Supporting Information

Stevens rearrangement of thioethers with arynes: a facile access to multi-substituted β-keto thioethers

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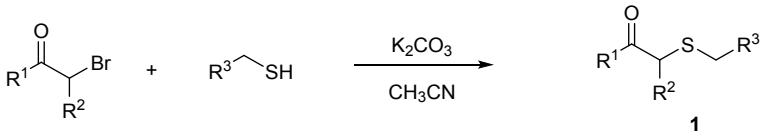
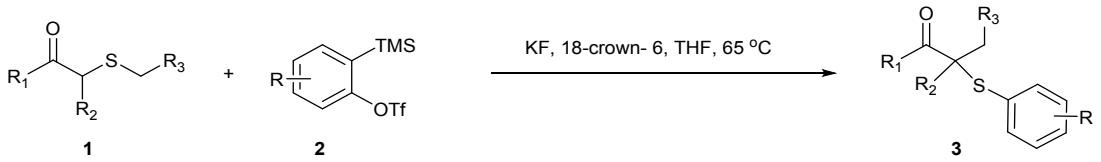
1. General Information

Unless otherwise noted, reactions were carried out in oven-dried glassware or sealed tube under atmosphere of nitrogen. Acetonitrile (CH_3CN) was distilled from calcium hydride. Tetrahydrofuran (THF) was dried and distilled from sodium. Reactions were monitored by analytical thin-layer chromatography (TLC) on Merck silica gel 60 F_{254} plates (0.25 mm), visualized by ultraviolet light (254 nm) or by staining with ceric ammonium molybdate. ^1H NMR spectra were obtained on an Agilent 400MR DD2 spectrometer at ambient temperature. Data were reported as follows: chemical shift on the δ scale using residual proton solvent as internal standard [δ 7.26 ($CDCl_3$); TMS: 0.00 ppm], multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = doublet of doublets), integration, and coupling constant (J) in hertz (Hz). ^{13}C NMR spectra were obtained with proton decoupling on an Agilent 400MR DD2 (100 MHz) spectrometer and were reported in ppm with residual solvent for internal standard [δ 77.0 ($CDCl_3$)]. Melting point was determined by WRS-2A Digital Melting Point Apparatus. High resolution mass spectra were obtained on a Bruker SolariX 7.0T spectrometer. TMS = trimethylsilyl, Tf = trifluoromethanesulfonate, TBAF = tetrabutylammonium fluoride, TBAT = tetrabutylammonium difluorotriphenylsilicate.

2. General Procedures



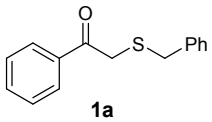
General procedure A[1]: To a solution of 2-bromo-1-ethanone (5 mmol, 1 equiv) and thiol (6.0 mmol, 1.2 equiv) in CH_3CN (30 mL) at r.t., K_2CO_3 (6.0 mmol, 1.2 equiv) was added. The resulting reaction mixture was stirred for 3 h and water was then added to the mixture. The product was extracted with EtOAc (30 mL × 3), and the combined organic extracts were dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel to afford the desired product **1**.[1]



General Procedure B: To a solution of thioethers **1** (0.20 mmol, 1.0 equiv), KF (29.0 mg, 0.50 mmol, 2.5 equiv) and 18-crown-6 (66.0 mg, 0.25 mmol, 1.25 equiv) in anhydrous THF (3 mL) at r.t. was added β-trimethylsilyltriflate **2** (0.25 mmol, 1.25 equiv) dropwise, and the resulting reaction mixture was stirred for 4 h at 65 °C. Then the reaction mixture was concentrated and purified by column chromatograph (silica gel, petroleum ether:EtOAc) to yield multi-substituted β-keto thioethers **3**.

3. Characterization of Products

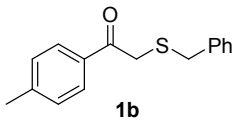
2-(Benzylthio)-1-phenylethan-1-one (1a):[1]



1a

Prepared according to general procedure **A**, from 2-bromoacetophenone (2.0 g, 10.0 mmol, 1.0 equiv) and benzyl mercaptan (1.2 mL, 10.5 mmol, 1.05 equiv) to give **1a** (2.30 g, 95%) as white solid; R_f = 0.52 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93 (d, *J* = 7.3 Hz, 2 H), 7.57 (t, *J* = 7.4 Hz, 1 H), 7.46 (t, *J* = 7.6 Hz, 2 H), 7.38 – 7.29 (m, 4 H), 7.28 – 7.25 (m, 1 H), 3.76 (s, 2 H), 3.67 (s, 2 H).

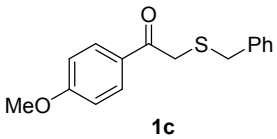
2-(Benzylthio)-1-(p-tolyl)ethan-1-one (1b):[1]



1b

Prepared according to general procedure **A**, from 2-bromo-1-(4-methylphenyl)ethanone (1.06 g, 5.0 mmol, 1.0 equiv) and benzyl mercaptan (745 mg, 6.0 mmol, 1.2 equiv) to give **1b** (1.16 g, 91%) as white solid; R_f = 0.5 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83 (d, *J* = 8.1 Hz, 2 H), 7.36 – 7.22 (m, 7 H), 3.75 (s, 2 H), 3.65 (s, 2 H), 2.41 (s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.1, 144.2, 137.3, 132.8, 129.3, 129.2, 128.8, 128.5, 127.2, 36.0, 35.8, 21.7.

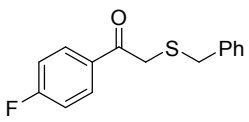
2-(Benzylthio)-1-(4-methoxyphenyl)ethan-1-one (1c):[1]



1c

Prepared according to general procedure A, from 2-bromo-4'-methoxyacetophenone (1.14 g, 5.0 mmol, 1.0 equiv) and benzyl mercaptan (745 mg, 6.0 mmol, 1.2 equiv) to give **1c** (1.28 g, 94%) as white solid; R_f = 0.4 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92 – 7.89 (m, 2 H), 7.36 – 7.22 (m, 5 H), 6.93– 6.90 (m, 2 H), 3.87 (s, 3 H), 3.76 (s, 2 H), 3.63 (s, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 193.2, 163.6, 137.4, 131.0, 129.2, 128.5, 128.4, 127.1, 113.8, 55.5, 36.1, 35.7.

2-(Benzylthio)-1-(4-fluorophenyl)ethan-1-one (1d):

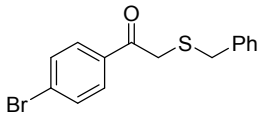


1d

Prepared according to general procedure A, from 2-bromo-4'-fluoroacetophenone (1.08 g, 5.0 mmol, 1.0 equiv) and benzyl mercaptan

(745 mg, 6.0 mmol, 1.2 equiv) to give **1d** (1.16 g, 89%) as white solid; m.p. 58-60 °C; R_f = 0.4 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96 – 7.93 (m, 2 H), 7.37 – 7.22 (m, 5 H), 7.12 (t, *J* = 8.6 Hz, 2 H), 3.75 (s, 2 H), 3.64 (s, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 192.9, 165.1 (d, *J* = 254 Hz), 137.1, 131.7, 131.2 (d, *J* = 9.4 Hz), 129.2, 128.5, 127.3, 115.7 (d, *J* = 21.8 Hz), 36.1, 35.8. HRMS (ESI): calcd for $C_{15}H_{13}FNaOS^+$ [M+Na$^+$]: 283.0563, found 283.0561.

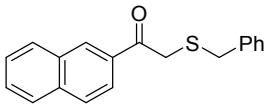
2-(Benzylthio)-1-(4-bromophenyl)ethan-1-one (1e):[2]



1e

Prepared according to general procedure A, from 2,4'-dibromoacetophenone (1.39 g, 5.0 mmol, 1.0 equiv) and benzyl mercaptan (745 mg, 6.0 mmol, 1.2 equiv) to give **1e** (1.46 g, 91%) as white solid; R_f = 0.3 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80 (d, *J* = 8.8 Hz, 2 H), 7.59 (d, *J* = 8.0 Hz, 2 H), 7.35 – 7.24 (m, 5 H), 3.74 (s, 2 H), 3.62 (s, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 193.3, 137.1, 134.1, 131.9, 130.2, 129.2, 128.5, 128.5, 127.3, 36.1, 35.8.

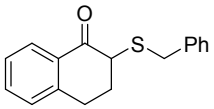
2-(Benzylthio)-1-(naphthalen-2-yl)ethanone (1f):



1f

Prepared according to general procedure A, from 2-bromo-2'-acetonaphthone (1.24 g, 5.0 mmol, 1.0 equiv) and benzyl mercaptan (745 mg, 6.0 mmol, 1.2 equiv) to give **1f** (1.39 g, 95%) as white solid; m.p. 63-65 °C; R_f = 0.5 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.42 (d, *J* = 1.8 Hz, 1 H), 8.04 – 7.82 (m, 4 H), 7.60 – 7.51 (m, 2 H), 7.42 – 7.21 (m, 5 H), 3.79 (s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.4, 137.3, 135.6, 132.7, 132.4, 130.5, 129.6, 129.3, 128.6, 128.5, 127.7, 127.2, 126.8, 124.2, 36.1, 35.9. HRMS (ESI): calcd for $C_{19}H_{16}NaOS^+$ [M+Na$^+$]: 315.0814, found 315.0813.

2-(Benzylthio)-3,4-dihydronaphthalen-1(2H)-one (1g):

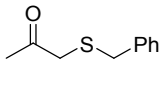


1g

Prepared according to general procedure A, from 2-bromo-1-tetralone (1.12 g, 5.0 mmol, 1.0 equiv) and benzyl mercaptan (745 mg, 6.0 mmol, 1.2 equiv) to give **1g** (1.00 g, 75%) as yellow solid; m.p. 57-58 °C; R_f = 0.5 (silica gel, petroleum ether:EtOAc, 20:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.12 (d, *J* = 7.9 Hz, 1 H), 7.47 (td, *J*

= 7.5, 1.4 Hz, 1 H), 7.41 (d, *J* = 7.2 Hz, 2 H), 7.37 – 7.18 (m, 6 H), 3.86 (d, *J* = 13.4 Hz, 1 H), 3.74 (d, *J* = 13.4 Hz, 1 H), 3.49 (t, *J* = 4.2 Hz, 1 H), 3.18 (ddd, *J* = 16.8, 11.8, 4.6 Hz, 1 H), 2.81 (dt, *J* = 17.1, 4.3 Hz, 1 H), 2.47 (ddt, *J* = 13.9, 11.9, 4.5 Hz, 1 H), 2.20 (dq, *J* = 13.9, 4.2 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 192.8, 142.8, 137.6, 133.4, 130.8, 129.3, 128.6, 128.5, 128.2, 127.1, 126.8, 46.8, 34.7, 28.6, 26.0. HRMS (ESI): calcd for $C_{17}H_{16}NaOS^+$ [M+Na$^+$]: 291.0814, found 291.0811.

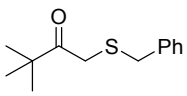
1-(Benzylthio)propan-2-one (1h):[3]



1h

Prepared according to general procedure A, from 1-methylsulfonyloxypropan-2-one (1.2 g, 8.0 mmol, 1.0 equiv) and benzyl mercaptan (990 mg, 8.0 mmol, 1.0 equiv) to give **1h** (756 mg, 52%) as colorless oil; R_f = 0.5 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.34 – 7.21 (m, 5 H), 3.67 (s, 2 H), 3.10 (s, 2 H), 2.22 (s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 203.5, 137.1, 129.1, 128.4, 127.2, 40.7, 35.9, 27.9.

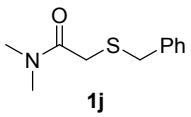
1-(Benzylthio)-3,3-dimethylbutan-2-one (1i):[3]



1i

Prepared according to general procedure A, from 1-bromopinacolone (890 mg, 5.0 mmol, 1.0 equiv) and benzyl mercaptan (745 mg, 6.0 mmol, 1.2 equiv) to give **1i** (899 mg, 81%) as colorless oil; R_f = 0.48 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.37 – 7.21 (m, 5 H), 3.76 (s, 2 H), 3.26 (s, 2 H), 1.15 (s, 9 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 210.3, 137.4, 129.2, 128.4, 127.1, 44.1, 35.8, 34.6, 26.8.

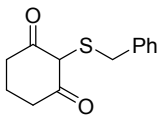
2-(Benzylthio)-N,N-dimethylacetamide (1j):



1j

From ethyl 2-(benzylthio)acetate (210 mg, 1.0 mmol, 1.0 equiv) and 40% aqueoussolution of dimethylamine (as solvent and reagent) to give **1j** (96 mg, 46%) as colorless oil; R_f = 0.4 (silica gel, petroleum ether:EtOAc, 1:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.38 – 7.33 (m, 2 H), 7.33 – 7.26 (m, 2 H), 7.26 – 7.17 (m, 1 H), 3.82 (s, 2 H), 3.17 (s, 2 H), 2.96 (s, 3 H), 2.93 (s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.9, 137.5, 129.0, 128.2, 126.9, 37.8, 36.0, 35.7, 32.2. MS calcd for $C_{11}H_{16}NOS^+$ [M+H$^+$]: 210, found 210.

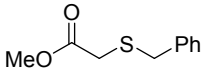
2-(Benzylthio)cyclohexane-1,3-dione (1k):



1k

Prepared according to general procedure **A**, from 2-bromocyclohexane-1,3-dione (950 mg, 5.0 mmol, 1.0 equiv) and benzyl mercaptan (745 mg, 6.0 mmol, 1.2 equiv) to give **1k** (462 mg, 48%) as colorless oil; R_f = 0.4 (silica gel, petroleum ether:EtOAc, 1:2); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.56 (s, 1 H), 7.28 – 7.22 (m, 3 H), 7.13 – 7.11 (m, 2 H), 3.77 (s, 2 H), 2.43 (dt, *J* = 22.7, 6.5 Hz, 4 H), 1.91 (p, *J* = 6.4 Hz, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.6, 179.4, 137.9, 128.8, 128.4, 127.3, 106.5, 37.7, 37.2, 28.0, 19.9. HRMS (ESI): calcd for $C_{13}H_{14}NaO_2S^+$ [M+Na$^+$]: 257.0607, found 257.0606.

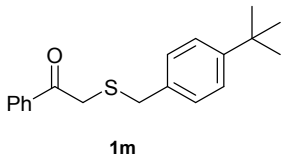
methyl 2-(benzylthio)acetate (1l):



1l

Prepared according to general procedure **A**, from methyl 2-bromoacetate (940 μL, 10.0 mmol, 1.0 equiv) and benzyl mercaptan (1.24 g, 10.0 mmol, 1.0 equiv) to give **1l** (1.7 g, 89%) as colorless oil; R_f = 0.6 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.35 – 7.30 (m, 4 H), 7.28 – 7.22 (m, 1 H), 3.82 (s, 2 H), 3.71 (s, 3 H), 3.08 (s, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.8, 137.1, 129.1, 128.5, 127.3, 52.3, 36.4, 32.1.

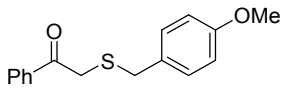
2-((4-(Tert-butyl)benzyl)thio)-1-phenylethanone (1m):



1m

Prepared according to general procedure **A**, from 2-bromoacetophenone (995 mg, 5.0 mmol, 1.0 equiv) and 4-(tert-Butyl)benzyl mercaptan (1.08 g, 6.0 mmol, 1.2 equiv) to give **1m** (1.28 g, 86%) as colorless oil; R_f = 0.5 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93 (d, *J* = 7.3 Hz, 2 H), 7.60 – 7.53 (m, 1 H), 7.45 (t, *J* = 7.6 Hz, 2 H), 7.33 (d, *J* = 8.3 Hz, 2 H), 7.30 – 7.24 (m, 2 H), 3.74 (s, 2 H), 3.68 (s, 2 H), 1.31 (s, 9 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.5, 150.2, 135.5, 134.2, 133.3, 128.9, 128.7, 128.6, 125.4, 36.0, 35.7, 34.5, 31.3. HRMS (ESI): calcd for $C_{19}H_{22}NaOS^+$ [M+Na$^+$]: 321.1284, found 321.1280.

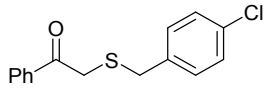
2-((4-Methoxybenzyl)thio)-1-phenylethan-1-one (1n):[4]



1n

Prepared according to general procedure **A**, from 2-bromoacetophenone (995 mg, 5.0 mmol, 1.0 equiv) and 4-methoxybenzyl mercaptan (924 mg, 6.0 mmol, 1.2 equiv) to give **1n** (1.22 g, 90%) as white solid; R_f = 0.4 (silica gel, petroleum ether:EtOAc, 20:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96– 7.91 (m, 2 H), 7.60 – 7.54 (m, 1 H), 7.45 (t, *J* = 7.8 Hz, 2 H), 7.28 – 7.23 (m, 2 H), 6.86 – 6.81 (m, 2 H), 3.79 (s, 3 H), 3.72 (s, 2 H), 3.66 (s, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.5, 158.8, 135.4, 133.3, 130.4, 129.2, 128.7, 128.6, 113.9, 55.2, 35.8, 35.5.

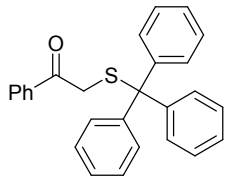
2-((4-Chlorobenzyl)thio)-1-phenylethan-1-one (1o):



1o

Prepared according to general procedure **A**, from 2-bromoacetophenone (995 mg, 5.0 mmol, 1.0 equiv) and 4-chlorobenzyl mercaptan (948 mg, 6.0 mmol, 1.2 equiv) to give **1o** (1.27 g, 92%) as white solid; m.p. 91-92 ^{o}C; R_f = 0.4 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93 (dt, *J* = 8.3, 1.4 Hz, 2 H), 7.58 (td, *J* = 7.3, 1.5 Hz, 1 H), 7.46 (td, *J* = 7.7, 1.5 Hz, 2 H), 7.32 – 7.25 (m, 4 H), 3.72 (s, 2 H), 3.65 (s, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.2, 135.8, 135.3, 133.4, 133.0, 130.6, 128.7, 128.6, 35.6, 35.3. HRMS (ESI): calcd for $C_{15}H_{13}ClNaOS^+$ [M+Na$^+$]: 299.0268, found 299.0265.

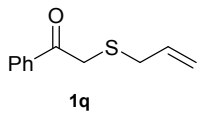
1-Phenyl-2-(tritylthio)ethan-1-one (1p):



1p

Prepared according to general procedure **A**, from 2-bromoacetophenone (995 mg, 5.0 mmol, 1.0 equiv) and triphenylmethyl mercaptan (1.66 g, 6.0 mmol, 1.2 equiv) to give **1p** (1.83 g, 93%) as white solid; m.p. 110-112 ^{o}C; R_f = 0.5 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.70 – 7.65 (m, 2 H), 7.55 – 7.45 (m, 7 H), 7.36 (t, *J* = 7.8 Hz, 2 H), 7.30 (dd, *J* = 8.5, 6.8 Hz, 6 H), 7.26 – 7.19 (m, 4 H), 3.56 (s, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.1, 144.2, 135.7, 133.3, 129.5, 128.5, 128.1, 126.9, 67.2, 39.6. HRMS (ESI): calcd for $C_{27}H_{22}NaOS^+$ [M+Na$^+$]: 417.1284, found 417.1282.

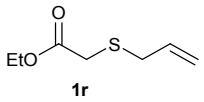
2-(Allylthio)-1-phenylethanone (1q):[5]



1q

Prepared according to general procedure **A**, from 2-bromoacetophenone (995 mg, 5.0 mmol, 1.0 equiv) and allyl mercaptan (444 mg, 6.0 mmol, 1.2 equiv) to give **1q** (682 mg, 71%) as colorless oil; R_f = 0.5 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.00 – 7.95 (m, 2 H), 7.63 – 7.56 (m, 1 H), 7.47 (dd, *J* = 8.4, 7.1 Hz, 2 H), 5.78 (ddt, *J* = 17.0, 9.8, 7.2 Hz, 1 H), 5.23 – 5.14 (m, 2 H), 3.77 (s, 2 H), 3.19 (dt, *J* = 7.2, 1.0 Hz, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.5, 135.5, 133.3, 132.9, 128.6, 118.5, 35.6, 34.7.

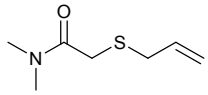
Ethyl 2-(allylthio)acetate (1r):



1r

From ethyl 2-mercaptoacetate (0.6 mL, 5.0 mmol, 1.0 equiv) and allyl bromide (0.43 mL, 5.0 mmol, 1.0 equiv) to give **1r** (1.15 g, 95%) as colorless oil; R_f = 0.68 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 5.82 – 5.70 (m, 1 H), 5.19 – 5.12 (m, 2 H), 4.19 (q, *J* = 7.1, 2 H), 3.24 (d, *J* = 7.1, 2 H), 3.16 (s, 2 H), 1.29 (t, *J* = 7.1, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.5, 132.9, 118.3, 61.2, 34.9, 31.7, 14.2. HRMS (ESI): calcd for $C_7H_{12}NaO_2S^+$ [M+Na$^+$]: 183.0450, found 183.0455.

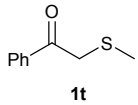
2-(Allylthio)-N,N-dimethylacetamide (1s):



1s

From **1q** (160 mg, 1.0 mmol, 1.0 equiv) and 40% aqueoussolution of dimethylamine (as solvent and reagent) to give **1s** (64 mg, 40%) as colorless oil; R_f = 0.38 (silica gel, petroleum ether:EtOAc, 1:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 5.86 – 5.73 (m, 1 H), 5.26 – 5.11 (m, 2 H), 3.31 – 3.21 (m, 4 H), 3.07 (s, 3 H), 2.97 (s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.2, 133.1, 118.1, 37.8, 35.7, 34.6, 31.7. HRMS (ESI): calcd for $C_7H_{13}NNaOS^+$ [M+Na$^+$]: 182.0610, found 182.0610.

2-(Methylthio)-1-phenylethan-1-one (1t):[6]

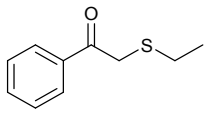


1t

From 2-bromoacetophenone (995 mg, 5.0 mmol, 1.0 equiv) and sodium thiomethoxide (1.2 equiv) to give **1t** (774 mg, 86%) as colorless oil; R_f = 0.56 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.98 (d, *J* = 7.5

Hz, 2 H), 7.60 – 7.54 (m, 1 H), 7.50 – 7.43 (m, 2 H), 3.76 (s, 2 H), 2.13 (s, 3 H),. ^{13}C NMR (100 MHz, $CDCl_3$): δ 193.9, 135.0, 133.2, 128.6, 128.5, 38.9, 15.8.

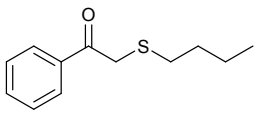
2-(Ethylthio)-1-phenylethan-1-one (1u):[6]



1u

From 2-bromoacetophenone (995 mg, 5.0 mmol, 1.0 equiv) and ethanethiol (372 mg, 6.0 mmol, 1.2 equiv) to give **1u** (774 mg, 86%) as colorless oil; R_f = 0.4 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.98 (dt, *J* = 7.3, 1.4 Hz, 2 H), 7.60 – 7.55 (m, 1 H), 7.47 (dd, *J* = 8.4, 7.0 Hz, 2 H), 3.80 (s, 2 H), 2.59 (q, *J* = 7.4 Hz, 2 H), 1.27 (t, *J* = 7.4 Hz, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.5, 135.2, 133.3, 128.7, 128.6, 36.7, 26.3, 14.1.

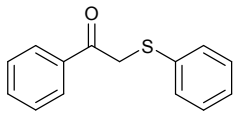
2-(Butylthio)-1-phenylethan-1-one (1v):[6]



1v

From 2-bromo-1-ethanone (995 mg, 5.0 mmol, 1.0 equiv) and butanethiol (540 mg, 6.0 mmol, 1.2 equiv) to give **1v** (874 mg, 84%) as colorless oil; R_f = 0.4 (silica gel, petroleum ether:EtOAc, 50:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.00 – 7.95 (m, 2 H), 7.60 – 7.55 (m, 1 H), 7.47 (td, *J* = 7.8, 7.4, 1.6 Hz, 2 H), 3.78 (s, 2 H), 2.57 (dd, *J* = 8.0, 6.8 Hz, 2 H), 1.64 – 1.54 (m, 2 H), 1.42 – 1.36 (m, *J* = 7.3 Hz, 2 H), 0.90 (t, *J* = 7.4 Hz, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 194.5, 135.3, 133.2, 128.7, 128.6, 37.1, 32.0, 31.0, 21.8, 13.6.

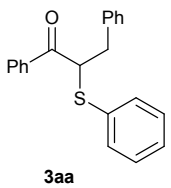
1-Phenyl-2-(phenylthio)ethan-1-one (1w):[5]



1w

Prepared according to general procedure **A**, from 2-bromo-1-ethanone (995 mg, 5.0 mmol, 1.0 equiv) and thiophenol (660 mg, 6.0 mmol, 1.2 equiv) to give **1w** (1.08 g, 95%) as colorless oil; R_f = 0.7 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96 – 7.91 (m, 2 H), 7.57 (t, *J* = 7.4 Hz, 1 H), 7.46 (t, *J* = 7.7 Hz, 2 H), 7.39 (d, *J* = 7.3 Hz, 2 H), 7.30 – 7.18 (m, 3 H), 4.27 (s, 2 H).

1,3-Diphenyl-2-(phenylthio)propan-1-one (3aa):[7]

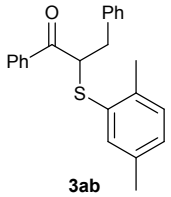


3aa

Prepared according to general procedure **B**, from 2-(benzylthio)-1-phenylethan-1-

one **1a** (48 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3aa** (52 mg, 82%) as white solid; R_f = 0.68 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83 (d, *J* = 7.6 Hz, 2 H), 7.51 (t, *J* = 7.2 Hz, 1 H), 7.39 (t, *J* = 7.6 Hz, 2 H), 7.32 – 7.15 (m, 10 H), 4.71 (dd, *J* = 8.4, 6.4 Hz, 1 H), 3.42 (dd, *J* = 14.0, 8.4 Hz, 1 H), 3.15 (dd, *J* = 14.0, 6.0 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.2, 138.6, 136.2, 134.5, 133.0, 132.0, 129.3, 129.0, 128.7, 128.5, 128.5, 128.5, 126.6, 52.9, 37.3.

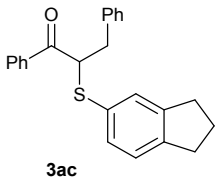
2-((2,5-Dimethylphenyl)thio)-1,3-diphenylpropan-1-one (3ab):



3ab

Prepared according to general procedure **B**, from 2-(benzylthio)-1-phenylethan-1-one **1a** (48 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2b** (78 mg, 1.2 equiv) to give **3ab** (47 mg, 69%) as yellow oil; R_f = 0.65 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.70 (d, *J* = 7.2 Hz, 2 H), 7.47 (t, *J* = 7.2 Hz, 1 H), 7.31 (t, *J* = 7.6 Hz, 2 H), 7.26 – 7.15 (m, 5 H), 7.02 (d, *J* = 8.0 Hz, 1 H), 6.98 – 6.94 (m, 2 H), 4.66 (dd, *J* = 8.8, 6.0 Hz, 1 H), 3.48 (dd, *J* = 14.0, 8.8 Hz, 1 H), 3.18 (dd, *J* = 14.0, 6.0 Hz, 1 H), 2.18 (s, 3 H), 2.17 (s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 196.1, 138.7, 138.2, 136.4, 136.0, 135.0, 132.9, 132.0, 130.2, 129.3, 128.5, 128.4, 128.3, 126.6, 53.2, 37.6, 20.7, 20.3. HRMS (ESI): calcd for $C_{23}H_{22}NaOS^+$ [M+Na$^+$]: 369.1284, found 369.1281.

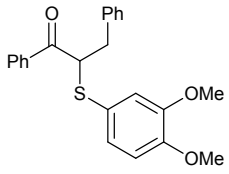
2-((2,3-Dihydro-1H-inden-5-yl)thio)-1,3-diphenylpropan-1-one (3ac):



3ac

Prepared according to general procedure **B**, from 2-(benzylthio)-1-phenylethan-1-one **1a** (48 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2c** (81 mg, 1.2 equiv) to give **3ac** (51 mg, 71%) as yellow oil; R_f = 0.61 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (d, *J* = 7.6 Hz, 2 H), 7.51 (t, *J* = 7.6 Hz, 1 H), 7.38 (t, *J* = 8.0 Hz, 2 H), 7.25 – 7.15 (m, 5 H), 7.11 (d, *J* = 8.4 Hz, 2 H), 7.06 (d, *J* = 8.0 Hz, 1 H), 4.64 (dd, *J* = 8.4, 6.0 Hz, 1 H), 3.39 (dd, *J* = 14.0, 8.0 Hz, 1 H), 3.19 (dd, *J* = 14.0, 6.0 Hz, 1 H), 2.87 (t, *J* = 7.6 Hz, 2 H), 2.83 (dd, *J* = 9.2, 6.8 Hz, 2 H), 2.10 – 2.02 (m, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.2, 145.6, 145.2, 138.9, 136.3, 133.0, 132.9, 131.2, 129.3, 128.6, 128.5, 128.4, 128.4, 126.4, 124.8, 53.1, 37.2, 32.6, 32.6, 25.4. HRMS (ESI): calcd for $C_{24}H_{22}NaOS^+$ [M+Na$^+$]: 381.1284, found 381.1280.

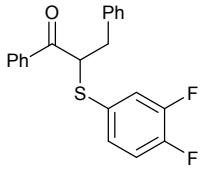
2-((3,4-Dimethoxyphenyl)thio)-1,3-diphenylpropan-1-one (3ad):



3ad

Prepared according to general procedure **B**, from 2-(benzylthio)-1-phenylethan-1-one **1a** (48 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2d** (86 mg, 1.2 equiv) to give **3ad** (47 mg, 63%) as colorless oil; R_f = 0.65 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (d, *J* = 7.2 Hz, 2 H), 7.53 (t, *J* = 7.6 Hz, 1 H), 7.40 (t, *J* = 7.6 Hz, 2 H), 7.28 – 7.16 (m, 4 H), 6.88 (dd, *J* = 8.2, 2.0 Hz, 1 H), 6.75 (d, *J* = 8.4 Hz, 1 H), 6.65 (d, *J* = 2.0 Hz, 1 H), 4.60 (dd, *J* = 7.6, 6.8 Hz, 1 H), 3.87 (s, 3 H), 3.72 (s, 3 H), 3.36 (dd, *J* = 14.0, 8.0 Hz, 1 H), 3.13 (dd, *J* = 14.0, 6.8 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.1, 150.0, 148.6, 138.8, 136.2, 133.0, 129.4, 128.7, 128.5, 128.5, 128.4, 126.5, 122.2, 118.2, 111.1, 55.8, 55.8, 53.3, 36.9. HRMS (ESI): calcd for $C_{23}H_{22}NaO_3S^+$ [M+Na$^+$]: 401.1182, found 401.1179.

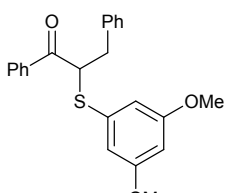
2-((3,4-Difluorophenyl)thio)-1,3-diphenylpropan-1-one (3ae):



3ae

Prepared according to general procedure **B**, from 2-(benzylthio)-1-phenylethan-1-one **1a** (48 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2e** (80 mg, 1.2 equiv) to give **3ae** (55 mg, 78%) as colorless oil; R_f = 0.72 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83 (d, *J* = 7.6 Hz, 2 H), 7.55 (t, *J* = 7.2 Hz, 1 H), 7.42 (t, *J* = 7.6 Hz, 2 H), 7.30 – 7.18 (m, 5 H), 7.08 – 6.97 (m, 3 H), 4.66 (dd, *J* = 8.0, 6.8 Hz, 1 H), 3.36 (dd, *J* = 14.0, 8.0 Hz, 1 H), 3.11 (dd, *J* = 14.0, 6.4 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.8, 138.2, 135.9, 133.3, 131.7 (dd, *J* = 6.3, 3.7 Hz), 129.3, 128.6, 128.5, 128.4, 126.8, 124.0 (dd, *J* = 16.0, 2.5 Hz), 117.6 (dd, *J* = 16.8, 1.6 Hz), 52.8, 37.0. HRMS (ESI): calcd for $C_{21}H_{16}F_2NaOS^+$ [M+Na$^+$]: 377.0782, found 377.0781.

2-((3,5-Dimethoxyphenyl)thio)-1,3-diphenylpropan-1-one (3af):

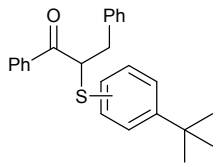


3af

Prepared according to general procedure **B**, from 2-(benzylthio)-1-phenylethan-1-one **1a** (48 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2f** (86 mg, 1.2 equiv) to give **3af** (50 mg, 67%) as colorless oil; R_f = 0.65 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR

(400 MHz, $CDCl_3$): δ 7.81 (d, *J* = 7.2 Hz, 2 H), 7.51 (t, *J* = 7.6 Hz, 1 H), 7.38 (t, *J* = 7.6 Hz, 2 H), 7.27 – 7.16 (m, 5 H), 6.39 – 6.36 (m, 3 H), 4.72 (dd, *J* = 7.9, 6.7 Hz, 1 H), 3.68 (s, 6 H), 3.45 (dd, *J* = 14.0, 8.0 Hz, 1 H), 3.17 (dd, *J* = 14.0, 6.6 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.6, 160.6, 138.6, 136.2, 134.4, 133.0, 129.4, 128.5, 128.4, 126.6, 111.0, 101.2, 55.4, 55.4, 53.3, 37.5. HRMS (ESI): calcd for $C_{23}H_{22}NaO_3S^+$ [M+Na^+]: 401.1182, found 401.1179.

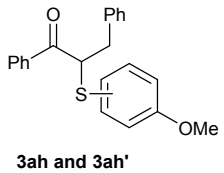
2-((4-(tert-Butyl)phenyl)thio)-1,3-diphenylpropan-1-one (3ag) and 2-((3-(tert-butyl)phenyl) thio)-1,3-diphenylpropan-1-one (3ag'):



3ag and 3ag'

Prepared according to general procedure **B**, from 2-(benzylthio)-1-phenylethan-1-one **1a** (48 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2g** (85 mg, 1.2 equiv) to give **3ag** and **3ag'** (ratio = 5:3, 54 mg, 73%) as colorless oil; R_f = 0.73 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83 – 7.80 (m, 2 H), 7.51 (t, *J* = 7.4 Hz, 1 H), 7.37 (t, *J* = 7.8 Hz, 2 H), 7.34 – 7.09 (m, 9 H), 4.71 – 4.65 (m, 1 H), 3.44 – 3.36 (m, 1 H), 3.18 – 3.11 (m, 1 H), 1.30 (s, 3.3 H), 1.24 (s, 5.7 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.3, 152.0, 138.7, 136.2, 134.5, 133.0, 131.9, 131.5, 129.3, 128.7, 128.5, 128.4, 126.5, 126.0, 125.8, 53.0, 37.1, 34.7, 31.1 (3 C). HRMS (ESI): calcd for $C_{25}H_{26}NaOS^+$ [M+Na^+]: 397.1597, found 397.1596.

2-((4-Methoxyphenyl)thio)-1,3-diphenylpropan-1-one (3ah) and 2-((3-methoxyphenyl)thio)-1,3-diphenylpropan-1-one (3ah'):

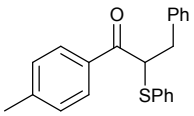


3ah and 3ah'

Prepared according to general procedure **B**, from 2-(benzylthio)-1-phenylethan-1-one **1a** (48 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2h** (78 mg, 1.2 equiv) to give **3ah** and **3ah'** (ratio = 4:3, 41 mg, 60%) as colorless oil; R_f = 0.58 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86 (d, *J* = 7.6 Hz, 2 H), 7.82 (d, *J* = 7.6 Hz, 2.6 H), 7.54 – 7.48 (m, 2.4 H), 7.42 – 7.32 (m, 4.8 H), 7.27 – 7.15 (m, 15.6 H), 6.88 – 6.76 (m, 5.6 H), 4.71 (dd, *J* = 7.9, 6.6 Hz, 1 H), 4.58 (dd, *J* = 8.4, 6.0 Hz, 1.4 H), 3.79 (s, 4.3 H), 3.70 (s, 2.9 H), 3.43 (dd, *J* = 14.0, 8.2 Hz, 1 H), 3.33 (dd, *J* = 14.0, 8.4 Hz, 1.4 H), 3.16 (dd, *J* = 14.0, 6.4 Hz, 1 H), 3.09 (dd, *J* = 14.0, 6.0 Hz, 1.4 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.4, 194.8, 160.6, 159.6, 138.8, 138.6, 137.4, 136.2, 136.0, 133.3, 133.0, 132.9, 129.7, 129.3, 129.2, 128.5, 128.4, 128.4, 126.6, 126.5, 126.2,

121.5, 118.9, 114.8, 114.4, 55.2, 53.0, 52.8, 37.3, 36.8. HRMS (ESI): calcd for $C_{22}H_{20}NaO_2S^+$ [M+Na$^+$]: 371.1076, found 371.1076.

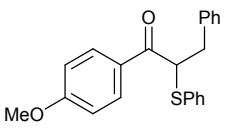
3-Phenyl-2-(phenylthio)-1-(p-tolyl)propan-1-one (3ba):



3ba

Prepared according to general procedure **B**, from 2-(benzylthio)-1-(p-tolyl)ethan-1-one **1b** (51 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ba** (48 mg, 73%) as colorless oil; R_f = 0.48 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.74 (d, *J* = 8.0 Hz, 2 H), 7.31 – 7.15 (m, 12 H), 4.68 (dd, *J* = 8.0, 6.4 Hz, 1 H), 3.39 (dd, *J* = 14.0, 8.4 Hz, 1 H), 3.12 (dd, *J* = 14.0, 6.1 Hz, 1 H), 2.38 (s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.1, 150.0, 148.6, 138.8, 136.2, 133.0, 129.4, 128.7, 128.5, 128.5, 128.4, 126.5, 122.2, 118.2, 111.1, 55.8, 55.8, 53.3, 36.9. HRMS (ESI): calcd for $C_{22}H_{20}NaOS^+$ [M+Na$^+$]: 355.1127, found 355.1126.

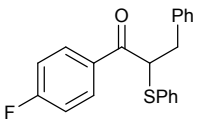
1-(4-Methoxyphenyl)-3-phenyl-2-(phenylthio)propan-1-one (3ca):



3ca

Prepared according to general procedure **B**, from 2-(benzylthio)-1-(4-methoxyphenyl)ethan-1-one **1c** (54 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ca** (45 mg, 65%) as colorless oil; R_f = 0.45 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 (d, *J* = 8.8 Hz, 2 H), 7.30 – 7.14 (m, 10 H), 6.85 (d, *J* = 8.8 Hz, 2 H), 4.67 (dd, *J* = 8.2, 6.4 Hz, 1 H), 3.83 (s, 3 H), 3.40 (dd, *J* = 14.0, 6.1 Hz, 1 H), 3.12 (dd, *J* = 14.0, 6.1 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.0, 163.5, 138.8, 134.2, 132.5, 130.8, 129.3, 129.0, 128.9, 128.5, 128.4, 126.5, 113.7, 55.4, 52.7, 37.5. HRMS (ESI): calcd for $C_{22}H_{20}NaO_2S^+$ [M+Na$^+$]: 371.1076, found 371.1073.

1-(4-Fluorophenyl)-3-phenyl-2-(phenylthio)propan-1-one (3da):

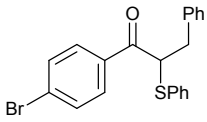


3da

Prepared according to general procedure **B**, from 2-(benzylthio)-1-(4-fluorophenyl)ethan-1-one **1d** (52 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3da** (51 mg, 76%); R_f = 0.54 (silica gel, petroleum ether:EtOAc, 10:1) as colorless oil; ^{1}H NMR (400 MHz,

$CDCl_3$): δ 7.85 – 7.80 (m, 2 H), 7.33 – 7.15 (m, 10 H), 7.03 (t, *J* = 8.6 Hz, 2 H), 4.64 (dd, *J* = 8.5, 6.1 Hz, 1 H), 3.40 (dd, *J* = 14.0, 8.5 Hz, 1 H), 3.14 (dd, *J* = 14.0, 6.1 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 193.8, 165.6 (d, *J* = 53.7 Hz), 138.5, 134.5, 132.5 (d, *J* = 13.0 Hz), 131.9, 131.1 (d, *J* = 92.4 Hz), 129.3, 129.0, 128.8, 128.5, 126.6, 115.6 (d, *J* = 21.8 Hz), 53.0, 37.3. HRMS (ESI): calcd for $C_{21}H_{17}FNaOS^+$ [M+Na$^+$]: 359.0876, found 359.0874.

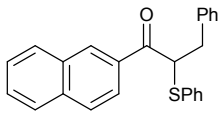
1-(4-Bromophenyl)-3-phenyl-2-(phenylthio)propan-1-one (3ea):



3ea

Prepared according to general procedure **B**, from 2-(benzylthio)-1-(4-bromophenyl)ethan-1-one **1e** (64 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ea** (57 mg, 72%) as colorless oil; R_f = 0.49 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67 (d, *J* = 8.5 Hz, 2 H), 7.50 (d, *J* = 8.4 Hz, 2 H), 7.33 – 7.16 (m, 10 H), 4.61 (dd, *J* = 8.4, 6.1 Hz, 1 H), 3.39 (dd, *J* = 14.0, 8.8 Hz, 1 H), 3.14 (dd, *J* = 14.0, 6.1 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.2, 138.5, 134.9, 134.6, 131.8, 131.7, 130.0, 129.3, 129.1, 128.9, 128.5, 128.2, 126.7, 53.0, 37.2. HRMS (ESI): calcd for $C_{21}H_{17}BrNaOS^+$ [M+Na$^+$]: 419.0076, found 419.0072.

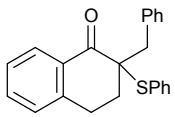
1-(Naphthalen-2-yl)-3-phenyl-2-(phenylthio)propan-1-one (3fa):



3fa

Prepared according to general procedure **B**, from 2-(benzylthio)-1-(naphthalen-2-yl)ethan-1-one **1f** (58 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3fa** (51 mg, 70%) as yellow oil; R_f = 0.52 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.22 (s, 1 H), 7.95 (dd, *J* = 8.7, 1.6 Hz, 1 H), 7.84 (d, *J* = 8.5 Hz, 2 H), 7.78 (d, *J* = 8.1 Hz, 1 H), 7.57 (ddd, *J* = 8.2, 6.9, 1.3 Hz, 1 H), 7.50 (ddd, *J* = 8.1, 6.8, 1.3 Hz, 1 H), 7.33 – 7.23 (m, 9 H), 7.21 – 7.16 (m, 1 H), 4.83 (dd, *J* = 8.2, 6.3 Hz, 1 H), 3.47 (dd, *J* = 14.0, 8.2 Hz, 1 H), 3.21 (dd, *J* = 14.0, 6.3 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.1, 138.7, 135.5, 134.6, 133.3, 132.3, 132.2, 130.1, 129.6, 129.4, 129.0, 128.8, 128.5, 128.3, 127.7, 126.6, 126.6, 124.3, 53.3, 37.3. HRMS (ESI): calcd for $C_{25}H_{20}NaOS^+$ [M+Na$^+$]: 391.1127, found 391.1127.

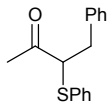
2-Benzyl-2-(phenylthio)-3,4-dihydronaphthalen-1(2*H*)-one (3ga):



3ga

Prepared according to general procedure **B**, from 2-(benzylthio)-3,4-dihydronaphthalen-1(2H)-one **1g** (53 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ga** (42 mg, 61%) as colorless oil; R_f = 0.57 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.11 (d, *J* = 7.8 Hz, 1 H), 7.46 – 7.38 (m, 4 H), 7.36 – 7.29 (m, 3 H), 7.20 – 7.10 (m, 6 H), 3.62 (d, *J* = 13.6 Hz, 1 H), 3.47 (ddd, *J* = 17.5, 12.7, 5.0 Hz, 1 H), 2.92 (d, *J* = 13.6 Hz, 1 H), 2.80 (ddd, *J* = 17.3, 5.1, 2.4 Hz, 1 H), 2.28 (td, *J* = 13.5, 13.1, 5.0 Hz, 1 H), 2.16 (ddd, *J* = 14.4, 5.1, 2.4 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.1, 142.3, 137.5, 137.1, 133.0, 131.7, 131.0, 129.7, 129.3, 128.8, 128.5, 128.4, 128.0, 126.7, 126.5, 58.9, 42.6, 31.9, 25.5. HRMS (ESI): calcd for $C_{23}H_{20}NaOS^+$ [M+Na$^+$]: 367.1127, found 367.1125.

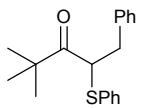
4-Phenyl-3-(phenylthio)butan-2-one (3ha):[8]



3ha

Prepared according to general procedure **B**, from 1-(benzylthio)propan-2-one **1h** (36 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ha** (31 mg, 62%) as colorless oil; R_f = 0.46 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.37 – 7.16 (m, 10 H), 3.90 (dd, *J* = 8.3, 6.8 Hz, 1 H), 3.17 (dd, *J* = 14.2, 8.4 Hz, 1 H), 3.00 (dd, *J* = 14.2, 6.8 Hz, 1 H), 2.20 (s, 3H).

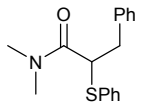
4,4-Dimethyl-1-phenyl-2-(phenylthio)pentan-3-one (3ia):



3ia

Prepared according to general procedure **B**, from 1-(benzylthio)-3,3-dimethylbutan-2-one **1i** (44 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ia** (35 mg, 59%) as colorless oil; R_f = 0.56 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.42 – 7.38 (m, 2 H), 7.35 – 7.31 (m, 3 H), 7.25 – 7.14 (m, 3 H), 7.09 (d, *J* = 7.4 Hz, 2 H), 4.19 (dd, *J* = 10.2, 4.8 Hz, 1 H), 3.21 (dd, *J* = 13.3, 10.1 Hz, 1 H), 3.00 (dd, *J* = 13.3, 4.8 Hz, 1 H), 0.93 (s, 9 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 210.3, 138.6, 133.8, 132.9, 129.5, 129.0, 128.4, 128.4, 126.6, 51.9, 44.1, 39.1, 26.3. HRMS (ESI): calcd for $C_{19}H_{22}NaOS^+$ [M+Na$^+$]: 321.1284, found 321.1280.

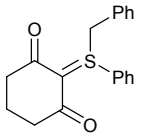
***N*,*N*-dimethyl-3-phenyl-2-(phenylthio)propanamide (3ja):**



3ja

Prepared according to general procedure **B**, from 2-(benzylthio)-N,N-dimethylacetamide **1j** (42 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ja** (32 mg, 57%) as colorless oil; R_f = 0.69 (silica gel, petroleum ether:EtOAc, 1:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.48 – 7.44 (m, 2 H), 7.33 – 7.15 (m, 8 H), 4.13 (dd, *J* = 9.6, 5.2 Hz, 1 H), 3.37 (dd, *J* = 13.5, 9.5 Hz, 1 H), 3.02 (dd, *J* = 13.5, 5.1 Hz, 1 H), 2.86 (s, 2 H), 2.68 (s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.3, 138.8, 133.5, 133.3, 129.1, 129.0, 128.4, 128.2, 126.6, 49.5, 39.0, 37.2, 36.0. HRMS (ESI): calcd for $C_{17}H_{19}NNaOS^+$ [M+Na^+]: 308.1080, found 308.1078.

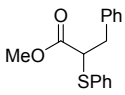
2-(Benzyl(phenyl)-λ^4-sulfanylidene)cyclohexane-1,3-dione (3ka):



3ka

Prepared according to general procedure **B**, from 2-(benzylthio)cyclohexane-1,3-dione **1k** (46 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ka** (42 mg, 68%) as colorless oil; R_f = 0.32 (silica gel, pure EtOAc); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.78 – 7.75 (m, 2 H), 7.52 – 7.47 (m, 1 H), 7.45 – 7.40 (m, 2 H), 7.33 – 7.26 (m, 5 H), 5.30 (d, *J* = 12.1 Hz, 1 H), 5.10 (d, *J* = 12.1 Hz, 1 H), 2.45 – 2.41 (m, 4 H), 1.92 – 1.85 (m, 2 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 193.5, 132.0, 130.5, 130.0, 129.7, 129.2, 129.0, 87.5, 77.2, 46.9, 38.2, 20.4. HRMS (ESI): calcd for $C_{19}H_{18}NaO_2S^+$ [M+Na^+]: 333.0920, found 333.0920.

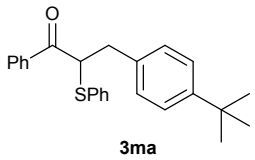
methyl 3-phenyl-2-(phenylthio)propanoate (3la):



3la

Prepared according to general procedure **B**, from methyl 2-(benzylthio)acetate **1l** (39 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3la** (28 mg, 53%) as colorless oil; R_f = 0.46 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.46 – 7.16 (m, 10 H), 3.90 (dd, *J* = 9.2, 6.3 Hz, 1 H), 3.58 (s, 3 H), 3.20 (dd, *J* = 13.9, 9.2 Hz, 1 H), 3.06 (dd, *J* = 13.9, 6.3 Hz, 1 H),. ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.1, 137.7, 133.1, 132.7, 129.0, 128.9, 128.5, 128.2, 126.9, 52.2, 52.1, 38.0. HRMS (ESI): calcd for $C_{16}H_{16}NaO_2S^+$ [M+Na^+]: 295.0763, found 295.0762.

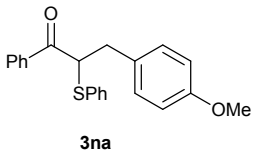
3-(4-(Tert-butyl)phenyl)-1-phenyl-2-(phenylthio)propan-1-one (3ma):



3ma

Prepared according to general procedure **B**, from 2-((4-(tert-butyl)benzyl)thio)-1-phenylethan-1-one **1m** (59 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ma** (50 mg, 67%) as colorless oil; R_f = 0.62 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85 – 7.81 (m, 2 H), 7.54 – 7.46 (m, 1 H), 7.41 – 7.35 (m, 2 H), 7.31 – 7.23 (m, 7 H), 7.17 – 7.13 (m, 2 H), 4.69 (dd, *J* = 8.3, 6.2 Hz, 1 H), 3.38 (dd, *J* = 14.1, 8.3 Hz, 1 H), 3.12 (dd, *J* = 14.1, 6.2 Hz, 1 H), 1.27 (s, 9 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.3, 149.4, 136.2, 135.6, 134.4, 132.9, 132.2, 128.9, 128.6, 128.5, 128.5, 125.4, 53.1, 36.8, 34.4, 31.3. HRMS (ESI): calcd for $C_{25}H_{26}NaOS^+$ [M+Na$^+$]: 397.1597, found 397.1594.

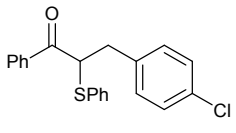
3-(4-Methoxyphenyl)-1-phenyl-2-(phenylthio)propan-1-one (3na):



3na

Prepared according to general procedure **B**, from 3-(4-methoxyphenyl)-1-phenyl-2-(phenylthio)propan-1-one **1n** (54 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3na** (28 mg, 41%) as colorless oil; R_f = 0.52 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85 – 7.80 (m, 2 H), 7.54 – 7.48 (m, 1 H), 7.39 (t, *J* = 7.7 Hz, 2 H), 7.33 – 7.22 (m, 5 H), 7.16 – 7.11 (m, 2 H), 6.81 – 6.75 (m, 2 H), 4.66 (dd, *J* = 8.6, 6.0 Hz, 1 H), 3.75 (s, 3 H), 3.34 (dd, *J* = 14.1, 8.6 Hz, 1 H), 3.08 (dd, *J* = 14.1, 6.0 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.3, 158.2, 136.2, 134.5, 133.0, 132.0, 130.6, 130.3, 129.0, 128.7, 128.5, 113.8, 55.2, 53.0, 36.4. HRMS (ESI): calcd for $C_{22}H_{20}NaO_2S^+$ [M+Na$^+$]: 371.1076, found 371.1077.

3-(4-Chlorophenyl)-1-phenyl-2-(phenylthio)propan-1-one (3oa):

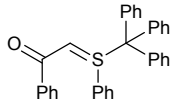


3oa

Prepared according to general procedure **B**, from 2-((4-chlorobenzyl)thio)-1-phenylethan-1-one **1o** (55 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **1a** (72 mg, 1.2 equiv) to give **3oa** (50 mg, 71%) as colorless oil; R_f = 0.54 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83 (d, *J* = 7.6 Hz, 2 H), 7.53 (t, *J* = 7.4 Hz, 1 H), 7.39 (t, *J* = 7.7 Hz, 2 H), 7.35 – 7.24 (m, 5 H), 7.21 (d, *J* = 8.4 Hz, 2 H), 7.15 (d, *J* = 8.4 Hz, 2 H), 4.65 (dd, *J* = 8.6, 6.0 Hz, 1 H), 3.36 (dd, *J* =

14.1, 8.6 Hz, 1 H), 3.10 (dd, J = 14.1, 6.0 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.9, 137.1, 136.0, 134.7, 133.1, 132.4, 131.6, 130.7, 129.0, 128.9, 128.6, 128.6, 128.5, 52.6, 36.6. HRMS (ESI): calcd for $C_{21}H_{17}ClNaOS^+$ [M+Na$^+$]: 375.0581, found 375.0577.

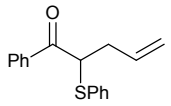
1,3,3,3-Tetraphenyl-2-(phenylthio)propan-1-one (3pa):



3pa

Prepared according to general procedure **B**, from 1-phenyl-2-(tritylthio)ethan-1-one **1p** (79 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3pa** (58 mg, 62%) as colorless oil; R_f = 0.55 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.47 – 7.23 (m, 18 H), 7.14 – 7.08 (m, 3 H), 7.01 (d, J = 4.3 Hz, 4 H), 5.86 (s, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 196.0, 138.6, 134.9, 133.5, 132.1, 130.6, 129.6, 128.8, 128.3, 128.2, 128.1, 128.0, 127.6, 126.7, 63.6, 61.5. HRMS (ESI): calcd for $C_{33}H_{26}NaOS^+$ [M+Na$^+$]: 493.1597, found 493.1594.

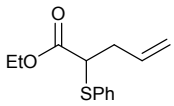
1-Phenyl-2-(phenylthio)pent-4-en-1-one (3qa):[9]



3qa

Prepared according to general procedure **B**, from 2-(allylthio)-1-phenylethan-1-one **1q** (38 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3qa** (46 mg, 86%) as colorless oil; R_f = 0.58 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94 – 7.89 (m, 2 H), 7.55 (t, J = 7.4 Hz, 1 H), 7.44 (t, J = 7.7 Hz, 2 H), 7.37 – 7.24 (m, 5 H), 5.88 (ddt, J = 17.1, 10.3, 6.8 Hz, 1 H), 5.15 – 5.05 (m, 2 H), 4.50 (t, J = 7.3 Hz, 1 H), 2.76 (dt, J = 14.7, 7.3 Hz, 1 H), 2.59 (dt, J = 14.3, 6.9 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.2, 136.1, 134.8, 133.1, 131.5, 128.9, 128.8, 128.6, 128.6, 117.7, 50.8, 35.1.

Ethyl 2-(phenylthio)pent-4-enoate (3ra):[10]

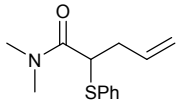


3ra

Prepared according to general procedure **B**, from ethyl 2-(allylthio)acetate **1r** (32 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ra** (29 mg, 62%) as colorless oil; R_f = 0.63 (silica gel, petroleum ether:EtOAc, 10:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.49 – 7.44 (m, 2 H), 7.34 – 7.27 (m, 3 H), 5.81 (ddt, J = 17.1, 10.2, 6.9 Hz, 1 H), 5.17 – 5.06 (m, 2 H), 4.11 (qd, J = 7.1, 1.8 Hz, 2 H), 3.70 (dd, J = 8.7, 6.4 Hz, 1

H), 2.67 – 2.58 (m, 1 H), 2.57 – 2.45 (m, 1 H), 1.17 (t, J = 7.1 Hz, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.6, 133.8, 133.1, 133.0, 128.9, 128.0, 118.0, 61.1, 50.2, 35.8, 14.1.

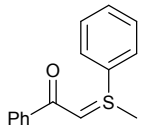
N,N-dimethyl-2-(phenylthio)pent-4-enamide (3sa):



3sa

Prepared according to general procedure **B**, from 2-(allylthio)-N,N-dimethylacetamide **1s** (31 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3sa** (25 mg, 53%) as colorless oil; R_f = 0.68 (silica gel, petroleum ether:EtOAc, 1:1); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.50 – 7.44 (m, 2 H), 7.34 – 7.27 (m, 3 H), 5.81 (ddt, J = 17.0, 10.1, 6.9 Hz, 1 H), 5.14 – 5.02 (m, 2 H), 3.90 (dd, J = 8.7, 5.9 Hz, 1 H), 2.94 (s, 6 H), 2.76 (dt, J = 14.8, 7.7 Hz, 1 H), 2.47 (dt, J = 13.8, 6.6 Hz, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.2, 135.1, 134.0, 132.6, 128.9, 128.3, 117.5, 47.2, 37.4, 36.5, 36.0. HRMS (ESI): calcd for $C_{13}H_{17}NNaOS^+$ [M+Na$^+$]: 258.0923, found 258.0924.

(*Z*)-2-(methyl(phenyl)-λ^4-sulfanylidene)-1-phenylethan-1-one (3ta)[11]:



3ta

Prepared according to general procedure **B**, from 2-(methylthio)-1-phenylethan-1-one **1t** (33 mg, 0.2 mmol, 1.0 equiv) and β-trimethylsilyltriflate **2a** (72 mg, 1.2 equiv) to give **3ta** (25 mg, 82%) as colorless oil; R_f = 0.25 (EtOAc); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.88 – 7.83 (m, 2 H), 7.78 – 7.72 (m, 3 H), 7.51 – 7.46 (m, 3 H), 7.39 – 7.33 (m, 3 H), 4.58 (s, 1 H), 3.20 (s, 3 H).

4. References

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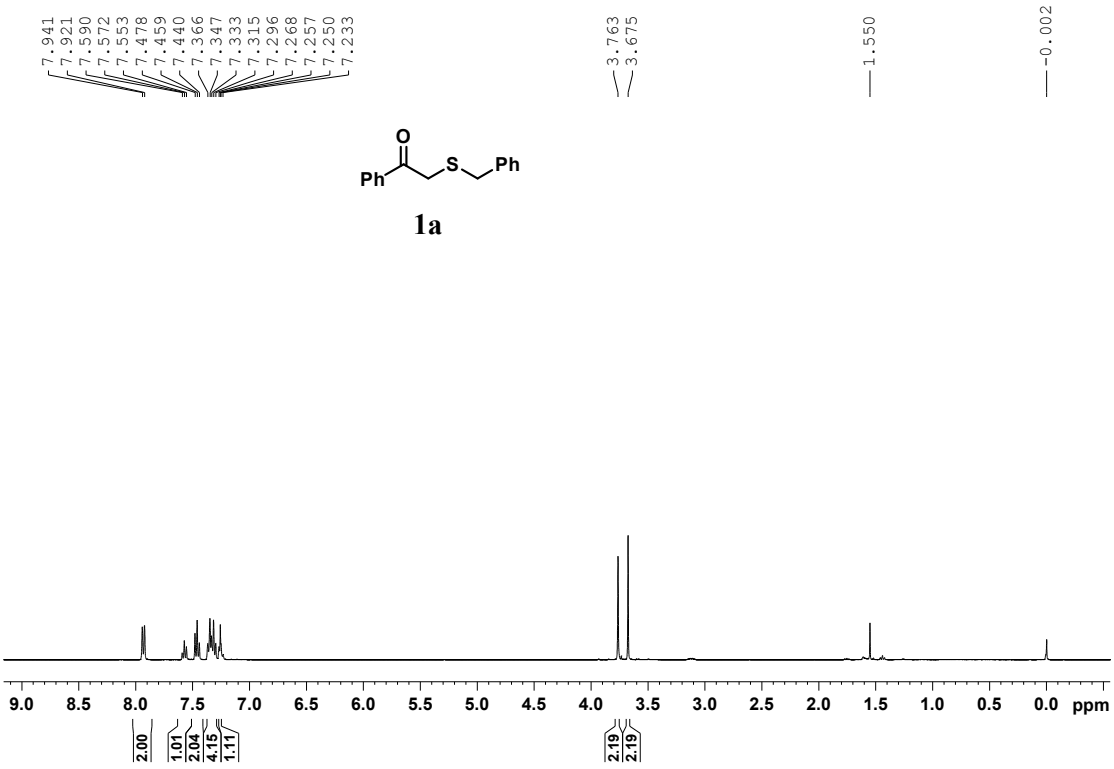
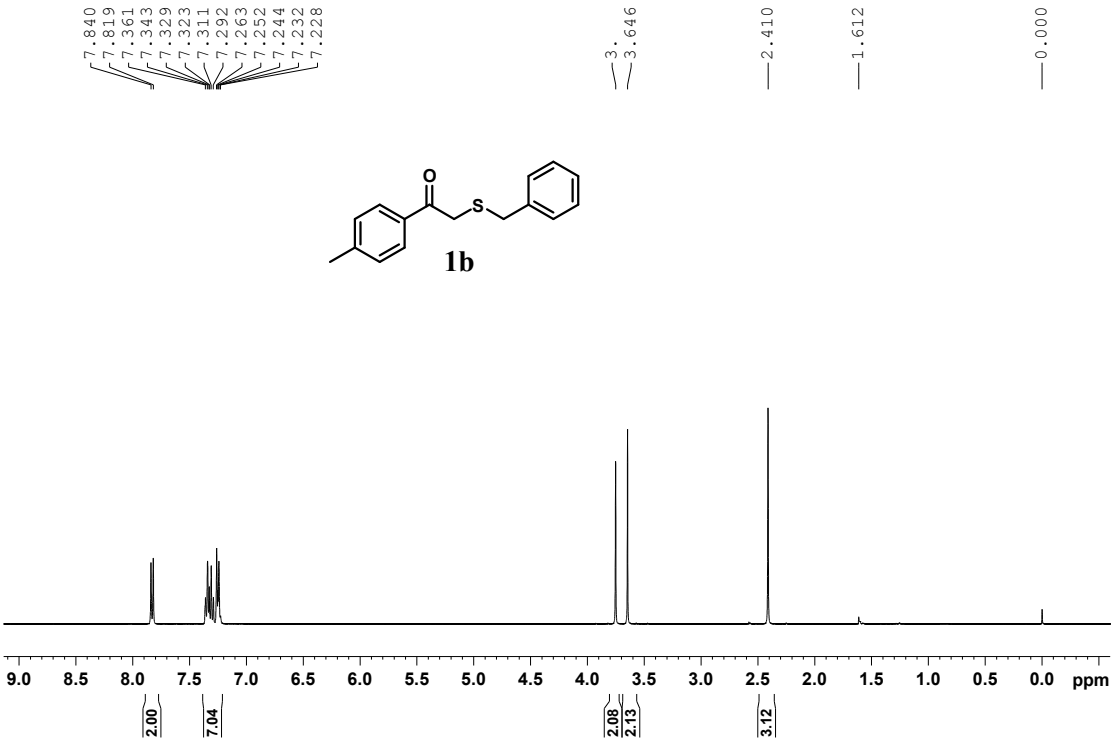
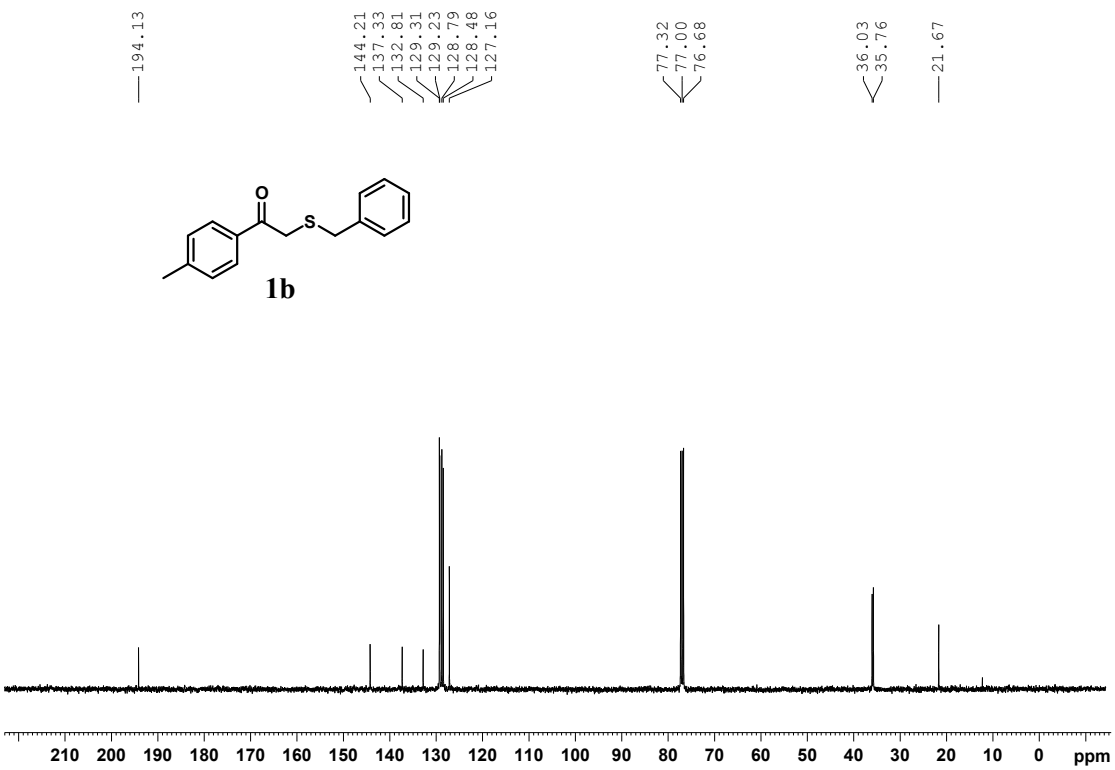
5. NMR Spectra

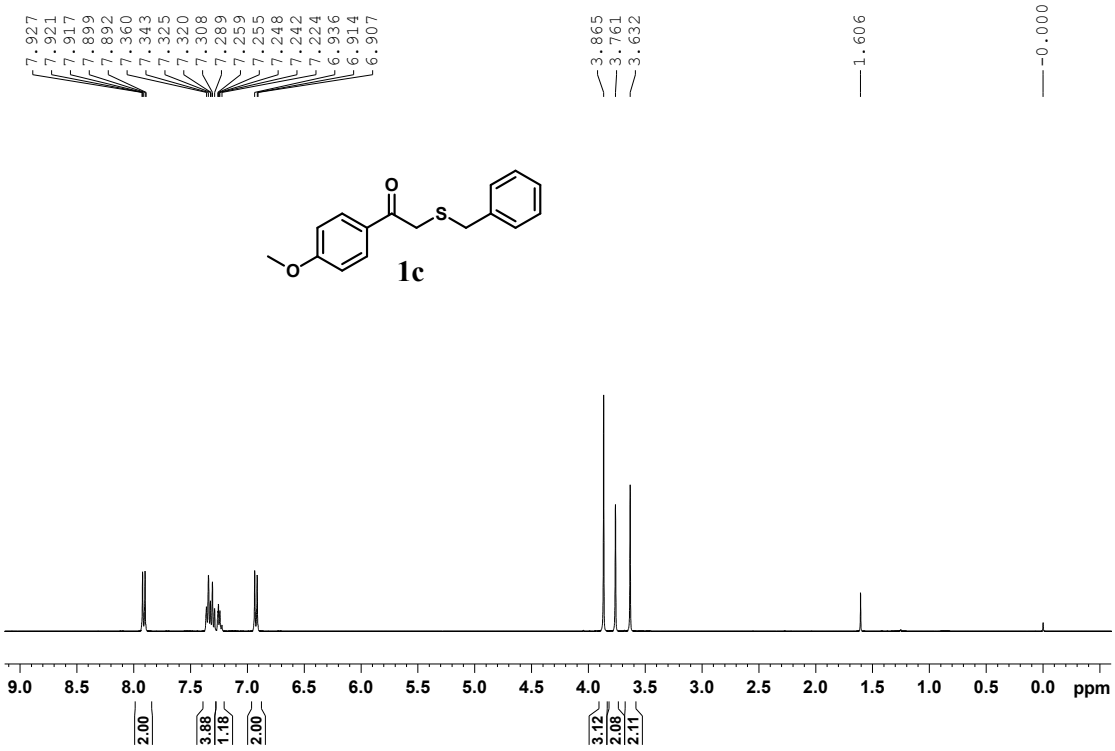


1a



1b


194.13
144.21
137.33
132.81
129.31
129.23
128.79
128.48
127.16
77.32
77.00
76.68
36.03
35.76
21.67
O
S
1b
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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7.921
7.917
7.899
7.892
7.360
7.343
7.325
7.320
7.308
7.289
7.259
7.255
7.248
7.242
7.224
6.936
6.914
6.907
3.865
3.761
3.632
1.606
0.000
O
S
O
1c
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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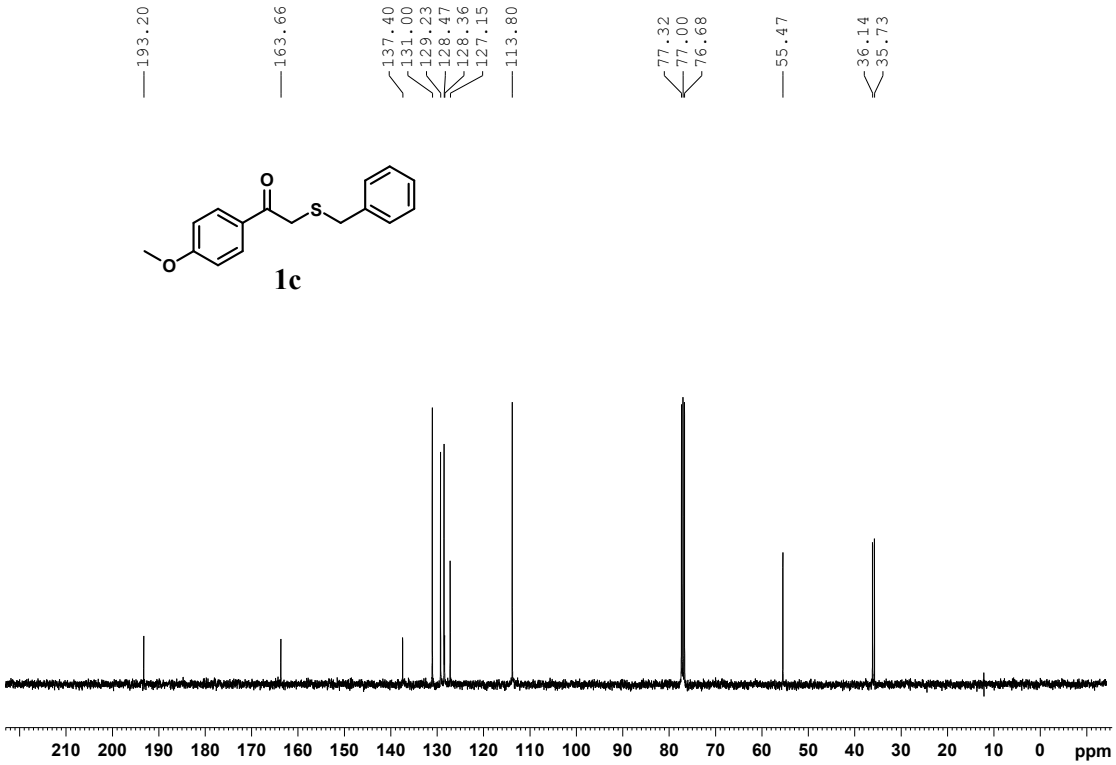
3.88
1.18
2.00
3.12
2.08
2.11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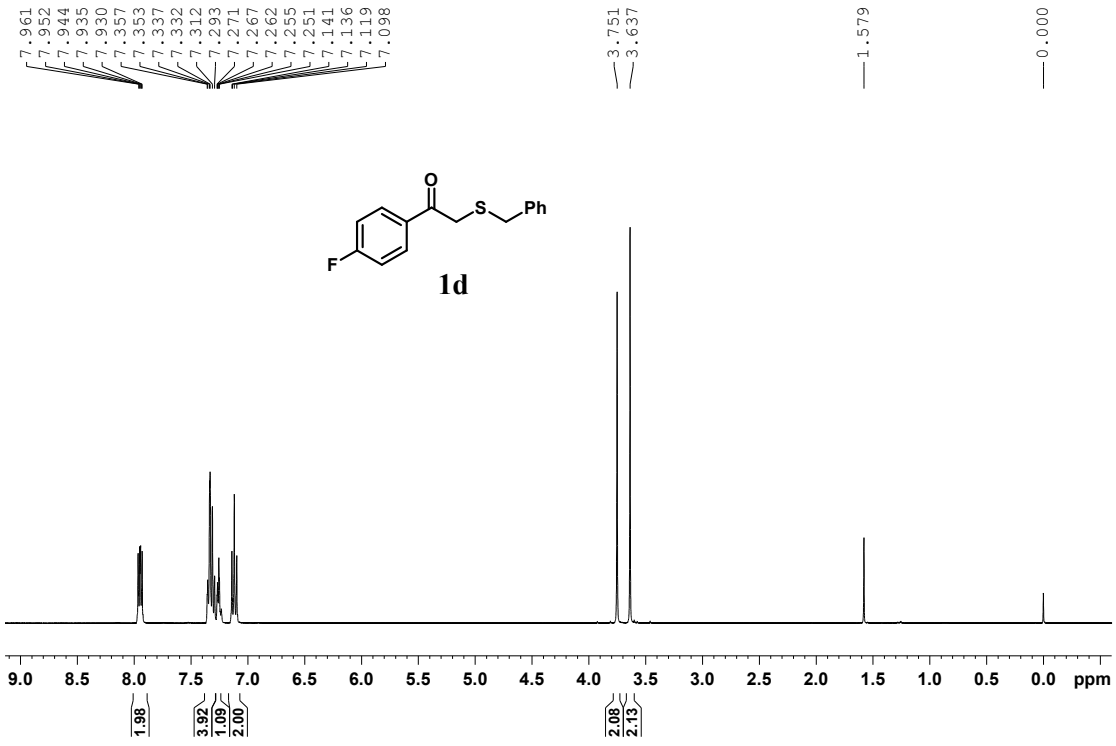
163.66
137.40
131.00
129.23
128.47
128.36
127.15
113.80
77.32
77.00
76.68
55.47
36.14
35.73
O
S
O
1c
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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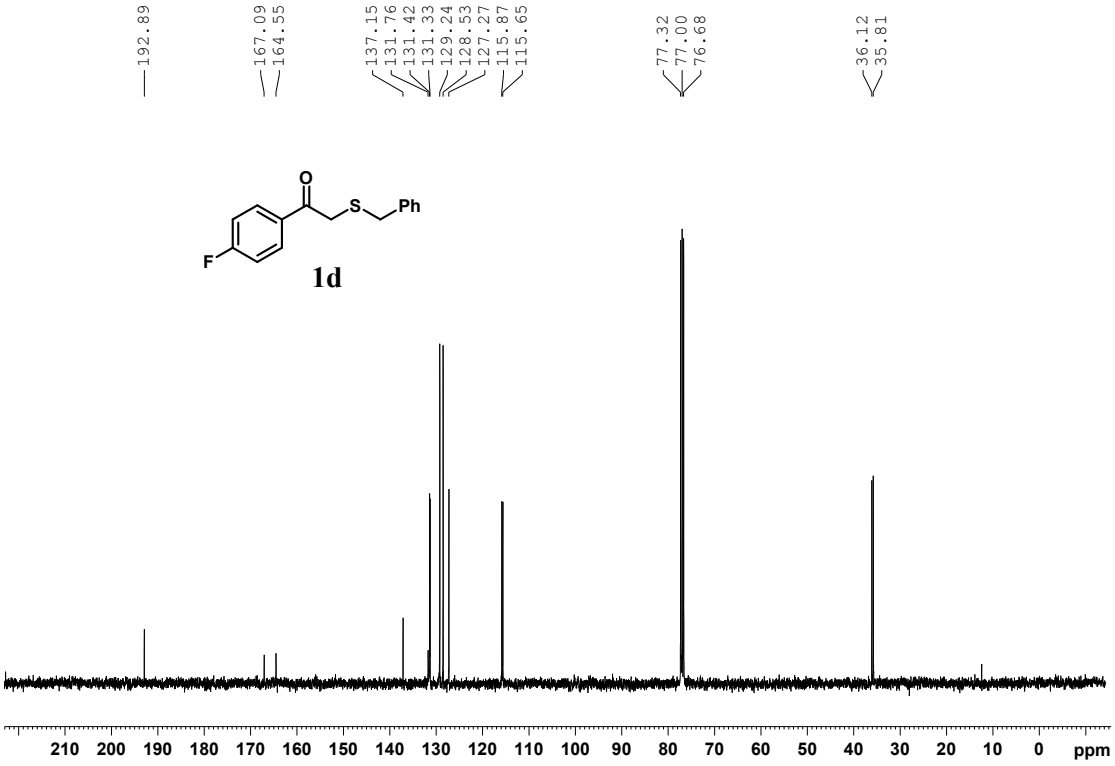
7.952
7.944
7.935
7.930
7.357
7.353
7.337
7.332
7.312
7.293
7.271
7.267
7.262
7.255
7.251
7.141
7.136
7.119
7.098
3.751
3.637
1.579
0.000
O
S
Ph
F
1d
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.98
3.92
1.09
2.00
2.08
2.13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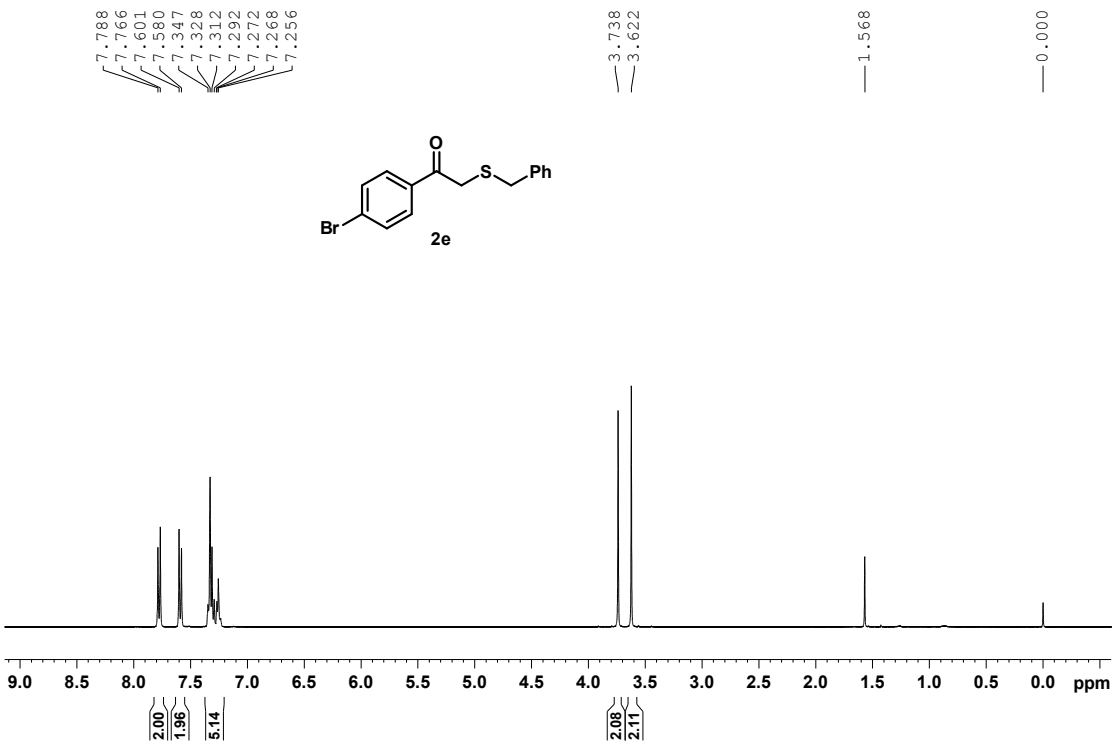
167.09
164.55
137.15
131.76
131.42
131.33
129.24
128.53
127.27
115.87
115.65
77.32
77.00
76.68
36.12
35.81
O
S
Ph
F
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

1d

1e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7.766
7.601
7.580
7.347
7.328
7.312
7.292
7.272
7.268
7.256
3.738
3.622
1.568
0.000
O
S
Ph
Br
2e
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
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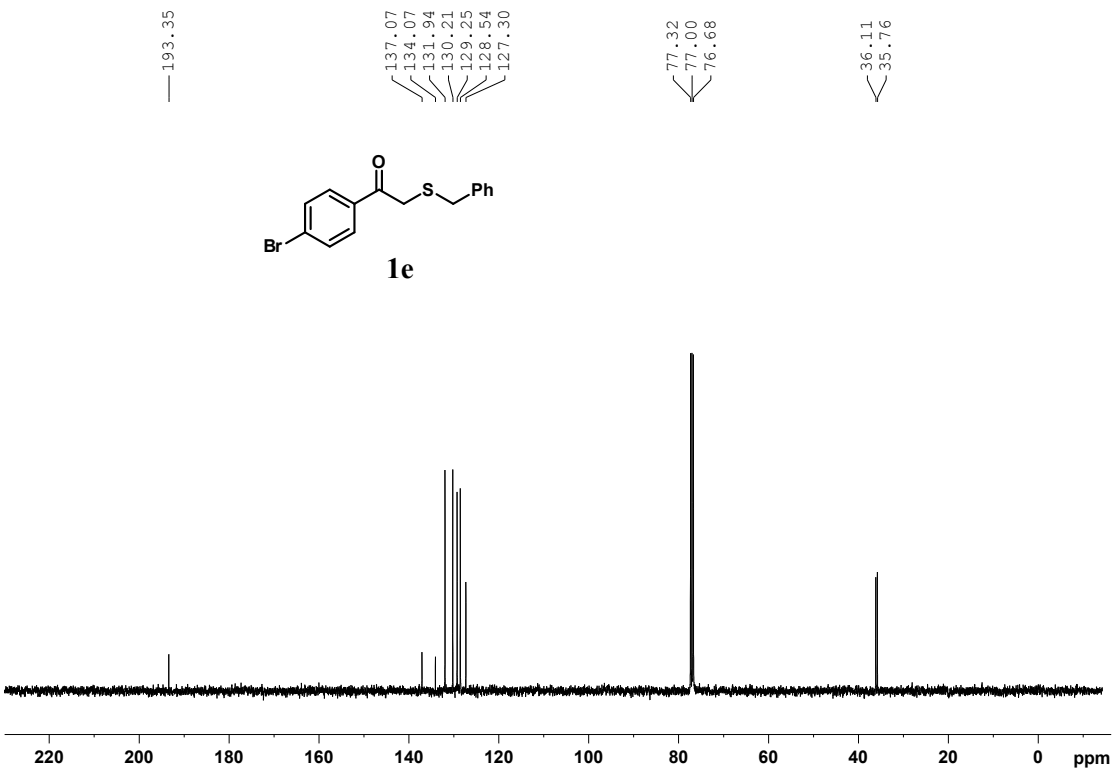
ppm
2.00
1.96
5.14
2.08
2.11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134.07
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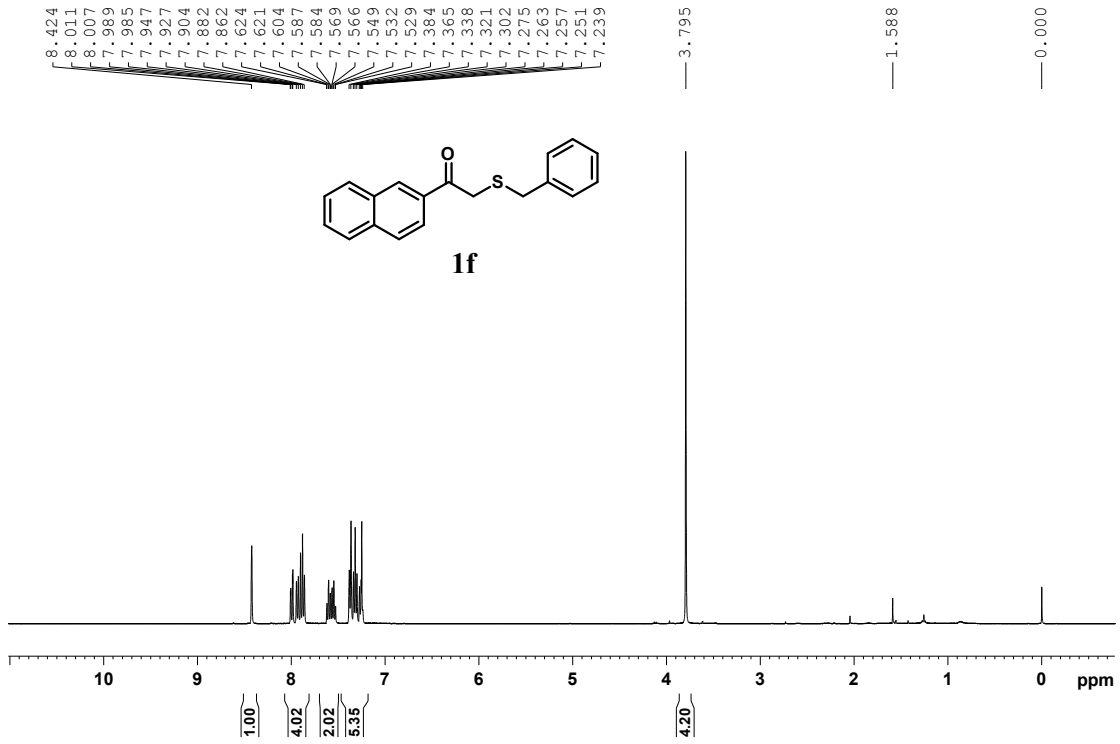
129.25
128.54
127.30
77.32
77.00
76.68
36.11
35.76
O
S
Ph
Br
220
200
180
160
140
120
100
80
60
40
20
0
ppm

1e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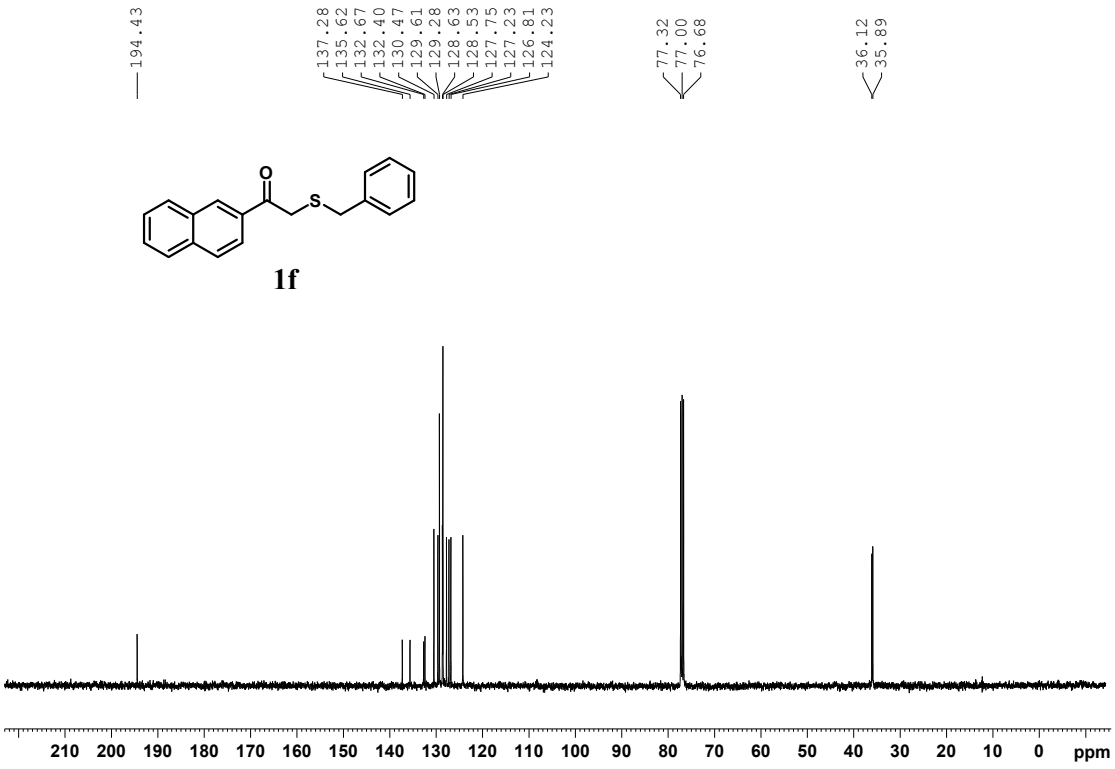
8.011
8.007
7.989
7.985
7.947
7.927
7.904
7.882
7.862
7.624
7.621
7.604
7.587
7.584
7.569
7.566
7.549
7.532
7.529
7.384
7.365
7.338
7.321
7.302
7.275
7.263
7.257
7.251
7.239
3.795
1.588
0.000
O
S
1f
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
4.02
2.02
5.35
4.20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127.23
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35.89
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S
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200
190
180
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140
130
120
110
100
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80
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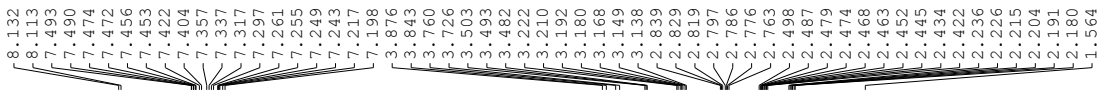
60
50
40
30
20
10
0
ppm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7.297
7.261
7.255
7.249
7.243
7.217
7.198
3.876
3.843
3.760
3.726
3.503
3.493
3.482
3.222
3.210
3.192
3.180
3.168
3.149
3.138
2.839
2.829
2.819
2.797
2.786
2.776
2.763
2.498
2.487
2.479
2.474
2.468
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2.445
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2.236
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2.215
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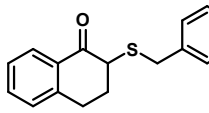
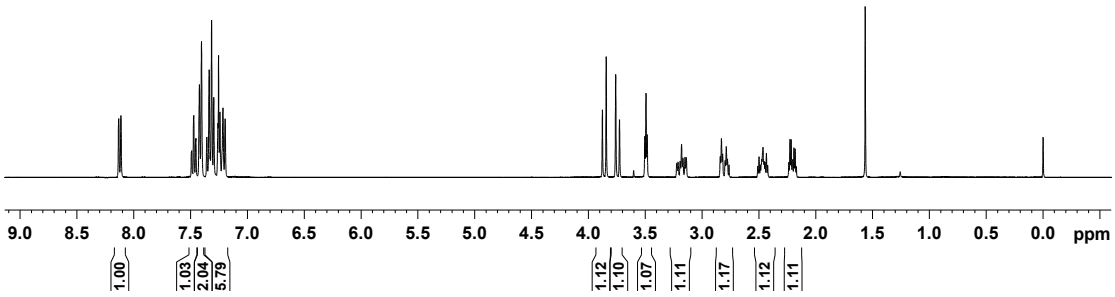
2.180
1.564


O
S

1g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1.03
2.04
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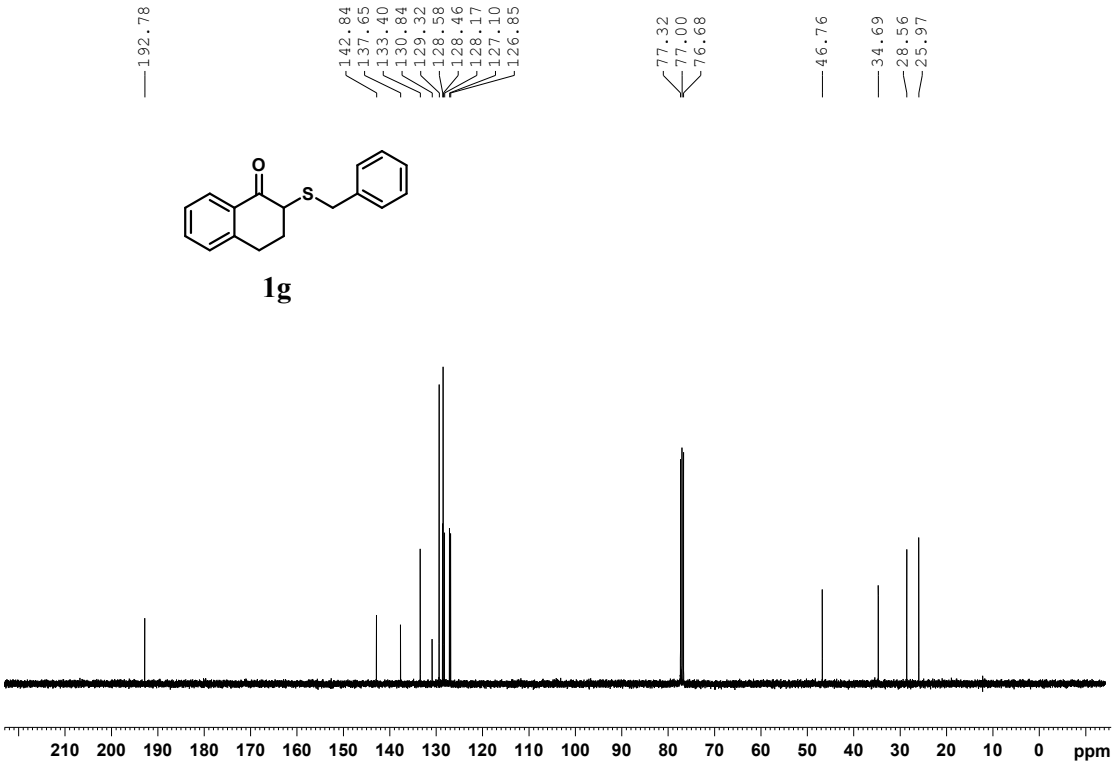
1.10
1.07
1.11
1.17
1.12
1.11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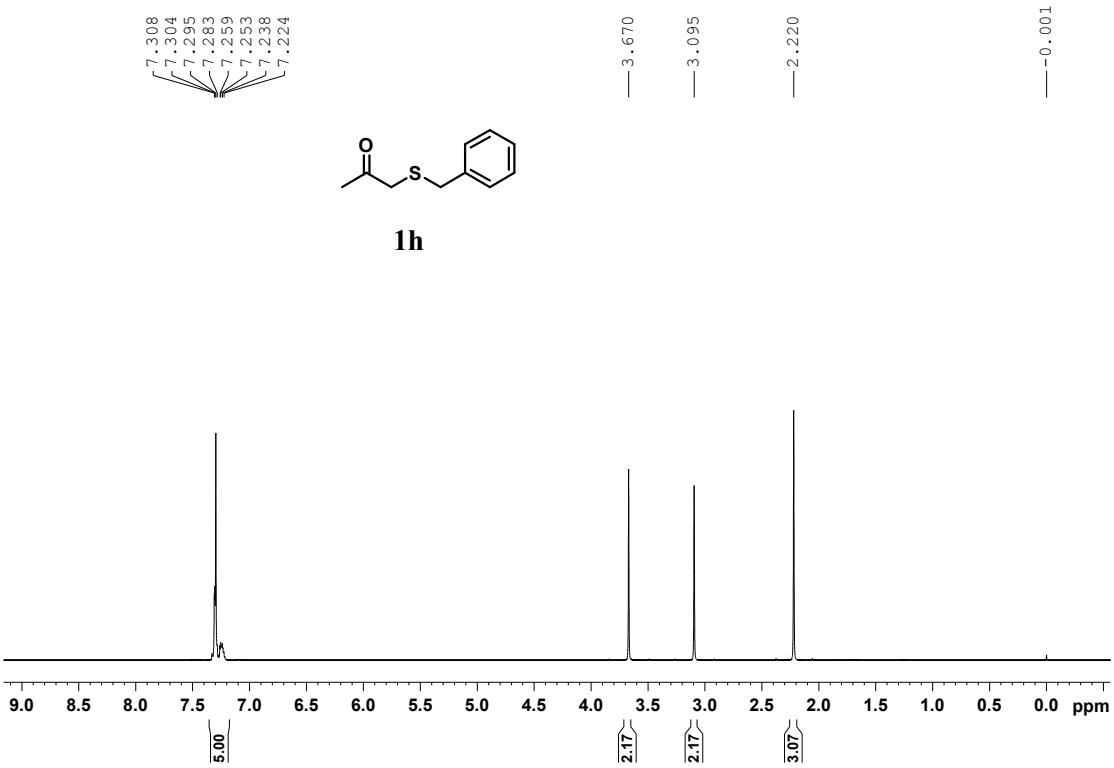
128.46
128.17
127.10
126.85
77.32
77.00
76.68
46.76
34.69
28.56
25.97
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

O
S

1g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7.259
7.253
7.238
7.224
3.670
3.095
2.220
0.001
O
S
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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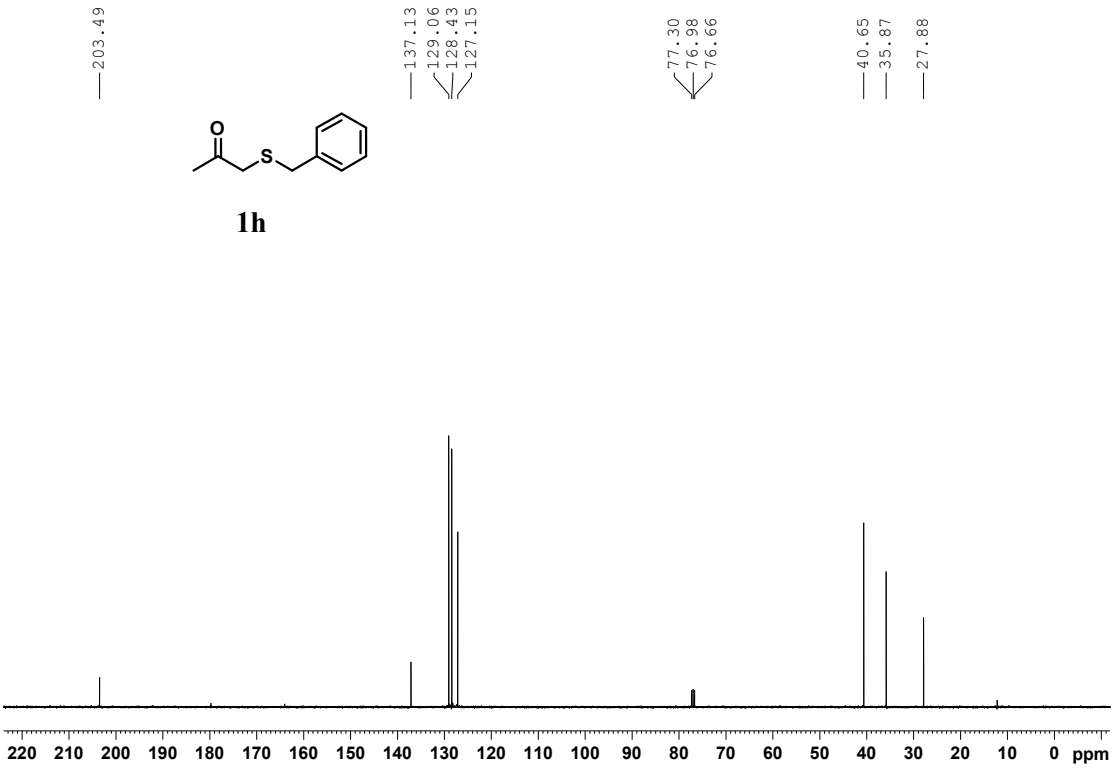
2.17
3.07

1h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127.15
77.30
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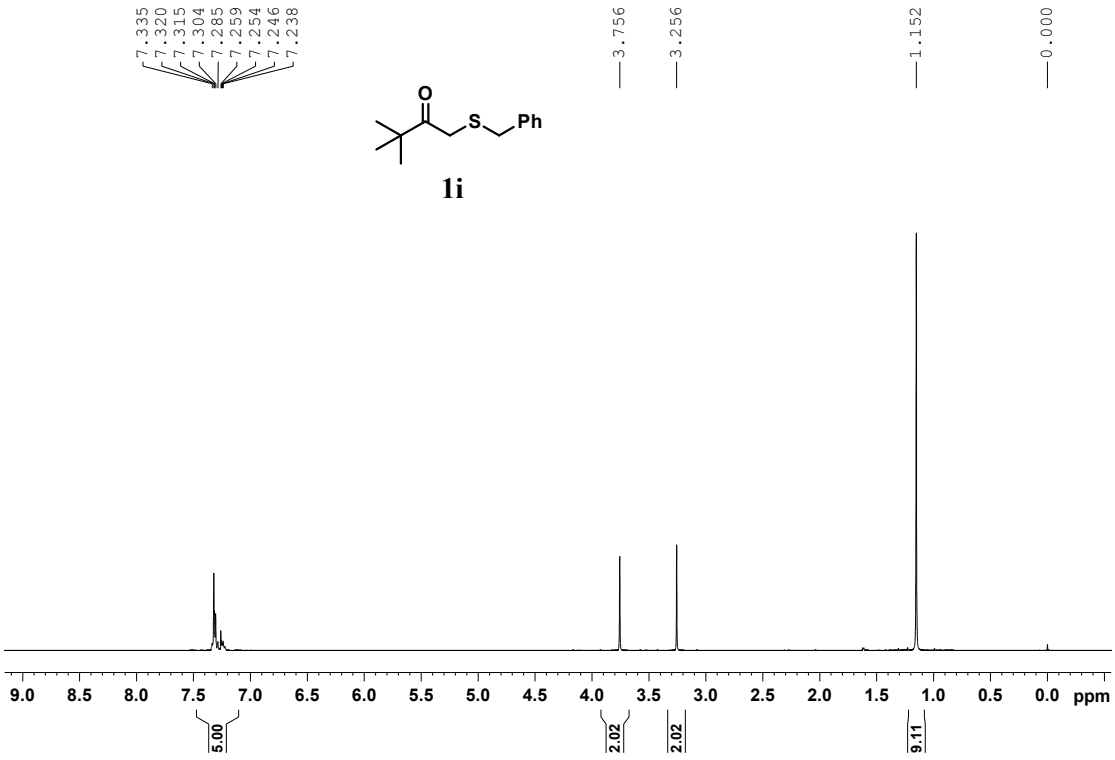
35.87
27.88
O
S
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

1h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7.254
7.246
7.238
3.756
3.256
1.152
0.000
O
S
Ph
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
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ppm
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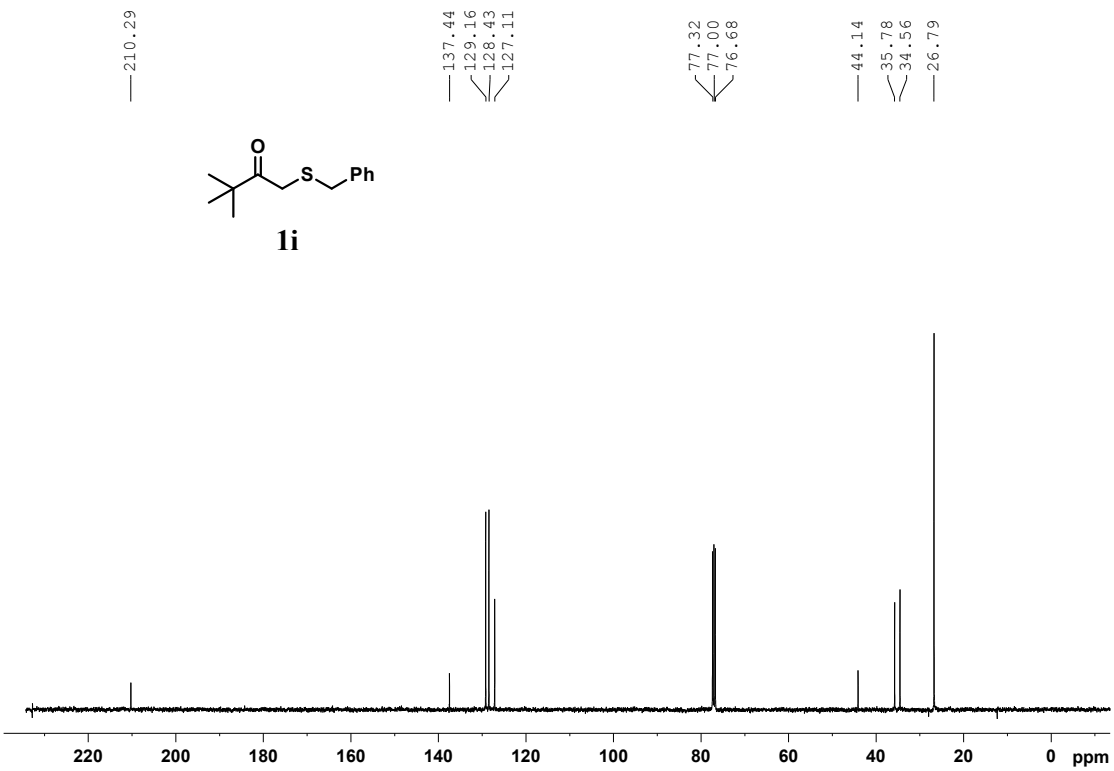
2.02
9.11

1i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77.00
76.68
44.14
35.78
34.56
26.79
O
S
Ph
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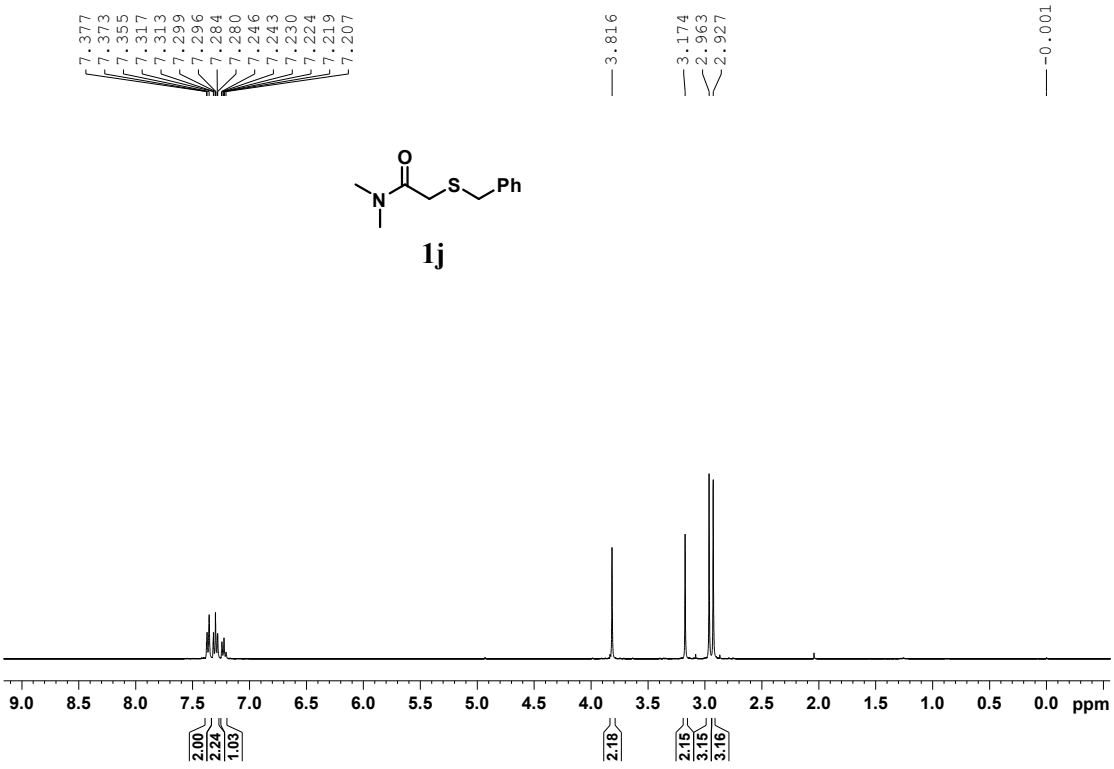
200
180
160
140
120
100
80
60
40
20
0
ppm

1i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7.284
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7.246
7.243
7.230
7.224
7.219
7.207
3.816
3.174
2.963
2.927
0.001
O
N
S
Ph
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
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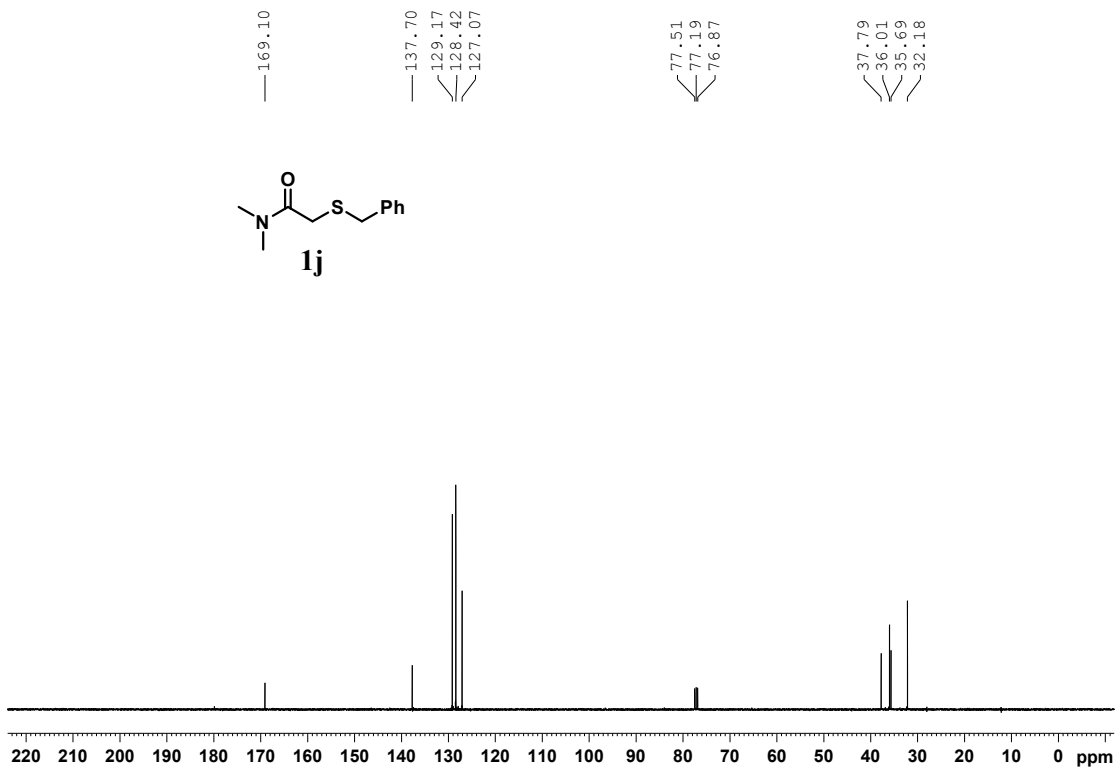
1.03
2.18
2.15
3.15
3.16

1j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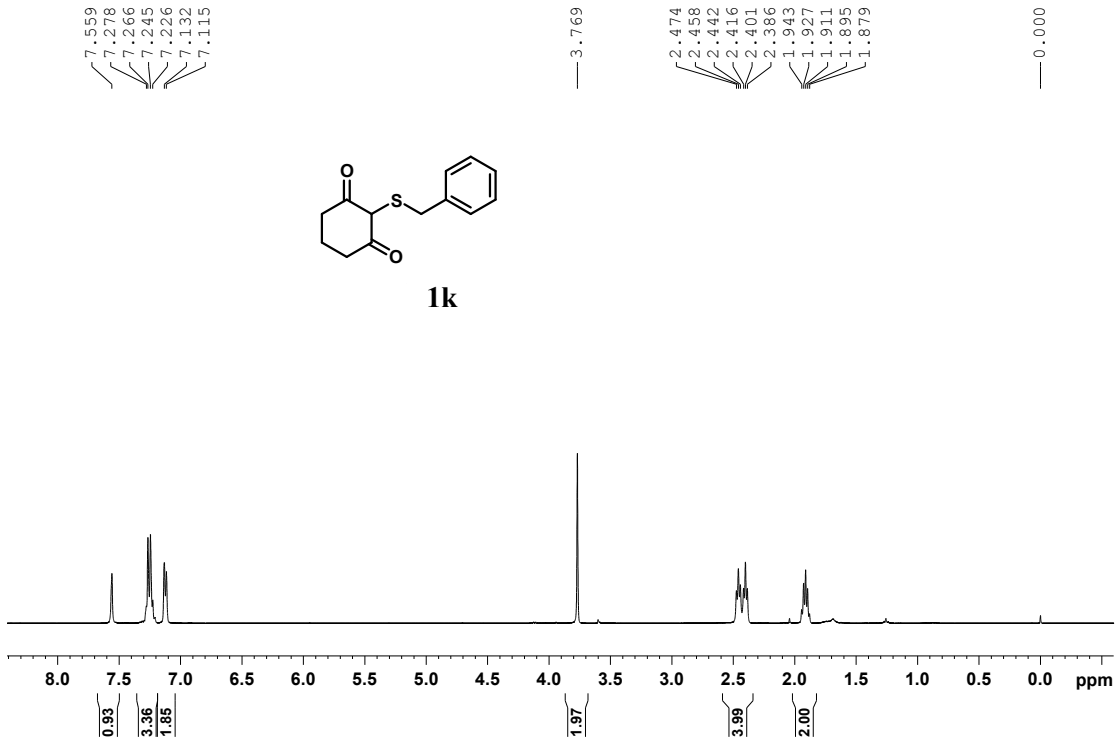
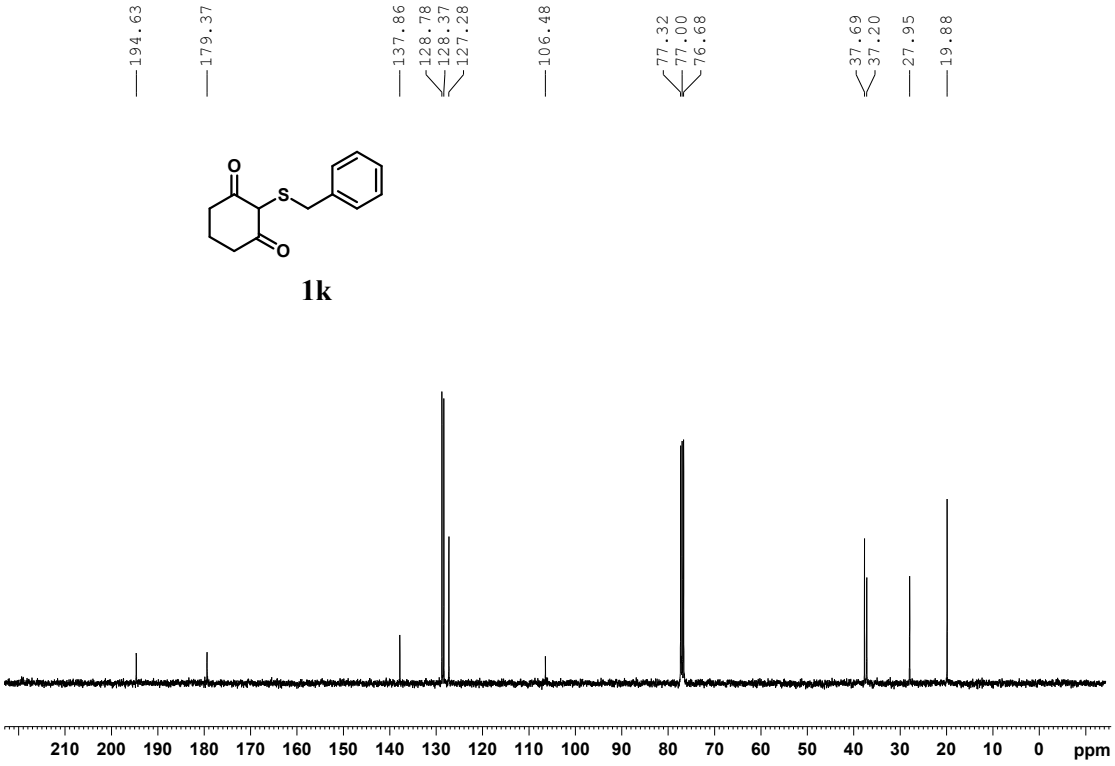
129.17
128.42
127.07
77.51
77.19
76.87
37.79
36.01
35.69
32.18
O
N
S
Ph
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

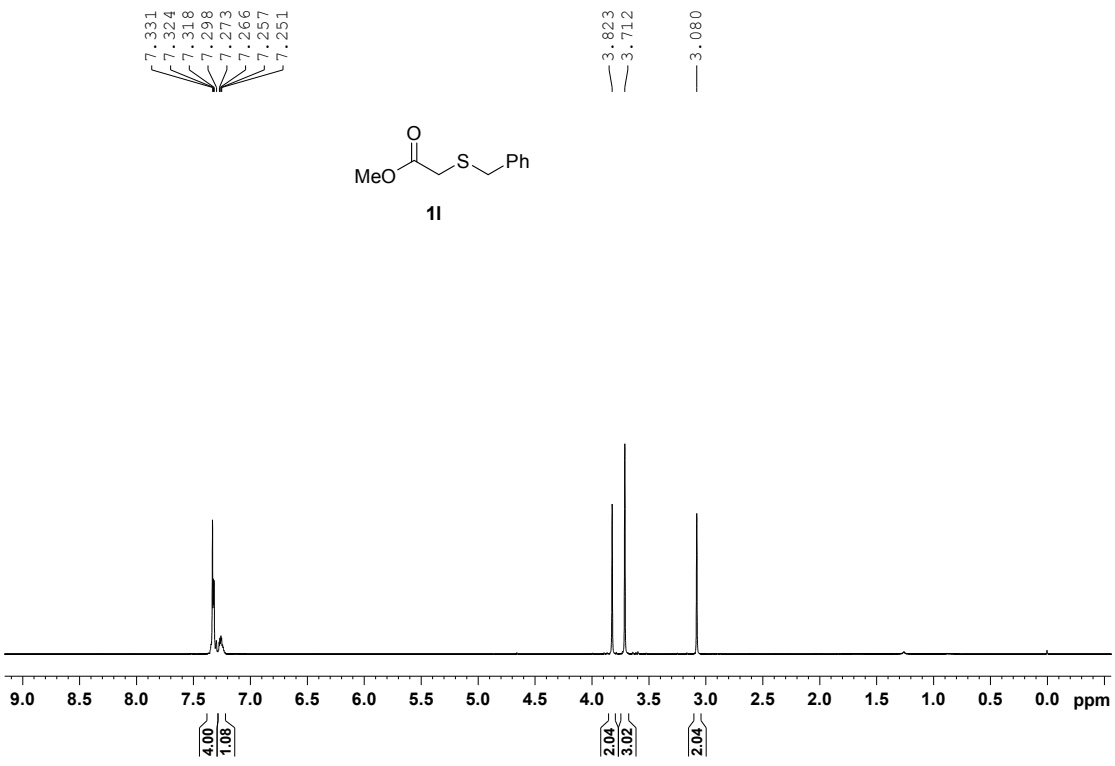
1j


7.559
7.278
7.266
7.245
7.226
7.132
7.115
3.769
2.474
2.458
2.442
2.416
2.401
2.386
1.943
1.927
1.911
1.895
1.879
0.000
O
S
O
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
0.93
3.36
1.85
1.97
3.99
2.00

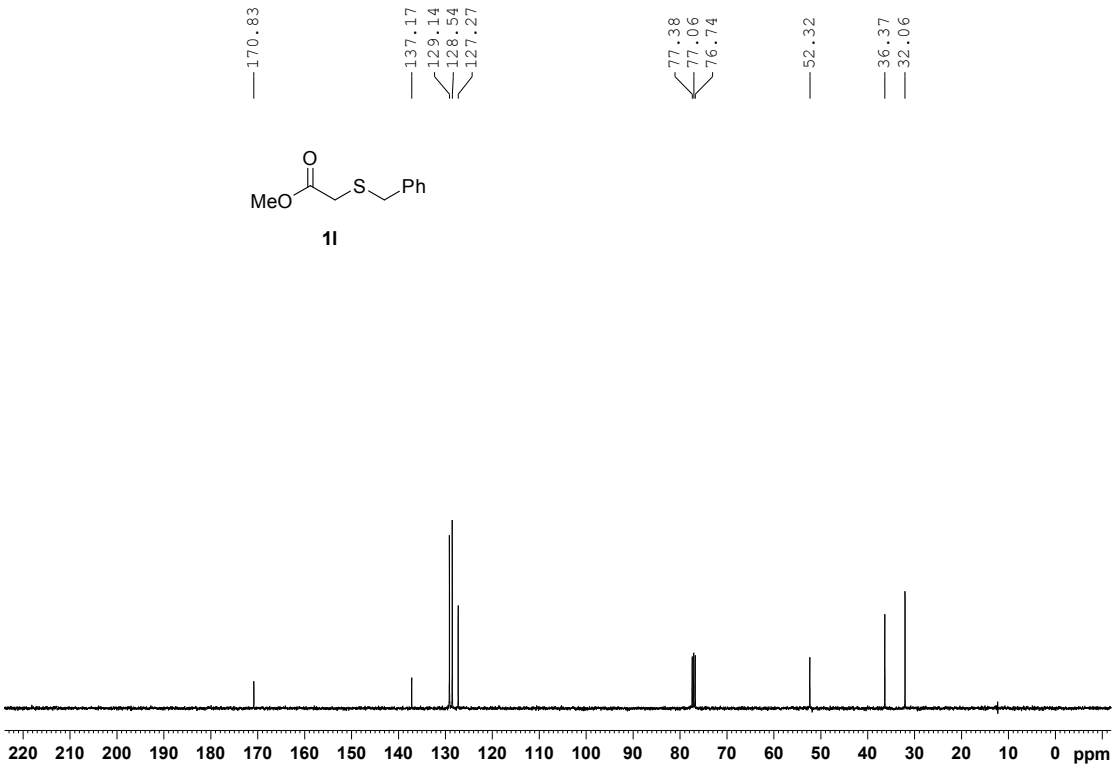
1k


194.63
179.37
137.86
128.78
128.37
127.28
106.48
77.32
77.00
76.68
37.69
37.20
27.95
19.88
O
S
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

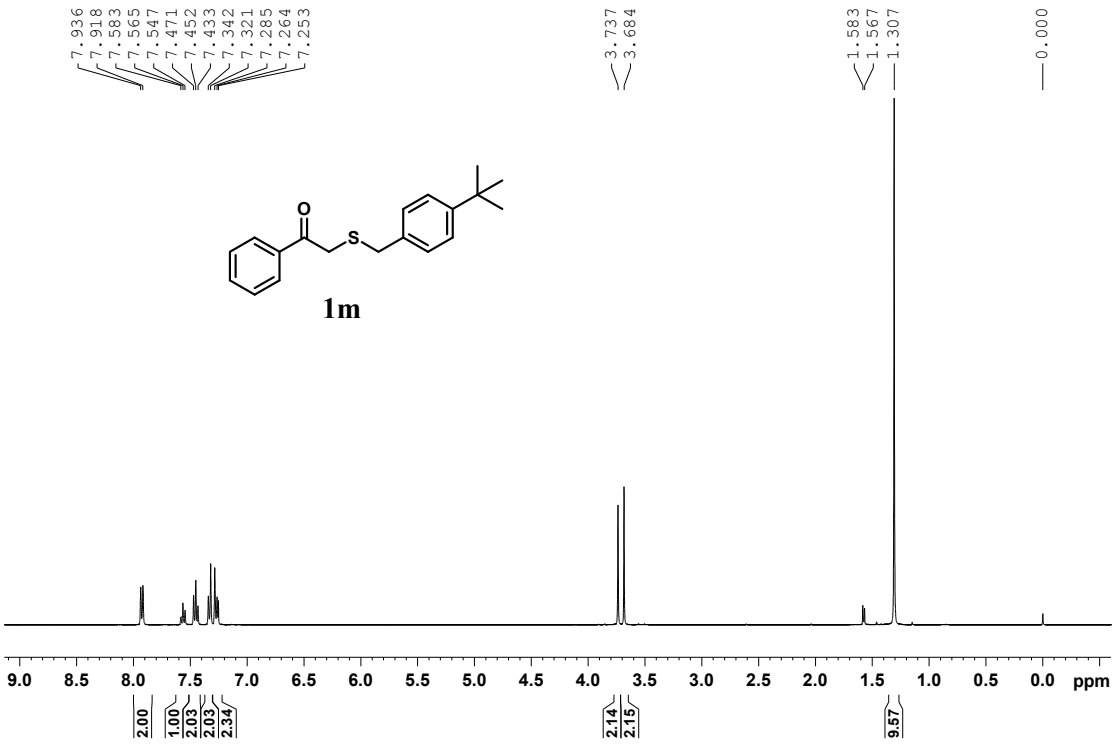
1k


7.331
7.324
7.318
7.298
7.273
7.266
7.257
7.251
3.823
3.712
3.080
MeO
O
S
Ph
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
4.00
1.08
2.04
3.02
2.04

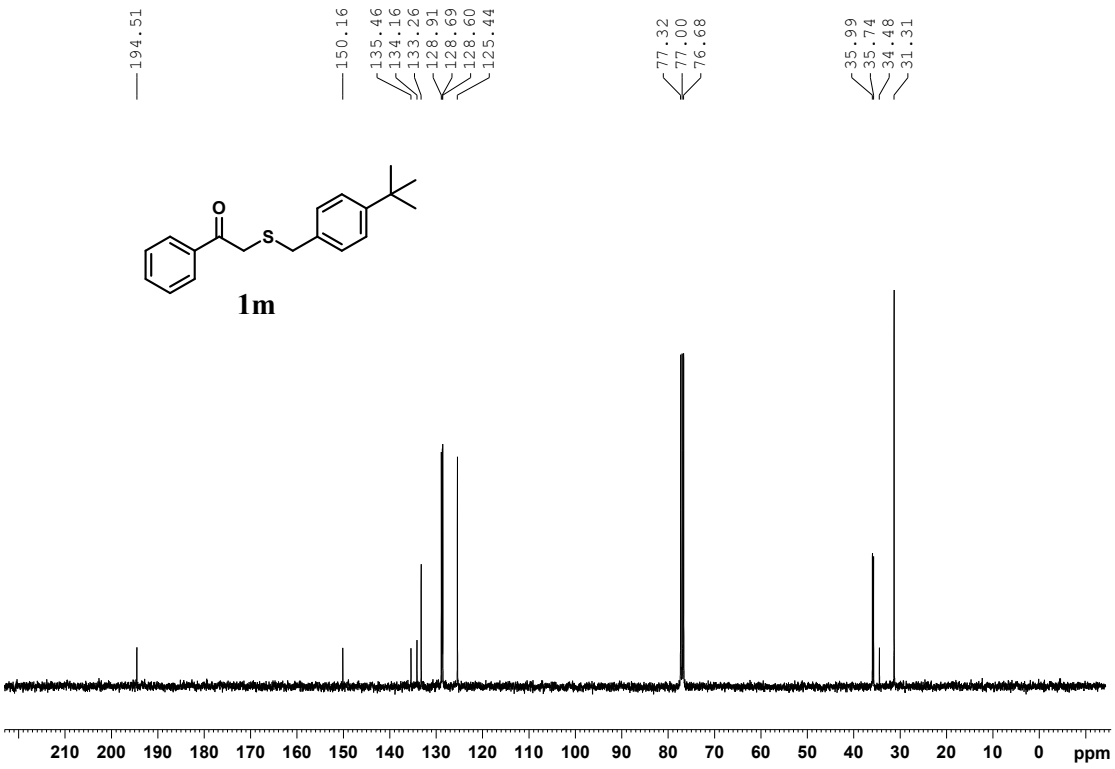
1l

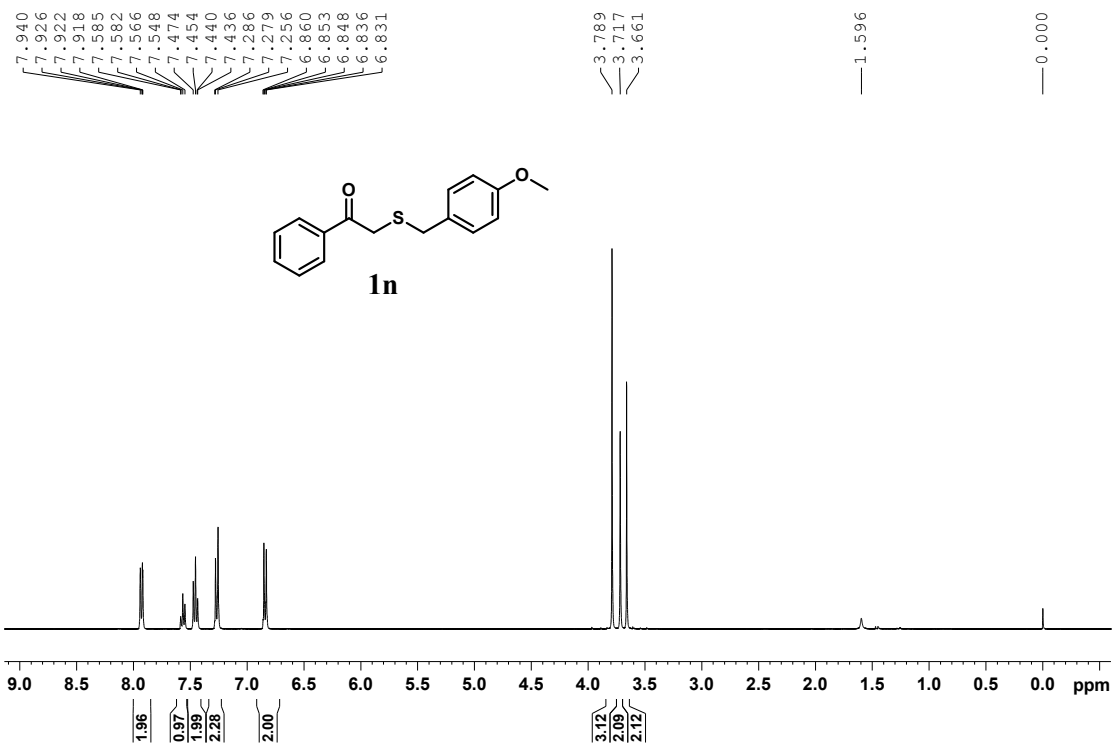

170.83
137.17
129.14
128.54
127.27
77.38
77.06
76.74
52.32
36.37
32.06
O
MeO
S
Ph
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

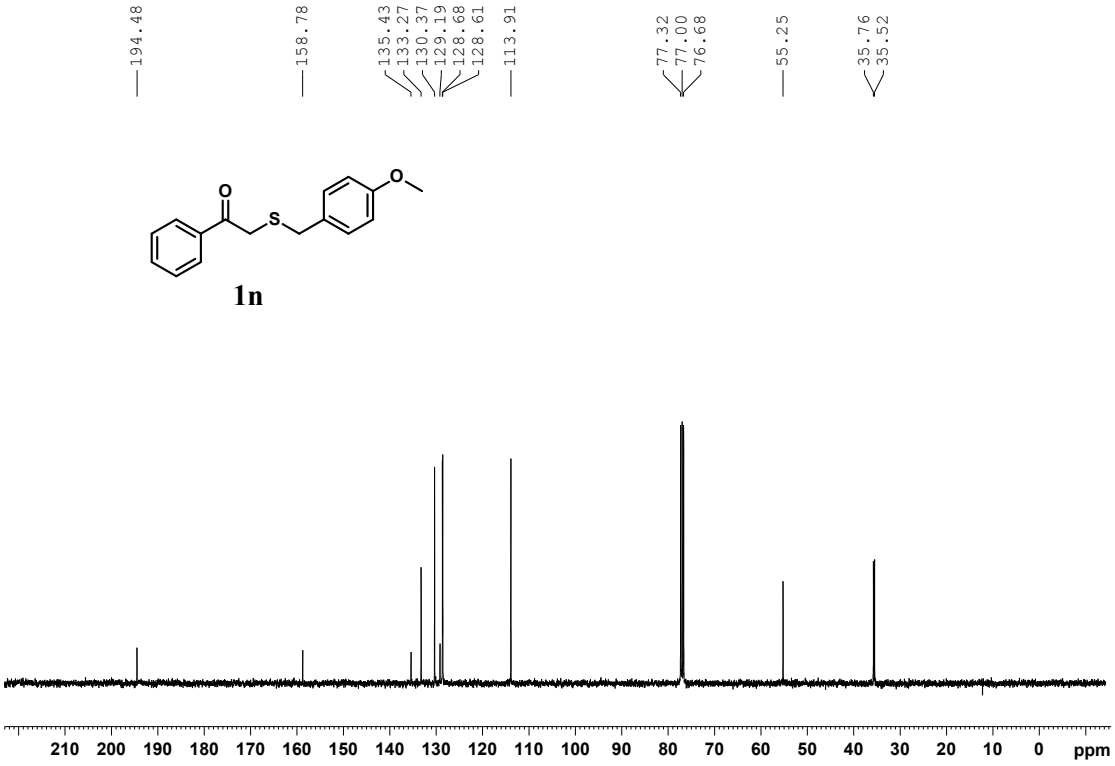
1l

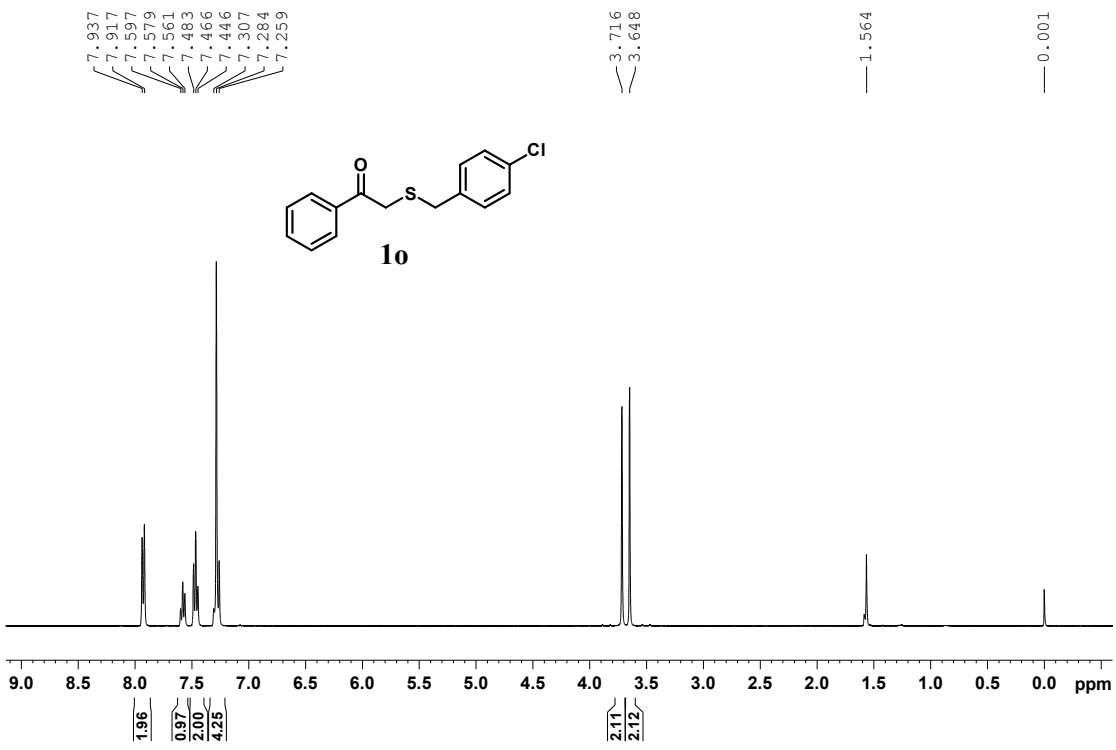

7.936
7.918
7.583
7.565
7.547
7.471
7.452
7.433
7.342
7.321
7.285
7.264
7.253
3.737
3.684
1.583
1.567
1.307
0.000
O
S
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.00
2.03
2.03
2.34
2.14
2.15
9.57

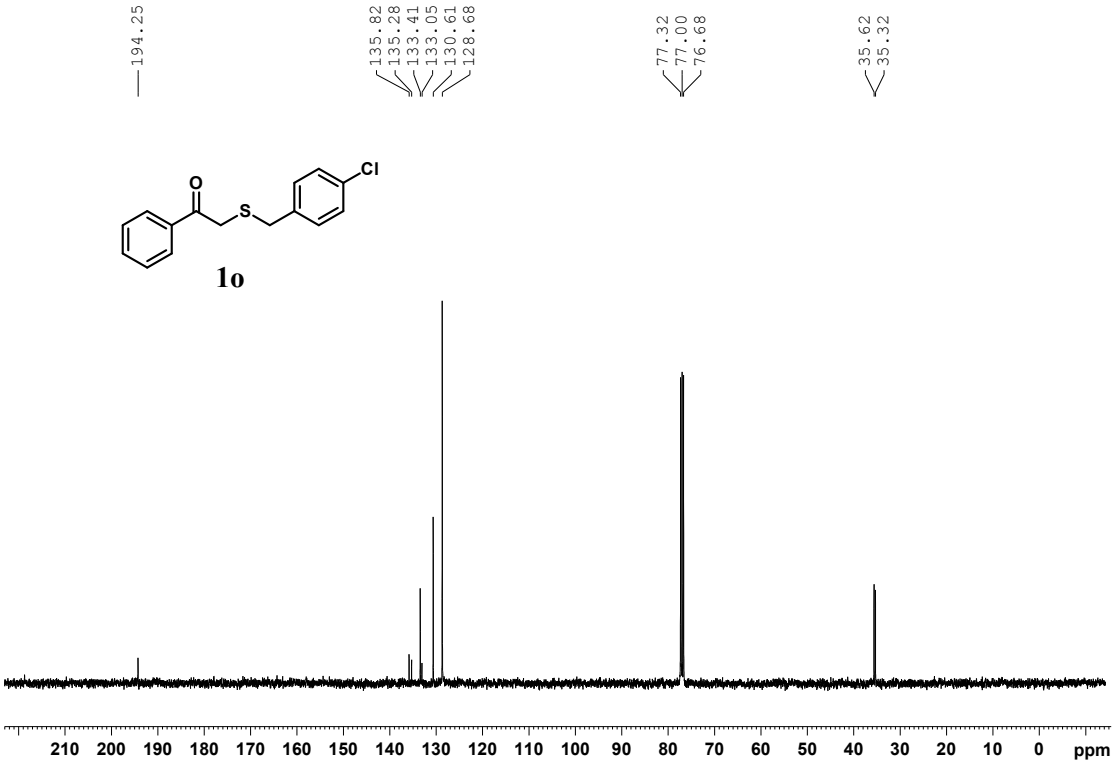
1m


194.51
150.16
135.46
134.16
133.26
128.91
128.69
128.60
125.44
77.32
77.00
76.68
35.99
35.74
34.48
31.31
O
S
1m
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

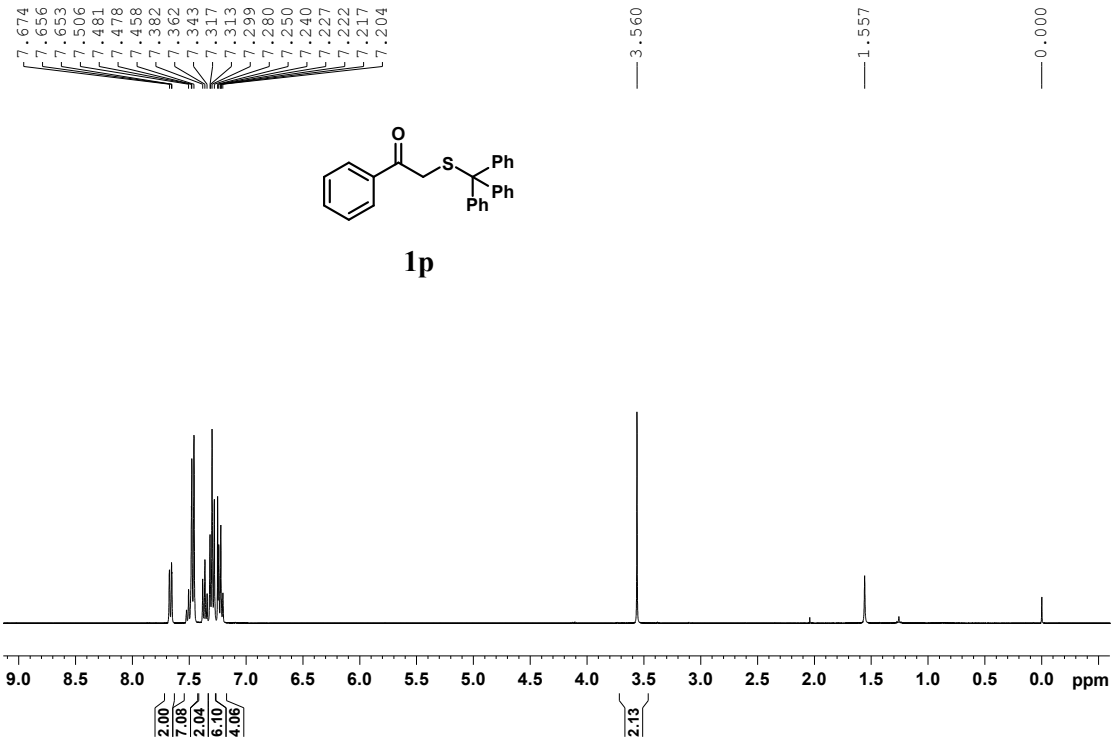

7.940
7.926
7.922
7.918
7.585
7.582
7.566
7.548
7.474
7.454
7.440
7.436
7.286
7.279
7.256
6.860
6.853
6.848
6.836
6.831
3.789
3.717
3.661
1.596
0.000
O
S
O
1n
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.96
0.97
1.99
2.28
2.00
3.12
2.09
2.12


194.48
158.78
135.43
133.27
130.37
129.19
128.68
128.61
113.91
77.32
77.00
76.68
55.25
35.76
35.52
O
S
O
1n
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

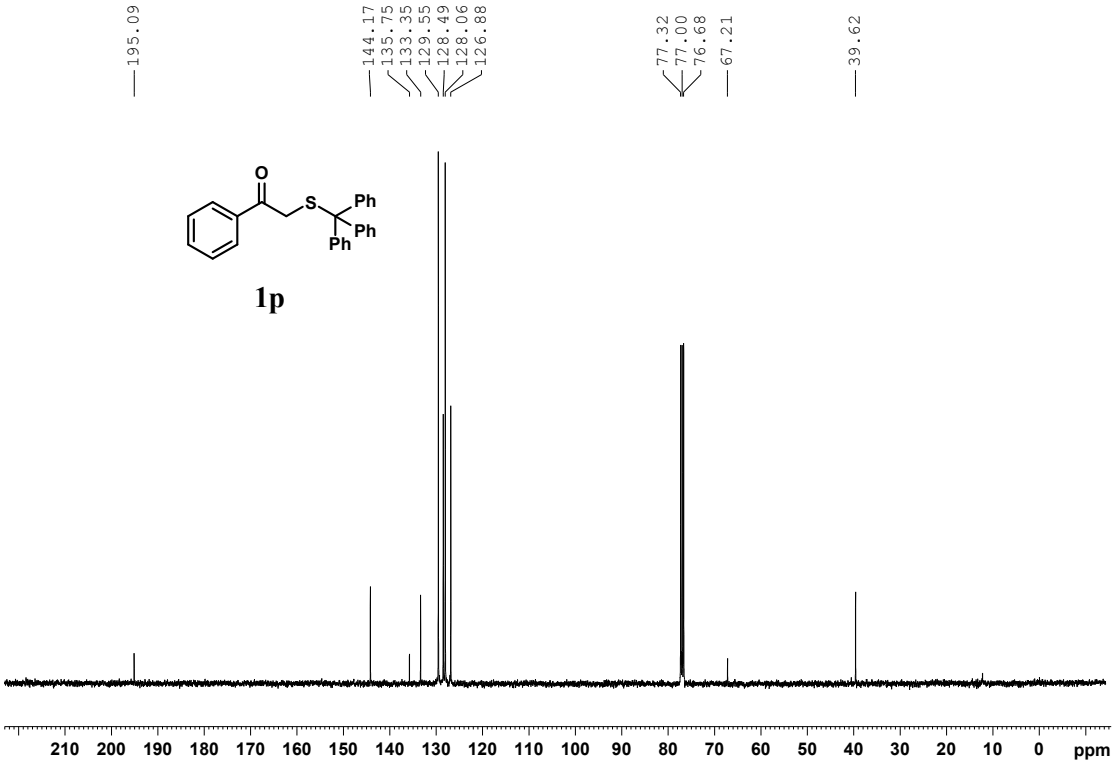

7.937
7.917
7.597
7.579
7.561
7.483
7.466
7.446
7.307
7.284
7.259
3.716
3.648
1.564
0.001
O
S
Cl
1o
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.96
0.97
2.00
4.25
2.11
2.12

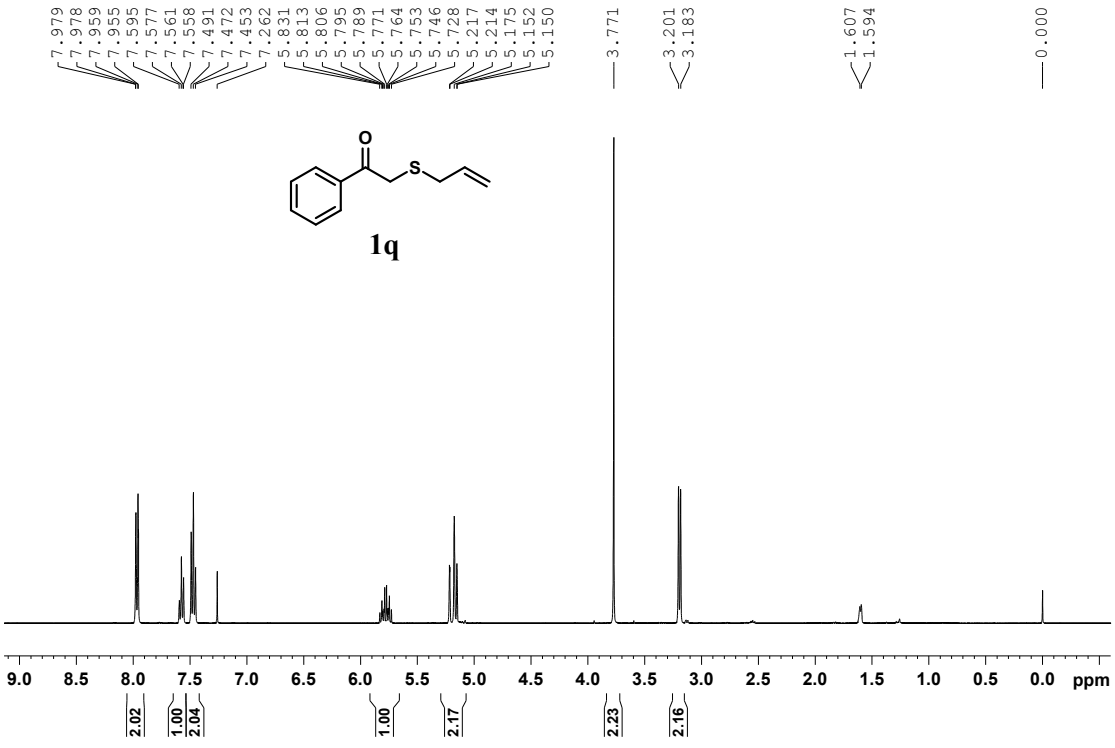

194.25
135.82
135.28
133.41
133.05
130.61
128.68
77.32
77.00
76.68
35.62
35.32
O
S
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

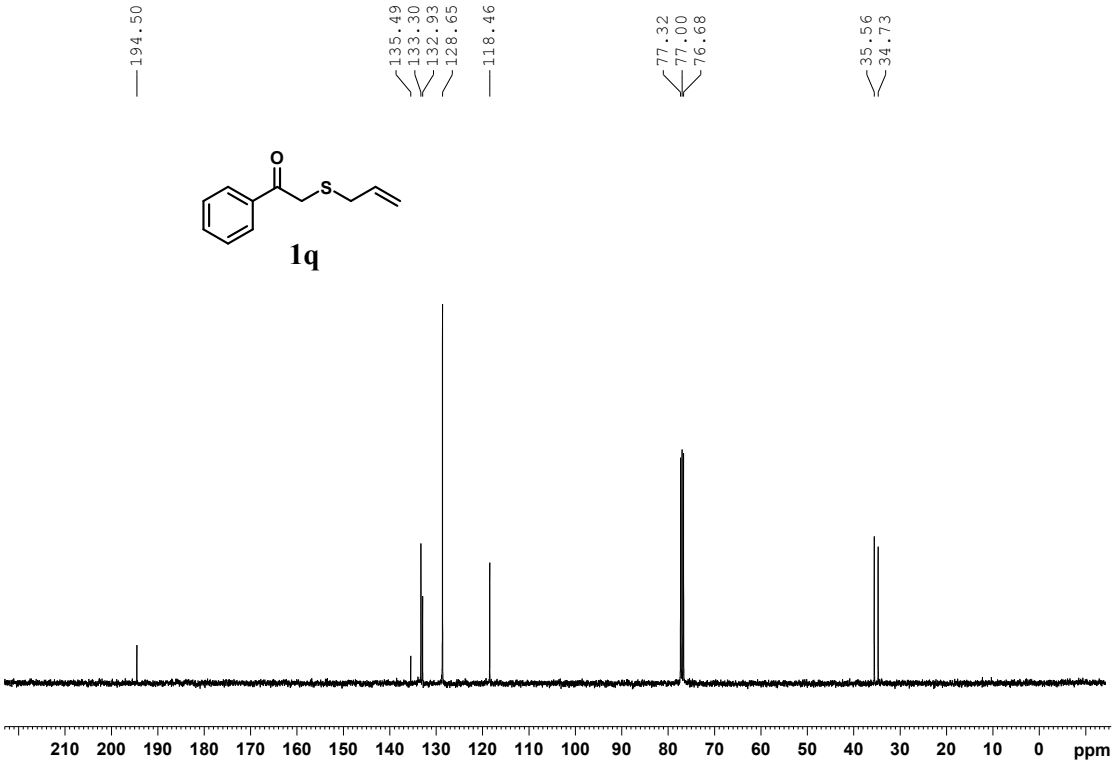
1o


7.674
7.656
7.653
7.506
7.481
7.478
7.458
7.382
7.362
7.343
7.317
7.313
7.299
7.280
7.250
7.240
7.227
7.222
7.217
7.204
3.560
1.557
0.000
O
S
Ph
Ph
Ph
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
7.08
2.04
6.10
4.06
2.13

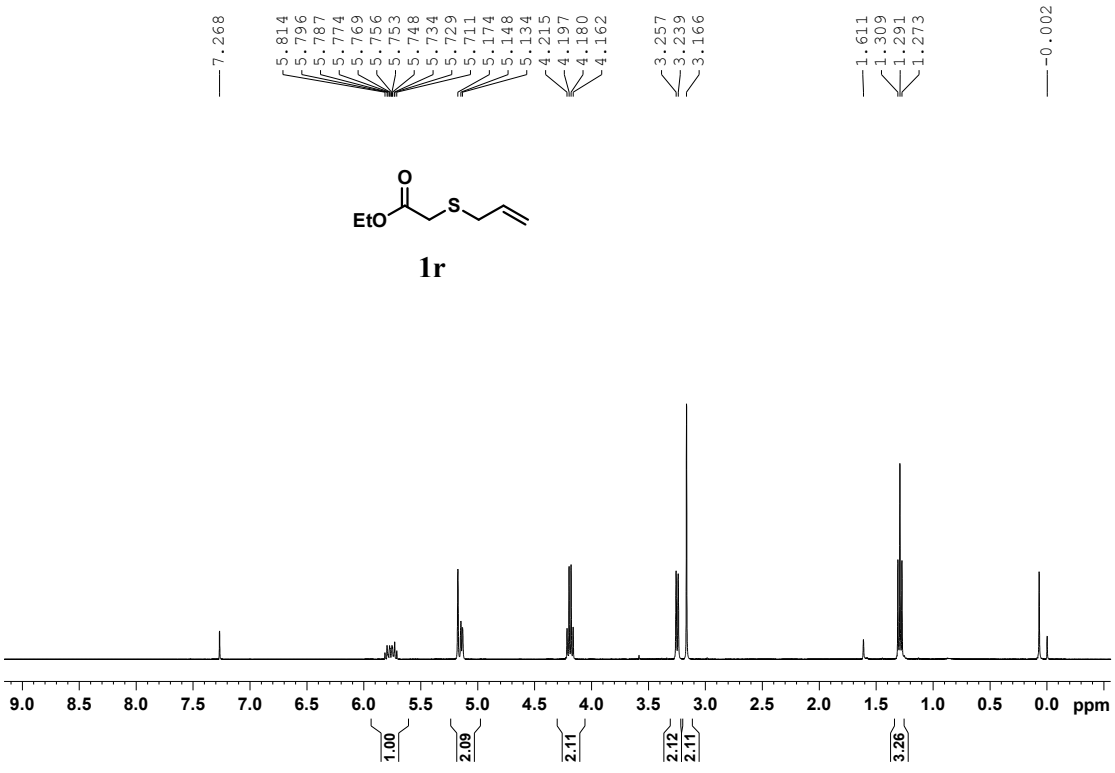
1p


195.09
144.17
135.75
133.35
129.55
128.49
128.06
126.88
77.32
77.00
76.68
67.21
39.62
O
S
Ph
Ph
Ph
1p
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

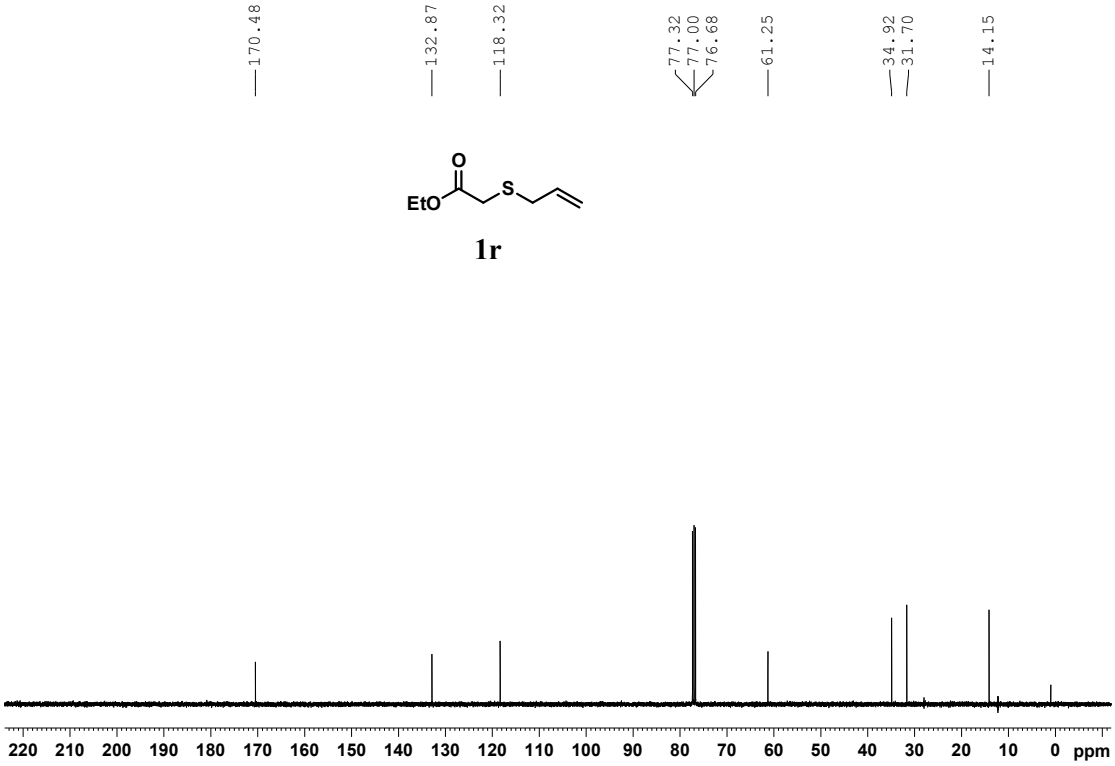

7.979
7.978
7.959
7.955
7.595
7.577
7.561
7.558
7.491
7.472
7.453
7.262
5.831
5.813
5.806
5.795
5.789
5.771
5.764
5.753
5.746
5.728
5.217
5.214
5.175
5.152
5.150
3.771
3.201
3.183
1.607
1.594
0.000
O
S
1q
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.02
1.00
2.04
1.00
2.17
2.23
2.16


194.50
135.49
133.30
132.93
128.65
118.46
77.32
77.00
76.68
35.56
34.73
O
S
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

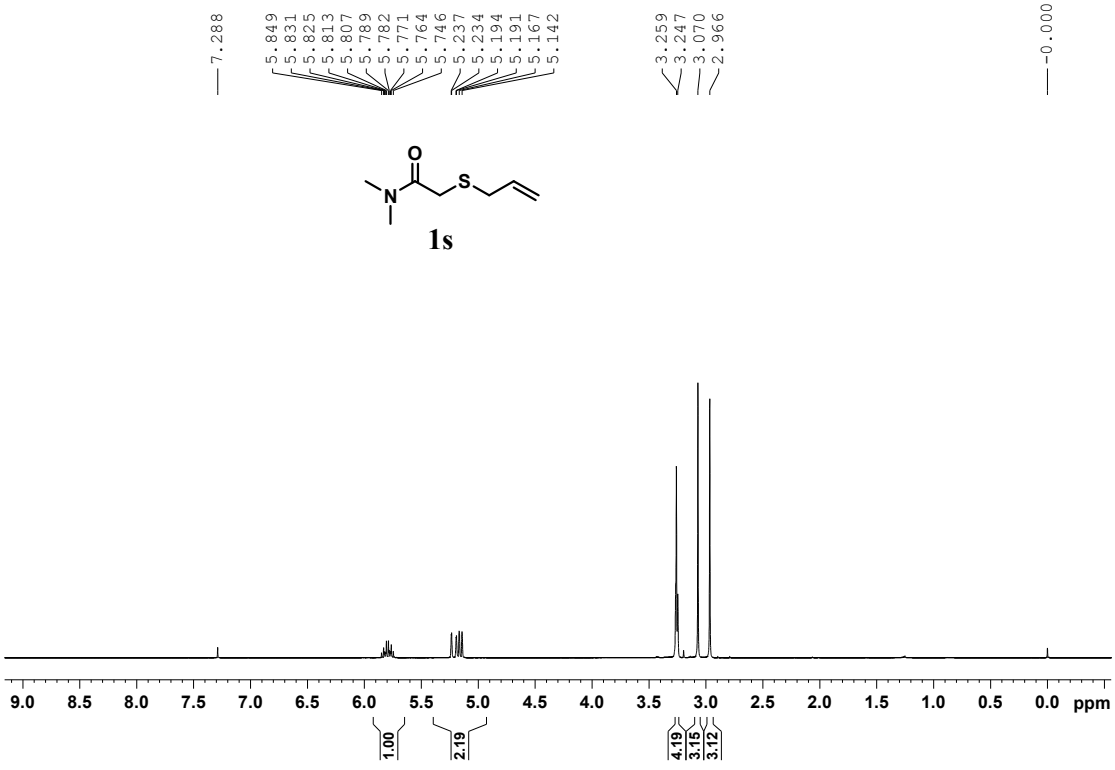
1q


7.268
5.814
5.796
5.787
5.774
5.769
5.756
5.753
5.748
5.734
5.729
5.711
5.174
5.148
5.134
4.215
4.197
4.180
4.162
3.257
3.239
3.166
1.611
1.309
1.291
1.273
-0.002
O
EtO
S
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.00
2.09
2.11
2.12
2.11
3.26

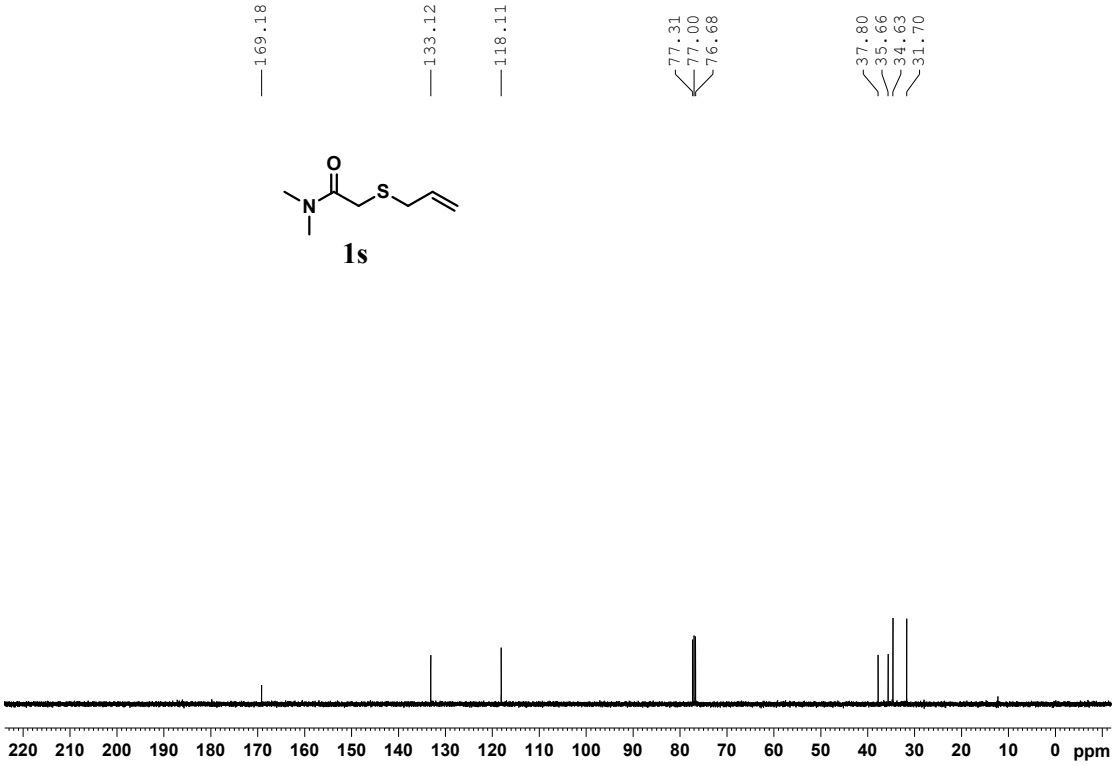
1r


170.48
132.87
118.32
77.32
77.00
76.68
61.25
34.92
31.70
14.15
O
EtO
S
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

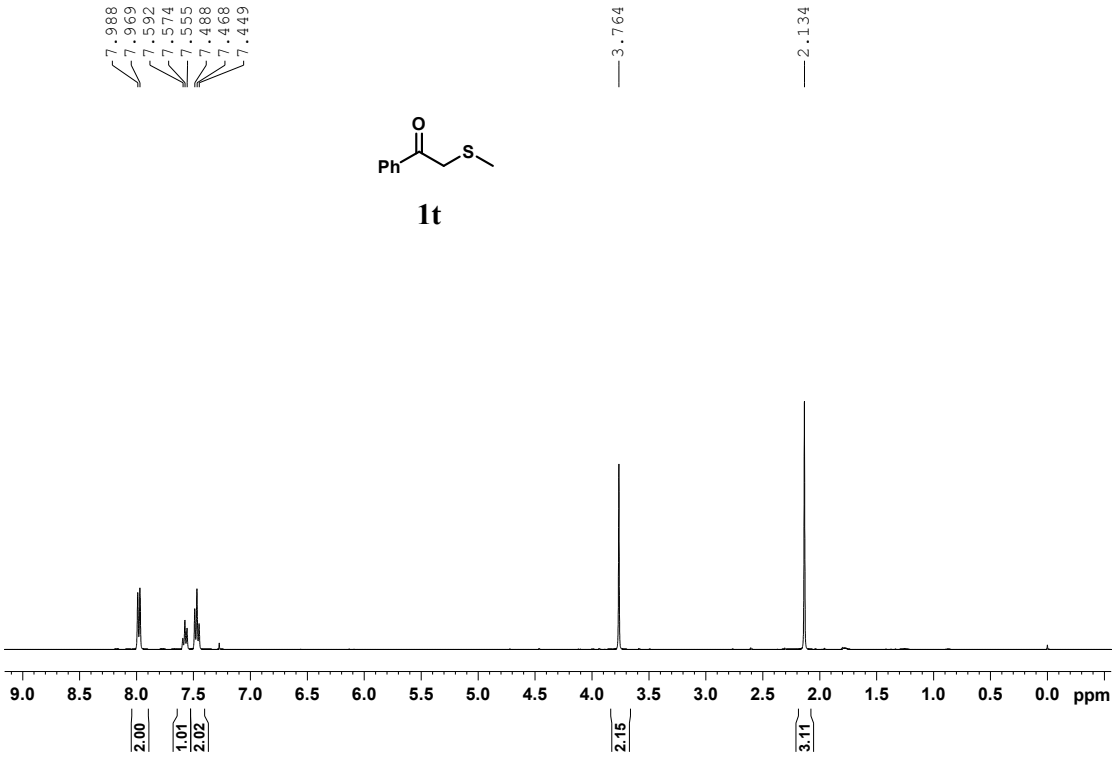
1r


7.288
5.849
5.831
5.825
5.813
5.807
5.789
5.782
5.771
5.764
5.746
5.237
5.234
5.194
5.191
5.167
5.142
3.259
3.247
3.070
2.966
0.000
O
N
S
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.00
2.19
4.19
3.15
3.12

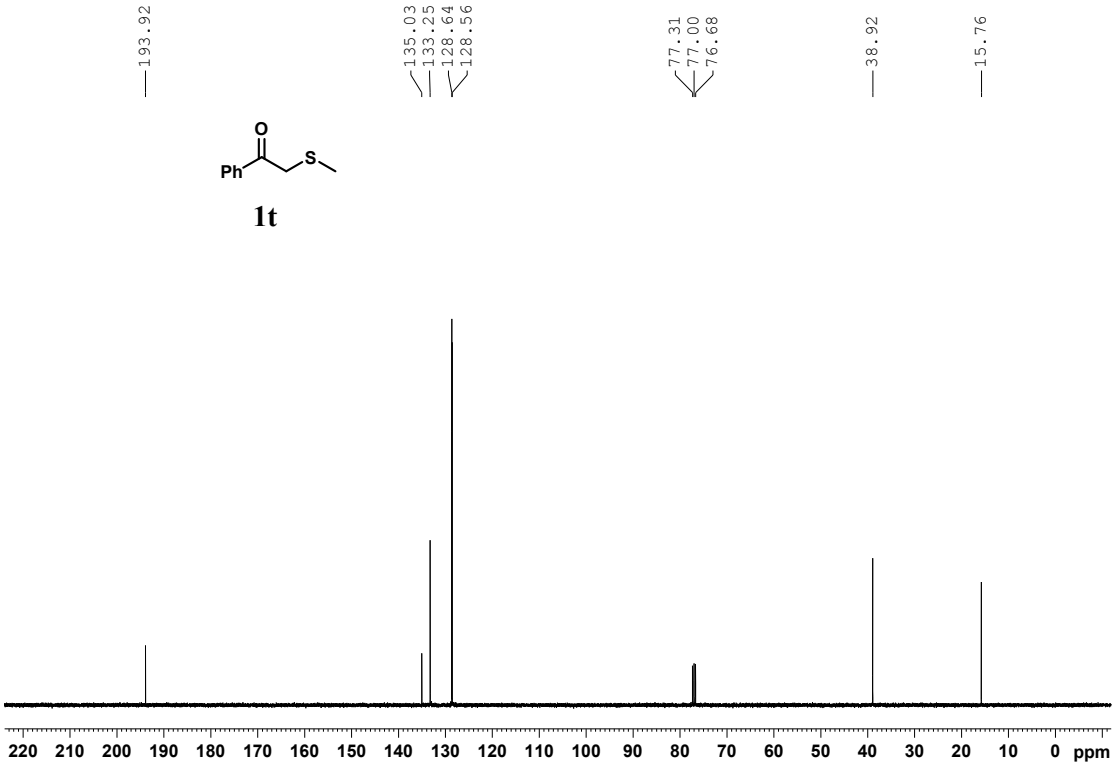
1s


169.18
133.12
118.11
77.31
77.00
76.68
37.80
35.66
34.63
31.70
O
N
S
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

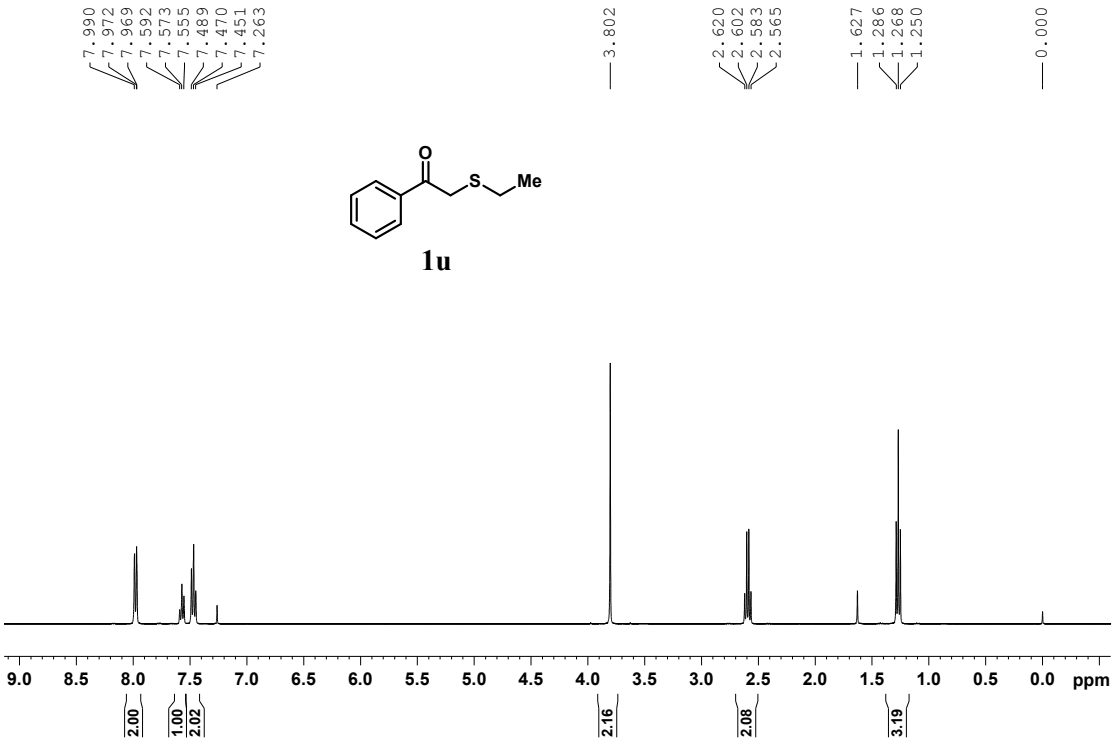
1s


7.988
7.969
7.592
7.574
7.555
7.488
7.468
7.449
3.764
2.134
O
Ph
S
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.01
2.02
2.15
3.11

1t

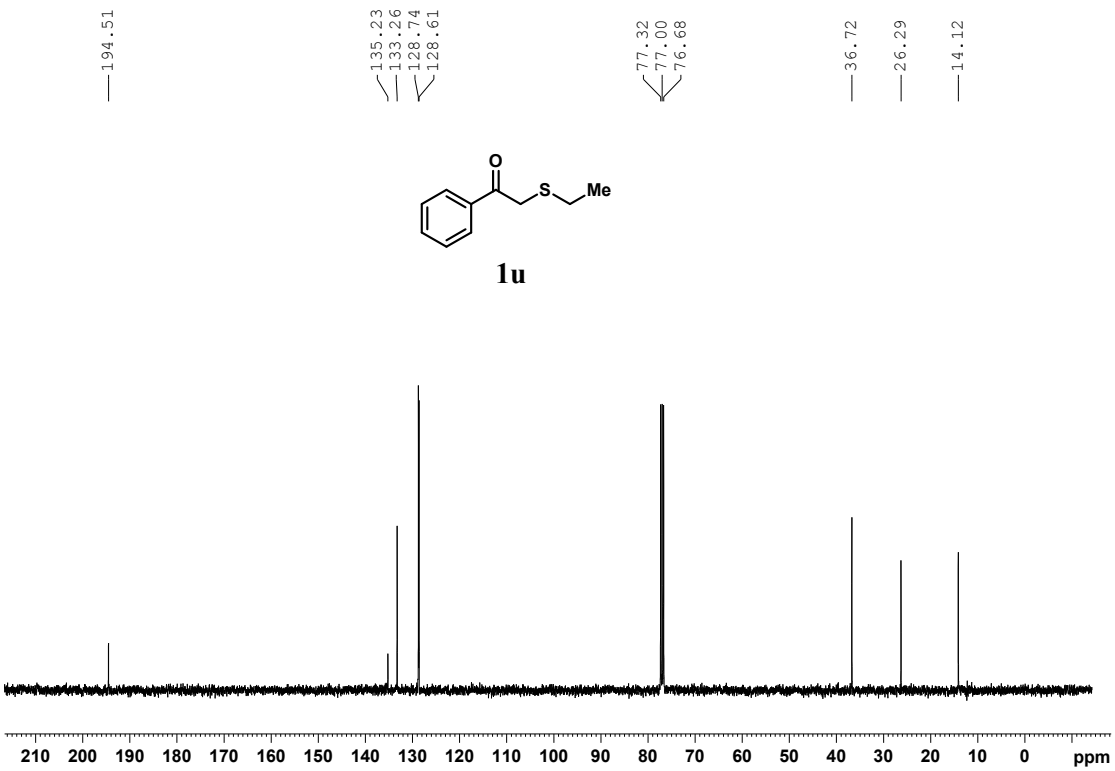

193.92
135.03
133.25
128.64
128.56
77.31
77.00
76.68
38.92
15.76
O
Ph
S
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

1t

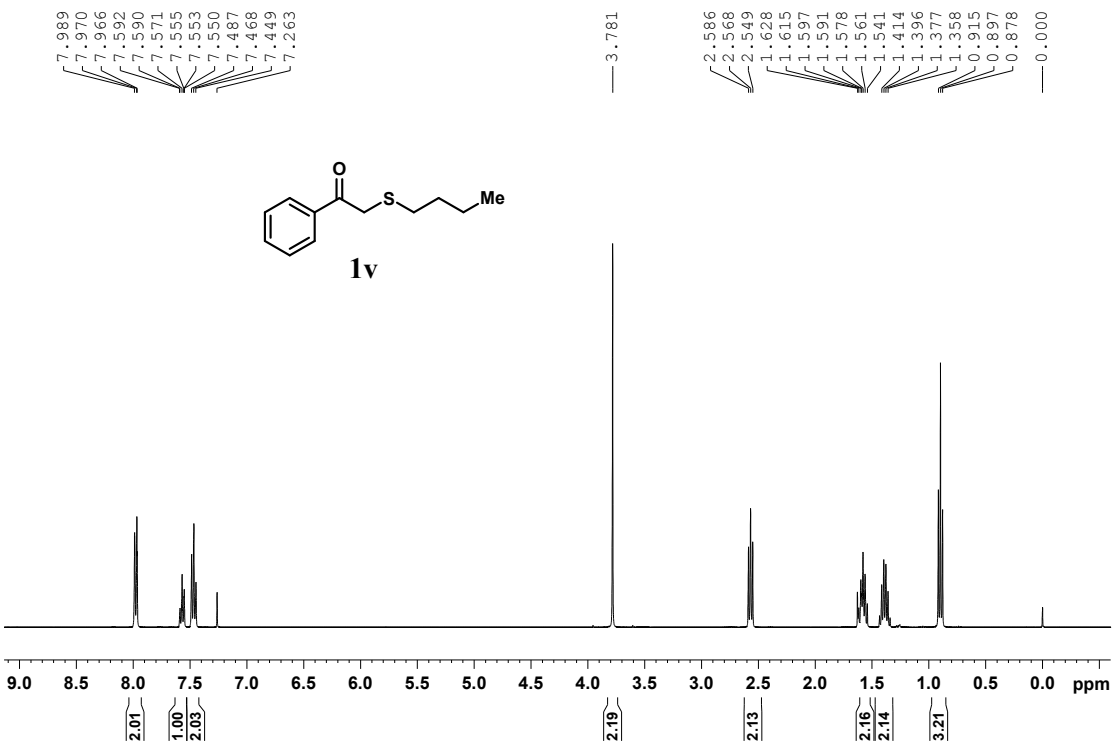

7.990
7.972
7.969
7.592
7.573
7.555
7.489
7.470
7.451
7.263
3.802
2.620
2.602
2.583
2.565
1.627
1.286
1.268
1.250
0.000
O
S
Me
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.00
2.02
2.16
2.08
3.19

1u

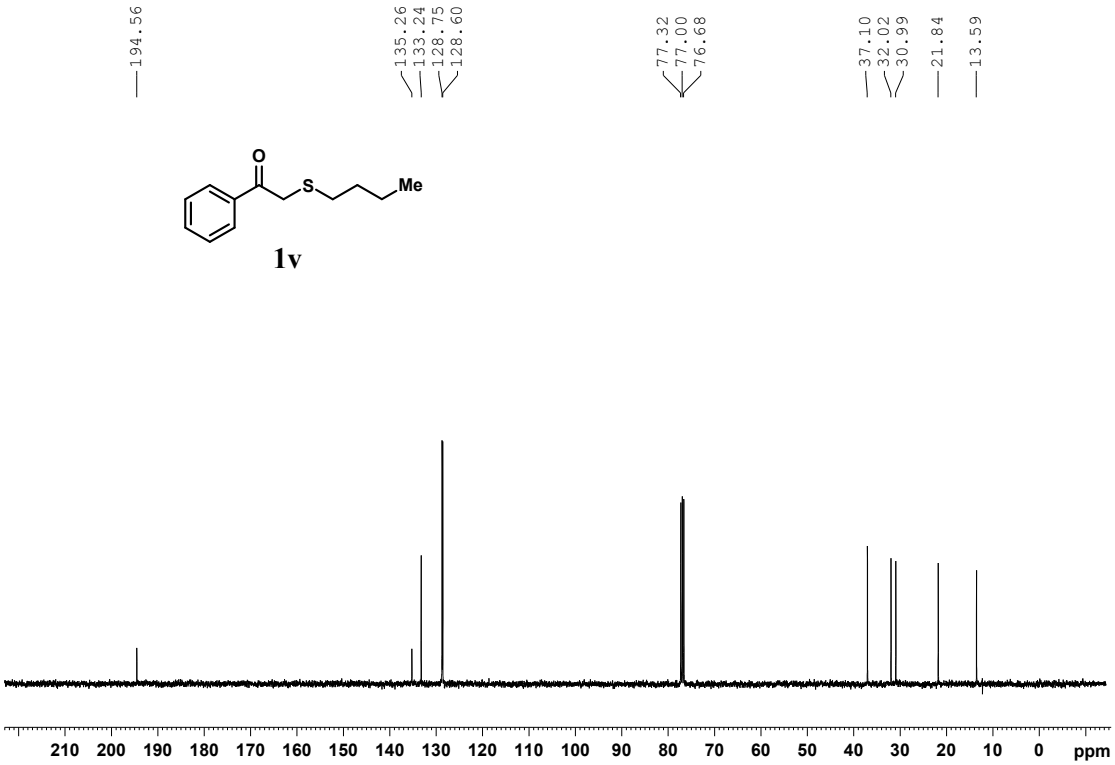
1t

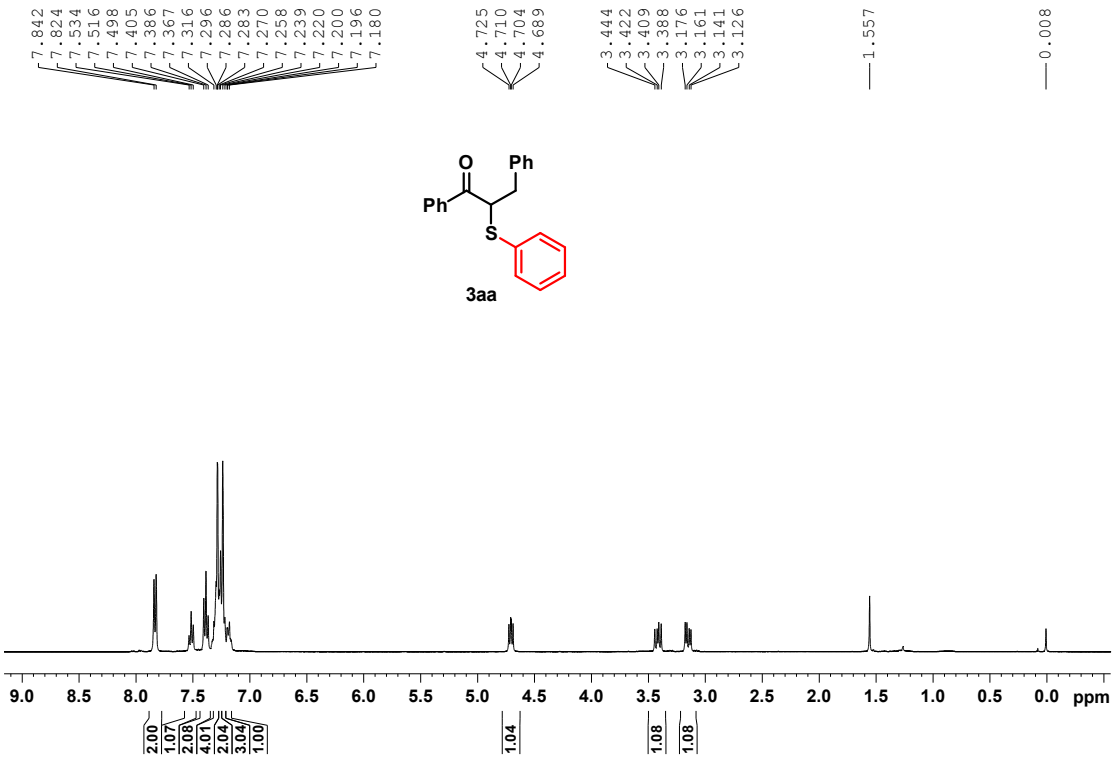

194.51
135.23
133.26
128.74
128.61
77.32
77.00
76.68
36.72
26.29
14.12
O
S
Me
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

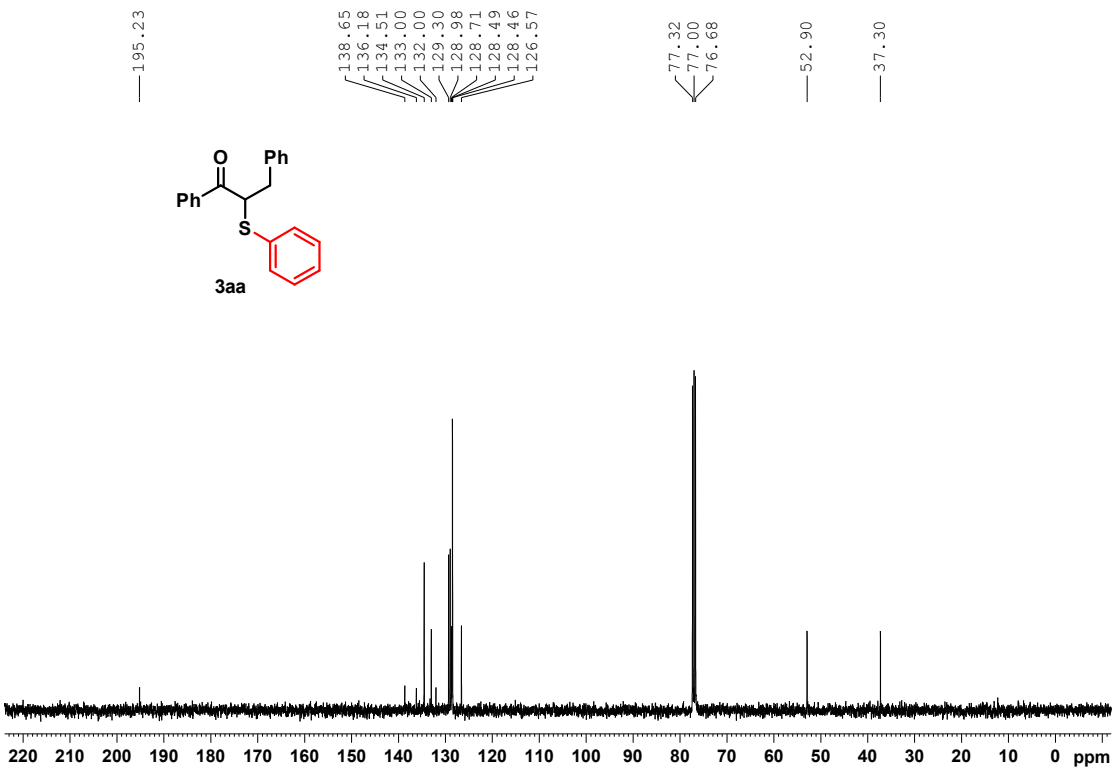
1u

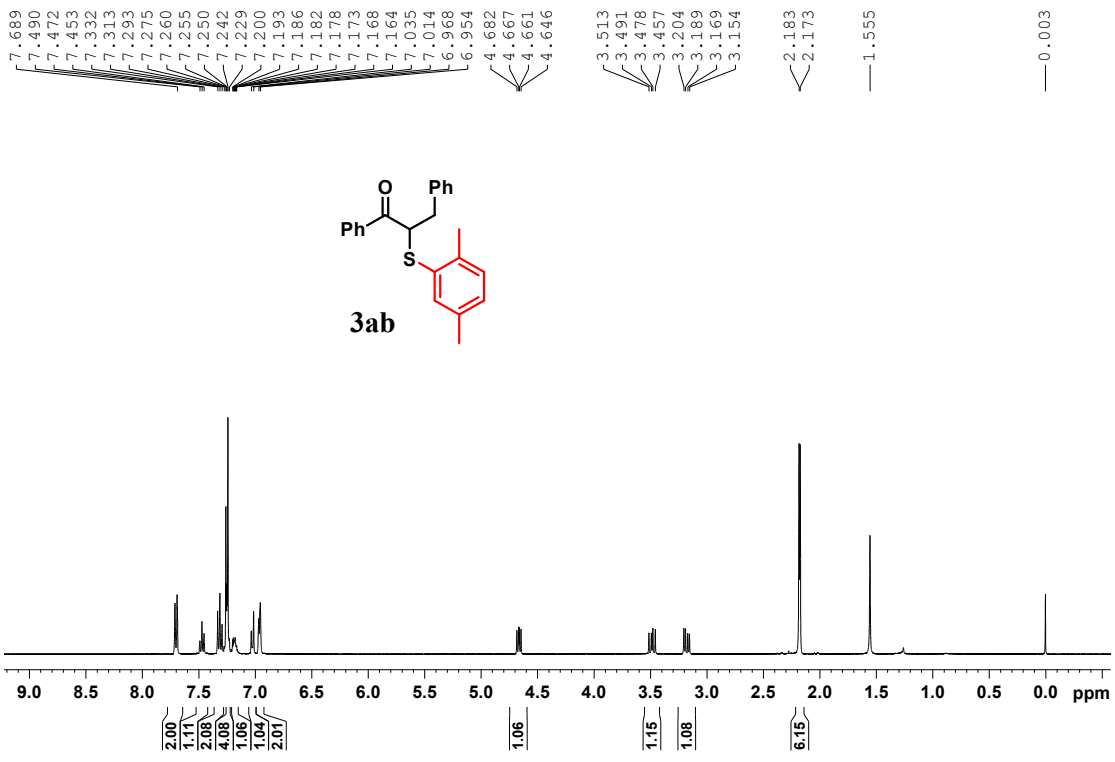

7.989
7.970
7.966
7.592
7.590
7.571
7.555
7.553
7.550
7.487
7.468
7.449
7.263
3.781
2.586
2.568
2.549
1.628
1.615
1.597
1.591
1.578
1.561
1.541
1.414
1.396
1.377
1.358
0.915
0.897
0.878
0.000
O
S
Me
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.01
1.00
2.03
2.19
2.13
2.16
2.14
3.21

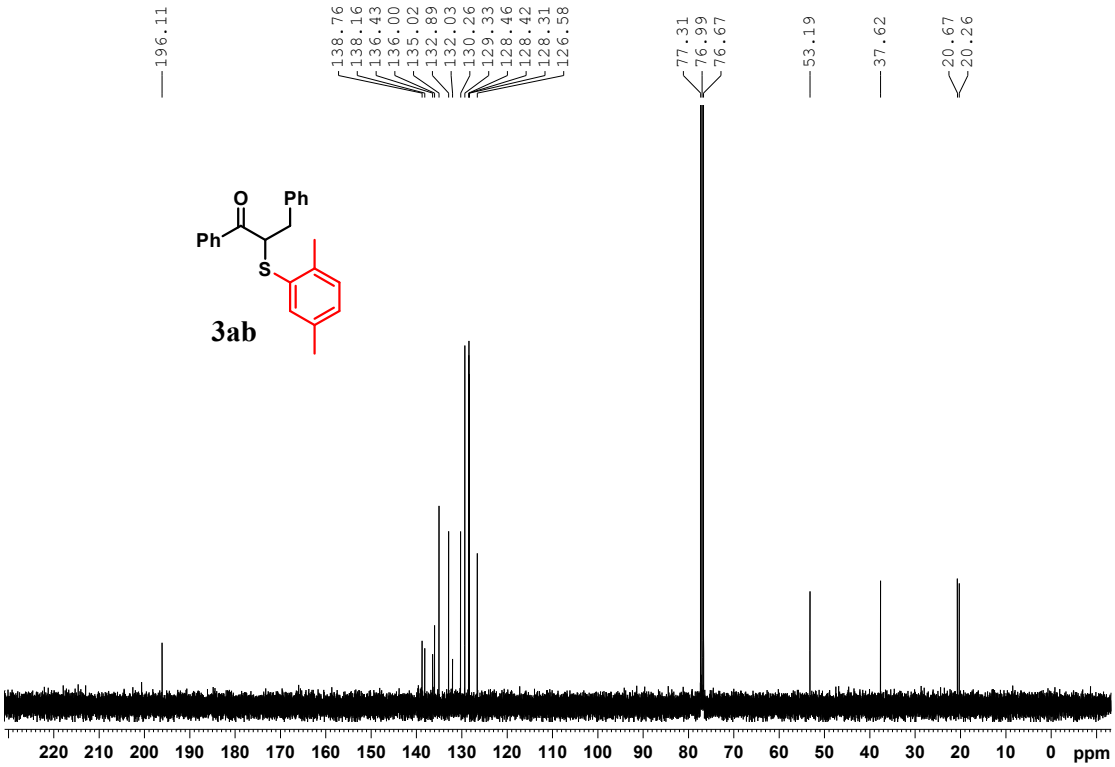
1v

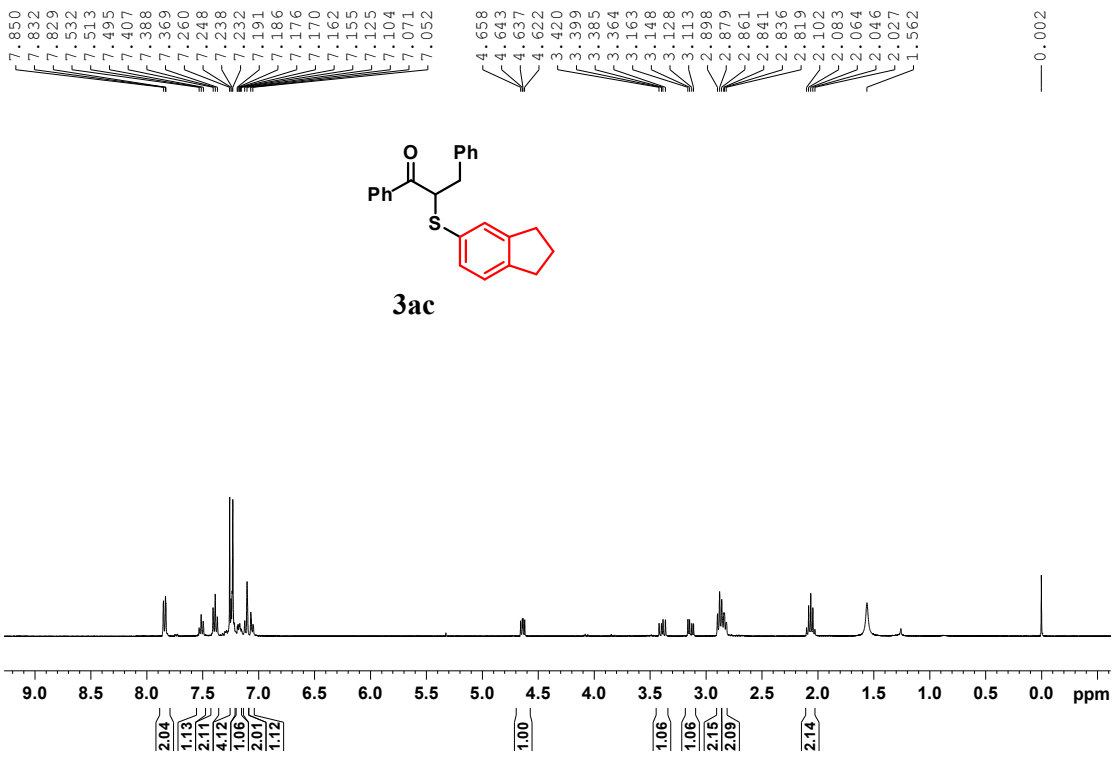

194.56
135.26
133.24
128.75
128.60
77.32
77.00
76.68
37.10
32.02
30.99
21.84
13.59
O
S
Me
1v
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


7.842
7.824
7.534
7.516
7.498
7.405
7.386
7.367
7.316
7.296
7.286
7.283
7.270
7.258
7.239
7.220
7.200
7.196
7.180
4.725
4.710
4.704
4.689
3.444
3.422
3.409
3.388
3.176
3.161
3.141
3.126
1.557
0.008
O
Ph
Ph
S
3aa
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.07
2.08
4.01
2.04
3.04
1.00
1.04
1.08
1.08


195.23
138.65
136.18
134.51
133.00
132.00
129.30
128.98
128.71
128.49
128.46
126.57
77.32
77.00
76.68
52.90
37.30
O
Ph
Ph
S
3aa
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


7.689
7.490
7.472
7.453
7.332
7.313
7.293
7.275
7.260
7.255
7.250
7.242
7.229
7.200
7.193
7.186
7.182
7.178
7.173
7.168
7.164
7.035
7.014
6.968
6.954
4.682
4.667
4.661
4.646
3.513
3.491
3.478
3.457
3.204
3.189
3.169
3.154
2.183
2.173
1.555
0.003
O
Ph
Ph
S
3ab
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.11
2.08
4.08
1.06
1.04
2.01
1.06
1.15
1.08
6.15


196.11
138.76
138.16
136.43
136.00
135.02
132.89
132.03
130.26
129.33
128.46
128.42
128.31
126.58
77.31
76.99
76.67
53.19
37.62
20.67
20.26
O
Ph
Ph
S
3ab
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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7.832
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7.513
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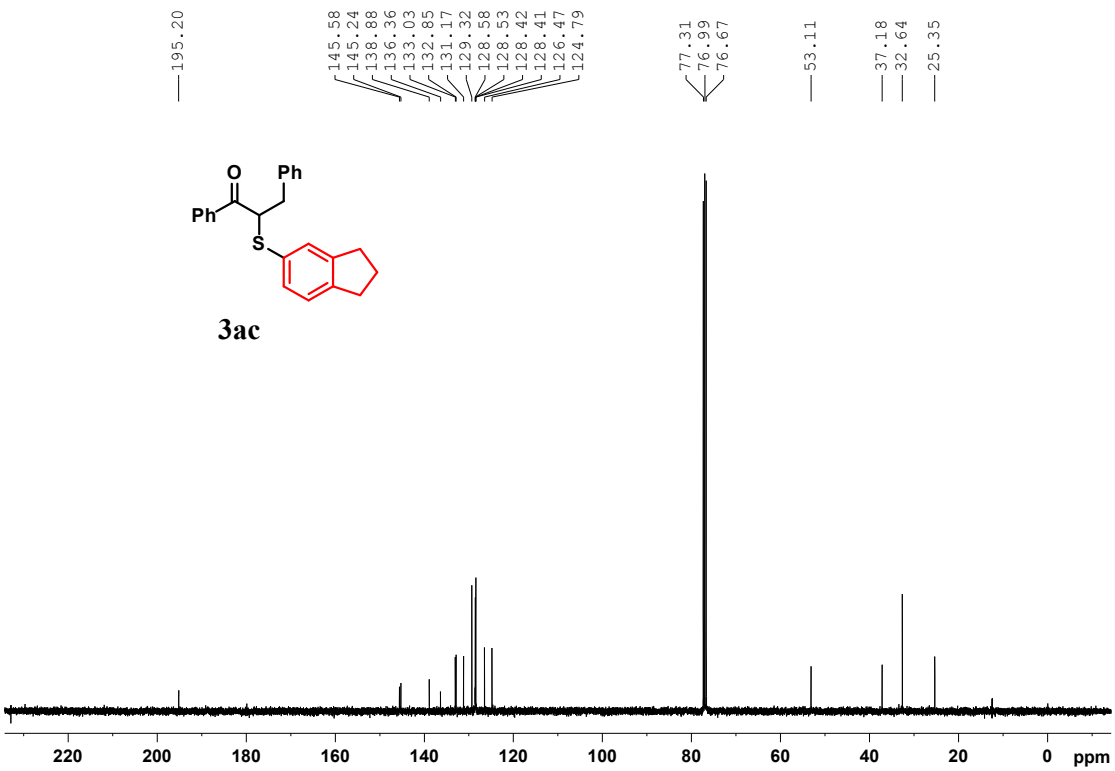
7.407
7.388
7.369
7.260
7.248
7.238
7.232
7.191
7.186
7.176
7.170
7.162
7.155
7.125
7.104
7.071
7.052
4.658
4.643
4.637
4.622
3.420
3.399
3.385
3.364
3.163
3.148
3.128
3.113
2.898
2.879
2.861
2.841
2.836
2.819
2.102
2.083
2.064
2.046
2.027
1.562
0.002
O
Ph
Ph
S
3ac
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.04
1.13
2.11
4.12
1.06
2.01
1.12
1.00
1.06
1.06
2.15
2.09
2.14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145.24
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131.17
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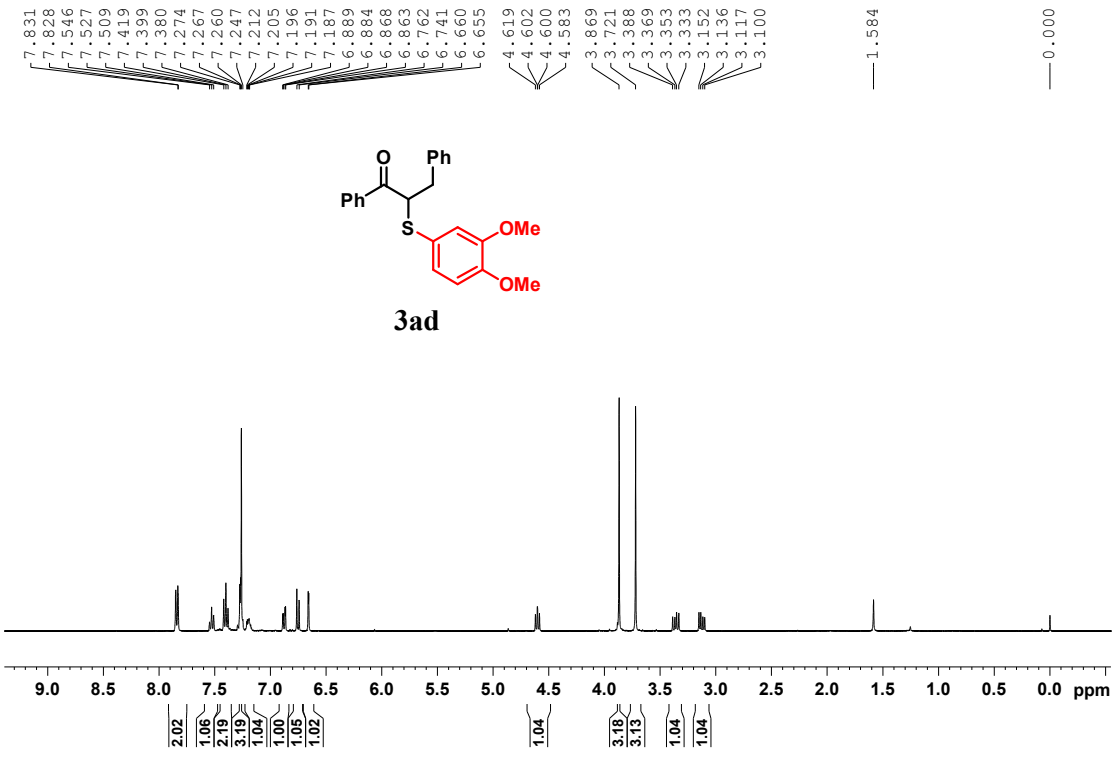
128.58
128.53
128.42
128.41
126.47
124.79
77.31
76.99
76.67
53.11
37.18
32.64
25.35
O
Ph
Ph
S
220
200
180
160
140
120
100
80
60
40
20
0
ppm

3ac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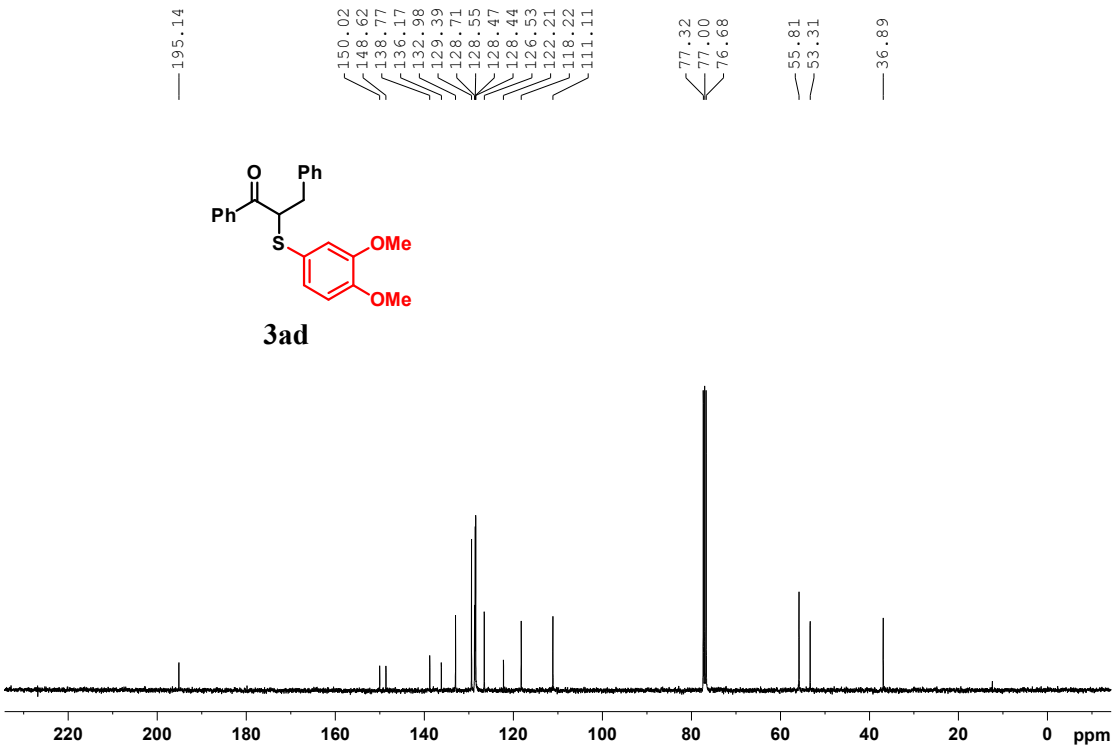
7.380
7.274
7.267
7.260
7.247
7.212
7.205
7.196
7.191
7.187
6.889
6.884
6.868
6.863
6.762
6.741
6.660
6.655
4.619
4.602
4.600
4.583
3.869
3.721
3.388
3.369
3.353
3.333
3.152
3.136
3.117
3.100
1.584
0.000
O
Ph
Ph
S
OMe
OMe
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.02
1.06
2.19
3.19
1.04
1.00
1.05
1.02
1.04
3.18
3.13
1.04
1.04

3ad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150.02
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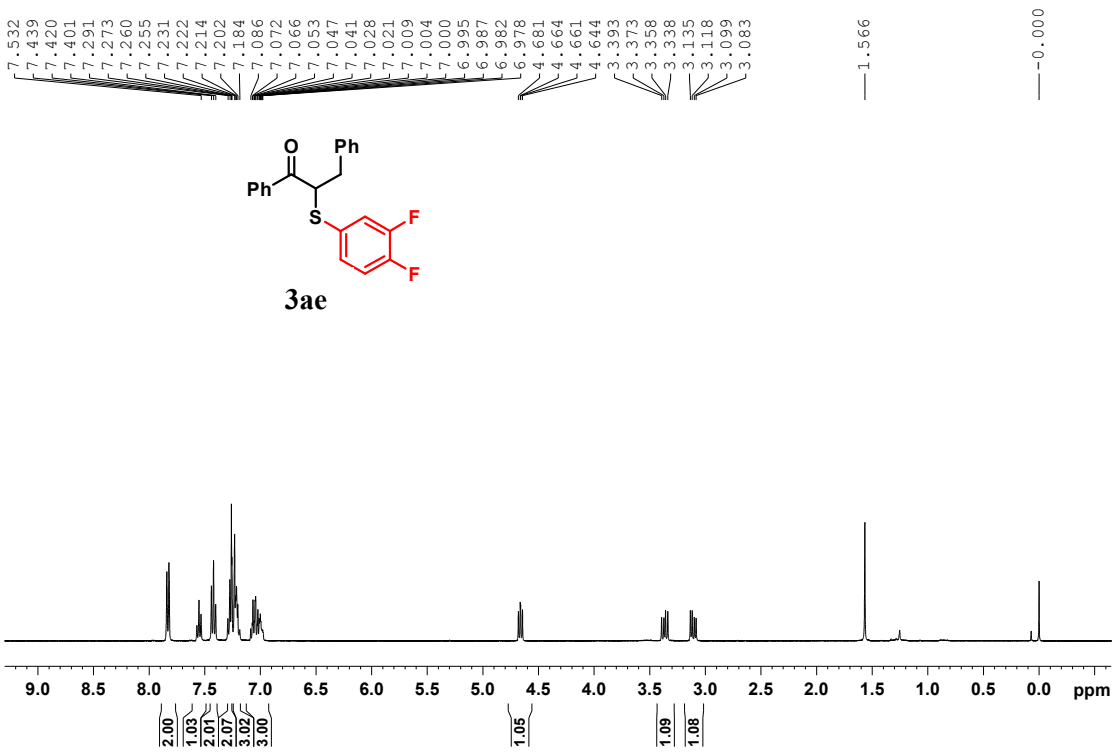
136.17
132.98
129.39
128.71
128.55
128.47
128.44
126.53
122.21
118.22
111.11
77.32
77.00
76.68
55.81
53.31
36.89
O
Ph
Ph
S
OMe
OMe
220
200
180
160
140
120
100
80
60
40
20
0
ppm

3ad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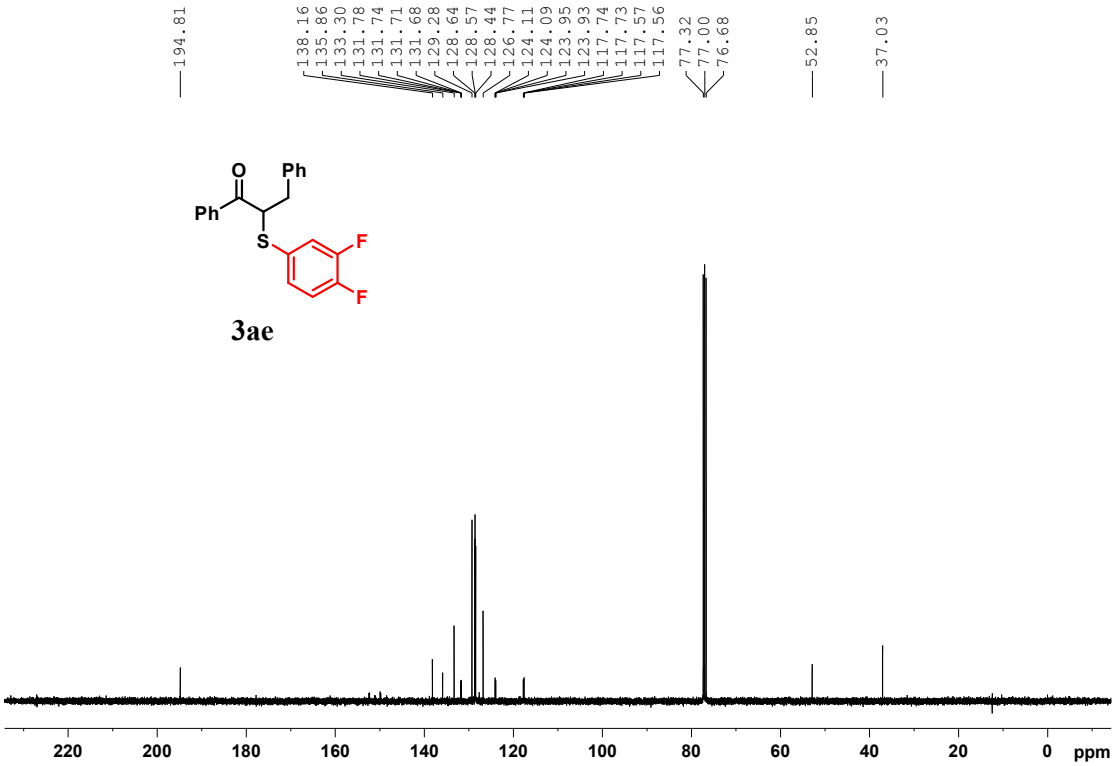
7.420
7.401
7.291
7.273
7.260
7.255
7.231
7.222
7.214
7.202
7.184
7.086
7.072
7.066
7.053
7.047
7.041
7.028
7.021
7.009
7.004
7.000
6.995
6.987
6.982
6.978
4.681
4.664
4.661
4.644
3.393
3.373
3.358
3.338
3.135
3.118
3.099
3.083
1.566
0.000
O
Ph
Ph
S
F
F
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
1.03
2.01
2.07
3.02
3.00
1.05
1.09
1.08

3ae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138.16
135.86
133.30
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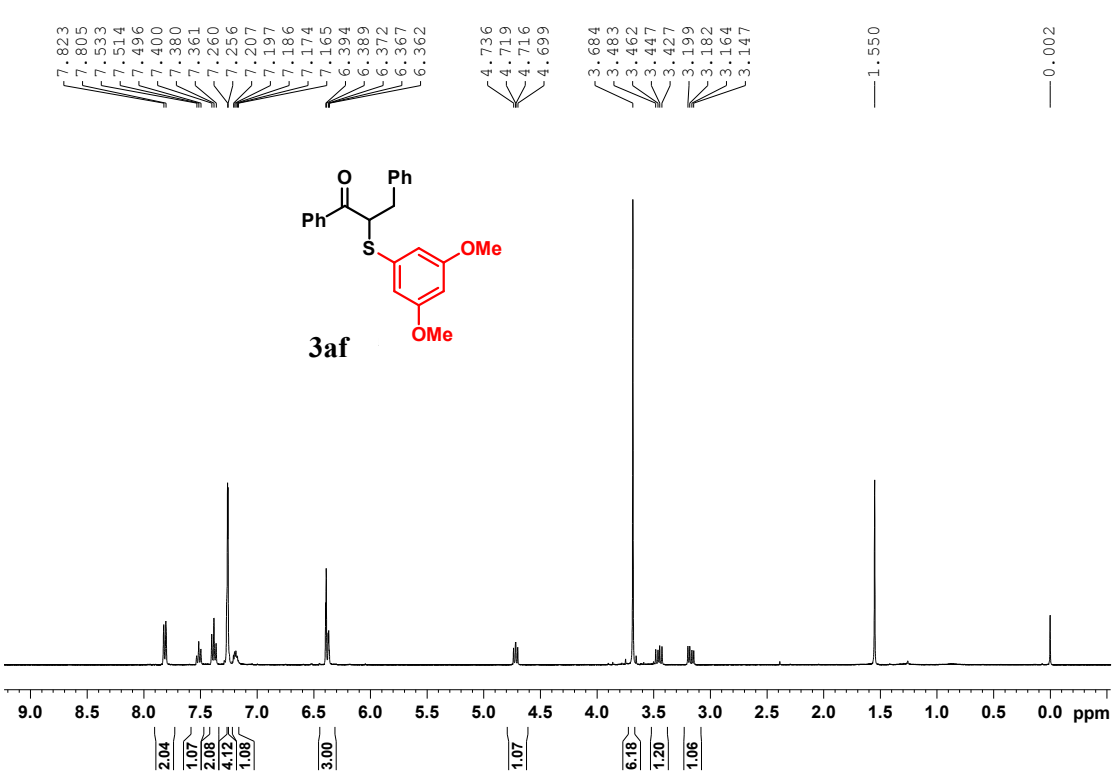
131.74
131.71
131.68
129.28
128.64
128.57
128.44
126.77
124.11
124.09
123.95
123.93
117.74
117.73
117.57
117.56
77.32
77.00
76.68
52.85
37.03
O
Ph
Ph
S
F
F
220
200
180
160
140
120
100
80
60
40
20
0
ppm

3ae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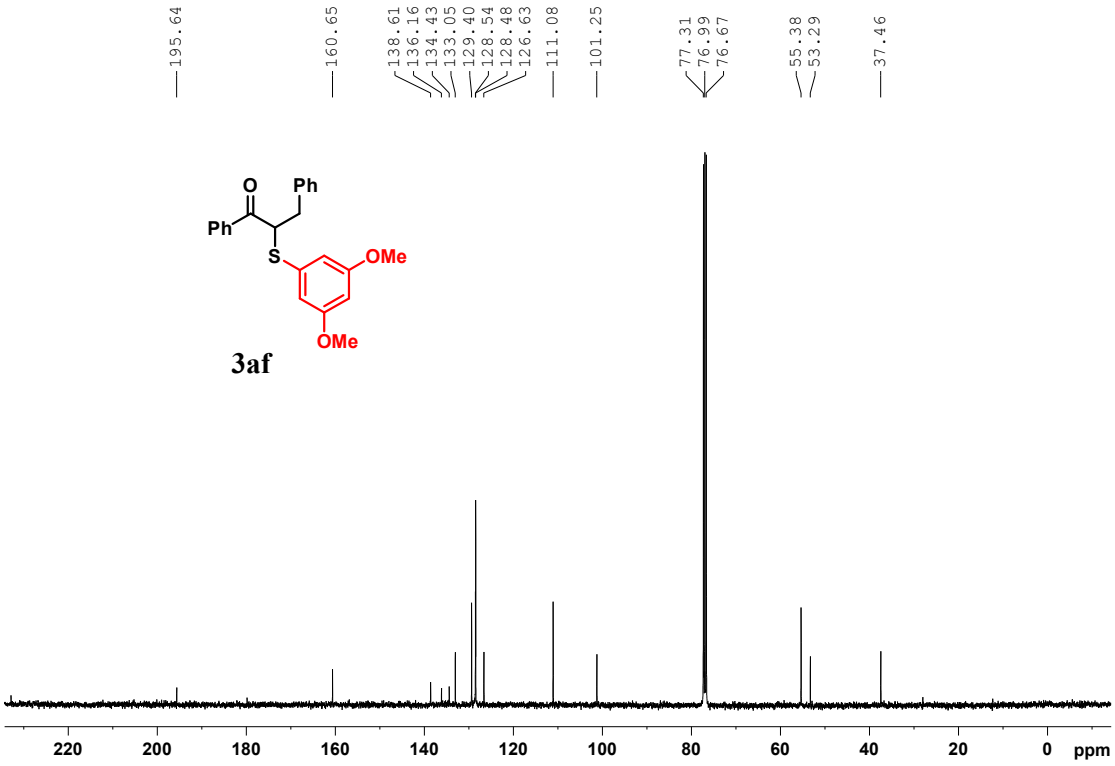
7.496
7.400
7.380
7.361
7.260
7.256
7.207
7.197
7.186
7.174
7.165
6.394
6.389
6.372
6.367
6.362
4.736
4.719
4.716
4.699
3.684
3.483
3.462
3.447
3.427
3.199
3.182
3.164
3.147
1.550
0.002
O
Ph
Ph
S
OMe
OMe
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.04
1.07
2.08
4.12
1.08
3.00
1.07
6.18
1.20
1.06

3af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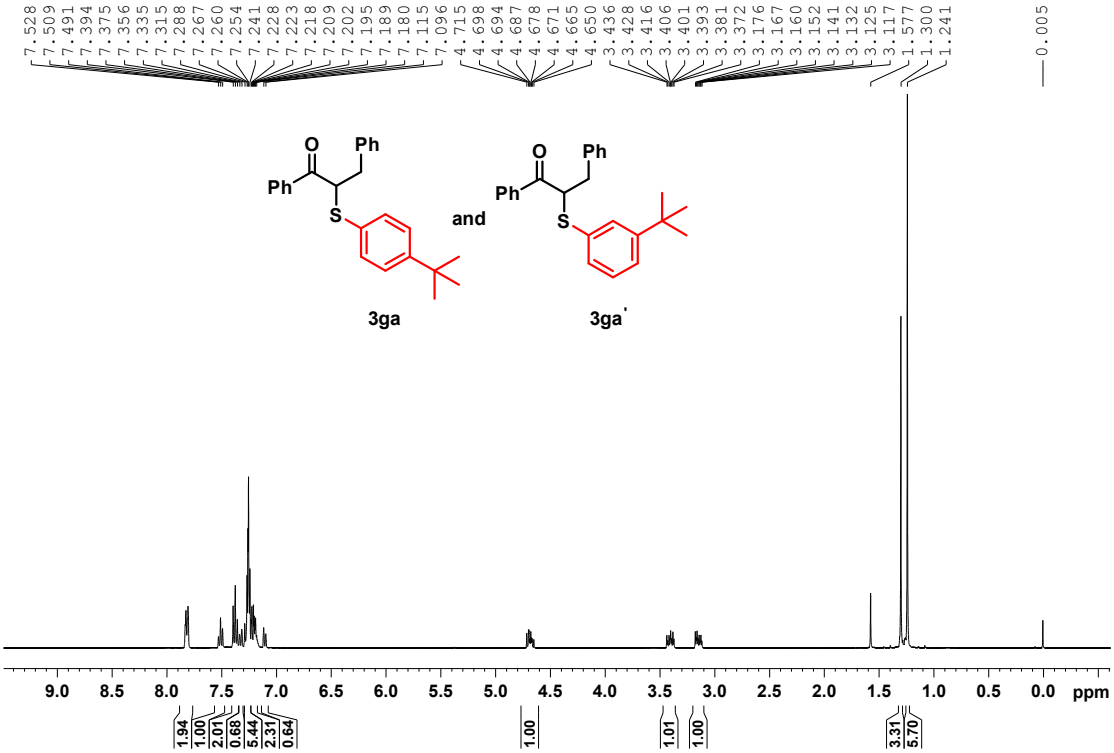
160.65
138.61
136.16
134.43
133.05
129.40
128.54
128.48
126.63
111.08
101.25
77.31
76.99
76.67
55.38
53.29
37.46
O
Ph
Ph
S
OMe
OMe
220
200
180
160
140
120
100
80
60
40
20
0
ppm

3af

3ag **3ag'**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7.335
7.315
7.288
7.267
7.260
7.254
7.241
7.228
7.223
7.218
7.209
7.202
7.195
7.189
7.180
7.115
7.096
4.715
4.698
4.694
4.687
4.678
4.671
4.665
4.650
3.436
3.428
3.416
3.406
3.401
3.393
3.381
3.372
3.176
3.167
3.160
3.152
3.141
3.132
3.125
3.117
1.577
1.300
1.241
0.005
O
Ph
Ph
S
and
3ga
3ga'
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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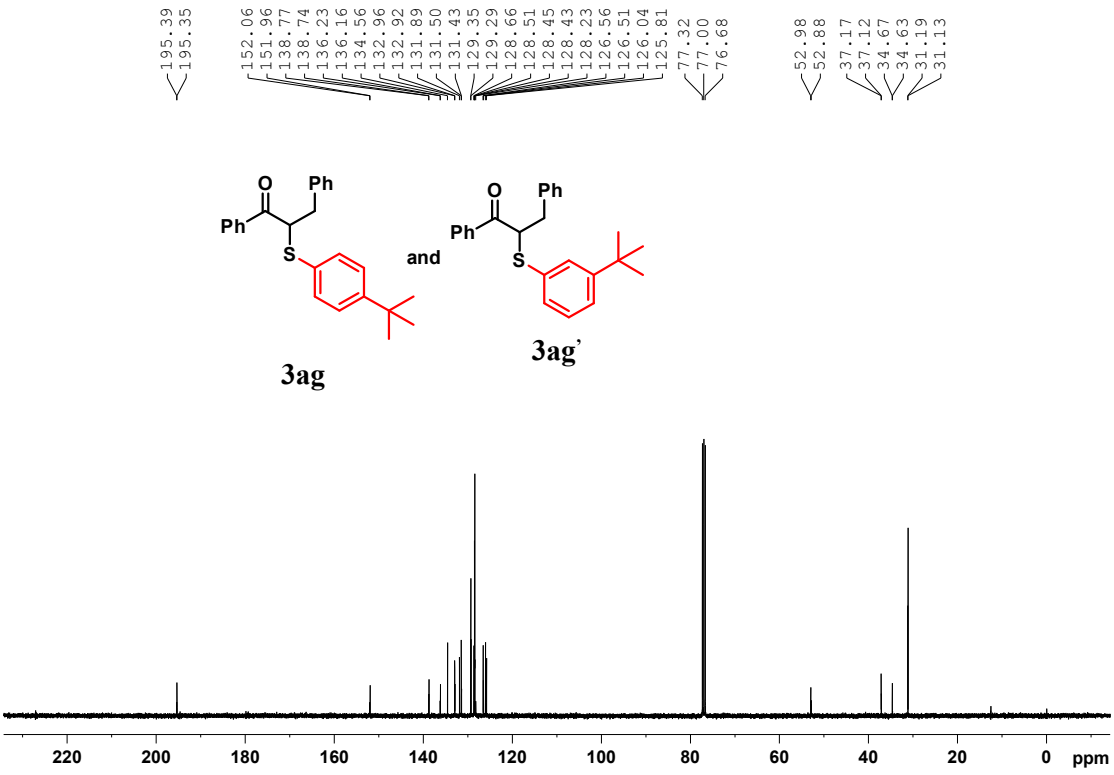
2.01
0.68
5.44
2.31
0.64
1.00
1.01
1.00
3.31
5.70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152.06
151.96
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138.74
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136.16
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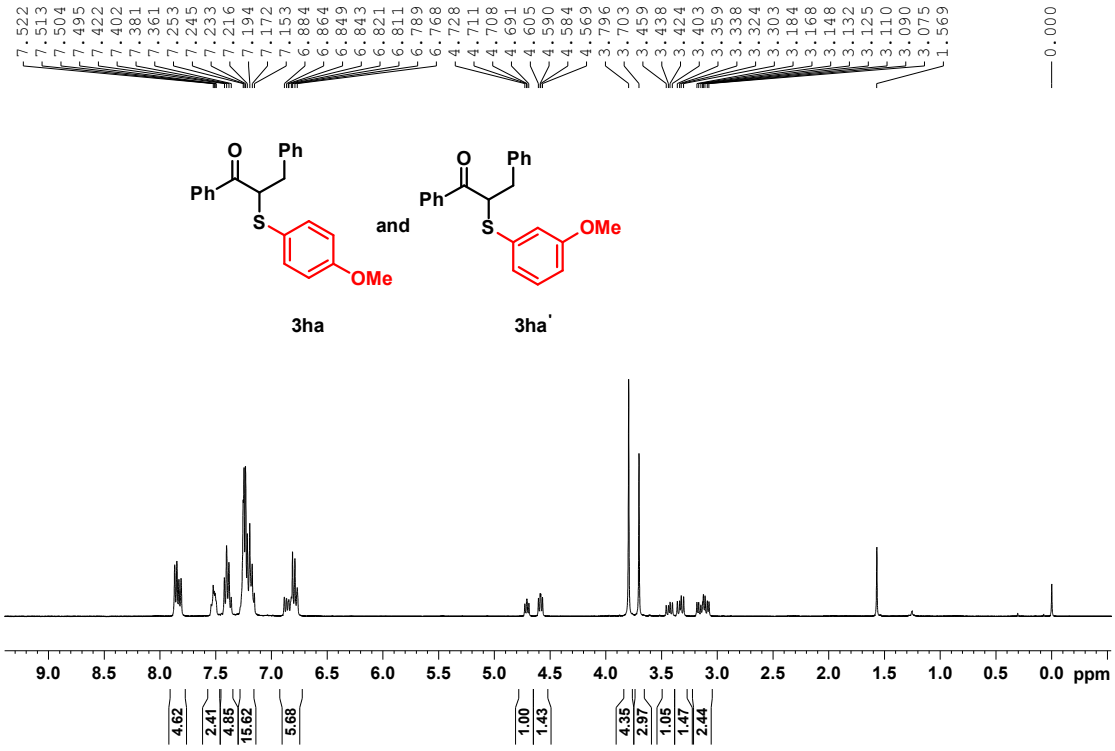
132.96
132.92
131.89
131.50
131.43
129.35
129.29
128.66
128.51
128.45
128.43
128.23
126.56
126.51
126.04
125.81
77.32
77.00
76.68
52.98
52.88
37.17
37.12
34.67
34.63
31.19
31.13
O
Ph
Ph
S
and
3ag
3ag'
220
200
180
160
140
120
100
80
60
40
20
0
ppm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7.402
7.381
7.361
7.253
7.245
7.233
7.216
7.194
7.172
7.153
6.884
6.864
6.849
6.843
6.821
6.811
6.789
6.768
4.728
4.711
4.708
4.691
4.605
4.590
4.584
4.569
3.796
3.703
3.459
3.438
3.424
3.403
3.359
3.338
3.324
3.303
3.184
3.168
3.148
3.132
3.125
3.110
3.090
3.075
1.569
0.000
Ph
O
Ph
S
OMe
and
3ha
3ha'
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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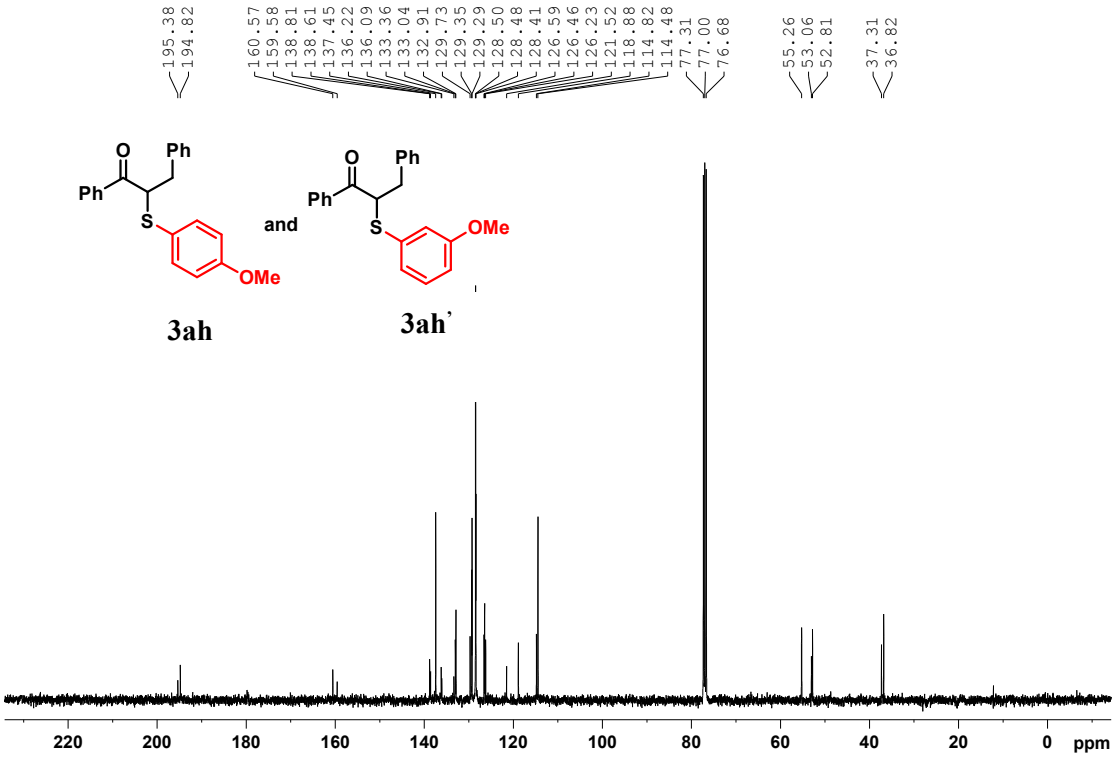
4.85
15.62
5.68
1.00
1.43
4.35
2.97
1.05
1.47
2.44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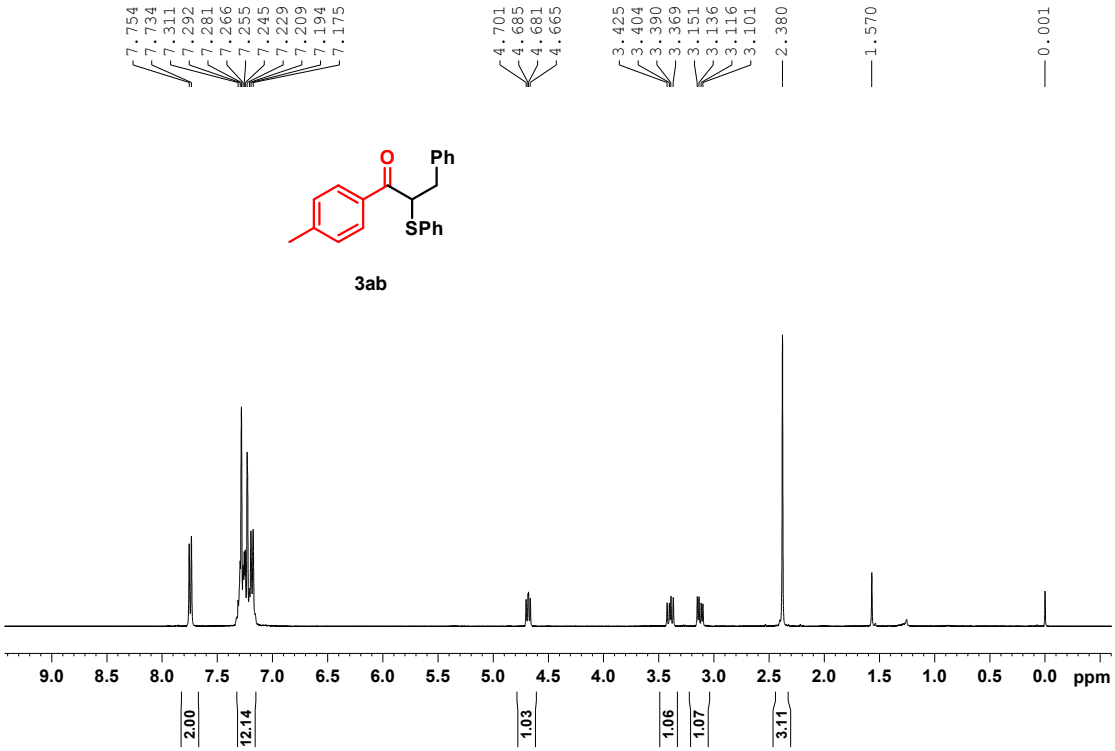
160.57
159.58
138.81
138.61
137.45
136.22
136.09
133.36
133.04
132.91
129.73
129.35
129.29
128.50
128.48
128.41
126.59
126.46
126.23
121.52
118.88
114.82
114.48
77.31
77.00
76.68
55.26
53.06
52.81
37.31
36.82
Ph
O
Ph
S
OMe
and
3ah
3ah'
220 200 180 160 140 120 100 80 60 40 20 0 ppm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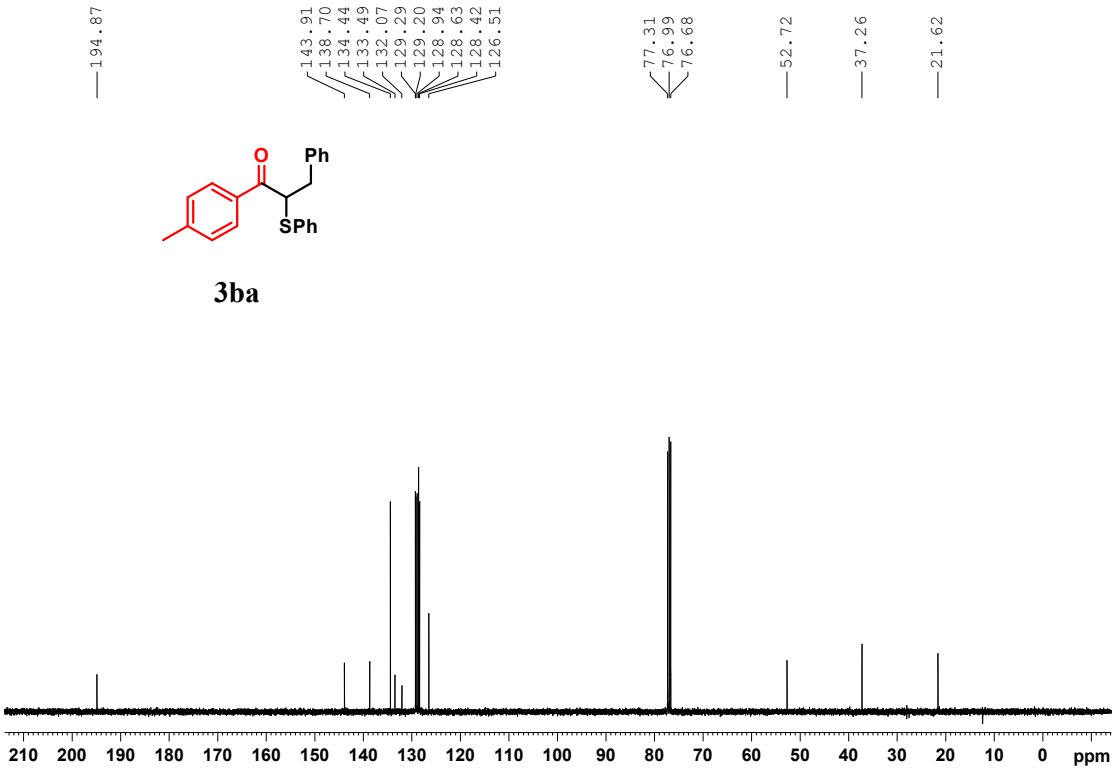
7.292
7.281
7.266
7.255
7.245
7.229
7.209
7.194
7.175
4.701
4.685
4.681
4.665
3.425
3.404
3.390
3.369
3.151
3.136
3.116
3.101
2.380
1.570
0.001
O
Ph
SPh
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
12.14
1.03
1.06
1.07
3.11

3ab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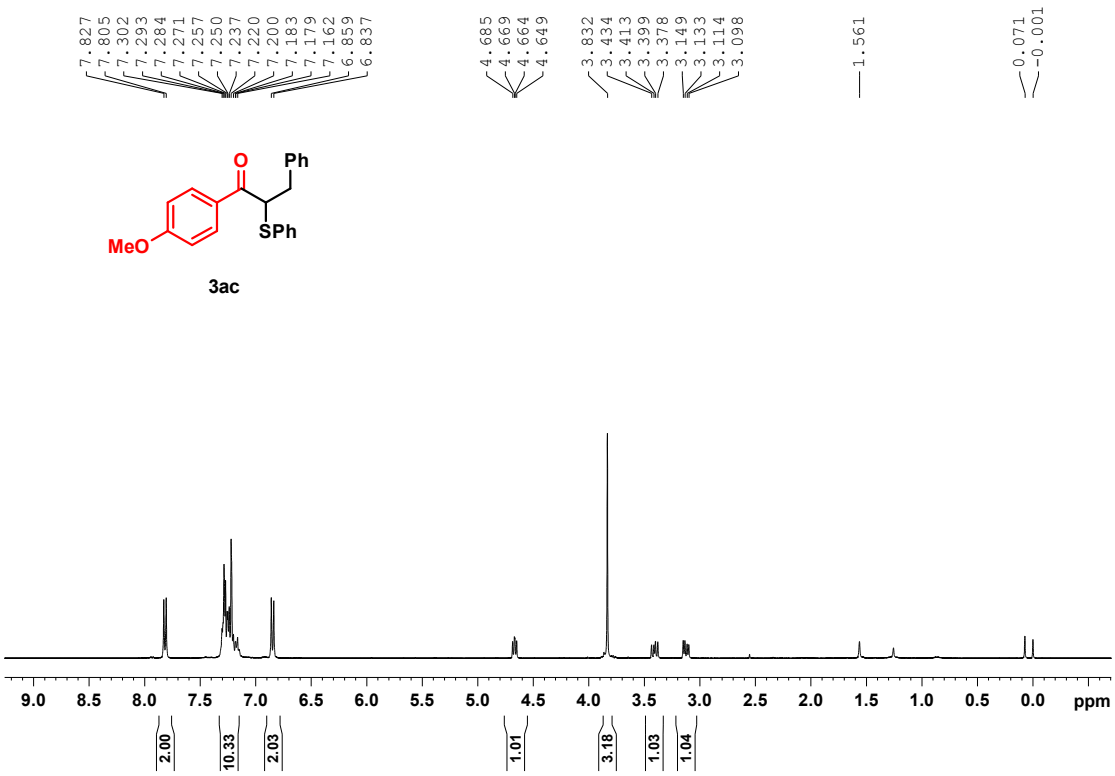
138.70
134.44
133.49
132.07
129.29
129.20
128.94
128.63
128.42
126.51
77.31
76.99
76.68
52.72
37.26
21.62
O
Ph
SPh
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

3ba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7.271
7.257
7.250
7.237
7.220
7.200
7.183
7.179
7.162
6.859
6.837
4.685
4.669
4.664
4.649
3.832
3.434
3.413
3.399
3.378
3.149
3.133
3.114
3.098
1.561
0.071
-0.001
O
Ph
MeO
SPh
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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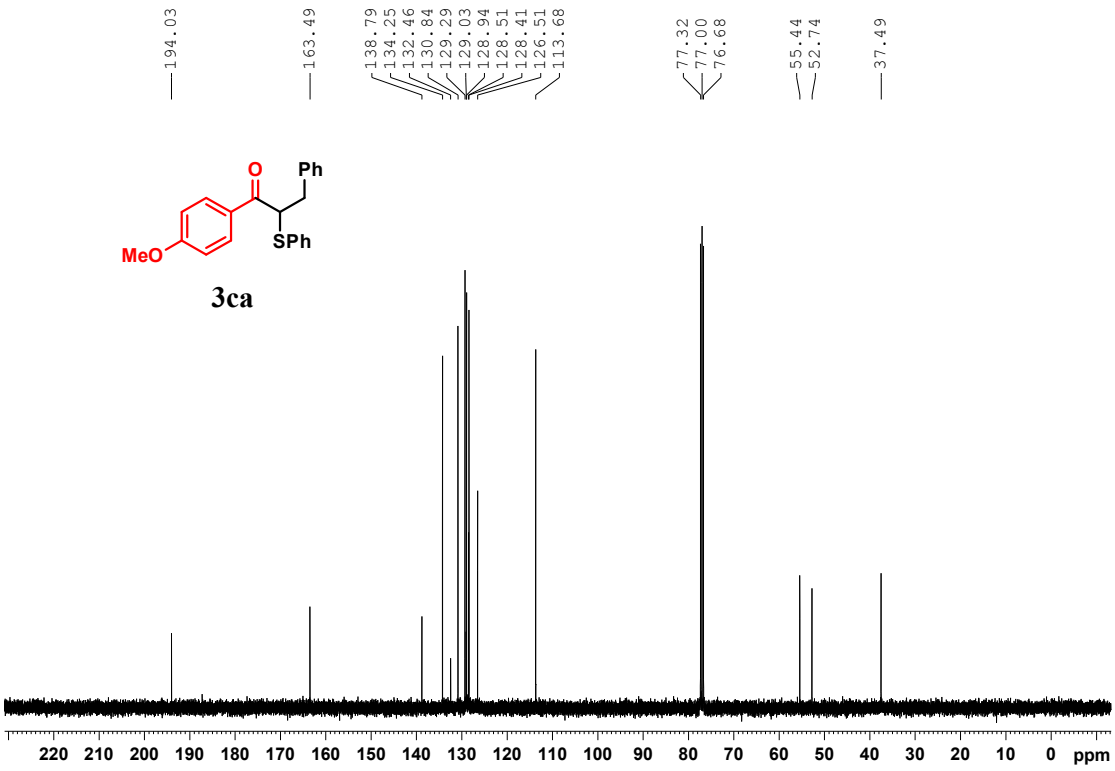
10.33
2.03
1.01
3.18
1.03
1.04

3ac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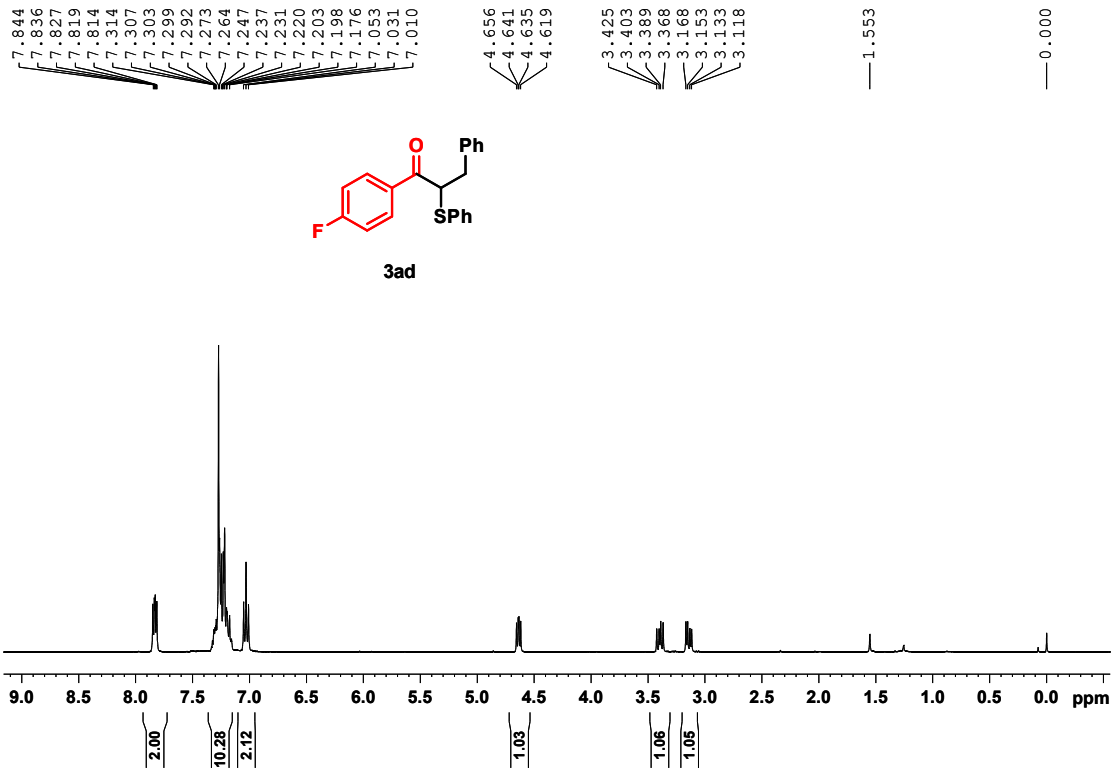
129.29
129.03
128.94
128.51
128.41
126.51
113.68
77.32
77.00
76.68
55.44
52.74
37.49
O
Ph
MeO
SPh
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

3ca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7.299
7.292
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7.264
7.247
7.237
7.231
7.220
7.203
7.198
7.176
7.053
7.031
7.010
4.656
4.641
4.635
4.619
3.425
3.403
3.389
3.368
3.168
3.153
3.133
3.118
1.553
0.000
O
Ph
SPh
F
3ad
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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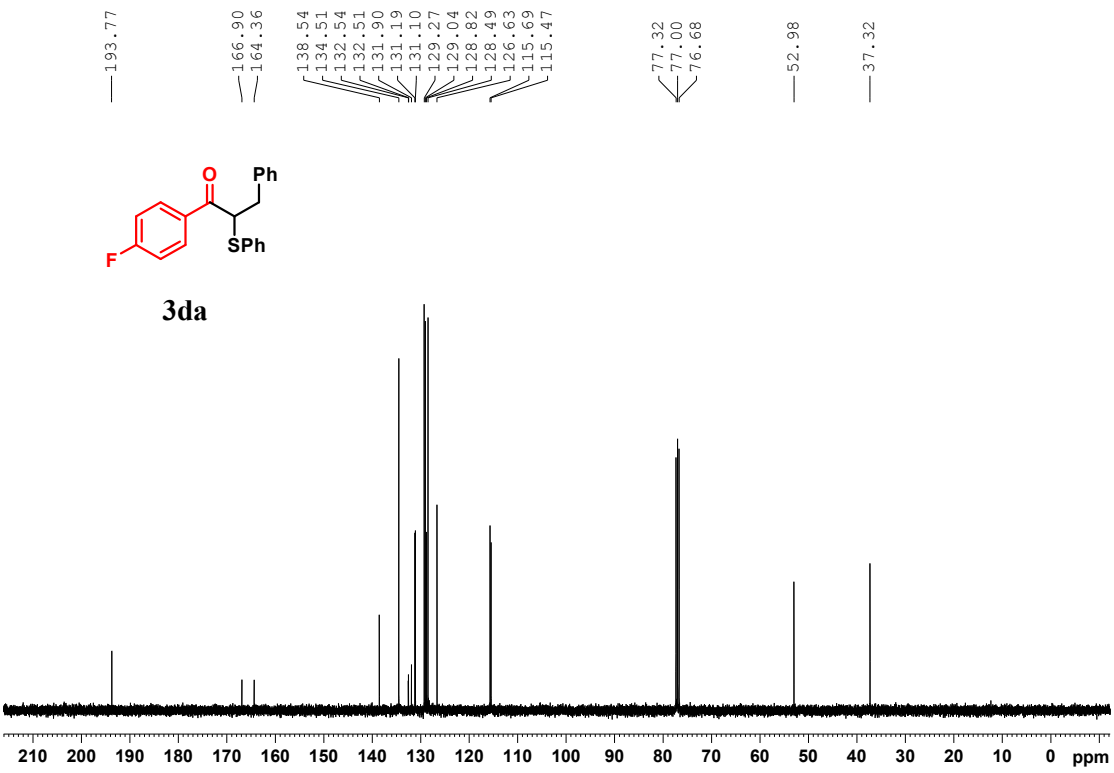
10.28
2.12
1.03
1.06
1.05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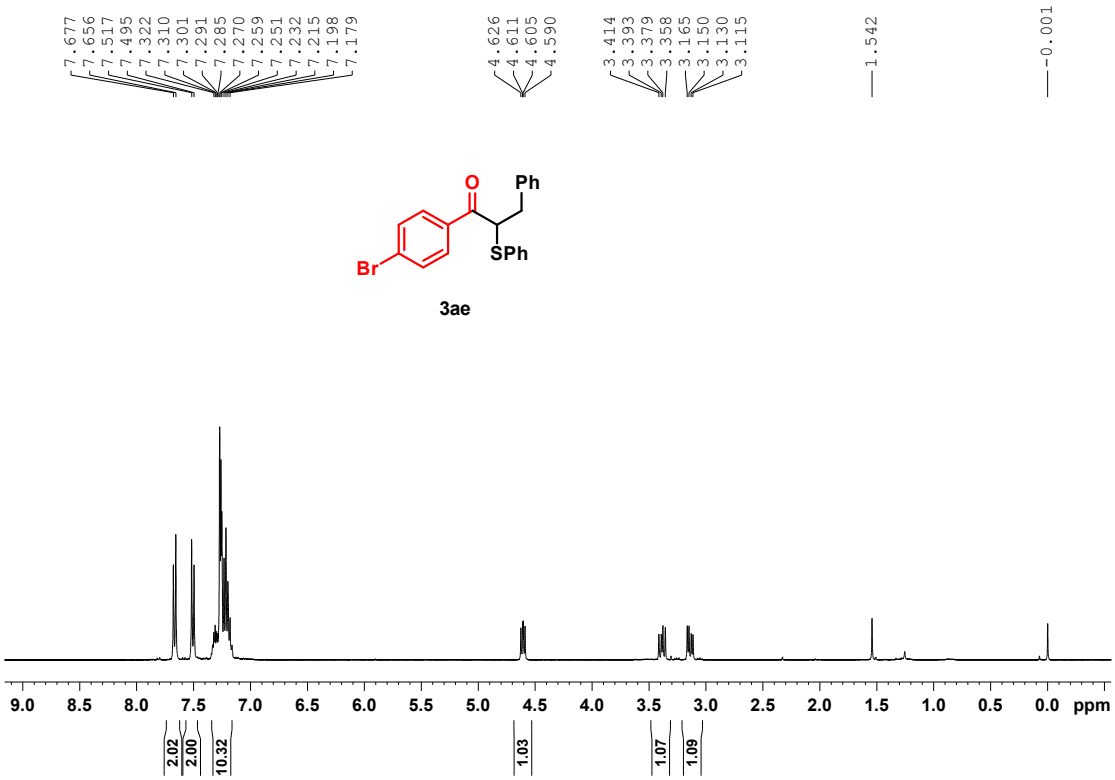
134.51
132.54
132.51
131.90
131.19
131.10
129.27
129.04
128.82
128.49
126.63
115.69
115.47
77.32
77.00
76.68
52.98
37.32
O
Ph
SPh
F
3da
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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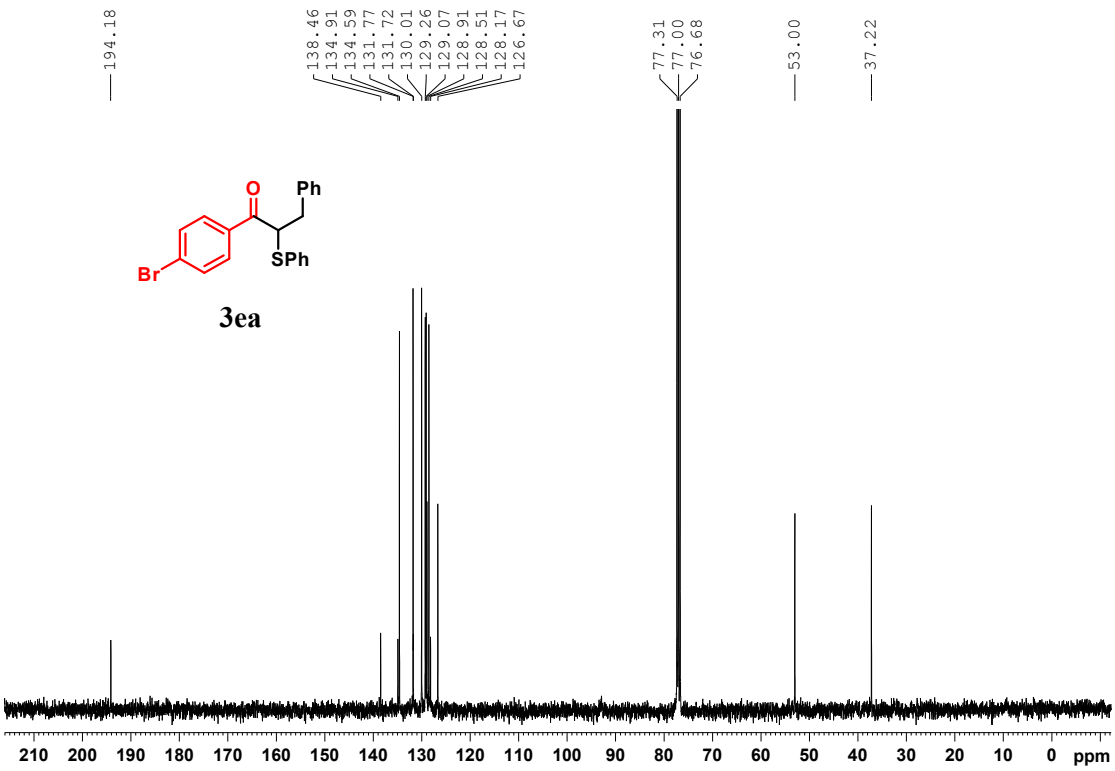
7.495
7.322
7.310
7.301
7.291
7.285
7.270
7.259
7.251
7.232
7.215
7.198
7.179
4.626
4.611
4.605
4.590
3.414
3.393
3.379
3.358
3.165
3.150
3.130
3.115
1.542
0.001
O
Ph
Br
SPh
3ae
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.02
2.00
10.32
1.03
1.07
1.09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134.59
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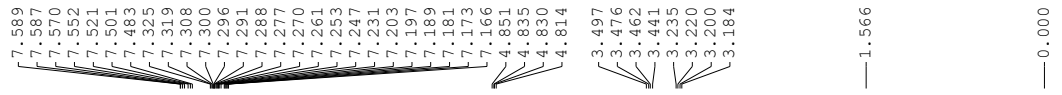
131.72
130.01
129.26
129.07
128.91
128.51
128.17
126.67
77.31
77.00
76.68
53.00
37.22
O
Ph
Br
SPh
3ea
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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7.521
7.501
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7.325
7.319
7.308
7.300
7.296
7.291
7.288
7.277
7.270
7.261
7.253
7.247
7.231
7.203
7.197
7.189
7.181
7.173
7.166
4.851
4.835
4.830
4.814
3.497
3.476
3.462
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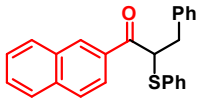
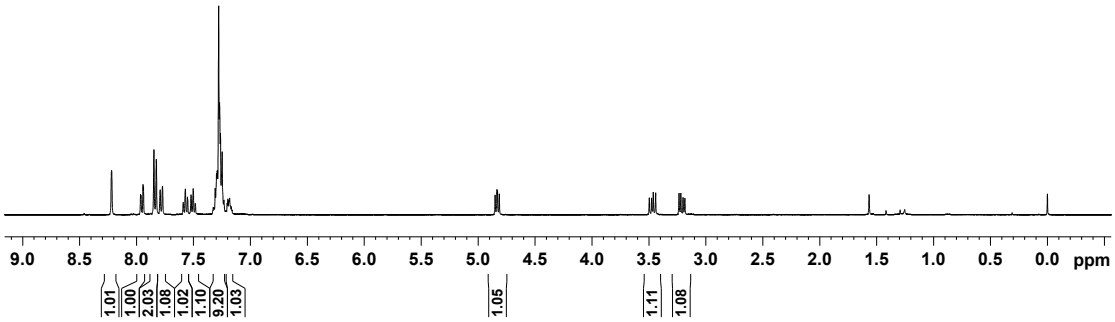
3.220
3.200
3.184
1.566
0.000

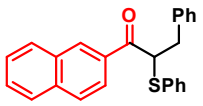

O
Ph
SPh

3fa

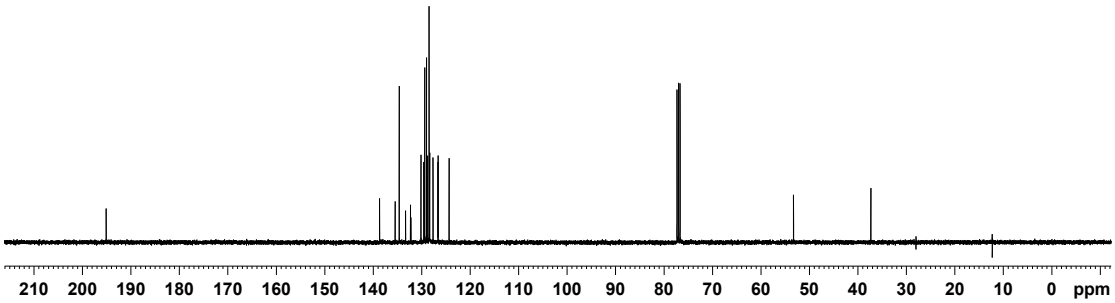

9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.01
1.00
2.03
1.08
1.02
1.10
9.20
1.03
1.05
1.11
1.08

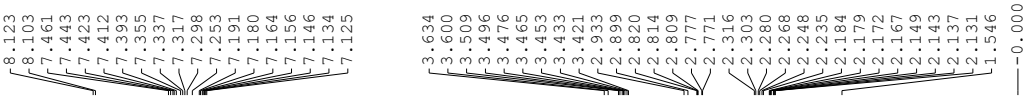
3fa

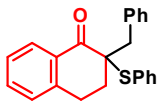

195.15
138.69
135.47
134.63
133.33
132.31
132.22
130.15
129.57
129.37
129.01
128.76
128.47
128.35
127.65
126.65
126.59
124.34
77.31
77.00
76.68
53.28
37.34


O
Ph
SPh

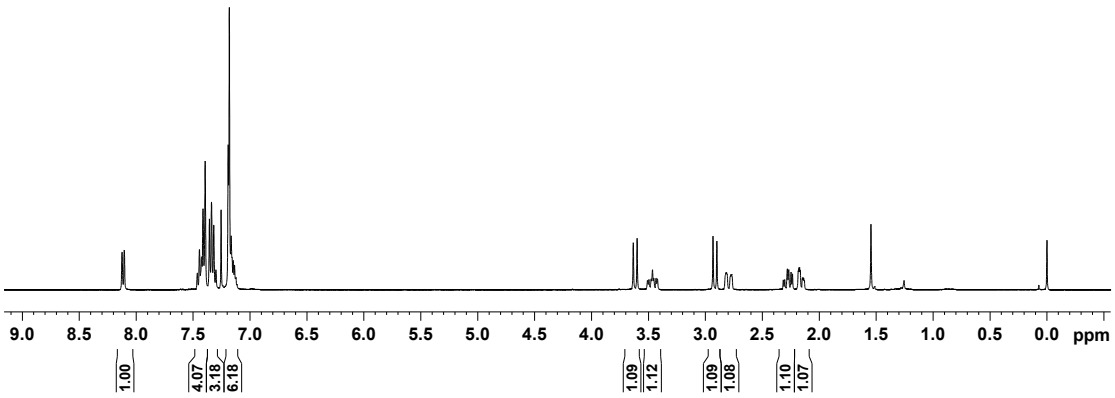
3af

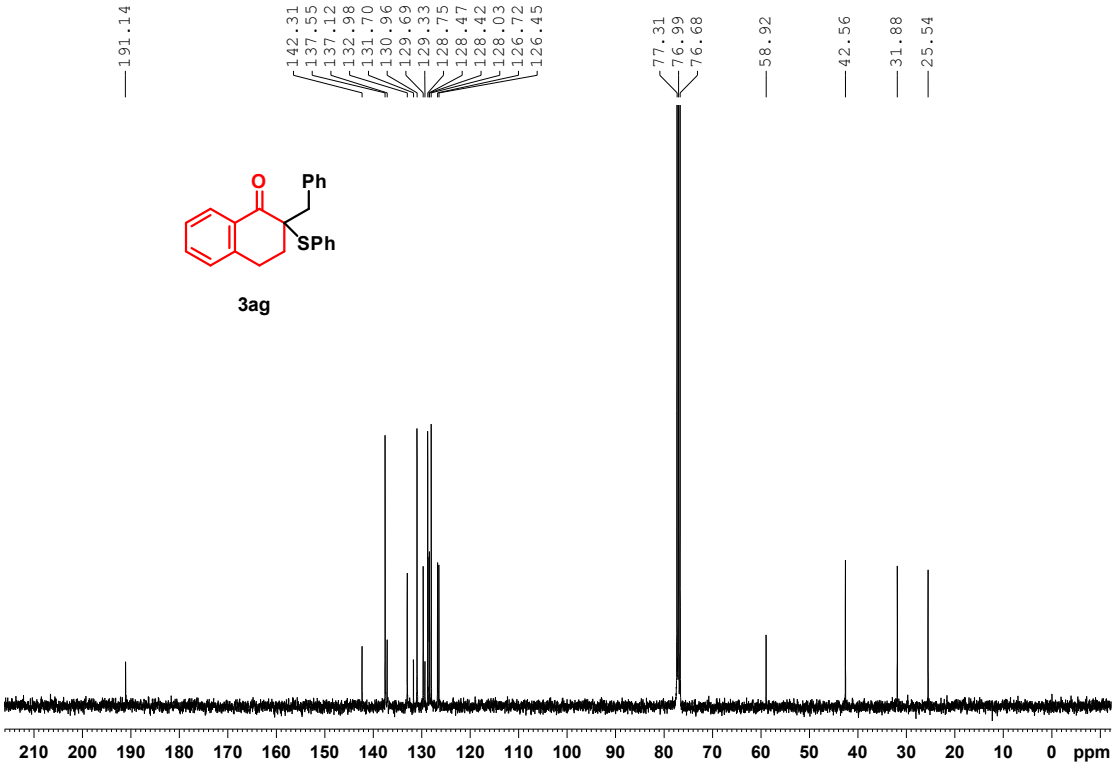

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

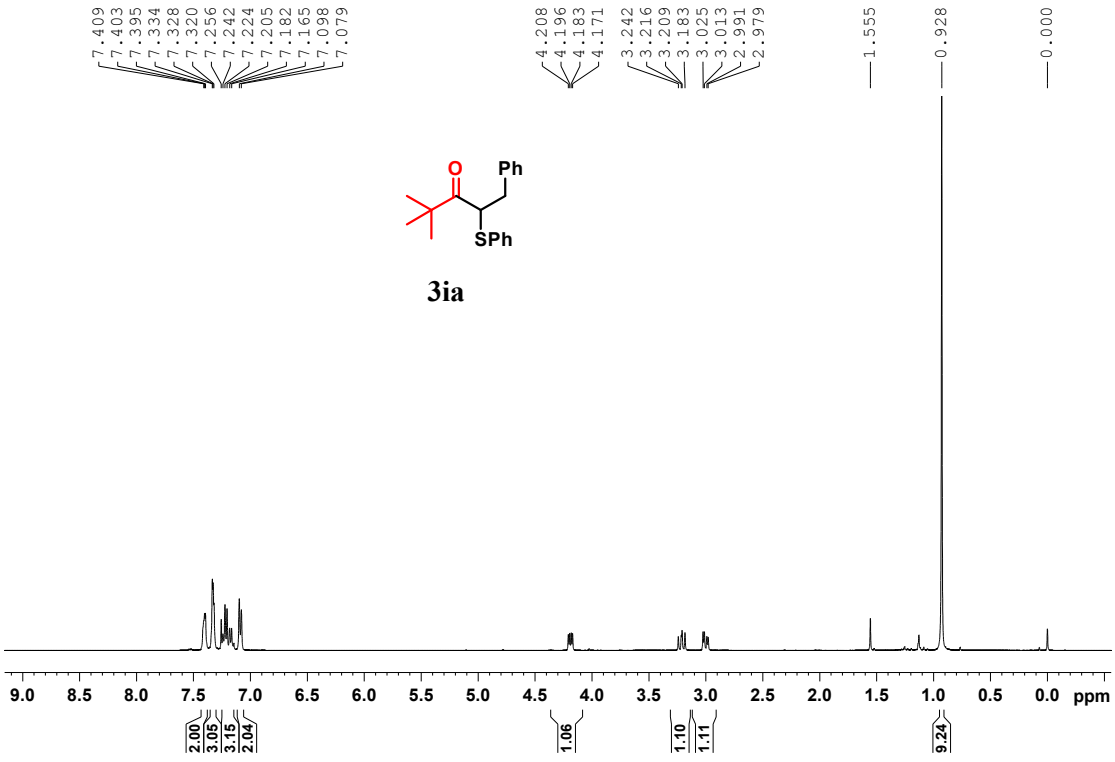

8.123
8.103
7.461
7.443
7.423
7.412
7.393
7.355
7.337
7.317
7.298
7.253
7.191
7.180
7.164
7.156
7.146
7.134
7.125
3.634
3.600
3.509
3.496
3.476
3.465
3.453
3.433
3.421
2.933
2.899
2.820
2.814
2.809
2.777
2.771
2.316
2.303
2.280
2.268
2.248
2.235
2.184
2.179
2.172
2.167
2.149
2.143
2.137
2.131
1.546
0.000

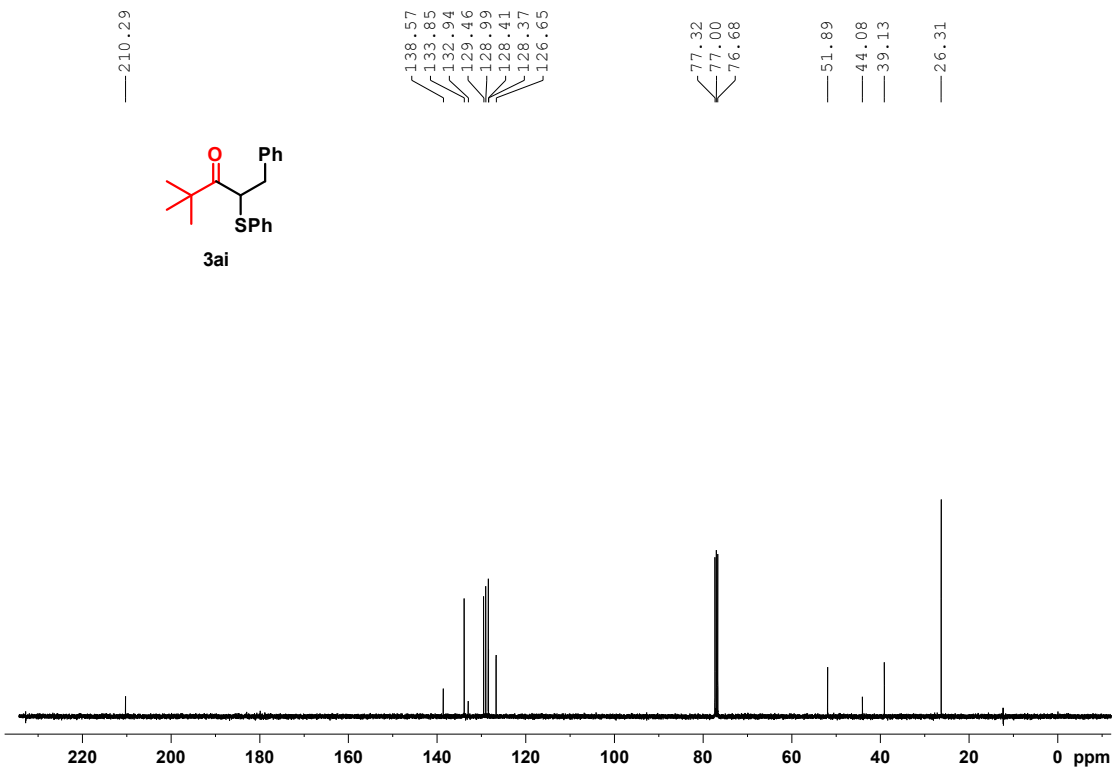

O
Ph
SPh

3ga

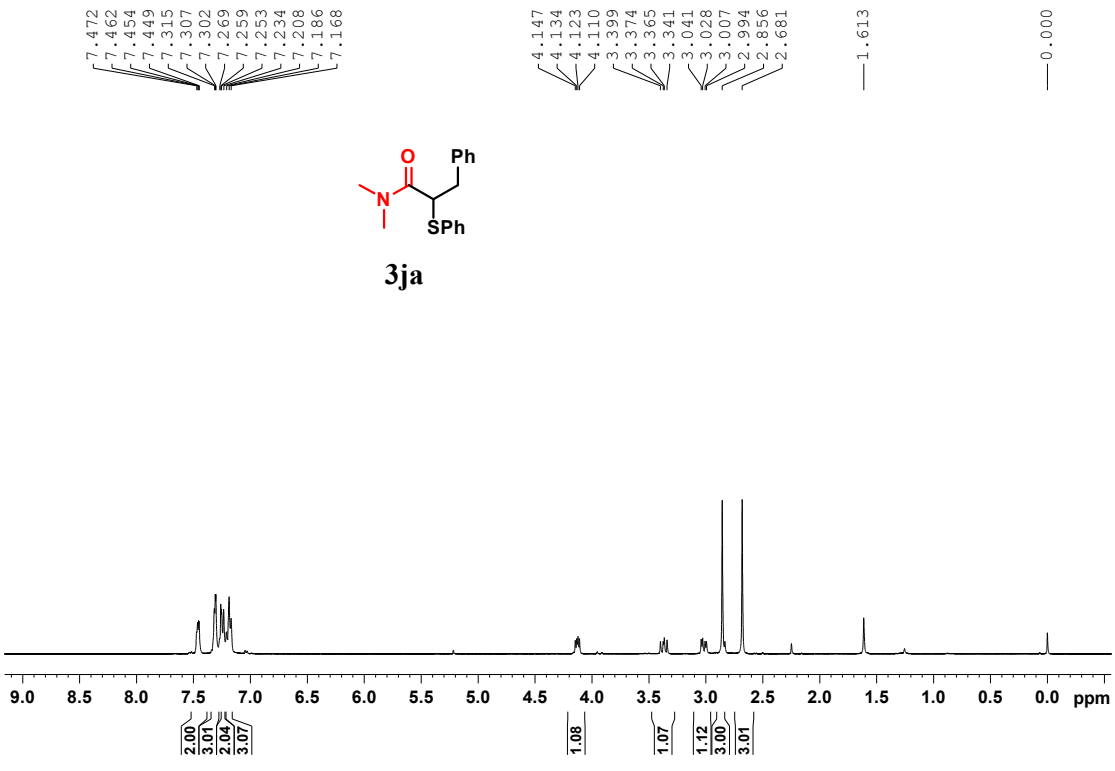

9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.00
4.07
3.18
6.18
1.09
1.12
1.09
1.08
1.10
1.07


191.14
142.31
137.55
137.12
132.98
131.70
130.96
129.69
129.33
128.75
128.47
128.42
128.03
126.72
126.45
77.31
76.99
76.68
58.92
42.56
31.88
25.54
O
Ph
SPh
3ag
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

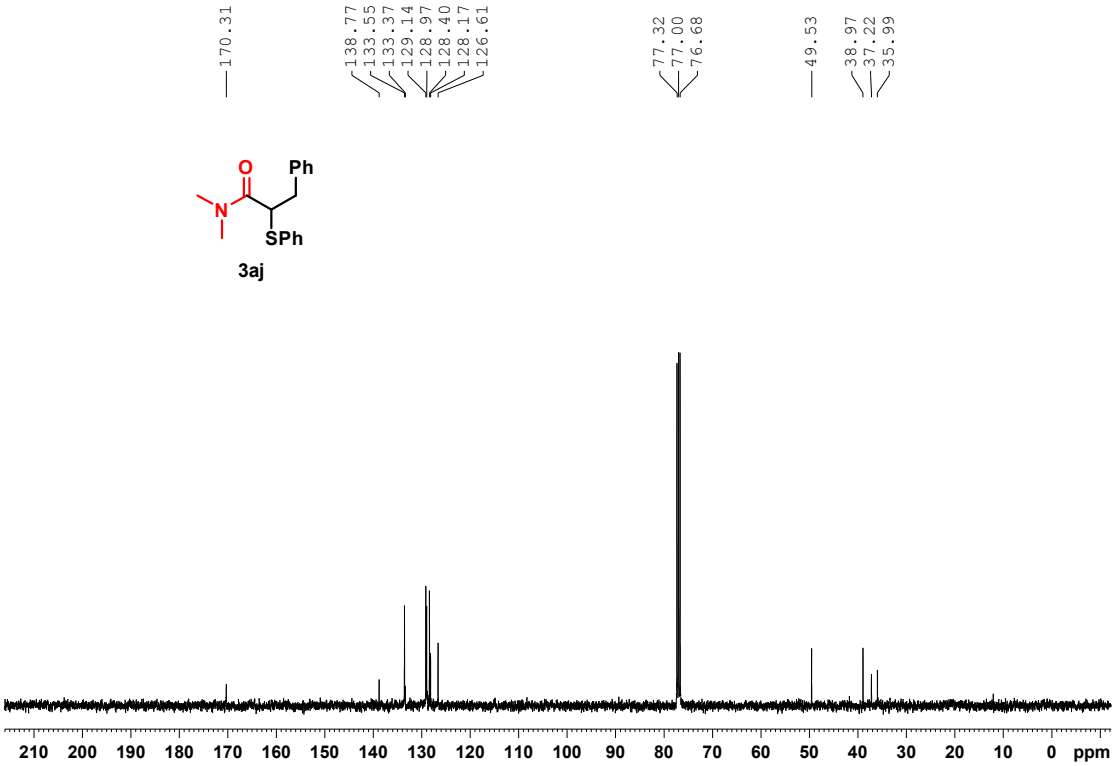

7.409
7.403
7.395
7.334
7.328
7.320
7.256
7.242
7.224
7.205
7.182
7.165
7.098
7.079
4.208
4.196
4.183
4.171
3.242
3.216
3.209
3.183
3.025
3.013
2.991
2.979
1.555
0.928
0.000
O
Ph
SPh
3ia
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
3.05
3.15
2.04
1.06
1.10
1.11
9.24


210.29
138.57
133.85
132.94
129.46
128.99
128.41
128.37
126.65
77.32
77.00
76.68
51.89
44.08
39.13
26.31
O
Ph
SPh
220
200
180
160
140
120
100
80
60
40
20
0 ppm

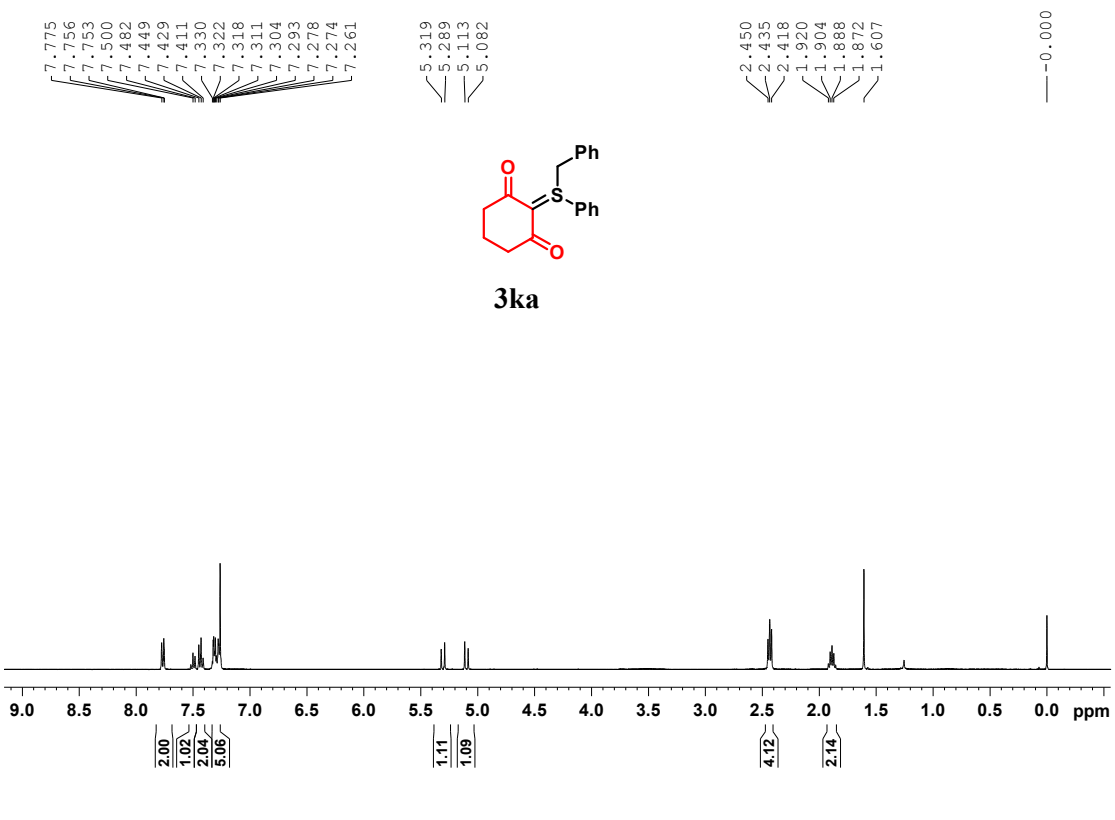
3ai


7.472
7.462
7.454
7.449
7.315
7.307
7.302
7.269
7.259
7.253
7.234
7.208
7.186
7.168
4.147
4.134
4.123
4.110
3.399
3.374
3.365
3.341
3.041
3.028
3.007
2.994
2.856
2.681
1.613
0.000
O
Ph
N
SPh
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0 ppm
2.00
3.01
2.04
3.07
1.08
1.07
1.12
3.00
3.01

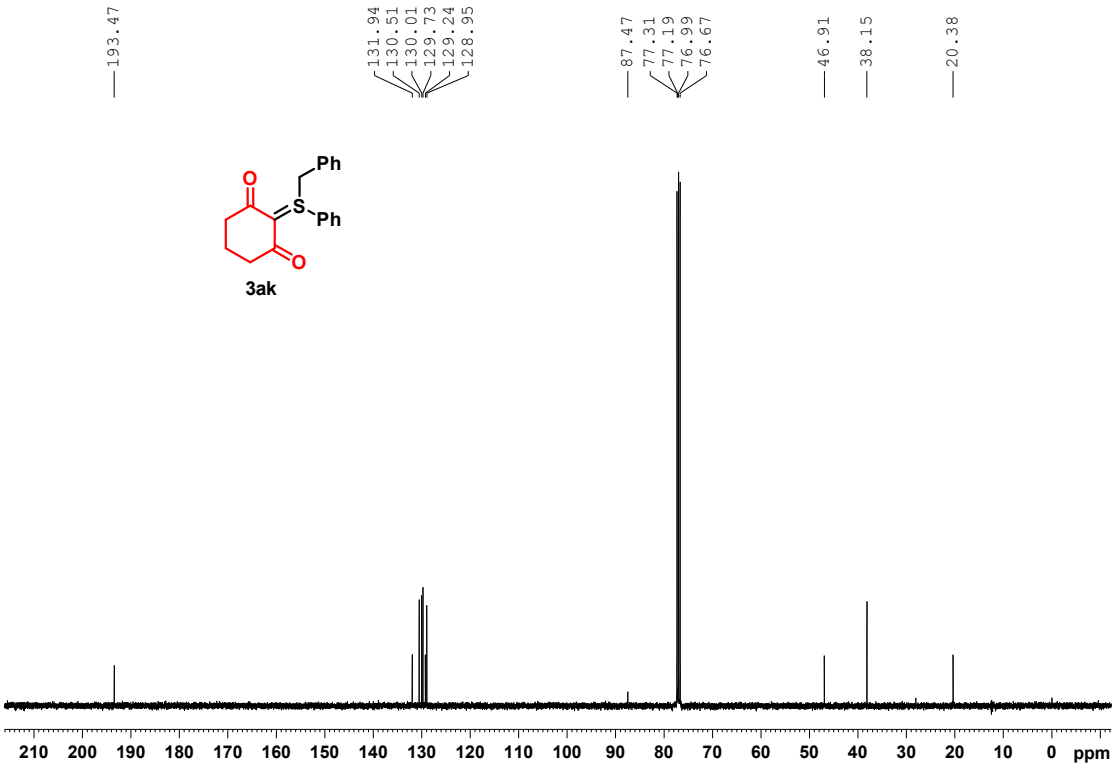
3ja

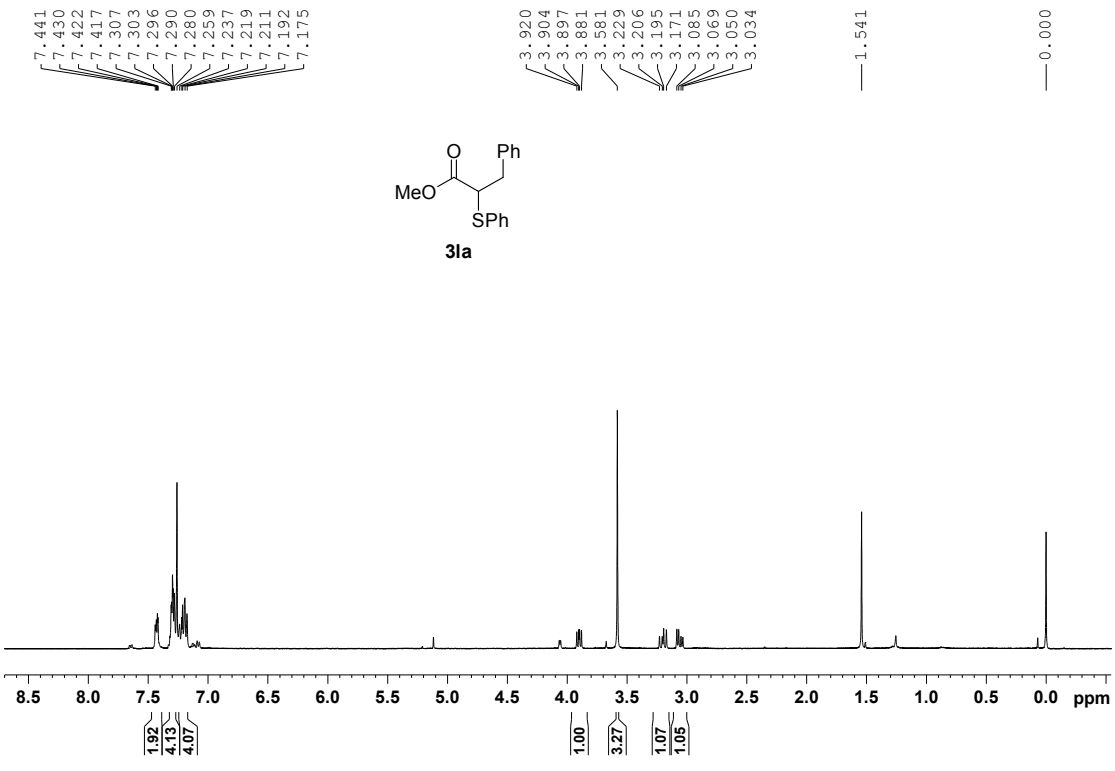

170.31
138.77
133.55
133.37
129.14
128.97
128.40
128.17
126.61
77.32
77.00
76.68
49.53
38.97
37.22
35.99
O
Ph
N
SPh
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

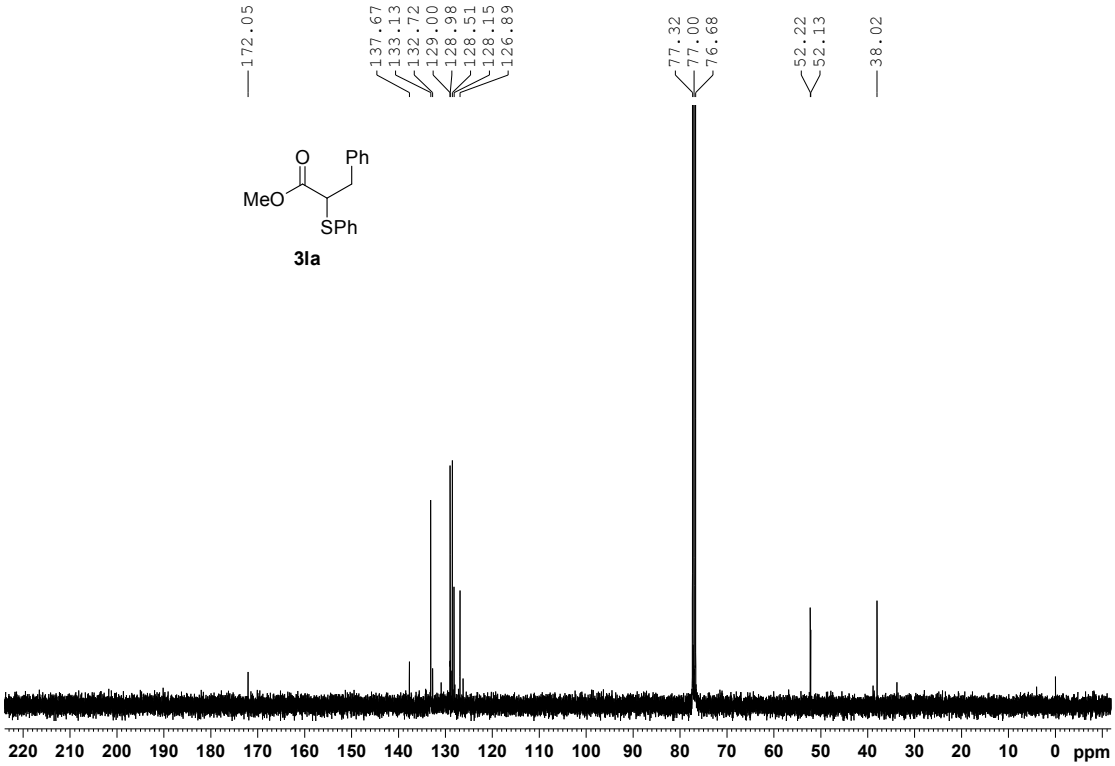
3aj


7.775
7.756
7.753
7.500
7.482
7.449
7.429
7.411
7.330
7.322
7.318
7.311
7.304
7.293
7.278
7.274
7.261
5.319
5.289
5.113
5.082
2.450
2.435
2.418
1.920
1.904
1.888
1.872
1.607
0.000
O
Ph
S
Ph
O
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.02
2.04
5.06
1.11
1.09
4.12
2.14

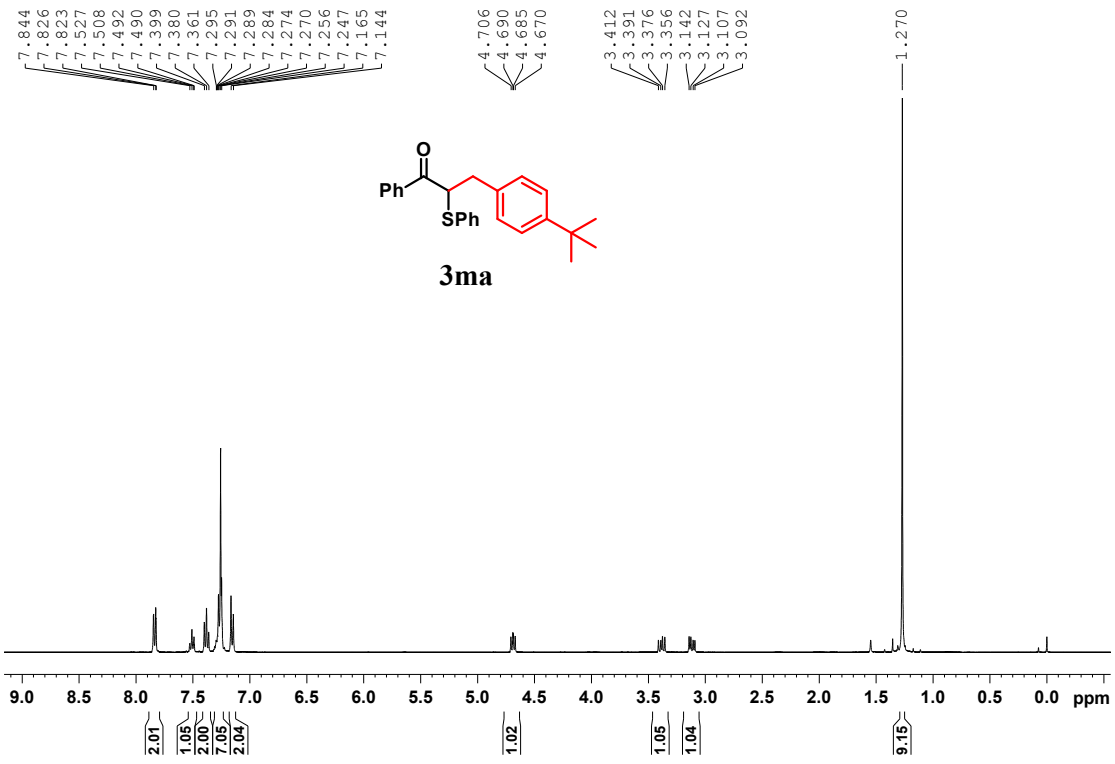
3ka


193.47
131.94
130.51
130.01
129.73
129.24
128.95
87.47
77.31
77.19
76.99
76.67
46.91
38.15
20.38
Ph
S
Ph
O
O
3ak
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

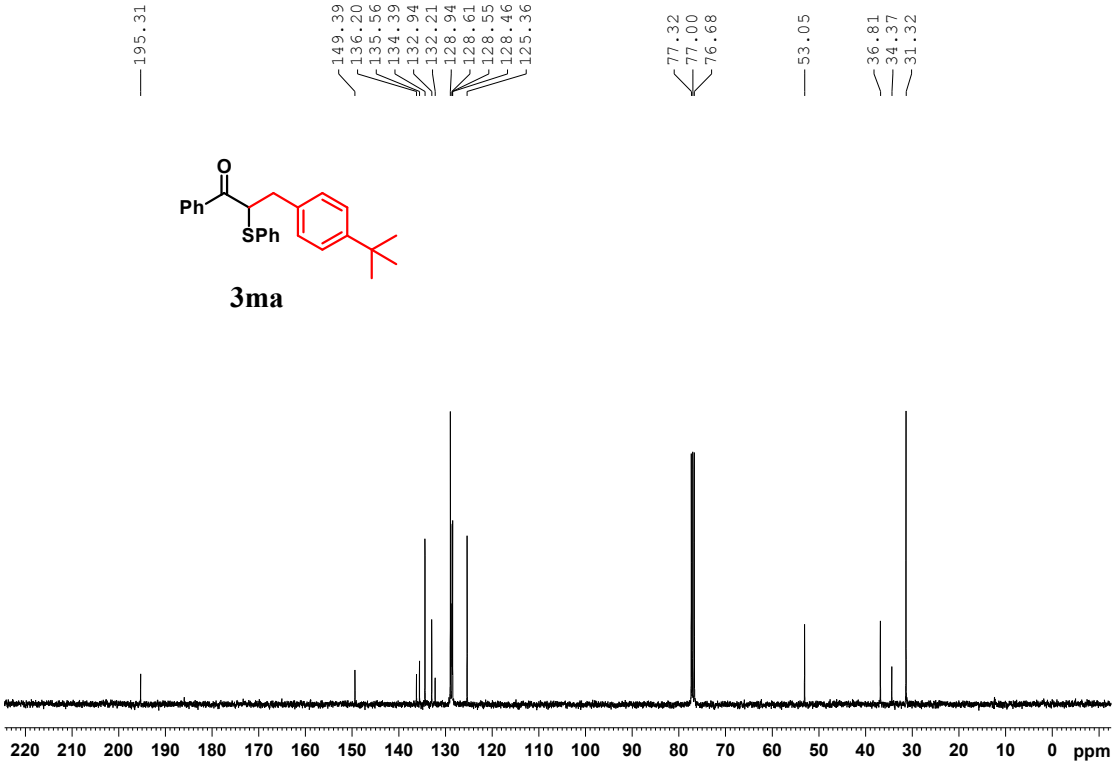

7.441
7.430
7.422
7.417
7.307
7.303
7.296
7.290
7.280
7.259
7.237
7.219
7.211
7.192
7.175
3.920
3.904
3.897
3.881
3.581
3.229
3.206
3.195
3.171
3.085
3.069
3.050
3.034
1.541
0.000
O
Ph
MeO
SPh
3la
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.92
4.13
4.07
1.00
3.27
1.07
1.05


172.05
137.67
133.13
132.72
129.00
128.98
128.51
128.15
126.89
77.32
77.00
76.68
52.22
52.13
38.02
O
Ph
MeO
SPh
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

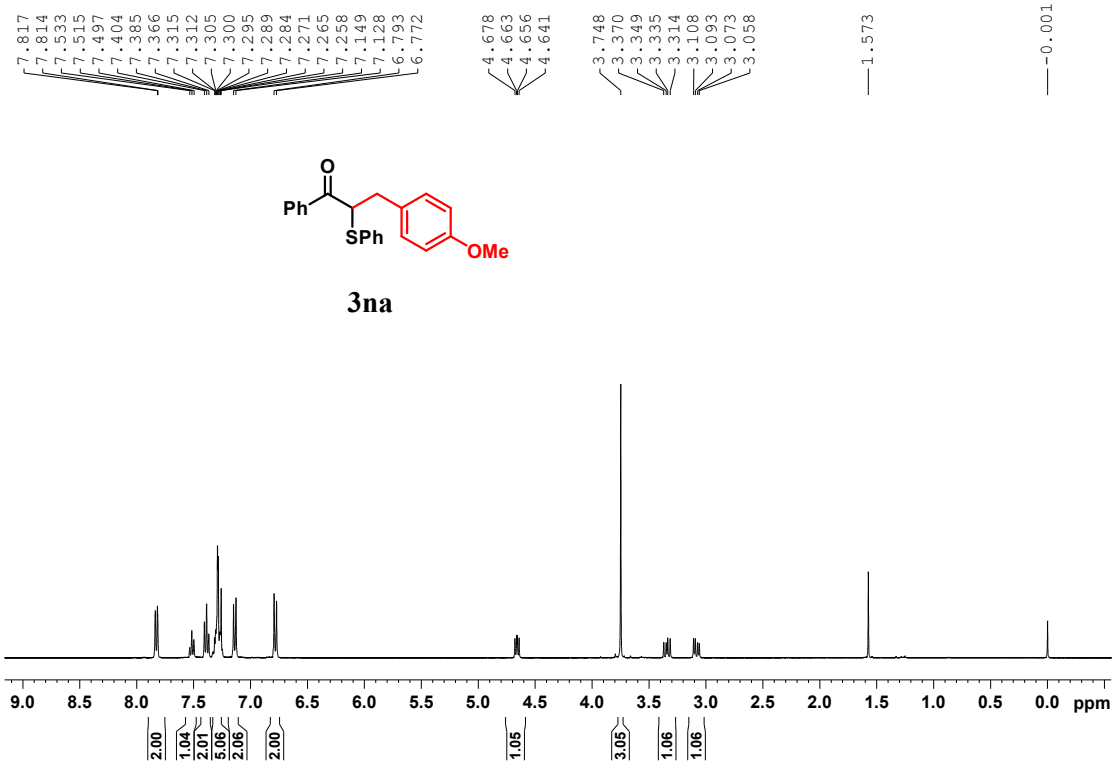
3la


7.844
7.826
7.823
7.527
7.508
7.492
7.490
7.399
7.380
7.361
7.295
7.291
7.289
7.284
7.274
7.270
7.256
7.247
7.165
7.144
4.706
4.690
4.685
4.670
3.412
3.391
3.376
3.356
3.142
3.127
3.107
3.092
1.270
O
Ph
SPh
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.01
1.05
2.00
7.05
2.04
1.02
1.05
1.04
9.15

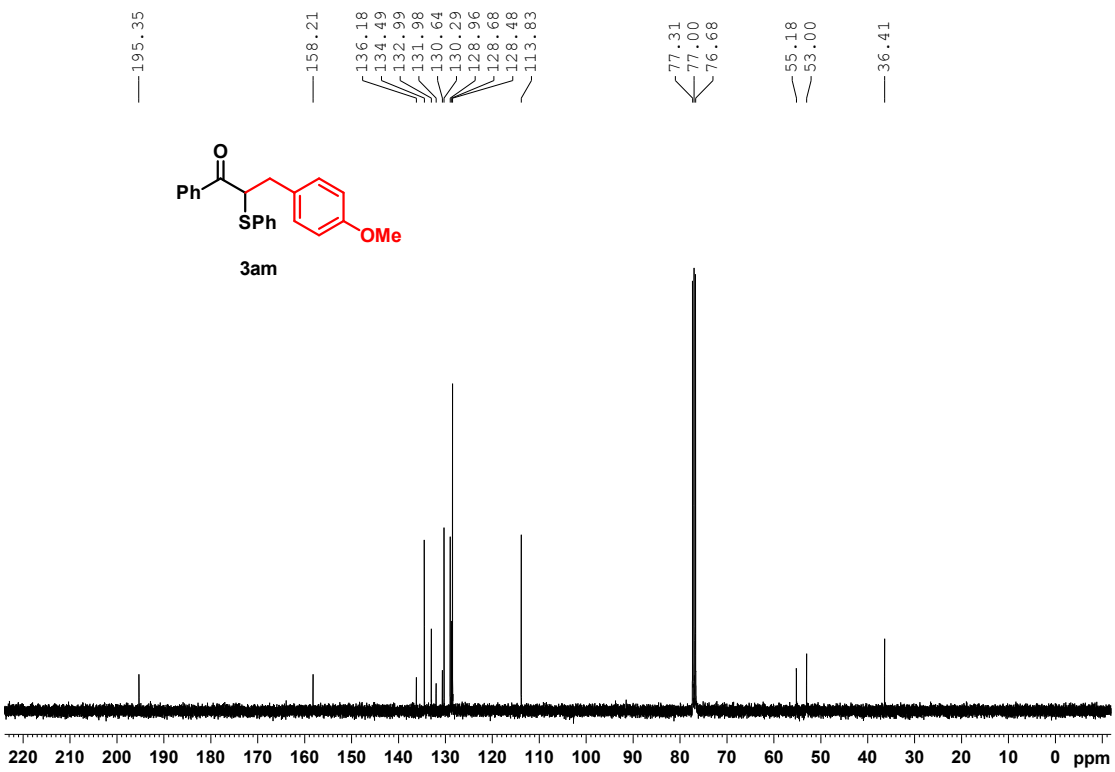
3ma


195.31
149.39
136.20
135.56
134.39
132.94
132.21
128.94
128.61
128.55
128.46
125.36
77.32
77.00
76.68
53.05
36.81
34.37
31.32
O
Ph
SPh
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

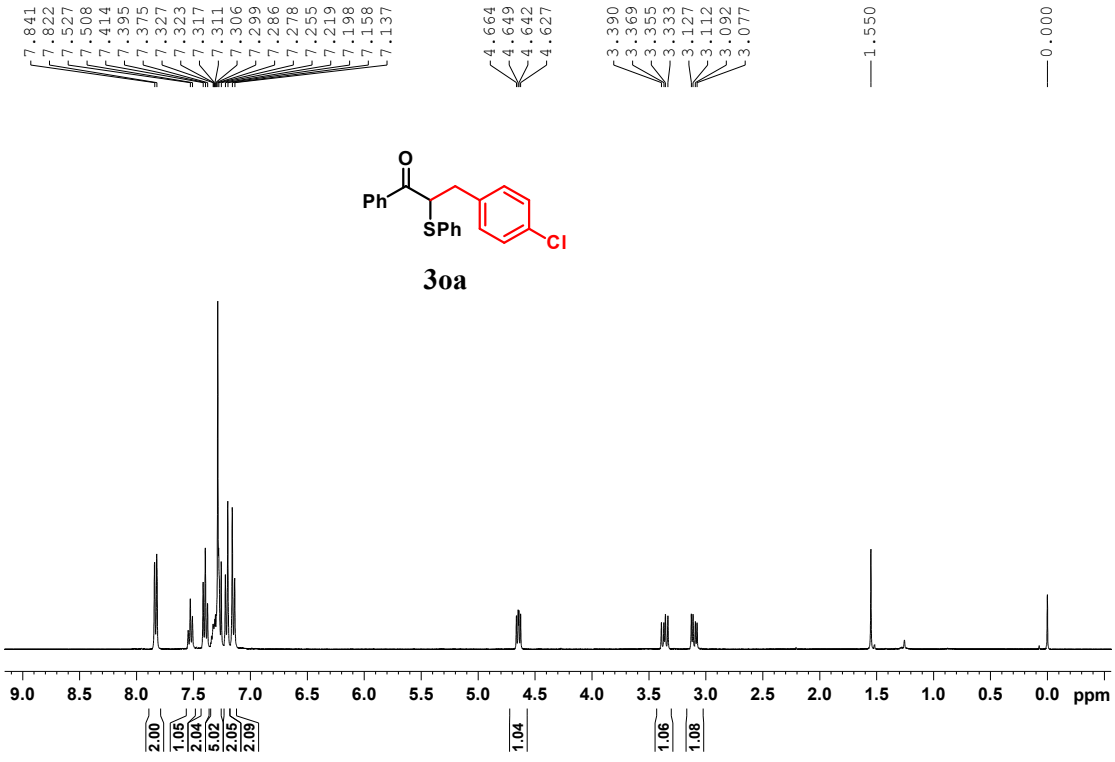
3ma


7.817
7.814
7.533
7.515
7.497
7.404
7.385
7.366
7.315
7.312
7.305
7.300
7.295
7.289
7.284
7.271
7.265
7.258
7.149
7.128
6.793
6.772
4.678
4.663
4.656
4.641
3.748
3.370
3.349
3.335
3.314
3.108
3.093
3.073
3.058
1.573
0.001
O
Ph
SPh
OMe
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.04
2.01
5.06
2.06
2.00
1.05
3.05
1.06
1.06

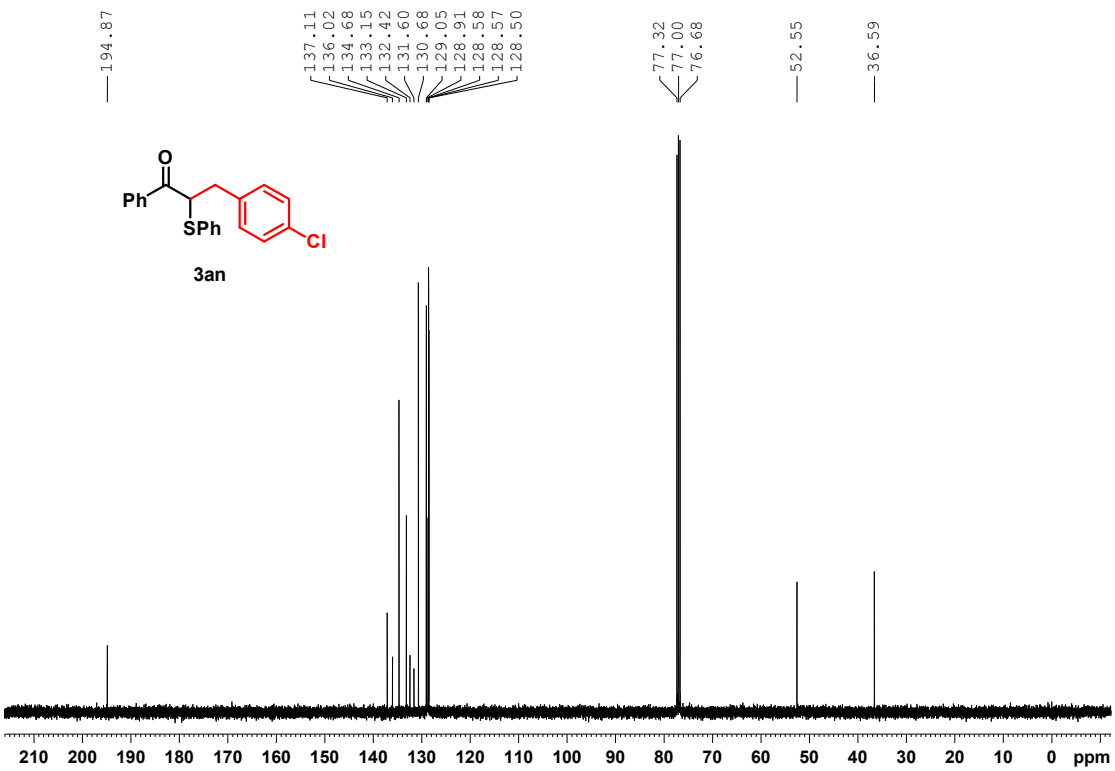
3na


195.35
158.21
136.18
134.49
132.99
131.98
130.64
130.29
128.96
128.68
128.48
113.83
77.31
77.00
76.68
55.18
53.00
36.41
O
Ph
SPh
OMe
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

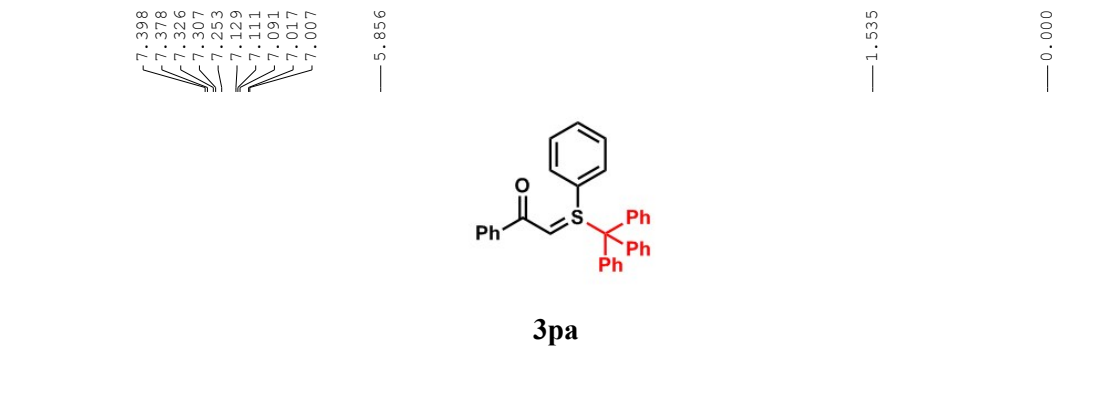
3am


7.841
7.822
7.527
7.508
7.414
7.395
7.375
7.327
7.323
7.317
7.311
7.306
7.299
7.286
7.278
7.255
7.219
7.198
7.158
7.137
4.664
4.649
4.642
4.627
3.390
3.369
3.355
3.333
3.127
3.112
3.092
3.077
1.550
0.000
O
Ph
SPh
Cl
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.05
2.04
5.02
2.05
2.09
1.04
1.06
1.08

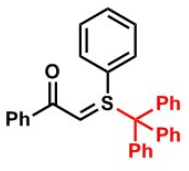
3oa

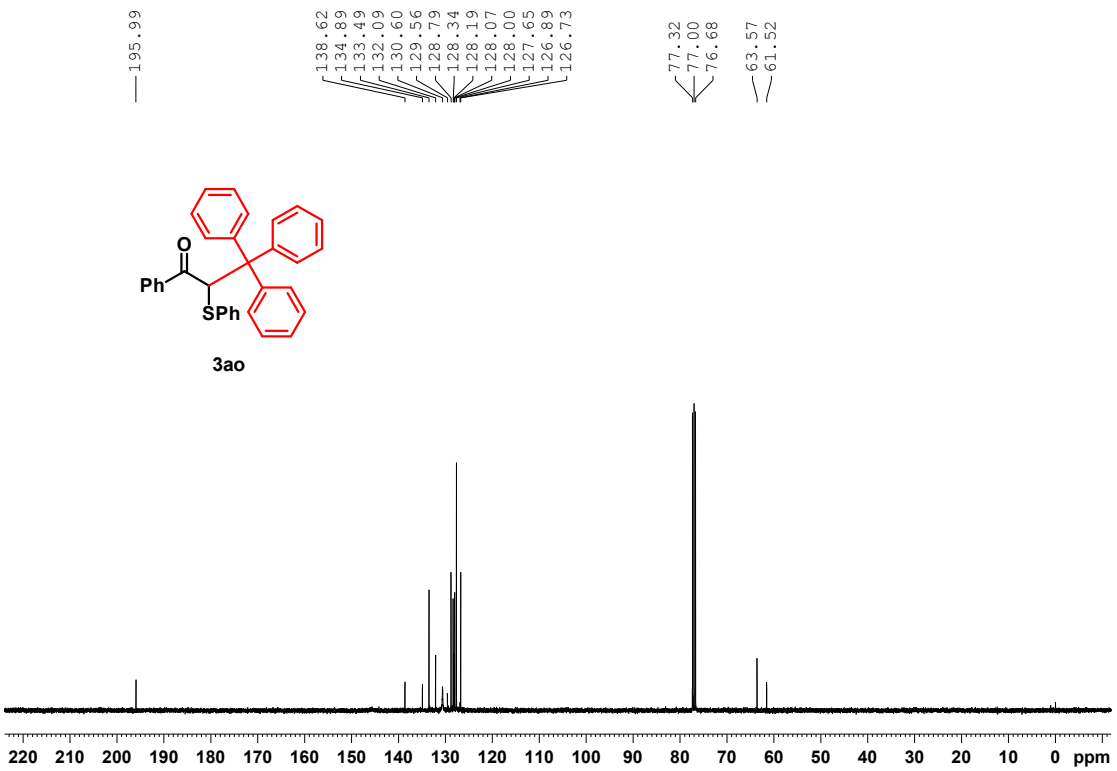

194.87
137.11
136.02
134.68
133.15
132.42
131.60
130.68
129.05
128.91
128.58
128.57
128.50
77.32
77.00
76.68
52.55
36.59
O
Ph
SPh
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

3an

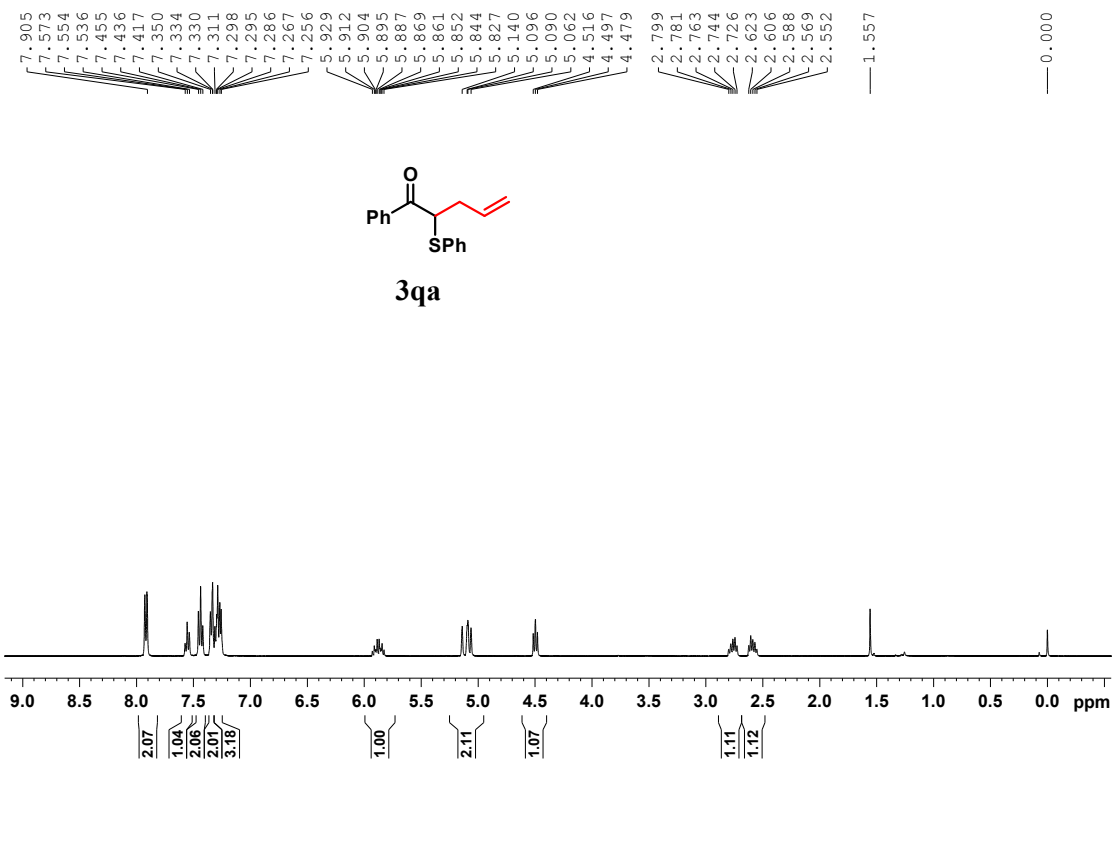

7.398
7.378
7.326
7.307
7.253
7.129
7.111
7.091
7.017
7.007
5.856
1.535
0.000
O
Ph
S
Ph
Ph
Ph
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
7.15
11.10
3.04
4.00
1.05

3pa

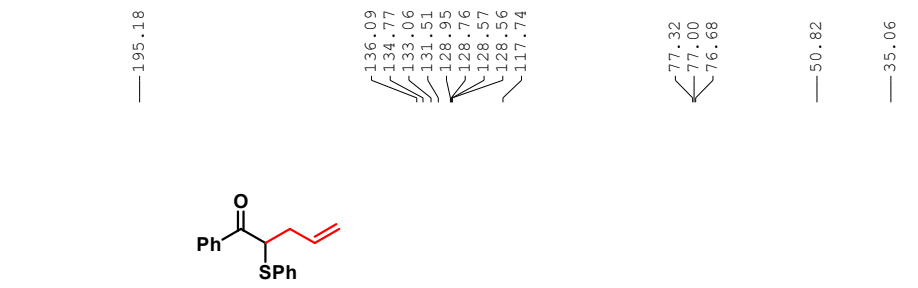

O
Ph
S
Ph
Ph
Ph


195.99
138.62
134.89
133.49
132.09
130.60
129.56
128.79
128.34
128.19
128.07
128.00
127.65
126.89
126.73
77.32
77.00
76.68
63.57
61.52
O
Ph
SPh
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

3ao

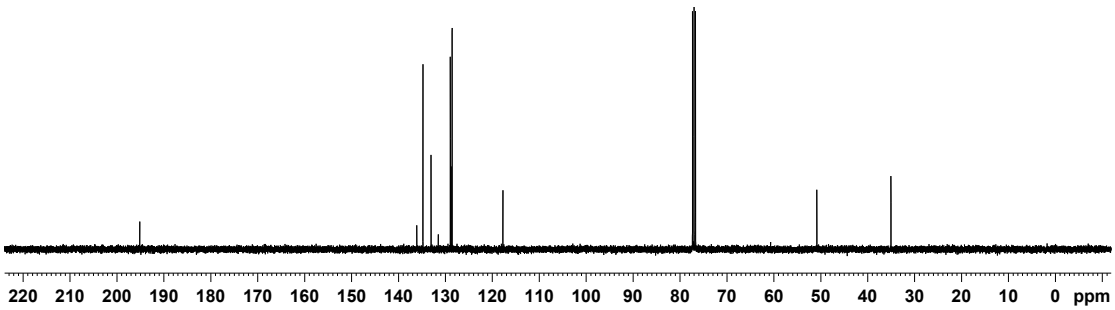

7.905
7.573
7.554
7.536
7.455
7.436
7.417
7.350
7.334
7.330
7.311
7.298
7.295
7.286
7.267
7.256
5.929
5.912
5.904
5.895
5.887
5.869
5.861
5.852
5.844
5.827
5.140
5.096
5.090
5.062
4.516
4.497
4.479
2.799
2.781
2.763
2.744
2.726
2.623
2.606
2.588
2.569
2.552
1.557
0.000
O
Ph
SPh
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.07
1.04
2.06
2.01
3.18
1.00
2.11
1.07
1.11
1.12

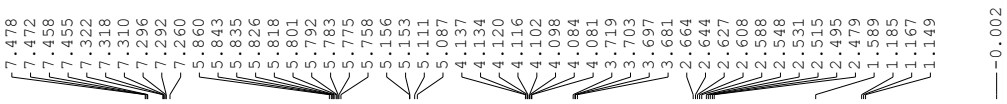
3qa

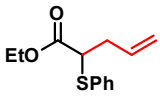

195.18
136.09
134.77
133.06
131.51
128.95
128.76
128.57
128.56
117.74
77.32
77.00
76.68
50.82
35.06

O
Ph
SPh

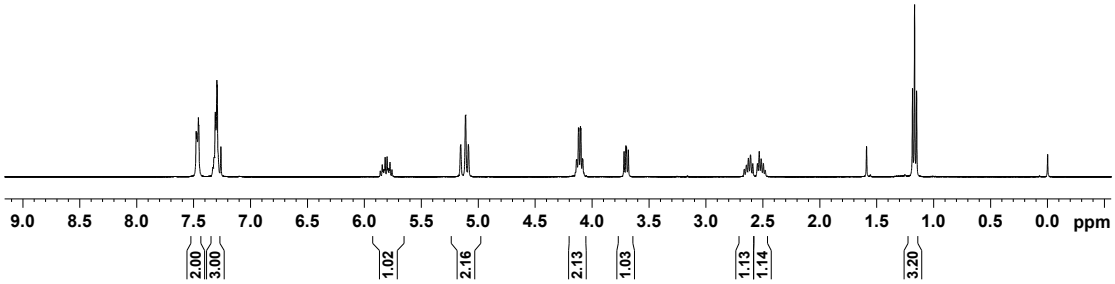
3ap

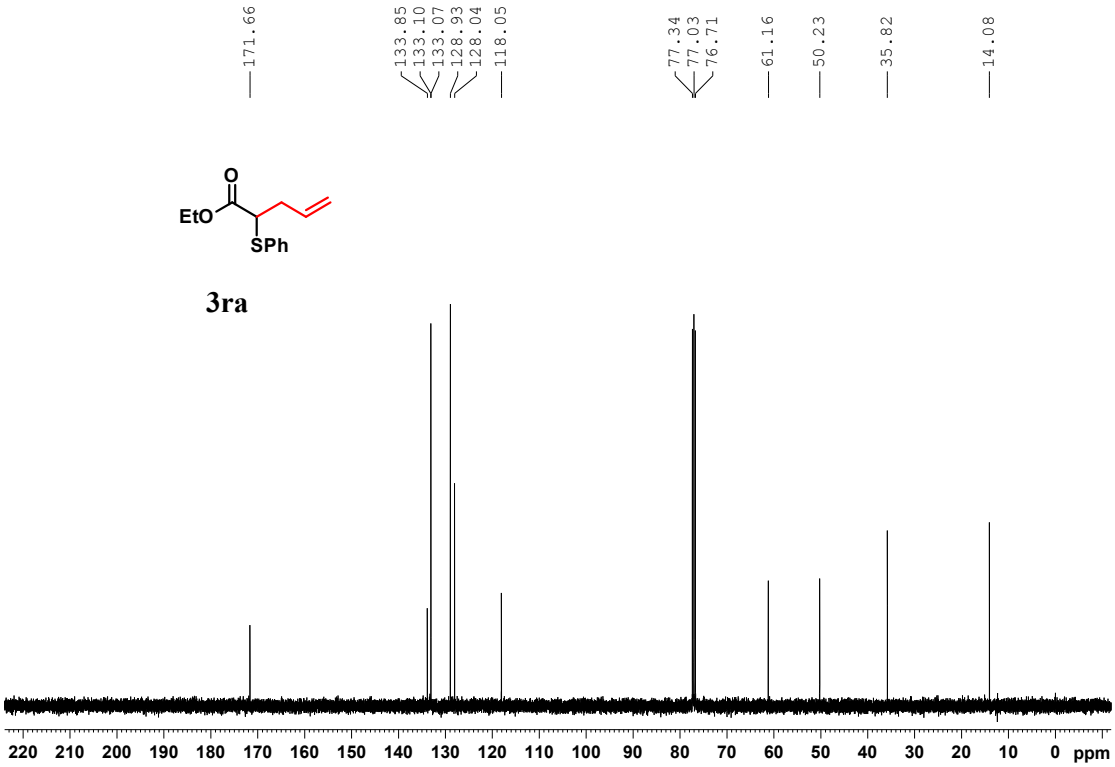

220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


7.478
7.472
7.458
7.455
7.322
7.318
7.310
7.296
7.292
7.260
5.860
5.843
5.835
5.826
5.818
5.801
5.792
5.783
5.775
5.758
5.156
5.153
5.111
5.087
4.137
4.134
4.120
4.116
4.102
4.098
4.084
4.081
3.719
3.703
3.697
3.681
2.664
2.644
2.627
2.608
2.588
2.548
2.531
2.515
2.495
2.479
1.589
1.185
1.167
1.149
-0.002

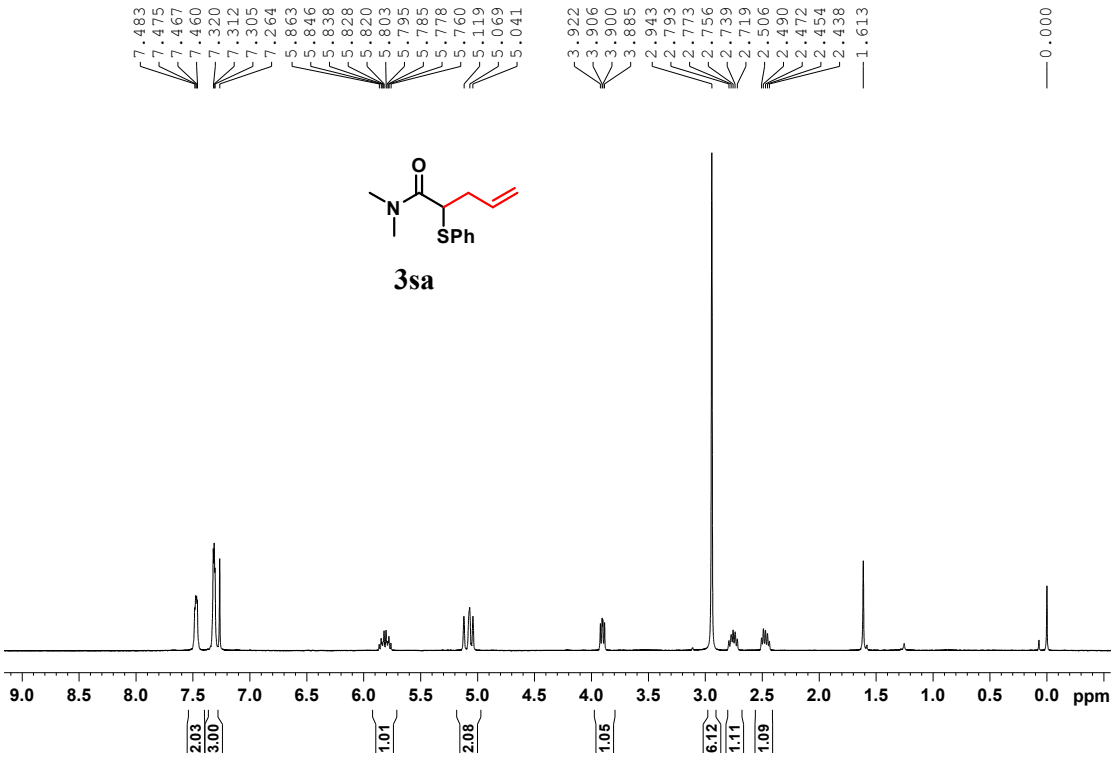

O
EtO
SPh

3ra

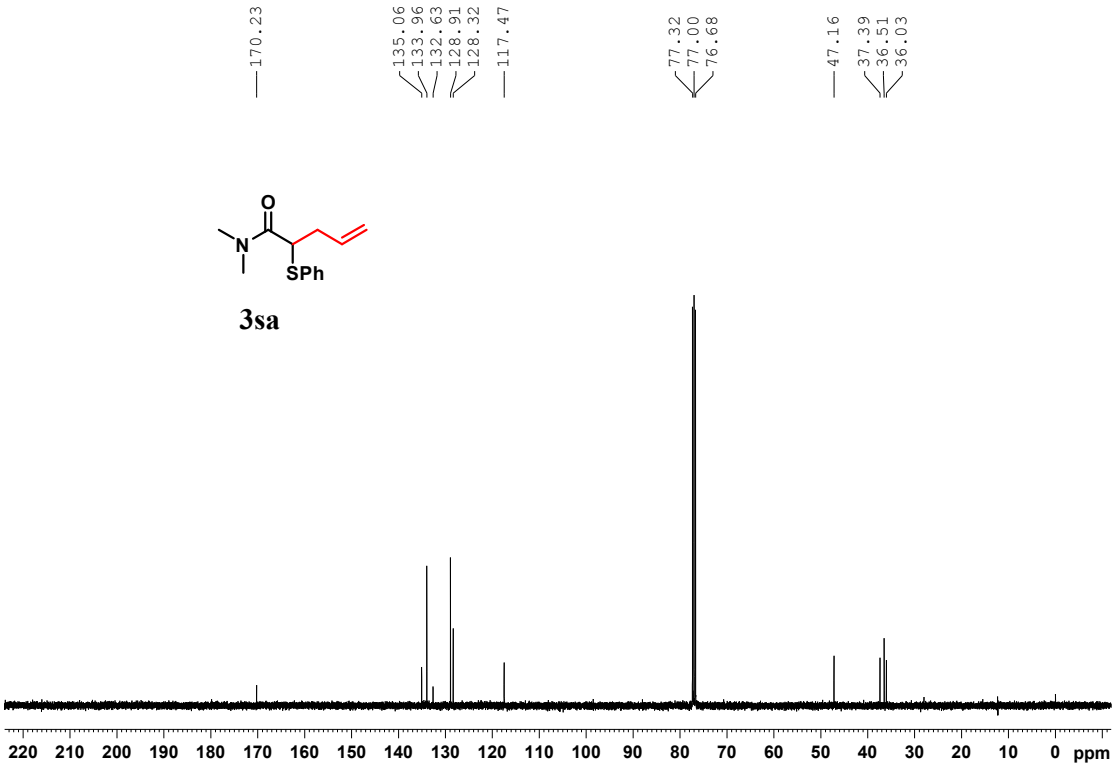

9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
3.00
1.02
2.16
2.13
1.03
1.13
1.14
3.20


171.66
133.85
133.10
133.07
128.93
128.04
118.05
77.34
77.03
76.71
61.16
50.23
35.82
14.08
O
EtO
SPh
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

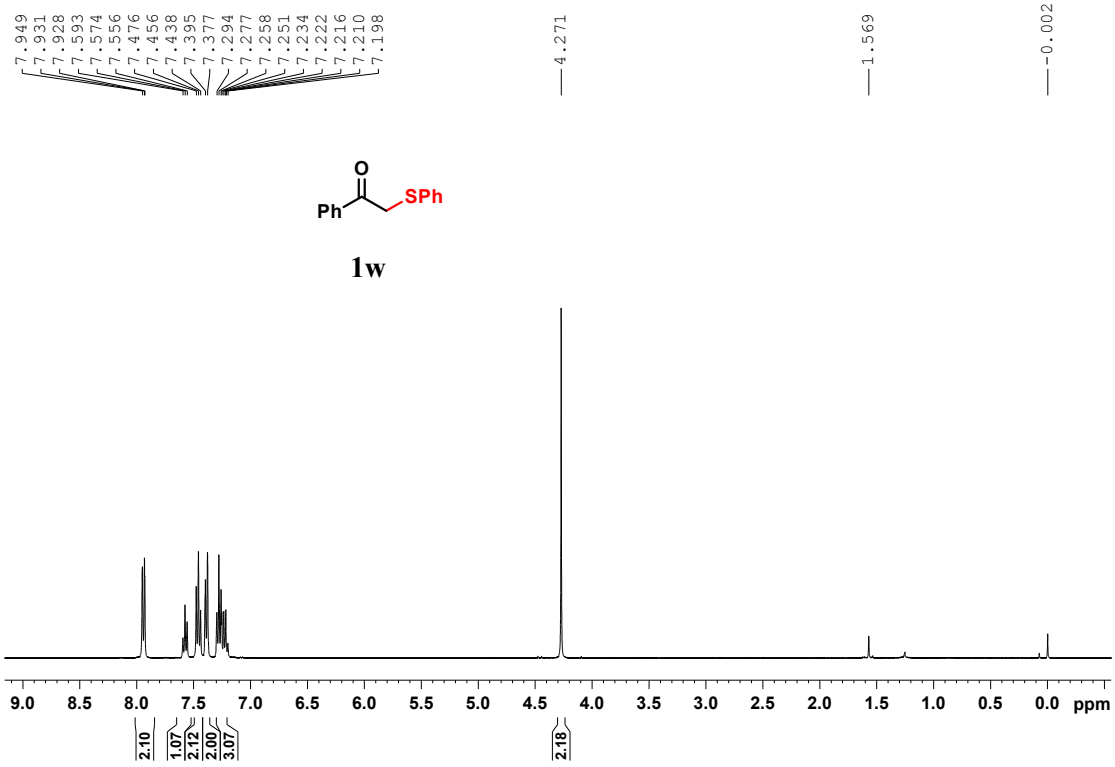
3ra


7.483
7.475
7.467
7.460
7.320
7.312
7.305
7.264
5.863
5.846
5.838
5.828
5.820
5.803
5.795
5.785
5.778
5.760
5.119
5.069
5.041
3.922
3.906
3.900
3.885
2.943
2.793
2.773
2.756
2.739
2.719
2.506
2.490
2.472
2.454
2.438
1.613
0.000
O
N
SPh
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.03
3.00
1.01
2.08
1.05
6.12
1.11
1.09

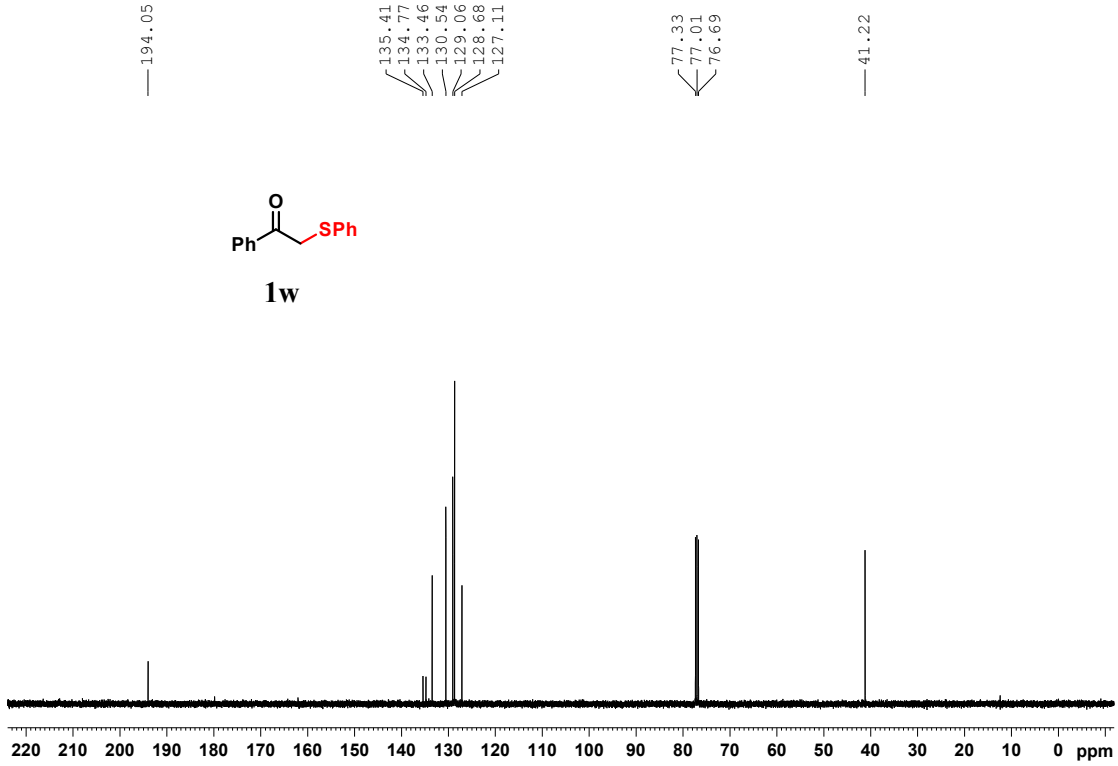
3sa


170.23
135.06
133.96
132.63
128.91
128.32
117.47
77.32
77.00
76.68
47.16
37.39
36.51
36.03
O
N
SPh
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

3sa


7.949
7.931
7.928
7.593
7.574
7.556
7.476
7.456
7.438
7.395
7.377
7.294
7.277
7.258
7.251
7.234
7.222
7.216
7.210
7.198
4.271
1.569
-0.002
O
Ph
SPh
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.10
1.07
2.12
2.00
3.07
2.18

1w


194.05
135.41
134.77
133.46
130.54
129.06
128.68
127.11
77.33
77.01
76.69
41.22
O
Ph
SPh
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

1w