Convenient synthesis of triphenylphosphanylidene spiro[cyclopentane-1,3'-indolines] and spiro[cyclopent[2]ene-1,3'-indolines] via three-component reactions

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Supporting Information

Figure 1-3 **2**

General Experimental Methods and Characterization of compounds **2-9**

^{1}H and ^{13}C NMR spectra of the compounds **10-30**

HRMS were measured at Bruker UHR-TOF maXis spectrometer. X-ray data were collected on a Bruker Smart APEX-2 diffractometer.

X-Ray Crystallographic Data: CIF in separate file.

Crystallographic data **1b** (CCDC 905184), **1d** (CCDC 906362), and **2a** (CCDC 933931)have been deposited vat the Cambridge Crystallographic Database Centre and is available on request from the Director, CCDC, 12 Union Road, Cambridge, CB2 1EZ, UK (http//www.ccdc.cam.ac.uk).

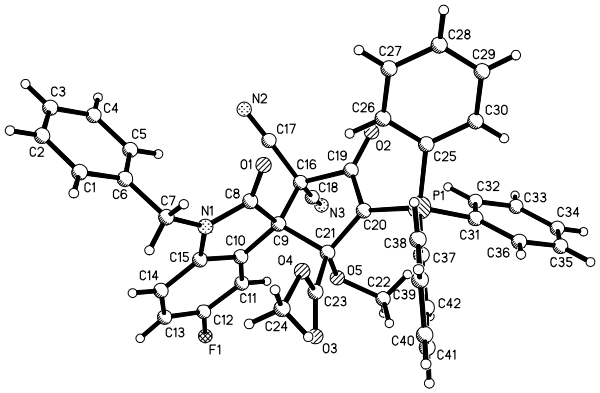


Fig. 1 Molecular structure of spiro compound 1b

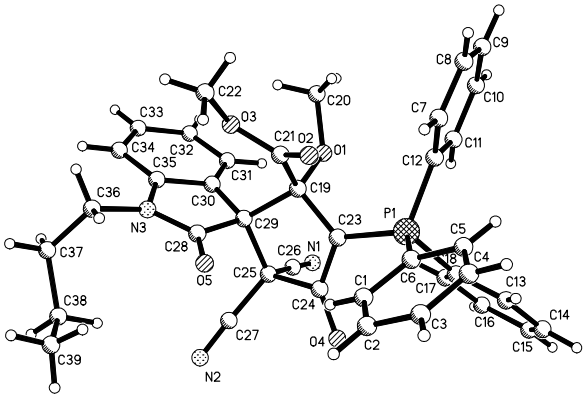


Fig. s1 Molecular structure of spiro compound 1d

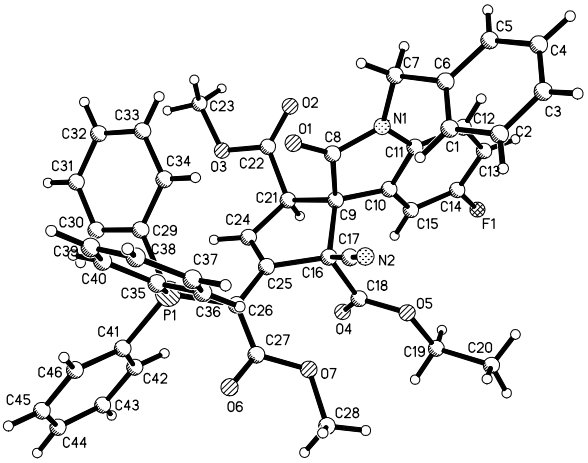


Fig. 2 Molecular structure of spiro compound 2g

Experimental section

General procedure for the synthesis of spirooxondoles 1a-1i and 2a-2k from three-component reaction: A mixture of dialkyl acetylenedicarboxylate or dialkyl hex-2-en-4-ynedioate (1.2 mmol) and isatylidene malononitrile (ethyl cyanoacetate) (1.0 mmol) in DME (5.0 mL) was cooled with ice bath. Then, a solution of triphenylphosphine (1.0 mmol) in DME (5.0 mmol) was added dropwise. The resulting mixture was stirred at room temperature for about two hours. The solvent was removed at reduced pressure. The resulting oily residue was subjected to chromatography with light petroleum and ethyl acetate (V/V = 1:1) as eluting solvent to give the pure product for analysis.

3. Methyl 1'-benzyl-2,2-dicyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1a): White solid, yield: 0.589g, 86%, m.p. 259-261℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.82-7.79 (m, 6H, ArH), 7.77-7.74 (m, 4H, ArH), 7.68-7.65 (m, 6H, ArH), 7.40-7.38 (m, 3H, ArH), 7.33-7.30 (m, 2H, ArH), 7.27-7.26 (m, 1H, ArH), 7.17 (t, *J* = 7.2Hz, 1H, ArH), 7.02 (d, *J* = 7.8Hz, 1H, ArH), 5.08 (d, *J* = 16.2Hz, 1H, CH_2), 4.87 (d, *J* = 16.2Hz, 1H, CH_2), 3.03 (s, 3H, OCH_3), 2.64 (s, 3H, OCH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 173.6 (d, *J* = 12.6Hz), 171.7, 168.0, 143.0, 135.5, 134.0 (d, *J* = 10.4Hz), 133.2, 130.5, 129.1 (d, *J* = 12.5Hz), 128.5, 127.6 (d, *J* = 6.3Hz), 127.5, 122.8, 122.4, 121.7, 113.6, 113.0, 109.8, 92.3 (d, *J* = 9.2Hz), 65.4, 64.7, 62.4(d, *J* = 10.2Hz), 51.7, 50.0(d, *J* = 15.6Hz), 43.4; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.0; IR (KBr) υ: 3059, 2947, 2899, 2241, 1827, 1722, 1642, 1486, 1437, 1367, 1238, 1184, 1096, 1000, 944, 859, 752, 725, 692 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{42}H_{32}N_3NaO_5P$ ([M+Na]$^+$): 712.1972. Found: 712.1971.

2. Methyl 1'-benzyl-2,2-dicyano-5'-fluoro-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1b): White solid, yield: 0.611g, 86%, m.p. 209-211℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.82-7.79 (m, 6H, ArH), 7.77-7.74 (m, 3H, ArH), 7.69-7.66 (m, 6H, ArH), 7.52-7.50 (m, 1H, ArH), 7.38-7.37 (m, 2H, ArH), 7.52-7.50 (m, 1H, ArH), 7.38-7.37 (m, 2H, ArH), 7.33-7.26 (m, 4H, ArH), 7.04 (q, *J* = 8.4Hz, 1H, ArH), 5.07 (d, *J* = 15.6Hz, 1H, CH_2), 4.88 (d, *J* = 15.6Hz, 1H, CH_2), 3.03 (s, 3H, OCH_3), 2.69 (s, 3H, OCH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 173.5 (d, *J* = 12.6Hz), 171.3, 167.8, 158.0 (d, *J* = 237.3Hz), 139.3, 135.2, 134.0 (d, *J* = 10.4Hz), 133.3, 129.2 (d, *J* = 12.6Hz), 128.6, 127.7, 127.5, 123.8 (d, *J* = 8.7Hz), 122.2, 121.6, 117.2 (d, *J* = 23.7Hz), 115.3 (d, *J* = 26.3Hz), 113.4 , 112.7, 110.9 (d, *J* = 8.1Hz), 92.2 (d, *J* = 9.3Hz), 65.1, 64.4, 62.5(d, *J* = 9.9Hz), 56.0, 51.9, 49.6(d, *J* = 15.6Hz), 43.5; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.0; IR (KBr) υ: 3057, 2950, 2936, 2895, 2834, 1749, 1724, 1635, 1488, 1439, 1348, 1272, 1239, 1177, 1092, 998, 896, 889, 857, 823, 785, 750, 694 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{42}H_{31}FN_3NaO_5P$ ([M+Na]$^+$): 730.1878. Found: 730.1867.

Methyl 1'-benzyl-5'-chloro-2,2-dicyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1c): White solid, yield: 0.637g, 88%, m.p. 242-244℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.81-7.78 (m, 6H, ArH), 7.75-7.74 (m, 3H, ArH), 7.71 (d, *J* = 1.8Hz, 1H, ArH), 7.69-7.66 (m, 6H, ArH), 7.52-7.50 (dd, *J* = 8.4Hz, *J* = 2.4Hz, 1H, ArH), 7.37-7.36 (m, 2H, ArH), 7.33-7.30 (m, 2H, ArH), 7.28-7.26 (m, 1H, ArH), 7.07 (d, *J* = 8.4Hz, 1H, ArH), 5.08 (d, *J* = 16.2Hz, 1H, CH_2), 4.89 (d, *J* = 16.2Hz, 1H, CH_2), 3.04 (s, 3H, OCH_3), 2.69 (s, 3H, OCH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 173.5 (d, *J* = 12.8Hz), 171.1, 167.8, 141.9, 135.1, 134.0 (d, *J* = 10.4Hz), 130.6, 129.2 (d, *J* = 12.5Hz), 128.6, 127.7, 127.5, 127.4, 126.8, 124.0, 122.1, 121.5, 113.4, 112.7, 111.5, 92.2 (d, *J* =

9.6Hz), 65.2, 64.4, 62.3(d, J = 10.2Hz), 56.0, 51.9, 49.6(d, J = 20.0Hz), 43.5; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.9; IR (KBr) υ: 3059, 2949, 2827, 2239, 1752, 1724, 1644, 1483, 1437, 1351, 1237, 1182, 1104, 999, 946, 893, 829, 748, 717, 693 cm^{-1}; MS (m/z): HRMS (ESI-TOF) Calcd. for $C_{42}H_{31}ClN_3NaO_5P$ ([M+Na]$^+$): 746.1582. Found: 746.1579.

6. Methyl 1'-n-butyl-2,2-dicyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1d): White solid, yield: 0.532g, 81%, m.p. 136-138℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.83-7.79 (m, 6H, ArH), 7.77-7.73 (m, 4H, ArH), 7.68-7.65 (m, 6H, ArH), 7.49-7.46 (m, 1H, ArH), 7.21-7.17 (m, 2H, ArH), 3.77-3.72 (m, 1H, CH_2), 3.68-3.64 (m, 1H, CH_2), 3.08 (s, 3H, OCH_3), 2.58 (s, 3H, OCH_3), 1.57-1.52 (m, 2H, CH_2), 1.38-1.33 (m, 2H, CH_2), 0.89 (t, J = 7.2Hz, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 173.2 (d, J = 13.5Hz), 171.5, 168.0, 143.4, 134.0 (d, J = 10.4Hz), 133.1, 130.6, 129.0 (d, J = 12.6Hz), 127.4, 122.4 (d, J = 7.2Hz), 121.8, 113.6, 112.7, 109.3, 92.3 (d, J = 9.0Hz), 65.6, 64.9, 61.9 (d, J = 10.4Hz), 56.0, 54.8, 51.7, 50.1 (d, J = 15.9Hz), 28.9, 19.5, 13.6; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.1; IR (KBr) υ: 3058, 2957, 2934, 2872, 2830, 2241, 1735, 1714, 1651, 1609, 1486, 1448, 1438, 1362, 1301, 1255, 1189, 1102, 1064, 1041, 998, 948, 896, 853, 799, 752, 729, 691 cm^{-1}; MS (m/z): HRMS (ESI-TOF) Calcd. for $C_{39}H_{34}N_3NaO_5P$ ([M+Na]$^+$): 678.2128. Found: 678.2114.

5. Methyl 1'-n-butyl-2,2-dicyano-5'-fluoro-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1e): White solid, yield: 0.561g, 83%, m.p. 150-152℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.83-7.79 (m, 6H, ArH), 7.76-7.74 (m, 3H, ArH), 7.68-7.65 (m, 6H, ArH), 7.50 (dd, J = 8.4Hz, J = 3.0Hz, 1H, ArH), 7.39-7.36 (m, 1H, ArH), 7.27-7.25 (m, 1H, ArH), 3.78-3.73 (m, 1H, CH_2), 3.69-3.64 (m, 1H, CH_2), 3.08 (s, 3H, OCH_3), 2.63 (s, 3H, OCH_3), 1.56-1.51 (m, 2H, CH_2), 1.37-1.31 (m, 2H, CH_2), 0.89 (t, J = 7.2Hz, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 173.2 (d, J = 13.2Hz), 171.1, 167.7, 157.9 (d, J = 237.0Hz),, 139.8, 134.0 (d, J = 10.4Hz), 133.2, 129.1 (d, J = 12.6Hz), 123.9 (d, J = 8.9Hz), 122.3, 121.7, 117.1 (d, J = 23.0Hz), 115.1 (d, J = 26.1Hz), 113.5, 112.5, 110.5 (d, J = 8.1Hz), 92.3 (d, J = 9.2Hz), 65.4, 64.6, 56.0,54.8, 51.8, 49.7(d, J = 15.9Hz), 28.8, 19.4, 13.5; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.2; IR (KBr) υ: 3061, 2958, 2935, 2873, 2832, 2230, 1742, 1716, 1653, 1622, 1489, 1438, 1348, 1254, 1188, 1064, 1039, 1000, 949, 904, 814, 790, 749, 724, 692 cm^{-1}; MS (m/z): HRMS (ESI-TOF) Calcd. for $C_{39}H_{33}FN_3NaO_5P$ ([M+Na]$^+$): 696.2034. Found: 696.2023.

6. Methyl 1'-n-butyl-5'-chloro-2,2-dicyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1f): White solid, yield: 0.591g, 86%, m.p. 148-150℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.82-7.78 (m, 6H, ArH), 7.76-7.74 (m, 3H, ArH), 7.70 (d, J = 1.8Hz, 1H, ArH), 7.68-7.65 (m, 6H, ArH), 7.58 (dd, J = 8.4Hz, J = 2.4Hz, 1H, ArH), 7.28 (d, J = 8.4Hz, 1H, ArH), 3.78-3.73 (m, 1H, CH_2), 3.70-3.65 (m, 1H, CH_2), 3.09 (s, 3H, OCH_3), 2.63 (s, 3H, OCH_3), 1.55-1.48 (m, 2H, CH_2), 1.36-1.30 (m, 2H, CH_2), 0.88 (t, J = 7.2Hz, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 173.1 (d, J = 12.8Hz), 170.9, 167.8, 142.4, 134.0 (d, J = 10.4Hz), 133.9, 133.8, 133.2, 130.5, 129.1 (d, J = 12.6Hz), 127.3, 126.5, 124.2, 122.2, 121.6, 113.5, 112.4, 110.0, 92.2 (d, J = 9.2Hz), 65.4, 64.7, 61.9(d, J = 10.2Hz), 56.0, 54.9, 51.9, 49.7(d, J = 15.8Hz), 28.7, 19.4, 13.5; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.3; IR (KBr) υ: 3061, 2958, 2934, 2872, 2830, 1737, 1717, 1654, 1608, 1483, 1438, 1346, 1302, 1218, 1188, 1104, 1064, 1040, 999, 948, 813, 691 cm^{-1}; MS (m/z): HRMS (ESI-TOF) Calcd. for $C_{39}H_{33}ClN_3NaO_5P$ ([M+Na]$^+$): 712.1739. Found: 712.1726.

7. 2-Ethyl 5-methyl 1'-n-benzyl-2-cyano-5'-fluoro-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-2,5-dicarboxylate (1g): White solid, yield: 0.487g, 65%, m.p. 209-211℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.87-7.84 (m, 6H, ArH), 7.71-7.70 (m, 3H, ArH), 7.63 (brs, 6H, ArH), 7.43-7.42 (m, 2H, ArH), 7.33-7.27 (m, 3H, ArH), 7.17-7.15 (m, 1H, ArH), 7.06 (d, J = 9.0Hz, 1H, ArH), 6.87 (brs, 1H, ArH), 5.11 (d, J = 15.6Hz, 1H, CH_2), 4.78 (d, J = 15.6Hz, 1H, CH_2), 4.28-4.25 (m, 2H, OCH_2), 2.92 (s, 3H, OCH_3), 2.68 (s, 3H, OCH_3), 1.23 (t, J = 6.6Hz, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 180.0 (d, J = 12.2Hz), 172.8, 168.7, 164.5, 157.4 (d, J = 235.1Hz), 139.4, 135.6, 134.3 (d, J = 10.2Hz), 134.0 (d, J = 10.4Hz), 132.8, 128.8 (d, J = 12.5Hz), 128.5, 127.6, 127.5, 124.3 (d, J = 9.2Hz), 123.4, 122.8, 117.0 (d, J = 26.3Hz), 116.5, 116.1 (d, J = 22.8Hz), 109.8 (d, J = 8.1Hz), 92.5 (d, J = 10.4Hz), 65.3 (d, J = 10.2Hz), 63.5, 63.2, 62.7, 61.9 (d, J = 13.8Hz), 59.7, 51.6, 43.3, 13.7; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.1; IR (KBr) υ: 3059, 2901, 2822, 1740, 1720, 1625, 1558, 1488, 1453, 1438, 1394, 1347, 1290, 1257, 1209, 1185, 1103, 1001, 950, 919, 888, 852, 822, 785, 752, 716, 694 cm^{-1}; MS (m/z): HRMS (ESI-TOF) Calcd. for $C_{44}H_{36}FN_2NaO_7P$ ([M+Na]$^+$): 777.2136. Found: 777.2124.

8. 2-Ethyl 5-methyl 1'-n-butyl-2-cyano-5'-fluoro-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-2,5-dicarboxylate (1h): White solid, yield: 0.448g, 62%, m.p. 226-228℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.87-7.83 (m, 6H, ArH), 7.70-7.68 (m, 3H, ArH), 7.62-7.59 (m, 6H, ArH), 7.22 (td, J = 9.0Hz, J = 2.4Hz, 1H, ArH), 7.11-7.06 (m, 1H, ArH), 7.06 (dd, J = 9.0Hz, J = 3.0Hz, 1H, ArH), 4.25-4.23 (m, 2H, OCH_2), 3.74-3.69 (m, 1H, CH_2), 3.63-3.59 (m, 1H, CH_2), 2.98 (s, 3H, OCH_3), 2.59 (s, 3H, OCH_3), 1.57-1.52 (m, 2H, CH_2), 1.40-1.34 (m, 2H, CH_2), 1.23 (t, J = 7.2Hz, 3H, CH_3), 0.90 (t, J = 7.2Hz, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 184.9 (d, J = 12.0Hz), 177.9, 169.8, 162.6 (d, J = 234.9Hz), 145.1, 139.6 (d, J = 10.4Hz), 139.2, 137.9, 134.0 (d, J = 12.5Hz), 129.7 (d, J = 9.2Hz), 128.6, 128.0, 121.9, 121.7, 121.4 (d, J = 5.4Hz), 121.3, 114.6 (d, J = 8.3Hz), 97.7 (d, J = 10.1Hz), 69.9 (d, J = 11.6Hz), 69.2, 68.4 (d, J = 11.4Hz), 67.4 (d, J = 14.0Hz), 58.5, 56.8, 34.1, 24.8, 18.9, 18.8; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.5; IR (KBr) υ: 3059, 2963, 2933, 2871, 2830, 1741, 1705, 1630, 1558, 1540, 1490, 1438, 1350, 1328, 1270, 1218, 1186, 1163, 1103, 1062, 1001, 974, 856, 840, 749, 721, 692 cm^{-1}; MS (m/z): HRMS (ESI-TOF) Calcd. for $C_{41}H_{38}FN_2NaO_7P$ ([M+Na]$^+$): 743.2293. Found: 743.2280.

9. 2-Ethyl 5-methyl 1'-benzyl-5'-chloro-2-cyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-2,5-dicarboxylate (1i): White solid, yield: 0.447g, 61%, m.p. 222-223℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.87-7.84 (m, 6H, ArH), 7.71-7.69 (m, 3H, ArH), 7.63-7.61 (m, 6H, ArH), 7.46-7.44 (m, 1H, ArH), 7.24 (brs, 1H, ArH), 7.15 (d, J = 8.4Hz, 1H, ArH), 4.27-4.20 (m, 2H, OCH_2), 3.75-3.70 (m, 1H, CH_2), 3.64-3.60 (m, 1H, CH_2), 2.98 (s, 3H, OCH_3), 2.59 (s, 3H, OCH_3), 1.56-1.51 (m, 2H, CH_2), 1.38-1.34 (m, 2H, CH_2), 1.24 (t, J = 7.2Hz, 3H, CH_3), 0.90 (t, J = 7.2Hz, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6) δ: 179.4 (d, J = 12.0Hz), 172.6, 168.7, 164.5, 142.5, 134.3 (d, J = 10.2Hz), 133.9 (d, J = 10.4Hz), 132.7, 129.5, 128.8 (d, J = 12.5Hz), 125.4, 124.7, 123.4, 122.7, 116.1, 110.1, 92.5 (d, J = 10.2Hz), 64.4, 64.3, 64.2, 63.4, 63.2, 62.1 (d, J = 14.4Hz), 59.7, 51.5, 28.8, 19.5, 13.7, 13.6; ^{31}P NMR (300 MHz, DMSO-d_6) δ: 14.2; IR (KBr) υ: 3060, 2959, 2234, 1743, 1716, 1630, 1558, 1540, 1521, 1456, 1395, 1347, 1252, 1218, 1104, 1065, 1001, 957, 841, 810, 749, 720, 692 cm^{-1}; MS (m/z): HRMS (ESI-TOF) Calcd. for $C_{41}H_{38}ClN_2NaO_7P$ ([M+Na]$^+$): 759.1997. Found: 759.1984.

10. Methyl 1'-benzyl-5,5-dicyano-2-(1-methoxy-1-oxo-1-

triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2a): White solid, yield: 0.569g, 80%, m.p. 238-239℃; ^{1}H NMR (600 MHz, $CDCl_3$) δ: 7.81-7.77 (m, 6H, ArH), 7.63-7.60 (m, 3H, ArH), 7.56-7.54 (m, 7H, ArH), 7.39-7.38 (m, 2H, ArH), 7.31 (t, *J* = 7.2Hz, 2H, ArH), 7.27-7.24 (m, 2H, ArH), 6.98 (t, *J* = 7.8Hz, 1H, ArH), 6.80 (d, *J* = 7.8Hz, 1H, ArH), 5.44 (brs, 1H, CH), 5.19 (d, *J* = 16.2Hz, 1H, CH_2), 4.80 (d, *J* = 16.2Hz, 1H, CH_2), 3.90 (d, *J* = 5.4Hz, 1H, CH), 3.41 (s, 3H, OCH_3), 2.95 (s, 3H, OCH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 171.6, 169.5 (d, *J* = 15.9Hz), 168.5, 142.7, 135.3, 133.8 (d, *J* = 9.9Hz), 132.5, 130.5, 128.9 (d, *J* = 12.5Hz), 128.7, 125.2, 125.0, 122.5, 112.4 (d, *J* = 61.1Hz), 109.4, 60.6, 58.5, 54.3, 51.6, 49.6, 44.5, 42.5, 41.7; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 21.8; IR (KBr) υ: 3060, 2944, 1717, 1633, 1488, 1435, 1367, 1286, 1222, 1181, 1104, 927, 749, 695 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{44}H_{34}N_3NaO_5P$ ($[M+Na]^+$): 738.2128. Found: 738.2114.

11. Methyl 1'-benzyl-5,5-dicyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-5'-methyl-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2b): White solid, yield: 0.549g, 75%, m.p. 202-204℃; ^{1}H NMR (600 MHz, $CDCl_3$) δ: 7.82-7.79 (m, 6H, ArH), 7.64-7.61 (m, 3H, ArH), 7.56-7.53 (m, 6H, ArH), 7.46 (s, 1H, ArH), 7.39-7.37 (m, 2H, ArH), 7.30 (t, *J* = 7.8Hz, 2H, ArH), 7.27-7.24 (m, 1H, ArH), 7.06 (d, *J* = 8.4Hz, 1H, ArH), 6.70 (d, *J* = 8.4Hz, 1H, ArH), 5.51 (brs, 1H, CH), 5.17 (d, *J* = 15.6Hz, 1H, CH_2), 4.77 (d, *J* = 15.6Hz, 1H, CH_2), 3.88 (d, *J* = 6.6Hz, 1H, CH), 3.45 (s, 3H, OCH_3), 2.97 (s, 3H, OCH_3) , 2.29 (s, 3H, CH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 171.5, 169.6 (d, *J* = 16.2Hz), 168.6, 140.3, 136.3, 135.5, 133.8 (d, *J* = 10.1Hz), 132.5, 132.1, 130.9, 130.4 (d, *J* = 6.6Hz), 128.9 (d, *J* = 12.5Hz), 128.7, 127.8, 126.0, 125.8, 125.3, 125.0, 112.8, 112.3, 109.1, 60.6, 54.3, 54.0, 51.6, 49.6, 44.5, 42.3, 41.5; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 21.8; IR (KBr) υ: 3059, 2944, 1715, 1628, 1498, 1435, 1346, 1287, 1224, 1201, 1103, 1031, 927, 817, 748, 695 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{45}H_{36}N_3NaO_5P$ ($[M+Na]^+$): 752.2285. Found: 752.2281.

12. methyl 1'-benzyl-5'-fluoro-5,5-dicyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2c): White solid, yield: 0.585g, 80%, m.p. 228-230℃; ^{1}H NMR (600 MHz, $CDCl_3$) δ: 7.80-7.76 (m, 6H, ArH), 7.63-7.61 (m, 3H, ArH), 7.56-7.53 (m, 6H, ArH), 7.41 (d, *J* = 8.4Hz, 1H, ArH)，7.37-7.36 (m, 2H, ArH), 7.32 (t, *J* = 7.2Hz, 2H, ArH), 7.28-7.26 (m, 1H, ArH), 6.96 (t, *J* = 8.4Hz, 1H, ArH), 6.72-6.70 (m, 1H, ArH), 5.42 (brs, 1H, CH), 5.17 (d, *J* = 15.6Hz, 1H, CH_2), 4.79 (d, *J* = 15.6Hz, 1H, CH_2), 3.92 (d, *J* = 6.0Hz, 1H, CH), 3.45 (s, 3H, OCH_3), 3.04 (s, 3H, OCH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 171.2, 169.3 (d, *J* = 15.5Hz), 168.2, 158.7 (d, *J* = 240.3Hz),, 138.7, 134.9, 133.8 (d, *J* = 10.1Hz), 129.6, 129.0 (d, *J* = 12.5Hz), 128.8, 127.9, 127.8, 126.5 (d, *J* = 8.7Hz), 125.7, 125.1, 117.0 (d, *J* = 23.6Hz), 113.6 (d, *J* = 26.3Hz), 112.5, 111.9, 110.0 (d, *J* = 8.0Hz), 60.9, 54.2, 51.8, 49.5, 42.4, 41.6; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 21.7; IR (KBr) υ: 3063, 2944, 1706, 1634, 1493, 1435, 1346, 1282, 1223, 1180, 1104, 1036, 999, 929, 865, 818, 746, 694 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{44}H_{33}FN_3NaO_5P$ ($[M+Na]^+$): 756.2034. Found: 756.2032.

13. Methyl 1'-benzyl-5'-chloro-5,5-dicyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2d): White solid, yield: 0.574g, 77%, m.p. 204-206℃; ^{1}H NMR (600 MHz, $CDCl_3$) δ: 7.79-7.76 (m, 6H, ArH), 7.67 (s, 1H, ArH), 7.62-7.59 (m, 3H, ArH), 7.55-7.53 (m, 6H, ArH), 7.36-7.35 (m, 2H, ArH), 7.32-7.30 (m, 2H, ArH), 7.28-7.23 (m, 2H, ArH), 6.71 (d, *J* = 8.4Hz, 1H, ArH), 5.34 (brs, 1H, CH), 5.16 (d, *J* = 15.6Hz, 1H, CH_2), 4.79 (d, *J* = 15.6Hz, 1H, CH_2), 3.90 (d, *J* = 5.4Hz,

1H, CH), 3.49 (s, 3H, OCH_3), 3.04 (s, 3H, OCH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 171.1, 169.4 (d, *J* = 15.8Hz), 168.1, 141.3, 136.6 (d, *J* = 10.7Hz), 135.0, 134.8, 133.8 (d, *J* = 9.6Hz), 132.6, 130.6, 129.0 (d, *J* = 12.5Hz), 128.9, 128.0, 127.8, 126.7, 125.7 (d, *J* = 4.4Hz), 125.1, 123.9, 112.5, 112.9,110.4,60.6, 58.4, 54.2, 51.9, 49.7, 44.7, 42.4, 41.5; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 21.6; IR (KBr) υ: 3064, 2943, 1732, 1631, 1485, 1435, 1343, 1285, 1222, 1179, 1104, 1030, 925, 819, 747, 694 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{44}H_{33}ClN_3NaO_5P$ ($[M+Na]^+$): 772.1739. Found: 772.1732.

14. Methyl 1'-butyl-5'-chloro-5,5-dicyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2e): White solid, yield: 0.548g, 77%, m.p. 226-228℃; ^1H NMR (600 MHz, $CDCl_3$) δ: 7.79-7.76 (m, 6H, ArH), 7.67 (s, 1H, ArH), 7.61-7.60 (m, 3H, ArH), 7.55-7.54 (m, 6H, ArH), 7.34 (d, *J* = 8.4Hz, 1H, ArH), 6.82 (d, *J* = 8.4Hz, 1H, ArH), 5.36 (brs, 1H, CH), 3.87-3.86 (m, 1H, CH_2), 3.84 (brs, 1H, CH), 3.73-3.68 (m, 1H, CH_2), 3.50 (s, 3H, OCH_3), 3.24 (s, 3H, OCH_3), 1.68-1.63 (m, 2H, CH_2), 1.44-1.48 (m, 2H, CH_2), 0.96 (t, *J* = 7.2Hz, 3H, CH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 170.7, 169.4 (d, *J* = 15.6Hz), 168.2, 141.8, 133.8 (d, *J* = 9.9Hz), 132.5, 130.6, 129.0 (d, *J* = 12.5Hz), 127.7, 126.8, 125.8 (d, *J* = 6.2Hz), 125.1, 112.4, 111.9, 109.6, 60.5, 58.5, 54.2, 51.9, 49.7, 40.5, 29.1, 19.9, 13.7; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 21.6; IR (KBr) υ: 3063, 2955, 2873, 2242, 1746, 1729, 1653, 1637, 1610, 1558, 1485, 1435, 1349, 1282, 1233, 1219, 1105, 1089, 1030, 998, 976, 929, 884, 835, 807, 748, 715, 693 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{41}H_{35}ClN_3NaO_5P$ ($[M+Na]^+$): 738.1895. Found: 738.1880.

15. 5-Ethyl 4-methyl 1'-benzyl-5-cyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2f): White solid, yield: 0.514g, 67%, m.p. 237-238℃; ^1H NMR (600 MHz, $CDCl_3$) δ: 7.84-7.80 (m, 6H, ArH), 7.54-7.52 (m, 3H, ArH), 7.48-7.46 (m, 8H, ArH), 7.35-7.32 (m, 2H, ArH), 7.27-7.25 (m, 1H, ArH), 7.16-7.13 (m, 2H, ArH), 6.91 (t, *J* = 7.8Hz, 1H, ArH), 6.63 (d, *J* = 7.8Hz, 1H, ArH), 5.02-4.93 (m, 2H, CH_2), 4.64 (s, 1H, CH), 4.25 (s, 1H, CH), 4.21-4.11 (m, 2H, OCH_2), 3.29 (brs, 6H, OCH_3), 1.10 (t, *J* = 6.6Hz, 3H, CH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 175.4, 170.1, 168.3 (d, *J* = 10.2Hz), 166.0, 144.0, 135.8, 134.2 (d, *J* = 9.8Hz), 131.6, 129.5, 128.6 (d, *J* = 12.8Hz), 127.5, 127.3, 123.6, 121.8, 109.6, 62.2, 56.4, 51.5, 44.3, 13.7; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 20.1; IR (KBr) υ: 3058, 2987, 2947, 2905, 2857, 1962, 1895, 1727, 1636, 1611, 1489 , 1435, 1363, 1326, 1226, 1177, 1102, 978, 938, 853, 819, 748, 693 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{46}H_{39}N_2NaO_7P$ ($[M+Na]^+$): 785.2387. Found: 785.2387.

16. 5-ethyl 4-methyl 1'-benzyl-5-cyano-5'-fluoro-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2g): White solid, yield: 0.510g, 65%, m.p. 185-187℃; ^1H NMR (600 MHz, $CDCl_3$) δ: 7.83-7.79 (m, 6H, ArH), 7.55-7.53 (m, 3H, ArH), 7.49-7.44 (m, 8H, ArH), 7.35-7.33 (m, 2H, ArH), 7.28-7.26 (m, 1H, ArH), 6.95 (brs, 1H, ArH), 6.87-6.84 (m, 1H, ArH), 6.55-6.53 (m, 1H, ArH), 4.99-4.91 (m, 2H, CH_2), 4.63 (s, 1H, CH), 4.28-4.23 (m, 2H, OCH_2), 4.21 (brs, 1H, CH), 3.32 (brs, 6H, OCH_3), 1.16 (t, *J* = 7.2Hz, 3H, CH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 175.2, 170.0, 168.3, 168.5, 158.6 (d, *J* = 238.5Hz), 140.0, 135.5, 134.2 (d, *J* = 9.9Hz), 131.7, 128.7, 128.6 (d, *J* = 12.5Hz), 127.5, 115.6 (d, *J* = 9.6Hz), 112.0, 110.1 (d, *J* = 5.7Hz), 62.3, 56.5, 51.6, 44.5, 13.8; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 20.1; IR (KBr) υ: 3060, 2984, 2948, 2840, 2432, 1970, 1893, 1724, 1640, 1617, 1492, 1435, 1330, 1231, 1177, 1102, 1080, 997, 919, 857, 808, 748, 694 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{46}H_{38}FN_2NaO_7P$ ($[M+Na]^+$): 803.2293. Found: 803.2289.

17. 5-ethyl 4-methyl 1'-n-butyl-5-cyano-5'-fluoro-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2h): White solid, yield: 0.509g, 68%, m.p. 177-178℃; ^{1}H NMR (600 MHz, $CDCl_3$) δ: 7.82-7.78 (m, 6H, ArH), 7.55-7.52 (m, 3H, ArH), 7.48-7.46 (m, 6H, ArH), 7.01-6.98 (m, 1H, ArH), 6.94 (brs, 1H, ArH), 6.79-6.76 (m, 1H, ArH), 4.58 (s, 1H, CH), 4.22-4.21 (m, 2H, CH_2), 4.14 (s, 1H, CH), 3.73-3.72 (m, 1H, OCH_2), 3.65-3.59 (m, 1H, OCH_2), 3.31 (brs, 6H, OCH_3), 1.73-1.68 (m, 2H, CH_2), 1.47-1.42 (m, 2H, CH_2), 1.17 (t, *J* = 7.2Hz, 3H, CH_3), 0.98 (t, *J* = 7.2Hz, 3H, CH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 174.7, 169.9, 168.3 (d, *J* = 12.9Hz), 165.8, 158.4 (d, *J* = 237.6Hz), 140.4, 134.2 (d, *J* = 9.8Hz), 131.6, 128.5 (d, *J* = 12.5Hz), 125.5 (d, *J* = 24.0Hz), 112.1, 108.8 (d, *J* = 6.9Hz), 62.3, 61.8, 56.4, 51.5, 40.3, 28.9, 20.2, 13.8, 13.7; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 20.0; IR (KBr) υ: 3065, 2955, 2872, 1985, 1736, 1614, 1491, 1436, 1331, 1273, 1230, 1186, 1143, 1103, 1050, 996, 892, 819, 748, 693 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{43}H_{40}FN_2NaO_7P$ ([M+Na]$^+$): 769.2449. Found: 769.2446.

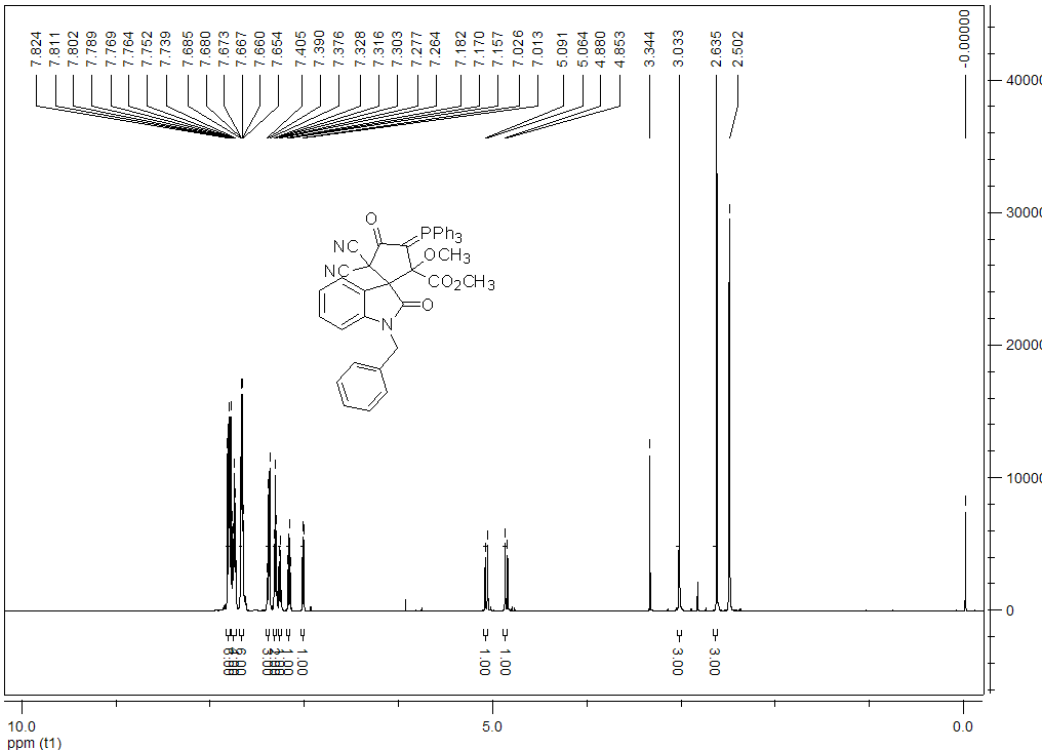
18. 5-ethyl 4-methyl 1'-n-butyl-5'-chloro-5-cyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2i): White solid, yield: 0.492g, 65%, m.p. 199-201℃; ^{1}H NMR (600 MHz, $CDCl_3$) δ: 7.81-7.78 (m, 6H, ArH), 7.55-7.52 (m, 3H, ArH), 7.48-7.47 (m, 6H, ArH), 7.27 (brs, 1H, ArH), 7.14 (brs, 1H, ArH), 6.79 (d, *J* = 8.4Hz, 1H, ArH), 4.56 (s, 1H, CH), 4.23-4.22 (m, 2H, CH_2), 4.15 (s, 1H, CH), 3.72-3.71 (m, 1H, OCH_2), 3.65-3.59 (m, 1H, OCH_2), 3.31 (brs, 6H, OCH_3), 1.71-1.67 (m, 2H, CH_2), 1.46-1.43 (m, 2H, CH_2), 1.17 (t, *J* = 7.2Hz, 3H, CH_3), 0.98 (t, *J* = 7.8Hz, 3H, CH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 174.5, 169.9, 168.2 (d, *J* = 13.5Hz), 165.8, 143.0, 134.2 (d, *J* = 11.1Hz), 131.6, 129.2, 128.5 (d, *J* = 12.5Hz), 126.8, 124.2, 109.3, 62.4 (d, *J* = 7.6Hz), 61.7, 56.3, 51.5, 40.3, 28.9, 20.3, 13.8, 13.7; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 20.0; IR (KBr) υ: 3060, 2956, 2871, 1979, 1722, 1639, 1609, 1485, 1433, 1326, 1301, 1224, 1184, 1156, 1103, 1055, 987, 897, 822, 747, 717, 694 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{43}H_{40}ClN_2NaO_7P$ ([M+Na]$^+$): 785.2154. Found: 785.2153.

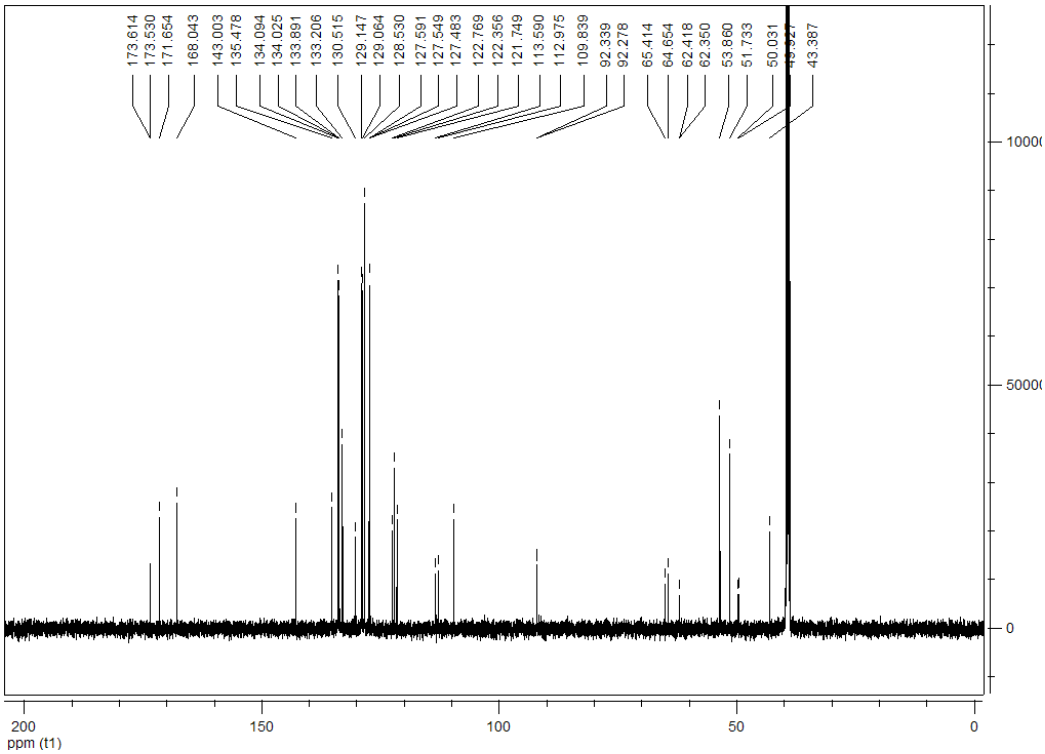
19. diethyl 1'-benzyl-5-cyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2j): White solid, yield: 0.473g, 64%, m.p. 210-211℃; ^{1}H NMR (600 MHz, $CDCl_3$) δ: 7.80-7.78 (m, 6H, ArH), 7.61-7.60 (m, 3H, ArH), 7.55-7.54 (m, 7H, ArH), 7.40-7.39 (m, 2H, ArH) , 7.31 (t, *J* = 7.2Hz, 2H, ArH), 7.27-7.22 (m, 2H, ArH), 6.96 (t, *J* = 7.2Hz, 1H, ArH), 6.78 (d, *J* = 7.2Hz, 1H, ArH), 5.45 (brs, 1H, CH), 5.08 (d, *J* = 15.6Hz, 1H, CH_2), 4.89 (d, *J* = 15.6Hz, 1H, CH_2), 4.13-4.10 (m, 1H, OCH_2), 3.86 (d, *J* = 5.4Hz, 1H, CH), 3.73-3.70 (m, 1H, OCH_2), 3.69-3.64 (m, 1H, OCH_2), 3.41-3.38 (m, 1H, OCH_2), 0.98 (brs, 3H, CH_3), 0.35 (t, *J* = 6.6Hz, 3H, CH_3); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 171.7, 169.3 (d, *J* = 21.8Hz), 167.9, 142.9, 136.1, 135.3, 133.8 (d, *J* = 9.9Hz), 132.3, 130.4, 130.2, 128.9 (d, *J* = 12.5Hz), 128.7, 127.9, 126.2, 125.6, 125.4, 125.3, 122.7, 112.7, 112.3, 109.3, 60.8, 60.4, 58.7, 58.5, 54.1, 44.6, 42.7, 41.8, 14.5, 12.9; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 22.2; IR (KBr) υ: 3059, 2978, 2935, 2901, 2243, 1733, 1651, 1613, 1558, 1540, 1486, 1438, 1357, 1347, 1295, 1201, 1102, 1082, 1028, 999, 920, 856, 751, 694 cm^{-1}; MS (*m*/*z*): HRMS (ESI-TOF) Calcd. for $C_{46}H_{38}N_3NaO_5P$ ([M+Na]$^+$): 766.2441. Found: 766.2436.

20. diethyl 1'-benzyl-5-cyano-5'fluoro-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2k): White solid, yield: 0.501g, 66%, m.p. 185-187℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.78-7.73 (m, 6H, ArH), 7.61-7.58 (m, 3H, ArH), 7.54-7.50 (m, 6H, ArH), 7.38-7.36 (m, 3H, ArH),

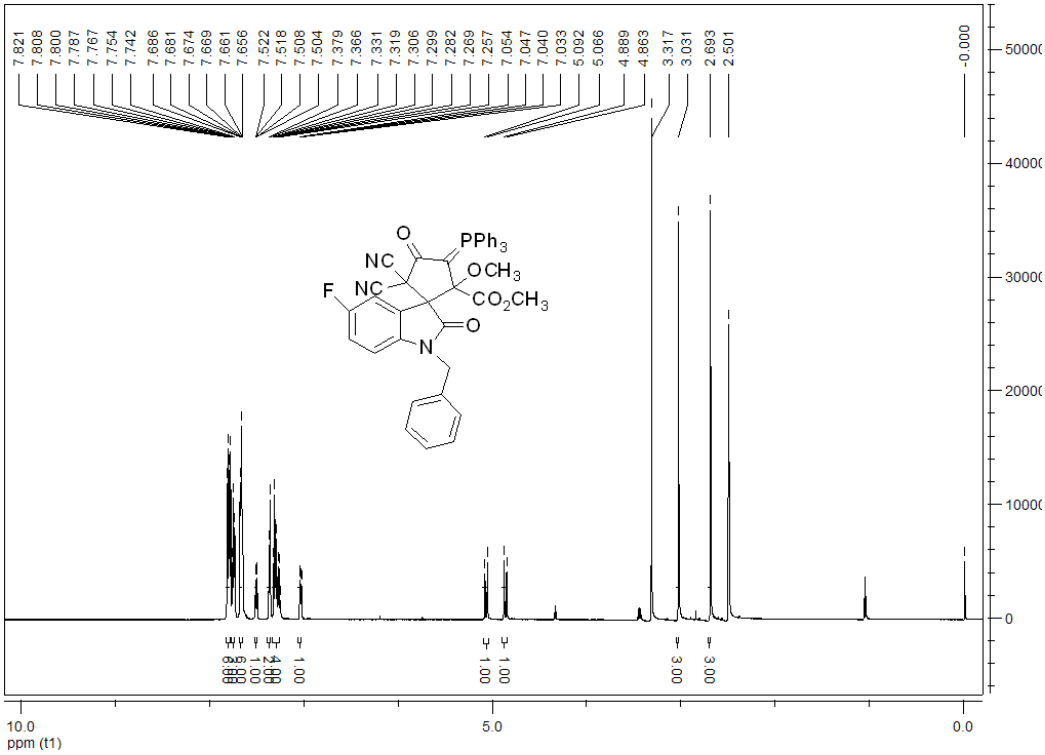
7.32-7.24 (m, 3H, ArH), 6.94 (td, J = 8.8Hz, J = 2.4Hz, 1H, ArH), 6.71-6.68 (m, 1H, ArH), 5.27 (brs, 1H, CH), 5.06 (d, J = 15.6Hz, 1H, CH_2), 4.87 (d, J = 15.6Hz, 1H, CH_2), 4.14-4.10 (m, 1H, OCH_2), 3.84 (dd, J = 6.0Hz, J = 1.2Hz, 1H, CH), 3.75-3.66 (m, 2H, OCH_2), 3.47-3.39 (m, 1H, OCH_2), 1.00 (brs, 3H, CH_3), 0.40 (t, J = 6.8Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 171.3, 169.2 (d, J = 15.0Hz), 167.6, 158.5 (d, J = 240.9Hz), 138.9 (d, J = 2.0Hz), 136.1 (d, J = 11.5Hz), 134.9, 133.8 (d, J = 9.8Hz), 132.4 (d, J = 2.8Hz), 129.5, 128.9, 128.8 (d, J = 2.8Hz), 127.9, 127.7, 126.6 (d, J = 8.6Hz), 126.1, 125.2, 116.8 (d, J = 23.5Hz), 113.9, 113.6, 112.5, 112.0 (d, J = 1.4Hz), 109.9 (d, J = 7.6Hz), 60.9, 60.7, 58.8, 53.9, 44.7, 43.1, 41.8, 14.2, 13.1; ^{31}P NMR (300 MHz, $CDCl_3$) δ: 22.2; IR (KBr) υ: 3062, 2978, 2935, 1965, 1737, 1624, 1492, 1438, 1367, 1344, 1285, 1221, 1190, 1102, 1077, 1028, 1000, 921, 865, 816, 751, 694 cm^{-1}; MS (m/z): HRMS (ESI-TOF) Calcd. for $C_{46}H_{37}FN_3NaO_5P$ ($[M+Na]^+$): 784.2347. Found: 784.2355.

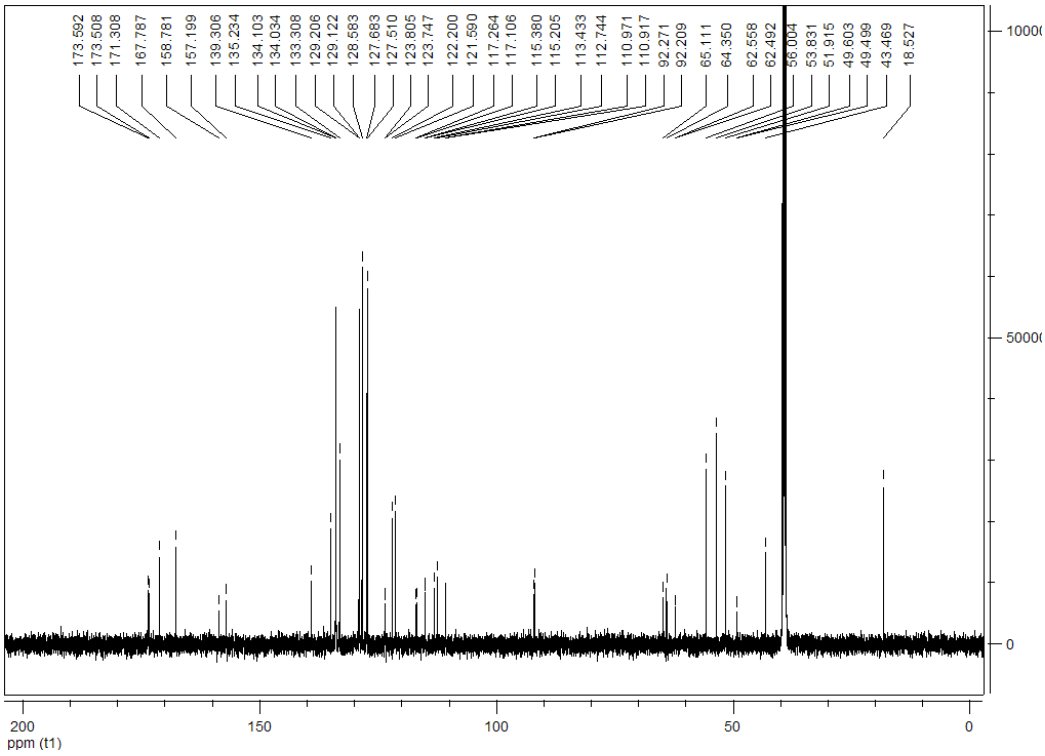
1. Methyl 1'-benzyl-2,2-dicyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1a):



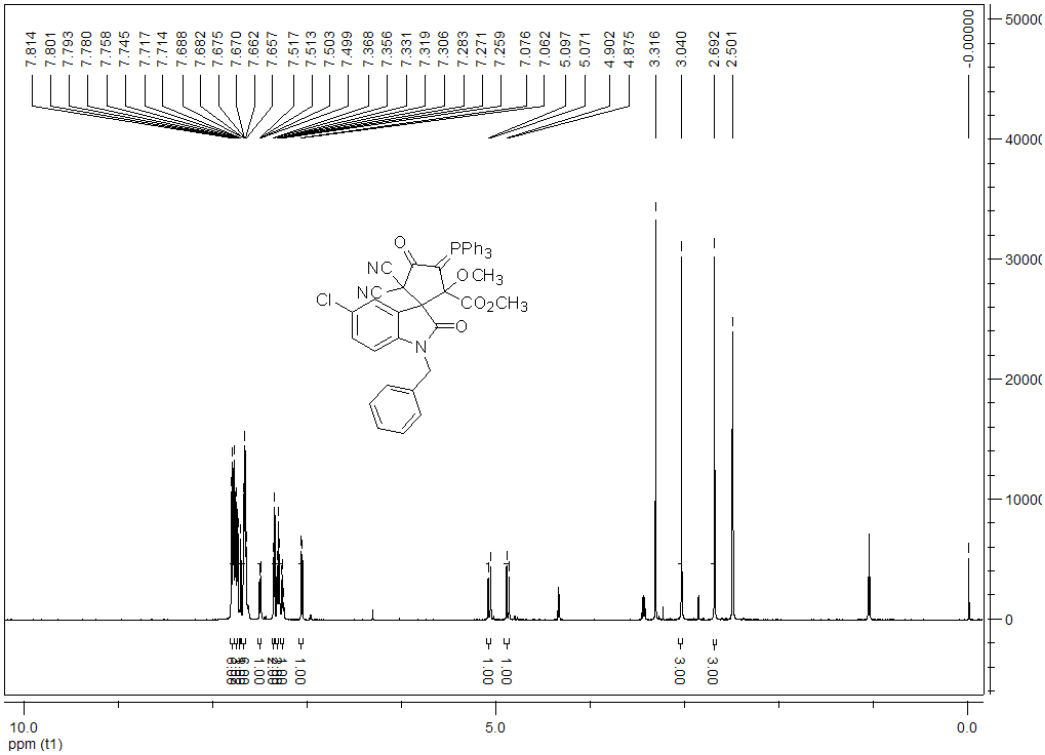


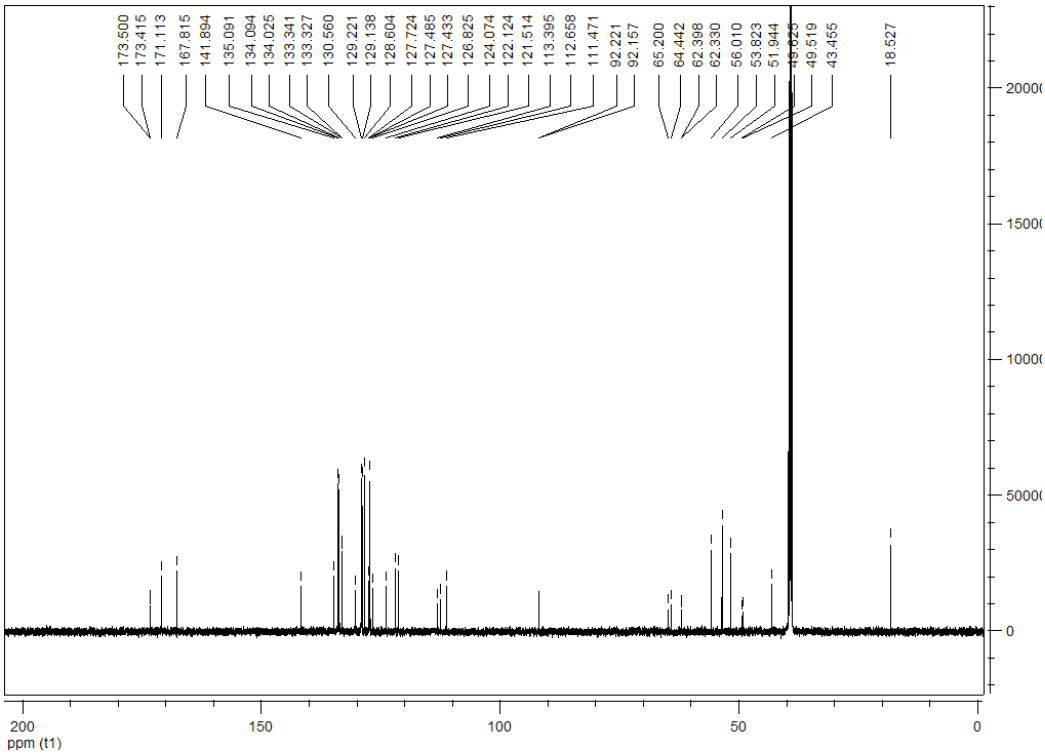
2. Methyl 1'-benzyl-2,2-dicyano-5'-fluoro-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1b):



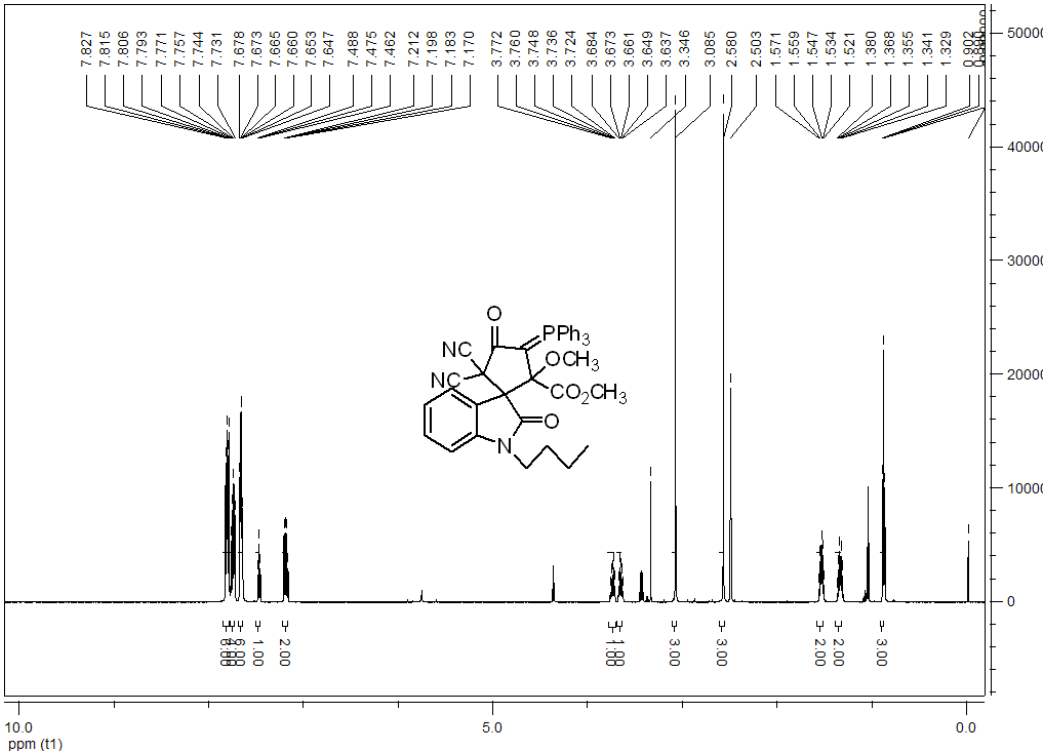


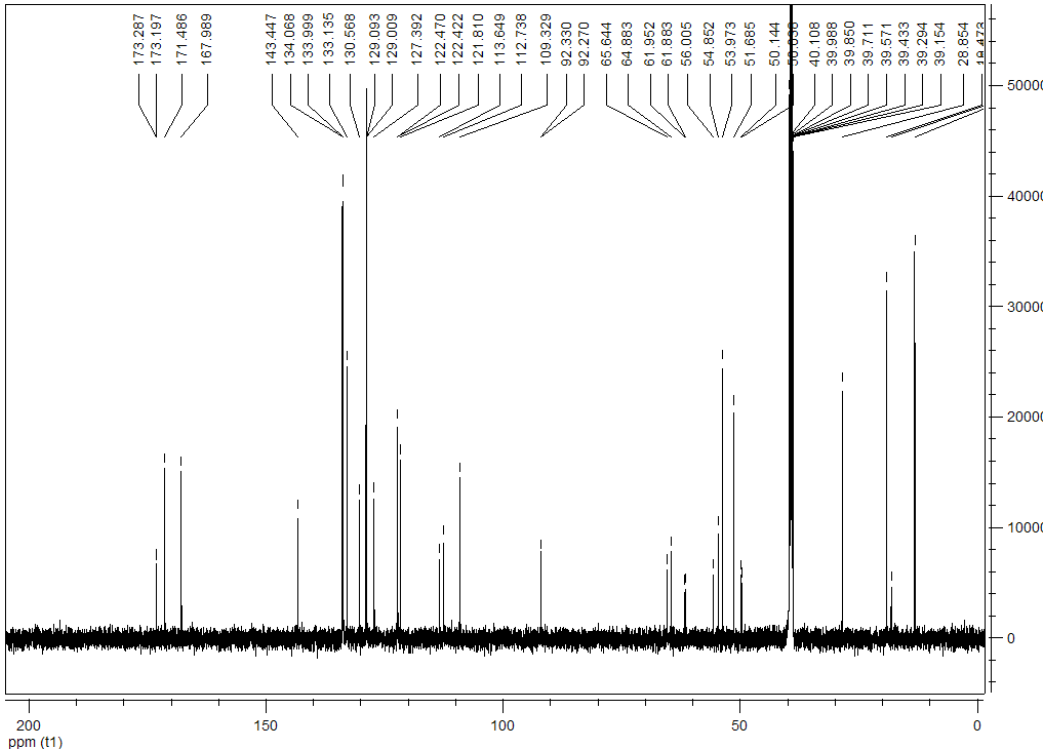
3. Methyl 1'-benzyl-5'-chloro-2,2-dicyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1c):



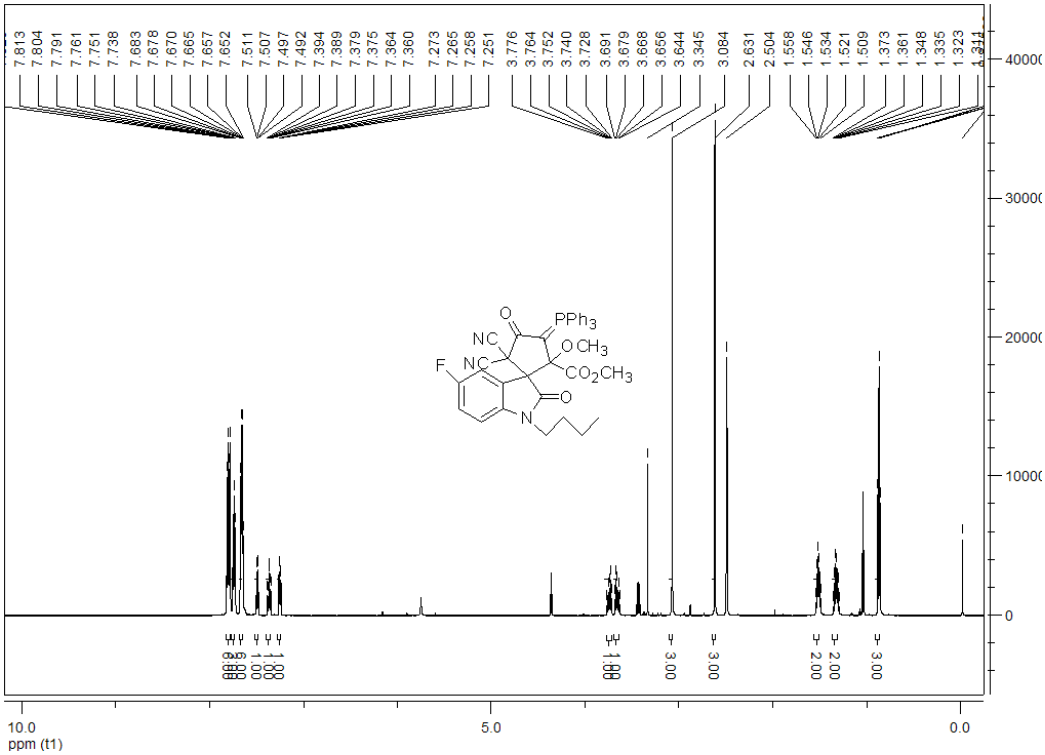


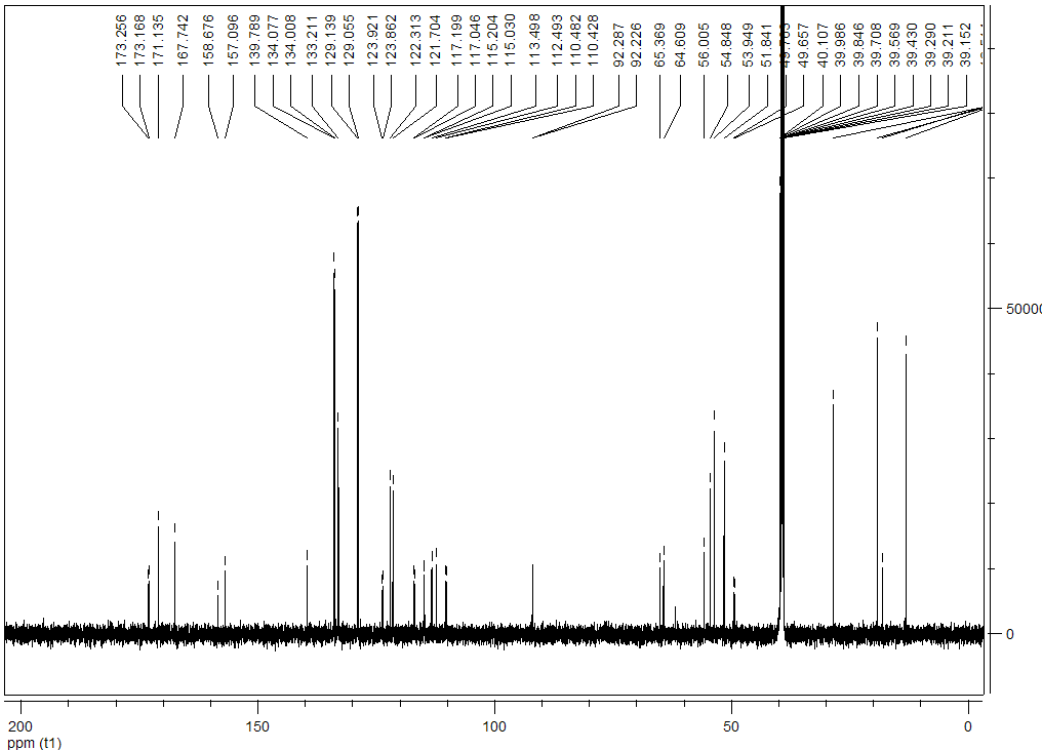
4. Methyl 1'-n-butyl-2,2-dicyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1d):



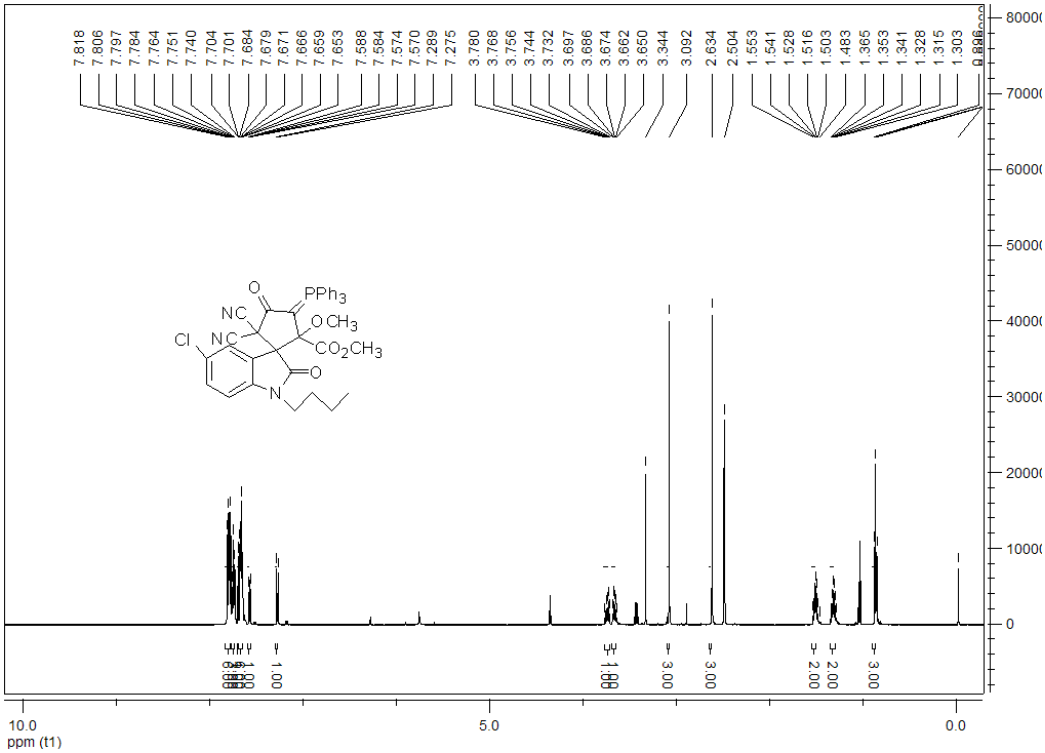


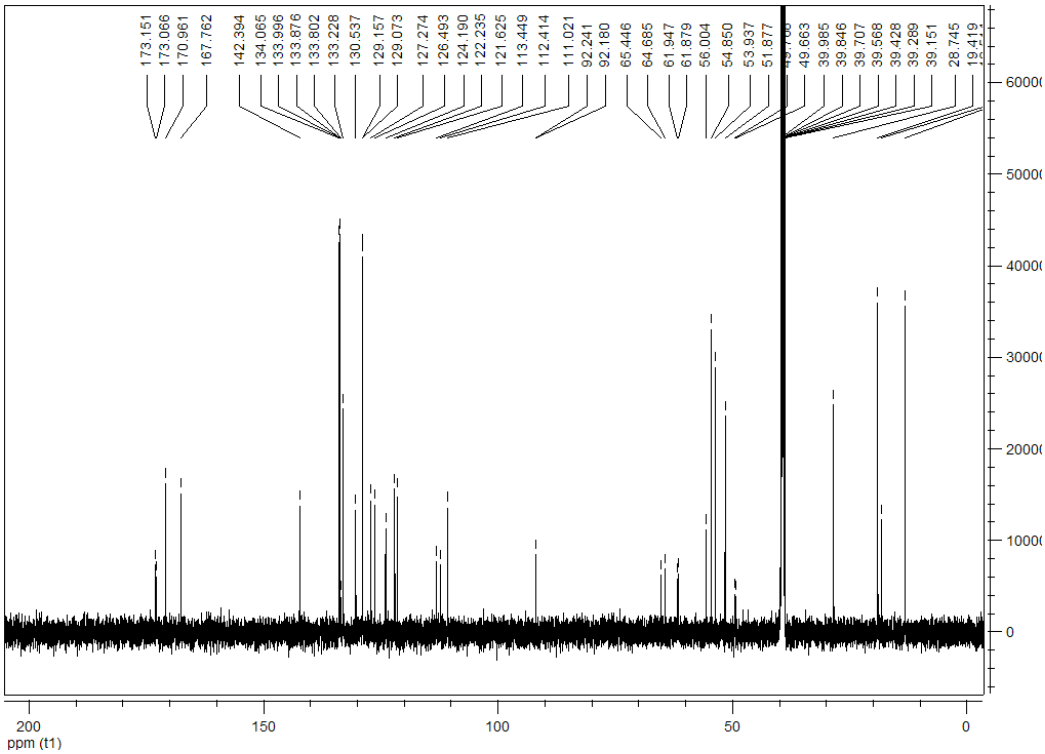
5. Methyl 1'-n-butyl-2,2-dicyano-5'-fluoro-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1e):



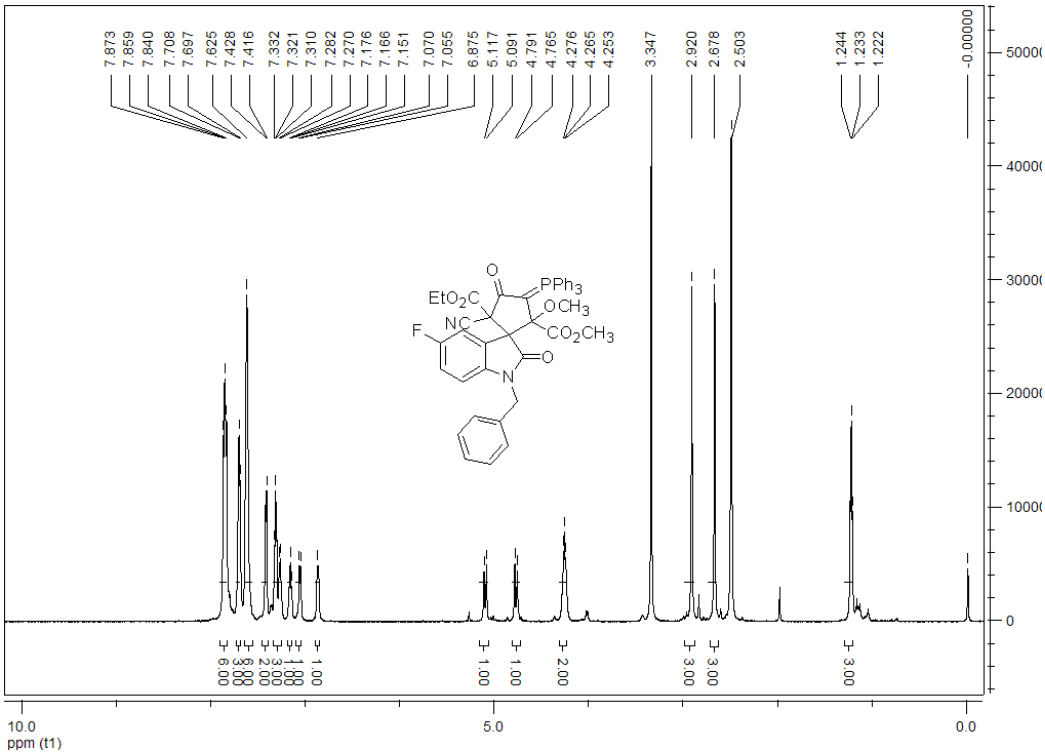


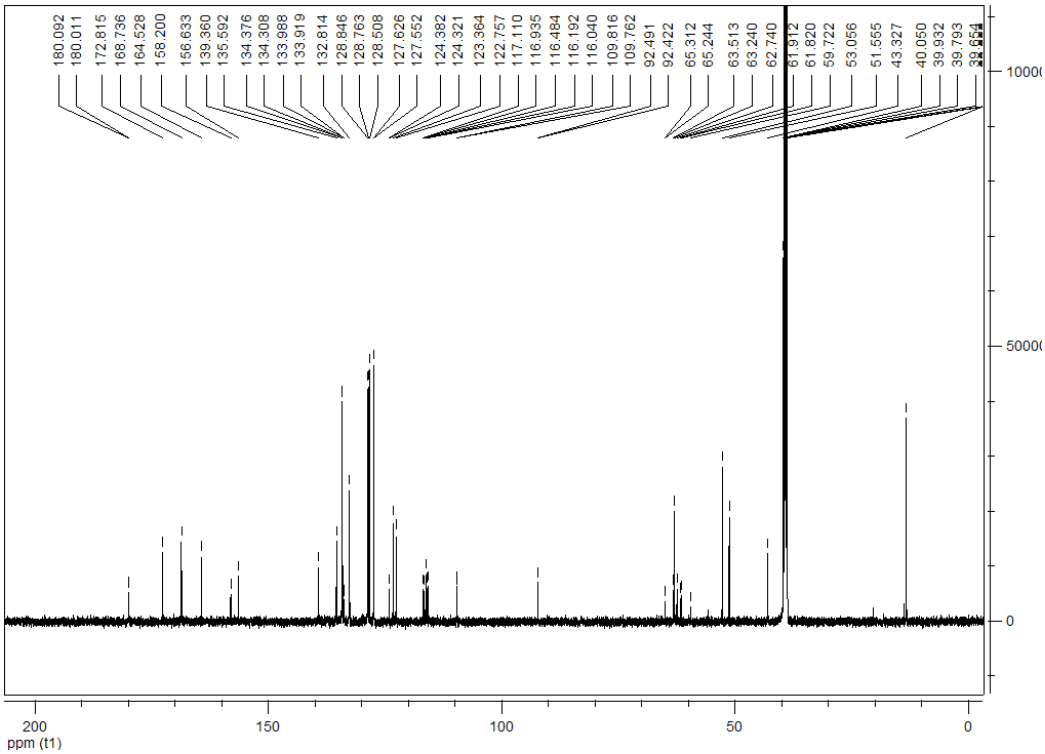
6. Methyl 1'-n-butyl-5'-chloro-2,2-dicyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-5-carboxylate (1f):



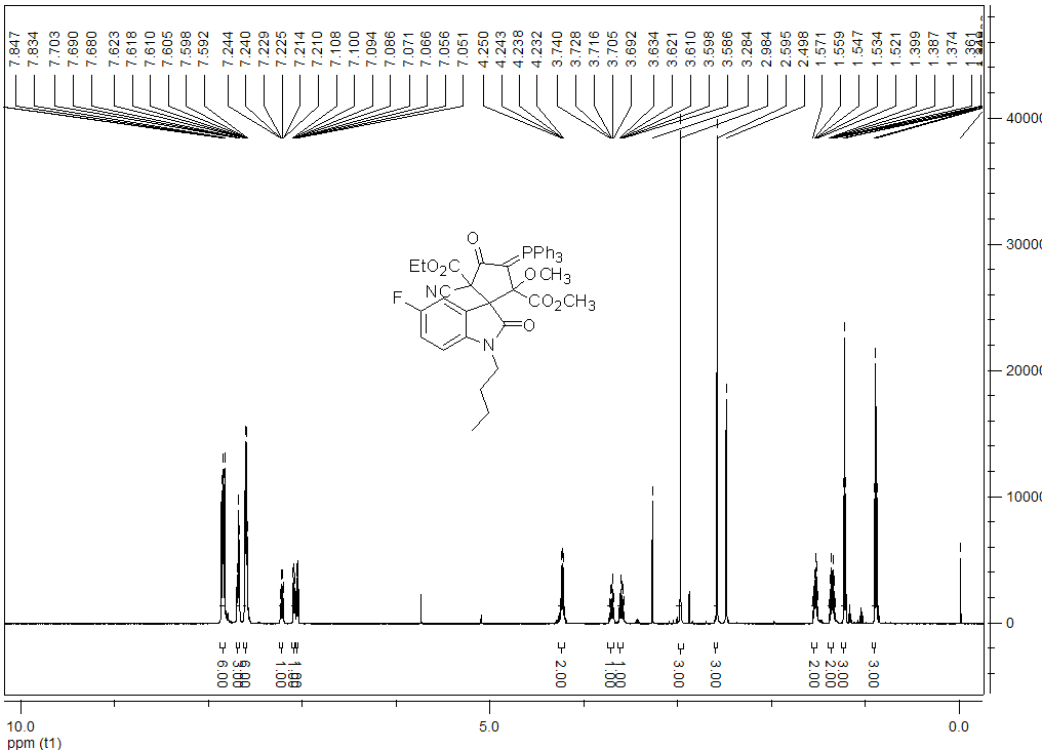


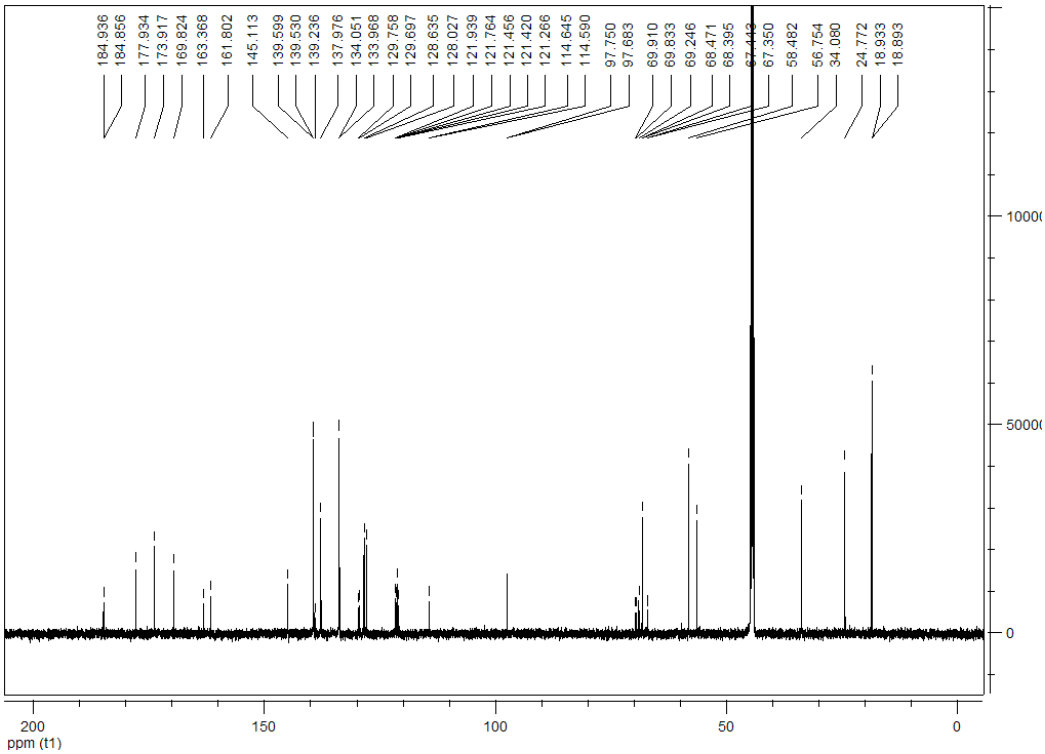
7. 2-ethyl 5-methyl 1'-benzyl-2-cyano-5'-fluoro-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-2,5-dicarboxylate (1g):



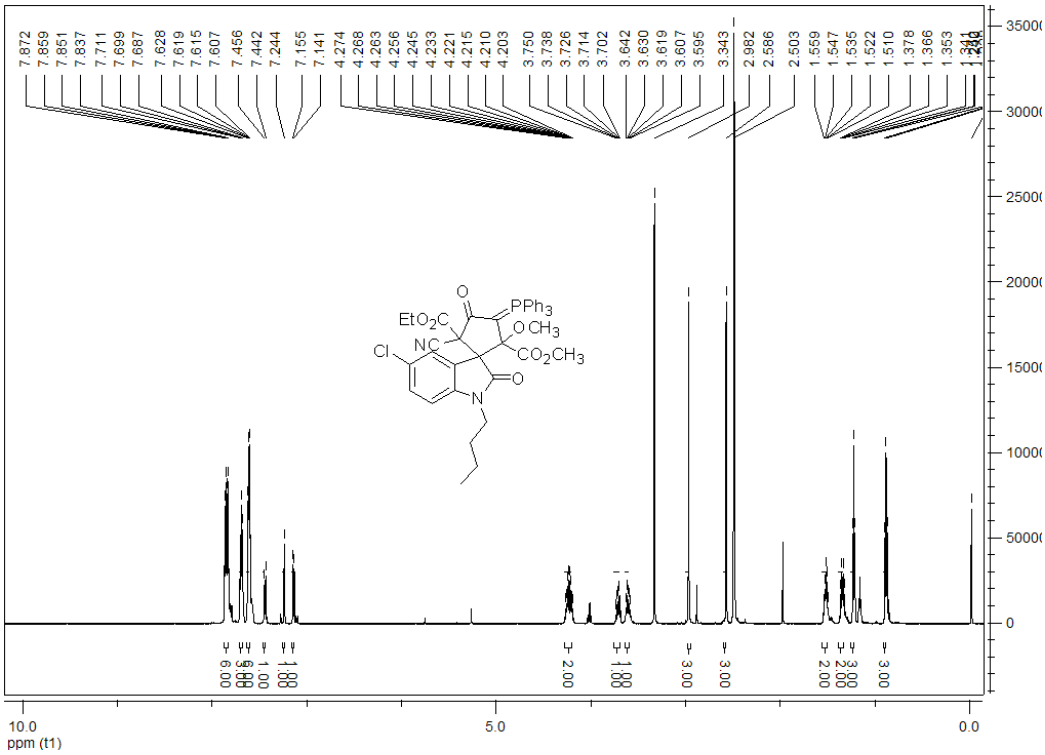


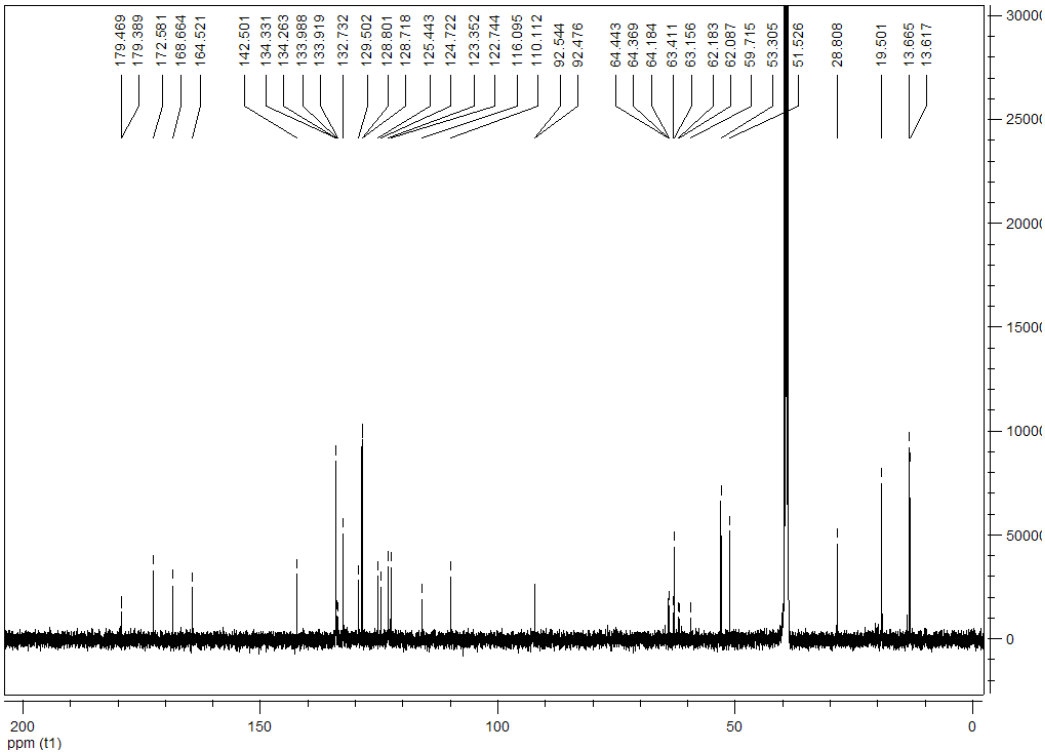
8. 2-ethyl 5-methyl 1'-n-butyl-2-cyano-5'-fluoro-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-2,5-dicarboxylate (1h):



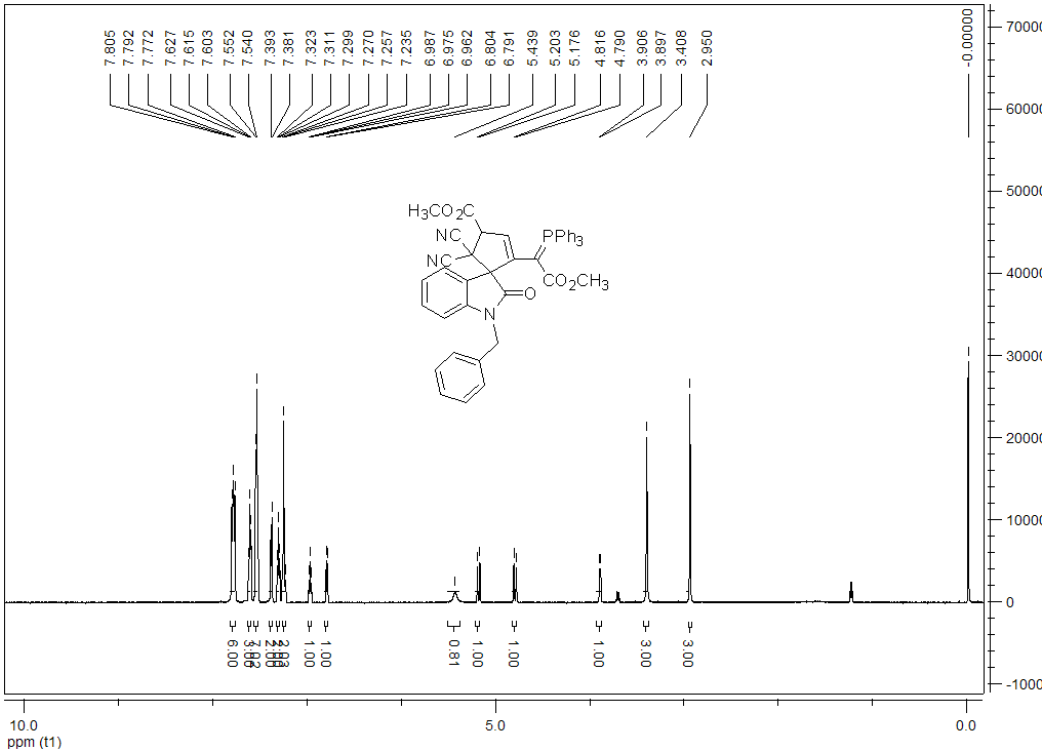


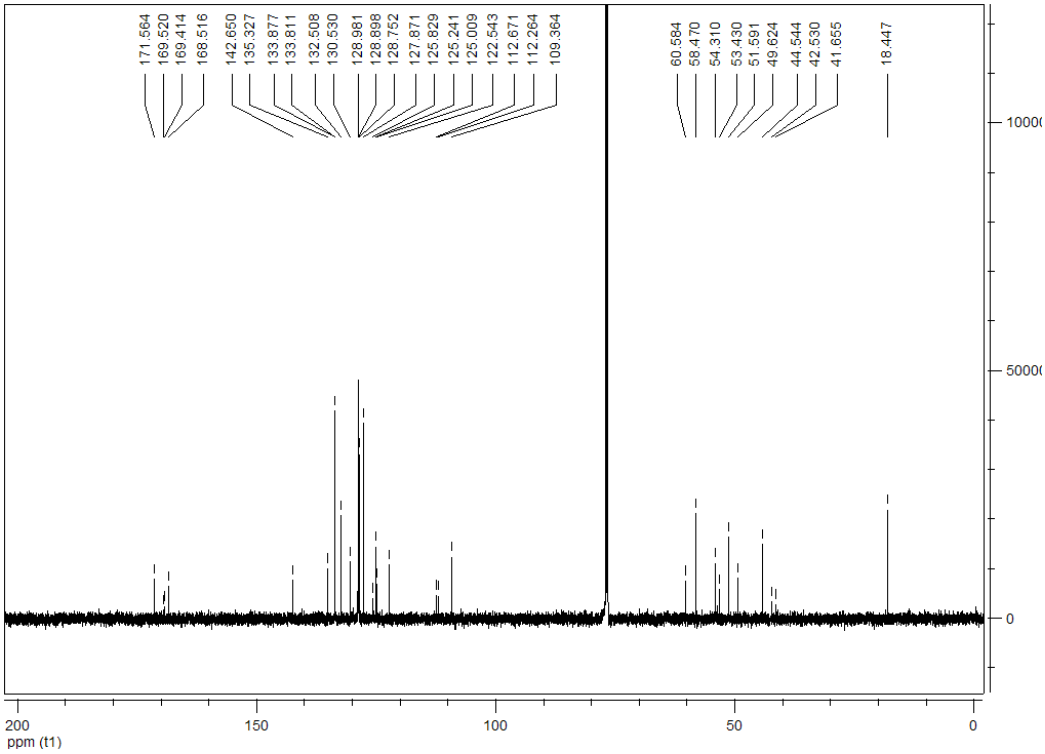
9. 2-ethyl 5-methyl 1'-n-butyl-5'-chloro-2-cyano-5-methoxy-4-triphenylphosphanylidene-2',3-dioxospiro[cyclopentane-1,3'-indoline]-2,5-dicarboxylate (1i):



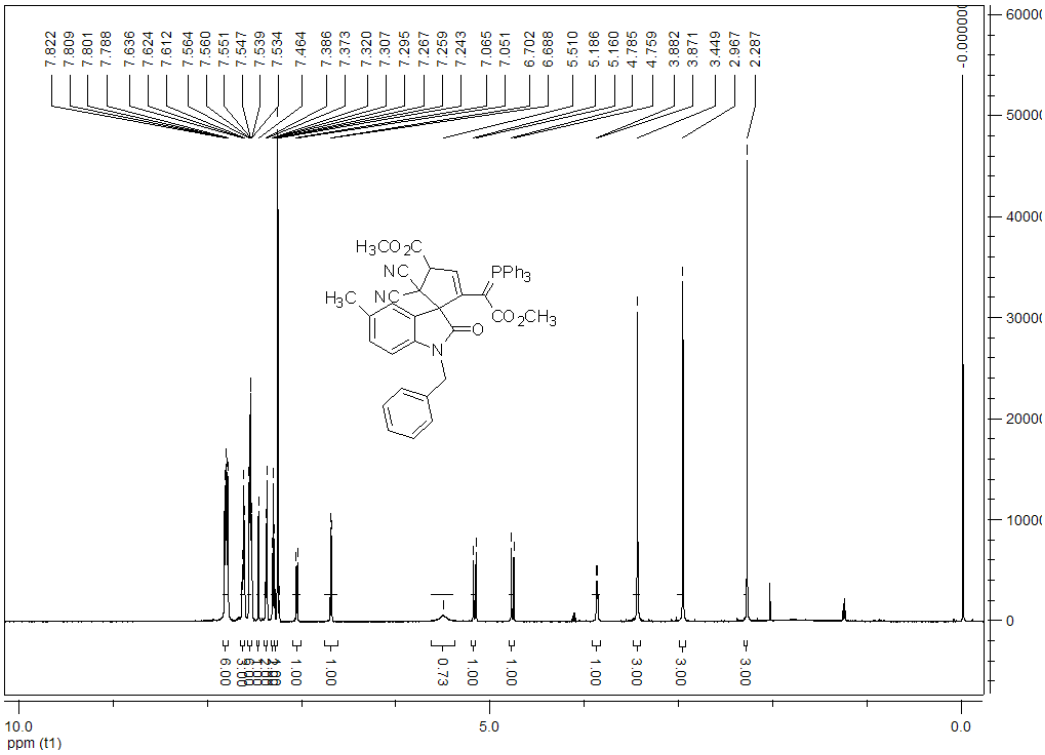


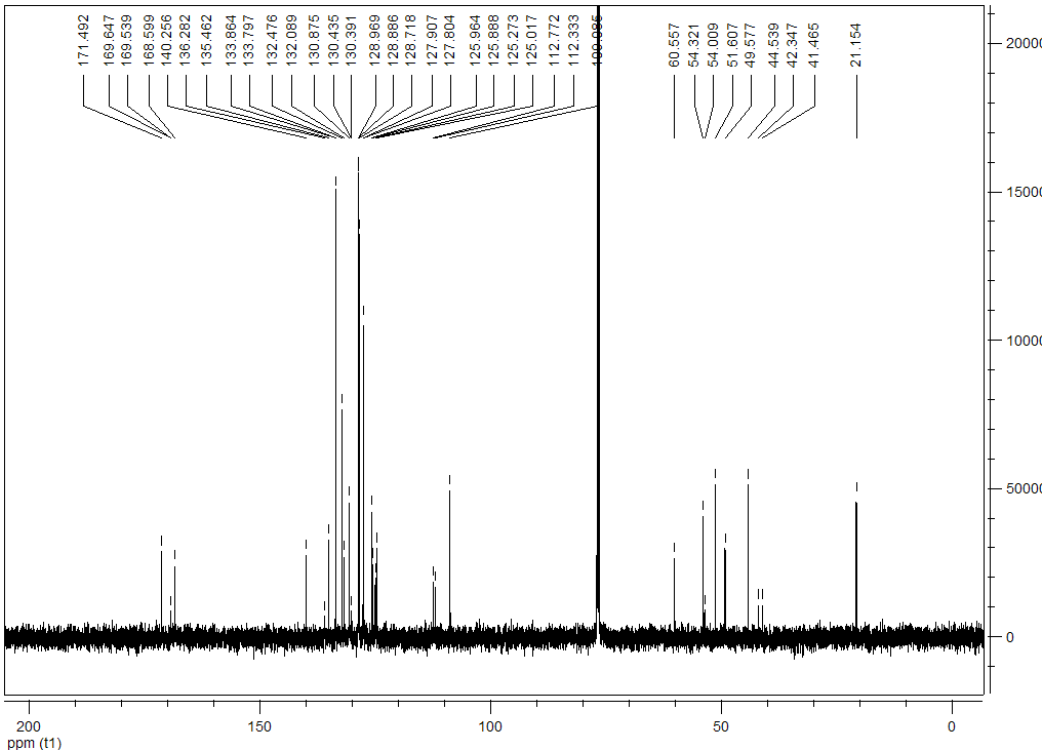
10. methyl 1'-benzyl-5,5-dicyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2a):



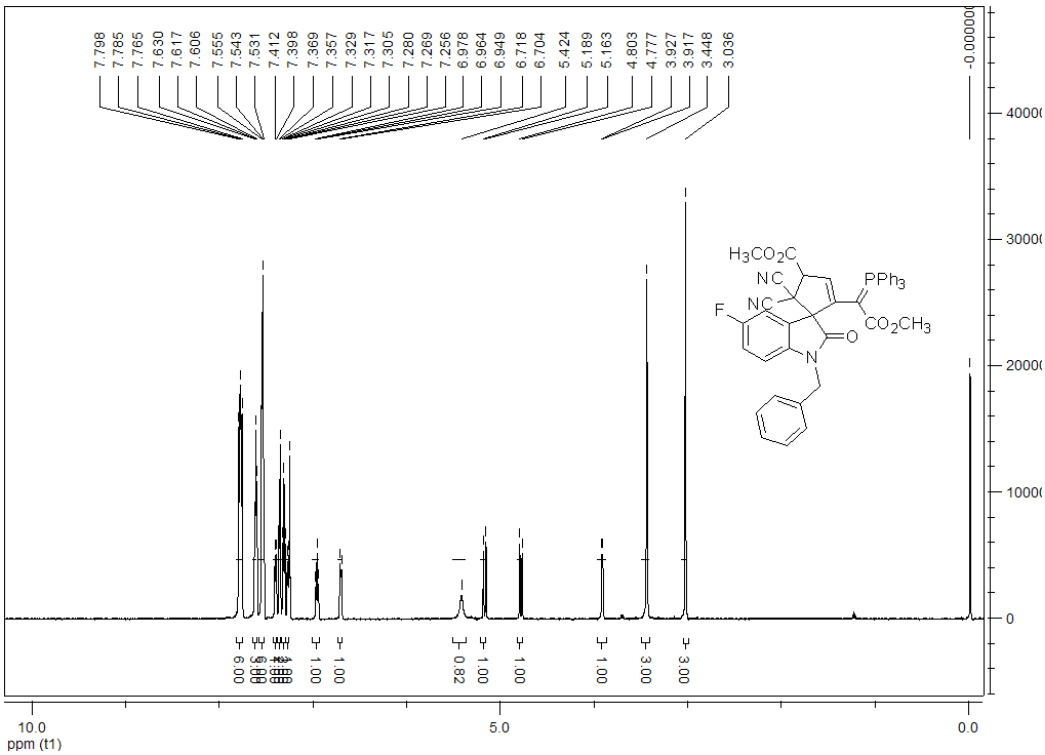


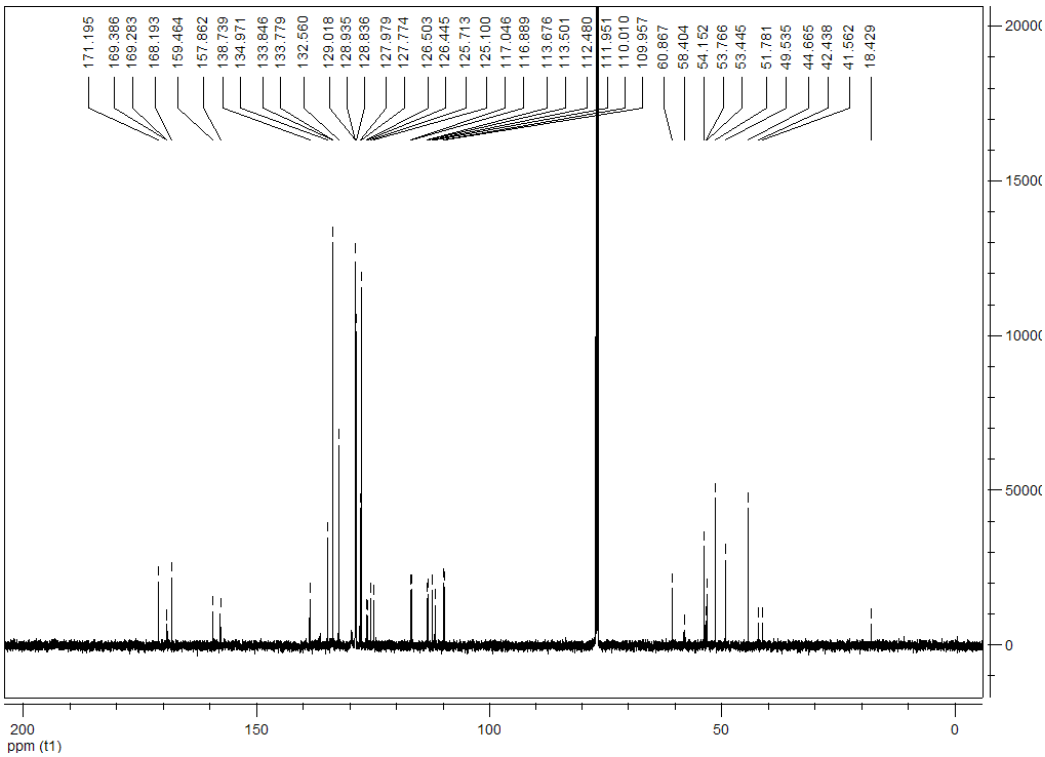
11. methyl 1'-benzyl-5,5-dicyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-5'-methyl-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2b):



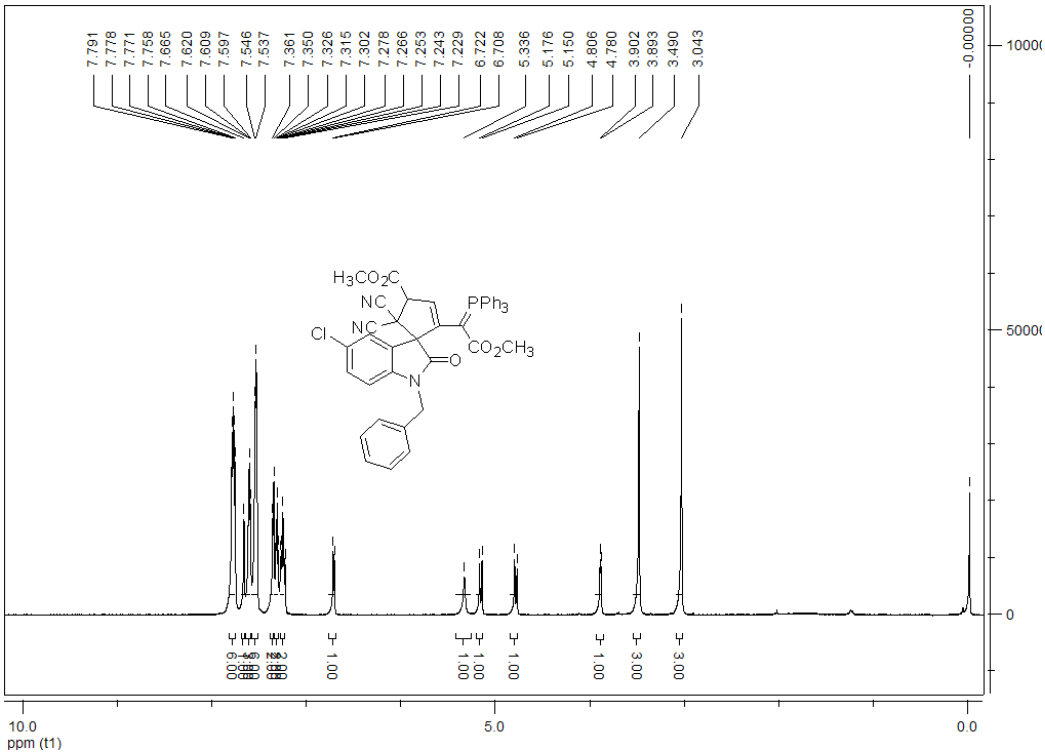


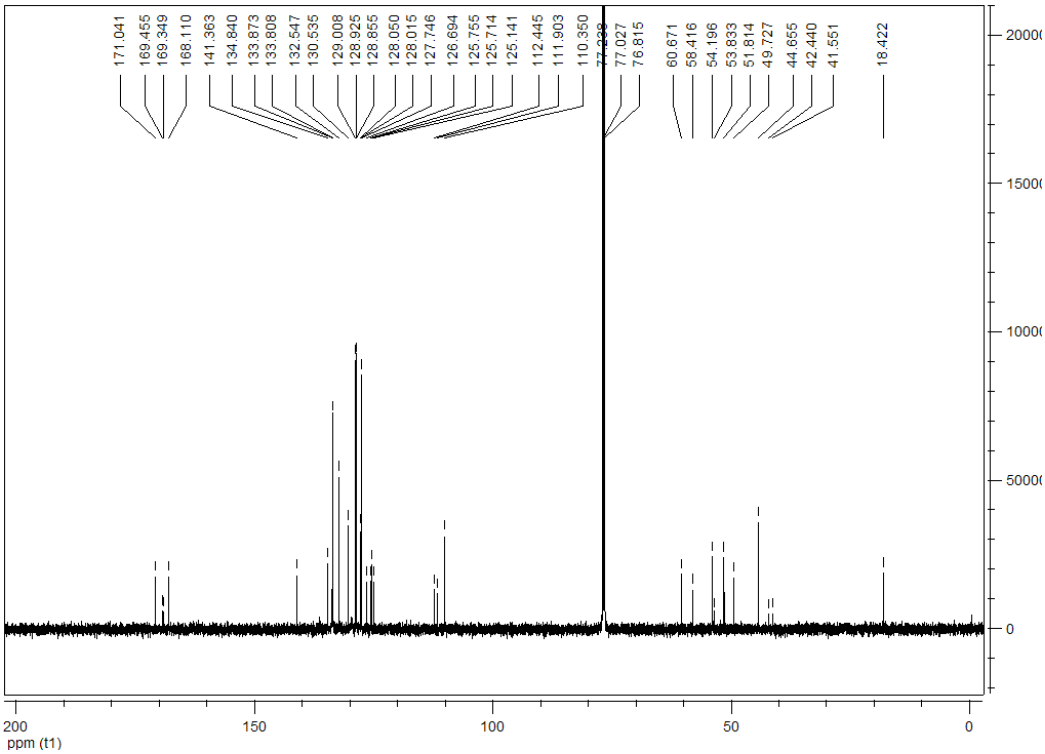
12. methyl 1'-benzyl-5,5-dicyano-5'-fluoro-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2c):



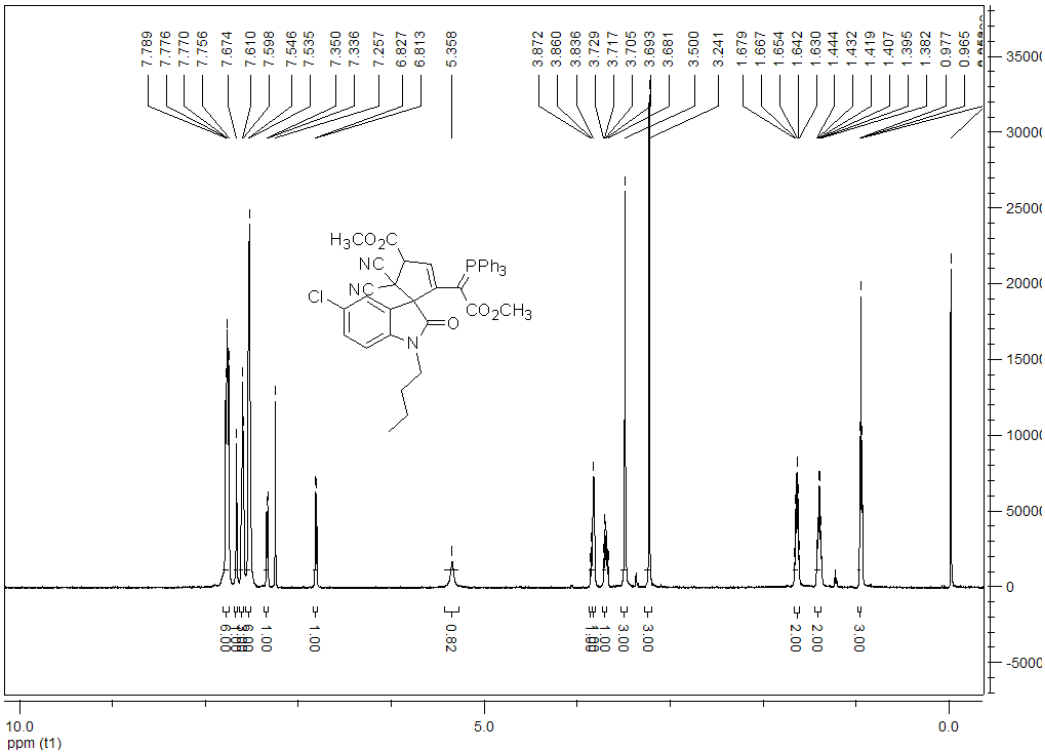


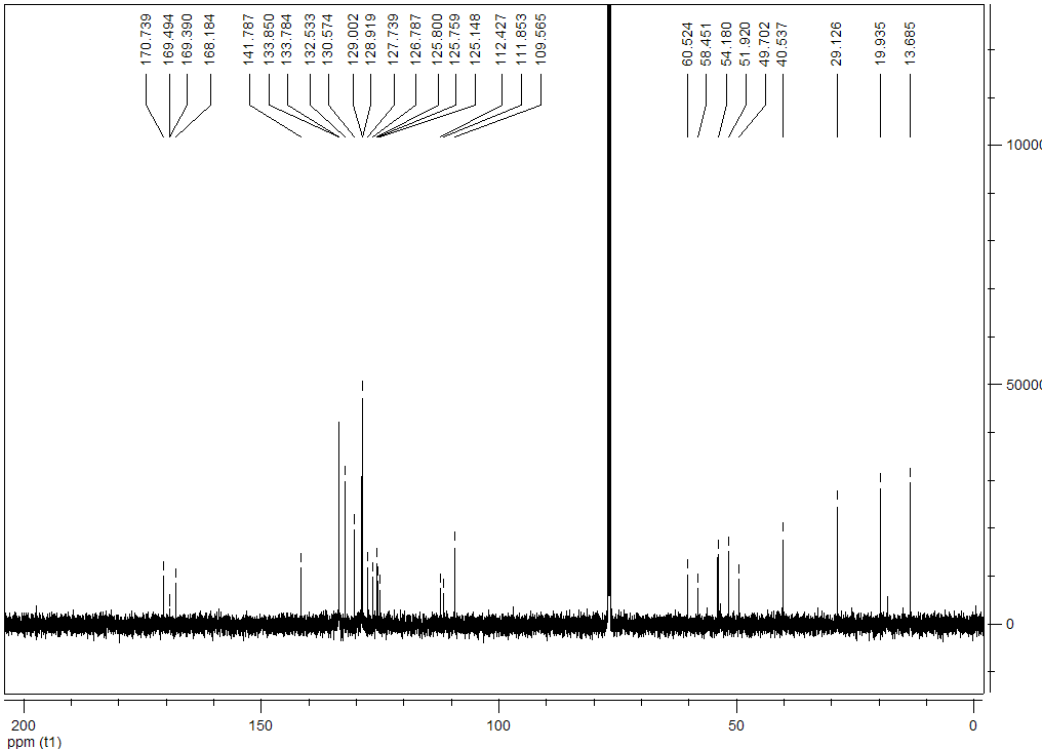
13. methyl 1'-benzyl-5'-chloro-5,5-dicyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2d):



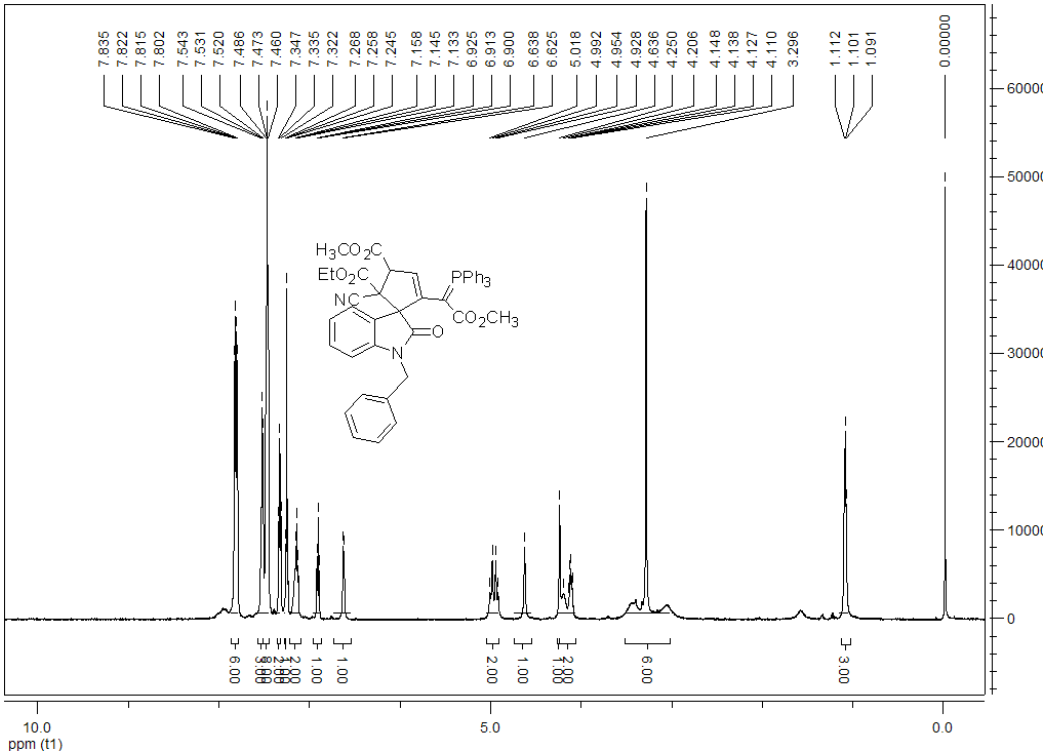


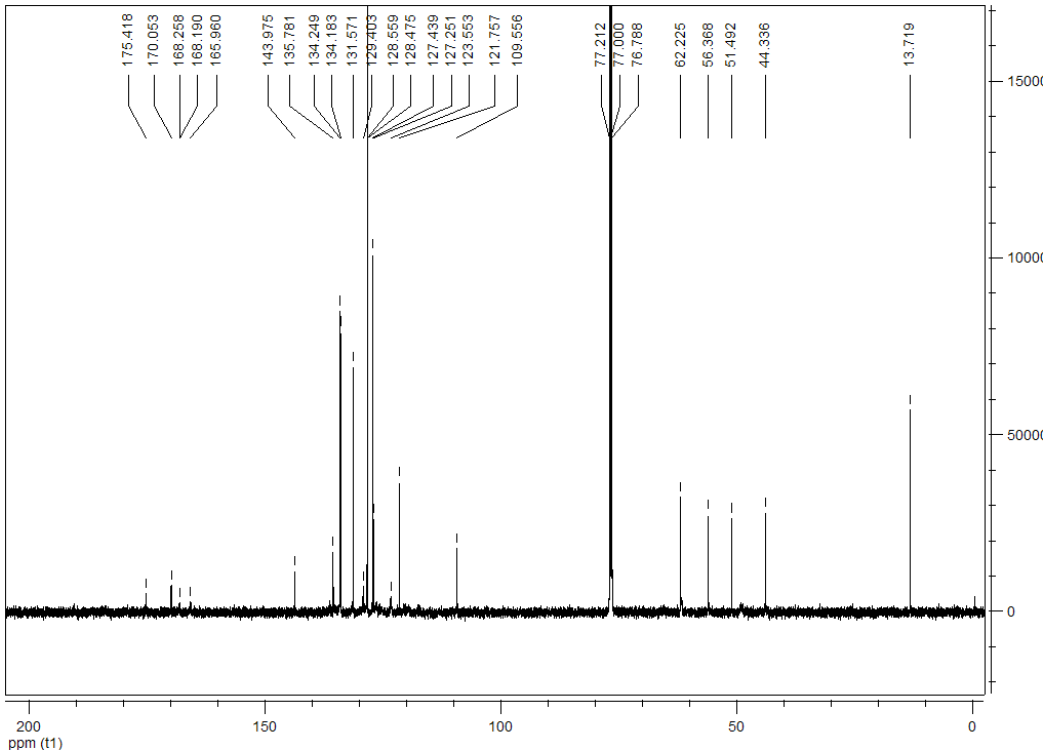
14. methyl 1'-butyl-5'-chloro-5,5-dicyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4-carboxylate (2e):



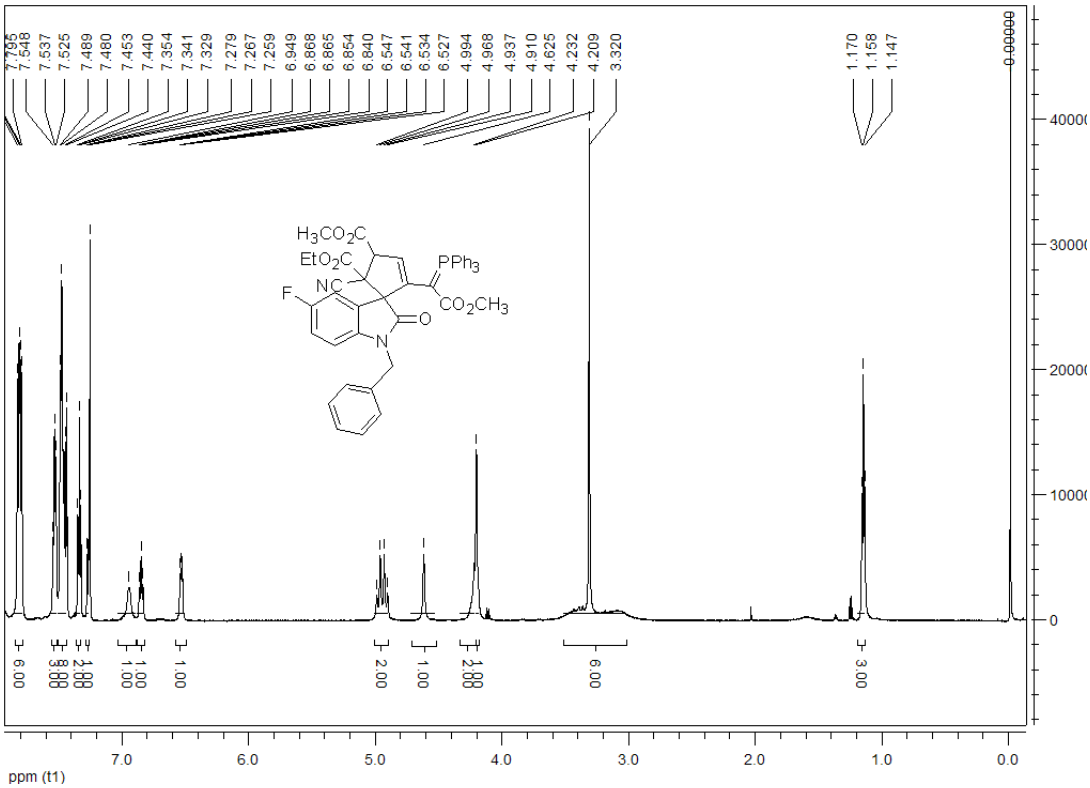


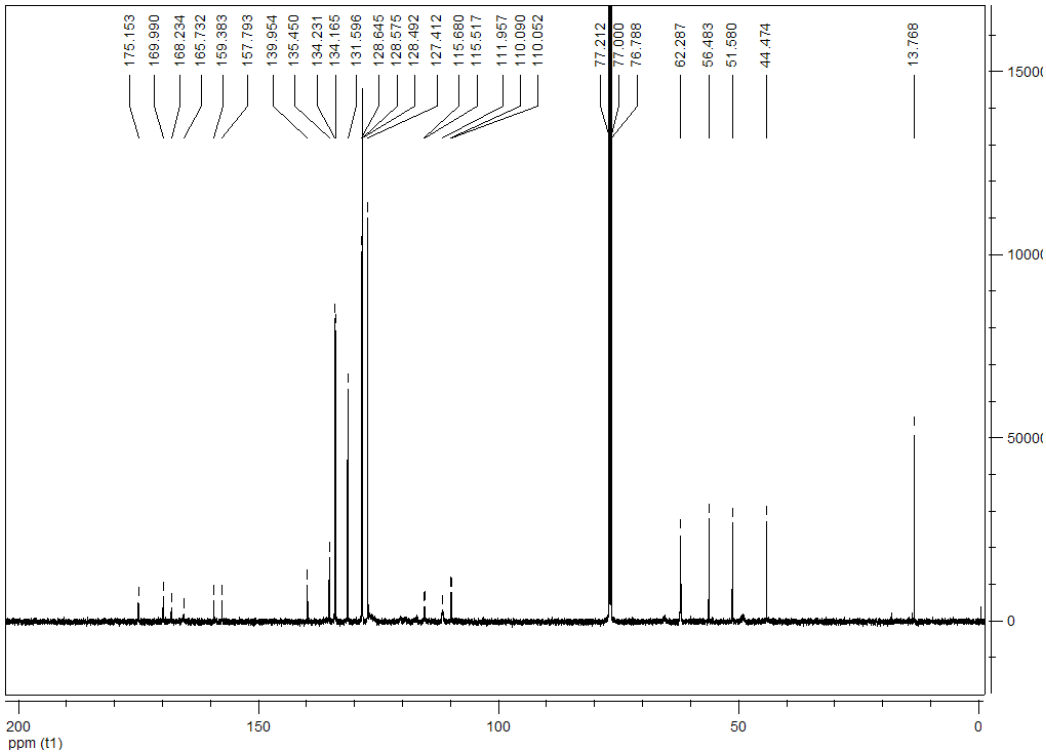
15. 5-ethyl 4-methyl 1'-benzyl-5-cyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2f):



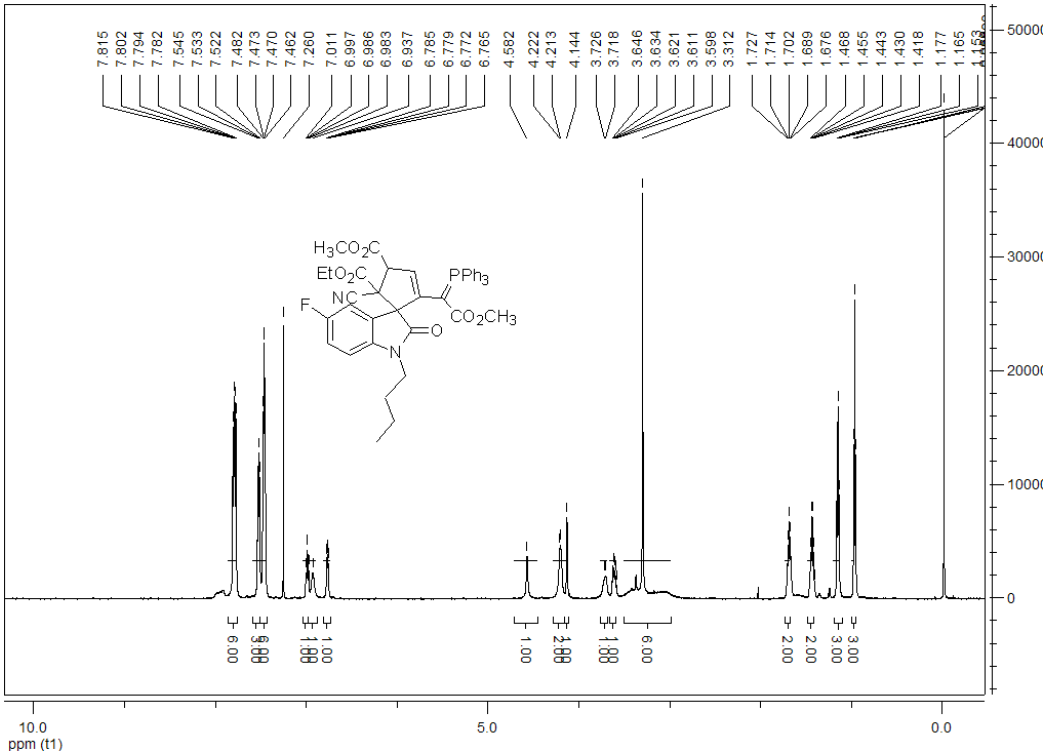


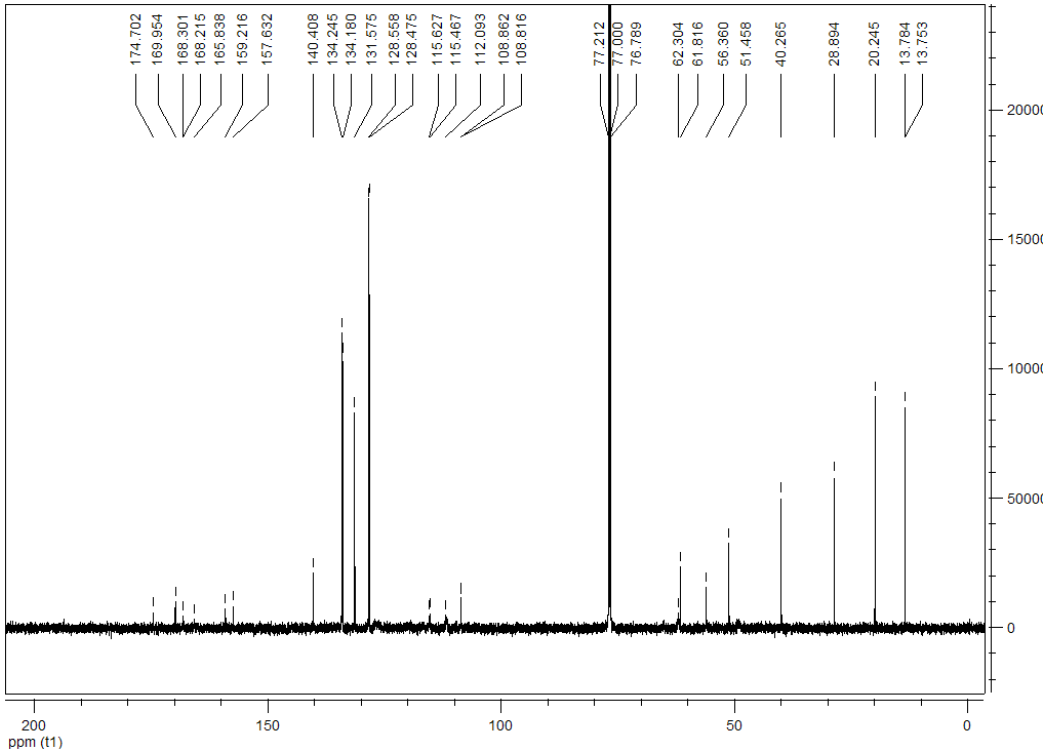
16. 5-ethyl 4-methyl 1'-benzyl-5-cyano-5'-fluoro-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2g):



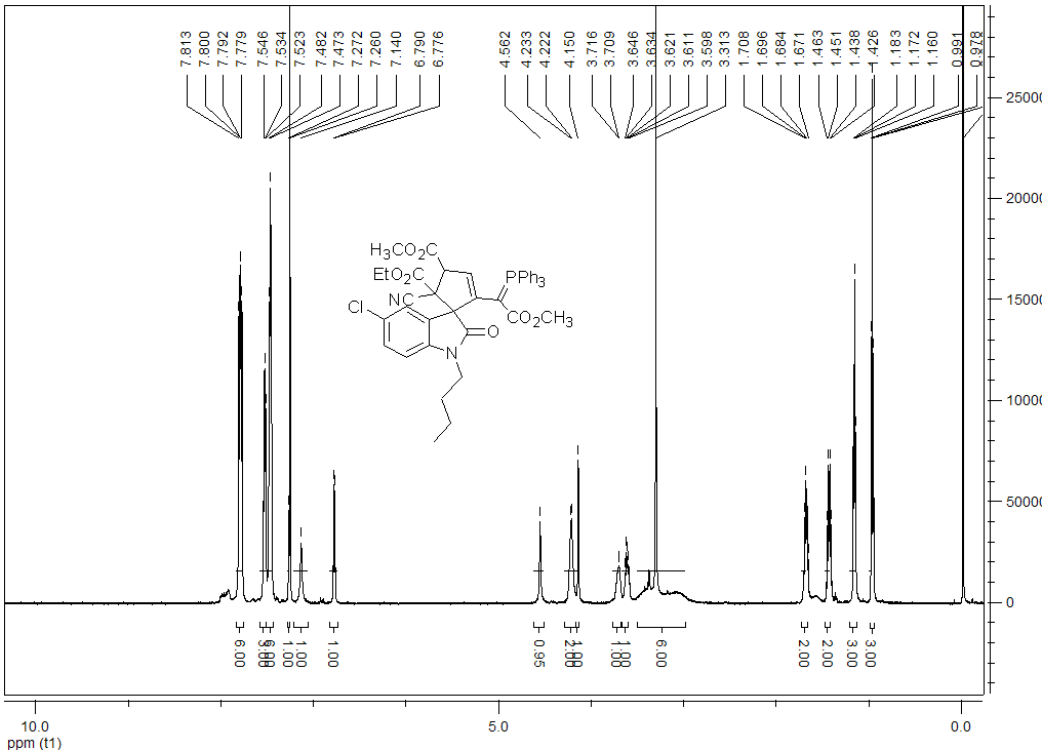


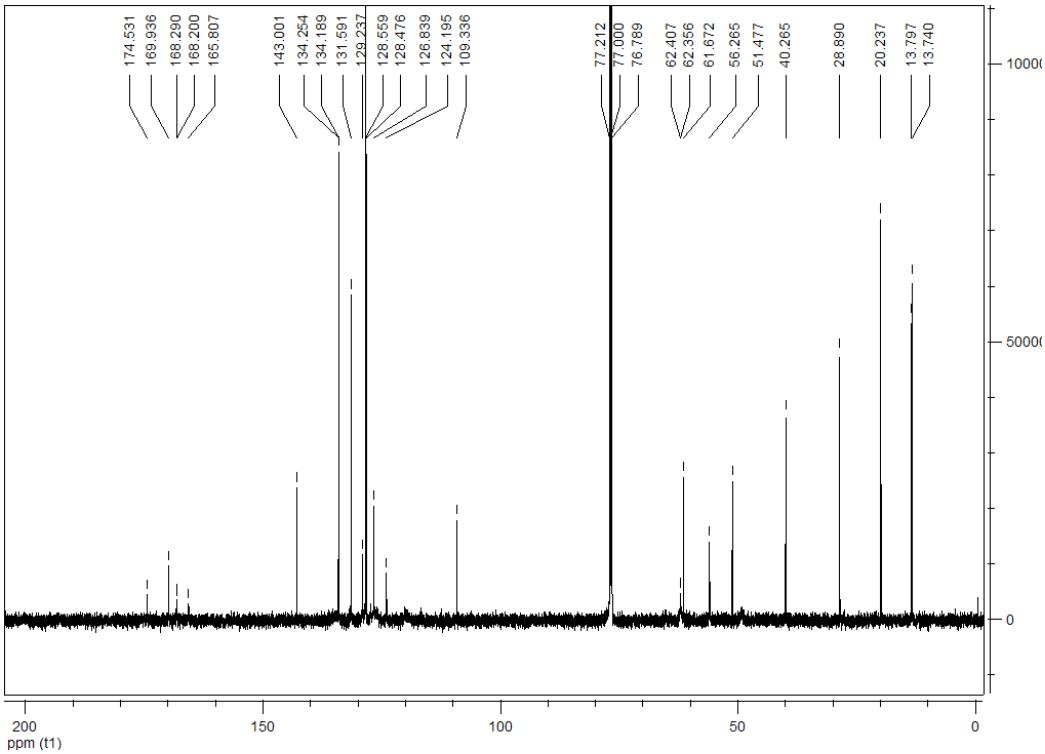
17. 5-ethyl 4-methyl 1'-n-butyl-5-cyano-5'-fluoro-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2h):



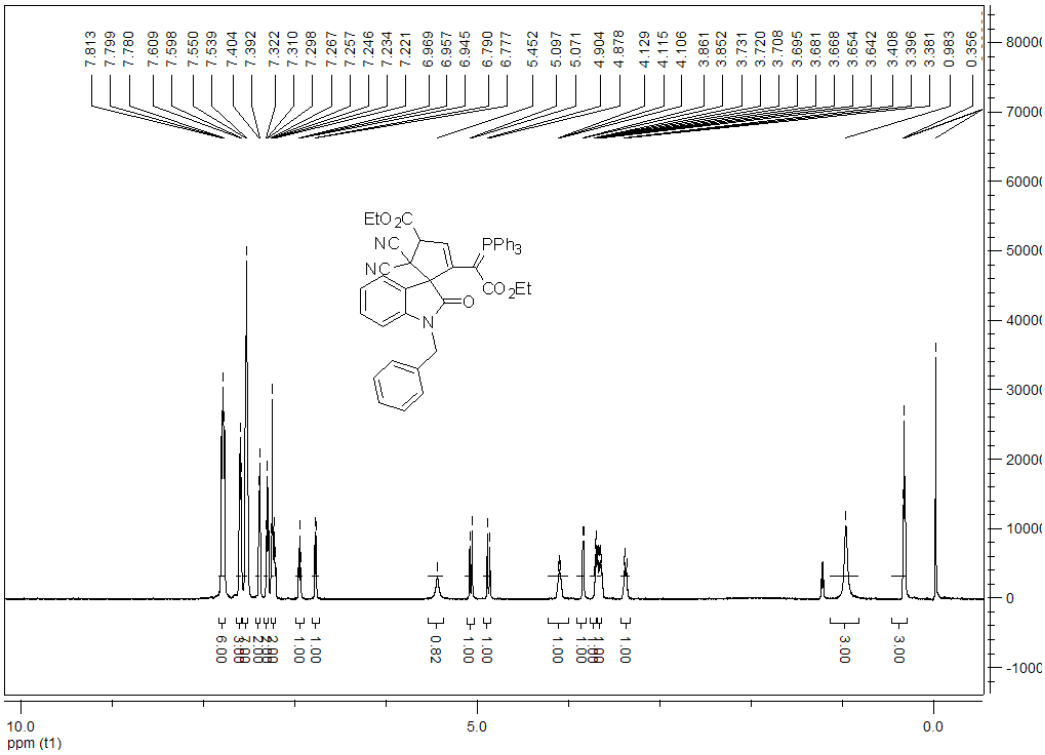


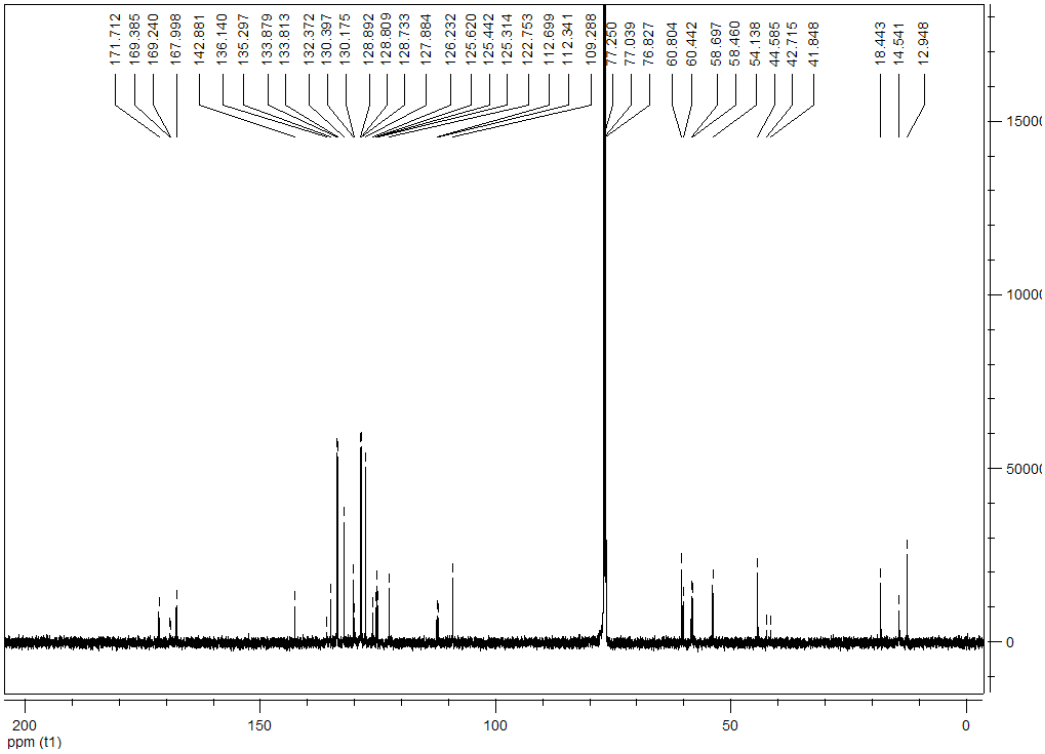
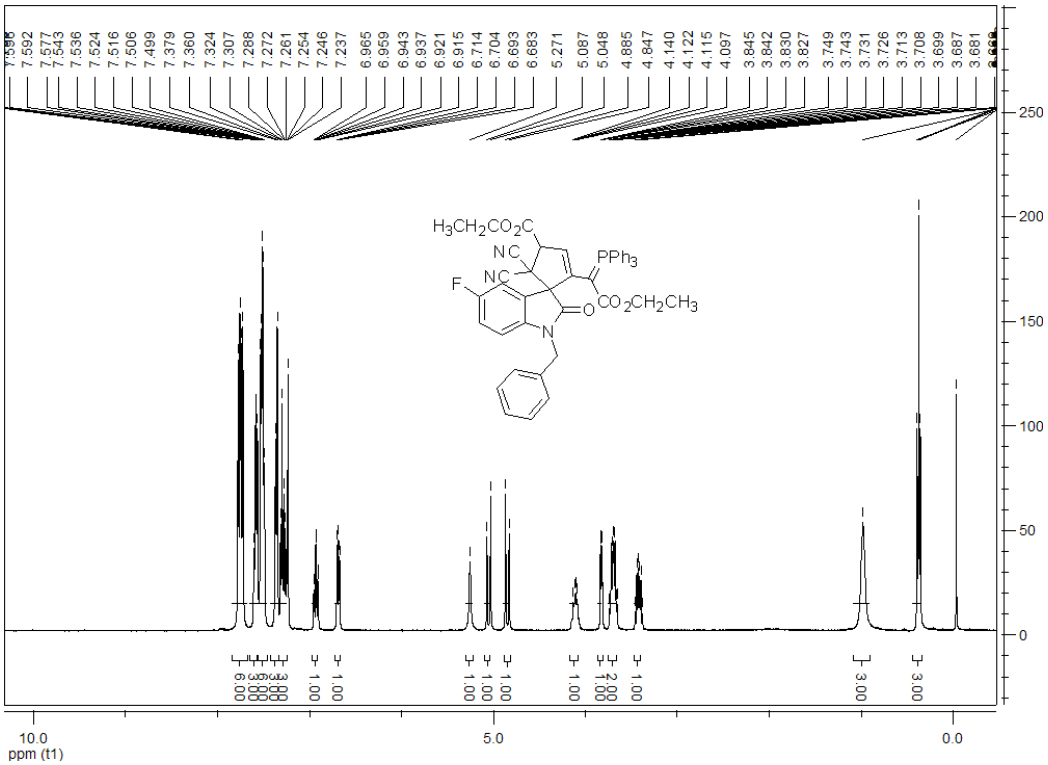
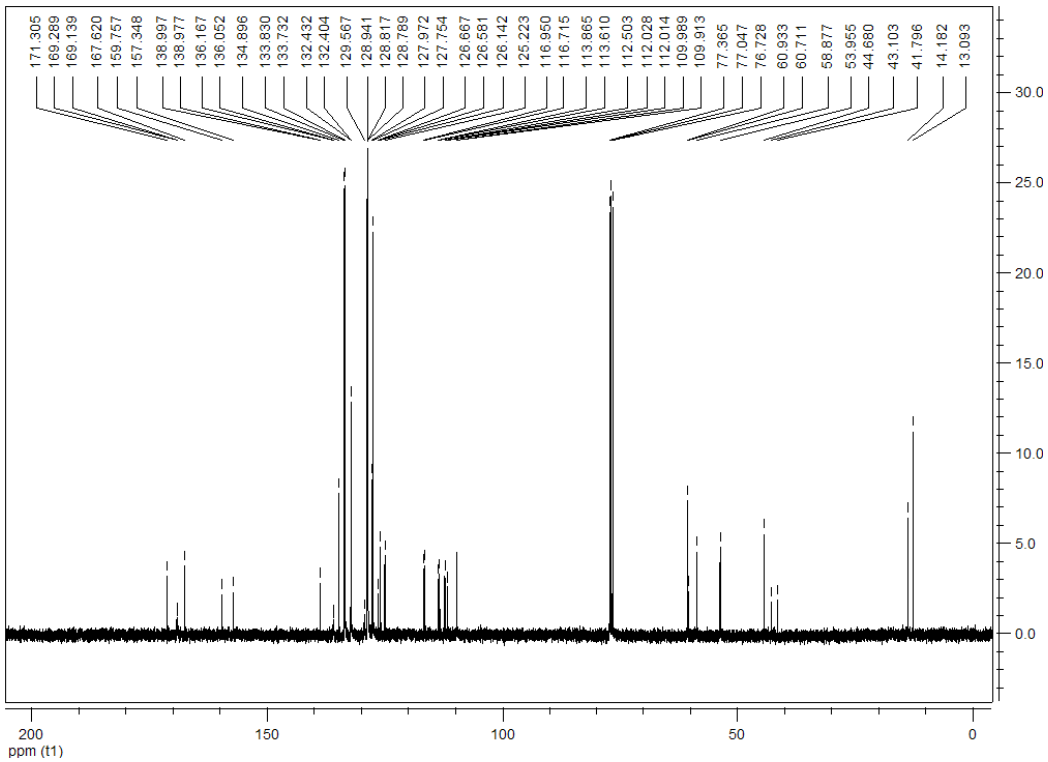
18. 5-ethyl 4-methyl 1'-n-butyl-5'-chloro-5-cyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2i):





19. diethyl 1'-benzyl-5-cyano-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2j):





20. diethyl 1'-benzyl-5-cyano-5'fluoro-2-(1-methoxy-1-oxo-1-triphenylphosphanylidenemethyl)-2'-oxospiro[cyclopent[2]ene-1,3'-indoline]-4,5-dicarboxylate (2k):