Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting information

Visible-Light Driven Photochemical activity of ternary Ag/AgBr/TiO_2 Nanotubes for Oxidation C(sp^3)-H and C(sp^2)-H Bonds

Mona Hosseini-Sarvari, *[a] Abdulhamid Dehghani [b]

[a] *Department of Chemistry, Shiraz University, Shiraz 7194684795, I.R. Iran*

* *Corresponding author, E-mail address: hossaini@shirazu.ac.ir (*Mona Hosseini-Sarvari)

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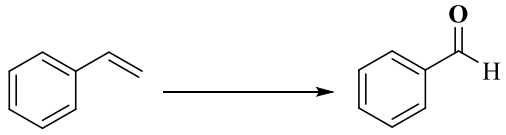
Table S1. An overview on the different catalysts for the oxidation of C(sp^3)-H and C(sp^2)-H bonds.

Oxidation C(sp^3)-H							
Entry	**Catalyst/ Base**	**Oxidant**	**Time**	**Temperature**	**Solvent**	**Irradiation**	Ref.
1	Ag/AgBr/TiO_2	aerobic oxidation	4-12 h	R.T	Solvent-Free	CFL White 15 W	this work
2	Co, Mn, Br_2	O_2 (27atm)	-	205 °C	HOAC	-	1
3	$KAuCl_4$. 0.5 H_2O	TBHP, Air	24h	90 °C	Pyridine	-	2
4	I_2	TBHP	18 h	70 °C	CH_3CN	-	3
5	LiHDMS (base)	O_2 (1 atm)	12 h	60 °C	THF	-	4
6	Flavin scandium complex (RFT)	Air	0.5-7 h	R.T	CH_3CN/HCl	Blue LED (440nm)	5
7	TBADT	O_2	45 min	R.T	CH_3CN/HCl	LED (365nm)	6
Oxidation C(sp^2)-H							
8	Ag/AgBr/TiO_2	aerobic oxidation	24-48 h	R.T	CH_3CN	CFL White 15 W	this work
9	Fe_3O_4	H_2O_2	2 h	80 °C	Solvent-Free	-	7
10	Co-Ag/ZnO	H_2O_2	24 h	80 °C	AcOH	-	8
11	Pd(II)-L complex	0.5 MPa O_2	12 h	80 °C	Water	-	9
12	Alumina-supported VxOy Nanoparticle	Anhydrous Hydrogen Peroxide	4.96 h	63 °C	Ethyl acetate	-	10
13	$[Cu_2(bipy)_2(btec)]\infty$	TBHP	6 h	75 °C	Dichloroethane, n-decane,	-	11
14	Eosin Y	air	9- 12 h	-	DMSO	Green LED	12

Optimization of reaction conditions:

Optimization of reaction conditions

Table S2. Optimization of the reaction parameters for the preparation of benzaldehyde [a]



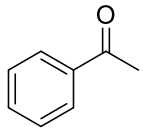
3a **4a**

Entry	photocatalyst	Amount of photocatalyst	Solvent	Light	Atmosphere	Conversion %
1	Ag/AgBr/TiO_2	0.005	EtOH	CFL 15 W White	air	5
2	Ag/AgBr/TiO_2	0.005	CH_3CN	CFL 15 W White	air	83
3	Ag/AgBr/TiO_2	0.005	EtOAC	CFL 15 W White	air	79
4	Ag/AgBr/TiO_2	0.005	Acetone	CFL 15 W White	air	82
5	Ag/AgBr/TiO_2	0.005	THF	CFL 15 W White	air	52
6	Ag/AgBr/TiO_2	0.005	MeOH	CFL 15 W White	air	51
7	Ag/AgBr/TiO_2	0.005	H_2O	CFL 15 W White	air	5
8	Ag/AgBr/TiO_2	0.005	CH_2Cl_2	CFL 15 W White	air	45
9	Ag/AgBr/TiO_2	0.005	$CHCl_3$	CFL 15 W White	air	55
10	Ag/AgBr/TiO_2	0.005	DMF	CFL 15 W White	air	51
11	Ag/AgBr/TiO_2	0.005	DMSO	CFL 15 W White	air	52
12	Ag/AgBr/TiO_2	0.005	CH_3CN/ H_2O	CFL 15 W White	air	80
13	Ag/AgBr/TiO_2	0.005	Solvent Free	CFL 15 W White	air	0
14	Ag/AgBr/TiO_2	0.001	CH_3CN	CFL 15 W White	air	15
15	Ag/AgBr/TiO_2	0.003	CH_3CN	CFL 15 W White	air	25
16	Ag/AgBr/TiO_2	0.007	CH_3CN	CFL 15 W White	air	84
17	Ag/AgBr/TiO_2	0.01	CH_3CN	CFL 15 W White	air	90
18	Ag/AgBr/TiO_2	0.015	CH_3CN	CFL 15 W White	air	90
19	Ag/AgBr/TiO_2	0.02	CH_3CN	CFL 15 W White	air	95
20	Ag/AgBr/TiO_2	0.01	CH_3CN	Blue LED 12 W	air	20
21	Ag/AgBr/TiO_2	0.01	CH_3CN	Green LED 12 W	air	10
22	Ag/AgBr/TiO_2	0.01	CH_3CN	Red LED 12 W	air	5
23	Ag/AgBr/TiO_2	0.01	CH_3CN	Dark	air	trace
24	Ag/AgBr/TiO_2	0.01	CH_3CN	Sun Light	air	50
25	Ag/AgBr/TiO_2	0.01	CH_3CN	CFL 15 W White	O_2 balloon	90
26	Ag/AgBr/TiO_2	0.01	CH_3CN	CFL 15 W White	Argon	50
27	AgBr	0.01	CH_3CN	CFL 15 W White	air	35
28	Ag/AgBr	0.003	CH_3CN	CFL 15 W White	air	50
29	TiO_2(P25)	0.003	CH_3CN	CFL 15 W White	air	20
30	Ag/TiO_2	0.003	CH_3CN	CFL 15 W White	air	70

[a] *Reaction conditions*: Styrene (0.3 mmol), catalyst in 2 mL of solvent for 24h, at room temperature.

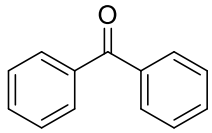
Characterization of products:

Acetophenone (2a, 4m)



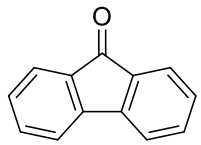
Clear colorless liquid; Yield: 96%(2a), 78%(4m); ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 7.97 (d, 2H, *J*= 7.2 Hz, ArH), 7.57 (dd, 1H, *J* = 7.2 Hz, ArH),7.46(dd, 2H, *J* = 7.2 Hz, ArH), 2.61 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) = 198.9, 137.1, 133.1, 128.6, 128.3, 26.6.

Benzophenone (2b)



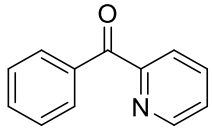
White solid; Yield: 82%; m.p. 48.5 °C (Lit[13]. 48.5 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 7.82 (d, 4H, *J* = 7.6 Hz, ArH), 7.60 (dd, 2H, *J* = 7.6 Hz, ArH), 7.49 (dd, 4H, *J* = 7.6 Hz, ArH); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 196.7, 137.6, 132.4, 130.1, 128.3.

9H-fluoren-9-one (2c)



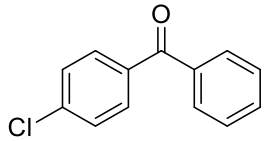
Yellow solid; Yield:41%; m.p. 84 °C (Lit[14]. 84 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 7.65 (d, 2H, *J* = 7.2 Hz, ArH), 7.09-7.45 (m, 4H, ArH), 7.30 (d, 2H, *J* = 7.2 Hz, ArH); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 193.9, 144.4, 134.7, 134.1, 129.1, 124.9, 120.3.

Phenyl(pyridin-2-yl) methanone (2d)



light yellow crystalline; Yield: 66%; mp 41−46 °C (lit[14]. 41− 46 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 8.81 (d, 2H, *J* = 4.4 Hz, ArH), 7.82 (d, 2H, *J* = 7.6 Hz, ArH), 7.64 (dd, 1H, *J* = 7.6 Hz, ArH), 7.58 (dd, 2H, *J* = 4.4 Hz, ArH), 7.52 (dd, 2H, *J* = 7.6 Hz, ArH); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) =195.2, 166.0, 152.7, 150.4, 144.4, 135.9, 133.5, 130.1, 128.7, 122.3.

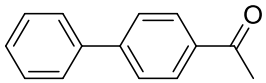
4-Chlorobenzophenone (2e)



White solid; Yield: 71%; m.p. 75 °C (Lit[13]. 75 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 7.85-7.73 (m, 4H, ArH), 7.63 (dd, 1H, *J* = 6.4 Hz, ArH), 7.52 (d, 2H, *J* = 6.4 Hz, ArH), 7.48

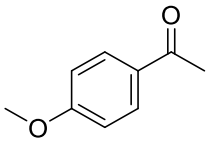
(dd, 2H, *J* = 6.4 Hz, ArH); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 195.5, 138.9, 137.2, 135.9, 132.7, 131.5, 129.9, 128.6, 128.4.

1-([1,1'-Biphenyl]-4-yl)ethan-1-one (2f)



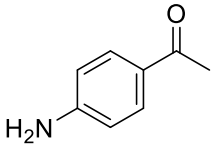
White solid; Yield: 84%, m.p. 119-120 °C (Lit[15]. 119-120 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 8.06 (d, 2H, *J* = 8.4 Hz, ArH), 7.72 (d, 2H, *J* = 10.4 Hz, ArH), 7.66 (d, 2H, *J* = 10.4 Hz, ArH), 7.49 (dd, 2H, *J* = 8.4 Hz, ArH), 7.43 (dd, 1H, *J* = 8.4 Hz, ArH), 2.67 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 197.8, 145.8, 139.9, 135.9, 129.0, 128.9, 128.2, 127.3, 127.2, 26.7.

1-(4-methoxyphenyl) ethan-1-one (2g)



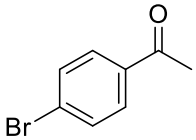
White solid; Yield: 92%, m.p. 35-36 °C (Lit[16]. 36-38 °C); ^{1}H NMR (250 MHz, DMSO-d_6): δ (ppm) = 7.52 (d, 2H, *J* = 9 Hz, ArH), 6.97 (d, 2H, *J* = 9 Hz, ArH), 3.76 (s, 3H, OMe), 2.48 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 196.6, 163.5, 130.5, 113.7, 55.4, 26.2

1-(4-aminophenyl) ethan-1-one (2h)



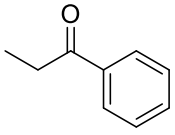
Yellow solid; Yield:48%; m.p. 103-105 °C (Lit[17]. 102.8-104.1 °C); ^{1}H NMR (250 MHz, DMSO-d_6): δ (ppm) = 7.65 (d, 2H, *J* = 8.7 Hz, ArH), 6.55 (d, 2H, *J* = 8.7 Hz, ArH), 6.01(s, 2H, NH_2), 2.36 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 196.4, 150.3, 141.4, 129.3, 123.8, 27.0.

1-(4-bromophenyl) ethan-1-one (2i)



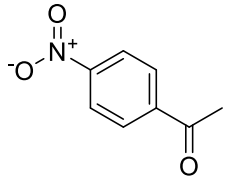
White solid; Yield: 65%; m.p. 50 °C (Lit[18]. 52-54 °C); ^{1}H NMR (250 MHz, DMSO-d_6): δ (ppm) = 7.86 (d, 2H, *J* = 8.7 Hz, ArH), 7.86 (d, 2H, *J* = 8.7 Hz, ArH), 2.55 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 197.0, 135.8, 131.9, 129.8, 128.3, 26.5.

Propiophenone (2j)



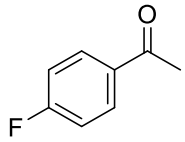
Colorless liquid; Yield: 83%; ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 7.94 (d, 2H, *J* = 7.2 Hz, ArH), 7.51 (dd, 1H, *J* = 7.2 Hz, ArH), 7.41 (dd, 2H, *J* = 7.2 Hz, ArH), 2.96 (q, 4H, J = 7.2 Hz, CH_2), 1.19 (t, 3H, *J* = 7.2 Hz, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) = 200.7, 136.8, 132.8, 128.52, 127.9, 31.7, 8.9.

1-(4-nitrophenyl) ethan-1-one (2k)



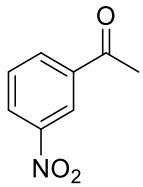
Light yellow solid, Yield: 91%; m.p. 79 °C (Lit[19]. 80-81 °C); ^{1}H NMR (250 MHz, DMSO-d_6): δ (ppm) = 8.27 (d, 2H, *J* = 8.5 Hz, ArH), 8.12 (d, 2H, *J* = 8.5 Hz, ArH), 2.63 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 196.4, 150.3, 141.4, 129.3, 123.8, 27.0.

1-(4-fluorophenyl) ethan-1-one (2l)



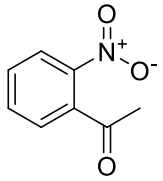
Clear colorless liquid[17]; Yield:86%, ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 7.88 (d, 2H, *J* = 4 Hz, ArH), 7.02 (d, 2H, *J* = 4Hz, ArH), 2.49 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 191.1, 134.2, 134.0, 129.0, 128.5, 46.1.

1-(3-nitrophenyl) ethan-1-one (2m)



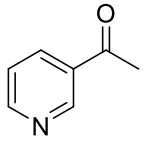
Yellow solid; Yield: 62%; m.p. 78°C (Lit[19]. 76-80 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 8.46 (s, 1H), 7.52 (dd, 1H, *J* = 7.6 Hz, ArH), 7.11 (d, 1H, *J* = 7.6 Hz, ArH), 7.05 (d, 1H, *J* = 7.6 Hz, ArH), 2.52 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 190.6, 131.8, 129.8, 115.9, 114.2, 55.4.

1-(2-nitrophenyl) ethan-1-one (2n)



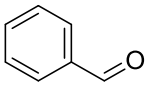
Brown oil[19]; Yield: 53%; ^{1}H NMR (250 MHz, $CDCl_3$): δ (ppm) = 8.16 (d, 1H, *J* = 7.5 Hz, ArH), 7.61 (dd, 1H, *J* = 7.5 Hz, ArH), 7.52 (dd, 1H, *J* = 7.5 Hz, ArH), 7.24 (d, 1H, J = 7.5 Hz, ArH), 1.18 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 197.8, 145.8, 139.9, 135.9, 129.0, 128.2, 127.3, 26.7.

1-(pyridin-3-yl) ethan-1-one (2o)



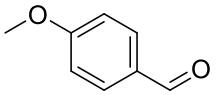
Liquid[17]; Yield:74%; ^{1}H NMR (400 MHz, $CDCl_3$); δ (ppm) = 8.94 (d, 1H, *J* = 8 Hz, ArH), 8.55 (dd, 1H, *J* = 4 Hz, ArH), 8.01 (d, 1H, *J* = 8 Hz, ArH), 7.22 (s, 1H, ArH), 2.44 (s. 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ (ppm) = 196.4, 167.0, 164.4, 133.6, 133.5, 130.9, 130.9, 115.7, 115.5, 26.4.

Benzaldehyde (4a, 4b)



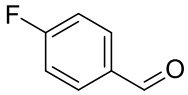
Colorless liquid; Yield: 90% (4a), 12% (4b); ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 10.03 (s, 1H), 7.89 (d, 2H, *J* = 7.8 Hz, ArH), 7.64 (dd, 1H, *J* = 6.9 Hz, ArH), 7.54 (dd, 2H, *J* = 7.8 Hz, ArH); ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) = 192.4, 136.4, 134.5, 129.7, 129.0.

4-methoxybenzaldehyde (4c)



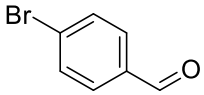
Clear liquid[20]; Yield: 52%; ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 9.88 (s, 1H), 7.84 (d, 2H, *J* = 8.7 Hz, ArH), 7.00 (d, 2H, *J* = 8.7 Hz, ArH), 3.89 (s, 3H, OMe); ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) = 190.8, 164.6, 132.0, 129.9, 114.3, 55.6.

4-fluorobenzaldehyde (4d)



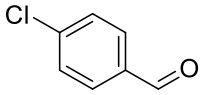
Yellow liquid; Yield:42%; ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 9.97 (s,1H), 7.91 (dd, 2H, *J*= 8.4, 5.4 Hz, ArH), 7.21 (dd, 2H, *J*= 8.7, 8.1 Hz, ArH); ^{13}C NMR (75 MHz, $CDCl_3$): δ(ppm) = 190.5, 166.5 (d, *J* = 255.0 Hz), 132.9(d, *J* = 2.0 Hz), 132.2 (d, *J* = 9.6 Hz), 116.3 (d, *J* = 22.3 Hz).

4-bromobenzaldehyde (4e)



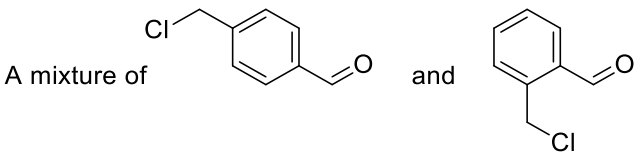
White solid; Yield: 49%; m.p. 56-58 °C; ^{1}H NMR (250 MHz, $CDCl_3$): δ (ppm) = 10.00 (s, 1H), 7.74 (d, 2H, *J* = 8.2 Hz, ArH), 7.69 (d, 2H, *J* = 8.2 Hz, ArH);^{13}C NMR (75 MHz, $CDCl_3$) δ 191.1, 135.0, 132.5, 131.0, 129.8.

4-chlorobenzaldehyde (4f)



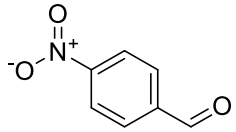
White solid; Yield: 56%; m.p. 47 °C (Lit[21]. 47.5 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 9.99 (s, 1H), 7.83 (d, 2H, *J* = 8.4 Hz, ArH), 7.52 (d, 2H, *J* = 8.4 Hz, ArH); ^{13}C NMR (100 MHz, $CDCl_3$): δ(ppm) = 190.9, 141.0, 134.7, 130.9, 129.5.

4-(chloromethyl)benzaldehyde and 2-(chloromethyl)benzaldehyde (4g)



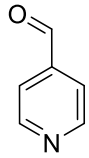
Colorless liquid; Yield: 88%, ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 9.95 (s, 1H), 9.94 (s, 1H), 7.83- 7.76 (m, 4H, ArH), 7.60 (d, 1H, *J* = 7.5 Hz, ArH), 4.48-7.50 (m, 3H, ArH), 4.58 (s, 2H, CH_2), 4.56 (s, 2H, CH_2); ^{13}C NMR (75 MHz, $CDCl_3$): δ(ppm) = 191.8, 191.7, 143.8, 138.6, 136.8, 136.1, 134.5, 130.1, 129.8, 129.5, 129.5, 129.1, 50.9, 45.3.

4-nitrobenzaldehyde (4h)



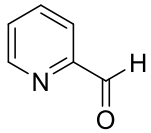
Yellow to brown crystalline powder; Yield: 62%; m.p. 103-105.5 °C (Lit[22]. 103-106 °C); ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 10.18 (s, 1H), 8.42 (d, 2H, *J* = 8.7 Hz, ArH), 8.10 (d, 2H, *J* = 8.7 Hz, ArH); ^{13}C NMR (75 MHz, $CDCl_3$): δ(ppm) = 190.3, 151.1, 140.0, 130.5, 124.3.

Isonicotinaldehyde (4i)



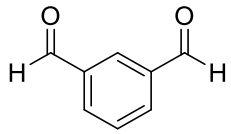
Slight brown liquid[20]; Yield: 54%, ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) = 10.02 (s, 1H), 8.81 (d, 2H, *J* = 5.6Hz, ArH), 7.64 (d, 2H, *J* = 5.6Hz, ArH); ^{13}C NMR (75 MHz, $CDCl_3$): δ(ppm) = 191.5, 151.2, 141.3, 122.1.

Picolinaldehyde (4j)



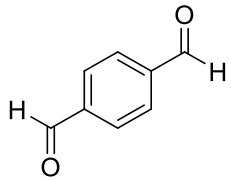
Brown liquid[20]; Yield: 57%; ^{1}H NMR (400 MHz $CDCl_3$): δ (ppm) = 10.07 (s, 1H), 8.78 (d, 1H, *J* = 4.8 Hz, ArH), 7.95 (d, 1H, *J* = 8 Hz, ArH), 7.87 (dd, 1H, *J* = 10.8, 8 Hz, ArH), 7.51 (dd, 1H, *J* = 10.8, 4.8 Hz, ArH); ^{13}CNMR (100 MHz, $CDCl_3$ ppm): δ(ppm) = 193.4, 152.8, 150.2, 137.1, 127.9, 121.7.

Isophthalaldehyde (4k)



White to yellow solid, Yield: 69%; m.p. 86-88 °C; ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 10.05 (s, 2H), 8.32 (s, 1H, ArH), 8.10 (d, 2H, *J* = 7.5 Hz, ArH), 7.67 (dd, 1H, *J* = 7.5 Hz, ArH); ^{13}C NMR (75 MHz, $CDCl_3$): δ(ppm) = 191.1, 137.0, 134.7, 131.0, 129.9.

Terephthalaldehyde (4l)



Light yellow solid, Yield: 55%; m.p. 114.5-116 °C; ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) = 10.14 (s, 2H), 8.06 (s, 4H); ^{13}C NMR (75 MHz, $CDCl_3$): δ(ppm) = 191.5, 140.0, 130.1.

^{1}H, ^{13}C NMR Spectra of Synthesized Compounds:

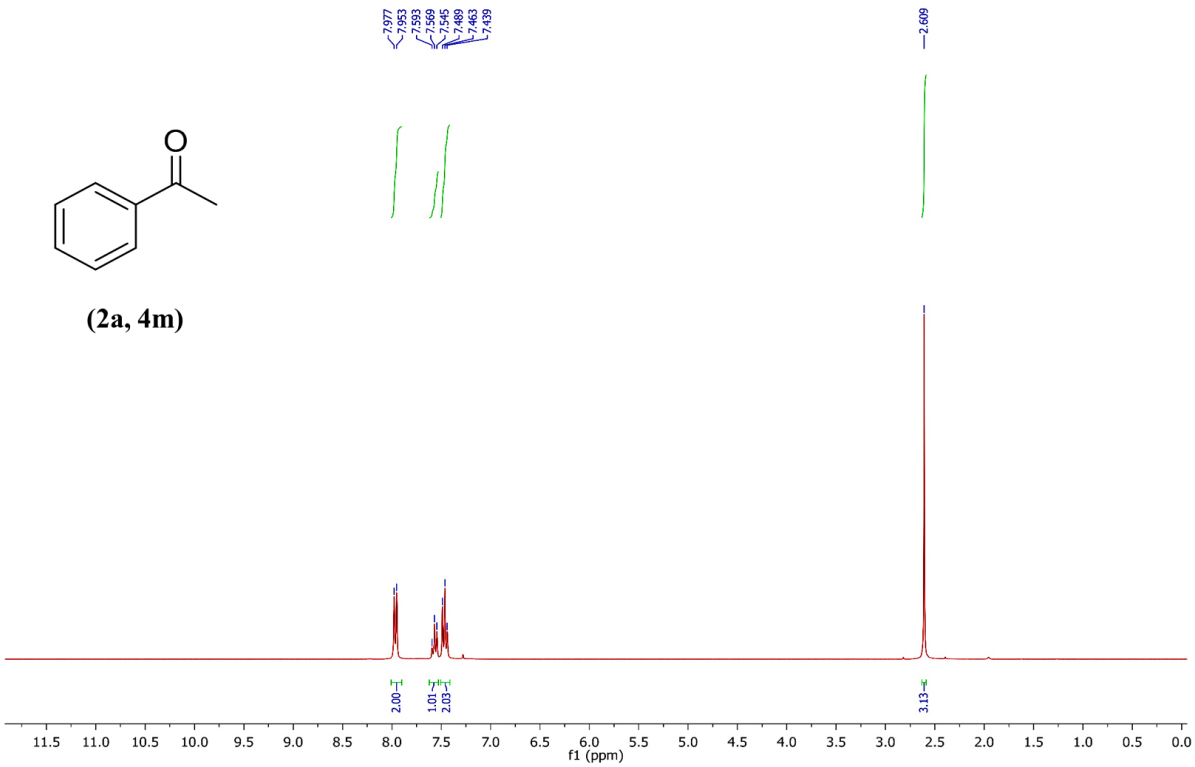


Figure 1:^{1}H NMR spectrum of Acetophenone (**2a, 4m**).

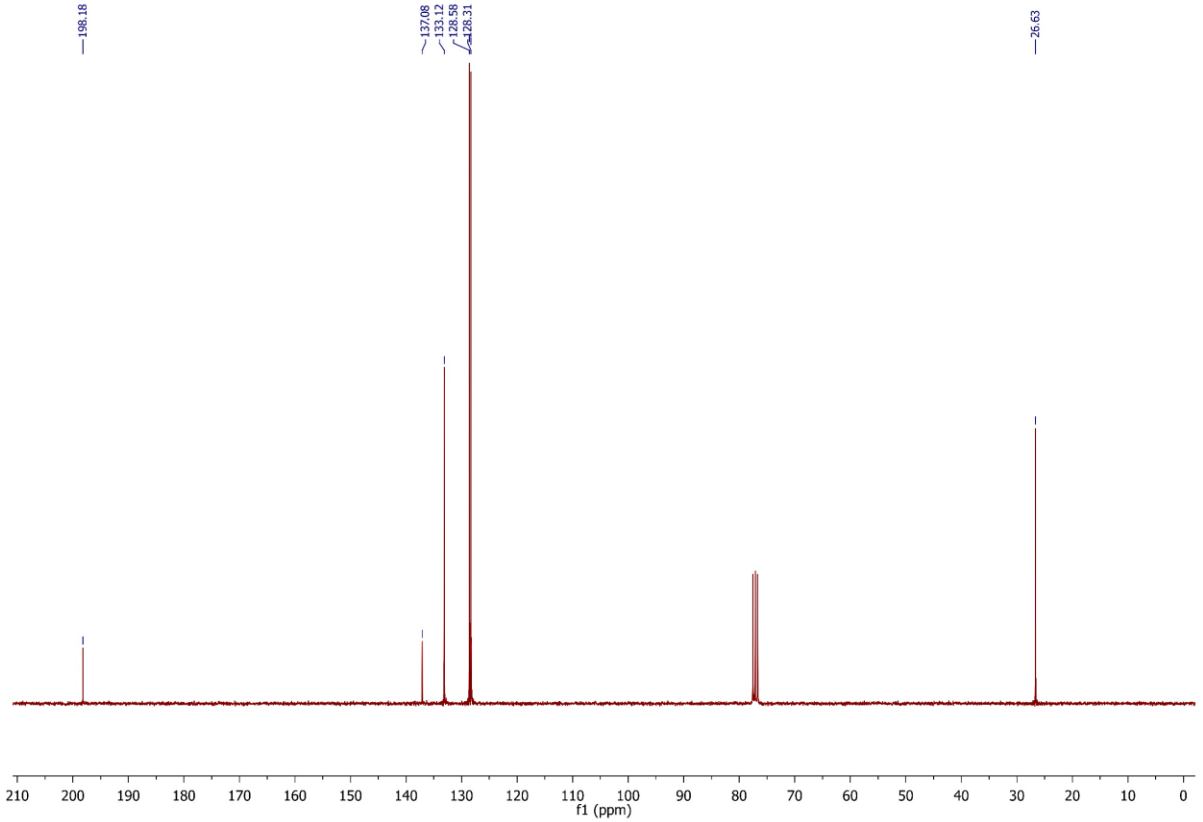


Figure 2:^{13}C NMR spectrum of Acetophenone (**2a, 4m**).

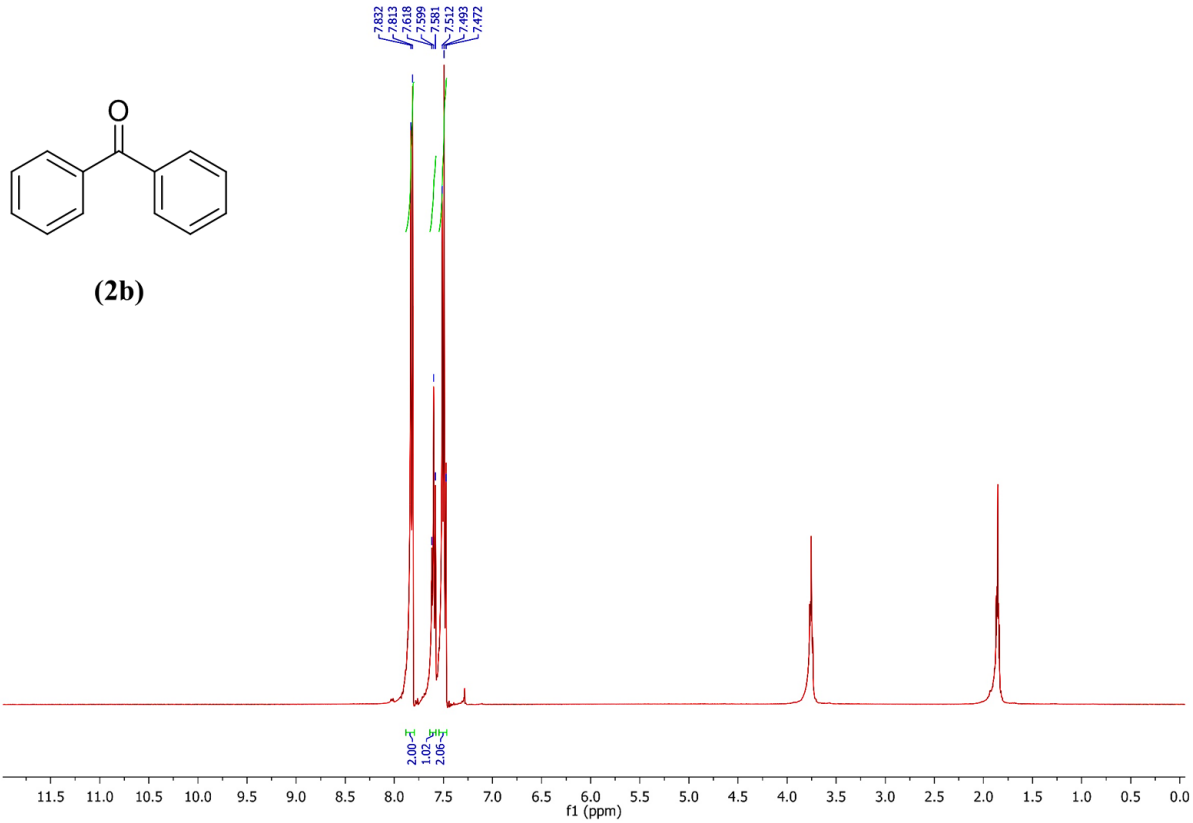


Figure 3:[1]H NMR spectrum of Benzophenone (**2b**).

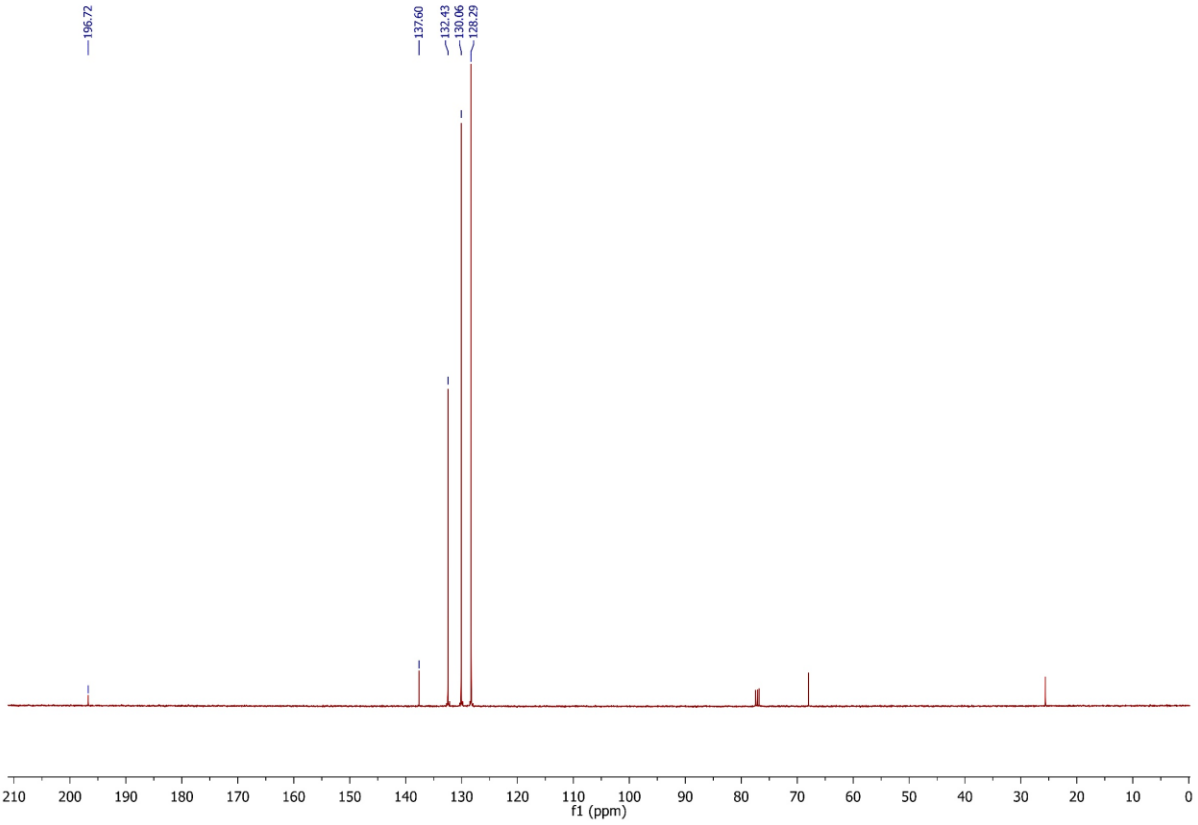


Figure 4:[13]C NMR spectrum of Benzophenone (**2b**).

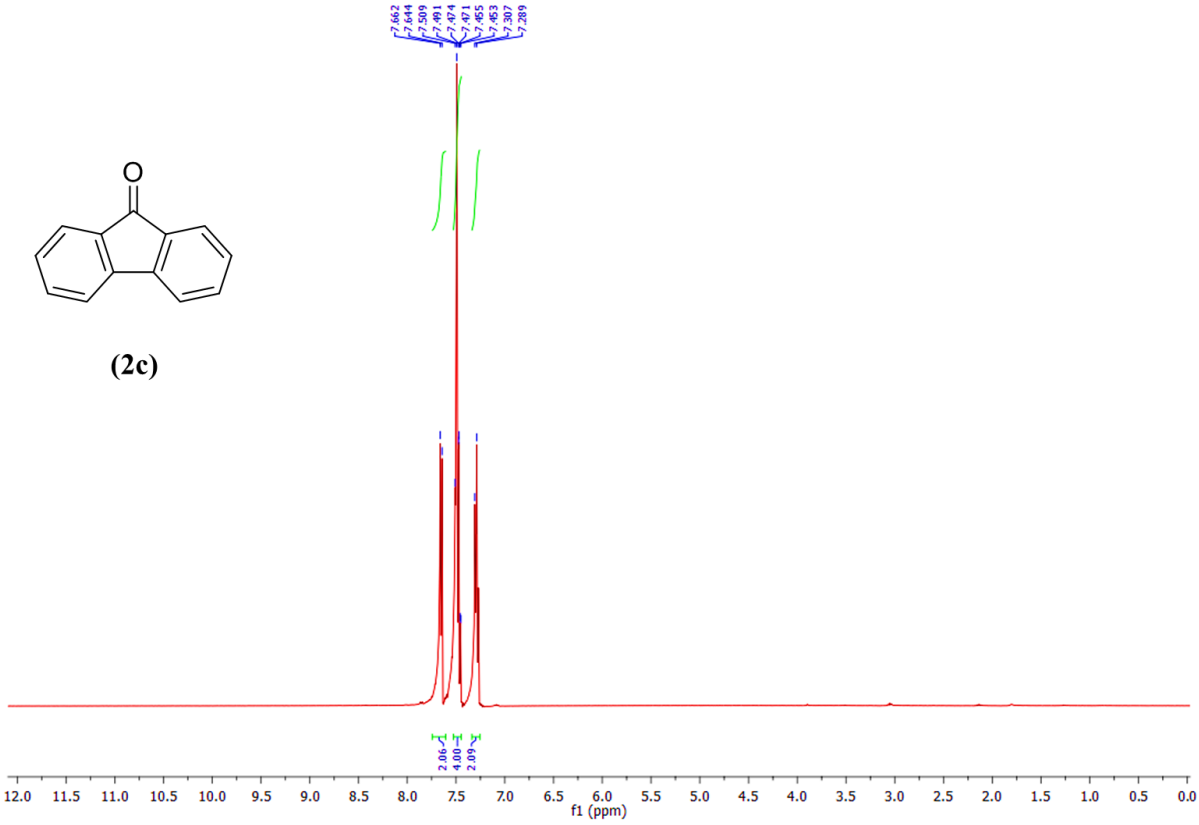


Figure 5:[1]H NMR spectrum of 9H-fluoren-9-one (**2c**).

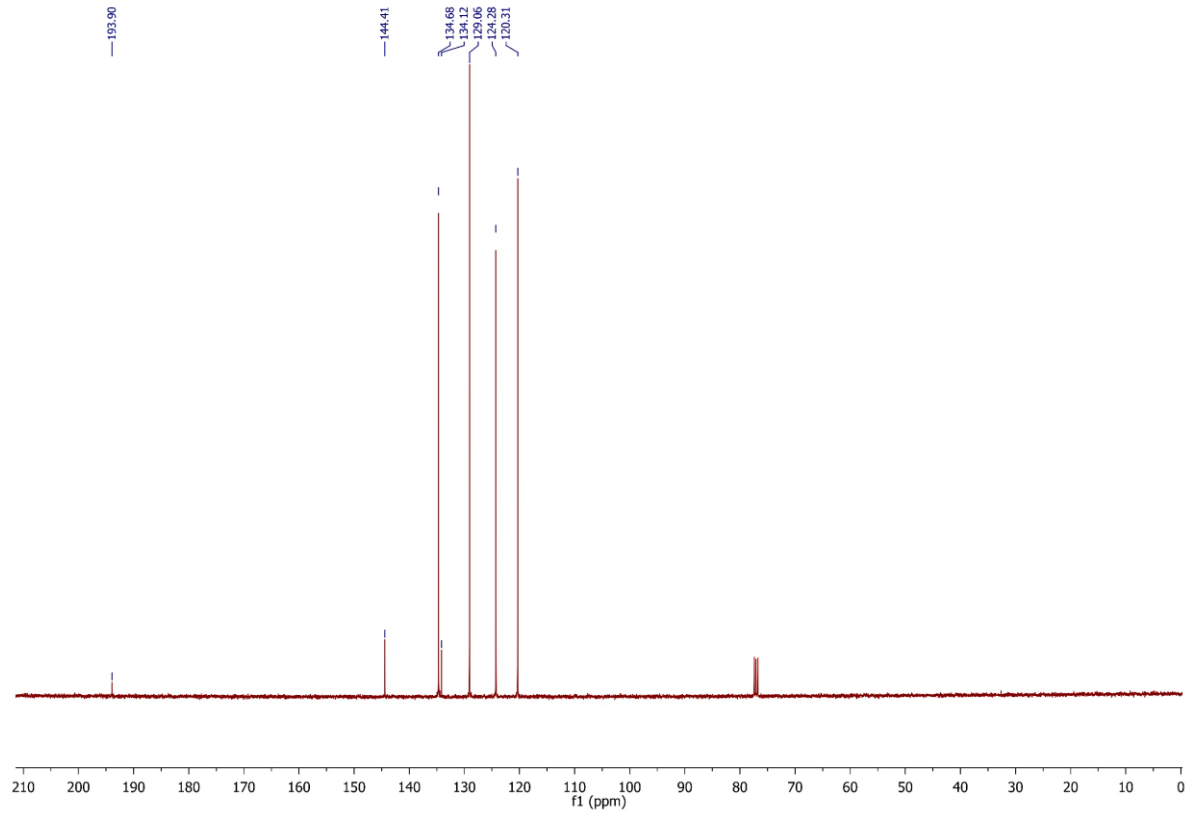


Figure 6:[13]C NMR spectrum of 9H-fluoren-9-one (**2c**).

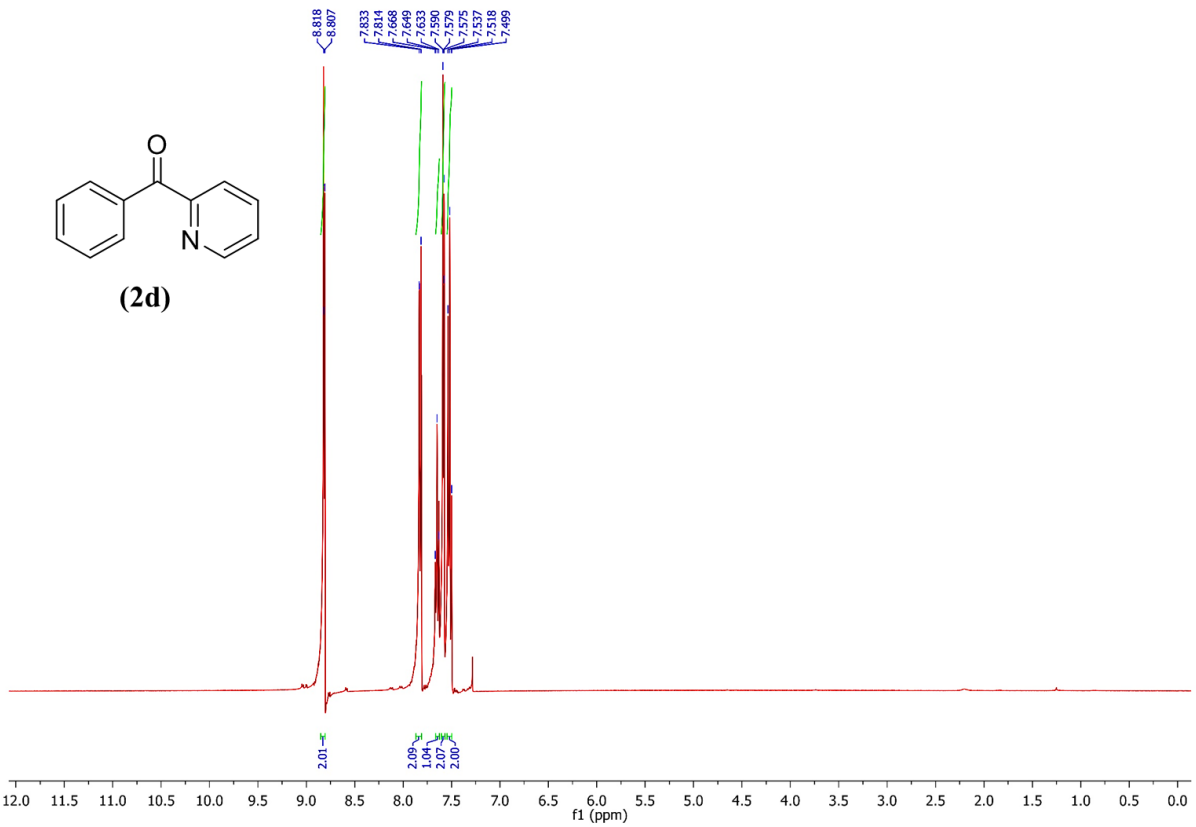


Figure 7*:*[1]H NMR spectrum of Phenyl(pyridin-2-yl) methanone (**2d**).

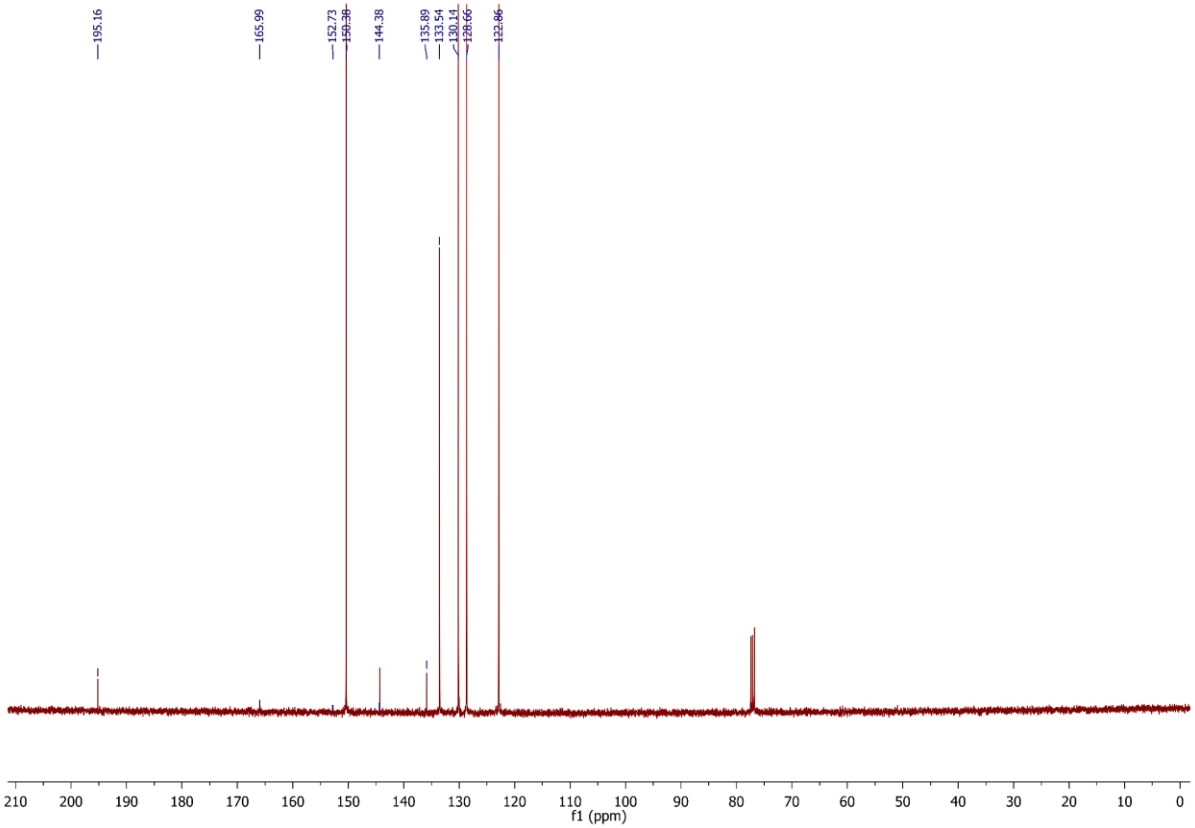


Figure 8:[13]C NMR spectrum of Phenyl(pyridin-2-yl) methanone (**2d**).

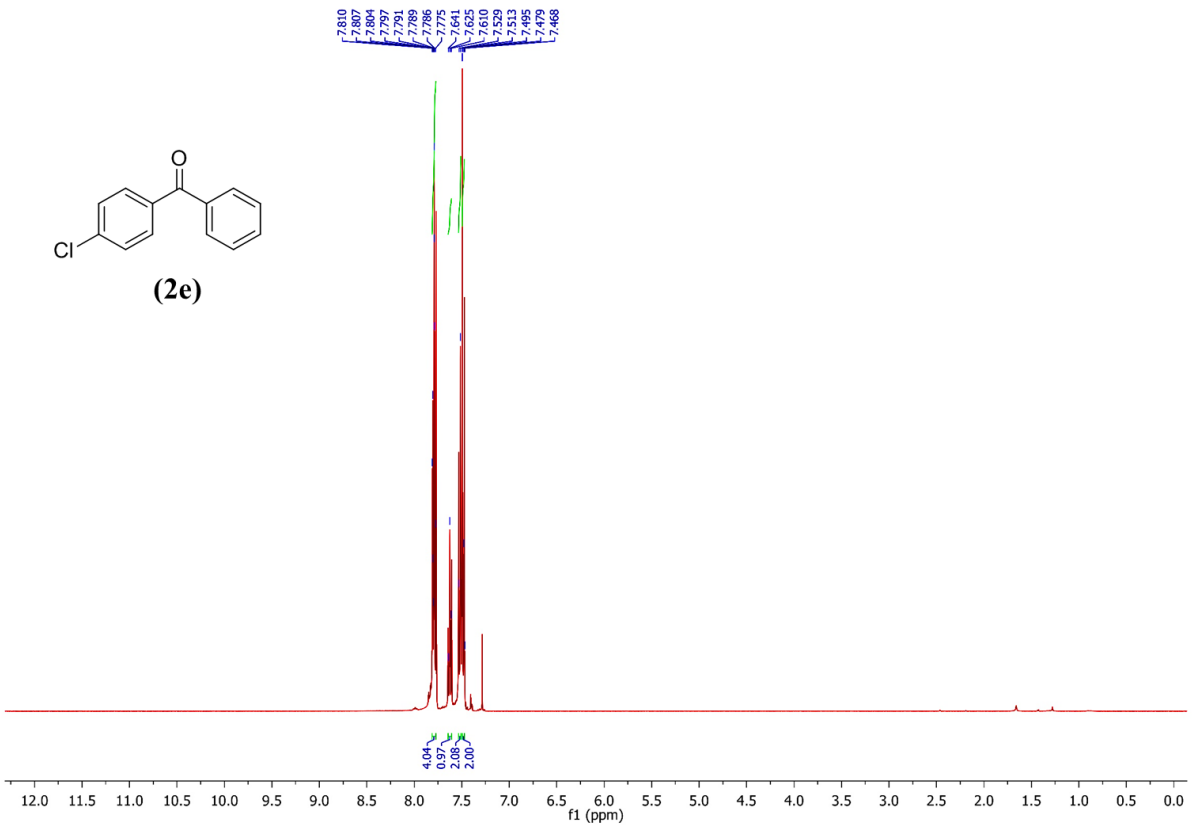


Figure 9:[1]H NMR spectrum of 4-Chlorobenzophenone (**2e**).

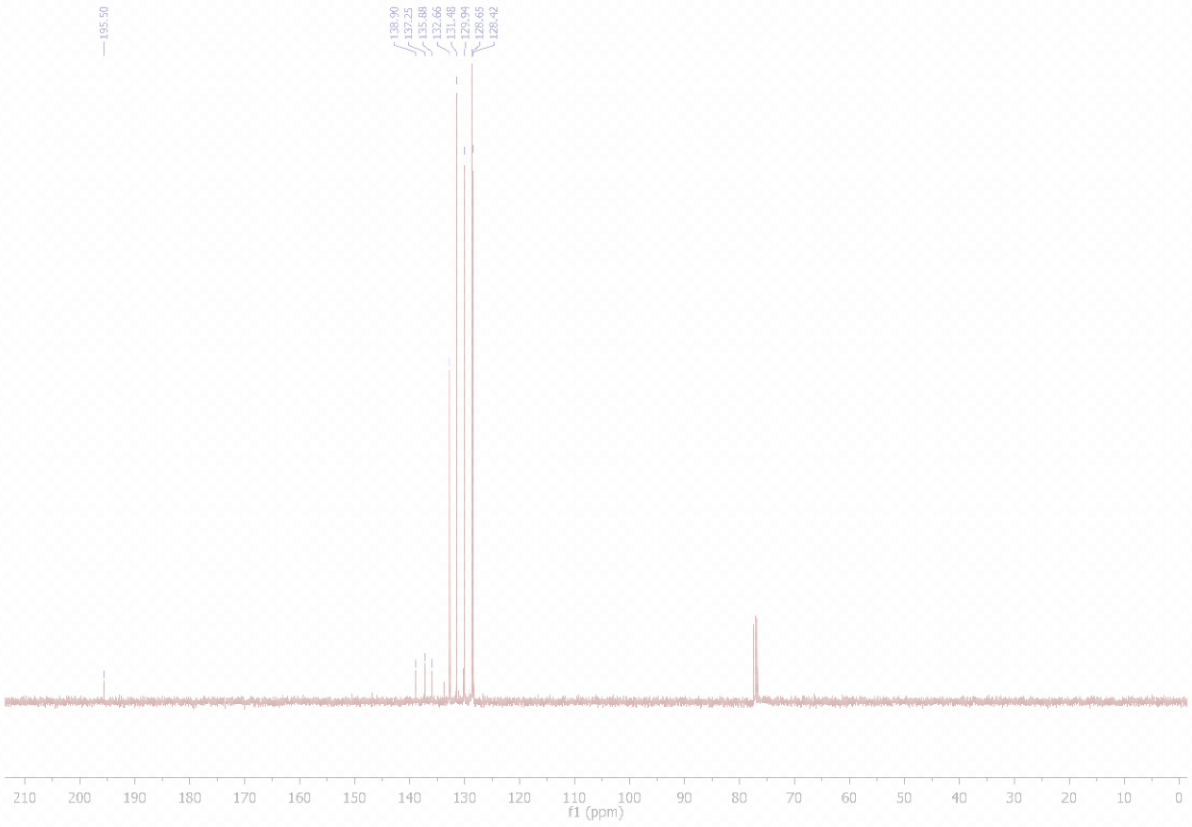


Figure 10:[13]C NMR spectrum of 4-Chlorobenzophenone (**2e**).

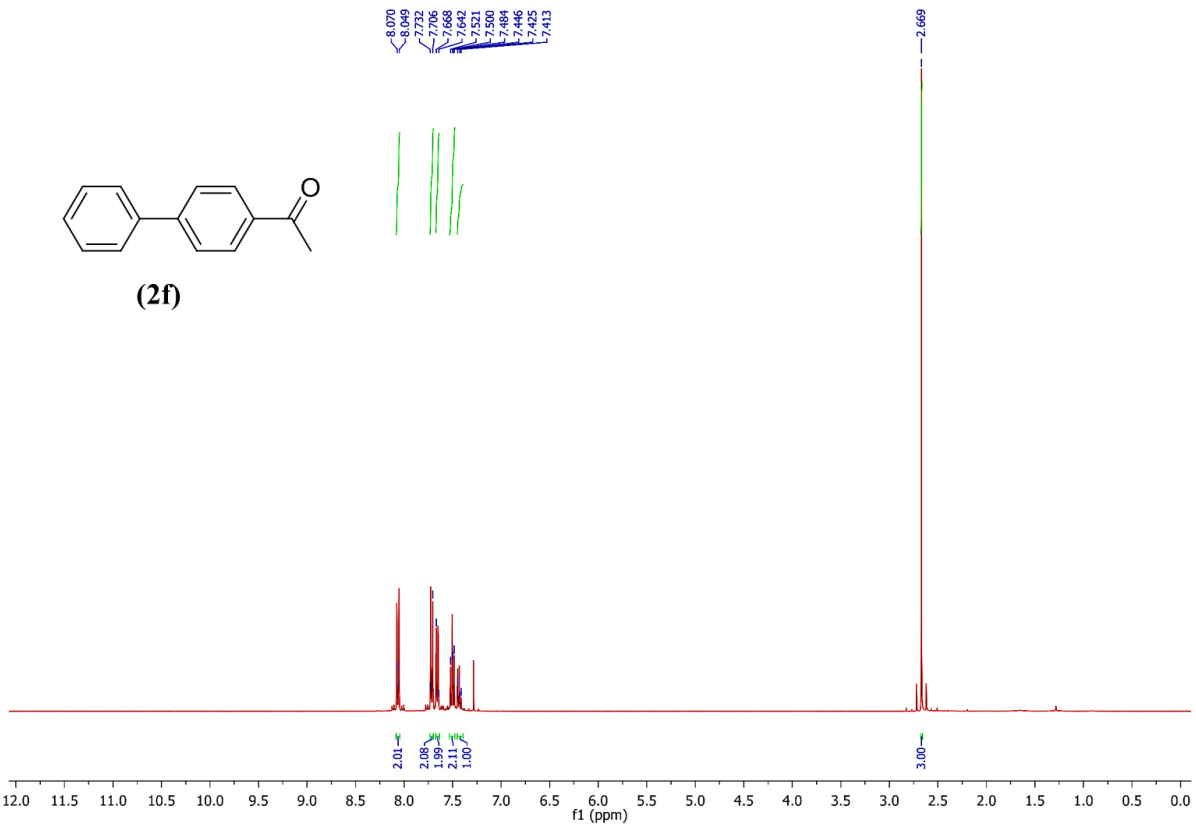


Figure 11:[1]H NMR spectrum of 1-([1,1'-Biphenyl]-4-yl)ethan-1-one (**2f**).

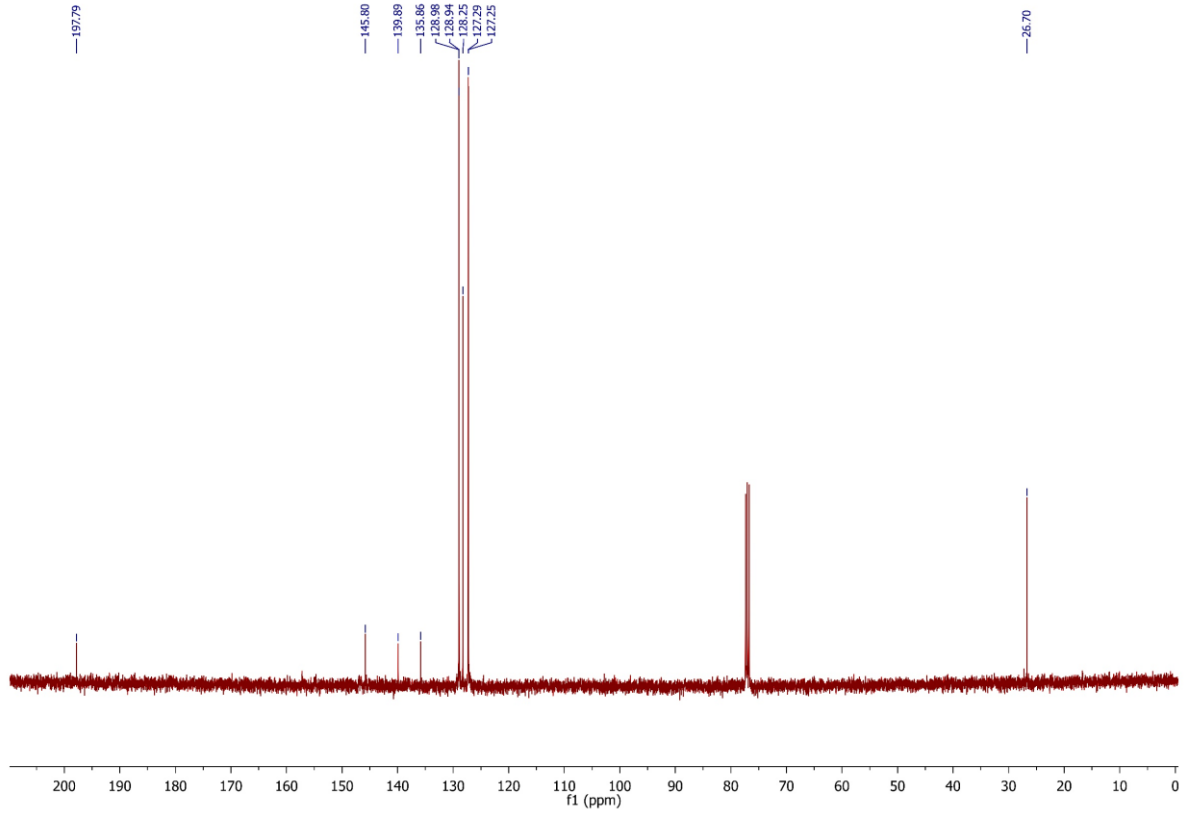


Figure 12:[13]C NMR spectrum of 1-([1,1'-Biphenyl]-4-yl)ethan-1-one (**2f**).

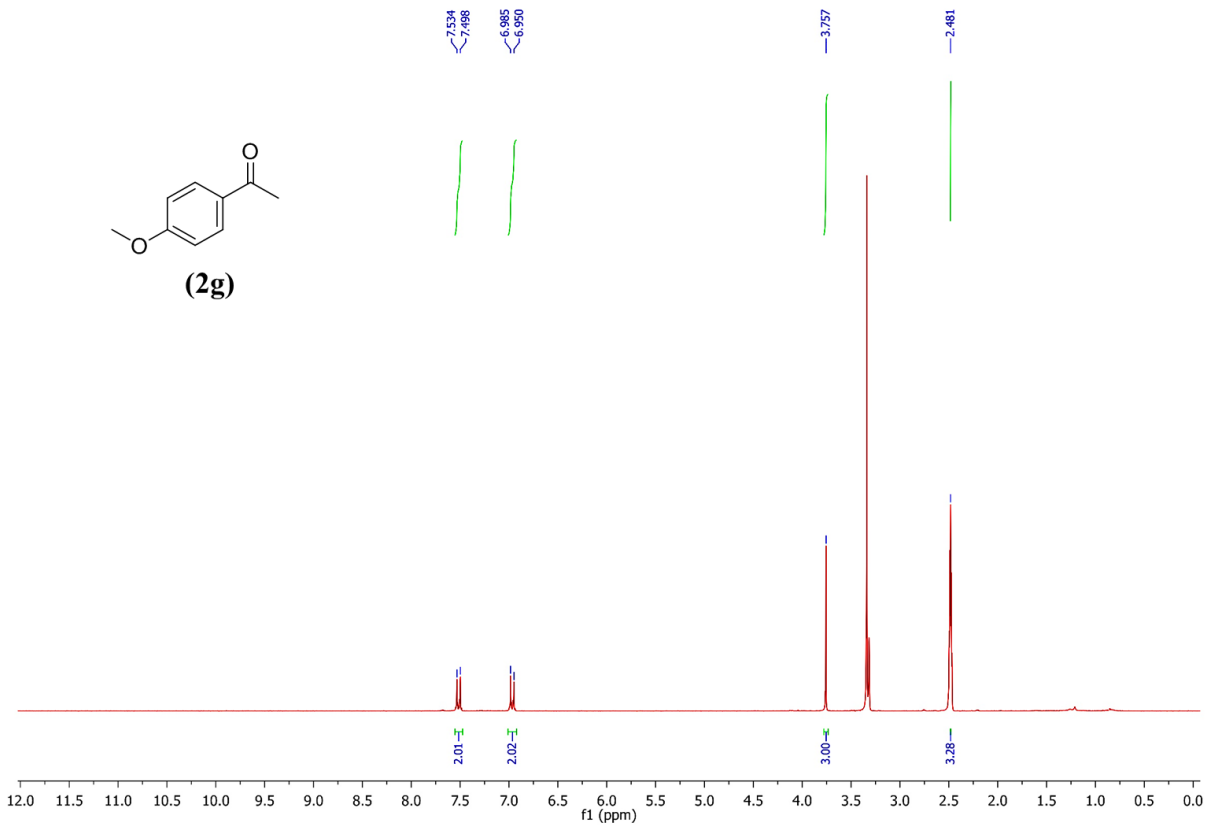


Figure 13:[1]H NMR spectrum of 1-(4-methoxyphenyl) ethan-1-one (**2g**).

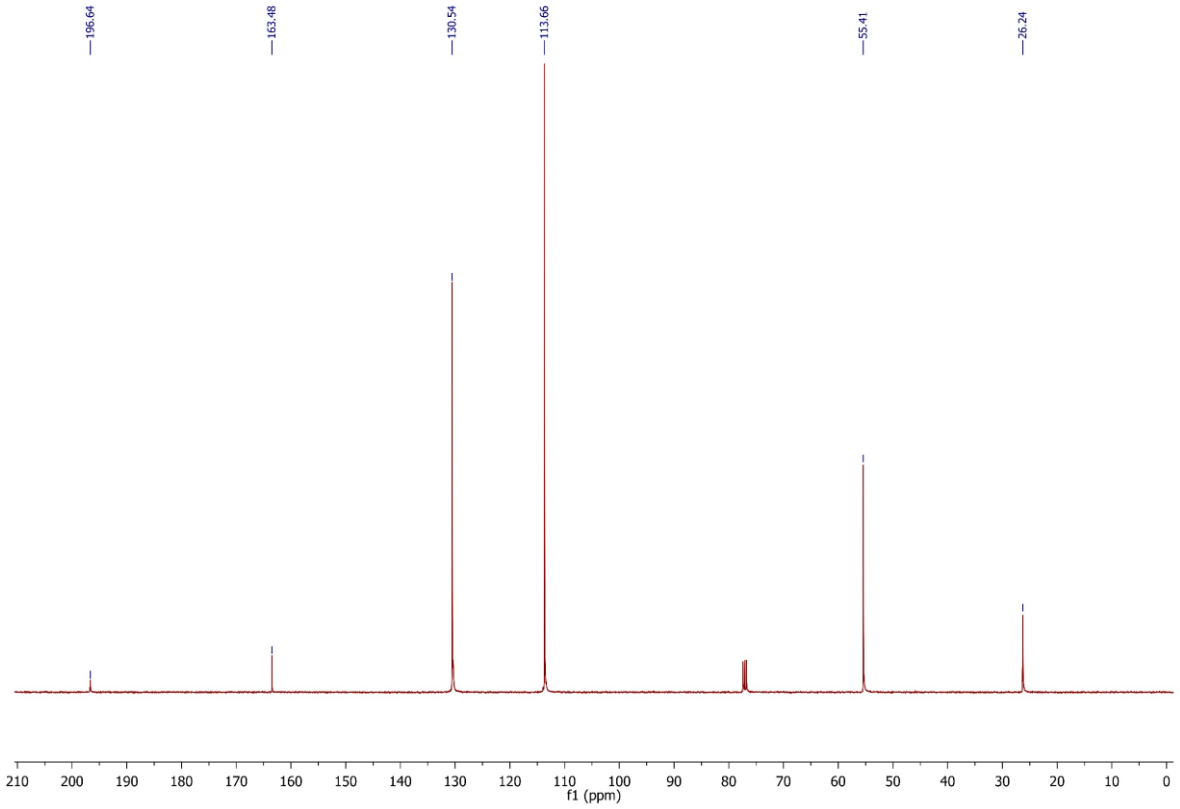


Figure 14:[13]C NMR spectrum of 1-(4-methoxyphenyl) ethan-1-one (**2g**).

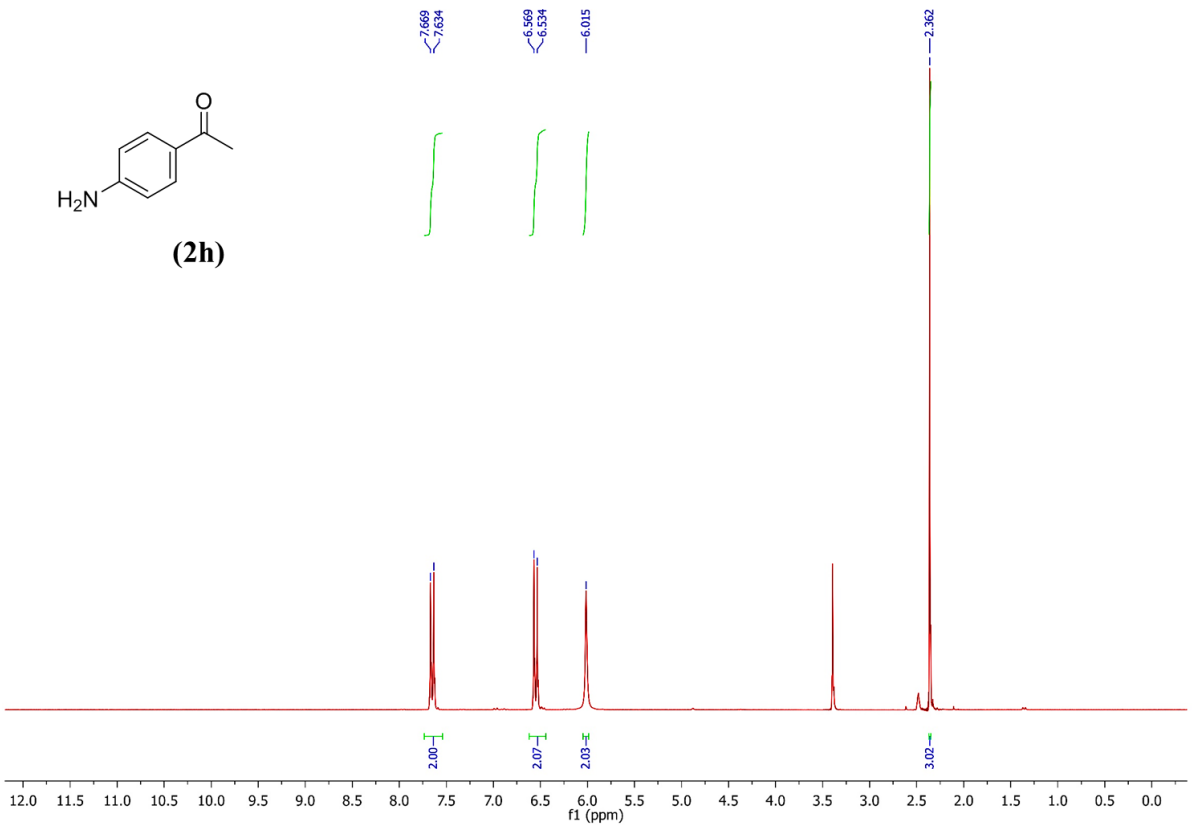


Figure 15:[1]H NMR spectrum of 1-(4-aminophenyl) ethan-1-one (**2h**).

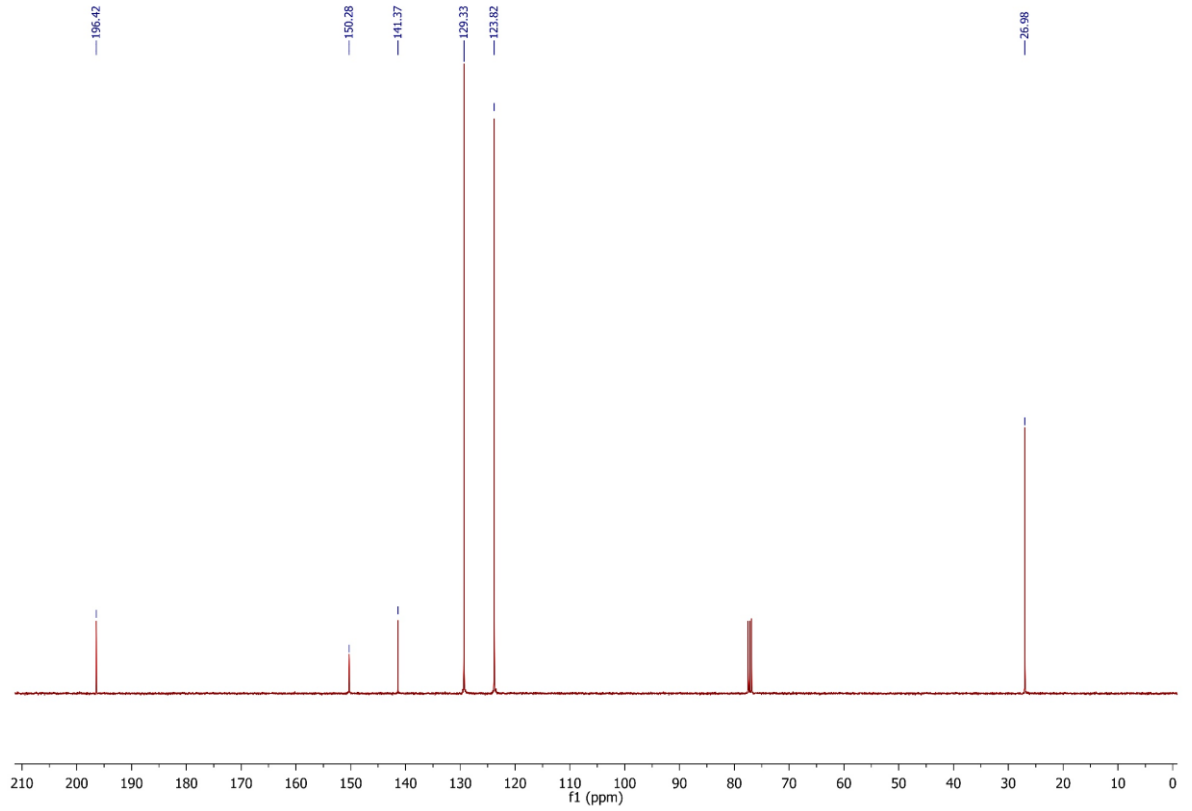


Figure 16:[13]C NMR spectrum of 1-(4-aminophenyl) ethan-1-one (**2h**).

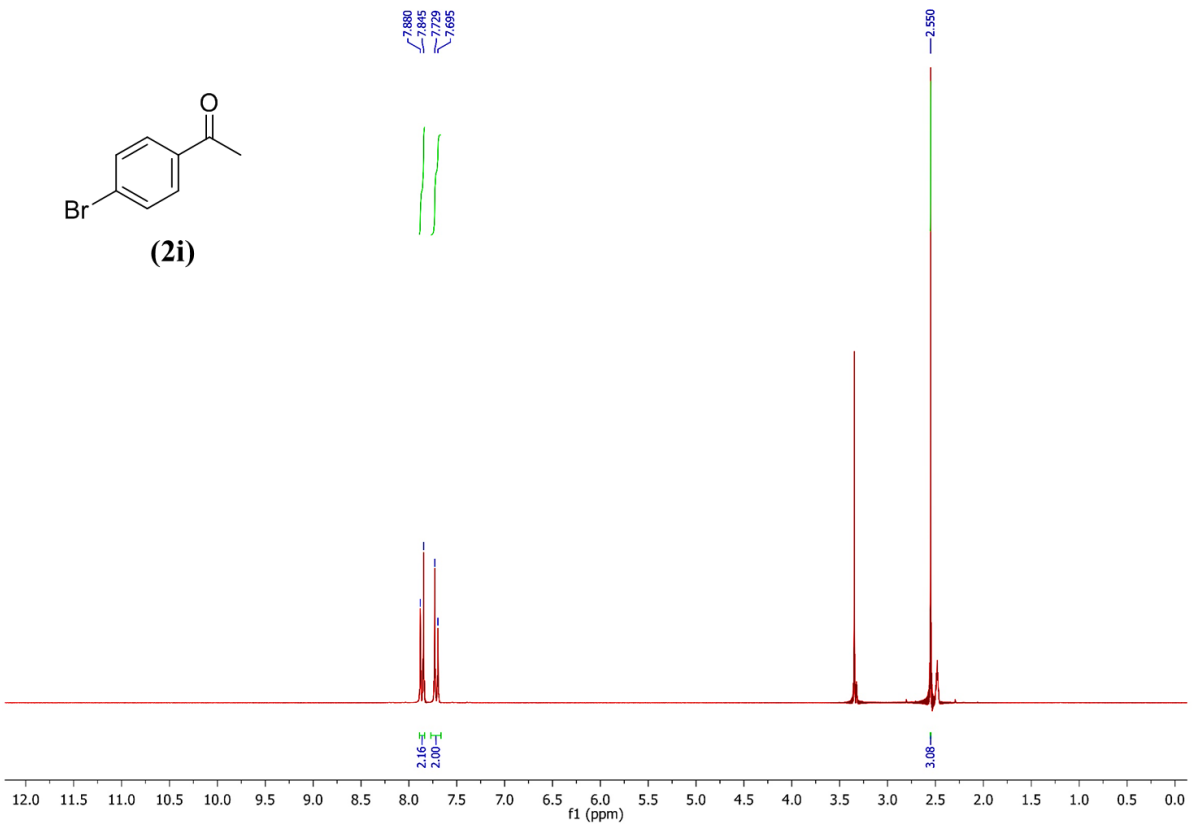


Figure 17:[1]H NMR spectrum of 1-(4-bromophenyl) ethan-1-one (**2i**).

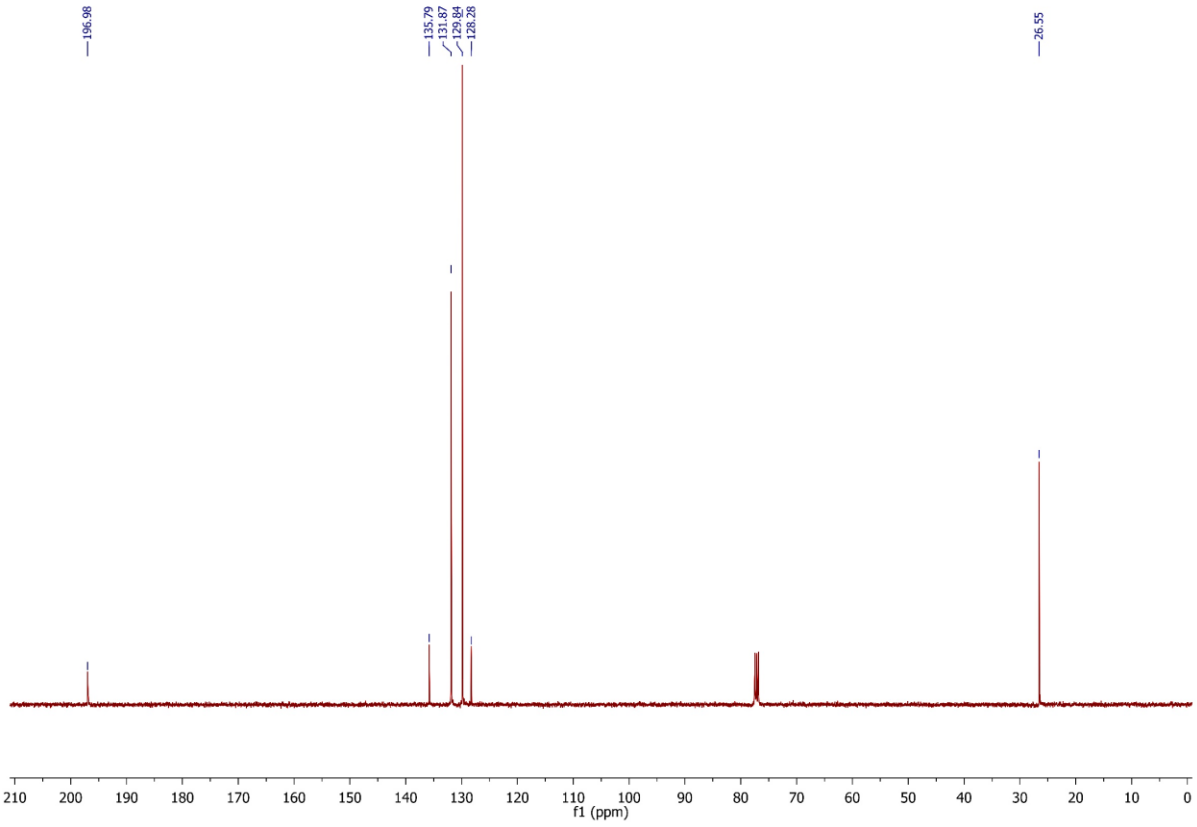


Figure 18:[13]C NMR spectrum of 1-(4-bromophenyl) ethan-1-one (**2i**).

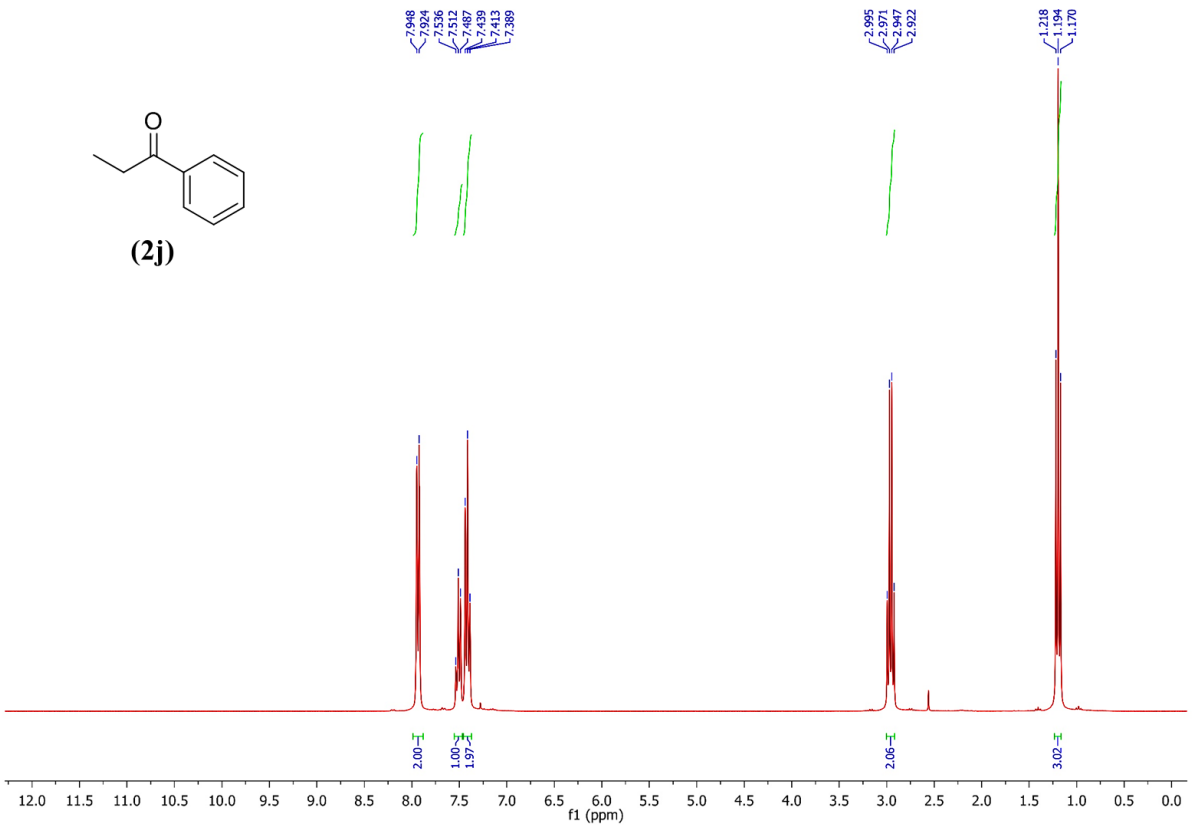


Figure 19: ^{1}H NMR spectrum of Propiophenone (**2j**).

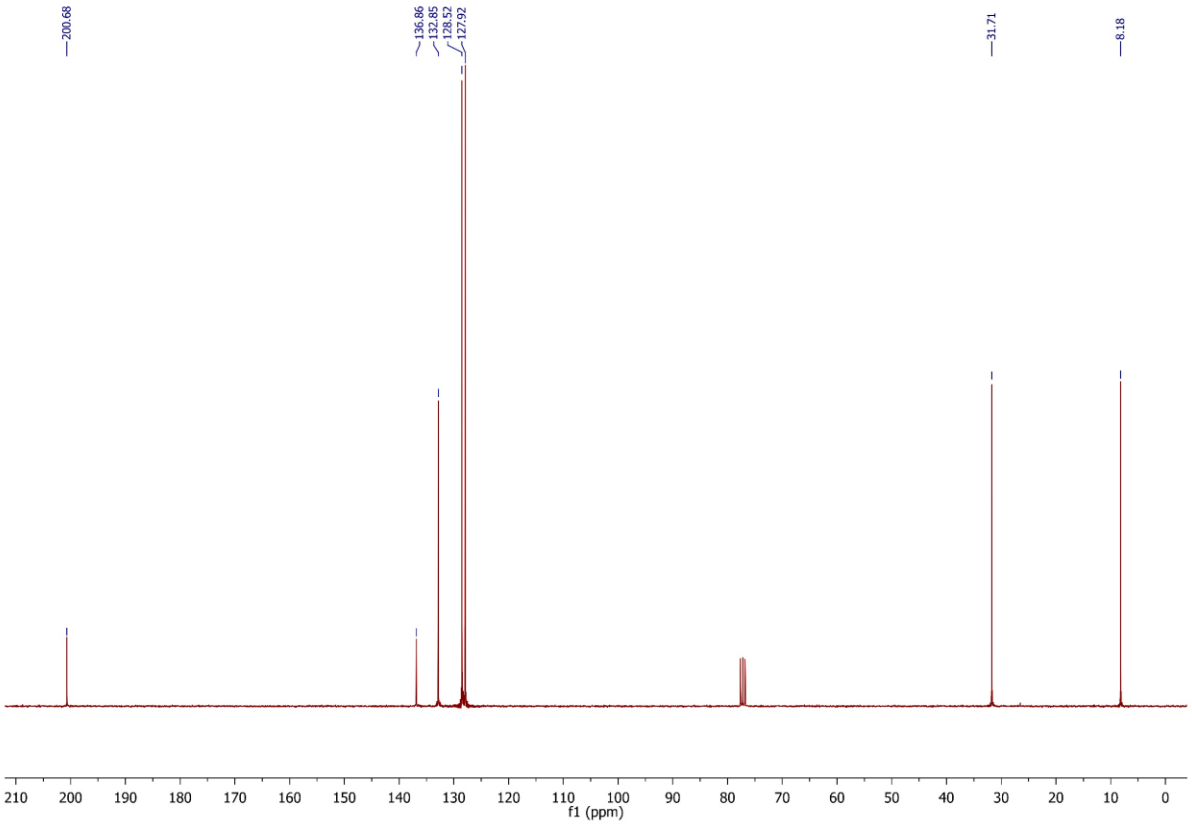


Figure 20: ^{13}C NMR spectrum of Propiophenone (**2j**).

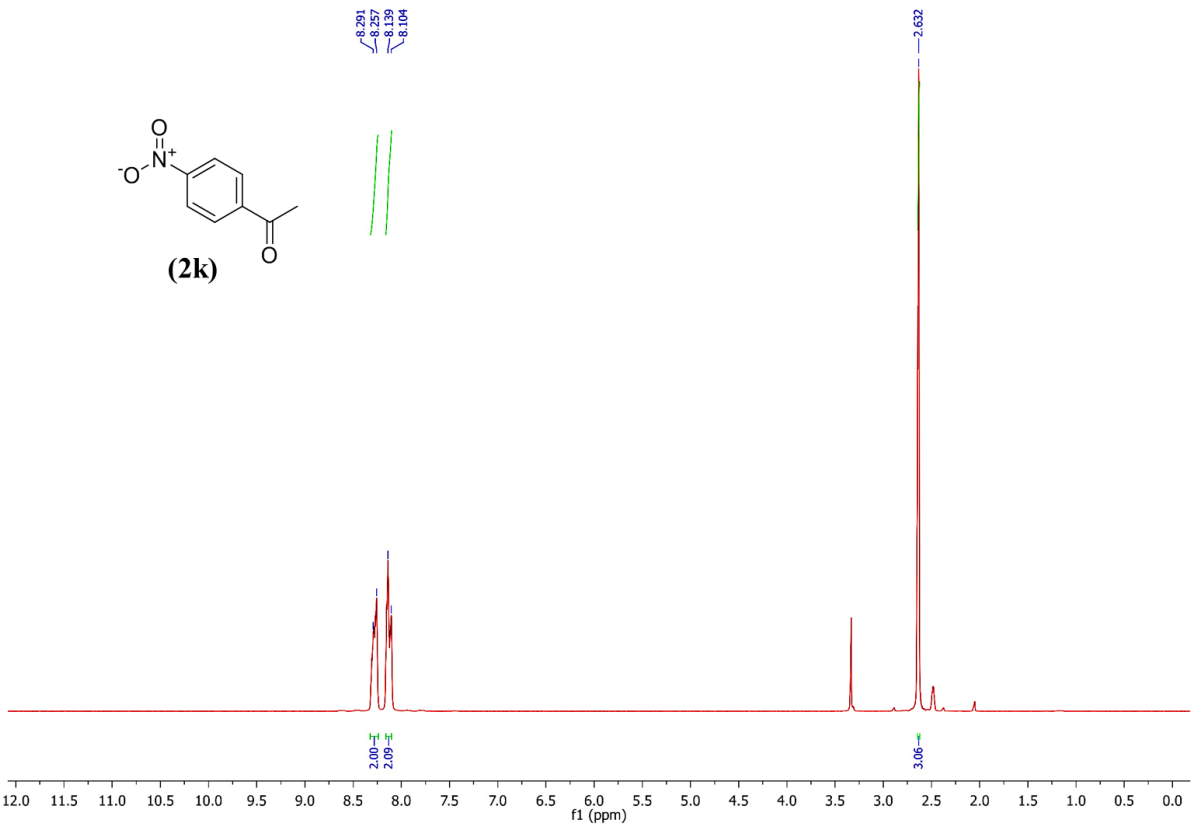


Figure 21:^{1}H NMR spectrum of 1-(4-nitrophenyl) ethan-1-one (**2k**).

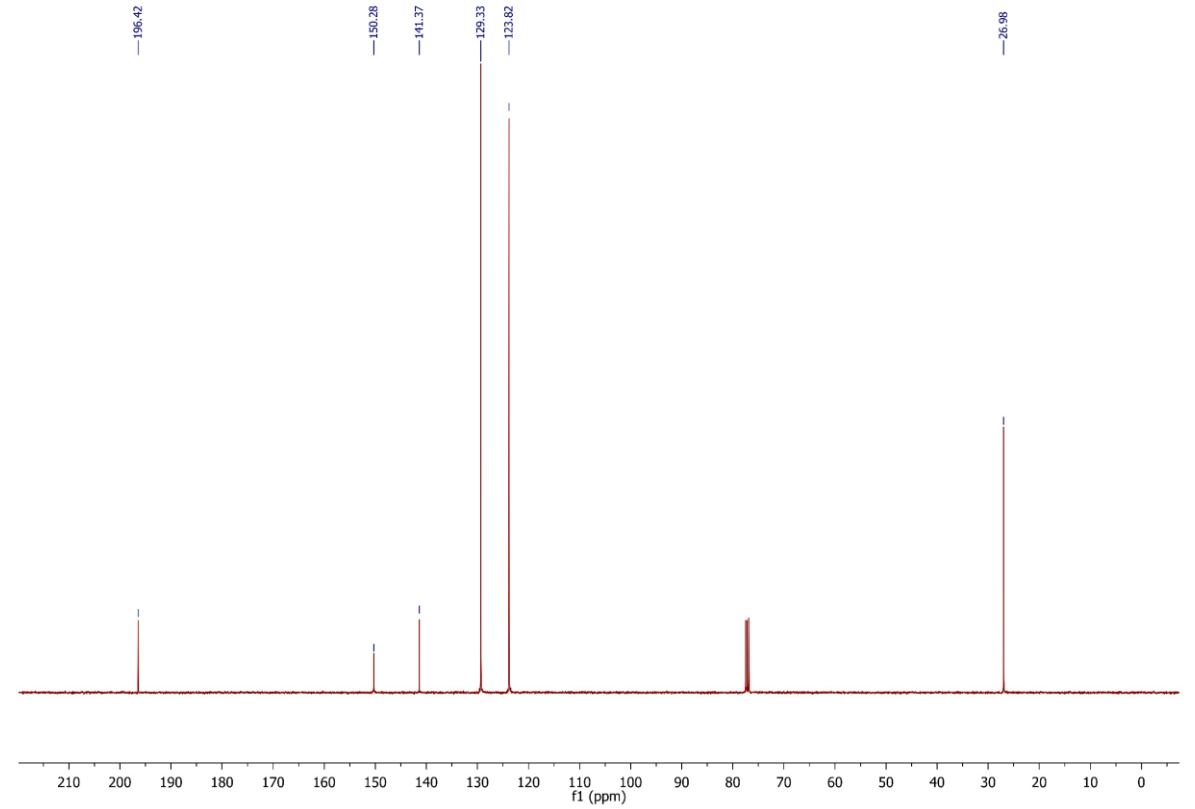


Figure 22:^{13}C NMR spectrum of 1-(4-nitrophenyl) ethan-1-one (**2k**).

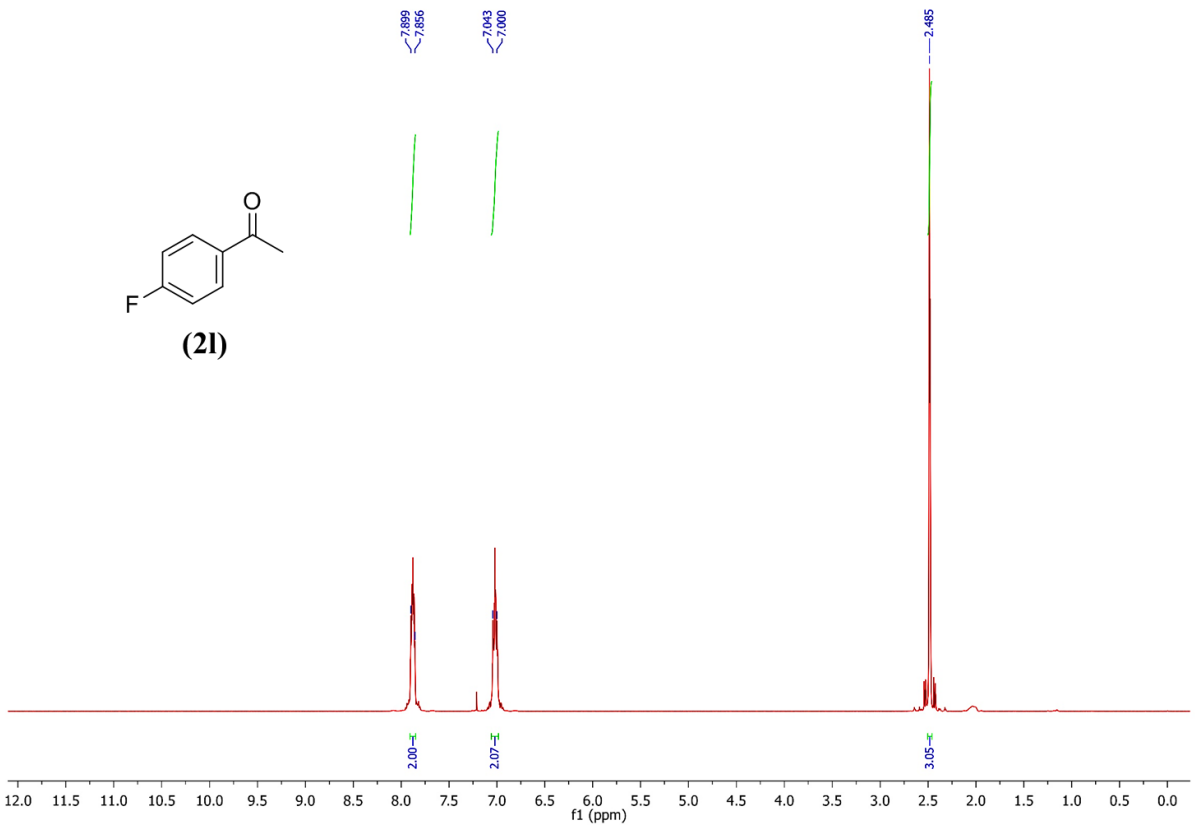


Figure 23:[1]H NMR spectrum of 1-(4-fluorophenyl) ethan-1-one (**2l**).

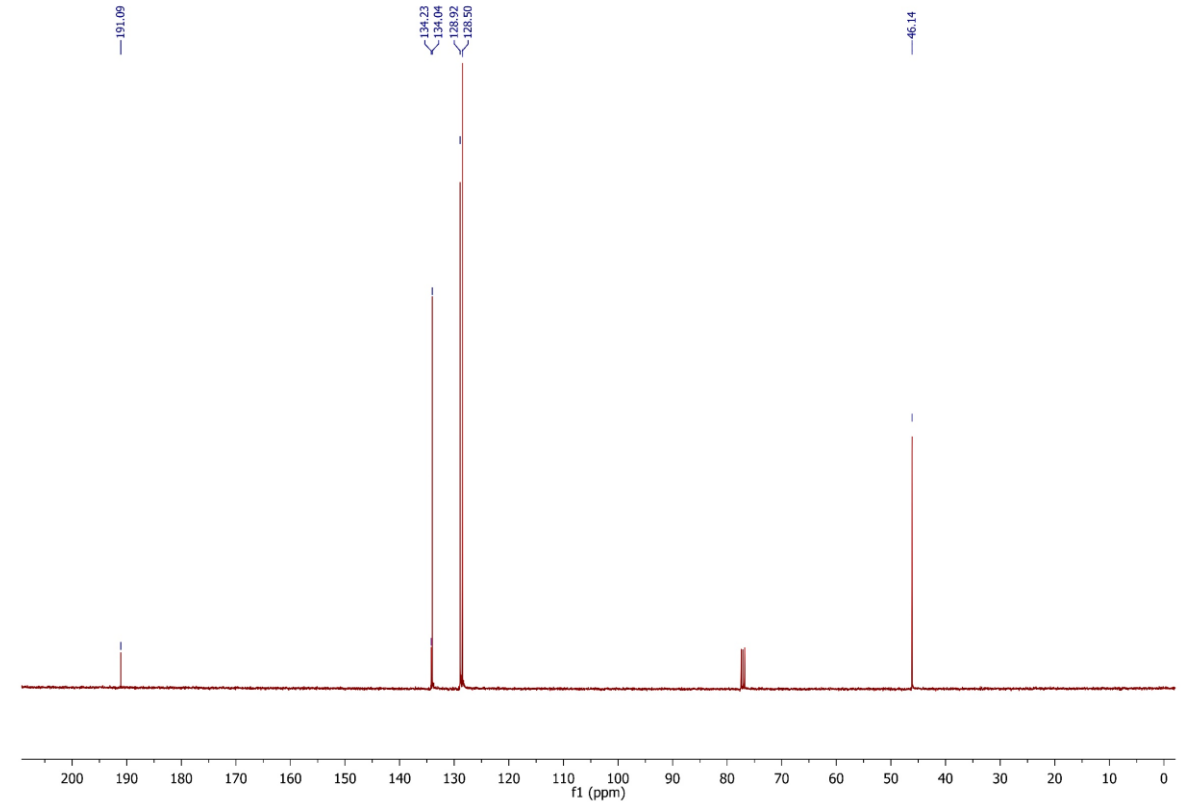


Figure 24:[13]C NMR spectrum of 1-(4-fluorophenyl) ethan-1-one (**2l**).

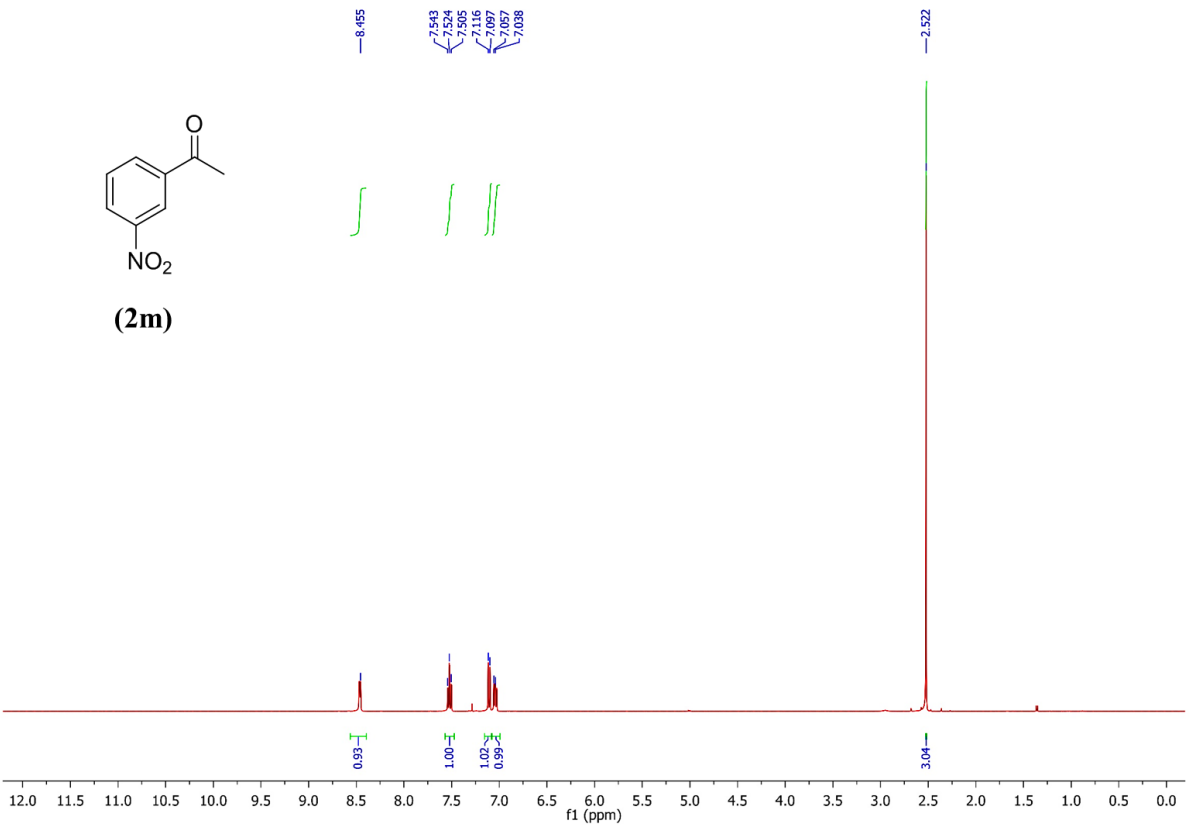


Figure 25:[1]H NMR spectrum of 1-(3-nitrophenyl) ethan-1-one (**2m**).

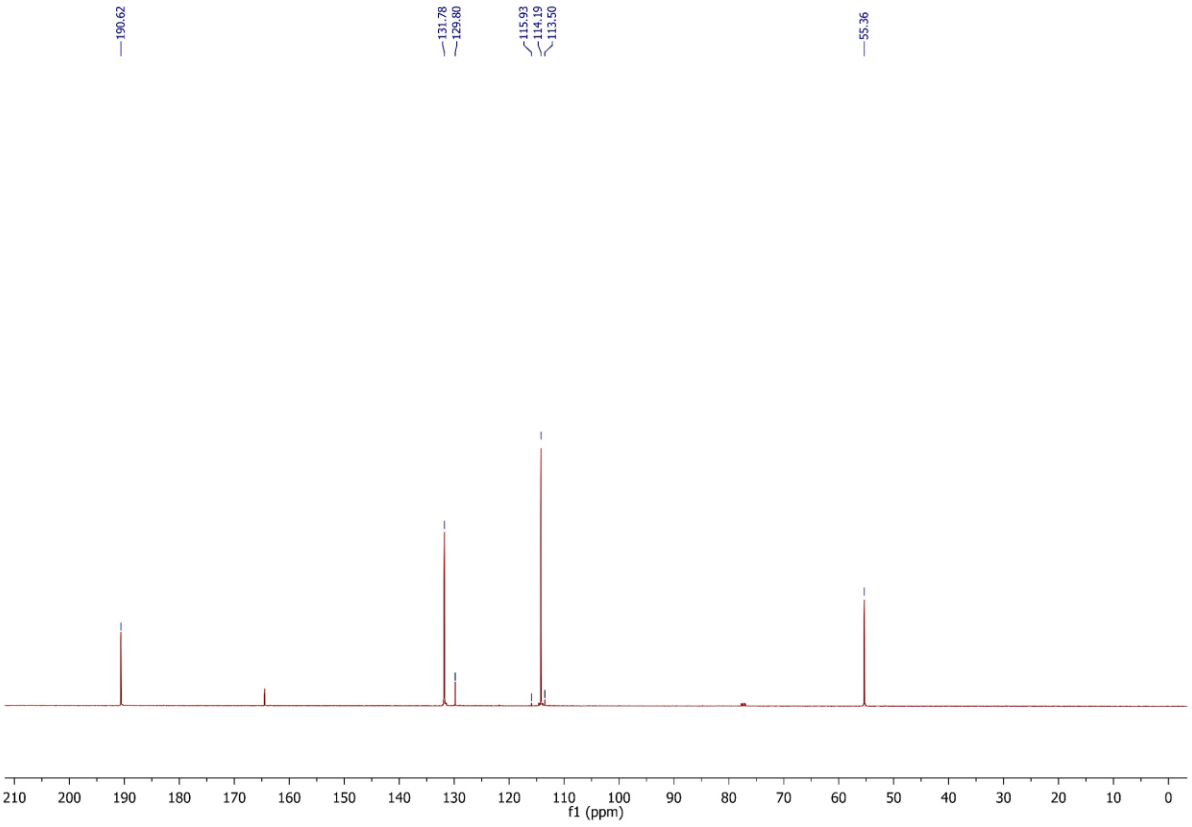


Figure 26:[13]C NMR spectrum of 1-(3-nitrophenyl) ethan-1-one (**2m**).

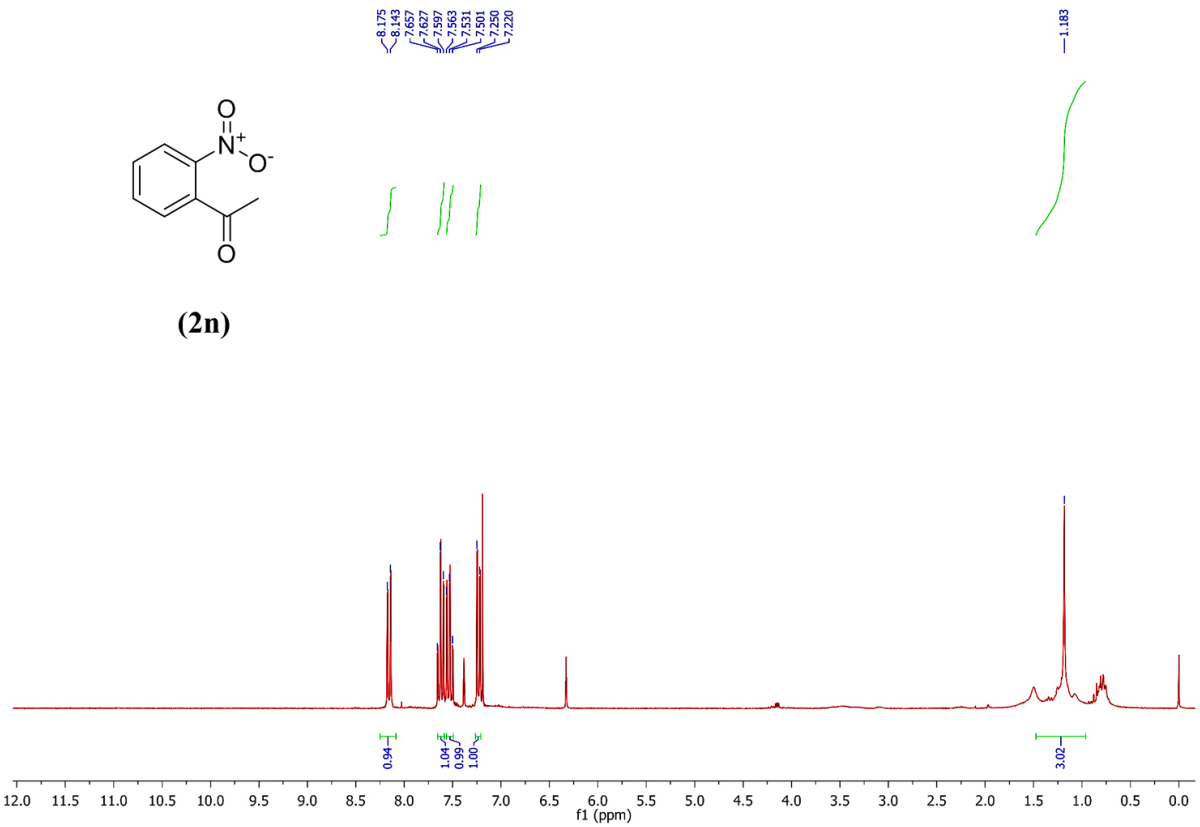


Figure 27:^{1}H NMR spectrum of 1-(2-nitrophenyl) ethan-1-one (**2n**).

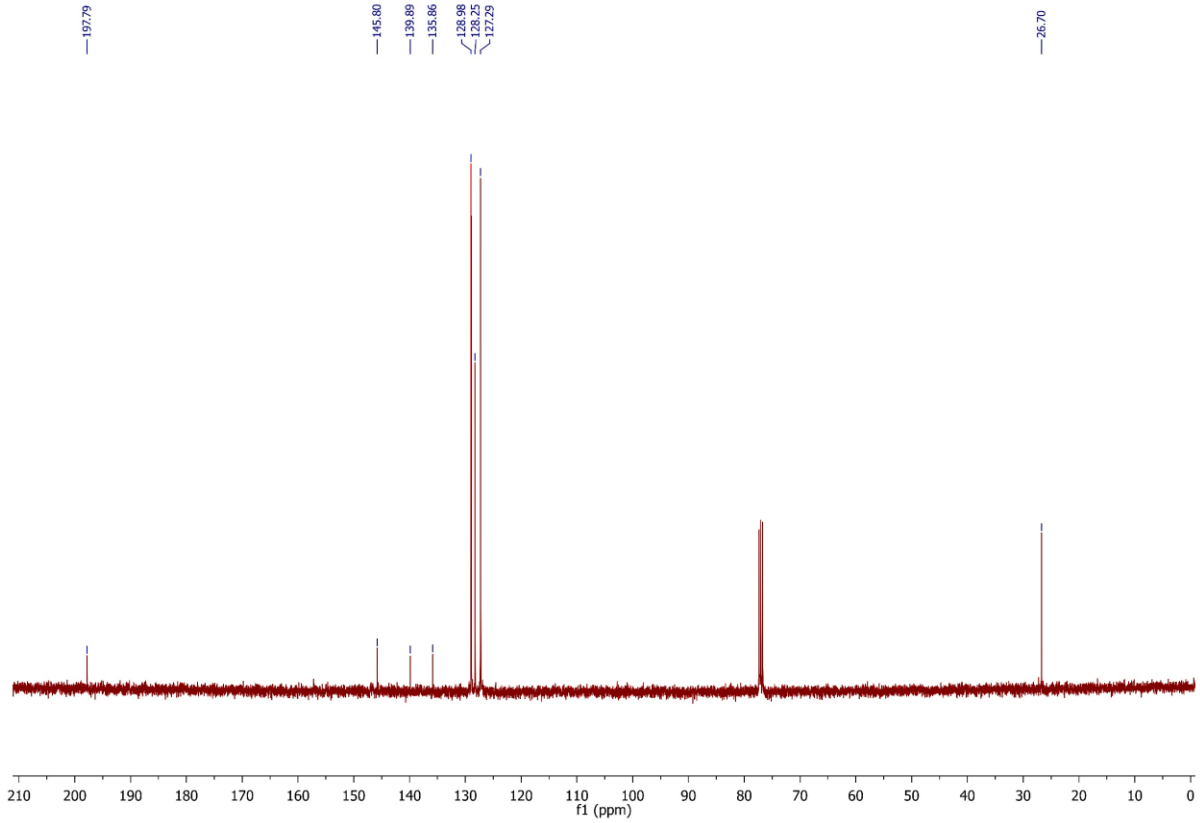


Figure 28:^{13}C NMR spectrum of 1-(2-nitrophenyl) ethan-1-one (**2n**).

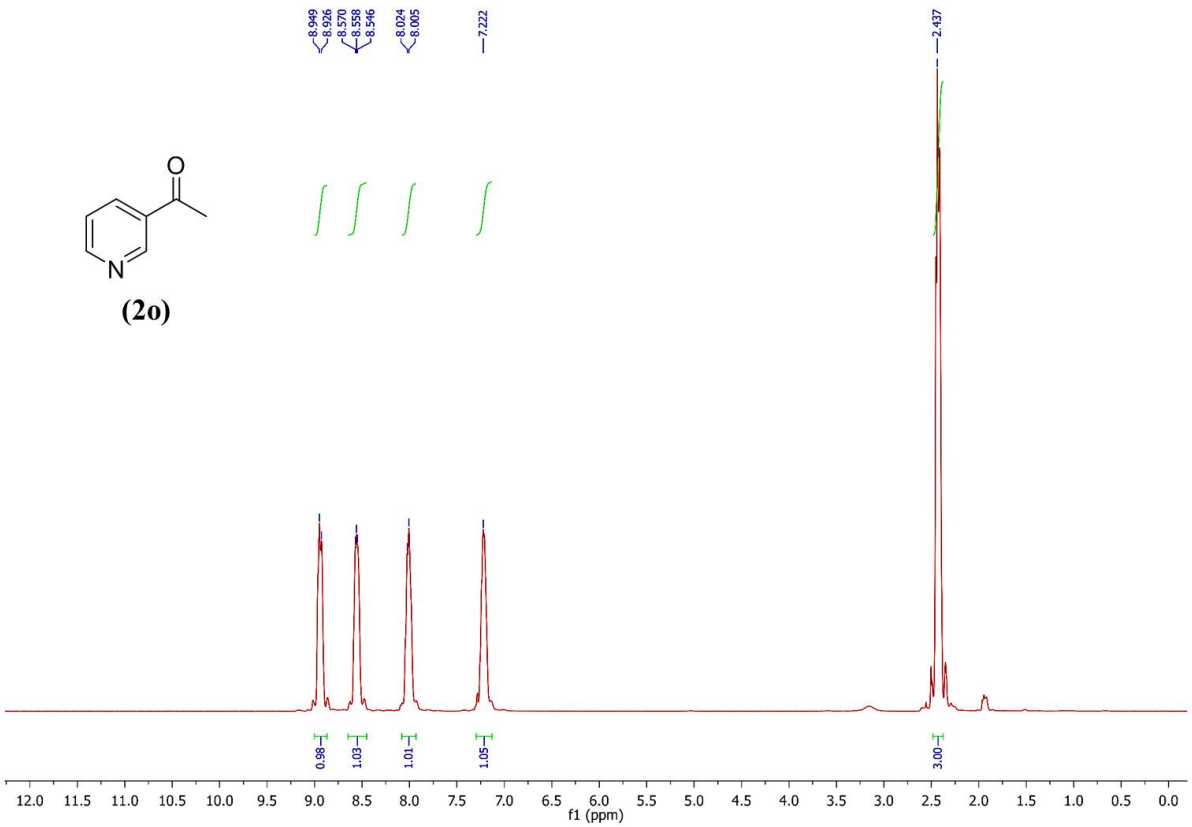


Figure 29: ^{1}H NMR spectrum of 1-(pyridin-3-yl) ethan-1-one (**2o**).

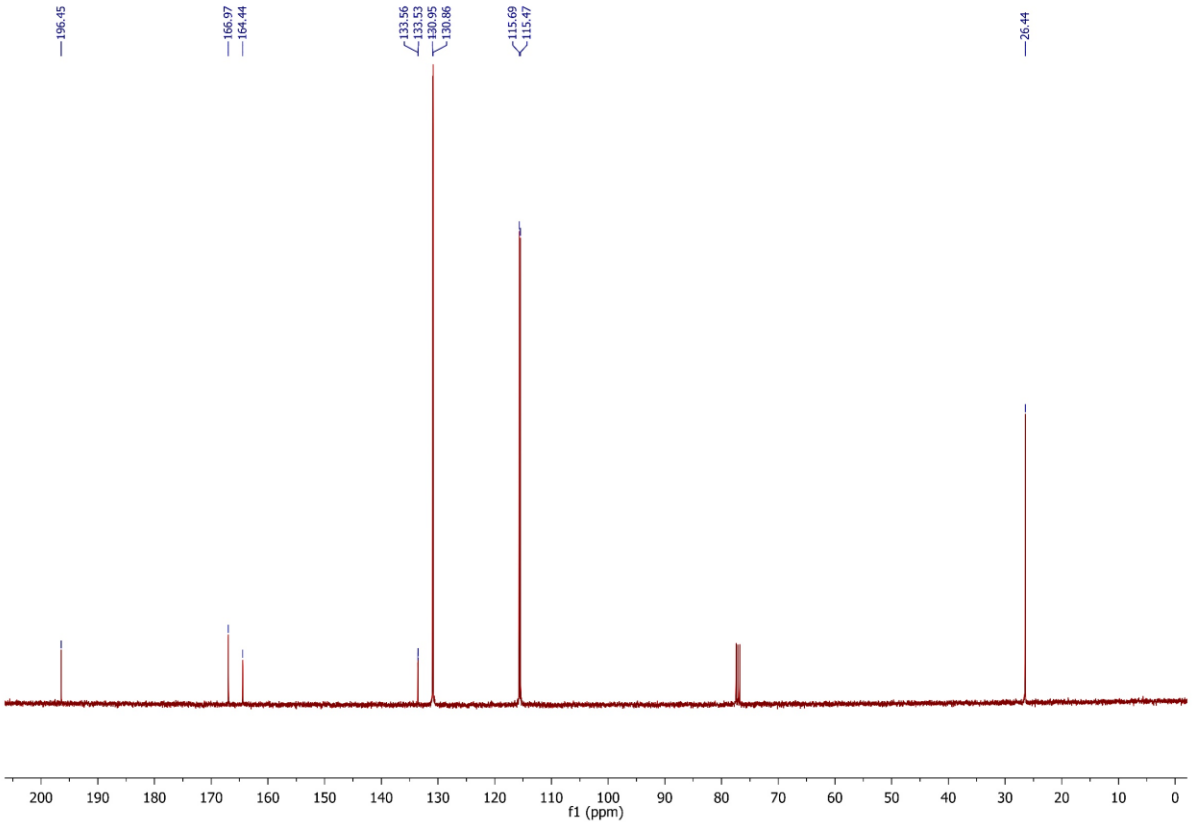


Figure 30: ^{13}C NMR spectrum of 1-(pyridin-3-yl) ethan-1-one (**2o**).

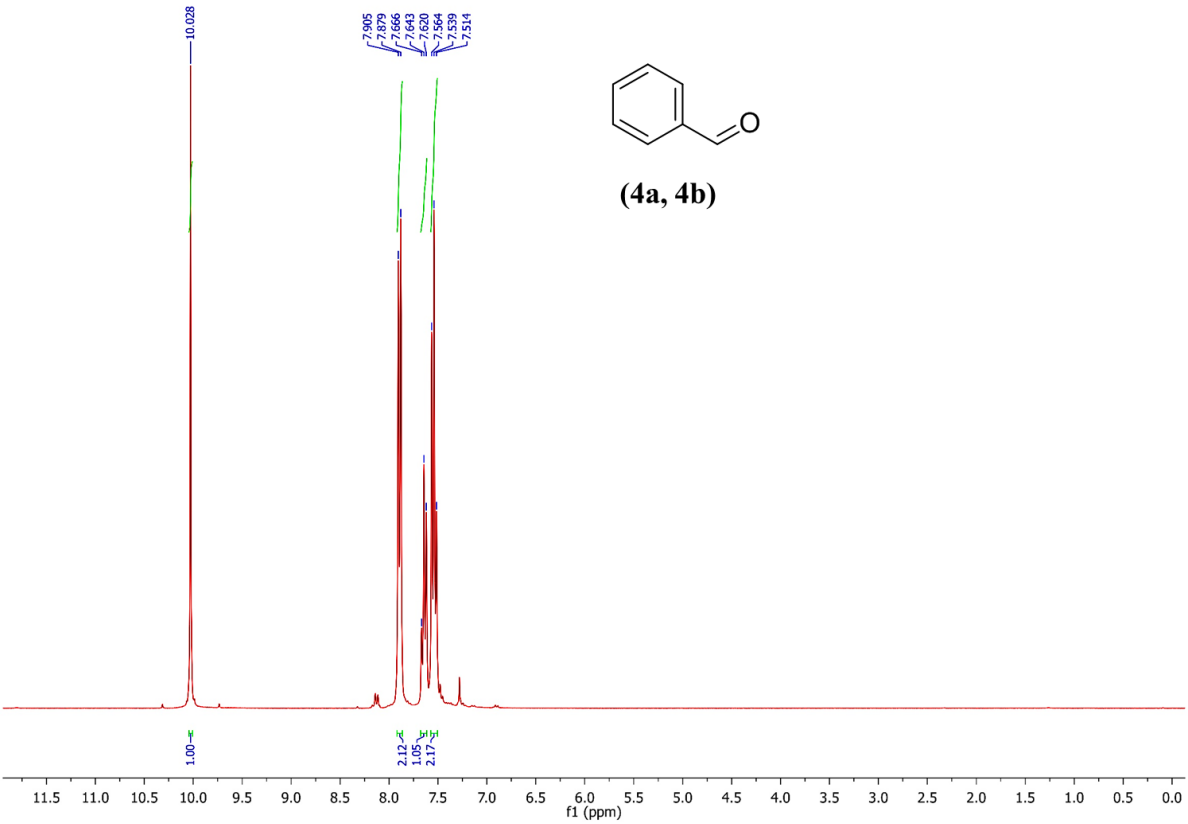


Figure 31:[1]H NMR spectrum of Benzaldehyde (**4a, 4b**).

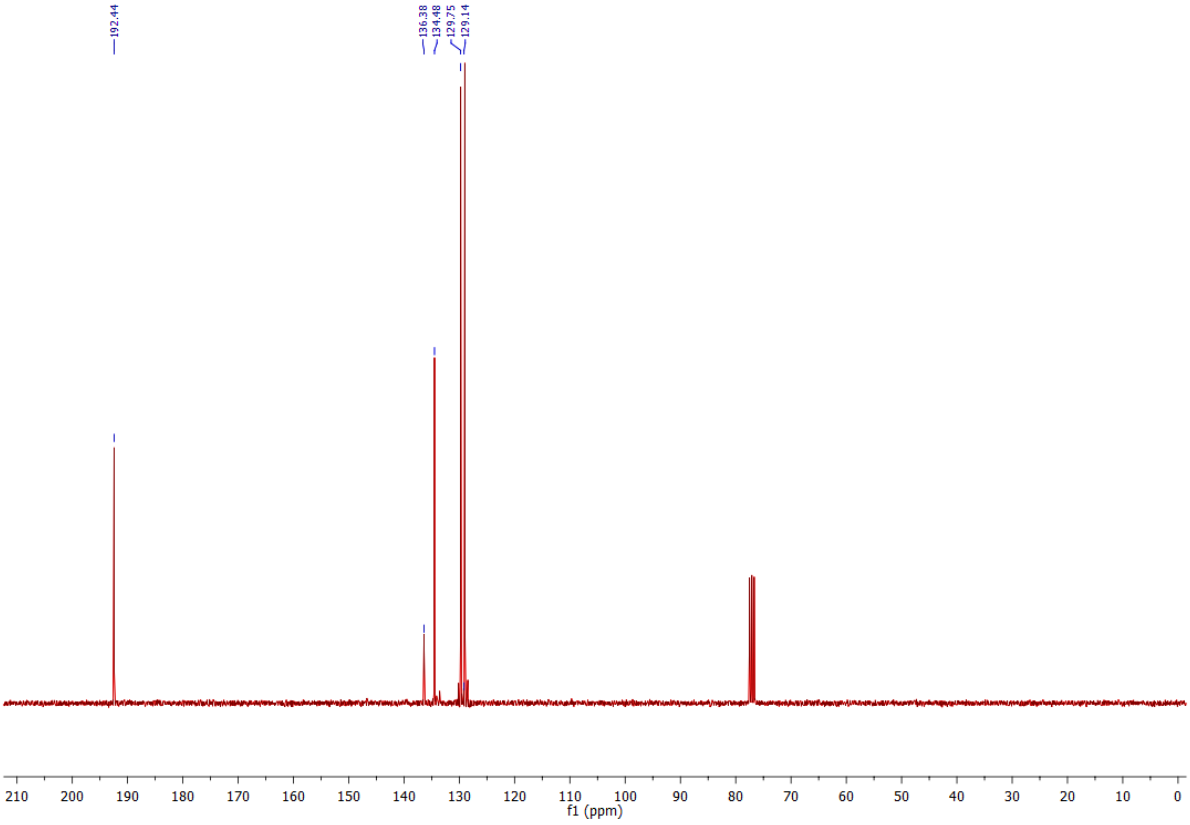


Figure 32:[13]C NMR spectrum of Benzaldehyde (**4a, 4b**).

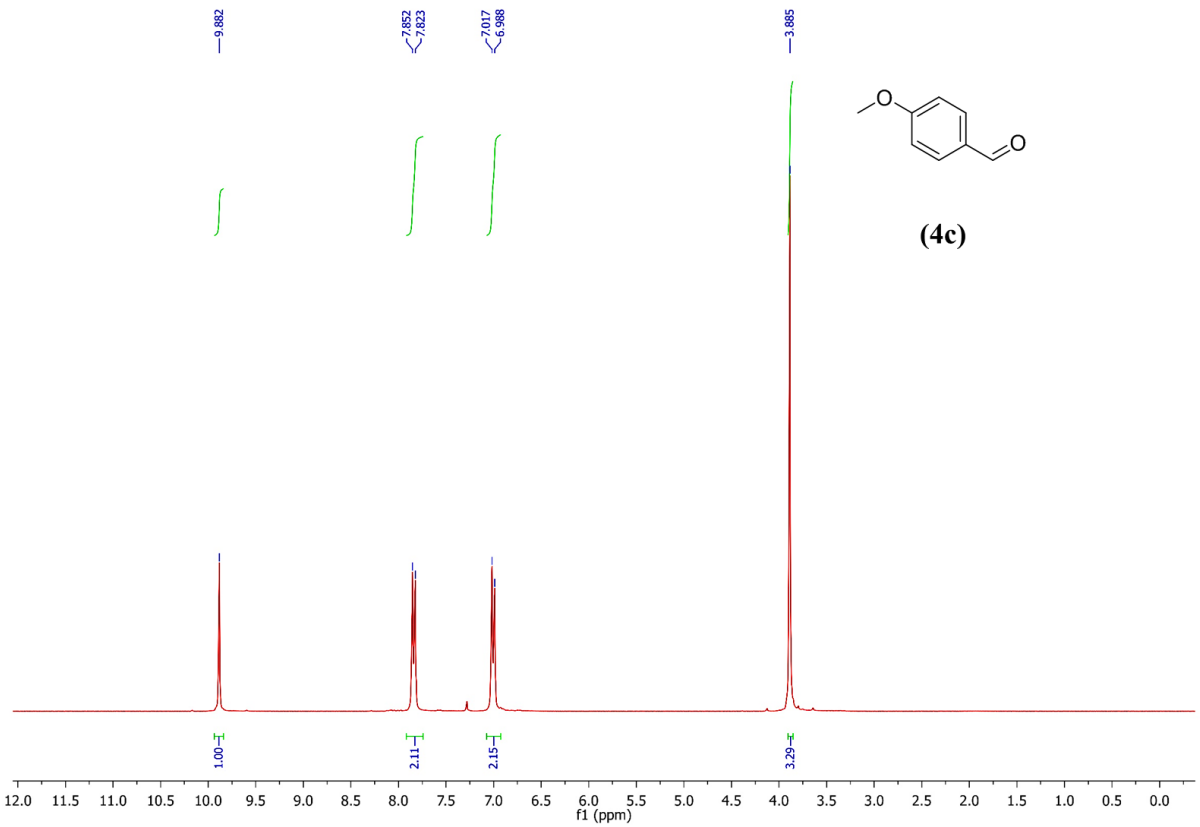


Figure 33: ^{1}H NMR spectrum of 4-methoxybenzaldehyde (**4c**).

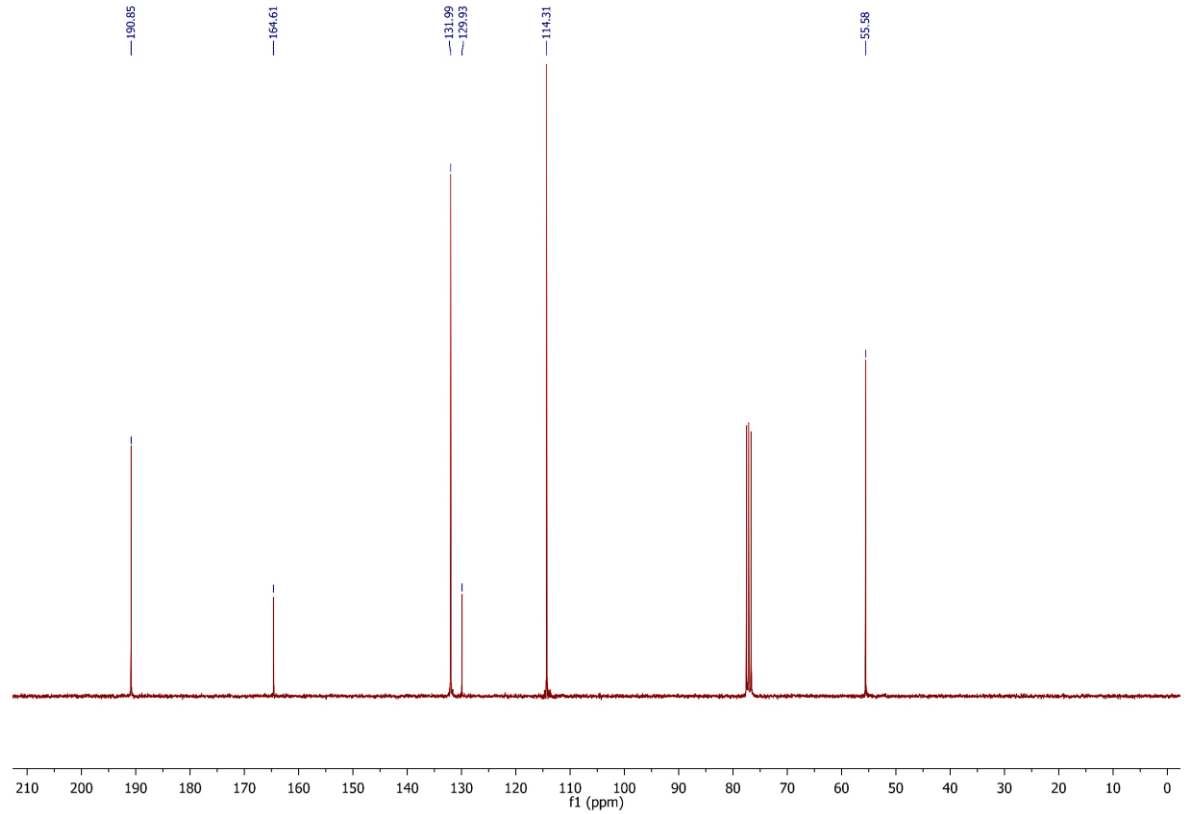


Figure 34: ^{13}C NMR spectrum of 4-methoxybenzaldehyde (**4c**).

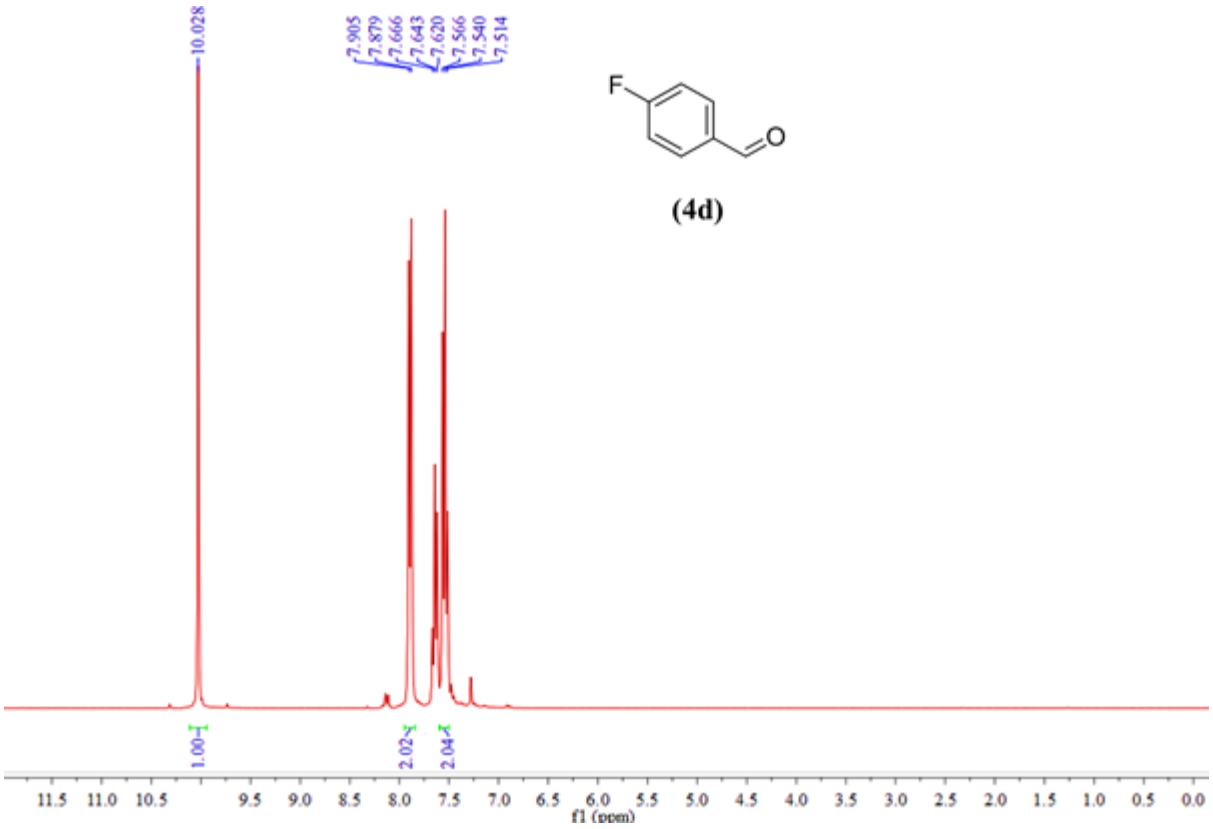


Figure 35: ^{1}H NMR spectrum of 4-fluorobenzaldehyde (**4d**).

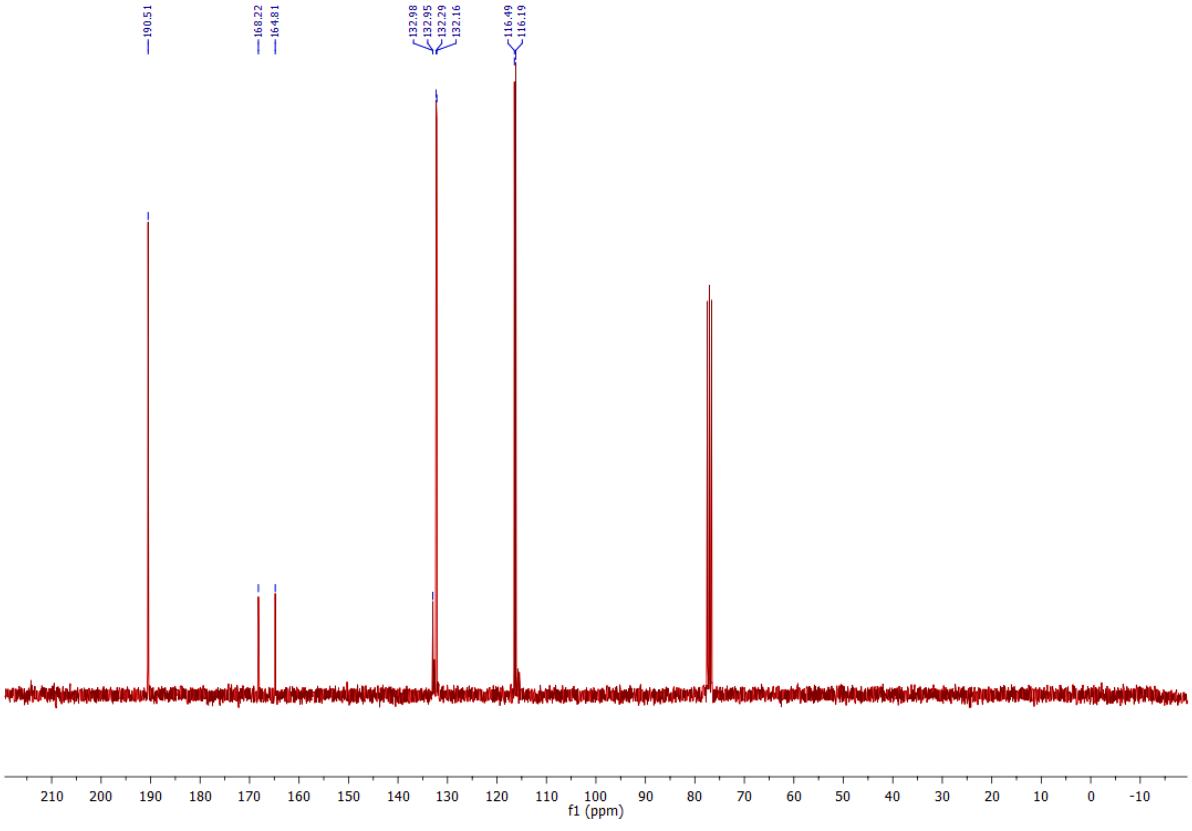


Figure 36: ^{13}C NMR spectrum of 4-fluorobenzaldehyde (**4d**).

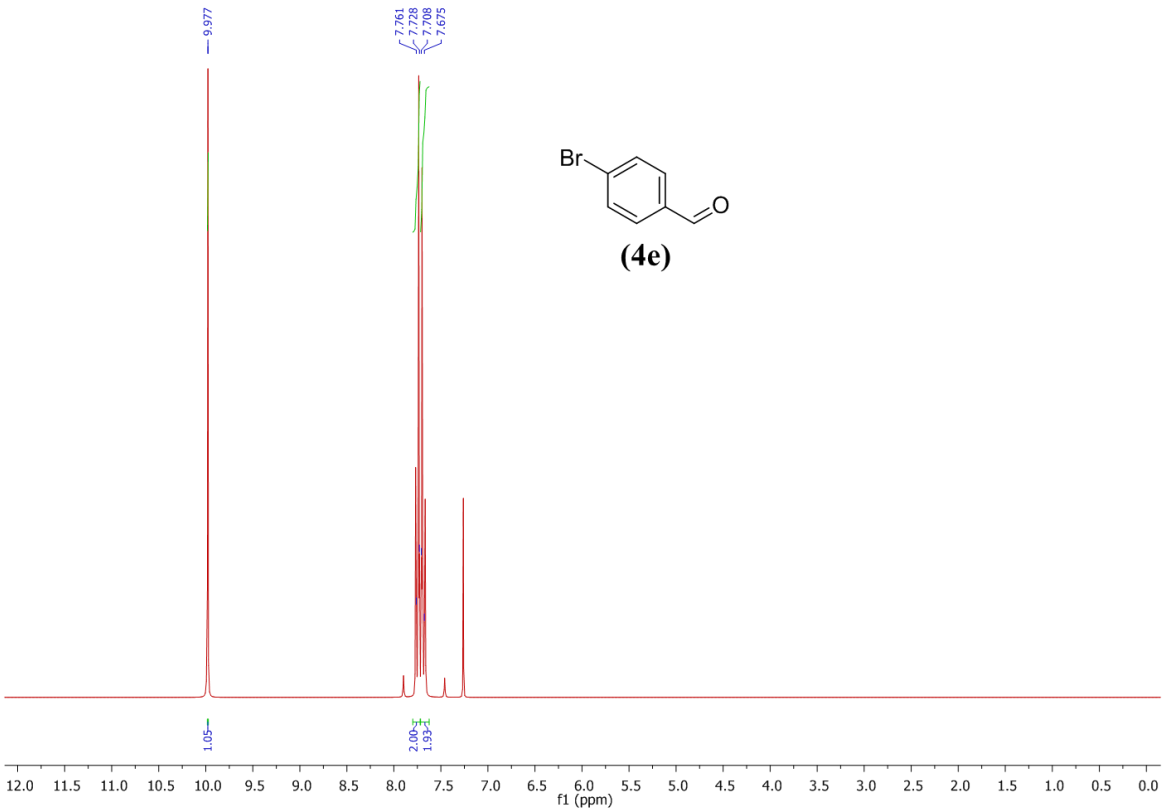


Figure 37:[1]H NMR spectrum of 4-bromobenzaldehyde (**4e**).

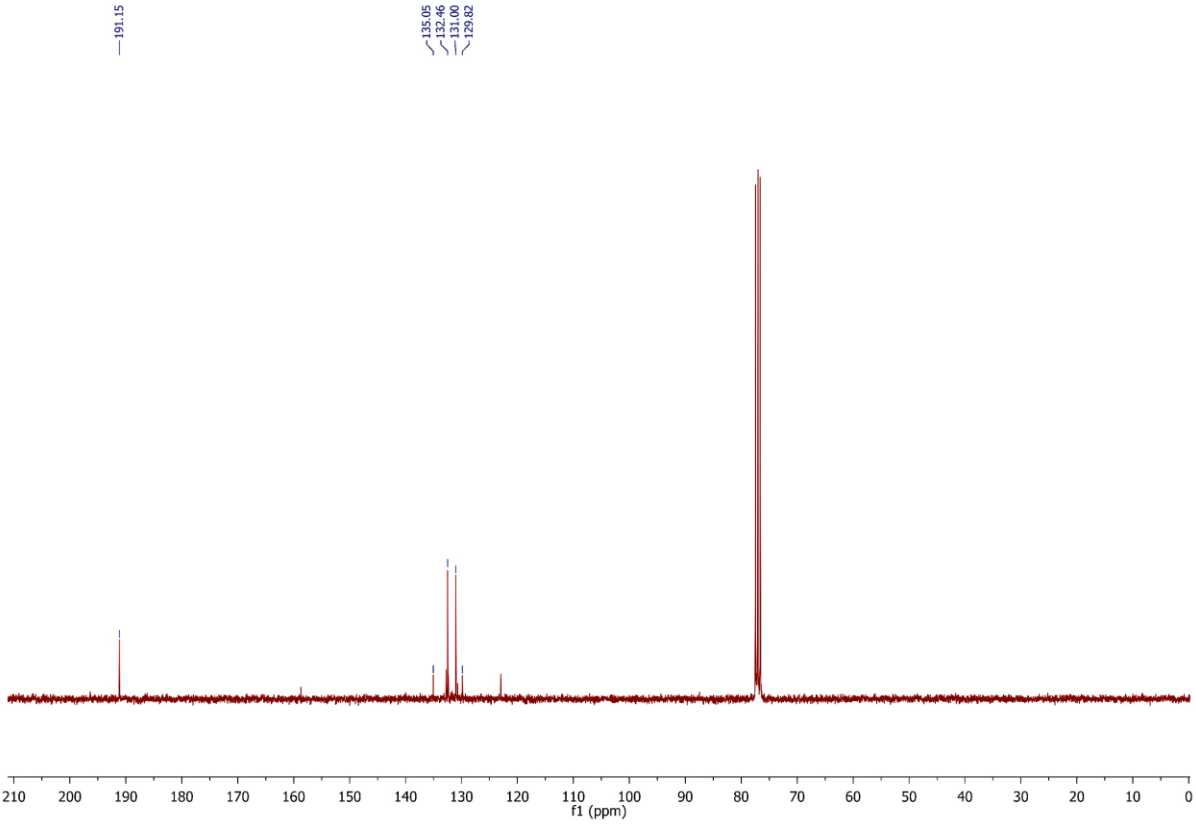


Figure 38:[13]C NMR spectrum of 4-bromobenzaldehyde (**4e**).

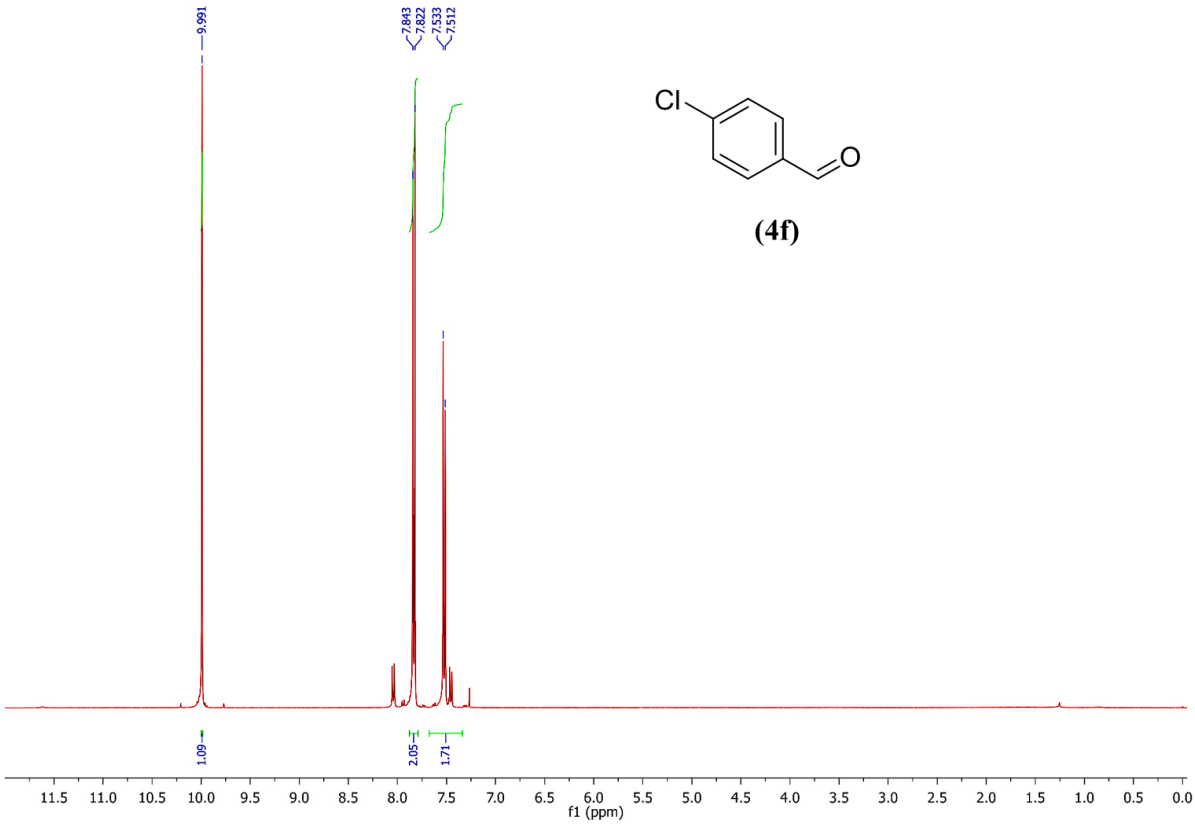


Figure 39: ^{1}H NMR spectrum of 4-chlorobenzaldehyde (**4f**).

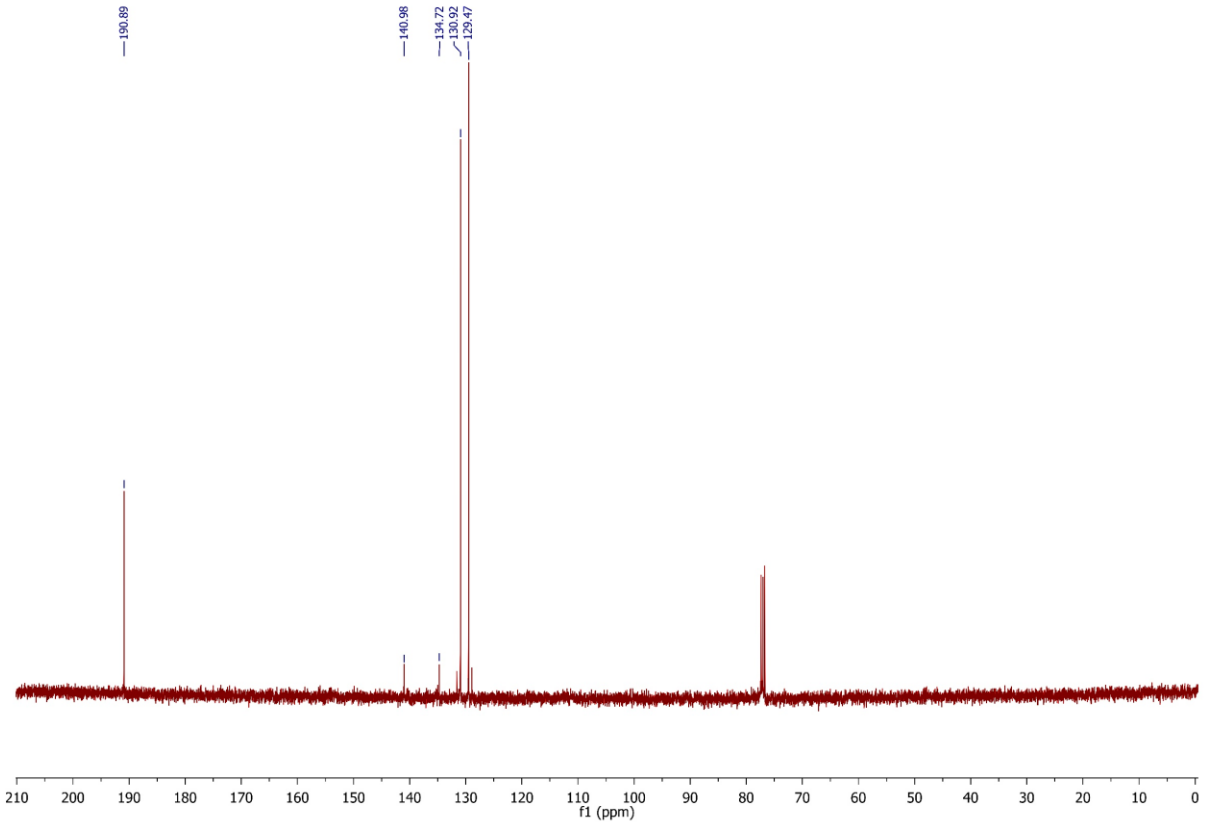


Figure 40: ^{13}C NMR spectrum of 4-chlorobenzaldehyde (**4f**).

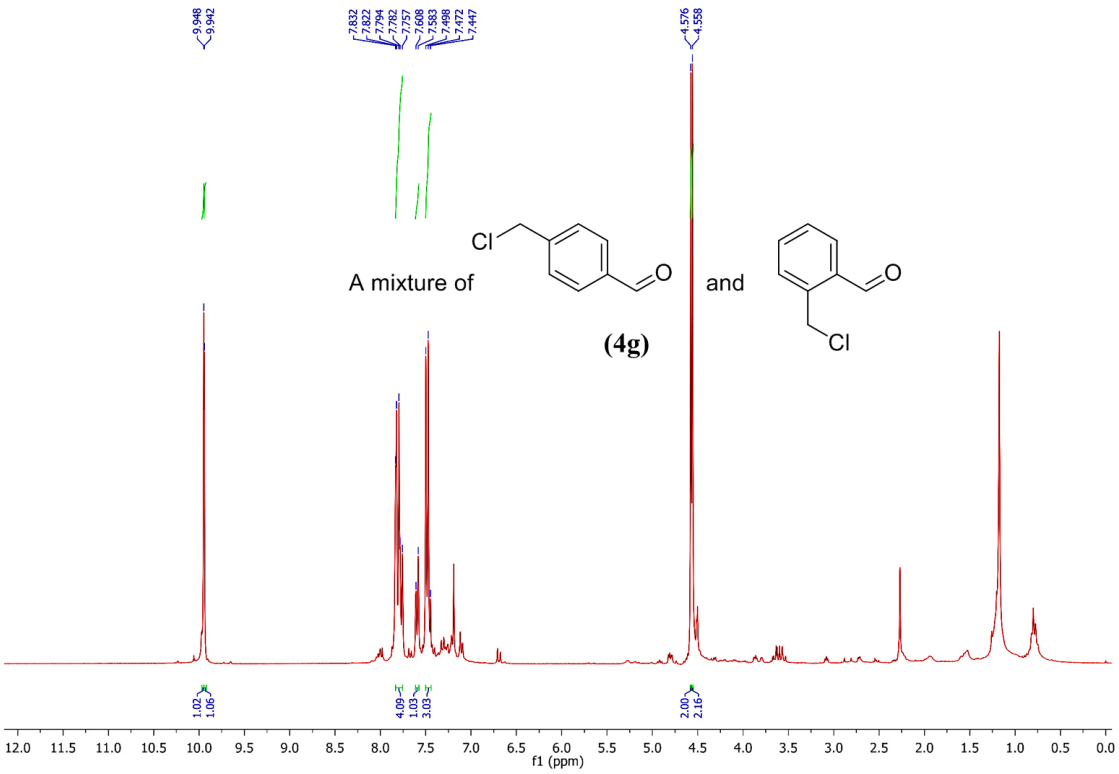


Figure 41: ^{1}H NMR spectrum of 4-(chloromethyl)benzaldehyde and 2-(chloromethyl)benzaldehyde (**4g**).

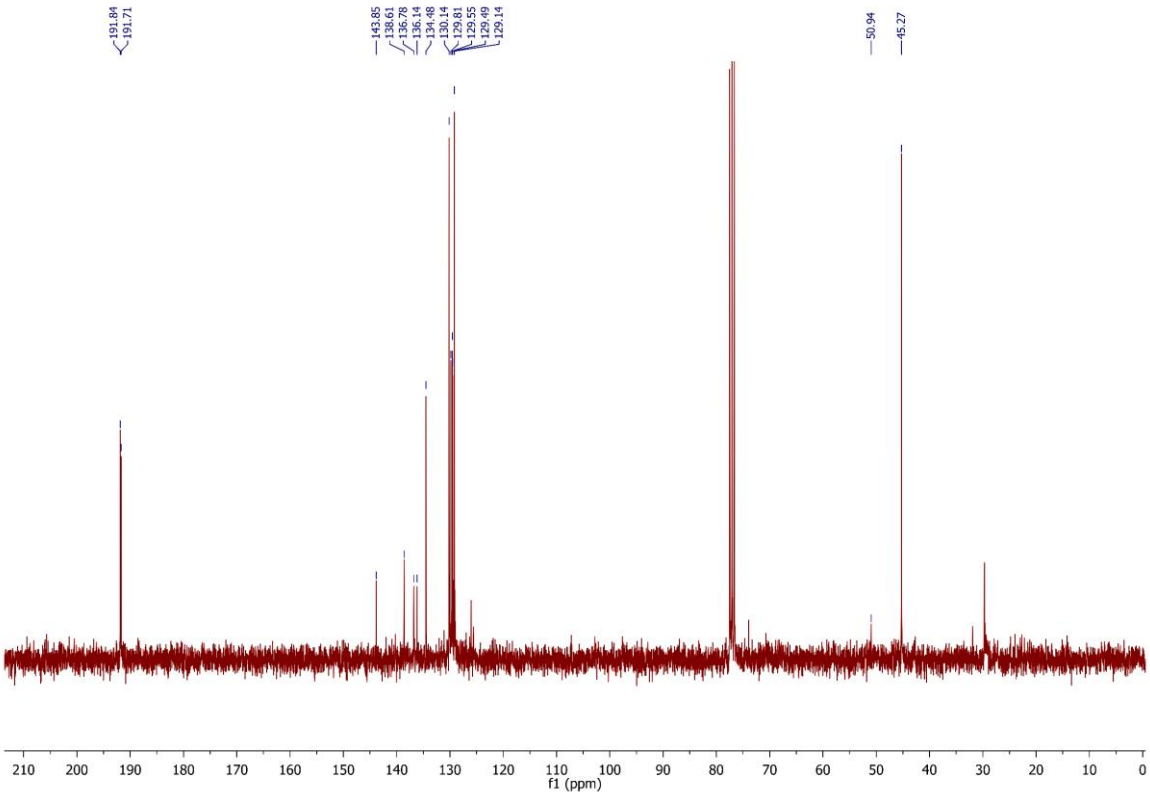


Figure 42: ^{13}C NMR spectrum of 4-(chloromethyl)benzaldehyde and 2-(chloromethyl)benzaldehyde (**4g**).

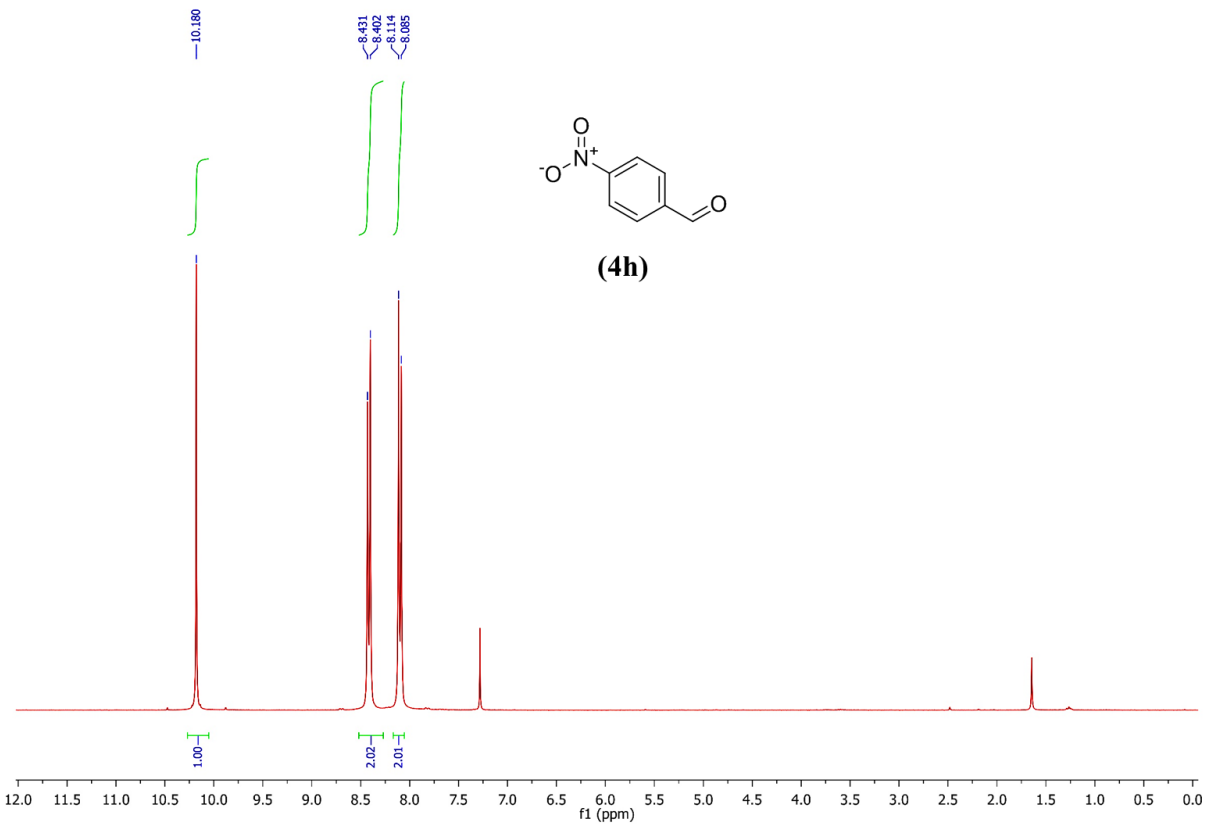


Figure 43:[1]H NMR spectrum of 4-nitrobenzaldehyde (**4h**).

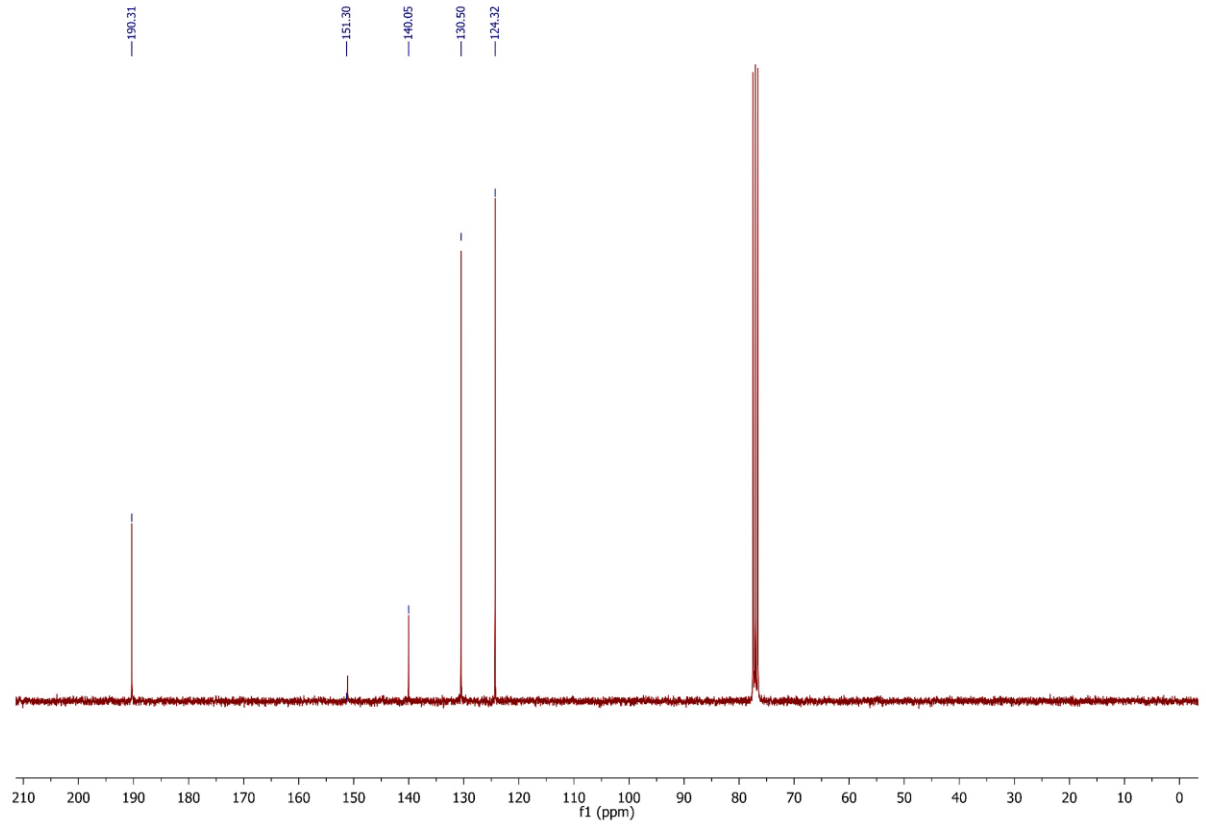


Figure 44:[13]C NMR spectrum of 4-nitrobenzaldehyde (**4h**).

XXX

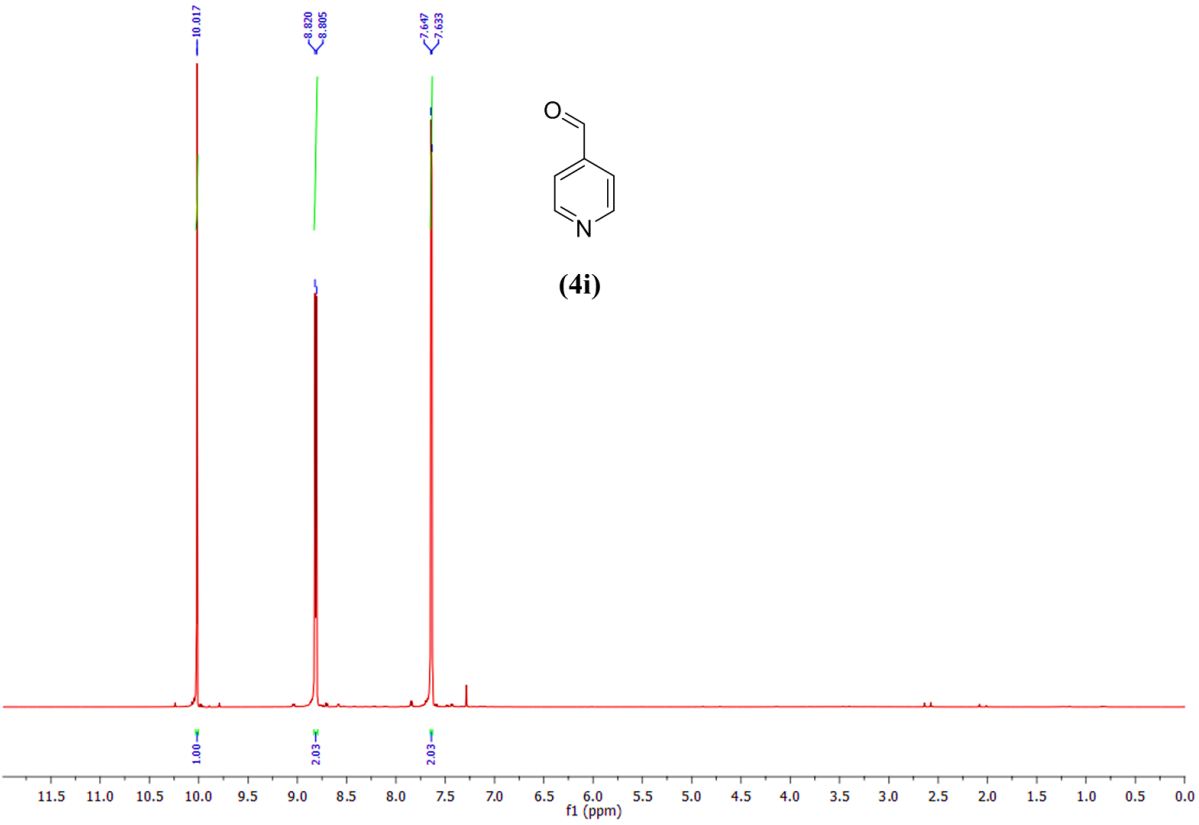


Figure 45:[1]H NMR spectrum of Isonicotinaldehyde (**4i**).

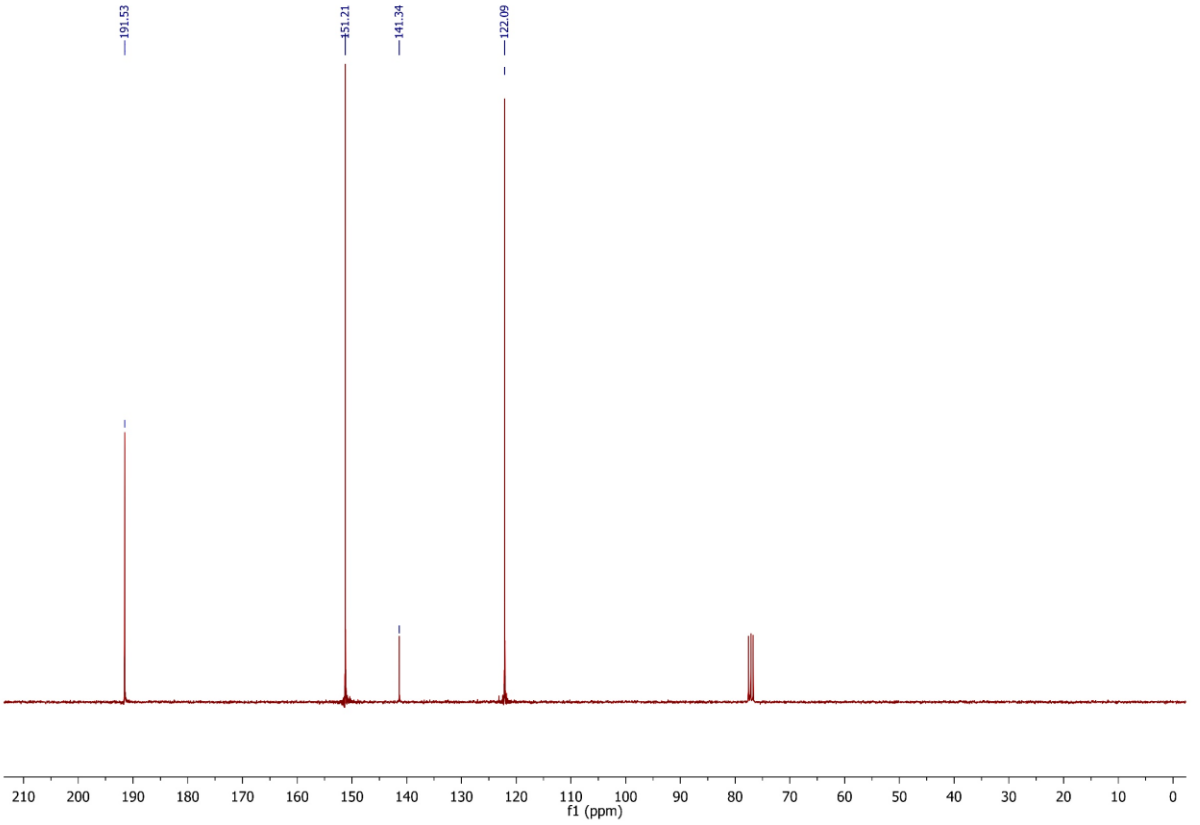


Figure 46:[13]C NMR spectrum of Isonicotinaldehyde (**4i**).

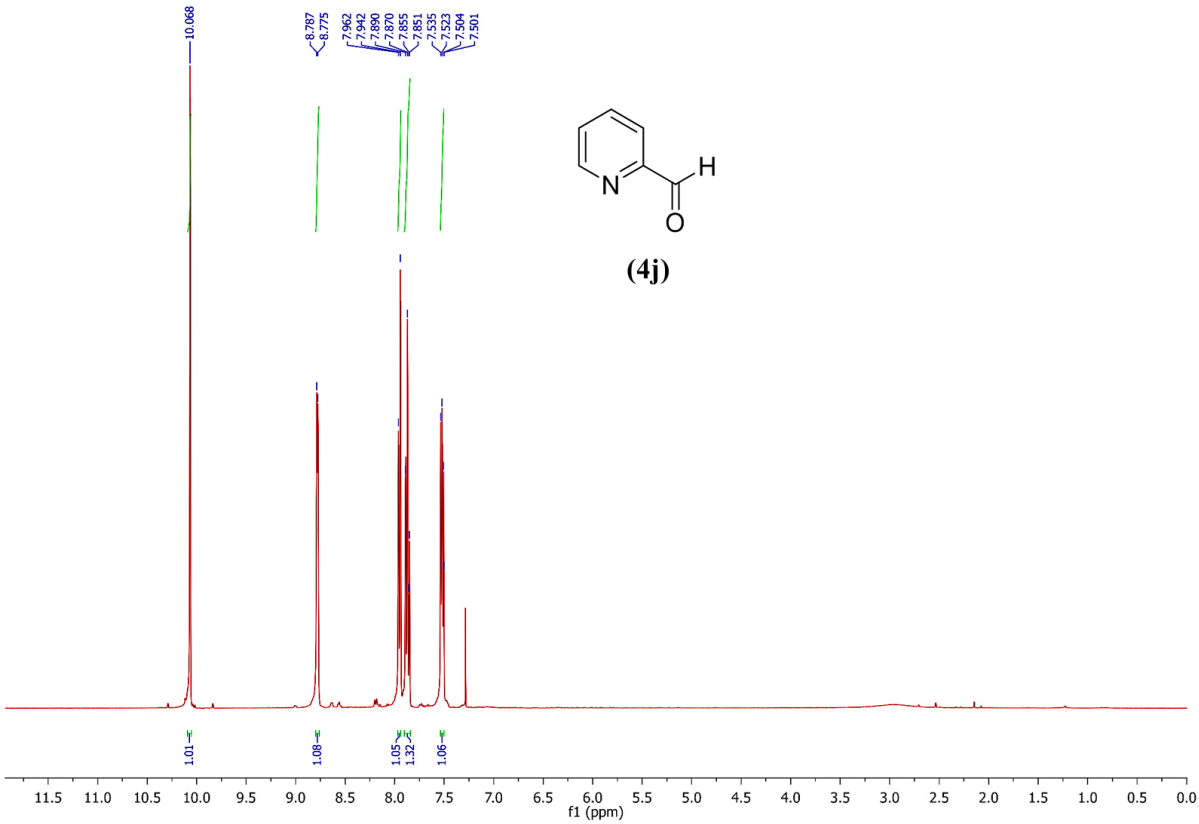


Figure 47:[1]H NMR spectrum of Picolinaldehyde (**4j**).

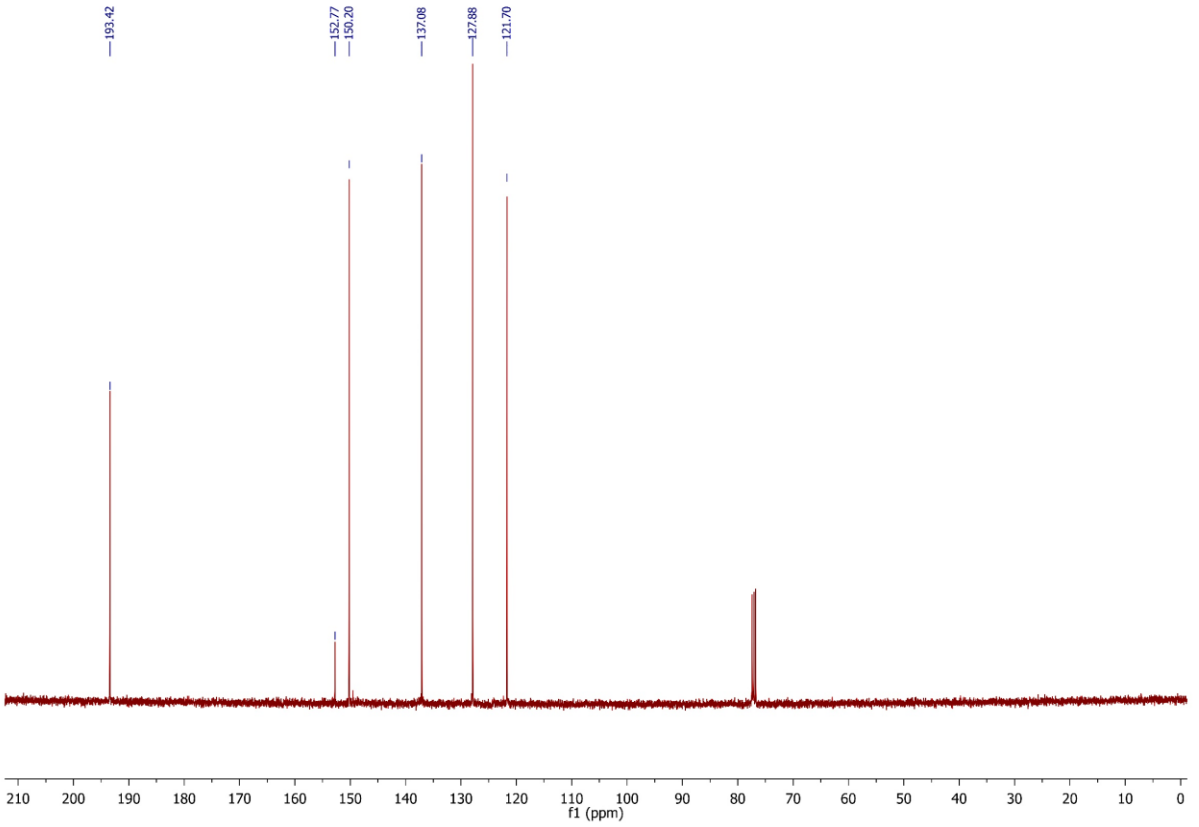


Figure 48:[13]C NMR spectrum of Picolinaldehyde (**4j**).

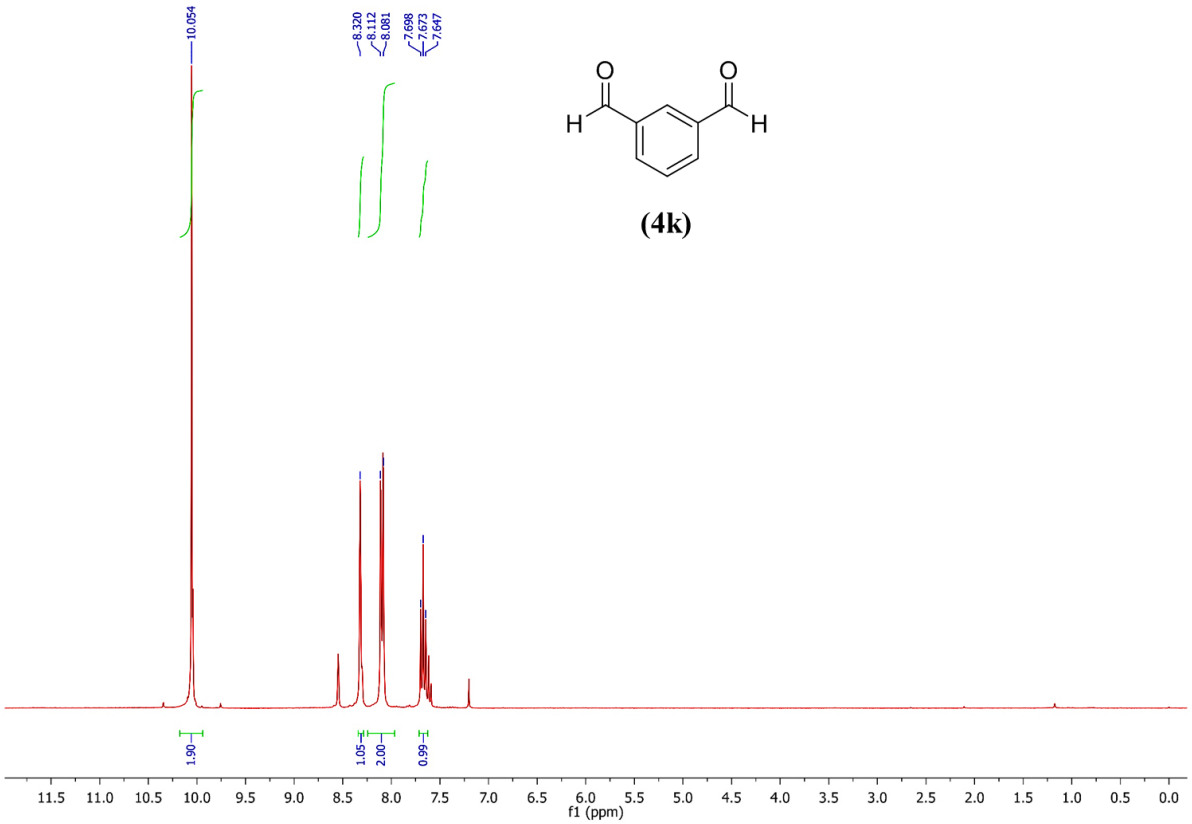


Figure 49:[1]H NMR spectrum of Isophthalaldehyde (**4k**).

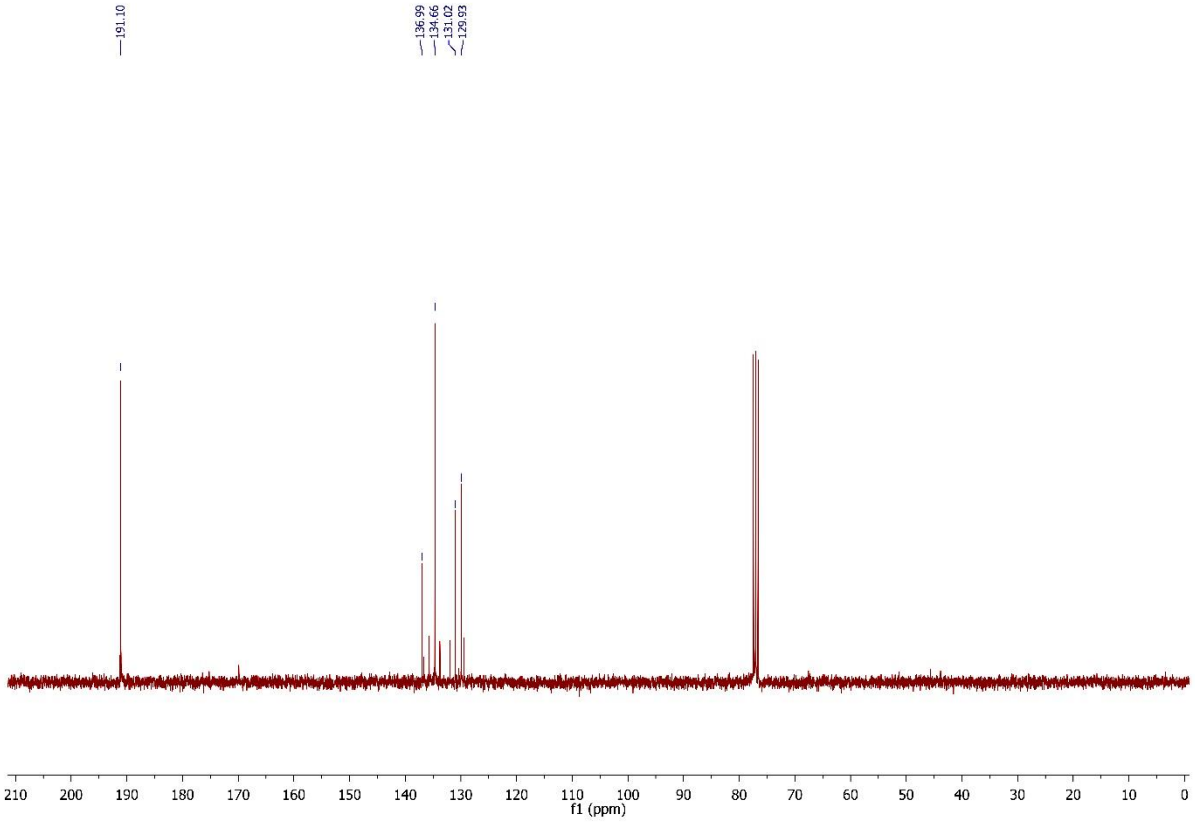


Figure 50:[13]C NMR spectrum of Isophthalaldehyde (**4k**).

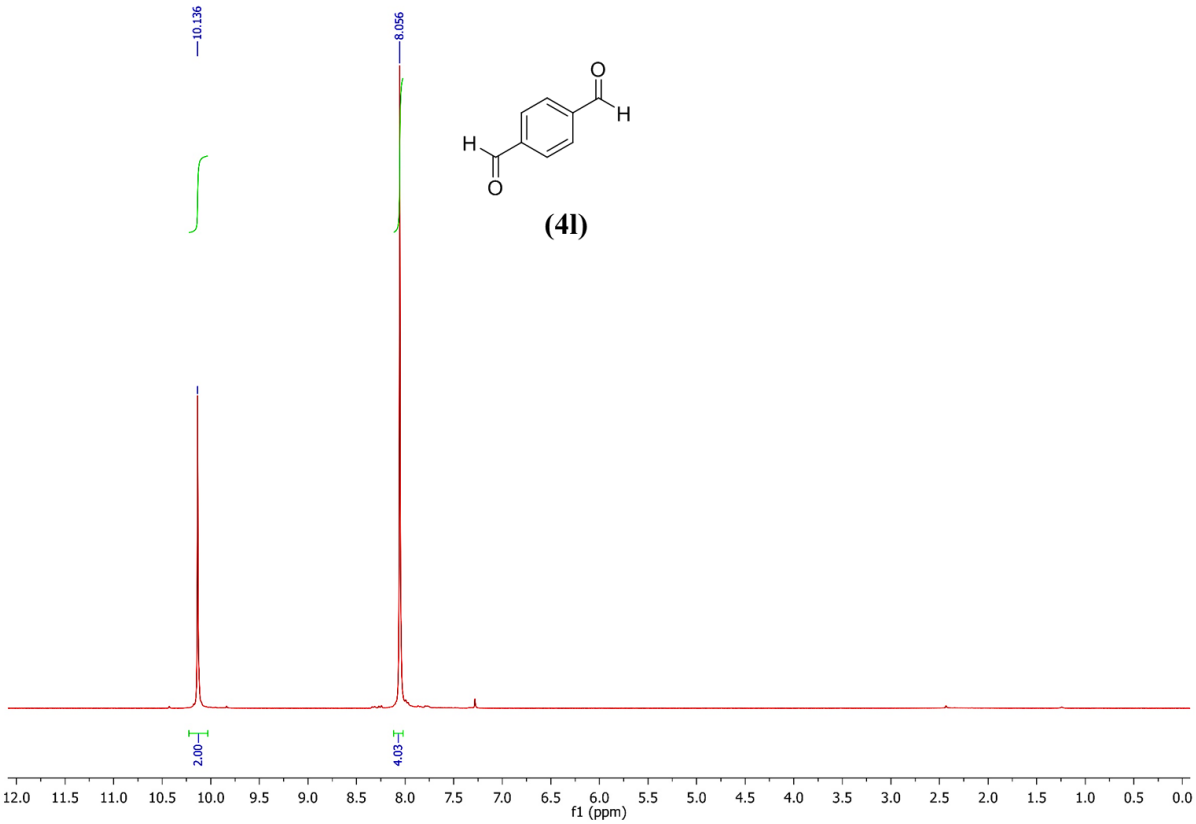


Figure 51:^{1}H NMR spectrum of Terephthalaldehyde (**4l**).

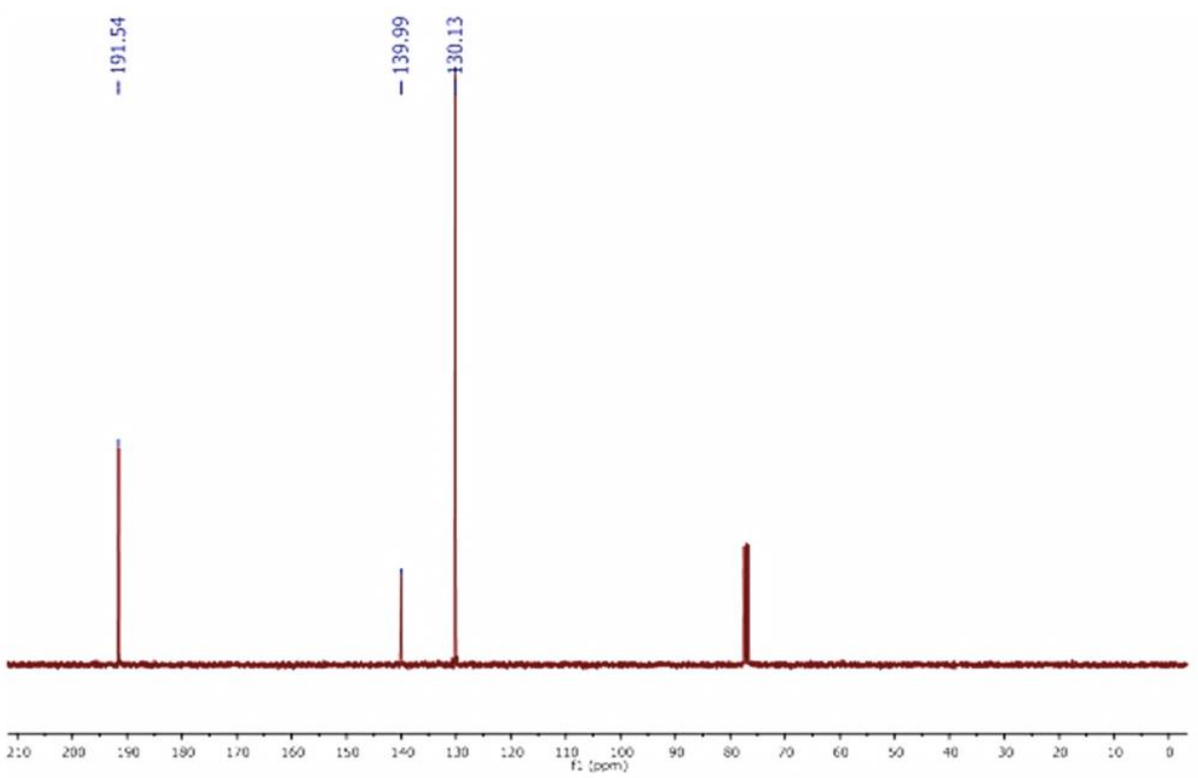


Figure 52:^{13}C NMR spectrum of Terephthalaldehyde (**4l**).

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