

Supporting Information

Synthesis of diversely substituted 2-(furan-3-yl)acetates from allenols through cascade carbonylations

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I. General Experimental Information

Commercial reagents were used without further purification, and the solvents were dried before using. Allenols (**1**) were synthesized through zinc promoted reaction of 1-bromobut-2-yne/1-bromopent-2-yne with the corresponding aldehydes.¹⁻³ Allenols (**5a-5i**) were prepared through CuI and dicyclohexylamine promoted reaction of 1-phenylprop-2-yn-1-ols with paraformaldehyde.⁴ 1,4-Diphenylbuta-2,3-dien-1-ol (**5j**) was synthesized through KBH₄ promoted reduction of the corresponding allenic ketones, which were prepared through reaction of 2-(triphenylphosphoranylidene)acetophenone with phenyl acetyl chloride based on a literature procedure.⁵ Melting points were recorded with a micro melting point apparatus and uncorrected. ¹H and ¹³C NMR spectra were recorded at 400 and 100 MHz, respectively. High-resolution mass spectra (HRMS) were obtained by using a MicrOTOF mass spectrometer. All reactions were monitored by thin-layer chromatography (TLC) using silica gel plates (silica gel 60 F254 0.25 mm) and components were visualized by observation under UV light (254 and 365 nm).

II. Experimental Procedures and Spectroscopic Data

1. Typical procedure for the preparation of ethyl 2-(4-methyl-2,5-diphenylfuran-3-yl)acetate (4a)

To a flask containing 2-methyl-1-phenylbuta-2,3-dien-1-ol (0.3 mmol) and iodobenzene (0.6 mmol) in CH₃CN (2 mL) was added PdCl₂ (0.03 mmol), PivOH (0.12 mmol), EtOH (3 mmol) and K₂CO₃ (0.3 mmol). The mixture was then stirred at 80 °C under CO atmosphere (1 atm). Upon completion, the reaction was quenched with aqueous NH₄Cl and extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with water and brine, and dried over anhydrous Na₂SO₄. The solvent was evaporated under vacuum and the crude product was purified by column chromatography on silica-gel to afford **4a** in 63% yield. Other furan derivatives **4b-4x** and **6a-6j** were prepared in a similar manner.

Ethyl 2-(4-methyl-2,5-diphenylfuran-3-yl)acetate (4a)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (60 mg, 63%); ¹H NMR (400 MHz, CDCl₃) δ: 1.31 (t, *J* = 7.2 Hz, 3H), 2.31 (s, 3H), 3.67 (s, 2H), 4.24 (q, *J* = 7.2 Hz, 2H), 7.31 (d, *J* = 7.2 Hz, 1H), 7.35 (d, *J* = 7.6 Hz, 1H), 7.43-7.48 (m, 4H), 7.72-7.76 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.0, 14.2, 30.8, 61.1, 116.5, 118.8, 125.7, 126.2, 126.9, 127.5, 128.5, 128.7, 131.0, 131.6, 148.0, 149.4, 171.3. HRMS calcd for C₂₁H₂₁O₃: 321.1485 [M+H]⁺, found: 321.1482.

Ethyl 2-(4-methyl-2-phenyl-5-o-tolylfuran-3-yl)acetate (4b)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (50 mg, 50%); ¹H NMR (400 MHz, CDCl₃) δ: 1.35 (t, *J* = 7.2 Hz, 3H), 2.13 (s, 3H), 2.47 (s, 3H), 3.70 (s, 2H), 4.28 (q, *J* = 7.2 Hz, 2H), 7.30-7.36 (m, 4H), 7.42-7.49 (m, 3H), 7.76 (d, *J* = 7.6 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 9.5, 14.2, 20.6, 31.0, 61.0, 115.3, 119.4, 125.5, 126.0, 127.4, 128.3, 128.6, 130.0, 130.6, 130.7, 131.2, 137.6, 149.0, 149.6, 171.3. HRMS calcd for C₂₂H₂₃O₃: 335.1642 [M+H]⁺, found: 335.1646.

Ethyl 2-(5-(3-bromophenyl)-4-methyl-2-phenylfuran-3-yl)acetate (4c)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (81 mg, 68%); ¹H NMR (400 MHz, CDCl₃) δ: 1.32 (t, *J* = 7.2 Hz, 3H), 2.09 (s, 3H), 3.67 (s, 2H), 4.25 (q, *J* = 7.2 Hz, 2H), 7.24-7.49 (m, 6H), 7.71 (d, *J* = 8.4 Hz, 1H), 7.76 (d, *J* = 8.4 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 9.7, 14.2, 31.0, 61.0, 115.3, 120.6, 123.6, 126.3, 127.0, 127.6, 128.6, 129.8, 131.0, 132.1, 132.3, 133.4, 147.5, 150.2, 171.2. HRMS calcd for C₂₁H₂₀BrO₃: 399.0590 [M+H]⁺, found: 399.0593.

Ethyl 2-(5-(3-fluorophenyl)-4-methyl-2-phenylfuran-3-yl)acetate (4d)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (65 mg, 64%); ¹H NMR (400 MHz, CDCl₃) δ: 1.31 (t, *J* = 7.2 Hz, 3H), 2.31 (s, 3H), 3.66 (s, 2H), 4.22-4.27 (m, 2H), 6.99 (t, *J* = 8.0 Hz, 1H), 7.34-7.51 (m, 6H), 7.75 (d, *J* = 7.6 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.1, 14.2, 30.7, 61.1, 112.1, 112.4, 113.5, 113.7, 116.6, 119.8, 121.06, 121.09, 126.3, 127.8, 128.7, 130.0, 130.1, 130.7, 133.6, 133.7, 146.70, 146.74, 149.8, 161.8, 164.2, 171.1. HRMS calcd for C₂₁H₂₀FO₃: 339.1391 [M+H]⁺, found: 339.1388.

Ethyl 2-(4-methyl-2-phenyl-5-(4-(trifluoromethyl)phenyl)furan-3-yl)acetate (4e)

Eluent: ethyl acetate/hexanes (5%); yellow solid (63 mg, 54%), mp 68-70 °C. ¹H NMR (400 MHz, CDCl₃) δ: 1.32 (t, *J* = 7.2 Hz, 3H), 2.34 (s, 3H), 3.67 (s, 2H), 4.25 (q, *J* = 7.2 Hz, 2H), 7.37 (t, *J* = 7.6 Hz, 1H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.69 (d, *J* = 8.0 Hz, 2H), 7.75 (d, *J* = 8.4 Hz, 2H), 7.82 (d, *J* = 8.0 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.2, 14.2, 30.7, 61.1, 116.8, 120.8, 125.4, 125.50, 125.53, 126.4, 128.0, 128.7, 130.6, 134.9, 146.5, 150.4, 171.0. HRMS calcd for C₂₂H₂₀F₃O₃: 389.1359 [M+H]⁺, found: 389.1365.

Ethyl 2-(5-(3,4-dimethoxyphenyl)-4-methyl-2-phenylfuran-3-yl)acetate (4f)

Eluent: ethyl acetate/hexanes (10%); yellow solid (65 mg, 57%), mp 54-55 °C. ¹H NMR (400 MHz, CDCl₃) δ: 1.31 (t, *J* = 7.2 Hz, 3H), 2.28 (s, 3H), 3.66 (s, 2H), 3.94 (s, 3H), 3.97 (s, 3H), 4.24 (q, *J* = 7.2 Hz, 2H), 6.95 (d, *J* = 8.4 Hz, 1H), 7.26 (t, *J* = 8.0 Hz, 1H), 7.33 (t, *J* = 8.0 Hz, 1H), 7.44-7.49 (m, 2H), 7.74 (d, *J* = 7.2 Hz, 2H), 8.14 (d, *J* = 7.6 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.0, 14.2, 30.9, 56.0,

61.1, 109.2, 111.2, 116.4, 117.5, 118.6, 124.8, 126.2, 127.4, 128.5, 128.7, 130.2, 131.0, 148.0, 148.9, 171.3. HRMS calcd for C₂₃H₂₅O₅: 381.1697 [M+H]⁺, found: 381.1699.

Ethyl 2-(4-methyl-5-(naphthalen-1-yl)-2-phenylfuran-3-yl)acetate (4g)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (53 mg, 48%); ¹H NMR (400 MHz, CDCl₃) δ: 1.35 (t, *J* = 7.2 Hz, 3H), 2.12 (s, 3H), 3.75 (s, 2H), 4.28 (q, *J* = 7.2 Hz, 2H), 7.34 (t, *J* = 7.2 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.48-7.64 (m, 4H), 7.78 (d, *J* = 8.0 Hz, 2H), 7.91-7.94 (m, 2H), 8.10-8.12 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 9.7, 14.3, 31.1, 61.1, 115.7, 120.7, 125.2, 126.0, 126.1, 126.3, 126.4, 127.5, 128.1, 128.3, 128.6, 128.7, 128.8, 131.1, 131.9, 133.9, 148.2, 150.1, 171.3. HRMS calcd for C₂₅H₂₂O₃Na: 393.1461 [M+Na]⁺, found: 393.1468.

Ethyl 2-(4-methyl-2-phenyl-5-(thiophen-2-yl)furan-3-yl)acetate (4h)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (56 mg, 57%); ¹H NMR (400 MHz, CDCl₃) δ: 1.30 (t, *J* = 7.2 Hz, 3H), 2.27 (s, 3H), 3.65 (s, 2H), 4.23 (q, *J* = 7.6 Hz, 2H), 7.12 (t, *J* = 4.4 Hz, 1H), 7.29-7.36 (m, 3H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.73 (d, *J* = 7.6 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 9.7, 14.2, 30.8, 61.1, 116.3, 118.4, 122.9, 124.0, 126.2, 127.4, 127.6, 128.7, 130.7, 133.8, 144.4, 149.1, 171.1. HRMS calcd for C₁₉H₁₉O₃S: 327.1049 [M+H]⁺, found: 327.1046.

(E)-Ethyl 2-(4-methyl-2-phenyl-5-styrylfuran-3-yl)acetate (4i)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (64 mg, 62%); ¹H NMR (400 MHz, CDCl₃) δ: 1.32 (t, *J* = 7.2 Hz, 3H), 2.19 (s, 3H), 3.64 (s, 2H), 4.22-4.27 (q, *J* = 7.2 Hz, 2H), 6.99 (d, *J* = 16.4 Hz, 1H), 7.13 (d, *J* = 16.0 Hz, 1H), 7.28 (d, *J* = 6.8 Hz, 1H), 7.35-7.41 (m, 3H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.55 (d, *J* = 7.6 Hz, 2H), 7.79 (d, *J* = 8.0 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 8.7, 14.2, 30.8, 61.1, 114.6, 116.3, 121.5, 125.9, 126.3, 127.3, 127.7, 128.7, 130.8, 137.5, 148.0, 149.8, 171.1. HRMS calcd for C₂₃H₂₃O₃: 347.1642 [M+H]⁺, found: 347.1643.

Ethyl 2-(5-benzyl-4-methyl-2-phenylfuran-3-yl)acetate (4j)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (52 mg, 52%); ^1H NMR (400 MHz, CDCl_3) δ : 1.30 (t, $J = 7.6$ Hz, 3H), 2.04 (s, 3H), 3.60 (s, 2H), 4.03 (s, 2H), 4.23 (d, $J = 7.2$ Hz, 2H), 7.24-7.35 (m, 6H), 7.41 (t, $J = 8.0$ Hz, 2H), 7.64 (d, $J = 7.6$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ : 8.5, 14.2, 31.0, 32.5, 61.0, 114.8, 117.8, 125.9, 126.3, 127.2, 128.4, 128.5, 128.6, 131.2, 138.7, 148.6, 148.9, 171.4. HRMS calcd for $\text{C}_{22}\text{H}_{23}\text{O}_3$: 335.1642 $[\text{M}+\text{H}]^+$, found: 335.1645.

Ethyl 2-(4-methyl-5-phenethyl-2-phenylfuran-3-yl)acetate (4k)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (57 mg, 55%); ^1H NMR (400 MHz, CDCl_3) δ : 1.31 (t, $J = 7.2$ Hz, 3H), 1.86 (s, 3H), 2.96 (d, $J = 7.2$ Hz, 2H), 3.01 (d, $J = 7.2$ Hz, 2H), 3.58 (s, 2H), 4.23 (q, $J = 7.6$ Hz, 2H), 7.21-7.34 (m, 6H), 7.45 (t, $J = 7.6$ Hz, 2H), 7.68 (d, $J = 8.0$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ : 8.2, 14.2, 28.5, 30.9, 34.9, 61.0, 114.7, 117.2, 126.0, 126.3, 127.1, 128.4, 128.5, 128.6, 131.4, 141.5, 148.4, 149.6, 171.4. HRMS calcd for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{Na}$: 371.1618 $[\text{M}+\text{Na}]^+$, found: 371.1612.

Ethyl 2-(4-ethyl-2-phenyl-5-p-tolylfuran-3-yl)acetate (4l)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (61 mg, 58%); ^1H NMR (400 MHz, CDCl_3) δ : 1.24-1.31 (m, 6H), 2.41 (s, 3H), 2.72 (q, $J = 7.6$ Hz, 2H), 3.67 (s, 2H), 4.23 (q, $J = 7.2$ Hz, 2H), 7.24-7.28 (m, 2H), 7.32 (t, $J = 7.6$ Hz, 1H), 7.45 (t, $J = 7.6$ Hz, 2H), 7.61 (d, $J = 7.6$ Hz, 2H), 7.74 (d, $J = 7.6$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.2, 14.4, 17.4, 21.3, 30.6, 61.1, 115.7, 124.4, 125.5, 126.1, 127.4, 128.6, 129.3, 136.8, 147.9, 150.9, 171.6. HRMS calcd for $\text{C}_{23}\text{H}_{25}\text{O}_3$: 349.1798 $[\text{M}+\text{H}]^+$, found: 349.1797.

Ethyl 2-(4-ethyl-5-(naphthalen-1-yl)-2-phenylfuran-3-yl)acetate (4m)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (55 mg, 48%); ^1H NMR (400 MHz, CDCl_3) δ : 1.10 (t, $J = 7.6$ Hz, 3H), 1.33 (t, $J = 7.2$ Hz, 3H), 2.54 (q, $J = 7.2$ Hz, 2H), 3.77 (s, 2H), 4.27 (q, $J = 7.2$ Hz, 2H), 7.32 (t, $J = 7.6$ Hz, 1H), 7.44 (t, $J = 7.6$ Hz, 2H), 7.52-7.62 (m, 4H), 7.75 (d, $J = 8.0$ Hz, 2H), 7.93 (d, $J = 7.6$ Hz, 2H), 8.04 (d, $J = 7.2$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.2, 14.9, 17.2, 31.0, 61.1, 114.9,

125.1, 126.0, 126.1, 126.3, 126.4, 126.7, 127.4, 128.20, 128.25, 128.6, 128.9, 129.0, 131.1, 132.4, 133.9, 148.0, 150.3, 171.5. HRMS calcd for C₂₆H₂₅O₃: 385.1798 [M+H]⁺, found: 385.1804.

Ethyl 2-(2-(4-methoxyphenyl)-4-methyl-5-phenylfuran-3-yl)acetate (4n)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (53 mg, 50%); ¹H NMR (400 MHz, CDCl₃) δ: 1.30-1.34 (m, 3H), 2.31 (s, 3H), 3.63 (s, 2H), 3.87 (s, 3H), 4.25 (q, *J* = 7.2 Hz, 2H), 7.01 (d, *J* = 8.8 Hz, 2H), 7.30 (t, *J* = 8.4 Hz, 1H), 7.45 (t, *J* = 8.0 Hz, 2H), 7.70-7.73 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.1, 14.2, 30.8, 55.3, 61.1, 114.1, 115.2, 118.7, 123.8, 125.5, 126.7, 127.7, 128.5, 131.8, 147.4, 149.5, 159.2, 171.4. HRMS calcd for C₂₂H₂₃O₄: 351.1591 [M+H]⁺, found: 351.1589.

Ethyl 2-(2-(2-bromo-4-fluorophenyl)-4-methyl-5-phenylfuran-3-yl)acetate (4o)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (97 mg, 78%); ¹H NMR (400 MHz, CDCl₃) δ: 1.29 (t, *J* = 7.2 Hz, 3H), 2.30 (s, 3H), 3.45 (s, 2H), 4.19 (q, *J* = 7.2 Hz, 2H), 7.31 (d, *J* = 7.6 Hz, 1H), 7.37-7.50 (m, 4H), 7.70-7.73 (m, 3H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.2, 14.2, 30.5, 61.1, 117.6, 118.8, 125.7, 126.9, 127.2, 127.6, 128.6, 128.7, 129.0, 131.4, 132.7, 132.8, 133.1, 135.3, 147.4, 149.0, 151.1, 160.6, 163.3, 171.0. HRMS calcd for C₂₁H₁₉BrFO₃: 417.0496 [M+H]⁺, found: 417.0499.

Ethyl 2-(5-(3,4-dimethoxyphenyl)-4-methyl-2-(2-(trifluoromethyl)phenyl)furan-3-yl)acetate (4p)

Eluent: ethyl acetate/hexanes (10%); yellow solid (110 mg, 82%), mp 56-57 °C. ¹H NMR (400 MHz, CDCl₃) δ: 1.28 (t, *J* = 7.2 Hz, 3H), 2.28 (s, 3H), 3.45 (s, 2H), 3.91 (s, 3H), 3.93 (s, 3H), 4.19 (q, *J* = 7.2 Hz, 2H), 6.93 (d, *J* = 8.4 Hz, 1H), 7.22 (d, *J* = 8.4 Hz, 1H), 7.30 (s, 1H), 7.51 (t, *J* = 7.6 Hz, 1H), 7.59-7.66 (m, 2H), 7.82 (d, *J* = 8.0 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.1, 14.1, 30.4, 55.7, 55.9, 61.0, 109.1, 111.2, 116.4, 118.3, 118.4, 124.6, 127.0, 127.1, 128.6, 128.9, 131.6, 131.8, 146.6, 148.3, 148.9, 149.1, 171.2. HRMS calcd for C₂₄H₂₄F₃O₅: 449.1570 [M+H]⁺, found: 449.1566.

Ethyl 2-(5-(3,4-dimethoxyphenyl)-2-(4-fluorophenyl)-4-methylfuran-3-yl)acetate (4q)

Eluent: ethyl acetate/hexanes (10%); yellow solid (84 mg, 70%), mp 78-90 °C. ¹H NMR (400 MHz, CDCl₃) δ: 1.30 (t, *J* = 7.2 Hz, 3H), 2.27 (s, 3H), 3.60 (s, 2H), 3.94 (s, 3H), 3.97 (s, 3H), 4.23 (q, *J* = 7.2 Hz, 2H), 6.95 (d, *J* = 8.8 Hz, 1H), 7.15 (t, *J* = 8.8 Hz, 2H), 7.22-7.23 (m, 2H), 7.70-7.73 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 9.9, 14.2, 30.8, 56.0, 61.1, 109.3, 111.3, 115.6, 115.8, 116.1, 117.4, 118.7, 124.6, 127.95, 128.03, 148.0, 148.1, 148.4, 149.0, 161.1, 163.4, 171.2. HRMS calcd for C₂₃H₂₄FO₅: 399.1602 [M+H]⁺, found: 399.1605.

Ethyl 2-(4-methyl-2,5-di(thiophen-2-yl)furan-3-yl)acetate (4r)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (48 mg, 48%); ¹H NMR (400 MHz, CDCl₃) δ: 1.29 (t, *J* = 7.6 Hz, 3H), 2.26 (s, 3H), 3.65 (s, 2H), 4.21 (q, *J* = 7.2 Hz, 2H), 7.10-7.12 (m, 1H), 7.20-7.22 (m, 1H), 7.29-7.40 (m, 2H), 7.71-7.73 (m, 1H), 7.92-7.93 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 9.5, 14.2, 30.7, 61.2, 116.2, 118.4, 123.1, 124.1, 124.2, 124.9, 127.4, 128.0, 133.2, 133.5, 143.0, 144.2, 170.7. HRMS calcd for C₁₇H₁₇O₃S₂: 333.0614 [M+H]⁺, found: 333.0616.

Methyl 2-(4-methyl-2,5-diphenylfuran-3-yl)acetate (4s)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (57 mg, 62%); ¹H NMR (400 MHz, CDCl₃) δ: 2.32 (s, 3H), 3.70 (s, 2H), 3.79 (s, 3H), 7.28-7.37 (m, 2H), 7.44-7.49 (m, 4H), 7.74 (t, *J* = 7.2 Hz, 4H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.0, 30.6, 52.2, 116.3, 118.7, 125.7, 126.2, 126.9, 127.6, 128.5, 128.7, 131.0, 131.6, 148.0, 149.4, 171.7. HRMS calcd for C₂₀H₁₉O₃: 307.1329 [M+H]⁺, found: 307.1333.

Butyl 2-(4-methyl-2,5-diphenylfuran-3-yl)acetate (4t)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (44 mg, 42%); ¹H NMR (400 MHz, CDCl₃) δ: 0.94 (t, *J* = 7.2 Hz, 3H), 1.37-1.43 (m, 2H), 1.59-1.69 (m, 2H), 2.31 (s, 3H), 3.67 (s, 2H), 4.18 (t, *J* = 6.8 Hz, 2H), 7.31-7.36 (m, 2H), 7.46 (t, *J* = 7.2 Hz, 4H), 7.73 (d, *J* = 8.0 Hz, 2H), 7.76 (d, *J* = 8.0 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.0, 13.7, 19.1, 30.6, 30.8, 65.0, 116.5, 118.8, 125.7, 126.2, 126.9, 127.5, 128.5, 128.7, 131.0, 131.7, 148.0, 149.4, 171.3. HRMS calcd for C₂₃H₂₅O₃: 349.1798 [M+H]⁺, found: 349.1803.

Hexyl 2-(4-methyl-2,5-diphenylfuran-3-yl)acetate (4u)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (45 mg, 40%); ^1H NMR (400 MHz, CDCl_3) δ : 0.88 (t, $J = 6.8$ Hz, 3H), 1.26-1.37 (m, 6H), 1.65 (q, $J = 6.8$ Hz, 2H), 2.31 (s, 3H), 3.67 (s, 2H), 4.17 (t, $J = 7.2$ Hz, 2H), 7.31 (d, $J = 7.2$ Hz, 1H), 7.35 (d, $J = 7.2$ Hz, 1H), 7.45 (t, $J = 7.2$ Hz, 4H), 7.72 (d, $J = 8.0$ Hz, 2H), 7.76 (d, $J = 8.0$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ : 10.0, 14.0, 22.5, 25.6, 28.6, 31.0, 31.4, 65.3, 116.5, 118.8, 125.7, 126.2, 126.9, 127.5, 128.5, 128.7, 131.0, 131.6, 148.0, 149.3, 171.3. HRMS calcd for $\text{C}_{25}\text{H}_{29}\text{O}_3$: 377.2111 $[\text{M}+\text{H}]^+$, found: 377.2113.

Benzyl 2-(4-methyl-2,5-diphenylfuran-3-yl)acetate (4v)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (57 mg, 50%); ^1H NMR (400 MHz, CDCl_3) δ : 2.27 (s, 3H), 3.72 (s, 2H), 5.23 (s, 2H), 7.29-7.47 (m, 11H), 7.71-7.74 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3) δ : 10.0, 30.8, 66.9, 116.3, 118.7, 125.7, 126.2, 126.9, 127.6, 128.2, 128.3, 128.5, 128.6, 128.7, 130.9, 131.6, 135.8, 148.0, 149.5, 171.1. HRMS calcd for $\text{C}_{26}\text{H}_{22}\text{O}_3\text{Na}$: 405.1461 $[\text{M}+\text{Na}]^+$, found: 405.1466.

Allyl 2-(4-methyl-2,5-diphenylfuran-3-yl)acetate (4w)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (40 mg, 40%); ^1H NMR (400 MHz, CDCl_3) δ : 2.21 (s, 3H), 3.71 (s, 2H), 4.68 (d, $J = 6.0$ Hz, 2H), 5.25-5.36 (m, 2H), 5.90-5.98 (m, 1H), 7.30-7.36 (m, 2H), 7.39-7.47 (m, 4H), 7.73 (t, $J = 8.4$ Hz, 4H). ^{13}C NMR (100 MHz, CDCl_3) δ : 10.1, 30.8, 65.7, 116.3, 118.5, 118.7, 125.7, 126.2, 127.0, 127.6, 128.6, 128.7, 130.9, 131.6, 132.0, 148.0, 149.4, 170.9. HRMS calcd for $\text{C}_{22}\text{H}_{21}\text{O}_3$: 333.1485 $[\text{M}+\text{H}]^+$, found: 333.1489.

***Tert*-butyl 2-(5-(3,4-dimethoxyphenyl)-4-methyl-2-(2-(trifluoromethyl)phenyl)furan-3-yl)acetate (4x)**

Eluent: ethyl acetate/hexanes (10%); yellow liquid (40 mg, 28%); ^1H NMR (400 MHz, CDCl_3) δ : 1.22 (s, 9H), 2.32 (s, 3H), 3.94 (s, 6H), 4.96 (s, 2H), 6.94 (d, $J = 8.4$ Hz, 1H), 7.24 (d, $J = 8.4$ Hz, 1H), 7.30 (s, 1H), 7.53-7.57 (m, 2H), 7.62 (d, $J = 7.2$ Hz, 1H), 7.83 (d, $J = 8.0$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3)

δ : 9.8, 27.1, 38.9, 55.8, 55.9, 57.3, 109.0, 109.1, 111.2, 116.3, 118.3, 120.3, 122.5, 124.4, 127.0, 127.1, 128.5, 128.9, 131.6, 131.9, 148.0, 148.4, 149.1, 149.2, 178.4. HRMS calcd for $C_{26}H_{28}F_3O_5$: 477.1883 $[M+H]^+$, found: 477.1886.

Ethyl 2-(2,5-diphenylfuran-3-yl)acetate (6a)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (55 mg, 60%); 1H NMR (400 MHz, $CDCl_3$) δ : 1.30 (t, J = 6.8 Hz, 3H), 3.71 (s, 2H), 4.21-4.24 (m, 2H), 6.81 (s, 1H), 7.28-7.49 (m, 6H), 7.72-7.76 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ : 14.2, 32.3, 61.1, 109.4, 115.6, 123.8, 126.1, 127.5, 127.6, 128.7, 130.8, 149.8, 152.5, 171.2. HRMS calcd for $C_{20}H_{19}O_3$: 307.1329 $[M+H]^+$, found: 307.1333.

Ethyl 2-(2-phenyl-5-*o*-tolylfuran-3-yl)acetate (6b)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (42 mg, 44%); 1H NMR (400 MHz, $CDCl_3$) δ : 1.31 (t, J = 6.8 Hz, 3H), 2.59 (s, 3H), 3.73 (s, 2H), 4.24 (q, J = 6.8 Hz, 2H), 6.70 (s, 1H), 7.23-7.37 (m, 4H), 7.45-7.49 (m, 2H), 7.73 (d, J = 7.6 Hz, 2H), 7.80 (d, J = 7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ : 14.2, 22.1, 32.3, 61.1, 112.9, 115.3, 126.0, 126.1, 126.9, 127.5, 127.6, 128.7, 129.8, 130.9, 131.3, 134.6, 149.5, 152.2, 171.2. HRMS calcd for $C_{21}H_{21}O_3$: 321.1485 $[M+H]^+$, found: 321.1482.

Ethyl 2-(5-(2-fluorophenyl)-2-phenylfuran-3-yl)acetate (6c)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (39 mg, 40%); 1H NMR (400 MHz, $CDCl_3$) δ : 1.30 (t, J = 7.2 Hz, 3H), 3.72 (s, 2H), 4.23 (q, J = 7.2 Hz, 2H), 6.98 (d, J = 3.6 Hz, 1H), 7.12-7.28 (m, 2H), 7.36 (t, J = 7.6 Hz, 1H), 7.48 (t, J = 7.6 Hz, 2H), 7.74 (d, J = 7.2 Hz, 2H), 7.90-7.93 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ : 13.2, 31.2, 60.1, 113.5, 113.6, 114.8, 114.9, 115.0, 117.8, 117.9, 123.26, 123.29, 124.89, 124.91, 125.2, 126.8, 127.3, 127.4, 127.70, 127.74, 129.6, 145.59, 145.60, 148.8, 156.9, 158.6, 170.0. HRMS calcd for $C_{20}H_{18}FO_3$: 325.1234 $[M+H]^+$, found: 325.1236.

Ethyl 2-(2-phenyl-5-*p*-tolylfuran-3-yl)acetate (6d)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (53 mg, 55%); ^1H NMR (400 MHz, CDCl_3) δ : 1.30 (t, $J = 6.8$ Hz, 3H), 2.39 (s, 3H), 3.70 (s, 2H), 4.23 (q, $J = 6.8$ Hz, 2H), 6.74 (s, 1H), 7.22 (d, $J = 8.0$ Hz, 2H), 7.34 (t, $J = 7.2$ Hz, 1H), 7.46 (t, $J = 8.0$ Hz, 2H), 7.64 (d, $J = 8.0$ Hz, 2H), 7.72 (d, $J = 7.2$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.2, 21.3, 32.3, 61.1, 108.7, 115.6, 123.8, 126.1, 127.5, 127.9, 128.7, 129.4, 130.9, 137.4, 149.4, 152.7, 171.2. HRMS calcd for $\text{C}_{21}\text{H}_{21}\text{O}_3$: 321.1485 $[\text{M}+\text{H}]^+$, found: 321.1489.

Ethyl 2-(5-(4-chlorophenyl)-2-phenylfuran-3-yl)acetate (6e)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (51 mg, 50%); ^1H NMR (400 MHz, CDCl_3) δ : 1.30 (t, $J = 7.2$ Hz, 3H), 3.70 (s, 2H), 4.23 (q, $J = 7.2$ Hz, 2H), 6.79 (s, 1H), 7.34-7.39 (m, 3H), 7.47 (t, $J = 8.0$ Hz, 2H), 7.65-7.72 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.2, 32.2, 61.2, 109.9, 115.8, 125.0, 126.2, 127.8, 128.9, 129.0, 129.2, 130.6, 133.1, 150.2, 151.4, 171.1. HRMS calcd for $\text{C}_{20}\text{H}_{18}\text{ClO}_3$: 341.0939 $[\text{M}+\text{H}]^+$, found: 341.0937.

Ethyl 2-(5-(naphthalen-1-yl)-2-phenylfuran-3-yl)acetate (6f)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (69 mg, 65%); ^1H NMR (400 MHz, CDCl_3) δ : 1.33 (t, $J = 7.2$ Hz, 3H), 3.79 (s, 2H), 4.27 (m, 2H), 6.91 (s, 1H), 7.37 (t, $J = 7.2$ Hz, 1H), 7.48-7.59 (m, 5H), 7.78 (d, $J = 8.0$ Hz, 2H), 7.84-7.93 (m, 3H), 8.55 (d, $J = 8.4$ Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.3, 32.3, 61.2, 113.7, 115.4, 125.4, 125.6, 126.0, 126.1, 126.2, 126.7, 127.7, 128.2, 128.61, 128.64, 128.8, 130.2, 130.9, 134.0, 150.3, 152.1, 171.2. HRMS calcd for $\text{C}_{24}\text{H}_{21}\text{O}_3$: 357.1485 $[\text{M}+\text{H}]^+$, found: 357.1489.

Ethyl 2-(2-phenyl-5-(thiophen-2-yl)furan-3-yl)acetate (6g)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (59 mg, 63%); ^1H NMR (400 MHz, CDCl_3) δ : 1.30 (t, $J = 7.2$ Hz, 3H), 3.68 (s, 2H), 4.23 (q, $J = 7.2$ Hz, 2H), 6.65 (s, 1H), 7.06-7.08 (m, 1H), 7.25-7.28 (m, 1H), 7.32-7.36 (m, 2H), 7.46 (t, $J = 7.6$ Hz, 2H), 7.69 (dd, $J_1 = 7.6$ Hz, $J_2 = 1.2$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.2, 32.2, 61.1, 109.3, 115.6, 122.8, 124.3, 126.2, 127.7, 128.7, 130.5, 133.5, 148.2, 149.4, 171.0. HRMS calcd for $\text{C}_{18}\text{H}_{17}\text{O}_3\text{S}$: 313.0893 $[\text{M}+\text{H}]^+$, found: 313.0892.

Ethyl 2-(2-(4-methoxyphenyl)-5-phenylfuran-3-yl)acetate (6h)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (50 mg, 50%); ^1H NMR (400 MHz, CDCl_3) δ : 1.30 (t, $J = 6.8$ Hz, 3H), 3.66 (s, 2H), 3.88 (s, 3H), 4.23 (q, $J = 6.8$ Hz, 2H), 6.77 (s, 1H), 7.36-7.42 (m, 3H), 7.47-7.52 (m, 2H), 7.66 (d, $J = 8.8$ Hz, 2H), 7.72 (d, $J = 7.6$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.2, 32.2, 55.4, 61.1, 109.3, 114.2, 123.7, 124.8, 126.3, 127.7, 128.0, 128.7, 129.5, 130.8, 151.9, 159.3, 171.4. HRMS calcd for $\text{C}_{21}\text{H}_{21}\text{O}_4$: 337.1434 $[\text{M}+\text{H}]^+$, found: 337.1436.

Ethyl 2-(2-(4-chlorophenyl)-5-phenylfuran-3-yl)acetate (6i)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (63 mg, 62%); ^1H NMR (400 MHz, CDCl_3) δ : 1.30 (t, $J = 7.2$ Hz, 3H), 3.67 (s, 2H), 4.23 (q, $J = 7.2$ Hz, 2H), 6.79 (s, 1H), 7.27-7.44 (m, 5H), 7.66 (d, $J = 8.4$ Hz, 2H), 7.73 (d, $J = 7.6$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.2, 32.3, 61.2, 109.5, 116.1, 123.9, 127.3, 127.7, 128.5, 128.6, 128.7, 128.9, 133.4, 152.8, 154.3, 171.0. HRMS calcd for $\text{C}_{20}\text{H}_{18}\text{ClO}_3$: 341.0939 $[\text{M}+\text{H}]^+$, found: 341.0945.

Ethyl 2-(2,5-diphenylfuran-3-yl)-2-phenylacetate (6j)

Eluent: ethyl acetate/hexanes (10%); yellow liquid (55 mg, 48%); ^1H NMR (400 MHz, CDCl_3) δ : 1.30 (t, $J = 7.6$ Hz, 3H), 4.23 (s, 1H), 4.27 (q, $J = 7.2$ Hz, 2H), 7.31-7.38 (m, 5H), 7.49 (s, 1H), 7.50-7.53 (m, 3H), 7.57-7.61 (m, 2H), 7.98 (d, $J = 8.0$ Hz, 2H), 8.03-8.07 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ : 14.2, 38.7, 61.0, 108.1, 115.7, 128.3, 128.4, 128.6, 128.7, 128.8, 128.9, 130.1, 132.0, 133.4, 135.3, 136.2, 138.3, 142.0, 144.0, 167.5. HRMS calcd for $\text{C}_{26}\text{H}_{23}\text{O}_3$: 383.1642 $[\text{M}+\text{H}]^+$, found: 383.1635.

2. Procedure for the preparation of 2-(4-methyl-2,5-diphenylfuran-3-yl)acetic acid (7a)

To a flask containing ethyl 2-(4-methyl-2,5-diphenylfuran-3-yl)acetate (**4a**, 0.2 mmol) in $\text{CH}_3\text{OH}/\text{H}_2\text{O}$ (1 mL, v/v = 1:1) was added KOH (0.4 mmol). After the mixture was stirred at 60 °C under air for 4 h, the reaction was quenched with aqueous HCl (2%) and extracted with ethyl acetate (5 mL \times 3). The combined organic layers were washed with water and brine, and then dried over anhydrous Na_2SO_4 . The

solvent was evaporated under vacuum and the crude product was purified by column chromatography on silica-gel to afford **7a** in 92% yield. **7b-7d** were prepared in a similar manner.

2-(4-Methyl-2,5-diphenylfuran-3-yl)acetic acid (7a)

Eluent: ethyl acetate/hexanes (20%); white solid (54 mg, 92%), mp 167-169 °C. ¹H NMR (400 MHz, CDCl₃) δ: 2.32 (s, 3H), 3.73 (s, 2H), 7.29-7.37 (m, 2H), 7.44 (d, *J* = 7.6 Hz, 2H), 7.48 (d, *J* = 7.6 Hz, 2H), 7.71-7.75 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.0, 30.5, 115.6, 118.6, 125.7, 126.2, 127.0, 127.7, 128.6, 128.8, 130.7, 131.5, 148.2, 149.6, 171.8. HRMS calcd for C₁₉H₁₇O₃: 293.1172 [M+H]⁺, found: 293.1174.

2-(2-(4-Methoxyphenyl)-4-methyl-5-phenylfuran-3-yl)acetic acid (7b)

Eluent: ethyl acetate/hexanes (20%); white solid (58 mg, 90%), mp 173-175 °C. ¹H NMR (400 MHz, CDCl₃) δ: 2.29 (s, 3H), 3.66 (s, 2H), 3.85 (s, 3H), 6.99 (d, *J* = 8.4 Hz, 2H), 7.27-7.30 (m, 1H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.65-7.70 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ: 10.0, 31.0, 55.3, 114.2, 118.5, 123.6, 125.6, 126.8, 127.7, 128.5, 131.6, 147.5, 149.7, 159.2, 168.5. HRMS calcd for C₂₀H₁₉O₄: 323.1278 [M+H]⁺, found: 323.1282.

2-(4-Methyl-2-phenyl-5-*o*-tolylfuran-3-yl)acetic acid (7c)

Eluent: ethyl acetate/hexanes (20%); white solid (56 mg, 91%), mp 161-162 °C. ¹H NMR (400 MHz, CDCl₃) δ: 2.11 (s, 3H), 2.45 (s, 3H), 3.74 (s, 2H), 7.28-7.35 (m, 4H), 7.39-7.47 (m, 3H), 7.71 (d, *J* = 7.6 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 9.5, 20.7, 30.8, 114.5, 119.4, 125.5, 126.0, 127.5, 128.3, 128.7, 130.0, 130.4, 130.7, 130.9, 137.6, 149.2, 149.8, 177.5. HRMS calcd for C₂₀H₁₉O₃: 307.1329 [M+H]⁺, found: 307.1336.

2-(2,5-Diphenylfuran-3-yl)acetic acid (7d)

Eluent: ethyl acetate/hexanes (20%); white solid (49 mg, 88%), mp 157-159 °C. ¹H NMR (400 MHz, CDCl₃) δ: 3.74 (s, 2H), 6.79 (s, 1H), 7.28-7.47 (m, 6H), 7.71 (t, *J* = 8.4 Hz, 4H). ¹³C NMR (100 MHz,

CDCl₃) δ : 31.0, 109.3, 123.8, 126.2, 127.5, 127.7, 128.7, 128.8, 130.4, 130.6, 142.8, 152.7, 159.8, 168.8.

HRMS calcd for C₁₈H₁₅O₃: 279.1016 [M+H]⁺, found: 279.1019.

3. Procedure for the preparation of 3-methyl-2-phenylnaphtho[1,2-*b*]furan-5-ol (**8a**)

To a flask containing 2-(4-methyl-2,5-diphenylfuran-3-yl)acetic acid (**7a**, 0.15 mmol) in CH₂Cl₂ (0.5 mL) was added TFAA (0.9 mmol) and TfOH (0.2 mmol). Then, the mixture was stirred at room temperature under air for 2 h. Upon completion, the reaction was quenched with aqueous NaHCO₃ and extracted with ethyl acetate (3 mL \times 3). The combined organic layers were washed with water and brine, and then dried over anhydrous Na₂SO₄. The solvent was evaporated under vacuum and the crude product was purified by column chromatography on silica-gel to afford **8a** in 63% yield. **8b-8d** were prepared in a similar manner.

3-Methyl-2-phenylnaphtho[1,2-*b*]furan-5-ol (**8a**)

Eluent: ethyl acetate/hexanes (20%); yellow solid (26 mg, 63%), mp 137-139 °C. ¹H NMR (400 MHz, CDCl₃) δ : 2.52 (s, 3H), 5.24 (s, 1H), 6.96 (s, 1H), 7.28-7.42 (m, 1H), 7.52 (t, *J* = 8.0 Hz, 3H), 7.61-7.64 (m, 1H), 7.89 (dd, *J*₁ = 7.6 Hz, *J*₂ = 1.2 Hz, 2H), 8.26 (d, *J* = 8.4 Hz, 1H), 8.34 (dd, *J*₁ = 8.4 Hz, *J*₂ = 0.8 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ : 9.7, 99.7, 112.3, 120.1, 122.7, 124.4, 125.8, 126.36, 126.40, 126.8, 127.5, 128.6, 128.7, 131.7, 144.5, 147.6, 150.5. MS: *m/z* 273 [MH]⁺.

7-Methoxy-3-methyl-2-phenylnaphtho[1,2-*b*]furan-5-ol (**8b**)

Eluent: ethyl acetate/hexanes (20%); yellow solid (32 mg, 71%), mp 147-149 °C. ¹H NMR (400 MHz, CDCl₃) δ : 2.50 (s, 3H), 3.99 (s, 3H), 5.38 (s, 1H), 6.95 (s, 1H), 7.30-7.38 (m, 2H), 7.51 (t, *J* = 7.6 Hz, 2H), 7.59 (d, *J* = 2.4 Hz, 1H), 7.86 (d, *J* = 8.0 Hz, 2H), 8.25 (d, *J* = 8.8 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ : 9.8, 31.0, 55.4, 100.3, 102.0, 112.2, 116.9, 119.0, 121.9, 124.1, 124.3, 126.2, 127.3, 128.6, 131.8, 144.9, 146.9, 149.7, 157.0. MS: *m/z* 303 [MH]⁺.

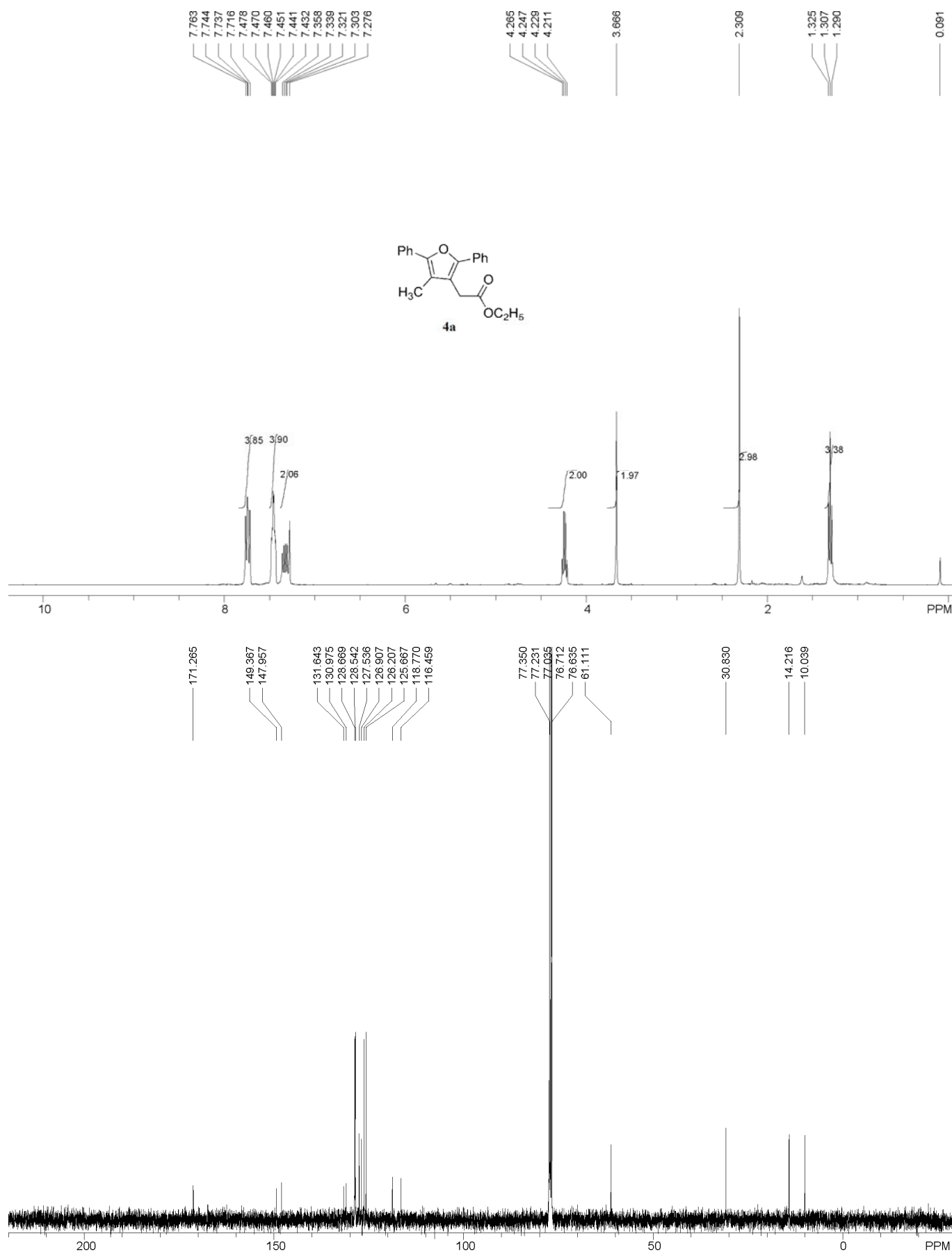
3-Methyl-2-*o*-tolyl-naphtho[1,2-*b*]furan-5-ol (**8c**)

Eluent: ethyl acetate/hexanes (20%); yellow solid (27 mg, 62%), mp 135-136 °C. ¹H NMR (400 MHz, CDCl₃) δ: 2.29 (s, 3H), 2.46 (s, 3H), 5.32 (s, 1H), 6.99 (s, 1H), 7.31-7.38 (m, 3H), 7.47-7.53 (m, 2H), 7.61 (t, *J* = 8.0 Hz, 1H), 8.27 (d, *J* = 8.4 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 9.1, 20.5, 100.0, 113.2, 120.0, 121.7, 122.68, 122.75, 124.3, 125.0, 125.6, 126.8, 128.8, 128.9, 130.5, 130.7, 138.1, 144.9, 147.4, 151.8. MS: m/z 287 [MH]⁺.

2-Phenylnaphtho[1,2-*b*]furan-5-ol (8d)

Eluent: ethyl acetate/hexanes (20%); yellow solid (18 mg, 47%), mp 118-120 °C. ¹H NMR (400 MHz, CDCl₃) δ: 5.23 (br s, 1H), 7.00 (s, 1H), 7.07 (s, 1H), 7.35-7.56 (m, 4H), 7.65 (t, *J* = 8.0 Hz, 1H), 7.93 (d, *J* = 7.6 Hz, 2H), 8.26 (d, *J* = 8.4 Hz, 1H), 8.36 (d, *J* = 8.4 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 101.1, 102.3, 120.0, 122.8, 124.3, 124.5, 124.6, 127.0, 128.2, 128.7, 128.8, 128.9, 130.9, 145.7, 147.9, 155.4. MS: m/z 259 [MH]⁺.

IV. Copies of ^1H and ^{13}C NMR spectra of 4a-4x



7.768
7.750
7.485
7.467
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7.424
7.419
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7.340
7.326
7.322
7.311
7.304
7.295

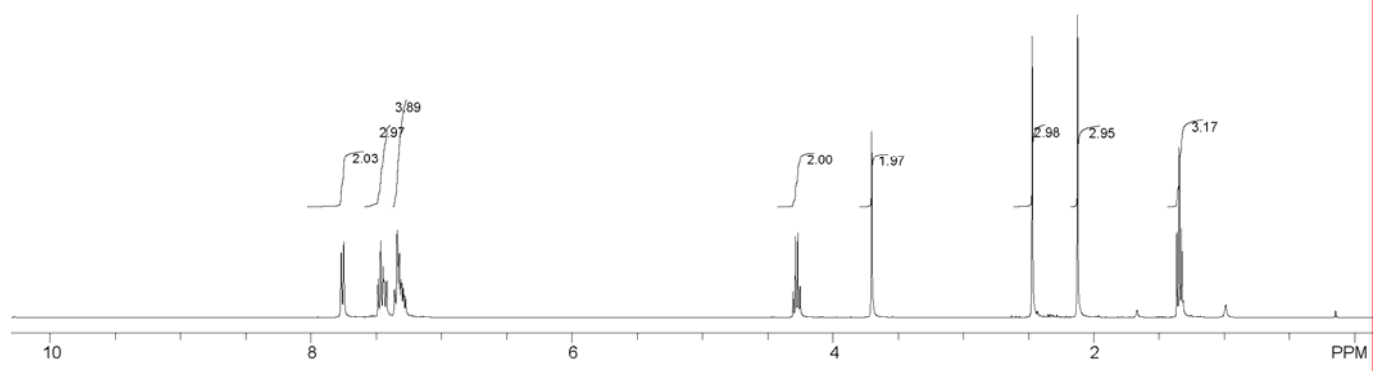
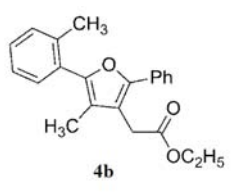
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4.270
4.252

3.704

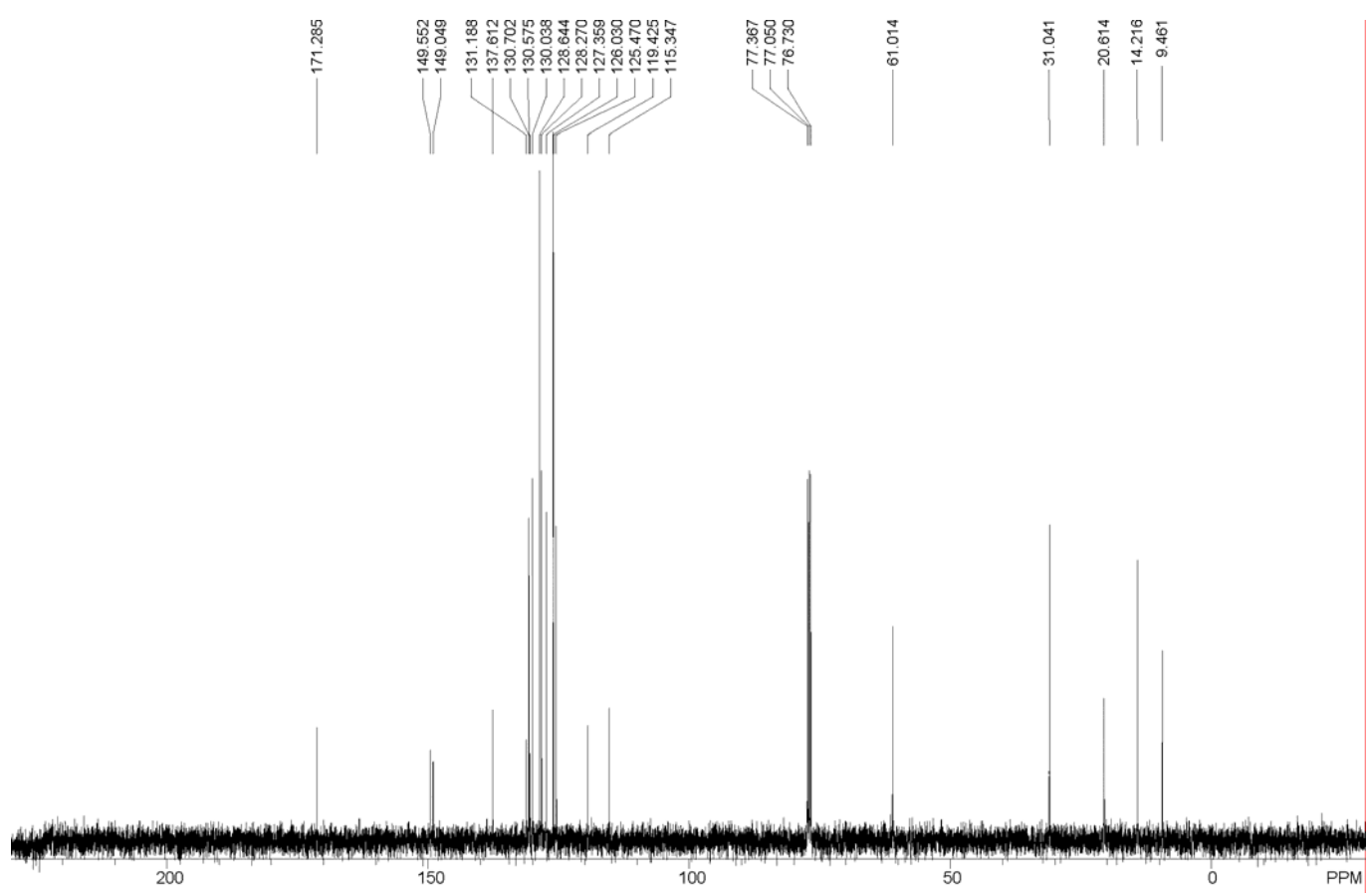
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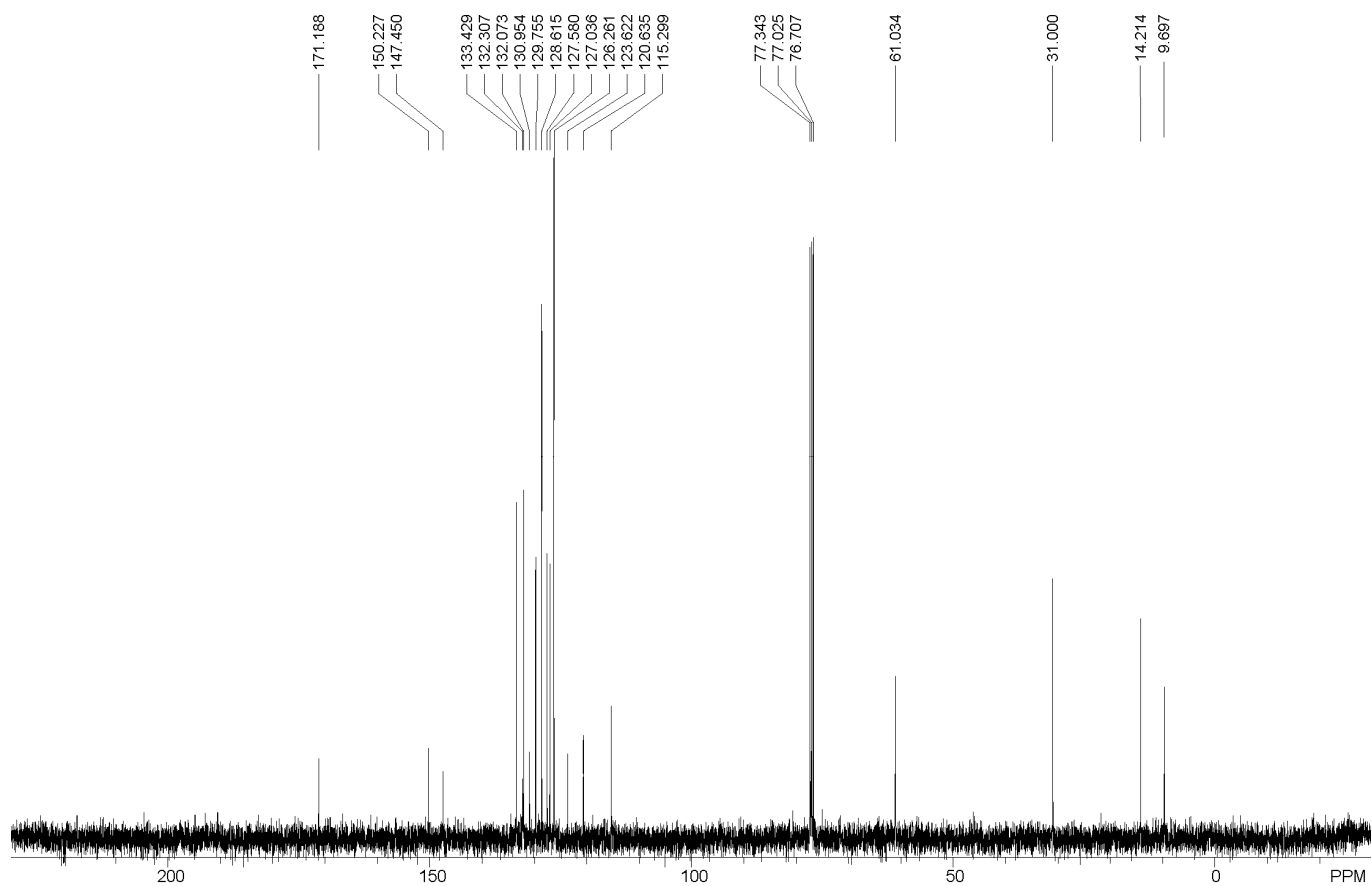
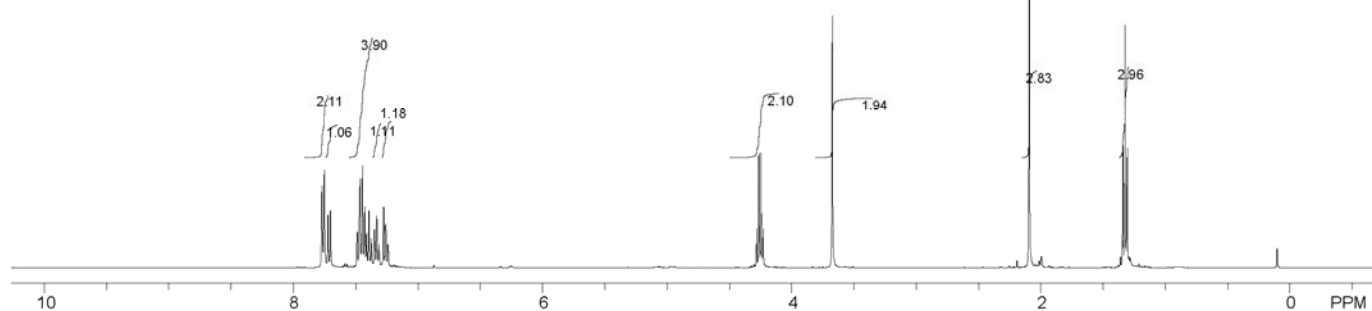
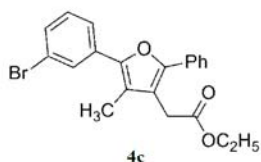
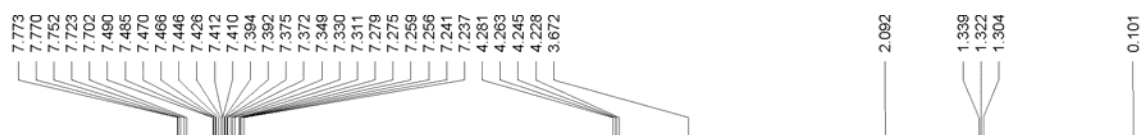
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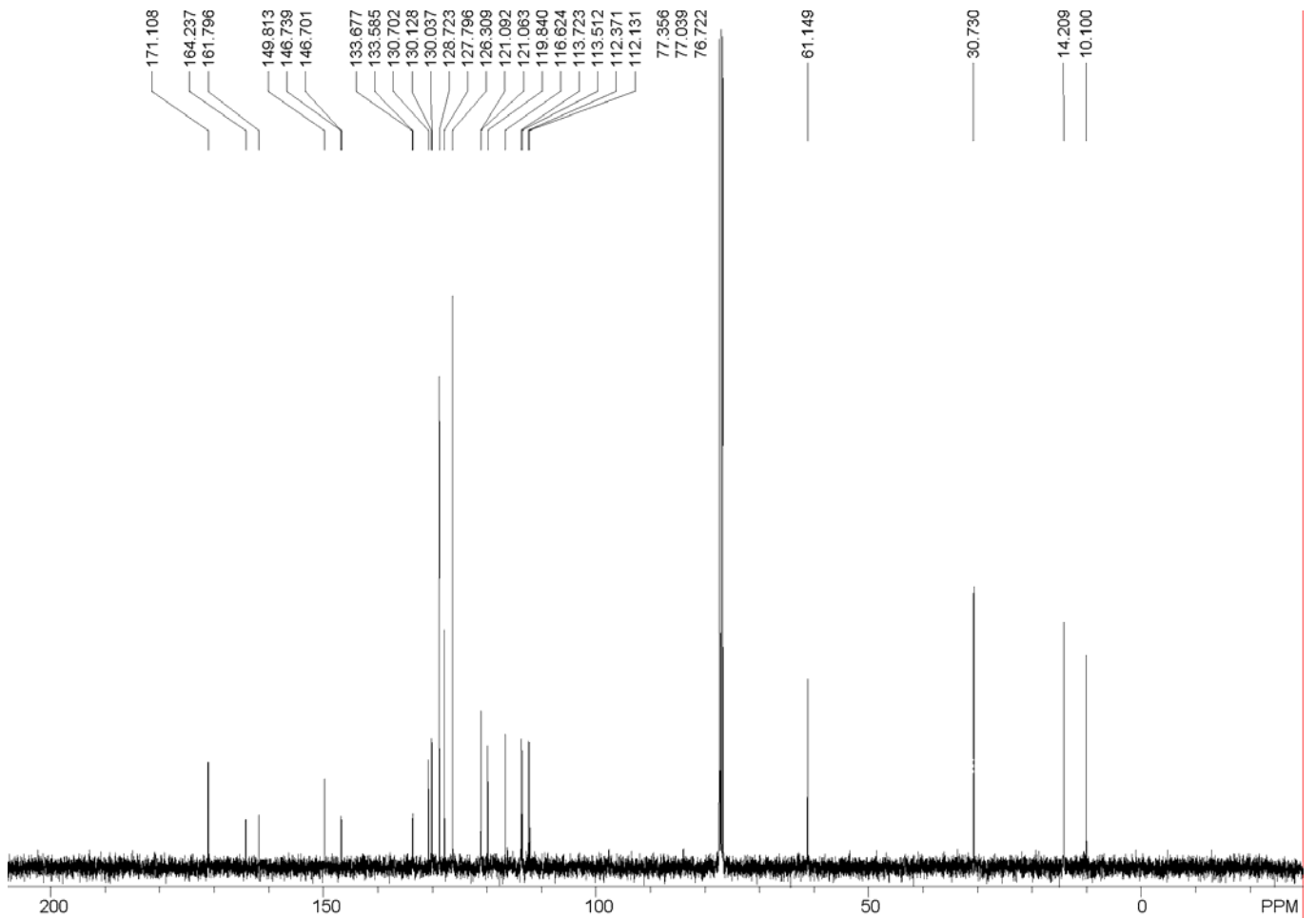
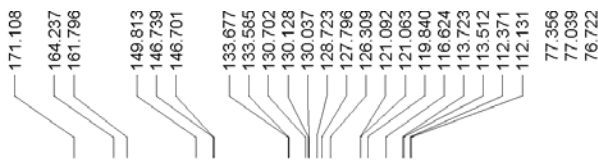
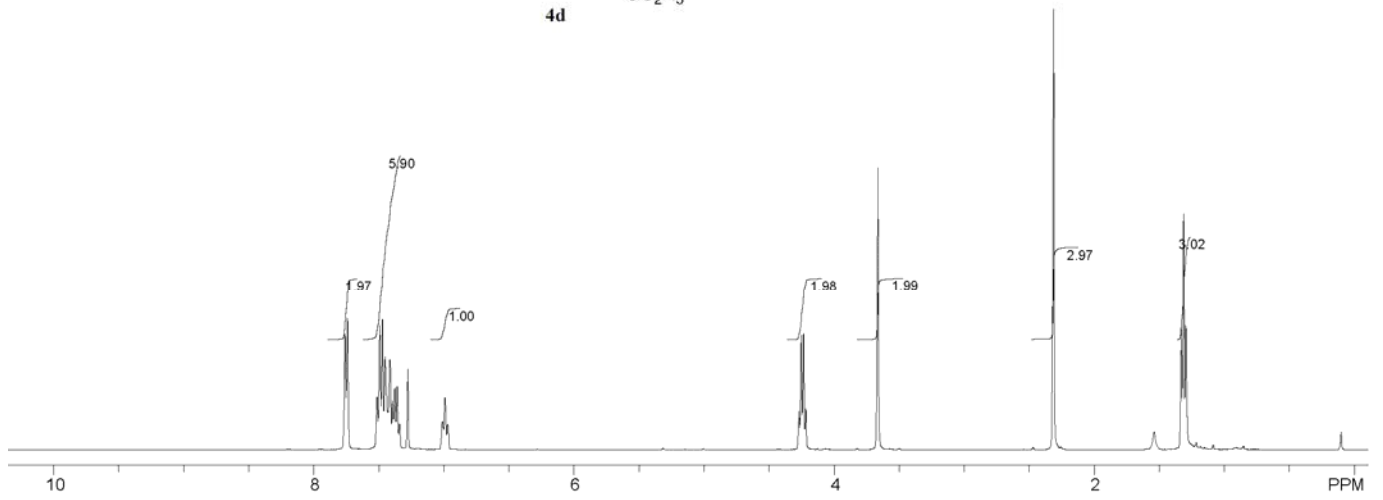
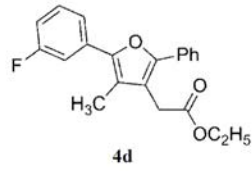
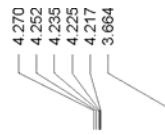
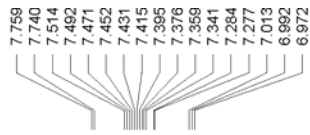
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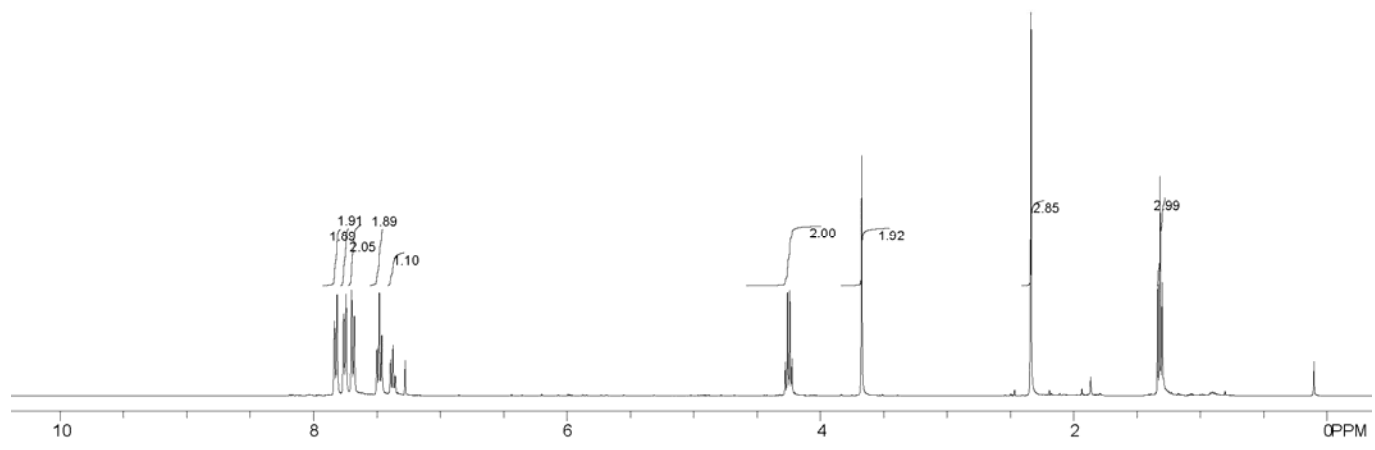
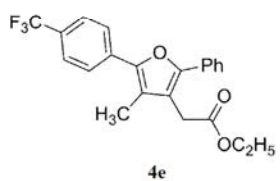
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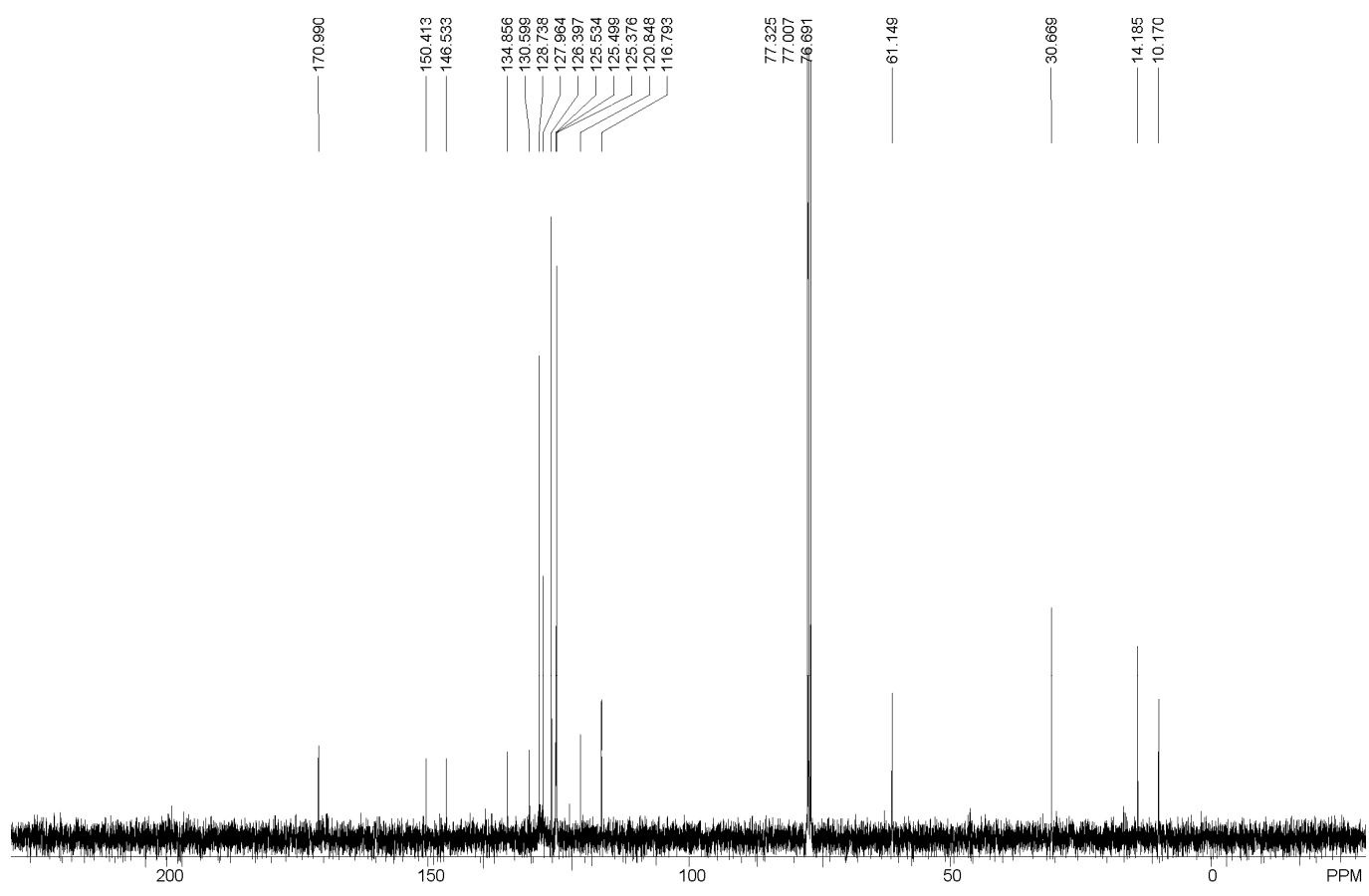
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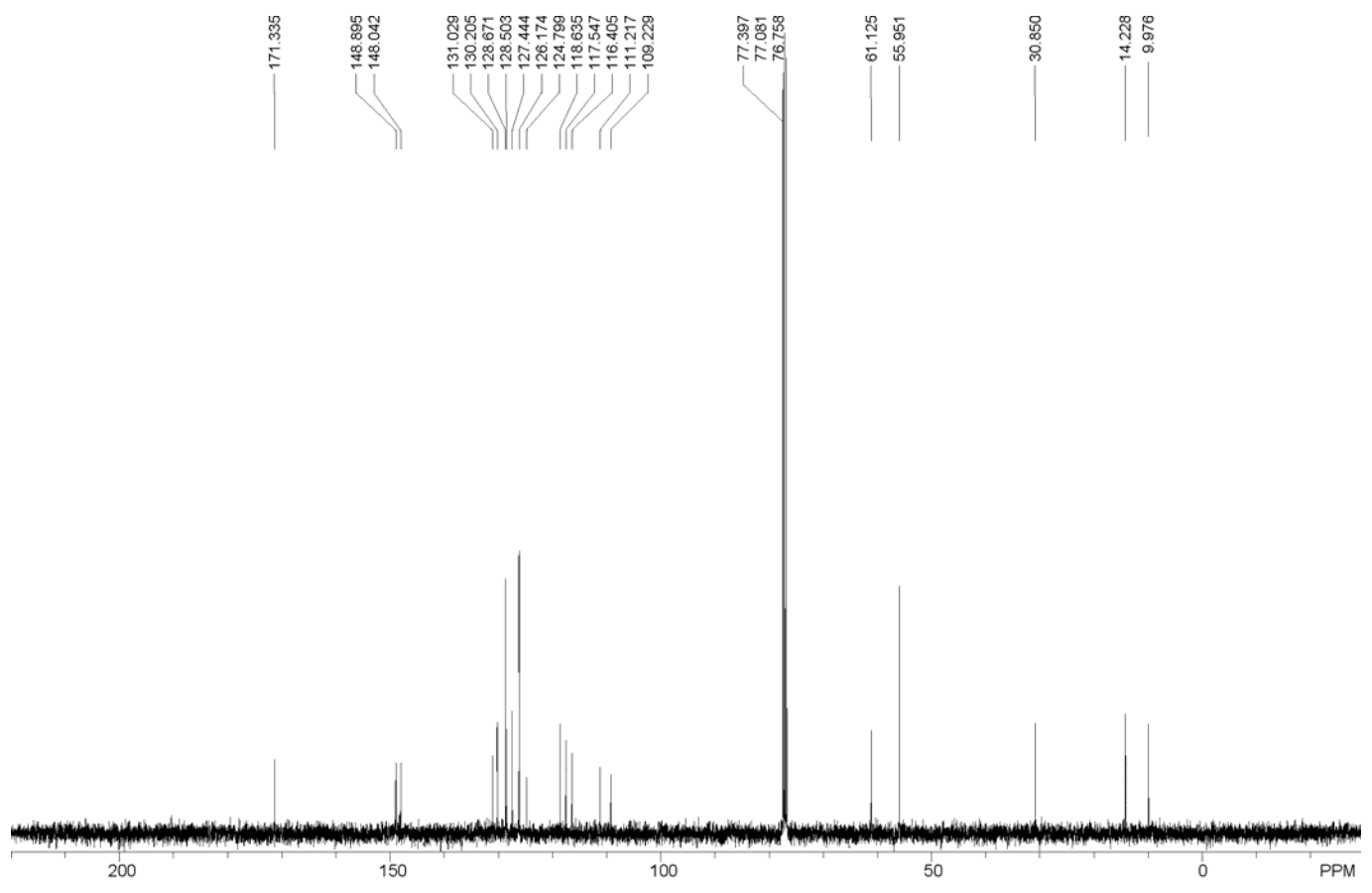
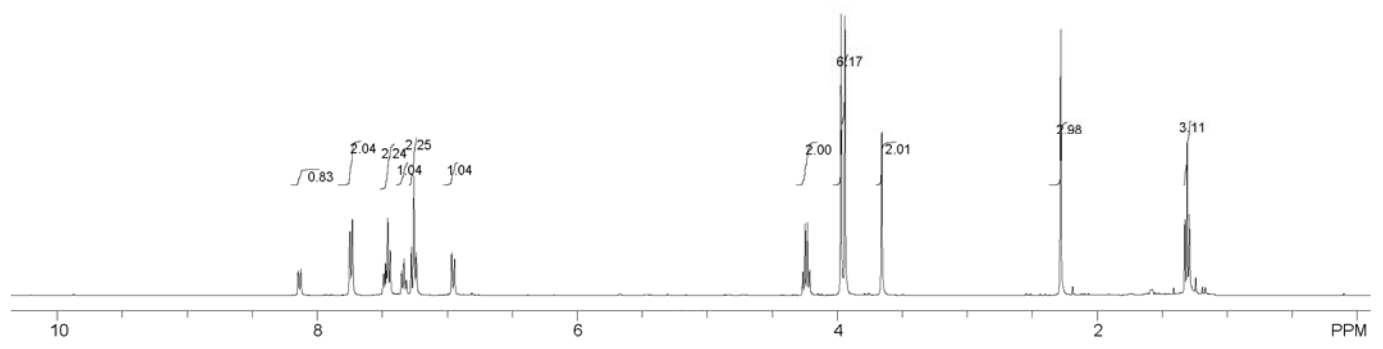
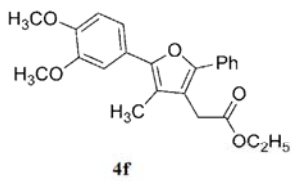
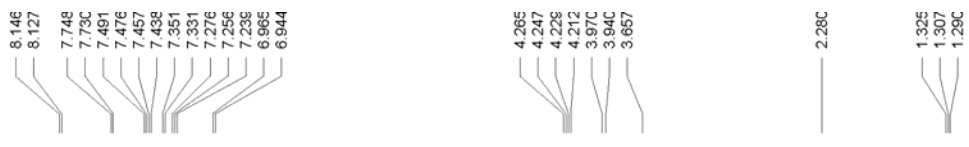
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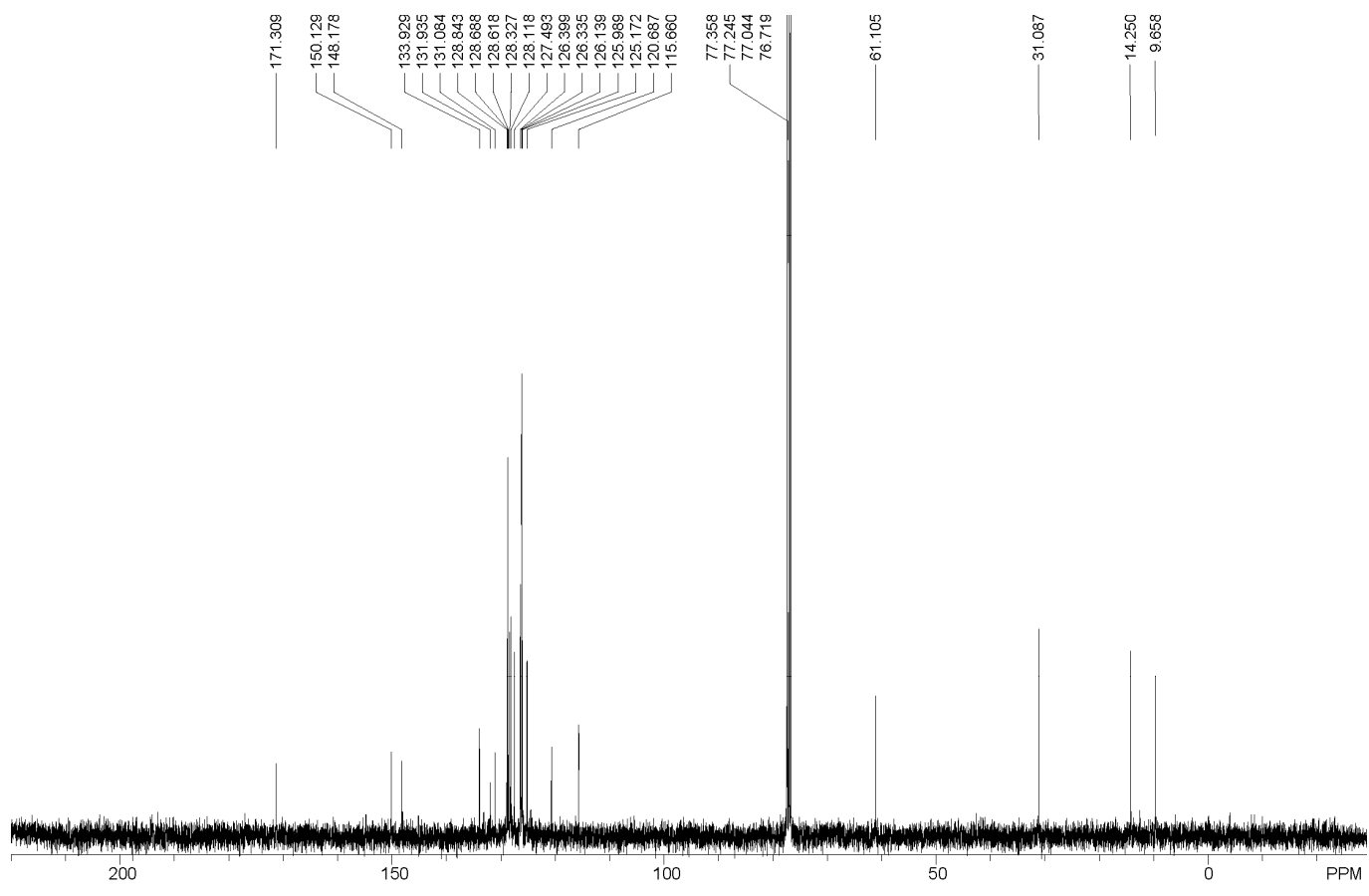
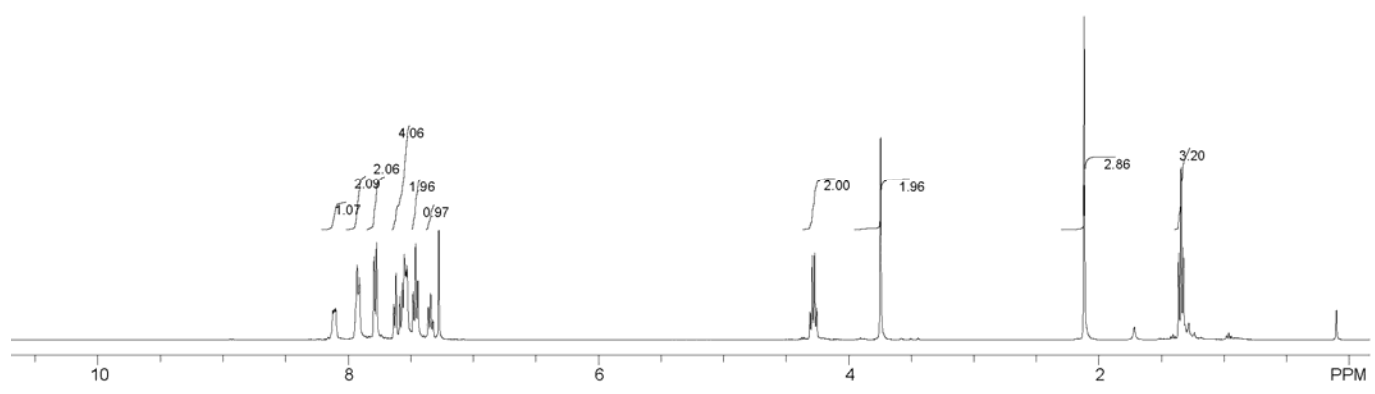
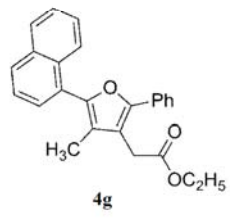
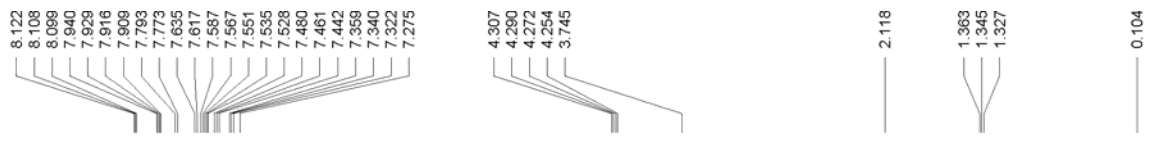
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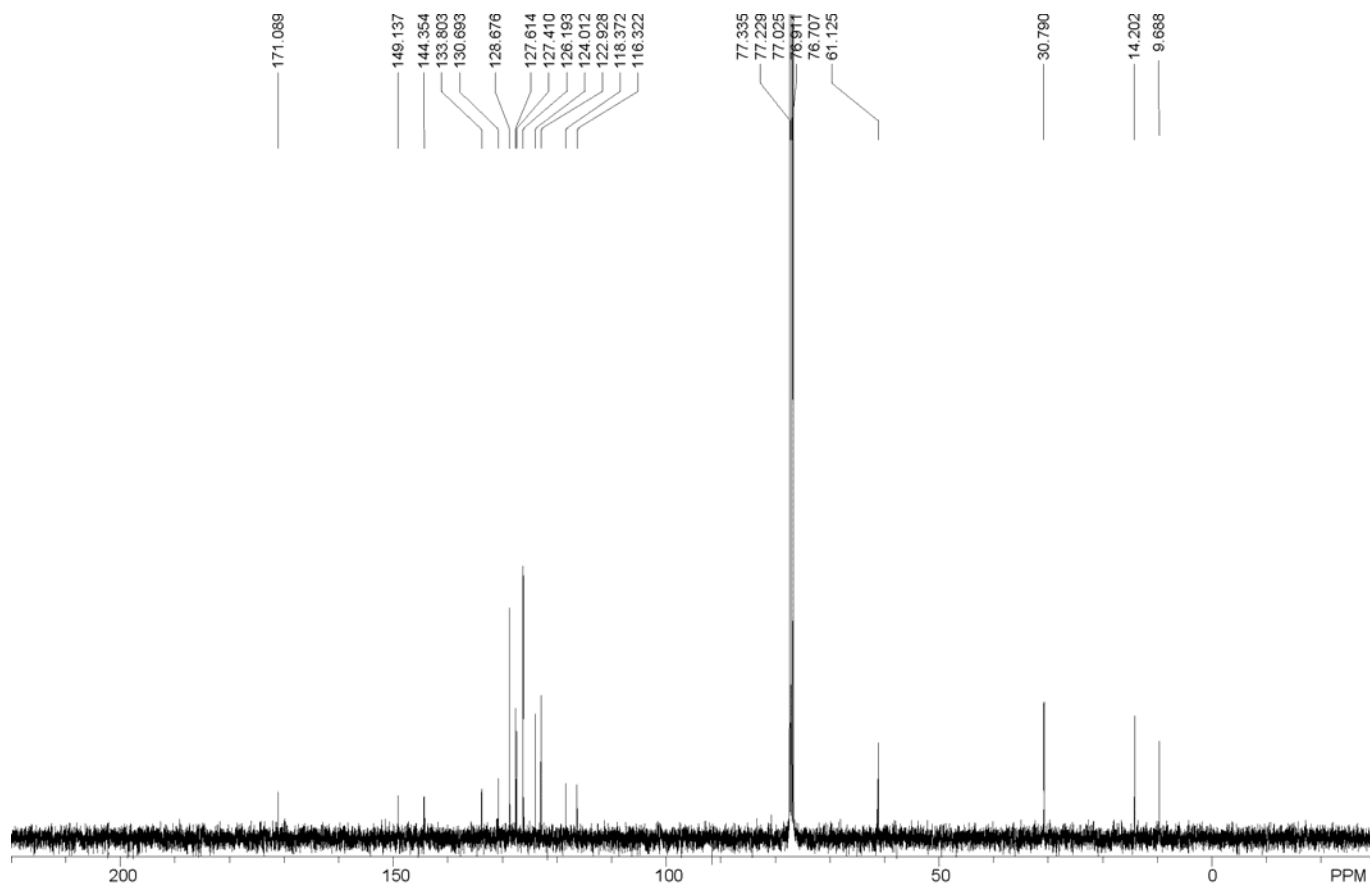
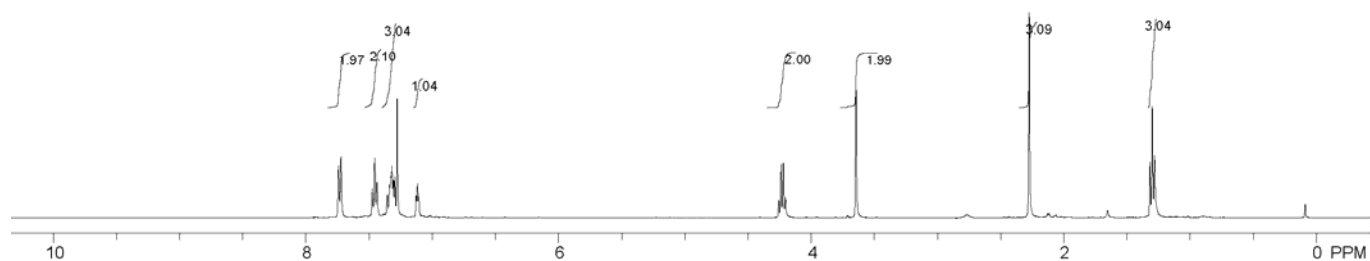
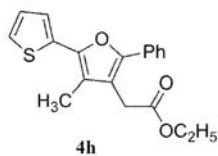
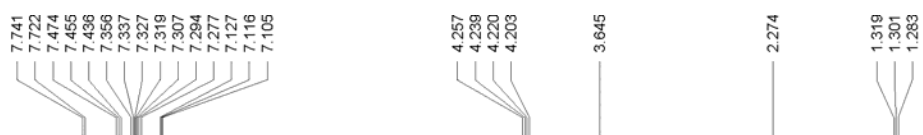
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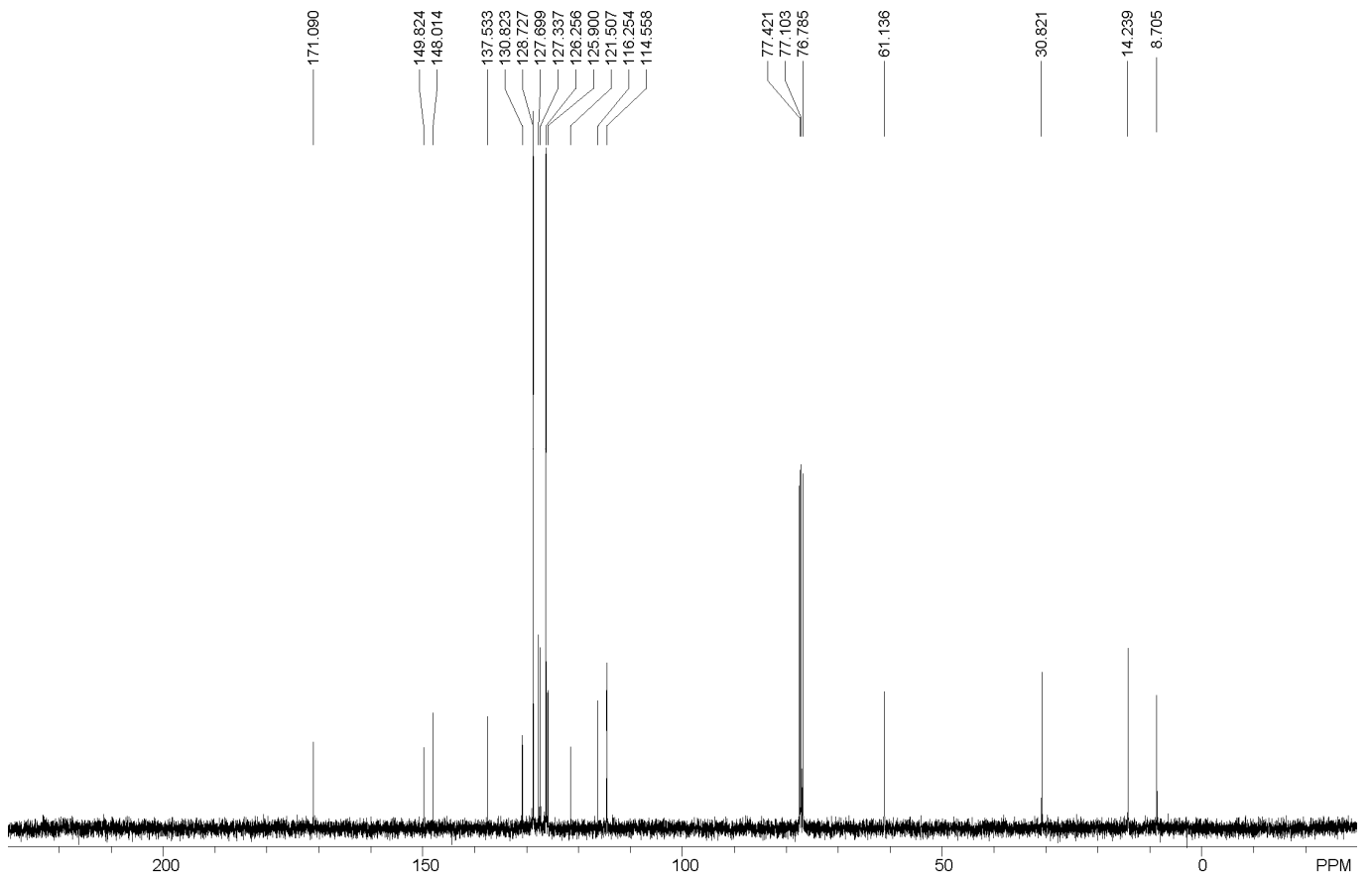
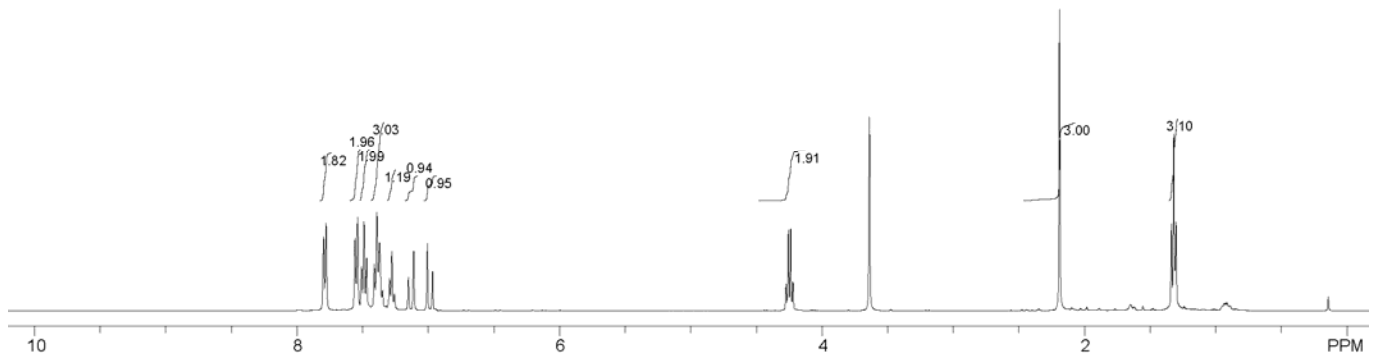
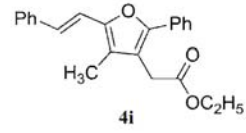
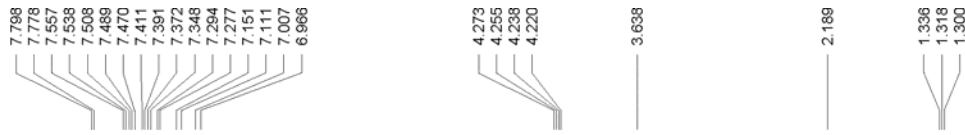
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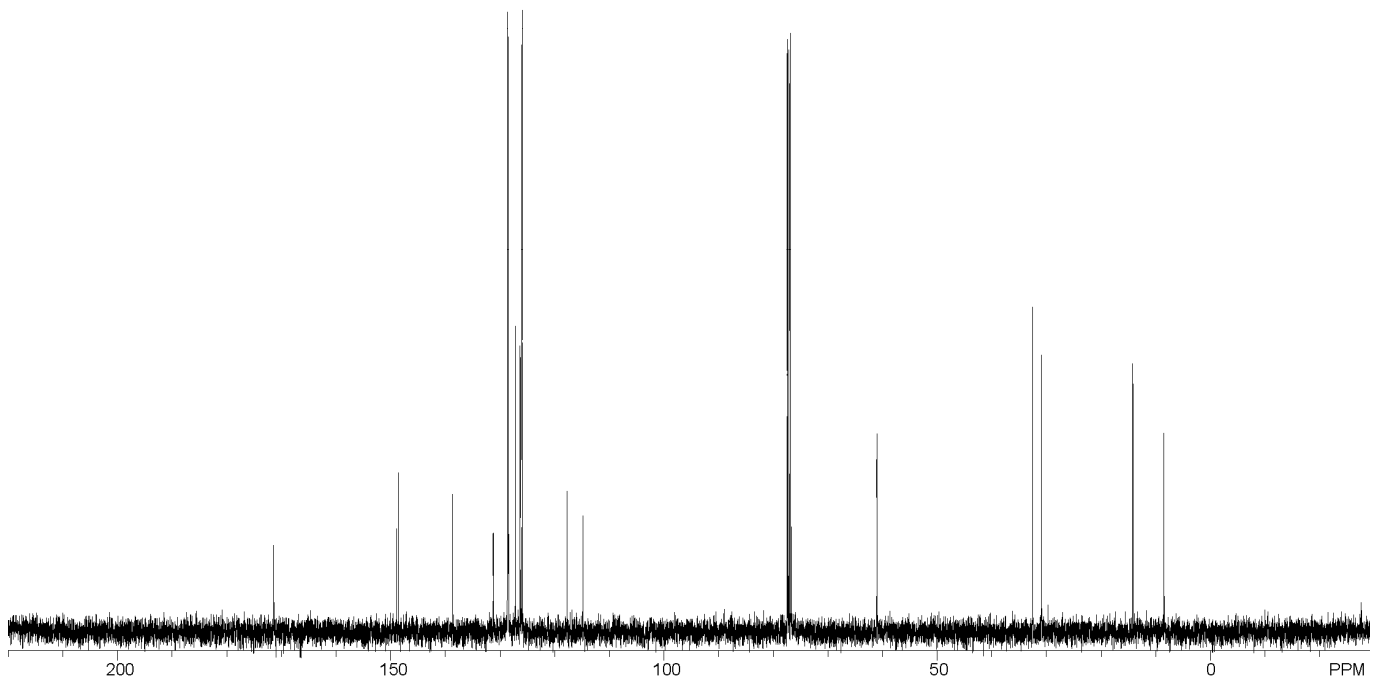
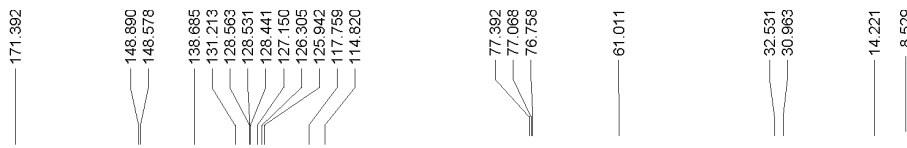
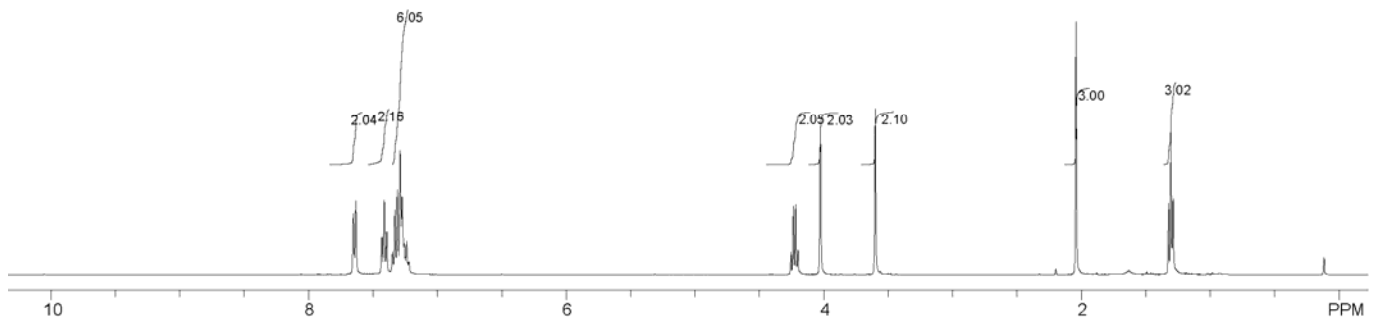
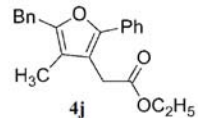
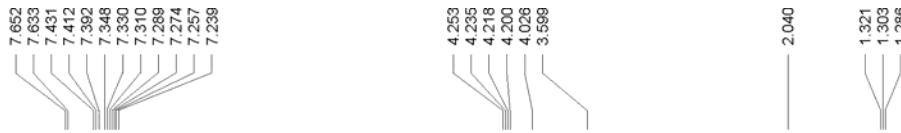












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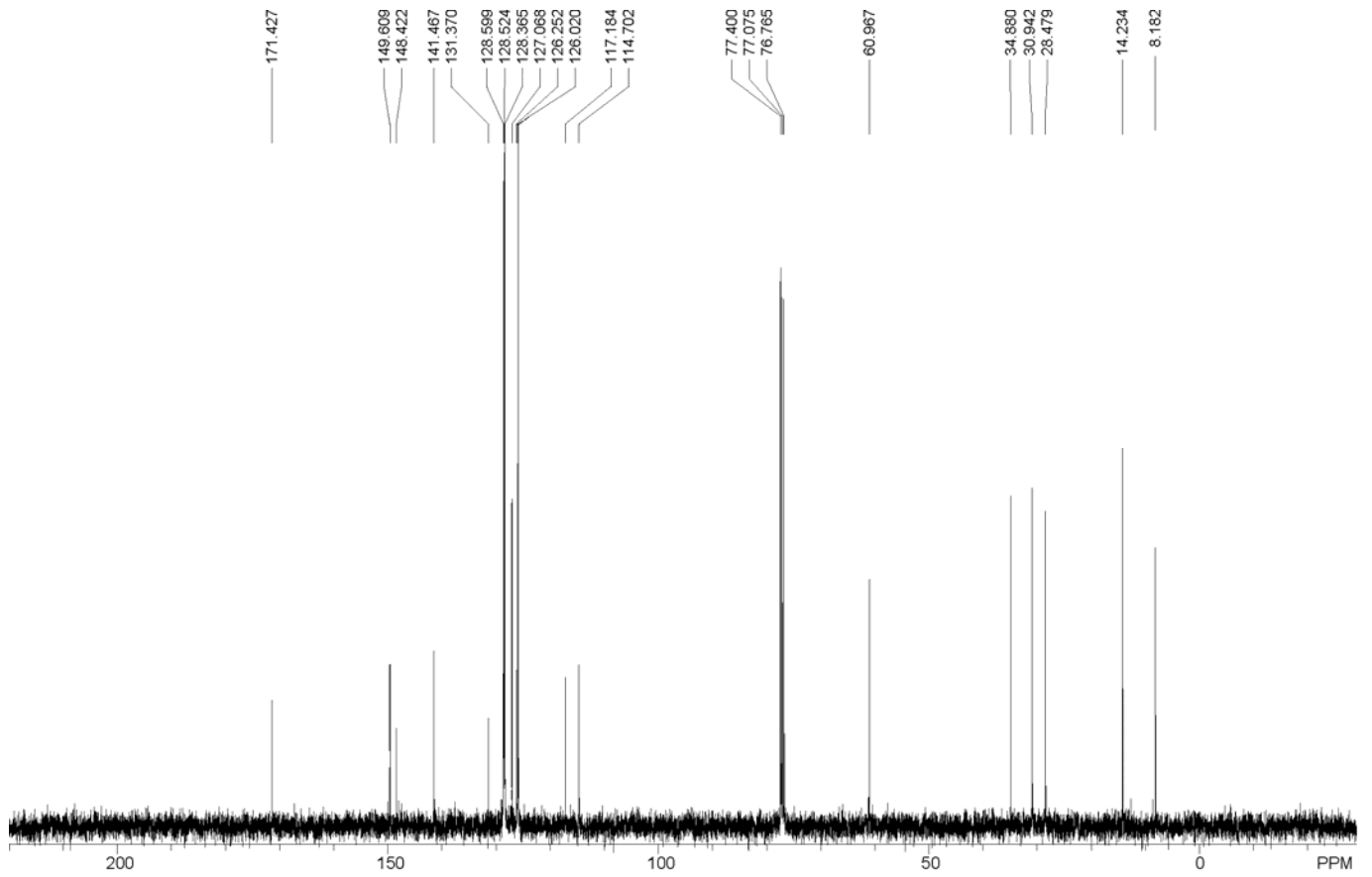
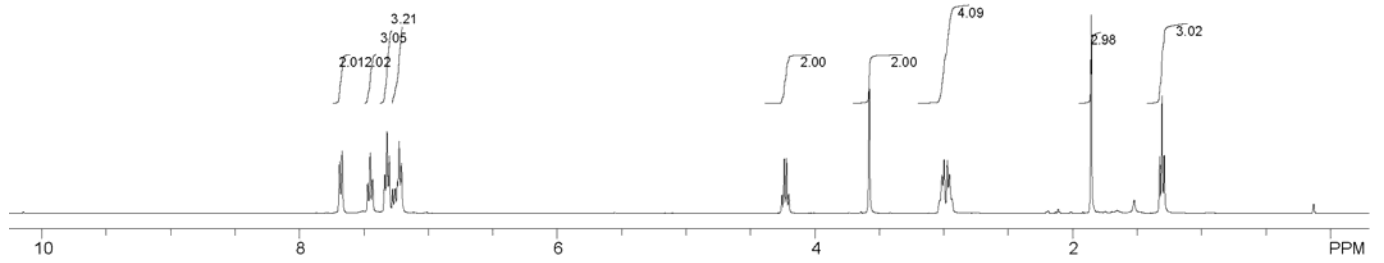
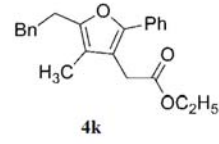
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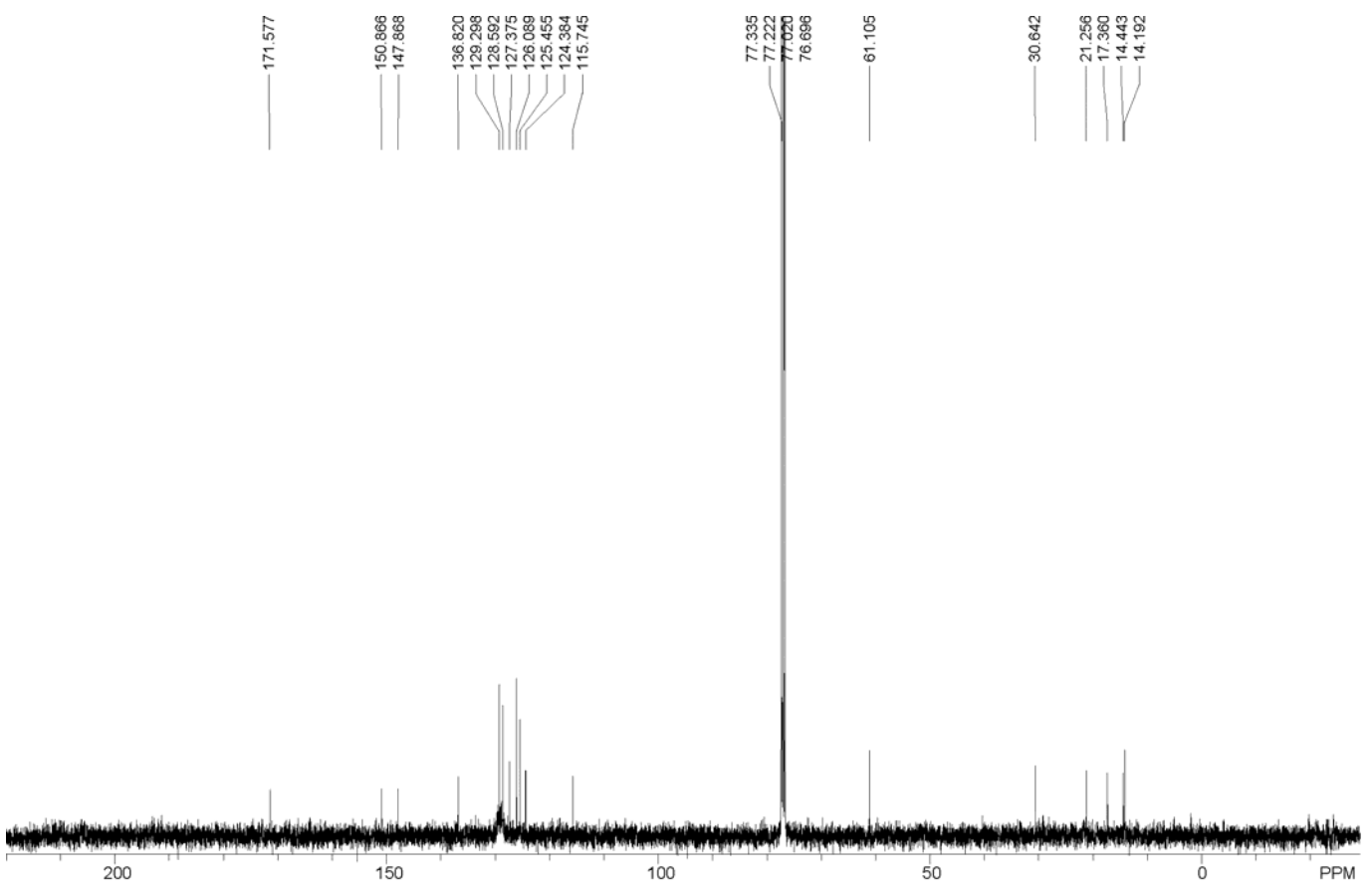
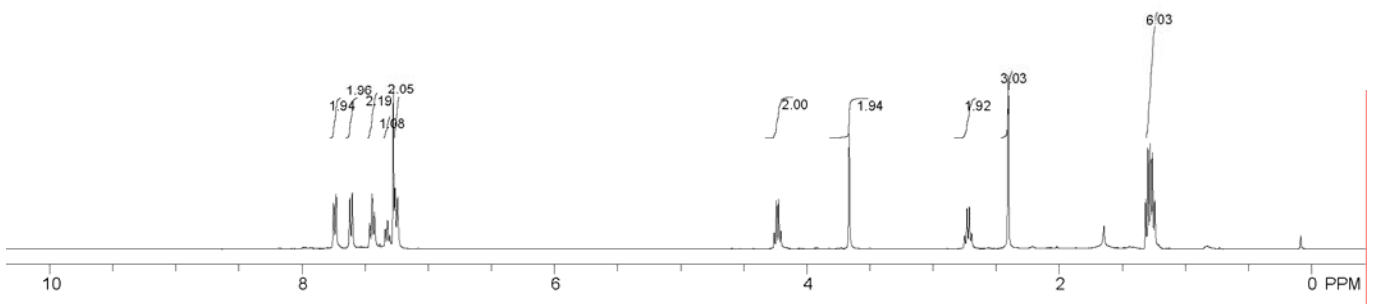
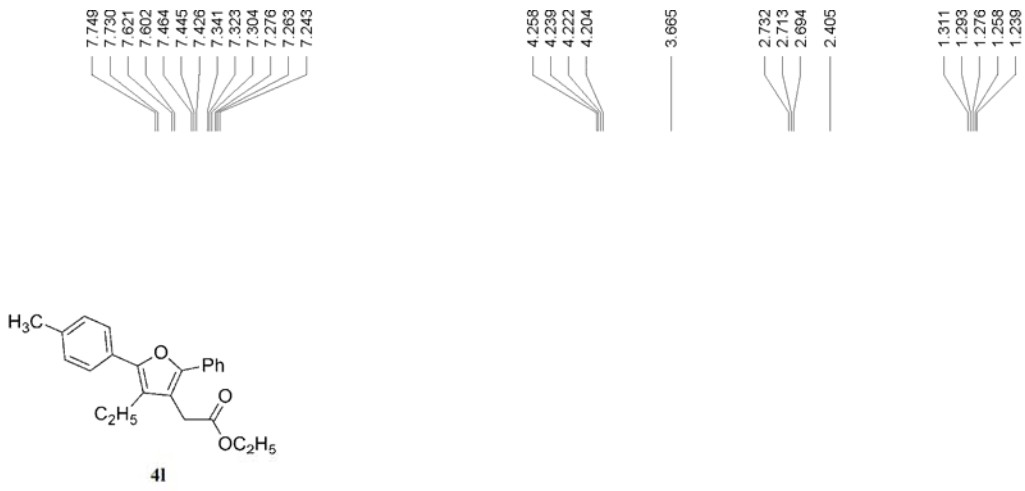
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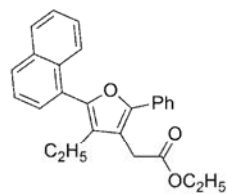
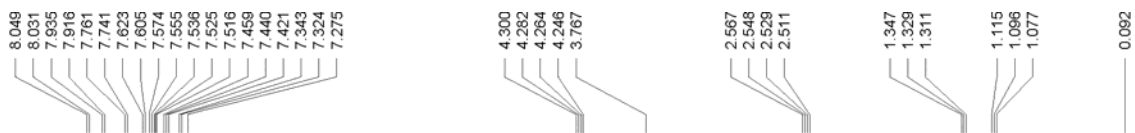
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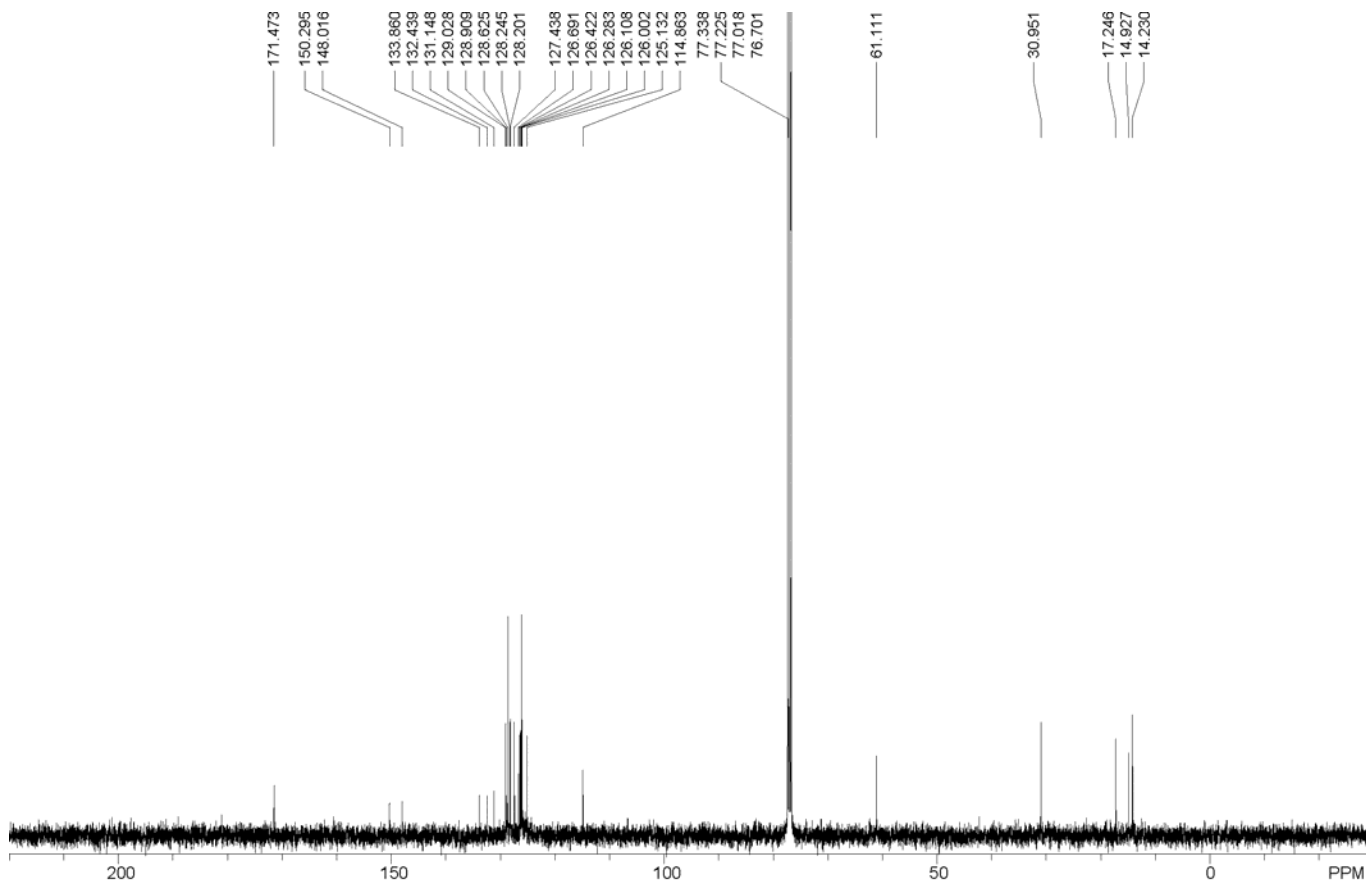
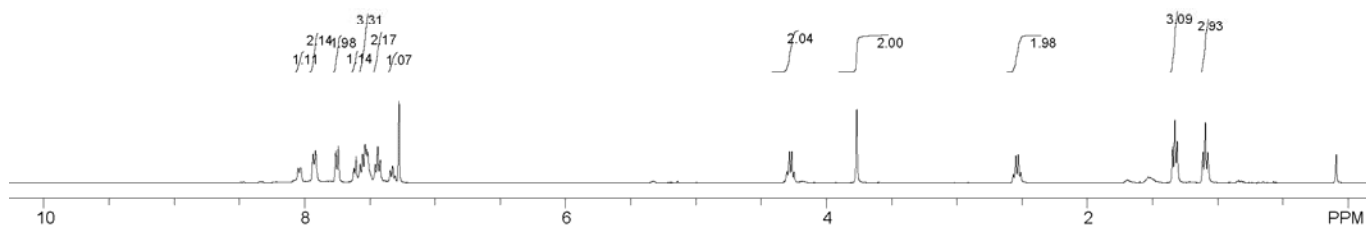
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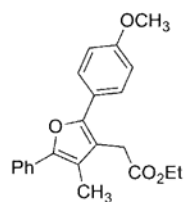


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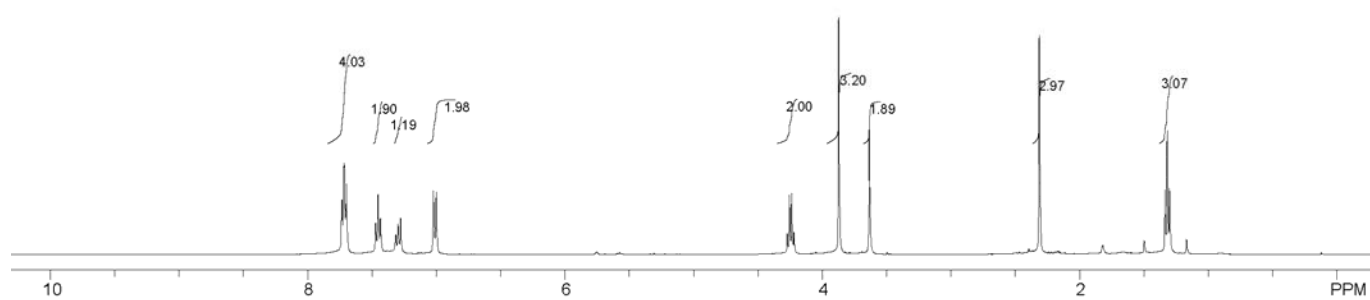
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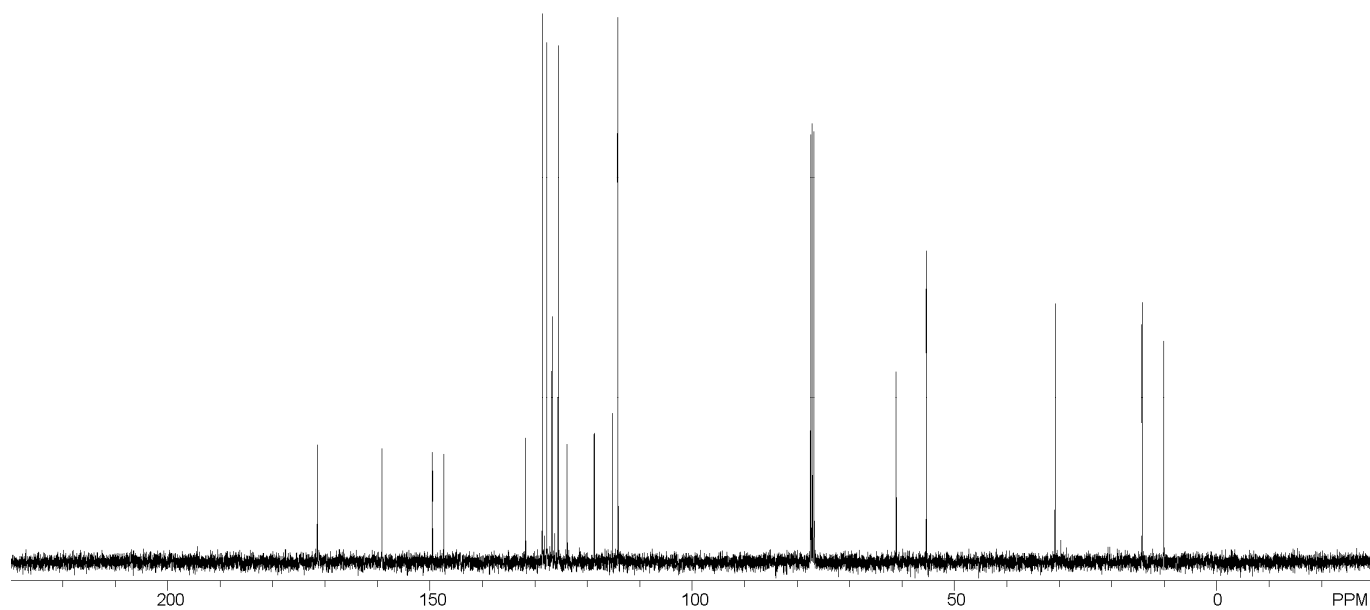
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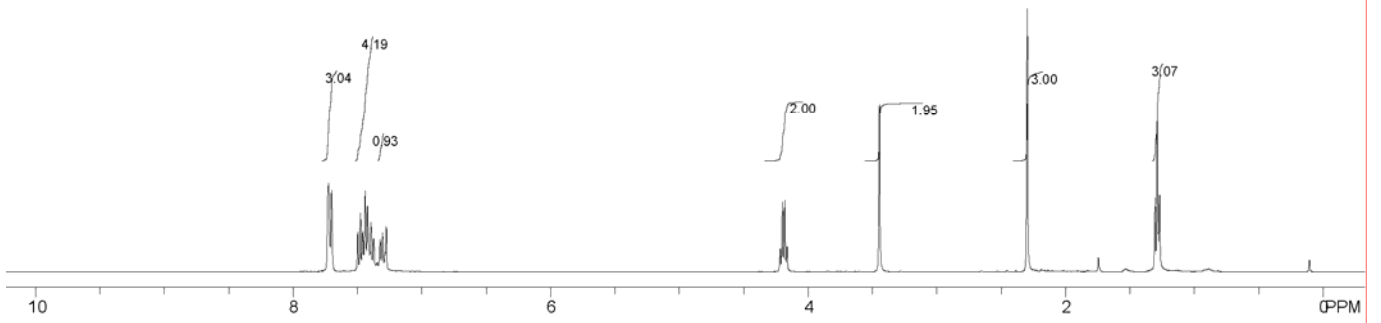
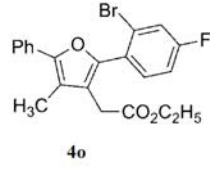
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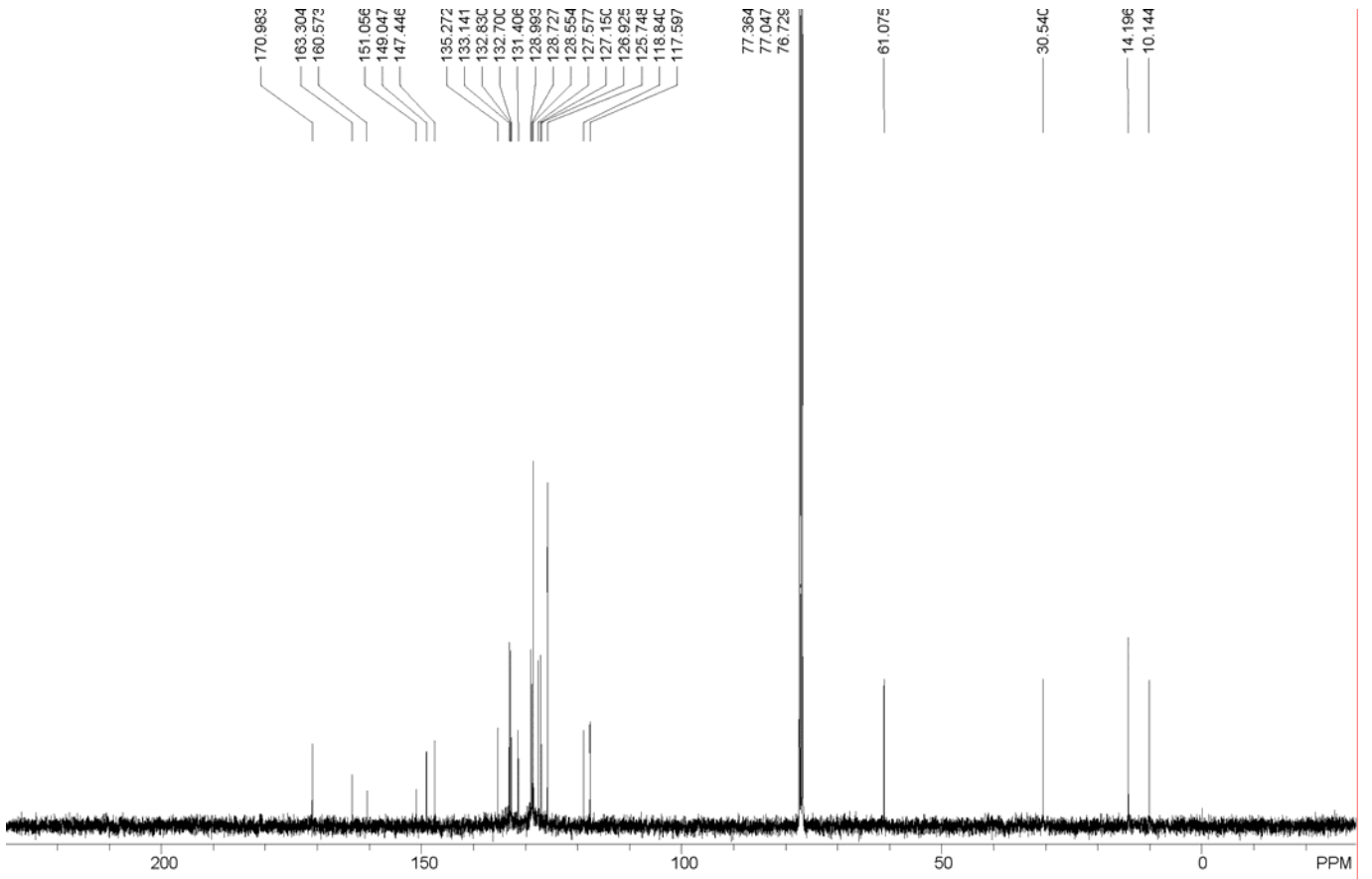
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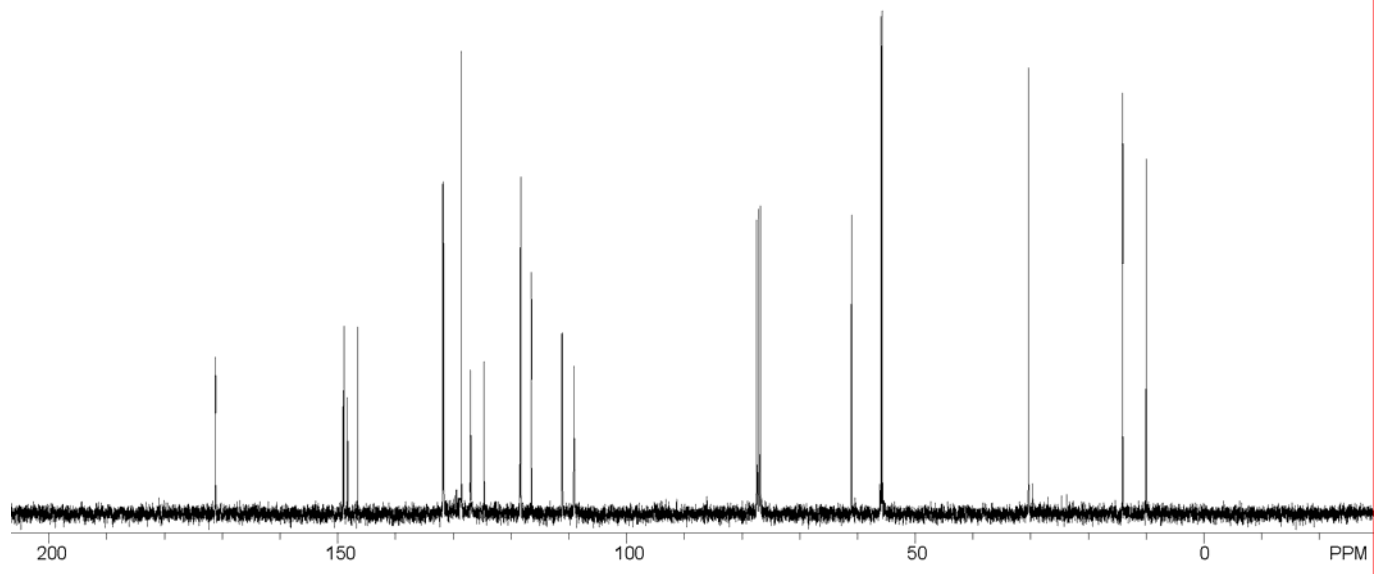
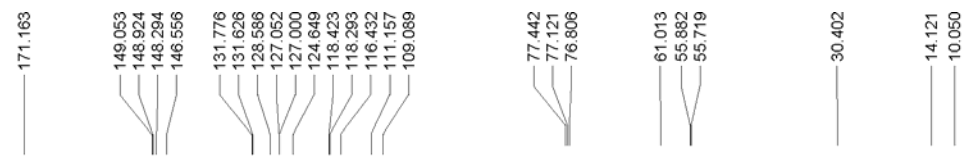
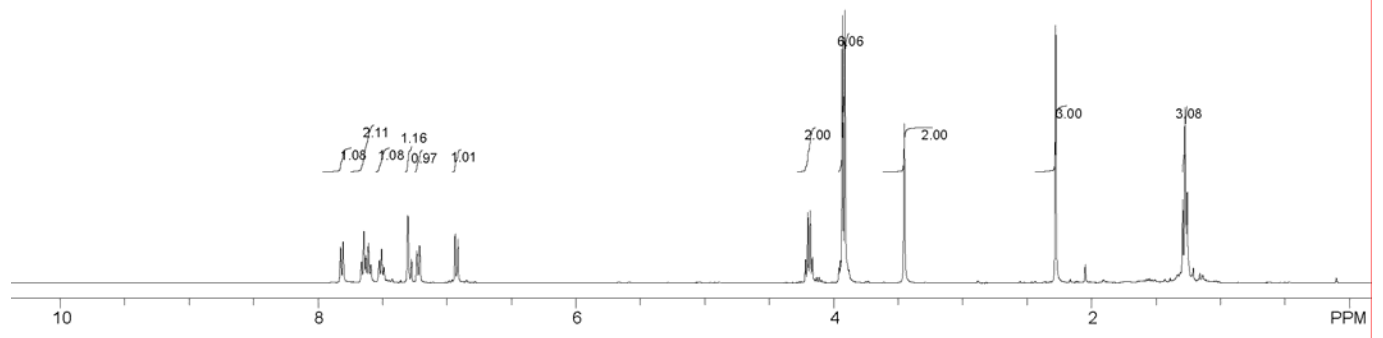
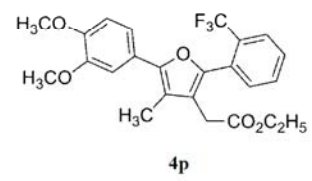
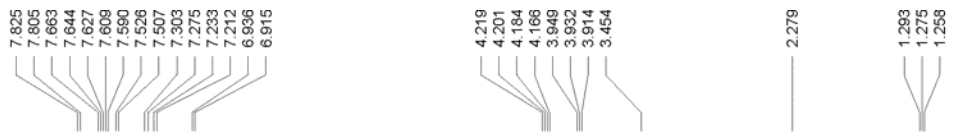
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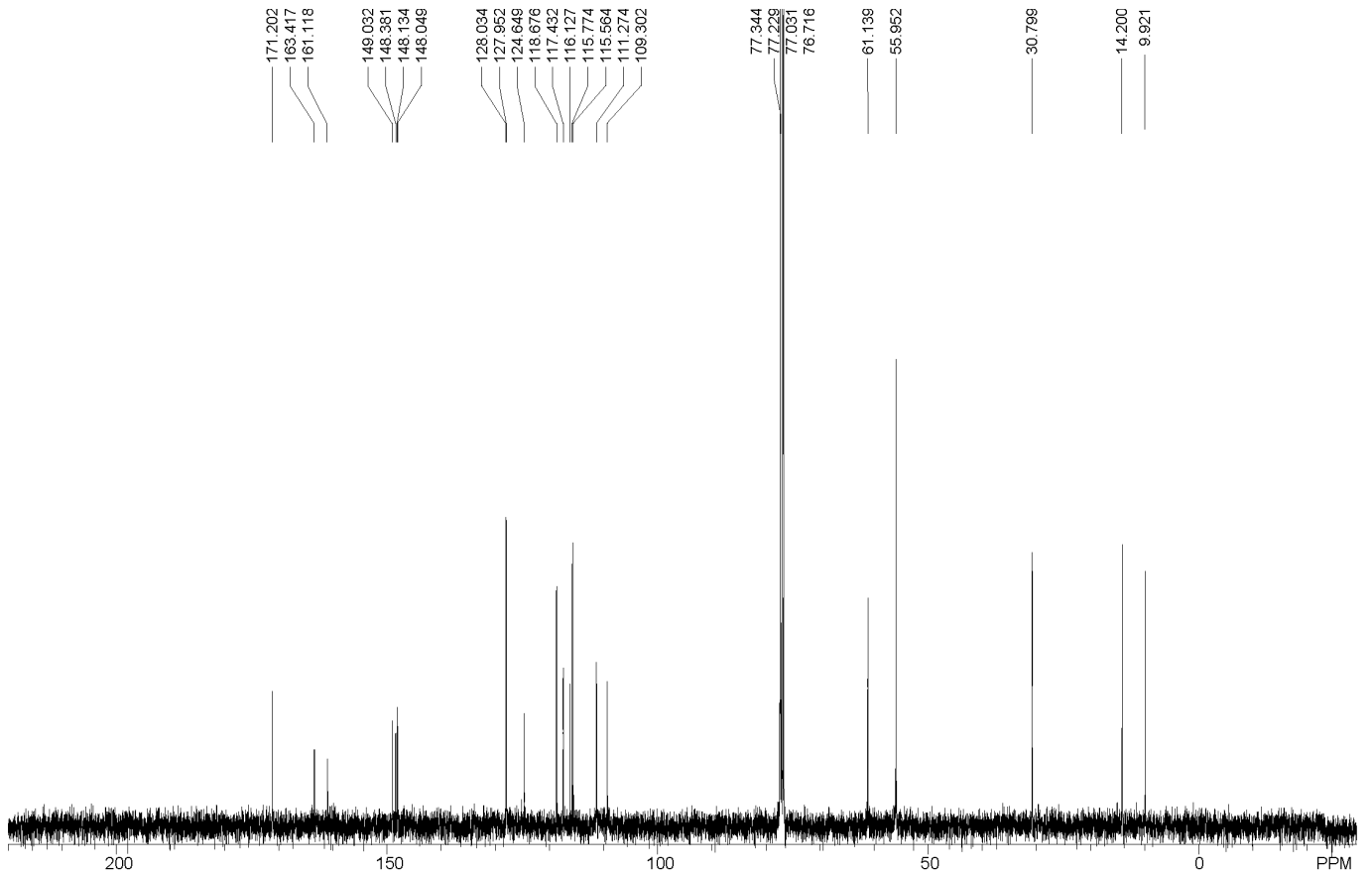
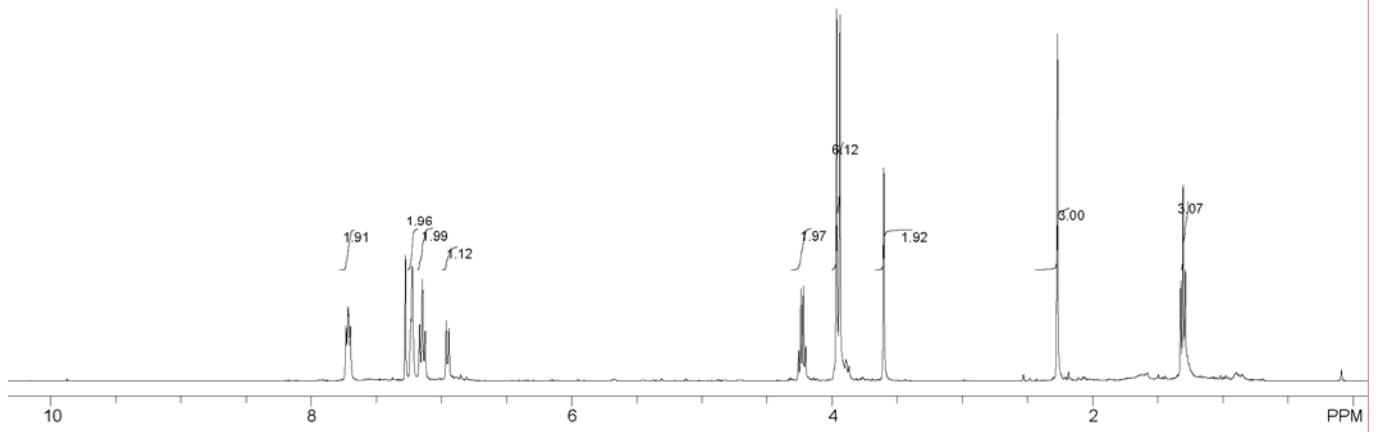
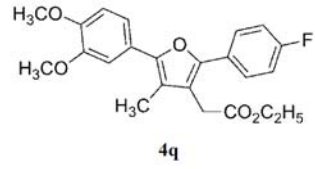
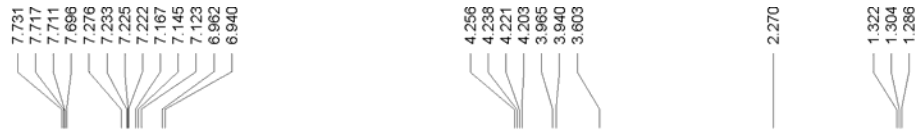
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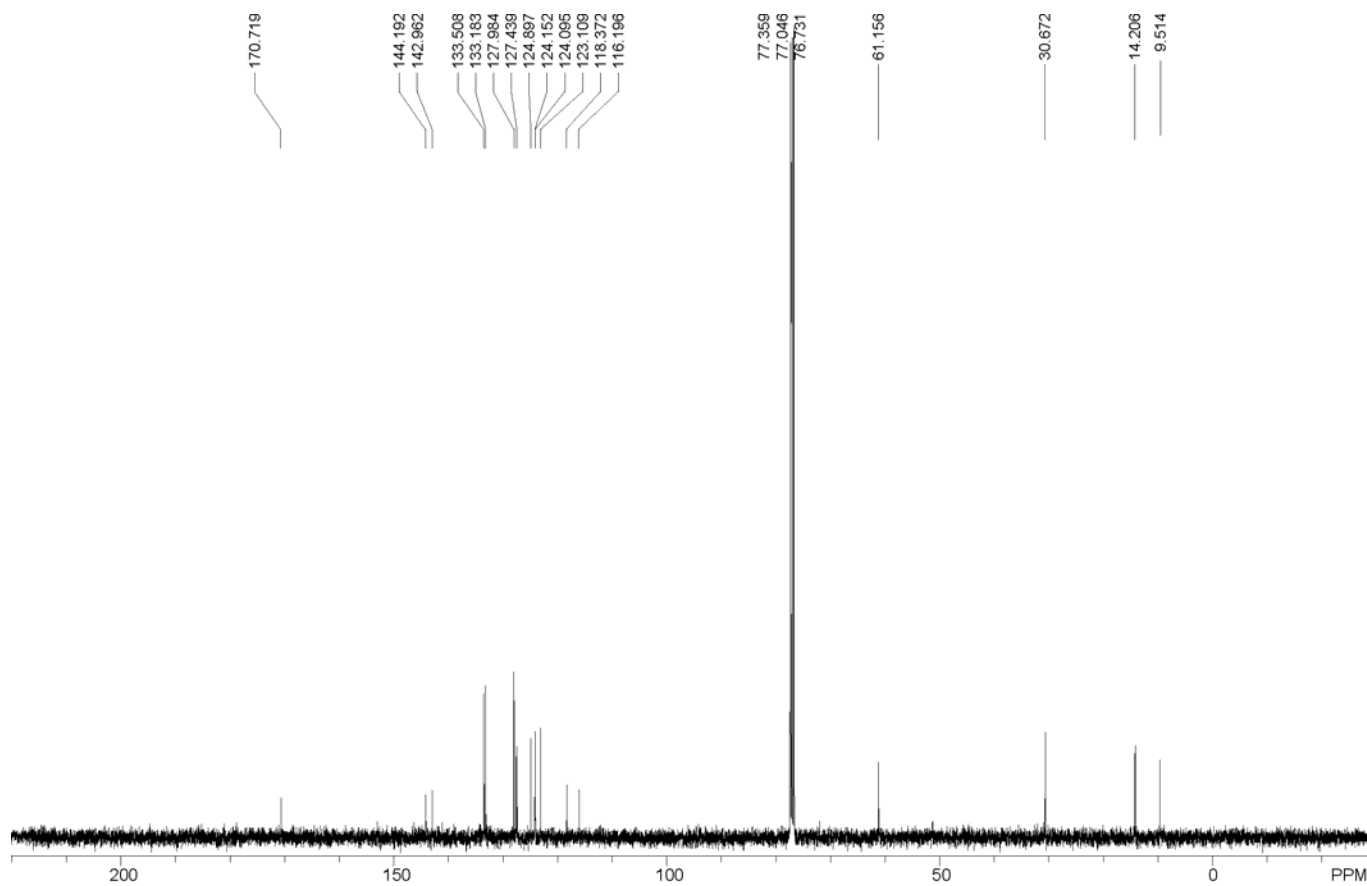
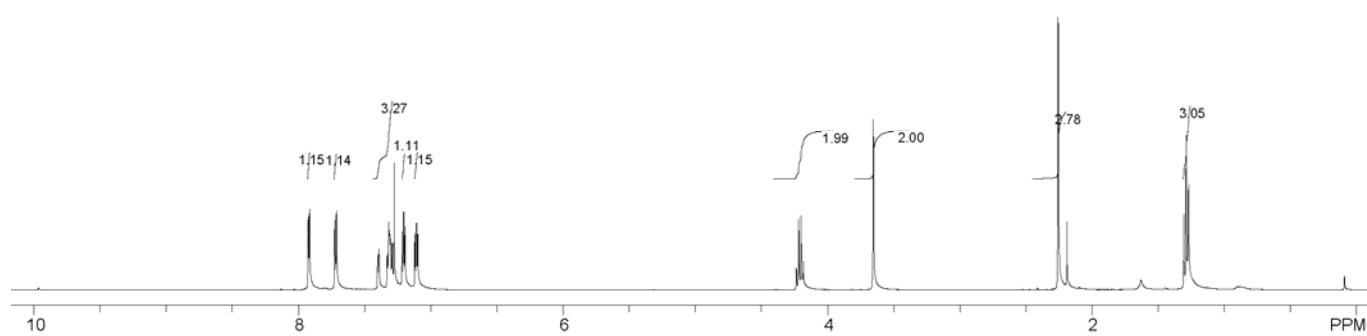
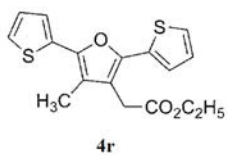
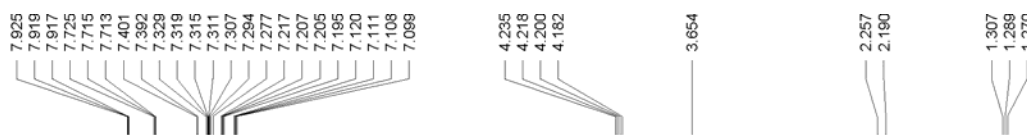
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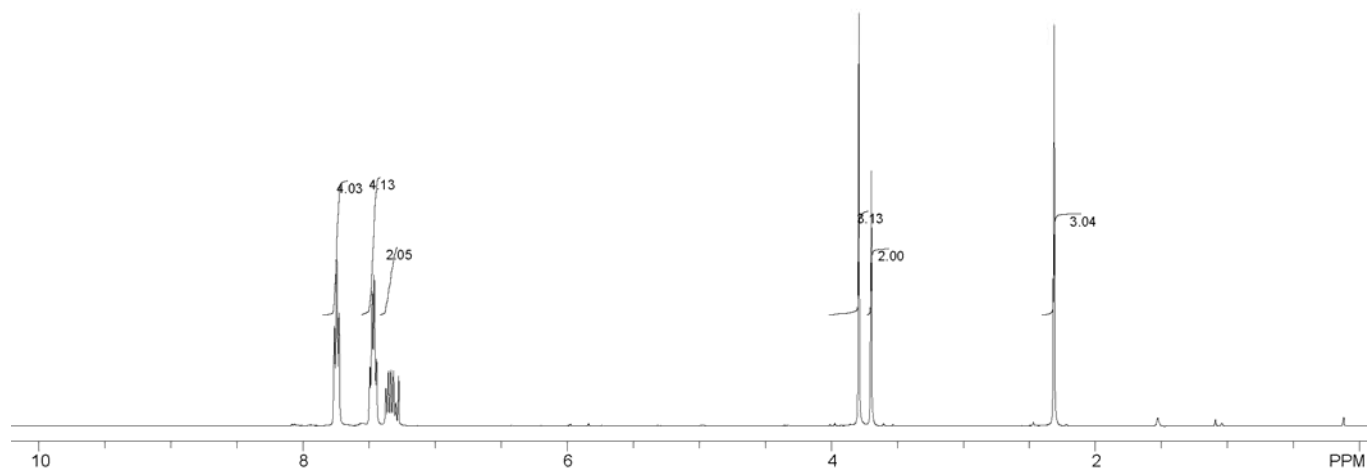
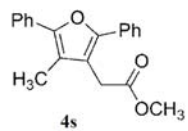




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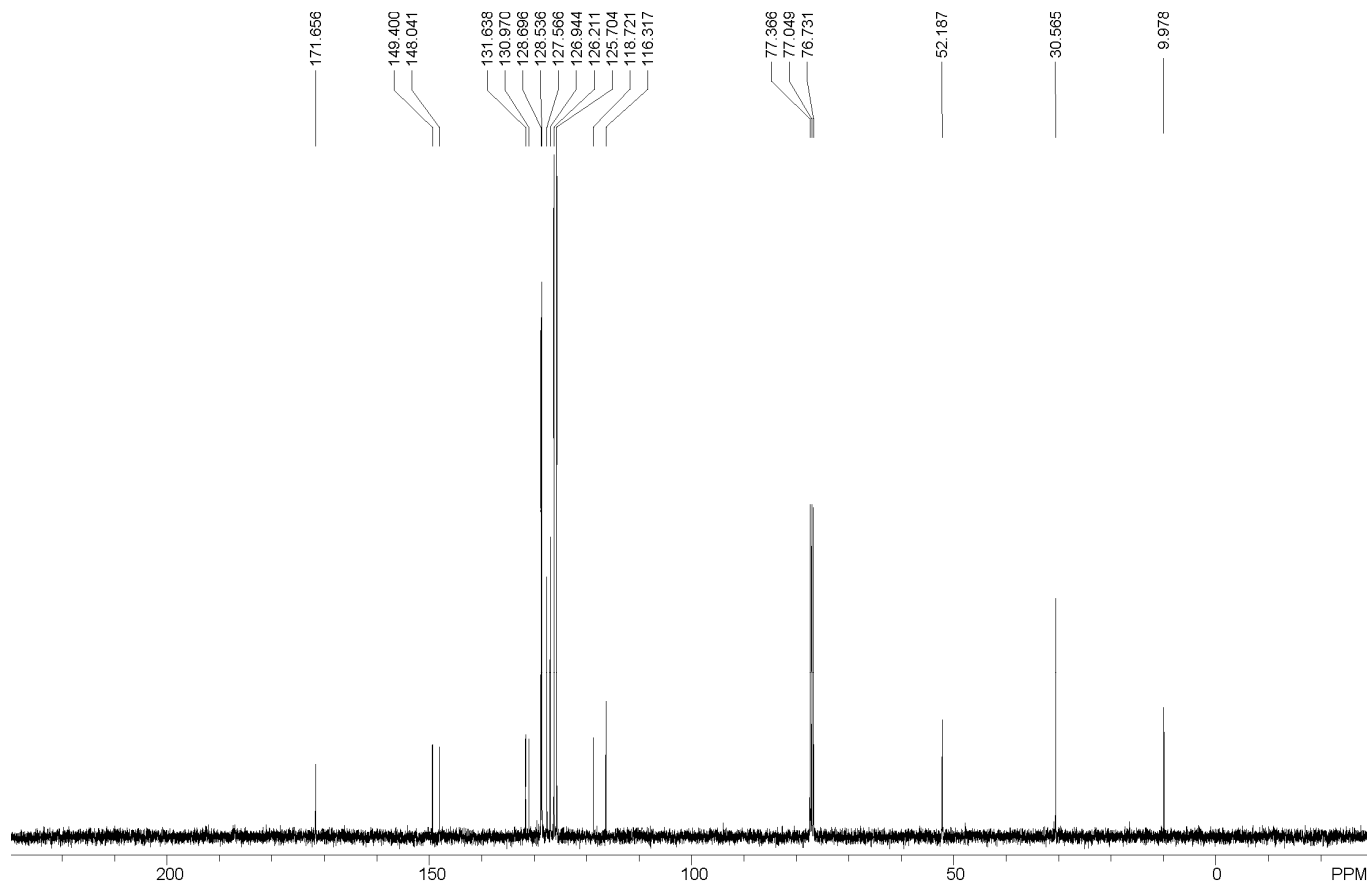
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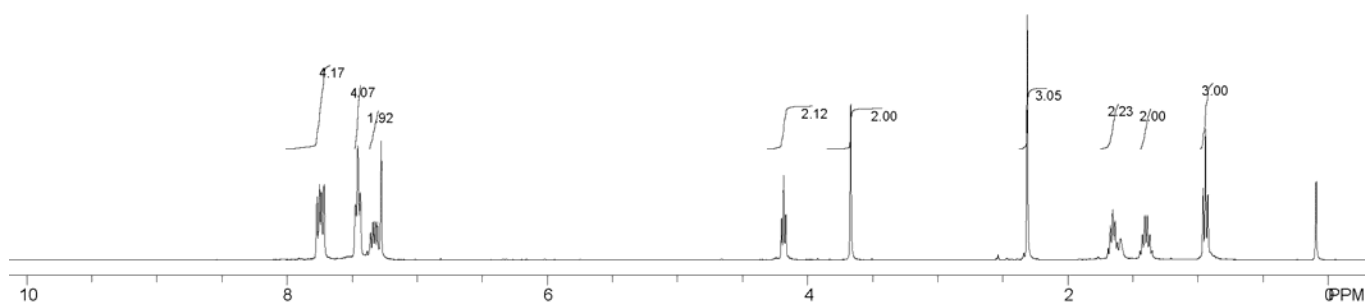
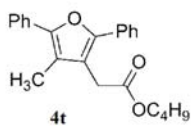
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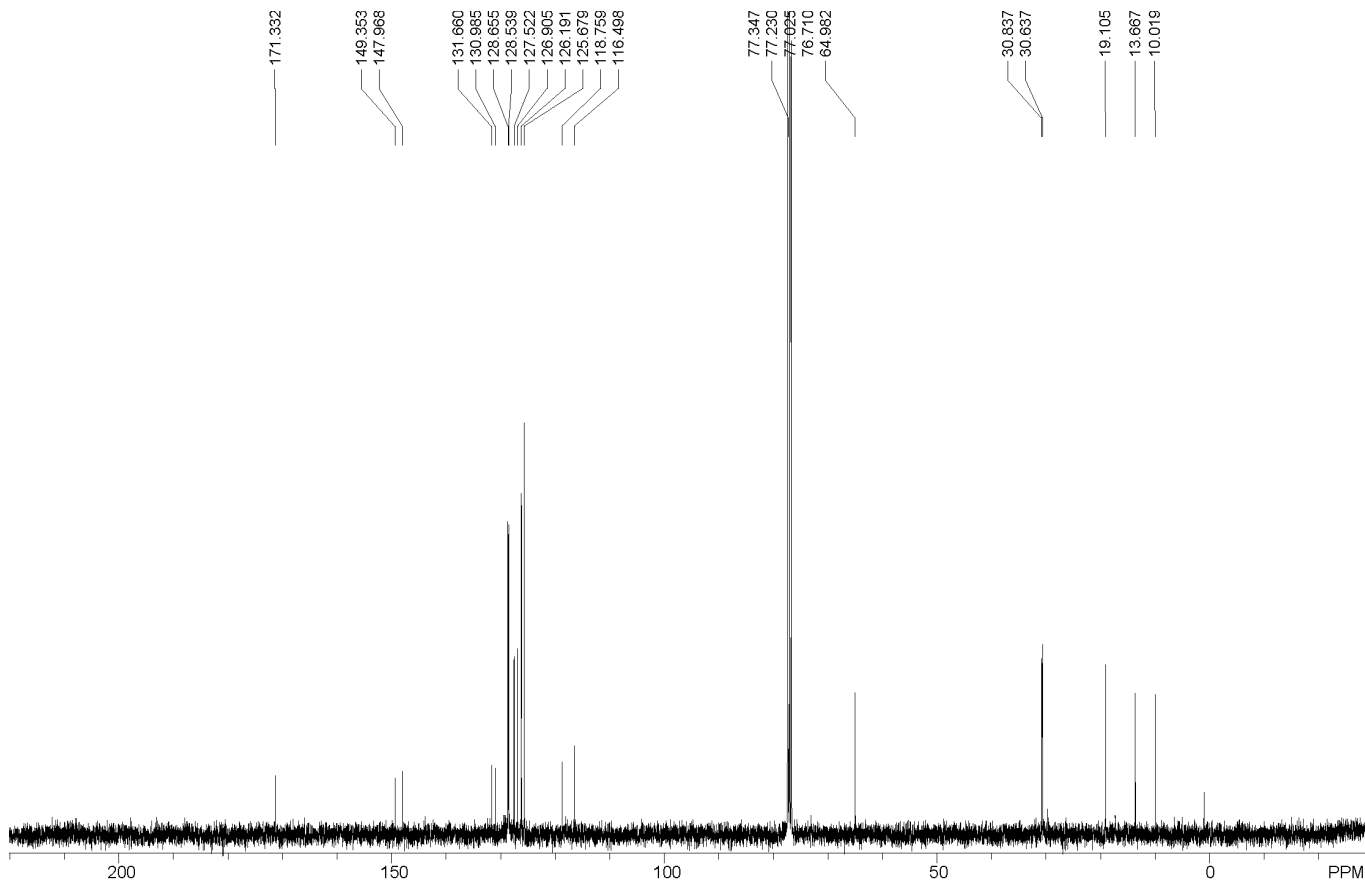
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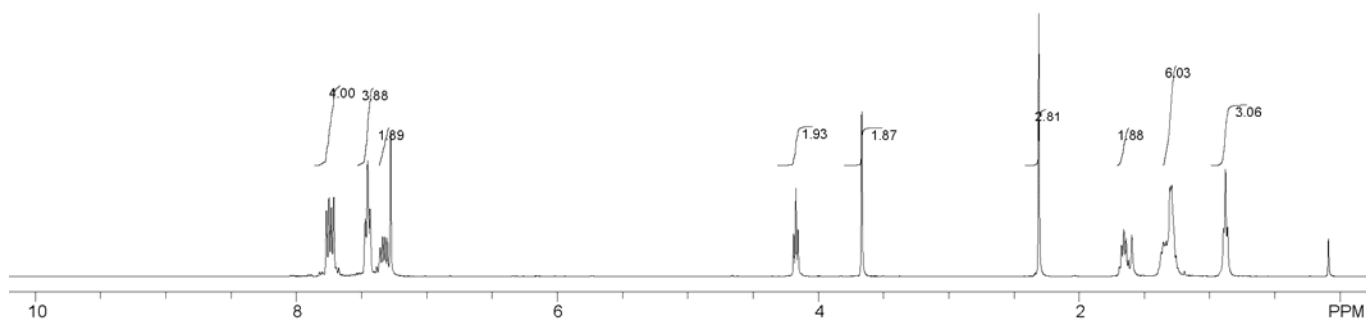
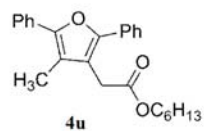
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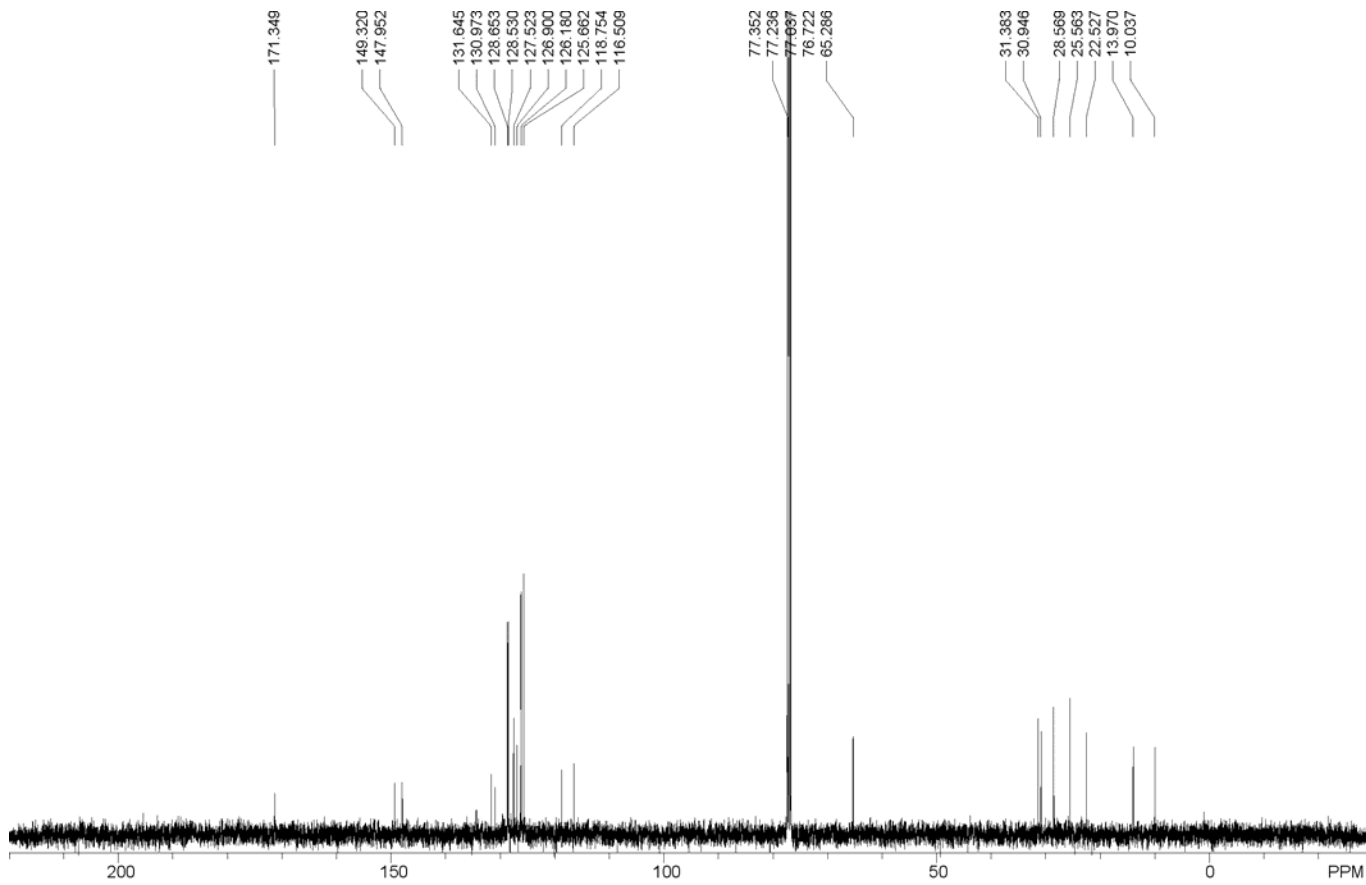
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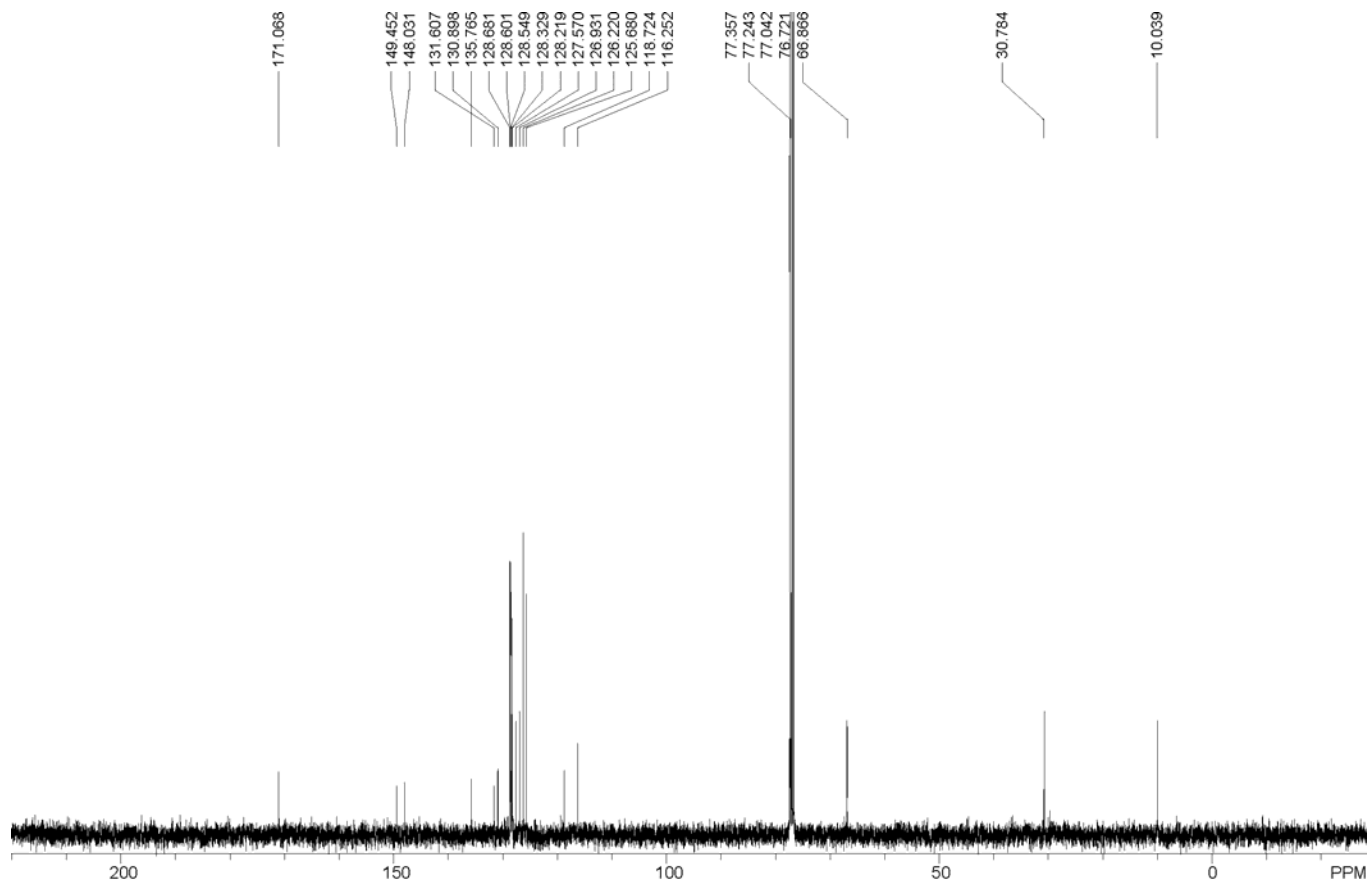
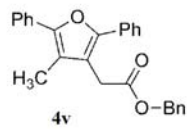
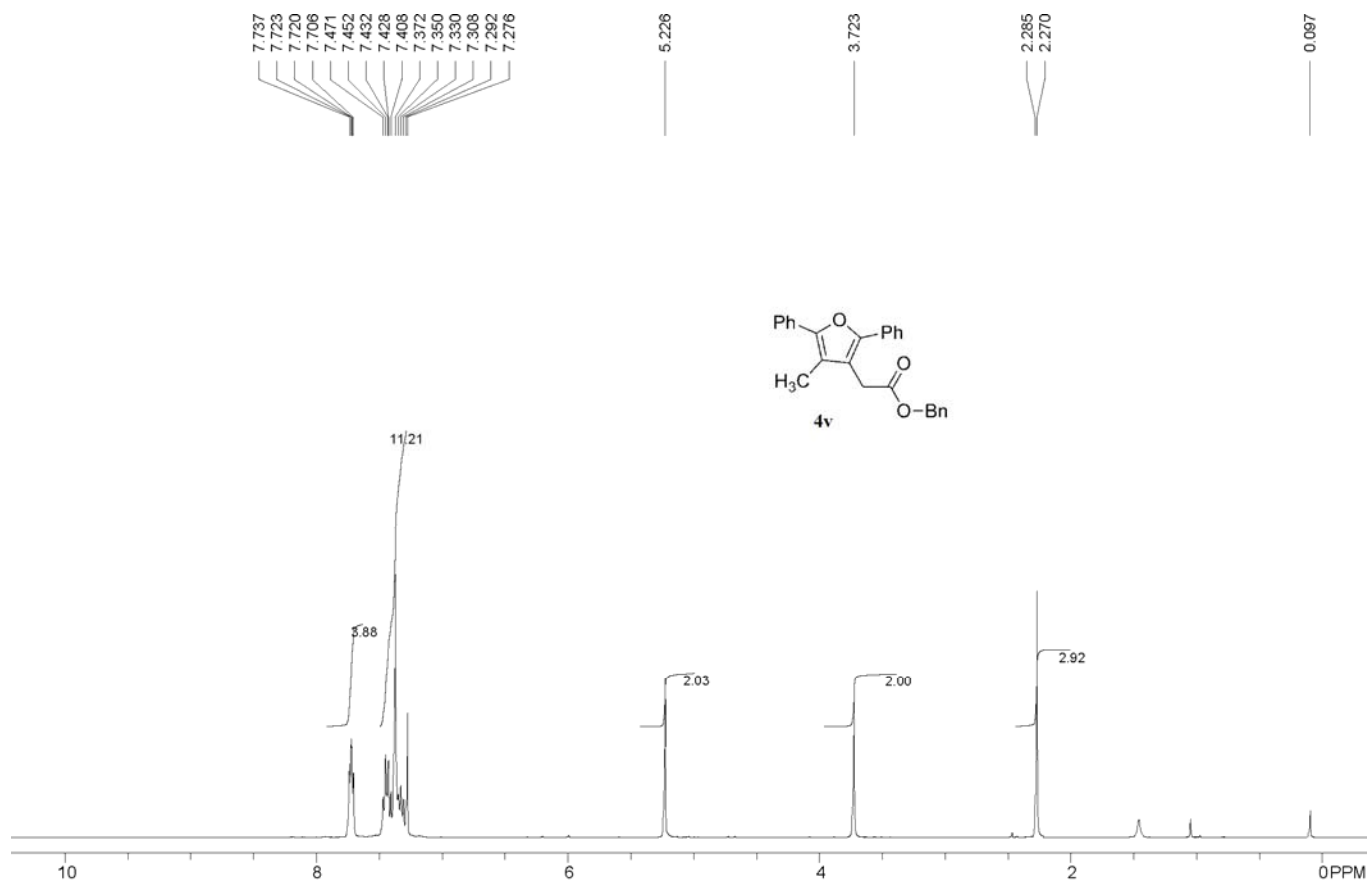
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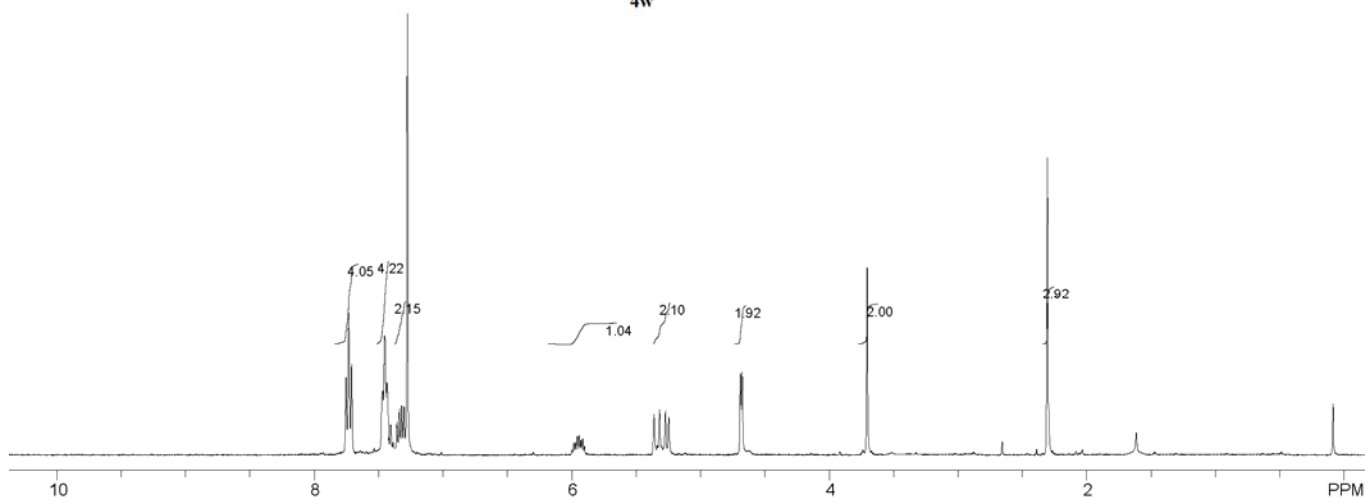
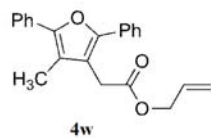


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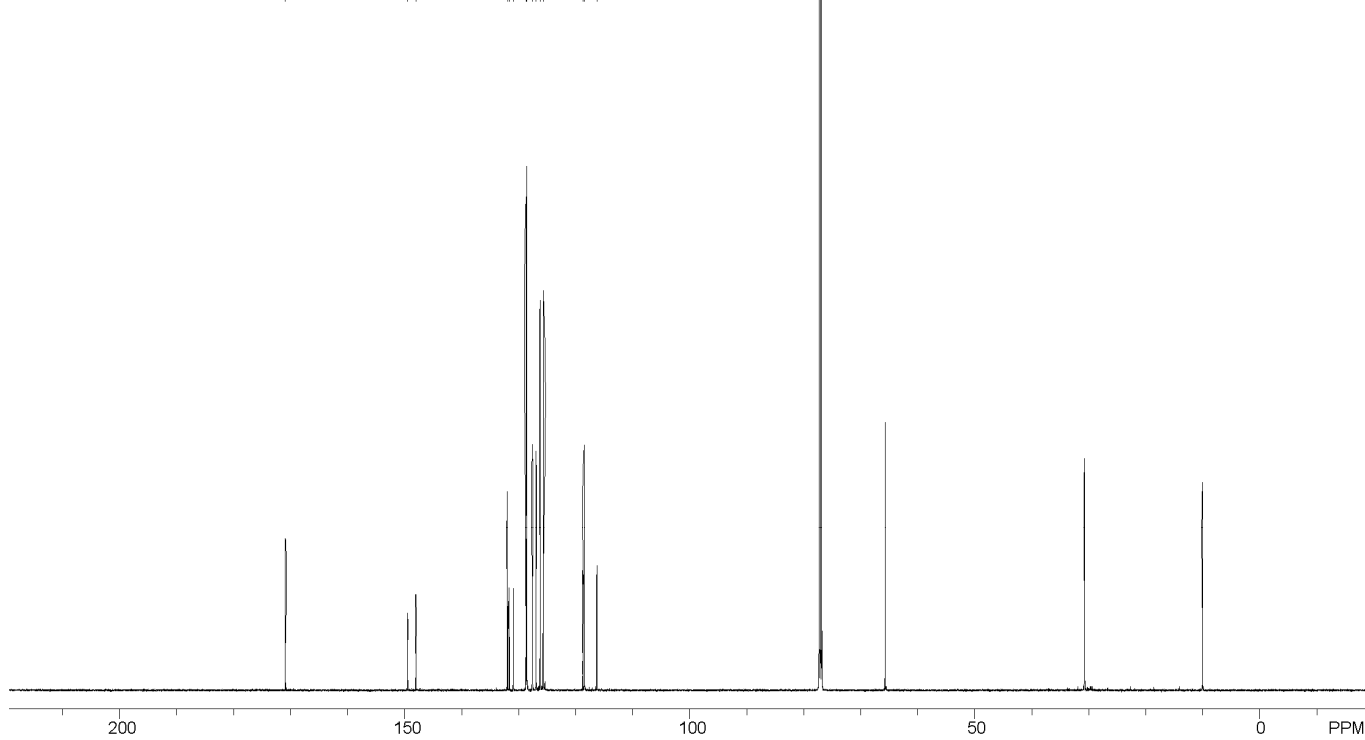
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116.283

77.262
77.051
76.839

65.706

30.750

10.067



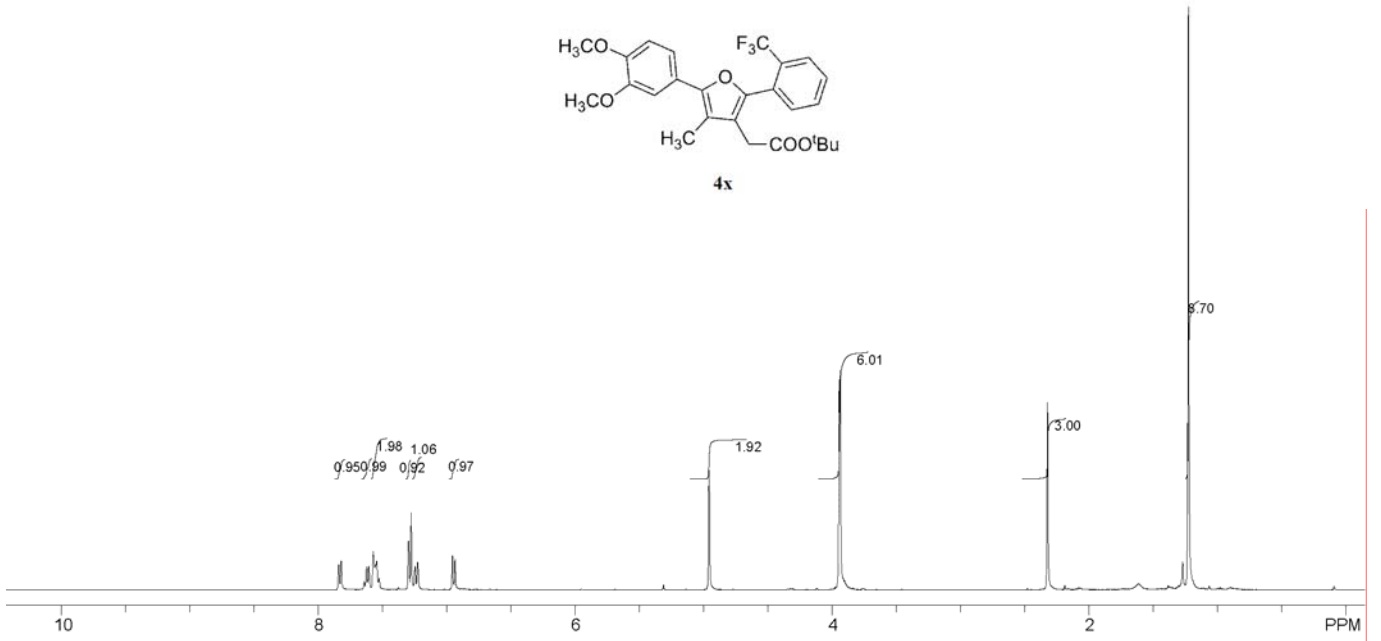
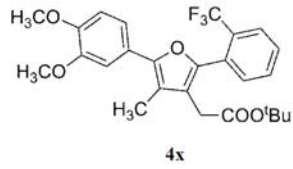
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7.608
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6.985
6.934

4.956

3.943
3.935

2.320

1.268
1.223



178.385

149.178
149.108
148.427
147.976

131.881
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109.081
109.016

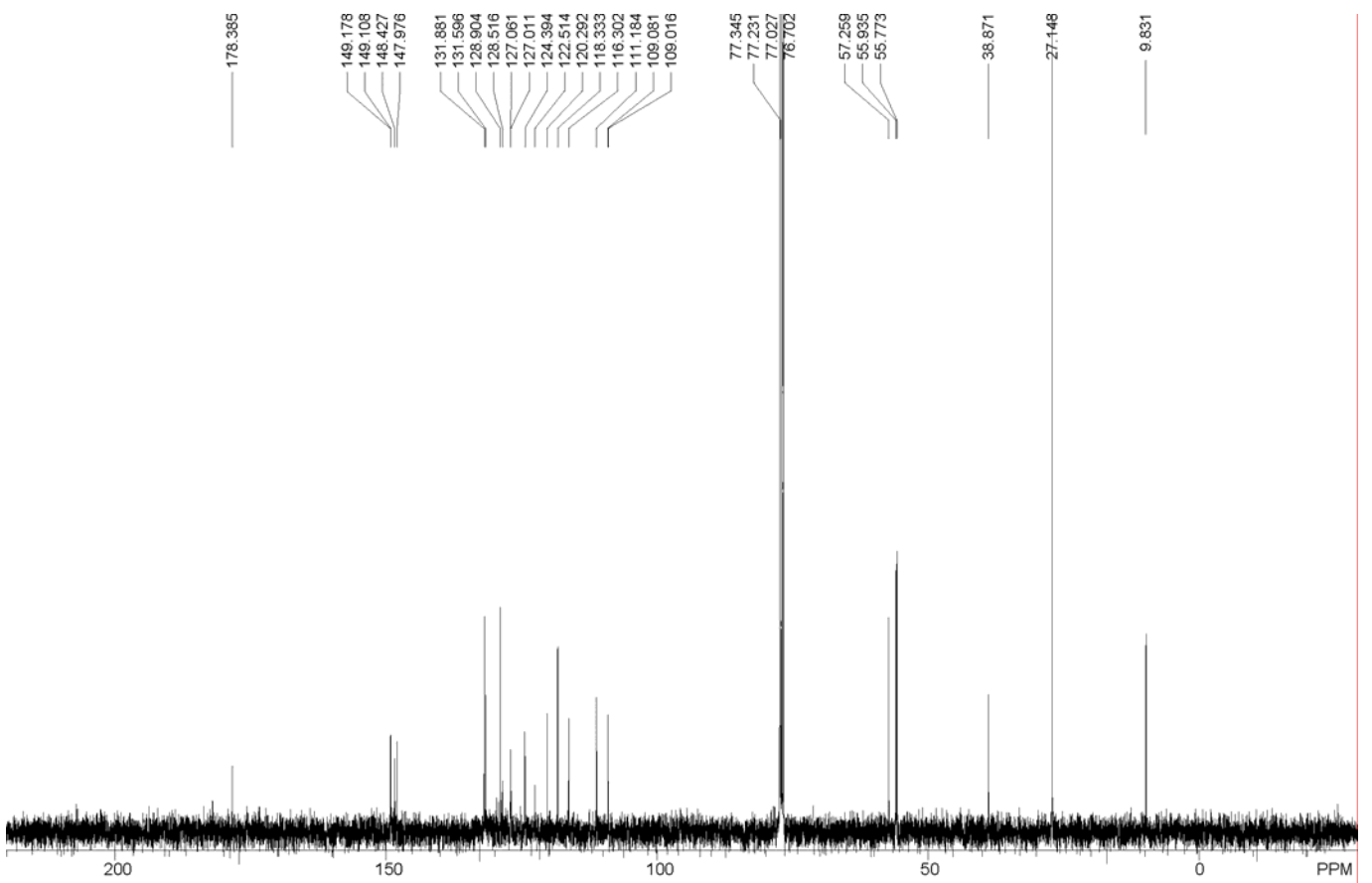
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77.231
77.027
76.702

57.259
55.935
55.773

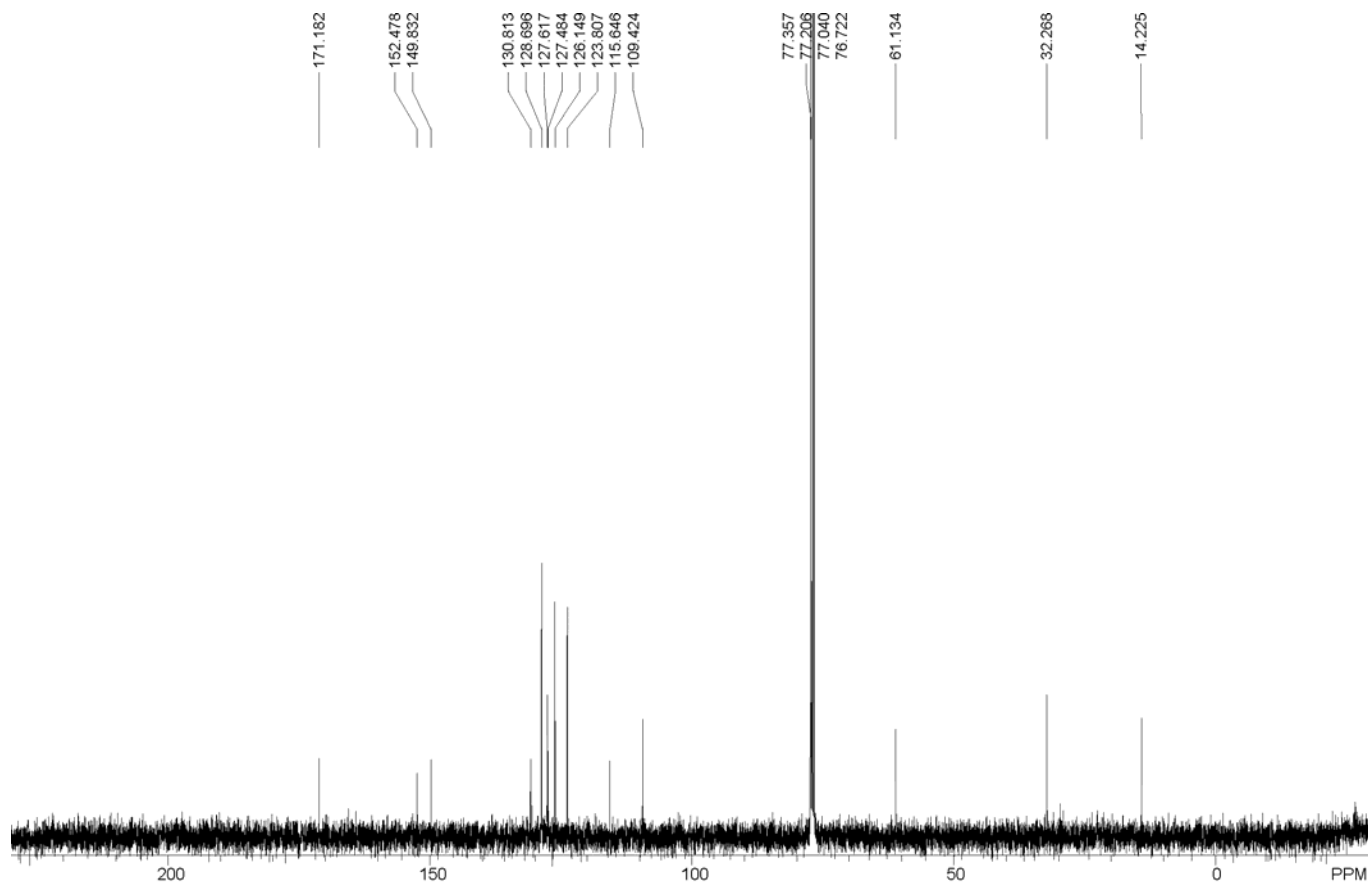
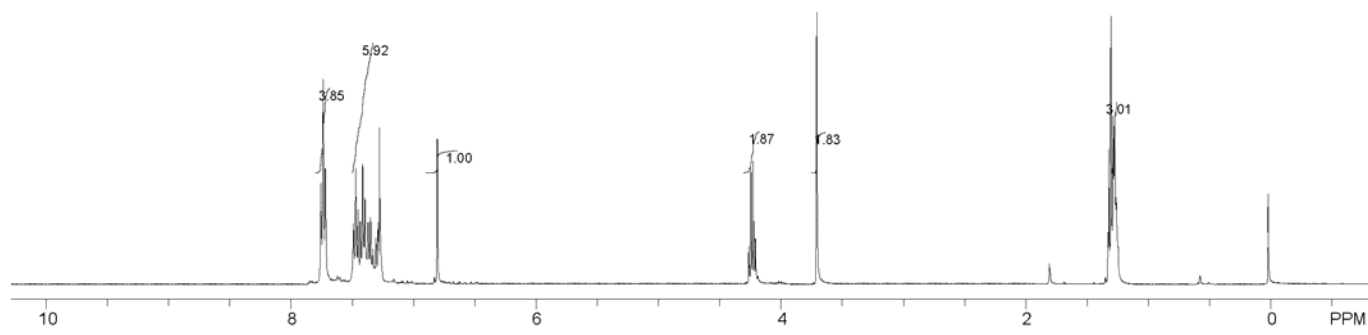
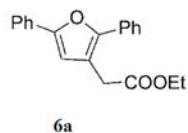
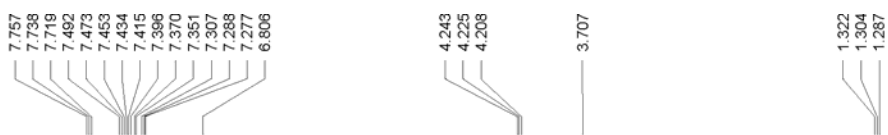
38.871

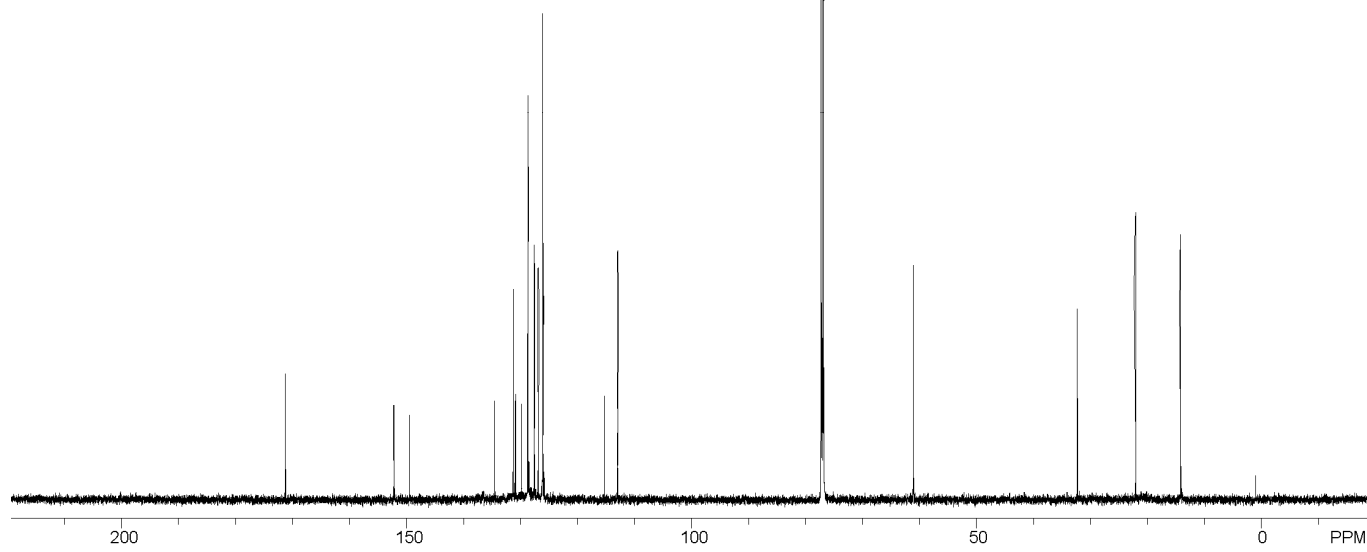
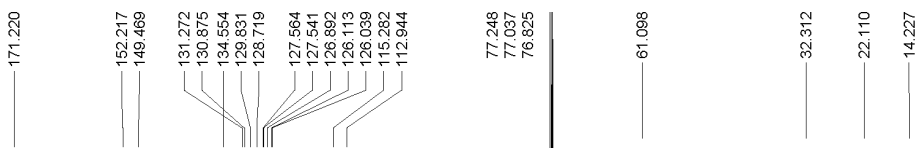
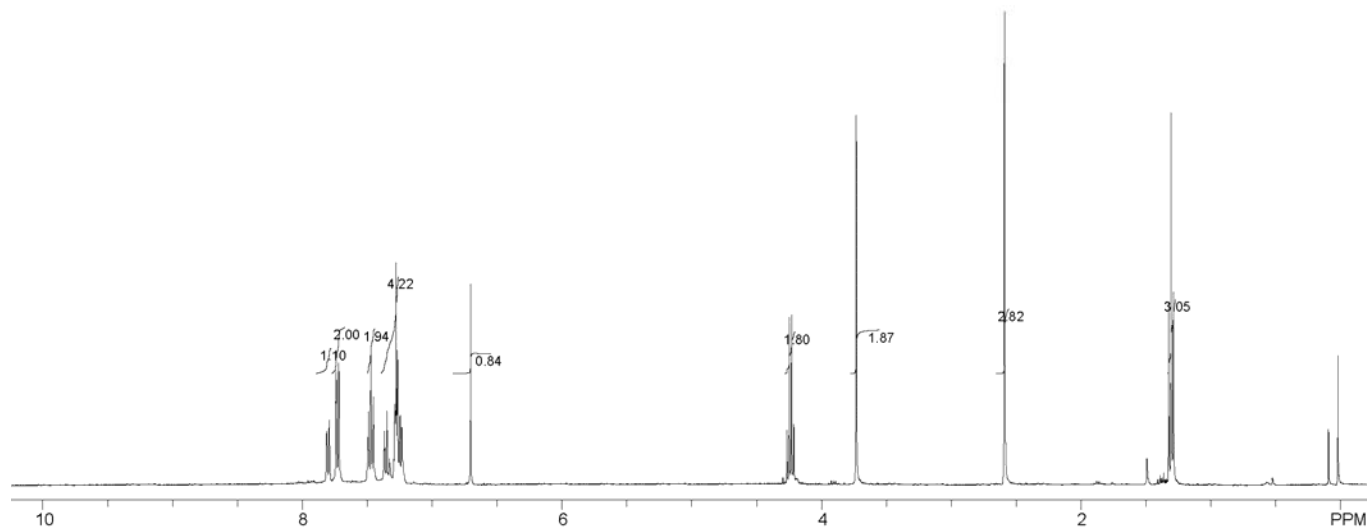
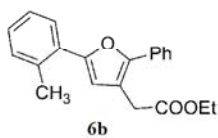
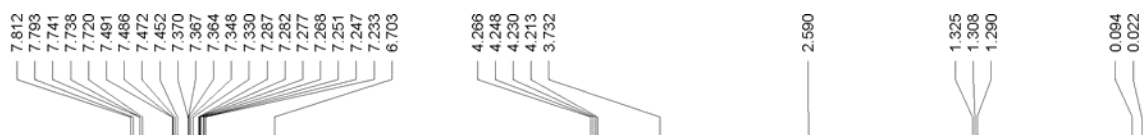
27.148

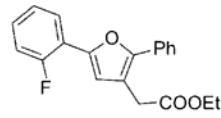
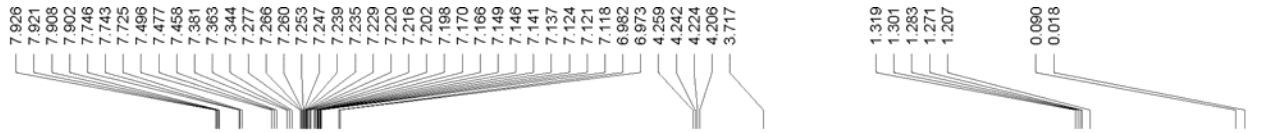
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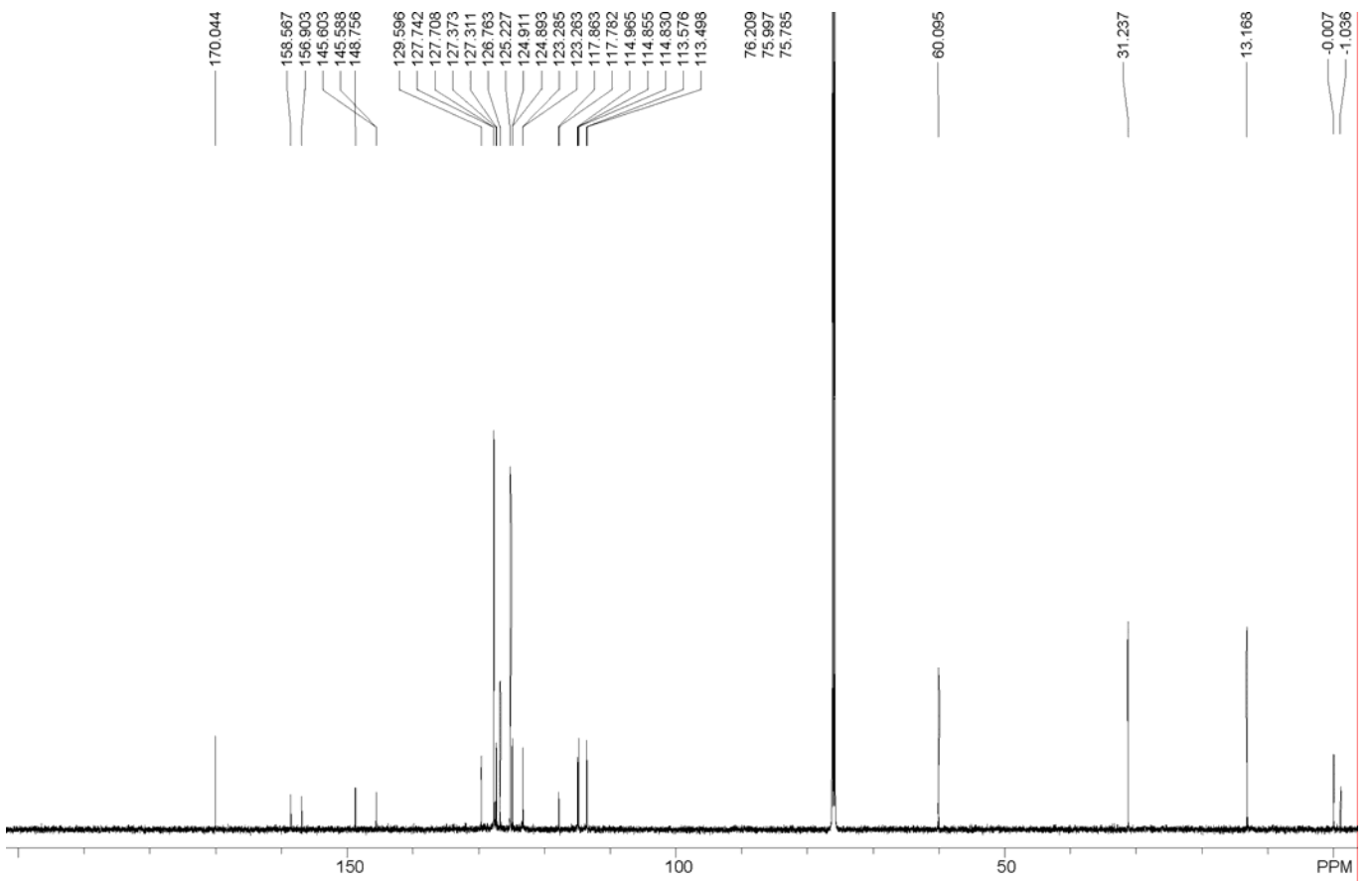
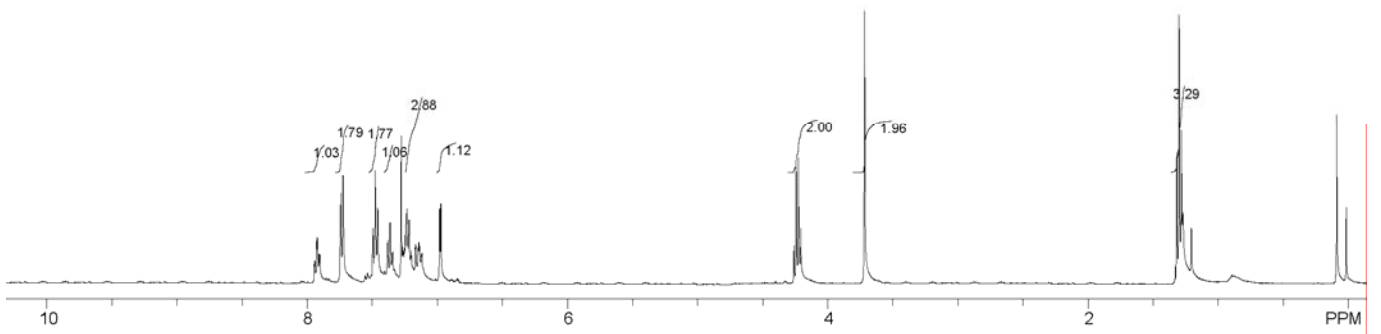
IV. Copies of ^1H and ^{13}C NMR spectra of 6a-6j

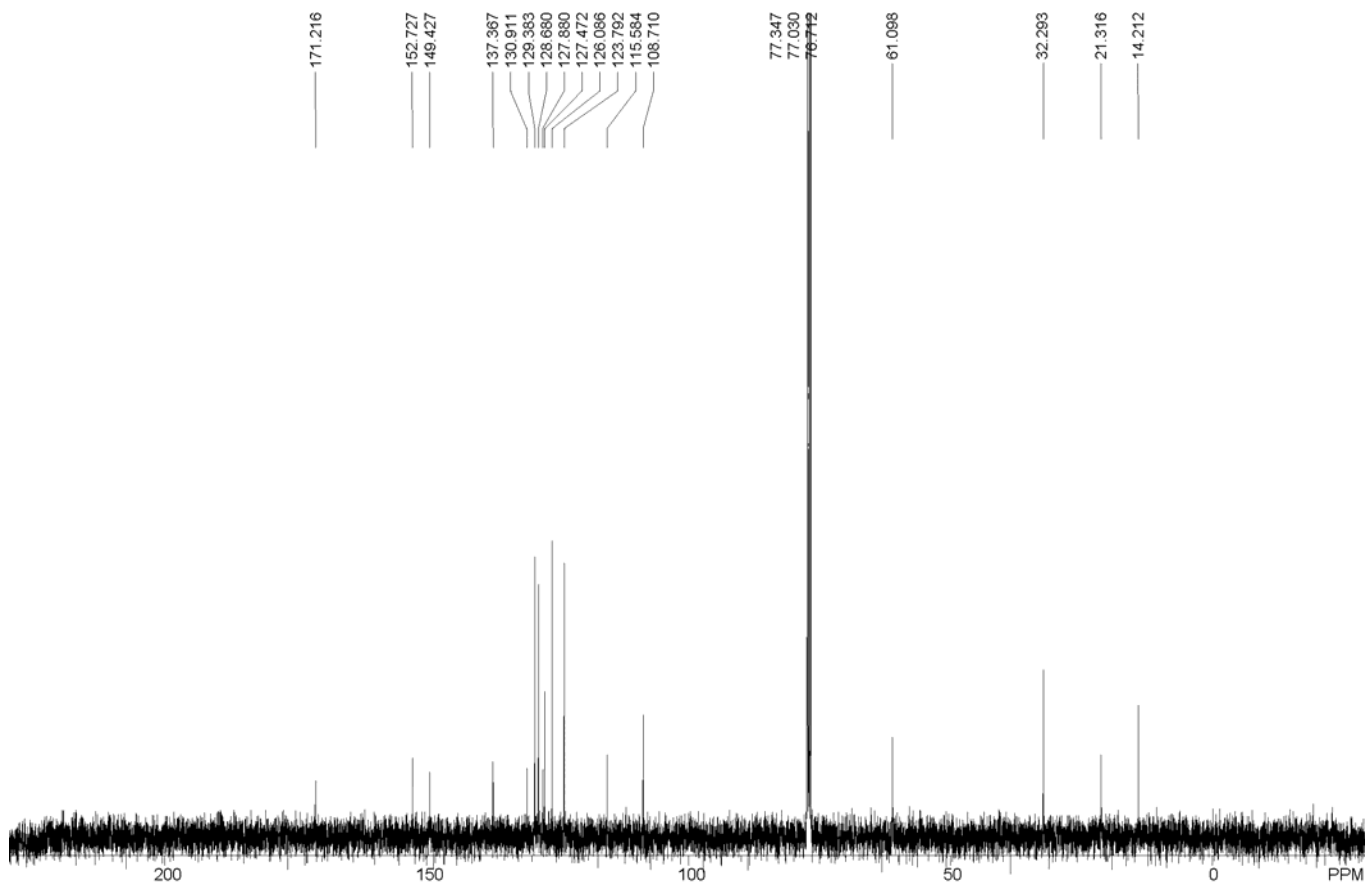
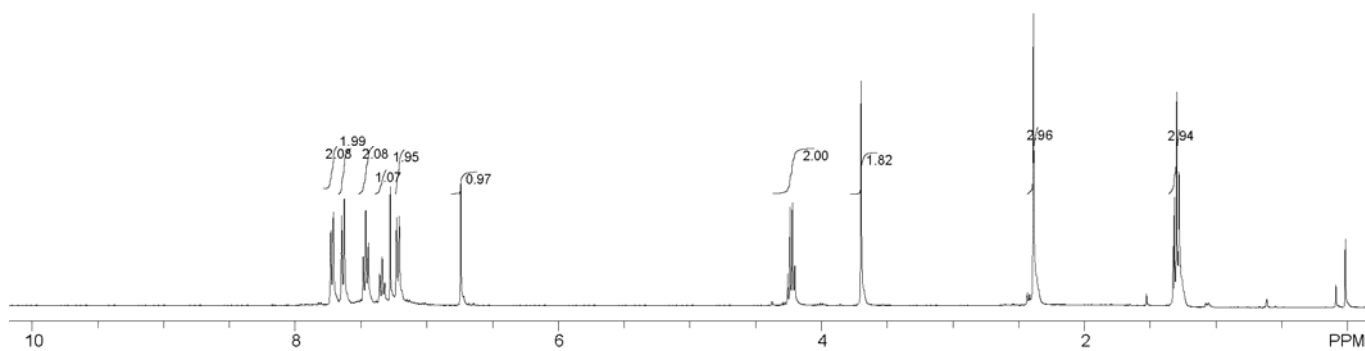
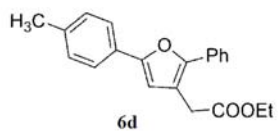
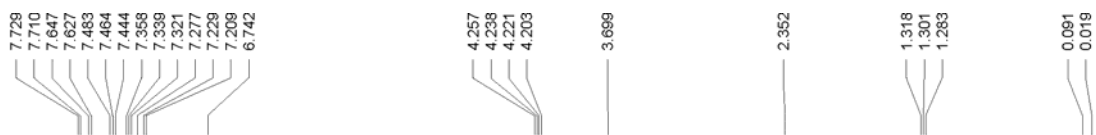






6c





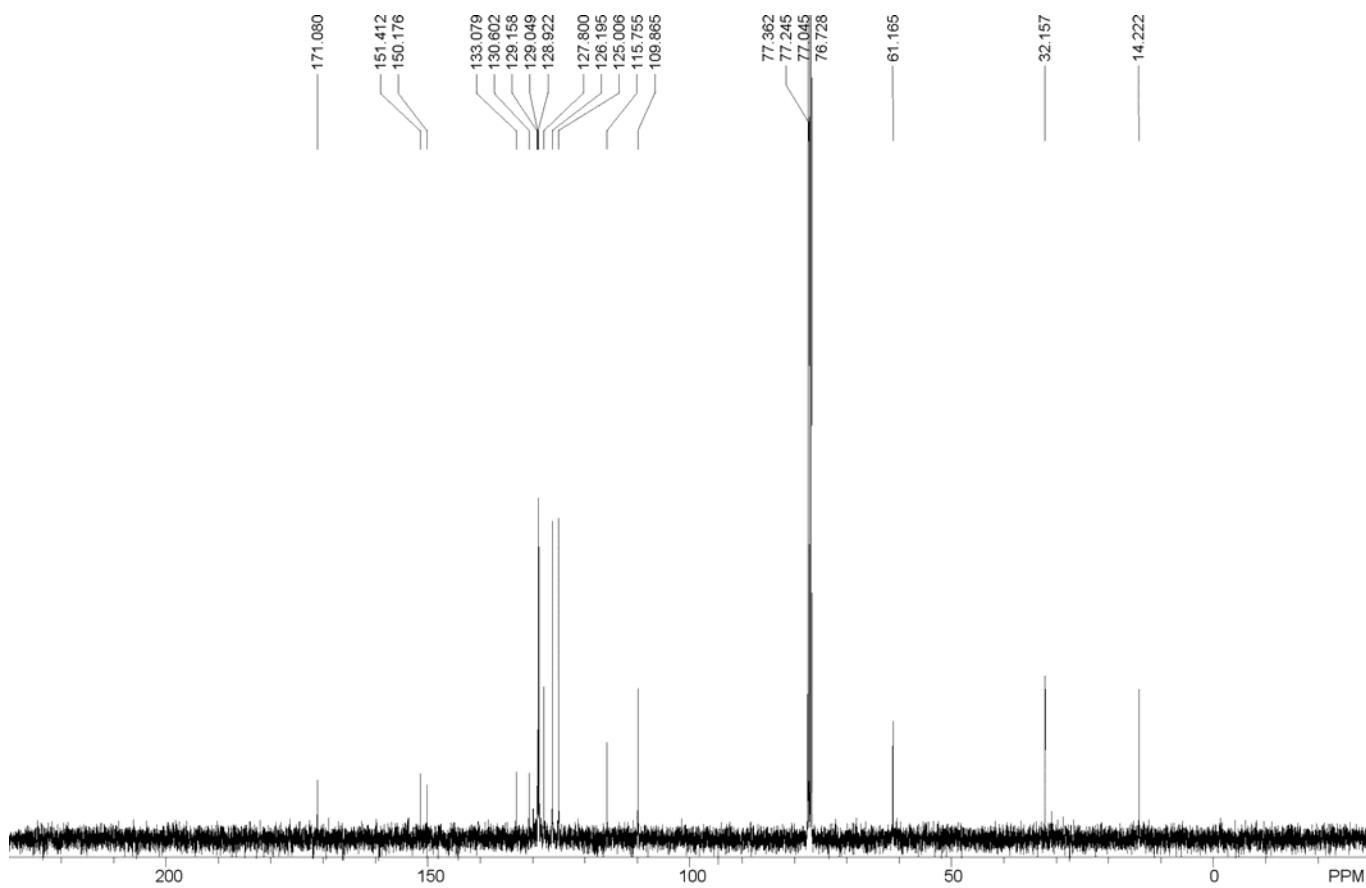
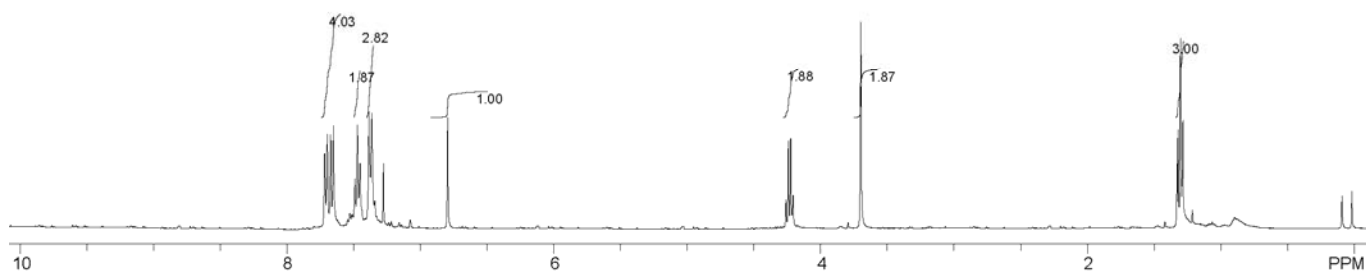
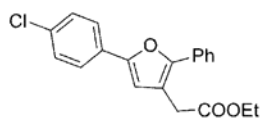
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7.715
7.697
7.672
7.650
7.490
7.471
7.385
7.380
7.363
7.342
7.339
7.276
6.794

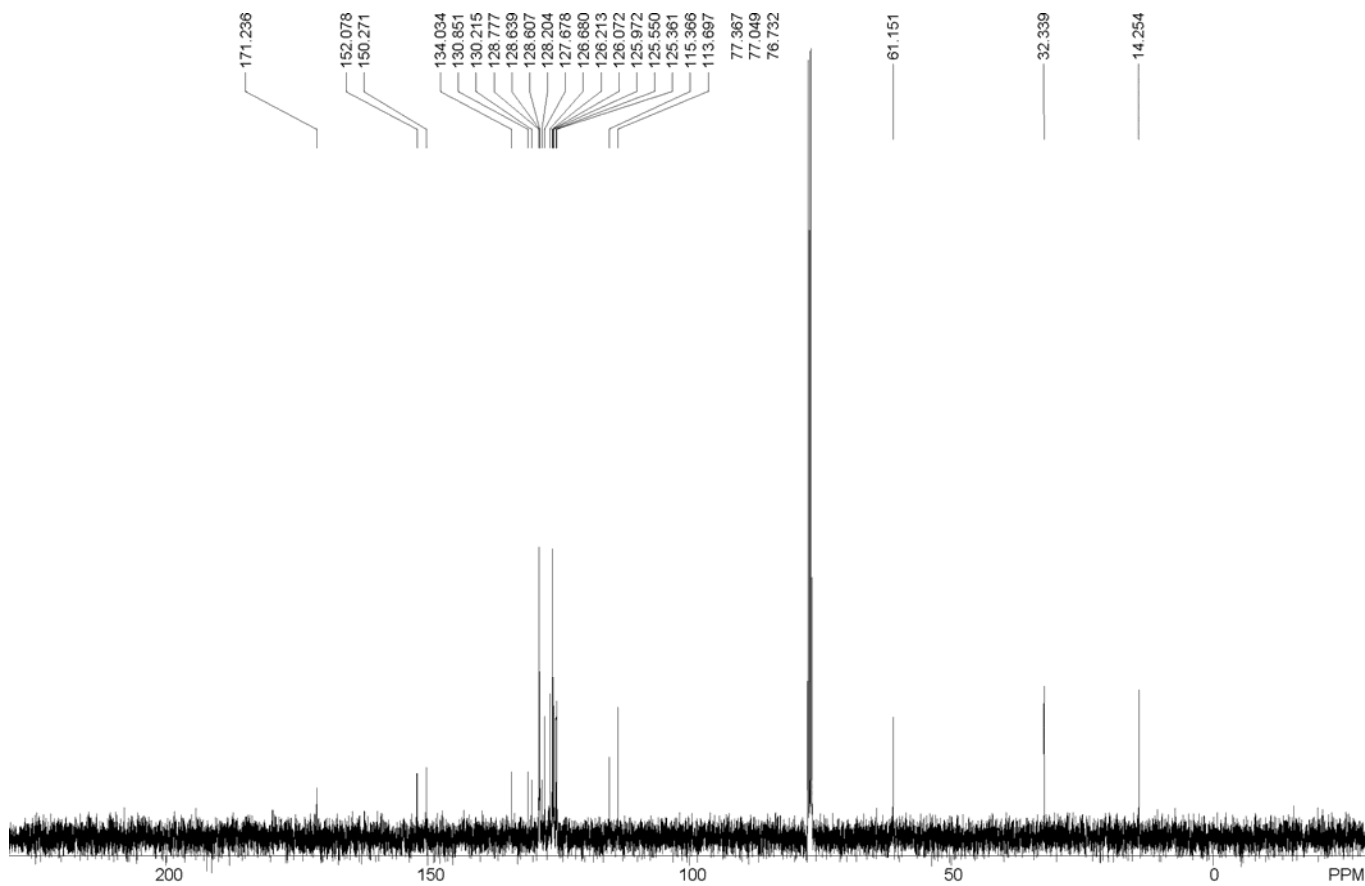
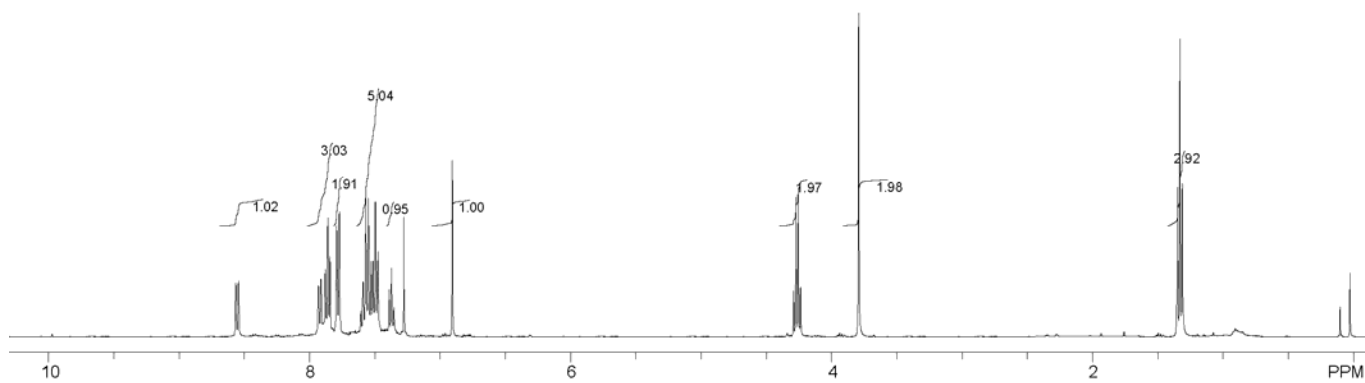
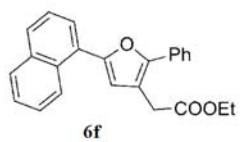
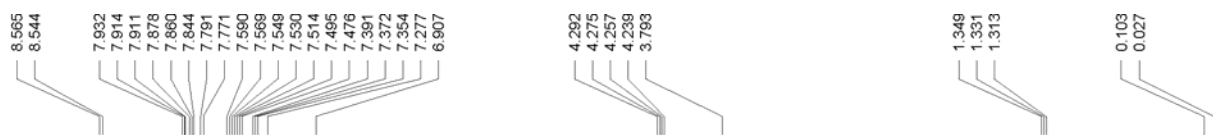
4.258
4.240
4.222
4.205

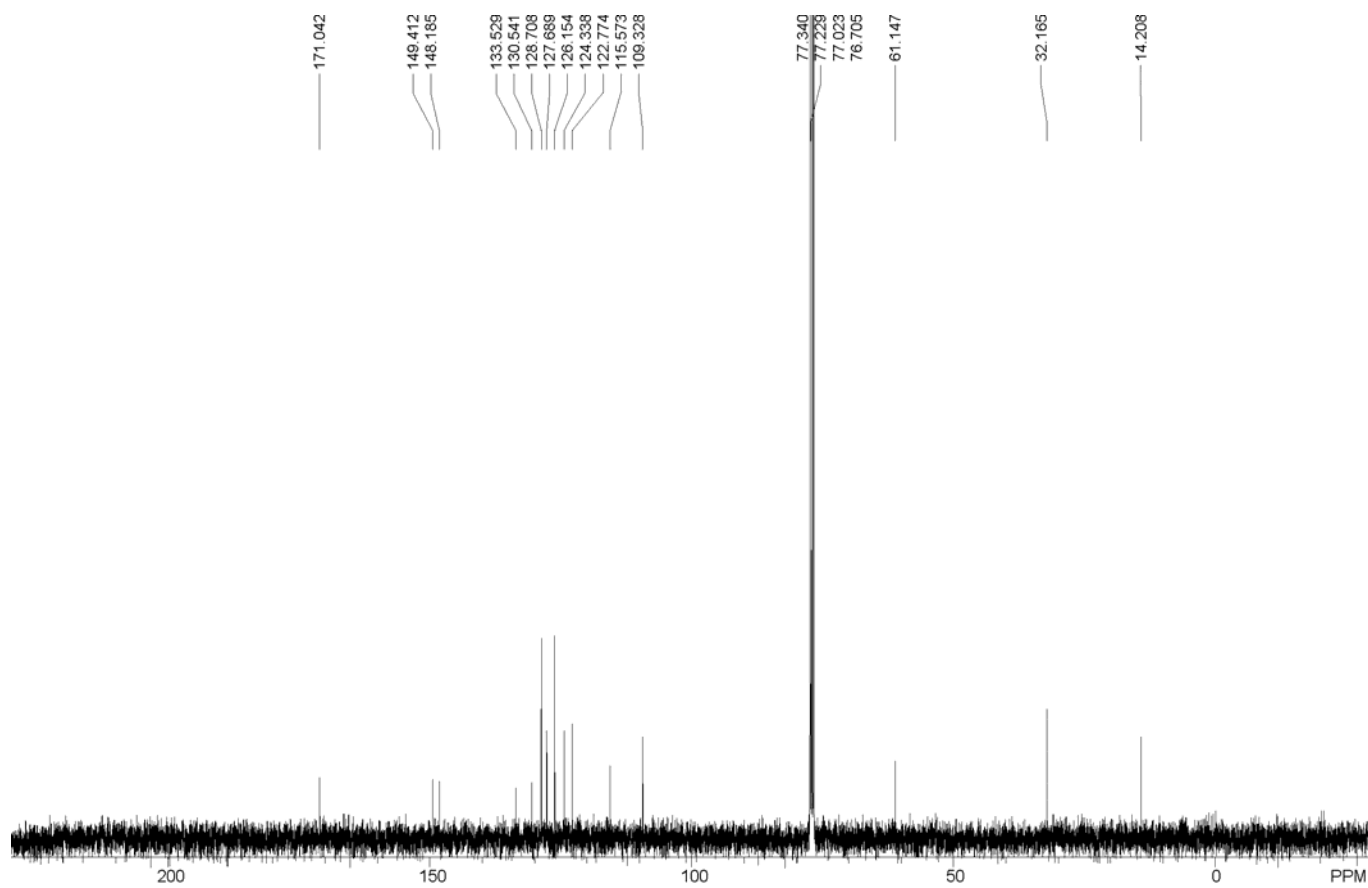
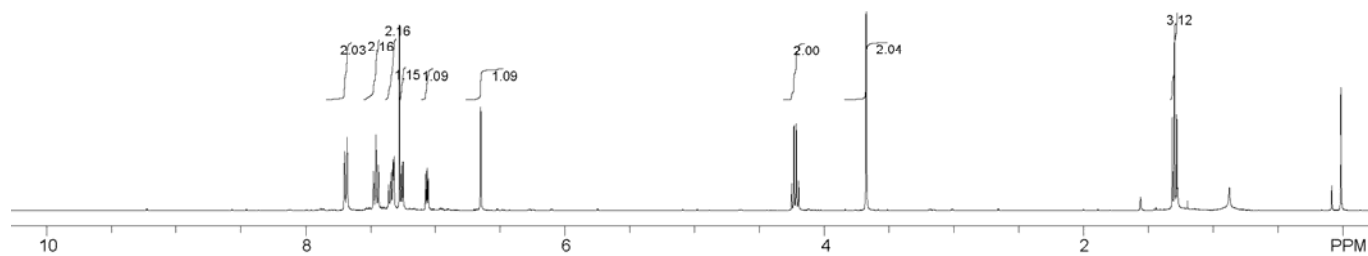
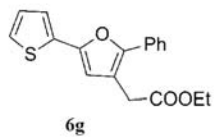
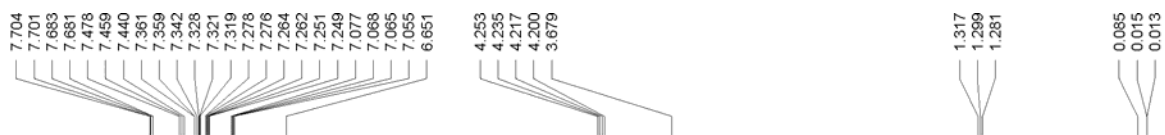
3.697

1.321
1.303
1.285

0.092
0.018





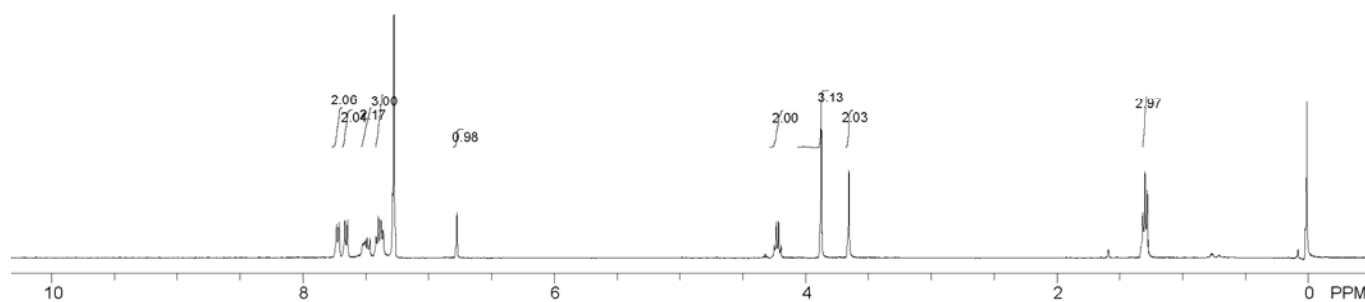
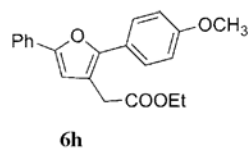


7.731
7.712
7.667
7.645
7.519
7.507
7.488
7.467
7.418
7.412
7.399
7.379
7.363
7.288
7.276
7.261
6.774

4.232
4.215
3.886
3.875
3.868
3.655

1.317
1.312
1.300
1.282

0.025
0.012



171.418

159.299

151.912

130.759

129.527

128.665

128.027

127.685

126.342

124.849

123.652

114.184

109.261

77.232

77.020

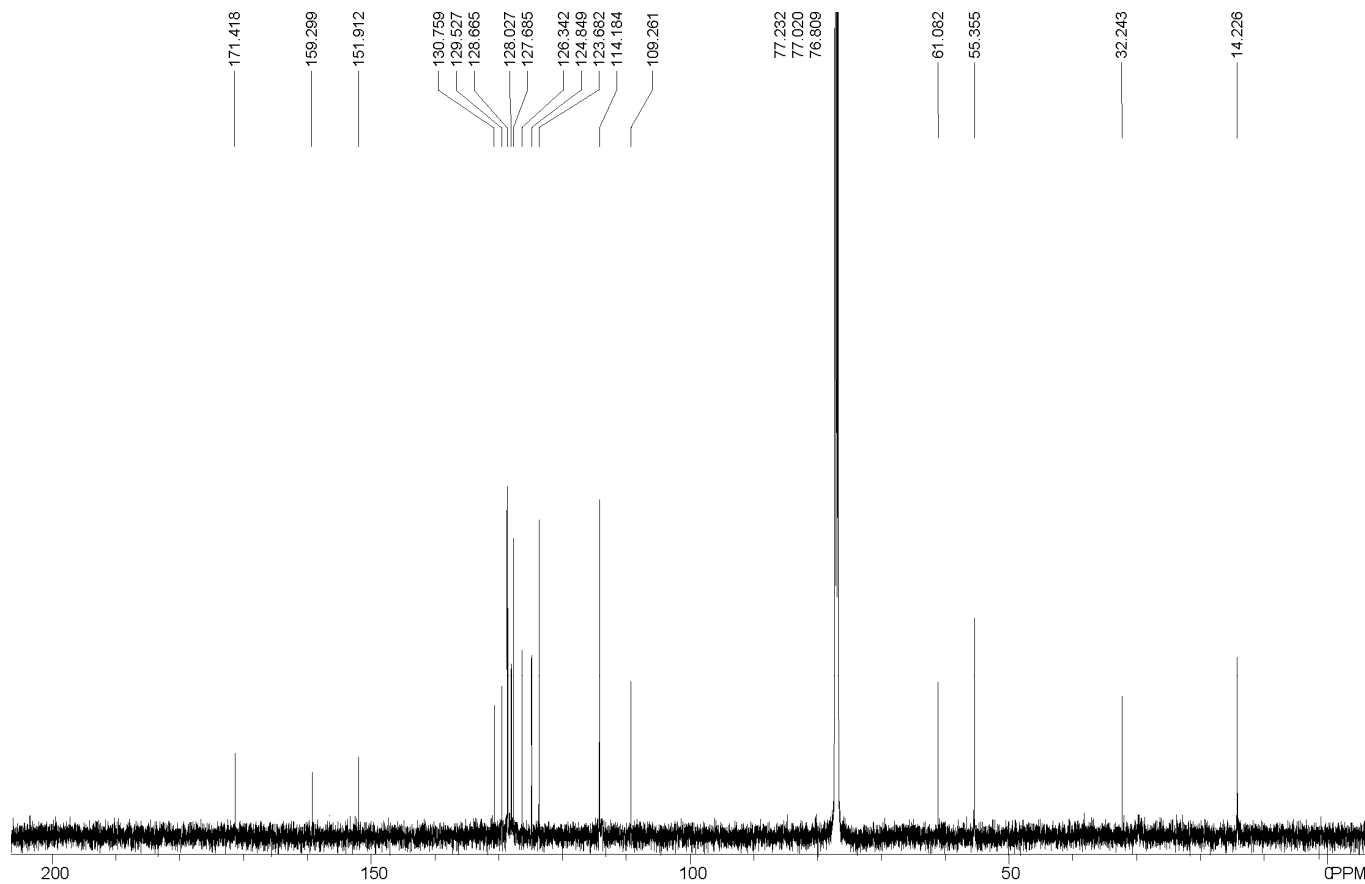
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61.082

55.955

32.243

14.226

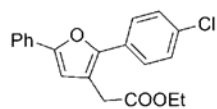


7.737
7.718
7.674
7.653
7.440
7.432
7.419
7.413
7.393
7.374
7.358
7.313
7.283
7.287
7.274
6.788

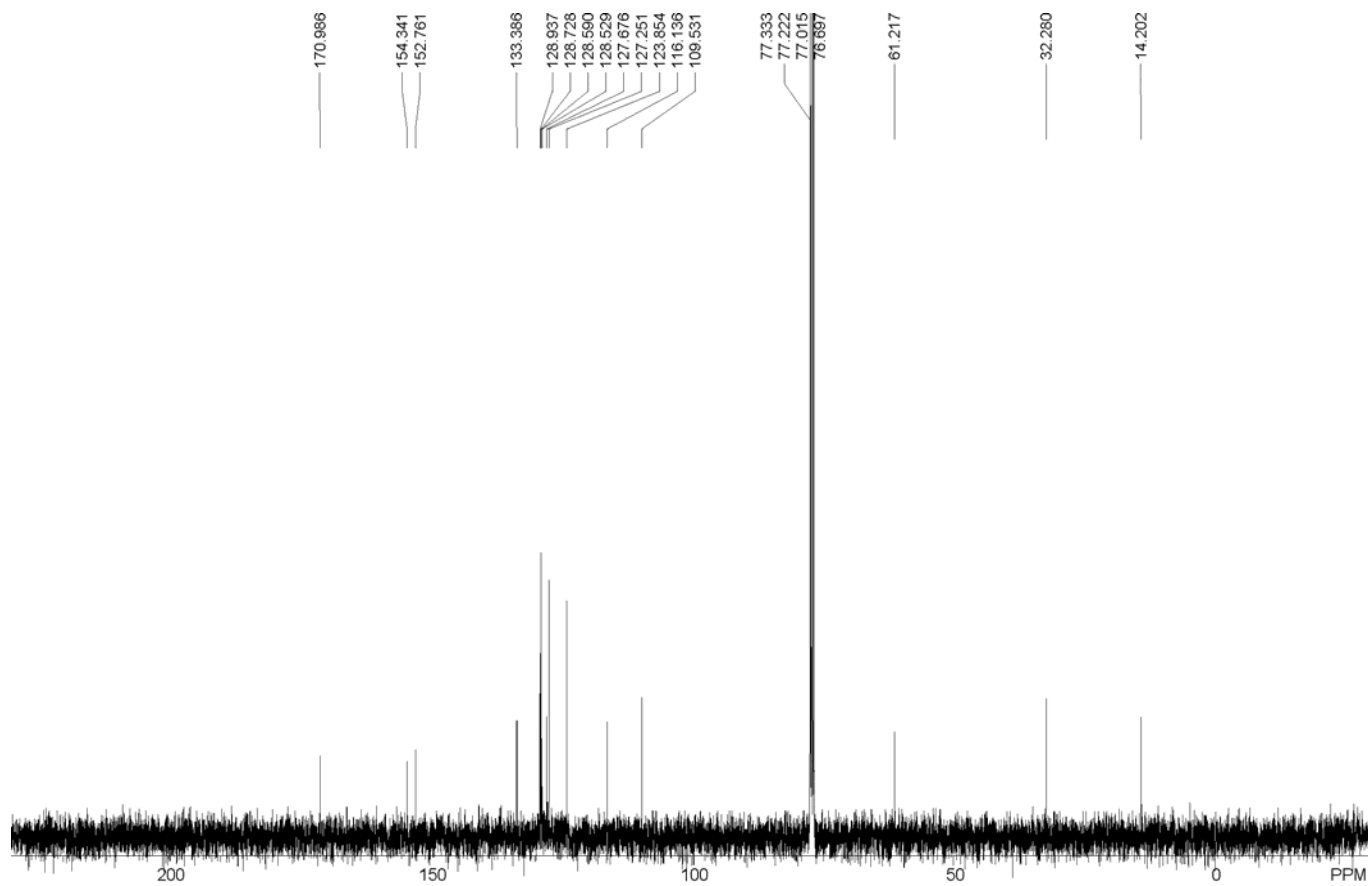
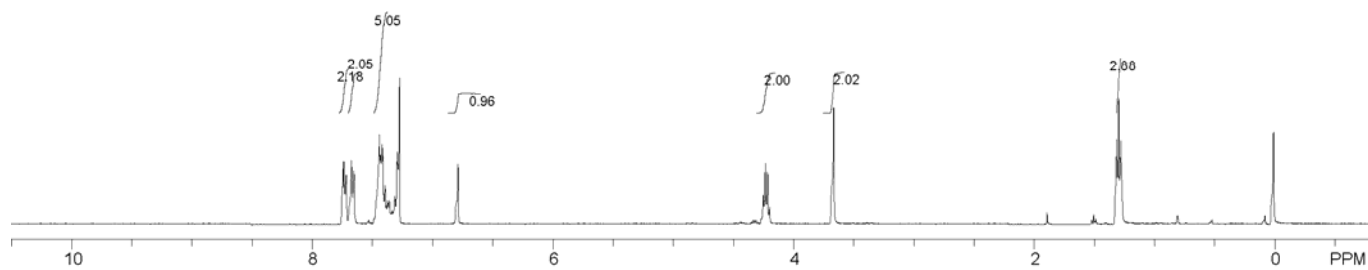
4.252
4.234
4.216
3.666

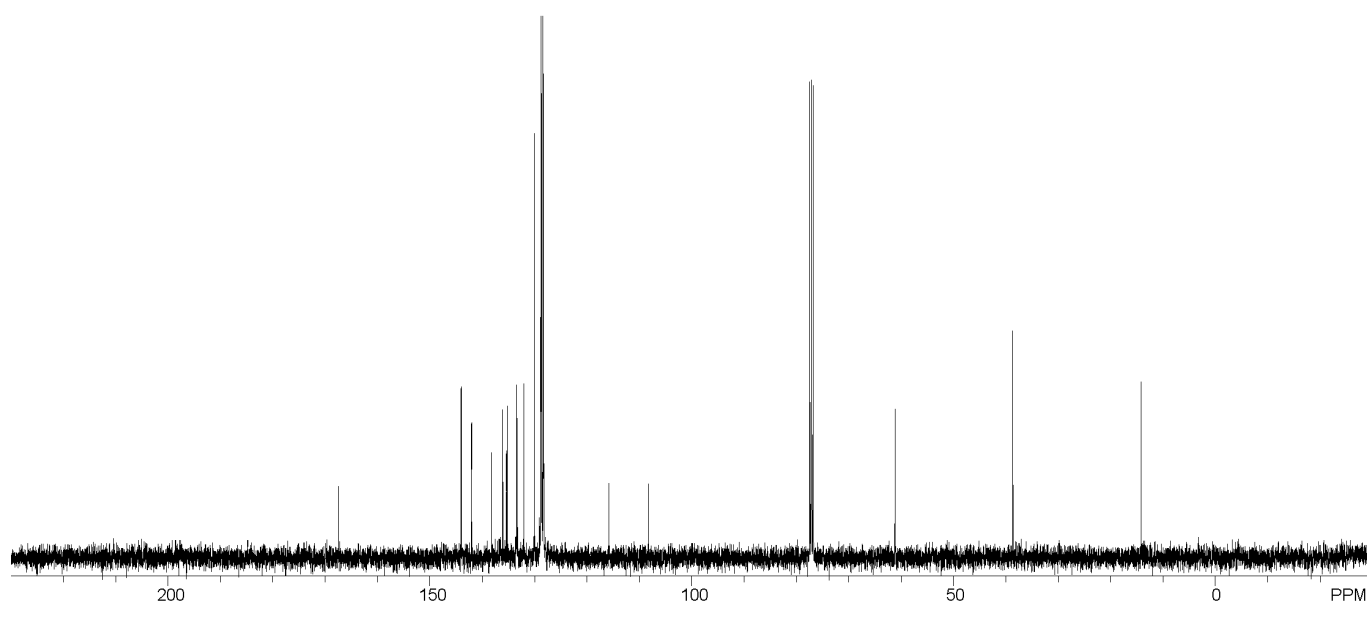
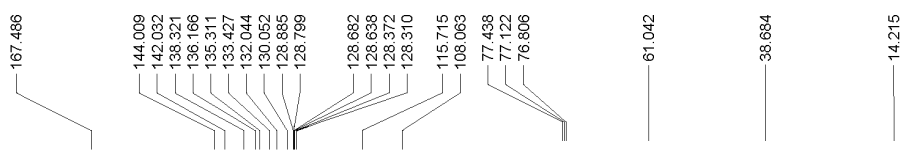
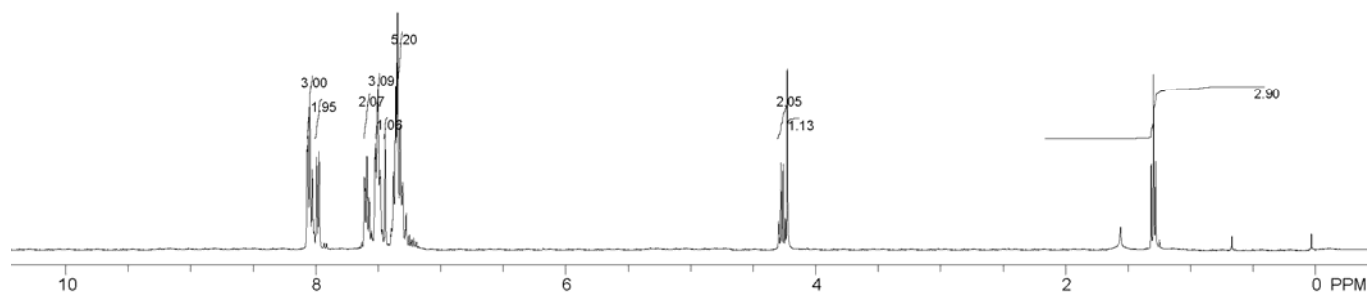
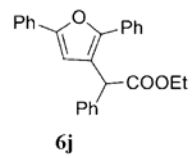
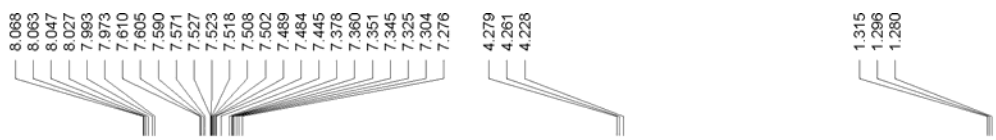
1.316
1.298
1.280

0.031
0.012

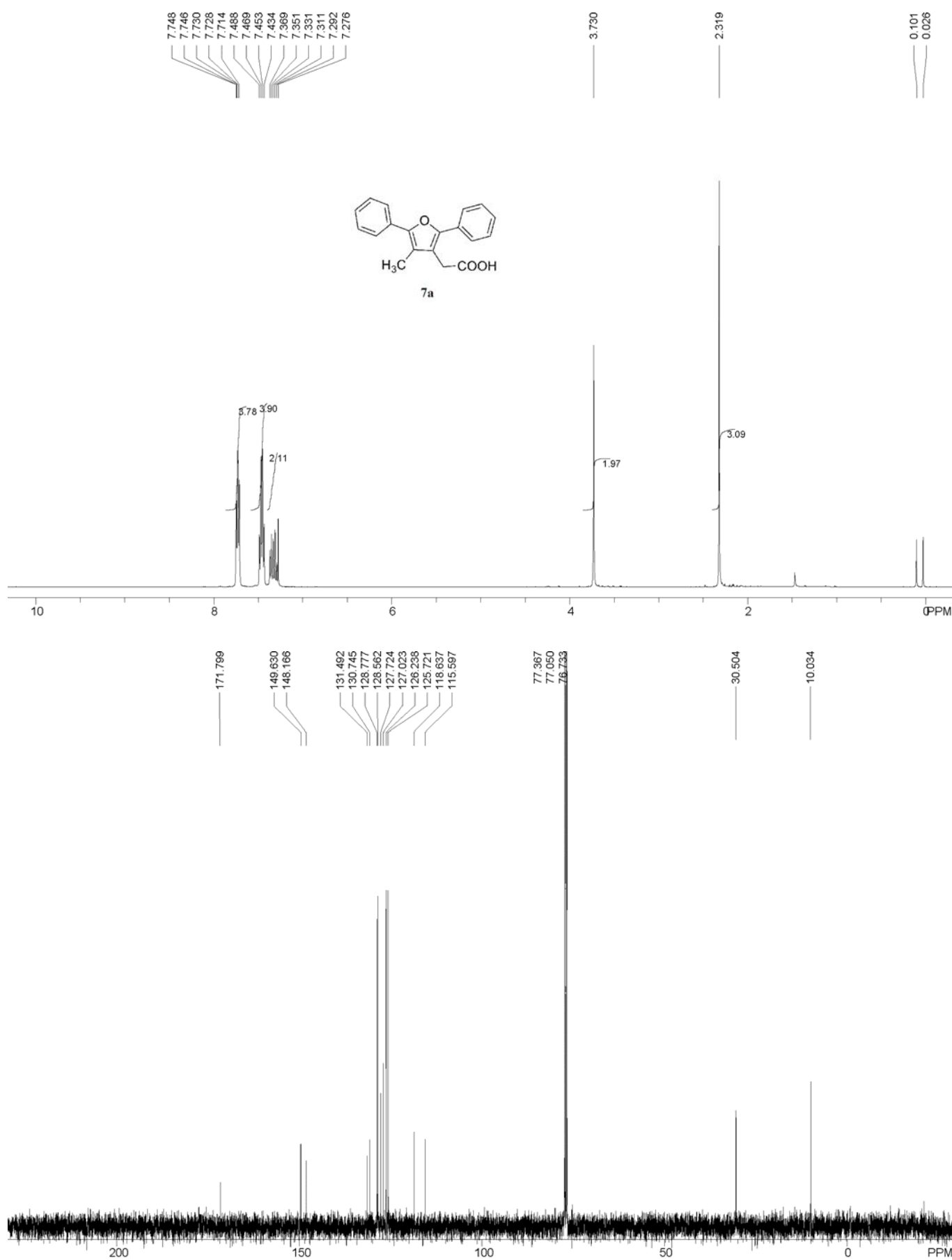


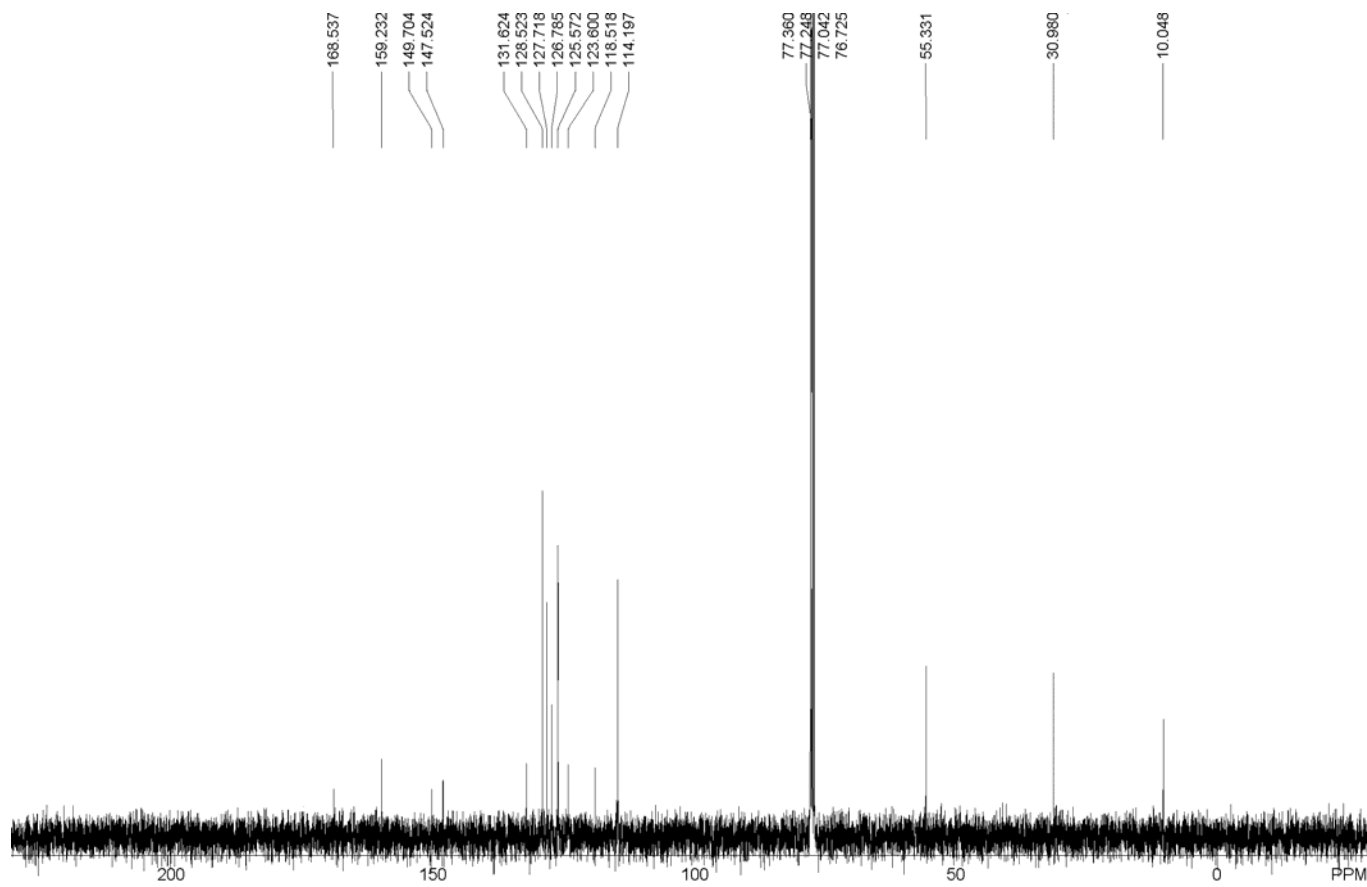
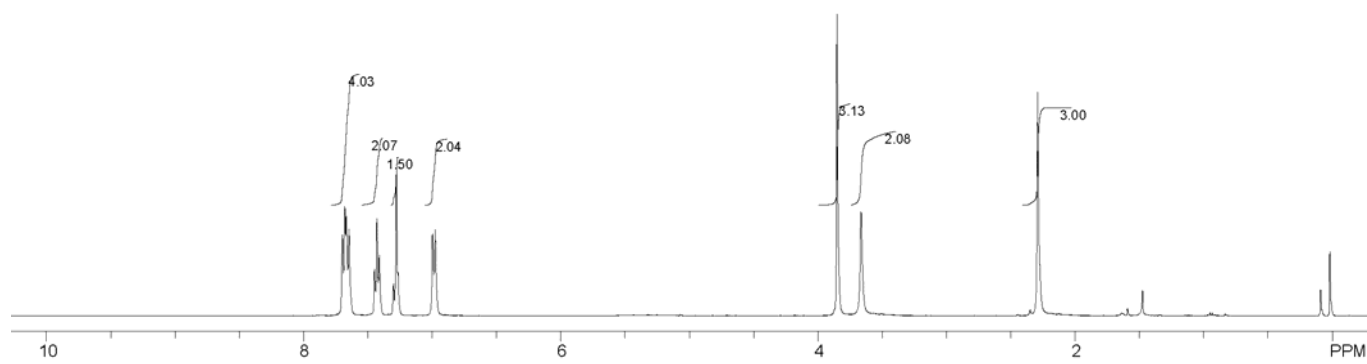
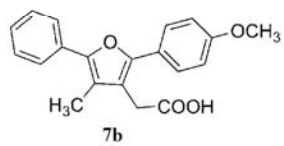
6i





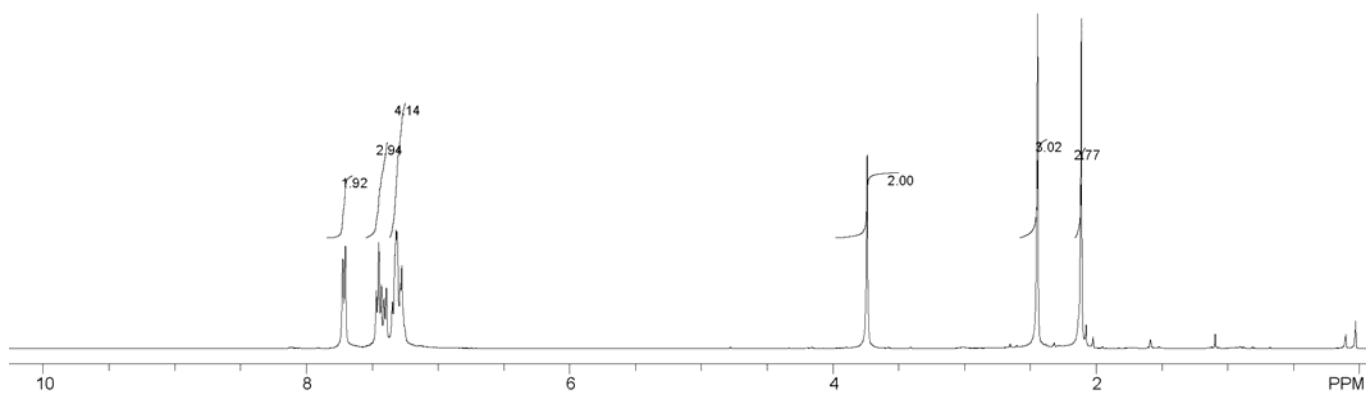
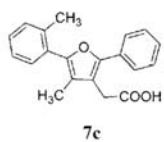
V. Copies of ^1H and ^{13}C NMR spectra of 7a-7d



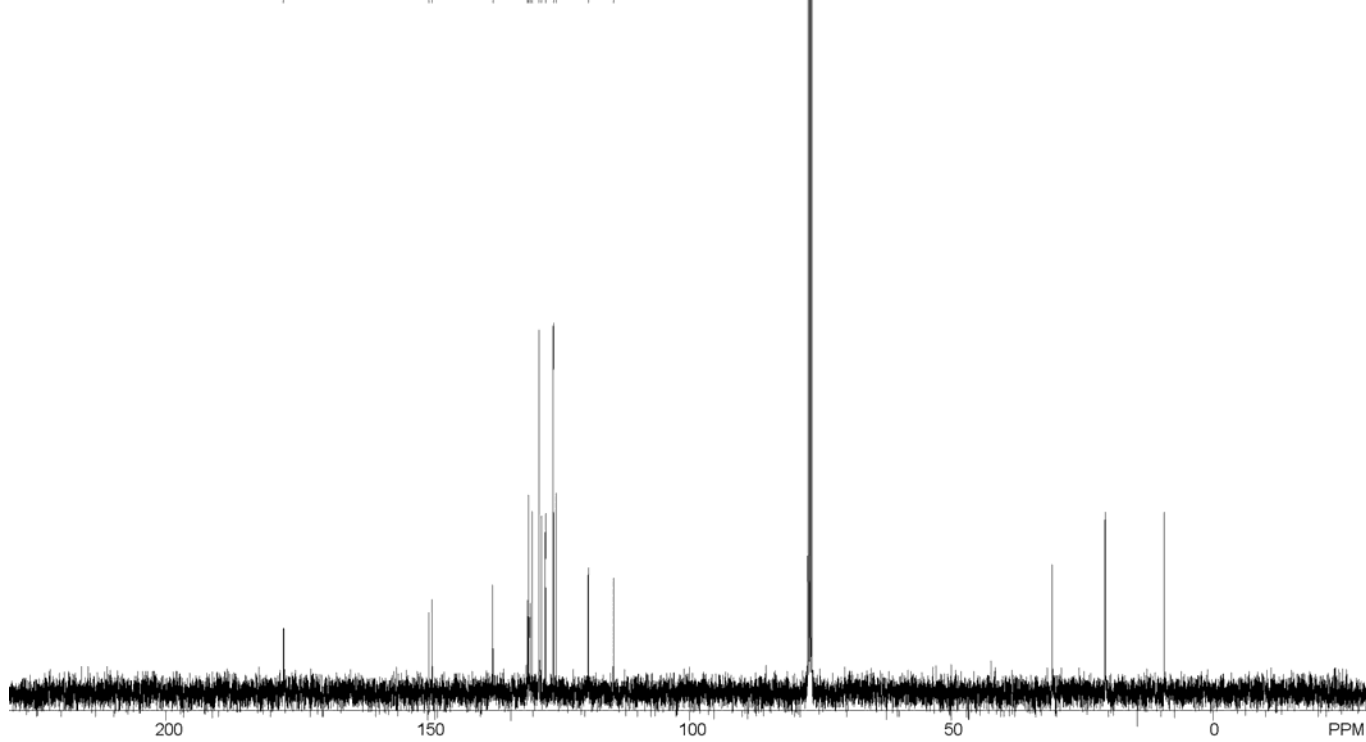


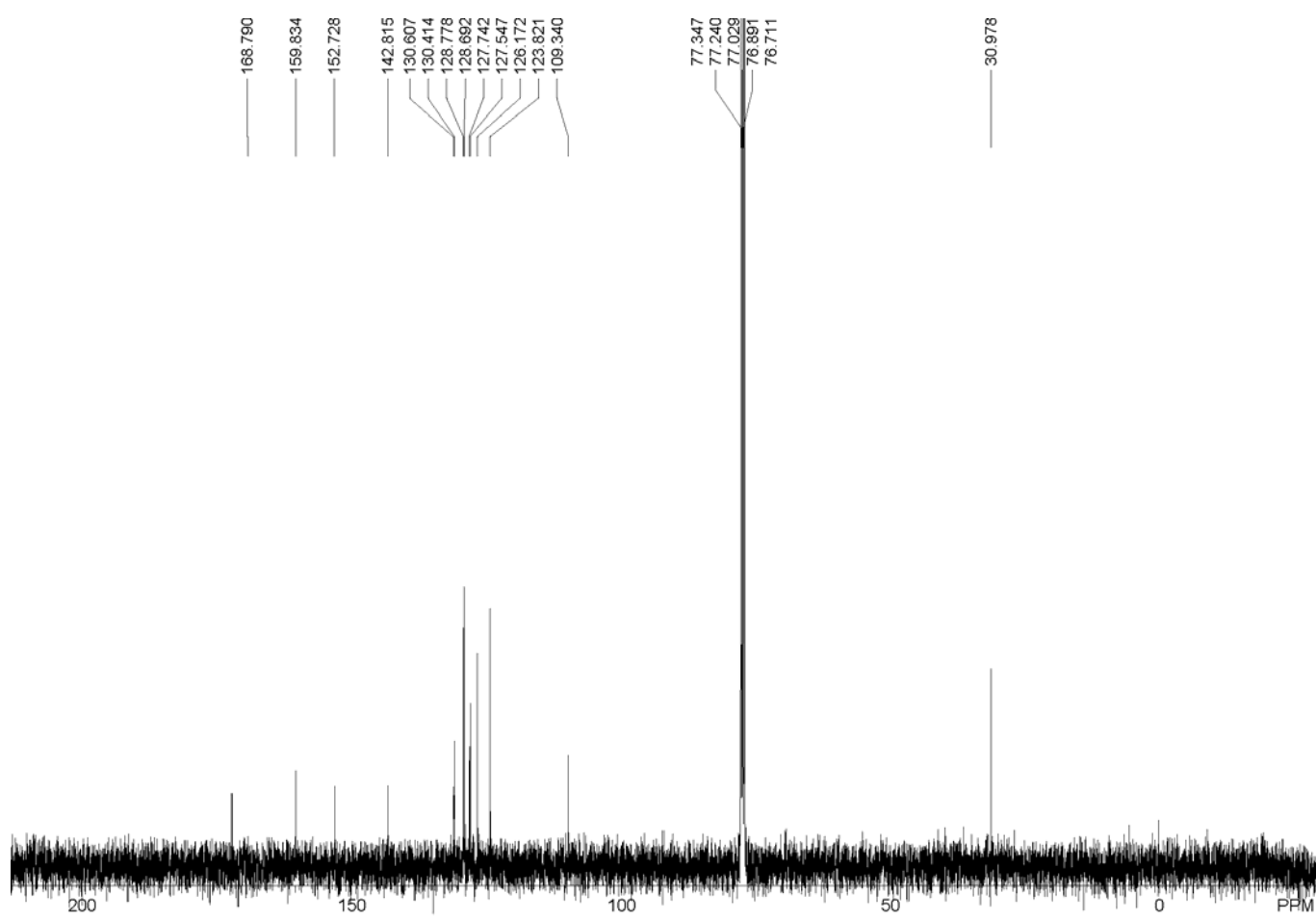
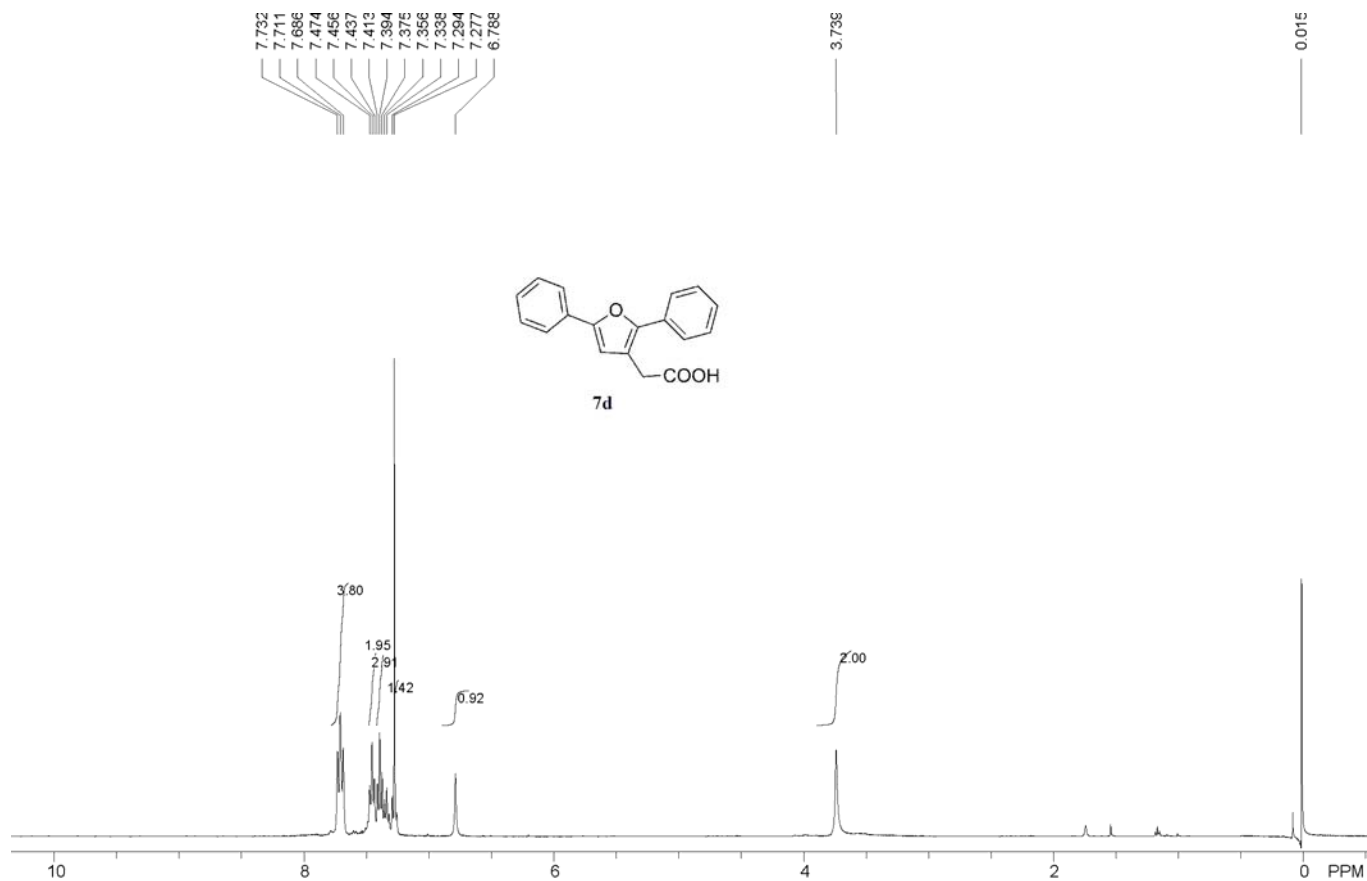
7.724
7.705
7.469
7.450
7.431
7.410
7.393
7.347
7.328
7.320
7.312
7.288
7.276

3.740
2.445
2.112

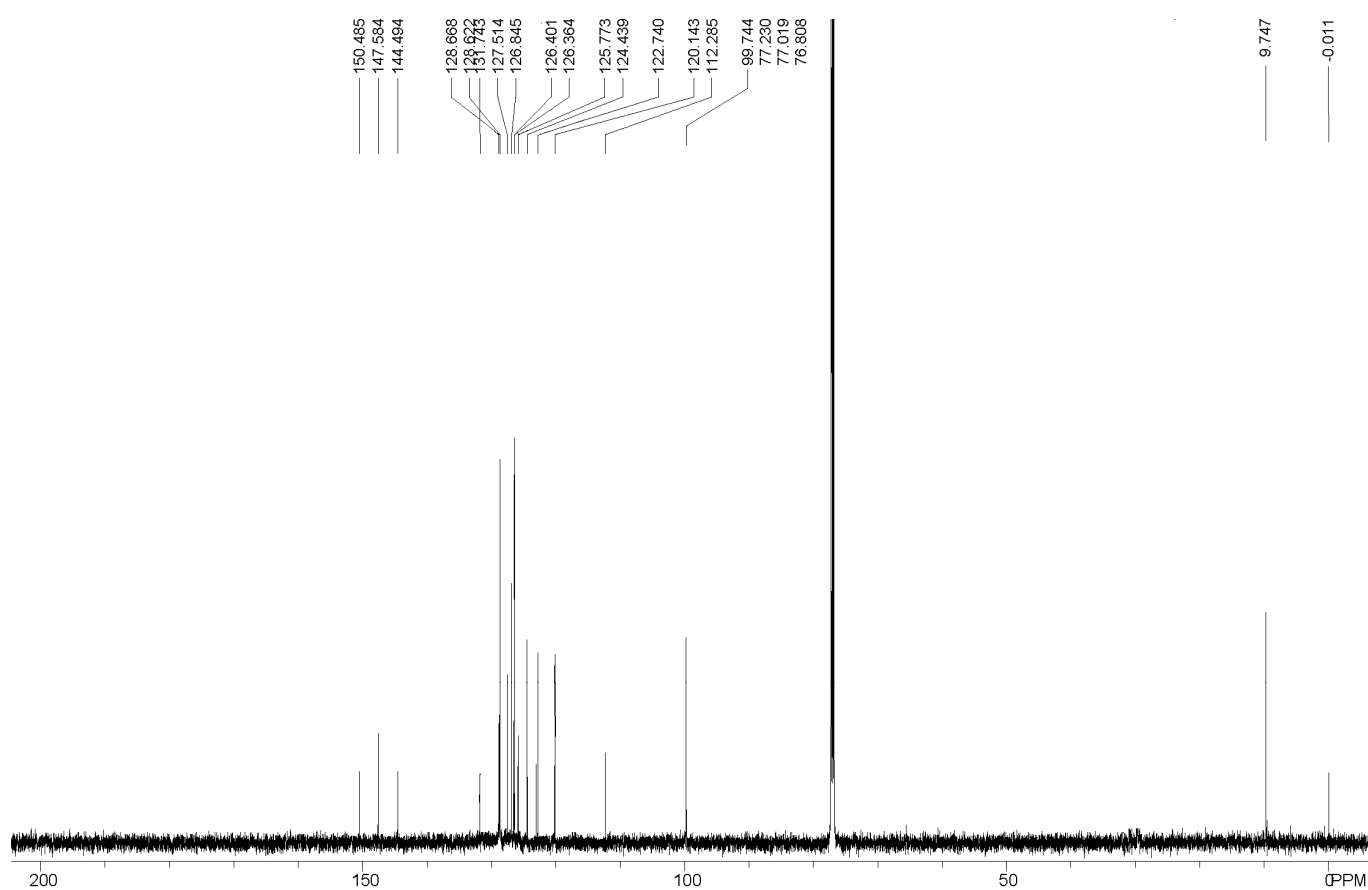
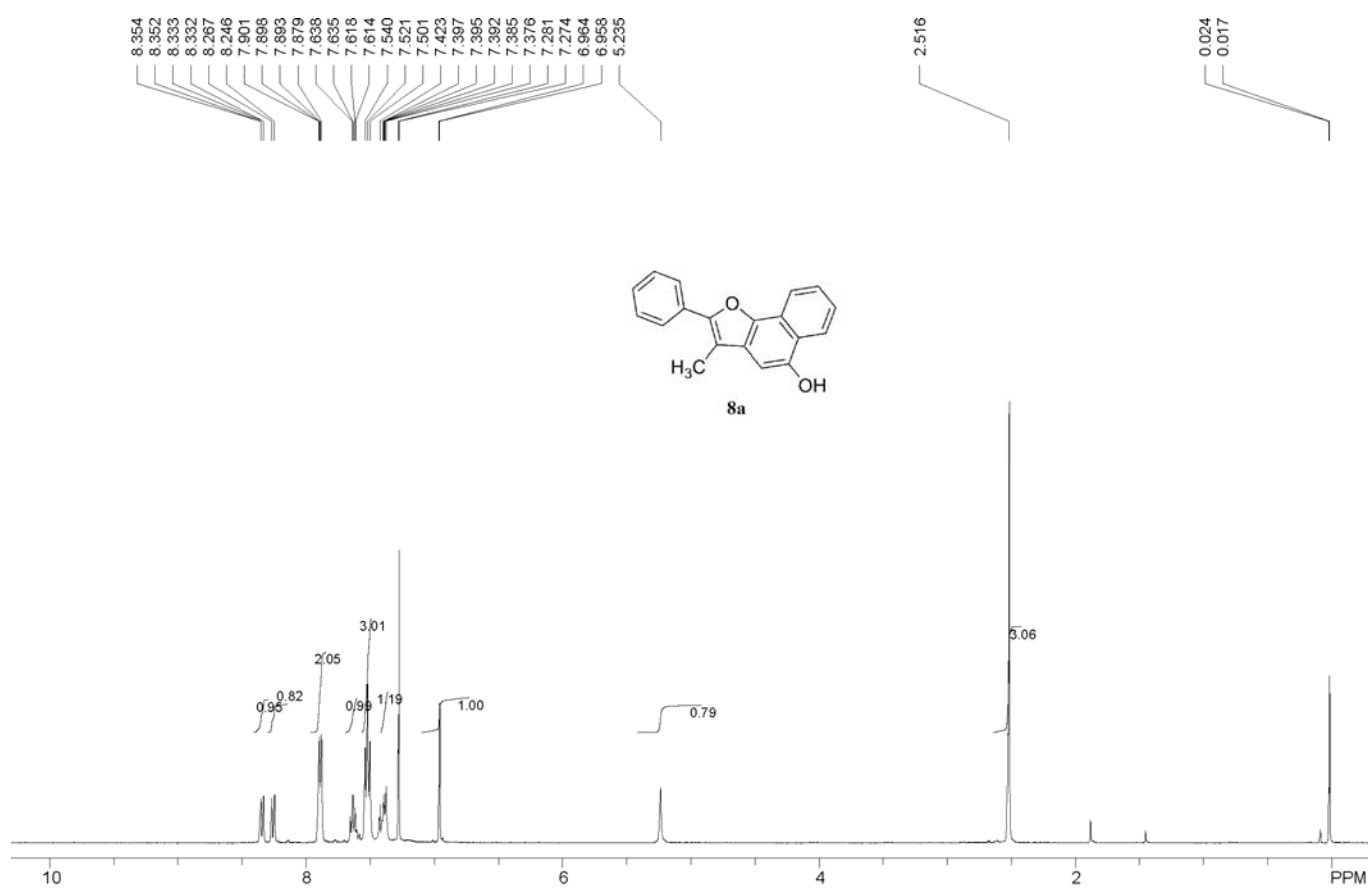


177.540
149.766
149.206
130.943
137.594
130.739
130.402
130.027
128.741
128.322
127.537
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77.364
77.047
76.729
76.619
30.798
20.693
9.463

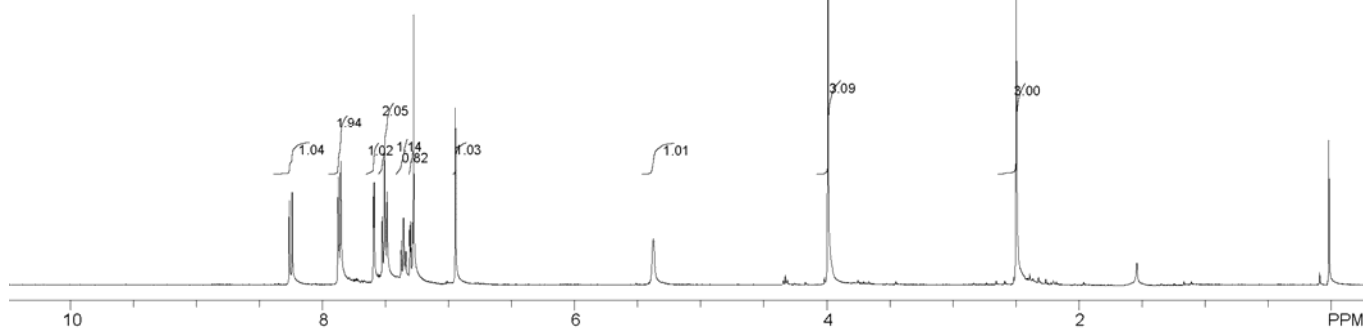
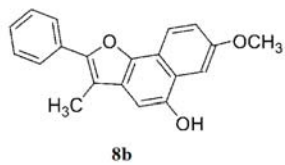




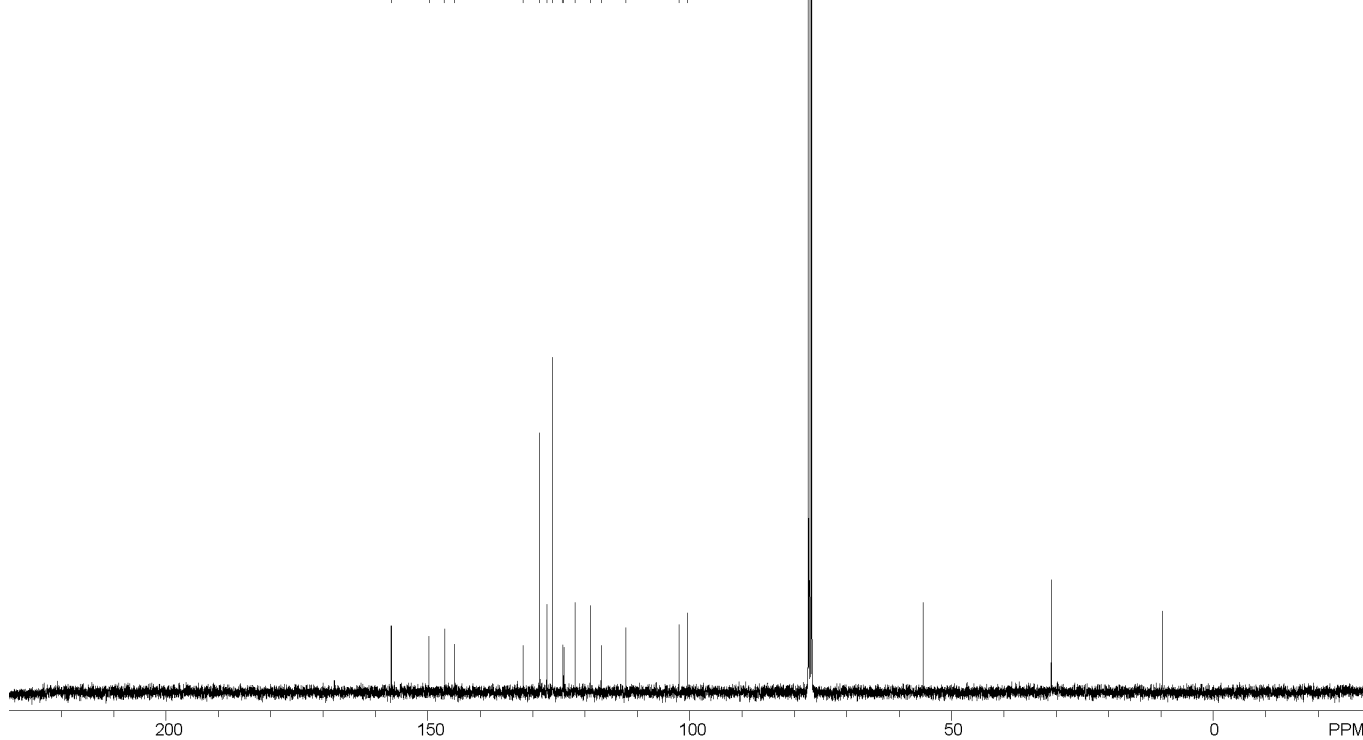
VI. Copies of ^1H and ^{13}C NMR spectra of 8a-8d

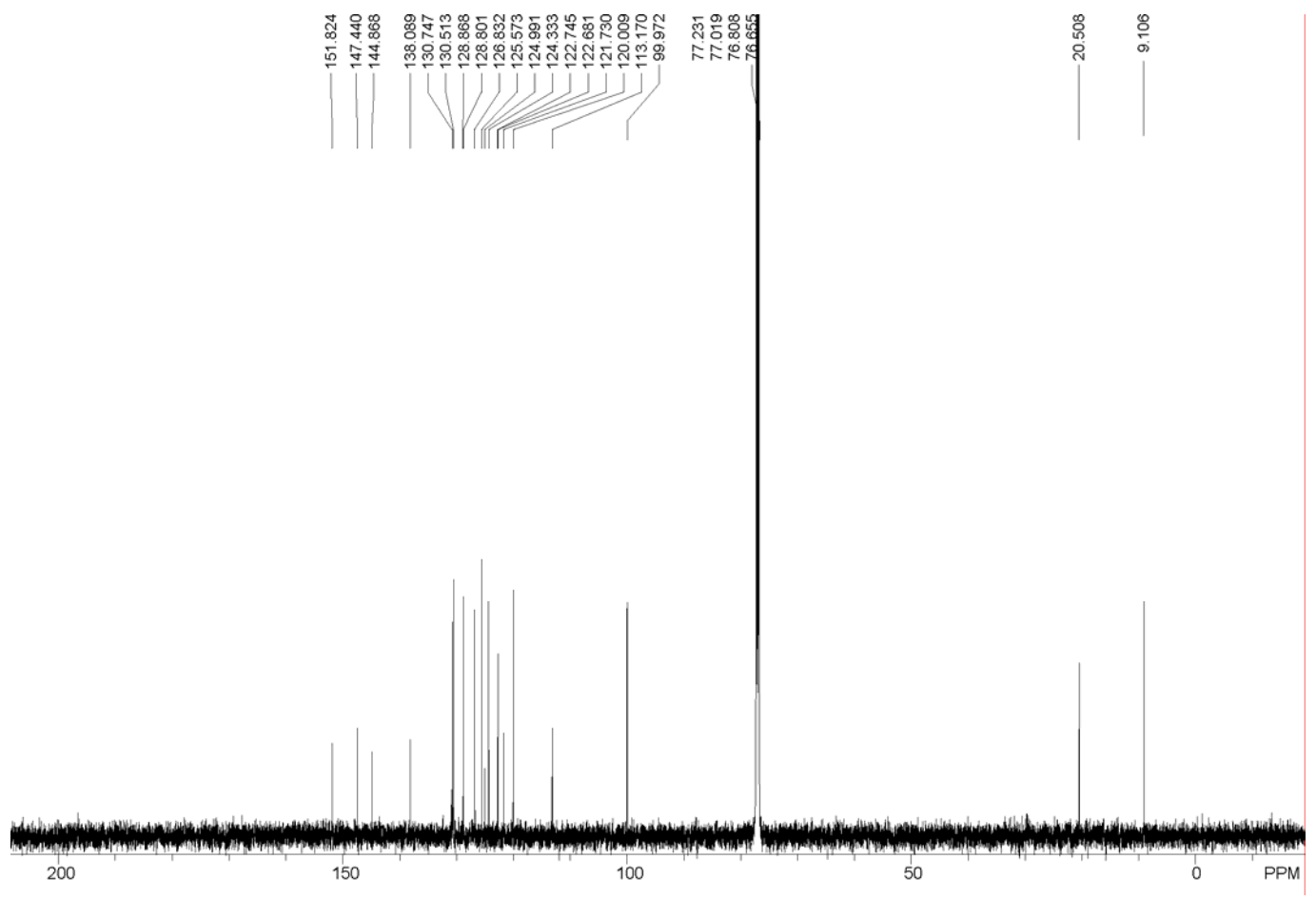
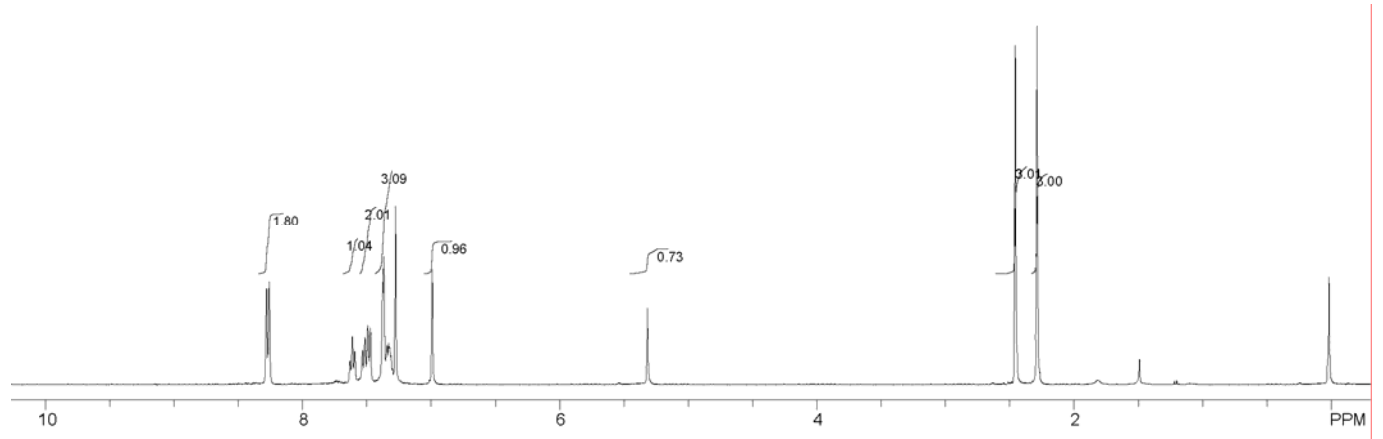
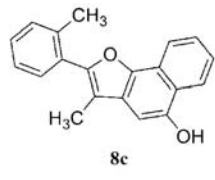


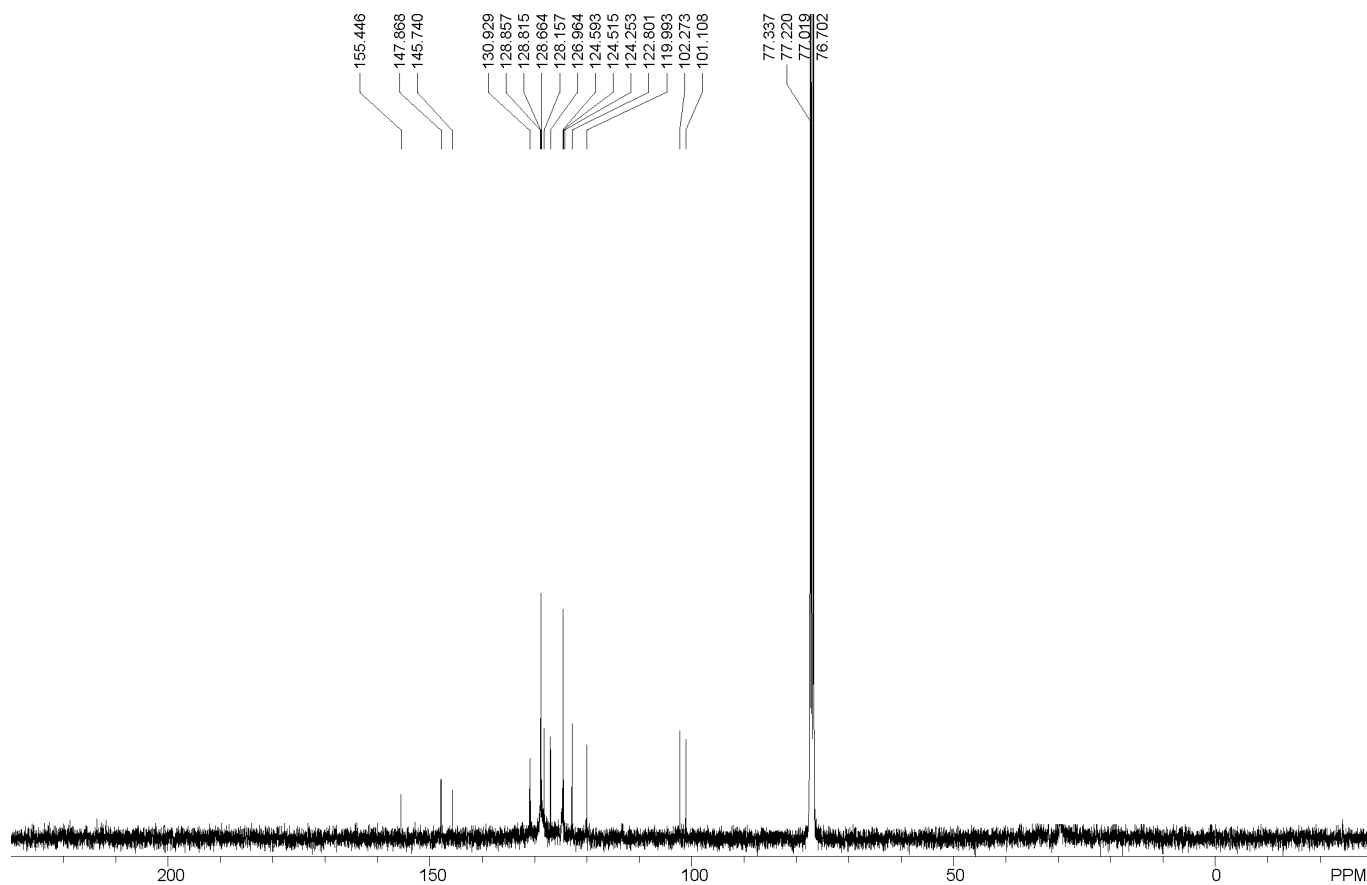
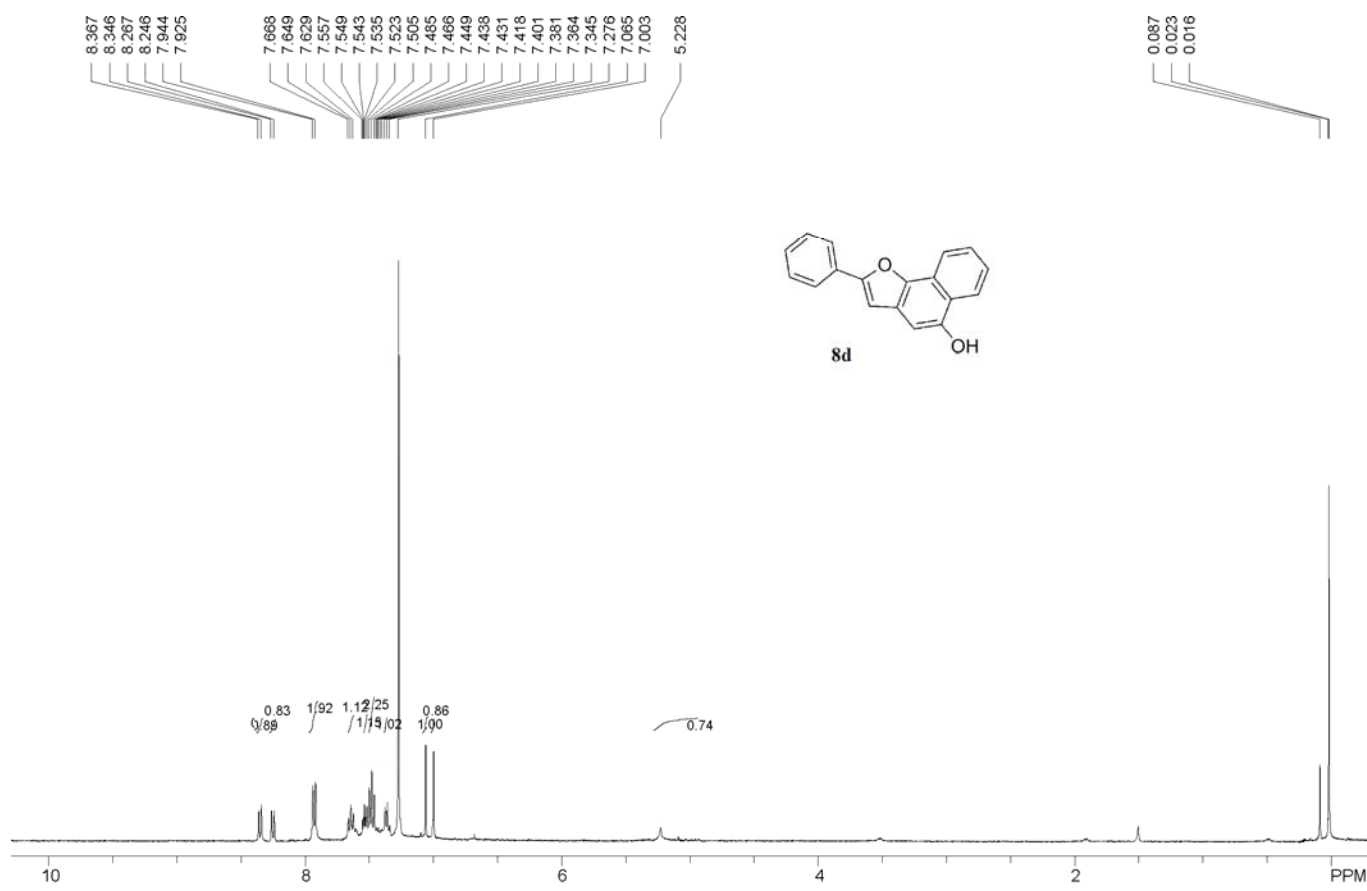
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7.507
7.488
7.376
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7.308
7.302
7.285
7.277
6.946
5.375
3.991
2.497
0.018



156.968
149.734
146.925
144.853
131.815
128.630
127.288
126.238
124.342
124.117
121.867
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116.868
112.298
102.032
100.344
77.340
77.022
76.892
76.705
55.427
30.950
9.812







VII. References

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- (2) J. Kuang, X. Xie and S. Ma, *Synthesis*, 2013, **45**, 592.
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- (5) N. A. Petasis and K. A. Teets, *J. Am. Chem. Soc.*, 1992, **114**, 10328.