

Supporting Information

Transition-Metal-Free Photoredox Intermolecular α -Arylation of Ketones

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Supplementary Material

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General Information:

Moisture sensitive reactions were performed under argon atmosphere and sensitive reagents were added via syringe and cannula techniques. All glass wares were washed with detergent, rinsed with acetone and dried in an oven at 125 °C prior to use. Commercial reagents and solvents were purified according to procedures prescribed in Perrin's handbook¹ and stored over 4A^o molecular sieves. Starting materials were prepared according to literature procedures. 9,10-Dimethoxyanthracene (DMA) was synthesized according to literature procedure². Reactions were monitored by thin layer chromatography (TLC) which were performed on silica gel coated aluminium plates (MERCK, 60F254) and visualized by UV fluorescence and/or by staining with iodine, alcoholic solution of phosphomolybdic acid and ninhydrin. Column chromatography (CC) was performed on silica gel of mesh size 60–120, 100–200, 230–400 obtained from S. D. Fine Chemical Co. India or SRL India.

Infra-Red (IR) spectra were recorded on a Perkin-Elmer FT-IR Spectrometer. Nuclear Magnetic Resonance (NMR) spectra were recorded on a BRUKER 400 ULTRA SHIELD (400 MHz for ¹H and 101 MHz for ¹³C, respectively) instrument using deuterated solvent. Chemical shifts are reported in ppm. Proton coupling constants (*J*) are reported as absolute values in Hz and multiplicity (br, broadened; s, singlet; d, doublet; t, triplet; dd, doublet of doublet; dt, doublet of triplet; td, triplet of doublet; qd, quartet of doublet; dq, doublet of quartet; p, pictet; m, multiplet). Data for ¹³C NMR spectra are described in terms of chemical shift (δ in ppm) relative to the central line of CDCl₃ (δ 77.16). High resolution mass (HRMS) spectra were performed on Agilent Technologies 6530 Accurate-Mass Q-TOF LC/MS using electron spray ionization (ESI) technique. Gas

chromatography (GC) was performed on Agilent 7890B GC and 5977A MSD equipped with a split-mode capillary injection system and flame-ionization detectors using an Agilent HP-1 column (30 m, 0.32 mm ID).

Evaluation of Thermodynamic Parameters

The thermodynamic feasibility of ET between excited state of DMA and 1-phenyl-2-(phenylselanyl)ethanone was established by estimating Gibbs free energy change (ΔG_{et}) for electron transfer using oxidation potential of donor (D) and reduction potential of acceptor (A) through Weller equation (eq.1).³

$$\Delta GDS^{+} AS^{-} = E_{1/2}^{ox.} (D) - E_{1/2}^{red.} (A) - E_{exc.} \text{ of D} \dots\dots\dots \text{Eq. 1}$$

$E_{1/2}^{ox.}$ of D = Oxidation potential of DMA

$E_{1/2}^{red.}$ of A = Reduction potential of 1-phenyl-2-(phenylselanyl)ethanone (1a, -1.28 eV)

$E_{exc.}$ of D = Singlet state excitation energy of DMA

$$\Delta GDS^{+} AS^{-} = 0.98 \text{ V} - (-1.28 \text{ V}) - 74 \text{ kcalM}^{-1}$$

$$\Delta GDS^{+} AS^{-} = -21.88 \text{ kcalM}^{-1}$$

$$\Delta GDS^{+} AS^{-} = E_{1/2}^{ox.} (D) - E_{1/2}^{red.} (A) - E_{exc.} \text{ of D} \dots\dots\dots \text{Eq. 1}$$

$E_{1/2}^{ox.}$ of D = Oxidation potential of DMA

$E_{1/2}^{red.}$ of A = Reduction potential of 1-phenyl-2-(phenylselanyl)ethanone (1d, -1.29 eV)

$E_{exc.}$ of D = Singlet state excitation energy of DMA

$$\Delta GDS^{+} AS^{-} = 0.98 \text{ V} - (-1.29 \text{ V}) - 74 \text{ kcalM}^{-1}$$

$$\Delta GDS^{+} AS^{-} = -21.65 \text{ kcalM}^{-1}$$

Similarly, ET feasibility from Anisole to DMA^{+} was evaluated by estimating ΔG_{et} employing the Eq.1.

$$- \Delta G_{et} = E_{1/2}^{ox.} - E_{1/2}^{red.}$$

$E_{1/2}^{ox.}$ = Oxidation potential of Anisole

$E_{1/2}^{red.}$ = Reduction potential of DMA^{+}

$$- \Delta G_{et} = 1.76 \text{ V} - 28.81 \text{ kcalM}^{-1}$$

$$- \Delta G_{et} = 40.58 \text{ kcal/M-1} - 28.81 \text{ kcalM}^{-1}$$

$$- \Delta G_{et} = 11.77 \text{ kcalM}^{-1}$$

Similarly, ET feasibility from Toluene to DMA^{+} was evaluated by estimating ΔG_{et} employing the Eq.1.

$$- \Delta G_{et} = E_{1/2}^{ox.} - E_{1/2}^{red.}$$

$E_{1/2}^{ox.}$ = Oxidation potential of Toluene

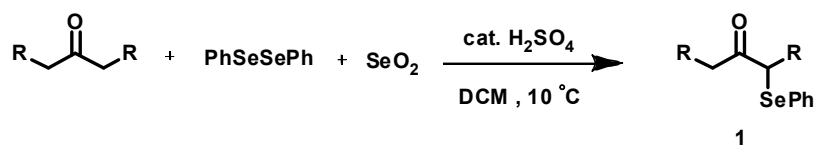
$E_{1/2}^{red.}$ = Reduction potential of DMA^{+}

$$- \Delta G_{et} = 1.98 \text{ V} - 28.81 \text{ kcalM}^{-1}$$

$$- \Delta G_{et} = 44.66 \text{ kcal/M-1} - 28.81 \text{ kcalM}^{-1}$$

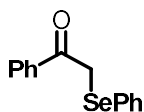
$$- \Delta G_{et} = 15.85 \text{ kcalM}^{-1}$$

General procedure for the synthesis of α -phenylselenenyl Carbonyl compound (1a-1d)⁴



To a suspension of selenium dioxide (3 mmol) in 5mL dichloromethane containing diphenyl diselenide (3 mmol) and a catalytic amount of sulfuric acid (0.6 mmol) was added a solution of ketone (5 mmol) in 5mL of dichloromethane at 10 °C. The mixture was stirred for 10 h at 10 °C until the color change from yellow to reddish brown with the precipitation of amorphous selenium. The reaction mixture was poured into 100 mL of ether and washed with saturated aqueous sodium hydrogen carbonate (20 mL x 2). The organic layer was dried (MgSO_4) and evaporated to give a reddish oil, which was purified by silica gel column chromatography to afford α -phenylselenenyl carbonyl compound (53 to 84 % yield) and unreacted diphenyl diselenide (0.6 mmol).

1-phenyl-2-(phenylselenanyl)ethanone (1a)

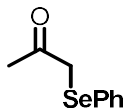


R_f = 0.60 (SiO_2 , ethyl acetate/hexane, 1:49); yellow liquid (58%);

^1H NMR (400 MHz, CDCl_3) δ 7.91 – 7.88 (m, 2H), 7.60 – 7.53 (m, 3H), 7.47 – 7.42 (m, 2H), 7.32 – 7.26 (m, 3H), 4.19 (s, 2H).

^{13}C NMR (101 MHz, CDCl_3) δ 195.08, 135.51, 134.08, 133.38, 129.36, 129.13, 128.80, 128.71, 128.18, 32.81.

1-(phenylselenanyl)propan-2-one (1b)

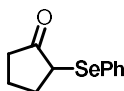


R_f = 0.60 (SiO_2 , ethyl acetate/hexane, 1:49); yellow liquid (53%);

^1H NMR (400 MHz, CDCl_3) δ 7.52 (ddd, J = 3.9, 3.0, 1.4 Hz, 2H), 7.30 – 7.27 (m, 3H), 3.59 (s, 2H), 2.27 (s, 3H).

^{13}C NMR (101 MHz, CDCl_3) δ 203.65, 133.38, 129.46, 128.81, 128.07, 36.95, 28.15.

2-(phenylselenanyl)cyclopentanone (1c)

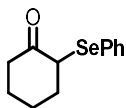


R_f = 0.60 (SiO_2 , ethyl acetate/hexane, 1:49); yellow liquid (38%);

^1H NMR (400 MHz, CDCl_3) δ 7.61 – 7.58 (m, 2H), 7.35 – 7.25 (m, 3H), 3.77 – 3.73 (m, 1H), 2.37 – 2.26 (m, 2H), 2.23 – 2.12 (m, 1H), 2.08 – 1.88 (m, 3H).

^{13}C NMR (101 MHz, CDCl_3) δ 214.54, 135.36, 129.23, 128.50, 127.91, 46.53, 36.37, 30.81, 21.04.

2-(phenylselanyl)cyclohexanone (1d)

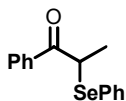


R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:49); yellow liquid (84%);

¹H NMR (400 MHz, CDCl₃) δ 7.57 – 7.53 (m, 2H), 7.32 – 7.25 (m, 3H), 3.93 (td, J = 5.3, 1.6 Hz, 1H), 3.00 (ddd, J = 15.7, 10.6, 5.9 Hz, 1H), 2.37 – 2.28 (m, 1H), 2.26 – 2.16 (m, 2H), 2.03 – 1.93 (m, 1H), 1.92 – 1.77 (m, 2H), 1.75 – 1.65 (m, 1H).

¹³C NMR (101 MHz, CDCl₃) δ 208.02, 134.72, 129.30, 128.65, 128.21, 51.69, 38.61, 34.10, 26.98, 23.00.

1-phenyl-2-(phenylselanyl)ethanone (1e)

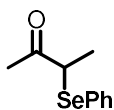


R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:49); yellow liquid (45%);

¹H NMR (400 MHz, CDCl₃) δ 7.90 (dd, J = 8.4, 1.3 Hz, 2H), 7.57 – 7.51 (m, 1H), 7.47 – 7.40 (m, 4H), 7.38 – 7.33 (m, 1H), 7.29 – 7.24 (m, 2H), 4.69 (q, J = 6.8 Hz, 1H), 1.64 (d, J = 6.9 Hz, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 196.43, 136.76, 135.91, 132.98, 132.04, 129.15, 129.09, 128.62, 128.51, 39.82, 17.36.

1-(phenylselanyl)propan-2-one (1f)

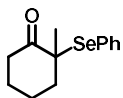


R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:49); yellow liquid (35%);

¹H NMR (400 MHz, CDCl₃) δ 7.57 – 7.52 (m, 2H), 7.37 – 7.27 (m, 3H), 3.83 (q, J = 7.0 Hz, 1H), 2.33 (s, 3H), 1.49 (d, J = 7.0 Hz, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 204.92, 135.87, 132.62, 129.28, 128.88, 46.12, 27.31, 16.48.

2-(phenylselanyl)cyclopentanone (1g)



R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:49); yellow liquid (30%);

¹H NMR (400 MHz, CDCl₃) δ 7.40 – 7.36 (m, 2H), 7.32 – 7.27 (m, 1H), 7.24 – 7.18 (m, 2H), 3.35 (ddd, J = 14.9, 14.0, 6.3 Hz, 1H), 2.29 – 2.18 (m, 2H), 2.08 – 1.90 (m, 2H), 1.86 – 1.77 (m, 1H), 1.73 – 1.66 (m, 1H), 1.59 (qd, J = 4.2, 1.0 Hz, 1H), 1.28 (s, 3H).

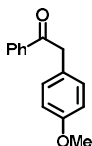
¹³C NMR (101 MHz, CDCl₃) δ 207.86, 137.59, 129.38, 129.06, 126.75, 55.38, 40.82, 37.28, 27.15, 24.95, 22.53.

General procedure for photoredox catalysis:

A mixture of **1** (1.0 mmol), arenes (**2**, 3 mmol) and a catalytic amount of 9,10-dimethoxyanthracene (DMA) (0.30 mmol) in acetonitrile (500 mL) was irradiated in the argon atmosphere utilizing visible-light (410 nm), obtained by using a combination of Pyrex and a CuSO₄:NH₃ solution filter⁵ from a 450-W Hanovia medium pressure mercury lamp⁶ in a specially designed double walled photoreactor. Progress of the reaction was monitored by following the disappearance of **1** by GC and HPLC (C18 reverse phase, ACN: H₂O/75:25). After 15-20 h of photo-irradiation, when almost all of the **1** was consumed, the solvent was removed by distillation under reduced pressure. After evaporation of the solvent, the mixture was purified by silica gel column chromatography to give respective α -arylated products **3** along with diphenyl diselenide. The yield was calculated based on the consumption of starting **1**.

Characterization of products:

2-(4-methoxyphenyl)-1-phenylethanone (3aa)



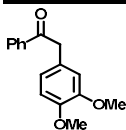
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); white solid (76%);

¹H NMR (400 MHz, CDCl₃) δ 8.04 – 7.99 (m, 2H), 7.58 – 7.53 (m, 1H), 7.45 (dd, J = 10.4, 4.7 Hz, 2H), 7.19 (d, J = 8.6 Hz, 2H), 6.87 (d, J = 8.6 Hz, 2H), 4.23 (s, 2H), 3.79 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 198.05, 158.65, 136.73, 133.22, 130.59, 128.74, 128.71, 126.61, 114.26, 55.36, 44.74.

HRMS (ESI) m/z calcd. for C₁₅H₁₅O₂[M+H]⁺ 227.1067, found 227.1067.

2-(3,4-dimethoxyphenyl)-1-phenylethanone (3ab)



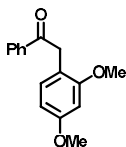
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); white solid (73%);

¹H NMR (400 MHz, CDCl₃) δ 8.04 – 7.97 (m, 2H), 7.55 (ddd, J = 6.7, 4.0, 1.3 Hz, 1H), 7.50 – 7.42 (m, 2H), 6.82 – 6.77 (m, 3H), 4.23 (s, 2H), 3.85 (d, J = 0.4 Hz, 6H).

¹³C NMR (101 MHz, CDCl₃) δ 198.01, 149.12, 148.09, 136.68, 133.27, 128.74, 128.70, 127.04, 121.72, 112.59, 111.43, 55.97, 55.95, 45.20.

HRMS (ESI) m/z calcd. for C₁₆H₁₇O₃[M+H]⁺ 257.1172, found 257.1174.

2-(2,4-dimethoxyphenyl)-1-phenylethanone (3ac)



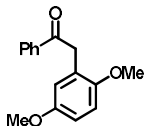
R_f = 0.50 (SiO₂, ethyl acetate/hexane, 1:9); white solid (76%);

¹H NMR (400 MHz, CDCl₃) δ 8.07 – 8.01 (m, 2H), 7.59 – 7.51 (m, 1H), 7.49 – 7.42 (m, 2H), 6.84 – 6.80 (m, 1H), 6.79 – 6.75 (m, 2H), 4.26 (s, 2H), 3.75 (s, 6H).

¹³C NMR (101 MHz, CDCl₃) δ 197.95, 153.64, 151.59, 137.03, 133.06, 128.63, 128.57, 124.86, 117.19, 112.87, 111.76, 56.16, 55.81, 40.21.

HRMS (ESI) m/z calcd. for C₁₆H₁₇O₃[M+H]⁺ 257.1172, found 257.1181.

2-(2,5-dimethoxyphenyl)-1-phenylethanone (3ad)



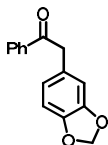
R_f = 0.50 (SiO₂, ethyl acetate/hexane, 1:9); white solid (72%);

¹H NMR (400 MHz, CDCl₃) δ 8.04 (dt, J = 8.5, 1.7 Hz, 2H), 7.58 – 7.52 (m, 1H), 7.49 – 7.41 (m, 2H), 7.11 – 7.05 (m, 1H), 6.51 – 6.44 (m, 2H), 4.21 (s, 2H), 3.80 (s, 3H), 3.77 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 198.39, 160.19, 158.19, 137.10, 132.93, 131.34, 128.58, 128.51, 116.11, 104.40, 98.83, 55.51, 55.45, 39.42.

HRMS (ESI) m/z calcd. for C₁₆H₁₇O₃[M+H]⁺ 257.1172, found 257.1182.

2-(benzo[d][1,3]dioxol-5-yl)-1-phenylethanone (3ae)



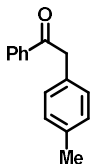
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); white solid (77%);

¹H NMR (400 MHz, CDCl₃) δ 8.00 (dd, J = 5.2, 3.3 Hz, 2H), 7.60 – 7.52 (m, 1H), 7.50 – 7.43 (m, 2H), 6.77 (d, J = 8.0 Hz, 2H), 6.71 (dd, J = 7.7, 1.8 Hz, 1H), 5.93 (s, 2H), 4.20 (s, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 197.79, 147.95, 146.67, 136.60, 133.31, 128.76, 128.68, 128.14, 122.67, 110.02, 108.55, 101.11, 45.20.

HRMS (ESI) m/z calcd. for C₁₅H₁₃O₃[M+H]⁺ 241.0859, found 241.0868.

1-phenyl-2-(p-tolyl)ethanone (3af)



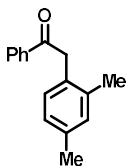
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:19); white solid (66%);

¹H NMR (400 MHz, CDCl₃) δ 8.06 – 7.99 (m, 2H), 7.61 – 7.51 (m, 1H), 7.51 – 7.42 (m, 2H), 7.20 – 7.12 (m, 4H), 4.26 (s, 2H), 2.34 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 197.93, 136.73, 136.57, 133.19, 131.53, 129.49, 129.41, 128.71, 45.23, 21.17.

HRMS (ESI) m/z calcd. for C₁₅H₁₅O[M+H]⁺ 211.1117, found 211.1122.

2-(2,4-dimethylphenyl)-1-phenylethanone (3ah)



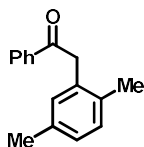
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:19); white solid (73%);

¹H NMR (400 MHz, CDCl₃) δ 8.07 – 8.02 (m, 2H), 7.59 (t, J = 7.4 Hz, 1H), 7.49 (dd, J = 11.5, 4.1 Hz, 2H), 7.04 (d, J = 9.9 Hz, 2H), 6.99 (d, J = 7.7 Hz, 1H), 4.29 (s, 2H), 2.33 (s, 3H), 2.25 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 197.80, 137.07, 136.85, 136.74, 133.19, 131.34, 130.45, 130.30, 128.74, 128.44, 126.90, 43.22, 21.11, 19.82.

HRMS (ESI) m/z calcd. for C₁₆H₁₇O[M+H]⁺ 225.1274, found 225.1277.

2-(2,5-dimethylphenyl)-1-phenylethanone (3ai)



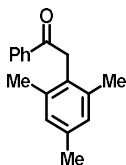
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:19); white solid (76%);

¹H NMR (400 MHz, CDCl₃) δ 8.07 – 8.00 (m, 2H), 7.60 (dd, J = 10.7, 4.1 Hz, 1H), 7.50 (t, J = 7.8 Hz, 2H), 7.12 (d, J = 7.7 Hz, 1H), 7.02 (d, J = 7.6 Hz, 1H), 6.97 (s, 1H), 4.29 (s, 2H), 2.31 (s, 3H), 2.24 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 197.77, 137.09, 135.62, 133.77, 133.33, 133.24, 131.14, 130.38, 128.78, 128.45, 128.06, 43.54, 21.04, 19.43.

HRMS (ESI) m/z calcd. for C₁₆H₁₇O[M+H]⁺ 225.1274, found 225.1273.

2-mesityl-1-phenylethanone (3aj)



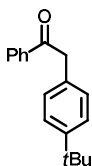
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:19); white solid (72%);

¹H NMR (800 MHz, CDCl₃) δ 8.10 (d, J = 8.0 Hz, 2H), 7.62 (t, J = 7.4 Hz, 1H), 7.53 (t, J = 7.7 Hz, 2H), 6.92 (s, 2H), 4.36 (s, 2H), 2.31 (s, 3H), 2.21 (s, 6H).

¹³C NMR (201 MHz, CDCl₃) δ 197.25, 137.25, 136.93, 136.46, 133.26, 129.38, 128.94, 128.80, 128.18, 39.42, 21.09, 20.42.

HRMS (ESI) m/z calcd. for C₁₇H₁₉O[M+H]⁺ 239.1430, found 239.1431.

2-(4-(tert-butyl)phenyl)-1-phenylethanone (3ak)

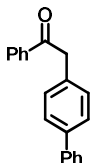


R_f = 0.50 (SiO₂, ethyl acetate/hexane, 1:19); white liquid (77%);

¹H NMR (800 MHz, CDCl₃) δ 8.04 (d, J = 7.8 Hz, 2H), 7.56 (t, J = 7.4 Hz, 1H), 7.47 (t, J = 7.7 Hz, 2H), 7.36 (d, J = 8.2 Hz, 2H), 7.22 (d, J = 8.1 Hz, 2H), 4.27 (s, 2H), 1.31 (s, 9H).

^{13}C NMR (201 MHz, CDCl_3) δ 197.95, 149.80, 136.79, 133.25, 131.52, 129.24, 128.76, 128.75, 125.75, 45.05, 34.56, 31.46.
HRMS (ESI) m/z calcd. for $\text{C}_{18}\text{H}_{21}\text{O}[\text{M}+\text{H}]^+$ 253.1587, found 253.1587.

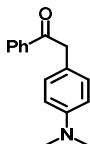
2-([1,1'-biphenyl]-4-yl)-1-phenylethanone (3al)



R_f = 0.40 (SiO_2 , ethyl acetate/hexane, 1:19); white solid (80%);

^1H NMR (400 MHz, CDCl_3) δ 8.08 – 8.03 (m, 2H), 7.59 (dd, J = 11.1, 4.0 Hz, 5H), 7.46 (dt, J = 15.1, 7.8 Hz, 4H), 7.35 (t, J = 8.4 Hz, 3H), 4.34 (s, 2H).
 ^{13}C NMR (101 MHz, CDCl_3) δ 197.68, 140.95, 139.99, 136.75, 133.69, 133.35, 130.04, 128.87, 128.81, 128.75, 127.55, 127.35, 127.19, 45.24.
HRMS (ESI) m/z calcd. for $\text{C}_{20}\text{H}_{17}\text{O}[\text{M}+\text{H}]^+$ 273.1274, found 273.1270.

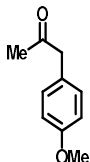
2-(4-(dimethylamino)phenyl)-1-phenylethanone (3an)



R_f = 0.50 (SiO_2 , ethyl acetate/hexane, 1:19); reddish solid (68%);

^1H NMR (400 MHz, CDCl_3) δ 8.03 (dd, J = 8.2, 1.0 Hz, 2H), 7.56 – 7.51 (m, 1H), 7.45 (dd, J = 10.8, 4.4 Hz, 2H), 7.15 (d, J = 8.5 Hz, 2H), 6.71 (d, J = 8.7 Hz, 2H), 4.19 (s, 2H), 2.92 (s, 6H).
 ^{13}C NMR (101 MHz, CDCl_3) δ 198.41, 149.69, 136.86, 133.01, 130.12, 128.78, 128.65, 122.28, 113.06, 44.77, 40.75.
HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{18}\text{NO}[\text{M}+\text{H}]^+$ 240.1383, found 240.1379.

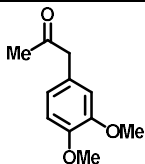
1-(4-methoxyphenyl)propan-2-one (3ba)



R_f = 0.40 (SiO_2 , ethyl acetate/hexane, 1:9); yellow solid (71%);

^1H NMR (400 MHz, CDCl_3) δ 7.14 (d, J = 8.7 Hz, 2H), 6.89 (d, J = 8.7 Hz, 2H), 3.82 (s, 3H), 3.65 (s, 2H), 2.16 (s, 3H).
 ^{13}C NMR (101 MHz, CDCl_3) δ 206.93, 158.70, 130.42, 126.31, 114.21, 55.27, 50.14, 29.14.
HRMS (ESI) m/z calcd. for $\text{C}_{10}\text{H}_{13}\text{O}_2[\text{M}+\text{H}]^+$ 165.0910, found 165.0933.

1-(3,4-dimethoxyphenyl)propan-2-one (3bb)



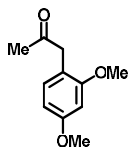
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); reddish liquid (73%);

¹H NMR (400 MHz, CDCl₃) δ 6.85 (d, J = 8.1 Hz, 1H), 6.77 (dd, J = 8.1, 2.0 Hz, 1H), 6.72 (d, J = 2.0 Hz, 1H), 3.88 (s, 6H), 3.65 (s, 2H), 2.16 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 206.90, 149.11, 148.17, 126.73, 121.59, 112.38, 111.41, 55.90, 55.88, 50.61, 29.10.

HRMS (ESI) m/z calcd. for C₁₁H₁₅O₃[M+H]⁺ 195.1016, found 195.1042.

1-(2,4-dimethoxyphenyl)propan-2-one (3bc)



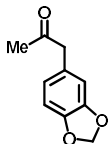
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); reddish liquid (71%);

¹H NMR (400 MHz, CDCl₃) δ 7.02 (d, J = 8.5 Hz, 1H), 6.47 – 6.43 (m, 2H), 3.80 (s, 3H), 3.78 (s, 3H), 3.59 (s, 2H), 2.11 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 207.67, 160.31, 158.34, 131.43, 116.12, 104.32, 98.71, 55.45, 55.44, 44.94, 29.17.

HRMS (ESI) m/z calcd. for C₁₁H₁₅O₃[M+H]⁺ 195.1016, found 195.1042.

1-(benzo[d][1,3]dioxol-5-yl)propan-2-one (3be)



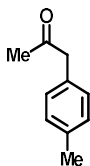
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:9); reddish semi-solid (66%);

¹H NMR (400 MHz, CDCl₃) δ 6.77 (d, J = 7.9 Hz, 1H), 6.69 – 6.66 (m, 1H), 6.66 – 6.62 (m, 1H), 5.94 (s, 2H), 3.60 (s, 2H), 2.14 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 206.68, 148.03, 146.82, 127.93, 122.63, 109.87, 108.60, 101.17, 50.67, 29.25.

HRMS (ESI) m/z calcd. for C₁₀H₁₁O₃[M+H]⁺ 179.0703, found 179.0691.

1-(p-tolyl)propan-2-one (3bf)



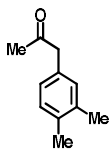
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); yellow solid (67%);

¹H NMR (400 MHz, CDCl₃) δ 7.15 (d, J = 7.9 Hz, 2H), 7.09 (d, J = 8.1 Hz, 2H), 3.66 (s, 2H), 2.34 (s, 3H), 2.14 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 206.84, 136.81, 131.30, 129.57, 129.37, 50.77, 29.27, 21.18.

HRMS (ESI) m/z calcd. for C₁₀H₁₃O[M+H]⁺ 149.0961, found 149.0969.

1-(3,4-dimethylphenyl)propan-2-one (3bg)



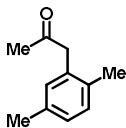
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); yellow liquid (71%);

¹H NMR (400 MHz, CDCl₃) δ 7.10 (d, J = 7.6 Hz, 1H), 6.98 (s, 1H), 6.94 (d, J = 7.7 Hz, 1H), 3.63 (s, 2H), 2.25 (s, 6H), 2.15 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 207.03, 137.08, 135.46, 131.72, 130.73, 130.11, 126.85, 50.80, 29.26, 19.83, 19.48.

HRMS (ESI) m/z calcd. for C₁₁H₁₅O[M+H]⁺ 163.1117, found 163.1102.

1-(2,5-dimethylphenyl)propan-2-one (3bi)



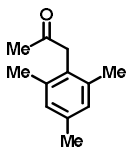
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); yellow liquid (71%);

¹H NMR (400 MHz, CDCl₃) δ 7.08 (d, J = 7.7 Hz, 1H), 7.00 (d, J = 7.8 Hz, 1H), 6.96 (s, 1H), 3.67 (s, 2H), 2.31 (s, 3H), 2.21 (s, 3H), 2.14 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 206.65, 135.83, 133.73, 133.07, 131.20, 130.52, 128.20, 49.22, 29.35, 20.99, 19.25.

HRMS (ESI) m/z calcd. for C₁₁H₁₅O[M+H]⁺ 163.1117, found 163.1106.

1-mesitylpropan-2-one (3bi)



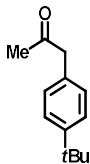
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); white solid (70%);

¹H NMR (800 MHz, CDCl₃) δ 6.89 (s, 2H), 3.74 (s, 2H), 2.28 (s, 3H), 2.22 (s, 6H), 2.15 (s, 3H).

¹³C NMR (201 MHz, CDCl₃) δ 206.83, 136.78, 136.61, 129.21, 129.13, 44.97, 29.44, 21.02, 20.40.

HRMS (ESI) m/z calcd. for C₁₂H₁₇O[M+H]⁺ 177.1274, found 177.1257.

1-(4-(tert-butyl)phenyl)propan-2-one (3bk)



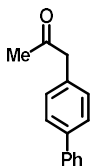
R_f = 0.50 (SiO₂, ethyl acetate/hexane, 1:9); white solid (69%);

¹H NMR (800 MHz, CDCl₃) δ 7.36 (d, J = 8.2 Hz, 2H), 7.15 (d, J = 8.1 Hz, 2H), 3.67 (s, 2H), 2.16 (s, 3H), 1.32 (s, 9H).

¹³C NMR (201 MHz, CDCl₃) δ 206.84, 150.00, 131.24, 129.14, 125.78, 50.61, 34.55, 31.43, 29.40.

HRMS (ESI) m/z calcd. for C₁₃H₁₉O[M+H]⁺ 191.1430, found 191.1459.

1-([1,1'-biphenyl]-4-yl)propan-2-one (3bl)



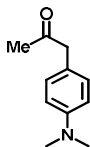
R_f = 0.50 (SiO₂, ethyl acetate/hexane, 1:9); white solid (68%);

¹H NMR (800 MHz, CDCl₃) δ 7.62 – 7.54 (m, 4H), 7.44 (t, J = 7.7 Hz, 2H), 7.35 (t, J = 7.4 Hz, 1H), 7.28 (d, J = 8.0 Hz, 2H), 3.75 (s, 2H), 2.20 (s, 3H).

¹³C NMR (201 MHz, CDCl₃) δ 206.56, 140.83, 140.17, 133.34, 129.97, 128.92, 127.63, 127.45, 127.19, 50.75, 29.57.

HRMS (ESI) m/z calcd. for C₁₅H₁₅O[M+H]⁺ 211.1117, found 211.1096.

1-(4-(dimethylamino)phenyl)propan-2-one (3bn)



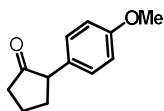
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); yellow solid (61%);

¹H NMR (400 MHz, CDCl₃) δ 7.07 (d, J = 8.8 Hz, 2H), 6.71 (d, J = 8.8 Hz, 2H), 3.58 (s, 2H), 2.94 (s, 6H), 2.12 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 207.58, 149.84, 130.11, 122.13, 113.03, 50.33, 40.72, 29.02.

HRMS (ESI) m/z calcd. for C₁₁H₁₆NO[M+H]⁺ 178.1226, found 178.1206.

2-(4-methoxyphenyl)cyclopentanone (3ca)



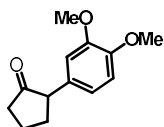
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:9); white solid (70%);

¹H NMR (800 MHz, CDCl₃) δ 7.12 (d, J = 8.6 Hz, 2H), 6.88 (d, J = 8.7 Hz, 2H), 3.79 (s, 3H), 3.27 (dd, J = 11.5, 8.7 Hz, 1H), 2.54 – 2.40 (m, 2H), 2.32 – 2.23 (m, 1H), 2.15 (dddd, J = 15.0, 8.8, 4.5, 2.2 Hz, 1H), 2.07 (ddd, J = 24.1, 11.6, 6.4 Hz, 1H), 1.95 – 1.88 (m, 1H).

¹³C NMR (201 MHz, CDCl₃) δ 218.63, 158.57, 130.50, 129.17, 114.13, 55.35, 54.67, 38.37, 31.88, 20.86.

HRMS (ESI) m/z calcd. for C₁₂H₁₅O₂[M+H]⁺ 191.1067, found 191.1059.

2-(3,4-dimethoxyphenyl)cyclopentanone (3cb)



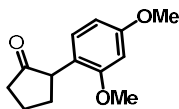
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); white solid (72%);

¹H NMR (400 MHz, CDCl₃) δ 6.83 (d, J = 8.7 Hz, 1H), 6.75 – 6.69 (m, 2H), 3.87 (s, 3H), 3.85 (s, 3H), 3.26 (dd, J = 11.1, 8.5 Hz, 1H), 2.54 – 2.41 (m, 2H), 2.34 – 2.22 (m, 1H), 2.20 – 2.02 (m, 2H), 1.99 – 1.84 (m, 1H).

¹³C NMR (101 MHz, CDCl₃) δ 218.39, 149.08, 148.12, 130.97, 120.13, 111.63, 111.44, 56.02, 55.97, 54.97, 38.41, 31.88, 20.86.

HRMS (ESI) m/z calcd. for C₁₃H₁₇O₃[M+H]⁺ 221.1172, found 221.1170.

2-(2,4-dimethoxyphenyl)cyclopentanone (3cc)



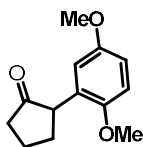
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); white solid (74%);

¹H NMR (400 MHz, CDCl₃) δ 6.99 – 6.95 (m, 1H), 6.47 – 6.42 (m, 2H), 3.78 (s, 3H), 3.74 (s, 3H), 3.30 (dd, J = 11.1, 8.9 Hz, 1H), 2.45 – 2.27 (m, 3H), 2.17 – 2.03 (m, 2H), 1.92 – 1.77 (m, 1H).

¹³C NMR (101 MHz, CDCl₃) δ 219.77, 160.16, 157.89, 130.86, 120.77, 104.53, 99.37, 55.48, 55.41, 51.98, 38.29, 31.27, 21.53.

HRMS (ESI) m/z calcd. for C₁₃H₁₇O₃[M+H]⁺ 221.1172, found 221.1170.

2-(2,5-dimethoxyphenyl)cyclopentanone (3cd)



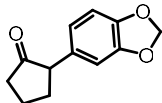
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); white solid (73%);

¹H NMR (400 MHz, CDCl₃) δ 6.80 (d, J = 8.9 Hz, 1H), 6.74 (dd, J = 8.9, 3.0 Hz, 1H), 6.66 (d, J = 3.0 Hz, 1H), 3.74 (s, 3H), 3.72 (s, 3H), 3.31 (dd, J = 11.0, 8.4 Hz, 1H), 2.43 – 2.30 (m, 3H), 2.20 – 2.07 (m, 2H), 1.93 – 1.80 (m, 1H).

¹³C NMR (101 MHz, CDCl₃) δ 219.14, 153.75, 151.21, 129.62, 117.02, 112.49, 112.38, 56.01, 55.79, 52.71, 38.31, 31.26, 21.63.

HRMS (ESI) m/z calcd. for C₁₃H₁₇O₃[M+H]⁺ 221.1172, found 221.1170.

2-(benzo[d][1,3]dioxol-5-yl)cyclopentanone (3ce)



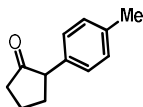
R_f = 0.40 (SiO₂, ethyl acetate-hexane, 1:9); white liquid (73%);

¹H NMR (800 MHz, CDCl₃) δ 6.77 (d, J = 7.9 Hz, 1H), 6.67 (d, J = 1.6 Hz, 1H), 6.64 (dd, J = 7.9, 1.6 Hz, 1H), 5.93 (s, 2H), 3.24 (dd, J = 11.6, 8.6 Hz, 1H), 2.50 – 2.42 (m, 2H), 2.30 – 2.23 (m, 1H), 2.14 (ddt, J = 13.1, 8.7, 6.4, 2.1 Hz, 1H), 2.04 (ddd, J = 24.2, 12.0, 6.4 Hz, 1H), 1.94 – 1.87 (m, 1H).

¹³C NMR (201 MHz, CDCl₃) δ 218.30, 147.91, 146.59, 132.16, 121.41, 108.63, 108.45, 101.09, 55.22, 38.36, 32.01, 20.81.

HRMS (ESI) m/z calcd. for C₁₂H₁₃O₃[M+H]⁺ 205.0859, found 205.0855.

2-(p-tolyl)cyclopentanone (3cf)



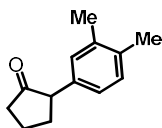
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); yellowish solid (67%);

¹H NMR (400 MHz, CDCl₃) δ 7.18 – 7.13 (d, 2H), 7.09 (dd, J = 8.1, 2.0 Hz, 2H), 3.33 – 3.25 (m, 1H), 2.54 – 2.42 (m, 2H), 2.34 (s, 3H), 2.32 – 2.23 (m, 1H), 2.21 – 2.05 (m, 2H), 2.00 – 1.88 (m, 1H).

¹³C NMR (101 MHz, CDCl₃) δ 218.38, 136.59, 135.52, 129.41, 128.10, 55.10, 38.47, 31.89, 21.15, 20.94.

HRMS (ESI) m/z calcd. for C₁₂H₁₅O[M+H]⁺ 175.1117, found 175.1046.

2-(3,4-dimethylphenyl)cyclopentanone (3cg)



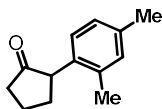
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); yellowish solid (61%);

¹H NMR (400 MHz, CDCl₃) δ 7.10 (d, J = 7.7 Hz, 1H), 6.95 (s, 1H), 6.94 – 6.90 (m, 1H), 3.26 (dd, J = 11.0, 9.0 Hz, 1H), 2.53 – 2.42 (m, 2H), 2.35 – 2.26 (m, 1H), 2.25 (s, 3H), 2.24 (s, 3H), 2.20 – 2.05 (m, 2H), 1.99 – 1.87 (m, 1H).

¹³C NMR (101 MHz, CDCl₃) δ 218.69, 136.88, 136.04, 135.33, 130.00, 129.59, 125.60, 55.24, 38.53, 32.07, 21.00, 19.96, 19.49.

HRMS (ESI) m/z calcd. for C₁₃H₁₇O[M+H]⁺ 189.1274, found 189.1269.

2-(2,4-dimethylphenyl)cyclopentanone (3ch)



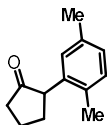
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); yellowish sticky liquid (63%);

¹H NMR (400 MHz, CDCl₃) δ 7.02 (s, 1H), 6.99 (d, J = 7.9 Hz, 1H), 6.90 (d, J = 7.8 Hz, 1H), 3.53 – 3.45 (m, 1H), 2.54 – 2.43 (m, 2H), 2.35 (dd, J = 10.7, 8.8 Hz, 1H), 2.30 (s, 3H), 2.29 (s, 3H), 2.23 – 2.12 (m, 1H), 2.09 – 1.88 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 219.00, 136.66, 136.54, 134.57, 131.48, 127.38, 127.05, 52.83, 38.72, 31.82, 21.12, 21.04, 19.94.

HRMS (ESI) m/z calcd. for C₁₃H₁₇O[M+H]⁺ 189.1274, found 189.1272.

2-(2,5-dimethylphenyl)cyclopentanone (3ci)



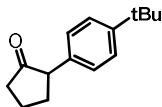
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:9); colorless sticky liquid (67%);

¹H NMR (400 MHz, CDCl₃) δ 7.08 (d, J = 7.7 Hz, 1H), 6.97 (dd, J = 7.7, 1.1 Hz, 1H), 6.81 (s, 1H), 3.53 – 3.46 (m, 1H), 2.55 – 2.44 (m, 2H), 2.35 (td, J = 10.6, 5.5 Hz, 1H), 2.29 (s, 3H), 2.27 (s, 3H), 2.23 – 2.14 (m, 1H), 2.10 – 1.88 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 219.03, 137.46, 135.72, 133.65, 130.54, 128.22, 127.74, 53.13, 38.86, 31.87, 21.16, 21.14, 19.54.

HRMS (ESI) m/z calcd. for C₁₃H₁₇O[M+H]⁺ 189.1274, found 189.1272.

2-(4-(tert-butyl)phenyl)cyclopentanone (3ck)



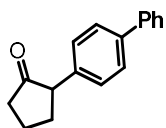
R_f = 0.70 (SiO₂, ethyl acetate/hexane, 1:9); yellowish solid (71%);

¹H NMR (800 MHz, CDCl₃) δ 7.37 (d, J = 7.6 Hz, 2H), 7.14 (d, J = 7.6 Hz, 2H), 3.33 – 3.29 (t, 1H), 2.52 – 2.45 (m, 2H), 2.33 – 2.26 (m, 1H), 2.19 – 2.09 (m, 2H), 1.97 – 1.89 (m, 1H), 1.32 (s, 9H).

¹³C NMR (201 MHz, CDCl₃) δ 218.54, 149.72, 135.40, 127.85, 125.65, 55.00, 38.53, 34.53, 31.82, 31.44, 20.97.

HRMS (ESI) m/z calcd. for C₁₅H₂₁O[M+H]⁺ 217.1587, found 217.1574.

2-([1,1'-biphenyl]-4-yl)cyclopentanone (3cl)



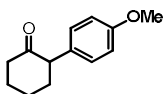
R_f = 0.80 (SiO₂, ethyl acetate/hexane, 1:19); white solid (75%);

¹H NMR (800 MHz, CDCl₃) δ 7.60 – 7.57 (m, 4H), 7.44 (t, J = 7.7 Hz, 2H), 7.35 (t, J = 7.4 Hz, 1H), 7.29 (d, J = 8.1 Hz, 2H), 3.39 (dd, J = 11.1, 8.5 Hz, 1H), 2.58 – 2.49 (m, 1H), 2.33 (ddd, J = 15.6, 10.7, 8.9 Hz, 1H), 2.23 – 2.14 (m, 2H), 2.00 – 1.94 (m, 1H).

¹³C NMR (201 MHz, CDCl₃) δ 218.30, 141.06, 140.05, 137.62, 128.92, 128.73, 127.55, 127.38, 127.26, 55.26, 38.59, 31.91, 21.05.

HRMS (ESI) m/z calcd. for C₁₇H₁₇O[M+H]⁺ 237.1274, found 237.1263.

2-(4-methoxyphenyl)cyclohexanone (3da)



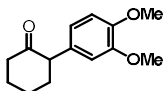
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:9); white solid (77%);

¹H NMR (400 MHz, CDCl₃) δ 7.07 (d, J = 8.7 Hz, 2H), 6.88 (d, J = 8.7 Hz, 2H), 3.80 (s, 3H), 3.57 (dd, J = 12.3, 5.5 Hz, 1H), 2.56 – 2.49 (m, 1H), 2.49 – 2.40 (m, 1H), 2.29 – 2.22 (m, 1H), 2.18 – 2.10 (m, 1H), 2.04 – 1.94 (m, 2H), 1.88 – 1.75 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 210.82, 158.52, 130.95, 129.54, 113.90, 56.67, 55.31, 42.29, 35.40, 27.96, 25.50.

HRMS (ESI) m/z calcd. for C₁₃H₁₇BrO₂[M+H]⁺ 205.1223, found 205.1253.

2-(3,4-dimethoxyphenyl)cyclohexanone (3db)



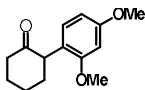
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); white solid (73%);

¹H NMR (400 MHz, CDCl₃) δ 6.83 (d, J = 8.2 Hz, 1H), 6.68 (dd, J = 8.3, 1.8 Hz, 1H), 6.65 (d, J = 1.9 Hz, 1H), 3.85 (s, 6H), 3.56 (dd, J = 12.0, 5.5 Hz, 1H), 2.54 – 2.38 (m, 2H), 2.29 – 2.22 (m, 1H), 2.14 (dt, J = 15.5, 4.8 Hz, 1H), 2.06 – 1.95 (m, 2H), 1.88 – 1.75 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 210.73, 148.79, 147.97, 131.39, 120.45, 111.93, 111.16, 57.01, 55.91, 55.88, 42.26, 35.29, 27.89, 25.43.

HRMS (ESI) m/z calcd. for C₁₄H₁₉O₃[M+H]⁺ 235.1329, found 235.1363.

2-(2,4-dimethoxyphenyl)cyclohexanone (3dc)



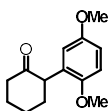
R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); white solid (71%);

¹H NMR (400 MHz, CDCl₃) δ 7.02 (d, J = 8.2 Hz, 1H), 6.48 (dt, J = 6.9, 2.4 Hz, 2H), 3.86 (dd, J = 12.9, 5.4 Hz, 1H), 3.80 (s, 3H), 3.75 (s, 3H), 2.55 – 2.43 (m, 2H), 2.23 – 2.11 (m, 2H), 2.06 – 1.94 (m, 2H), 1.89 – 1.71 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 210.35, 159.78, 157.94, 129.12, 120.40, 104.24, 98.74, 55.49, 55.38, 50.55, 42.39, 33.70, 27.71, 25.87.

HRMS (ESI) m/z calcd. for C₁₄H₁₉O₃[M+H]⁺ 235.1329, found 135.1365.

2-(2,5-dimethoxyphenyl)cyclohexanone (3dd)

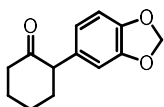


R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); white solid (74%); ¹H NMR (400 MHz, CDCl₃) δ 6.84 – 6.73 (m, 2H), 6.71 (d, J = 2.7 Hz, 1H), 3.90 (dd, J = 12.8, 5.2 Hz, 1H), 3.76 (s, 3H), 3.73 (s, 3H), 2.57 – 2.44 (m, 2H), 2.19 (ddd, J = 16.5, 9.3, 4.4 Hz, 2H), 2.08 – 1.95 (m, 2H), 1.82 (t, J = 15.6 Hz, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 209.78, 153.59, 151.34, 129.22, 115.55, 111.92, 111.58, 56.15, 55.71, 51.25, 42.34, 33.41, 27.57, 25.70.

HRMS (ESI) m/z calcd. for C₁₄H₁₉O₃[M+H]⁺ 235.1329, found 135.1363.

2-(benzo[d][1,3]dioxol-5-yl)cyclohexanone (3de)



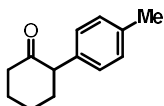
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:9); white solid (77%);

¹H NMR (400 MHz, CDCl₃) δ 6.77 (d, J = 7.9 Hz, 1H), 6.64 (d, J = 1.7 Hz, 1H), 6.59 – 6.55 (m, 1H), 5.94 (s, 2H), 3.54 (dd, J = 12.2, 5.4 Hz, 1H), 2.56 – 2.49 (m, 1H), 2.48 – 2.39 (m, 1H), 2.27 – 2.21 (m, 1H), 2.18 – 2.10 (m, 1H), 2.02 – 1.90 (m, 2H), 1.87 – 1.75 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 210.60, 147.71, 146.55, 132.69, 121.65, 109.12, 108.30, 101.06, 57.25, 42.33, 35.53, 27.93, 25.54.

HRMS (ESI) m/z calcd. for C₁₃H₁₄O₃[M+H]⁺ 219.1016, found 219.1049.

2-(p-tolyl)cyclohexanone (3df)



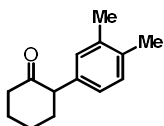
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); white solid (68%);

¹H NMR (400 MHz, CDCl₃) δ 7.18 (d, J = 7.8 Hz, 2H), 7.06 (d, J = 8.0 Hz, 2H), 3.60 (dd, J = 11.9, 5.4 Hz, 1H), 2.58 – 2.41 (m, 2H), 2.36 (s, 3H), 2.32 – 2.23 (m, 1H), 2.20 – 2.12 (m, 1H), 2.10 – 1.95 (m, 2H), 1.90 – 1.77 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 210.61, 136.49, 135.79, 129.15, 128.42, 57.07, 42.24, 35.17, 27.90, 25.41, 21.16.

HRMS (ESI) m/z calcd. for C₁₃H₁₇BrO[M+H]⁺ 189.1274, found 189.1305.

2-(3,4-dimethylphenyl)cyclohexanone (3dg)



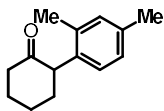
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); white solid (63%);

¹H NMR (400 MHz, CDCl₃) δ 7.12 (d, J = 7.6 Hz, 1H), 6.94 – 6.87 (m, 2H), 3.56 (dd, J = 12.0, 5.1 Hz, 1H), 2.48 (ddd, J = 20.9, 19.6, 9.8 Hz, 2H), 2.29 (d, J = 18.1 Hz, 1H), 2.26 (s, 6H), 2.19 – 2.11 (m, 1H), 2.11 – 1.97 (m, 2H), 1.89 – 1.76 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 210.79, 136.54, 136.31, 135.25, 129.92, 129.79, 125.90, 57.14, 42.27, 35.12, 27.92, 25.45, 19.98, 19.52.

HRMS (ESI) m/z calcd. for $C_{14}H_{19}O[M+H]^+$ 203.1430, found 203.1466.

2-(2,4-dimethylphenyl)cyclohexanone (3dh)



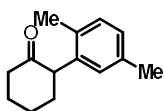
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); white solid (65%);

¹H NMR (400 MHz, CDCl₃) δ 7.02 (d, J = 7.3 Hz, 3H), 3.75 (dd, J = 12.8, 5.3 Hz, 1H), 2.60 – 2.45 (m, 2H), 2.31 (s, 3H), 2.29 – 2.19 (m, 2H), 2.17 (s, 3H), 2.11 – 1.98 (m, 2H), 1.92 – 1.75 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 210.29, 136.41, 136.05, 134.43, 131.27, 127.61, 126.81, 53.65, 42.64, 34.35, 27.90, 26.04, 21.09, 19.76.

HRMS (ESI) m/z calcd. for $C_{14}H_{19}O[M+H]^+$ 203.1430, found 203.1460.

2-(2,5-dimethylphenyl)cyclohexanone (3di)



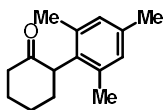
R_f = 0.60 (SiO₂, ethyl acetate/hexane, 1:9); white solid (69%);

¹H NMR (400 MHz, CDCl₃) δ 7.08 (d, J = 7.6 Hz, 1H), 7.00 (d, J = 8.5 Hz, 1H), 6.96 (s, 1H), 3.77 (dd, J = 12.9, 5.3 Hz, 1H), 2.62 – 2.46 (m, 2H), 2.34 (s, 3H), 2.32 – 2.20 (m, 2H), 2.18 (s, 3H), 2.13 – 2.01 (m, 2H), 1.92 – 1.78 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 210.19, 137.22, 135.32, 133.06, 130.25, 128.46, 127.67, 53.94, 42.64, 34.26, 27.86, 25.99, 21.27, 19.36.

HRMS (ESI) m/z calcd. for $C_{14}H_{19}O[M+H]^+$ 203.1430, found 203.1462.

2-mesitylcyclohexanone (3dj)



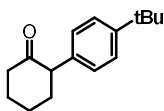
R_f = 0.70 (SiO₂, ethyl acetate/hexane, 1:9); white solid (69%);

¹H NMR (400 MHz, CDCl₃) δ 6.87 (s, 2H), 3.76 (dd, J = 11.0, 7.3 Hz, 1H), 2.66 (d, J = 16.1 Hz, 1H), 2.43 (ddd, J = 16.3, 13.9, 5.1 Hz, 1H), 2.26 (s, 3H), 2.20 (s, 6H), 2.17 – 2.09 (m, 2H), 2.07 – 1.96 (m, 2H), 1.90 – 1.69 (m, 2H).

¹³C NMR (101 MHz, CDCl₃) δ 209.47, 136.19, 136.15, 134.11, 129.79, 52.28, 41.67, 31.95, 25.48, 25.42, 21.50, 20.93.

HRMS (ESI) m/z calcd. for $C_{15}H_{21}O[M+H]^+$ 217.1587, found 217.1593.

2-(4-(tert-butyl)phenyl)cyclohexanone (3dk)

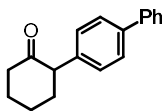


R_f = 0.70 (SiO₂, ethyl acetate/hexane, 1:9); white solid (78%);

¹H NMR (800 MHz, CDCl₃) δ 7.36 (d, J = 8.1 Hz, 2H), 7.08 (d, J = 8.1 Hz, 2H), 3.59 (dd, J = 12.0, 5.4 Hz, 1H), 2.53 (dd, J = 14.0, 3.6 Hz, 1H), 2.45 (td, J = 12.8, 5.8 Hz, 1H), 2.29 – 2.24 (m, 1H), 2.15 (dd, J = 9.2, 3.1 Hz, 1H), 2.06 – 1.98 (m, 2H), 1.82 (ddd, J = 11.2, 10.7, 3.6 Hz, 2H), 1.32 (s, 9H).

^{13}C NMR (201 MHz, CDCl_3) δ 210.77, 149.60, 135.75, 128.21, 125.44, 57.01, 42.33, 35.22, 34.55, 31.50, 27.99, 25.46.
HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{23}\text{O}[\text{M}+\text{H}]^+$ 231.1743, found 231.1781.

2-([1,1'-biphenyl]-4-yl)cyclohexanone (3dl)



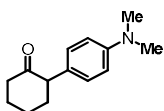
R_f = 0.50 (SiO_2 , ethyl acetate/hexane, 1:9); white solid (80%);

^1H NMR (400 MHz, CDCl_3) δ 7.59 (t, J = 8.5 Hz, 4H), 7.44 (t, J = 7.7 Hz, 2H), 7.34 (t, J = 7.3 Hz, 1H), 7.24 (t, J = 8.1 Hz, 2H), 3.67 (dd, J = 12.3, 5.4 Hz, 1H), 2.61 – 2.44 (m, 2H), 2.36 – 2.28 (m, 1H), 2.22 – 2.13 (m, 1H), 2.05 (ddt, J = 15.5, 14.3, 7.8 Hz, 2H), 1.86 (pd, J = 12.1, 3.8 Hz, 2H).

^{13}C NMR (101 MHz, CDCl_3) δ 210.53, 141.11, 139.93, 137.93, 129.06, 128.82, 127.27, 127.23, 57.23, 42.37, 35.32, 27.96, 25.51.

HRMS (ESI) m/z calcd. for $\text{C}_{18}\text{H}_{19}\text{O}[\text{M}+\text{H}]^+$ 251.1430, found 164.1448.

2-(4-(dimethylamino)phenyl)cyclohexanone (3dn)



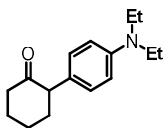
R_f = 0.40 (SiO_2 , ethyl acetate/hexane, 1:9); yellowish sticky solid (65%);

^1H NMR (400 MHz, CDCl_3) δ 7.03 (d, J = 8.6 Hz, 2H), 6.74 (d, J = 8.8 Hz, 2H), 3.54 (dd, J = 11.8, 5.4 Hz, 1H), 2.94 (s, 6H), 2.56 – 2.49 (m, 1H), 2.44 (dddd, J = 13.5, 12.1, 5.8, 1.0 Hz, 1H), 2.29 – 2.21 (m, 1H), 2.17 – 2.09 (m, 1H), 2.05 – 1.95 (m, 2H), 1.89 – 1.74 (m, 2H).

^{13}C NMR (101 MHz, CDCl_3) δ 211.29, 149.68, 129.08, 126.72, 112.81, 56.46, 42.20, 40.78, 35.16, 27.99, 25.40.

HRMS (ESI) m/z calcd. for $\text{C}_{15}\text{H}_{21}\text{NO}[\text{M}+\text{H}]^+$ 218.1539, found 218.1539.

2-(4-(diethylamino)phenyl)cyclohexanone (3do)



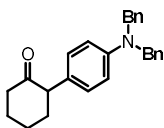
R_f = 0.40 (SiO_2 , ethyl acetate/hexane, 1:9); yellowish sticky solid (69%);

^1H NMR (400 MHz, CDCl_3) δ 6.98 (d, J = 8.8 Hz, 2H), 6.65 (d, J = 8.8 Hz, 2H), 3.51 (dd, J = 11.6, 5.4 Hz, 1H), 3.34 (q, J = 7.1 Hz, 4H), 2.55 – 2.48 (m, 1H), 2.47 – 2.37 (m, 1H), 2.28 – 2.20 (m, 1H), 2.16 – 2.07 (m, 1H), 2.00 (ddt, J = 16.2, 10.8, 7.4 Hz, 2H), 1.88 – 1.73 (m, 2H), 1.15 (t, J = 7.1 Hz, 6H).

^{13}C NMR (101 MHz, CDCl_3) δ 211.49, 146.87, 129.27, 125.34, 111.79, 56.42, 44.40, 42.20, 35.18, 28.02, 25.40, 12.78.

HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{24}\text{NO}[\text{M}+\text{H}]^+$ 246.1852, found 246.1864.

2-(4-(dibenzylamino)phenyl)cyclohexanone (3dp)



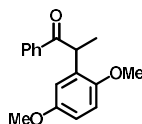
R_f = 0.50 (SiO_2 , ethyl acetate/hexane, 1:9); yellowish sticky solid (45%);

^1H NMR (400 MHz, CDCl_3) δ 7.40 – 7.34 (m, 4H), 7.29 (d, J = 23.6 Hz, 6H), 7.00 (d, J = 8.3 Hz, 2H), 6.77 (d, J = 7.9 Hz, 2H), 4.68 (s, 4H), 3.55 (dd, J = 11.2, 4.4 Hz, 1H), 2.61 – 2.39 (m, 2H), 2.28 (d, J = 11.1 Hz, 1H), 2.15 (s, 1H), 2.04 (d, J = 21.4 Hz, 2H), 1.91 – 1.76 (m, 2H).

^{13}C NMR (101 MHz, CDCl_3) δ 211.18, 148.22, 138.81, 129.20, 128.66, 126.91, 126.80, 112.46, 56.39, 54.28, 42.17, 35.14, 27.94, 25.38.

HRMS (ESI) m/z calcd. for $\text{C}_{26}\text{H}_{28}\text{NO}[\text{M}+\text{H}]^+$ 370.2165, found 370.2169.

2-(4-methoxyphenyl)-1-phenylethanone (3ed)



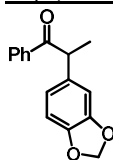
R_f = 0.60 (SiO_2 , ethyl acetate/hexane, 1:9); white solid (55%);

^1H NMR (400 MHz, CDCl_3) δ 7.97 – 7.93 (m, 2H), 7.47 – 7.42 (m, 1H), 7.38 – 7.33 (m, 2H), 7.01 (d, J = 8.4 Hz, 1H), 6.45 (d, J = 2.4 Hz, 1H), 6.39 (dd, J = 8.4, 2.5 Hz, 1H), 5.00 (q, J = 6.8 Hz, 1H), 3.85 (s, 3H), 3.75 (s, 3H), 1.43 (d, J = 6.8 Hz, 3H).

^{13}C NMR (101 MHz, CDCl_3) δ 201.68, 159.84, 156.85, 136.68, 132.62, 128.63, 128.60, 128.43, 122.69, 104.68, 98.99, 55.62, 55.40, 39.84, 17.85.

HRMS (ESI) m/z calcd. for $\text{C}_{17}\text{H}_{19}\text{O}_3[\text{M}+\text{H}]^+$ 271.3304, found 271.3310.

2-(3,4-dimethoxyphenyl)-1-phenylethanone (3ee)



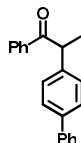
R_f = 0.40 (SiO_2 , ethyl acetate/hexane, 1:9); white solid (57%);

^1H NMR (400 MHz, CDCl_3) δ 7.95 (dd, J = 8.4, 1.2 Hz, 2H), 7.51 – 7.46 (m, 1H), 7.42 – 7.36 (m, 2H), 6.77 (d, J = 1.1 Hz, 1H), 6.73 (dd, J = 2.1, 1.1 Hz, 2H), 5.90 (dd, J = 6.4, 1.4 Hz, 2H), 4.60 (q, J = 6.8 Hz, 1H), 1.49 (d, J = 6.9 Hz, 3H).

^{13}C NMR (101 MHz, CDCl_3) δ 200.37, 148.16, 146.62, 136.53, 135.33, 132.94, 128.87, 128.63, 121.15, 108.79, 108.22, 101.16, 47.53, 19.67.

HRMS (ESI) m/z calcd. for $\text{C}_{16}\text{H}_{15}\text{O}_3[\text{M}+\text{H}]^+$ 255.2880, found 255.2884.

2-(2,4-dimethoxyphenyl)-1-phenylethanone (3el)



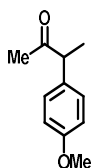
R_f = 0.70 (SiO_2 , ethyl acetate/hexane, 1:9); white solid (53%);

^1H NMR (400 MHz, CDCl_3) δ 8.01 – 7.98 (m, 2H), 7.57 – 7.51 (m, 4H), 7.49 (dt, J = 2.6, 1.7 Hz, 1H), 7.44 – 7.30 (m, 7H), 4.75 (q, J = 6.8 Hz, 1H), 1.58 (d, J = 6.9 Hz, 3H).

^{13}C NMR (101 MHz, CDCl_3) δ 200.44, 140.75, 140.57, 139.94, 136.57, 133.00, 128.93, 128.86, 128.67, 128.32, 127.83, 127.39, 127.13, 47.60, 19.63.

HRMS (ESI) m/z calcd. for $\text{C}_{21}\text{H}_{19}\text{O}[\text{M}+\text{H}]^+$ 287.3744, found 287.3738.

1-(4-methoxyphenyl)propan-2-one (3fa)



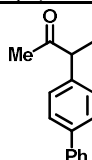
R_f = 0.50 (SiO₂, ethyl acetate/hexane, 1:9); yellow solid (58%);

¹H NMR (400 MHz, CDCl₃) δ 7.13 (d, J = 8.7 Hz, 2H), 6.87 (d, J = 8.7 Hz, 2H), 3.80 (s, 3H), 3.69 (q, J = 7.0 Hz, 1H), 2.04 (s, 3H), 1.36 (d, J = 7.0 Hz, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 209.27, 158.74, 132.65, 128.84, 114.34, 55.29, 52.86, 28.24, 17.27.

HRMS (ESI) m/z calcd. for C₁₁H₁₅O₂[M+H]⁺ 179.2351, found 179.2357.

1-(3,4-dimethoxyphenyl)propan-2-one (3fl)



R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:9); white solid (53%);

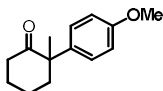
¹H NMR (400 MHz, CDCl₃) δ 7.61 – 7.55 (m, 4H), 7.47 – 7.42 (m, 2H), 7.38 – 7.32 (m, 1H), 7.32 – 7.28 (m, 2H), 3.80 (q, J = 7.0 Hz, 1H), 2.10 (s, 3H), 1.44 (d, J = 7.0 Hz, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 206.90, 149.11, 148.17, 126.73, 121.59, 112.38, 111.41, 55.90, 55.88, 50.61, 29.10.

¹³C NMR (101 MHz, CDCl₃) δ 208.95, 140.72, 140.27, 139.71, 128.92, 128.38, 127.78, 127.47, 127.15, 53.50, 28.59, 17.37.

HRMS (ESI) m/z calcd. for C₁₆H₁₇O[M+H]⁺ 225.3050, found 225.3056.

2-(4-methoxyphenyl)cyclohexanone (3ga)



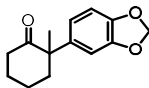
R_f = 0.50 (SiO₂, ethyl acetate/hexane, 1:9); white solid (61%);

¹H NMR (400 MHz, CDCl₃) δ 7.09 (d, J = 8.9 Hz, 2H), 6.88 (d, J = 8.9 Hz, 2H), 3.79 (s, 3H), 2.67 – 2.58 (m, 1H), 2.42 – 2.32 (m, 1H), 2.27 (dt, J = 6.9, 4.2 Hz, 1H), 1.95 (ddd, J = 9.6, 4.6, 2.2 Hz, 1H), 1.76 – 1.66 (m, 4H), 1.24 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 214.43, 158.25, 135.36, 127.28, 114.42, 55.36, 53.70, 39.84, 38.42, 28.62, 28.56, 21.96.

HRMS (ESI) m/z calcd. for C₁₄H₁₉O₂[M+H]⁺ 219.2989, found 219.2995.

2-(3,4-dimethoxyphenyl)cyclohexanone (3ge)



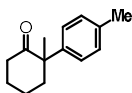
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:9); white solid (58%);

¹H NMR (400 MHz, CDCl₃) δ 6.77 (d, J = 8.1 Hz, 1H), 6.69 (d, J = 1.9 Hz, 1H), 6.61 (dd, J = 8.1, 1.9 Hz, 1H), 5.94 (dd, J = 2.9, 1.4 Hz, 2H), 2.60 – 2.52 (m, 1H), 2.44 – 2.35 (m, 1H), 2.32 – 2.24 (m, 1H), 1.96 (ddt, J = 12.5, 6.4, 3.1 Hz, 1H), 1.81 – 1.66 (m, 4H), 1.23 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 214.08, 148.34, 146.23, 137.28, 119.40, 108.76, 106.77, 101.20, 54.09, 39.87, 38.52, 28.64, 28.48, 21.93.

HRMS (ESI) m/z calcd. for C₁₄H₁₇O₃[M+H]⁺ 233.2824, found 233.2820

2-(2,4-dimethoxyphenyl)cyclohexanone (3gf)



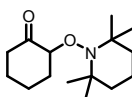
R_f = 0.40 (SiO₂, ethyl acetate/hexane, 1:9); white solid (53%);

¹H NMR (400 MHz, CDCl₃) δ 7.16 (d, J = 8.1 Hz, 2H), 7.07 (d, J = 8.3 Hz, 2H), 2.70 – 2.62 (m, 1H), 2.38 (td, J = 13.0, 5.9 Hz, 1H), 2.33 (s, 3H), 2.31 – 2.25 (m, 1H), 1.99 – 1.90 (m, 1H), 1.77 – 1.66 (m, 4H), 1.25 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 214.45, 140.41, 136.32, 129.80, 126.10, 77.16, 54.13, 39.97, 38.31, 28.63, 28.60, 22.00, 21.06.

HRMS (ESI) m/z calcd. for C₁₄H₁₉O[M+H]⁺ 203.2995, found 203.2997.

2-((2,2,6,6-tetramethylpiperidin-1-yl)oxy)cyclohexanone (5)



R_f = 0.30 (SiO₂, ethyl acetate/hexane, 1:9); yellowish liquid (69%);

¹H NMR (400 MHz, CDCl₃) δ 4.16 (ddd, J = 7.0, 4.1, 1.4 Hz, 1H), 2.80 – 2.71 (m, 1H), 2.29 – 2.21 (m, 1H), 2.16 – 2.06 (m, 1H), 2.00 (dddd, J = 9.4, 7.9, 4.0, 3.1 Hz, 1H), 1.94 – 1.83 (m, 2H), 1.80 – 1.69 (m, 1H), 1.58 (ddd, J = 6.9, 6.2, 3.1 Hz, 1H), 1.48 – 1.40 (m, 4H), 1.25 (s, 2H), 1.16 (s, 6H), 1.12 (s, 3H), 0.98 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 212.07, 89.38, 41.11, 40.38, 34.98, 28.62, 22.25, 20.34, 17.25.

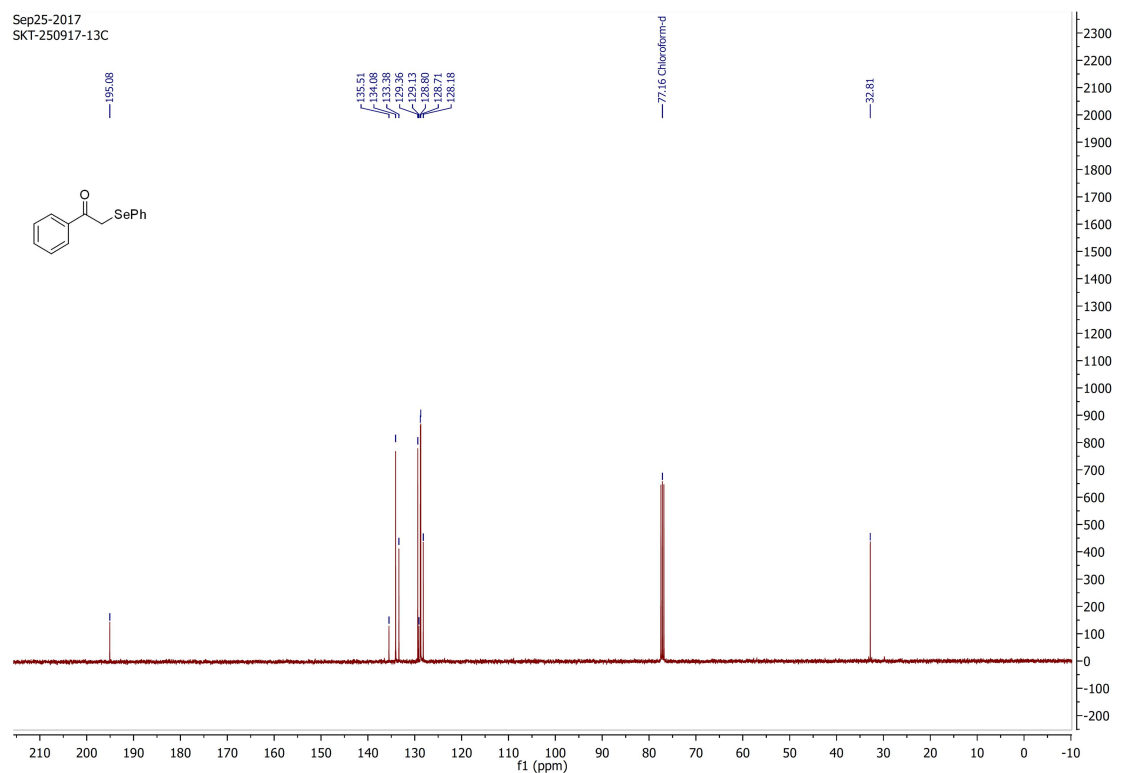
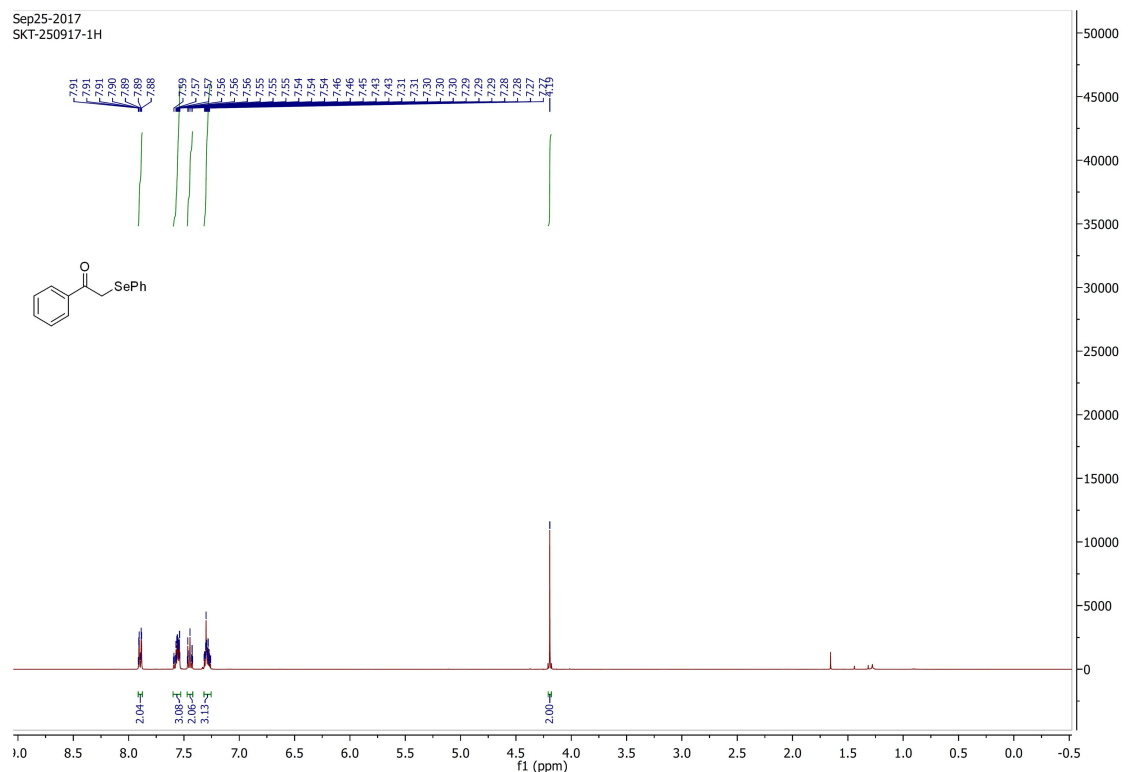
HRMS (ESI) m/z calcd. for C₁₅H₂₈NO₂[M+H]⁺ 254.3878, found 254.2098.

References

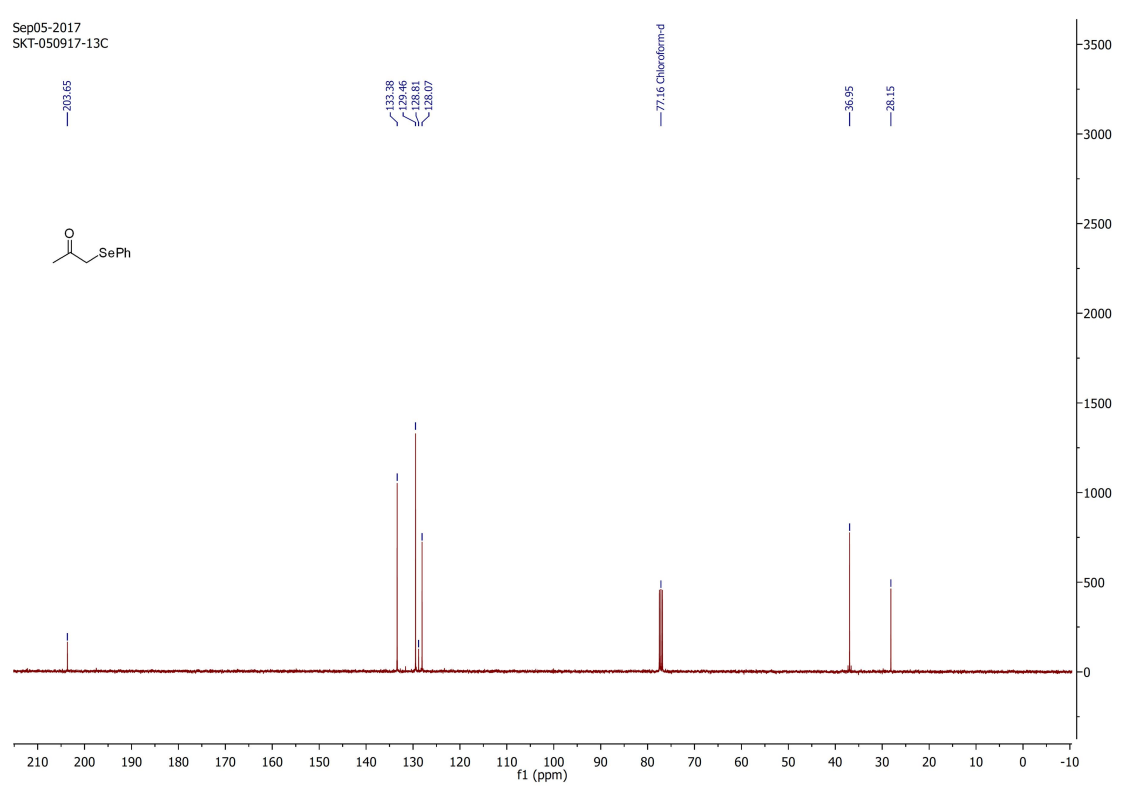
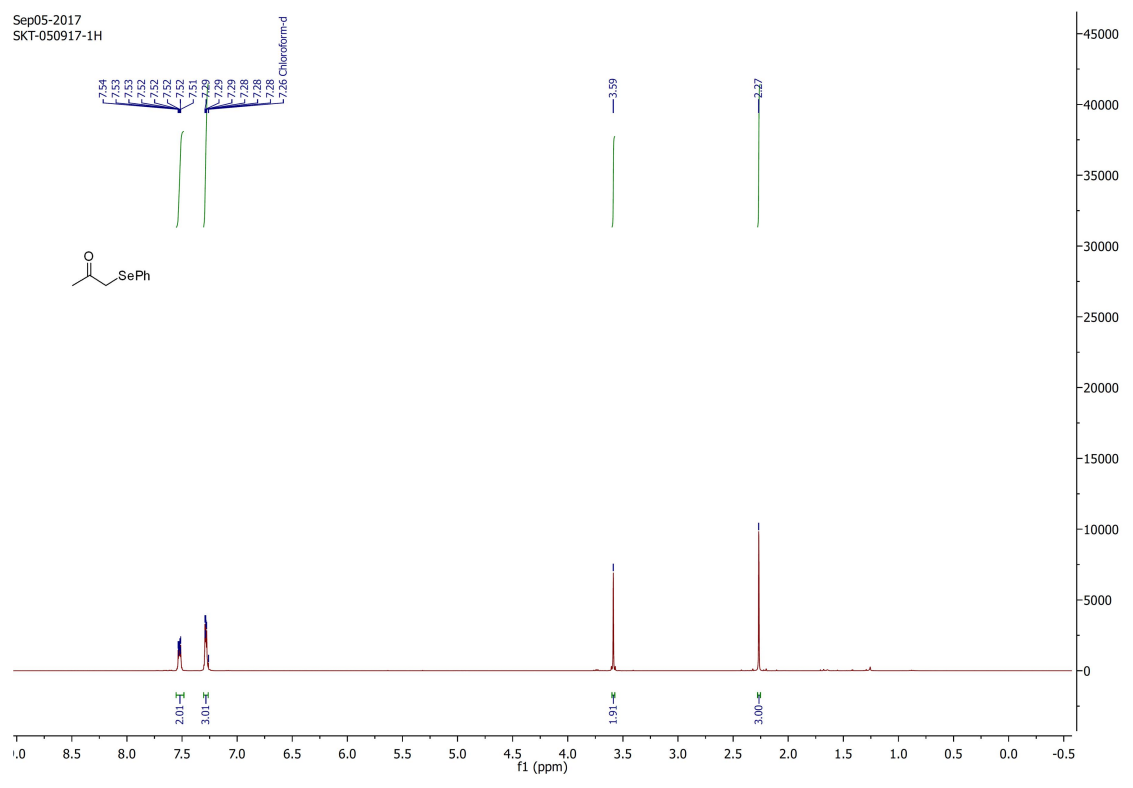
1. Armarego, W. L. F.; Perrin, D. D. *Purification of Laboratory Chemicals*, Fourth Edition; Butterworth Heinemann: Oxford, **1997**.
2. Rao, K. S. S. P.; Ph.D Thesis entitled “ Photosensitized electron transfer (PET) reductive activation of – C-Se- and –Si-Se- bonds: mechanism and synthetic perspective” submitted to Pune University, Pune, India, **1997**.
3. Rehm, D.; Weller, A. *Isr. J. Chem.*, **1970**, 8, 259.
4. Miyoshi, N.; Yamamoto, T.; Kambe, N.; Murai, S; Sonoda, N; *Tet. Lett.* **1986**, 23, 4813.
5. J. G. Calvert, J. N. Pitts, *Photochemistry Wiley, New York*, **1966**, p. 736.
6. This setup was used in the absence of a commercially available LED source in this wavelength range, Any lamp emitting at 410 nm with appropriate intensity (ca.6.0×10¹⁵ photons per second) can be used.

^1H and ^{13}C spectra of Starting Material

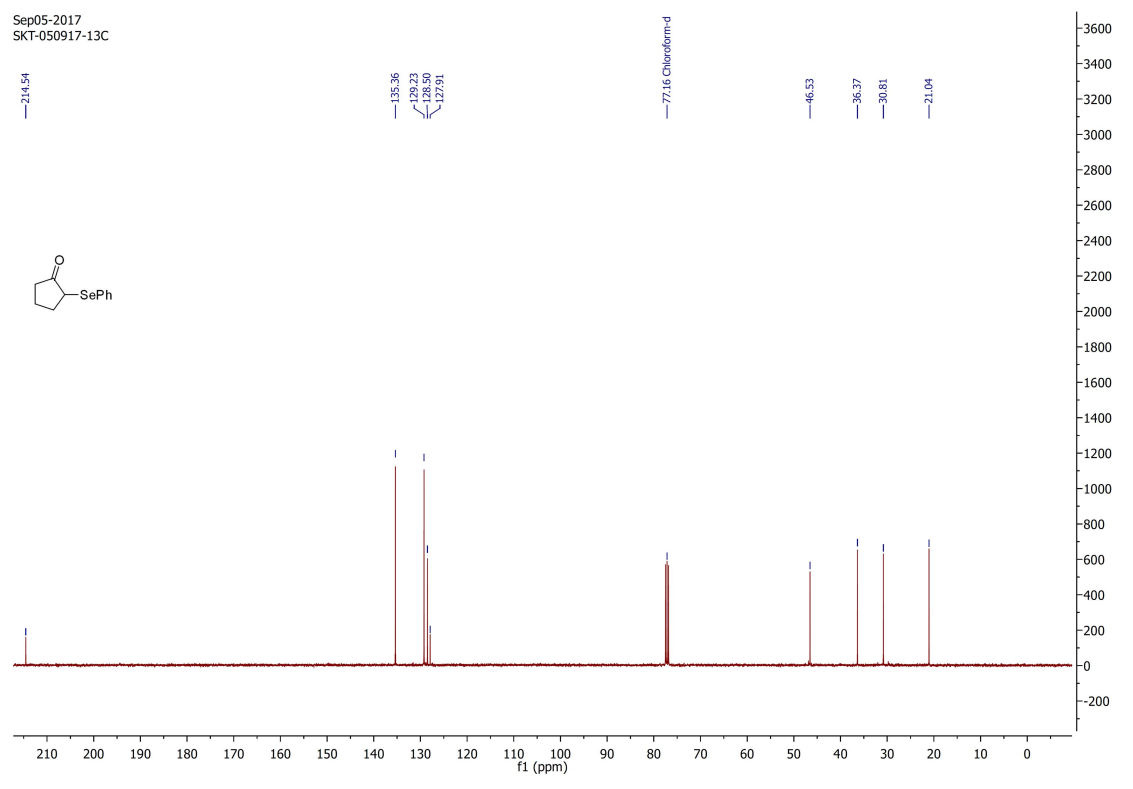
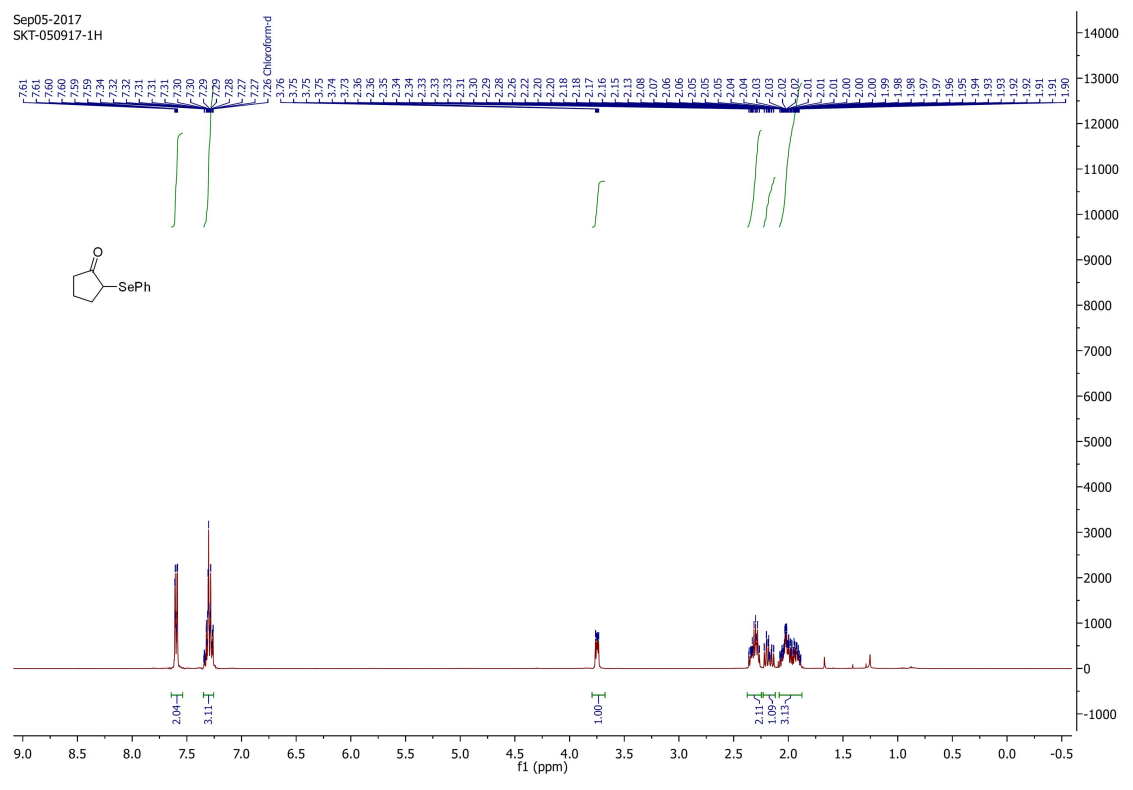
¹H and ¹³C spectra of (1a)



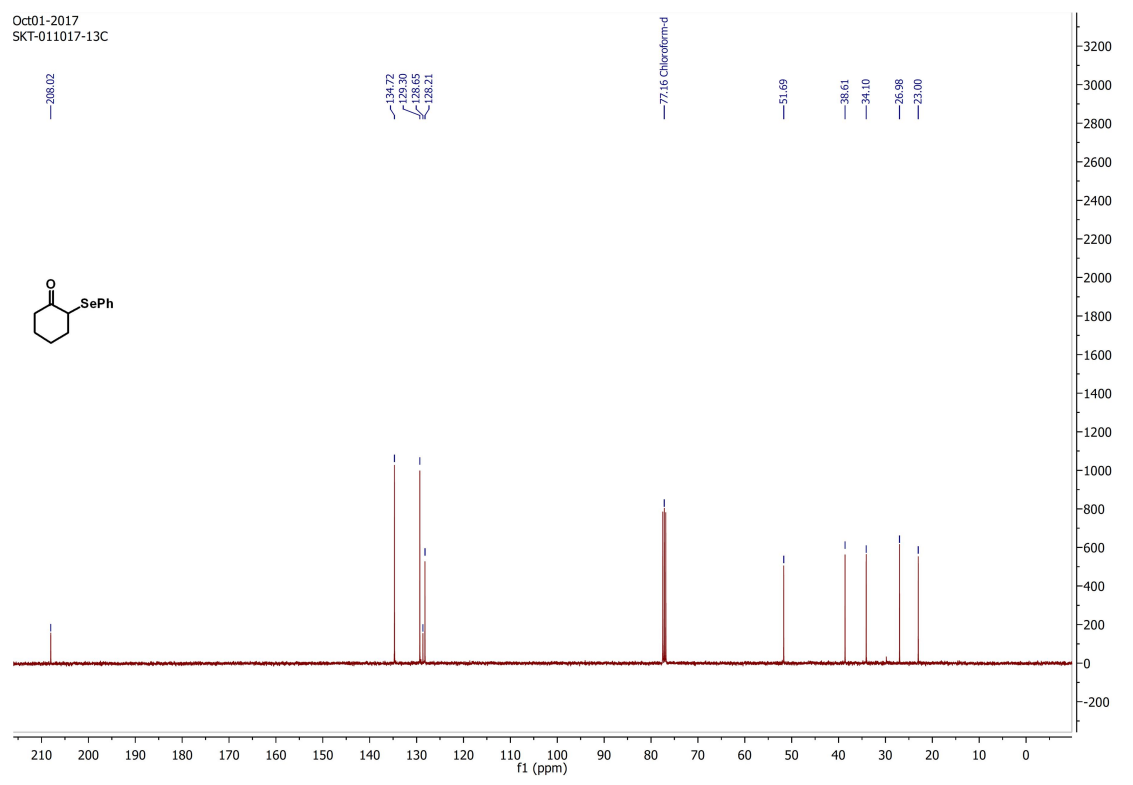
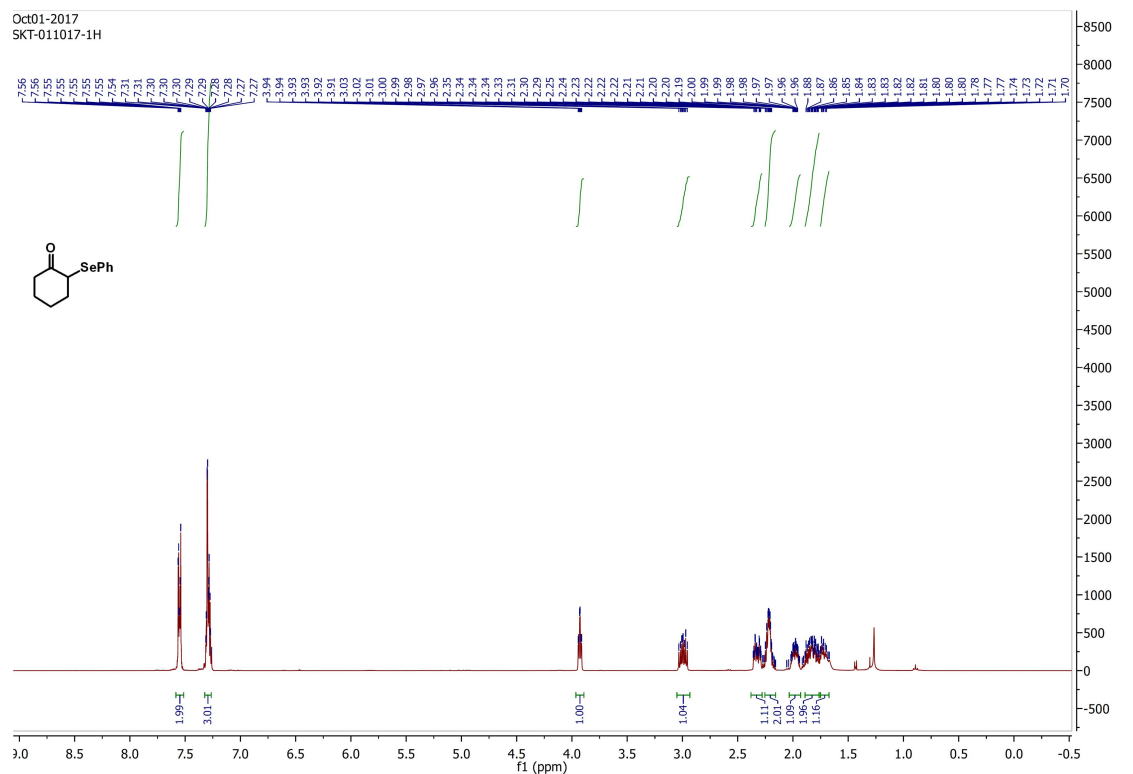
¹H and ¹³C spectra of (1b)



¹H and ¹³C spectra of (1c)

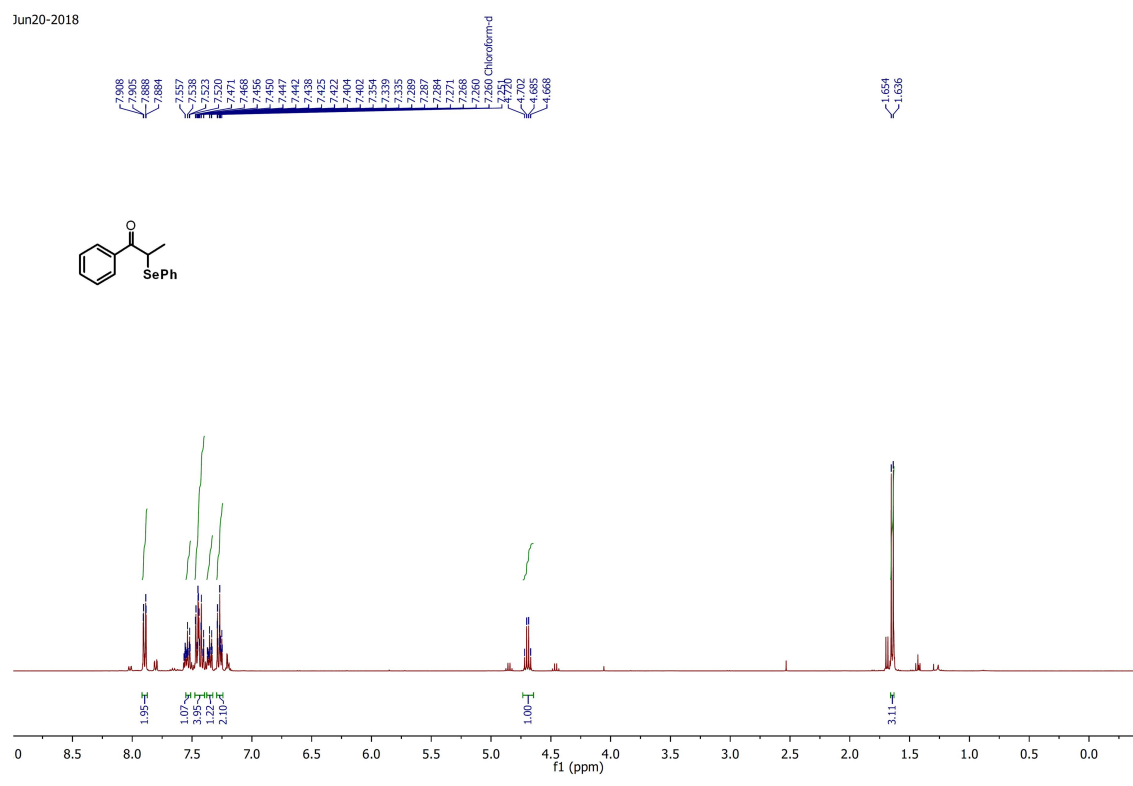


¹H and ¹³C spectra of (1d)

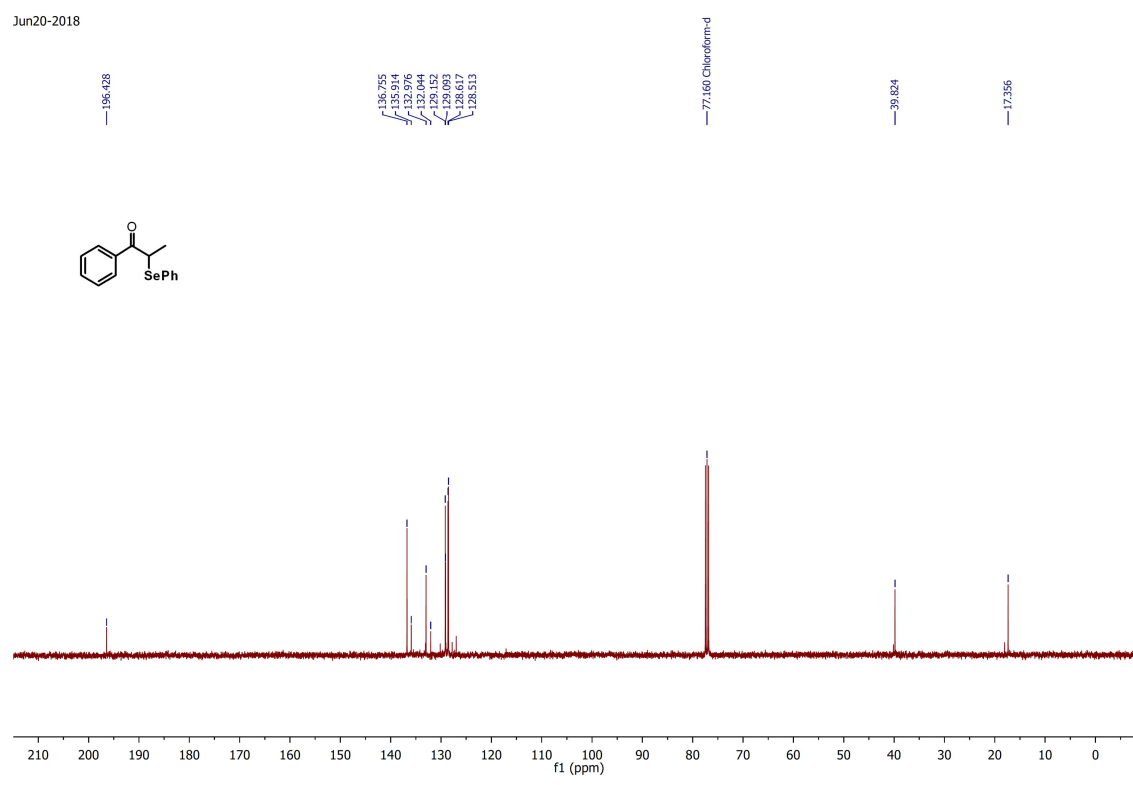


¹H and ¹³C spectra of (1e)

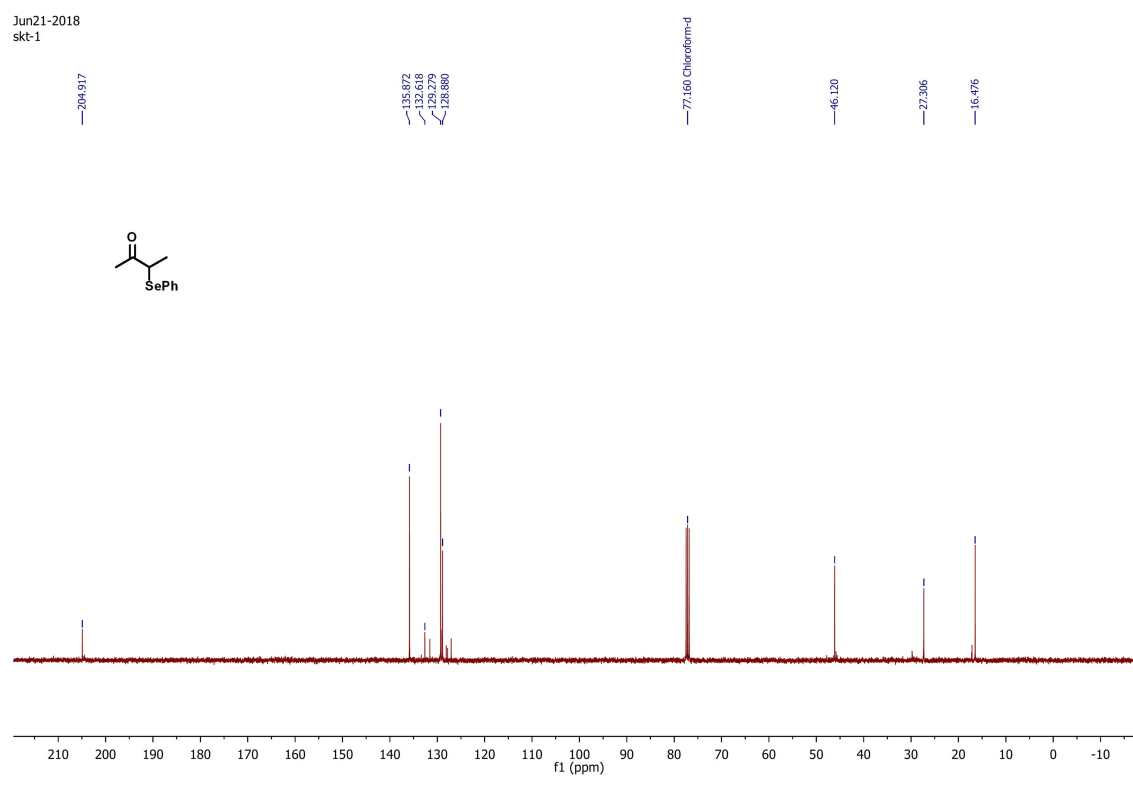
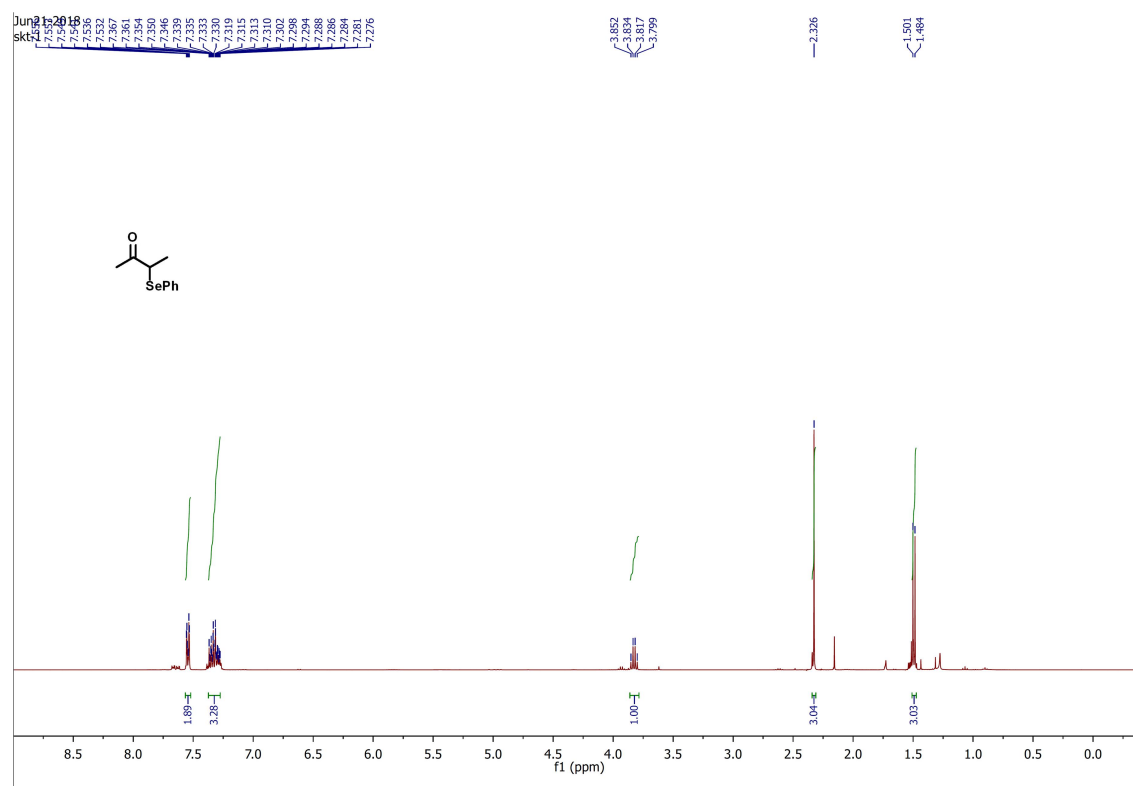
Jun20-2018



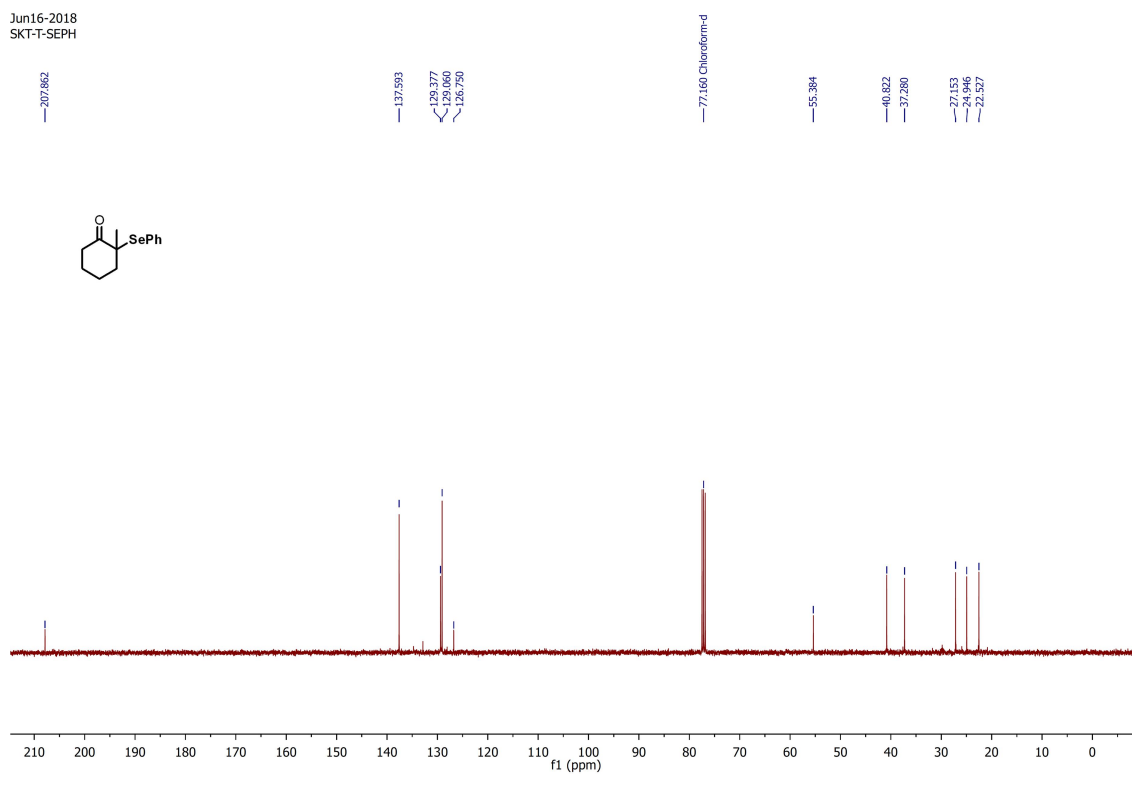
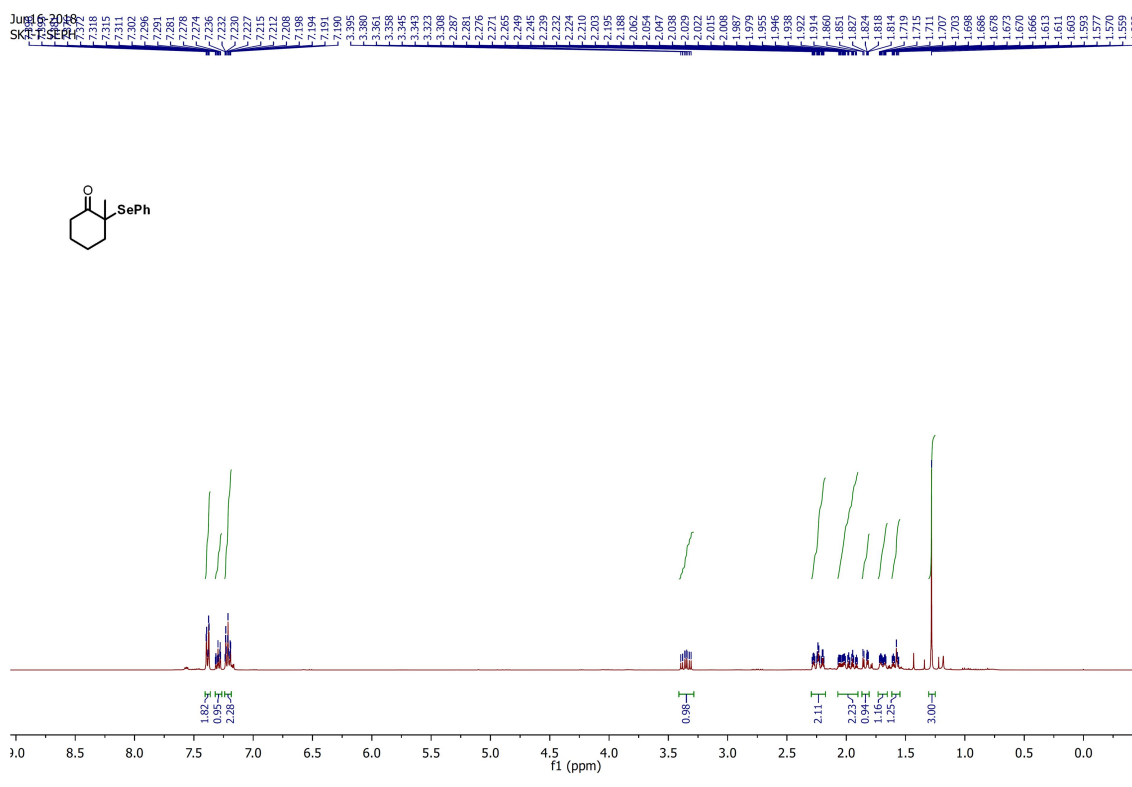
Jun20-2018



¹H and ¹³C spectra of (1f)



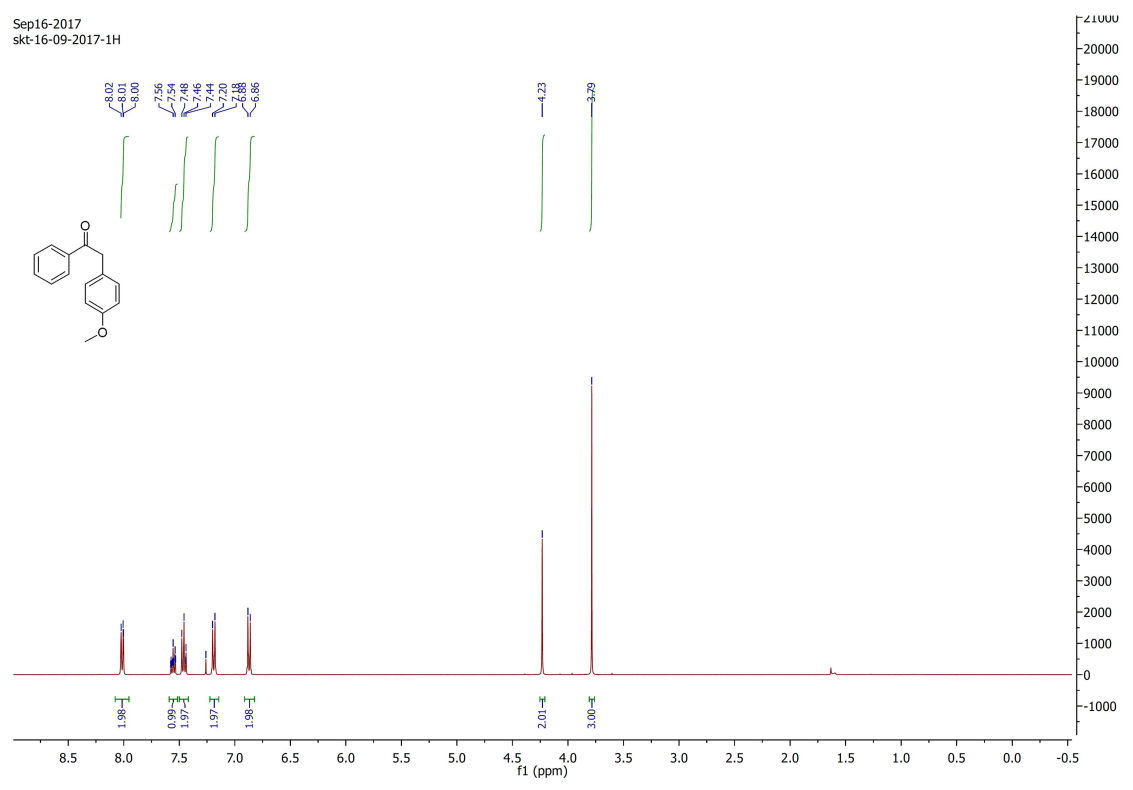
¹H and ¹³C spectra of (1g)



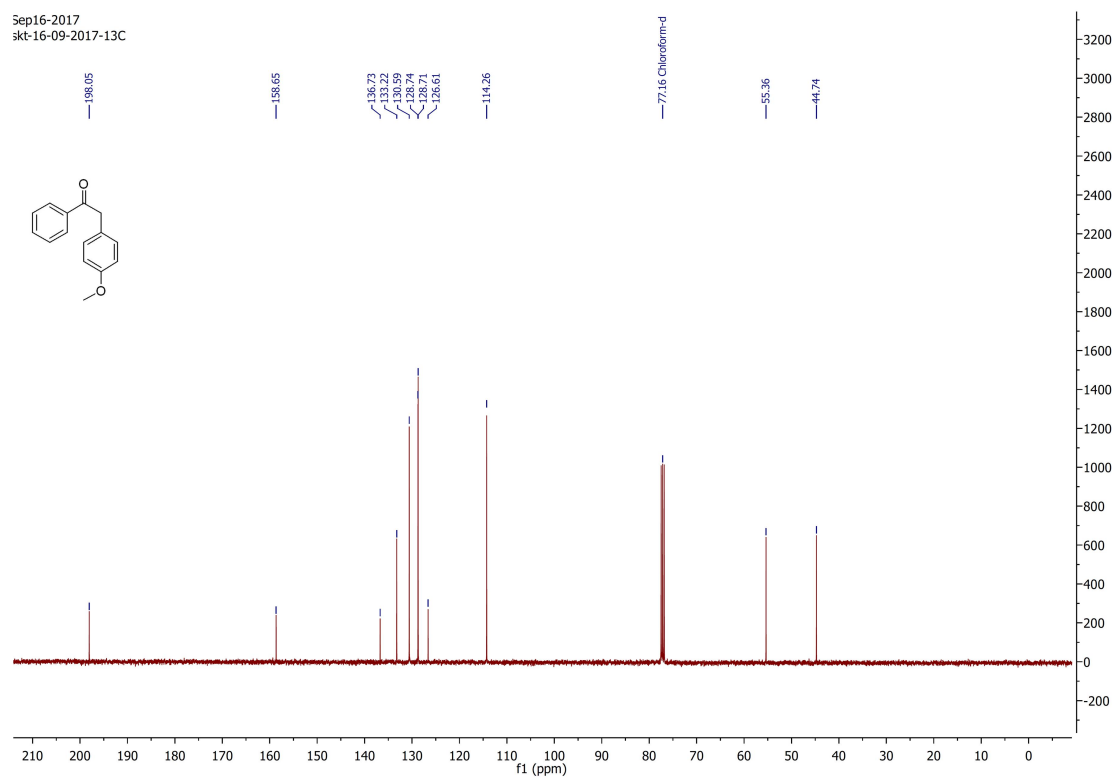
^1H and ^{13}C spectra of Products

¹H and ¹³C spectra of (3aa)

Sep16-2017
skt-16-09-2017-1H

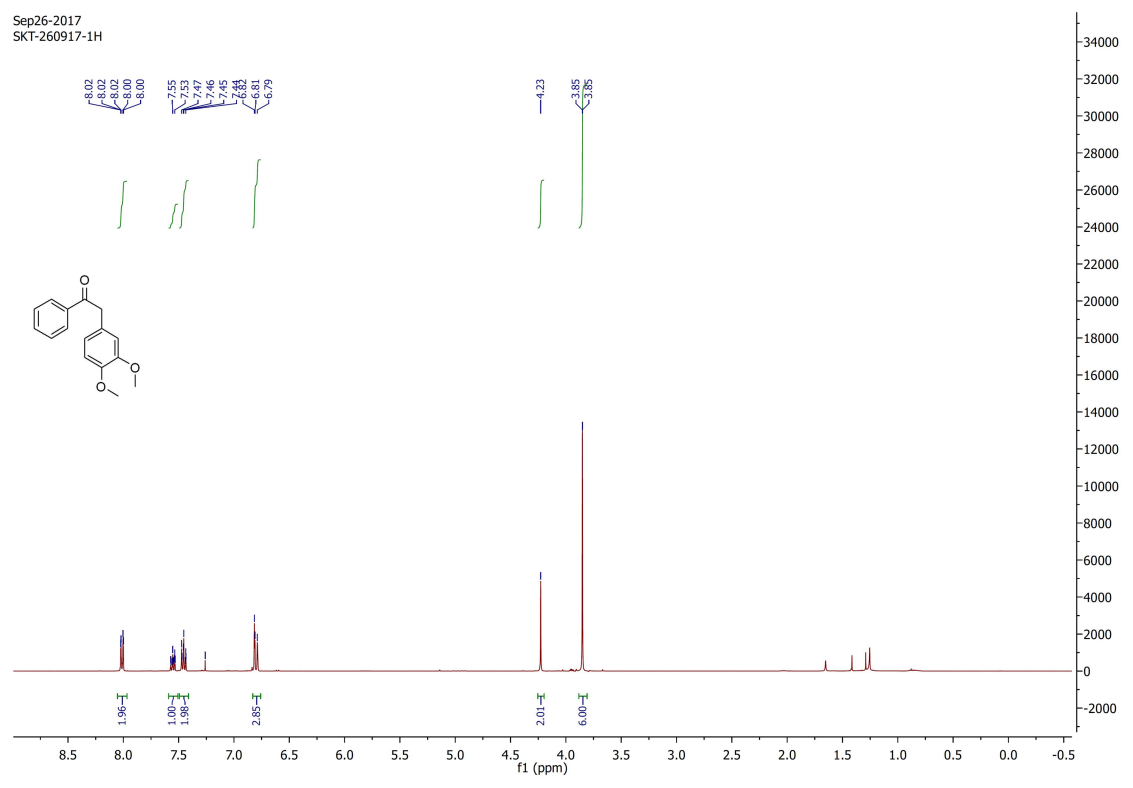


Sep16-2017
skt-16-09-2017-13C

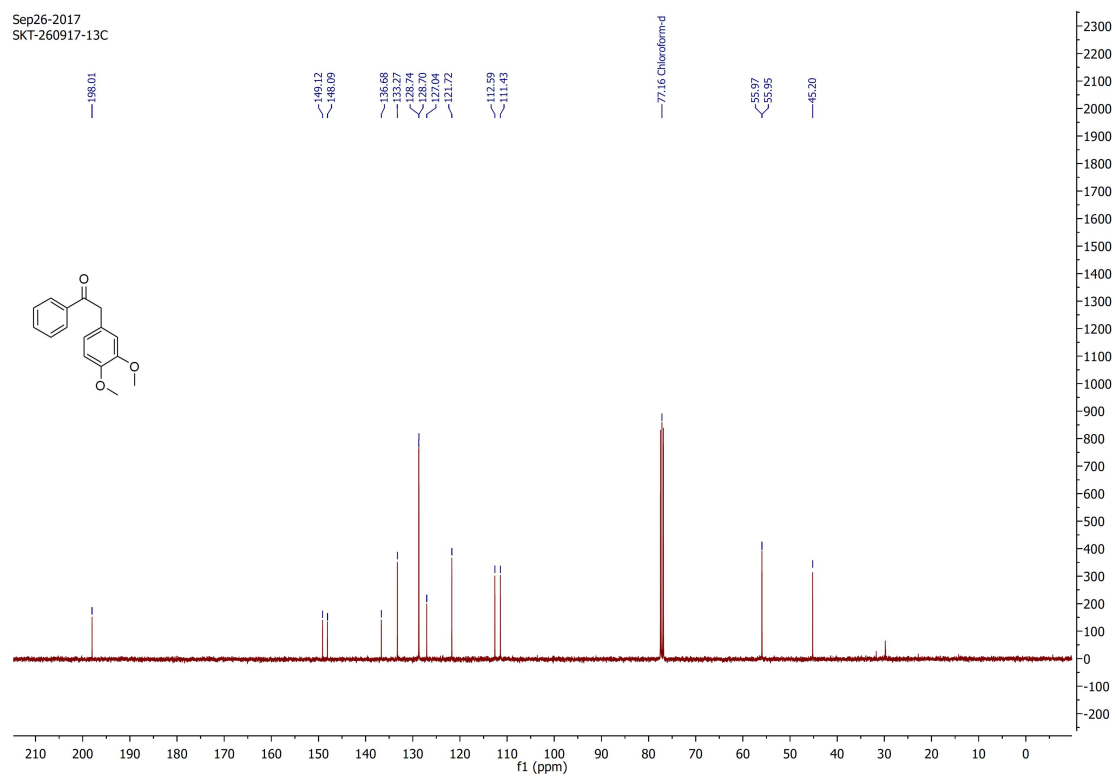


¹H and ¹³C spectra of (3ab)

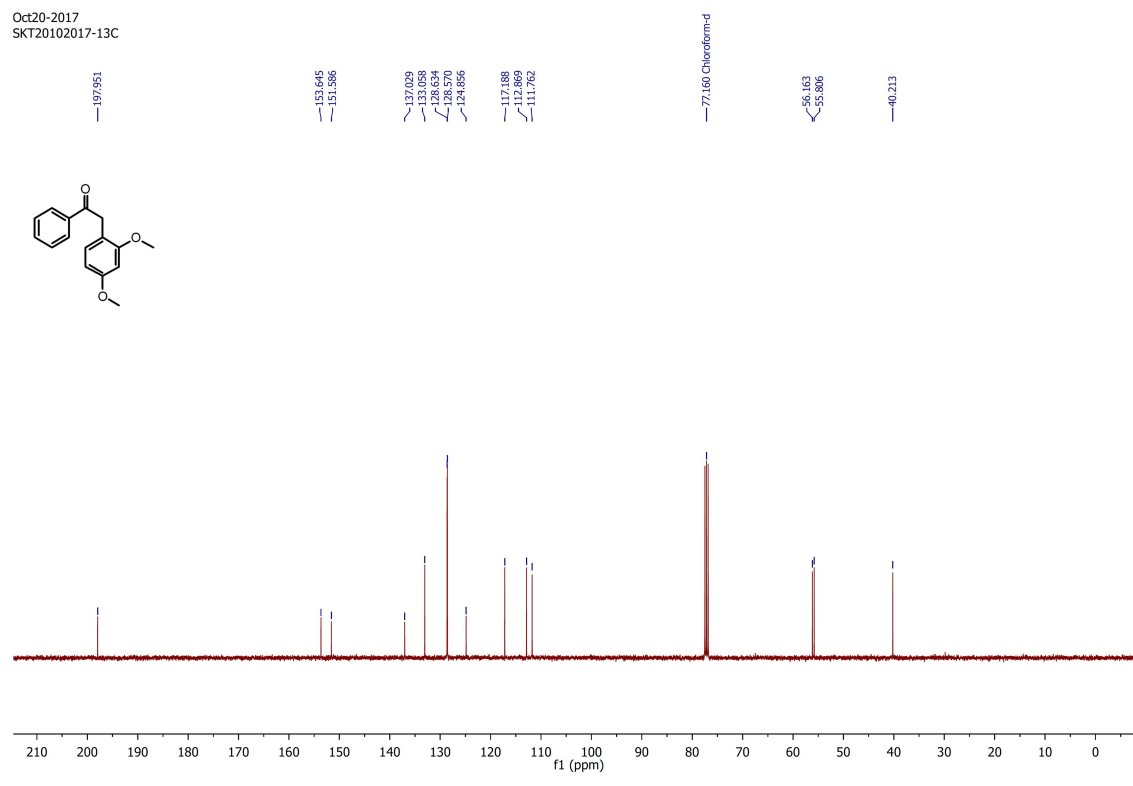
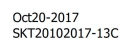
Sep26-2017
SKT-260917-1H



Sep26-2017
SKT-260917-13C

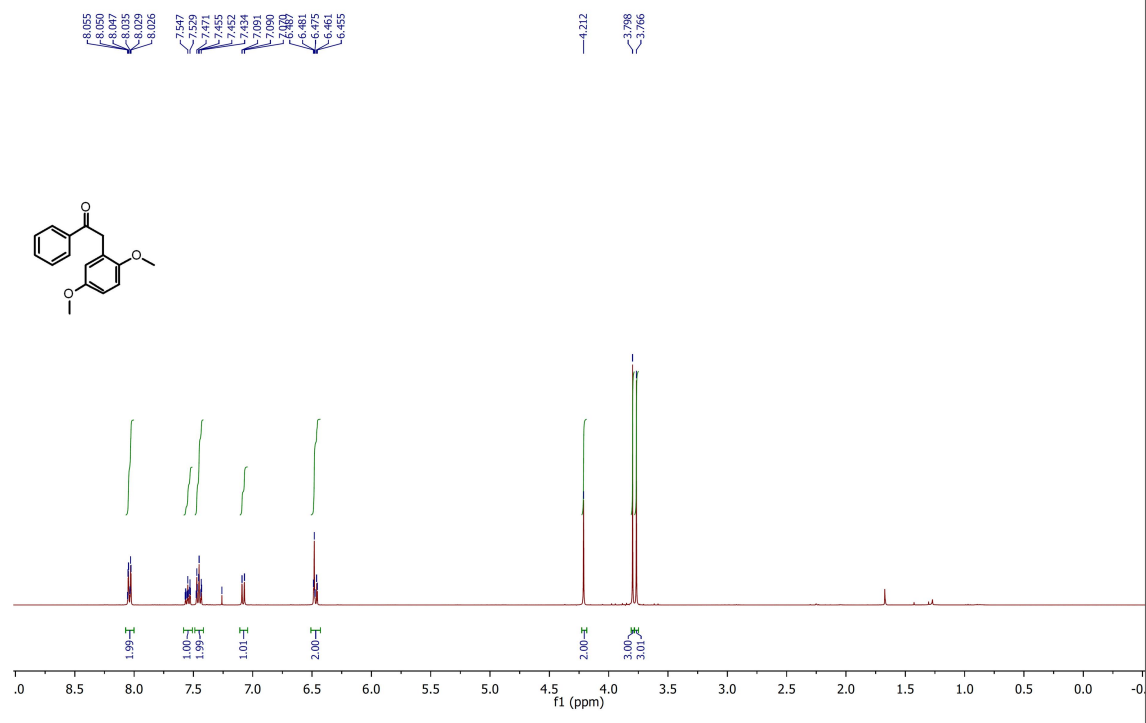


Oct20-2017
SKT20102017-1H

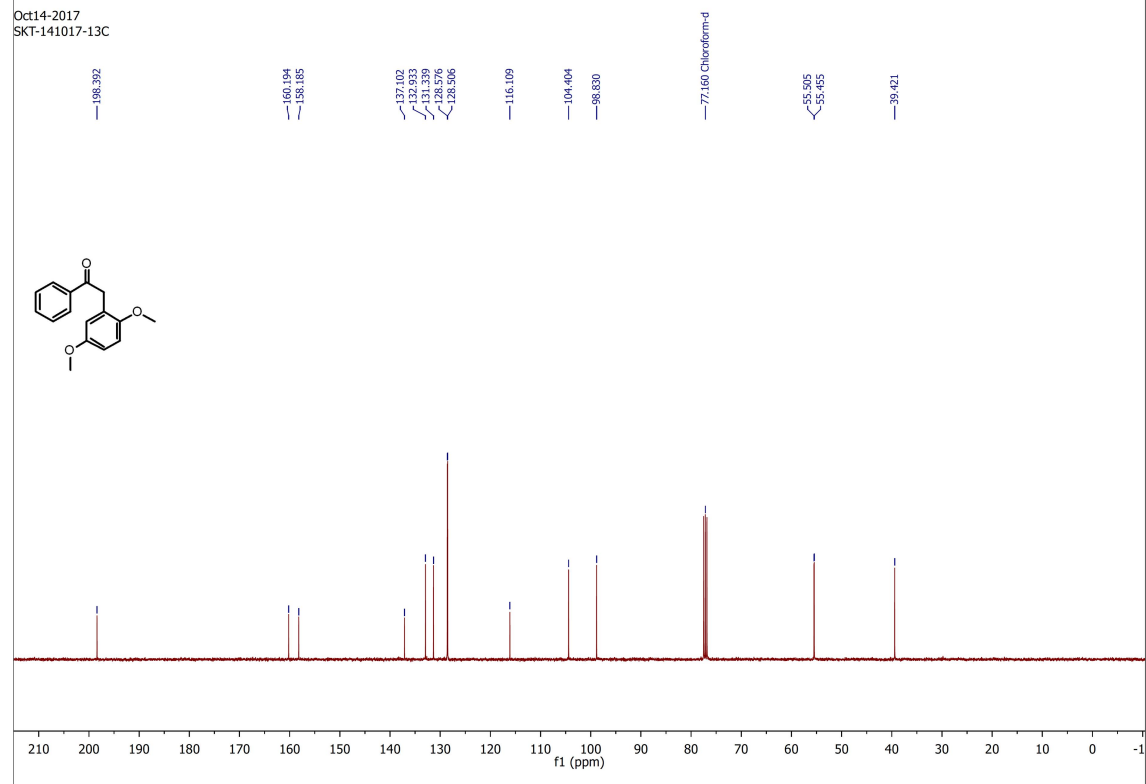


¹H and ¹³C spectra of (3ad)

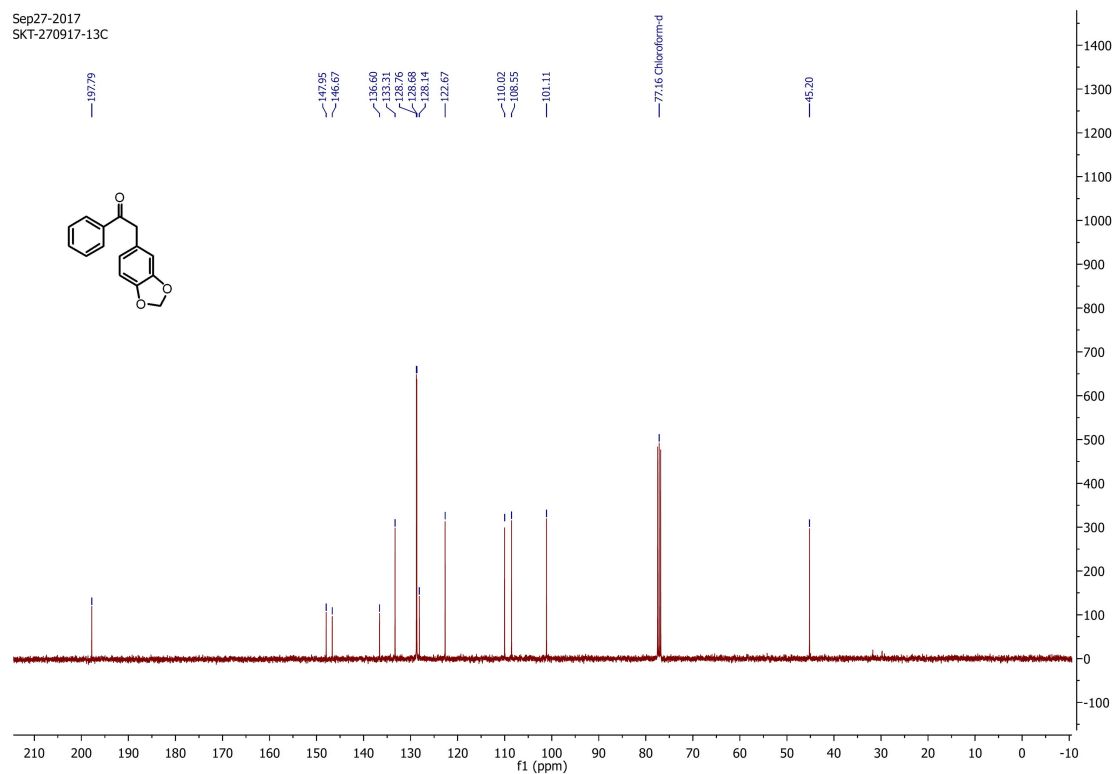
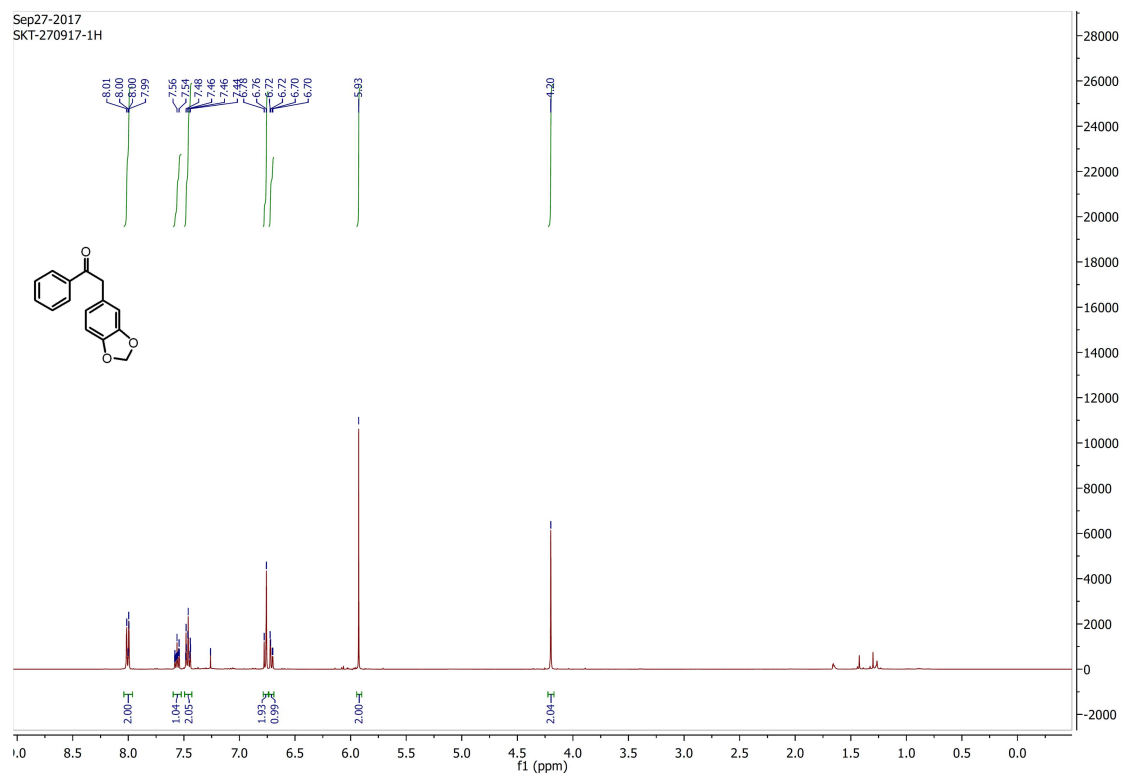
Oct14-2017
SKT-141017-1H



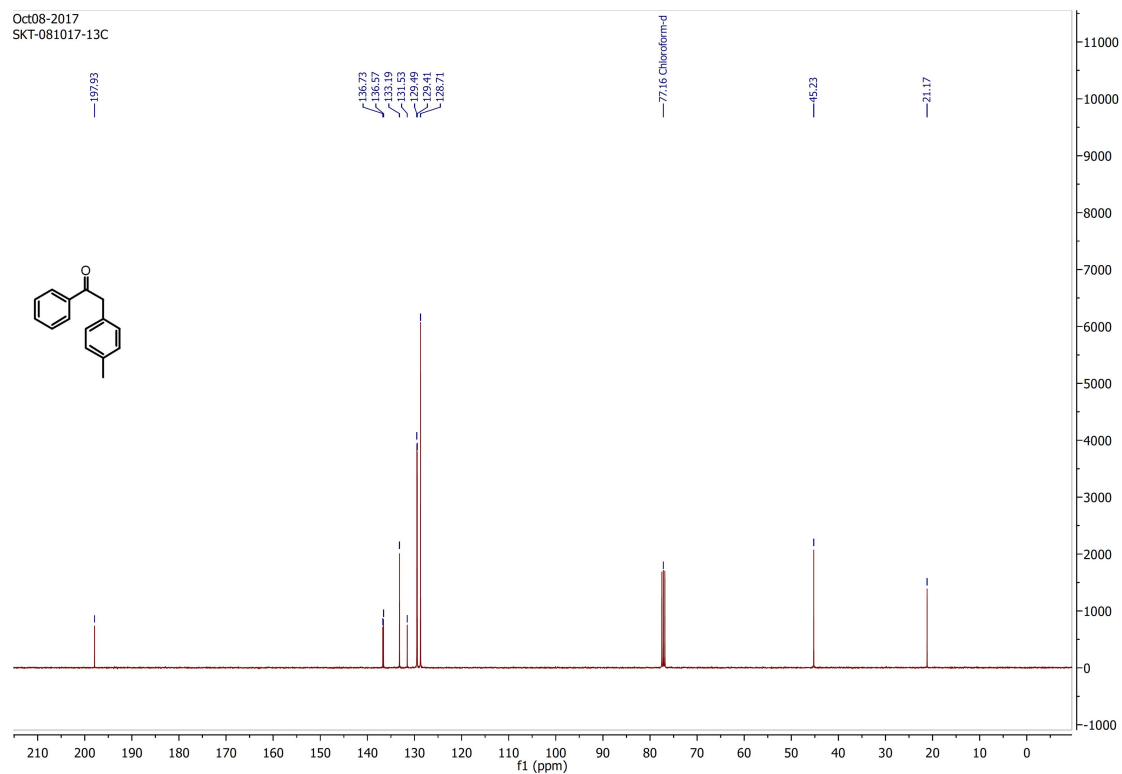
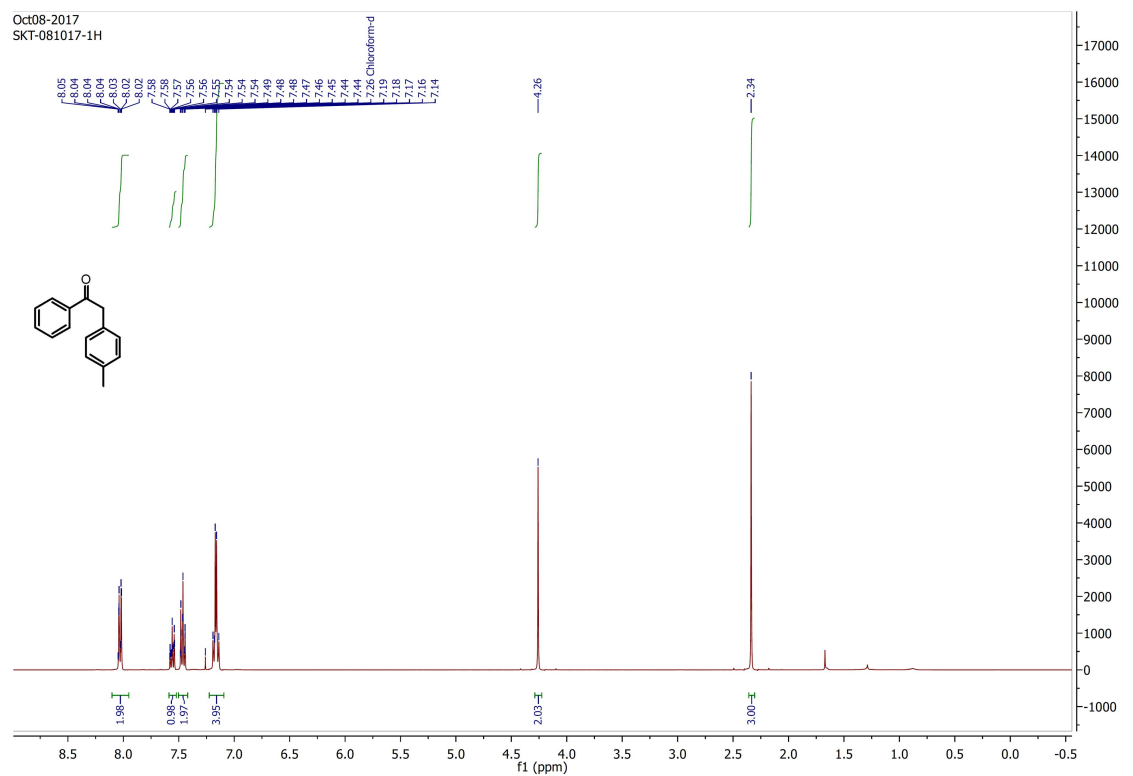
Oct14-2017
SKT-141017-13C



^1H and ^{13}C spectra of (3ae)

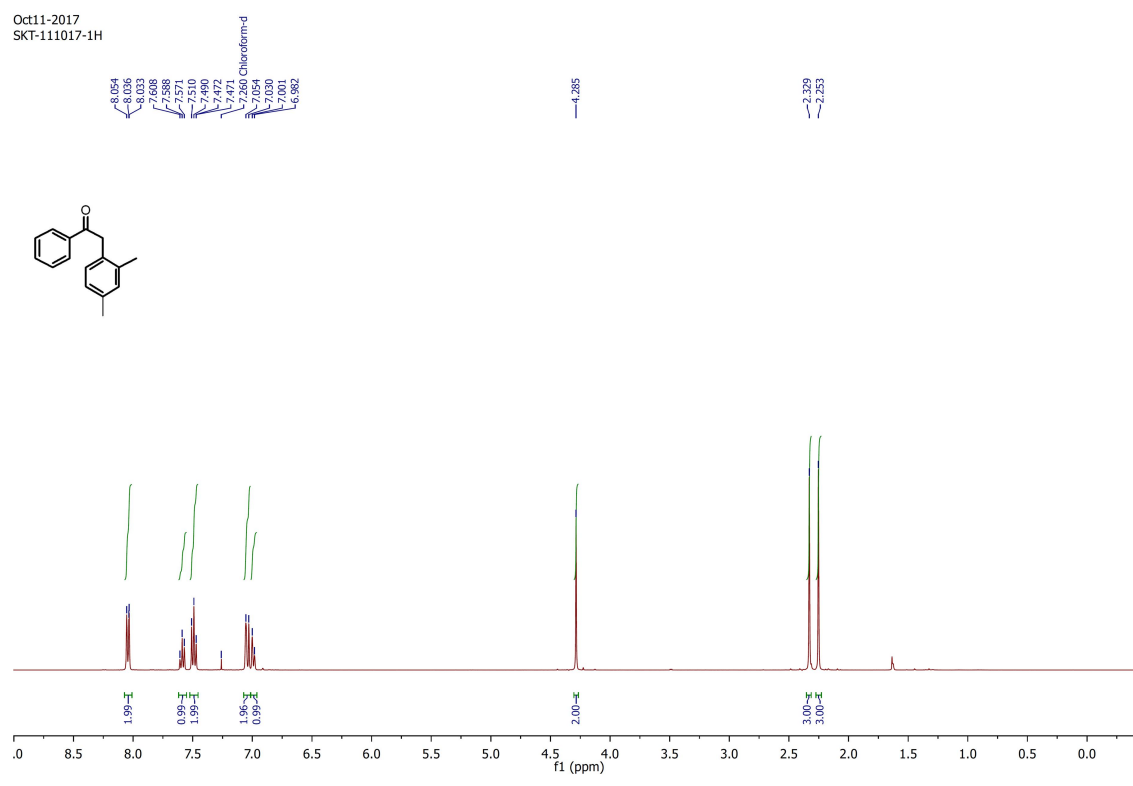


¹H and ¹³C spectra of (3af)

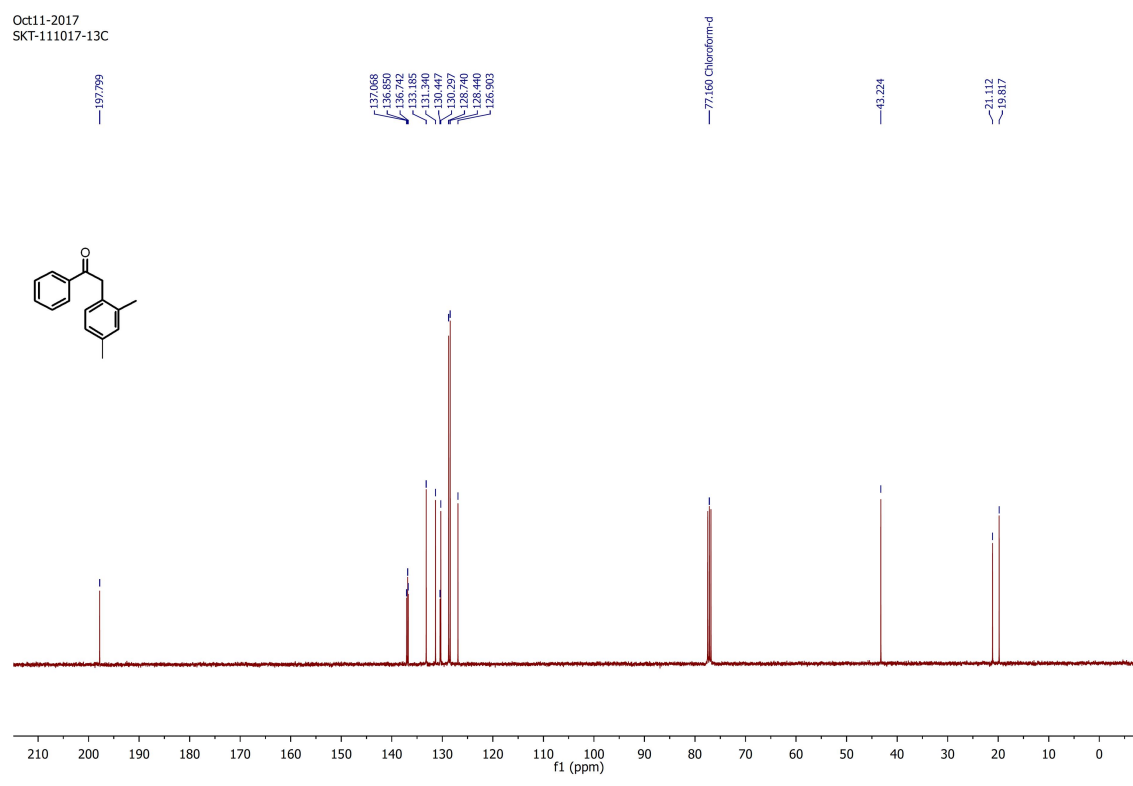


¹H and ¹³C spectra of (3ah)

Oct11-2017
SKT-111017-1H

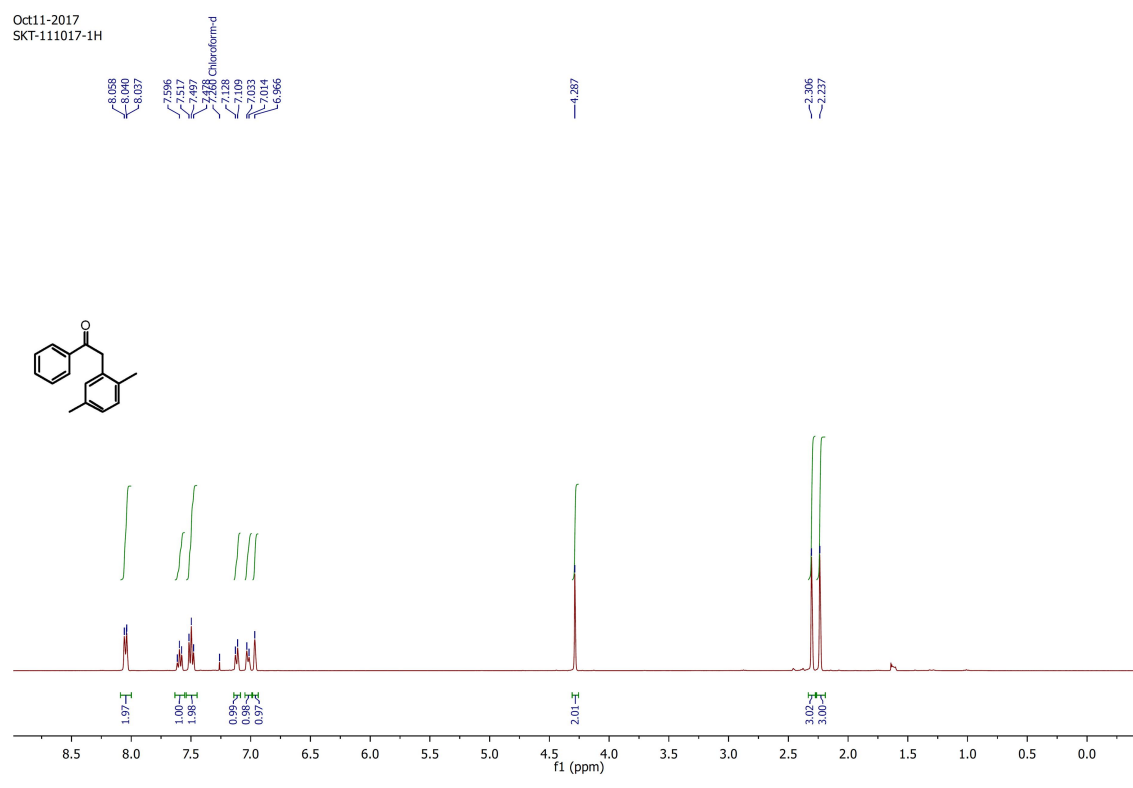


Oct11-2017
SKT-111017-13C

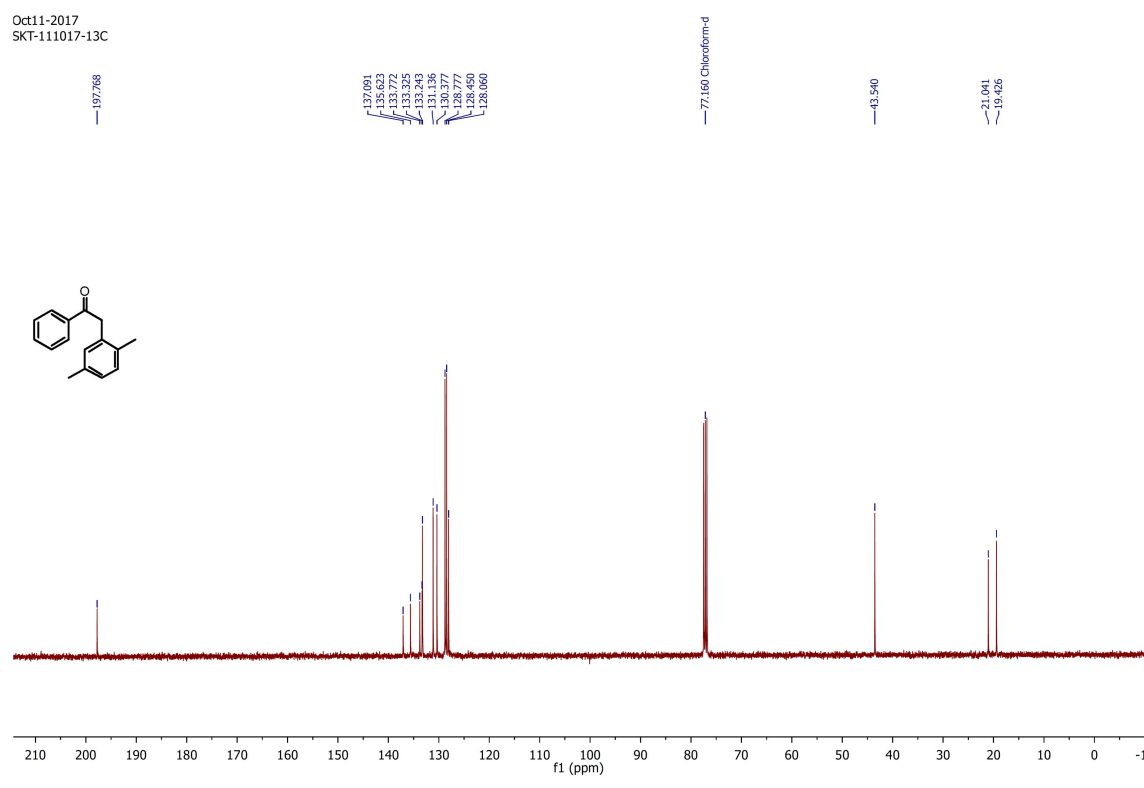


¹H and ¹³C spectra of (3ai)

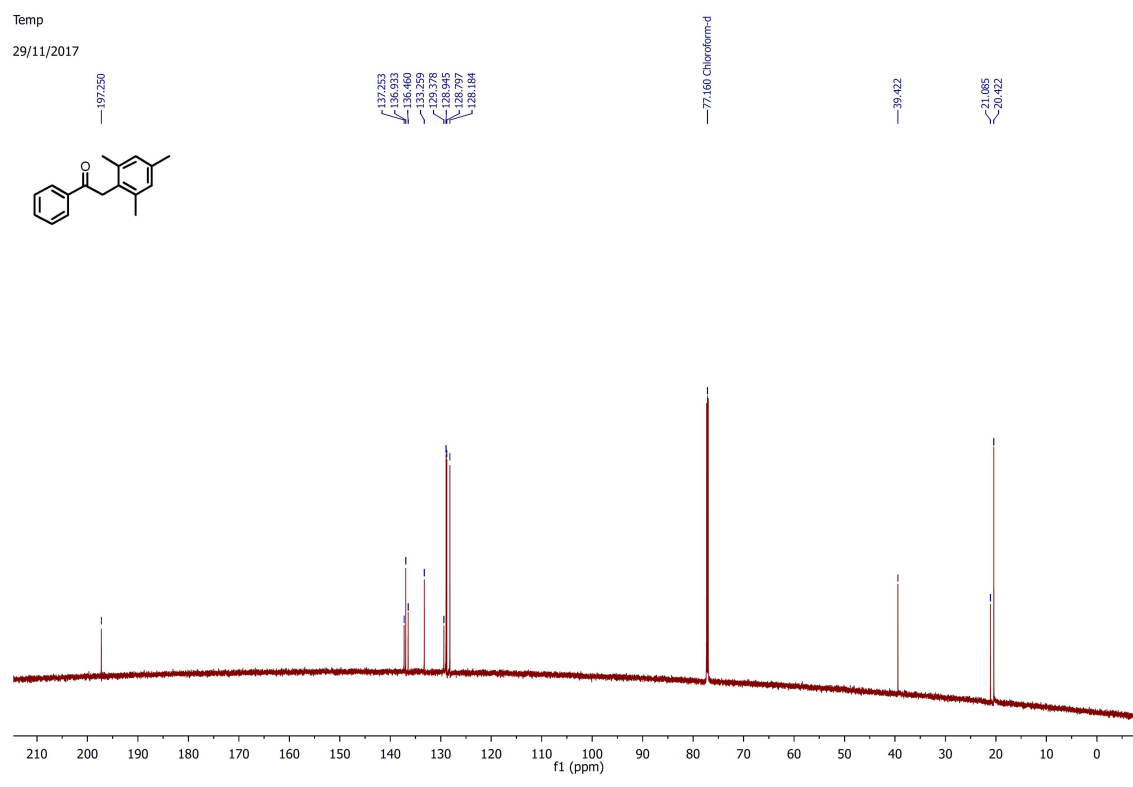
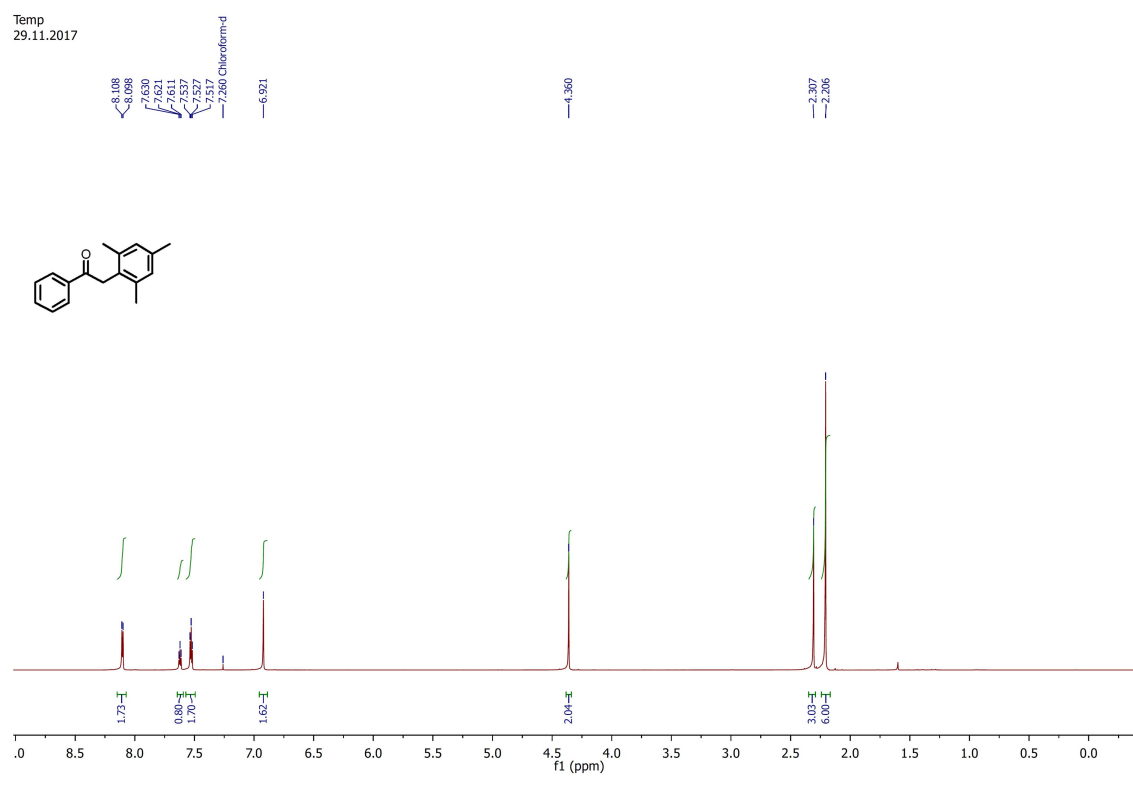
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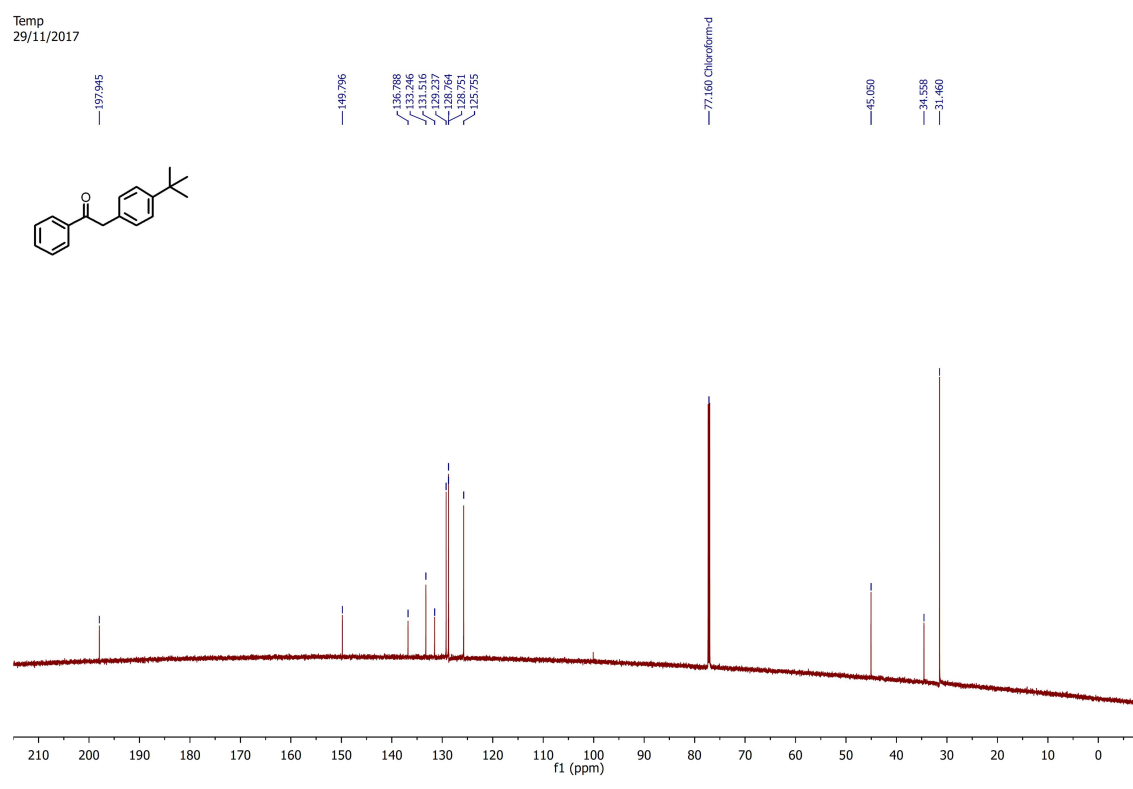
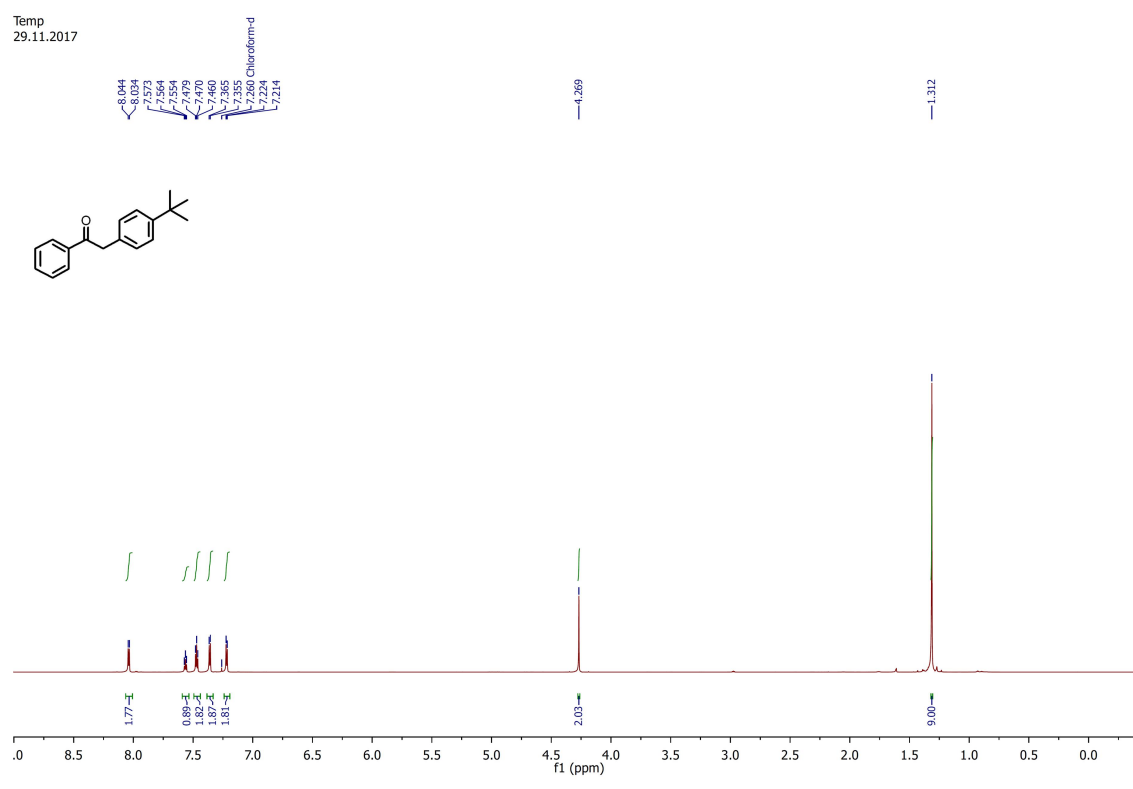
Oct11-2017
SKT-111017-13C



^1H and ^{13}C spectra of (3aj)

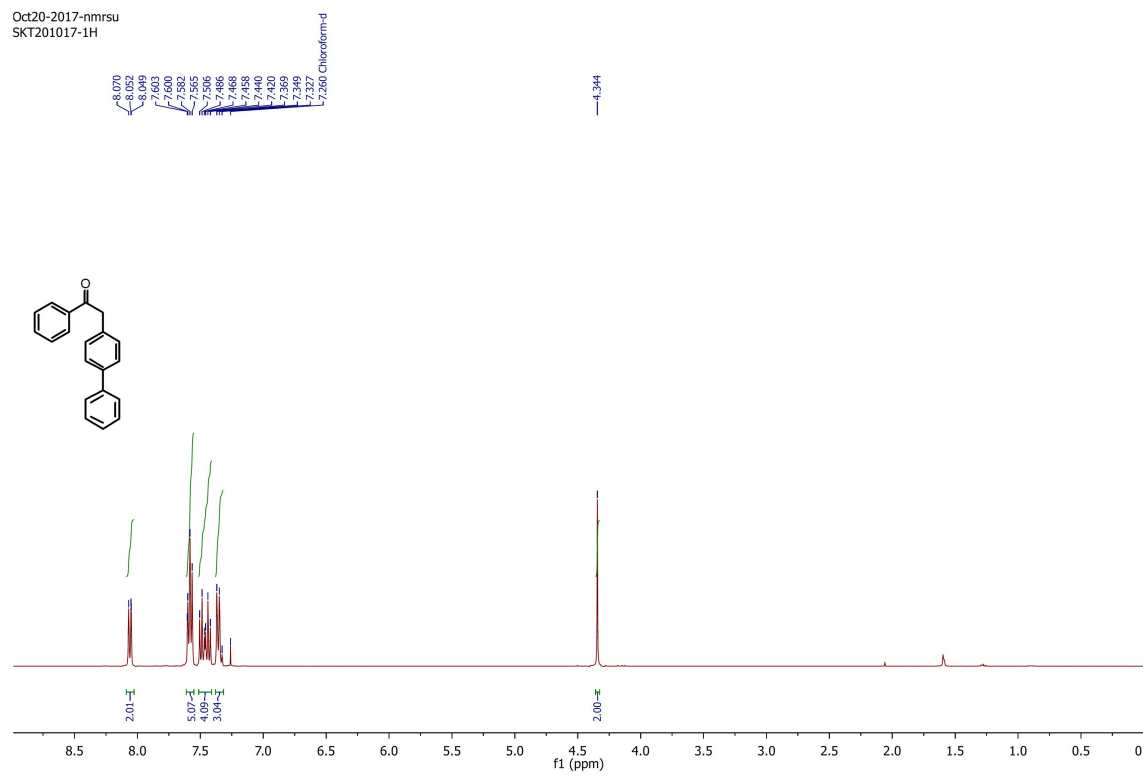


^1H and ^{13}C spectra of (3ak)

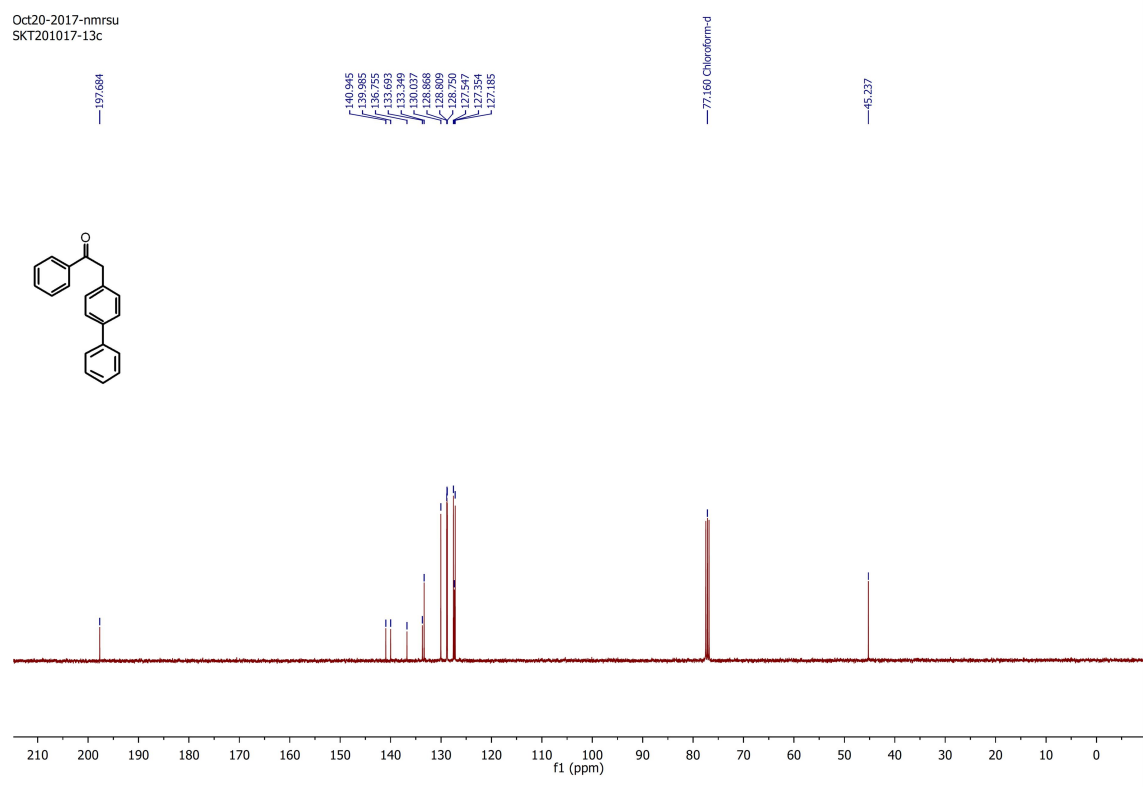


^1H and ^{13}C spectra of (3al)

Oct20-2017-nmrsu
SKT201017-1H

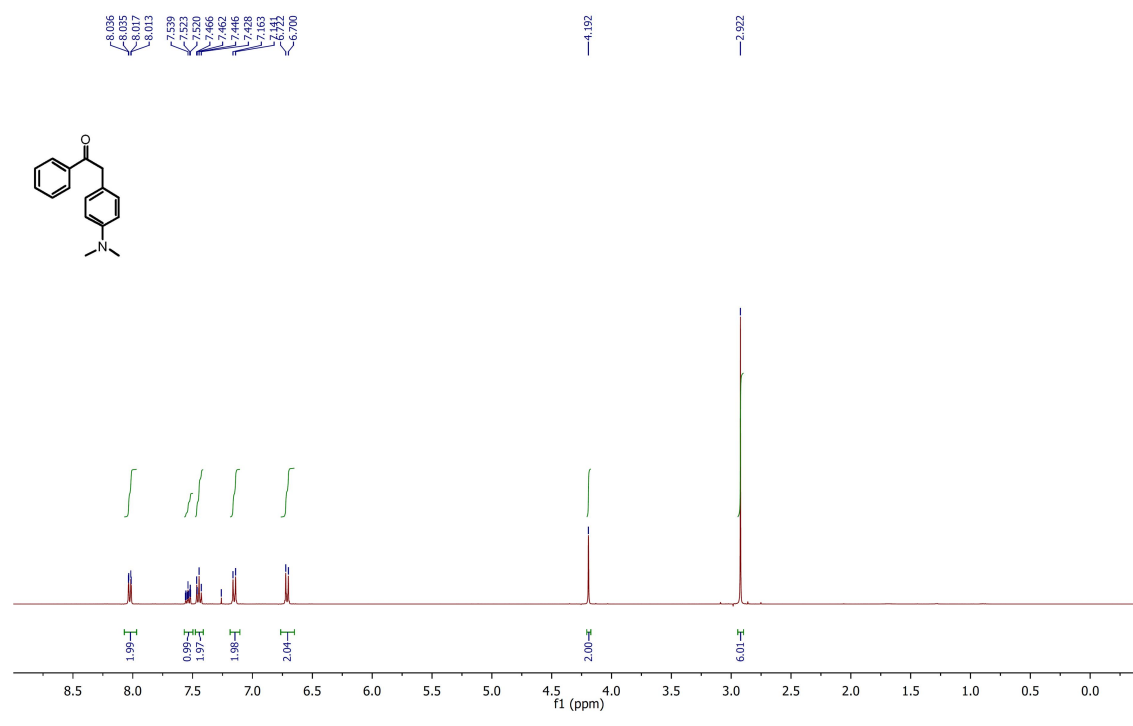


Oct20-2017-nmrsu
SKT201017-13c

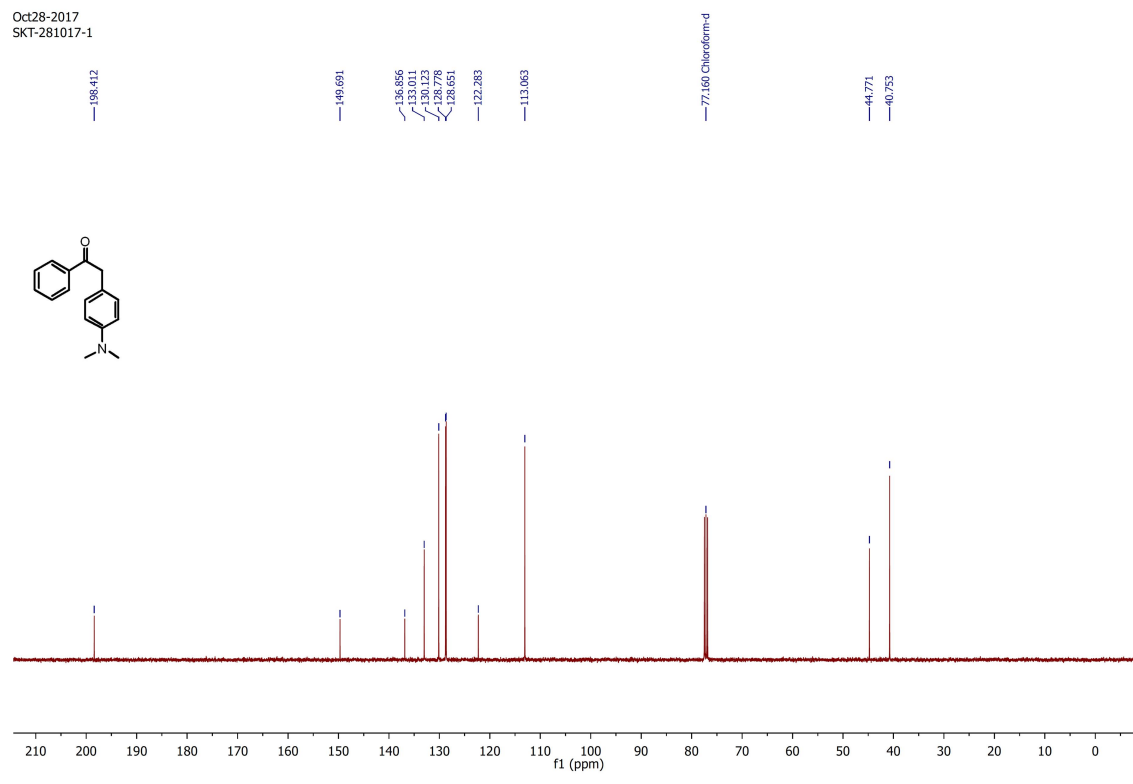


^1H and ^{13}C spectra of (3an)

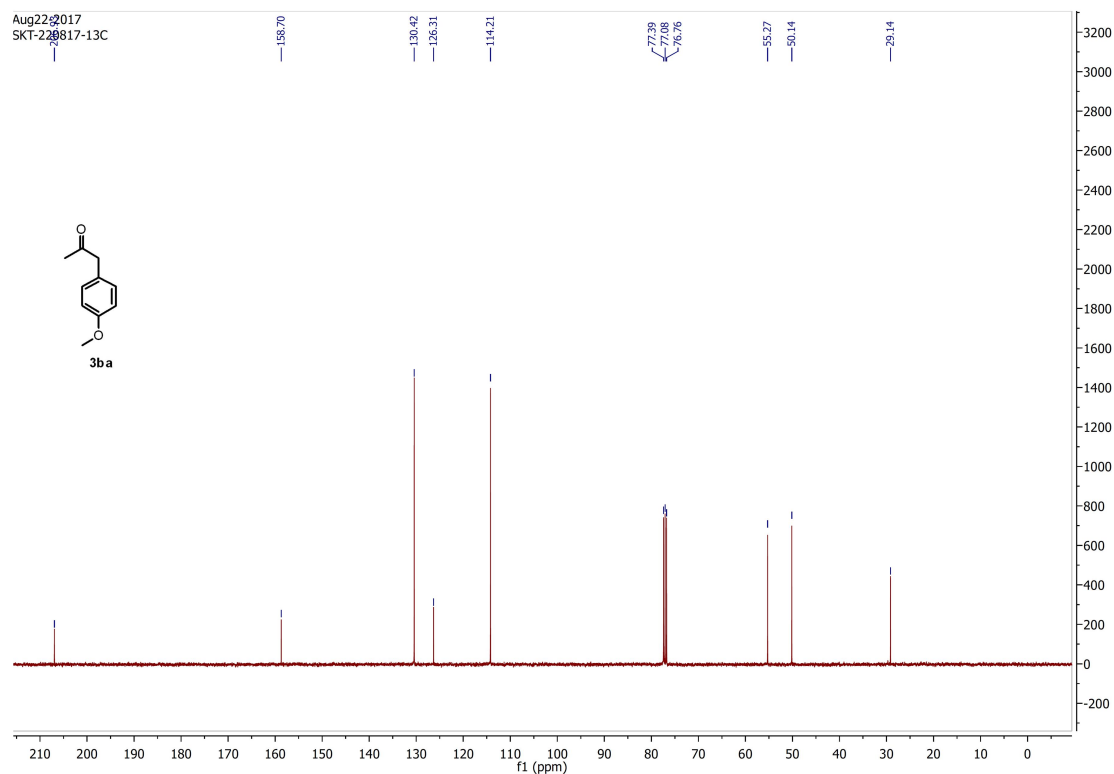
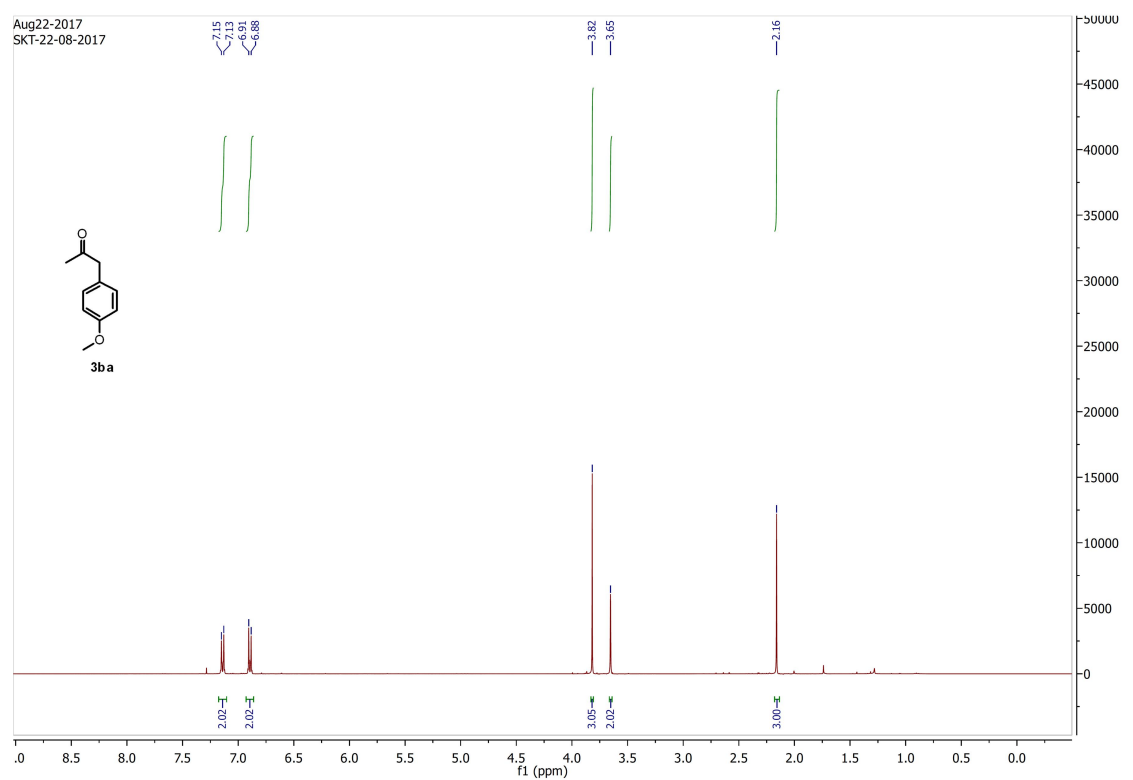
Oct28-2017
SKT-281017-1



Oct28-2017
SKT-281017-1

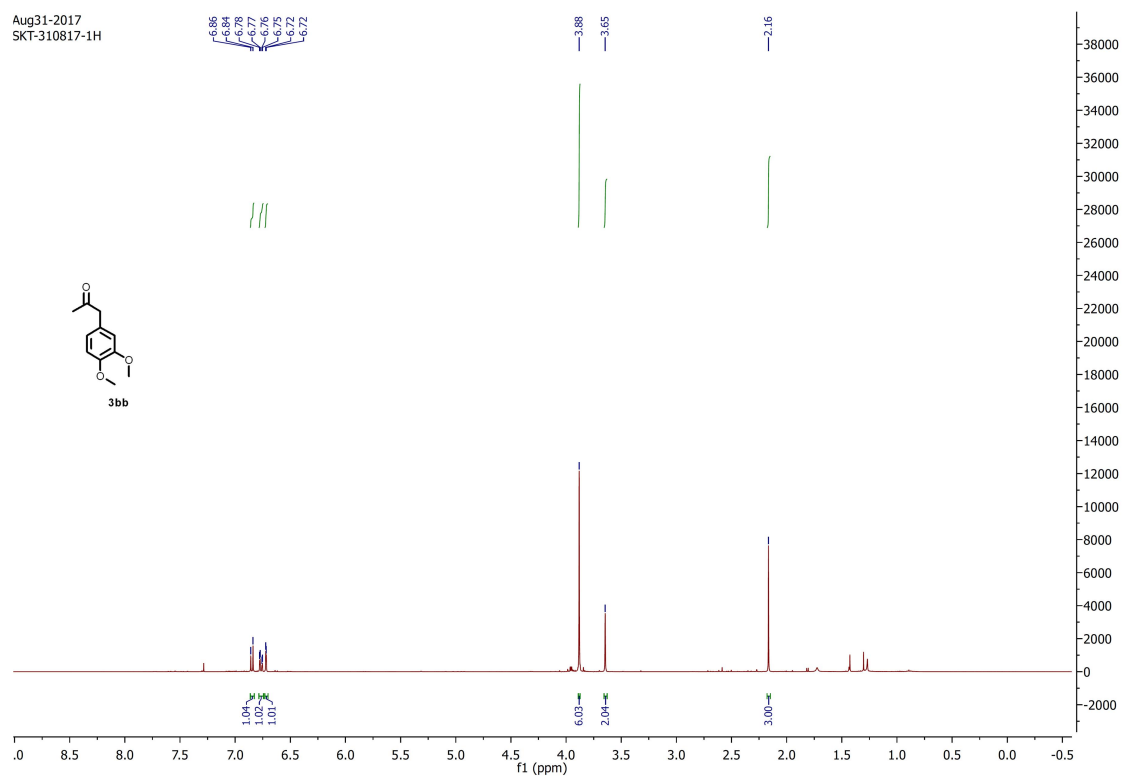


^1H and ^{13}C spectra of (3ba)

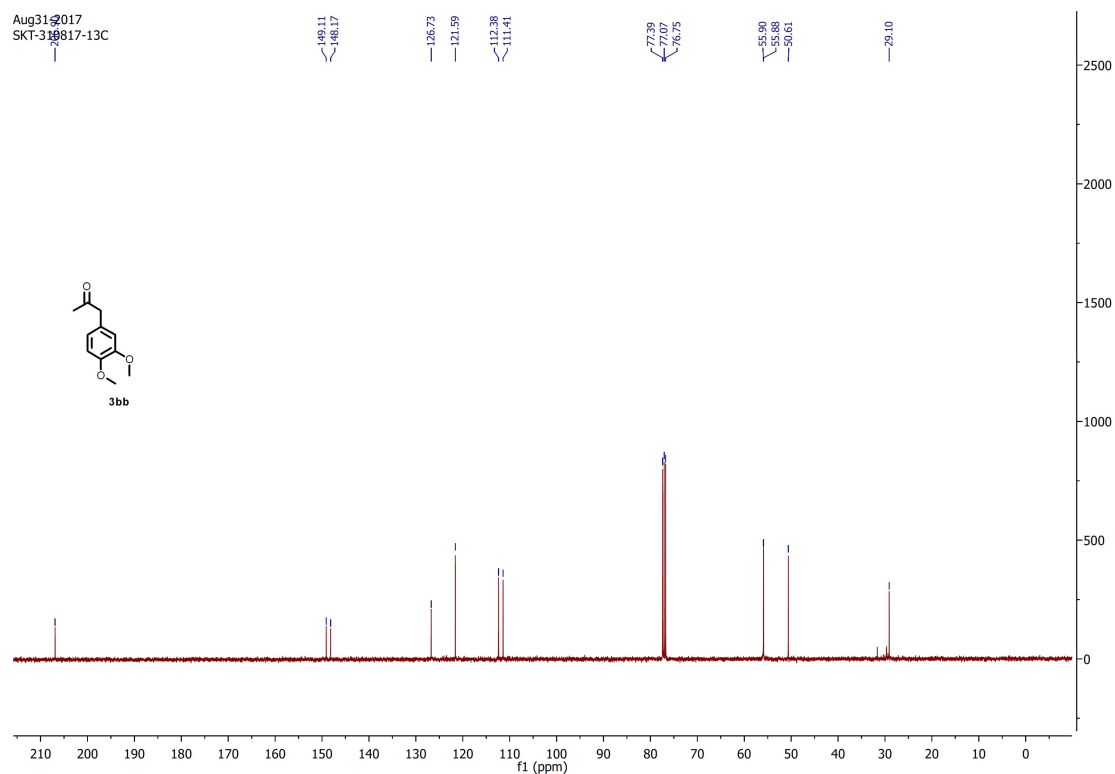


¹H and ¹³C spectra of (3bb)

Aug31-2017
SKT-310817-1H

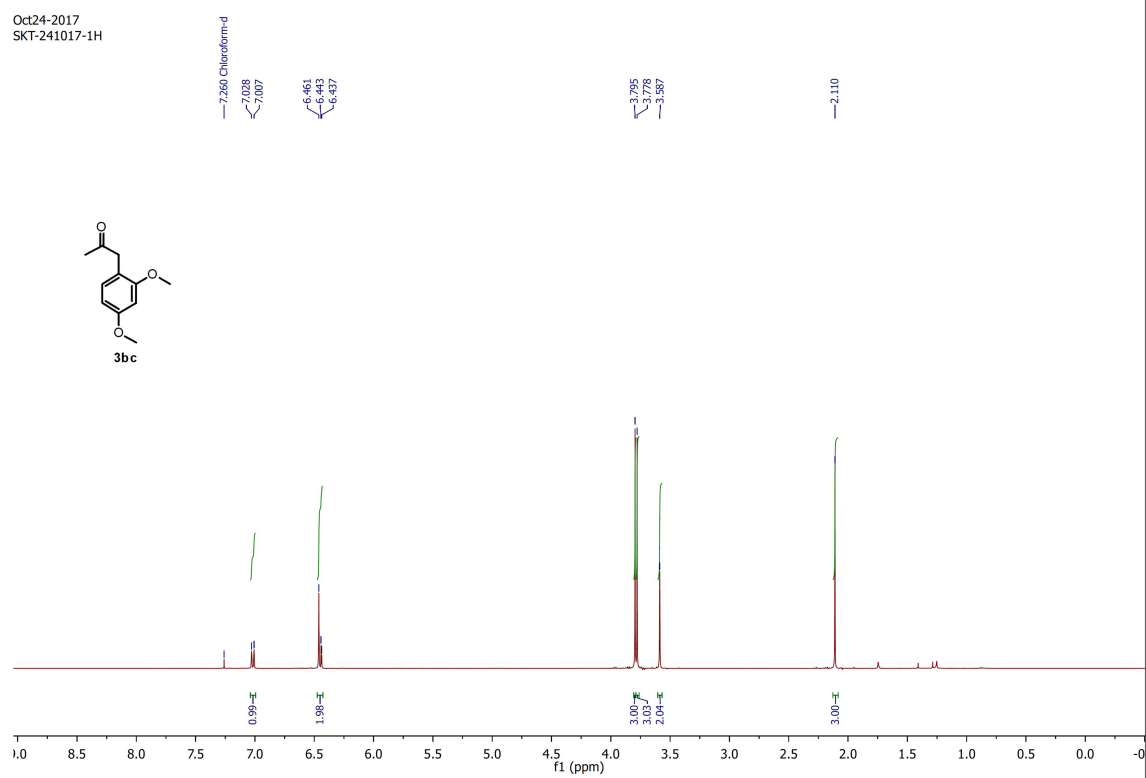


Aug31-2017
SKT-310817-13C

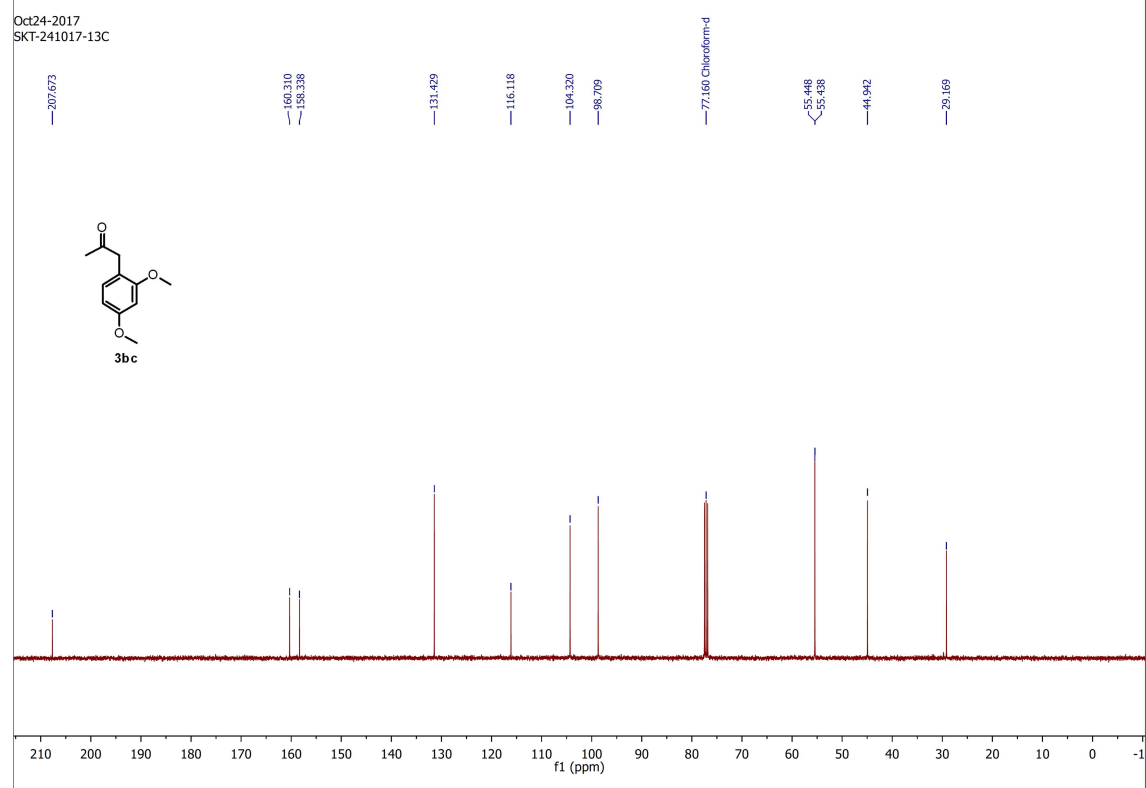


^1H and ^{13}C spectra of (3bc)

Oct24-2017
SKT-241017-1H

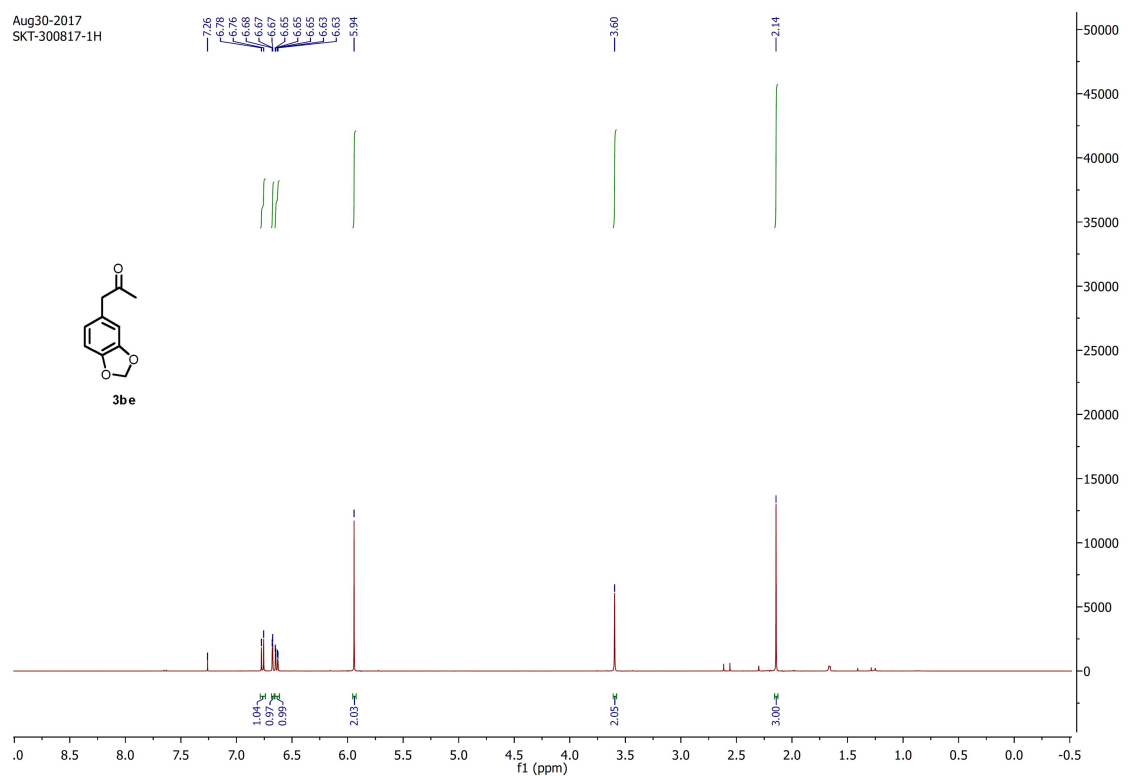


Oct24-2017
SKT-241017-13C

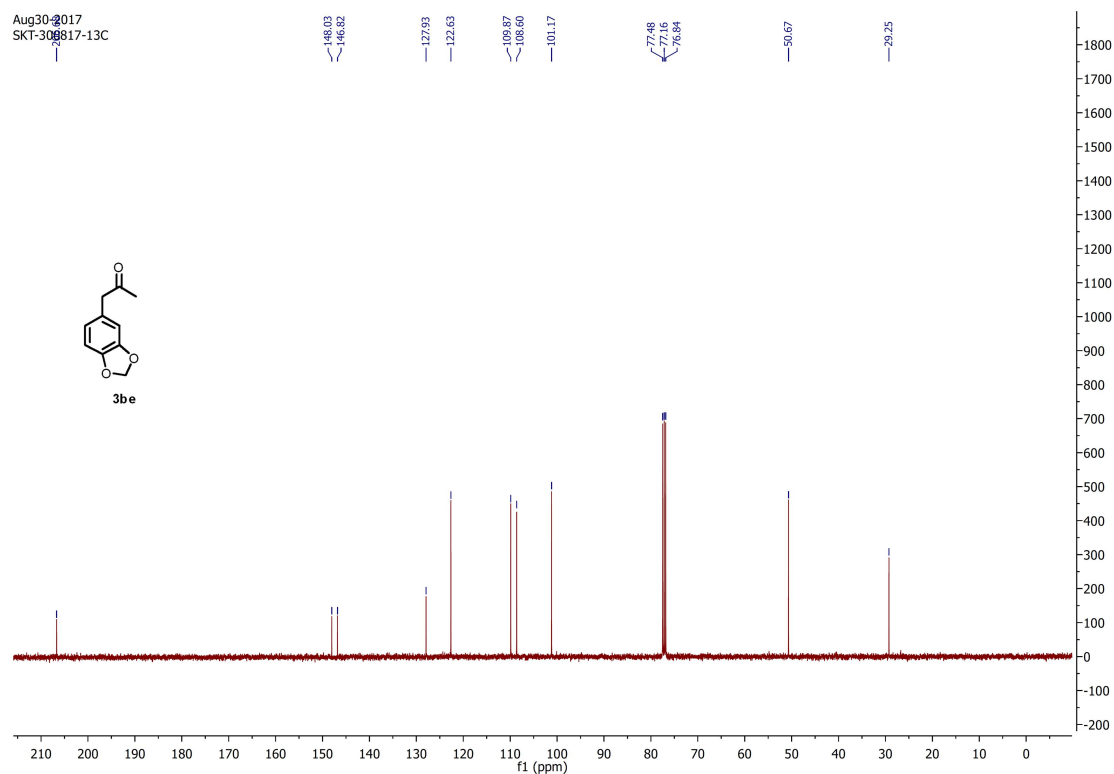


^1H and ^{13}C spectra of (3be)

Aug30-2017
SKT-300817-1H

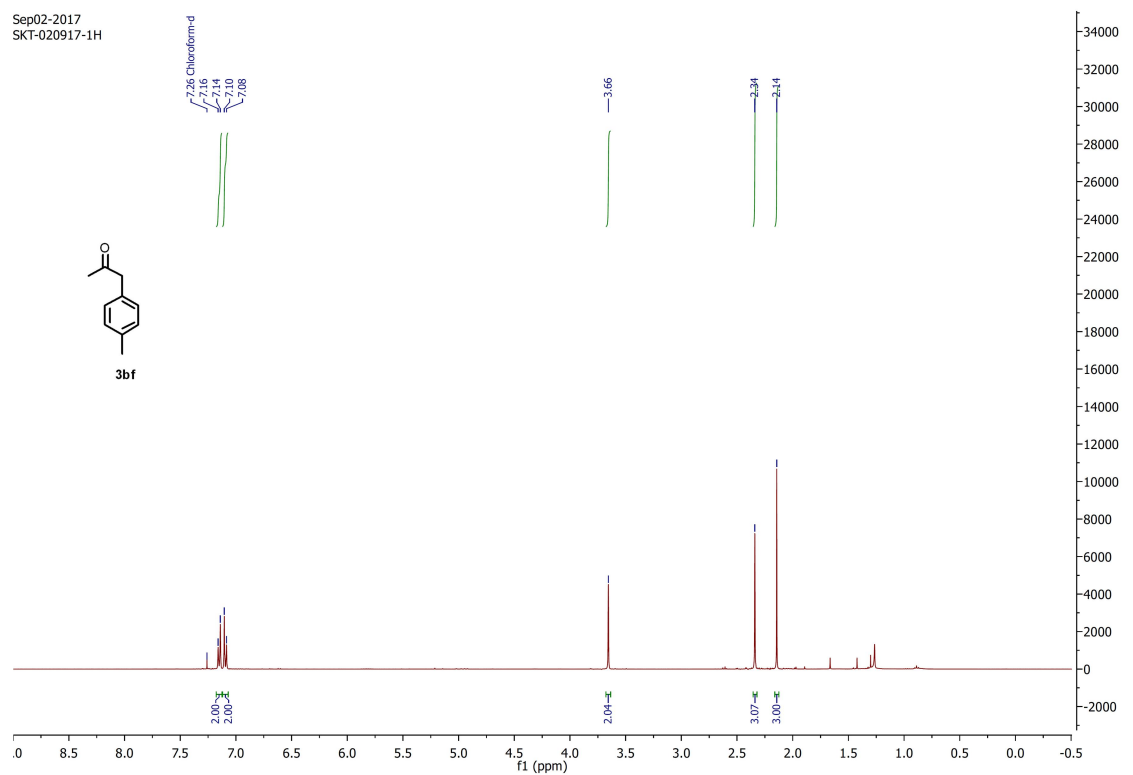


Aug30-2017
SKT-300817-13C

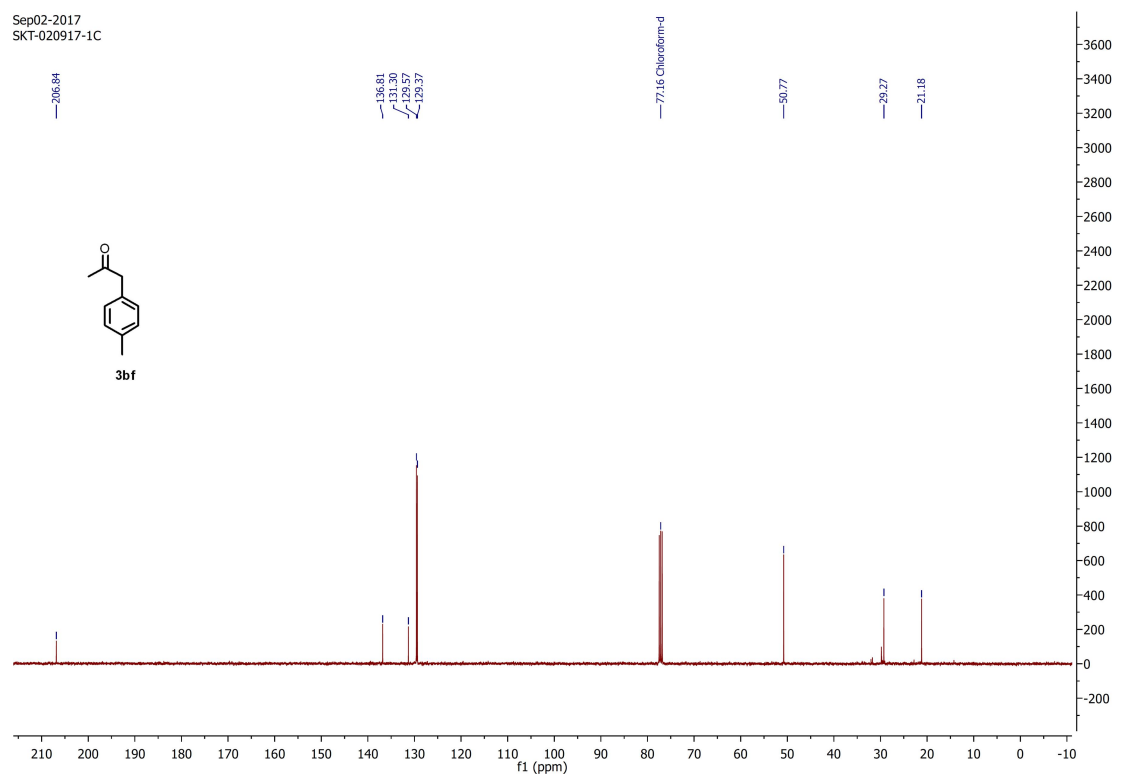


^1H and ^{13}C spectra of (3bf)

Sep02-2017
SKT-020917-1H

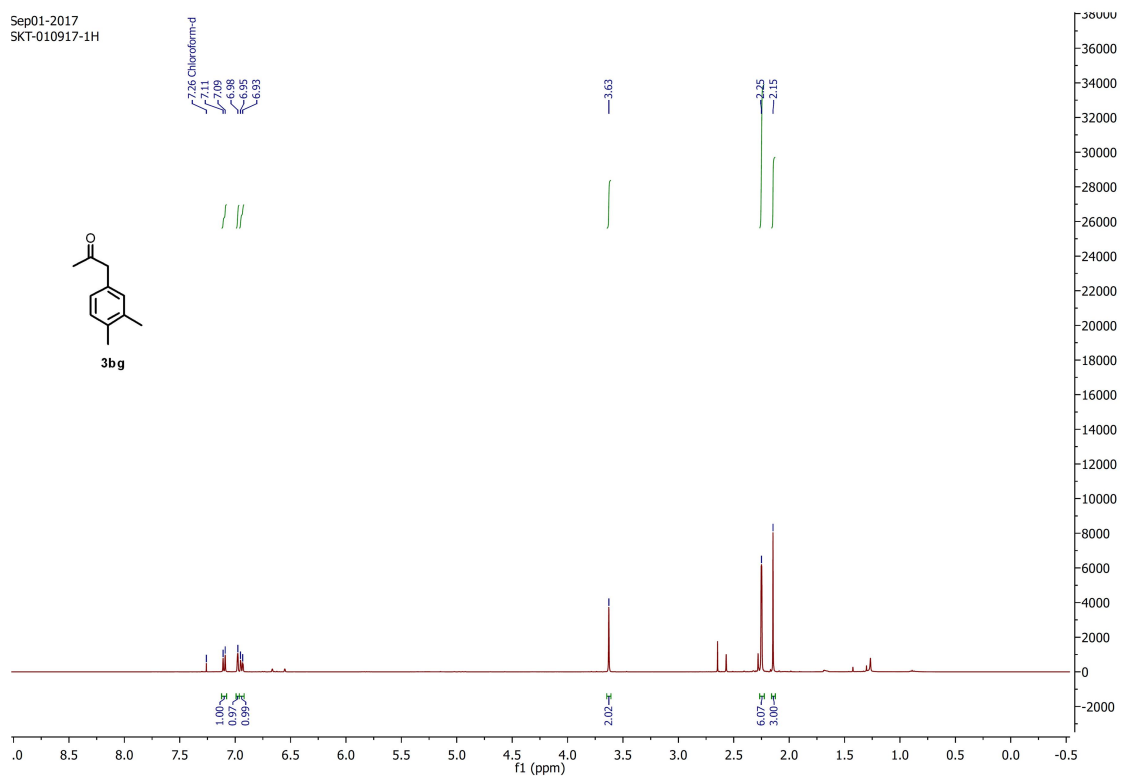


Sep02-2017
SKT-020917-1C

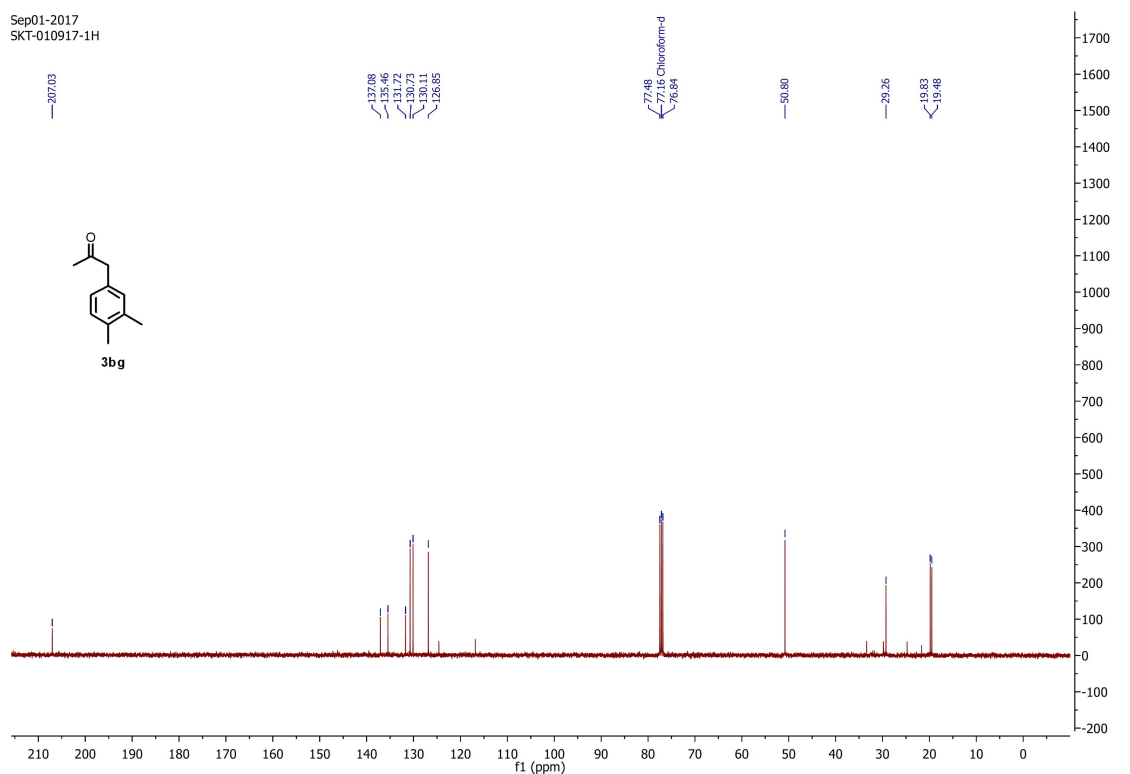


^1H and ^{13}C spectra of (3bg)

Sep01-2017
SKT-010917-1H

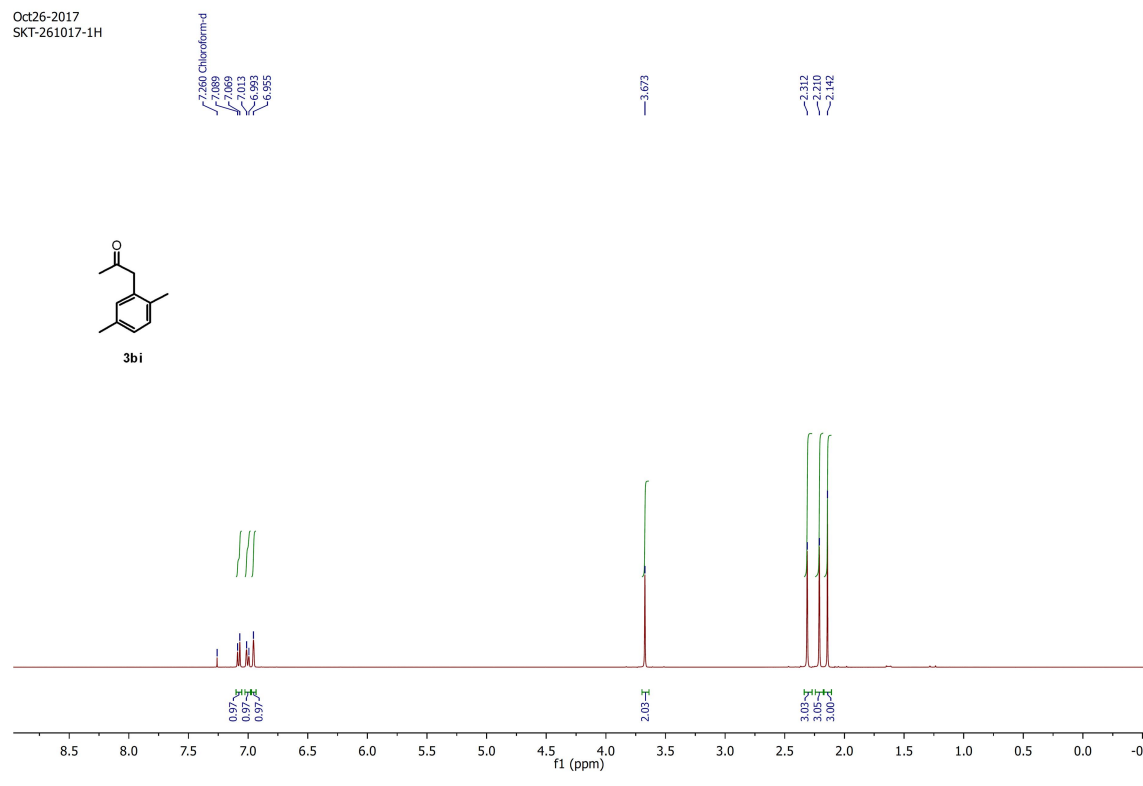


Sep01-2017
SKT-010917-1H

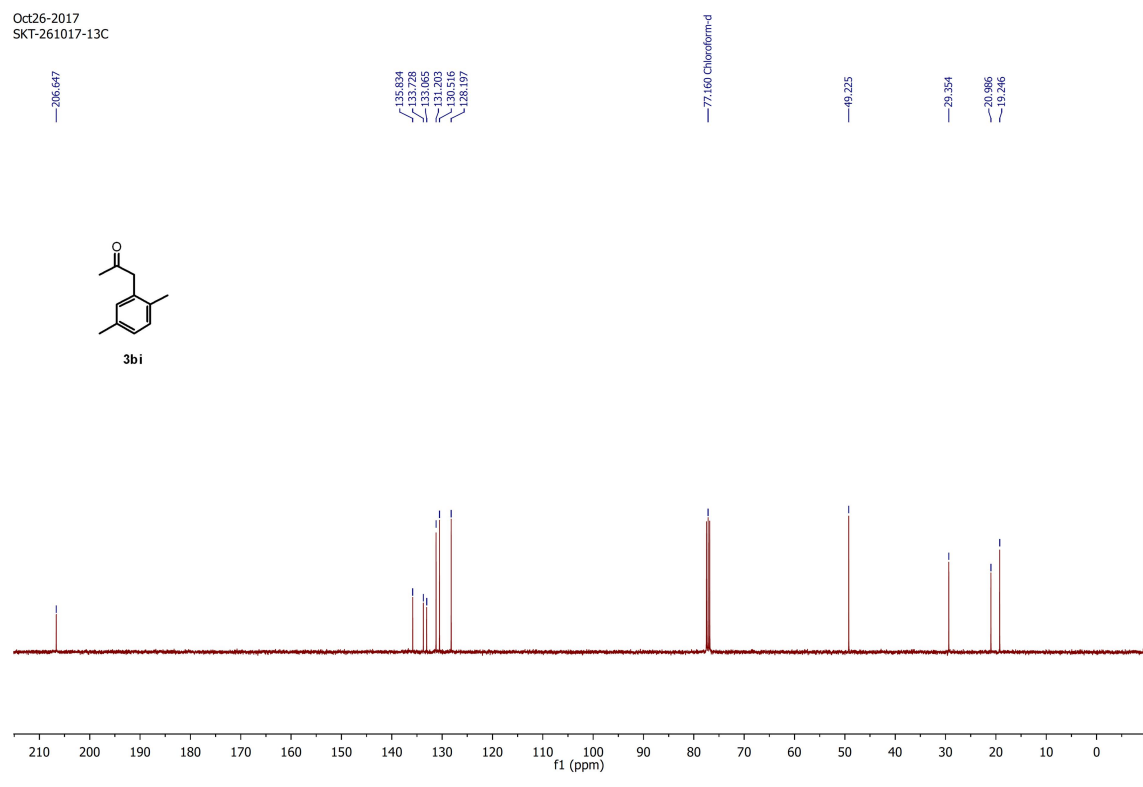


^1H and ^{13}C spectra of (3bi)

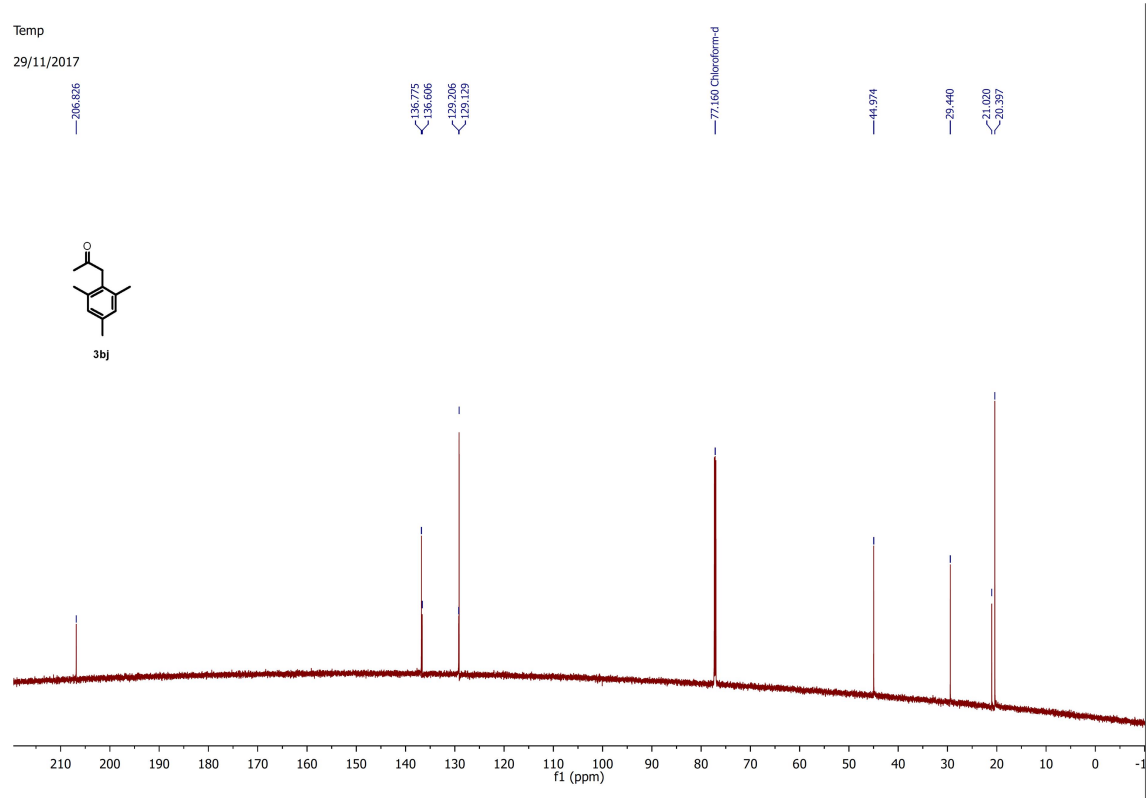
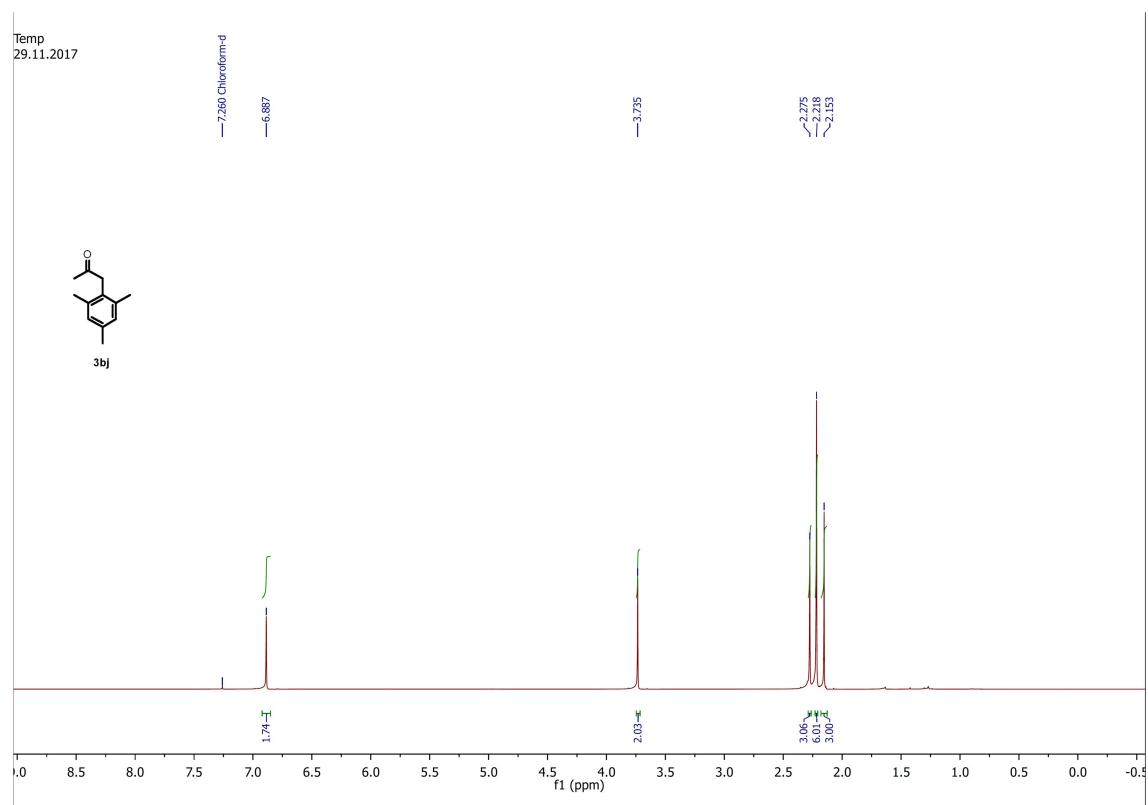
Oct26-2017
SKT-261017-1H



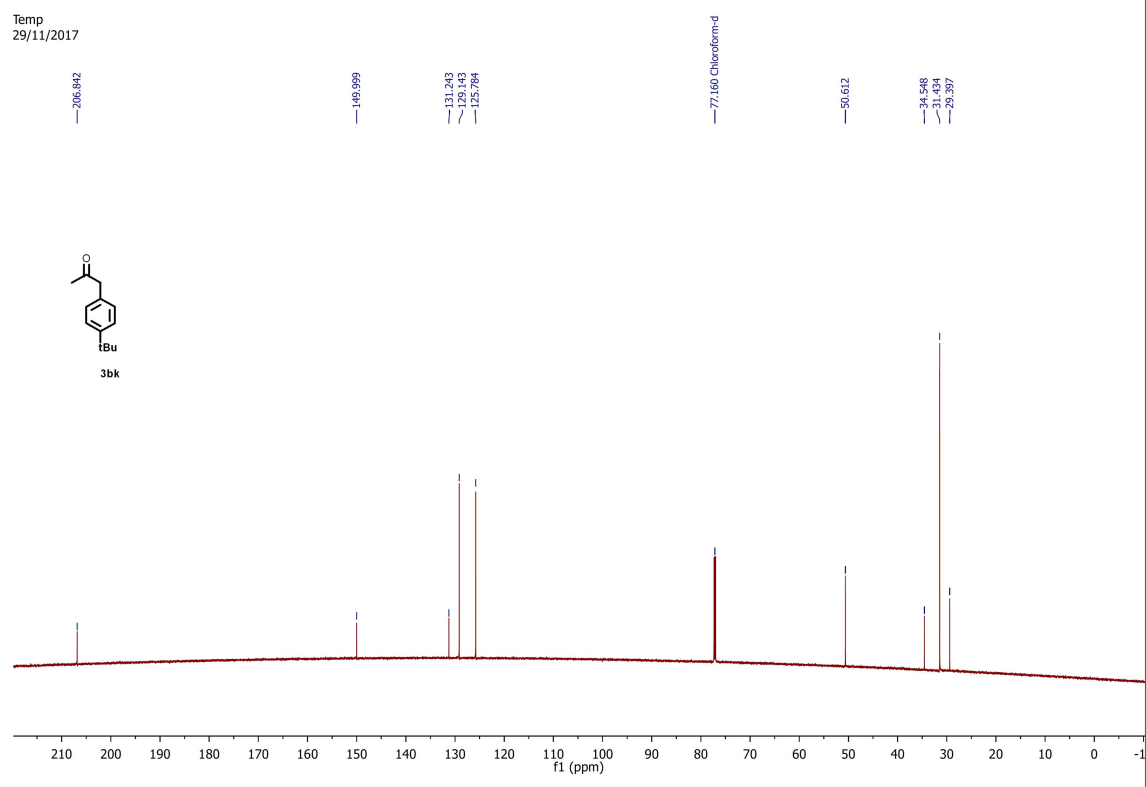
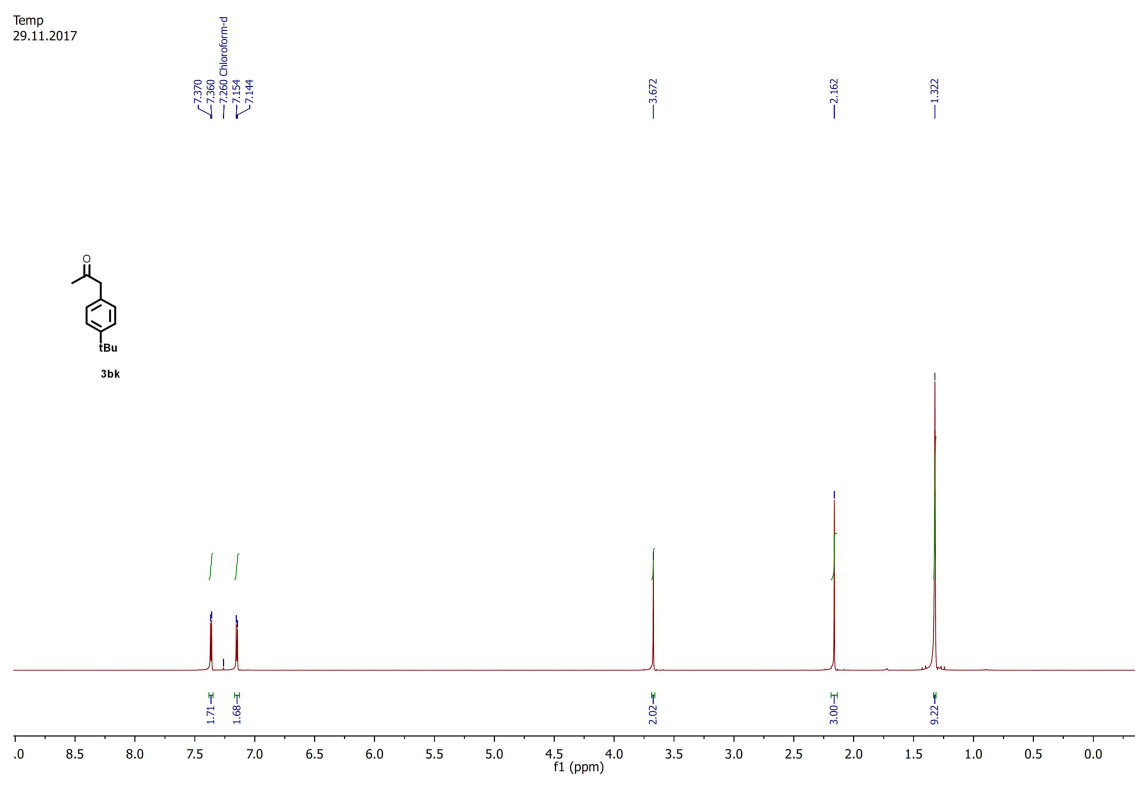
Oct26-2017
SKT-261017-13C



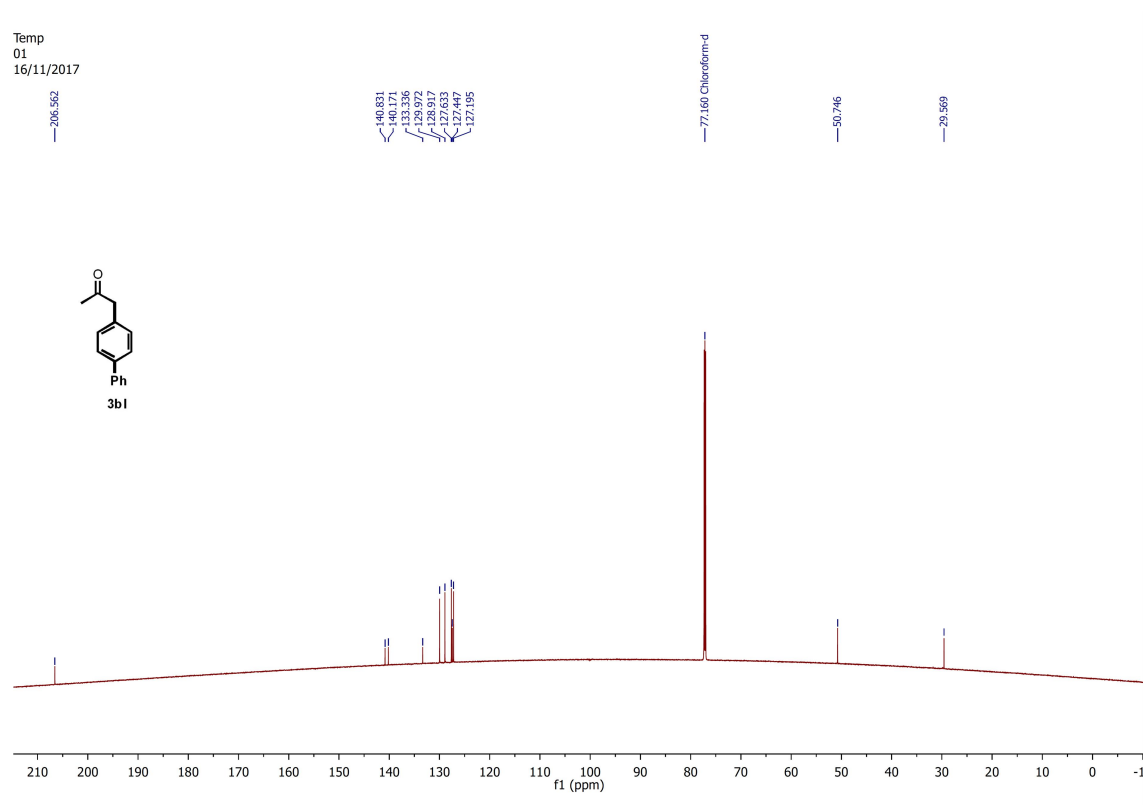
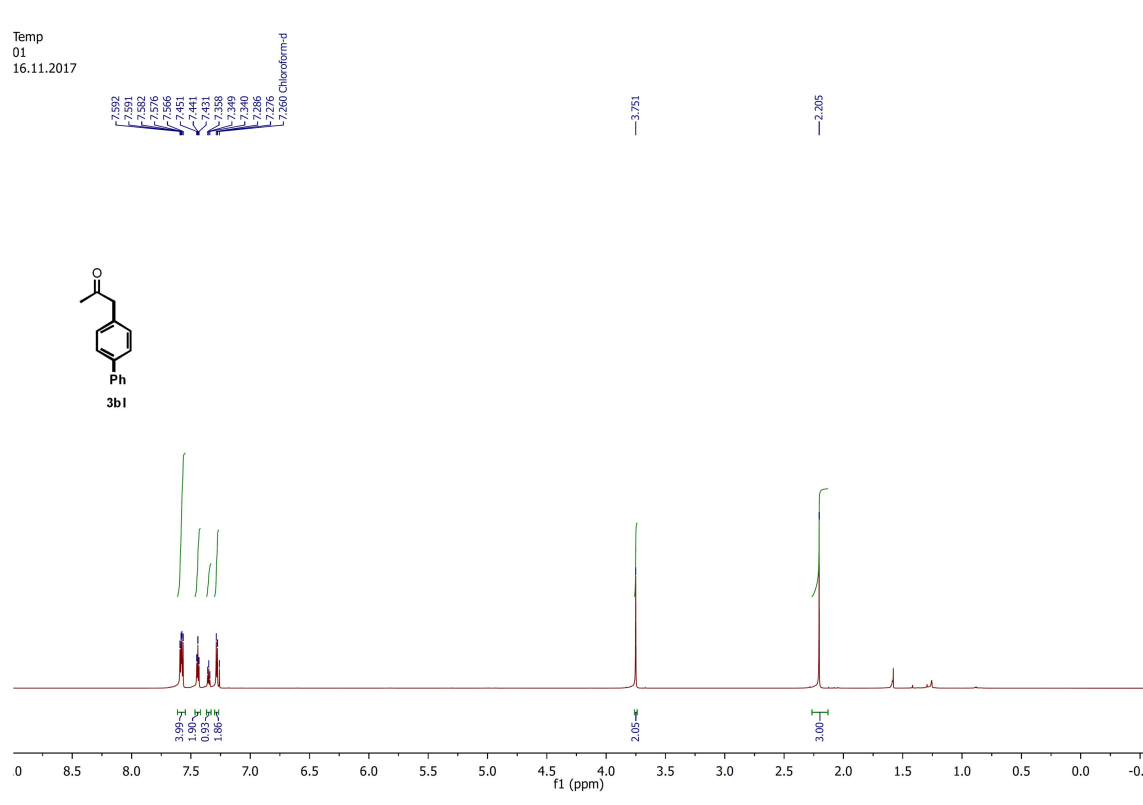
¹H and ¹³C spectra of (3bj)



^1H and ^{13}C spectra of (3bk)

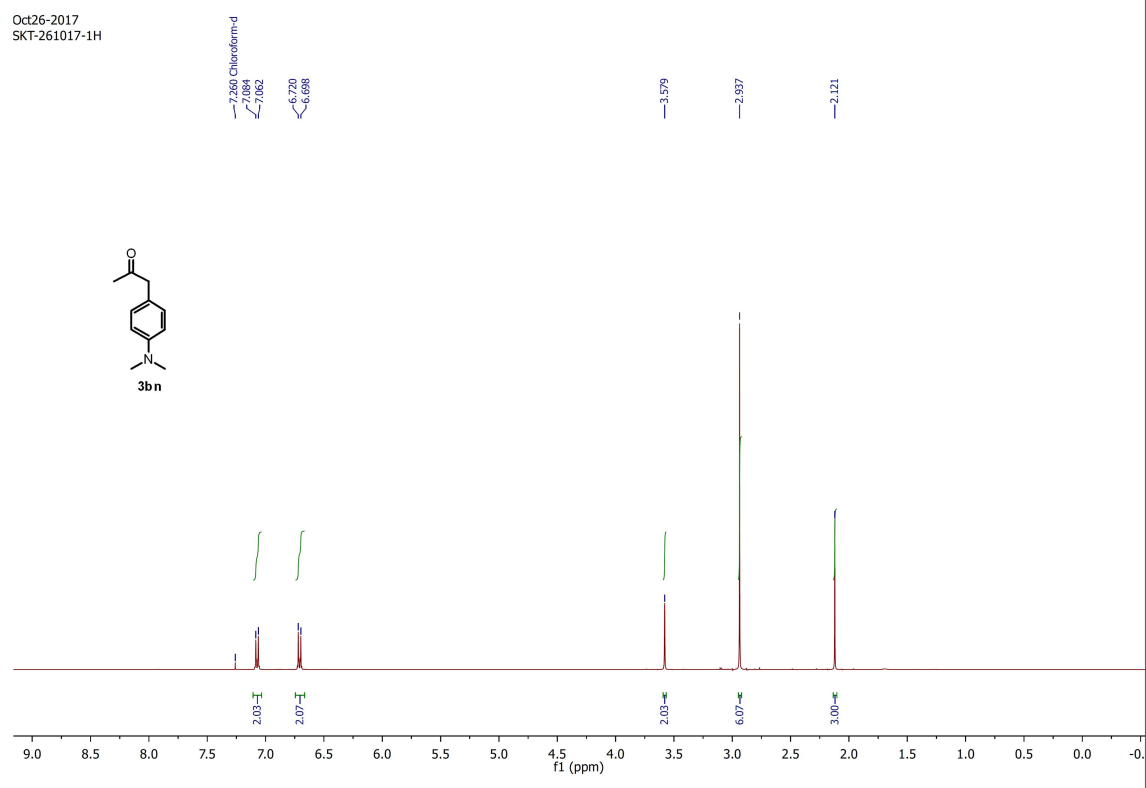


¹H and ¹³C spectra of (3bl)

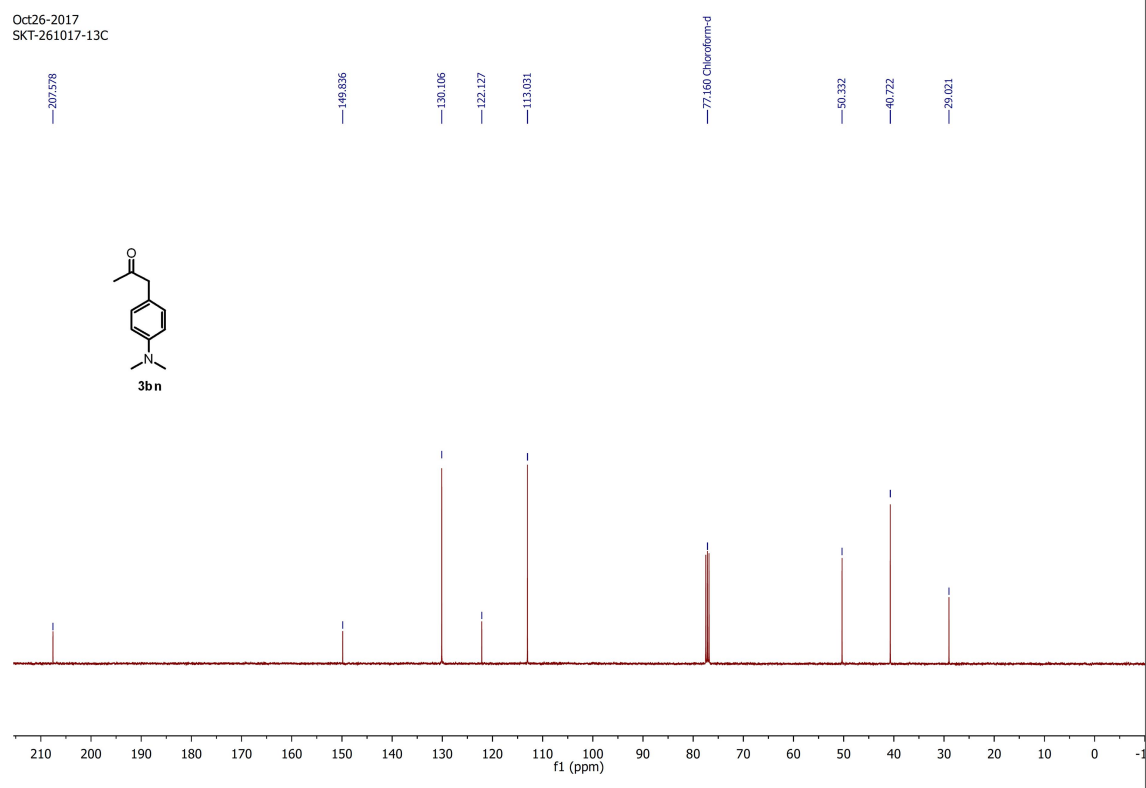


¹H and ¹³C spectra of (3bn)

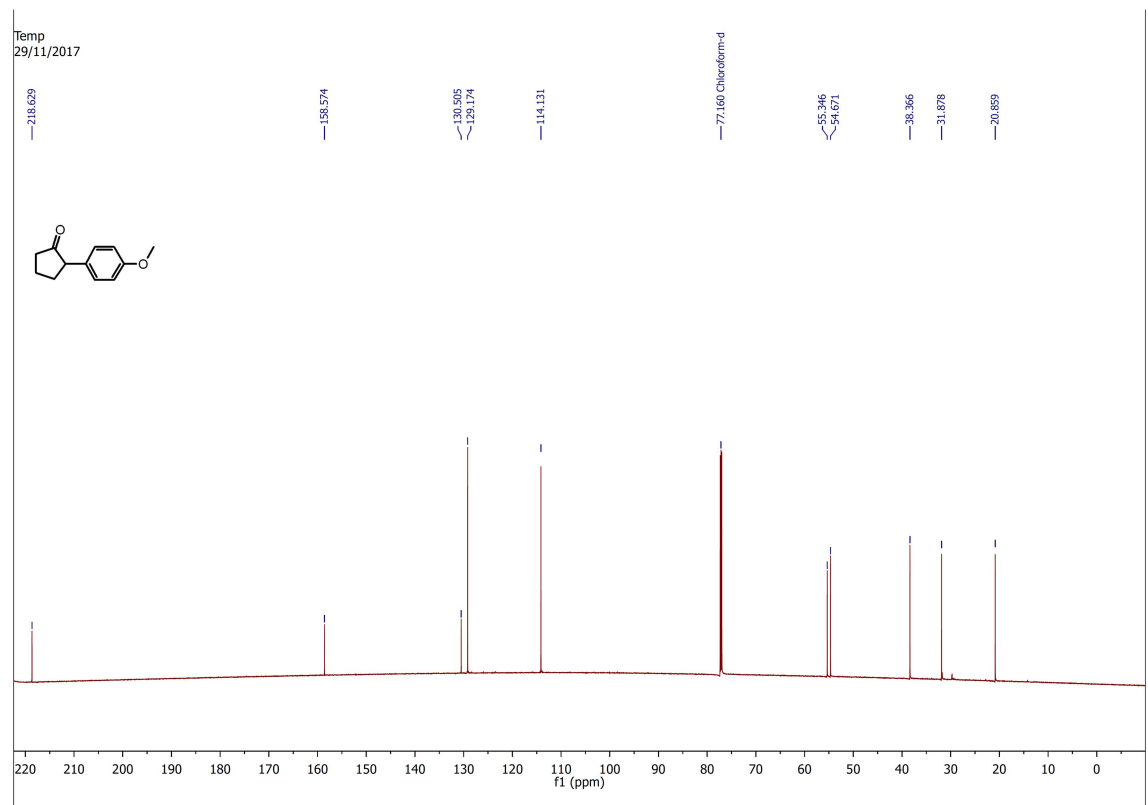
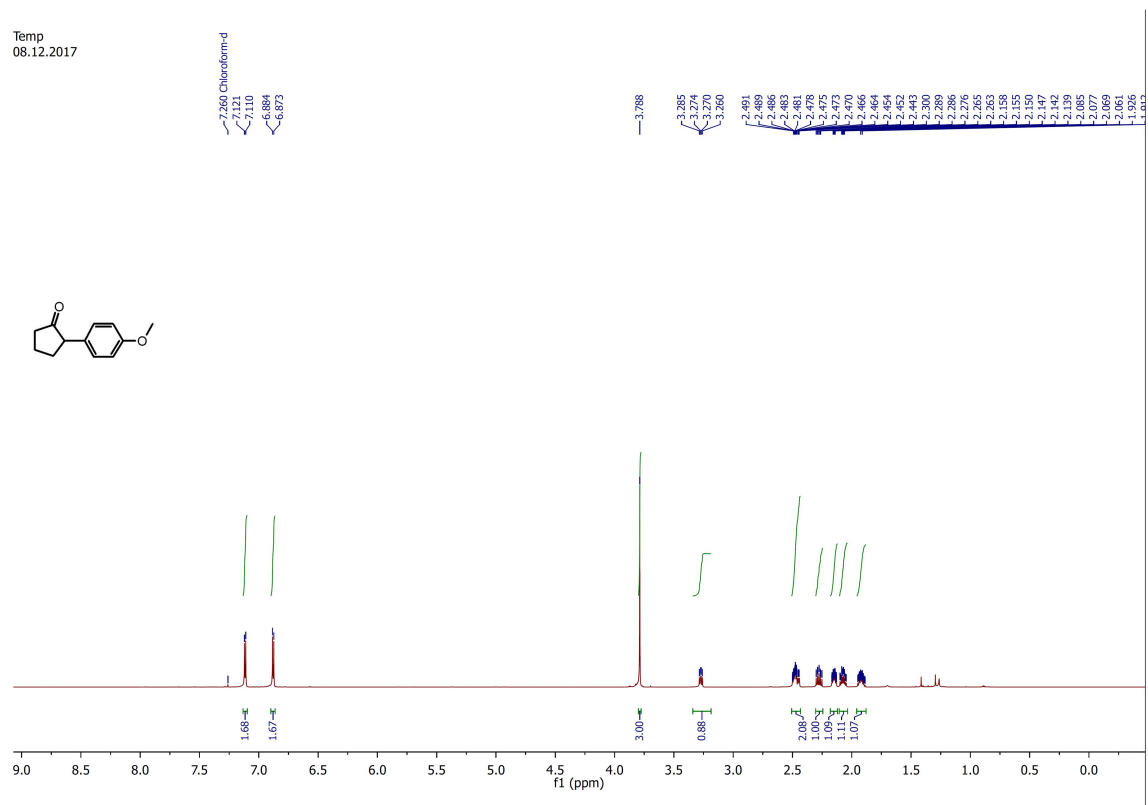
Oct26-2017
SKT-261017-1H



Oct26-2017
SKT-261017-13C



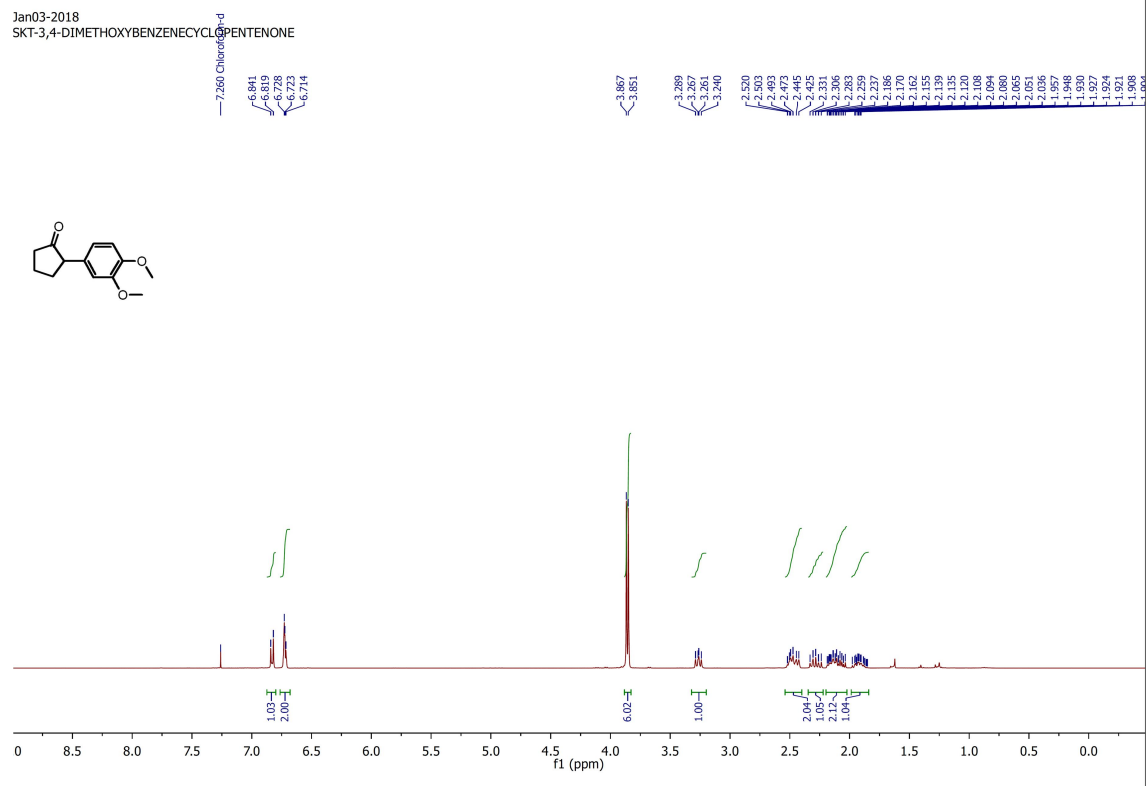
^1H and ^{13}C spectra of (3ca)



^1H and ^{13}C spectra of (3cb)

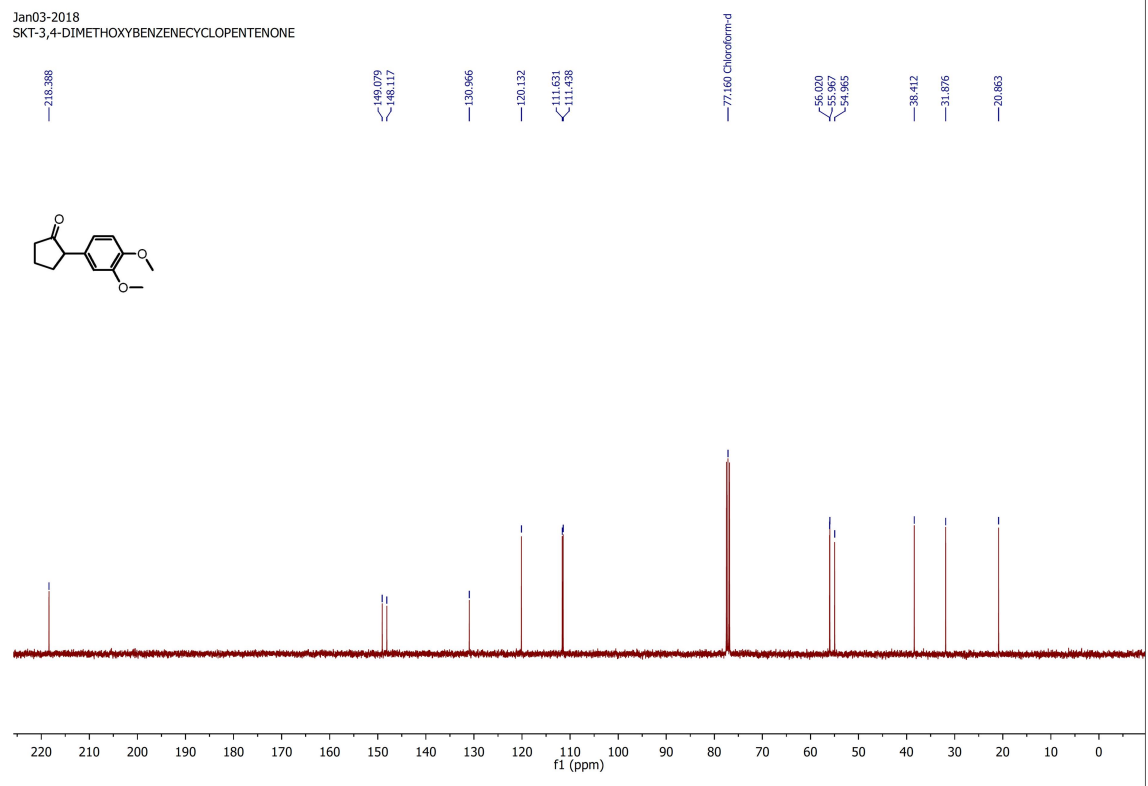
Jan03-2018

SKT-3,4-DIMETHOXYBENZENECYCLOPENTENONE

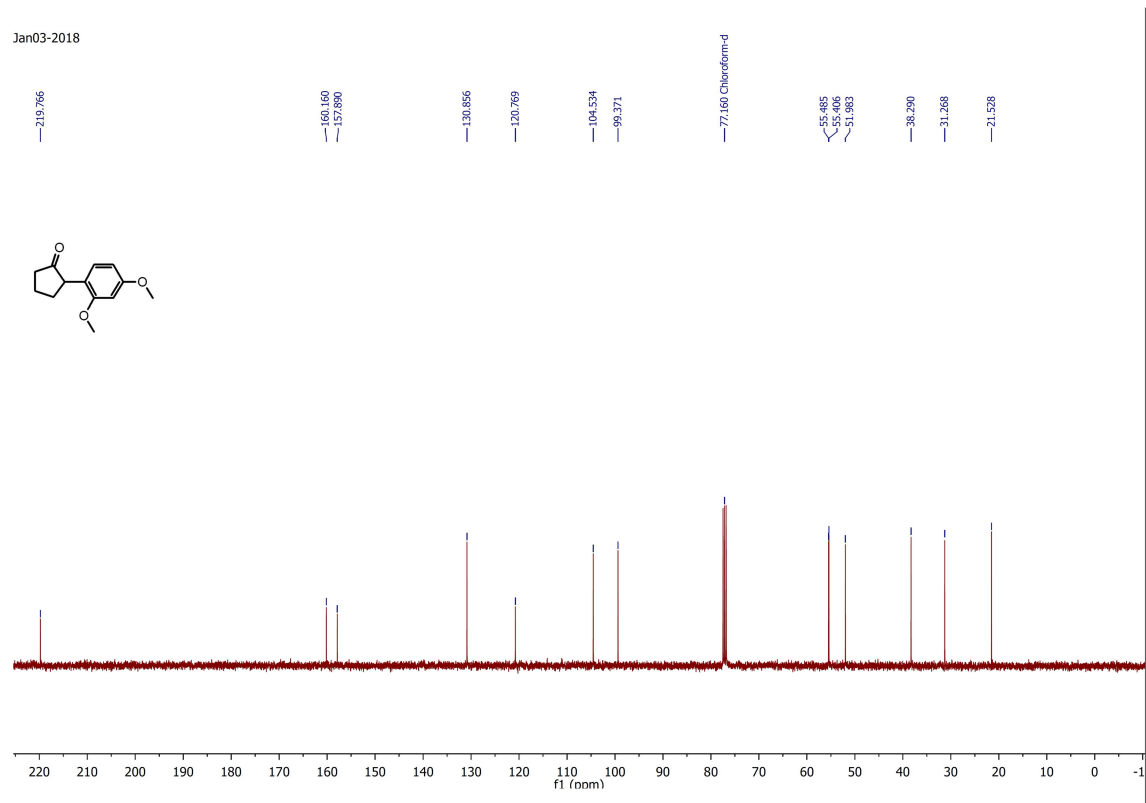
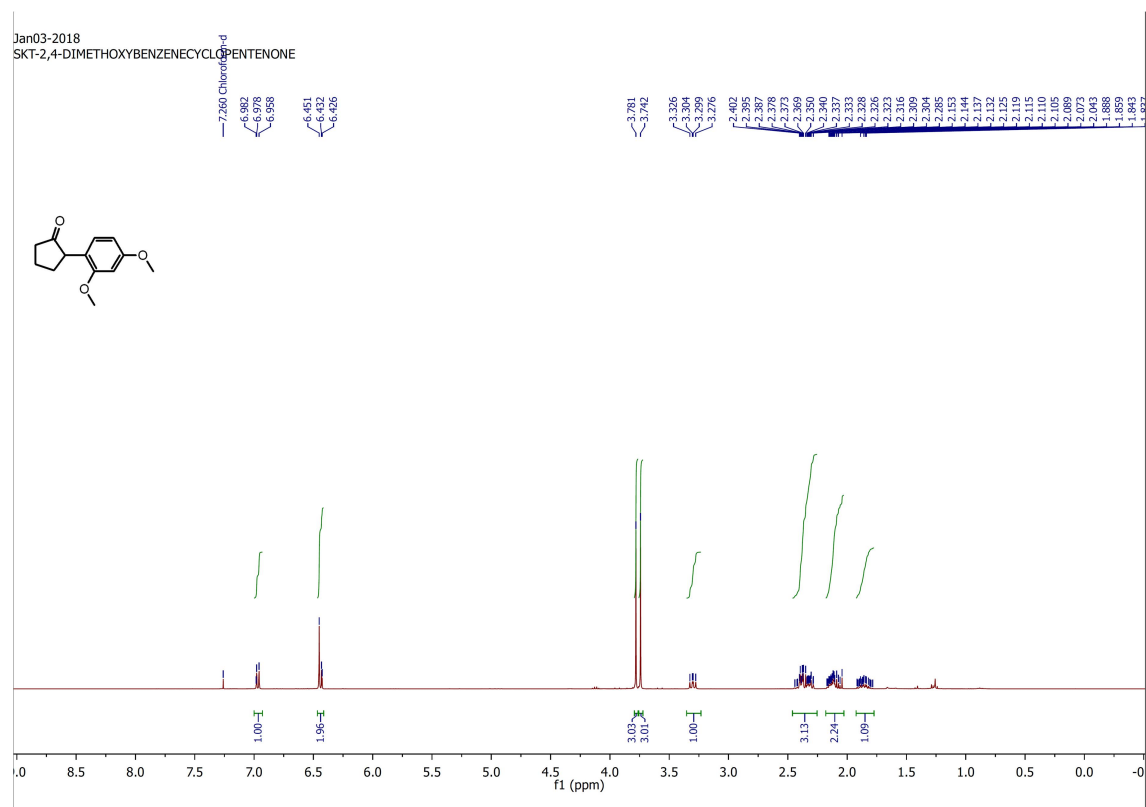


Jan03-2018

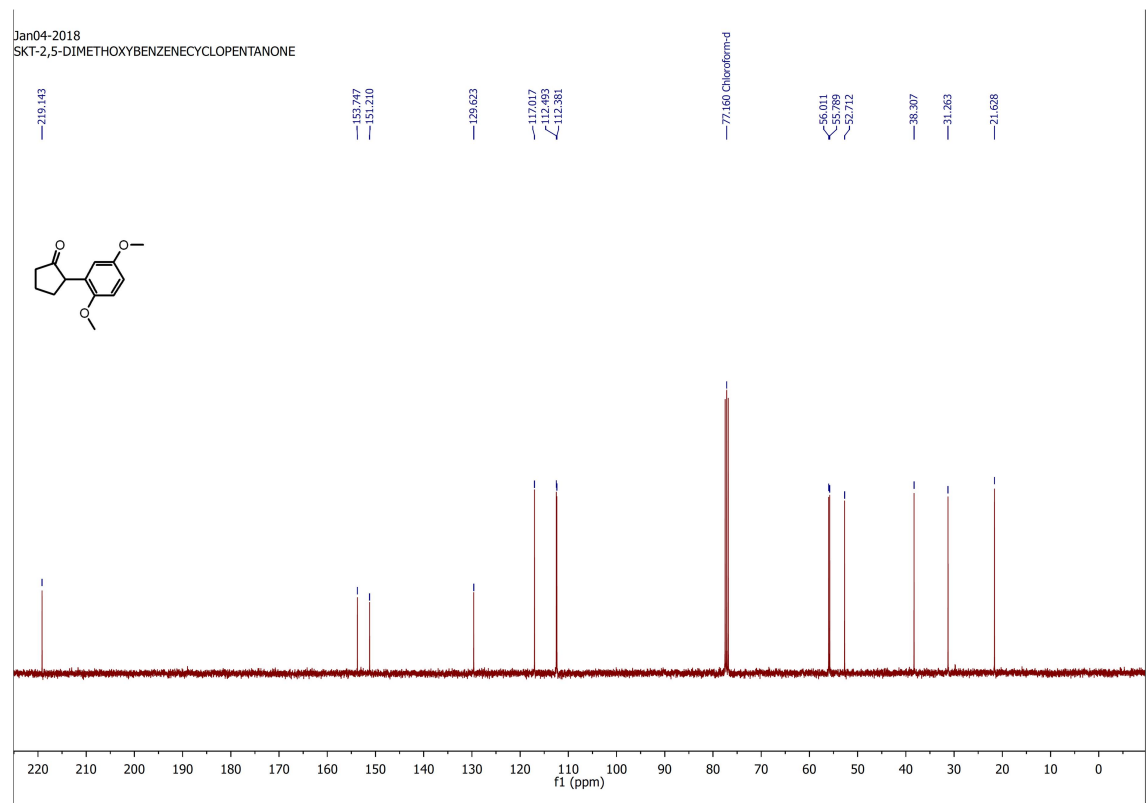
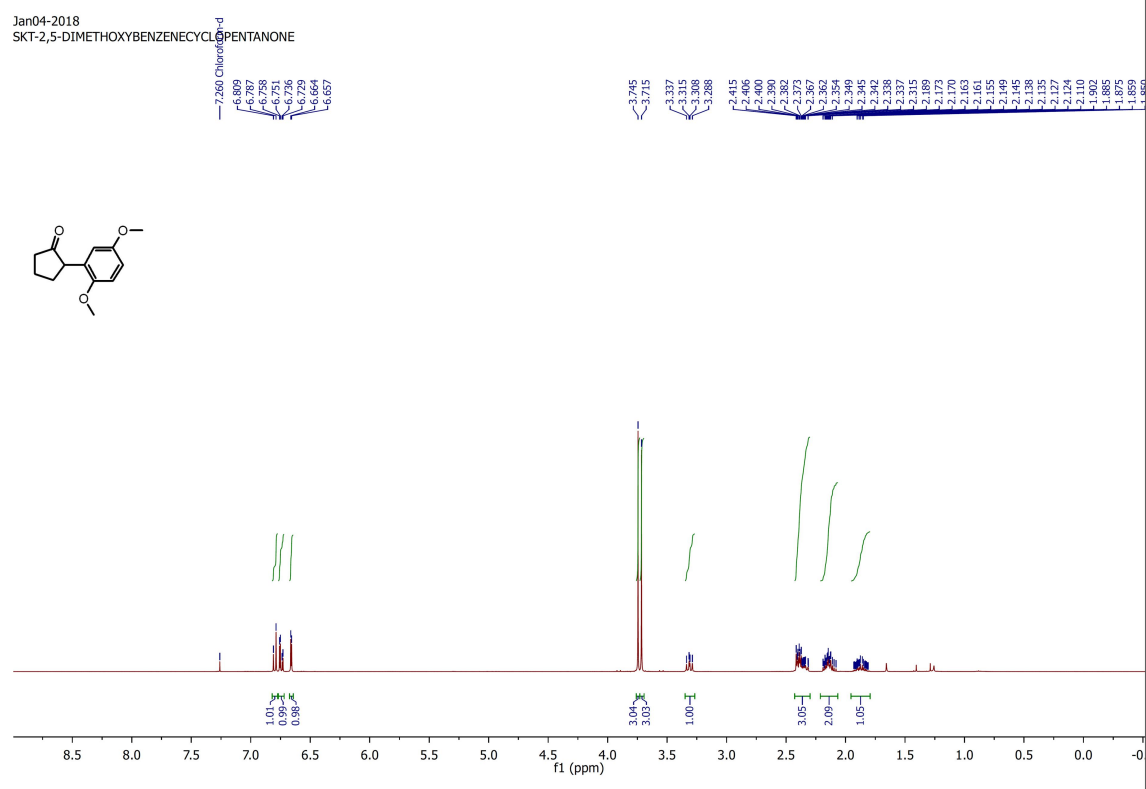
SKT-3,4-DIMETHOXYBENZENECYCLOPENTENONE



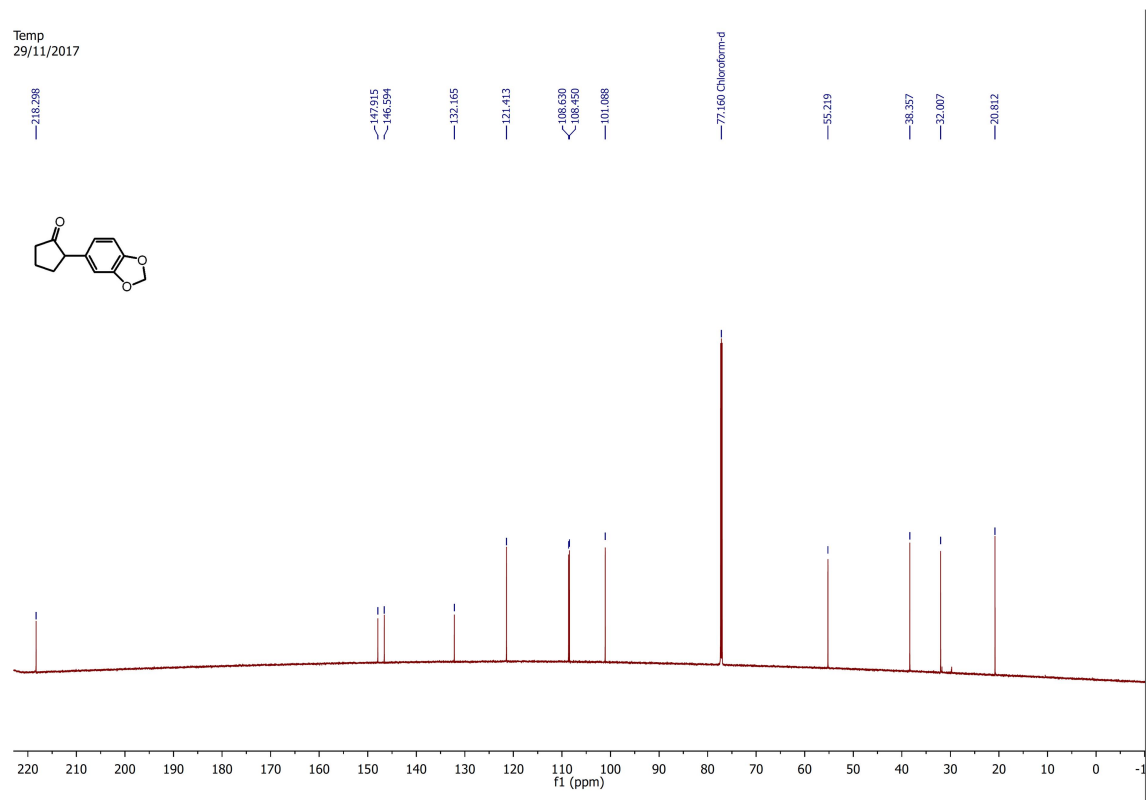
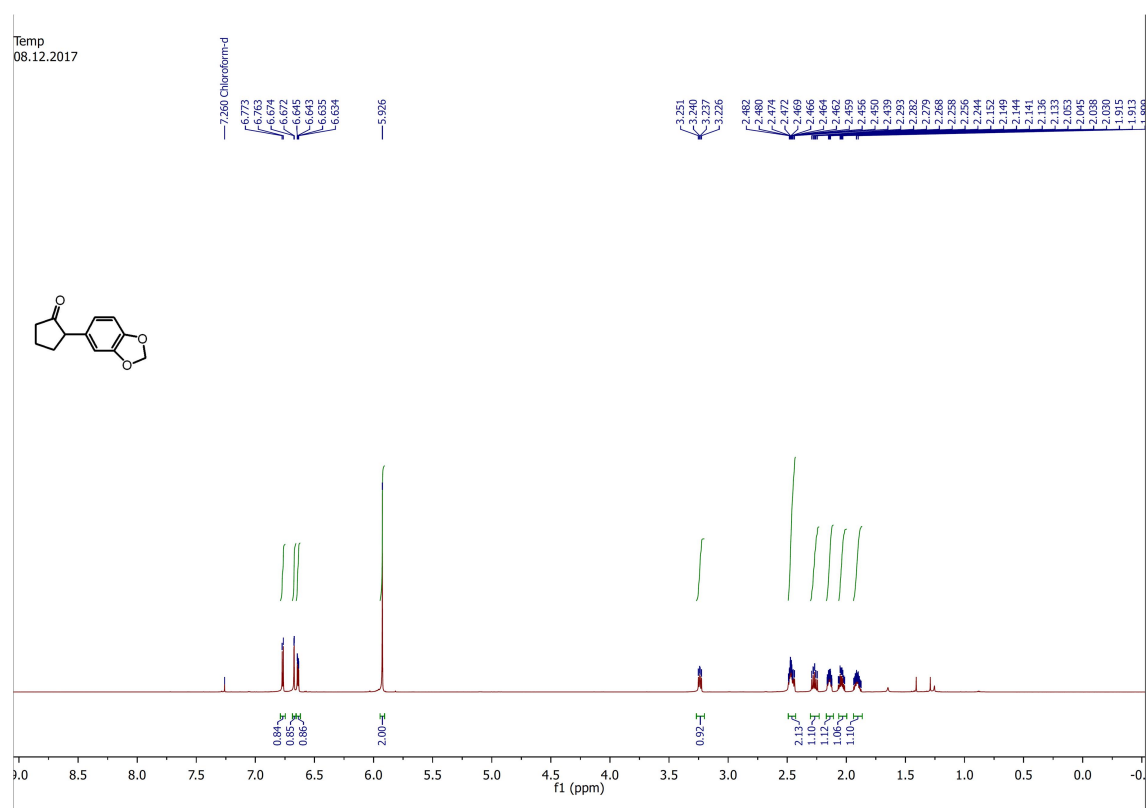
^1H and ^{13}C spectra of (3cc)



^1H and ^{13}C spectra of (3cd)

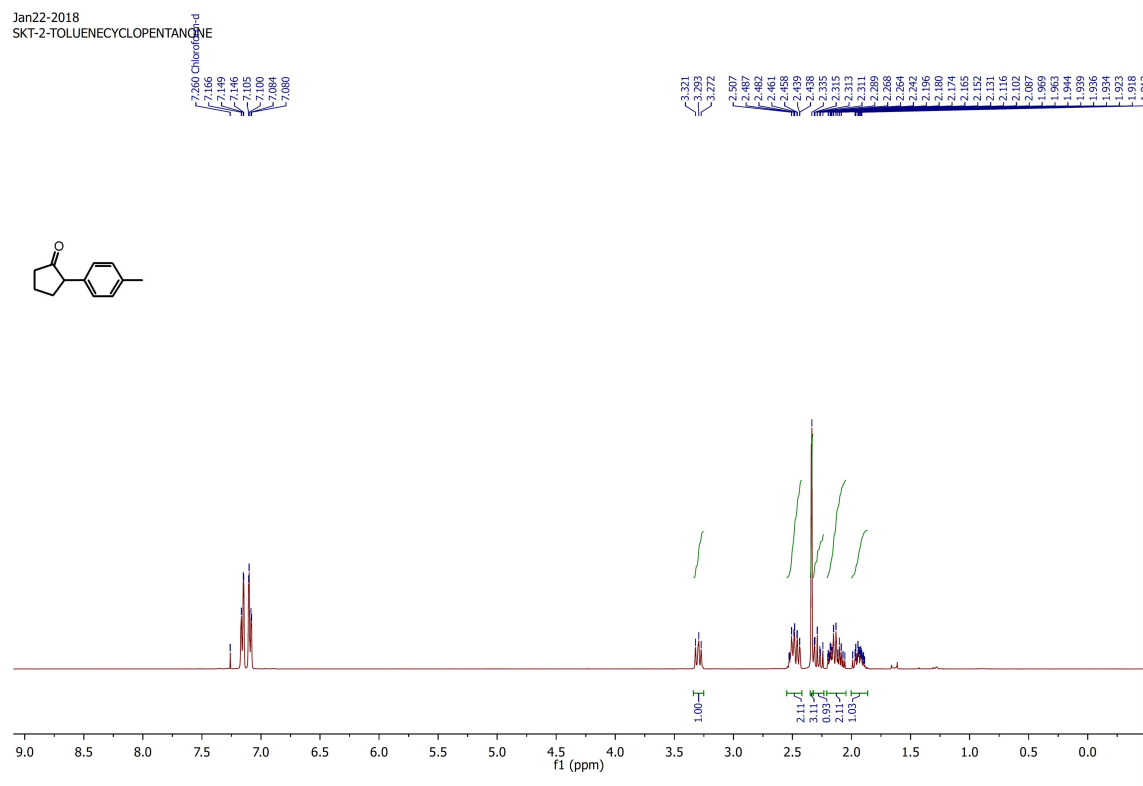


^1H and ^{13}C spectra of (3ce)

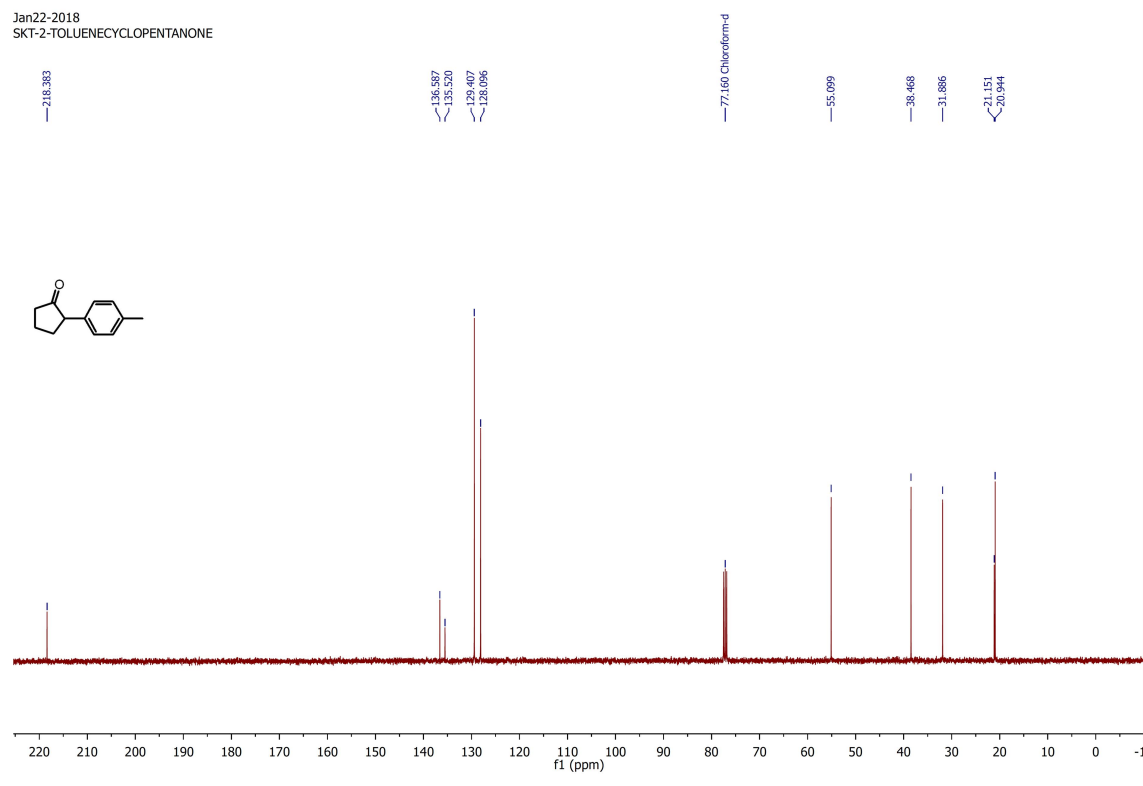


^1H and ^{13}C spectra of (3cf)

Jan22-2018
SKT-2-TOLUENECYCLOPENTANONE

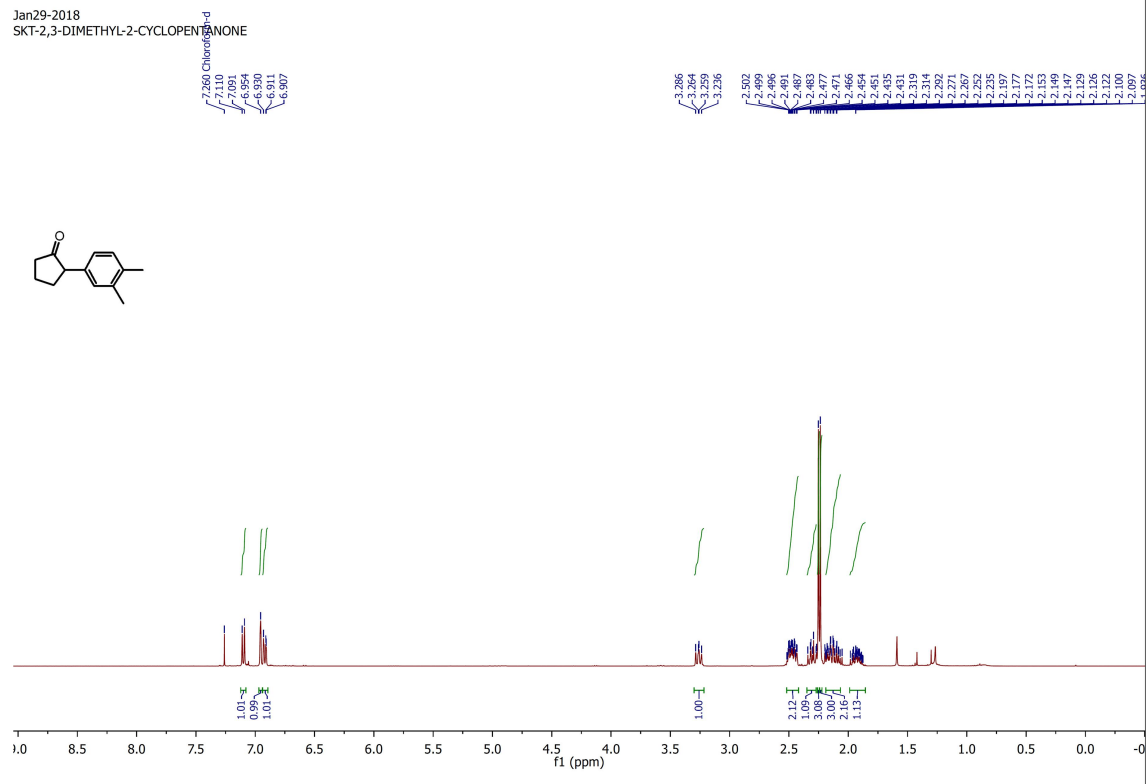


Jan22-2018
SKT-2-TOLUENECYCLOPENTANONE

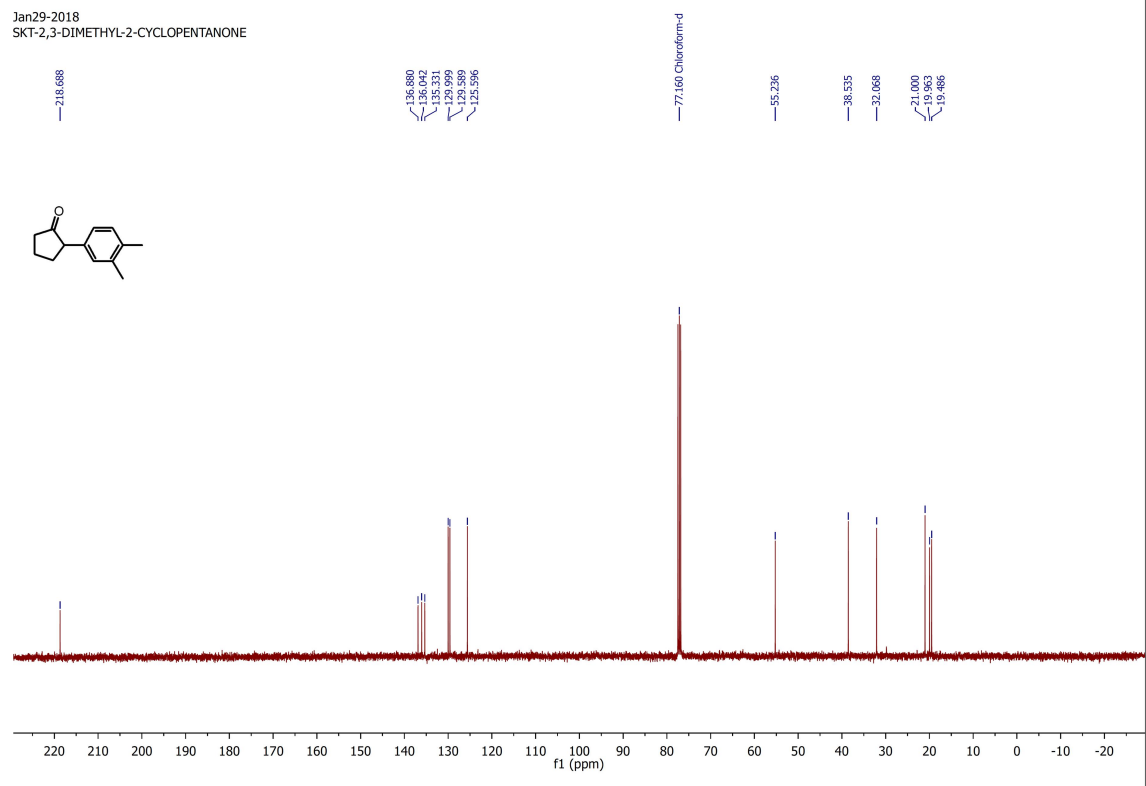


^1H and ^{13}C spectra of (3cg)

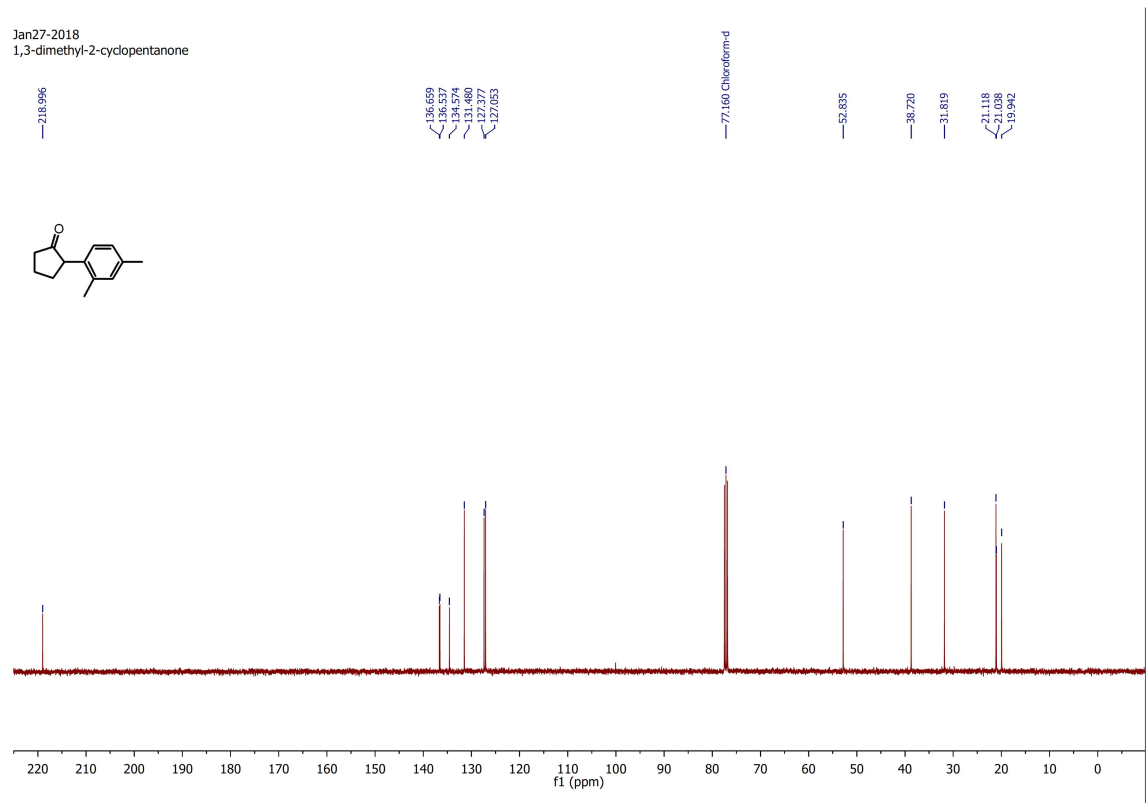
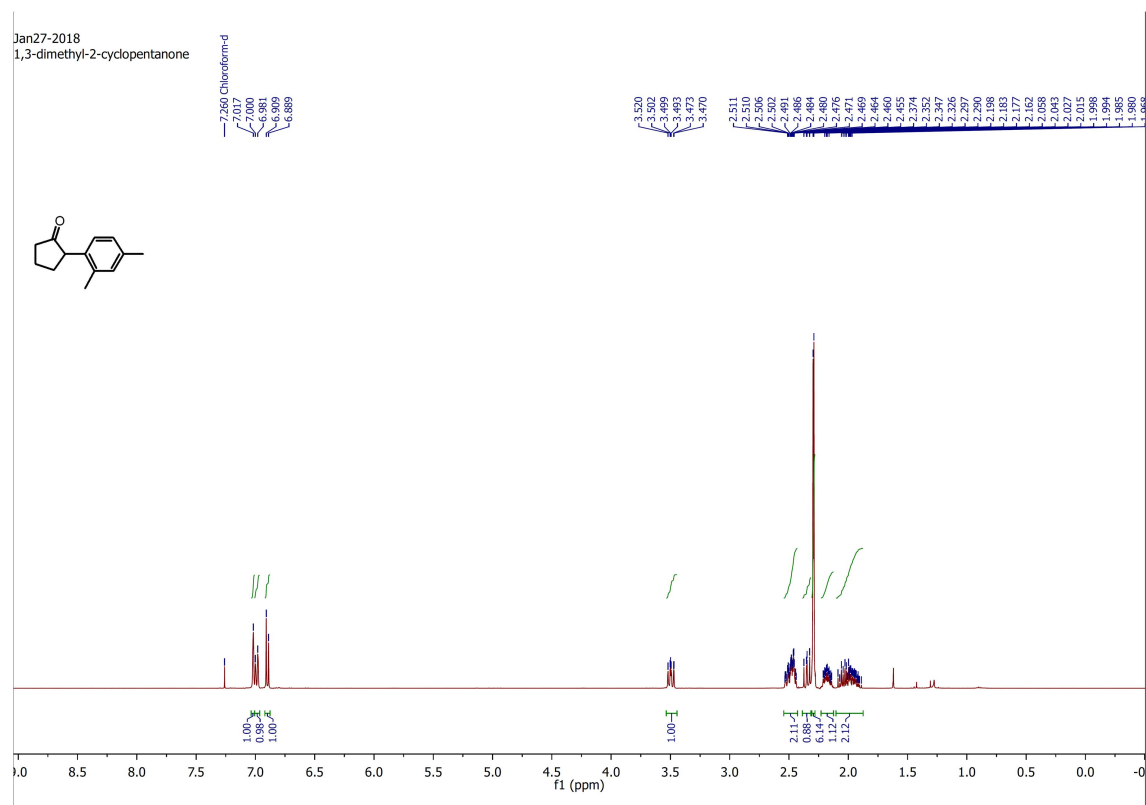
Jan29-2018
SKT-2,3-DIMETHYL-2-CYCLOPENTANONE



Jan29-2018
SKT-2,3-DIMETHYL-2-CYCLOPENTANONE



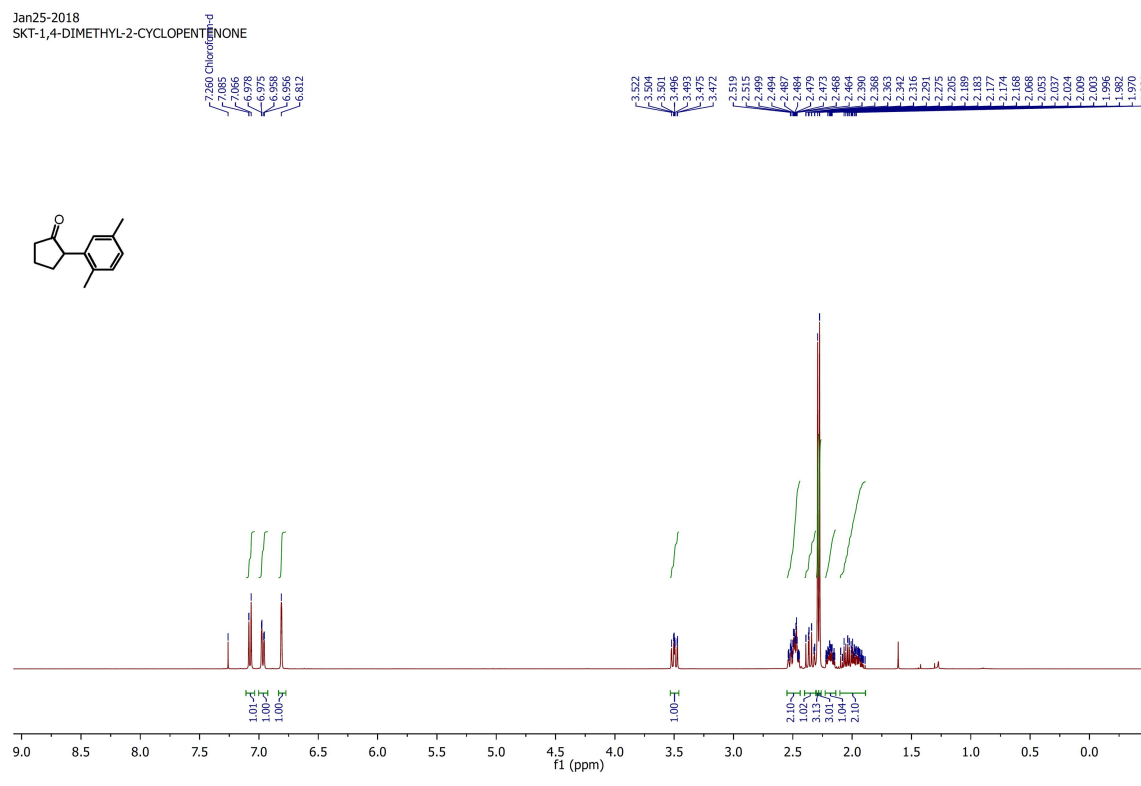
^1H and ^{13}C spectra of (3ch)



¹H and ¹³C spectra of (3ci)

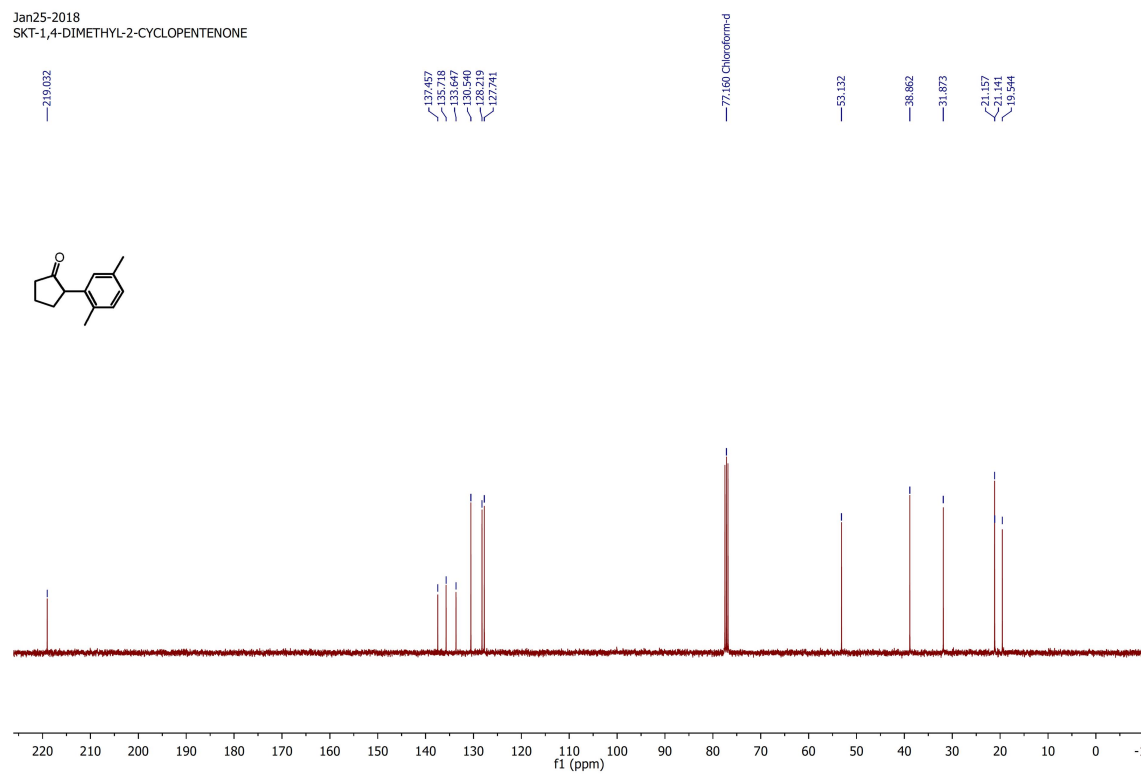
Jan25-2018

SKT-1,4-DIMETHYL-2-CYCLOPENTENONE



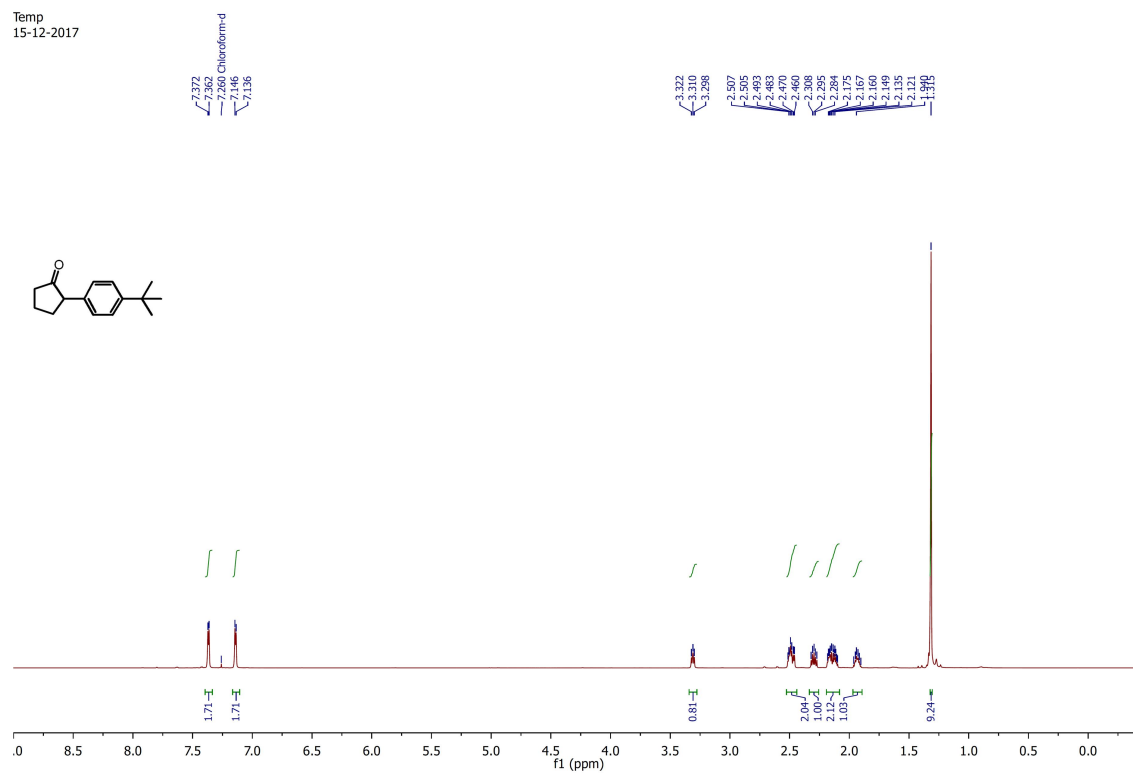
Jan25-2018

SKT-1,4-DIMETHYL-2-CYCLOPENTENONE

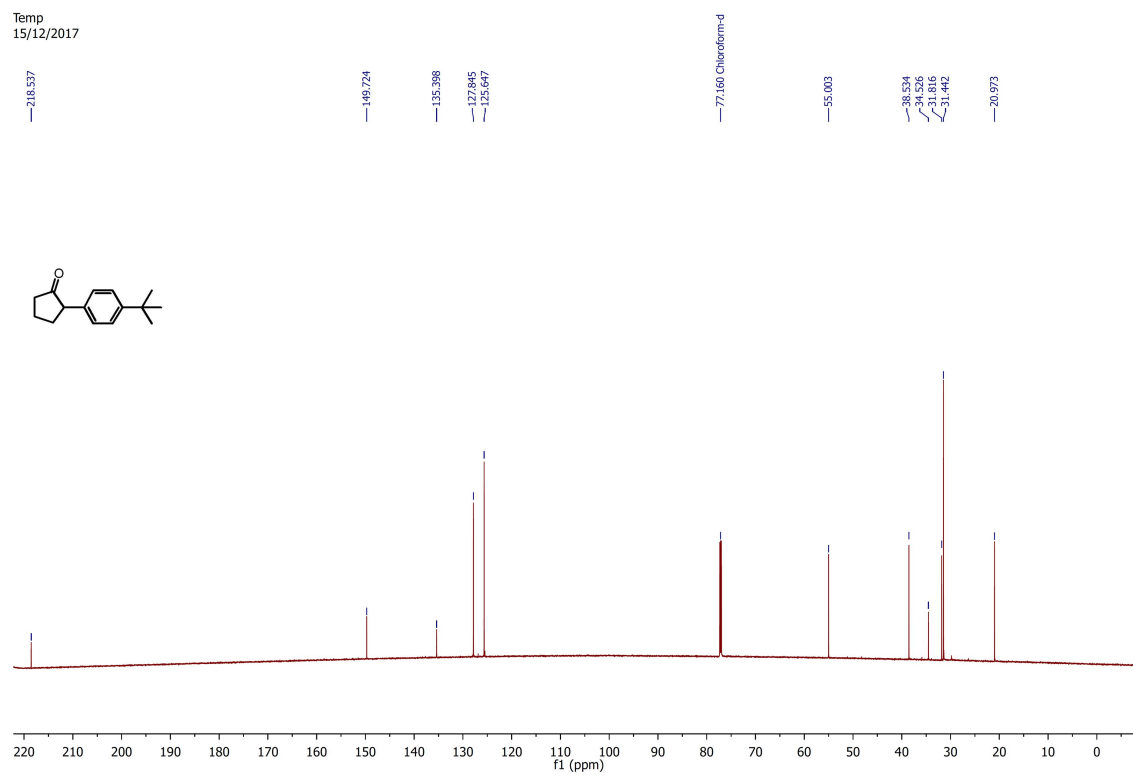


^1H and ^{13}C spectra of (3ck)

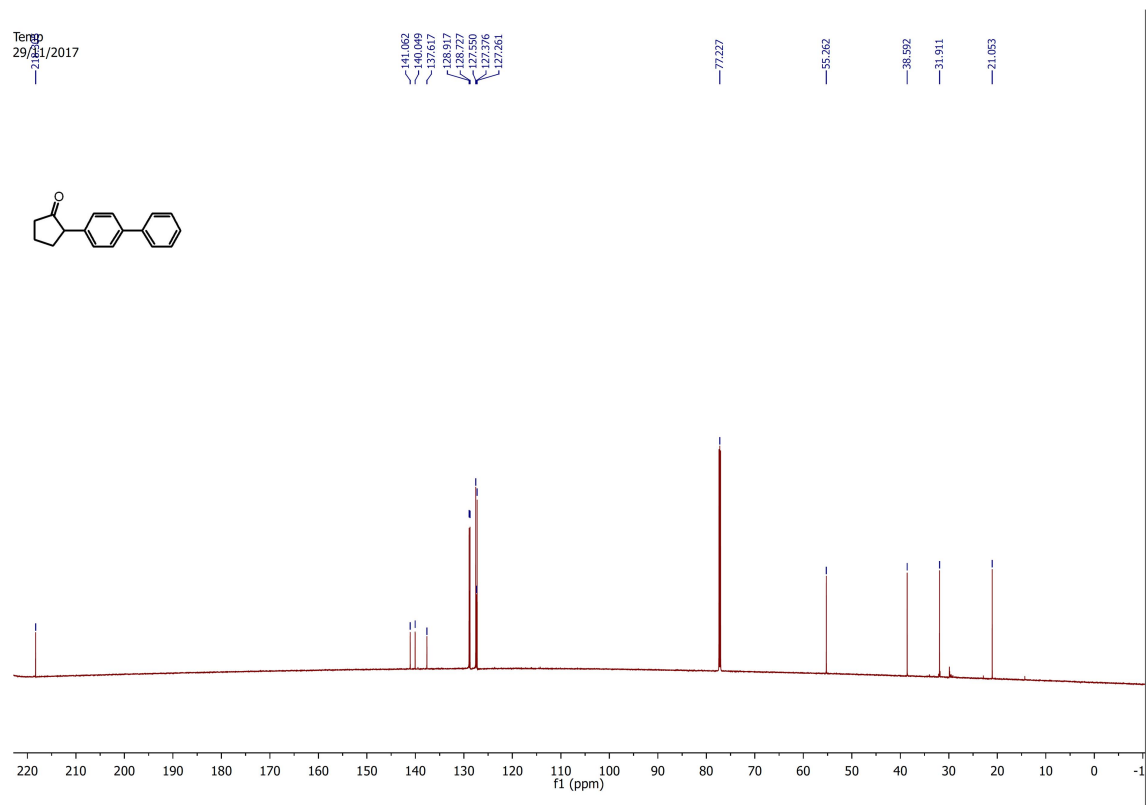
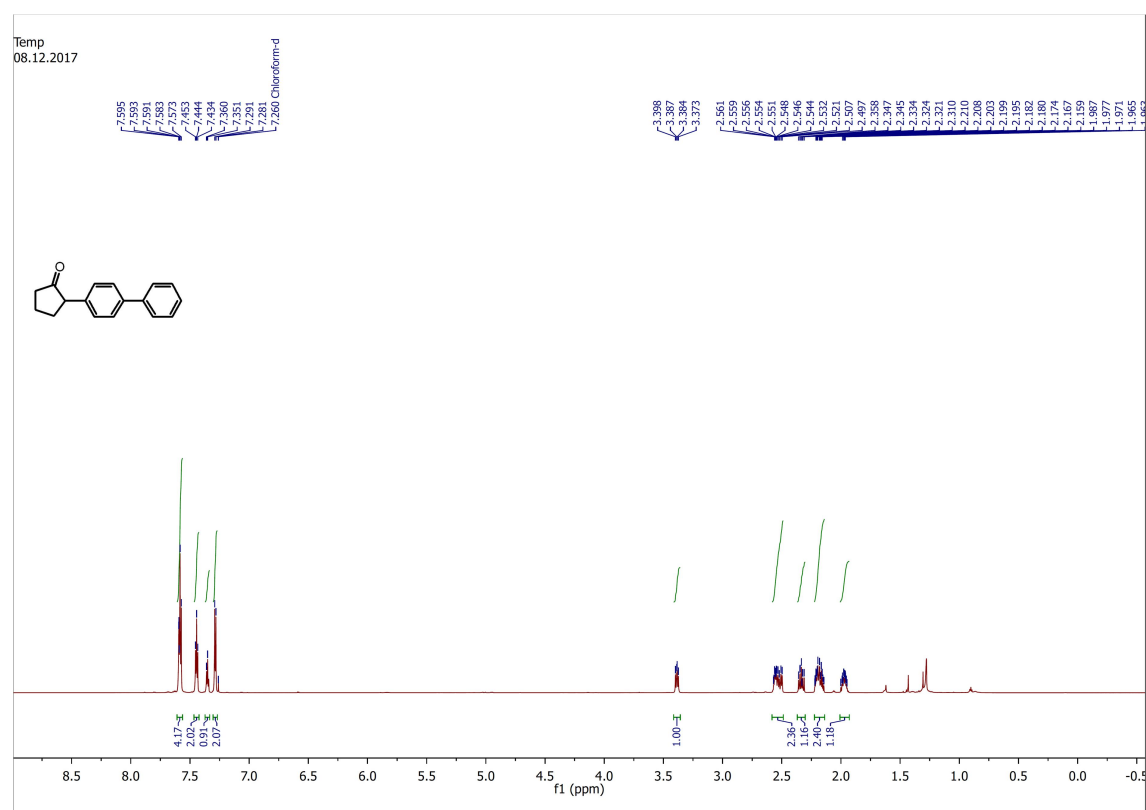
Temp
15-12-2017



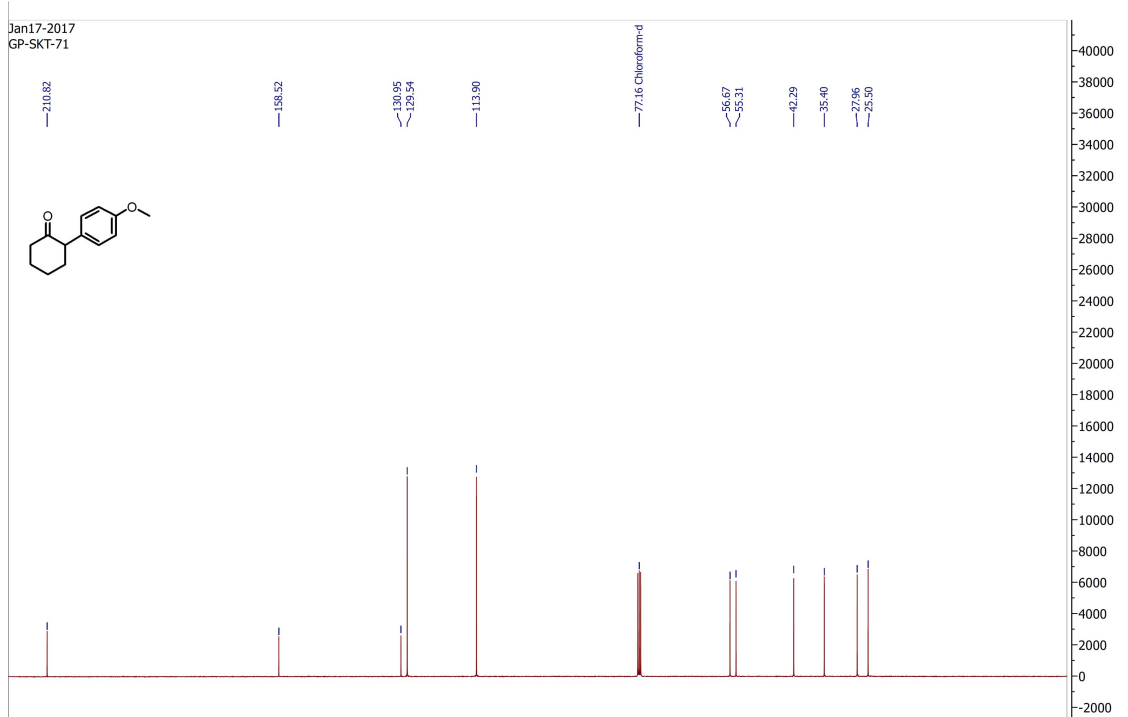
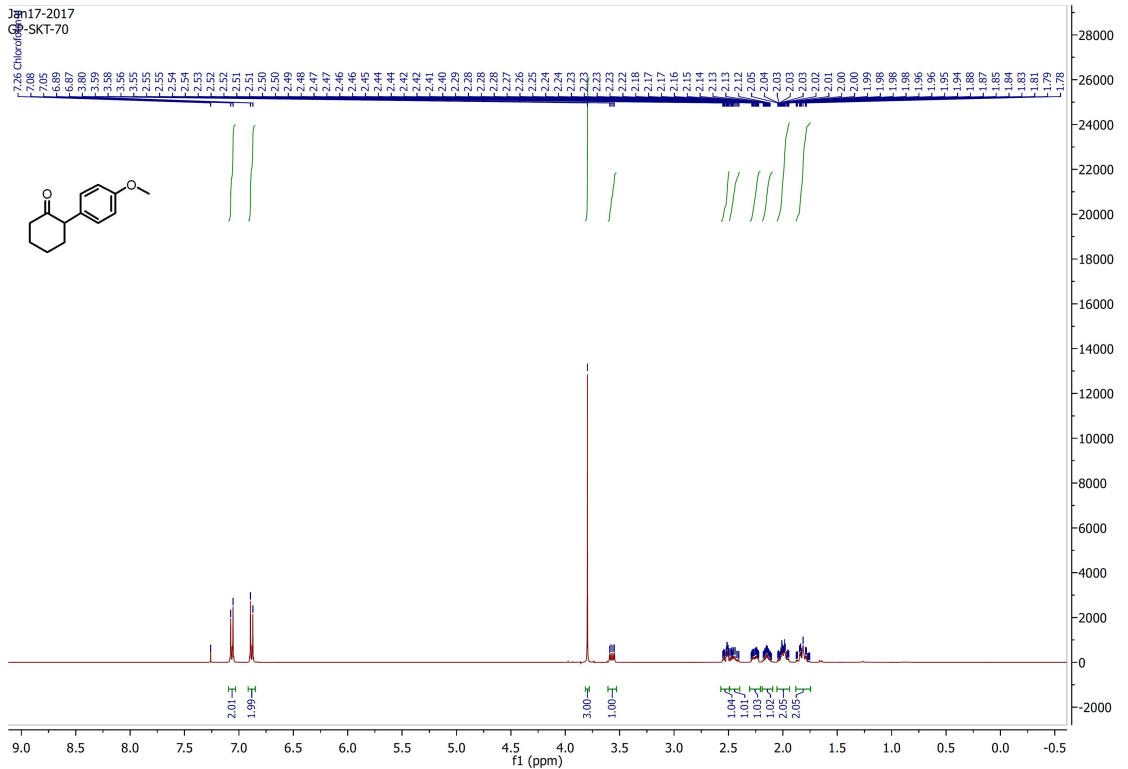
Temp
15/12/2017



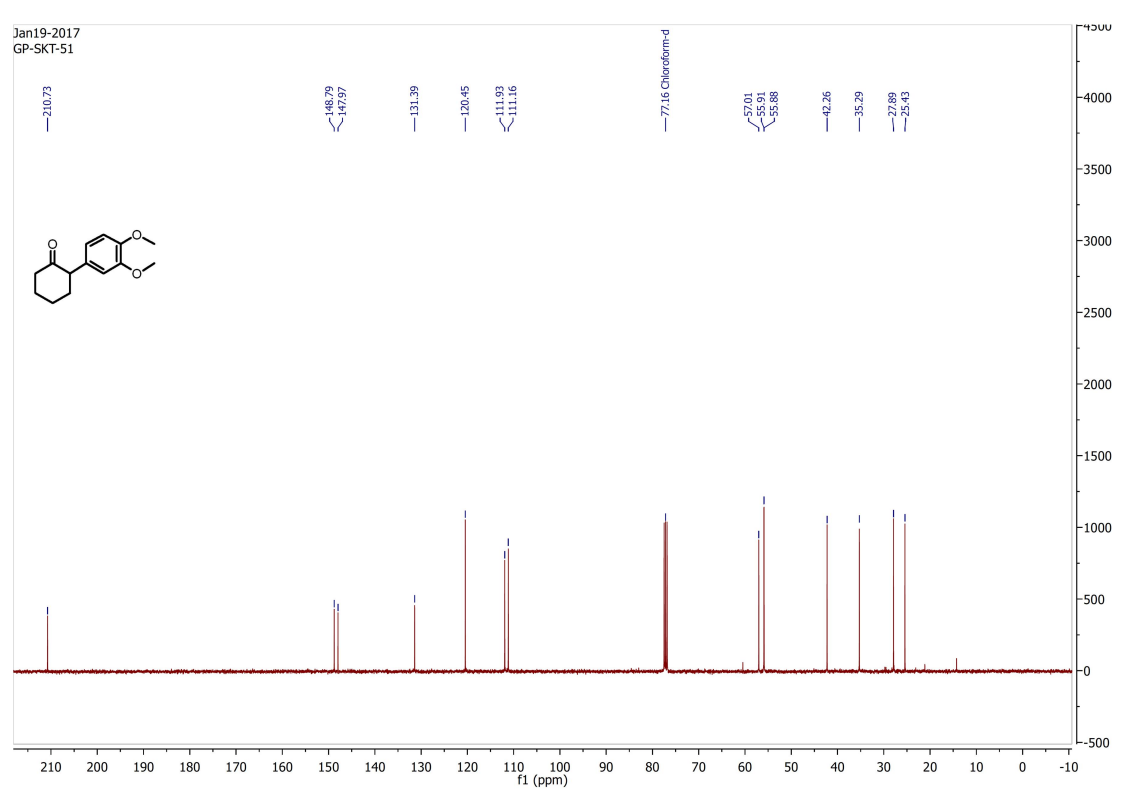
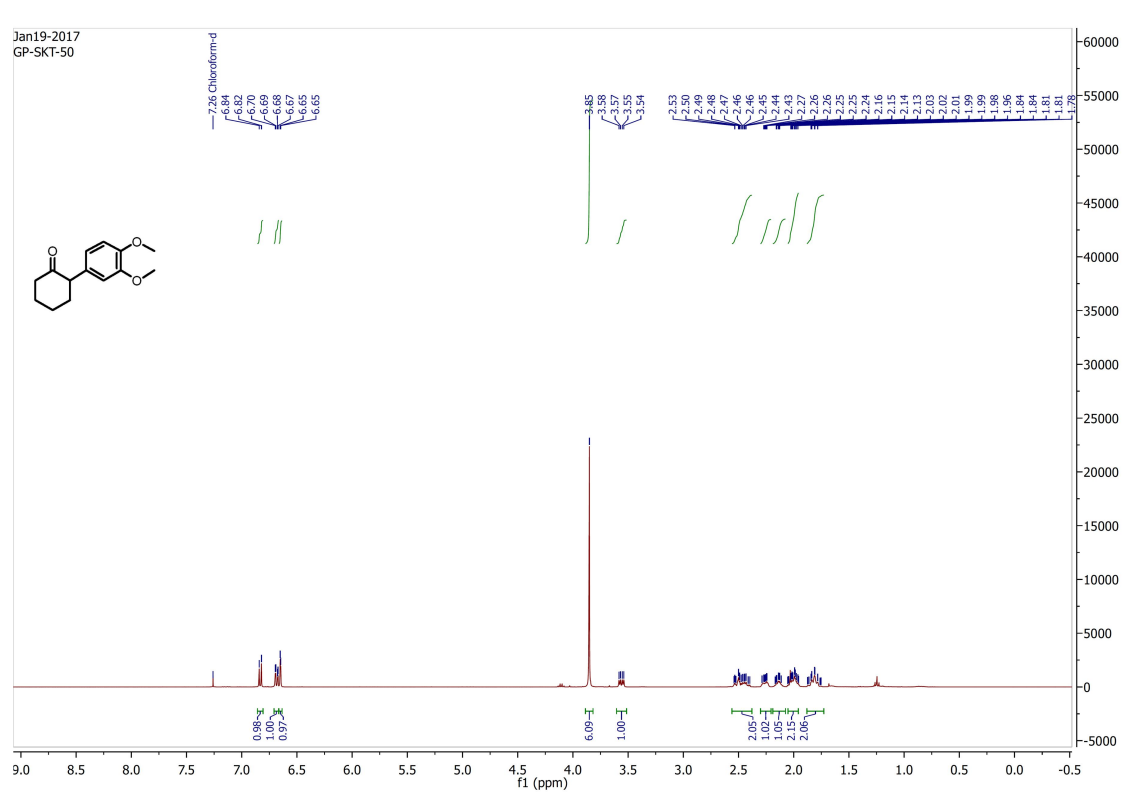
¹H and ¹³C spectra of (3cl)



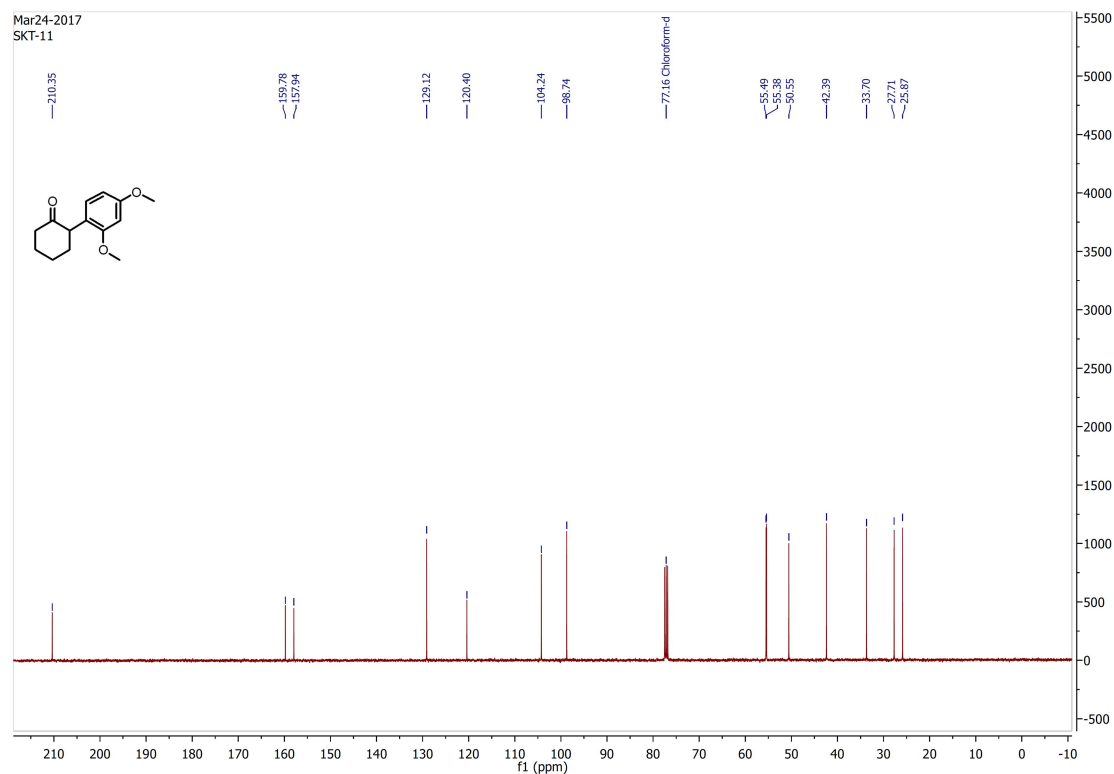
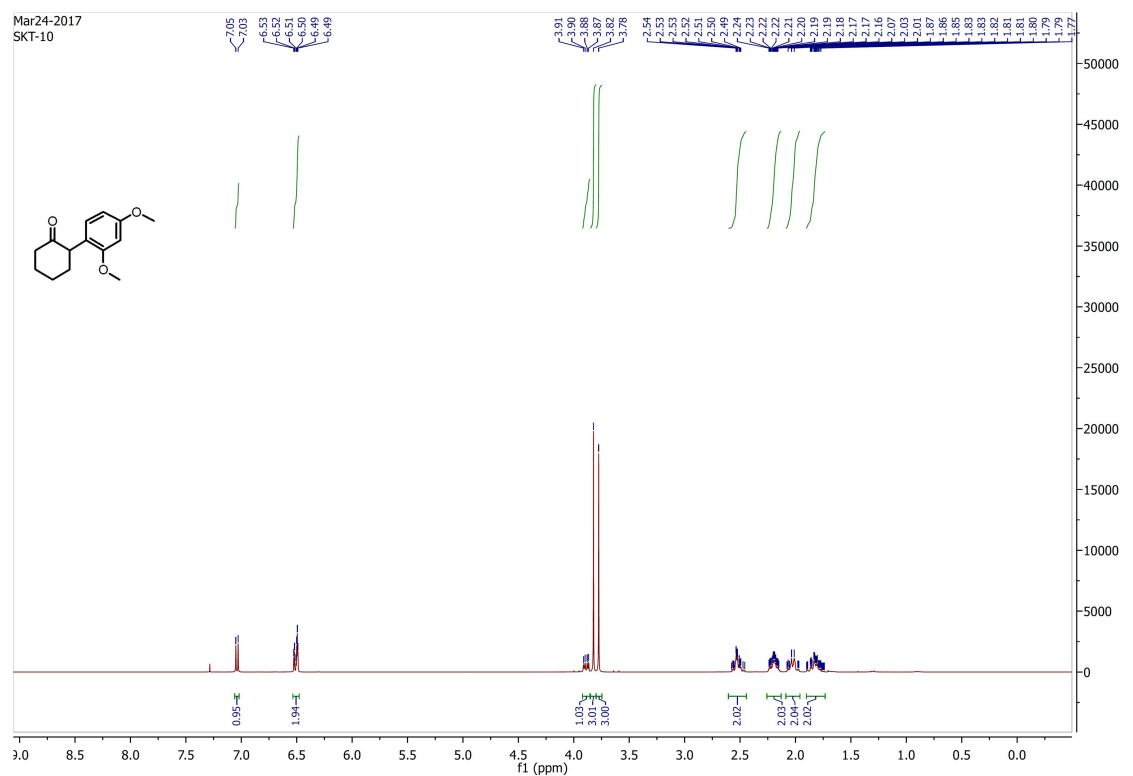
¹H and ¹³C spectra of (3da)



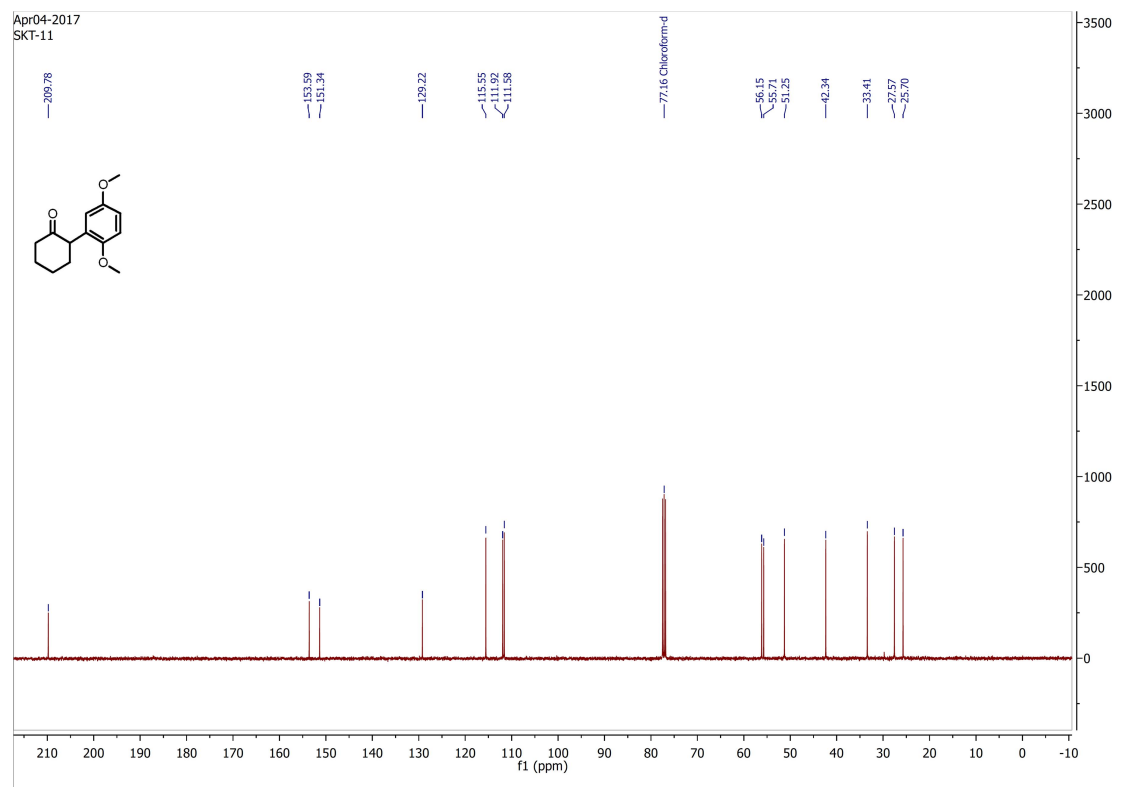
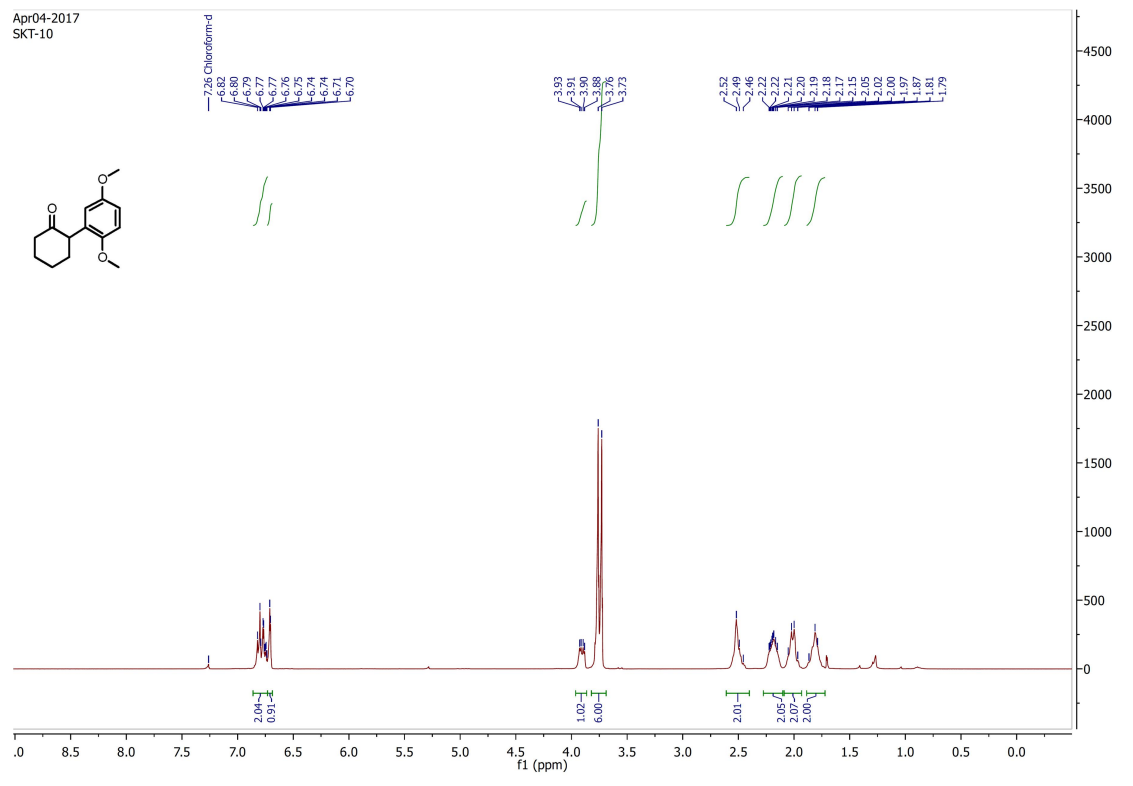
^1H and ^{13}C spectra of (3db)



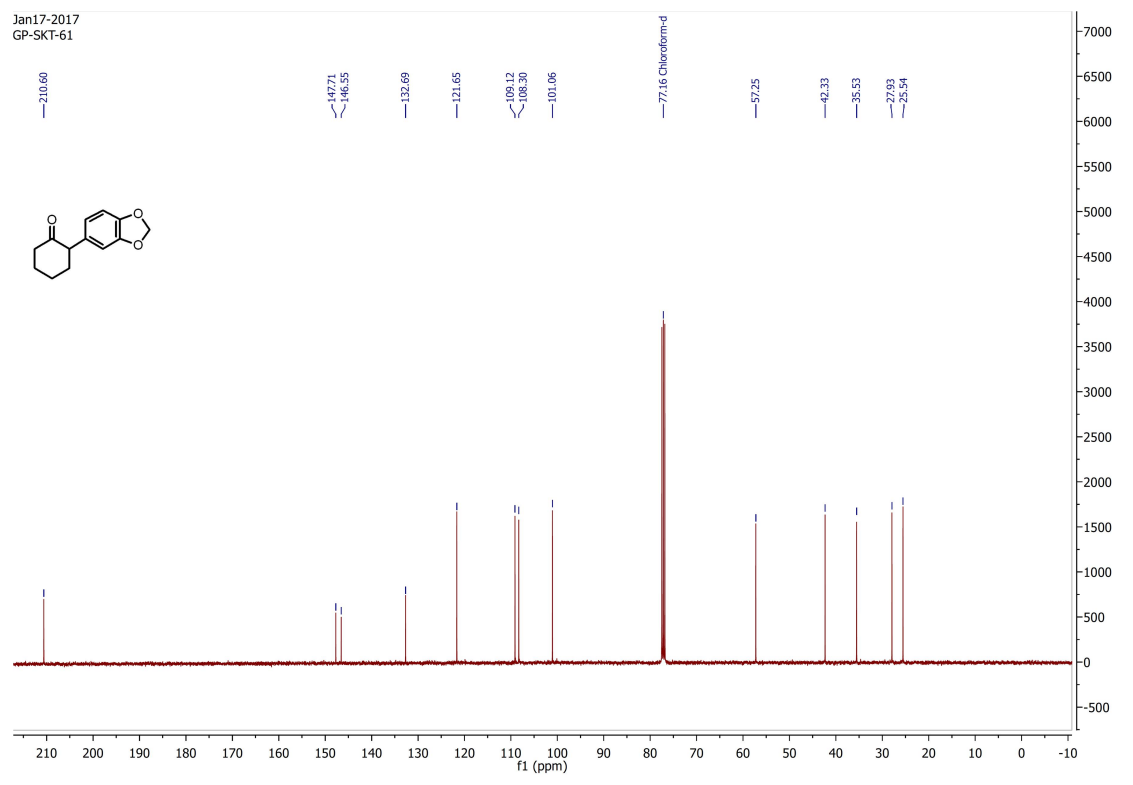
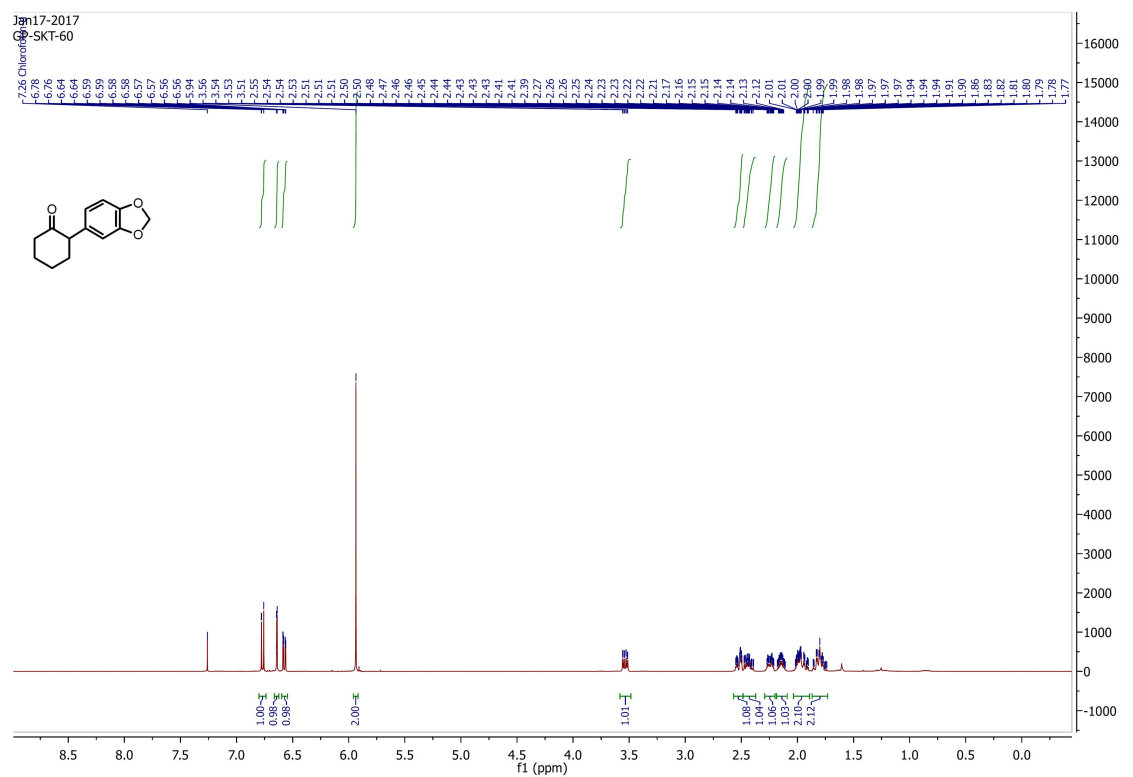
^1H and ^{13}C spectra of (3dc)



^1H and ^{13}C spectra of (3dd)



^1H and ^{13}C spectra of (3de)



Jan 17-2017
G01-SKT-80

7.18
7.16
7.17
7.07
7.05
7.06
7.01
7.01
3.61
3.59
3.58
2.57
2.57
2.56
2.54
2.54
2.53
2.53
2.52
2.51
2.50
2.49
2.49
2.48
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2.47
2.47
2.46
2.46
2.46
2.44
2.44
2.43
2.43
2.36
2.31
2.30
2.30
2.29
2.29
2.29
2.27
2.27
2.26
2.26
2.19
2.19
2.17
2.17
2.16
2.16
2.15
2.15
2.14
2.14
2.09
2.07
2.06
2.06
2.05
2.05
2.04
2.03
2.03
2.02
2.02
2.01
2.01
2.00
2.00
1.99
1.99
1.98
1.87
1.86
1.85
1.85
1.84
1.83
1.83
1.81
1.81

14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000

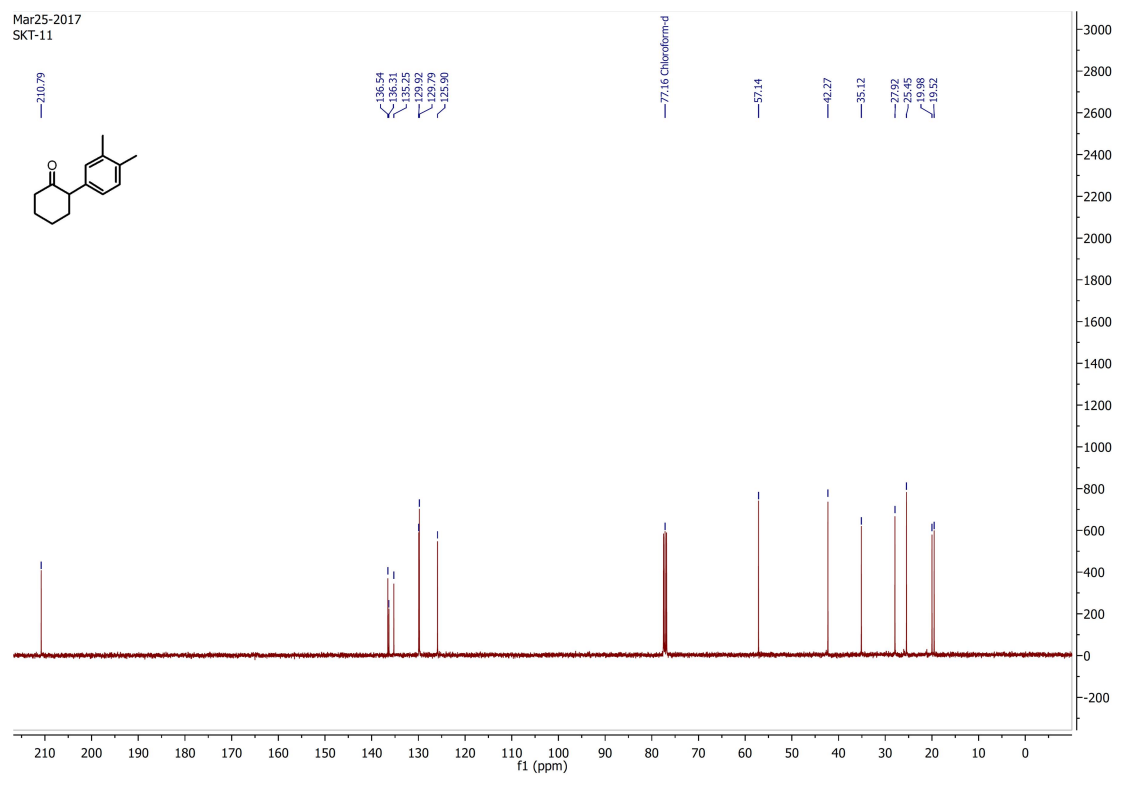
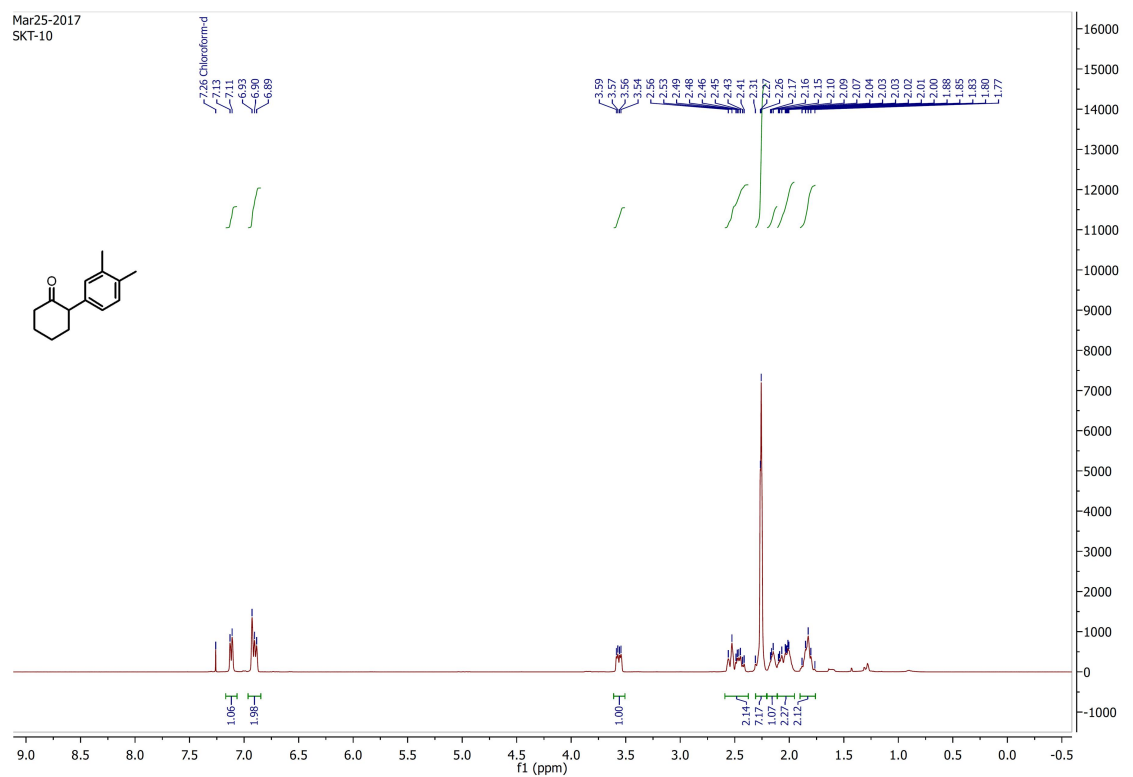
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

f1 (ppm)

2.01
2.00
1.00
2.10
3.00
1.00
2.10
2.00

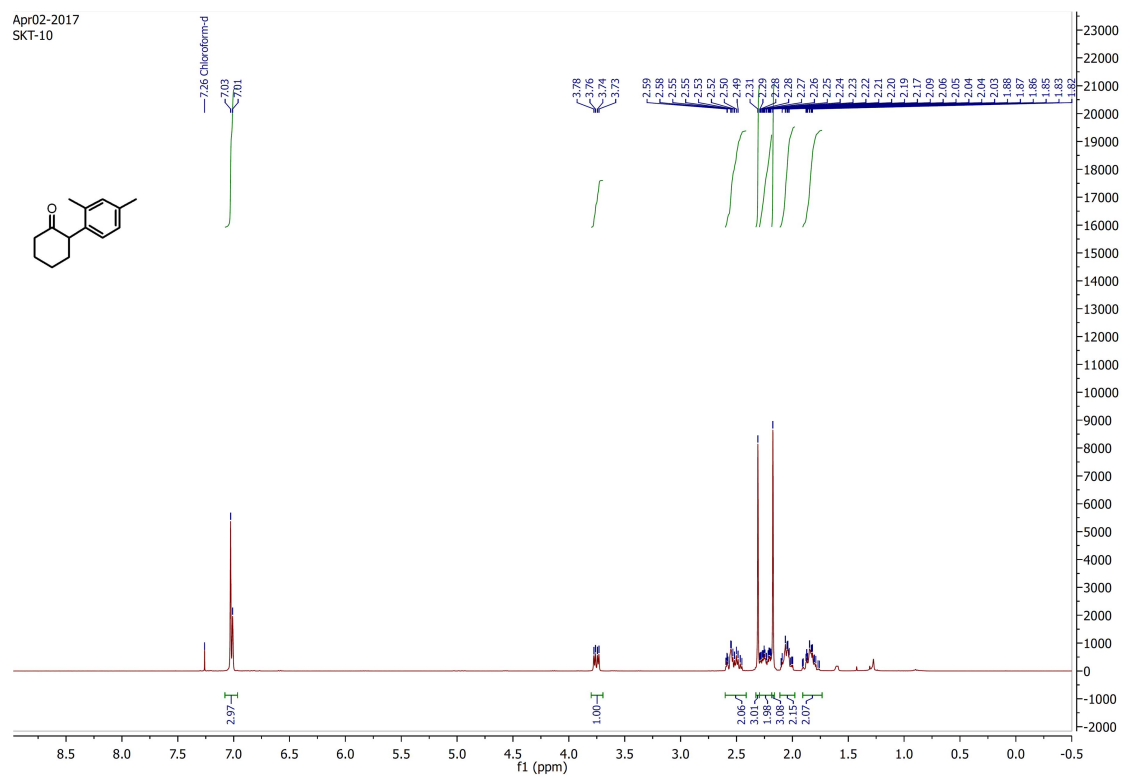
O=C1CCCCC1c2ccc(C)cc2

^1H and ^{13}C spectra of (3dg)

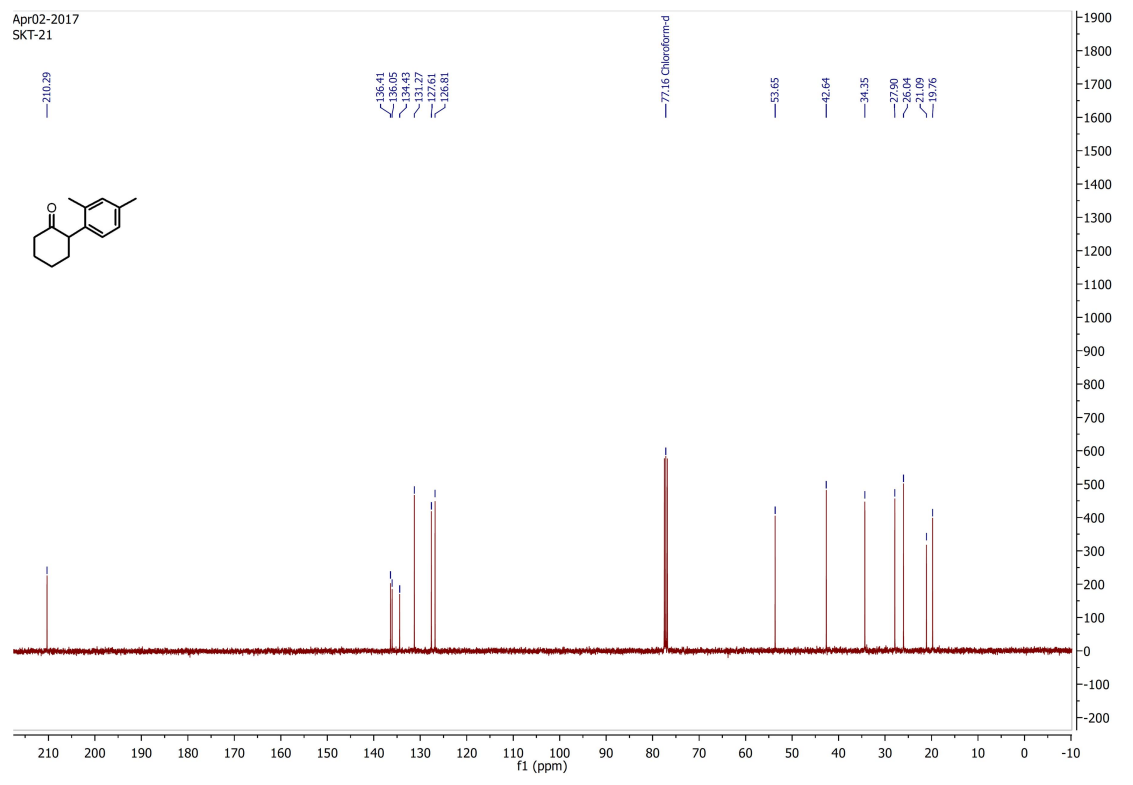


^1H and ^{13}C spectra of (3dh)

Apr02-2017
SKT-10

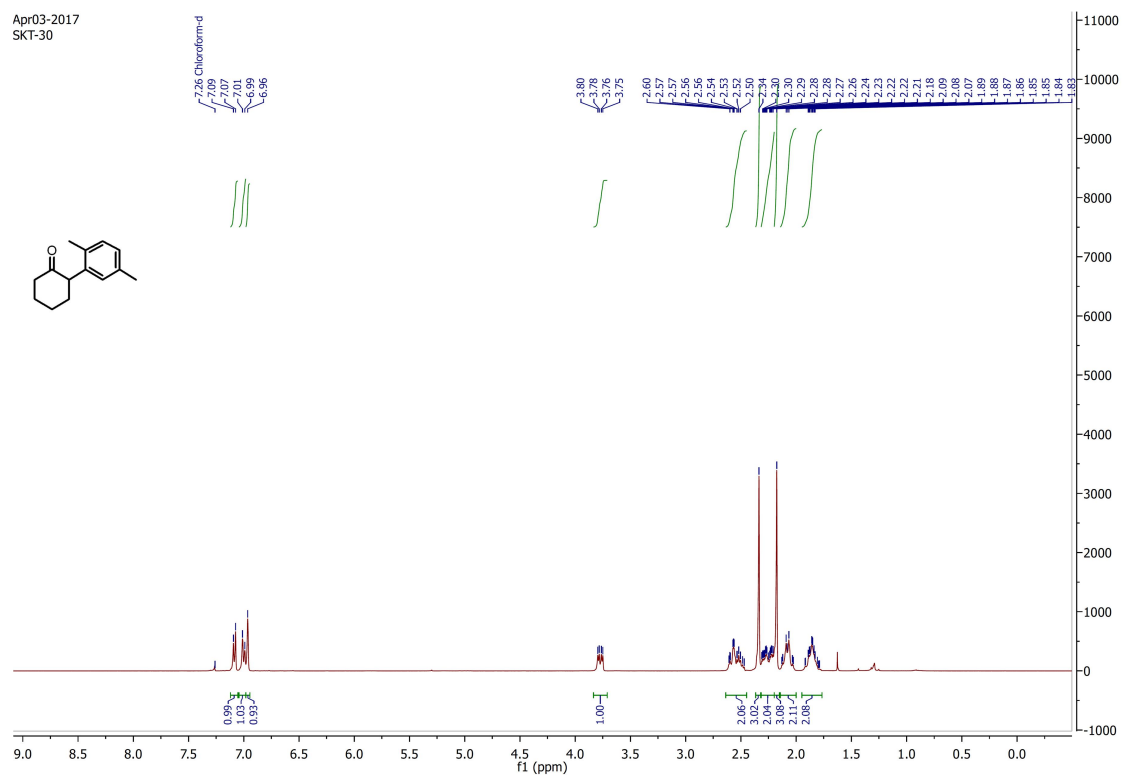


Apr02-2017
SKT-21

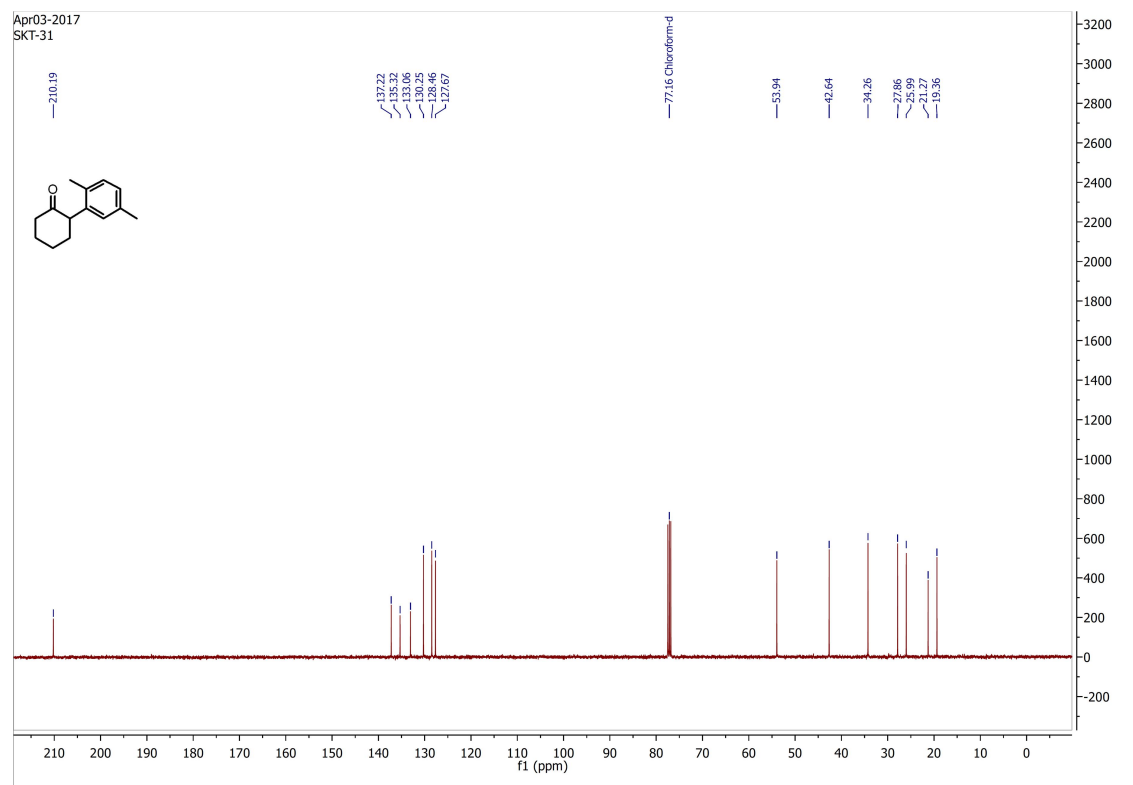


^1H and ^{13}C spectra of (3di)

Apr03-2017
SKT-30

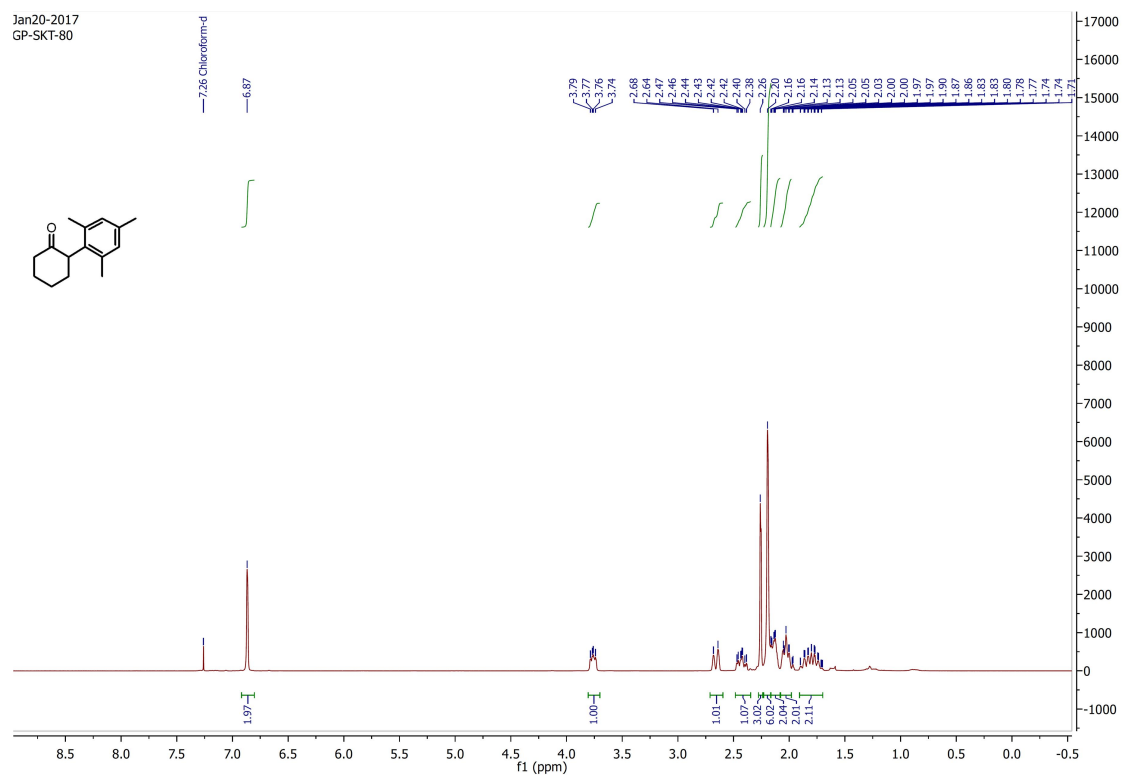


Apr03-2017
SKT-31

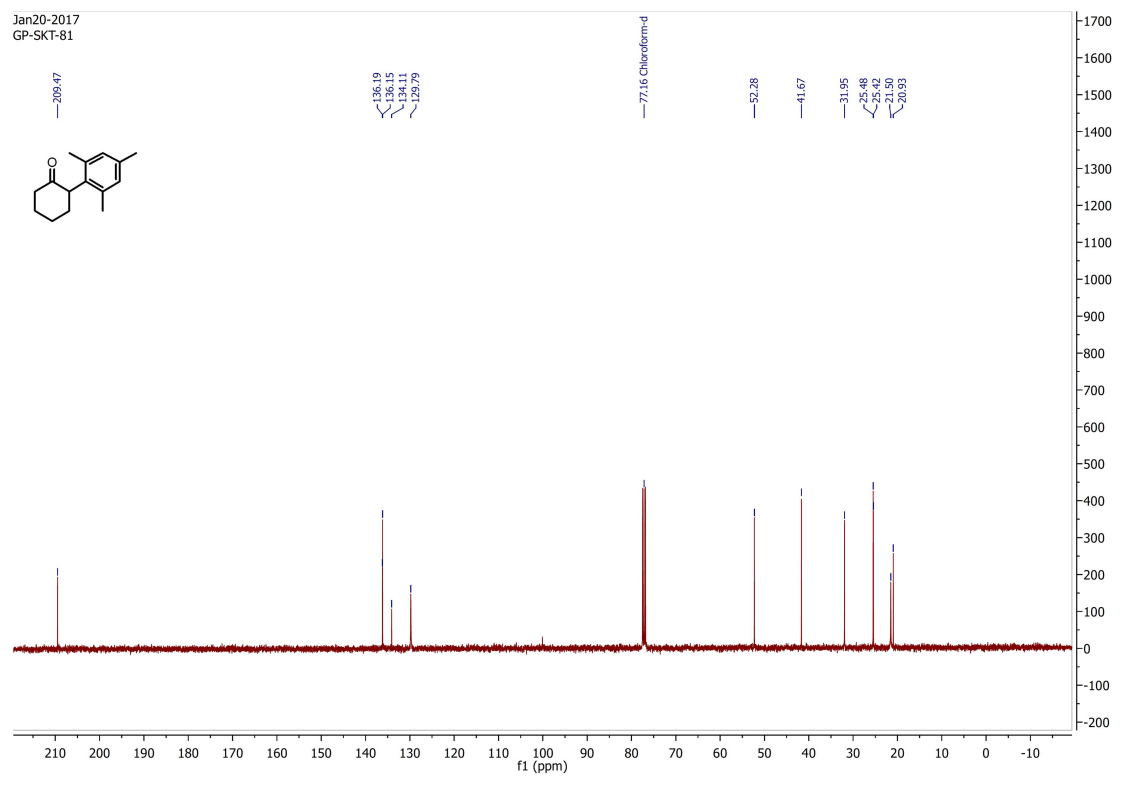


^1H and ^{13}C spectra of (3dj)

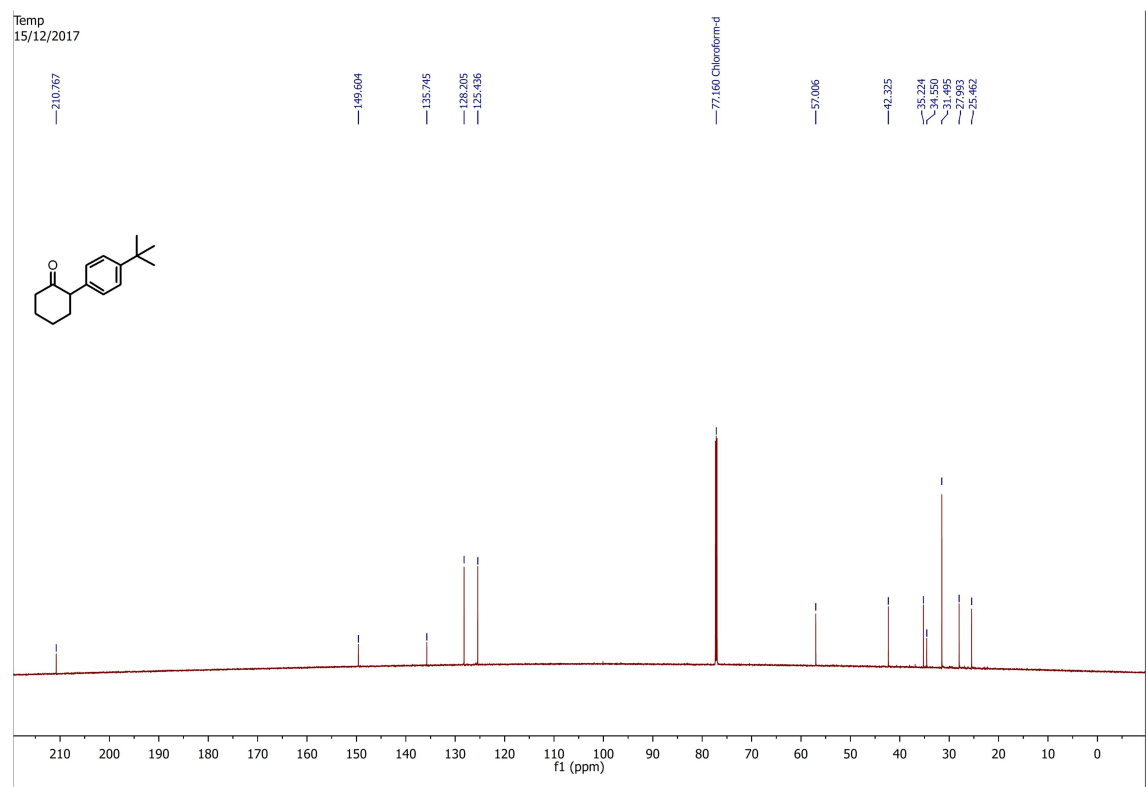
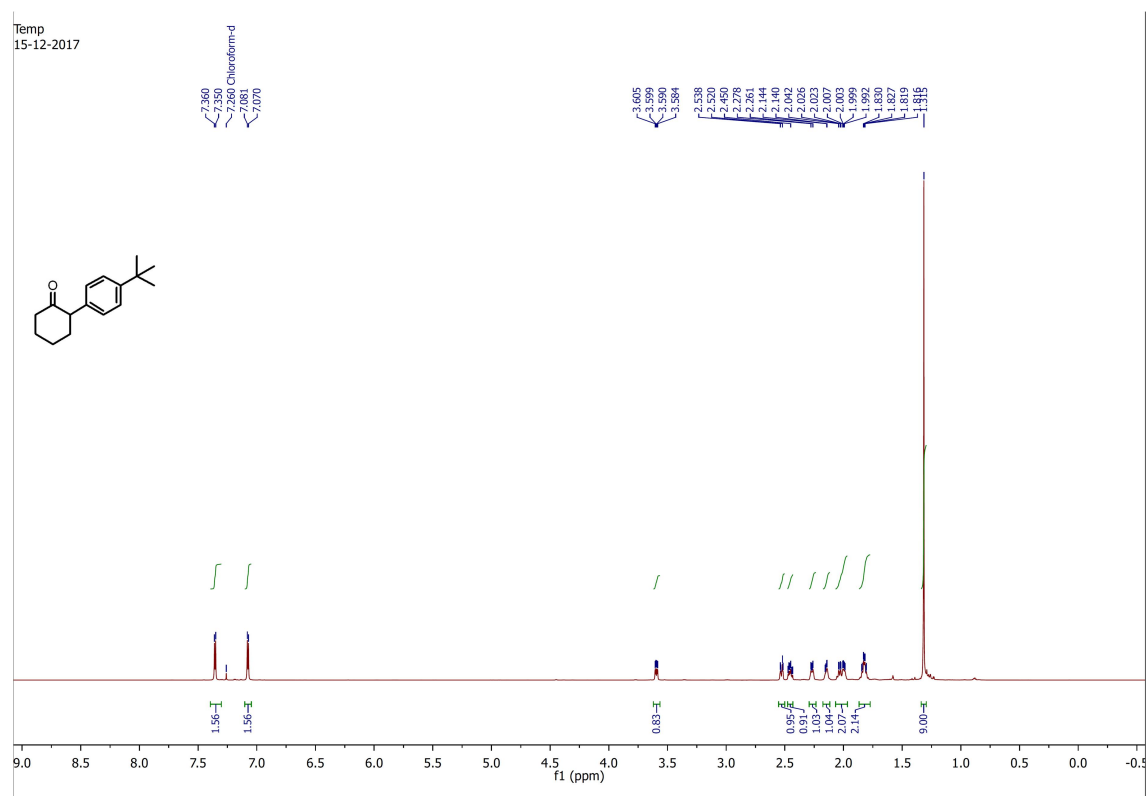
Jan20-2017
GP-SKT-80



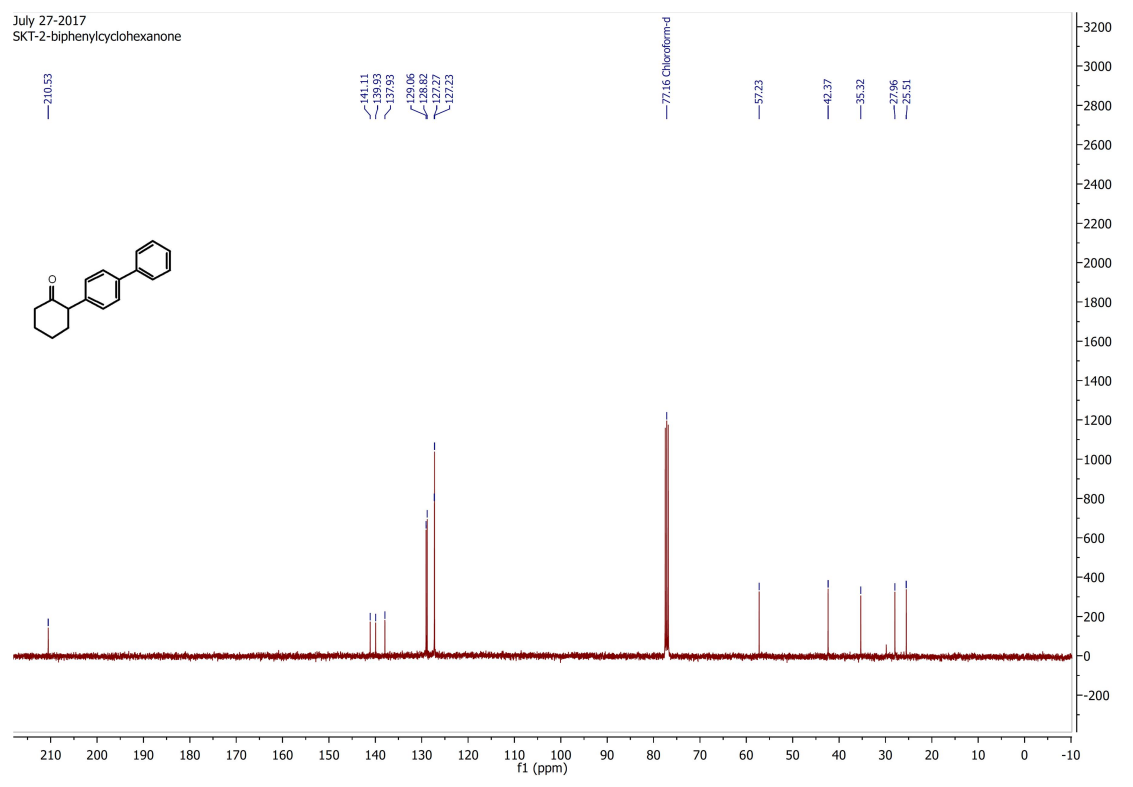
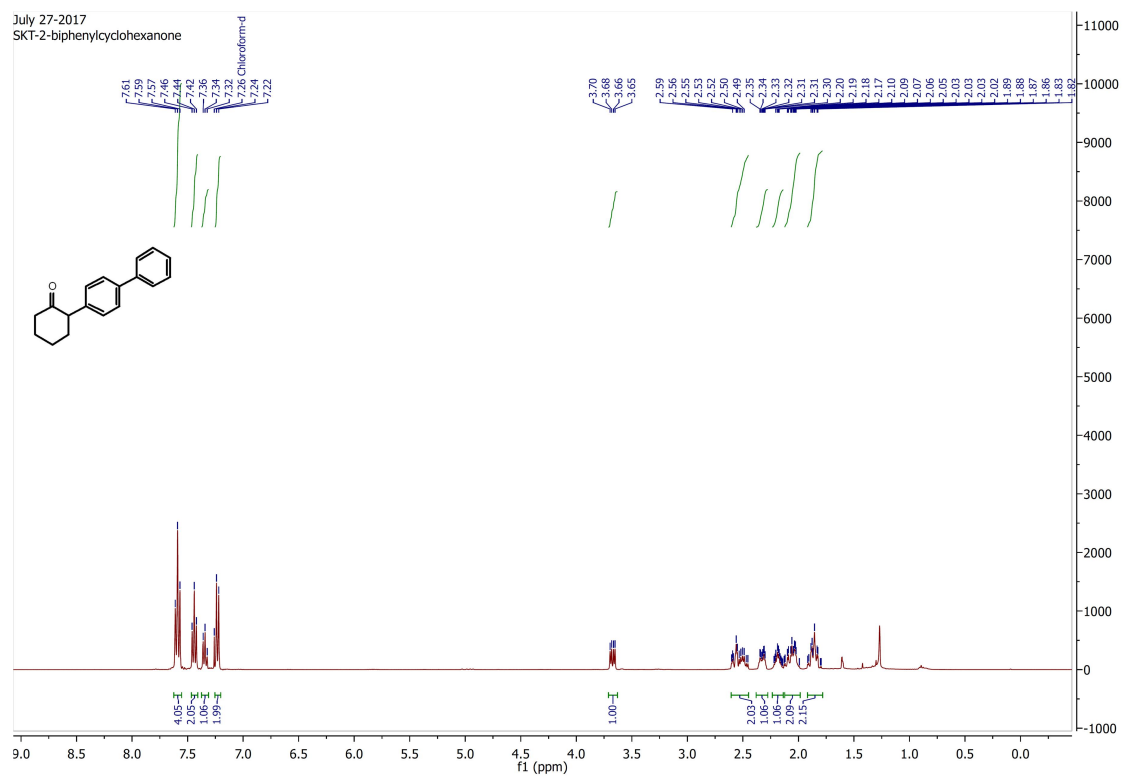
Jan20-2017
GP-SKT-81



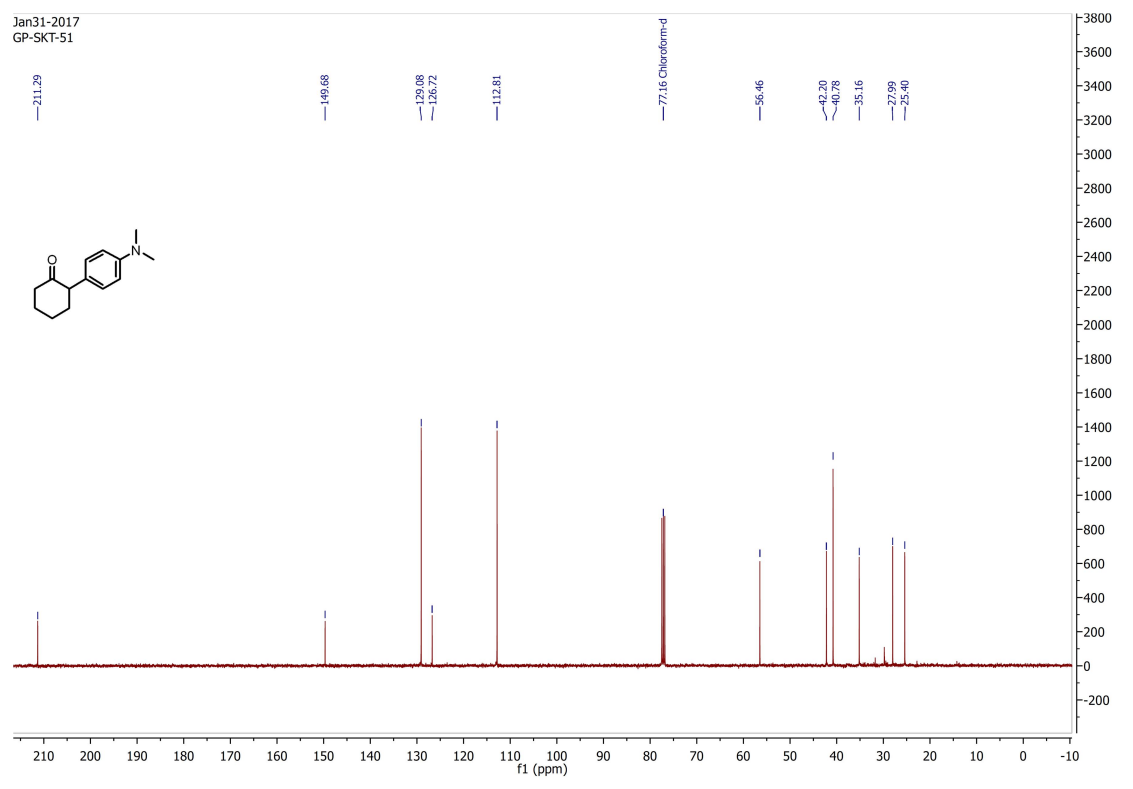
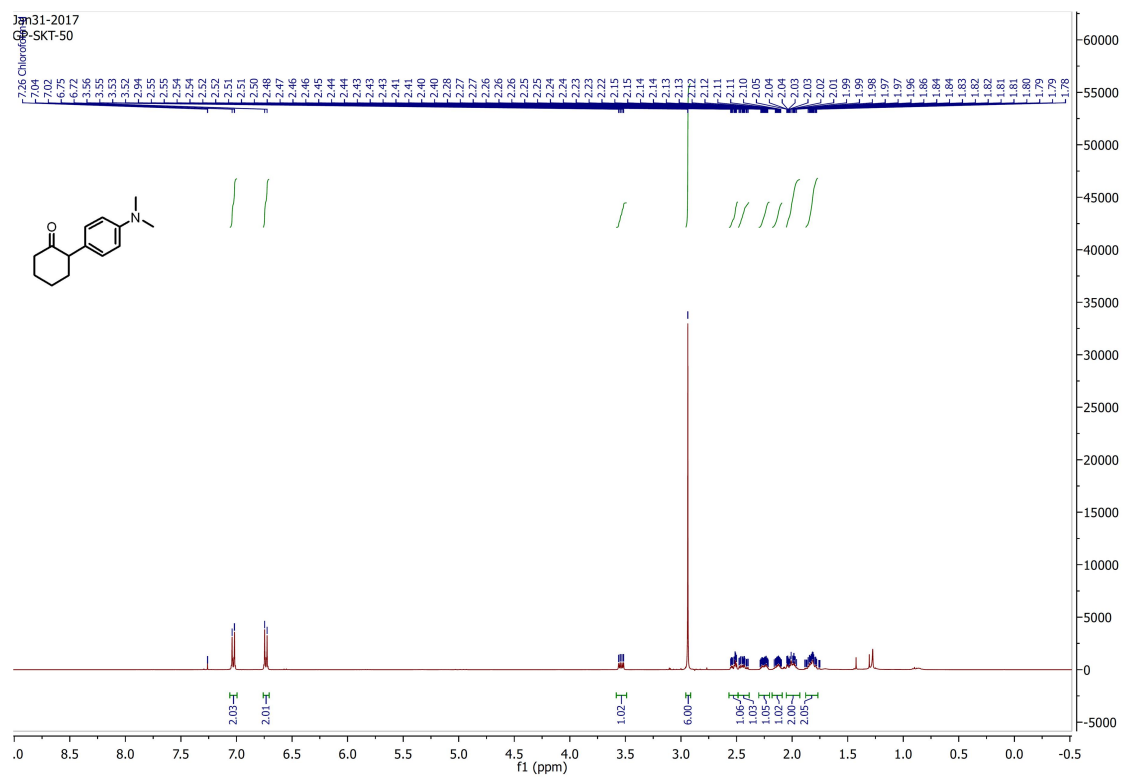
^1H and ^{13}C spectra of (3dk)



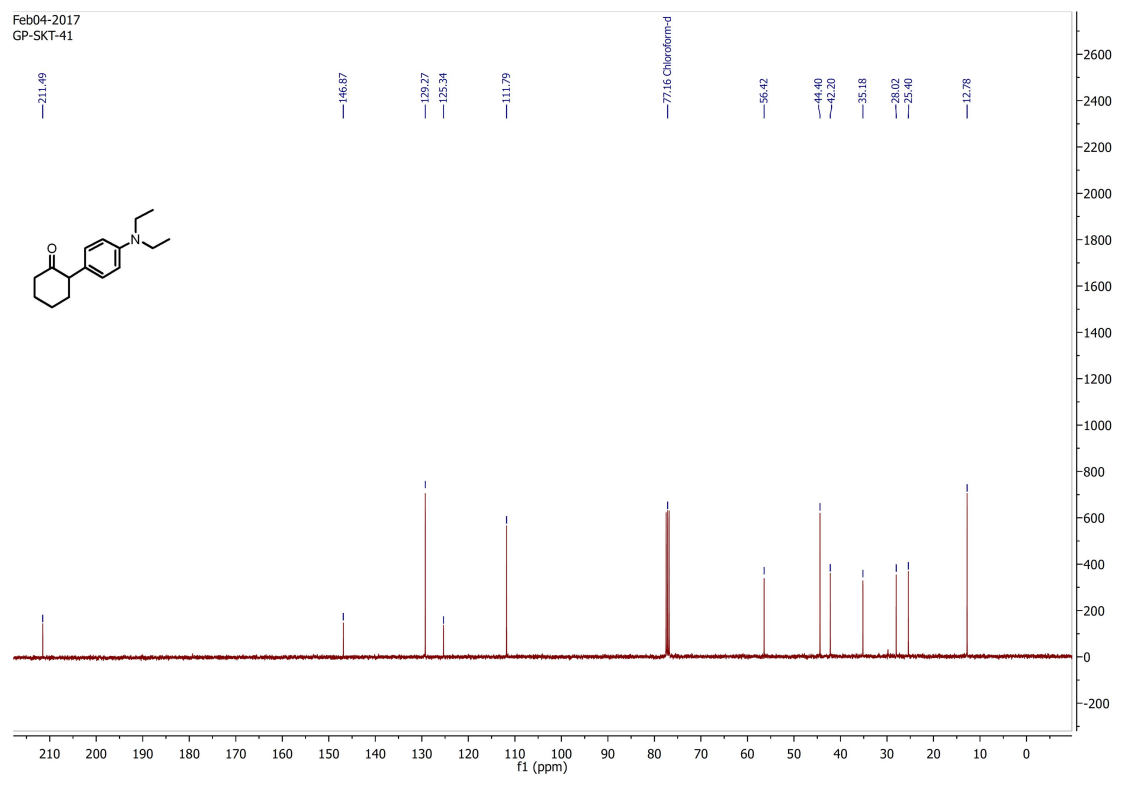
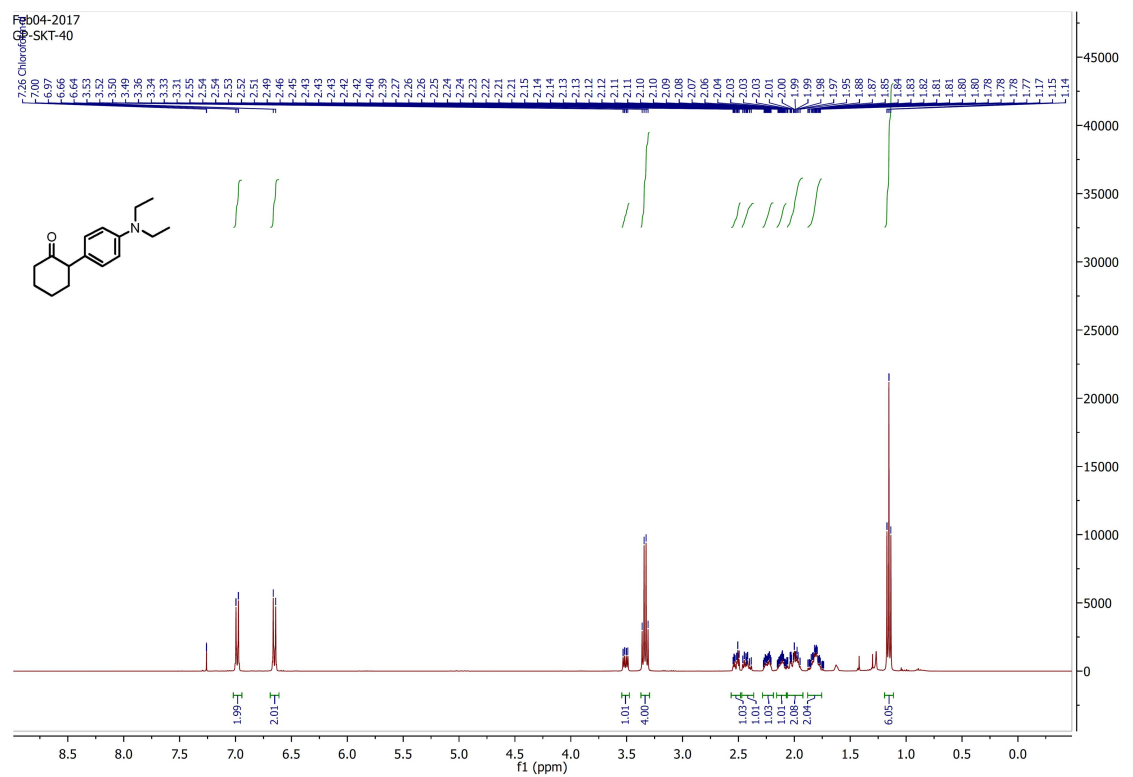
^1H and ^{13}C spectra of (3dl)



^1H and ^{13}C spectra of (3dn)

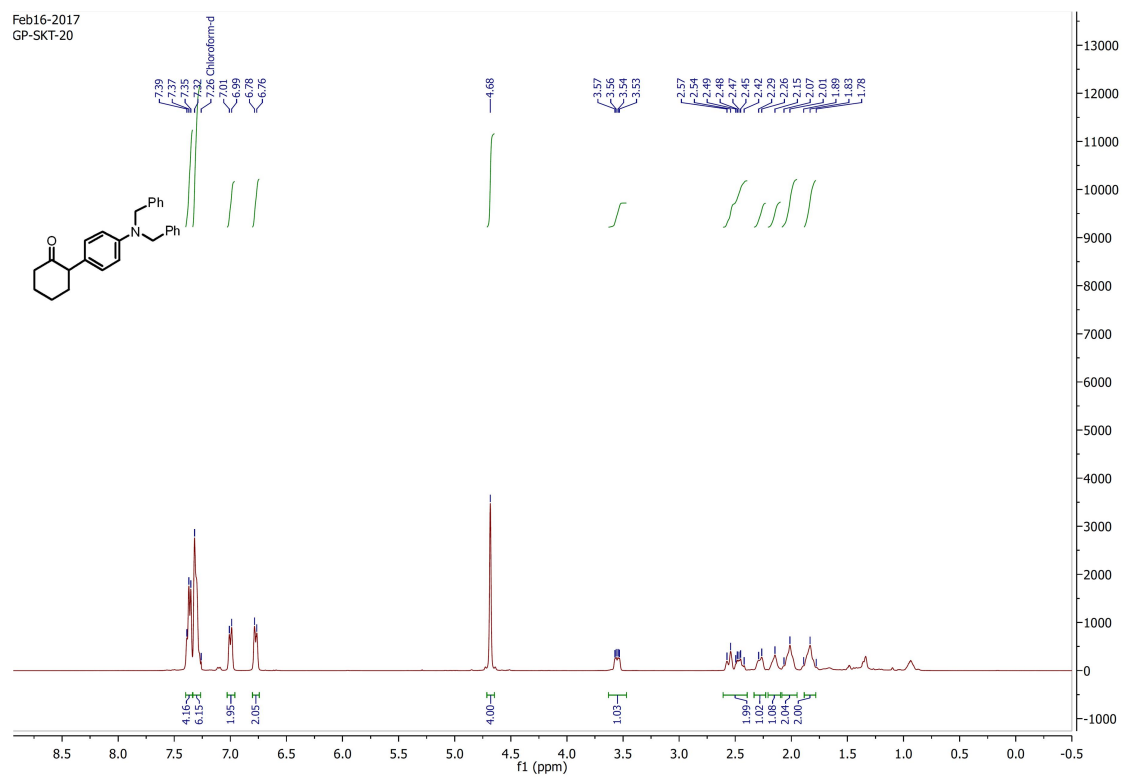


^1H and ^{13}C spectra of (3do)

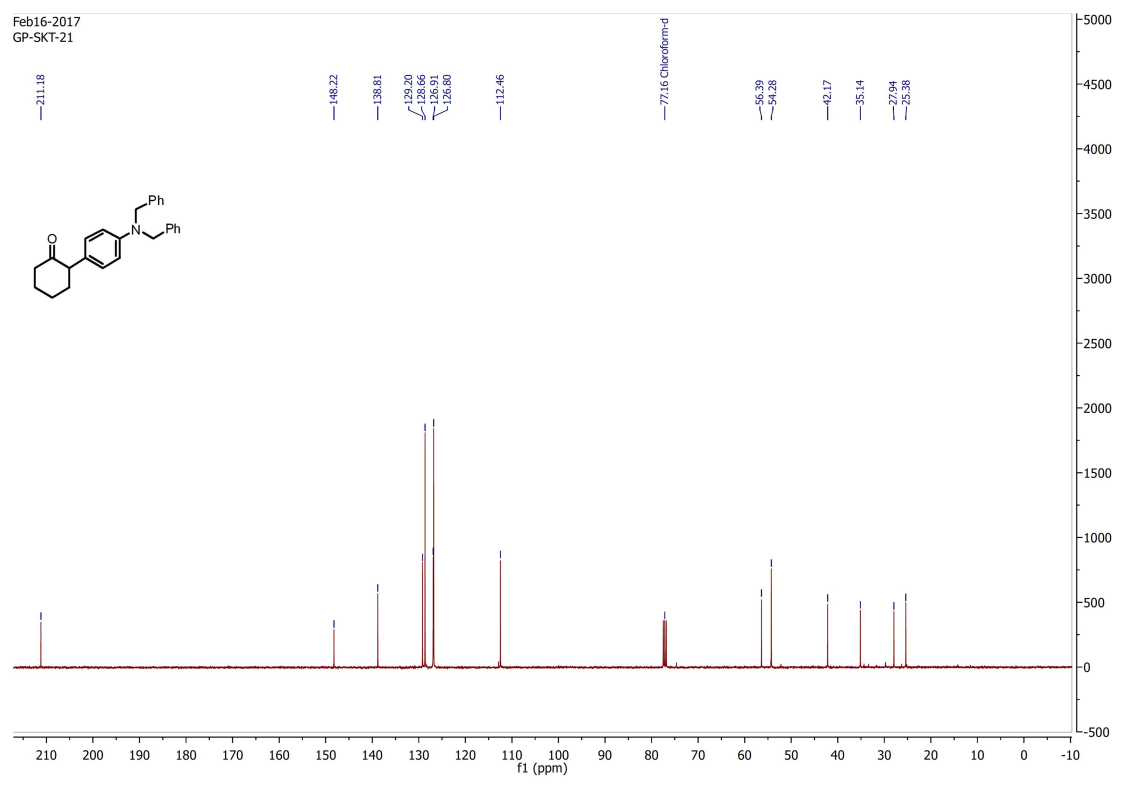


^1H and ^{13}C spectra of (3dp)

Feb16-2017
GP-SKT-20

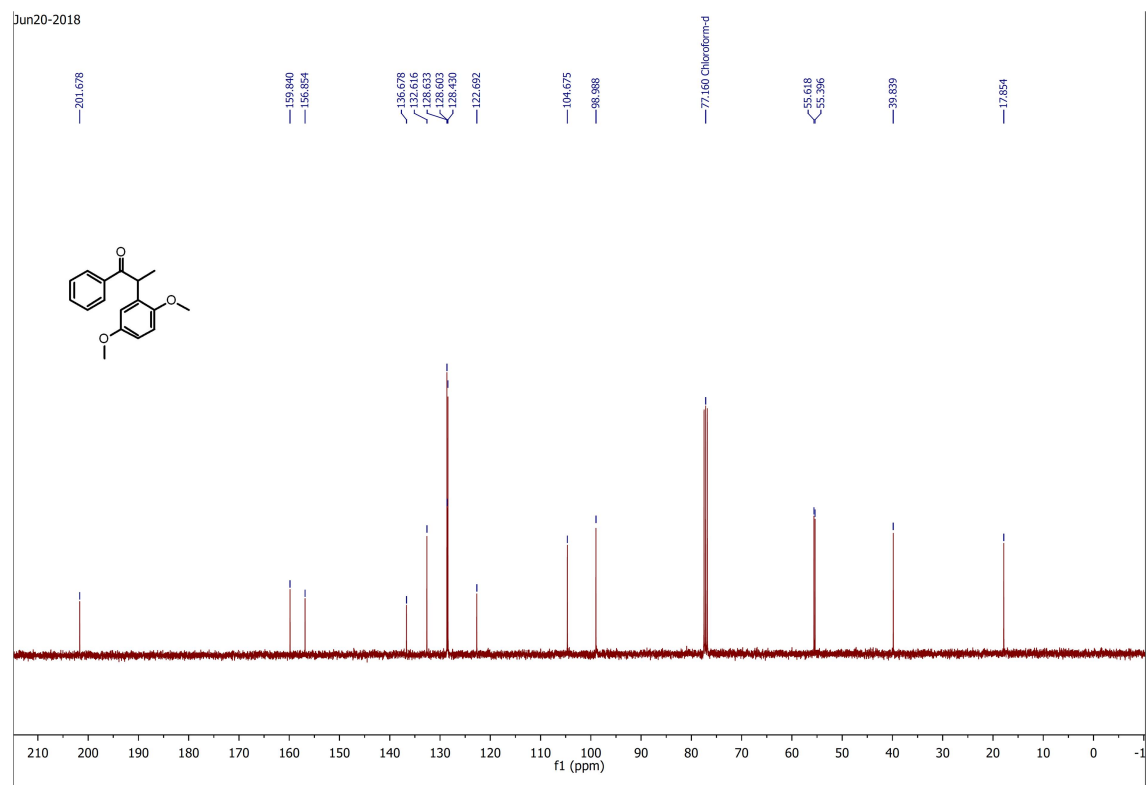
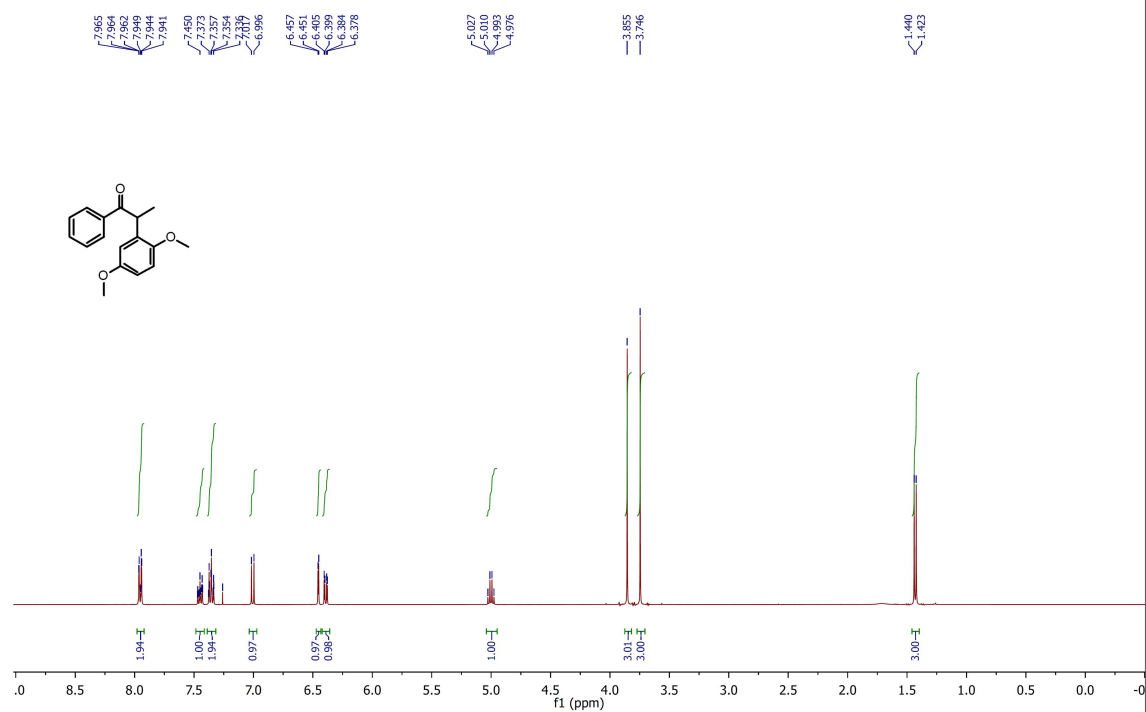


Feb16-2017
GP-SKT-21



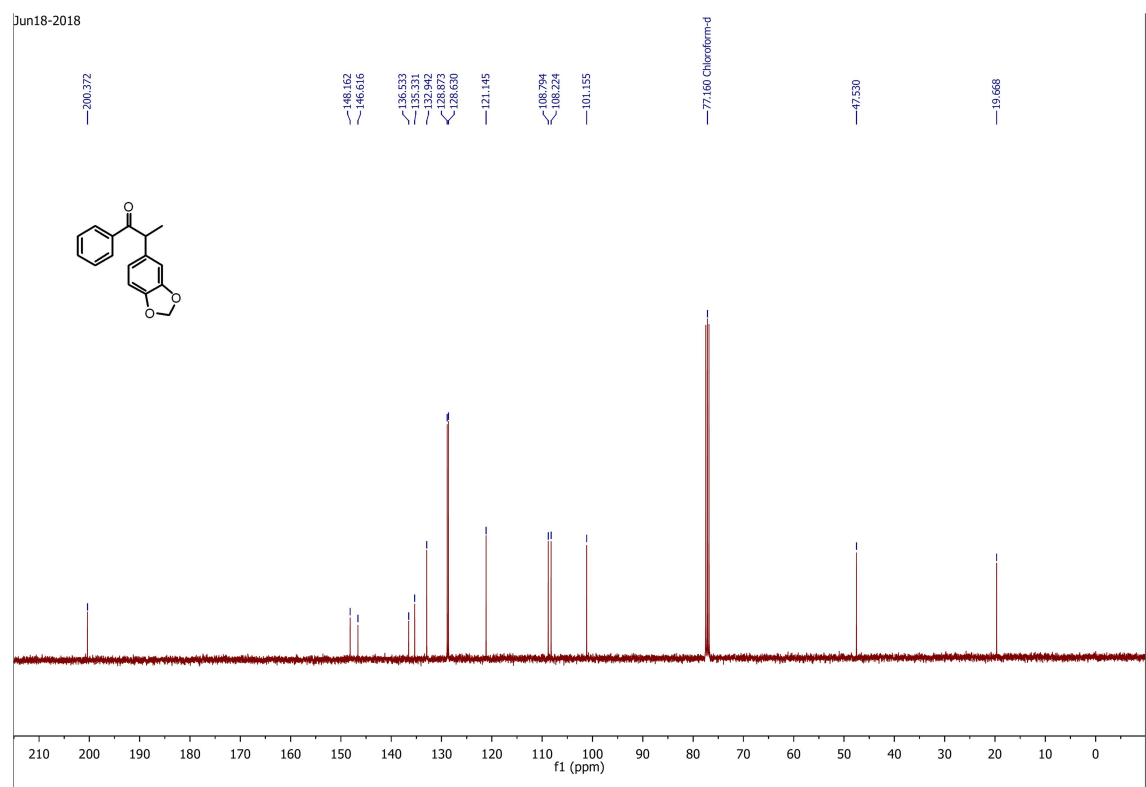
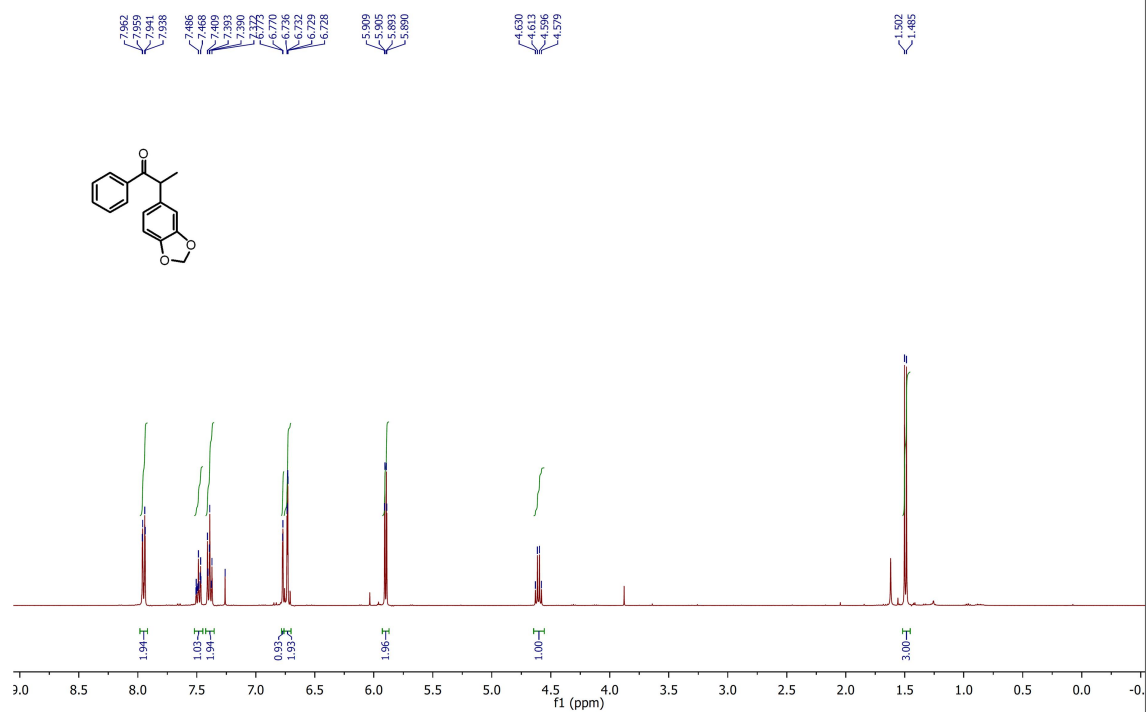
^1H and ^{13}C spectra of (3ed)

Jun20-2018



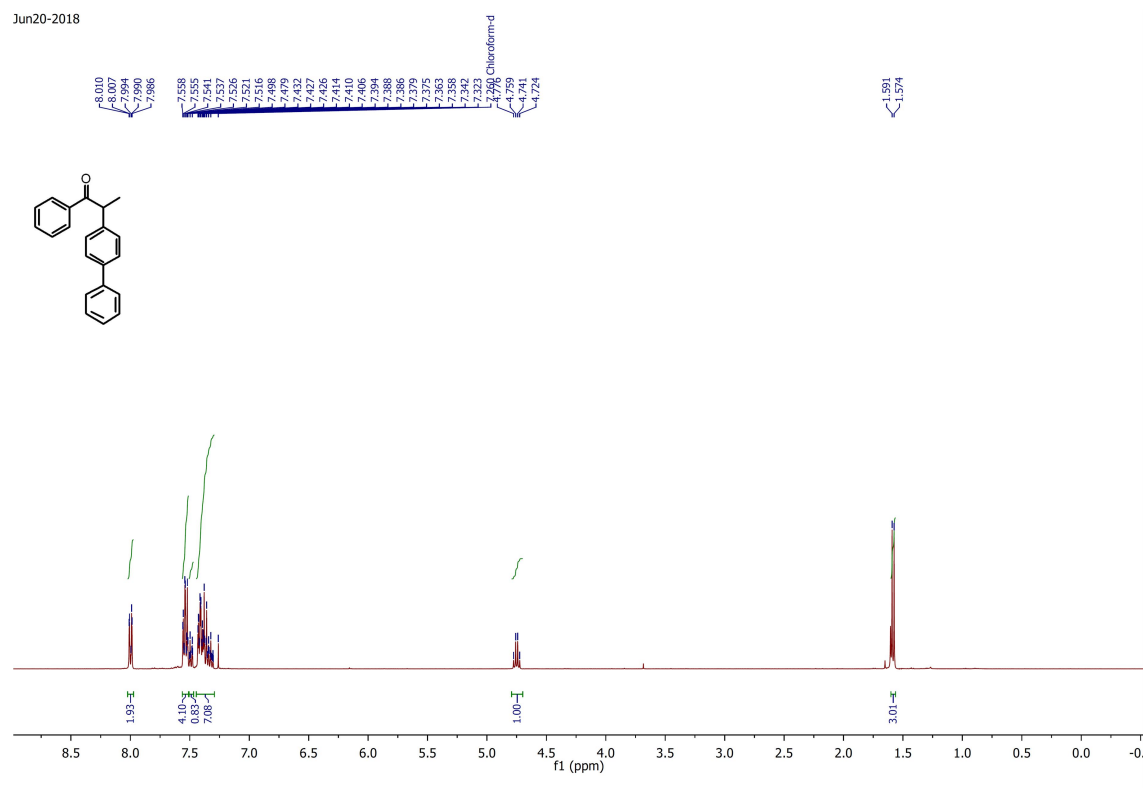
^1H and ^{13}C spectra of (3ee)

Jun18-2018

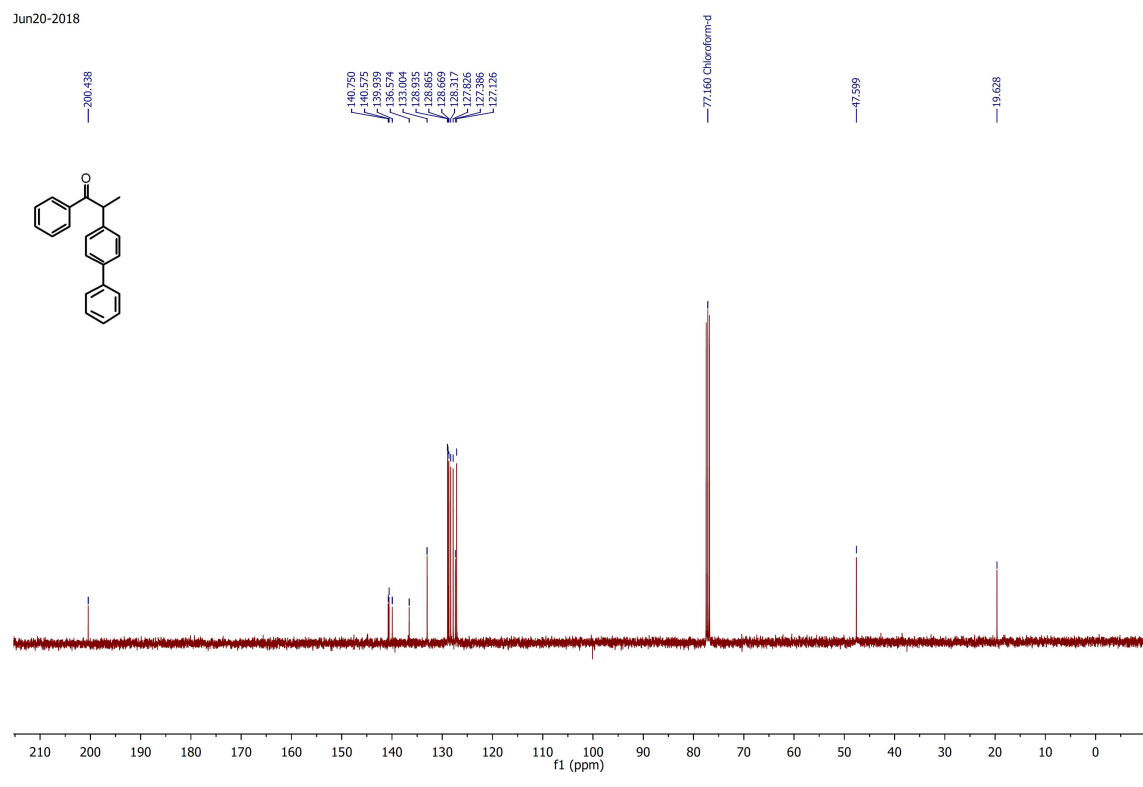


¹H and ¹³C spectra of (3el)

Jun20-2018

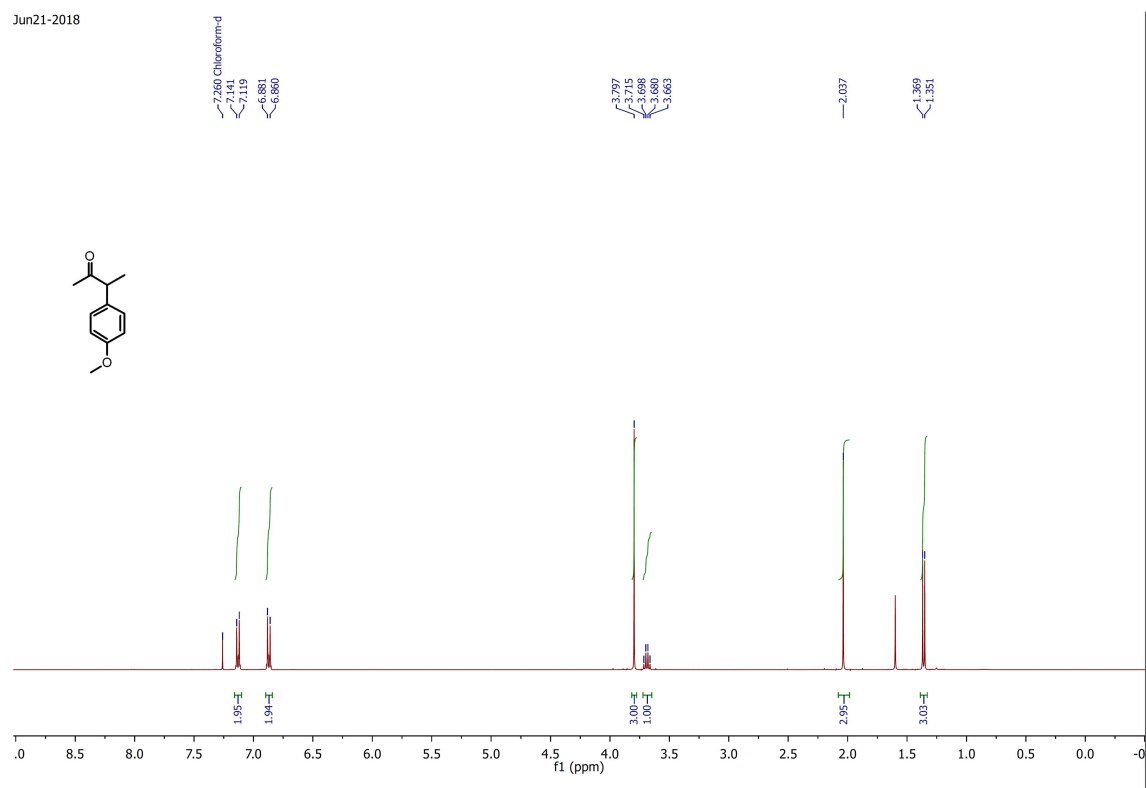


Jun20-2018

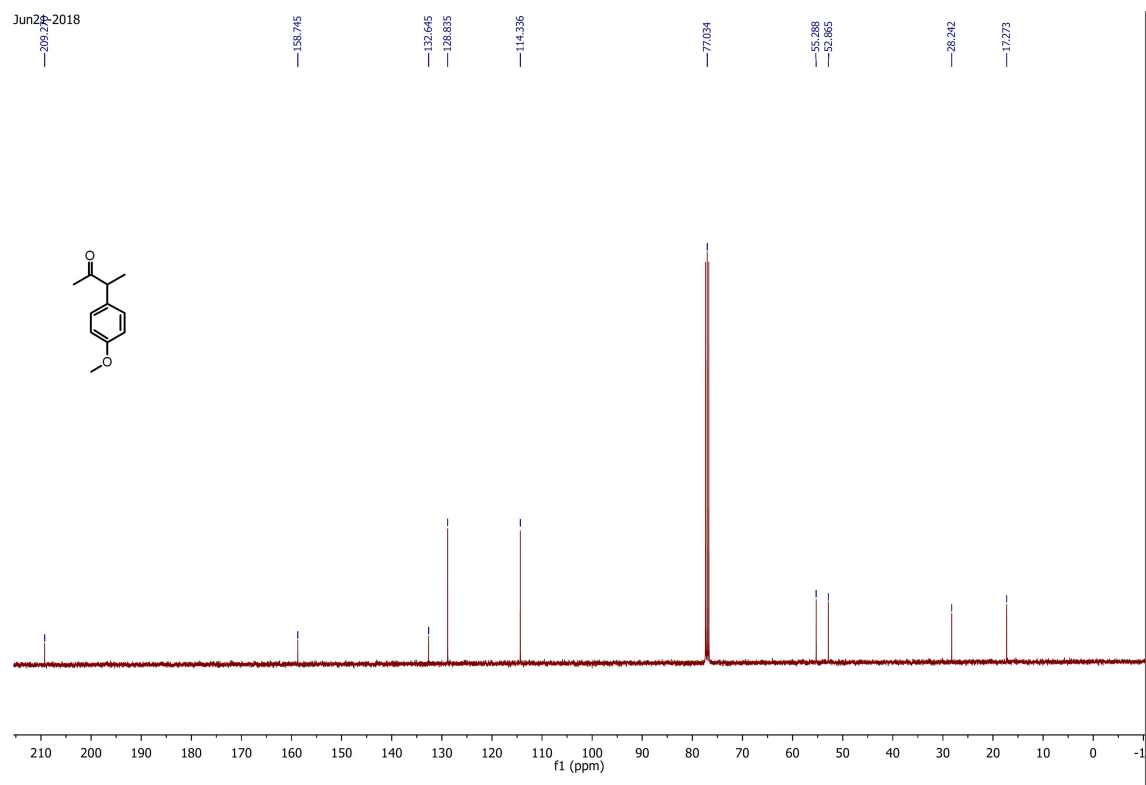


¹H and ¹³C spectra of (3fa)

Jun21-2018

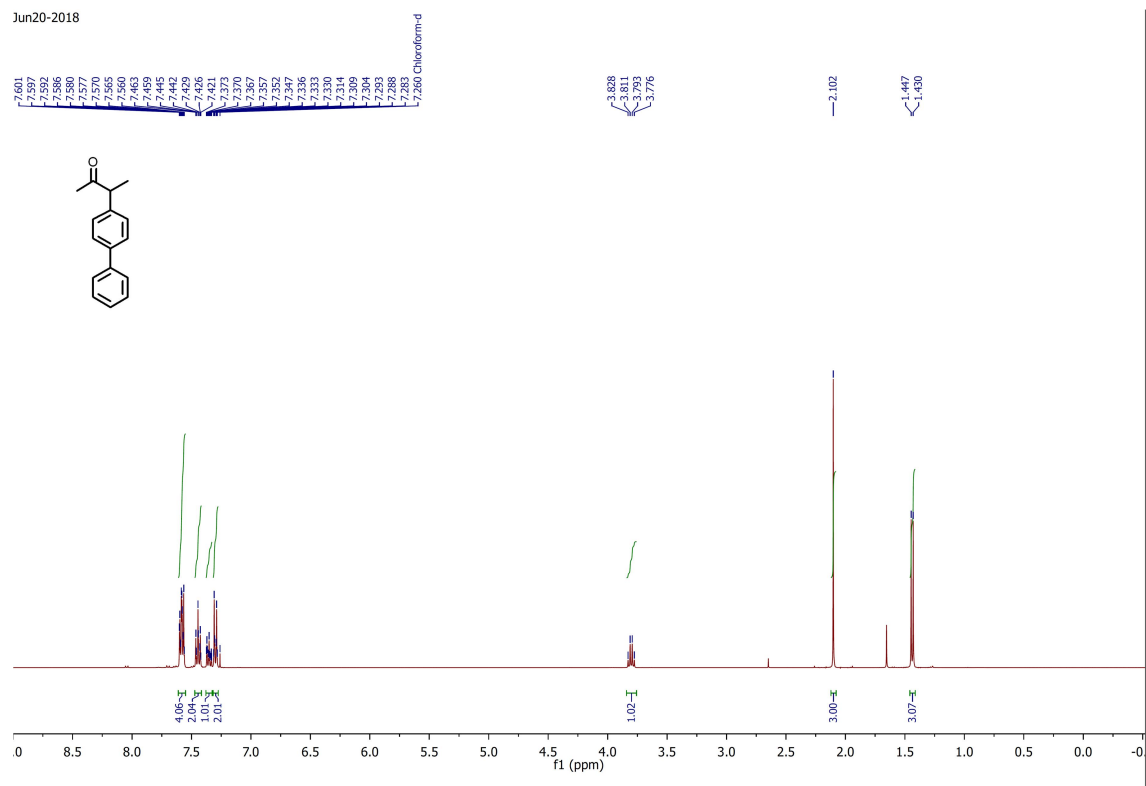


Jun24-2018

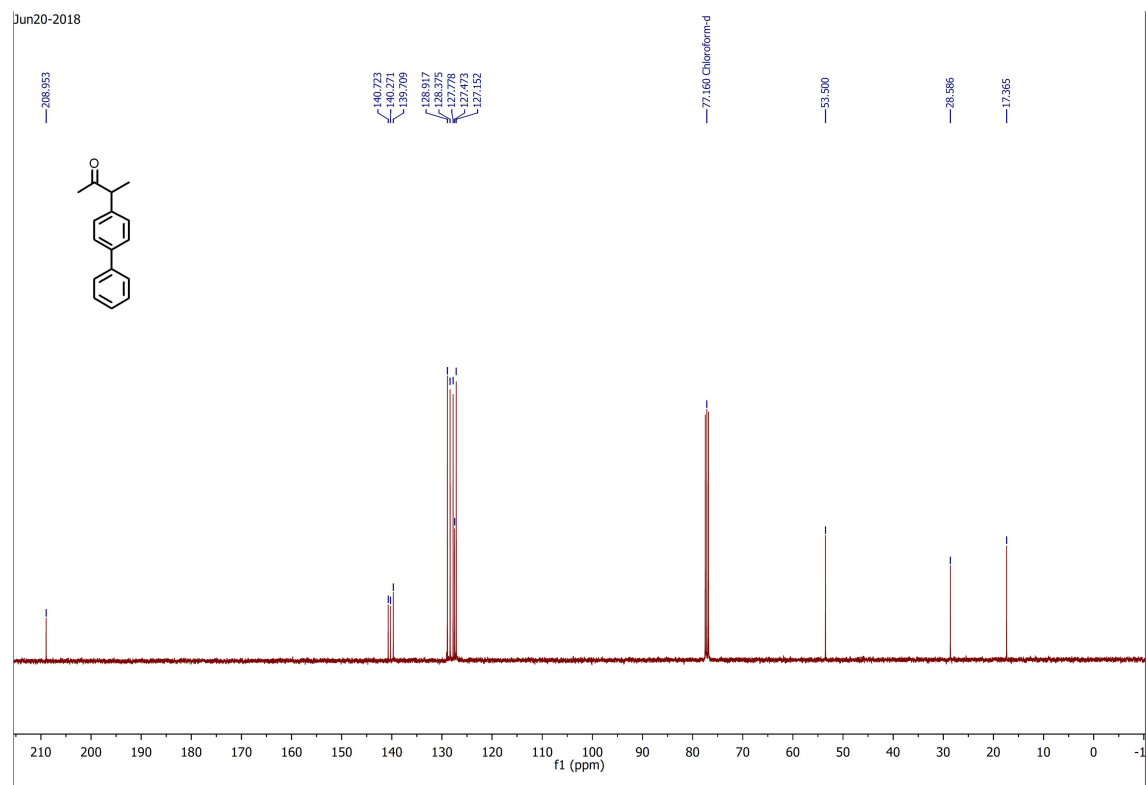


¹H and ¹³C spectra of (3fl)

Jun20-2018

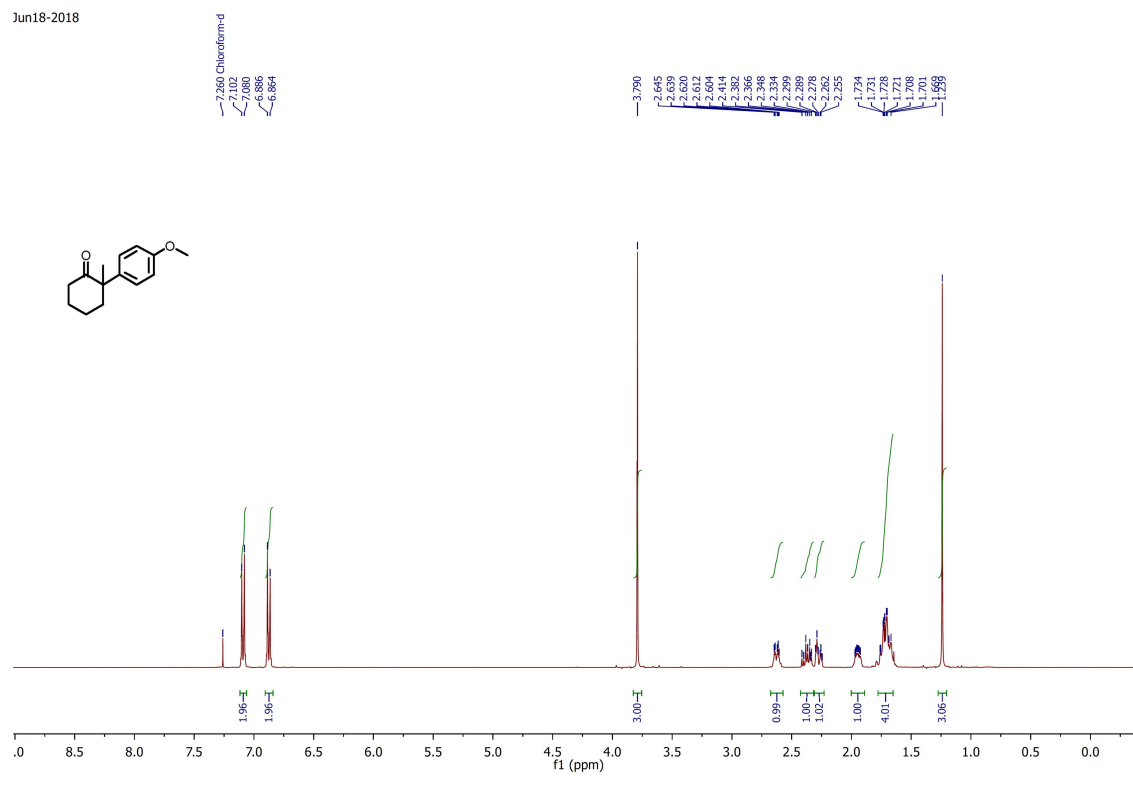


Jun20-2018

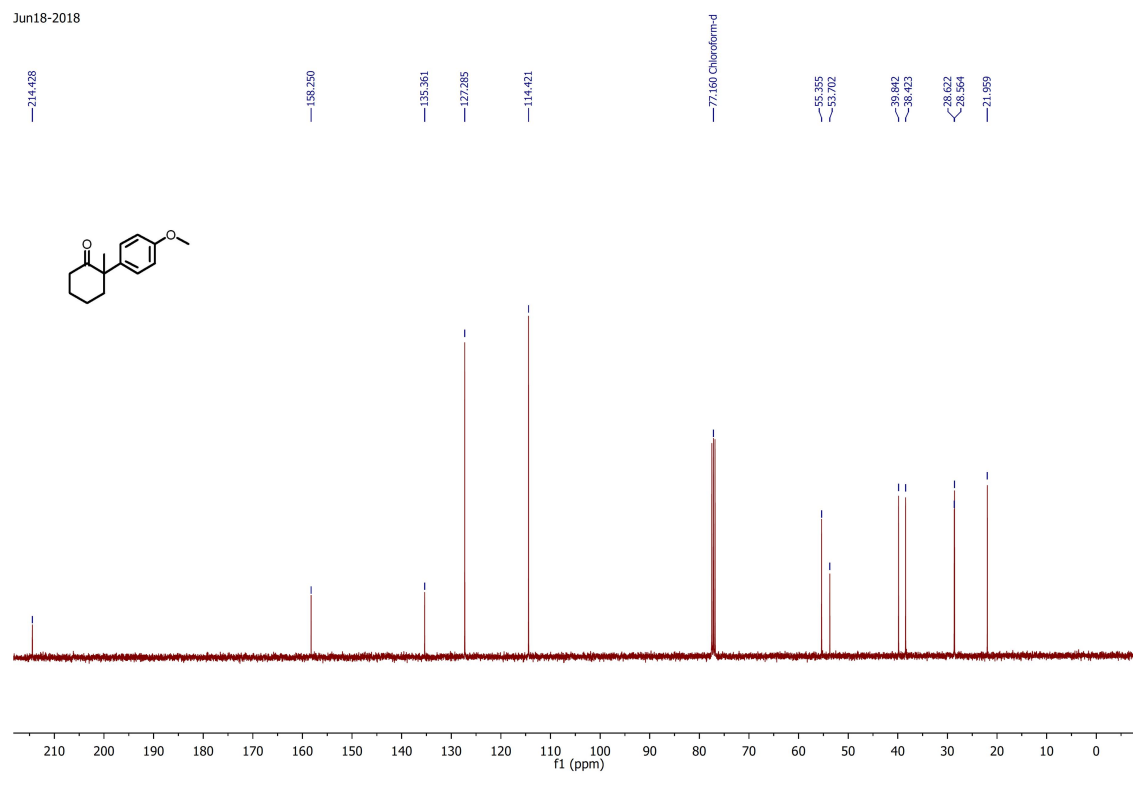


^1H and ^{13}C spectra of (3ga)

Jun18-2018

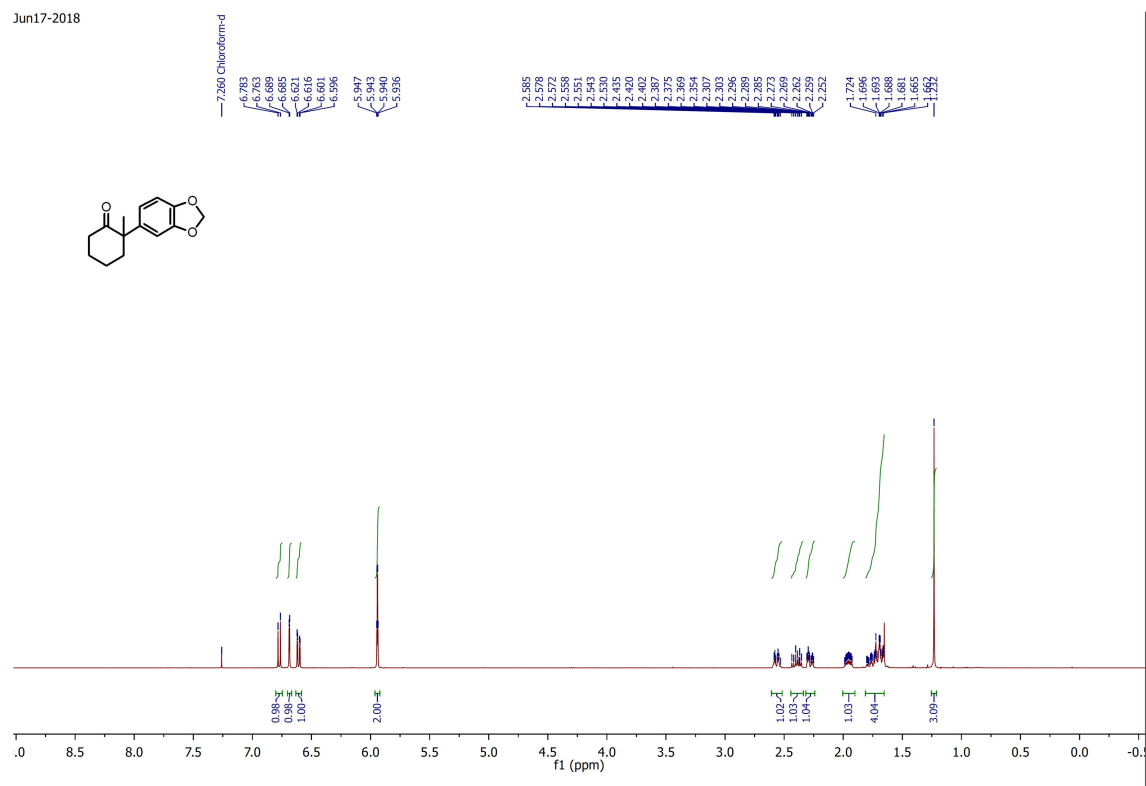


Jun18-2018

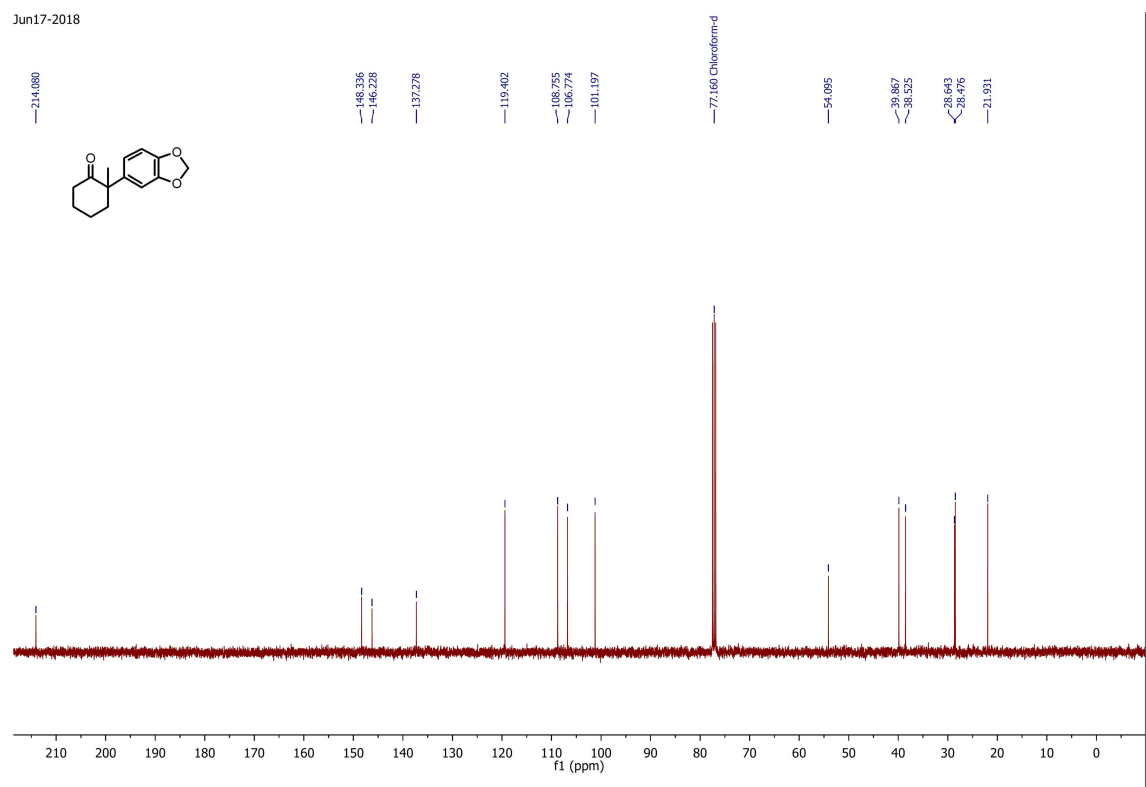


¹H and ¹³C spectra of (3ge)

Jun17-2018

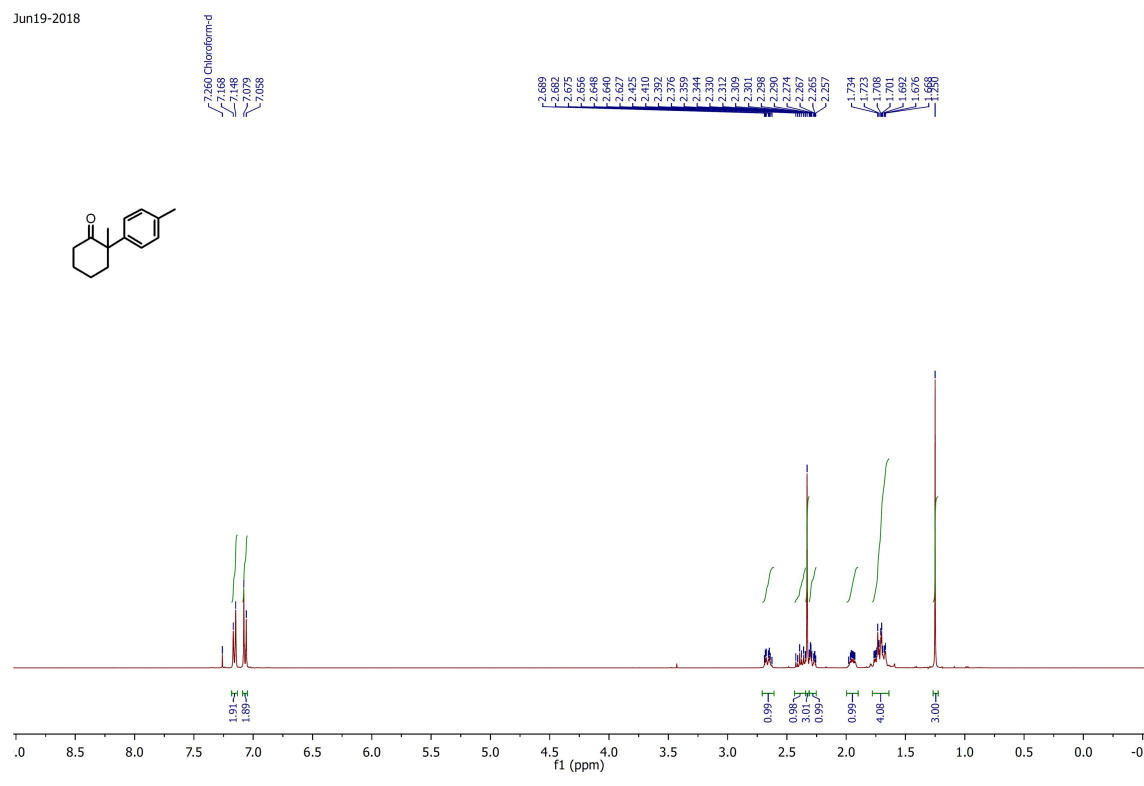


Jun17-2018

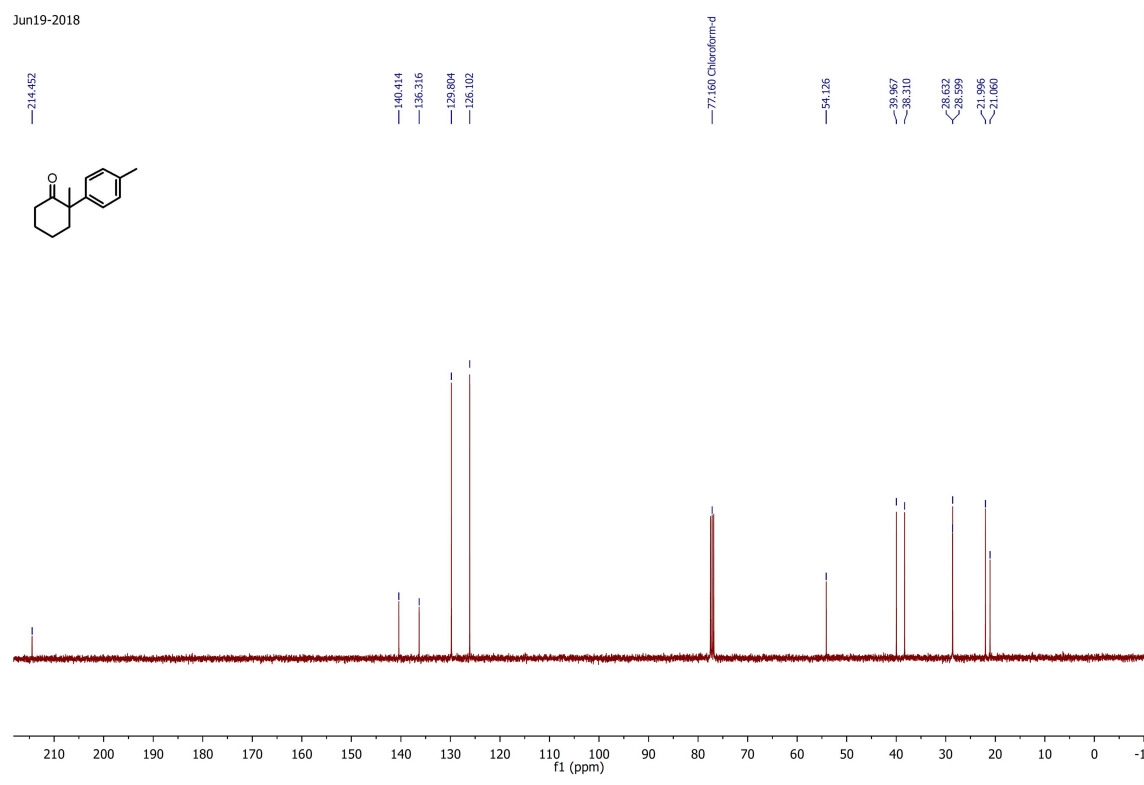


^1H and ^{13}C spectra of (3gf)

Jun19-2018

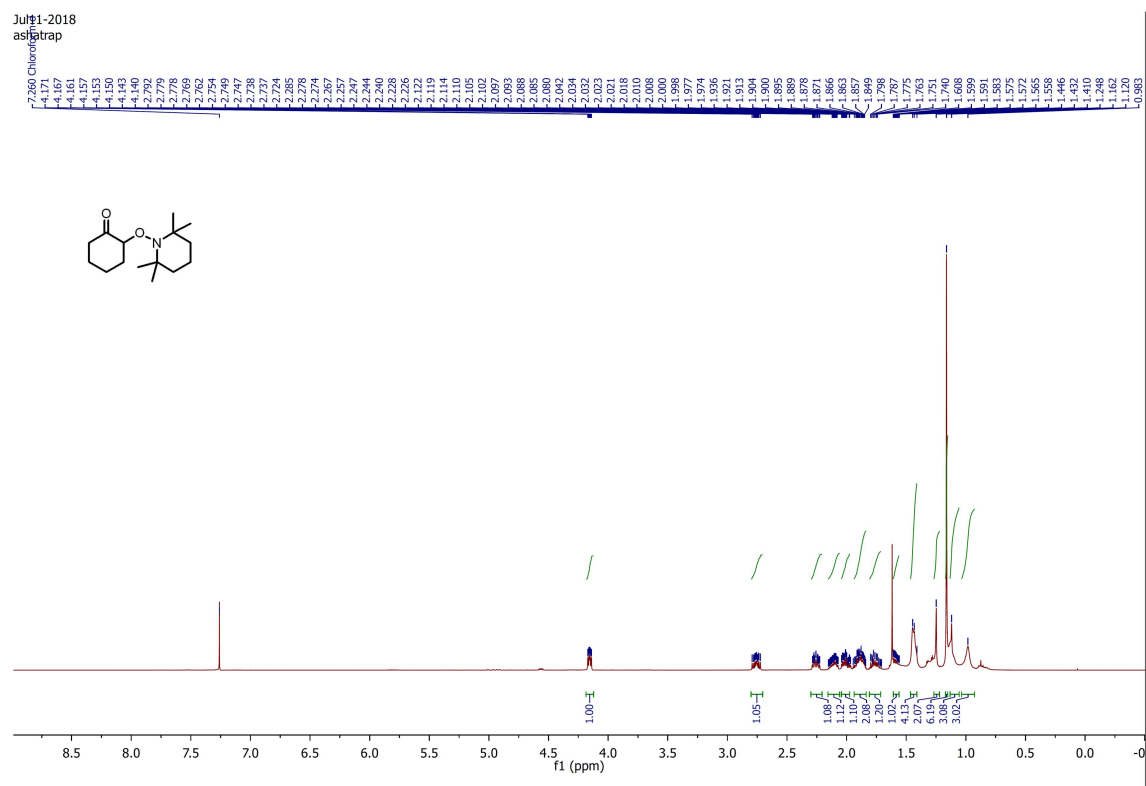


Jun19-2018



^1H and ^{13}C spectra of (5)

Jul11-2018
ashatrap



Jul11-2018
ashatrap

