Supporting Information

KBr-Enabled electrochemical transformation of alkynes into α-bromoketones/1,2-diketones

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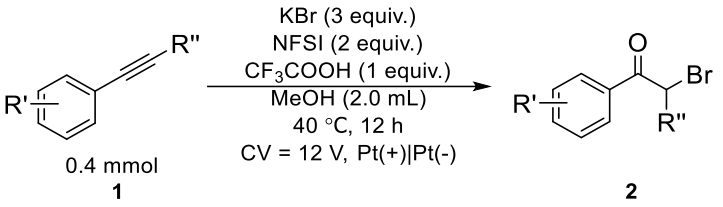
Table of Contents

1. General Information

All reagents and solvents were purchased from J&K Chemicals, Energy Chemical or other commercial suppliers and used as received without further purification.The constant voltage was provided by GWINSTEK PSR 60-6. Proton nuclear magnetic resonance (^{1}H NMR) spectra were recorded on a Bruker Avance III HD 400 (400 MHz) spectrometer，Bruker Avance 500 (500 MHz) spectrometer or Bruker Avance 600 (600 MHz) spectrometer. Chemical shifts were recorded in parts per million (ppm, δ) relative to tetramethylsilane (δ 0.00). ^{1}H NMR splitting patterns are designated as singlet (s), doublet (d), triplet (t), quartet (q), dd (doublet of doublets); m (multiplets), and etc. All first-order splitting patterns were assigned on the basis of the appearance of the multiplet. Splitting patterns that could not be easily interpreted are designated as multiplet (m) or broad (br). Carbon nuclear magnetic resonance (^{13}C NMR) spectra were recorded on a Bruker Avance III HD 400 (100 MHz), Bruker Avance 500 (125 MHz) spectrometer or Bruker Avance 600 (150 MHz) spectrometer. High resolution mass spectral analysis (HRMS) was performed on an Ultima Global spectrometer with an ESI source. Flash chromatography was performed using Qingdao Haiyang silica gel 100 - 200 with distilled solvents. Visualization was performed using a UV lamp.

2. General Procedures for Products

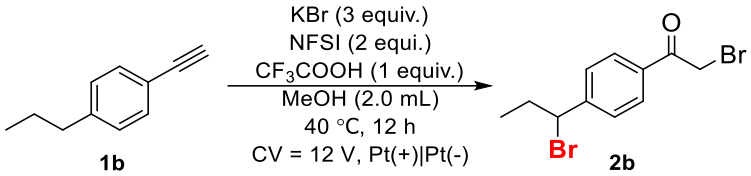
2.1 General procedures for α-bromoketones.



R'= H, alkyl, alkoxy, alkynyl, halo
R"= H, alkyl

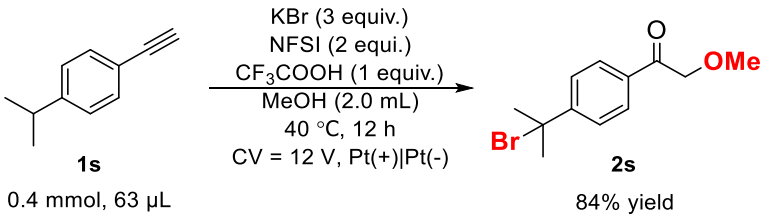
To a dry three-necked flask equipped with a magnetic stir bar, was added **1** (0.4 mmol), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 °C for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1 or 20:1, v/v) to afford α-bromoketones **2**.

a) General procedure for 2b.



To a dry three-necked flask equipped with a magnetic stir bar, was added **1b** (0.4 mmol, 65 μL), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 °C for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 50:1, v/v) to afford **2b** as slight yellow oil, 44.9 mg, 47% yield.

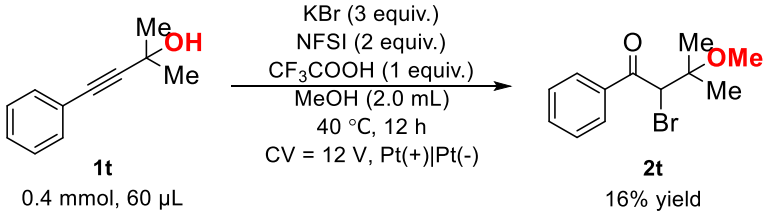
b) General procedure for 2s.



To a dry three-necked flask equipped with a magnetic stir bar, was added **1s** (0.4 mmol,

63 μL), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 °C for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 30:1, v/v) to afford **2s** as slight yellow oil, 91.1 mg, 84% yield.

c) General procedure for 2t.

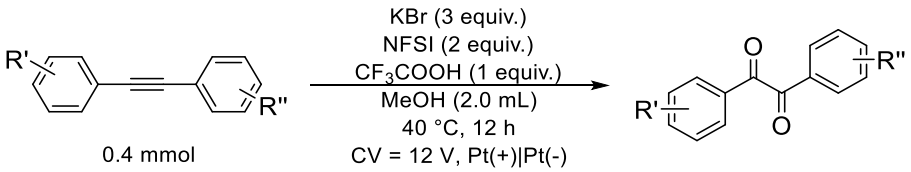


1t
0.4 mmol, 60 μL

2t
16% yield

To a dry three-necked flask equipped with a magnetic stir bar, was added **1t** (0.4 mmol, 60 μL), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 °C for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v) to afford **2t** as slight yellow oil, 16.9 mg, 16% yield.

2.2 General procedures for diketones.



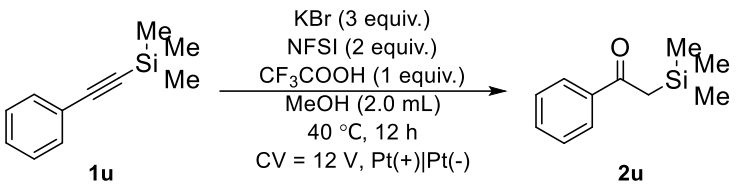
0.4 mmol
1o-1r

R'= H, alkyl, halo
R"= H, alkyl, halo

2o-2r

To a dry three-necked flask equipped with a magnetic stir bar, was added **1o-1r** (0.4 mmol), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 °C for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1 or 20:1) to afford **2o-2r**.

a) General procedure for 2u.



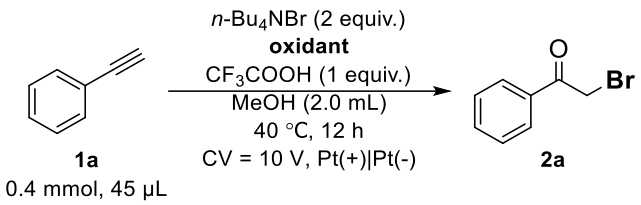
1u
0.4 mmol, 79 μL

2u
97% yield

To a dry three-necked flask equipped with a magnetic stir bar, was added **1u** (0.4 mmol, 79 μL), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 °C for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1) to afford **2u** as yellow oil, 77.4 mg, 97% yield.

3. Additional Optimization Experiments

a) General procedure for optimization of oxidant:

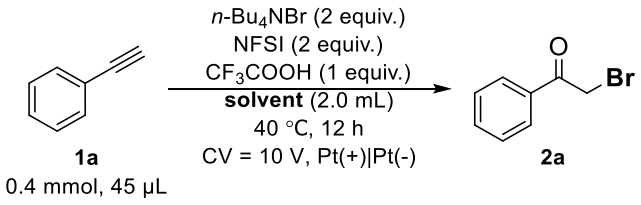


To a dry three-necked flask equipped with a magnetic stir bar, was added **1a** (0.4 mmol, 45 μL), *n*-Bu$_4$NBr (257.9 mg, 2 equiv.), **oxidant**, CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 ºC for 12 h under 10 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v) to afford α-bromoketone **2a**.

Table S1: Optimization of oxidant:

Entry	Oxidant (equiv.)	Yield (%)
1	NFSI (1)	38
2	$K_2S_2O_8$ (1)	22
3	DTBP (1)	21
4	TBHP (1)	3
5	DDQ (1)	7
6	$NaNO_2$ (1)	2
7	NFSI (0)	22
8	NFSI (2)	70
9	NFSI (3)	18

b) General procedure for optimization of solvent:



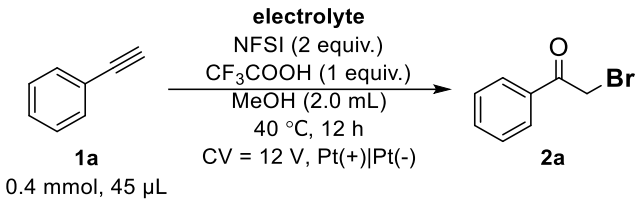
To a dry three-necked flask equipped with a magnetic stir bar, was added **1a** (0.4 mmol, 45 μL), *n*-Bu$_4$NBr (257.9 mg, 2 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and **solvent** (2 mL). The mixture was stirred in a pre-heated oil bath at 40 ºC for 12 h under 10 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent:

petroleum ether/ethyl acetate = 60:1, v/v) to afford α-bromoketone **2a**.

Table S2: Optimization of solvent:

Entry	Solvent (2.0 mL)	Yield (%)
1	CH_3CN	0
2	DCM	0
3	Toluene	0
4	THF	0
5	MeOH	70
6	MeOH:H_2O=100:1	63
7	MeOH:H_2O=50:1	57
8	H_2O	0

c) General procedure for optimization of electrolyte:

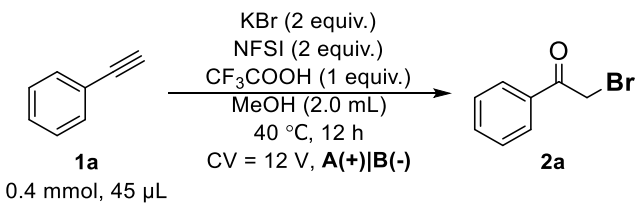


To a dry three-necked flask equipped with a magnetic stir bar, was added **1a** (0.4 mmol, 45 μL), **electrolyte**, NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 ºC for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v) to afford α-bromoketone **2a.**

Table S3: Optimization of electrolyte:

Entry	Electrolyte (equiv.)	Yield (%)
1	*n*-Bu_4NBr (2)	71
2	KBr (1)	51
3	KBr (2)	94
4	KBr (3)	98

d) General procedure for optimization of electrode:



To a dry three-necked flask equipped with a magnetic stir bar, was added **1a** (0.4 mmol,

45 μL), KBr (95.2 mg, 2 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and MeOH (2 mL). The mixture was stirred in a pre-heated oil bath at 40 ºC for 12 h under 12 V with different electrode. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v) to afford α-bromoketone **2a**.

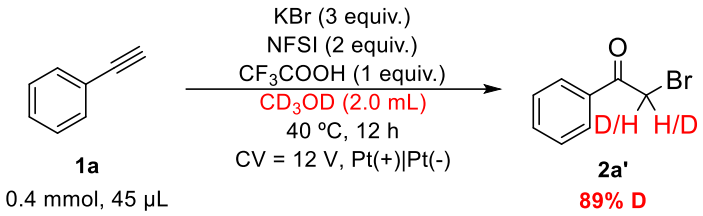
Table S4: Optimization of electrode:

Entry	Electrode	Yield (%)
1	Pt(+)|Pt(-)	94
2	C(+)|Ni(-)	41
3	C(+)|Ag(-)	34
4	C(+)|C(-)	6
5	C(+)|Cu(-)	43
6	Pt(+)|Cu(-)	43

4. Mechanistic Analysis

4.1 Deuterium-labelling experiments

a) CD_3OD instead of CH_3OH

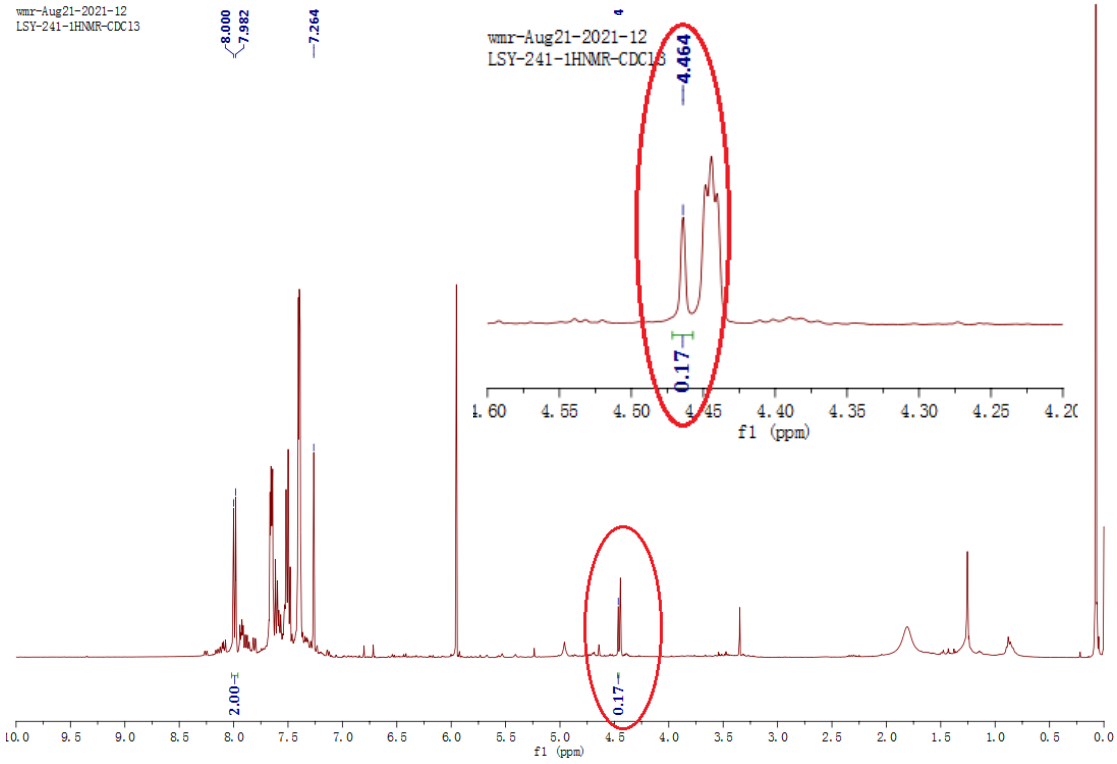


1a
0.4 mmol, 45 μL

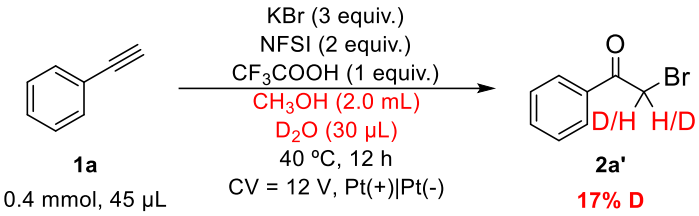
2a'
89% D

To a dry three-necked flask equipped with a magnetic stir bar, was added **1a** (0.4 mmol), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.) and CD_3OD (2 mL). The mixture was stirred in a pre-heated oil bath at 40 °C for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v). The resulting crude product was dissolved in $CDCl_3$ for crude ^1H NMR analysis.

Crude ^1H NMR (400 MHz, $CDCl_3$)

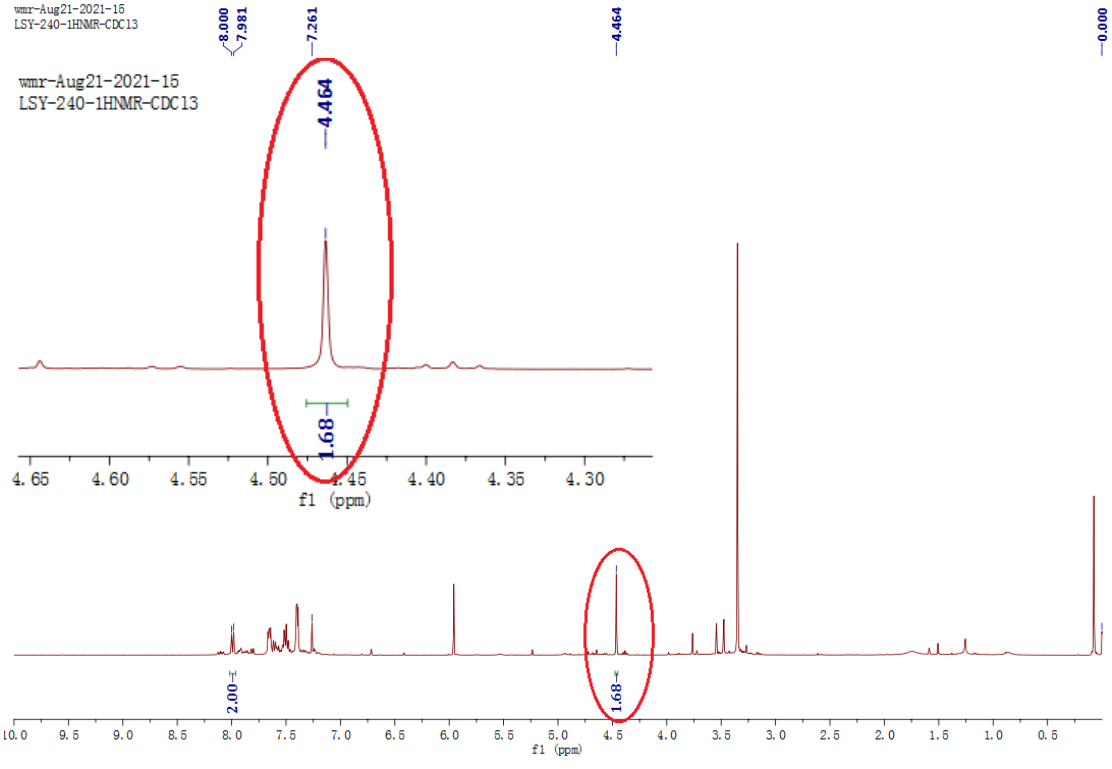


b) MeOH + D_2O

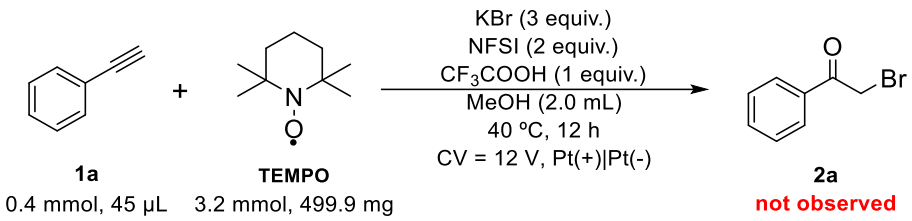


To a dry three-necked flask equipped with a magnetic stir bar, was added **1a** (0.4 mmol), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.), MeOH (2 mL) and D_2O (30 μL), The mixture was stirred in a pre-heated oil bath at 40 °C for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1 or 20:1, v/v). The resulting crude product was dissolved in $CDCl_3$ for crude ^1H NMR analysis.

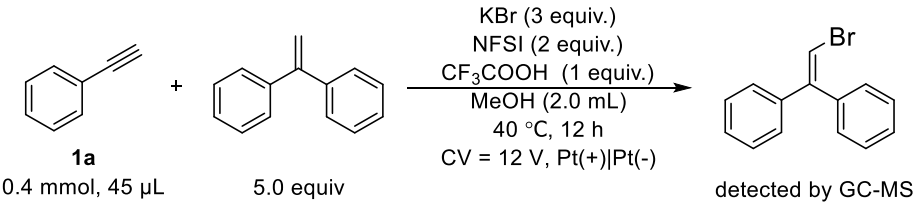
<u>Crude ^1H NMR (400 MHz, $CDCl_3$)</u>



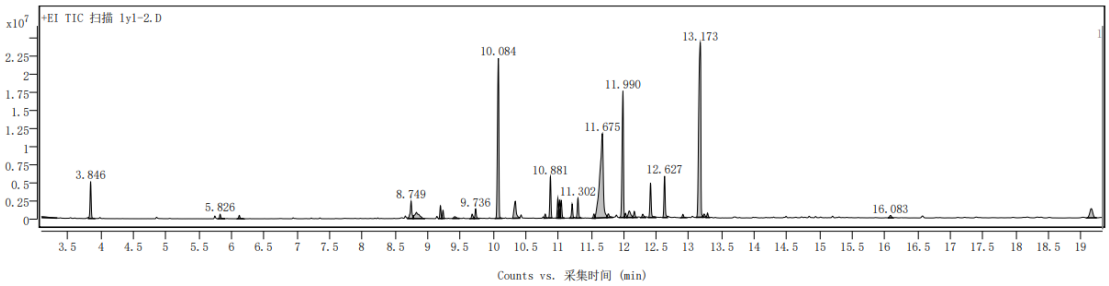
4.2 Free radical scavenging and trapping experiment

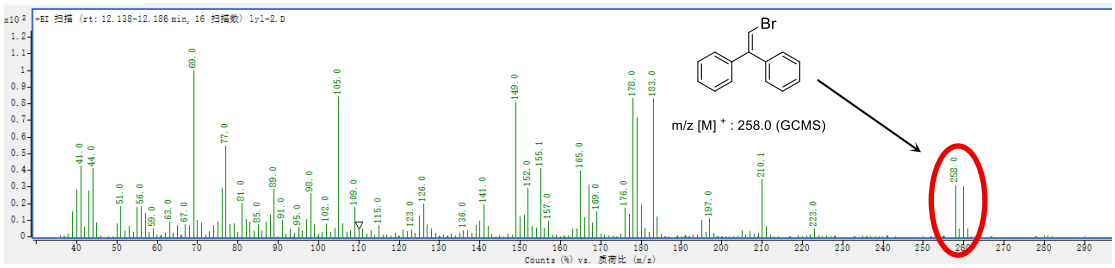


To a dry three-necked flask equipped with a magnetic stir bar, was added **1a** (0.4 mmol, 45 μL), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.), 2,2,6,6-Tetramethyl-1-piperidinyloxy (TEMPO, 499.9 mg, 8 equiv.) and MeOH (2 mL), The mixture was stirred in a pre-heated oil bath at 40 ºC for 12 h under 12 V with Pt(+)|Pt(-). The reaction mixture was monitored using an UV lamp. And the product **2a** was not observed. Free radical scavenging experiment showed difunctionalization of phenylacetylene alkyne **1a** was inhibited by adding 8 equiv 2,2,6,6-tetramethylpiperidinooxy (TEMPO) into reaction. So such reactions were likely to involve free radicals.

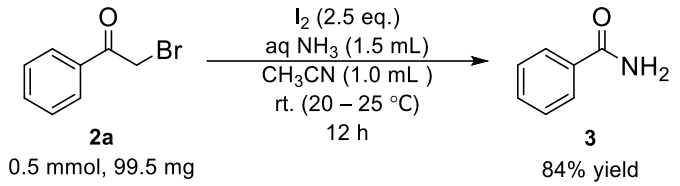


To a dry three-necked flask equipped with a magnetic stir bar, was added **1a** (0.4 mmol, 45 μL), KBr (142.8 mg, 3 equiv.), NFSI (252.3 mg, 2 equiv.), CF_3COOH (30 μL, 1 equiv.), 1,1-diphenylethylene (881 μL, 5 equiv.) and MeOH (2 mL), The mixture was stirred in a pre-heated oil bath at 40 ºC for 12 h under 12 V with Pt(+)|Pt(-).Crude product was analyzed by GC-MS.




+EI 扫描 (rt: 12.138-12.186 min, 16 扫描数) lyl-2.D
Br
m/z [M] + : 258.0 (GCMS)
Counts (%) vs. 质荷比 (m/z)

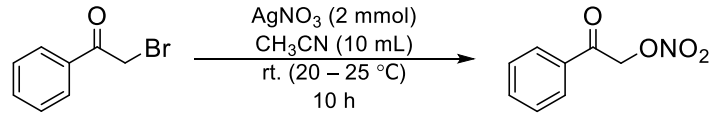
5. Derivatization Experiments



2a
0.5 mmol, 99.5 mg

3
84% yield

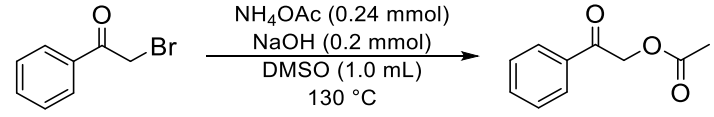
To a dry schlenk tube with a magnetic stir bar, was added **2a** (0.5 mmol, 99.5 mg), I_2 (1.25 mmol, 317.3 mg), NH_3 (aq, 1.5 mL) and CH_3CN (1.0 mL). The mixture was stirred at room temperature (20-25 °C) for 12 h. The solvent was removed by rotate evaporation. The mixture was purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 3:1, v/v) to afford **3**, 84% yield.



2a
2 mmol, 398.1 mg

4
96% yield

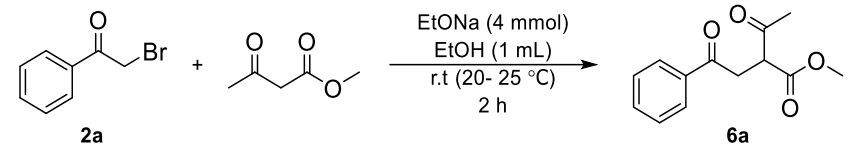
To a dry flask (50 mL) with a magnetic stir bar, was added **2a** (2 mmol, 398.1 mg), $AgNO_3$ (2 mmol, 339.8 mg) and CH_3CN (10 mL). The mixture was stirred at room temperature (20-25 °C) for 10 h. Completion of the reaction after TLC. DCM was added and stirred for 10 min. AgBr was deposited at rest. The resulting solution was removed by rotate evaporation. The mixture was purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 8:1, v/v) to afford **4**, 96% yield.



2a
0.2 mmol, 39.8 mg

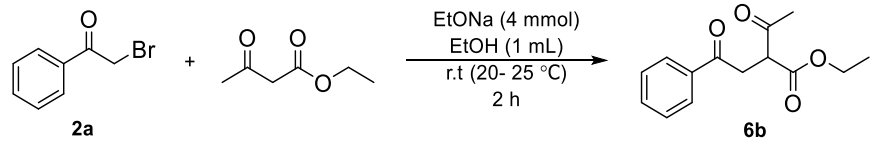
5
37% yield

To a dry schlenk tube with a magnetic stir bar, was added **2a** (0.2 mmol, 39.8 mg), NH_4OAc (0.24 mmol, 18.5 mg), NaOH (0.2 mmol, 8.0 mg) and DMSO (1.0 mL). The mixture was stirred in a pre-heated oil bath at 130 °C for 1 h. Then the reaction was quenched with water (5 mL) and the organic phase was extracted with ethyl acetate. The solvent was removed by rotate evaporation. The mixture was purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 8:1, v/v) to afford **5**, 37% yield.



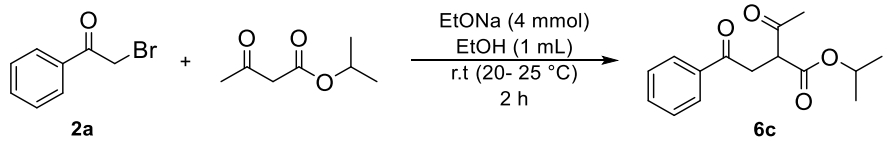
2a 0.4 mmol, 79.8 mg | 0.5 mmol, 54 μL | **6a** 32% yield

To a dry schlenk tube with a magnetic stir bar, was added EtONa (4 mmol, 272.2 mg) and EtOH (1.0 mL). Then methyl acetoacetate (0.5 mmol, 54 μL) was added to the solution drop by drop. The mixture was stirred at room temperature for 10 min. **2a** (0.4 mmol, 79.8 mg) was soluble in EtOH (2 mL). Mixing the above two solutions and stirring for 2 h. The reaction was quenched with water and the organic phase was extracted with ethyl acetate. The solvent was removed by rotate evaporation. The mixture was purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 10:1, v/v) to afford **6a**, 32% yield.



2a 0.4 mmol, 79.8 mg | 0.5 mmol, 63 μL | **6b** 39% yield

To a dry schlenk tube with a magnetic stir bar, was added EtONa (4 mmol, 272.2 mg) and EtOH (1.0 mL). Then ethyl acetoacetate (0.5 mmol, 63 μL) was added to the solution drop by drop. The mixture was stirred at room temperature for 10 min. **2a** (0.4 mmol, 79.8 mg) was soluble in EtOH (2 mL). Mixing the above two solutions and stirring for 2 h. The reaction was quenched with water and the organic phase was extracted with ethyl acetate. The solvent was removed by rotate evaporation. The mixture was purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 10:1, v/v) to afford **6b**, 39% yield.



2a 0.4 mmol, 79.8 mg | 0.5 mmol, 73 μL | **6c** 40% yield

To a dry schlenk tube with a magnetic stir bar, was added EtONa (4 mmol, 272.2 mg) and EtOH (1.0 mL). Then isoproyl acetoacetate (0.5 mmol, 73 μL) was added to the solution drop by drop. The mixture was stirred at room temperature for 10 min. **2a** (0.4 mmol, 79.8 mg) was soluble in EtOH (2 mL). Mixing the above two solutions and

stirring for 2 h. The reaction was quenched with water and the organic phase was extracted with ethyl acetate. The solvent was removed by rotate evaporation. The mixture was purified by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 10:1, v/v) to afford **6c**, 40% yield.

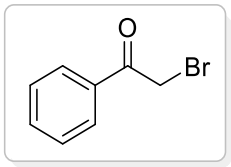
6. Reference

1. S. Shohei, K. Yuhsuke, M. Katsuhiko, T. Hideo, *Org. Lett.,* 2016, **18**, 784-787.

2. R. N. Ram and V. K. Soni, *J. Org. Chem.,* 2015, **80**, 8922-8928.

3. C. Liu, J. Zhao, Y. Qiao, W. Huang, Z. Rao, Y. Gu, *Tetrahedron*., 2018, **74**, 7351-7357.

7. Characterizations Data for Products



2a

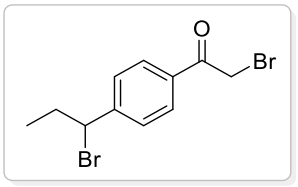
2-bromo-1-phenylethan-1-one:

Following the general procedure, compound **2a** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 68.8 mg, 98% yield, white solid, melting point: 47.6 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.15 – 7.91 (m, 2H), 7.62 (t, *J* = 7.5 Hz, 1H), 7.50 (t, *J* = 7.8 Hz, 2H), 4.46 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 191.3, 133.9, 133.9, 128.9, 128.9, 30.9.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for C_8H_7BrO, 220.9577; Found 220.9588.



2b

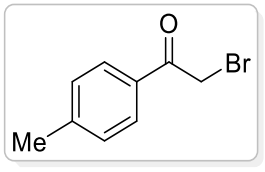
2-bromo-1-(4-(1-bromopropyl)phenyl)ethan-1-one:

Following the general procedure, compound **2b** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 44.9 mg, 47% yield, slight yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.4 Hz, 2H), 7.51 (d, *J* = 8.4 Hz, 2H), 4.88 (dd, *J* = 8.0, 6.8 Hz, 1H), 4.43 (s, 2H), 2.50 – 2.21 (m, 1H), 2.23 – 1.99 (m, 1H), 1.02 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 190.6, 148.1, 133.6, 129.4, 127.9, 55.5, 32.9, 30.7, 12.8.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd for $C_{11}H_{12}Br_2O$, 340.9152; Found 340.9152.



2c

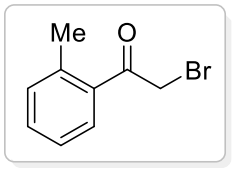
2-bromo-1-(p-tolyl)ethan-1-one:

Following the general procedure, compound **2c** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 72.2 mg, 85% yield, slight yellow solid, melting point:50.9 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.4 Hz, 2H), 7.51 (d, *J* = 8.4 Hz, 2H), 4.88 (dd, *J* = 8.0, 6.8 Hz, 1H), 4.43 (s, 2H), 2.50 – 2.21 (m, 1H), 2.23 – 1.99 (m, 1H), 1.02 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 190.9, 145.0, 131.4, 129.5, 129.0, 30.9, 21.7.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for C_9H_9BrO, 234.9734; Found 234.9718.



2d

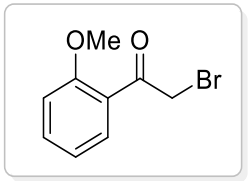
2-bromo-1-(o-tolyl)ethan-1-one:

Following the general procedure, compound **2d** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), and then purified by silica gel plate (Eluent: petroleum ether/ethyl acetate = 10:1, v/v), 78.1 mg, 92% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.4 Hz, 1H), 7.43 (t, *J* = 7.6 Hz, 1H), 7.32 – 7.27 (m, 2H), 4.43 (s, 2H), 2.53 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 194.2, 139.7, 134.4, 132.33, 132.31, 128.9, 125.8, 33.7, 21.4.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for C_9H_9BrO, 234.9734; Found 234.9726.



2e

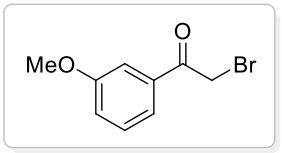
2-bromo-1-(2-methoxyphenyl)ethan-1-one:

Following the general procedure, compound **2e** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 71.9 mg, 78% yield, slight yellow solid, melting point: 43.1 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 7.8, 2.0 Hz, 1H), 7.52 (m, 1H), 7.13 – 6.80 (m, 2H), 4.61 (s, 2H), 3.95 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 192.3, 158.8, 134.7, 131.5, 124.8, 121.1, 111.6, 55.7, 37.7.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_9H_9BrO_2$, 250.9683; Found 250.9701.



2f

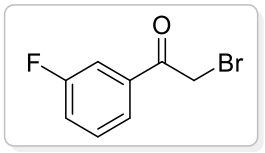
2-bromo-1-(3-methoxyphenyl)ethan-1-one:

Following the general procedure, compound **2f** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 44.8 mg, 49% yield, slight yellow solid, melting point: 64.5 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, *J* = 8.0 Hz, 1H), 7.52 – 7.48 (m, 1H), 7.40 (t, *J* = 8.0 Hz, 1H), 7.15 (dd, *J* = 8.4Hz, 1H), 4.45 (s, 2H), 3.86 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 191.1, 159.9, 135.2, 129.8, 121.4, 120.5, 113.0, 55.5, 30.9.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_9H_9BrO_2$, 250.9683; Found 250.9673.



2g

2-bromo-1-(3-fluorophenyl)ethan-1-one:

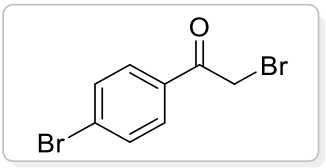
Following the general procedure, compound **2g** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 64.0 mg, 74% yield, yellow oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.90 – 7.74 (m, 1H), 7.67 (m, 1H), 7.48 (m, 1H), 7.32 (m, 1H), 4.43 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 190.1 (d, J_{C-F} = 2.3 Hz), 162.8 (d, J_{C-F} = 247.3 Hz), 135.9 (d, J_{C-F} = 6.4 Hz), 130.6 (d, J_{C-F} = 7.7 Hz), 124.7 (d, J_{C-F}= 3.0 Hz), 121.0 (d, J_{C-F} = 21.3 Hz), 115.7 (d, J_{C-F} = 22.5 Hz), 30.5.

^{19}F NMR (377 MHz, $CDCl_3$) δ -111.0.

HRMS (ESI-TOF) [M + Na] $^+$ Calcd. for C_8H_6BrFO, 238.9483; Found 238.9507.



2h

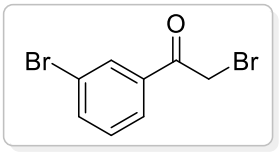
2-bromo-1-(4-bromophenyl)ethan-1-one:

Following the general procedure, compound **2h** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 81.9 mg, 74% yield, slight yellow solid, melting point: 106.5 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, J = 8.4 Hz, 2H), 7.64 (d, J = 8.4 Hz, 2H), 4.41 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 190.4, 132.6, 132.2, 130.4, 129.3, 30.3

HRMS (ESI-TOF) [M + Na] $^+$ Calcd. for $C_8H_6Br_2O$, 298.8682; Found 298.8699.



2i

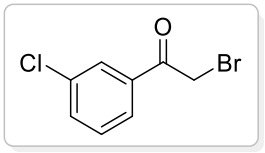
2-bromo-1-(3-bromophenyl)ethan-1-one:

Following the general procedure, compound **2i** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 89.8 mg, 89% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (t, J = 2.0 Hz, 1H), 7.95 – 7.83 (m, 1H), 7.74 (m, 1H), 7.38 (t, J = 8.0 Hz, 1H), 4.42 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 189.9, 136.8, 135.6, 131.9, 130.4, 127.4, 123.1, 30.4.

HRMS (ESI-TOF) [M + Na] $^+$ Calcd. for $C_8H_6Br_2O$, 298.8682; Found 298.8672.



2j

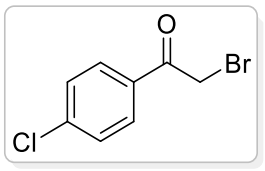
2-bromo-1-(3-chlorophenyl)ethan-1-one:

Following the general procedure, compound **2j** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 43.3 mg, 46% yield, yellow oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (t, *J* = 2.0 Hz, 1H), 7.86 (dt, *J* = 7.8, 1.4 Hz, 1H), 7.58 (m, 1H), 7.45 (t, *J* = 7.8 Hz, 1H), 4.42 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 190.1, 135.4, 135.2, 133.9, 130.2, 128.9, 127.0, 30.4.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for C_8H_6BrClO, 254.9188; Found 254.9163.



2k

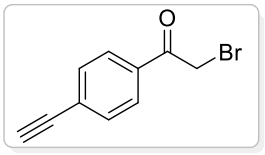
2-bromo-1-(4-chlorophenyl)ethan-1-one:

Following the general procedure, compound **2k** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 74.5 mg, 86% yield, slight yellow solid, melting point: 96.2 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.4 Hz, 2H), 7.47 (d, *J* = 8.4 Hz, 2H), 4.42 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 190.2, 140.5, 132.2, 130.3, 129.2, 30.4.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for C_8H_6BrClO, 254.9188; Found 254.9187.



2l

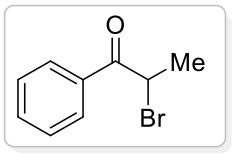
2-bromo-1-(4-ethynylphenyl)ethan-1-one:

Following the general procedure, compound **2l** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 13.5 mg, 15% yield, slight yellow solid, melting point: 46.2 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.4 Hz, 1H), 7.59 (d, *J* = 8.4 Hz, 1H), 4.43 (s, 1H), 3.29 (s, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 190.5, 133.6, 132.5, 128.8, 127.8, 82.5, 81.1, 30.5.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_{10}H_7BrO$, 244.9577; Found 244.9590.



2m

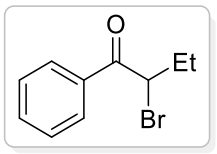
2-bromo-1-phenylpropan-1-one:

Following the general procedure, compound **2m** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 53.8 mg, 63% yield, slight yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 – 7.92 (m, 2H), 7.77 – 7.53 (m, 1H), 7.49 (dd, *J* = 8.2, 6.8 Hz, 2H), 5.30 (q, *J* = 6.6 Hz, 1H), 1.91 (d, *J* = 6.4 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 193.3, 133.9, 133.7, 128.9, 128.7, 41.4, 20.1.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for C_9H_9BrO, 234.9734; Found 234.9750.



2n

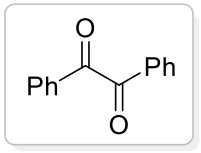
2-bromo-1-phenylbutan-1-one:

Following the general procedure, compound **2n** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 200:1, v/v), 53.2 mg, 59% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 7.6 Hz, 2H), 7.60 (t, *J* = 7.2 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 5.08 (dd, *J* = 7.6, 6.4 Hz, 1H), 2.30 – 2.09 (m, 2H), 1.09 (t, *J* = 7.6 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 193.2, 134.5, 133.6, 128.8, 128.7, 49.0, 26.9, 12.1.

HRMS (ESI-TOF) [M + Na] $^{+}$ Calcd. for $C_{10}H_{11}BrO$, 248.9890; Found 248.9871.



2o

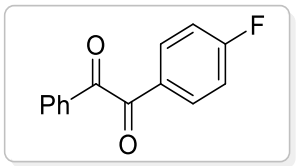
Benzil:

Following the general procedure, compound **2o** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 71.3 mg, 65% yield, slight yellow solid, melting point: 85.7 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.0 Hz, 4H), 7.68 – 7.64 (m, 2H), 7.51 (t, *J* = 7.8 Hz, 4H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 194.6, 134.9, 132.9, 129.9, 129.0.

HRMS (ESI-TOF) [M + Na] $^{+}$ Calcd. for $C_{14}H_{10}O_2$, 233.0578; Found 233.0568.



2p

1-(4-fluorophenyl)-2-phenylethane-1,2-dione:

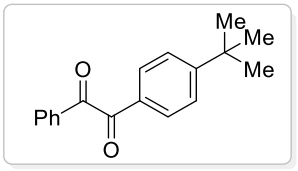
Following the general procedure, compound **2p** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 20:1, v/v), 45.7 mg, 50% yield, yellow solid, melting point: 60.2 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (dd, *J* = 8.4, 5.2 Hz, 2H), 7.98 (d, *J* = 7.6 Hz, 2H), 7.68 (t, *J* = 7.2 Hz, 1H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.19 (t, *J* = 8.4 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 194.1, 192.7, 135.0, 132.9, 132.8, 132.7, 129.9, 129.1, 116.5, 116.3.

^{19}F NMR (377 MHz, $CDCl_3$) δ -101.2.

HRMS (ESI-TOF) [M + Na] $^{+}$ Calcd. for $C_{14}H_9FO_2$, 251.0484; Found 251.0495.



2q

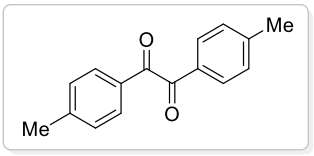
1-(4-(tert-butyl)phenyl)-2-phenylethane-1,2-dione:

Following the general procedure, compound **2q** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 100:1, v/v), 48.0 mg, 45% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.0 Hz, 2H), 7.91 (d, *J* = 8.0 Hz, 2H), 7.65 (t, *J* = 7.2 Hz, 1H), 7.54 – 7.49 (m, 4H), 1.34 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 194.8, 194.3, 159.0, 134.8, 133.1, 130.4, 129.9, 128.9, 126.0, 35.4, 30.9.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_{18}H_{18}O_2$, 289.1204; Found 289.1196.



2r

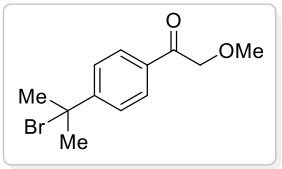
1,2-di-p-tolylethane-1,2-dione:

Following the general procedure, compound **2r** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 100:1, v/v), 58.8 mg, 62% yield, yellow solid, melting point: 105.7 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.86 (d, *J* = 8.4 Hz, 4H), 7.30 (d, *J* = 8.0 Hz, 4H), 2.43 (s, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 194.1, 146.1, 130.7, 130.0, 129.7, 21.9

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_{16}H_{14}O_2$, 261.0891; Found 261.0891.



2s

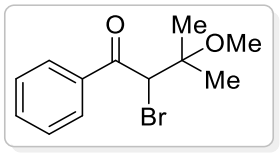
1-(4-(2-bromopropan-2-yl)phenyl)-2-methoxyethan-1-one:

Following the general procedure, compound **2s** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 20:1, v/v), 91.1 mg, 84% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.0 Hz, 2H), 7.54 (d, *J* = 8.4 Hz, 2H), 4.45 (s, 2H), 3.11 (s, 3H), 1.55 (s, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 190.9, 152.9, 132.6, 129.0, 126.3, 50.8, 30.8, 27.7.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_{12}H_{15}BrO_2$, 293.0152; Found 293.0142.



2t

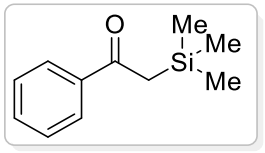
2-bromo-3-methoxy-3-methyl-1-phenylbutan-1-one:

Following the general procedure, compound **2t** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 16.9 mg, 16% yield, slight yellow oil.

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.56 (d, *J* = 7.6 Hz, 1H), 8.22 (t, *J* = 7.4 Hz, 1H), 8.09 (t, *J* = 7.6 Hz, 2H), 6.06 (s, 1H), 3.75 (s, 3H), 2.03 (s, 3H), 1.94 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 195.3, 137.2, 134.7, 129.8, 129.6, 77.8, 53.8, 50.2, 23.7, 21.3.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_{12}H_{15}BrO_2$, 293.0152; Found 293.0156.



2u

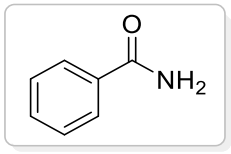
1-phenyl-2-(trimethylsilyl)ethan-1-one:

Following the general procedure, compound **2u** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 60:1, v/v), 74.4 mg, 97% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 – 7.92 (m, 2H), 7.67 – 7.55 (m, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 4.46 (s, 2H), 0.07 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 191.3, 133.9, 133.9, 128.9, 128.9, 30.9, 1.0.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_{11}H_{16}OSi$, 215.0867; Found 215.0883.



3

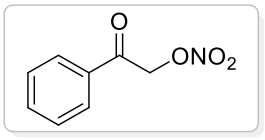
Benzamide:

Following the general procedure, compound **3** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 3:1, v/v), 58.9 mg, 84% yield, white solid, melting point: 128.6 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 – 7.79 (m, 2H), 7.54 (t, *J* = 7.6 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 6.27 (d, *J* = 44.4 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 133.1, 132.1, 128.6, 127.3.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for C_7H_7NO, 144.0425; Found 144.0402.



4

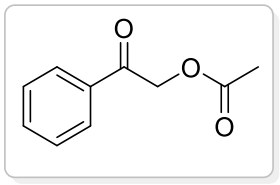
2-oxo-2-phenylethyl nitrate:

Following the general procedure, compound **4** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 8:1, v/v), 347.6 mg, 96% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 6.8 Hz, 2H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.8 Hz, 2H), 5.63 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 189.9, 134.6, 133.3, 129.1, 127.8, 72.1.

HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_8H_7NO_4$, 204.0272; Found 204.0270.



5

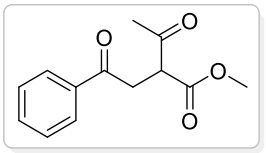
2-oxo-2-phenylethyl acetate:

Following the general procedure, compound **5** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 8:1, v/v), 347.6 mg, 37% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 – 7.90 (m, 2H), 7.62 (t, *J* = 7.2 Hz, 1H), 7.50 (t, *J* = 8.0 Hz, 2H), 5.35 (s, 2H), 2.24 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 192.1, 170.4, 134.2, 133.9, 128.9, 127.8, 66.0, 20.6.

HRMS (ESI-TOF) [M + Na] $^+$ Calcd. for $C_{10}H_{10}O_3$, 201.0527; Found 201.0628.



6a

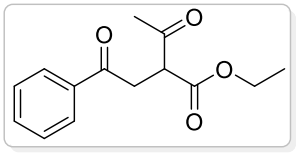
methyl 2-acetyl-4-oxo-4-phenylbutanoate:

Following the general procedure, compound **6a** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 10:1, v/v), 347.6 mg, 37% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 7.2 Hz, 2H), 7.58 (t, *J* = 7.2 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 2H), 4.24 (dd, *J* = 8.2, 5.6 Hz, 1H), 3.78 (s, 3H), 3.75 – 3.50 (m, 2H), 2.45 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 202.3, 197.0, 169.4, 135.9, 133.5, 128.6, 128.1, 53.5, 52.7, 37.4, 30.3.

HRMS (ESI-TOF) [M + Na] $^+$ Calcd. for $C_{13}H_{14}O_4$, 257.0789; Found 257.0797.



6b

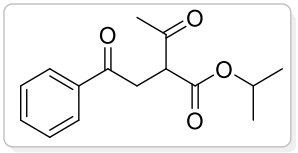
ethyl 2-acetyl-4-oxo-4-phenylbutanoate:

Following the general procedure, compound **6b** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 10:1, v/v), 347.6 mg, 39% yield, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 – 7.97 (m, 2H), 7.58 (t, *J* = 7.2 Hz, 1H), 7.47 (t, *J* = 7.8 Hz, 2H), 4.26 – 4.20 (m, 3H), 3.76 – 3.49 (m, 2H), 2.45 (s, 3H), 1.29 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 202.4, 197.1, 168.8, 135.9, 133.5, 128.6, 128.1, 61.7, 53.8, 37.3, 30.3, 13.9.

HRMS (ESI-TOF) [M + Na] $^+$ Calcd. for $C_{14}H_{16}O_4$, 271.0946; Found 270.2700.



6c

isopropyl 2-acetyl-4-oxo-4-phenylbutanoate:

Following the general procedure, compound **6c** was obtained by column chromatography on silica gel (Eluent: petroleum ether/ethyl acetate = 10:1, v/v), 347.6 mg, 40% yield, yellow oil.

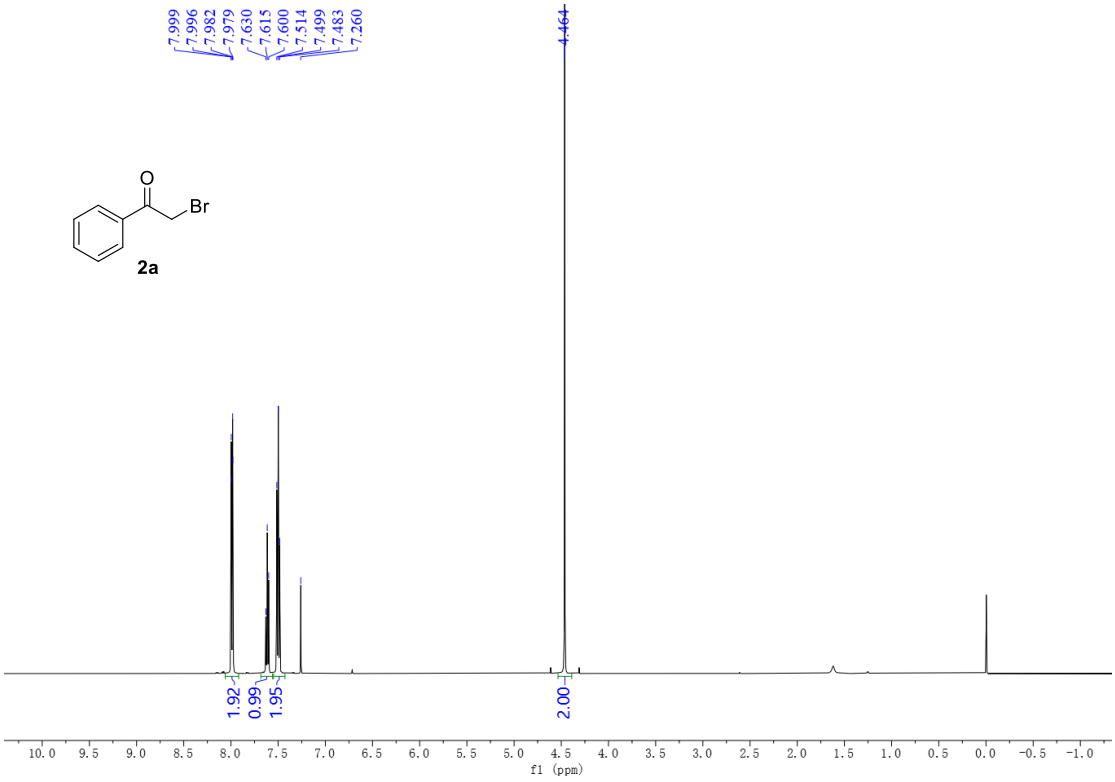
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 7.2 Hz, 2H), 7.58 (t, *J* = 7.2 Hz, 1H), 7.47 (t, *J* = 8.0 Hz, 2H), 5.08 (dt, *J* = 12.8, 6.4 Hz, 1H), 4.20 (dd, *J* = 8.4, 5.6 Hz, 1H), 3.75 – 3.48 (m, 2H), 2.44 (s, 3H), 1.29 (d, *J* = 6.4 Hz, 3H), 1.26 (d, *J* = 6.4 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 202.4, 197.2, 168.3, 136.0, 133.4, 128.6, 128.1, 69.4, 54.1, 37.3, 30.2, 21.6, 21.5.

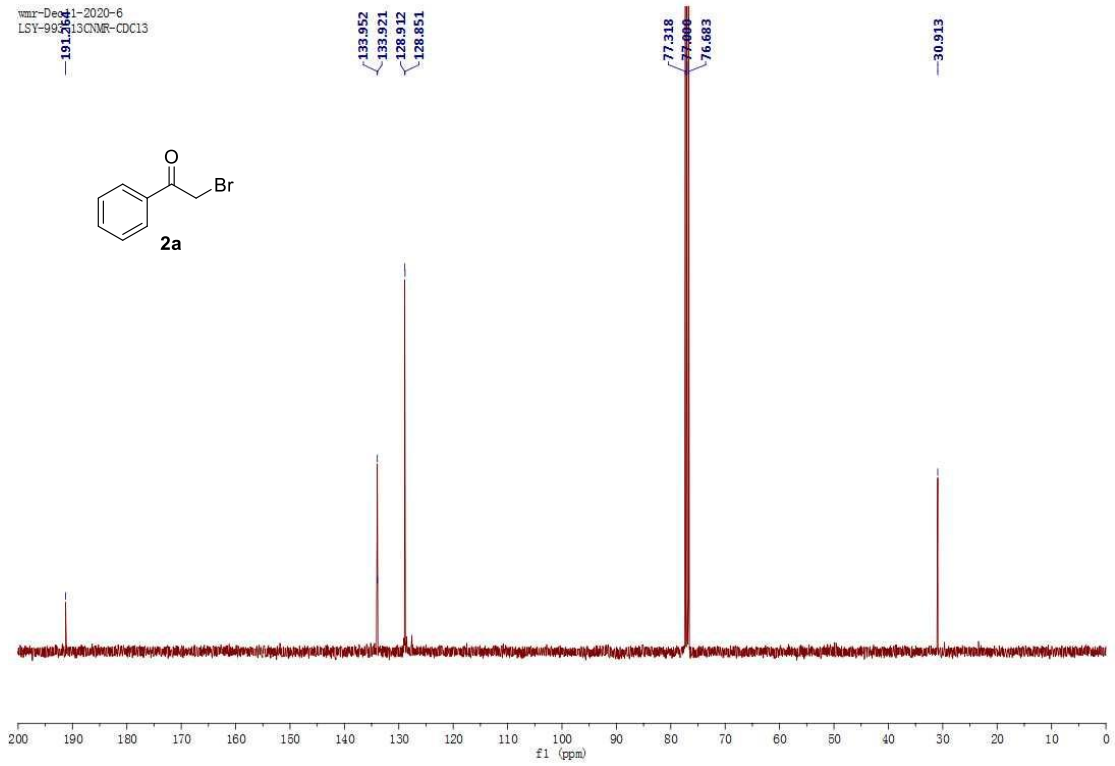
HRMS (ESI-TOF) $[M + Na]^+$ Calcd. for $C_{15}H_{18}O_4$, 285.1102; Found 285.1083.

8. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR Spectra

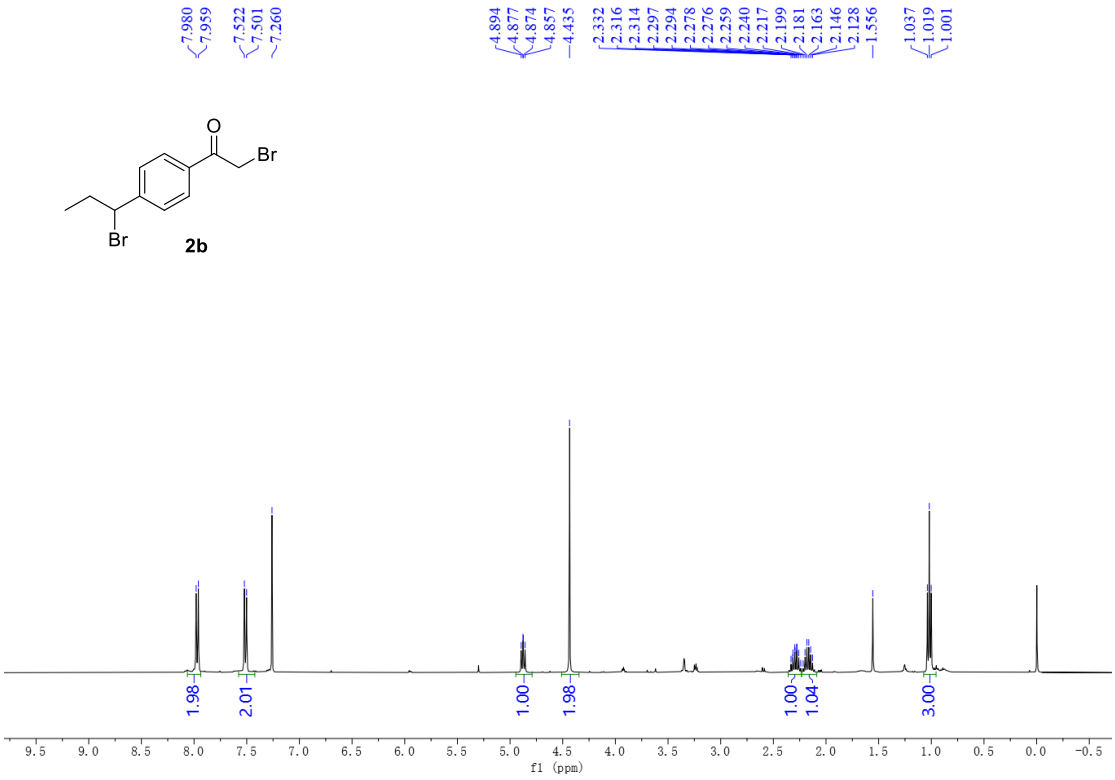
^{1}H NMR (500 MHz, $CDCl_3$)



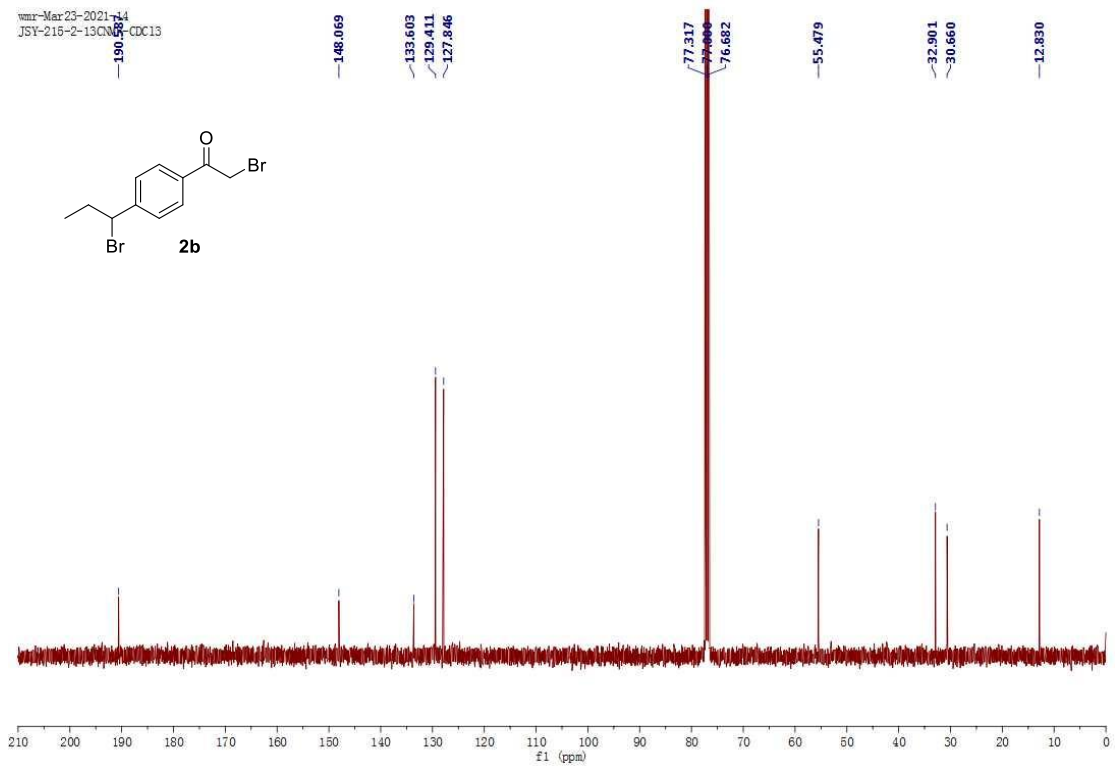
^{13}C NMR (100 MHz, $CDCl_3$)



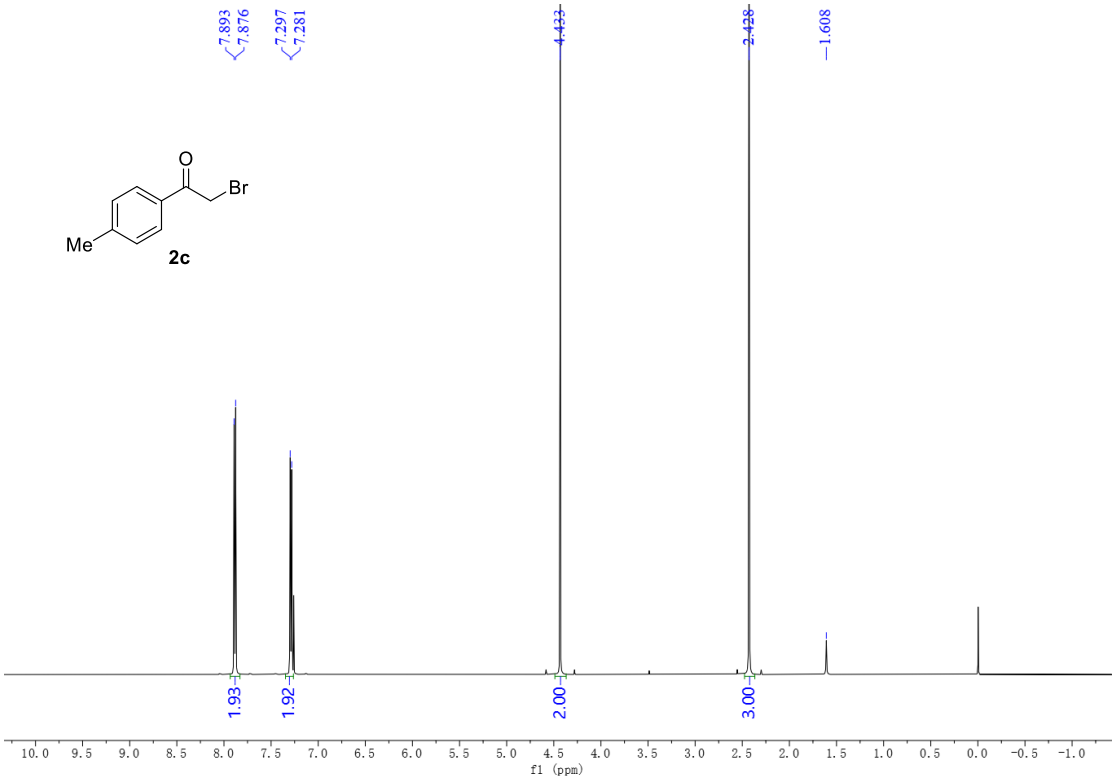
^{1}H NMR (400 MHz, $CDCl_3$)



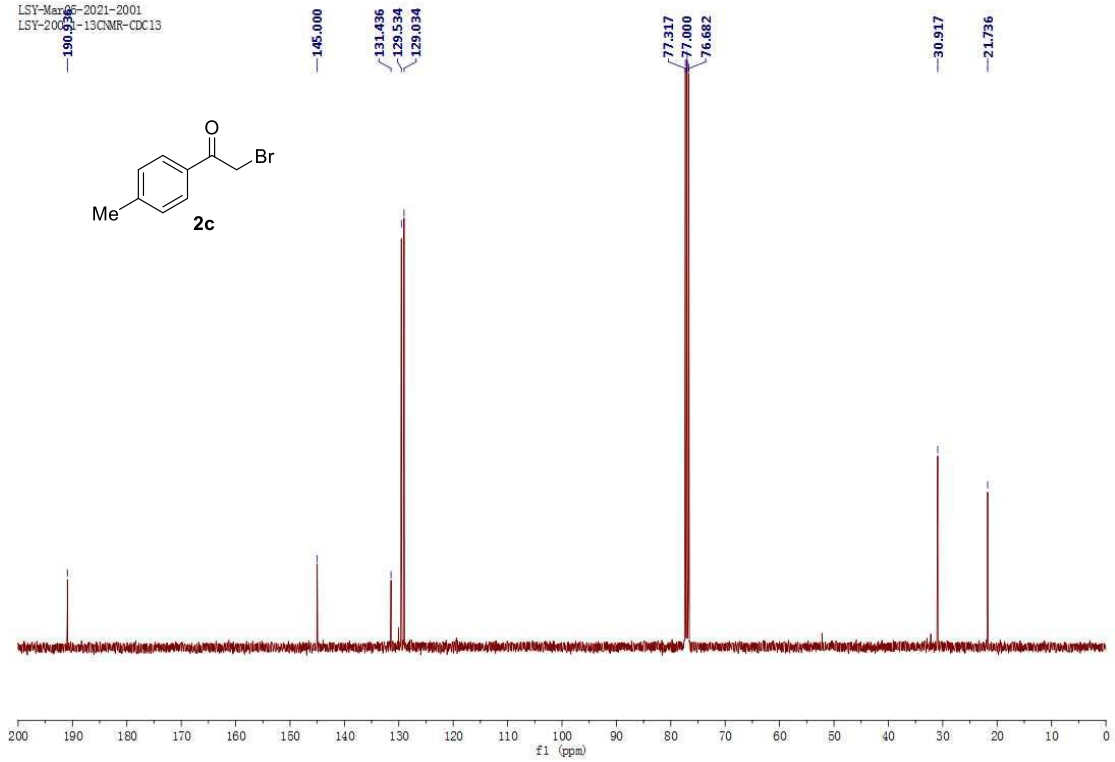
^{13}C NMR (100 MHz, $CDCl_3$)



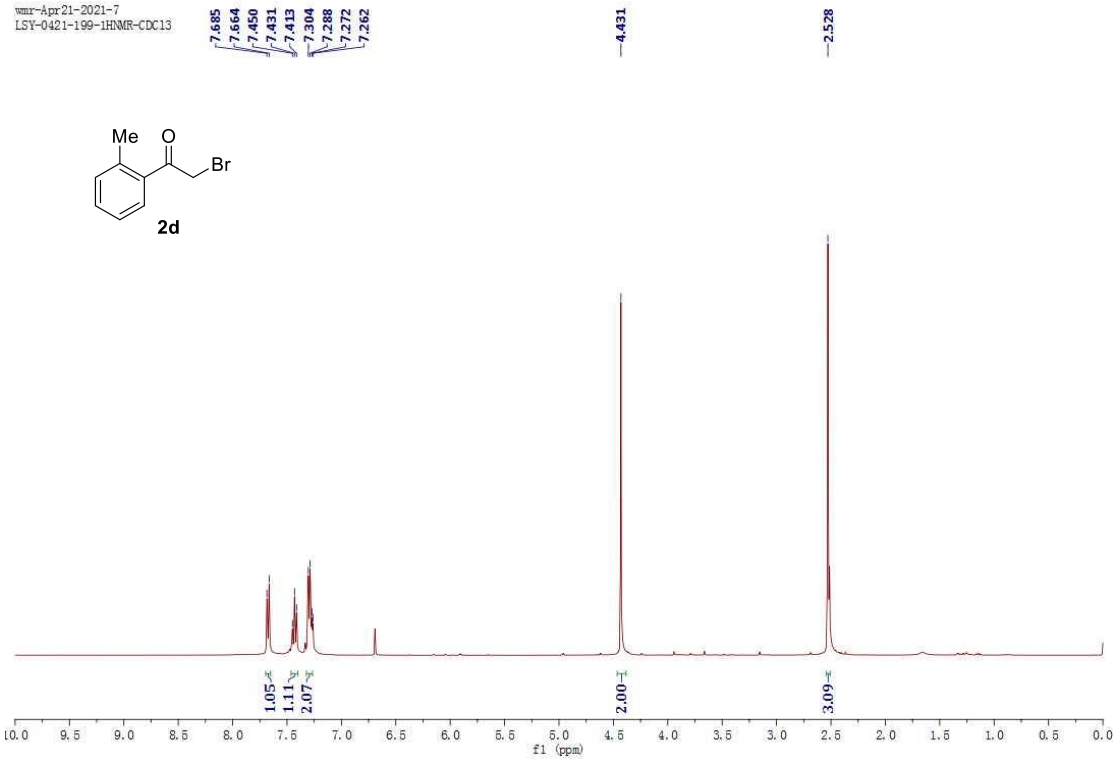
^{1}H NMR (500 MHz, $CDCl_3$)



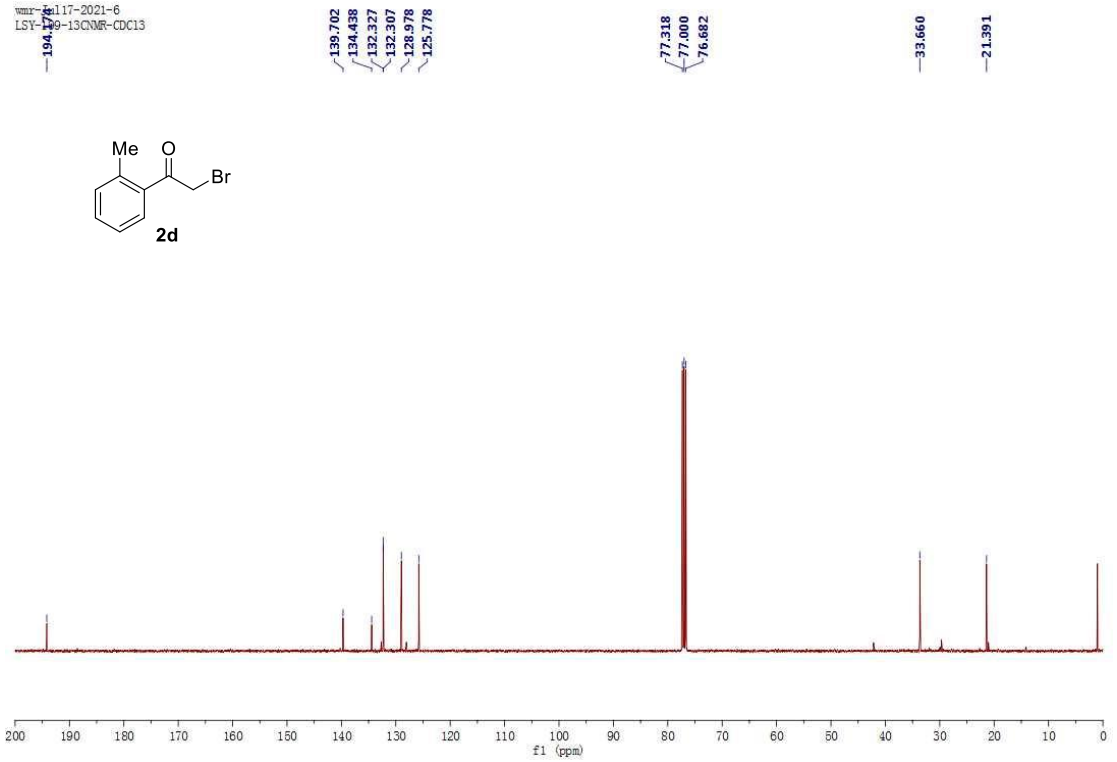
^{13}C NMR (100 MHz, $CDCl_3$)



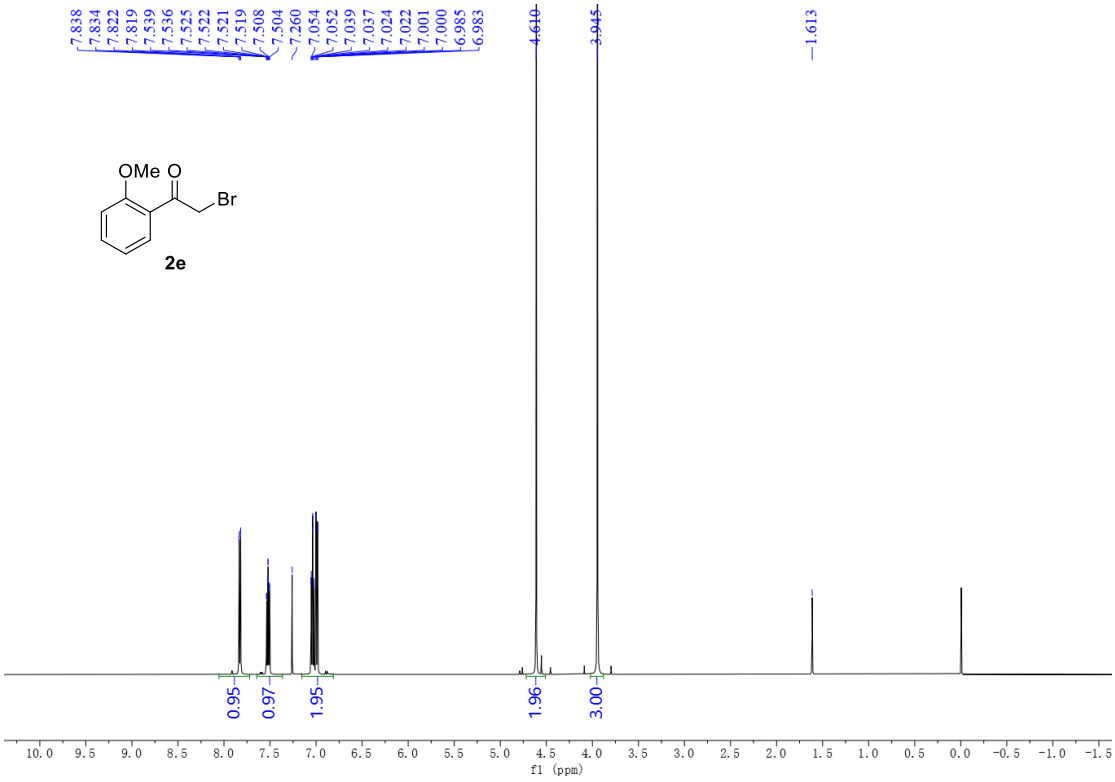
^{1}H NMR (400 MHz, $CDCl_3$)



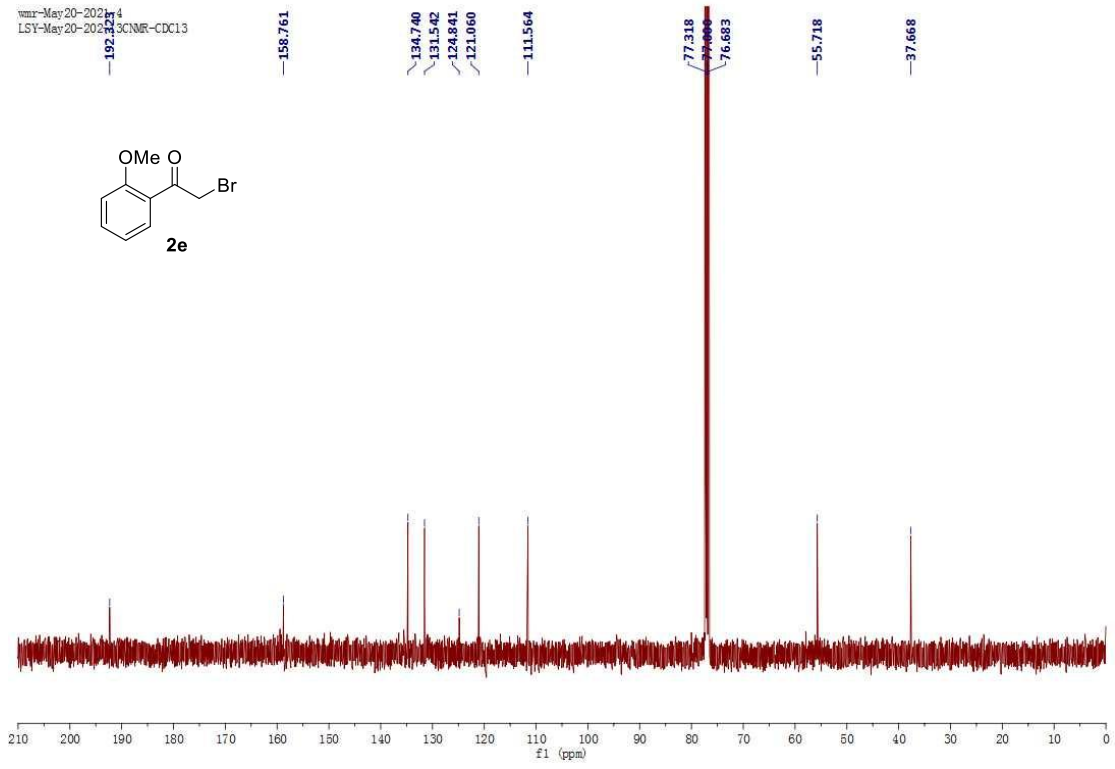
^{13}C NMR (100 MHz, $CDCl_3$)



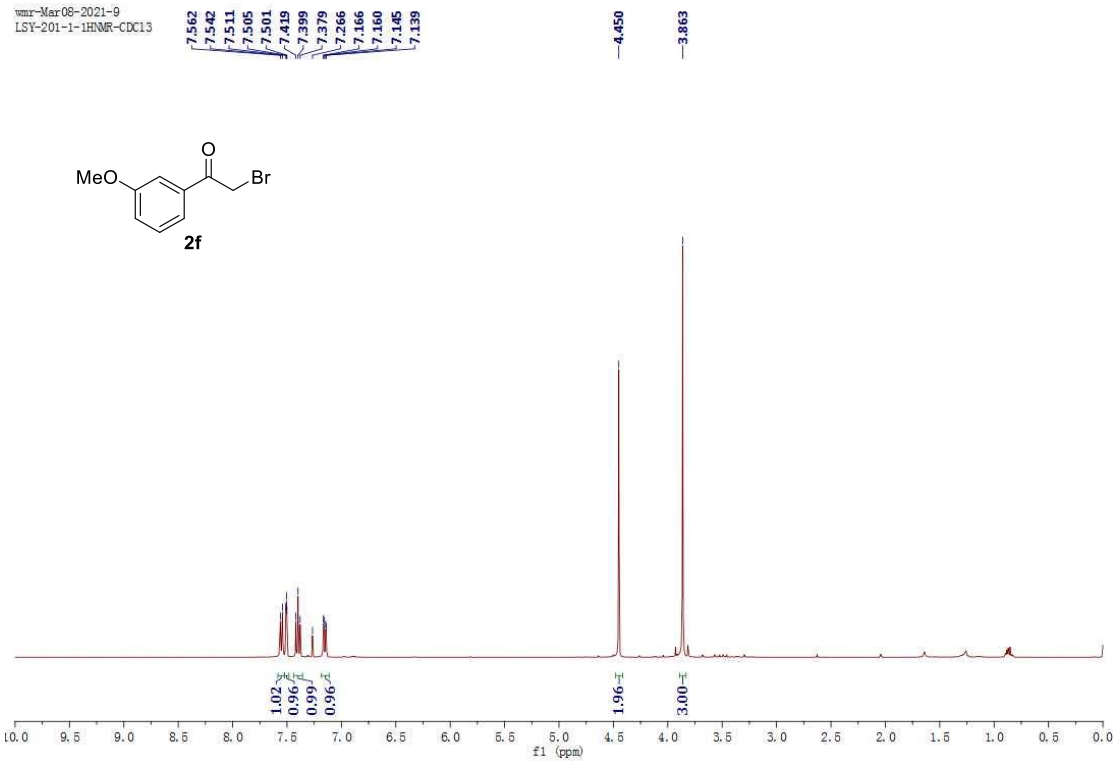
^{1}H NMR (500 MHz, $CDCl_3$)



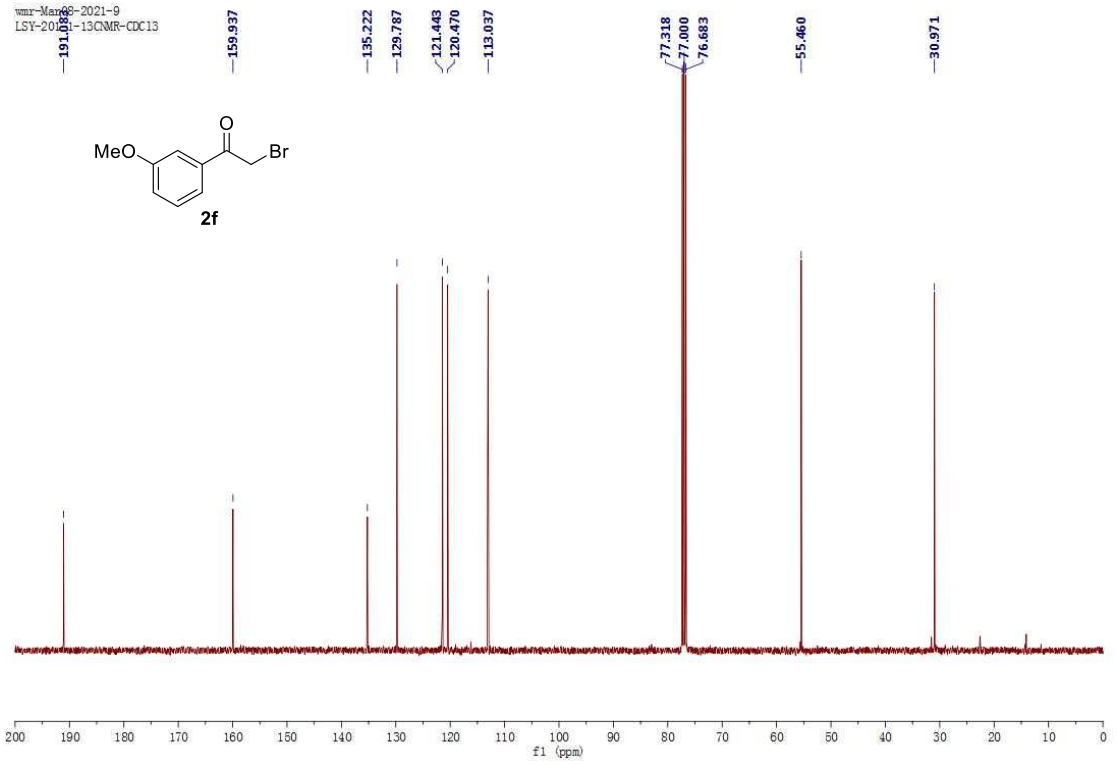
^{13}C NMR (100 MHz, $CDCl_3$)



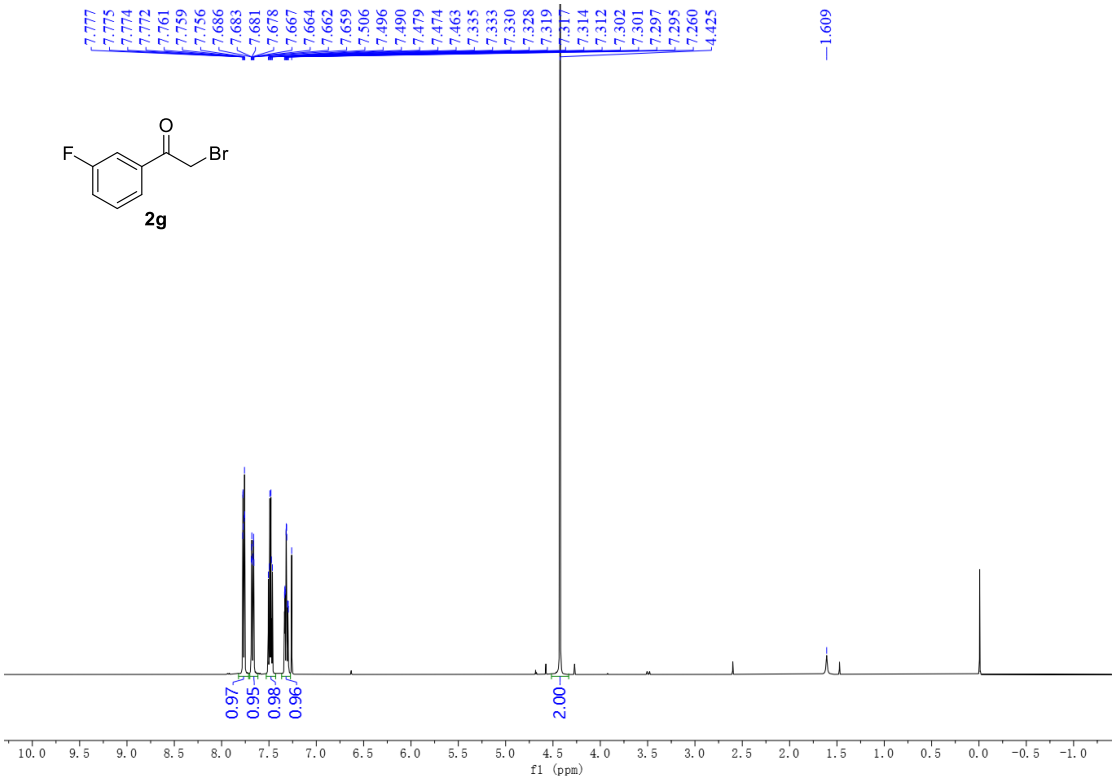
^{1}H NMR (400 MHz, $CDCl_3$)



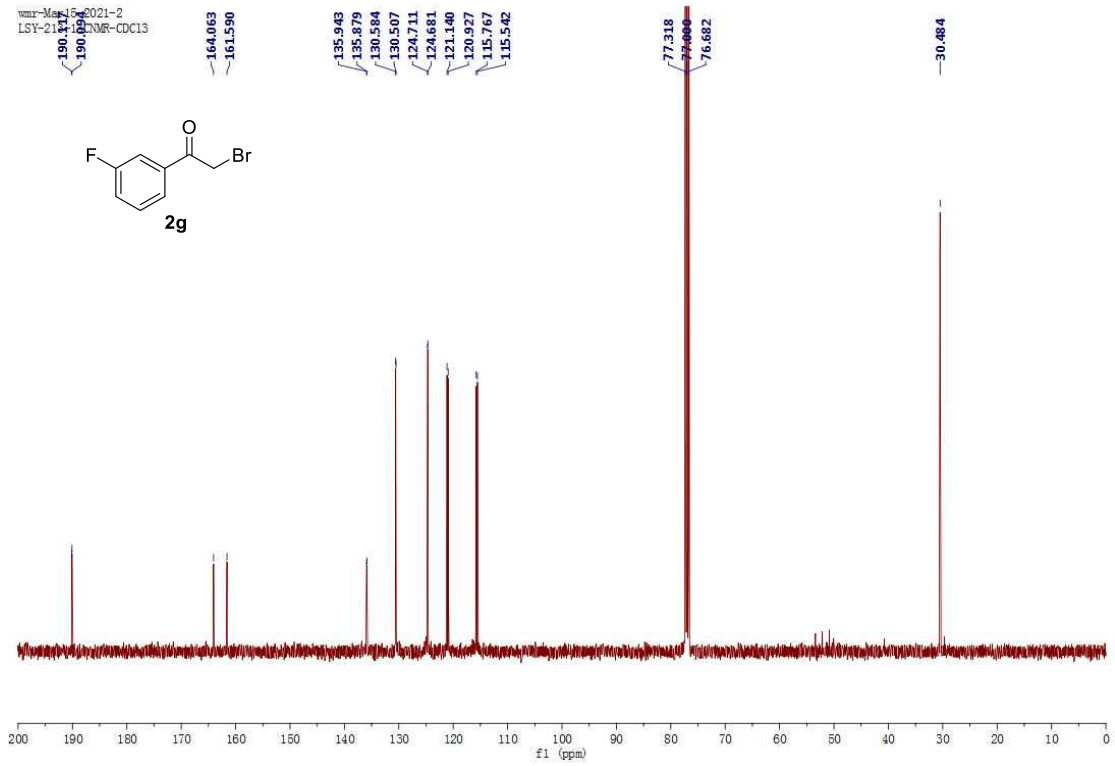
^{13}C NMR (100 MHz, $CDCl_3$)



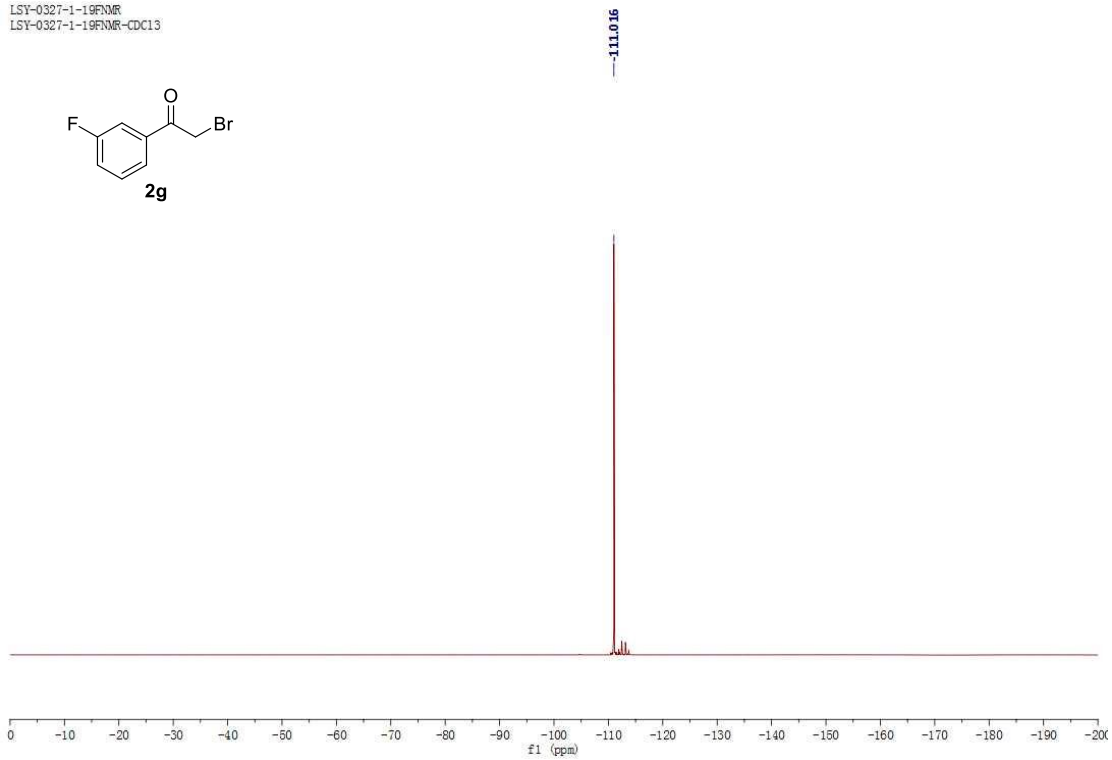
^{1}H NMR (500 MHz, $CDCl_3$)



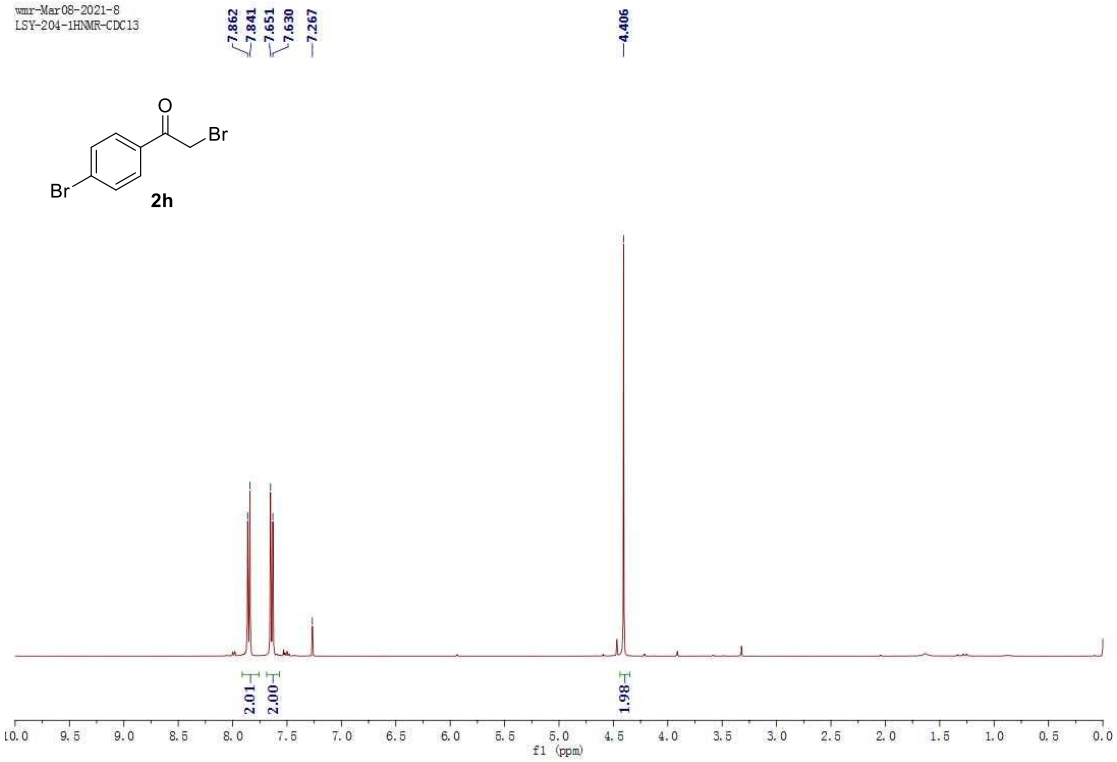
^{13}C NMR (100 MHz, $CDCl_3$)



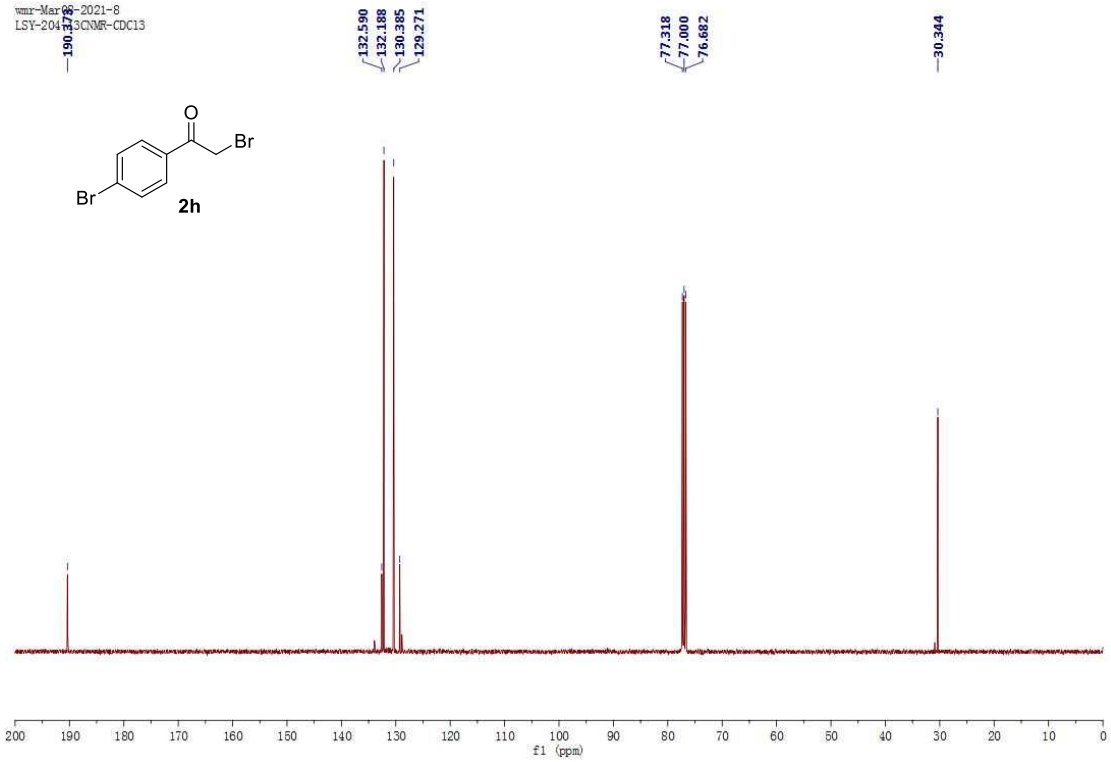
^{19}F NMR (377 MHz, $CDCl_3$)



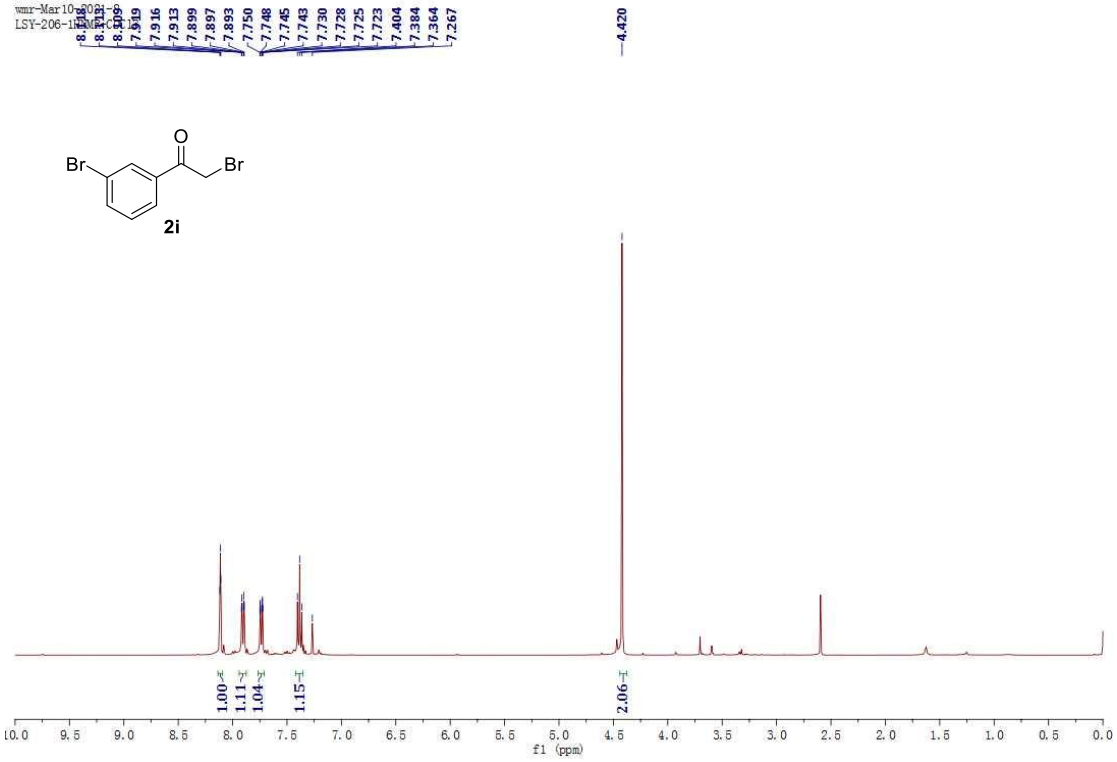
^{1}H NMR (400 MHz, $CDCl_3$)



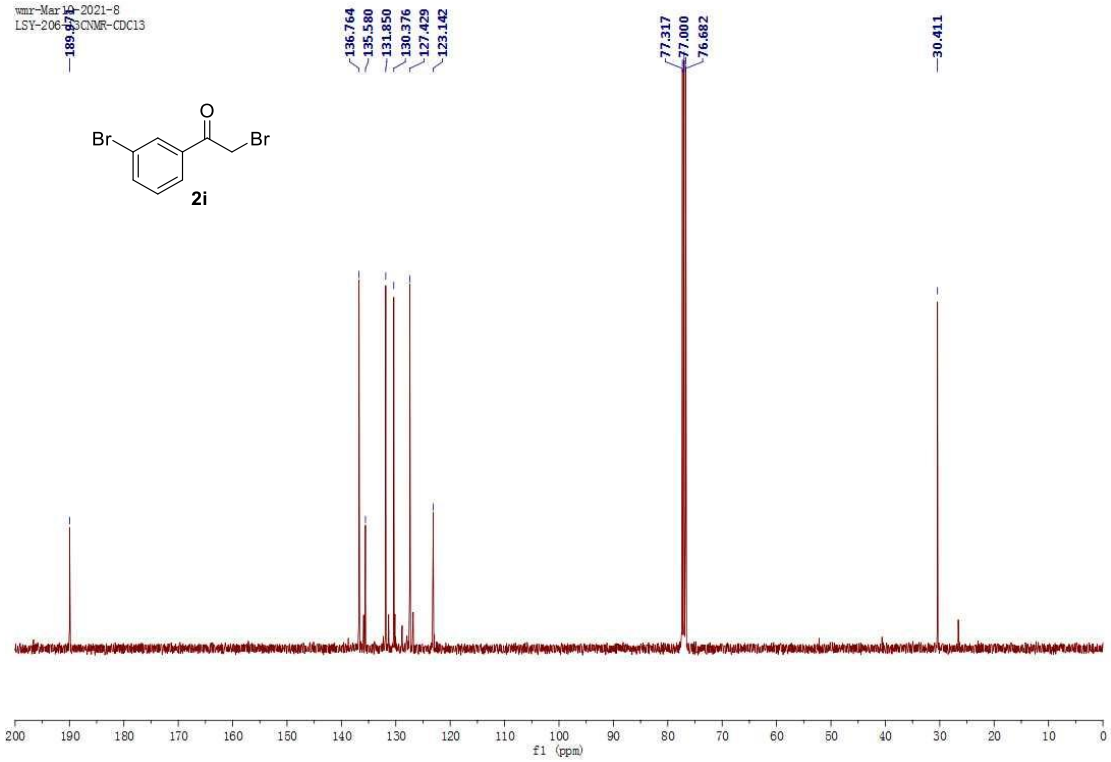
^{13}C NMR (100 MHz, $CDCl_3$)



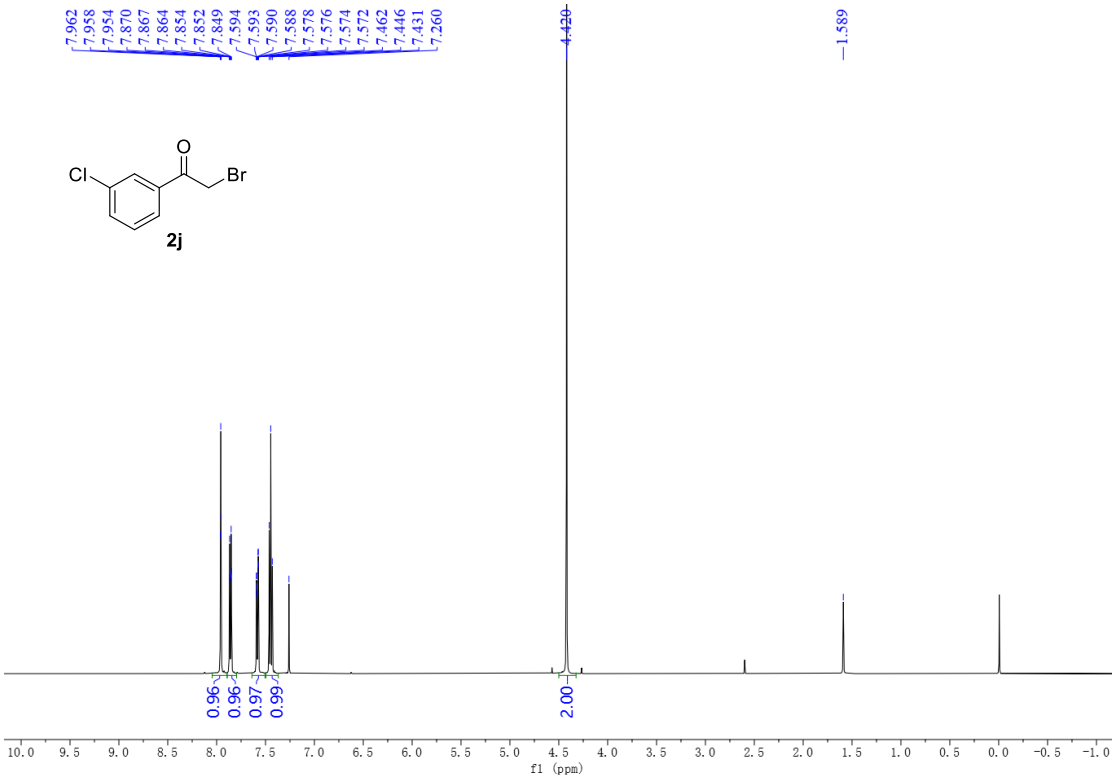
^{1}H NMR (400 MHz, $CDCl_3$)



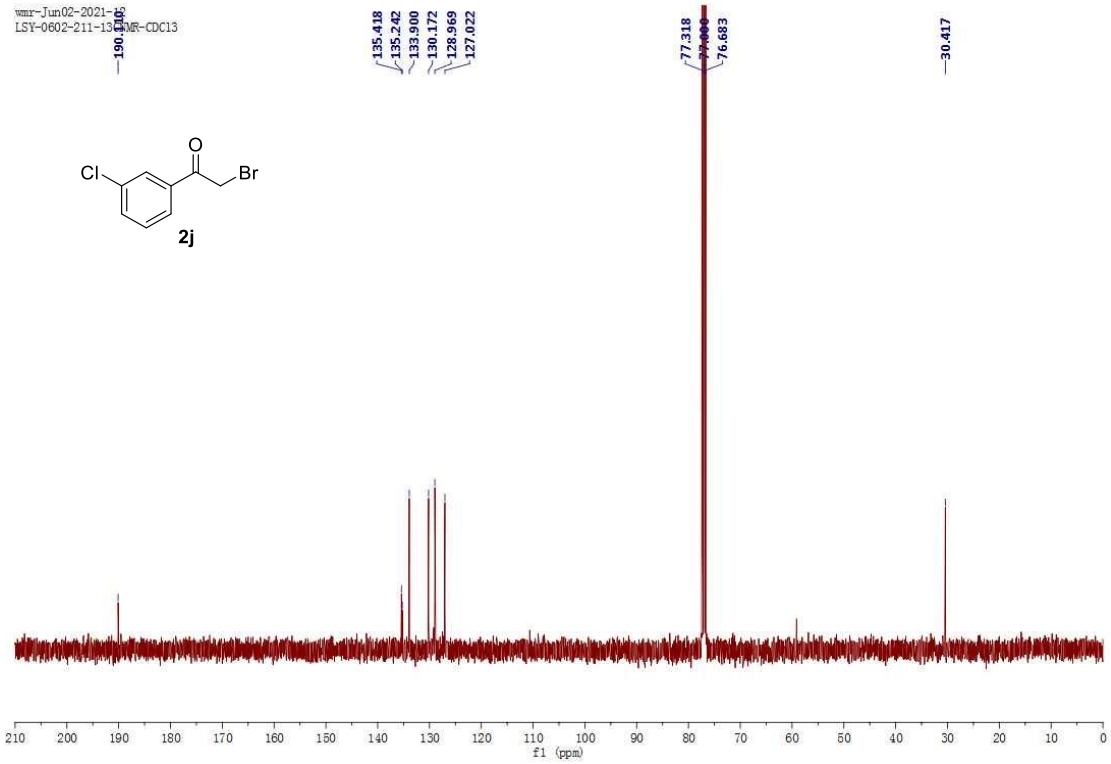
^{13}C NMR (100 MHz, $CDCl_3$)



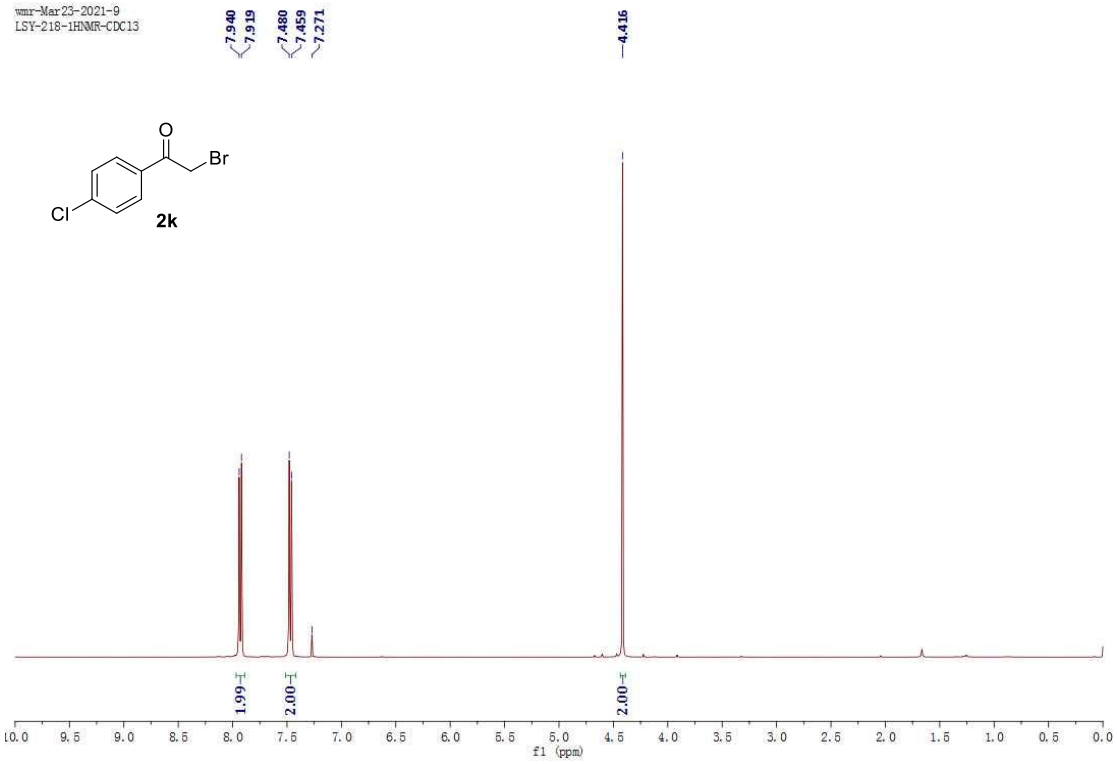
^{1}H NMR (500 MHz, $CDCl_3$)



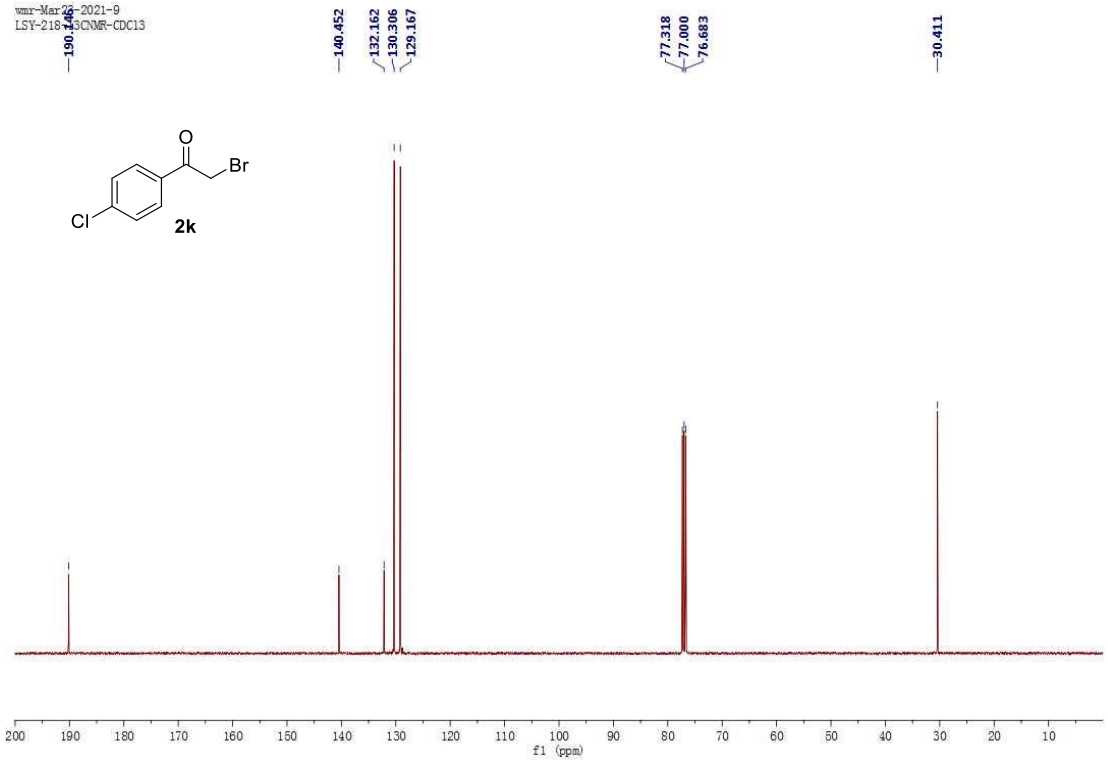
^{13}C NMR (100 MHz, $CDCl_3$)



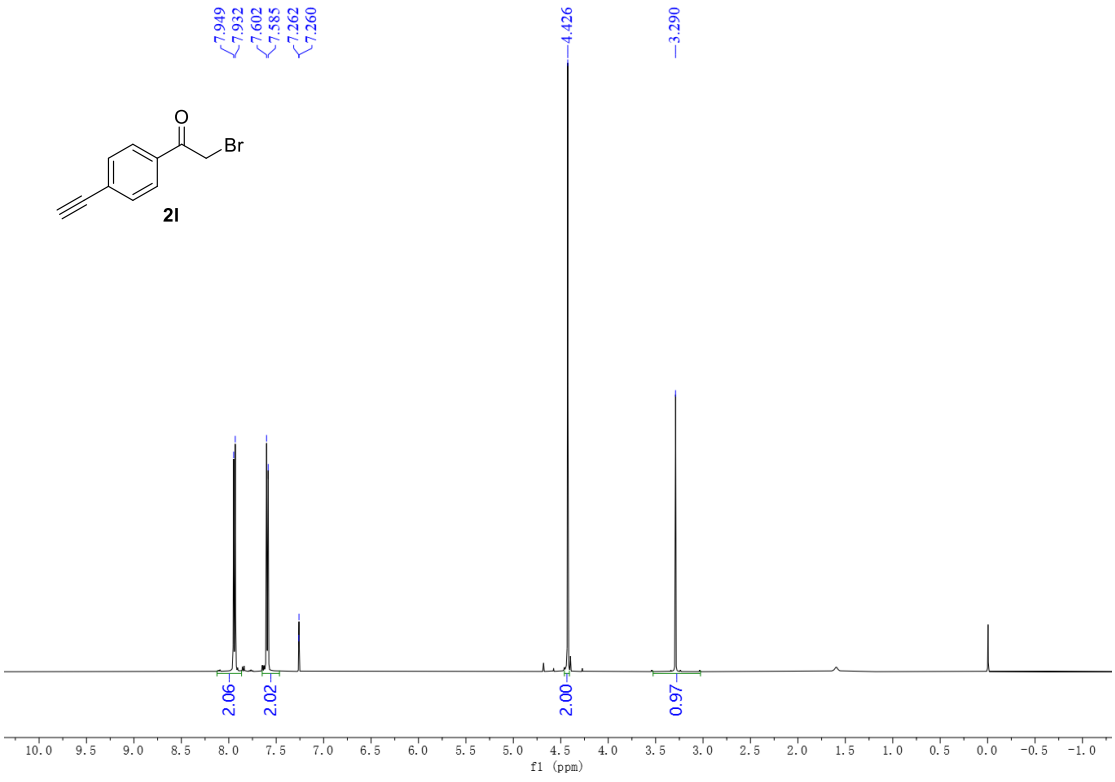
^{1}H NMR (400 MHz, $CDCl_3$)



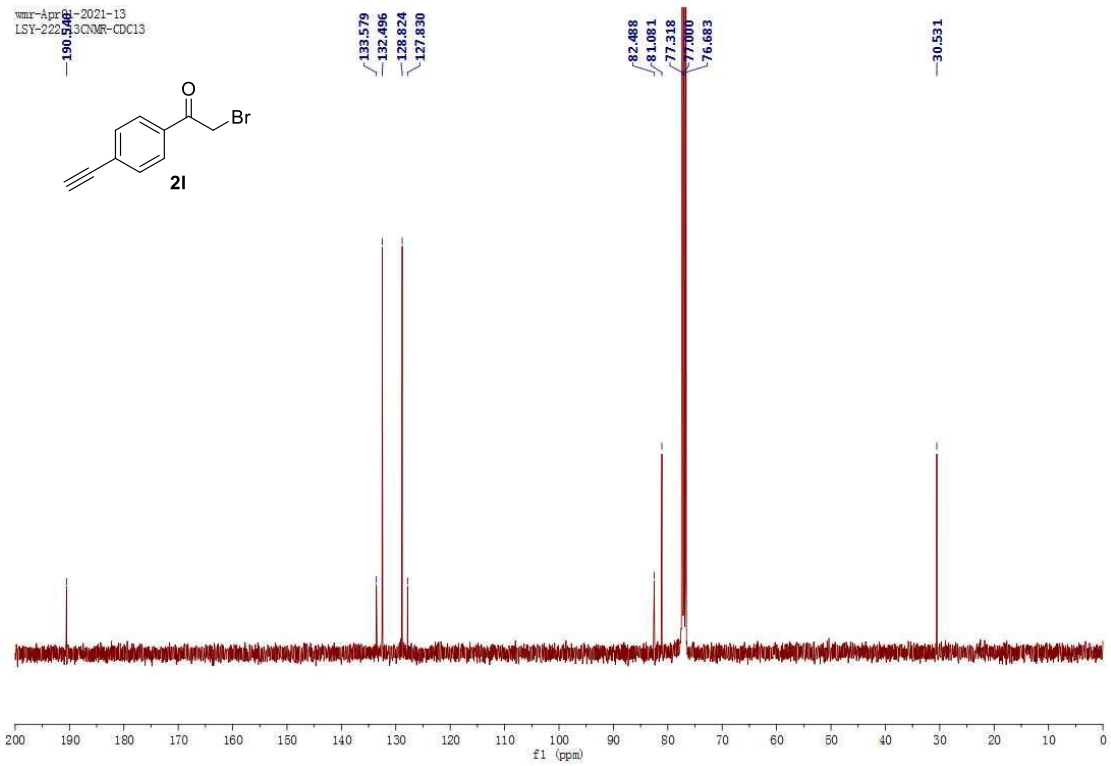
^{13}C NMR (100 MHz, $CDCl_3$)



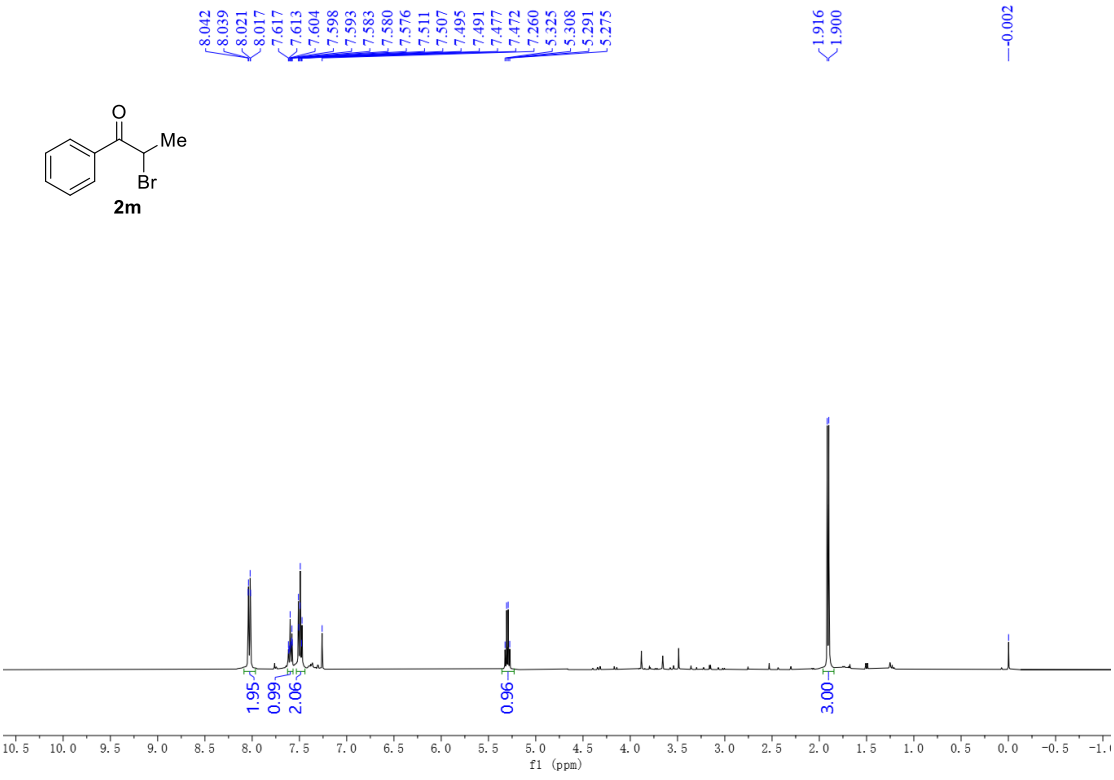
^{1}H NMR (500 MHz, $CDCl_3$)



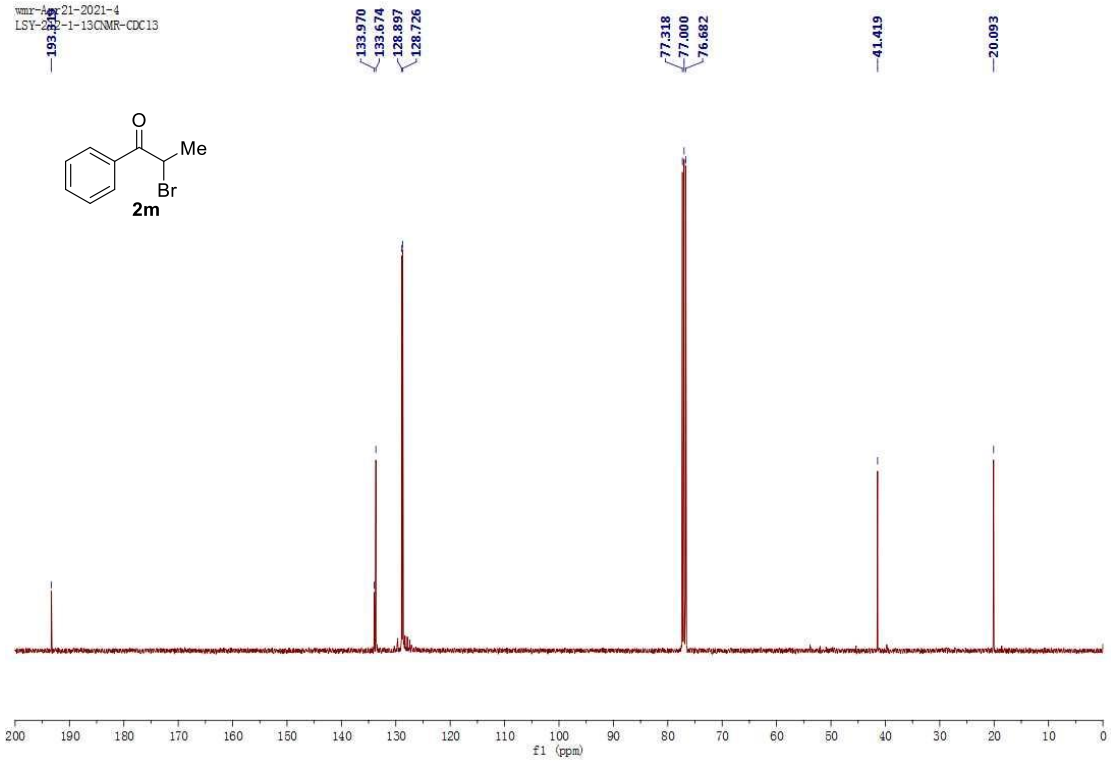
^{13}C NMR (100 MHz, $CDCl_3$)



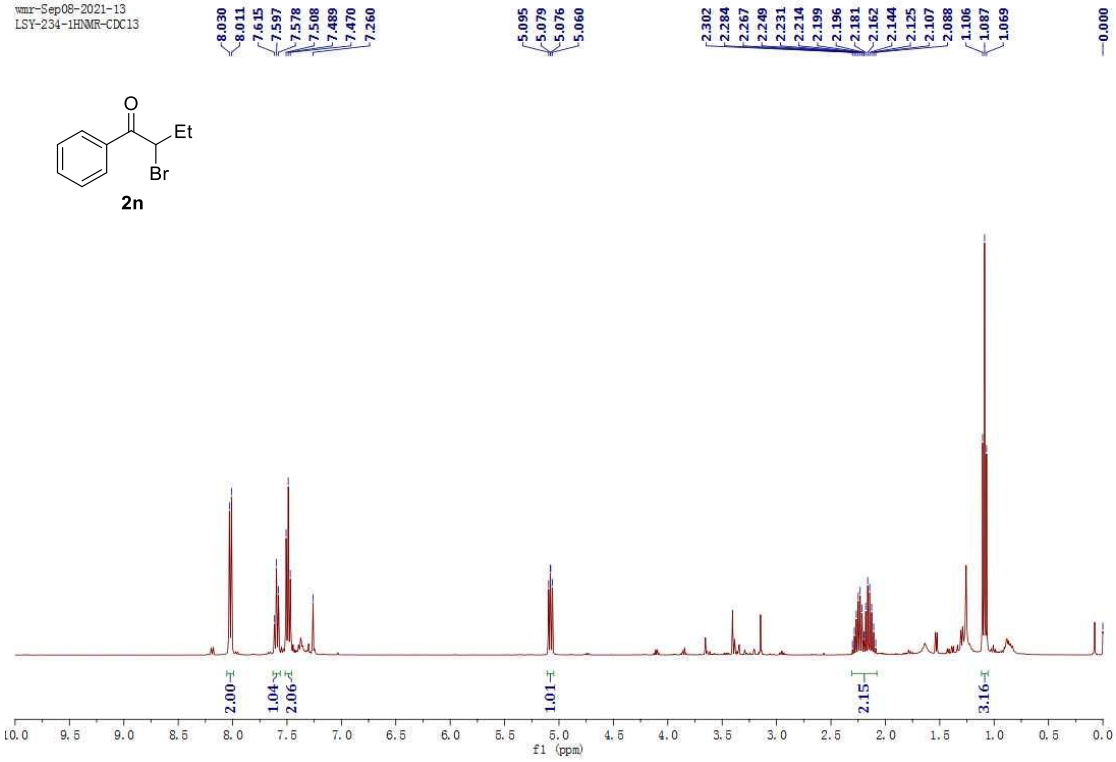
^{1}H NMR (400 MHz, $CDCl_3$)



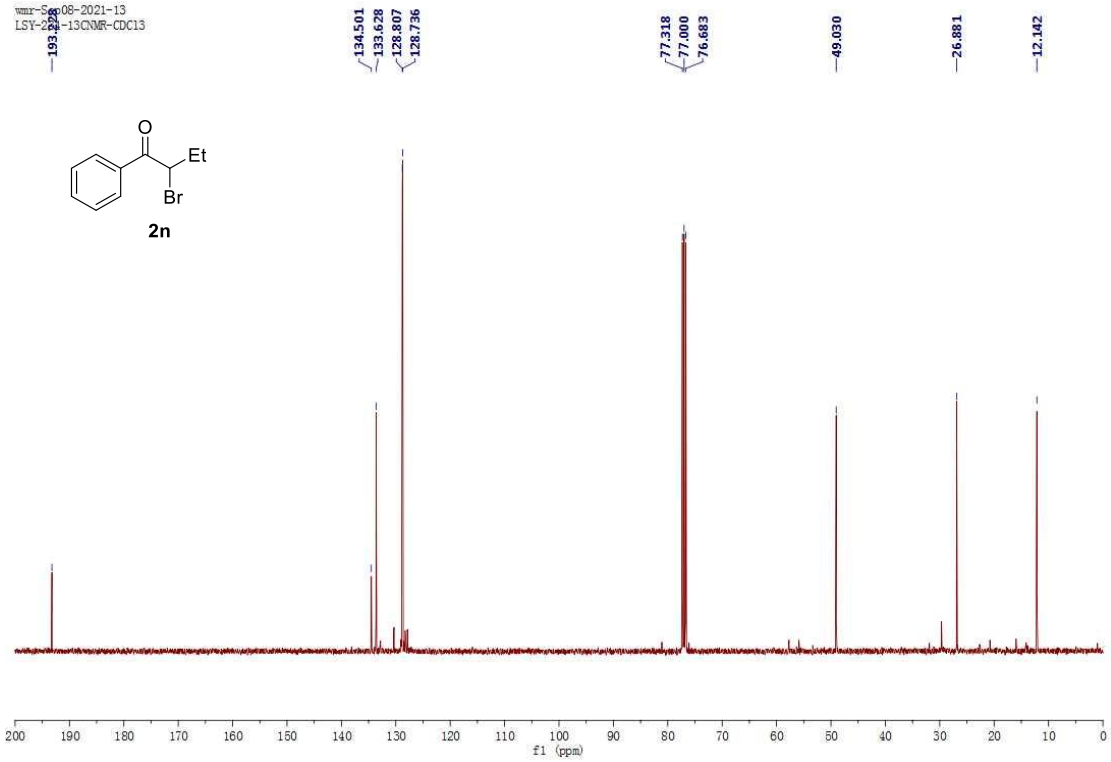
^{13}C NMR (100 MHz, $CDCl_3$)



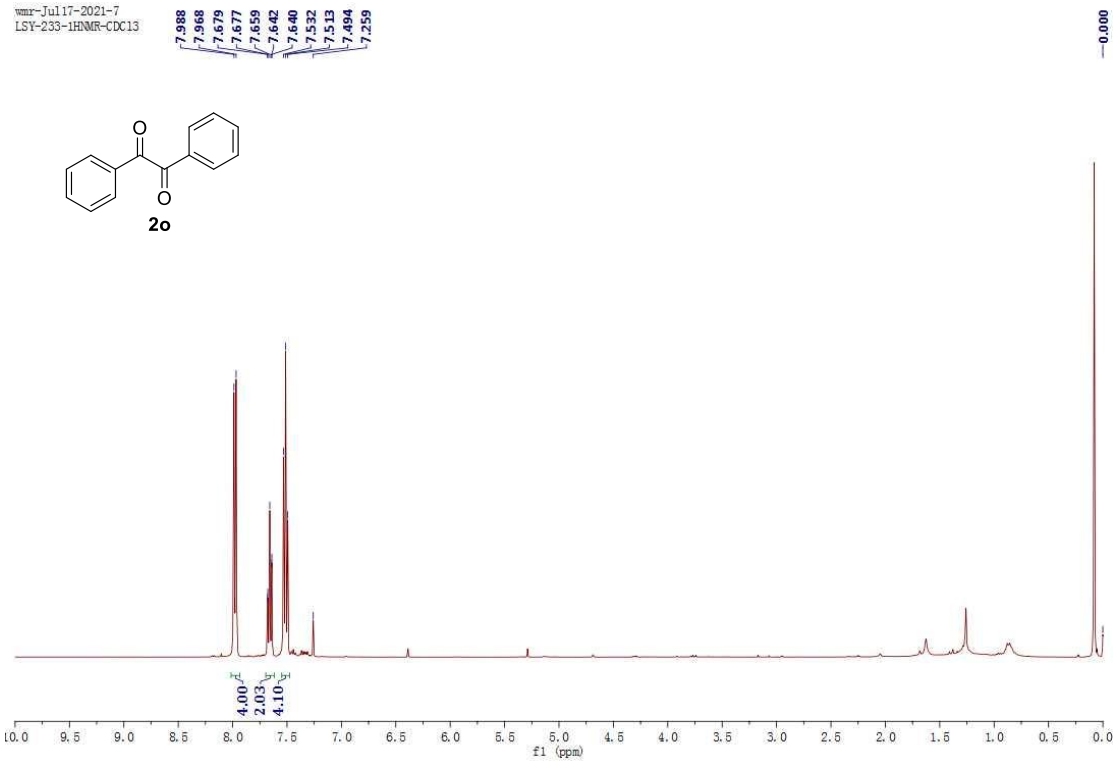
^{1}H NMR (400 MHz, $CDCl_3$)



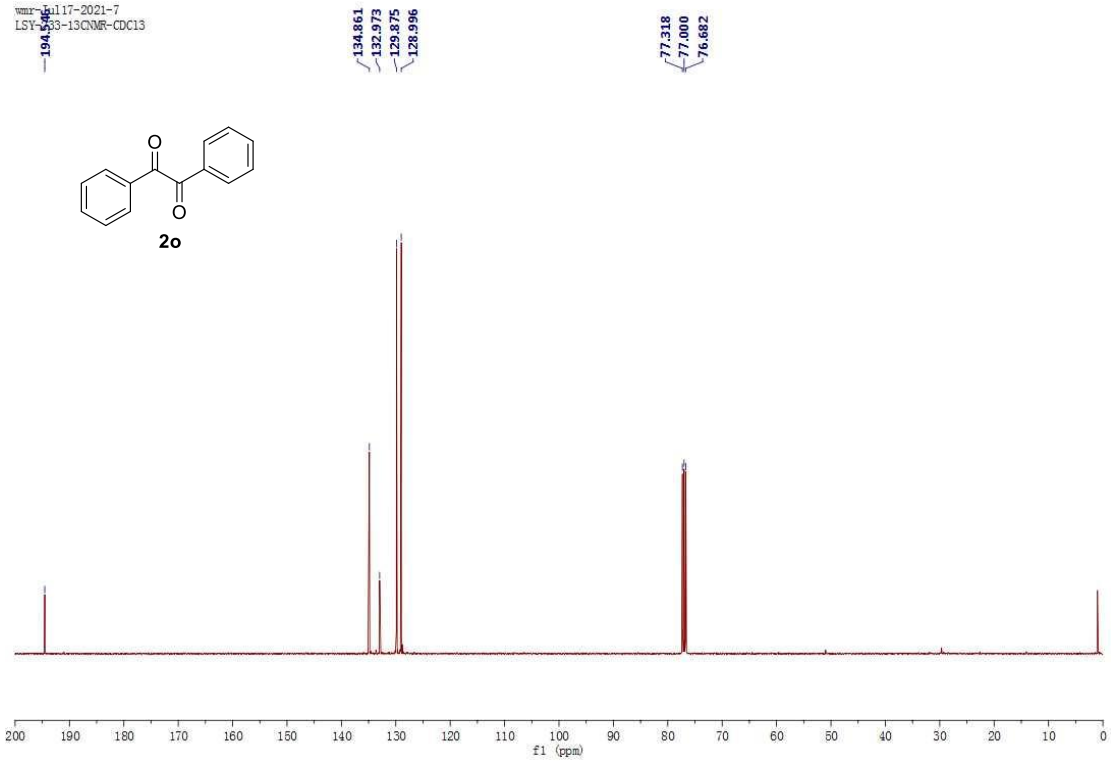
^{13}C NMR (100 MHz, $CDCl_3$)



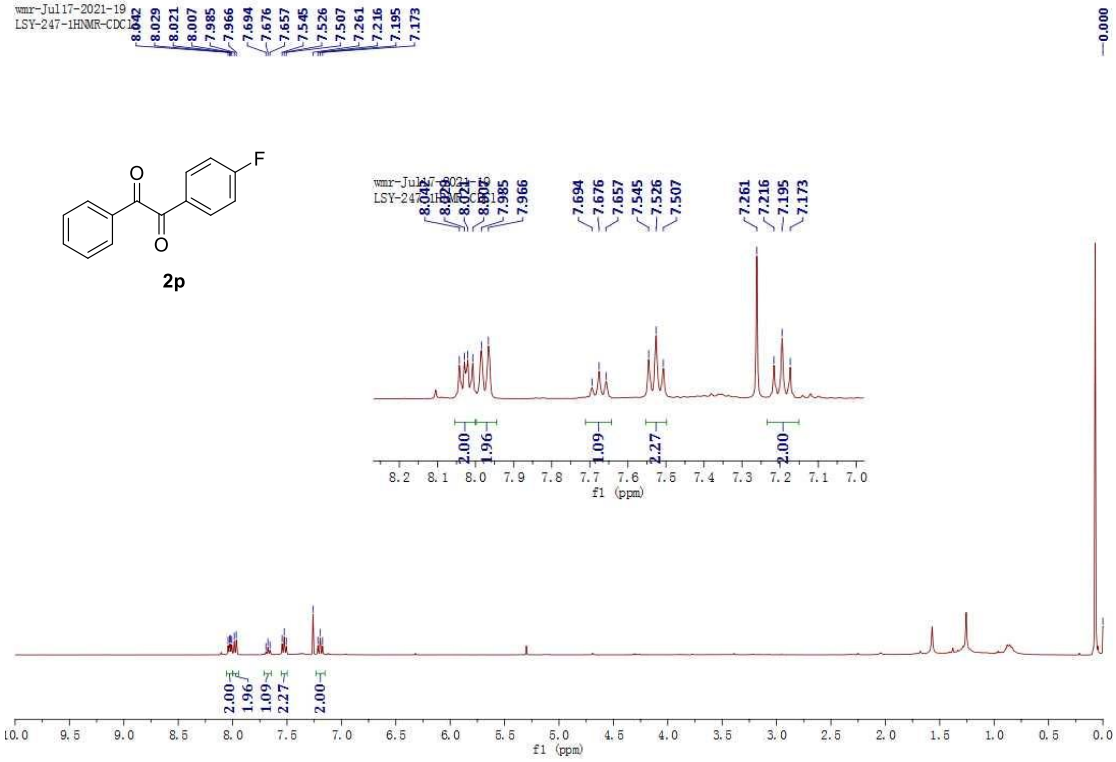
^{1}H NMR (400 MHz, $CDCl_3$)



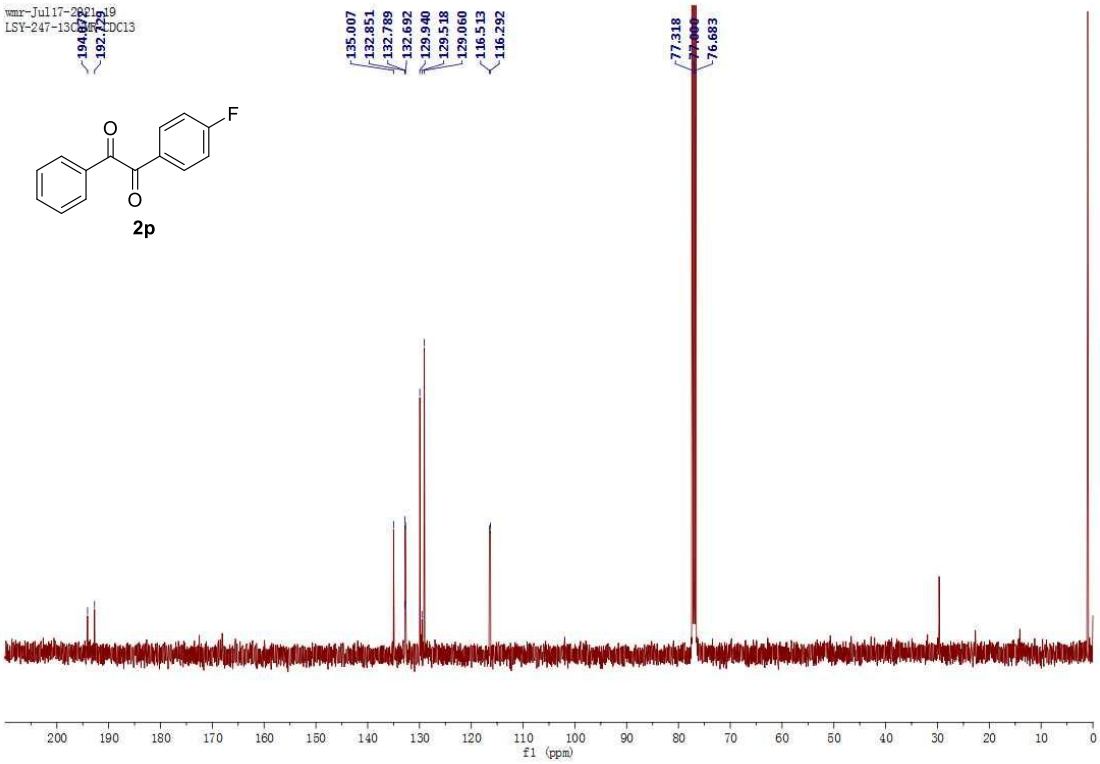
^{13}C NMR (100 MHz, $CDCl_3$)



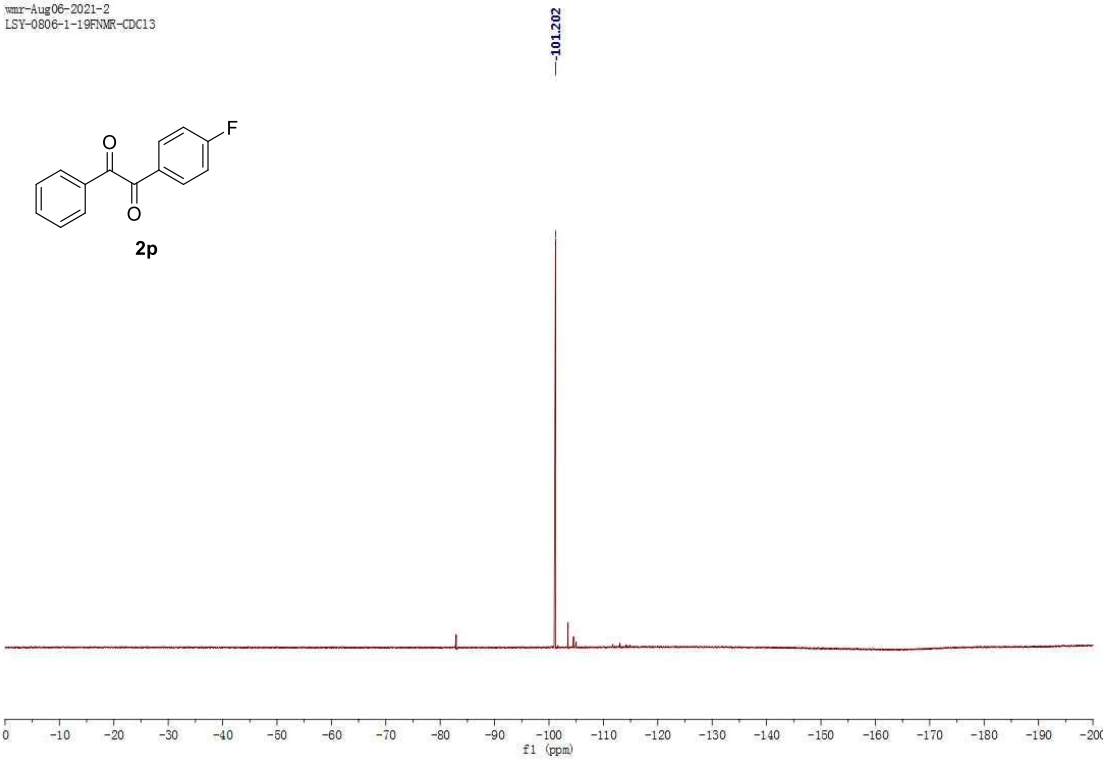
^{1}H NMR (400 MHz, $CDCl_3$)



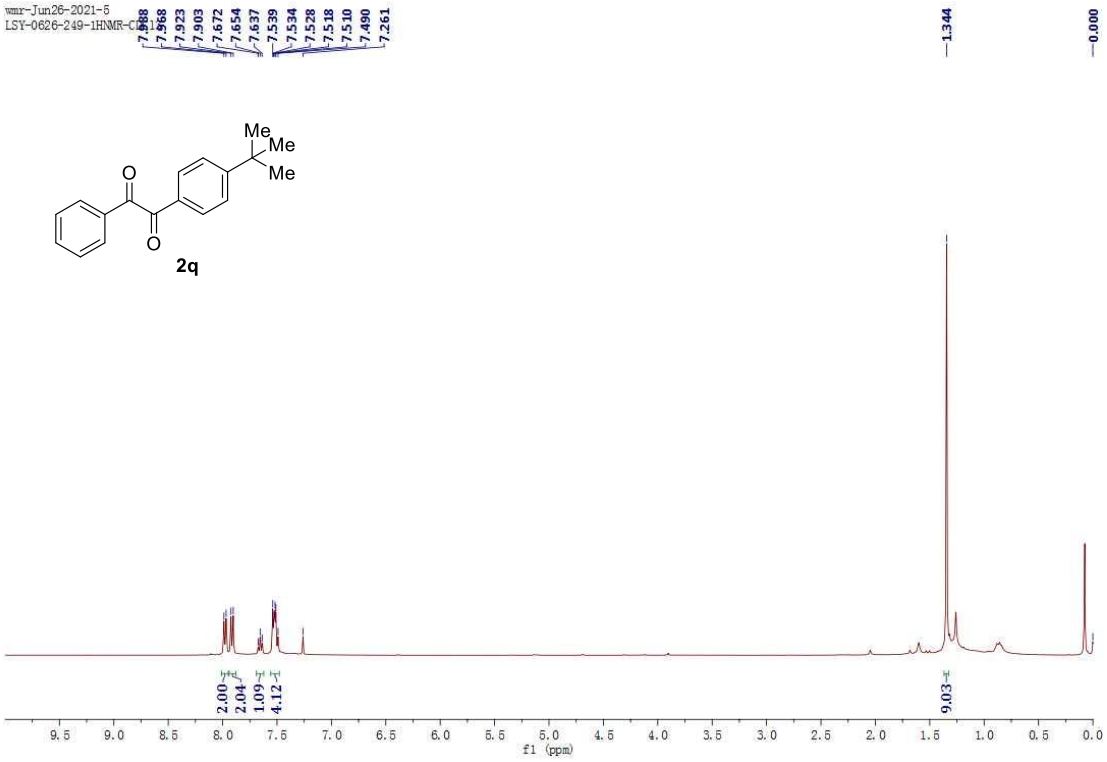
^{13}C NMR (100 MHz, $CDCl_3$)



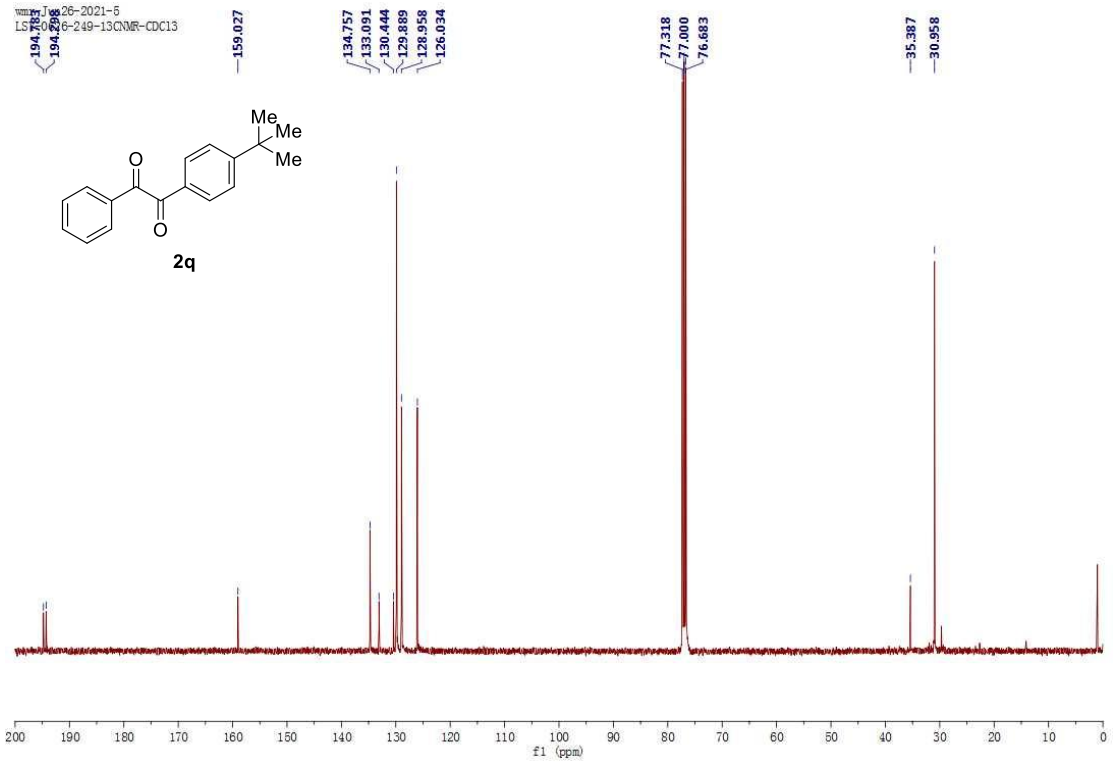
^{19}F NMR (377 MHz, $CDCl_3$)



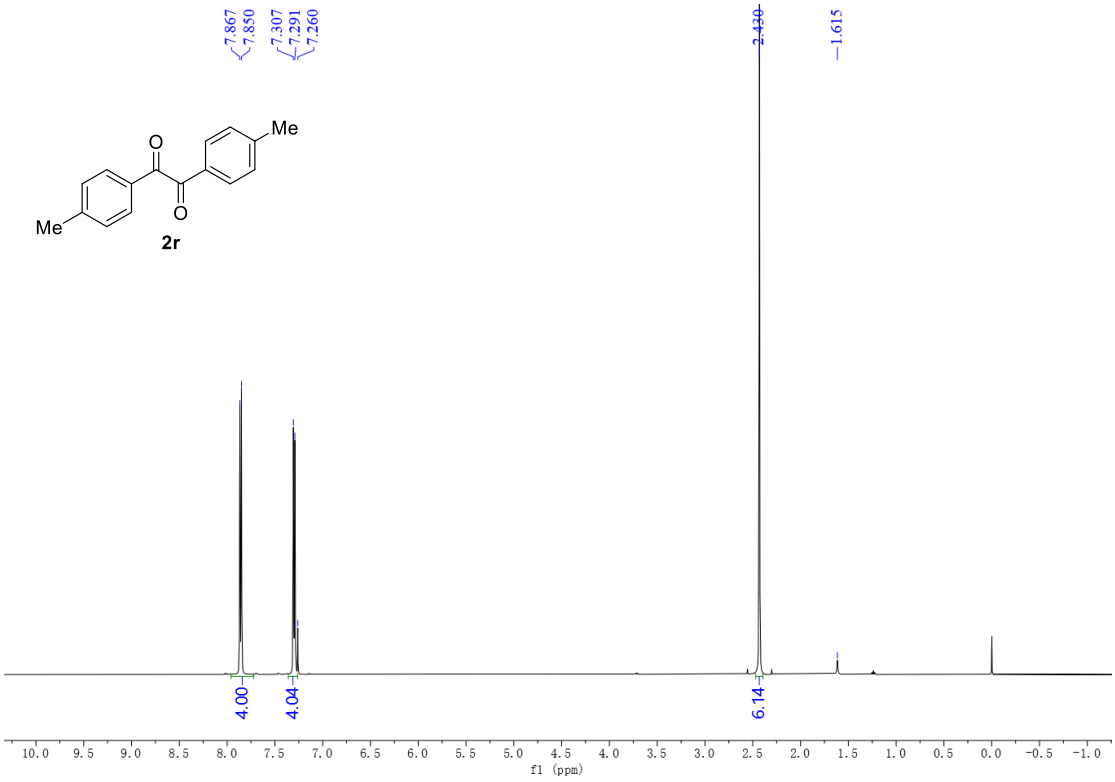
^{1}H NMR (400 MHz, $CDCl_3$)



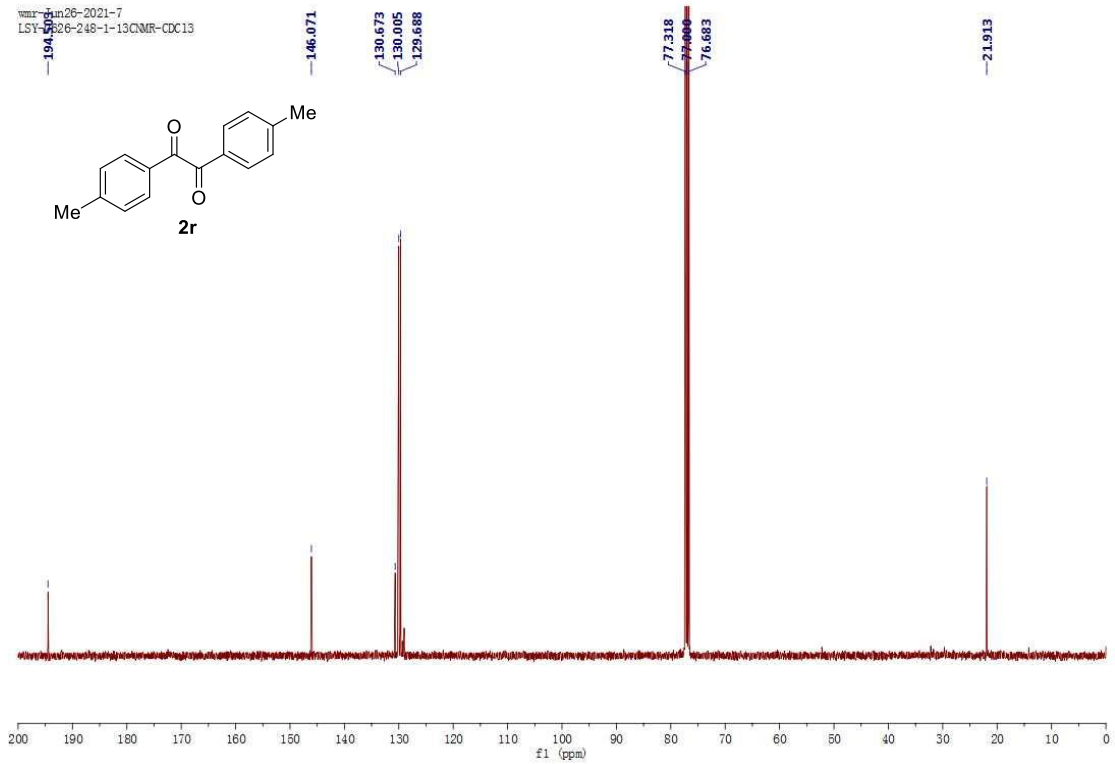
^{13}C NMR (100 MHz, $CDCl_3$)



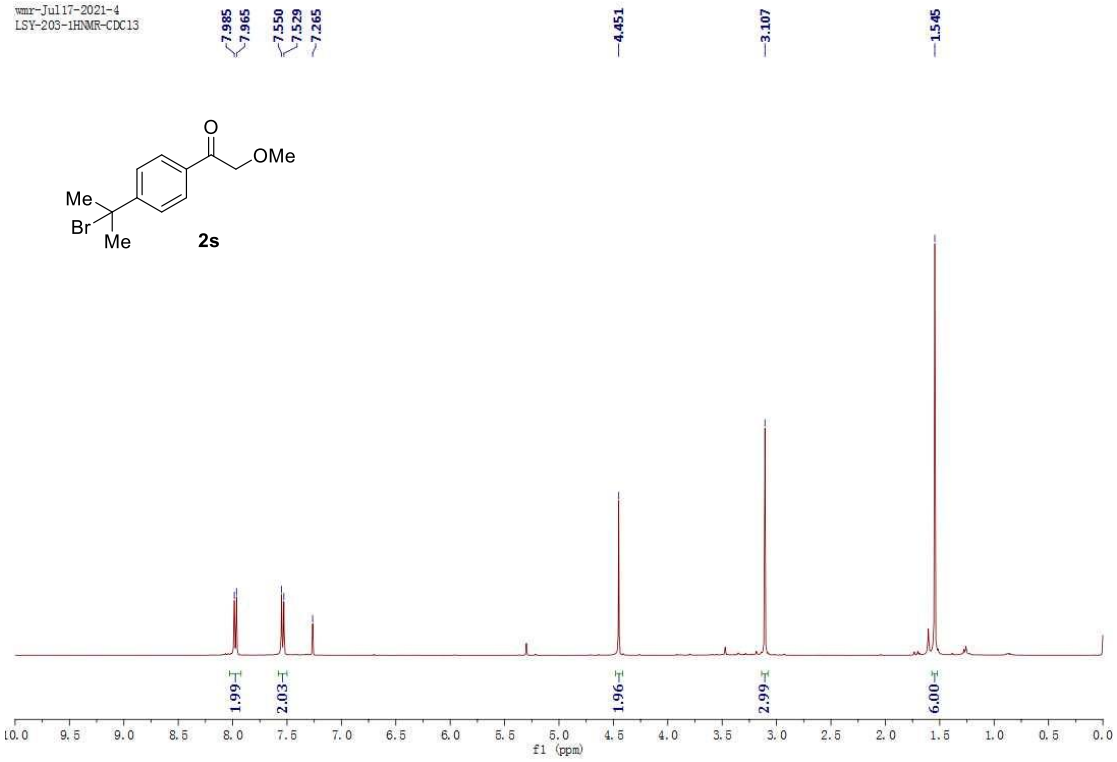
^{1}H NMR (500 MHz, $CDCl_3$)



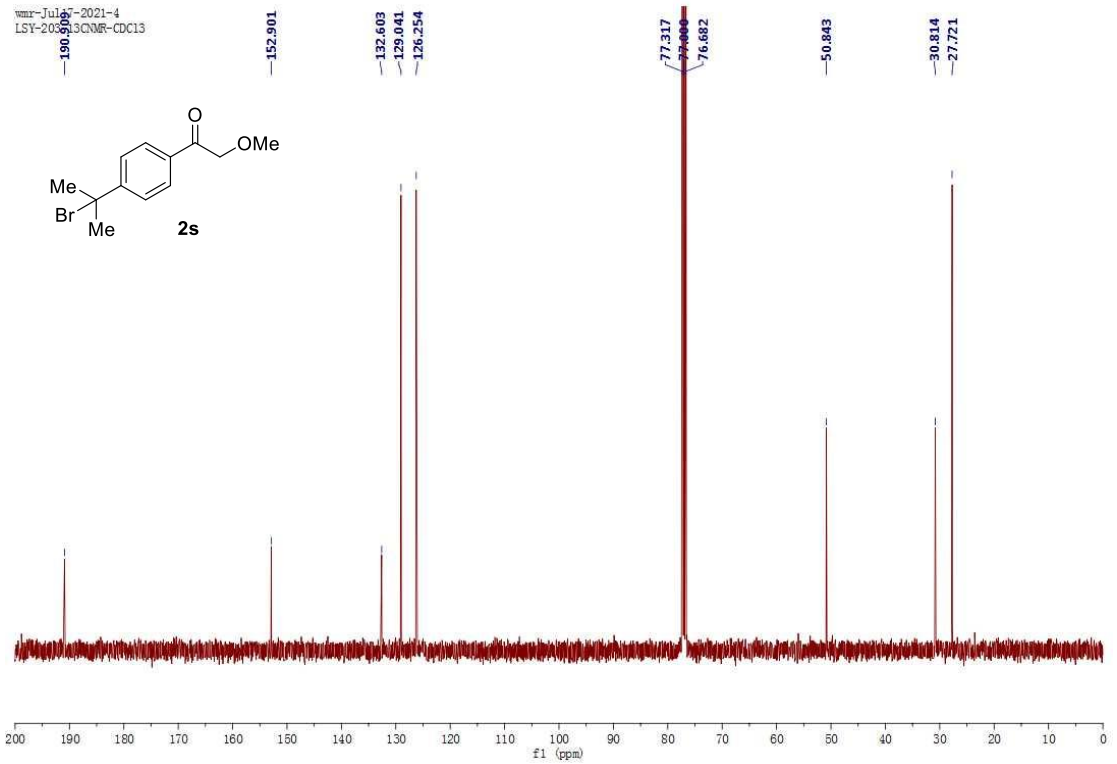
^{13}C NMR (100 MHz, $CDCl_3$)



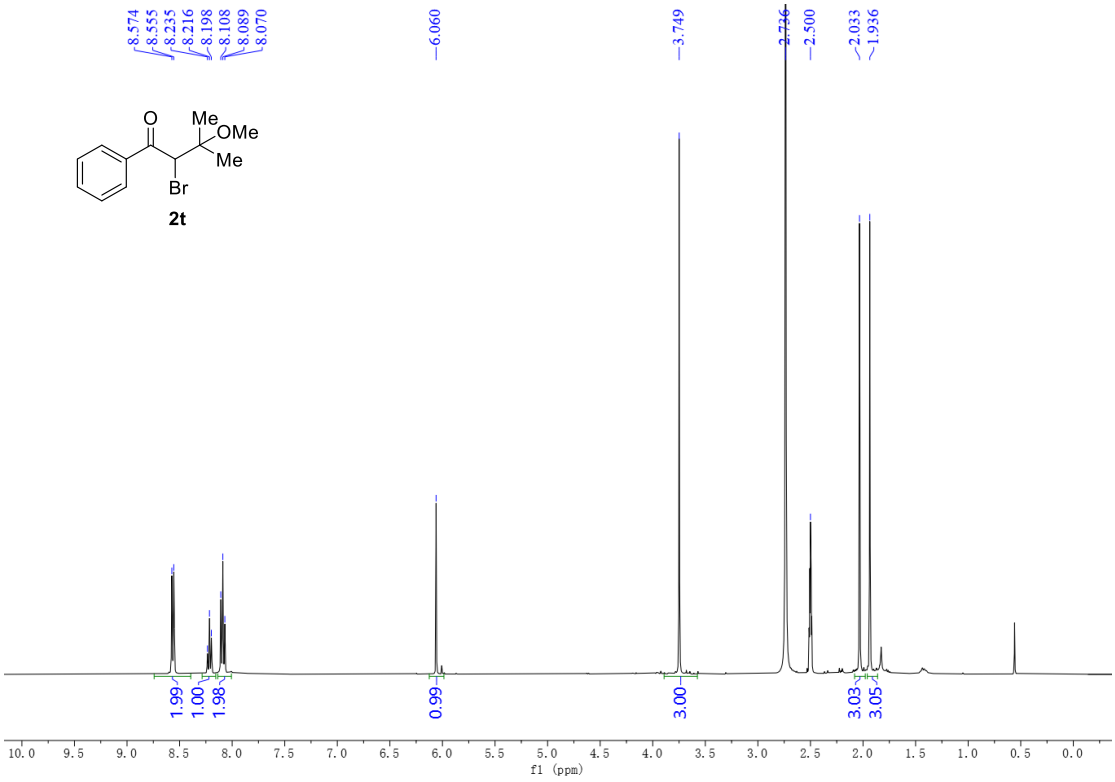
^{1}H NMR (400 MHz, $CDCl_3$)



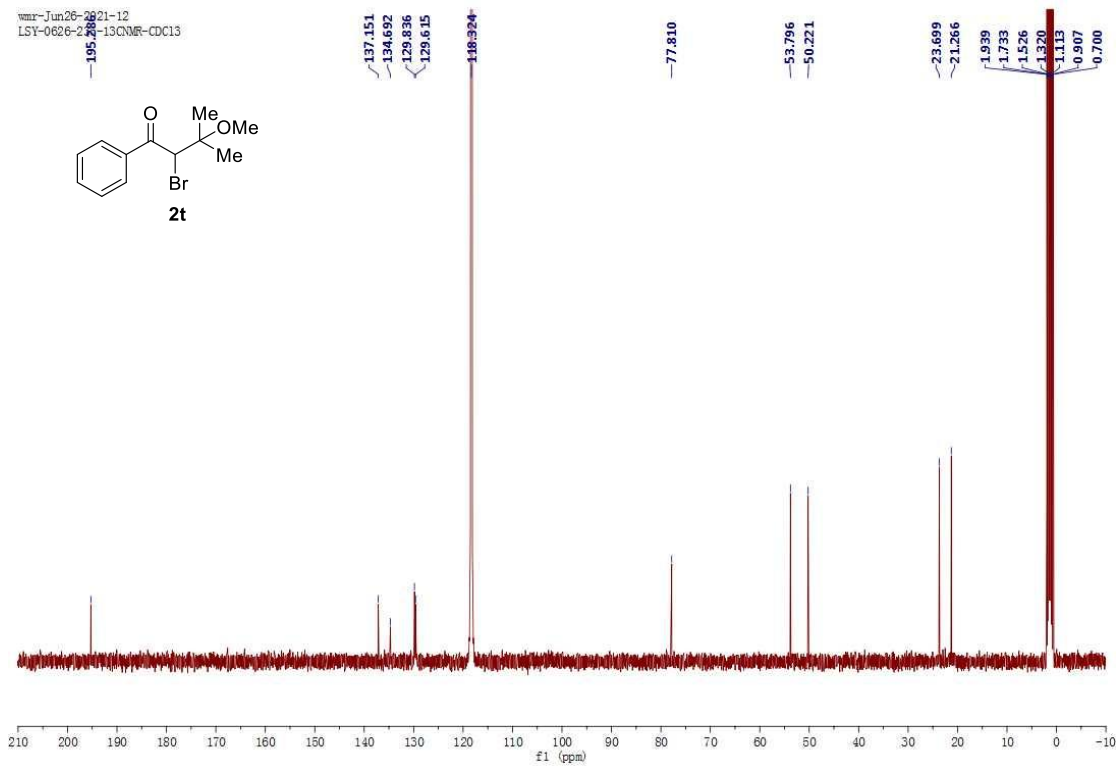
^{13}C NMR (100 MHz, $CDCl_3$)



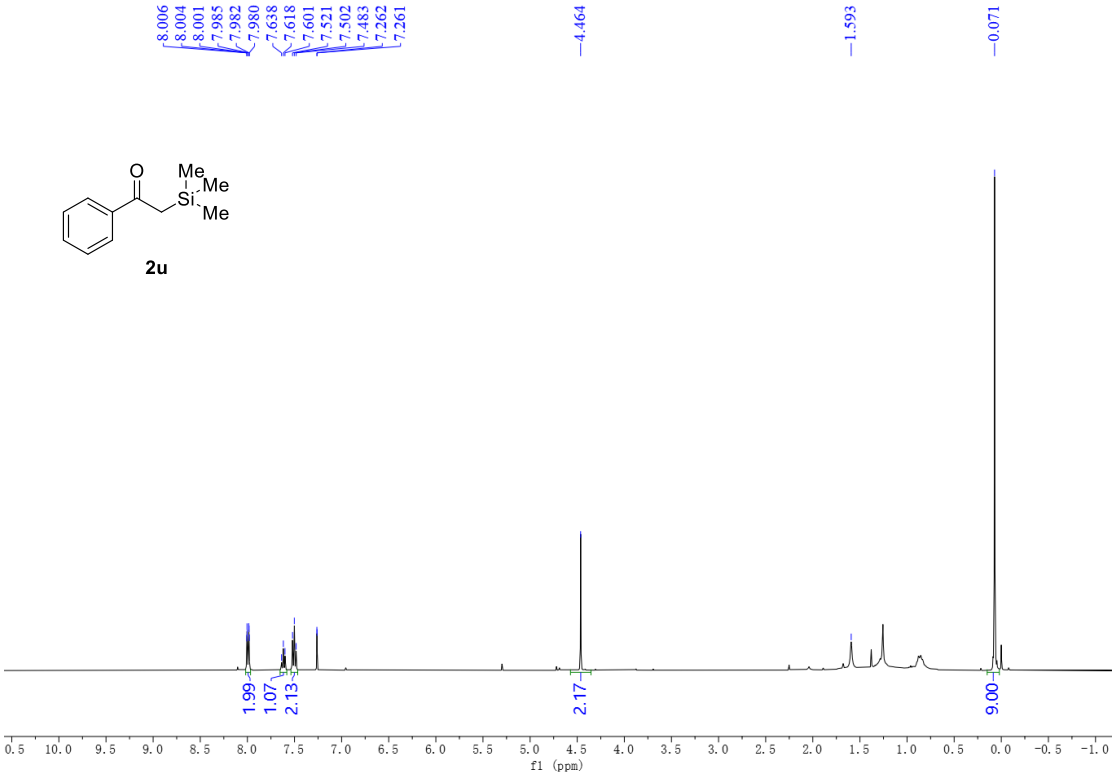
^{1}H NMR (400 MHz, DMSO-d_6)



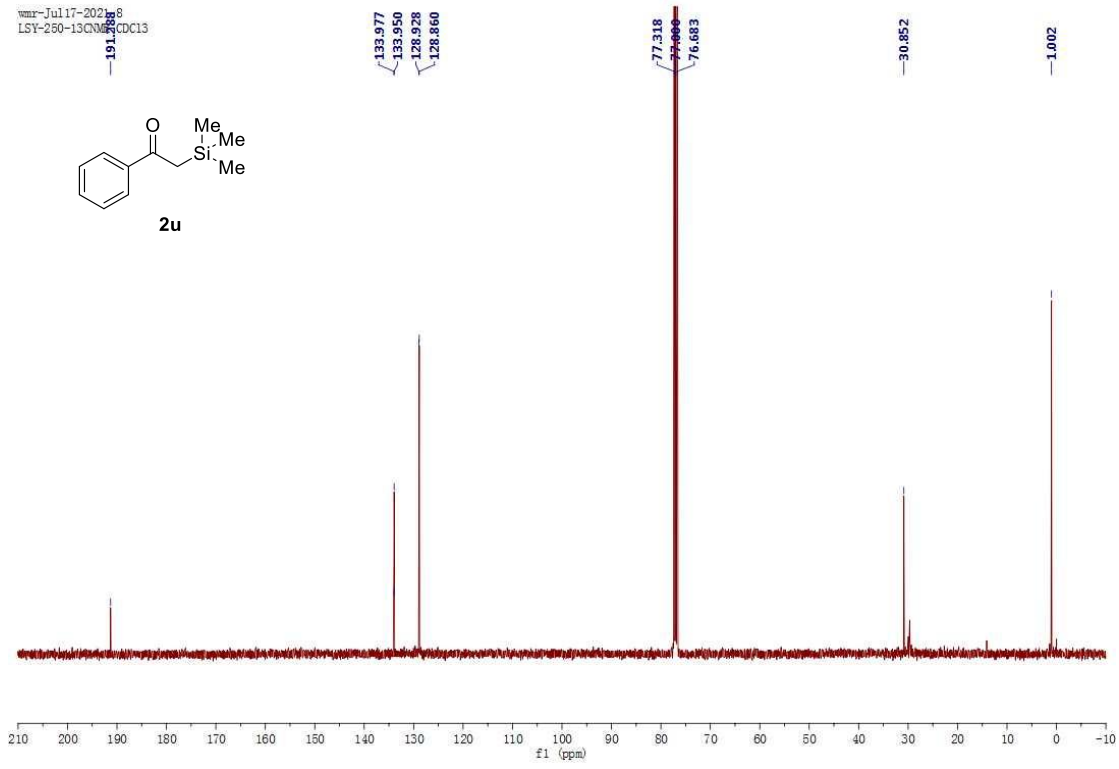
^{13}C NMR (100 MHz, $CDCl_3$)



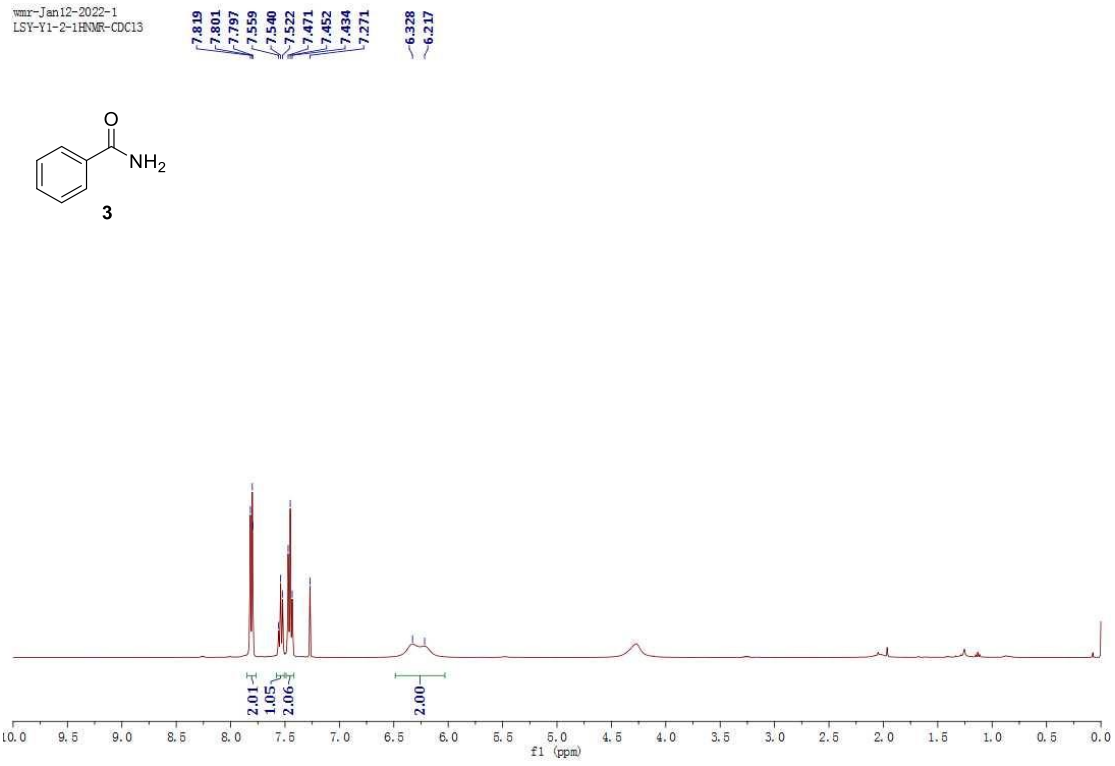
^{1}H NMR (400 MHz, $CDCl_3$)



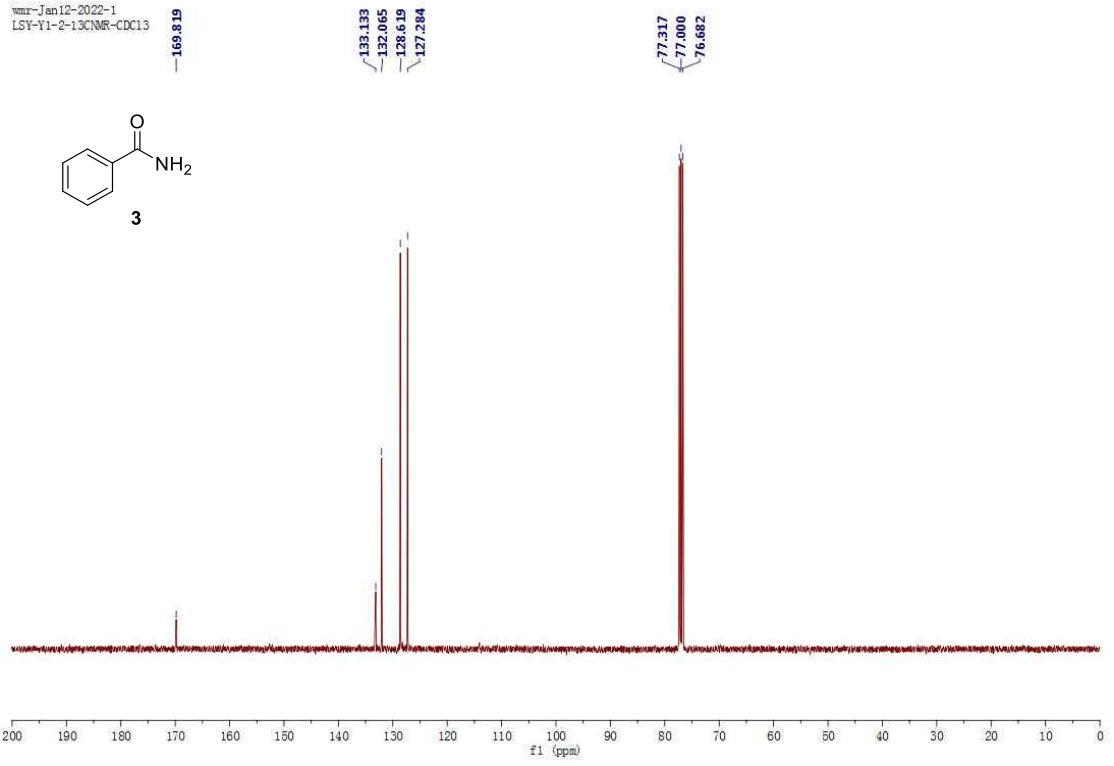
^{13}C NMR (100 MHz, $CDCl_3$)



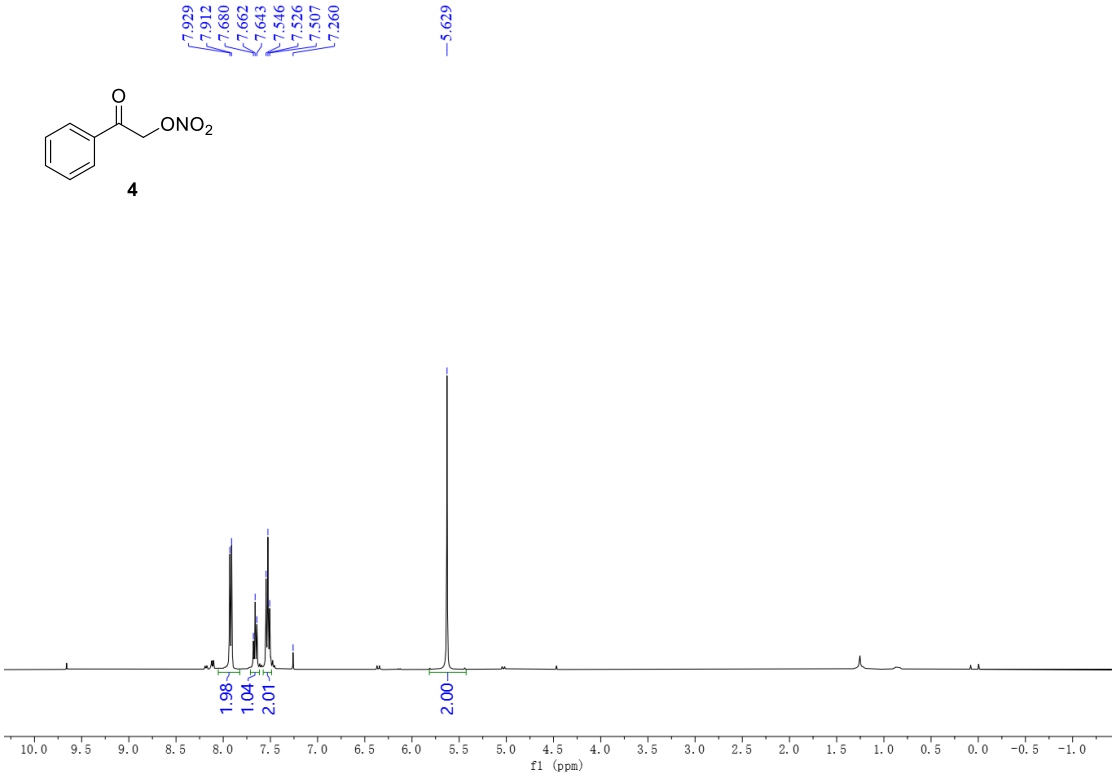
^{1}H NMR (400 MHz, $CDCl_3$)



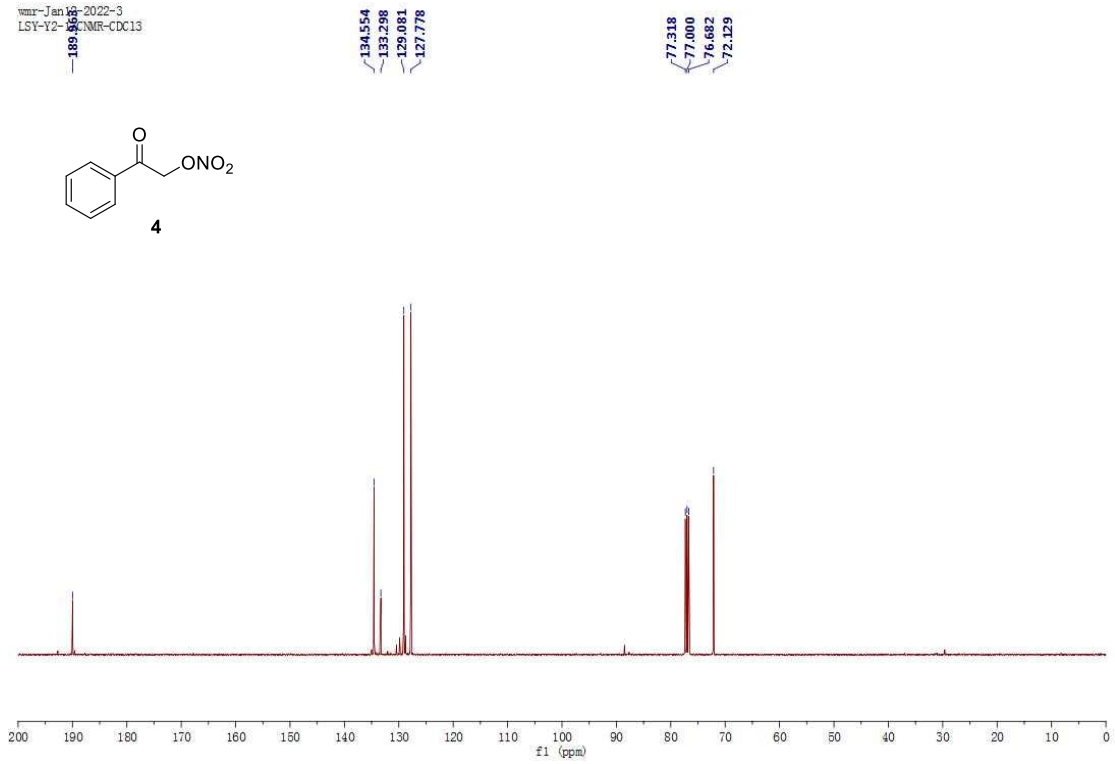
^{13}C NMR (100 MHz, $CDCl_3$)



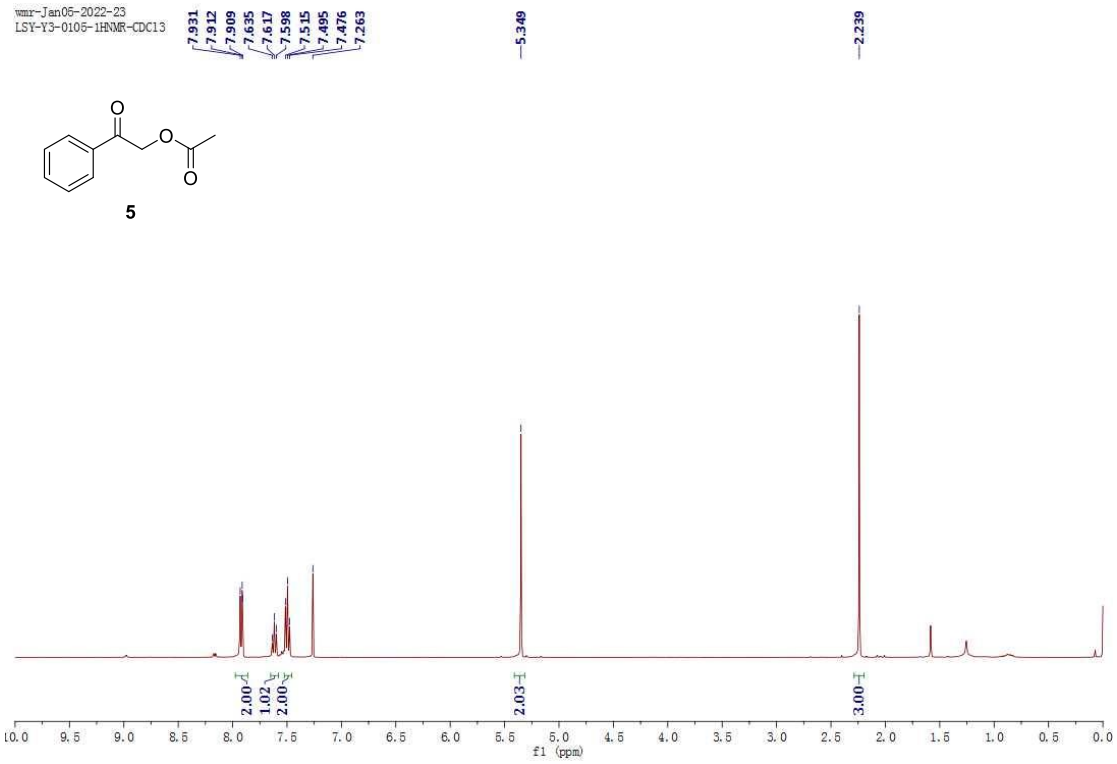
^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C NMR (100 MHz, $CDCl_3$)

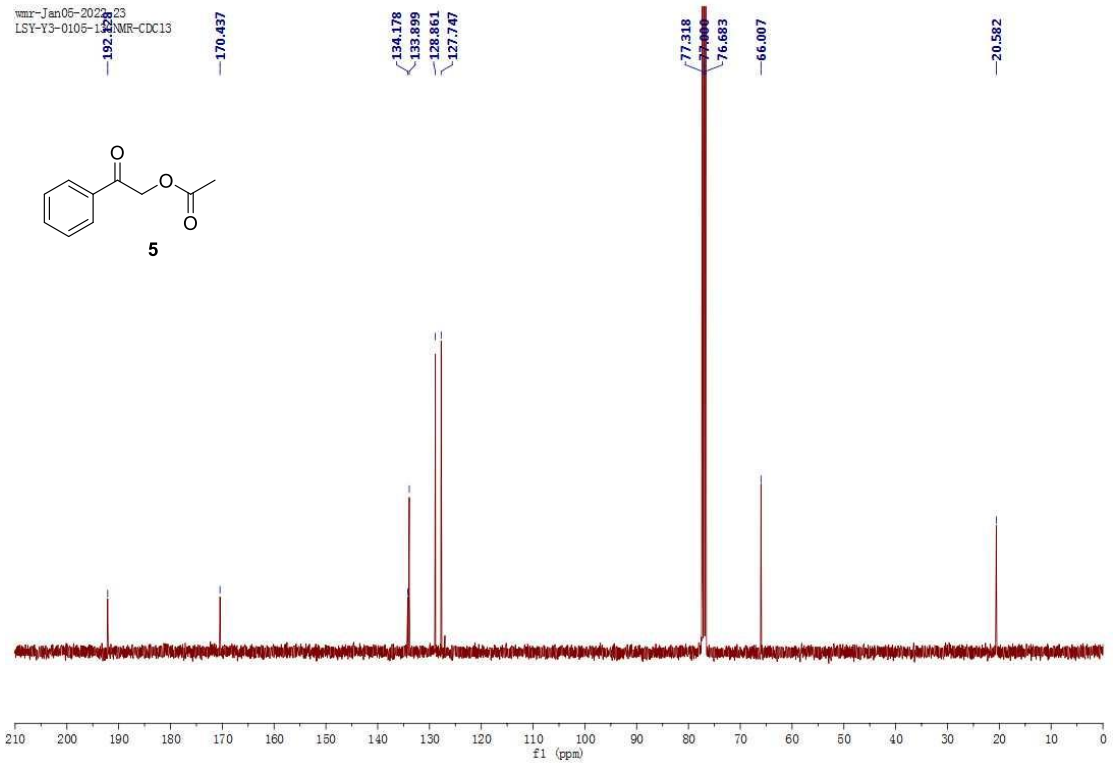


^{1}H NMR (400 MHz, $CDCl_3$)



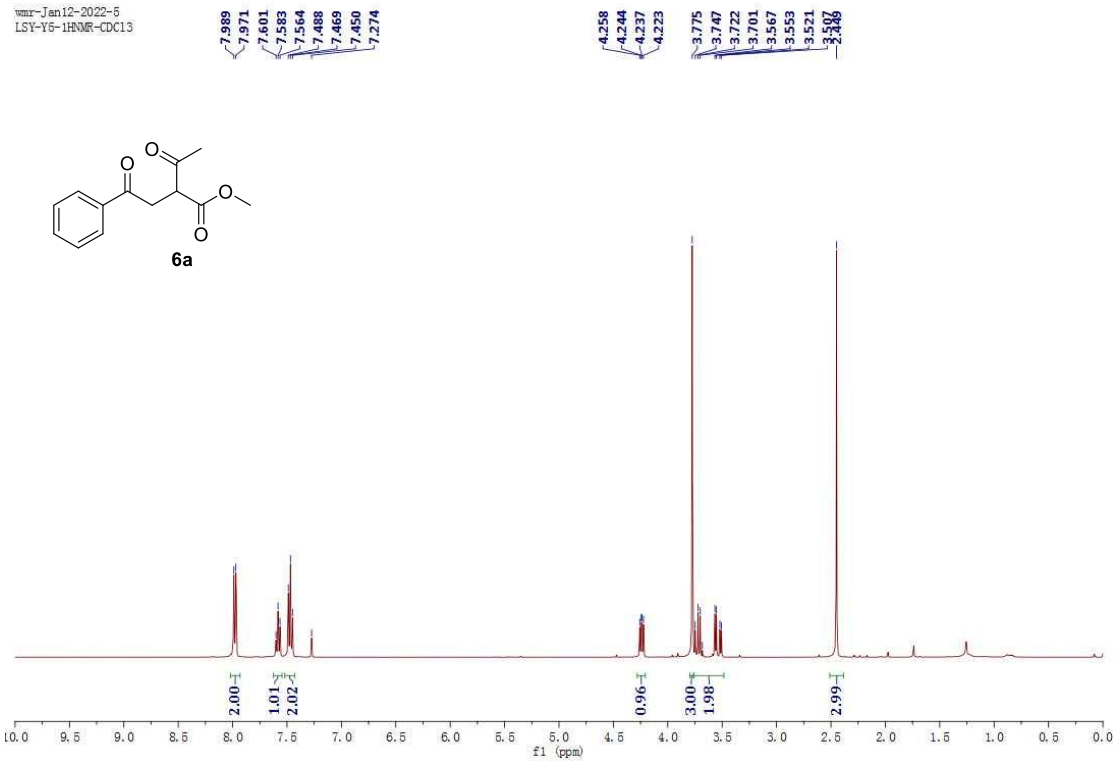
5

^{13}C NMR (100 MHz, $CDCl_3$)

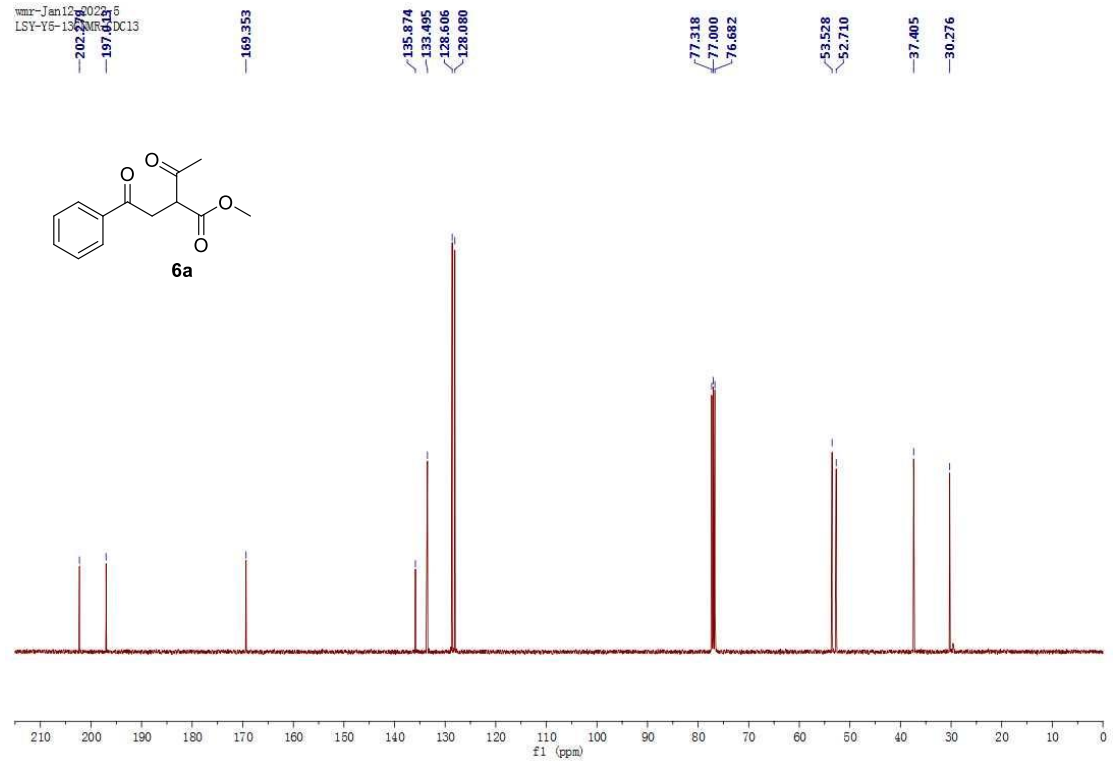


5

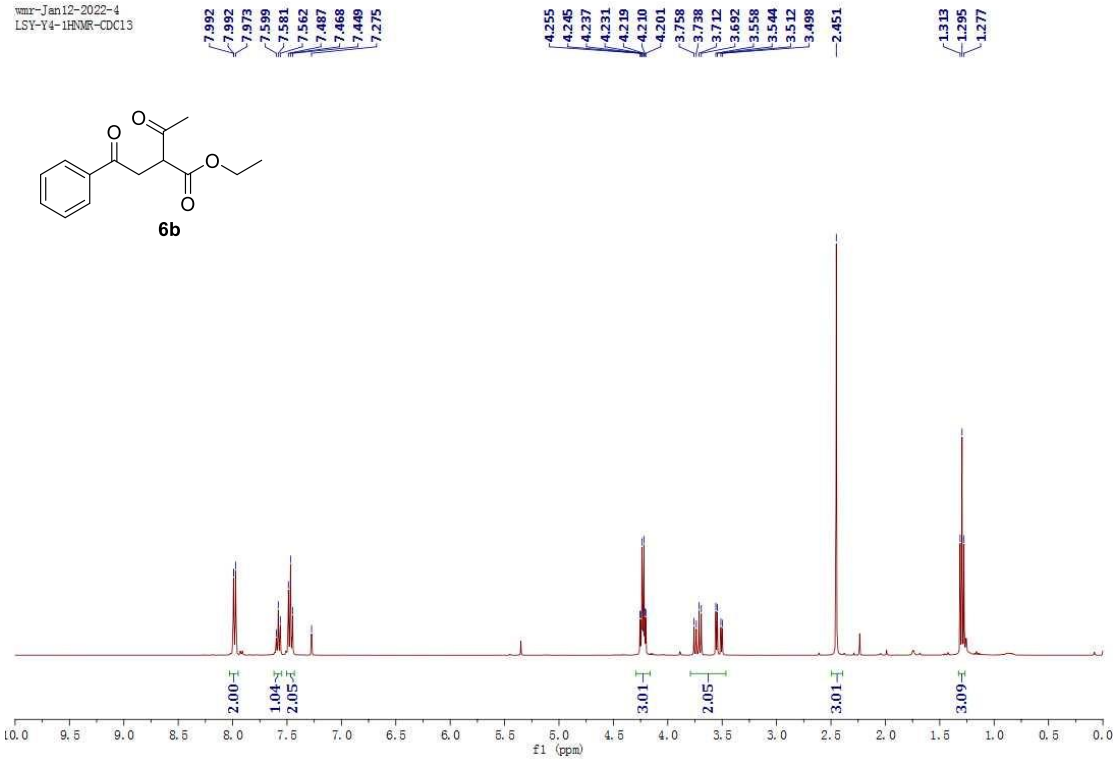
^{1}H NMR (400 MHz, $CDCl_3$)



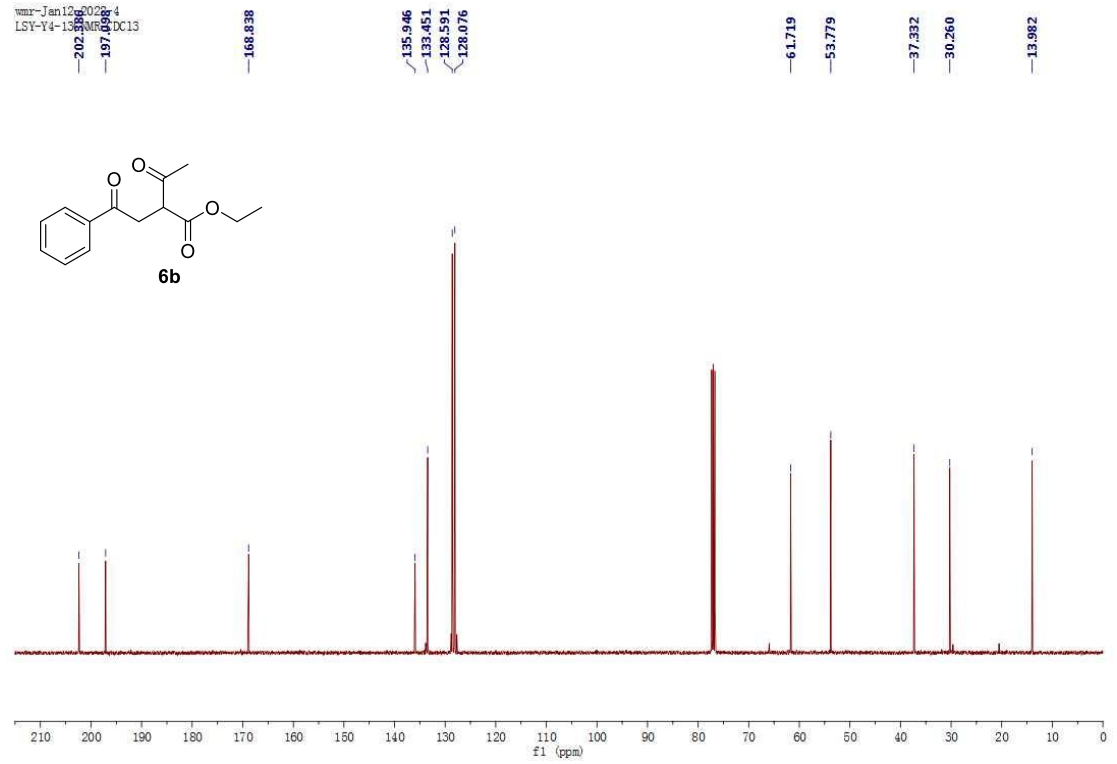
^{13}C NMR (100 MHz, $CDCl_3$)



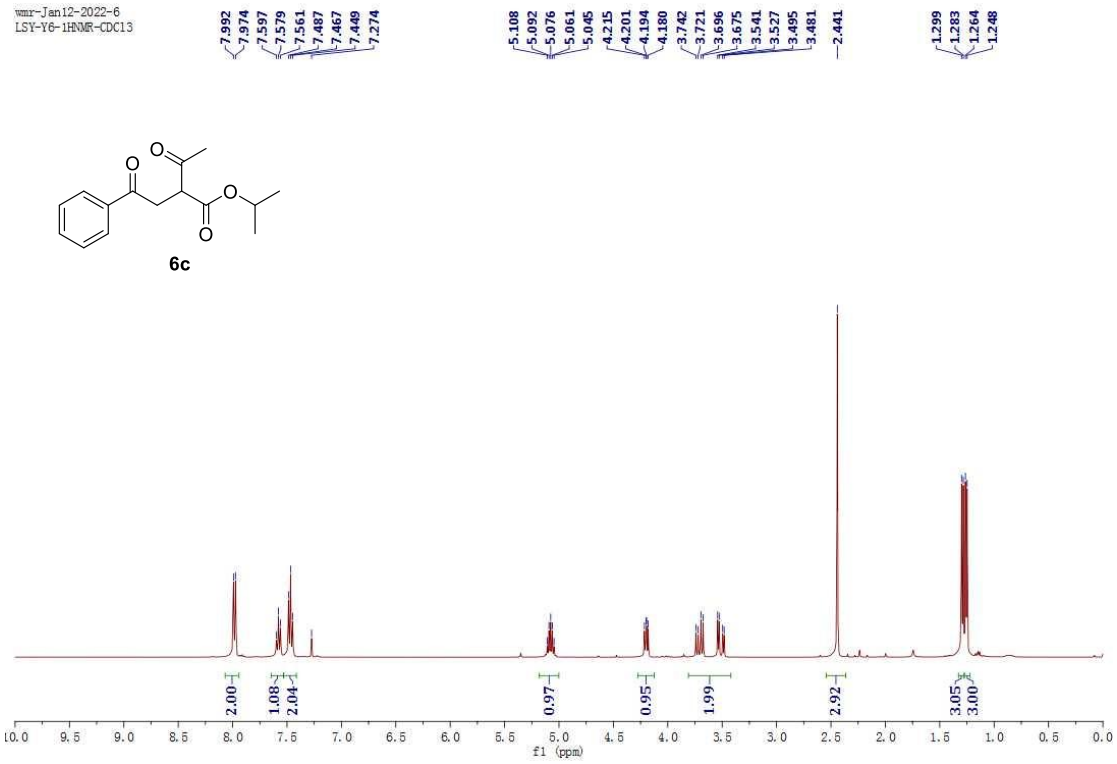
^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C NMR (100 MHz, $CDCl_3$)



^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C NMR (100 MHz, $CDCl_3$)