

**Efficient synthesis of polyfunctionalized carbazoles and pyrrolo[3,4-c]carbazoles
via domino Diels-Alder reaction**

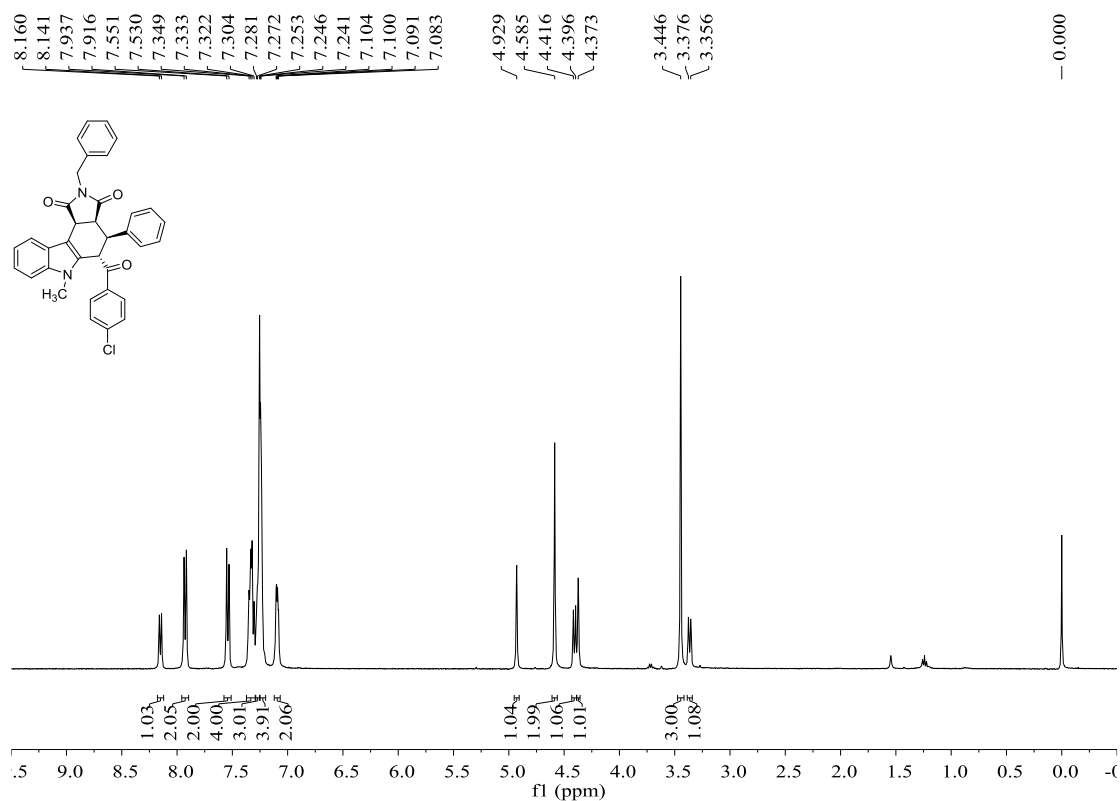
Ren-Jie Fang, Chen Yan, Jing Sun,* Ying Han, Chao-Guo Yan*

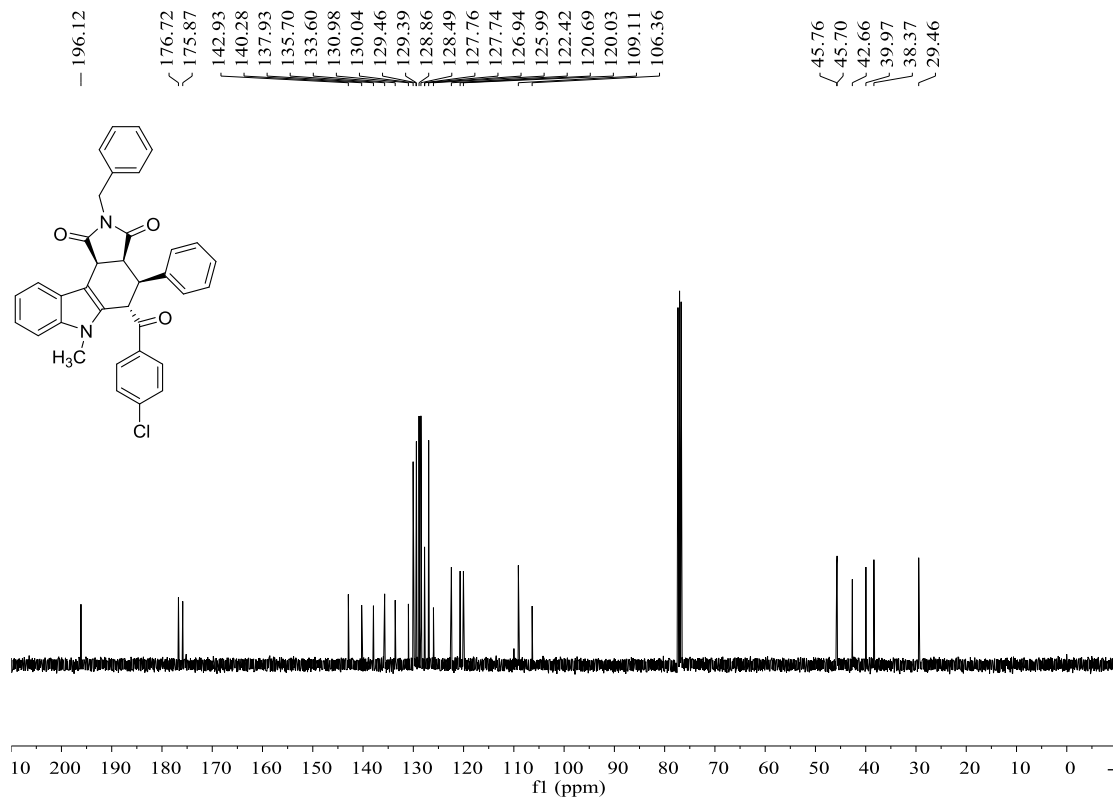
Supporting Information

Characterization data and ^1H , ^{13}C , HRMS spectra of the compounds

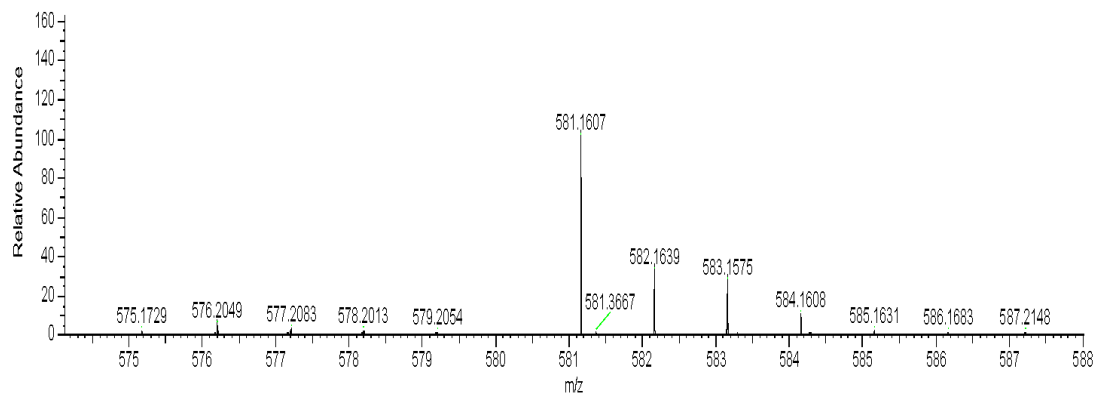
2-57

2-benzyl-5-(4-chlorobenzoyl)-6-methyl-4-phenyl-4,5,6,10c-tetrahydropyrrolo[3,4-c]carbazole-1,3(2H,3aH)-dione (3a): white solid, 18%, m.p. 221-223 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.15 (d, *J* = 7.6 Hz, 1H, ArH), 7.93 (d, *J* = 8.4 Hz, 2H, ArH), 7.54 (d, *J* = 7.6 Hz, 2H, ArH), 7.35-7.30 (m, 4H, ArH), 7.28-7.24 (m, 7H, ArH), 7.10-7.08 (m, 2H, ArH), 4.93 (s, 1H, CH), 4.59 (s, 2H, CH), 4.41 (d, *J* = 8.0 Hz, 1H, CH), 4.37 (s, 1H, CH), 3.45 (s, 3H, CH₃), 3.37 (d, *J* = 8.0 Hz, 1H, CH); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 196.1, 176.7, 175.8, 142.9, 140.2, 137.9, 135.7, 133.6, 130.9, 130.0, 129.4, 129.3, 128.8, 128.4, 127.8, 127.7, 126.9, 125.9, 122.4, 120.6, 120.0, 109.1, 106.3, 45.7, 45.6, 42.6, 39.9, 38.3, 29.4; IR (KBr) ν: 2988, 2876, 1832, 1711, 1632, 1485, 1446, 1354, 1312, 1186, 1034, 967, 788, 732 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₅H₂₇ClN₂O₃ ([M+Na]⁺): 581.1602, Found: 581.1607.

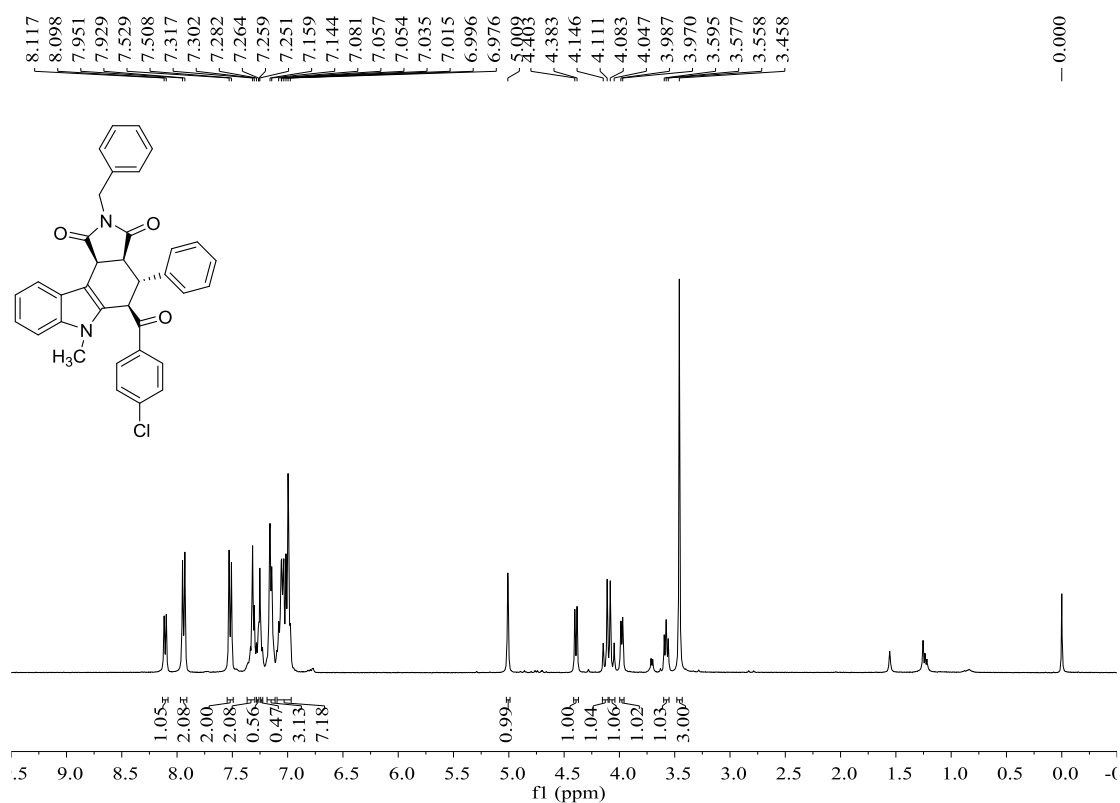


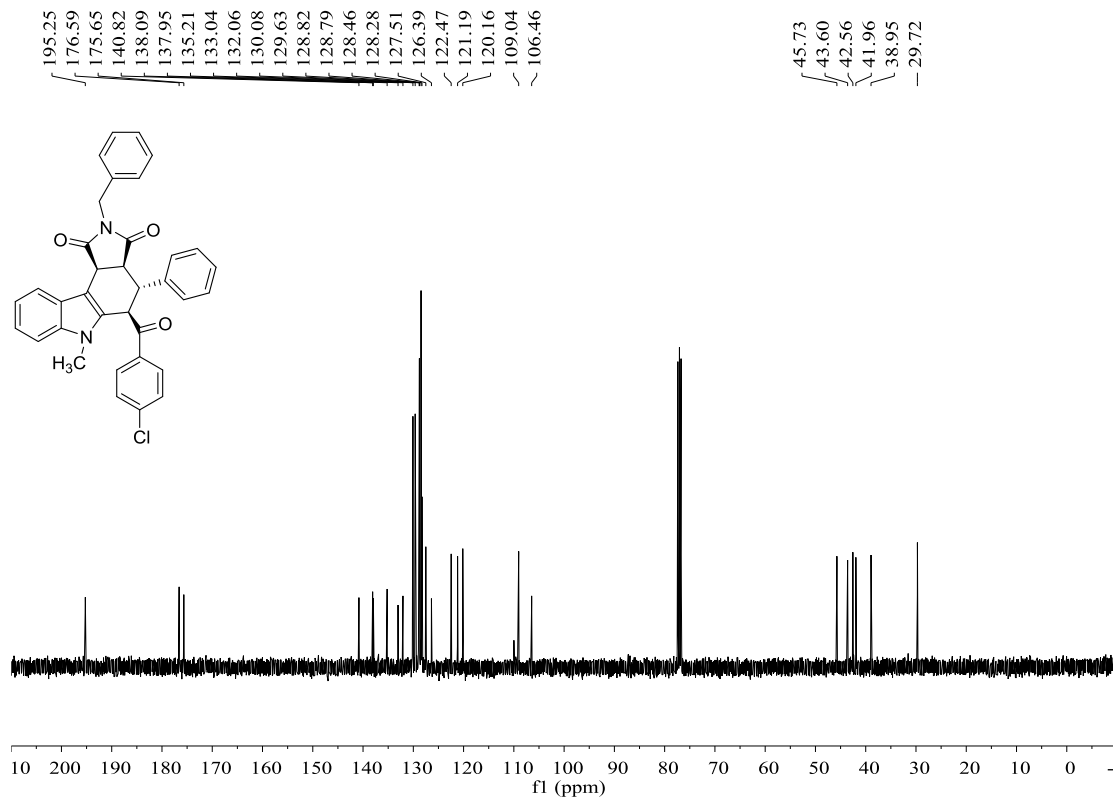


YC7 #60 RT: 0.76 AV: 1 NL: 1.81E+005
 T: FTMS + p ESI Full ms [100.0000-1500.0000]

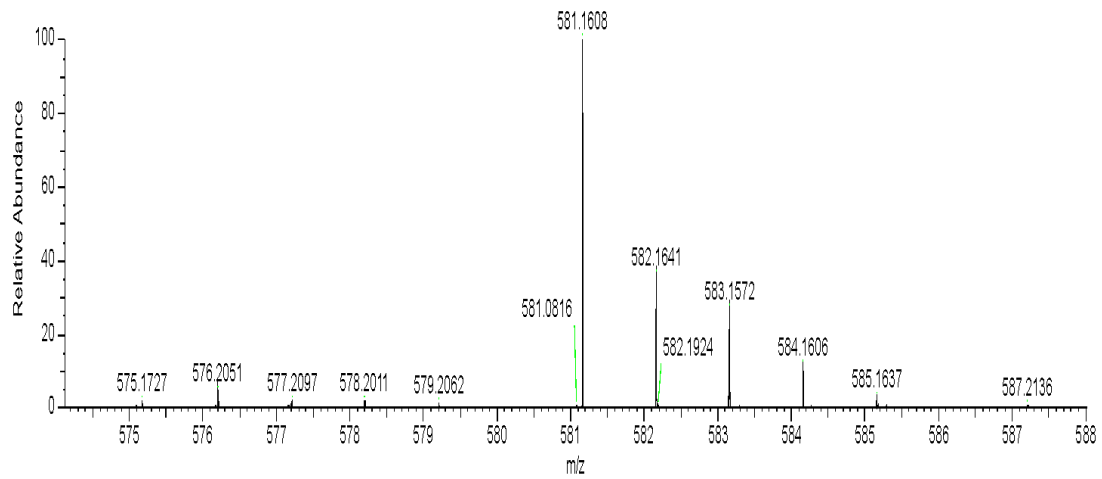


2-benzyl-5-(4-chlorobenzoyl)-6-methyl-4-phenyl-4,5,6,10c-tetrahydropyrrolo[3,4-c]carbazole-1,3(2H,3aH)-dione (3b): white solid, 71%, m.p. 227-229 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.15 (d, *J* = 7.6 Hz, 1H, ArH), 7.94 (d, *J* = 8.8 Hz, 2H, ArH), 7.52 (d, *J* = 8.4 Hz, 2H, ArH), 7.37-7.30 (m, 2H, ArH), 7.28-7.23 (m, 1H, ArH), 7.16-7.14 (m, 3H, ArH), 7.08-6.98 (m, 7H, ArH), 5.01 (s, 1H, CH), 4.39 (d, *J* = 8.0 Hz, 1H, CH), 4.13 (d, *J* = 14.0 Hz, 1H, CH), 4.07 (d, *J* = 14.0 Hz, 1H, CH), 3.98 (d, *J* = 6.4 Hz, 1H, CH), 3.58 (t, *J* = 7.6 Hz, 1H, CH), 3.46 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 195.2, 176.5, 175.6, 140.8, 138.0, 137.9, 135.2, 133.0, 132.0, 130.0, 129.6, 128.8, 128.7, 128.4, 128.2, 127.5, 126.3, 122.4, 121.1, 120.1, 109.0, 106.4, 45.7, 43.5, 42.5, 41.9, 38.9, 29.7; IR (KBr) ν: 2976, 2854, 1841, 1722, 1627, 1479, 1450, 1361, 1322, 1179, 1045, 966, 779, 745 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₅H₂₇ClNaN₂O₃ ([M+Na]⁺): 581.1602, Found: 581.1608.

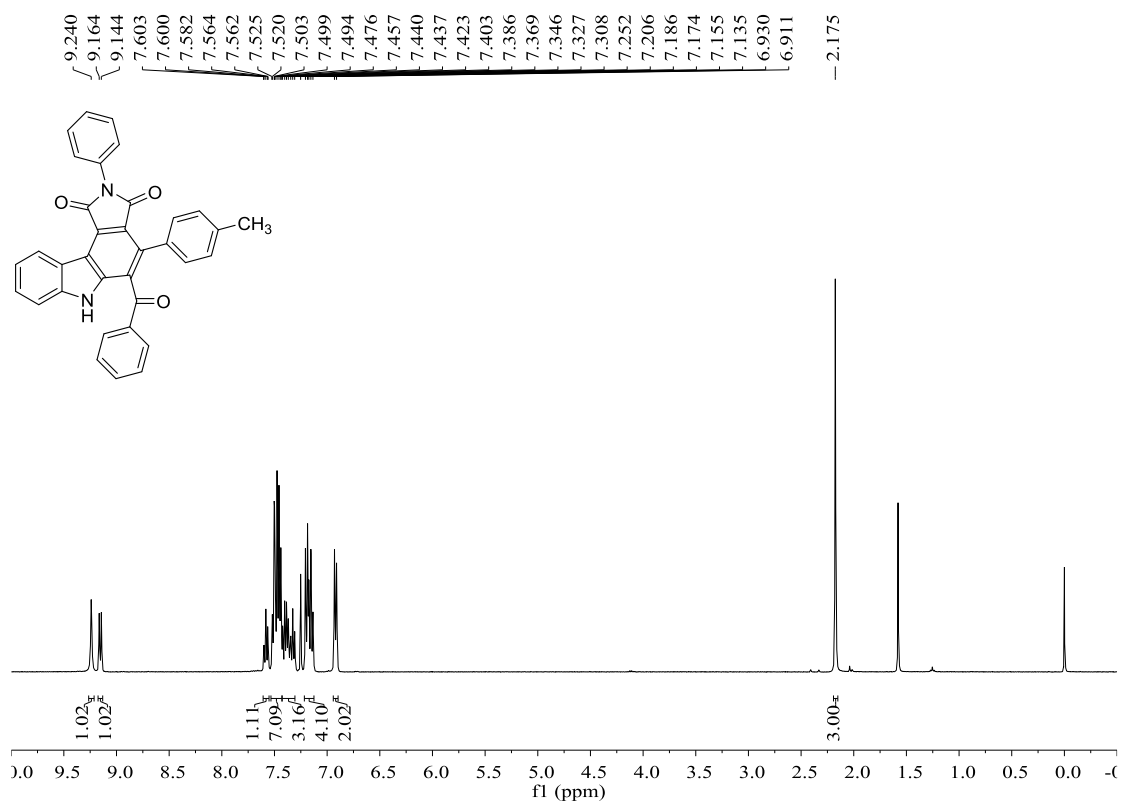


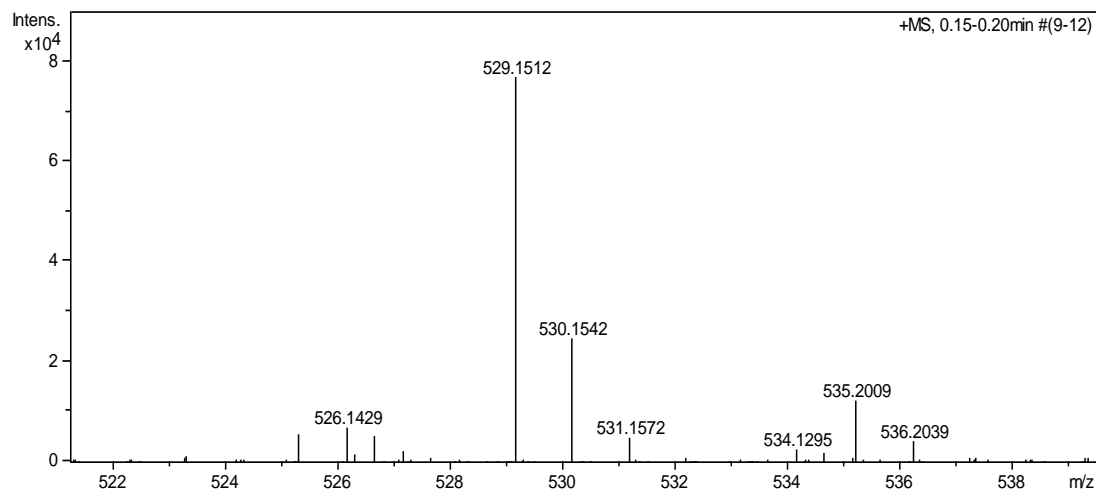
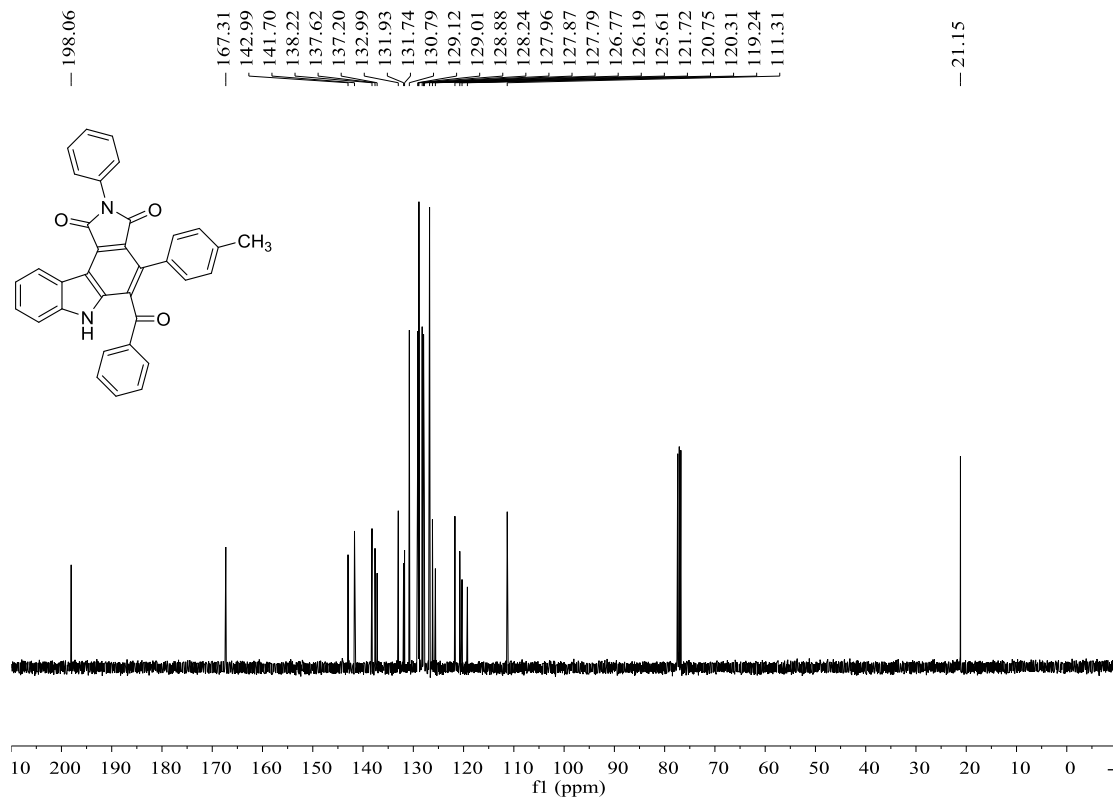


YC7 #75 RT: 0.95 AV: 1 NL: 1.39E+005
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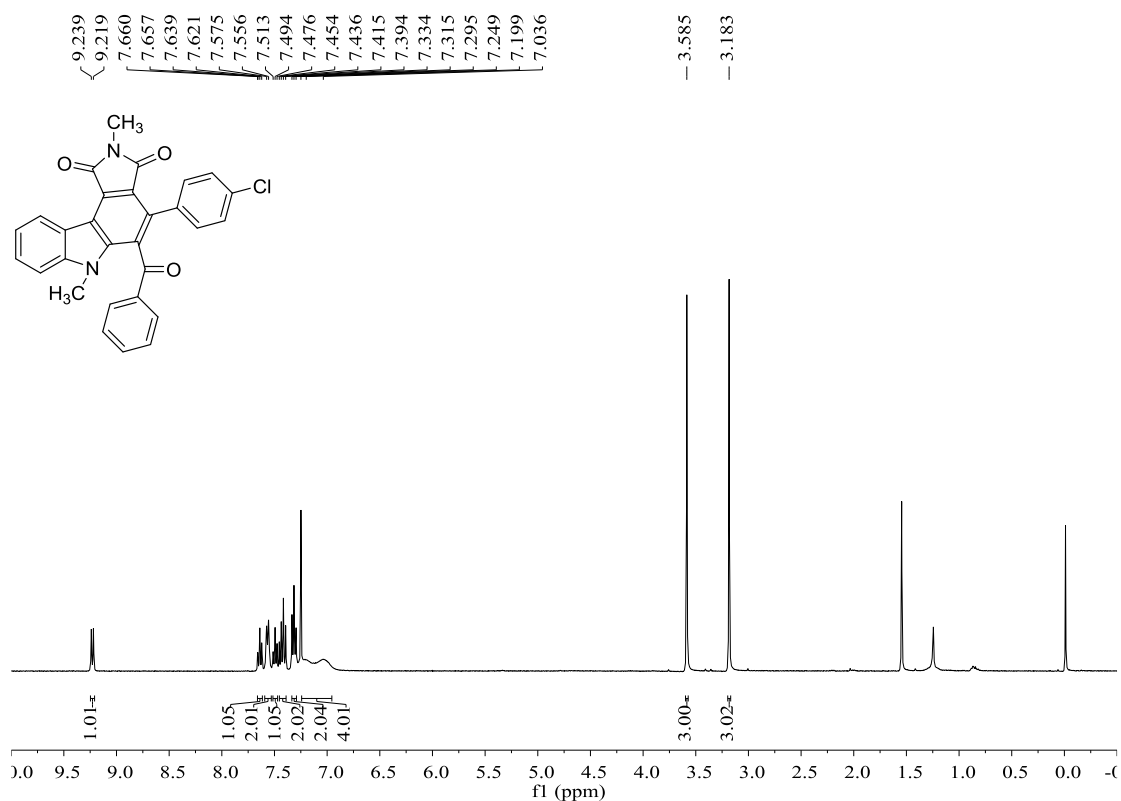
5-benzoyl-2-phenyl-4-(*p*-tolyl)pyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-dione (4a): green solid, 87%, m.p. 234-236 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.24 (s, 1H, ArH), 9.15 (d, *J* = 8.0 Hz, 1H, ArH), 7.60-7.56 (m, 1H, ArH), 7.53-7.44 (m, 7H, ArH), 7.42-7.31 (m, 3H, ArH), 7.21-7.14 (m, 4H, ArH), 6.92 (d, *J* = 7.6 Hz, 2H, ArH), 2.18 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 198.0, 167.3, 142.9, 141.7, 138.2, 137.6, 137.2, 132.9, 131.9, 131.7, 130.7, 129.1, 129.0, 128.8, 128.2, 127.9, 127.8, 127.7, 126.7, 126.1, 125.6, 121.7, 120.7, 120.3, 119.2, 111.3, 21.1; IR (KBr) ν: 2988, 1786, 1734, 1611, 1485, 1456, 1357, 1314, 1185, 1021, 988, 786, 734 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₄H₂₂NaN₂O₃ ([M+Na]⁺): 529.1523, Found: 529.1512.

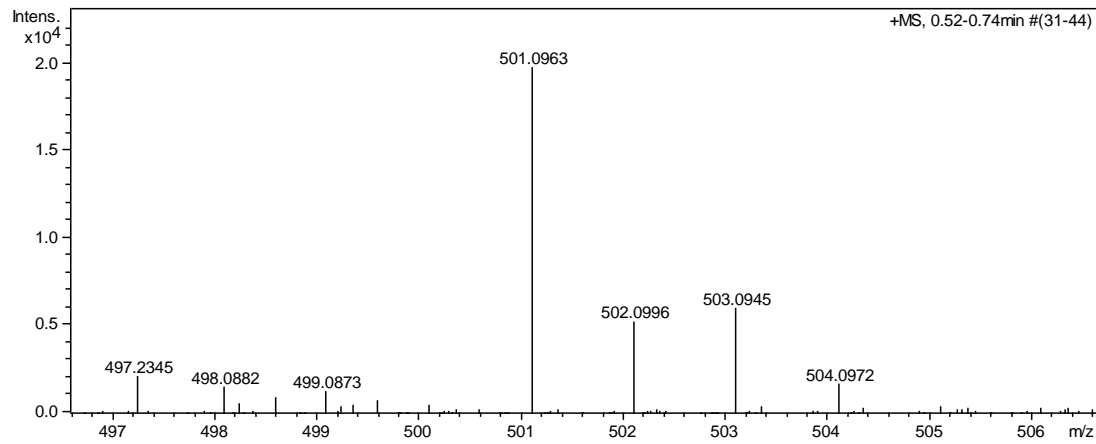
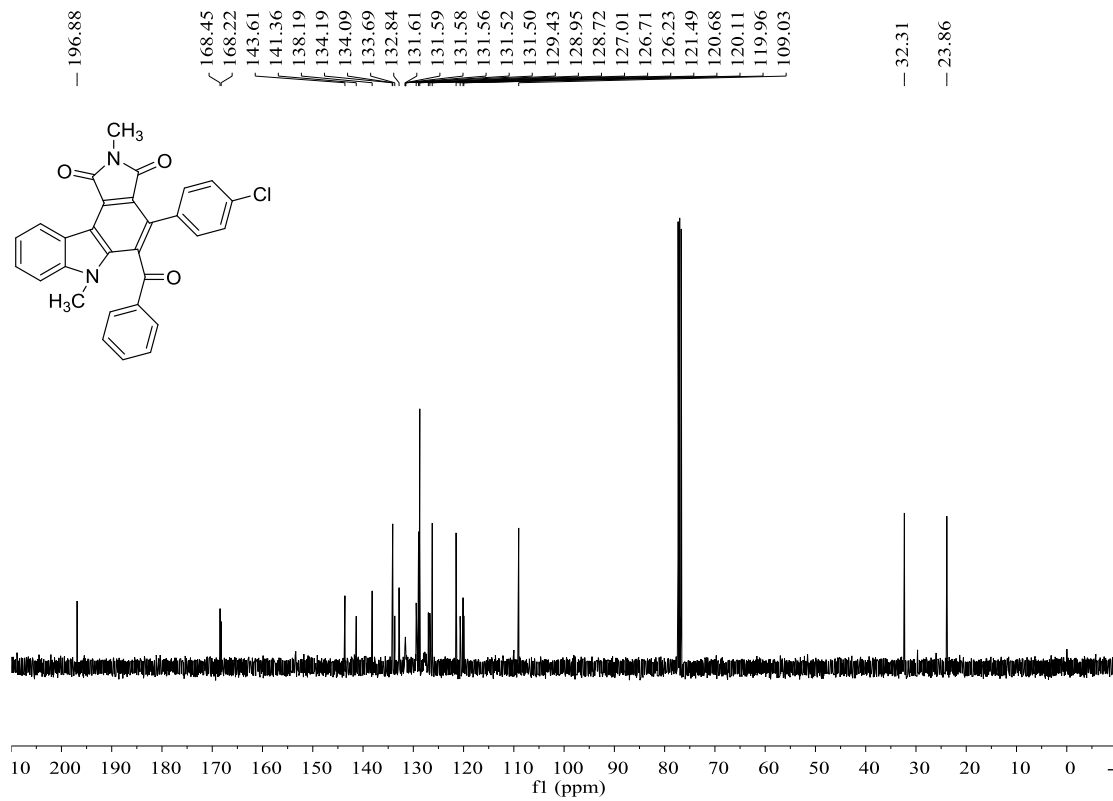




5-benzoyl-4-(4-chlorophenyl)-2,6-dimethylpyrrolo[3,4-c]carbazole-1,3(2H,6H)-dione

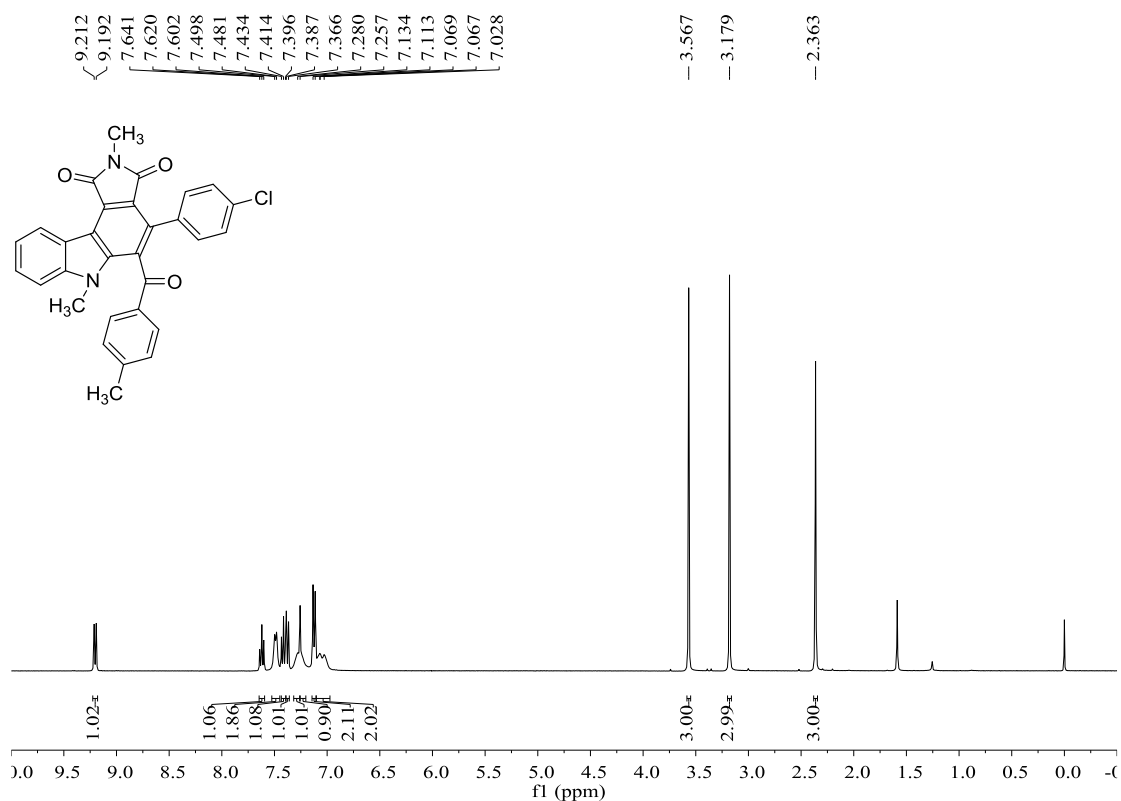
(4b): green solid, 89%, m.p. 231-233 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.23 (d, *J* = 8.0 Hz, 1H, ArH), 7.66-7.62 (m, 1H, ArH), 7.57 (d, *J* = 7.6 Hz, 2H, ArH), 7.49 (d, *J* = 7.6 Hz, 1H, ArH), 7.45-7.39 (m, 2H, ArH), 7.32 (t, *J* = 8.0 Hz, 2H, ArH), 7.20-7.04 (m, 4H, ArH), 3.59 (s, 3H, CH₃), 3.18 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 196.8, 168.4, 168.2, 143.6, 141.3, 138.1, 134.1, 134.0, 133.6, 132.8, 131.6, 131.7, 131.6, 131.5, 131.4, 131.3, 129.4, 128.9, 128.7, 127.0, 126.7, 126.2, 121.4, 120.6, 120.1, 119.9, 109.0, 32.3, 23.8; IR (KBr) ν: 2967, 1786, 1714, 1612, 1488, 1456, 1358, 1312, 1188, 1025, 988, 767, 756 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₂₉H₁₉ClN₂O₃ ([M+Na]⁺): 501.0976, Found: 501.0963.

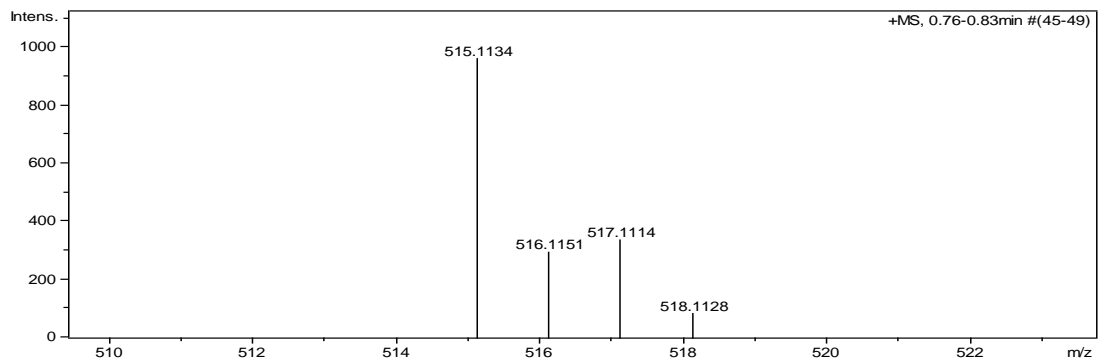
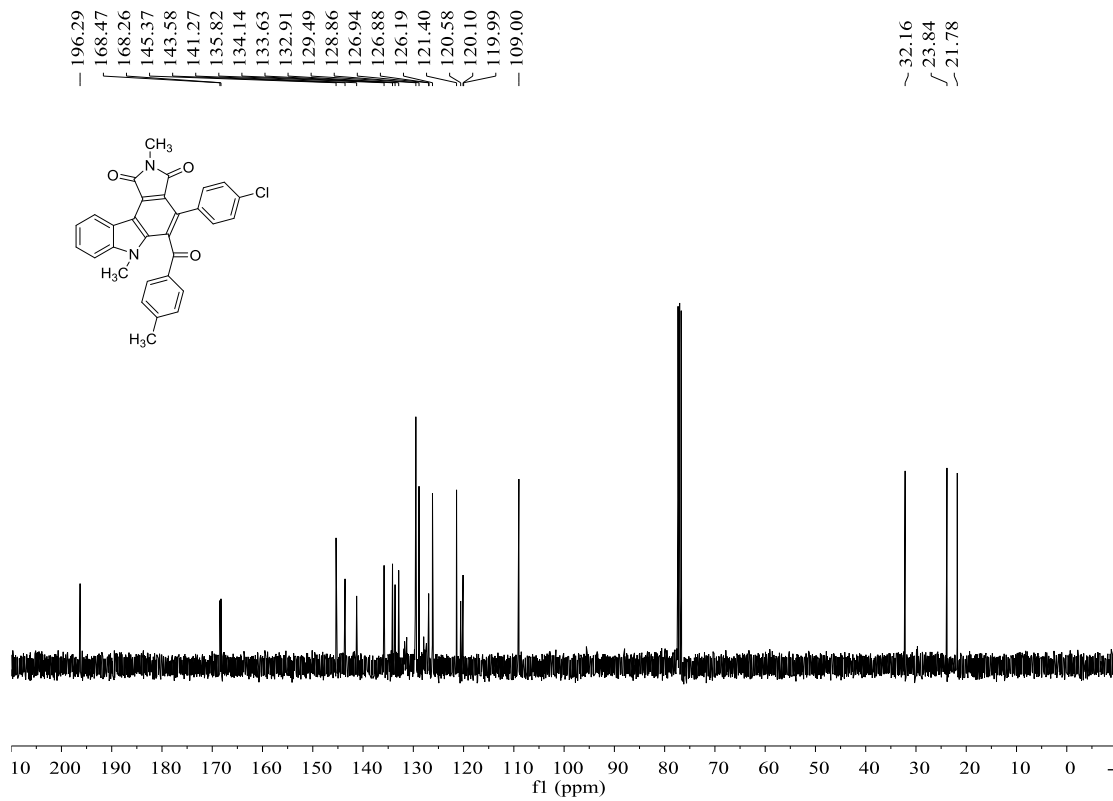




4-(4-chlorophenyl)-2,6-dimethyl-5-(4-methylbenzoyl)pyrrolo[3,4-*c*]carbazole-

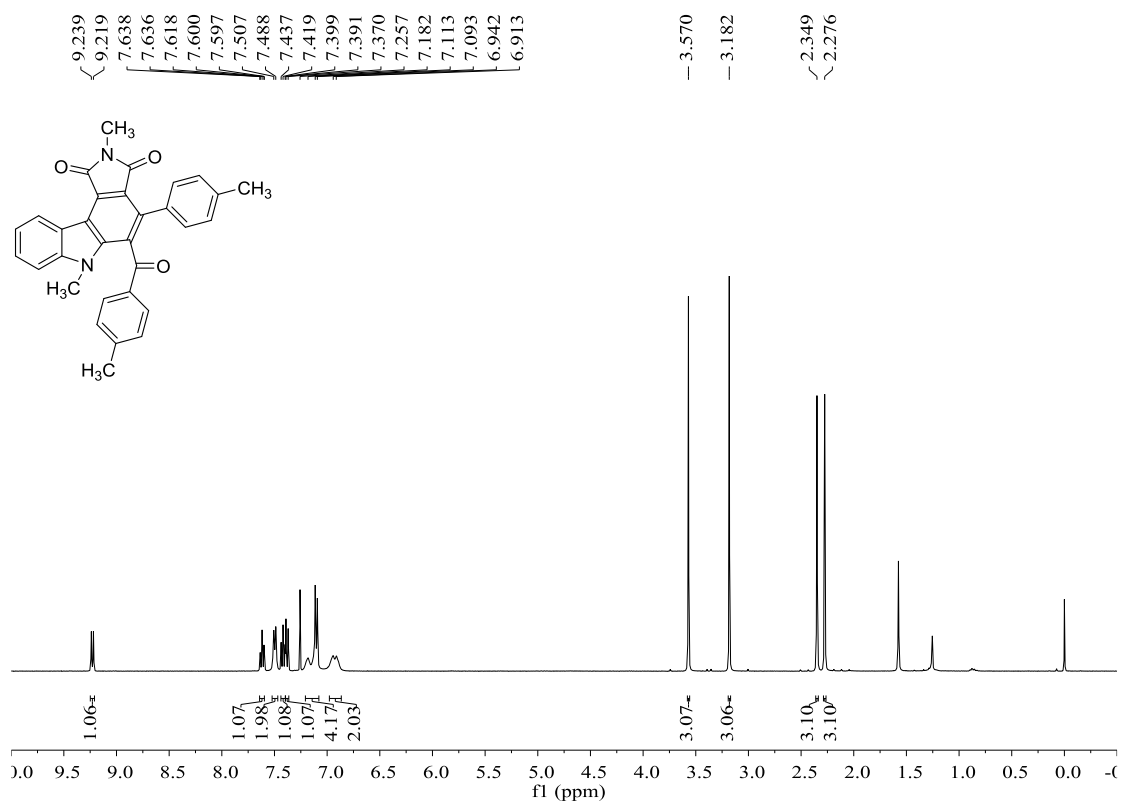
1,3(2*H*,6*H*)-dione (4c): green solid, 92%, m.p. 225-227 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.20 (d, *J* = 8.0 Hz, 1H, ArH), 7.64-7.60 (m, 1H, ArH), 7.49 (d, *J* = 7.6 Hz, 2H, ArH), 7.41 (t, *J* = 8.0 Hz, 1H, ArH), 7.38 (d, *J* = 8.4 Hz, 1H, ArH), 7.28-7.26 (m, 2H, ArH), 7.12 (d, *J* = 8.4 Hz, 2H, ArH), 7.07-7.03 (m, 2H, ArH), 3.57 (s, 3H, CH₃), 3.18 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 196.2, 168.4, 168.2, 145.3, 143.5, 141.2, 135.8, 134.1, 133.6, 132.9, 129.4, 128.8, 126.9, 126.8, 126.1, 121.3, 120.5, 120.1, 119.9, 108.9, 32.1, 23.8, 21.7; IR (KBr) ν: 2943, 1767, 1732, 1611, 1485, 1467, 1358, 1323, 1185, 1032, 981, 786, 732 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₀H₂₁NaN₂O₃ ([M+Na]⁺): 515.1133, Found: 515.1134.

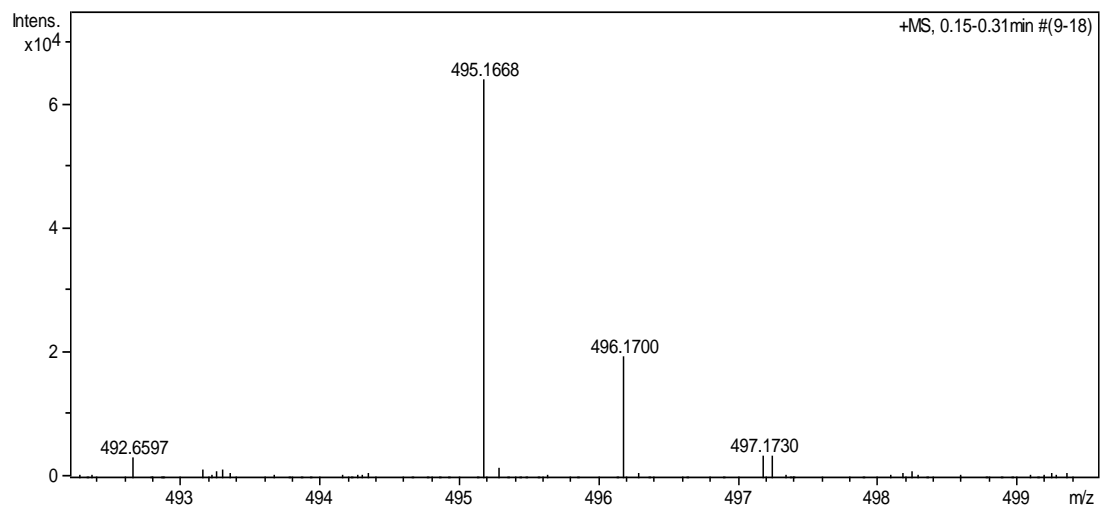
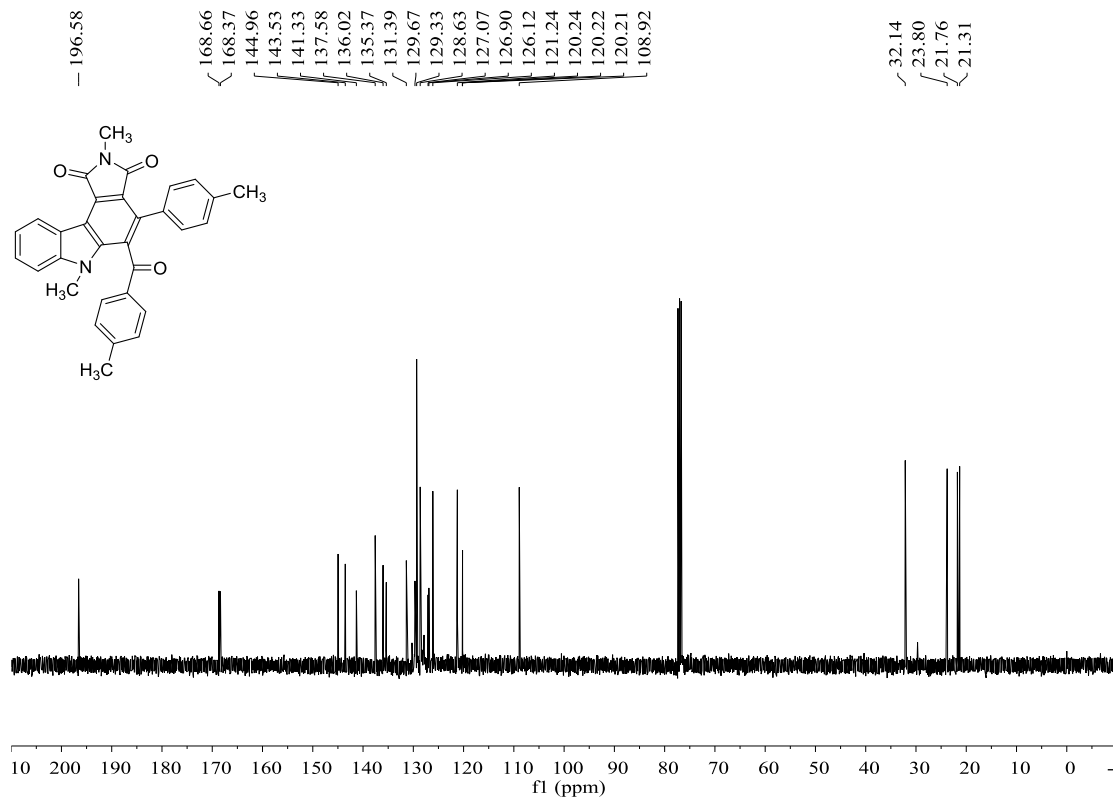




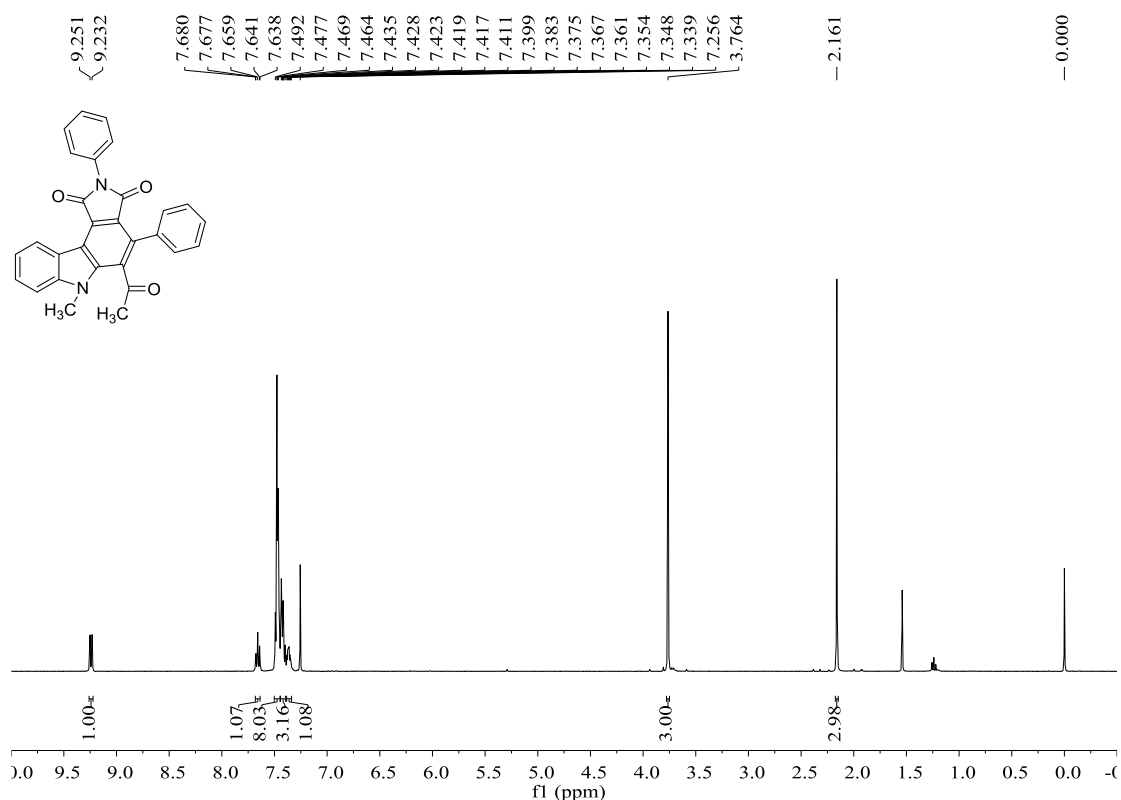
2,6-dimethyl-5-(4-methylbenzoyl)-4-(*p*-tolyl)pyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-dione

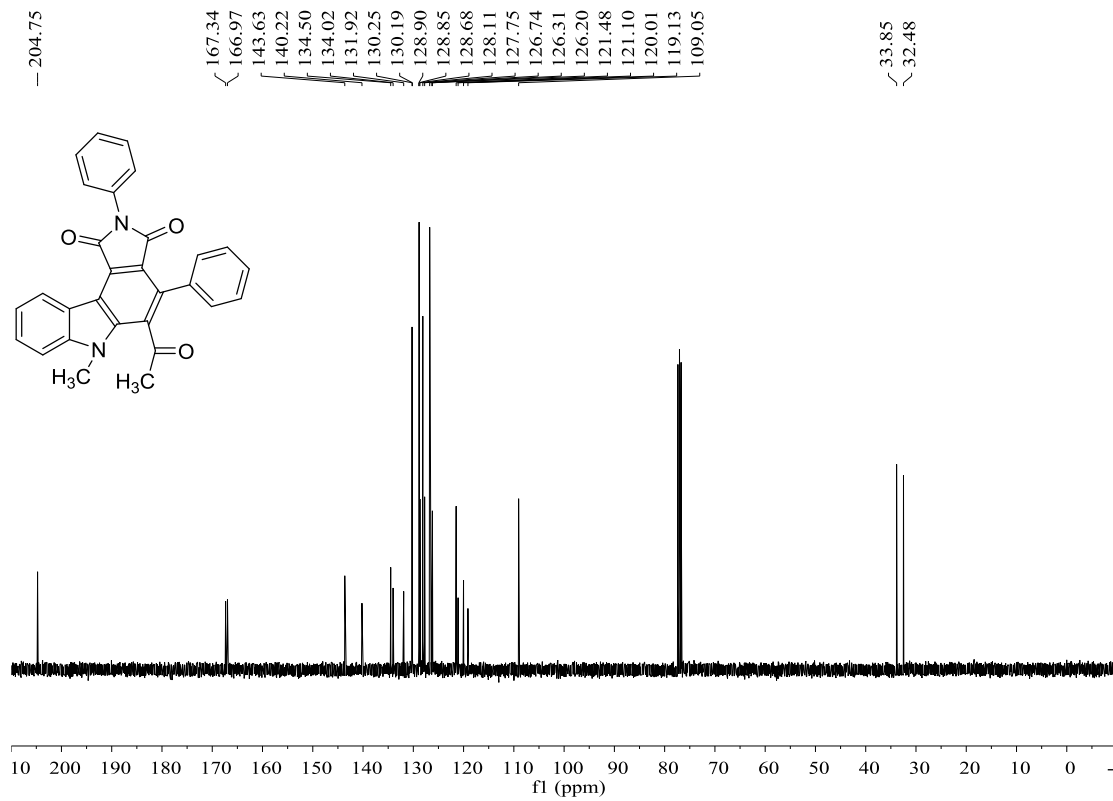
(**4d**): green solid, 91%, m.p. 216-218 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.23 (d, *J* = 8.0 Hz, 1H, ArH), 7.64-7.60 (m, 1H, ArH), 7.50 (d, *J* = 7.6 Hz, 2H, ArH), 7.42 (t, *J* = 8.0 Hz, 1H, ArH), 7.18-7.09 (m, 4H, ArH), 6.93 (d, *J* = 11.6 Hz, 2H, ArH), 3.57 (s, 3H, CH₃), 3.18 (s, 3H, CH₃), 2.35 (s, 3H, CH₃), 2.28 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 196.5, 168.6, 168.3, 144.9, 143.5, 141.3, 137.5, 136.0, 135.3, 131.3, 129.6, 129.3, 128.6, 127.0, 126.9, 126.1, 121.2, 120.4, 120.3, 120.2, 108.9, 32.1, 23.7, 21.7, 21.3; IR (KBr) ν: 2965, 1763, 1732, 1611, 1485, 1458, 1376, 1311, 1185, 1021, 968, 786, 754 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₁H₂₄NaN₂O₃ ([M+Na]⁺): 495.1679, Found: 495.1668.



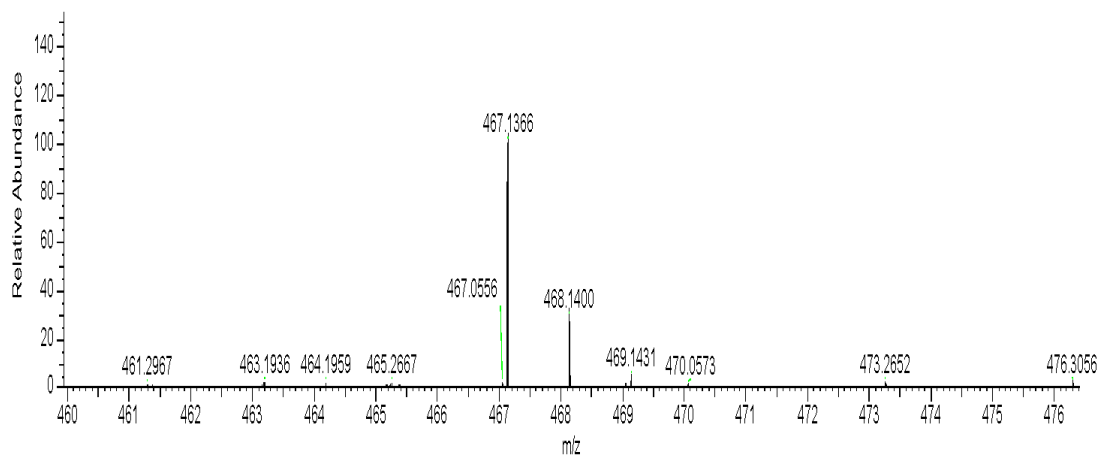


5-acetyl-6-methyl-2,4-diphenylpyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-dione (4e): green solid, 85%, m.p. 239-241 °C; ^1H NMR (400 MHz, CDCl_3) δ : 9.24 (d, $J = 7.6$ Hz, 1H, ArH), 7.68-7.64 (m, 1H, ArH), 7.49-7.46 (m, 8H, ArH), 7.44-7.40 (m, 3H, ArH), 7.38-7.34 (m, 1H, ArH), 3.76 (s, 3H, CH_3), 2.16 (s, 3H, CH_3); ^{13}C { ^1H } NMR (100 MHz, CDCl_3) δ : 204.7, 167.3, 166.9, 143.6, 140.2, 134.4, 134.0, 131.9, 130.2, 130.1, 128.9, 128.8, 128.6, 128.1, 127.7, 126.7, 126.3, 126.2, 121.4, 121.0, 120.0, 119.1, 109.0, 33.8, 32.4; IR (KBr) ν : 2876, 1863, 1732, 1632, 1488, 1468, 1367, 1321, 1188, 1021, 988, 789, 743 cm^{-1} ; MS (m/z): HRMS (ESI-TOF) Calcd. for $\text{C}_{29}\text{H}_{20}\text{NaN}_2\text{O}_3$ ($[\text{M}+\text{Na}]^+$): 467.1366, Found: 467.1366.

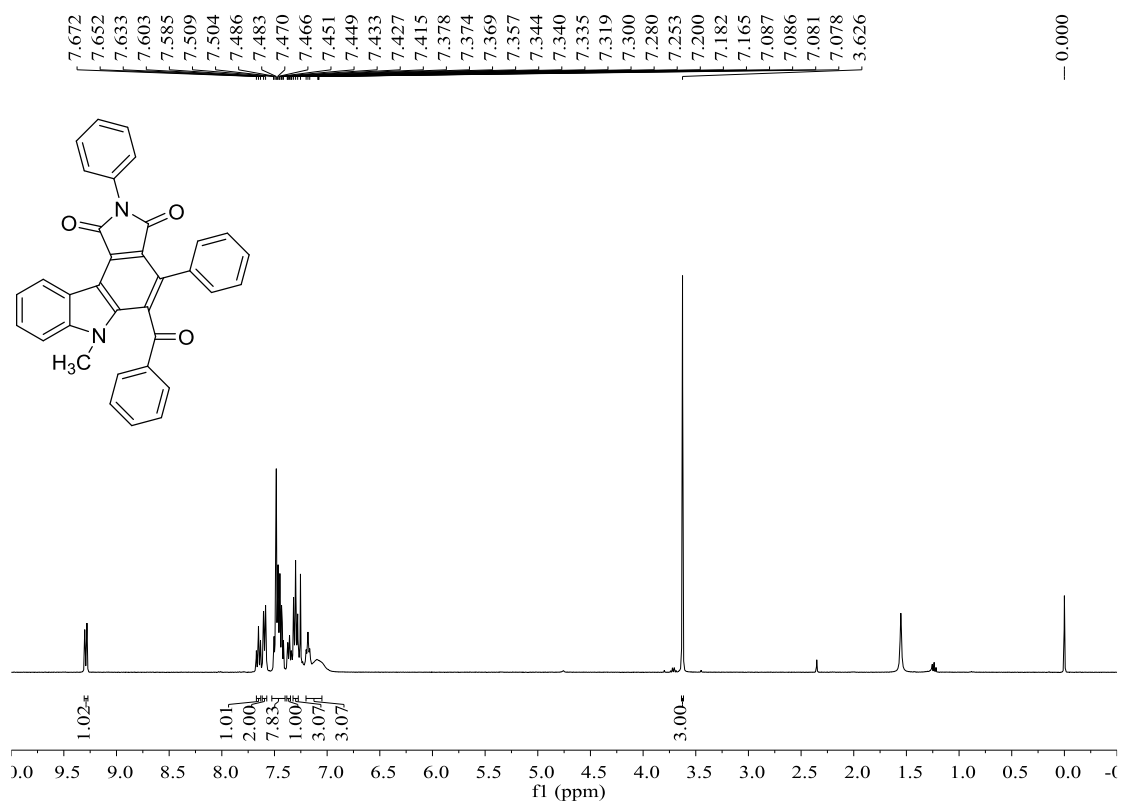


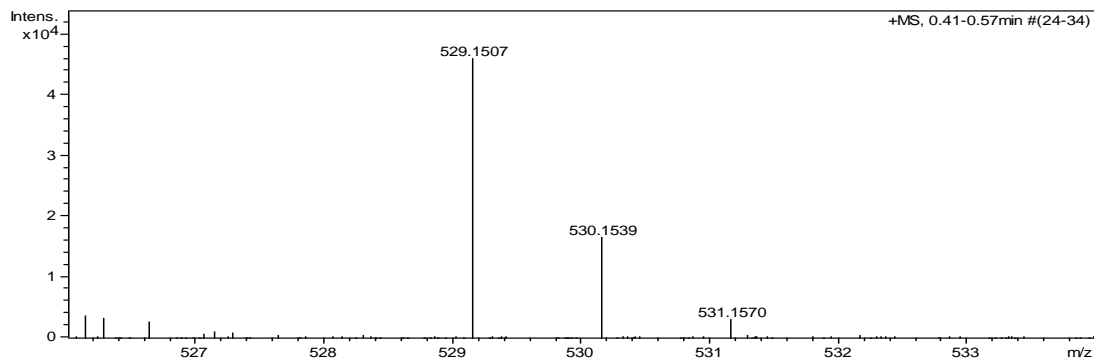
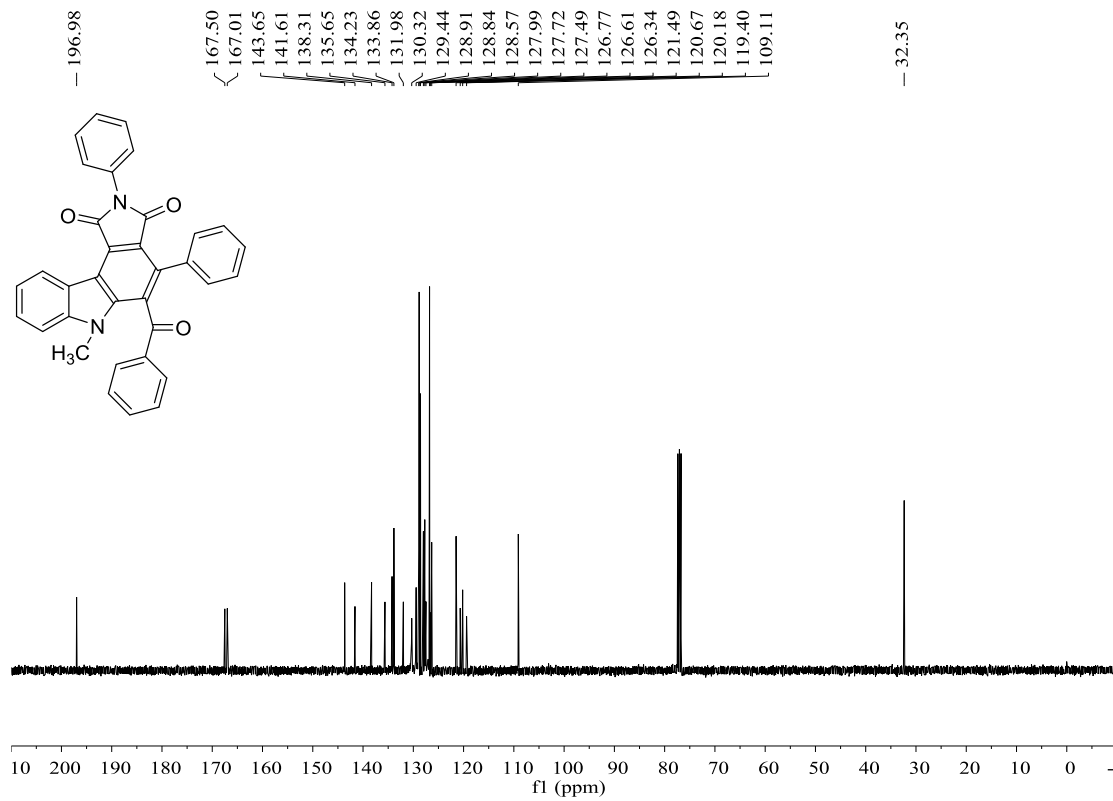


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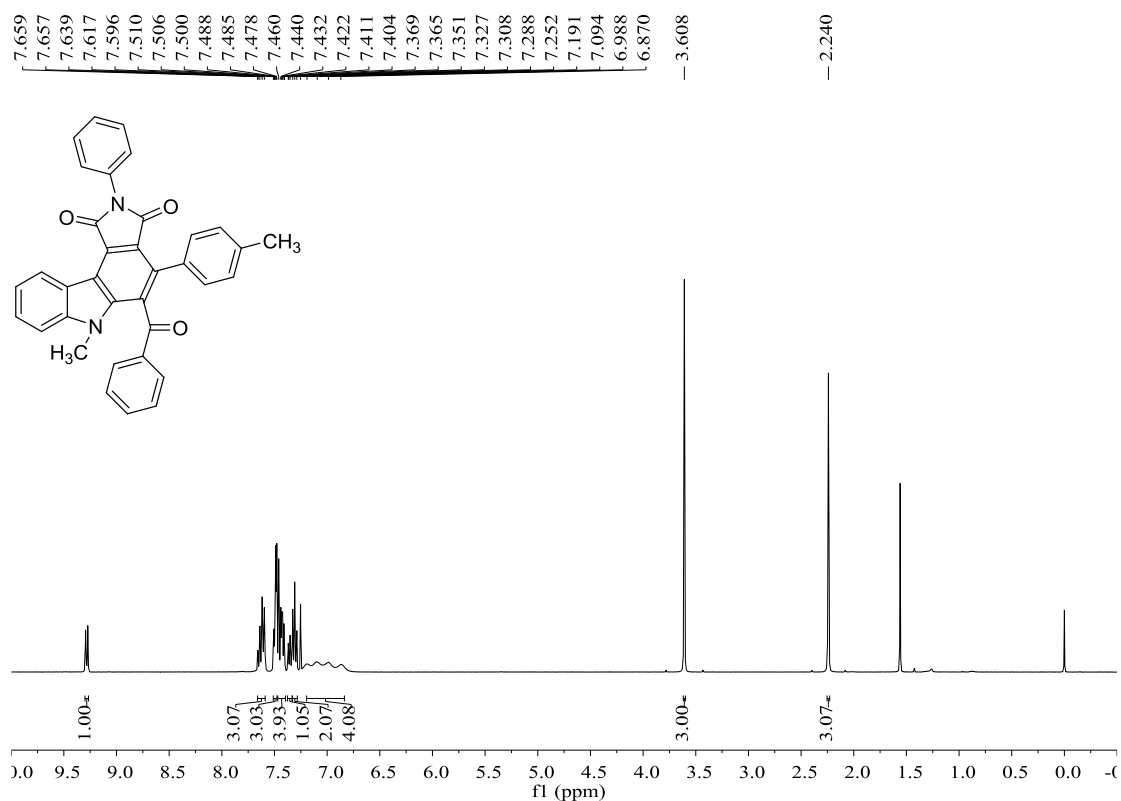


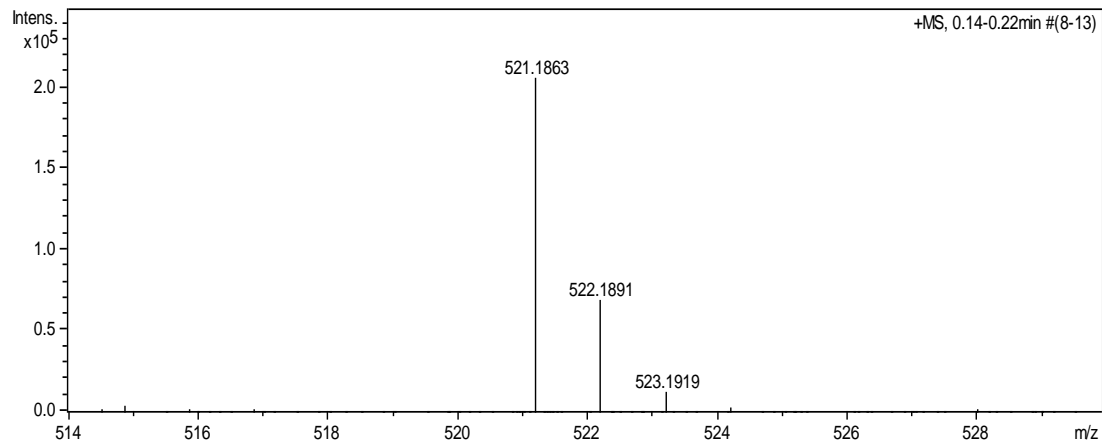
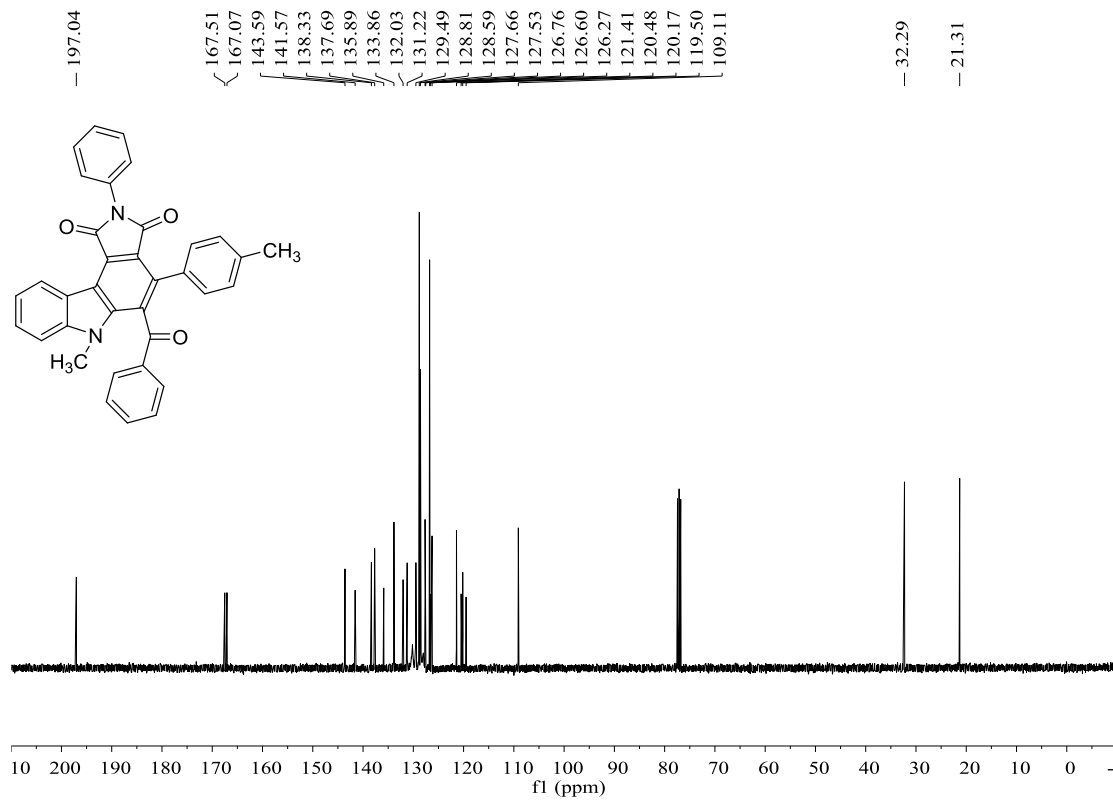
5-benzoyl-6-methyl-2,4-diphenylpyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-dione (4f): green solid, 84%, m.p. 218-220 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.29 (d, *J* = 8.0 Hz, 1H, ArH), 7.65 (t, *J* = 8.0 Hz, 1H, ArH), 7.60 (d, *J* = 7.2 Hz, 2H, ArH), 7.51-7.42 (m, 8H, ArH), 7.38-7.34 (m, 4H, ArH), 7.30 (t, *J* = 8.0 Hz, 3H, ArH), 7.20-7.08 (m, 3H, ArH), 3.63 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 196.9, 167.5, 167.0, 143.6, 141.6, 138.3, 135.6, 134.2, 133.8, 131.9, 130.3, 129.4, 128.9, 128.8, 128.5, 127.9, 127.7, 127.4, 126.7, 126.6, 126.3, 121.4, 120.6, 120.1, 119.4, 109.1, 32.3; IR (KBr) ν: 1831, 1725, 1611, 1495, 1458, 1375, 1321, 1185, 1021, 986, 793, 732 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₄₃H₃₃NaN₃O₄ ([M+Na]⁺): 529.1523, Found: 529.1507.



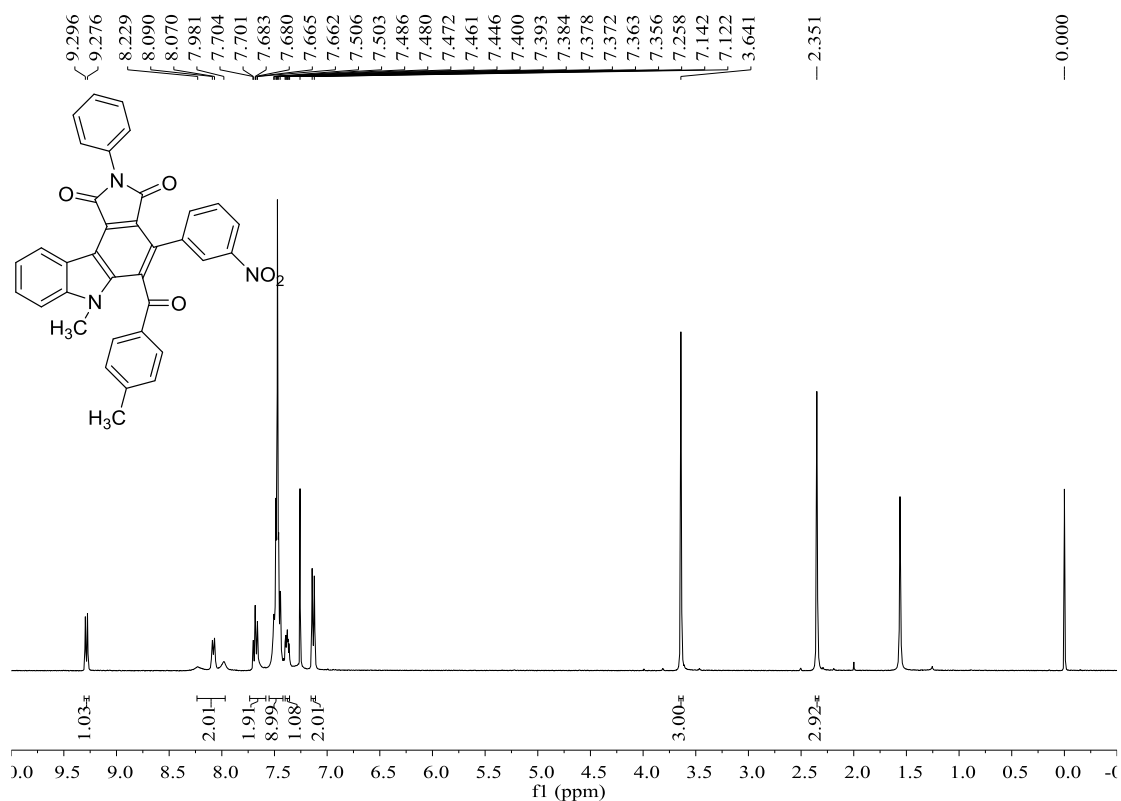


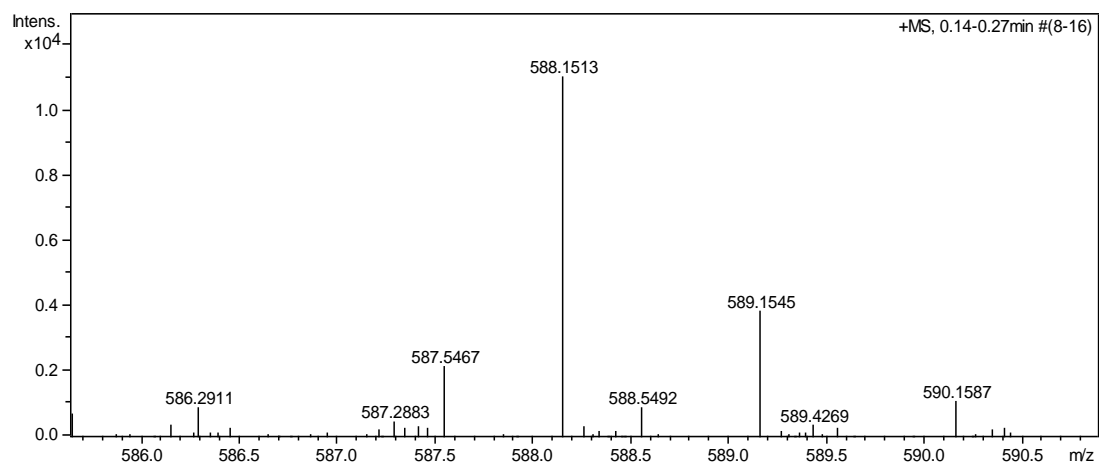
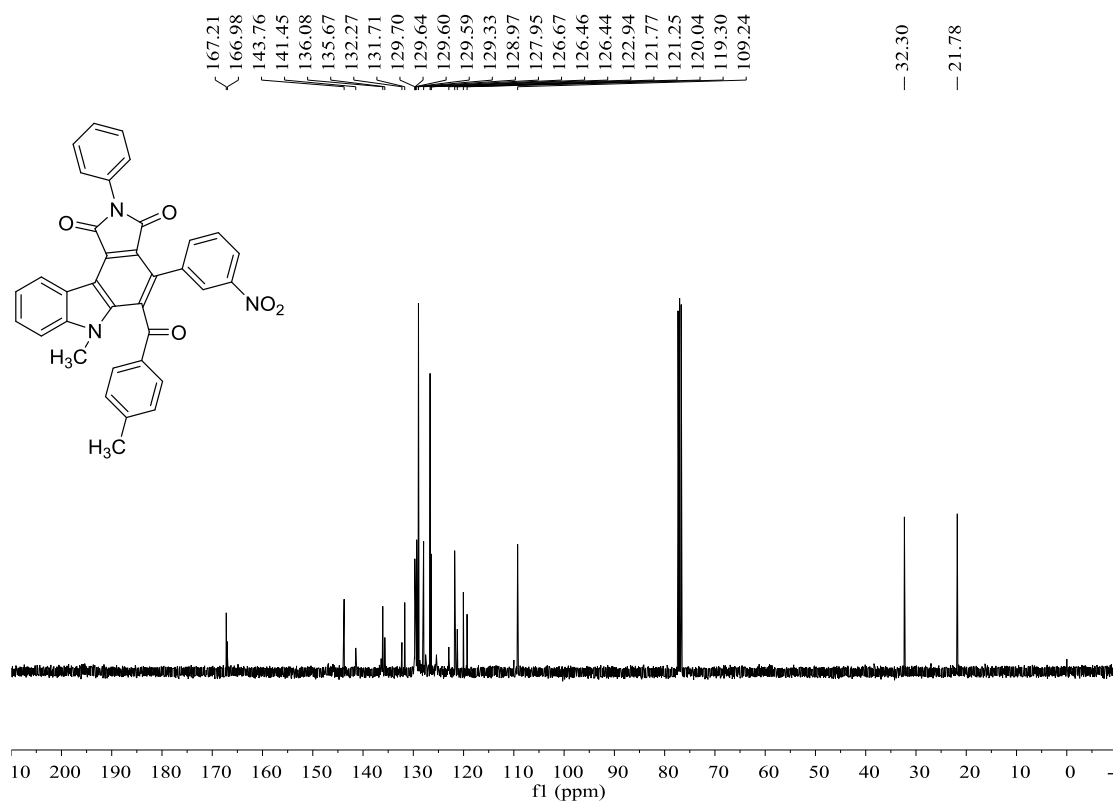
5-benzoyl-6-methyl-2-phenyl-4-(*p*-tolyl)pyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-dione (4g): green solid, 93%, m.p. 225-227 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.28 (d, *J* = 8.0 Hz, 1H, ArH), 7.66-7.60 (m, 3H, ArH), 7.51-7.48 (m, 3H, ArH), 7.46-7.40 (m, 4H, ArH), 7.37-7.35 (m, 1H, ArH), 7.31 (t, *J* = 8.0 Hz, 2H, ArH), 7.19-6.87 (m, 4H, ArH), 3.61 (s, 3H, CH₃), 2.24 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 197.0, 167.5, 167.0, 143.5, 141.5, 138.3, 137.6, 135.8, 133.8, 132.0, 131.2, 129.4, 128.8, 128.5, 127.6, 127.5, 126.7, 126.6, 126.2, 121.4, 120.4, 120.1, 119.4, 109.1, 32.2, 21.3; IR (KBr) ν: 2934, 1756, 1716, 1611, 1485, 1456, 1375, 1311, 1185, 1023, 974, 786, 747 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₅H₂₅N₂O₃ ([M+H]⁺): 521.1860, Found: 521.1863.



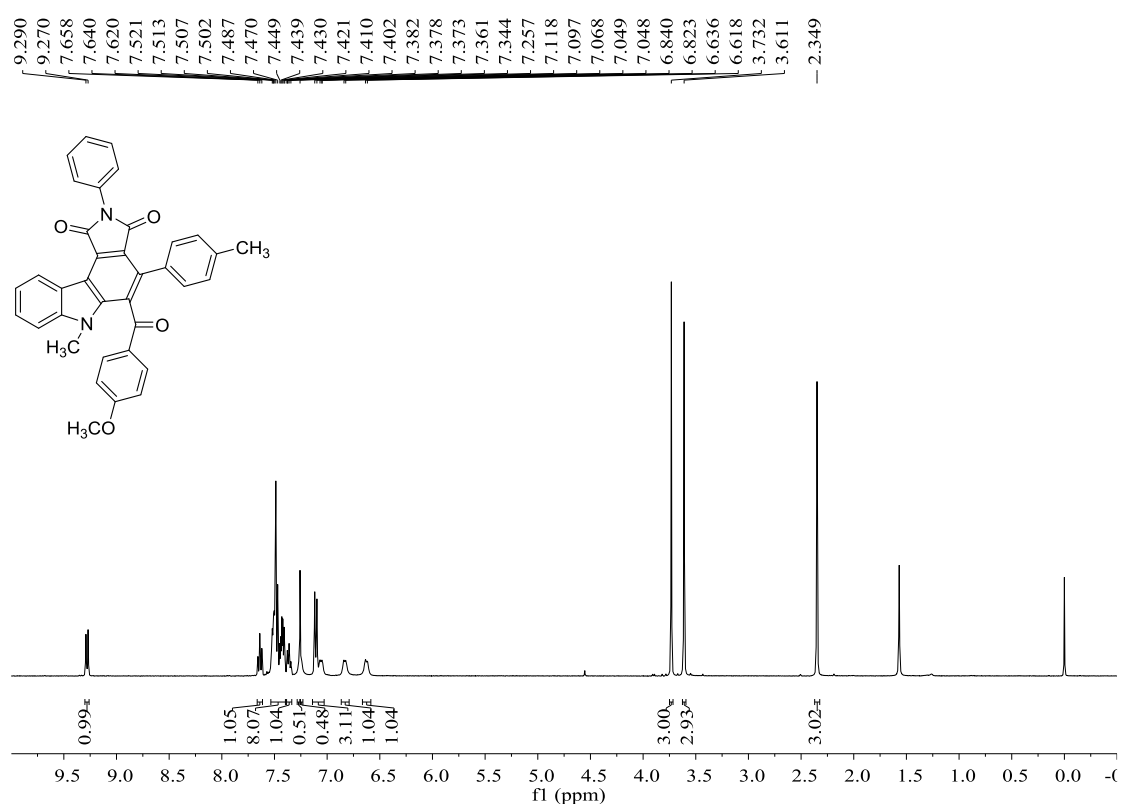


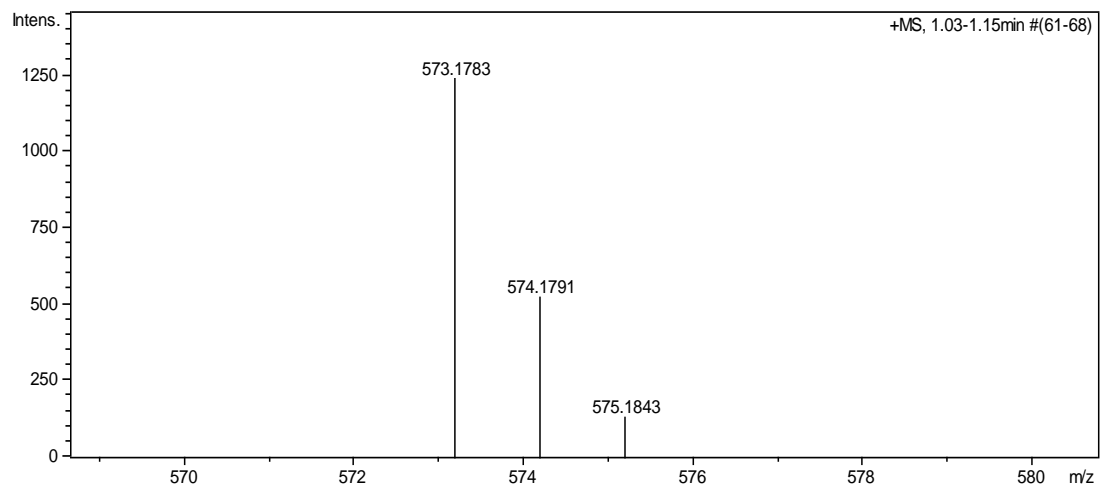
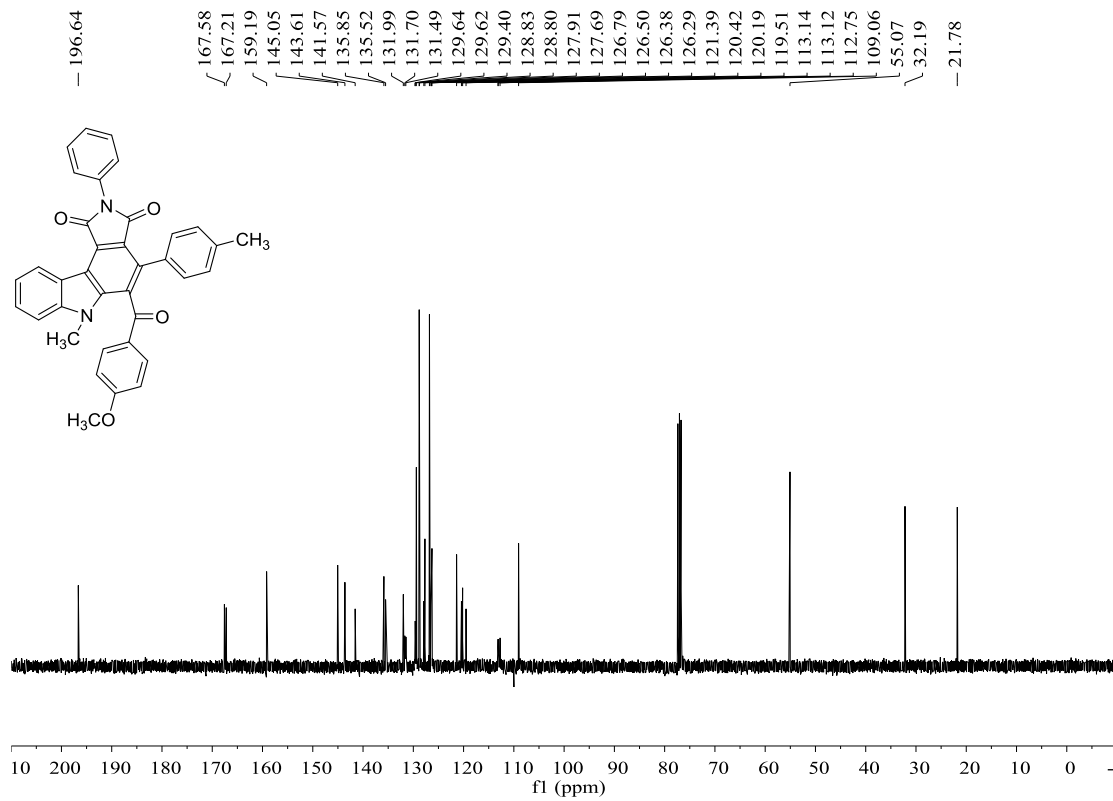
6-methyl-5-(4-methylbenzoyl)-4-(3-nitrophenyl)-2-phenylpyrrolo[3,4-c]carbazole-1,3(2H,6H)-dione (4h): yellow solid, 76%, m.p. 228-230 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.29 (d, *J* = 8.0 Hz, 1H, ArH), 8.23-7.98 (m, 2H, ArH), 7.70-7.66 (m, 2H, ArH), 7.51-7.45 (m, 9H, ArH), 7.40-7.36 (m, 1H, ArH), 7.13 (t, *J* = 8.0 Hz, 2H, ArH), 3.64 (s, 3H, CH₃), 2.35 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 167.2, 166.9, 143.7, 141.4, 136.0, 135.6, 132.2, 131.7, 129.7, 129.6, 129.5, 129.5, 129.3, 128.9, 127.9, 126.6, 126.4, 126.4, 122.9, 121.7, 121.2, 120.0, 119.3, 109.2, 32.3, 21.7; IR (KBr) ν: 2968, 1785, 1732, 1627, 1485, 1476, 1358, 1321, 1184, 1026, 975, 785, 736 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₅H₂₃NaN₃O₅ ([M+Na]⁺): 588.1530, Found: 588.1513.



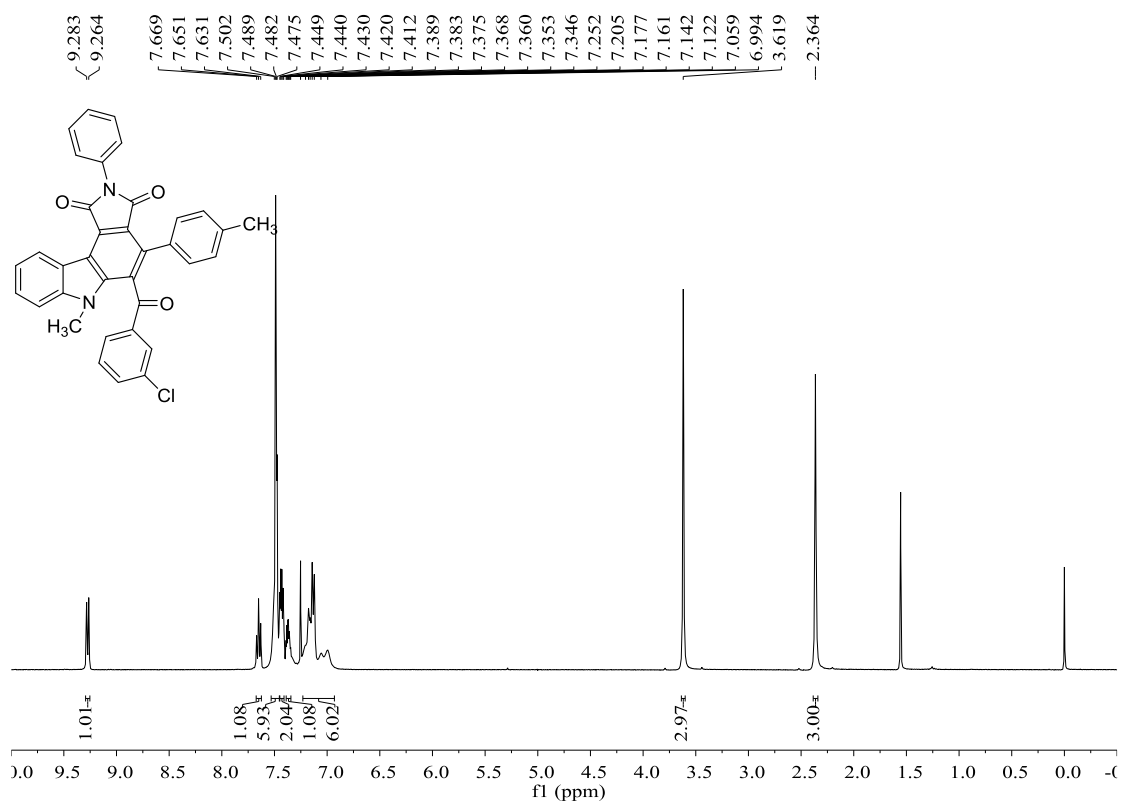


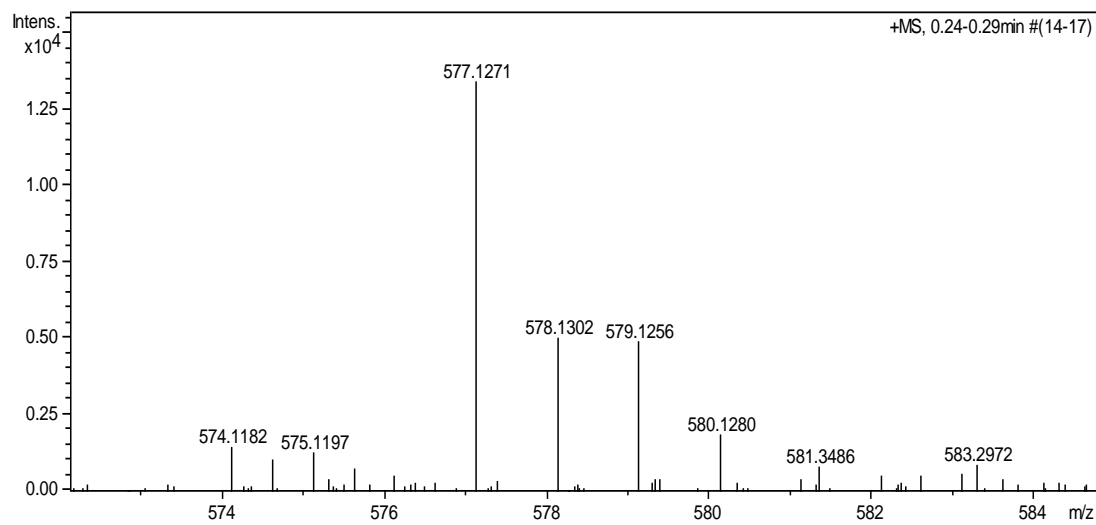
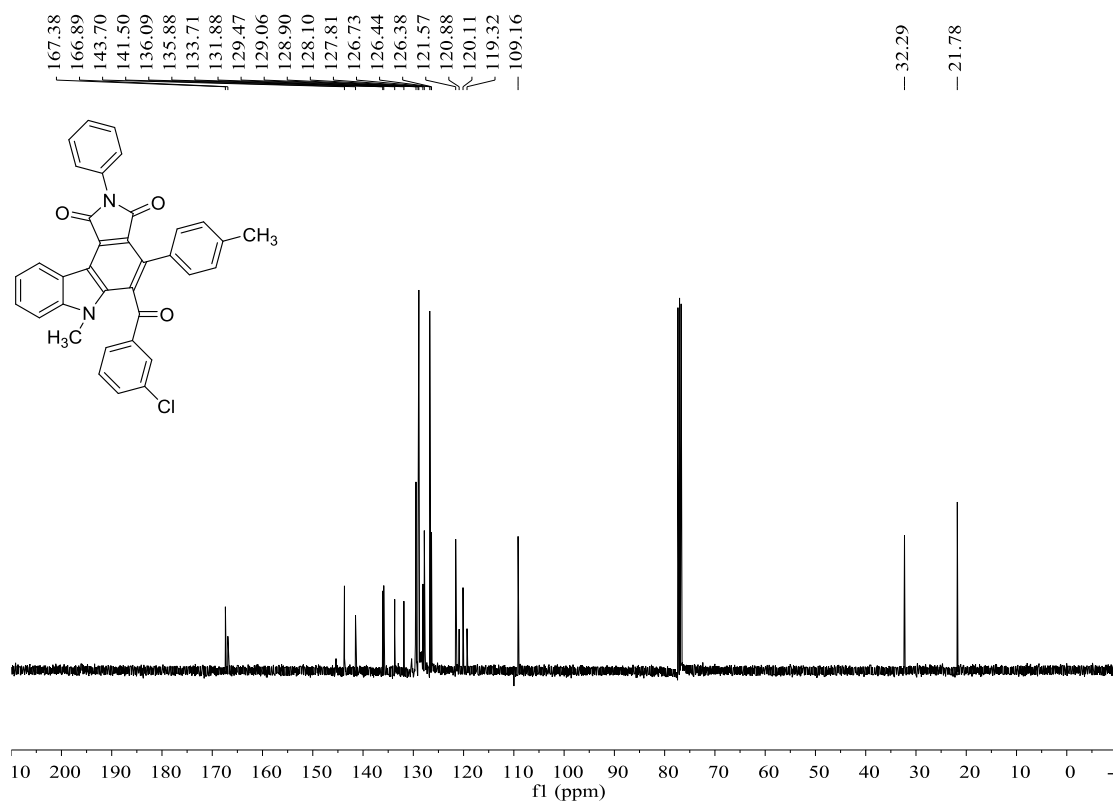
5-(4-methoxybenzoyl)-6-methyl-2-phenyl-4-(*p*-tolyl)pyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-dione (4i): yellow solid, 86%, m.p. 232-234 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.28 (d, *J* = 8.0 Hz, 1H, ArH), 7.64 (t, *J* = 8.0 Hz, 1H, ArH), 7.52-7.40 (m, 8H, ArH), 7.38-7.34 (m, 1H, ArH), 7.26 (s, 1H, ArH), 7.12-7.05 (m, 3H, ArH), 6.83 (d, *J* = 6.8 Hz, 1H, ArH), 6.63 (d, *J* = 7.2 Hz, 1H, ArH), 3.73 (s, 3H, OCH₃), 3.61 (s, 3H, OCH₃), 2.35 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 196.6, 167.5, 167.2, 159.1, 145.0, 143.6, 141.5, 135.8, 135.5, 131.9, 131.6, 131.4, 129.6, 129.6, 129.3, 128.8, 128.7, 127.9, 127.6, 126.7, 126.5, 126.3, 126.2, 121.3, 120.4, 120.1, 119.5, 113.1, 113.1, 112.7, 109.0, 55.0, 32.1, 21.7; IR (KBr) ν: 3056, 1832, 1754, 1611, 1524, 1474, 1368, 1311, 1185, 1023, 985, 787, 747 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₆H₂₆NaN₂O₄ ([M+Na]⁺): 573.1785, Found: 573.1783.



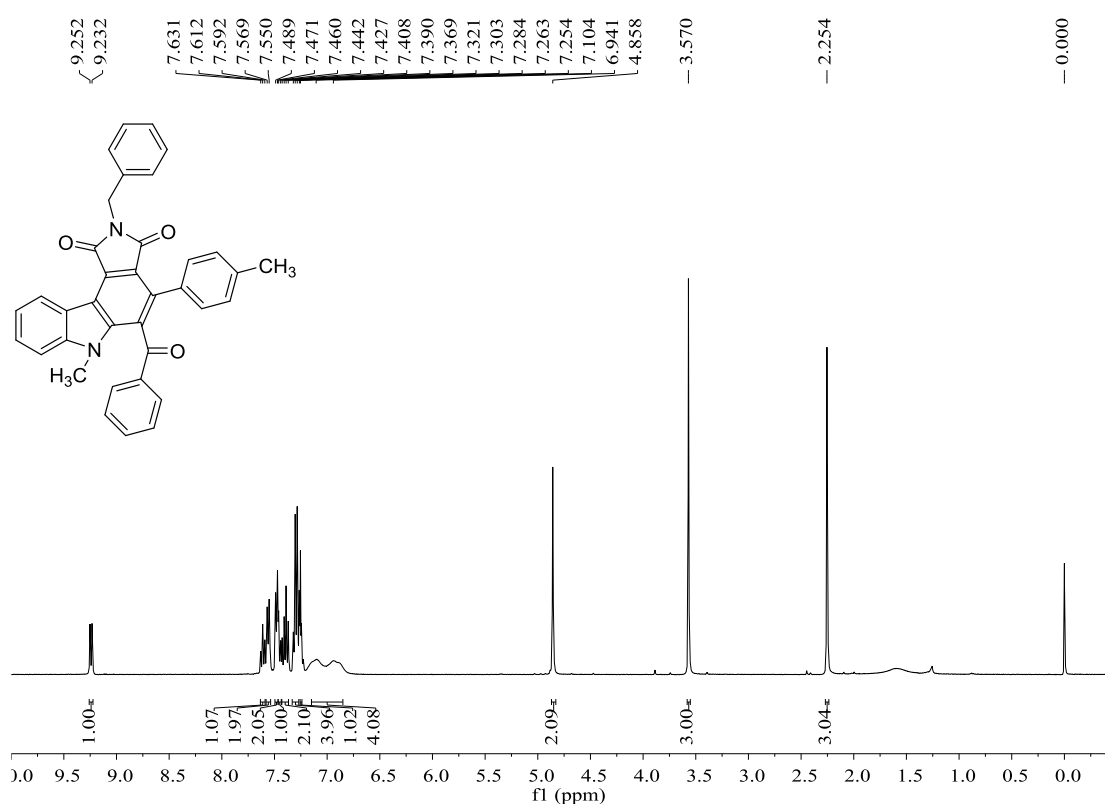


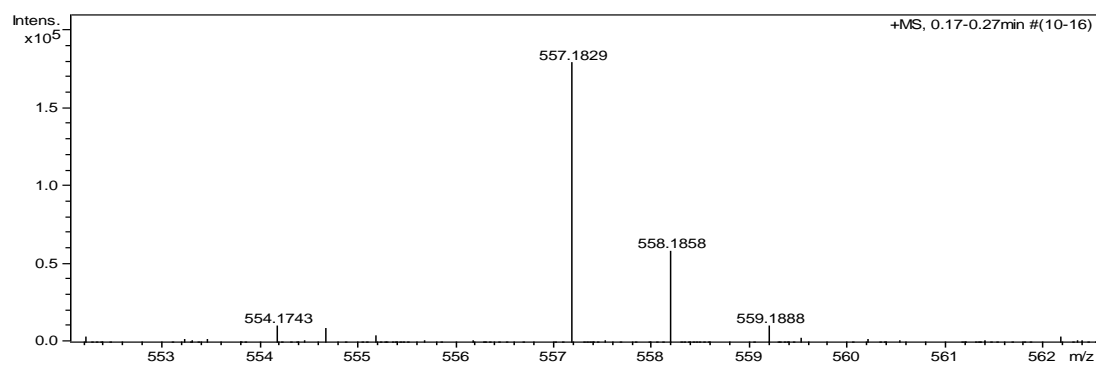
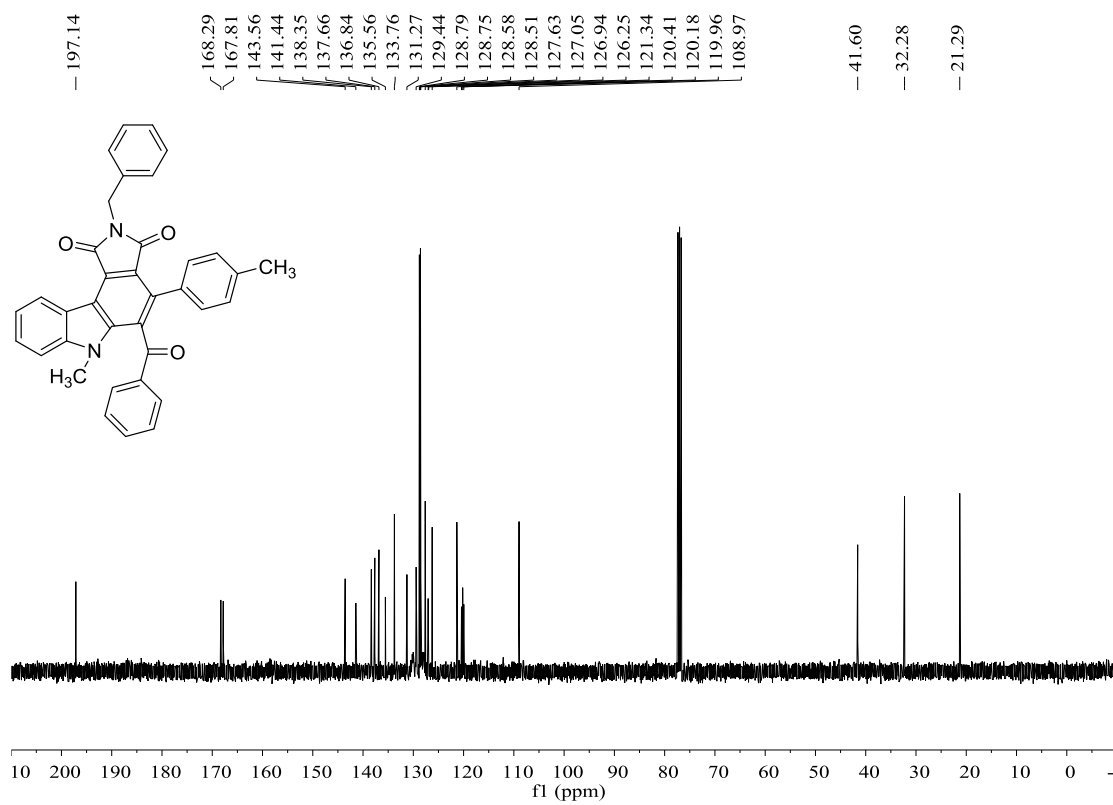
5-(3-chlorobenzoyl)-6-methyl-2-phenyl-4-(*p*-tolyl)pyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-dione (4j): green solid, 84%, m.p. 211-213 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.27 (d, *J* = 7.6 Hz, 1H, ArH), 7.65 (t, *J* = 8.0 Hz, 1H, ArH), 7.50-7.48 (m, 6H, ArH), 7.45-7.41 (m, 2H, ArH), 7.39-7.35 (m, 1H, ArH), 7.21-6.99 (m, 6H, ArH), 3.62 (s, 3H, CH₃), 2.36 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 167.3, 166.8, 143.6, 141.4, 136.0, 135.8, 133.7, 131.8, 129.4, 129.0, 128.9, 128.1, 127.8, 126.7, 126.4, 126.3, 121.5, 120.8, 120.1, 119.3, 109.1, 32.2, 21.7; IR (KBr) ν: 2932, 1832, 1723, 1621, 1588, 1456, 1354, 1321, 1186, 1023, 956, 789, 768 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₅H₂₃ClNaN₂O₃ ([M+Na]⁺): 577.1289, Found: 577.1271.





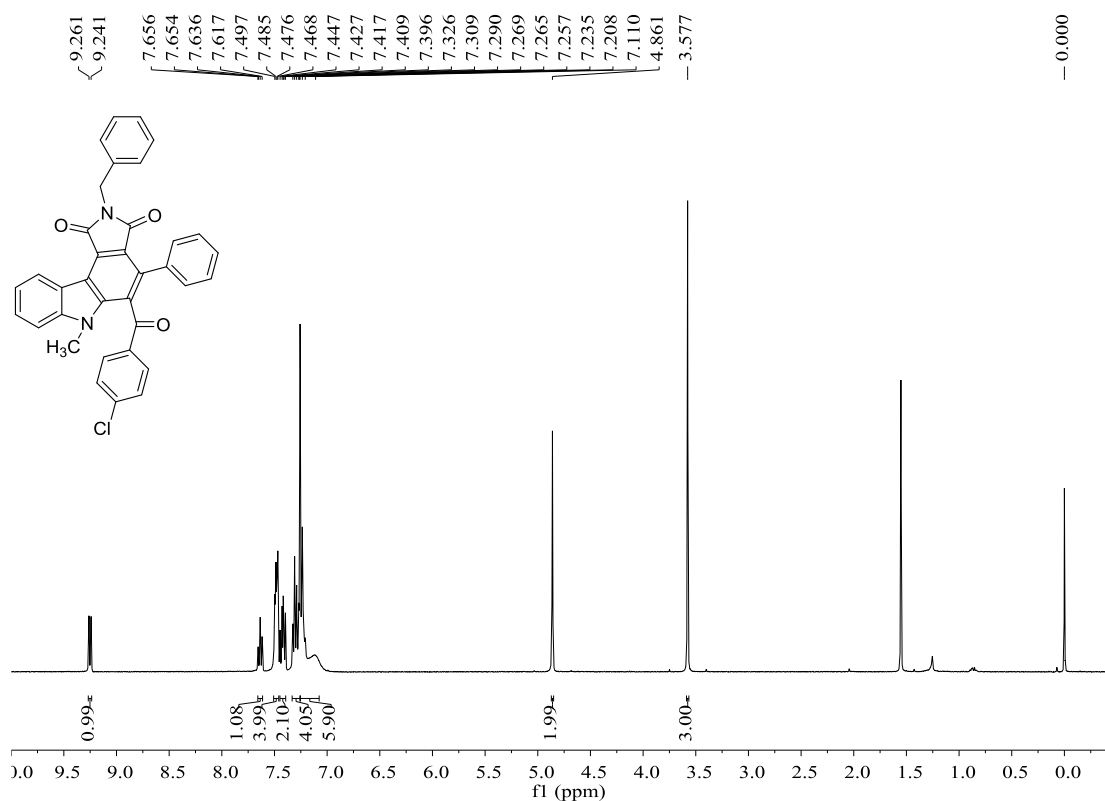
5-benzoyl-2-benzyl-6-methyl-4-(*p*-tolyl)pyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-dione (4k): green solid, 93%, m.p. >300 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.24 (d, *J* = 8.0 Hz, 1H, ArH), 7.61 (t, *J* = 8.0 Hz, 1H, ArH), 7.56 (d, *J* = 7.6 Hz, 2H, ArH), 7.49-7.44 (m, 3H, ArH), 7.43-7.37 (m, 2H, ArH), 7.32-7.28 (m, 4H, ArH), 7.25-7.23 (m, 1H, ArH), 7.10-6.94 (m, 4H, ArH), 4.86 (s, 2H, CH), 3.57 (s, 3H, CH₃), 2.25 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 197.1, 168.2, 167.8, 143.5, 141.4, 138.3, 137.6, 136.8, 135.5, 133.7, 131.2, 129.4, 128.8, 128.7, 128.6, 128.5, 127.6, 127.0, 126.9, 126.2, 121.3, 120.4, 120.1, 119.9, 108.9, 41.5, 32.2, 21.2; IR (KBr) ν: 2967, 1876, 1754, 1632, 1556, 1468, 1378, 1323, 1186, 1023, 965, 785, 736 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₆H₂₆NaN₂O₃ ([M+Na]⁺): 557.1836, Found: 557.1829.

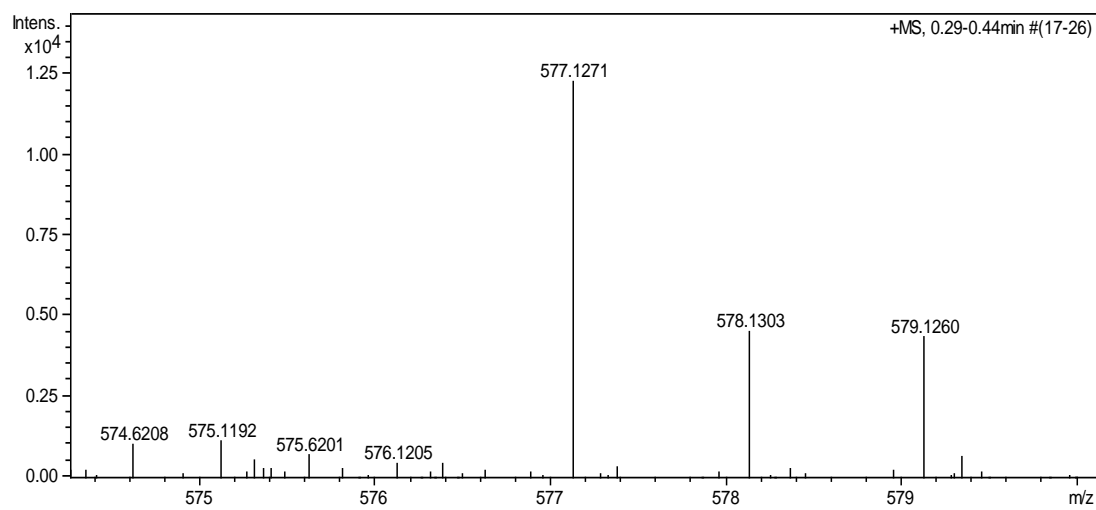
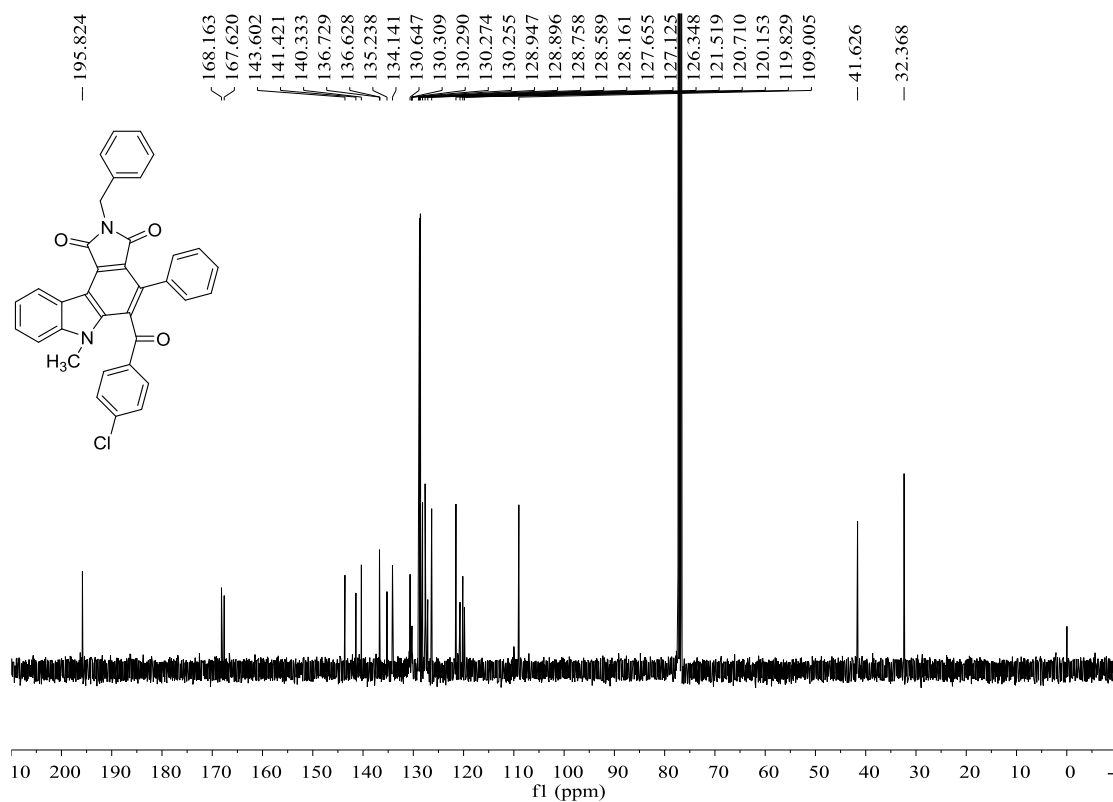




2-benzyl-5-(4-chlorobenzoyl)-6-methyl-4-phenylpyrrolo[3,4-*c*]carbazole-1,3(2*H*,6*H*)-

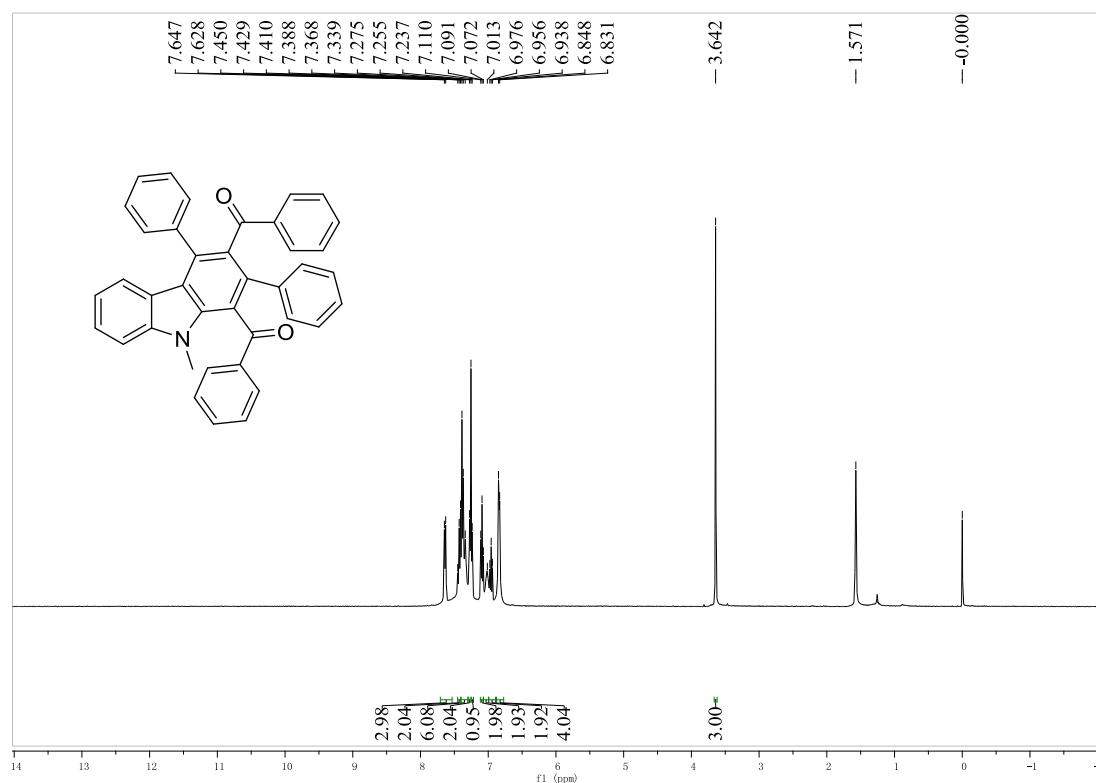
dione (4l): yellow solid, 87%, m.p. 215-217 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.25 (d, *J* = 8.0 Hz, 1H, ArH), 7.66-7.62 (m, 1H, ArH), 7.50-7.47 (m, 4H, ArH), 7.45-7.40 (m, 2H, ArH), 7.33-7.27 (m, 4H, ArH), 7.24-7.11 (m, 6H, ArH), 4.86 (s, 2H, CH), 3.58 (s, 3H, CH₃); ¹³C {¹H} NMR (100 MHz, CDCl₃) δ: 195.8, 168.1, 167.6, 143.6, 141.4, 140.3, 136.7, 136.6, 135.2, 134.1, 130.6, 130.3, 130.2, 130.2, 130.2, 128.9, 128.8, 128.7, 128.5, 128.1, 127.6, 127.1, 126.3, 121.5, 120.7, 120.1, 119.8, 109.0, 41.6, 32.3; IR (KBr) ν: 1835, 1723, 1653, 1527, 1468, 1367, 1321, 1186, 1023, 986, 785, 768 cm⁻¹; MS (*m/z*): HRMS (ESI-TOF) Calcd. for C₃₅H₂₃ClN₂O₃ ([M+Na]⁺): 577.1289, Found: 577.1271.

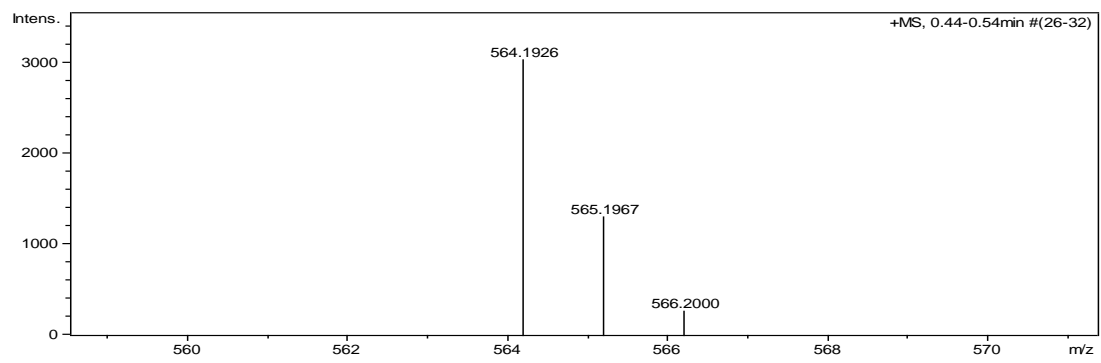
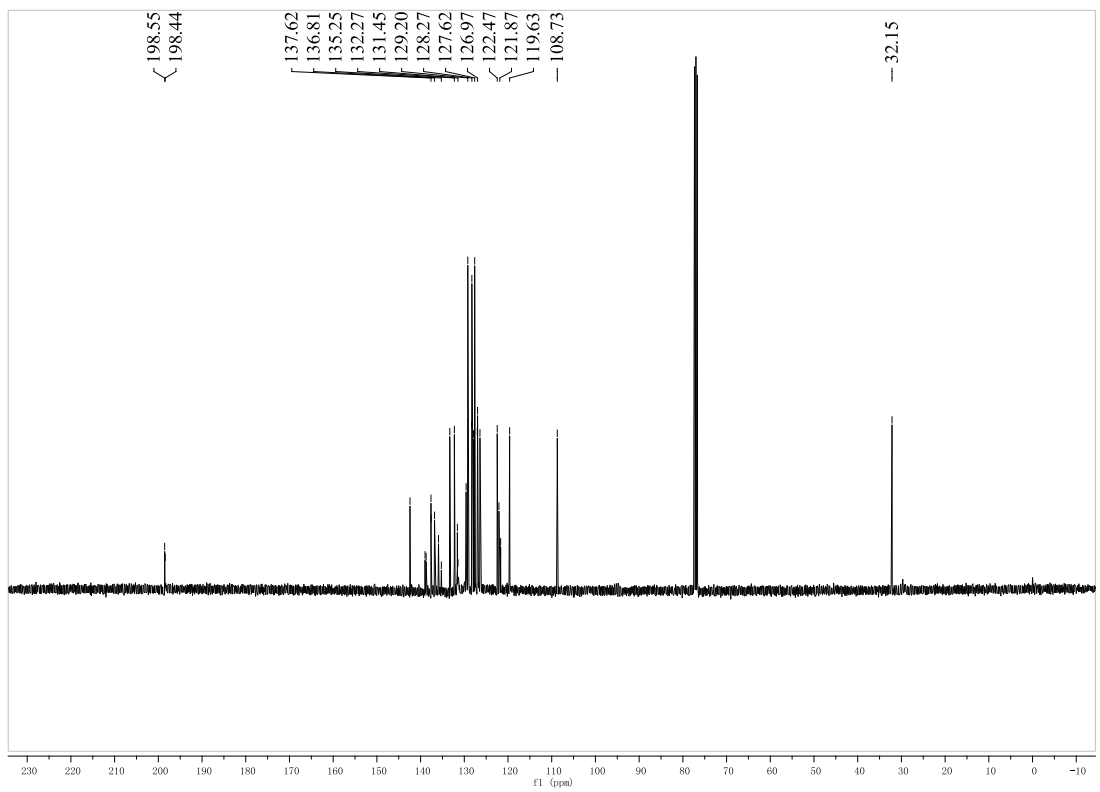




(9-methyl-2,4-diphenyl-9H-carbazole-1,3-diyl)bis(phenylmethanone) (6a):

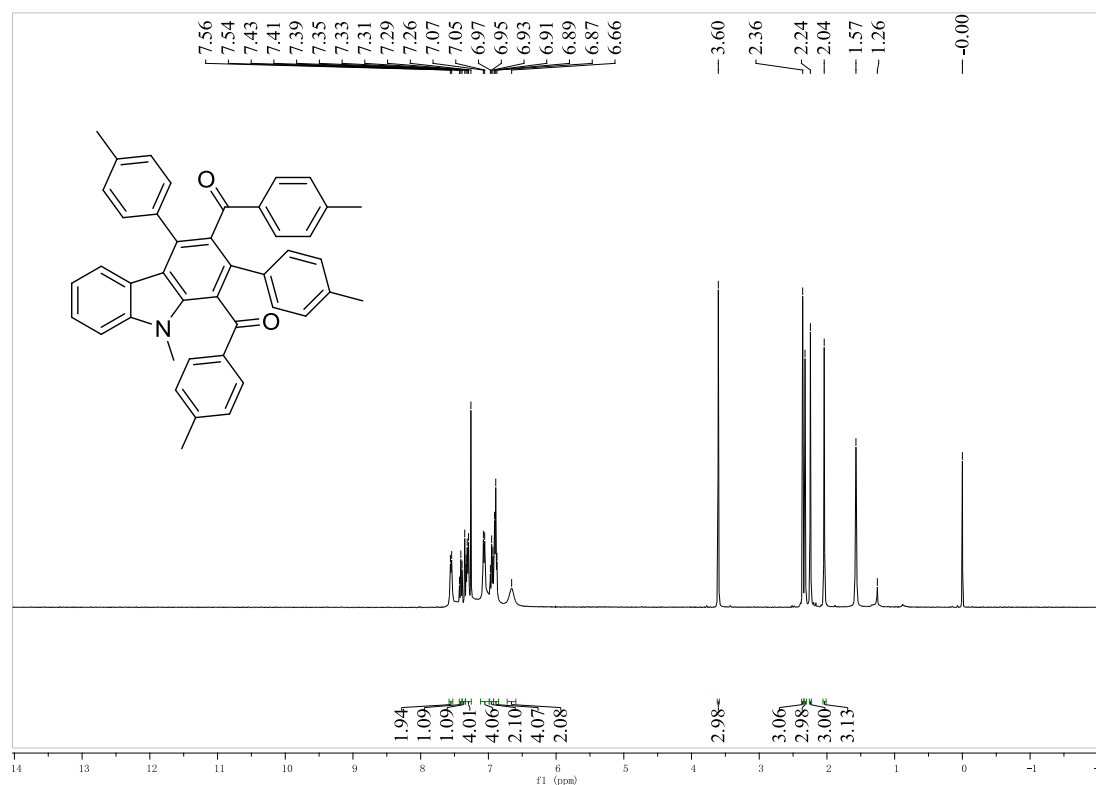
White solid, 61%, m.p. 249-251 °C; ^1H NMR (400 MHz, CDCl_3) δ : 7.64 (d, $J = 7.6$ Hz, 3H, ArH), 7.43 (t, $J = 7.8$ Hz, 2H, ArH), 7.39-7.34 (m, 6H, ArH), 7.28-7.24 (m, 3H, ArH), 7.09 (t, $J = 7.6$ Hz, 2H, ArH), 7.01 (s, 2H, ArH), 6.96 (t, $J = 7.8$ Hz, 2H, ArH), 6.84 (d, $J = 6.8$ Hz, 4H, ArH), 3.64 (s, 3H, CH_3); ^{13}C NMR (400 MHz, CDCl_3) δ : 198.5, 198.4, 142.4, 138.9, 138.7, 137.6, 137.5, 136.8, 135.9, 135.2, 133.3, 132.2, 131.5, 131.4, 129.5, 129.2, 128.3, 128.2, 127.8, 127.6, 127.0, 126.9, 126.4, 122.4, 122.0, 121.8, 121.6, 119.6, 108.7, 32.1; IR(KBr) ν : 3057, 3023, 2907, 2360, 2339, 1720, 1605, 1482, 1320, 1267, 1172, 1009, 936, 805, 743, 612, 447 cm^{-1} ; MS (m/z): HRMS (ESI) Calcd. for $\text{C}_{39}\text{H}_{27}\text{NO}_2$ ($[\text{M}+\text{Na}]^+$): 564.1934, found: 564.1926.

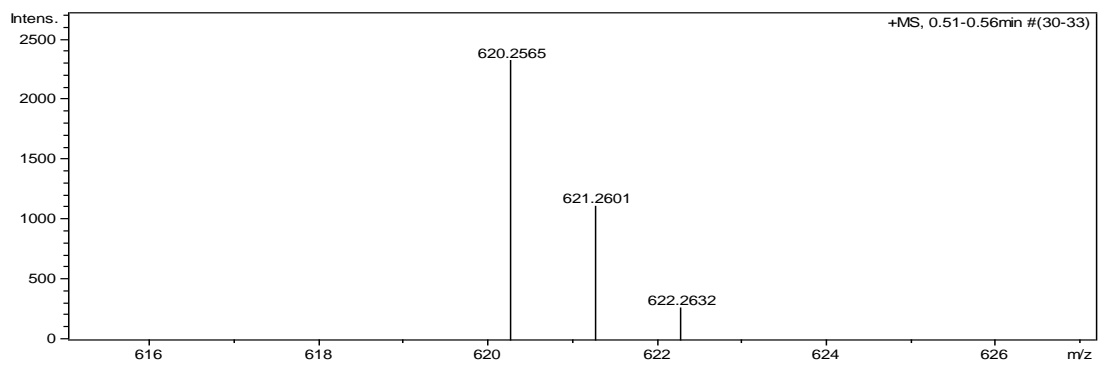
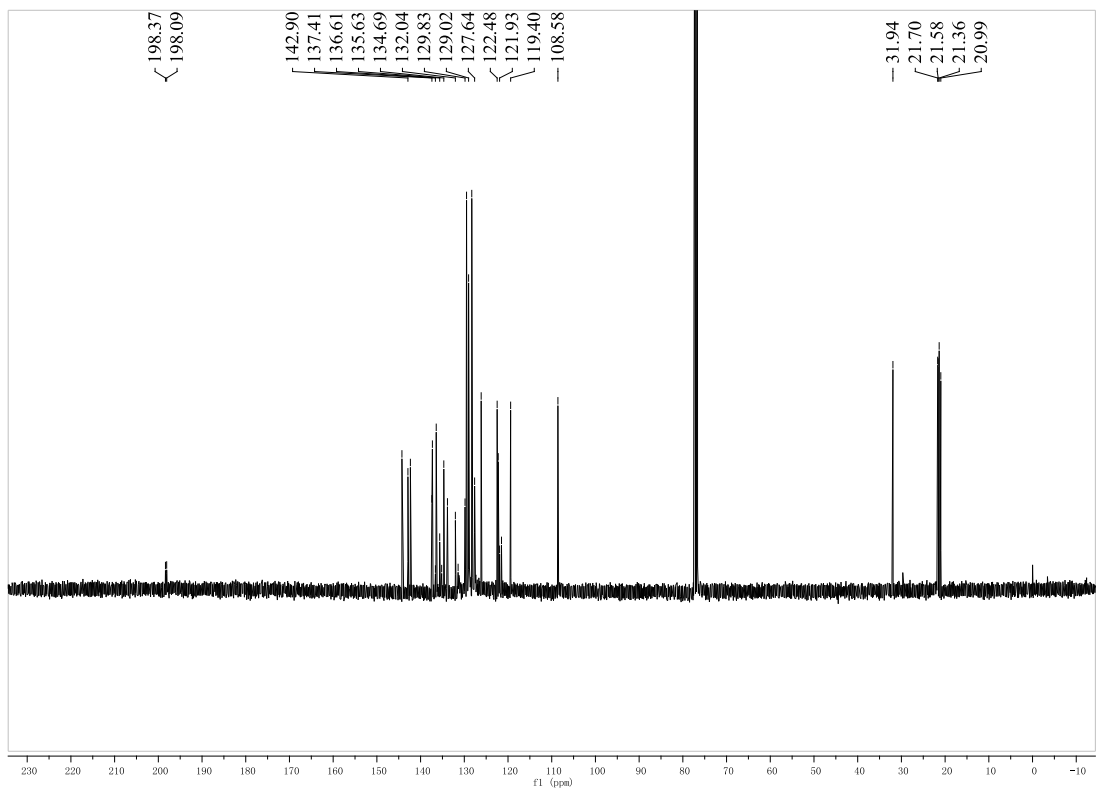




(9-methyl-2,4-di-p-tolyl-9H-carbazole-1,3-diyl)bis(p-tolylmethanone) (6b):

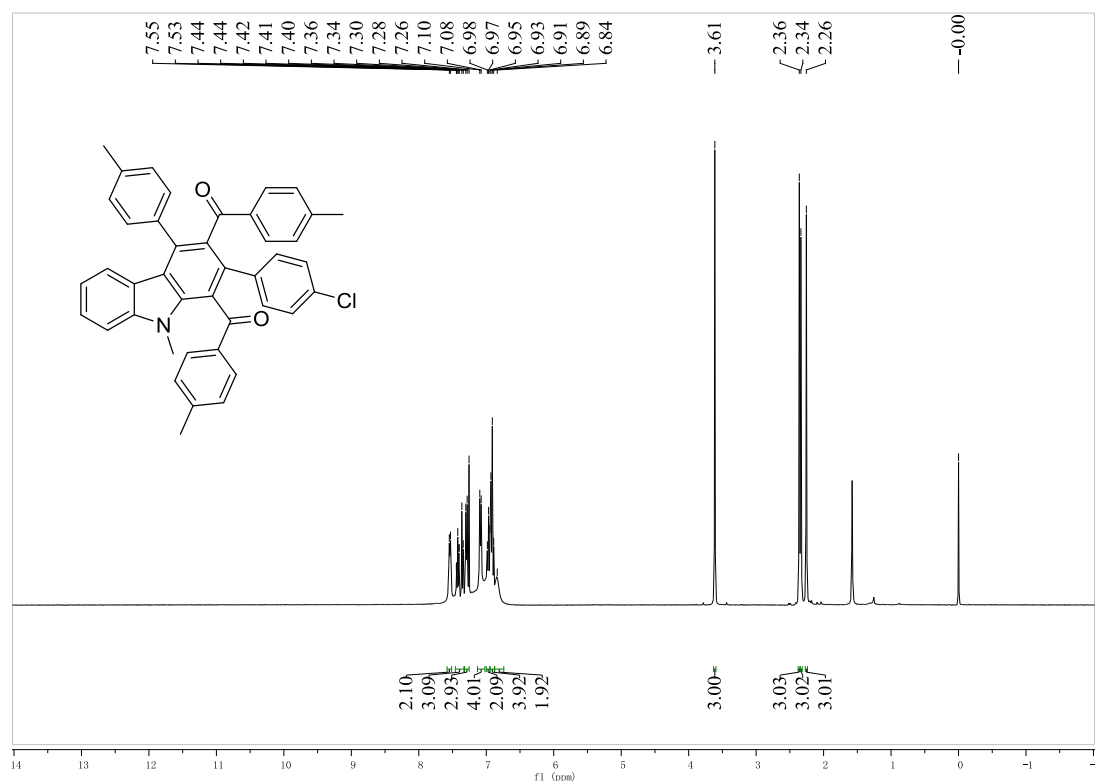
White solid, 63%, m.p. 174-175 °C; ^1H NMR (400 MHz, CDCl_3) δ : 7.55 (d, $J = 7.2$ Hz, 2H, ArH), 7.41 (t, $J = 7.6$ Hz, 1H, ArH), 7.35 (s, 1H, ArH), 7.33-7.26 (m, 4H, ArH), 7.06 (d, $J = 7.6$ Hz, 4H, ArH), 6.95 (t, $J = 7.6$ Hz, 2H, ArH), 6.89 (t, $J = 7.6$ Hz, 4H, ArH), 6.66 (s, 2H, ArH), 3.60 (s, 3H, CH_3), 2.36 (s, 3H, CH_3), 2.32 (s, 3H, CH_3), 2.25 (s, 3H, CH_3), 2.04 (s, 3H, CH_3); ^{13}C NMR (400 MHz, CDCl_3) δ : 198.3, 198.0, 144.2, 142.8, 142.3, 137.4, 137.2, 136.6, 136.4, 135.6, 135.1, 134.6, 133.8, 132.0, 131.4, 129.8, 129.4, 129.0, 128.2, 127.6, 126.1, 122.4, 122.2, 121.9, 121.4, 119.4, 108.5, 31.9, 21.7, 21.5, 21.3, 20.9; IR(KBr) ν : 3025, 2919, 2863, 2339, 1720, 1605, 1482, 1320, 1267, 1172, 1009, 937, 818, 773, 670, 447 cm^{-1} ; MS (m/z): HRMS (ESI) Calcd. for $\text{C}_{43}\text{H}_{35}\text{NO}_2$ ($[\text{M}+\text{Na}]^+$): 620.2560, found: 620.2565.

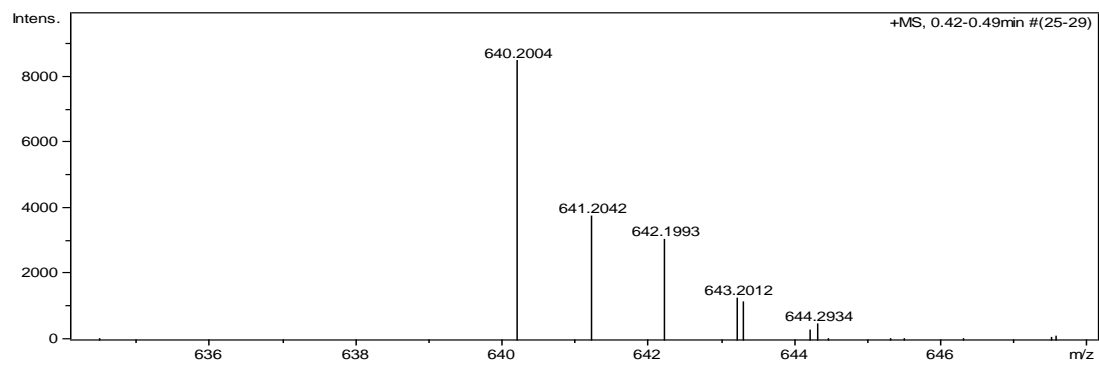
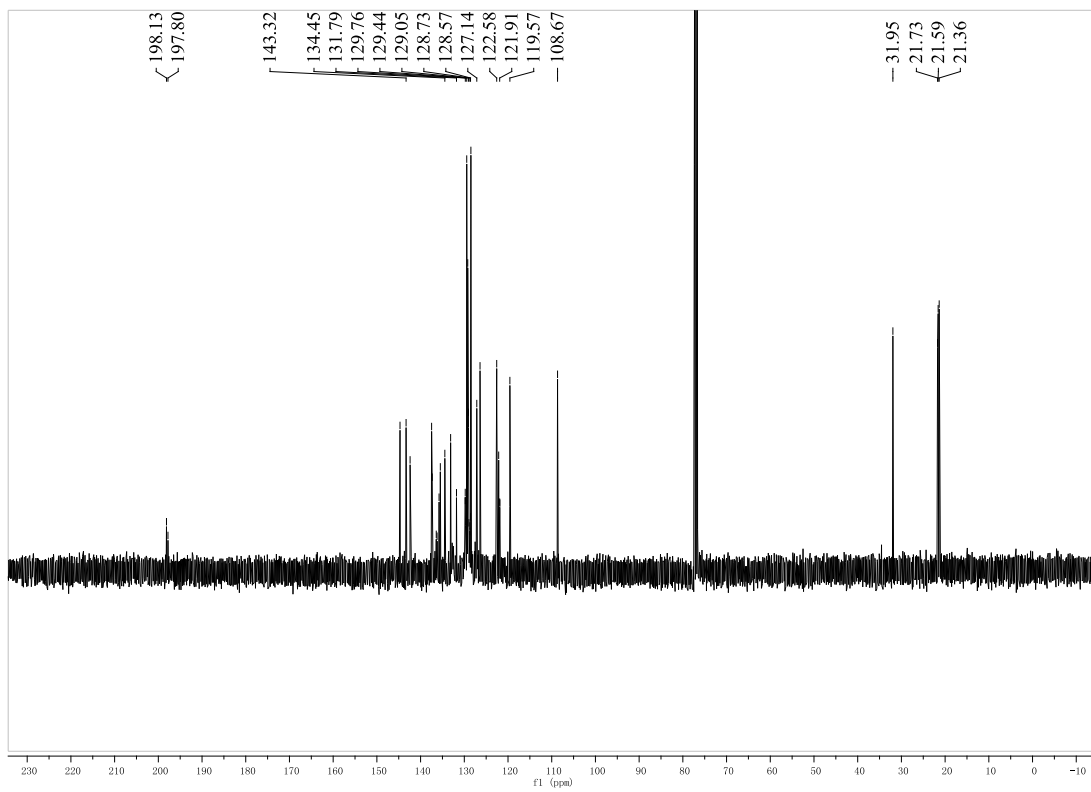




(2-(4-chlorophenyl)-9-methyl-4-(p-tolyl)-9H-carbazole-1,3-diyl)bis(p-tolylmethanone)
(6c):

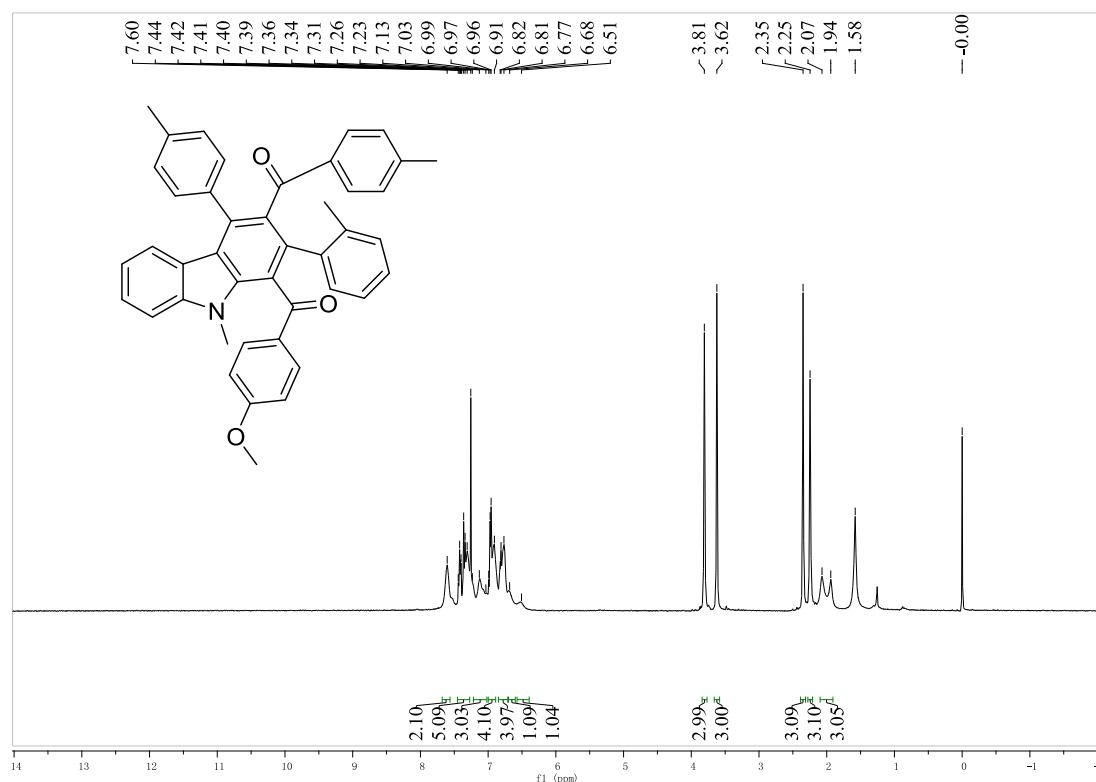
White solid, 68%, m.p. 171-173 °C; ^1H NMR (400 MHz, CDCl_3) δ : 7.54 (d, $J = 7.2$ Hz, 2H, ArH), 7.44-7.34 (m, 3H, ArH), 7.30-7.26 (m, 3H, ArH), 7.09 (d, $J = 8.0$ Hz, 4H, ArH), 6.97 (t, $J = 7.6$ Hz, 2H, ArH), 6.93-6.89 (m, 4H, ArH), 6.84 (s, 2H, ArH), 3.61 (s, 3H, CH_3), 2.36 (s, 3H, CH_3), 2.34 (s, 3H, CH_3), 2.26 (s, 3H, CH_3); ^{13}C NMR (400 MHz, CDCl_3) δ : 198.1, 197.7, 144.7, 143.3, 142.4, 137.4, 137.3, 136.4, 136.2, 135.7, 135.4, 134.4, 133.1, 131.7, 129.7, 129.7, 129.5, 129.4, 129.2, 129.0, 128.9, 128.7, 128.6, 128.5, 128.4, 127.1, 126.4, 122.5, 122.1, 121.9, 121.8, 119.5, 108.6, 31.9, 21.7, 21.5, 21.3; IR(KBr) ν : 3021, 2917, 2863, 2339, 1721, 1605, 1481, 1320, 1267, 1172, 1009, 937, 818, 773, 670, 447 cm^{-1} ; MS (m/z): HRMS (ESI) Calcd. for $\text{C}_{42}\text{H}_{32}\text{ClNO}_2$ ($[\text{M}+\text{Na}]^+$): 640.2014, found: 640.2004.

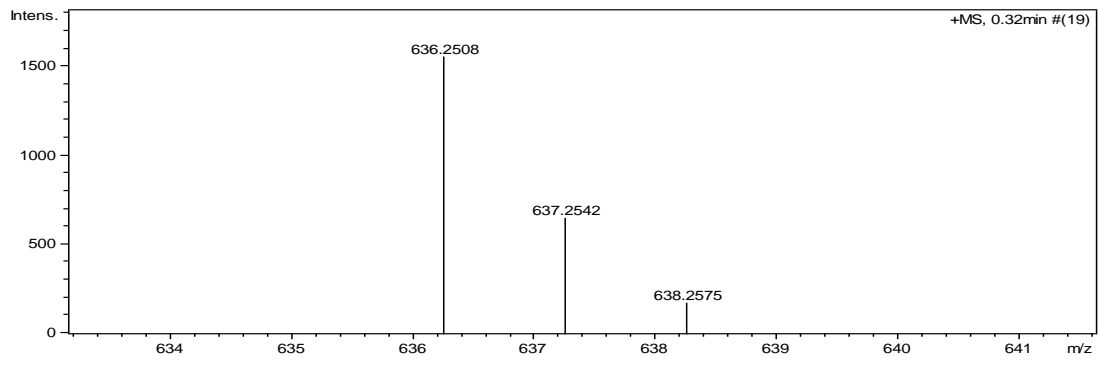
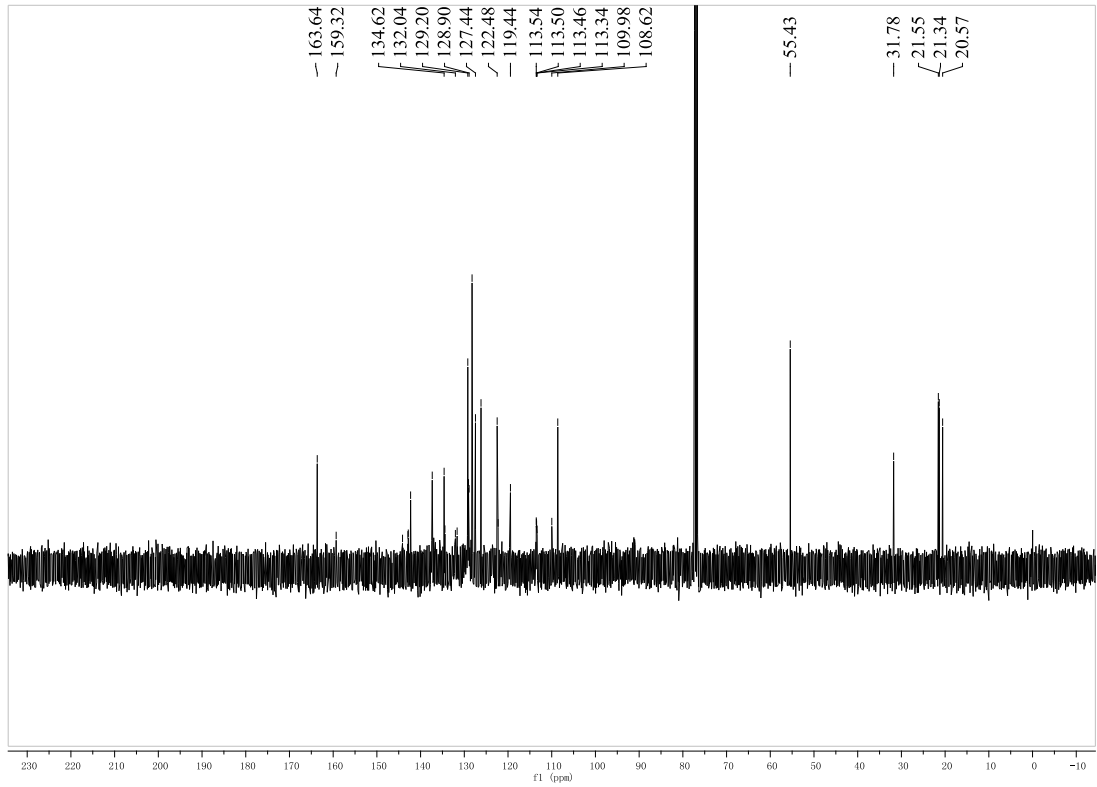




(1-(4-methoxybenzoyl)-9-methyl-2-(o-tolyl)-4-(p-tolyl)-9H-carbazol-3-yl)(p-tolyl)methanone) (6d):

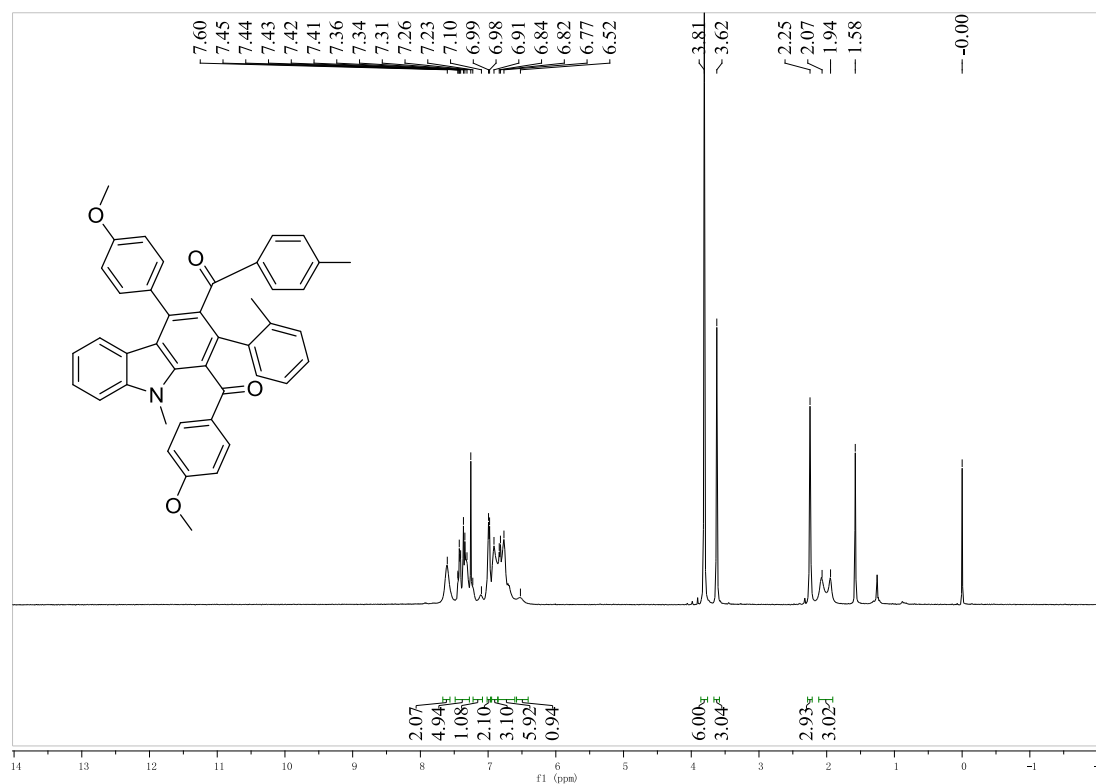
White solid, 64%, m.p. 168-169 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.60 (s, 2H, ArH), 7.44-7.31 (m, 5H, ArH), 7.23-7.03 (m, 3H, ArH), 6.99-6.91 (m, 4H, ArH), 6.82-6.77 (m, 4H, ArH), 6.68 (s, 1H, ArH), 6.51 (s, 1H, ArH), 3.81 (s, 3H, OCH₃), 3.62 (s, 3H, CH₃), 2.35 (s, 3H, CH₃), 2.25 (s, 3H, CH₃), 2.01 (d, *J* = 7.6 Hz, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 163.6, 159.3, 144.1, 142.9, 142.8, 142.2, 137.3, 134.6, 134.4, 132.0, 131.6, 129.2, 129.0, 128.9, 128.2, 127.4, 126.1, 122.4, 122.2, 119.4, 113.5, 113.5, 113.4, 113.3, 109.9, 108.6, 55.4, 31.7, 21.5, 21.3, 20.5; IR(KBr) ν: 3054, 2920, 1887, 1665, 1447, 1320, 1267, 1172, 1009, 952, 805, 743, 651, 462 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₃₅NO₄ ([M+Na]⁺): 636.2509, found: 636.2508.

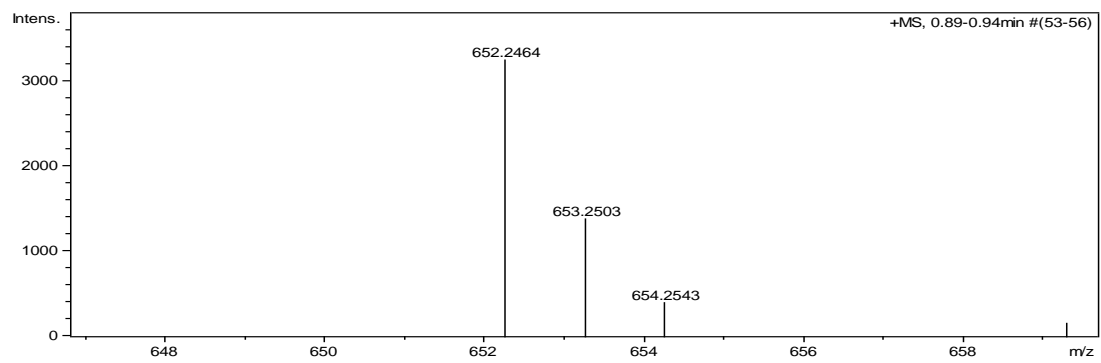
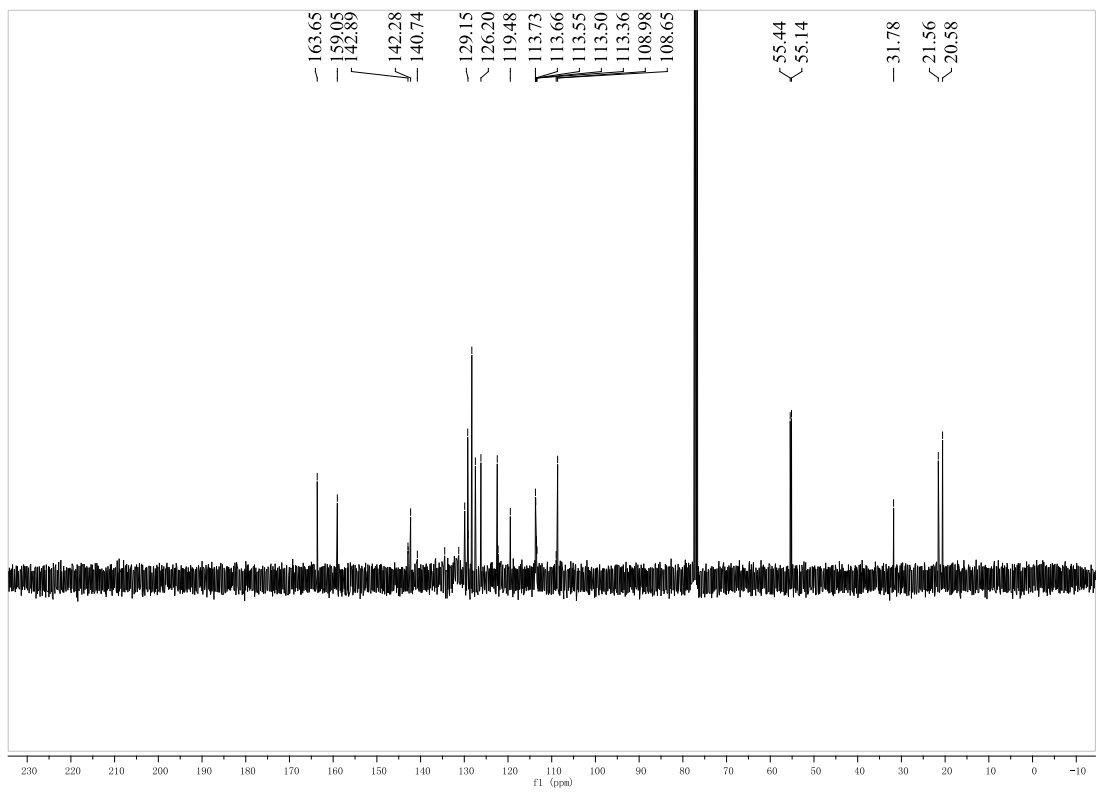




(1-(4-methoxybenzoyl)-4-(4-methoxyphenyl)-9-methyl-2-(o-tolyl)-9H-carbazol-3-yl)(p-tolyl)methanone) (6e):

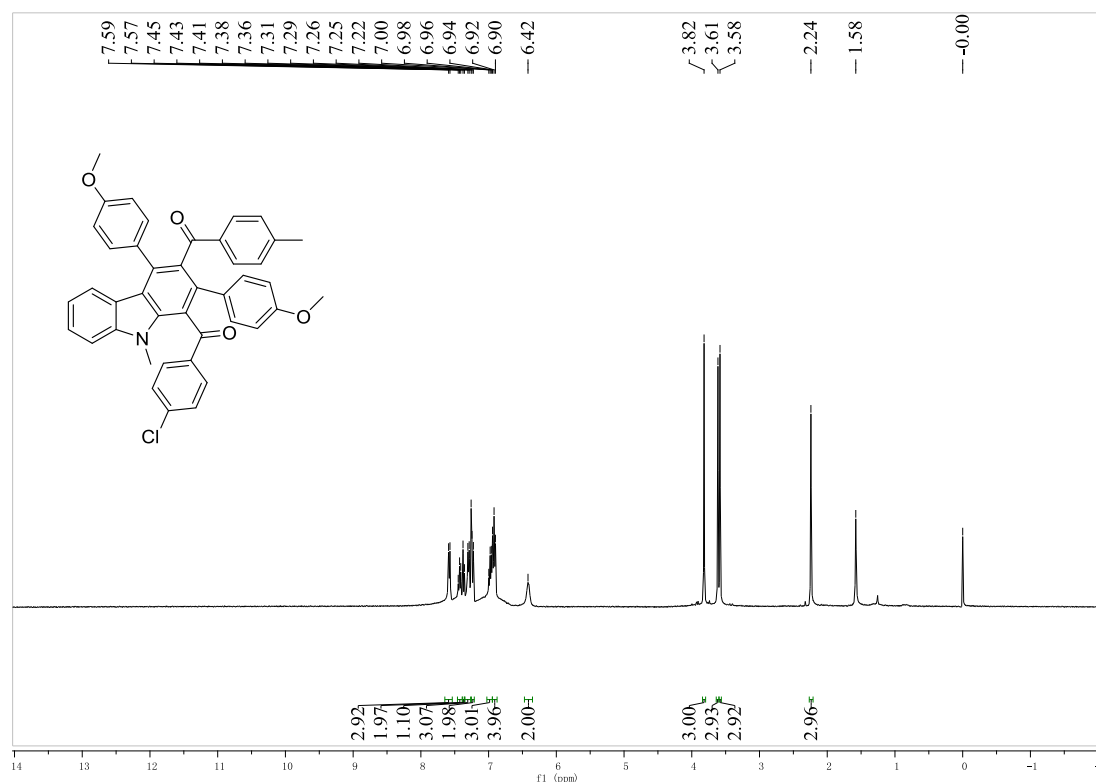
White solid, 62%, m.p. 161-162 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.60 (s, 2H, ArH), 7.45-7.31 (m, 5H, ArH), 7.23-7.10 (m, 1H, ArH), 6.98 (d, *J* = 6.4 Hz, 2H, ArH), 6.91 (s, 3H, ArH), 6.84-6.77 (m, 6H, ArH), 6.52 (s, 1H, ArH), 3.81 (s, 6H, OCH₃), 3.62 (s, 3H, CH₃), 2.25 (s, 3H, CH₃), 2.01 (d, *J* = 10.4 Hz, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 163.6, 159.0, 142.8, 142.8, 142.2, 140.7, 134.4, 131.2, 129.9, 129.2, 129.1, 128.2, 127.4, 126.1, 122.4, 122.2, 119.4, 113.7, 113.6, 113.5, 113.5, 113.3, 108.9, 108.6, 55.4, 55.1, 31.7, 21.5, 20.5.; IR(KBr) ν: 3055, 2920, 2360, 1664, 1433, 1320, 1267, 1131, 1009, 937, 807, 743, 636, 462 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₃₅NO₄ ([M+Na]⁺): 652.2458, found: 652.2464.

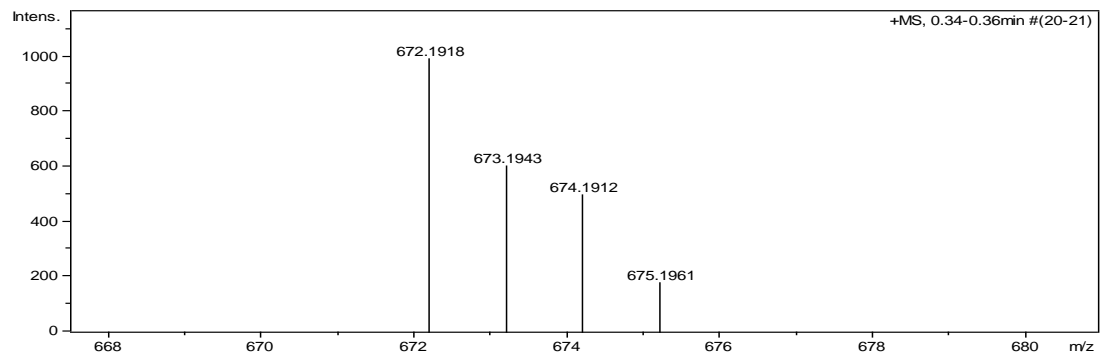
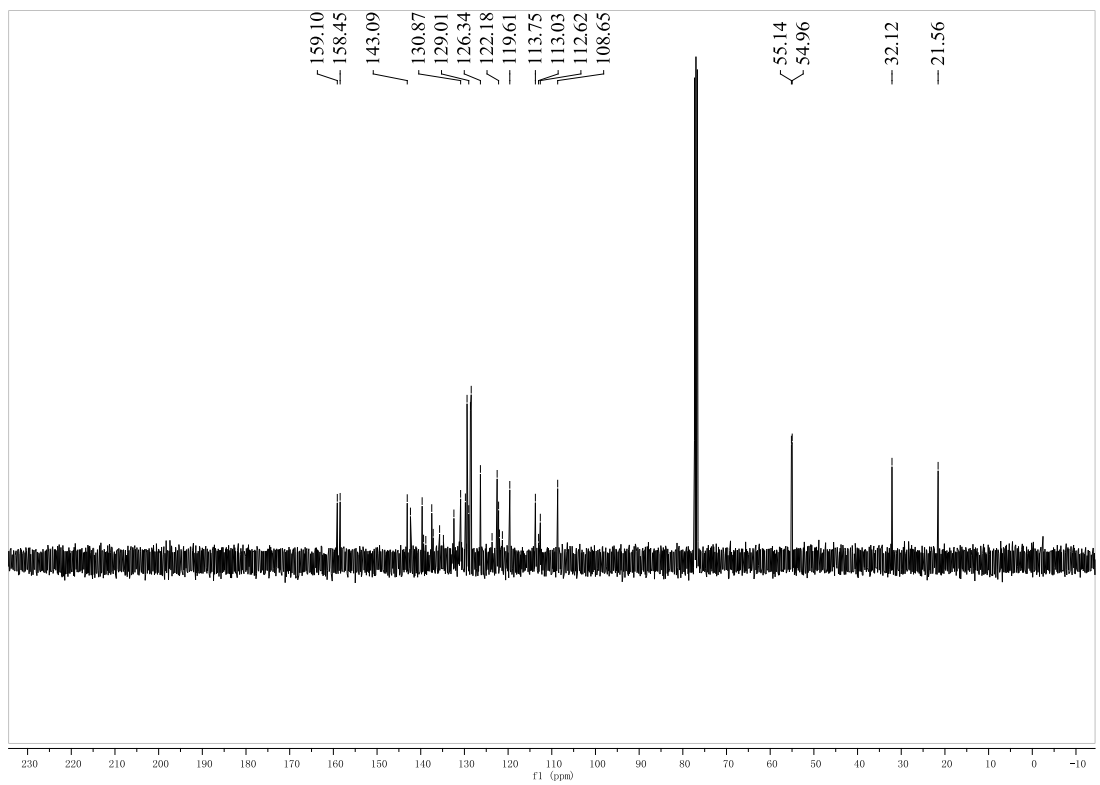




(2,4-bis(4-methoxyphenyl)-9-methyl-3-(4-methylbenzoyl)-9H-carbazol-1-yl)(4-chlorophenyl)methanone (6f):

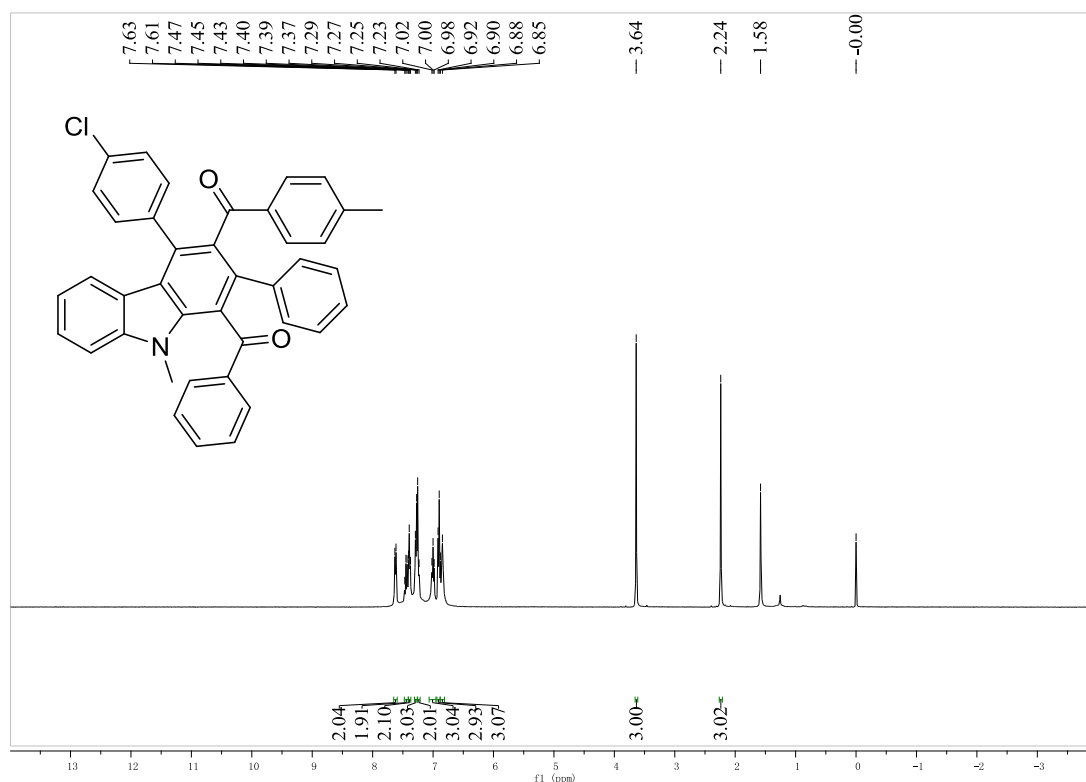
White solid, 66%, m.p. 191-192 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.58 (d, *J* = 8.0 Hz, 3H, ArH), 7.43 (t, *J* = 7.2 Hz, 2H, ArH), 7.36 (d, *J* = 8.4 Hz, 1H, ArH), 7.29 (d, *J* = 7.6 Hz, 3H, ArH), 7.24 (d, *J* = 8.0 Hz, 2H, ArH), 6.98 (t, *J* = 7.6 Hz, 3H, ArH), 6.92 (t, *J* = 8.4 Hz, 4H, ArH), 6.42 (s, 2H, ArH), 3.82 (s, 3H, OCH₃), 3.61 (s, 3H, CH₃), 3.58 (s, 3H, CH₃), 2.24 (s, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 159.1, 158.4, 143.0, 142.3, 139.6, 139.3, 138.8, 137.4, 137.1, 135.6, 134.8, 132.4, 130.8, 129.7, 129.3, 129.0, 128.6, 128.4, 126.3, 123.6, 122.5, 122.1, 121.9, 121.3, 119.6, 113.7, 113.0, 112.6, 108.6, 55.1, 54.9, 32.1, 21.5; IR(KBr) ν: 3025, 2919, 2359, 1664, 1432, 1321, 1265, 1132, 1009, 937, 807, 743, 636, 462 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₂H₃₂ClNO₄ ([M+Na]⁺): 672.1912, found: 672.1918.

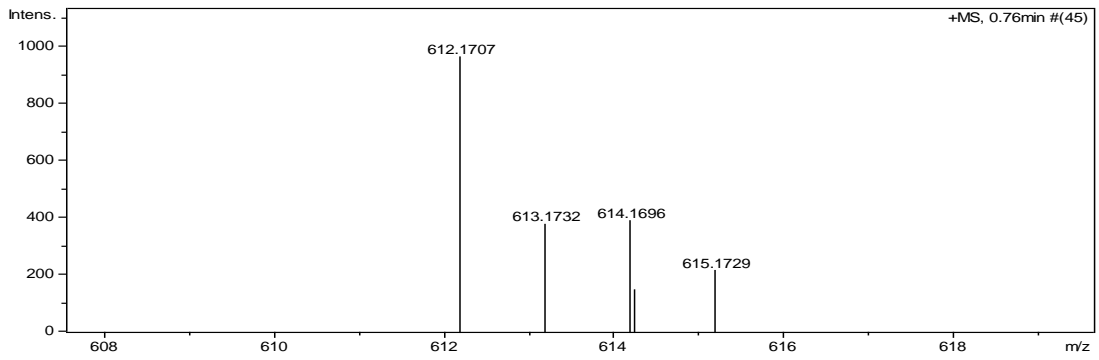
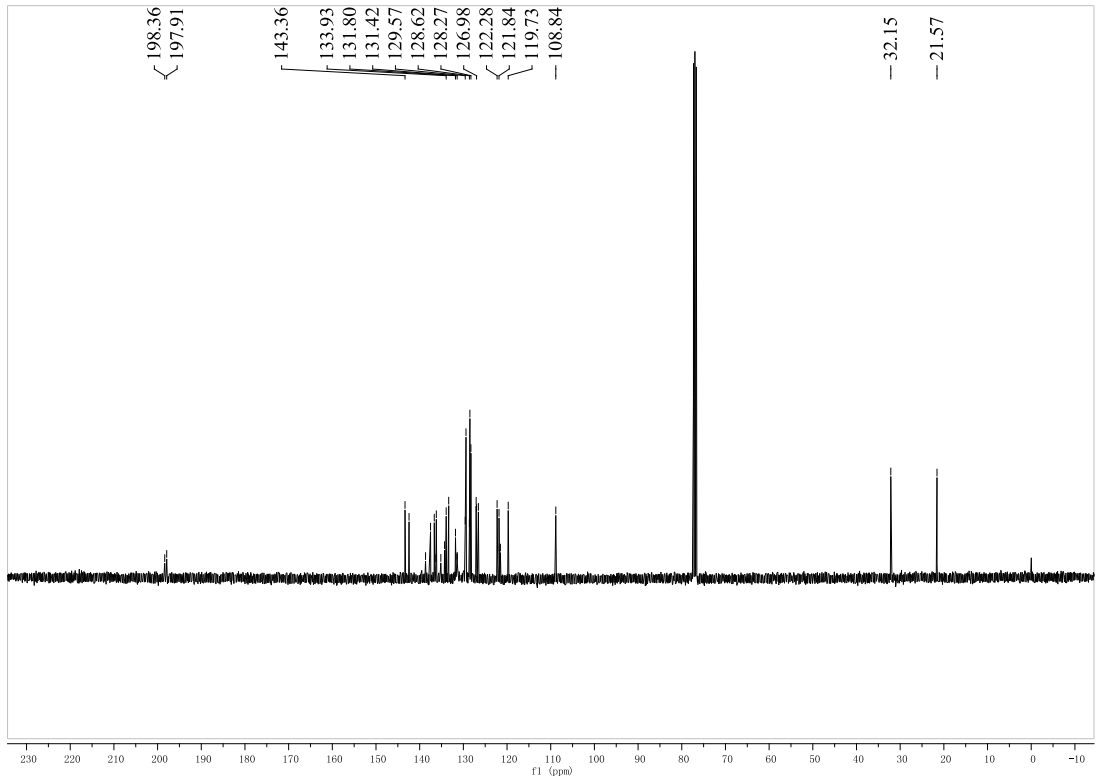




(1-benzoyl-4-(4-chlorophenyl)-9-methyl-2-phenyl-9H-carbazol-3-yl)(p-tolyl)methanone
(6g):

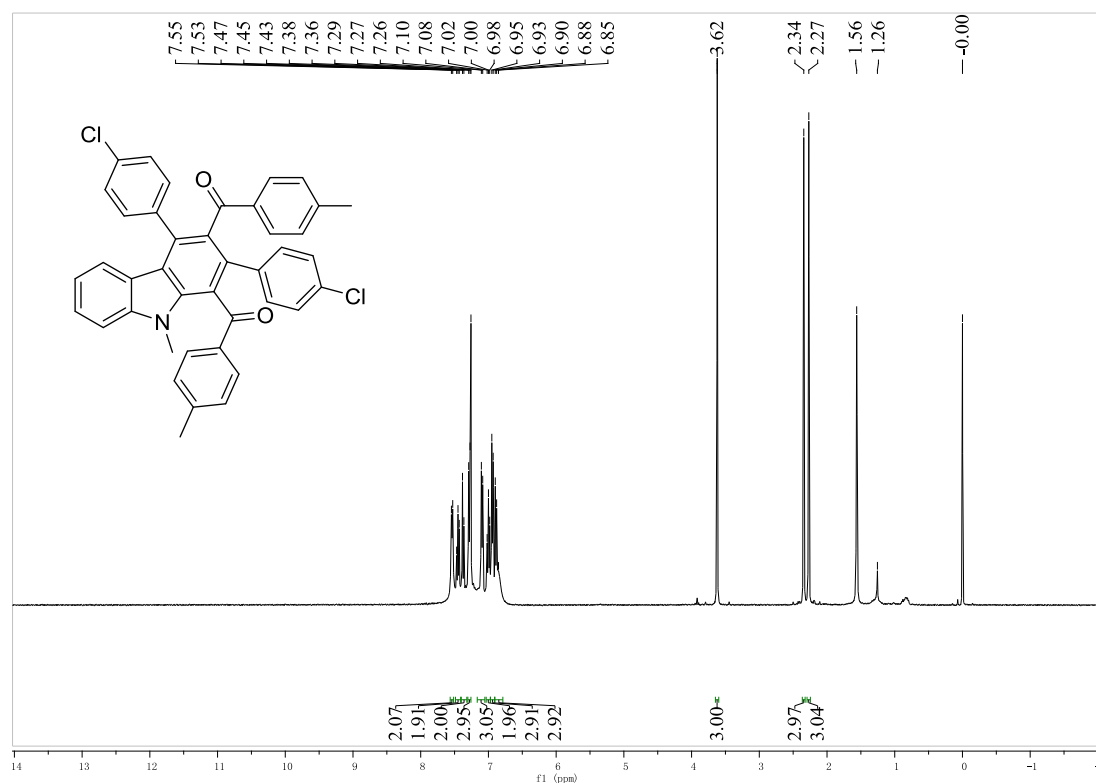
White solid, 59%, m.p. 171-172 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.62 (d, *J* = 7.2 Hz, 2H, ArH), 7.45 (t, *J* = 7.6 Hz, 2H, ArH), 7.40-7.37 (m, 2H, ArH), 7.29-7.23 (m, 5H, ArH), 7.00 (t, *J* = 7.6 Hz, 3H, ArH), 6.90 (d, *J* = 7.6 Hz, 3H, ArH), 6.88-6.85 (m, 3H, ArH), 3.64 (s, 3H, CH₃), 2.24 (s, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 198.3, 197.9, 143.3, 142.4, 138.6, 137.5, 136.6, 136.3, 136.1, 135.1, 134.3, 133.9, 133.3, 131.8, 131.4, 131.4, 131.4, 129.5, 129.3, 128.6, 128.5, 128.2, 127.0, 126.9, 126.5, 122.2, 122.1, 121.8, 121.5, 119.7, 108.8, 32.1, 21.5; IR(KBr) ν: 3053, 2931, 2361, 1662, 1430, 1320, 1262, 1132, 1009, 937, 803, 727, 642, 479 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₀H₂₈ClNO₂ ([M+Na]⁺): 612.1701, found: 612.1707.

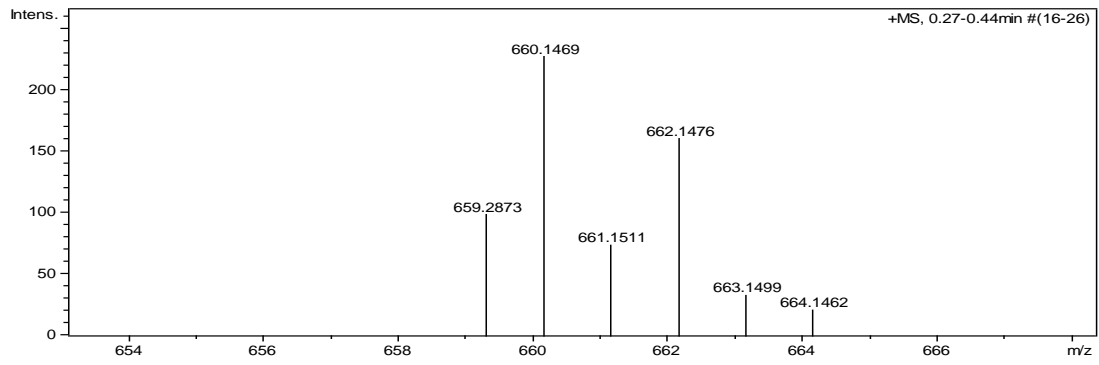
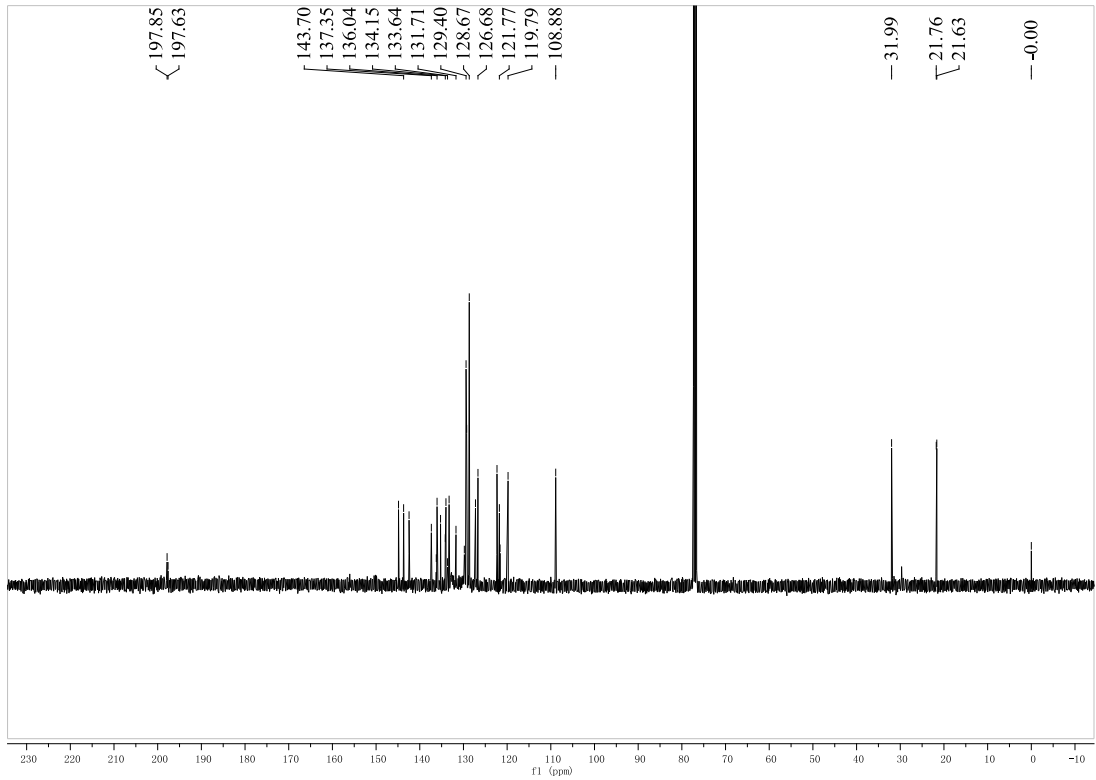




(2,4-bis(4-chlorophenyl)-9-methyl-9H-carbazole-1,3-diyl)bis(p-tolylmethanone) (6h):

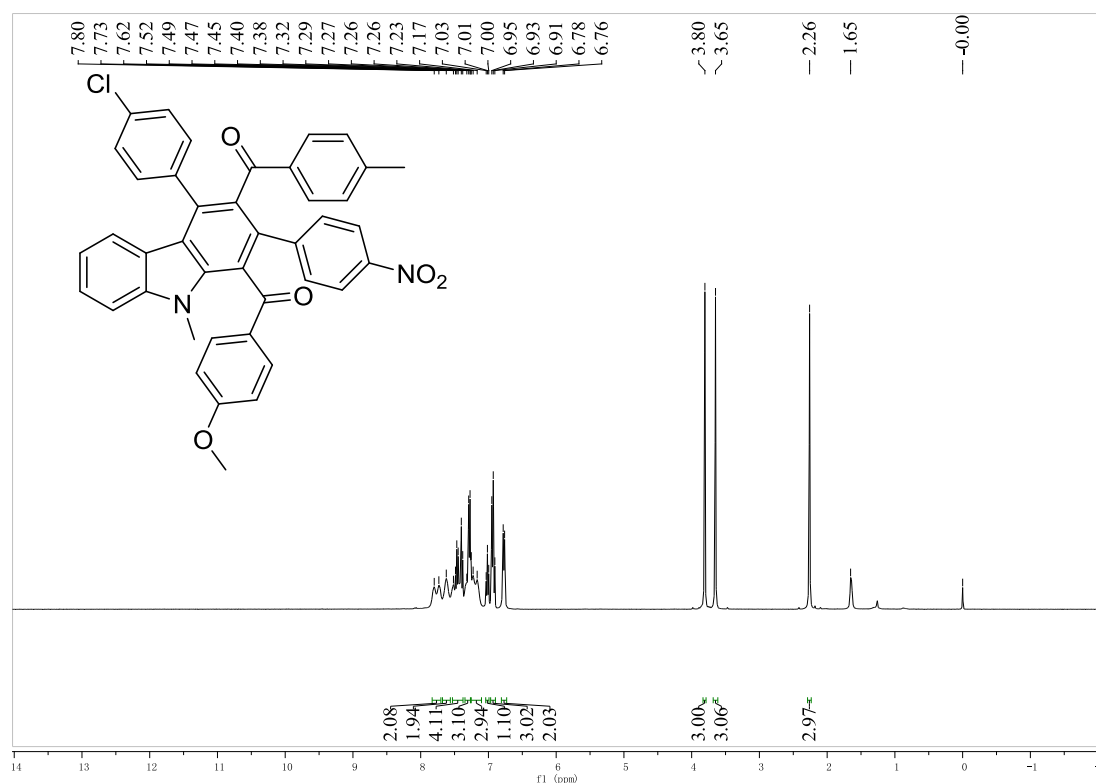
White solid, 60%, m.p. 182-183 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.54 (d, *J* = 7.6 Hz, 2H, ArH), 7.45 (t, *J* = 8.0 Hz, 2H, ArH), 7.37 (d, *J* = 8.0 Hz, 2H, ArH), 7.29-7.26 (m, 3H, ArH), 7.09 (d, *J* = 7.6 Hz, 3H, ArH), 7.00 (t, *J* = 7.2 Hz, 2H, ArH), 6.98 (d, *J* = 8.0 Hz, 3H, ArH), 6.90-6.85 (m, 3H, ArH), 3.62 (s, 3H, CH₃), 2.34 (s, 3H, CH₃), 2.27 (s, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 197.8, 197.6, 144.8, 143.6, 142.4, 137.3, 136.2, 136.0, 135.2, 134.1, 134.0, 133.6, 133.2, 131.7, 129.7, 129.4, 129.2, 128.6, 127.2, 126.6, 122.3, 121.7, 121.6, 119.7, 108.8, 31.9, 21.7, 21.6; IR(KBr) ν: 30531, 2932, 2360, 1661, 1430, 1320, 1262, 1132, 1009, 937, 804, 726, 643, 478 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₁H₂₉Cl₂NO₂ ([M+Na]⁺): 660.1468, found: 660.1469.

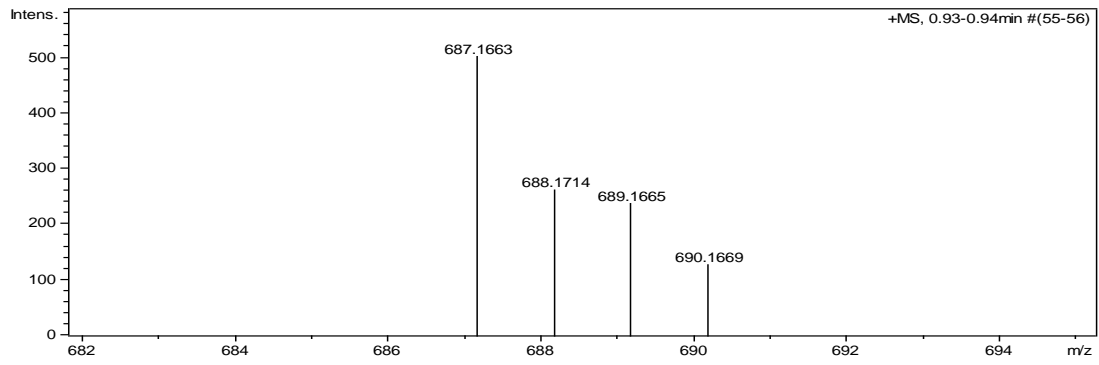
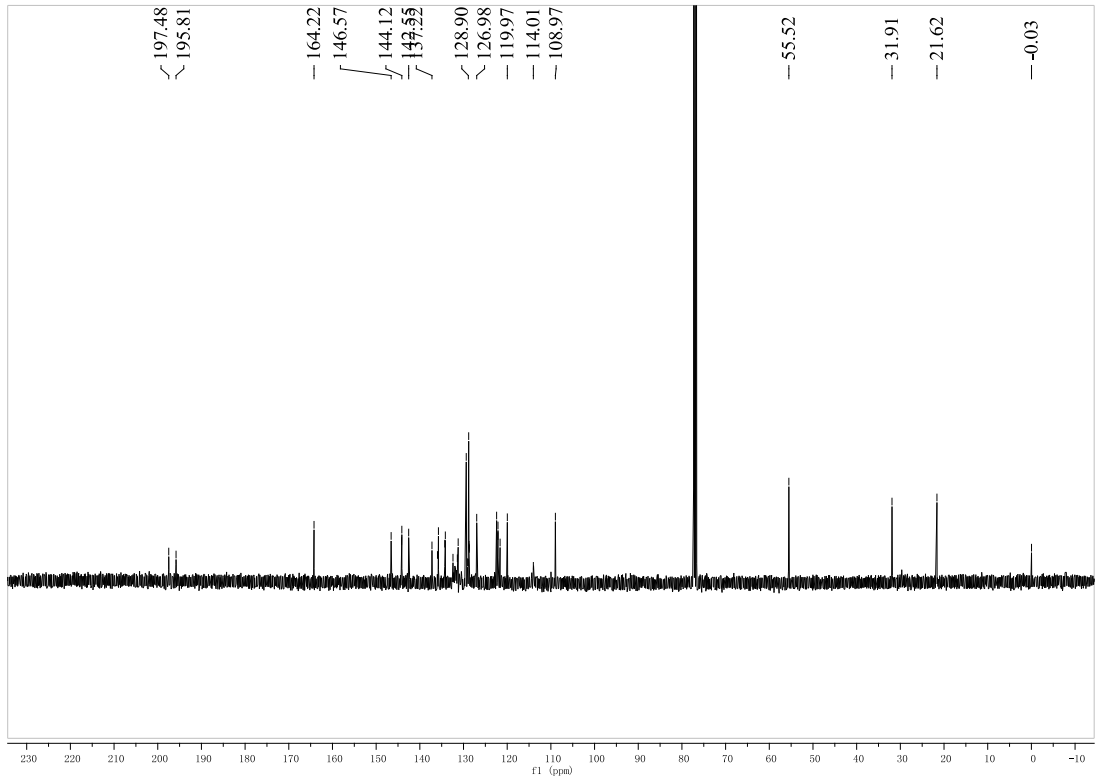




(4-(4-chlorophenyl)-1-(4-methoxybenzoyl)-9-methyl-2-(4-nitrophenyl)-9H-carbazol-3-yl)(p-tolyl)methanone (6i):

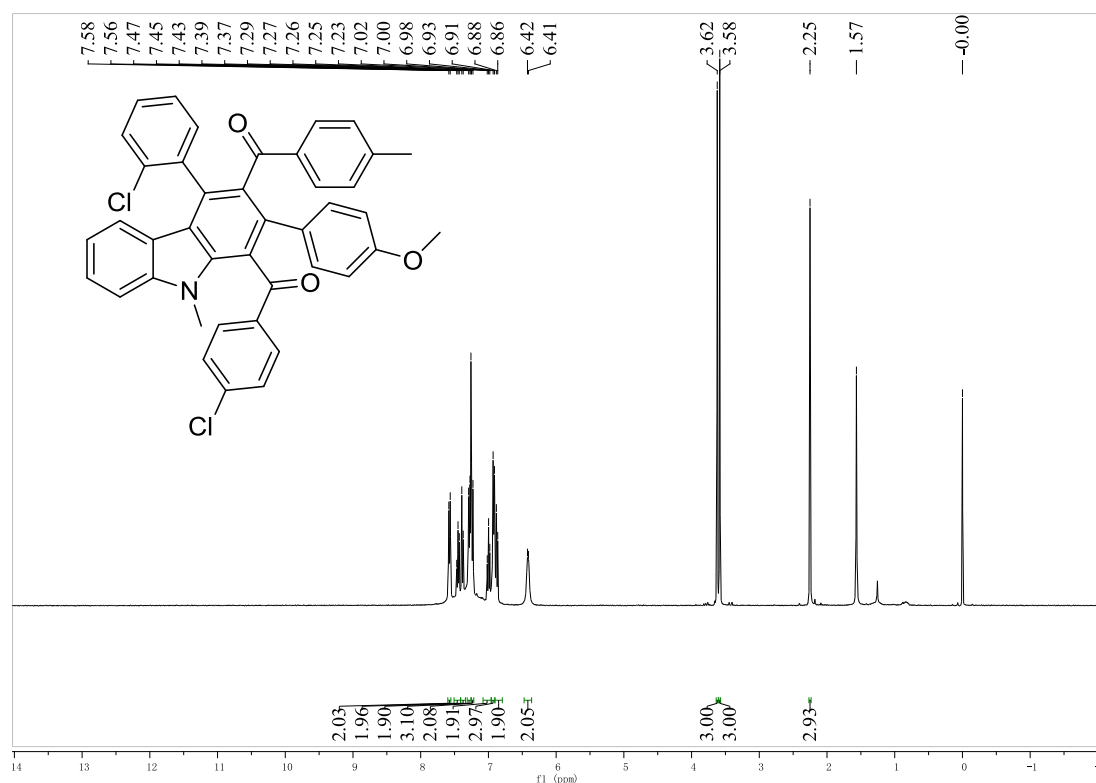
White solid, 69%, m.p. 196-197 °C; ^1H NMR (400 MHz, CDCl_3) δ : 7.76 (d, $J = 27.2$ Hz, 2H, ArH), 7.62 (s, 2H, ArH), 7.52-7.38 (m, 4H, ArH), 7.32-7.27 (m, 3H, ArH), 7.26-7.17 (m, 3H, ArH), 7.01 (t, $J = 7.2$ Hz, 1H, ArH), 6.93 (t, $J = 8.4$ Hz, 1H, ArH), 6.70 (d, $J = 8.4$ Hz, 2H, ArH), 3.81 (s, 3H, OCH_3), 3.65 (s, 3H, CH_3), 2.26 (s, 3H, CH_3); ^{13}C NMR (400 MHz, CDCl_3) δ : 197.4, 195.8, 164.2, 146.5, 144.1, 144.1, 142.5, 137.2, 135.9, 135.7, 134.2, 134.1, 132.4, 131.4, 131.2, 129.3, 129.0, 128.8, 128.8, 128.7, 128.7, 128.6, 126.9, 122.4, 122.1, 122.1, 121.6, 119.9, 114.0, 108.9, 55.5, 31.9, 21.6; IR(KBr) ν : 3055, 2934, 2363, 1661, 1431, 1321, 1262, 1133, 1007, 935, 803, 727, 644, 476 cm^{-1} ; MS (m/z): HRMS (ESI) Calcd. for $\text{C}_{41}\text{H}_{29}\text{ClN}_2\text{O}_5$ ($[\text{M}+\text{Na}]^+$): 687.1657, found: 687.1663.

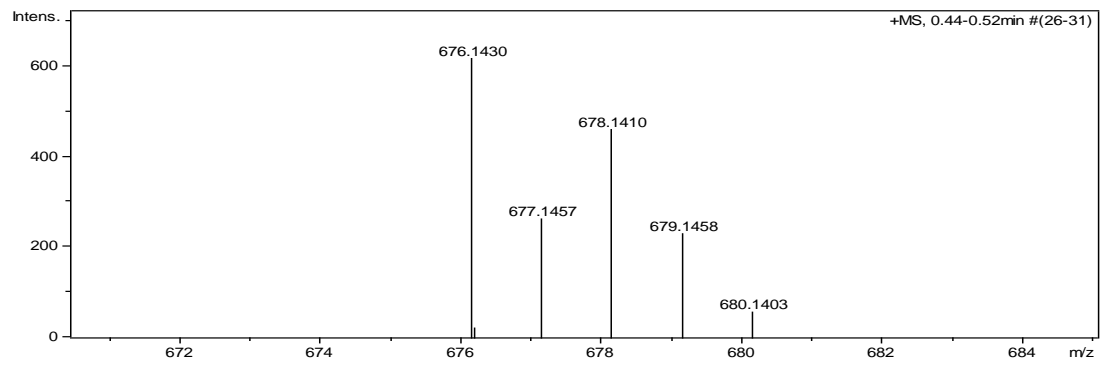
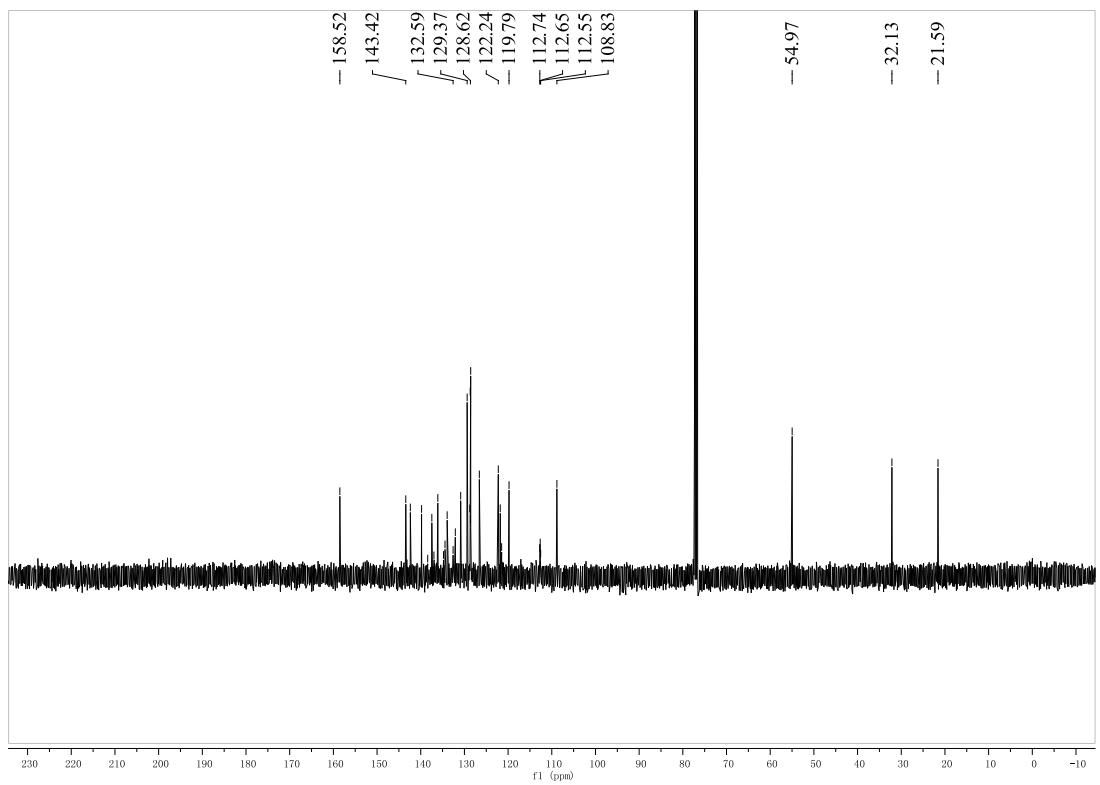




(1-(4-chlorobenzoyl)-4-(2-chlorophenyl)-2-(4-methoxyphenyl)-9-methyl-9H-carbazol-3-yl)(p-tolyl)methanone) (6j):

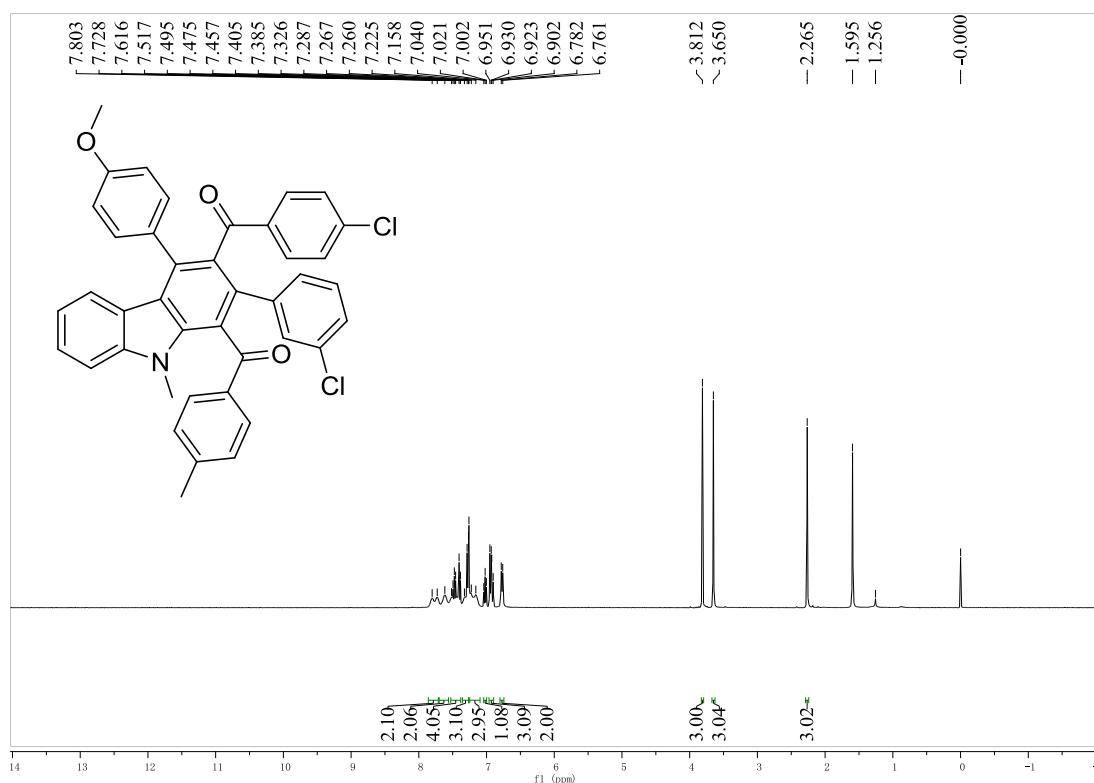
White solid, 63%, m.p. 187-188 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.58 (d, *J* = 8.4 Hz, 2H, ArH), 7.45 (t, *J* = 8.0 Hz, 2H, ArH), 7.38 (d, *J* = 8.0 Hz, 2H, ArH), 7.29-7.23 (m, 5H, ArH), 7.00 (t, *J* = 7.6 Hz, 2H, ArH), 6.92 (d, *J* = 7.6 Hz, 3H, ArH), 6.87 (d, *J* = 8.0 Hz, 2H, ArH), 6.41 (d, *J* = 5.6 Hz, 2H, ArH), 3.62 (s, 3H, CH₃), 3.58 (s, 3H, OCH₃), 2.25 (s, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 158.5, 143.4, 142.3, 139.8, 138.4, 137.4, 136.9, 136.0, 134.7, 134.4, 133.9, 132.5, 132.0, 130.8, 129.3, 128.7, 128.6, 128.6, 128.5, 126.5, 122.2, 121.8, 121.4, 119.7, 112.7, 112.6, 112.5, 108.8, 54.9, 32.1, 21.5; IR(KBr) ν: 3054, 2932, 2362, 1661, 1431, 1322, 1261, 1131, 1008, 937, 803, 727, 642, 478 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₁H₂₉Cl₂NO₃ ([M+Na]⁺): 676.1417, found: 676.1430.

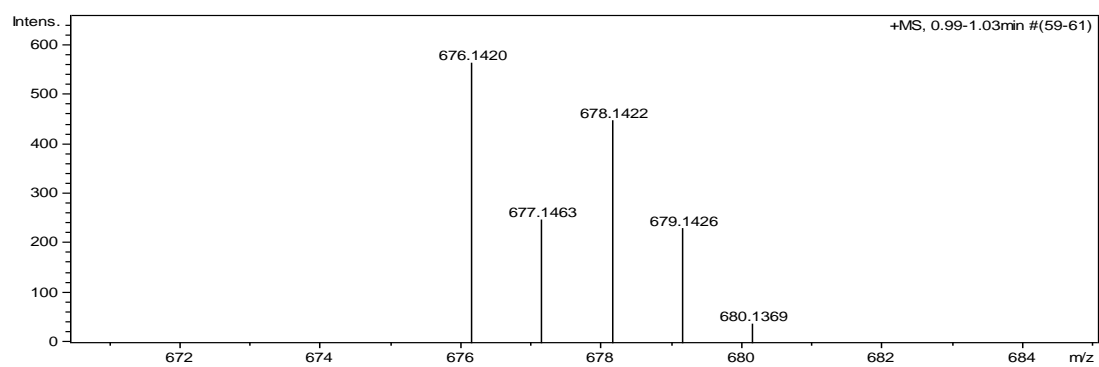
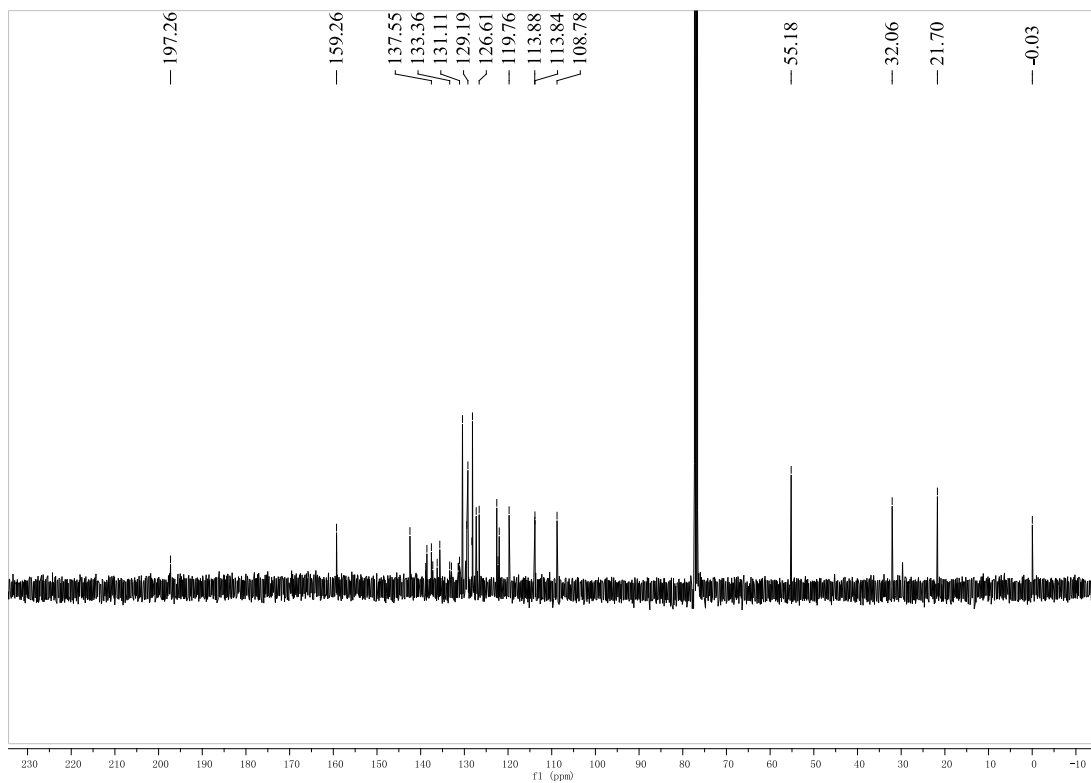




(3-(4-chlorobenzoyl)-2-(3-chlorophenyl)-4-(4-methoxyphenyl)-9-methyl-9H-carbazol-1-yl)(p-tolyl)methanone) (6k):

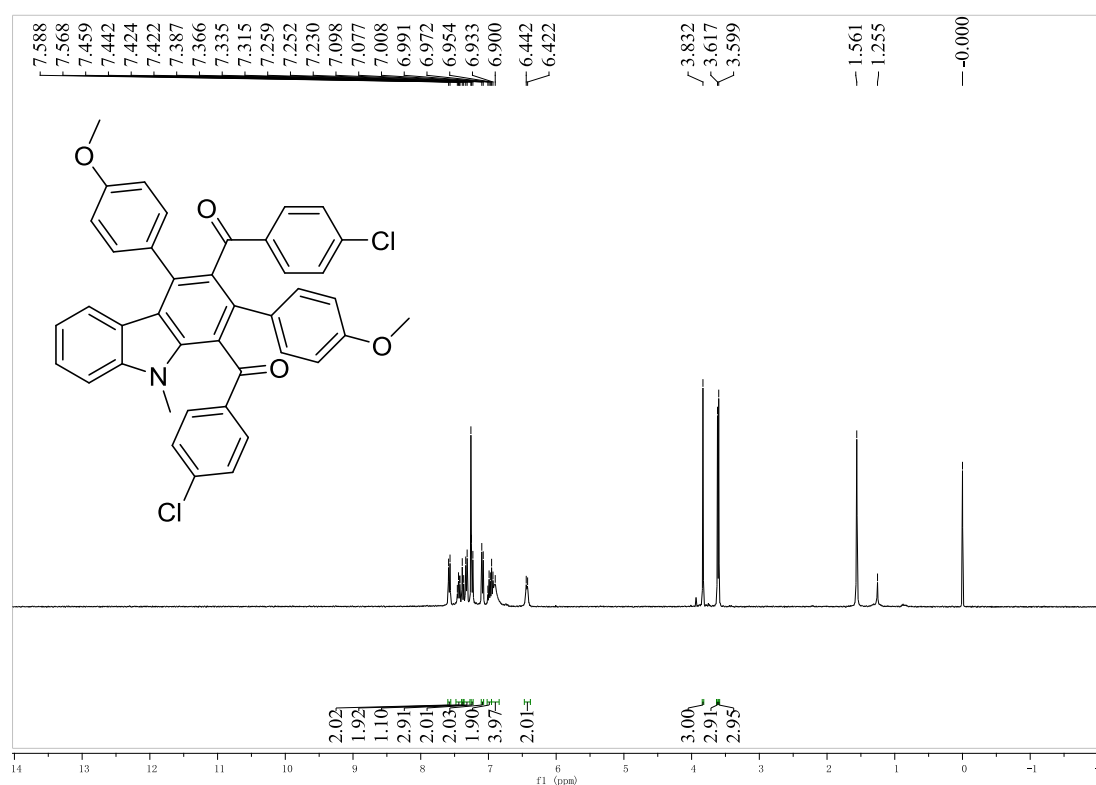
White solid, 61%, m.p. 184-185 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.76 (d, *J* = 30.0 Hz, 2H, ArH), 7.62 (s, 2H, ArH), 7.52-7.39 (m, 4H, ArH), 7.33-7.27 (m, 3H, ArH), 7.23-7.16 (m, 3H, ArH), 7.02 (d, *J* = 7.6 Hz, 1H, ArH), 6.95-6.90 (m, 3H, ArH), 6.77 (d, *J* = 8.4 Hz, 2H, ArH), 3.81 (s, 3H, OCH₃), 3.65 (s, 3H, CH₃), 2.27 (s, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 197.2, 159.2, 142.4, 138.8, 138.5, 137.5, 137.2, 136.2, 135.6, 133.3, 132.9, 131.3, 131.3, 131.1, 130.4, 129.6, 129.4, 129.1, 128.2, 128.1, 127.2, 126.6, 122.5, 122.2, 122.0, 119.7, 113.8, 113.8, 108.7, 55.1, 32.0, 21.7; IR(KBr) ν: 3055, 2932, 2363, 1664, 1430, 1320, 1262, 1135, 1011, 937, 802, 727, 642, 474 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₁H₂₉Cl₂NO₃ ([M+Na]⁺): 676.1417, found: 676.1420.

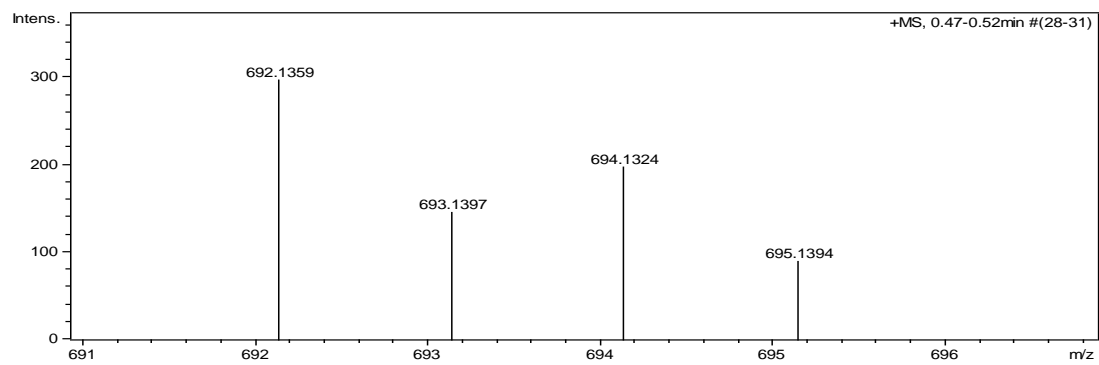
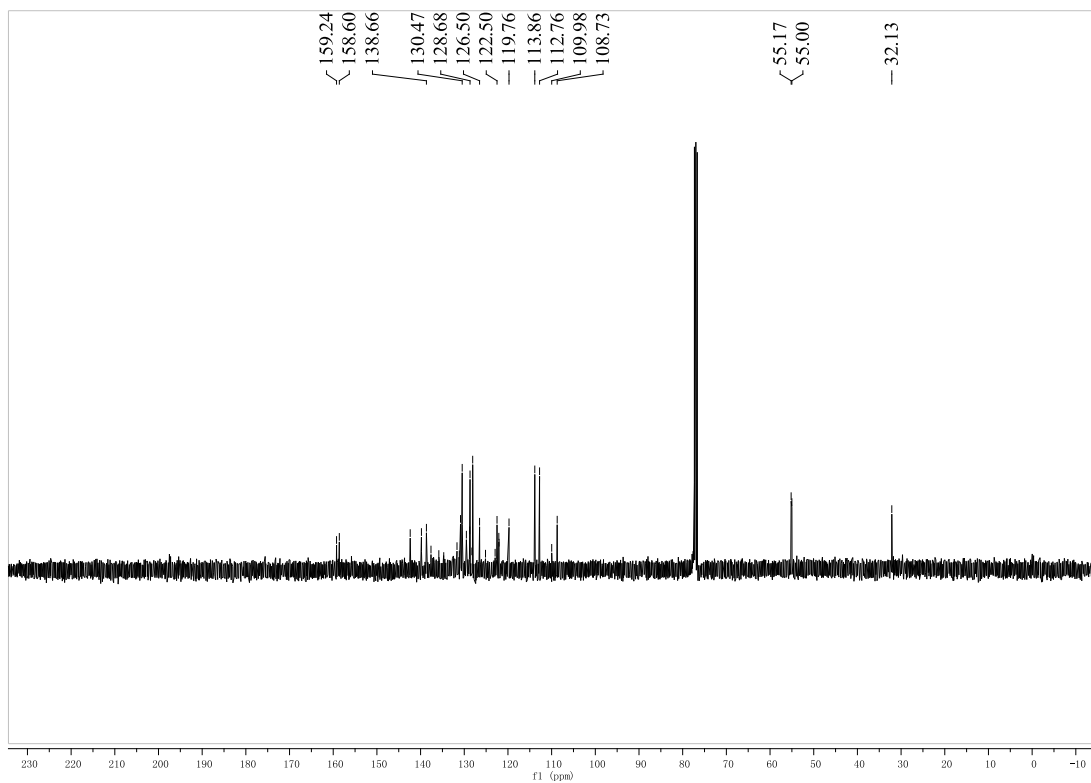




(2,4-bis(4-methoxyphenyl)-9-methyl-9H-carbazole-1,3-diyl)bis((4-chlorophenyl)methanone) (6l):

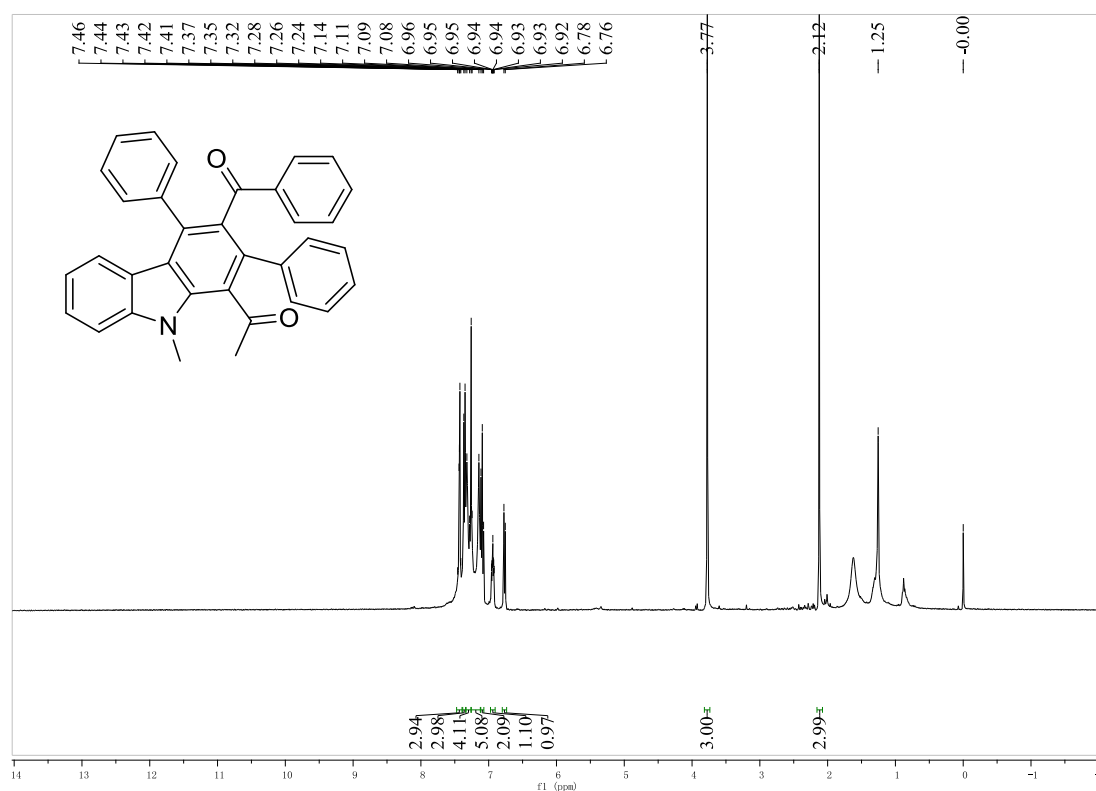
White solid, 62%, m.p. 165-166 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.58 (d, *J* = 8.4 Hz, 2H, ArH), 7.44 (t, *J* = 7.6 Hz, 2H, ArH), 7.37 (d, *J* = 8.4 Hz, 1H, ArH), 7.35 (d, *J* = 8.0 Hz, 3H, ArH), 7.24 (d, *J* = 8.8 Hz, 2H, ArH), 7.09 (d, *J* = 8.8 Hz, 2H, ArH), 6.99 (t, *J* = 7.6 Hz, 2H, ArH), 6.95-6.90 (m, 4H, ArH), 6.43 (d, *J* = 8.0 Hz, 2H, ArH), 3.83 (s, 3H, OCH₃), 3.62 (s, 3H, CH₃), 3.60 (s, 3H, OCH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 159.2, 158.6, 142.3, 139.8, 138.6, 137.6, 135.8, 134.7, 131.6, 131.1, 130.8, 130.4, 129.5, 128.7, 128.6, 128.2, 128.0, 126.4, 125.1, 122.9, 122.5, 122.0, 122.0, 119.7, 113.8, 112.7, 109.9, 108.7, 55.1, 55.0, 32.1; IR(KBr) ν: 3053, 2935, 2361, 1664, 1430, 1320, 1262, 1135, 1010, 937, 802, 728, 644, 477 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₁H₂₉Cl₂NO₄ ([M+Na]⁺): 692.1366, found: 692.1359.

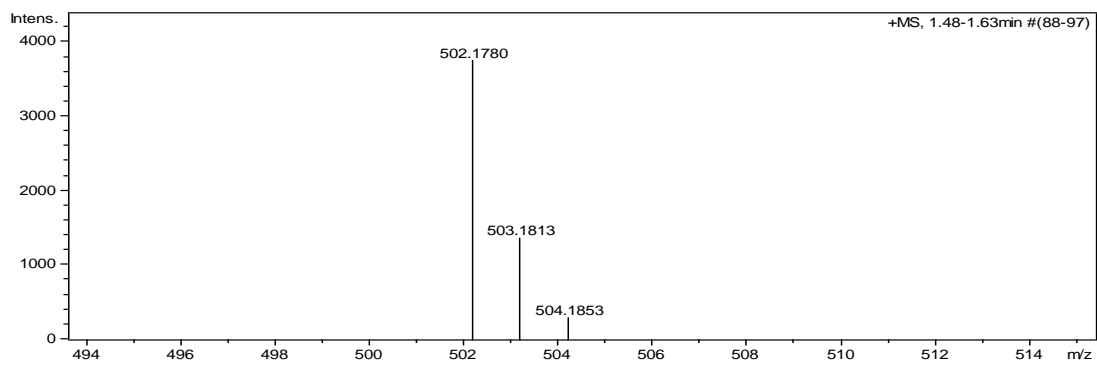
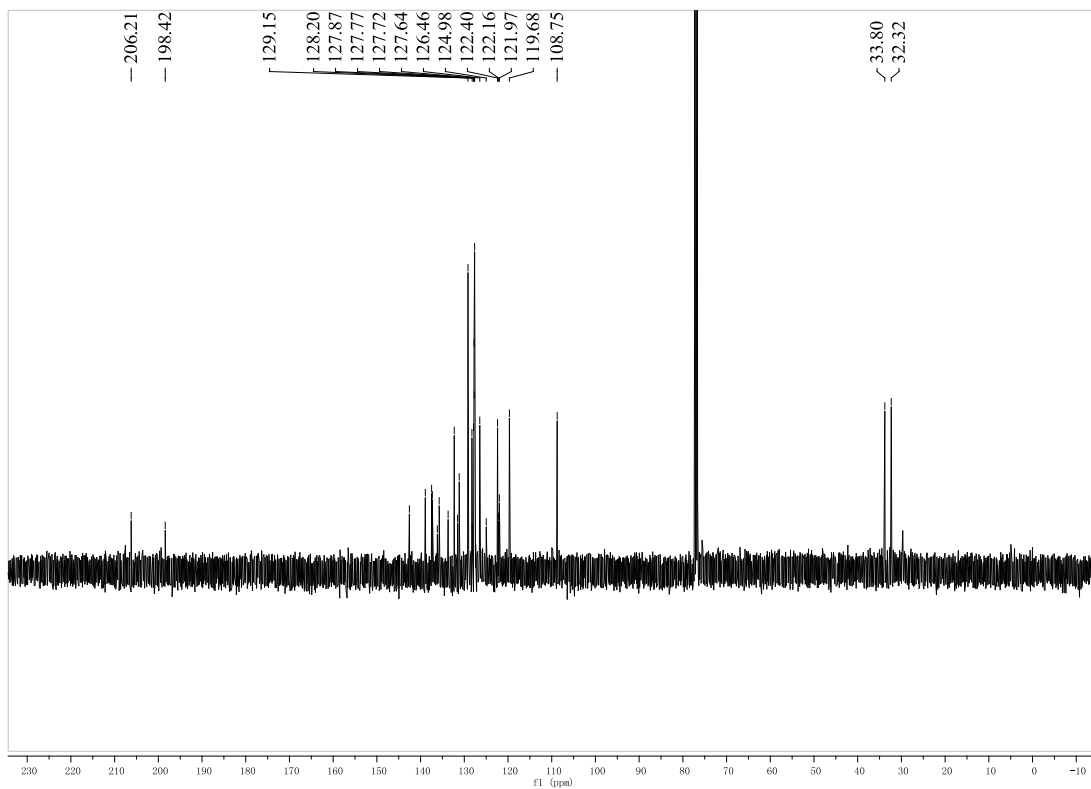




(1-(3-benzoyl-9-methyl-2,4-diphenyl-9H-carbazol-1-yl)ethan-1-one) (6m):

White solid, 31%, m.p. 154-155 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.46-7.41 (m, 3H, ArH), 7.36 (d, *J* = 7.2 Hz, 3H, ArH), 7.32-7.26 (m, 4H, ArH), 7.25-7.15 (m, 5H, ArH), 7.01 (t, *J* = 7.6 Hz, 2H, ArH), 6.96-6.92 (m, 1H, ArH), 6.77 (d, *J* = 8.0 Hz, 1H, ArH), 3.78 (s, 3H, CH₃), 2.12 (s, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 206.2, 198.4, 142.5, 138.9, 137.4, 137.3, 136.1, 135.7, 133.7, 132.2, 131.5, 131.1, 129.1, 128.2, 128.2, 127.8, 127.7, 127.7, 127.6, 126.4, 124.9, 122.3, 122.1, 121.9, 119.6, 108.7, 33.8, 32.3; IR(KBr) ν: 3052, 2923, 2343, 1666, 1653, 1421, 1332, 1266, 1134, 1009, 937, 802, 728, 641, 433 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₄H₂₅NO₂ ([M+Na]⁺): 502.1778,found: 502.1780.





(1-(4-(4-chlorophenyl)-9-methyl-3-(4-methylbenzoyl)-2-phenyl-9H-carbazol-1-yl)ethan-1-one) (6n):

White solid, 32%, m.p. 162-163 °C; ¹H NMR (400 MHz, CDCl₃) δ: 7.48-7.42 (m, 3H, ArH), 7.40-7.30 (m, 3H, ArH), 7.27-7.26 (m, 2H, ArH), 7.25 (s, 1H, ArH), 7.21-7.15 (m, 4H, ArH), 7.01-6.97 (m, 1H, ArH), 6.91 (d, *J* = 8.0 Hz, 2H, ArH), 6.82 (d, *J* = 8.0 Hz, 1H, ArH), 3.77 (s, 3H, CH₃), 2.25 (s, 3H, CH₃), 2.11 (s, 3H, CH₃); ¹³C NMR (400 MHz, CDCl₃) δ: 206.1, 197.7, 143.3, 142.5, 137.1, 136.2, 136.0, 136.0, 134.1, 133.9, 133.6, 131.7, 131.1, 129.3, 128.5, 128.5, 128.5, 127.7, 127.7, 126.6, 125.2, 122.2, 121.9, 121.7, 119.7, 108.8, 33.7, 32.3, 21.5; IR(KBr) ν: 3051, 2923, 2341, 1667, 1653, 1421, 1331, 1266, 1132, 1009, 937, 802, 728, 643, 435 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₂₆ClNO₂ ([M+Na]⁺): 550.1544, found: 550.1540.

