Palladium-catalyzed allylic C–H oxidation under simple operation and mild conditions

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Supporting Information

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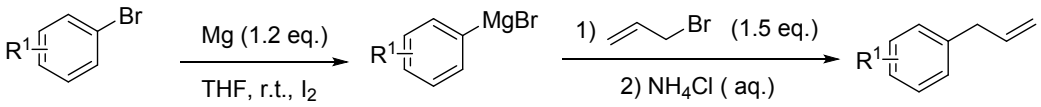
1. General Information

All experiments were carried out under an air atmosphere unless otherwise noted. Commercial reagents were purchased from Aldrich or Adamas-beta unless otherwise stated. All solvents were dried and distilled before use according to the standard methods. Analytical thin layer chromatography (TLC) was performed on precoated silica gel 60 F254 plates. Visualization on TLC was achieved with UV light (254 nm) and potassium permanganate as visualization methods. ^{1}H NMR spectra were recorded on Mercury Plus-400 (400 MHz), BRUKER DRX-400 (400 MHz) and BRUKER DRX-500 (500 MHz). Chemical shifts were quoted in parts per million (ppm) referenced to the appropriate solvent peak or 0.0 ppm for tetramethylsilane. Data for ^{1}H NMR spectra are reported as follows: chemical shift (δ shift), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = double of doublet, ddd = double of dd, dt = double of triplet, td = triple of doublet), integration, coupling constant (Hz), and assignment. ^{13}C NMR spectra were recorded on Mercury Plus-400 (100 MHz). Chemical shifts were reported in ppm referenced to the center line of a triplet at 77.0 ppm of chloroform-*d*. Infrared (IR) spectra were recorded on an AVATAR 370 Spectrometer with a thin film on the KBr plate. High resolution mass spectra were obtained with ACQUITY^{TM} UPLC & Q-TOF MS Premier Spectrometer, and EI mass spectra were obtained with 7890B-5977B Spectrometer.

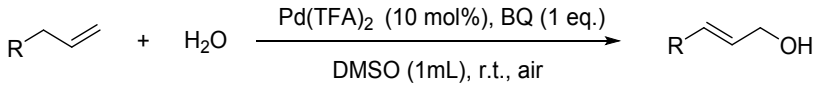
2. Experimental Section

2.1 General methods for the synthesis of allylic alkenes[1]



In an oven-dried 50 mL round Schlenk tube containing a stirring bar, aryl bromide (5 mmol, 1 equiv.) and an iodide grain were dissolved in anhydrous THF (20 mL). Then Mg (6 mmol, 1.2 equiv.) was added into the Schlenk tube under a N_2 atmosphere. After the color of the mixture faded, allyl bromide (7.5 mmol, 1.5 equiv.) was carefully added under room temperature. Then the mixture was stirred at room temperature for 2h. After that, aqueous saturated NH_4Cl solution was added slowly to quench the reaction. The aqueous phase was separated and extracted with ethyl acetate (3 x 30 mL). The combined organic phases were dried with Na_2SO_4 and concentrated under reduced pressure. The crude residue was purified by column chromatography on silica gel to afford pure allylic alkenes (**1b**, **1d**, **1f-1i** and **1n-1s**).

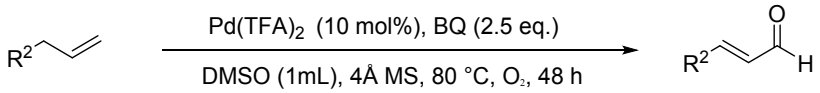
2.2 General procedure for the synthesis of allylic alcohols



$Pd(TFA)_2$ (0.03 mmol, 10.0 mg) and DMSO (1.0 mL) were added to an oven-dried 40 mL sample vial containing a stirring bar under air. The solution was stirred at room temperature for 5 minutes. Corresponding allylic alkenes (0.3 mmol), BQ (0.3 mmol, 32.4 mg) and H_2O (3 mmol, 54 mg) were added to the above mixture. The sample vial was sealed with a screw cap. The reaction mixture was stirred at room temperature for corresponding time. The resulting orange mixture was diluted with ethyl acetate, and

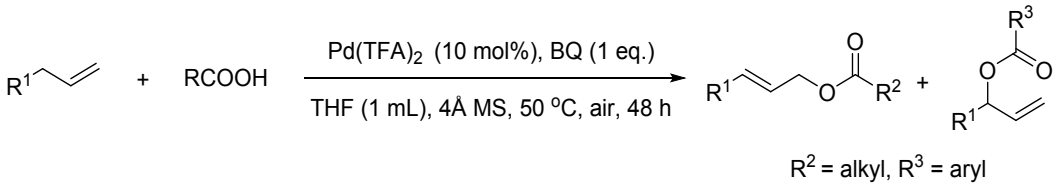
washed with brine. The aqueous layer was extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried over Na_2SO_4, and the filtrate was concentrated. The crude was purified by column chromatography with eluent (petroleum ether/ethyl acetate = 5:1 to 10:1) to afford the corresponding products.

2.3 General procedure for the synthesis of (*E*)–acrylaldehydes



$Pd(TFA)_2$ (0.02 mmol, 6.7 mg) and DMSO (1.0 mL) were added to an oven-dried 25 mL Schlenk tube containing a stirring bar under oxygen. The solution was stirred at room temperature for 5 minutes. Corresponding allylic alkenes (0.2 mmol), BQ (0.5 mmol, 54.0 mg) and 4Å molecular sieves were added to the above mixture. The Schlenk tube was sealed with a Teflon-lined screw cap. Heating up to 80 °C for 48 h, the resulting mixture was allowed to cool to room temperature, diluted with ethyl acetate, and washed with brine. The aqueous layer was extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried over Na_2SO_4, and the filtrate was concentrated. The crude was purified by column chromatography with eluent (petroleum ether/ethyl acetate = 50:1 to 20:1) to afford the corresponding products.

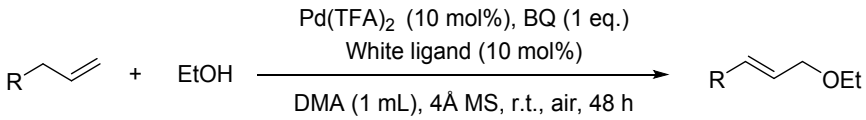
2.4 General procedure for the synthesis of allylic esters



R^2 = alkyl, R^3 = aryl

$Pd(TFA)_2$ (0.03 mmol, 10.0 mg) and THF (1.0 mL) were added to an oven-dried 25 mL Schlenk tube containing a stirring bar under air. The solution was stirred at room temperature for 5 minutes. Corresponding allylic alkenes (0.3 mmol), BQ (0.3 mmol, 32.4 mg), carboxylic acids (0.04 mmol, 2 equiv.) and 4Å molecular sieves were added to the above mixture. The Schlenk tube was sealed with a Teflon-lined screw cap. Heating up to 50 °C for 48 h, the resulting mixture was allowed to cool to room temperature, diluted with ethyl acetate and washed with brine. The aqueous layer was extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried over Na_2SO_4, and the filtrate was concentrated. The crude was purified by column chromatography with eluent (petroleum ether/ethyl acetate = 50:1 to 30:1) to afford the corresponding products.

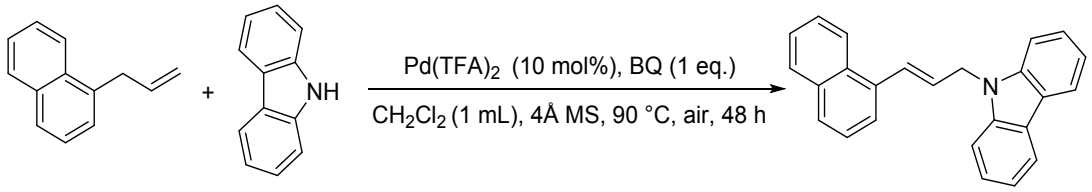
2.5 General procedure for the synthesis of allylic ethers



$Pd(TFA)_2$ (0.02 mmol, 6.7 mg), 1,2-bis(phenylsulfinyl)ethane (0.02 mmol, 5.6 mg) and DMA (1.0 mL) were added to an oven-dried 25 mL Schlenk tube containing a stirring bar under air. The solution was stirred at room temperature for 30 minutes. Corresponding allylic alkenes (0.2 mmol), ethanol (0.5 ml), BQ (0.2 mmol, 21.6 mg) and 4Å molecular sieves were added to the above mixture. The Schlenk tube was sealed with a Teflon-lined screw cap. The reaction mixture was stirred at room temperature for 48 h, the resulting mixture was diluted with ethyl acetate, and washed

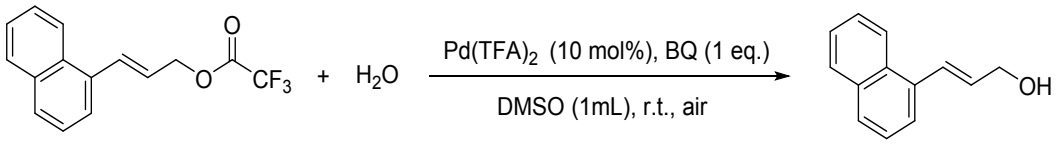
with brine. The aqueous layer was extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried over Na_2SO_4, and the filtrate was concentrated. The crude was purified by column chromatography with eluent (petroleum ether/ethyl acetate = 30:1 to 20:1) to afford the corresponding products.

2.6 General procedure for the synthesis of allylic carbazole



$Pd(TFA)_2$ (0.02 mmol, 6.7 mg) and CH_2Cl_2 (1.0 mL) were added to an oven-dried 25 mL Schlenk tube containing a stirring bar under air. The solution was stirred at room temperature for 5 minutes. 1-Allylnaphthalene (0.2 mmol, 33.6 mg), carbazole (0.4 mmol, 66.8 mg), BQ (0.2 mmol, 21.6 mg) and 4Å molecular sieves were added to the above mixture. The Schlenk tube was sealed with a Teflon-lined screw cap. Heating up to 90 °C for 48 h, the resulting mixture was allowed to cool to room temperature, diluted with ethyl acetate, and washed with brine. The aqueous layer was extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried over Na_2SO_4, and the filtrate was concentrated. The crude was purified by column chromatography with eluent (petroleum ether/ethyl acetate = 30:1) to afford the corresponding product.

2.7 The procedure for the synthesis of 2a using 3a ((E)-3-(Naphthalen-1-yl)allyl 2,2,2-trifluoroacetate) as starting material

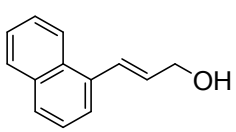


3a **2a**

$Pd(TFA)_2$ (0.02 mmol, 6.6 mg) and DMSO (1.0 mL) were added to an oven-dried 25 mL Schlenk tube containing a stirring bar under air. The solution was stirred at room temperature for 5 minutes. **3a** (0.2 mmol, 56.0 mg), BQ (0.2 mmol, 21.6 mg) and H_2O (2 mmol, 36 mg) were added to the above mixture. The sample vial was sealed with a screw cap. The reaction mixture was stirred at room temperature for 39 hours. The resulting orange mixture was diluted with ethyl acetate, and washed with brine. The aqueous layer was extracted with ethyl acetate (3 × 20 mL). The combined organic layers were dried over Na_2SO_4, and the filtrate was concentrated. The crude was purified by column chromatography with eluent (petroleum ether/ethyl acetate = 5:1) to afford **2a** in 79% yield.

3. Analytical data

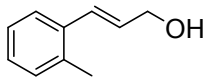
(*E*)-3-(Naphthalen-1-yl)prop-2-en-1-ol (2a)[2]**:** yield: 86% (47 mg); yellow oil; **IR**



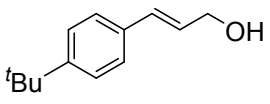
(KBr) ν(cm^{-1}): 3343, 3049, 2920, 2860, 1590, 1008, 967, 780; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 - 8.10 (m, 1H), 7.87 - 7.83 (m,

1H), 7.78 (d, *J* = 8.2 Hz, 1H), 7.59 (d, *J* = 7.2 Hz, 1H), 7.54 - 7.47 (m, 2H), 7.47 - 7.42 (m, 1H), 7.38 (d, *J* = 15.6 Hz, 1H), 6.40 (dt, *J* = 15.6, 5.6 Hz, 1H), 4.44 (dd, *J* = 5.6, 1.6 Hz, 2H), 1.65 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M+Na]^+$ calcd for $C_{13}H_{12}O$ 207.08, found: 207.09.

(*E*)-3-(*o*-Tolyl)prop-2-en-1-ol (2b)[2]**:** yield: 81% (36 mg); yellow oil; **IR** (KBr) *v*(cm^{-1}): 3337, 3020, 2924, 1653, 1484, 1459, 967, 745; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.46 - 7.43 (m,1H), 7.19 - 7.13 (m, 3H), 6.83 (d, *J* = 15.8 Hz,1H), 6.26 (dt, *J* = 15.8, 5.4 Hz, 1H), 4.35 (d, *J* = 5.4 Hz, 2H), 2.35 (s, 3H), 1.52 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{10}H_{12}O$ 149.10, found: 148.99.

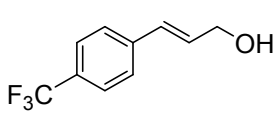


(*E*)-3-(4-Methoxyphenyl)prop-2-en-1-ol (2c)[2]**:** yield: 77% (38 mg); pale yellow solid, **m.p.** 76-78 °C; **IR** (KBr) *v*(cm^{-1}): 3515, 3033, 2918, 2840, 1661, 1512, 1245, 1026, 971; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35 - 7.31 (m, 2H), 6.88 - 6.84 (m, 2H), 6.56 (d, *J* = 15.8 Hz, 1H), 6.24 (dt, *J* = 15.8, 5.4 Hz, 1H), 4.30 (d, *J* = 5.4 Hz, 2H), 3.81(S, 3H), 1.58 (S, 1H); **MS** (ESI-TOF) *m/z*: $[M-H_2O+H]^+$ calcd for $C_{10}H_{12}O_2$ 147.08, found: 146.97.

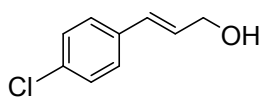


(*E*)-3-(4-(tert-Butyl)phenyl)prop-2-en-1-ol (2d)[2]**:** yield: 45 mg (79%); pale yellow oil; **IR** (KBr) *v*(cm^{-1}): 3395, 2961, 2867, 1720, 1606, 1363, 1091, 969; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.36 - 7.31 (m, 4H), 6.60 (d, *J* = 15.8 Hz, 1H), 6.34 (dt, *J* = 15.8, 5.8 Hz, 1H), 4.32 (dd, *J* = 5.8, 1.0 Hz, 2H), 1.57 (s, 1H) , 1.32 (s, 9H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{13}H_{18}O$ 191.14, found: 189.98.

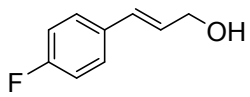
(*E*)-3-(4-(Trifluoromethyl)phenyl)prop-2-en-1-ol (2e)[2]**:** yield: 83% (50 mg); white solid, **m.p.** 47-49 °C; **IR** (KBr) ν(cm^{-1}): 3342, 2926, 1614, 1329, 1124, 969; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.57 (d, J = 8.0 Hz, 2H), 7.47 (d, J = 8.0 Hz, 2H), 6.66 (d, J = 16.0 Hz, 1H), 6.46 (dt, J = 16.0, 4.4 Hz, 1H), 4.37 (d, J = 4.4 Hz, 2H), 1.62 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M-H_2O+H]^+$ calcd for $C_{10}H_9F_3O$ 185.06, found: 184.97.



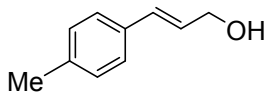
(*E*)-3-(4-Chlorophenyl)prop-2-en-1-ol (2f)[2]**:** yield: 75% (38 mg); pale yellow oil; **IR** (KBr) ν(cm^{-1}): 3338, 2922, 2859, 1593, 1565, 1478, 1201, 964, 774, 681; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.33 - 7.27 (m, 4H), 6.58 (d, J = 16.0 Hz, 1H), 6.34 (dt, J = 16.0, 5.5 Hz, 1H), 4.33 (dd, J = 5.5, 1.5 Hz, 2H), 1.58 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M+Na]^+$ calcd for C_9H_9ClO 191.02, found: 190.90.



(*E*)-3-(4-Fluorophenyl)prop-2-en-1-ol. (2g)[2]**:** yield: 81% (37 mg); yellow oil; **IR** (KBr) ν(cm^{-1}): 3426, 2921, 2851, 1600, 1227, 1158, 834; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.38 - 7.32 (m,2H), 7.01 (m, 2H), 6.58 (d, J = 16.0 Hz, 1H), 6.28 (dt, J = 16.0, 5.5 Hz, 1H), 4.32 (dd, J = 5.5, 1.5 Hz, 2H), 1.62 (1H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for C_9H_9FO 153.07, found: 153.00.

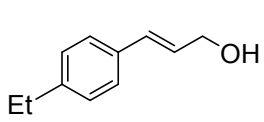


(*E*)-3-(*p*-Tolyl)prop-2-en-1-ol (2h)[2]**:** yield: 86% (38 mg;) yellow oil; **IR** (KBr) ν(cm^{-1}): 3372, 2921, 2859, 1512, 1248, 1809, 968; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.28 (d, J = 8.0 Hz, 2H), 7.13 (d, J = 8.0 Hz, 2H), 6.58 (d, J = 16.0 Hz, 1H), 6.32 (dt, J = 16.0, 6.0 Hz, 1H), 4.31 (dd, J = 6.0,



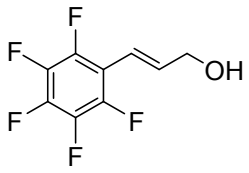
1.5 Hz, 1H), 2.34 (s, 3H) , 1.59 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M-H_2O+H]^+$ calcd for $C_{10}H_{12}O$ 131.09, found: 130.98.

(*E*)-3-(4-Ethylphenyl)prop-2-en-1-ol (2i): yield: 80% (39 mg); yellow oil; **^{1}H NMR**



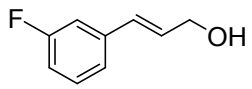
(500 MHz, $CDCl_3$) δ 7.31 (d, *J* = 8.0 Hz, 2H), 7.15 (d, *J* = 8.0 Hz, 2H), 6.59 (d, *J* = 16.0 Hz, 1H), 6.33 (dt, *J* = 16.0, 6.0 Hz, 1H), 4.31 (dd, *J* = 6.0, 1.5 Hz, 2H), 2.64 (q, *J* = 8.0 Hz, 2H), 1.59 (s, 1H) , 1.23 (t, *J* = 8.0 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 144.0, 134.0, 131.2, 128.1, 127.4, 126.4, 63.9, 28.6, 15.5; **HRMS** (ESI-TOF) *m/z*: $[M-H_2O+H]^+$ calcd for $C_{11}H_{14}O$ 145.1017, found: 144.1011.

(*E*)-3-(Perfluorophenyl)prop-2-en-1-ol (2j)[2]**:** yield: 82% (55 mg); yellow oil; **IR**



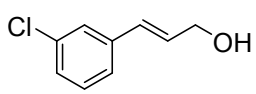
(KBr) *v*(cm^{-1}): 3336, 2934, 2859, 1657, 1524, 1049, 982, 779, 709; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.71 (dt, *J* = 16.4, 4.8 Hz, 1H), 6.58 (dt, *J* = 16.4, 1.6 Hz, 1H), 4.40 (d, *J* = 4.8 Hz, 2H), 1.62 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M-H_2O+H]^+$ calcd for $C_9H_5F_5O$ 207.02, found: 207.08.

(*E*)-3-(3-Fluorophenyl)prop-2-en-1-ol (2k)[3]**:** yield: 70% (32 mg); yellow oil; **IR**



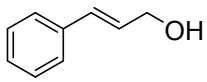
(KBr) *v*(cm^{-1}): 3355, 2923, 2855, 1610, 1582, 1488, 1446, 967, 776, 682; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31 - 7.26 (m, 1H), 7.14 (d, *J* = 7.8 Hz, 1H), 7.11 - 7.06 (m, 1H), 6.97 - 6.91 (m, 1H), 6.60 (d, *J* = 16.0 Hz, 1H), 6.37 (dt, *J* = 16.0, 5.6 Hz, 1H), 4.34 (dd, *J* = 5.6, 1.6 Hz, 2H), 1.58 (s, 1H). **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for C_9H_9FO 153.07, found 152.98.

(*E*)-3-(3-Chlorophenyl)prop-2-en-1-ol (2l)[2]**:** yield: 81% (41 mg); colorless oil; **IR**

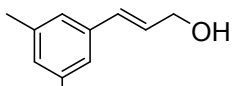


(KBr) v(cm^{-1}): 3394, 2925, 2856, 1680, 1594, 1077, 966, 777, 682; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.37(s, 1H) , 7.26 - 7.24 (m, 2H), 7.23 - 7.20 (m, 1H), 6.57 (dt, J = 16.0, 1.2 Hz, 1H), 6.37 (dt, J = 16.0, 5.6 Hz, 1H), 4.34 (d, J = 5.6 Hz, 2H), 1.61 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for C_9H_9ClO 169.04, found: 168.95.

(*E*)-3-Phenylprop-2-en-1-ol (2m)[2]**:** yield: 85% (34 mg); yellow oil; **IR** (KBr) v (cm^{-1}): 3415, 2924, 1722, 967, 746, 692; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.39 (d, J = 7.5 Hz, 2H), 7.32 (t, J = 7.5 Hz, 2H), 7.26 - 7.22 (m, 1H), 6.62 (d, J = 15.0 Hz, 1H), 6.37 (dt, J = 15.0, 5.5 Hz, 1H), 4.33 (d, J = 5.5 Hz, 2H), 1.58 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_9H_{10}O$ 135.08, found: 135.01.



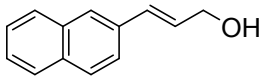
(*E*)-3-(3,5-Dimethylphenyl)prop-2-en-1-ol (2n)[2]**:** yield: 80% (39 mg); pale yellow oil; **IR** (KBr) v(cm^{-1}): 3340, 2917, 2861, 1602, 1453, 1092, 966, 850, 689; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.01 (s, 2H) , 6.89 (s, 2H) , 6.55 (d, J = 16.0 Hz, 1H), 6.34 (dt, J = 16.0, 5.5 Hz, 1H), 4.30 (d, J = 5.5 Hz, 2H), 2.30 (s, 6H) , 1.59 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M-H_2O+H]^+$ calcd for $C_{11}H_{14}O$ 145.10, found: 145.03.



(*E*)-3-(2,5-Dimethylphenyl)prop-2-en-1-ol (2o): yield: 76% (37 mg); yellow oil; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.27 (s, 1H) , 7.04 (d, J = 7.5 Hz, 1H), 6.98 (d, J = 7.5 Hz, 1H), 6.81 (d, J = 16.0 Hz, 1H), 6.25 (dt, J = 16.0, 6.0 Hz, 1H), 4.34 (d, J = 6.0 Hz, 2H), 2.31 (s, 3H) , 2.31 (s, 3H) , 1.56 (s, 1H); **^{13}C NMR** (125 MHz, $CDCl_3$) δ 135.9, 135.4, 132.6, 132.4, 130.2, 129.5, 129.1, 128.4, 126.4, 64.0, 21.0, 19.3; **HRMS** (ESI-TOF) *m/z*: $[M-H_2O+H]^+$ calcd for

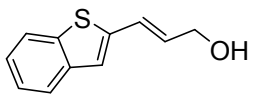
$C_{11}H_{14}O$ 145.1017, found: 145.1006.

(*E*)-3-(Naphthalen-2-yl)prop-2-en-1-ol (2p)[2]**:** yield: 78% (43 mg); yellow oil; **IR**



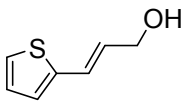
(KBr) ν(cm^{-1}): 3328, 2921, 2852, 1659, 1594, 1090, 1009, 963, 738; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.82 - 7.77 (m, 3H), 7.74 (s, 1H) , 7.60 (dd, *J* = 8.5, 1.5 Hz, 1H), 7.49 - 7.42 (m, 2H), 6.78 (d, *J* = 16.0 Hz, 1H), 6.50 (dt, J = 16.0, 5.5 Hz, 1H), 4.39 (dd, *J* = 5.5, 1.5 Hz, 2H), 1.58 (1H); **MS** (ESI-TOF) *m/z*: $[M\text{-}H_2O+H]^+$ calcd for $C_{13}H_{12}O$ 167.09, found: 166.90.

(*E*)-3-(Benzo[*b*]thiophen-2-yl)prop-2-en-1-ol (2q)[4]**:** yield: 84% (48 mg); yellow



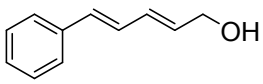
solid, m.p. 117-119 °C; **IR** (KBr) ν(cm^{-1})3394, 2924, 2853, 1730, 1645, 1353, 1241, 1174,1089, 1013, 954,839, 741, 724; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.77 - 7.72 (m, 1H), 7.69 - 7.64 (m, 1H), 7.33 - 7.26 (m, 2H), 7.13 (s, 1H) , 6.84 (d, *J* = 15.5 Hz, 1H), 6.28 (dt, *J* = 15.5, 5.5 Hz, 1H), 4.33 (dd, *J* = 5.5, 1.5 Hz, 2H), 1.65 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M\text{-}H_2O+H]^+$ calcd for $C_{11}H_{10}OS$ 173.04, found: 172.95.

(*E*)-3-(Thiophen-2-yl)prop-2-en-1-ol (2r)[2]**:** yield: 86% (36 mg); yellow oil; **IR**



(KBr) ν(cm^{-1}): 3404, 3104, 2924, 1718, 1655, 1509, 1414, 1235, 1039, 957, 853, 702; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.18 - 7.14 (m, 1H), 6.99 - 6.94 (m, 2H), 6.75 (d, *J* = 16.0 Hz, 1H), 6.21 (dt, *J* = 16.0, 5.5 Hz, 1H), 4.29 (d, *J* = 5.5 Hz, 2H), 1.58 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M\text{-}H_2O+H]^+$ calcd for C_7H_8OS 123.03, found: 122.90.

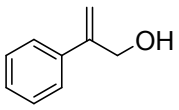
(2*E*,4*E*)-5-Phenylpenta-2,4-dien-1-ol (2s)[2]**:** yield: 56% (27 mg); yellow oil; **IR**



(KBr) ν(cm^{-1}): 3342, 3029, 2922, 2861, 1659, 1593, 772, 681;

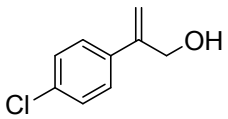
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 - 7.38 (m, 2H), 7.32 (m, 2H), 7.25 - 7.21 (m, 1H), 6.79 (dd, *J* = 15.5, 10.5 Hz, 1H), 6.56 (d, *J* = 15.5 Hz, 1H), 6.43 (dd, *J* = 15.5, 10.5 Hz, 1H), 5.97 (dt, *J* = 15.5, 5.5 Hz, 1H), 4.26 (d, *J* = 5.5 Hz, 2H), 1.57 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M+Na]^+$ calcd for $C_{11}H_{12}O$ 183.08, found: 183.01.

2-Phenylprop-2-en-1-ol (2t)[2]**:** yield: 85% (34 mg); yellow oil; **IR** (KBr) *v*(cm^{-1}):

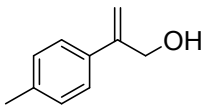


3354, 3056, 2922, 2857, 1631, 1495, 1291, 1025, 905, 779, 707; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 7.2 Hz, 2H), 7.39 - 7.27 (m, 3H), 5.47 (s, 1H) , 5.35 (s, 1H) , 4.55 (s, 2H) , 1.60 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M+Na]^+$ calcd for $C_9H_{10}O$ 157.06, found: 156.94.

2-(4-Chlorophenyl)prop-2-en-1-ol (2u)[2]**:** yield: 71% (36 mg); yellow oil; **IR** (KBr)

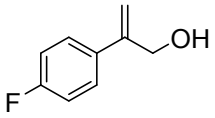


v(cm^{-1}): 3368, 2918, 2857, 1630, 1493, 1298, 1043, 833, 765; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.41 - 7.37 (m, 2H), 7.34 - 7.30 (m, 2H), 5.47 (d, *J* = 1.2 Hz, 1H), 5.38 - 5.36 (q, *J* = 1.2 Hz, 1H), 4.52 (s, 2H) , 1.58 (s, 1H); **MS** (EI) *m/z*: 168.0, found: 168.0.



2-(*p*-Tolyl)prop-2-en-1-ol (2v)[2]**:** yield: 83% (37 mg); yellow oil; **IR** (KBr) *v*(cm^{-1}): 3411, 3026, 2921, 1682, 1607, 1514, 1181, 1108, 1043, 817, 722; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 8.0 Hz, 2H), 7.16 (d, *J* = 8.0 Hz, 2H), 5.43 (d, *J* = 1.2 Hz, 1H), 5.30 (d, *J* = 1.2 Hz, 1H), 4.52 (s, 2H) , 2.35 (s, 3H) , 1.61 (s, 1H); **MS** (ESI-TOF) *m/z*: $[M+NH_4]^+$ calcd for $C_{10}H_{12}O$ 166.12, found: 165.99.

2-(4-Fluorophenyl)prop-2-en-1-ol (2w)[2]**:** yield: 72% (33 mg); yellow solid, m.p.



143-145 °C; **IR** (KBr) *v*(cm^{-1}): 2917, 2849, 1460, 1041, 893, 824;

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 - 7.41 (m, 2H), 7.06 - 7.02 (m, 2H), 5.42 (s, 1H) , 5.33 (s, 1H) , 4.52 (s, 2H) , 1.56 (s, 1H); **MS** (EI) *m/z*: 152.1, found: 152.1.

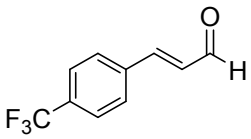
(*E*)-3-(Naphthalen-1-yl)allyl 2,2,2-trifluoroacetate (3a): yield: 7% (11 mg); pale yellow oil; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.07 (d, *J* = 8.0 Hz, 1H), 7.89 - 7.82 (m, 2H), 7.62 (d, *J* = 7.0 Hz, 1H), 7.57 - 7.50 (m, 3H), 7.49 - 7.45 (m, 1H), 6.33 (dt, *J* = 15.5, 6.5 Hz, 1H), 5.10 (d, *J* = 6.5 Hz, 2H); **^{13}C NMR** (125 MHz, $CDCl_3$) δ 157.9, 157.6, 157.2, 156.9 (q, *J* = 41.3 Hz), 134.3, 133.5, 133.1, 131.0, 129.0, 128.6, 126.5, 126.0, 125.5, 124.4, 123.4, 123.2, 117.9, 115.6, 113.4, 111.1 (q, *J* = 283.8 Hz), 68.6; **^{19}F NMR** (471 MHz, $CDCl_3$) δ -74.9; **HRMS** (ESI-TOF) *m/z*: $[M+NH_4]^+$ calcd for $C_{15}H_{11}F_3O_2$ 298.1055, found: 298.1046.

(*E*)-3-(Naphthalen-1-yl)acrylaldehyde (5a)[2]**:** yield: 60% (22 mg); yellow oil; **IR** (KBr) *v*(cm^{-1}): 3426, 3053, 2924, 2851, 1677, 1508, 1127, 970, 796, 773; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.87 (d, *J* = 7.5 Hz, 1H), 8.35 (d, *J* = 15.5 Hz, 1H), 8.20 (d, *J* = 8.0 Hz, 1H), 7.97 (d, *J* = 8.0 Hz, 1H), 7.92 (d, *J* = 7.5 Hz, 1H), 7.84 (d, *J* = 7.5 Hz, 1H), 7.65 - 7.61 (m, 1H), 7.60 - 7.52 (m, 2H), 6.86 (dd, *J* = 15.5, 7.5 Hz, 1H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{13}H_{10}O$ 183.08, found: 182.99.

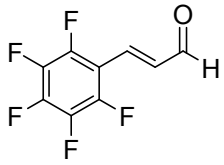
(*E*)-3-(4-Methoxyphenyl)acrylaldehyde (5b)[2]**:** yield: 62% (20 mg); pale yellow oil; **IR** (KBr) *v*(cm^{-1}): 2958, 2925, 2853, 1677, 1602, 1512, 1254, 1177, 1125, 969, 817, 707; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.66 (d, *J* = 8.5 Hz, 1H), 7.53 (d, *J* = 8.5 Hz, 2H), 7.43 (d, *J* = 16.0 Hz, 1H), 6.95 (d, *J* =

8.5 Hz, 2H), 6.62 (dd, *J* = 16.0, 8.5 Hz, 1H), 3.86 (s, 3H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{10}H_{10}O_2$ 163.08, found: 162.98.

(*E*)-3-(4-(Trifluoromethyl)phenyl)acrylaldehyde (5c)[2]**:** yield: 73% (29 mg);

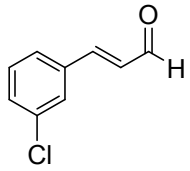


yellow solid, **m.p.** 56-58 °C; **IR** (KBr) *v*(cm^{-1}): 3336, 3057, 1679, 1629, 1576, 1421, 1322, 821, 759; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.76 (d, *J* = 7.6 Hz, 1H), 7.69 (m, 4H) , 7.51 (d, *J* = 16.0 Hz, 1H), 6.78 (dd, *J* = 16.0, 7.6 Hz, 1H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{10}H_8F_3O$ 201.05, found: 200.98.



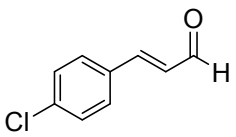
(*E*)-3-(Perfluorophenyl)acrylaldehyde (5d)[5]**:** yield: 56% (25 mg); yellow oil; **IR** (KBr) *v*(cm^{-1}): 3417, 3001, 2937, 1709, 1670, 1592, 1515, 821, 759; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.74 (d, *J* = 7.5 Hz, 1H), 7.46 (d, *J* = 16.5 Hz, 1H), 6.99 (dd, *J* = 16.5, 7.5 Hz, 1H); **MS** (EI) *m/z*: 222.0, found: 222.0.

(*E*)-3-(3-Chlorophenyl)acrylaldehyde (5e)[2] **:** yield: 76% (25 mg); yellow oil; **IR**



(KBr) *v*(cm^{-1}): 3339, 3063, 2925, 1680, 1628, 1565, 1237, 1157, 1140, 1026, 861, 812, 765; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.72 (d, *J* = 7.6 Hz, 1H), 7.55 (s, 1H), 7.49 - 7.35 (m, 4H), 6.78 - 6.66 (dd, *J* = 15.2, 8.4, 1H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for C_9H_7ClO 167.03, found: 166.92.

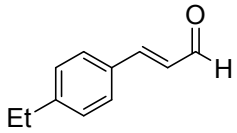
(*E*)-3-(4-Chlorophenyl)acrylaldehyde (5f)[2]**:** yield: 69% (23 mg); yellow oil; **IR**



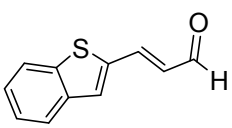
(KBr) *v*(cm^{-1}): 3414, 2922, 2851, 1699, 1491, 1299, 1125, 1088, 976, 807, 683; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.71 (d, *J* = 7.5 Hz, 1H), 7.51 (d, *J* = 8.5 Hz, 2H), 7.46 - 7.40 (m, 3H), 6.69 (dd, *J* = 16.0, 7.5 Hz, 1H);

MS (ESI-TOF) *m/z*: $[M+H]^+$ calcd for C_9H_7ClO 167.03, found: 166.95.

(*E*)-3-(4-Ethylphenyl)acrylaldehyde (5g)[2]**:** yield: 62% (20 mg); yellow oil; **IR**

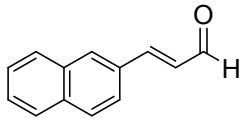


(KBr) *v*(cm^{-1}): 3434, 2924, 2853, 1680, 1623, 1279, 1178, 1123, 819; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.69 (d, *J* = 7.5 Hz, 1H), 7.50 (d, *J* = 8.5 Hz, 2H), 7.47 (d, *J* = 16.0 Hz, 1H), 7.28 (s, 2H) , 6.70 (dd, *J* = 16.0, 7.5 Hz, 1H), 2.70 (q, *J* = 7.5 Hz, 2H), 1.27 (t, *J* = 7.5 Hz, 3H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{11}H_{12}O$ 161.10, found: 161.05.



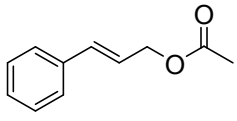
(*E*)-3-(Benzo[*b*]thiophen-2-yl)acrylaldehyde (5h)[6]**:** yield: 65% (24 mg); yellow solid, **m.p.** 63-65 °C; **IR** (KBr) *v*(cm^{-1}): 3782, 3326, 3056, 2923, 2799, 1667, 1612, 1236, 1113, 962, 821, 756, 724, 692; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.70 (d, *J* = 7.5 Hz, 1H), 7.84 - 7.79 (m, 2H), 7.69 (d, *J* = 15.5 Hz, 1H), 7.58 (s, 1H) , 7.45 - 7.36 (m, 2H), 6.57 (dd, *J* = 15.5, 7.5 Hz, 1H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{11}H_8OS$ 189.04, found: 188.91.

(*E*)-3-(Naphthalen-2-yl)acrylaldehyde (5i)[7]**:** yield: 66% (24 mg); white solid, **m.p.**



125-127 °C; **IR** (KBr) *v*(cm^{-1}): 3434, 2920, 2851, 1662, 1618, 1384, 1123, 978, 826, 750; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.77 (d, *J* = 7.6 Hz), 8.00, 7.92 - 7.84 (m), 7.69 (dd, *J* = 8.4, 2.0 Hz), 7.65 (d, *J* = 16.0 Hz), 7.60 - 7.51 (m), 6.84 (dd, J = 16.0, 7.6 Hz); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{13}H_{10}O$ 183.08, found: 182.99.

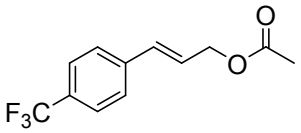
Cinnamyl acetate (7a)[8]**:** yield: 63% (33 mg); yellow oil; **IR** (KBr) *v*(cm^{-1}): 3460,



3028, 2924, 2852, 1738, 1599, 1495, 1449, 1381, 1362, 1231, 1025, 965, 826, 746, 693; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.41 -

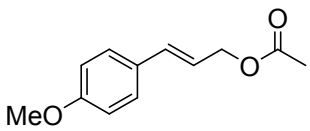
7.38 (m, 2H), 7.35 - 7.30 (m, 2H), 7.28 - 7.25(m, 1H) , 6.66 (d, *J* = 15.5 Hz, 1H), 6.29 (dt, *J* = 15.5, 6.5 Hz, 1H), 4.73 (dd, *J* = 6.5, 1.5 Hz, 2H), 2.11 (s, 3H); **MS** (ESI-TOF) *m/z*: $[M\text{-}AcOH+H]^+$ calcd for $C_{11}H_{12}O_2$ 117.07, found: 116.96.

(*E*)-3-(4-(Trifluoromethyl)phenyl)allyl acetate (7b)[8]**:** yield: 53% (39 mg); yellow



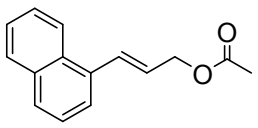
oil; **IR** (KBr) *v*(cm^{-1}): 3464, 2929, 1741, 1616, 1415, 1364, 1326, 1230, 1165, 1122, 1067, 1017, 968, 855, 596; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.58 (d, *J* = 8.0 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 6.68 (d, *J* = 16.0 Hz, 1H), 6.38 (dt, *J* = 16.0, 6.5 Hz, 1H), 4.75 (dd, *J* = 6.5, 1.0 Hz, 1H), 2.12 (s, 3H); **MS** (ESI-TOF) *m/z*: $[M\text{-}CF_3]^+$ calcd for $C_{12}H_{11}F_3O_2$ 157.08, found: 175.01; $[M\text{-}AcOH+H]^+$ 185.06; found 185.02.

(*E*)-3-(4-Methoxyphenyl)allyl acetate (7c)[8]**:** yield: 50% (31 mg); yellow oil; **IR**



(KBr) *v*(cm^{-1}): 3487, 2931, 2838, 1738, 1608, 1512, 1246, 1175, 1031, 967, 842; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.33 (d, *J* = 9.0 Hz, 2H), 6.86 (d, *J* = 9.0 Hz, 2H), 6.60 (d, *J* = 16.0 Hz, 1H), 6.15 (dt, *J* = 16.0, 7.0 Hz, 1H), 4.70 (dd, *J* = 7.0, 1.1 Hz, 2H), 3.81 (s, 3H), 2.09 (s, 3H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{12}H_{14}O_3$ 207.10; found: 206.97.

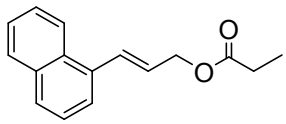
(*E*)-3-(Naphthalen-1-yl)allyl acetate (7d)[9]**:** yield: 78% (53 mg); yellow oil; **IR**



(KBr) *v*(cm^{-1}): 3456, 3051, 2939, 2881, 1930, 1738, 1591, 1509, 1442, 1379, 1362, 1236, 1076, 1025, 965, 789, 755, 605; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.09 (d, *J* = 8.5 Hz, 1H), 7.87 - 7.82 (d, *J* = 7.5 Hz, 1H), 7.79 (d, *J* = 8.5 Hz, 1H), 7.59 (d, *J* = 7.5 Hz, 1H), 7.54 - 7.46 (m, 2H), 7.46 - 7.38 (m,

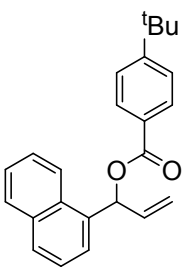
2H), 6.31 (dt, *J* = 15.5, 6.5 Hz, 1H), 4.83 (dd, *J* = 6.5, 1.5 Hz, 1H), 2.13 (s, 3H); **MS** (ESI-TOF) *m/z*: $[M+NH_4]^+$ calcd for $C_{15}H_{14}O_2$ 244.13, found: 244.03.

(*E*)-3-(Naphthalen-1-yl)allyl propionate (7e): yield: 65% (47 mg); yellow oil; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.09 (d, *J* = 8.5 Hz, 1H), 7.84 (d, *J* = 7.5 Hz, 1H), 7.79 (d, *J* = 8.5 Hz, 1H), 7.60 (d, *J* = 7.5 Hz, 1H), 7.55 - 7.47 (m, 2H), 7.46 - 7.38 (m, 2H), 6.32 (dt, *J* = 15.5, 6.0 Hz, 1H), 4.85 (d, *J* = 6.0 Hz, 2H), 2.41 (q, *J* = 7.5 Hz, 2H), 1.19 (t, *J* = 7.5 Hz, 3H); **^{13}C NMR** (125 MHz, $CDCl_3$) δ 174.2, 134.0, 133.6, 131.1, 131.1, 128.5, 128.3, 126.6, 126.2, 125.8, 125.5, 124.1, 123.6, 65.0, 27.6, 9.1; **HRMS** (ESI-TOF) *m/z*: $[M+NH_4]^+$ calcd for $C_{16}H_{16}O_2$ 258.1494, found: 258.1479.



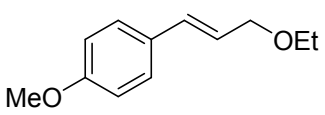
(*E*)-3-(Naphthalen-1-yl)allyl butyrate (7f): yield: 60% (46 mg); yellow oil; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.09 (d, *J* = 8.0 Hz, 1H), 7.86 - 7.83 (d, *J* = 7.5 Hz, 1H), 7.79 (d, *J* = 8.0 Hz, 1H), 7.59 (d, *J* = 7.5 Hz, 1H), 7.54 - 7.48 (m, 2H), 7.46 - 7.38 (m, 2H), 6.32 (dt, *J* = 15.5, 6.5 Hz, 1H), 4.85 (dd, *J* = 6.5, 1.5 Hz, 2H), 2.37 (t, *J* = 7.5 Hz, 2H), 1.75 - 1.67 (m, 2H), 0.98 (t, *J* = 7.5 Hz, 3H); **^{13}C NMR** (125 MHz, $CDCl_3$) δ 173.5, 134.0, 133.6, 131.1, 131.1, 128.5, 128.3, 126.6, 126.2, 125.8, 125.5, 124.1, 123.7, 64.9, 36.2, 18.5, 13.7; **HRMS** (ESI-TOF) *m/z*: $[M+Na]^+$ calcd for $C_{17}H_{18}O_2$ 277.1204; found: 277.1270.

1-(1-(4-(*tert*-Butyl)phenyl)allyl)naphthalene (7g): yield: 26% (18mg); pale yellow oil; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.24 (d, *J* = 8.0 Hz, 1H), 8.05 (d, *J* = 8.0 Hz, 2H), 7.91 - 7.81 (m, 2H), 7.69 (d, *J* = 6.8 Hz, 1H), 7.55 - 7.43 (m, 5H), 7.21 (d, *J* = 5.2 Hz, 1H), 6.30 (ddd, *J* = 17.2, 10.4, 5.2



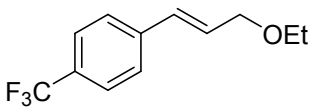
Hz, 1H), 5.42 (d, *J* = 17.2 Hz, 1H), 5.34 (d, *J* = 10.4 Hz, 1H) 1.33 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 165.6, 156.8, 136.1, 134.6, 133.9, 130.8, 129.6, 129.0, 128.8, 127.3, 126.3, 125.7, 125.5, 125.4, 125.3, 123.9, 117.2, 74.1, 35.1, 31.1; **HRMS** (ESI-TOF) *m/z*: $[M+NH_4]^+$ calcd for $C_{24}H_{24}O_2$ 362.2120; found: 362.2144.

(*E*)-1-(3-Ethoxyprop-1-en-1-yl)-4-methoxybenzene (9a)[10]**:** yield: 44% (17 mg);



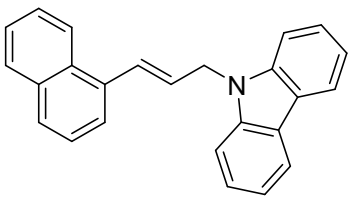
pale yellow oil; **IR** (KBr) *v*(cm^{-1}): 3437, 2973, 2929, 1735, 1608, 1512, 1462, 1374, 1301, 1248, 1175, 1106, 1034, 968, 836; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.32 (d, *J* = 8.5 Hz, 2H), 6.85 (d, *J* = 8.5 Hz, 2H), 6.55 (d, *J* = 16.0 Hz, 1H), 6.17 (dt, *J* = 16.0, 6.0 Hz, 1H), 4.12 (dd, *J* = 6.0, 1.5 Hz, 2H), 3.81 (s, 3H), 3.54 (q, *J* = 7.0 Hz, 2H), 1.24 (t, *J* = 7.0 Hz, 3H); **MS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{12}H_{16}O_2$ 193.12; found: 193.01.

(*E*)-1-(3-Ethoxyprop-1-en-1-yl)-4-(trifluoromethyl)benzene (9b): yield: 48% (22



mg); yellow oil; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.56 (d, *J* = 8.0 Hz, 2H), 7.47 (d, *J* = 8.0 Hz, 2H), 6.65 (d, *J* = 16.0 Hz, 1H), 6.40 (dt, *J* = 16.0, 5.5 Hz, 1H), 4.16 (dd, *J* = 5.5, 1.5 Hz, 2H), 3.57 (q, *J* = 7.0 Hz, 2H), 1.26 (t, *J* = 7.0 Hz, 3H); **^{13}C NMR** (125 MHz, $CDCl_3$) δ 140.3, 130.4, 129.20, 129.16, 128.7, 126.6, 125.5 (q, *J* = 3.8 Hz) 70.81, 66.02, 15.21.; **^{19}F NMR** (471 MHz, $CDCl_3$) δ -62.5; **HRMS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{12}H_{13}F_3O$ 231.0997; found: 231.0991.

(*E*)-9-(3-(Naphthalen-1-yl)allyl)-9*H*-carbazole (10b): yield: 23% (15 mg); white



solid, **m.p.** 81-83 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 7.6 Hz, 2H), 7.85 - 7.77 (m, 2H), 7.72 (d, *J*

= 8.0 Hz, 1H), 7.52 - 7.46 (m, 5H), 7.45 - 7.40 (m, 2H), 7.39 - 7.34 (m, 1H), 7.29 - 7.25 (m, 2H), 7.18 (d, *J* = 15.6 Hz, 1H), 6.37 (dt, *J* = 15.6, 5.2 Hz, 1H), 5.19 (dd, *J* = 5.2, 2.0 Hz, 2H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 140.4, 134.1, 133.5, 130.9, 129.3, 128.4, 128.1, 127.1, 126.1, 125.8, 125.7, 125.5, 123.9, 123.6, 123.1, 120.4, 119.1, 108.9, 45.2; **HRMS** (ESI-TOF) *m/z*: $[M+H]^+$ calcd for $C_{25}H_{19}N$ 334.1596.; found: 334.1592.

4. References

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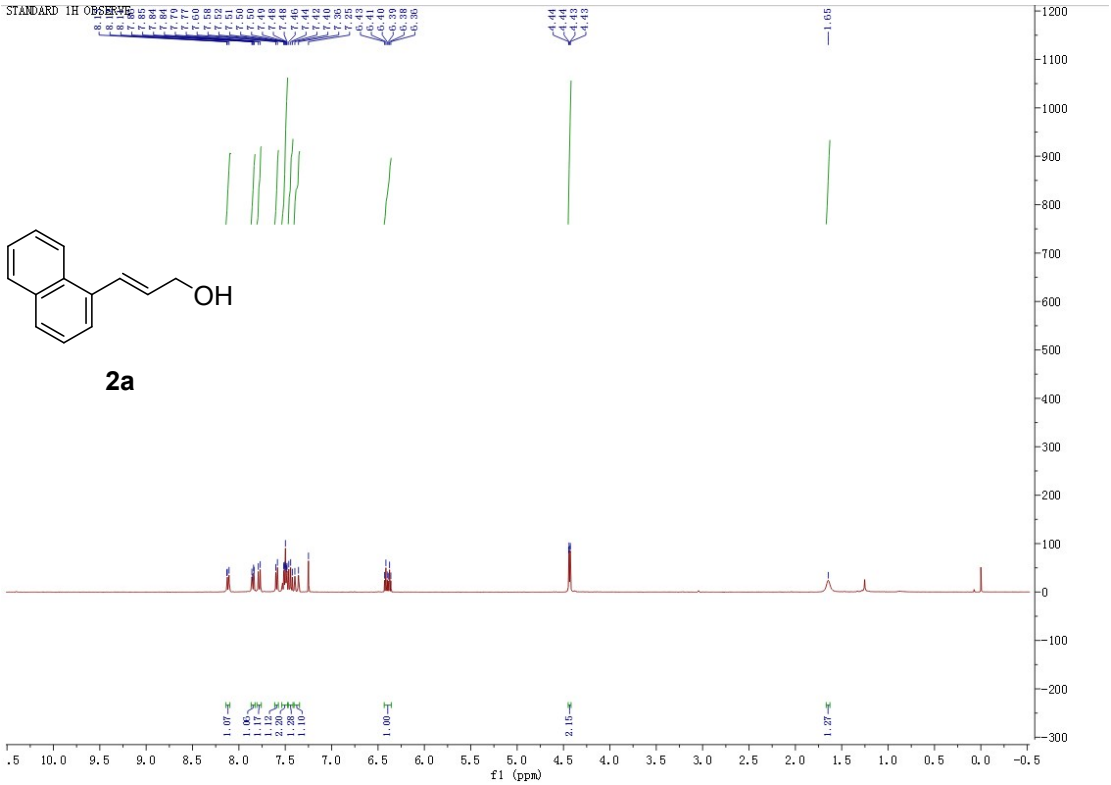
5. Spectra of ^{1}H and ^{13}C NMR



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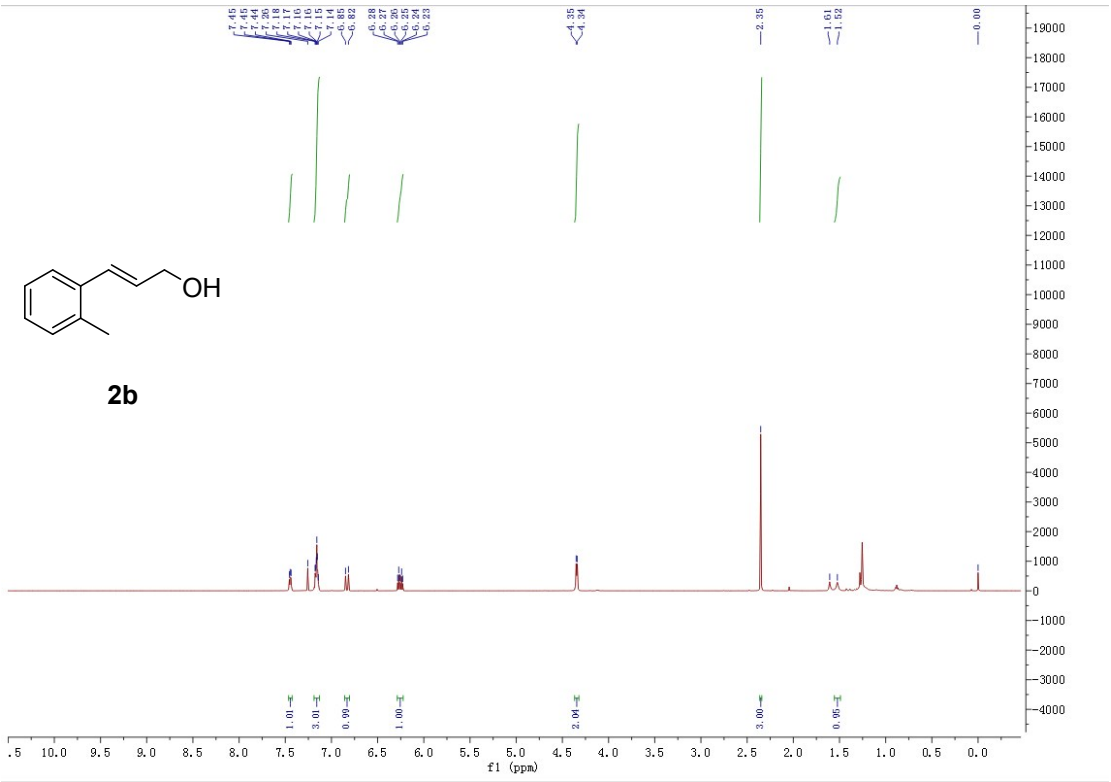

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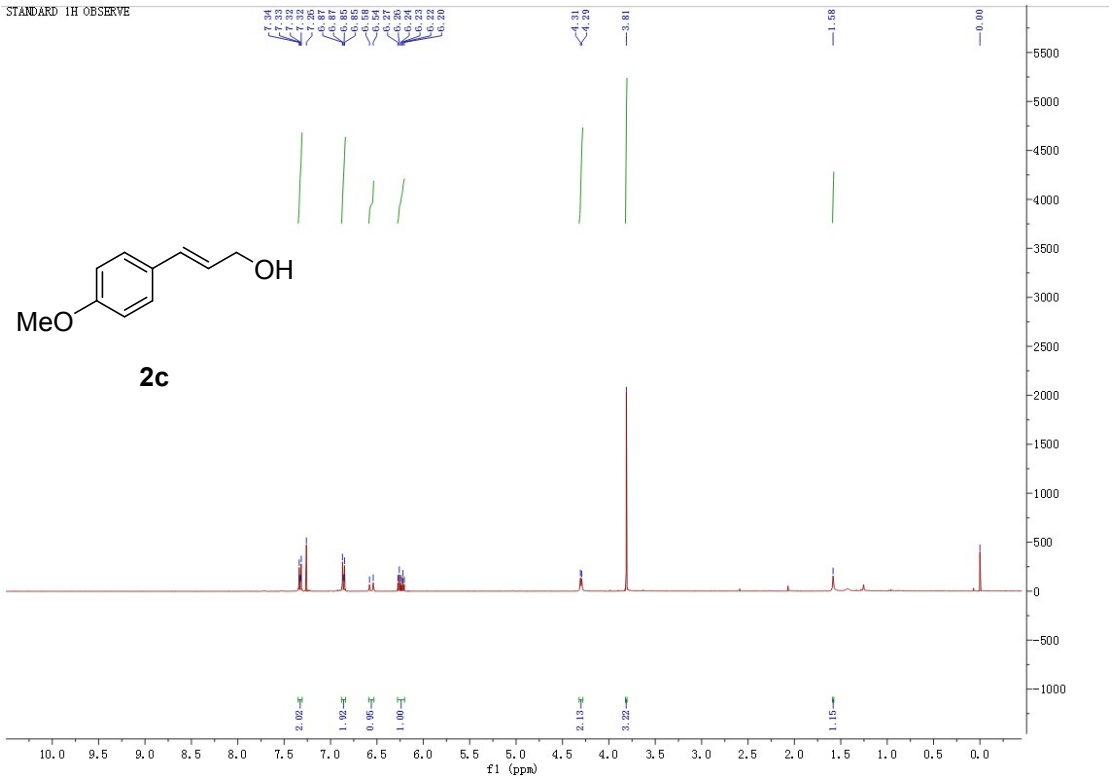

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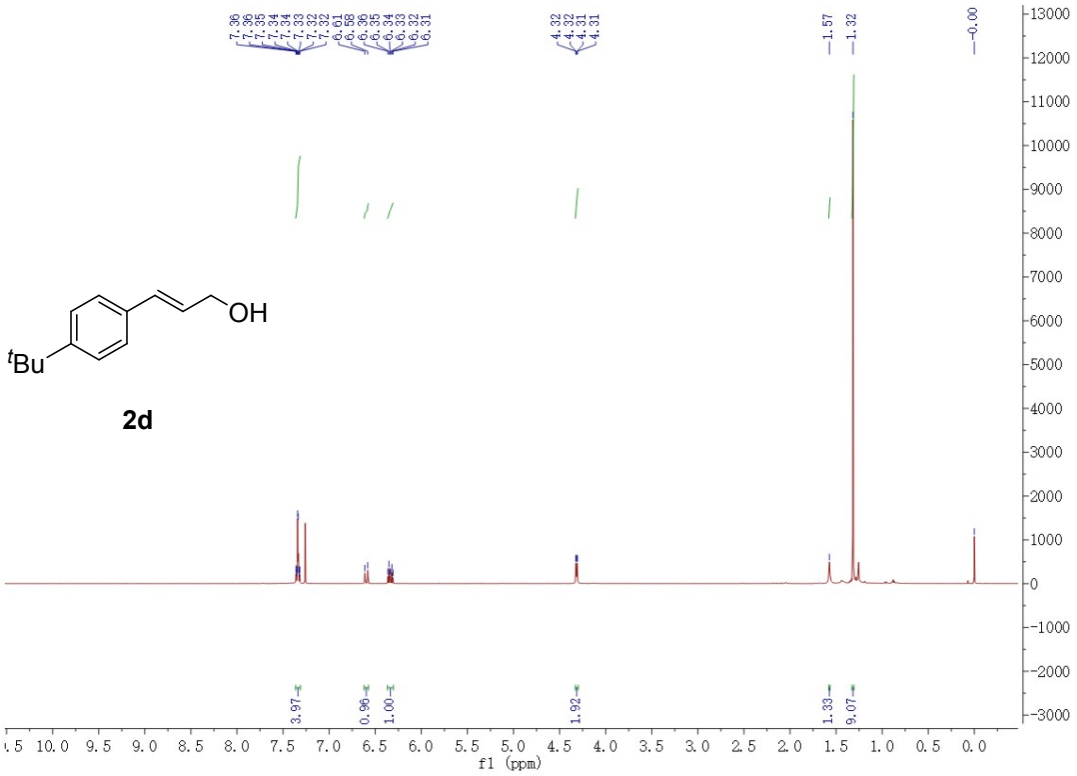
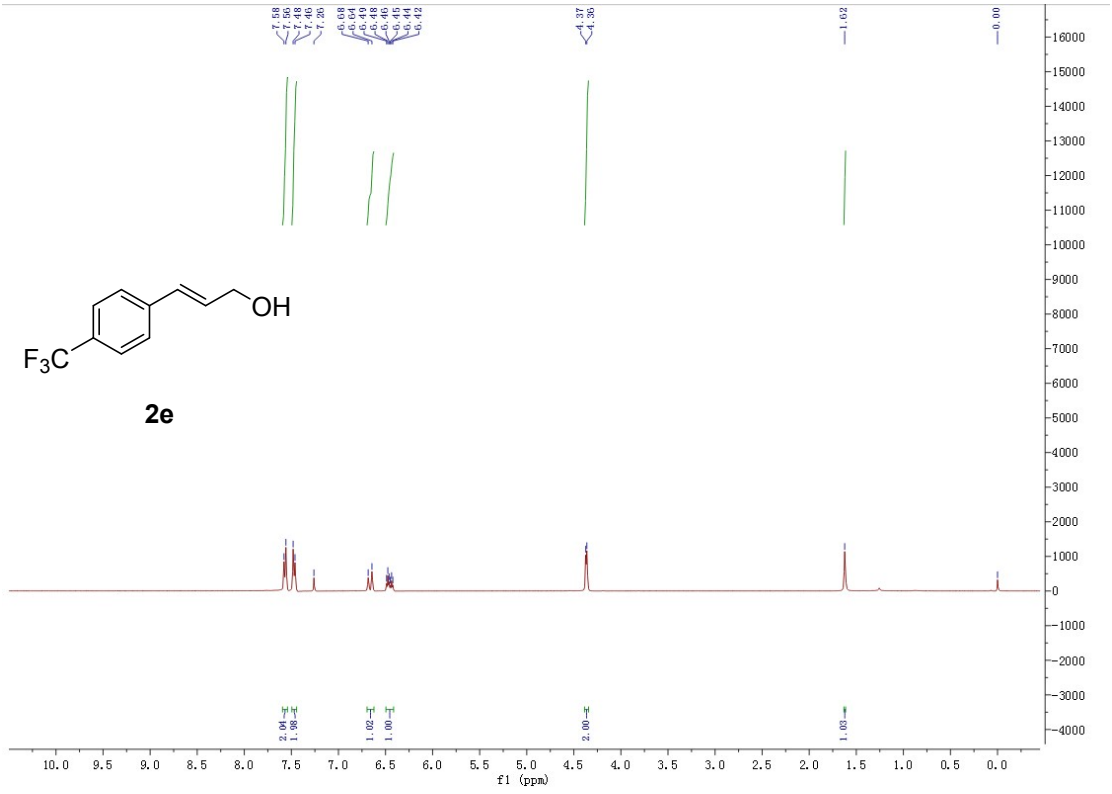


2d



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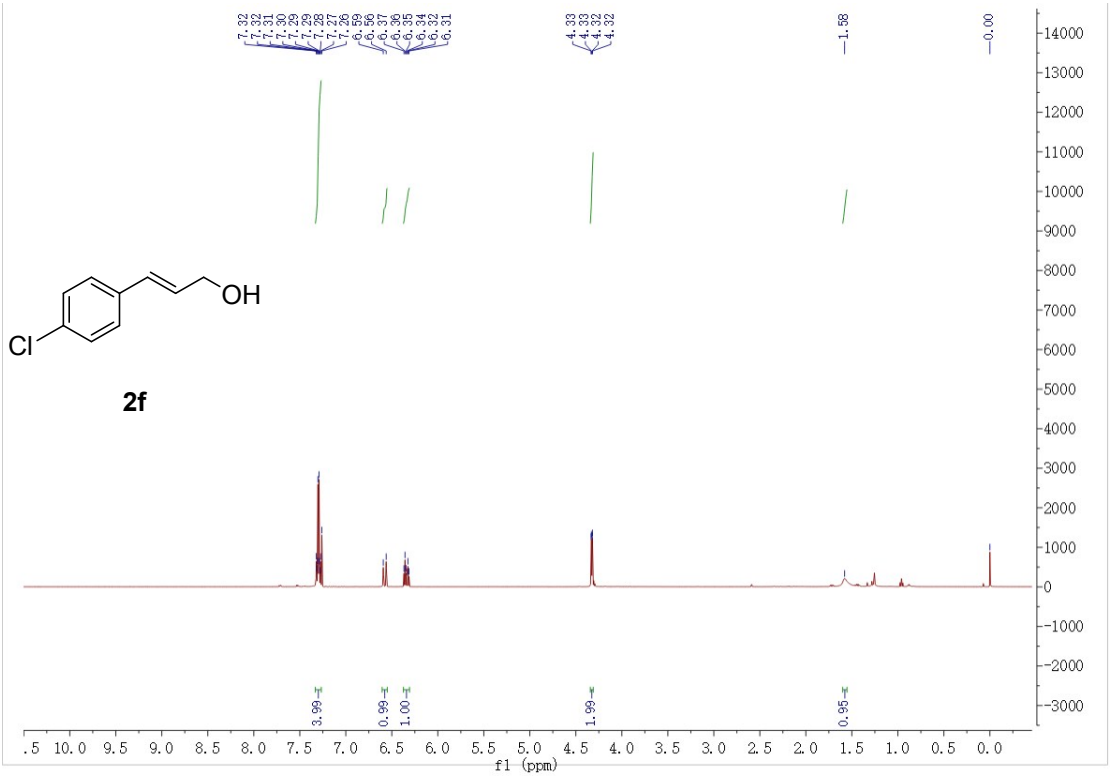

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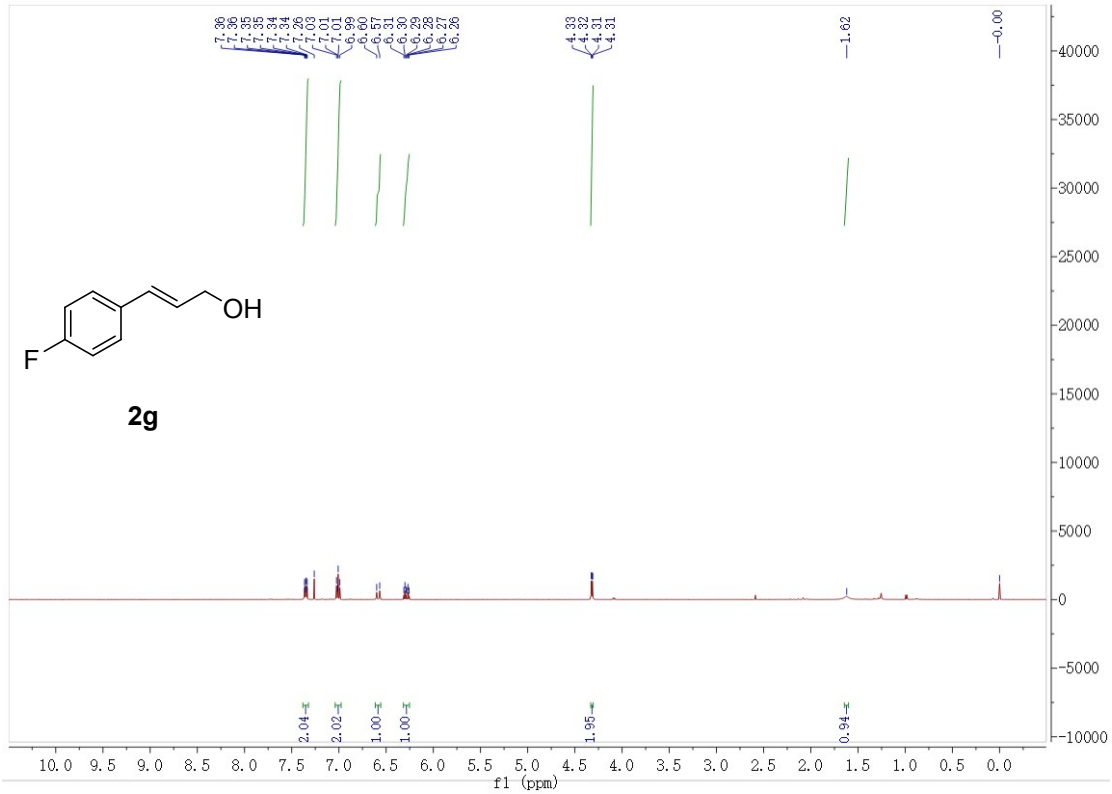

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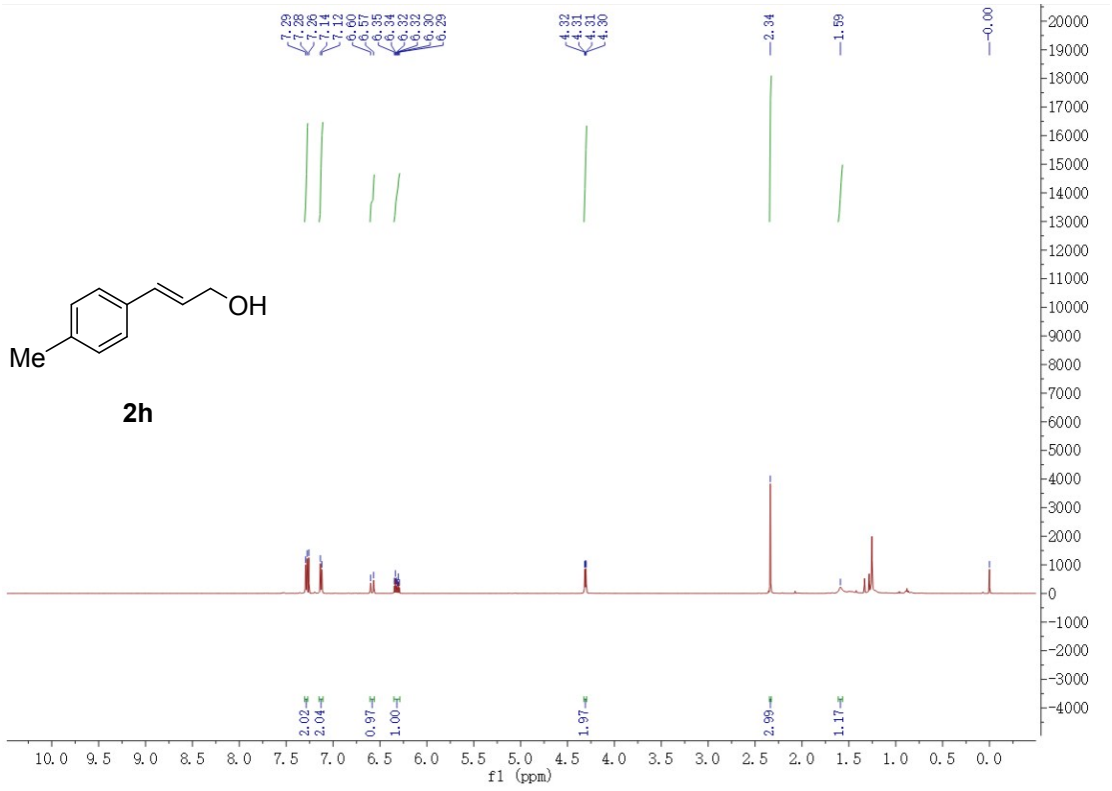

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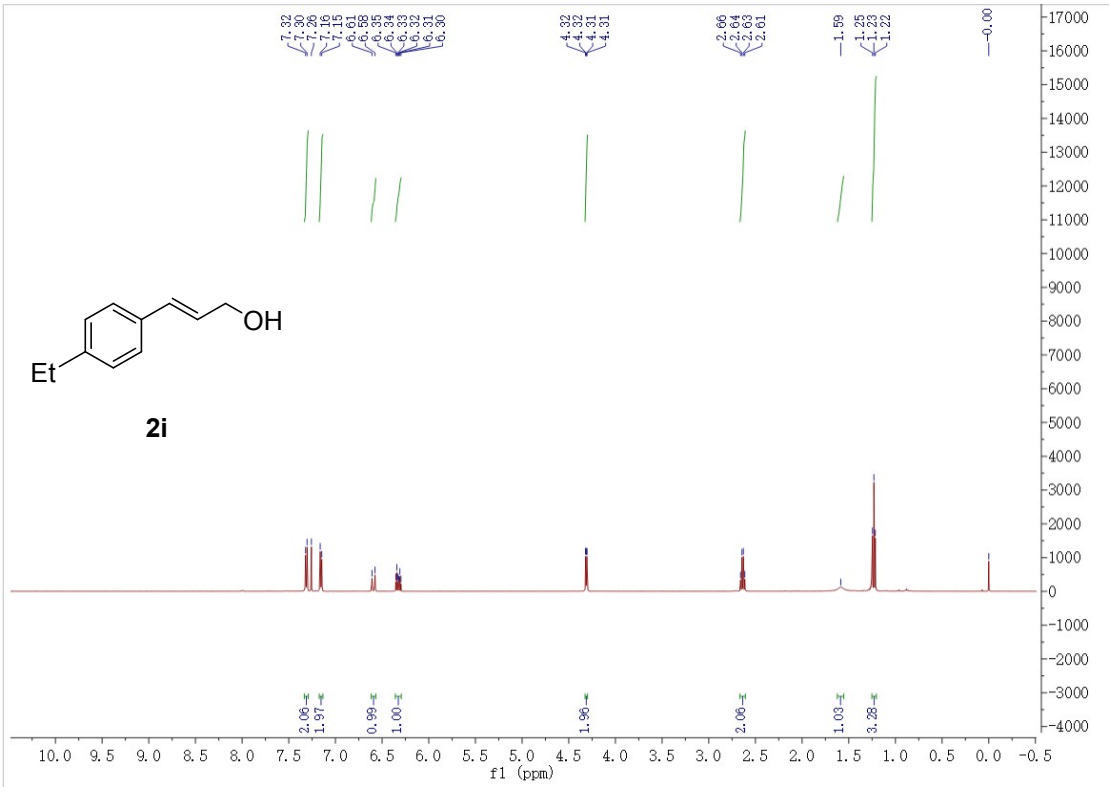
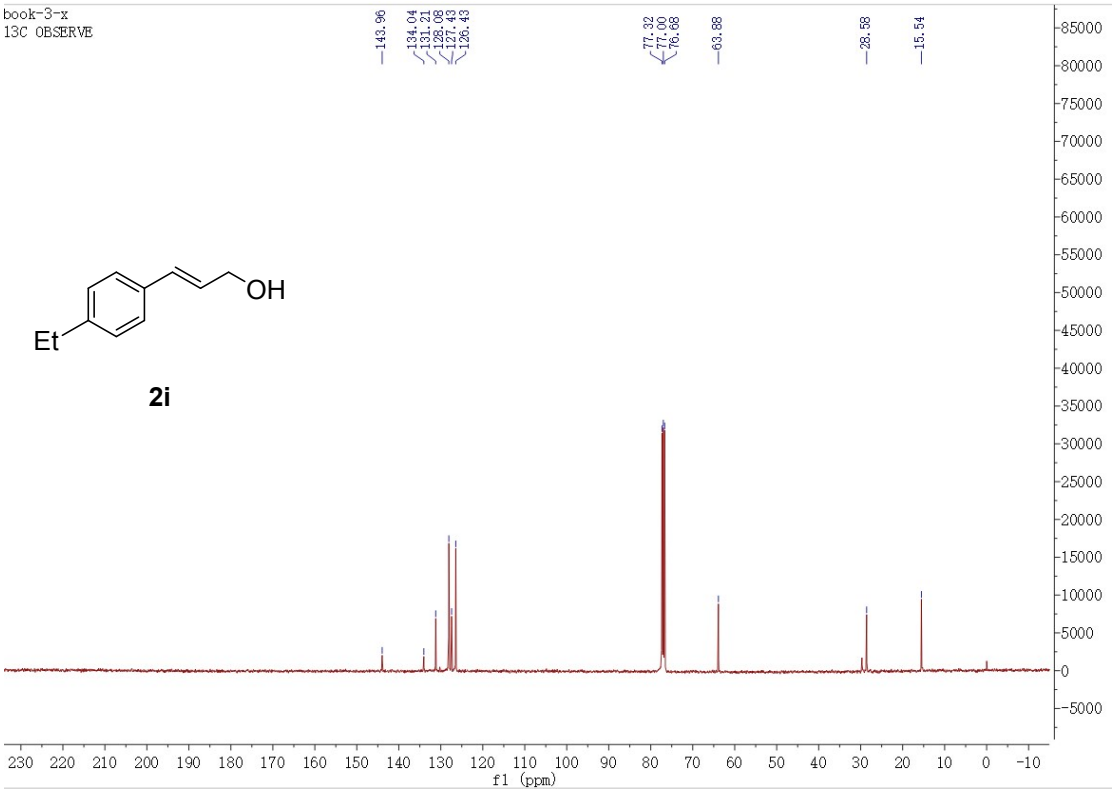

7.32
7.30
7.26
7.16
7.15
6.61
6.58
6.35
6.34
6.33
6.32
6.31
6.30
4.32
4.32
4.31
4.31
2.66
2.64
2.63
2.61
1.59
1.25
1.23
1.22
0.00
OH
Et
2i
2.06
1.97
0.99
1.00
1.96
2.06
1.03
3.28
f1 (ppm)


book-3-x
13C OBSERVE
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134.04
131.21
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77.32
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76.68
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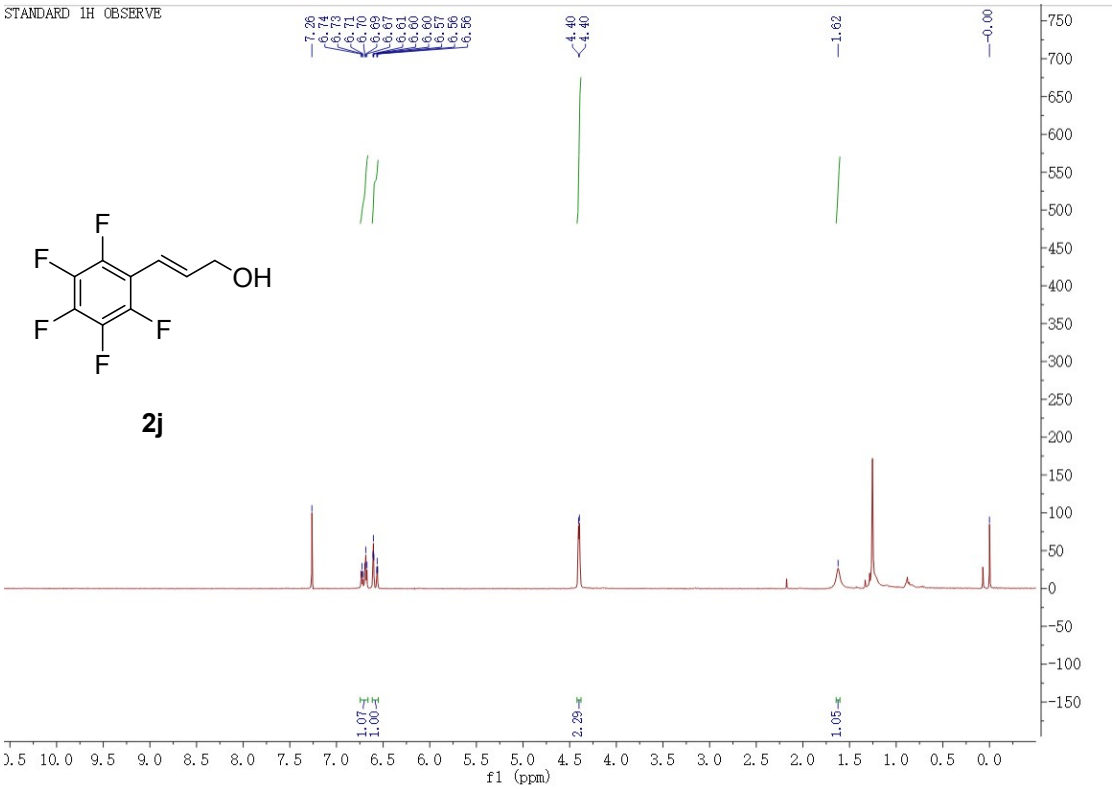
15.54
OH
Et
2i
f1 (ppm)



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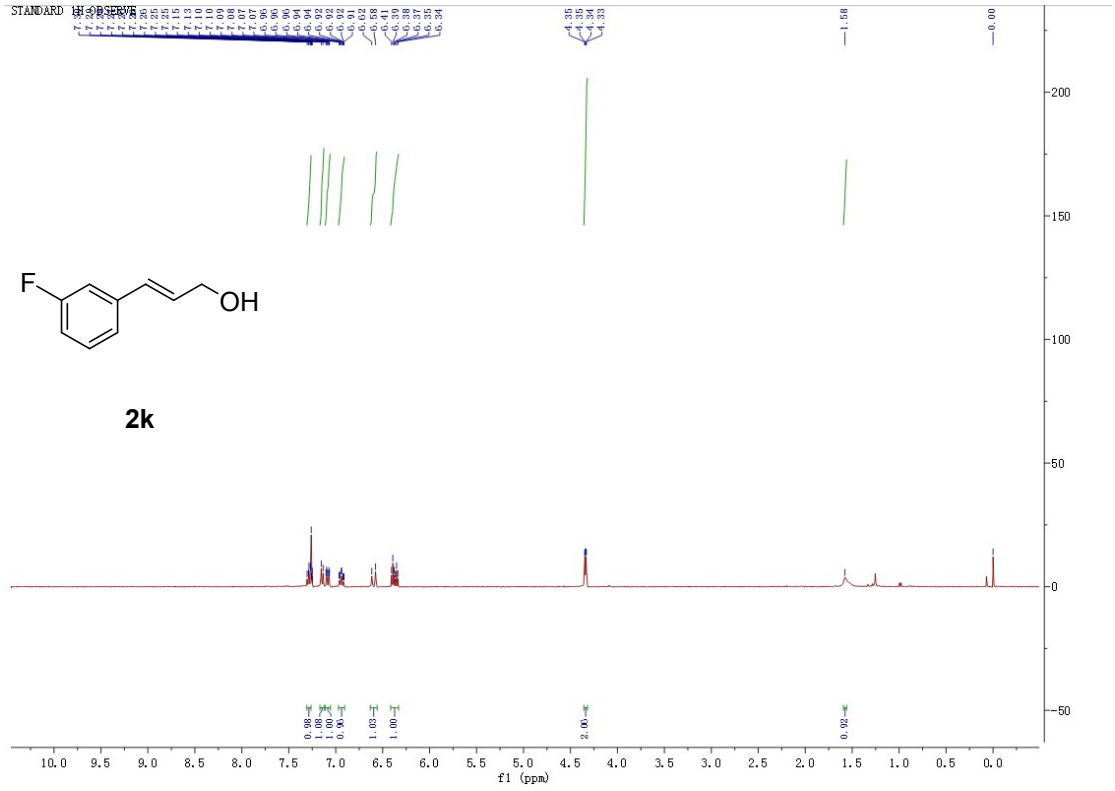

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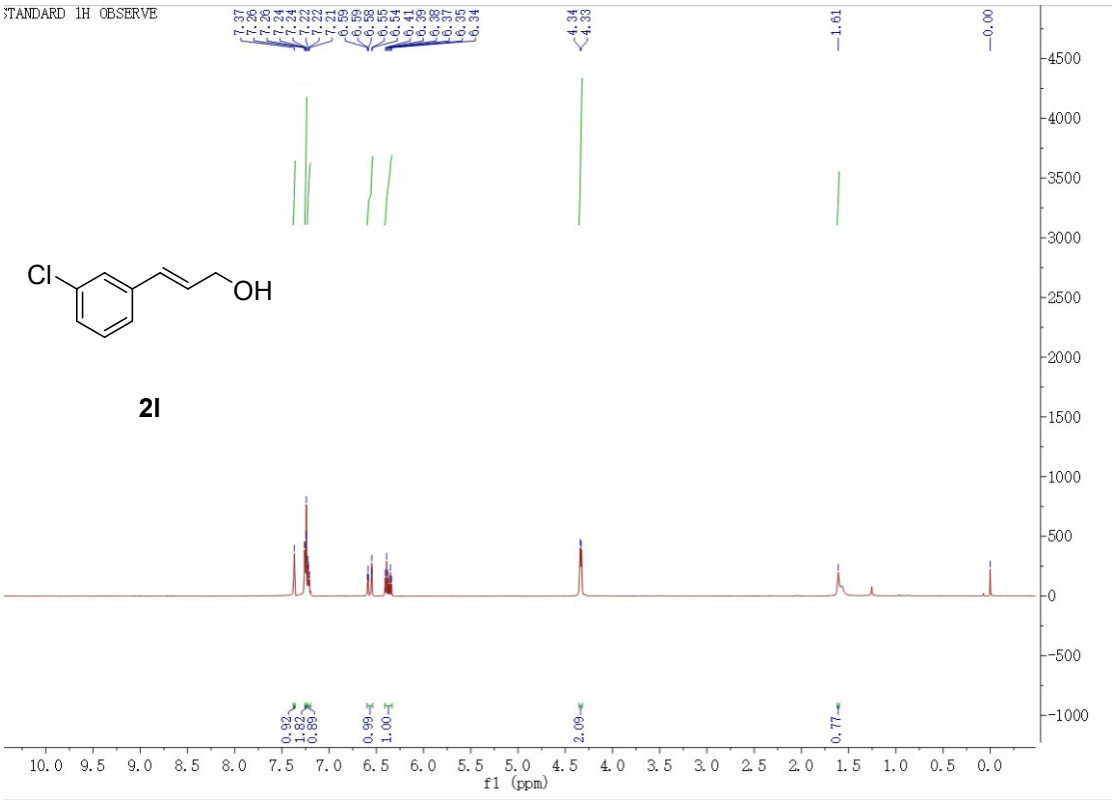

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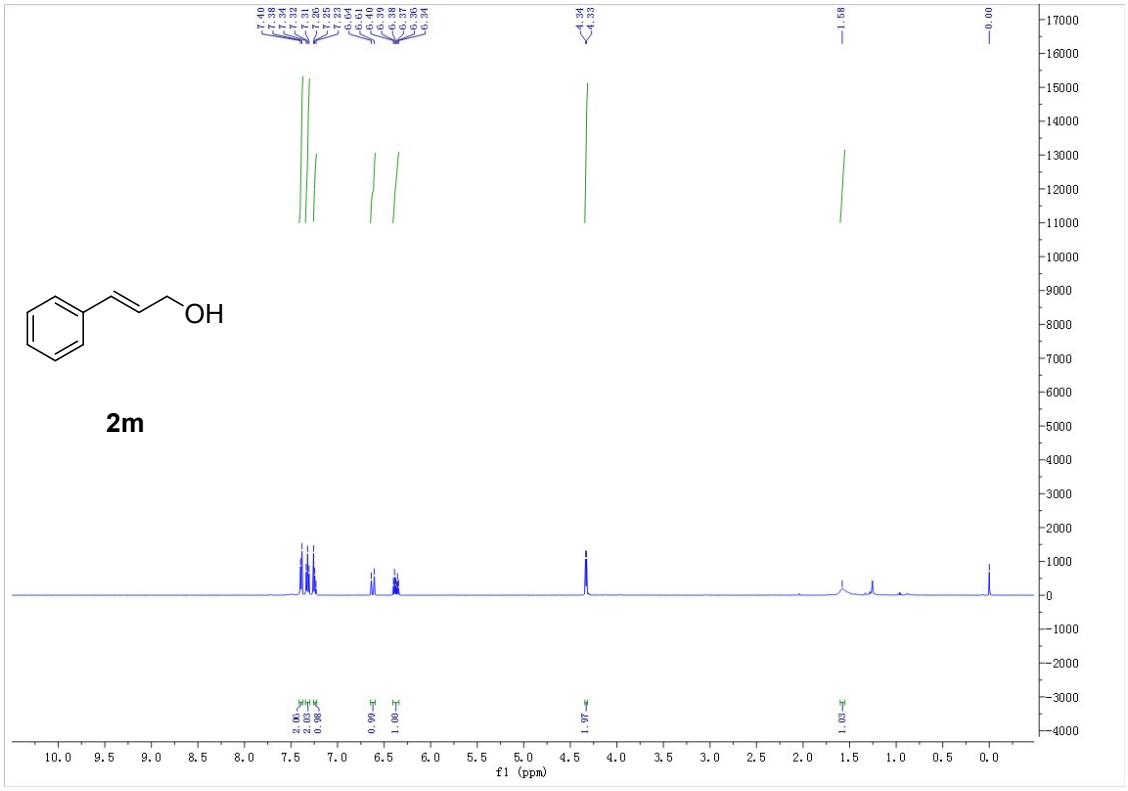
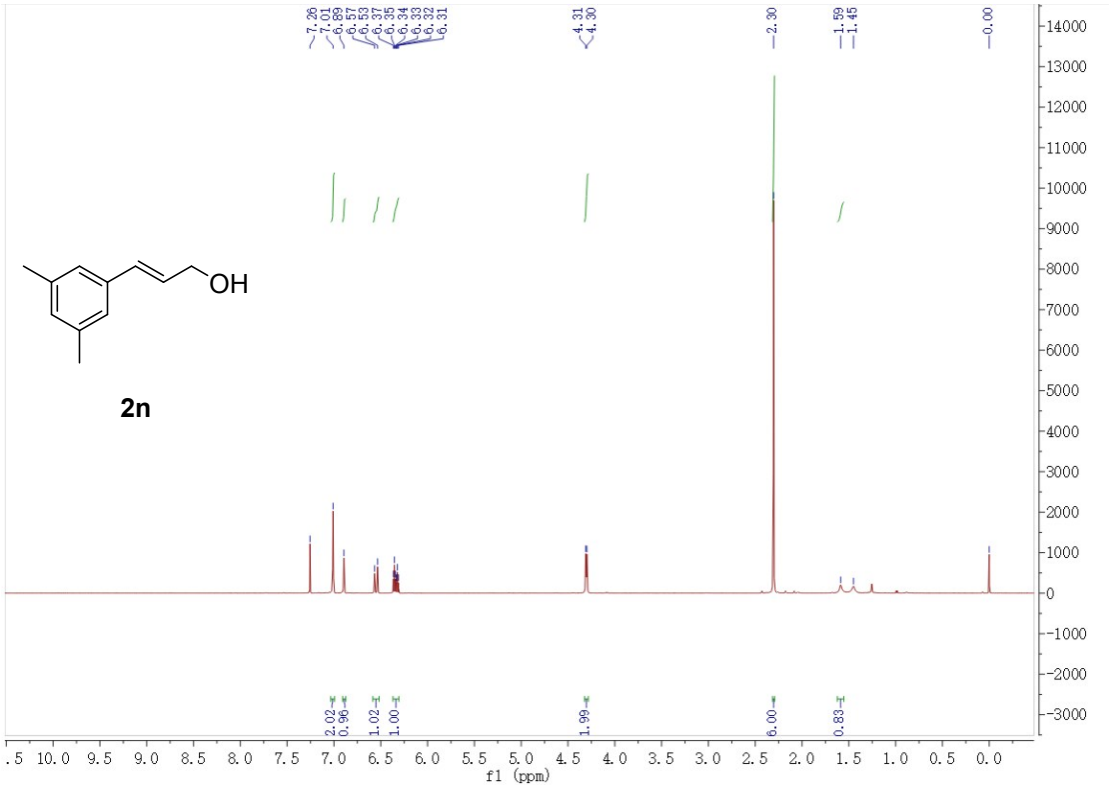


2m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6.35
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6.33
6.32
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4.31
4.30
2.30
1.59
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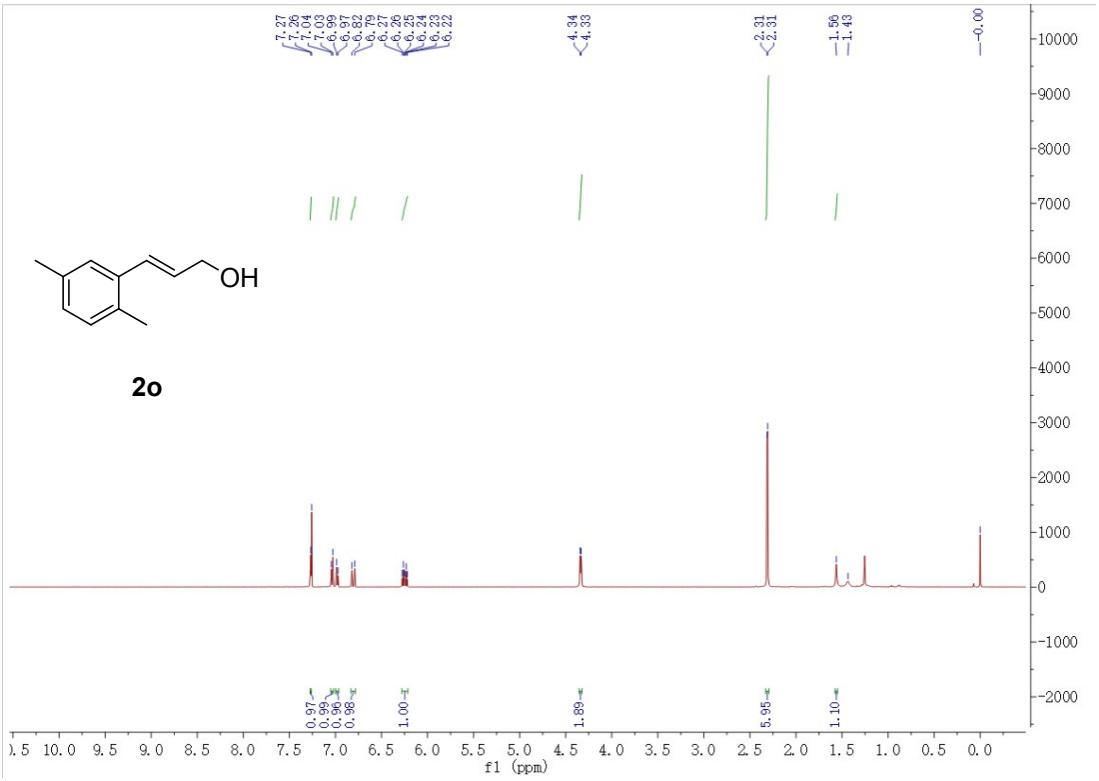
2.02
0.96
1.02
1.00
1.99
6.00
0.83
f1 (ppm)

2n


OH
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6.82
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6.27
6.26
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6.24
6.23
6.22
4.34
4.33
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2.31
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0.99
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0.98
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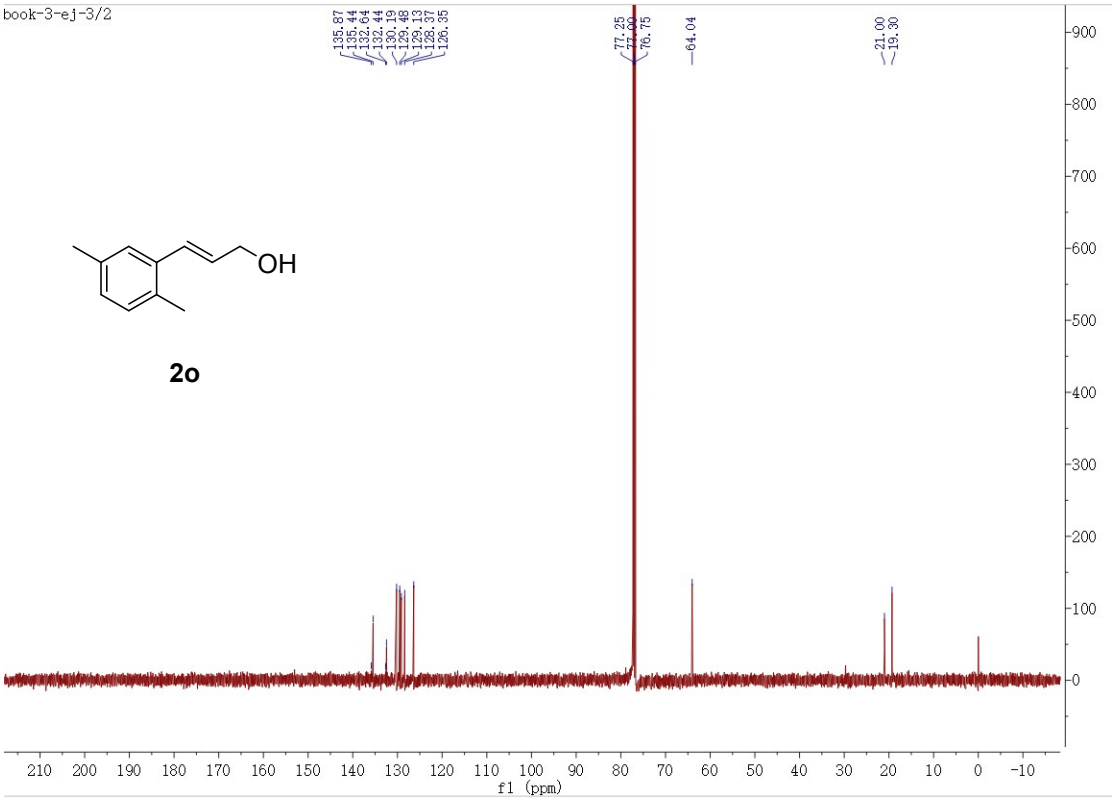
f1 (ppm)

2o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21.00
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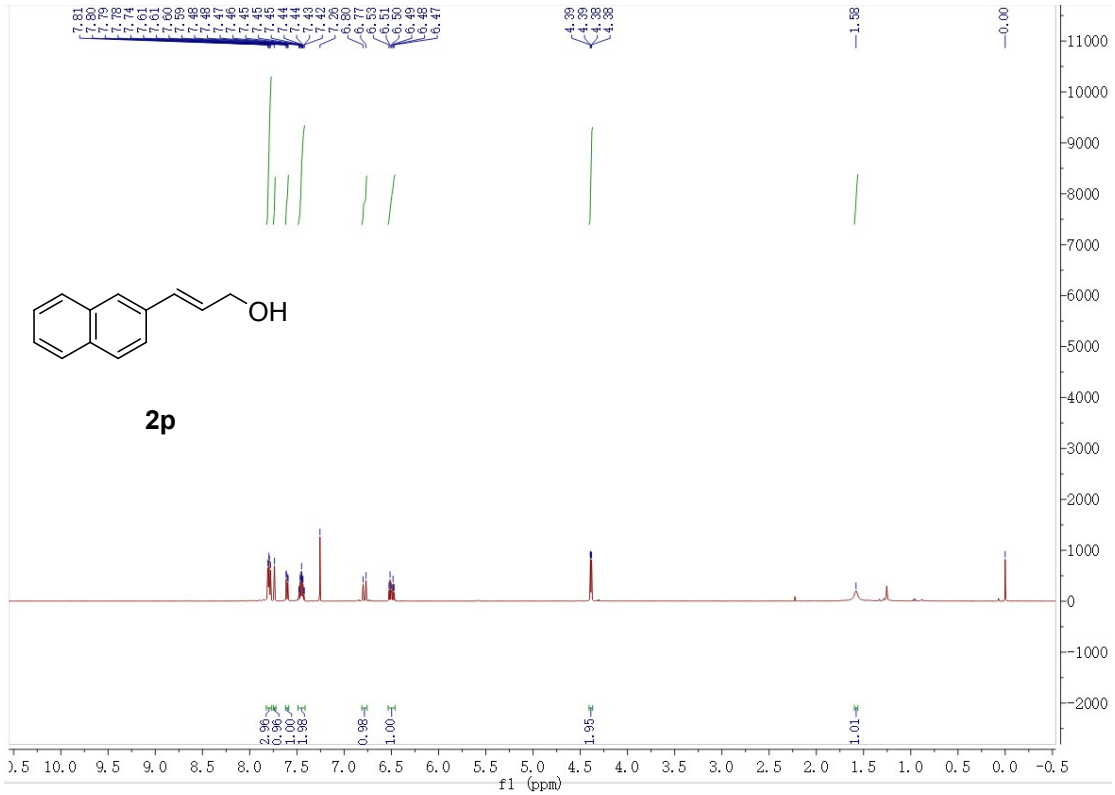
OH
f1 (ppm)

2o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7.48
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6.48
6.47
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4.39
4.38
4.38
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0.00
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0.96
1.00
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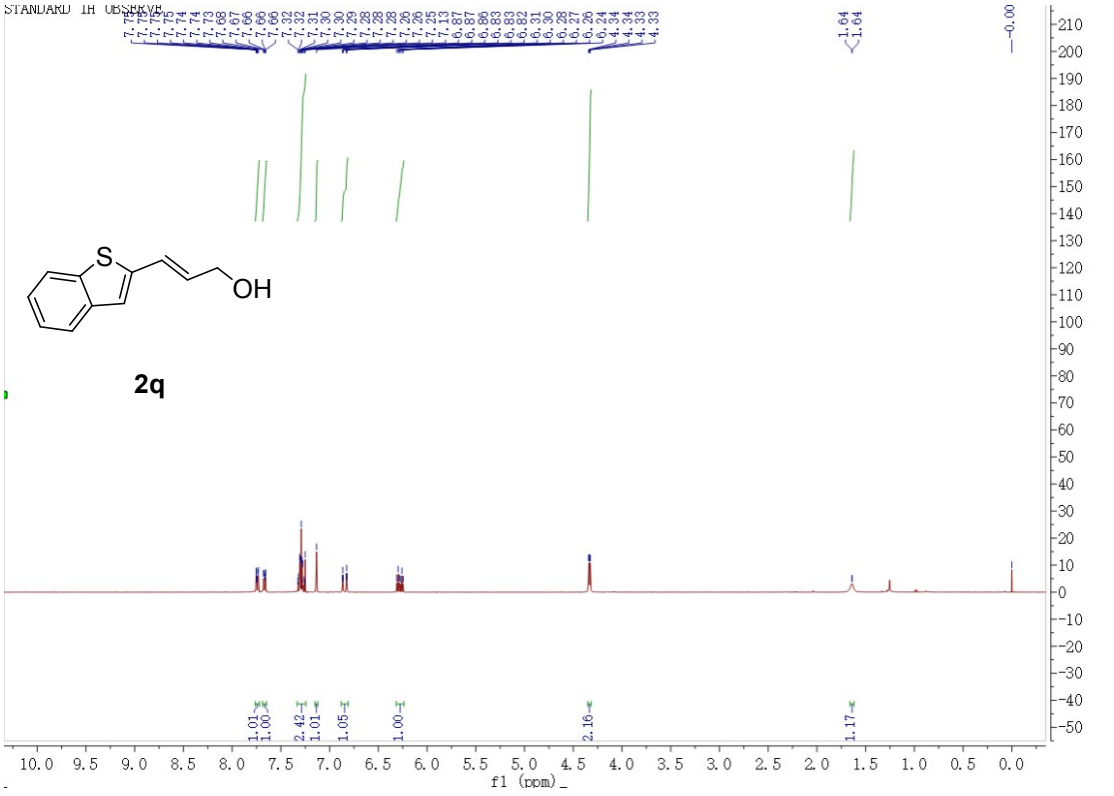
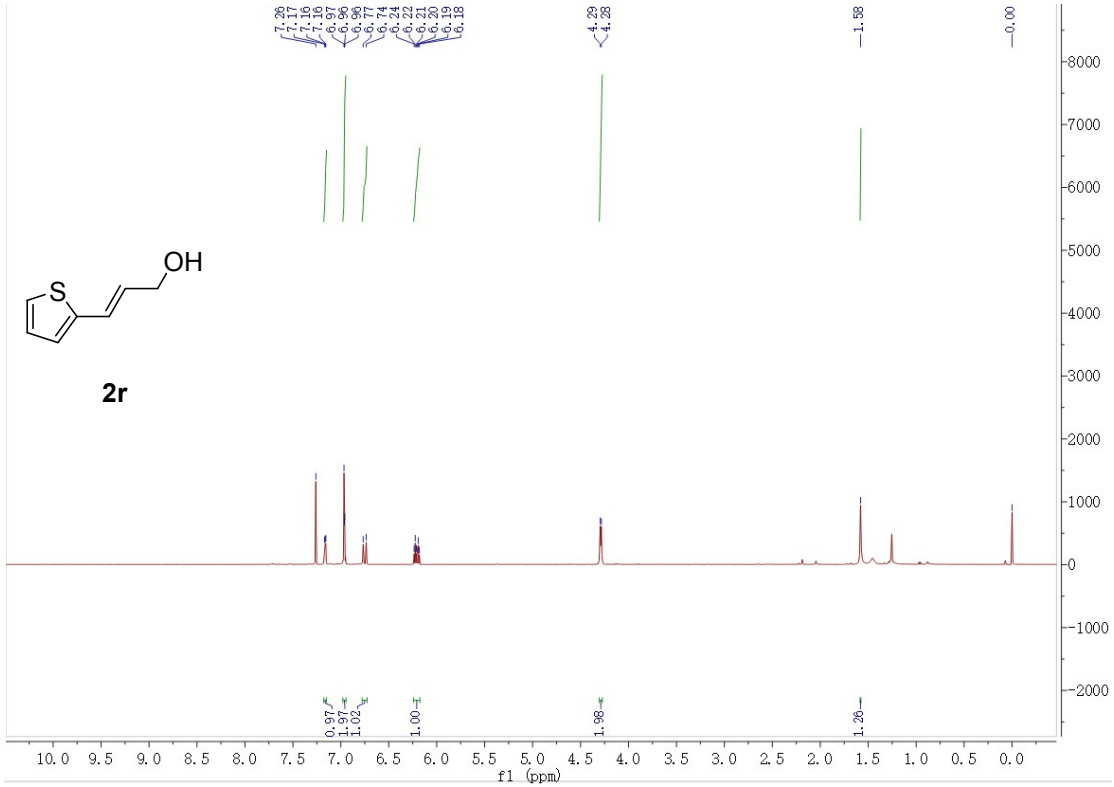
1.00
1.95
1.01
OH
f1 (ppm)

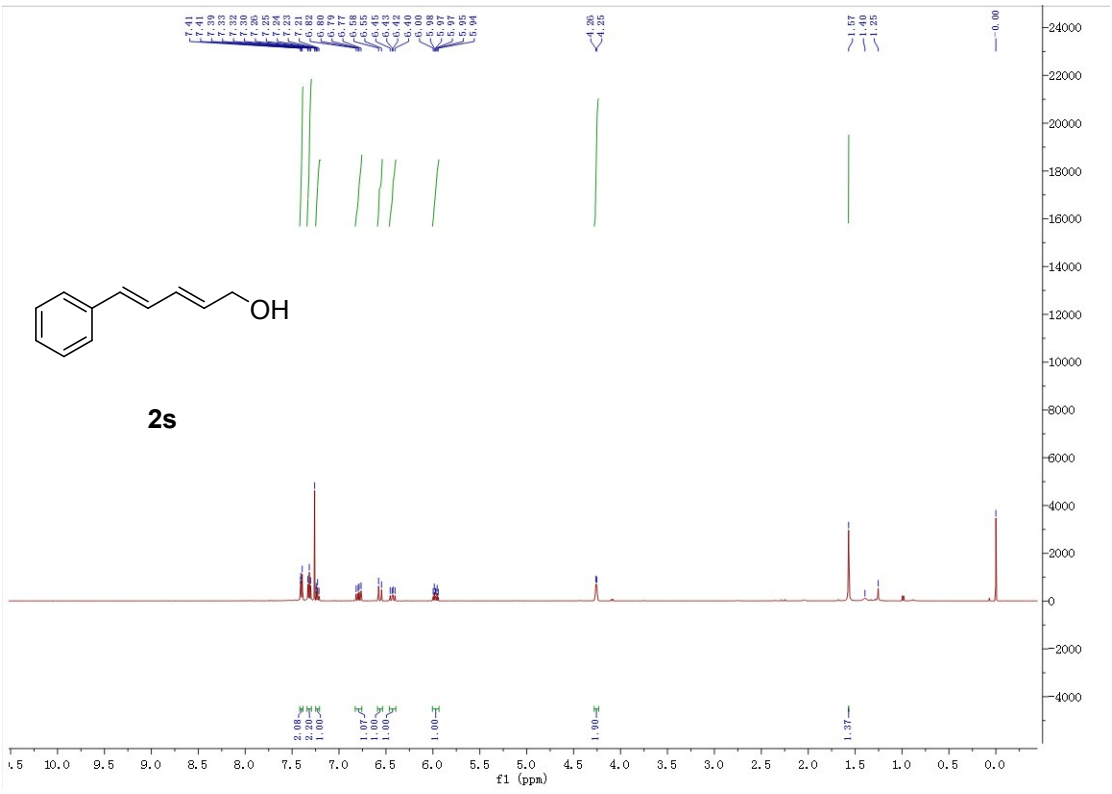
2p



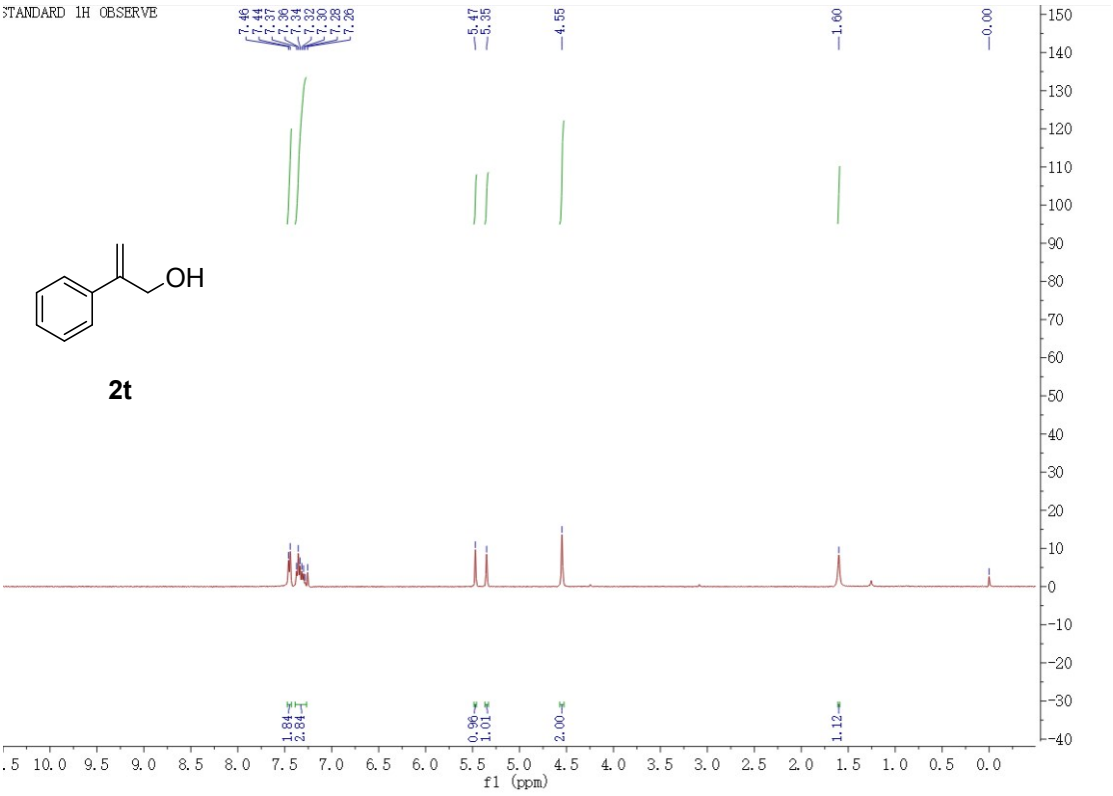
2q



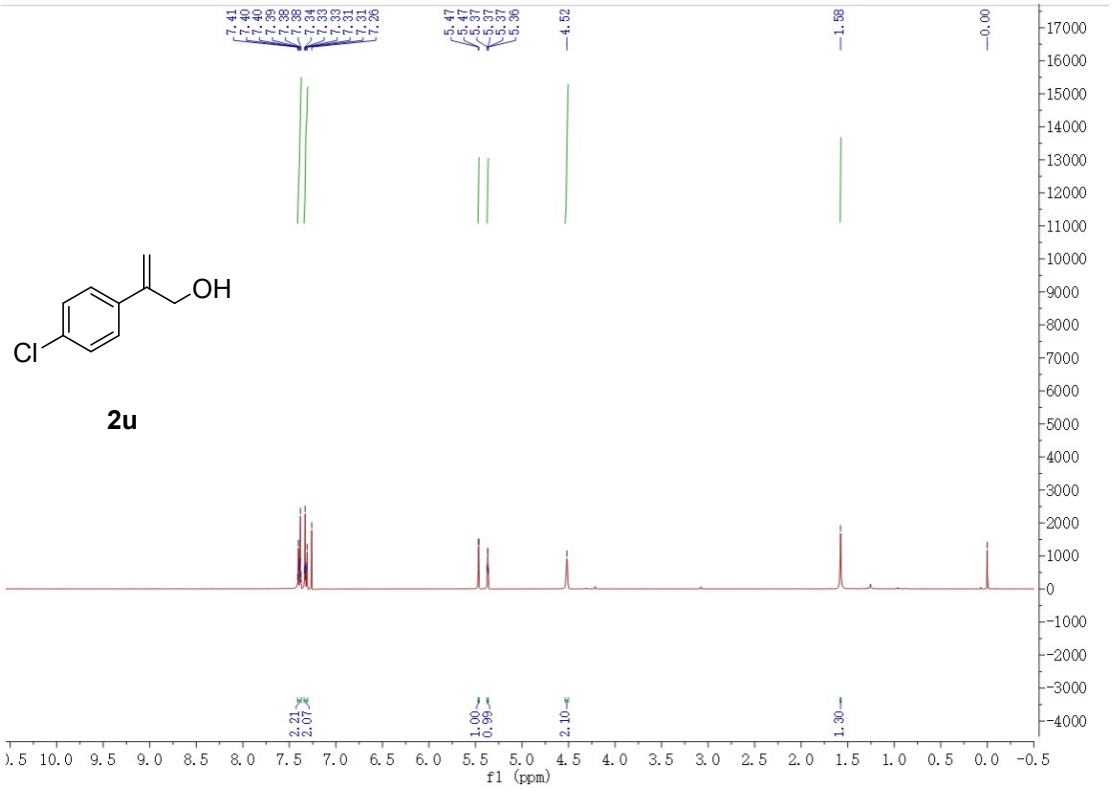
2r



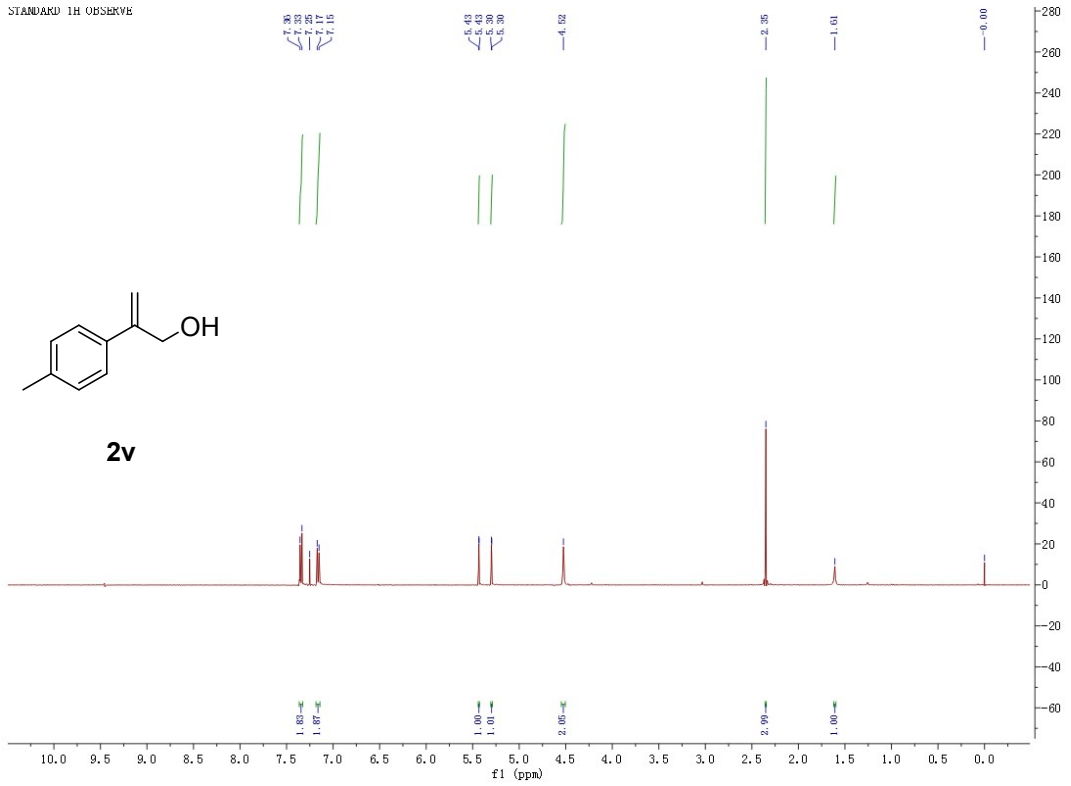
2s



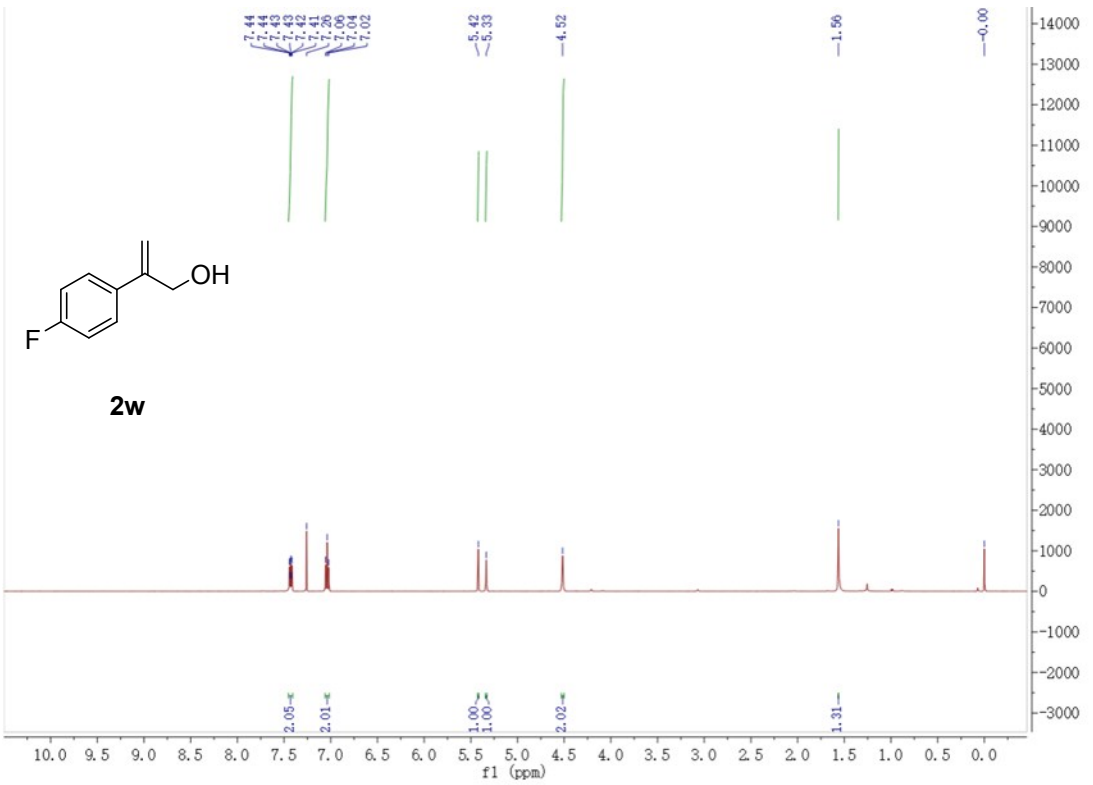
2t

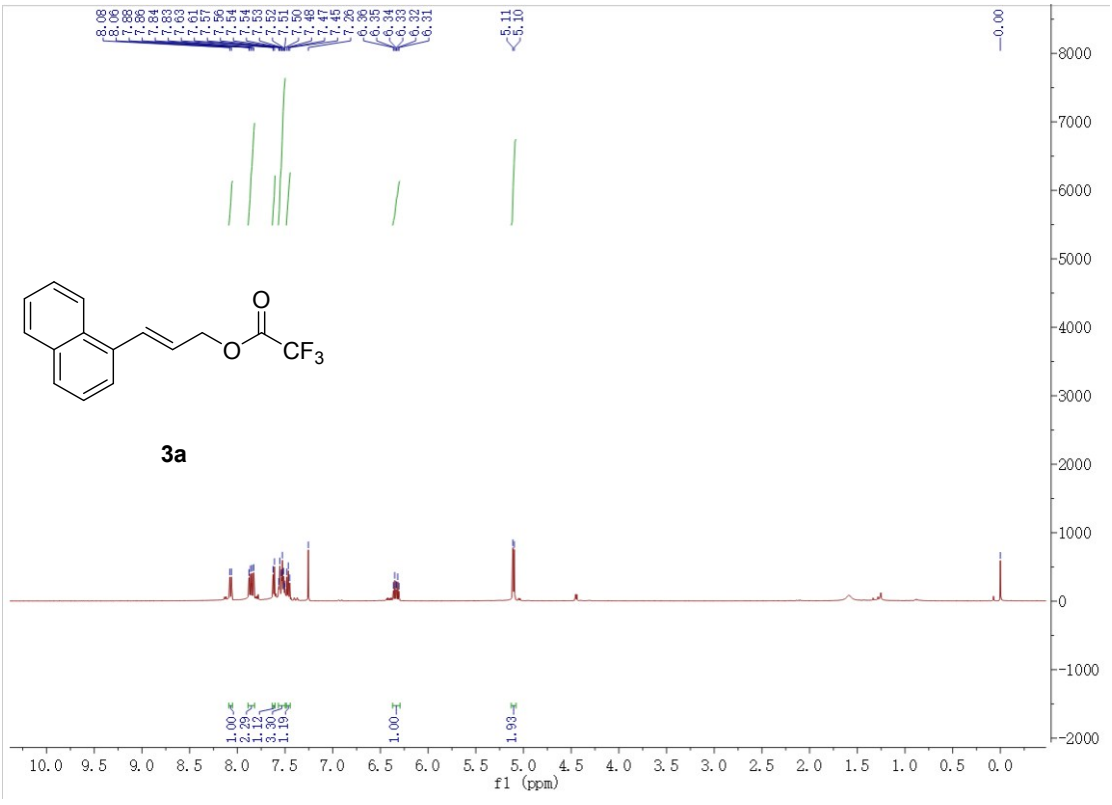


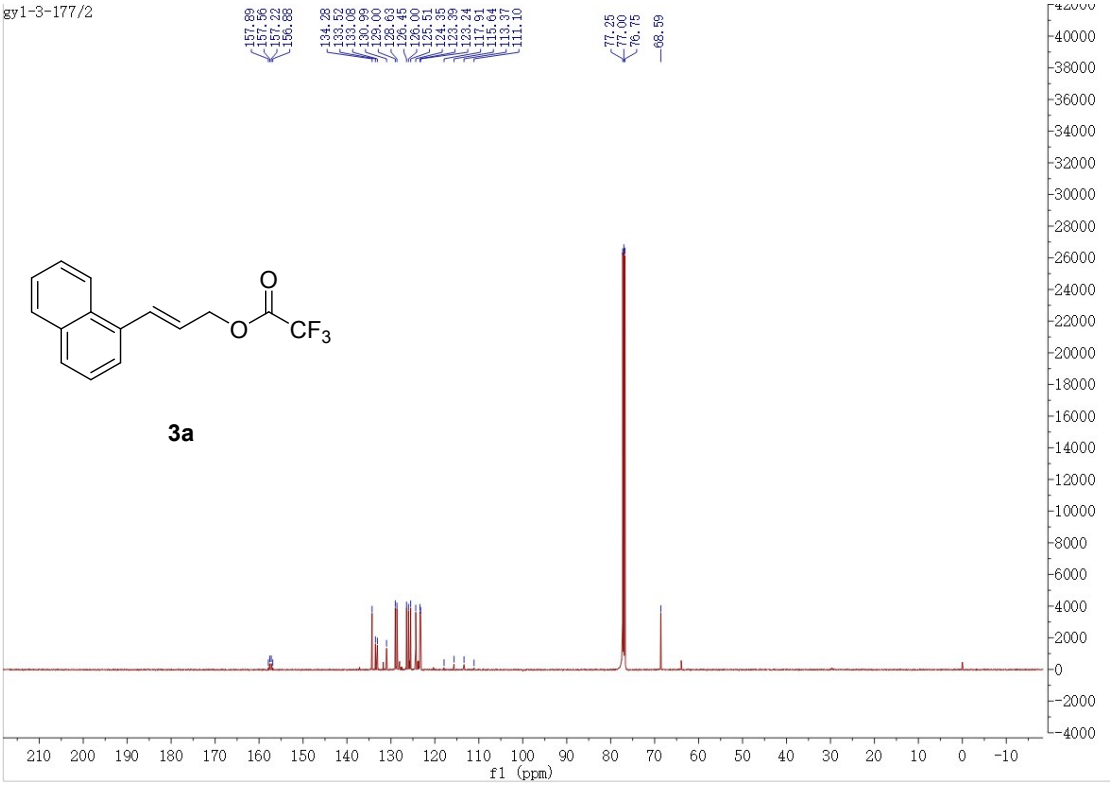
2u

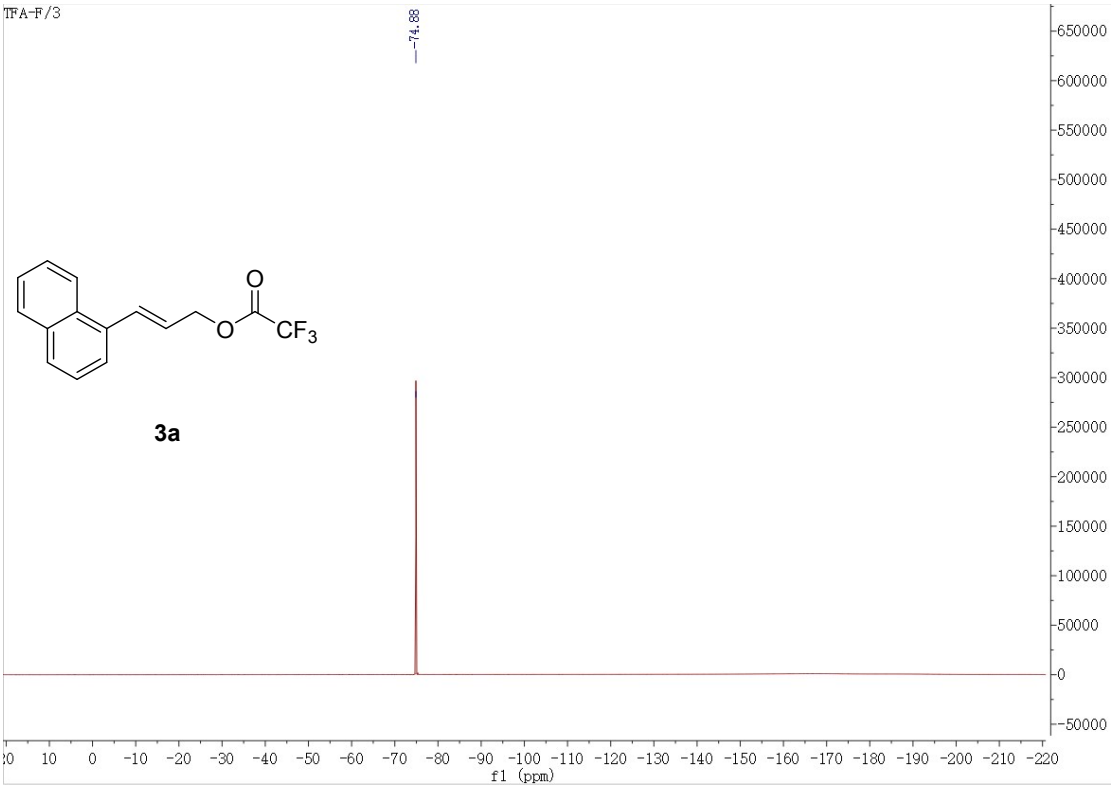


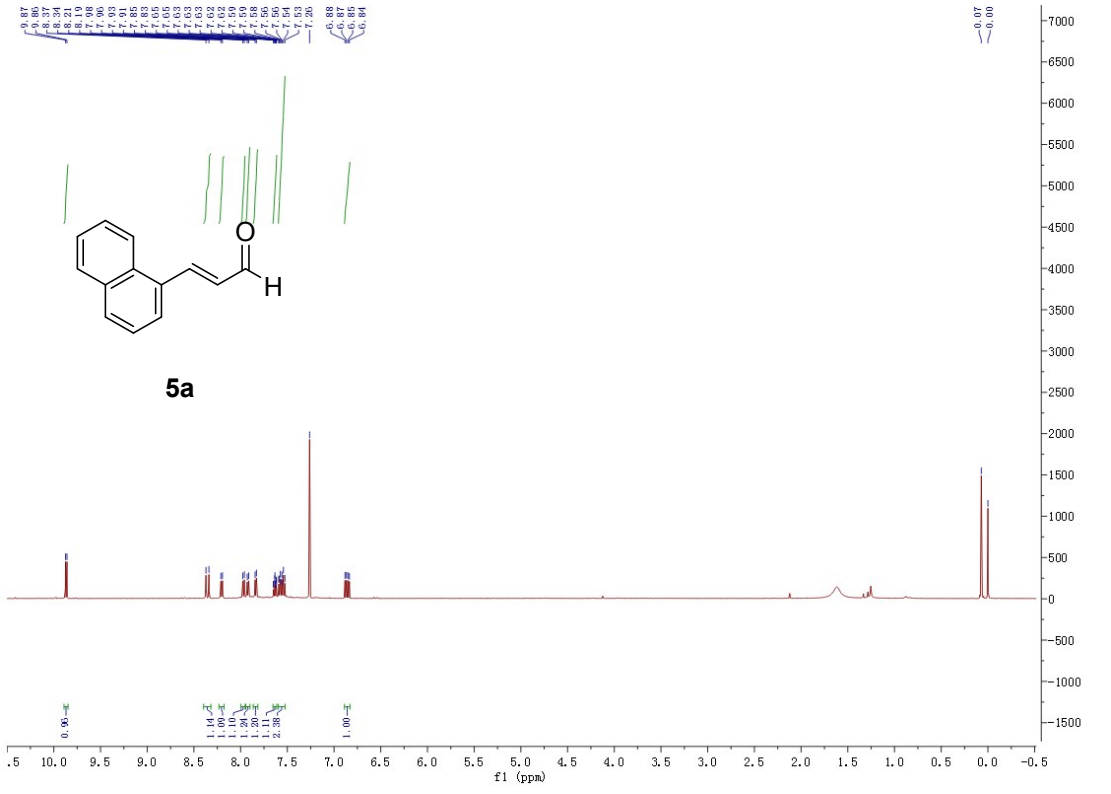
2v


OH
F
2w
f1 (ppm)

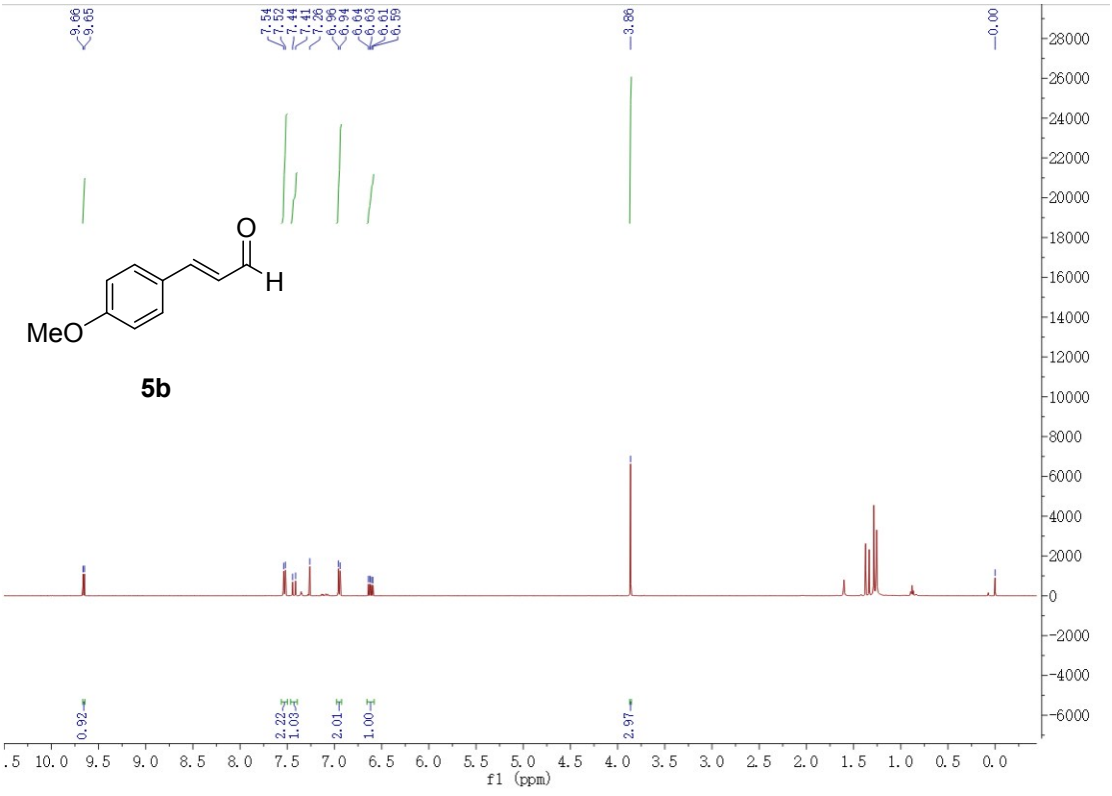

O
O
CF3
3a
f1 (ppm)


gy1-3-177/2
157.89
157.56
157.22
156.88
134.28
133.52
133.08
130.99
129.00
128.63
126.45
126.00
125.51
124.35
123.39
122.24
117.91
115.64
111.97
111.10
77.25
77.00
76.75
68.59
O
O
CF3
3a
f1 (ppm)

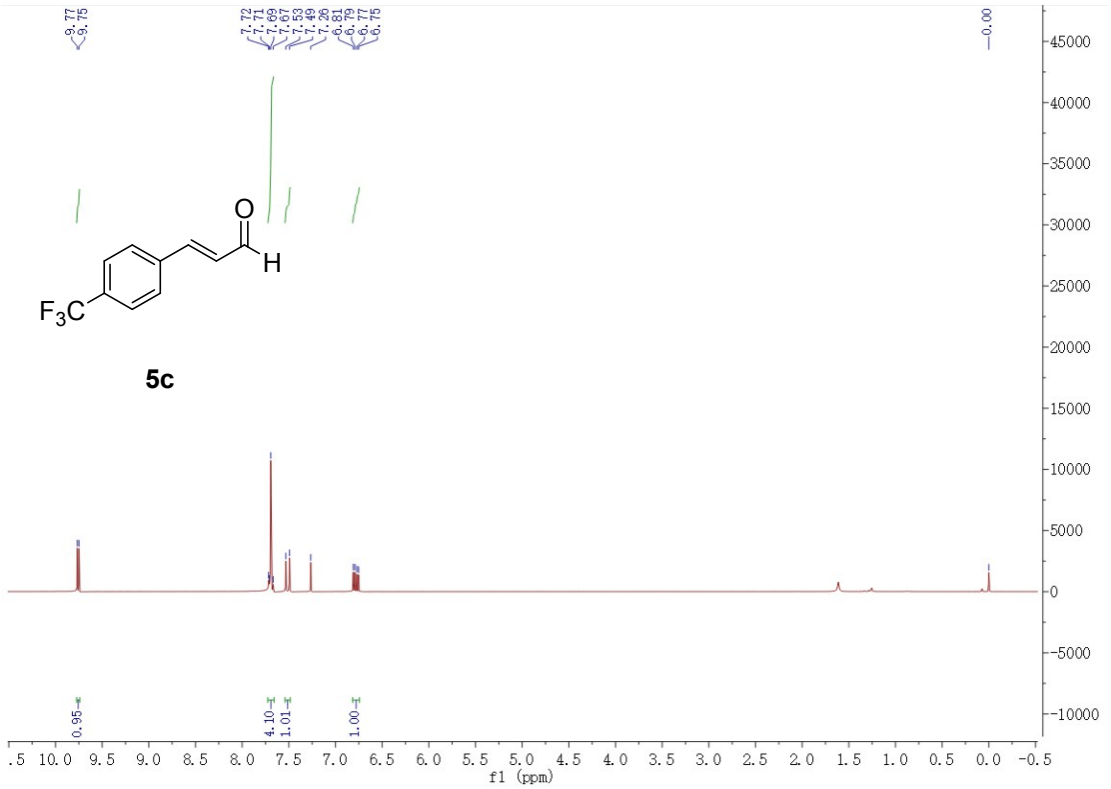

TFA-F/3
-74.88
O
O
CF3
3a
f1 (ppm)



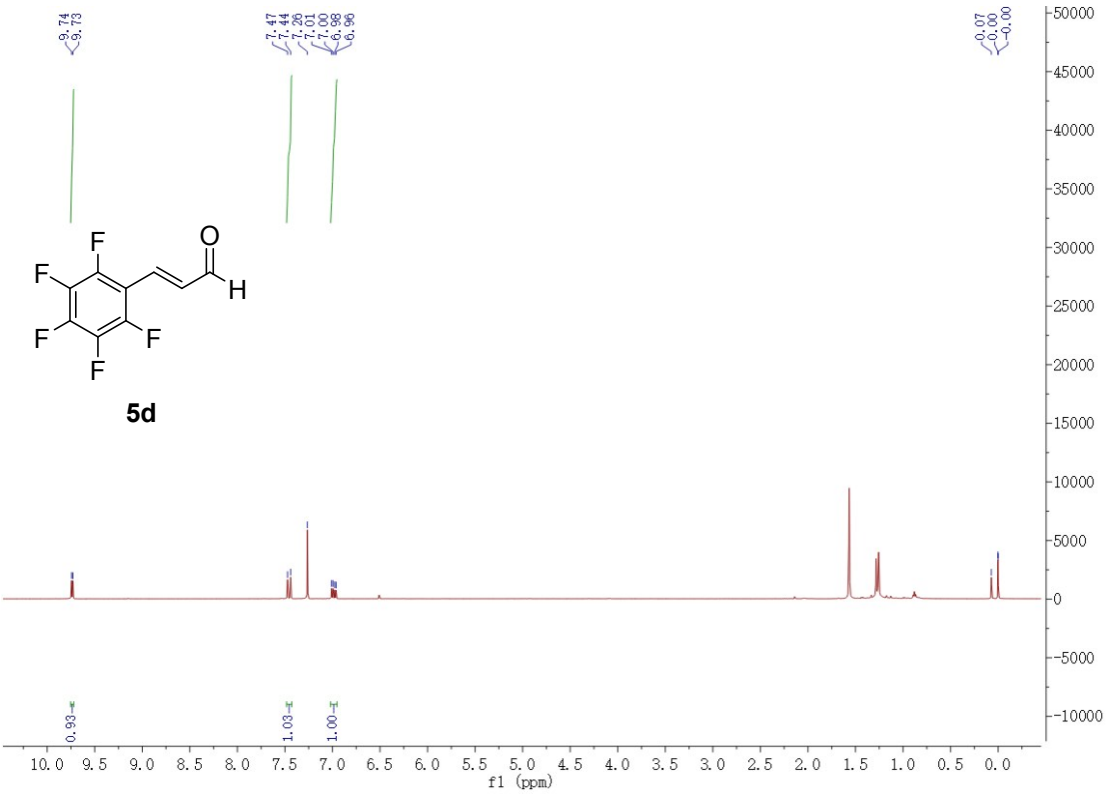
5a



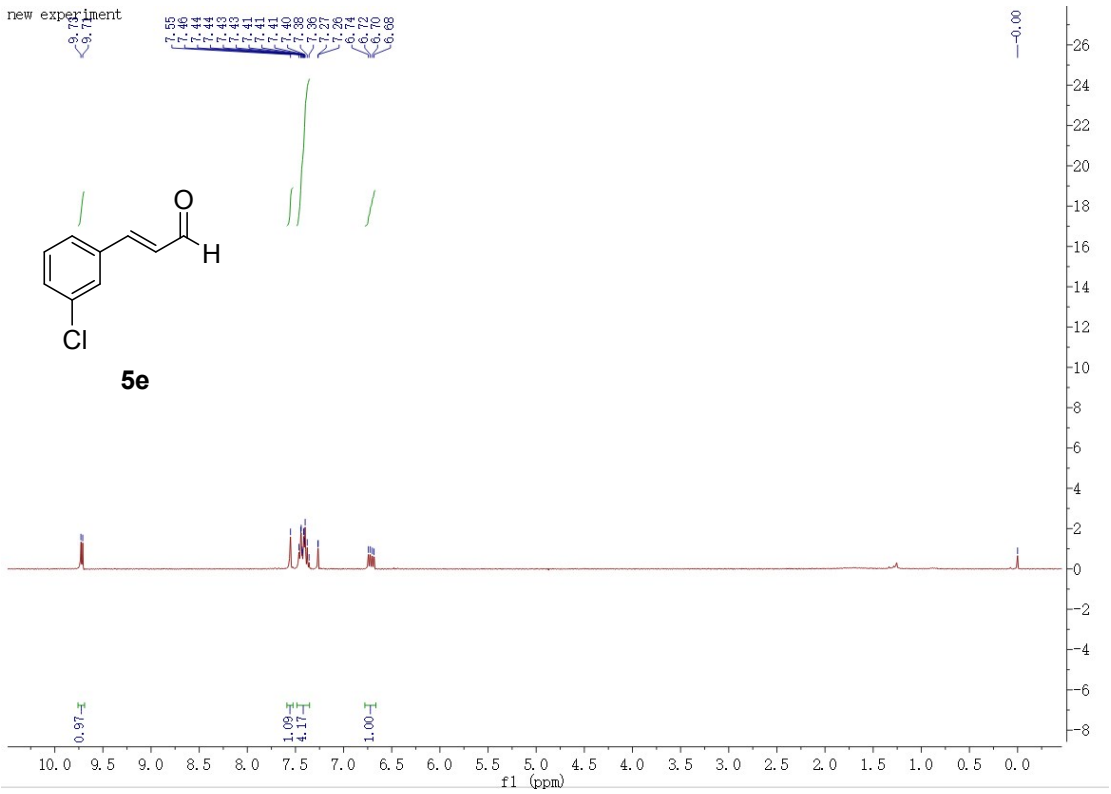
5b


9.77
9.75
7.72
7.71
7.69
7.67
7.53
7.49
7.26
6.81
6.79
6.77
6.75
0.00
O
H
F3C
0.95
4.10
1.01
1.00
f1 (ppm)

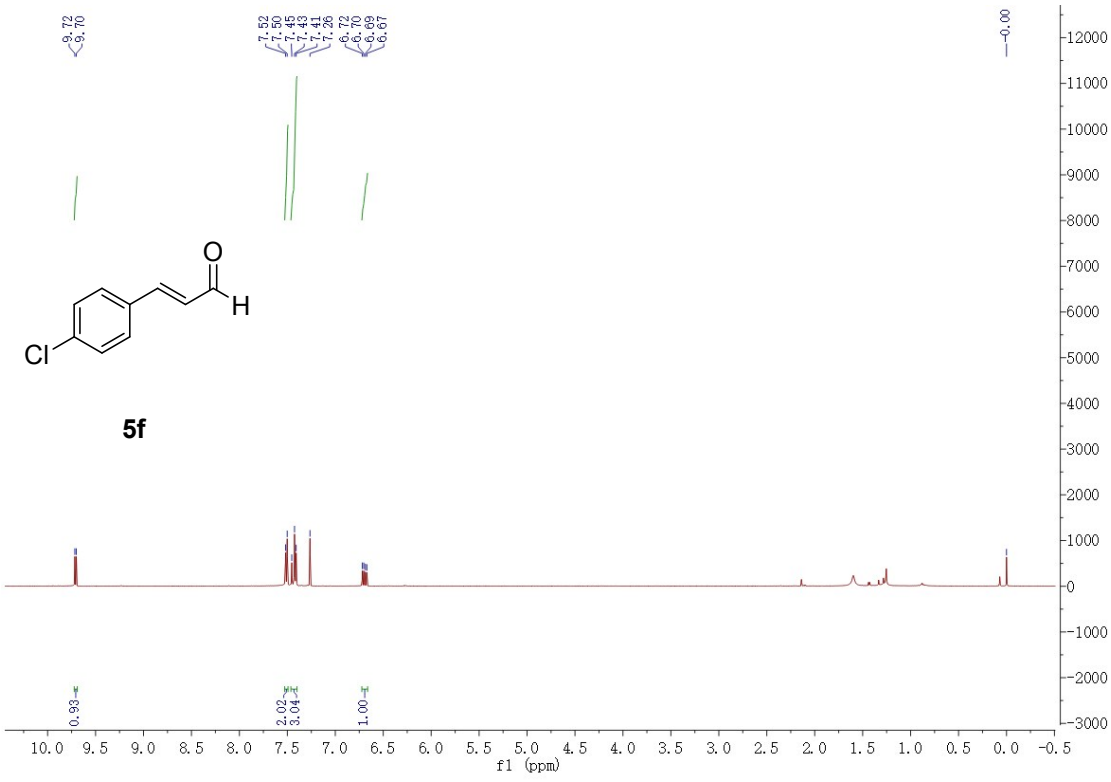
5c


9.74
9.73
7.47
7.44
7.26
7.01
7.00
6.98
6.96
0.07
0.00
-0.00
O
H
F
F
F
F
F
0.93
1.03
1.00
f1 (ppm)

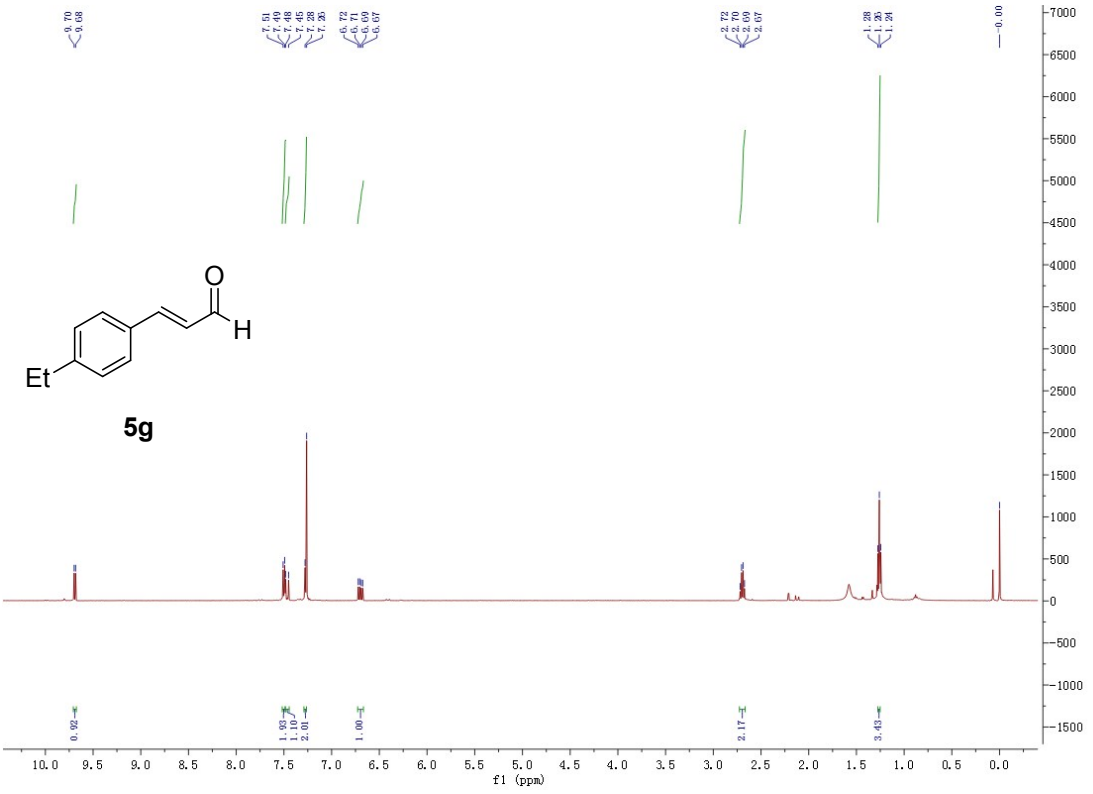
5d


new experiment
9.73
9.71
7.55
7.46
7.44
7.44
7.43
7.43
7.41
7.41
7.40
7.38
7.36
7.27
7.26
6.74
6.72
6.70
6.68
-0.00
O
H
Cl
0.97
1.09
4.17
1.00
f1 (ppm)

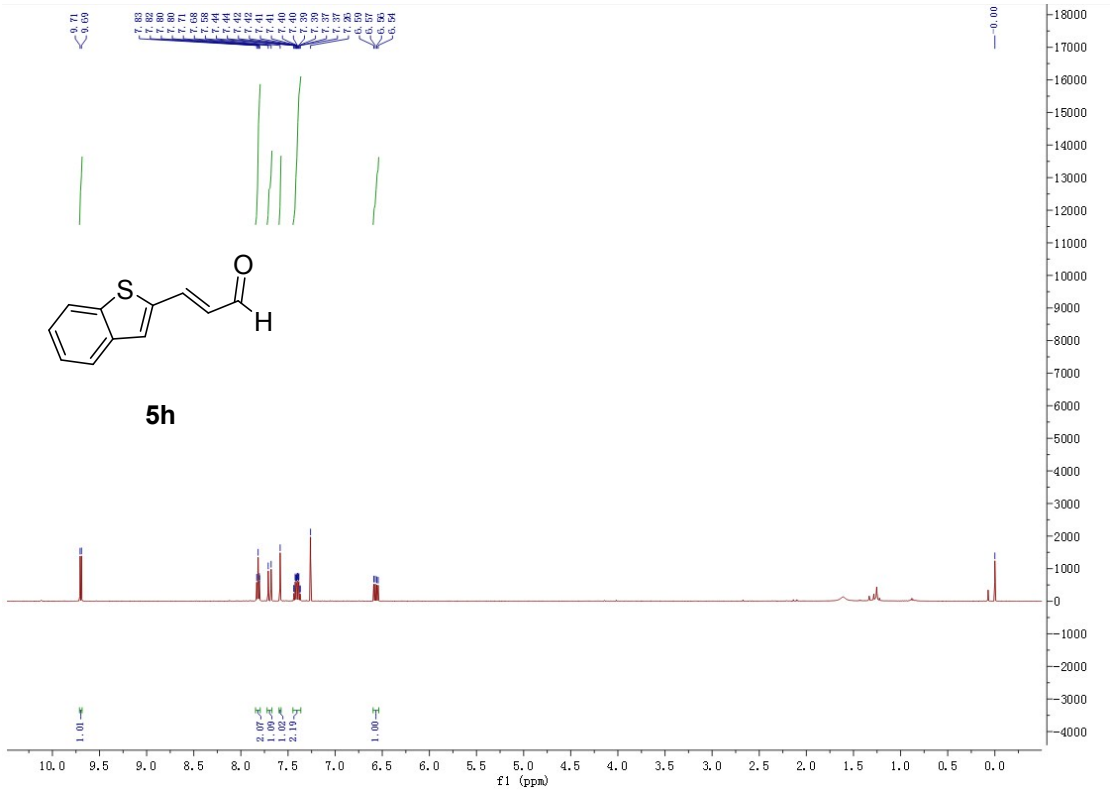
5e


9.72
9.70
7.52
7.50
7.45
7.43
7.41
7.26
6.72
6.70
6.69
6.67
-0.00
O
H
Cl
0.93
2.02
3.04
1.00
f1 (ppm)

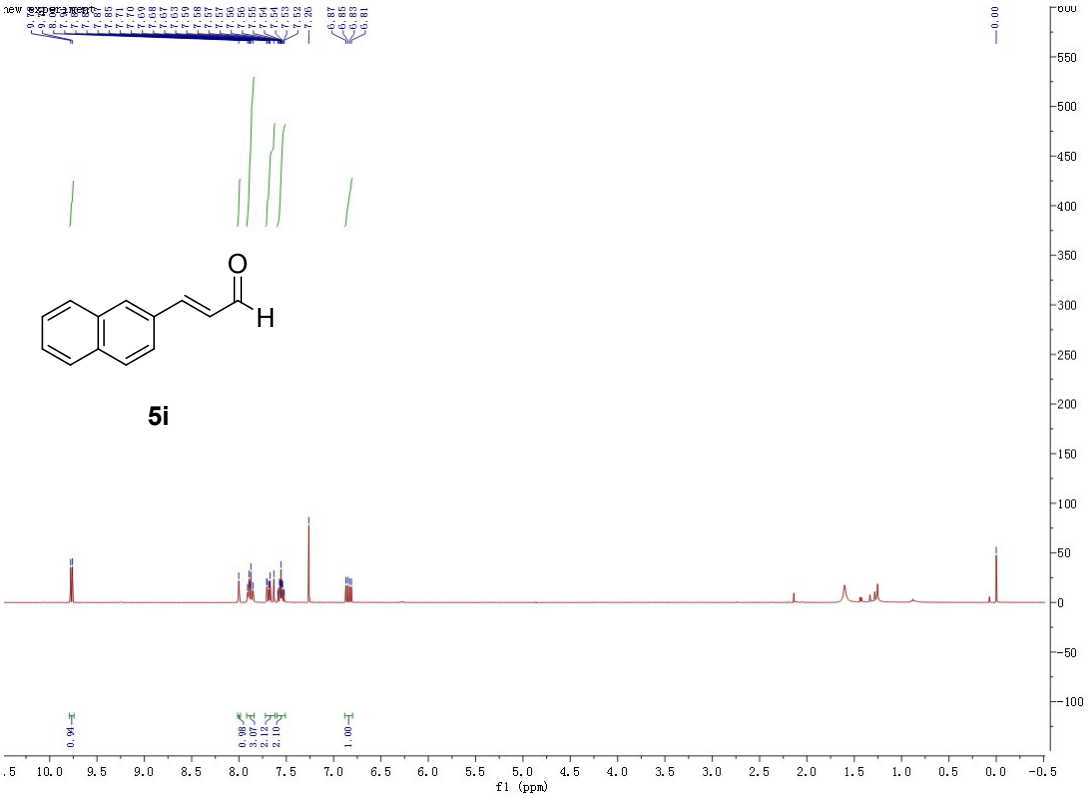
5f

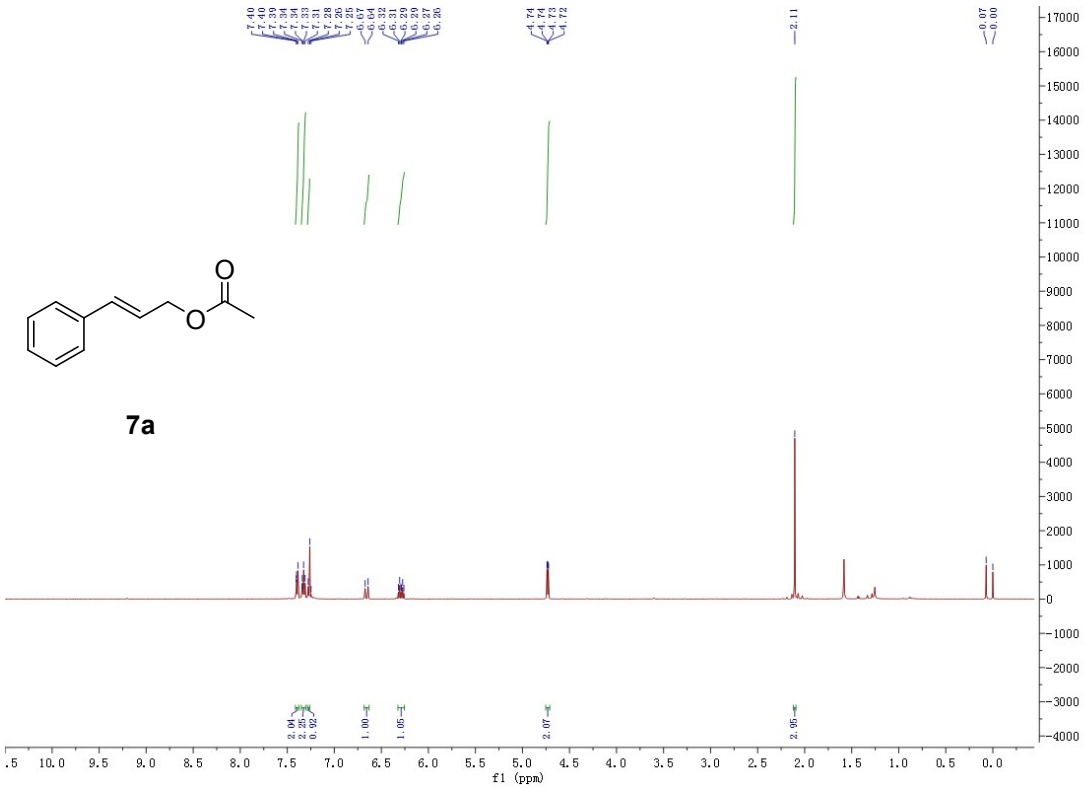


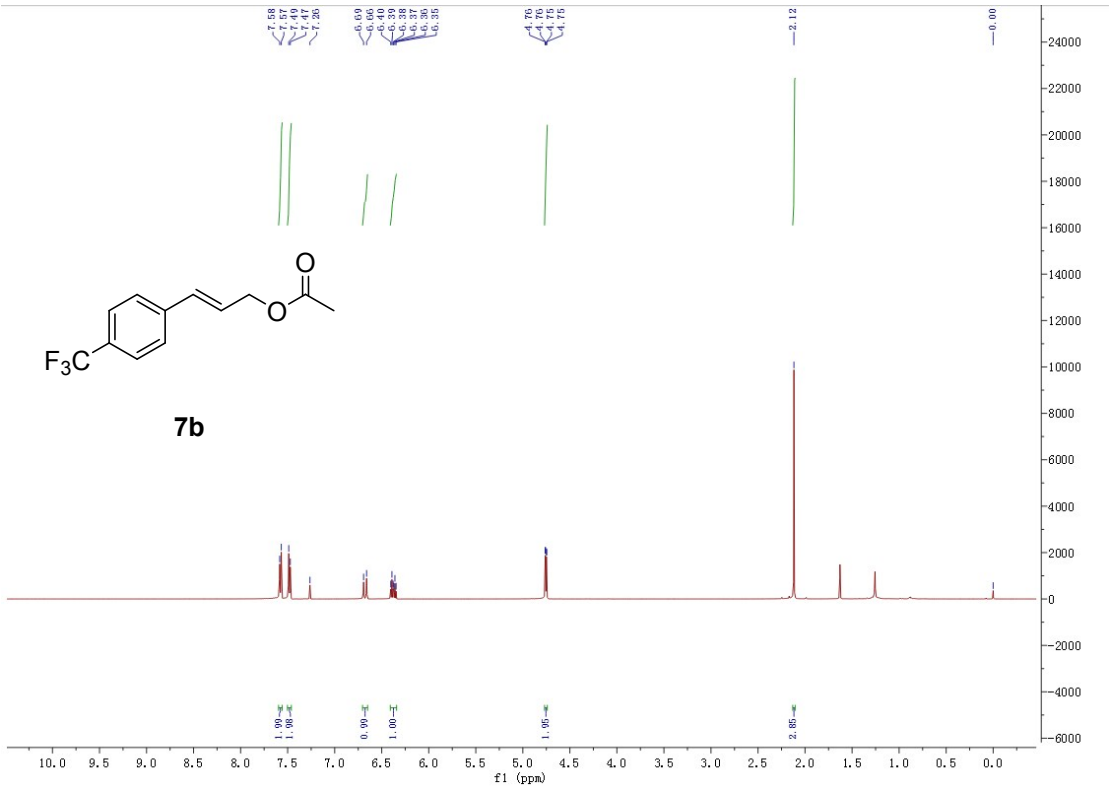
5g

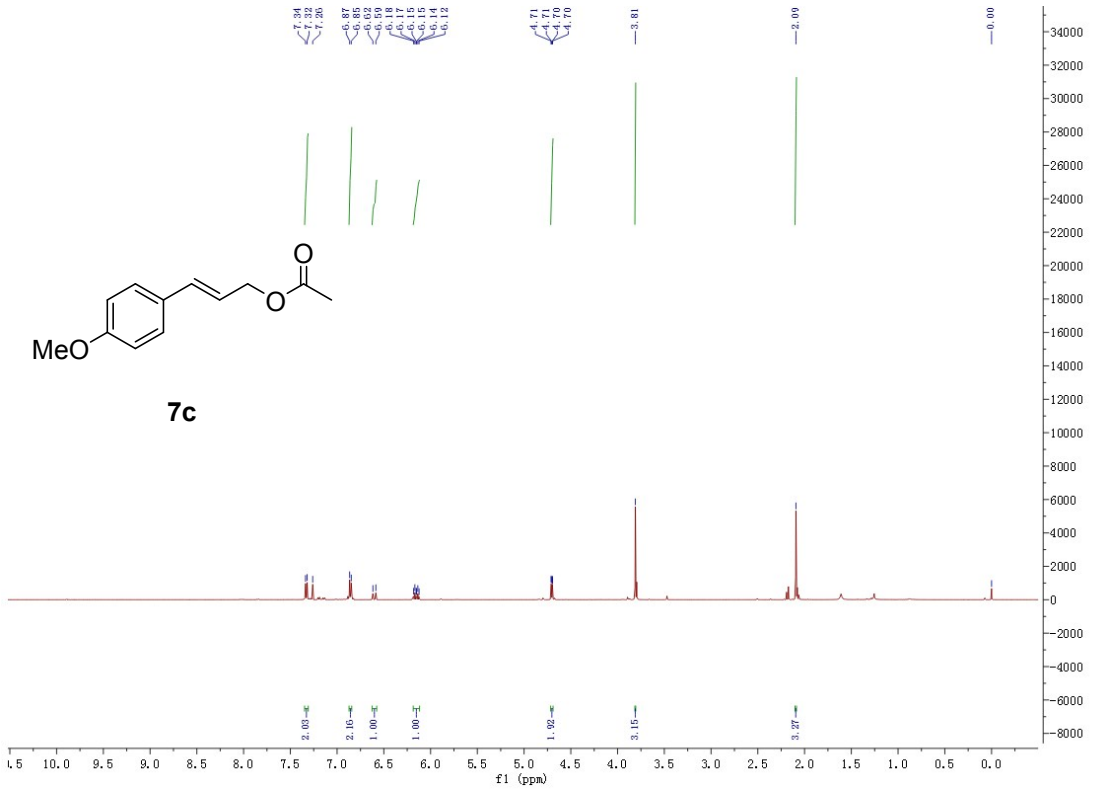


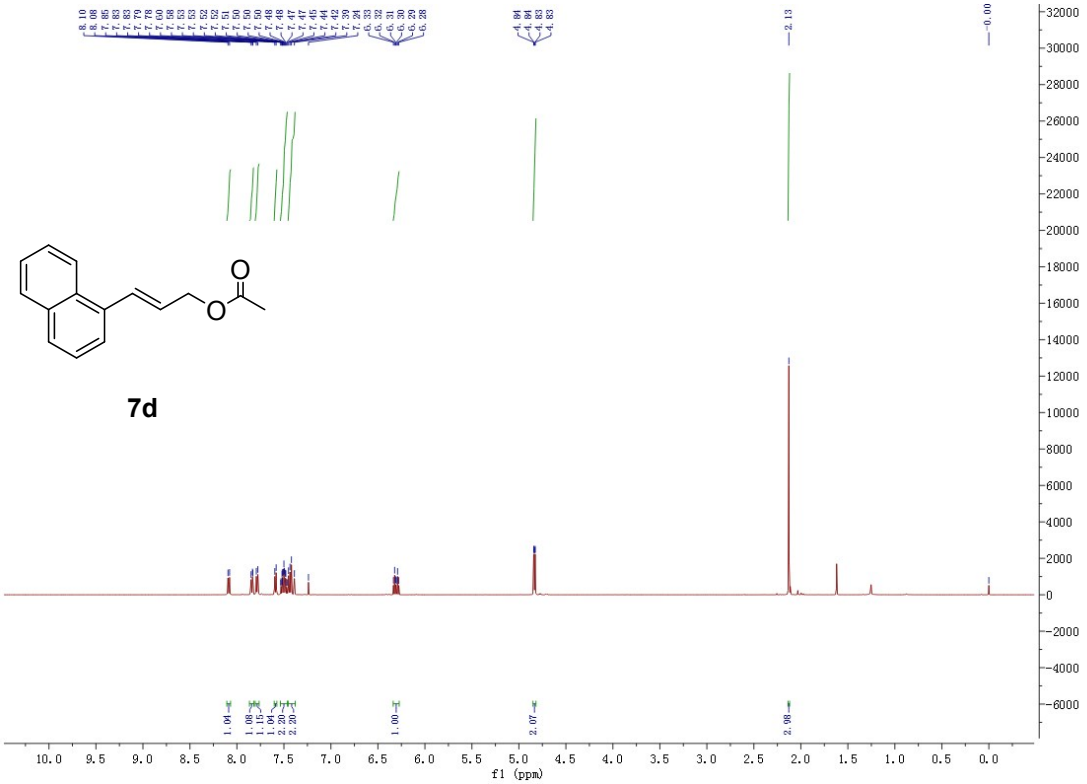
5h


O
H
5i
f1 (ppm)

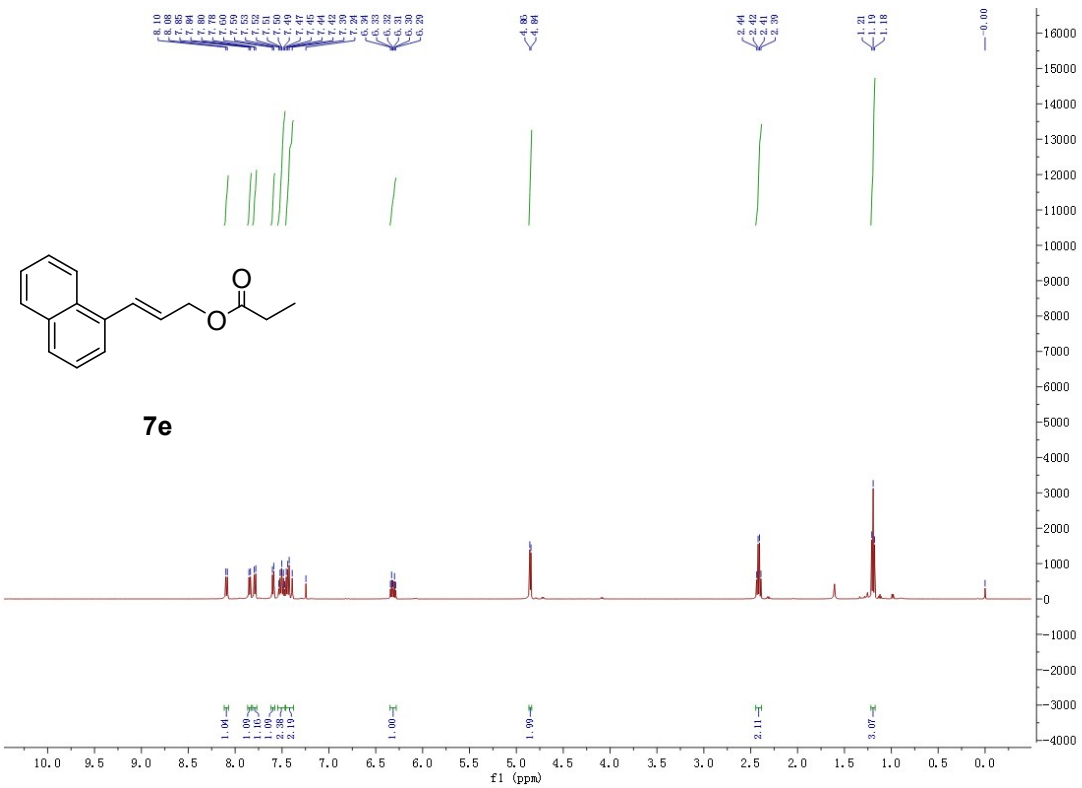

O
O
7a
f1 (ppm)


F3C
O
O
7b
f1 (ppm)

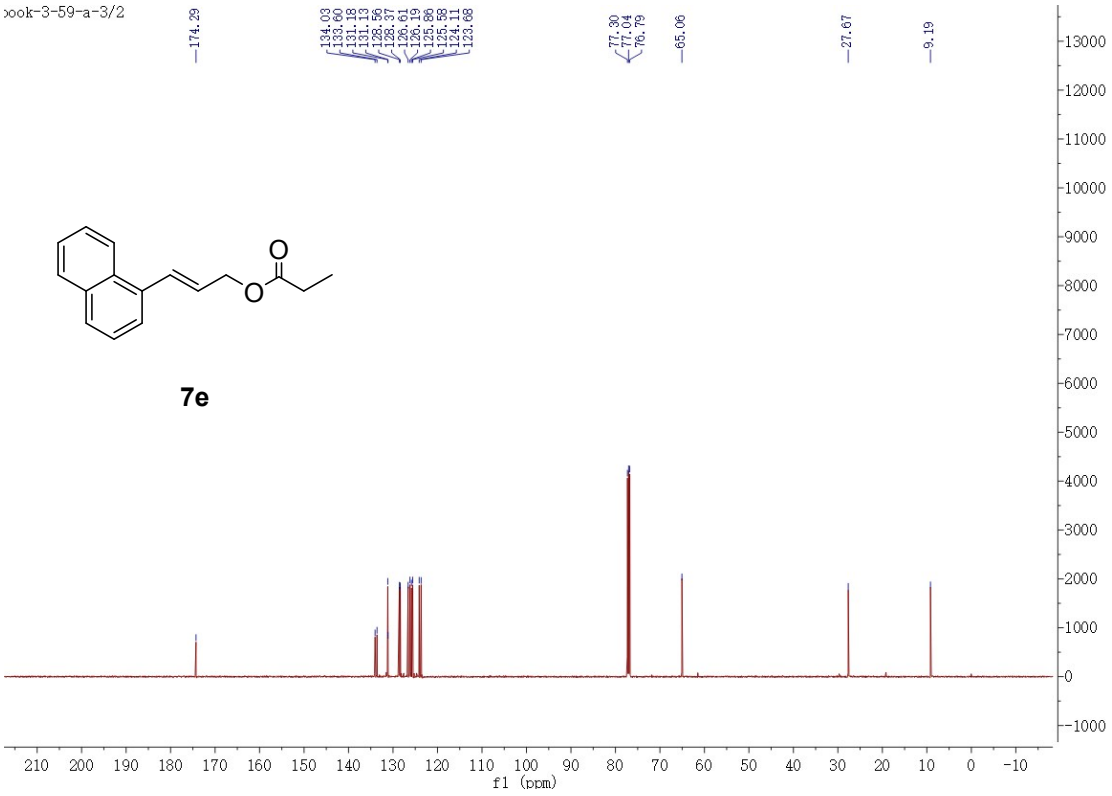

MeO
O
O
7c
f1 (ppm)



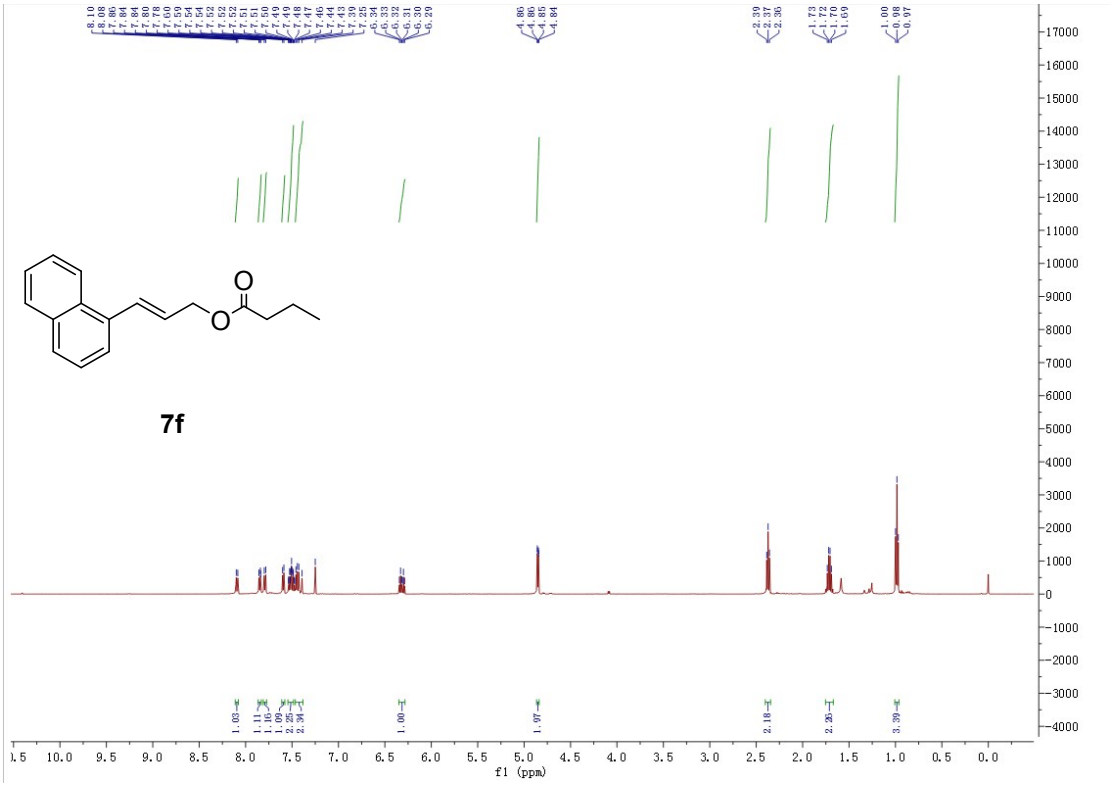
7d



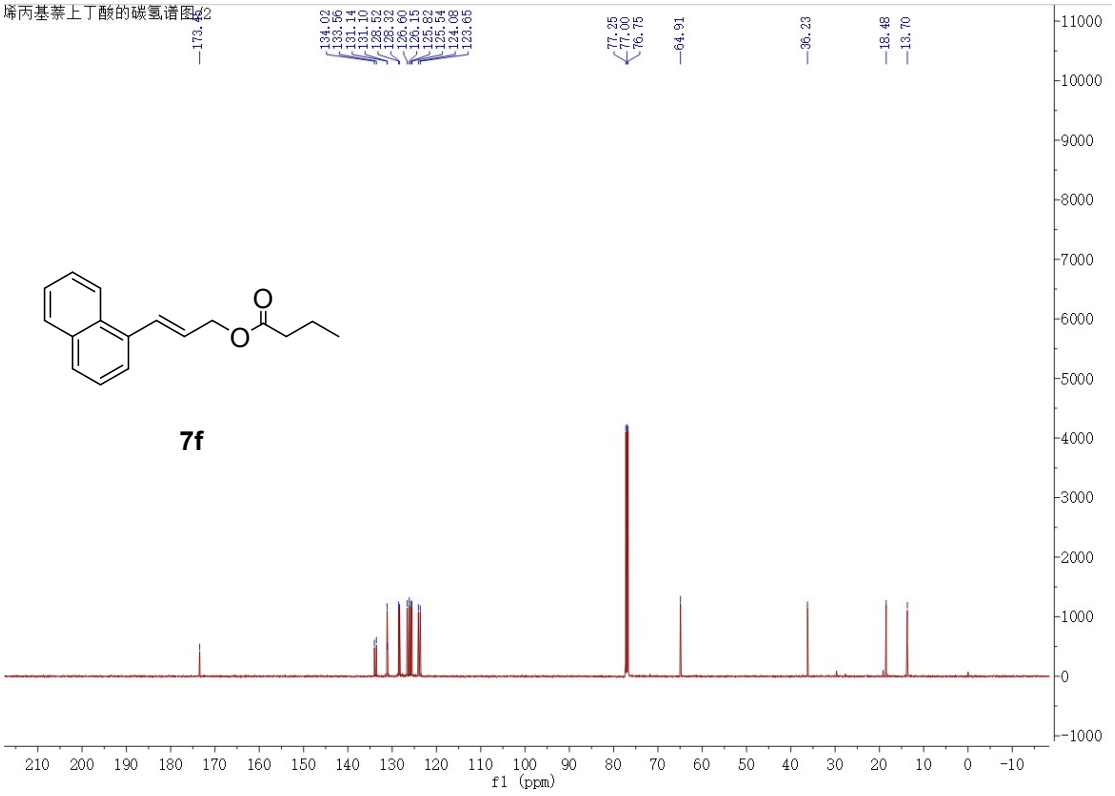
7e

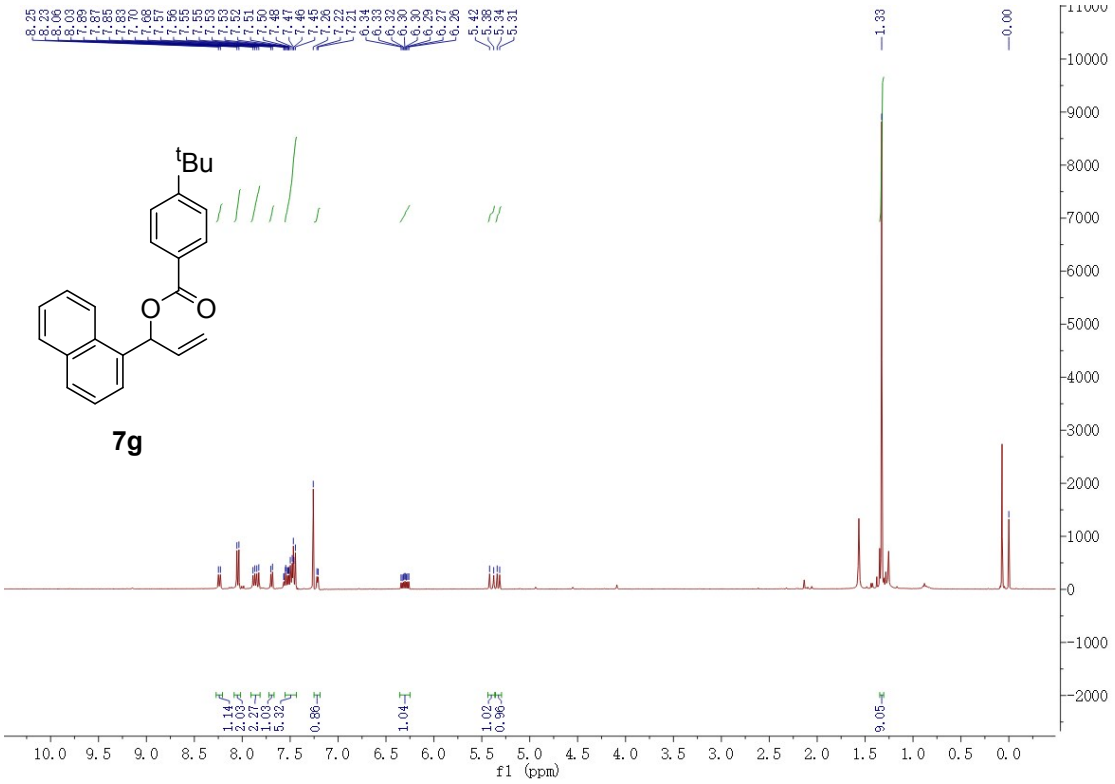

ook-3-59-a-3/2
174.29
134.03
133.60
133.18
131.13
128.56
128.37
126.61
126.19
125.86
125.58
124.11
123.68
77.30
77.04
76.79
65.06
27.67
9.19
f1 (ppm)

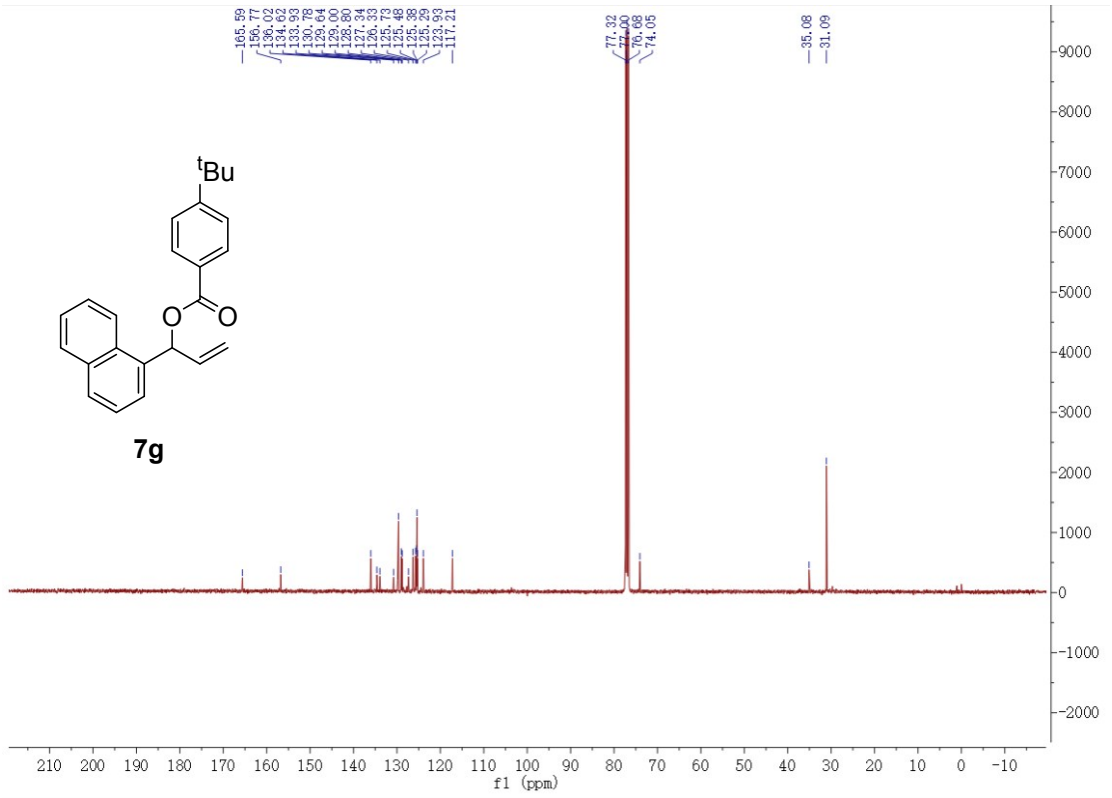
7e

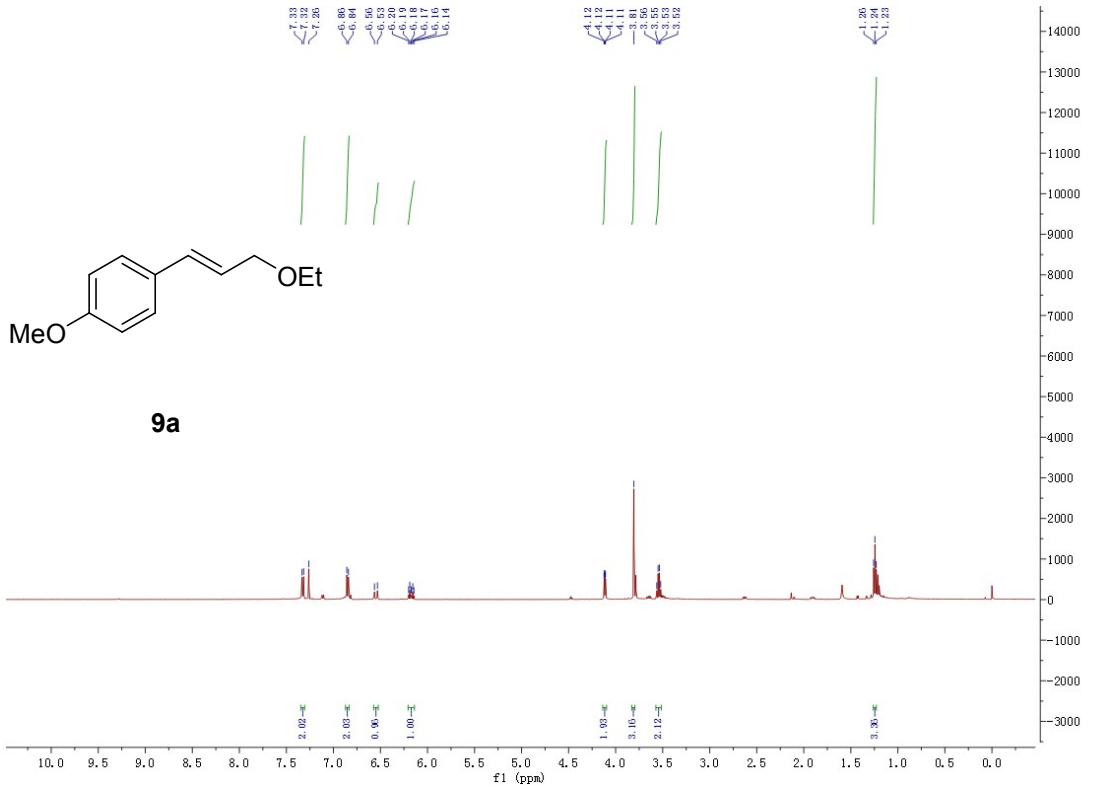

8.10
8.08
8.06
7.89
7.84
7.80
7.78
7.60
7.59
7.54
7.52
7.52
7.51
7.51
7.50
7.49
7.49
7.48
7.47
7.46
7.44
7.43
7.39
7.25
6.34
6.33
6.32
6.31
6.30
6.29
4.86
4.86
4.85
4.84
2.39
2.37
2.36
1.73
1.72
1.70
1.69
1.00
0.98
0.97
1.03
1.11
1.16
1.08
2.25
2.34
1.00
1.97
2.18
2.35
3.39
f1 (ppm)

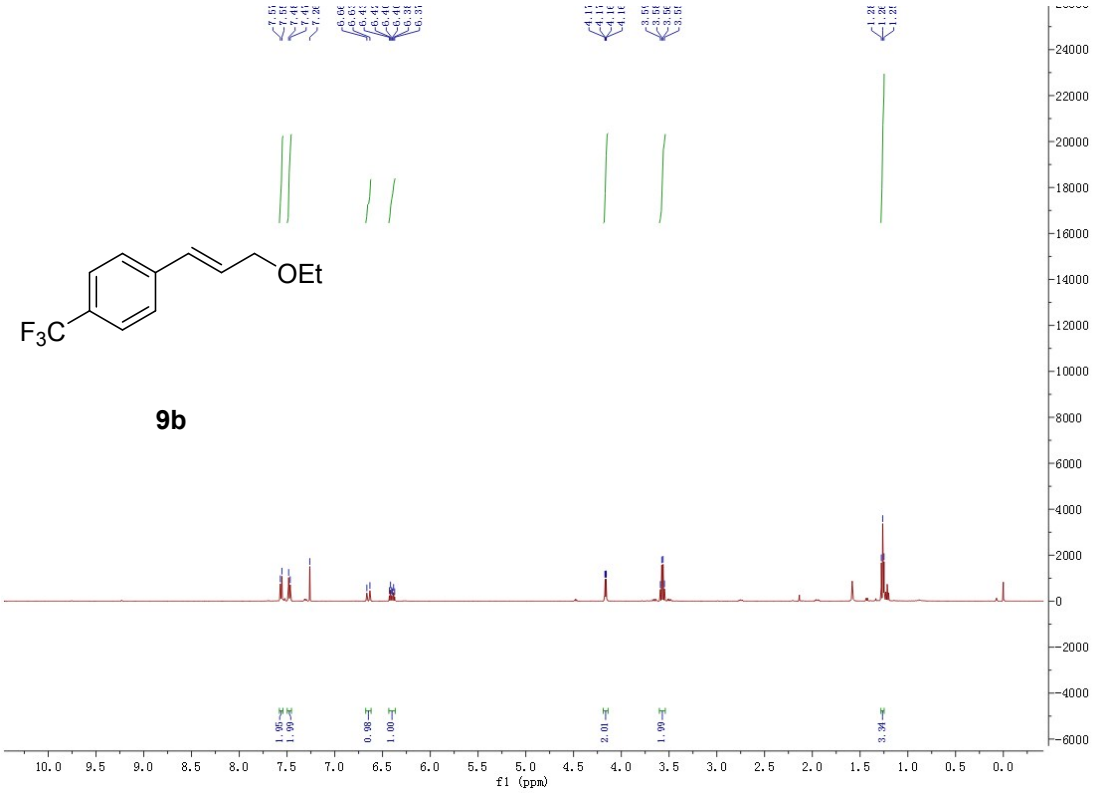
7f

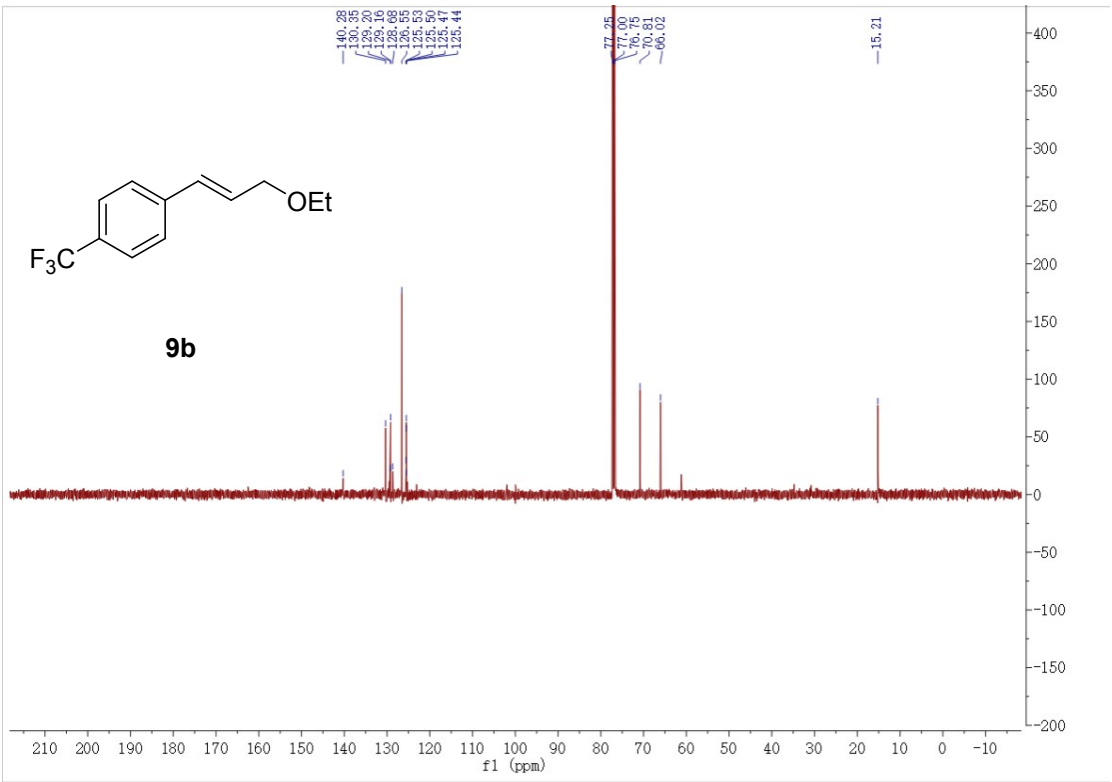

烯丙基萘上丁酸的碳氢谱图-2
173.42
134.02
133.96
131.14
131.10
128.52
128.32
126.60
126.15
125.82
125.54
124.08
123.65
77.25
77.00
76.75
64.91
36.23
18.48
13.70
O
O
7f
f1 (ppm)

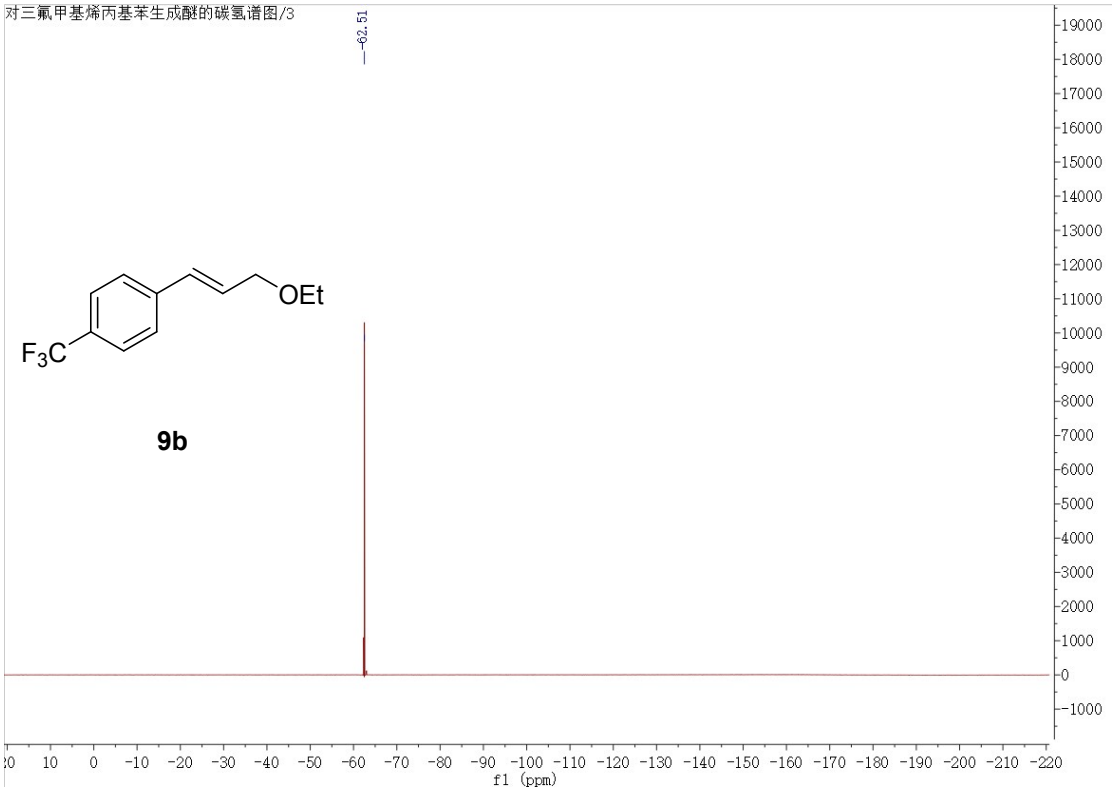

8.25
8.23
8.06
8.03
7.89
7.87
7.85
7.83
7.70
7.68
7.57
7.56
7.55
7.53
7.52
7.51
7.50
7.48
7.47
7.46
7.45
7.26
7.22
7.21
6.34
6.33
6.32
6.30
6.30
6.29
6.27
6.26
5.42
5.38
5.34
5.31
1.33
0.00
tBu
O
O
7g
1.14
2.03
2.07
1.03
5.32
0.86
1.04
1.02
0.96
9.05
f1 (ppm)

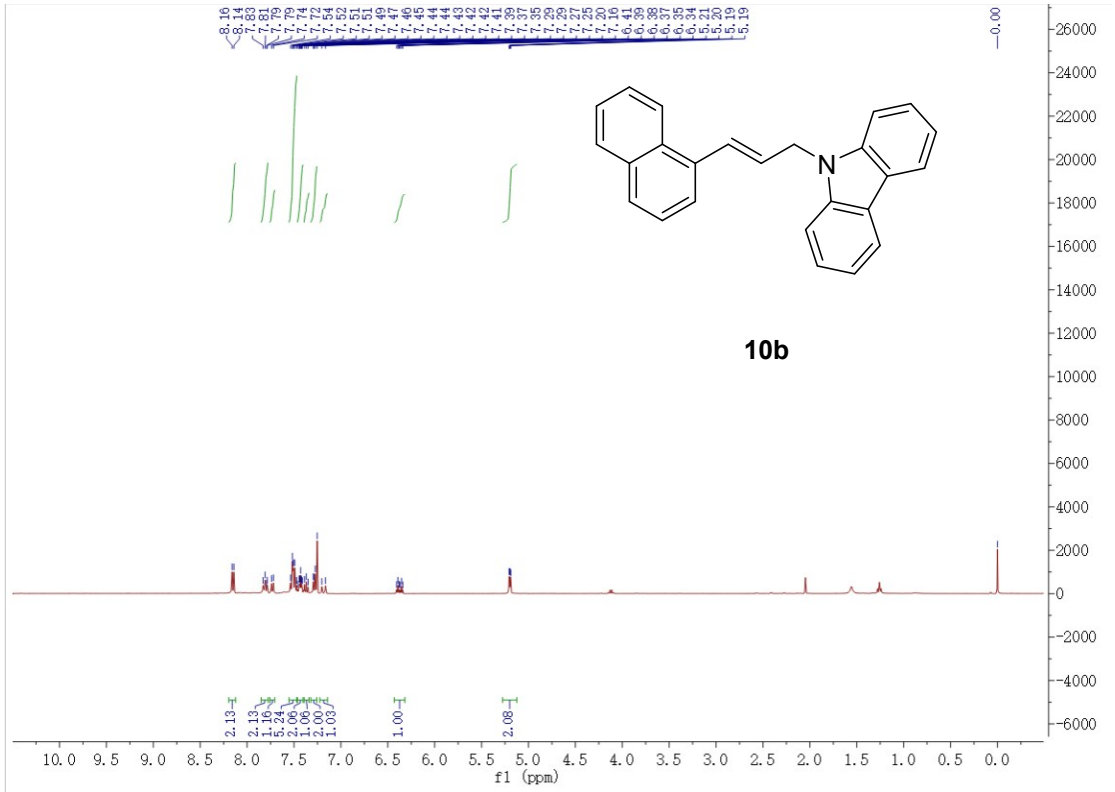

tBu
O
O
7g
165.89
156.77
136.62
134.62
133.93
130.78
129.64
129.00
128.80
127.34
126.33
125.73
125.48
125.38
125.29
123.93
117.21
77.32
77.00
76.68
74.05
35.08
31.09
f1 (ppm)

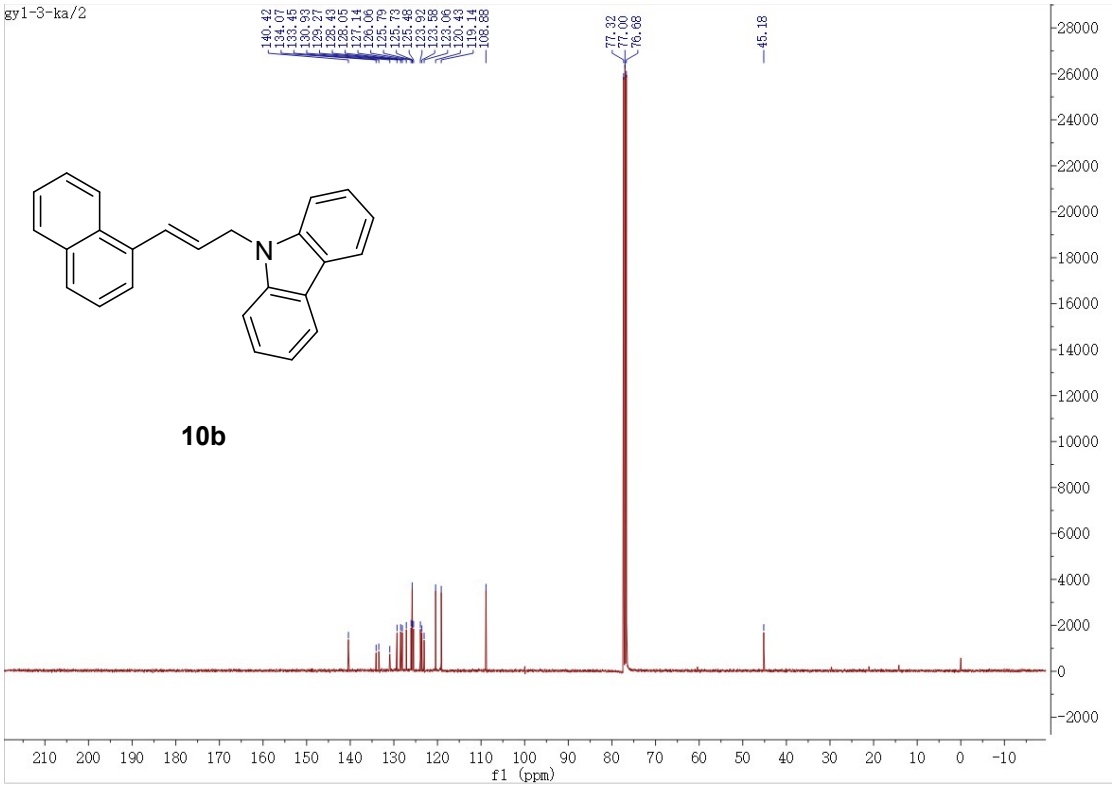

OEt
MeO
9a
7.33
7.32
7.26
6.86
6.84
6.56
6.53
6.20
6.19
6.18
6.17
6.16
6.14
4.12
4.12
4.11
4.11
3.81
3.56
3.55
3.53
3.52
1.26
1.24
1.23
2.02
2.03
0.90
1.00
1.93
3.10
2.12
3.30
f1 (ppm)


OEt
F3C
9b
f1 (ppm)

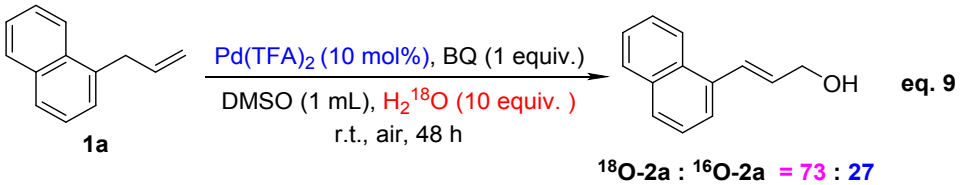

OEt
F3C
9b
f1 (ppm)


对三氟甲基烯丙基苯生成醚的碳氢谱图/3
-62.51
OEt
F3C
9b
f1 (ppm)


N
10b
f1 (ppm)

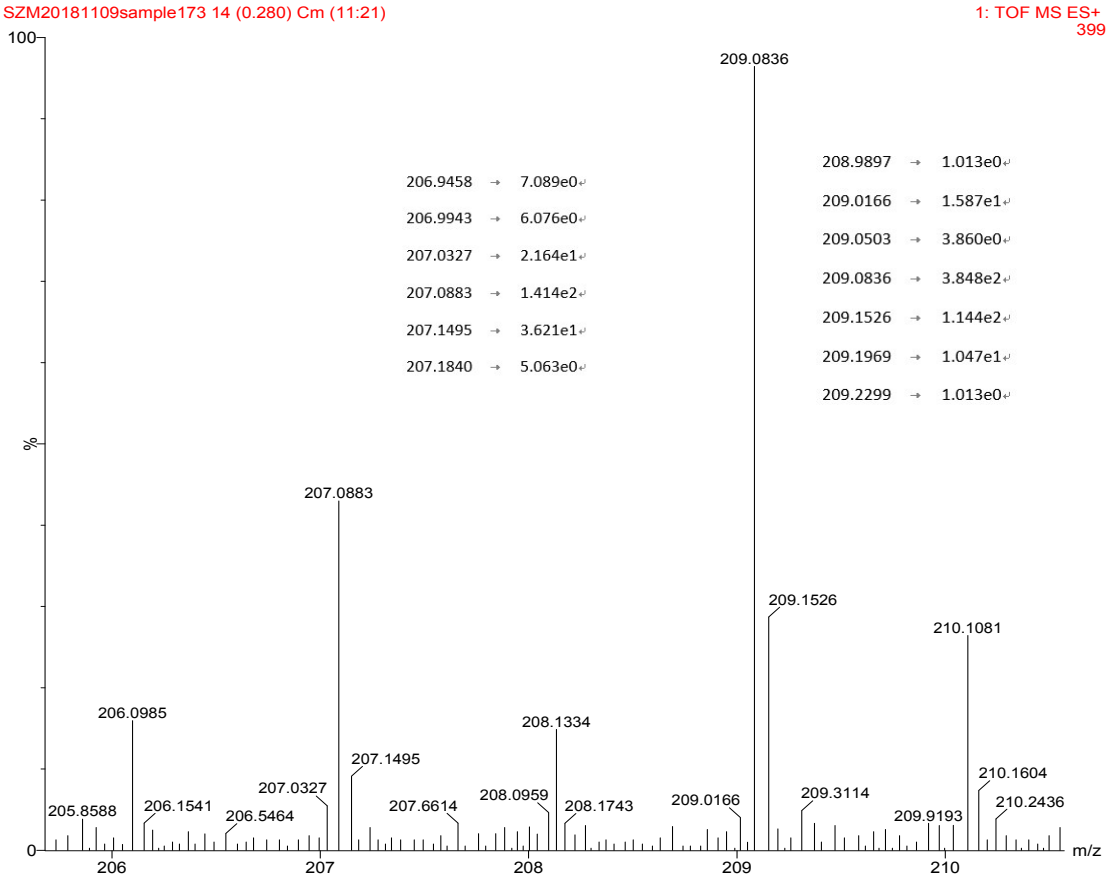

gy1-3-ka/2
140.42
134.07
133.45
130.93
129.27
128.43
128.05
127.14
126.06
125.79
125.73
125.48
123.92
123.58
123.06
120.43
119.14
106.88
77.32
77.00
76.68
45.18
N
10b
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

HRMS for eqn (9)

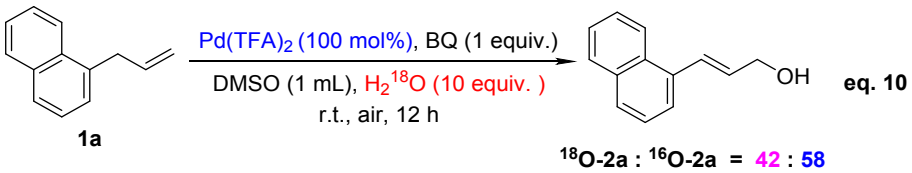


1a **eq. 9**

^{18}O-2a : ^{16}O-2a = 73 : 27



HRMS for eqn (10)



eq. 10

^{18}O-2a : ^{16}O-2a = 42 : 58