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Synthesis, characterization, and antibacterial activity of novel bis(indolyl)methanes sourced from biorenewable furfurals using gluconic acid aqueous solution (GAAS) as a sustainable catalyst

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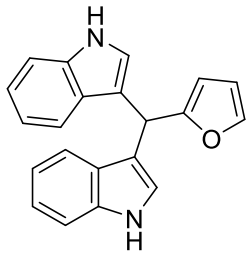
Characterization of synthesized compounds

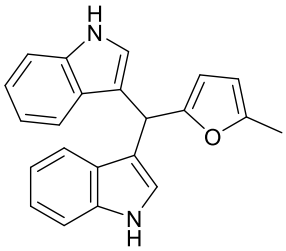
3,3'-(furan-2-ylmethylene)bis(1*H*-indole) (**1a**):



1a

Red solid; 1.559 g, 96%; Melting Point: 122-124 °C; ^{1}H-NMR (DMSO-d$_{6,}$ 400 MHz) δ (ppm): 10.92 (br., 2H, -N**H**), 7.55-7.40 (m, 5H, Ar-**H**), 7.10-7.06 (m, 4H, Ar-**H**), 6.96 (d, 2H, Ar-**H**), 6.38 (d, 1H, Ar-**H**), 6.14 (d, 1H, Ar-**H**), 5.97 (s, 1H, -C**H**); ^{13}C-NMR (DMSO-d$_{6,}$ 100 MHz) δ (ppm): 157.6, 141.2, 136.4, 126.4, 123.2, 120.8, 119.0, 118.2, 115.7, 111.4, 110.2, 105.8; FTIR (cm^{-1}): 3411, 2924, 1455, 1418, 784, 741. Elemental analysis (CHN): Calculated (%): C: 80.75, H: 5.16, N: 8.97; Experimental (%): C: 80.45, H: 5.46, N: 8.73.

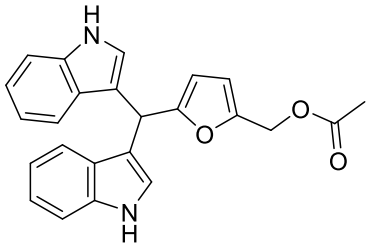
3,3'-((5-methylfuran-2-yl)methylene)bis(1*H*-indole) **(1b)**:



1b

Red solid; 1.304 g, 88%; Melting Point: 112-114 °C; ^{1}H-NMR (DMSO-d$_{6,}$ 400 MHz) δ (ppm): 10.84 (br., 2H, -N**H**), 7.43-7.03 (m, 6H, Ar-**H**), 7.06-7.01 (m, 4H, Ar-**H**), 6.91 (d, 2H, Ar-**H**), 6.87 (d, 1H, Ar-**H**), 5.93 (s, 1H, Ar-**H**), 2.19 (s, 3H, -C**H**$_3$); ^{13}C-NMR (DMSO-d$_{6,}$ 100 MHz) δ (ppm): 156.1, 150.0, 136.8, 126.8, 123.7, 121.2, 119.5, 118.6, 116.3, 111.9, 106.9, 106.5, 13.8; FTIR (cm^{-1}): 3409, 2922, 1454, 1093, 783, 743. Elemental analysis (CHN): Calculated (%): C: 80.96, H: 5.56, N: 8.58; Experimental (%): C: 81.16, H: 5.7, N: 8.66.

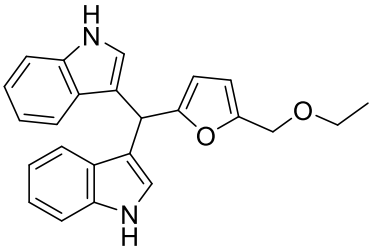
(5-(di(1*H*-indol-3-yl)methyl)furan-2-yl)methyl acetate (**1c**):



1c

Red solid; 1.028 g, 90%; Melting point: 80-82 °C; ^{1}H-NMR (DMSO-d_6, 400 MHz) δ (ppm): 10.88 (br., 2H, -N**H**), 7.43-7.33 (m, 6H, Ar-**H**), 7.06-6.87 (m, 4H, Ar-**H**), 6.41 (d, 1H, furyl-C**H**), 6.08 (d, 1H, furyl-C**H**), 5.92 (s, 1H), 4.98 (s, 2H, -C**H**$_2$), 1.99 (s, 3H, -C**H**$_3$); ^{13}C-NMR (DMSO-d_6, 100 MHz) δ (ppm): 170.4, 158.9, 148.1, 136.8, 126.7, 123.7, 121.3, 119.4, 118.7, 115.9, 111.9, 107.3, 58.2, 34.1, 21.1; FTIR (cm^{-1}): 3411, 2955, 2921, 1456, 758, 744. Elemental analysis (CHN): Calculated (%): C: 74.98, H: 5.24, N: 7.29; Experimental (%): C: 74.84, H: 5.54, N: 7.63.

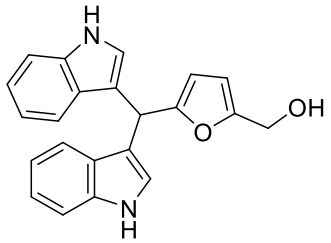
3,3'-((5-(ethoxymethyl)furan-2-yl)methylene)bis(1*H*-indole) (**1d**):



1d

Red solid; 0.985 g, 82%; Melting Point: 110-112 °C; ^{1}H-NMR (DMSO-d6, 400 MHz) δ (ppm): 10.87 (br., 2H, -N**H**), 7.43 (d, 2H, Ar-**H**), 7.36 (d, 2H, Ar-**H**), 7.06-7.02 (m, 4H, Ar-**H**), 6.91 (t, 2H, Ar-**H**), 6.29 (d, 1H, *J* = 3.2 Hz, furyl-C**H**,), 6.03 (s, 1H, *J* = 3.2 Hz, furyl-C**H**), 5.8 (s, 1H), 4.30 (s, 2H, -C**H**$_2$), 3.40 (t, 3H, -OCH$_2$C**H**$_3$); ^{13}C-NMR (100 MHz, DMSO-d_6, 100 MHz) δ (ppm): 157.6, 150.3, 136.4, 126.3, 123.3, 120.9, 119.0, 118.3, 115.6, 111.5, 109.9, 106.5, 64.4, 63.8, 33.7, 15.02; FTIR (cm^{-1}): 3412, 2920, 1455, 1093, 784, 743. Elemental analysis (CHN): Calculated (%): C: 77.81, H: 5.99, N: 7.56; Experimental (%): C: 77.94, H: 6.15, N: 7.51.

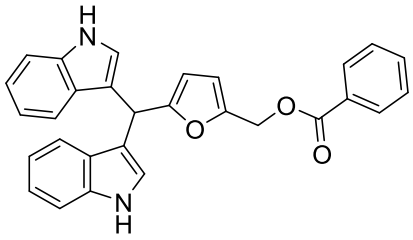
(5-(di(1*H*-indol-3-yl)methyl)furan-2-yl)methanol (**1e**):



1e

Red solid; 0.922 g, 68%; Melting Point 86-88 °C; ^{1}H-NMR (DMSO-d_6, 400 MHz,) δ (ppm): 10.87 (br., 2H, -N**H**), 7.46-7.36 (m, 4H, Ar-**H**), 7.08-6.90 (m, 6H, Ar-**H**), 6.19 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 6.03 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.90 (s, 1H, -C**H**), 5.16 (s, 1H, -O**H**), 4.35 (s, 2H, -C**H**$_2$OH); ^{13}C-NMR (DMSO-d_6, 100 MHz,) δ (ppm): 157.0, 153.9, 136.6, 126.5, 123.5, 121.1, 119.2, 118.5, 115.9, 111.7, 107.7, 106.6, 56.0, 33.8; FTIR (cm^{-1}): 3408, 2924, 1455, 1214, 976, 742. Elemental analysis (CHN): Calculated (%): C: 77.17, H: 5.30, N: 8.18; Experimental (%): C: 70.36, H: 5.31, N: 8.19.

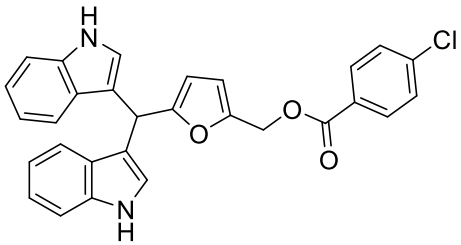
(5-(di(1*H*-indol-3-yl)methyl)furan-2-yl)methyl benzoate (**1f**):



1f

Red solid; 0.853 g, 88%; Melting point: 168-170 °C; ^{1}H-NMR (DMSO-d_6, 400 MHz) δ (ppm): 10.90 (br., 2H, -N**H**), 7.91 (d, 2H, Ar-**H**), 7.67 (t, 1H, Ar-**H**), 7.52 -7.35 (m, 6H, Ar-**H**), 7.10-7.03 (m, 4H, Ar-**H**), 6.90 (t, 2H), 6.52 (d, 1H, furyl-C**H**), 6.14 (d, 1H, furyl-C**H**), 5.94 (s, 1H, C**H**), 5.28 (s, 2H); ^{13}C-NMR (DMSO-d_6, 100 MHz) δ (ppm): 165.3, 158.6, 147.5, 136.4, 133.4, 129.4, 129.2, 128.7, 126.3, 123.3, 120.8, 119.0, 118.3, 115.5, 111.7, 111.4, 106.9, 58.6, 33.77; FTIR (cm^{-1}): 3410, 2926, 1712, 1453, 1269, 744. Elemental analysis (CHN): Calculated (%): C: 78.01, H: 4.97, N: 6.27; Experimental (%): C: 77.91, H: 4.88, N: 6.38.

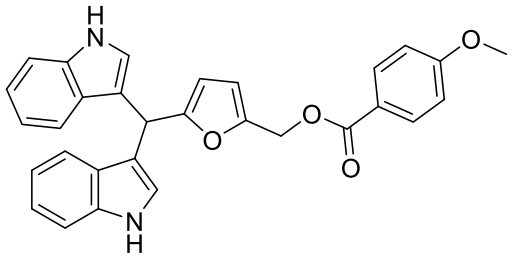
(5-(di(1*H*-indol-3-yl)methyl)furan-2-yl)methyl 4-chlorobenzoate (**1g**):



1g

Red solid, 85%; Melting point: 162-164 °C; ^{1}H-NMR (DMSO-d$_6$, 400 MHz) δ (ppm): 10.87 (br., 2H, -N**H**), 7.88 (d, 2H, Ar-**H**), 7.58 (d, 2H, Ar-**H**), 7.43-7.33 (m, 4H, Ar-**H**), 7.08-6.85 (m, 6H, Ar-**H**), 6.52 (d, 1H, *J* = 3.2 Hz, furyl-C**H**), 6.13 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.92 (s,1H), 5.26 (s, 2H); ^{13}C-NMR (DMSO-d$_6$, 100 MHz) δ (ppm): 164.4, 158.7, 147.3, 138.3, 136.3, 131.0, 128.9, 128.2, 126.3, 123.2, 120.8, 118.9, 118.2, 115.4, 111.8, 111.4, 106.9, 58.8, 33.7; FTIR (cm^{-1}): 3413, 2925, 1713, 1456, 1269, 744. Elemental analysis (CHN): Calculated (%): C: 72.42, H: 4.40, N: 5.82; Experimental (%): C: 72.04, H: 4.72, N: 5.98.

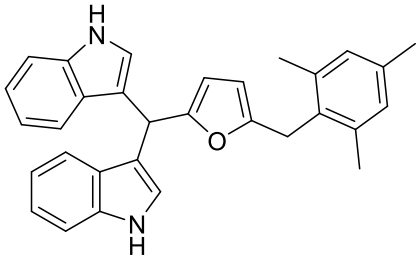
(5-(di(1*H*-indol-3-yl)methyl)furan-2-yl)methyl 4-methoxybenzoate (**1h**):



1h

Red solid; 0.603 g, 68%; Melting point: 98-100 °C; ^{1}H-NMR (DMSO-d$_6$, 400 MHz) δ (ppm): 10.87 (br., 2H, -N**H**), 7.85 (d, 2H, Ar-**H**), 7.43 (d, 2H, Ar-**H**), 7.35 (d, 2H, Ar-**H**), 7.07-7.01 (m, 6H, Ar-**H**), 6.90 (t, 2H, Ar-**H**), 6.50 (d, 1H, furyl-C**H**), 6.12 (d, 1H, furyl-C**H**), 5.91 (s,1H), 5.21 (s, 2H), 3.83 (s, OC**H$_3$**); ^{13}C-NMR (DMSO-d$_6$, 100 MHz) δ (ppm): 165.0, 163.2, 158.5, 147.7, 136.4, 131.3, 126.3, 123.2, 121.6, 120.8, 119.0, 118.3, 115.5, 114.0, 111.5, 111.4, 106.9, 58.3, 55.5, 33.7; FTIR (cm^{-1}): 3411, 2925, 1705, 1605, 1257, 746. Elemental analysis (CHN): Calculated (%): C: 72.42, H: 4.40, N: 5.82; Experimental (%): C: 72.04, H: 4.72, N: 5.98.

3,3'-((5-(2,4,6-trimethylbenzyl)furan-2-yl)methylene)bis(1*H*-indole) (**1i):**

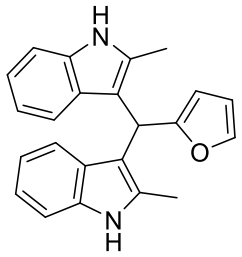


1i

Red solid; 0.759 g, 78%; Melting Point: 95-97 °C; ^{1}H-NMR (DMSO-d$_6$, 400 MHz) δ (ppm): 10.82 (br., 2H, -N**H**), 7.37-7.31 (m, 4H, Ar-**H**), 7.03-7.00 (m, 4H, Ar-**H**), 6.87-6.82 (m, 4H, Ar-**H**), 5.90 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.67 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.81 (s, 1H, -CH), 3.84 (s, 2H, C**H$_2$**), 2.22 (s, 6H, -C**H$_3$**), 2.2 (s, 3H, -C**H$_3$**); ^{13}C-NMR (DMSO-d$_6$, 100 MHz)

δ (ppm): 156.3, 152.3, 136.8, 136.6, 135.4, 132.1, 129.1, 126.8, 123.5, 121.2, 119.5, 118.6, 116.3, 111.8, 106.8, 106.1, 34.1, 28.2, 21.0, 20.0; FTIR (cm^{-1}): 3414, 2920, 1735, 1457, 1180, 783, 743; Elemental analysis (CHN): Calculated (%): C: 83.75, H: 6.35, N: 6.30; Experimental (%): C: 83.47, H: 6.73, N:6.88.

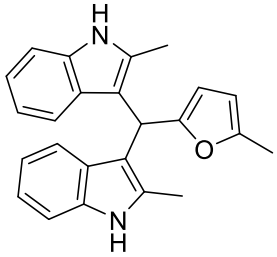
3,3'-(furan-2-ylmethylene)bis(2-methyl-1*H*-indole) **(1j)**:



1j

Light yellow solid; 1.682 g, 95%; Melting Point: 210-212 °C; ^{1}H-NMR (DMSO-d_6, 400 MHz) δ (ppm): 10.74 (br., 2H, -N**H**), 7.58 (d, 1H, Ar-**H**), 7.21-6.87 (m, 6H, Ar-**H**), 6.74 (m, 2H, Ar-**H**), 6.37 (d, 1H, Ar-**H**), 5.82 (d, 1H, Ar-**H**), 5.81 (s, 1H, -C**H**), 2.13(s, 6H, -C**H**$_3$); ^{13}C-NMR (DMSO-d_6, 100 MHz) δ (ppm): 157.0, 141.3, 134.9, 131.8, 127.8, 119.6, 118.1, 118.1, 110.7, 110.4, 110.3, 106.9, 32.6, 11.5; FTIR (cm^{-1}): 3400, 2923, 1460, 1302, 1010, 806, 743. Elemental analysis (CHN): Calculated (%): C: 81.15, H: 5.92, N: 8.23; Experimental (%): C: 81.37, H: 5.93, N: 8.21.

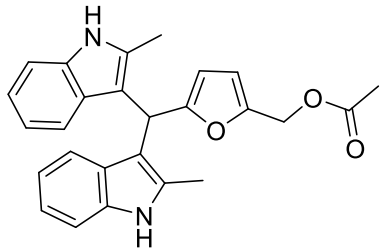
3,3'-((5-methylfuran-2-yl)methylene)bis(2-methyl-1*H*-indole) (**1k**):



1k

Light brown solid; 1.512 g, 94%; Melting Point: 225 °C; ^{1}H-NMR (DMSO-d_6, 400 MHz) δ (ppm): 10.74 (br., 2H, -N**H**), 7.22 (d, 2H, Ar-**H**), 7.00 (d, 2H, Ar-**H**), 6.93 - 6.73 (m, 4H, Ar-**H**), 5.96 (d, 1H, furyl-C**H,** J = 3.2 Hz), 5.77 (s, 1H, -C**H**), 5.65 (s, 1H, furyl-C**H,** J = 3.2 Hz), 2.22 (s, 3H, -C**H**$_3$), 2.16 (s, 6H, -C**H**$_3$); ^{13}C-NMR (DMSO-d6, 100 MHz) δ (ppm): 155.0, 149.7, 134.9, 131.7, 127.8, 119.6, 118.1, 118.0, 110.7, 110.3, 107.4, 106.1, 32.65, 13.42, 11.63; FTIR (cm^{-1}): 3401, 2955, 2920, 1460, 1378, 1018, 744. Elemental analysis (CHN): Calculated (%): C: 81.33, H: 6.26, N: 7.90; Experimental (%): C: 81.16, H: 6.22, N: 8.00.

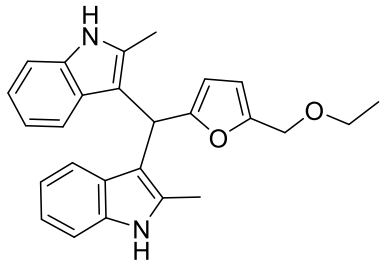
(5-(bis(2-methyl-1*H*-indol-3-yl)methyl)furan-2-yl)methyl acetate (**1l**):



1l

Light brown solid; 1.103 g, 90%; Melting point: 170 - 172 °C; ^{1}H-NMR (DMSO-d$_6$, 400 MHz) δ (ppm): 10.77 (br., 2H, -N**H**), 7.22 (d, 2H, *J* = 8 Hz, Ar-**H)**, 6.96 (d, 2H, Ar-**H**, *J* = 8 Hz), 6.91 - 6.72 (m, 2H, Ar-**H**), 6.42 (d, 1H, furyl-C**H**, *J* = 2.8 Hz), 5.82 (s, 1H, C**H**), 5.76 (d, 1H, furyl-C**H**, *J* = 2.8 Hz,), 4.98 (s, 2H, -C**H$_2$**), 2.15 (s, 6H, -C**H$_3$**), 1.96 (s, 3H, -C**H$_3$**); ^{13}C-NMR (DMSO-d$_6$, 100 MHz) δ (ppm): 169.8, 157.8, 147.9, 134.9, 131.9, 127.7, 119.6, 118.0, 118.0, 111.5, 110.3, 110.3, 107.8, 57.6, 32.6, 20.5, 11.5; FTIR (cm^{-1}): 3398, 2955, 2921, 1734, 1460, 742. Elemental analysis (CHN): Calculated (%): C: 75.71, H: 5.86, N: 6.79; Experimental (%): C: 75.51, H: 6.78, N: 6.77.

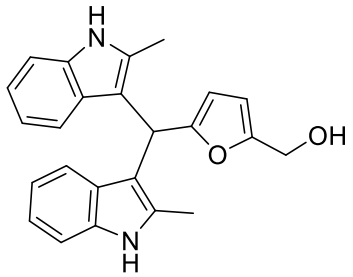
3,3'-((5-(ethoxymethyl)furan-2-yl)methylene)bis(2-methyl-1*H*-indole) (**1m**):



1m

Light yellow solid; 1.007 g, 78%; Melting Point: 218-220 °C; ^{1}H-NMR (DMSO-d$_6$, 400 MHz) δ (ppm): 10.76 (br., 2H, -N**H**), 7.22 (d, 2H, Ar-H, *J* = 8 Hz), 6.99 (d, 2H, *J* = 8 Hz, Ar-**H**), 6.92 - 6.72 (m, 4H, Ar-**H**), 6.30 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.81 (s, 1H, -C**H**), 5.73 (d, 1H, *J* = 3.2 Hz, furyl-C**H**), 4.31 (s, 2H, -C**H$_2$**), 3.43 (q, 2H, -OC**H$_2$**CH$_3$, *J* = 6.8 Hz), 2.16 (s, 6H, -C**H$_3$**), 1.07 (t, 3H, -OCH$_2$C**H$_3$**, *J* = 6.8 Hz); ^{13}C-NMR (DMSO-d$_6$, 100 MHz) δ (ppm): 157.1, 150.3, 134.9, 131.8, 127.7, 119.6, 118.1, 118.0, 110.5, 110.3, 109.9, 107.5, 64.2, 63.7, 32.7, 14.9, 11.6; FTIR (cm^{-1}): 3402, 2923, 1460, 1302, 1088, 1017, 743. Elemental analysis (CHN): Calculated (%): C: 78.36, H: 6.58, N: 7.03; Experimental (%): C: 78.39, H: 6.58, N: 7.04.

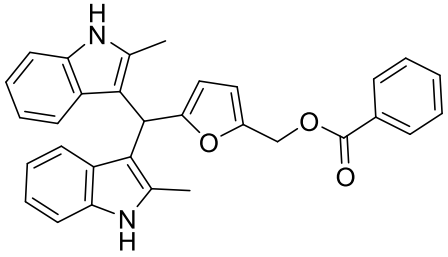
(5-(bis(2-methyl-1*H*-indol-3-yl)methyl)furan-2-yl)methanol (**1n**):



1n

Light blue solid; 1.115g, 76%; Melting Point: 204-206 °C; ^{1}H-NMR (DMSO-d_6, 400 MHz) δ (ppm): 10.74 (br., 2H, -N**H**), 7.22 (d, 2H, Ar-**H**, *J* = 8 Hz), 7.01 (d, 2H, *J* = 8 Hz, Ar-**H**), 6.92 - 6.73 (m, 4H, Ar-**H**), 6.17 (d, 2H, furyl-C**H,** *J* = 3.2 Hz), 5.80 (s, 1H, -C**H**), 5.70 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.14 (t, 1H, -O**H**, *J* = 5.6 Hz), 4.35 (d, 2H, -C**H₂**OH), 2.16 (s, 6H, -C**H₃**); ^{13}C-NMR (DMSO-d_6, 100 MHz) δ (ppm): 156.1, 154.0, 134.9, 131.8, 127.8, 119.6, 118.0, 110.6, 110.3, 107.3, 55.7, 32.7, 11.6; FTIR (cm^{-1}): 3408, 2924, 1455, 1214, 976, 742. Elemental analysis (CHN): Calculated (%): C: 77.81, H: 5.99, N: 7.56; Experimental (%): C: 77.52, H: 5.97, N: 7.54.

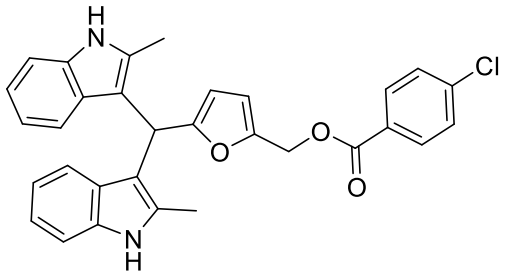
(5-(bis(2-methyl-1*H*-indol-3-yl)methyl)furan-2-yl)methyl benzoate (**1o**):



1o

Light brown solid; 0.927 g, 90%; Melting point: 203 °C; ^{1}H-NMR (DMSO-d_6, 400 MHz) δ (ppm): 10.77 (br., 2H, -N**H**), 7.88 - 7.47 (m, 5H, Ar-**H**), 7.21 (d, 1H, Ar-**H**), 6.97 -6.70 (m, 6H, Ar-**H**), 6.54 (d, 1H, furyl-C**H**, *J* = 3.2 Hz), 5.84 (s, 1H, -C**H**), 5.81 (d, 1H, furyl-C**H**, *J* = 3.2 Hz), 5.26 (s, 2H, C**H₂**), 2.16 (s, 6H, -C**H₃**); ^{13}C-NMR (DMSO-d_6, 100 MHz) δ (ppm): 165.2, 158.1, 147.7, 134.9, 133.4, 131.9, 129.4, 129.2, 128.7, 127.7, 119.6, 118.1, 118.0, 111.9, 110.4, 110.3, 107.9, 58.5, 32.7, 11.5; FTIR (cm^{-1}): 3399, 2920, 1712, 1460, 1270, 753. Elemental analysis (CHN): Calculated (%): C: 78.46, H: 5.52, N: 5.90; Experimental (%): C: 78.72, H: 5.53, N: 5.92.

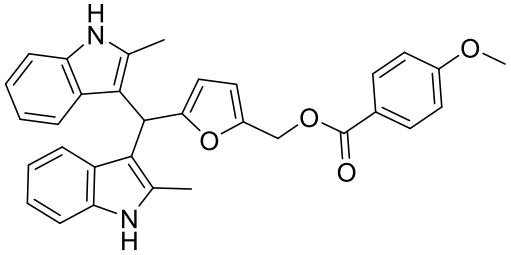
(5-(bis(2-methyl-1*H*-indol-3-yl)methyl)furan-2-yl)methyl 4-chlorobenzoate (**1p**):



1p

Light brown solid; 0.807g, 84%; Melting point: 202 °C; ^{1}H-NMR (DMSO-d$_6$, 400 MHz) δ (ppm): 10.76 (br., 2H, -N**H**), 7.86 (d, 2H, Ar-**H,** *J* = 8 Hz), 7.57 (d, 2H, *J* = 8 Hz, Ar-**H**), 7.21 (d, 2H, *J* = 8 Hz, Ar-**H**), 6.96 (d, 2H, *J* = 8 Hz, Ar-**H**), 6.90 - 6.69 (m, 4H, Ar-**H)**, 6.54 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.83 (s, 1H, -C**H**), 5.80 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.26 (s, 2H, -C**H**$_2$), 2.15 (s, 6H, -C**H**$_3$); ^{13}C-NMR (DMSO-d$_6$, 100 MHz) δ (ppm): 147.5, 138.3, 134.9, 131.9, 131.0, 128.8, 128.2, 127.7, 119.6, 118.1, 118.0, 112.0, 110.4, 110.3, 107.9, 58.8, 32.7, 11.5; FTIR (cm^{-1}): 2909, 1713, 1459, 1300, 1092, 741. Elemental analysis (CHN): Calculated (%): C: 73.15, H: 4.95, N: 5.50; Experimental (%): C: 73.10, H: 4.94, N: 5.49.

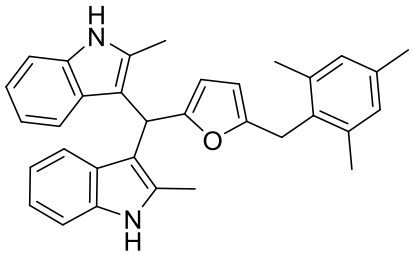
(5-(bis(2-methyl-1*H*-indol-3-yl)methyl)furan-2-yl)methyl 4-methoxybenzoate (**1q**):



1q

Brown solid; 0.833 g, 86%; Melting point: 198-200 °C; ^{1}H-NMR (DMSO-d$_6$, 400 MHz) δ (ppm): 10.75 (br., 2H, -N**H**), 7.82 (d, 2H, Ar-**H,** *J* = 8.4 Hz), 7.20 (d, 2H, Ar-**H**), 7.02 (d, 2H, Ar-**H,** *J* = 8.4 Hz), 6.96 - 6.88 (m, 4H, Ar-**H**), 6.73 (t, 2H, Ar-**H**), 6.51 (d, 1H, furyl-C**H**, *J* = 3.2 Hz), 5.83 (s, 1H, -C**H**), 5.80 (d, 1H, furyl-C**H,** *J* = 3.2 Hz), 5.20 (s, 2H, -C**H**$_2$), 3.84 (s, -OC**H**$_3$), 2.14 (s, 6H, -C**H**$_3$); ^{13}C-NMR (DMSO-d$_6$, 100 MHz) δ (ppm): 164.9, 163.2, 158.0, 147.9, 134.9, 131.8, 131.3, 127.7, 121.5, 119.6, 118.1, 118.0, 113.9, 111.7, 110.4, 110.3, 107.8, 58.2, 55.5, 32.6, 11.5; FTIR (cm^{-1}): 3411, 2925, 1705, 1605, 1257, 746. Elemental analysis (CHN): Calculated (%): C: 76.17, H: 5.59, N: 5.55; Experimental (%): C: 76.37, H: 5.60, N: 5.55.

3,3'-((5-(2,4,6-trimethylbenzyl)furan-2-yl)methylene)bis(2-methyl-1*H*-indole) (**1r**):



1r

Light brown solid; 0.829 g, 80%; Melting Point: 227-229 °C; ^{1}H-NMR (DMSO-d_6, 400 MHz) δ (ppm): 10.71 (br., 2H, -N**H**), 7.21 - 6.94 (m, 6H, Ar-**H**), 6.90 - 6.72 (m, 4H, Ar-**H**), 5.77 (s, 1H, -C**H**), 5.64 (d, 2H, furyl-C**H**), 3.84 (s, 2H, -C**H$_2$**), 2.21 (s, 9H, -C**H$_3$**), 2.11 (s, 6H, -CH_3); ^{13}C-NMR (DMSO-d_6, 100 MHz) δ (ppm): 155.3, 151.9, 136.2, 135.0, 134.9, 131.7, 131.3, 128.6, 127.8, 119.5, 118.2, 117.9, 110.7, 110.2, 107.4, 105.7, 32.6, 27.8, 20.5, 19.4, 11.5; FTIR (cm^{-1}): 3401, 2919, 1735, 1615, 1459, 1012, 743. Elemental analysis (CHN): Calculated (%): C: 83.86, H: 6.82, N: 5.93; Experimental (%): C: 84.17, H: 6.87, N: 5.95.

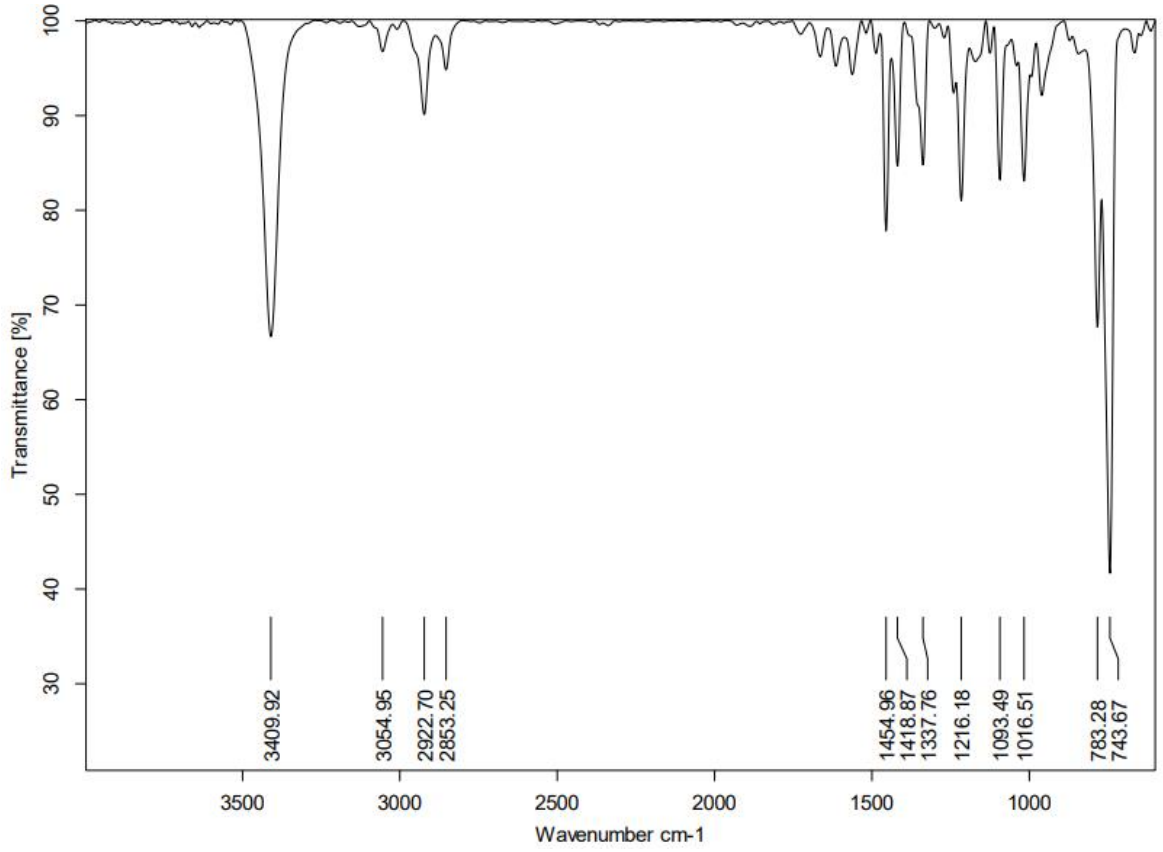


Figure S1. The FTIR spectrum of **1a**.

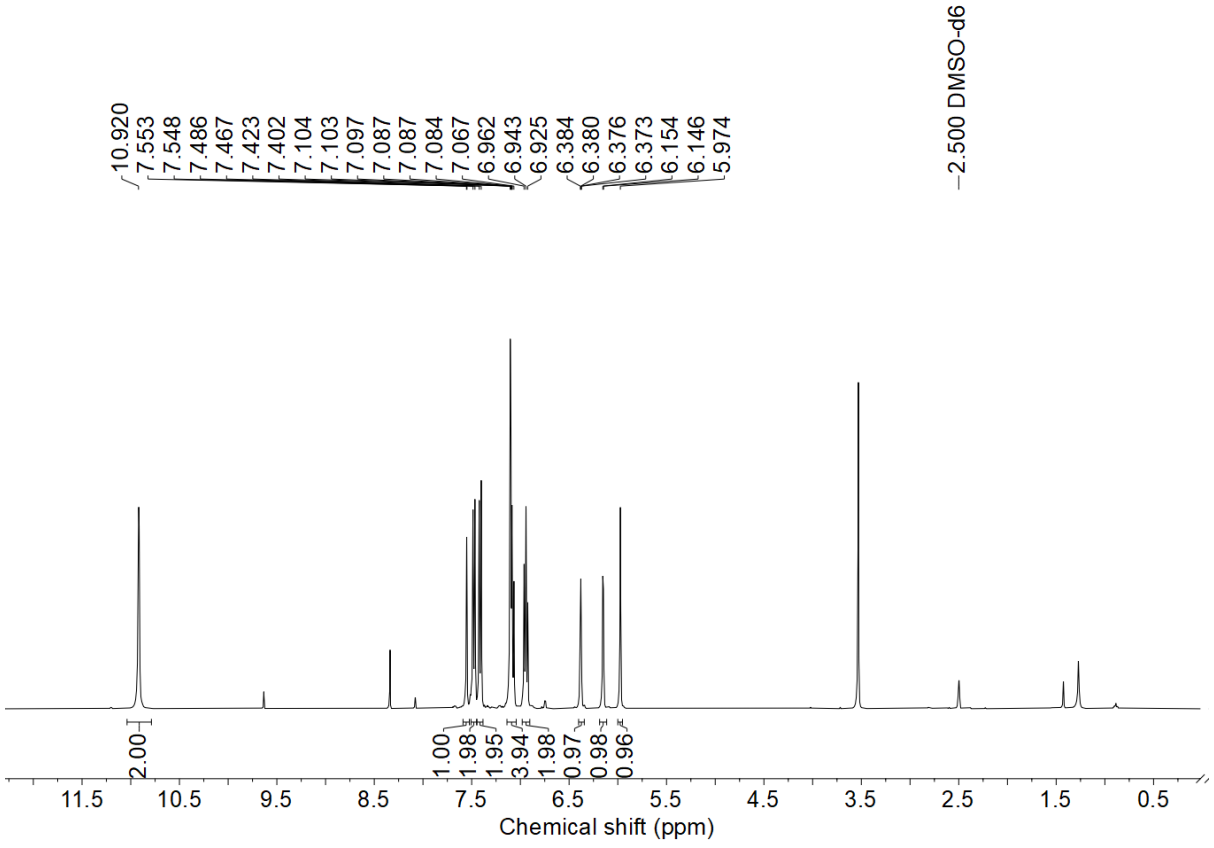


Figure S2. The ^{1}H-NMR spectrum of **1a**.

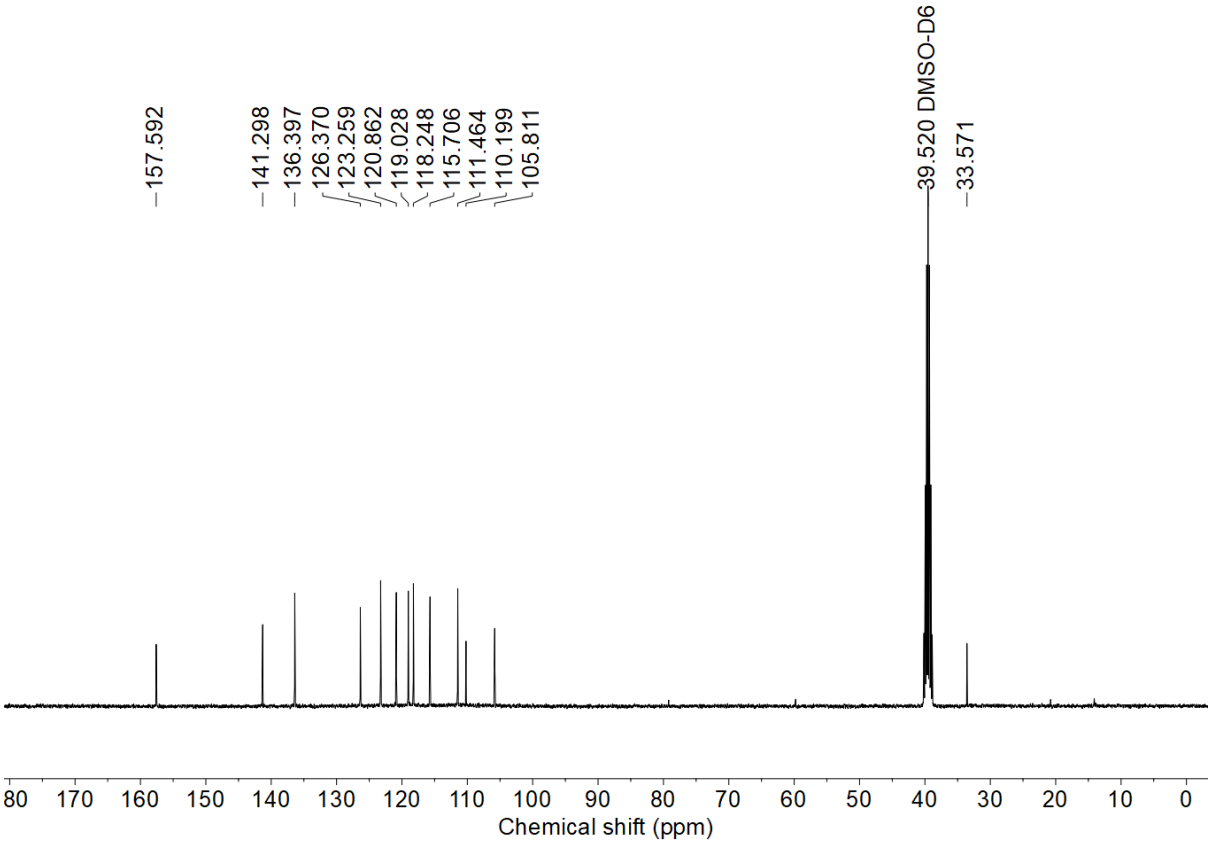


Figure S3. The ^{13}C-NMR spectrum of **1a**.

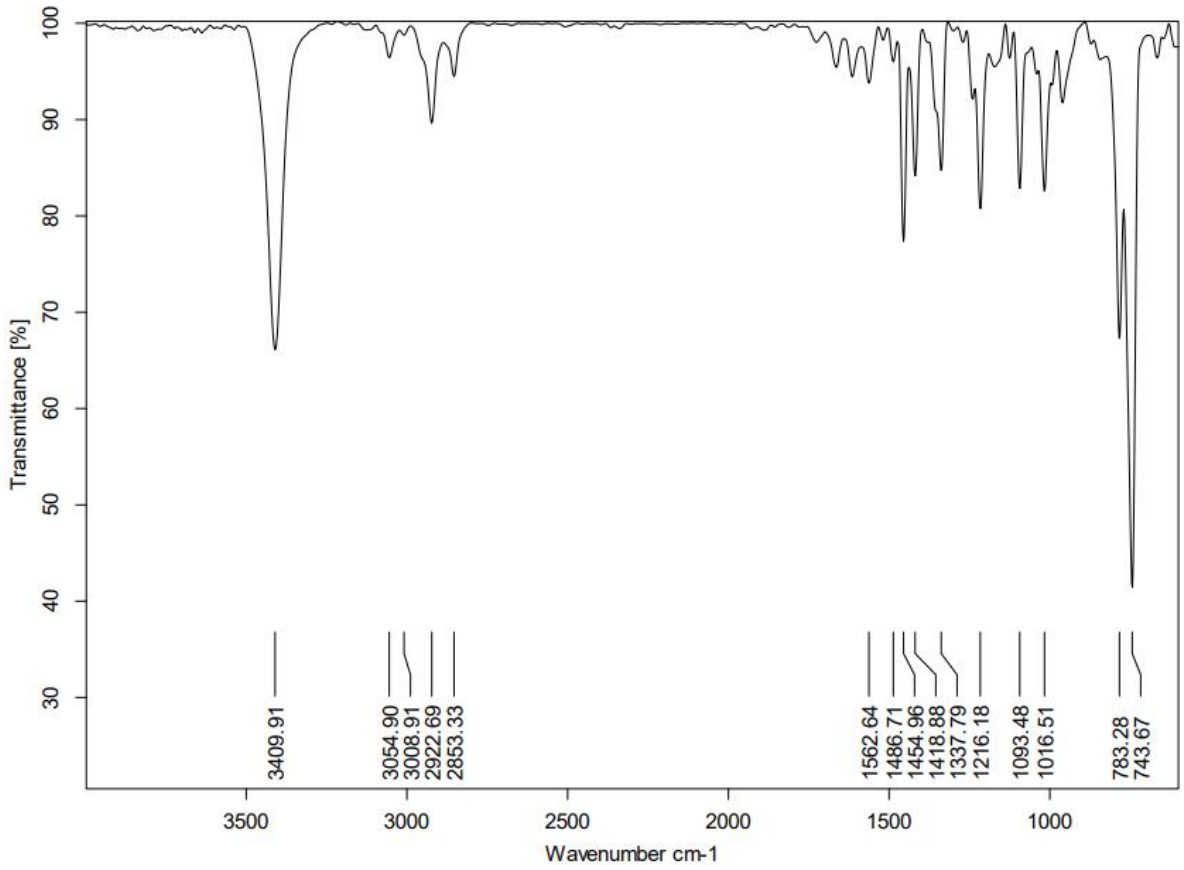


Figure S4. The FTIR spectrum of **1b**.

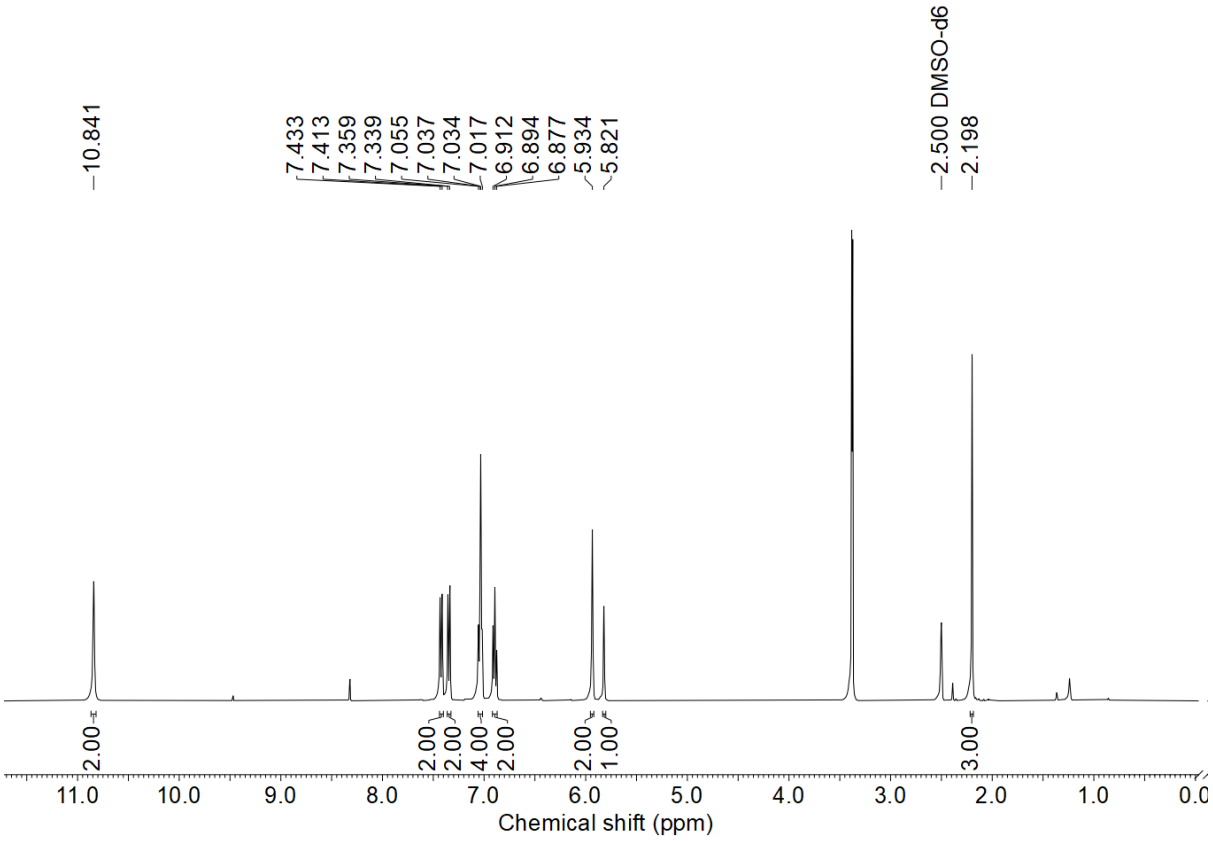


Figure S5. The ^{1}H-NMR spectrum of **1b**.

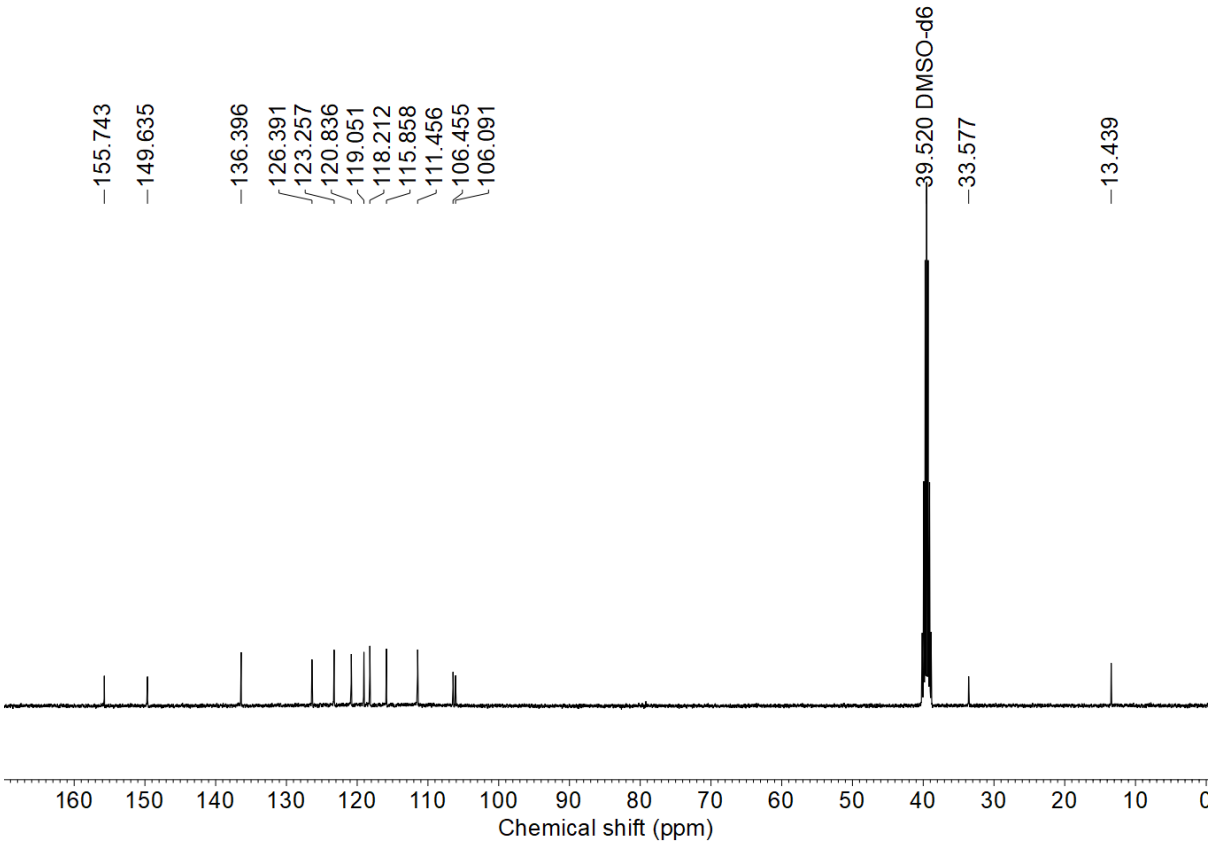


Figure S6. The ^{13}C-NMR spectrum of **1b.**

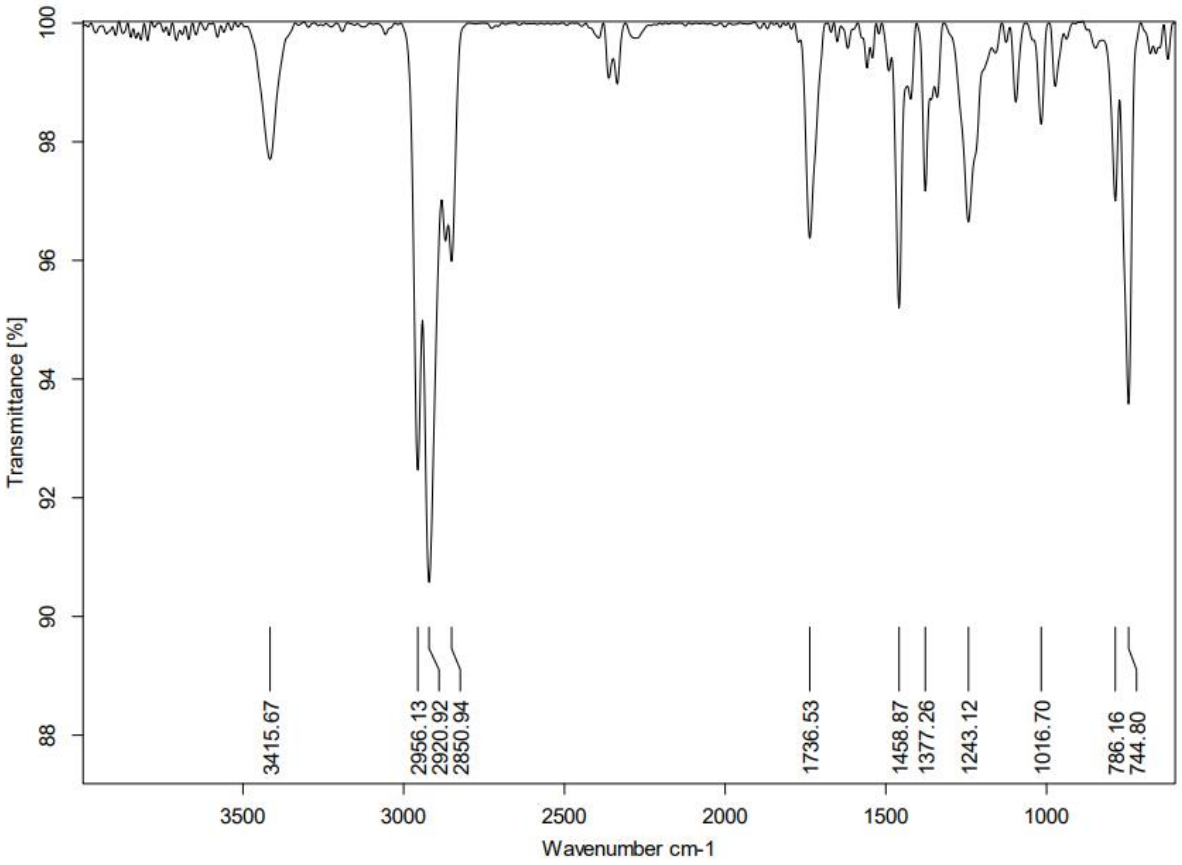


Figure S7. The FTIR spectrum of **1c**.

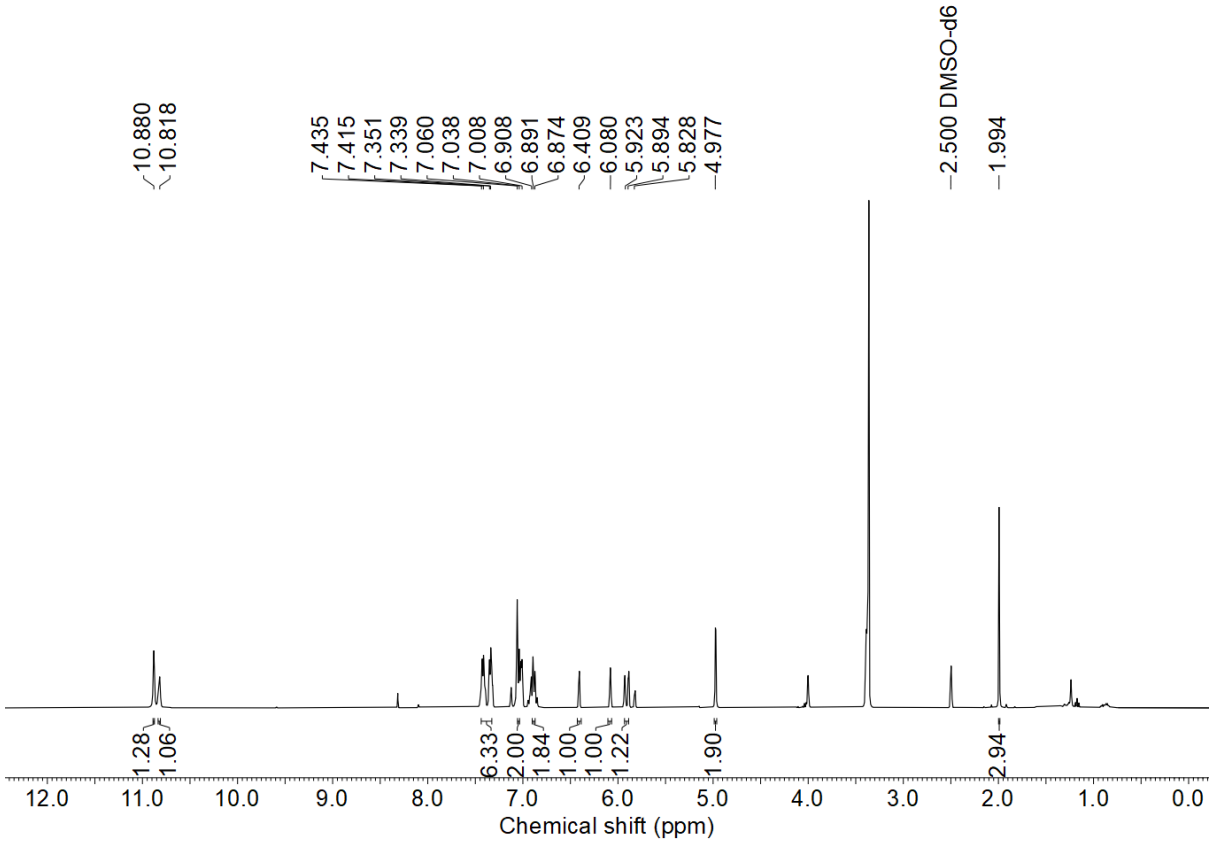


Figure S8. The ^{1}H-NMR spectrum of **1c**.

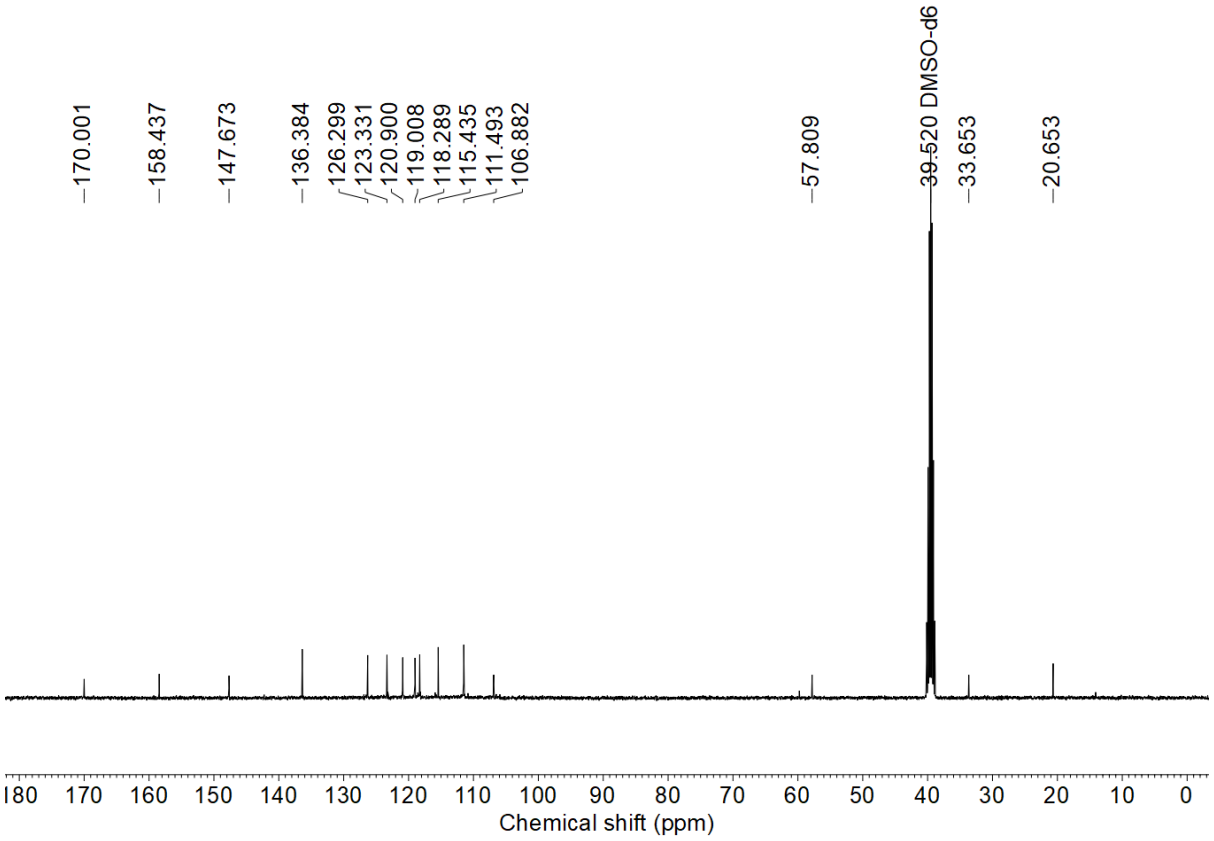


Figure S9. The ^{13}C-NMR spectrum of **1c.**

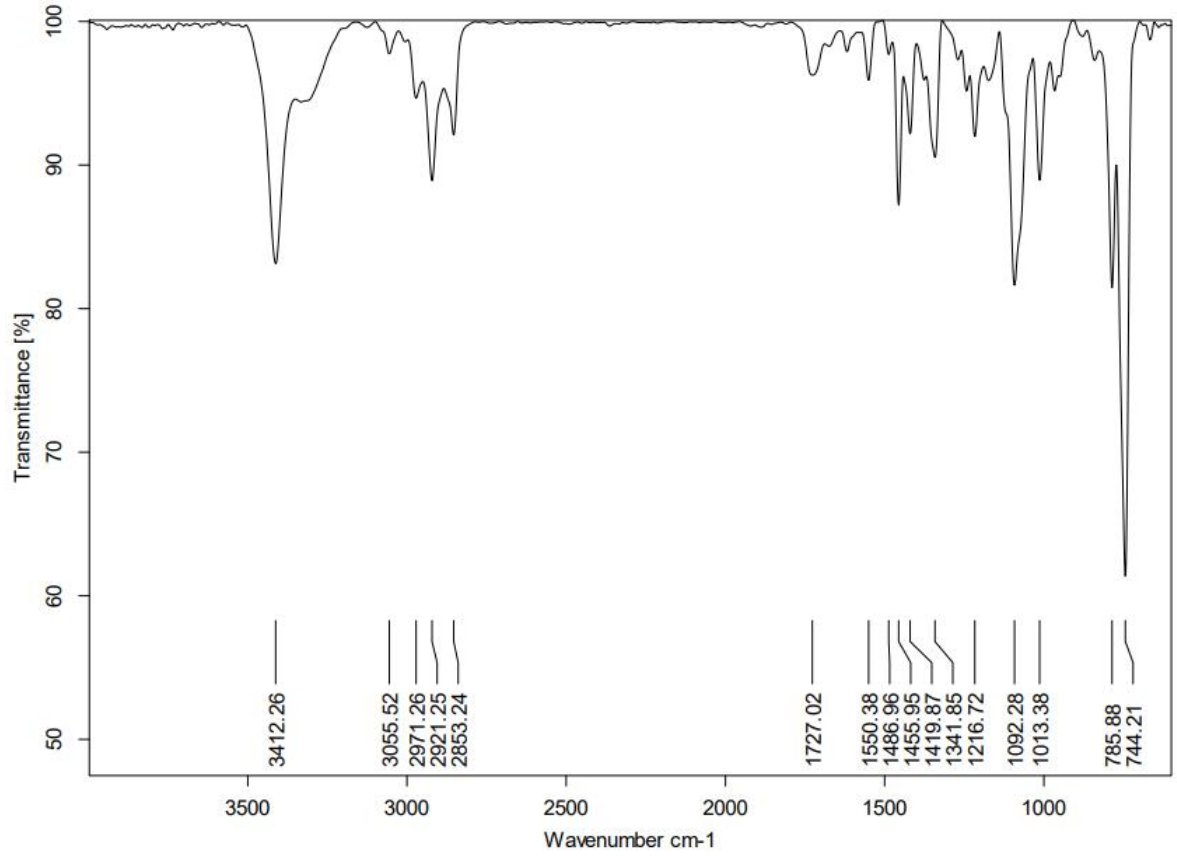


Figure S10. The FTIR spectrum of **1d**.

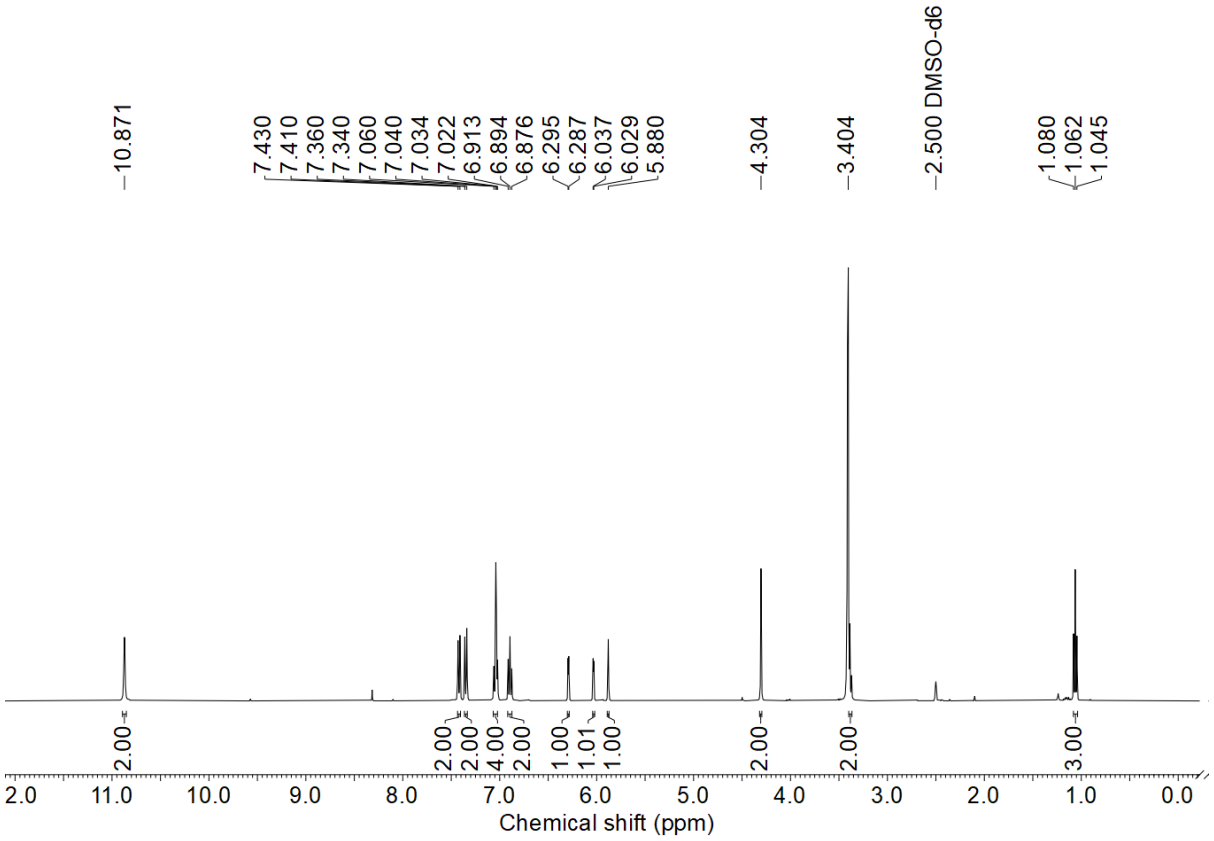


Figure S11. The ^{1}H-NMR spectrum of **1d**.

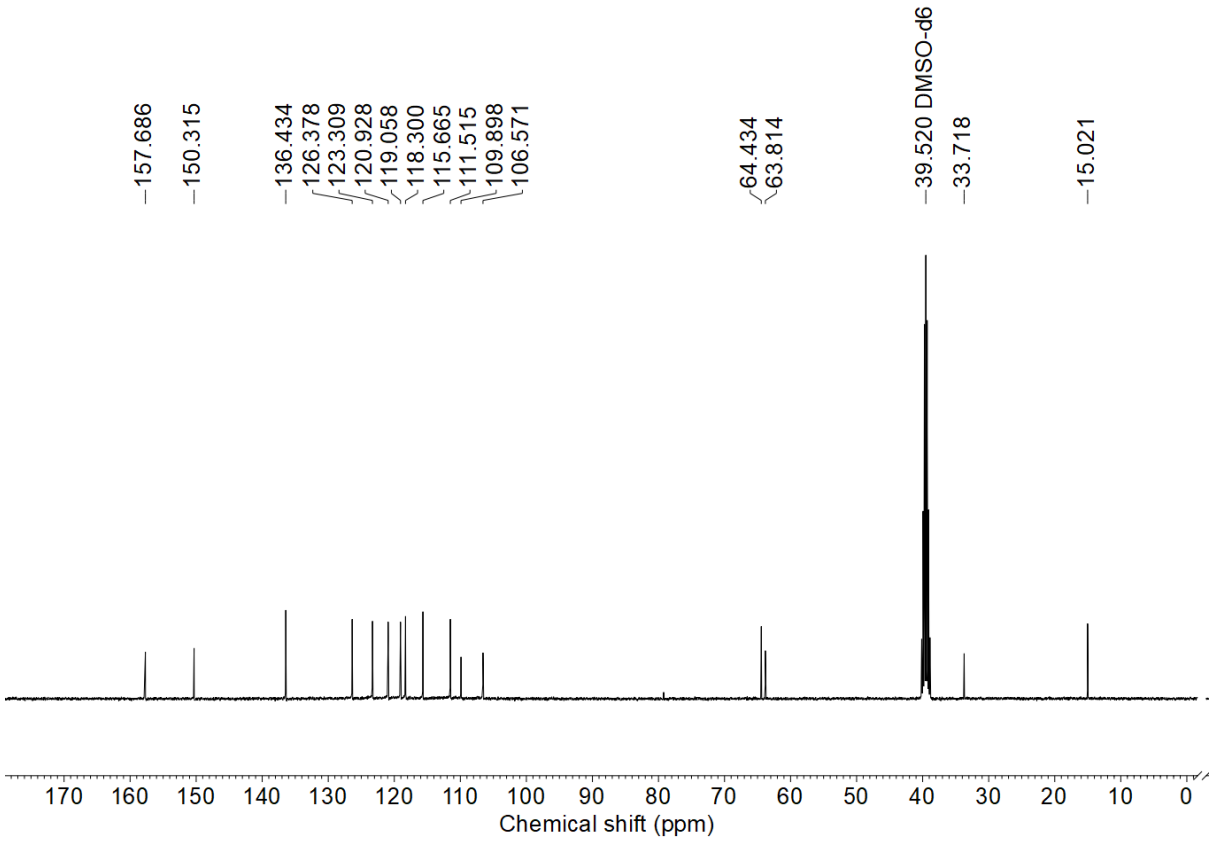


Figure S12. The ^{13}C-NMR spectrum of **1d**.

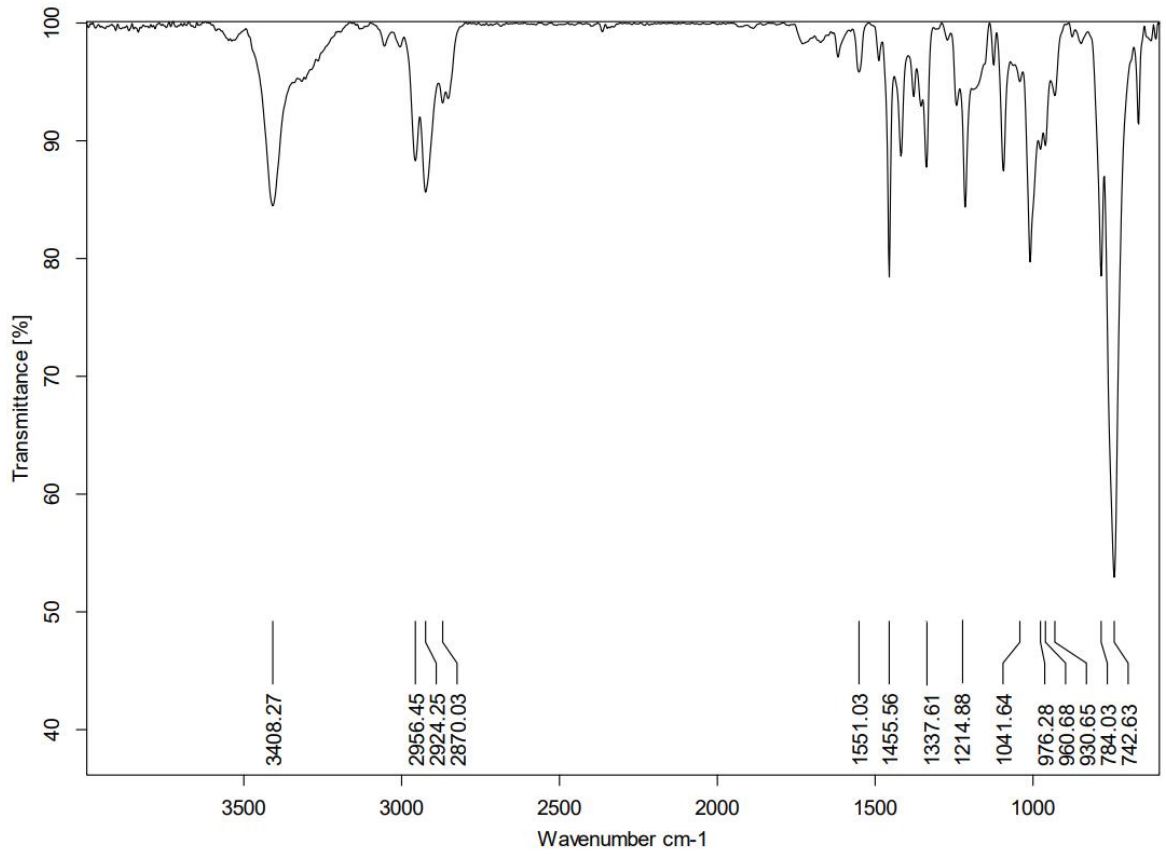


Figure S13. The FTIR spectrum **1e**.

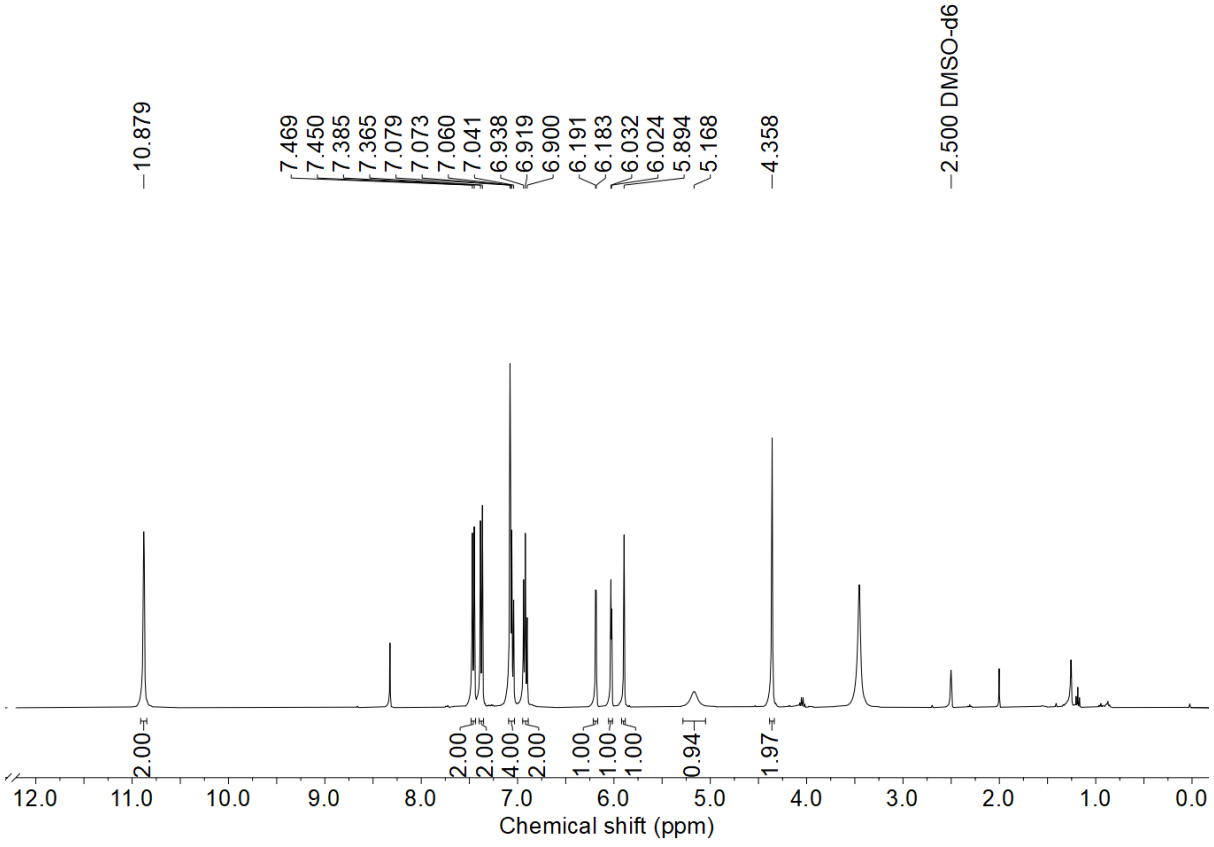


Figure S14. The ^{1}H-NMR spectrum **1e**.

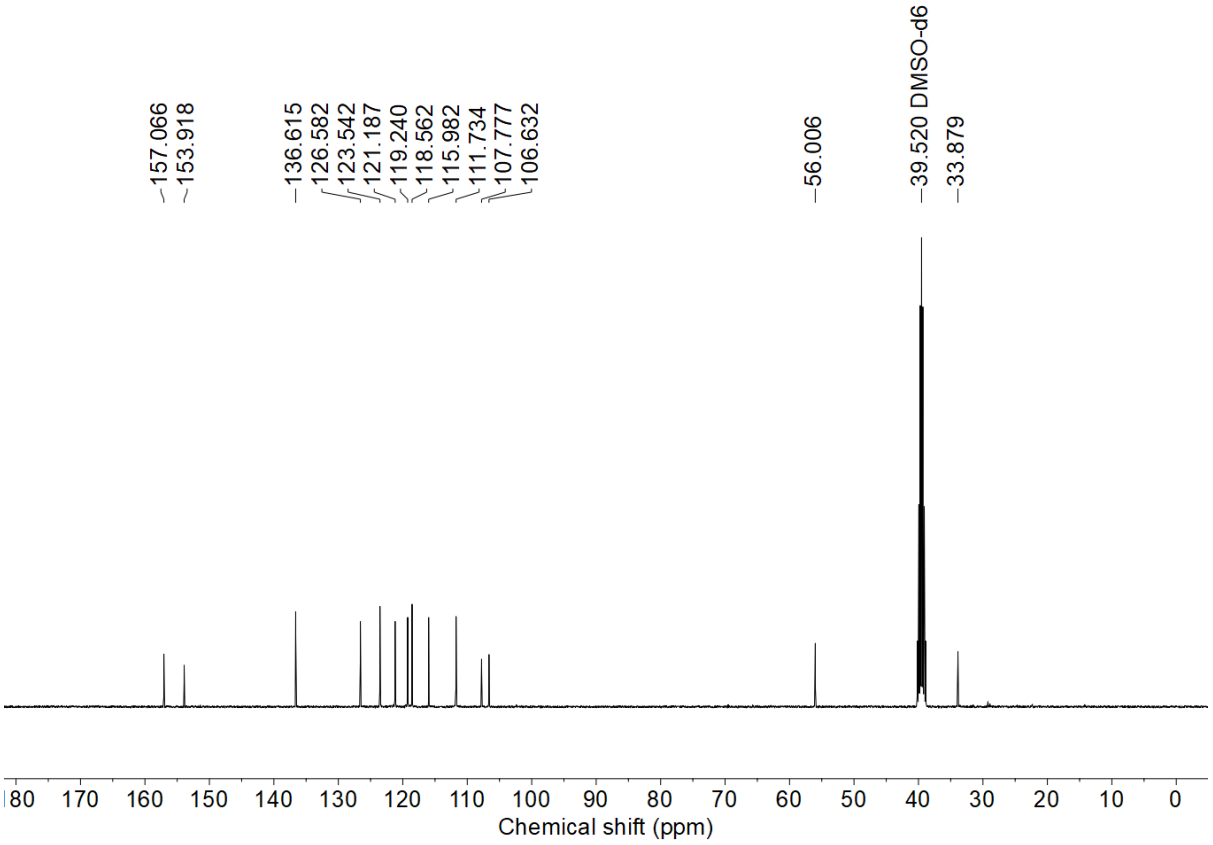


Figure S15. The ^{13}C-NMR spectrum **1e**.

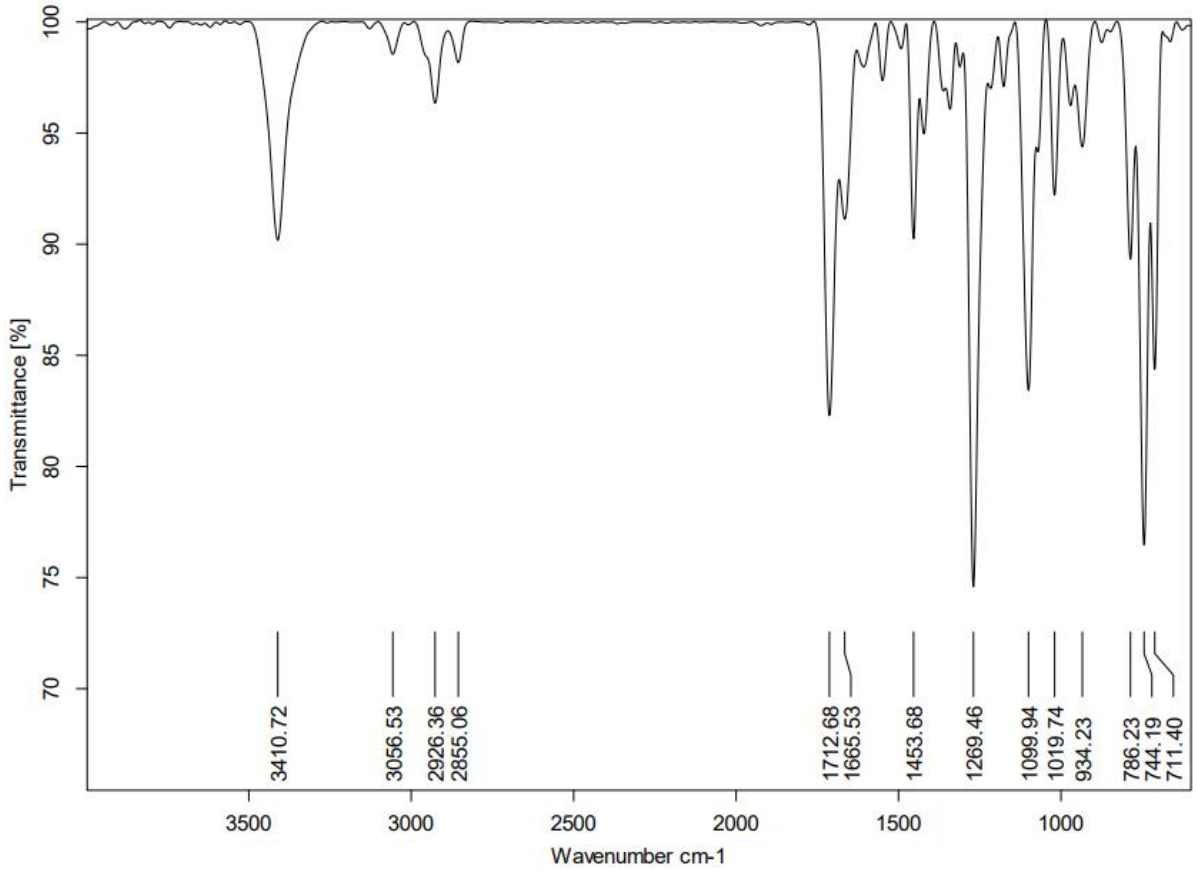


Figure S16. The FTIR spectrum of **1f.**

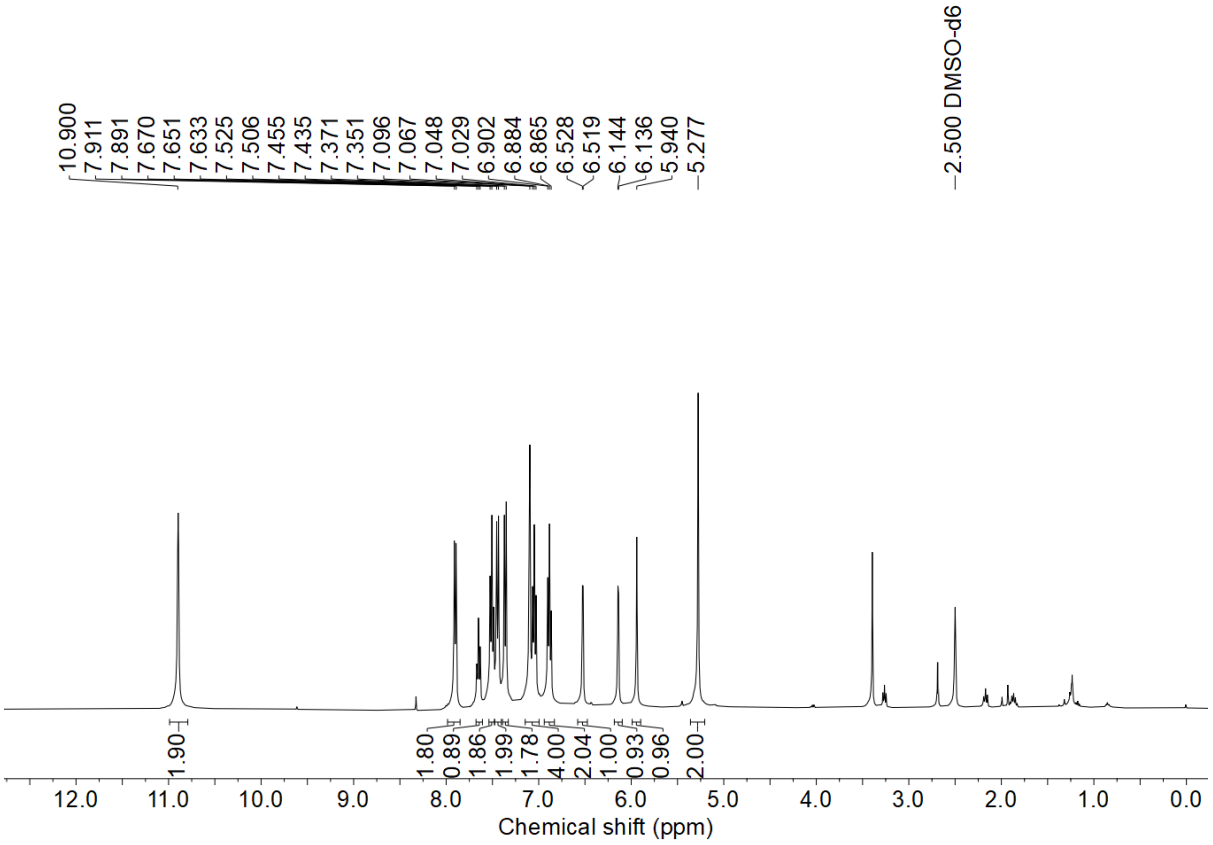


Figure S17. The ^{1}H-NMR spectrum of **1f**.

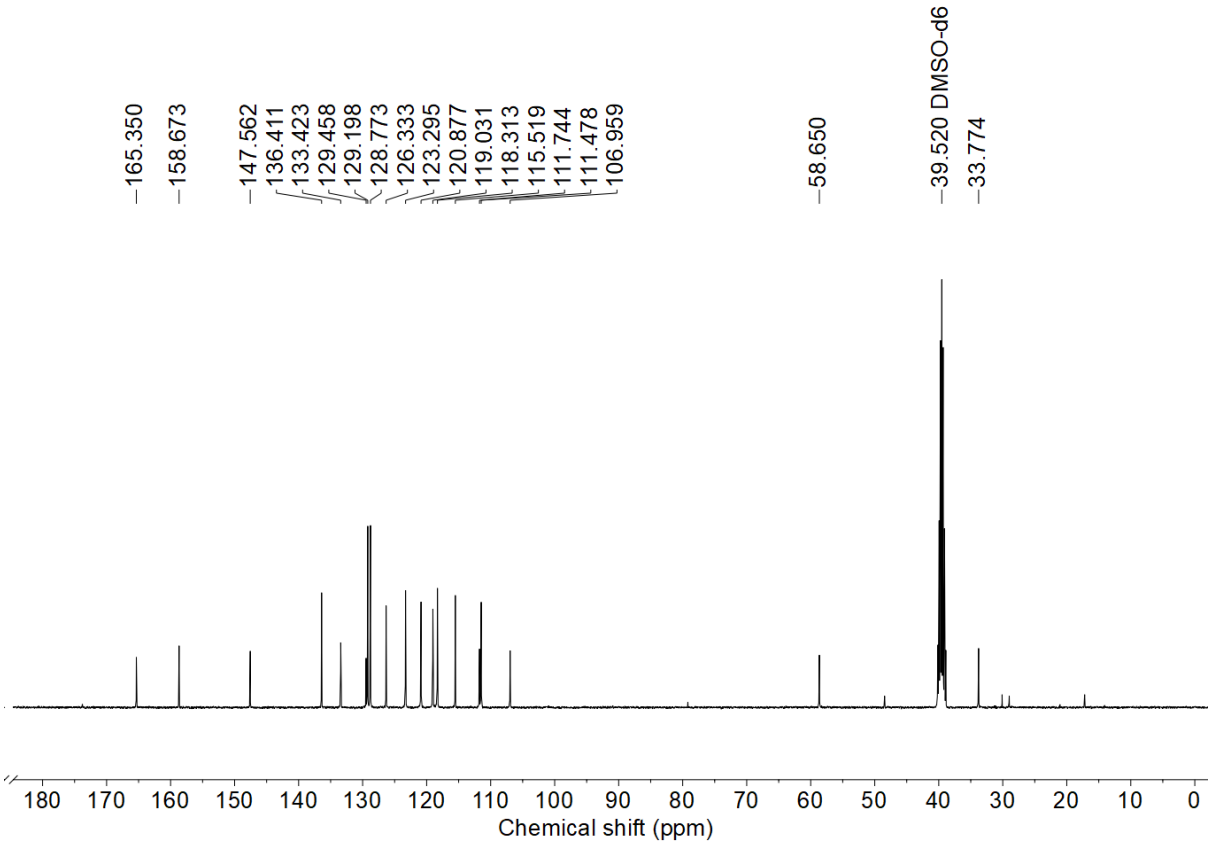


Figure S18. The ^{13}C-NMR spectrum of **1f**.

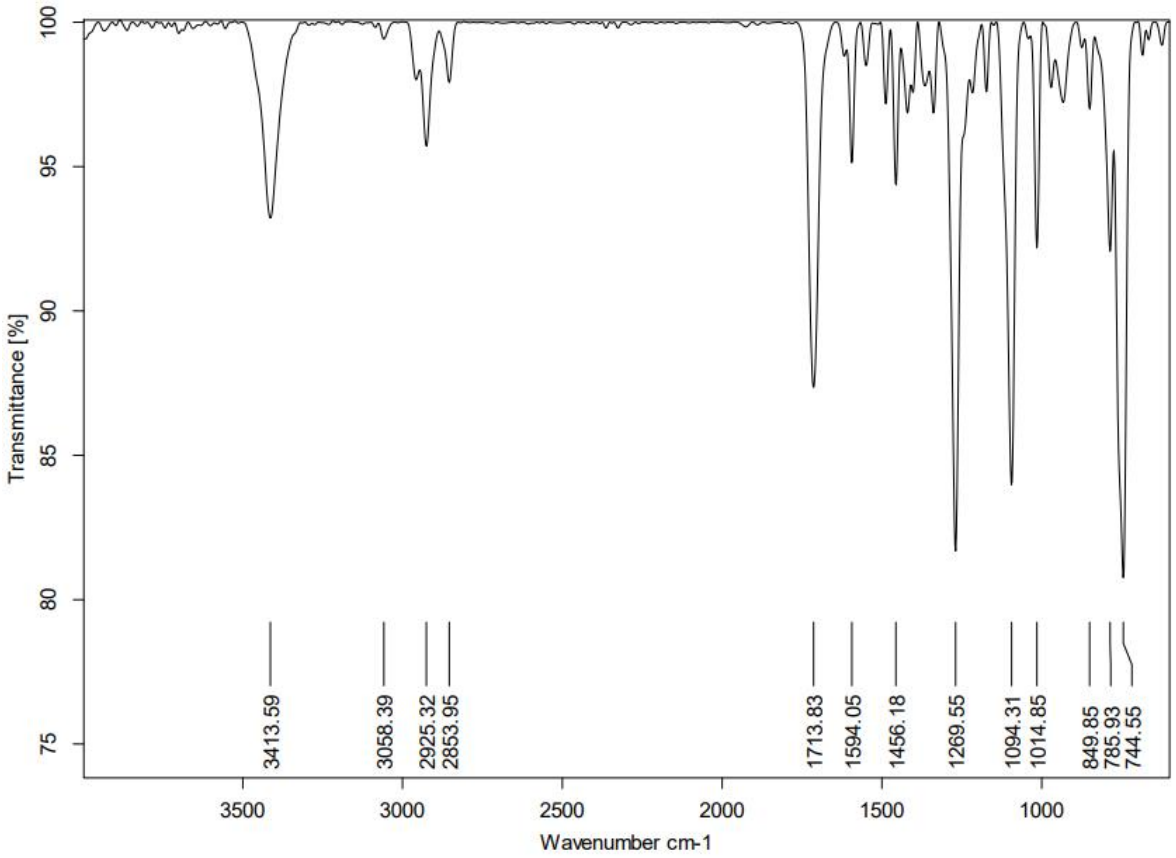


Figure S19. The FTIR spectrum of **1g**.

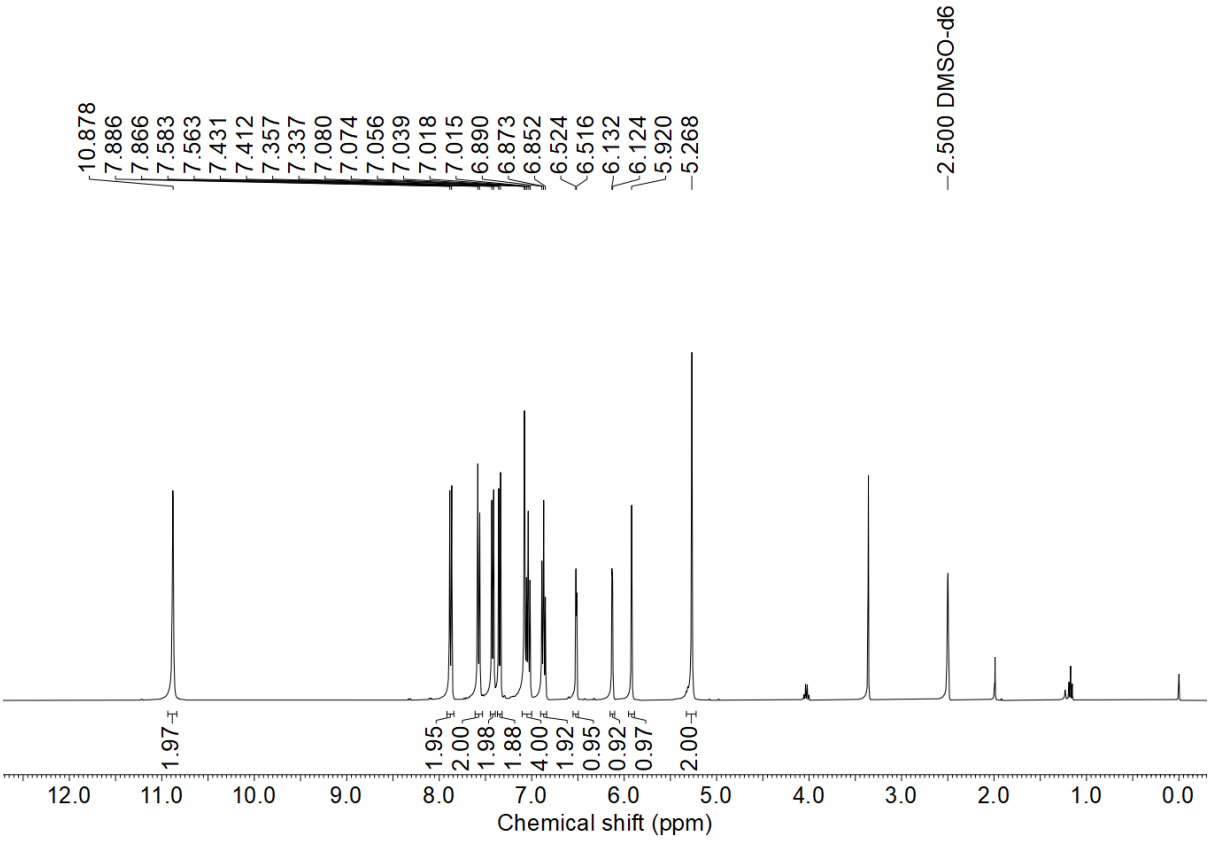


Figure S20. The ^{1}H-NMR spectrum of **1g**.

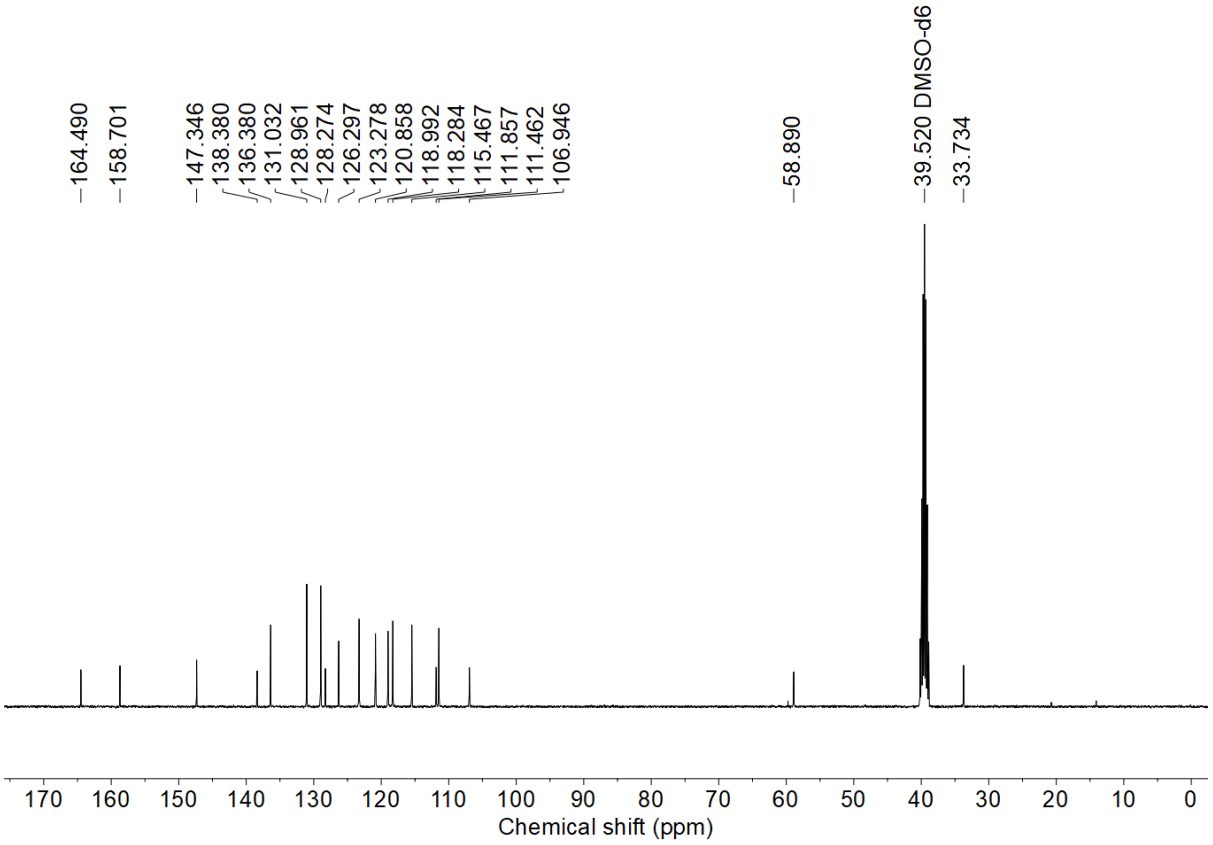


Figure S21. The ^{13}C-NMR spectrum of **1g**.

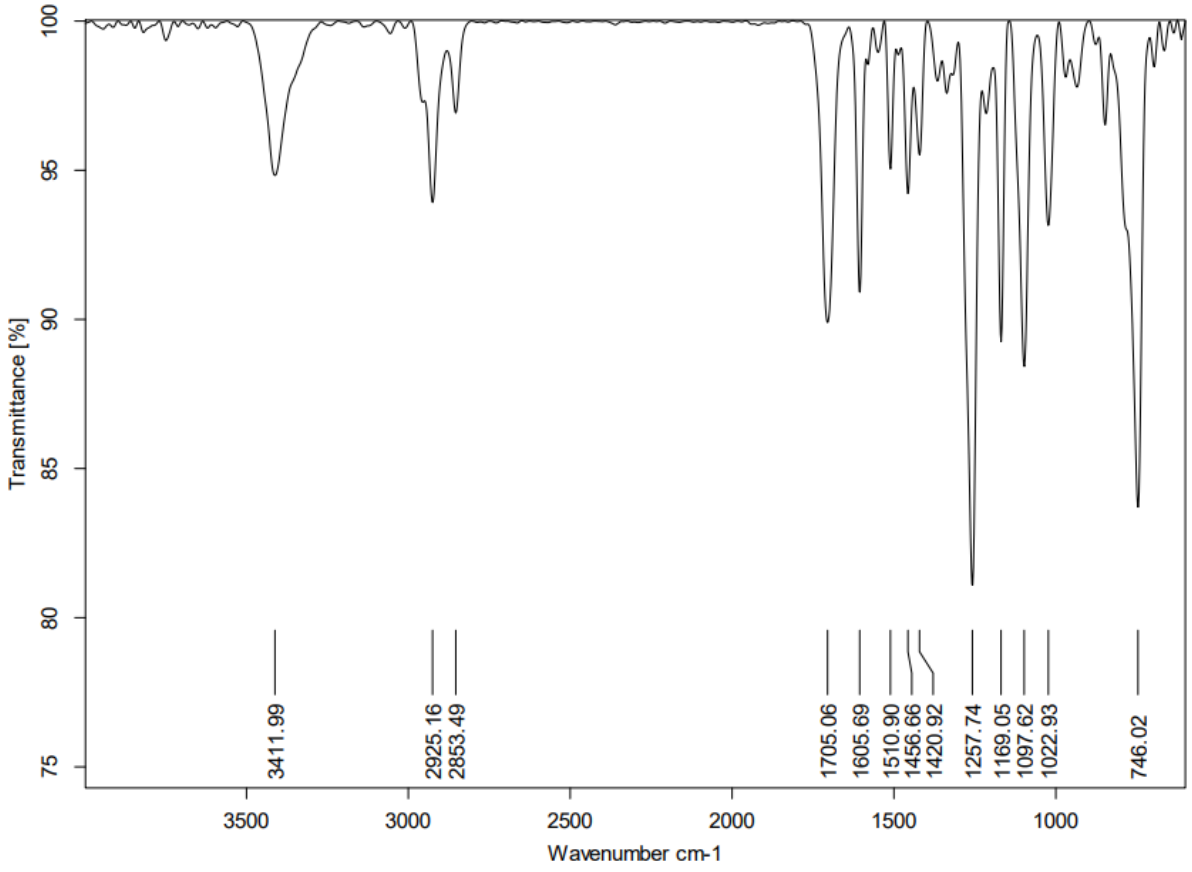


Figure S22. The FTIR spectrum of **1h**.

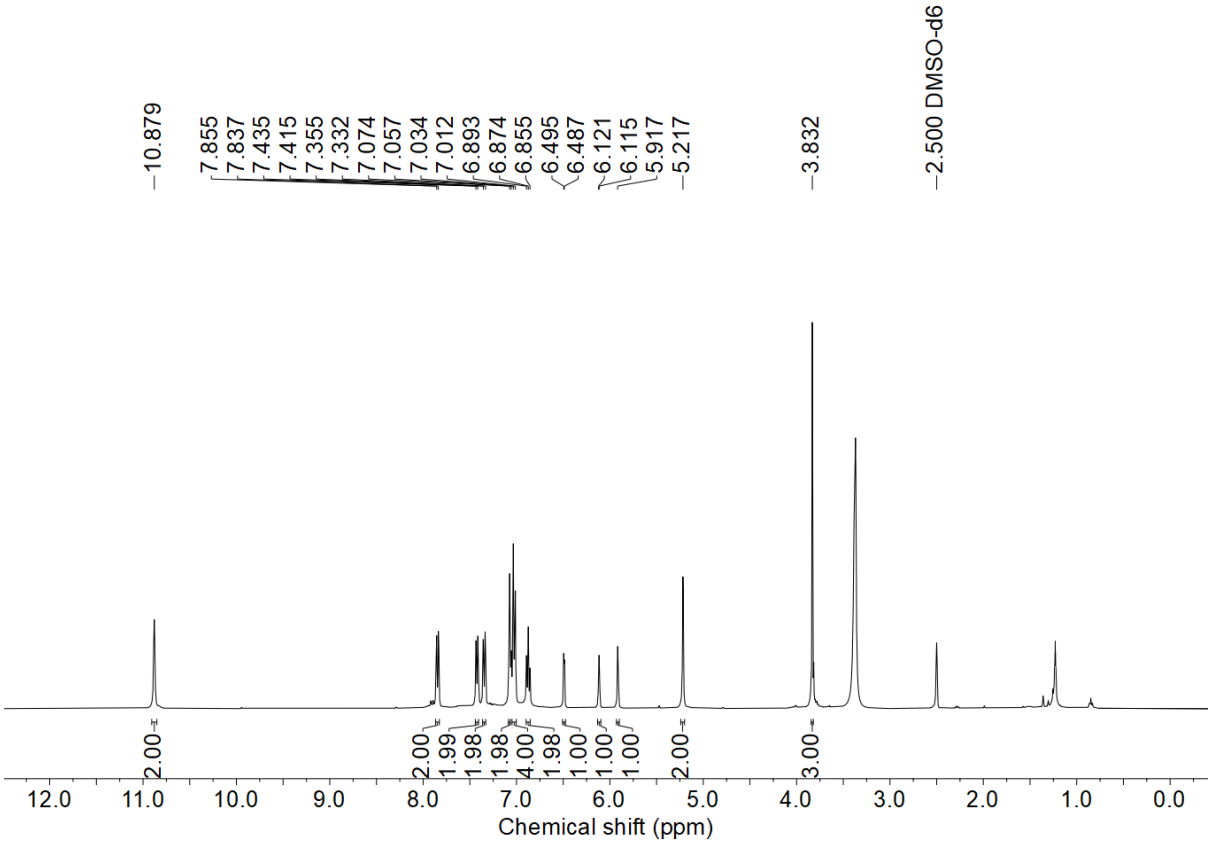


Figure S23. The ^{1}H-NMR spectrum of **1h**.

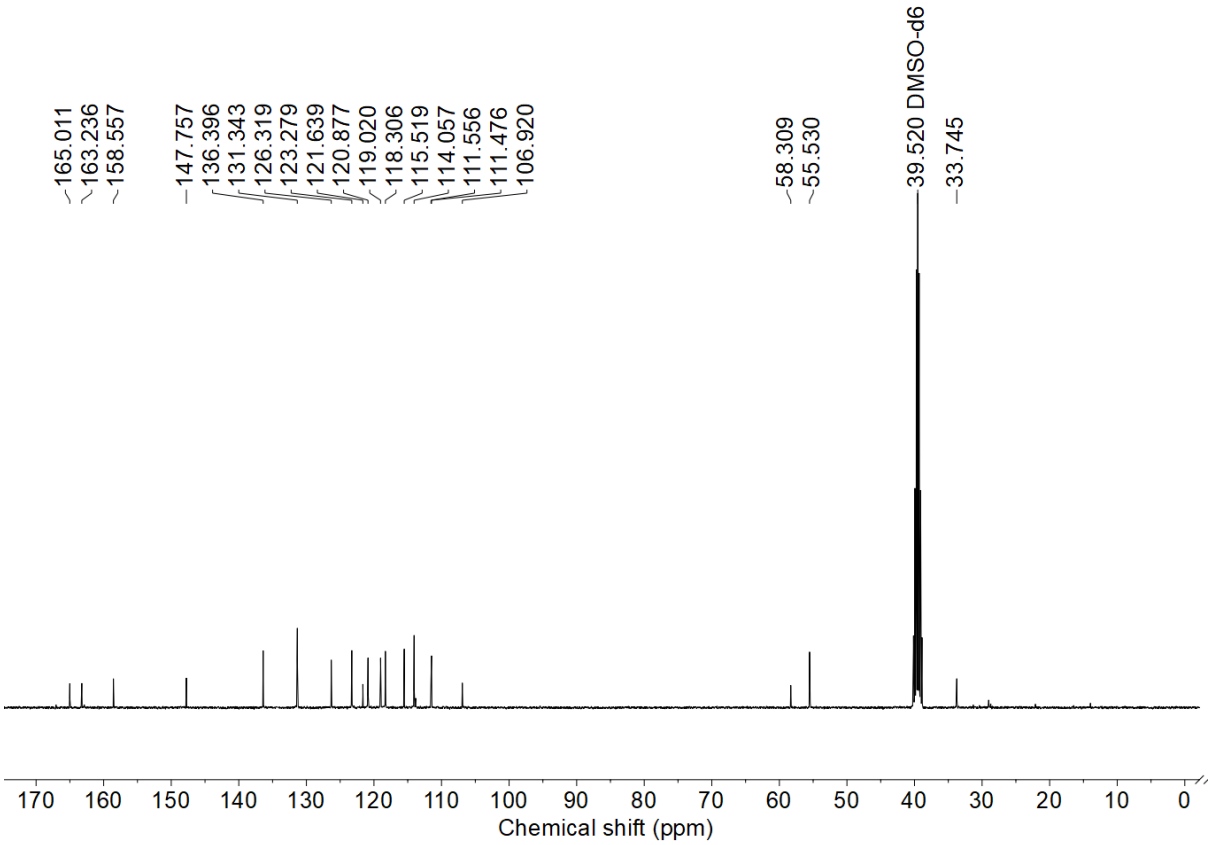


Figure S24. The ^{13}C-NMR spectrum of **1h.**

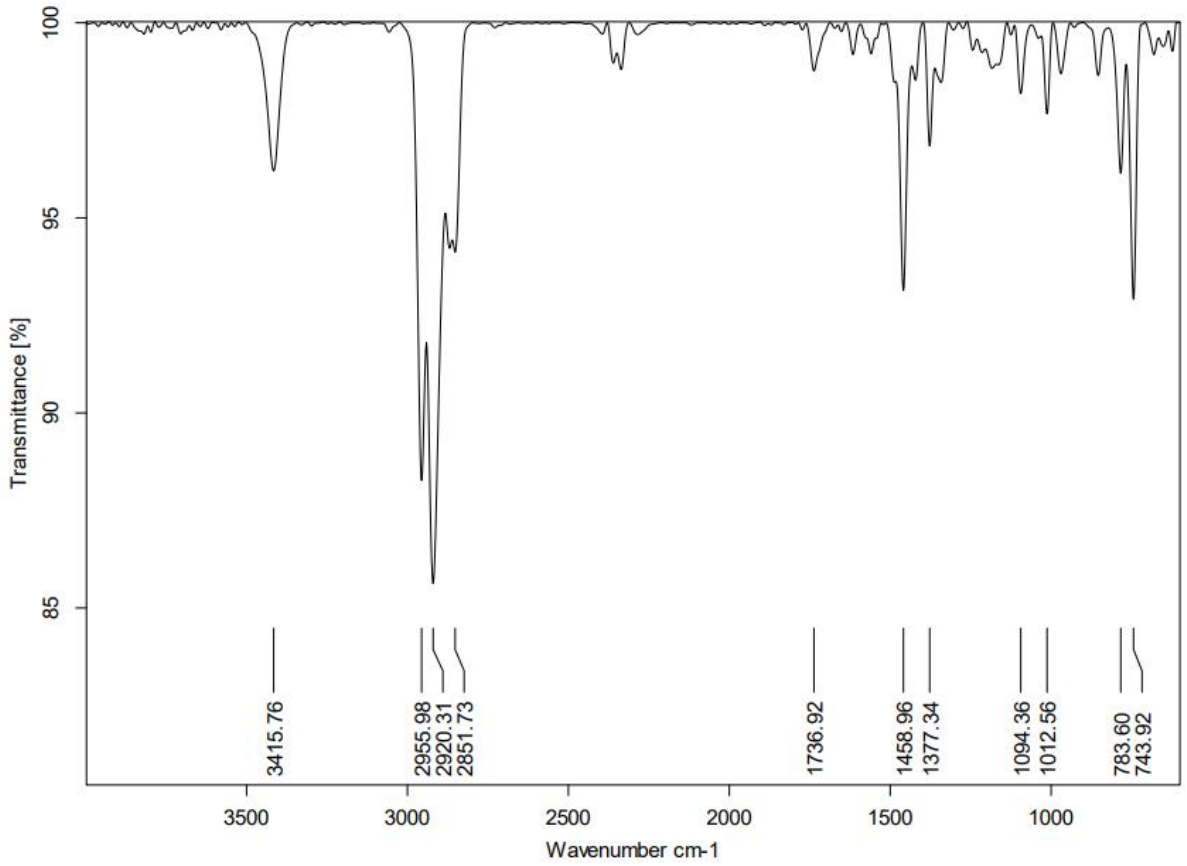


Figure S25. The FTIR spectrum of **1i**.

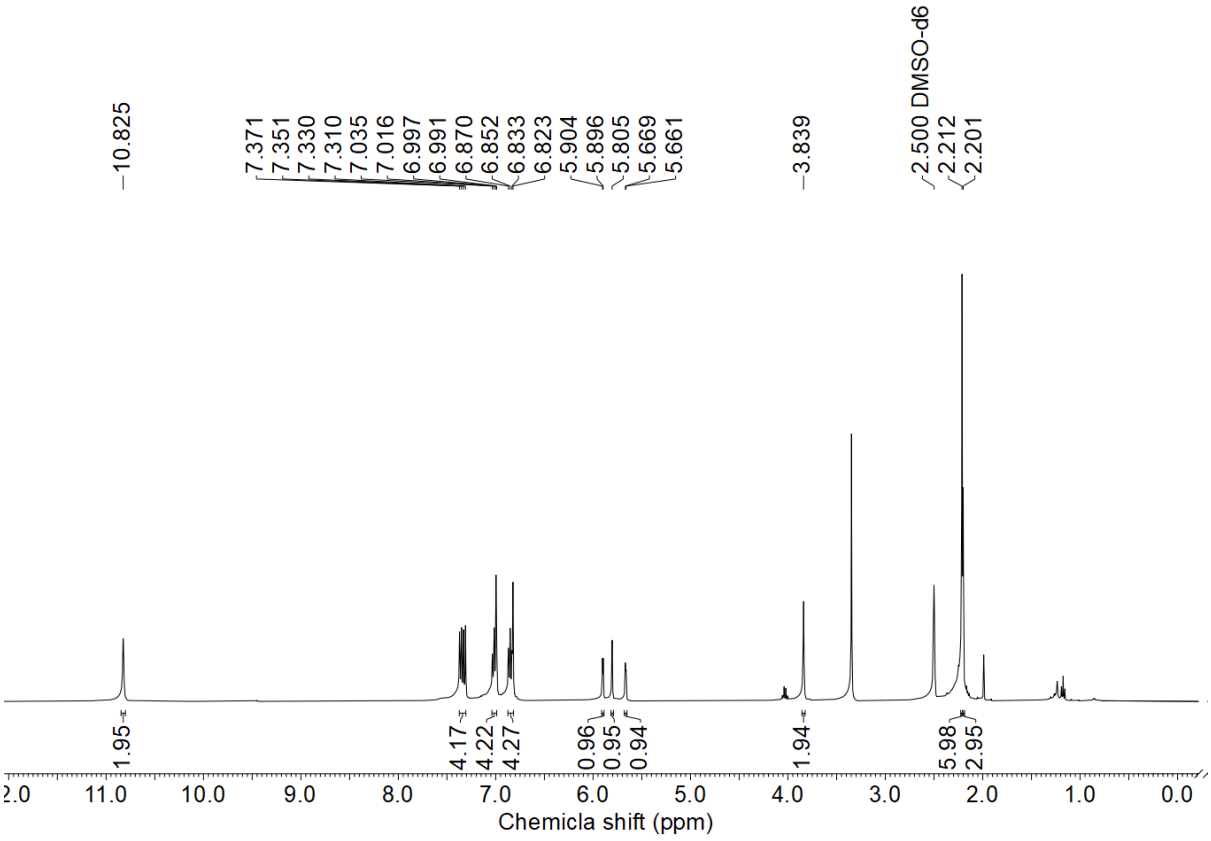


Figure S26. The ^{1}H-NMR spectrum of **1i**.

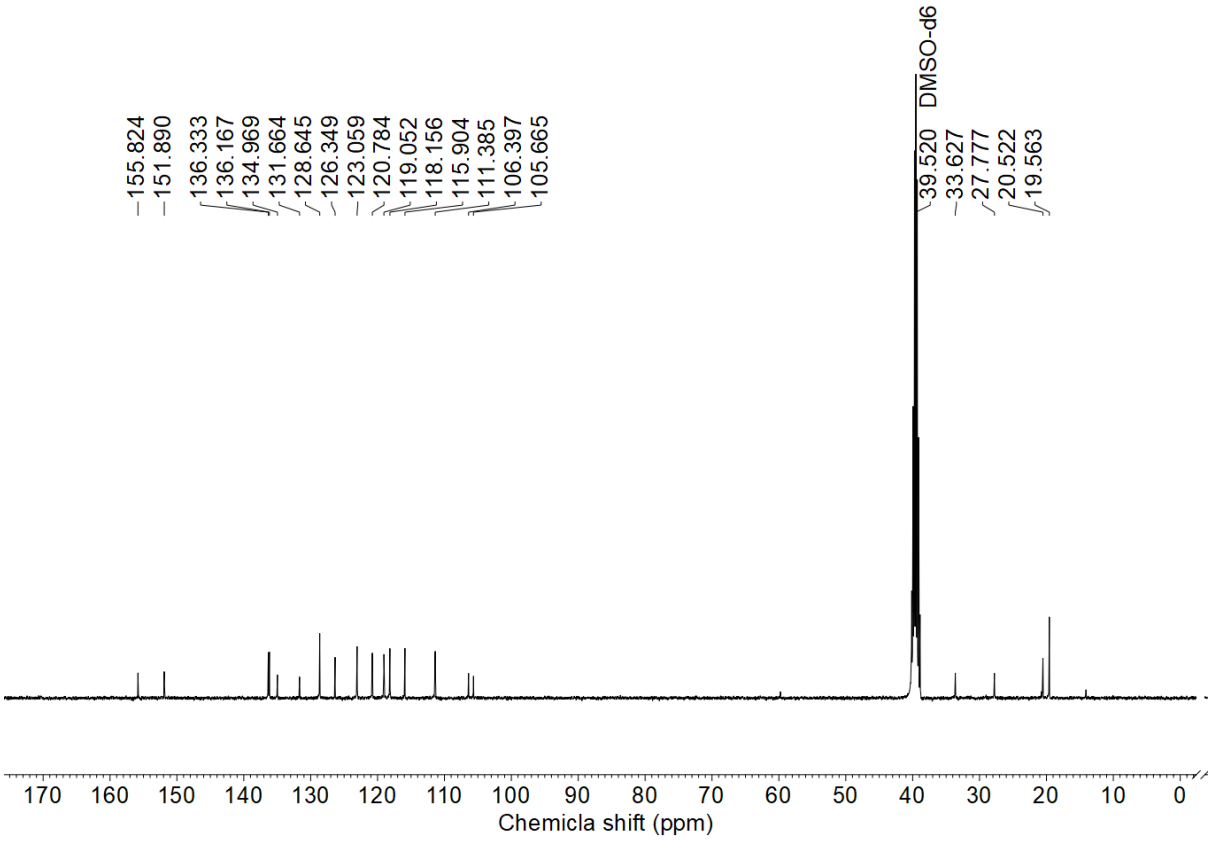


Figure S27. The ^{13}C-NMR spectrum of **1i**.

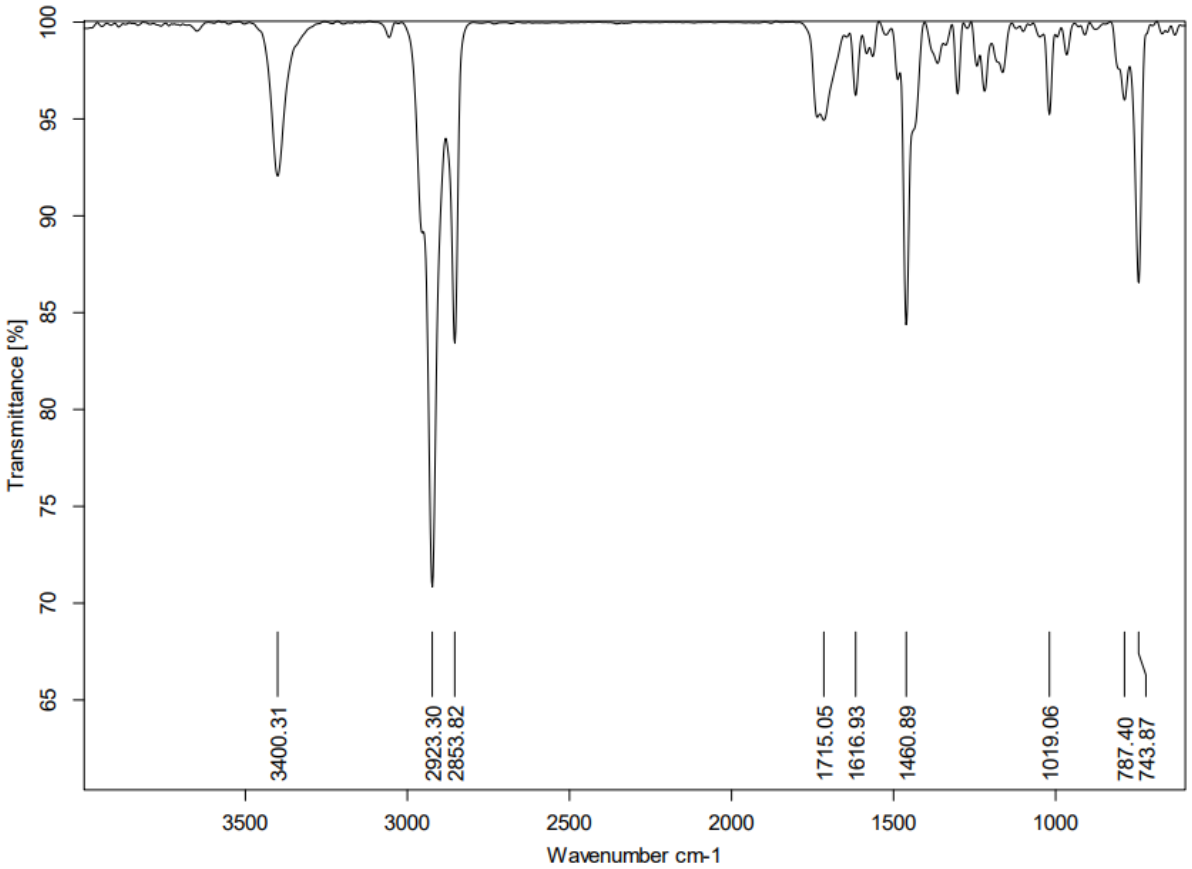


Figure S28. The FTIR spectrum of **1j**.

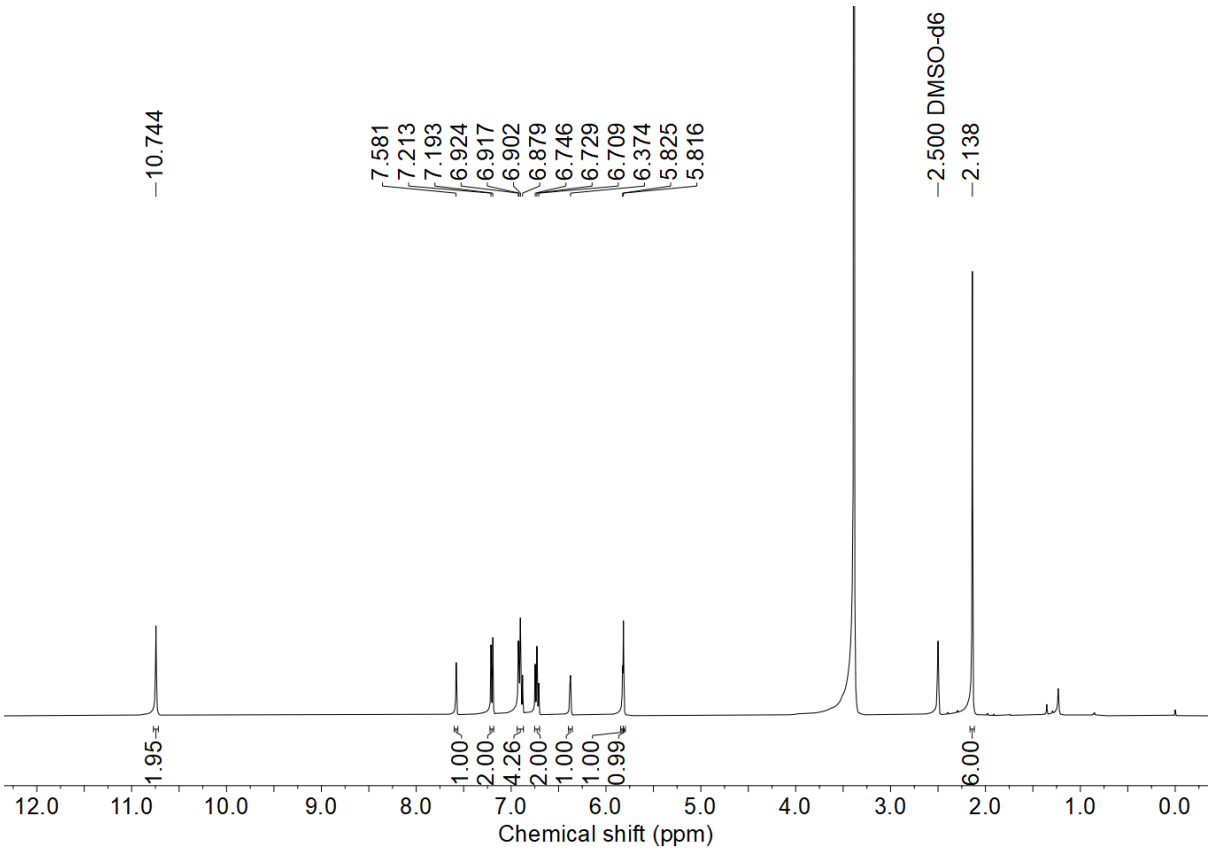


Figure S29. The ^{1}H-NMR spectrum of **1j**.

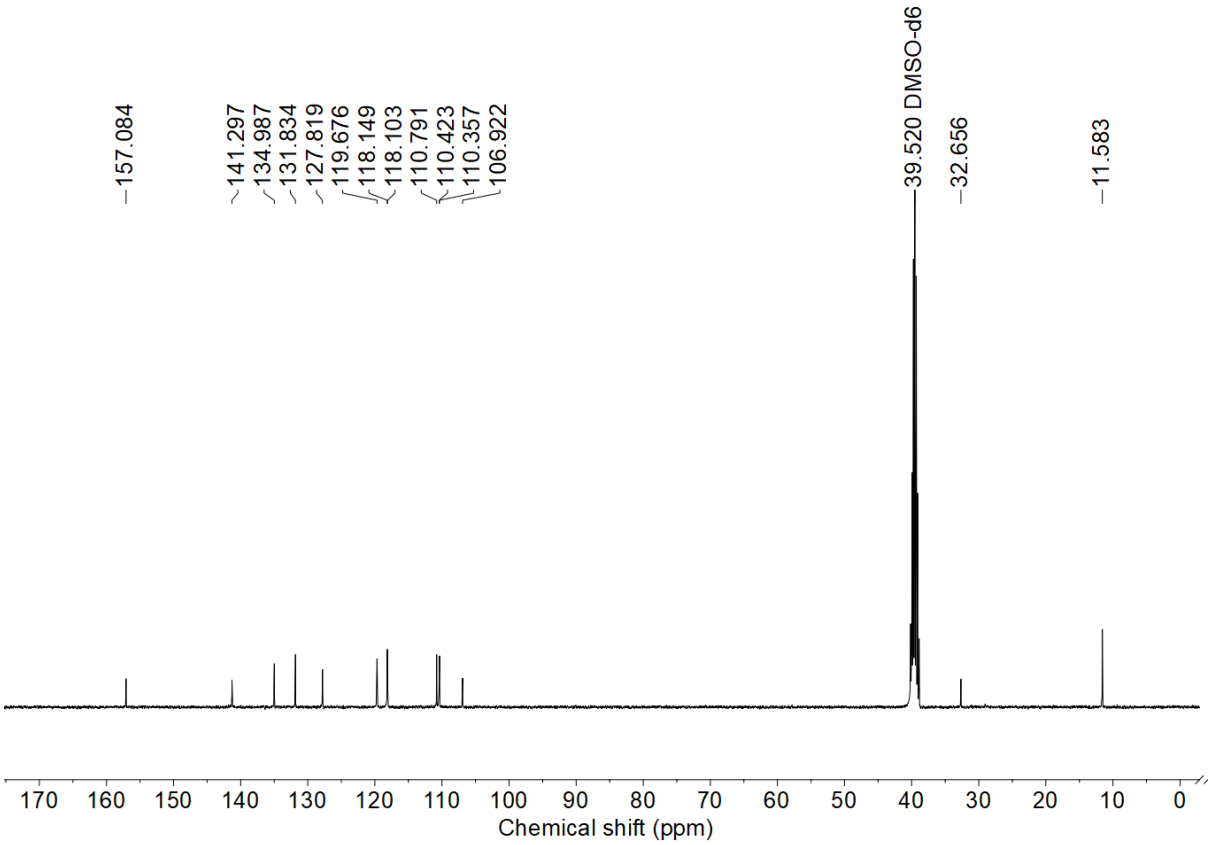


Figure S30. The ^{13}C-NMR spectrum of **1j**.

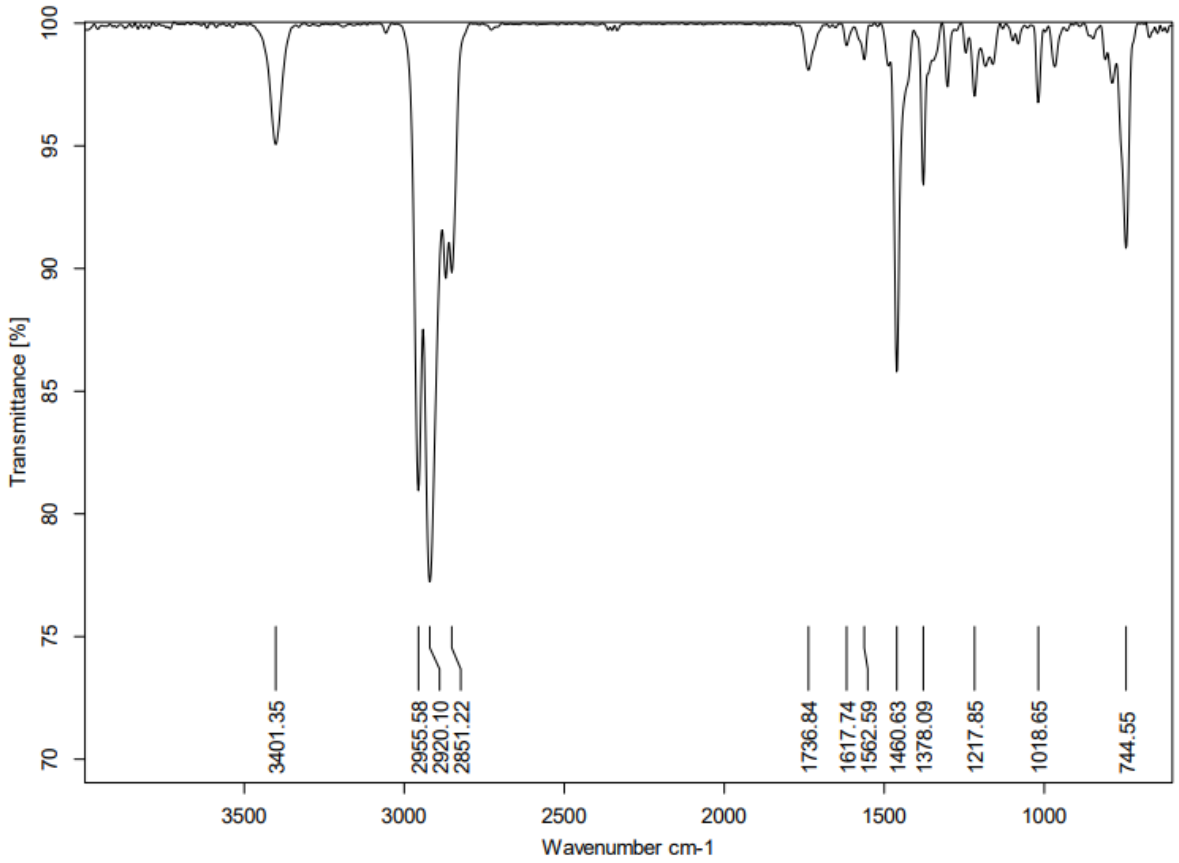


Figure S31. The FTIR spectrum of **1k**.

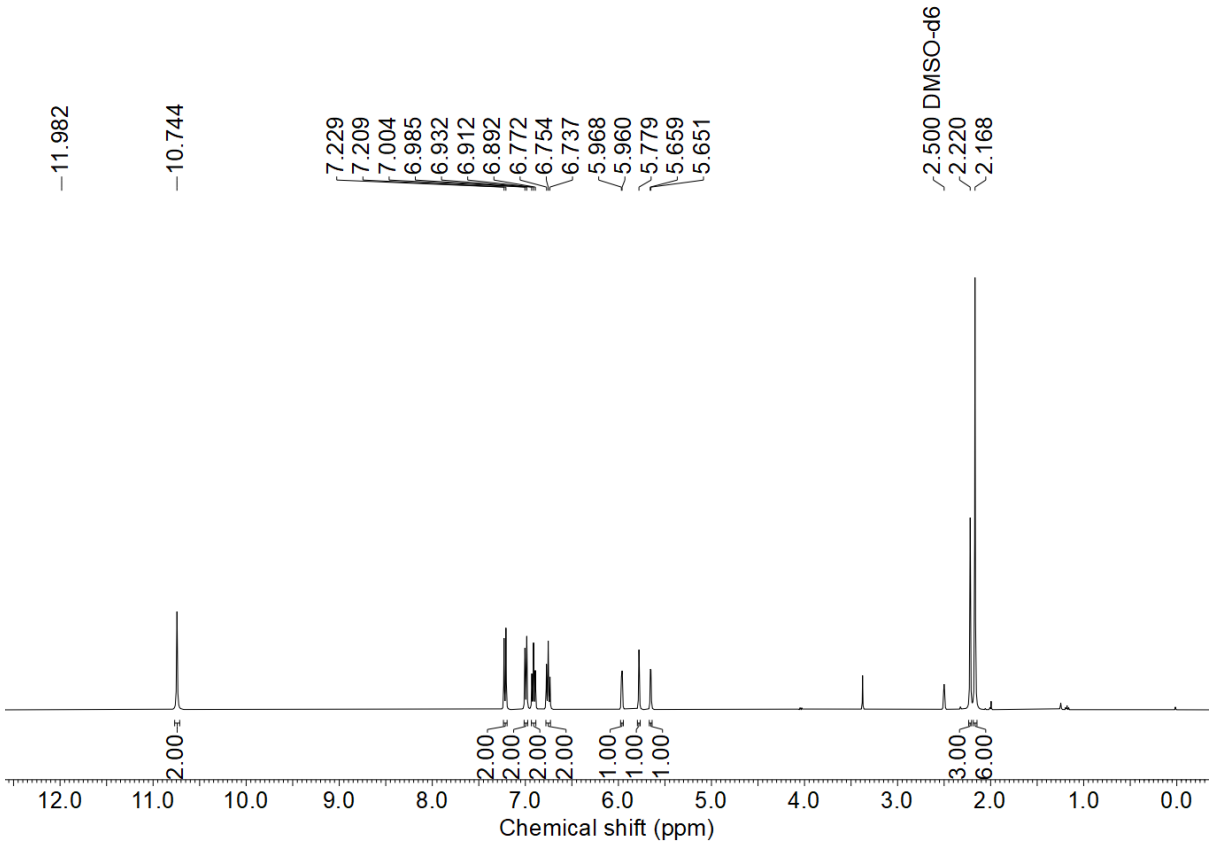


Figure S32. The ^{1}H-NMR spectrum of **1k**.

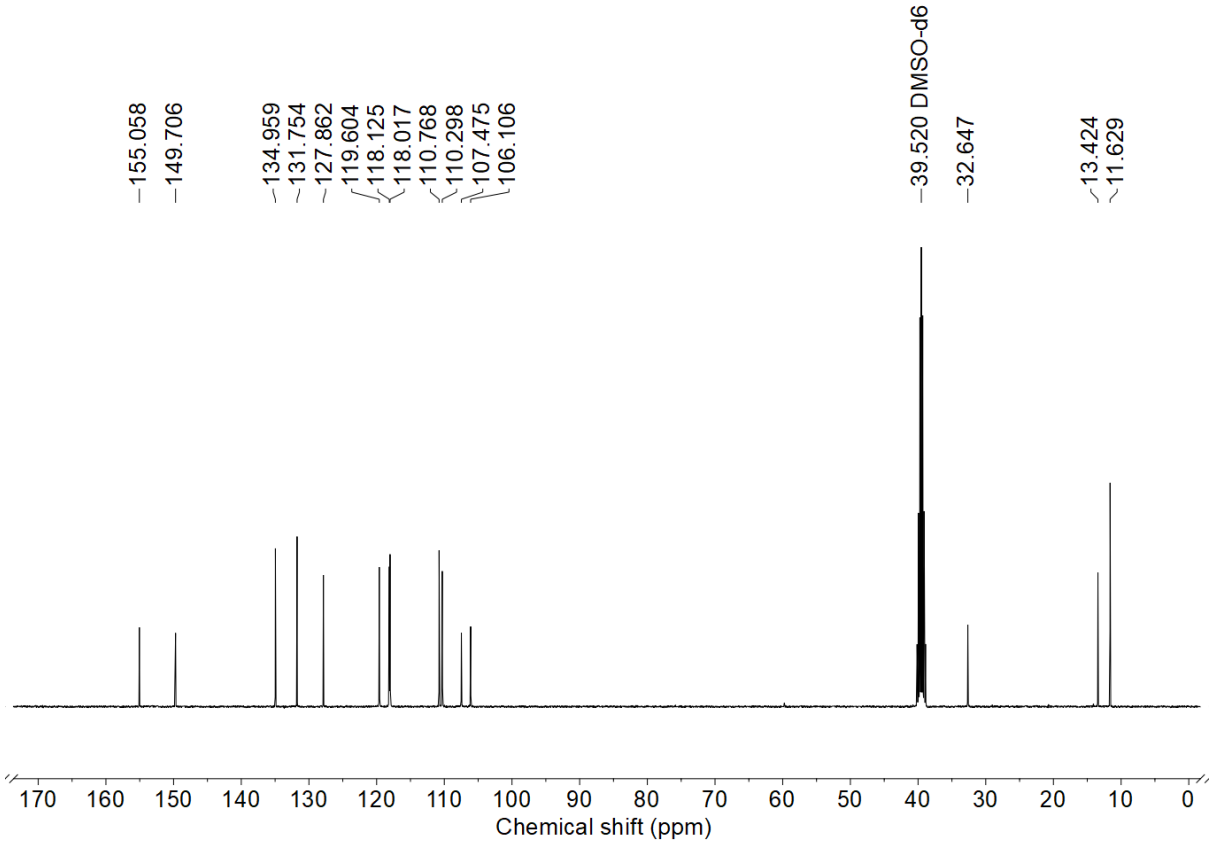


Figure S33. The ^{13}C-NMR spectrum of **1k**.

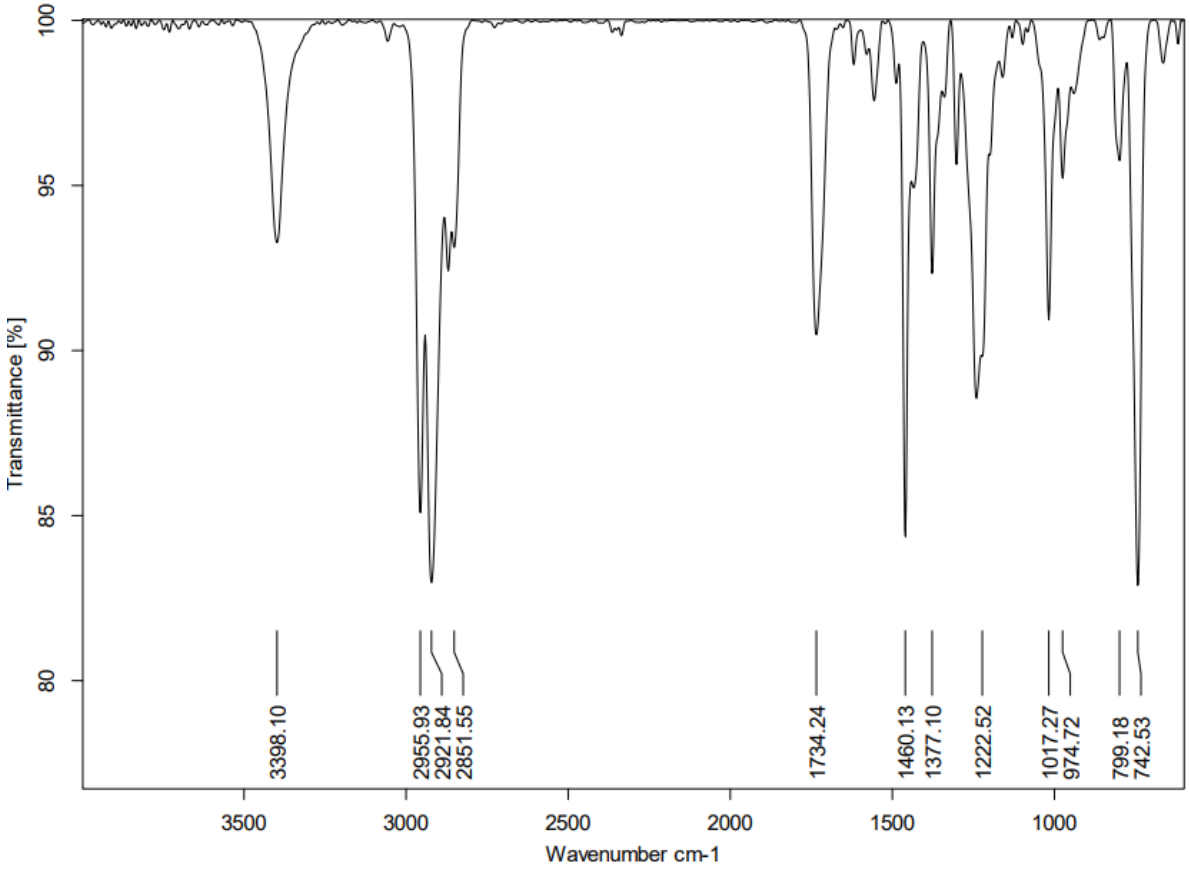


Figure S34. The FTIR spectrum of **1l**.

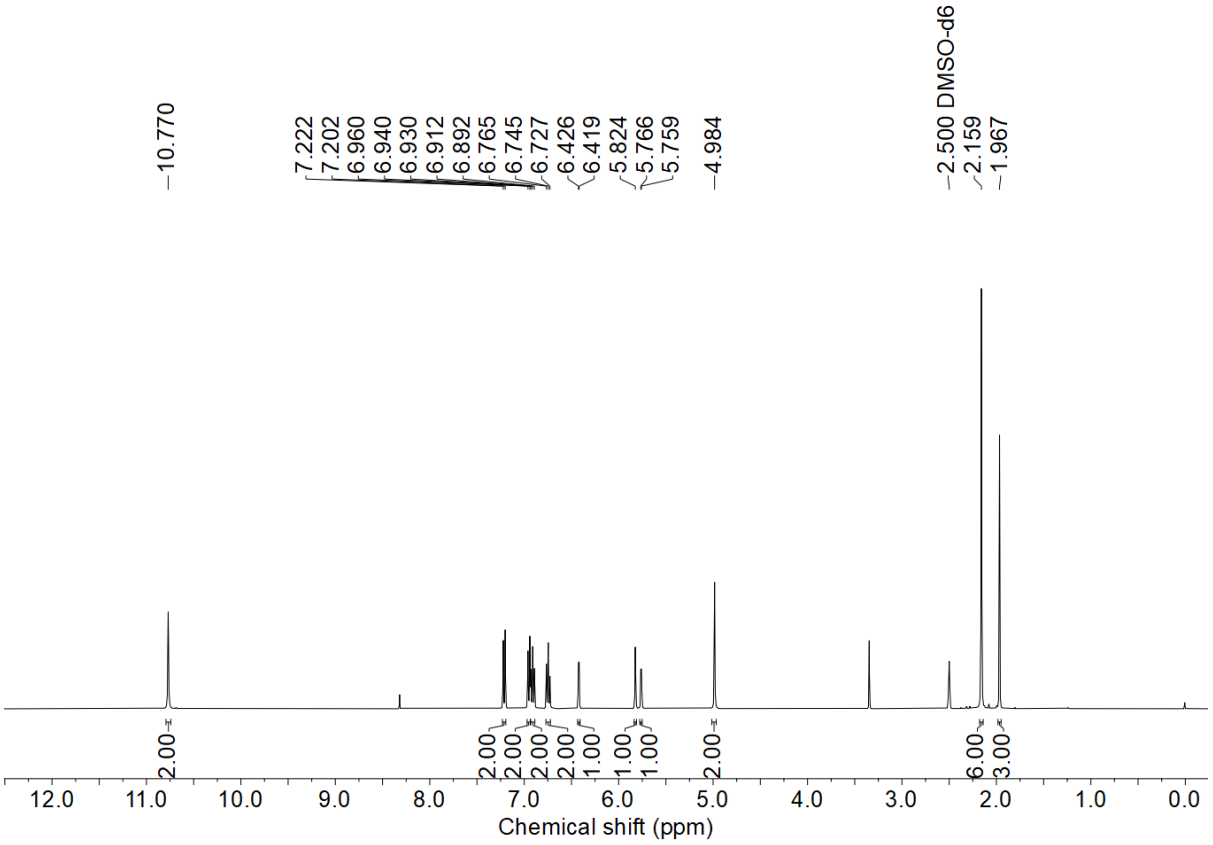


Figure S35. The ^{1}H-NMR spectrum of **1l**.

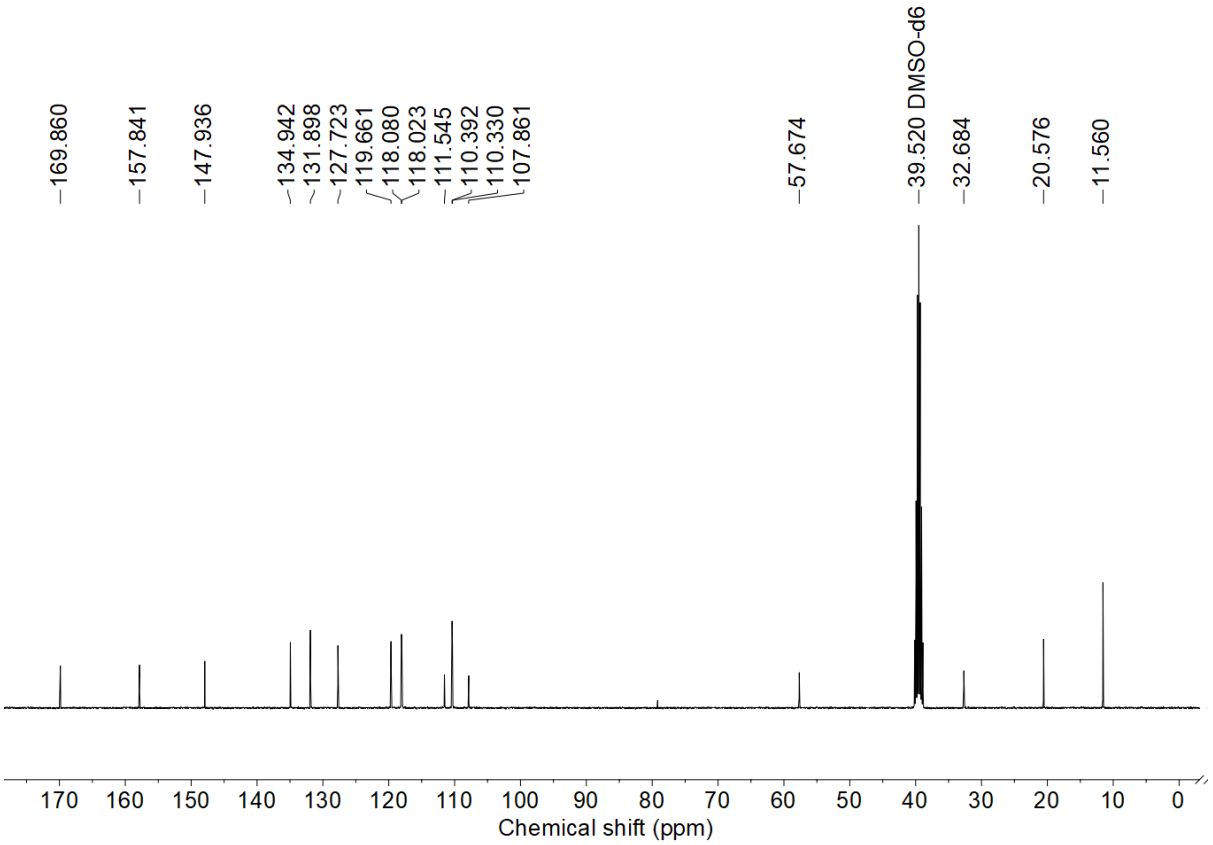


Figure S36. The ^{13}C-NMR spectrum of **1l**.

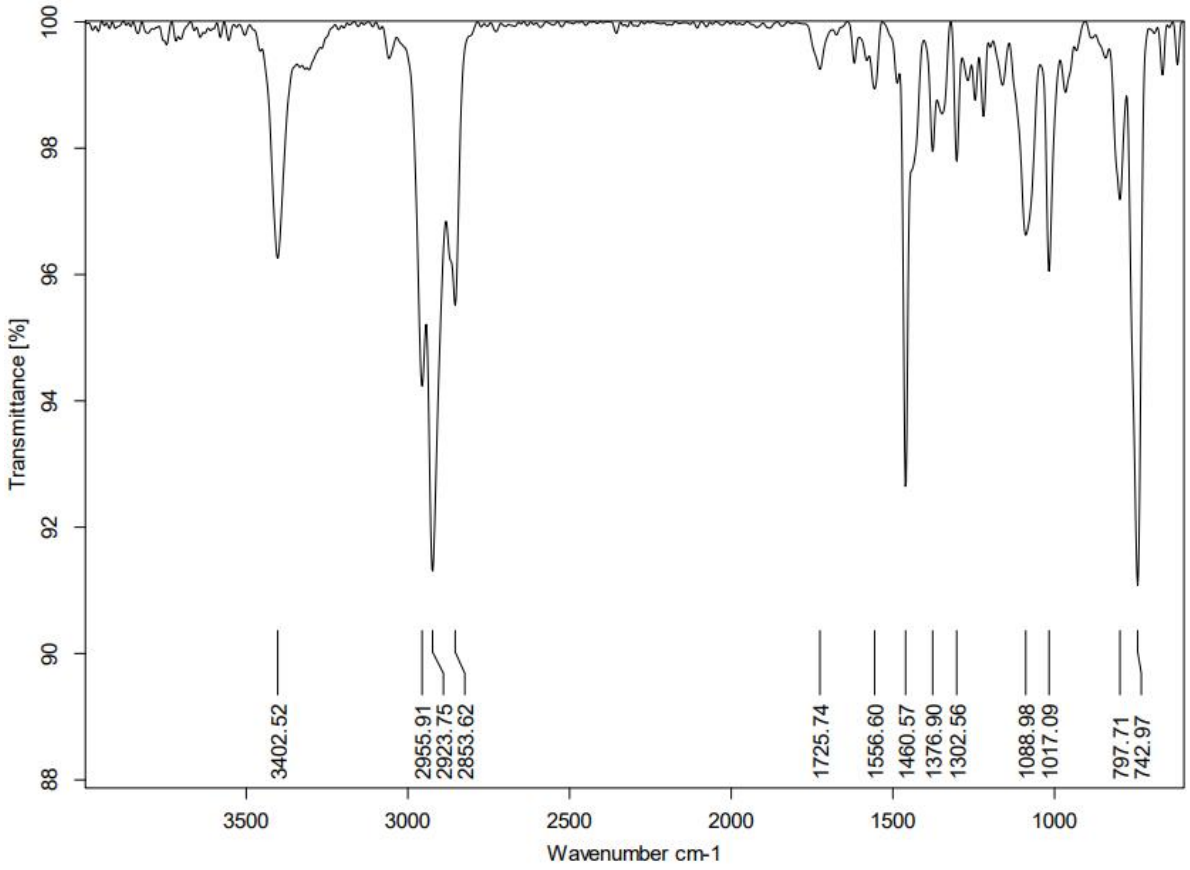


Figure S37. The FTIR spectrum of **1m**.

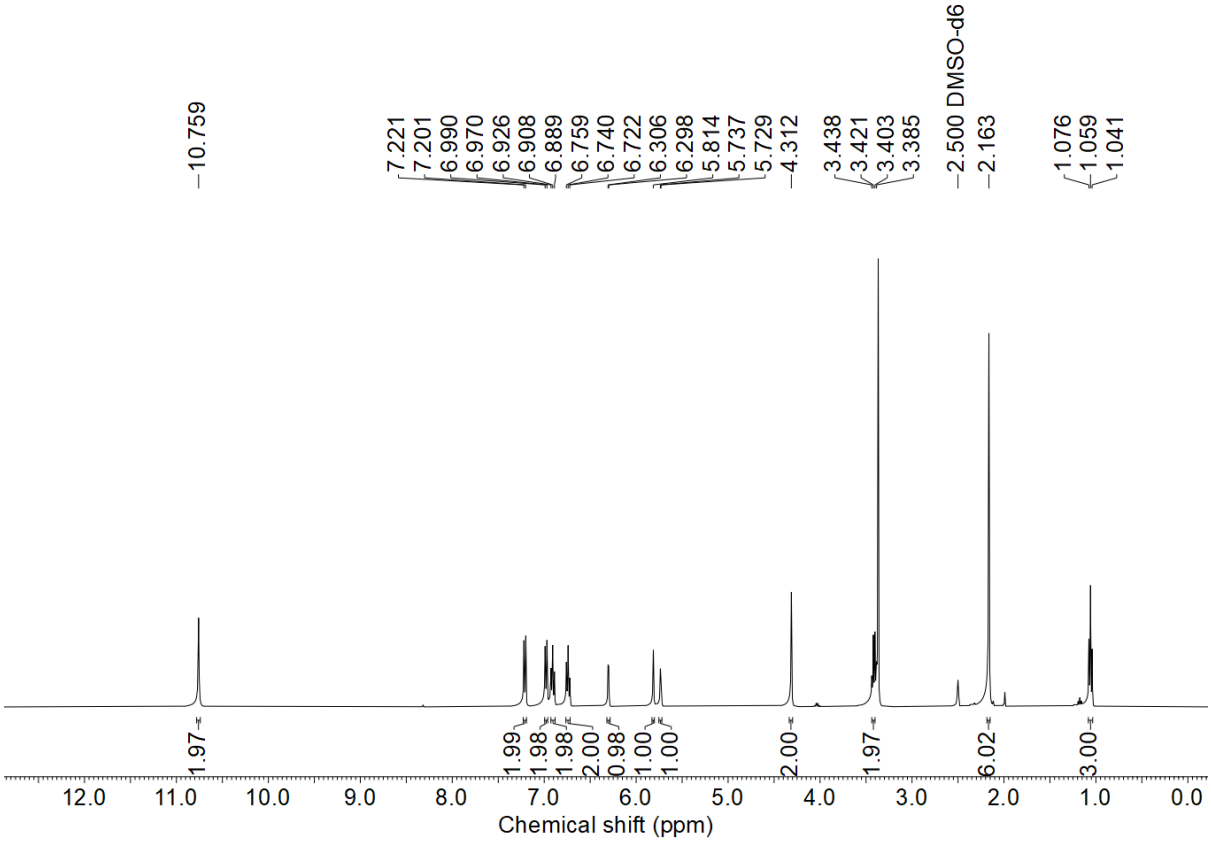


Figure S38. The ^{1}H-NMR spectrum of **1m**.

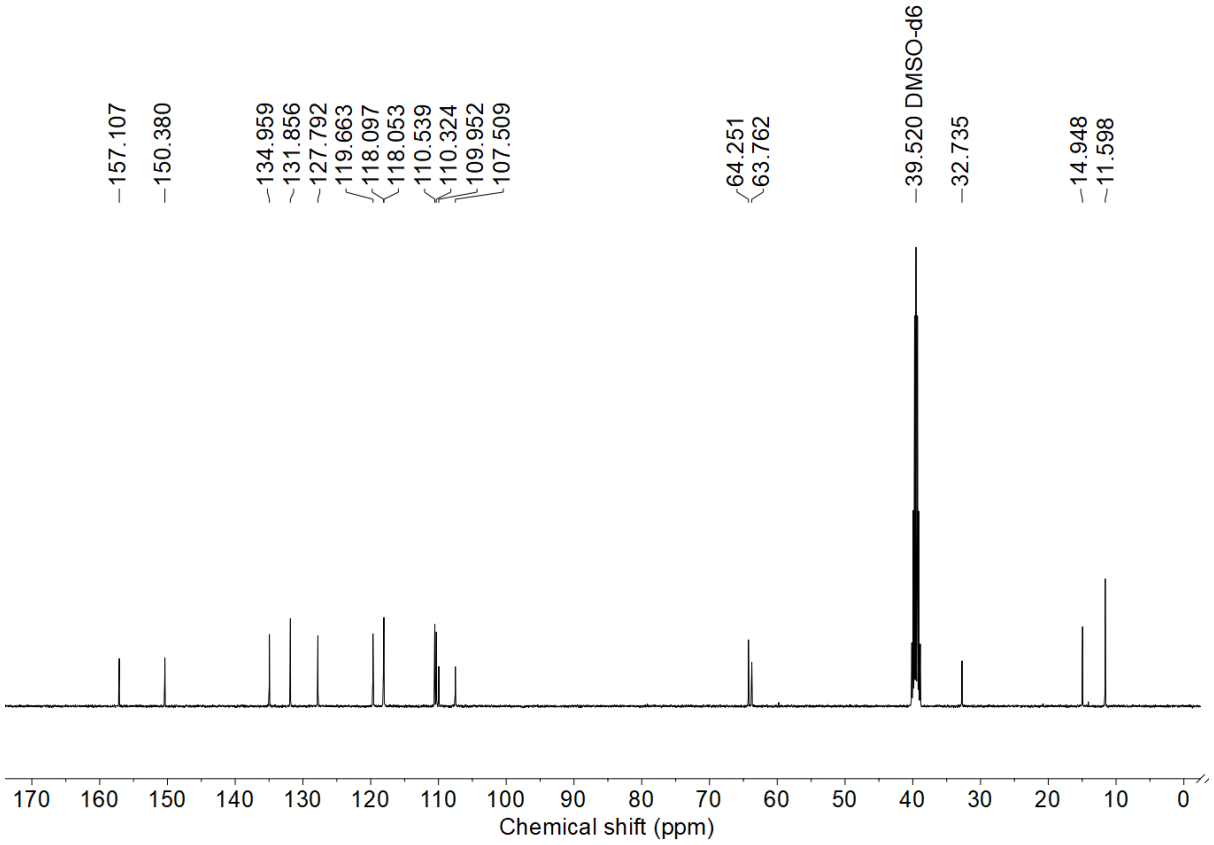


Figure S39. The ^{13}C-NMR spectrum of **1m**.

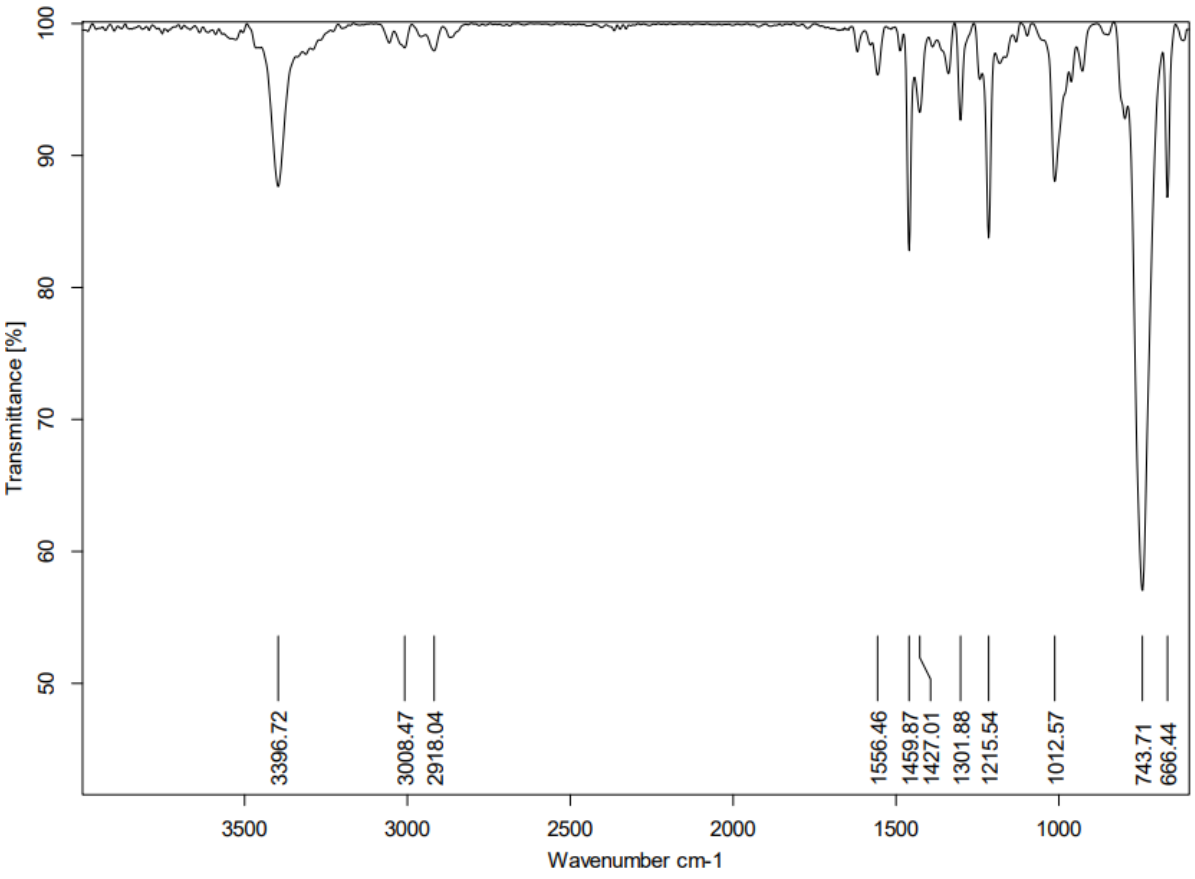


Figure S40. The FTIR spectrum of **1n**.

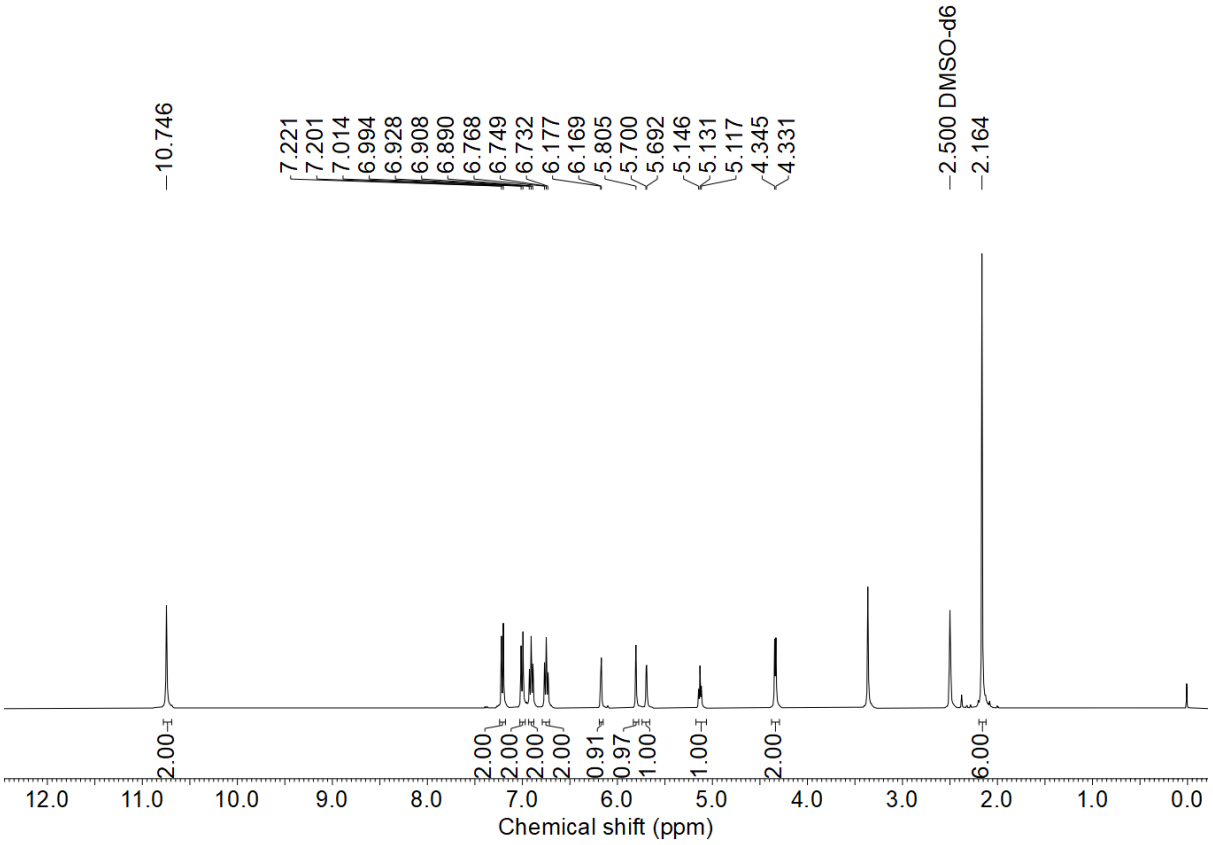


Figure S41. The ^{1}H-NMR spectrum of **1n**.

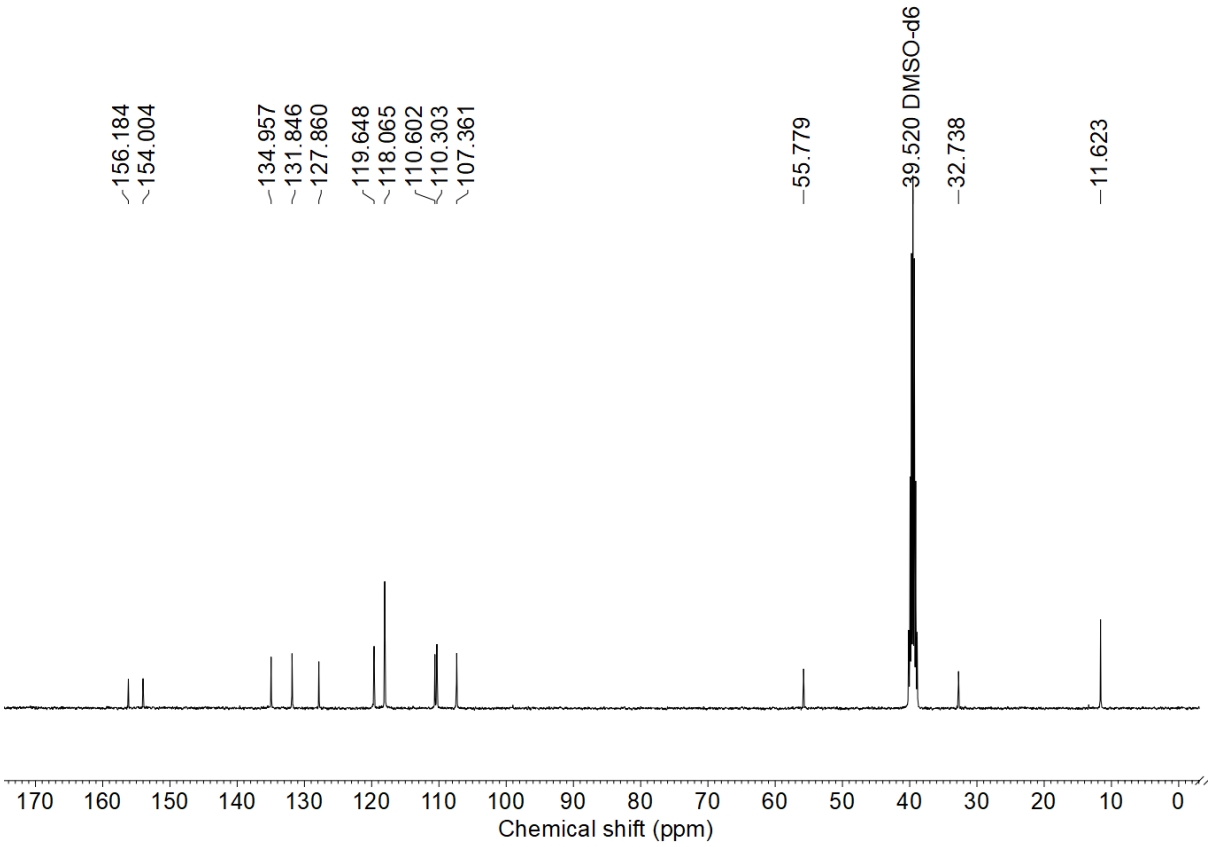


Figure S42. The ^{13}C-NMR spectrum of **1n**.

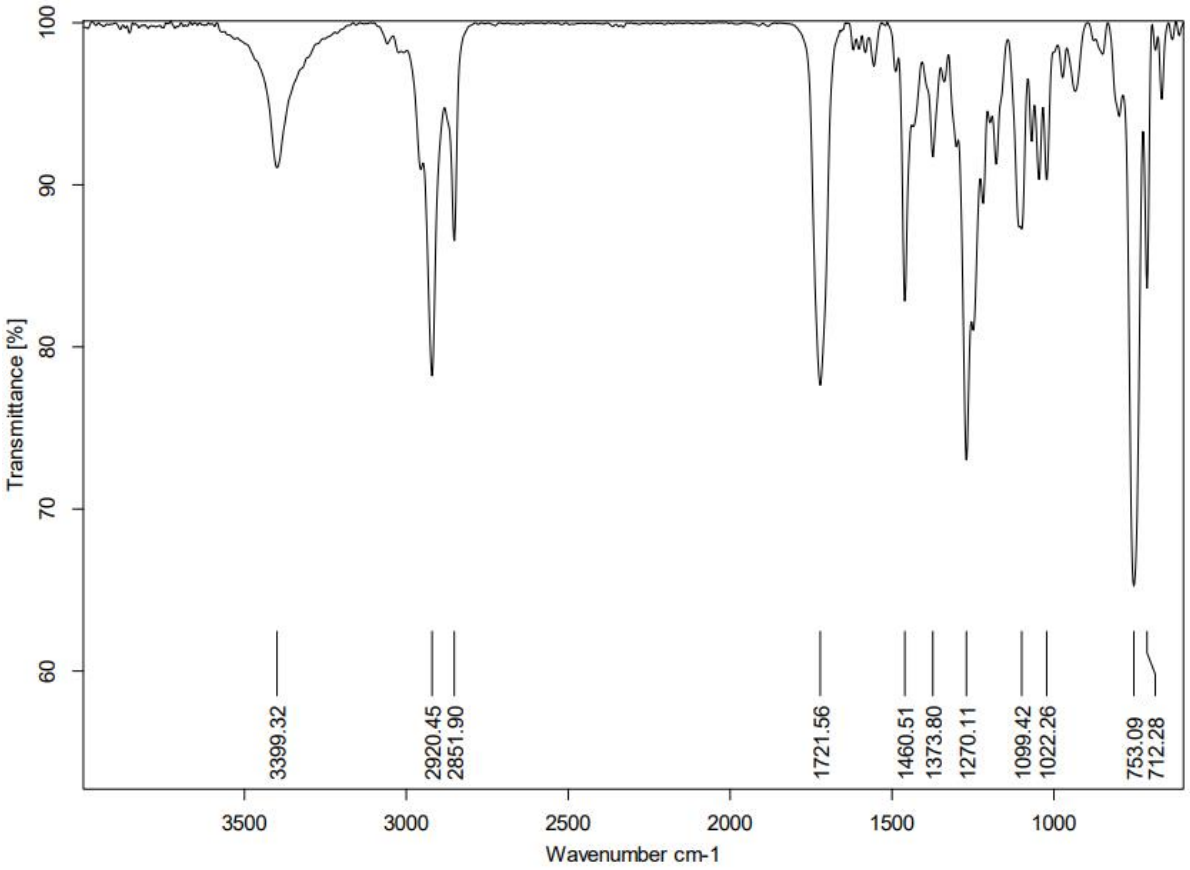


Figure S43. The FTIR spectrum of **1o**.

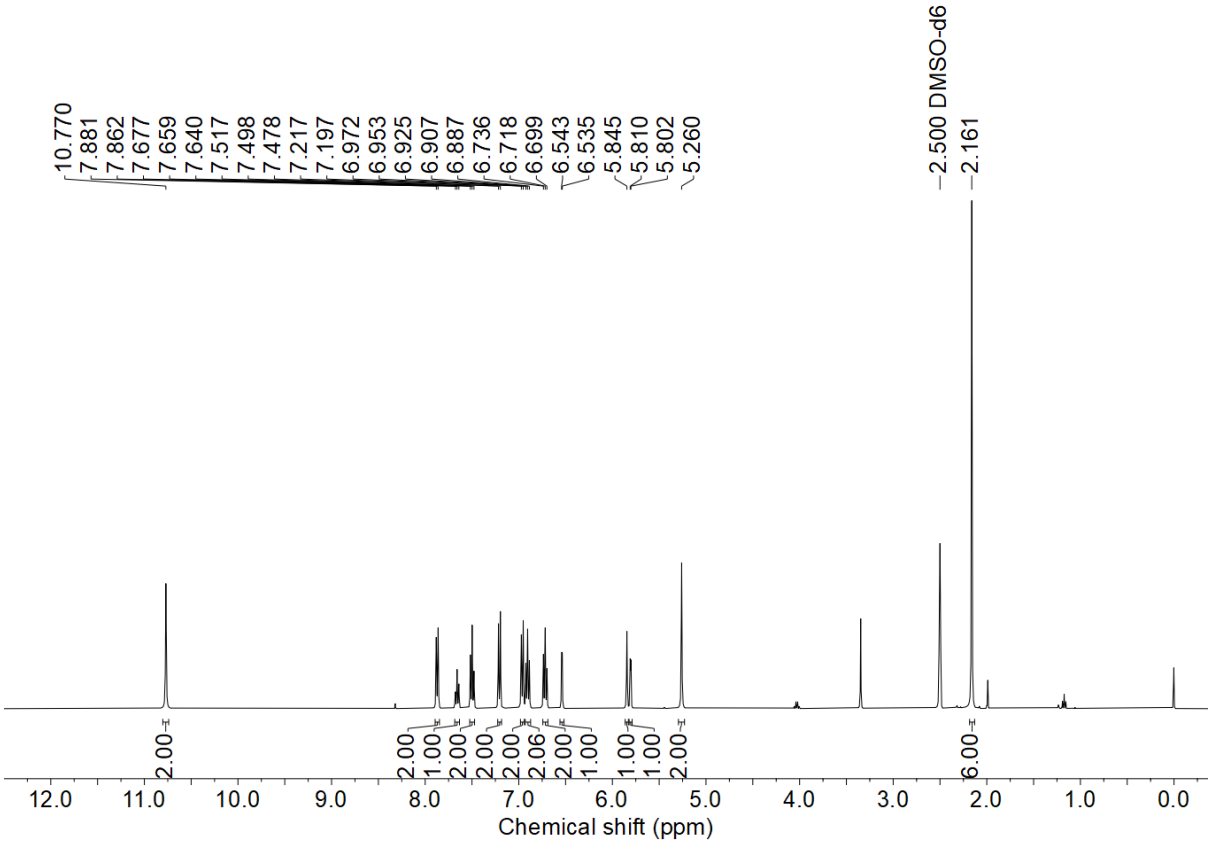


Figure S44. The ^{1}H-NMR spectrum of **1o**.

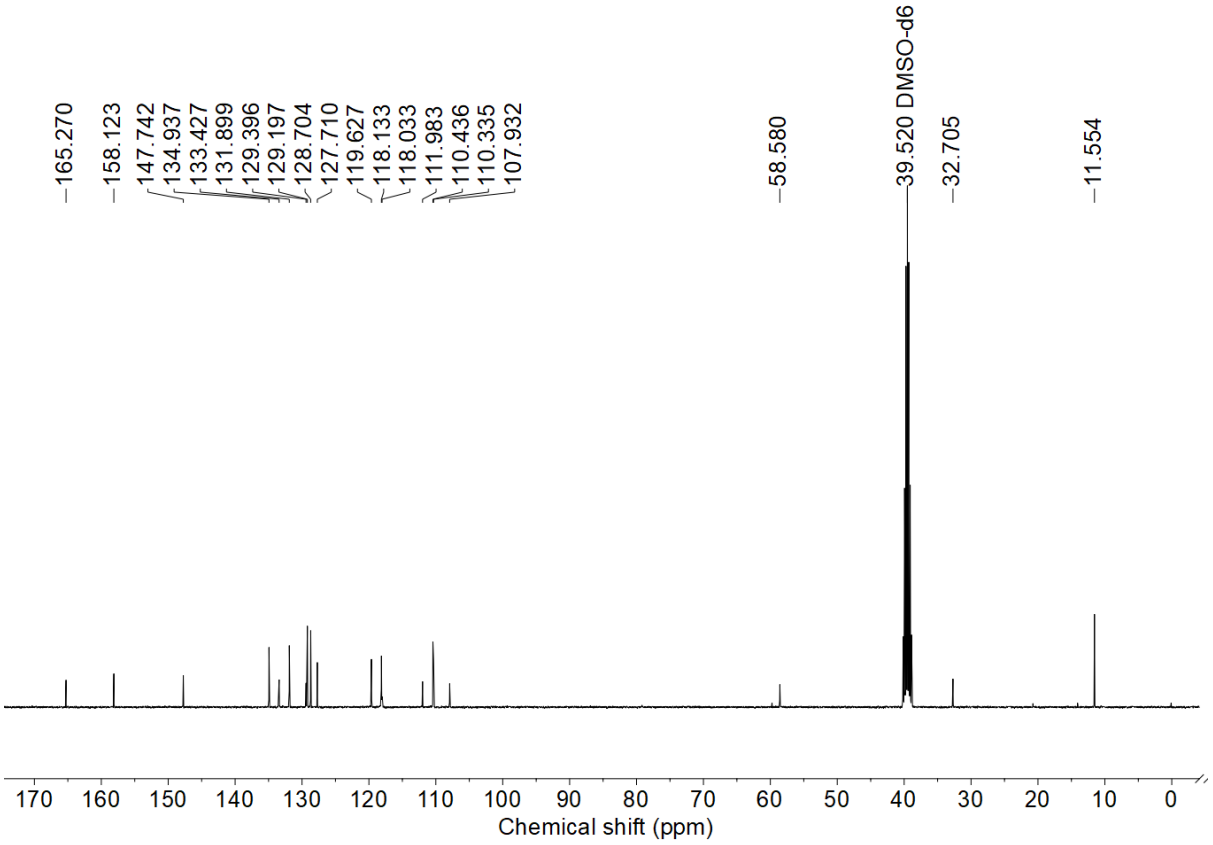


Figure S45. The ^{13}C-NMR spectrum of **1o**.

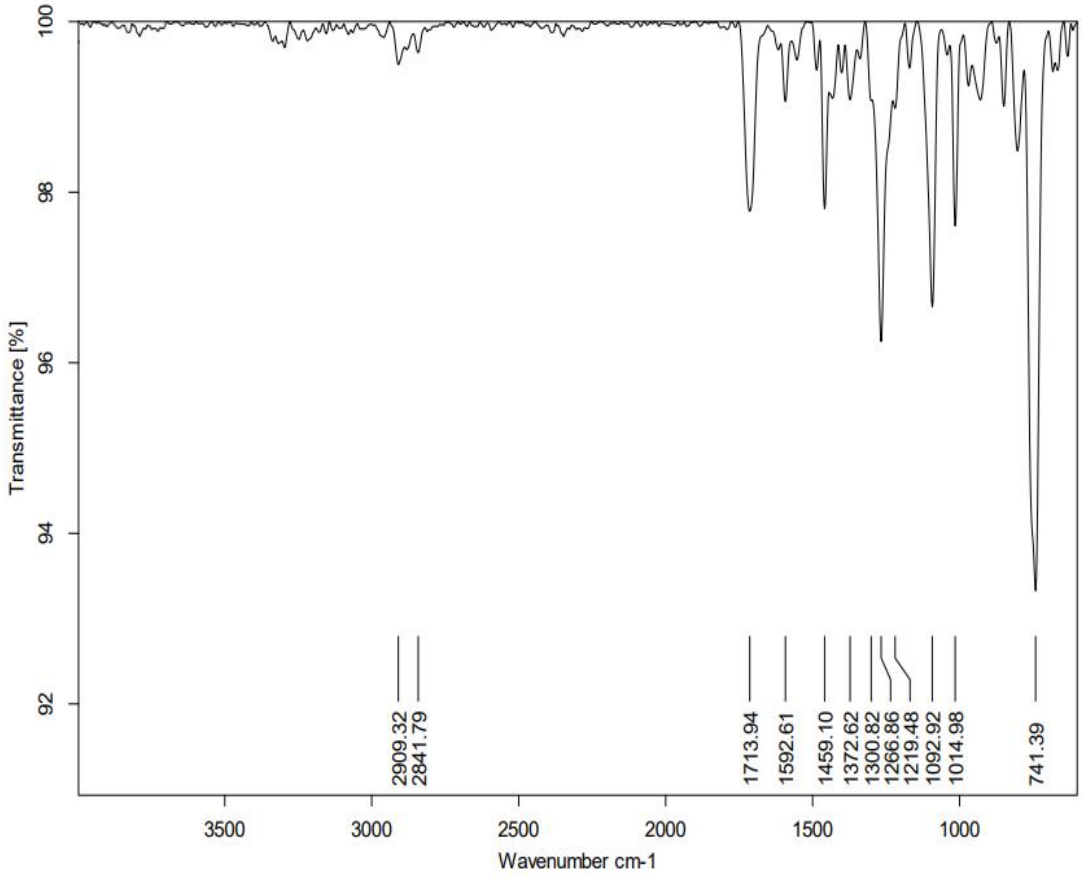


Figure S46. The FTIR spectrum of **1p**.

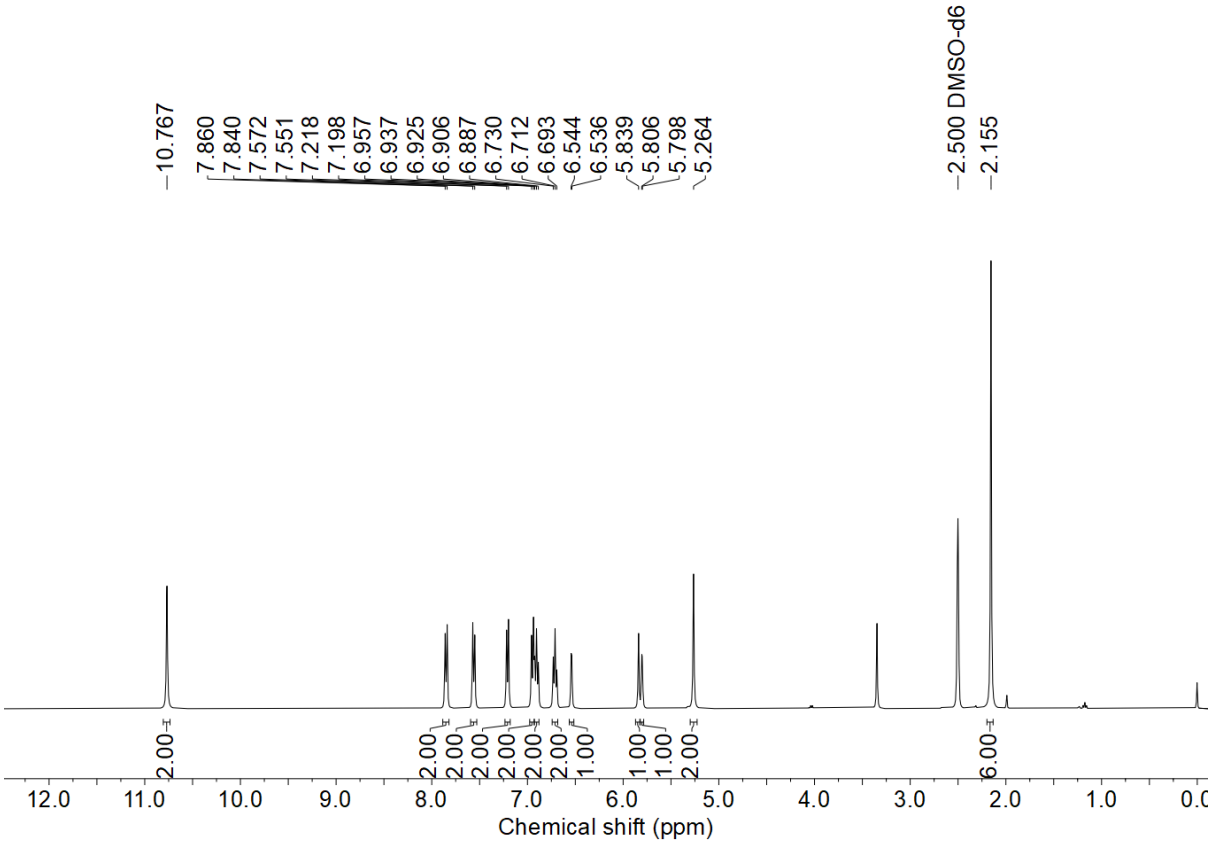


Figure S47. The ^{1}H-NMR spectrum of **1p**.

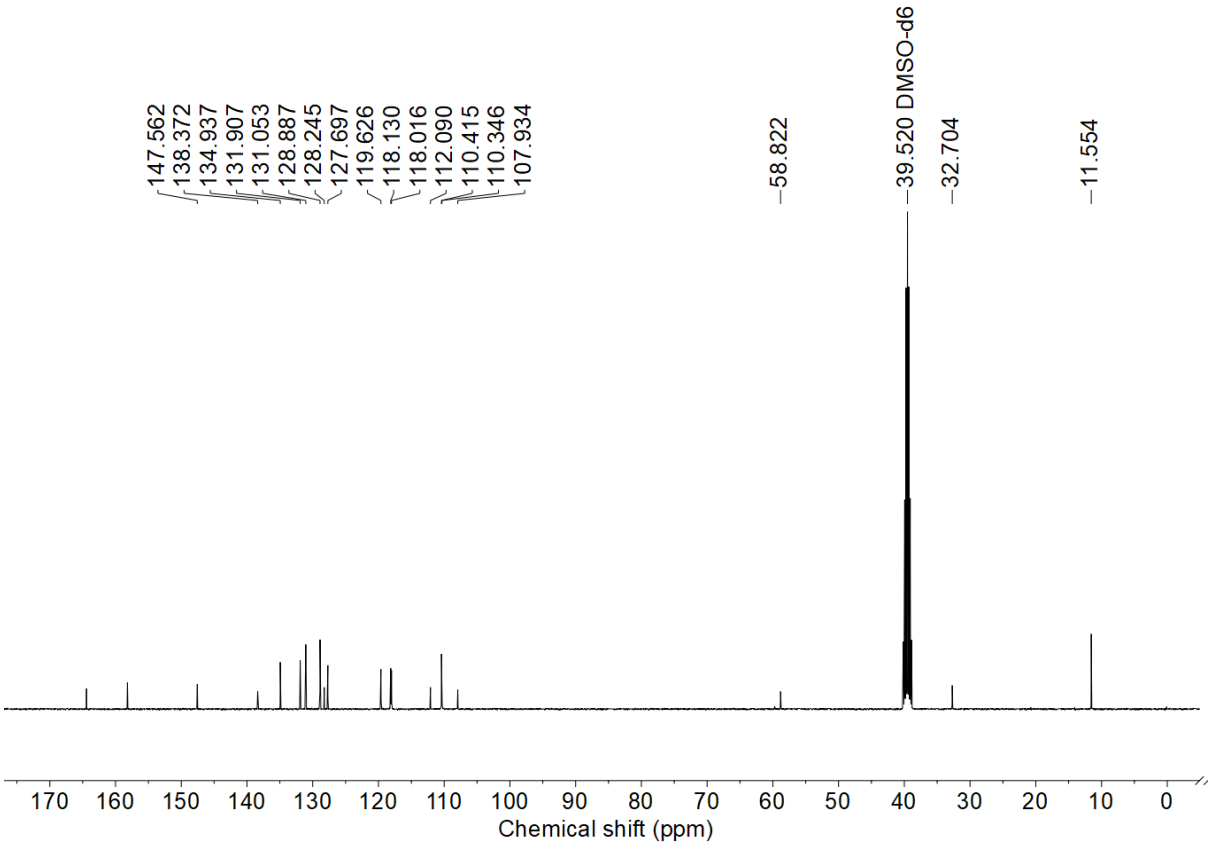


Figure S48. The ^{13}C-NMR spectrum of **1p**.

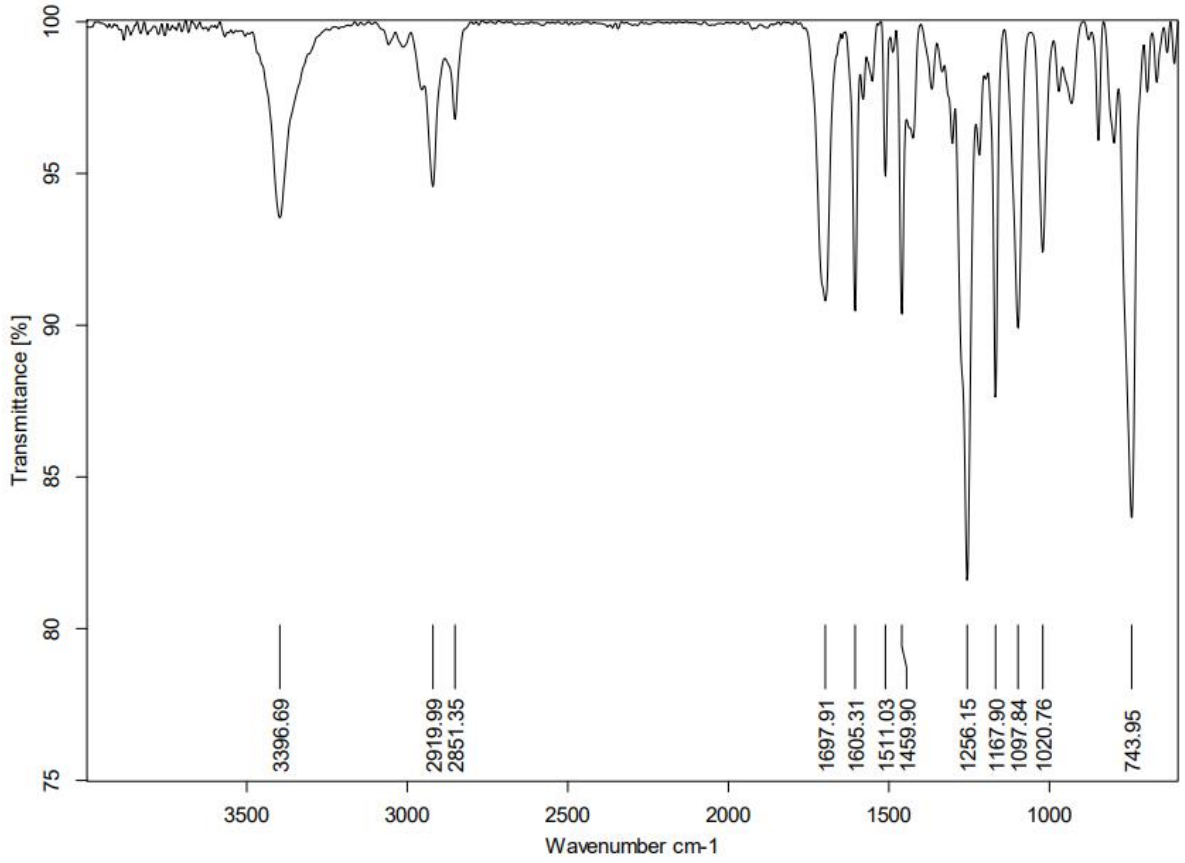


Figure S49. The FTIR spectrum of **1q**.

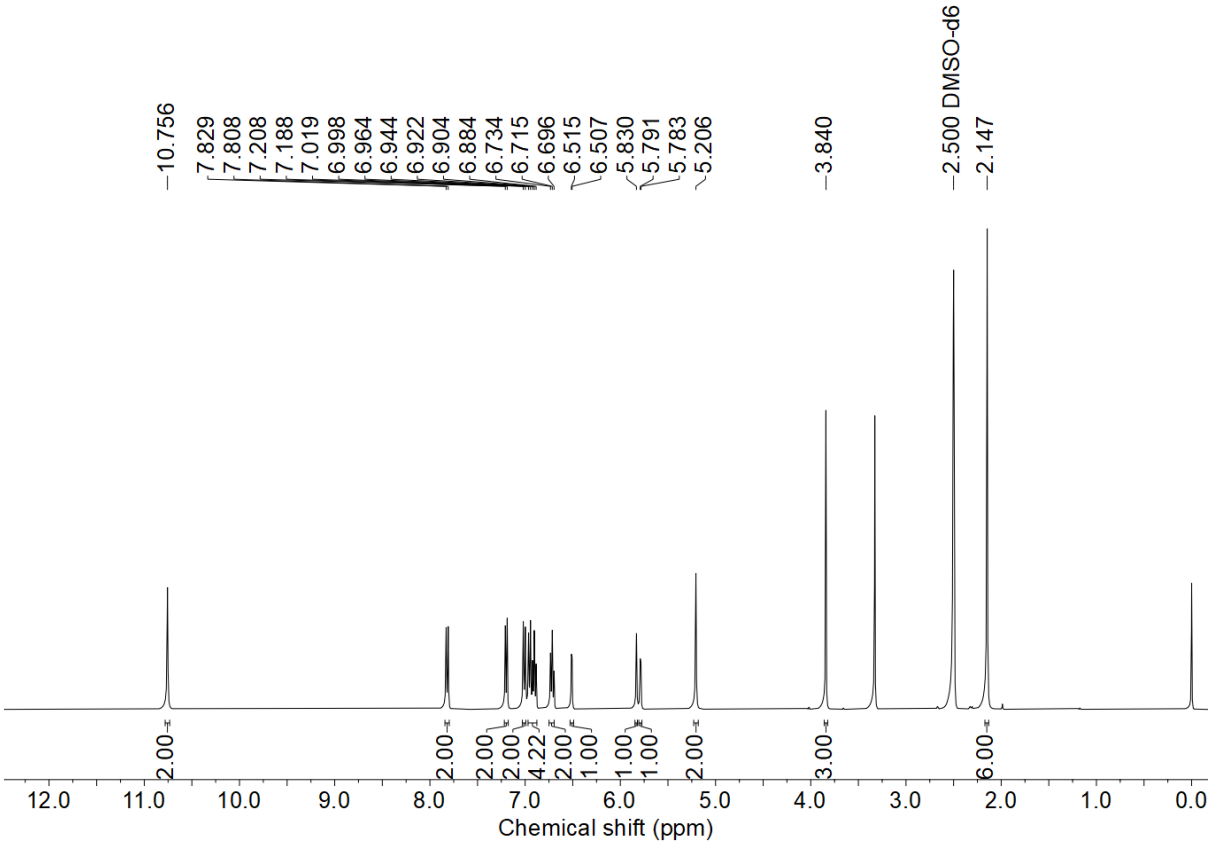


Figure S50. The ^{1}H-NMR spectrum of **1q**.

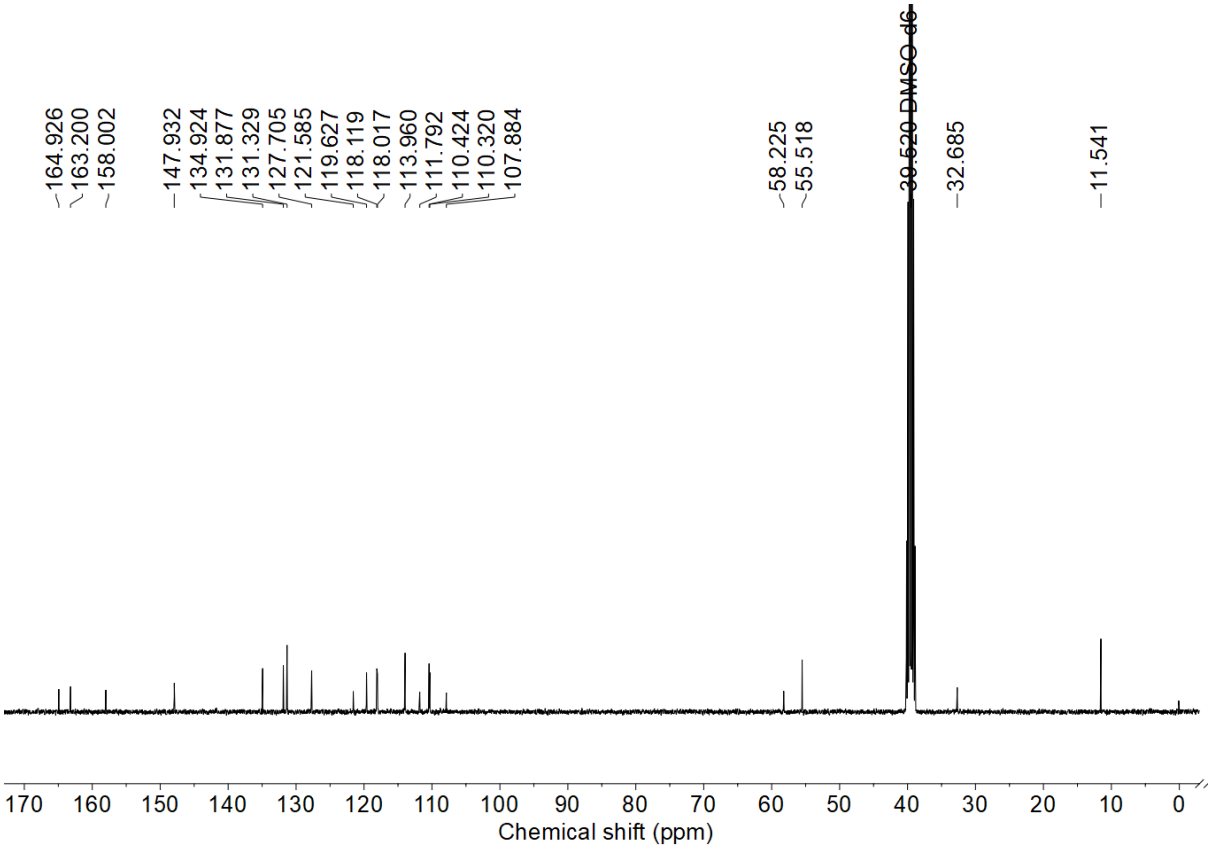


Figure S51. The ^{13}C-NMR spectrum of **1q.**

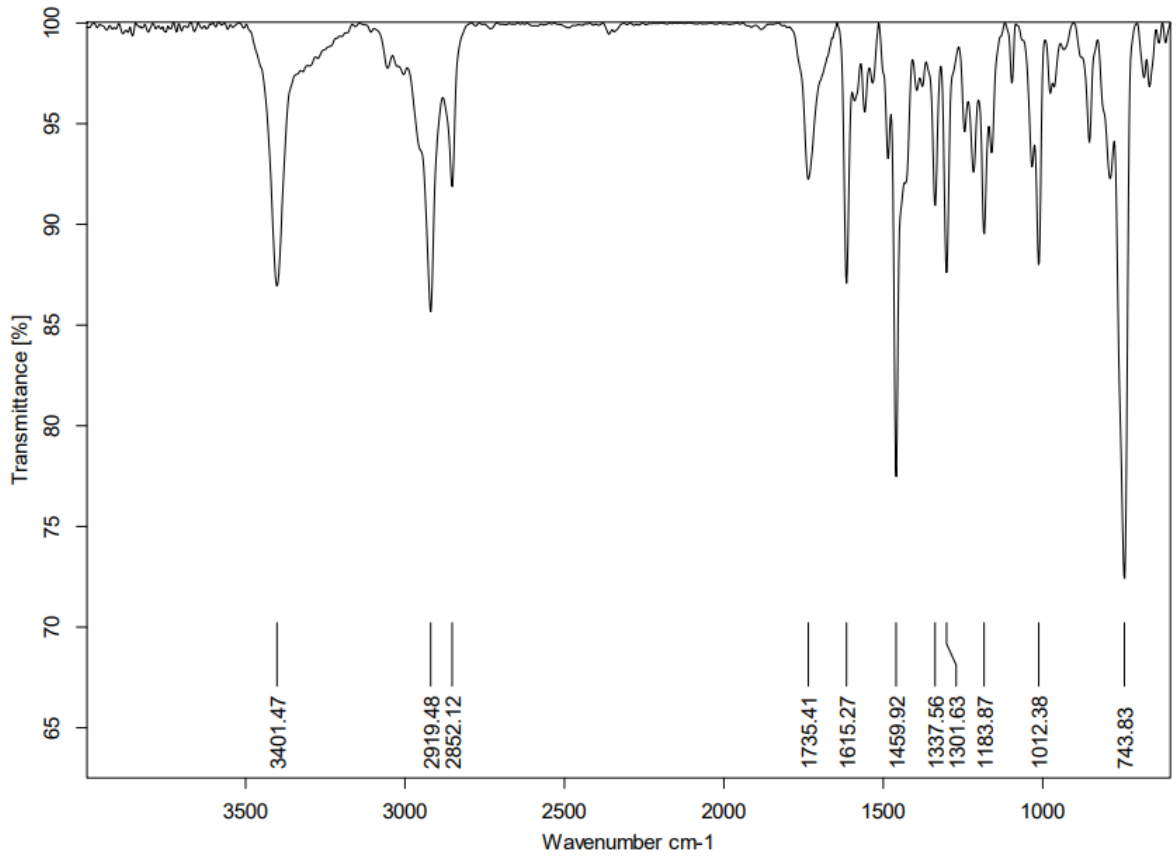


Figure S52. The FTIR spectrum of **1r**.

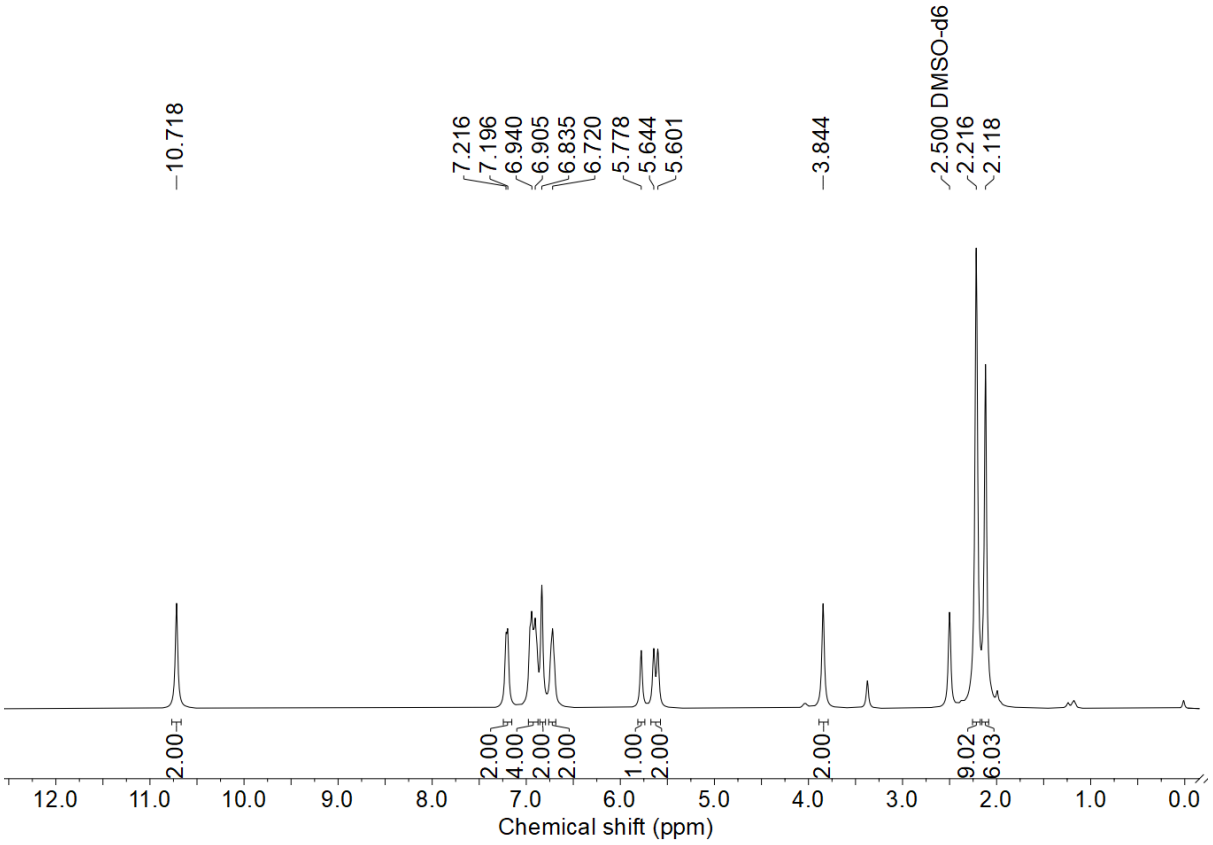


Figure S53. The ^{1}H-NMR spectrum of **1r**.

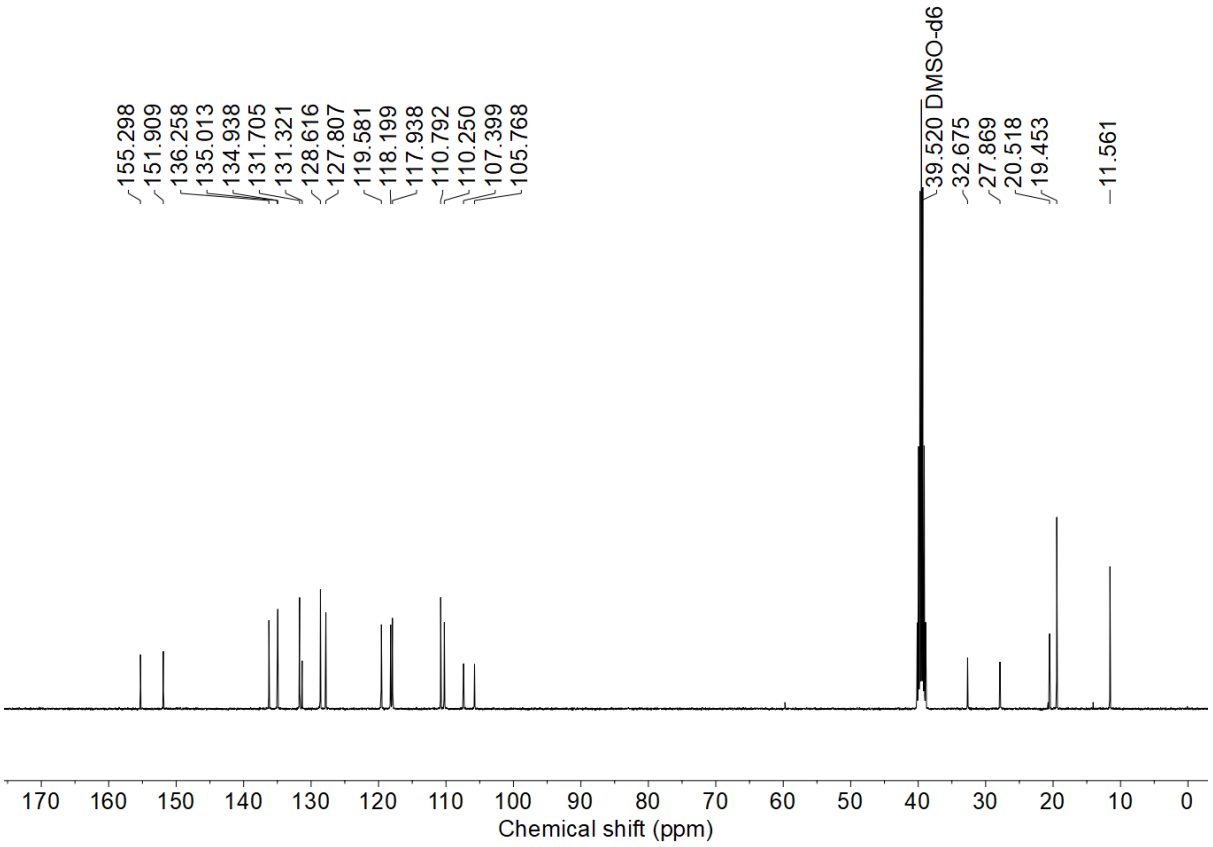


Figure S54. The ^{13}C-NMR spectrum of **1r**.