

# Ag(I)/persulfate-catalyzed Decarboxylative Coupling of $\alpha$ -Oxocarboxylates with Organotrifluoroborates under Room Temperature

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## Supporting Materials

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## **General**

Starting materials and solvents were purchased from common commercial sources and were used without additional purification.  $^1\text{H}$  NMR spectra were recorded at 400 MHz and  $^{13}\text{C}$  NMR spectra were recorded at 100 MHz, using TMS as internal standard. Multiplicities are reported as: singlet (s), doublet (d), triplet (t) and multiplet (m). HRMS (EI) data were collected on High Resolution mass spectrometer.

### **Preparation of Potassium Aryltrifluoroborate Salts:**

The arylboronic acid (10 mmol) was dissolved in methanol (5 mL), A solution of saturated  $\text{KHF}_2$ (10 mL) was added slowly to the mixture with intense stirring in 10 min. The precipitation was washed with cold methanol and using acetonitrile for recrystallization to afford the corresponding aryltrifluoroborate salts.

### **Preparation of Preparation of Potassium $\alpha$ -Oxocarboxylates:**

A mixture of aryl methyl ketone (10.0 mmol) and selenium dioxide (20.0 mmol) in dry pyridine (5 mL) was stirred at  $120^\circ\text{C}$  under nitrogen for 12 h. After the disappearance of acetophenone detected by TLC, the mixture was filtrated and removing the organic solvent by evaporation. Then 2 M potassium hydroxide solution was added to the residue and some ethyl acetate followed. The aqueous was subsequently evaporated and potassium  $\alpha$ -oxocarboxylates were obtained by recrystallization.

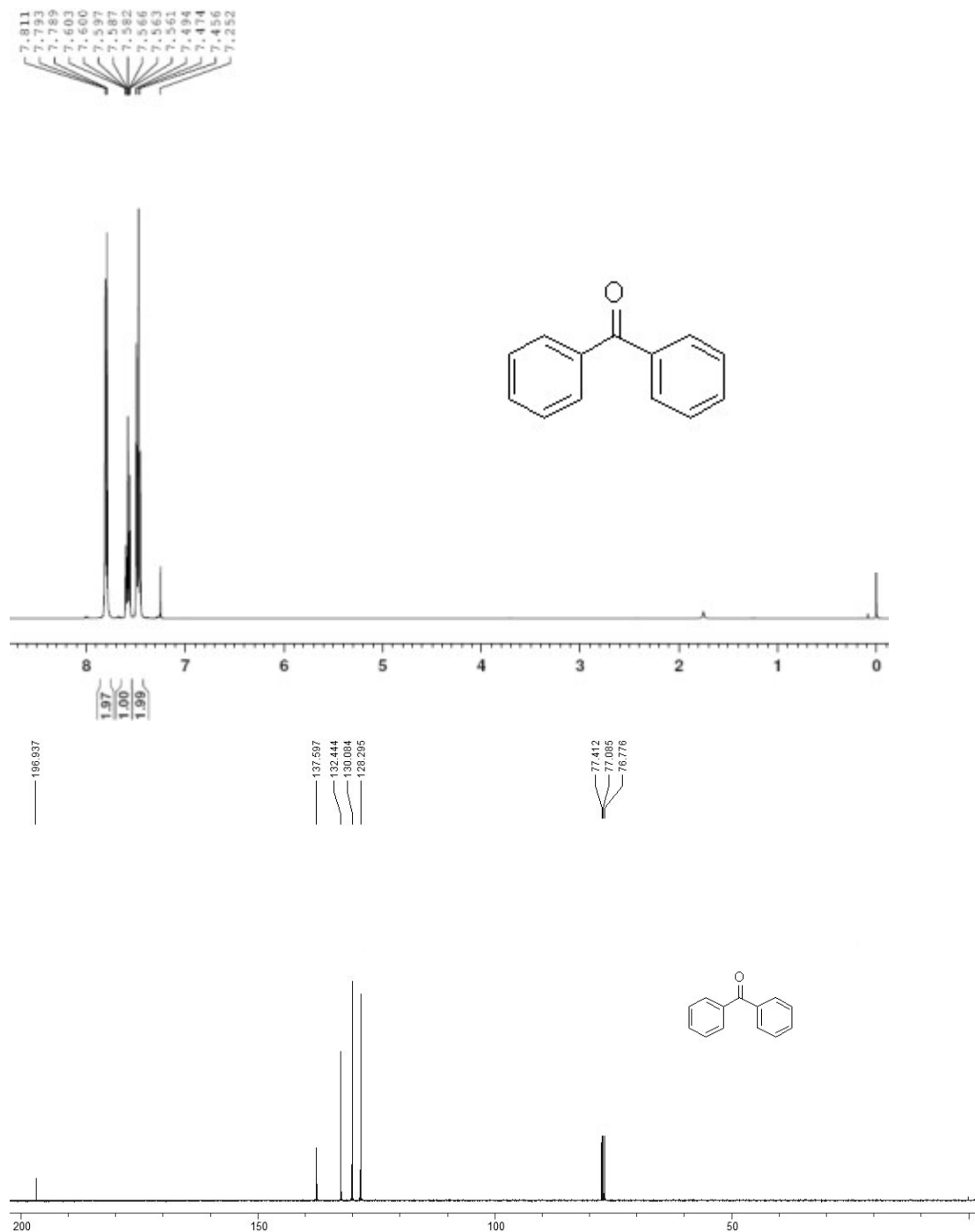
### **General procedure for Ag(I)/persulfate-catalyzed Decarboxylative Coupling**

A mixture of potassium  $\alpha$ -oxocarboxylates (1 mmol), aryltrifluoroborates (1.05 mmol),  $\text{AgNO}_3$  (0.05 mol) and  $\text{K}_2\text{S}_2\text{O}_8$  (1.5 mmol) was stirred in  $\text{H}_2\text{O}$  (2 mL) under room temperature for the indicated time. Afterward, the reaction solution was extracted four times with  $\text{CH}_2\text{Cl}_2$  ( $3 \times 2\text{mL}$ ), and the combined organic phase was subjected to evaporation. The further purification of the product was achieved by flash chromatography on a silica gel column.

Characterization data of the product

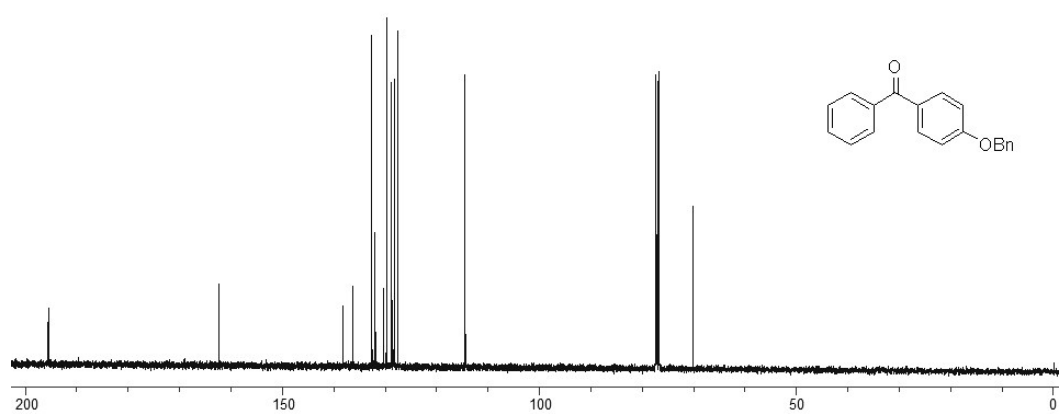
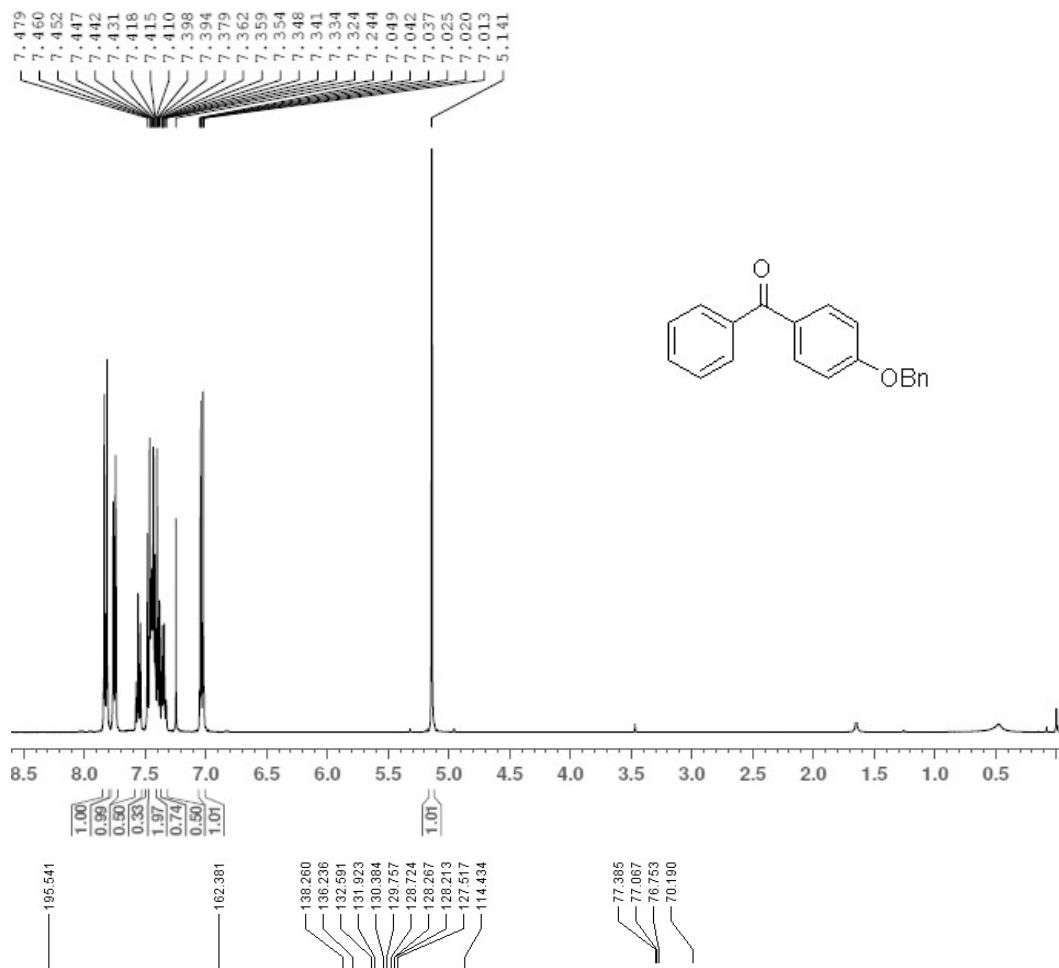
**(1) benzophenone (3a)**

m.p. 48–49 °C (lit.<sup>1</sup> mp 47–48 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.82 ( d, *J* = 8.0 Hz, 4 H ), 7.58 ( t, *J* = 7.6 Hz, 2 H ), 7.47 ( t, *J* = 7.6 Hz, 4 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 197.0, 137.6, 132.5, 130.1, 128.3. HRMS (EI) Calcd for C<sub>13</sub>H<sub>10</sub>O (M<sup>+</sup>) 182.0732, Found 182.0738.



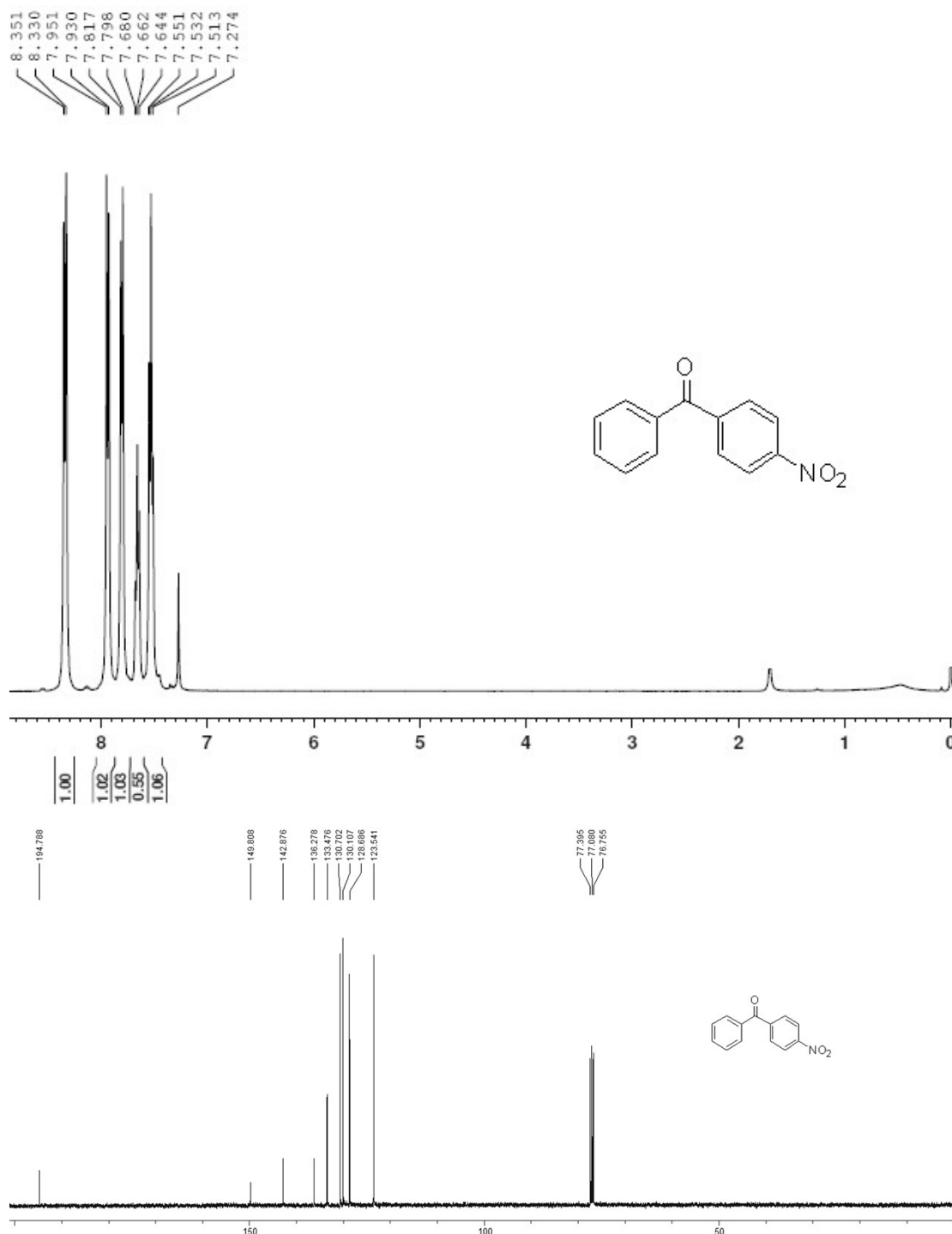
**(2) 4-benzyloxy-benzophenone (3b)**

m.p. 83–85 °C (lit.<sup>1</sup> mp 82–85 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.82 ( d, *J* = 8.4 Hz, 2 H ), 7.75 ( t, *J* = 7.2 Hz, 2 H ), 7.55 ( t, *J* = 7.2 Hz, 1 H ), 7.32-7.48 ( m, 7 H ), 7.03 ( d, *J* = 8.4 Hz, 2 H ), 5.14 ( s, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.5, 162.4, 138.3, 136.2, 132.6, 131.9, 130.4, 129.8, 128.7, 128.3, 128.2, 127.5, 114.4, 70.2. HRMS (EI) Calcd for C<sub>20</sub>H<sub>16</sub>O<sub>2</sub> (M<sup>+</sup>) 288.1150, Found 288.1143.



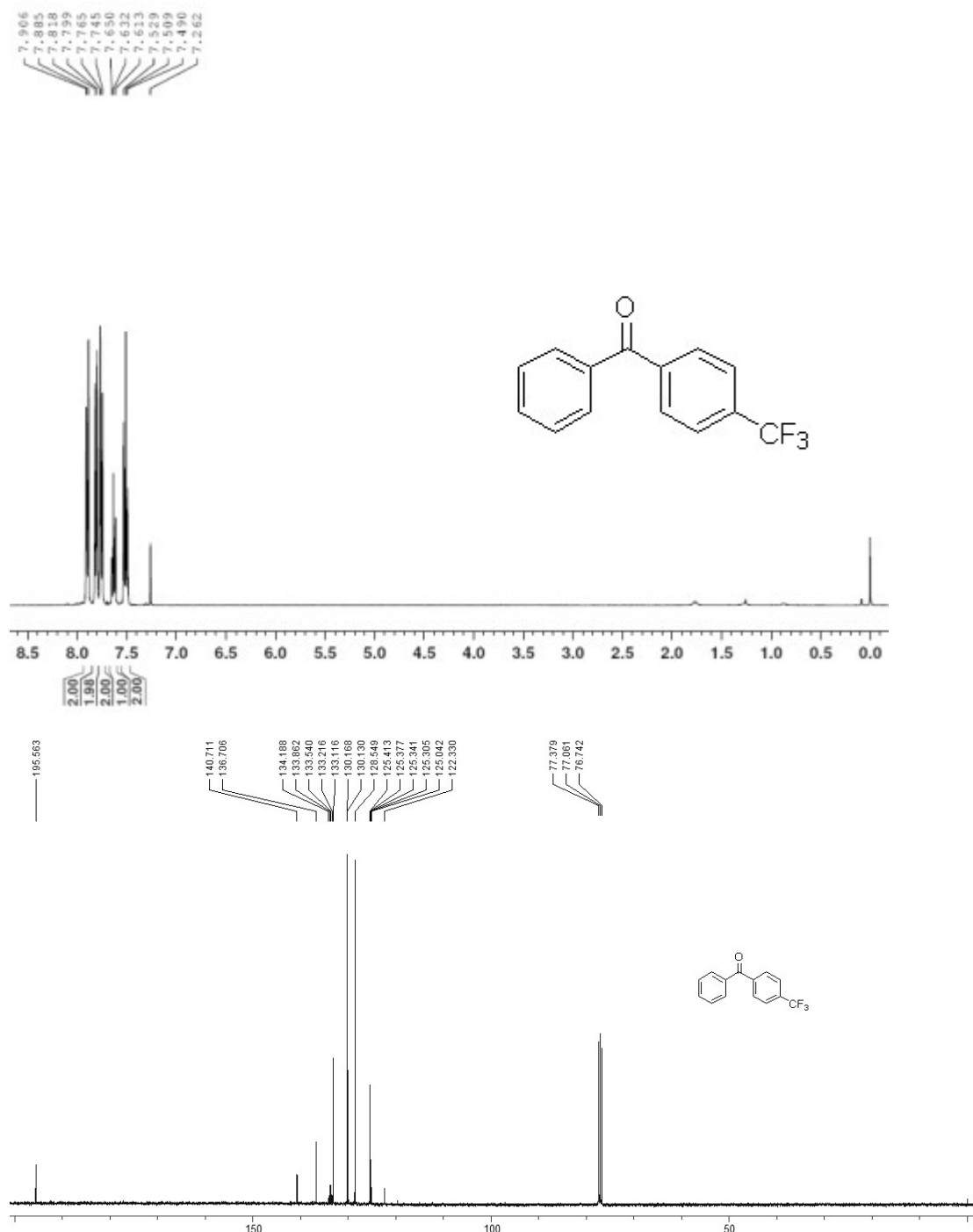
(3) 4-nitrobenzophenone (3c)

m.p. 142–143 °C (lit.<sup>2</sup> mp 140–142 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 8.36 ( d, *J* = 7.6 Hz, 2 H ), 7.94 ( d, *J* = 7.6 Hz, 2 H ), 7.83 ( d, *J* = 7.6 Hz, 2 H ), 7.67 ( t, *J* = 7.6 Hz, 1 H ), 7.51 ( t, *J* = 7.6 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 194.8, 149.8, 142.9, 136.3, 133.5, 130.7, 130.1, 128.7, 123.5. HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>NO<sub>3</sub> (M<sup>+</sup>) 227.0582, Found 227.0586.



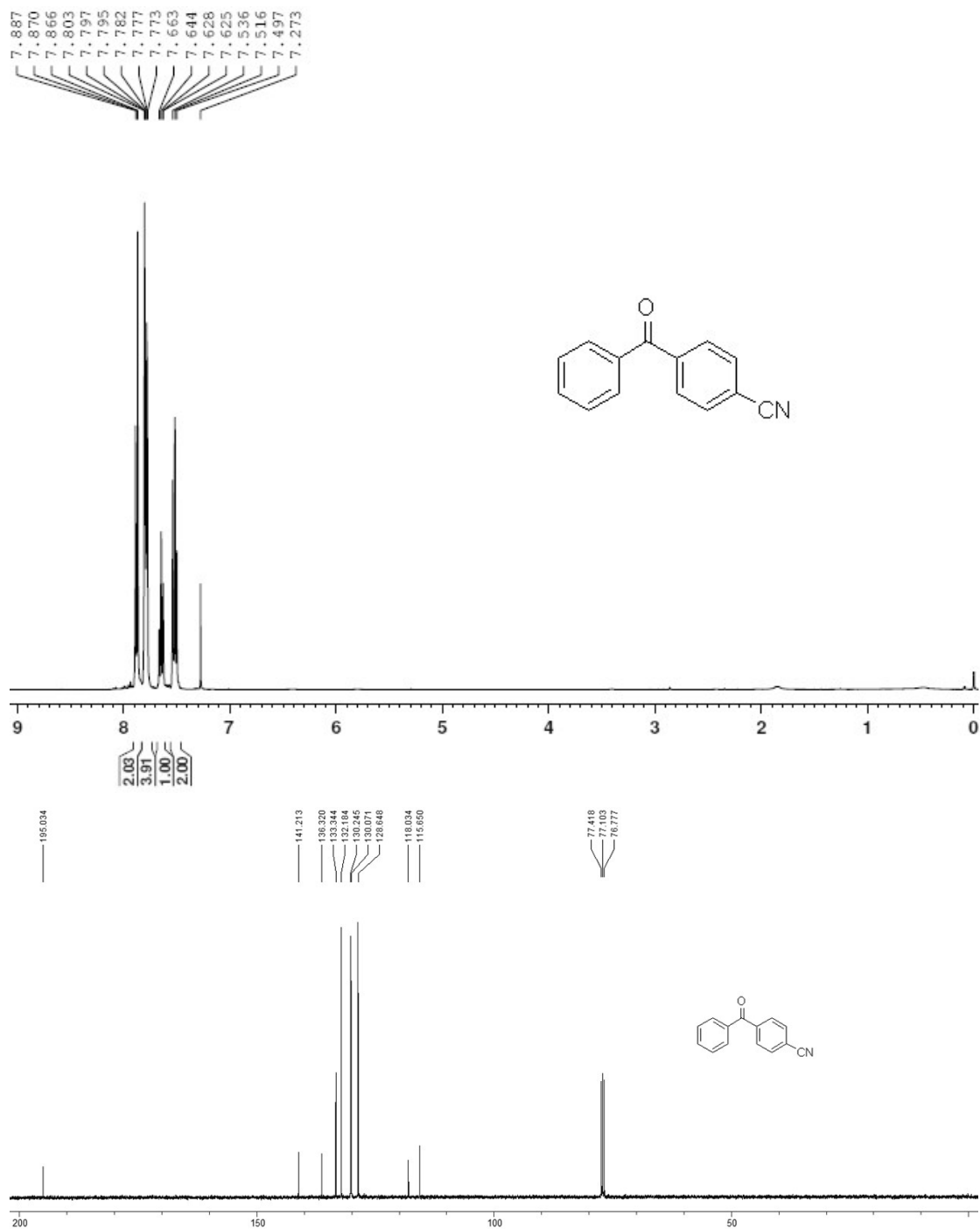
(4) 4-trifluoromethyl-benzophenone (3d)

m.p. 115–117 °C (lit.<sup>2</sup> mp 116–117 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.90 ( d, *J* = 8.0 Hz, 2 H ), 7.81 ( d, *J* = 7.2 Hz, 2 H ), 7.75 ( d, *J* = 8.0 Hz, 2 H ), 7.63 ( t, *J* = 7.2 Hz, 1 H ), 7.52 ( t, *J* = 7.2 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.6, 140.7, 136.7, 133.7 ( dd, *J*<sub>1</sub> = 64.6 Hz, *J*<sub>2</sub> = 32.6 Hz ), 133.1, 130.2 ( d, *J* = 3.8 Hz ), 128.6, 125.4 ( dd, *J*<sub>1</sub> = 7.2 Hz, *J*<sub>2</sub> = 3.6 Hz ), 123.7 ( d, *J* = 271.2 Hz ). HRMS (EI) Calcd for C<sub>14</sub>H<sub>9</sub>F<sub>3</sub>O (M<sup>+</sup>) 250.0605, Found 250.0602



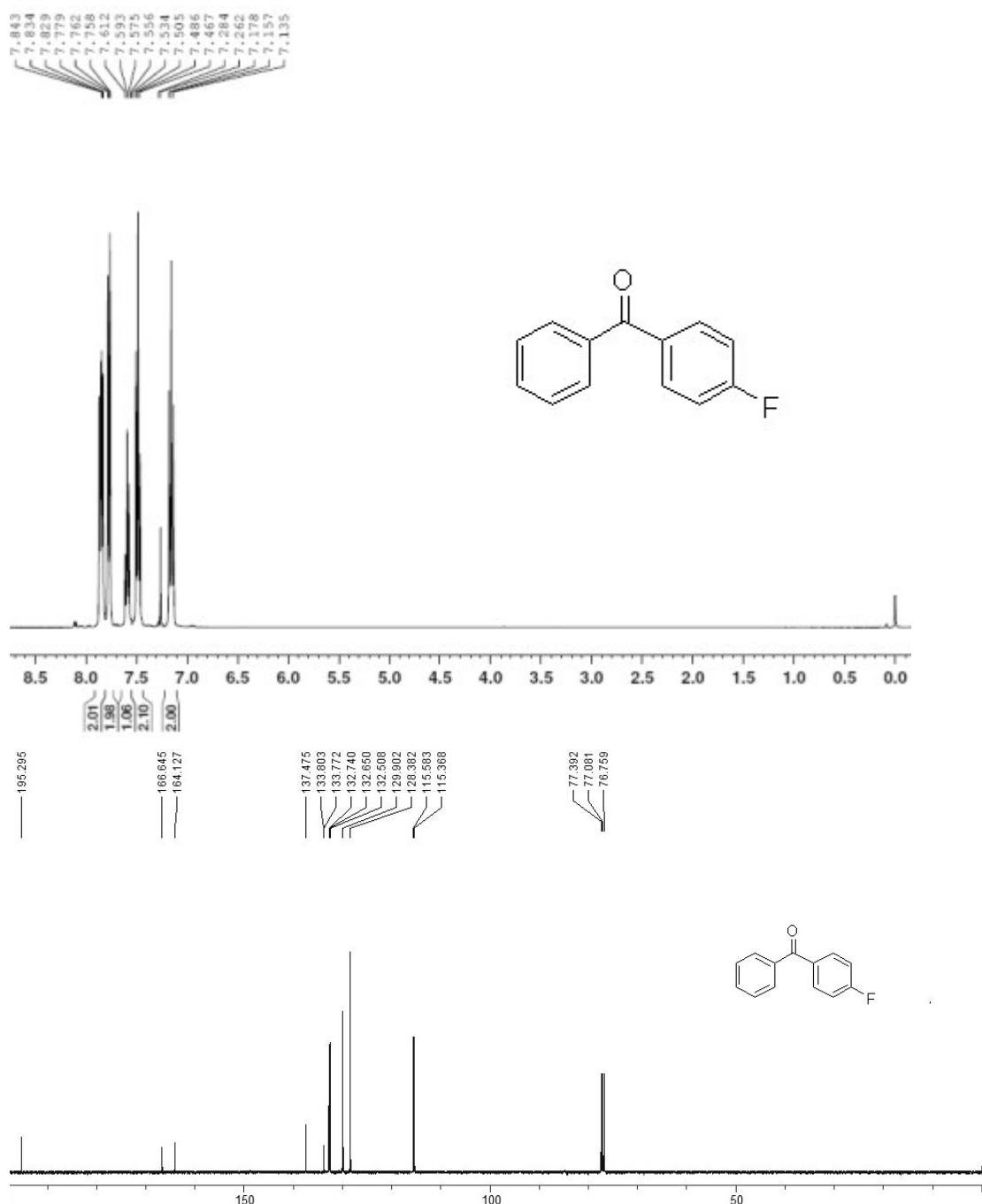
(5) 4-benzoylbenzotrile (3e)

m.p. 114–115 °C (lit.<sup>2</sup> mp 114–116 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.88 ( t, *J* = 8.0 Hz, 2 H ), 7.77-7.80 ( m, 4 H ), 7.64 ( t, *J* = 7.6 Hz, 1 H ), 7.52 ( t, *J* = 7.6 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.0, 141.2, 136.3, 133.3, 132.2, 130.3, 130.1, 128.7, 118.0, 115.7. HRMS (EI) Calcd for C<sub>14</sub>H<sub>9</sub>NO (M<sup>+</sup>) 207.0684, Found 207.0680.



**(6) 4-fluorobenzophenone (3f)**

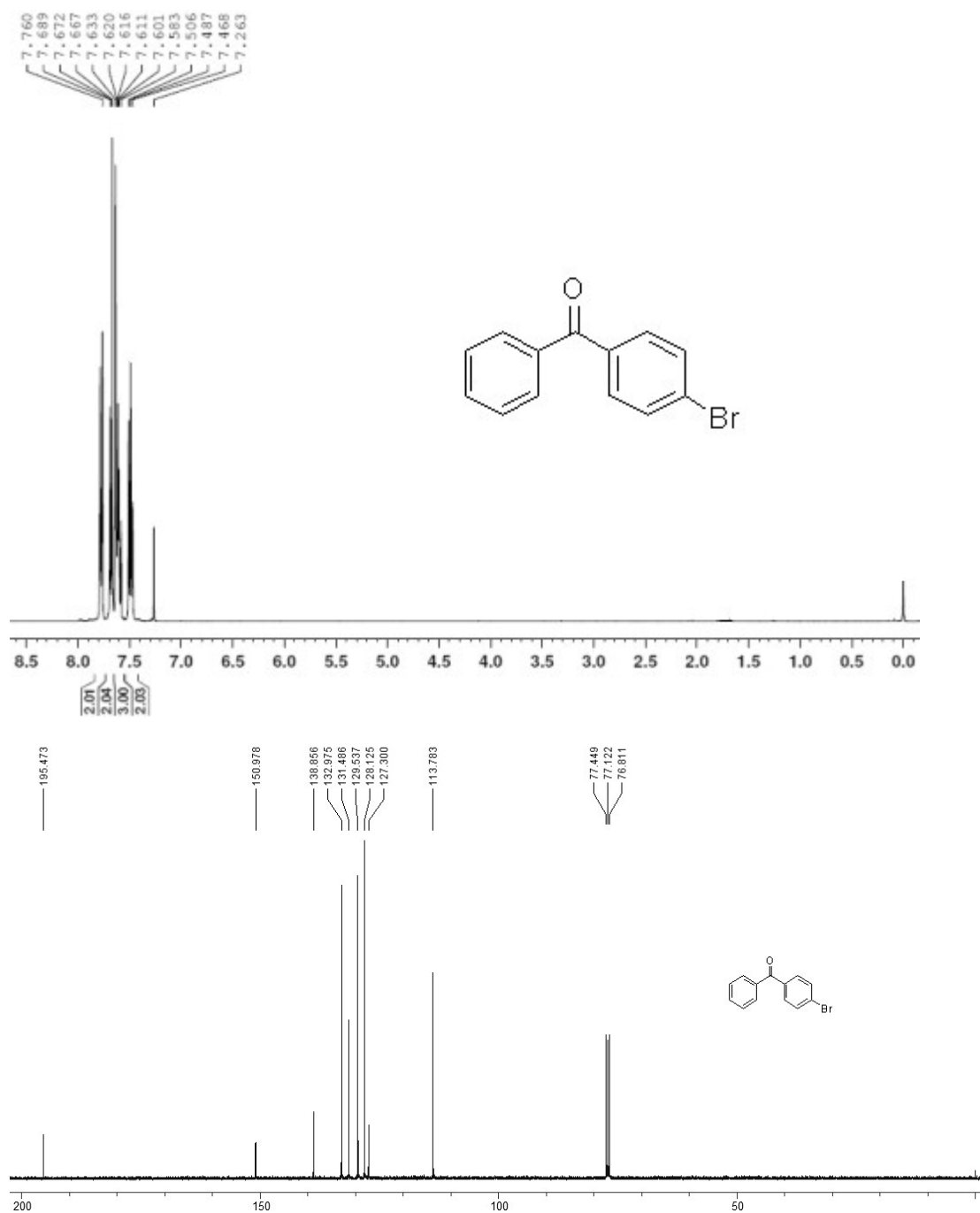
m.p. 46–48 °C (lit.<sup>3</sup> mp 45–47 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.86 ( dd, *J*<sub>1</sub> = 8.4 Hz, *J*<sub>2</sub> = 5.2 Hz, 2 H ), 7.77 ( d, *J* = 7.2 Hz, 2 H ), 7.58 ( t, *J* = 7.2 Hz, 1 H ), 7.48 ( t, *J* = 7.6 Hz, 2 H ), 7.16 ( t, *J* = 8.0 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.3, 166.7 (d, *J* = 252 Hz), 137.5, 133.8, 132.7 (d, *J* = 9.0 Hz), 132.5, 129.9, 128.4, 115.6 (d, *J* = 21 Hz). HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>FO (M<sup>+</sup>) 200.0637, Found 200.0638.



(7) 4-bromobenzophenone (3g)

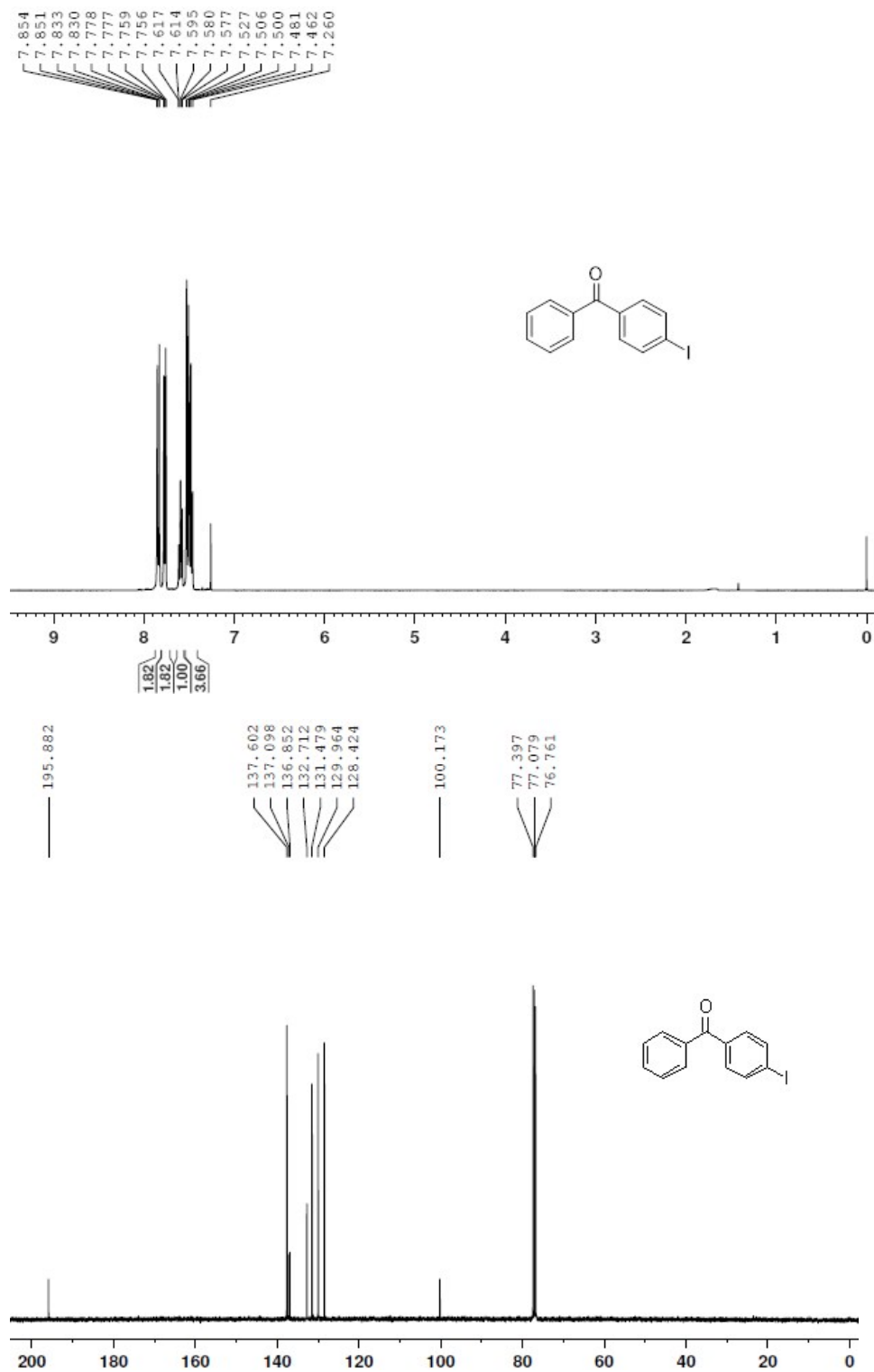


m.p. 81–82 °C (lit.<sup>4</sup> mp 81–83 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.77 ( d, *J* = 8.4 Hz, 2 H ), 7.58-7.69 ( m, 5 H ), 7.49 ( t, *J* = 7.6 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.7, 137.1, 136.3, 132.7, 131.63, 131.60, 130.0, 128.4, 127.5. HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>BrO (M<sup>+</sup>) 259.9837, Found 259.9832.



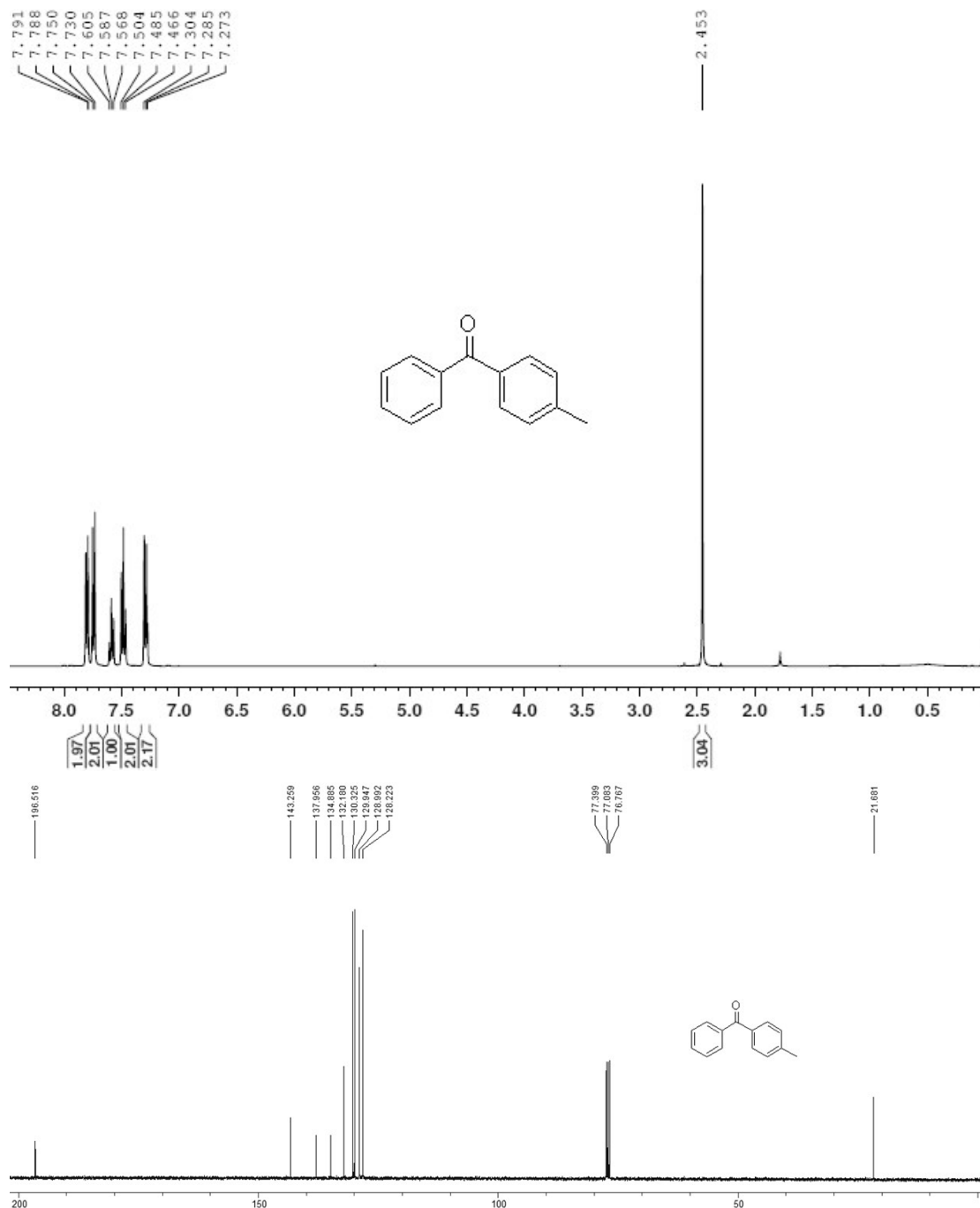
**(8) 4-iodobenzophenone (3h)**

m.p. 101–102 °C (lit.<sup>5</sup> mp 100–101 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.84 ( dd, *J*<sub>1</sub> = 8.4 Hz, *J*<sub>2</sub> = 1.2 Hz, 2 H ), 7.77 ( dd, *J*<sub>1</sub> = 8.4 Hz, *J*<sub>2</sub> = 1.2 Hz, 2 H ), 7.60 ( t, *J* = 7.2 Hz, 1 H ), 7.46-7.53 ( m, 3 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.9, 137.6, 137.1, 136.9, 132.7, 131.5, 130.0, 128.4, 100.2. HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>IO (M<sup>+</sup>) 367.9698, Found 367.9692.



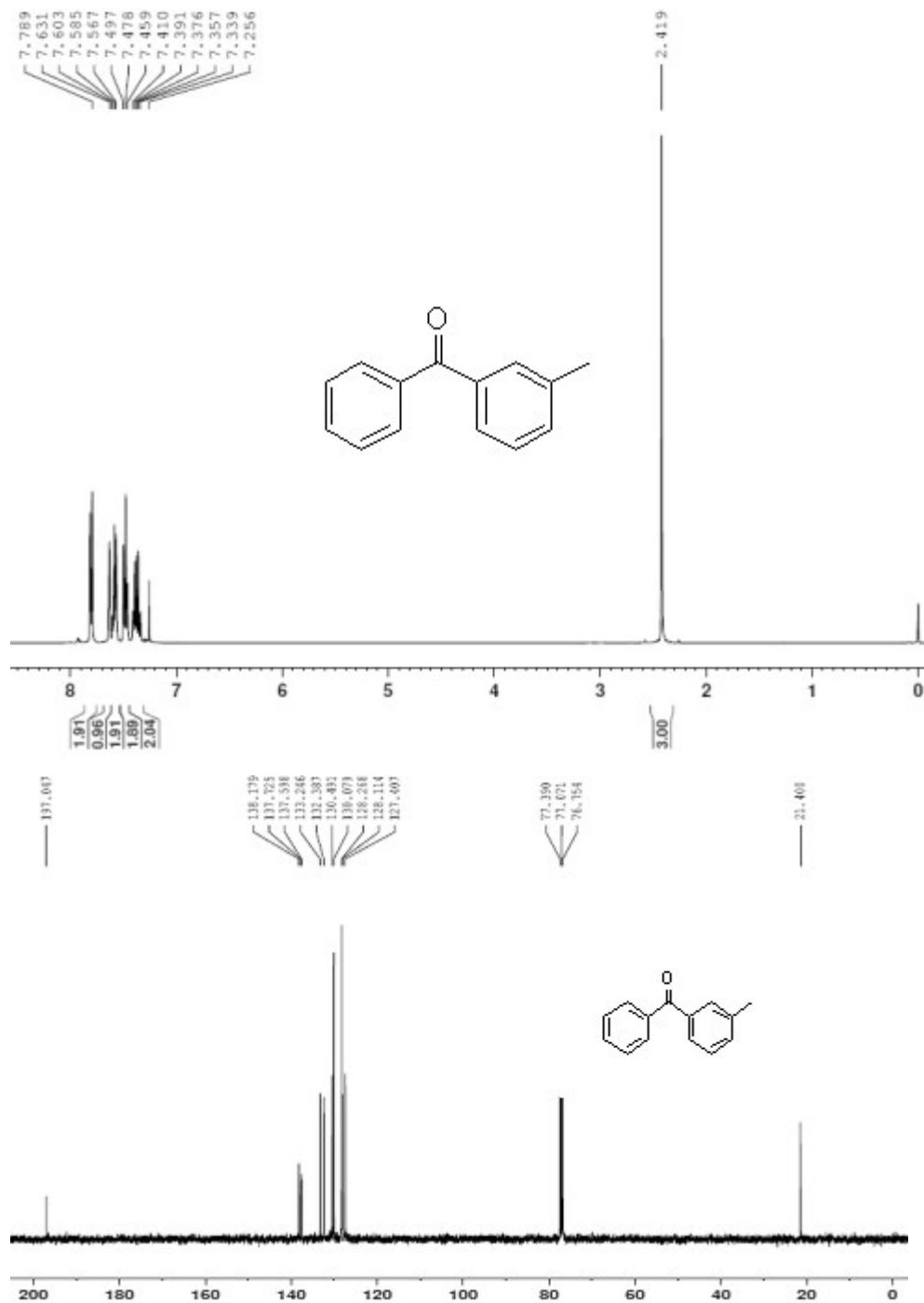
(9) 4-methylbenzophenone (3i)

m.p. 55–57 °C (lit.<sup>2</sup> mp 56–58 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.81 ( d, *J* = 7.2 Hz, 2 H ), 7.73 ( d, *J* = 7.6 Hz, 2 H ), 7.58 ( t, *J* = 7.2 Hz, 1 H ), 7.47 ( t, *J* = 7.6 Hz, 2 H ), 7.28 ( d, *J* = 8.0 Hz, 2 H ), 2.44 ( s, 3 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 196.5, 143.3, 138.0, 134.9, 132.2, 130.3, 129.9, 129.0, 128.2, 21.7. HRMS (EI) Calcd for C<sub>14</sub>H<sub>12</sub>O (M<sup>+</sup>) 196.0888, Found 196.0893.



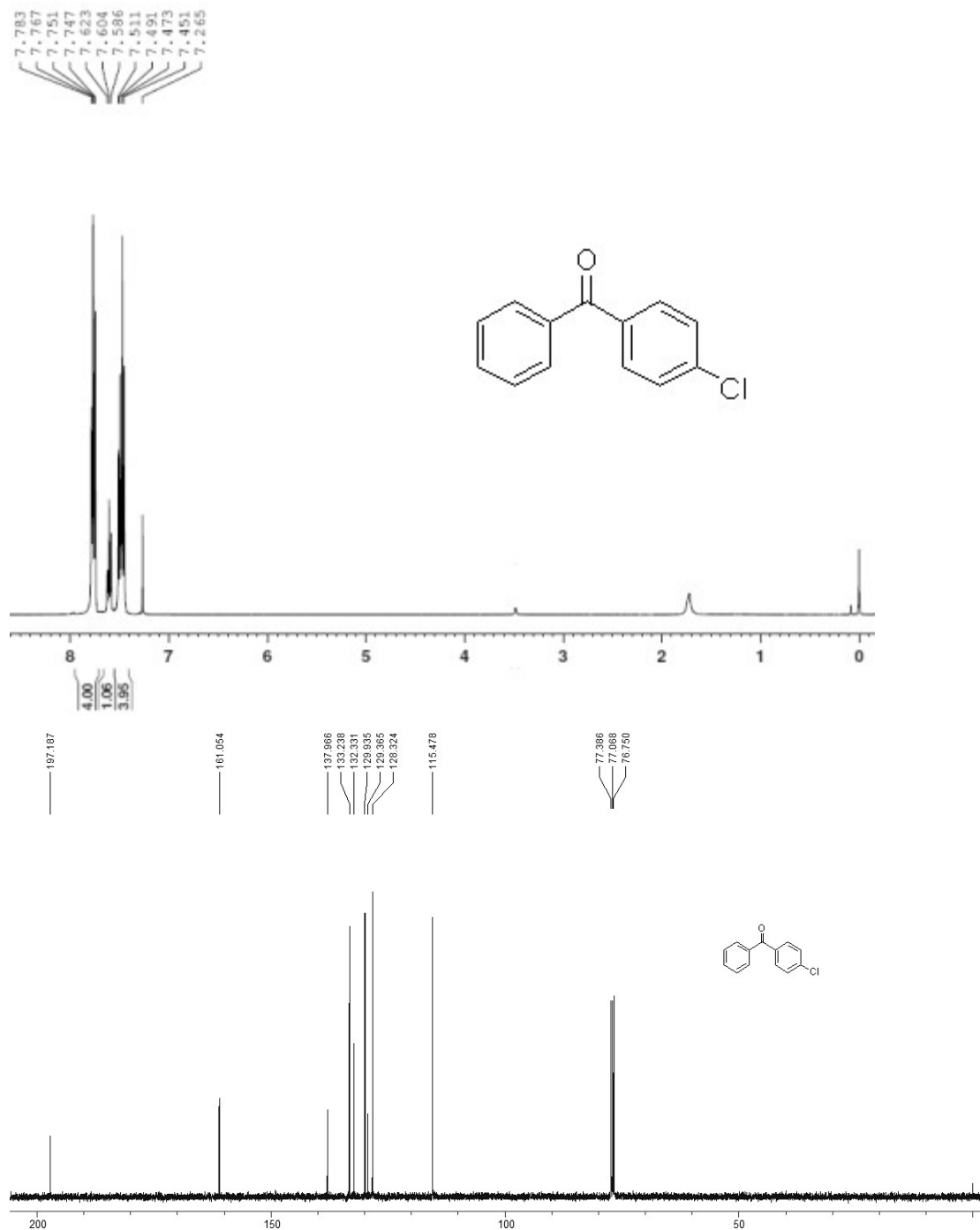
(10) 3-methyl-benzophenone (3j)

$^1\text{H}$  NMR ( 400 MHz,  $\text{CDCl}_3$ , TMS )  $\delta$ 7.82 ( d,  $J = 6.8$  Hz, 2 H ), 7.64 ( s, 1 H ) 7.58 ( d,  $J = 7.6$  Hz, 2 H ), 7.48 ( t,  $J = 7.6$  Hz, 2 H ), 7.34-7.43 ( m, 2 H ), 2.43 ( s, 3 H ).  $^{13}\text{C}$  NMR ( 100 MHz,  $\text{CDCl}_3$  )  $\delta$  197.1, 138.2, 137.7, 137.6, 133.3, 132.4, 130.5, 130.1, 128.3, 128.1, 127.4, 21.4. HRMS (EI) Calcd for  $\text{C}_{14}\text{H}_{12}\text{O}$  ( $\text{M}^+$ ) 196.0888, Found 196.0883.



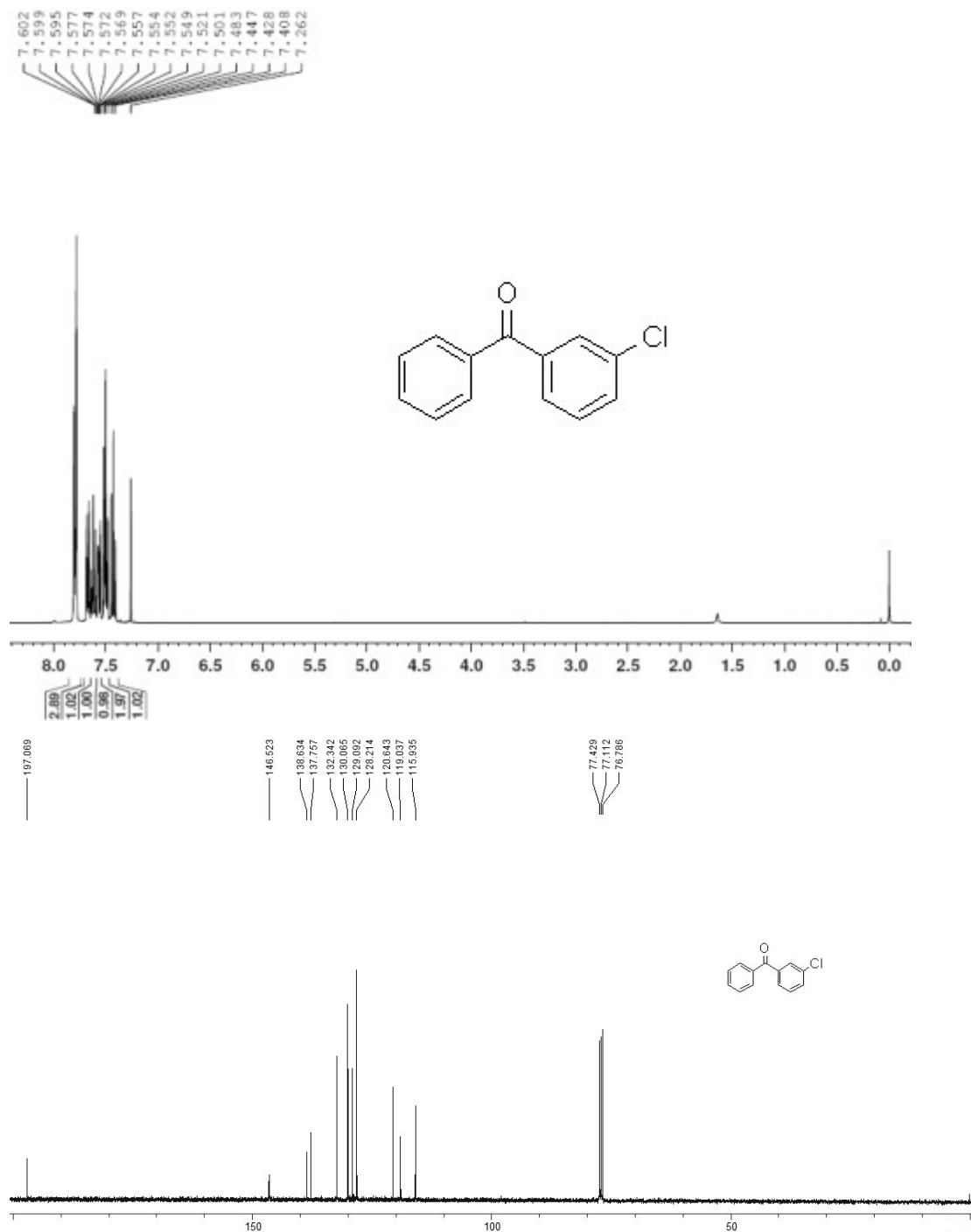
(11) 4-chloro-benzophenone (3k)

m.p. 73–75 °C (lit.<sup>1</sup> mp 74–75 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.81 ( br, 1 H ), 7.78 ( d, *J* = 8.8 Hz, 4 H ), 7.58 ( t, *J* = 7.6 Hz, 1 H ), 7.47 ( t, *J* = 7.6 Hz, 2 H ), 7.47 ( d, *J* = 8.8 Hz, 2 H ).  
<sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 197.2, 161.1, 138.0, 133.2, 132.3, 129.9, 129.4, 128.3, 115.5.  
HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>ClO (M<sup>+</sup>) 216.0342, Found 216.0347.



(12) 3-chloro-benzophenone (31)

m.p. 84–85 °C (lit.<sup>6</sup> mp 84 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.78 ( d, *J* = 7.6 Hz, 2 H ), 7.78 ( s, 1 H ), 7.66 ( d, *J* = 6.8 Hz, 1 H ), 7.62 ( t, *J* = 7.6 Hz, 1 H ), 7.56 ( d, *J* = 8.0 Hz, 1 H ), 7.50 ( t, *J* = 7.6 Hz, 2 H ), 7.42 ( t, *J* = 8.0 Hz, 1 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.3, 139.2, 136.9, 134.6, 132.9, 132.4, 130.1, 129.9, 129.7, 128.5, 128.1. HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>ClO (M<sup>+</sup>) 216.0342, Found 216.0335.



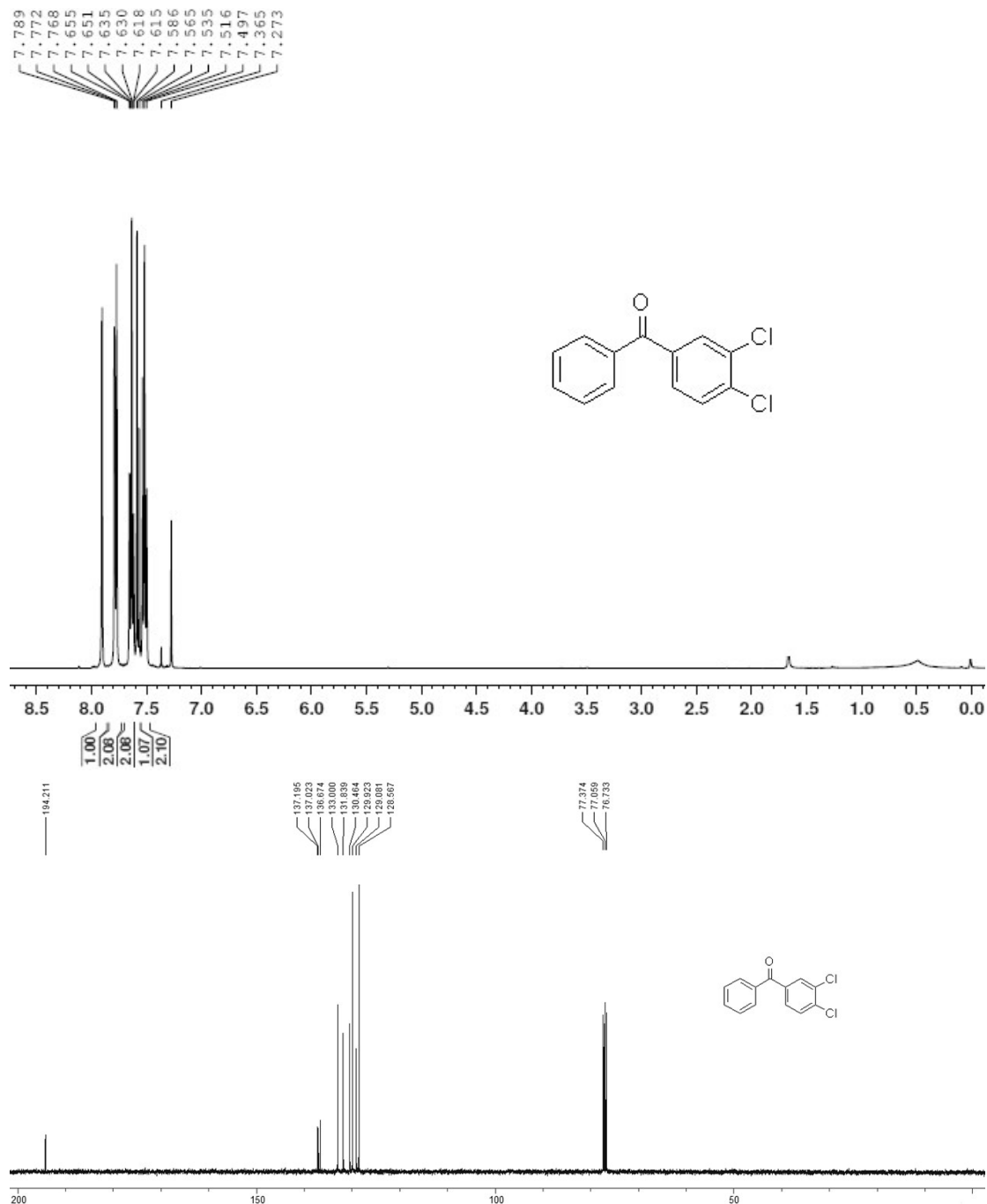
(13) 3,4-dimethylbenzophenone (3m)

m.p. 48–49 °C (lit.<sup>4</sup> mp 47–49 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.83 ( d, *J* = 8.0 Hz, 2 H ), 7.65 ( s, 1 H ), 7.53-7.60 ( m, 2 H ), 7.49 ( t, *J* = 7.6 Hz, 2 H ), 7.24 ( t, *J* = 8.0 Hz, 1 H ), 2.37 ( s, 3 H ), 2.33 ( s, 3 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 196.7, 142.0, 138.1, 136.8, 135.3, 132.1, 131.2, 129.9, 129.5, 128.2, 128.1, 20.1, 19.8. HRMS (EI) Calcd for C<sub>15</sub>H<sub>14</sub>O (M<sup>+</sup>) 210.1045, Found 210.1040.



**(14) 3,4-dichlorobenzophenone (3n)**

m.p. 103–105 °C (lit.<sup>7</sup> mp 102–103 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.92 ( s, 1 H ), 7.77 ( d, *J* = 7.2 Hz, 2 H ), 7.64 ( t, *J* = 8.0 Hz, 2 H ), 7.58 ( d, *J* = 8.0 Hz, 1 H ), 7.50 ( t, *J* = 7.6 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 194.2, 137.2, 137.0, 136.7, 133.0, 131.9, 130.5, 129.9, 129.1, 128.6. HRMS (EI) Calcd for C<sub>13</sub>H<sub>8</sub>Cl<sub>2</sub>O (M<sup>+</sup>) 249.9952, Found 249.9956.

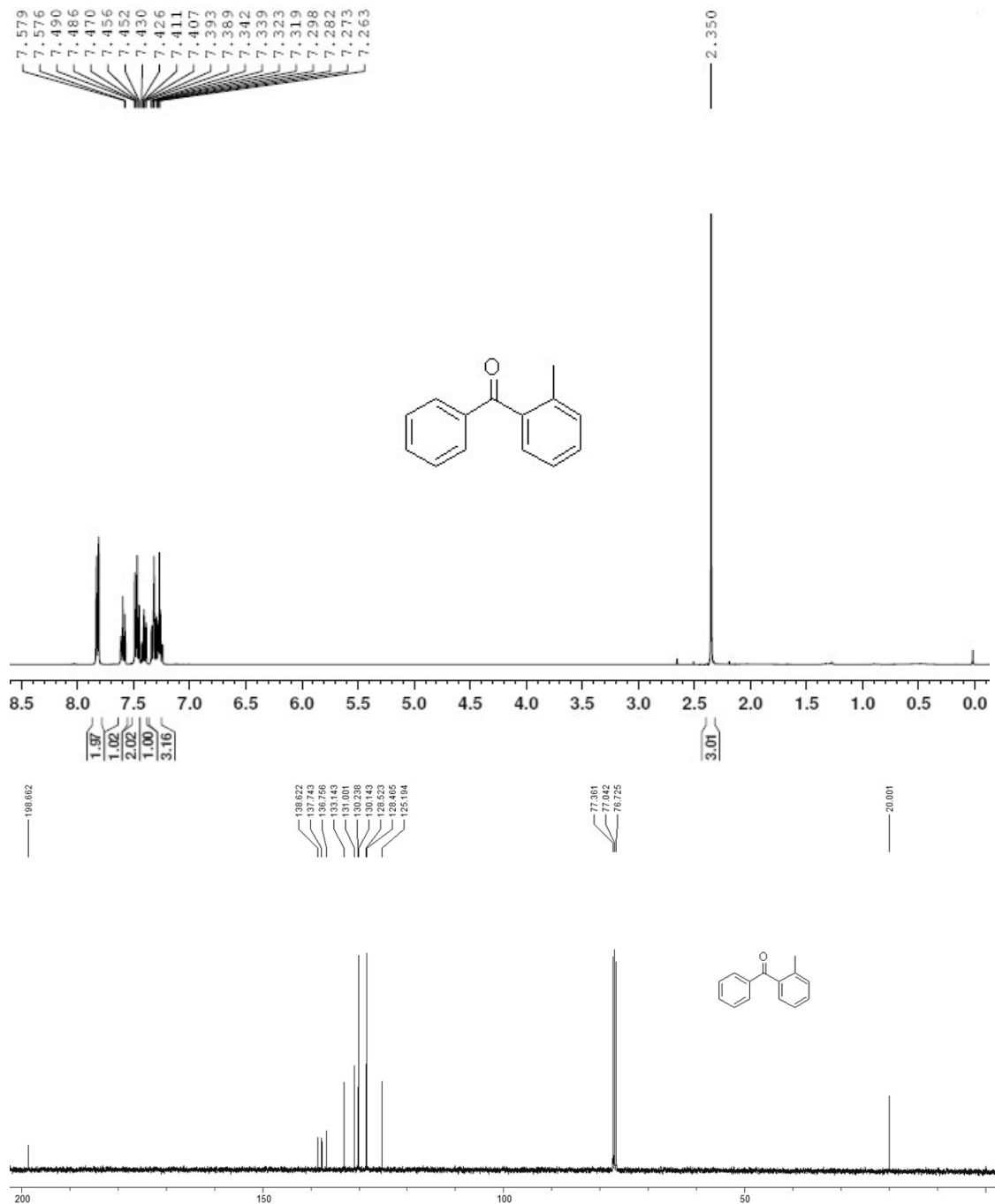


(15) 2-methylbenzophenone (30)



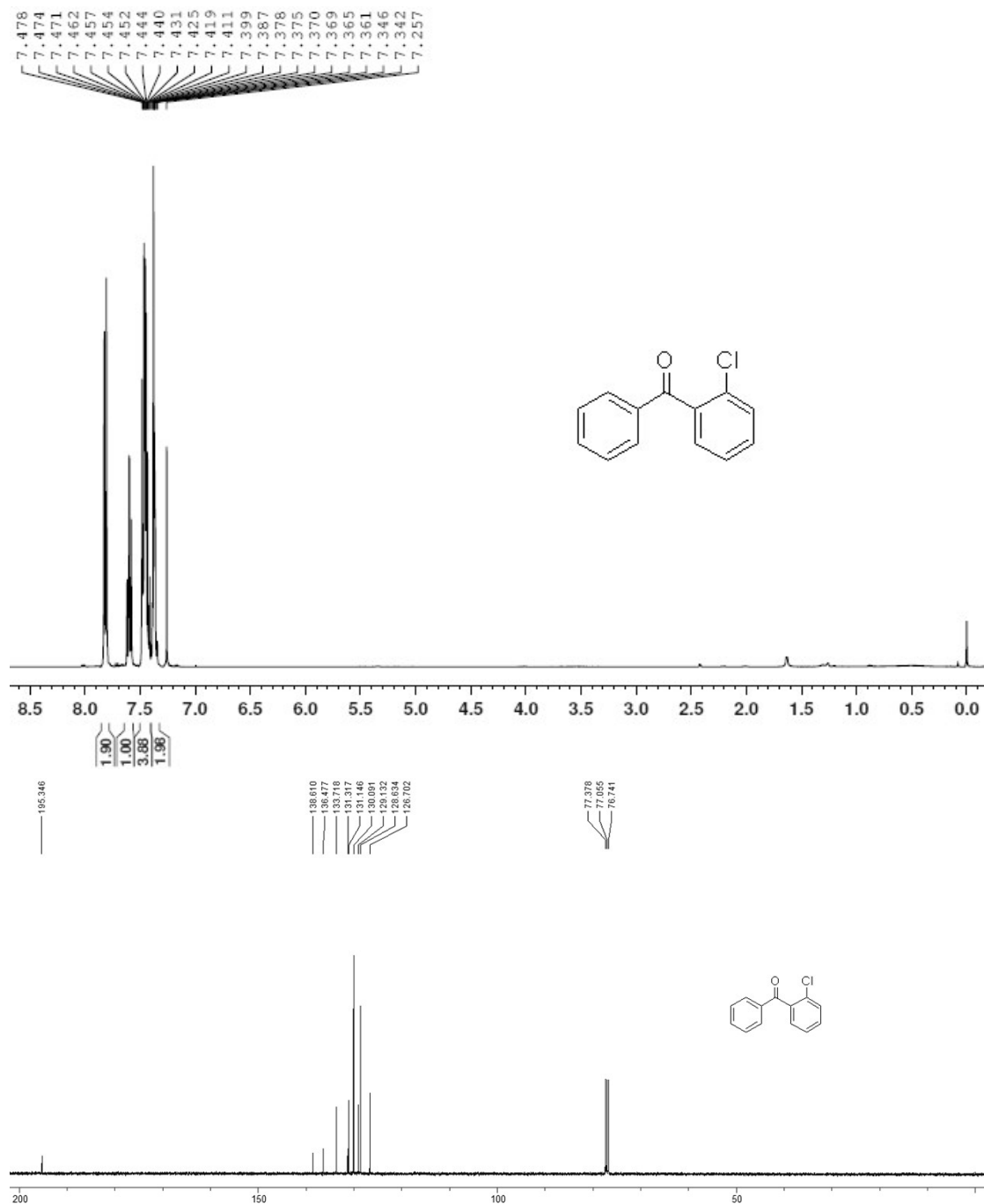
$^1\text{H}$  NMR ( 400 MHz,  $\text{CDCl}_3$ , TMS )  $\delta$  7.84 ( d,  $J = 8.4$  Hz, 2 H ), 7.60 ( t,  $J = 7.6$  Hz, 1 H ), 7.48 ( t,  $J = 7.6$  Hz, 2 H ), 7.41 ( t,  $J = 7.6$  Hz, 1 H ), 7.23-7.34 ( m, 3 H ), 2.36 (s, 3H).  $^{13}\text{C}$  NMR ( 100 MHz,  $\text{CDCl}_3$  )  $\delta$  198.7, 138.6, 137.7, 136.8, 133.1, 131.0, 130.3, 130.1, 128.5, 128.5, 125.2, 20.0.

HRMS (EI) Calcd for  $\text{C}_{14}\text{H}_{12}\text{O}$  ( $\text{M}^+$ ) 196.0888, Found 196.0882.



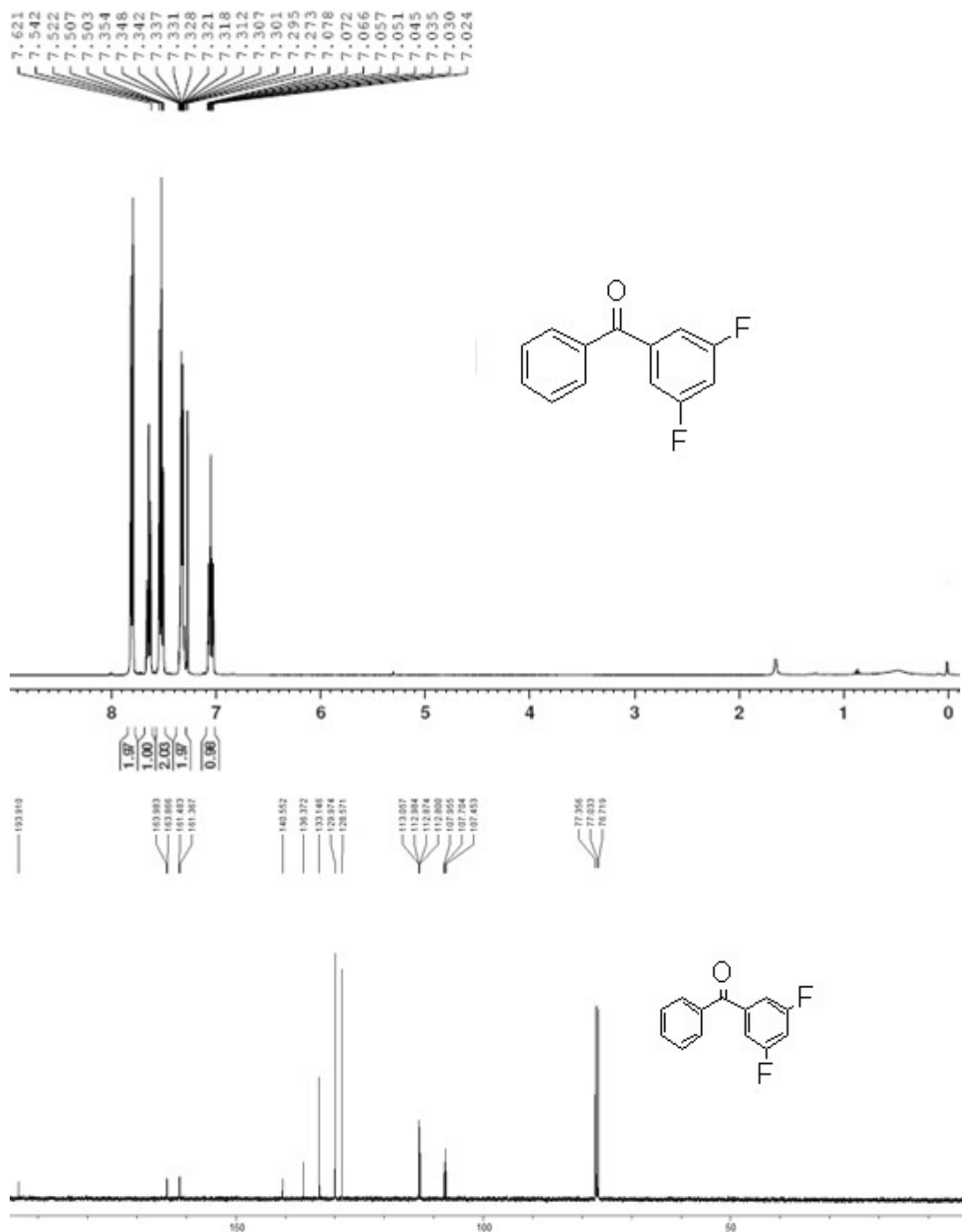
(16) 2-chlorobenzophenone (3p)

m.p. 44–45 °C (lit.<sup>1</sup> mp 43–45 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.81( d, *J* = 8.4 Hz, 2 H ), 7.61 ( t, *J* = 7.6 Hz, 1 H ), 7.41-7.49 ( m, 4 H ), 7.35-7.39 ( m, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.6, 138.6, 136.5, 133.7, 131.3, 131.2, 130.1, 129.1, 128.6, 126.7. HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>ClO (M<sup>+</sup>) 216.0342, Found 216.0340.

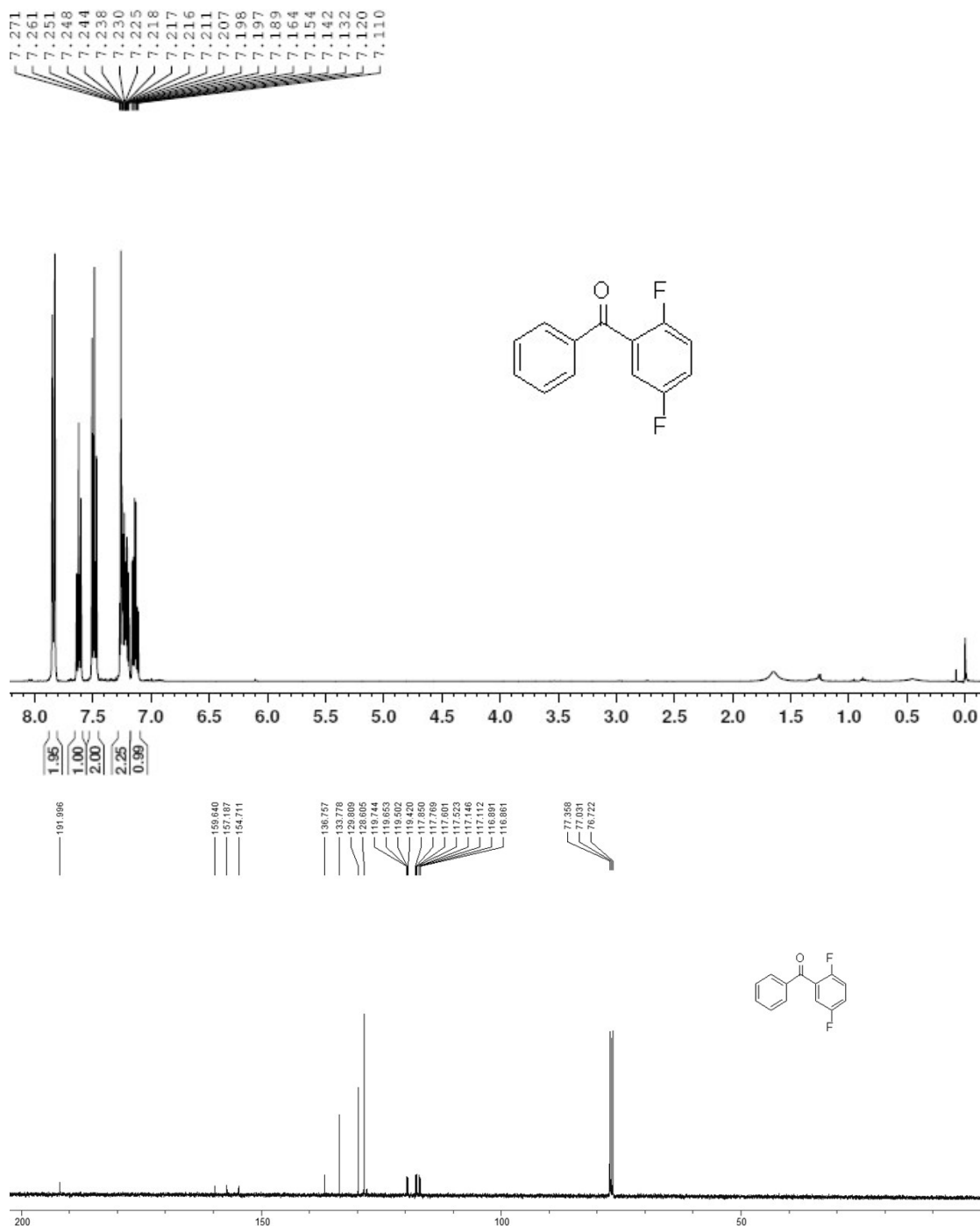


(17) 3,5-difluorobenzophenone (3q)

m.p. 58–60 °C (lit.<sup>8</sup> mp 57–59 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.81 ( d, *J* = 7.2 Hz, 2 H ), 7.64 ( t, *J* = 7.2 Hz, 1 H ), 7.53 ( t, *J* = 7.2 Hz, 2 H ), 7.31 ( dd, *J*<sub>1</sub> = 7.2 Hz, *J*<sub>2</sub> = 2.4 Hz, 2 H ), 7.05 ( tt, *J*<sub>1</sub> = 8.4 Hz, *J*<sub>2</sub> = 2.4 Hz, 1 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 194.02, 163.92 ( dd, *J*<sub>1</sub> = 250 Hz, *J*<sub>2</sub> = 11.7 Hz ), 140.55 ( t, *J* = 7.2 Hz ), 136.4, 133.2, 130.0, 128.6, 112.9 ( dd, *J*<sub>1</sub> = 18.4 Hz, *J*<sub>2</sub> = 7.2 Hz ), 107.7 ( t, *J* = 25.2 Hz ). HRMS (EI) Calcd for C<sub>13</sub>H<sub>8</sub>F<sub>2</sub>O (M<sup>+</sup>) 218.0543, Found 218.0549.

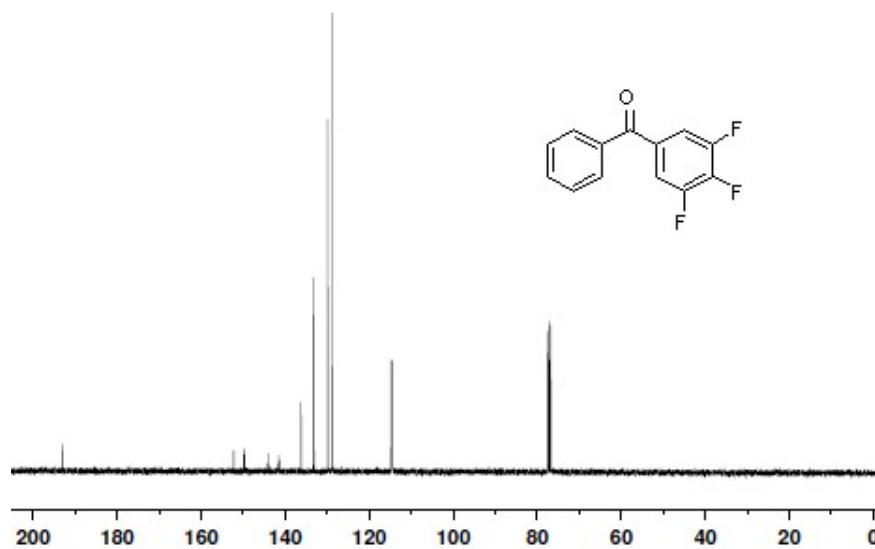
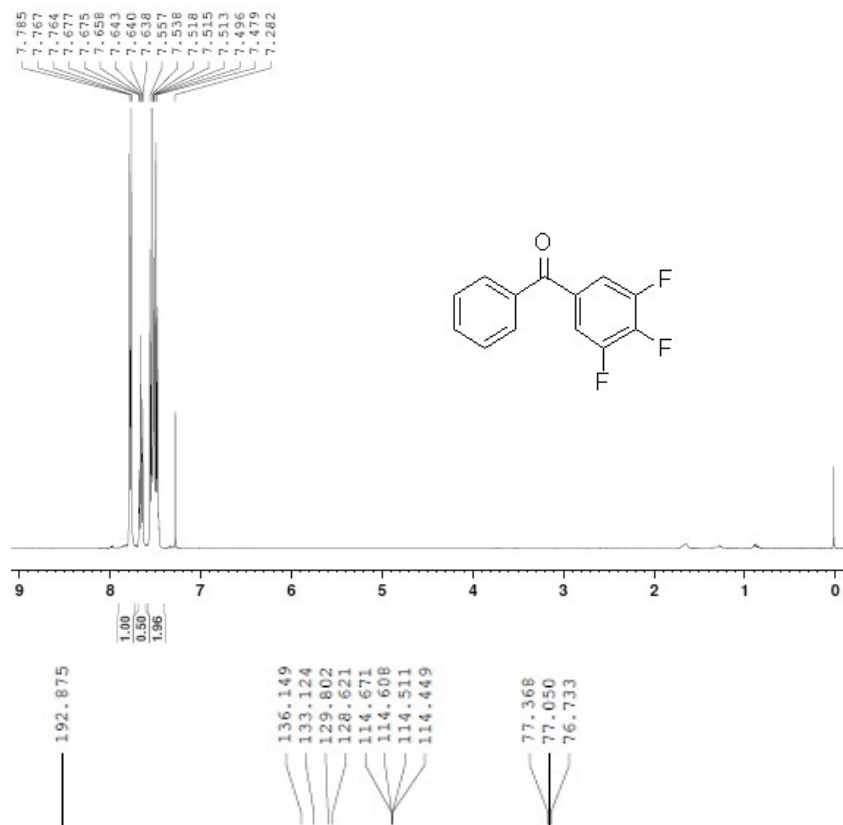


$^1\text{H}$  NMR ( 400 MHz,  $\text{CDCl}_3$ , TMS )  $\delta$  7.83 ( d,  $J = 8.4$  Hz, 2 H ), 7.62 ( tt,  $J_1 = 7.2$  Hz,  $J_2 = 1.6$  Hz, 1 H ), 7.48 ( d,  $J = 7.6$  Hz, 2 H ), 7.19-7.28 ( m, 2 H ), 7.11-7.17 ( m, 1 H ).  $^{13}\text{C}$  NMR ( 100 MHz,  $\text{CDCl}_3$  )  $\delta$  192.0, 159.7, 157.2 ( d,  $J = 252$  Hz ), 136.8, 133.8, 129.8, 128.6, 128.1 ( dd,  $J_1 = 17.2$  Hz,  $J_2 = 6.4$  Hz ), 119.6 ( dd,  $J_1 = 23.6$  Hz,  $J_2 = 8.6$  Hz ), 117.7 ( dd,  $J_1 = 24.8$  Hz,  $J_2 = 8.0$  Hz ), 117.0 ( dd,  $J_1 = 18.4$  Hz,  $J_2 = 7.2$  Hz ), 112.9 ( dd,  $J_1 = 25.2$  Hz,  $J_2 = 3.2$  Hz ). HRMS (EI) Calcd for  $\text{C}_{13}\text{H}_8\text{F}_2\text{O}$  ( $\text{M}^+$ ) 218.0543, Found 218.0548.



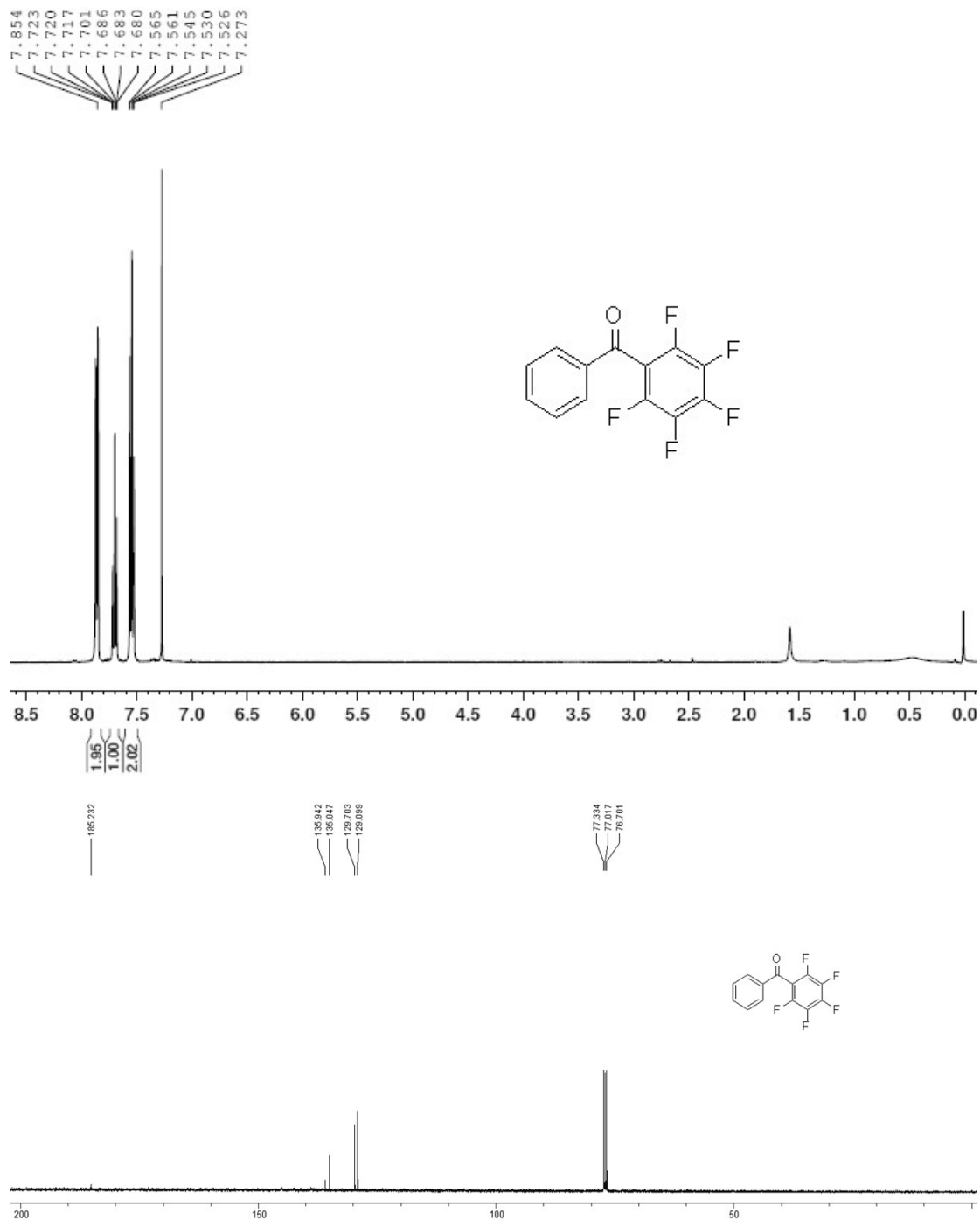
(19) 3,4,5-trifluorobenzophenone (3s)

m.p. 120–122 °C (lit.<sup>8</sup> mp 119–122 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.81 ( d, *J* = 8.4 Hz, 2 H ), 7.66 ( t, *J* = 7.6 Hz, 1 H ), 7.54 ( t, *J* = 8.0 Hz, 2 H ), 7.50 ( t, *J* = 7.2 Hz, 1 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 192.9, 152.2 ( dd, *J*<sub>1</sub> = 41.2 Hz, *J*<sub>2</sub> = 12 Hz ), 149.7 ( dd, *J*<sub>1</sub> = 40.8 Hz, *J*<sub>2</sub> = 14 Hz ), 144.0 ( t, *J* = 62.4 Hz ), 141.4 ( t, *J* = 61.6 Hz ), 136.2, 133.1, 129.8, 128.6, 114.6 ( dd, *J*<sub>1</sub> = 64 Hz, *J*<sub>2</sub> = 24.8 Hz ). HRMS (EI) Calcd for C<sub>13</sub>H<sub>7</sub>F<sub>3</sub>O (M<sup>+</sup>) 236.0449, Found 236.0438.



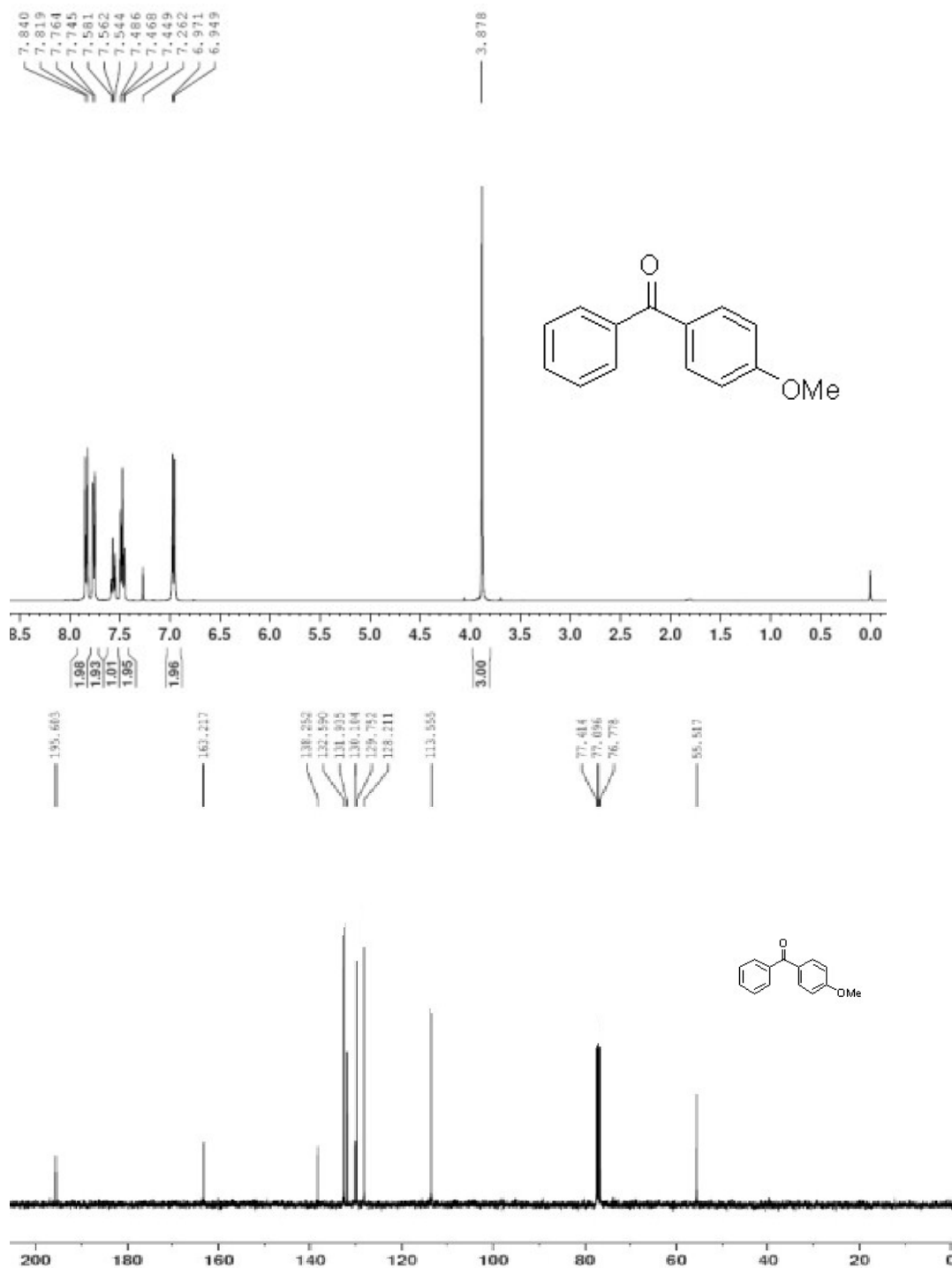
(20) 2,3,4,5,6-perfluoro-benzophenone (3t)

m.p. 35–36 °C (lit.<sup>9</sup> mp 33–34 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.85 ( d, *J* = 7.6 Hz, 2 H ), 7.70 ( t, *J* = 7.6 Hz, 1 H ), 7.54 ( t, *J* = 7.6 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 185.3, 135.9, 135.1, 129.7, 129.1. HRMS (EI) Calcd for C<sub>13</sub>H<sub>5</sub>F<sub>5</sub>O (M<sup>+</sup>) 272.0261, Found 272.0265.



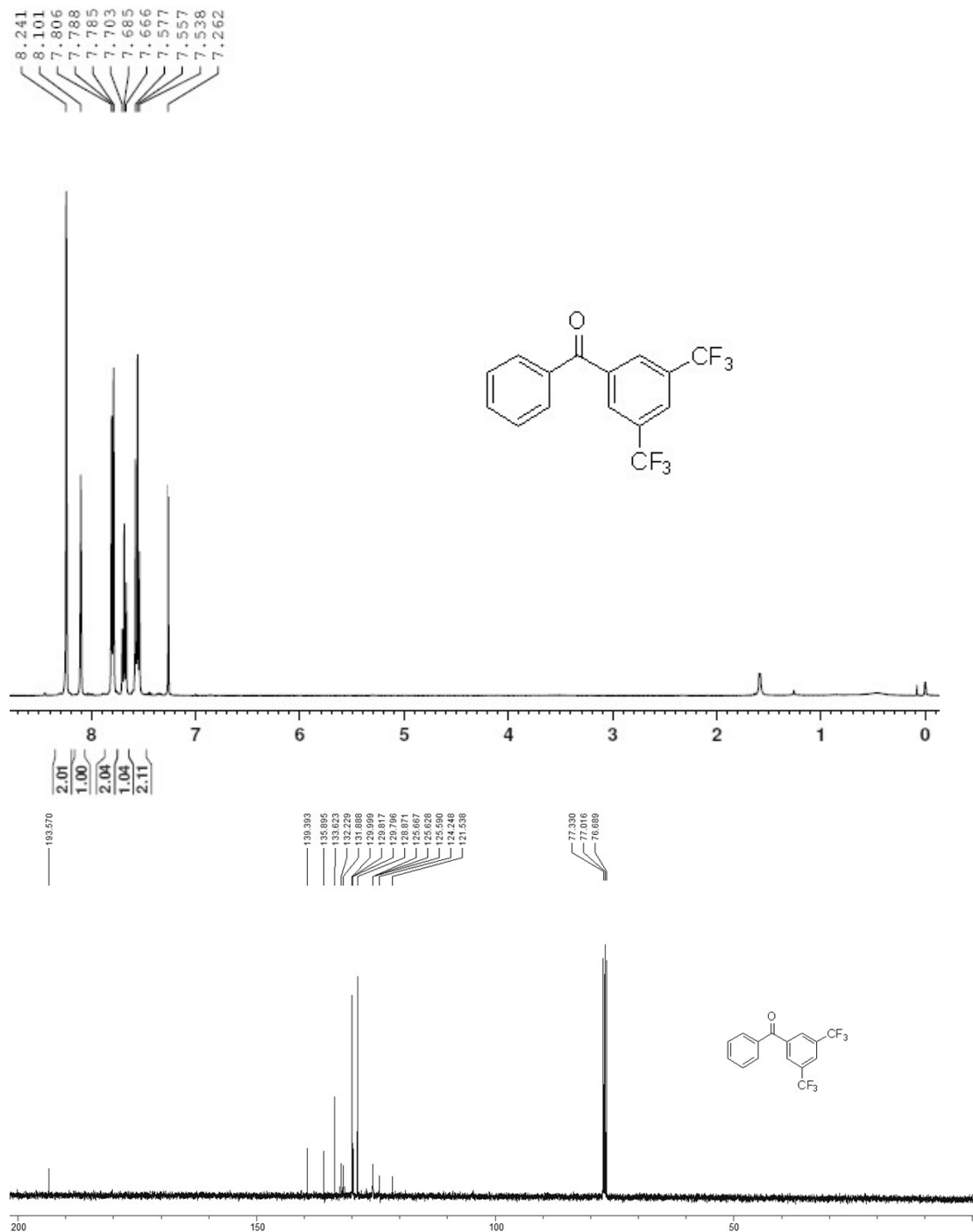
(21) 4-methoxy-benzophenone (4a)

m.p. 57–58 °C (lit.<sup>1</sup> mp 58–59 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.82 ( d, *J* = 8.4 Hz, 2 H ), 7.74 ( t, *J* = 7.6 Hz, 2 H ), 7.56 ( t, *J* = 7.6 Hz, 1 H ), 7.46 ( t, *J* = 7.6 Hz, 2 H ), 6.95 ( d, *J* = 8.8 Hz, 2 H ), 3.87 ( s, 3 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 195.6, 163.2, 138.3, 132.6, 131.9, 130.1, 129.8, 128.2, 113.6, 55.5. HRMS (EI) Calcd for C<sub>14</sub>H<sub>12</sub>O<sub>2</sub> (M<sup>+</sup>) 212.0837, Found 212.0843.



(22) 3,5-bis(trifluoromethyl)benzophenone (4e)

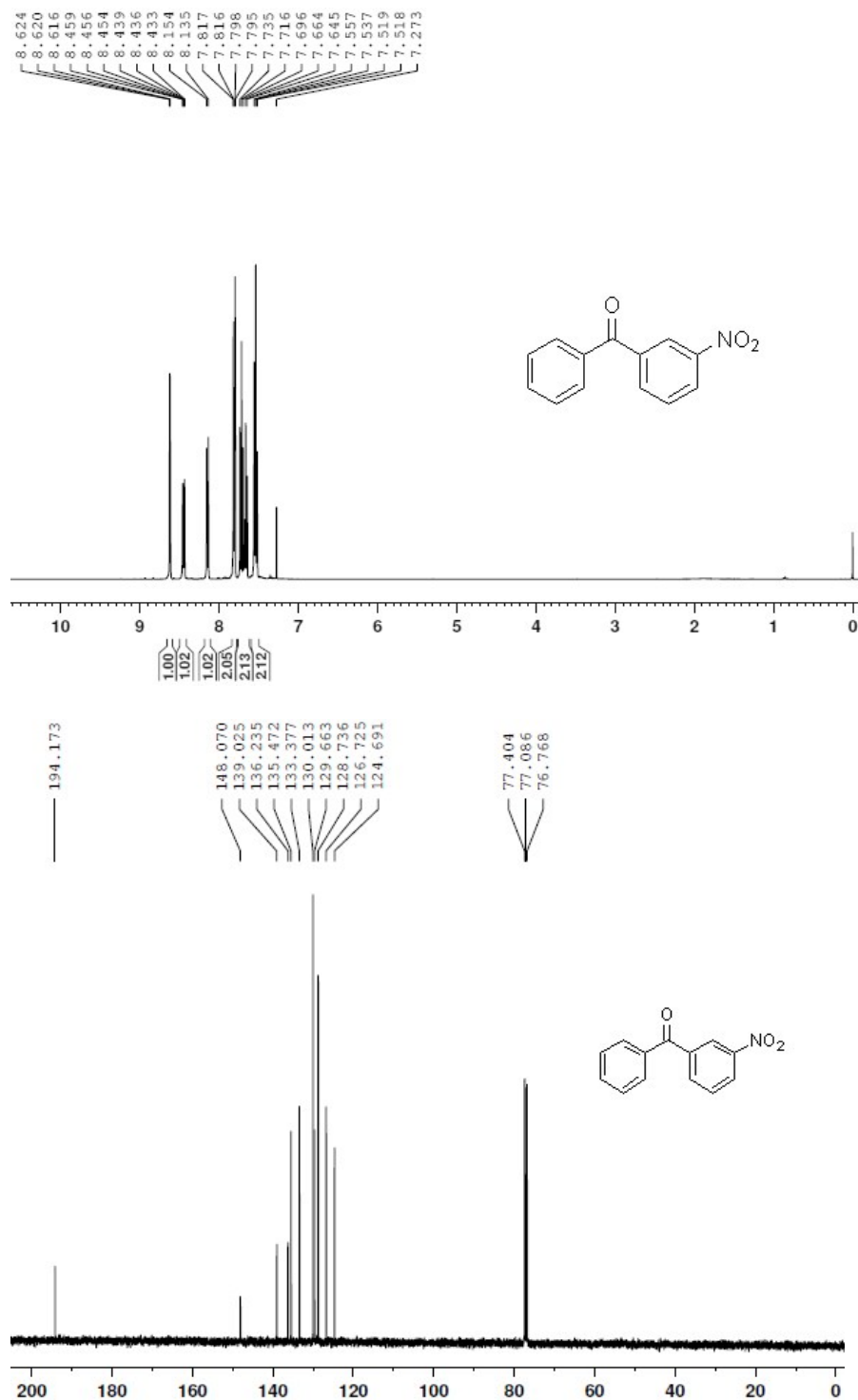
m.p. 109–112 °C (lit.<sup>10</sup> mp 109–111 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.80 ( d, *J* = 7.2 Hz, 2 H ), 7.65 ( t, *J* = 7.2 Hz, 1 H ), 7.52 ( t, *J* = 7.6 Hz, 2 H ), 7.31 ( dd, *J*<sub>1</sub> = 7.2 Hz, *J*<sub>2</sub> = 2.4 Hz, 2 H ), 7.04 ( tt, *J*<sub>1</sub> = 8.4 Hz, *J*<sub>2</sub> = 2.4 Hz, 1 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 194.0, 163.9 ( dd, *J*<sub>1</sub> = 250 Hz, *J*<sub>2</sub> = 11.6 Hz ), 140.6 ( t, *J* = 7.2 Hz ), 136.4, 133.2, 129.9, 128.6, 112.9 ( dd, *J*<sub>1</sub> = 18.4 Hz, *J*<sub>2</sub> = 7.2 Hz ), 107.7 ( t, *J* = 25.2 Hz ). HRMS (EI) Calcd for C<sub>13</sub>H<sub>8</sub>F<sub>2</sub>O (M<sup>+</sup>) 218.0543, Found 218.0541.





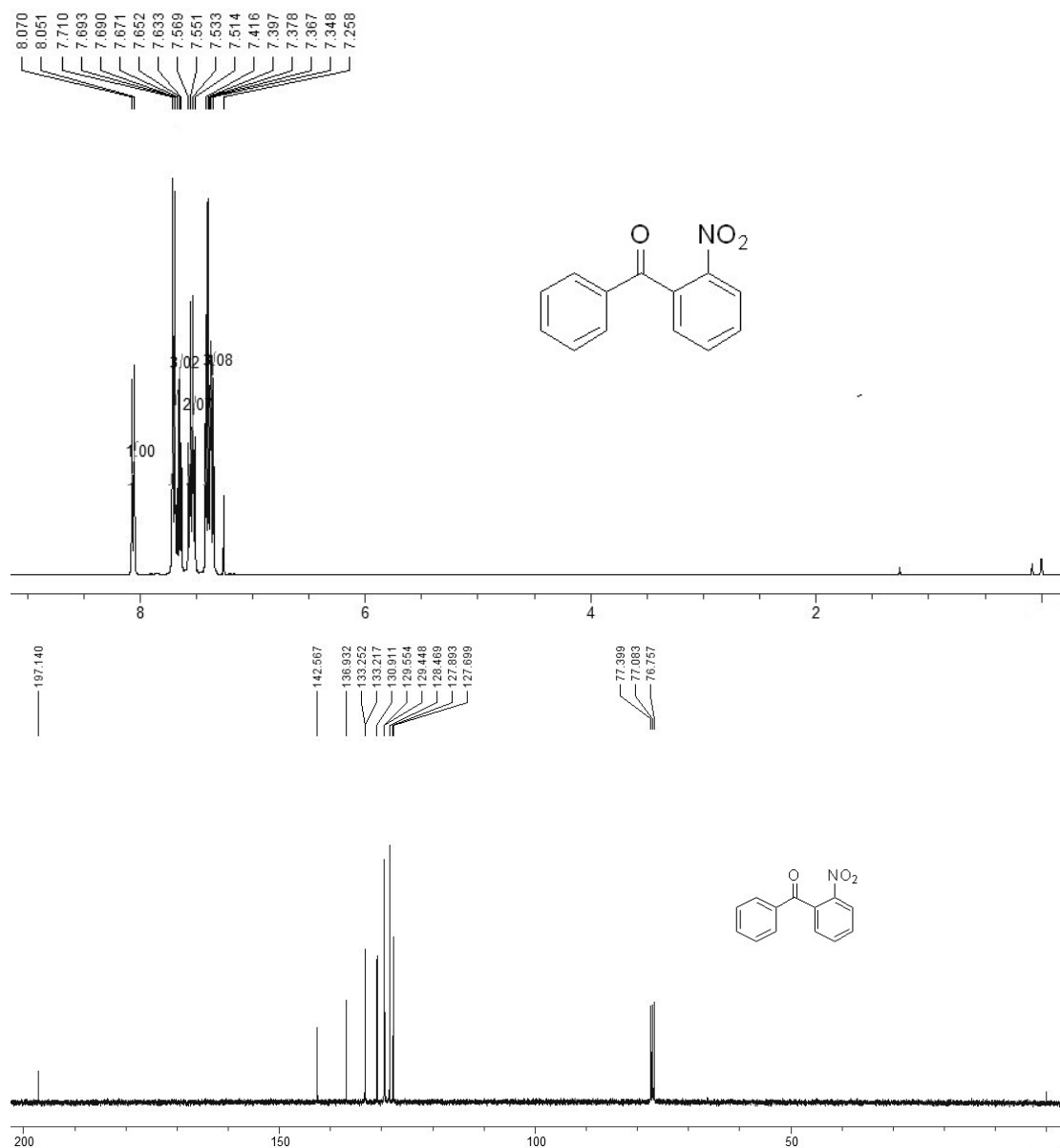
**(23) 3-nitrobenzophenone (4l)**

m.p. 95–97 °C (lit.<sup>11</sup> mp 95-96 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 8.62 ( s, 1 H ), 8.45 ( d, *J* = 8.0 Hz, 1 H ), 8.14 ( d, *J* = 8.0 Hz, 1 H ), 7.81 ( d, *J* = 8.0 Hz, 2 H ), 7.72 ( t, *J* = 8.0 Hz, 1 H ), 7.66 ( t, *J* = 7.6 Hz, 1 H ), 7.54 ( t, *J* = 8.0 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 194.2, 148.1,139.0, 136.2, 135.5, 133.4, 130.0, 129.7, 128.7, 126.7, 124.7. HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>NO<sub>3</sub> (M<sup>+</sup>) 227.0582, Found 227.0586.



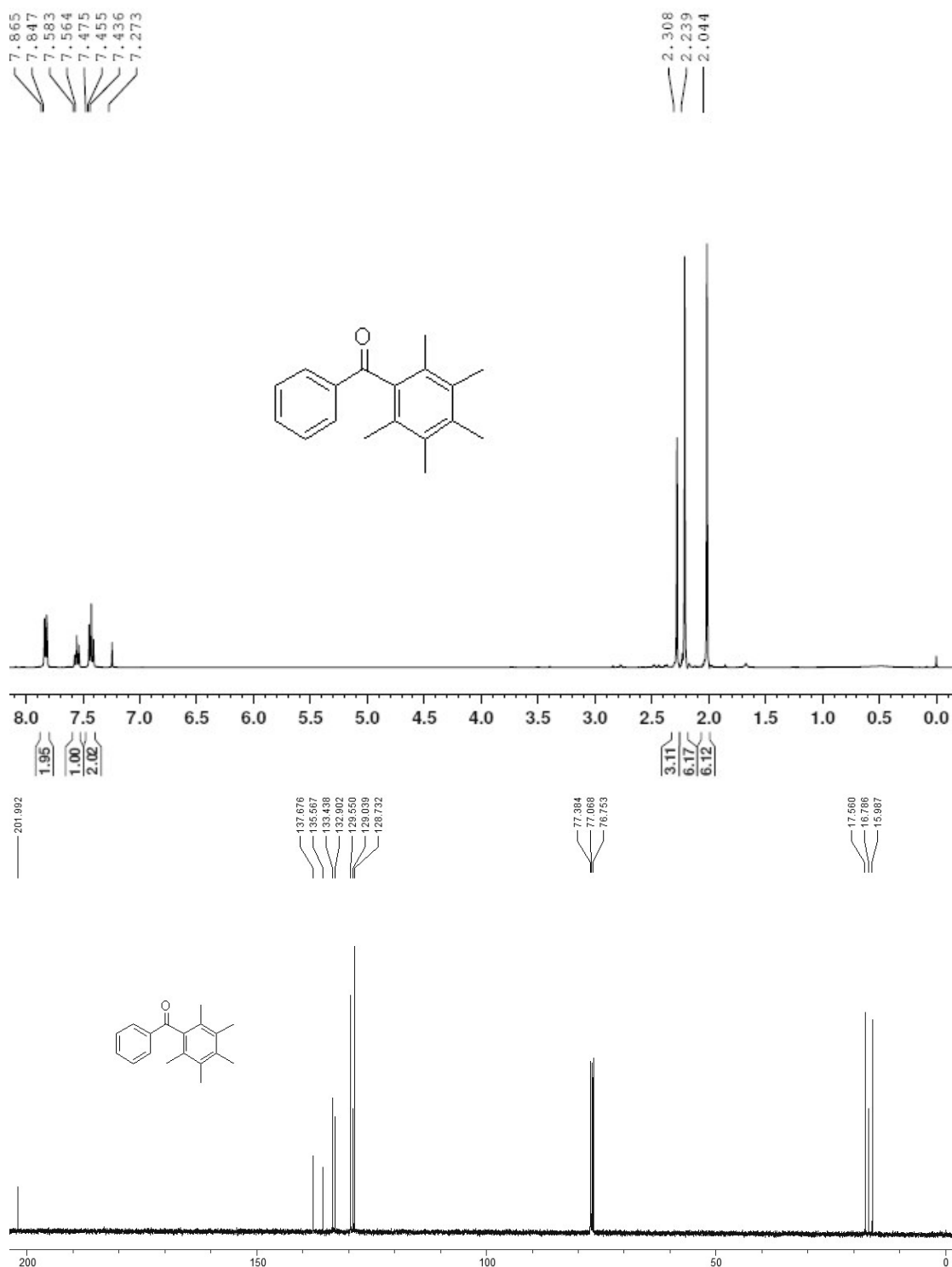
**(24) 2-nitrobenzophenone (4n)**

m.p. 104–105 °C (lit.<sup>12</sup> mp 105-106 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 8.06 ( d, *J* = 7.6 Hz, 1 H ), 7.63-7.71 ( m, 3 H ), 7.54 ( q, *J* = 7.2 Hz, 2 H ), 7.34-7.42 ( m, 3 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 197.1, 142.6, 136.9, 133.3, 133.2 130.9, 129.6, 129.4, 128.5, 127.9, 127.7. HRMS (EI) Calcd for C<sub>13</sub>H<sub>9</sub>NO<sub>3</sub> (M<sup>+</sup>) 227.0582, Found 227.0589.



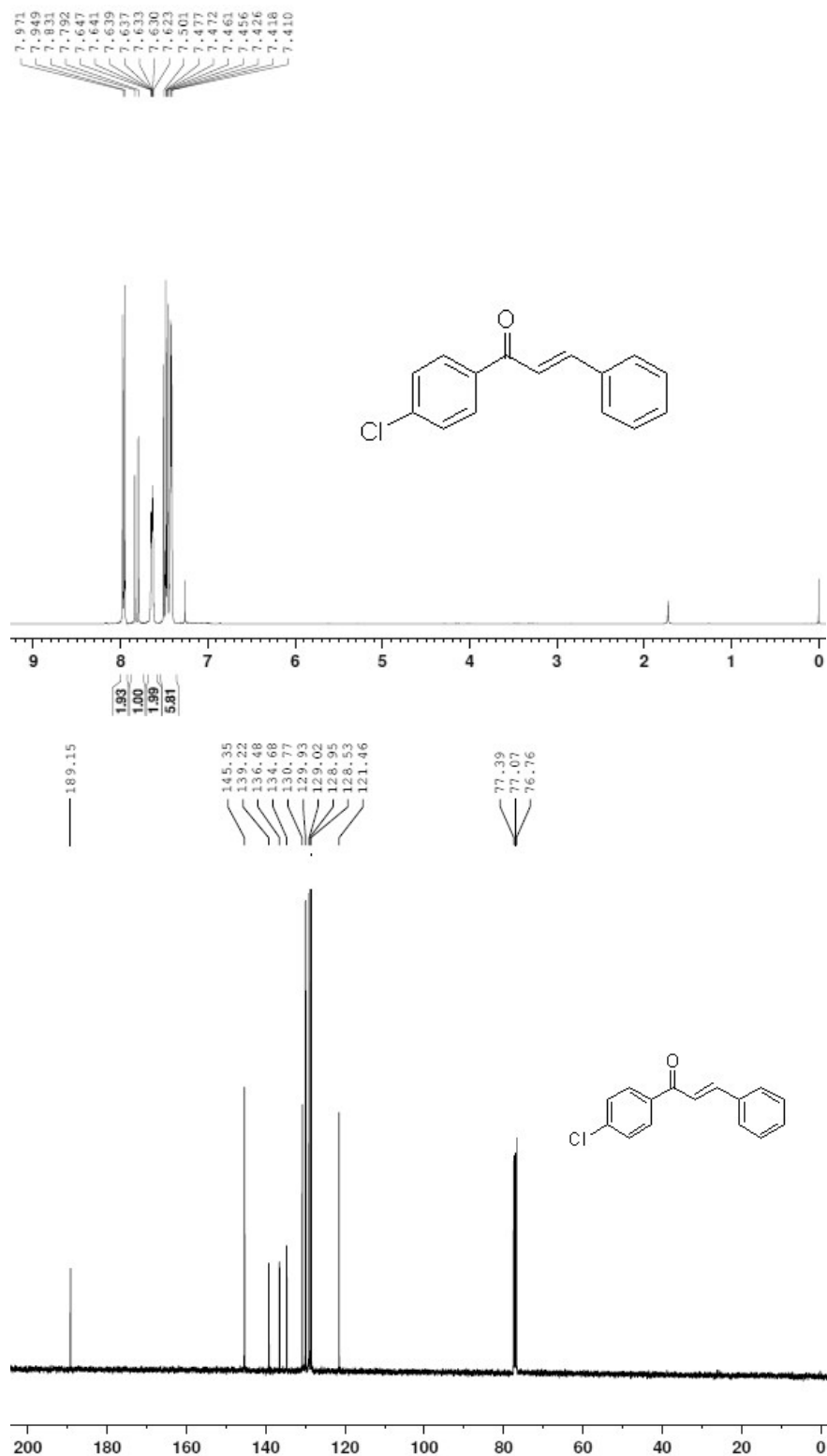
**(25) 2,3,4,5,6-pentamethyl-benzophenone (4o)**

m.p. 135–137 °C (lit.<sup>13</sup> mp 135–136 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.82 ( d, *J* = 7.2 Hz, 2 H ), 7.55 ( t, *J* = 7.2 Hz, 1 H ), 7.43 ( t, *J* = 7.6 Hz, 2 H ), 2.28 ( s, 3 H ), 2.21 ( s, 6 H ), 2.02 ( s, 6 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 202.0, 137.7, 135.6, 133.4, 132.9, 129.6, 129.0, 128.7, 17.6, 16.8, 15.9. HRMS (EI) Calcd for C<sub>18</sub>H<sub>20</sub>O (M<sup>+</sup>) 252.1514, Found 252.1516.



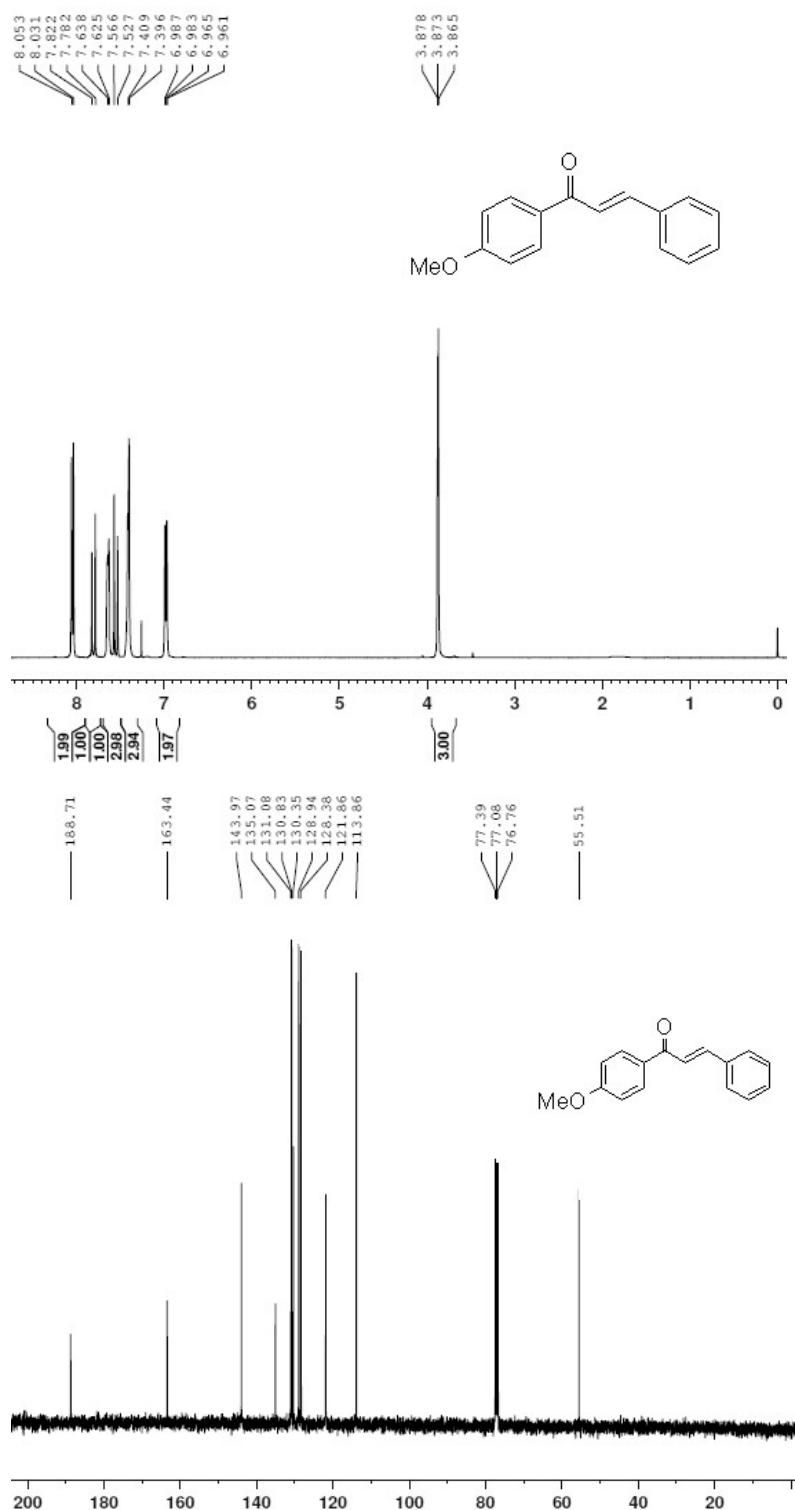
**(26) (E)-1-(4-chlorophenyl)-3-phenylprop-2-en-1-one**

m.p. 94-95 °C (lit.<sup>14</sup> mp 95 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 7.96 ( d, *J* = 8.8 Hz, 2 H ), 7.81 ( d, *J* = 16.0 Hz, 1 H ), 7.62-7.65 ( m, 2 H ), 7.48 ( d, *J* = 16.0 Hz, 1 H ), 7.46 ( d, *J* = 8.8 Hz, 2 H ), 7.42 ( t, *J* = 3.2 Hz, 2 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 189.2, 145.4, 139.2, 136.5, 134.7, 130.8, 129.9, 129.0, 128.5, 121.5. HRMS (EI) Calcd for C<sub>15</sub>H<sub>11</sub>ClO (M<sup>+</sup>) 242.0498, Found 242.0491.



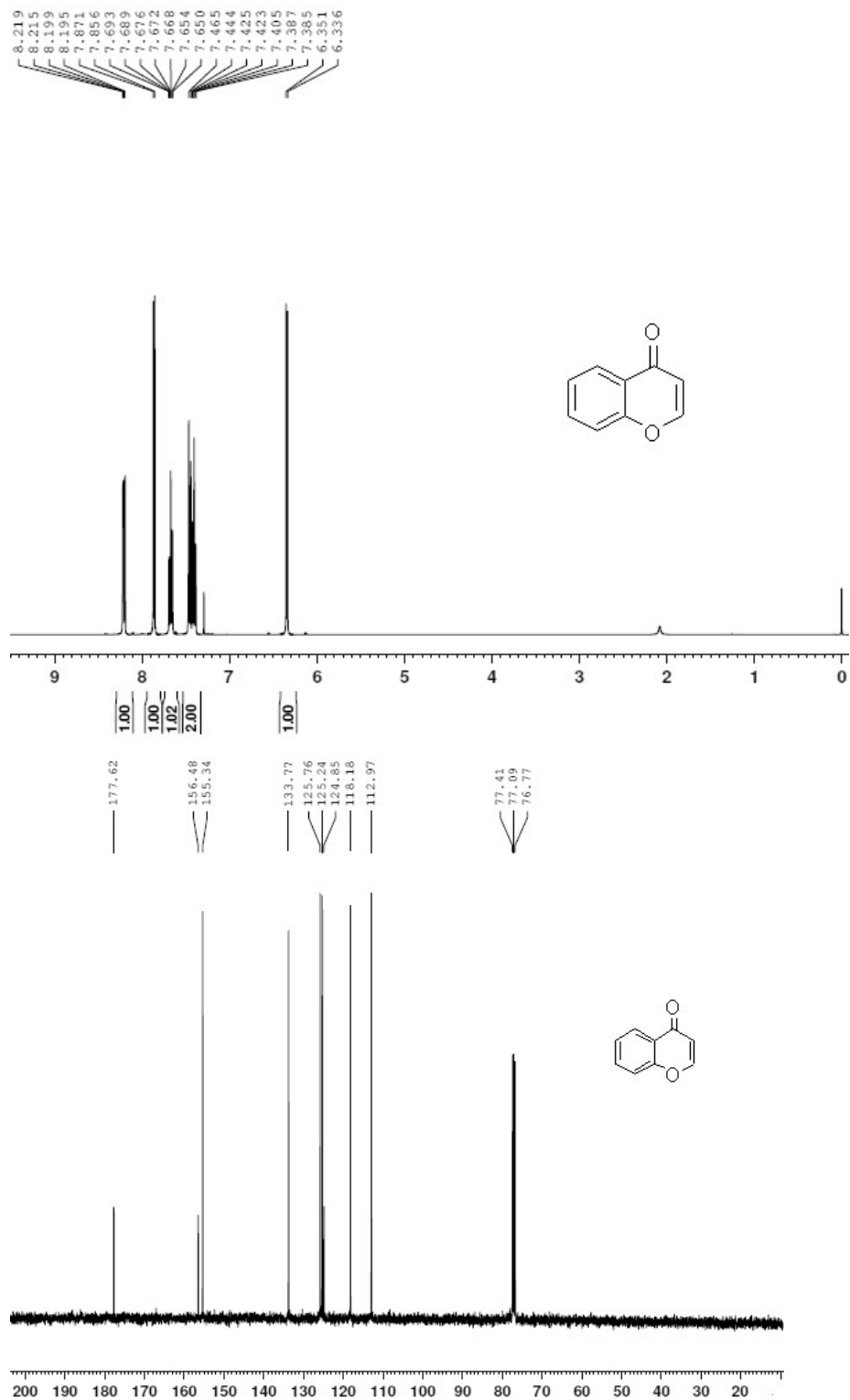
**(27)(E)-1-(4-methoxyphenyl)-3-phenylprop-2-en-1-one**

m.p. 104-106 °C (lit.<sup>15</sup> mp 104-105 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 8.04 ( d, *J* = 8.8 Hz, 2 H ), 7.80 ( d, *J* = 15.6 Hz, 1 H ), 7.62-7.64 ( m, 2 H ), 7.54 ( d, *J* = 15.6 Hz, 1 H ), 7.39-7.41 ( m, 3 H ), 6.97 ( dd, *J*<sub>1</sub> = 8.8 Hz, *J*<sub>2</sub> = 1.6 Hz, 2 H ), 3.87 ( s, 3 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 188.7, 163.5, 144.0, 135.1, 131.1, 130.8, 130.4, 128.9, 128.4, 121.9, 113.9, 55.5. HRMS (EI) Calcd for C<sub>16</sub>H<sub>14</sub>O<sub>2</sub>(M<sup>+</sup>) 238.0994, Found 238.0999.



**(28) 4H-chromen-4-one**

m.p. 59-60 °C (lit.<sup>16</sup> mp 58-60 °C); <sup>1</sup>H NMR ( 400 MHz, CDCl<sub>3</sub>, TMS ) δ 8.21 ( dd,  $J_1= 8.0$  Hz,  $J_2= 1.6$  Hz, 1 H ), 7.86 ( d,  $J = 6.0$  Hz, 1 H ), 8.21 ( dt,  $J_1= 7.6$  Hz,  $J_2= 1.6$  Hz, 1 H ), 7.45 ( d,  $J = 8.8$  Hz, 1 H ), 7.41 ( t,  $J = 8.0$  Hz, 1 H ), 6.34 ( d,  $J = 6.0$  Hz, 1 H ). <sup>13</sup>C NMR ( 100 MHz, CDCl<sub>3</sub> ) δ 177.6, 156.5, 155.3, 133.8, 125.8, 125.2, 124.9, 116.2, 113.0. HRMS (EI) Calcd for C<sub>9</sub>H<sub>6</sub>O<sub>2</sub>(M<sup>+</sup>) 146.0348, Found 146.0355.



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