

Gold-Catalyzed Tandem Cyclization/Friedel-Crafts Type

Reactions toward Furan Derivatives

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General Remarks

Column chromatography was carried out on silica gel. ¹H NMR spectra were recorded on 300/400 MHz in CDCl₃ and ¹³C NMR spectra were recorded on 75/100 MHz in CDCl₃. IR spectra were recorded on a FT-IR spectrometer and only major peaks are reported in cm⁻¹. Melting points were determined on a microscopic apparatus and were uncorrected. All compounds were further characterized by elemental analysis; copies of their ¹H NMR and ¹³C NMR spectra are provided in the Supporting Information. Room temperature is 23–25°C. Commercially available reagents and solvents were used without further purification. THF was distilled immediately before use from Na/benzophenone.

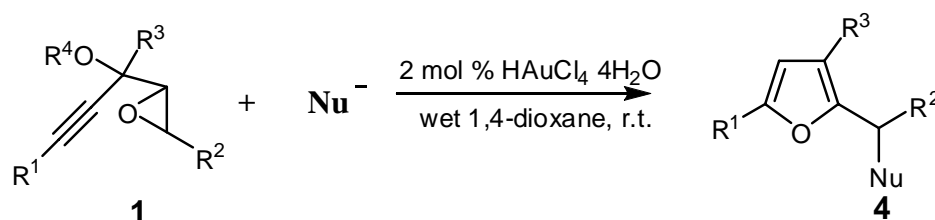
The known substrates 1a-1l were prepared according to the literature.¹

1. (a) X.-Z. Shu, X.-Y. Liu, H.-Q. Xiao, K.-G. Ji, L.-N. Guo, C.-Z. Qi, Y.-M. Liang, *Adv. Synth. Catal.* **2007**, *349*, 2493. (b) K.-G. Ji, Y.-W. Shen, X.-Z. Shu, H.-Q. Xiao, Y.-J. Bian, Y.-M. Liang, *Adv. Synth. Catal.* **2008**, *350*, 1275.

The known nucleophiles were prepared according to the literature.²

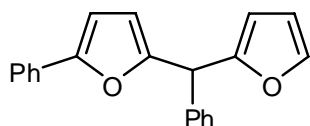
2. (a) P. Srivastava, R. Srivastava, *Tetrahedron Letters* **2007**, *48*, 4489. (b) D. A. Evans, G. Borg, K. A. Scheidt, *Angew. Chem., Int. Ed.* **2002**, *41*, 3188.

General procedure A: Gold (III)-catalyzed reaction of 1-oxiranyl-2-alkynyl ester 1 with nucleophiles for synthesis of 4.

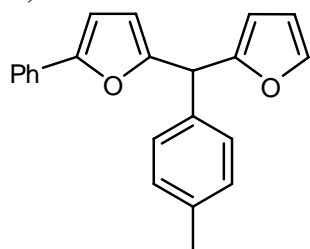


To a solution of esters of 1-oxiranyl-2-alkyn-1-ols **1** (0.50 mmol), **5** mmol of nucleophiles (10 equivs) in wet 1,4-dioxane (2.0 mL) was added 4.00 mg (0.01 mmol, 2 mol %) of $\text{HAuCl}_4 \cdot 4\text{H}_2\text{O}$ under air at room temperature. When the reaction was considered complete as determined by TLC analysis, the reaction mixture was diluted with ethyl ether (40 mL), washed with water, saturated brine, dried over Na_2SO_4 and evaporated under reduced pressure. The residue was purified by chromatography on silica gel to afford corresponding furan derivatives **4**.

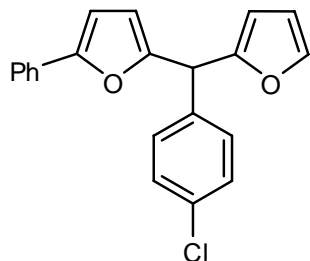
Characterization Data of **4**.



2-(furan-2-yl(phenyl)methyl)-5-phenylfuran (4a): Compound **4a** was isolated in 71 % yield as an oil following the general procedure **A**. Reaction time: 20 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.68-7.66 (d, $J = 7.5$ Hz, 2H), 7.43-7.24 (m, 9 H), 6.65-6.63 (d, $J = 3.6$ Hz, 1 H), 6.39-6.6.38 (dd, $J = 3.3, 1.8$ Hz, 1 H), 6.15 (s, 2H), 5.58 (s, 1H). ^{13}C NMR (75 MHz, CDCl_3) δ 154.3, 153.9, 153.3, 141.9, 139.4, 130.8, 128.5, 128.5, 128.3, 127.2, 127.1, 123.5, 110.2, 109.7, 107.6, 105.7, 45.1. IR (neat, cm^{-1}) 2924, 1450, 1163, 1018, 694. Anal.Calcd for $\text{C}_{21}\text{H}_{16}\text{O}_2$: C, 83.98; H, 5.37. Found: C, 83.82; H, 5.30.

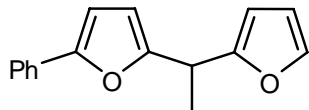


2-(furan-2-yl(p-tolyl)methyl)-5-phenylfuran (4b): Compound **4b** was isolated in 73 % yield as an oil following the general procedure **A**. Reaction time: 10 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.61-7.58 (d, $J = 7.5$ Hz, 2H), 7.35-7.11(m, 8 H), 6.57-6.55(t, $J = 3.0$ Hz, 1 H), 6.31-6.30(dd, $J = 3.0, 1.2$ Hz, 1 H), 6.08-6.06(t, $J = 3.0$ Hz, 2 H), 5.47(s, 1H), 2.32(s, 3H) ^{13}C NMR (75 MHz, CDCl_3) δ 154.6, 154.2, 153.2, 141.9, 136.8, 136.4, 130.9, 129.2, 128.6, 128.2, 127.1, 123.6, 110.2, 109.6, 107.5, 105.7, 44.8, 21.1. IR (neat, cm^{-1}) 2921, 1509, 1208, 1018, 762. Anal.Calcd for $\text{C}_{22}\text{H}_{18}\text{O}_2$: C, 84.05; H, 5.77. Found: C, 84.02; H, 5.73.

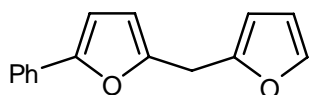


2-((4-chlorophenyl)(furan-2-yl)methyl)-5-phenylfuran (4c): Compound **4c** was isolated in 70 % yield as an oil following the general procedure **A**. Reaction time: 10 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.51-7.49 (d, $J = 7.8$ Hz, 2H), 7.26-7.18(m, 5 H),

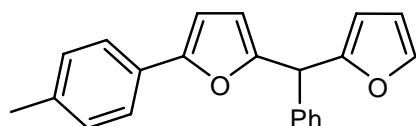
7.14-7.09(m, 3 H), 6.48-6.47(d, $J = 3.0$ Hz, 1 H), 6.24-6.22(t, $J = 3.0$ Hz, 1 H), 6.00-5.99(d, $J = 2.4$ Hz, 2 H), 5.38(s, 1H) ^{13}C NMR (75 MHz, CDCl_3) δ 153.7, 153.5, 153.3, 142.1, 137.9, 133.0, 130.7, 129.7, 128.7, 128.6, 127.2, 123.5, 110.3, 109.8, 107.7, 105.6, 44.5. IR (neat, cm^{-1}) 2926, 1594, 1543, 1488, 1017, 761. Anal. Calcd for $\text{C}_{21}\text{H}_{15}\text{ClO}_2$: C, 75.34; H, 4.52. Found: C, 75.39; H, 4.63.



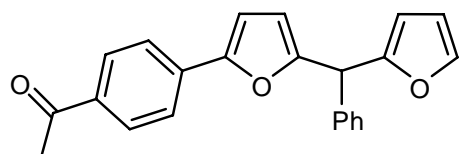
2-(1-(furan-2-yl)ethyl)-5-phenylfuran (4d): Compound **4d** was isolated in 50 % yield as an oil following the general procedure **A**. Reaction time: 20 min.; ^1H NMR (400 MHz, CDCl_3) δ 7.64-7.61(dd, $J = 7.6, 1.6$ Hz, 2H), 7.37-7.33(m, 3 H), 7.24-7.20 (m, 1 H), 6.57-6.56 (d, $J = 3.2$ Hz, 1 H), 6.32-6.30(dd, $J = 3.2, 2.0$ Hz, 2H), 6.12-6.09 (m, 2 H), 4.31-4.25 (q, $J = 7.2$ Hz, 1 H), 1.66-1.65 (d, $J = 7.2$ Hz, 3 H). ^{13}C NMR (100 MHz, CDCl_3) δ 156.4, 156.2, 152.7, 141.3, 131.1, 128.6, 127.0, 123.5, 110.1, 107.1, 105.6, 105.1, 33.3, 18.1. IR (neat, cm^{-1}) 2980, 2935, 1545, 1485, 1015, 760. Anal. Calcd for $\text{C}_{16}\text{H}_{14}\text{O}_2$: C, 80.65; H, 5.92. Found: C, 80.60; H, 4.88.



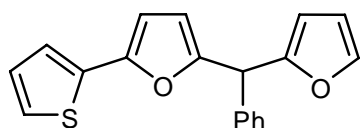
2-(furan-2-ylmethyl)-5-phenylfuran (4e): Compound **4e** was isolated in 43 % yield as an oil following the general procedure **A**. Reaction time: 20 min.; ^1H NMR (400 MHz, CDCl_3) δ 7.64-7.61(d, $J = 7.6$ Hz, 2 H), 7.36-7.33(t, $J = 7.6$ Hz, 3 H) 7.25-7.20 (m, 1 H), 6.57-6.56 (d, $J = 3.2$ Hz, 1 H), 6.31(s, 1 H), 6.16-6.13 (dd, $J = 8.0, 3.2$ Hz, 2H), 4.07(s, 2 H). ^{13}C NMR (100 MHz, CDCl_3) δ 153.1, 151.5, 151.3, 141.6, 131.0, 128.6, 127.0, 123.5, 110.4, 108.6, 106.6, 105.8, 28.4. IR (neat, cm^{-1}) 2924, 1597, 1459, 1017, 758. Anal. Calcd for $\text{C}_{16}\text{H}_{14}\text{O}_2$: C, 80.34; H, 5.39. Found: C, 80.50; H, 4.51.



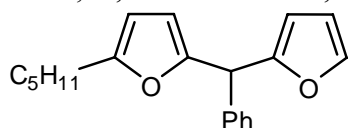
2-(furan-2-yl(phenyl)methyl)-5-p-tolylfuran (4f): Compound **4f** was isolated in 68 % yield as an oil following the general procedure **A**. Reaction time: 10 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.51-7.48(d, $J = 8.1$ Hz, 2 H), 7.36-7.35(d, $J = 1.2$ Hz, 1 H), 7.32-7.30 (m, 5 H), 7.14-7.12 (d, $J = 8.1$ Hz, 2 H), 6.51-6.50 (d, $J = 2.7$ Hz, 1 H), 6.32-6.30 (dd, $J = 3.0, 1.8$ Hz, 1 H), 6.08-6.06 (t, $J = 3.0$ Hz, 2 H), 5.50(s, 1 H), 2.32 (s, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ 154.4, 153.5, 153.5, 141.9, 139.5, 136.9, 129.2, 128.5, 128.4, 128.2, 127.1, 123.6, 110.2, 109.6, 107.6, 104.9, 45.1, 21.2. IR (neat, cm^{-1}) 3027, 2921, 1498, 1016, 730. Anal. Calcd for $\text{C}_{22}\text{H}_{18}\text{O}_2$: C, 84.05; H, 5.77. Found: C, 84.01; H, 5.70.



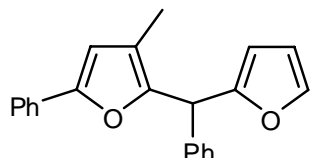
1-(4-(5-(furan-2-yl(phenyl)methyl)furan-2-yl)phenyl)ethanone (4g): Compound **4g** was isolated in 58 % yield as an oil following the general procedure **A**. Reaction time: 50 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.94-7.91(dd, $J = 9.0, 1.2$ Hz, 2 H), 7.68-7.64 (dd, $J = 8.7, 1.2$ Hz, 2 H), 7.38 (s, 1 H), 7.34-7.24 (m, 5 H), 6.73-6.72 (t, 1H), 6.34-6.33(dd, $J = 2.7, 1.8$ Hz, 1 H), 6.15-6.14 (d, $J = 3.0$ Hz, 1 H), 6.09-6.08 (t, 1H), 5.53 (s, 1 H), 2.57(s, 3 H). ^{13}C NMR (75 MHz, CDCl_3) δ 197.3, 155.4, 153.9, 152.2, 142.1, 139.1, 135.3, 134.8, 128.9, 128.6, 128.3, 127.3, 123.3, 110.3, 110.2, 108.3, 107.7, 45.2, 26.5. IR (neat, cm^{-1}) 2922, 1679, 1607, 1266, 1016, 731. Anal.Calcd for $\text{C}_{22}\text{H}_{18}\text{O}_2$: C, 80.68 ; H, 5.30. Found: C, 80.60; H, 5.22.



2-(furan-2-yl(phenyl)methyl)-5-(thiophen-2-yl)furan (4h): Compound **4h** was isolated in 60 % yield as an oil following the general procedure **A**. Reaction time: 10 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.36 (s, 1H), 7.33-7.23(m, 5 H), 7.18-7.15(m, 2 H), 7.00-6.97(m, 1 H), 6.42-6.41(d, $J = 3.6$ Hz, 1 H), 6.33-6.31 (dd, $J = 3.0, 1.8$ Hz, 1 H), 6.08-6.04(m, 2 H), 5.48 (s, 1 H). ^{13}C NMR (75 MHz, CDCl_3) δ 154.2, 153.6, 148.8, 142.0, 128.5, 128.4, 127.5, 127.2, 123.8, 122.4, 110.3, 109.7, 107.7, 105.8, 45.1. IR (neat, cm^{-1}) 3114, 1598, 1499, 1013, 730, 697. Anal.Calcd for $\text{C}_{14}\text{H}_{19}\text{O}_2\text{S}$: C, 74.48; H, 4.61. Found: C, 74.40; H, 4.55.

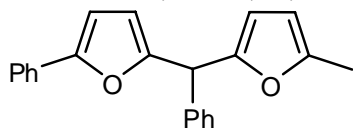


2-(furan-2-yl(phenyl)methyl)-5-pentylfuran (4i): Compound **4i** was isolated in 41 % yield as an oil following the general procedure **A**. Reaction time: 60 min.; ^1H NMR (400 MHz, CDCl_3) δ 7.34-7.23 (m, 6 H), 6.31-6.29(dd, $J = 2.8, 2.0$ Hz, 1 H), 6.01-6.00 (d, $J = 3.2$ Hz, 1 H), 5.89-5.86 (dd, $J = 8.4, 3.2$ Hz, 2 H), 5.39 (s, 1 H) 2.58-2.54(t, $J = 7.6$ Hz, 2 H), 1.68-1.61(m, 2 H), 1.48-1.32(m, 4 H), 0.95-0.91(t, $J = 7.2$ Hz, 3 H). ^{13}C NMR (100 MHz, CDCl_3) δ 156.1, 154.8, 152.2, 141.8, 139.8, 128.4, 128.4, 127.0, 110.2, 108.0, 107.4, 105.2, 45.1, 31.9, 29.7, 27.7, 22.7, 14.1. IR (neat, cm^{-1}) 2926, 1560, 1499, 1458, 1013, 800, 730. Anal.Calcd for $\text{C}_{20}\text{H}_{22}\text{O}_2$: C, 81.60; H, 7.53. Found: C, 81.70; H, 7.66.

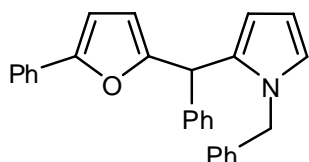


2-(furan-2-yl(phenyl)methyl)-3-methyl-5-phenylfuran (4j): Compound **4j** was isolated in 72 % yield as an oil following the general procedure **A**. Reaction time: 10 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.58-7.55(dd, $J = 8.1, 1.2$ Hz, 2 H), 7.35-7.17(m, 9 H), 6.46(s, 1 H), 6.31-6.29(dd, $J = 3.0, 1.8$ Hz, 1 H), 6.09-6.08(d, $J = 3.3$ Hz, 1 H), 5.50 (s, 1 H), 1.93(s, 3 H). ^{13}C NMR (75 MHz, CDCl_3) δ 154.5, 151.9, 148.2, 141.7, 139.7, 130.9, 128.5, 128.5, 128.3, 126.9, 126.9, 123.4, 117.9, 110.2, 108.7, 107.8,

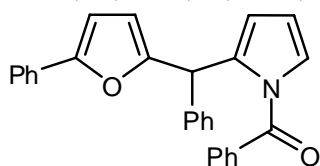
43.2, 9.8. IR (neat, cm^{-1}) 2924, 1601, 1489, 1450, 1175, 1011, 735. Anal.Calcd for $\text{C}_{22}\text{H}_{18}\text{O}_2$: C, 84.05; H, 5.77. Found: C, 84.00; H, 5.71.



2-methyl-5-(phenyl(5-phenylfuran-2-yl)methyl)furan (4aa): Compound **4aa** was isolated in 73 % yield as an oil following the general procedure **A**. Reaction time: 30 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.61-7.58 (dd, $J = 8.7, 1.5$ Hz, 2 H), 7.34-7.19(m, 8 H), 6.56-6.55(d, $J = 3.6$ Hz, 1 H), 6.08-6.07(d, $J = 3.6$ Hz, 1 H), 5.93-5.91(d, $J = 3.6$ Hz, 1 H), 5.89-5.88 (d, $J = 3.6$ Hz, 1 H), 5.45 (s, 1 H), 2.24 (s, 3 H). ^{13}C NMR (75 MHz, CDCl_3) δ 154.3, 153.2, 152.5, 151.5, 139.7, 130.9, 128.5, 128.5, 128.4, 127.0, 123.6, 109.6, 108.4, 106.1, 105.7, 45.2, 13.6. IR (neat, cm^{-1}) 3029, 1544, 1489, 1450, 1215, 1022, 760, 695. Anal.Calcd for $\text{C}_{22}\text{H}_{18}\text{O}_2$: C, 84.05; H, 5.77. Found: C, 83.97; H, 5.68.



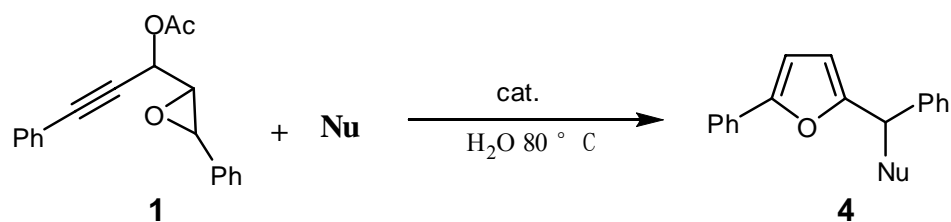
1-benzyl-2-(phenyl(5-phenylfuran-2-yl)methyl)-1H-pyrrole(4ab): Compound **4ab** was isolated in 81% yield as an oil following the general procedure **A**. Reaction time: 15 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.57-7.55(d, $J = 6.9$ Hz, 2 H), 7.33-7.12(m, 11 H), 6.95-6.93 (d, $J = 7.2$ Hz, 2 H), 6.65-6.64 (d, $J = 2.4$ Hz, 1 H), 6.52-6.51 (d, $J = 3.6$ Hz, 1 H), 6.14-6.12 (t, 1 H), 5.91-5.90 (d, $J = 3.6$ Hz, 1 H), 5.84-5.83 (d, $J = 1.8$ Hz, 1 H), 5.26 (s, 1 H), 4.90(s, 1 H), 4.88 (s, 1 H). ^{13}C NMR (75 MHz, CDCl_3) δ 155.3, 153.1, 140.4, 138.1, 132.4, 130.9, 128.7, 128.5, 128.4, 127.4, 127.0, 126.9, 126.4, 123.5, 122.0, 109.9, 109.4, 107.1, 105.6, 50.5, 43.3. IR (neat, cm^{-1}) 3029, 2925, 1711, 1543, 1489, 1450, 1293, 1074, 1022, 760, 714, 697. Anal.Calcd for $\text{C}_{28}\text{H}_{23}\text{NO}$: C, 86.34; H, 5.95; N, 3.60; Found: C, 86.22; H, 5.88; N, 3.48.



phenyl(2-(phenyl(5-phenylfuran-2-yl)methyl)-1H-pyrrol-1-yl)methanone(4ac): Compound **4ac** was isolated in 57 % yield as an oil following the general procedure **A**. Reaction time: 60 min.; ^1H NMR (300 MHz, CDCl_3) δ 7.61-7.58 (dd, $J = 7.2, 1.5$ Hz, 4 H), 7.50-7.16(m, 11 H), 6.82(s, 1 H), 6.54-6.52 (t, $J = 3.6$ Hz, 1 H), 6.38(s, 1 H), 6.12-6.11(d, $J = 3.6$ Hz, 1 H), 6.03 (s, 1 H), 5.96-5.95(t, $J = 2.7$ Hz, 1 H). ^{13}C NMR (75 MHz, CDCl_3) δ 169.1, 155.6, 153.0, 140.6, 136.4, 134.0, 132.3, 130.9, 129.7, 128.6, 128.5, 128.3, 128.2, 126.9, 126.8, 124.2, 123.5, 115.2, 110.2, 109.7, 105.6, 44.2. IR (neat, cm^{-1}) 3030, 1696, 1598, 1487, 1325, 1128, 1023, 876, 696. Anal.Calcd for $\text{C}_{28}\text{H}_{21}\text{NO}_2$: C, 83.35; H, 5.25; N, 3.47; Found: C, 83.30; H, 5.22; N, 3.41.

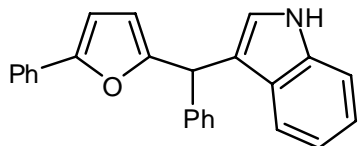
General procedure B: Gold (III)-catalyzed reaction of 1-oxiranyl-2-alkynyl ester 1 with nucleophiles in water at 80 °C for

synthesis of 4ad-4af.

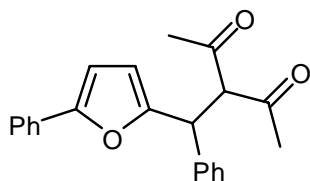


Nu: 1H-indole, pentane-2,4-dione, NaN₃

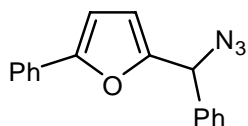
To a solution of esters of 1-oxiranyl-2-alkyn-1-ols **1a** (0.50 mmol), **0.60** mmol of nucleophiles (1.2 equivs) in water (0.8 mL) was added 10.00 mg (0.01 mmol, 5 mol %) of HAuCl₄·4H₂O at 80°C. When the reaction was considered complete as determined by TLC analysis, the reaction mixture was diluted with ethyl ether (40 mL), washed with water, saturated brine, dried over Na₂SO₄ and evaporated under reduced pressure. The residue was purified by chromatography on silica gel to afford corresponding furan derivatives **4**.



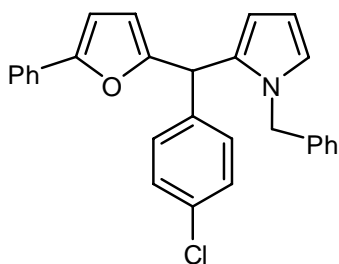
3-(phenyl(5-phenylfuran-2-yl)methyl)-1H-indole(4ad): Compound **4ad** was isolated in 51 % yield as an oil following the general procedure **B**. Reaction time: 10h.; ¹H NMR (300 MHz, CDCl₃) δ 7.85 (s, 1 H), 7.60-7.58 (d, *J* = 7.8 Hz, 2 H), 7.40-7.37 (d, *J* = 8.1 Hz, 1 H), 7.34-7.12 (m, 10 H), 7.04-6.99(t, *J* = 7.5 Hz, 1 H), 6.77-6.76 (d, *J* = 2.1 Hz, 1 H), 6.56-6.54 (d, *J* = 3.3 Hz, 1 H), 6.02-6.01(d, *J* = 3.0 Hz, 1 H), 5.71(s, 1 H). ¹³C NMR (75 MHz, CDCl₃) δ 156.6, 152.9, 141.8, 136.5, 131.1, 128.6, 128.5, 128.4, 126.9, 126.7, 126.6, 123.5, 123.3, 122.1, 119.6, 119.5, 117.4, 111.1, 109.6, 105.7, 42.8. IR (neat, cm⁻¹) 3422, 1739, 1453, 1021, 740. Anal.Calcd for C₂₅H₁₉NO: C, 85.93; H, 5.48; N, 4.01; Found: C, 85.88; H, 5.39; N, 3.97.



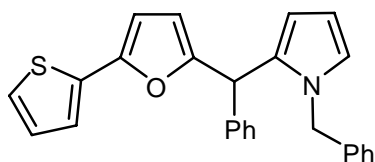
3-(phenyl(5-phenylfuran-2-yl)methyl)pentane-2,4-dione(4ae): Compound **4ae** was isolated in 38 % yield as a solid following the general procedure **B**, along with 20 % **6a** was isolated. Reaction time: 8h. mp = 97-99 °C; ¹H NMR (300 MHz, CDCl₃) δ 7.58-7.55 (d, *J* = 7.5 Hz, 2 H), 7.38-7.20 (m, 8 H), 6.51-6.49 (d, *J* = 3.6 Hz, 1 H), 6.08-6.07 (d, *J* = 3.6 Hz, 1 H), 4.94-4.90 (d, *J* = 12.3 Hz, 1 H), 4.69-4.65 (d, *J* = 11.7 Hz, 1 H), 2.21(s, 3 H), 1.96(s, 3 H). ¹³C NMR (75 MHz, CDCl₃) δ 202.1, 202.0, 153.8, 153.4, 138.6, 130.6, 128.9, 128.7, 128.3, 127.5, 127.3, 123.5, 109.1, 105.8, 73.4, 45.2, 30.1, 29.1. IR (neat, cm⁻¹) 2921, 1732, 1700, 1356, 1022, 761, 697. Anal.Calcd for C₂₂H₂₀O₃: C, 79.50; H, 6.06; Found: C, 79.45; H, 5.98.



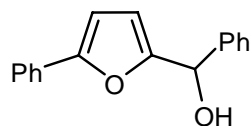
2-(azido(phenyl)methyl)-5-phenylfuran (4af): Compound **4af** was isolated in 46 % yield as an oil following the general procedure **B**. Reaction time: 8h.; ^1H NMR (300 MHz, CDCl_3) δ 7.57-7.55(d, $J = 7.5$ Hz, 2 H), 7.50-7.47(d, $J = 6.9$ Hz, 1 H), 7.34-7.29(m, 5 H), 7.20-7.14(m, 2 H), 6.51-6.50 (d, $J = 3.3$ Hz, 1 H), 6.16-6.15(d, $J = 3.0$ Hz, 1 H), 5.62(s, 1 H). ^{13}C NMR (75 MHz, CDCl_3) δ 154.6, 151.7, 136.7, 130.4, 128.7, 128.5, 127.7, 127.4, 125.3, 123.9, 111.0, 105.5, 62.3 IR (neat, cm^{-1}) 3062, 2096, 1600, 1487, 1451, 1238, 1024, 761, 696. Anal.Calcd for $\text{C}_{17}\text{H}_{13}\text{N}_3\text{O}$: C, 74.17; H, 4.76; N, 15.26; Found: C, 74.03; H,4.66; N,15.11.



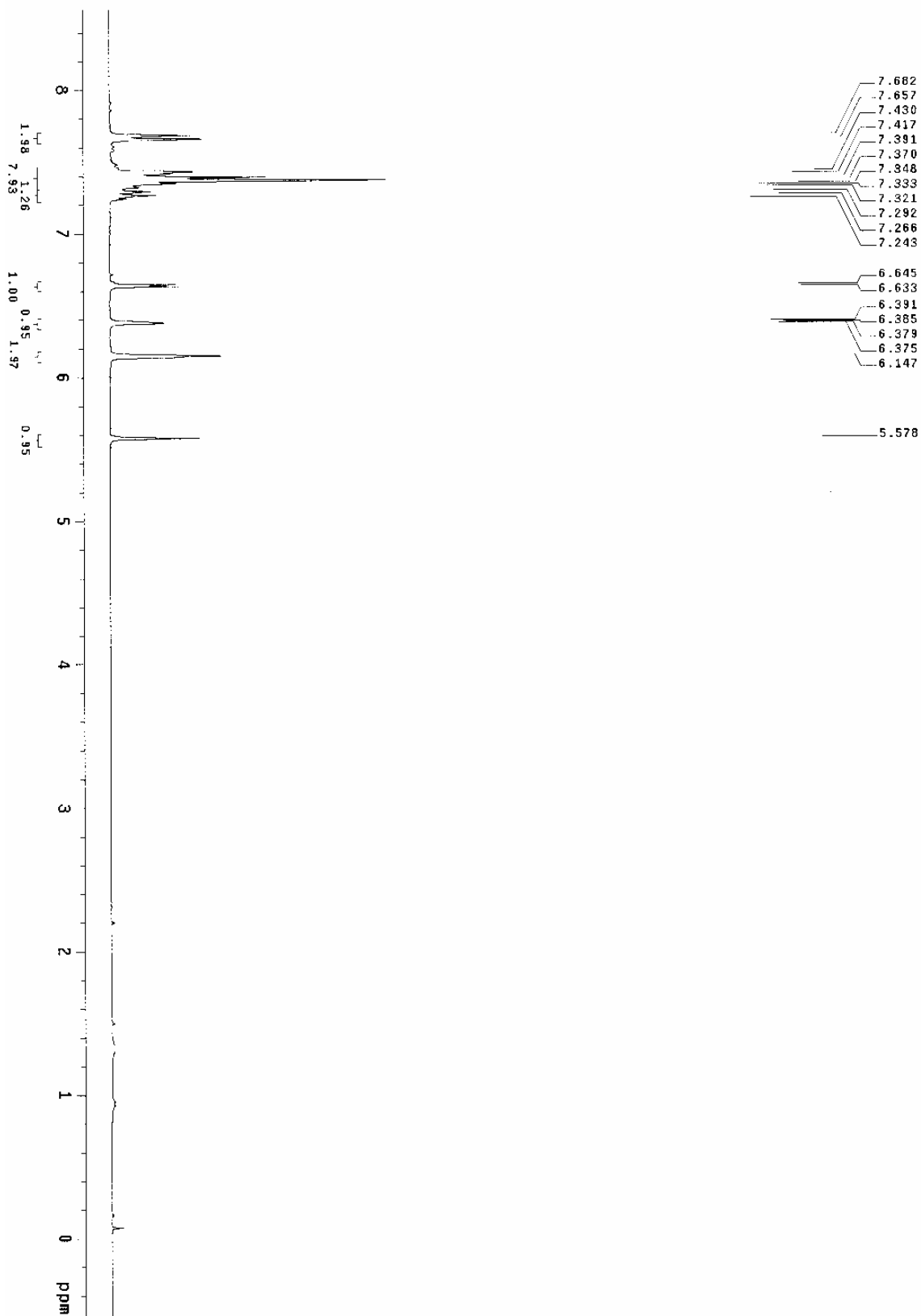
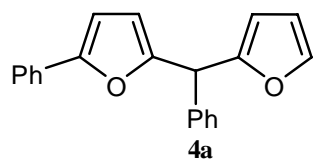
1-benzyl-2-((4-chlorophenyl)(5-phenylfuran-2-yl)methyl)-1H-pyrrole (4ag): Compound **4ag** was isolated in 79% yield as an oil following the general procedure **A**. ^1H NMR (300 MHz, CDCl_3) δ 7.49-7.46 (d, $J = 7.5$ Hz, 2 H), 7.23-7.09 (m, 9 H), 6.97-6.94 (d, $J = 8.4$ Hz, 2 H), 6.86-6.84 (d, $J = 6.3$ Hz, 1 H), 6.59(s, 1 H), 6.44-6.32 (d, $J = 3.6$ Hz, 1 H), 6.05-6.04 (d, $J = 2.7$ Hz, 1 H), 5.83-5.81 (d, $J = 4.2$ Hz, 1 H), 5.74-5.73 (t, $J = 1.8$ Hz, 1 H), 5.14 (s, 1 H), 4.83 (s, 1 H), 4.81 (s, 1 H). ^{13}C NMR (75 MHz, CDCl_3) δ 154.7, 153.3, 139.0, 138.0, 132.7, 131.9, 130.8, 129.8, 128.7, 128.6, 127.5, 127.1, 126.5, 126.3, 123.5, 122.3, 110.0, 109.6, 107.2, 105.6, 50.6, 42.7. IR (neat, cm^{-1}) 2923, 1489, 1451, 1292, 1019, 760, 714. Anal.Calcd for $\text{C}_{28}\text{H}_{22}\text{ClNO}$: C, 79.33; H, 5.23; N, 3.30; Found: C, 79.10; H,5.12; N, 3.18.

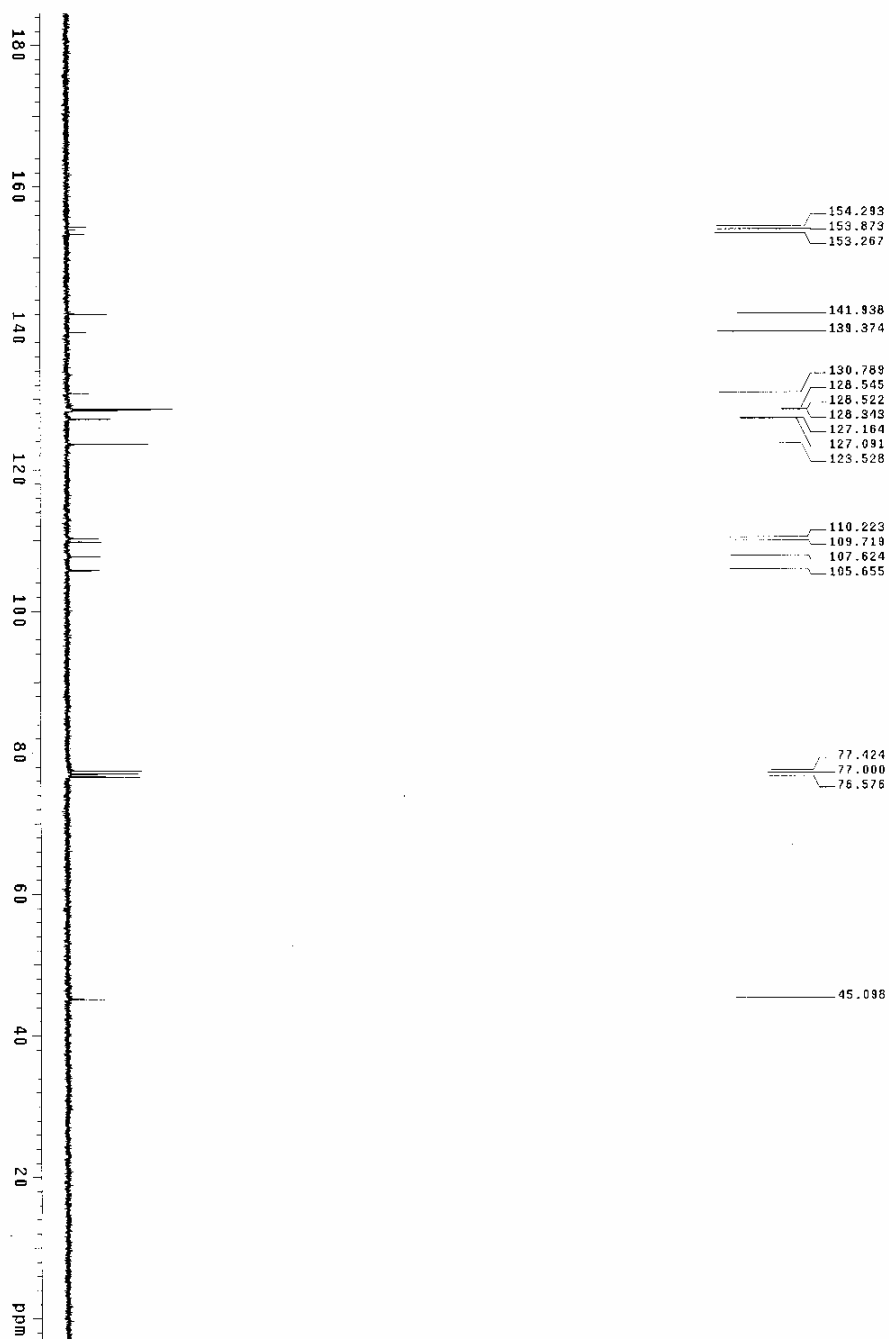
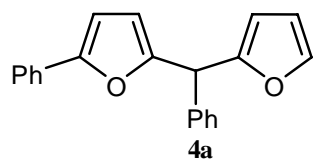


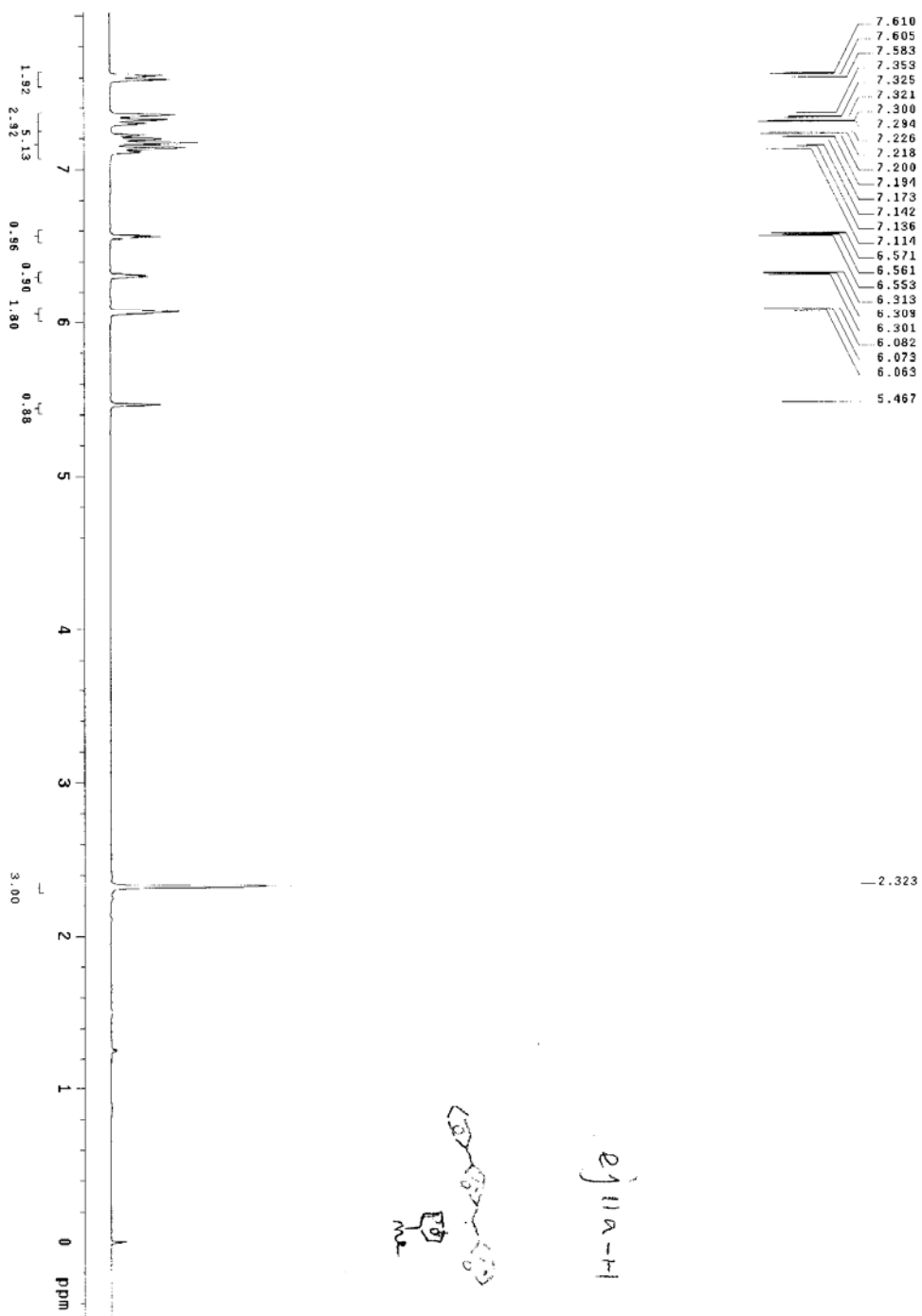
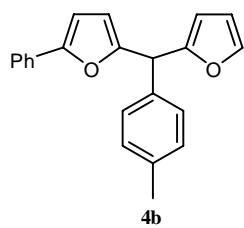
1-benzyl-2-(phenyl(5-(thiophen-2-yl)furan-2-yl)methyl)-1H-pyrrole(4ah): Compound **4ah** was isolated in 63 % yield as an oil following the general procedure **A**. ^1H NMR (300 MHz, CDCl_3) δ 7.29-7.11 (m, 11 H), 6.97-6.93 (m, 2 H), 6.64(d, $J = 2.4$ Hz, 1 H), 6.36-6.35 (d, $J = 3.0$ Hz, 1 H), 6.12-6.11 (d, $J = 3.0$ Hz, 1 H), 5.87-5.86 (d, $J = 3.0$ Hz, 1 H), 5.83-5.82 (d, $J = 1.8$ Hz, 1 H), 5.23 (s, 1 H), 4.90 (s, 1 H), 4.89(s, 1 H). ^{13}C NMR (75 MHz, CDCl_3) δ 155.0, 148.6, 140.3, 138.1, 135.6, 133.9, 132.3, 128.7, 128.5, 128.4, 127.4, 127.2, 126.9, 126.5, 123.7, 122.2, 109.8, 109.4, 107.1, 105.7, 50.5, 43.2. IR (neat, cm^{-1}) 3028, 2924, 1493, 1451, 1298, 1074, 1015, 782, 699. Anal.Calcd for $\text{C}_{26}\text{H}_{21}\text{NOS}$: C, 78.95; H, 5.35; N, 3.54; Found: C, 78.99; H, 5.19; N, 3.38.

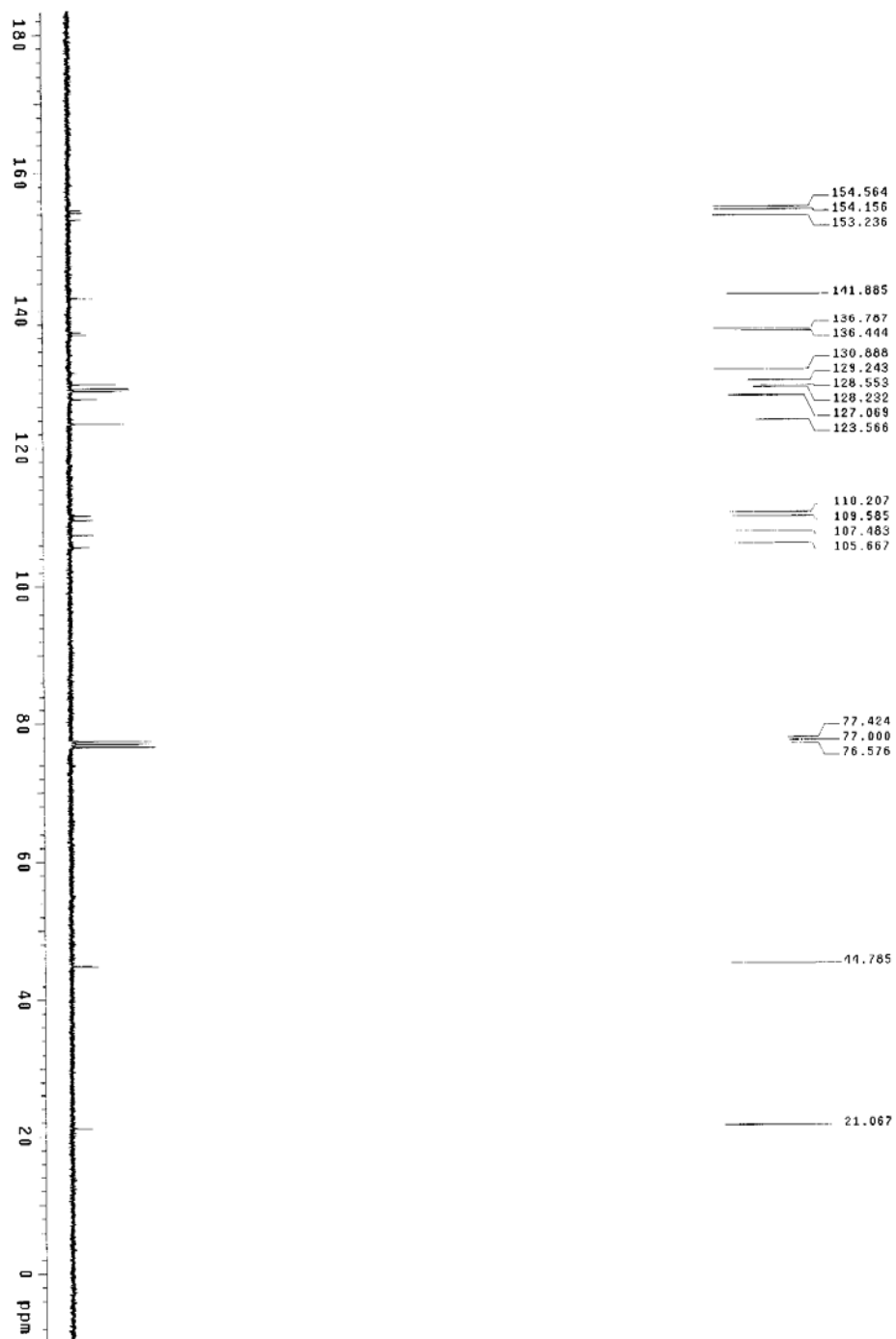
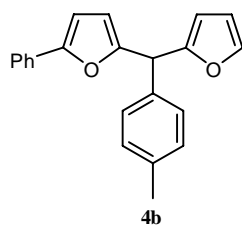


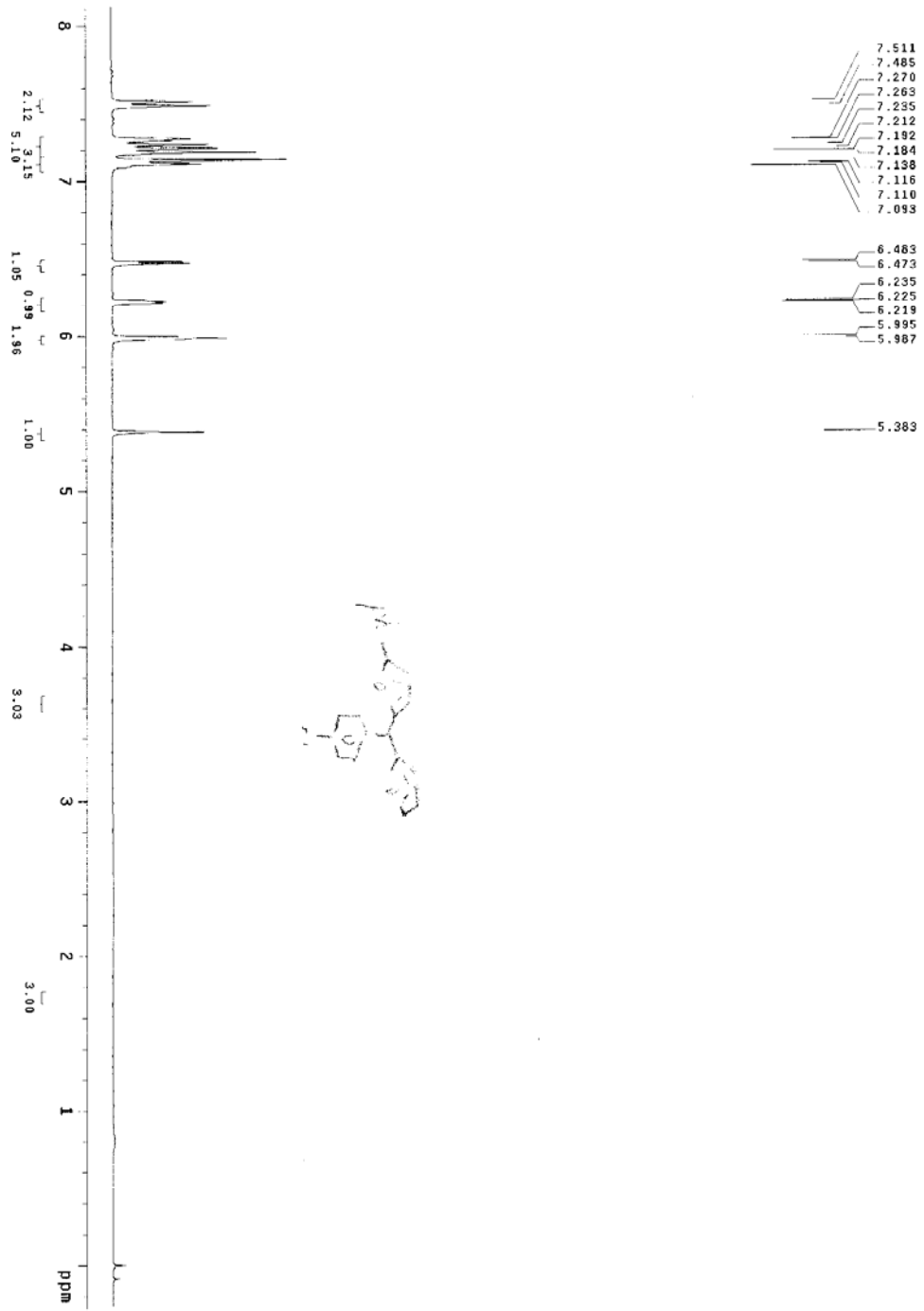
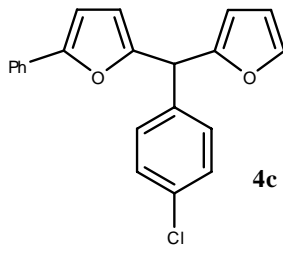
phenyl(5-phenylfuran-2-yl)methanol (3a): ^1H NMR (300 MHz, CDCl_3) δ 7.63-7.61 (d, $J = 7.8$ Hz, 2H), 7.47-7.45 (d, $J = 7.2$ Hz, 2 H), 7.38-7.20 (m, 6 H), 6.55-6.54 (d, $J = 3.6$ Hz, 1 H), 6.15-6.14 (d, $J = 3.0$ Hz, 1 H), 5.84 (s), 2.64 (s); ^{13}C NMR(75 MHz, CDCl_3) δ 155.4, 153.9, 140.7, 130.6, 128.6, 128.4, 128.0, 127.4, 126.6, 123.7, 109.6, 105.5, 70.2. IR (neat, cm^{-1}) 2924, 1457, 1187, 1018, 689. Anal.Calcd for $\text{C}_{17}\text{H}_{14}\text{O}_2$: C, 81.58; H, 5.64. Found: C, 81.62; H, 5.67.

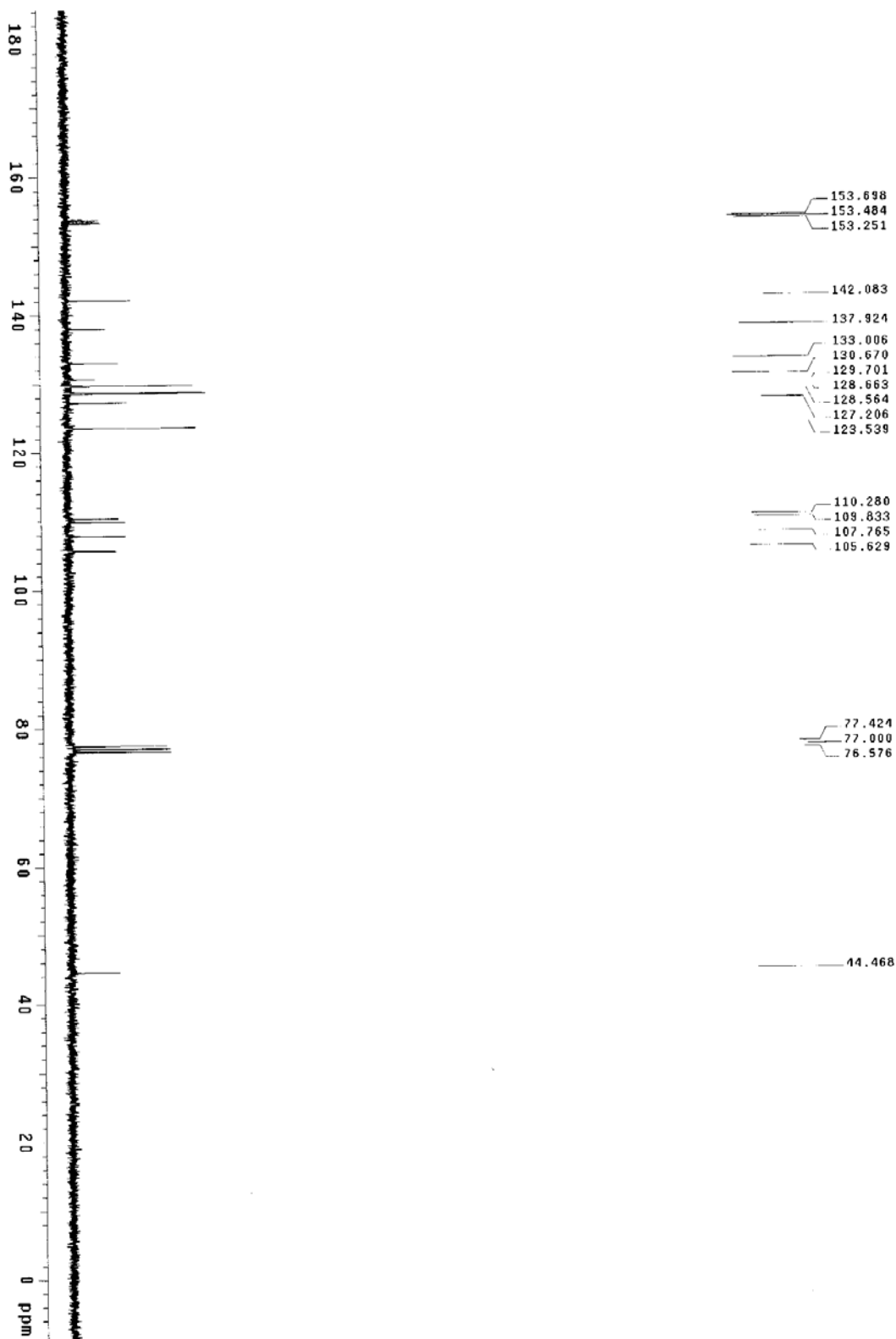
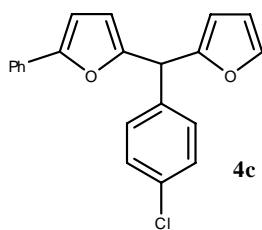


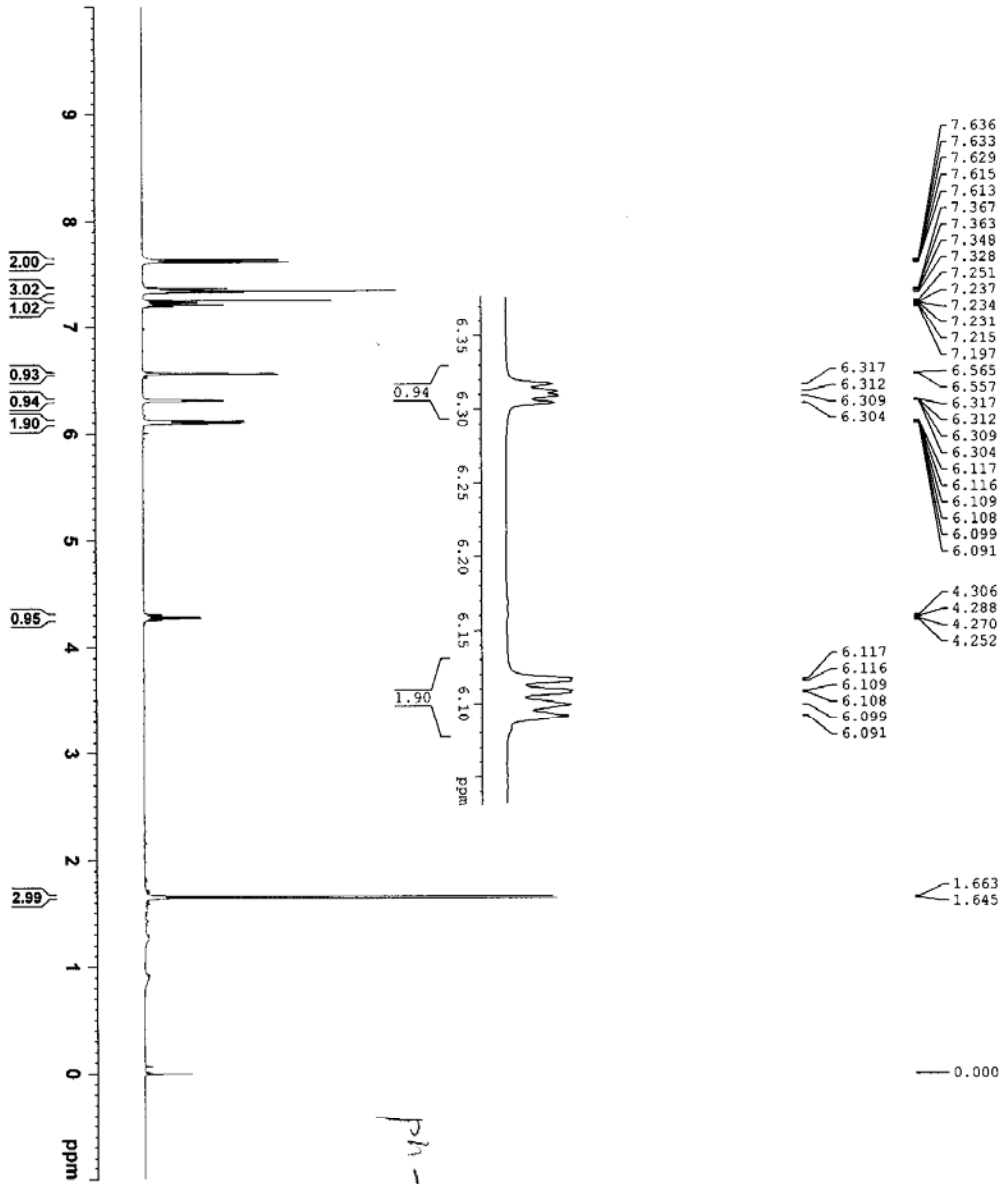
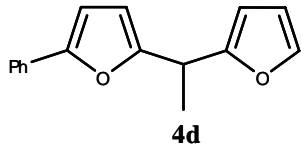








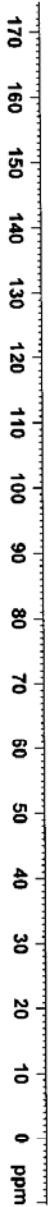
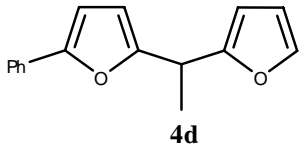




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DS           2
SWH          8223.685 Hz
FIDRES       0.125483 Hz
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RG           327
WDW          EM
SSB          0
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PL1          0 dB
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SFO1         400.1300088 MHz
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 PROCNO: 1
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 AQ: 1.361398 sec
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 RW: 20.800 usec
 DC: 6.50 usec
 TE: 297.4 K
 D1: 2.0000000 sec
 D11: 0.0300000 sec
 TD0: 1

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 PL1: 0.00 dB
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 SFO1: 100.6228298 MHz

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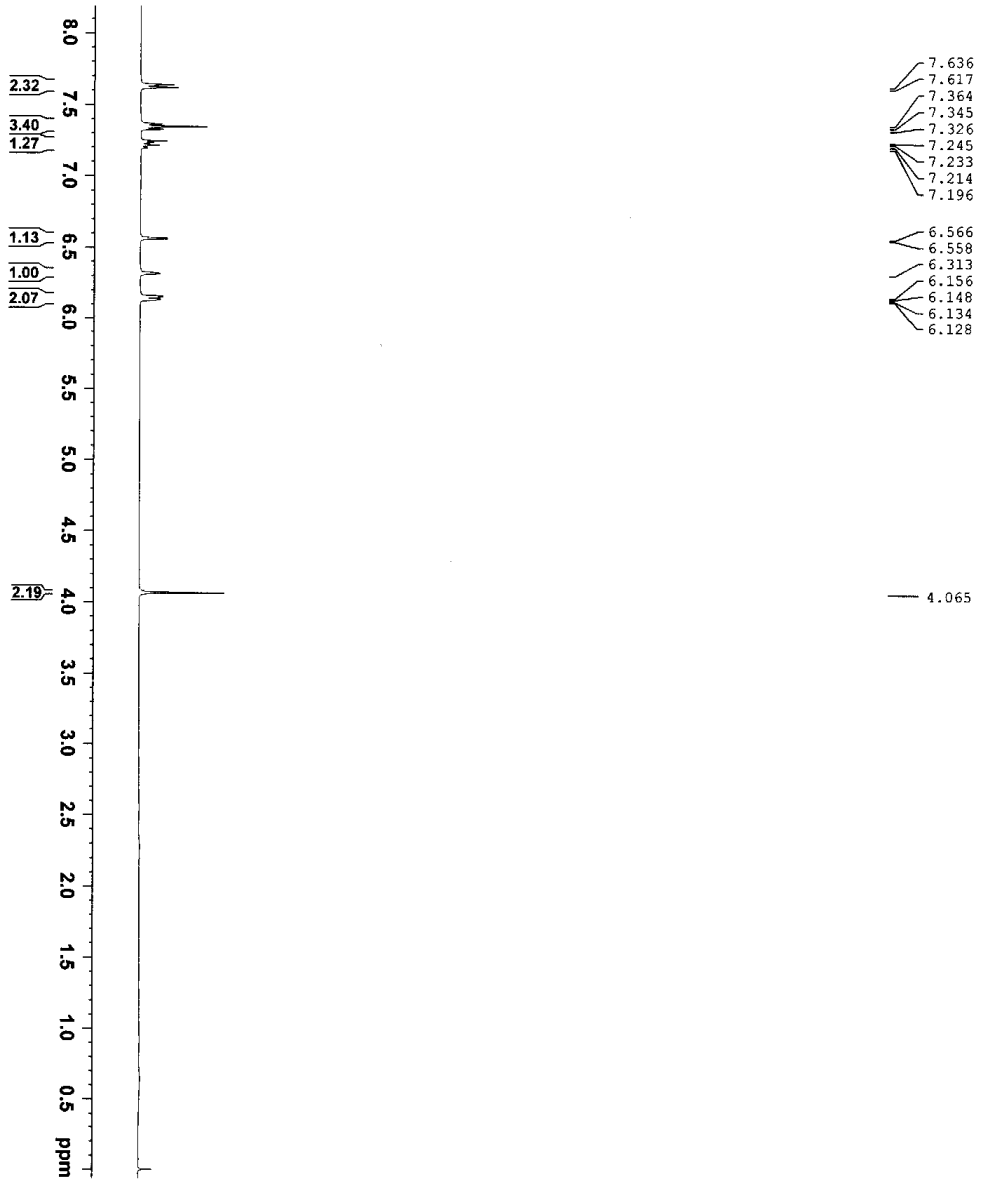
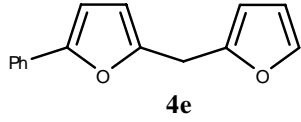
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 PL4: 0.00 dB
 F4F4: 57.32143073 MHz
 SFO4: 100.6228298 MHz

jikg10a-c

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- 156.22
- 152.68
- 141.32
- 131.05
- 128.57
- 126.97
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- 33.28
- 18.07

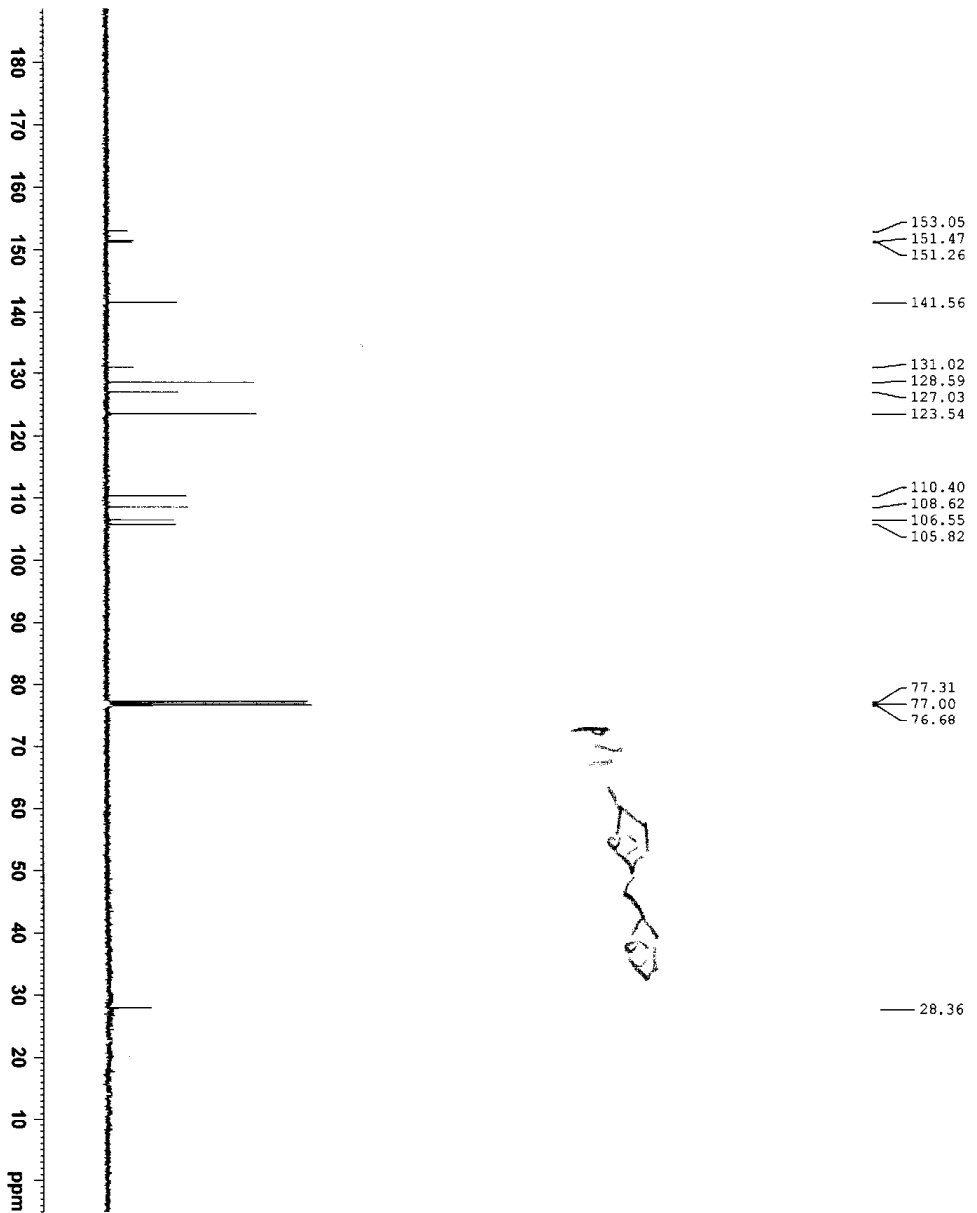
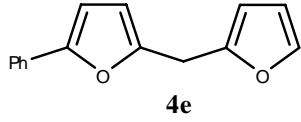
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PROCNO        1
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Time         17.05
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RG           45.2
RM           60.800 usec
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TE           297.9 K
DE           1.00000000 sec
D1           1
TDO          1

===== CHANNEL f1 =====
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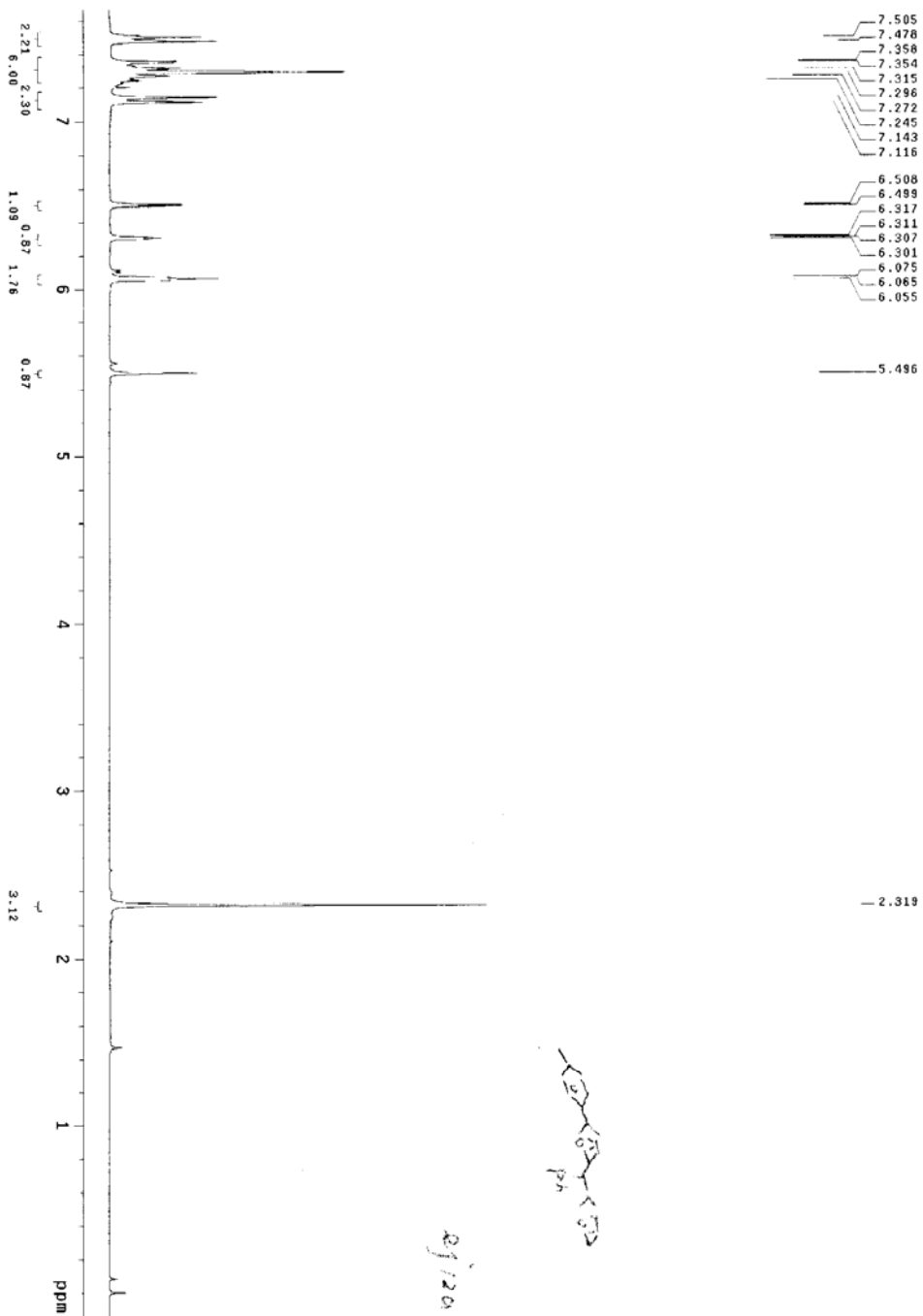
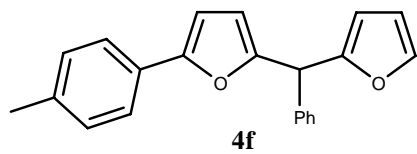
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76.68

28.36

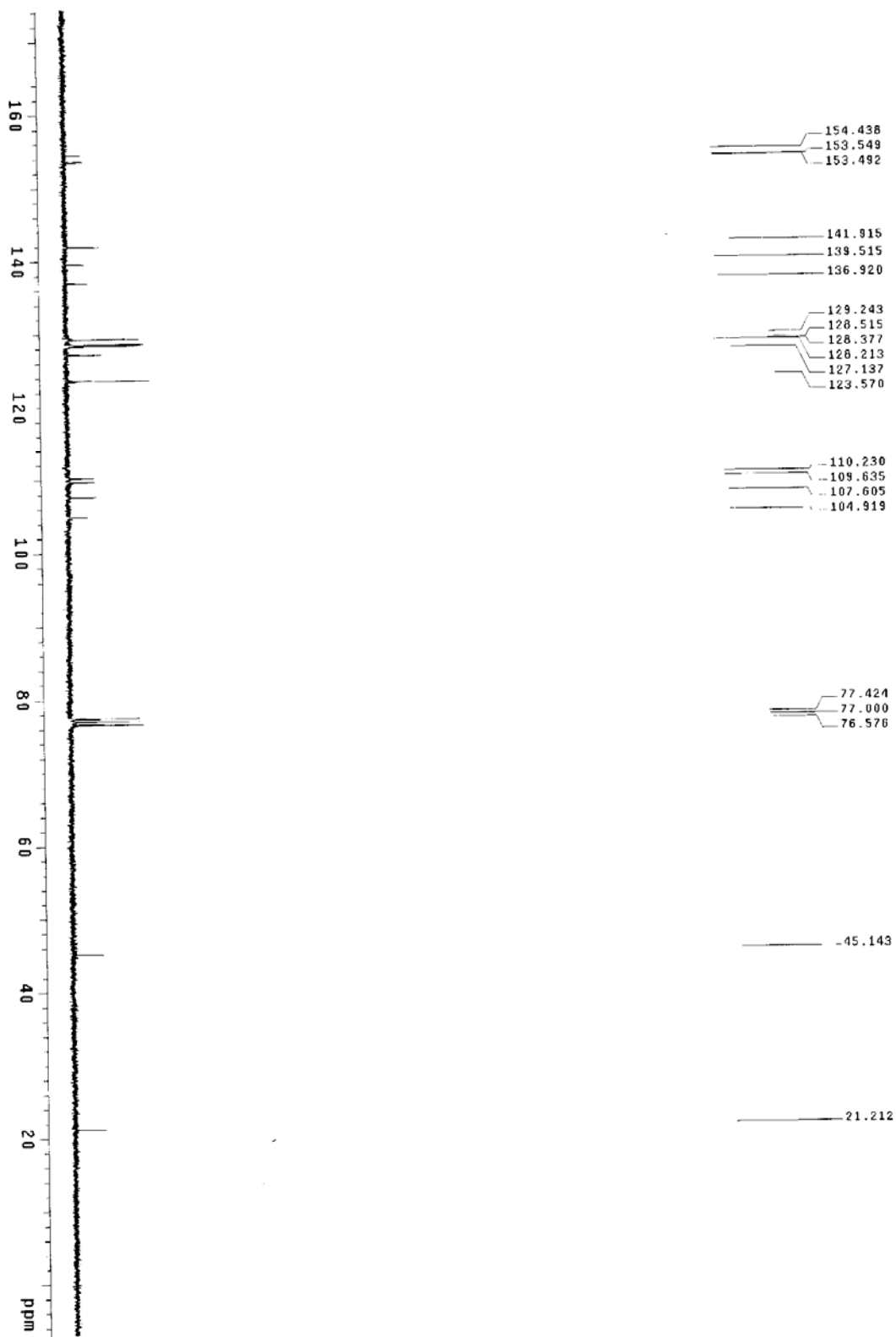
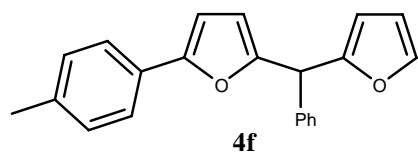
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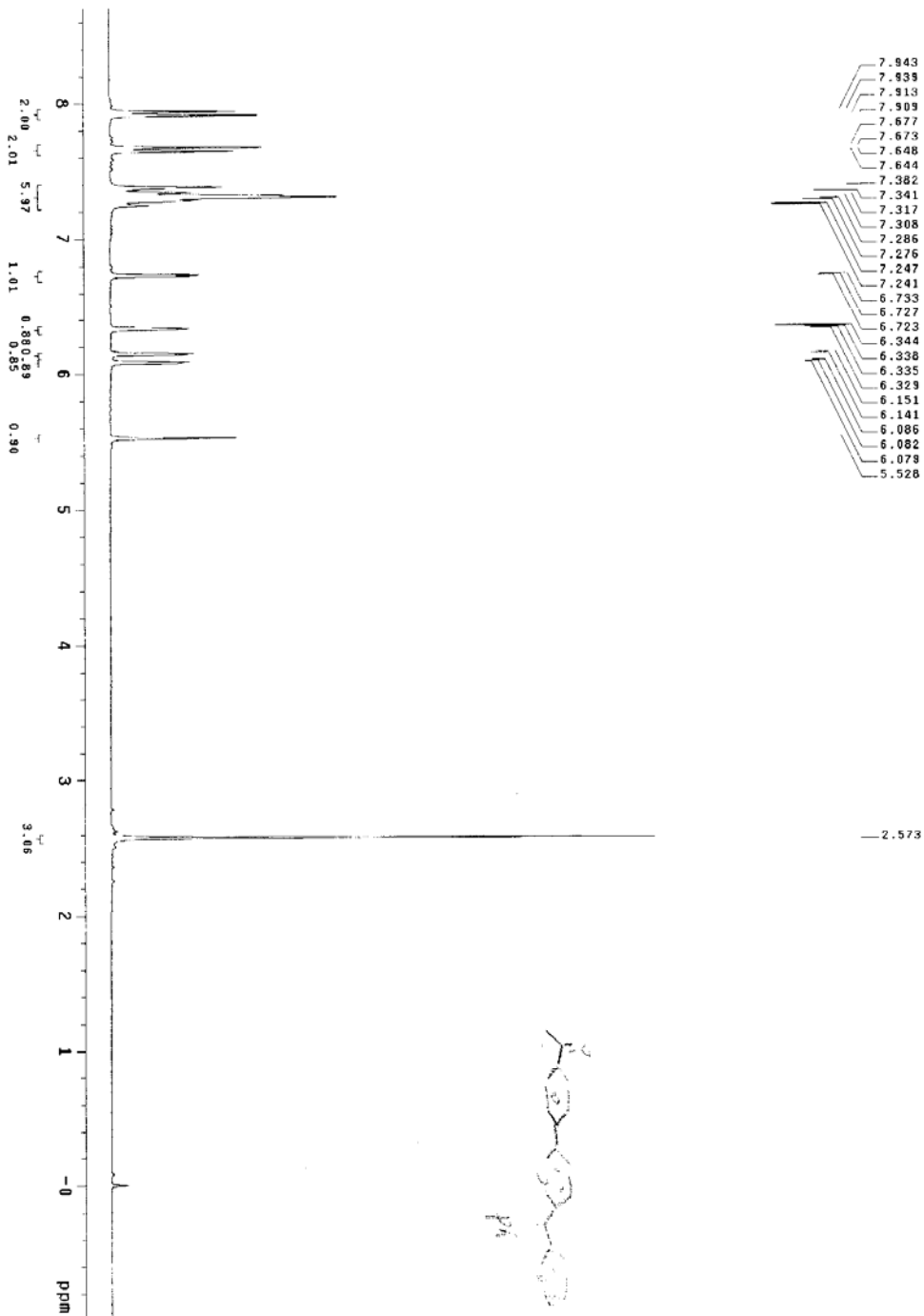
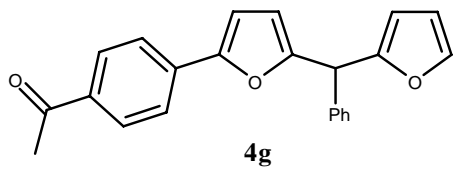
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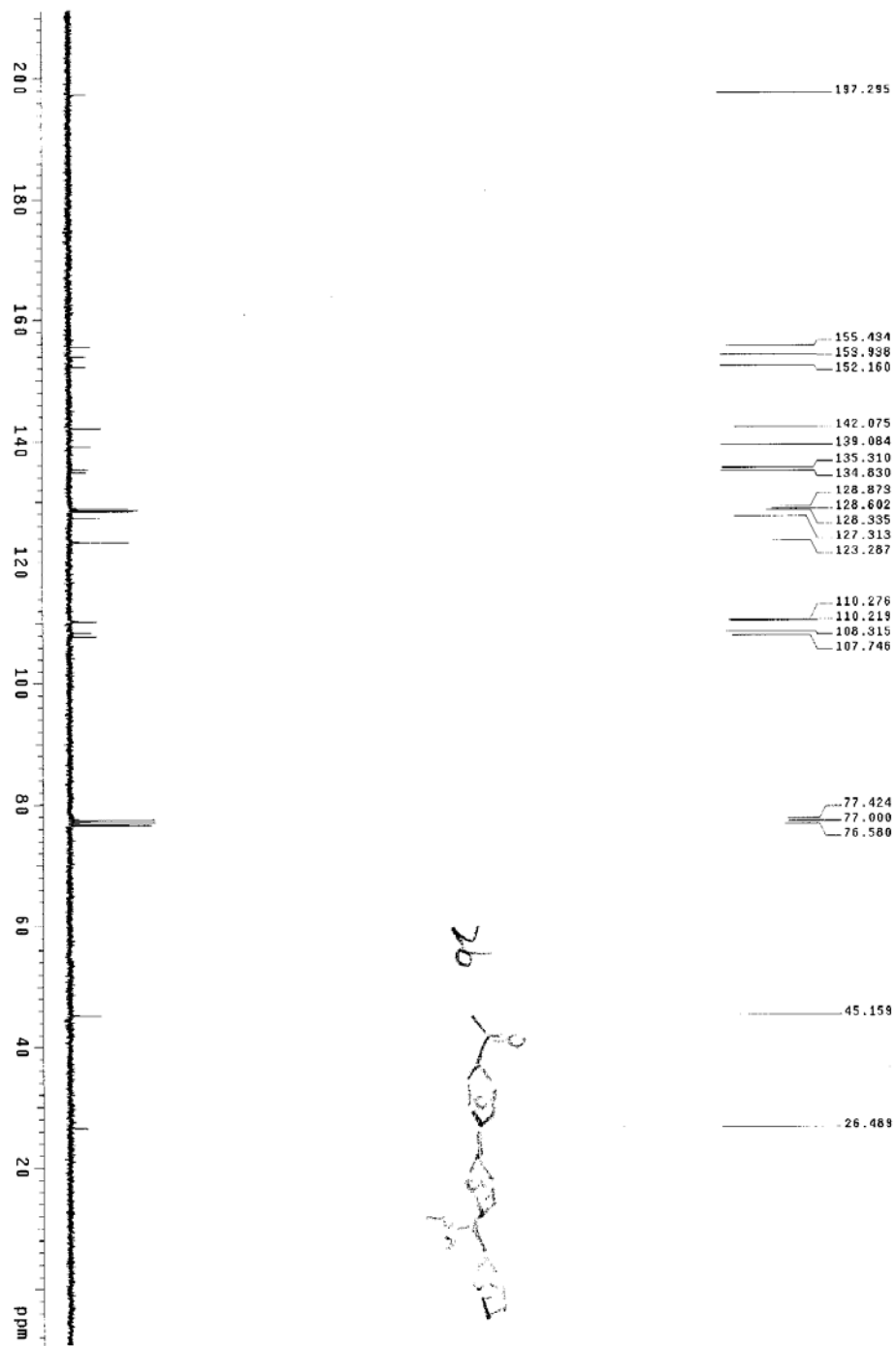
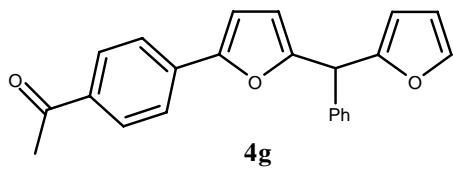
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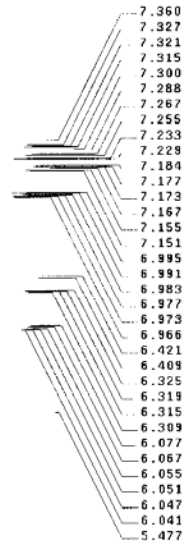
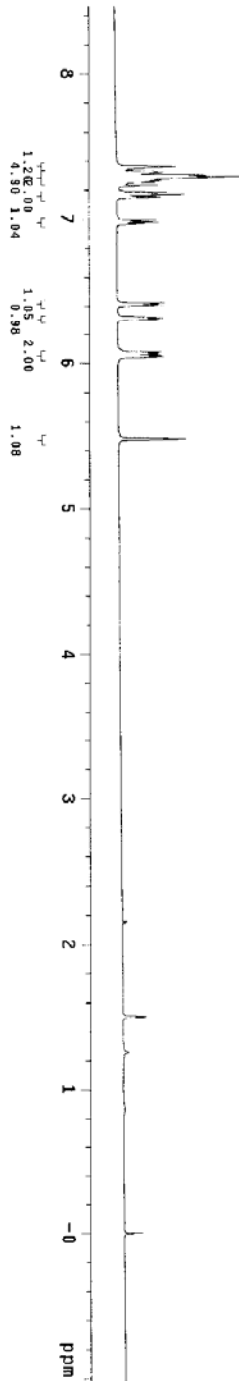
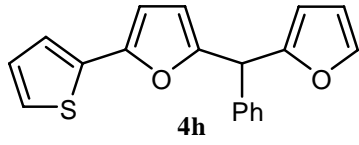


20120-14

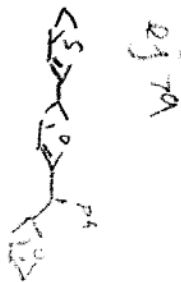
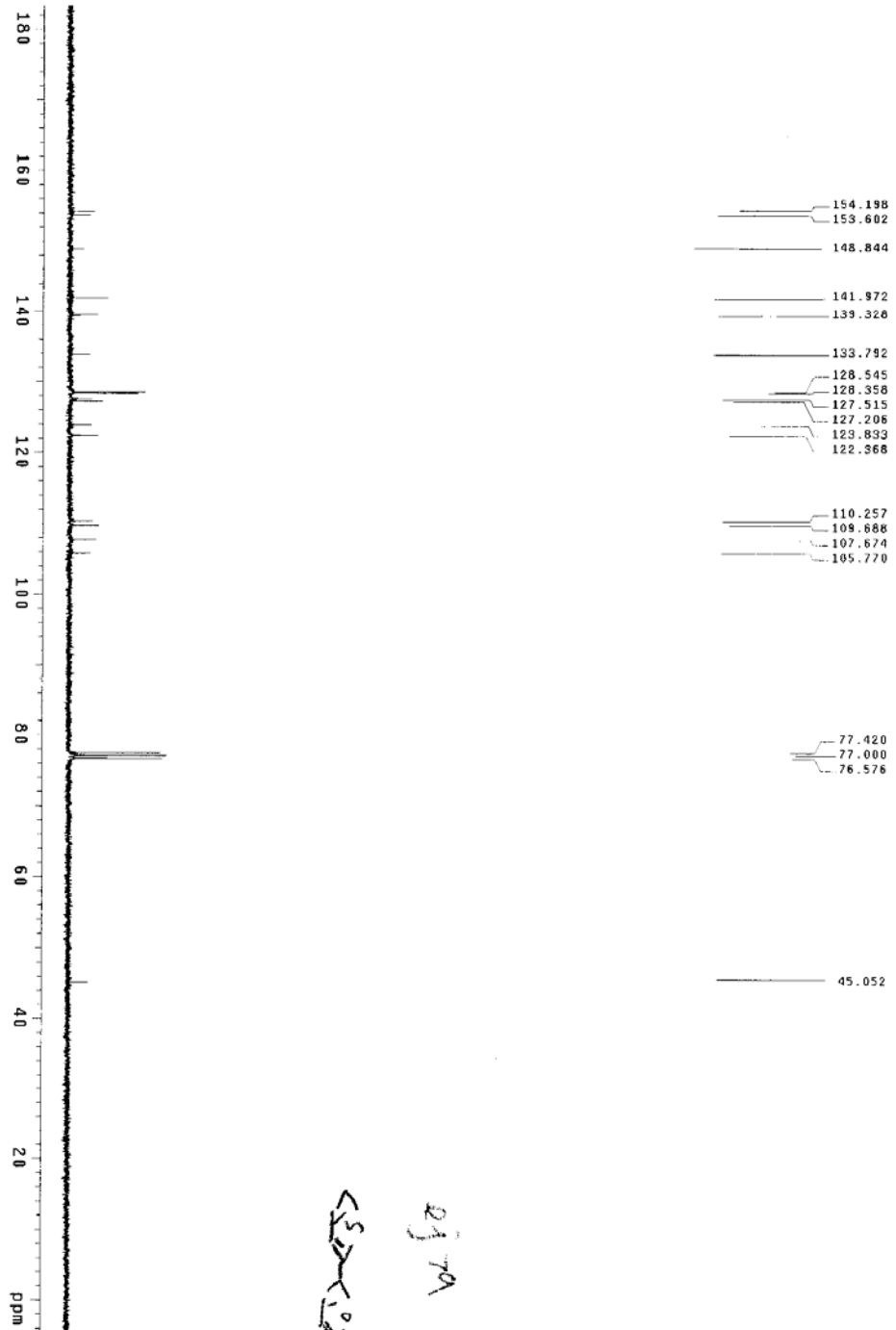
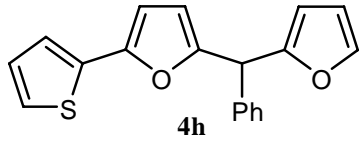


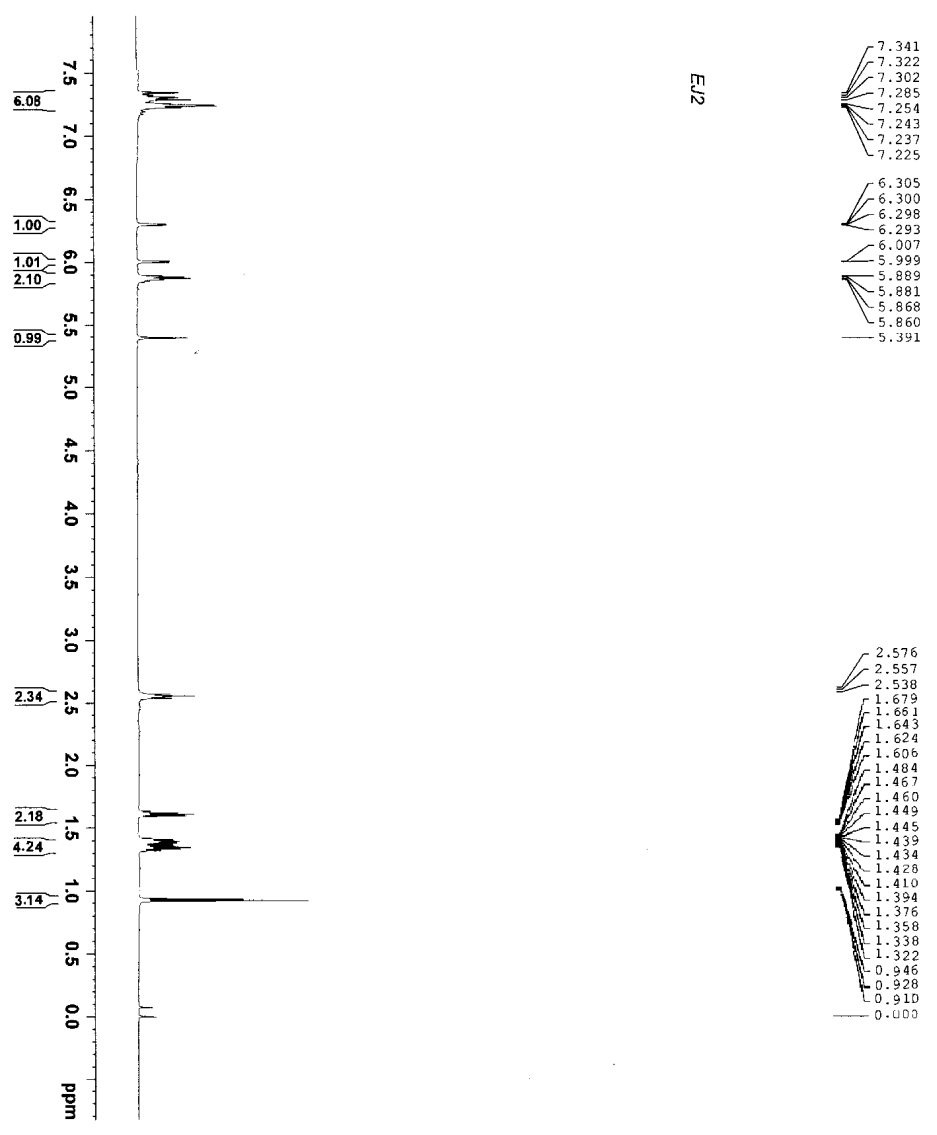
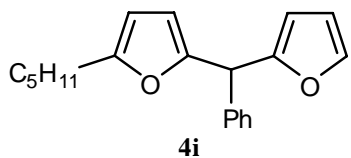






of 70

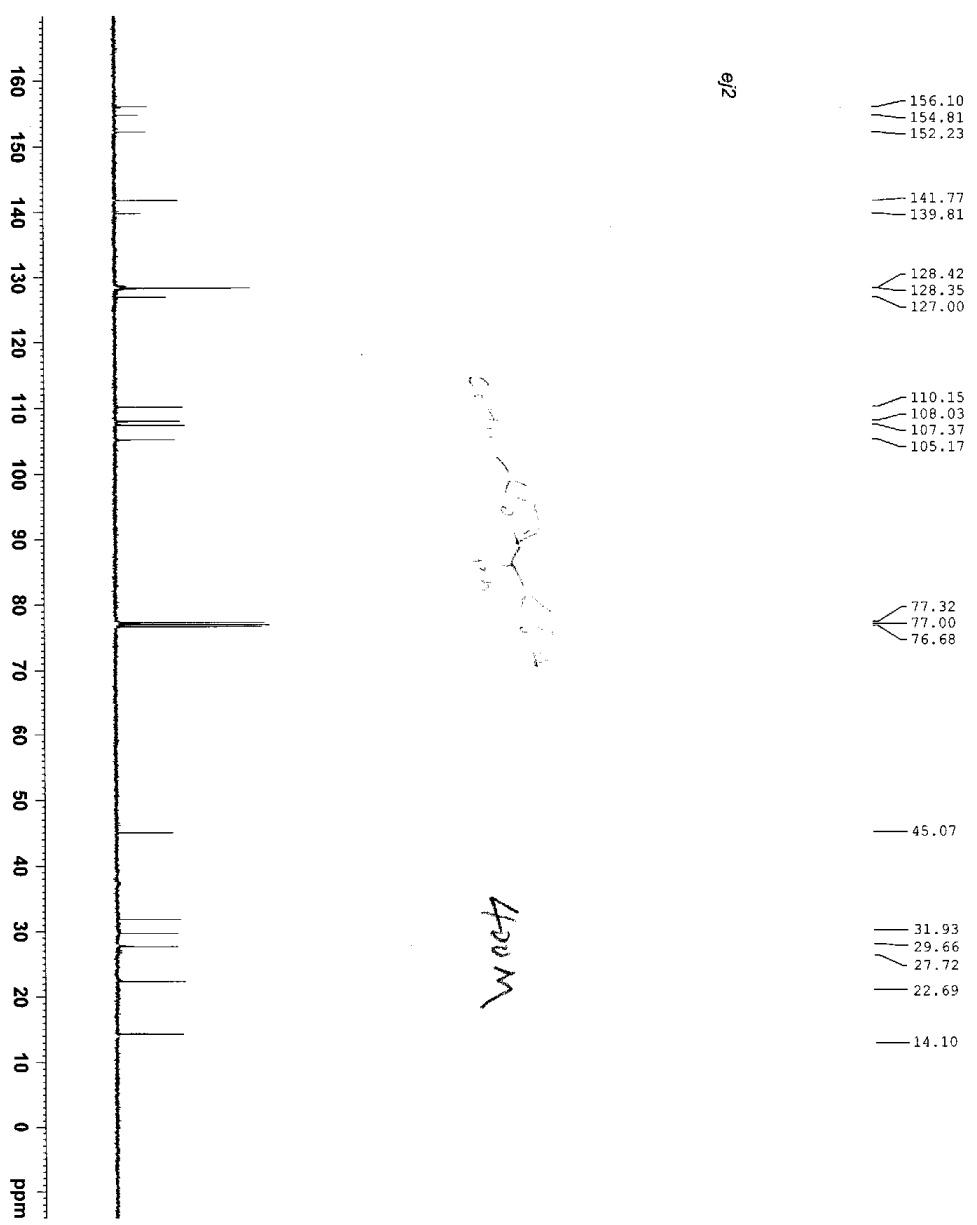
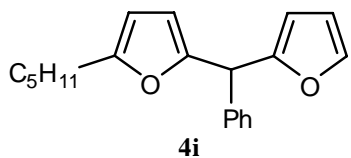




EJ2

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PROCNO                              1
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PCPDPRG                               cpc13
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ETDRES                               0.120483 Hz
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RG2                                    1.0
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TE                                     296.3 K
D1                                     1.00000000 sec
D10                                    1
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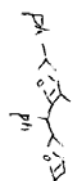
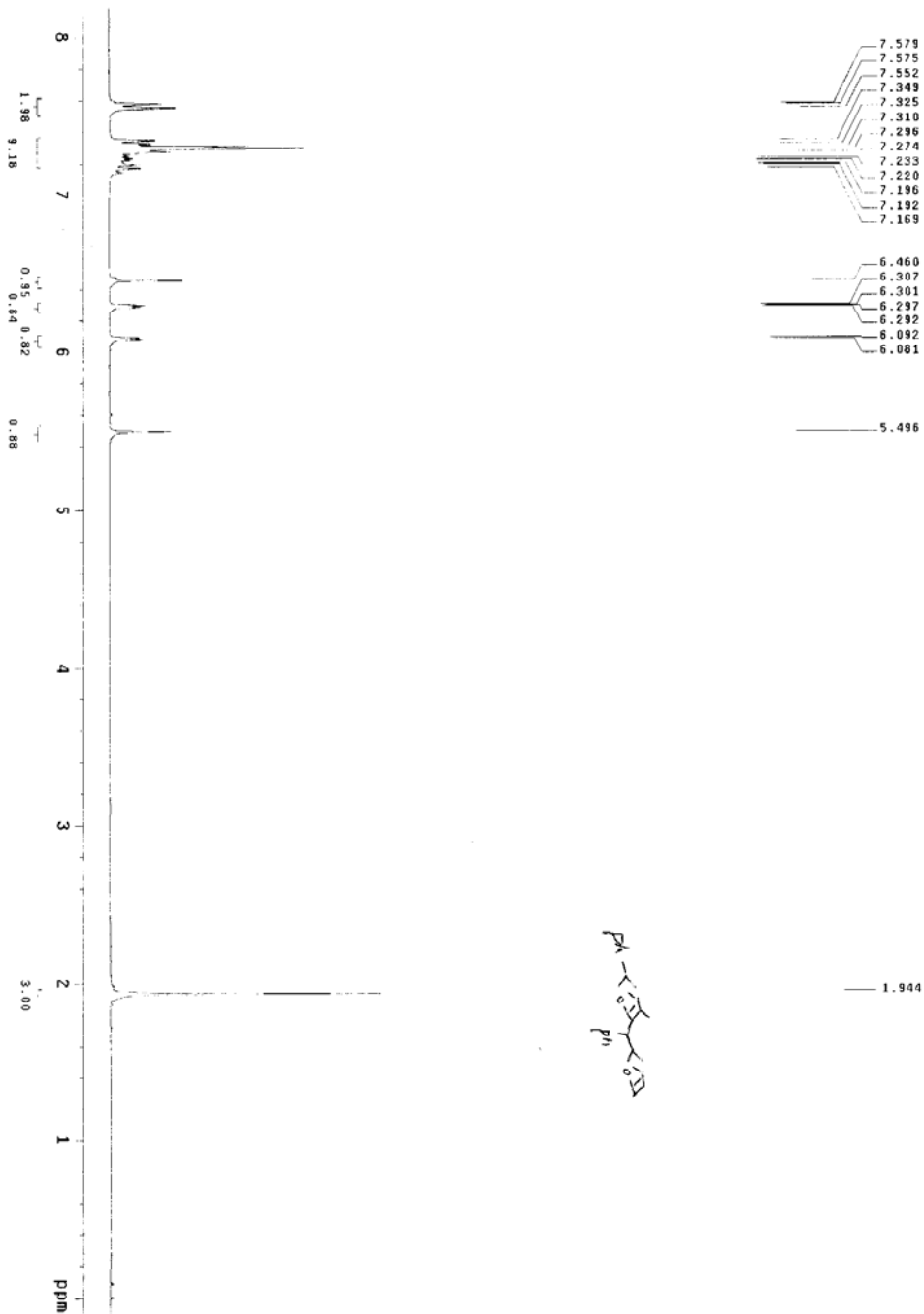
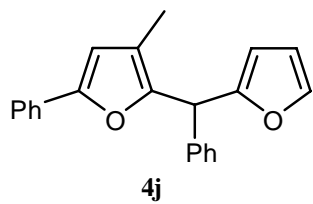
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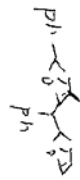
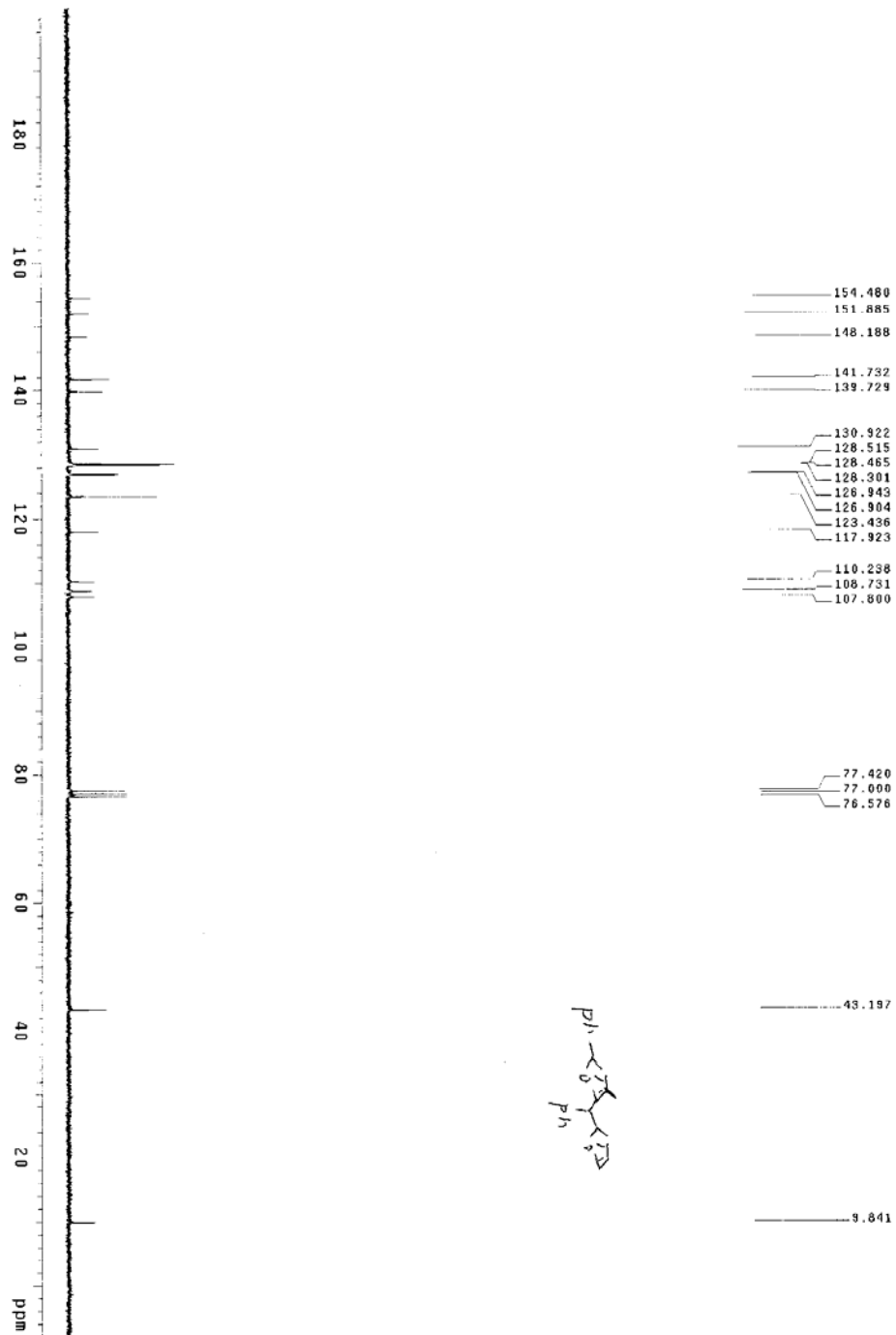
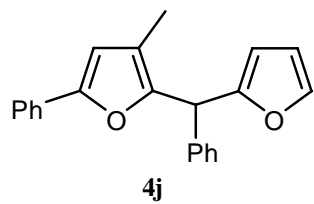
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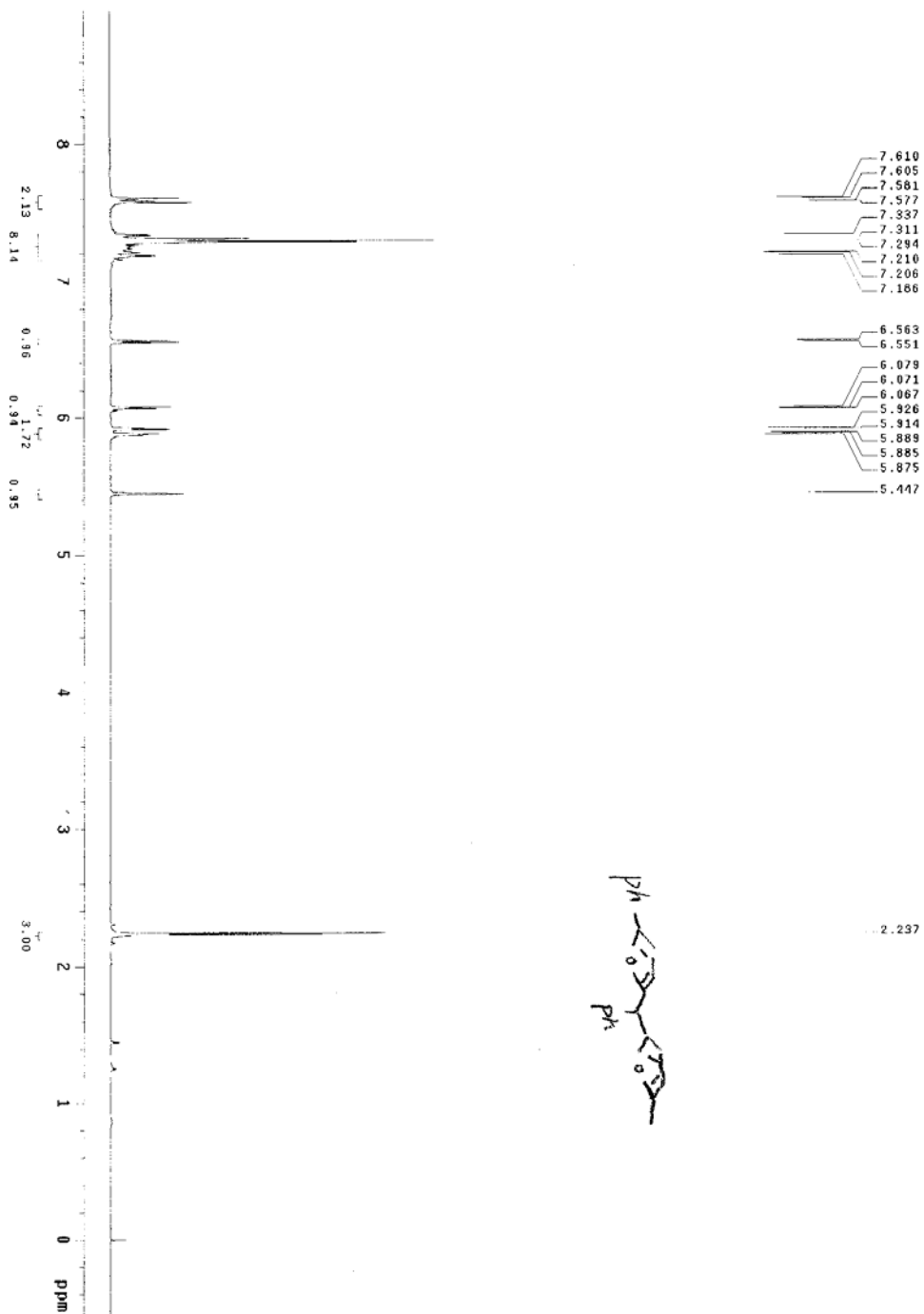
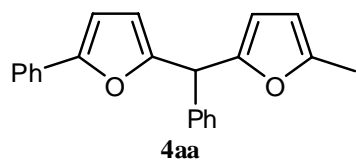
NAME          e12
EXPNO        11
PROCNO       20080618
Time         16:02
INSTRUM      5 mm PASPO HR-
PROBHD       QNP1H
PULPROG      zgpg30
TD           65536
SOLVENT      CDCl3
NS           150
DS           4
SFO          243.8444 Hz
AQ          0.366798 Hz
RG           1.361988 sec
NO          2050
SI           25.800 usec
SF           201.25 usec
DE           2.13 usec
TE           2.00000000 sec
D:1          0.03000000 sec
TDC          1

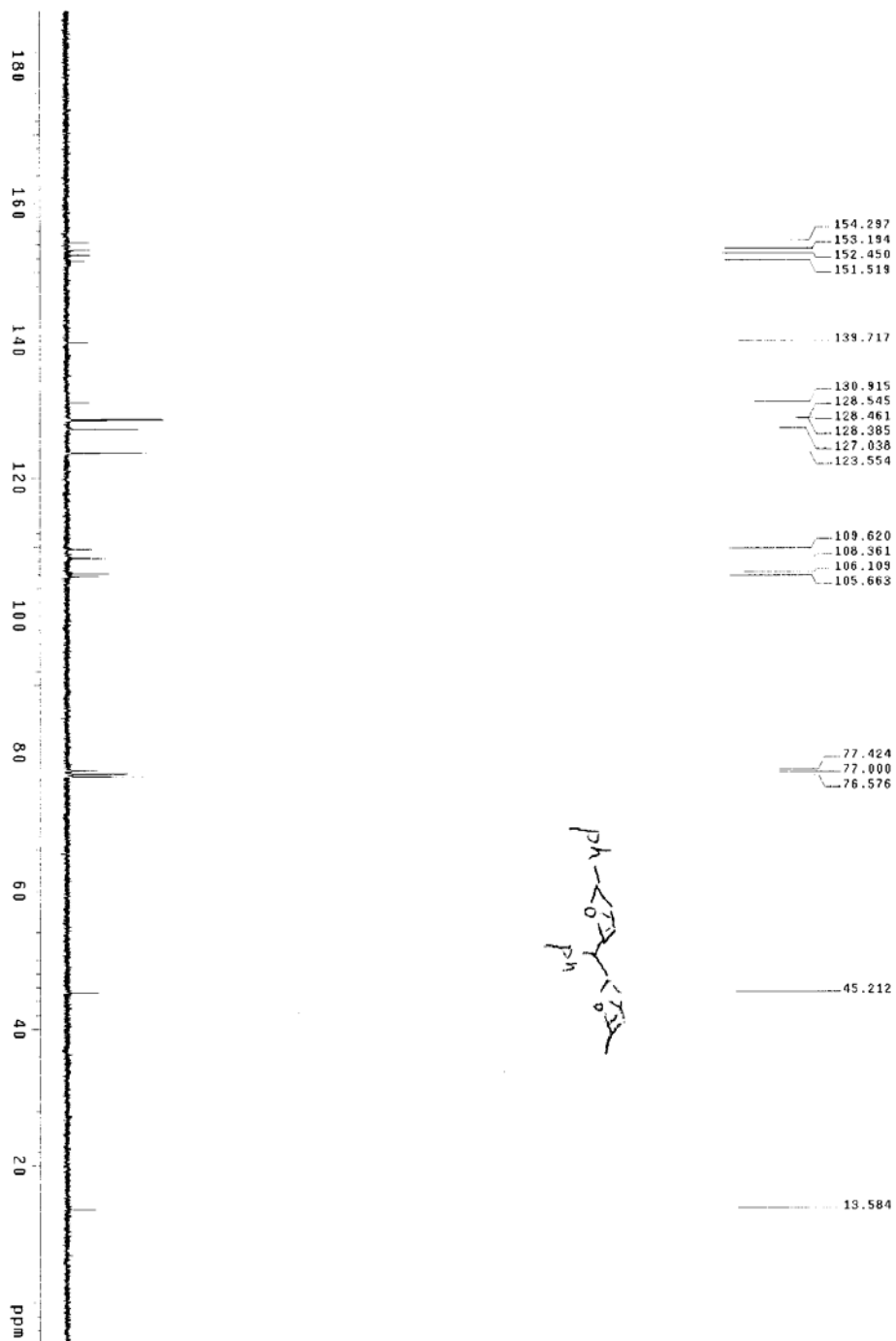
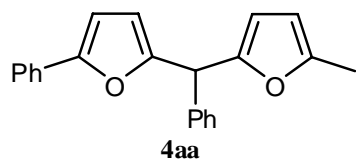
===== CHANNEL f1 =====
NUC1         13C
P1           9.40 usec
PL1         -2.00 dB
RF1M        57.32743973 MHz
SFO1        100.628358 MHz

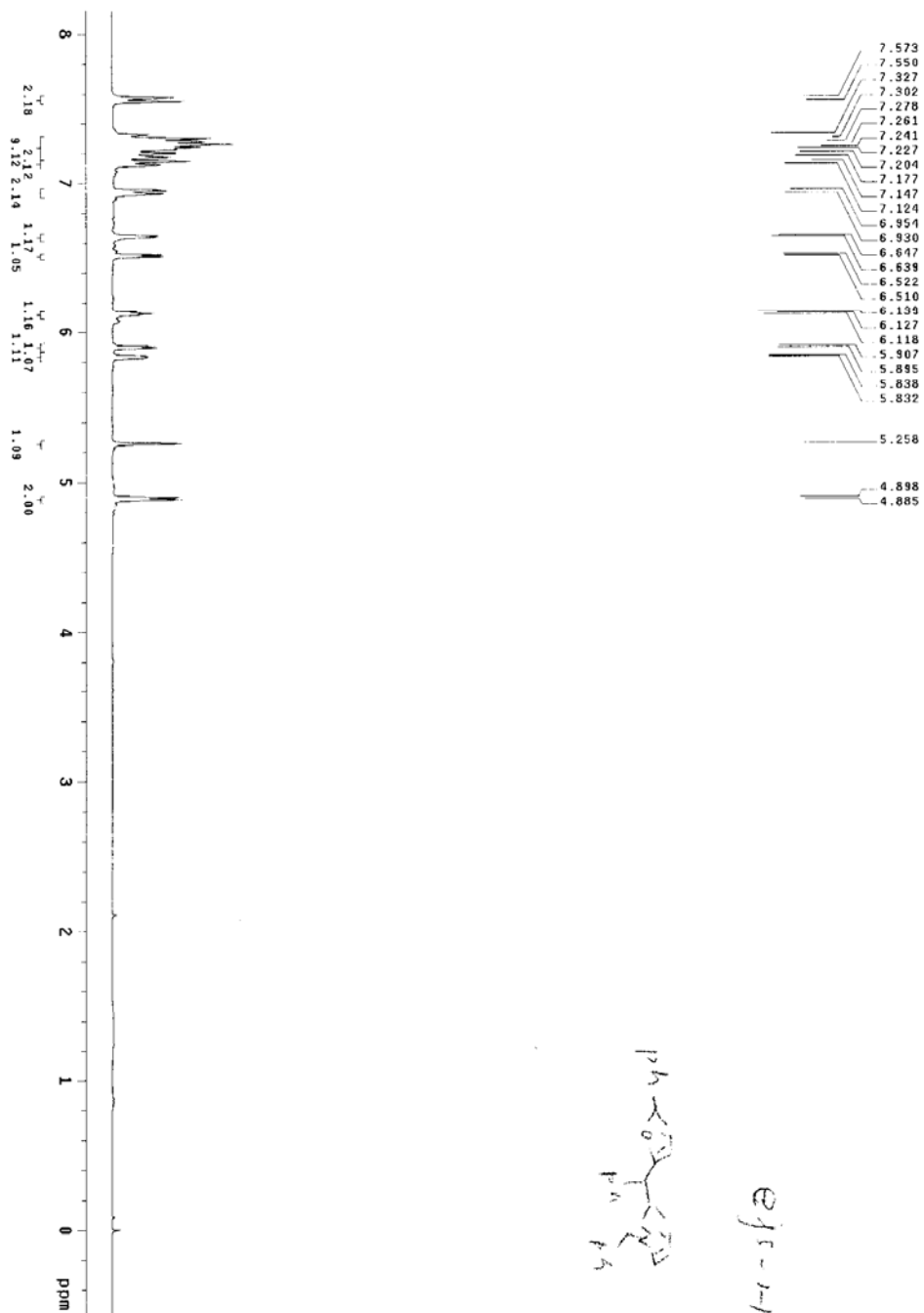
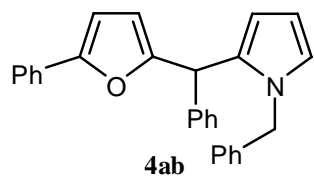
===== CHANNEL f2 =====
NAME         wait216
NUC2         1H
P2           90.18 usec
PL2         -2.00 dB
RF2M        400.1316005 MHz
SFO2        400.1316005 MHz
SI           32768
SF           100.6127700 MHz
DS           4
SFO         201.25 usec
TE           2.00 usec
D:1         0.03000000 sec
PC           1.40
  
```

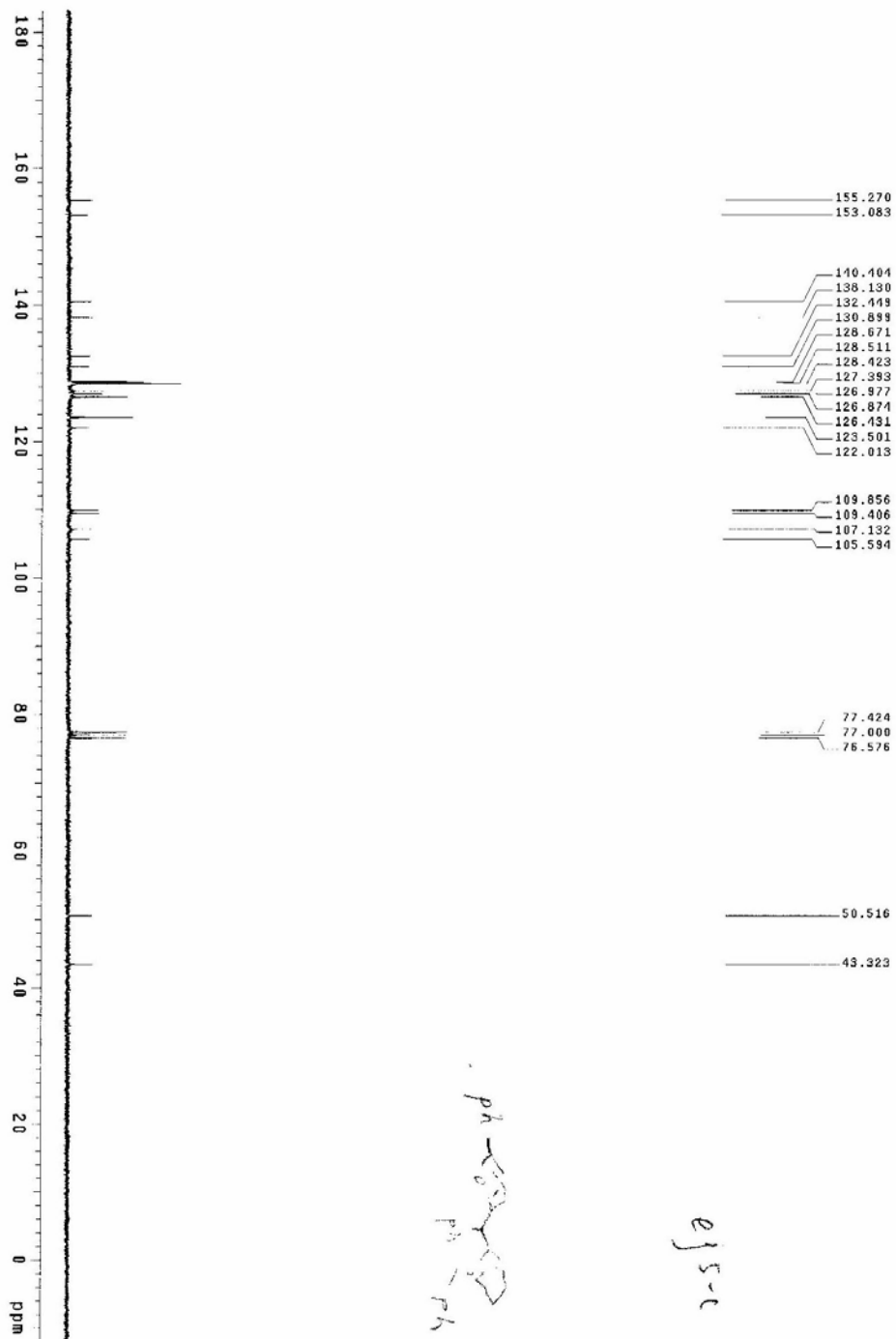
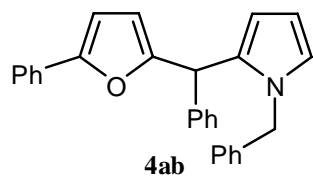


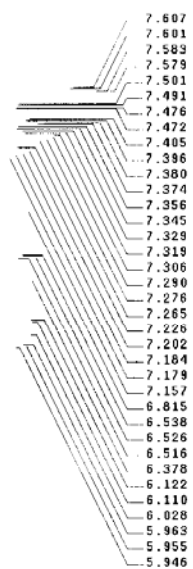
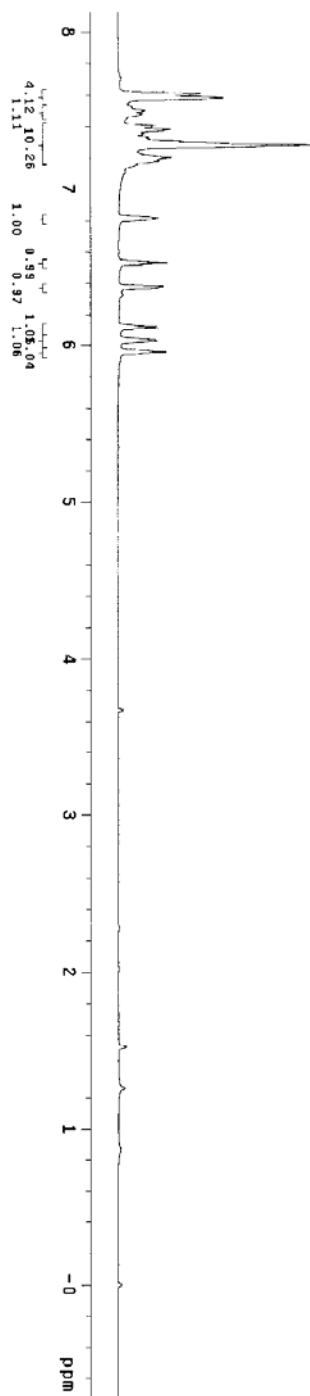
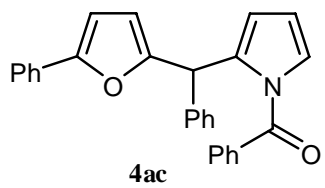




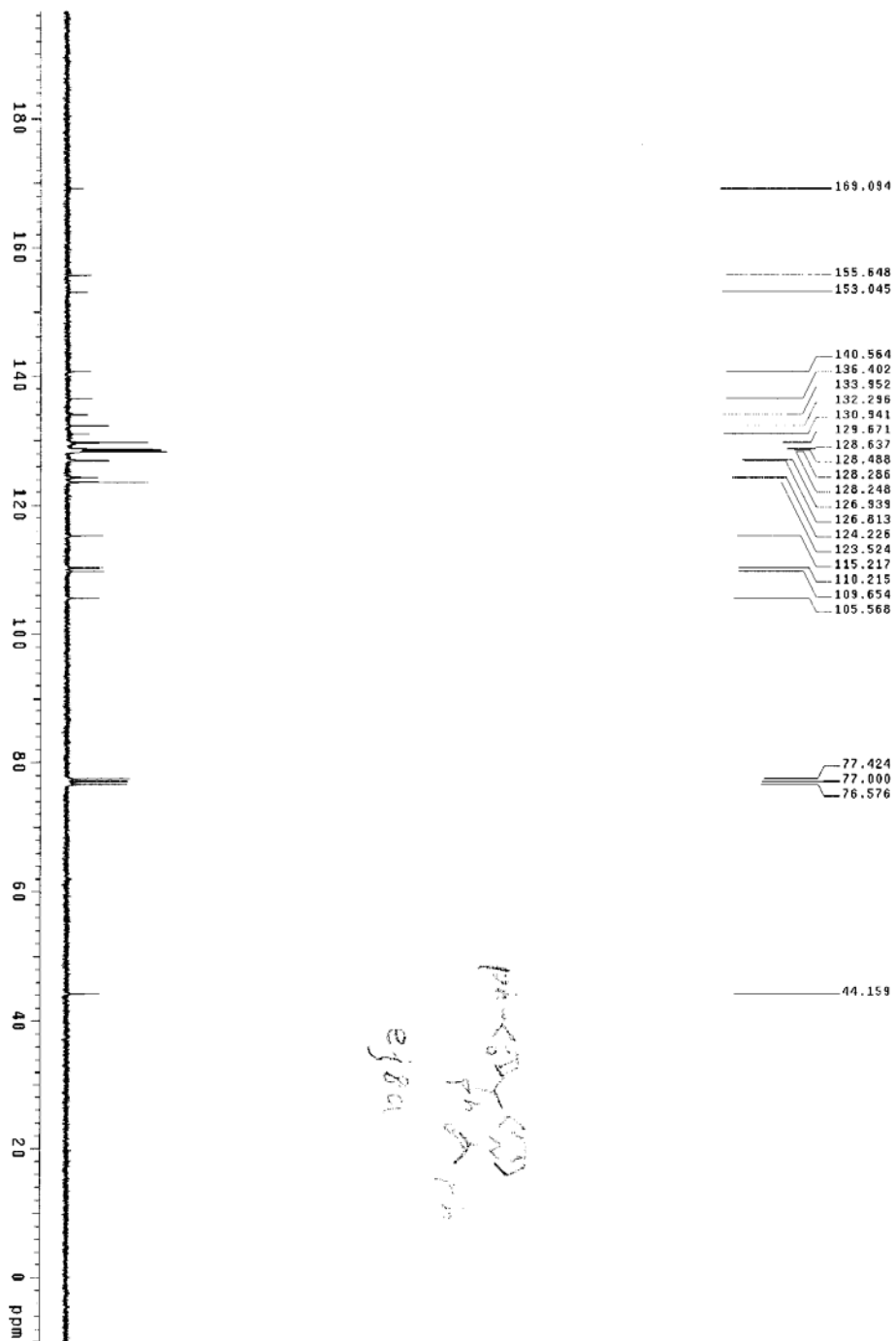
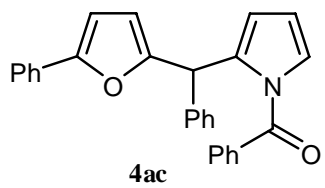


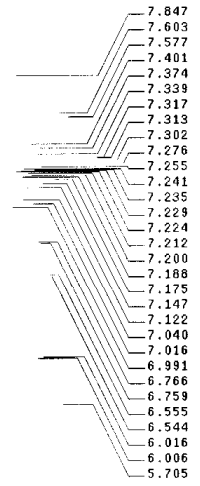
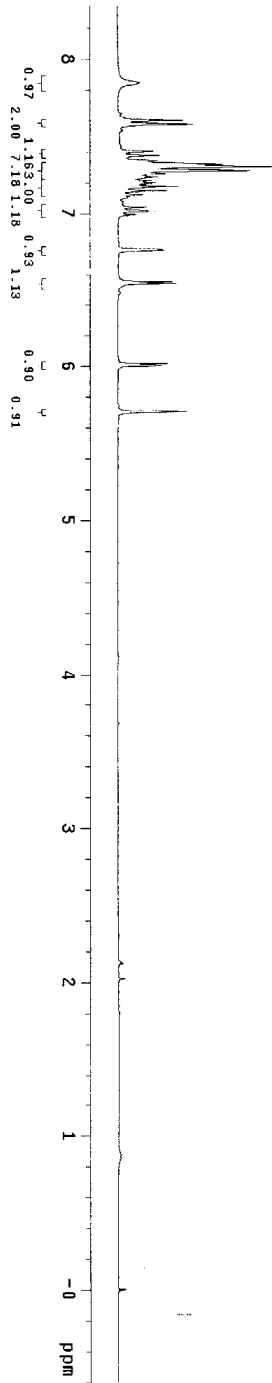
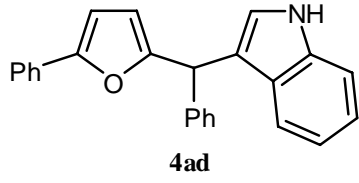


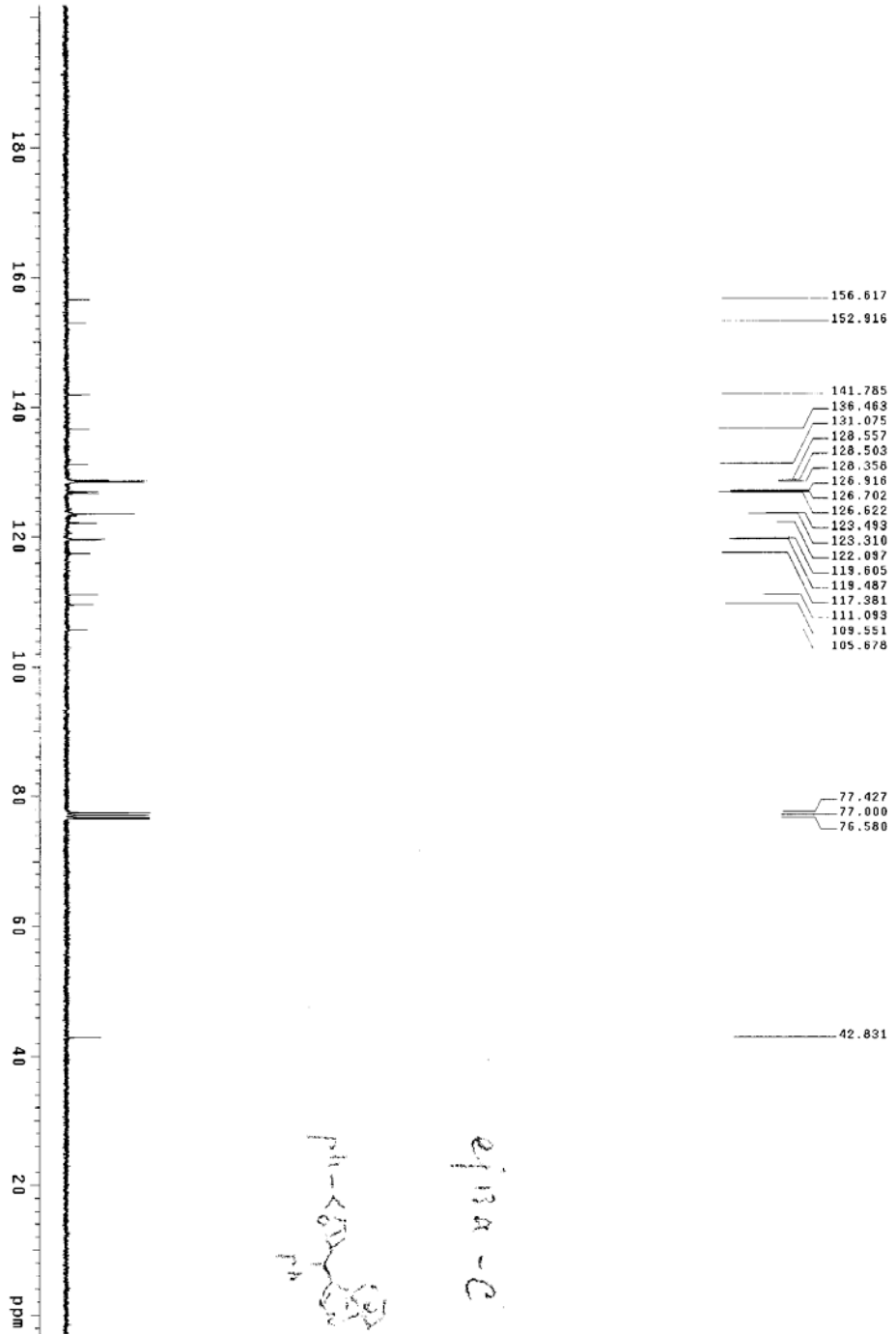
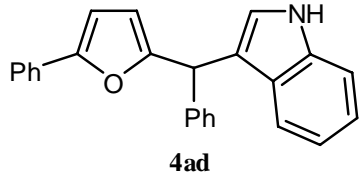


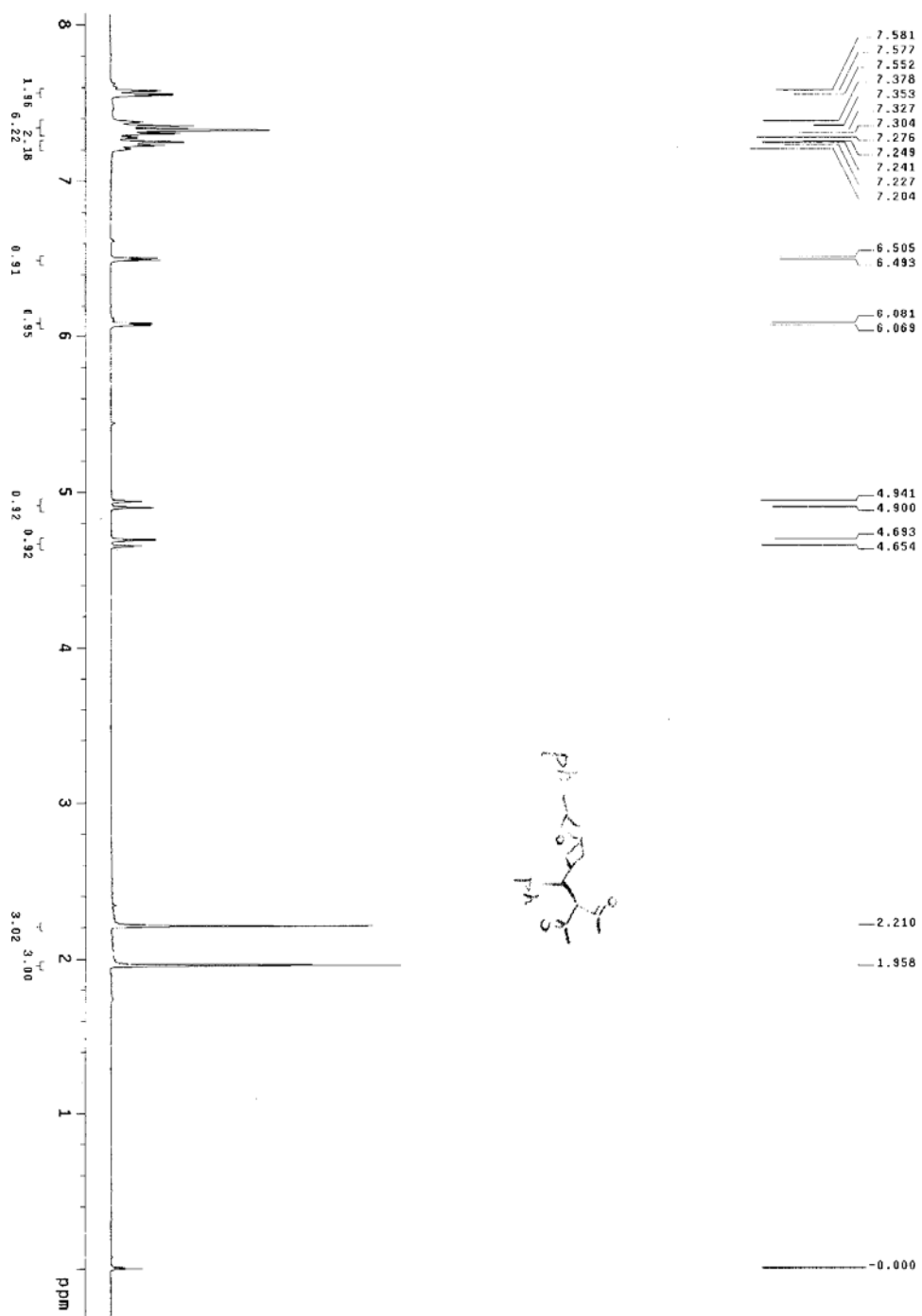
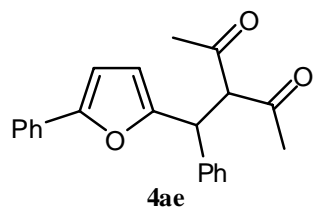


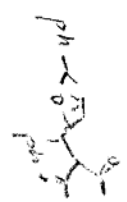
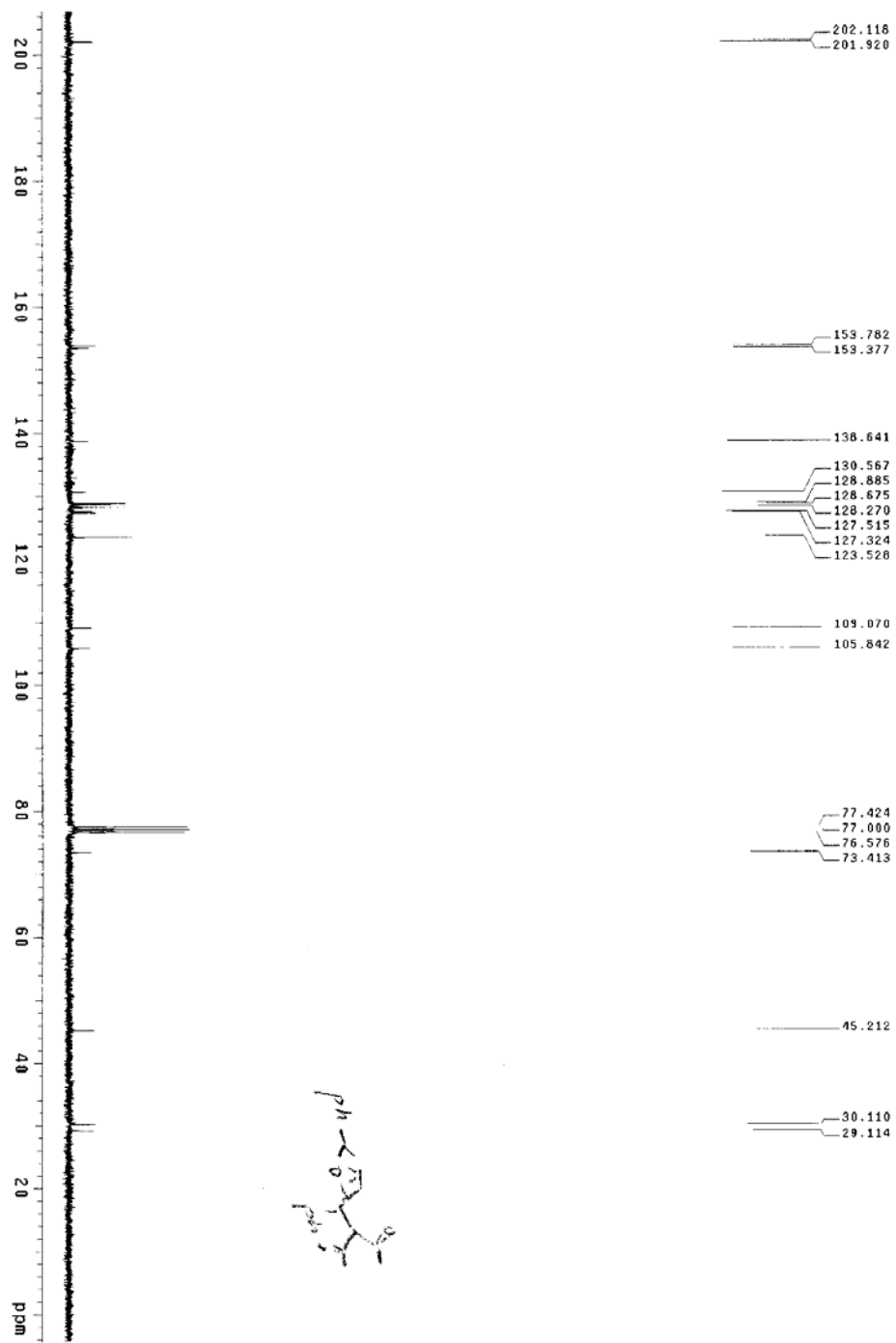
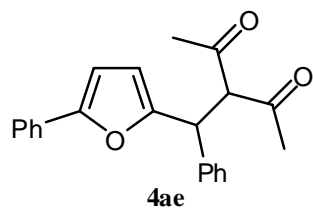
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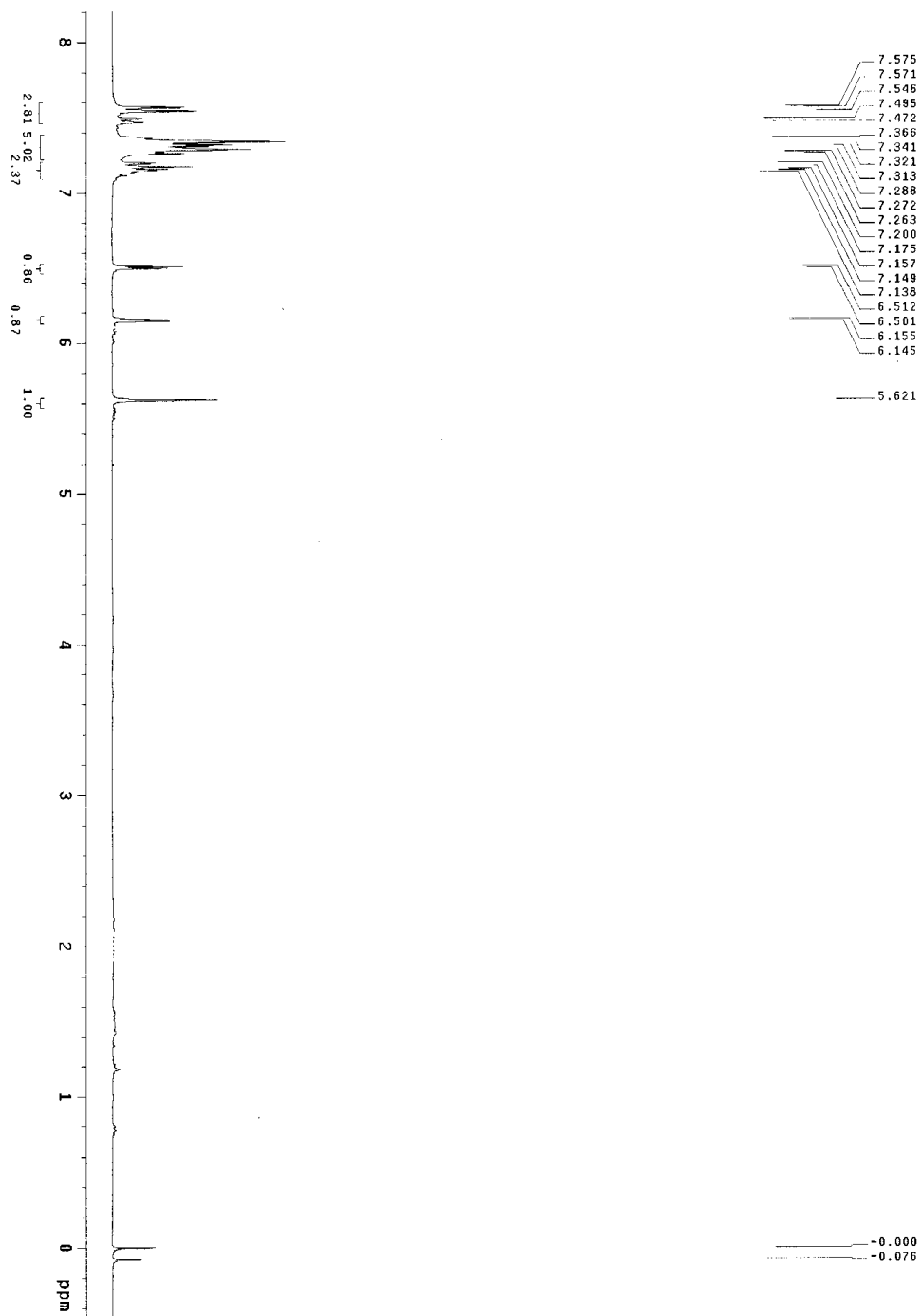
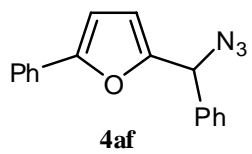


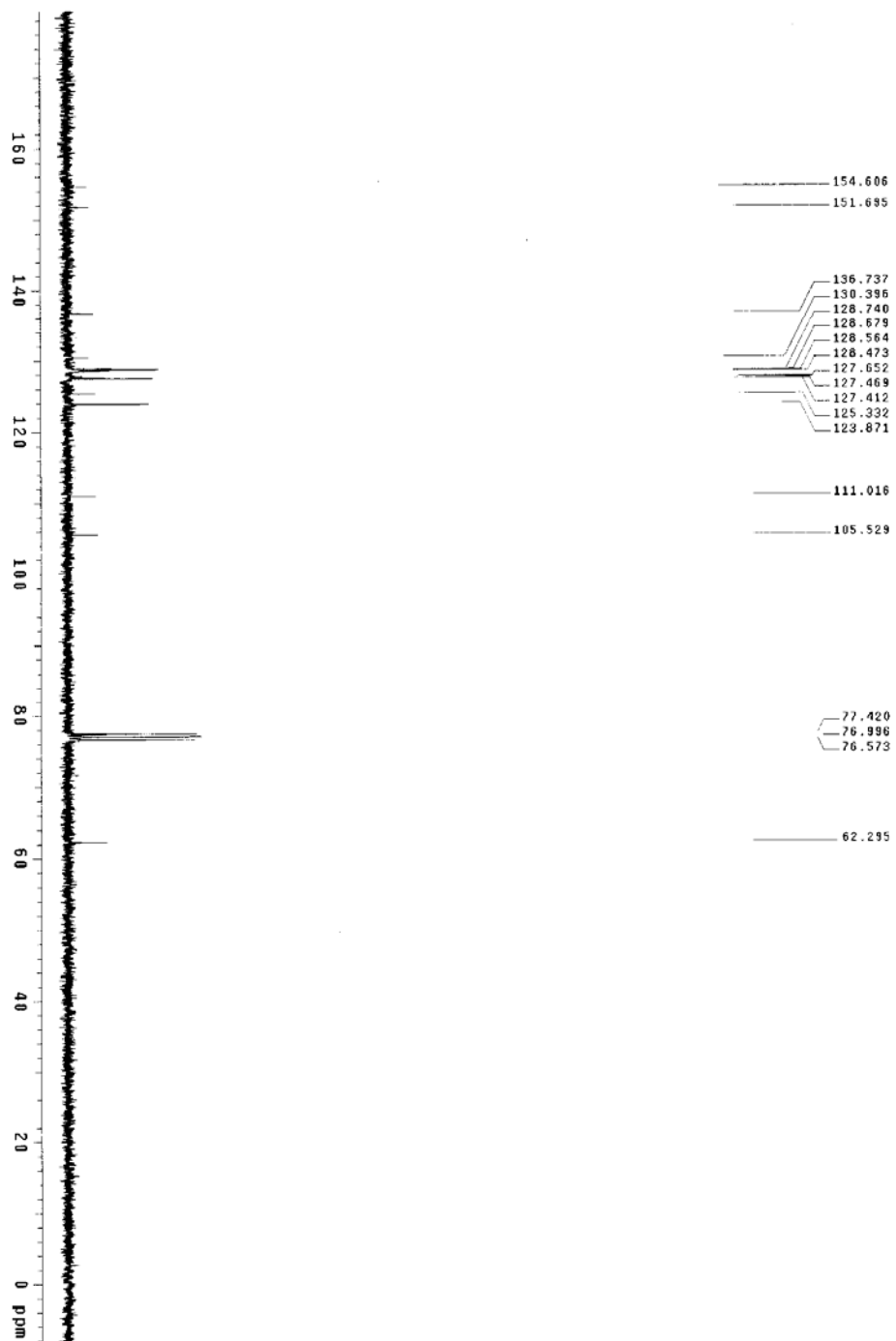
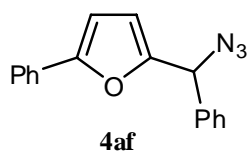


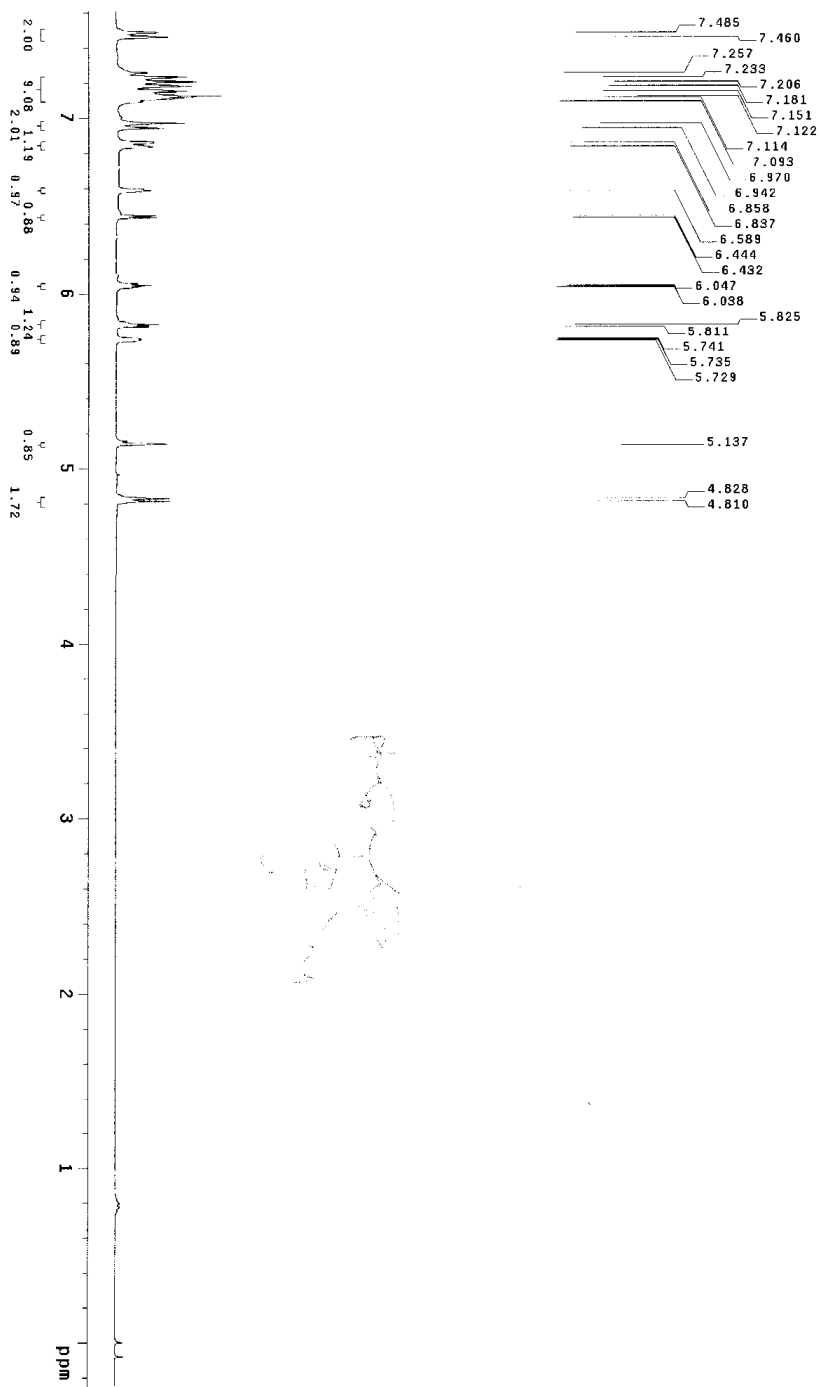
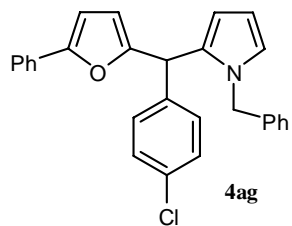


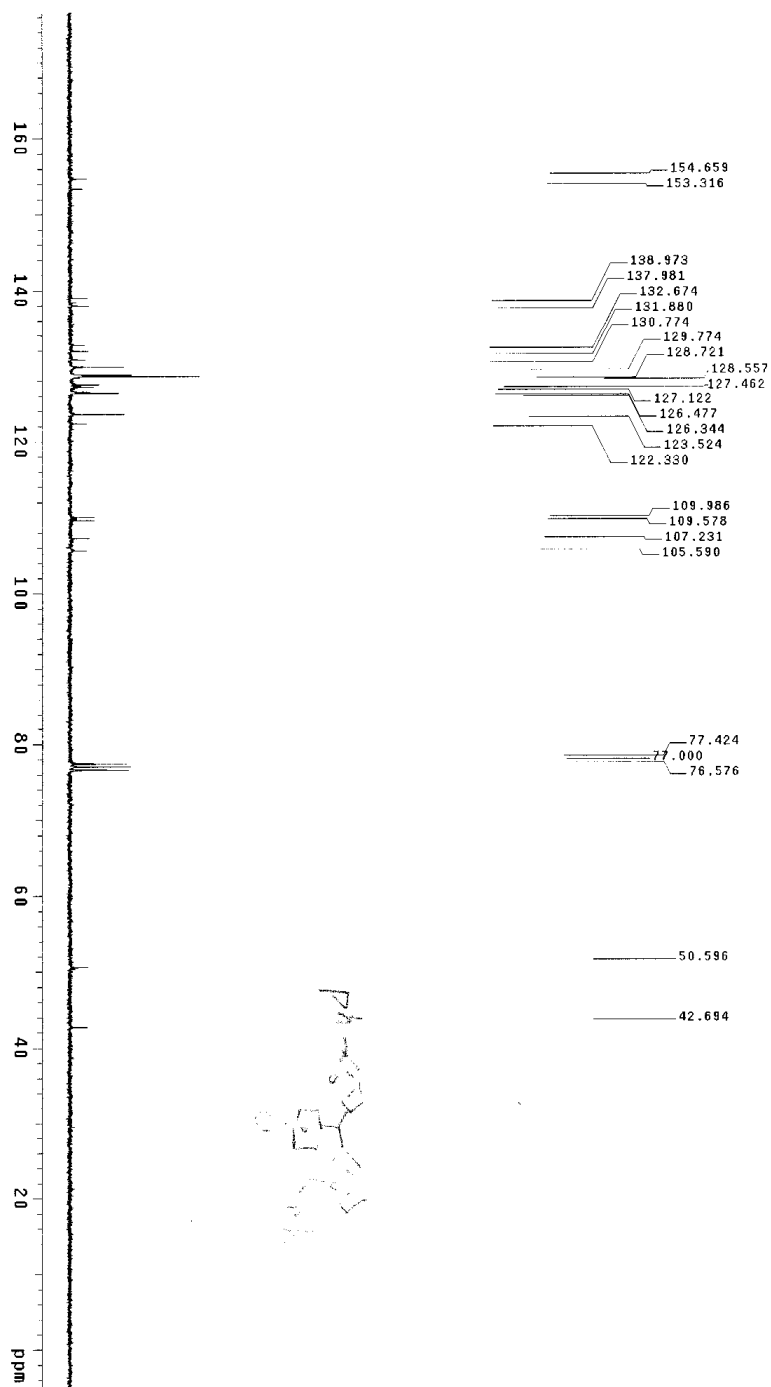
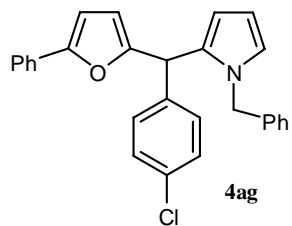


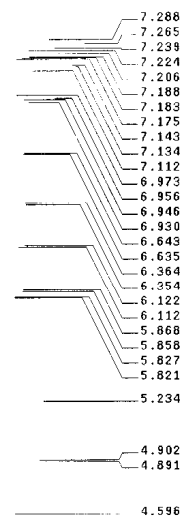
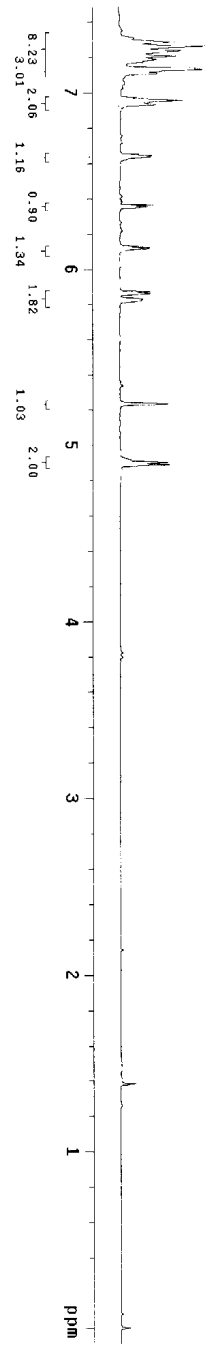
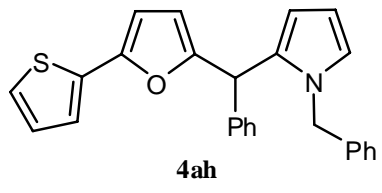


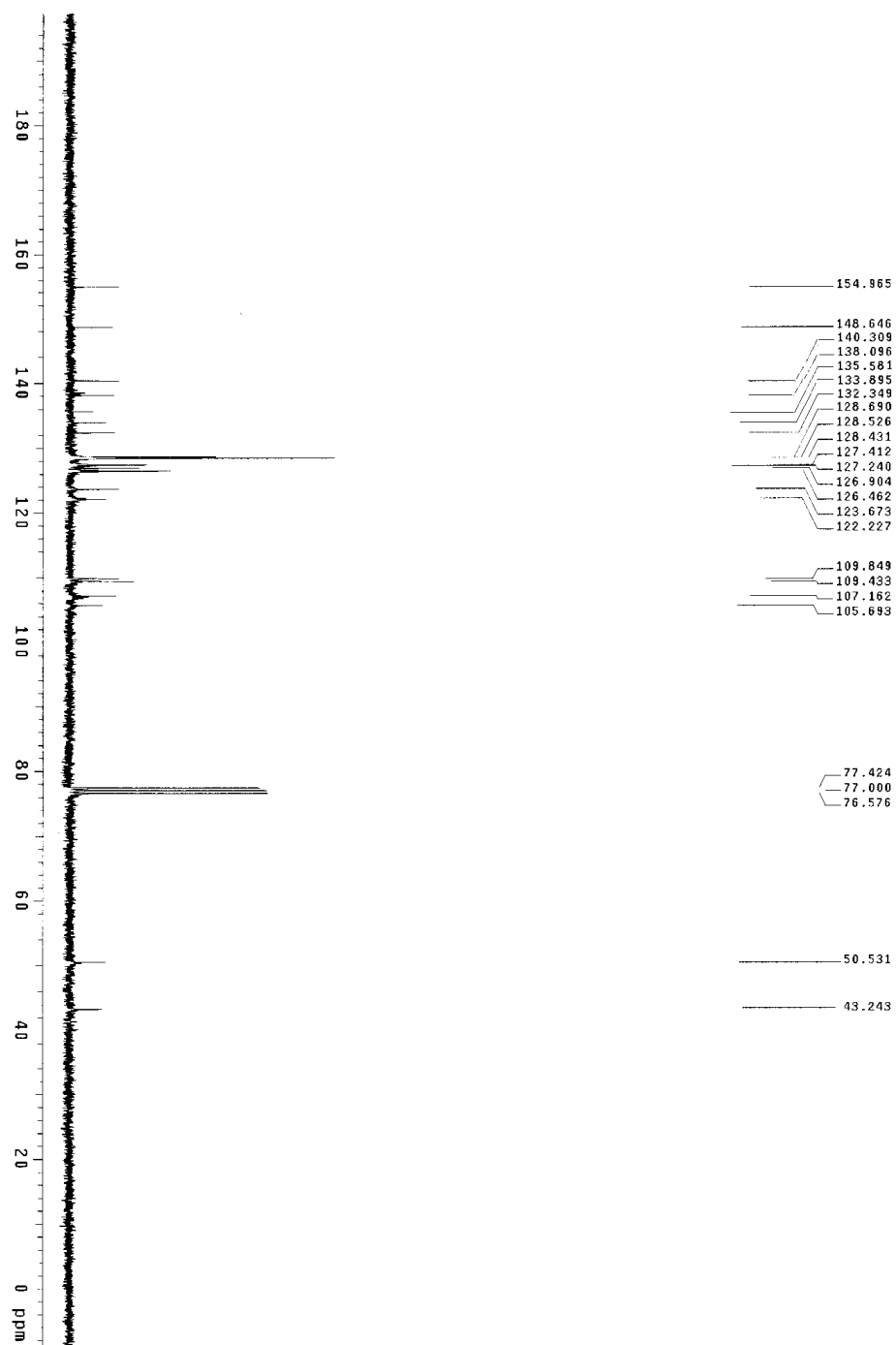
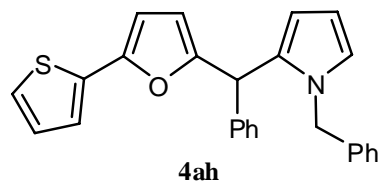


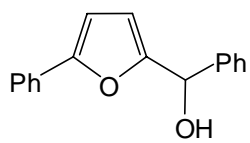




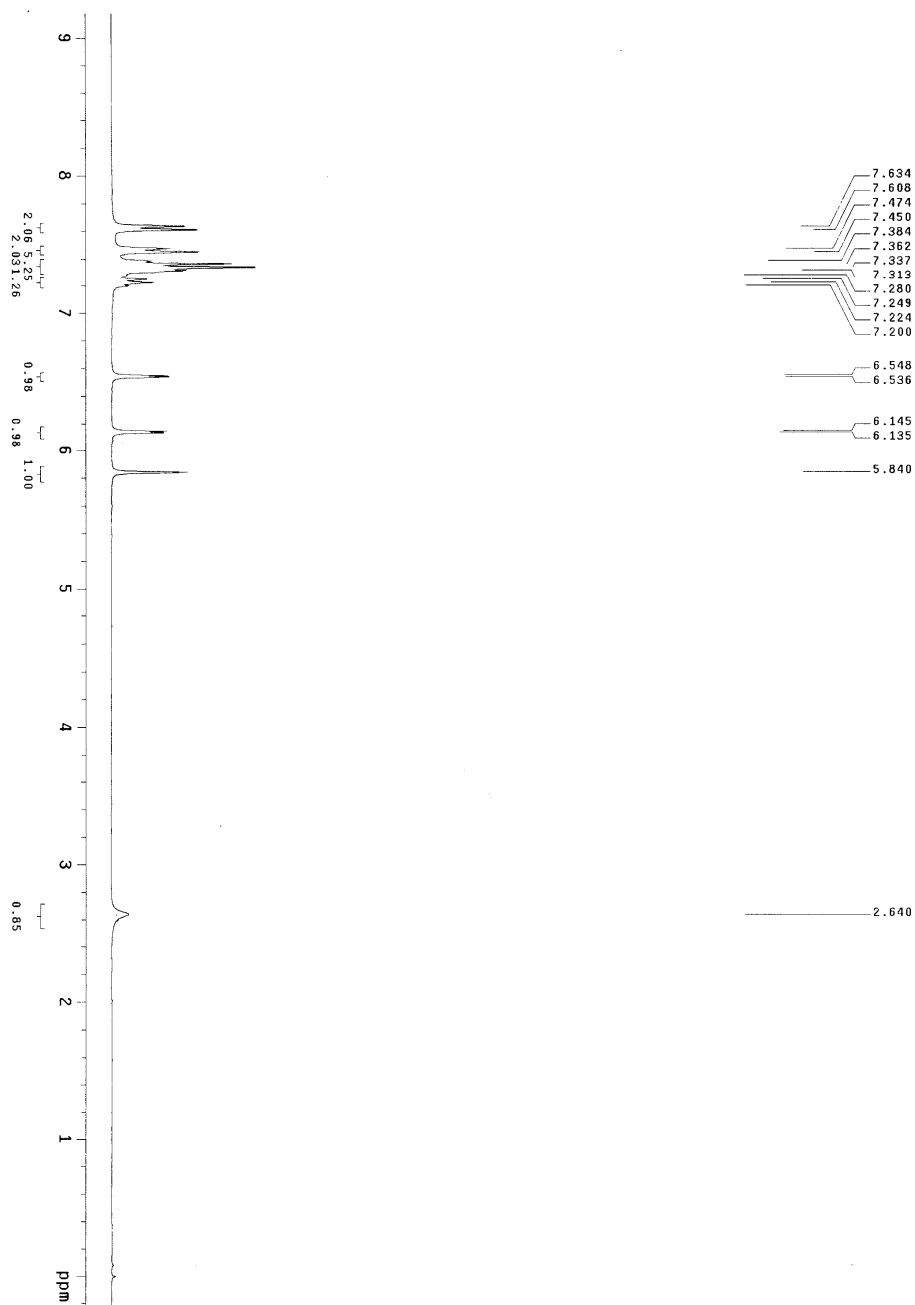


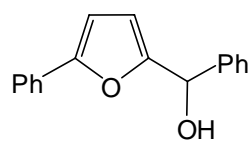






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