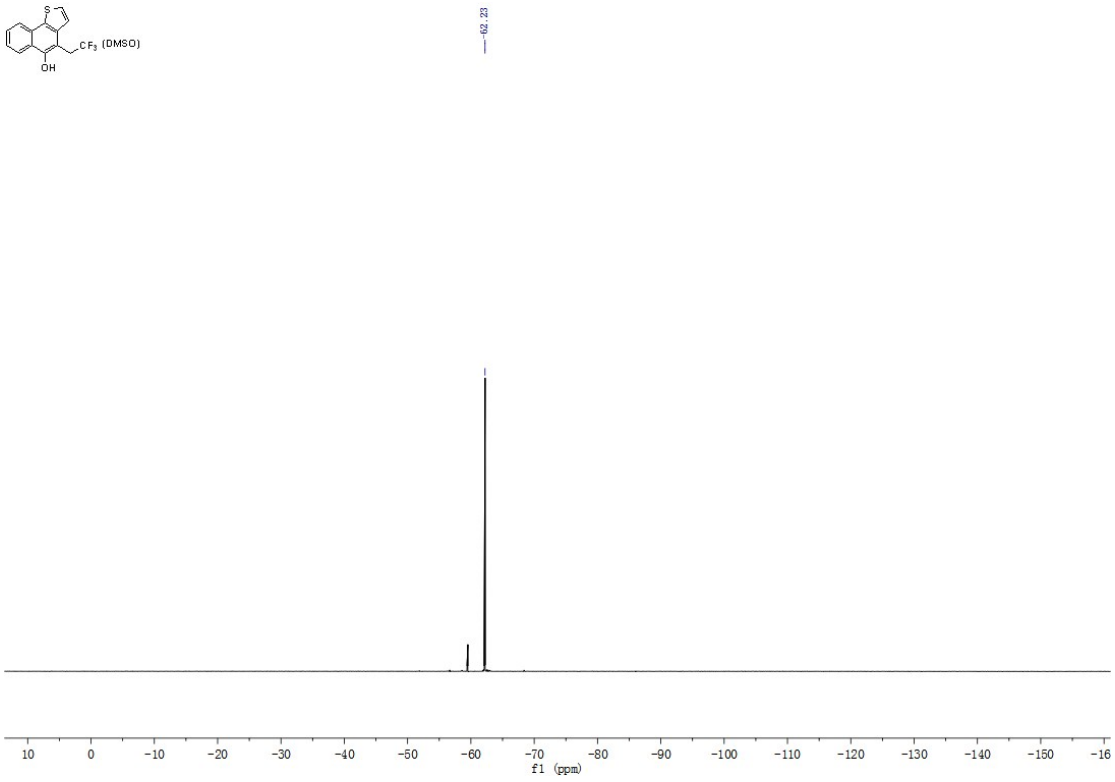
3p^{1}H NMR



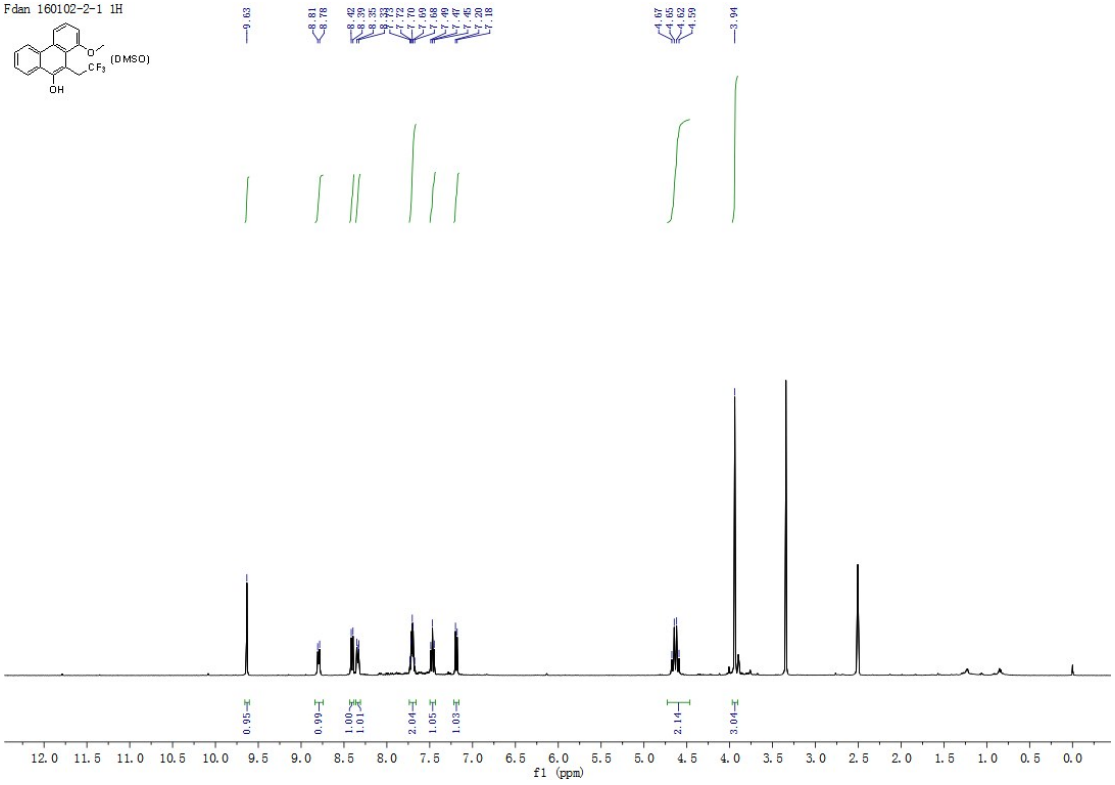
3p^{13}C NMR



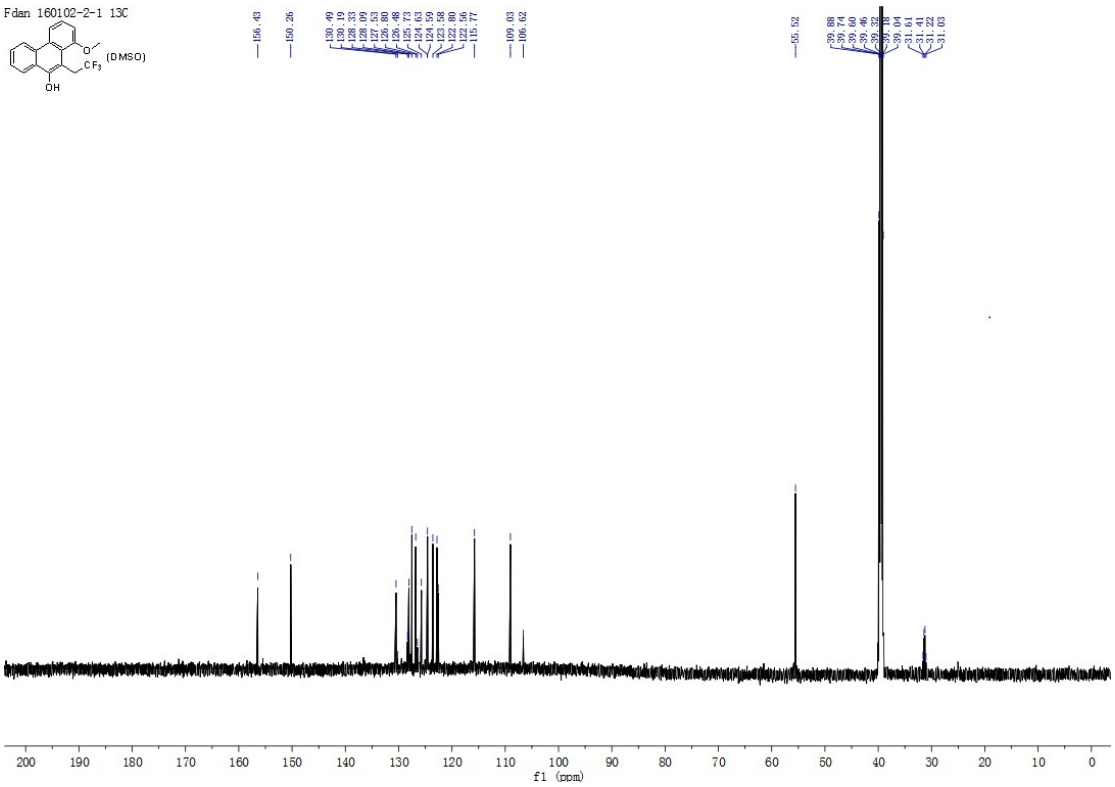
3p^{19}F NMR



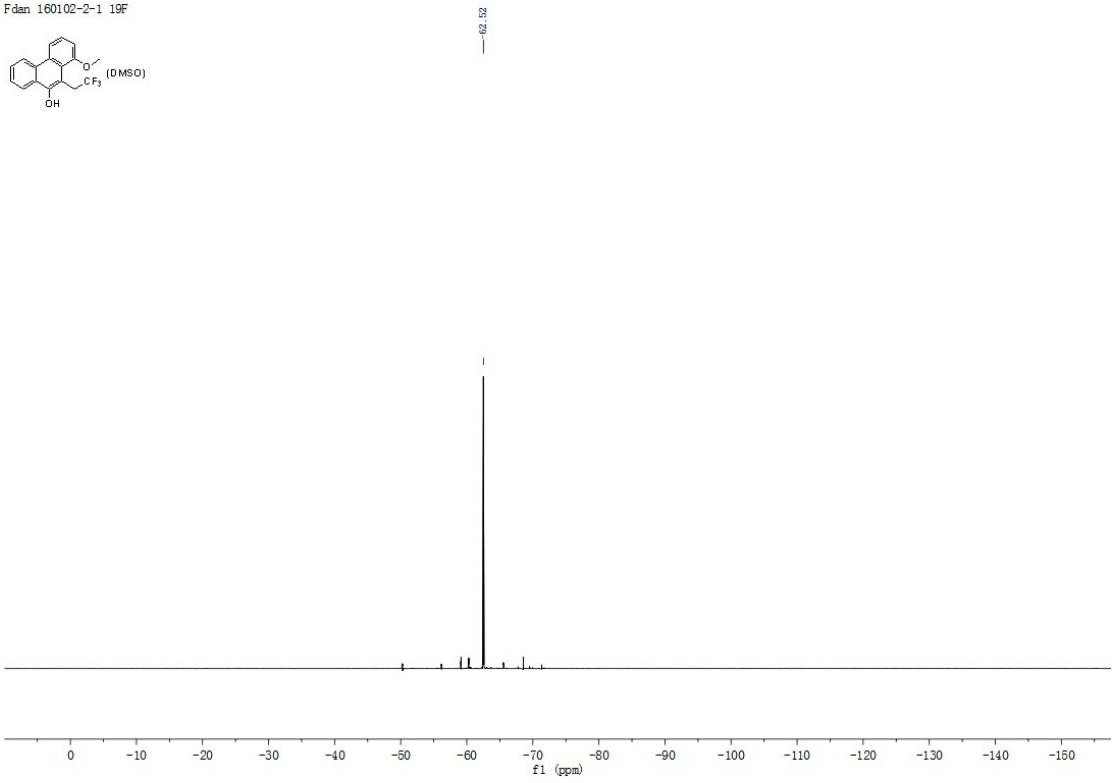
3q-1 ^{1}H NMR



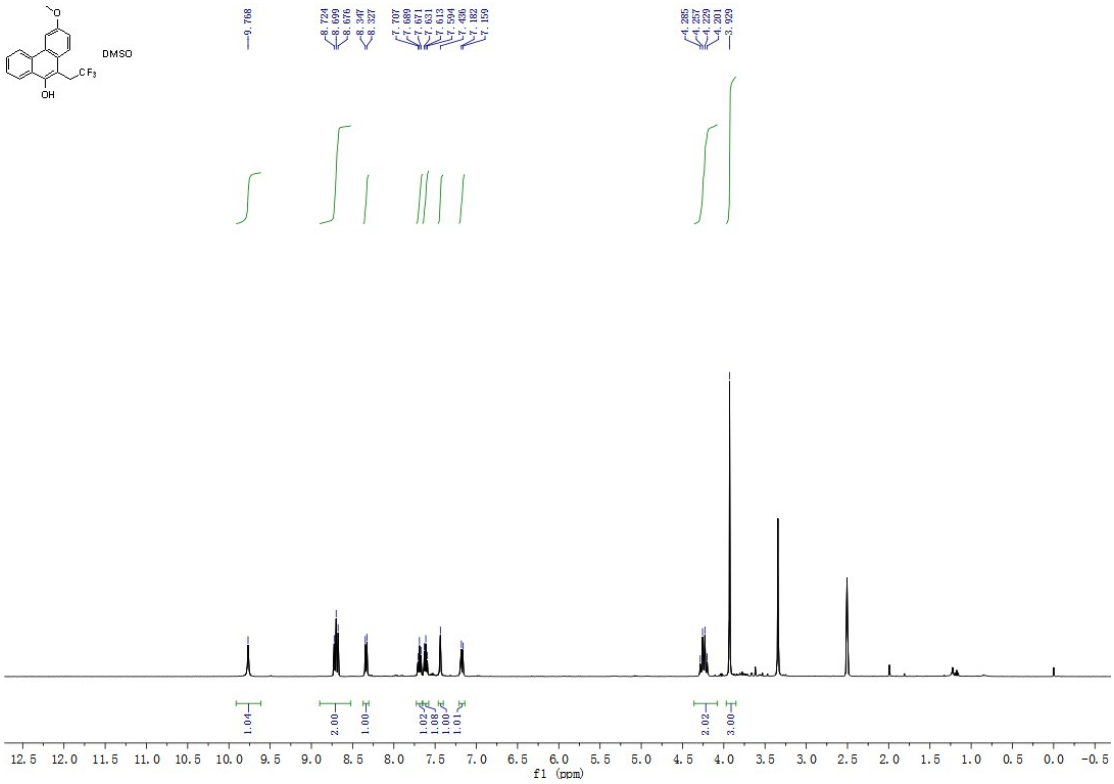
3q-1 ^{13}C NMR



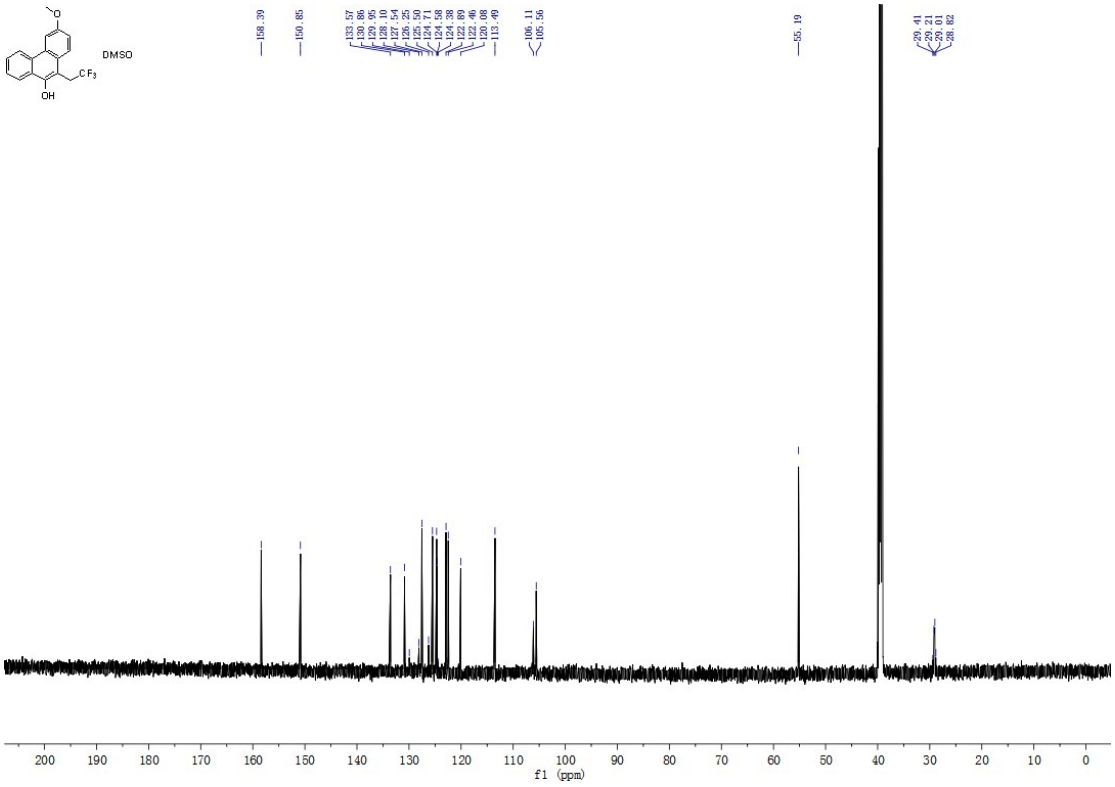
3q-1 ^{19}F NMR



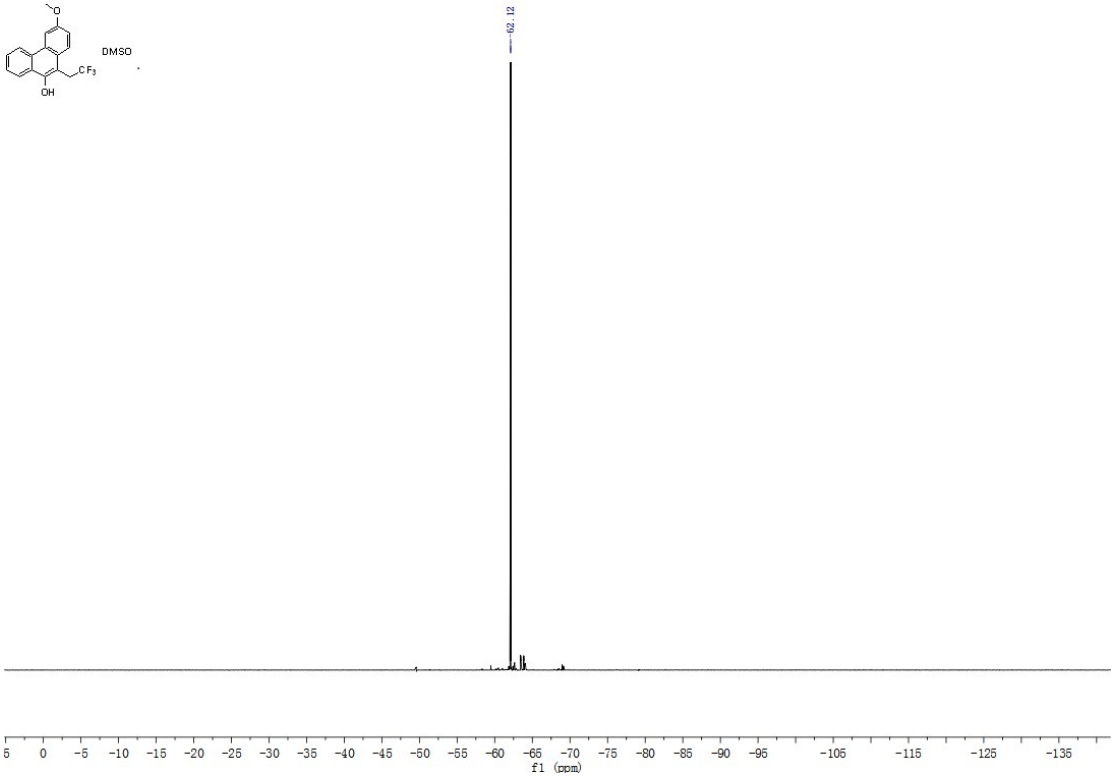
3q-2 ^{1}H NMR



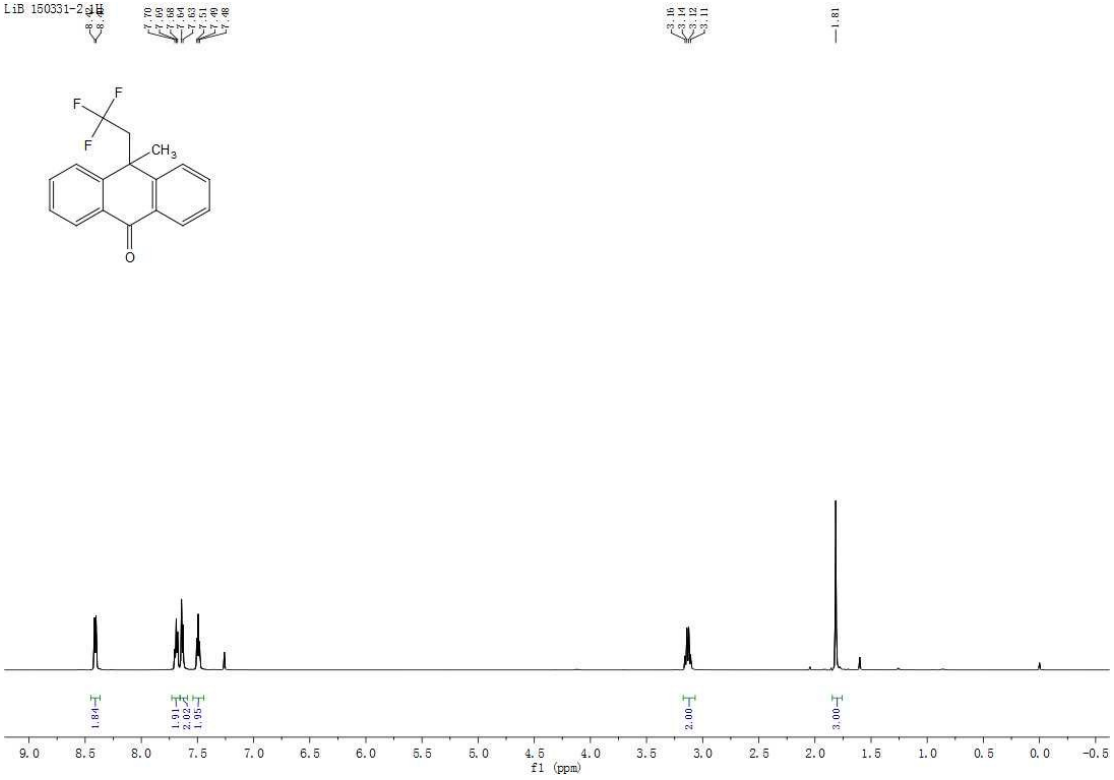
3q-2^{13}C NMR



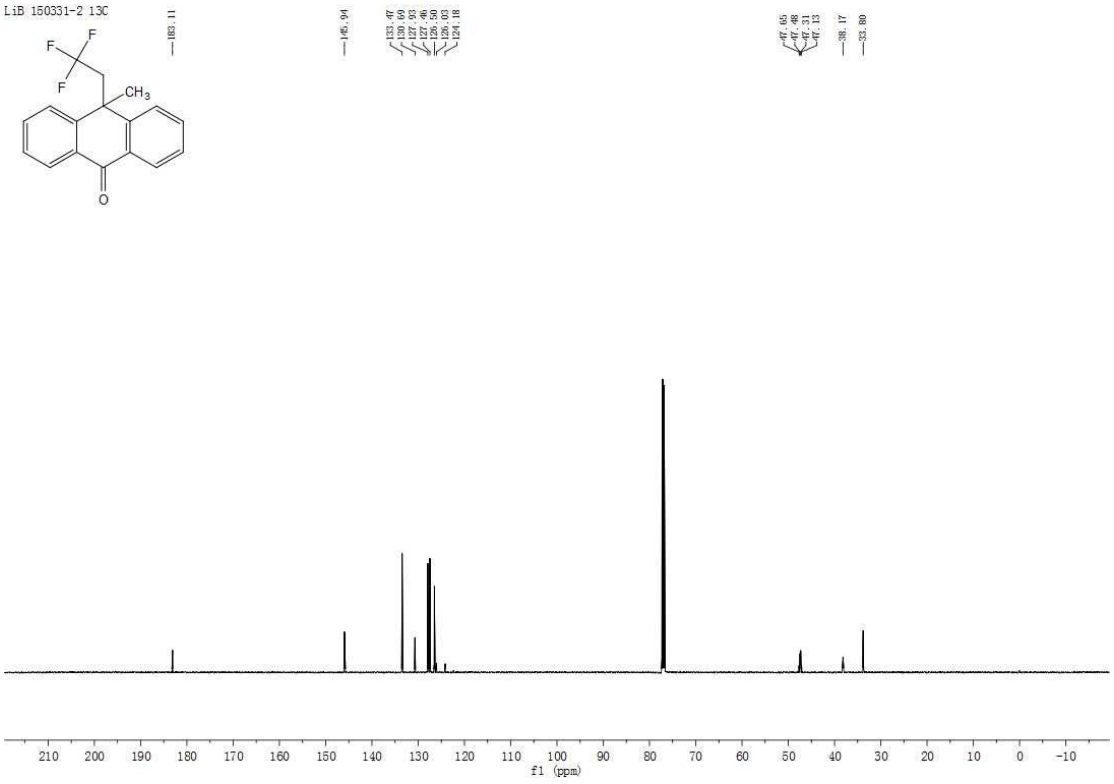
3q-2^{19}F NMR



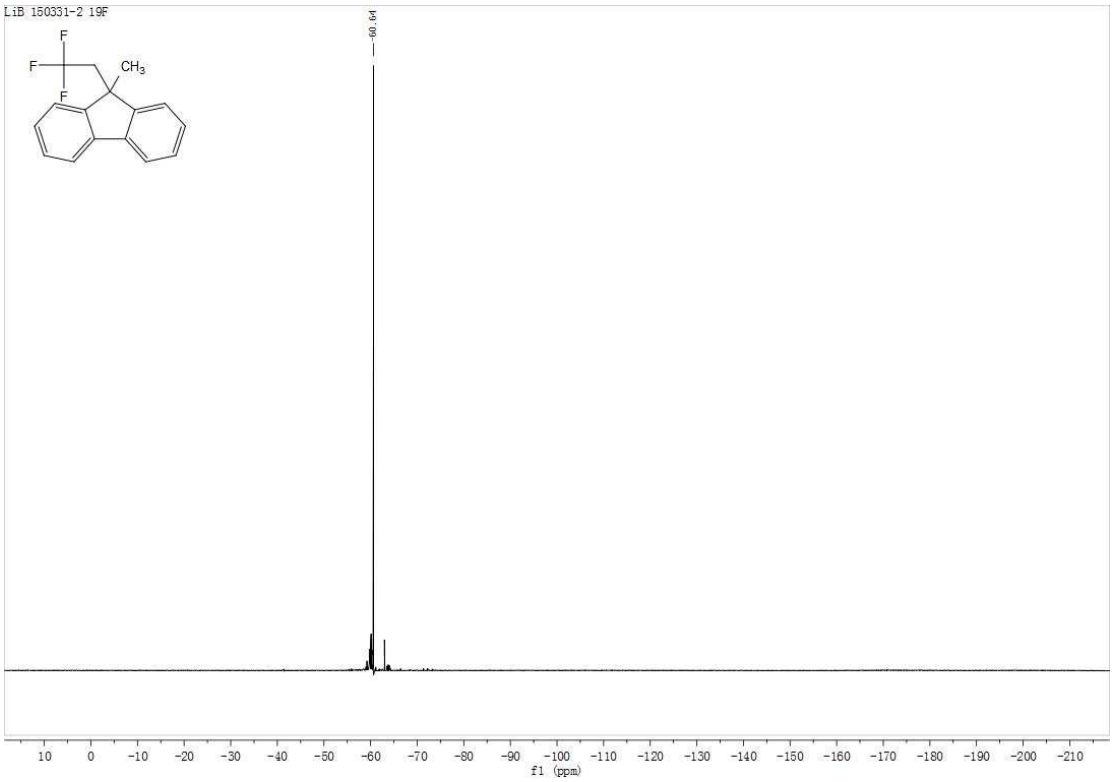
5a ^{1}H NMR



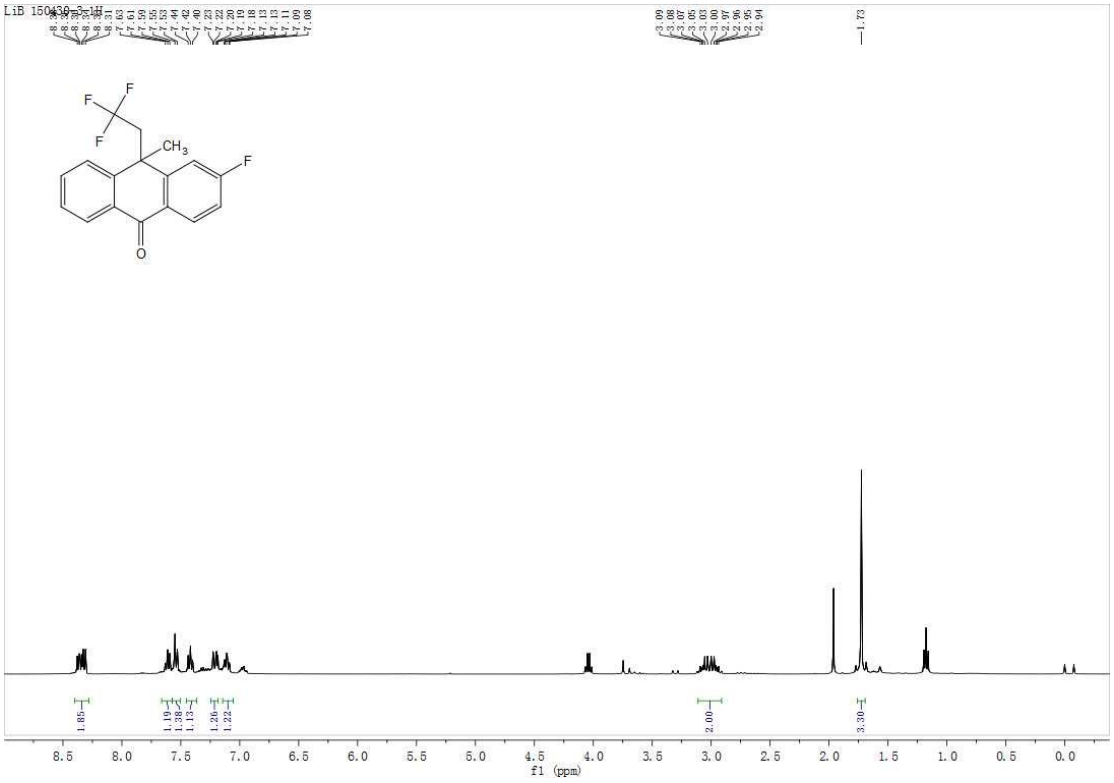
5a ^{13}C NMR



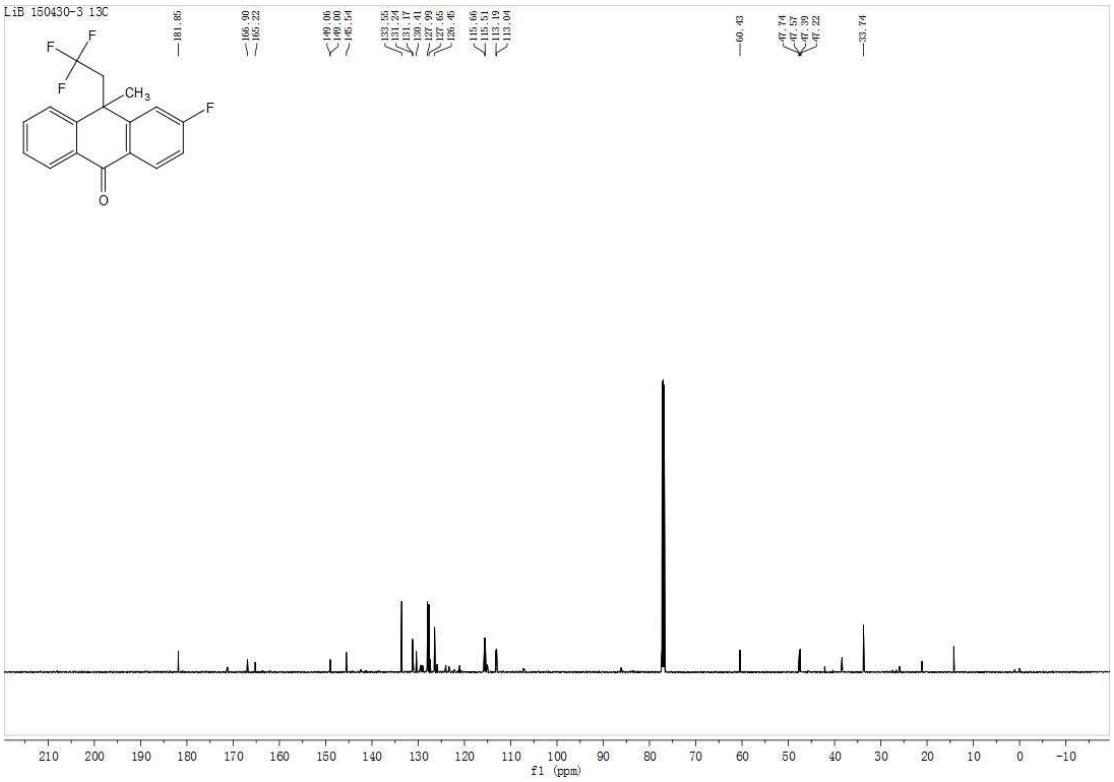
5a ^{19}F NMR



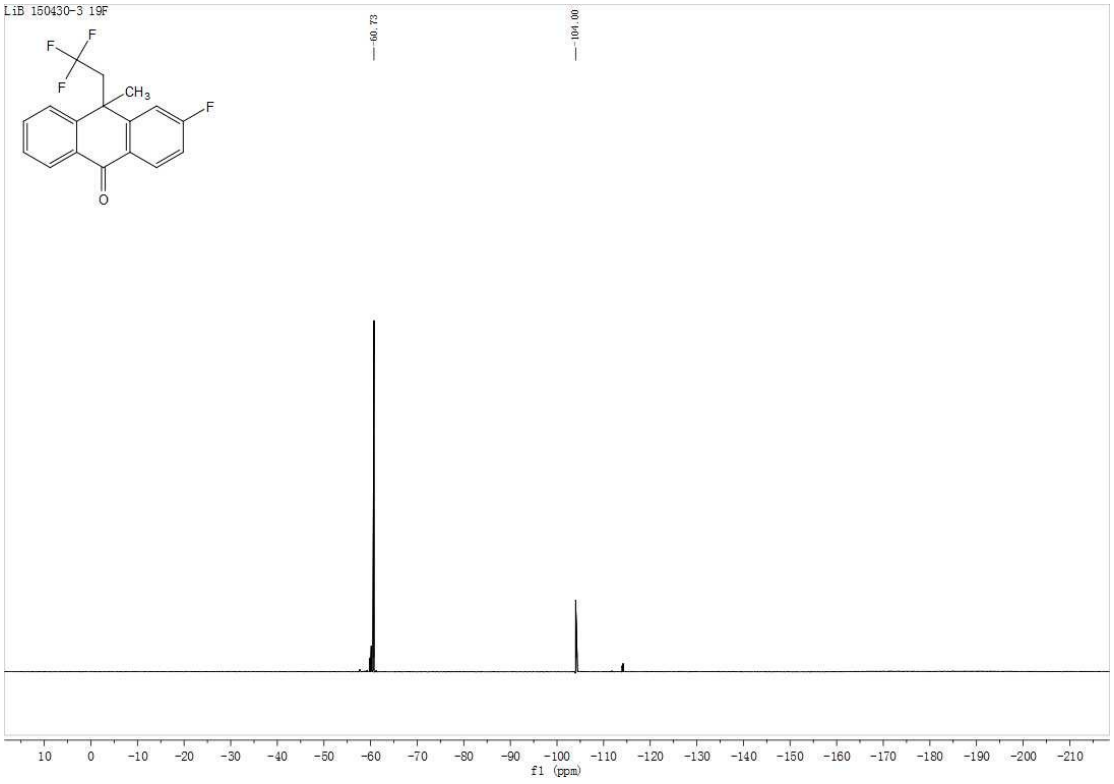
5b ^{1}H NMR



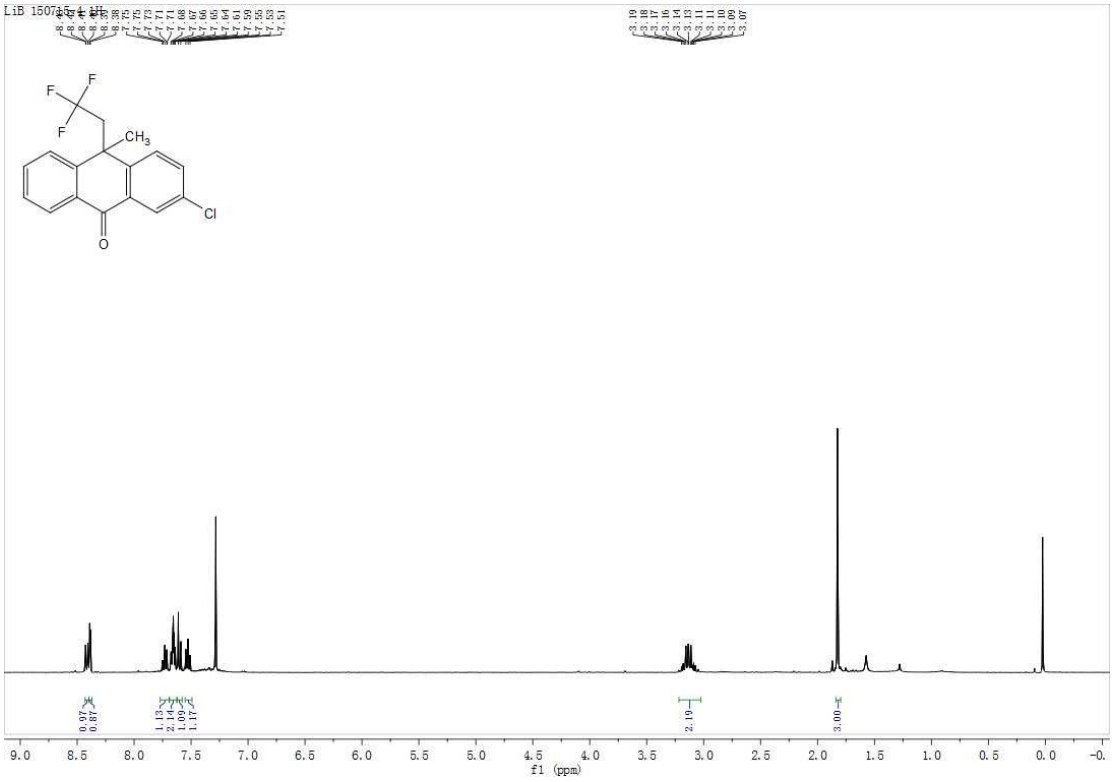
5b ^{13}C NMR



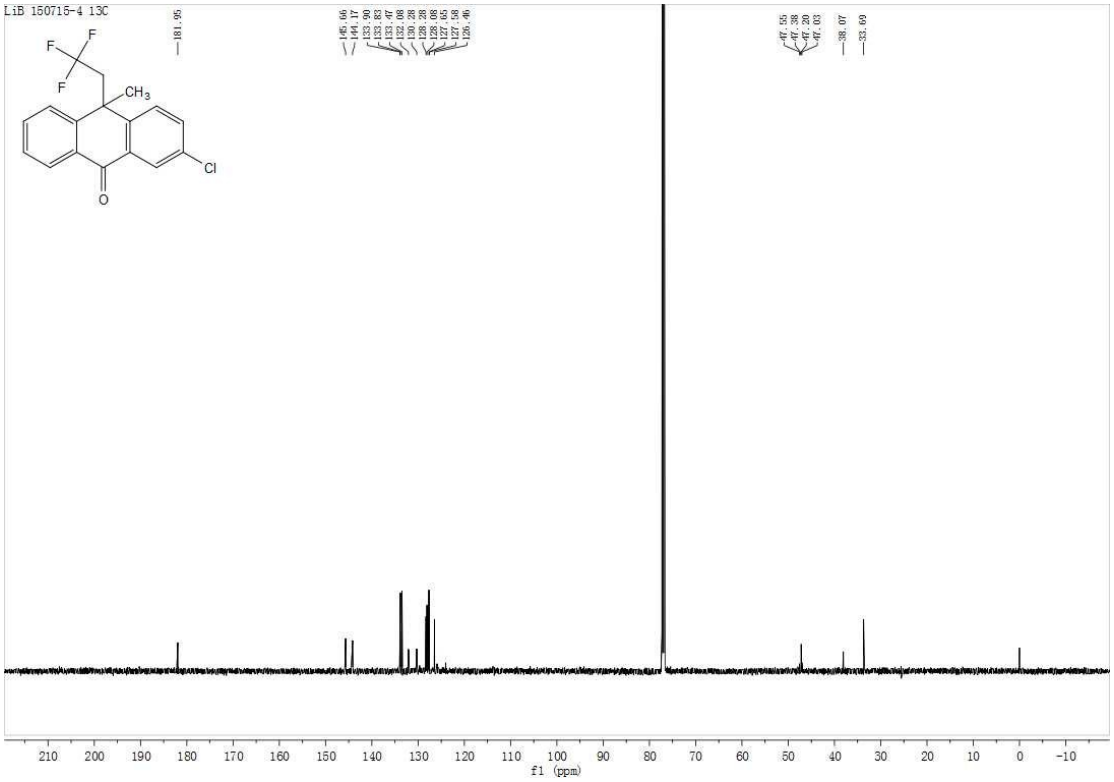
5b ^{19}F NMR



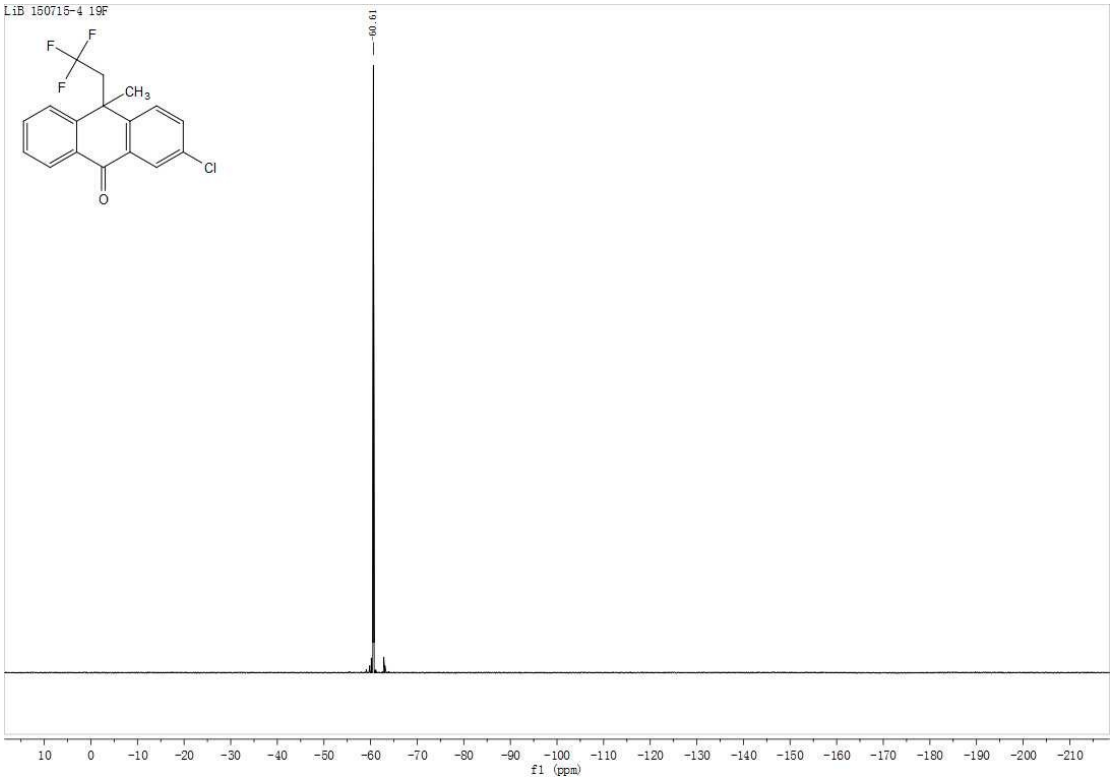
5g ^{1}H NMR



5g ^{13}C NMR



5g ^{19}F NMR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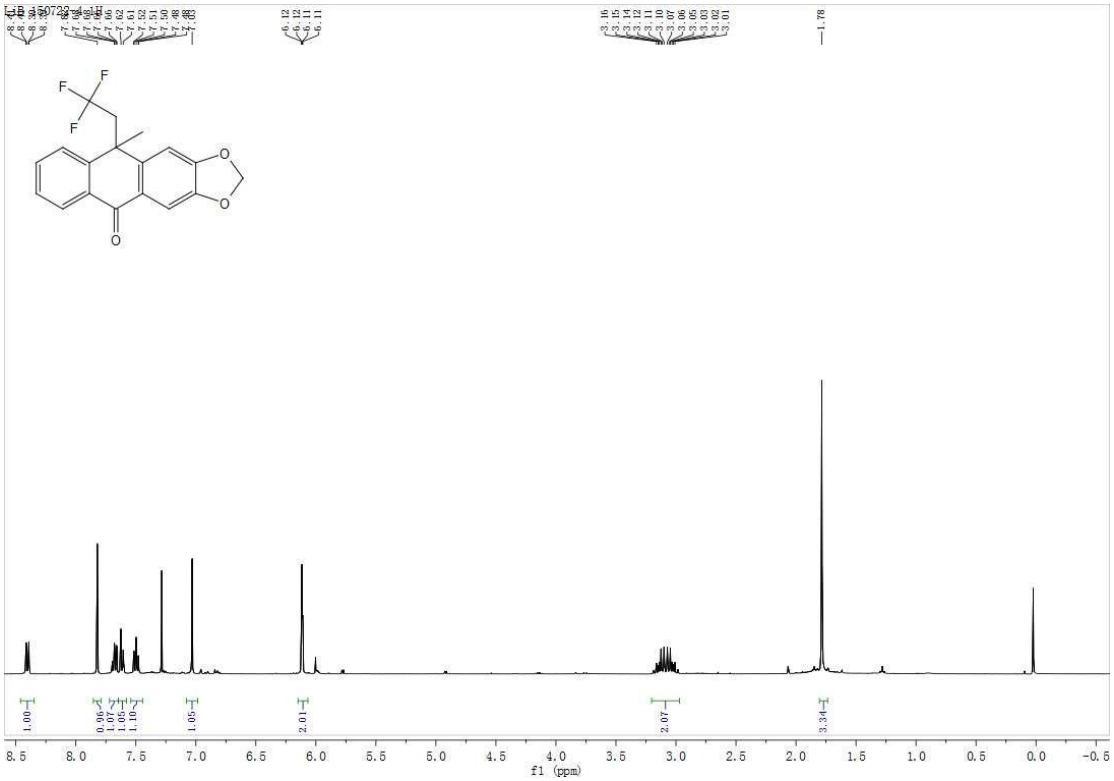
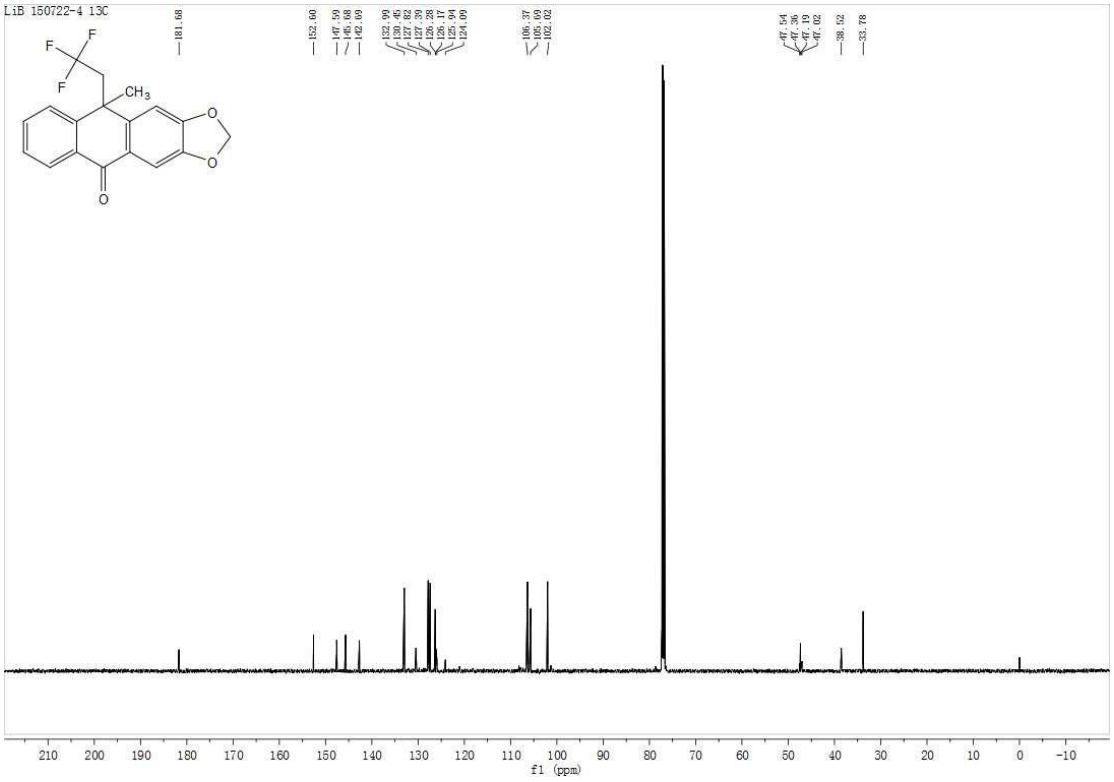
-60.61
F
F
F
CH3
Cl
O
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

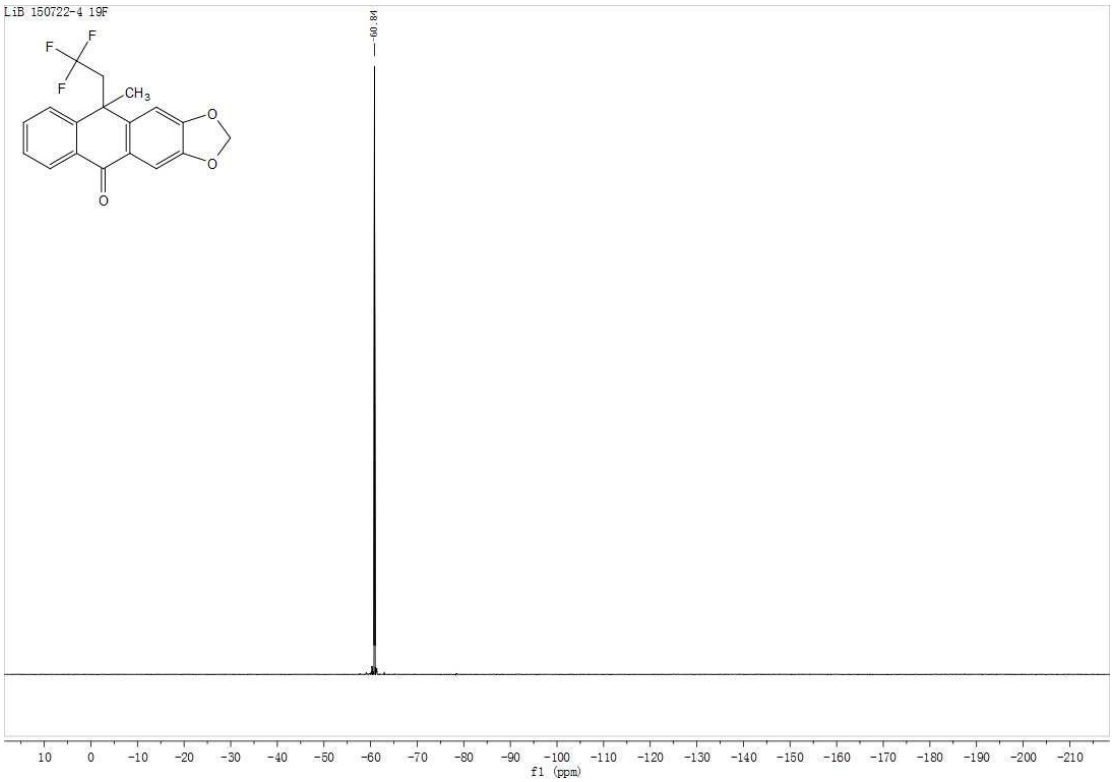
5i ^{1}H NMR


F
F
F
O
O
O
1.00
0.96
1.07
1.05
1.10
1.05
2.01
2.07
3.34
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

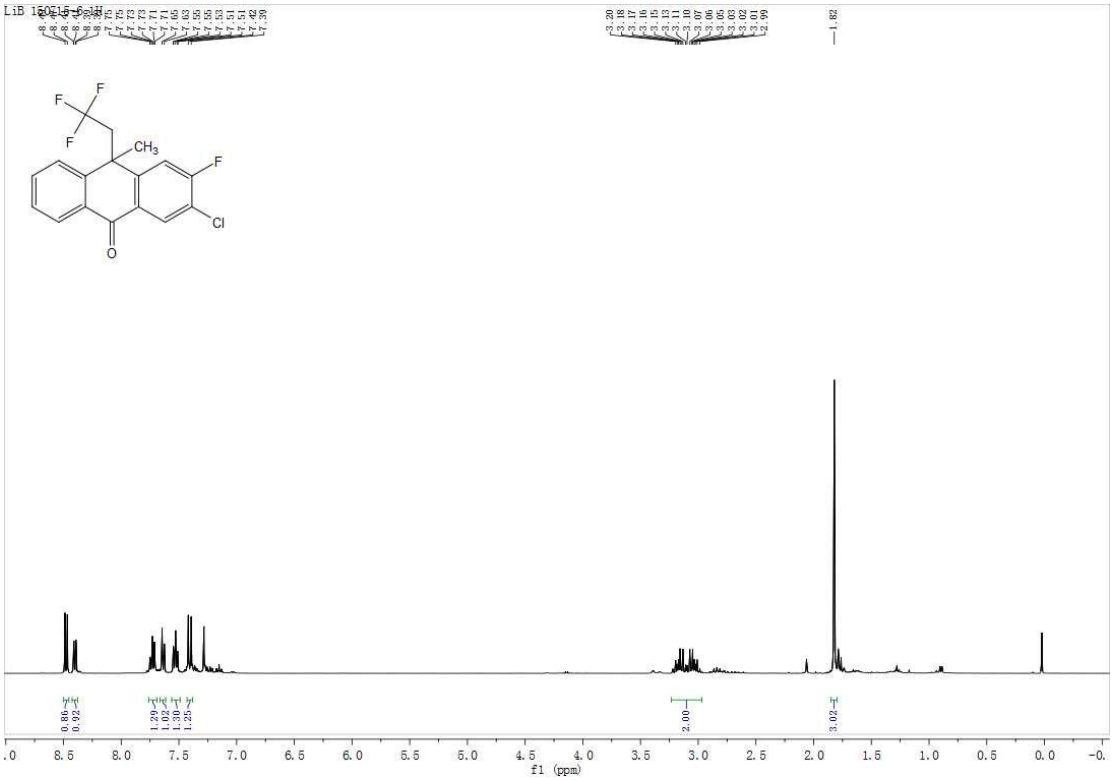
5i ^{13}C NMR



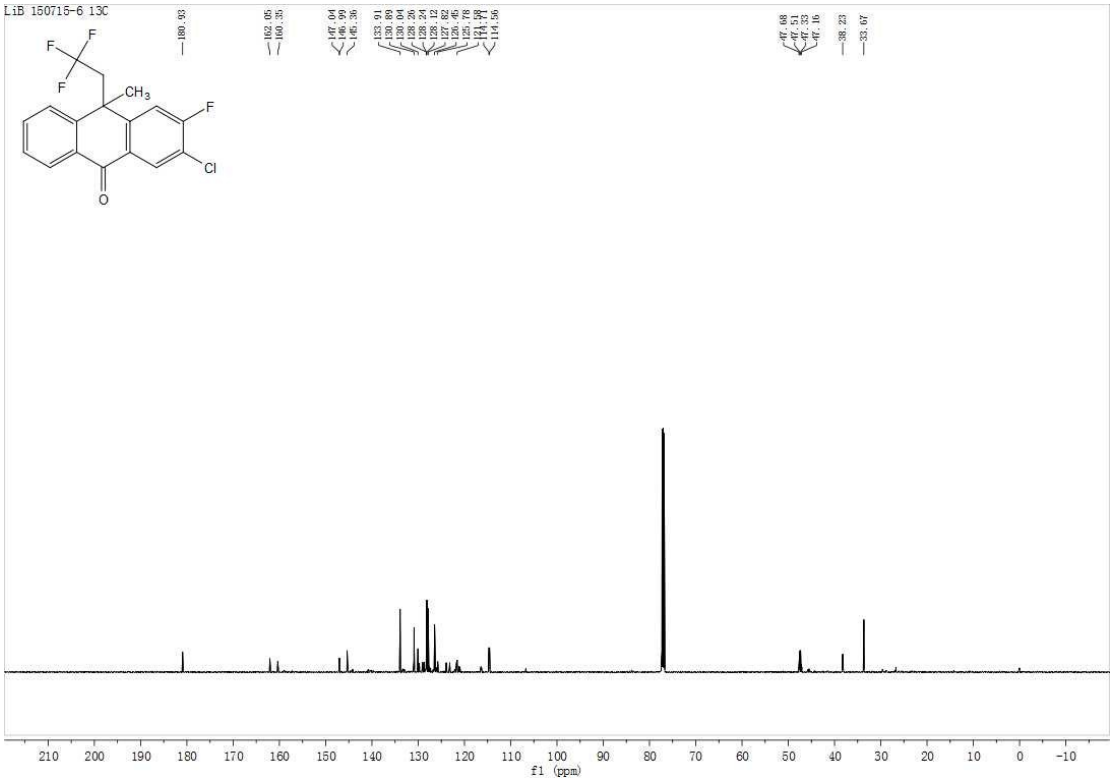
5i ^{19}F NMR



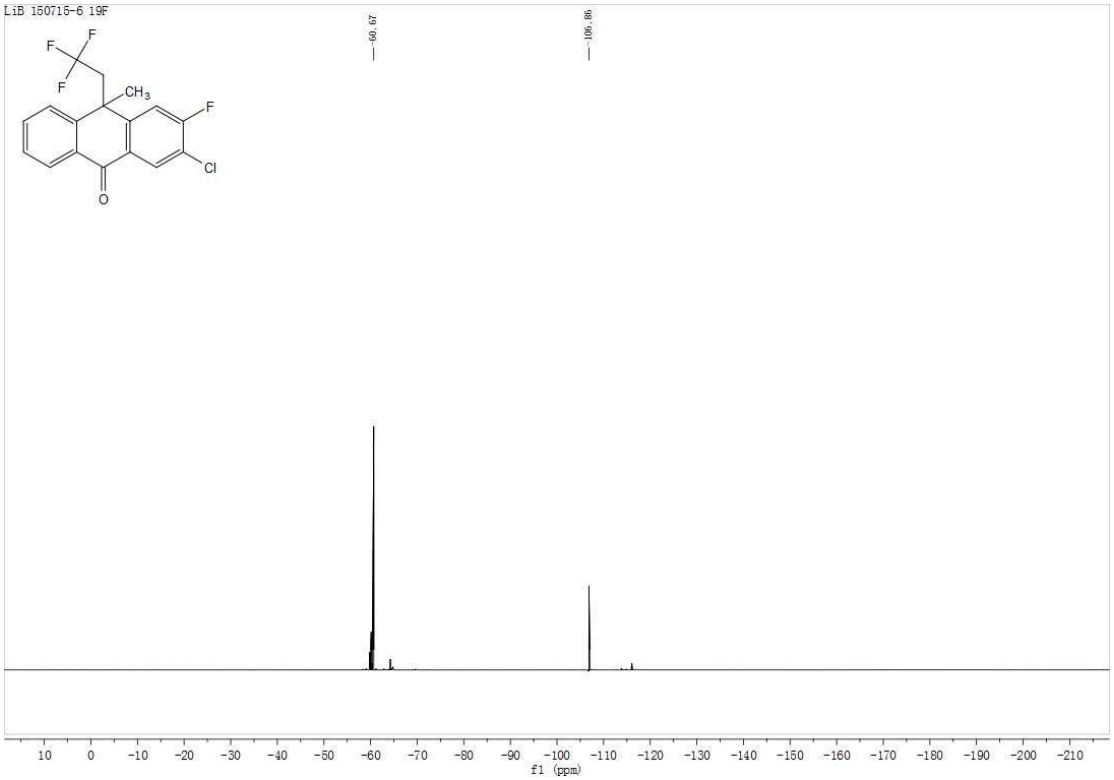
5j ^{1}H NMR



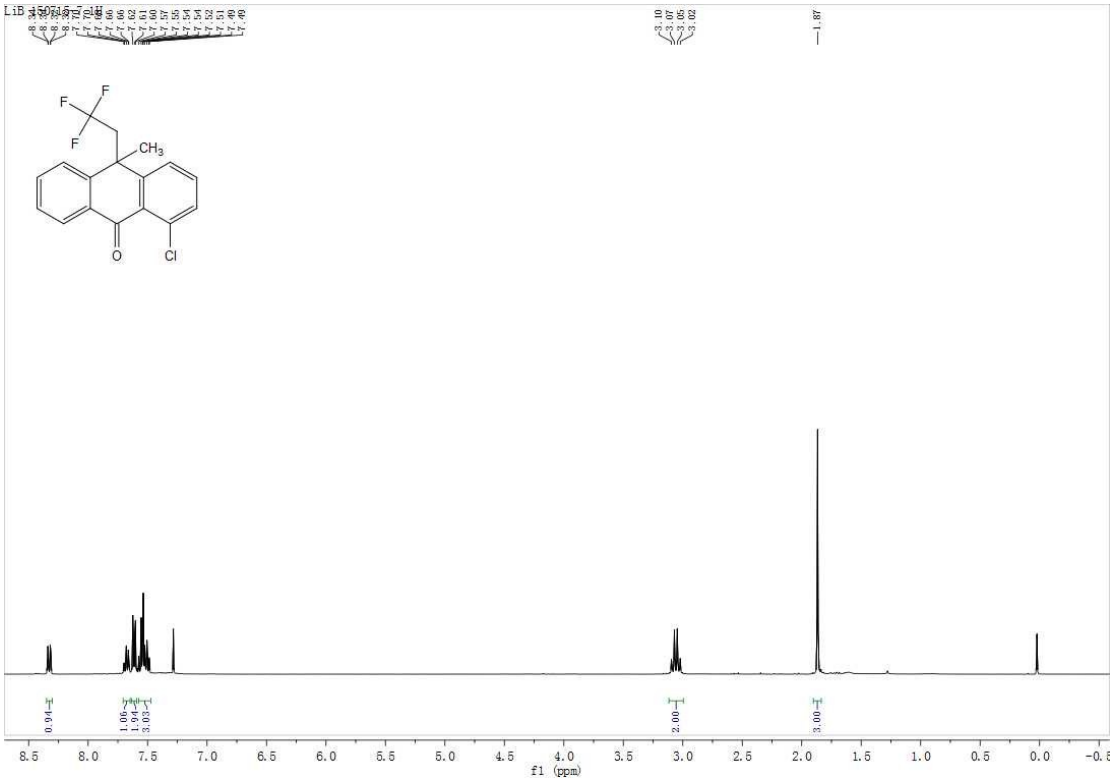
5j ^{13}C NMR



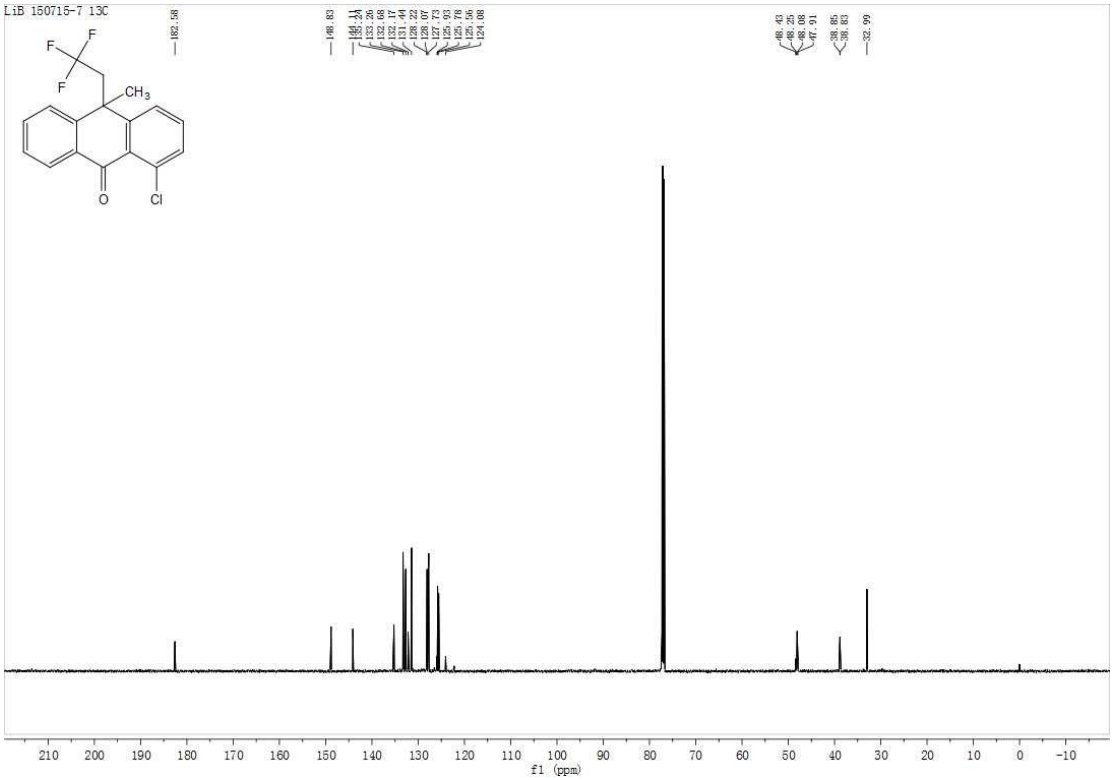
5j ^{19}F NMR



5k ^{1}H NMR



5k ^{13}C NMR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141.24
133.26
132.68
132.17
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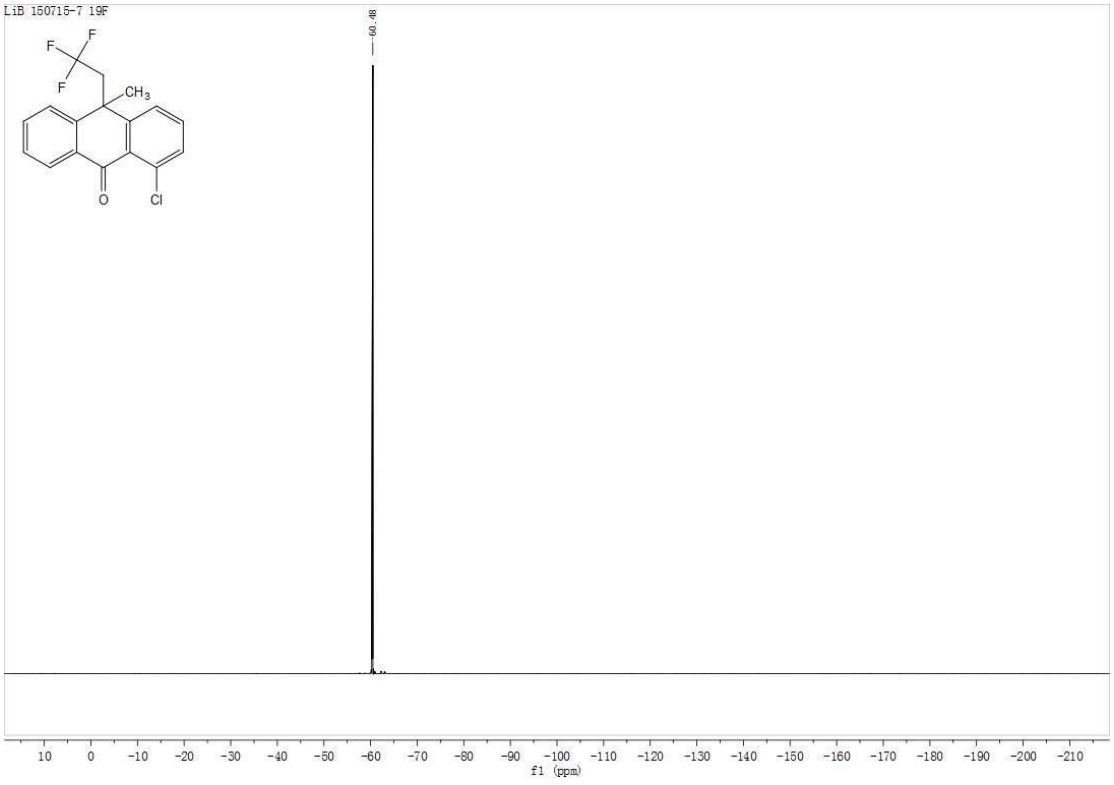
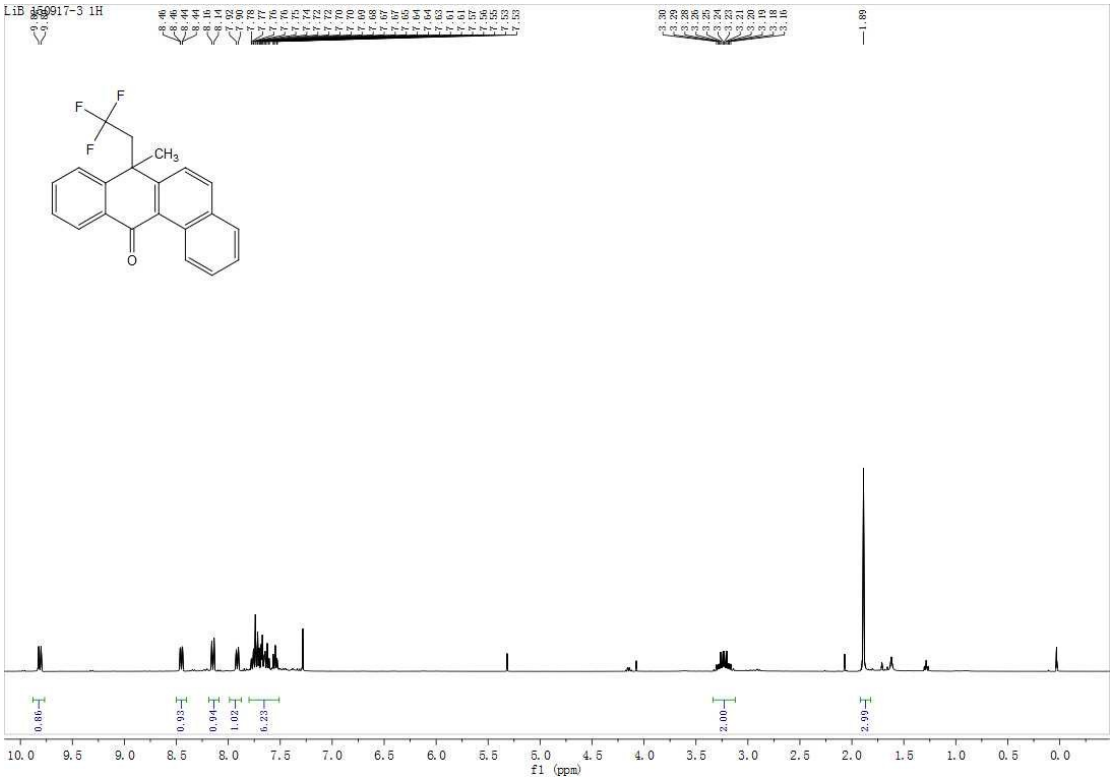
128.22
128.07
127.73
125.93
125.78
125.56
124.08
68.43
68.25
68.08
67.91
38.85
38.83
32.99
F
F
F
CH3
O
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

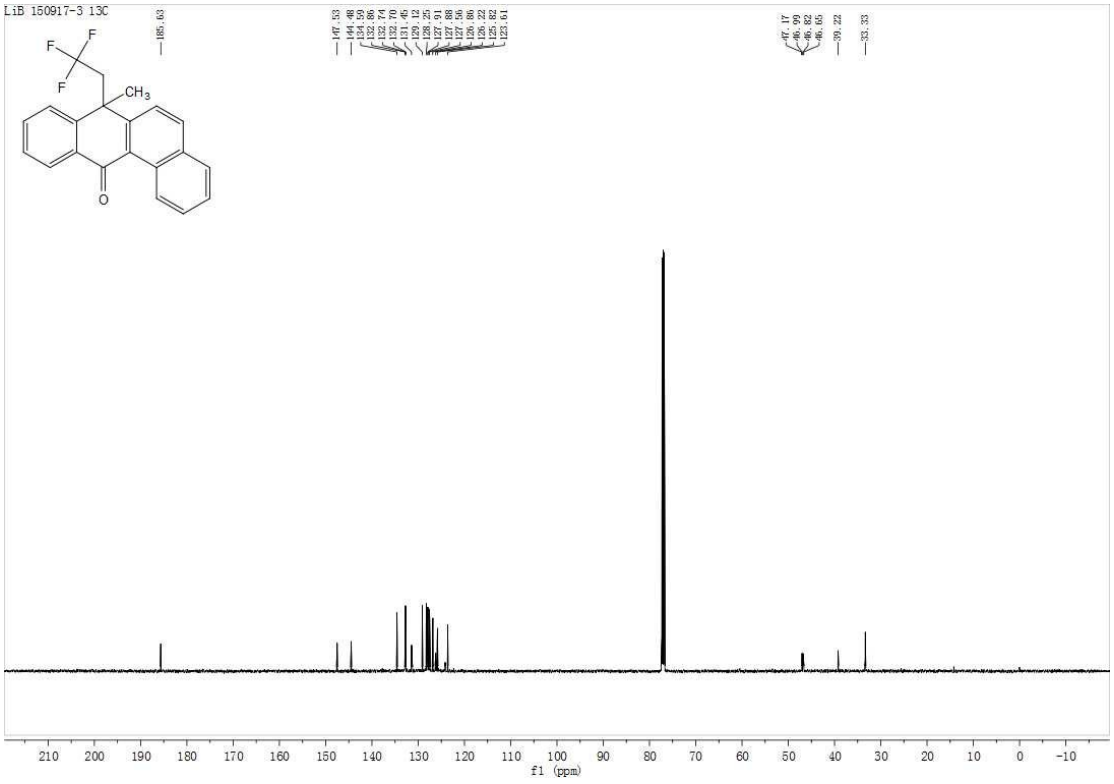
5k ^{19}F NMR


LiB 150715-7 19F
-60.48
F
F
F
CH3
O
Cl
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

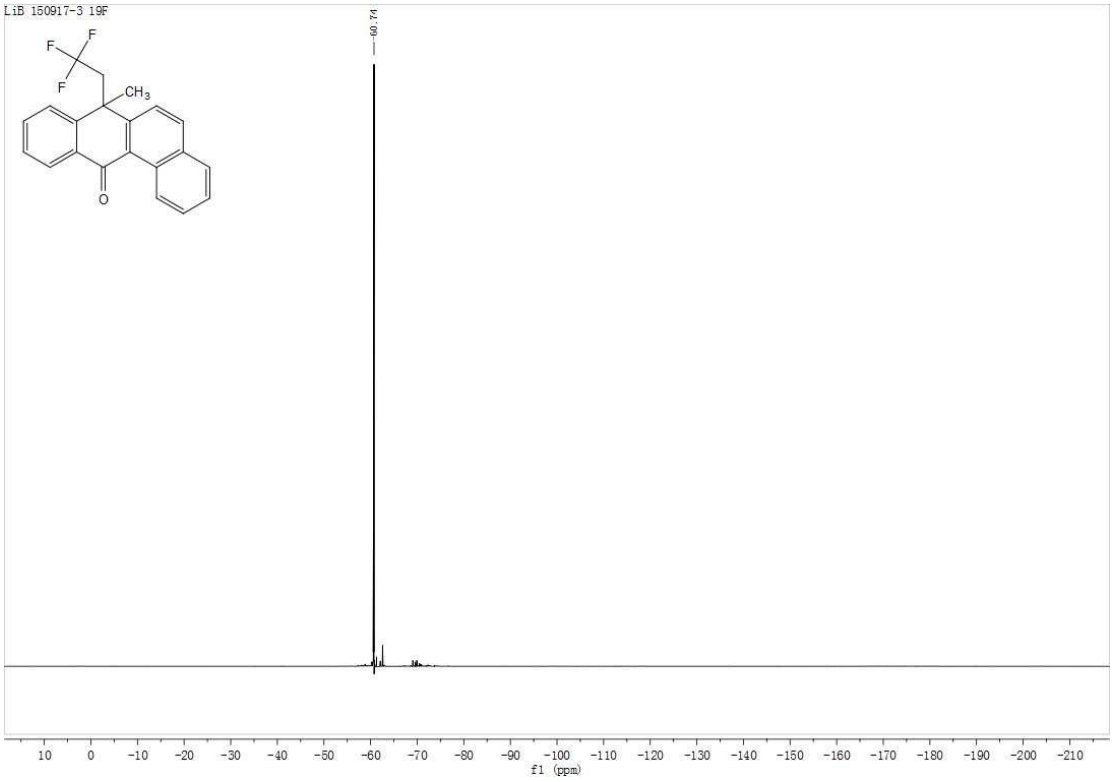
5l ^{1}H NMR



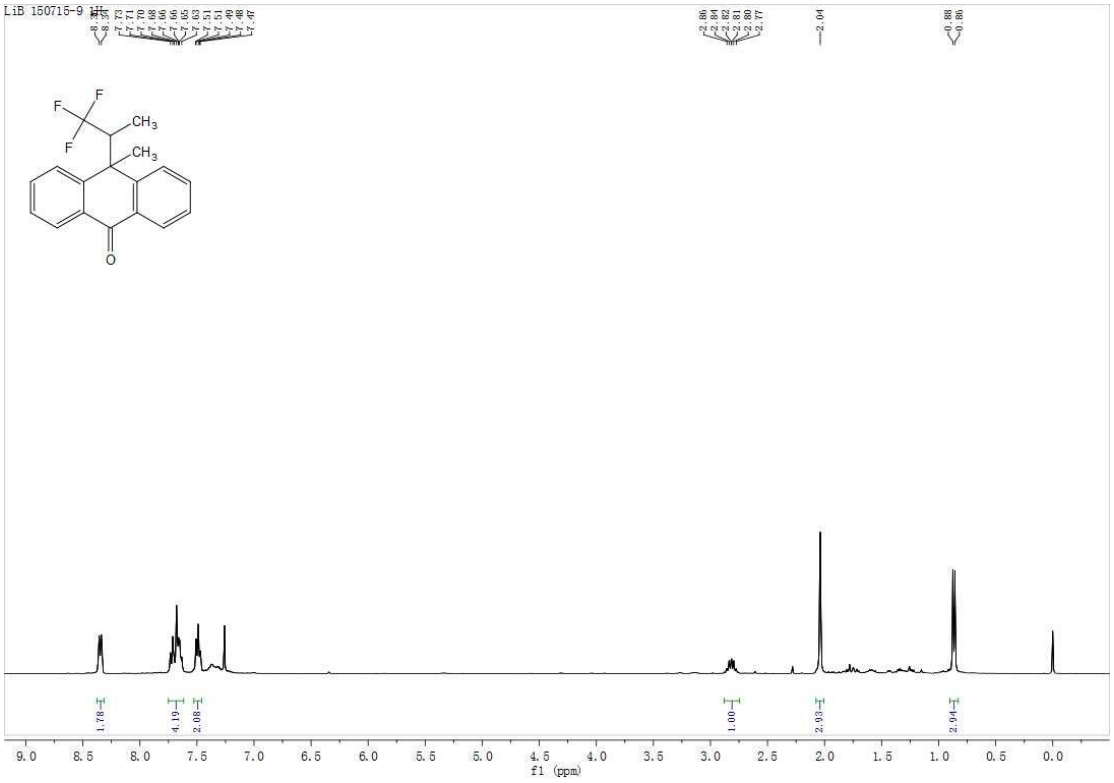
5l ^{13}C NMR



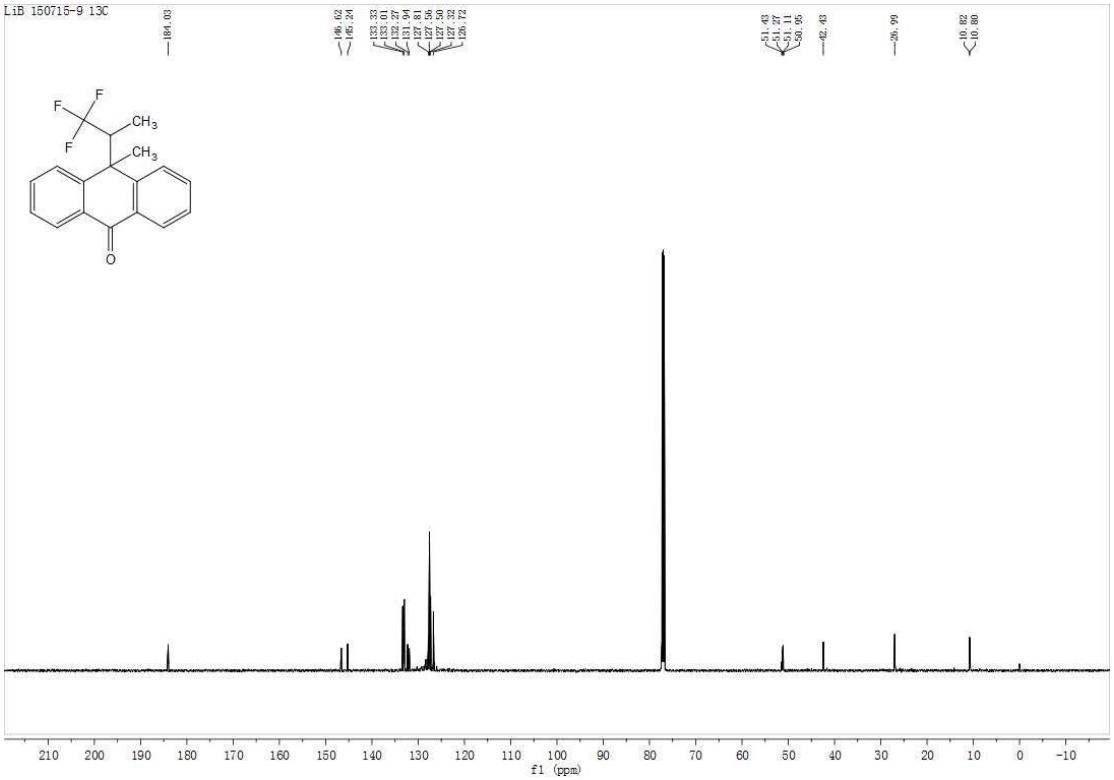
5l ^{19}F NMR



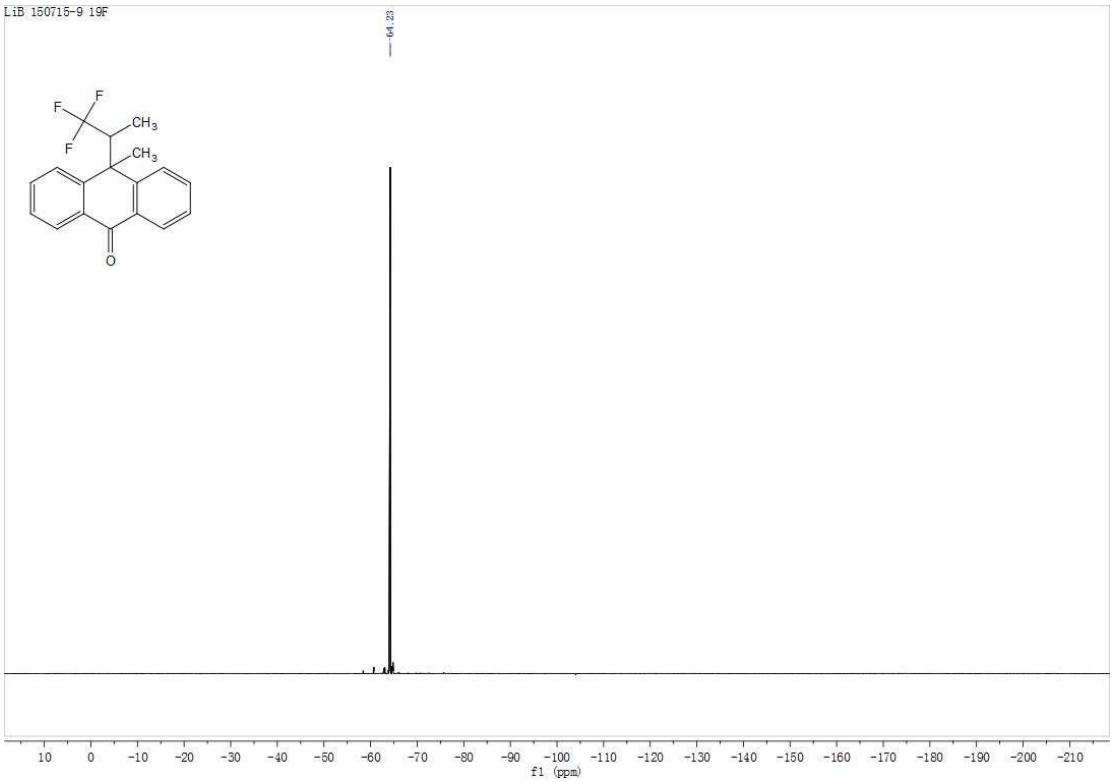
5m ^{1}H NMR



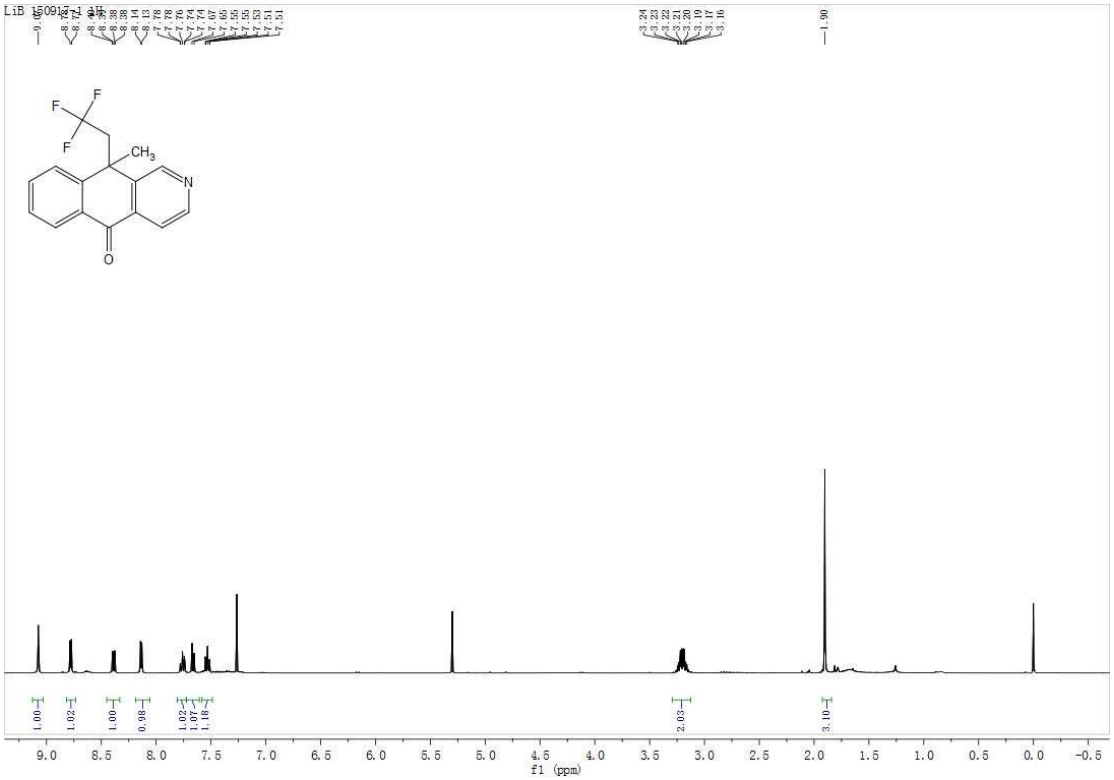
5m ^{13}C NMR



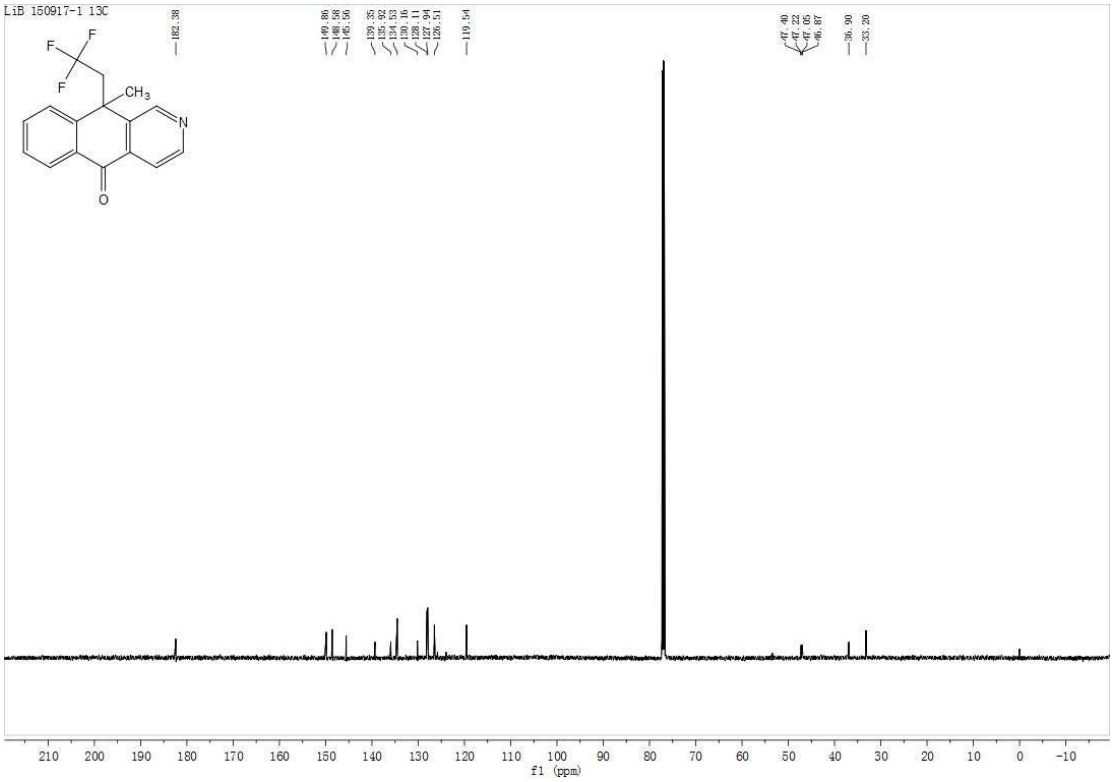
5m ^{19}F NMR



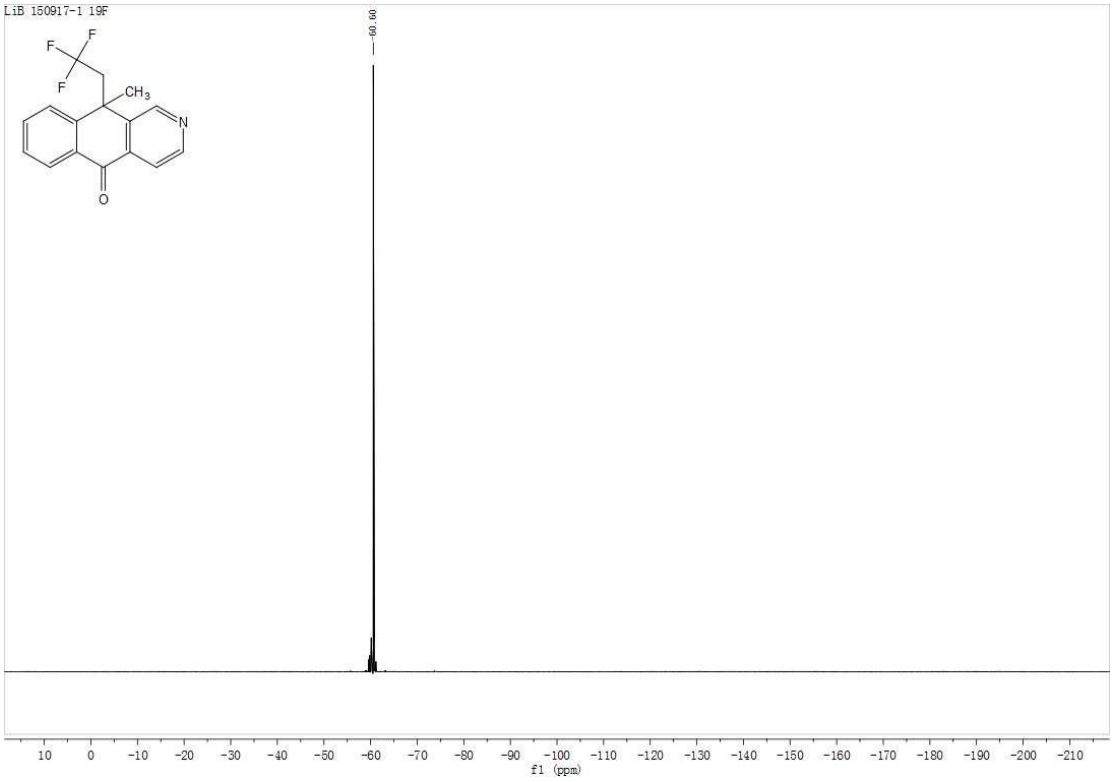
5n ^{1}H NMR



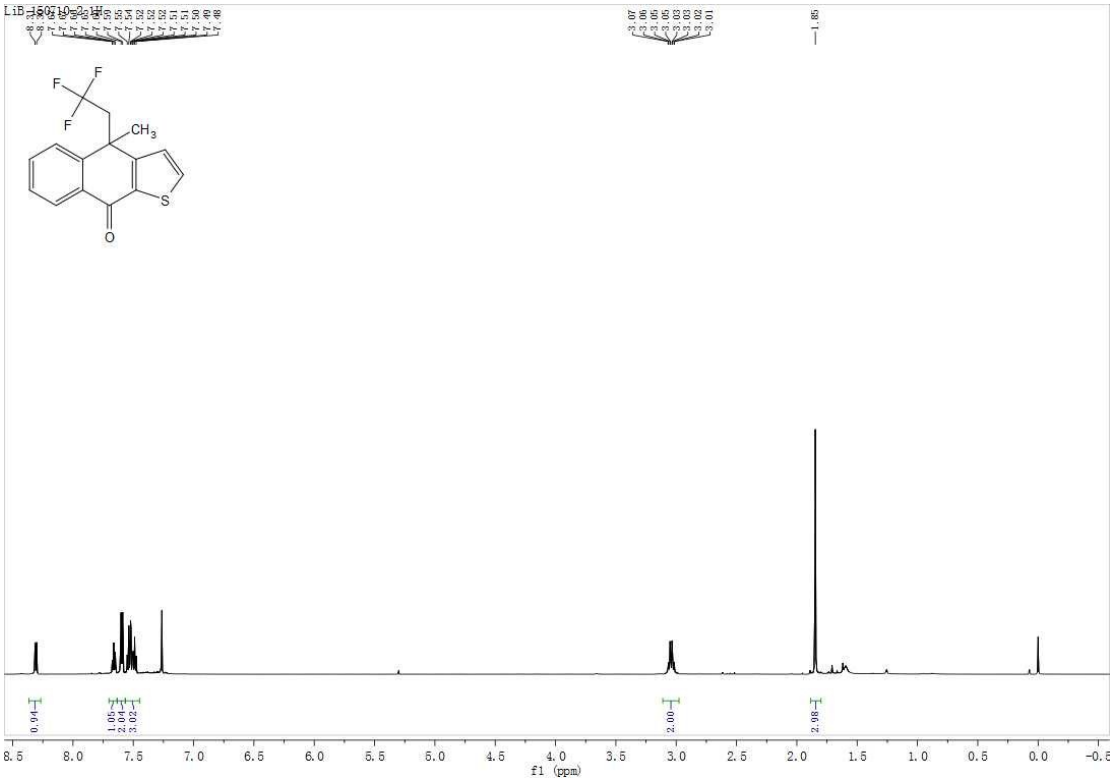
5n ^{13}C NMR



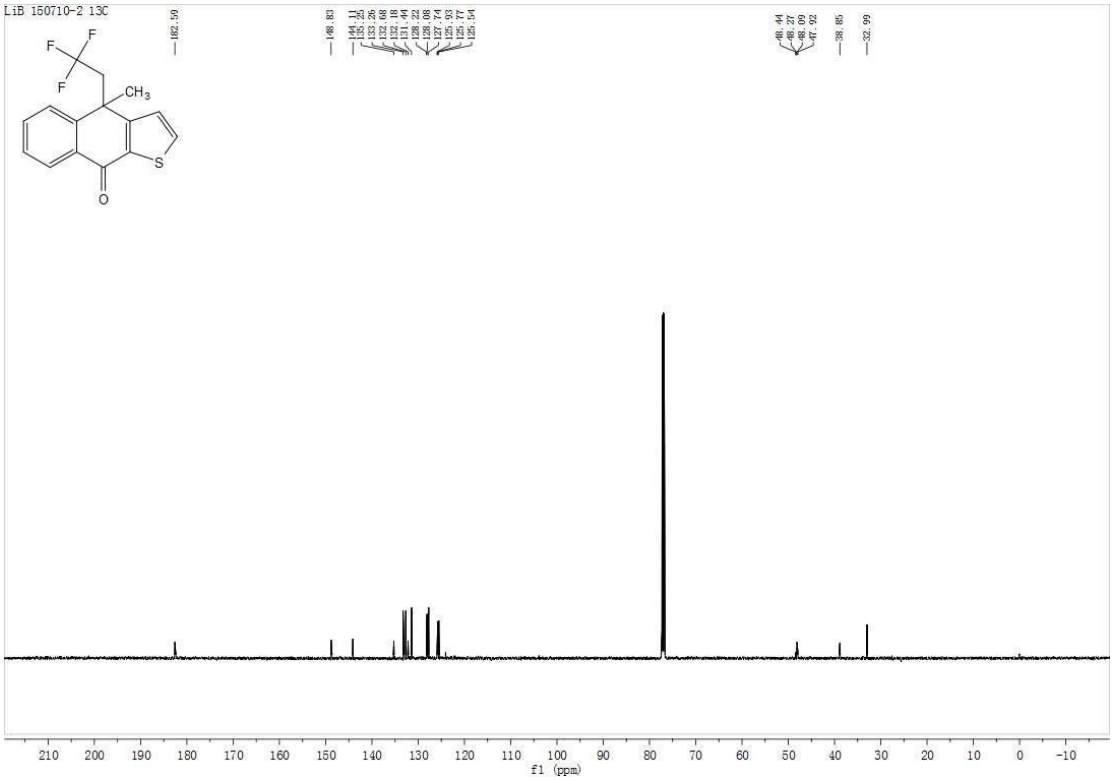
5n ^{19}F NMR



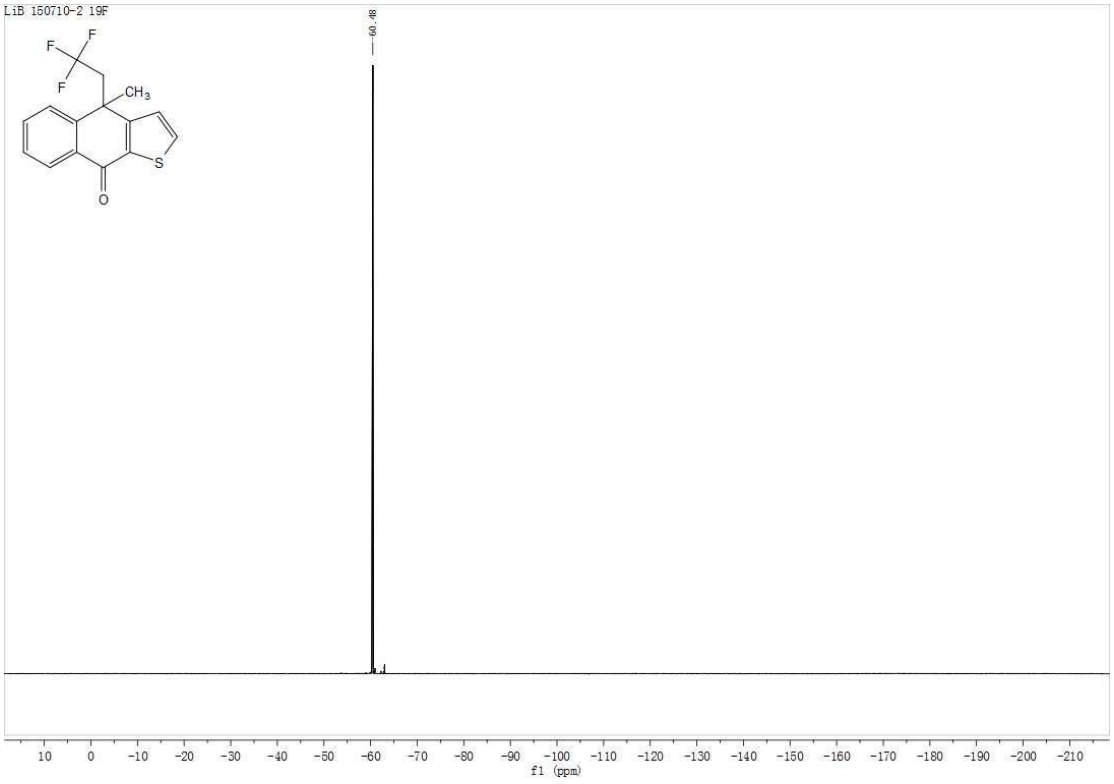
5o ^{1}H NMR



5o ^{13}C NMR

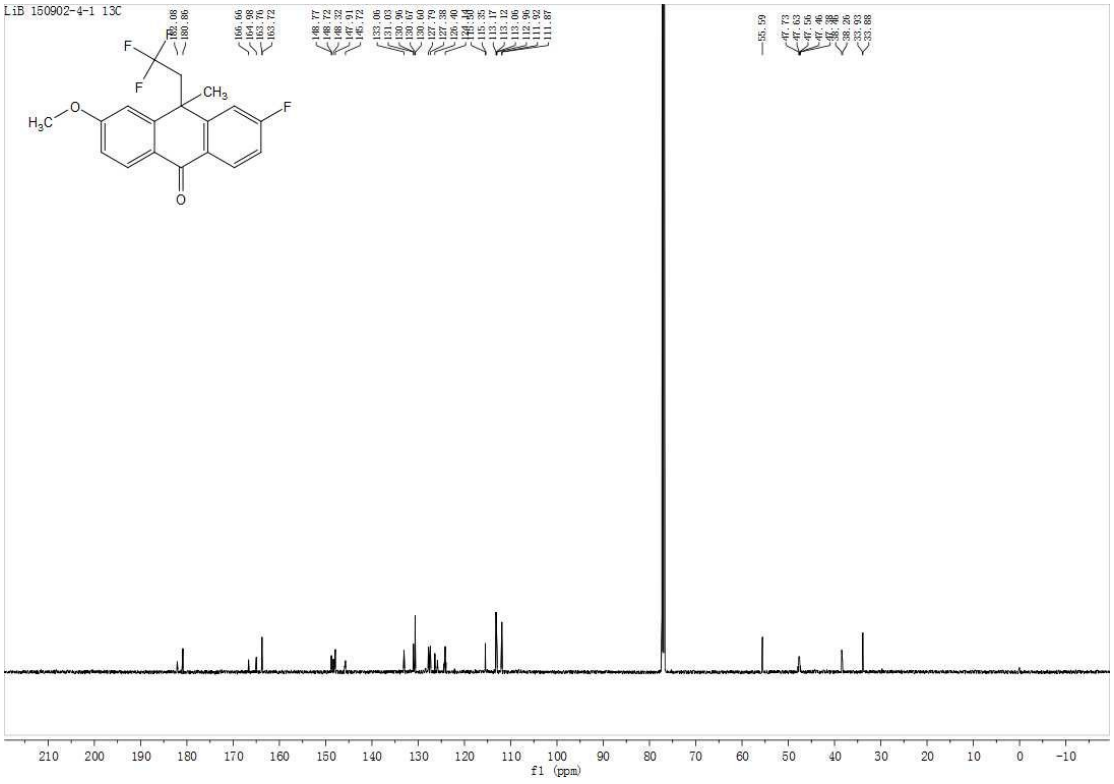


5o ^{19}F NMR

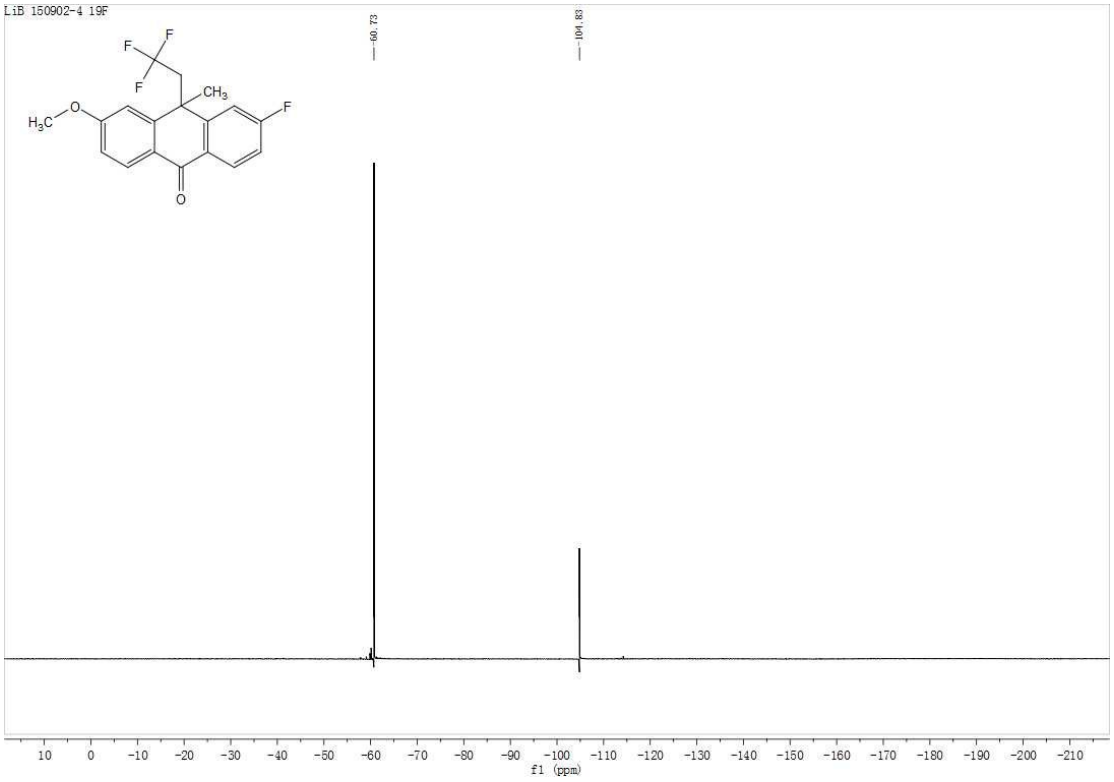


5p ^{1}H NMR

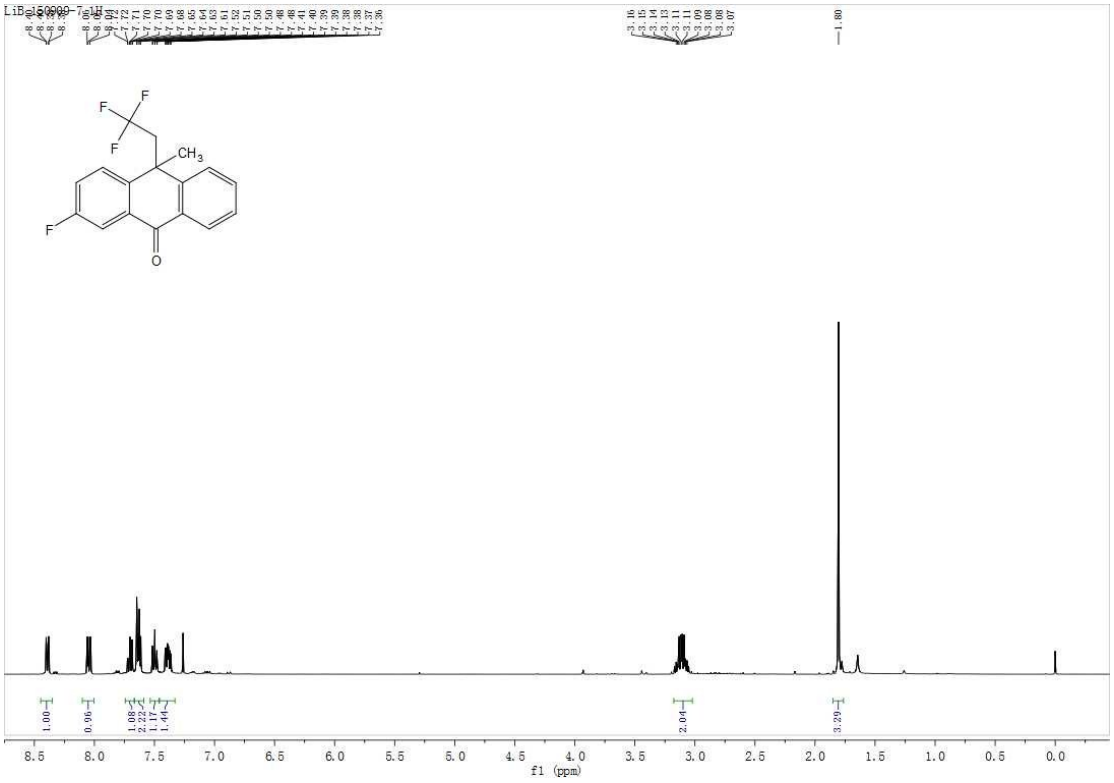
5p ^{13}C NMR



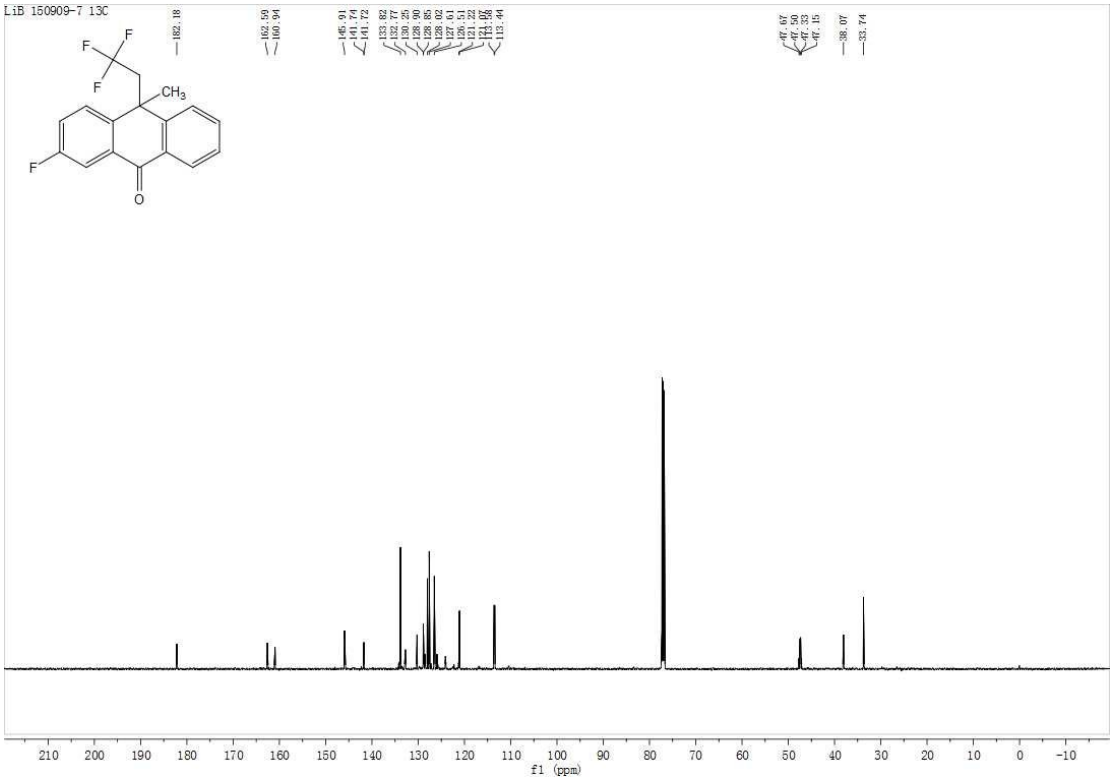
5p ^{19}F NMR



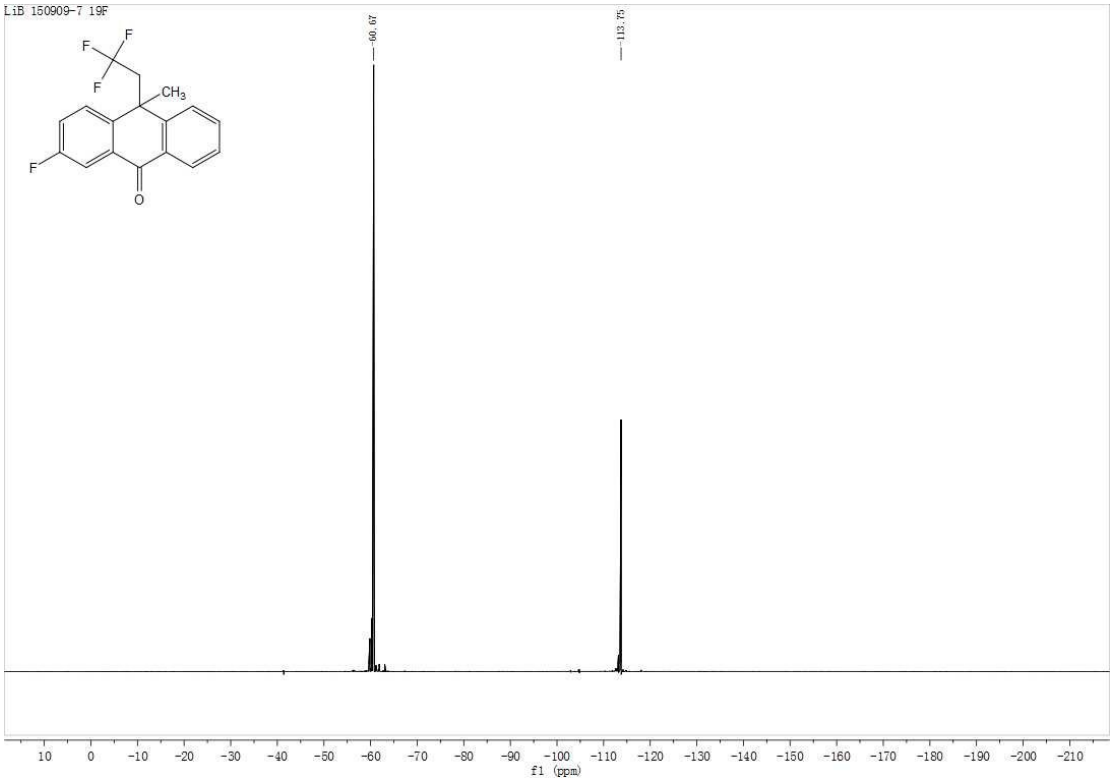
5q ^{1}H NMR



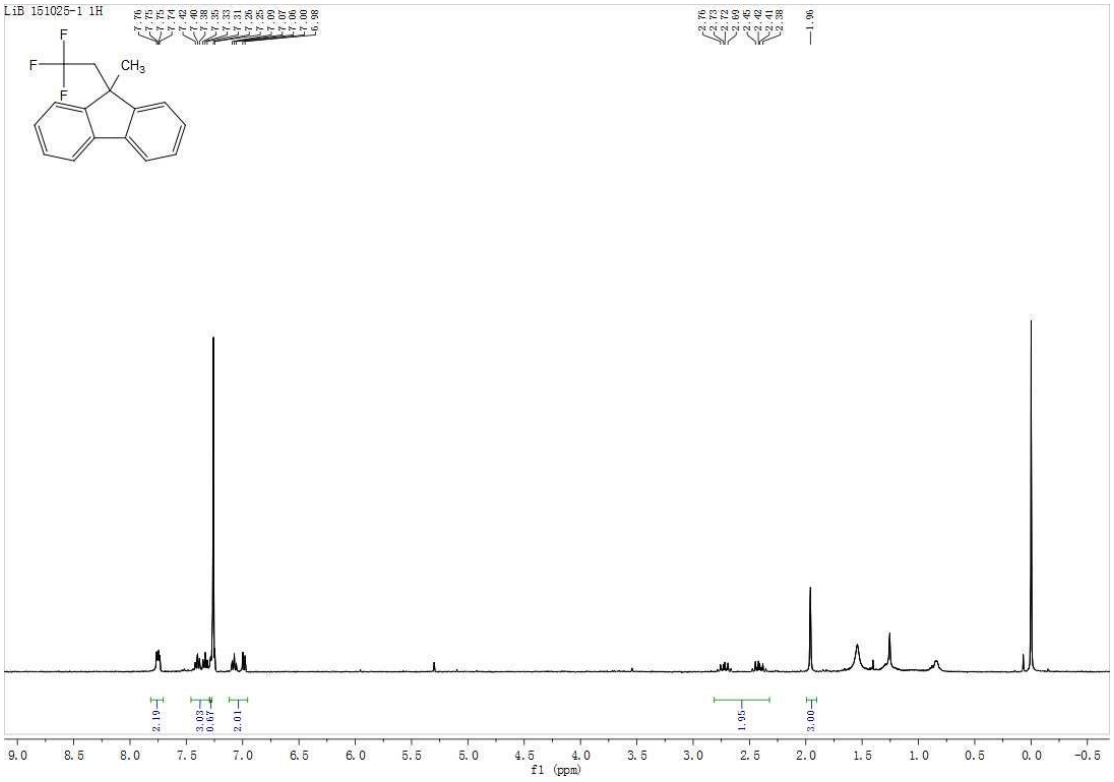
5q ^{13}C NMR


LiB 150909-7 13C
182.18
162.59
160.94
145.91
141.74
141.72
133.82
132.77
130.25
128.90
128.85
128.82
127.61
125.51
121.22
113.58
113.44
47.67
47.50
47.33
47.15
38.07
33.74
F
F
F
CH3
F
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

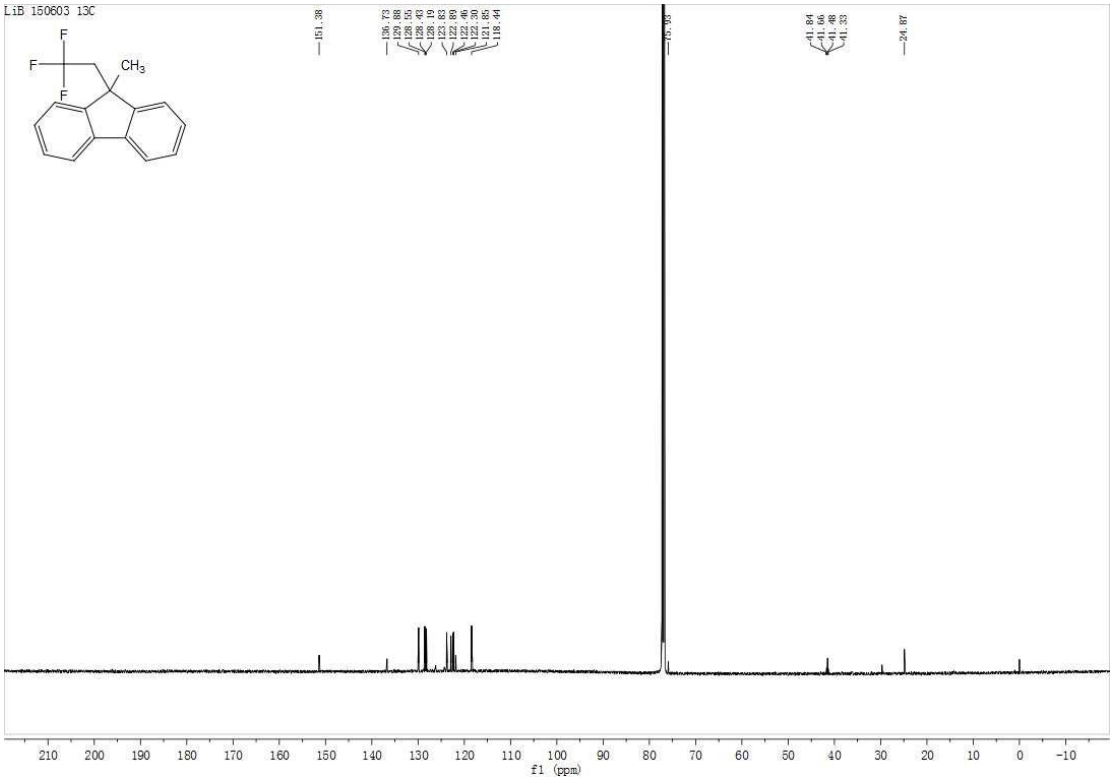
5q ^{19}F NMR


LiB 150909-7 19F
-60.67
-113.75
F
F
F
CH3
F
O
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

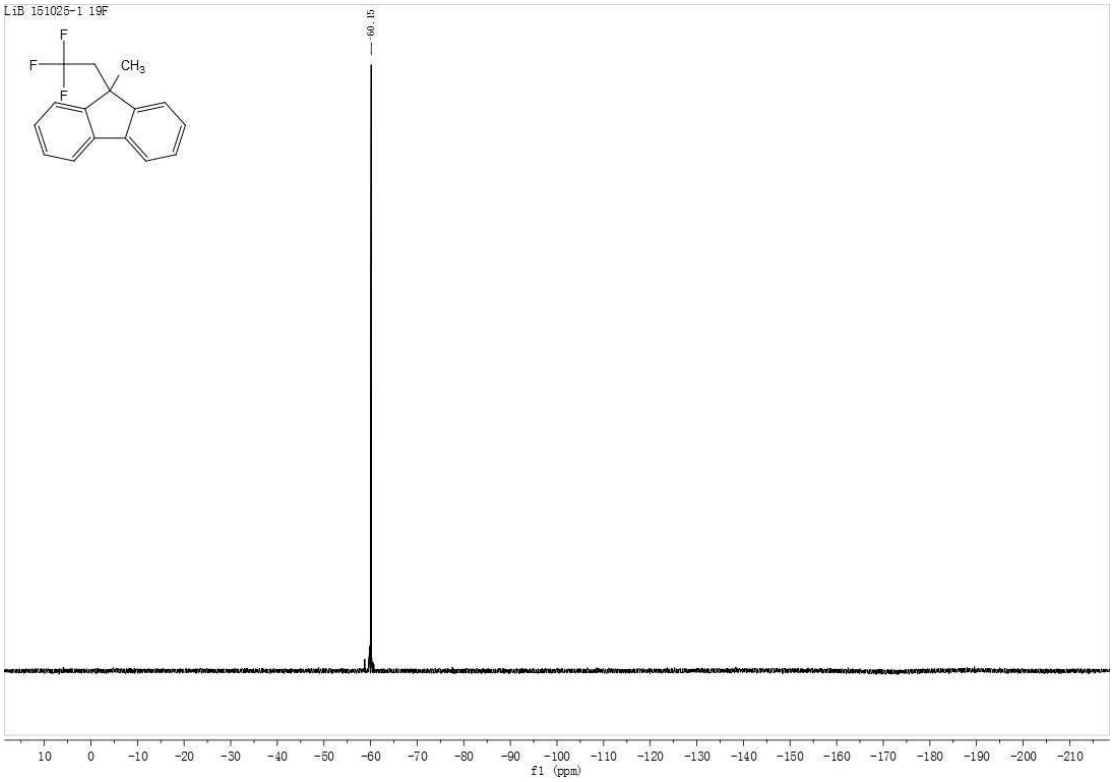
5r ^{1}H NMR



5r ^{13}C NMR


LiB 150603 13C
F
F
CH3
F
151.38
136.73
129.88
128.15
128.45
128.19
123.83
122.89
122.46
122.30
121.85
118.44
75.93
41.84
41.66
41.48
41.33
24.87
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

5r ^{19}F NMR


LiB 151026-1 19F
F
F
CH3
F
-60.15
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)