

A New Route to Naphthyl Ketones via Copper-Mediated Intramolecular Aerobic Oxidative Cyclization of Alkynes and Sulfonylcrotonates

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Supporting Information

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General Information

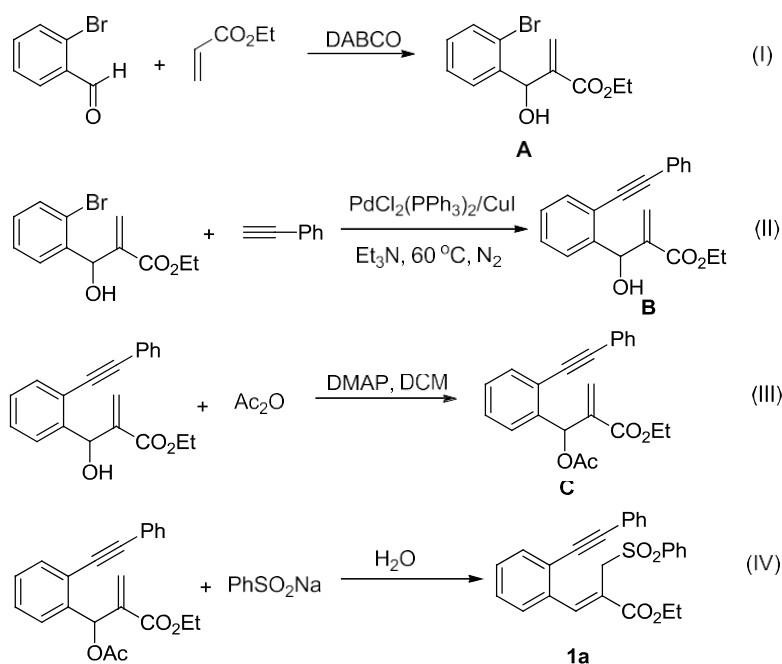
NMR spectra were recorded on a 400 MHz Bruker AVANCE III NMR spectrometer with CDCl_3 as the solvent and tetramethylsilane (TMS) as the internal standard. HRMS was recorded on a Thermo LTQ-Orbitrap ETD spectrometer.

Typical experimental procedure

Typical experimental procedure for the preparation of starting materials:

Starting materials were prepared according to the literature procedure.^{1,2}

The detailed procedure to construct **1a** was illustrated in scheme 1 below.



Scheme 1. Reagents and conditions: (I) ethyl acrylate (3 equiv), DABCO (1 equiv), rt, 5 d; (II) ethynylbenzene (1.2 equiv), $\text{PdCl}_2(\text{PPh}_3)_2$ (5 mol%), CuI (3 mol%), Et_3N (10 mL), 60 °C, N_2 , 12 h; (III) Ac_2O (1.5 equiv), DMAP (20 mol%), CH_2Cl_2 , rt, 3 h; (IV) PhSO_2Na (2 equiv), H_2O (10 mL), 70 ~ 80 °C, 6 - 7 h.

- (I) A mixture of *o*-bromo aldehyde (10 mmol), ethyl acrylate (30 mmol), DABCO (1.23 g, 10 mmol) was stirred without solvent at room temperature for 5 days. The reaction mixture was diluted with water (20 mL) and extracted with DCM (3 × 10 mL). The combined organic layers were dried over anhydrous magnesium sulfate and the solvent was evaporated in vacuo to give the corresponding B-H adduct A. The residue was used without purification.
- (II) CuI (3 mol%) and PdCl₂(PPh₃)₂ (5 mol%) were added to a mixture of B-H adduct A (5 mmol), and phenylacetylene (6 mmol) in Et₃N (10 mL). Then the tube was charged with N₂ (1 atm), and was stirred at 60 °C for 12 h. The reaction mixture was diluted in ethyl acetate and the solid was removed by filtration. The solvent was evaporated under reduced pressure, and the resulting residue was purified by silica gel column chromatography (hexane/ethyl acetate 7:1) to afford the desired product B.
- (III) To a stirred solution of B (5 mmol) in CH₂Cl₂ (15 mL) at room temperature was added acetic anhydride (7.5 mmol) and *N,N'*-dimethylaminopyridine (20 mol%). After stirring at the same temperature for 3 h, the reaction mixture was poured into water (15 mL) and extracted with dichloromethane (3 x 10 mL). The solvent was evaporated under reduced pressure, and the

resulting residue was purified by silica gel column chromatography (hexane/ethyl acetate 10:1) to afford the desired product C as yellow oil.

(IV) To a flask containing the product C (1 mmol) in H₂O (10 mL), the sodium benzenesulfinate (1.2 mmol) was added. The suspension was magnetically stirred at 70 – 80 °C until the reaction was complete (TLC monitoring). The reaction mixture was extracted with dichloromethane (2 x 10 mL). The combined organic layers were dried over anhydrous magnesium sulfate and the solvent was evaporated in vacuo. The resulting residue was purified by silica gel column chromatography (hexane/ethyl acetate 3:1) to afford the desired product **1a** as yellow solid.

*(The procedure for the preparation of other starting material was the same as described in the preparation of **1a**. However, the residual was used without purification in the step IV for most time).*

Typical experimental procedure for the preparation of naphthyl ketones 2:

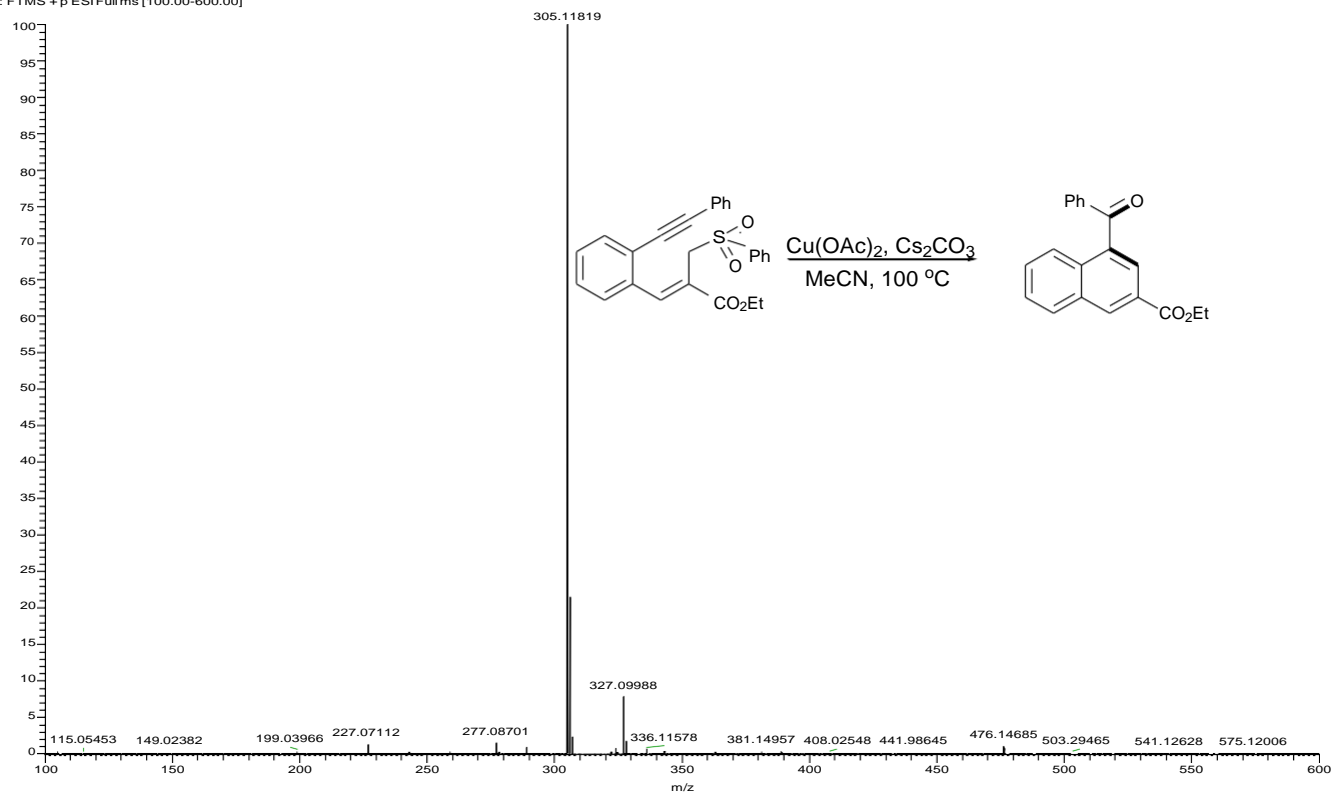
To a Schlenk tube were added 2-alkynyl sulfonylcrotonates **1** (0.15 mmol), Cs₂CO₃ (0.3 mmol), Cu(OAc)₂ (0.15 mmol) and MeCN (2 mL).

Then the tube was stirred at 100 °C in air for the indicated time until complete consumption of starting material as monitored by TLC. After the reaction was finished, the reaction mixture was diluted in diethyl ether

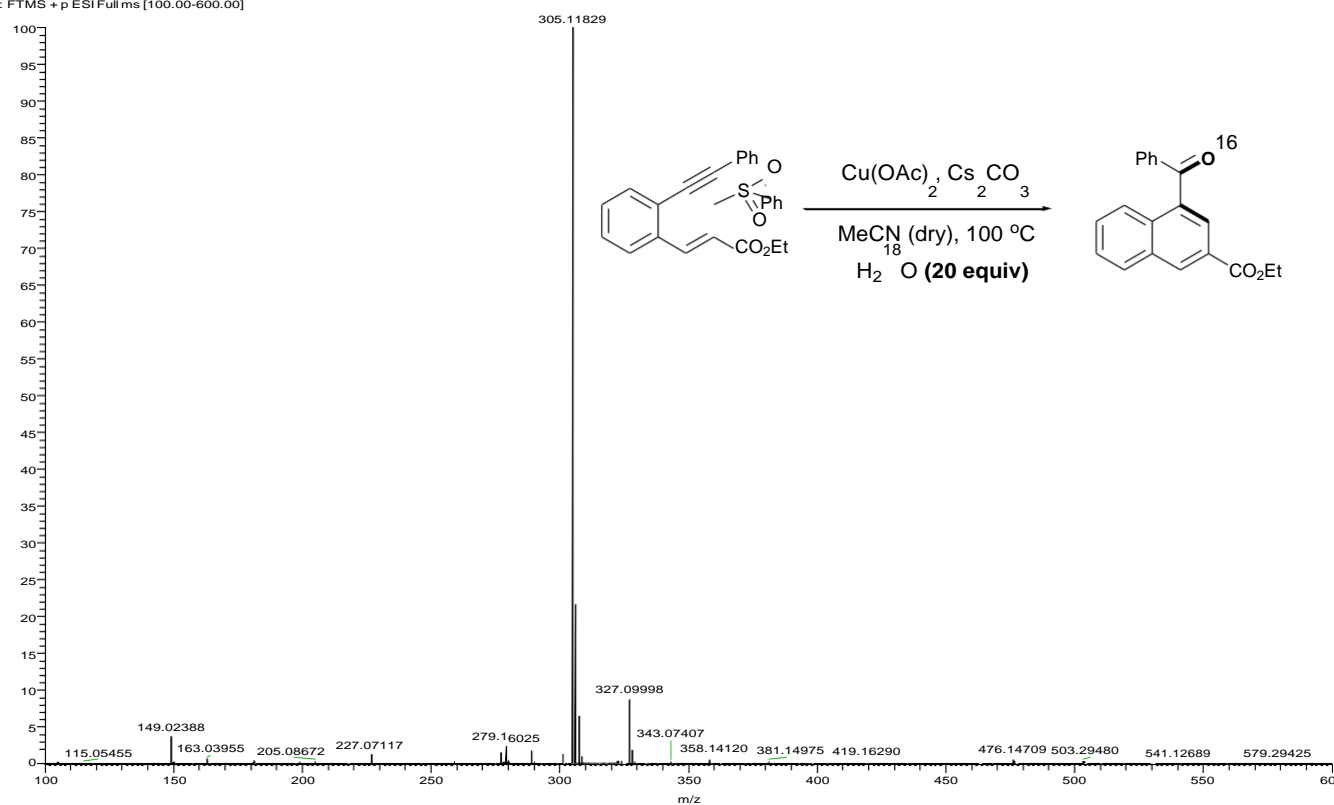
and the solid was removed by filtration. The solvent was evaporated under reduced pressure, and the resulting residue was purified by silica gel column chromatography (hexane/ethyl acetate) to afford the desired product **2**.

¹⁸O-Labeled experiment

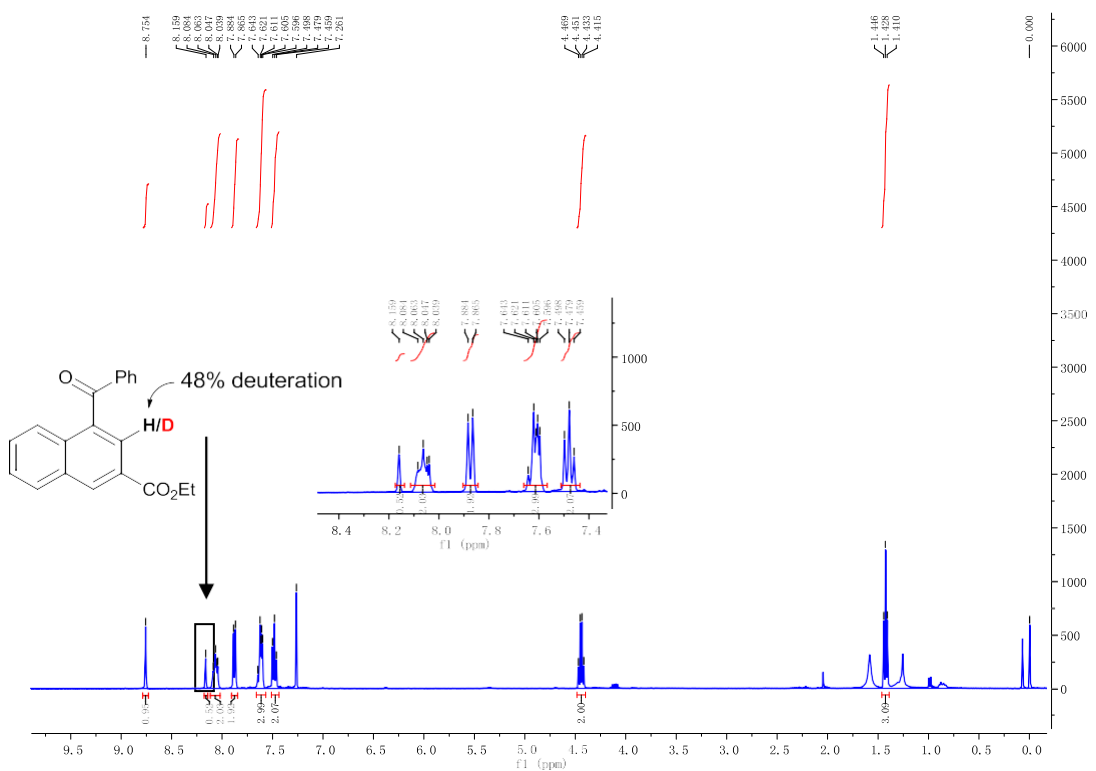
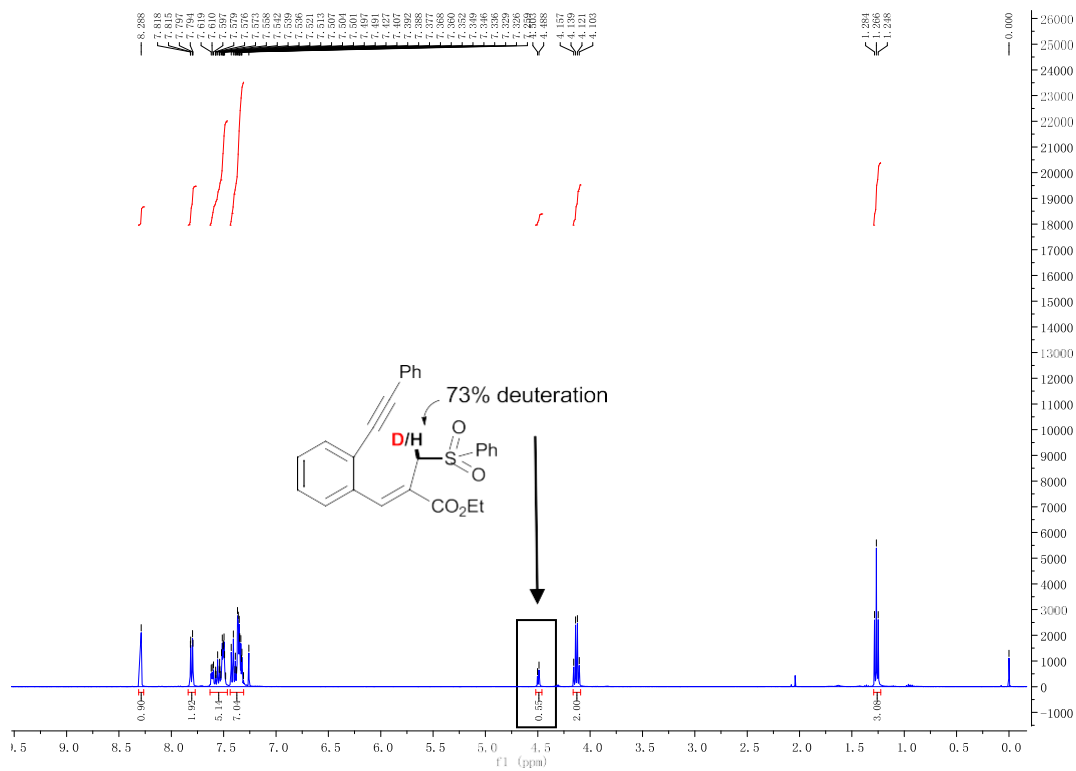
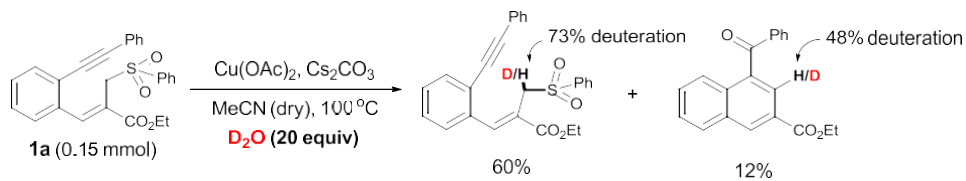
9 #9 RT: 0.19 AV: 1 NL: 2.87E8
T: FTMS + p ESI Full ms [100.00-600.00]



10 #10 RT: 0.21 AV: 1 NL: 3.12E8
T: FTMS + p ESI Full ms [100.00-600.00]

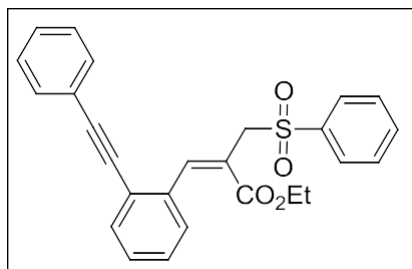


Deuteration reaction



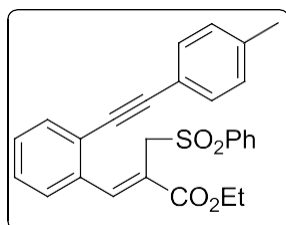
Analytical data for 1 and 2

ethyl 3-(2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1a)



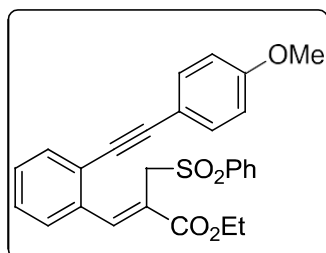
^1H NMR (400 MHz, CDCl_3) δ : 8.29 (s, 1H), 7.81 (d, $J = 8.0$ Hz, 2H), 7.62 – 7.49 (m, 5H), 7.41 (t, $J = 8.0$ Hz, 2H), 7.37 – 7.33 (m, 5H), 4.50 (s, 2H), 4.16 – 4.10 (m, 2H), 1.27 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.1, 144.3, 138.9, 135.6, 133.5, 132.0, 131.6, 131.4, 131.6, 129.0, 128.9, 128.4, 128.3, 128.0, 123.3, 122.6, 122.3, 95.9, 87.2, 61.5, 54.6, 14.0.

ethyl 2-((phenylsulfonyl)methyl)-3-(2-(p-tolyethynyl)phenyl)acrylate (1b)



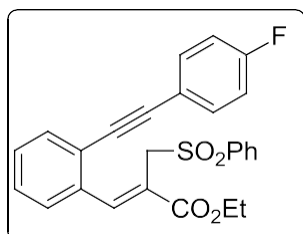
^1H NMR (400 MHz, CDCl_3) δ : 8.18 (s, 1H), 7.70 (d, $J = 8.0$ Hz, 2H), 7.49 – 7.42 (m, 2H), 7.38 – 7.27 (m, 5H), 7.20 (t, $J = 4.0$ Hz, 2H), 7.06 (d, $J = 8.0$ Hz, 2H), 4.40 (s, 2H), 4.06 – 4.01 (m, 2H), 2.26 (s, 3H), 1.17 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.1, 144.3, 138.9 (2C), 135.5, 133.5, 131.9, 131.3, 129.1, 129.0, 128.9, 128.3, 128.1, 128.0, 123.5, 122.3, 119.6, 96.2, 86.6, 61.4, 54.6, 21.4, 14.0.

ethyl 3-(2-((4-methoxyphenyl)ethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1c)



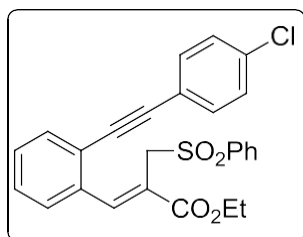
^1H NMR (400 MHz, CDCl_3) δ : 8.27 (s, 1H), 7.80 (d, $J = 8.0$ Hz, 2H), 7.57 – 7.53 (m, 2H), 7.45 – 7.38 (m, 5H), 7.30 (d, $J = 2.0$ Hz, 2H), 6.88 (d, $J = 8.0$ Hz, 2H), 4.50 (s, 2H), 4.16 – 4.11 (m, 2H), 3.82 (s, 3H), 1.27 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.2, 159.9, 144.5, 139.0, 135.4, 133.5, 132.9, 131.8, 129.0, 128.9, 128.4, 128.0 (2C), 123.7, 122.2, 114.8, 114.0, 96.1, 86.0, 61.4, 55.2, 54.7, 14.1.

ethyl 3-(2-((4-fluorophenyl)ethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1d)



^1H NMR (400 MHz, CDCl_3) δ : 8.18 (s, 1H), 7.72 (d, $J = 8.0$ Hz, 2H), 7.53 – 7.39 (m, 5H), 7.33 (t, $J = 8.0$ Hz, 2H), 7.25 (t, $J = 4.0$ Hz, 2H), 6.97 (t, $J = 8.0$ Hz, 2H), 4.41 (s, 2H), 4.07 – 4.01 (m, 2H), 1.17 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.1, 162.8 (d, $J = 250$ Hz, 1C), 144.4, 139.1, 135.7, 134.5 (d, $J = 10$ Hz, 1C), 133.6, 133.4 (d, $J = 10$ Hz, 1C), 132.0, 129.1, 129.0, 128.5, 128.4 (d, $J = 20$ Hz, 1C), 123.2, 122.5, 118.9, 115.9 (d, $J = 20$ Hz, 1C), 94.8, 86.9, 61.5, 54.7, 14.1.

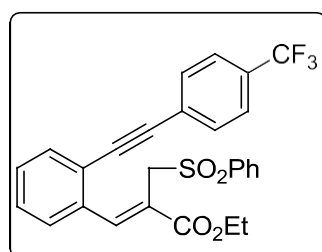
ethyl 3-(2-((4-chlorophenyl)ethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1e)



^1H NMR (400 MHz, CDCl_3) δ : 8.25 (s, 1H), 7.80 (d, $J = 8.0$ Hz, 2H), 7.61 (d, $J = 8.0$ Hz, 1H), 7.57 – 7.53 (m, 1H), 7.51 – 7.38 (m, 5H), 7.34 – 7.30 (m, 4H), 4.49 (s, 2H), 4.15 – 4.10 (m, 2H), 1.26 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.0, 144.2, 139.0, 135.7, 134.7, 133.5, 132.6, 132.0, 129.1, 128.9, 128.7, 128.6, 128.3, 128.1, 12.30, 122.5, 121.2, 94.7, 88.1, 61.5, 54.6, 14.0.

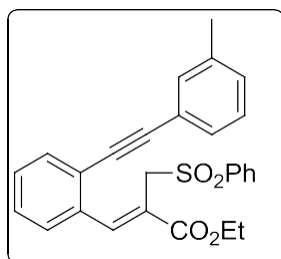
ethyl 2-((phenylsulfonyl)methyl)-3-(2-((4-(trifluoromethyl)phenyl)ethynyl)phenyl)acrylate

(1f)



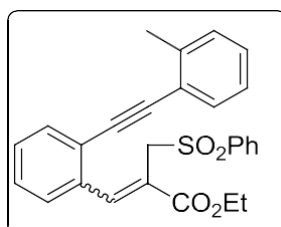
^1H NMR (400 MHz, CDCl_3) δ 8.27 (s, 1H), 7.81 (d, $J = 8.0$ Hz, 2H), 7.65 – 7.52 (m, 7H), 7.43 – 7.35 (m, 4H), 4.50 (s, 2H), 4.16 – 4.10 (m, 2H), 1.26 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.1, 144.1, 139.1, 136.0, 133.6, 132.3, 131.7, 130.4 (q, $J = 40$ Hz, 1C), 129.2, 129.1, 129.0, 128.4, 128.3, 125.2 (q, $J = 10$ Hz, 1C), 126.5, 126.4 (q, $J = 240$ Hz, 1C), 125.4 (q, $J = 10$ Hz, 1C), 122.7 (d, $J = 20$ Hz, 1C), 94.3, 89.5, 61.6, 54.7, 14.1.

ethyl 2-((phenylsulfonyl)methyl)-3-(2-(*m*-tolylethynyl)phenyl)acrylate (1g)



^1H NMR (400 MHz, CDCl_3) δ : 8.28 (s, 1H), 7.81 (d, $J = 8.0$ Hz, 2H), 7.60 (t, $J = 4.0$ Hz, 1H), 7.55 (t, $J = 8.0$ Hz, 1H), 7.48 (t, $J = 8.0$ Hz, 1H), 7.40 (t, $J = 8.0$ Hz, 2H), 7.32 – 7.31 (m, 4H), 7.24 (t, $J = 8.0$ Hz, 1H), 7.16 (d, $J = 4.0$ Hz, 1H), 4.50 (s, 2H), 4.16 – 4.11 (m, 2H), 2.35 (s, 3H), 1.27 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.1, 144.4, 139.0, 138.0, 135.6, 133.5, 132.1, 131.9, 129.6, 129.0, 128.9, 128.6, 128.4, 128.3 (2C), 128.1, 123.4, 122.5, 122.4, 96.2, 86.8, 61.5, 54.7, 21.1, 14.1.

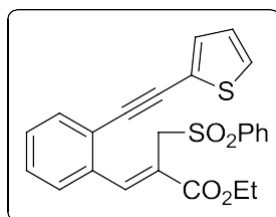
ethyl 2-((phenylsulfonyl)methyl)-3-(2-(o-tolylethynyl)phenyl)acrylate (Z/E = 1.6) (1h)



^1H NMR (400 MHz, CDCl_3) δ : 8.18 (s, 0.58H), 7.85 (s, 0.39H), 7.71 (t, $J = 8.0$ Hz, 2H), 7.54 – 7.35 (m, 5H), 7.30 (t, $J = 8.0$ Hz, 1H), 7.24 – 7.21 (m, 2H), 7.16 – 7.05 (m, 3H), 4.39 (s, 1.24 H), 4.27 (s, 0.76H), 4.03 – 3.96 (m, 2H), 2.35 (s, 3H), 1.14 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.0, 165.7, 144.7, 144.4, 139.8, 139.0, 135.3, 134.0, 133.6, 133.5, 132.7, 132.2, 131.8, 130.5, 129.8, 129.4, 129.0, 128.9 (2C), 128.6, 128.2 (1C), 128.1, 127.4, 125.5, 123.8, 123.5, 122.4, 94.6, 90.9, 61.5,

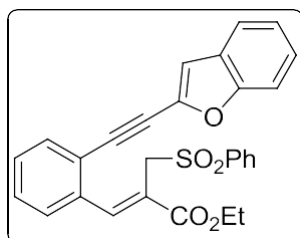
61.4, 54.7 (2C), 20.6, 13.9 (2C).

ethyl 2-((phenylsulfonyl)methyl)-3-(2-(thiophen-2-ylethynyl)phenyl)acrylate (1i)



^1H NMR (400 MHz, CDCl_3) δ 8.21 (s, 1H), 7.81 (d, $J = 8.0$ Hz, 2H), 7.61 – 7.54 (m, 2H), 7.48 – 7.40 (m, 3H), 7.33 (d, $J = 4.0$ Hz, 3H), 7.28 (d, $J = 4.0$ Hz, 1H), 7.02 (t, $J = 4.0$ Hz, 1H), 4.49 (s, 2H), 4.15 – 4.10 (m, 2H), 1.26 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.0, 144.1, 139.0, 135.4, 133.5, 132.2, 131.8, 129.0, 128.9, 128.5, 128.4, 128.2, 127.8, 127.2, 123.0, 122.6, 122.5, 90.9, 89.0, 61.5, 54.7, 14.1.

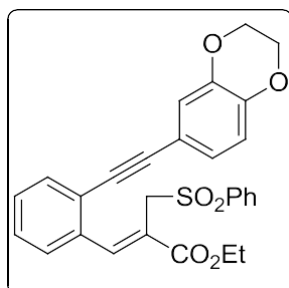
ethyl 3-(2-(benzofuran-2-ylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1j)



^1H NMR (400 MHz, CDCl_3) δ : 8.25 (s, 1H), 7.84 (d, $J = 4.0$ Hz, 2H), 7.67 (d, $J = 8.0$ Hz, 1H), 7.62 – 7.55 (m, 4H), 7.51 – 7.43 (m, 3H), 7.40 – 7.31 (m, 2H), 7.26 (t, $J = 8.0$ Hz, 1H), 7.02 (s, 1H), 4.50 (s, 2H), 4.16 – 4.11 (m, 2H), 1.28 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.0, 155.0, 143.7, 139.1, 138.1, 135.8, 133.6, 132.3, 129.3, 129.2, 129.0, 128.5, 128.4, 127.6, 125.8, 123.4, 123.0, 122.0, 121.3, 112.2, 111.2, 92.7, 85.7, 61.6, 54.8, 14.1.

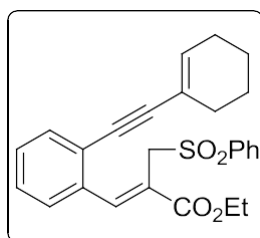
ethyl

3-(2-((2,3-dihydrobenzo[b][1,4]dioxin-6-yl)ethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1k)



^1H NMR (400 MHz, CDCl_3) δ : 8.25 (s, 1H), 7.79 (d, $J = 8.0$ Hz, 2H), 7.57 – 7.53 (m, 2H), 7.45 – 7.39 (m, 3H), 7.31 – 7.26 (m, 2H), 7.03 – 6.99 (m, 2H), 6.83 (d, $J = 8.0$ Hz, 1H), 4.50 (s, 2H), 4.26 – 4.25 (m, 4H), 4.17 – 4.12 (m, 2H), 1.28 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.2, 144.5, 144.4, 143.3, 139.0, 135.5, 133.5, 131.8, 129.0, 128.9, 128.4 (2C), 128.1, 125.1, 123.6, 122.3, 120.3, 117.4, 115.4, 96.0, 85.8, 64.4, 64.1, 61.5, 54.7, 14.1.

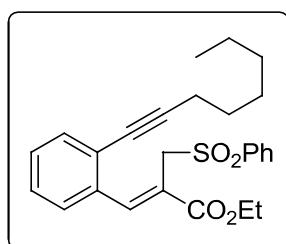
ethyl 3-(2-(cyclohex-1-en-1-ylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1l)



^1H NMR (400 MHz, CDCl_3) δ : 8.17 (s, 1H), 7.81 (d, $J = 4.0$ Hz, 2H), 7.59 – 7.55 (m, 2H), 7.44 (t, $J = 8.0$ Hz, 2H), 7.38 (t, $J = 4.0$ Hz, 1H), 7.28 – 7.25 (m, 2H), 6.21 (s, 1H), 4.46 (s, 2H), 4.14 – 4.08 (m, 2H), 2.20 – 2.15 (m, 4H), 1.68 – 1.62 (m, 4H), 1.26 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR

(100 MHz, CDCl₃) δ : 166.2, 144.6, 139.2, 135.8, 135.3, 133.5, 131.9, 129.0, 128.9, 128.4, 128.1, 127.8, 123.9, 122.1, 120.5, 97.9, 84.7, 61.4, 54.9, 29.0, 25.7, 22.2, 21.4, 14.1.

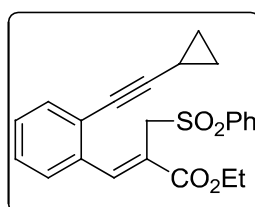
ethyl 3-(2-(oct-1-yn-1-yl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1m)



¹H NMR (400 MHz, CDCl₃) δ : 8.18 (s, 1H), 7.83 (d, J = 8.0 Hz, 2H), 7.60 – 7.57 (m, 2H), 7.46 (t, J = 8.0 Hz, 2H), 7.37 (t, J = 8.0 Hz, 1H), 7.27 (d, J = 4.0 Hz, 2H), 4.45 (s, 2H), 4.12 – 4.07 (m, 2H), 2.41 (t, J = 8.0 Hz, 2H), 1.64 – 1.55 (m, 2H), 1.44 – 1.42 (m, 2H), 1.31 – 1.24 (m, 7H), 0.89 (t, J = 6.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ : 166.3, 144.9, 139.4, 135.4, 133.5, 132.3, 129.0 (2C), 128.4, 128.2, 127.7, 124.3, 122.0, 97.2, 78.5, 61.4, 55.1, 31.3, 28.6, 28.5, 22.5, 19.5, 14.1, 14.0.

(Z)-ethyl

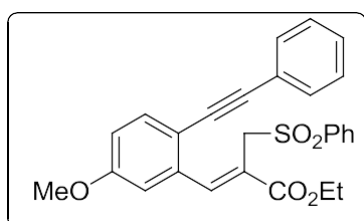
3-(2-(cyclopropylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1n)



¹H NMR (400 MHz, CDCl₃) δ : 8.12 (s, 1H), 7.81 (d, J = 8.0 Hz, 2H), 7.60 – 7.54 (m, 2H), 7.45 (t, J = 8.0 Hz, 2H), 7.34 (t, J = 8.0 Hz, 1H), 7.27 – 7.23 (m, 2H), 4.44 (s, 2H), 4.14 – 4.09 (m, 2H), 1.47 – 1.42 (m, 1H),

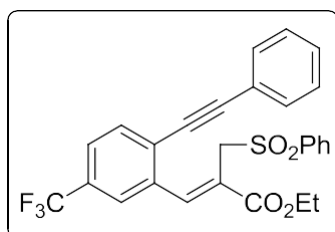
1.27 (t, $J = 8.0$ Hz, 3H), 0.91 – 0.86 (m, 2H), 0.80 – 0.78 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.2, 144.7, 139.2, 135.5, 133.5, 132.1, 129.0, 128.9, 128.4, 128.0, 127.5, 124.1, 121.9, 100.5, 73.5, 61.4, 54.9, 14.1, 8.9, 0.2.

ethyl 3-(5-methoxy-2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1o)



^1H NMR (400 MHz, CDCl_3) δ : 8.30 (s, 1H), 7.85 (d, $J = 8.0$ Hz, 2H), 7.58 (t, $J = 8.0$ Hz, 1H), 7.45 (t, $J = 8.0$ Hz, 5H), 7.38 (s, 1H), 7.32 – 7.31 (m, 3H), 6.90 (d, $J = 12.0$ Hz, 1H), 4.50 (s, 2H), 4.11 – 4.06 (m, 2H), 3.90 (s, 3H), 1.24 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 166.1, 159.6, 144.7, 137.1, 133.6, 133.4, 131.2 (2C), 129.0, 128.4, 128.3 (2C), 123.1, 122.4, 116.1, 115.4, 113.3, 94.4, 87.3, 61.5, 55.8, 55.2, 14.1.

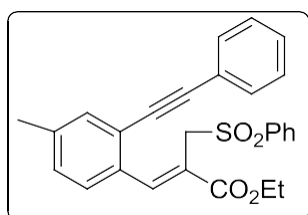
ethyl 3-(2-(phenylethynyl)-5-(trifluoromethyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1p)



^1H NMR (400 MHz, CDCl_3) δ 8.27 (s, 1H), 7.81 (d, $J = 8.0$ Hz, 2H), 7.65 – 7.52 (m, 7H), 7.43 – 7.35 (m, 4H), 4.50 (s, 2H), 4.16 – 4.10 (m, 2H), 1.26 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3); ^{13}C NMR (100

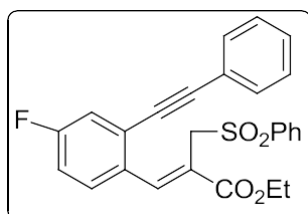
MHz, CDCl₃) δ : 166.1, 144.1, 139.1, 136.0, 133.6, 132.3, 131.7, 130.4 (q, $J = 40$ Hz, 1C), 129.2, 129.1, 129.0, 128.4, 128.3, 125.2 (q, $J = 10$ Hz, 1C), 126.5, 126.4 (q, $J = 240$ Hz, 1C), 125.4 (q, $J = 10$ Hz, 1C), 122.7 (d, $J = 20$ Hz, 1C), 94.3, 89.5, 61.6, 54.7, 14.1.

ethyl 3-(4-methyl-2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1q)



¹H NMR (400 MHz, CDCl₃) δ : 8.31 (s, 1H), 7.82 (d, $J = 8.0$ Hz, 2H), 7.56 (t, $J = 8.0$ Hz, 2H), 7.50 – 7.49 (m, 2H), 7.42 (t, $J = 8.0$ Hz, 2H), 7.35 – 7.34 (m, 4H), 7.15 (d, $J = 4.0$ Hz, 1H), 4.51 (s, 2H), 4.13- 4.07 (m, 2H), 2.36 (s, 3H), 1.25 (t, $J = 8.0$ Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ : 166.3, 144.5, 139.4, 139.2, 133.5, 132.8, 132.7, 131.4, 129.4, 128.9, 128.6, 128.4 (2C), 128.1, 123.4, 122.8, 121.6, 95.5, 87.4, 61.4, 54.9, 21.1, 14.1.

ethyl 3-(4-fluoro-2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1r)

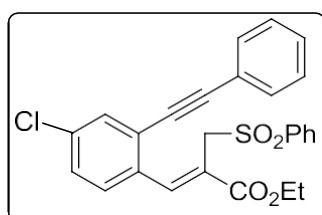


¹H NMR (400 MHz, CDCl₃) δ : 8.26 (s, 1H), 7.83 (d, $J = 8.0$ Hz, 2H), 7.71 (t, $J = 8.0$, 1H), 7.58 (t, $J = 8.0$ Hz, 1H), 7.51 – 7.50 (m, 2H), 7.44 (t, $J = 8.0$ Hz, 2H), 7.37 – 7.36 (m, 3H), 7.21 (d, $J = 8.0$ Hz, 1H), 7.07 (t, $J =$

8.0 Hz, 1H), 4.47 (s, 2H), 4.13 – 4.08 (m, 2H), 1.25 (t, $J = 8.0$ Hz, 3H);

^{13}C NMR (100 MHz, CDCl_3) δ : 166.0, 162.6 (d, $J = 250$ Hz, 1C), 143.4, 139.1, 133.7, 131.9, 135.6, 130.3 (d, $J = 10$ Hz, 1C), 129.1, 129.0, 128.8, 128.5, 125.7 (d, $J = 10$ Hz, 1C), 122.3 (d, $J = 10$ Hz, 1C), 118.9 (d, $J = 10$ Hz, 1C), 116.0, 115.8, 97.0, 86.1, 61.6, 54.8, 14.1.

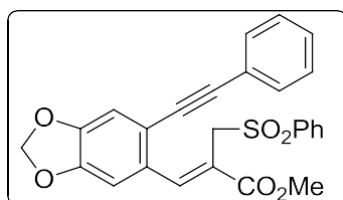
ethyl 3-(4-chloro-2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1s)



^1H NMR (400 MHz, CDCl_3) δ : 8.23 (s, 1H), 7.82 (d, $J = 8.0$ Hz, 2H), 7.63 – 7.56 (m, 2H), 7.51 – 7.42 (m, 5H), 7.37 – 7.31 (m, 4H), 4.46 (s, 2H), 4.14 – 4.09 (m, 2H), 1.25 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 165.9, 143.2, 139.0, 135.1, 134.0, 133.7, 131.8, 131.5, 129.4, 129.1, 129.0, 128.8, 128.6, 128.5, 125.1, 122.8, 122.2, 97.1, 85.9, 61.6, 54.7, 14.0.

methyl 3-(6-(phenylethynyl)benzo[d][1,3]dioxol-5-yl)-2-((phenylsulfonyl)methyl)acrylate

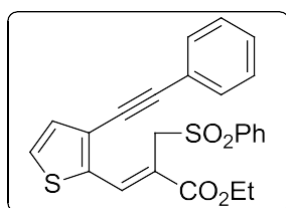
(1t)



^1H NMR (400 MHz, CDCl_3) δ : 8.30 (s, 1H), 7.86 (d, $J = 4.0$ Hz, 2H), 7.59 (t, $J = 8.0$ Hz, 1H), 7.48 – 7.45 (m, 4H), 7.35 – 7.34 (m, 3H), 7.25 (s,

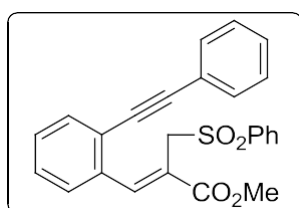
1H), 6.95 (s, 1H), 6.04 (s, 2H), 4.50 (s, 2H), 3.62 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ: 166.7, 148.6, 148.2, 144.7, 139.2, 133.7, 131.3, 130.4, 129.0, 128.6, 128.4 (2C), 122.8, 120.6, 118.2, 111.7, 108.5, 102.0, 95.1, 87.2, 55.0, 52.3.

ethyl 3-(3-(phenylethynyl)thiophen-2-yl)-2-((phenylsulfonyl)methyl)acrylate (1u)



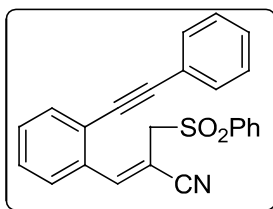
¹H NMR (400 MHz, CDCl₃) δ: 8.52 (s, 1H), 7.92 (d, *J* = 8.0 Hz, 2H), 7.62 – 7.46 (m, 6H), 7.38 - 7.37 (m, 3H), 7.18 (d, *J* = 4.0 Hz, 1H), 4.70 (s, 2H), 4.05 - 4.00 (m, 2H), 1.22 (t, *J* = 8.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ: 166.3, 139.3, 138.1, 136.6, 133.8, 131.5, 129.7, 129.3, 129.0, 128.9, 128.8, 128.7, 128.4, 122.5, 116.9, 96.8, 83.2, 61.5, 56.0, 14.1.

methyl 3-(2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1v)



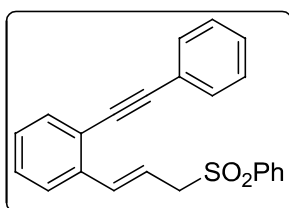
¹H NMR (400 MHz, CDCl₃) δ: 8.29 (s, 1H), 7.80 (d, *J* = 8.0 Hz, 2H), 7.61 – 7.50 (m, 5H), 7.43 – 7.32 (m, 7H), 4.49 (s, 2H), 3.67 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ: 166.6, 144.8, 139.0, 135.6, 133.6, 132.2, 131.5 (2C), 129.1, 129.0, 128.7, 128.4 (2C), 128.2, 123.4, 122.7, 122.1, 96.0, 87.2, 54.8, 52.4.

3-(2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylonitrile (1w)



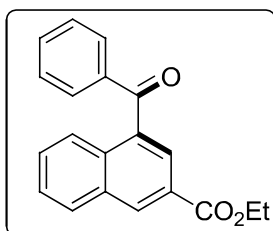
^1H NMR (400 MHz, CDCl_3) δ : 7.96 (d, $J = 4.0$ Hz, 1H), 7.87 (d, $J = 8.0$ Hz, 2H), 7.69 (s, 1H), 7.57 – 7.45 (m, 6H), 7.36 – 7.32 (m, 5H), 4.03 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ : 150.0, 137.5, 134.6, 133.7, 132.8, 131.7, 131.0, 129.5, 129.0, 128.8, 128.7, 128.5, 127.3, 124.7, 122.4, 116.8, 99.8, 96.6, 86.0, 61.3.

(E)-1-(phenylethynyl)-2-(3-(phenylsulfonyl)prop-1-en-1-yl)benzene (1x)



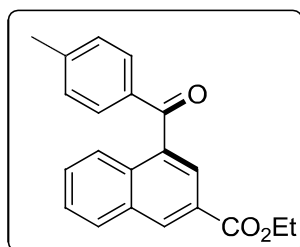
^1H NMR (400 MHz, CDCl_3) δ : 7.88 (d, $J = 8.0$ Hz, 2H), 7.54 – 7.43 (m, 6H), 7.37 – 7.36 (m, 3H), 7.32 – 7.24 (m, 3H), 6.88 (d, $J = 16.0$ Hz, 1H), 6.28 – 6.24 (m, 1H), 4.02 (d, $J = 8.0$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ : 138.2, 137.2, 137.0, 133.8, 132.6, 131.5, 129.7, 129.0, 128.5 (2C), 128.4, 128.2, 125.4, 123.0, 122.1, 117.1, 94.3, 87.2, 60.8.

ethyl 4-benzoyl-2-naphthoate (2a)



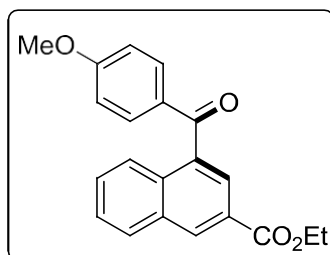
^1H NMR (400 MHz, CDCl_3) δ : 8.76 (s, 1H), 8.16 (d, $J = 4.0$ Hz, 1H), 8.11 – 8.02 (m, 2H), 7.87 (d, $J = 4.0$ Hz, 2H), 7.64 – 7.59 (m, 3H), 7.47 (t, $J = 6.0$ Hz, 2H), 4.47 – 4.41 (m, 2H), 1.42 (t, $J = 6.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 197.3, 166.0, 137.7, 136.8, 133.6, 133.5, 132.9, 132.8, 130.4, 129.8, 129.4, 128.6, 127.2, 126.5 (2C), 125.7, 61.4, 14.3; HRMS (EI) calcd for $\text{C}_{20}\text{H}_{17}\text{O}_3$ $[\text{M} + \text{H}]^+$: 305.1172, found 305.1182.

ethyl 4-(4-methylbenzoyl)-2-naphthoate (2b)



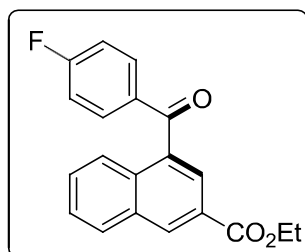
^1H NMR (400 MHz, CDCl_3) δ : 8.74 (s, 1H), 8.15 (s, 1H), 8.04 – 8.03 (m, 2H), 7.77 (d, $J = 8.0$ Hz, 2H), 7.60 – 7.57 (m, 2H), 7.26 (d, $J = 8.0$ Hz, 2H), 4.46 – 4.41 (m, 2H), 2.43 (s, 3H), 1.42 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 196.9, 166.0, 144.6, 137.2, 135.2, 133.3, 132.9, 132.8, 130.5, 129.8, 129.3 (2C), 127.1, 126.5, 126.1, 125.7, 61.3, 21.7, 14.3; HRMS (EI) calcd for $\text{C}_{21}\text{H}_{19}\text{O}_3$ $[\text{M} + \text{H}]^+$: 319.1329, found 319.1341.

ethyl 4-(4-methoxybenzoyl)-2-naphthoate (2c)



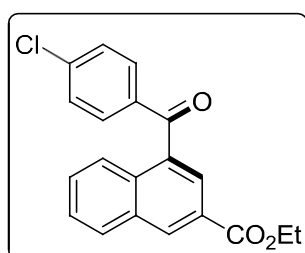
^1H NMR (400 MHz, CDCl_3) δ : 8.73 (s, 1H), 8.14 (s, 1H), 8.04 – 7.99 (m, 2H), 7.86 (d, $J = 8.0$ Hz, 2H), 7.59 – 7.57 (m, 2H), 6.94 (d, $J = 8.0$ Hz, 2H), 4.47 – 4.42 (m, 2H), 3.87 (s, 3H), 1.43 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 195.9, 166.1, 164.0, 137.5, 133.1, 132.9, 132.8 (2C), 13.6, 129.8, 129.2, 127.1, 126.6, 125.7 (2C), 113.8, 61.3, 55.5, 14.3; HRMS (EI) calcd for $\text{C}_{21}\text{H}_{19}\text{O}_4$ $[\text{M} + \text{H}]^+$: 335.1278, found 335.1289.

ethyl 4-(4-fluorobenzoyl)-2-naphthoate (2d)



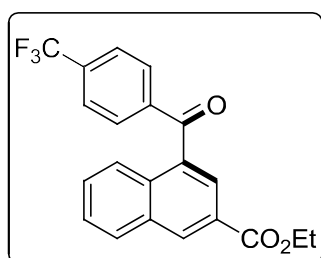
^1H NMR (400 MHz, CDCl_3) δ : 8.76 (s, 1H), 8.14 (s, 1H), 8.06 – 8.03 (m, 2H), 7.92 – 7.89 (m, 2H), 7.63 – 7.60 (m, 2H), 7.15 (t, $J = 8.0$ Hz, 2H), 4.47 – 4.42 (m, 2H), 1.43 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 195.6, 166.1 (d, $J = 250$ Hz, 1C), 165.9, 136.6, 134.1, 133.7, 133.1, 133.0, 132.7, 129.9, 129.5, 127.3, 126.5, 126.4, 125.6, 115.9 (d, $J = 20$ Hz, 1C), 61.4, 14.3; HRMS (EI) calcd for $\text{C}_{20}\text{H}_{16}\text{FO}_3$ $[\text{M} + \text{H}]^+$: 323.1078, found 323.1089.

ethyl 4-(4-chlorobenzoyl)-2-naphthoate (2e)



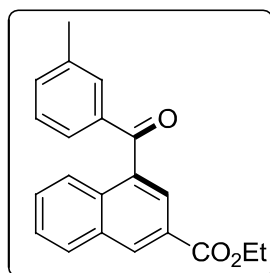
^1H NMR (400 MHz, CDCl_3) δ : 8.76 (s, 1H), 8.14 (s, 1H), 8.06 – 8.04 (m, 2H), 7.81 (d, $J = 8.0$ Hz, 2H), 7.63 – 7.60 (m, 2H), 7.45 (d, $J = 8.0$ Hz, 2H), 4.47 – 4.42 (m, 2H), 1.43 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 196.0, 165.9, 140.1, 136.6, 133.8, 133.0, 132.7, 131.7, 129.9, 129.6, 128.9, 127.3, 126.6, 126.5, 125.6, 61.5, 14.3; HRMS (EI) calcd for $\text{C}_{20}\text{H}_{16}\text{ClO}_3$ $[\text{M} + \text{H}]^+$: 339.0782, found 339.0795.

ethyl 4-(4-(trifluoromethyl)benzoyl)-2-naphthoate (2f)



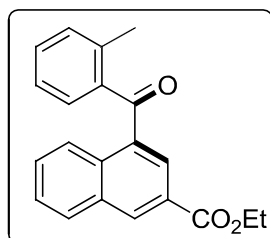
^1H NMR (400 MHz, CDCl_3) δ : 8.79 (s, 1H), 8.15 (s, 1H), 8.13 (d, $J = 8.0$ Hz, 1H), 8.08 – 8.06 (m, 1H), 7.98 (d, $J = 12.0$ Hz, 2H), 7.75 (d, $J = 8.0$ Hz, 2H), 7.67 – 7.62 (m, 2H), 4.48 – 4.42 (m, 2H), 1.43 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 196.1, 165.8, 140.7, 135.7, 134.3, 133.1, 132.8, 130.6, 130.0, 129.9, 127.5, 127.3, 126.5, 125.7 (q, $J = 10$ Hz, 1C), 125.5, 123.6 (q, $J = 270$ Hz, 1C), 61.5, 14.3; HRMS (EI) calcd for $\text{C}_{21}\text{H}_{16}\text{F}_3\text{O}_3$ $[\text{M} + \text{H}]^+$: 373.1046, found 373.1058.

ethyl 4-(3-methylbenzoyl)-2-naphthoate(2g)



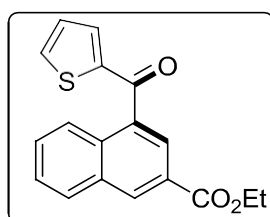
^1H NMR (400 MHz, CDCl_3) δ : 8.75 (s, 1H), 8.15 (s, 1H), 8.05 (t, $J = 8.0$ Hz, 2H), 7.73 (s, 1H), 7.62 – 7.58 (m, 3H), 7.43 (d, $J = 8.0$ Hz, 1H), 7.34 (t, $J = 8.0$ Hz, 1H), 4.47 – 4.41 (m, 2H), 2.39 (s, 3H), 1.42 (t, $J = 6.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 197.5, 166.0, 138.5, 137.8, 137.1, 134.4, 133.4, 132.9 (2C), 130.6, 129.8, 129.4, 128.4, 127.8, 127.2, 126.5, 126.3, 125.7, 61.4, 21.3, 14.3; HRMS (EI) calcd for $\text{C}_{21}\text{H}_{19}\text{O}_3$ [$\text{M} + \text{H}$] $^+$: 319.1329, found 319.1341.

ethyl 4-(2-methylbenzoyl)-2-naphthoate (2h)



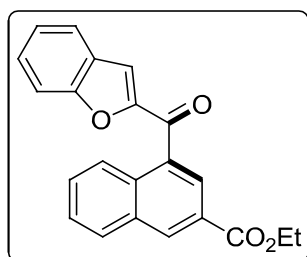
^1H NMR (400 MHz, CDCl_3) δ : 8.74 (s, 1H), 8.41 (d, $J = 8.0$ Hz, 1H), 8.11 (s, 1H), 8.04 (d, $J = 8.0$ Hz, 1H), 7.68 – 7.59 (m, 2H), 7.43 (t, $J = 8.0$ Hz, 1H), 7.35 (t, $J = 8.0$ Hz, 2H), 7.19 (t, $J = 8.0$ Hz, 1H), 4.44 – 4.39 (m, 2H), 2.53 (s, 3H), 1.41 (t, $J = 6.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 199.5, 165.9, 138.9, 138.5, 137.4, 134.4, 133.1, 132.9, 131.7 (2C), 131.0, 129.9 (2C), 128.4, 127.2, 126.5, 125.8, 125.5, 61.4, 20.9, 14.3; HRMS (EI) calcd for $\text{C}_{21}\text{H}_{19}\text{O}_3$ [$\text{M} + \text{H}$] $^+$: 319.1329, found 319.1341.

ethyl 4-(thiophene-2-carbonyl)-2-naphthoate (2i)



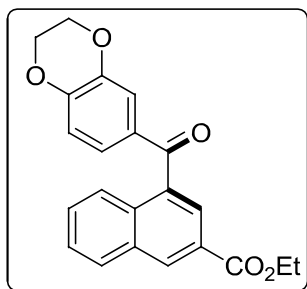
^1H NMR (400 MHz, CDCl_3) δ : 8.75 (s, 1H), 8.32 (s, 1H), 8.18 (d, $J = 8.0$ Hz, 1H), 8.03 (d, $J = 8.0$ Hz, 1H), 7.78 (d, $J = 8.0$ Hz, 1H), 7.65 – 7.58 (m, 2H), 7.49 (d, $J = 4.0$ Hz, 1H), 7.12 (t, $J = 4.0$ Hz, 1H), 4.48 – 4.43 (m, 2H), 1.44 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 188.9, 165.9, 144.9, 136.5, 135.9, 135.4, 133.7, 133.0, 132.5, 129.8, 129.5, 128.3, 127.3, 126.4, 126.1, 125.5, 61.4, 14.3; HRMS (EI) calcd for $\text{C}_{18}\text{H}_{15}\text{O}_3\text{S}$ $[\text{M} + \text{H}]^+$: 311.0736, found 311.0749.

ethyl 4-(benzofuran-2-carbonyl)-2-naphthoate (2j)



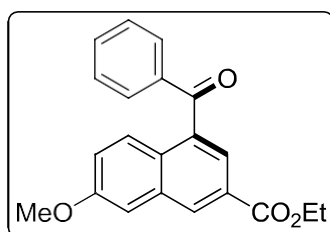
^1H NMR (400 MHz, CDCl_3) δ : 8.80 (s, 1H), 8.45 (s, 1H), 8.28 (d, $J = 8.0$ Hz, 1H), 8.06 (d, $J = 8.0$ Hz, 1H), 7.71 – 7.62 (m, 4H), 7.53 (t, $J = 8.0$ Hz, 1H), 7.38 (s, 1H), 7.34 (t, $J = 8.0$ Hz, 1H), 4.50 – 4.45 (m, 2H), 1.45 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 185.4, 165.9, 156.5, 152.7, 135.4, 134.4, 133.1, 132.7, 129.9 (2C), 128.9, 127.4, 127.0, 126.9, 126.5, 125.4, 124.1, 123.6, 118.1, 112.7, 61.5, 14.4; HRMS (EI) calcd for $\text{C}_{22}\text{H}_{17}\text{O}_4$ $[\text{M} + \text{H}]^+$: 345.1121, found 345.1134.

ethyl 4-(2,3-dihydrobenzo[b][1,4]dioxine-6-carbonyl)-2-naphthoate (2k)



^1H NMR (400 MHz, CDCl_3) δ : 8.72 (s, 1H), 8.12 (s, 1H), 8.03 – 7.98 (m, 2H), 7.59 – 7.57 (m, 2H), 7.44 (s, 1H), 7.38 (d, $J = 8.0$ Hz, 1H), 6.90 (d, $J = 8.0$ Hz, 1H), 4.46 – 4.41 (m, 2H), 4.32 (d, $J = 4.0$ Hz, 2H), 4.27 (d, $J = 4.0$ Hz, 2H), 1.43 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 195.8, 166.0, 148.6, 143.3, 137.3, 133.1, 132.9, 132.8, 131.4, 129.8, 129.2, 127.1, 126.5, 125.7 (2C), 124.8, 119.7, 117.3, 64.7, 64.0, 61.3, 143 ; HRMS (EI) calcd for $\text{C}_{22}\text{H}_{19}\text{O}_5$ $[\text{M} + \text{H}]^+$: 363.1227, found 363.1242.

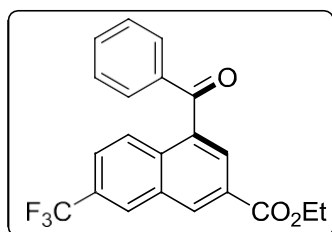
ethyl 4-benzoyl-7-methoxy-2-naphthoate (2o)



^1H NMR (400 MHz, CDCl_3) δ : 8.64 (s, 1H), 8.04 – 7.96 (m, 2H), 8.01 (s, 1H), 7.86 (d, $J = 8.0$ Hz, 1H), 7.61 (t, $J = 8.0$ Hz, 1H), 7.46 (t, $J = 7.8$ Hz, 2H), 7.32 (d, $J = 4.0$ Hz, 1H), 7.27 – 7.24 (m, 1H), 4.45 – 4.40 (m, 2H), 3.94 (s, 3H), 1.41 (t, $J = 6.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ : 197.4, 166.1, 158.3, 137.8, 136.7, 134.5, 133.5, 132.2, 130.4, 128.5, 128.3, 127.1, 127.0, 124.5, 122.2, 107.4, 61.3, 55.4, 14.3; HRMS (EI)

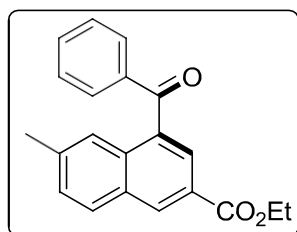
calcd for $C_{21}H_{19}O_4$ $[M + H]^+$: 335.1278, found 335.1289.

ethyl 4-benzoyl-7-(trifluoromethyl)-2-naphthoate (2p)



1H NMR (400 MHz, $CDCl_3$) δ : 8.85 (s, 1H), 8.36 (s, 1H), 8.29 (s, 1H), 8.23 (d, $J = 8.0$ Hz, 1H), 7.86 (d, $J = 8.0$ Hz, 2H), 7.77 (d, $J = 8.0$ Hz, 1H), 7.65 (t, $J = 8.0$ Hz, 1H), 7.53 – 7.48 (m, 2H), 4.49 – 4.43 (m, 2H), 1.44 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ : 196.5, 165.4, 137.4, 137.0, 134.1, 133.9, 132.0, 130.4, 129.3, 129.0, 128.7, 128.6, 128.0, 127.4 (q, $J = 10$ Hz, 1C), 127.0, 125.0 (q, $J = 10$ Hz, 1C), 123.8 (q, $J = 280$ Hz, 1C), 61.7, 14.3; HRMS (EI) calcd for $C_{21}H_{16}F_3O_3$ $[M + H]^+$: 373.1046, found 373.1058.

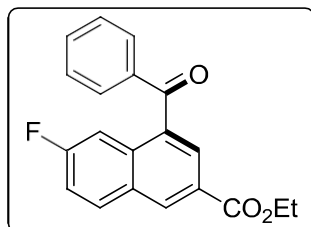
ethyl 4-benzoyl-6-methyl-2-naphthoate (2q)



1H NMR (400 MHz, $CDCl_3$) δ : 8.70 (s, 1H), 8.11 (s, 1H), 7.94 (d, $J = 8.0$ Hz, 1H), 7.89 – 7.88 (m, 3H), 7.62 (t, $J = 8.0$ Hz, 1H), 7.50 – 7.43 (m, 3H), 4.45 – 4.40 (m, 2H), 2.48 (s, 3H), 1.41 (t, $J = 6.0$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ : 197.5, 166.1, 140.0, 137.8, 136.0, 133.5, 133.4, 133.2, 131.3, 130.4, 129.6, 129.5, 128.6, 126.7, 125.5, 124.7, 61.3, 22.2,

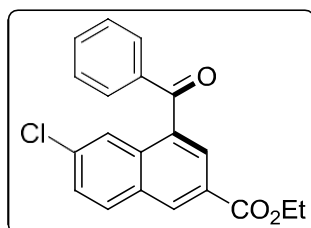
144 ; HRMS (EI) calcd for $C_{21}H_{19}O_3$ $[M + H]^+$: 319.1329, found 319.1340.

ethyl 4-benzoyl-6-fluoro-2-naphthoate (2r)



1H NMR (400 MHz, $CDCl_3$) δ : 8.75 (s, 1H), 8.21 (s, 1H), 8.07 – 8.03 (m, 1H), 7.88 – 7.82 (m, 3H), 7.64 (t, $J = 8.0$ Hz, 1H), 7.49 (t, $J = 6.0$ Hz, 2H), 7.42 – 7.37 (m, 1H), 4.46 – 4.41 (m, 2H), 1.42 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ : 196.7, 165.8, 163.0 (d, $J = 250$ Hz, 1C), 137.6, 135.9, 134.2 (d, $J = 10$ Hz, 1C), 133.6, 132.4, 132.3, 130.4, 130.1, 128.6, 128.1, 125.9, 117.9 (d, $J = 30$ Hz, 1C), 109.9 (d, $J = 20$ Hz, 1C), 61.5, 14.3; HRMS (EI) calcd for $C_{20}H_{16}FO_3$ $[M + H]^+$: 323.1078, found 323.1089.

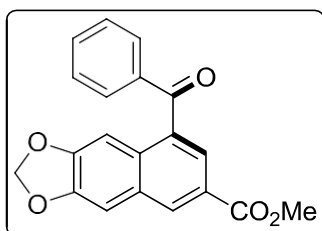
ethyl 4-benzoyl-6-chloro-2-naphthoate (2s)



1H NMR (400 MHz, $CDCl_3$) δ : 8.72 (s, 1H), 8.17 (d, $J = 12.0$ Hz, 2H), 7.98 (d, $J = 8.0$ Hz, 1H), 7.87 (d, $J = 8.0$ Hz, 2H), 7.64 (t, $J = 6.0$ Hz, 1H), 7.56 (d, $J = 8.0$ Hz, 1H), 7.50 (t, $J = 8.0$ Hz, 2H), 4.46 – 4.41 (m, 2H), 1.42 (t, $J = 8.0$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ : 196.6, 165.7,

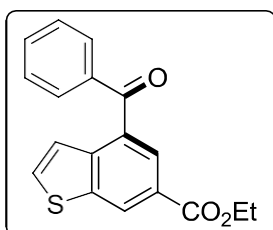
137.5, 136.0, 135.8, 133.7, 133.5, 133.4, 131.3, 131.2, 130.4, 128.7, 18.4, 127.8, 126.7, 124.9, 61.5, 14.3; HRMS (EI) calcd for C₂₀H₁₆ClO₃ [M + H]⁺: 339.0782, found 339.0795.

ethyl 8-benzoylnaphtho[2,3-d][1,3]dioxole-6-carboxylate (2t)



¹H NMR (400 MHz, CDCl₃) δ: 8.53 (s, 1H), 8.01 (s, 1H), 7.85 (d, *J* = 8.0 Hz, 2H), 7.61 (t, *J* = 6.0 Hz, 1H), 7.49 – 7.45 (m, 3H), 7.26 (s, 1H), 6.08 (s, 2H), 3.93 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ: 197.4, 166.6, 150.9, 148.5, 137.8, 135.4, 133.4, 132.4, 131.0, 130.6, 130.4, 128.5, 125.9, 124.6, 105.3, 102.4, 101.8, 52.3; HRMS (EI) calcd for C₂₀H₁₅O₅ [M + H]⁺: 335.0914, found 335.0925.

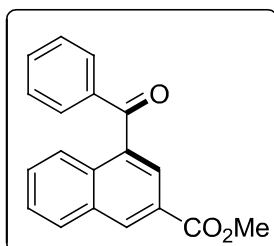
ethyl 4-benzoylbenzo[b]thiophene-6-carboxylate (2u)



¹H NMR (400 MHz, CDCl₃) δ: 8.79 (s, 1H), 8.26 (s, 1H), 7.85 (d, *J* = 8.0 Hz, 2H), 7.81 – 7.77 (m, 2H), 7.63 (t, *J* = 6.0 Hz, 1H), 7.50 (t, *J* = 8.0 Hz, 2H), 4.44 – 4.39 (m, 2H), 1.41 (t, *J* = 6.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ: 196.2, 165.9, 141.4, 141.1, 137.7, 133.0, 132.6, 132.5, 130.2, 128.5, 127.9, 127.7, 125.5, 123.9, 61.4, 14.3; HRMS (EI) calcd for

$C_{18}H_{15}O_3S$ $[M + H]^+$: 311.0736, found 311.0749.

methyl 4-benzoyl-2-naphthoate (2v)



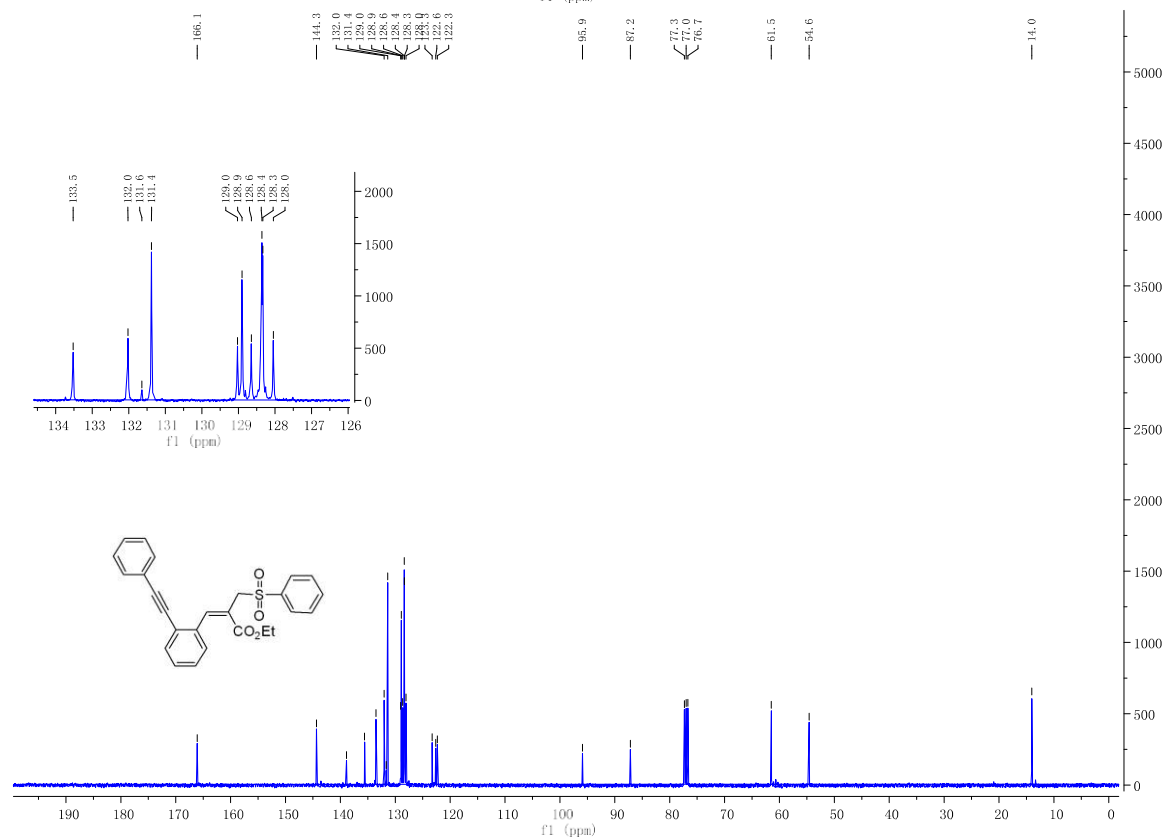
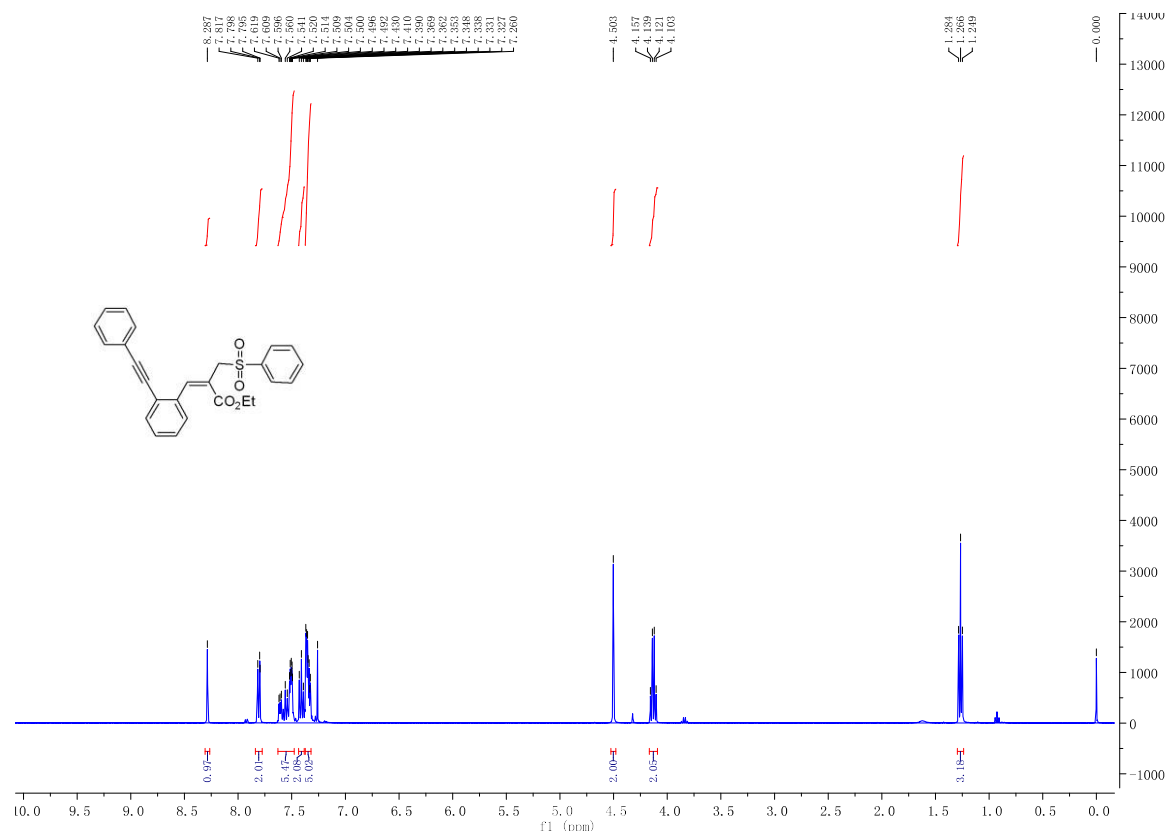
1H NMR (400 MHz, $CDCl_3$) δ : 8.75 (s, 1H), 8.16 (s, 1H), 8.11 – 8.09 (m, 1H), 8.05 – 8.02 (m, 1H), 7.87 (d, $J = 8.0$ Hz, 2H), 7.63 – 7.58 (m, 3H), 7.47 (t, $J = 8.0$ Hz, 2H), 3.96 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ : 197.2, 166.4, 137.7, 136.8, 133.7, 133.5, 133.0, 132.9, 130.4, 129.8, 129.5, 128.6, 127.2, 126.6, 126.1, 125.7, 52.4; HRMS (EI) calcd for $C_{19}H_{15}O_3$ $[M + H]^+$: 291.1016, found 291.1027.

References

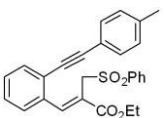
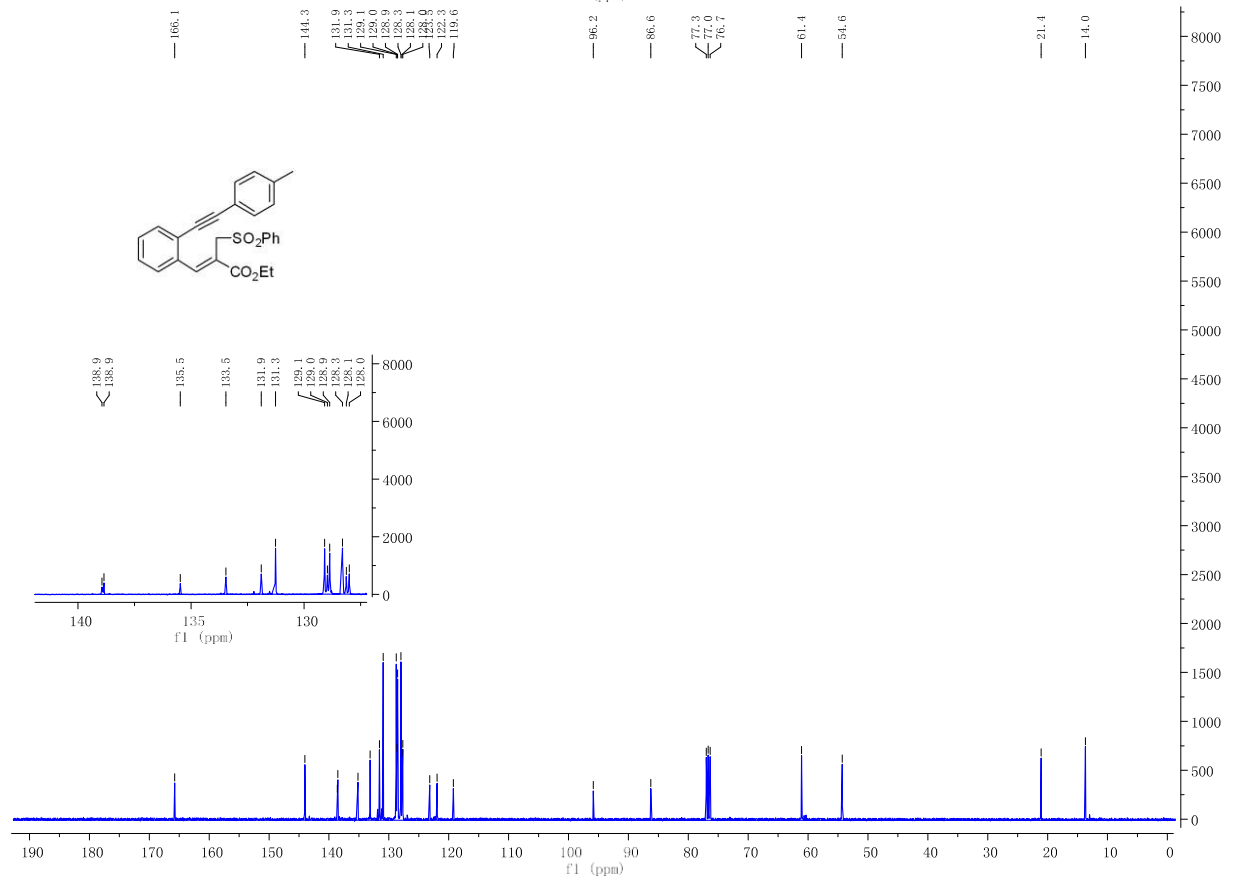
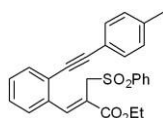
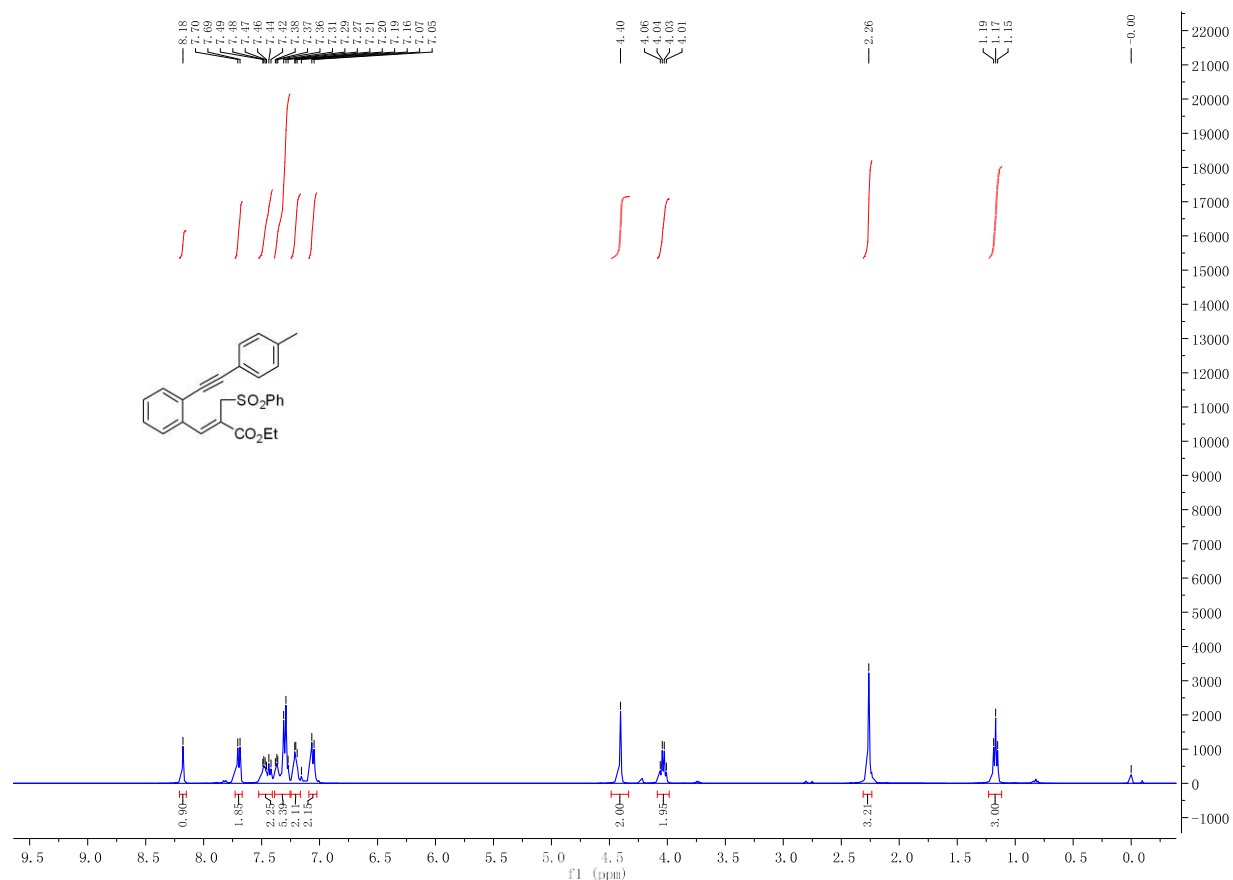
1. S. H. Ko, K.-J. Lee, *J. Heterocyclic Chem.*, 2004, **41**, 613.
2. K. Karnakar, J. Shankar, S. N. Murthy and Y. V. D. Nageswar, *Helvetica Chimica Acta*, 2011, **94**, 875.

Spectra of 1 and 2

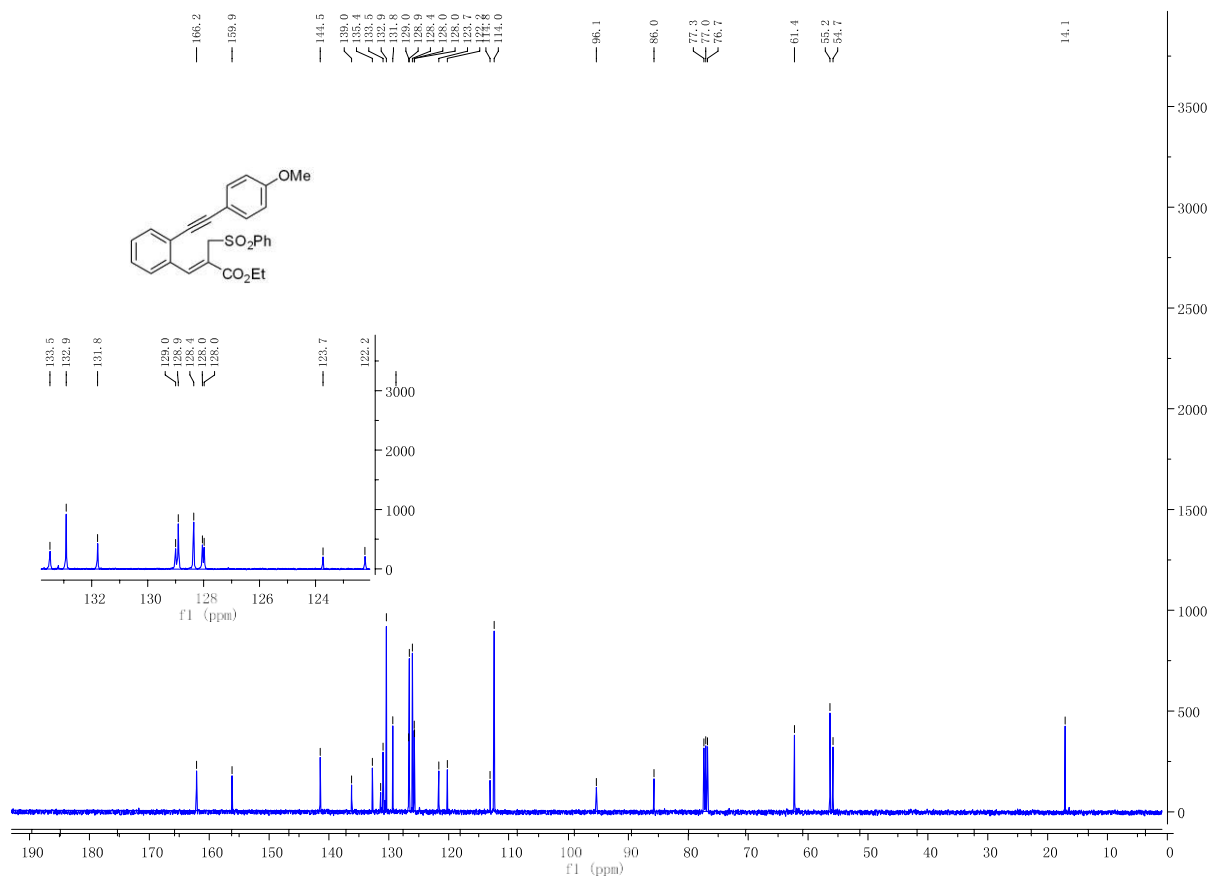
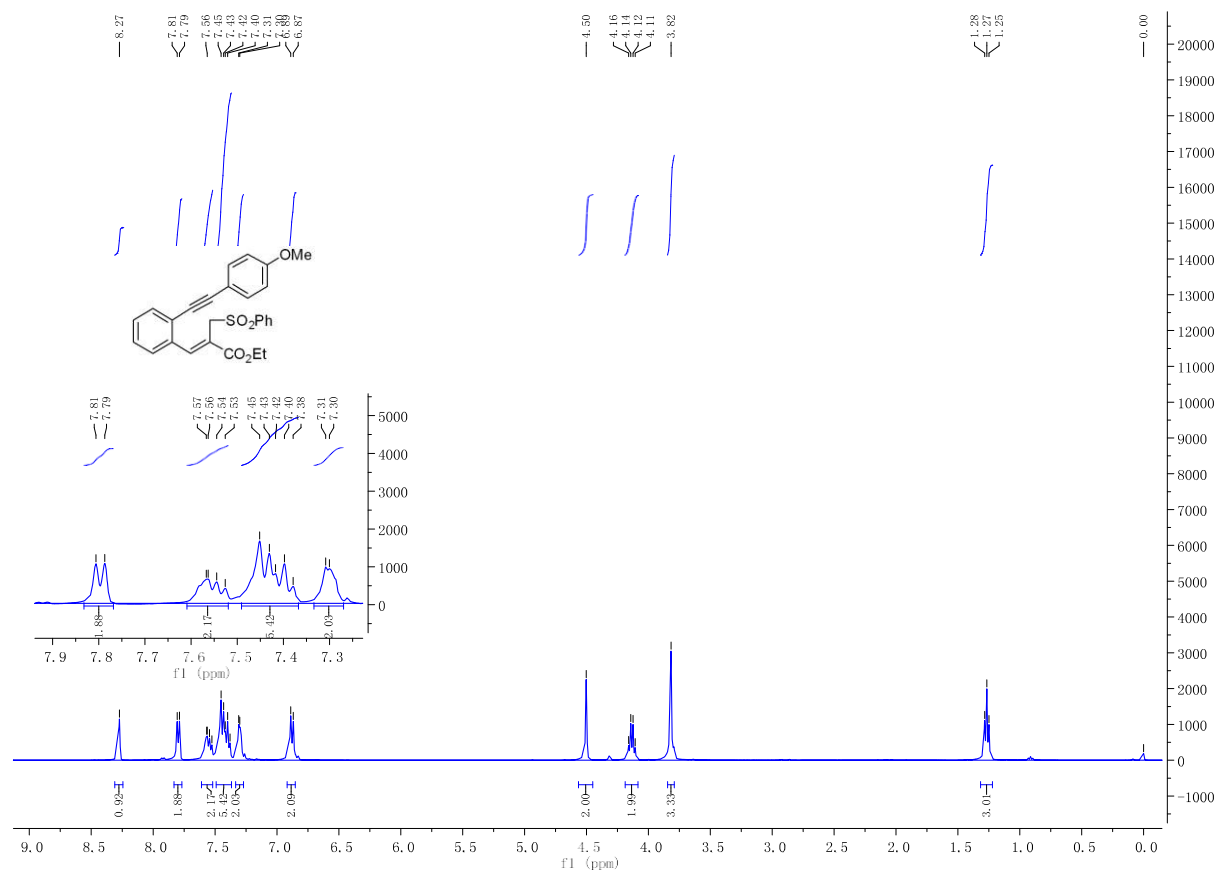
ethyl 3-(2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1a)



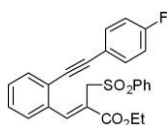
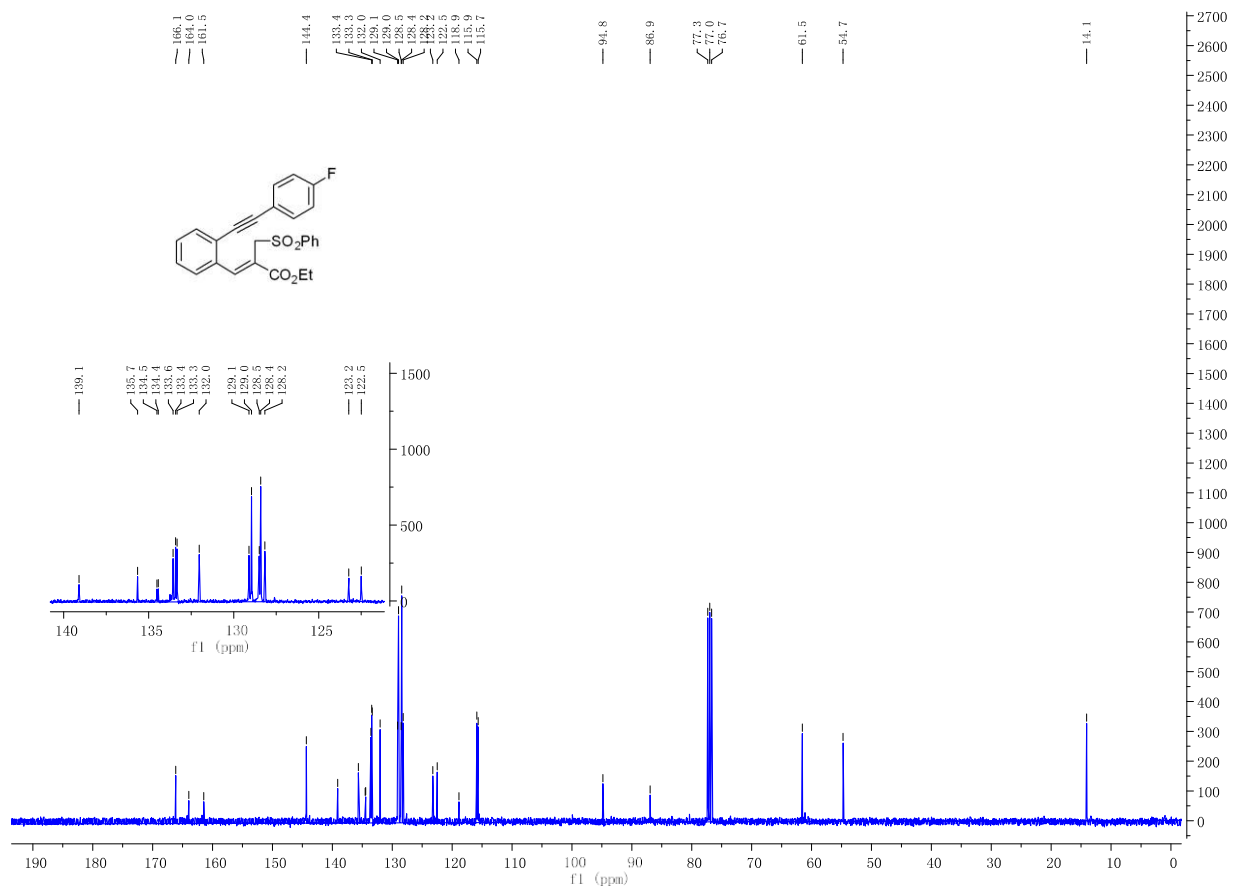
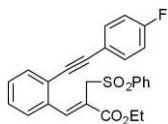
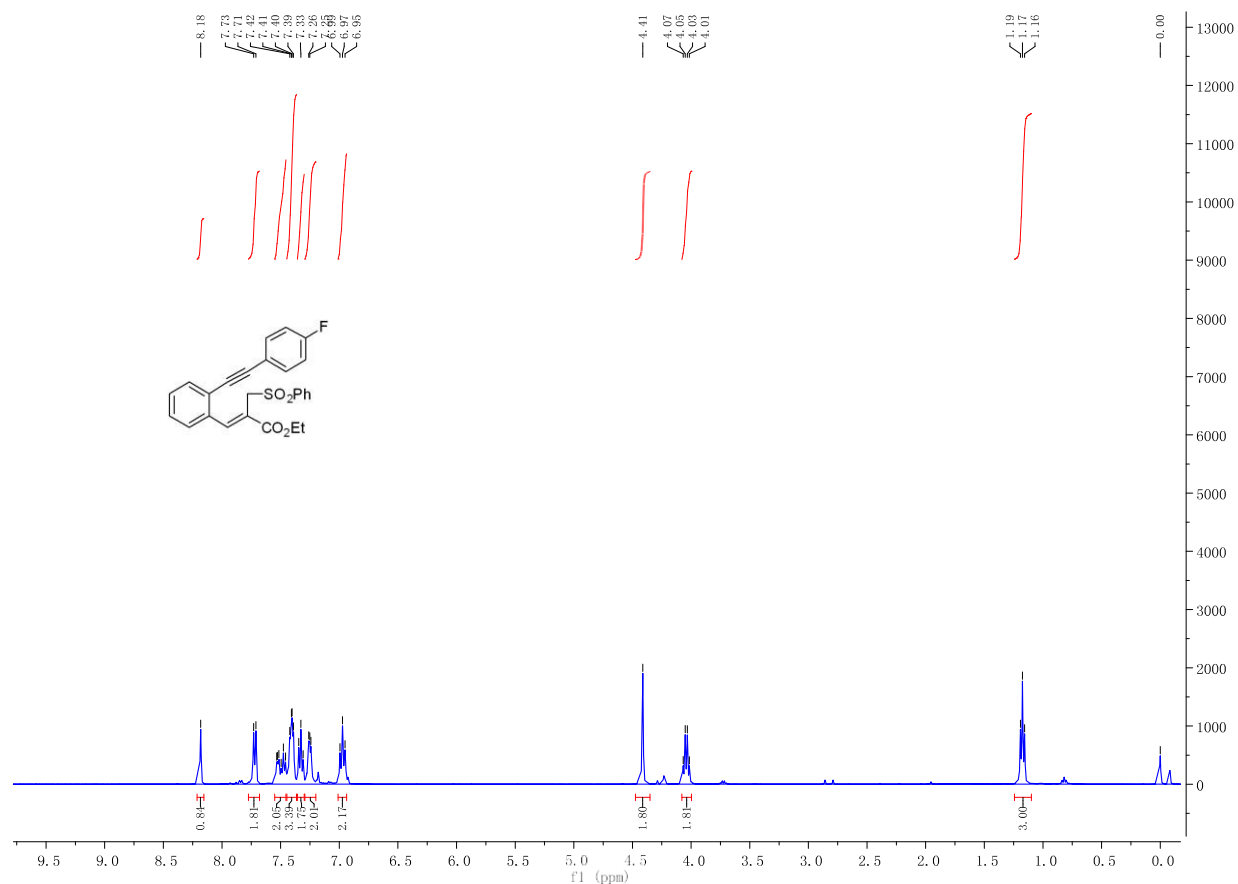
ethyl 2-((phenylsulfonyl)methyl)-3-(2-(p-tolylethynyl)phenyl)acrylate (1b)



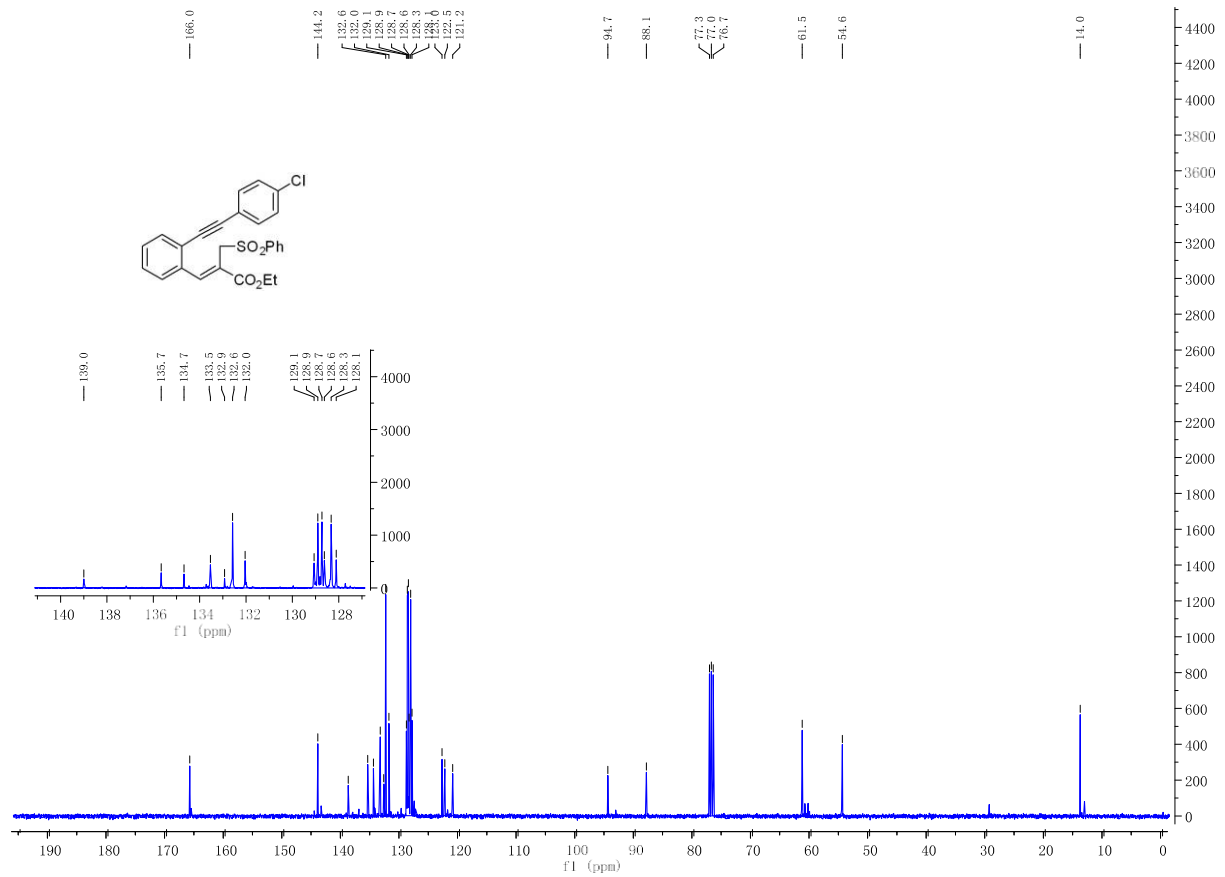
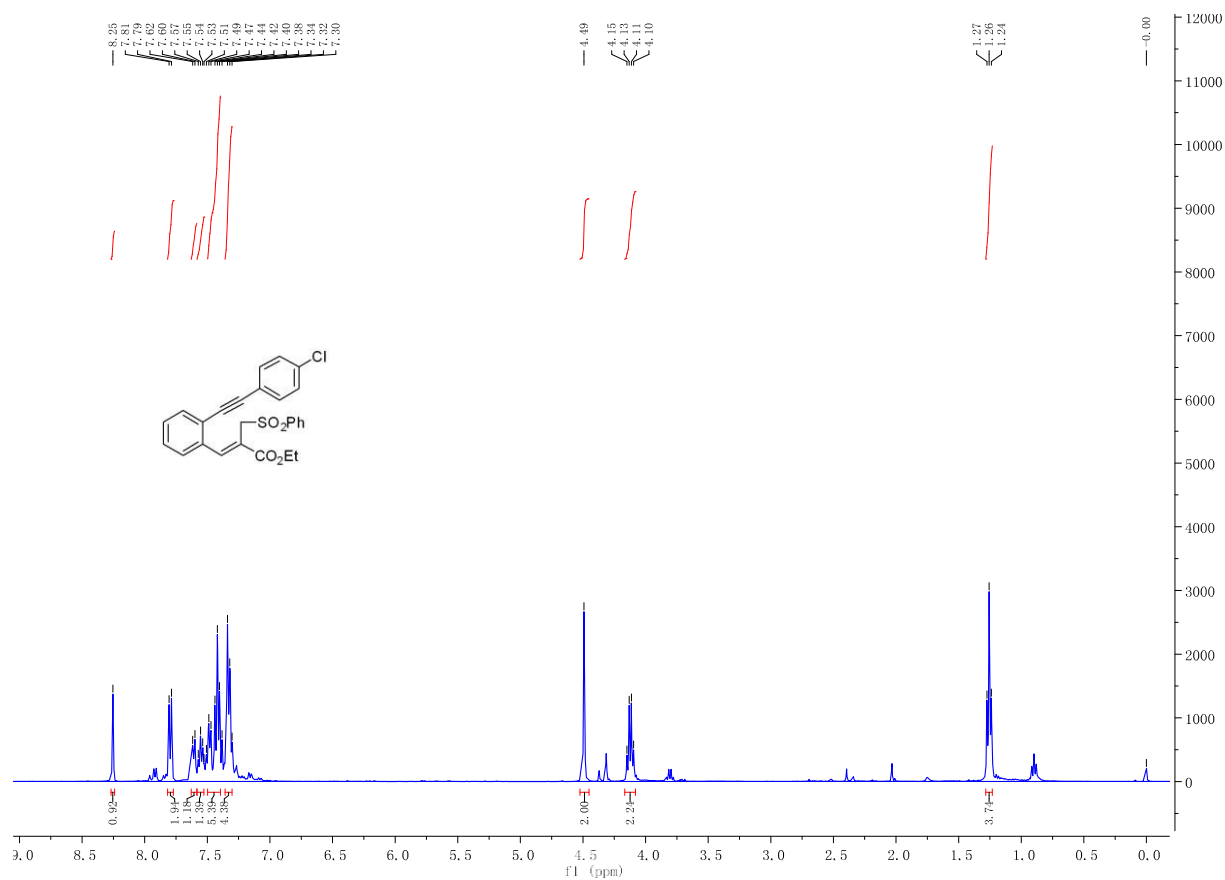
ethyl 3-(2-((4-methoxyphenyl)ethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1c)



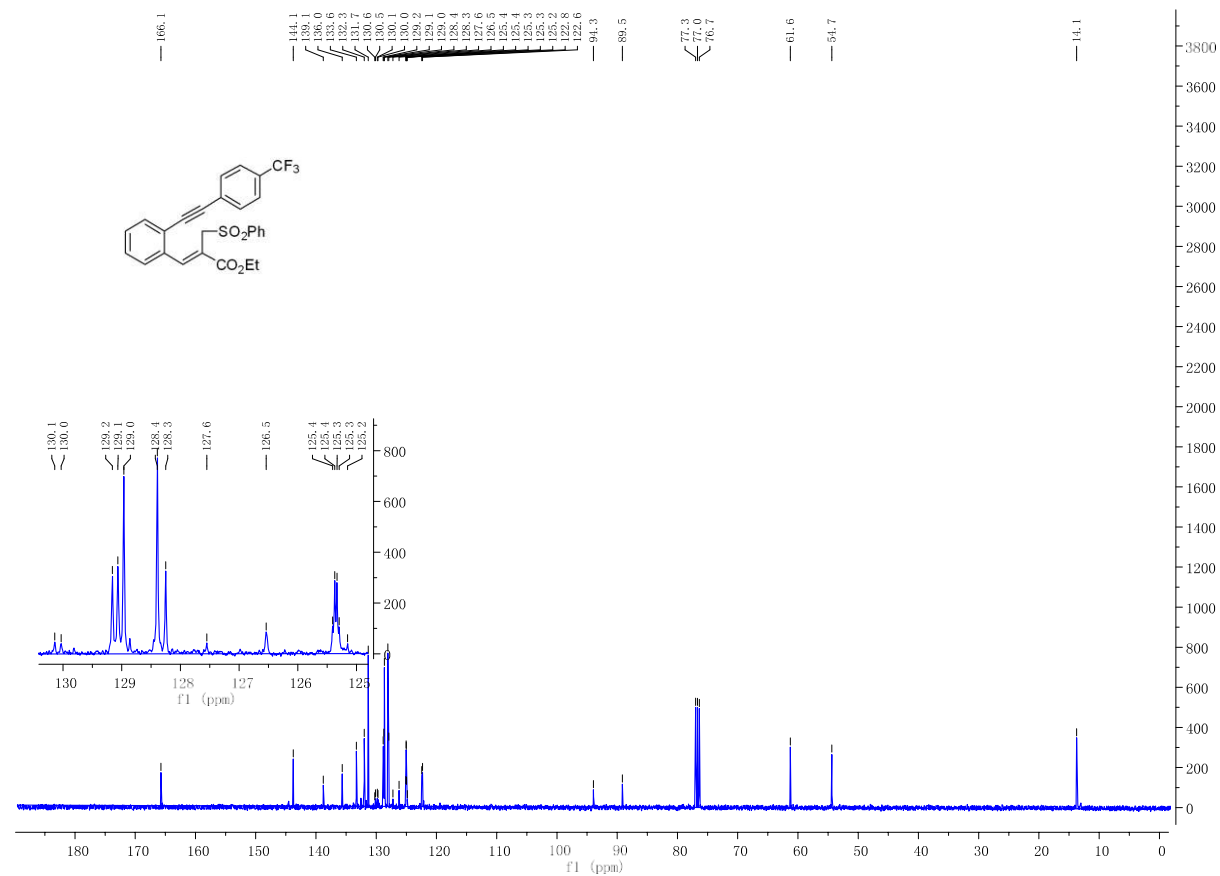
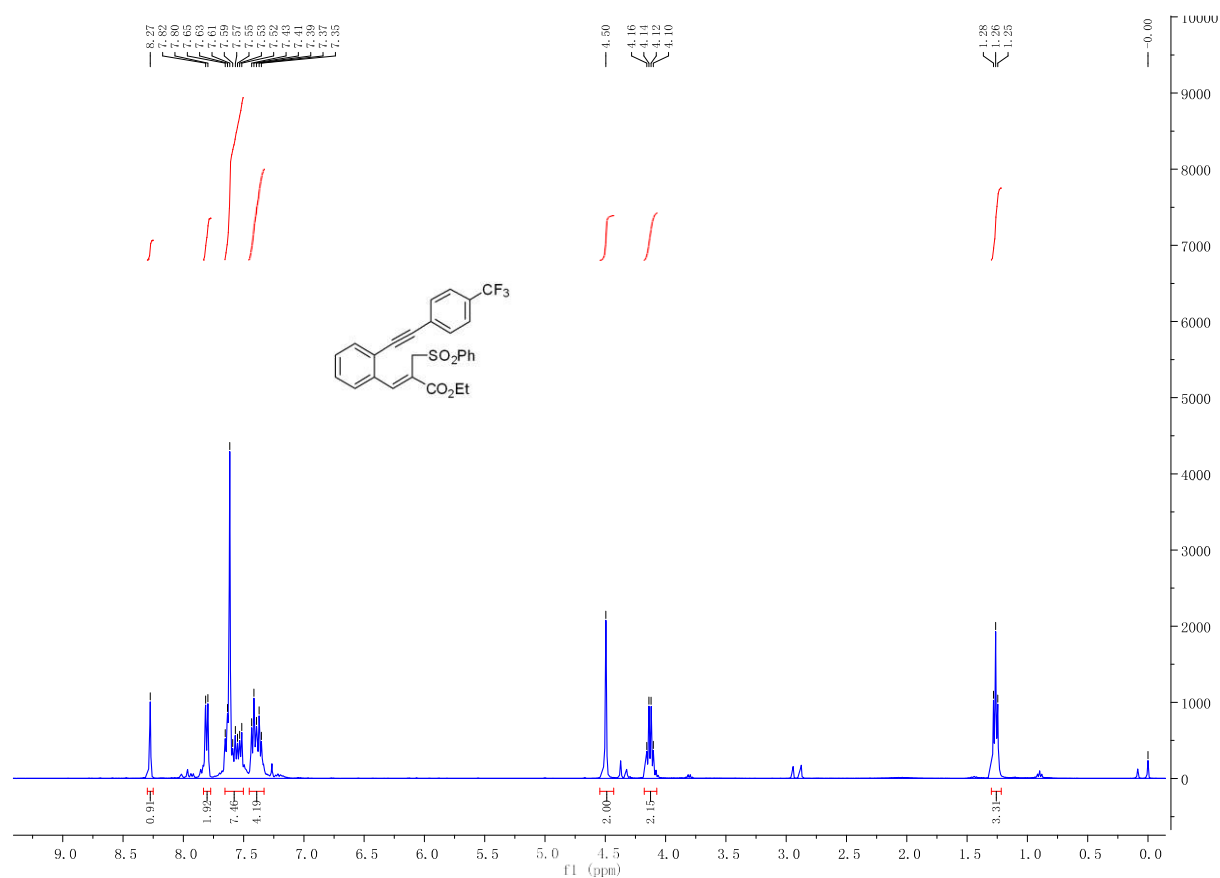
ethyl 3-(2-((4-fluorophenyl)ethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1d)



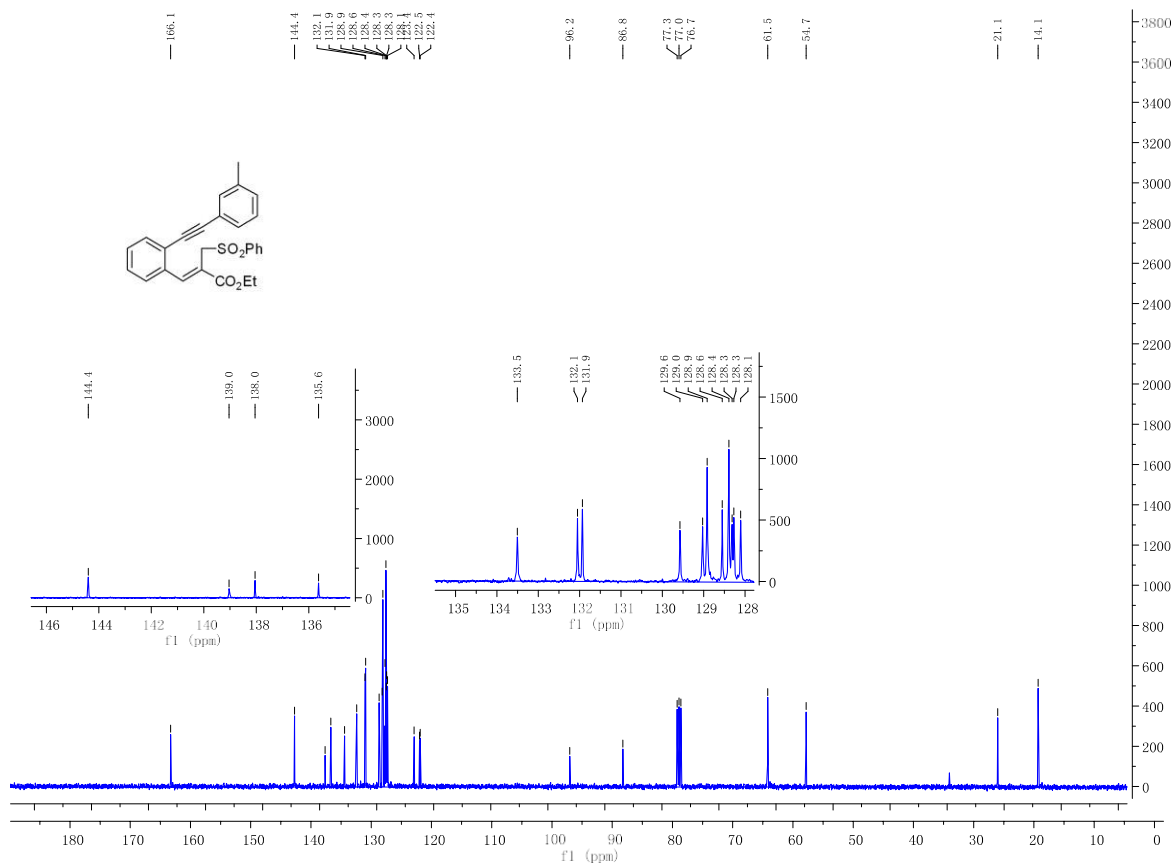
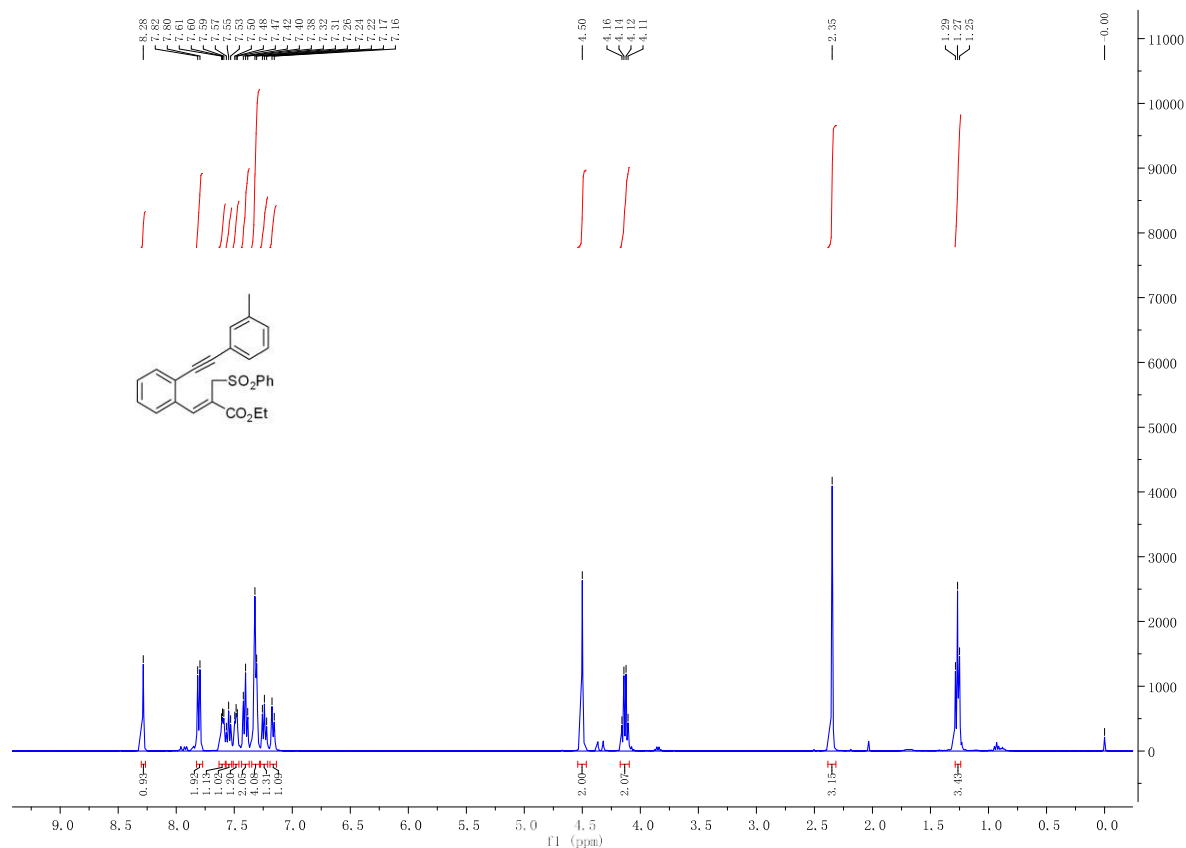
ethyl 3-(2-((4-chlorophenyl)ethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1e)



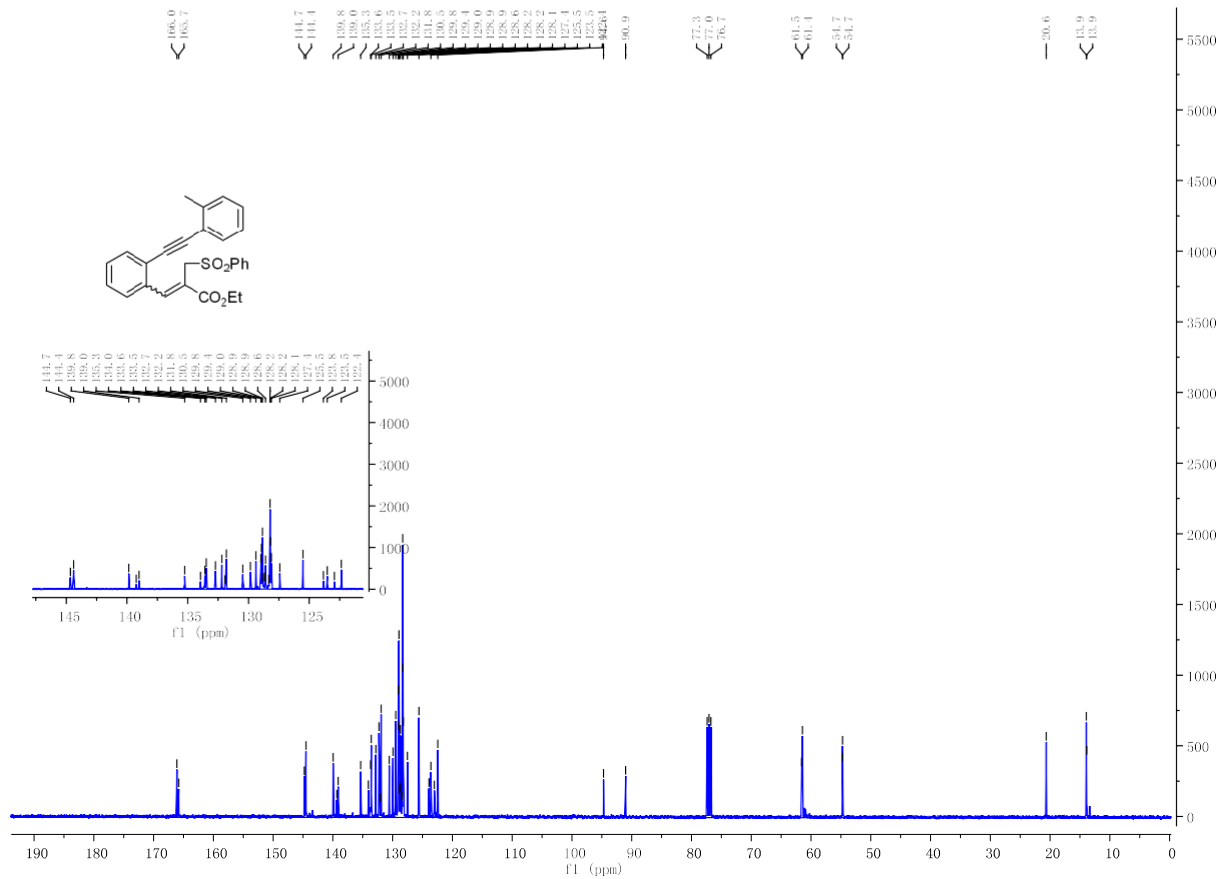
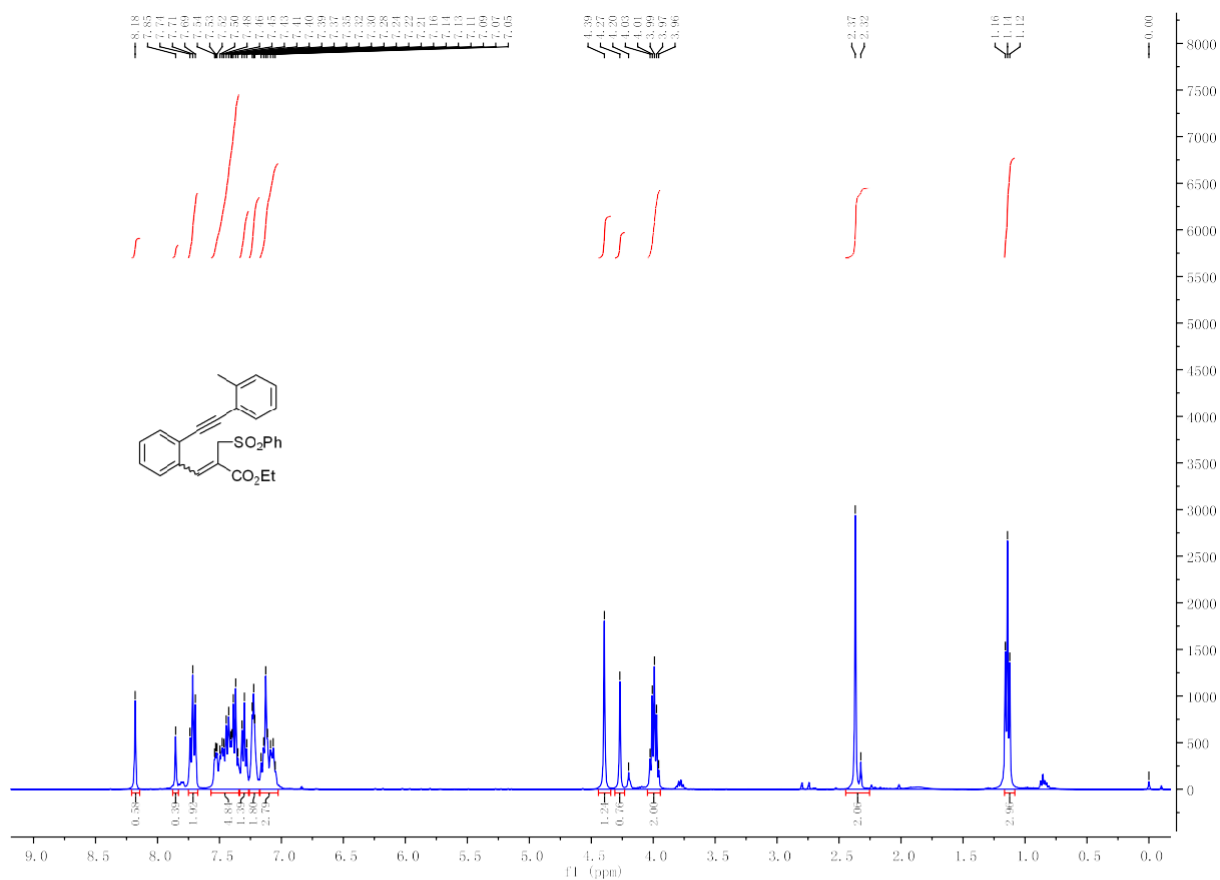
ethyl 2-((phenylsulfonyl)methyl)-3-(2-((4-(trifluoromethyl)phenyl)ethynyl)phenyl)acrylate (1f)



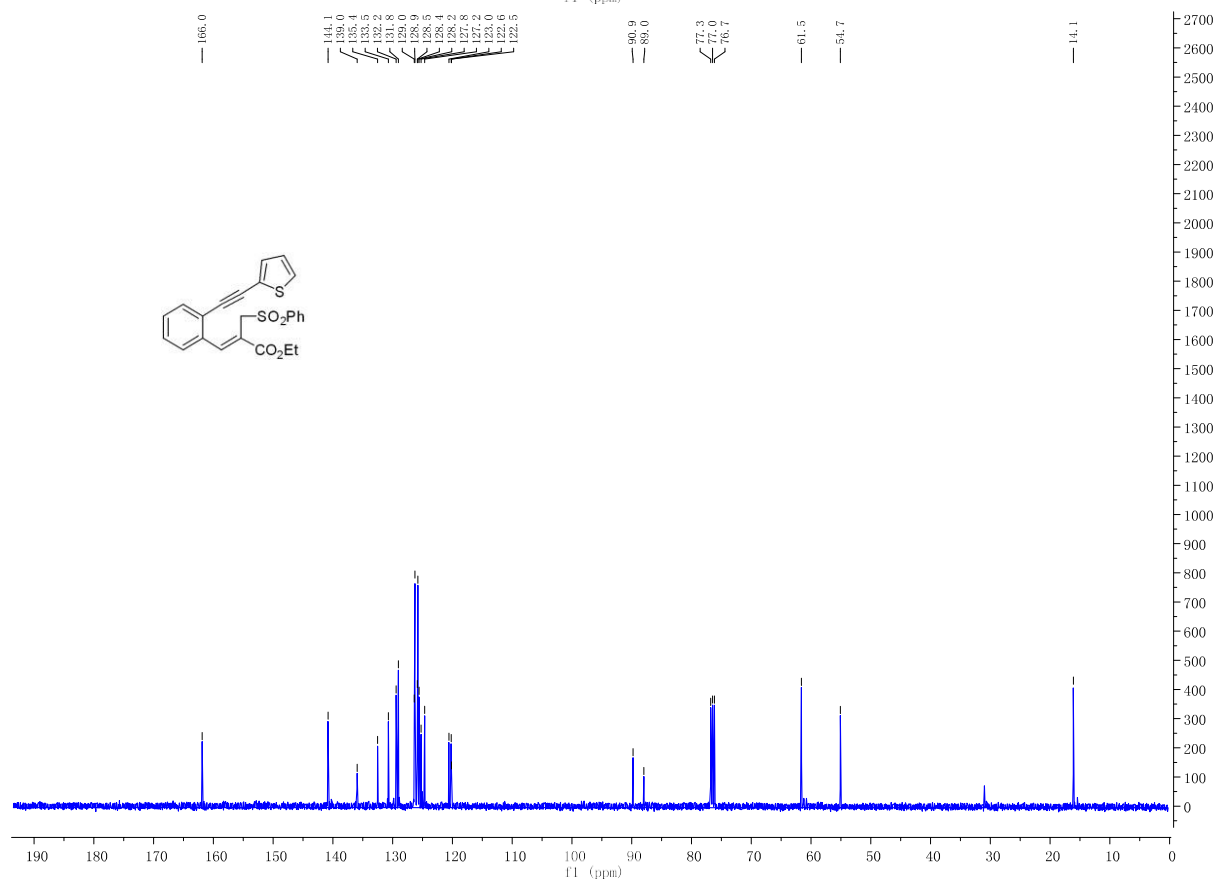
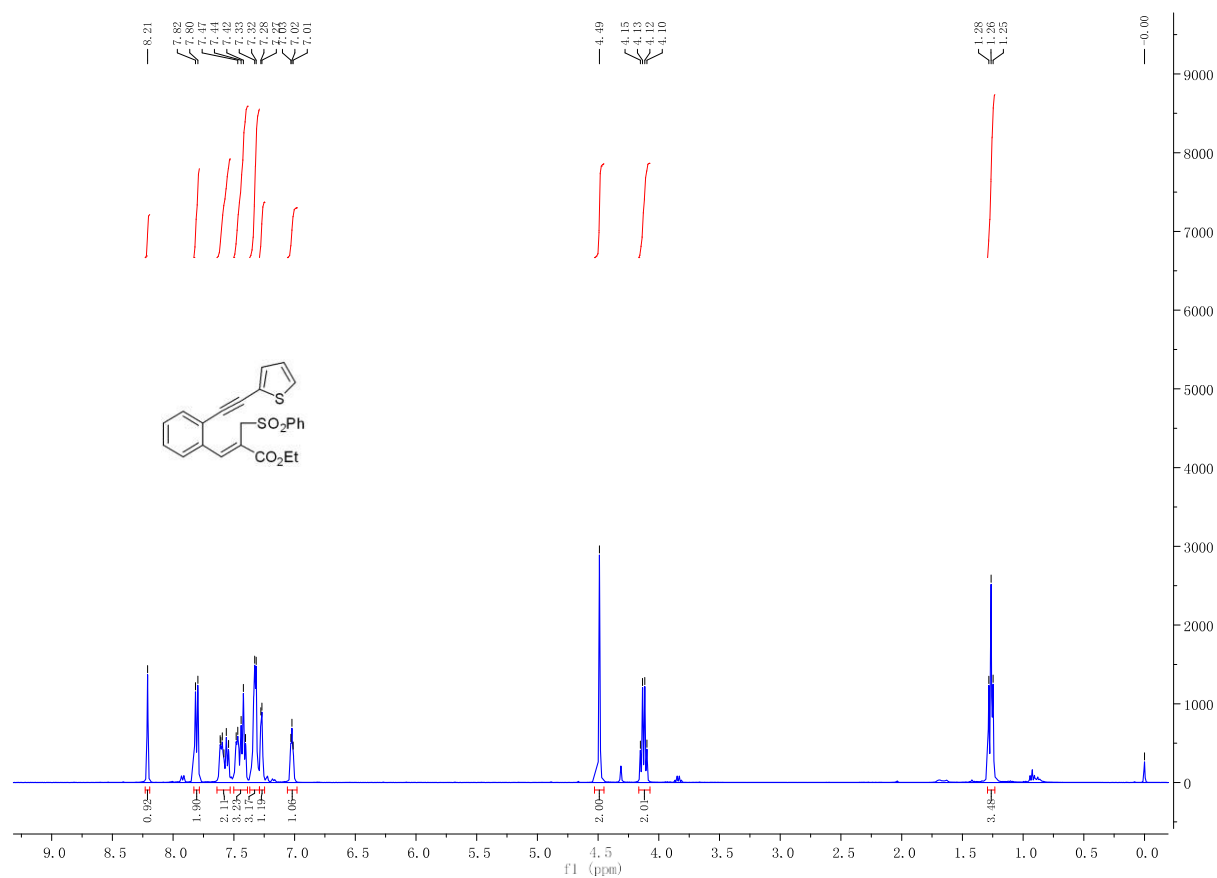
ethyl 2-((phenylsulfonyl)methyl)-3-(2-(m-tolyethynyl)phenyl)acrylate (1g)



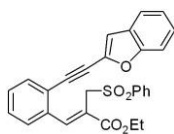
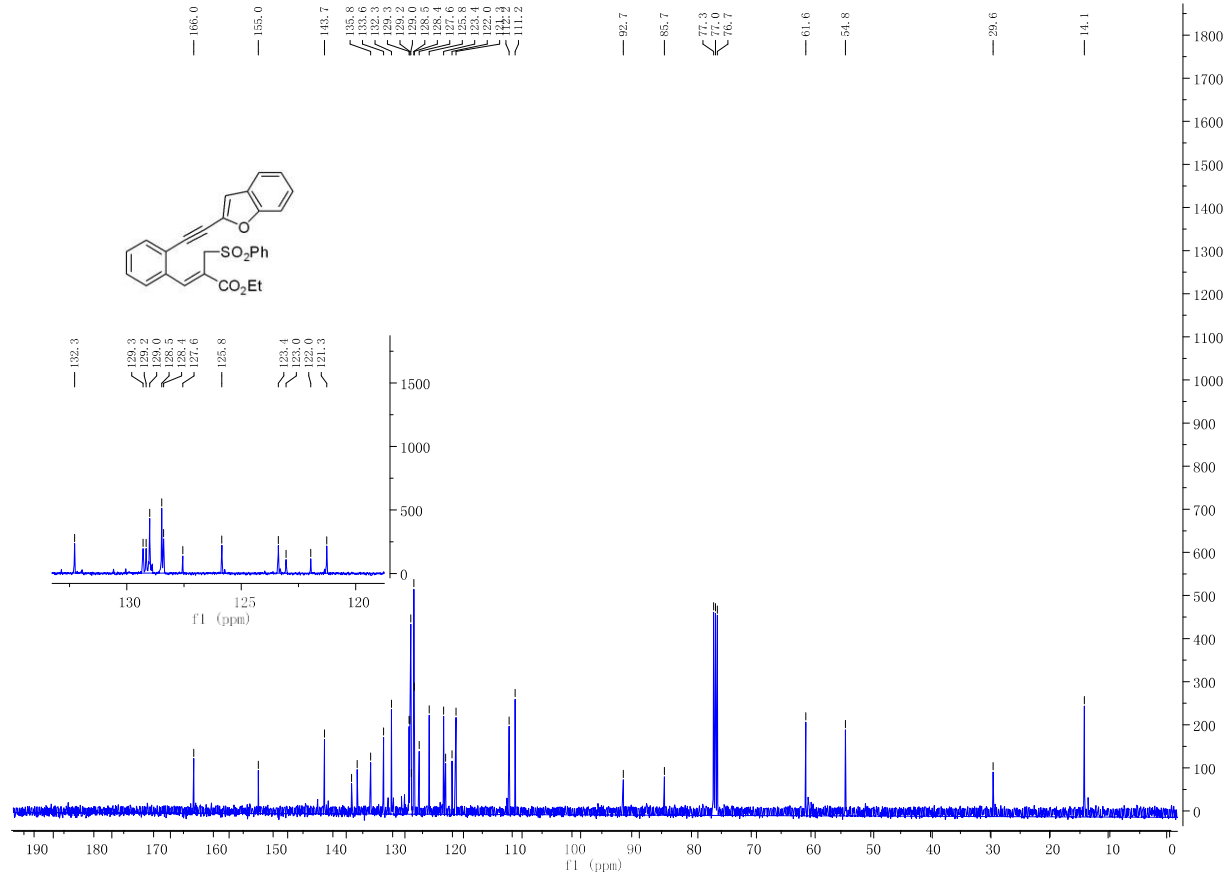
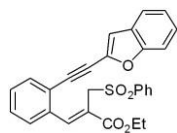
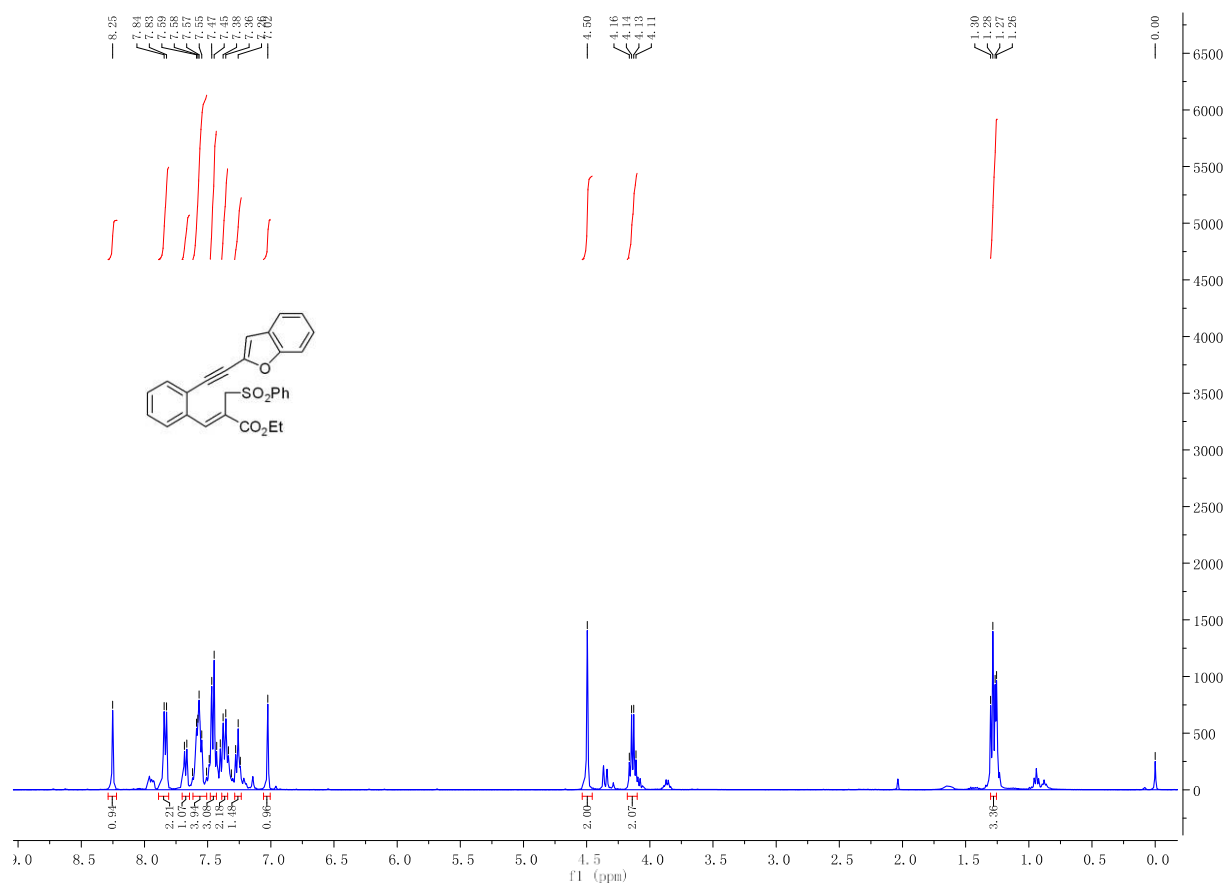
ethyl 2-((phenylsulfonyl)methyl)-3-(2-(o-tolylethynyl)phenyl)acrylate (1h)



ethyl 2-((phenylsulfonyl)methyl)-3-(2-(thiophen-2-ylethynyl)phenyl)acrylate (1i)

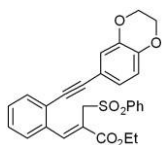
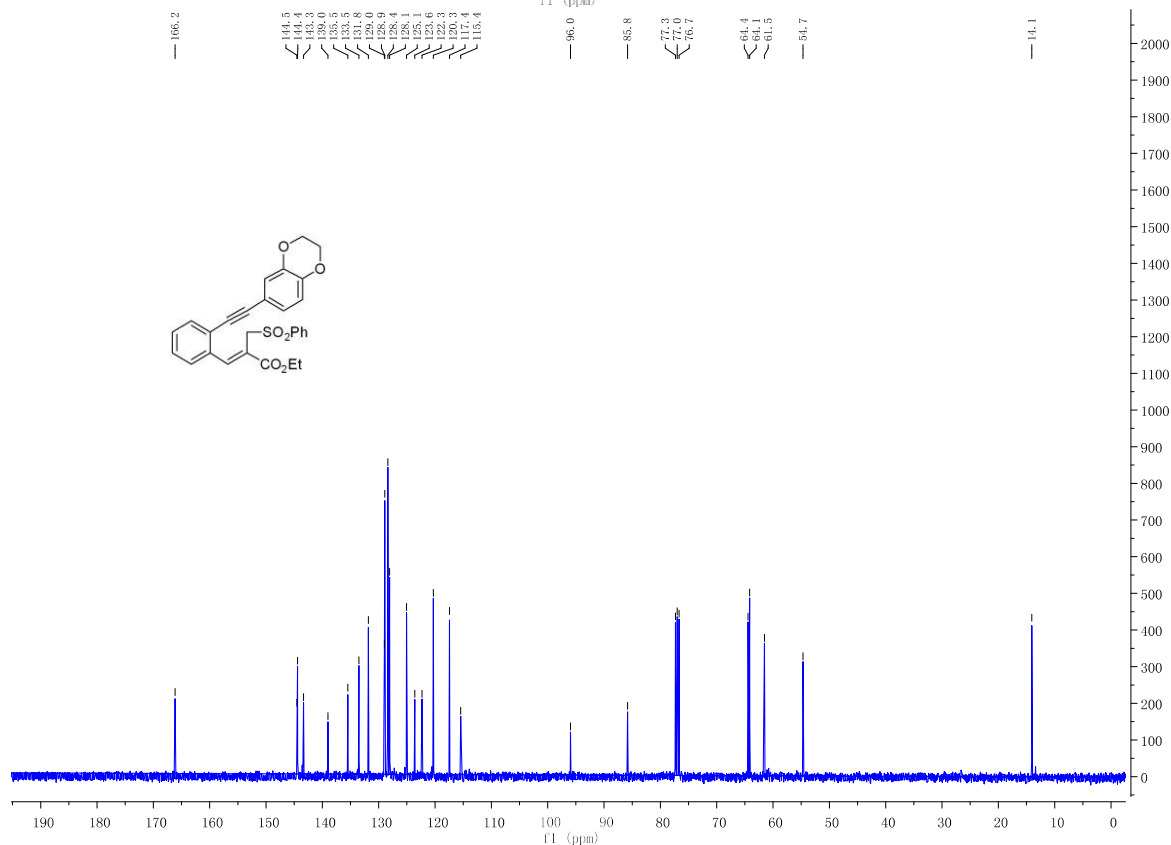
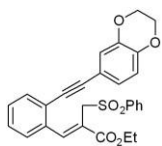
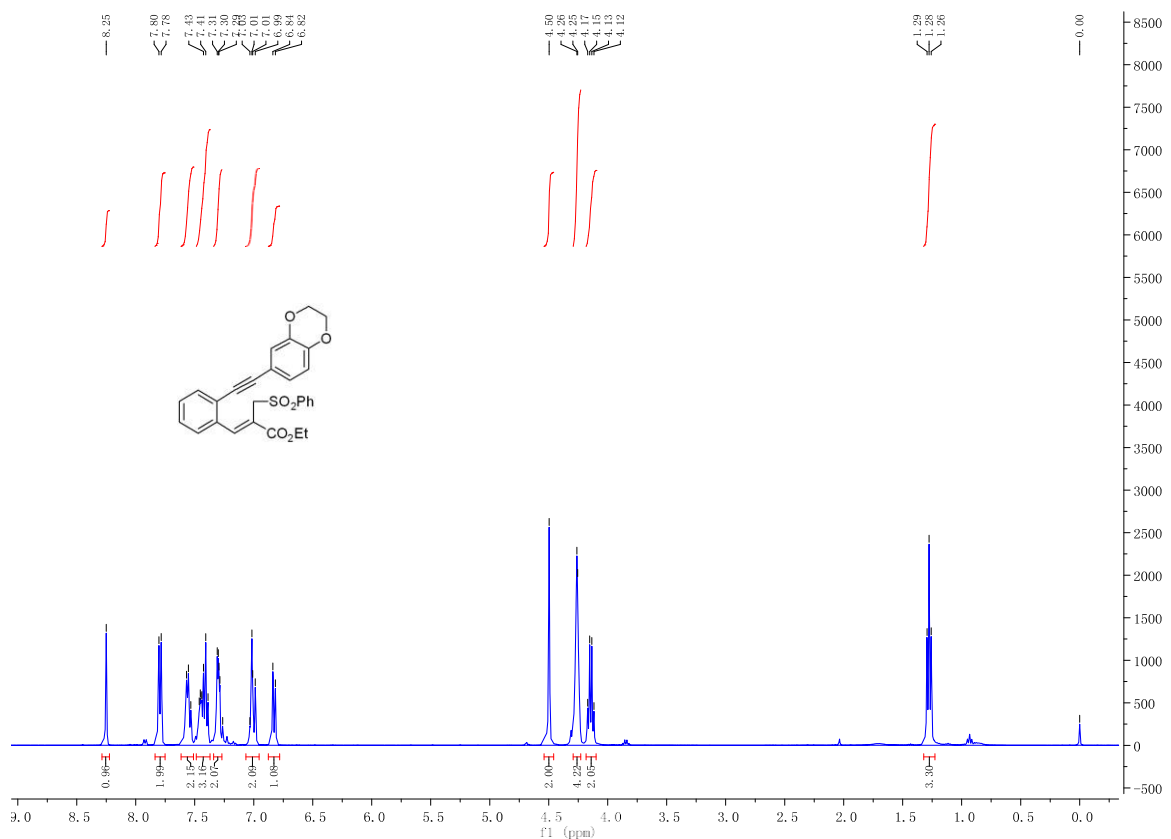


ethyl 3-(2-(benzofuran-2-ylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1j)

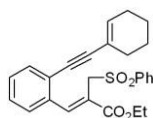
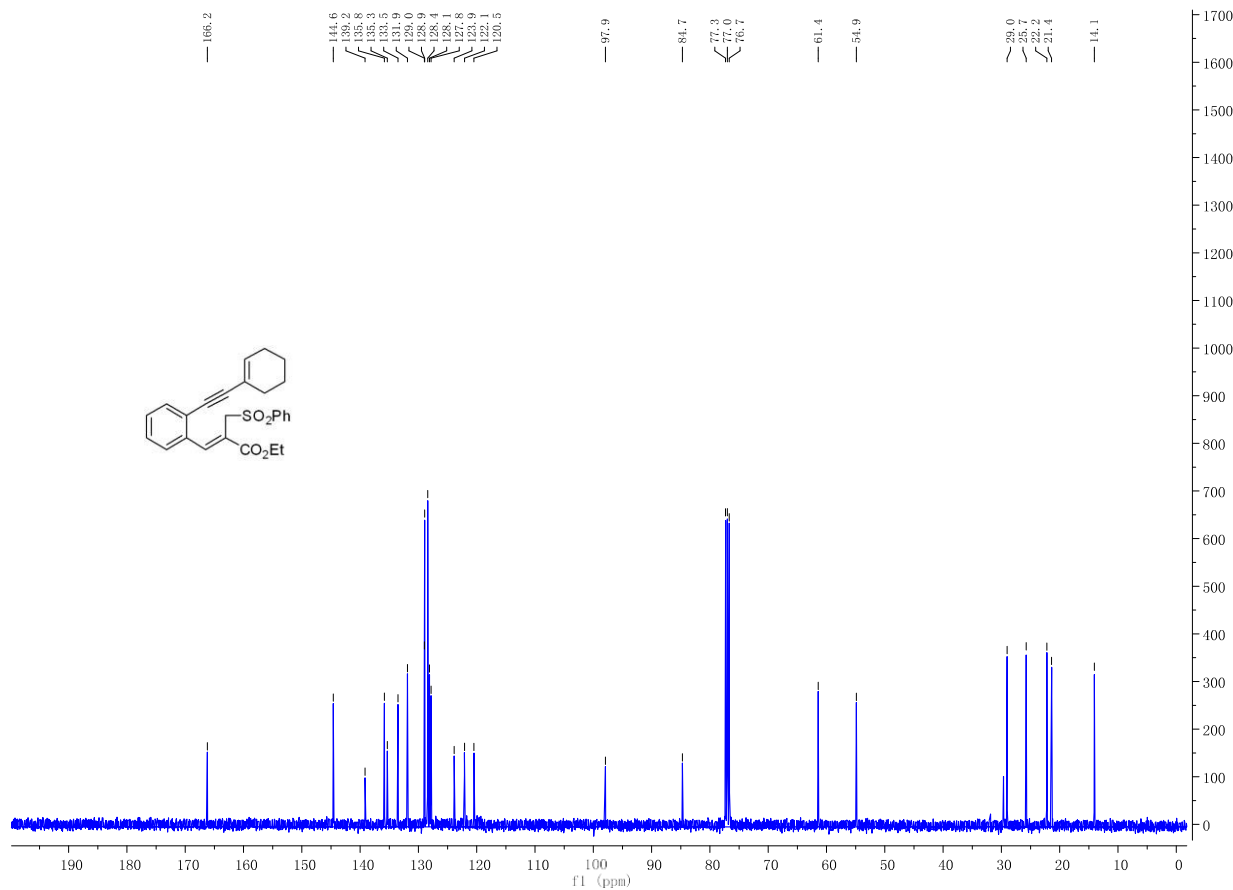
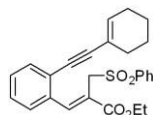
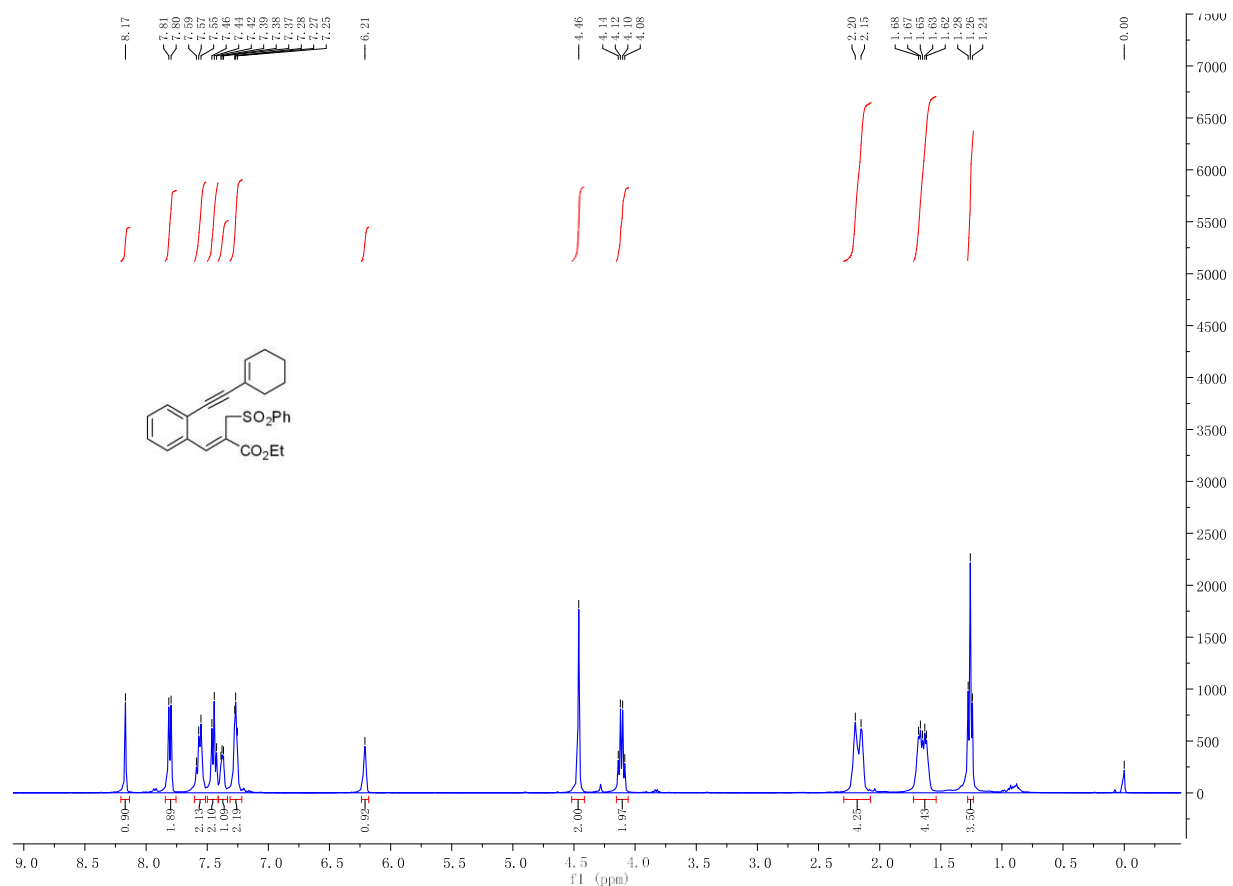


ethyl 3-(2-((2,3-dihydrobenzo[b][1,4]dioxin-6-yl)ethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate

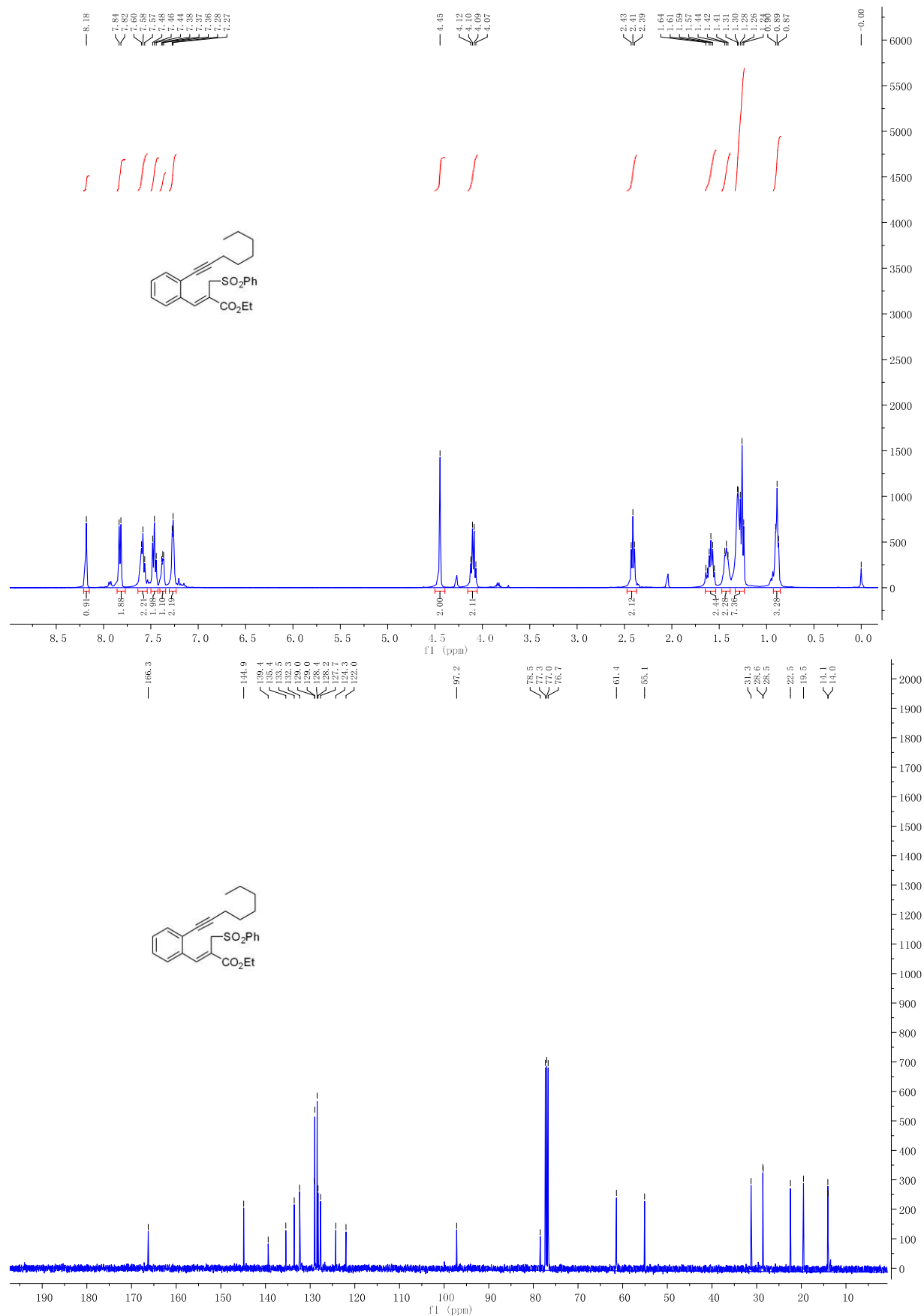
(1k)



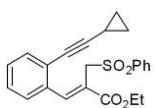
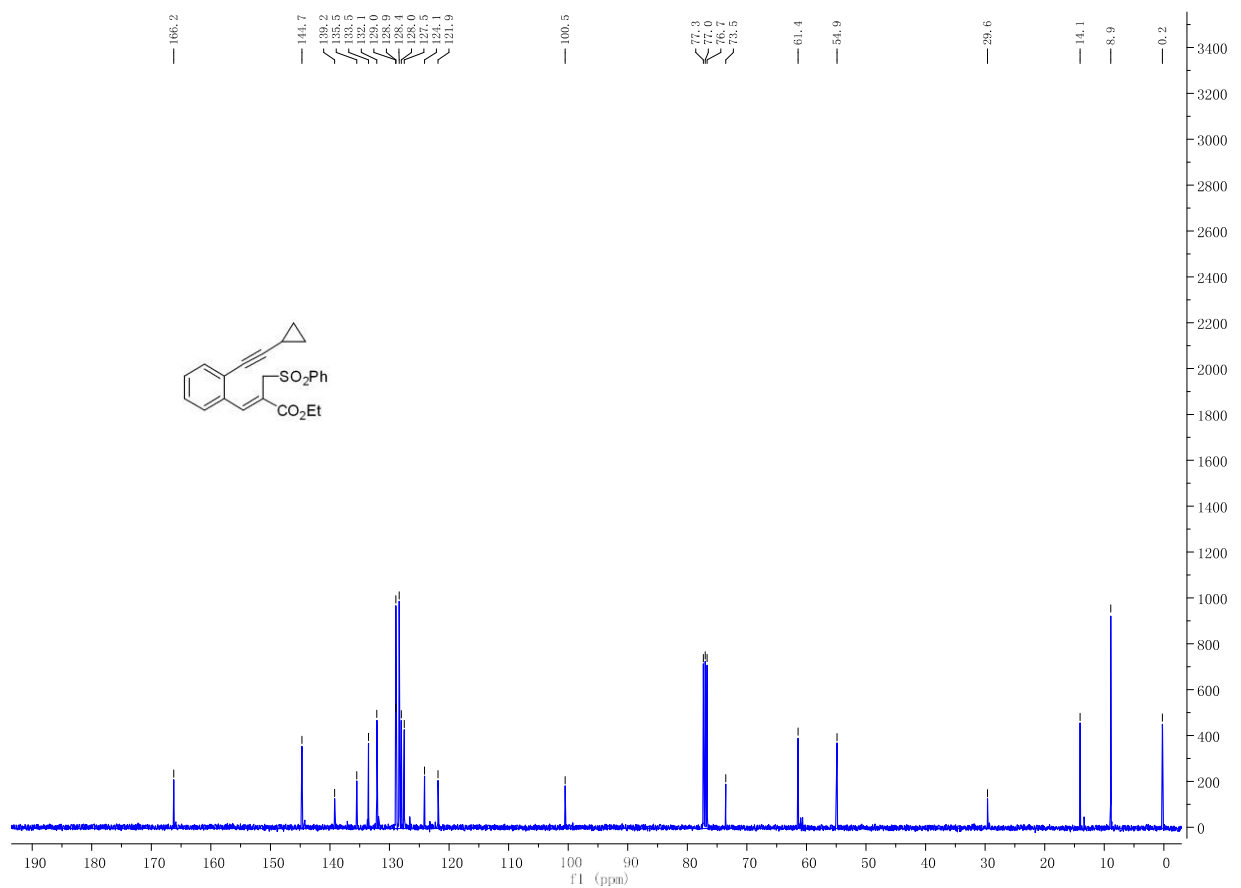
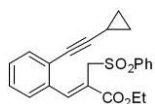
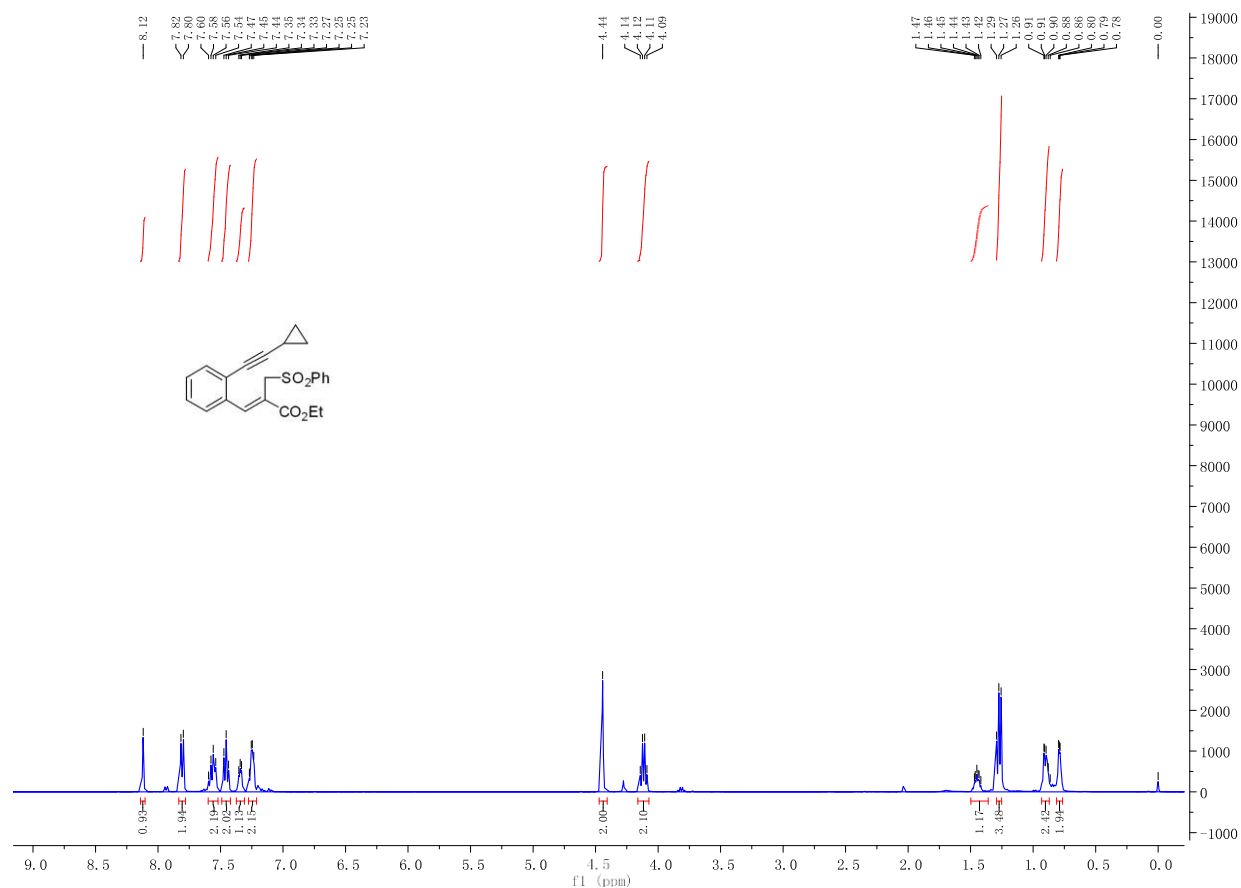
ethyl 3-(2-(cyclohex-1-en-1-ylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1l)



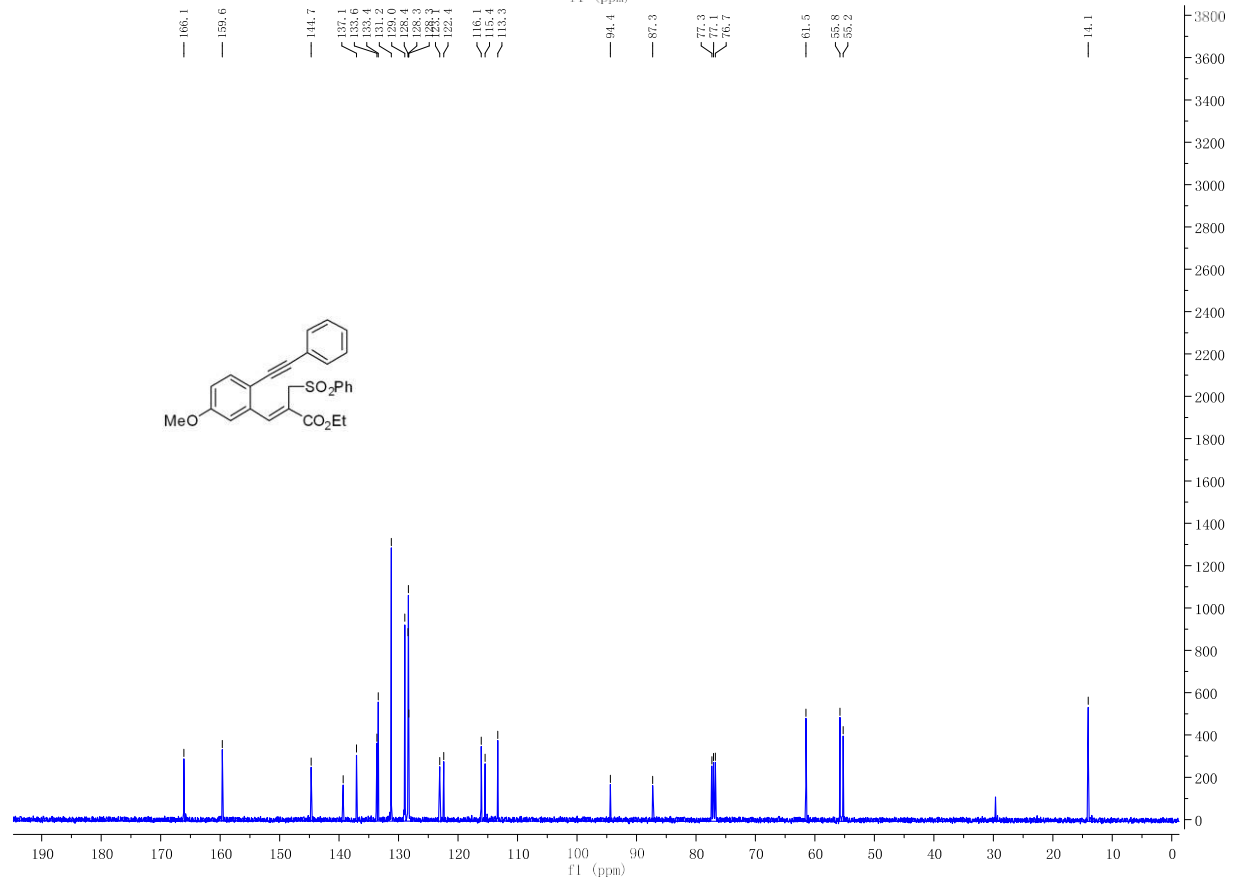
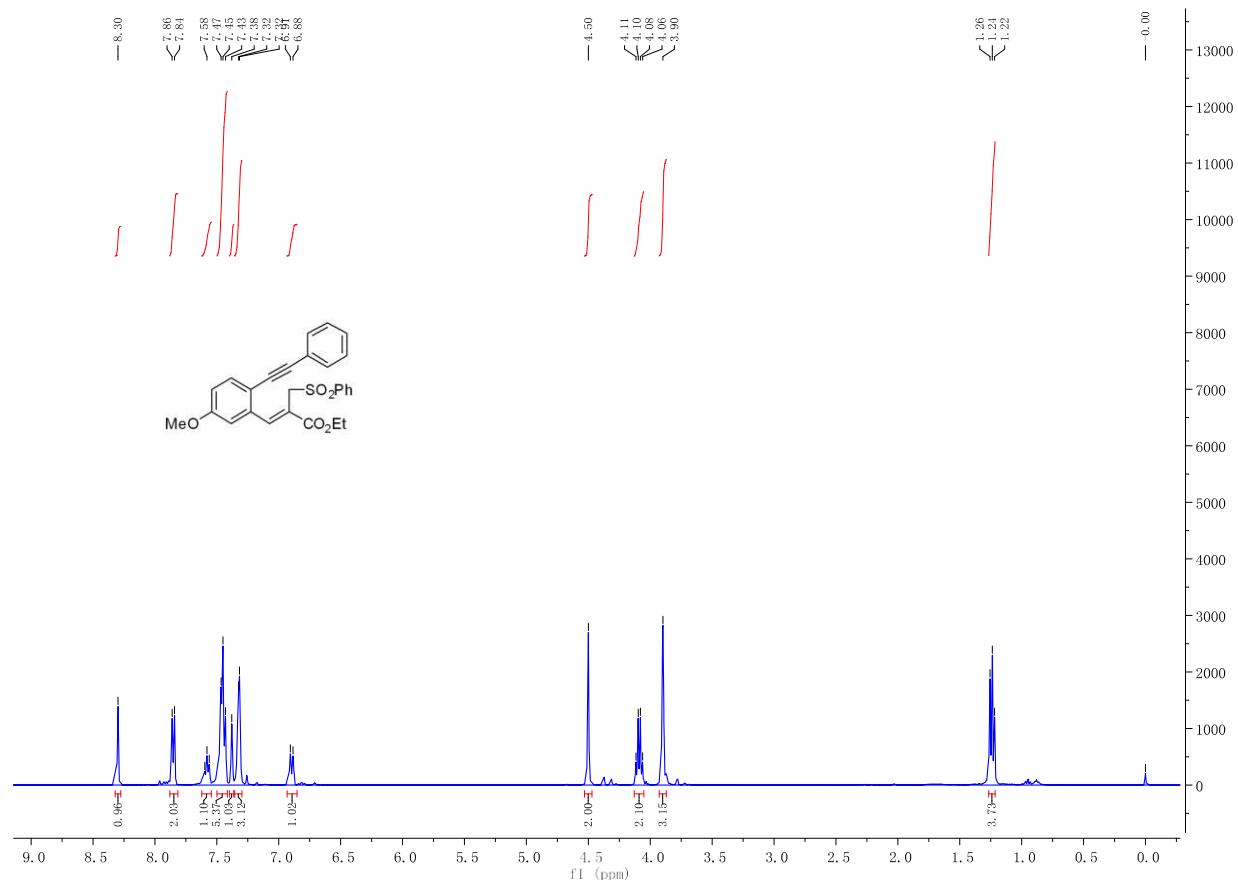
ethyl 3-(2-(oct-1-yn-1-yl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1m)



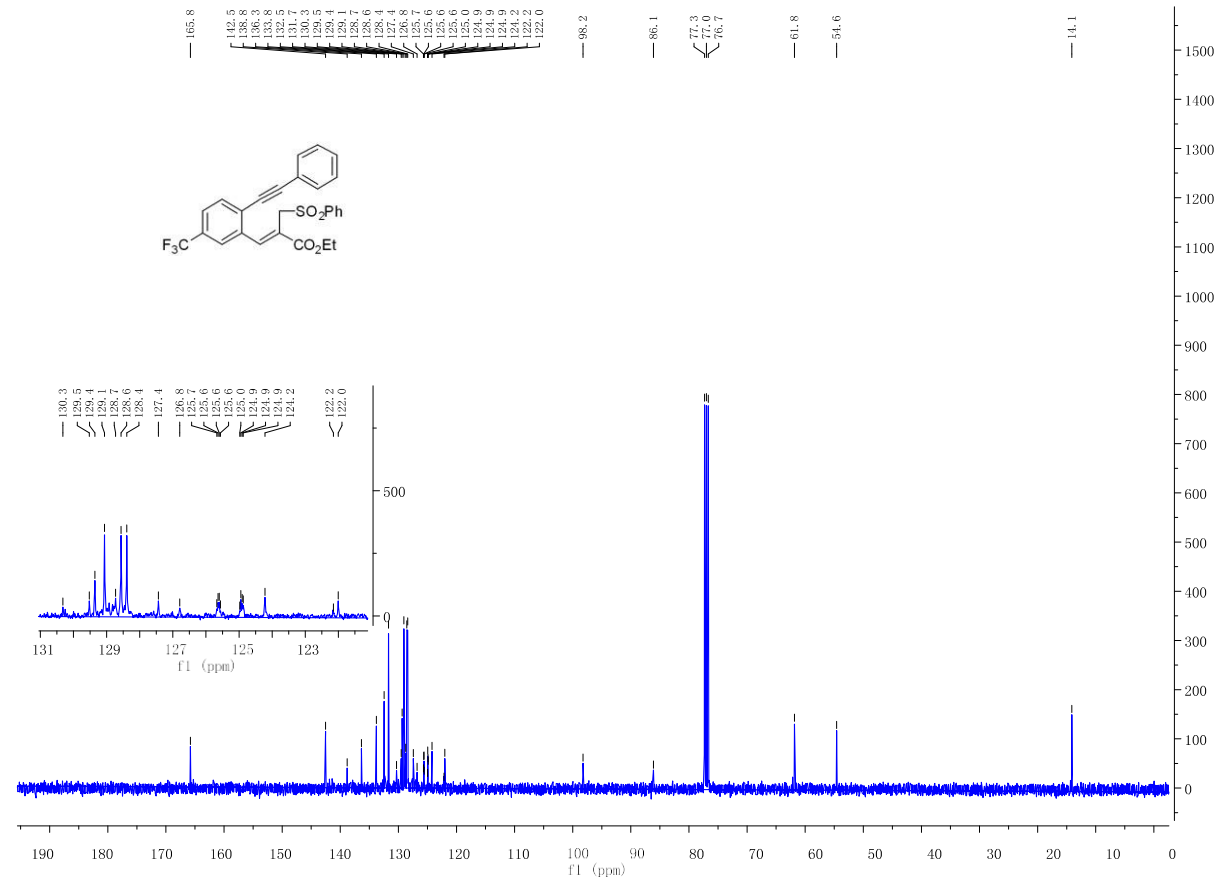
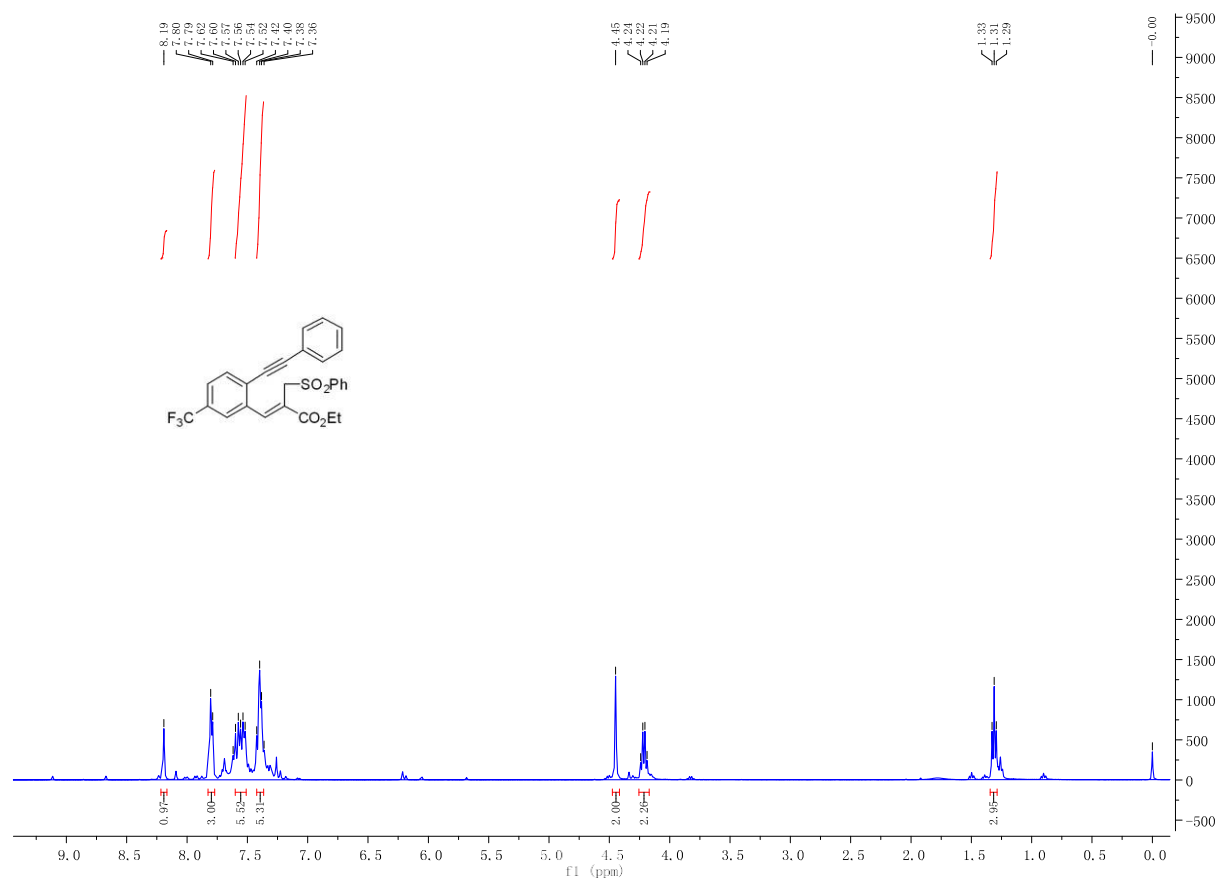
ethyl 3-(2-(cyclopropylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1n)



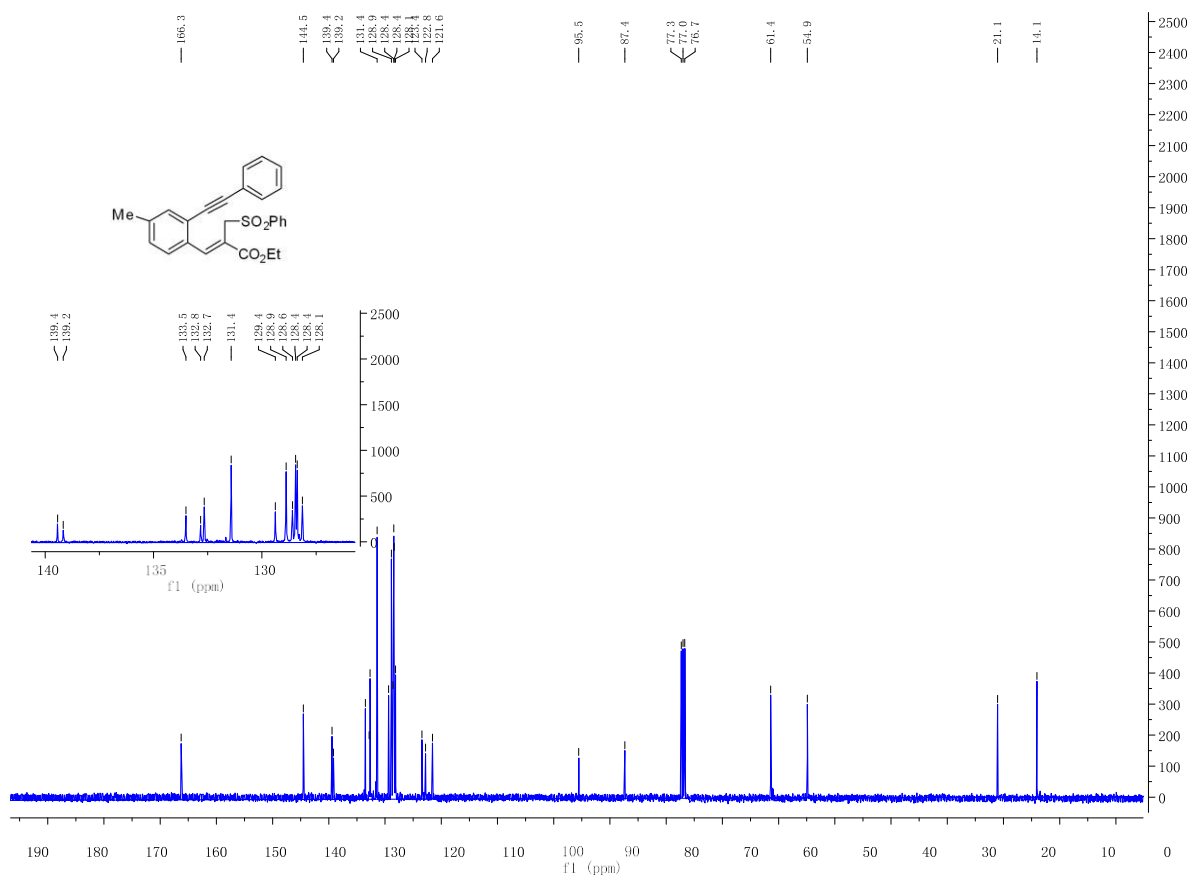
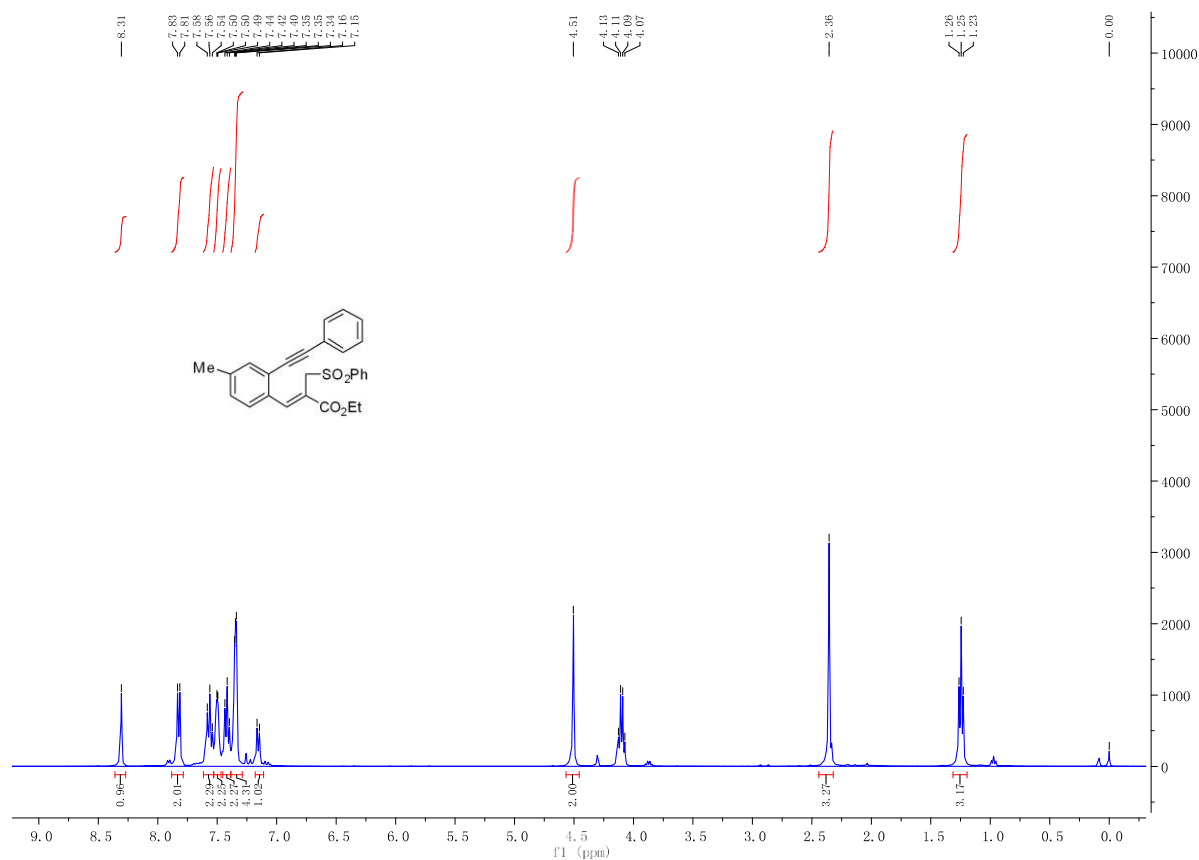
ethyl 3-(5-methoxy-2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1o)



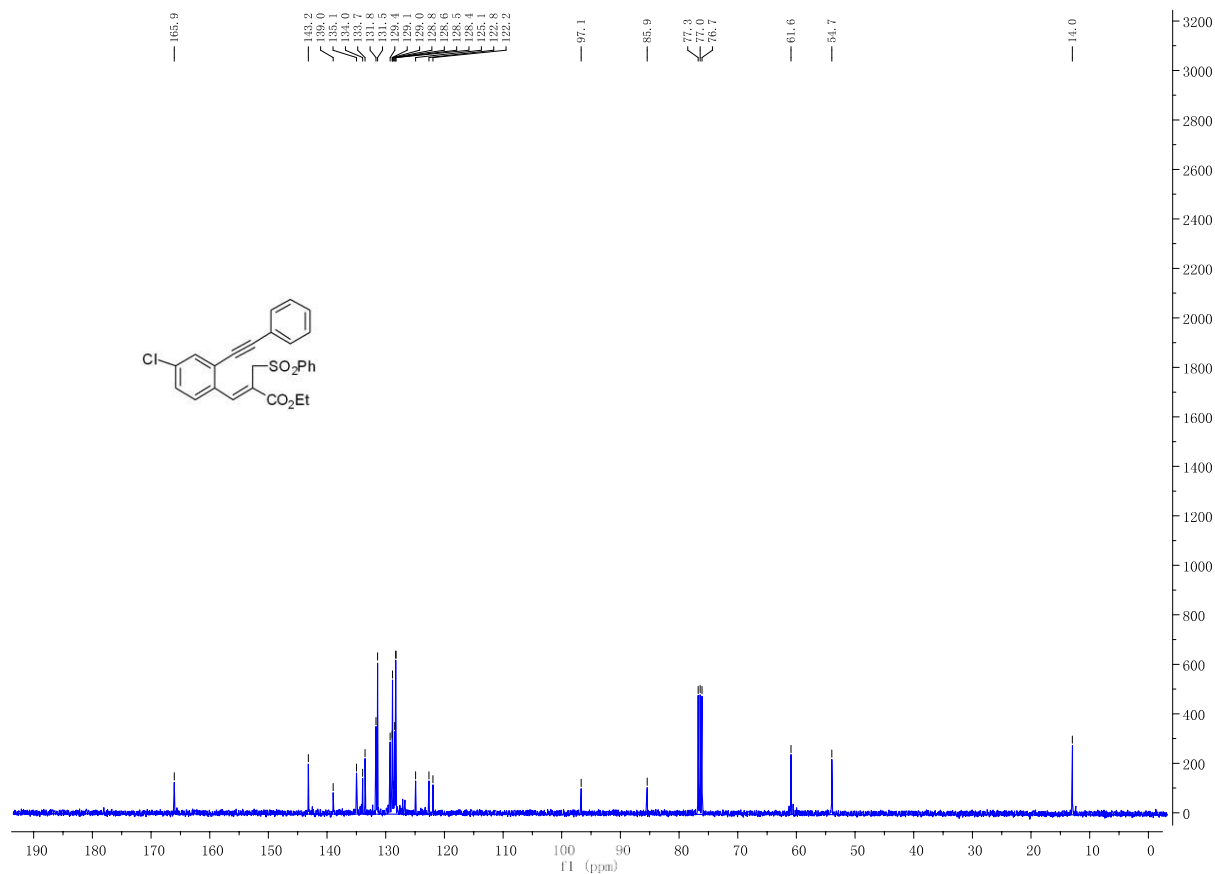
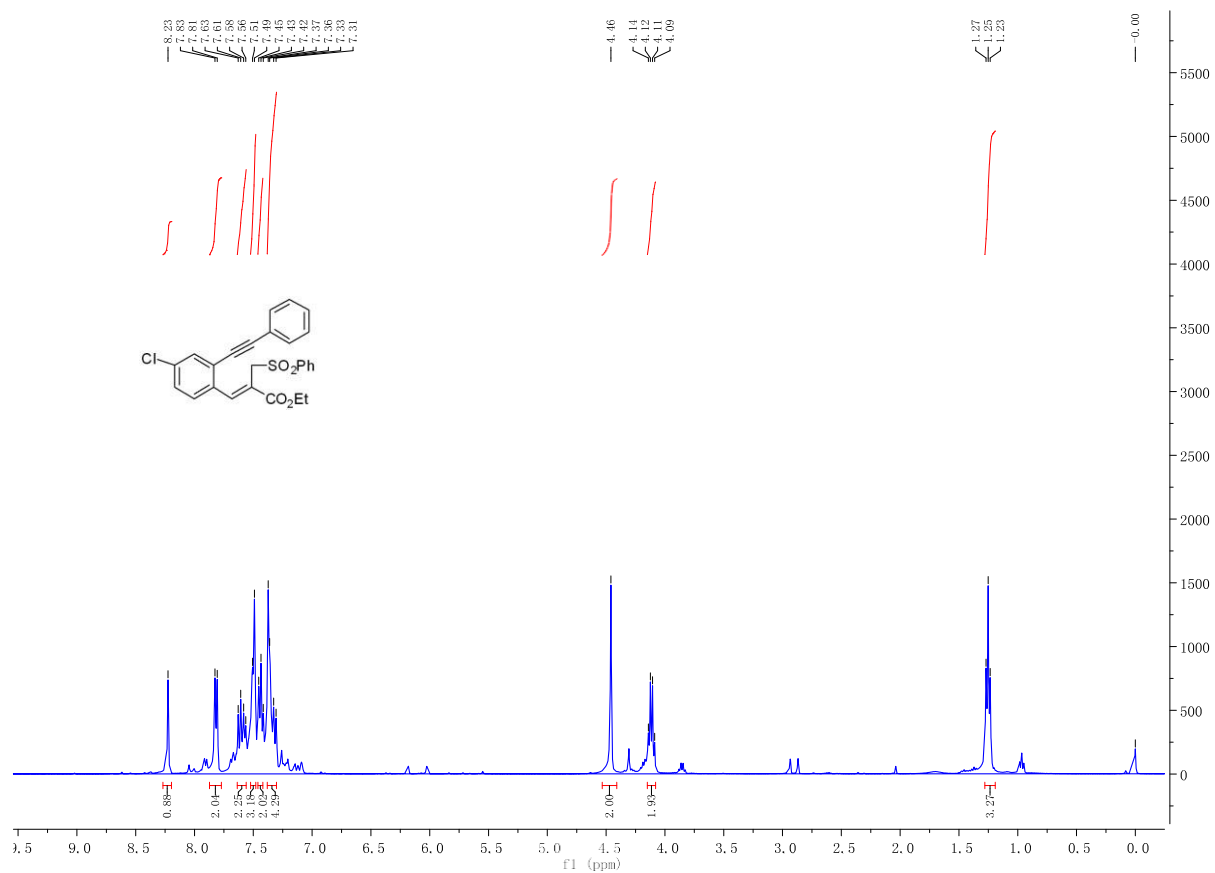
ethyl 3-(2-(phenylethynyl)-5-(trifluoromethyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1p)



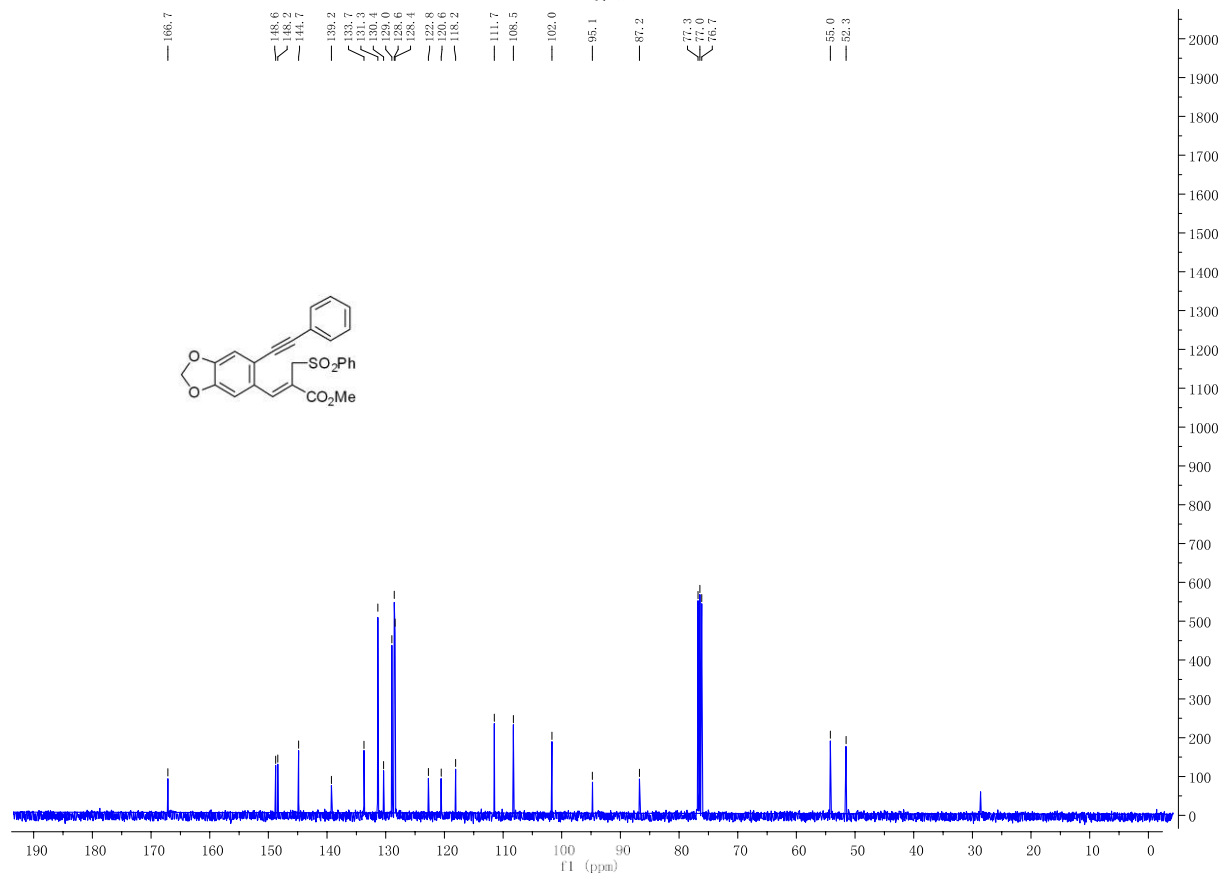
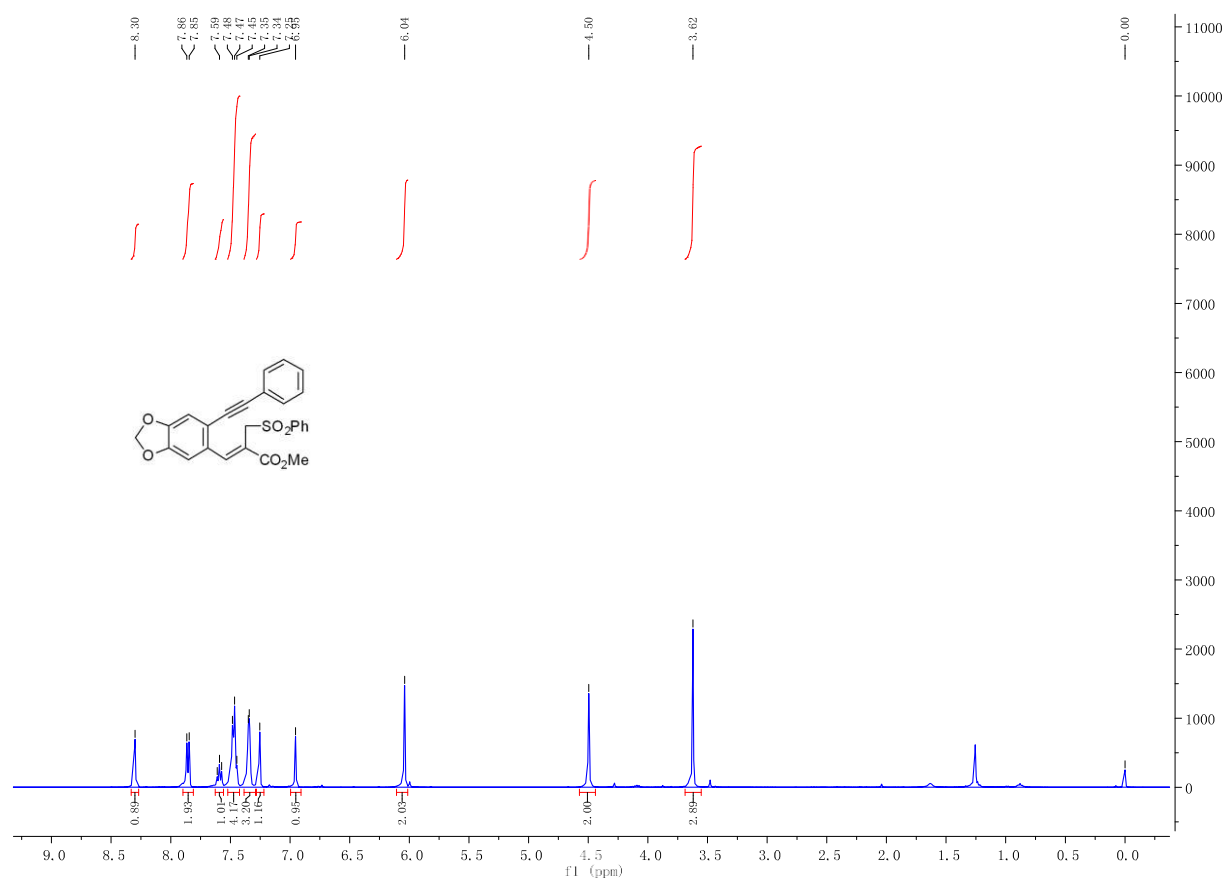
ethyl 3-(4-methyl-2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1q)



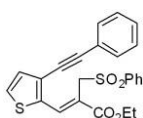
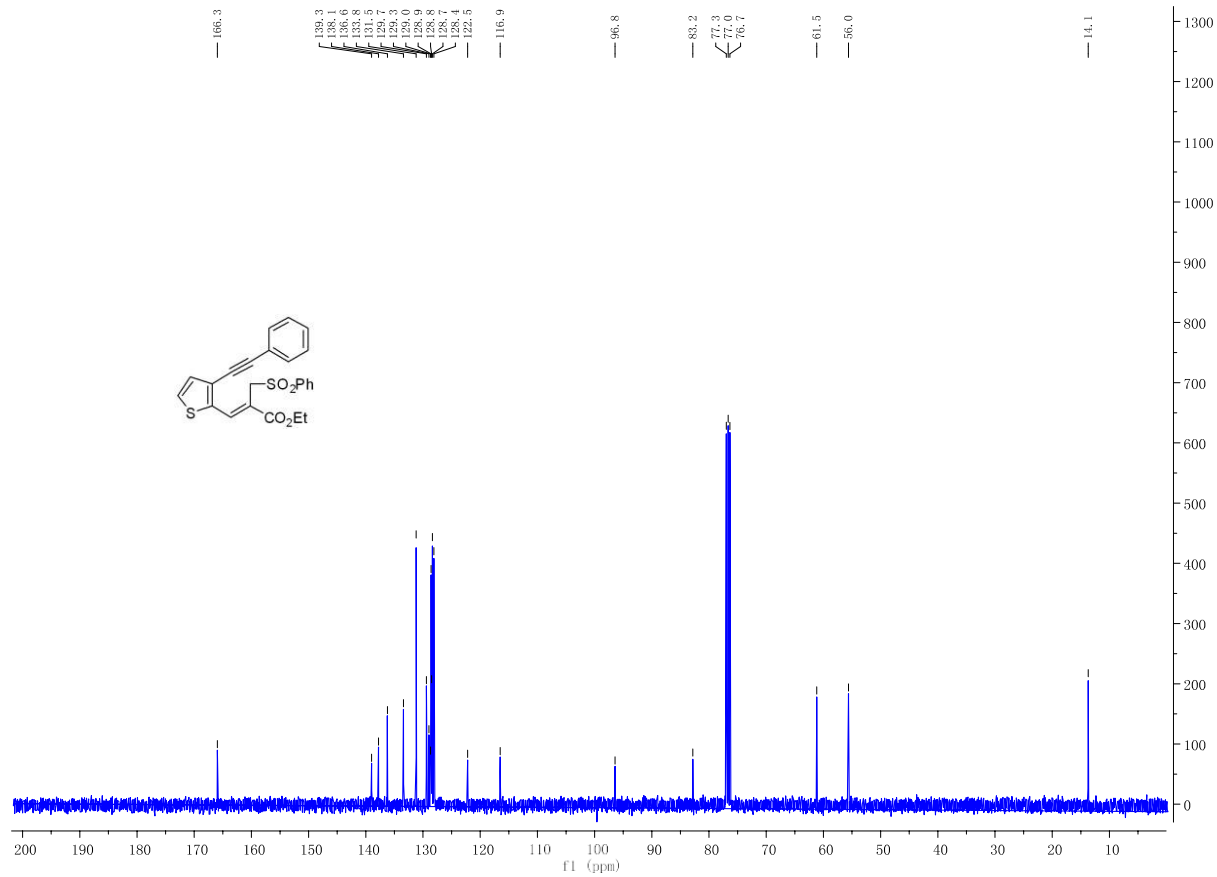
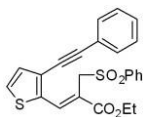
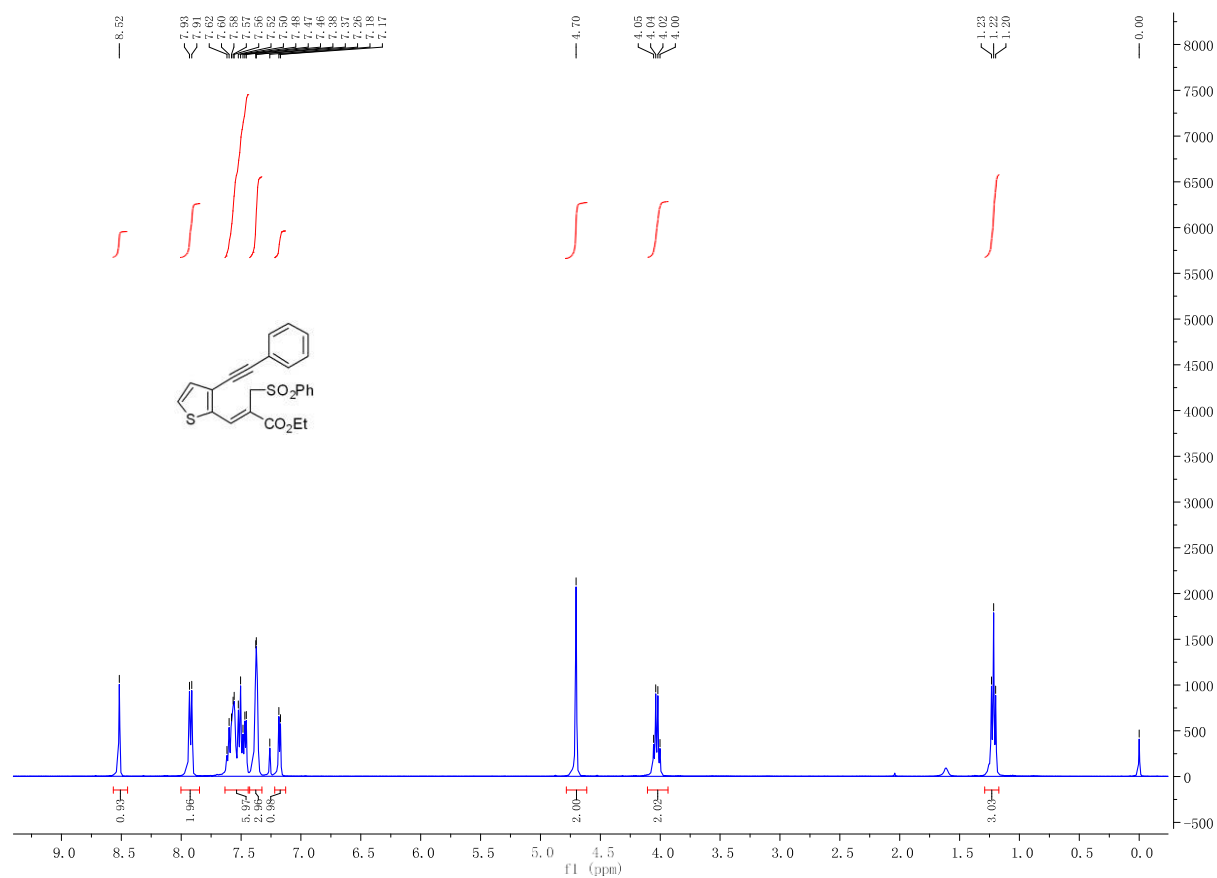
ethyl 3-(4-chloro-2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1s)



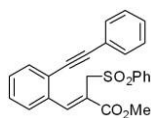
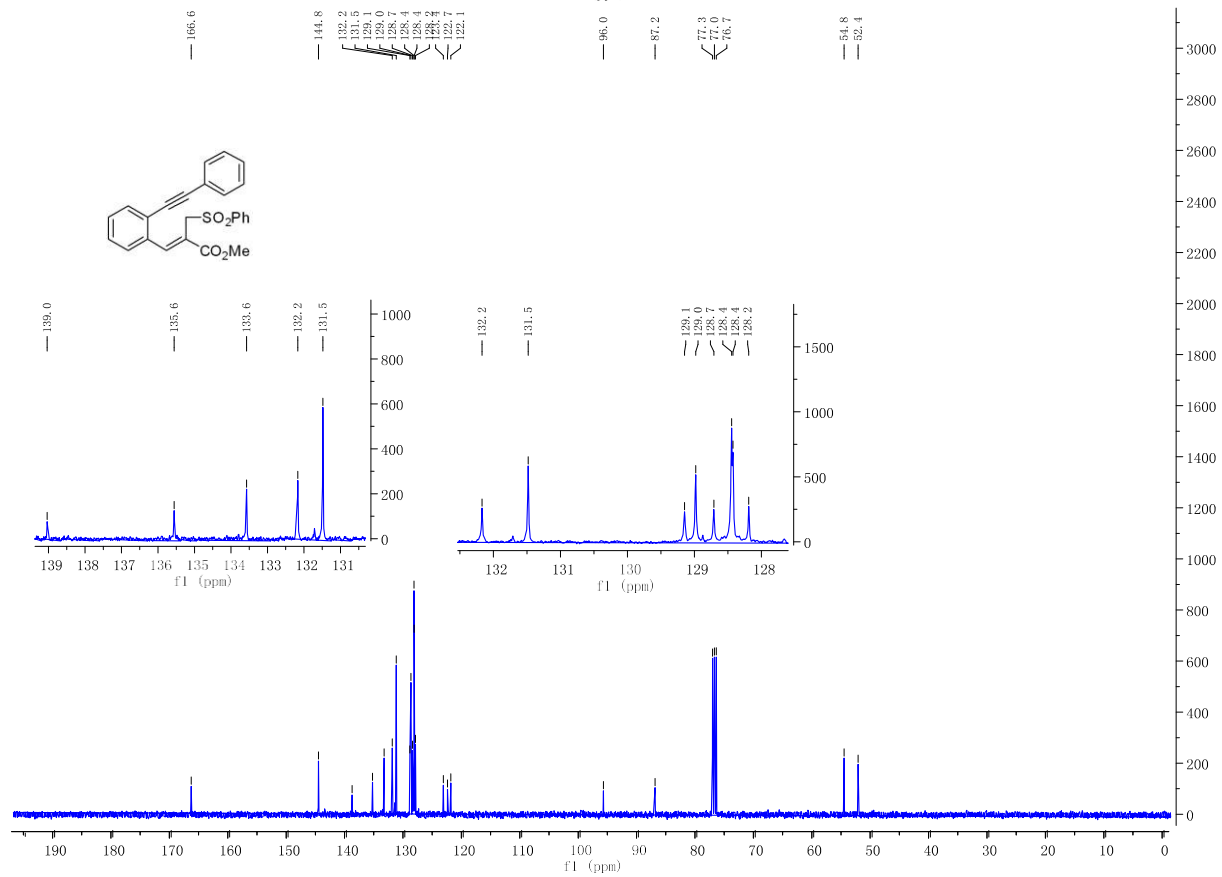
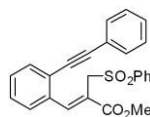
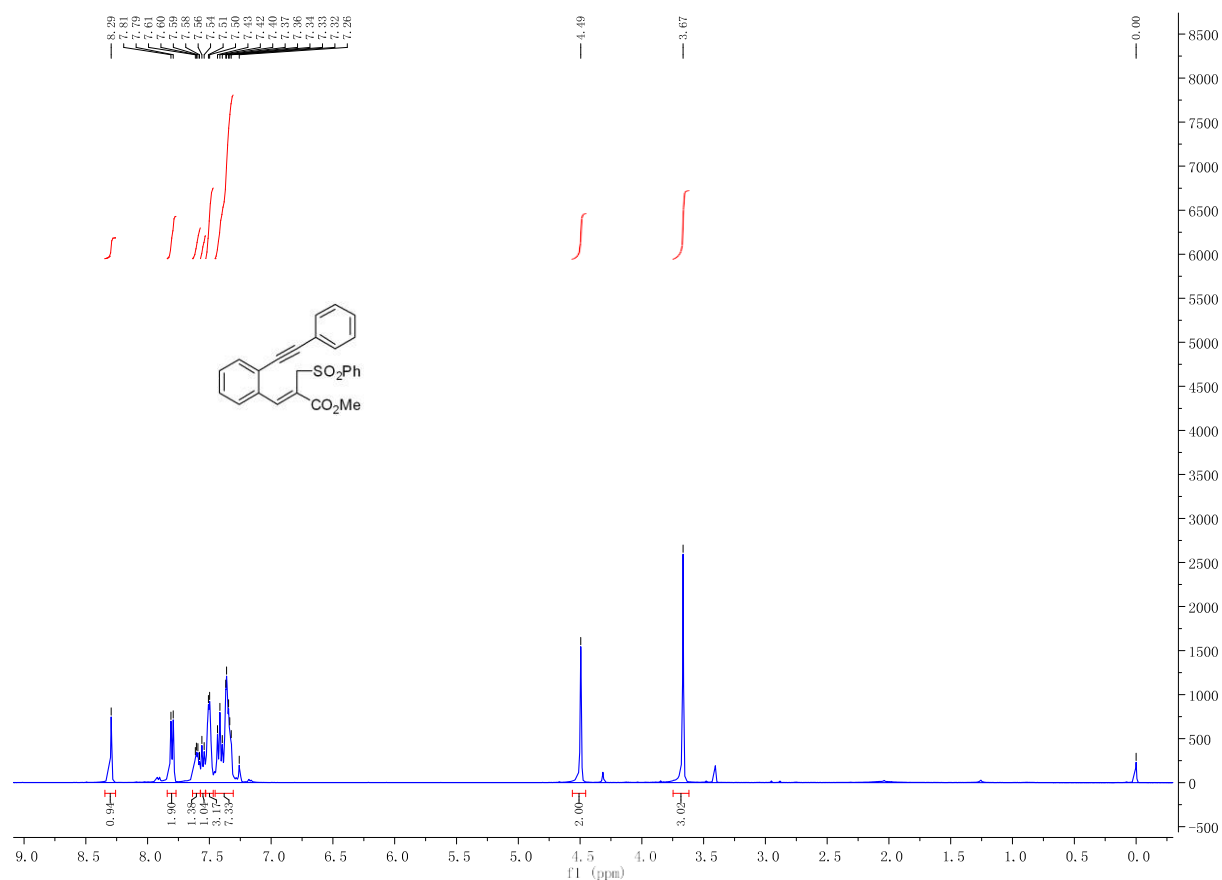
methyl 3-(6-(phenylethynyl)benzo[d][1,3]dioxol-5-yl)-2-((phenylsulfonyl)methyl)acrylate (1t)



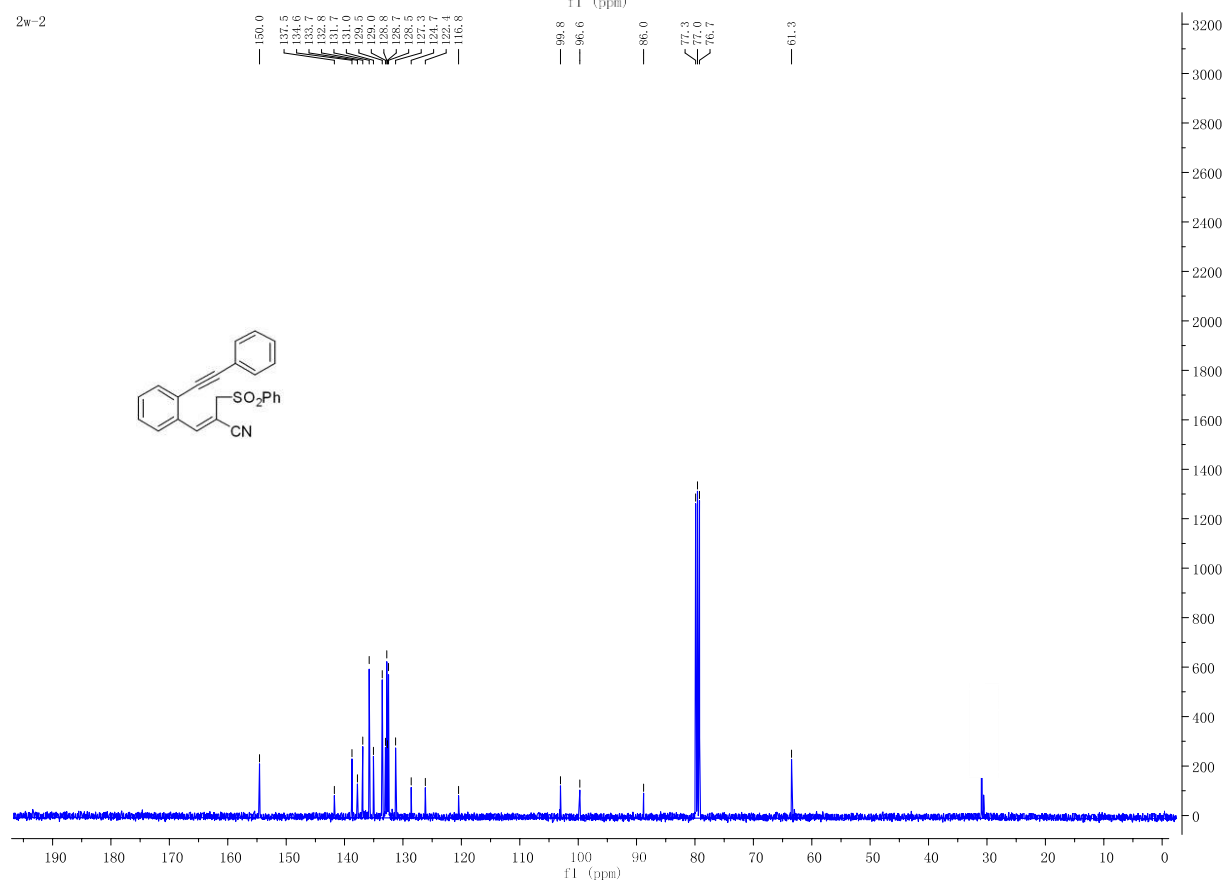
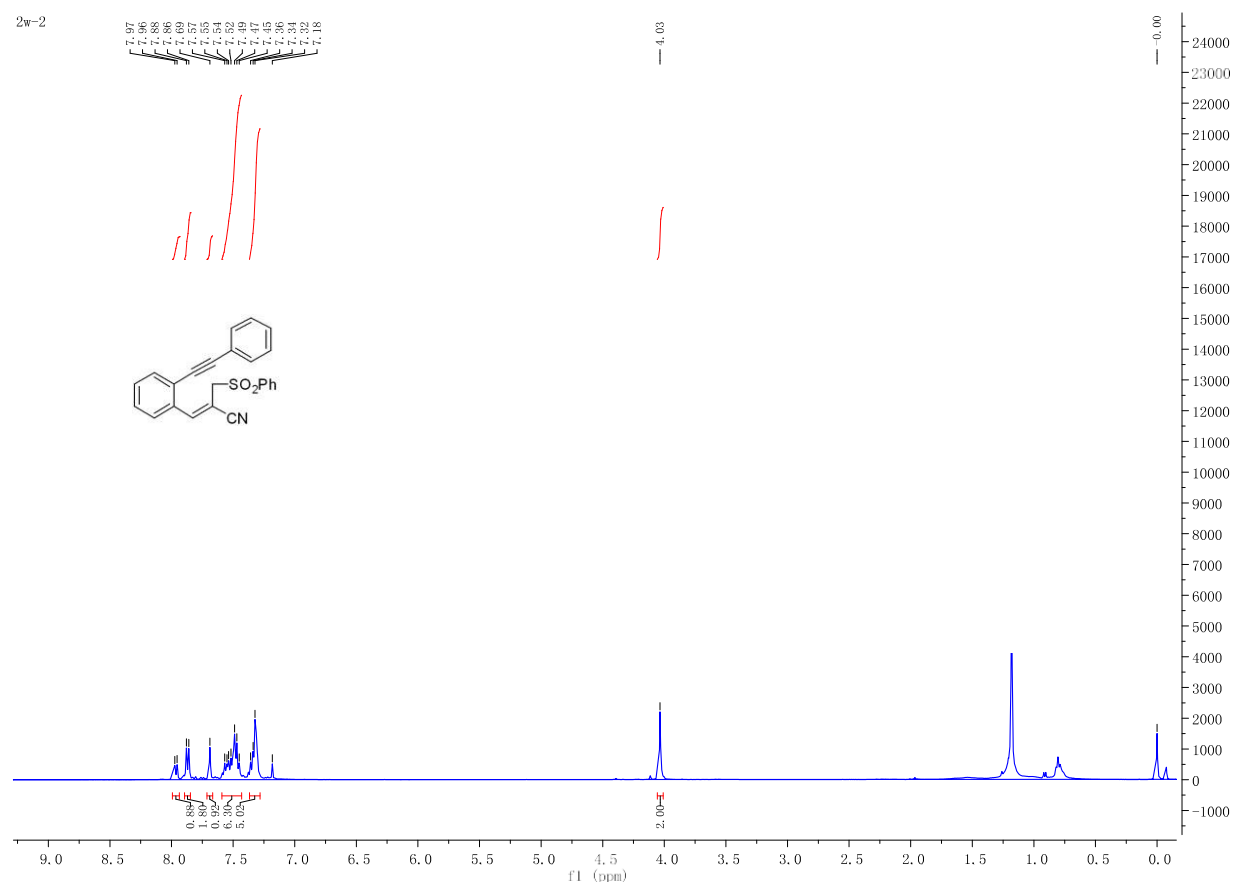
ethyl 3-(3-(phenylethynyl)thiophen-2-yl)-2-((phenylsulfonyl)methyl)acrylate (1u)



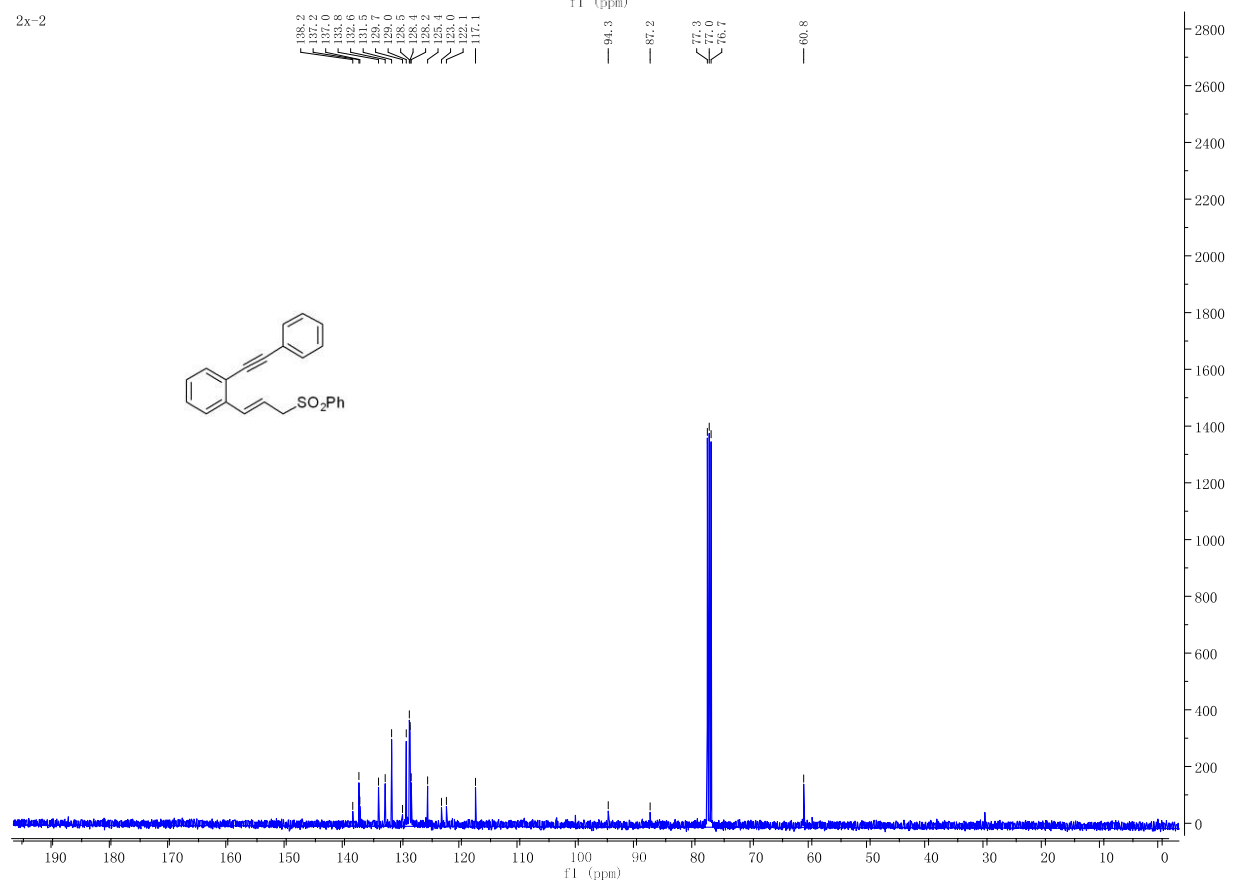
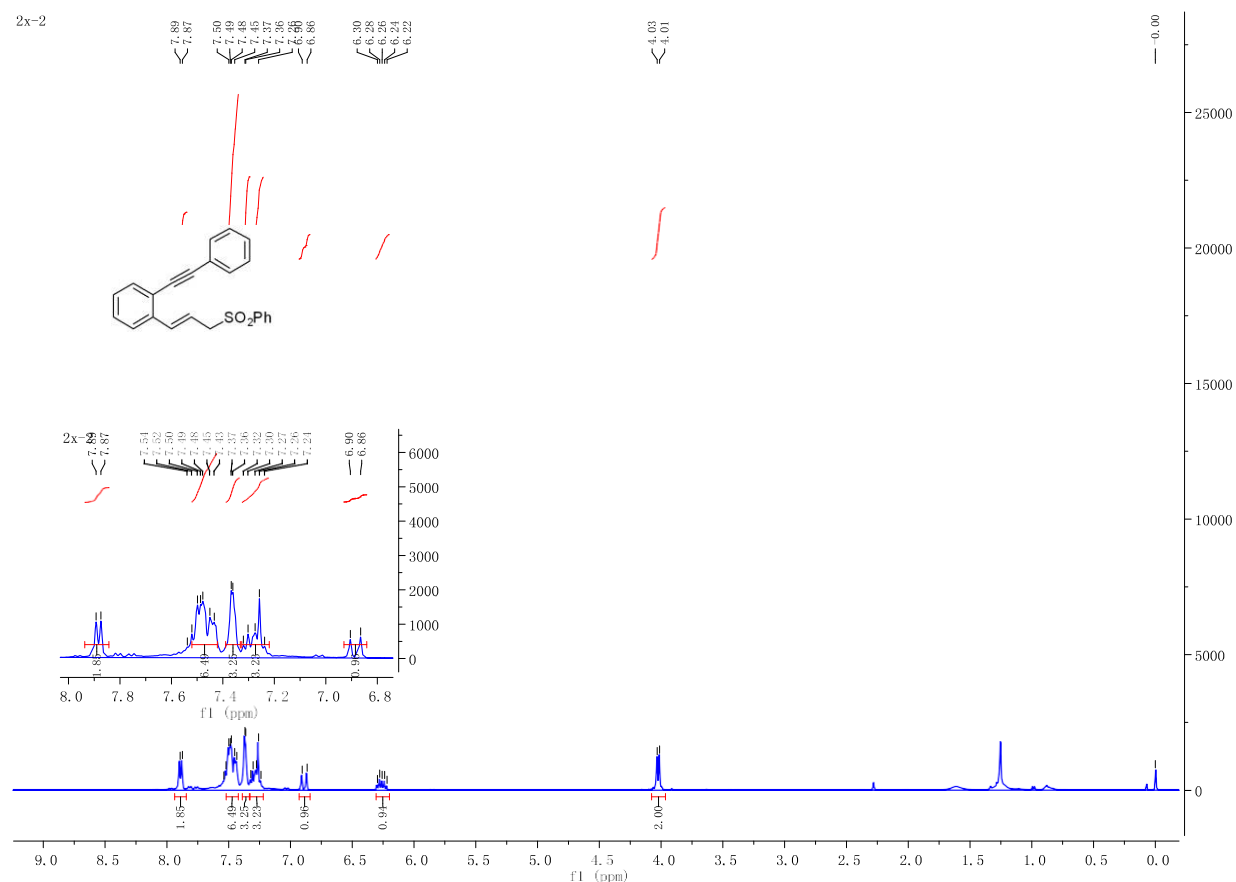
methyl 3-(2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylate (1v)



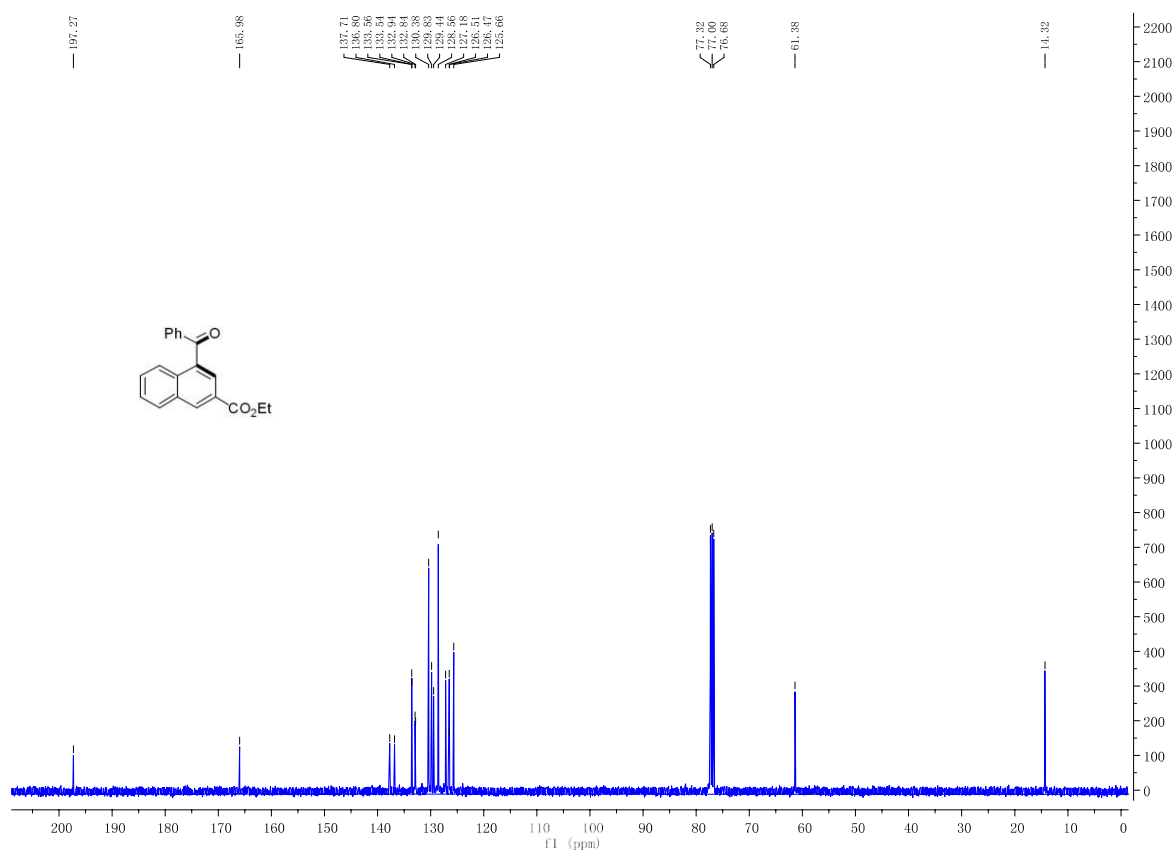
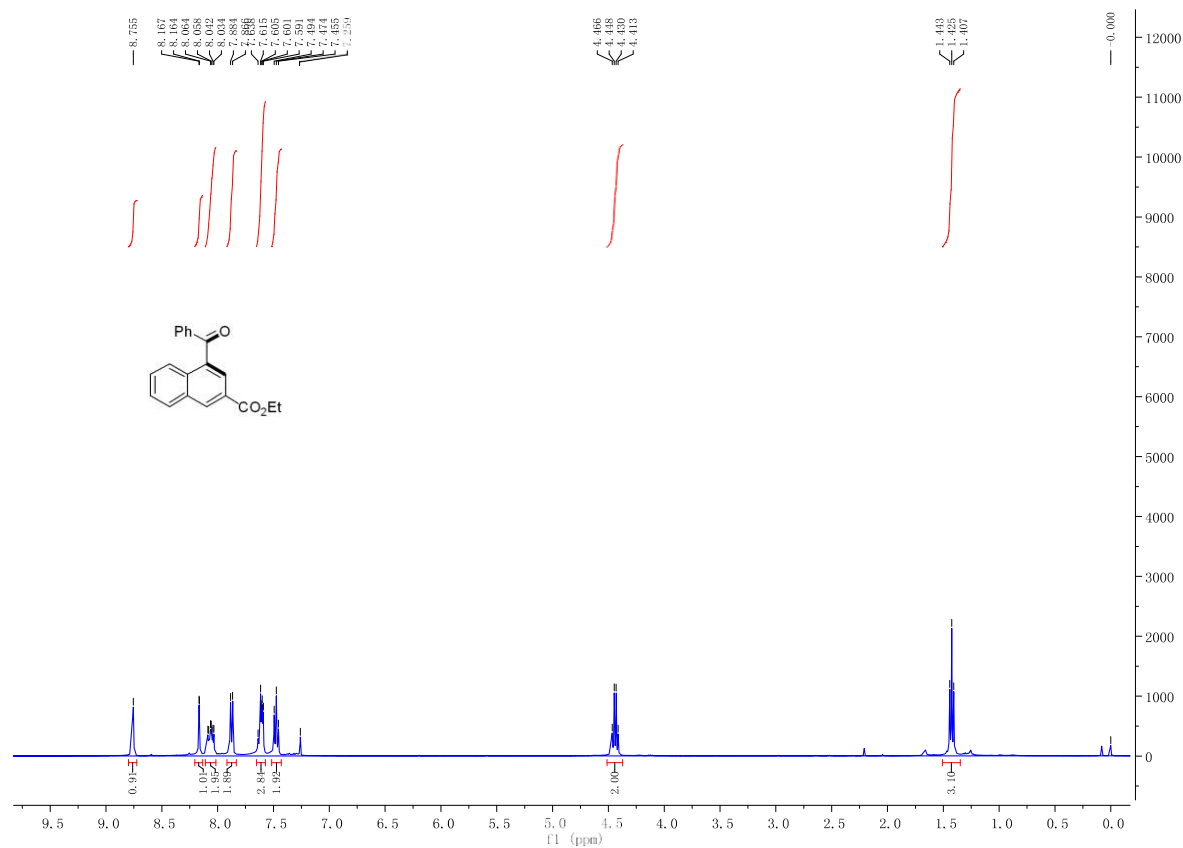
3-(2-(phenylethynyl)phenyl)-2-((phenylsulfonyl)methyl)acrylonitrile (1w)



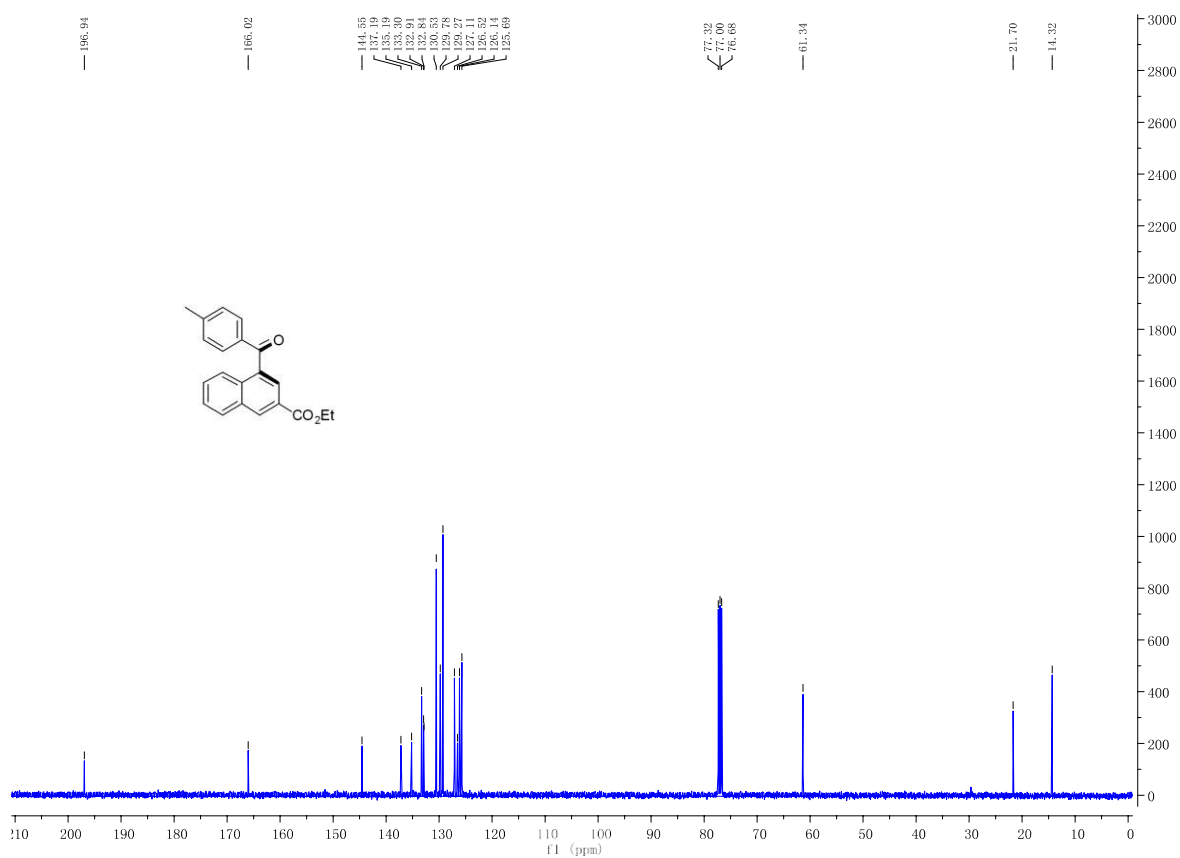
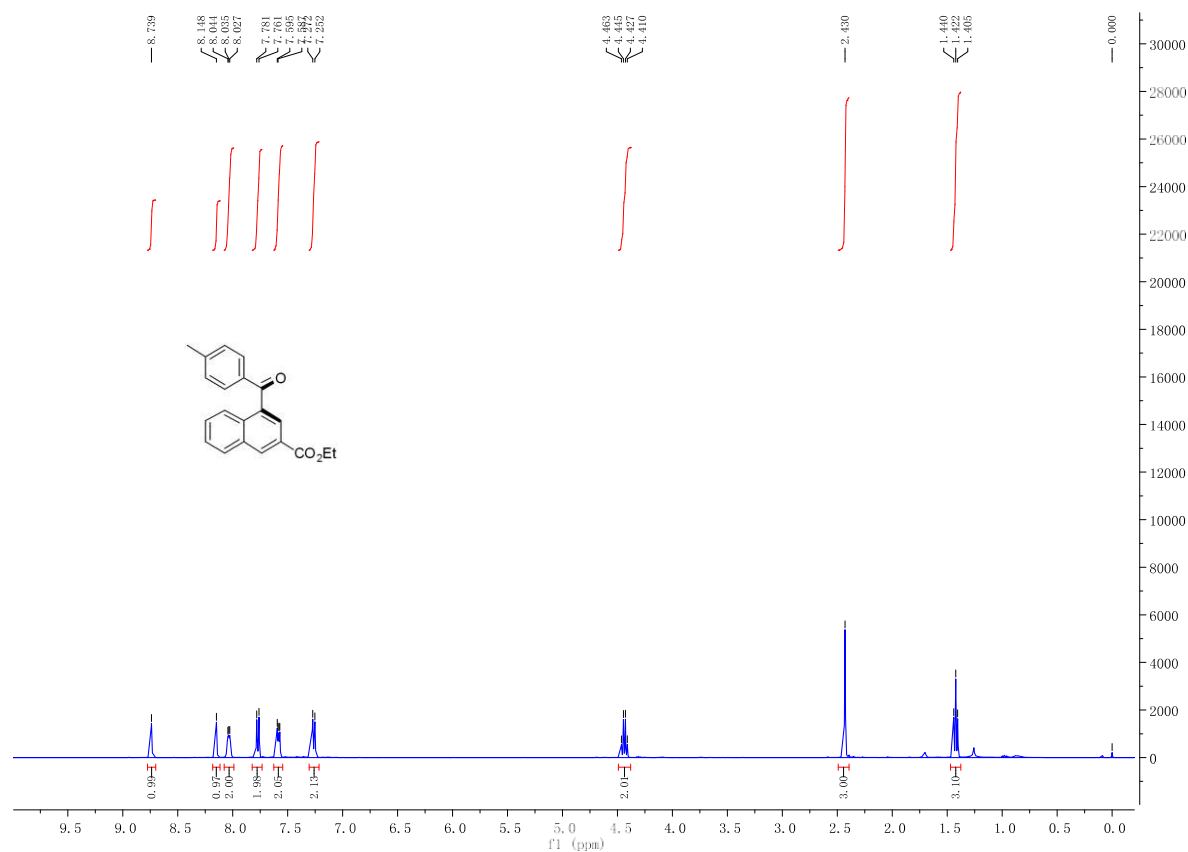
1-(phenylethynyl)-2-(3-(phenylsulfonyl)prop-1-en-1-yl)benzene (1x)



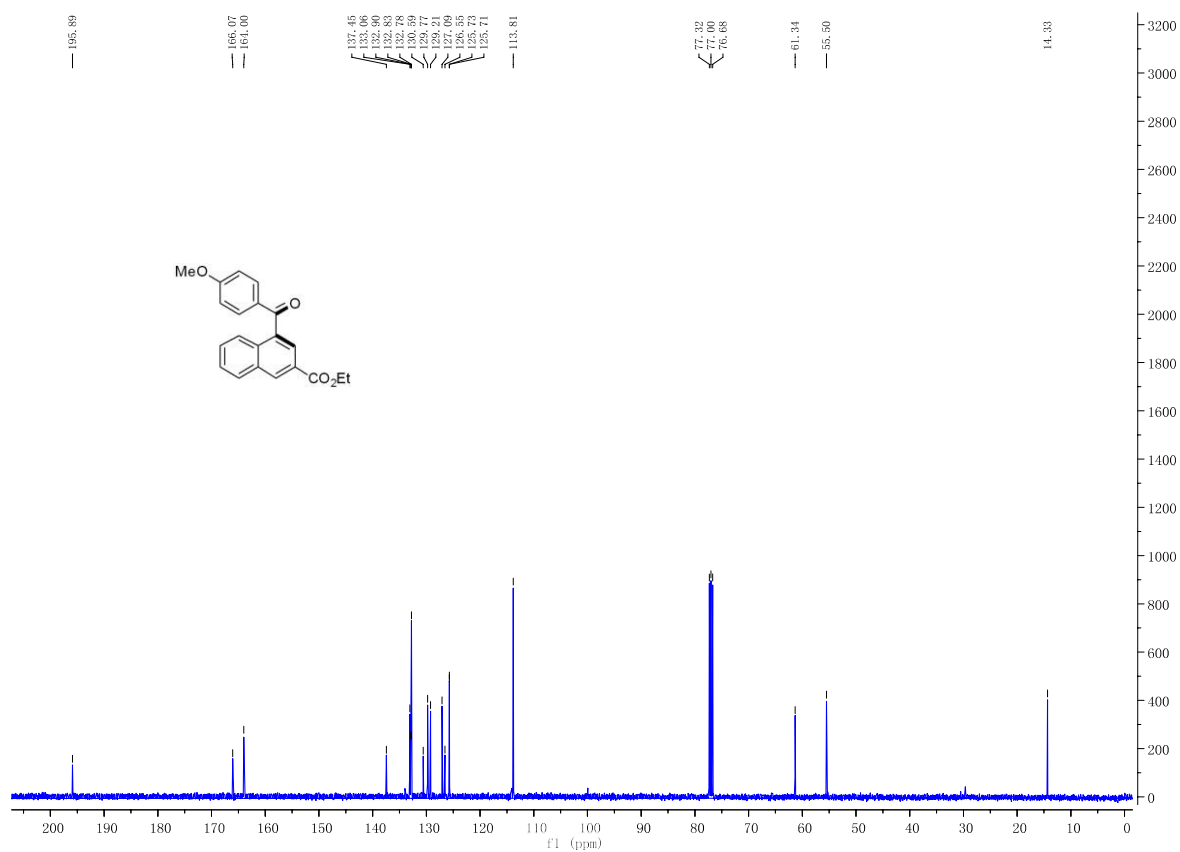
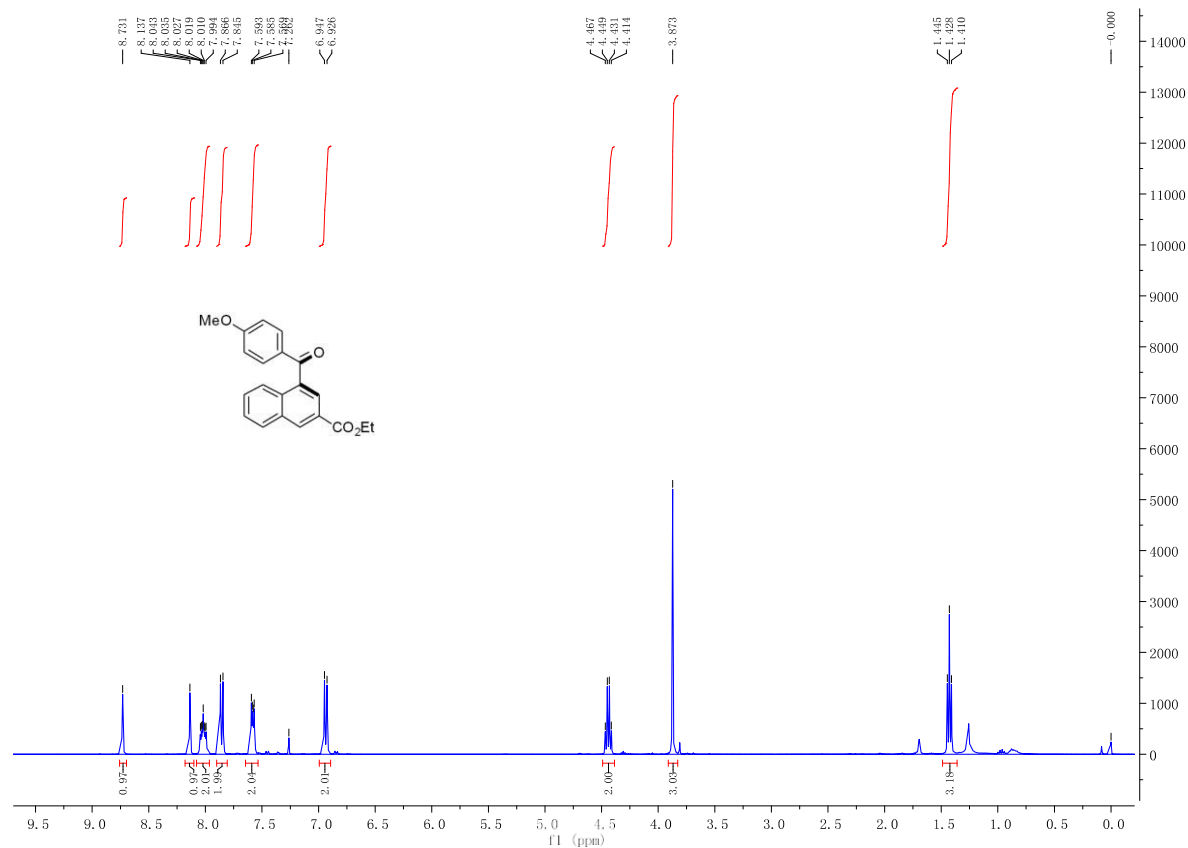
ethyl 4-benzoyl-2-naphthoate (2a)



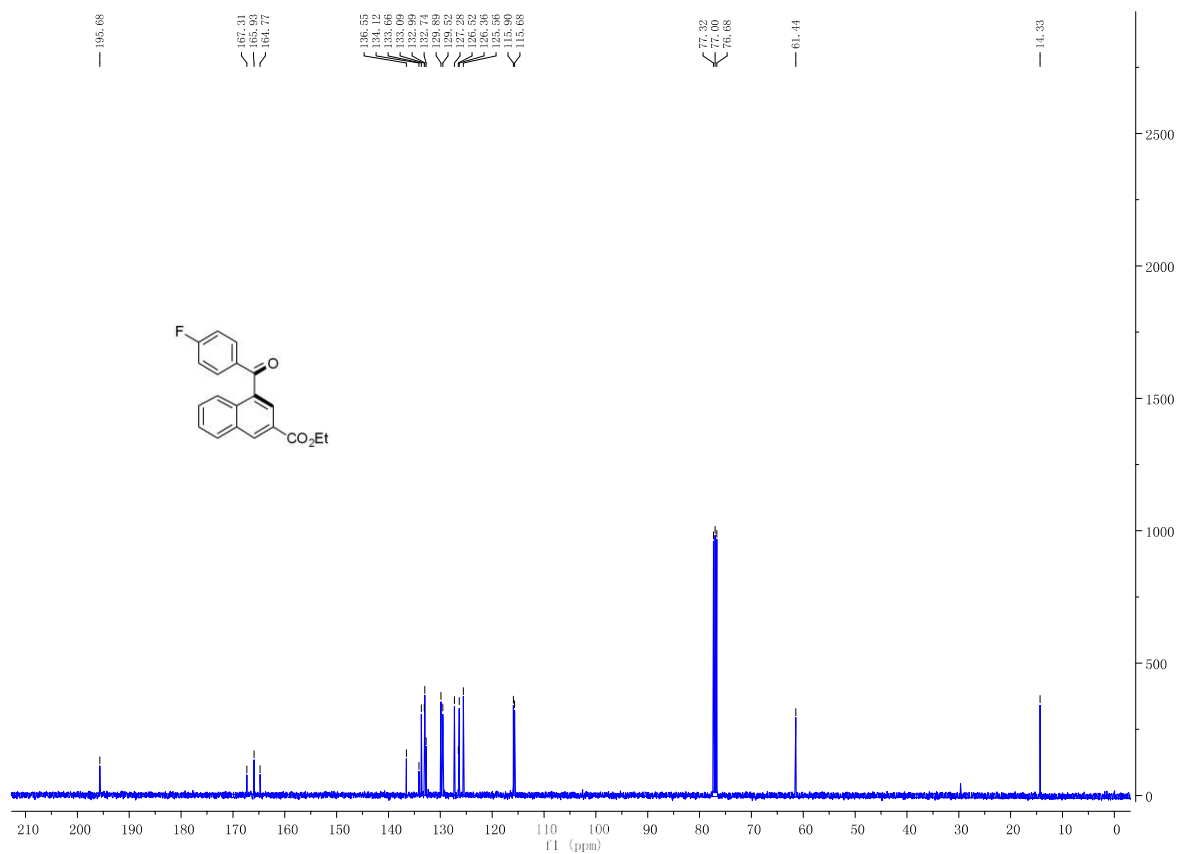
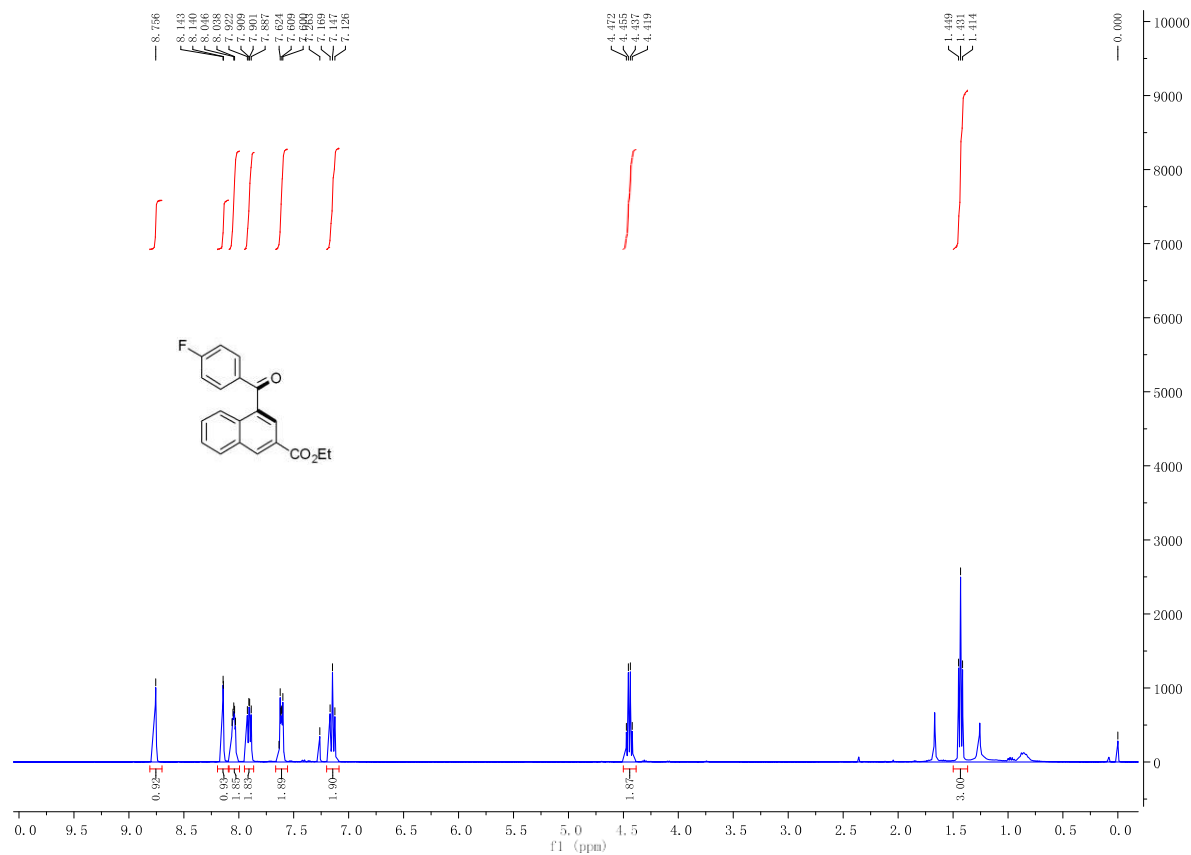
ethyl 4-(4-methylbenzoyl)-2-naphthoate (2b)



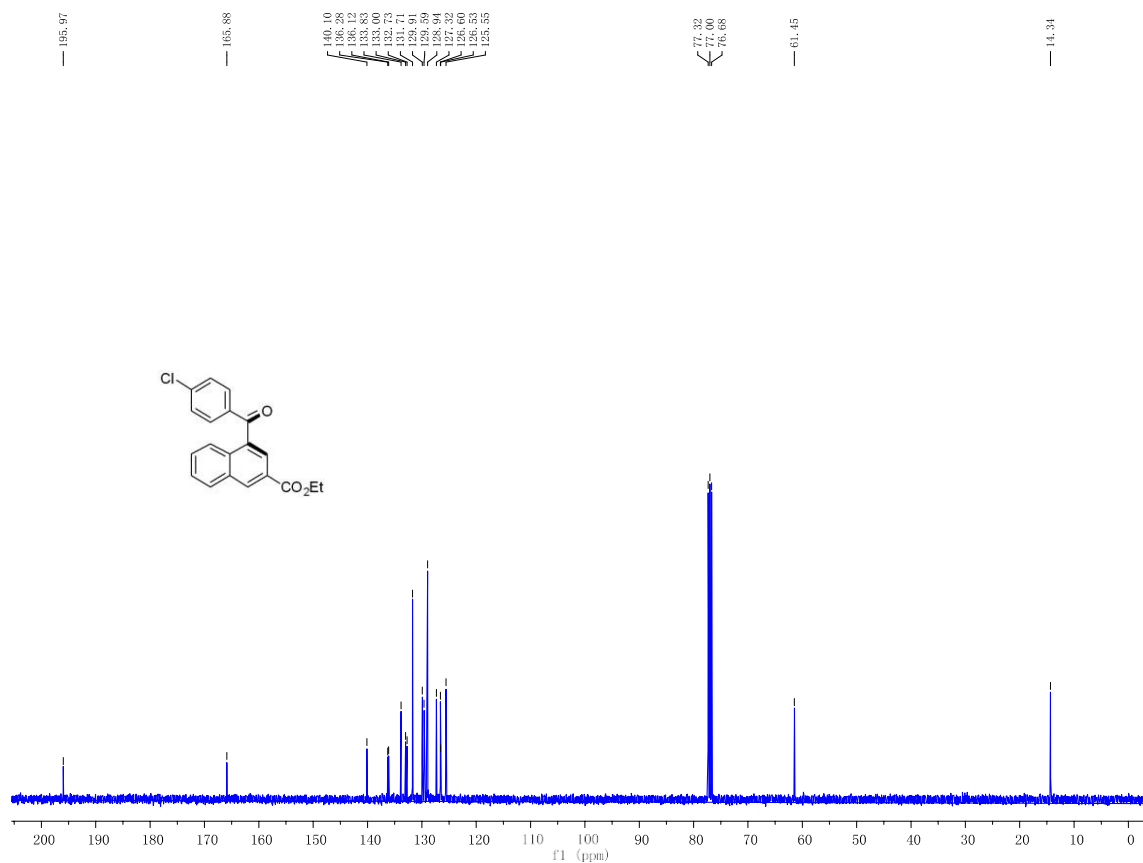
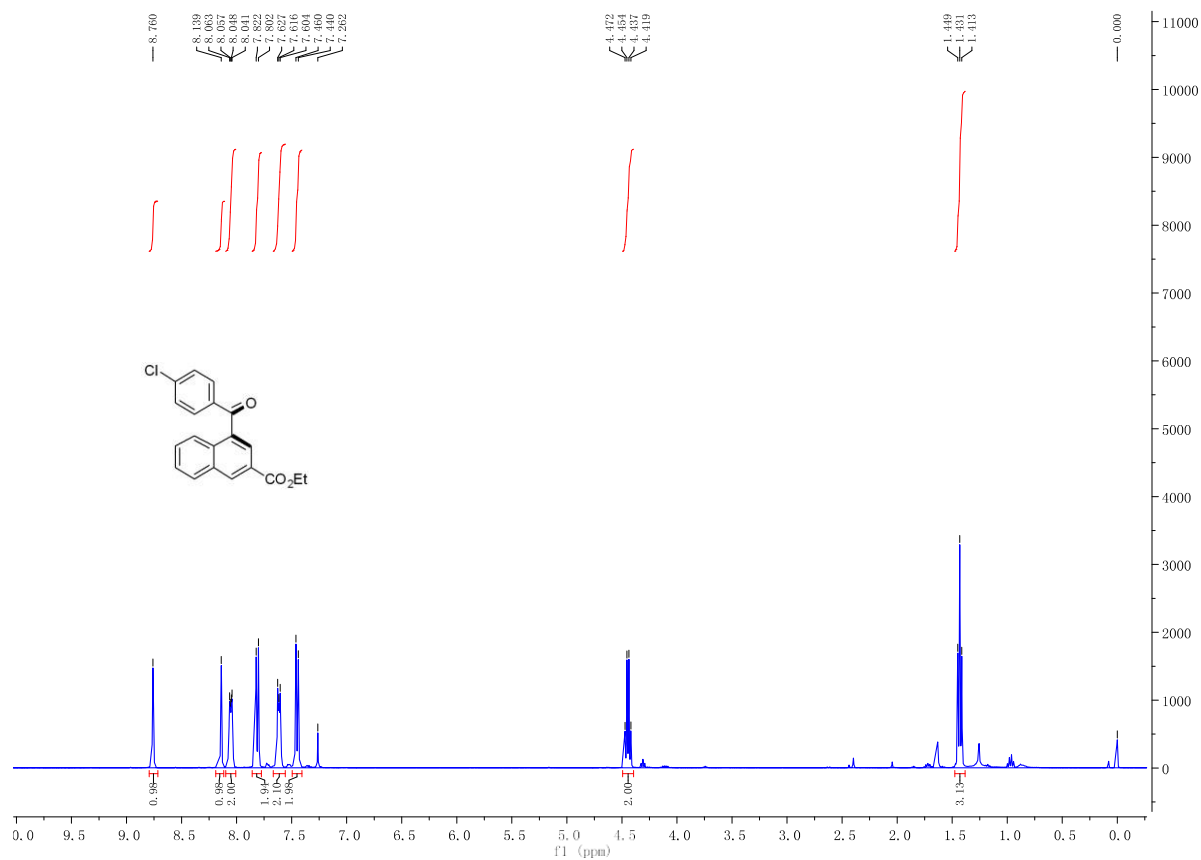
ethyl 4-(4-methoxybenzoyl)-2-naphthoate (2c)



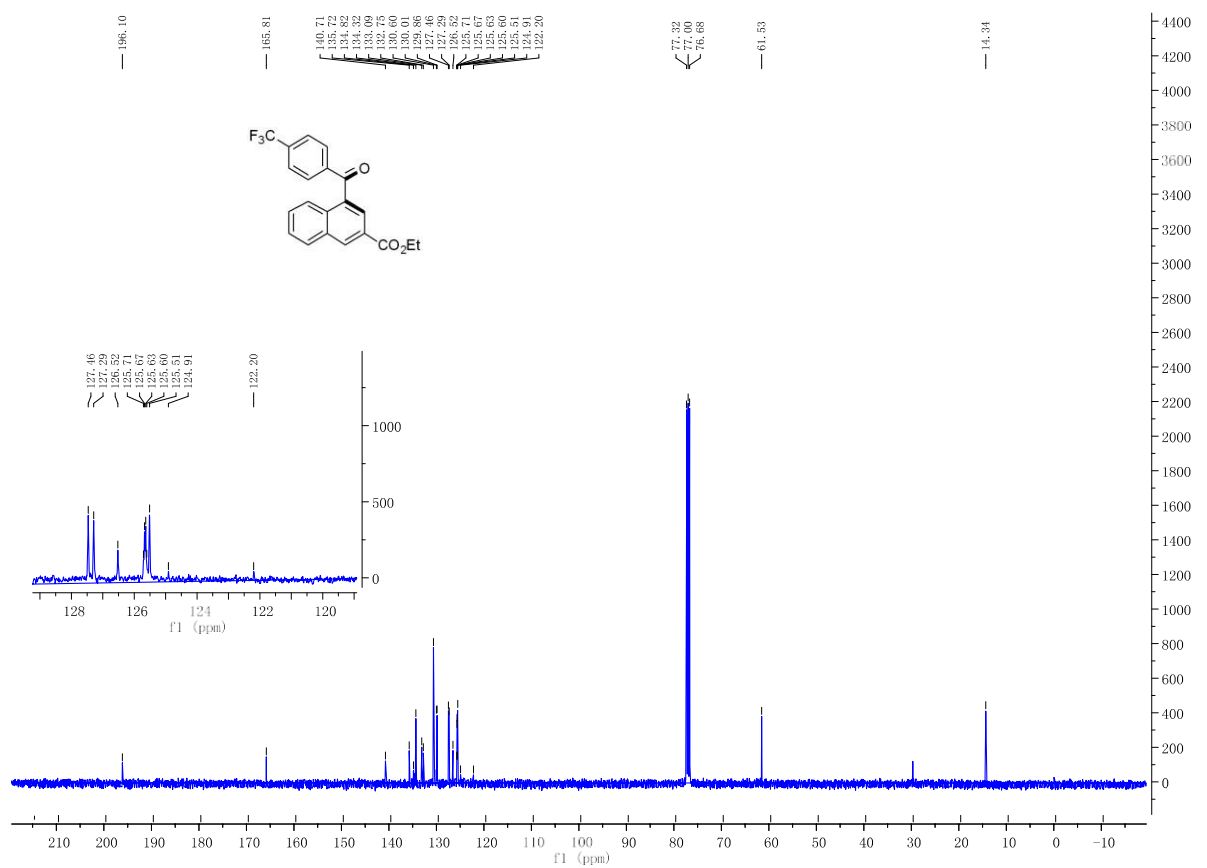
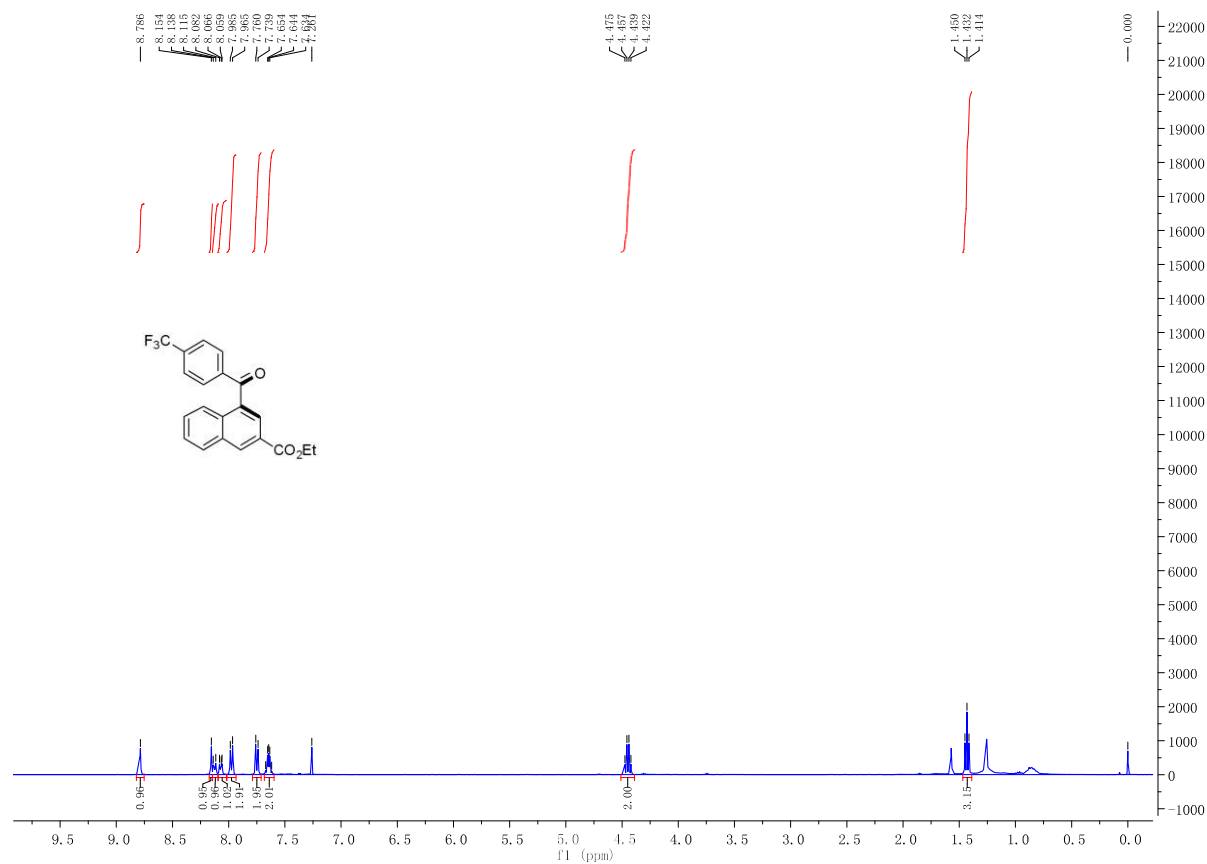
ethyl 4-(4-fluorobenzoyl)-2-naphthoate (2d)



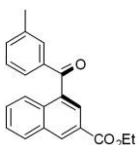
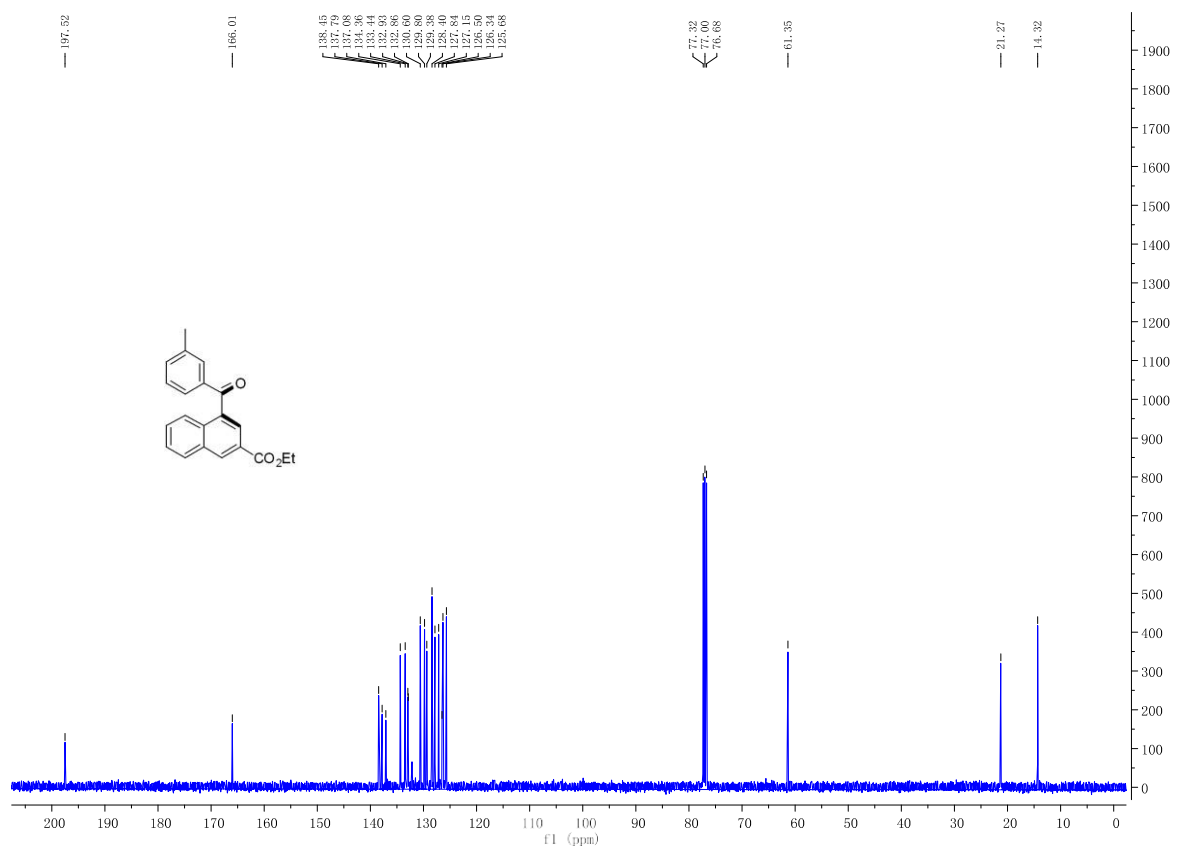
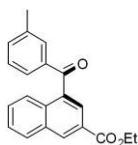
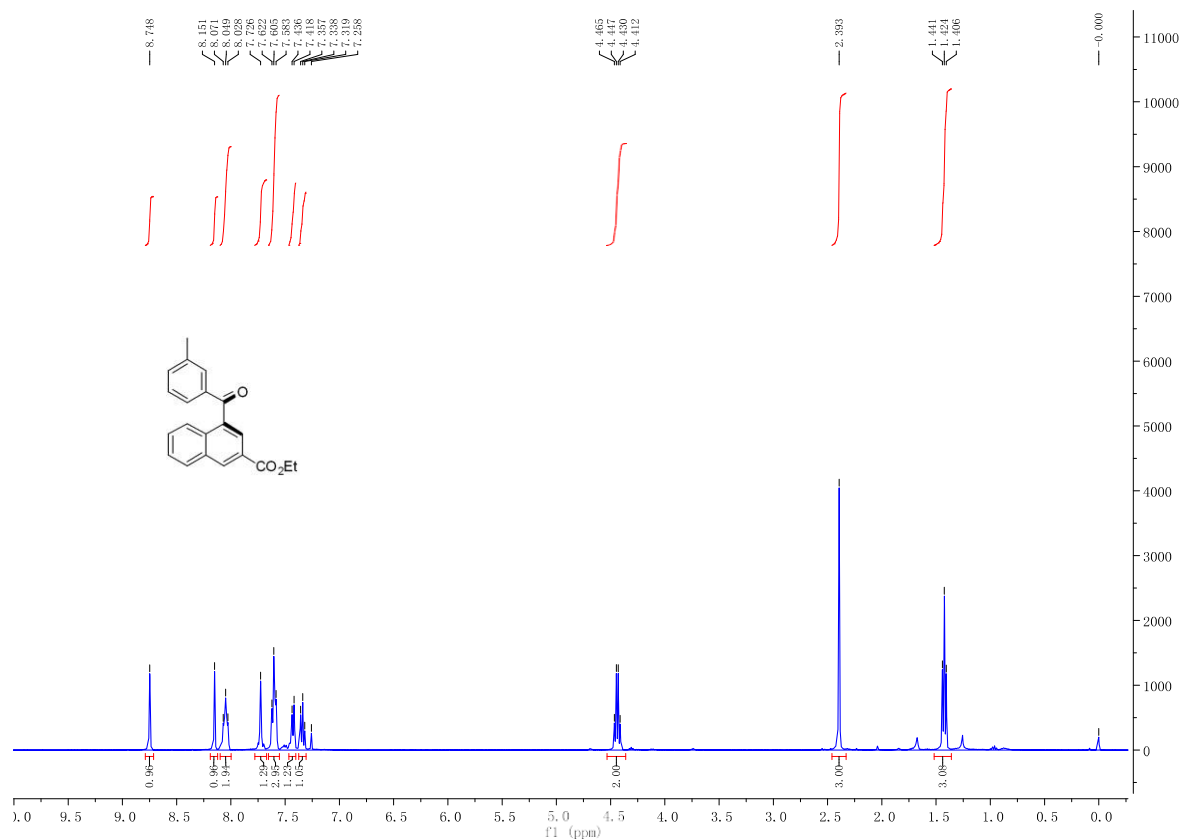
ethyl 4-(4-chlorobenzoyl)-2-naphthoate(2e)



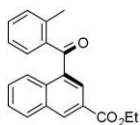
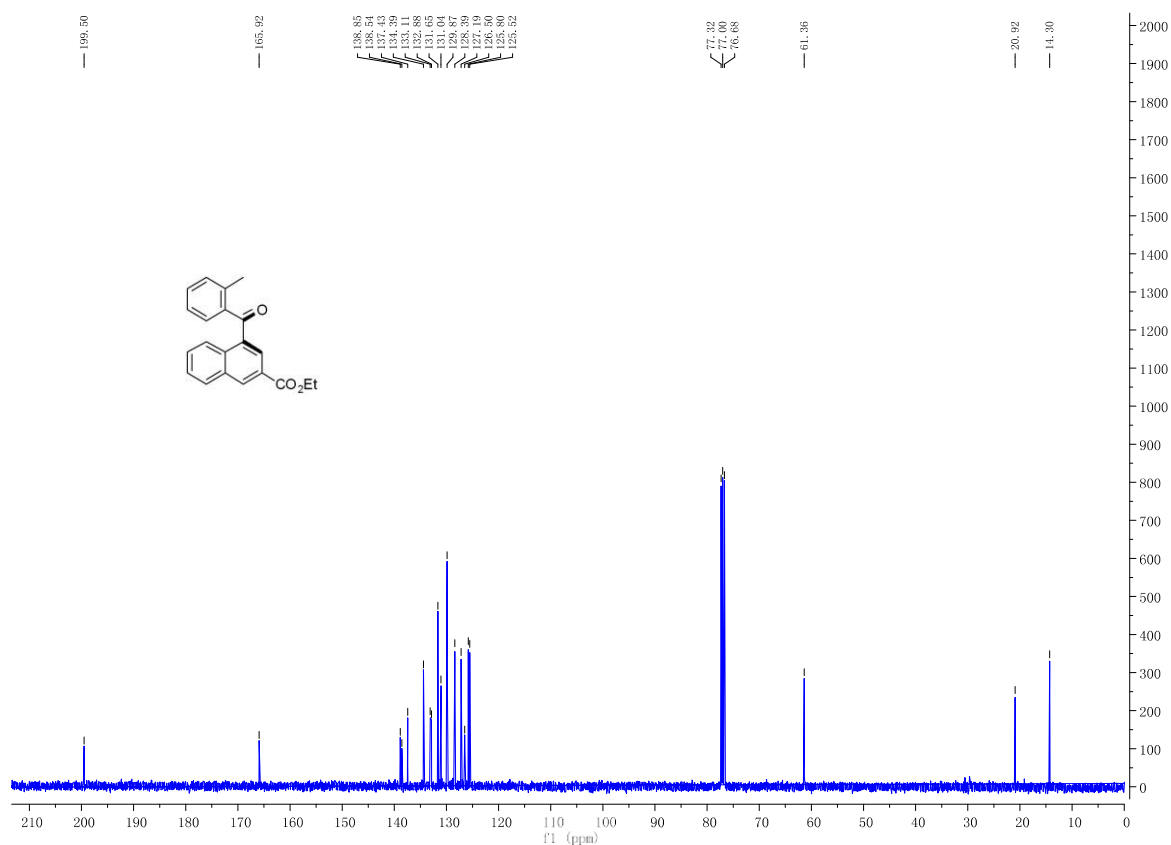
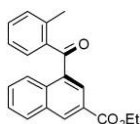
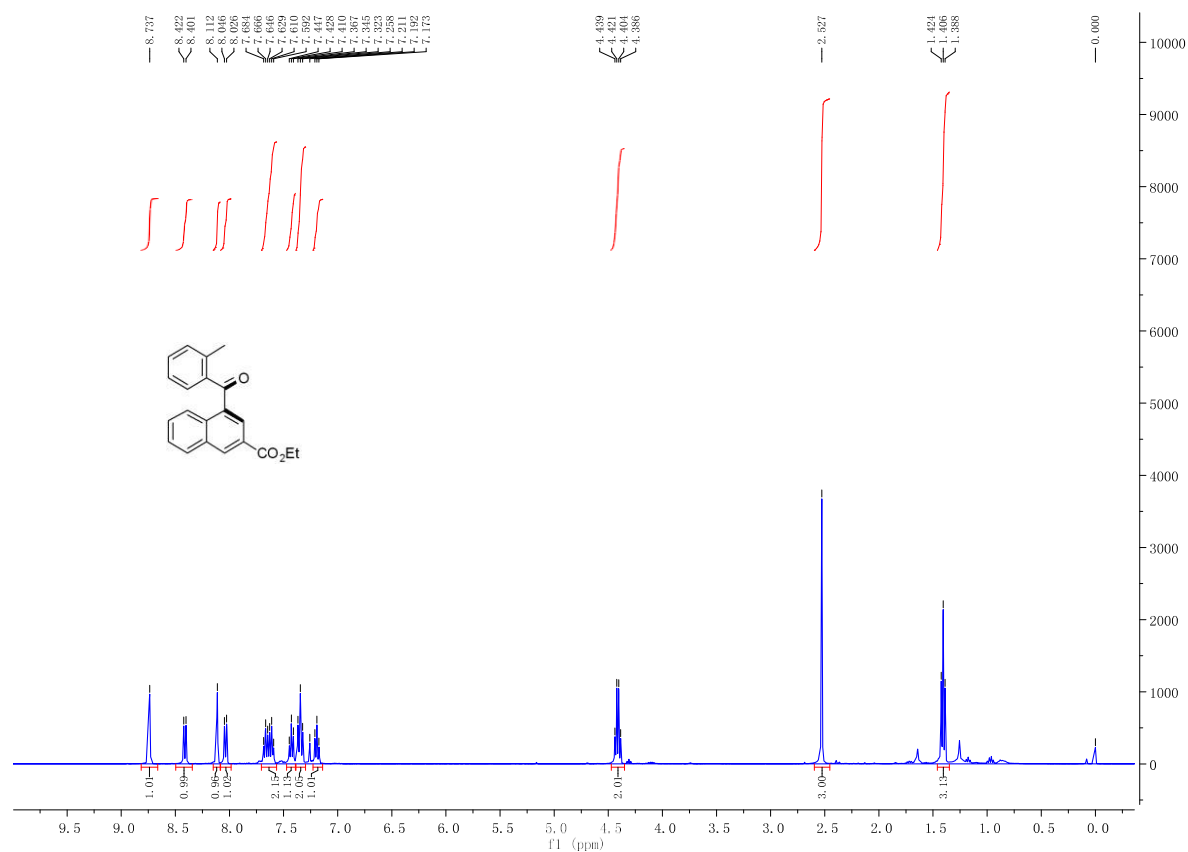
ethyl 4-(4-(trifluoromethyl)benzoyl)-2-naphthoate (2f)



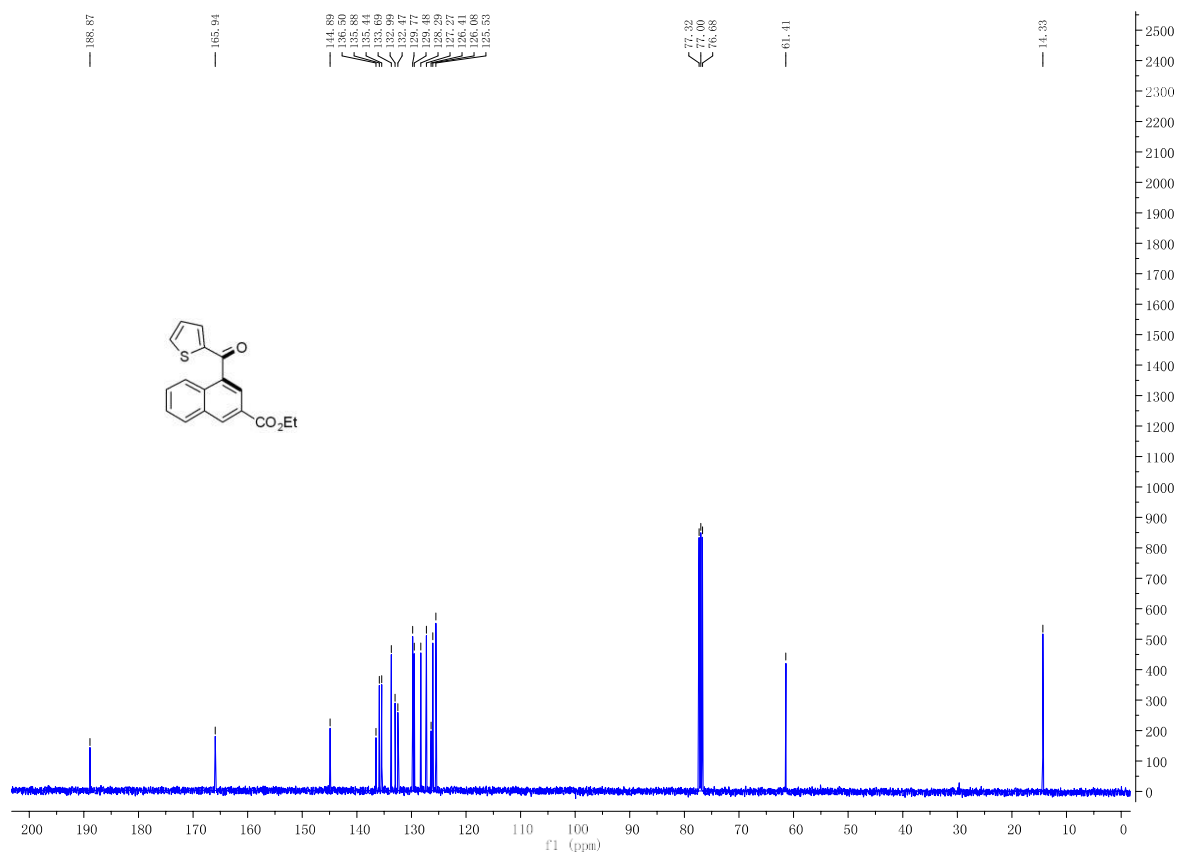
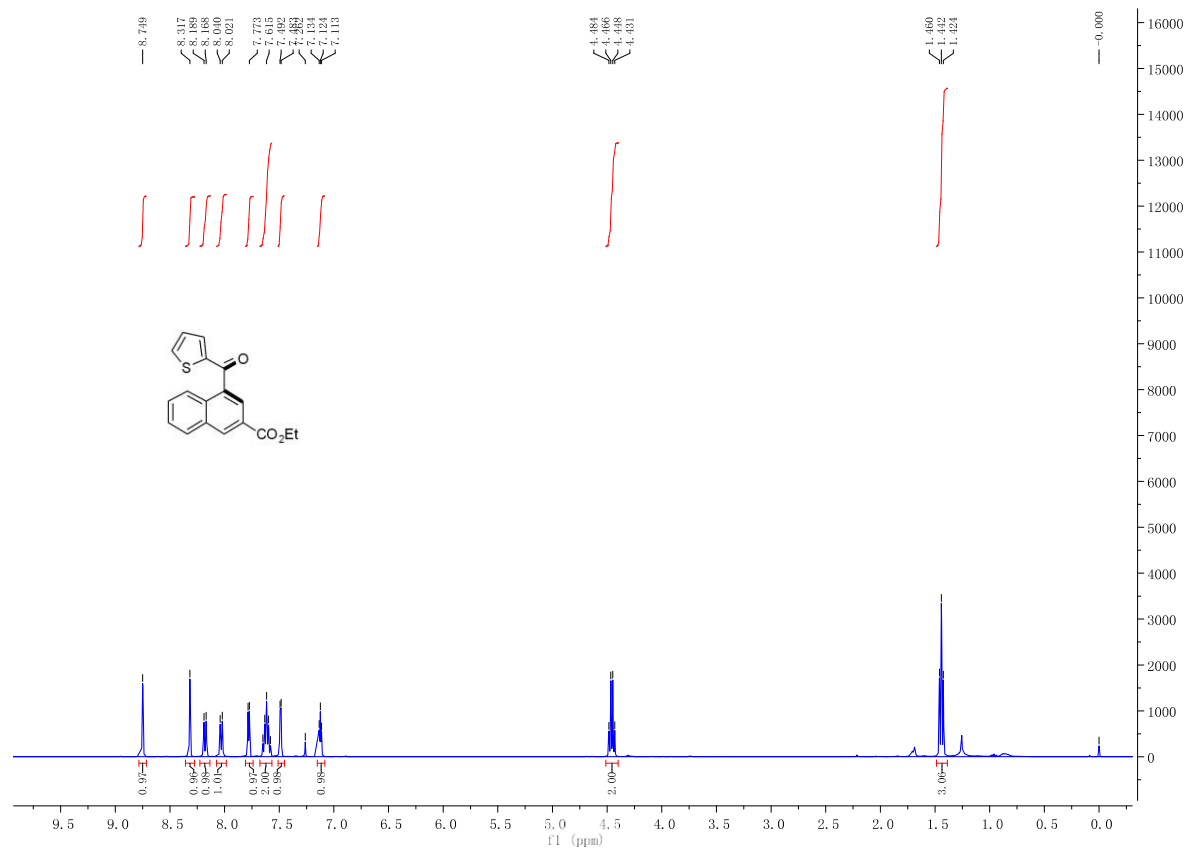
ethyl 4-(3-methylbenzoyl)-2-naphthoate (2g)



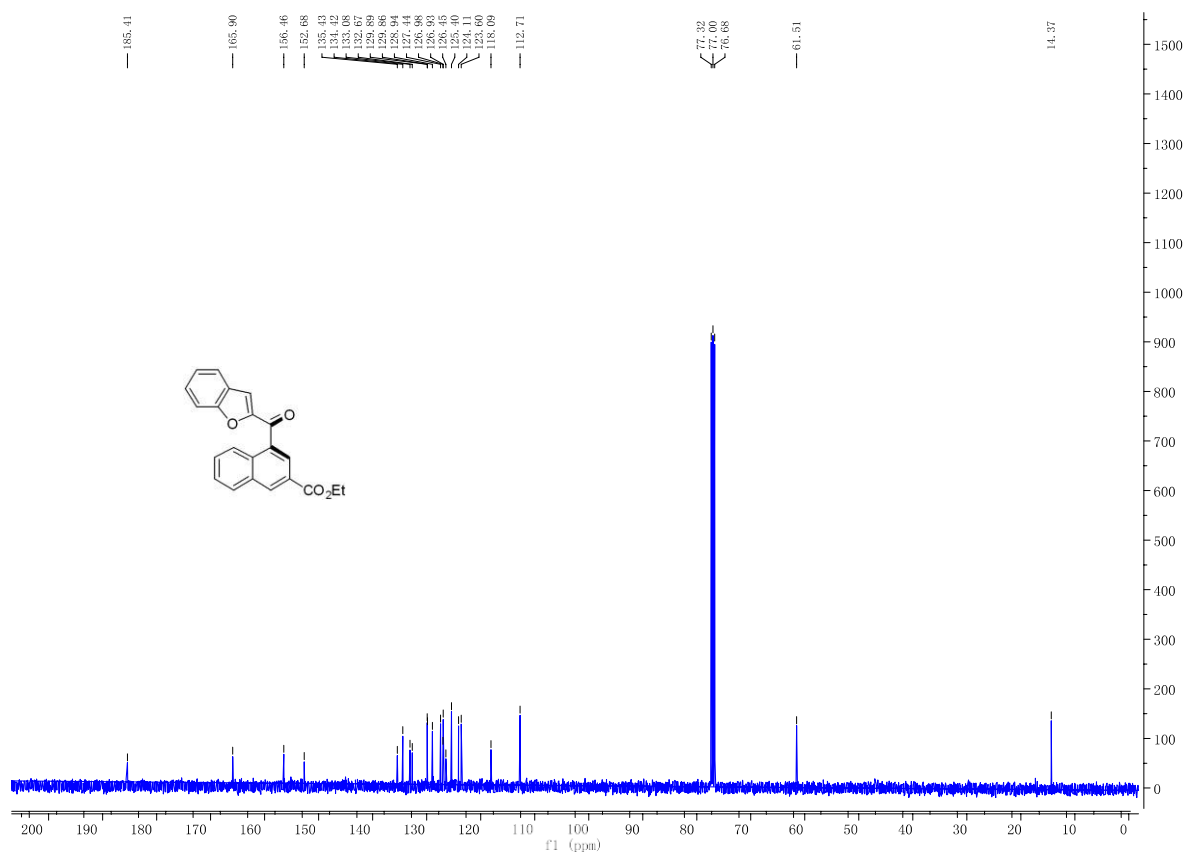
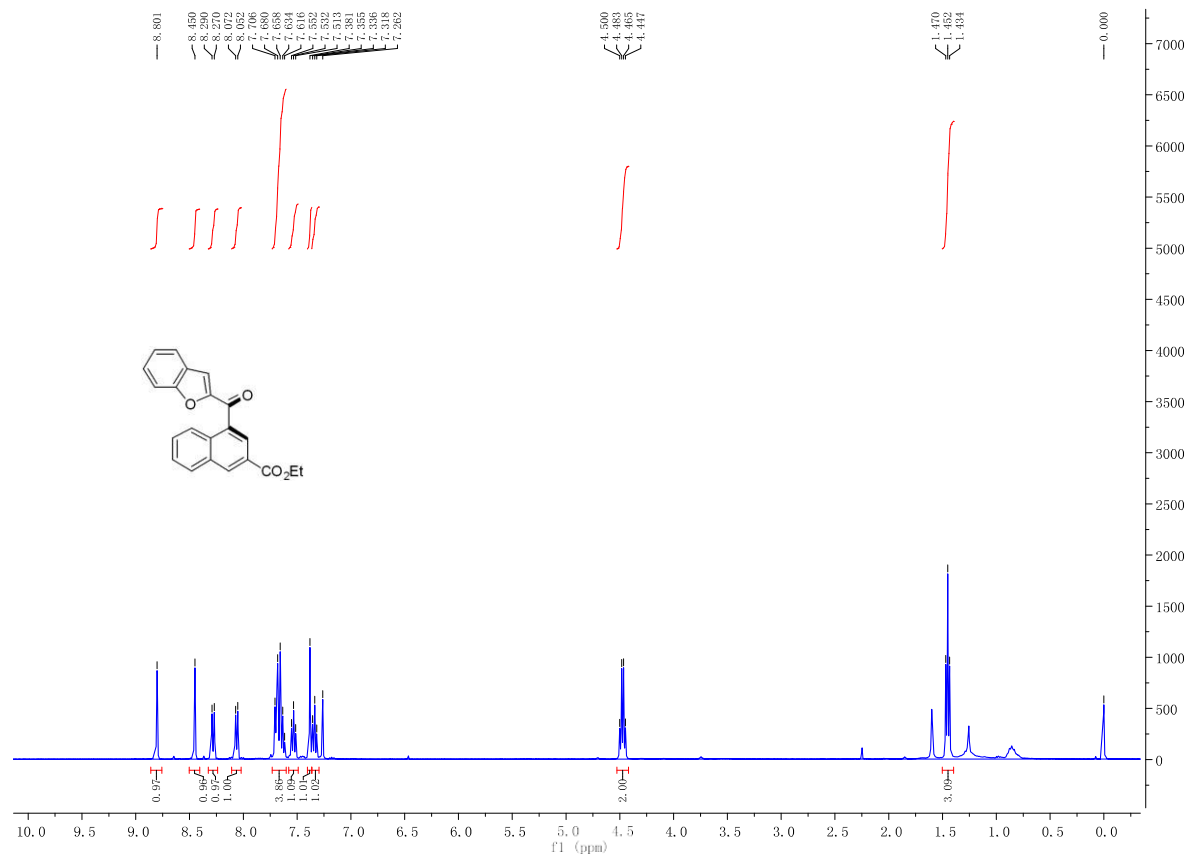
ethyl 4-(2-methylbenzoyl)-2-naphthoate(2h)



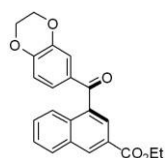
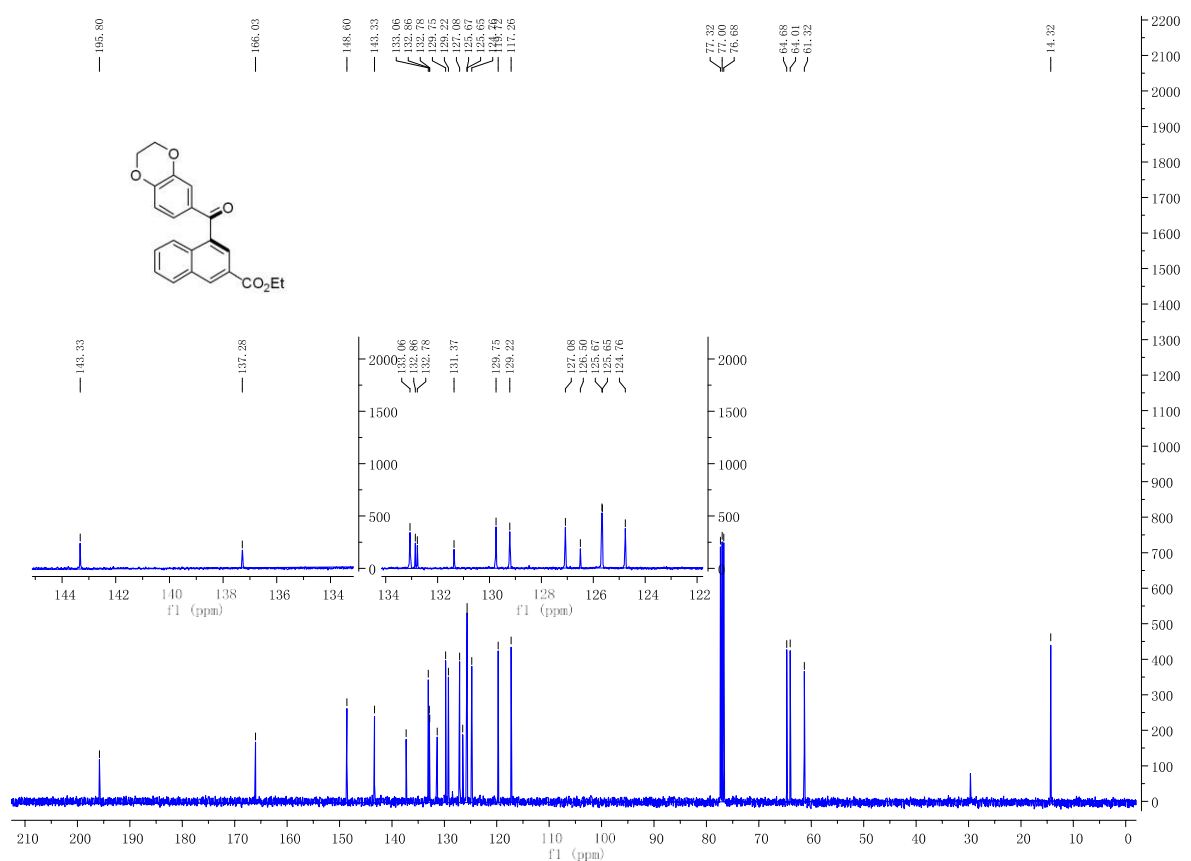
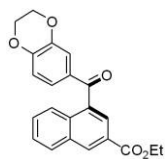
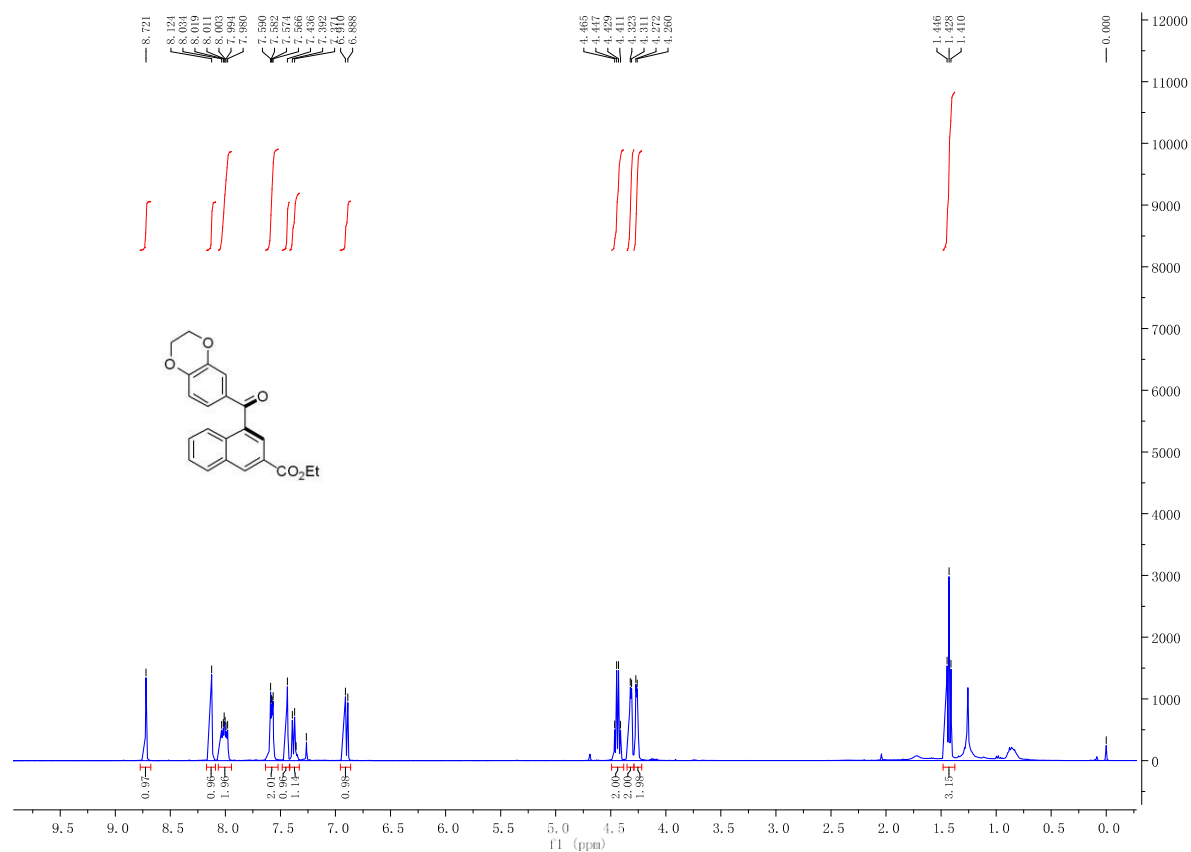
ethyl 4-(thiophene-2-carbonyl)-2-naphthoate (2i)



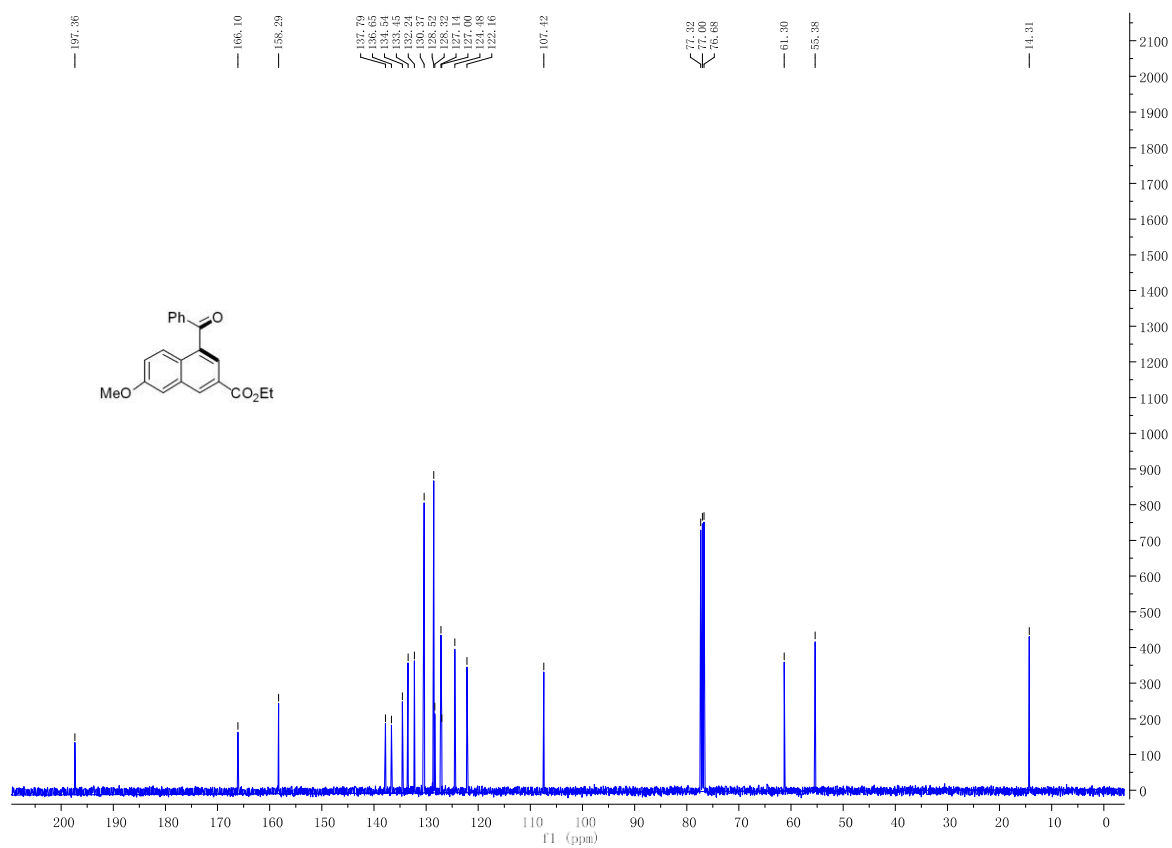
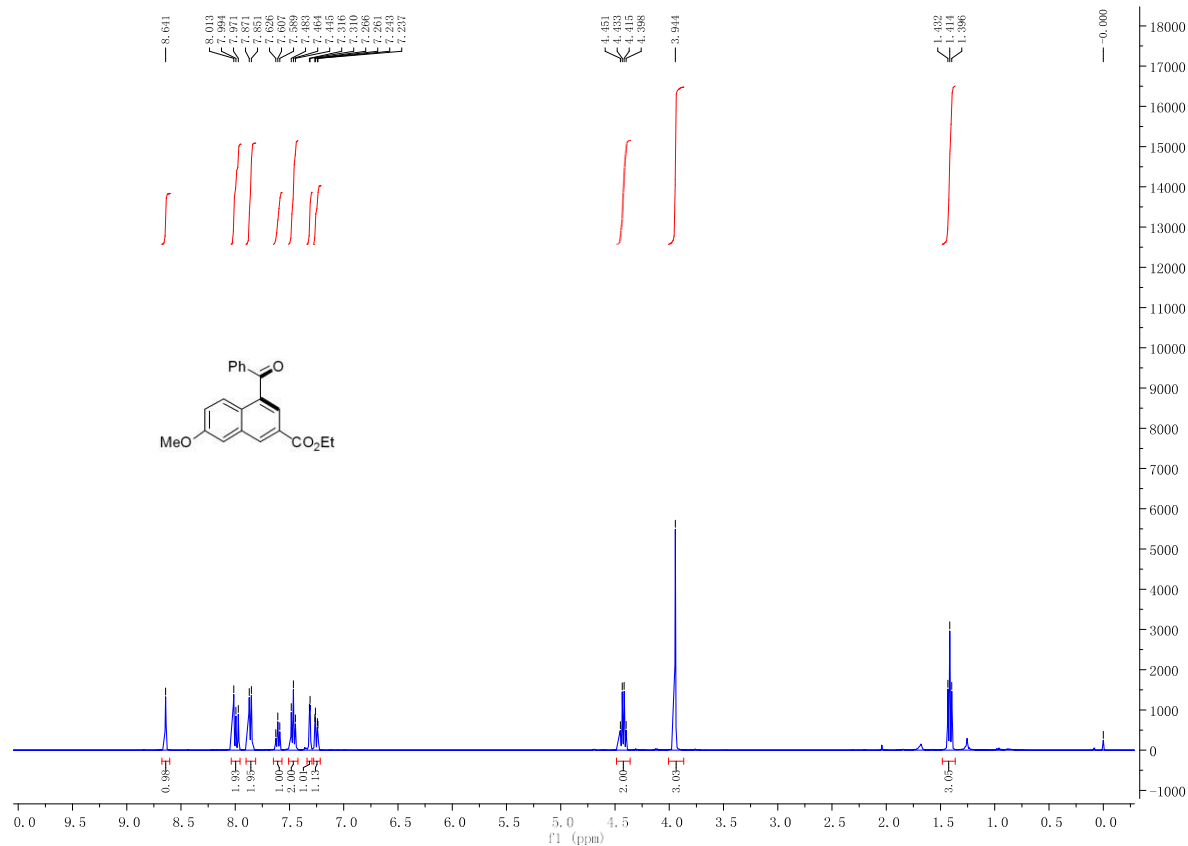
ethyl 4-(benzofuran-2-carbonyl)-2-naphthoate (2j)



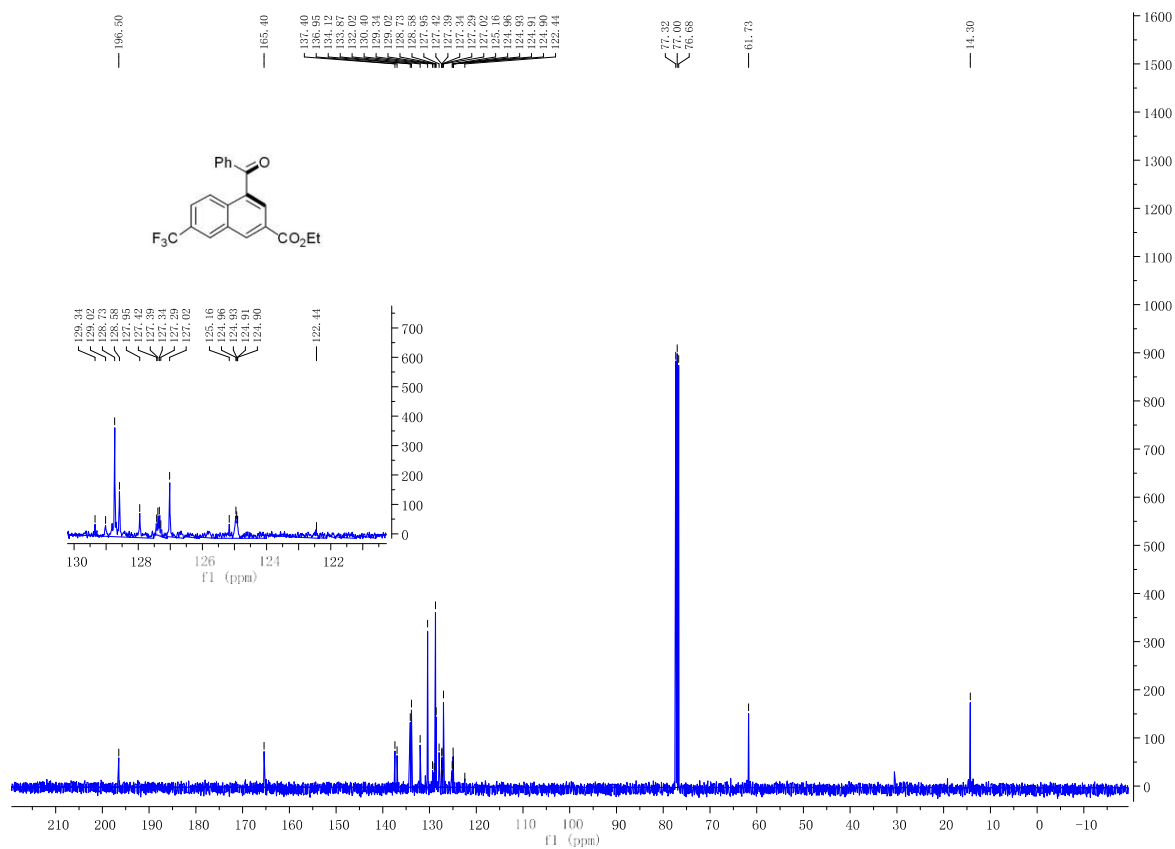
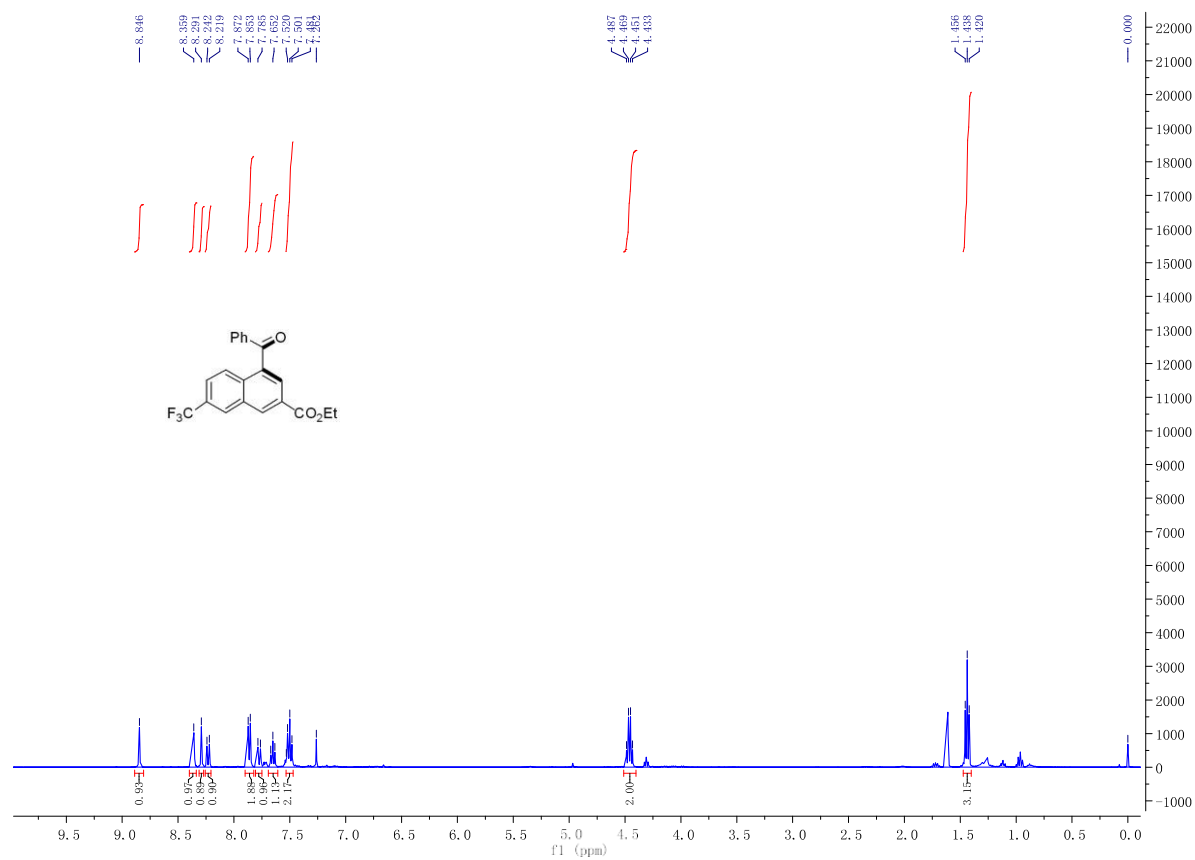
ethyl 4-(2,3-dihydrobenzo[b][1,4]dioxine-6-carbonyl)-2-naphthoate (2k)



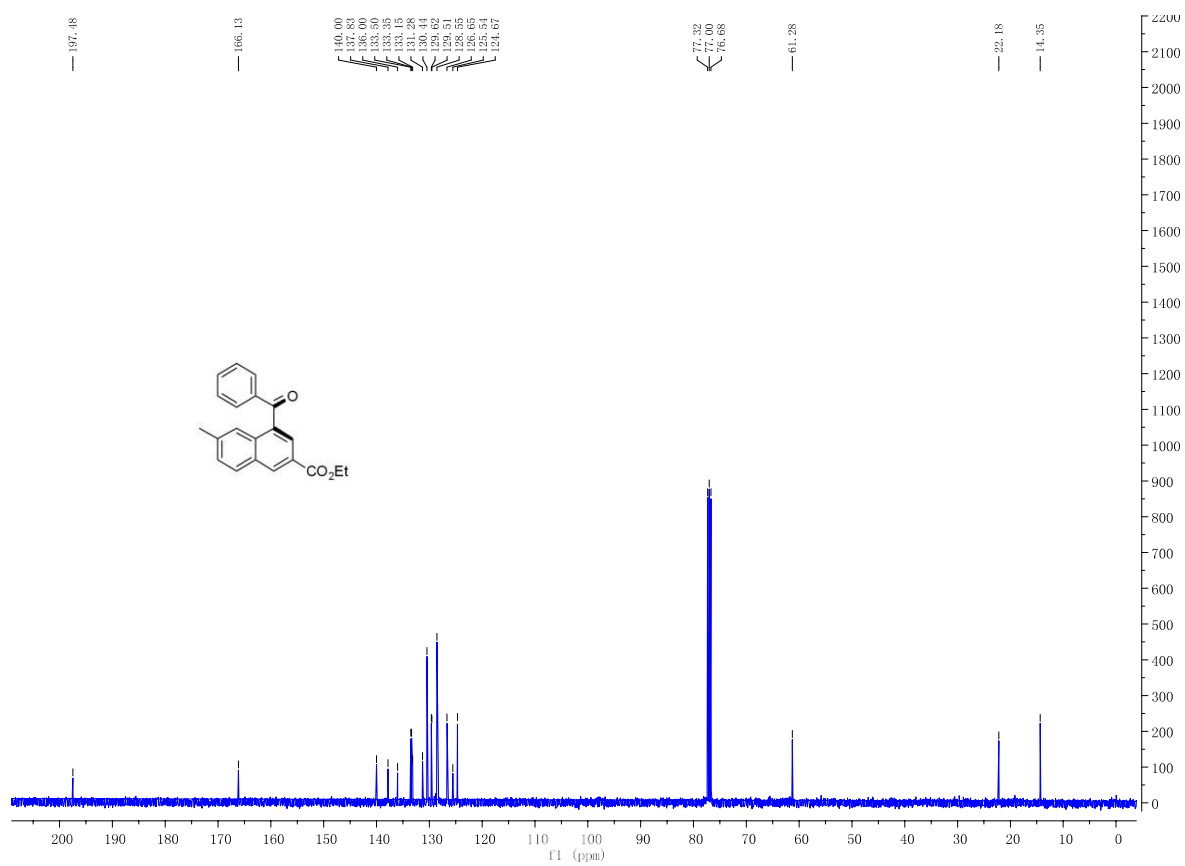
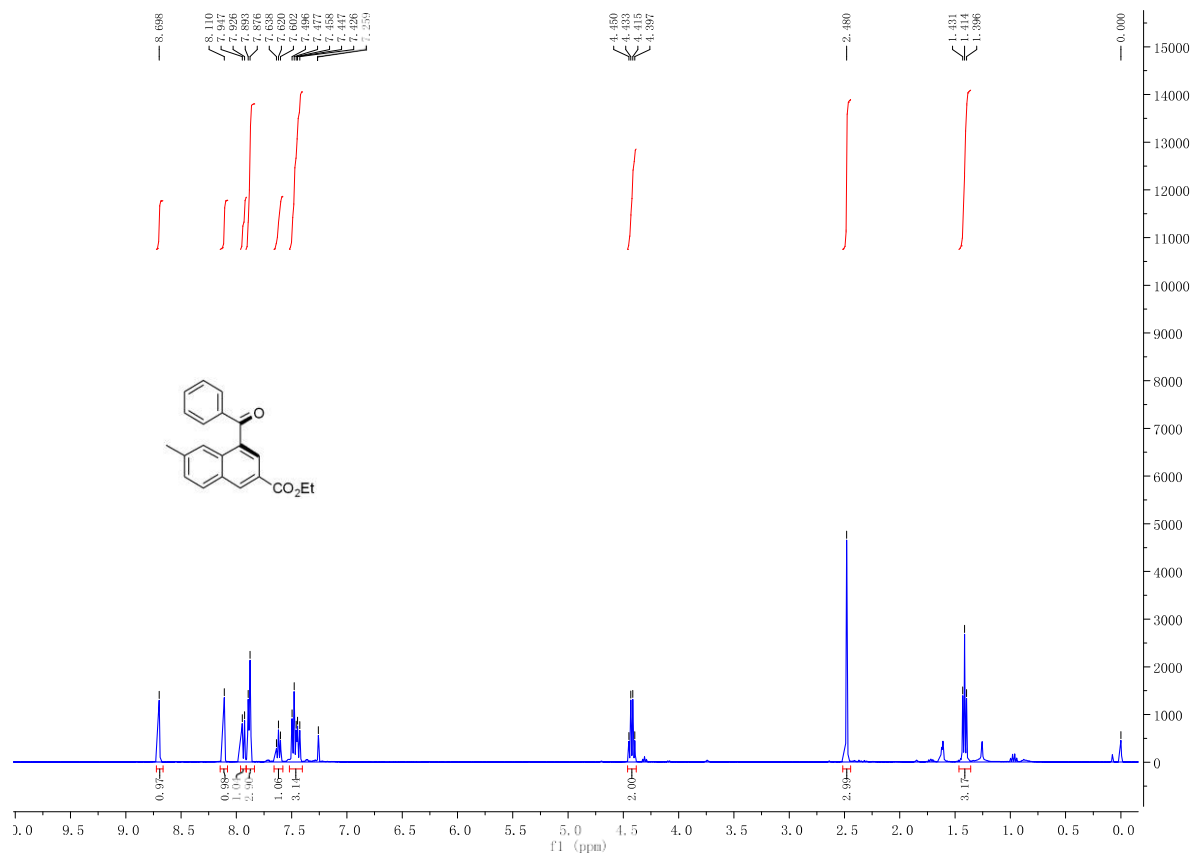
ethyl 4-benzoyl-7-methoxy-2-naphthoate (2o)



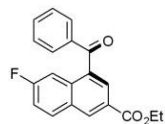
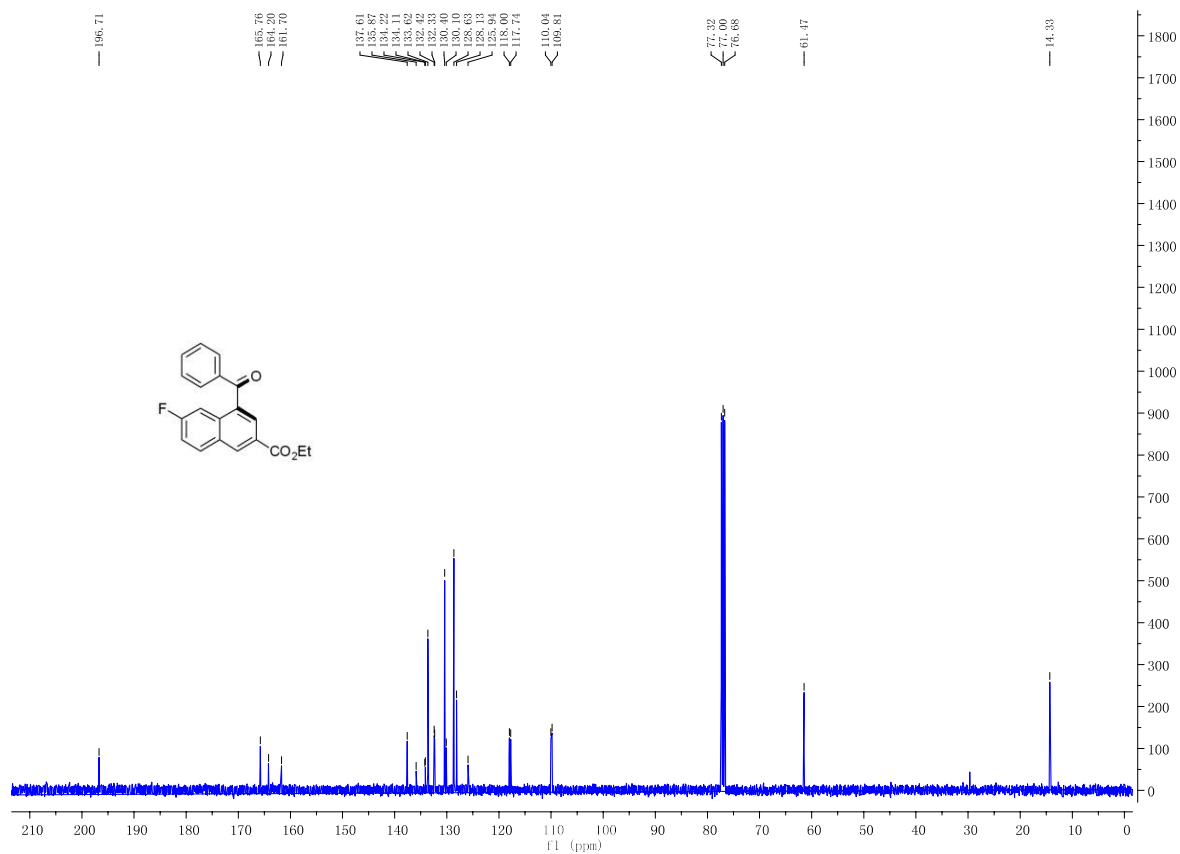
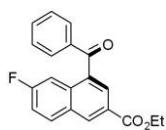
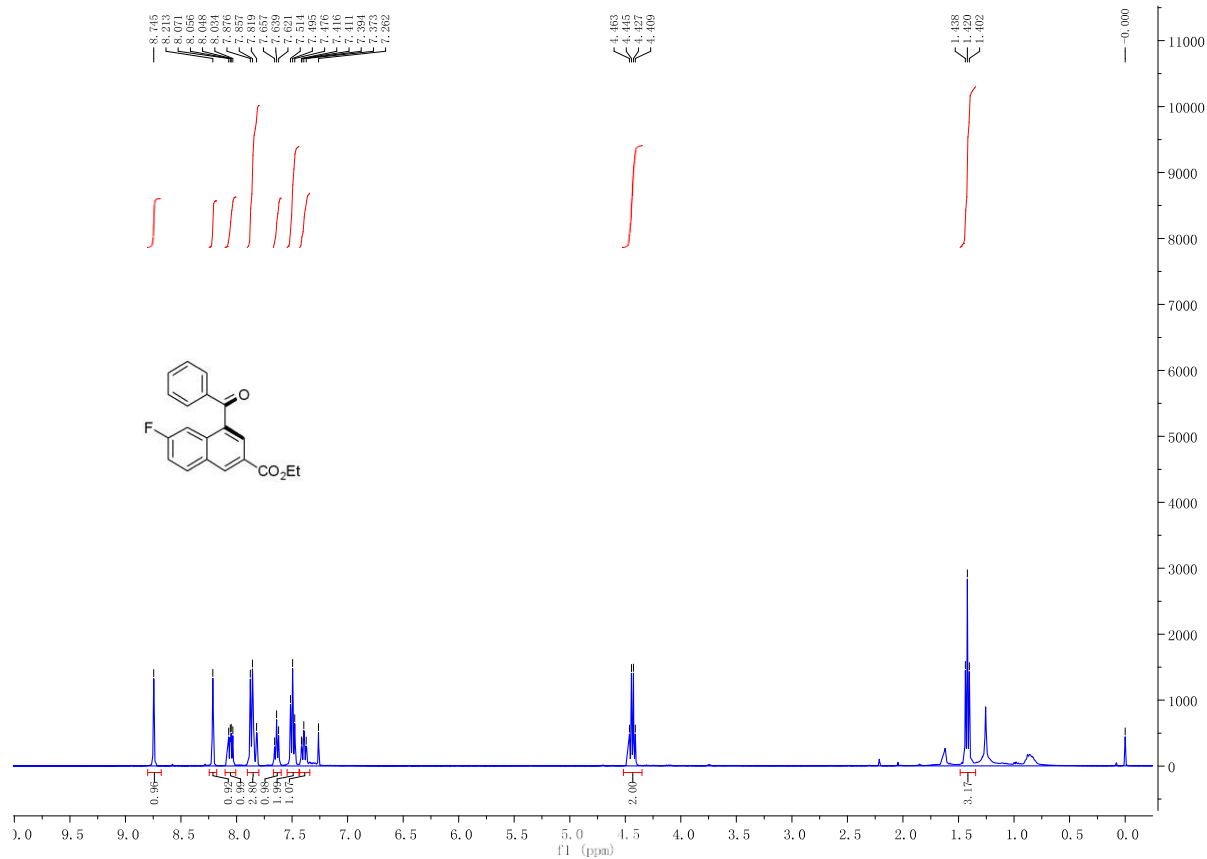
ethyl 4-benzoyl-7-(trifluoromethyl)-2-naphthoate (2p)



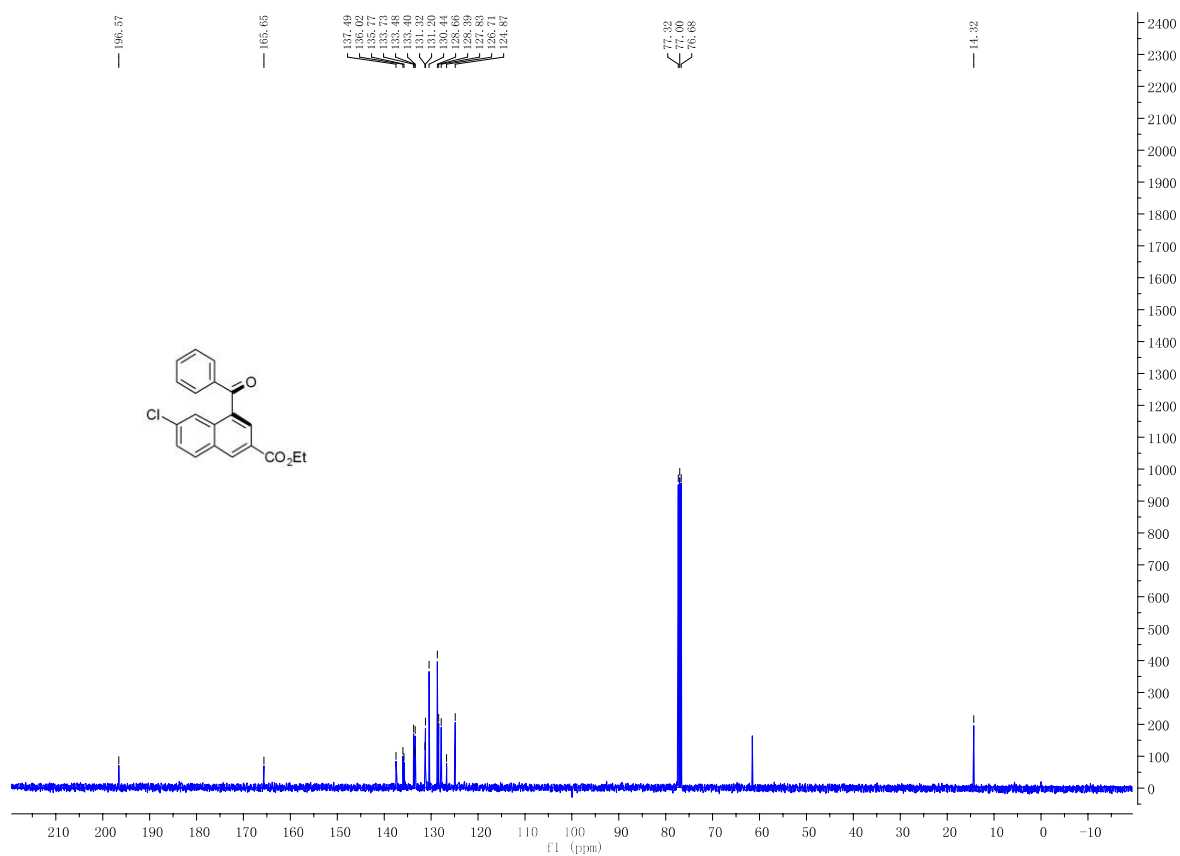
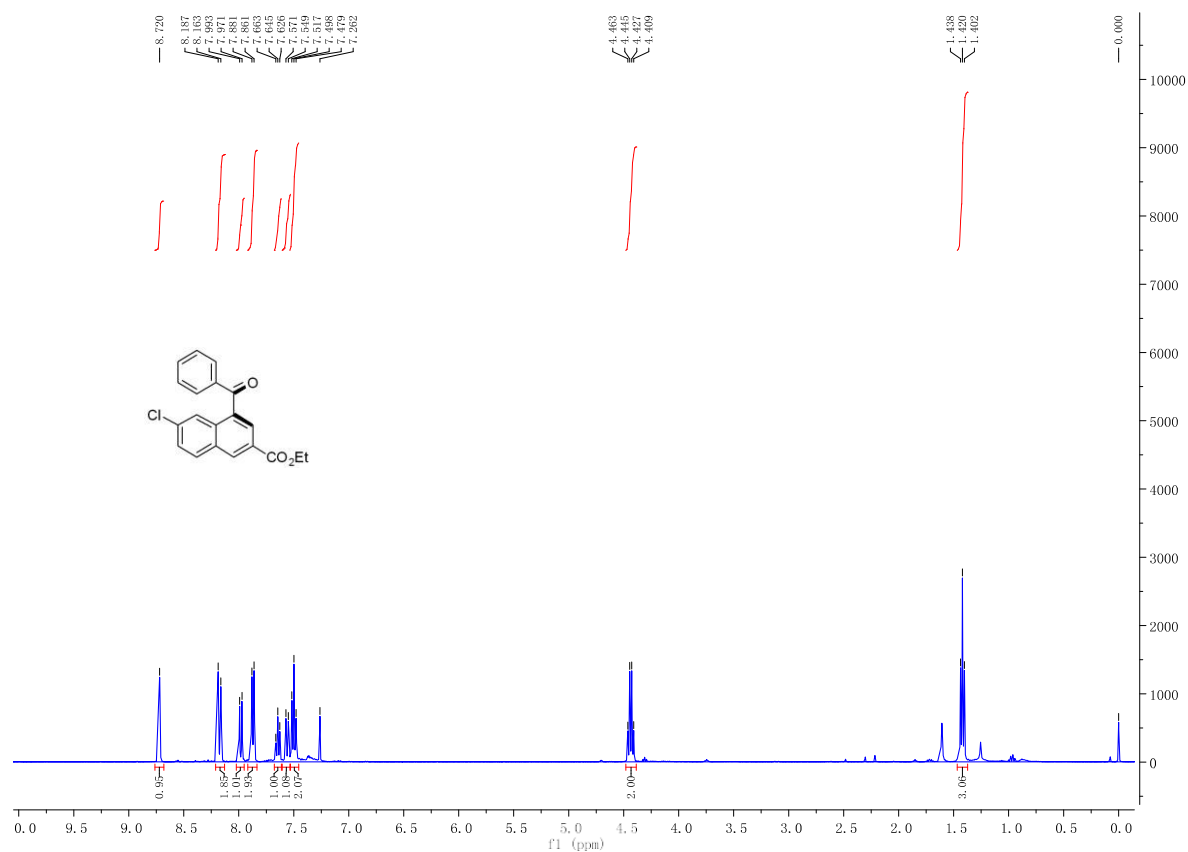
ethyl 4-benzoyl-6-methyl-2-naphthoate(2q)



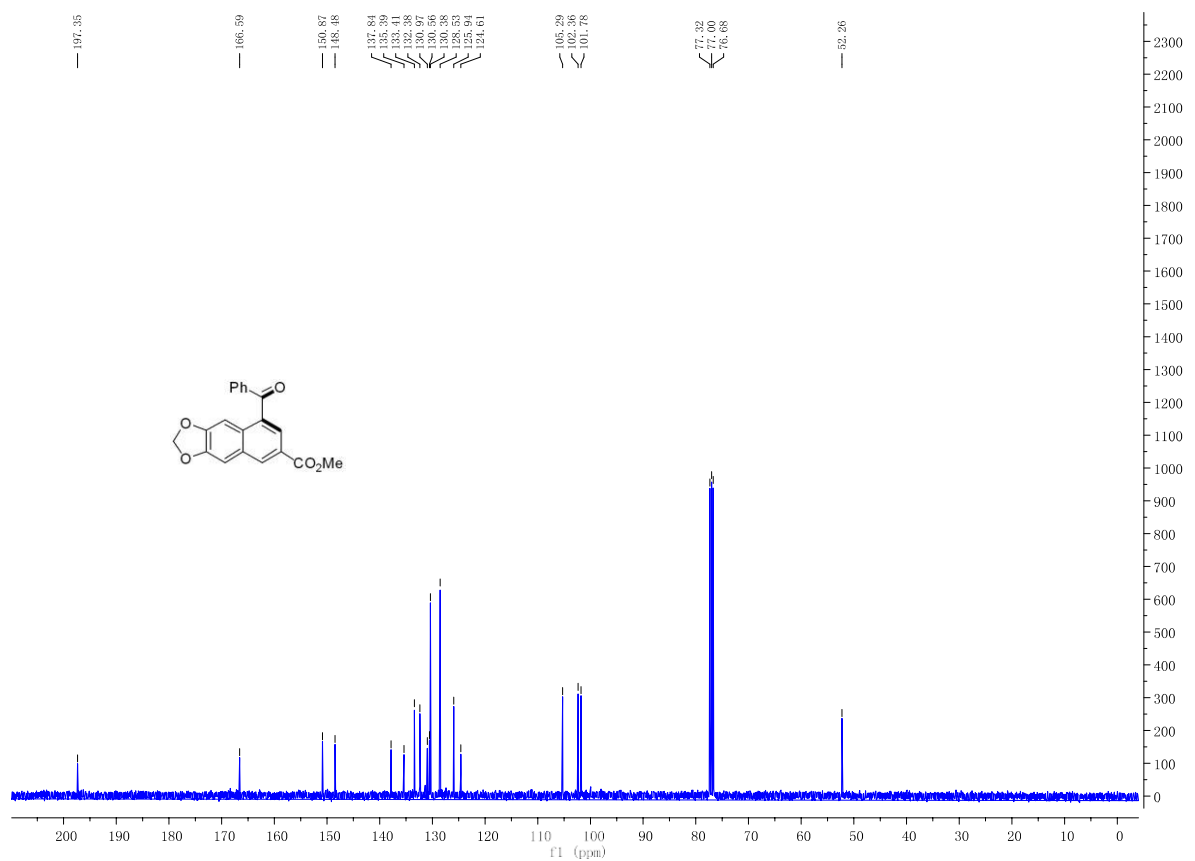
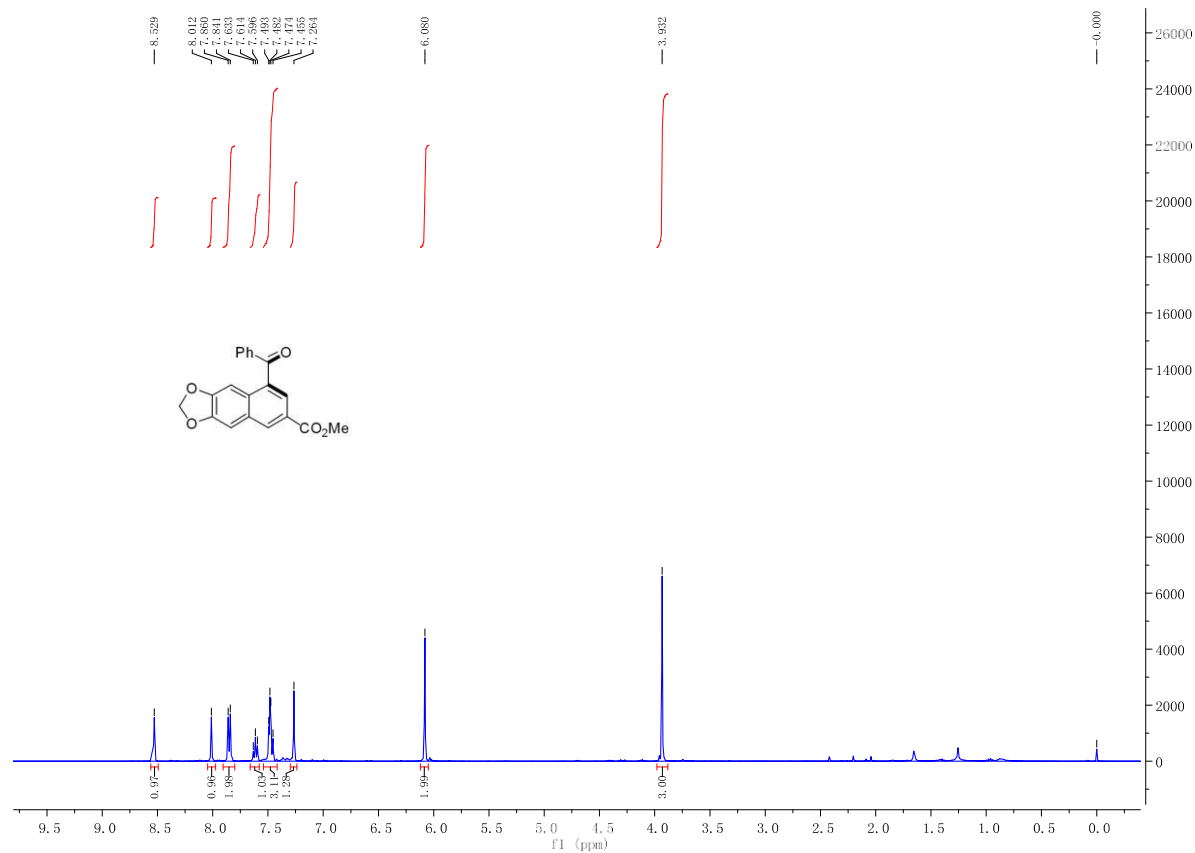
ethyl 4-benzoyl-6-fluoro-2-naphthoate(2r)



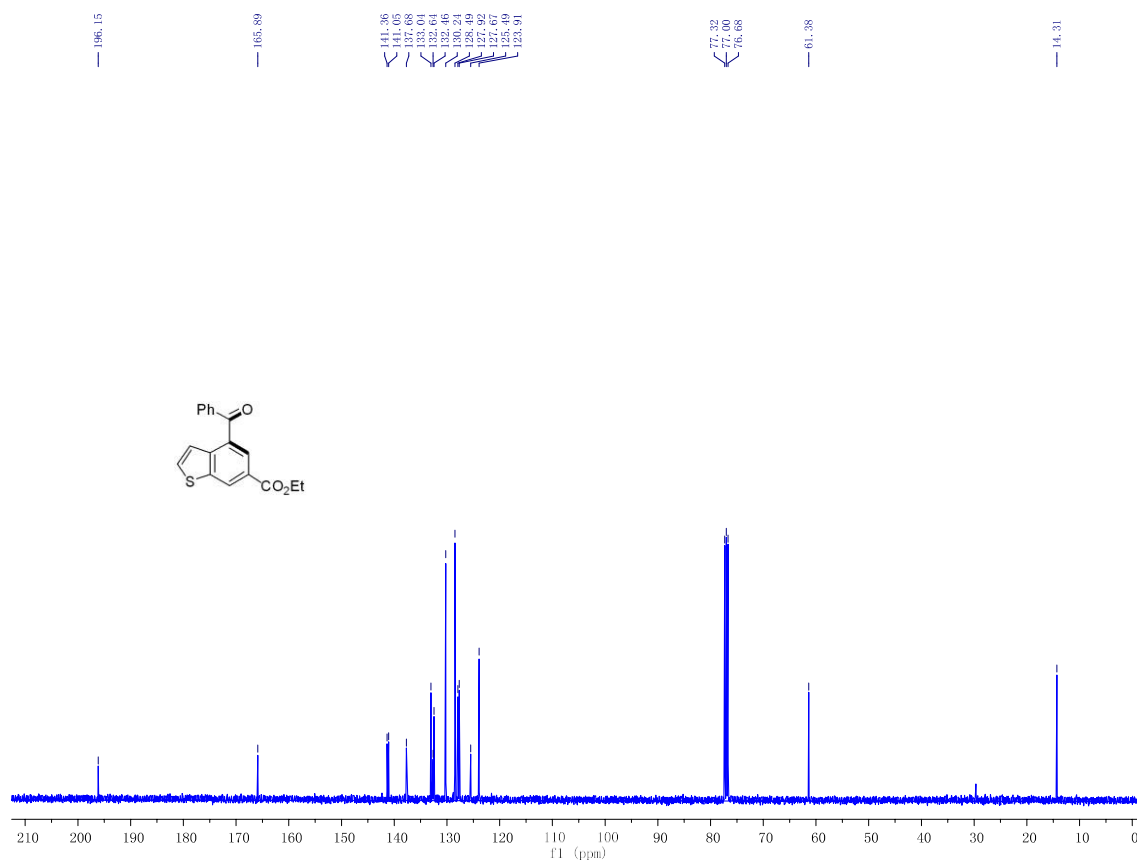
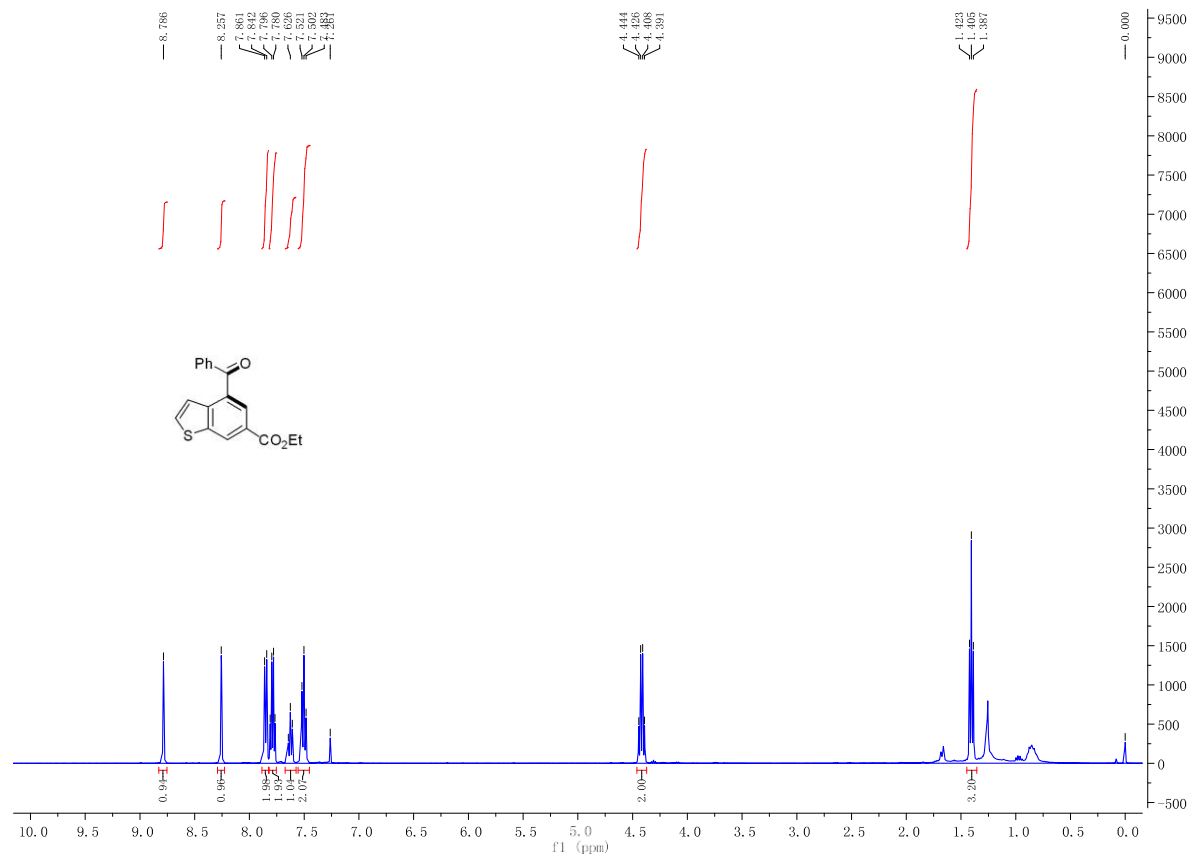
ethyl 4-benzoyl-6-chloro-2-naphthoate (2s)



ethyl 8-benzoylnaphtho[2,3-d][1,3]dioxole-6-carboxylate (2t)



ethyl 4-benzoylbenzo[b]thiophene-6-carboxylate (2u)



methyl 4-benzoyl-2-naphthoate (2v)

