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Supporting Information

Visible-light Promoted γ-Cyanoalkyl Radical Generation: Three-Component Cyanopropylation/etherification of Unactivated Alkenes

Linyong Li,[a] Haoguo Chen,[a] Mingjing Mei[a] and Lei Zhou[a,*]

School of Chemistry, Sun Yat-Sen University, 135 Xingang West Road, Guangzhou 510275, China

E-mail: zhoul39@mail.sysu.edu.cn

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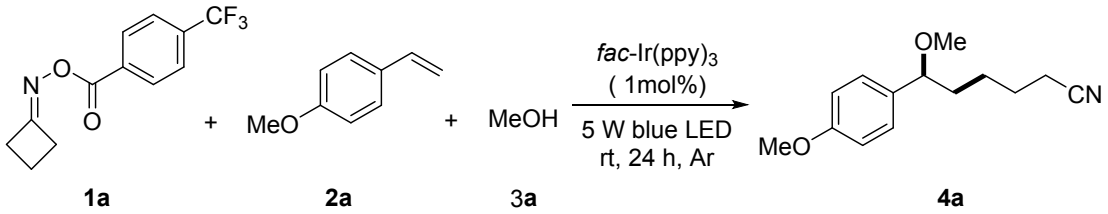
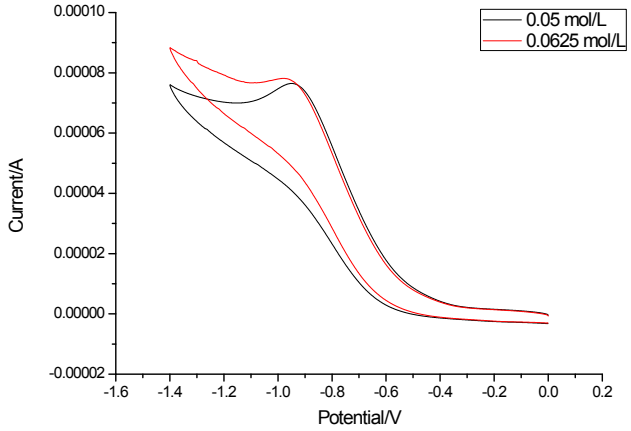
General Unless otherwise noted, all reactions were performed in a 10 mL microwave tube at room temperature. Photo-irradiation was carried out with a 5W blue LED. For chromatography, 200-300 mesh silica gel (Qingdao, China) was employed. ^{1}H NMR and ^{13}C NMR spectra were measured in $CDCl_3$ and recorded on Brucker ARX 400 spectrometer. HRMS spectra were recorded on ThermoFisher LTQ Orbitrap Elite. Chemical shifts (δ) were given in ppm, referenced to the residual proton resonance of $CDCl_3$ (7.26), to the carbon resonance of $CDCl_3$ (77.16). Coupling constants (J) were given in Hertz (Hz). Cyclobutanones[1] and *O*-acyl oximes[2] were prepared according to previous reported procedures. Materials obtained from commercial suppliers were used without further purification.

Typical procedure for the synthesis of 4a



To a 10 mL test tube equipped with a magnetic stir bar was charged with *O*-acyl oxime **1a** (0.2 mmol, 51.4 mg), 4-methoxystyrene **2a** (0.4 mmol, 53.6 mg), *fac*-Ir(ppy)$_3$ (1 mol %, 1.3 mg) and 2 mL of MeOH. The solution was stirred at room temperature with the irradiation of a 5 W blue LED under argon for 24 h. Then the solvent was evaporated under vacuum and the crude product was purified by column chromatography on silica gel with ethyl acetate/hexane (1/20) as the eluent, giving the pure product **4a** as colorless oil (43.8 mg, 94% yield).

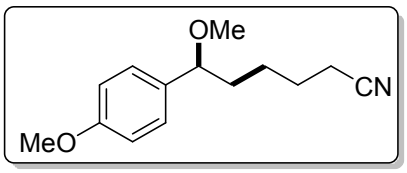
Cyclic Voltammograms of 1a



Cyclic voltammograms were recorded on a CHI750E Electrochemical Analyzer using a three-electrode cell at room temperature. The reference electrode was the saturated Ag/AgCl. A glassy carbon electrode was used as the working electrode and a platinum wire as the auxiliary electrode. Tetrabutylammonium hexafluorophosphate (0.1 M in CH_2Cl_2) was used as the supporting electrolyte. Voltammograms were taken in a solution of cyclobutanone *O*-(*p*-CF_3-benzoyl) oxime **1a** in CH_2Cl_2 (0.05 mol.L^{-1} and 0.0625 mol.L^{-1}), which were purged with Ar. The peak potentials for the irreversible reduction of **1a** were measured as -0.946 V vs. Ag/AgCl (-0.991 V vs. SCE) respectively.

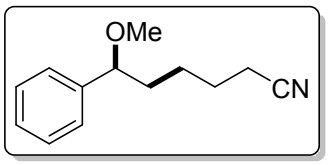
Compound characterization data:

6-methoxy-6-(4-methoxyphenyl)hexanenitrile (4a):



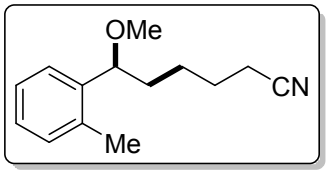
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 – 7.16 (m, 2H), 6.91 – 6.86 (m, 2H), 4.03 (dd, *J* = 7.2, 5.8 Hz, 1H), 3.81 (s, 3H), 3.17 (s, 3H), 2.30 (t, *J* = 7.1 Hz, 2H), 1.87 – 1.76 (m, 1H), 1.66 – 1.50 (m, 4H), 1.43 – 1.33 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.3, 133.9, 127.9, 119.8, 114.0, 83.2, 56.5, 55.4, 37.4, 25.5, 25.2, 17.2. HRMS (ESI) calcd for $C_{14}H_{19}O_2N_1Na_1$ $[M + Na]^+$ 256.1308, found 256.1304.

6-methoxy-6-phenylhexanenitrile (4b):



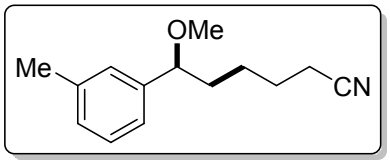
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.26 (m, 5H), 4.09 (dd, *J* = 7.4, 5.3 Hz, 1H), 3.20 (s, 3H), 2.31 (t, *J* = 7.0 Hz, 2H), 1.86 – 1.77 (m, 1H), 1.68 – 1.52 (m, 4H), 1.47 – 1.36 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.0, 128.6, 127.8, 126.7, 119.8, 83.7, 56.8, 37.5, 25.5, 25.2, 17.2. HRMS (ESI) calcd for $C_{14}H_{19}O_1N_1Na_1$ $[M + Na]^+$ 226.1199, found 226.1197.

6-methoxy-6-(*o*-tolyl)hexanenitrile (4c):



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (d, *J* = 7.3 Hz, 1H), 7.25 – 7.11 (m, 3H), 4.38 (dd, *J* = 7.9, 3.8 Hz, 1H), 3.20 (s, 3H), 2.35 – 2.31 (m, 5H), 1.77 – 1.64 (m, 5H), 1.53 – 1.46 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 140.1, 135.3, 130.6, 127.3, 126.4, 125.9, 119.8, 80.1, 56.7, 36.5, 25.6, 25.4, 19.2, 17.2. HRMS (ESI) calcd for $C_{14}H_{19}O_1N_1Na_1$ $[M + Na]^+$ 240.1359, found 240.1356.

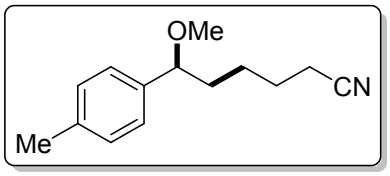
6-methoxy-6-(*m*-tolyl)hexanenitrile (4d):



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (t, *J* = 7.4 Hz, 1H), 7.08 (dd, *J* = 11.4, 10.2 Hz, 3H), 4.05 (dd, *J* = 7.5, 5.3 Hz, 1H), 3.20 (s, 3H), 2.36 (s, 3H), 2.31 (t, *J* = 7.0 Hz, 2H), 1.85 – 1.76 (m, 1H), 1.68 – 1.54 (m, 4H), 1.45 – 1.36 (m, 1H). ^{13}C

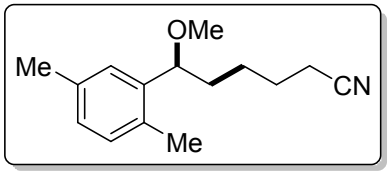
NMR (101 MHz, $CDCl_3$) δ 141.9, 138.2, 128.5, 128.4, 127.3, 123.8, 119.8, 83.7, 56.7, 37.4, 25.5, 25.2, 21.6, 17.2. HRMS (ESI) calcd for $C_{14}H_{19}O_1N_1Na_1$ $[M + Na]^+$ 240.1359, found 240.1356.

6-methoxy-6-(*p*-tolyl)hexanenitrile (4e):



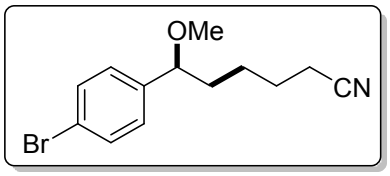
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.16 (s, 4H), 4.06 (dd, *J* = 7.4, 5.5 Hz, 1H), 3.19 (s, 3H), 2.35 (s, 3H), 2.30 (t, *J* = 7.1 Hz, 2H), 1.86 – 1.75 (m, 1H), 1.68 – 1.51 (m, 4H), 1.46 – 1.34 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 138.9, 137.5, 129.3, 126.7, 119.8, 83.5, 56.6, 37.4, 25.5, 25.2, 21.3, 17.2. HRMS (ESI) calcd for $C_{14}H_{19}O_1N_1Na_1$ $[M + Na]^+$ 240.1359, found 240.1356.

6-(2,5-dimethylphenyl)-6-methoxyhexanenitrile (4f):



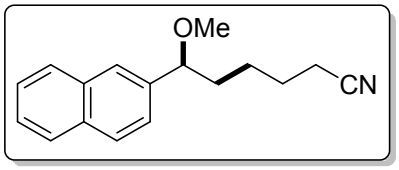
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.14 (s, 1H), 7.04 – 6.97 (m, 2H), 4.35 (dd, *J* = 7.9, 4.0 Hz, 1H), 3.20 (s, 3H), 2.35 – 2.31 (m, 5H), 2.28 (s, 3H), 1.76 – 1.62 (m, 5H), 1.54 – 1.44 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 139.8, 135.8, 132.1, 130.5, 128.0, 126.4, 119.8, 80.1, 56.7, 36.5, 25.5, 25.4, 21.2, 18.7, 17.2 HRMS (ESI) calcd for $C_{15}H_{21}O_1N_1Na_1$ $[M + Na]^+$ 254.1515, found 254.1513.

6-(4-bromophenyl)-6-methoxyhexanenitrile (4g):



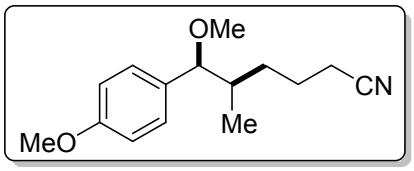
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.45 (m, 2H), 7.17 – 7.13 (m, 2H), 4.05 (dd, *J* = 7.5, 5.1 Hz, 1H), 3.18 (s, 3H), 2.31 (t, *J* = 7.1 Hz, 2H), 1.82 – 1.73 (m, 1H), 1.65 – 1.50 (m, 4H), 1.45 – 1.35 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.1, 131.8, 128.4, 121.6, 119.7, 83.1, 56.9, 37.4, 25.5, 25.1, 17.2. HRMS (ESI) calcd for $C_{13}H_{16}O_1N_1Br_1Na_1$ $[M + Na]^+$ 304.0308, found 304.0304.

6-methoxy-6-(naphthalen-2-yl)hexanenitrile (4h):



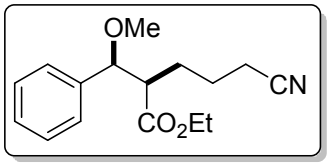
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.81 (m, 3H), 7.71 (s, 1H), 7.53 – 7.38 (m, 3H), 4.26 (dd, *J* = 7.3, 5.8 Hz, 1H), 3.24 (s, 3H), 2.32 – 2.29 (m, 2H), 1.98 – 1.84 (m, 1H), 1.80 – 1.71 (m, 1H), 1.67 – 1.56 (m, 3H), 1.49 – 1.38 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 139.4, 133.3, 133.3, 128.6, 127.9, 127.9, 126.3, 126.0, 126.0, 124.3, 119.8, 83.9, 56.9, 37.3, 25.5, 25.3, 17.2. HRMS (ESI) calcd for $C_{17}H_{19}O_1N_1Na_1$ $[M + Na]^+$ 276.1359, found 276.1354.

6-methoxy-6-(4-methoxyphenyl)-5-methylhexanenitrile (4i):



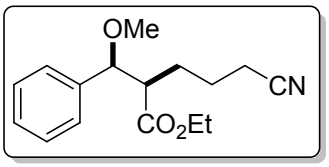
A mixture of two inseparable diastereomers (dr = 1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.14 (d, *J* = 8.3 Hz, 2H), 6.88 (dd, *J* = 8.6, 1.7 Hz, 2H), 3.85 (d, *J* = 6.3 Hz, 0.5H, **dia. 1**), 3.81 (s, 3H), 3.74 (d, *J* = 7.6 Hz, 0.5H, **dia. 2**), 3.17 (s, 1.50H, **dia. 1**), 3.14 (s, 1.48H, **dia. 2**), 2.38 – 2.17 (m, 2H), 1.82 – 1.67 (m, 2H), 1.60 – 1.04 (m, 3H), 0.93 (d, *J* = 6.7 Hz, 1.51H, **dia. 1**), 0.69 (d, *J* = 6.8 Hz, 1.50H, **dia. 2**). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2 (**dia. 1**), 159.1 (**dia. 2**), 132.7 (**dia. 1**), 132.5 (**dia. 2**), 128.7 (**dia. 1**), 128.5 (**dia. 2**), 112.0 (**dia. 1**), 119.8 (**dia. 2**), 113.7 (**dia. 1**), 113.7 (**dia. 2**), 88.1 (**dia. 1**), 87.6 (**dia. 2**), 57.0 (**dia. 1**), 56.8 (**dia. 2**), 55.4, 39.5 (**dia. 1**), 39.3 (**dia. 2**), 32.5 (**dia. 1**), 32.2 (**dia. 2**), 23.5 (**dia. 1**), 23.4 (**dia. 2**), 17.6 (**dia. 1**), 17.5 (**dia. 2**), 16.0 (**dia. 1**), 15.4 (**dia. 2**). HRMS (ESI) calcd for $C_{15}H_{21}O_2N_1Na_1$ $[M + Na]^+$ 270.1465, found 270.1458.

ethyl -5-cyano-2-methoxy(phenyl)methyl)pentanoate (4j, major diastereomer):



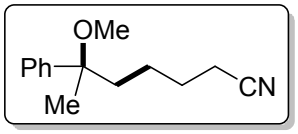
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.32 (m, 3H), 7.31 – 7.25 (m, 2H), 4.31 – 4.17 (m, 3H), 3.13 (s, 3H), 2.70 – 2.60 (m, 1H), 2.26 – 2.12 (m, 2H), 1.61 – 1.42 (m, 3H), 1.31 (t, *J* = 7.1 Hz, 3H), 1.20 – 1.10 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 174.0, 138.7, 128.8, 128.7, 127.7, 119.1, 85.2, 60.9, 56.9, 52.7, 27.9, 23.3, 17.0, 14.5. HRMS (ESI) calcd for $C_{16}H_{22}O_3N_1$ $[M + H]^+$ 276.1594, found 276.1589.

ethyl -5-cyano-2-methoxy(phenyl)methyl)pentanoate (4j', minor diastereomer):



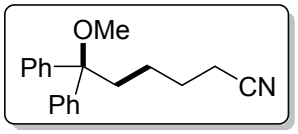
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.31 (m, 2H), 7.30 – 7.25 (m, 3H), 4.26 (d, *J* = 8.5 Hz, 1H), 3.90 (dtt, *J* = 10.8, 7.3, 3.7 Hz, 2H), 3.19 (s, 3H), 2.67 (ddd, *J* = 10.1, 8.6, 3.7 Hz, 1H), 2.34 (t, *J* = 7.3 Hz, 2H), 2.06 – 1.96 (m, 1H), 1.93 – 1.81 (m, 1H), 1.76 – 1.64 (m, 2H), 0.97 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.8, 139.3, 128.5, 128.3, 127.4, 119.5, 84.3, 60.6, 57.0, 53.3, 28.2, 23.8, 17.3, 14.1. HRMS (ESI) calcd for $C_{16}H_{22}O_3N_1$ $[M + H]^+$ 276.1594, found 276.1593.

6-methoxy-6-phenylheptanenitrile (4k):



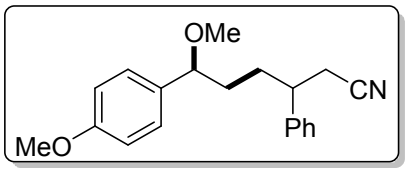
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.31 (m, 4H), 7.28 – 7.22 (m, 1H), 3.08 (s, 3H), 2.27 (t, *J* = 7.2 Hz, 2H), 1.79 – 1.69 (m, 2H), 1.62 – 1.56 (m, 2H), 1.54 (s, 3H), 1.45 – 1.29 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.9, 128.3, 127.0, 126.2, 119.7, 78.9, 50.5, 42.6, 25.9, 23.4, 22.7, 17.2. HRMS (ESI) calcd for $C_{14}H_{19}O_1N_1Na_1$ $[M + Na]^+$ 240.1359, found 240.1357.

6-methoxy-6,6-diphenylhexanenitrile (4l):



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.26 (m, 8H), 7.23 – 7.19 (m, 2H), 3.05 (s, 3H), 2.35 – 2.29 (m, 2H), 2.26 (t, *J* = 7.3 Hz, 2H), 1.67 – 1.58 (m, 2H), 1.33 – 1.24 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 145.2, 128.1, 127.0, 126.9, 119.7, 82.2, 50.2, 34.5, 25.9, 22.4, 17.3. HRMS (ESI) calcd for $C_{19}H_{21}O_1N_1Na_1$ $[M + Na]^+$ 302.1515, found 302.1509.

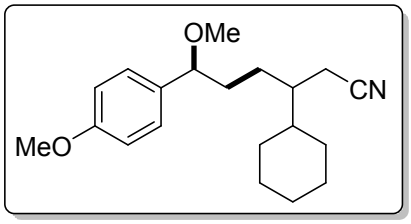
6-methoxy-6-(4-methoxyphenyl)-3-phenylhexanenitrile (4m):



A mixture of two inseparable diastereomers (dr = 1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.22 (m, 3H), 7.21 – 7.09 (m, 4H), 6.90 – 6.82 (m, 2H), 4.06 – 3.92 (m, 1H), 3.80 (s, 3H), 3.15 (s, 1.51H, **dia. 1**), 3.13 (s, 1.50H, **dia. 2**), 2.98 –

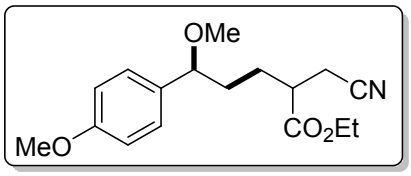
2.82 (m, 1H), 2.56 (d, J = 7.1 Hz, 2H), 2.04 – 1.84 (m, 1H), 1.80 – 1.62 (m, 2H), 1.57 – 1.41 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2 (**dia. 1**), 159.2 (**dia. 2**), 141.5, 133.9 (**dia. 1**), 133.7 (**dia. 2**), 129.0 (**dia. 1**), 129.0 (**dia. 2**), 127.9 (**dia. 1**), 127.8 (**dia. 2**), 127.5, 127.3, 118.6, 113.9 (**dia. 1**), 113.9 (**dia. 2**), 83.2 (**dia. 1**), 83.1 (**dia. 2**), 56.5 (**dia. 1**), 56.4 (**dia. 2**), 55.3, 42.4 (**dia. 1**), 42.2 (**dia. 2**), 35.8 (**dia. 1**), 35.8 (**dia. 2**), 31.3 (**dia. 1**), 31.3 (**dia. 2**), 25.4 (**dia. 1**), 25.3 (**dia. 2**). HRMS (ESI) calcd for $C_{20}H_{23}O_2N_1Na_1$ $[M + Na]^+$ 332.1621, found 332.1614.

3-cyclohexyl-6-methoxy-6-(4-methoxyphenyl)hexanenitrile (4n):



A mixture of two inseparable diastereomers (dr = 1:1); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.19 (d, J = 8.5 Hz, 2H), 6.90 – 6.87 (m, 2H), 4.02 – 4.00 (m, 1H), 3.81 (s, 3H), 3.17 (s, 1.57H, **dia. 1**), 3.16 (s, 1.48H, **dia. 2**), 2.35 – 2.22 (m, 2H), 1.86 – 1.71 (m, 3H), 1.67 – 1.40 (m, 7H), 1.28 – 1.17 (m, 3H), 1.14 – 1.06 (m, 1H), 1.01 – 0.91 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.3, 134.0 (**dia. 1**), 134.0 (**dia. 2**), 127.9 (**dia. 1**), 127.9 (**dia. 2**), 119.7 (**dia. 1**), 119.6 (**dia. 2**), 114.0, 83.7 (**dia. 1**), 83.5 (**dia. 2**), 56.5, 55.4, 40.8, 40.3 (**dia. 1**), 40.2 (**dia. 2**), 35.9 (**dia. 1**), 35.8 (**dia. 2**), 30.1 (**dia. 1**), 30.0 (**dia. 2**), 29.5 (**dia. 1**), 29.4 (**dia. 2**), 27.3 (**dia. 1**), 27.1 (**dia. 2**), 26.6 (**dia. 1**), 26.5 (**dia. 2**), 19.2 (**dia. 1**), 19.1 (**dia. 2**). HRMS (ESI) calcd for $C_{20}H_{29}O_2N_1Na_1$ $[M + Na]^+$ 338.2091, found 338.2083.

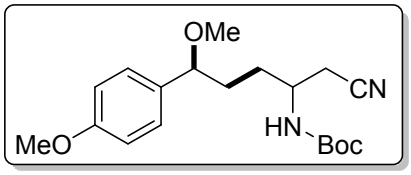
ethyl-2-(cyanomethyl)-5-methoxy-5-(4-methoxyphenyl)pentanoate (4o):



A mixture of two inseparable diastereomers (dr = 1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 – 7.15 (m, 2H), 6.90 – 6.86 (m, 2H), 4.17 (q, J = 7.1 Hz, 2H), 4.06 – 4.01 (m, 1H), 3.80 (s, 3H), 3.15 (s, 3H), 2.75 – 2.46 (m, 3H), 1.94 – 1.76 (m, 2H), 1.72 – 1.60 (m, 2H), 1.25 (t, J = 7.1 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 159.3, 133.6 (**dia. 1**), 133.5 (**dia. 2**), 127.8 (**dia. 1**), 117.9 (**dia. 2**), 117.8, 114.0, 83.0 (**dia. 1**), 82.9 (**dia. 2**), 61.5, 56.5, 55.4, 41.6 (**dia. 1**), 41.4 (**dia. 2**), 35.1 (**dia. 1**), 35.0 (**dia. 2**), 28.0 (**dia. 1**), 27.9 (**dia. 2**), 19.6 (**dia. 1**), 19.4 (**dia. 2**), 14.3. HRMS

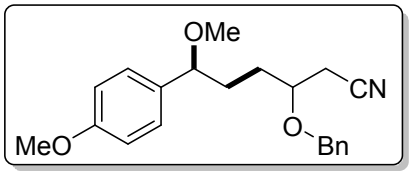
(ESI) calcd for $C_{17}H_{23}O_4N_1Na_1$ [M + Na]$^+$ 328.1519, found 328.1514.

tert-butyl-1-cyano-5-methoxy-5-(4-methoxyphenyl)pentan-2-yl)carbamate (4p):



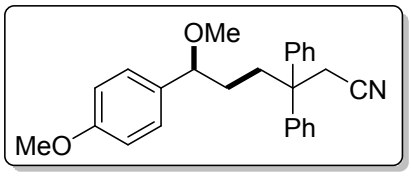
A mixture of two inseparable diastereomers (dr = 1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (d, *J* = 8.6 Hz, 2H), 6.88 (dd, *J* = 8.6, 1.8 Hz, 2H), 4.77 (dd, *J* = 17.7, 7.6 Hz, 1H), 4.15 – 4.00 (m, 1H), 3.83 – 3.76 (m, 4H), 3.17 (s, 1.51H, **dia. 1**), 3.16 (s, 1.50H, **dia. 2**), 2.75 – 2.70 (m, 1H), 2.50 (dd, *J* = 16.6, 3.0 Hz, 1H), 1.88 – 1.77 (m, 1H), 1.70 – 1.54 (m, 3H), 1.43 – 1.42 (m, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.4 (**dia. 1**), 159.3 (**dia. 2**), 155.3 (**dia. 1**), 155.2 (**dia. 2**), 133.7 (**dia. 1**), 133.5 (**dia. 2**), 127.9 (**dia. 1**), 127.8 (**dia. 2**), 117.5, 114.1 (**dia. 1**), 114.0 (**dia. 2**), 82.8 (**dia. 1**), 82.7 (**dia. 2**), 80.2 (**dia. 1**), 80.2 (**dia. 2**), 56.6 (**dia. 1**), 56.5 (**dia. 2**), 55.4, 47.5 (**dia. 1**), 47.2 (**dia. 2**), 34.6 (**dia. 1**), 34.6 (**dia. 2**), 30.1 (**dia. 1**), 29.9 (**dia. 2**), 28.4, 24.1 (**dia. 1**), 24.1 (**dia. 2**). HRMS (ESI) calcd for $C_{17}H_{26}O_3N_5Na_1$ [M + Na]$^+$ 371.1937, found 371.1731.

3-(benzyloxy)-6-methoxy-6-(4-methoxyphenyl)hexanenitrile (4q):



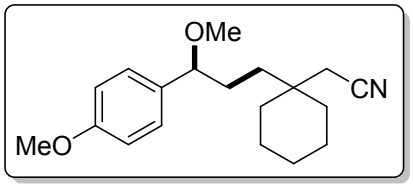
A mixture of two inseparable diastereomers (dr = 1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.27 (m, 5H), 7.18 (d, *J* = 8.5 Hz, 2H), 6.89 (d, *J* = 8.6 Hz, 2H), 4.62 – 4.47 (m, 2H), 4.02 (t, *J* = 6.4 Hz, 1H), 3.81 (s, 3H), 3.71 – 3.63 (m, 1H), 3.17 (s, 1.45H, **dia. 1**), 3.16 (s, 1.47H, **dia. 2**), 2.58 – 2.45 (m, 2H), 1.96 – 1.76 (m, 2H), 1.70 – 1.51 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.3 (**dia. 1**), 159.3 (**dia. 2**), 137.6 (**dia. 1**), 137.6 (**dia. 2**), 133.8 (**dia. 1**), 133.7 (**dia. 2**), 128.6, 128.1, 128.0 (**dia. 1**), 128.0 (**dia. 2**), 127.9 (**dia. 1**), 127.9 (**dia. 2**), 117.7, 114.0, 83.3 (**dia. 1**), 83.1 (**dia. 2**), 74.6 (**dia. 1**), 74.3 (**dia. 2**), 72.0 (**dia. 1**), 71.8 (**dia. 2**), 56.5 (**dia. 1**), 56.5 (**dia. 2**), 55.4, 33.7 (**dia. 1**), 33.3 (**dia. 2**), 30.9 (**dia. 1**), 30.5 (**dia. 2**), 23.1 (**dia. 1**), 23.0 (**dia. 2**). HRMS (ESI) calcd for $C_{21}H_{25}O_3N_1Na_1$ [M + Na]$^+$ 362.1727, found 362.1719.

6-methoxy-6-(4-methoxyphenyl)-3,3-diphenylhexanenitrile (4r):



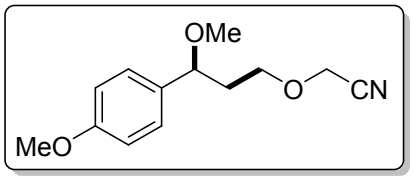
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.20 (m, 6H), 7.15 – 7.04 (m, 6H), 6.89 – 6.80 (m, 2H), 3.96 (t, *J* = 6.7 Hz, 1H), 3.80 (s, 3H), 3.13 (s, 3H), 3.06 (d, *J* = 2.2 Hz, 2H), 2.48 (ddd, *J* = 13.8, 12.0, 4.5 Hz, 1H), 2.13 (ddd, *J* = 13.8, 11.9, 4.4 Hz, 1H), 1.60 – 1.53 (m, 1H), 1.42 – 1.33 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.3, 145.0, 144.8, 133.6, 128.5, 128.0, 127.6, 127.5, 127.0, 127.0, 118.0, 114.0, 83.4, 56.5, 55.4, 48.4, 35.0, 32.8, 29.5. HRMS (ESI) calcd for $C_{26}H_{27}O_2N_1Na_1$ $[M + Na]^+$ 408.1934, found 408.1931.

2-(1-(3-methoxy-3-(4-methoxyphenyl)propyl)cyclohexyl)acetonitrile (4s):



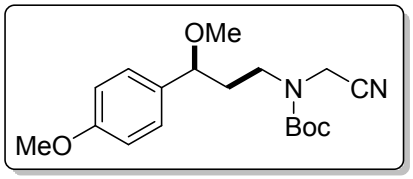
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (d, *J* = 8.6 Hz, 2H), 6.89 (d, *J* = 8.7 Hz, 2H), 4.01 –3.97 (m, 1H), 3.81 (s, 3H), 3.16 (s, 3H), 2.30 – 2.20 (m, 2H), 1.74 – 1.68 (m, 1H), 1.61 – 1.50 (m, 2H), 1.43 – 1.30 (m, 10H), 1.29 – 1.25 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.3, 134.0, 128.0, 118.0, 114.0, 83.9, 56.5, 55.4 , 35.2, 35.0, 33.8, 31.7, 26.7, 25.8, 23.3, 21.6, 21.5. HRMS (ESI) calcd for $C_{19}H_{27}O_2N_1Na_1$ $[M + Na]^+$ 324.1934, found 324.1930.

2-(3-methoxy-3-(4-methoxyphenyl)propoxy)acetonitrile (4t):



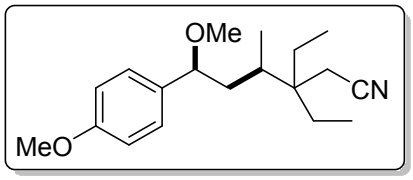
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 (d, *J* = 8.6 Hz, 2H), 6.91 – 6.88 (m, 2H), 4.24 – 4.18 (m, 3H), 3.81 (s, 3H), 3.70 (ddd, *J* = 8.9, 7.2, 5.6 Hz, 1H), 3.52 (dt, *J* = 9.0, 6.0 Hz, 1H), 3.18 (s, 3H), 2.09 (ddt, *J* = 14.1, 8.2, 5.9 Hz, 1H), 1.92 – 1.81 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.3, 133.4, 127.9, 116.2, 114.0, 79.8, 68.7, 56.5, 56.4, 55.4, 37.8. HRMS (ESI) calcd for $C_{13}H_{17}O_3N_1Na_1$ $[M + Na]^+$ 258.1101, found 258.1098.

tert-butyl-(cyanomethyl)(3-methoxy-3-(4-methoxyphenyl)propyl)carbamate (4u):



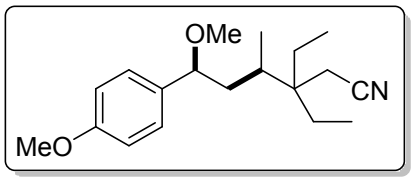
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (d, *J* = 8.6 Hz, 2H), 6.88 (d, *J* = 8.6 Hz, 2H), 4.24 – 3.95 (m, 3H), 3.80 (s, 3H), 3.39 (s, 2H), 3.16 (s, 3H), 2.04 – 1.85 (m, 2H), 1.46 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.4, 133.3, 127.8, 116.4, 114.1, 81.6, 80.8, 56.4, 55.4, 45.3, 36.6, 35.7, 28.3. HRMS (ESI) calcd for $C_{18}H_{26}O_4N_2Na_1$ $[M + Na]^+$ 357.1785, found 357.1780.

3,3-diethyl-6-methoxy-6-(4-methoxyphenyl)hexanenitrile (4v, major diastereomer):



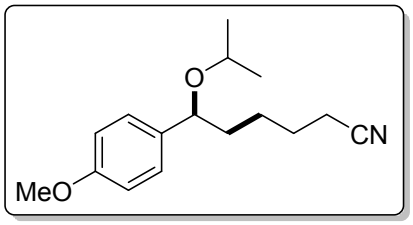
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 – 7.18 (m, 2H), 6.93 – 6.85 (m, 2H), 4.08 (dd, *J* = 10.3, 2.7 Hz, 1H), 3.81 (s, 3H), 3.16 (s, 3H), 2.22 (s, 2H), 2.02 – 1.92 (m, 1H), 1.89 – 1.79 (m, 1H), 1.55 – 1.42 (m, 4H), 1.22 – 1.15 (m, 1H), 0.97 (d, *J* = 6.9 Hz, 3H), 0.89 (q, *J* = 7.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2, 135.1, 127.7, 119.6, 114.0, 81.4, 56.8, 55.4, 41.0, 40.3, 34.6, 27.5, 27.3, 23.9, 14.2, 8.3, 8.2. HRMS (ESI) calcd for $C_{19}H_{29}O_2N_1Na_1$ $[M + Na]^+$ 326.2091, found 326.2082.

3,3-diethyl-6-methoxy-6-(4-methoxyphenyl)hexanenitrile (4v', minor diastereomer):



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 – 7.17 (m, 2H), 6.91 – 6.86 (m, 2H), 4.07 (dd, *J* = 9.4, 5.0 Hz, 1H), 3.81 (s, 3H), 3.14 (s, 3H), 2.15 – 2.04 (m, 2H), 1.84 – 1.74 (m, 1H), 1.68 – 1.62 (m, 1H), 1.42 – 1.37 (m, 2H), 1.25 – 1.21 (m, 1H), 0.98 (d, *J* = 6.8 Hz, 3H), 0.93 – 0.83 (m, 2H), 0.71 – 0.65 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.5, 133.3, 128.4, 119.4, 114.0, 83.1, 56.3, 55.4, 40.4, 39.3, 34.7, 27.3, 27.2, 23.7, 14.6, 8.1, 8.0. HRMS (ESI) calcd for $C_{19}H_{29}O_2N_1Na_1$ $[M + Na]^+$ 326.2091, found 326.2083.

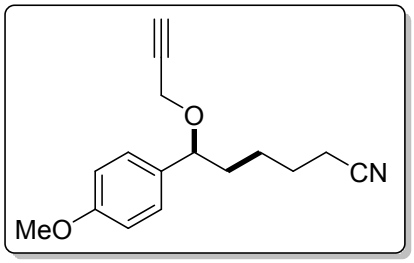
6-isopropoxy-6-(4-methoxyphenyl)hexanenitrile (4w):



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.18 (m, 2H),

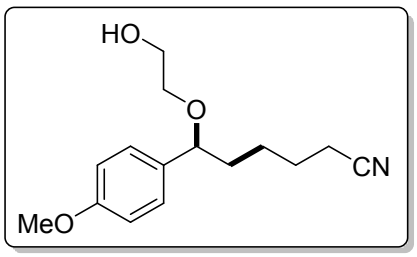
6.91 – 6.84 (m, 2H), 4.26 (dd, J = 7.9, 4.7 Hz, 1H), 3.80 (s, 3H), 3.44 (dt, J = 12.2, 6.1 Hz, 1H), 2.30 (t, J = 7.0 Hz, 2H), 1.78 – 1.56 (m, 5H), 1.45 – 1.32 (m, 1H), 1.12 (d, J = 6.0 Hz, 3H), 1.05 (d, J = 6.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.0, 135.5, 127.7, 119.9, 113.8, 78.4, 68.6, 55.4, 38.1, 25.5, 25.4, 23.6, 21.3, 17.2. HRMS (ESI) calcd for $C_{16}H_{23}O_2N_1$ Na $_1$[M + Na]$^+$ 284.1621, found 284.1617.

6-(4-methoxyphenyl)-6-(prop-2-yn-1-yloxy)hexanenitrile (4x):



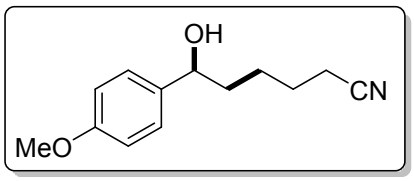
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 – 7.18 (m, 2H), 6.92 – 6.86 (m, 2H), 4.41 (dd, J = 7.6, 5.6 Hz, 1H), 4.06 (dd, J = 15.7, 2.4 Hz, 1H), 3.82 – 3.78 (m, 4H), 2.40 (t, J = 2.4 Hz, 1H), 2.31 (t, J = 7.1 Hz, 2H), 1.91 – 1.81 (m, 1H), 1.72 – 1.62 (m, 3H), 1.60 – 1.51 (m, 1H), 1.47 – 1.37 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.5, 132.9, 128.2, 119.8, 114.1, 80.1, 79.9, 74.2, 55.4, 37.1, 25.4, 25.2, 17.2. HRMS (ESI) calcd for $C_{16}H_{19}O_2N_1Na_1$ [M + Na]$^+$ 280.1308, found 280.1303.

6-(2-hydroxyethoxy)-6-(4-methoxyphenyl)hexanenitrile (4y):



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 – 7.17 (m, 2H), 6.90 – 6.86 (m, 2H), 4.21 – 4.17 (m, 1H), 3.80 (s, 3H), 3.73 – 3.62 (m, 2H), 3.43 – 3.31 (m, 2H), 2.31 (t, J = 7.0 Hz, 2H), 2.02 – 1.81 (m, 2H), 1.67 – 1.53 (m, 4H), 1.46 – 1.34 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.4, 134.0, 127.9, 119.8, 114.1, 82.0, 69.8, 62.2, 55.4, 37.4, 25.4, 25.2, 17.2. HRMS (ESI) calcd for $C_{15}H_{21}O_3N_1Na_1$ [M + Na]$^+$ 286.1414, found 286.1411.

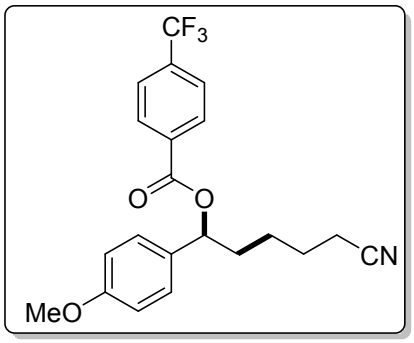
6-hydroxy-6-(4-methoxyphenyl)hexanenitrile (5):



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.22 (m, 2H), 6.91 – 6.85 (m, 2H), 4.62 (dd, J = 7.2, 6.0 Hz, 1H), 3.80 (s, 3H), 2.32 (t, J = 7.1 Hz, 2H), 1.86 – 1.78

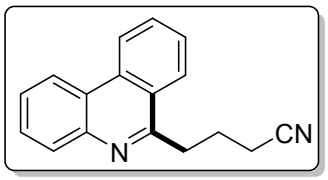
(m, 1H), 1.75 – 1.64 (m, 3H), 1.61 – 1.51 (m, 1H), 1.47 – 1.36 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2, 136.5, 127.1, 119.7, 113.9, 73.8, 55.3, 38.0, 25.3, 25.1, 17.1. HRMS (ESI) calcd for $C_{13}H_{17}O_2N_1Na_1$ $[M + Na]^+$ 242.1152, found 242.1150.

5-cyano-1-(4-methoxyphenyl)pentyl 4-(trifluoromethyl)benzoate (6):



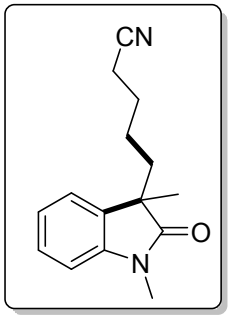
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, *J* = 8.1 Hz, 2H), 7.70 (d, *J* = 8.2 Hz, 2H), 7.37 – 7.32 (m, 2H), 6.92 – 6.88 (m, 2H), 5.95 (t, *J* = 7.0 Hz, 1H), 3.80 (s, 3H), 2.33 (t, *J* = 7.1 Hz, 2H), 2.18 – 2.08 (m, 1H), 2.00 – 1.90 (m, 1H), 1.76 – 1.67 (m, 2H), 1.63 – 1.53 (m, 1H), 1.51 – 1.40 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.8, 159.7, 134.6 (q, *J* = 32.6 Hz), 133.7, 131.9, 130.1, 128.0, 125.5 (q, *J* = 3.6 Hz), 123.7 (q, *J* = 272.9 Hz), 119.5, 114.2, 76.7, 55.4, 35.4, 25.2, 24.9, 17.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.12 (s, 3F). HRMS (ESI) calcd for $C_{21}H_{20}O_3N_1Na_1F_3$ $[M + Na]^+$ 414.1288, found 414.1286.

4-(phenanthridin-6-yl)butanenitrile (8):



^{1}H NMR (400 MHz, $CDCl_3$) δ 8.66 (d, *J* = 8.3 Hz, 1H), 8.56 (d, *J* = 8.1 Hz, 1H), 8.24 (d, *J* = 8.4 Hz, 1H), 8.12 (d, *J* = 8.1 Hz, 1H), 7.86 (t, *J* = 7.6 Hz, 1H), 7.73 (t, *J* = 7.4 Hz, 2H), 7.65 (t, *J* = 7.5 Hz, 1H), 3.54 (t, *J* = 7.2 Hz, 2H), 2.65 (t, *J* = 7.1 Hz, 2H), 2.45 – 2.38 (m, *J* = 7.1 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2, 143.5, 133.0, 130.8, 129.7, 128.9, 127.7, 126.9, 125.7, 125.3, 123.8, 122.8, 122.1, 120.0, 33.5, 23.9, 17.1. HRMS (ESI) calcd for $C_{17}H_{15}N_2$ $[M + H]^+$ 247.1230, found 247.1226.

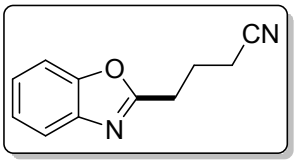
5-(1,3-dimethyl-2-oxoindolin-3-yl)pentanenitrile (10):



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (td, *J* = 7.7, 1.3 Hz, 1H), 7.16 (dd, *J* = 7.3, 0.8 Hz, 1H), 7.07 (td, *J* = 7.5, 1.0 Hz, 1H), 6.85 (d, *J* = 7.8 Hz, 1H), 3.21 (s, 3H), 2.28 – 2.13 (m, 2H), 1.96 – 1.87 (m,

1H), 1.78 – 1.74 (m, 1H), 1.60 – 1.46 (m, 2H), 1.35 (s, 3H), 1.16 – 0.95 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 180.5, 143.3, 133.6, 128.0, 122.8, 122.5, 119.5, 108.2, 48.3, 37.5, 26.3, 25.5, 24.0, 23.9, 17.0. HRMS (ESI) calcd for $C_{15}H_{19}O_1N_2$ $[M + H]^+$ 243.1492, found 243.1489.

4-(benzo[d]oxazol-2-yl)butanenitrile (12):



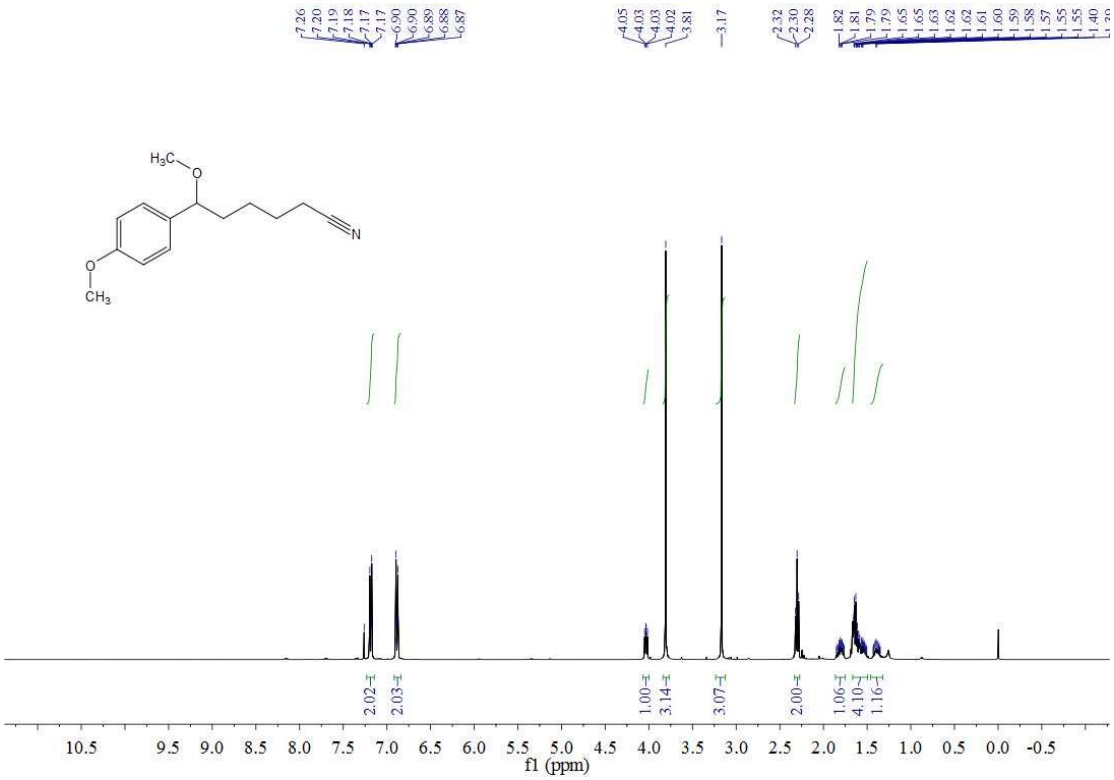
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 – 7.65 (m, 1H), 7.52 – 7.47 (m, 1H), 7.35 – 7.29 (m, 2H), 3.11 (t, *J* = 7.1 Hz, 2H), 2.60 (t, *J* = 7.1 Hz, 2H), 2.28 (p, *J* = 7.1 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.8, 150.9, 141.2, 125.1, 124.5, 119.8, 119.0, 110.6, 27.2, 22.6, 16.7. HRMS (ESI) calcd for $C_{11}H_{11}O_1N_2$ $[M + H]^+$ 187.0866, found 187.0859.

Reference

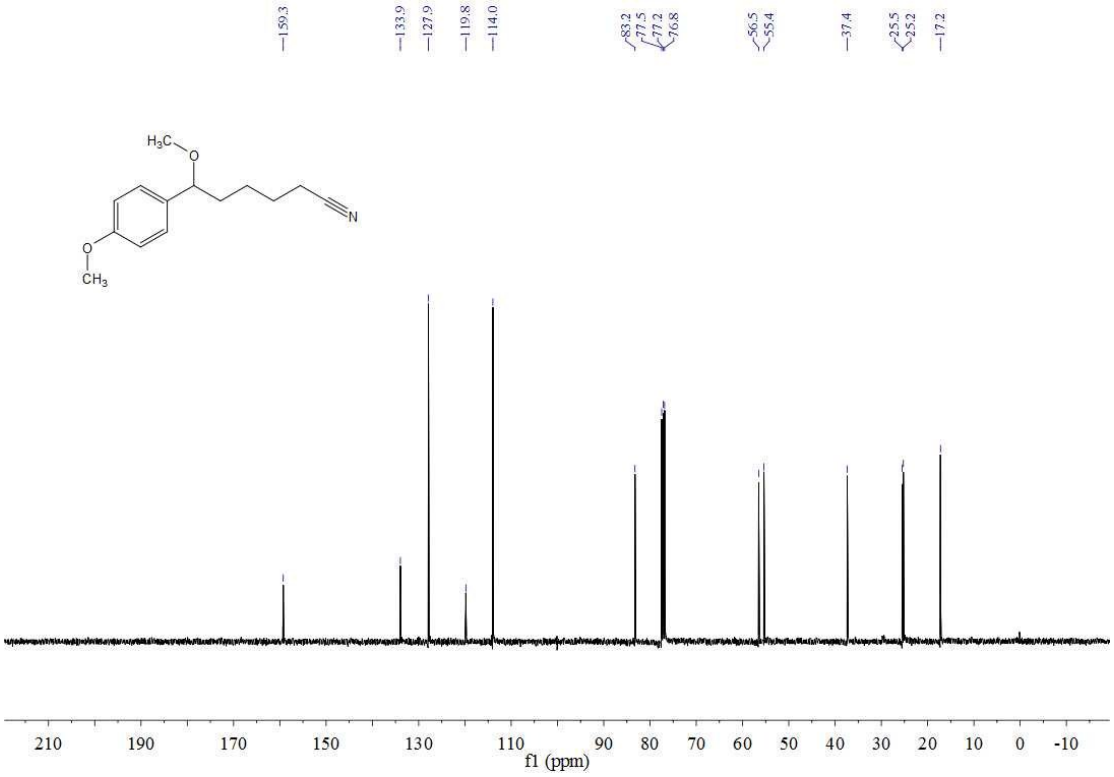
[1] J. Ramnauth and E. Lee-Ruff, *Can. J. Chem*., 2001, **79**, 114–120.

[2] T. Nishimura, Y. Nishiguchi, Y. Maeda and S. Uemura, *J. Org. Chem*., 2004, **69**, 5342–5347.

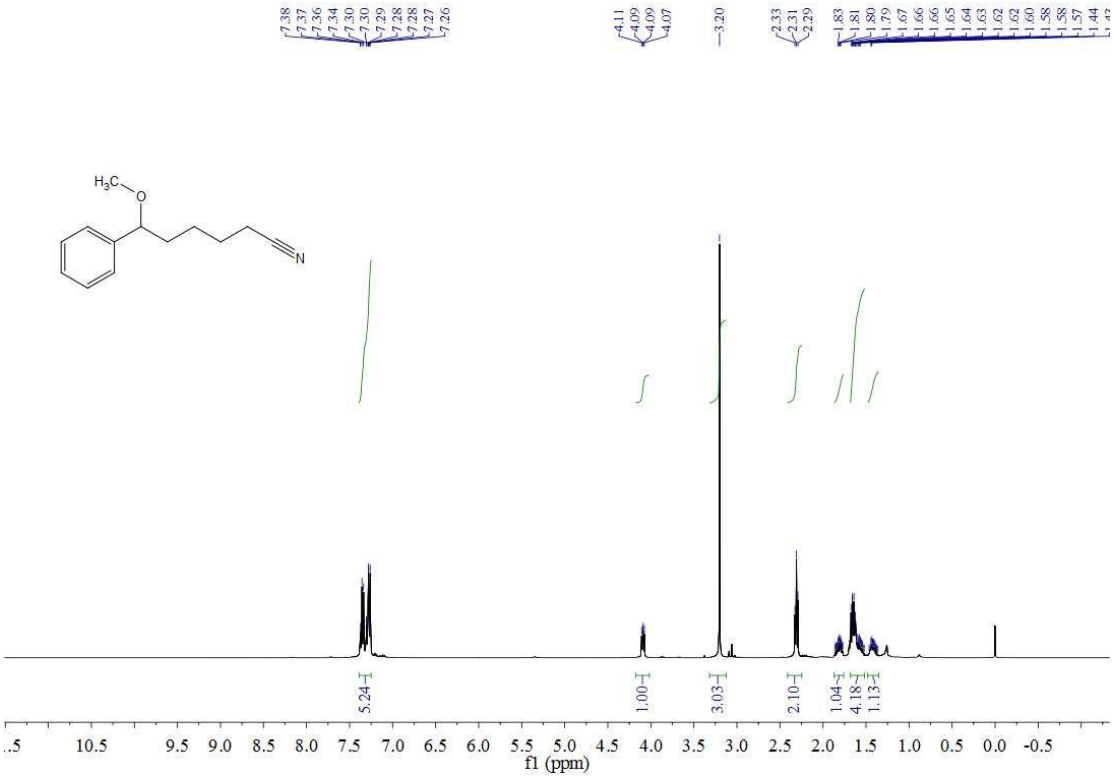
^{1}H NMR, ^{13}C NMR spectra



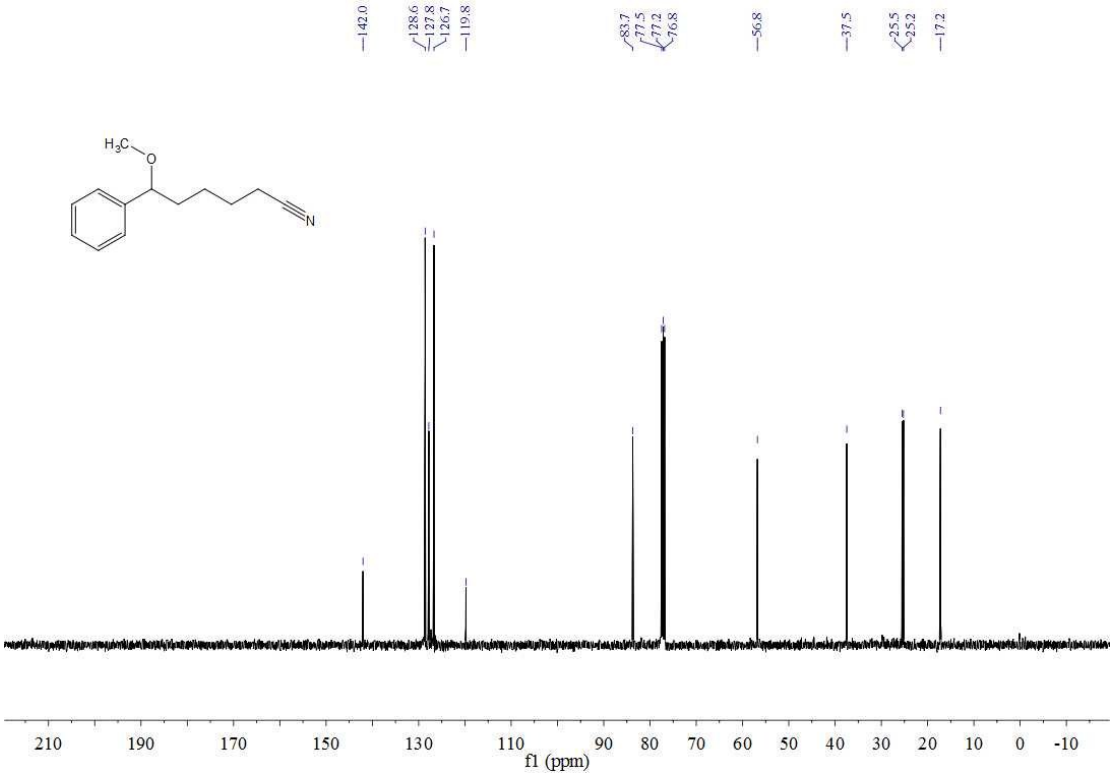
^{1}H NMR of **4a**



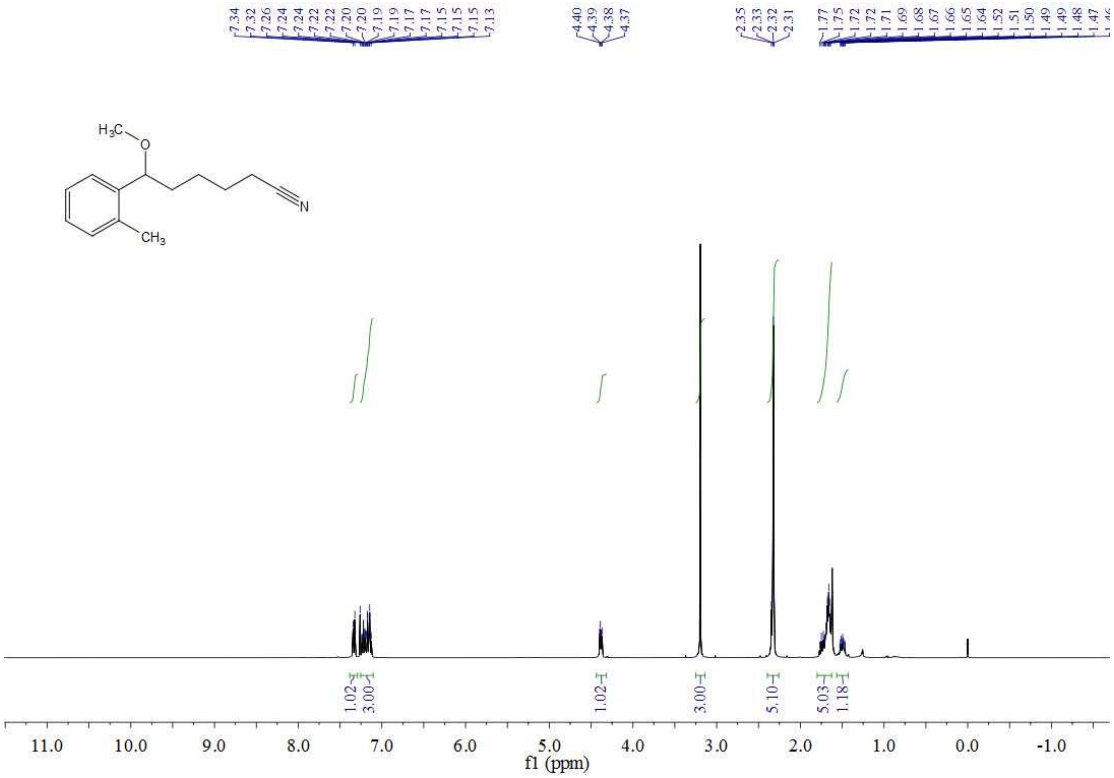
^{13}C NMR of **4a**



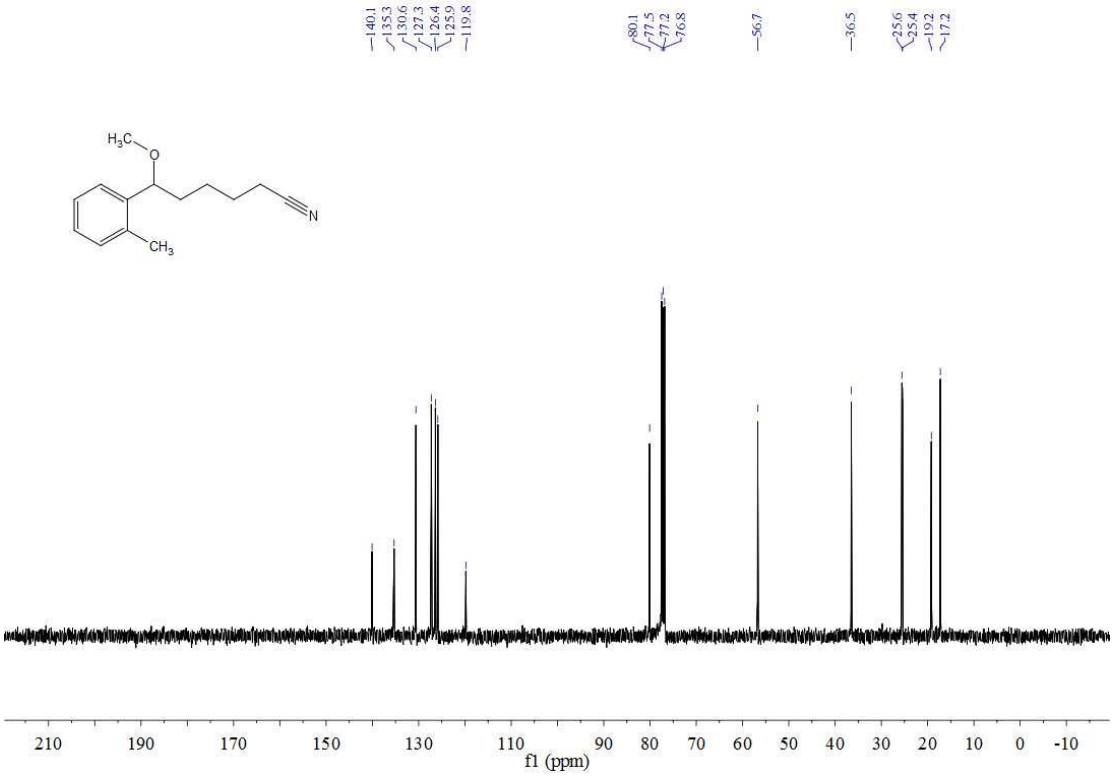
^{1}H NMR of **4b**



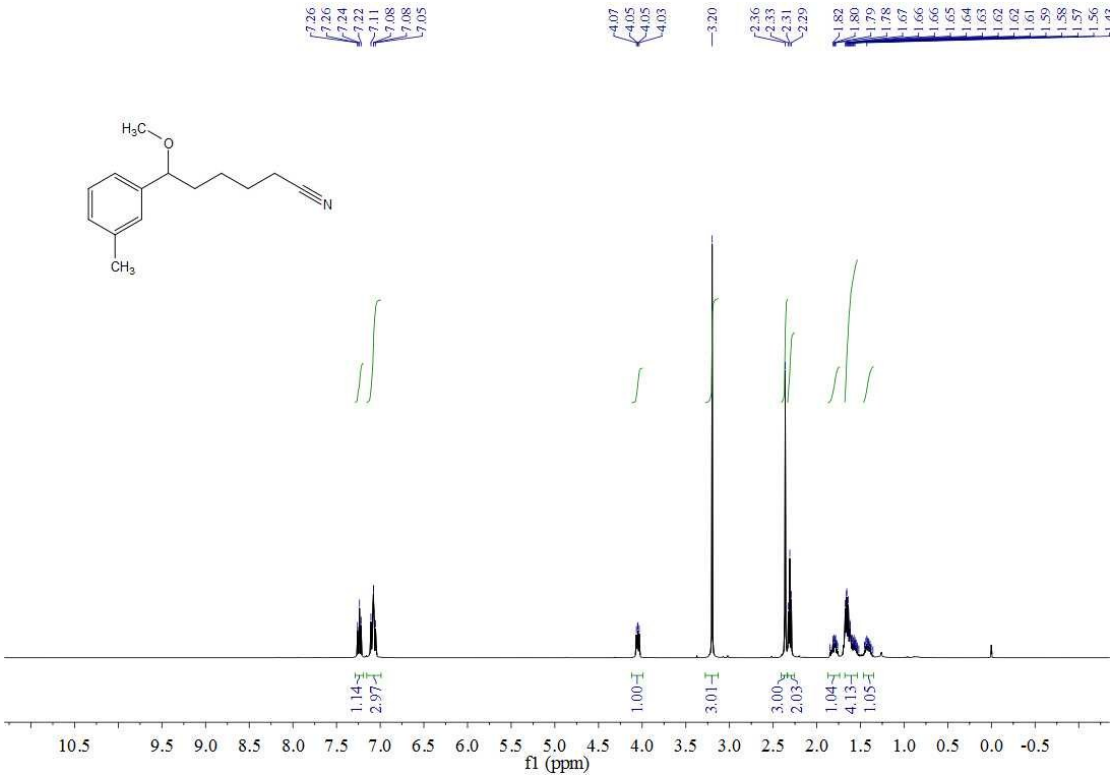
^{13}C NMR of **4b**



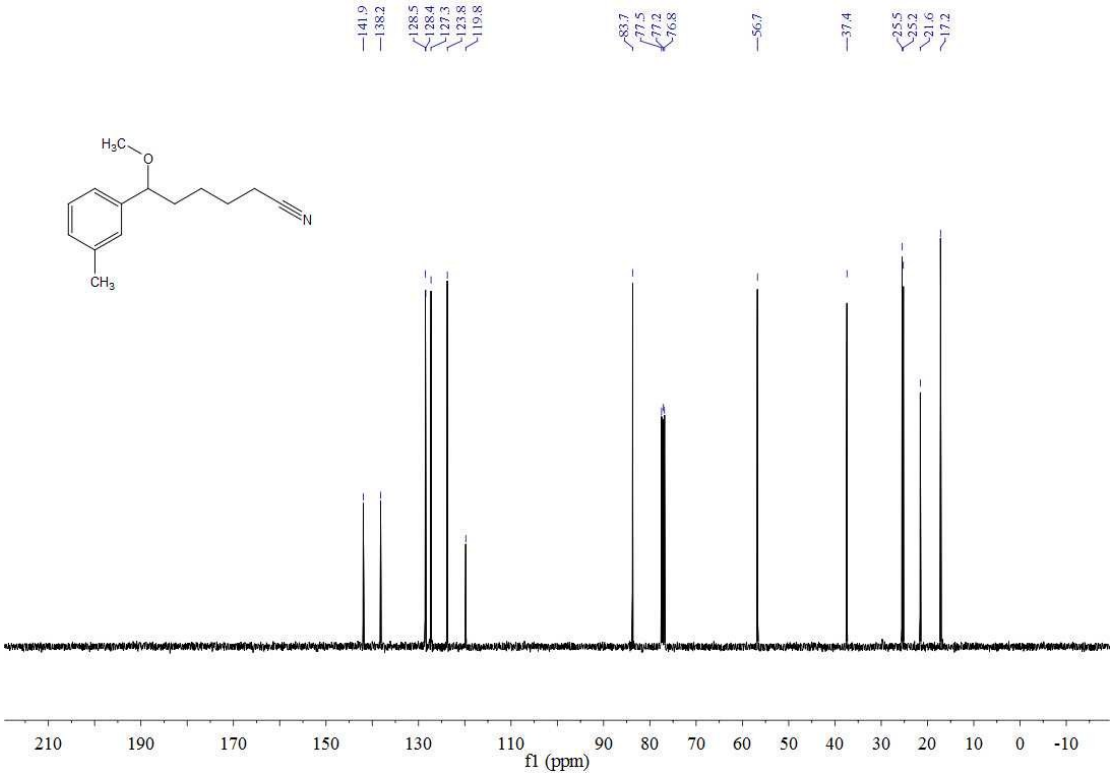
^{1}H NMR of **4c**



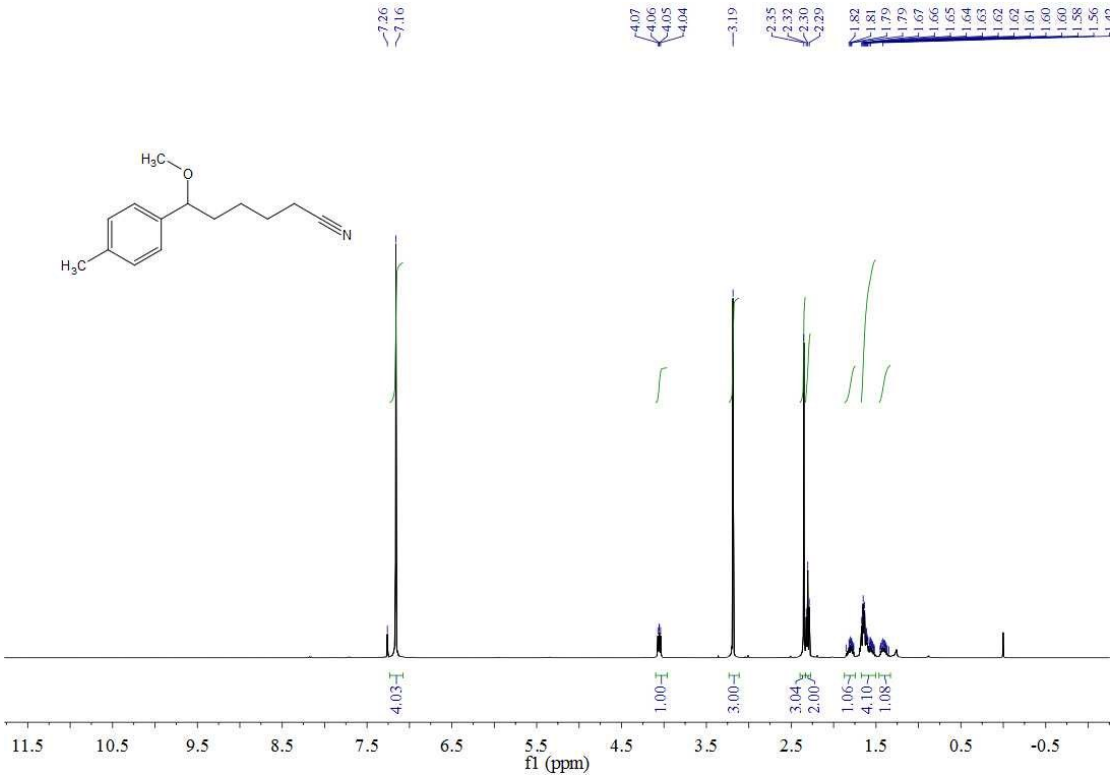
^{13}C NMR of **4c**



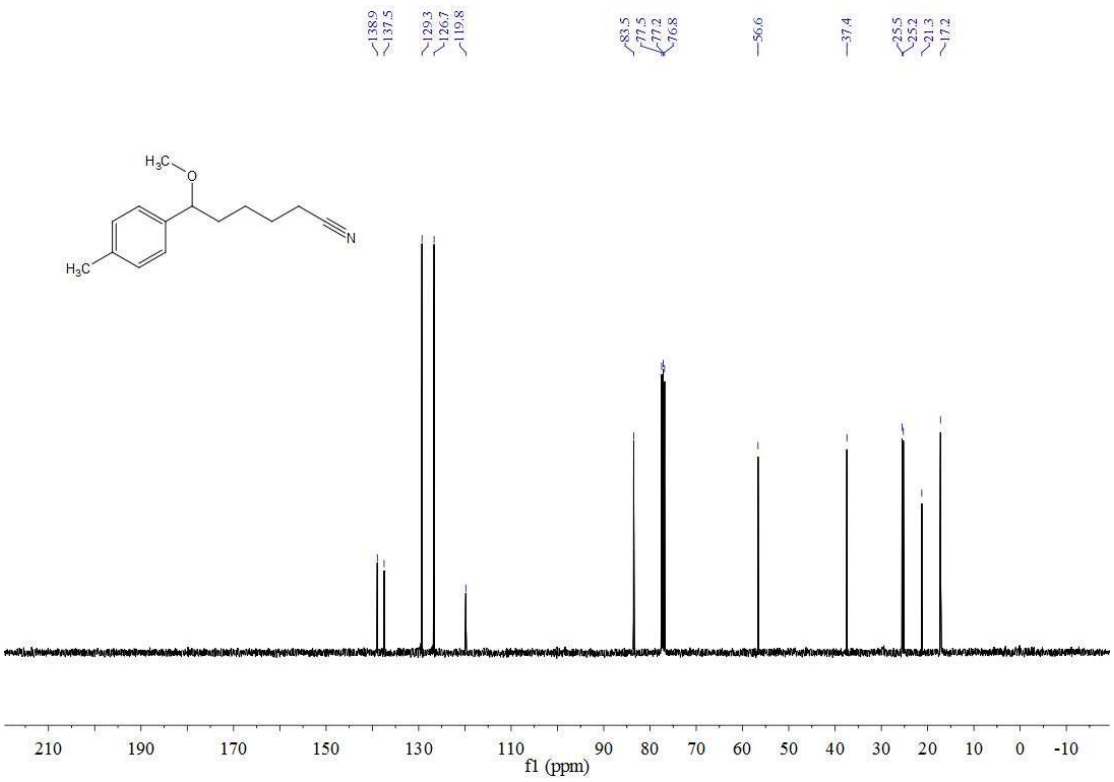
^{1}H NMR of **4d**



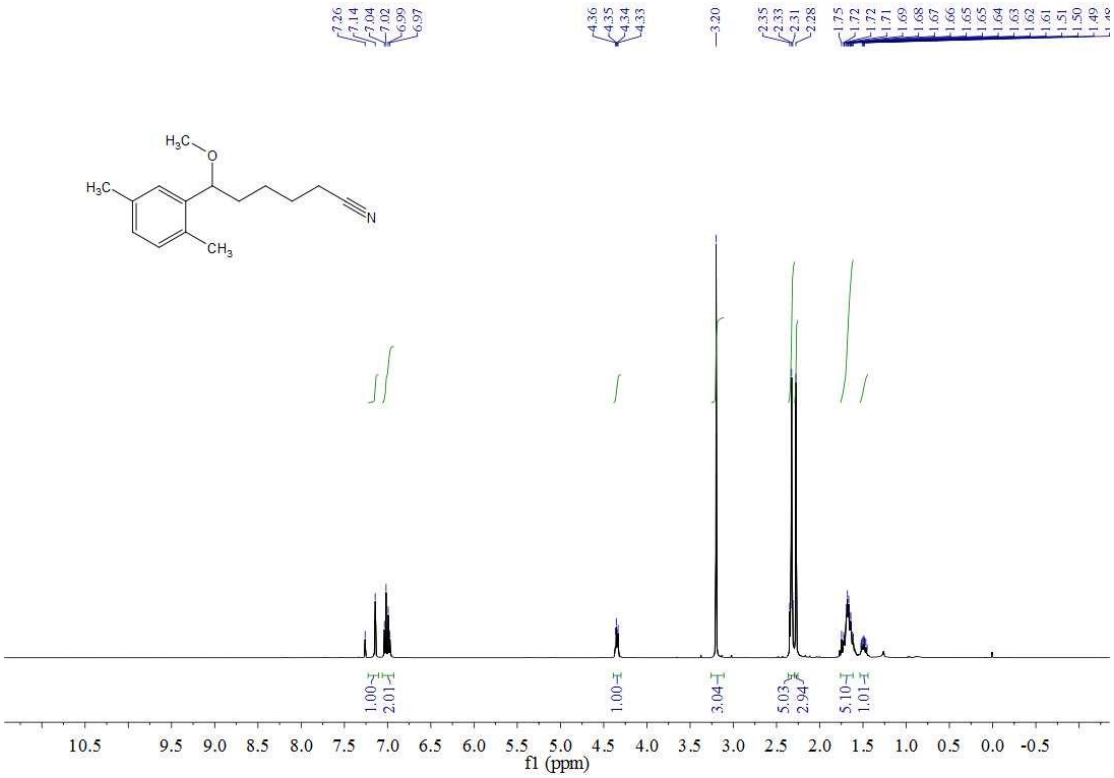
^{13}C NMR of **4d**



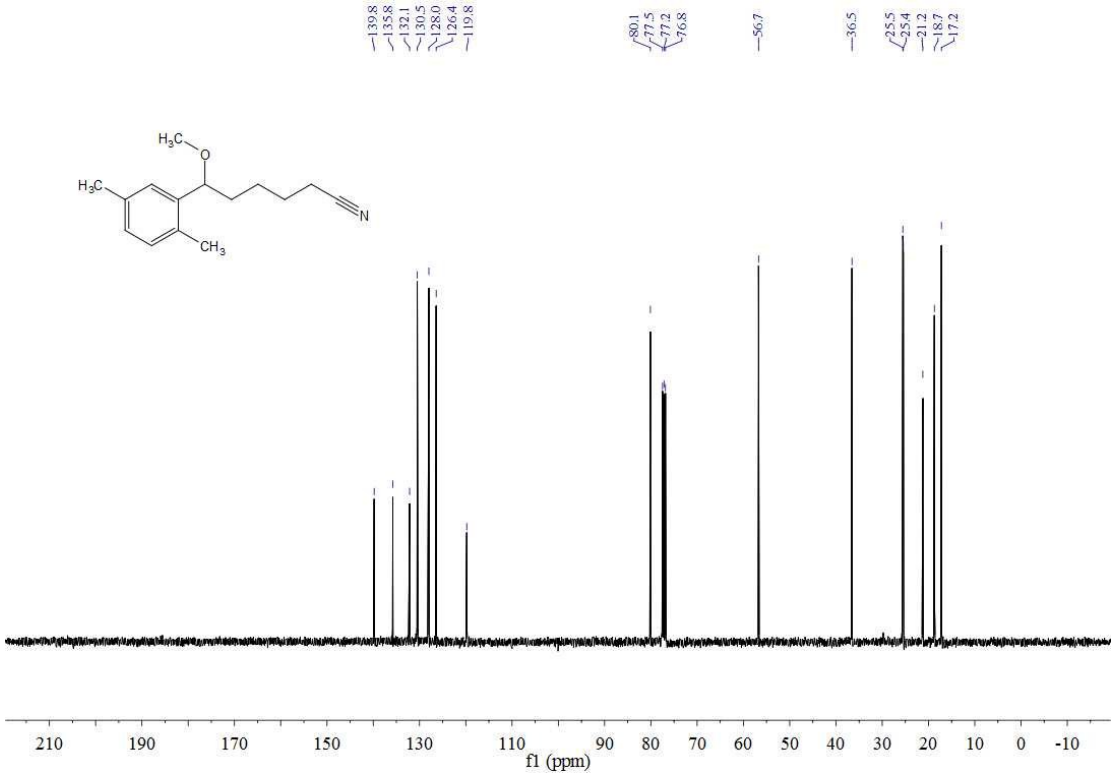
^{1}H NMR of **4e**



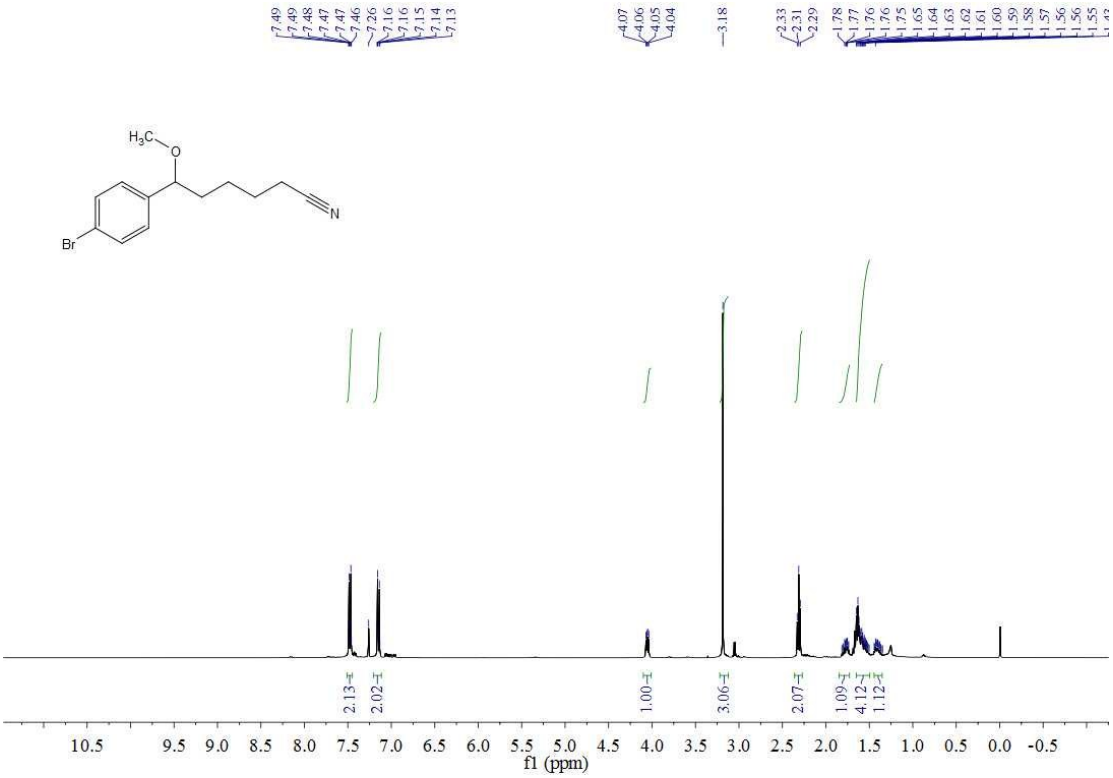
^{13}C NMR of **4e**



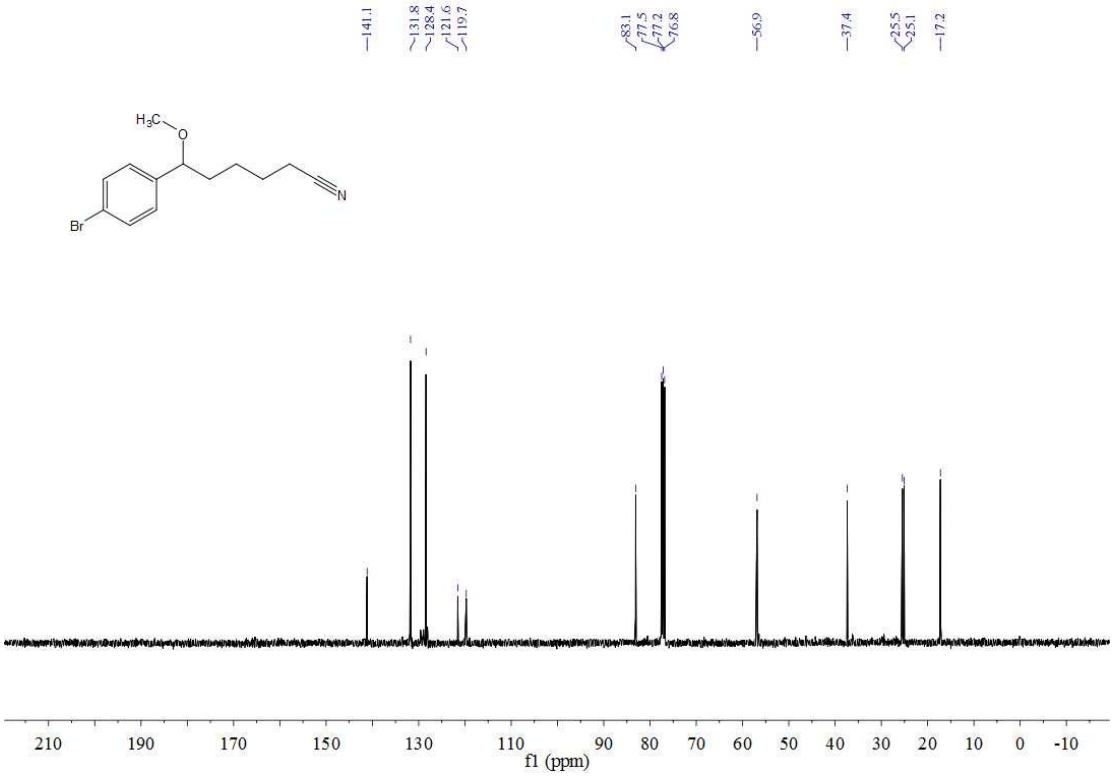
^{1}H NMR of **4f**



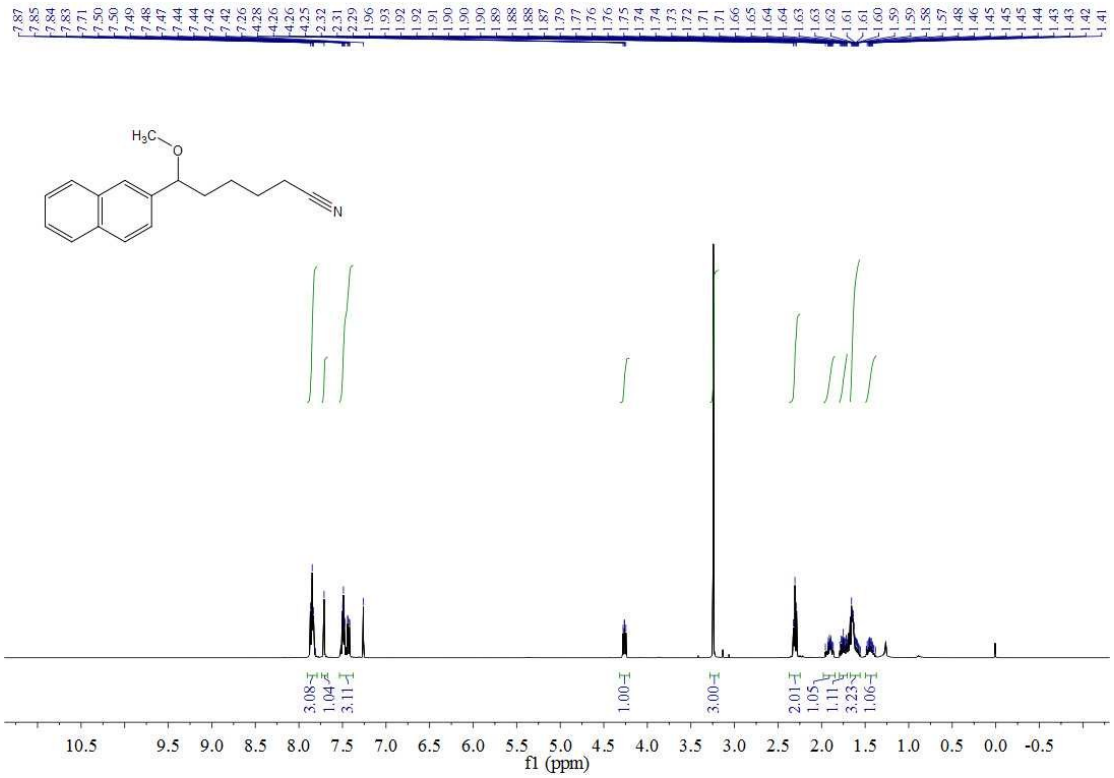
^{13}C NMR of **4f**



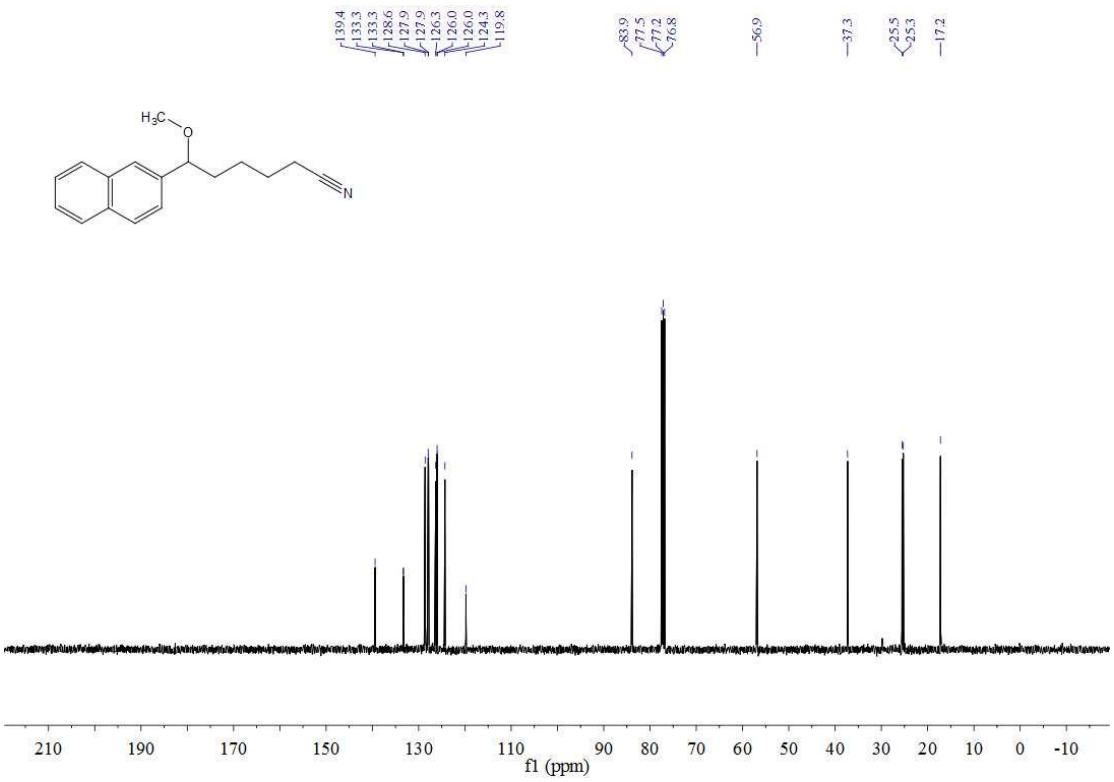
^{1}H NMR of **4g**



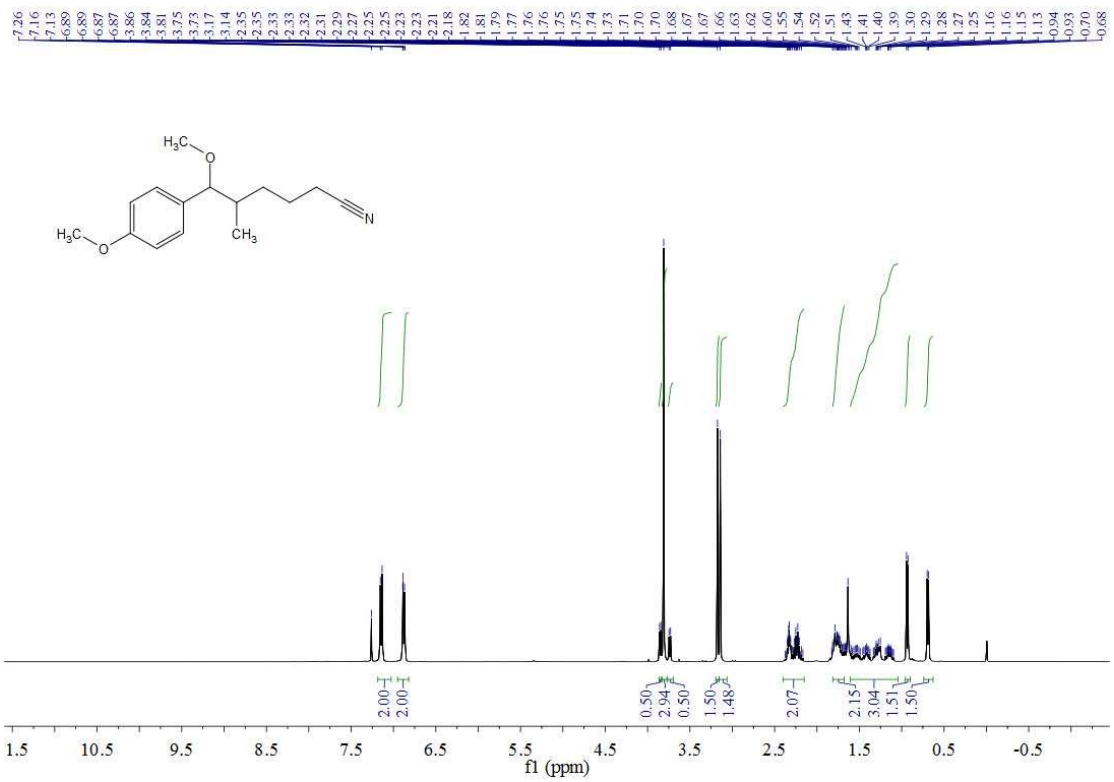
^{13}C NMR of **4g**



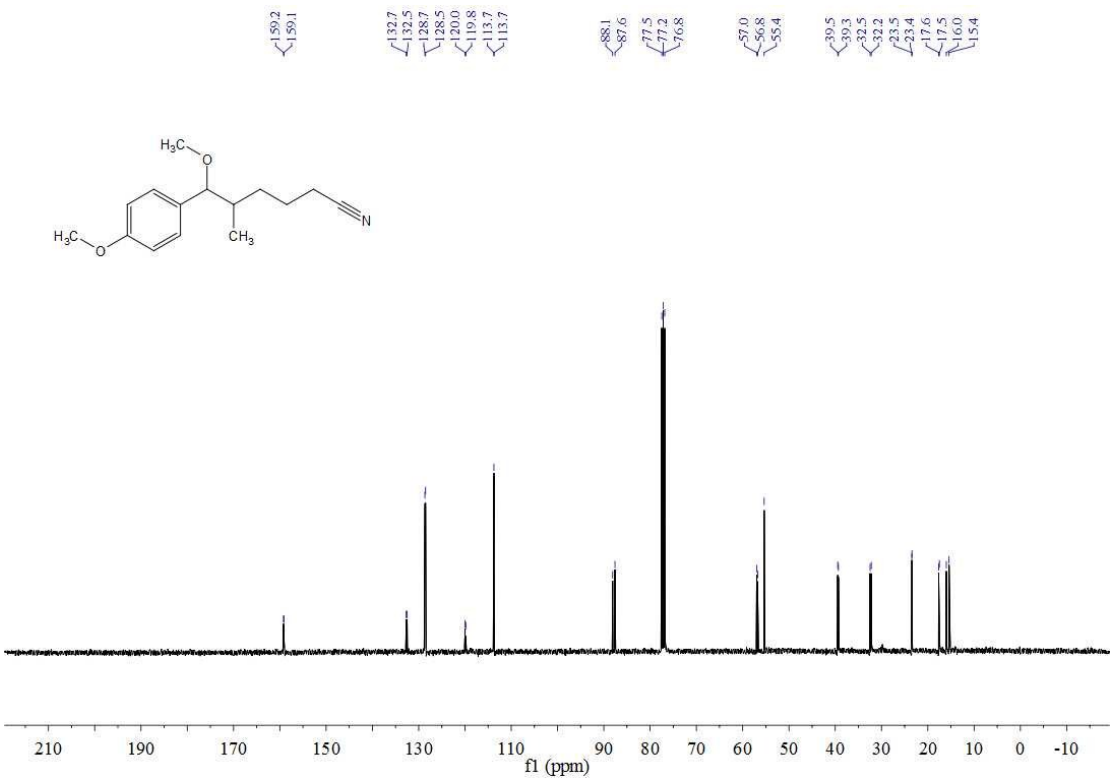
^{1}H NMR of **4h**



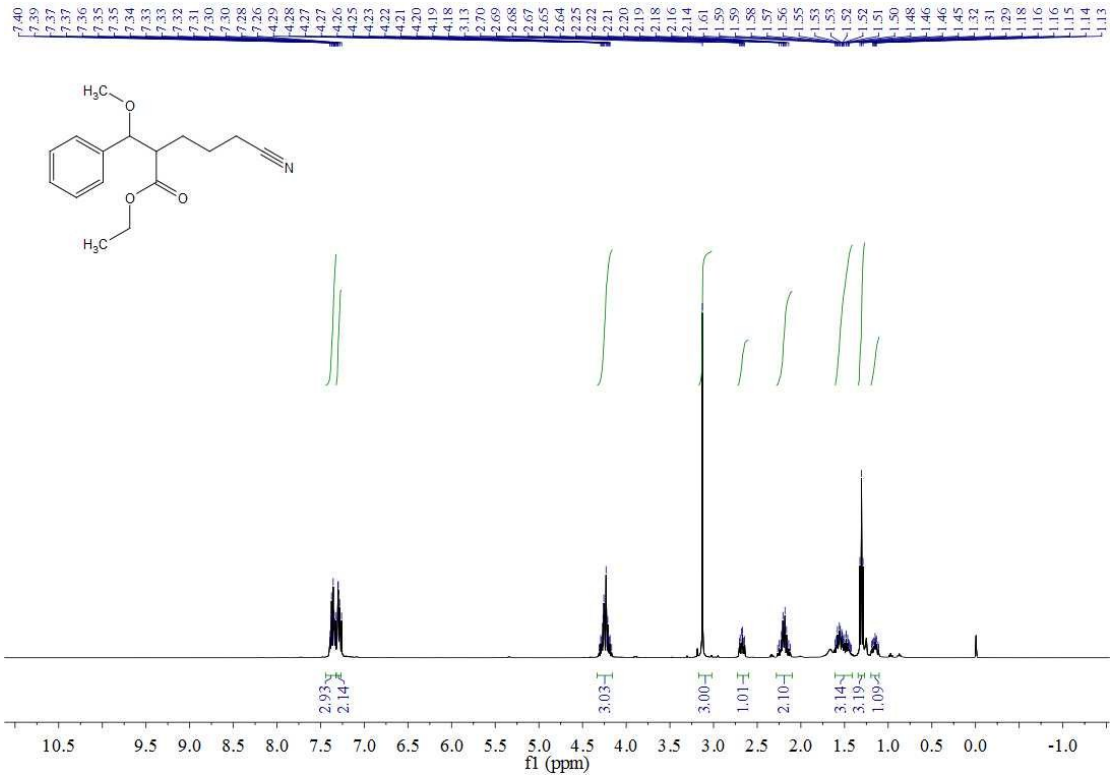
^{13}C NMR of **4h**



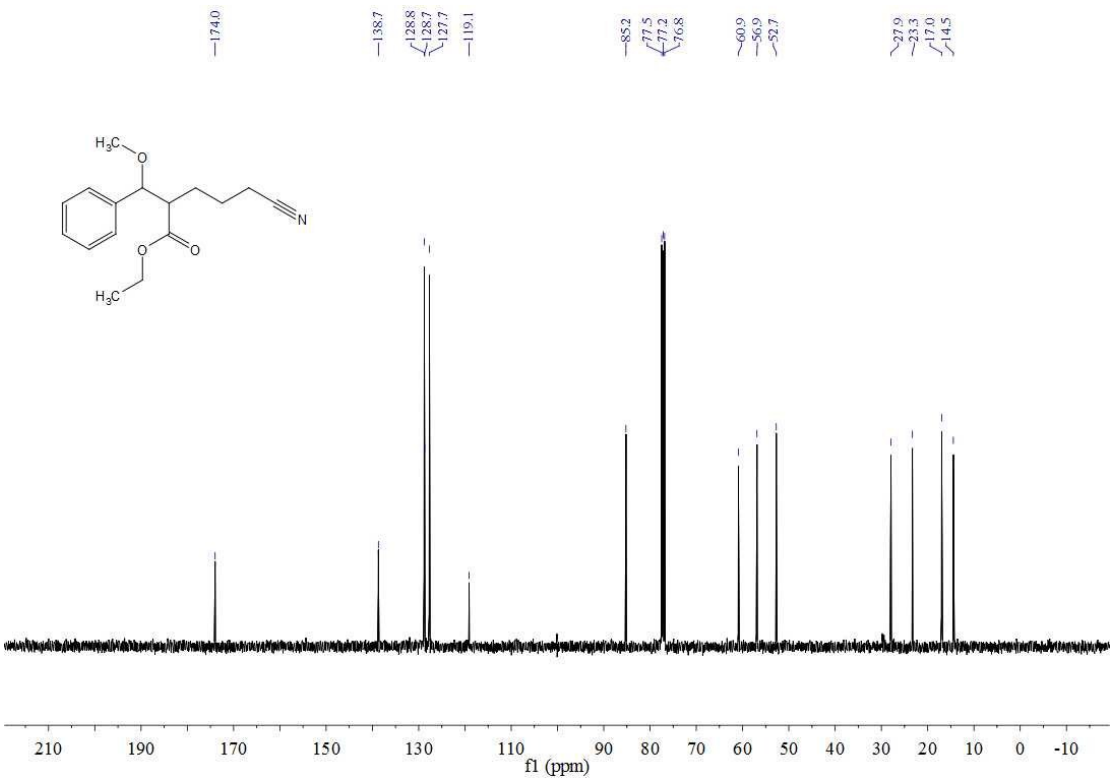
^{1}H NMR of **4i**



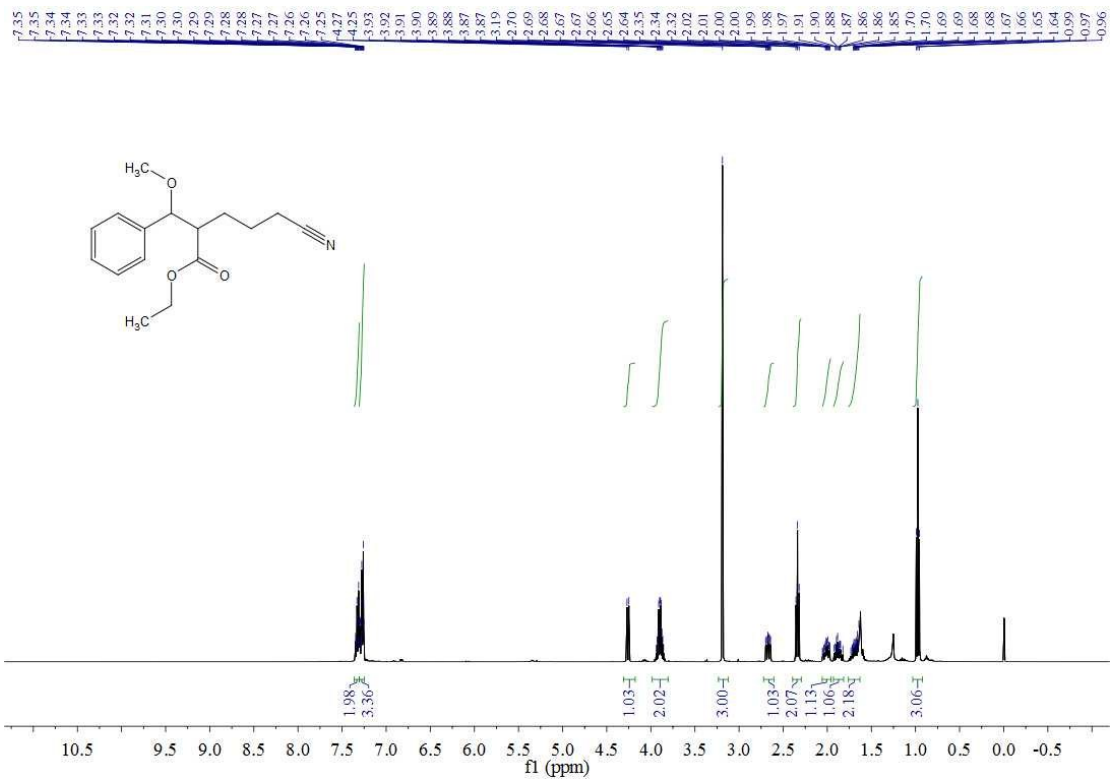
^{13}C NMR of **4i**



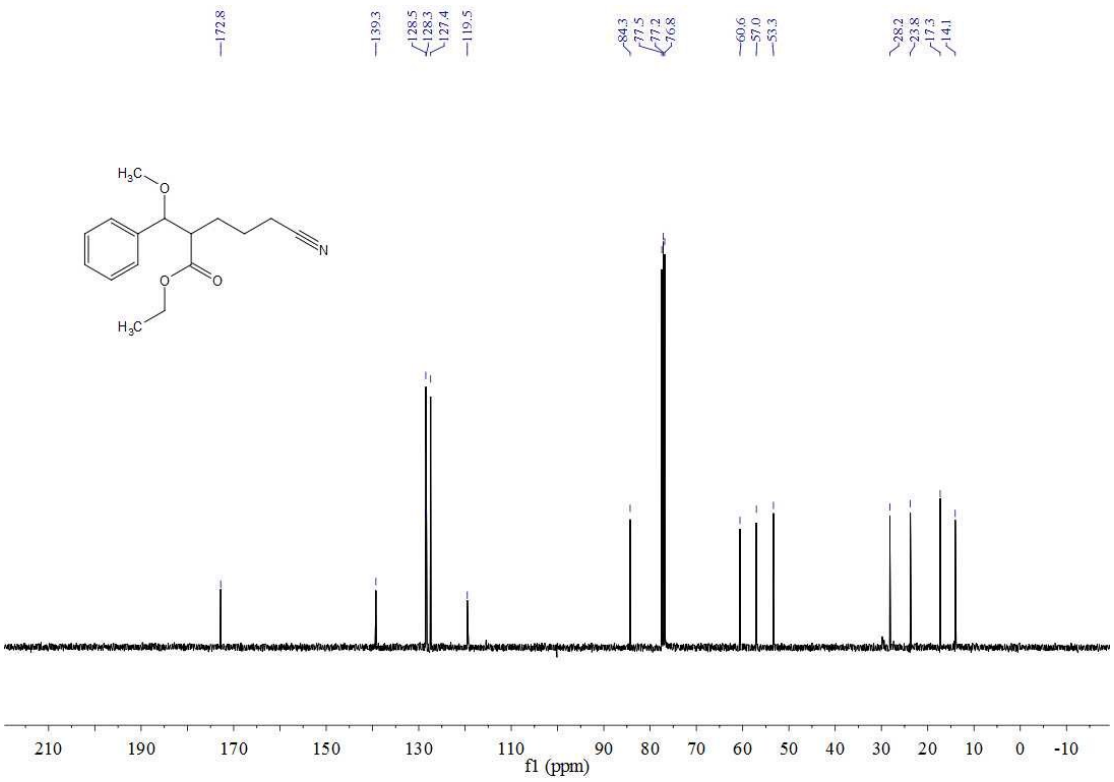
^{1}H NMR of **4j** (major diastereomer)



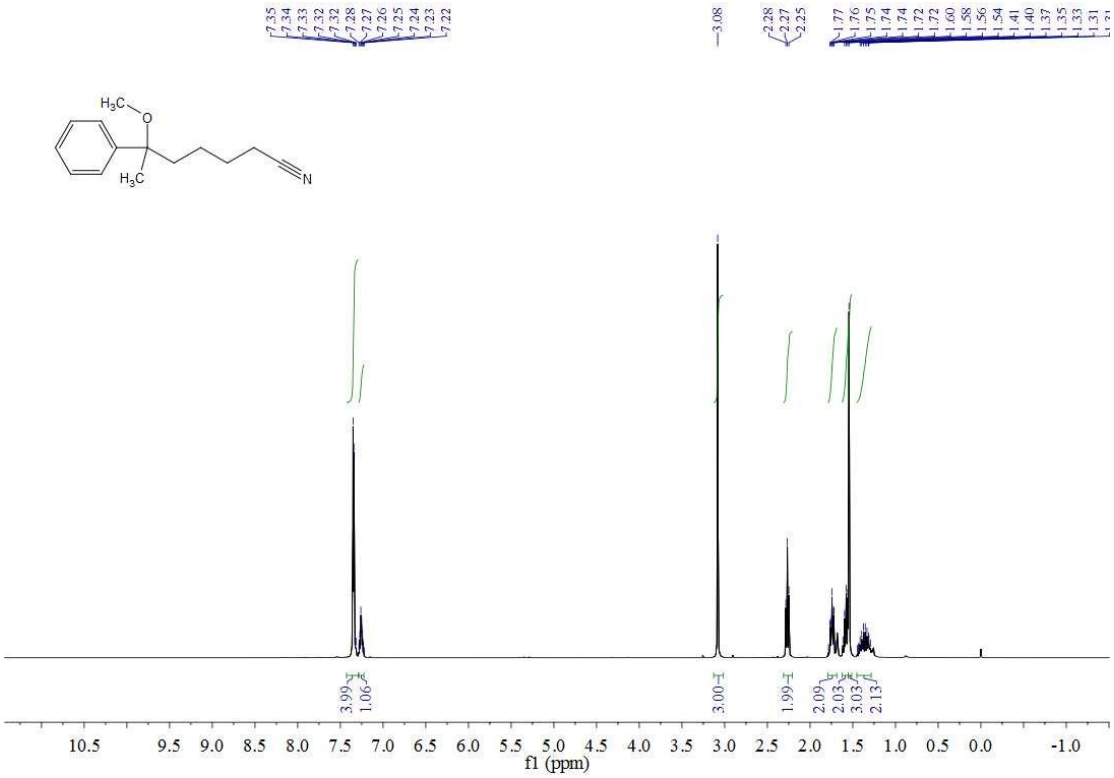
^{13}C NMR of **4j** (major diastereomer)



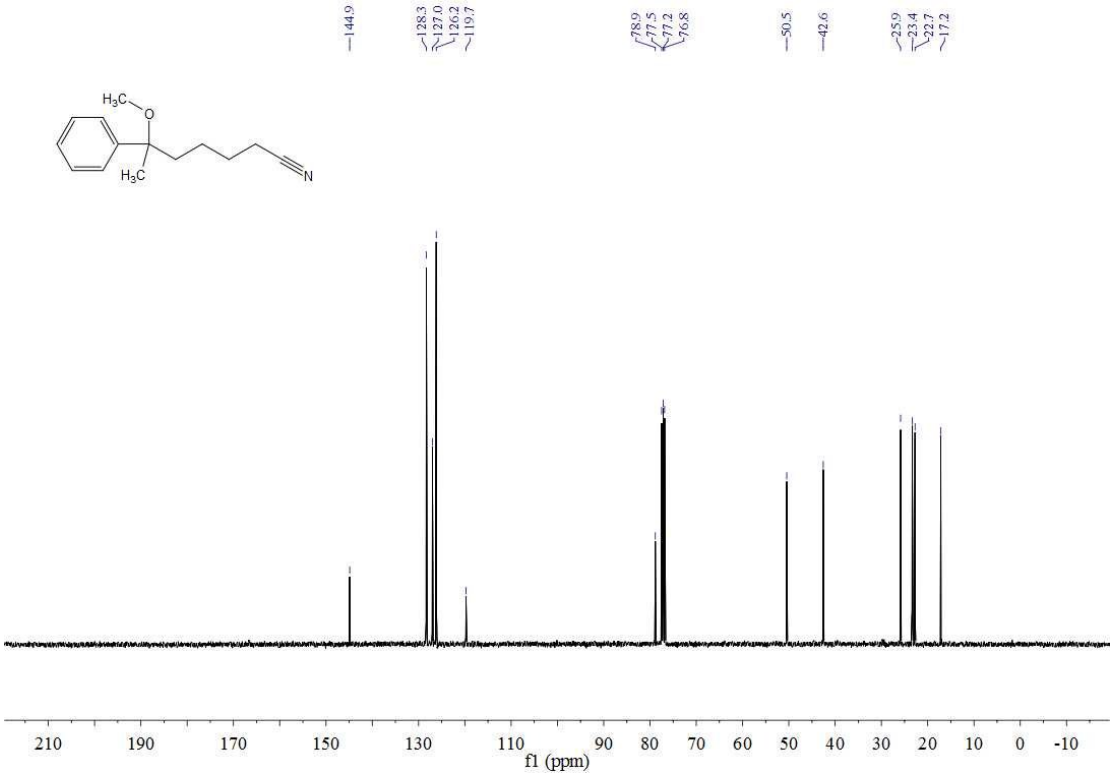
^{1}H NMR of **4j'** (minor diastereomer)



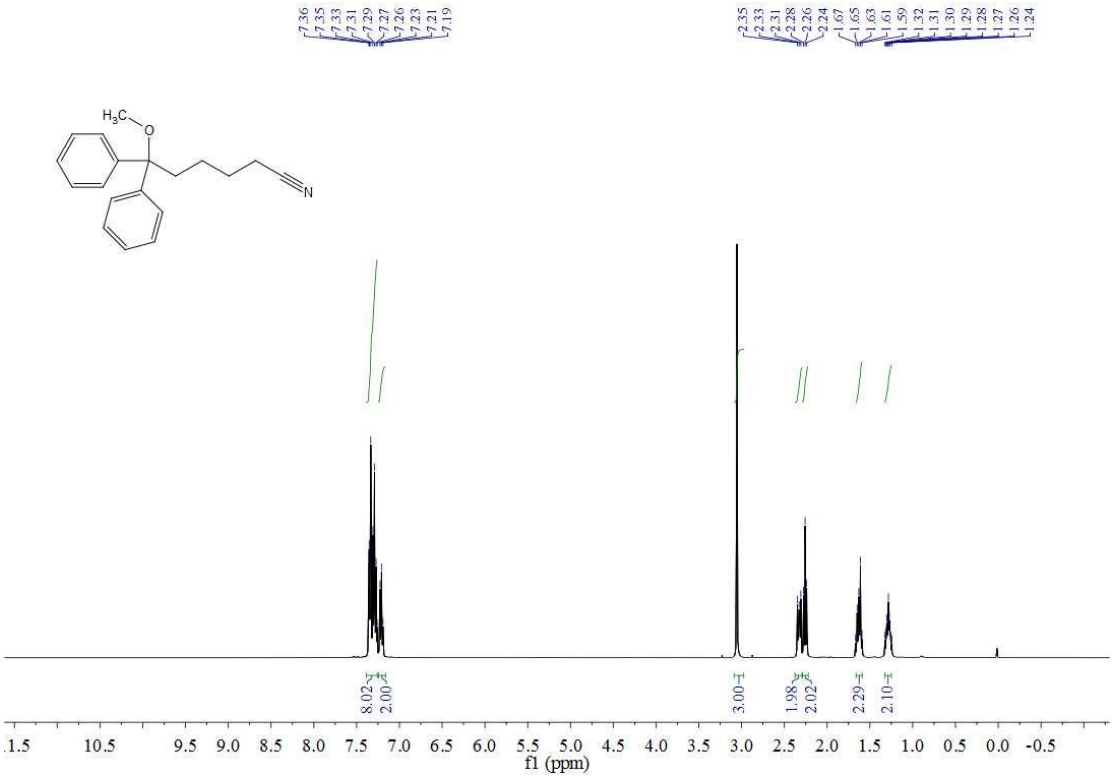
^{13}C NMR of **4j'** (minor diastereomer)



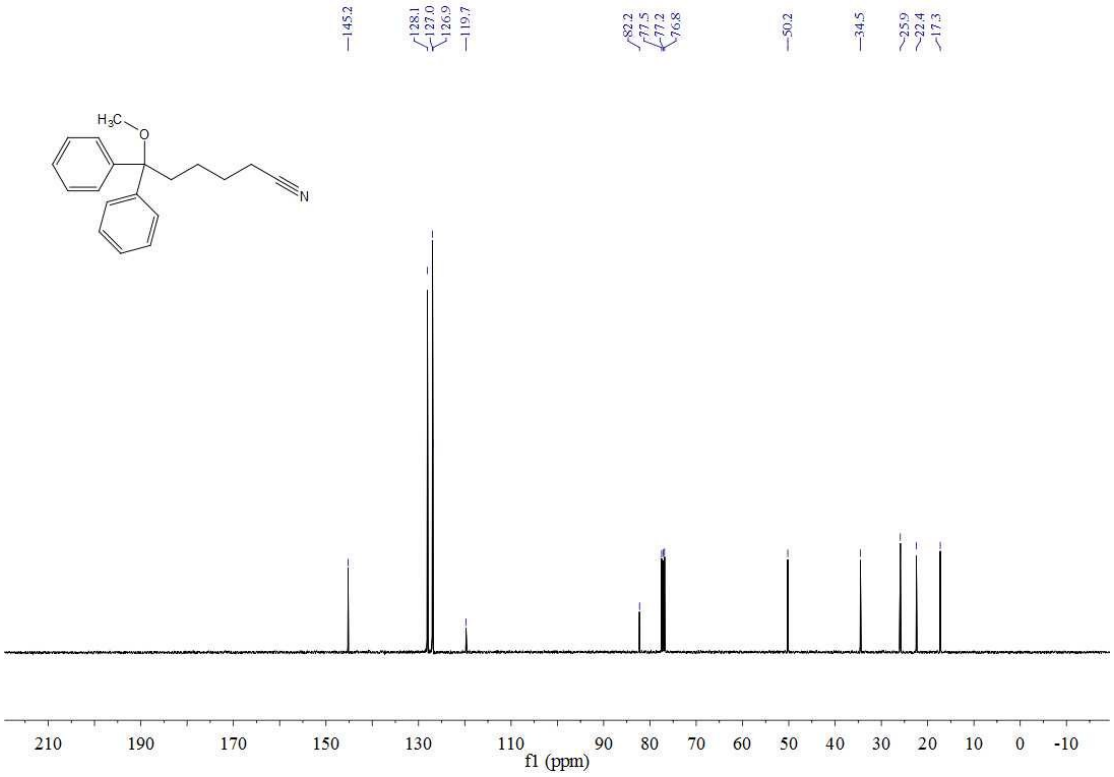
^{1}H NMR of **4k**



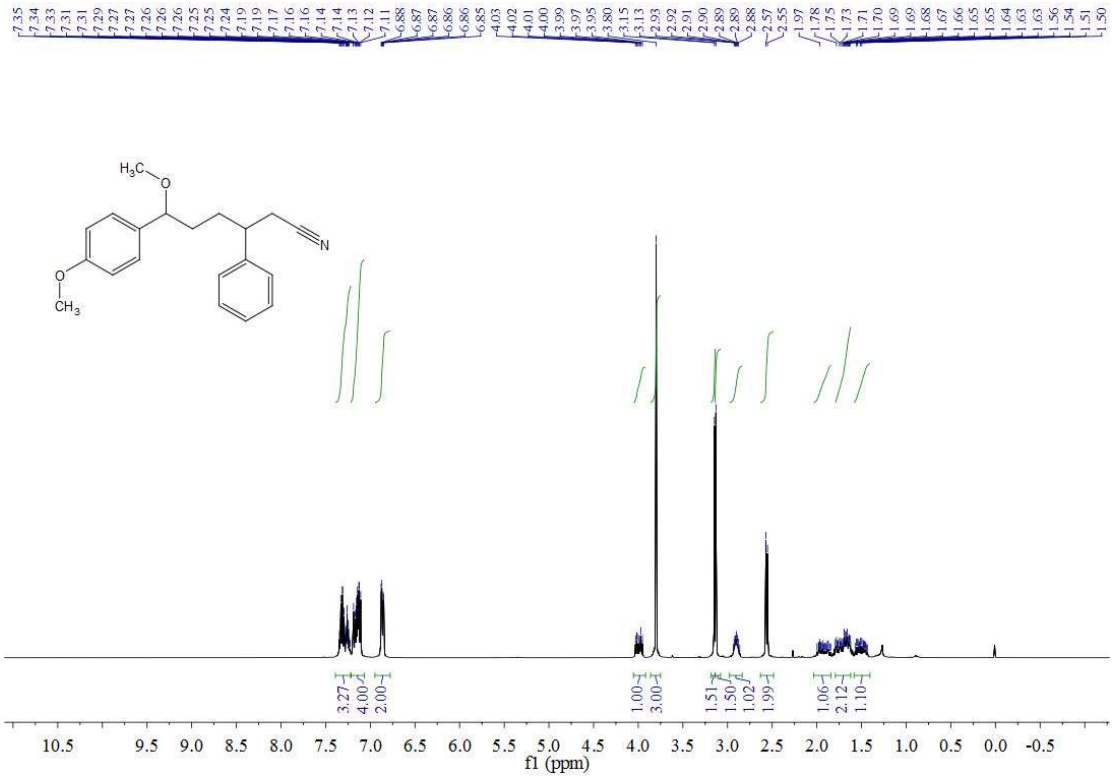
^{13}C NMR of **4k**



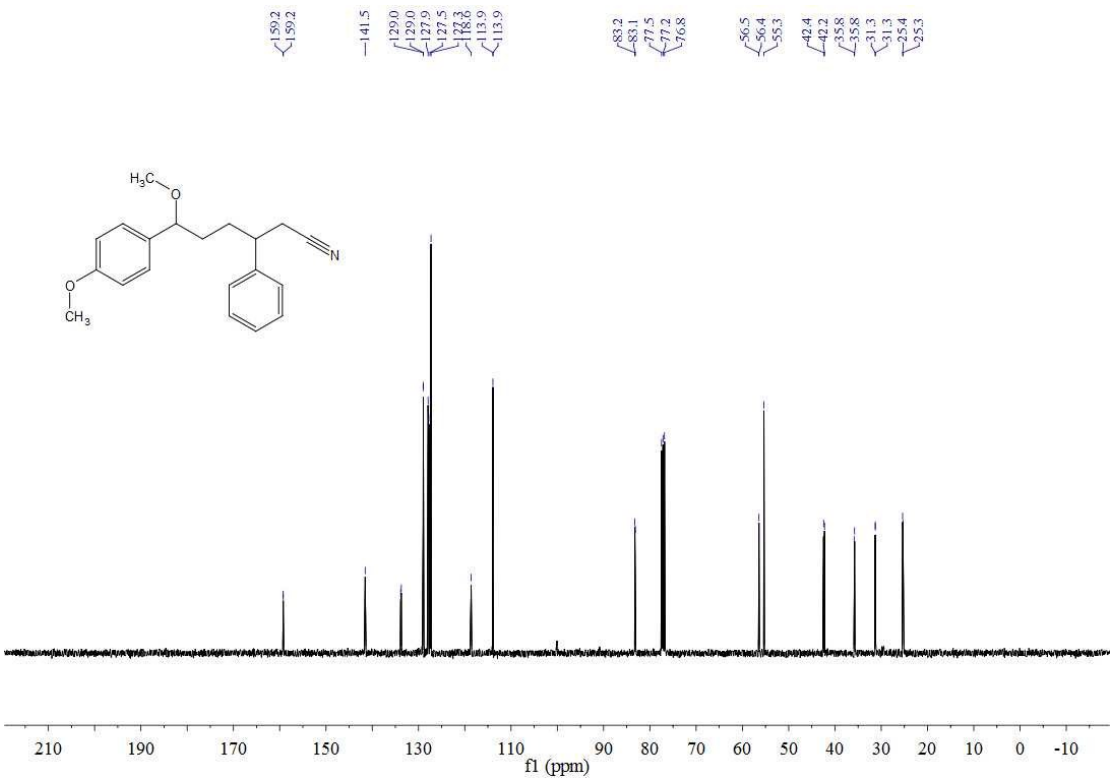
^{1}H NMR of **4l**



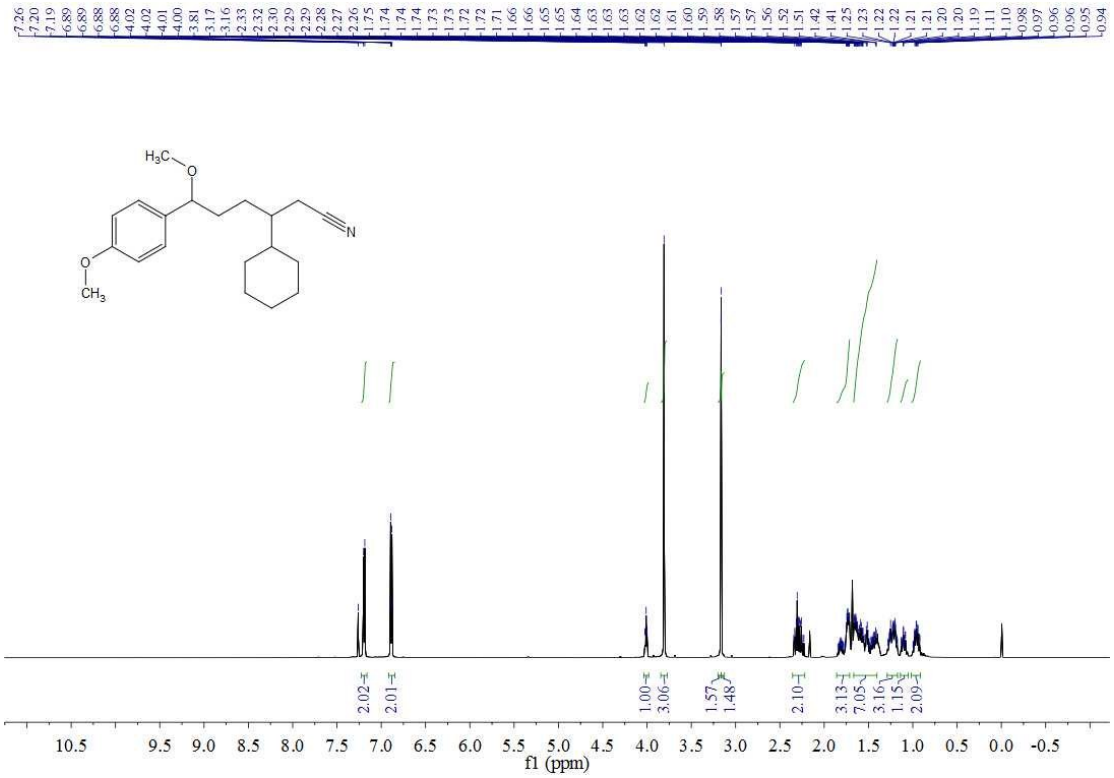
^{13}C NMR of **4l**



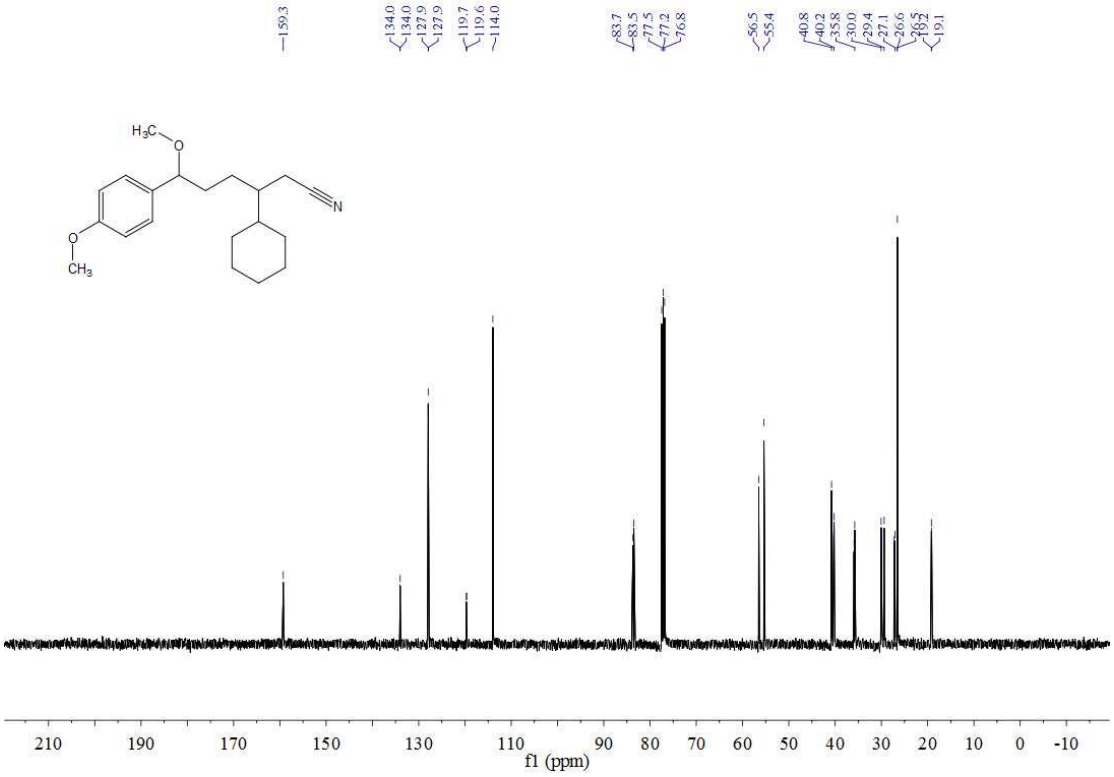
^{1}H NMR of **4m**



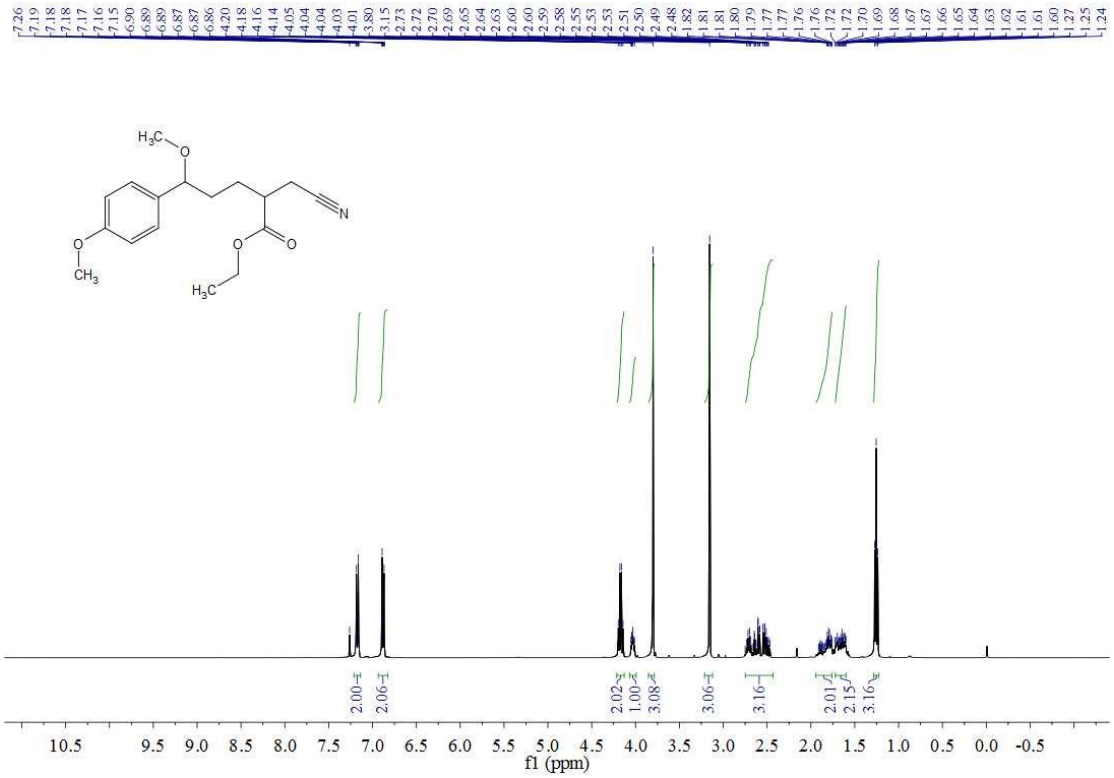
^{13}C NMR of **4m**



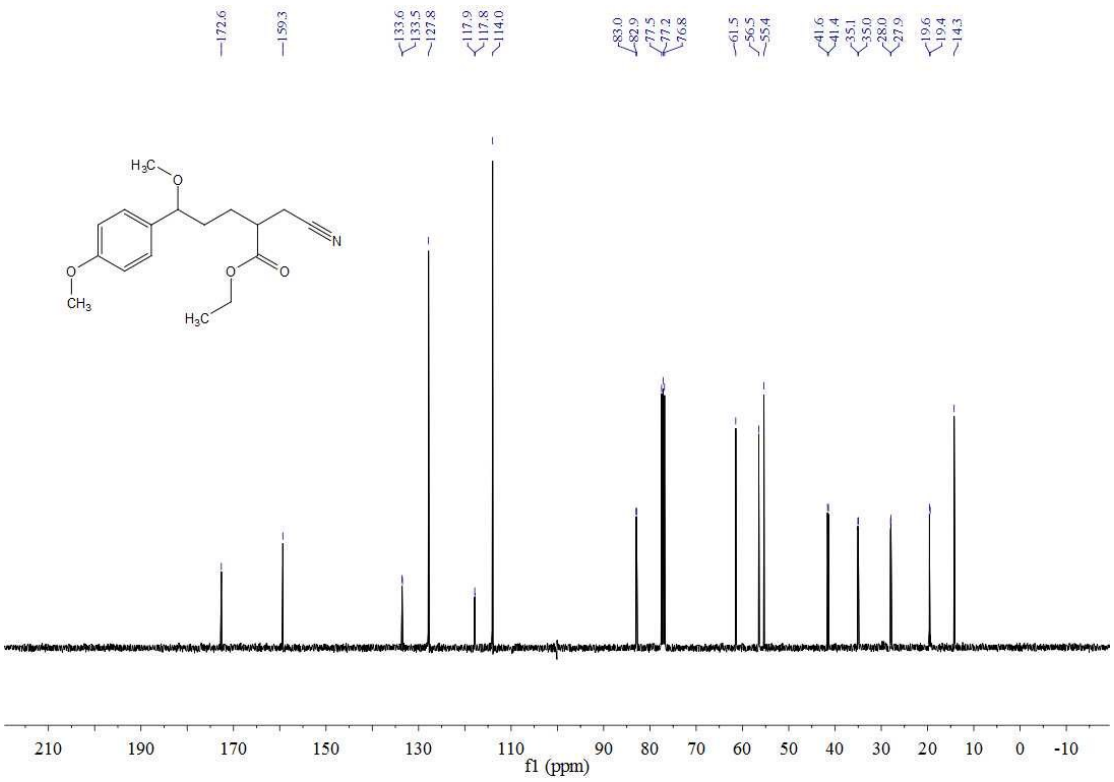
^{1}H NMR of **4n**



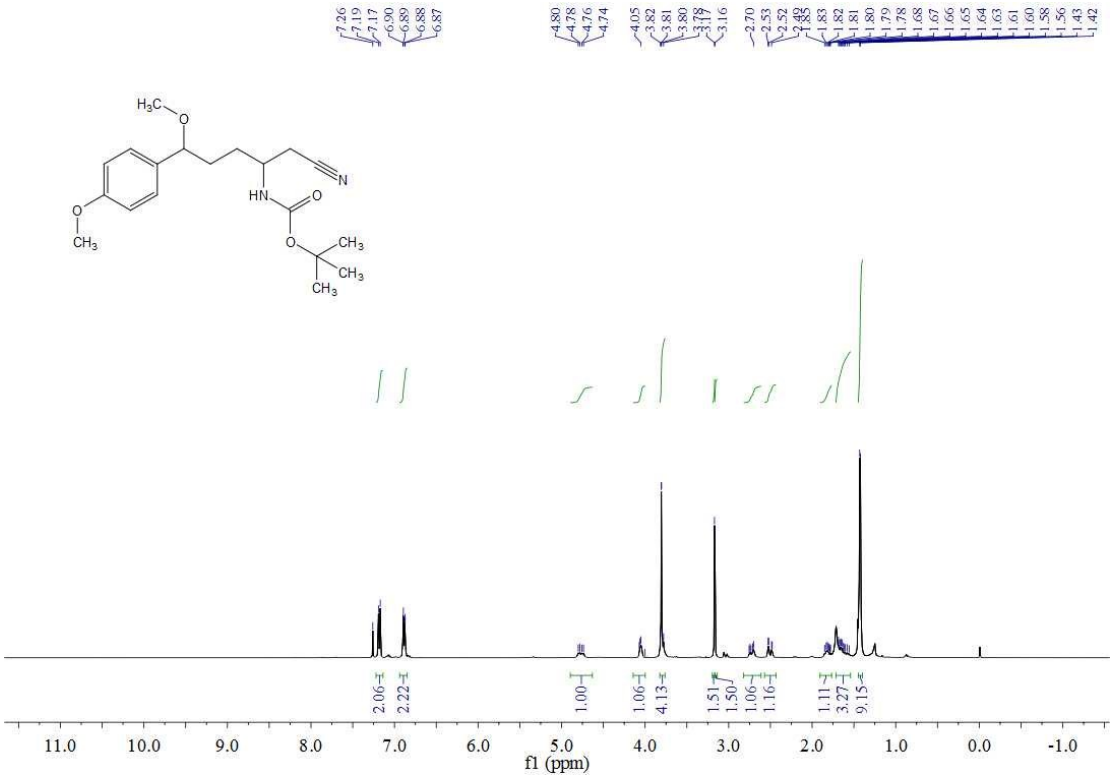
^{13}C NMR of **4n**



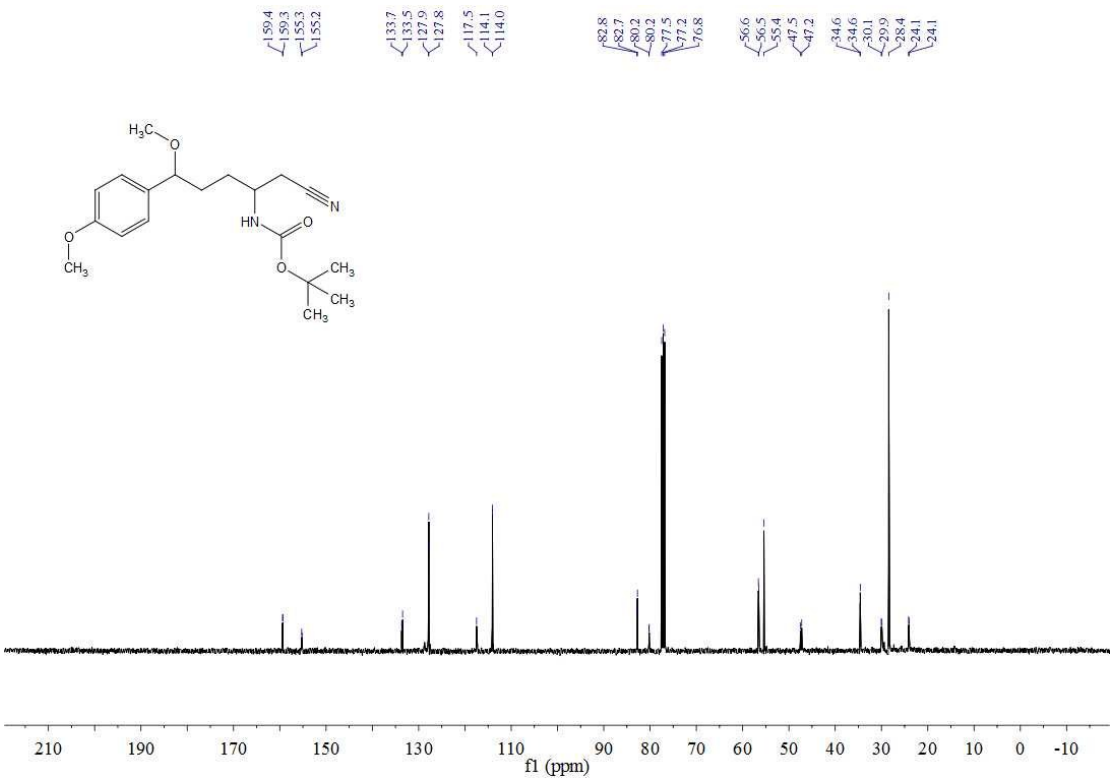
^{1}H NMR of **4o**



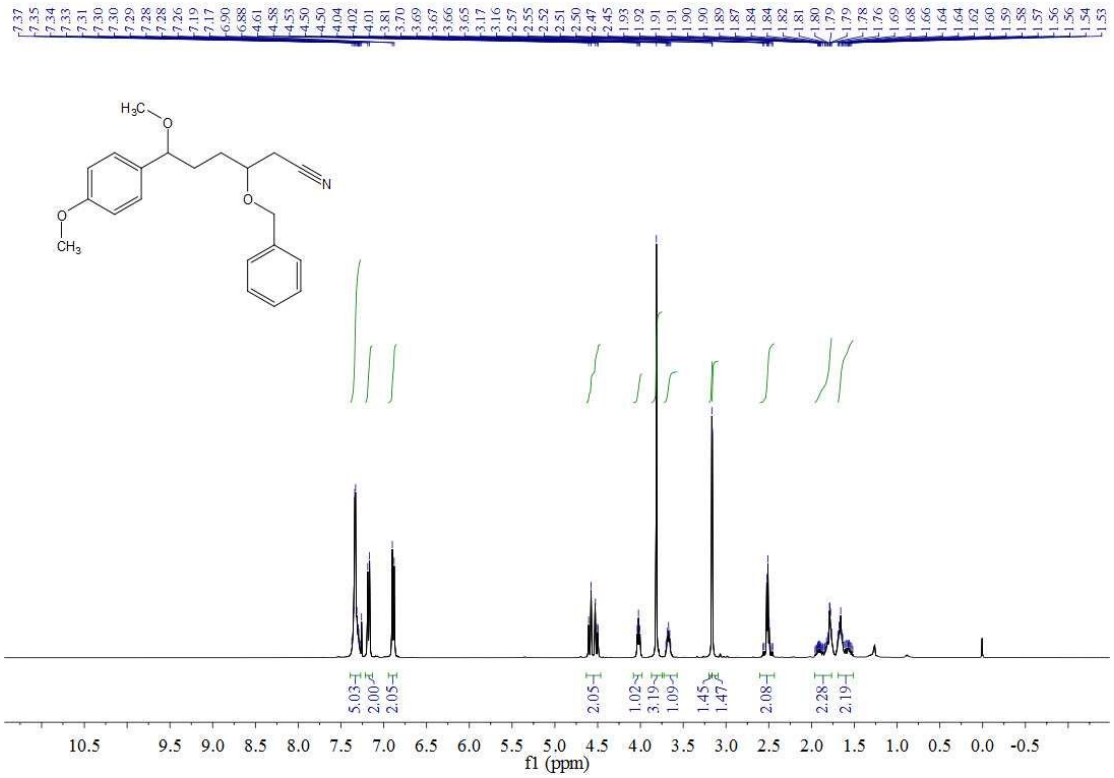
^{13}C NMR of **4o**



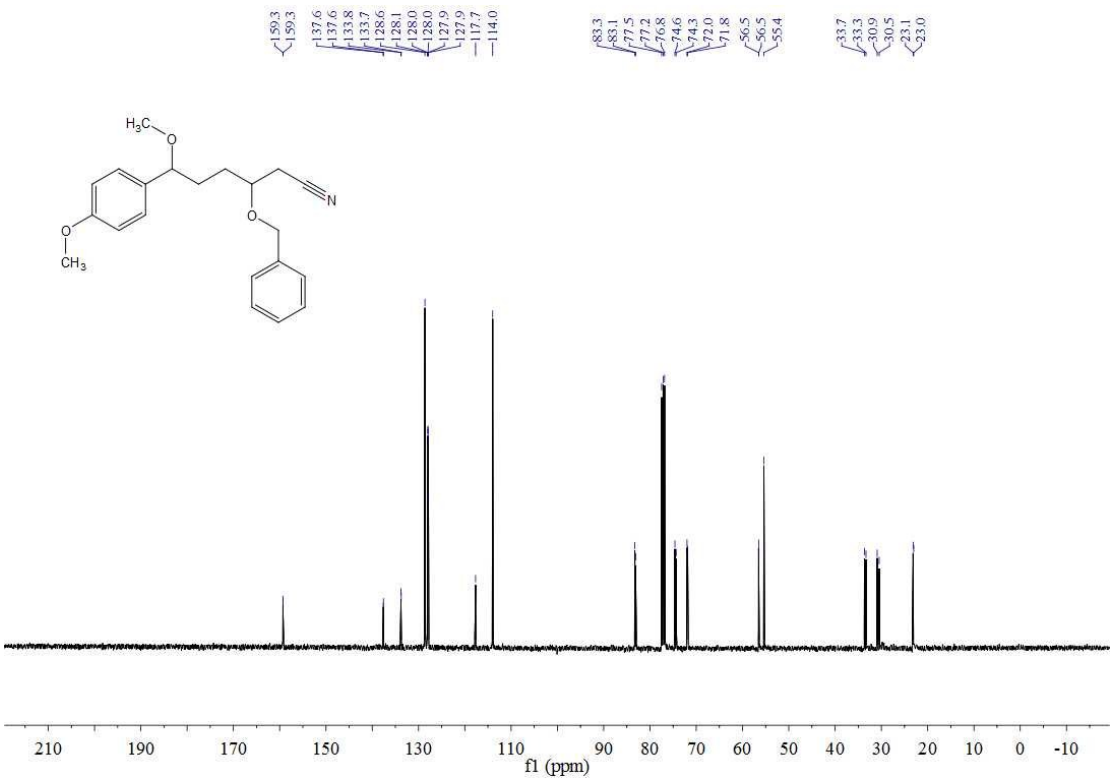
^{1}H NMR of **4p**



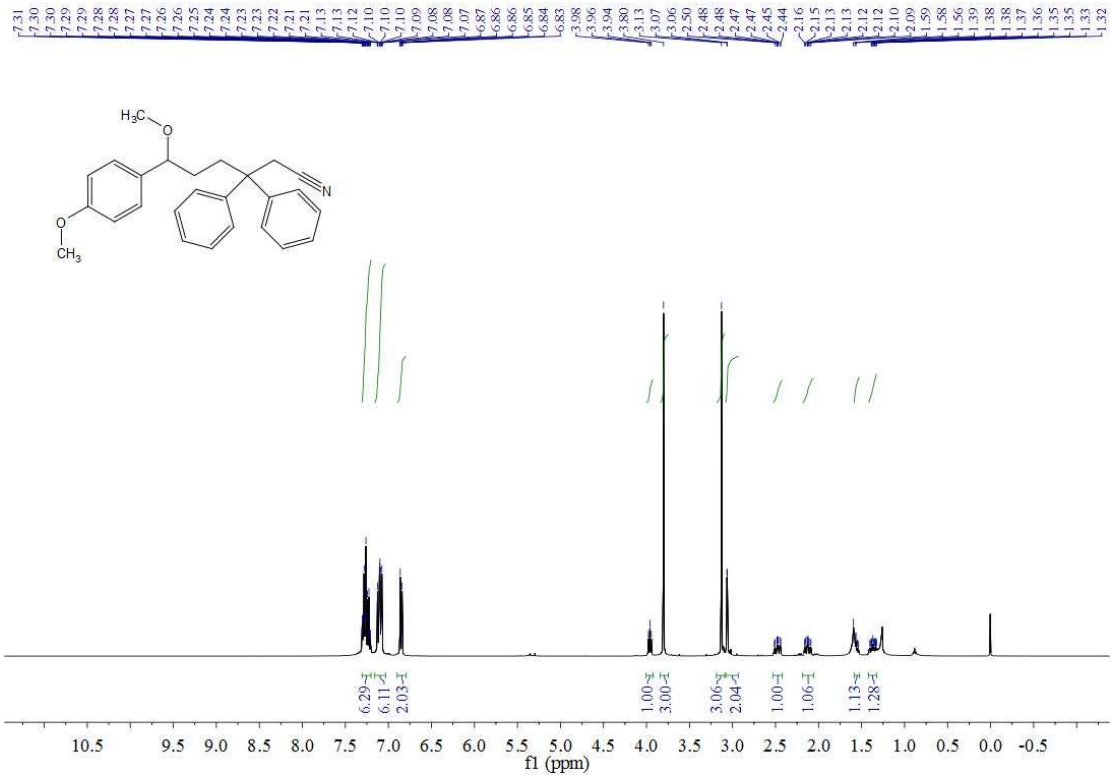
^{13}C NMR of **4p**



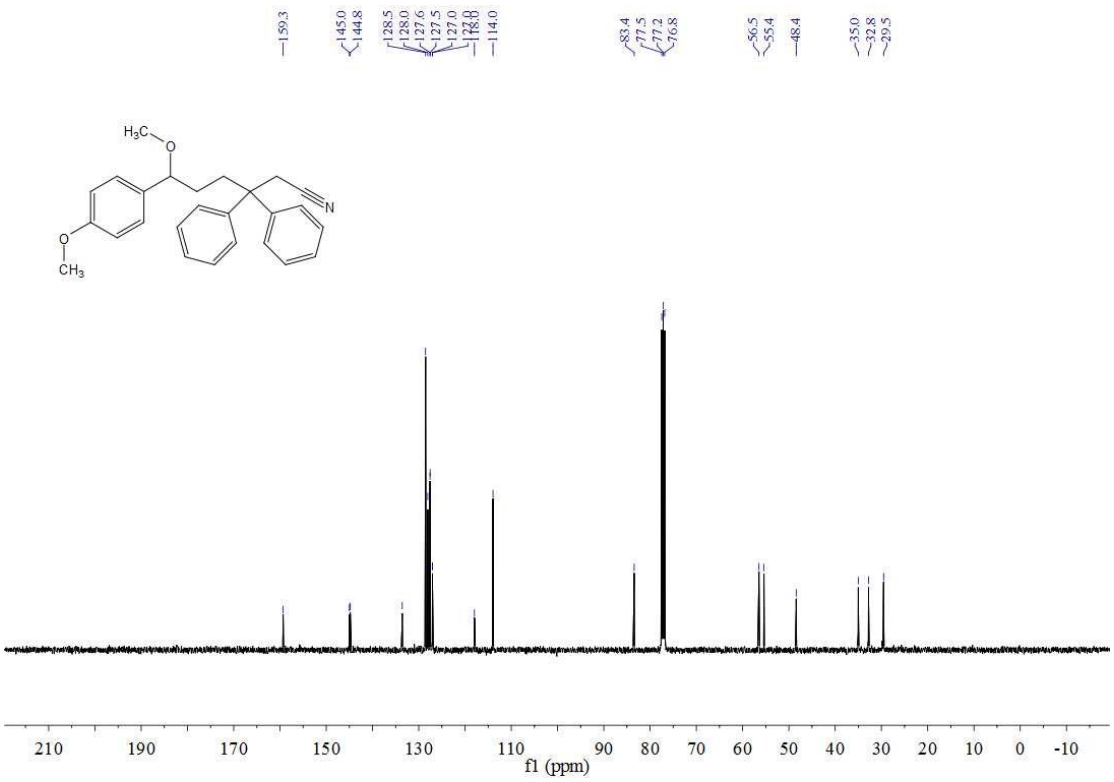
^{1}H NMR of **4q**



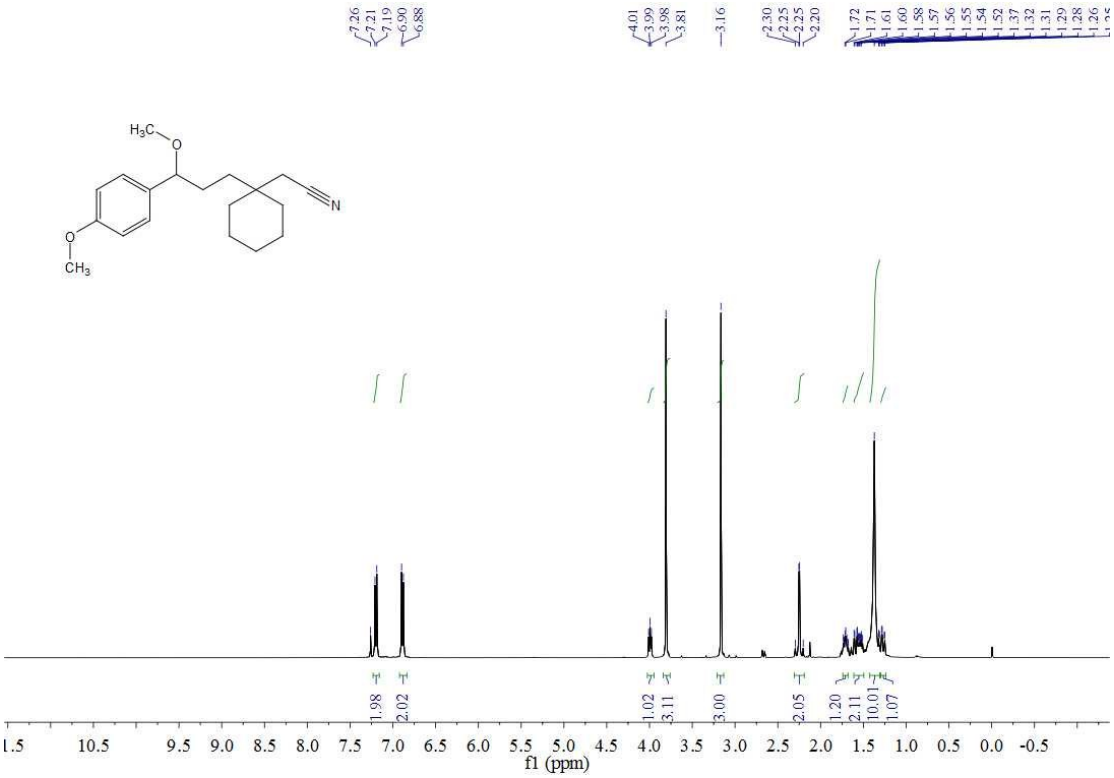
^{13}C NMR of **4q**



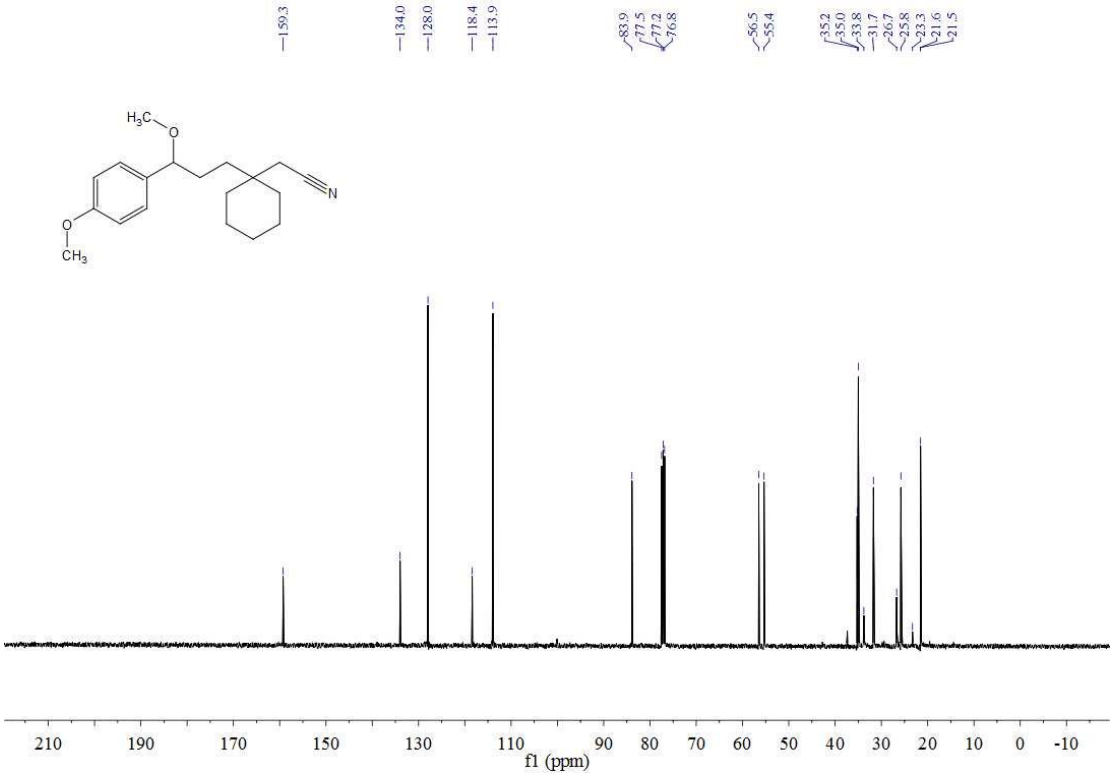
^{1}H NMR of **4r**



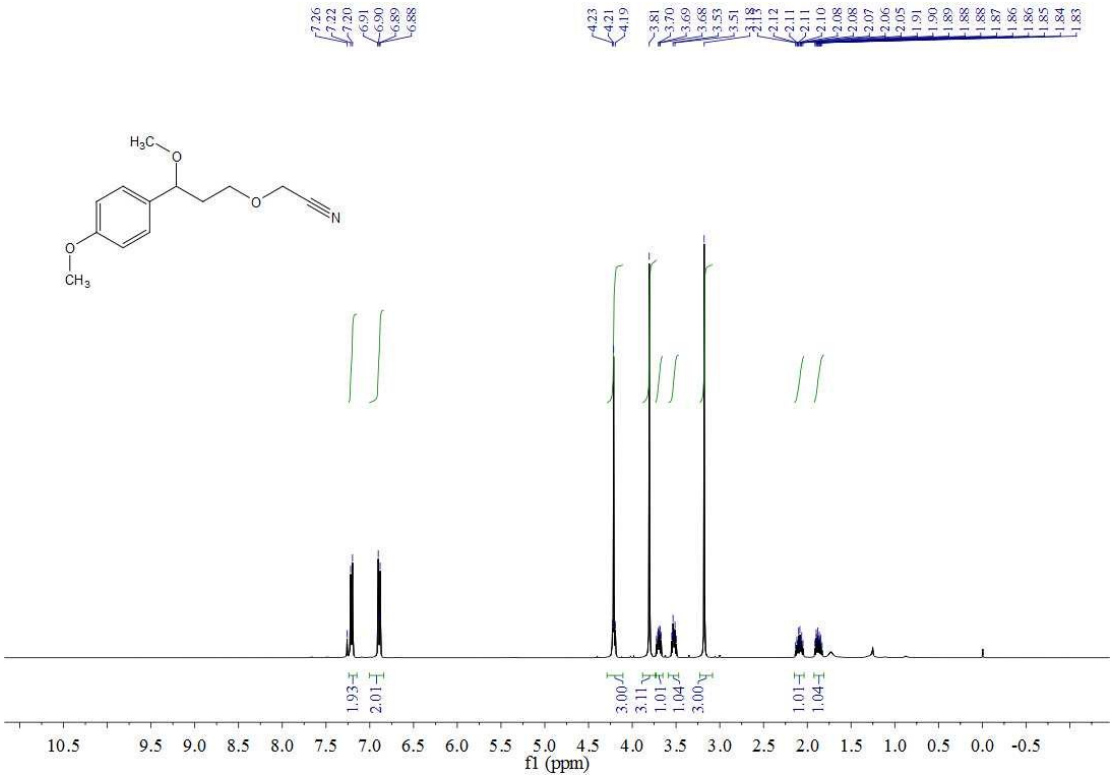
^{13}C NMR of **4r**



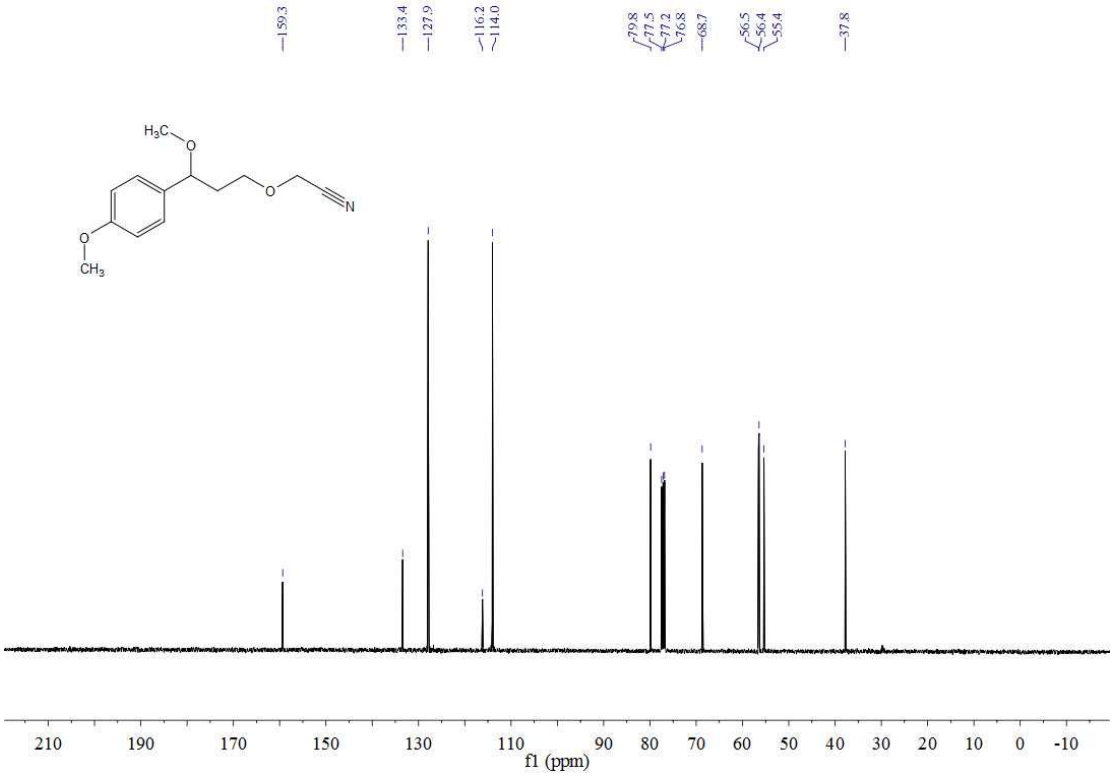
^{1}H NMR of **4s**



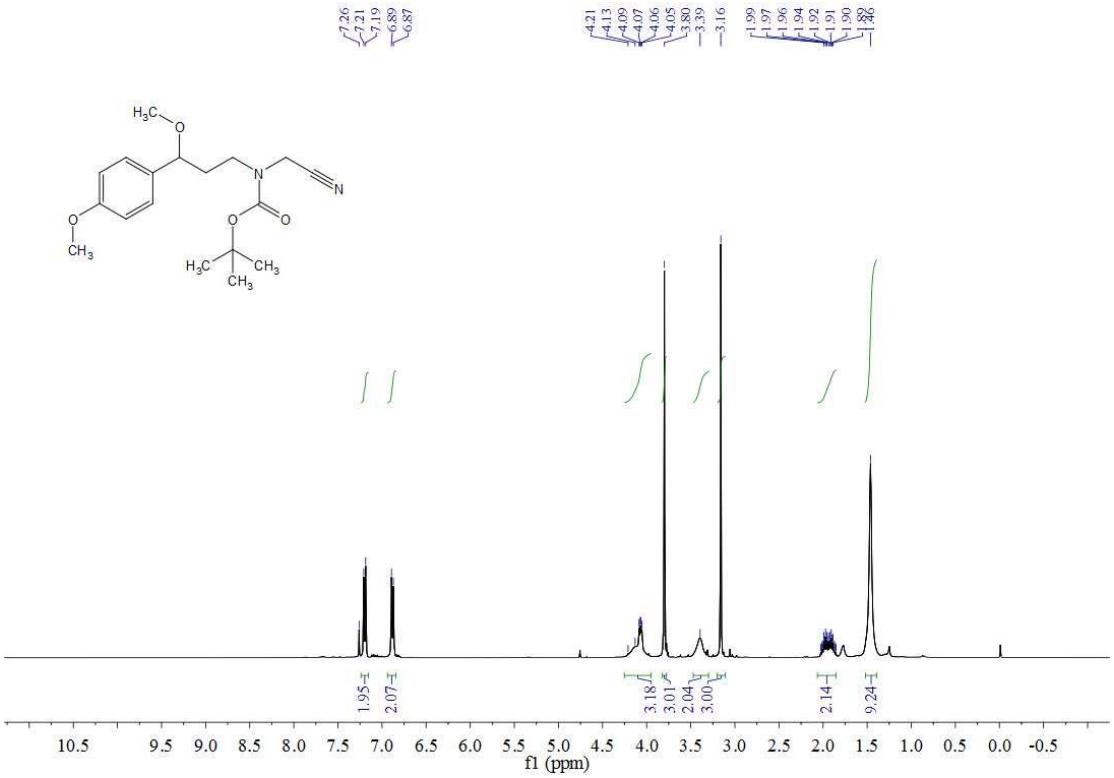
^{13}C NMR of **4s**



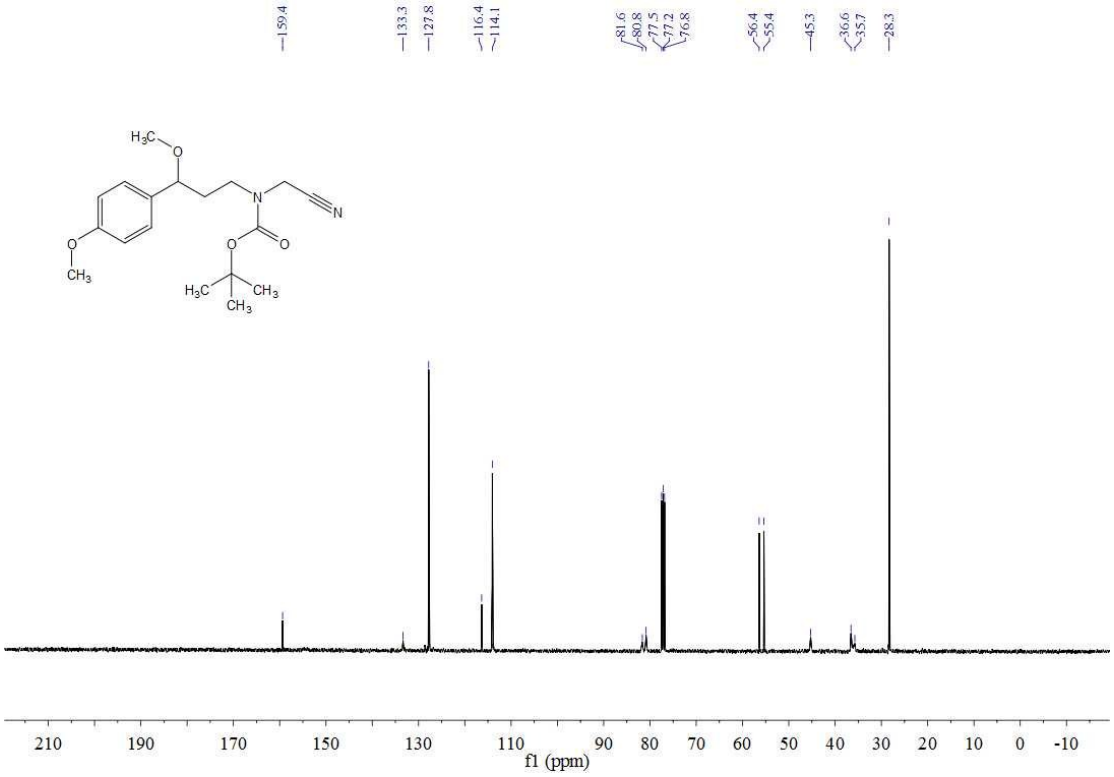
^{1}H NMR of **4t**



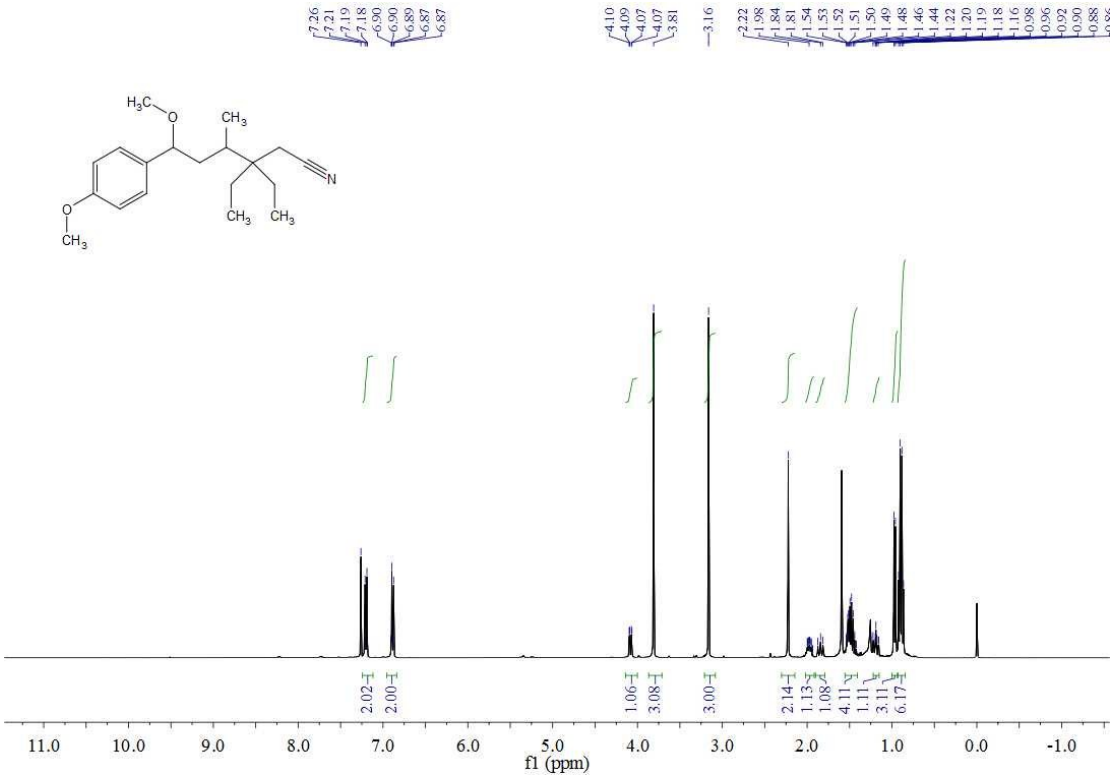
^{13}C NMR of **4t**



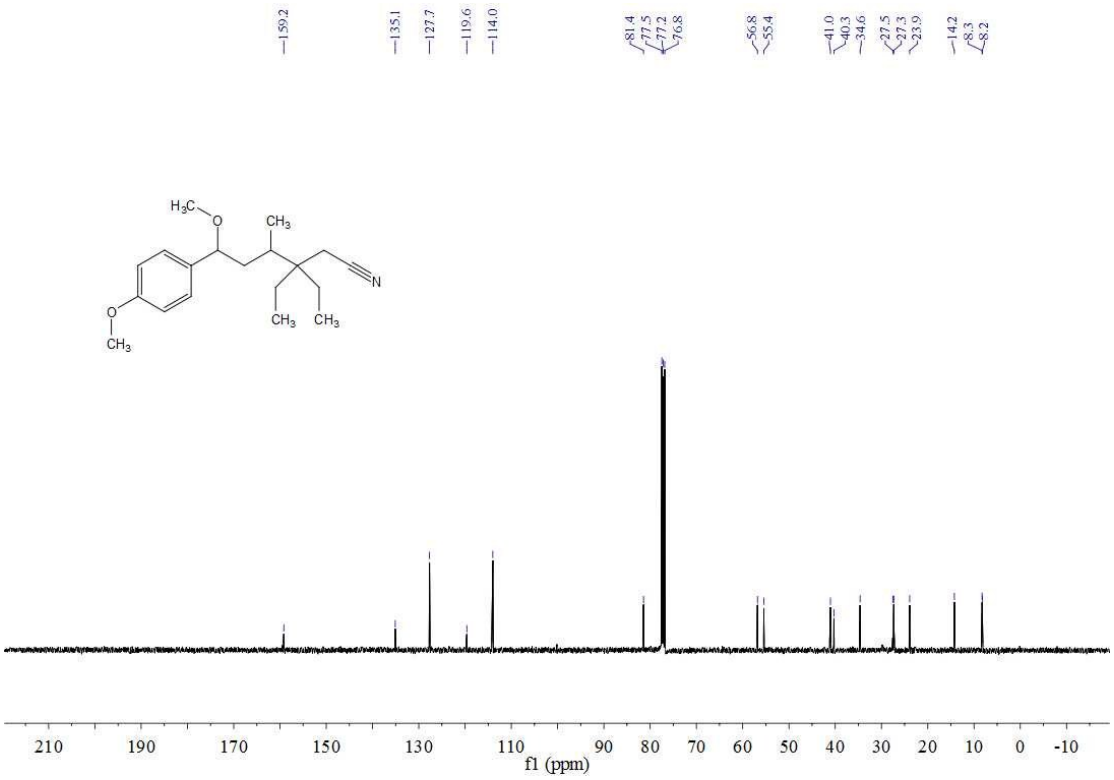
^{1}H NMR of **4u**



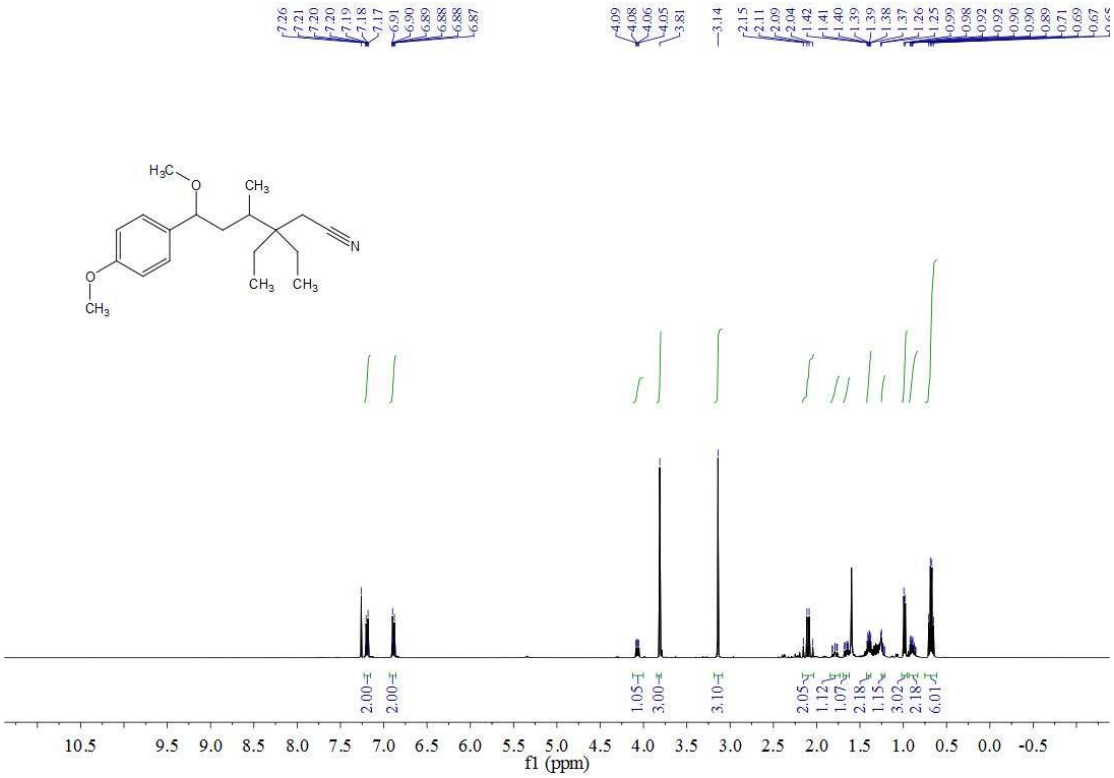
^{13}C NMR of **4u**



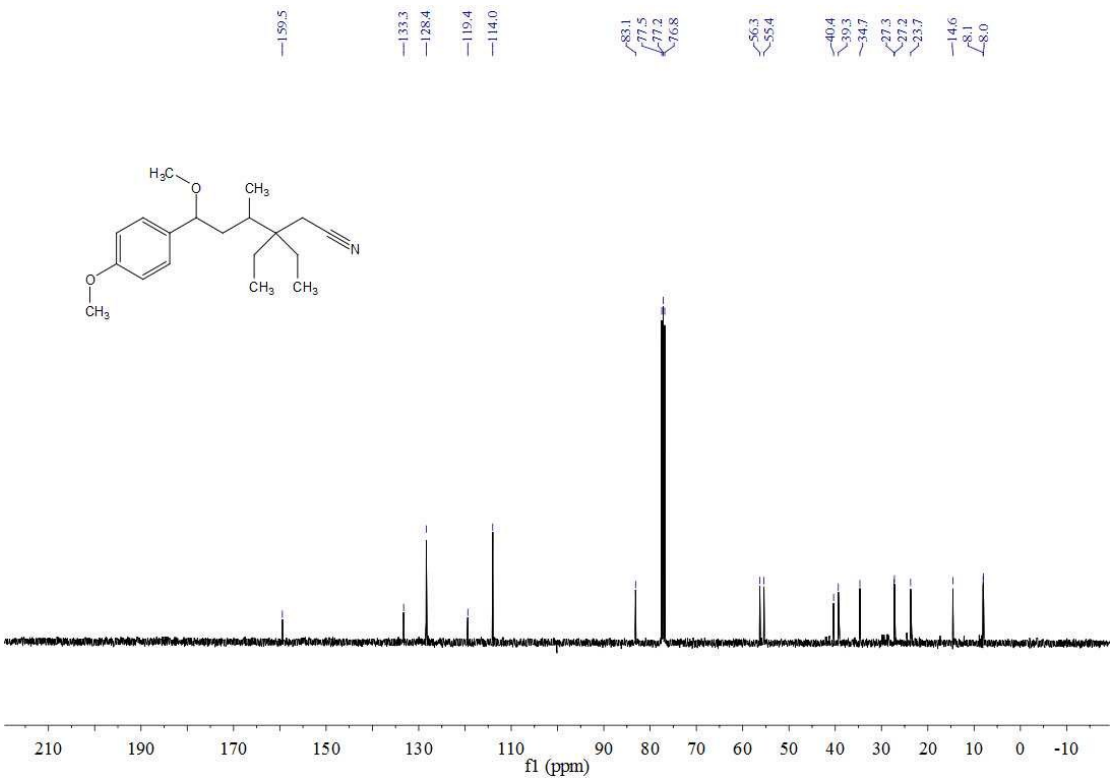
^{1}H NMR of **4v** (major diastereomer)



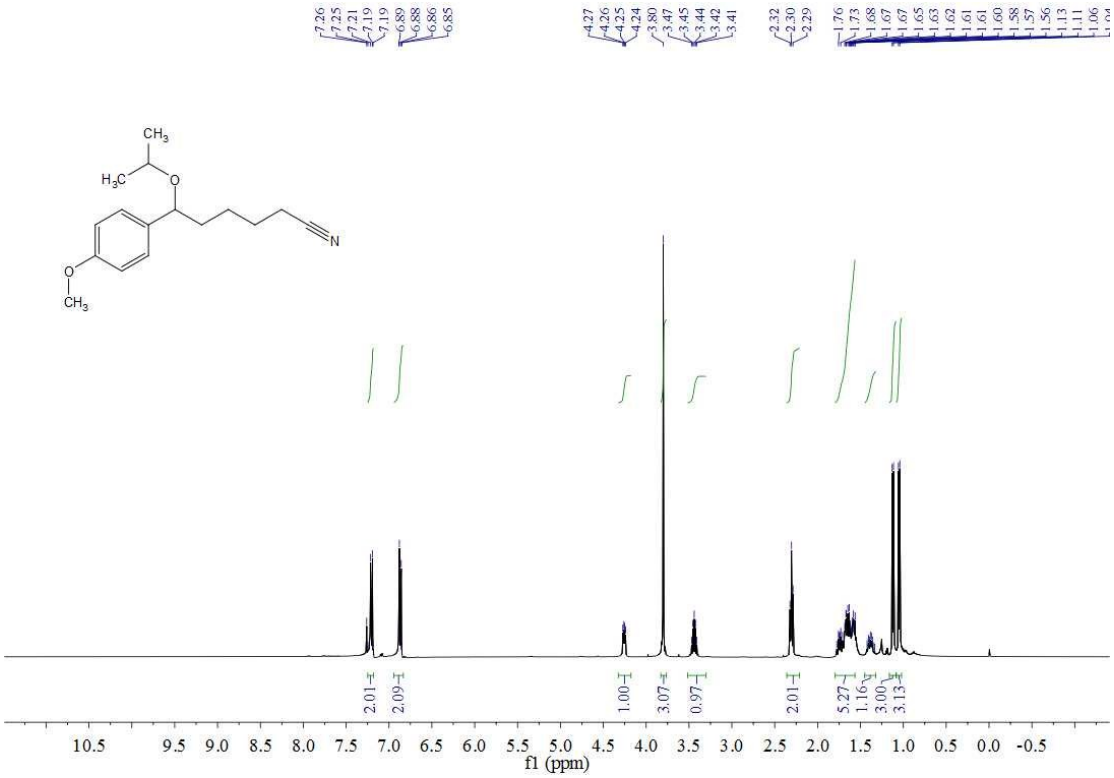
^{13}C NMR of **4v** (major diastereomer)



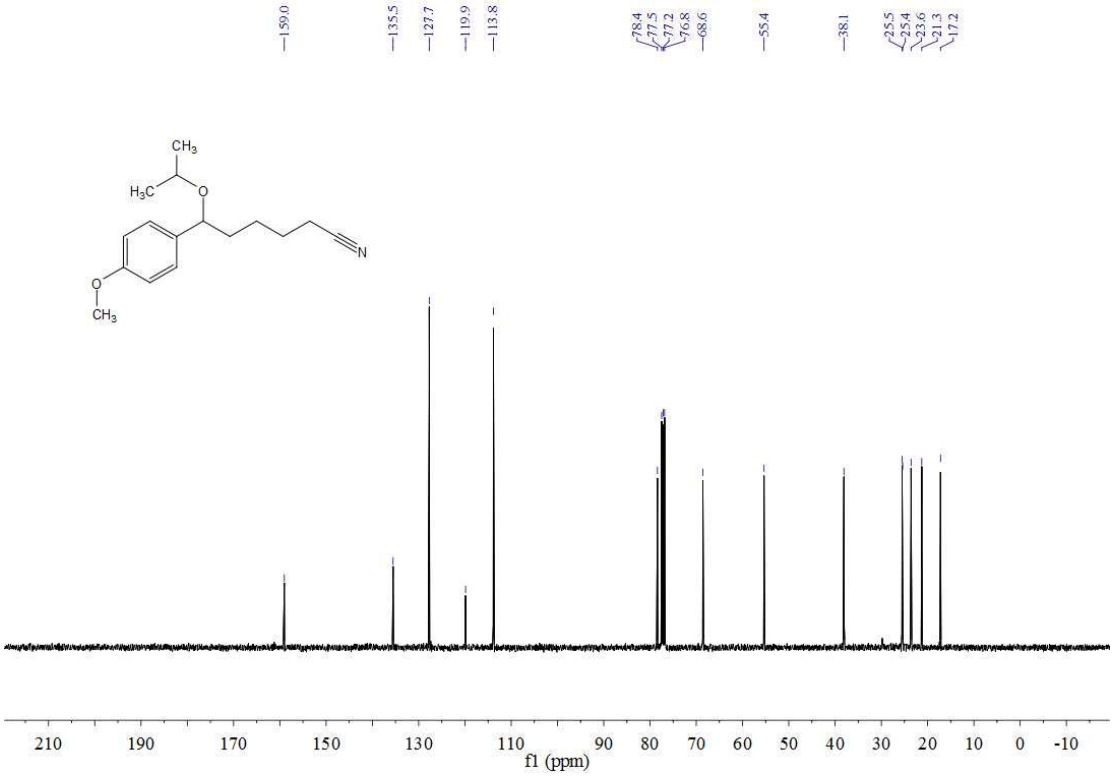
^{1}H NMR of **4v'** (minor diastereomer)



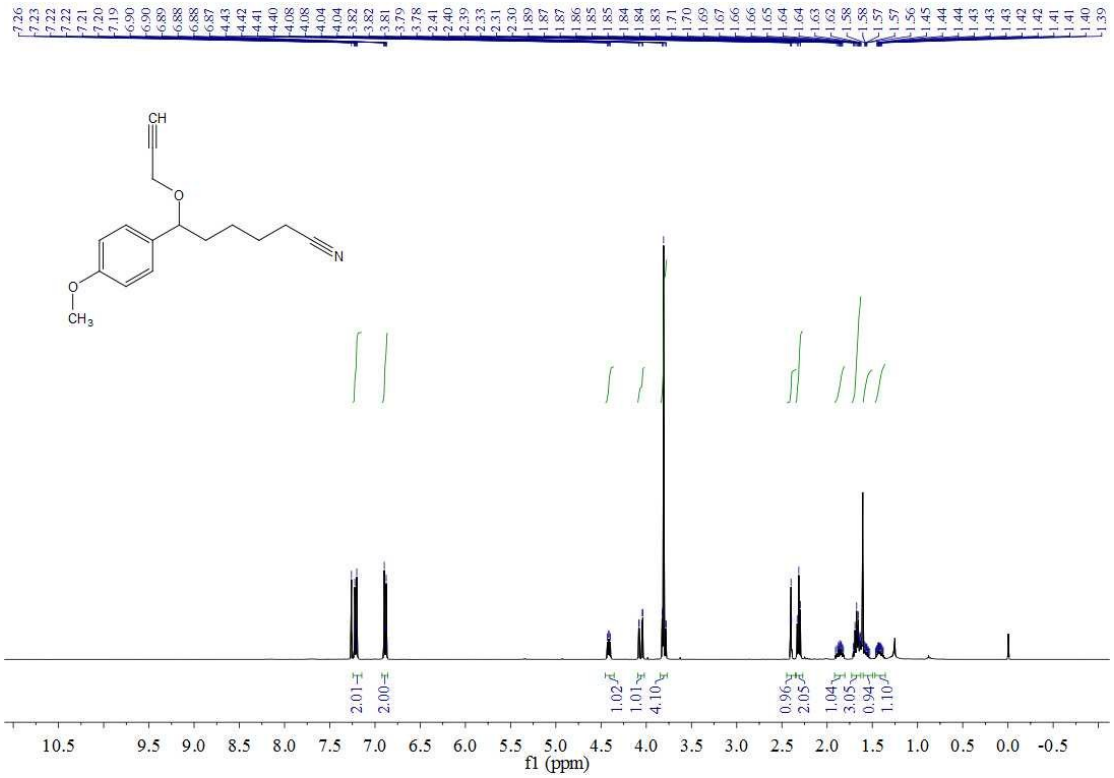
^{13}C NMR of **4v'** (minor diastereomer)



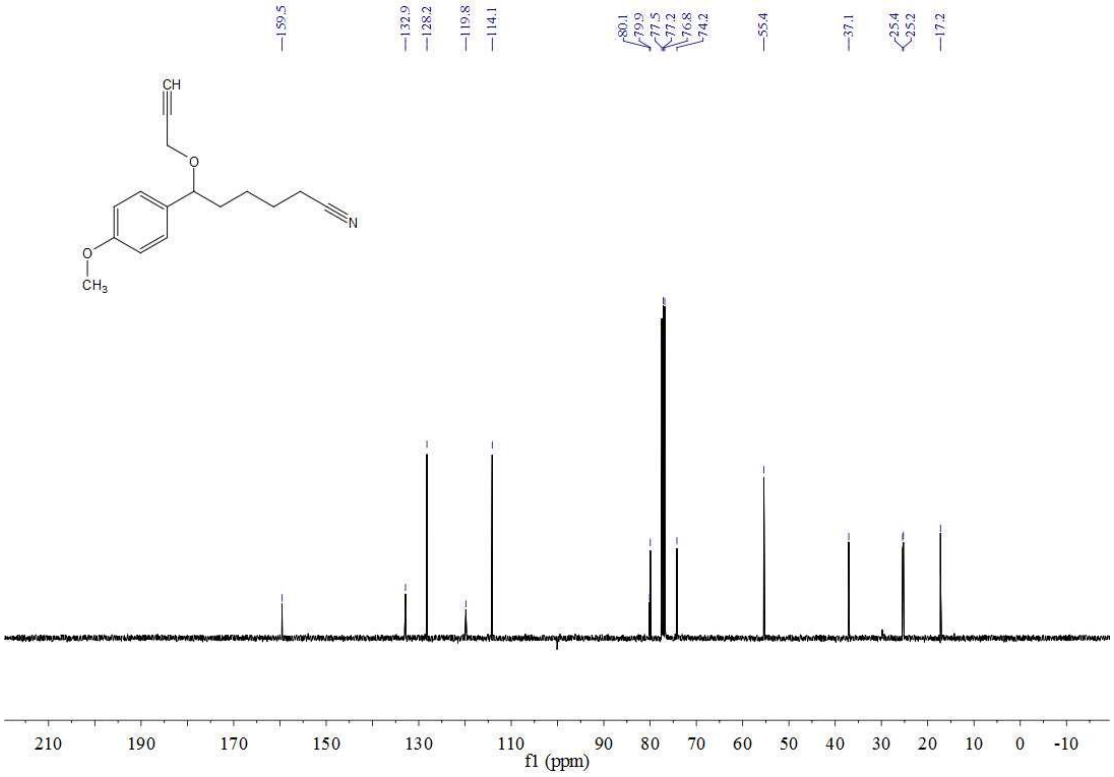
^{1}H NMR of **4w**



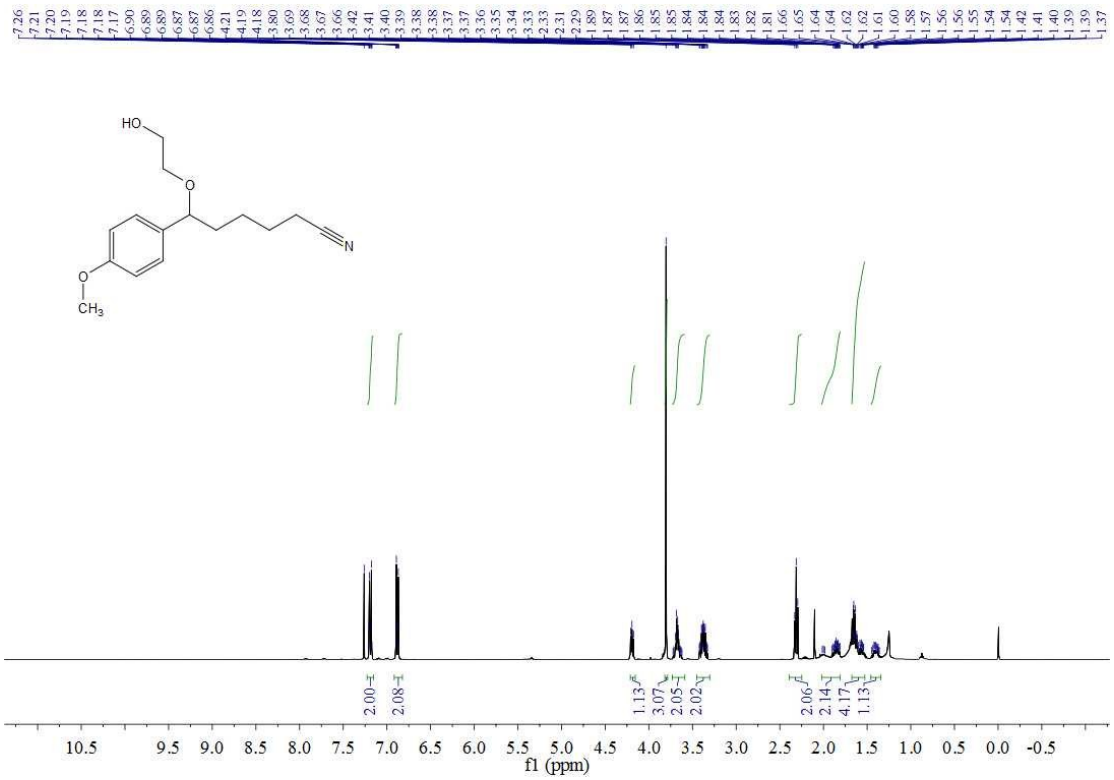
^{13}C NMR of **4w**



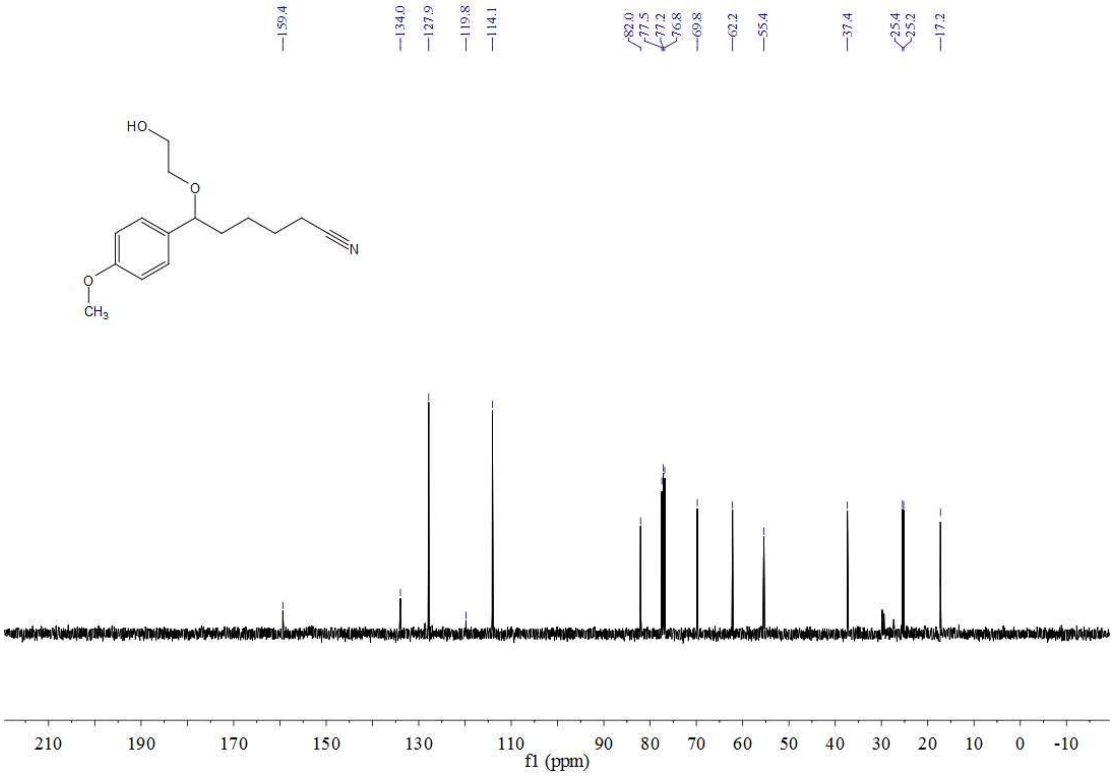
^{1}H NMR of **4x**



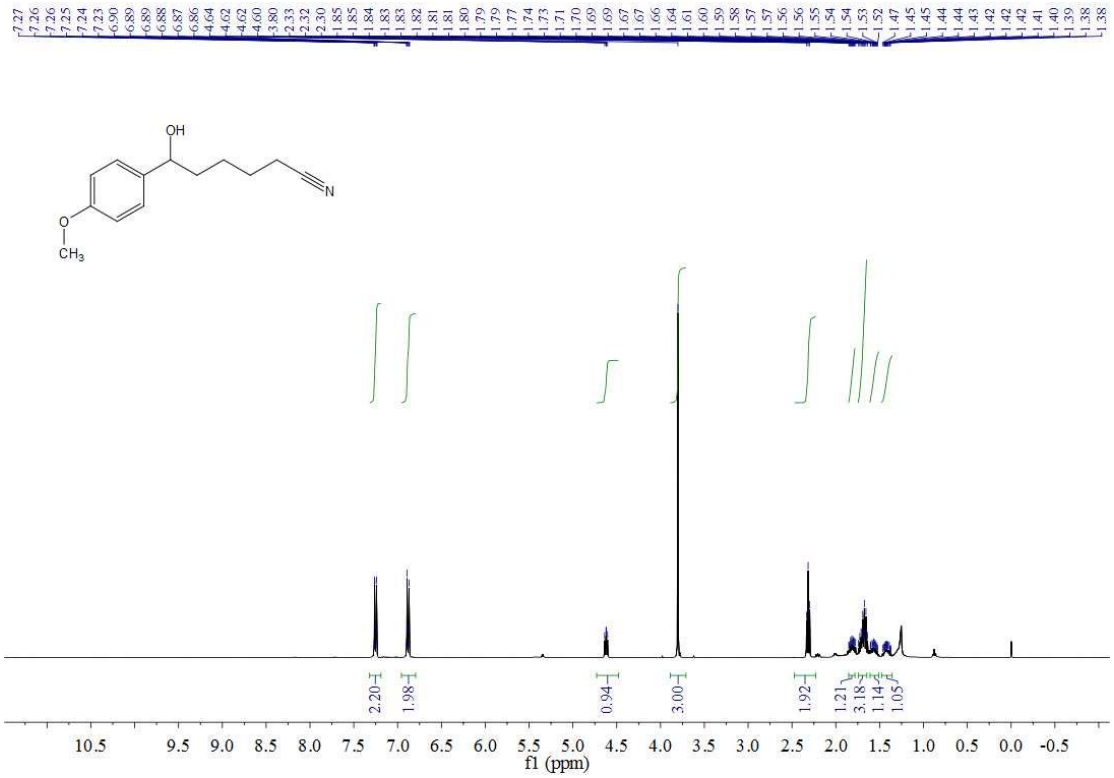
^{13}C NMR of **4x**



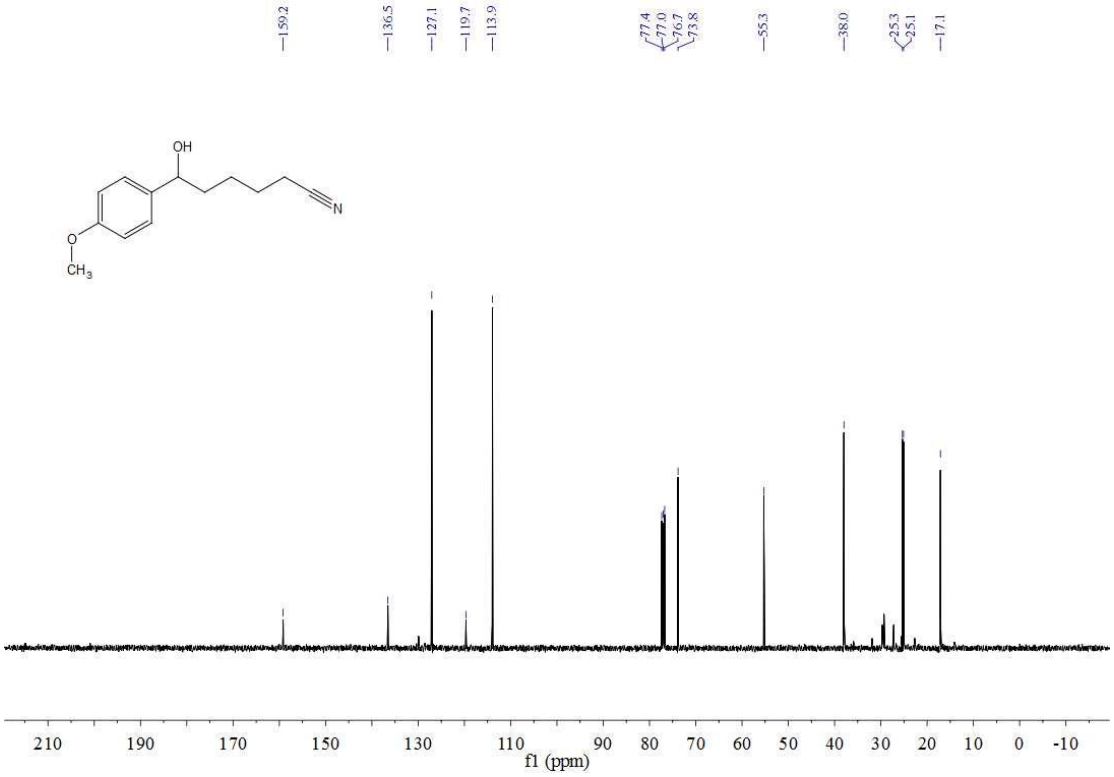
^{1}H NMR of **4y**



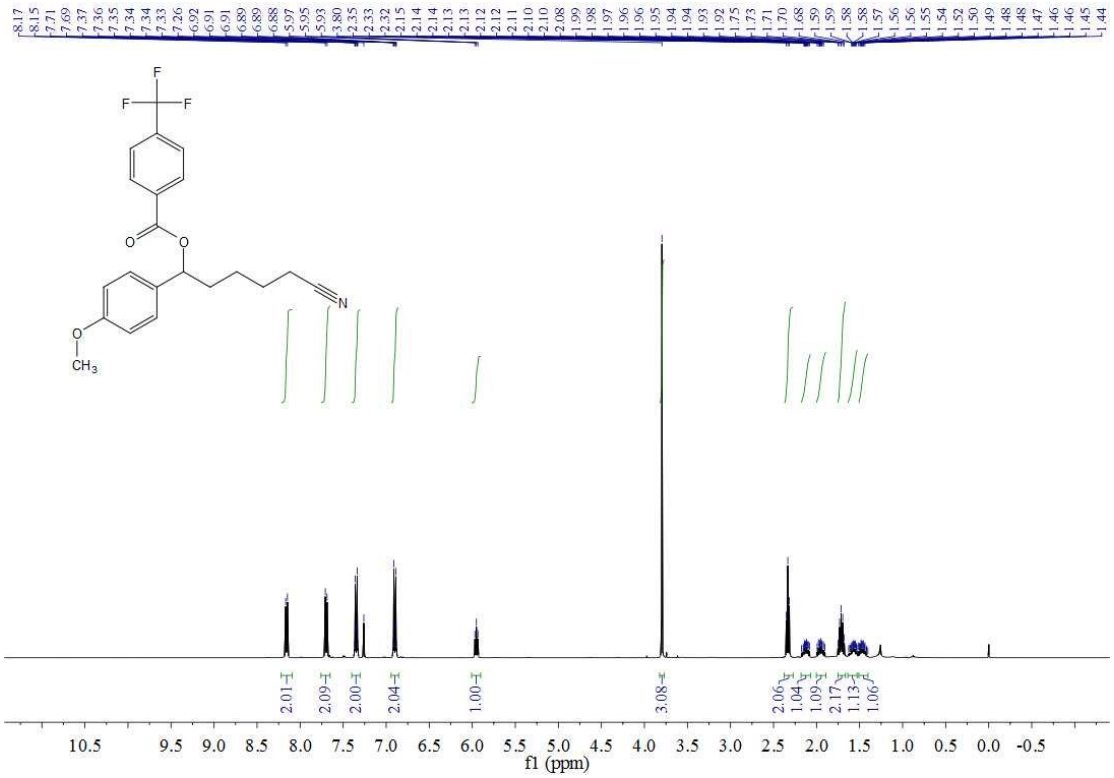
^{13}C NMR of **4y**



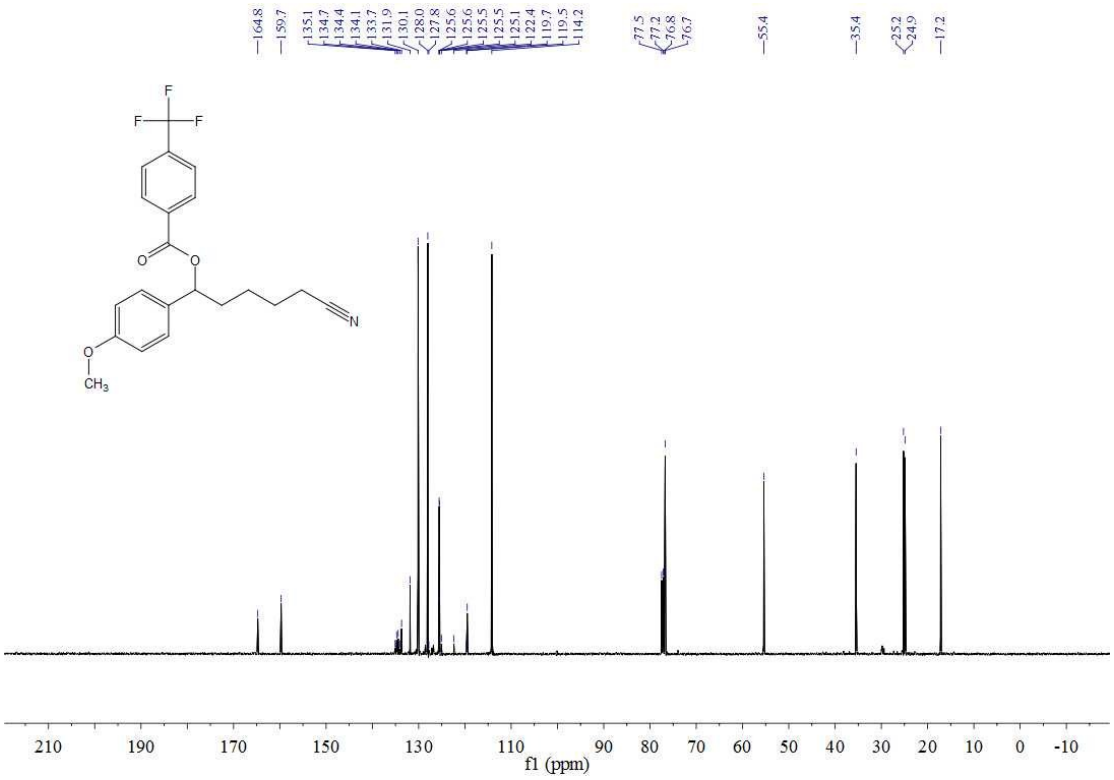
^{1}H NMR of **5**



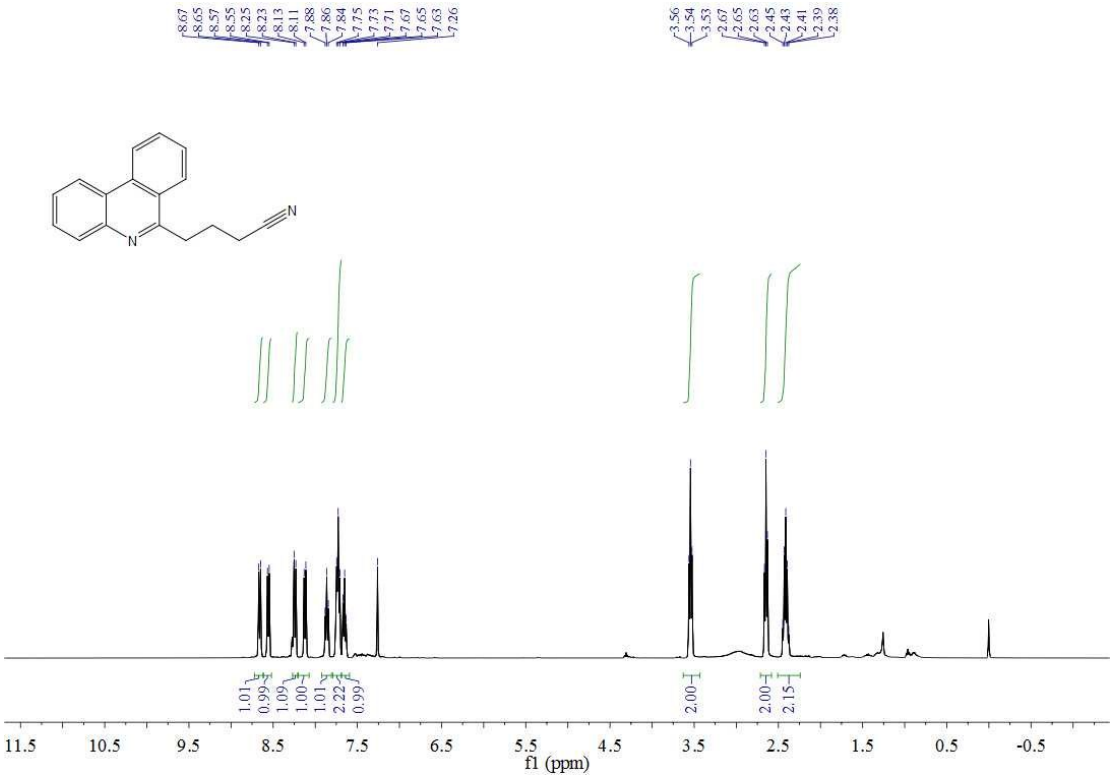
^{13}C NMR of **5**



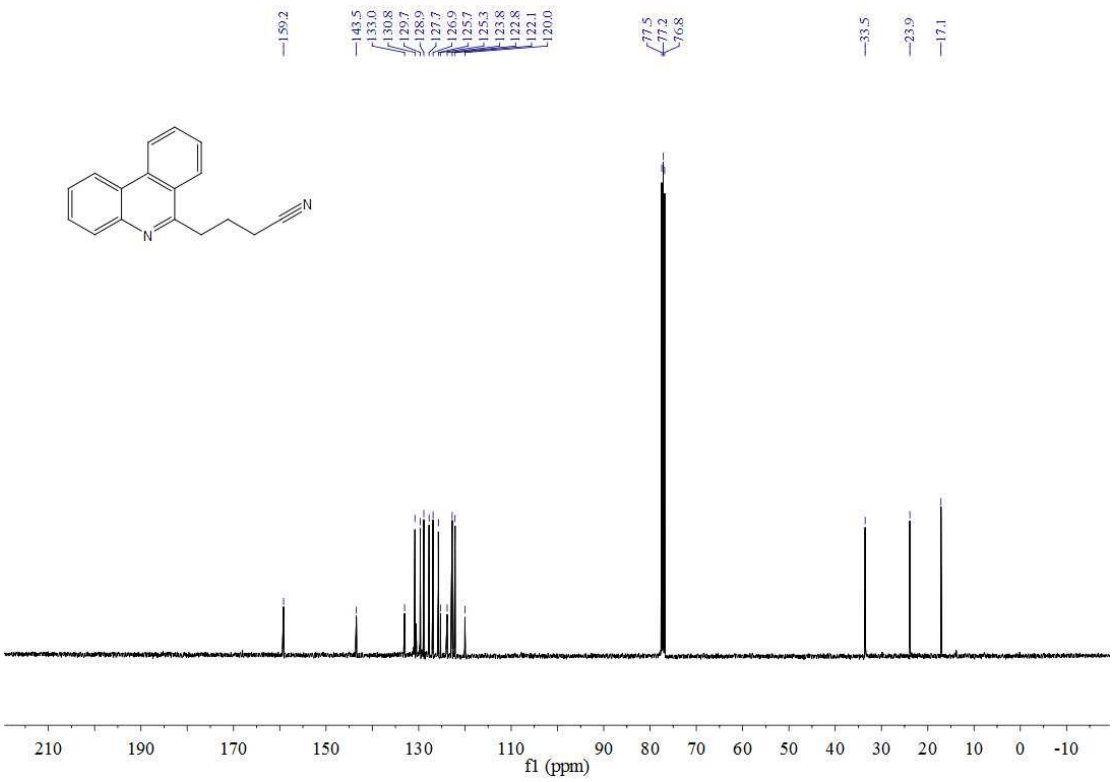
^{1}H NMR of **6**



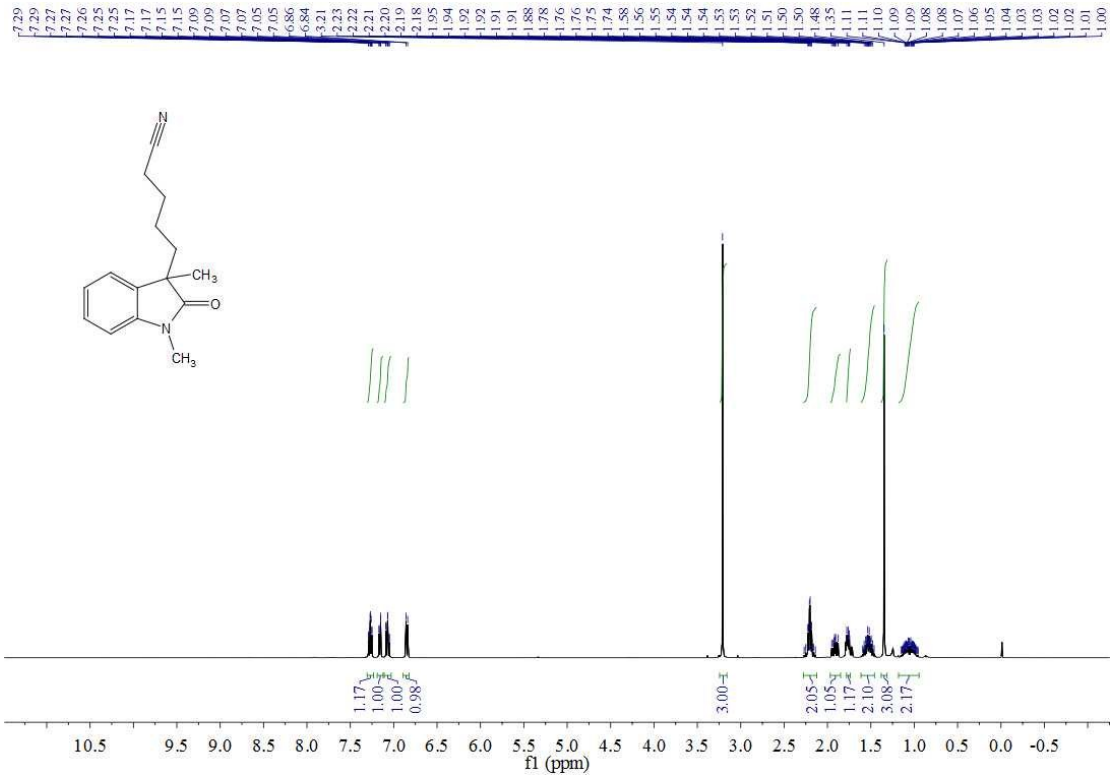
^{13}C NMR of **6**



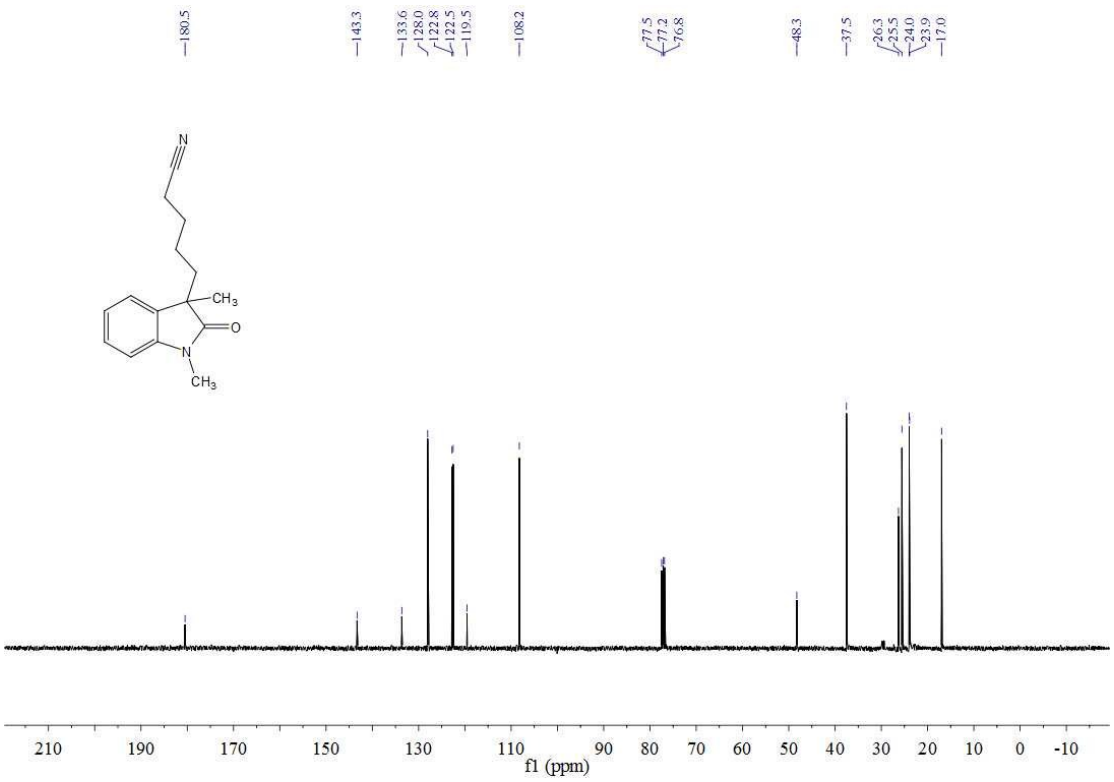
^{1}H NMR of **8**



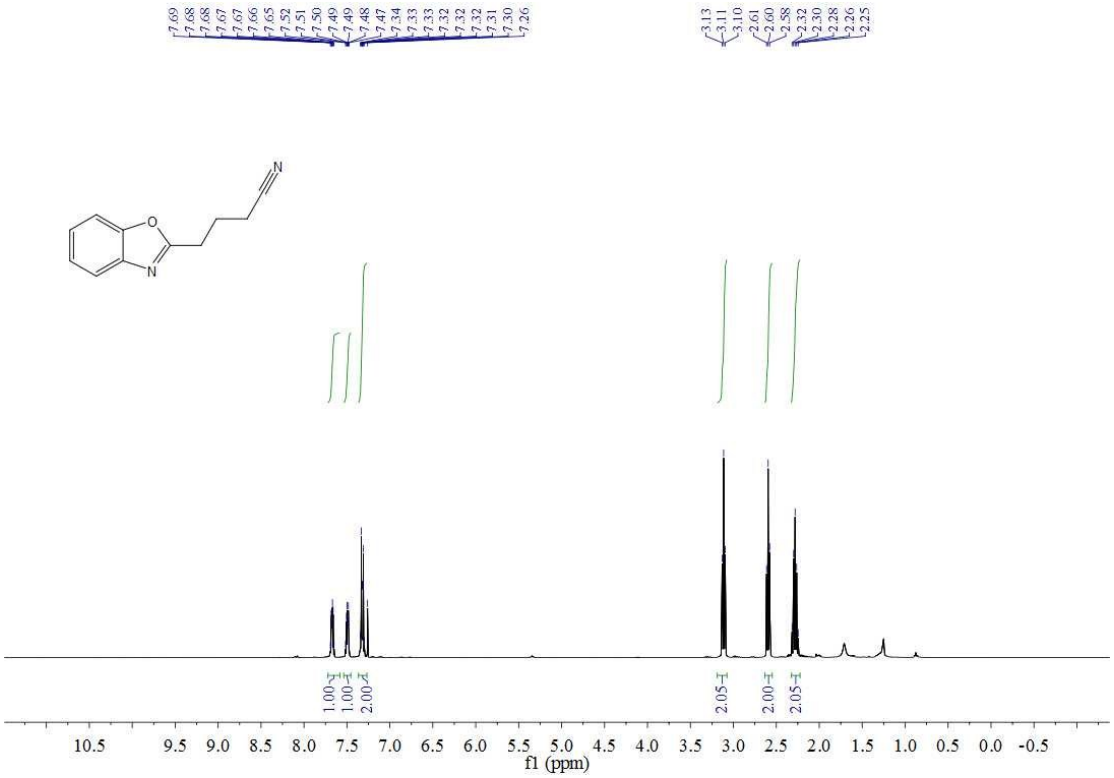
^{13}C NMR of **8**



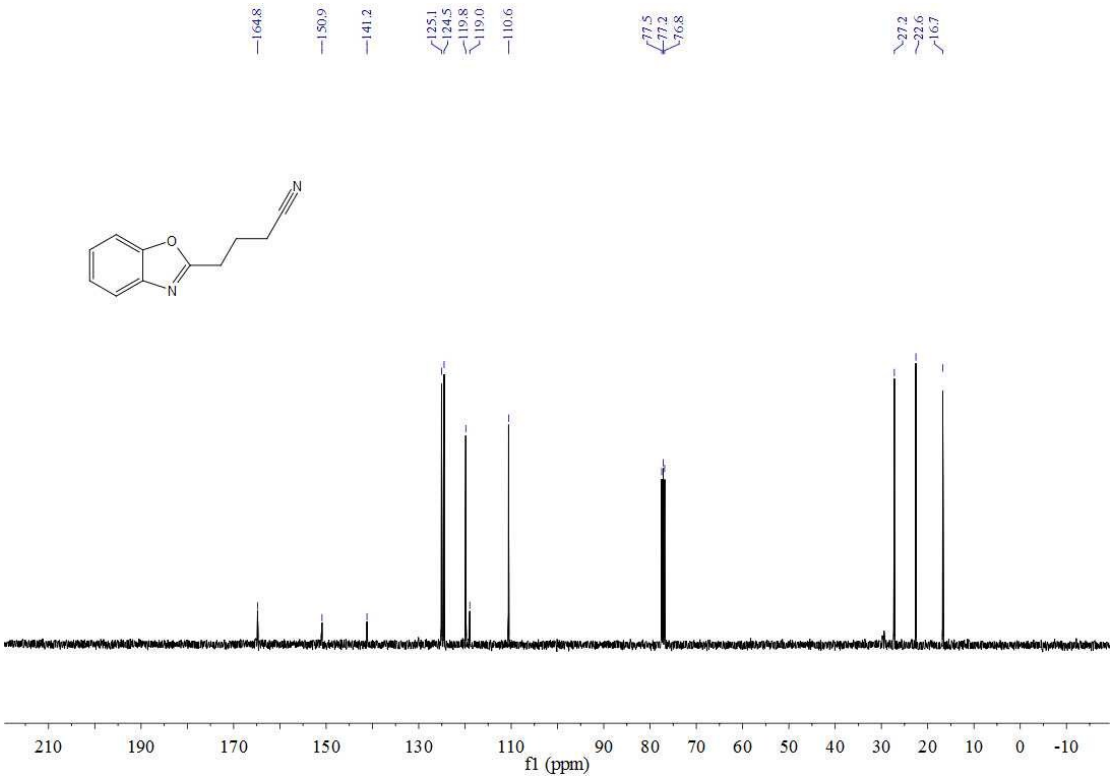
^{1}H NMR of **10**



^{13}C NMR of **10**



^{1}H NMR of **12**



^{13}C NMR of **12**