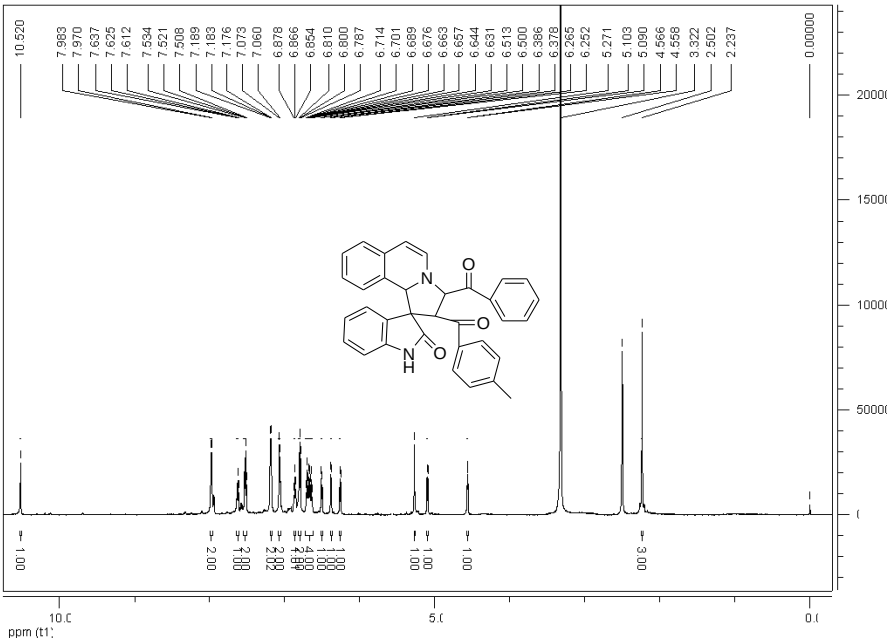
Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry

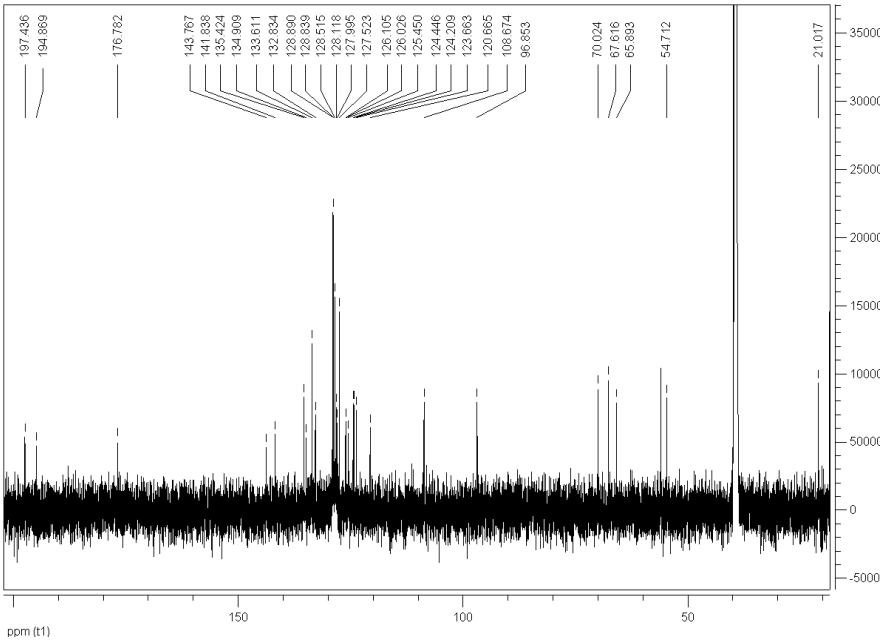
Facile Synthesis of spiro[indoline-3,3'-pyrrolo[1,2-a]quinolines] and spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinolines] via 1,3-cycloaddition reactions of heteroaromatic ammonium salts with 3-phenacylideneoxindoles

Lei Wu, Jing Sun, Chao-Guo Yan*

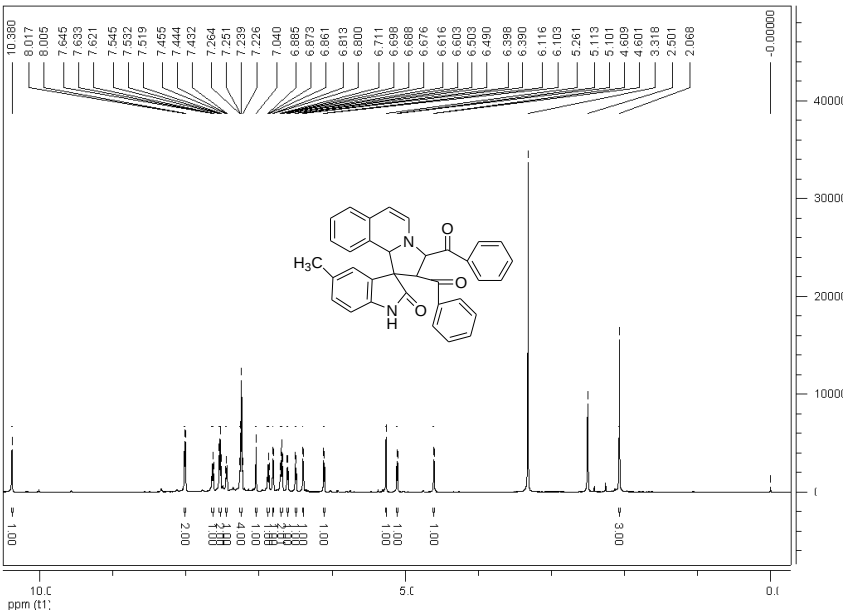
Supporting Information

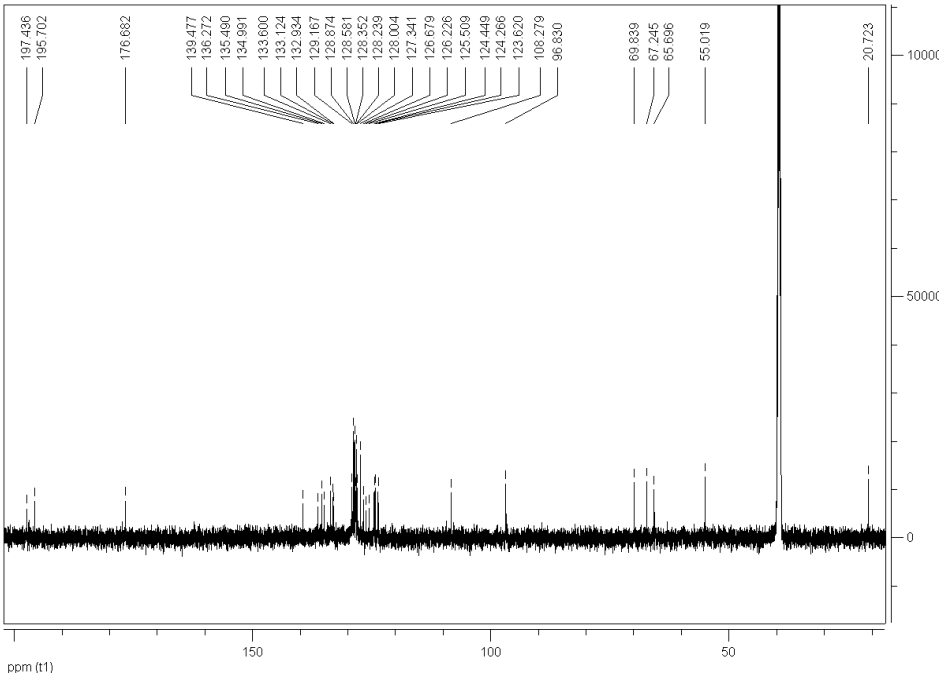
3'-benzoyl-2'-(4-methylbenzoyl)-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinolin]-2-one (3a): Yellow solid, yield: 86%, m.p. 184-186 ^{o}C, IR (KBr) ν = 3781, 3697, 3661, 3407, 3062, 2379, 2340, 1701, 1621, 1466, 1339, 1295, 1230, 1181, 975, 879, 765, 686, 556 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.52 (s, 1H, NH), 7.98 (d, *J* = 7.8 Hz, 2H, ArH), 7.63 (t, *J* = 7.8 Hz, 1H, ArH), 7.52 (d, *J* = 7.8 Hz, 2H, ArH), 7.18（d, *J* = 7.8 Hz, 2H, ArH), 7.06 (d, *J* = 7.8 Hz, 2H, ArH), 6.87 (t, *J* = 7.2 Hz, 1H, ArH), 6.80 (d, *J* = 7.8 Hz, 2H, ArH), 6.71-6.63 (m, 4H, ArH), 6.51 (d, *J* = 7.8 Hz, 1H, ArH), 6.38 (d, *J* = 5.4 Hz, 1H, CH), 6.26 (d, *J* = 7.8 Hz, 1H, CH), 5.27 (s, 1H, CH), 5.10 (d, *J* = 7.8 Hz, 1H, CH), 4.57 (d, *J* = 4.8 Hz, 1H, CH) 2.24 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.4, 194.9, 176.8, 143.8, 141.8, 135.4, 134.9, 133.6, 132.8, 128.9, 128.8, 128.5, 128.1, 128.0, 127.5, 126.1, 126.0, 125.5, 124.4, 124.2, 123.7, 120.7, 108.9, 70.0, 67.6, 65.9, 54.7, 21.0; HRMS (ESI) Calcd. for $C_{34}H_{27}N_2O_3$ ([M+H]$^{+}$): 511.2016. Found: 511.2024.



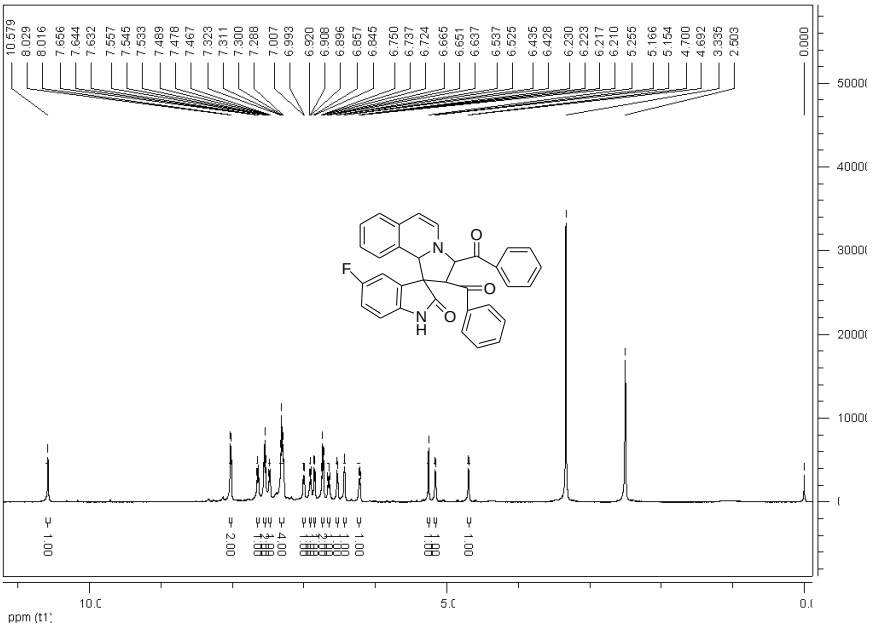


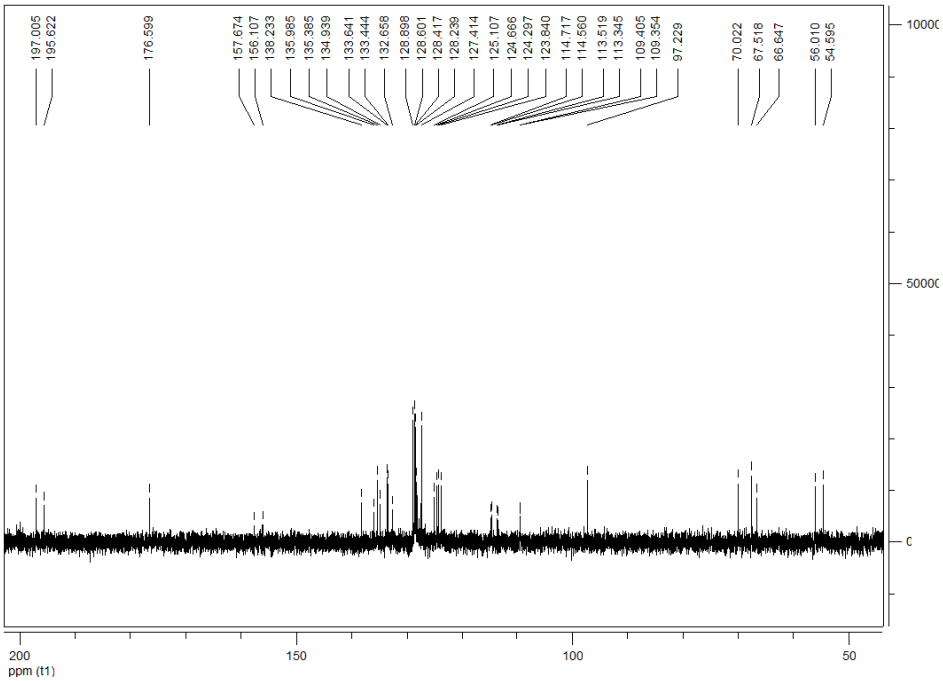
(5-methyl-2-oxo-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinoline]-2',3'-diyl)bis(phenylmethanone (3b): Yellow solid, yield: 87%, m.p. 192-194 ^{o}C, IR (KBr) ν = 3780, 3697, 3160, 3032, 2923, 2862, 2379, 2340, 1700, 1625, 1489, 1455, 1329, 1233, 1171, 999, 970, 935, 900, 809, 766, 692, 618, 557, 490, 438 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.38 (s, 1H, NH), 8.01 (d, *J* = 7.2 Hz, 2H, ArH), 7.63 (t, *J* = 7.2 Hz, 1H, ArH), 7.53 (d, *J* = 7.8 Hz, 2H, ArH), 7.44（t, *J* = 7.2 Hz, 1H, ArH), 7.26-7.23 (m, 4H, ArH), 7.04 (s, 1H, ArH), 6.87 (t, *J* = 7.2 Hz, 1H, ArH), 6.81 (d, *J* = 7.8 Hz, 1H, ArH), 6.71-6.68 (m, 2H, ArH), 6.60 (d, *J* = 7.8 Hz, 1H, ArH), 6.50 (d, *J* = 7.8 Hz, 1H, ArH), 6.40 (d, *J* = 5.4 Hz, 1H, CH), 6.11 (d, *J* = 7.8 Hz, 1H, CH), 5.26 (s, 1H, CH), 5.11 (d, *J* = 7.2 Hz, 1H, CH), 4.61 (d, *J* = 5.4 Hz, 1H, CH), 2.07 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.4, 195.7, 176.7, 139.5, 136.3, 135.5, 135.0, 133.6, 133.1, 132.9, 129.2, 128.9, 128.6, 128.4, 128.2, 128.0, 127.3, 126.7, 126.2, 125.5, 124.4, 124.3, 123.6, 108.3, 69.8, 67.2, 65.7, 55.0, 20.7; HRMS (ESI) Calcd. for $C_{34}H_{27}N_2O_3$ ([M+H]$^{+}$): 511.2016. Found: 511.2023.



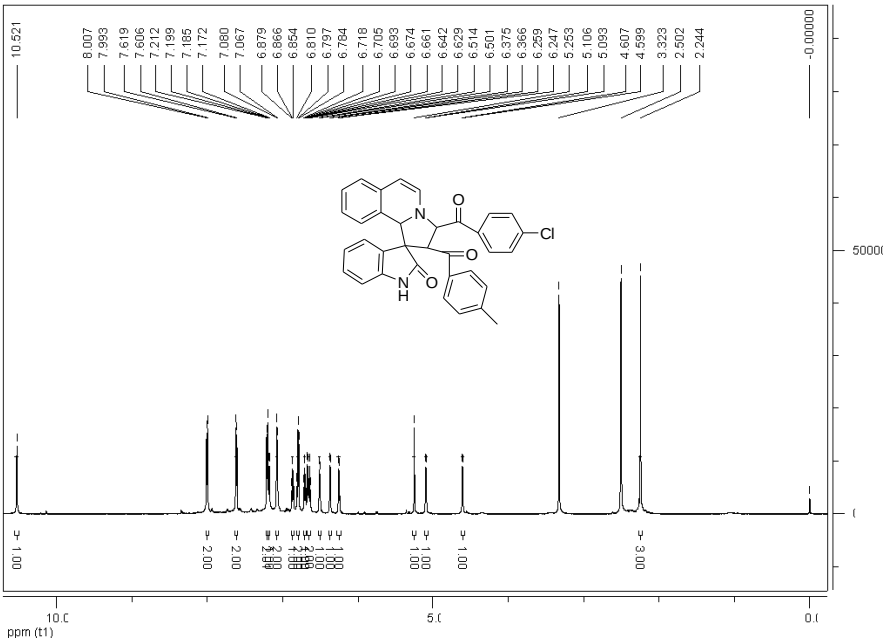


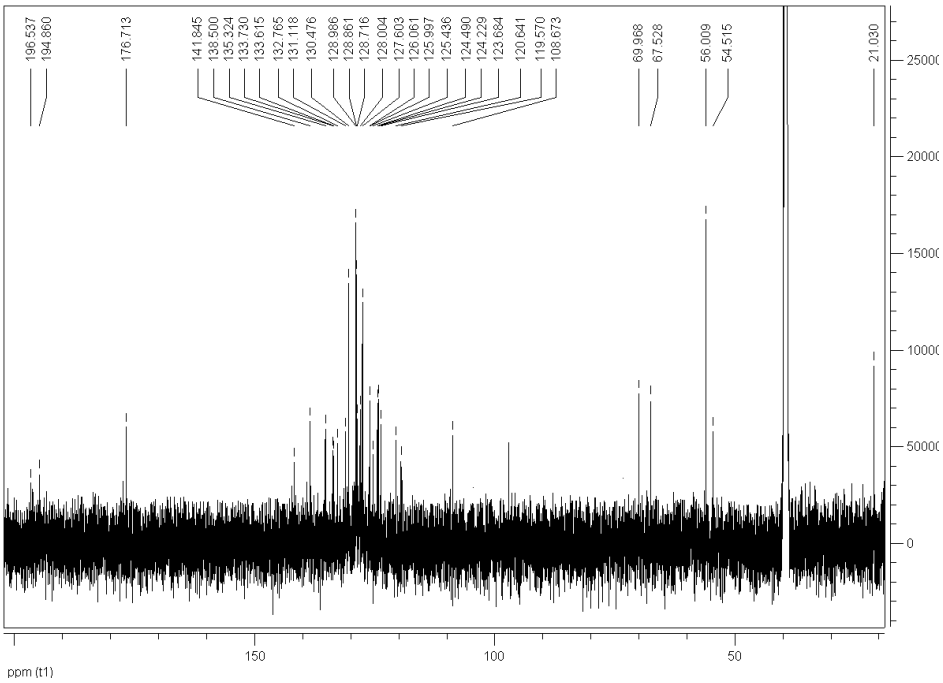
(5-fluoro-2-oxo-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinoline]-2',3'-diyl) bis(phenylmethanone) (3c): Yellow solid, yield: 91%, m.p. 164-166 ^{o}C, IR (KBr) ν = 3788, 3354, 3065, 2974, 1693, 1626, 1484, 1330, 1292, 1236, 1203, 1130, 1045, 1000, 879, 810, 764, 736, 693, 668, 616, 557 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.58 (s, 1H, NH), 8.02 (d, *J* = 7.8 Hz, 2H, ArH), 7.64 (t, *J* = 7.2 Hz, 1H, ArH), 7.55 (t, *J* = 7.2 Hz, 2H, ArH), 7.48 (t, *J* = 6.6 Hz, 1H, ArH), 7.32-7.29 (m, 4H, ArH), 7.00 (d, *J* = 7.8 Hz, 1H, ArH), 6.91 (t, *J* = 7.2 Hz, 1H, ArH), 6.85 (d, *J* = 7.2 Hz, 1H, ArH), 6.74 (d, *J* = 7.8 Hz, 2H, ArH), 6.65 (t, *J* = 8.4 Hz, 1H, ArH), 6.53 (d, *J* = 7.2 Hz, 1H, ArH), 6.43 (d, *J* = 4.2 Hz, 1H, CH), 6.23-6.21 (m, 1H, CH), 5.26 (s, 1H, CH), 5.16 (d, *J* = 7.2 Hz, 1H, CH), 4.70 (d, *J* = 4.8 Hz, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.0, 195.6, 176.6, 156.9 (d, *J* = 235.1 Hz), 138.2, 136.0, 135.4, 134.9, 133.6, 133.4, 132.7, 128.9, 128.6, 128.4, 128.2, 127.4, 125.1, 124.7, 124.3, 123.8, 114.6 (d, *J* = 23.6 Hz), 113.4 (d, *J* = 26.1 Hz), 109.4 (d, *J* = 7.7 Hz), 97.2, 70.0, 67.5, 66.6, 56.0, 54.6; HRMS (ESI) Calcd. for $C_{33}H_{24}FN_2O_3$ ([M+H]$^{+}$): 515.1765. Found: 515.1772.



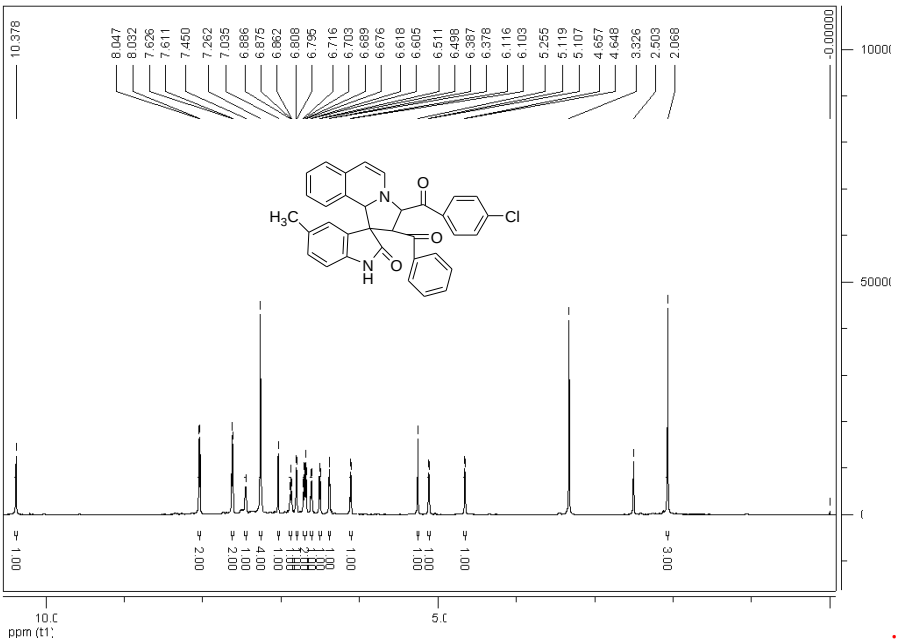


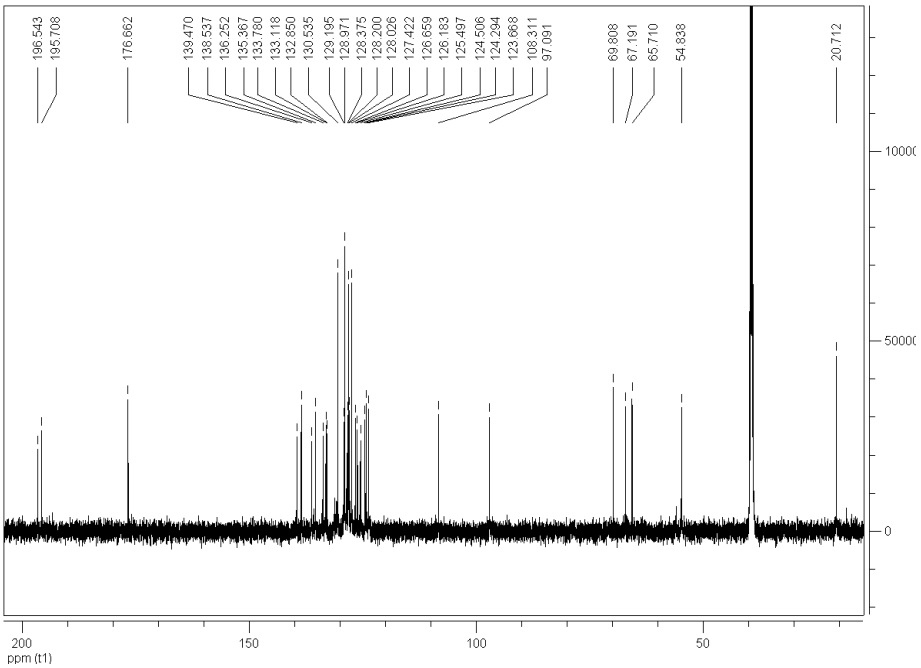
3'-(4-chlorobenzoyl)-2'-(4-methylbenzoyl)-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2, 1-a]isoquinolin]-2-one (3d): Yellow solid, yield: 80%, m.p. 182-184 ^{o}C, IR (KBr) ν = 3781, 3697, 3662, 3635, 3405, 2378, 2340, 1707, 1621, 1469, 1403, 1298, 1231, 1180, 1094, 977, 836, 755, 677 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.52 (s, 1H, NH), 8.00 (d, *J* = 8.4 Hz, 2H, ArH), 7.61 (d, *J* = 8.4 Hz, 2H, ArH), 7.21 (d, *J* = 7.8 Hz, 2H, ArH), 7.18（d, *J* = 7.8 Hz, 1H, ArH), 7.07 (d, *J* = 7.8 Hz, 2H, ArH), 6.87 (t, *J* = 7.5 Hz, 1H, ArH), 6.80 (t, *J* = 7.8 Hz, 2H, ArH), 6.71 (t, *J* = 7.5 Hz, 1H, ArH), 6.65 (m, 2H, ArH), 6.51 (d, *J* = 7.8 Hz, 1H, ArH), 6.37 (d, *J* = 5.4 Hz, 1H, CH), 6.25 (d, *J* = 7.8 Hz, 1H, CH), 5.25 (s, 1H, CH), 5.10 (d, *J* = 7.8 Hz, 1H, CH), 4.60 (d, *J* = 4.8 Hz, 1H, CH), 2.24 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.5, 194.8, 176.7, 141.8, 138.5, 135.3, 133.7, 133.6, 132.8, 131.1, 130.5, 129.0, 128.9, 128.7, 128.0, 127.6, 126.1, 126.0, 125.4, 124.2, 123.7, 120.6, 119.6, 108.7, 70.0, 67.5, 56.0, 54.5, 21.0;HRMS (ESI) Calcd. for $C_{34}H_{26}ClN_2O_3$ ([M+H]$^{+}$): 545.1626. Found: 545.1621.



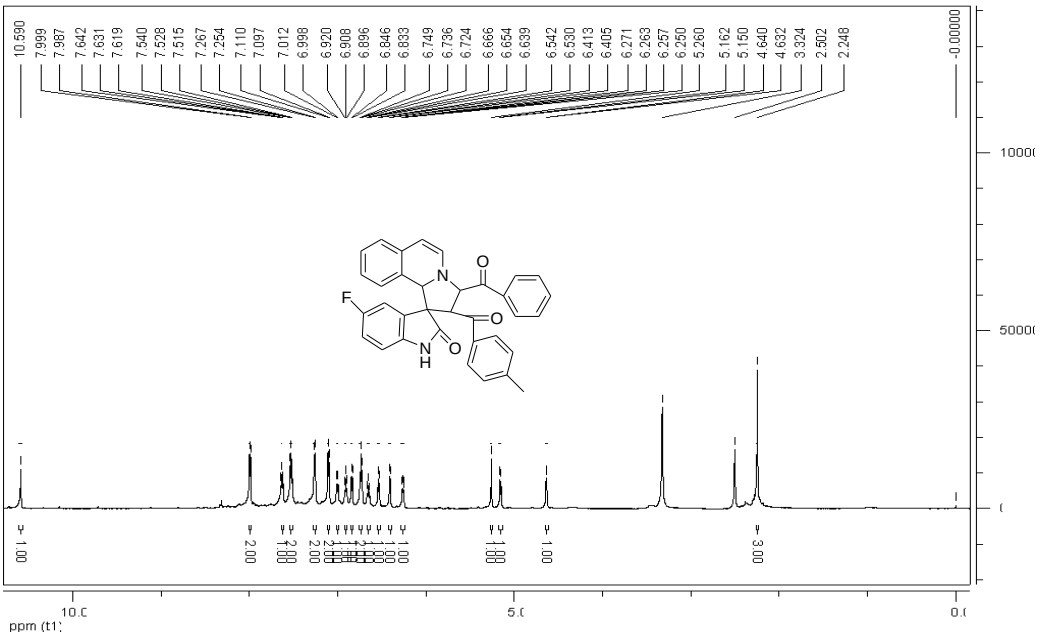


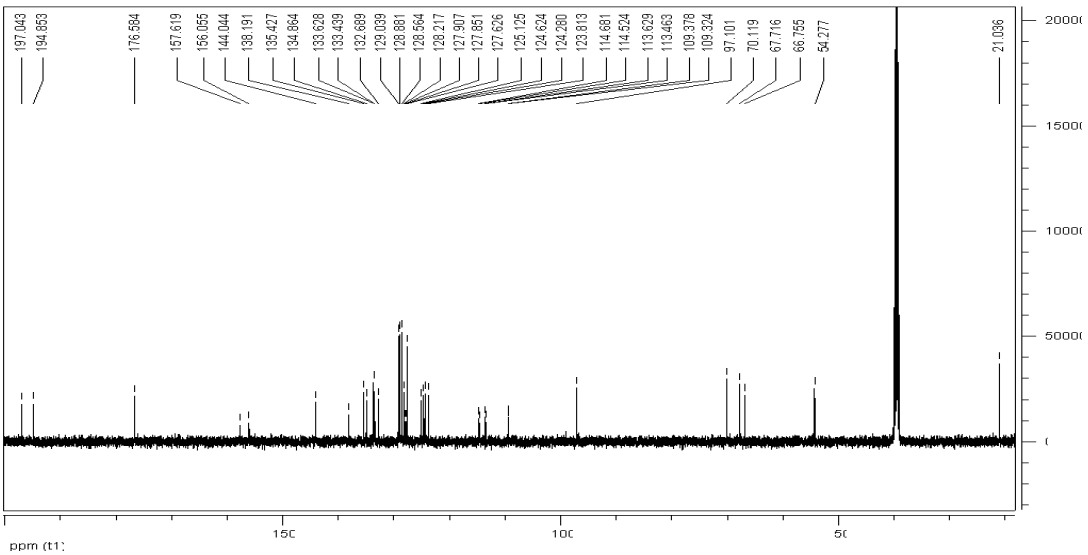
2'-benzoyl-3'-(4-chlorobenzoyl)-5-methyl-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinolin]-2-one (3e): Yellow solid, yield: 84%, m.p. 190-192 ^{o}C, IR (KBr) ν = 3780, 3697, 3034, 2859, 2378, 2340, 1700, 1625, 1594, 1489, 1460, 1296, 1230, 1171, 1092, 1001, 878, 832, 763, 691, 661, 619, 489 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.38 (s, 1H, NH), 8.04 (d, *J* = 9.0 Hz, 2H, ArH), 7.62 (d, *J* = 9.0 Hz, 2H, ArH), 7.45 (s, 1H, ArH), 7.26（m, 4H, ArH), 7.04 (s, 1H, ArH), 6.88 (t, *J* = 7.2 Hz, 1H, ArH), 6.80 (d, *J* = 7.8 Hz, 1H, ArH), 6.72-6.68 (m, 2H, ArH), 6.61 (d, *J* = 7.8 Hz, 1H, ArH), 6.51 (d, *J* = 7.8 Hz, 1H, ArH), 6.38 (d, *J* = 5.4 Hz, 1H, CH), 6.11 (d, *J* = 7.8 Hz, 1H, CH), 5.26 (s, 1H, CH), 5.12 (d, *J* = 7.2 Hz, 1H, CH), 4.65 (d, *J* = 5.4 Hz, 1H, CH), 2.07 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.5, 195.7, 176.7, 139.5, 138.5, 136.3, 135.4, 133.8, 133.1, 132.9, 130.5, 129.2, 129.0, 128.4, 127.4, 126.7, 126.2, 125.5, 124.5, 124.3, 123.7, 108.3, 69.8, 67.2, 65.7, 54.8, 20.7; HRMS (ESI) Calcd. for $C_{34}H_{26}ClN_2O_3$ ([M+H]$^{+}$): 545.1626. Found: 545.1629.



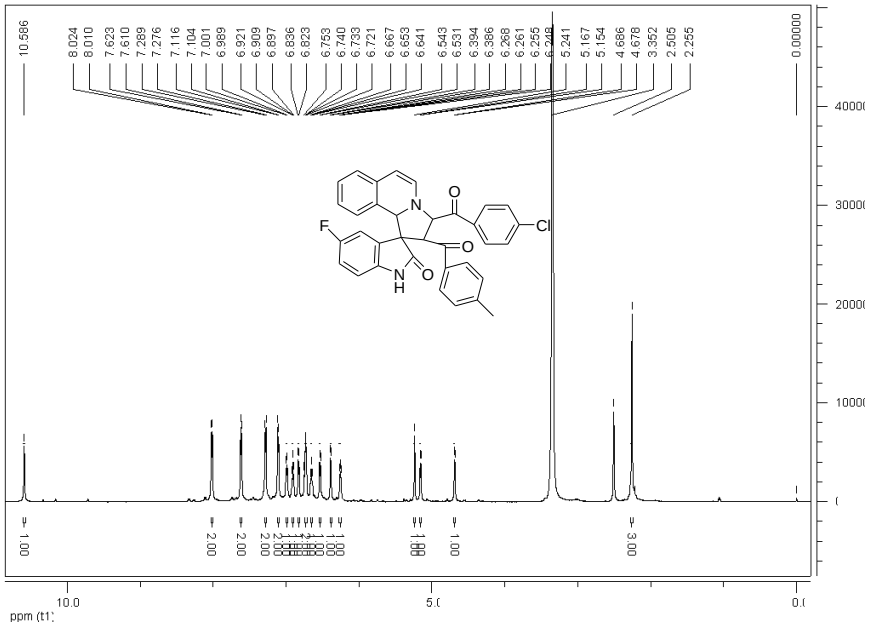


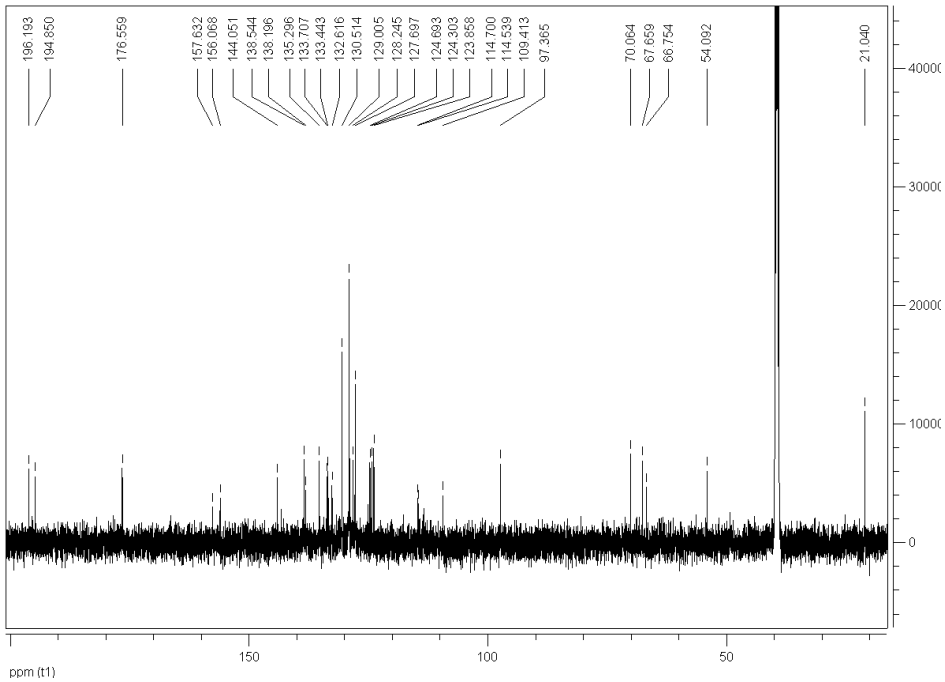
1'-benzoyl-5-fluoro-2'-(4-methylbenzoyl)-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a] isoquinolin]-2-one (3f): Yellow solid, yield: 78%, m.p. 186-188 ^{o}C, IR (KBr) ν = 3777, 3698, 3063, 2946, 2379, 1667, 1617, 1488, 1452, 1377, 1342, 1286, 1227, 1196, 1152, 1107, 1030, 946, 842, 768, 735, 686, 634, 554, 446 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.59 (s, 1H, NH), 8.00 (d, *J* = 7.2 Hz, 2H, ArH), 7.63 (d, *J* = 7.2 Hz, 1H, ArH), 7.53 (d, *J* = 7.2 Hz, 2H, ArH), 7.26（d, *J* = 7.8 Hz, 2H, ArH), 7.11 (d, *J* = 7.8 Hz, 2H, ArH), 7.01 (d, *J* = 8.4 Hz, 1H, ArH), 6.91 (t, *J* = 7.2 Hz, 1H, ArH), 6.84 (d, *J* = 7.8 Hz, 1H, ArH), 6.74 (d, *J* = 7.2 Hz, 2H, ArH), 6.65 (t, *J* = 7.8 Hz, 1H, ArH), 6.53 (d, *J* = 7.2 Hz, 1H, ArH), 6.40 (d, *J* = 4.8 Hz, 1H, CH), 6.27-6.25 (m, 1H, CH), 5.26 (s, 1H, CH), 5.16 (d, *J* = 7.2 Hz, 1H, CH), 4.63 (d, *J* = 4.8 Hz, 1H, CH), 2.25 (s, 3H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.0, 194.9, 176.6, 156.8 (d, *J* = 234.6 Hz), 144.0, 138.2, 135.4, 134.9, 133.6, 133.4, 132.7, 129.0, 128.9, 128.6, 128.2, 127.9, 127.8, 127.6, 125.1, 124.6, 124.3, 123.8, 114.6 (d, *J* = 23.6 Hz), 113.6 (d, *J* = 24.9 Hz), 109.3 (d, *J* = 8.1 Hz), 97.1, 70.1, 67.5, 66.8, 54.3, 21.0; HRMS (ESI) Calcd. for $C_{34}H_{26}FN_2O_3$ ([M+H]$^{+}$): 529.1921. Found: 529.1923.

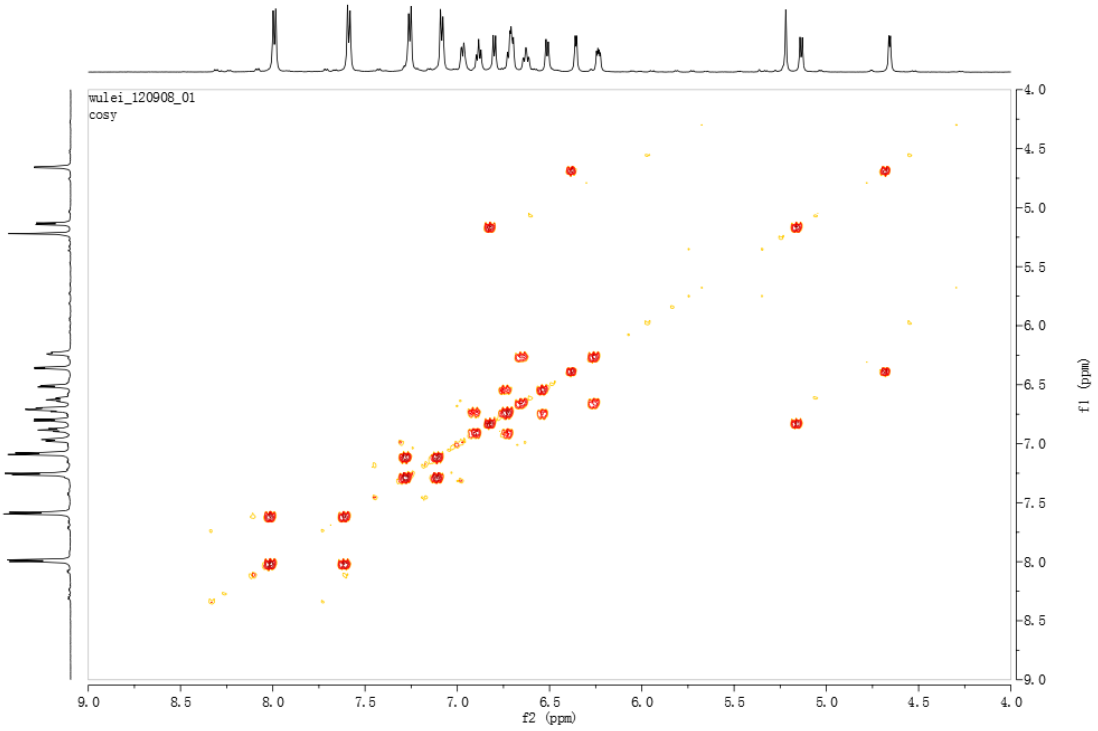




3'-(4-chlorobenzoyl)-5-fluoro-2'-(4-methylbenzoyl)-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinolin]-2-one (3g): Yellow solid, yield: 89%, m.p. 188-190 ^{o}C, IR (KBr) ν = 3780, 3697, 3423, 3077, 2378, 2340, 1711, 1675, 1630, 1601, 1486, 1404, 1373, 1321, 1236, 1185, 1158, 1092, 1043, 1010, 967, 896, 826, 765, 657, 600, 560, 529 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.59 (s, 1H, NH), 8.02 (d, *J* = 7.8 Hz, 2H, ArH), 7.62 (d, *J* = 7.8 Hz, 2H, ArH), 7.29 (d, *J* = 7.8 Hz, 2H, ArH), 7.11（d, *J* = 7.8 Hz, 2H, ArH), 7.00 (d, *J* = 7.2 Hz, 1H, ArH), 6.91 (t, *J* = 7.2 Hz, 1H, ArH), 6.83 (d, *J* = 7.8 Hz, 1H, ArH), 6.75-6.72 (m, 2H, ArH), 6.65 (t, *J* = 7.8 Hz, 1H, ArH), 6.54 (d, *J* = 7.8 Hz, 1H, ArH), 6.39 (d, *J* = 4.8 Hz, 1H, CH), 6.27-6.25 (m, 1H, CH), 5.24 (s, 1H, CH), 5.16 (d, *J* = 7.8 Hz, 1H, CH), 4.68 (d, *J* = 4.8 Hz, 1H, CH), 2.26 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.2, 194.9, 176.6, 156.9 (d, *J* = 234.6 Hz), 144.1, 138.5, 138.2, 135.3, 133.7, 133.4, 132.6, 130.5, 129.0, 128.2, 127.7, 124.7, 124.3, 123.9, 114.6 (d, *J* = 24.2 Hz), 109.4 (d, *J* = 9.5 Hz), 70.1, 67.7, 66.8, 54.1, 21.0; HRMS (ESI) Calcd. for $C_{34}H_{25}ClFN_2O_3$ ([M+H]$^{+}$): 563.1532. Found: 563.1527.

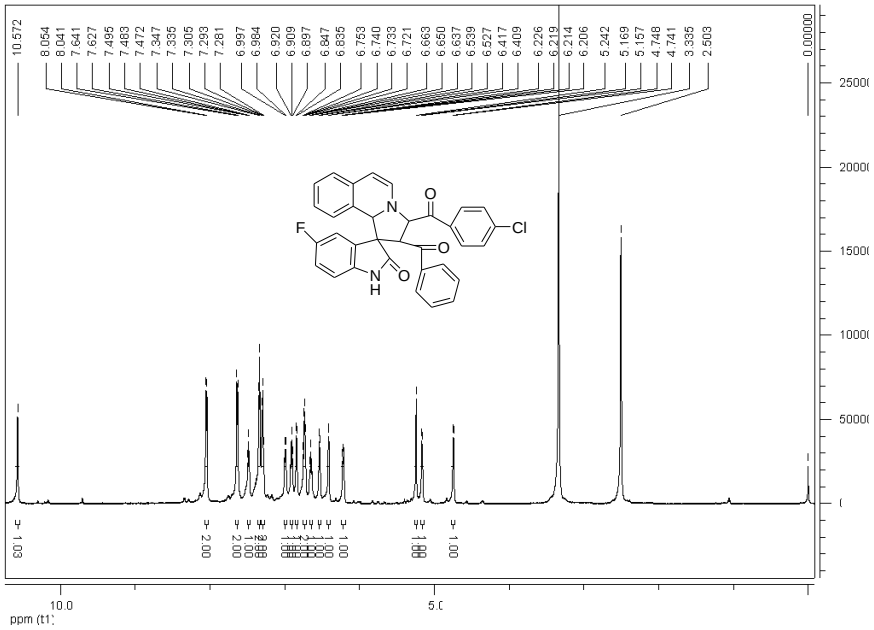


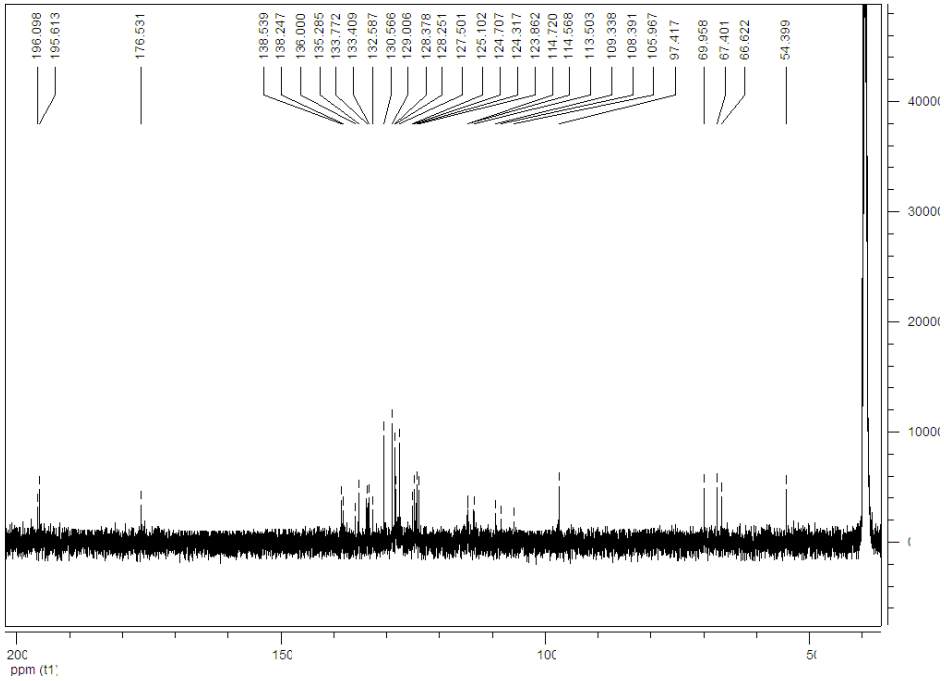




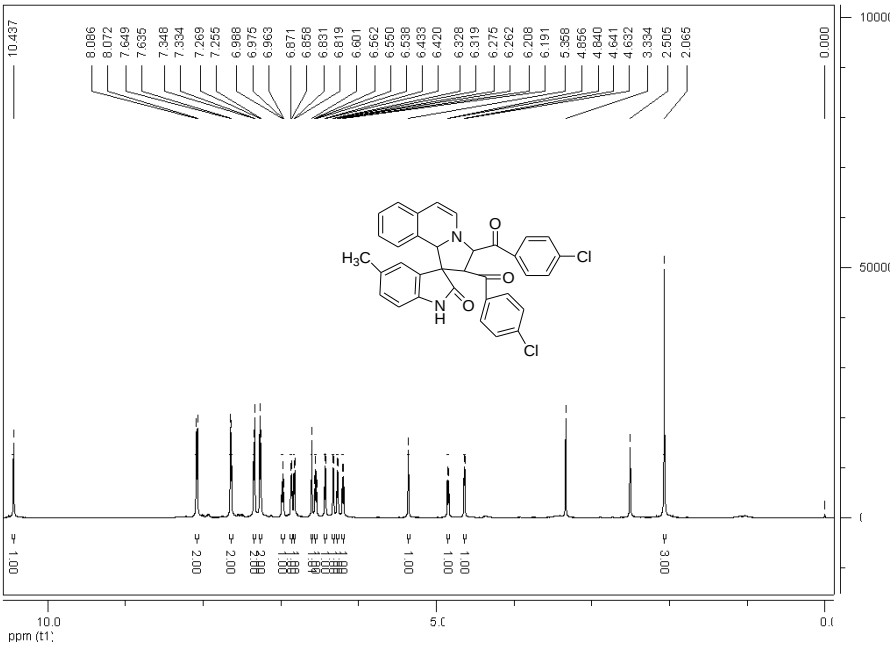
H-H COSY

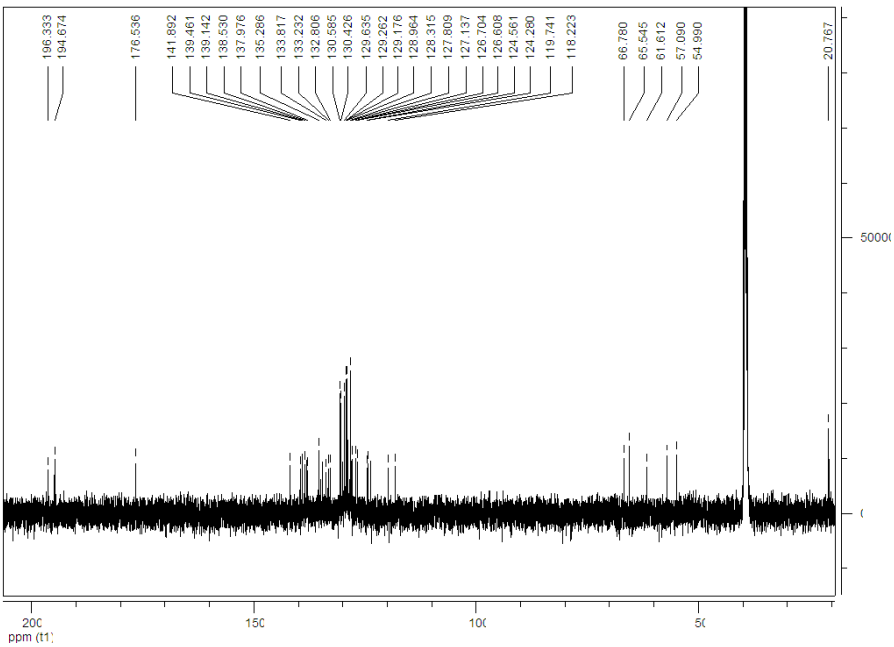
2'-benzoyl-3'-(4-chlorobenzoyl)-5-fluoro-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinolin]-2-one (3h): Yellow solid, yield: 85%, m.p. 172-174 ^{o}C, IR (KBr) ν = 3167, 3057, 2883, 1703, 1629, 1596, 1485, 1403, 1378, 1323, 1235, 1210, 1091, 1017, 981, 915, 882, 839, 815, 765, 692, 662, 627, 556, 528, 468 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.57 (s, 1H, NH), 8.05 (d, *J* = 7.8 Hz, 2H, ArH), 7.63 (t, *J* = 7.8 Hz, 2H, ArH), 7.48 (t, *J* = 7.2 Hz, 1H, ArH), 7.34（d, *J* = 7.2 Hz, 2H, ArH), 7.30 (t, *J* = 7.2 Hz, 2H, ArH), 7.00 (d, *J* = 7.8 Hz, 1H, ArH), 6.91 (t, *J* = 7.2 Hz, 1H, ArH), 6.84 (d, *J* = 7.2 Hz, 1H, ArH), 6.75-6.72 (m, 2H, ArH), 6.65 (t, *J* = 7.8 Hz, 1H, ArH), 6.53 (d, *J* = 7.2 Hz, 1H, ArH), 6.42 (d, *J* = 4.8 Hz, 1H, CH), 6.23-6.21 (m, 1H, CH), 5.24 (s, 1H, CH), 5.17 (d, *J* = 7.2 Hz, 1H, CH), 4.74 (d, *J* = 4.2 Hz, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm):196.1, 195.6, 176.5, 138.5, 138.2, 136.0, 135.3, 133.8, 133.4, 132.6, 130.6, 129.0, 128.4, 128.3, 127.5, 125.1, 124.7, 124.3, 123.9, 114.7 (d, *J* = 22.8 Hz), 113.5 (d, *J* = 25.8 Hz), 109.4 (d, *J* = 10.1 Hz), 108.4, 105.9, 97.4, 69.9, 67.4, 66.6, 54.4; HRMS (ESI) Calcd. for $C_{33}H_{23}ClFN_2O_3$ ([M+H]$^{+}$): 549.1376. Found: 549.1380.



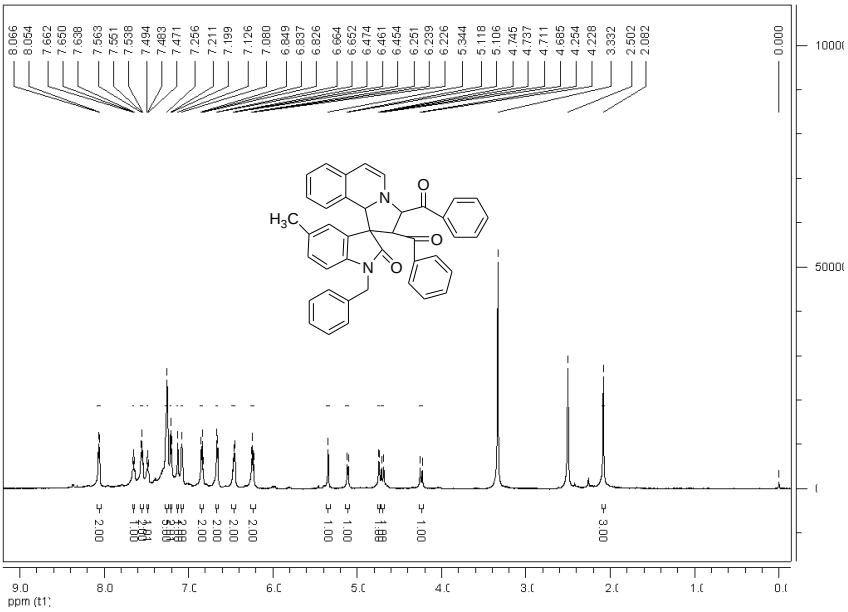


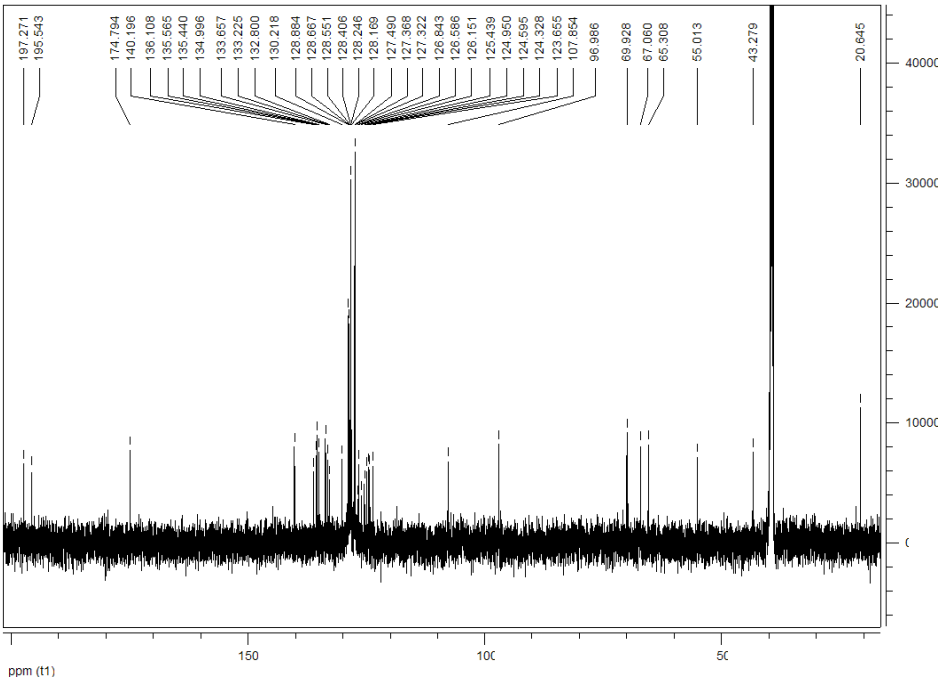
(5-methyl-2-oxo-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinoline]-2',3'-diyl)bis((4-chlorophenyl)methanone) (3i): Yellow solid, yield: 77%, m.p. 166-168 ^{o}C, IR (KBr) ν = 3788, 3638, 3189, 1699, 1625, 1589, 1489, 1459, 1399, 1326, 1285, 1231, 1170, 1093, 1005, 836, 811, 766, 663, 628, 533, 491 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.44 (s, 1H, NH), 8.08 (d, *J* = 7.8 Hz, 2H, ArH), 7.64 (d, *J* = 7.8 Hz, 2H, ArH), 7.34 (d, *J* = 7.8 Hz, 2H, ArH), 7.26 （d, *J* = 7.8 Hz, 2H, ArH), 6.98 (t, *J* = 7.2 Hz, 1H, ArH), 6.86 (d, *J* = 7.8 Hz, 1H, ArH), 6.82 (d, *J* = 7.2 Hz, 1H, ArH), 6.60 (s, 1H, CH), 6.55 (t, *J* = 7.2 Hz, 1H, ArH), 6.43 (d, *J* = 7.8 Hz, 1H, ArH), 6.32 (d, *J* = 5.4 Hz, 1H, ArH), 6.26 (d, *J* = 7.8 Hz, 1H, ArH), 6.20 (d, *J* = 9.6 Hz, 1H, CH), 5.36 (s, 1H, CH), 4.85 (d, *J* = 9.6 Hz, 1H, CH), 4.63 (d, *J* = 5.4 Hz, 1H, CH), 2.07 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm):196.3, 194.7, 176.5, 141.9, 139.5, 139.1, 138.5, 138.0, 135.3, 133.8, 133.2, 132.8, 130.6, 130.4, 129.6, 129.3, 129.2, 129.0, 128.3, 127.8, 127.1, 126.7, 126.6, 124.6, 124.3, 119.7, 118.2, 66.8, 66.5, 61.6, 57.1, 55.0; HRMS (ESI) Calcd. for $C_{34}H_{25}Cl_2N_2O_3$ ([M+H]$^{+}$): 579.1237. Found: 579.1239.



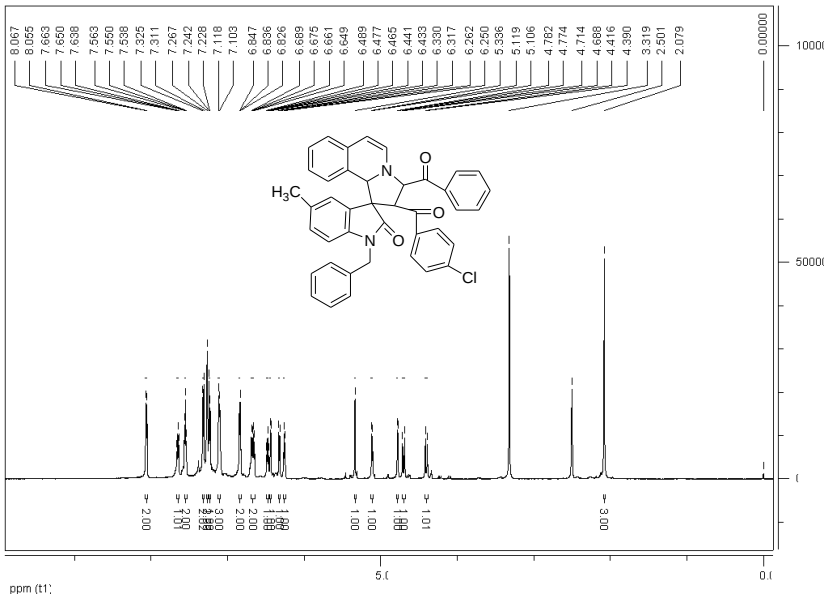


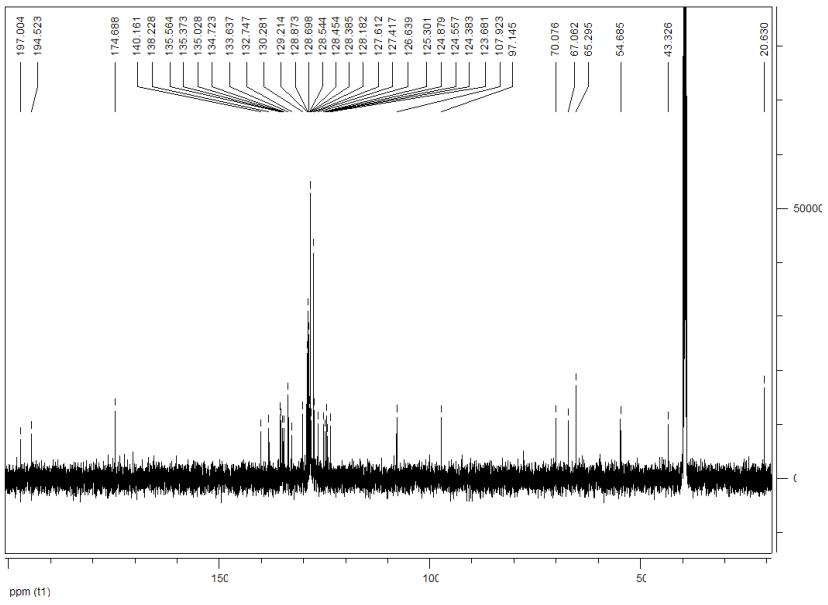
(1-benzyl-5-methyl-2-oxo-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinoline] -2',3'-diyl)bis(phenylmethanone) (**3j**): Yellow solid, yield: 88%, m.p. 174-176 ^{o}C, IR (KBr) ν = 3790, 3662, 3061, 2917, 1694, 1624, 1598, 1493, 1448, 1366, 1542, 1232, 1175, 1002, 984, 882, 804, 767, 733, 702, 666, 617, 556, 488 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 8.06 (d, *J* = 7.2 Hz, 2H, ArH), 7.65 (t, *J* = 7.2 Hz, 1H, ArH), 7.55 (t, *J* = 7.2 Hz, 2H, ArH), 7.48 (t, *J* = 7.2 Hz, 1H, ArH), 7.26 (brs, 5H, ArH), 7.20 (d, *J* = 7.2 Hz, 2H, ArH), 7.13 (brs, 1H, ArH), 7.08 (brs, 2H, ArH), 6.84 (d, *J* = 7.2 Hz, 2H, ArH), 6.66 (d, *J* = 7.2 Hz, 2H, ArH), 6.47-6.45 (m, 2H, CH), 6.24 (t, *J* = 7.2 Hz, 2H, ArH), 5.34 (s, 1H, CH), 5.11 (d, *J* = 7.2 Hz, 1H, CH), 4.74 (d, *J* = 4.8 Hz, 1H, CH), 4.70 (d, *J* = 15.6 Hz, 1H, CH), 4.24 (d, *J* = 15.6 Hz, 1H, CH), 2.08 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.3, 195.5, 174.8, 140.2, 136.1, 135.6, 135.4, 135.0, 133.7, 133.2, 132.8, 130.2, 128.9, 128.7, 128.6, 128.4, 128.3, 128.2, 127.5, 127.4, 127.3, 126.8, 126.6, 126.2, 125.4, 125.0, 124.6, 124.3, 123.7, 107.9, 97.0, 69.9, 67.1, 65.3, 55.0, 43.3, 20.6; HRMS (ESI) Calcd. for $C_{41}H_{33}N_2O_3$ ([M+H]$^{+}$): 601.2486. Found: 601.2488.



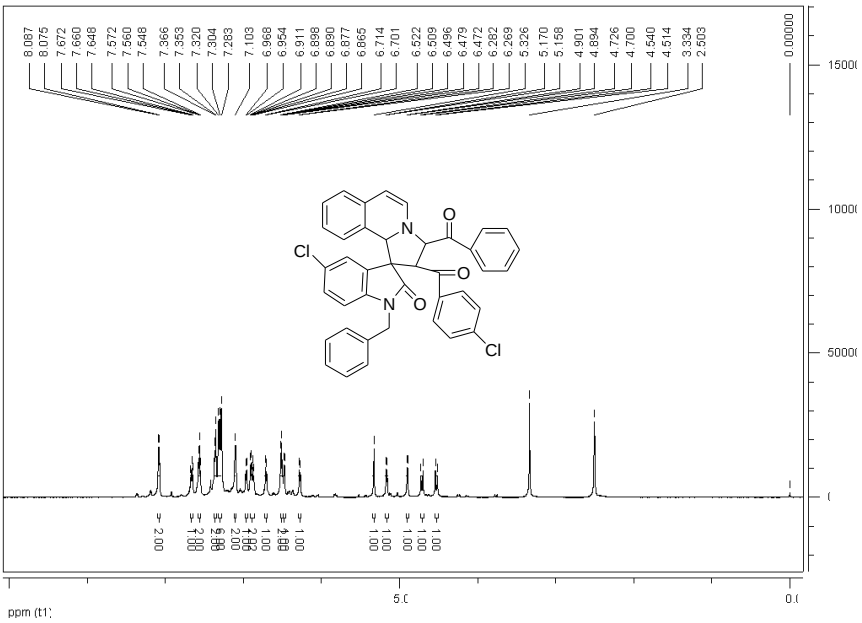


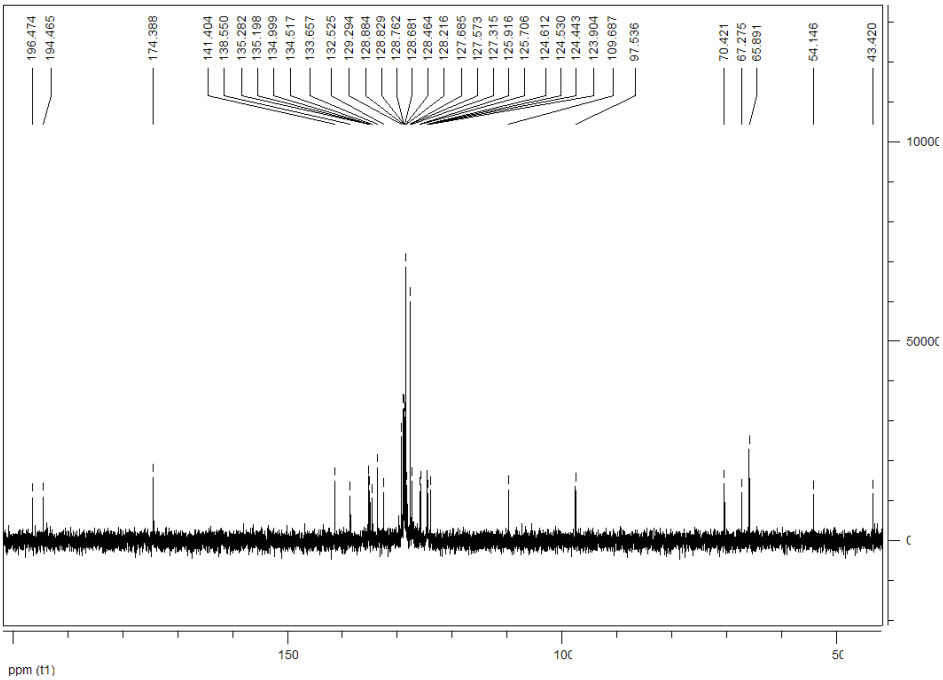
3'-benzoyl-1-benzyl-2'-(4-chlorobenzoyl)-5-methyl-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinolin]-2-one (3k): Yellow solid, yield: 86%, m.p. 168-170 ^{o}C, IR (KBr) ν = 3662, 3061, 2918, 1677, 1625, 1588, 1493, 1454, 1432, 1400, 1365, 1342, 1283, 1230, 1193, 1155, 1127, 1110, 1091, 1010, 969, 934, 897, 863, 844, 820, 808, 768, 744, 694, 663, 556, 529, 494 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 8.07 (d, *J* = 7.2 Hz, 2H, ArH), 7.65 (t, *J* = 7.2 Hz, 1H, ArH), 7.55 (t, *J* = 7.2 Hz, 2H, ArH), 7.32 (d, *J* = 8.4 Hz, 2H, ArH), 7.27 (brs, 3H, ArH), 7.23 (d, *J* = 8.4 Hz, 2H, ArH), 7.11 (d, *J* = 8.4 Hz, 3H, ArH), 6.84 (t, *J* = 6.6 Hz, 2H, ArH), 6.69-6.65 (m, 2H, ArH), 6.48 (t, *J* = 7.2 Hz, 1H, ArH), 6.43 (d, *J* = 4.8 Hz, 1H, CH), 6.32 (d, *J* = 7.8 Hz, 1H, ArH), 6.25 (d, *J* = 7.2 Hz, 1H, CH), 5.34 (s, 1H, CH), 5.11 (d, *J* = 7.8 Hz, 1H, CH), 4.78 (d, *J* = 4.8 Hz, 1H, CH), 4.70 (d, *J* = 15.6 Hz, 1H, CH), 4.40 (d, *J* = 15.6 Hz, 1H, CH), 2.08 (s, 3H, CH_3);^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.0, 194.5, 174.7, 140.2, 138.2, 135.6, 135.4, 135.0, 134.7, 133.6, 132.7, 130.3, 129.2, 128.9, 128.7, 128.5, 128.4, 128.3, 128.2, 127.6, 127.4, 126.6, 125.3, 124.9, 124.6, 124.4, 123.7, 107.9, 97.1, 70.1, 67.1, 65.3, 54.7, 43.3, 20.6; HRMS (ESI) Calcd. for $C_{41}H_{32}ClN_2O_3$ ([M+H]$^{+}$): 635.2096. Found: 635.2096.



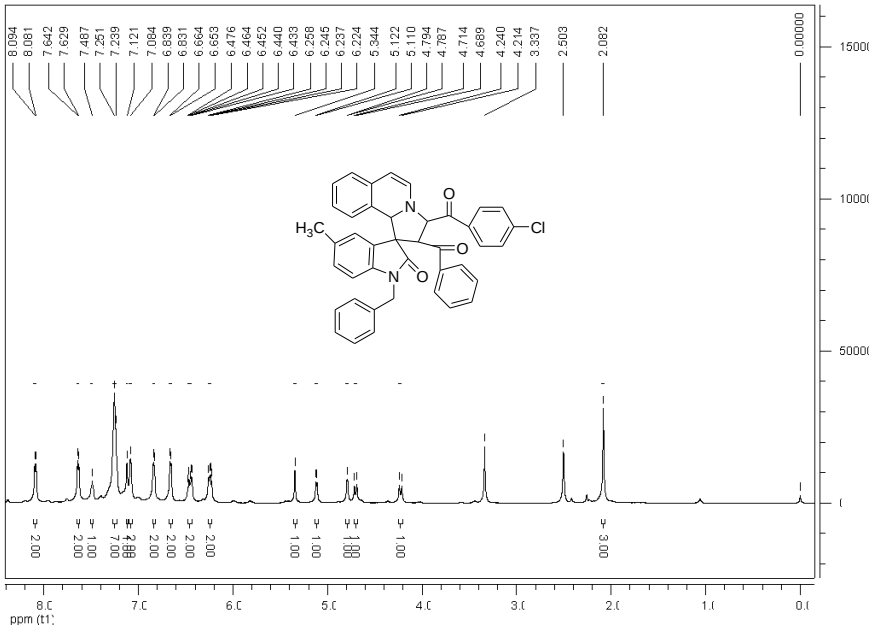


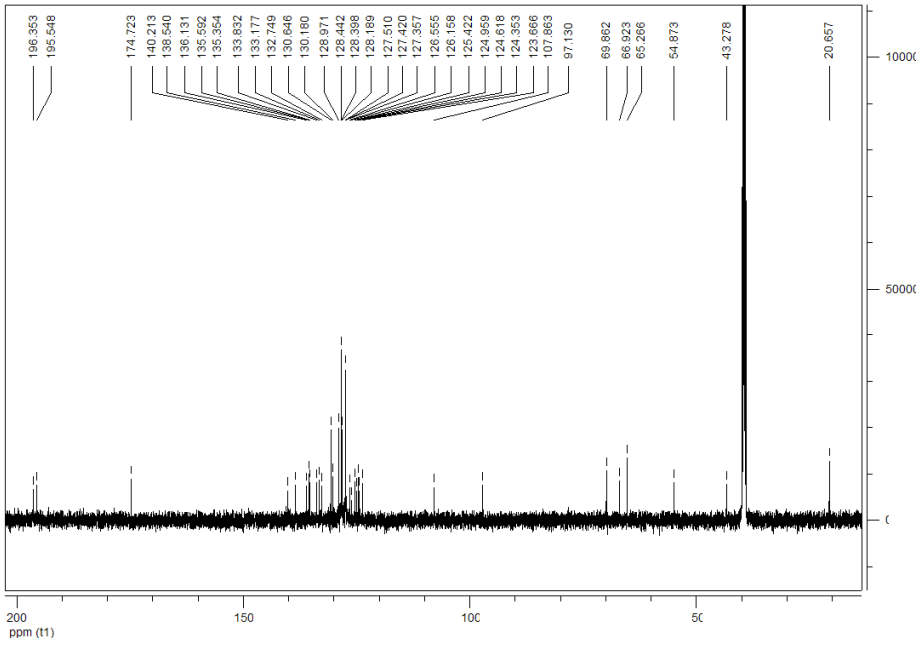
3'-benzoyl-1-benzyl-5-chloro-2'-(4-chlorobenzoyl)-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinolin]-2-one (3l): Yellow solid, yield: 87%, m.p. 164-166 ^{o}C, IR (KBr) ν = 3662, 3061, 2981, 1715, 1681, 1619, 1589, 1483, 1454, 1431, 1398, 1344, 1281, 1206, 1171, 1093, 1010, 933, 900, 878, 843, 808, 767, 741, 692, 620, 573, 483 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 8.08 (d, *J* = 7.2 Hz, 2H, ArH), 7.66 (t, *J* = 7.2 Hz, 1H, ArH), 7.56 (t, *J* = 7.2 Hz, 2H, ArH), 7.36（d, *J* = 7.8 Hz, 2H, ArH), 7.32-7.28 (m, 6H, ArH), 7.10 (brs, 2H, ArH), 6.96 (d, *J* = 7.2 Hz, 1H, ArH), 6.91-6.87 (m, 2H, ArH), 6.70 (d, *J* = 7.8 Hz, 1H, ArH), 6.52-6.50 (m, 2H, ArH), 6.47 (d, *J* = 4.2 Hz, 1H, CH), 6.27 (d, *J* = 7.8 Hz, 1H, CH), 5.33 (s, 1H, CH), 5.16 (d, *J* = 7.2 Hz, 1H, CH), 4.90 (d, *J* = 4.2 Hz, 1H, CH), 4.71 (d, *J* = 15.6 Hz, 1H, CH), 4.52 (d, *J* = 15.6 Hz, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.5, 194.5, 174.4, 141.4, 138.6, 135.3, 135.2, 135.0, 134.5, 133.7, 132.5, 129.3, 128.9, 128.8, 128.7, 128.6, 128.5, 128.2, 127.7, 127.6, 127.3, 125.9, 125.7, 124.6, 124.5, 124.4, 123.9, 109.7, 97.5, 70.4, 67.3, 65.9, 54.1, 43.4; HRMS (ESI) Calcd. for $C_{40}H_{29}Cl_2N_2O_3$ ([M+H]$^{+}$): 655.1550. Found: 655.1548.



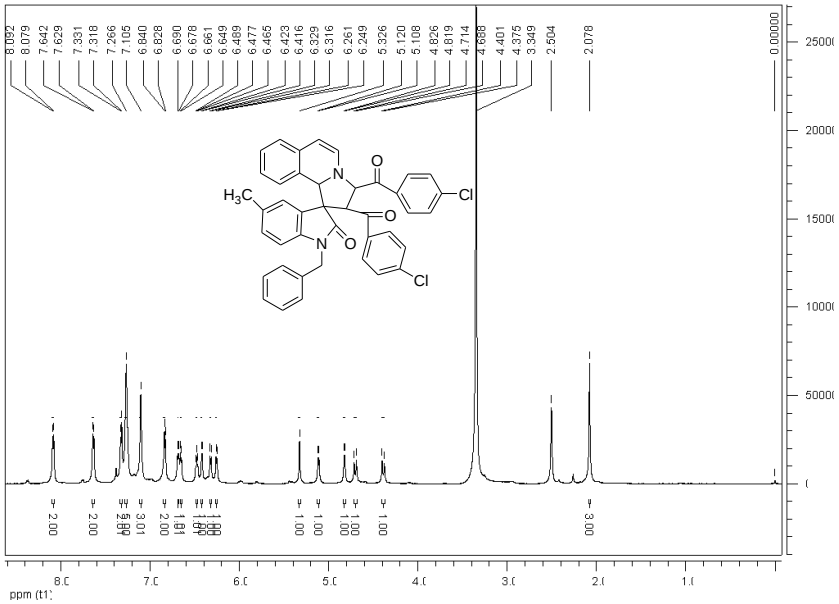


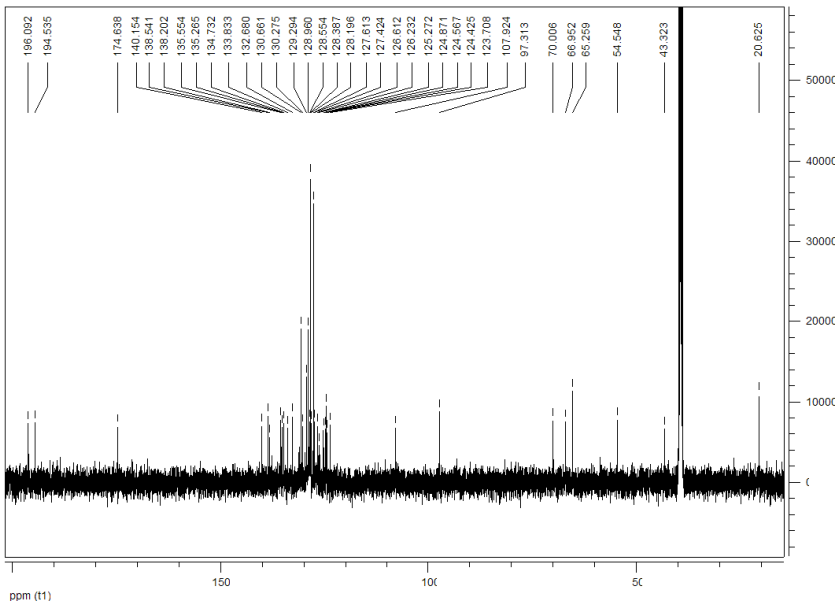
2'-benzoyl-1-benzyl-3'-(4-chlorobenzoyl)-5-methyl-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinolin]-2-one (3m): Yellow solid, yield: 84%, m.p. 184-186 ^{o}C, IR (KBr) ν = 3384, 3062, 2914, 1695, 1683, 1622, 1596, 1567, 1492, 1459, 1370, 1343, 1300, 1231, 1171, 1129, 1113, 1093, 1042, 986, 902, 882, 845, 768, 743, 727, 698, 660, 616, 556, 533, 488 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 8.09 (d, *J* = 7.8 Hz, 2H, ArH), 7.63 (d, *J* = 7.8 Hz, 2H, ArH), 7.49 (brs, 1H, ArH), 7.25（brs, 7H, ArH), 7.12 (brs, 1H, ArH), 7.08 (brs, 2H, ArH), 6.83 (d, *J* = 4.8 Hz, 2H, ArH), 6.66 (d, *J* = 6.6 Hz, 2H, ArH), 6.48-6.43 (m, 2H, CH), 6.26-6.22 (m, 2H, ArH), 5.34 (s, 1H, CH), 5.12 (d, *J* = 7.2 Hz, 1H, CH), 4.79 (d, *J* = 4.2 Hz, 1H, CH), 4.70 (d, *J* = 15.6 Hz, 1H, CH), 4.22 (d, *J* = 15.6 Hz, 1H, CH), 2.08 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.4, 195.5, 174.7, 140.2, 138.5, 136.1, 135.6, 135.4, 133.8, 133.2, 132.7, 130.6, 130.2, 129.0, 128.4, 128.3, 128.2, 127.5, 127.4, 127.3, 126.6, 126.2, 125.4, 125.0, 124.6, 124.4, 123.7, 107.9, 97.1, 69.9, 66.9, 65.3, 54.9, 43.3, 20.7; HRMS (ESI) Calcd. for $C_{41}H_{32}ClN_2O_3$ ([M+H]$^{+}$): 635.2096. Found: 635.2093.



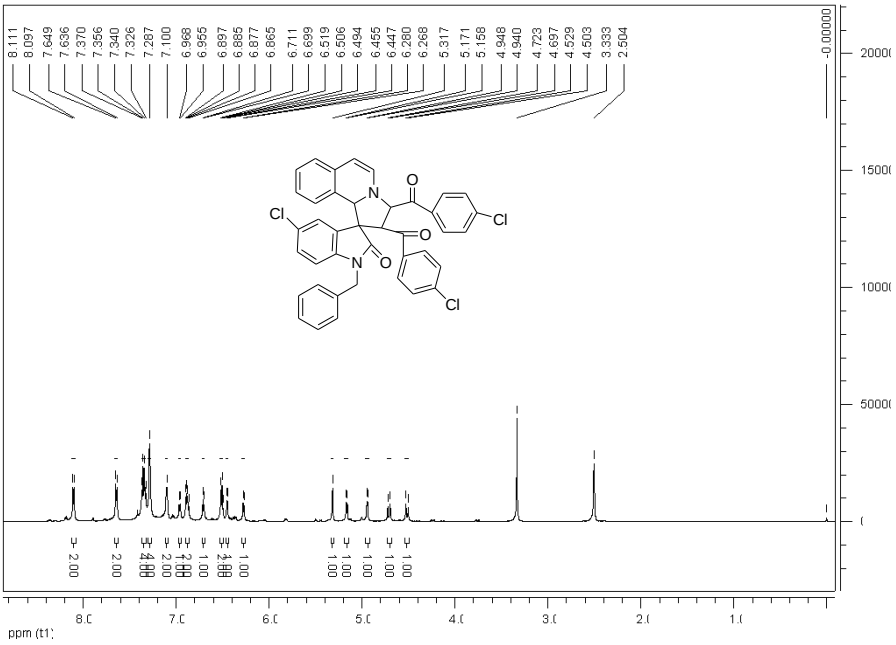


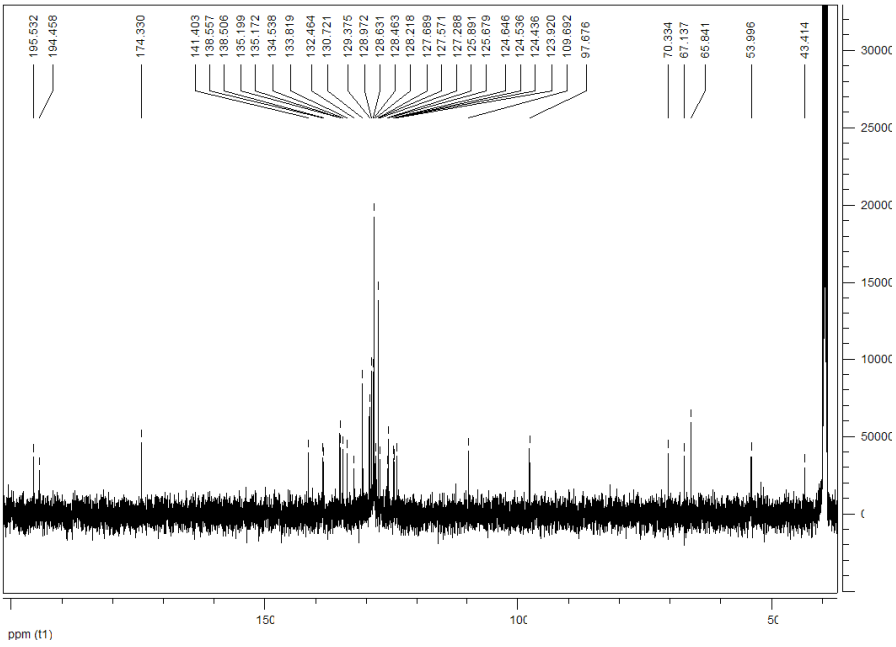
(1-benzyl-5-methyl-2-oxo-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinoline] -2',3'-diyl)bis((4-chlorophenyl)methanone) (3n): Yellow solid, yield: 87%, m.p. 170-172 ^{o}C, IR (KBr) ν = 3662, 3062, 2915, 1708, 1680, 1623, 1588, 1492, 1457, 1428, 1398, 1360, 1283, 1232, 1196, 1156, 1089, 1001, 931, 897, 833, 786, 763, 726, 697, 673, 642, 559, 528, 497 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 8.08 (d, *J* = 7.8 Hz, 2H, ArH), 7.64 (d, *J* = 7.8 Hz, 2H, ArH), 7.32 (d, *J* = 7.8 Hz, 2H, ArH), 7.27 (brs, 5H, ArH), 7.11 (brs, 3H, ArH), 6.84 (d, *J* = 7.2 Hz, 2H, ArH), 6.68 (d, *J* = 7.2 Hz, 1H, ArH), 6.65 (d, *J* = 7.2 Hz, 1H, ArH), 6.48 (t, *J* = 7.2 Hz, 1H, ArH), 6.42 (d, *J* = 4.2 Hz, 1H, CH), 6.32 (d, *J* = 7.8 Hz, 1H, ArH), 6.25 (d, *J* = 7.2 Hz, 1H, CH), 5.33 (s, 1H, CH), 5.11 (d, *J* = 7.2 Hz, 1H, CH), 4.82 (d, *J* = 4.2 Hz, 1H, CH), 4.70 (d, *J* = 15.6 Hz, 1H, CH), 4.39 (d, *J* = 15.6 Hz, 1H, CH), 2.08 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.1, 194.5, 174.6, 140.2, 138.5, 138.2, 135.6, 135.3. 134.7, 133.8, 132.7, 130.7, 130.3, 129.3, 129.0, 128.6, 128.4, 128.2, 127.6, 127.4, 126.6, 126.2, 125.3, 124.9, 124.6, 124.4, 123.7, 107.9, 97.3, 70.0, 67.0, 65.3, 54.5, 43.3, 20.6; HRMS (ESI) Calcd. for $C_{41}H_{31}Cl_2N_2O_3$ ([M+H]$^{+}$): 669.1706. Found: 669.1696.



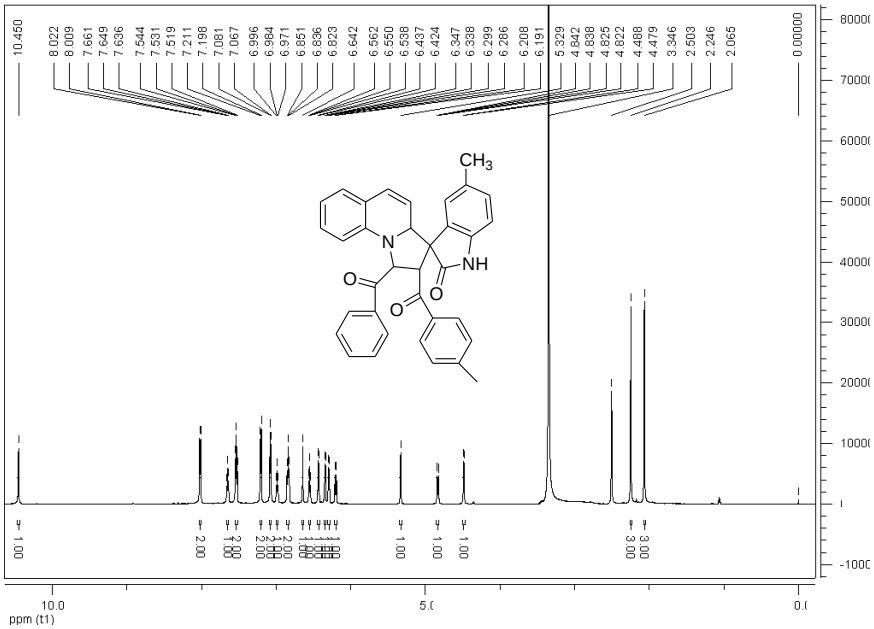


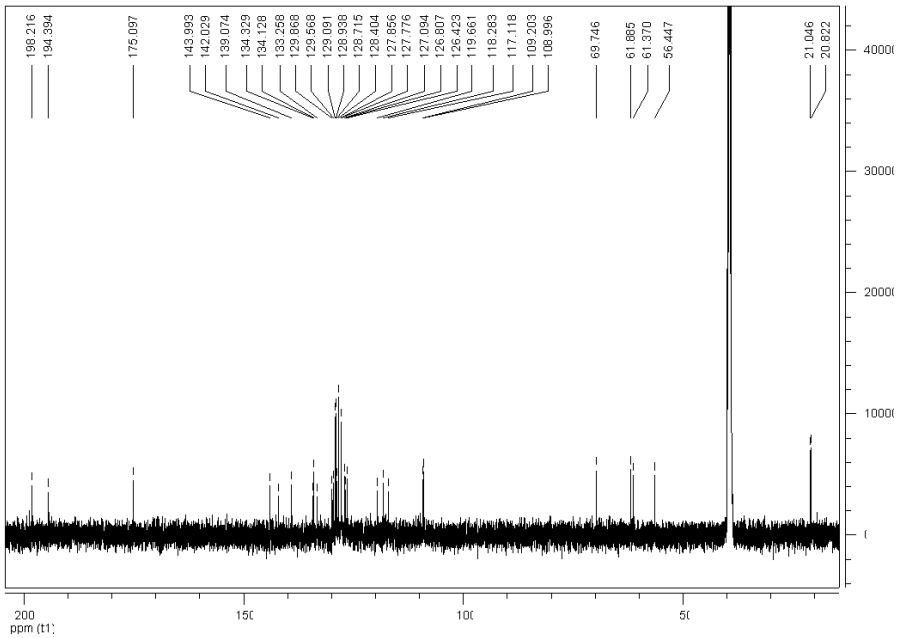
(1-benzyl-5-chloro-2-oxo-3',10b'-dihydro-2'H-spiro[indoline-3,1'-pyrrolo[2,1-a]isoquinoline]-2',3'-diyl)bis((4-chlorophenyl)methanone) (3o): Yellow solid, yield: 81%, m.p. 162-164 ^{o}C, IR (KBr) ν = 3660, 3066, 1713, 1672, 1629, 1587, 1485, 1455, 1431, 1401, 1343, 1212, 1171, 1125, 1093, 1031,1009, 979, 952, 897, 875, 834, 805, 768, 726, 696, 618, 570, 529, 496 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 8.10 (d, *J* = 8.4 Hz, 2H, ArH), 7.64 (d, *J* = 7.8 Hz, 2H, ArH), 7.35 (q, *J* = 8.4 Hz, 4H, ArH), 7.29（brs, 4H, ArH), 7.10 (brs, 2H, ArH), 6.96 (d, *J* = 7.8 Hz, 1H, ArH), 6.90-6.87 (m, 2H, ArH), 6.70 (d, *J* = 7.2 Hz, 1H, ArH), 6.52-6.49 (m, 2H, ArH), 6.45 (d, *J* = 4.8 Hz, 1H, CH), 6.27 (d, *J* = 7.2 Hz, 1H, CH), 5.32 (s, 1H, CH), 5.16 (d, *J* = 7.8 Hz, 1H, CH), 4.94 (d, *J* = 4.8 Hz, 1H, CH), 4.71 (d, *J* = 15.6 Hz, 1H, CH), 4.51 (d, *J* = 15.6 Hz, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 195.5, 194.5, 174.3, 141.1, 138.6, 138.5, 135.2, 135.1, 134.5, 133.8, 132.5, 130.7, 129.4, 129.0, 128.6, 128.5, 128.2, 127.7, 127.6, 127.3, 125.9, 125.7, 124.6, 124.5, 124.4, 123.9, 109.7, 97.7, 70.3, 67.1, 65.8, 54.0, 43.4; HRMS (ESI) Calcd. for $C_{40}H_{28}Cl_3N_2O_3$ ([M+H]$^{+}$): 689.1160. Found: 689.1143.



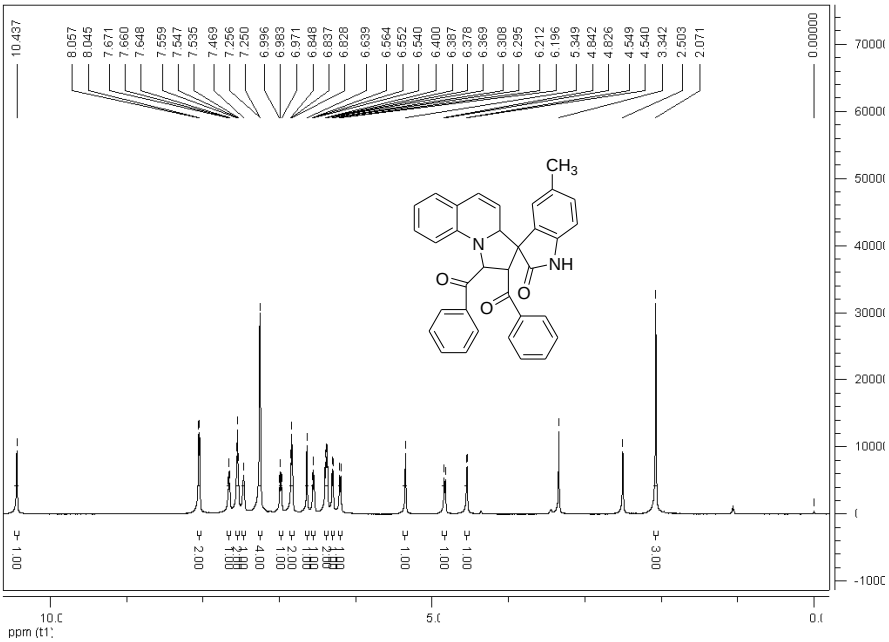


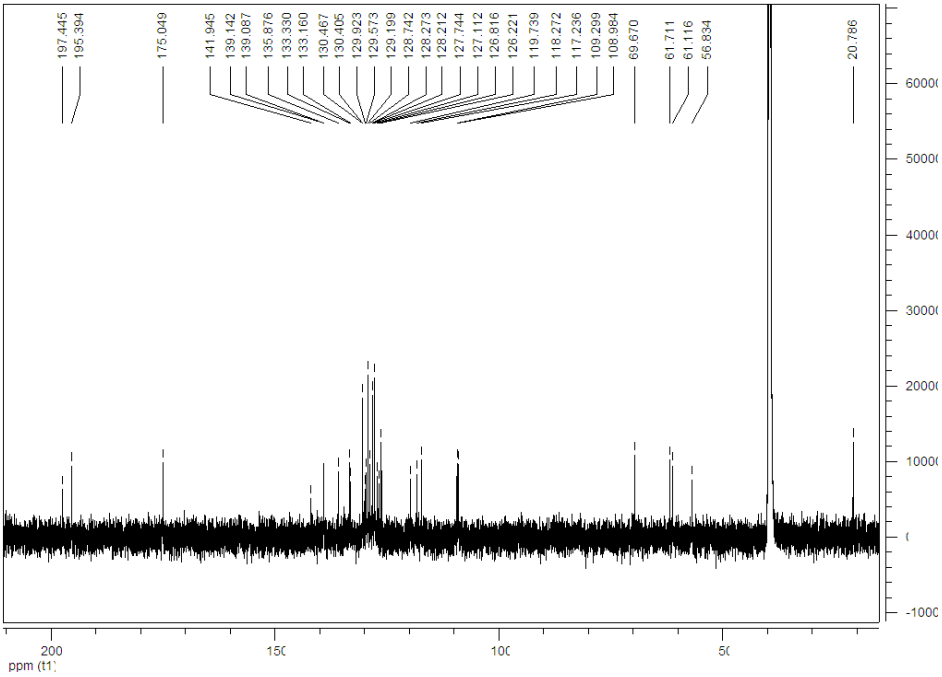
1'-benzoyl-5-methyl-2'-(4-methylbenzoyl)-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (**4a**): Yellow solid, yield: 85%, m.p. 210-212 ^{o}C, IR (KBr) ν = 3780, 3696, 3241, 3035, 2920, 2378, 2340, 1706, 1602, 1493, 1457, 1409, 1311, 1250, 1205, 1047, 977, 891, 823, 745, 698, 664, 595 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.45 (s, 1H, NH), 8.02 (d, *J* = 7.8 Hz, 2H, ArH), 7.65 (t, *J* = 7.5 Hz, 1H, ArH), 7.53 (d, *J* = 7.8Hz, 2H, ArH), 7.20（d, *J* = 7.8Hz, 2H, ArH), 7.07 (d, *J* = 7.8 Hz, 2H, ArH), 6.98 (t, *J* = 7.5 Hz, 1H, ArH), 6.84 (t, *J* = 8.4 Hz, 2H, ArH), 6.64 (s, 1H, ArH), 6.55 (t, *J* = 7.2 Hz, 1H, ArH), 6.43 (d, *J* = 7.8Hz, 1H, ArH), 6.34 (d, *J* = 5.4 Hz, 1H, ArH), 6.30 (d, *J* = 7.8 Hz, 1H, CH), 6.20 (d, *J* = 10.2Hz, 1H, CH), 5.33 (s, 1H, CH), 4.84 (d, *J* = 7.8 Hz, 1H, CH), 4.49 (d, *J* = 5.4 Hz, 1H, CH), 2.25 (s, 3H, CH_3), 2.07 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 198.2, 194.4, 175.1, 144.0, 142.0, 139.1, 134.3, 134.1, 133.3, 129.9, 129.6, 129.1, 128.9, 128.7, 128.4, 127.9, 127.8, 127.1, 126.8, 126.4, 119.7, 118.3, 117.1, 109.2, 109.0, 69.7, 61.9, 61.4, 56.4, 21.0, 20.8; HRMS (ESI) Calcd. for $C_{35}H_{29}N_2O_3$ ([M+H]$^{+}$): 525.2173. Found: 525.2175.



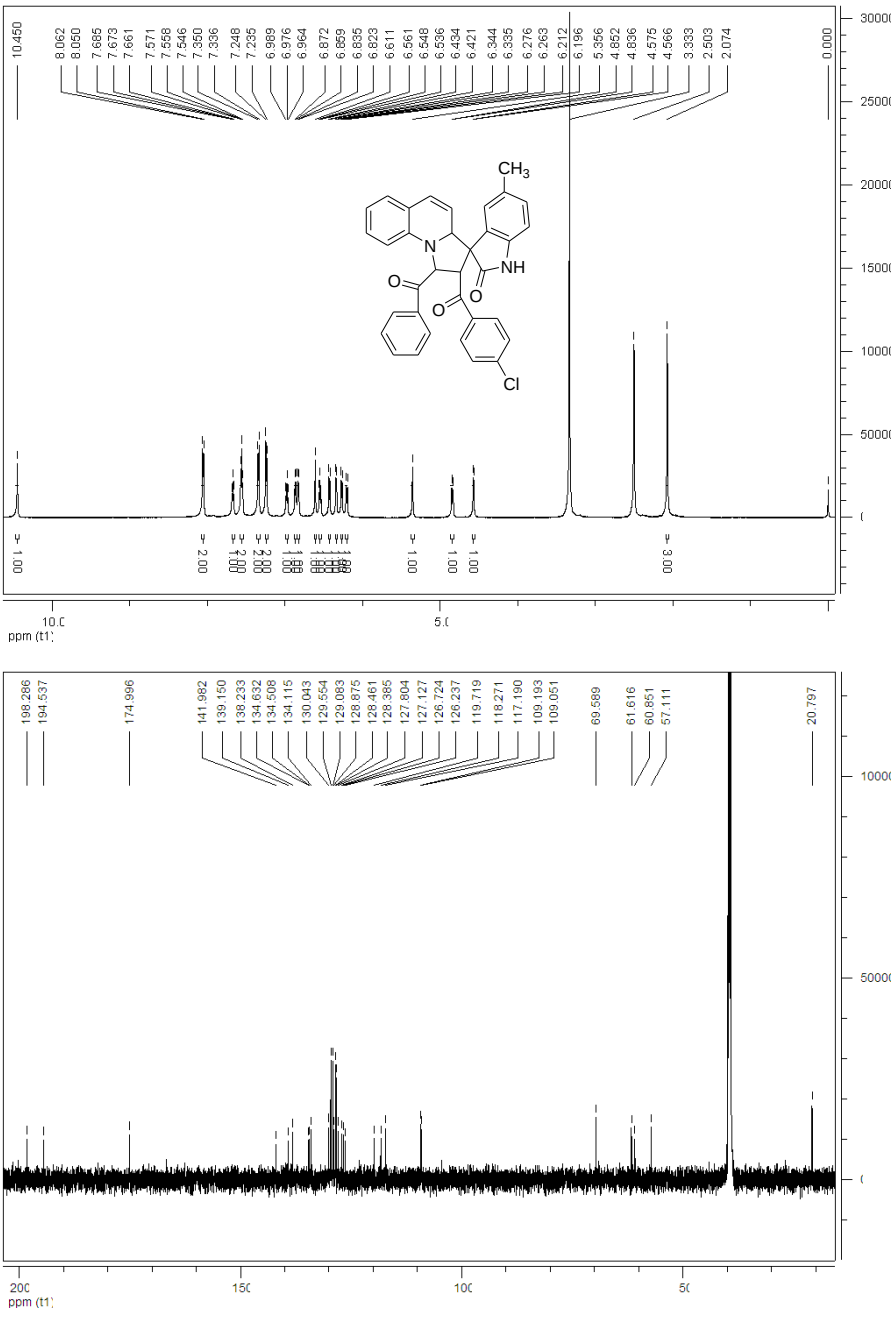


(5-methyl-2-oxo-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinoline]-1',2'-diyl)bis (phenylmethanone) (**4b**): Yellow solid, yield: 86%, m.p. 208-210 ^{o}C, IR (KBr) ν = 3788, 3638, 3029, 2848, 1700, 1624, 1596, 1493, 1447, 1411, 1313, 1237, 1203, 1181, 1048, 976, 931, 889, 805, 769, 743, 692, 618, 509 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.44 (s, 1H, NH), 8.05 (d, *J* = 7.2 Hz, 2H, ArH), 7.66 (t, *J* = 7.2 Hz, 1H, ArH), 7.55 (t, *J* = 7.2 Hz, 2H, ArH), 7.47 （brs, 1H, ArH), 7.25 (d, *J* = 3.6 Hz, 4H, ArH), 6.98 (t, *J* = 7.2 Hz, 1H, ArH), 6.84 (t, *J* = 6.0 Hz, 2H, ArH), 6.64 (s, 1H, ArH), 6.55 (t, *J* = 7.2 Hz, 1H, ArH), 6.40-6.37 (m, 2H, ArH), 6.30 (d, *J* = 7.8 Hz, 1H, CH), 6.20 (d, *J* = 9.6 Hz, 1H, CH), 5.35 (s, 1H, CH), 4.84 (d, *J* = 9.6 Hz, 1H, CH), 4.54 (d, *J* = 5.4 Hz, 1H, CH), 2.07 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 198.2, 195.3, 175.1, 142.0, 139.1, 135.9, 134.4, 134.1, 133.4, 129.9, 129.6, 129.1, 128.7, 128.4, 128.3, 127.8, 127.7, 127.1, 126.8, 126.3, 119.7, 118.3, 117.2, 109.2, 109.0, 69.7, 61.7, 61.1, 56.9, 20.8; HRMS (ESI) Calcd. for $C_{34}H_{27}N_2O_3$ ([M+H]$^{+}$): 511.2016. Found: 511.2021.

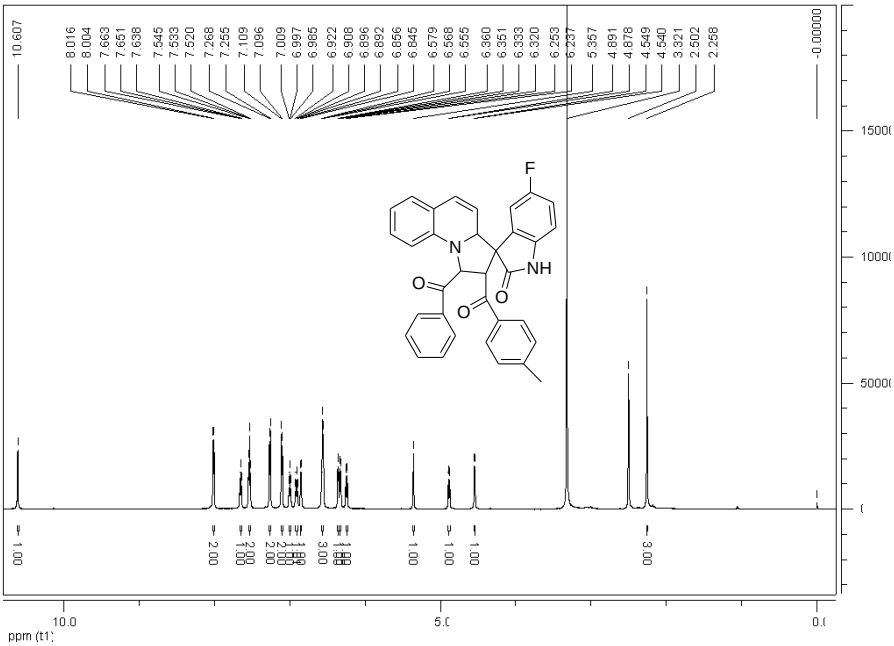


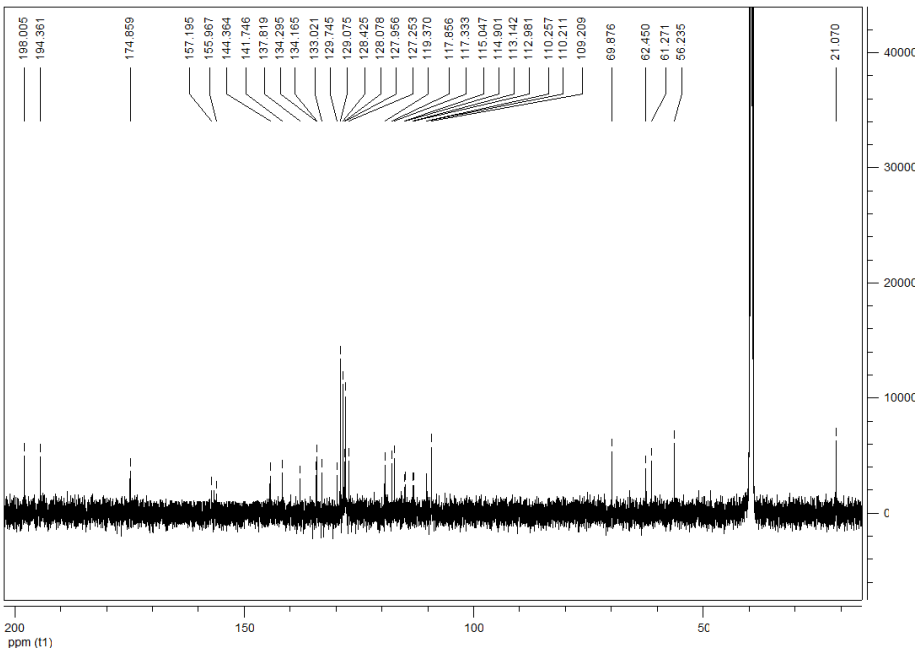


1'-benzoyl-2'-(4-chlorobenzoyl)-5-methyl-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (4c): Yellow solid, yield: 89%, m.p. 204-206 ^{o}C, IR (KBr) ν = 3638, 3214, 3067, 2925, 1710, 1643, 1621, 1596, 1492, 1460, 1389, 1329, 1287, 1235, 1200, 1179, 1089, 1049, 976, 828, 794, 771, 746, 701, 664, 590, 517, 477, 440 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.45 (s, 1H, NH), 8.06 (d, *J* = 7.2 Hz, 2H, ArH), 7.67 (t, *J* = 7.2 Hz, 1H, ArH), 7.56 (d, *J* = 7.2 Hz, 2H, ArH), 7.35 (d, *J* = 7.8 Hz, 2H, ArH), 7.24 (d, *J* = 7.8 Hz, 2H, ArH), 6.98 (t, *J* = 7.2 Hz, 1H, ArH), 6.86 (d, *J* = 7.2 Hz, 1H, ArH), 6.83 (d, *J* = 7.2 Hz, 1H, ArH), 6.61 (s, 1H, ArH), 6.55 (t, *J* = 7.2 Hz, 1H, ArH), 6.43 (d, *J* = 7.8 Hz, 1H, ArH), 6.34 (d, *J* = 5.4 Hz, 1H, CH), 6.27 (d, *J* = 7.8 Hz, 1H, CH), 6.20 (d, *J* = 9.6 Hz, 1H, CH), 5.36 (s, 1H, CH), 4.84 (d, *J* = 9.6 Hz, 1H, CH), 4.57 (d, *J* = 5.4 Hz, 1H, CH), 2.07 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 198.3, 194.5, 175.0, 142.0, 139.2, 138.2, 134.6, 134.5, 134.1, 130.0, 129.6, 129.1, 128.9, 128.5, 128.4, 127.8, 127.1, 126.7, 126.2, 119.7, 118.3, 117.2, 109.2, 109.1, 69.6, 61.6, 60.9, 57.1, 20.8; HRMS (ESI) Calcd. for $C_{34}H_{26}ClN_2O_3$ ([M+H]$^{+}$): 545.1626. Found: 545.1631.

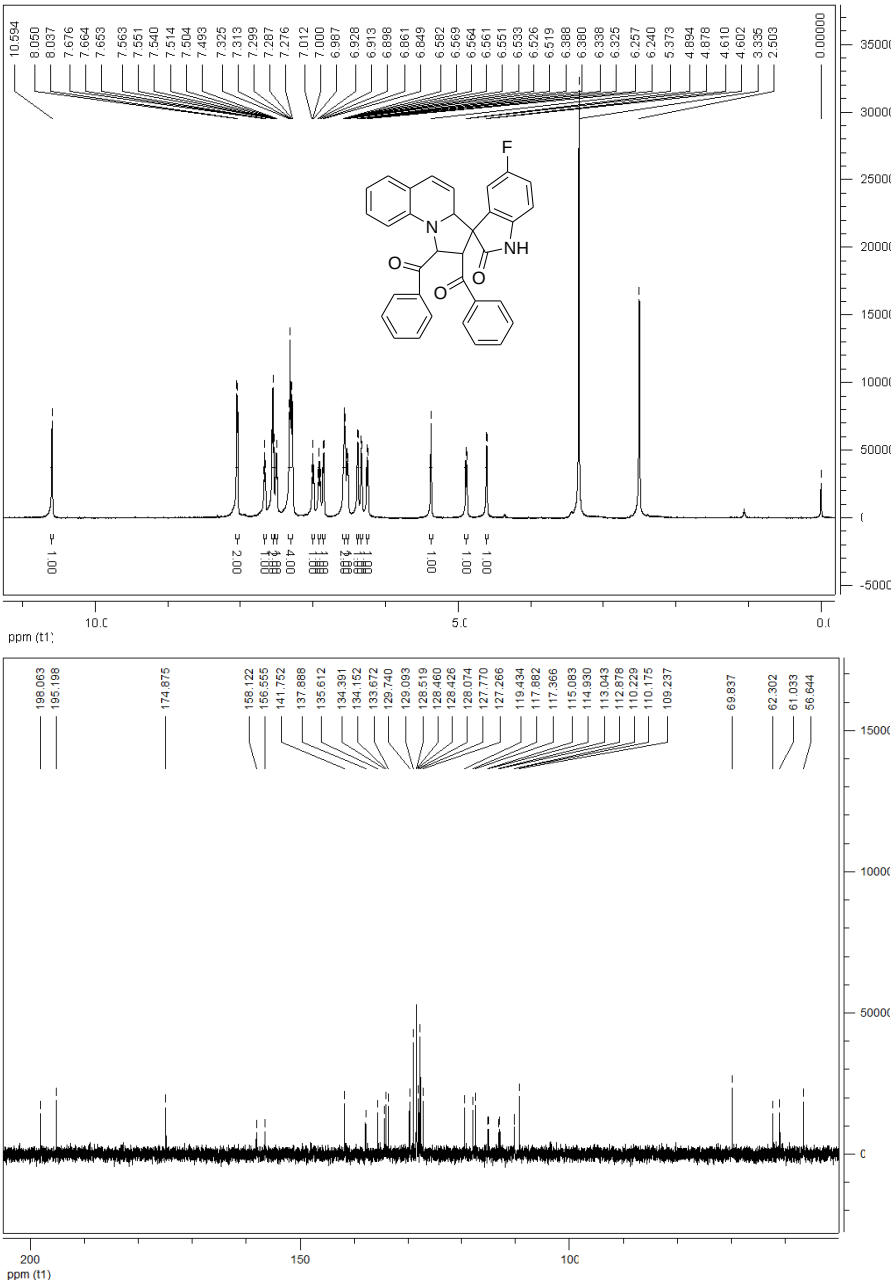


1'-benzoyl-5-fluoro-2'-(4-methylbenzoyl)-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (4d): Yellow solid, yield: 92%, m.p. 192-194 ^{o}C, IR (KBr) ν = 3781, 3697, 3662, 3264, 3040, 2379, 2340, 1711, 1684, 1603, 1493, 1409, 1305, 1244, 1203, 1125, 1049, 973, 886, 824, 747, 707, 652, 572 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.61 (s, 1H, NH), 8.01 (d, *J* = 7.2 Hz, 2H, ArH), 7.65 (t, *J* = 7.2 Hz, 1H, ArH), 7.54 (d, *J* = 7.2Hz, 2H, ArH), 7.27（d, *J* = 7.8 Hz, 2H, ArH), 7.10 (d, *J* = 7.8 Hz, 2H, ArH), 7.00 (t, *J* = 7.2 Hz, 1H, ArH), 6.91 (t, *J* = 7.8 Hz, 1H, ArH), 6.86 (d, *J* = 6.6 Hz, 1H, ArH), 6.58-6.56 (m, 3H, ArH), 6.36 (d, *J* = 6.6 Hz, 1H, ArH), 6.33 (d, *J* = 7.8 Hz, 1H, CH), 6.25 (d, *J* = 9.6 Hz, 1H, CH), 5.36 (s, 1H, CH), 4.89 (d, *J* = 7.8 Hz, 1H, CH) 4.54 (d, *J* = 5.4 Hz, 1H, CH), 2.26 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 198.0, 194.4, 174.9, 157.3 (d, *J* = 235.6 Hz), 144.4, 141.7, 137.8, 134.3, 134.2, 133.0, 129.7, 129.1, 128.4, 128.1, 128.0, 127.3, 119.4, 117.6 (d, *J* =80.0 Hz), 115.0 (d, *J* = 21.9 Hz), 113.1 (d, *J* = 24.2 Hz), 110.2 (d, *J* = 9.9 Hz), 109.2, 69.9, 62.5, 61.3, 56.2, 21.1; HRMS (ESI) Calcd. for $C_{34}H_{26}FN_2O_3$ ([M+H]$^{+}$): 529.1922. Found: 529.1924.

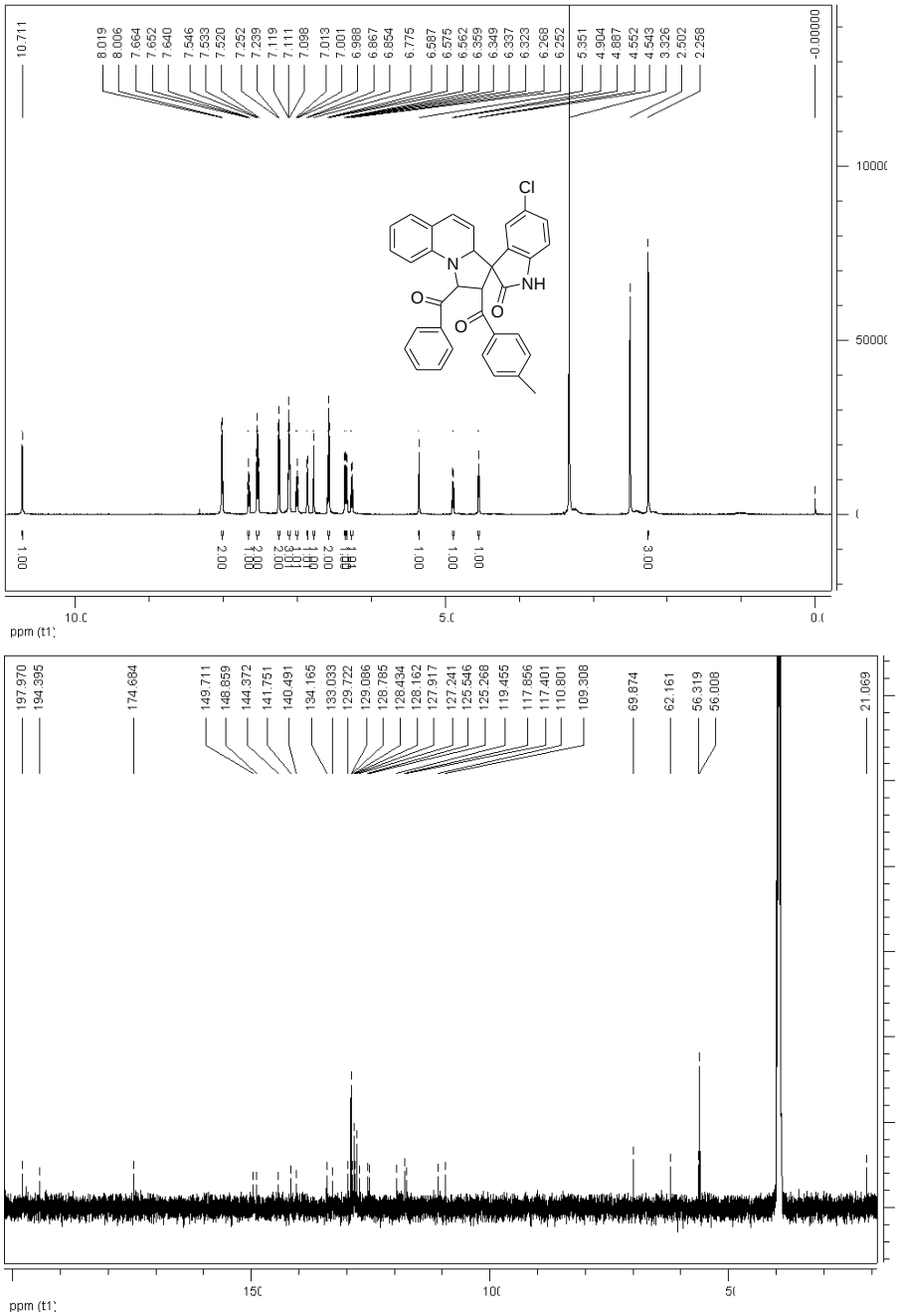




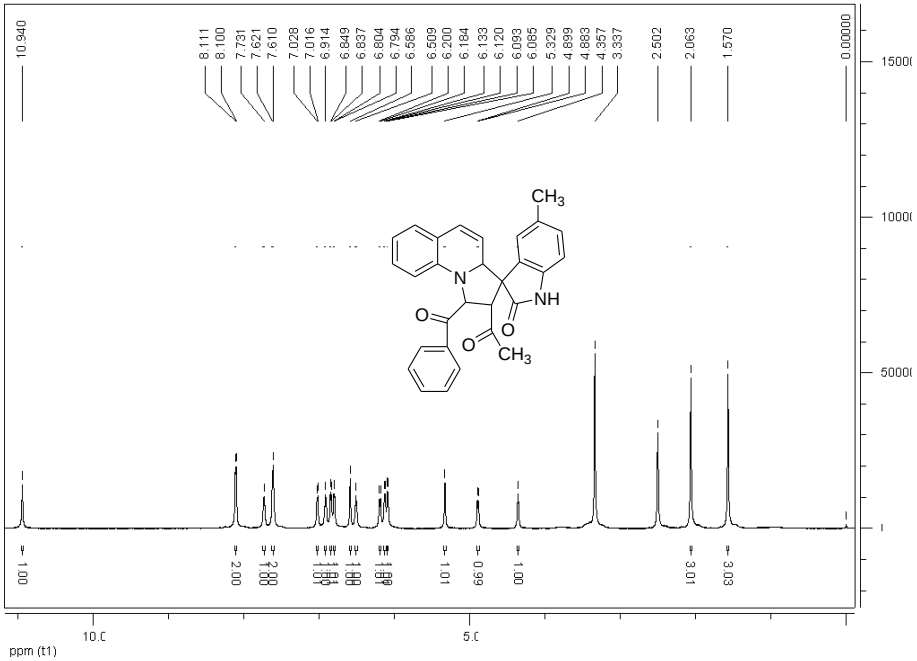
(5-fluoro-2-oxo-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinoline]-1',2'-diyl)bis(phenylmethanone) (**4e**): Yellow solid, yield: 81%, m.p. 212-214 ^{o}C, IR (KBr) ν = 3787, 3037, 1711, 1686, 1636, 1597, 1488, 1463, 1408, 1294, 1256, 1200, 1122, 1048, 978, 915, 894, 812, 769, 739, 692, 623, 597, 512, 470 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.59 (s, 1H, NH), 8.04 (d, *J* = 7.2 Hz, 2H, ArH), 7.66 (t, *J* = 7.2 Hz, 1H, ArH), 7.55 (d, *J* = 7.2 Hz, 2H, ArH), 7.50 (t, *J* = 6.0 Hz, 1H, ArH), 7.33-7.28 (m, 4H, ArH), 7.00 (t, *J* = 7.2 Hz, 1H, ArH), 6.91 (t, *J* = 9.0 Hz, 1H, ArH), 6.86 (d, *J* = 7.2 Hz, 1H, ArH), 6.58-6.55 (m, 2H, ArH), 6.53-6.52 (m, 1H, ArH), 6.38 (d, *J* = 4.8 Hz, 1H, CH), 6.33 (d, *J* = 7.8 Hz, 1H, ArH), 6.25 (d, *J* = 9.6 Hz, 1H, CH), 5.37 (s, 1H, CH), 4.89 (d, *J* = 9.6 Hz, 1H, CH), 4.61 (d, *J* = 4.8 Hz, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 198.1, 195.2, 174.9, 157.3 (d, *J* = 235.1 Hz), 141.8, 137.9, 135.6, 134.4, 134.2, 133.7, 129.7, 129.1, 128.5, 128.4, 128.3, 128.1, 127.8, 127.3, 119.4, 117.6 (d, *J* = 77.4 Hz), 115.0 (d, *J* = 23.0 Hz), 113.0 (d, *J* = 24.8 Hz), 110.2(d, *J* = 8.1 Hz), 109.2, 69.8, 62.3, 61.0, 56.6; HRMS (ESI) Calcd. for $C_{33}H_{24}FN_2O_3$ ([M+H]$^{+}$): 515.1765. Found: 515.1768.

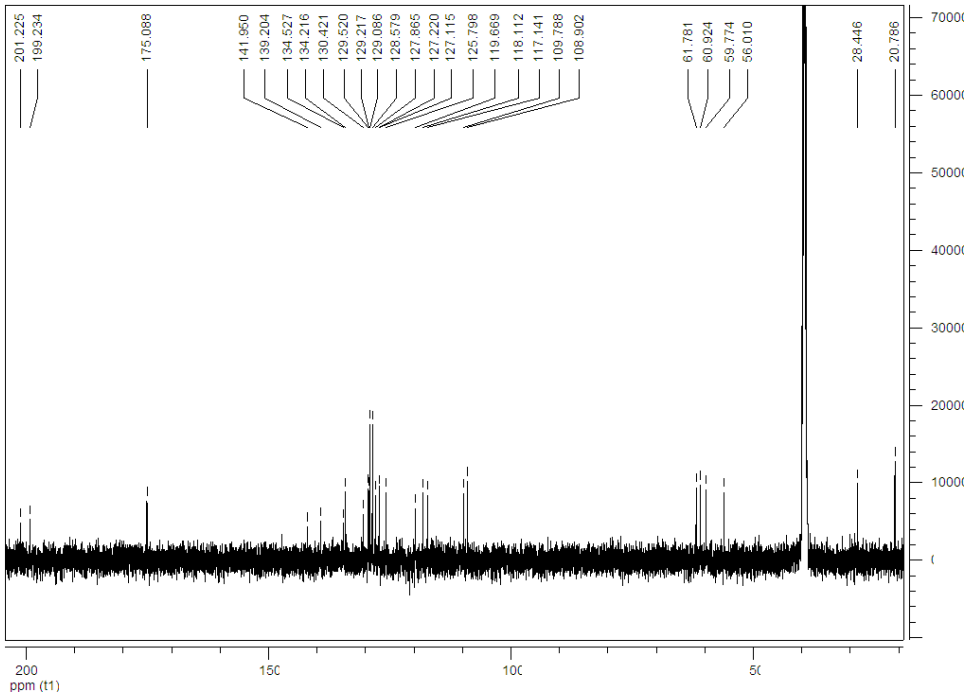


1'-benzoyl-5-chloro-2'-(4-methylbenzoyl)-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (4f): Yellow solid, yield: 88%, m.p. 196-198 ^{o}C, IR (KBr) ν = 3781, 3696, 3332, 3062, 2944, 2818, 2379, 2339, 1731, 1688, 1633, 1602, 1488, 1407, 1293, 1254, 1186, 1121, 1050, 976, 913, 827, 788, 750, 693, 628, 594, 515 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.71 (s, 1H, NH), 8.01 (d, *J* = 7.8 Hz, 2H, ArH), 7.65 (t, *J* = 7.2 Hz, 1H, ArH), 7.53 (d, *J* = 7.8Hz, 2H, ArH), 7.24（d, *J* = 7.8Hz, 2H, ArH), 7.11 (m, 3H, ArH), 7.00 (t, *J* = 7.2 Hz, 1H, ArH), 6.86 (d, *J* = 7.8Hz, 1H, ArH), 6.78 (brs, 1H, ArH), 6.58 (t, *J* = 7.4 Hz, 2H, ArH), 6.35 (d, *J* = 6.0Hz, 1H, ArH), 6.33 (d, *J* = 7.8 Hz, 1H, CH), 6.26 (d, *J* = 8.0 Hz, 1H, CH), 5.35 (s, 1H, CH), 4.90 (d, *J* = 8.4 Hz, 1H, CH), 4.55 (d, *J* = 5.4 Hz, 1H, CH), 2.26 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 198.0, 194.4, 174.7, 149.7, 148.9, 144.4, 141.8, 140.5, 134.2, 133.0, 129.7, 129.1, 128.8, 128.4, 128.2, 127.9, 127.2, 125.5, 125.3, 119.5, 117.9, 117.4, 110.8, 109.3, 69.9, 62.2, 56.3, 56.0, 21.1; HRMS (ESI) Calcd. for $C_{34}H_{26}ClN_2O_3$ ([M+H]$^{+}$): 545.1626. Found: 545.1627.

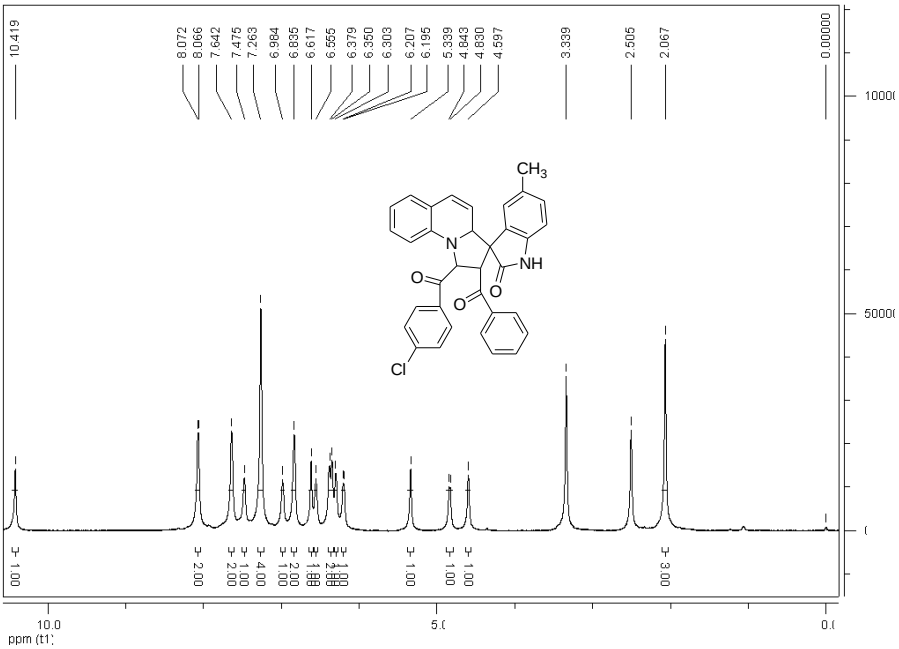


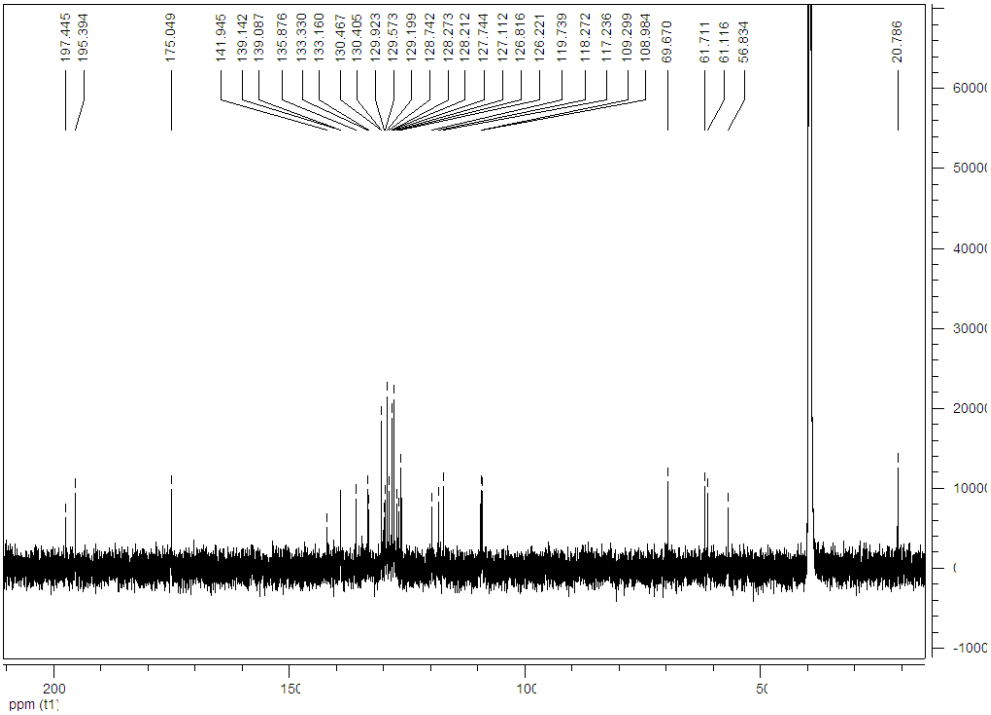
2'-acetyl-1'-benzoyl-5-methyl-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one(4g): White solid, yield: 72%, m.p. 120-122 ^{o}C, IR (KBr) ν = 3376, 3187, 2349, 1690, 1645, 1597, 1491, 1460, 1410, 1309, 1235, 1205, 1164, 1045, 981, 820, 772, 743, 697, 661, 617 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.94 (s, 1H, NH), 8.10 (d, *J* = 6.6 Hz, 2H, ArH), 7.73 (brs, 1H, ArH), 7.61 (brs, 2H, ArH), 7.02（d, *J* = 7.2 Hz, 1H, ArH), 6.91 (brs, 1H, ArH), 6.84 (d, *J* = 7.2 Hz, 1H, ArH), 6.80 (d, *J* = 6.0 Hz, 1H, ArH), 6.59 (s, 1H, CH), 6.51 (brs, 1H, ArH), 6.20 (d, *J* = 9.6 Hz, 1H, CH), 6.13 (d, *J* = 7.8 Hz, 1H, ArH), 6.09 (d, *J* = 4.8 Hz, 1H, ArH), 5.33 (s, 1H, CH), 4.90 (d, *J* = 9.6 Hz, 1H, CH), 4.36 (s, 1H, CH), 2.06 (s, 3H, CH_3), 1.57 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 201.2, 199.2, 175.1, 142.0, 139.2, 134.5, 134.2, 130.4, 129.5, 129.2, 129.1, 128.6, 127.9, 127.2, 127.1, 125.8, 119.7, 118.1, 117.1, 109.8, 108.9, 69.8, 60.9, 59.8, 56.0, 28.4, 20.8; HRMS (ESI) Calcd. for $C_{29}H_{25}N_2O_3$ ([M+H]$^{+}$): 449.1860. Found: 449.1860.



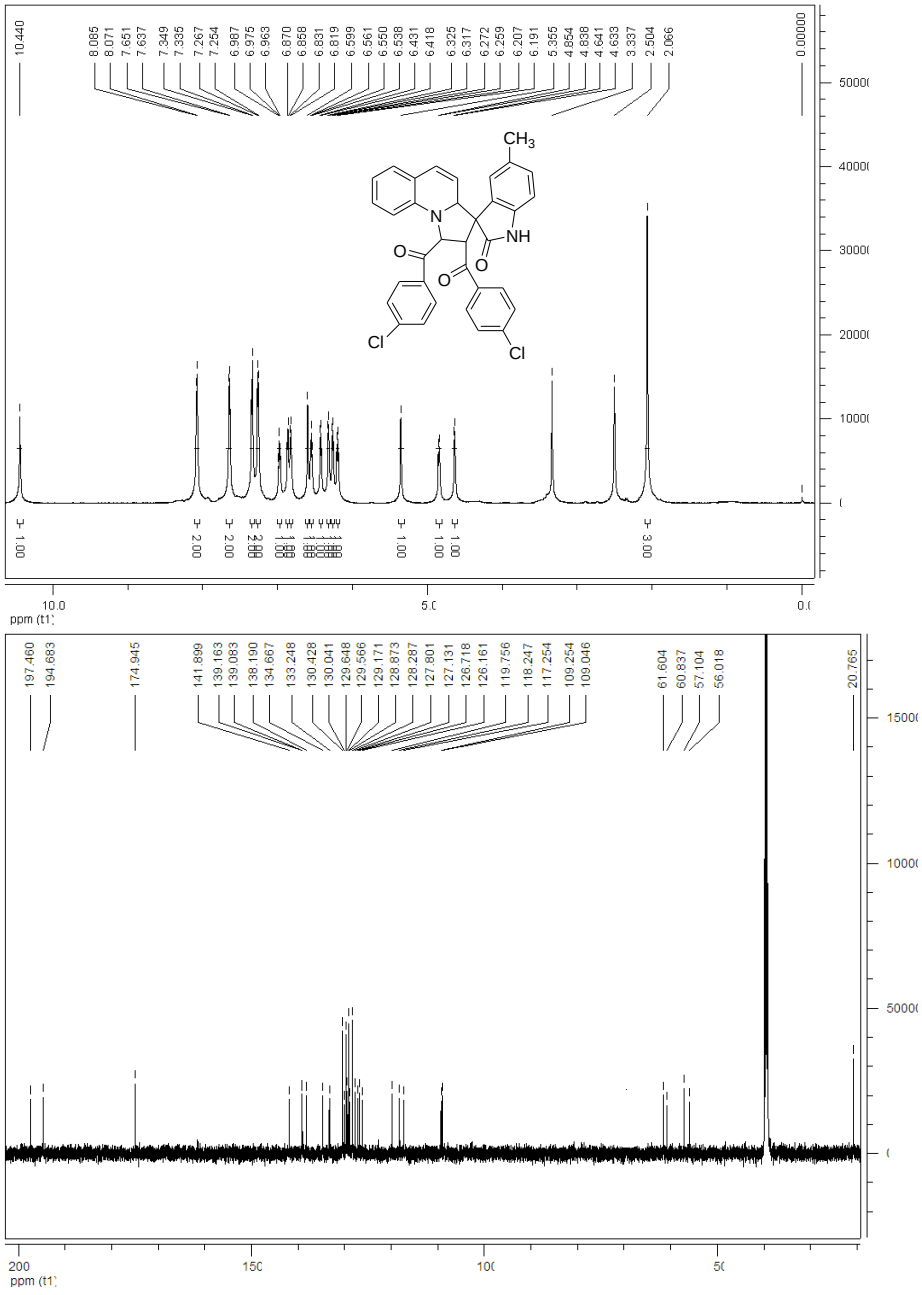


2'-benzoyl-5-methyl-1'-(4-chlorobenzoyl)-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (4h): Yellow solid, yield: 80%, m.p. 188-190 ^{o}C, IR (KBr) ν = 3789, 3174, 3035, 1702, 1645, 1623, 1594, 1493, 1460, 1401, 1310, 1238, 1201, 1178, 1091, 1048, 1016, 979, 890, 835, 764, 743, 692, 526, 472 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.42 (s, 1H, NH), 8.07 (d, J = 3.6 Hz, 2H, ArH), 7.64 (brs, 2H, ArH), 7.48 (brs, 1H, ArH), 7.26（brs, 4H, ArH), 6.98 (brs, 1H, ArH), 6.84 (brs, 2H, ArH), 6.62 (brs, 1H, ArH), 6.56 (brs, 1H, ArH), 6.36 (d, J = 12.0 Hz, 2H, ArH), 6.30 (brs, 1H, CH), 6.20 (d, J = 7.2 Hz, 1H, CH), 5.33 (s, 1H, CH), 4.84 (d, J = 7.8 Hz, 1H, CH), 4.60 (s, 1H, CH), 2.07 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.4, 195.4, 175.0, 141.9, 139.1, 139.0, 135.9, 133.3, 133.2, 130.5, 130.4, 130.0, 129.6, 129.2, 128.7, 128.3, 127.7, 127.1, 126.8, 126.2, 119.7, 118.3, 117.2, 109.3, 109.0, 69.7, 61.7, 61.1, 56.8, 20.8; HRMS (ESI) Calcd. for $C_{34}H_{26}ClN_2O_3$ ([M+H]$^{+}$): 545.1626. Found: 545.1631.

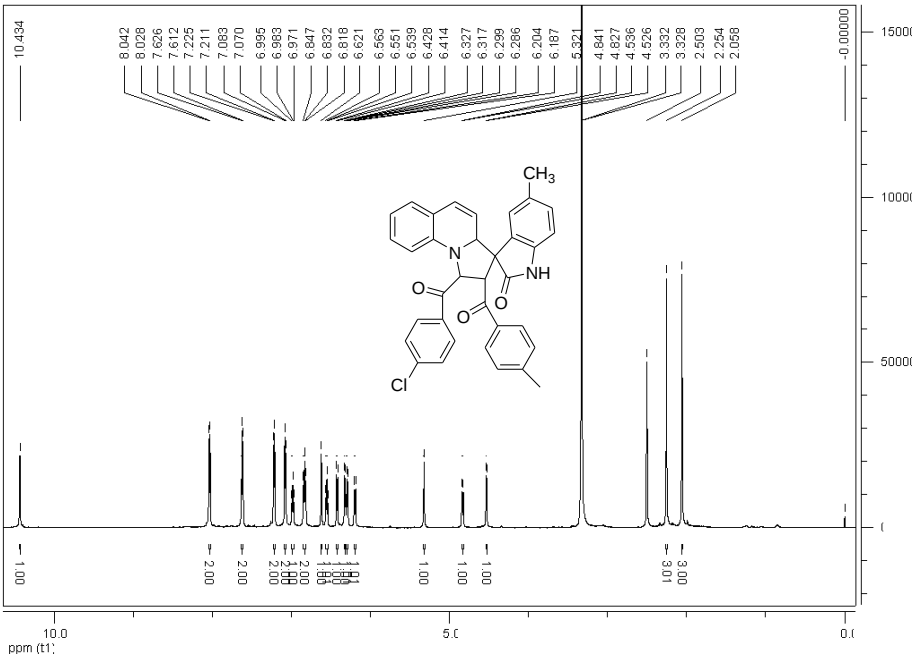


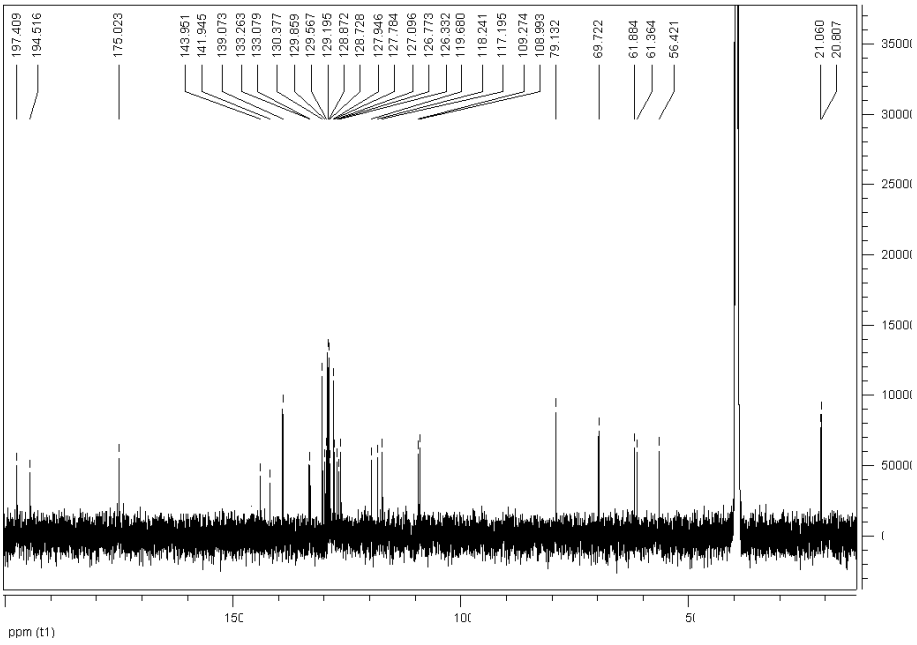


(5-methyl-2-oxo-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinoline]-1',2'-diyl)bis((4-chlorophenyl)methanone) (4i): Yellow solid, yield: 84%, m.p. 200-202 ^{o}C, IR (KBr) ν = 3788, 3661, 3601, 3035, 1700, 1647, 1623, 1591, 1492, 1460, 1402, 1311, 1240, 1202, 1091, 1037, 1011, 977, 885, 830, 791, 740, 659, 618, 592, 527, 473, 440 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.44 (s, 1H, NH), 8.08 (d, *J* = 7.8 Hz, 2H, ArH), 7.65 (d, *J* = 7.8 Hz, 2H, ArH), 7.34 (d, *J* = 7.8 Hz, 2H, ArH), 7.26（d, *J* = 7.8 Hz, 2H, ArH), 6.98 (t, *J* = 7.2 Hz, 1H, ArH), 6.87 (d, *J* = 7.2 Hz, 1H, ArH), 6.82 (d, *J* = 7.2 Hz, 1H, ArH), 6.60 (s, 1H, ArH), 6.55 (d, *J* = 7.2 Hz, 1H, ArH), 6.43 (t, *J* = 7.8 Hz, 1H, ArH), 6.32 (d, *J* = 4.8 Hz, 1H, CH), 6.27 (d, *J* = 7.8 Hz, 1H, ArH), 6.20 (d, *J* = 9.6 Hz, 1H, CH), 5.36 (s, 1H, CH), 4.84 (d, *J* = 9.6 Hz, 1H, CH), 4.63 (d, *J* = 4.8 Hz, 1H, CH), 2.07 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.5, 194.7, 174.9, 141.9, 139.2, 139.1, 138.2, 134.7, 133.2, 130.4, 130.0, 129.6, 129.5, 129.2, 128.9, 128.3, 127.8, 127.1, 126.7, 126.2, 119.8, 118.2, 117.3, 109.3, 109.0, 61.6, 60.8, 57.1, 56.0, 20.8; HRMS (ESI) Calcd. for $C_{34}H_{25}Cl_2N_2O_3$ ([M+H]$^{+}$): 579.1237. Found: 579.1235.

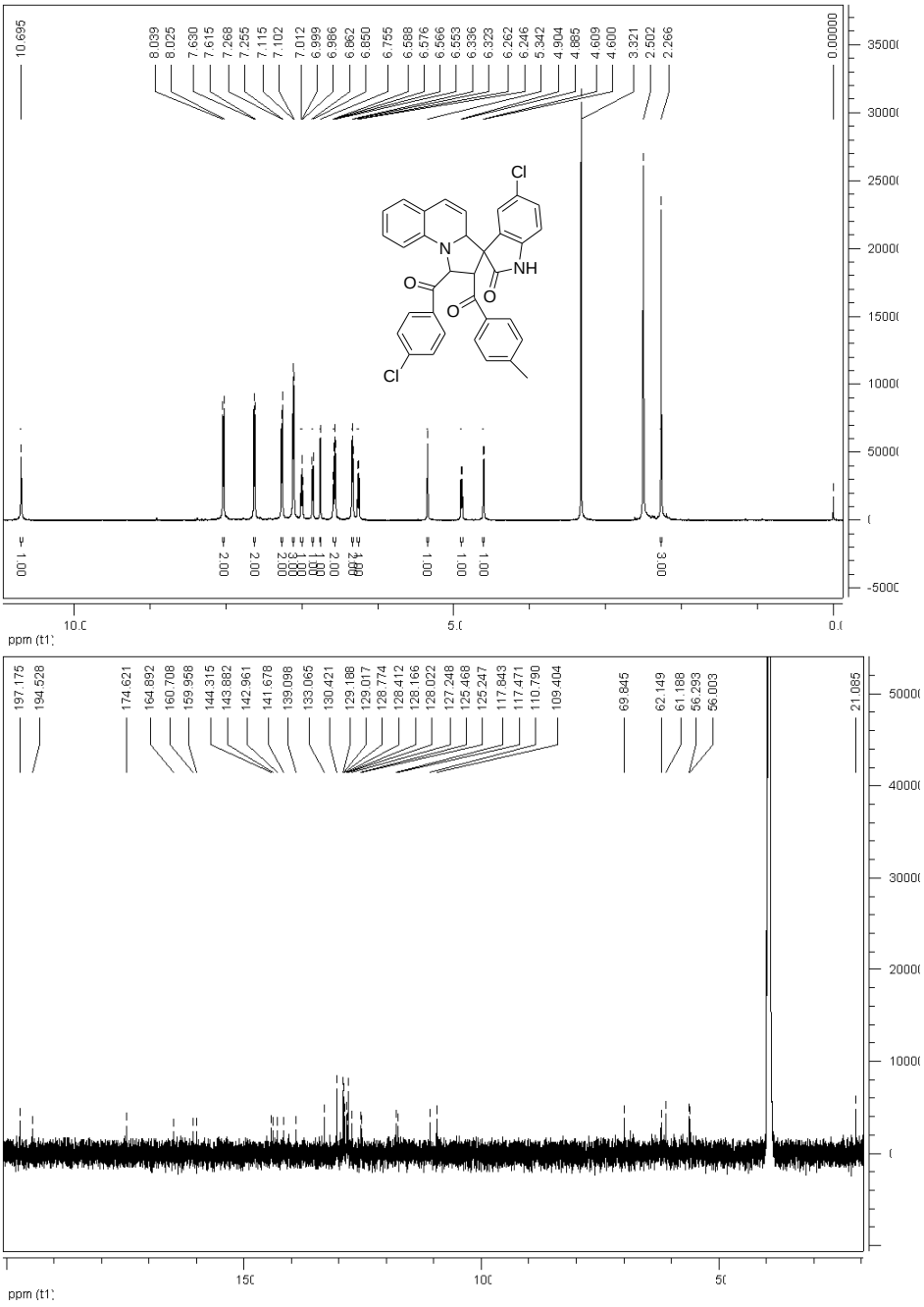


1'-(4-chlorobenzoyl)-5-methyl-2'-(4-methylbenzoyl)-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (4j): Yellow solid, yield: 82%, m.p. 214-216 ^{o}C, IR (KBr) ν = 3780, 3407, 3166, 3035, 2379, 2340, 1701, 1599, 1493, 1460, 1408, 1313, 1246, 1205, 1090, 1042, 979, 825, 745, 660 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.43 (s, 1H, NH), 8.04 (d, *J* = 8.4 Hz, 2H, ArH), 7.62 (d, *J* = 8.4 Hz, 2H, ArH), 7.22 (d, *J* = 8.4Hz, 2H, ArH), 7.08（d, *J* = 8.4Hz, 2H, ArH), 6.98 (t, *J* = 7.2 Hz, 1H, ArH), 6.83 (t, *J* = 8.4 Hz, 2H, ArH), 6.62 (s, 1H, ArH), 6.55 (t, *J* = 7.2 Hz, 1H, ArH), 6.42 (d, *J* = 7.5 Hz, 1H, ArH), 6.32 (d, *J* = 6.0Hz, 1H, ArH), 6.30 (d, *J* = 7.5 Hz, 1H, CH), 6.20 (d, *J* = 10.2 Hz, 1H, CH), 5.32 (s, 1H, CH), 4.84 (d, *J* = 8.4 Hz, 1H, CH), 4.54 (d, *J* = 6.0 Hz, 1H, CH), 2.25 (s, 3H, CH_3), 2.06 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.4, 194.5, 175.0, 144.0, 141.9, 139.1, 133.3, 133.1, 130.4, 129.9, 129.6, 129.2, 128.9, 128.7, 127.9, 127.8, 127.1, 126.8, 126.3, 119.7, 118.2, 117.2, 109.3, 109.0, 79.1, 69.7, 61.9, 61.4, 56.4, 21.1, 20.8 ; HRMS (ESI) Calcd. for $C_{35}H_{28}ClN_2O_3$ ([M+H]$^{+}$): 559.1783. Found: 559.1784.

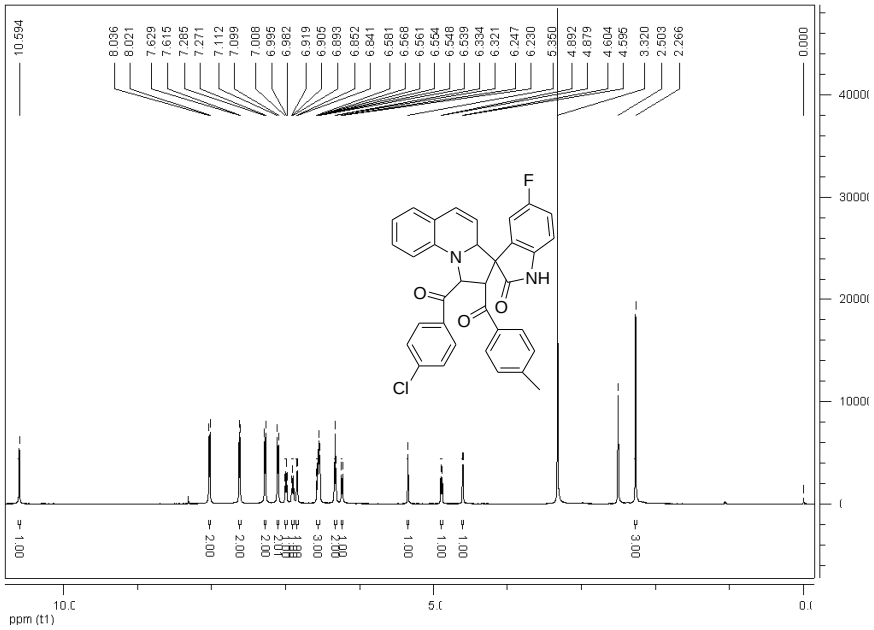


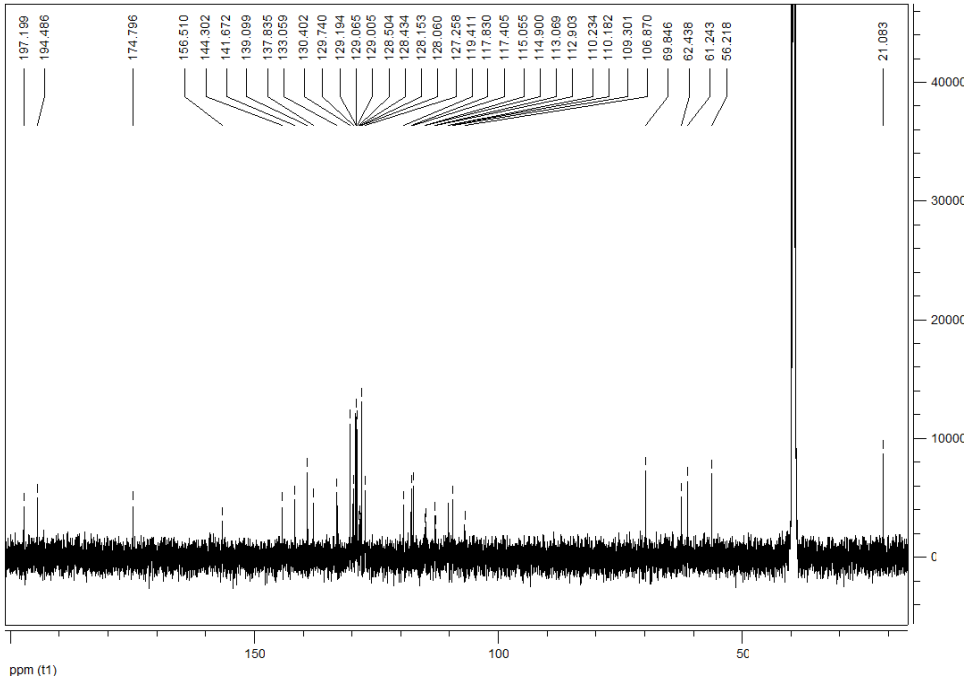


5-chloro-1'-(4-chlorobenzoyl)-2'-(4-methylbenzoyl)-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (4k): Yellow solid, yield: 90%, m.p. 200-202 ^{o}C, IR (KBr) ν = 3780, 3260, 3041, 2378, 2339, 1716, 1684, 1640, 1599, 1489, 1405, 1304, 1256, 1201, 1094, 1043, 980, 917, 878, 830, 795, 742, 692, 653, 598, 531 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.70 (s, 1H, NH), 8.03 (d, *J* = 8.4 Hz, 2H, ArH), 7.62 (d, *J* = 8.4 Hz, 2H, ArH), 7.26 (d, *J* = 7.8Hz, 2H, ArH), 7.10（d, *J* = 7.8Hz, 3H, ArH), 7.00 (t, *J* = 7.8 Hz, 1H, ArH), 6.86 (d, *J* = 7.2 Hz, 1H, ArH), 6.76 (brs, 1H, ArH), 6.57 (m, 2H, ArH), 6.33 (m, 2H, ArH), 6.25 (d, *J* = 9.6 Hz, 1H, CH), 5.34 (s, 1H, CH), 4.90 (d, *J* = 9.6 Hz, 1H, CH), 4.60 (d, *J* = 5.4 Hz, 1H, CH), 2.27 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.2, 194.5, 174.6, 164.9, 160.7, 160.0, 144.3, 143.9, 143.0, 141.7, 139.1, 133.1, 130.4, 129.2, 129.0, 128.8, 128.4, 128.2, 128.0, 127.2, 125.5, 125.2, 117.8, 117.5, 110.8, 109.4, 69.8, 62.1, 61.2, 56.3, 56.0, 21.1; HRMS (ESI) Calcd. for $C_{34}H_{25}Cl_2N_2O_3$ ([M+H]$^{+}$): 579.1207. Found: 579.1203.

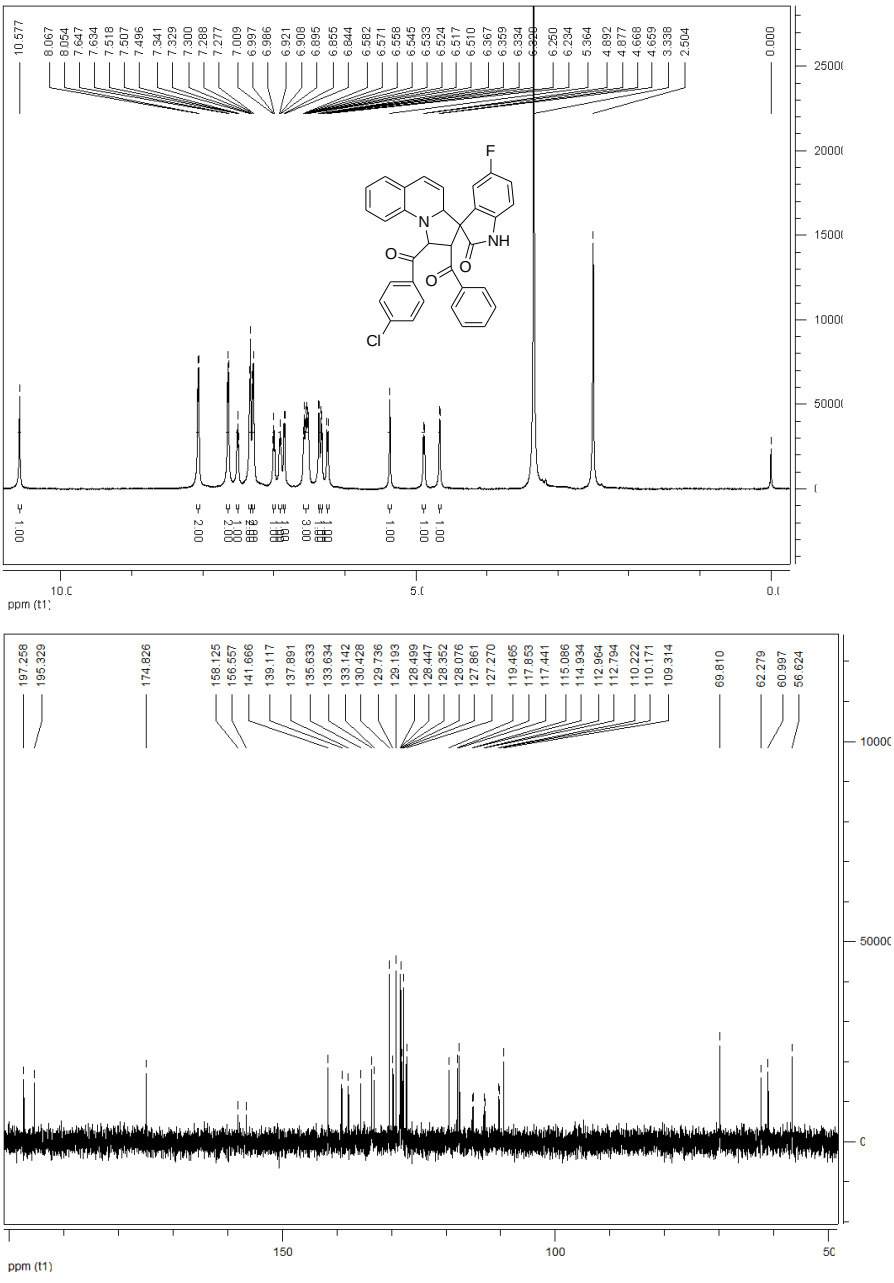


1'-(4-chlorobenzoyl)-5-fluoro-2'-(4-methylbenzoyl)-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (4l): Yellow solid, yield: 84%, m.p. 194-196 ^{o}C, IR (KBr) ν = 3781, 3696, 3661, 3635, 3408, 3039, 2378, 2340, 1711, 1601, 1491, 1406, 1306, 1247, 1200, 1124, 1092, 1046, 981, 887, 830, 792, 743, 688, 648, 584 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.59 (s, 1H, NH), 8.03 (d, *J* = 8.4 Hz, 2H, ArH), 7.62 (d, *J* = 8.4 Hz, 2H, ArH), 7.28 (d, *J* = 8.4Hz, 2H, ArH), 7.11（d, *J* = 8.4 Hz, 2H, ArH), 7.00 (t, *J* = 7.8 Hz, 1H, ArH), 6.91 (t, *J* = 7.8 Hz, 1H, ArH), 6.85 (d, *J* = 6.6 Hz, 1H, ArH), 6.58-6.54 (m, 3H, ArH), 6.34 (d, *J* = 7.8 Hz, 2H, ArH), 6.24 (d, *J* = 10.2 Hz, 1H, ArH), 5.35 (s, 1H, CH), 4.88 (d, *J* = 7.8 Hz, 1H, CH), 4.60 (d, *J* = 5.4 Hz, 1H, CH), 2.27 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.2, 194.5, 174.8, 156.5, 144.3, 141.7, 139.1, 137.8, 133.1, 130.4, 129.7, 129.2, 129.1, 129.0, 128.5, 128.4, 128.2, 128.1, 127.3, 119.4, 117.6 (d, *J* = 63.8 Hz), 115.0 (d, *J* = 23.3 Hz), 113.0 (d, *J* = 24.9 Hz), 110.2 (d, *J* = 7.8 Hz), 109.3, 106.9, 69.8, 62.4, 61.2, 56.2, 21.1; HRMS (ESI) Calcd. for $C_{34}H_{25}ClFN_2O_3$ ([M+H]$^{+}$): 563.1532. Found: 563.1530.

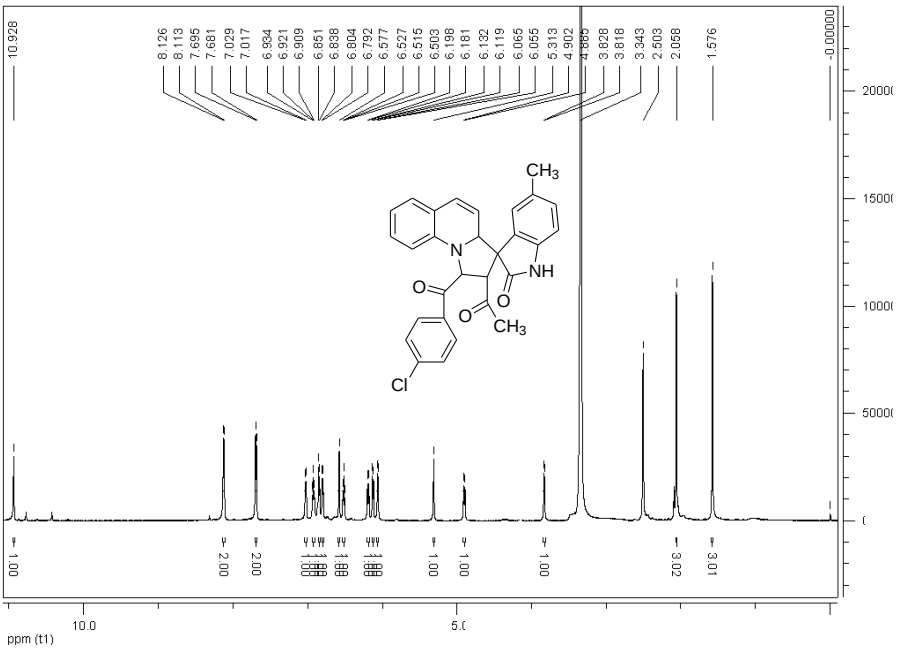


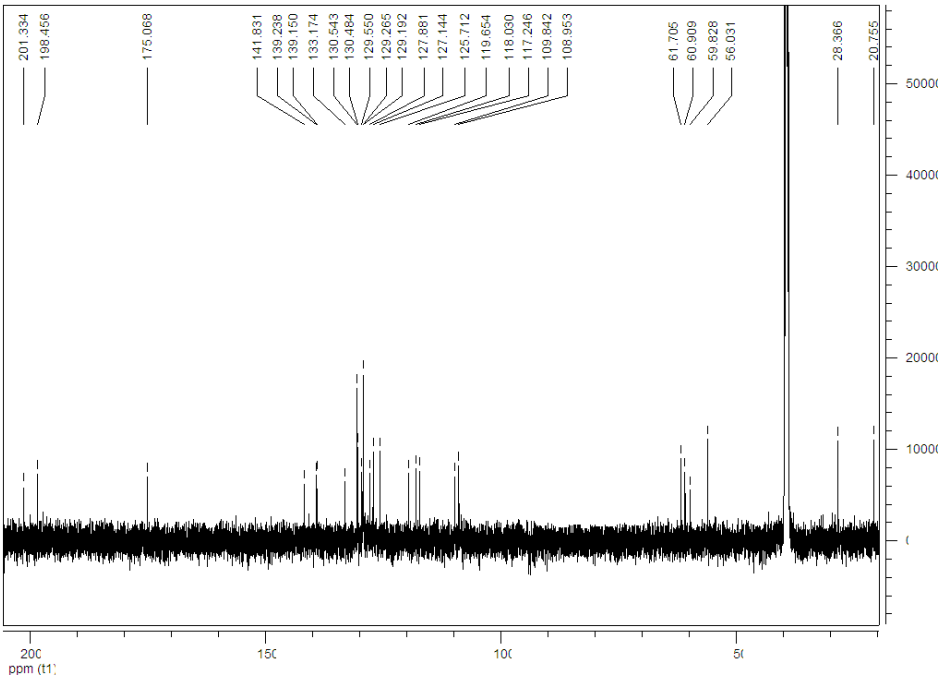


2'-benzoyl-1'-(4-chlorobenzoyl)-5-fluoro-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a]quinolin]-2-one (4m): Yellow solid, yield: 86%, m.p. 198-200 ^{o}C, IR (KBr) ν = 3789, 3189, 3083, 1712, 1686, 1633, 1584, 1486, 1461, 1399, 1292, 1253, 1223, 1195, 1122, 1088, 1052, 983, 913, 892, 833, 811, 765, 743, 691, 652, 618, 597, 525, 473 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.58 (s, 1H, NH), 8.06 (d, *J* = 7.8 Hz, 2H, ArH), 7.64 (d, *J* = 7.2 Hz, 2H, ArH), 7.51 (d, *J* = 6.6 Hz, 1H, ArH), 7.34（d, *J* = 7.2 Hz, 2H, ArH), 7.30 (d, *J* = 7.2 Hz, 2H, ArH), 7.00 (t, *J* = 7.2 Hz, 1H, ArH), 6.91 (t, *J* = 7.8 Hz, 1H, ArH), 6.85 (d, *J* = 6.6 Hz, 1H, ArH), 6.58-6.51 (m, 3H, ArH), 6.37 (t, *J* = 4.8 Hz, 1H, ArH), 6.32 (d, *J* = 8.4 Hz, 1H, CH), 6.24 (d, *J* = 9.6 Hz, 1H, CH), 5.36 (s, 1H, CH), 4.89 (d, *J* = 9.6 Hz, 1H, CH), 4.66 (d, *J* = 5.4 Hz, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 197.3, 195.3, 174.8, 157.3 (d, *J* = 235.2 Hz), 141.7, 139.1, 137.9, 135.6, 133.6, 133.1, 130.4, 129.7, 129.2, 128.5, 128.4, 128.3, 128.1, 127.9, 127.3, 119.5, 117.6 (d, *J* = 61.8 Hz), 115.0 (d, *J* = 22.7 Hz), 112.8 (d, *J* = 25.5 Hz), 110.2 (d, *J* = 7.7 Hz), 109.3, 69.8, 62.3, 61.0, 56.6; HRMS (ESI) Calcd. for $C_{33}H_{23}ClFN_2O_3$ ([M+H]$^{+}$): 549.1376. Found: 549.1377.

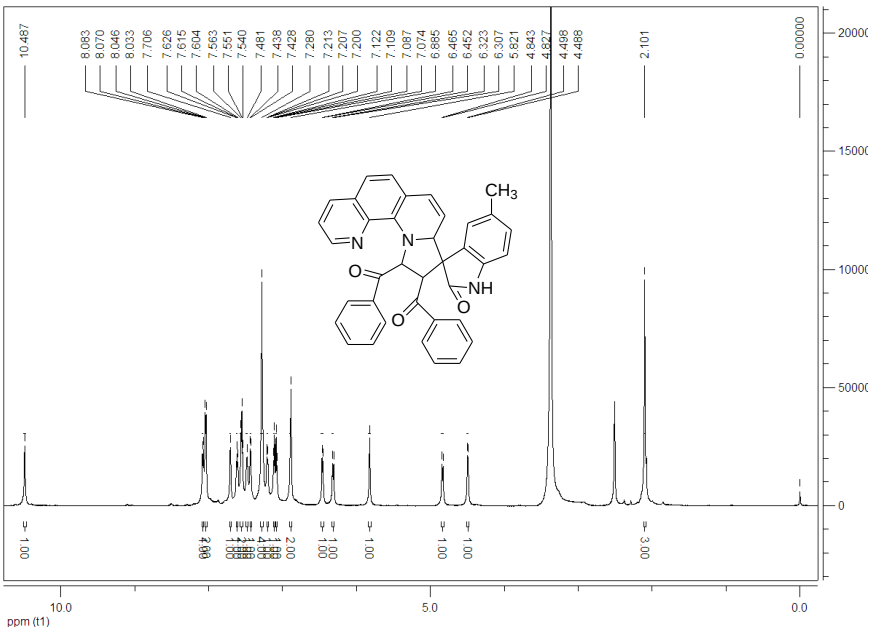


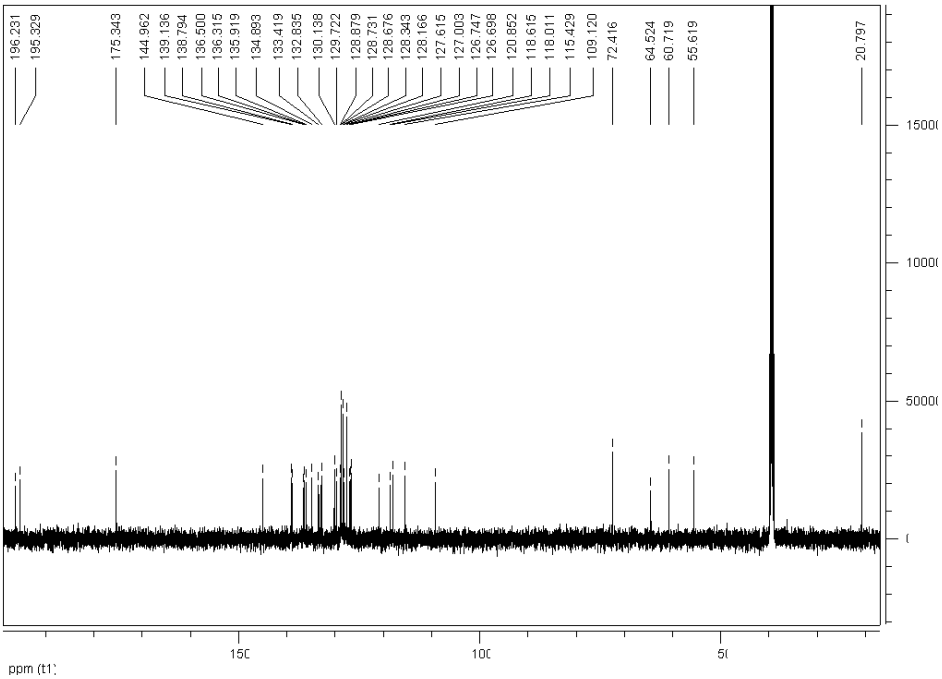
2'-acetyl-1'-(4-chlorobenzoyl)-5-methyl-2',3a'-dihydro-1'H-spiro[indoline-3,3'-pyrrolo[1,2-a] quinolin]-2-one (4n): White solid, yield: 70%, m.p. 126-128 ^{o}C, IR (KBr) ν = 3186, 3038, 1709, 1624, 1596, 1492, 1462, 1400, 1311, 1203, 1167, 1092, 1048, 1014, 984, 900, 829, 946, 744, 692, 629, 544, 492 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.93 (s, 1H, NH), 8.12 (d, *J* = 7.8 Hz, 2H, ArH), 7.69 (d, *J* = 7.8 Hz, 2H, ArH), 7.02 (d, *J* = 7.2 Hz, 1H, ArH), 6.92（t, *J* = 7.2 Hz, 1H, ArH), 6.84 (d, *J* = 7.8 Hz, 1H, ArH), 6.80 (d, *J* = 7.2 Hz, 1H, ArH), 6.58 (s, 1H, CH), 6.52 (t, *J* = 7.2 Hz, 1H, ArH), 6.19 (d, *J* = 9.6 Hz, 1H, CH), 6.12 (d, *J* = 7.8 Hz, 1H, ArH), 6.06 (d, *J* = 6.0 Hz, 1H, ArH), 5.31 (s, 1H, CH), 4.90 (d, *J* = 9.6 Hz, 1H, CH), 3.82 (d, *J* = 6.0 Hz, 1H, CH), 2.06 (s, 3H, CH_3), 1.58 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 201.3, 198.5, 175.1, 141.8, 139.3, 139.2, 133.2, 130.5, 130.4, 129.6, 129.3, 129.2, 127.9, 127.1, 125.7, 119.7, 118.0, 117.2, 109.8, 109.0, 69.8, 61.7, 60.9, 59.8, 56.0, 28.4, 20.8; HRMS (ESI) Calcd. for $C_{29}H_{24}ClN_2O_3$ ([M+H]$^{+}$): 483.1470. Found: 483.1474.



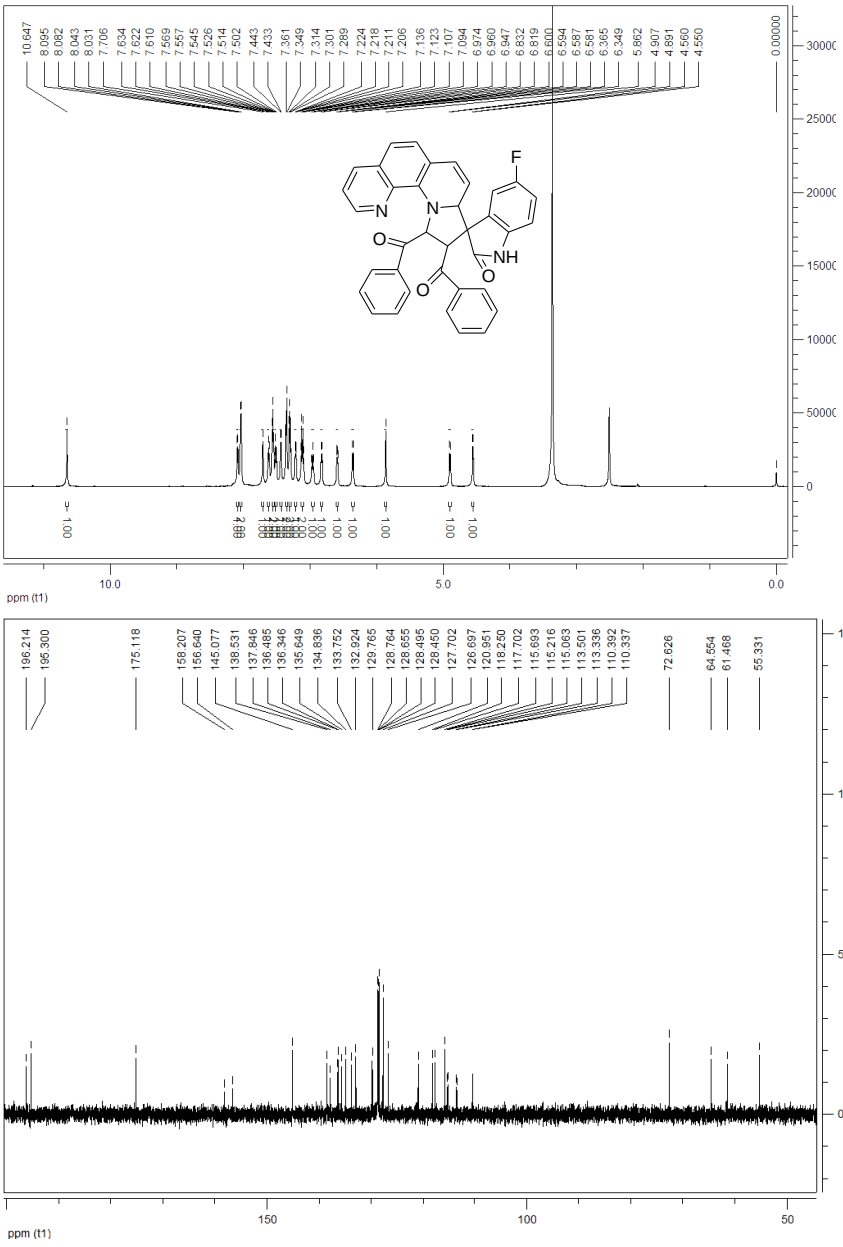


(5'-methyl-2'-oxo-2,3a-dihydro-1H-spiro[benzo[h]pyrrolo[1,2-a]quinoline-3,3'-indoline]-1,2-diyl)bis(phenylmethanone) (5a): Yellow solid, yield: 83%, m.p. 212-214 ^{o}C, IR (KBr) ν = 3157, 3033, 2844, 1701, 1623, 1596, 1546, 1506, 1489, 1448, 1401, 1365, 1312, 1283, 1215, 1184, 1167, 1025, 988, 887, 864, 830, 813, 791, 779, 731, 697, 653, 592, 559, 496, 450 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.49 (s, 1H, NH), 8.07 (d, *J* = 7.8 Hz, 1H, ArH), 8.04 (d, *J* = 7.8 Hz, 2H, ArH), 7.71 (s, 1H, ArH), 7.62 (t, *J* = 6.6 Hz, 1H, ArH), 7.55 (t, *J* = 7.2 Hz, 2H, ArH), 7.48 (brs, 1H, ArH), 7.43 (d, *J* = 6.0 Hz, 1H, ArH), 7.28 (brs, 4H, ArH), 7.21-7.20 (m, 1H, ArH), 7.11 (d, *J* = 7.8 Hz, 1H, ArH), 7.08 (d, *J* = 7.8 Hz, 1H, ArH), 6.89 (brs, 2H, ArH), 6.45 (d, *J* = 7.8 Hz, 1H, CH), 6.31 (d, *J* = 9.6 Hz, 1H, CH), 5.82 (s, 1H, CH), 4.83 (d, *J* = 9.6 Hz, 1H, CH), 4.49 (d, *J* = 6.0 Hz, 1H, CH), 2.10 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.2, 195.3, 175.3, 145.0, 139.1, 138.8, 136.5, 136.3, 136.0, 134.9, 133.4, 132.8, 130.1, 129.7, 128.9, 128.7, 128.6, 128.4, 128.2, 127.6, 127.0, 126.7, 126.6, 120.9, 118.6, 118.0, 115.4, 109.0, 72.4, 74.5, 60.7, 55.6, 20.8; HRMS (ESI) Calcd. for $C_{37}H_{28}N_3O_3$ ([M+H]$^{+}$): 562.2125. Found: 562.2134.

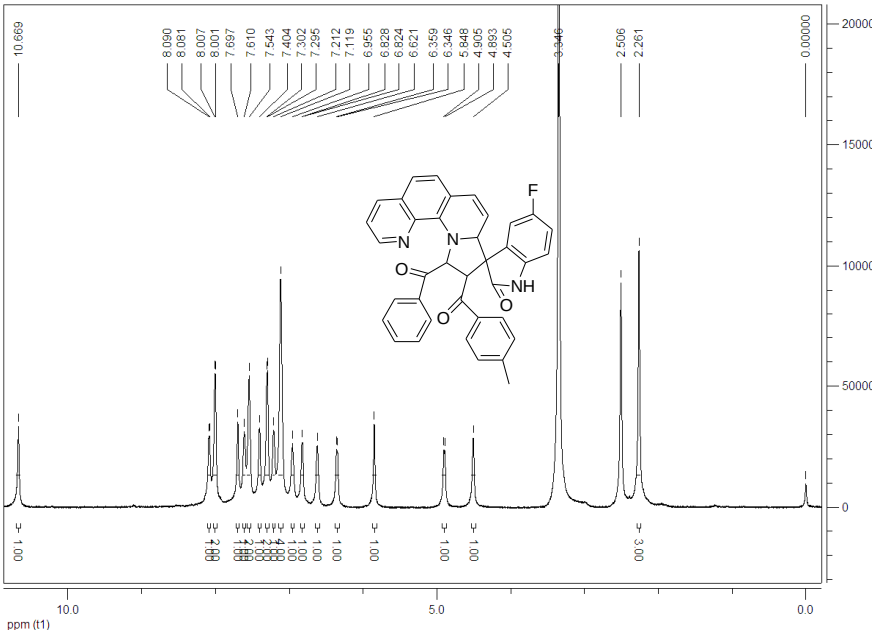


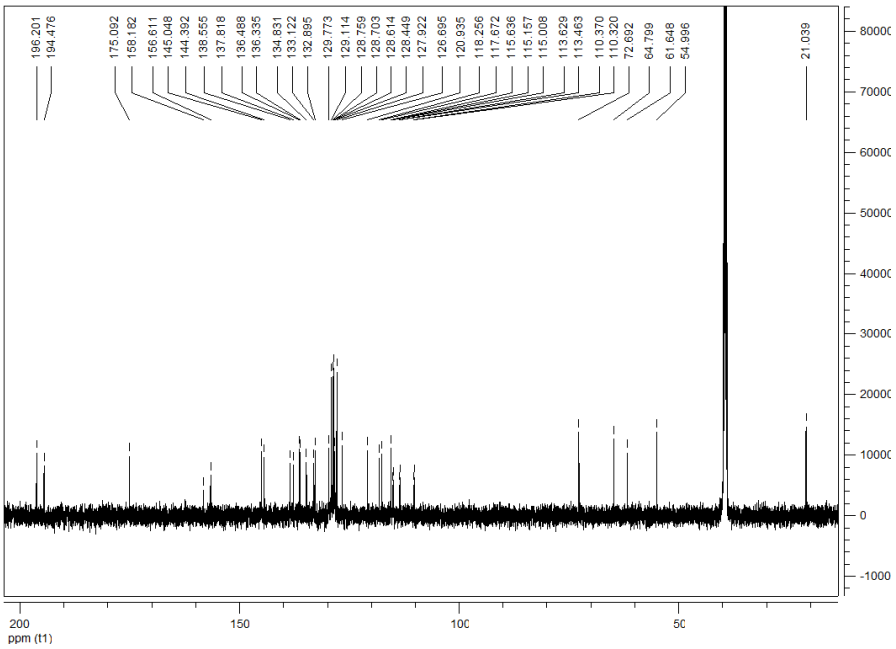


(5'-fluoro-2'-oxo-2,3a-dihydro-1H-spiro[benzo[h]pyrrolo[1,2-a]quinoline-3,3'-indoline]-1,2-diyl)bis(phenylmethanone) (5b): Yellow solid, yield: 71%, m.p. 214-216 ^{o}C, IR (KBr) ν = 3664, 3210, 3043, 2813, 1711, 1651, 1628, 1595, 1552, 1508, 1484, 1456, 1408, 1368, 1288, 1258, 1196, 1126, 1043, 989, 954, 917, 880, 820, 800, 759, 681, 598, 570, 508, 486, 440, 406 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.65 (s, 1H, NH), 8.09 (d, *J* = 7.8 Hz, 1H, ArH), 8.03 (d, *J* = 7.2 Hz, 2H, ArH), 7.71 (brs, 1H, ArH), 7.62 (t, *J* = 7.2 Hz, 1H, ArH), 7.56 (t, *J* = 7.2 Hz, 2H, ArH), 7.51 (t, *J* = 7.2 Hz, 1H, ArH), 7.44 (d, *J* = 6.0 Hz, 1H, ArH), 7.35 (d, *J* = 7.2 Hz, 2H, ArH), 7.30 (t, *J* = 7.2 Hz, 2H, ArH), 7.22-7.21 (m, 1H, ArH), 7.11 (q, *J* = 7.8 Hz, 2H, ArH), 6.96 (t, *J* = 7.8 Hz, 1H, ArH), 6.82 (d, *J* = 7.8 Hz, 1H, ArH), 6.60-6.58 (m, 1H, CH), 6.36 (d, *J* = 9.6 Hz, 1H, CH), 5.86 (s, 1H, CH), 4.90 (d, *J* = 9.6 Hz, 1H, CH), 4.55 (d, *J* = 6.0 Hz, 1H, CH); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.2, 195.3, 175.1, 157.4 (d, *J* = 235.1 Hz), 145.1, 138.5, 137.8, 136.5, 136.3, 135.6, 134.8, 133.8, 132.9, 129.8, 128.8, 128.7, 128.5, 128.4, 127.7, 126.7, 121.0, 117.9 (d, *J* = 82.2 Hz), 115.7, 115.1 (d, *J* = 23.0 Hz), 113.4 (d, *J* = 24.8 Hz), 110.4 (d, *J* = 7.7 Hz), 72.6, 64.6, 61.5, 55.3; HRMS (ESI) Calcd. for $C_{36}H_{25}FN_3O_3$ ([M+H]$^{+}$): 566.1874. Found: 566.1886.

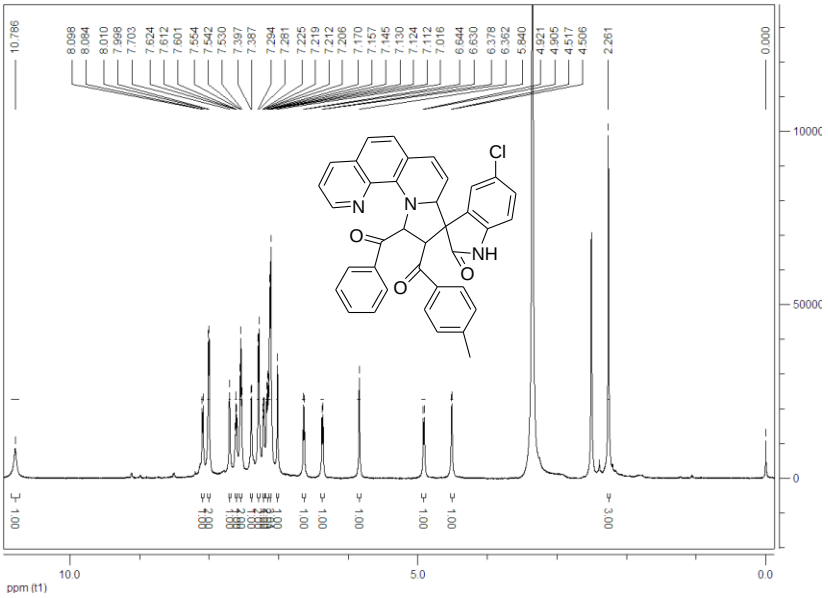


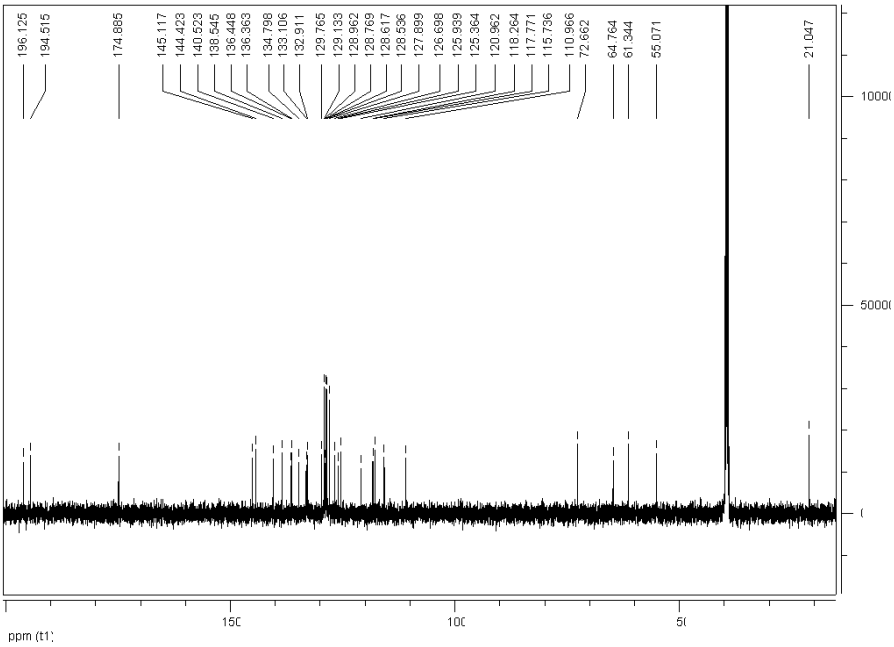
1-benzoyl-5'-fluoro-2-(4-methylbenzoyl)-2,3a-dihydro-1H-spiro[benzo[h]pyrrolo[1,2-a]quinoline-3,3'-indolin]-2'-one (5c): Yellow solid, yield: 77%, m.p. 178-180 ^{o}C, IR (KBr) ν = 3787, 3414, 3188, 3038, 1712, 1684, 1655, 1550, 1509, 1485, 1457, 1410, 1366, 1312, 1288, 1259, 1185, 1125, 1039, 991, 959, 917, 827, 802, 782, 745, 716, 698, 682, 624, 598, 562 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.67 (s, 1H, NH), 8.08 (d, *J* = 5.4 Hz, 1H, ArH), 8.00 (d, *J* = 3.6 Hz, 2H, ArH), 7.70 (brs, 1H, ArH), 7.61(brs, 1H, ArH), 7.54 (brs, 2H, ArH), 7.40 (brs, 1H, ArH), 7.30 (d, *J* = 4.2 Hz, 2H, ArH), 7.21 (brs, 1H, ArH), 7.12 (brs, 4H, ArH), 6.96 (brs, 1H, ArH), 6.82 (d, *J* = 2.4 Hz, 1H, ArH), 6.62 (brs, 1H, CH), 6.35 (d, *J* = 7.8 Hz, 1H, CH), 5.85 (s, 1H, CH), 4.90 (d, *J* = 7.2 Hz, 1H, CH), 4.51 (brs, 1H, CH), 2.26 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.2, 194.5, 175.1, 157.4 (d, *J* = 235.7 Hz), 145.0, 144.4, 138.6, 137.8, 136.5, 136.3, 134.8, 133.1, 132.9, 129.8, 129.1, 128.8, 128.7, 128.6, 128.4, 127.9, 126.7, 120.9, 118.0 (d, *J* = 87.6 Hz), 115.1(d, *J* = 22.4 Hz), 113.5 (d, *J* = 24.9 Hz), 110.3 (d, *J* = 7.5 Hz), 72.7, 64.8, 61.6, 55.0, 21.0; HRMS (ESI) Calcd. for $C_{37}H_{27}FN_3O_3$ ([M+H]$^{+}$): 580.2031. Found: 580.2025.



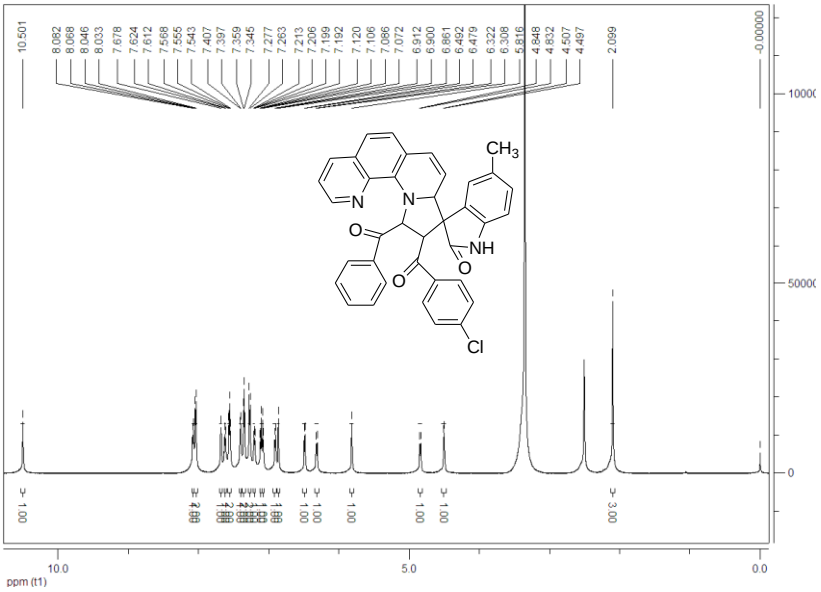


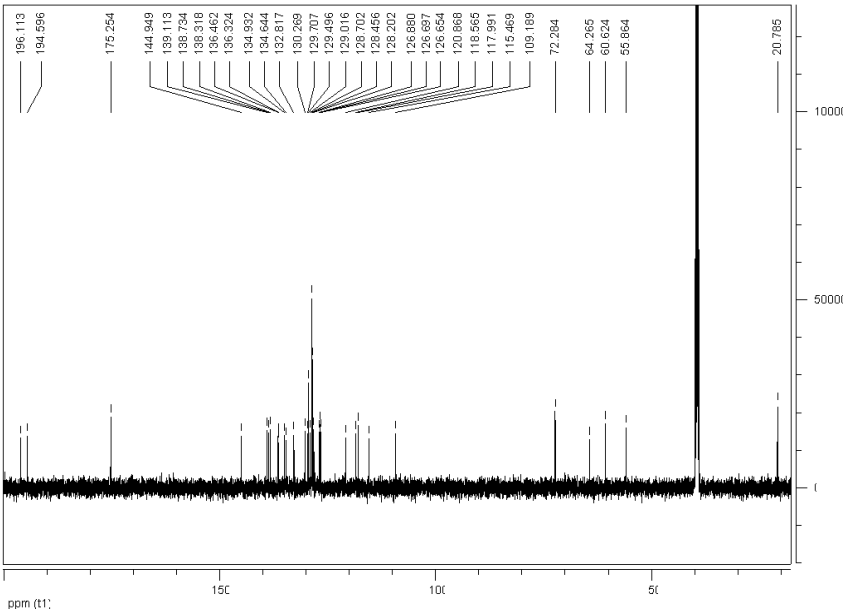
1-benzoyl-5'-chloro-2-(4-methylbenzoyl)-2,3a-dihydro-1H-spiro[benzo[h]pyrrolo[1,2-a]quinoline-3,3'-indolin]-2'-one (5d): Yellow solid, yield: 83%, m.p. 210-212 ^{o}C, IR (KBr) ν = 3788, 3173, 3060, 1874, 1710, 1686, 1684, 1550, 1509, 1476, 1451, 1408, 1366, 1315, 1284, 1239, 1214, 1184, 1088, 1065, 1032, 965, 891, 841, 827, 802, 779, 761, 709, 674, 648, 617, 584, 562, 508, 485, 440 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.79 (s, 1H, NH), 8.09 (d, *J* = 8.4 Hz, 1H, ArH), 8.00 (d, *J* = 7.2 Hz, 2H, ArH), 7.70 (brs, 1H, ArH), 7.61(t, *J* = 7.2 Hz, 1H, ArH), 7.54 (t, *J* = 7.2 Hz, 2H, ArH), 7.39 (d, *J* = 6.0 Hz, 1H, ArH), 7.28 (d, *J* = 7.8 Hz, 2H, ArH), 7.23-7.21 (m, 1H, ArH), 7.16 (t, *J* = 7.2 Hz, 2H, ArH), 7.13-7.11 (m, 3H, ArH), 7.02 (brs, 1H, ArH), 6.63 (d, *J* = 8.4 Hz, 1H, CH), 6.37 ((d, *J* = 9.6 Hz, 1H, CH), 5.84 (s, 1H, CH), 4.91 (d, *J* = 9.6 Hz, 1H, CH), 4.51 (d, *J* = 6.6 Hz, 1H, CH), 2.26 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.1, 194.5, 174.9, 145.1, 144.4, 140.5, 138.5, 136.4, 136.3, 134.8, 133.1, 132.9, 129.8, 129.1, 129.0, 128.8, 128.6, 128.5, 127.9, 126.7, 125.9, 125.4, 121.0, 118.3, 117.8, 115.7, 111.0, 72.7, 64.8, 61.3, 55.1, 21.0; HRMS (ESI) Calcd. for $C_{37}H_{27}ClN_3O_3$ ([M+H]$^{+}$): 596.1735. Found: 596.1715.



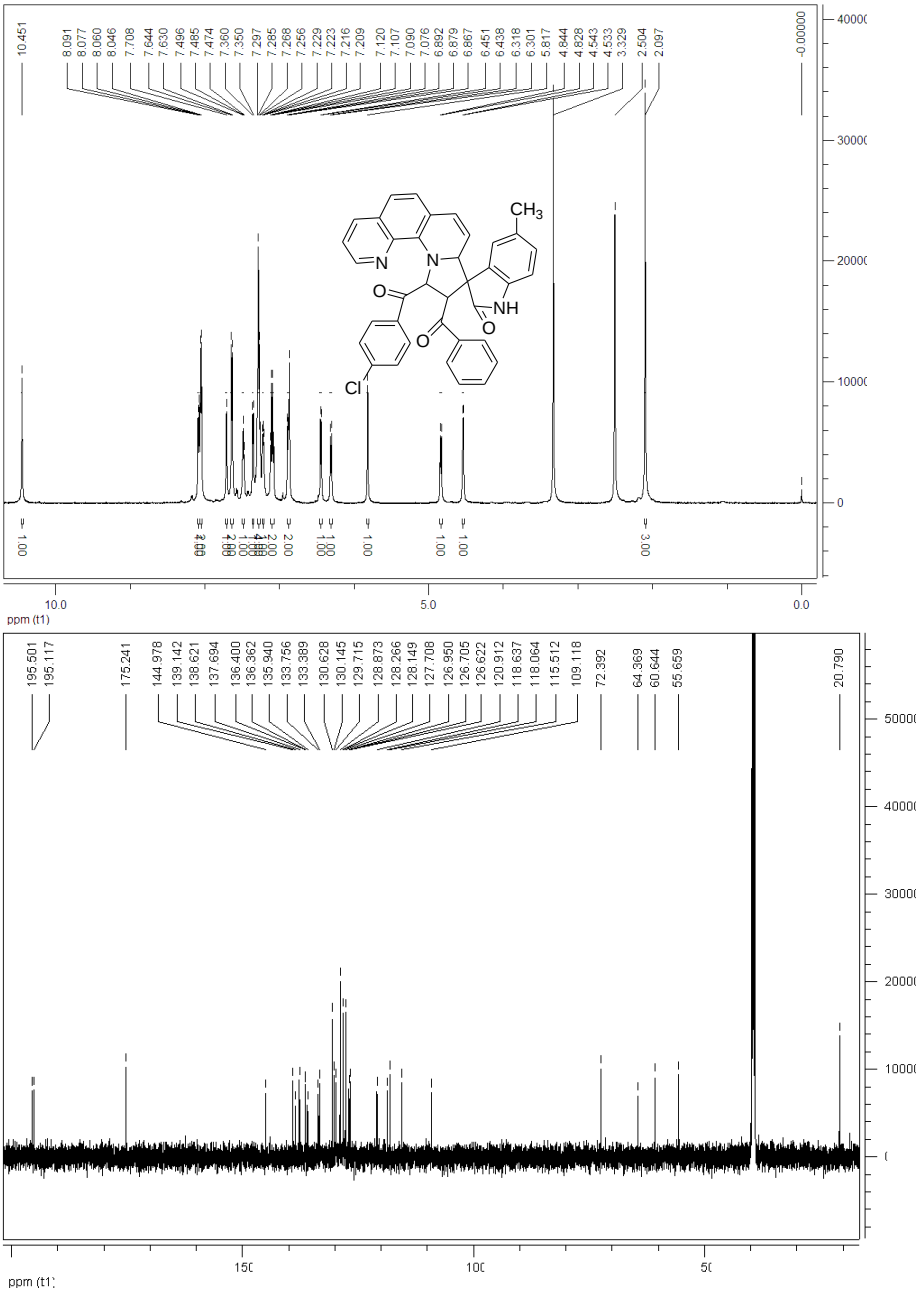


1-benzoyl-2-(4-chlorobenzoyl)-5'-methyl-2,3a-dihydro-1H-spiro[benzo[h]pyrrolo[1,2-a]quinoline-3,3'-indolin]-2'-one (5e): Yellow solid, yield: 82%, m.p. 214-216 ^{o}C, IR (KBr) ν = 3190, 3055, 1702, 1650, 1627, 1592, 1549, 1508, 1491, 1457, 1402, 1366, 1312, 1286, 1239, 1209, 1160, 1125, 983, 955, 886, 847, 824, 810, 700, 653, 588, 486, 440 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.50 (s, 1H, NH), 8.07 (d, *J* = 8.4 Hz, 1H, ArH), 8.04 (d, *J* = 7.8 Hz, 2H, ArH), 7.68 (brs, 1H, ArH), 7.61 (d, *J* = 7.2 Hz, 1H, ArH), 7.56 (t, *J* = 7.8 Hz, 2H, ArH), 7.40 (d, *J* = 6.0 Hz, 1H, ArH), 7.35 (d, *J* = 8.4 Hz, 2H, ArH), 7.27 (d, *J* = 8.4 Hz, 2H, ArH), 7.21-7.19 (m, 1H, ArH), 7.11 (d, *J* = 8.4 Hz, 1H, ArH), 7.08 (d, *J* = 8.4 Hz, 1H, ArH), 6.90 (d, *J* = 7.2 Hz, 1H, ArH), 6.86 (brs, 1H, ArH), 6.48 (d, *J* = 7.8 Hz, 1H, CH), 6.31 (d, *J* = 9.6 Hz, 1H, CH) 5.82 (s, 1H, CH), 4.84 (d, *J* = 9.6 Hz, 1H, CH), 4.50 (d, *J* = 6.0 Hz, 1H, CH), 2.10 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 196.1, 194.6, 175.3, 144.9, 139.1, 138.7, 138.3, 136.5, 136.3, 134.9, 134.6, 132.8, 130.3, 129.7, 129.5, 129.0, 128.7, 128.5, 128.2, 126.9, 126.7, 126.6, 120.9, 118.6, 118.0, 115.5, 109.2, 72.3, 64.3, 60.6, 55.9, 20.8; HRMS (ESI) Calcd. for $C_{37}H_{27}ClN_3O_3$ ([M+H]$^{+}$): 596.1735. Found: 596.1739.

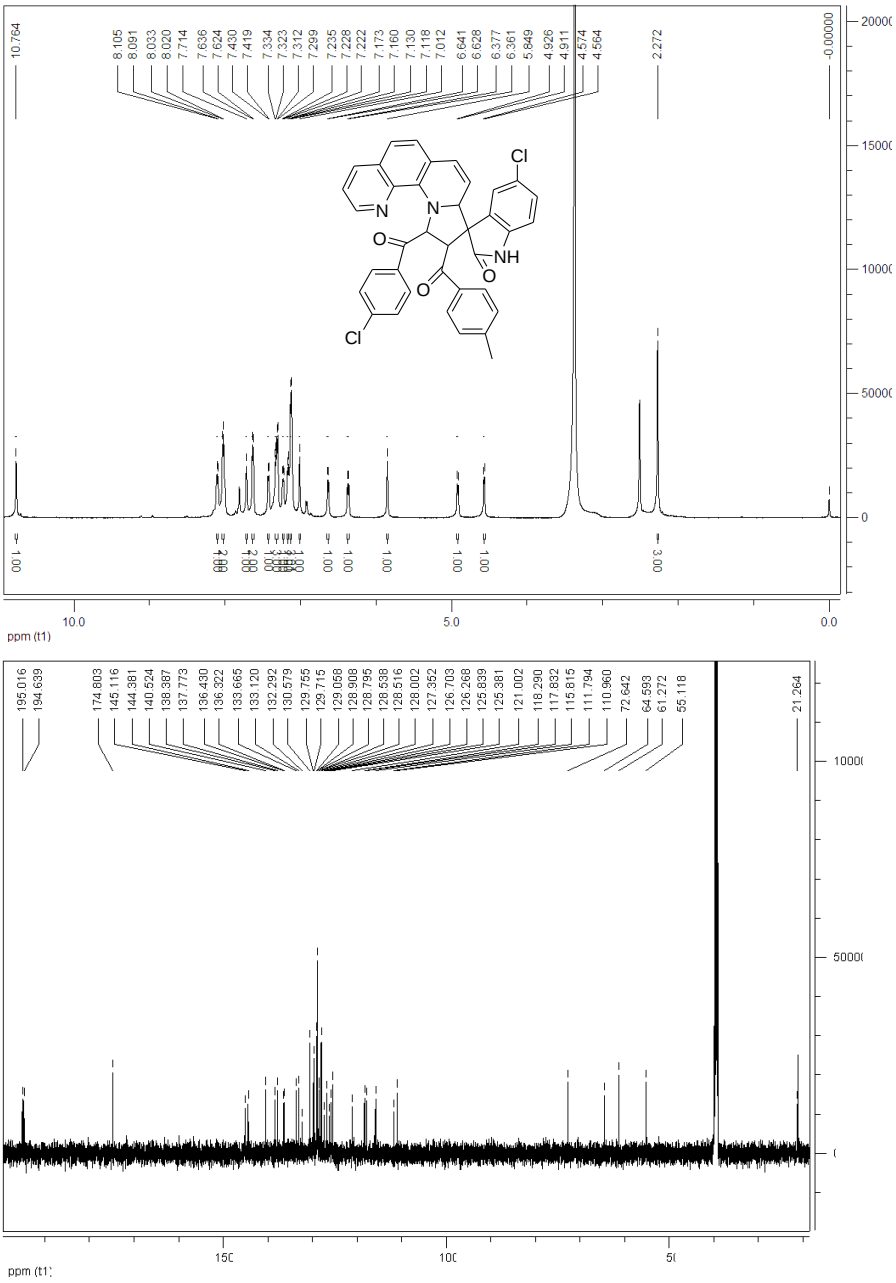




2-benzoyl-1-(4-chlorobenzoyl)-5'-methyl-2,3a-dihydro-1H-spiro[benzo[h]pyrrolo[1,2-a]quinoline-3,3'-indolin]-2'-one (5f): Yellow solid, yield: 85%, m.p. 216-218 ^{o}C, IR (KBr) ν = 3782, 3318, 3028, 1731, 1680, 1624, 1592, 1509, 1490, 1453, 1401, 1364, 1260, 1202, 1166, 1124, 1091, 993, 964, 888, 864, 827, 799, 782, 760, 723, 678, 654, 566, 525, 438 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.45 (s, 1H, NH), 8.09 (d, *J* = 8.4 Hz, 1H, ArH), 8.05 (d, *J* = 8.4 Hz, 2H, ArH), 7.71 (brs, 1H, ArH), 7.64 (d, *J* = 8.4 Hz, 2H, ArH), 7.49 (t, *J* = 6.6 Hz, 1H, ArH), 7.36 (d, *J* = 6.0 Hz, 1H, ArH), 7.30-7.26 (m, 4H, ArH), 7.23-7.21 (m, 1H, ArH), 7.10 (q, *J* = 8.4 Hz, 2H, ArH), 6.87 (d, *J* = 7.2 Hz, 2H, ArH), 6.44 (d, *J* = 7.8 Hz, 1H, CH), 6.31 (d, *J* = 9.6 Hz, 1H, CH), 5.82 (s, 1H, CH), 4.83 (d, *J* = 9.6 Hz, 1H, CH), 4.53 (d, *J* = 6.0 Hz, 1H, CH), 2.10 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 195.5, 195.1, 175.2, 145.0, 139.1, 138.6, 137.7, 136.4, 136.3, 135.9, 133.8, 133.4, 130.6, 130.1, 129.7, 128.9, 128.3, 128.1, 127.7, 127.0, 126.7, 126.6, 120.9, 118.6, 118.1, 115.5, 109.1, 72.4, 64.6, 60.6, 55.7, 20.8; HRMS (ESI) Calcd. for $C_{37}H_{27}ClN_3O_3$ ([M+H]$^{+}$): 596.1735. Found: 596.1737.



5'-chloro-1-(4-chlorobenzoyl)-2-(4-methylbenzoyl)-2,3a-dihydro-1H-spiro[benzo[h]pyrrolo[1,2-a]quinoline-3,3'-indolin]-2'-one (5g): Grey solid, yield: 79%, m.p. 202-204 ^{o}C, IR (KBr) ν = 3789, 3661, 3319, 3043, 2855, 1737, 1705, 1688, 1675, 1658, 1510, 1473, 1453, 1401, 1366, 1309, 1287, 1258, 1234, 1185, 1152, 1125, 995, 963, 887, 843, 778, 669, 566, 492 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.76 (s, 1H, NH), 8.10 (d, *J* = 8.4 Hz, 1H, ArH), 8.02 (d, *J* = 7.8 Hz, 2H, ArH), 7.72 (brs, 1H, ArH), 7.63 (d, *J* = 7.2 Hz, 2H, ArH), 7.42 (d, *J* = 7.2 Hz, 1H, ArH), 7.33-7.30 (m, 3H, ArH), 7.23 (t, *J* = 7.8 Hz, 1H, ArH), 7.16 (d, *J* = 7.8 Hz, 1H, ArH), 7.12 (d, *J* = 7.2 Hz, 3H, ArH), 7.01 (brs, 1H, ArH), 6.63 (d, *J* = 7.8 Hz, 1H, CH), 6.37 (d, *J* = 9.6 Hz, 1H, CH), 5.85 (s, 1H, CH), 4,92 (d, *J* = 9.6 Hz, 1H, CH), 4.56 (d, *J* = 6.0 Hz, 1H, CH), 2.27 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 195.0, 194.6, 174.8, 145.1, 144.4, 140.5, 138.4, 137.8, 136.4, 136.3, 133.7, 133.1, 132.3, 130.6, 129.8, 129.7, 129.1, 128.9, 128.8, 128.5, 128.4, 128.0, 127.4, 126.7, 126.3, 125.8, 125.4, 121.0, 118.3, 117.8, 115.8, 111.8, 72.6, 64.6, 61.3, 55.1, 21.3; HRMS (ESI) Calcd. for $C_{37}H_{26}Cl_2N_3O_3$ ([M+H]$^{+}$): 630.1346. Found: 630.1343.



(5'-methyl-2'-oxo-2,3a-dihydro-1H-spiro[benzo[h]pyrrolo[1,2-a]quinoline-3,3'-indoline]-1,2-diyl)bis((4-chlorophenyl)methanone) (5h): Grey solid, yield: 87%, m.p. 222-224 ^{o}C, IR (KBr) ν = 3790, 3318, 1728, 1682, 1624, 1590, 1510, 1489, 1454, 1401, 1364, 1312, 1285, 1260, 1240, 1219, 1125, 994, 965, 889, 827, 811, 728, 679, 646, 565, 530, 490 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6) δ (ppm): 10.49 (s, 1H, NH), 8.08 (d, *J* = 7.8 Hz, 1H, ArH), 8.06 (d, *J* = 7.8 Hz, 2H, ArH), 7.69 (s, 1H, ArH), 7.64 (d, *J* = 8.4 Hz, 2H, ArH), 7.34 (t, *J* = 8.4 Hz, 3H, ArH), 7.28 (d, *J* = 7.8 Hz, 2H, ArH), 7.23-7.21 (m, 1H, ArH), 7.10 (q, *J* = 7.8 Hz, 2H, ArH), 6.90 (d, *J* = 7.8 Hz, 1H, ArH), 6.85 (brs, 1H, ArH), 6.48 (d, *J* = 7.8 Hz, 1H, CH), 6.31 (d, *J* = 9.6 Hz, 1H, CH), 5.82 (s, 1H, CH), 4.84 (d, *J* = 9.6 Hz, 1H, CH), 4.56 (d, *J* = 6.0 Hz, 1H, CH), 2.10 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ(ppm): 195.0, 194.8, 175.2, 144.9, 139.1, 138.6, 138.2, 137.6, 136.4, 136.3, 134.7, 133.8, 130.7, 130.4, 130.3, 129.7, 129.6, 129.2, 129.0, 128.8, 128.3, 128.2, 126.9, 126.7, 126.5, 120.9, 118.6, 118.1, 115.5, 109.2, 72.3, 64.1, 60.5, 55.9, 20.8; HRMS (ESI) Calcd. for $C_{37}H_{26}Cl_2N_3O_3$ ([M+H]$^{+}$): 630.1346. Found: 630.1344.