Dearomative oxyphosphorylation of indoles enables facile access to 2,2-disubstituted indolin-3-ones

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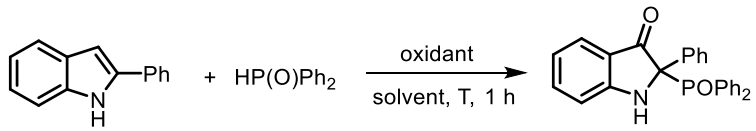
Contents

1. General Information

NMR spectra were recorded with BrukerAvance III HD500 and BrukerAvance III HD400 spectrometer at 500 MHz or 400 MHz. All ^{1}H, ^{19}F, ^{31}P and ^{13}C NMR spectra were recorded using $CDCl_3$ or [D_6] DMSO as solvent. Tetramethylsilane (TMS) signals or residual solvent signals were used [TMS $\delta = 0.00$ (^{1}H NMR), $CDCl_3$ $\delta = 77.16$ (^{13}C NMR), DMSO-d_6 $\delta = 2.50$ (^{1}H NMR), 39.52 (^{13}C NMR)] as internal standards. The following abbreviations were used to describe peak splitting patterns when appropriate: s = singlet, d = doublet, dd = double doublet, t = triplet, q = quartet, m = multiplet, qd = quartet doublet. HRMS (ESI) Mass spectra were recorded on Thermo Fisher Scientific LTQ FT Ultra. All the reactions were monitored by thin layer chromatography (TLC), carried out on 0.25 mm silica gel plates using UV light as visualizing agent. Column chromatography was carried out on silica gel (particle size 300-400 mesh). The C2 substituted indoles and TEMPO oxoammonium salts were synthesized according to procedures described in the literature. [1,2] Substrates **2** were prepared according to the literature method.[3]

2. Experiment Section

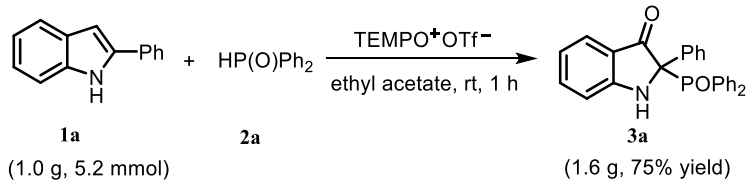
2.1 Experimental procedure for optimization of reaction conditions (Table 1):



1a **2a** **3a**

To a solution of 2-phenyl-1*H*-indole **1a** (0.1 mmol) in 1.5 mL solvent was added oxidant (0.1 mmol) at rt and stirred for 5 min. Then *H*-phosphine oxides **2a** (1.5 mmol) in ethyl acetate (0.5 mL) were added to the mixture. The mixture was stirred at room temperature for 1 h. After reaction, the solution was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate = 2:1) to give the product **3a**.

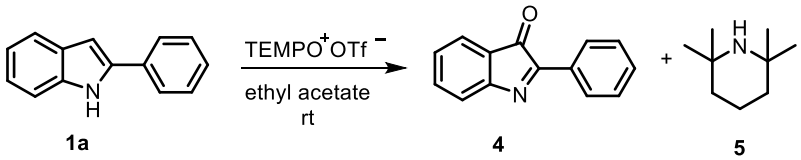
2.2 Experimental procedure for gram-scale reaction (Scheme 4):



1a (1.0 g, 5.2 mmol) **2a** **3a** (1.6 g, 75% yield)

A solution of 2-phenyl-1*H*-indole **1a** (1.0 g, 5.2 mmol) and $TEMPO^{+}OTf^{-}$ (1.6 g, 5.2 mmol) in 80 mL ethyl acetate were added to 250 mL round bottom flask at rt until the disappearance of **1a**. *H*-phosphorus oxide **2a** (1.6 g, 7.8 mmol) in ethyl acetate (10 mL) were added to the mixture for 1h. After reaction, the solution was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate =2:1 to 1:1) to give the product **3a** (1.6 g) in 75% yield.

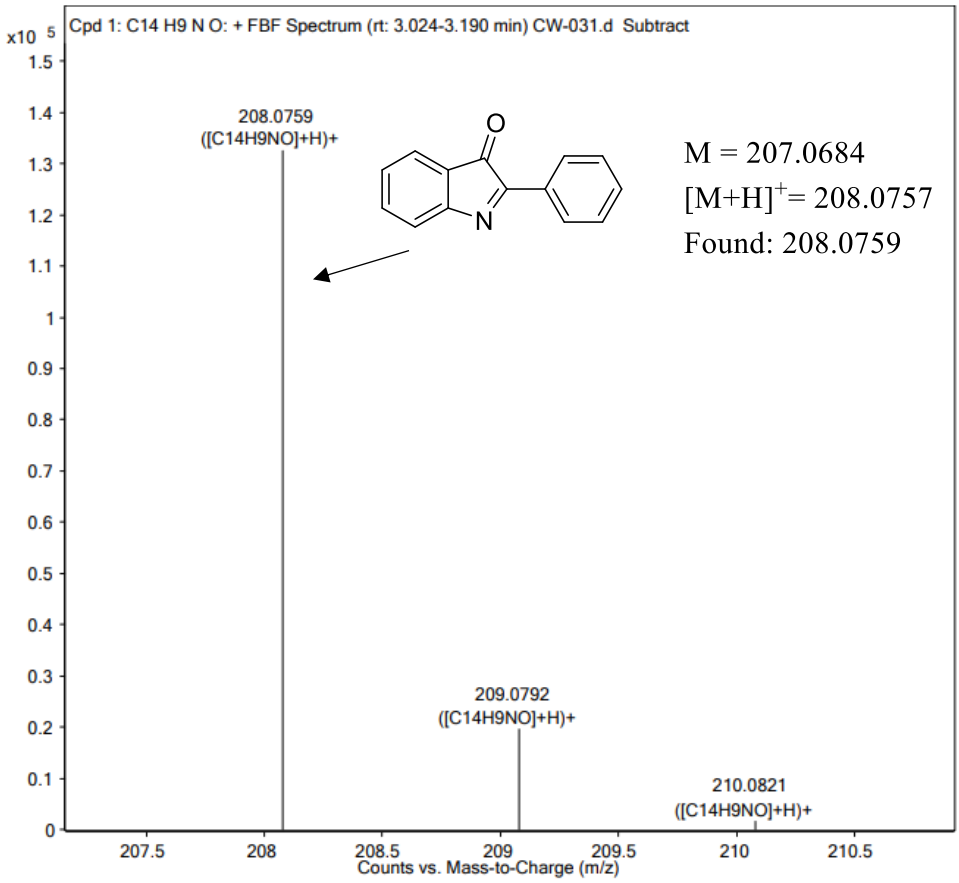
2.3 Mechanism studies (Scheme 5):



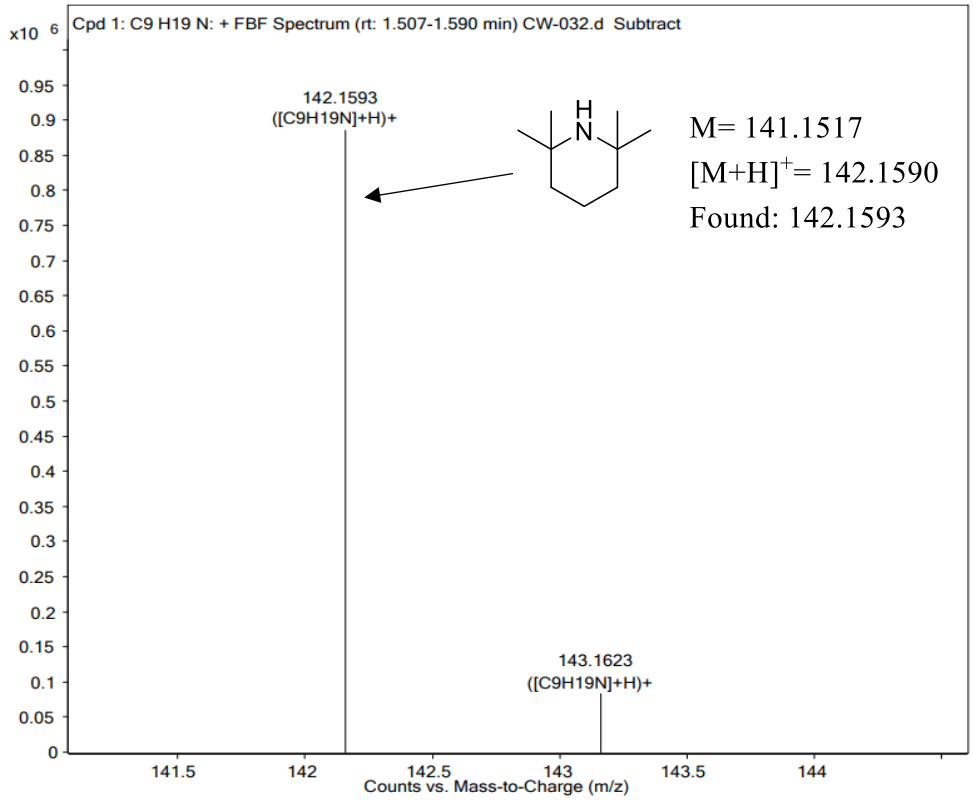
1a **4** **5**

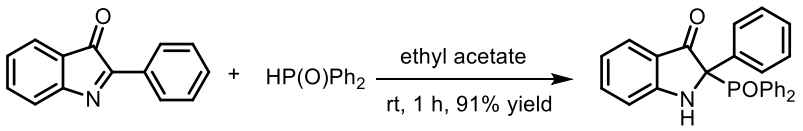
A solution of 2-phenyl-1*H*-indole **1a** (0.1 mmol) in 2 mL ethyl acetate was added $TEMPO^{+}OTf^{-}$ (0.1 mmol) at rt. The mixture was stirred until the disappearance of **1a**. Then, the solution was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate =50:1) to afford the red solid product **4**. The ^{1}H NMR of **4** was consistent with that reported previously.[4] ESI-MS analysis was performed with 2,2,6,6- tetramethylpiperidine **5**.

2-phenyl-3*H*-indol-3-one (4), **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.40–8.34 (m, 2H), 7.57–7.51 (m, 3H), 7.50–7.45 (m, 2H), 7.41 (d, *J* = 7.4 Hz, 1H), 7.25–7.22 (m, 1H). **HRMS** (ESI) m/z calcd for: $C_{14}H_9NO$ $[M+H]^{+}$: 208.0757, found: 208.0759.



2,2,6,6-tetramethylpiperidine (5), **HRMS** (ESI) m/z calcd for: $C_9H_{19}N$ $[M+H]^+$: 142.1590, found:142.1593.





4 **2a** **3a**

A solution of ketimines **4** (0.0207 g, 0.1 mmol) and *H*-phosphorus oxide **2a** (0.0303 g, 0.15 mmol) in ethyl acetate (2 mL) were added to cntrifugal tube. The reaction mixture was stirred at room temperature for 1 h. After reaction, the solution was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate = 2:1) to give the product **3a** (0.0371 g) in 91% yield.

3. Reference

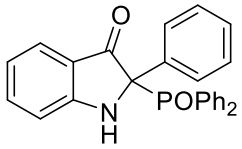
[1] (a) S. K. Bhunia, A. Polley, R. Natarajan, R. Jana, *Chem.Eur.J.,* 2015, **21**,16786–16791; (b) N. Jacob, L. Guillemard, J. Wencel-Delord, *Synthesis,* 2020, **52**, 574-580.

[2] X. Liu, X. Yan, Y. Tang, C. S. Jiang, J. H. Yu, K. Wang, H. Zhang, *Chem. Commun.*, 2019, **55**, 6535-6538.

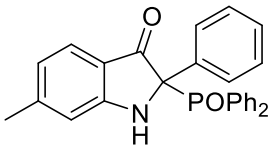
[3] C. A. Busacca, J. C. Lorenz, N. Grinberg, N. Haddad, M. Hrapchak, B. Latli, H. Lee, P. Sabila, A. Saha, M. Sarvestani, S. Shen, R. Varsolona, X. Wei, C. H. Senanayake, *Org. Lett*., 2005, **7**, 4277.

[4] (a) K. Q. Ling, *Synth. Commun.,* 1995, **25**, 3831; (b) J.-X. Liu, Q. Q. Zhou, J. G. Deng, Y. C. Chen, *Org. Biomol. Chem.,* 2013, **11**, 8175; (c) E. Najahi, A. Valentin, P.-L. Fabre, K. Reybier, F. Nepveu, *Eur. J. Med. Chem.*, 2014, **78**, 269.

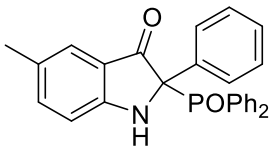
4. Characterization data of the compounds

2-(diphenylphosphoryl)-2-phenylindolin-3-one (3a). Yellow solid, 33.0 mg, 81% yield. 

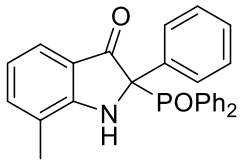
^{1}H NMR (500 MHz, DMSO-d_6) δ 8.65 (s, 1H), 7.83–7.74 (m, 4H), 7.65–7.58 (m, 2H), 7.51 (t, *J* = 7.0 Hz, 2H), 7.43–7.35 (m, 5H), 7.34–7.28 (m, 3H), 7.22 (d, *J* = 7.7 Hz, 1H), 6.96 (d, *J* = 8.3 Hz, 1H), 6.61 (t, *J* = 7.4 Hz, 1H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 195.50, 160.82 (d, *J* = 4.9 Hz), 137.83, 133.85, 133.03 (d, *J* = 8.3 Hz), 132.72 (d, *J* = 2.2 Hz), 132.61 (d, *J* = 2.4 Hz), 132.09 (d, *J* = 8.7 Hz), 130.64 (d, *J* = 97.4 Hz), 129.31 (d, *J* = 97.0 Hz), 128.72 (d, *J* = 11.5 Hz), 128.48 (d, *J* = 11.4 Hz), 128.41, 128.33 (d, *J* = 1.4 Hz), 127.14 (d, *J* = 3.5 Hz), 124.32, 119.80, 118.73, 112.83, 74.32 (d, *J* = 68.2 Hz); **^{31}P NMR** (202 MHz, DMSO-d_6) δ 25.82; **HRMS** (ESI) m/z calcd for: $C_{26}H_{20}NO_2PNa$ $[M+Na]^+$: 432.1124, found: 432.1124.

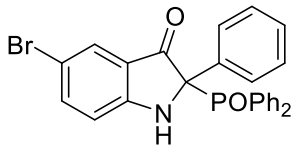
2-(diphenylphosphoryl)-6-methyl-2-phenylindolin-3-one (3b). Yellow solid, 35.9 mg, 85% yield. 

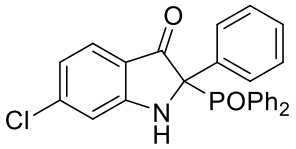
^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.07–7.98 (m, 2H), 7.89 (dd, *J* = 11.0, 7.8 Hz, 2H), 7.77 (d, *J* = 7.8 Hz, 2H), 7.58–7.51 (m, 2H), 7.46 – 7.36 (m, 3H), 7.33 (d, *J* = 8.0 Hz, 1H), 7.28–7.23 (m, 2H), 7.23–7.14 (m, 3H), 6.64 (s, 1H), 6.49 (d, *J* = 7.9 Hz, 1H), 2.23 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.07 (d, *J* = 1.2 Hz), 160.70 (d, *J* = 4.0 Hz), 149.04, 133.35 (d, *J* = 1.8 Hz), 133.10 (d, *J* = 9.2 Hz), 132.28 (d, *J* = 2.8 Hz), 132.19 (d, *J* = 9.1 Hz), 132.12 (d, *J* = 2.9 Hz), 129.23 (d, *J* = 96.6 Hz),128.86 (d, *J* = 98.6 Hz) 128.13 – 128.05 (m), 127.99 (d, *J* = 1.5 Hz), 127.89 (d, *J* = 2.0 Hz), 127.57 (d, *J* = 4.0 Hz), 124.22, 120.72, 119.11, 112.22, 75.13 (d, *J* = 63.0 Hz), 22.44; **^{31}P NMR** (202 MHz, Chloroform-d) δ 29.65; **HRMS** (ESI) m/z calcd for: $C_{27}H_{22}NO_2PNa$ $[M+Na]^+$: 446.1280, found: 446.1280.

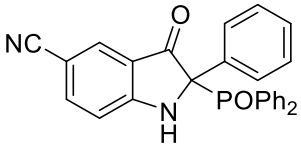
2-(diphenylphosphoryl)-5-methyl-2-phenylindolin-3-one (3c). Yellow solid, 37.3 mg, 88% yield. 

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.07–7.97 (m, 2H), 7.92–7.84 (m, 2H), 7.82–7.76 (m, 2H), 7.57 (s, 1H), 7.54–7.50 (m, 1H), 7.45–7.39 (m, 2H), 7.39–7.34 (m, 1H), 7.28–7.16 (m, 6H), 7.12 (dd, *J* = 8.4, 1.8 Hz, 1H), 6.78 (d, *J* = 8.4 Hz, 1H), 2.19 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.82, 158.74 (d, *J* = 4.0 Hz), 138.93, 133.36 (d, *J* = 2.0 Hz), 133.08 (d, *J* = 9.1 Hz), 132.27 (d, *J* = 2.9 Hz), 132.18 (d, *J* = 9.1 Hz), 132.07 (d, *J* = 2.8 Hz), 129.23 (d, *J* = 96.5 Hz), 128.84 (d, *J* = 98.5 Hz), 128.29, 128.09 (d, *J* = 1.8 Hz), 127.99 (d, *J* = 1.5 Hz), 127.95, 127.91 (d, *J* = 2.3 Hz), 127.58 (d, *J* = 3.9 Hz), 123.72, 121.44, 112.23, 75.26 (d, *J* = 62.6 Hz), 20.48; **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 29.44; **HRMS** (ESI) m/z calcd for: $C_{27}H_{22}NO_2PNa$ $[M+Na]^+$: 446.1280, found: 446.1280.

2-(diphenylphosphoryl)-7-methyl-2-phenylindolin-3-one (3d). Yellow solid, 34.5 mg, 82% yield.  **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.03–7.95 (m, 2H), 7.84–7.77 (m, 2H), 7.77–7.71 (m, 2H), 7.51 (t, *J* = 7.3 Hz, 1H), 7.44–7.38 (m, 2H), 7.30-7.35 (m, 2H), 7.24–7.18 (m, 5H), 7.09 (d, *J* = 7.1 Hz, 1H), 6.60 (t, *J* = 7.5 Hz, 1H), 6.39 (s, 1H), 2.19 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.83, 158.81 (d, *J* = 2.4 Hz), 137.20, 133.14, 133.04 (d, *J* = 9.1 Hz), 132.46 (d, *J* = 2.2 Hz), 132.23 (d, *J* = 2.1 Hz), 131.92 (d, *J* = 8.8 Hz), 128.13 (d, *J* = 12.2 Hz), 128.12 (d, *J* = 1.4Hz), 128.05 (d, *J* = 0.64 Hz), 128.37 (d, *J* = 91.50 Hz), 127.90 (d, *J* = 11.8 Hz),127.56 (d, *J* = 91.09 Hz), 127.53 (d, *J* = 3.6 Hz), 121.92, 121.39, 121.37, 119.56, 74.98 (d, *J* = 60.0 Hz), 15.79; **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 29.68; **HRMS** (ESI) m/z calcd for: $C_{27}H_{22}NO_2PNa$ $[M+Na]^+$: 446.1280, found: 446.1280.

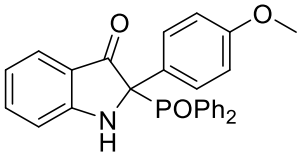
5-bromo-2-(diphenylphosphoryl)-2-phenylindolin-3-one (3e). Yellow solid, 22.1 mg, 45% yield.  **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.21 (s, 1H), 7.97 (dd, *J* = 10.7, 8.1 Hz, 2H), 7.91–7.82 (m, 2H), 7.72 (d, *J* = 7.8 Hz, 2H), 7.58 – 7.50 (m, 2H), 7.46–7.38 (m, 3H), 7.31 (dd, *J* = 8.7, 2.0 Hz, 1H), 7.29–7.27 (m, 2H), 7.21 (t, *J* = 7.2 Hz, 1H), 7.15 (t, *J* = 7.5 Hz, 2H), 6.76 (d, *J* = 8.7 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 195.66, 158.88 (d, *J* = 3.4 Hz), 139.84, 133.03 (d, *J* = 9.2 Hz), 132.57, 132.54 (d, *J* = 2.6 Hz), 132.46 (d, *J* = 1.9 Hz), 132.11 (d, *J* = 9.0 Hz), 130.54 (d, *J* = 93.6 Hz), 129.24 (d, *J* = 93.0 Hz), 128.26 (d, *J* = 9.0 Hz), 128.18, 128.17 (d, *J* = 9.1 Hz), 128.02 (d, *J* = 1.4 Hz), 127.47 (d, *J* = 3.5 Hz), 126.83, 122.58, 113.95, 110.77, 75.80 (d, *J* = 62.2 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 29.27; **HRMS** (ESI) m/z calcd for: $C_{26}H_{19}NO_2PBrNa$ $[M+Na]^+$: 510.0229 (^{79}Br), found: 510.0229.

6-chloro-2-(diphenylphosphoryl)-2-phenylindolin-3-one (3f). Yellow solid, 21.0 mg, 47% yield.  **^{1}H NMR** (500 MHz, DMSO-d_6) δ 8.92 (s, 1H), 7.84–7.77 (m, 2H), 7.73 (d, *J* = 5.5 Hz, 2H), 7.66–7.59 (m, 2H), 7.53 (q, *J* = 6.7 Hz, 2H), 7.48–7.39 (m, 4H), 7.38–7.28 (m, 3H), 7.24 (d, *J* = 8.3 Hz, 1H), 6.96 (s, 1H), 6.65–6.58 (m, 1H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 194.33, 160.96 (d, *J* = 4.5 Hz), 142.61, 133.47, 133.05 (d, *J* = 8.4 Hz), 132.91 (d, *J* = 2.3 Hz), 132.79 (d, *J* = 2.7 Hz), 132.09 (d, *J* = 8.7 Hz), 130.31 (d, *J* = 97.6 Hz), 128.99 (d, *J* = 96.8 Hz), 128.81 (d, *J* = 11.7 Hz), 128.60 (d, *J* = 11.2 Hz), 128.57, 128.44 (d, *J* = 1.5 Hz), 127.05 (d, *J* = 3.6 Hz), 126.05, 119.11, 118.65, 112.03, 74.98 (d, *J* = 66.6 Hz); **^{31}P NMR** (202 MHz, DMSO-d_6) δ 25.73; **HRMS** (ESI) m/z calcd for: $C_{26}H_{19}NO_2PClNa$ $[M+Na]^+$: 466.0734, found: 466.0734.

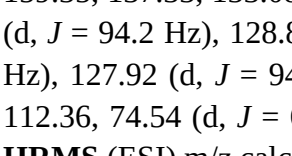
2-(diphenylphosphoryl)-3-oxo-2-phenylindoline-5-carbonitrile (3g). Yellow solid, 34.0 mg, 78% yield.  **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.00 (dd, *J* = 10.8, 8.0 Hz, 2H), 7.91–7.82 (m, 2H), 7.80–7.73 (m, 2H), 7.72 (s, 1H), 7.54–7.48 (m, 1H), 7.44–7.39 (m, 3H), 7.34 (t, *J* = 6.9 Hz, 1H), 7.20 (dd, *J* = 9.9, 4.0 Hz, 3H), 7.16 (t, *J* = 7.3 Hz, 2H), 6.84 (d, *J* = 8.3 Hz, 1H), 6.63 (t, *J* = 7.3 Hz, 1H); **^{13}C**

NMR (126 MHz, Chloroform-*d*) δ 196.88, 160.18 (d, *J* = 3.7 Hz), 137.36, 133.10 (d, *J* = 2.2 Hz), 133.08 (d, *J* = 9.2 Hz), 132.37 (d, *J* = 2.8 Hz), 132.18 (d, *J* = 3.3 Hz), 132.17 (d, *J* = 9.0 Hz), 128.99 (d, *J* = 96.7 Hz), 128.62 (d, *J* = 98.6Hz), 128.12 (d, *J* = 7.5 Hz), 128.02, 128.02 (d, *J* = 7.1 Hz), 127.97 (d, *J* = 2.1 Hz), 127.56 (d, *J* = 3.9 Hz), 124.53, 121.29, 118.83, 112.31, 112.21, 75.01 (d, *J* = 62.0 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 29.50; **HRMS** (APCI) m/z calcd for: $C_{27}H_{19}N_2O_2P$ $[M+H]^+$: 435.1257, found: 435.1272.

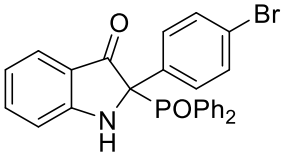
2-(diphenylphosphoryl)-2-(4-methoxyphenyl)indolin-3-one (3h). Yellow solid, 35.2 mg, 80% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.04–7.95 (m, 2H), 7.88–7.80 (m, 2H), 7.68 (d, *J* = 7.5 Hz, 2H), 7.60 (s, 1H), 7.51 (t, *J* = 7.3 Hz, 1H), 7.41 (t, *J* = 6.8 Hz, 3H), 7.34 (t, *J* = 7.3 Hz, 1H), 7.28–7.18 (m, 3H), 6.84 (d, *J* = 8.3 Hz, 1H), 6.69 (d, *J* = 8.8 Hz, 2H), 6.63 (t, *J* = 7.4 Hz, 1H), 3.71 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 197.16, 160.11 (d, *J* = 2.7 Hz), 159.35, 137.33, 133.08 (d, *J* = 8.6 Hz), 132.34, 132.15 (d, *J* = 5.7 Hz), 132.11, 129.04 (d, *J* = 94.2 Hz), 128.82 (d, *J* = 3.0 Hz), 128.11 (d, *J* = 10.4 Hz), 128.02 (d, *J* = 10.0 Hz), 127.92 (d, *J* = 94.6 Hz), 125.02, 124.51, 121.30, 118.81, 113.46 – 113.36 (m), 112.36, 74.54 (d, *J* = 63.9 Hz), 55.18; **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 29.74; **HRMS** (ESI) m/z calcd for: $C_{27}H_{22}NO_3PNa$ $[M+Na]^+$: 462.1230, found: 462.1230.



2-(diphenylphosphoryl)-2-(4-fluorophenyl)indolin-3-one (3i). Yellow solid, 32.1 mg, 75% yield. 1H NMR (500 MHz, Chloroform-d) δ 8.12 (s, 1H), 8.00 (dd, J = 11.2, 7.7 Hz, 2H), 7.94–7.82 (m, 2H), 7.83–7.73 (m, 2H), 7.58–7.50 (m, 1H), 7.49–7.40 (m, 3H), 7.39–7.33 (m, 1H), 7.30–7.20 (m, 3H), 6.88–6.77 (m, 3H), 6.64 (t, J = 7.4 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.89, , 162.54 (dd, *J* = 247.2, 2.3 Hz), 160.28 (d, *J* = 3.7 Hz), 137.53, 133.04 (d, *J* = 9.1 Hz), 132.54 (d, *J* = 2.8 Hz), 132.31 (d, *J* = 2.7 Hz), 132.09 (d, *J* = 9.1 Hz), 129.45 (dd, *J* = 8.2, 3.7 Hz), 128.86 (d, *J* = 3.0 Hz), 128.78 (d, *J* = 96.5 Hz), 128.47 (d, *J* =95.4 Hz), 128.21 (d, *J* = 9.8 Hz), 128.11 (d, *J* = 9.5 Hz), 124.55, 121.11, 118.87, 114.73 (dd, *J* = 21.3, 2.1 Hz), 112.32, 74.52 (d, *J* = 61.6 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 29.53; **^{19}F NMR** (471 MHz, Chloroform-*d*) δ -114.10; **HRMS** (ESI) m/z calcd for: $C_{26}H_{19}NO_2PFNa$ $[M+Na]^+$: 450.1030 found: 450.1031.

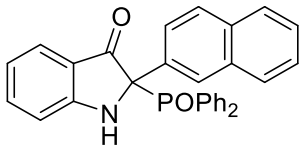


2-(4-bromophenyl)-2-(diphenylphosphoryl)indolin-3-one (3j). Yellow solid, 33.9 mg, 70% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.05–7.98 (m, 2H), 7.95 (s, 1H), 7.90–7.84 (m, 2H), 7.63 (dd, *J* = 8.7, 1.9 Hz, 2H), 7.59–7.53 (m, 1H), 7.49–7.44 (m, 2H), 7.42 (d, *J* = 7.8 Hz, 1H), 7.40–7.34 (m, 1H), 7.29–7.26 (m, 2H), 7.26–7.22 (m, 3H), 6.80 (d, *J* = 8.3 Hz, 1H), 6.65 (t, *J* = 7.4 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.52 (d, *J* = 1.0 Hz), 160.22 (d, *J* = 3.6 Hz), 137.57, 133.04 (d, *J* = 9.2 Hz), 132.63 (d, *J* = 2.9 Hz), 132.36 (d, *J* = 2.8 Hz), 132.24 (d, *J* = 2.15Hz), 132.06 (d, *J* = 9.1 Hz), 130.97 (d, *J* = 2.1 Hz), 129.29 (d, *J* =

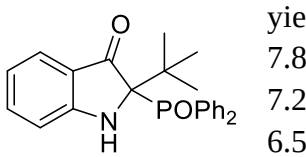


3.8 Hz), 128.71（d, *J* = 99.9 Hz), 128.36 (d, *J* = 98.4 Hz), 128.28 (d, *J* = 12.2 Hz), 128.14 (d, *J* = 11.9 Hz), 124.58, 122.48 (d, *J* = 3.2 Hz), 121.08, 118.98, 112.29, 74.64 (d, *J* = 61.0 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 29.27; **HRMS** (ESI) m/z calcd for: $C_{26}H_{19}NO_2PBrNa$ $[M+Na]^+$:510.0229 (^{79}Br), found: 510.0229.

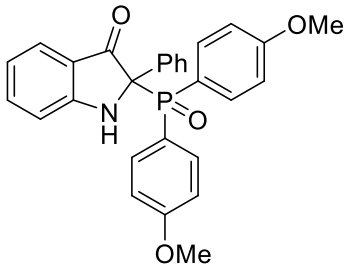
2-(diphenylphosphoryl)-2-(naphthalen-2-yl)indolin-3-one (3k). Yellow solid, 33.1 mg, 72% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.19 (s, 1H), 8.05–7.99 (m, 2H), 7.93–7.86 (m, 3H), 7.71 (d, *J* = 8.1 Hz, 1H), 7.59 (dd, *J* = 23.7, 8.5 Hz, 3H), 7.52–7.46 (m, 1H), 7.46–7.40 (m, 2H), 7.40–7.31 (m, 4H), 7.26–7.21 (m, 3H), 6.85 (d, *J* = 8.3 Hz, 1H), 6.68–6.63 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.79, 160.13 (d, *J* = 3.9 Hz), 137.45, 133.10 (d, *J* = 9.2 Hz), 132.81 (d, *J* = 1.5 Hz), 132.75 (d, *J* = 2.1 Hz), 132.48 (d, *J* = 2.9 Hz), 132.30 (d, *J* = 2.7 Hz), 132.22 (d, *J* = 9.1 Hz), 130.53 (d, *J* = 2.2 Hz), 128.83 (d, *J* = 96.5 Hz), 128.58, 128.35 (d, *J* = 99.0 Hz), 128.19 (d, *J* = 5.3 Hz), 128.09 (d, *J* = 5.0 Hz), 127.62 (d, *J* = 1.2 Hz), 127.31, 127.09 (d, *J* = 5.1 Hz), 126.28, 125.89, 125.05 (d, *J* = 2.8 Hz), 124.60, 121.33, 119.04, 112.41, 75.17 (d, *J* = 61.9 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 29.92; **HRMS** (ESI) m/z calcd for: $C_{30}H_{22}NO_2PNa$ $[M+Na]^+$: 482.1280, found: 482.1281.



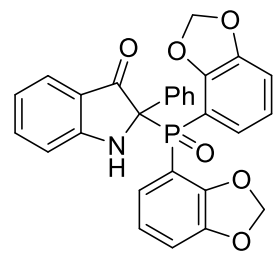
2-(tert-butyl)-2-(diphenylphosphoryl)indolin-3-one (3l). Yellow solid, 25.1 mg, 65% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.50–8.44 (m, 2H), 7.82–7.75 (m, 2H), 7.60–7.50 (m, 3H), 7.25 (d, *J* = 7.8 Hz, 1H), 7.20–7.12 (m, 2H), 7.11–7.06 (m, 2H), 6.67 (d, *J* = 8.3 Hz, 1H), 6.52 (t, *J* = 7.3 Hz, 1H), 6.44 (s, 1H), 1.10 (s, 9H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 200.00 (d, *J* = 2.4 Hz), 160.45 (d, *J* = 3.2 Hz), 136.83, 133.01 (d, *J* = 9.1 Hz), 132.66 (d, *J* = 91.5 Hz), 132.18 (d, *J* = 3.0 Hz), 131.90 (d, *J* = 8.6 Hz), 131.39 (d, *J* = 2.8 Hz), 130.52 (d, *J* = 97.3 Hz), 128.42 (d, *J* = 12.0 Hz), 127.48 (d, *J* = 11.7 Hz), 123.93, 122.81, 118.40, 111.43, 78.48 (d, *J* = 60.5 Hz), 40.72 (d, *J* = 1.6 Hz), 27.00 (d, *J* = 4.2 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 22.82; **HRMS** (ESI) m/z calcd for: $C_{24}H_{24}NO_3PNa$ $[M+Na]^+$: 412.1437, found: 412.1437.



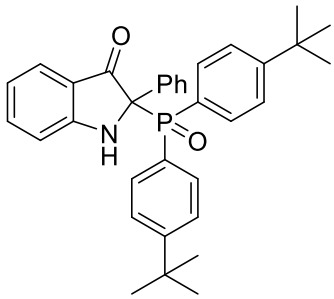
2-(bis(4-methoxyphenyl)phosphoryl)-2-phenylindolin-3-one (3m). Yellow solid, 36.6 mg, 78% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.84 (t, *J* = 9.3 Hz, 2H), 7.72 (d, *J* = 7.7 Hz, 3H), 7.70 (s, 1H), 7.42 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.29 (d, *J* = 7.5 Hz, 1H), 7.19 (d, *J* = 6.8 Hz, 4H), 6.90 (d, *J* = 7.8 Hz, 2H), 6.85 (d, *J* = 8.2 Hz, 1H), 6.71 (d, *J* = 7.6 Hz, 2H), 6.65 (t, *J* = 7.4 Hz, 1H), 3.82 (s, 3H), 3.71 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 197.06, 162.74, 162.50, 160.07, 137.27, 134.93 (d, *J* = 10.2 Hz), 134.05 (d, *J* = 9.1 Hz), 133.37, 127.93, 127.92, 127.50 (d, *J* = 1.8 Hz), 124.54, 124.09 (d, *J* = 98.2 Hz), 122.71 (d, *J* = 99.3 Hz), 121.49, 118.90, 113.70 (d, *J* = 9.5 Hz), 113.60 (d, *J* = 9.6 Hz), 112.34, 75.07 (d, *J* = 41.2 Hz),55.30, 55.25; **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 30.32; **HRMS** (ESI) m/z calcd for: $C_{28}H_{25}NO_4P$ $[M+H]^+$: 470.1516, found: 470.1516.



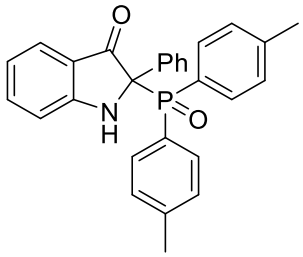
2-(bis(benzo[d][1,3]dioxol-4-yl)phosphoryl)-2-phenylindolin-3-one (3n). Yellow solid 27.2 mg, 55% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.80–7.73 (m, 2H), 7.48 (dd, *J* = 11.6, 8.3 Hz, 1H), 7.46–7.40 (m, 2H), 7.32 (q, *J* = 6.4, 5.6 Hz, 2H), 7.25–7.17 (m, 4H), 6.88 (d, *J* = 8.3 Hz, 1H), 6.82 (dd, *J* = 8.0, 2.3 Hz, 1H), 6.69 (t, *J* = 7.4 Hz, 1H), 6.66 – 6.61 (m, 1H), 6.03–5.97 (m, 2H), 5.91–5.84 (m, 2H), **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.90, 160.04 (d, *J* = 3.3 Hz), 151.17 (d, *J* = 2.6 Hz), 150.94 (d, *J* = 2.7 Hz), 147.65 (d, *J* = 9.6 Hz), 147.50 (d, *J* = 8.9 Hz), 137.44, 133.24, 128.83 (d, *J* = 9.8 Hz), 128.11 (d, *J* = 1.9 Hz), 128.08, 127.84 (d, *J* = 10.1 Hz), 127.48 (d, *J* = 3.8 Hz), 124.64, 121.96 (d, *J* = 98.1 Hz), 121.41, 121.13 (d, *J* = 99.0 Hz), 119.05, 112.36 (d, *J* = 12.2 Hz), 112.34, 111.67 (d, *J* = 12.2 Hz), 108.46 (d, *J* = 15.4 Hz), 108.29 (d, *J* = 15.0 Hz), 101.58, 101.50, 75.16 (d, *J* = 62.6 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 30.32; **HRMS** (ESI) m/z calcd for: $C_{28}H_{21}NO_6P$ $[M+H]^+$: 498.1101, found: 498.1101.



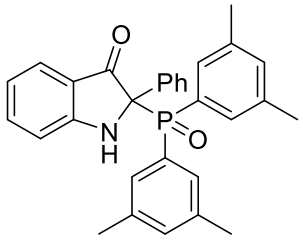
2-(bis(4-(tert-butyl)phenyl)phosphoryl)-2-phenylindolin-3-one (3o). Yellow solid 37.9 mg, 73% yield. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 7.89 (t, *J* = 9.3 Hz, 2H), 7.76 (m, 4H), 7.63 (s, 1H), 7.42 (d, *J* = 7.4 Hz, 2H), 7.37 (d, *J* = 7.7 Hz, 1H), 7.18 (dd, *J* = 21.4, 7.1 Hz, 6H), 6.81 (d, *J* = 8.1 Hz, 1H), 6.59 (t, *J* = 7.3 Hz, 1H), 1.31 (s, 9H), 1.18 (s, 9H); **^{13}C NMR** (101 MHz, Chloroform-*d*) δ 196.92, 160.24, 157.11 – 154.58 (m), 136.99, 133.43 – 133.37 (m), 132.97 (d, *J* = 9.5 Hz), 132.17 (d, *J* = 9.4 Hz), 127.88 (d, *J* = 1.6 Hz), 127.83 (d, *J* = 1.9 Hz), 127.62 (d, *J* = 3.7 Hz), 125.73 (d, *J* = 99.5 Hz),125.44 (d, *J* = 101.0Hz) 125.10 (d, *J* = 12.4 Hz), 124.93 (d, *J* = 12.0 Hz), 124.49, 121.46, 118.61, 112.41, 75.19 (d, *J* = 60.8 Hz),35.02, 34.85, 31.09, 30.92; **^{31}P NMR** (162 MHz, Chloroform-*d*) δ 30.03; **HRMS** (ESI) m/z calcd for: $C_{34}H_{36}NO_2PBr_2$ $[M+H]^+$: 522.2556, found: 522.2551.



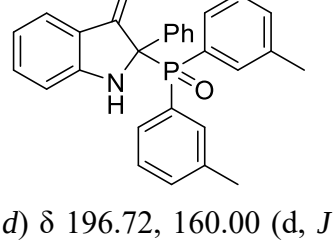
2-(di-p-tolylphosphoryl)-2-phenylindolin-3-one (3p). Yellow solid, 35.1 mg, 80% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.83 (dd, *J* = 11.0, 7.9 Hz, 2H), 7.76 (d, *J* = 7.6 Hz, 2H), 7.71 (dd, *J* = 11.0, 7.9 Hz, 2H), 7.57 (s, 1H), 7.44 (d, *J* = 7.8 Hz, 1H), 7.29 (dd, *J* = 15.3, 1.3 Hz, 1H), 7.26–7.15 (m, 5H), 7.03 (dd, *J* = 8.0, 2.7 Hz, 2H), 6.85 (d, *J* = 8.3 Hz, 1H), 6.66 (t, *J* = 7.4 Hz, 1H), 2.39 (s, 3H), 2.27 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.94, 160.13 (d, *J* = 3.4 Hz), 142.81 (d, *J* = 2.5 Hz), 142.57 (d, *J* = 2.4 Hz), 137.21, 133.32, 133.02 (d, *J* = 9.4 Hz), 132.13 (d, *J* = 9.3 Hz), 128.85 (d, *J* = 7.9 Hz), 128.75 (d, *J* = 7.7 Hz), 127.90, 127.88, 127.56 (d, *J* = 3.5 Hz), 125.86 (d, *J* = 99.9 Hz), 125.44 (d, *J* = 100.8 Hz), 124.53, 121.38, 118.70, 112.32, 75.03 (d, *J* = 61.1 Hz), 21.67, 21.47; **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 30.35; **HRMS** (ESI) m/z calcd for: $C_{28}H_{25}NO_2P[M+H]^+$: 438.1617, found: 438.1623.



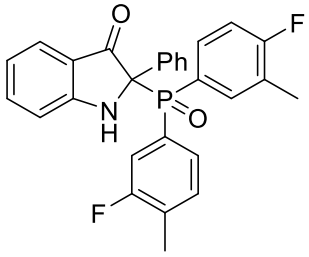
2-((2,4-dimethylphenyl) (3,5- dimethylphenyl) phosphoryl)-2-phenylindolin-3-one (3q). Yellow solid, 37.0 mg, 80% yield. **^{1}H NMR** (400 MHz, Chloroform-d) δ 7.78–7.67 (m, 2H), 7.45 (d, *J* = 9.7 Hz, 3H), 7.38 (d, *J* = 11.5 Hz, 2H), 7.27 (d, J = 9.4 Hz, 3H), 7.11 (s, 2H), 7.04 (s, 1H), 6.95 (s, 1H), 6.83 (d, *J* = 8.0 Hz, 1H), 6.66 (t, *J* = 7.0 Hz, 1H), 2.28 (s, 6H), 2.13 (s, 6H); **^{13}C NMR** (101 MHz, Chloroform-*d*) δ 196.59, 159.87, 137.72 (d, *J* = 8.3 Hz), 137.59 (d, *J* = 8.8 Hz), 137.06, 134.09 (d, *J* = 2.4 Hz), 133.83 (d, *J* = 2.5 Hz), 133.24, 130.65 (d, *J* = 9.1 Hz), 129.83 (d, *J* = 8.9 Hz), 128.47 (d, *J* = 94.8 Hz), 127.91 (d, *J* = 97.8 Hz), 127.92 (d, *J* = 1.8 Hz), 127.84–127.76 (m), 127.61 (d, *J* = 3.4 Hz), 124.40, 121.92, 119.02, 112.28, 74.85 (d, *J* = 59.8 Hz), 21.14, 21.10; **^{31}P NMR** (162 MHz, Chloroform-*d*) δ 31.24; **HRMS** (ESI) m/z calcd for: $C_{30}H_{29}NO_2P$ $[M+H]^+$: 466.1930, found: 466.1932.



2-(di-m-tolylphosphoryl)-2-phenylindolin-3-one (3r). Yellow solid, 34.8 mg, 80% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.78 (dd, *J* = 8.3, 2.9 Hz, 1H), 7.76–7.70 (m, 2H), 7.66 (dd, *J* = 11.6, 5.6 Hz, 2H), 7.62–7.53 (m, 1H), 7.43 (d, *J* = 7.7 Hz, 1H), 7.34–7.29 (m, 3H), 7.28 (s, 1H), 7.19 (q, *J* = 7.9, 6.5 Hz, 3H), 7.16–7.09 (m, 2H), 6.83 (d, *J* = 8.3 Hz, 1H), 6.65 (t, *J* = 7.4 Hz, 1H), 2.31 (s, 3H), 2.16 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.72, 160.00 (d, *J* = 3.5 Hz),137.91 (d, *J* = 1.7 Hz), 137.82 (d, *J* = 1.6 Hz) , 137.19, 133.59 (d, *J* = 8.6 Hz), 133.17 (d, *J* = 2.0 Hz), 133.13 (d, *J* = 3.0 Hz), 132.91 (d, *J* = 2.9 Hz), 132.79 (d, *J* = 8.6 Hz), 130.06 (d, *J* = 9.8 Hz), 129.16 (d, *J* = 9.7 Hz), 128.73 (d, *J* = 95.9Hz), 128.25 (d, *J* = 96.4 Hz), 127.95 (d, *J* = 2.2 Hz), 127.87 (d, *J* = 2.0 Hz), 127.84, 127.57 (d, *J* = 3.9 Hz), 124.48, 121.62, 118.92, 112.27, 74.92 (d, *J* = 60.8 Hz), 21.40, 21.22; **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 30.31; **HRMS** (ESI) m/z calcd for: $C_{28}H_{25}NO_2P$ $[M+H]^+$: 438.1617, found: 438.1621.

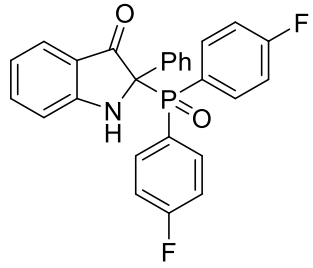


2-((4-fluoro-3-methylphenyl)(3-fluoro-4-methylphenyl)phosphoryl)-2-phenylindolin-3-one (3s). Yellow solid 36.0 mg, 76% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.84 (s, 1H), 7.78 (d, *J* = 7.7 Hz, 2H), 7.70–7.59 (m, 2H), 7.52–7.43 (m, 3H), 7.30 (t, *J* = 7.3 Hz, 1H), 7.25–7.17 (m, 4H), 7.05 (q, *J* = 7.3 Hz, 1H), 6.86 (d, *J* = 8.3 Hz, 1H), 6.67 (t, *J* = 7.4 Hz, 1H), 2.30 (s, 3H), 2.18 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.73, 161.71 (dd, *J* = 17.3, 13.3 Hz), 160.25 (d, *J* = 4.1 Hz), 159.74 (dd, *J* = 17.3, 14.0 Hz), 137.59, 132.75 (d, *J* = 2.0 Hz), 131.57 (t, *J* = 4.9 Hz), 131.46 (t, *J* = 4.7 Hz), 130.21 (dd, *J* = 17.1, 2.5 Hz), 130.00 (dd, *J* = 17.2, 2.6 Hz), 128.58 (d, *J* = 3.6 Hz), 128.51 (d, *J* = 3.6 Hz), 128.28 (dd, *J* = 97.8, 6.0 Hz), 128.24 (d, *J* = 2.1 Hz), 128.10 (d, *J* = 1.9 Hz), 127.78 (dd, *J* =100.6, 6.1 Hz), 127.50 (d, *J* = 3.8 Hz), 124.60, 121.09, 119.46 (dd, *J* = 24.5, 10.4 Hz), 118.95, 118.72 (dd, *J* = 24.1, 10.1 Hz), 112.36, 74.96 (d, *J* = 64.9 Hz),14.84 (d, *J* = 3.6 Hz), 14.63 (d, *J* = 3.4 Hz) ; **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 27.70; **^{19}F NMR** (471 MHz, Chloroform-*d*) δ -

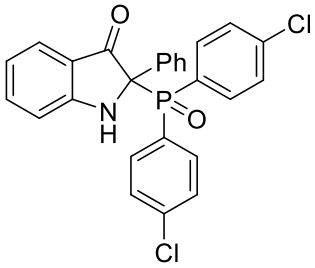


115.64, -115.72; **HRMS** (ESI) m/z calcd for: $C_{28}H_{23}NO_2PF_2$ $[M+H]^+$: 474.1429, found: 474.1428.

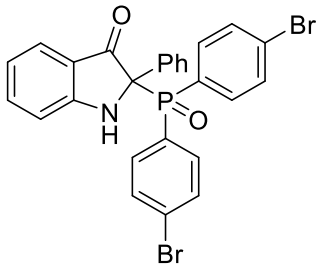
2-(bis(4-fluorophenyl)phosphoryl)-2-phenylindolin-3-one (3t). Yellow solid 31.5 mg, 71% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.09 – 8.00 (m, 2H), 7.91 – 7.81 (m, 2H), 7.77 (d, *J* = 7.2 Hz, 3H), 7.45 (d, *J* = 7.8 Hz, 1H), 7.33 (t, *J* = 7.7 Hz, 1H), 7.27 – 7.18 (m, 2H), 7.17 – 7.10 (m, 2H), 6.94 (t, *J* = 8.4 Hz, 2H), 6.86 (d, *J* = 8.3 Hz, 1H), 6.70 (t, *J* = 7.4 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 197.00 (d, *J* = 1.2 Hz), 166.30 (dd, *J* = 30.4, 3.4 Hz), 164.28 (dd, *J* = 30.4, 3.4 Hz), 160.23 (d, *J* = 4.0 Hz), 137.74, 135.61 (dd, *J* = 10.6, 9.0 Hz), 134.69 (dd, *J* = 10.4, 9.1 Hz), 132.80 (d, *J* = 2.1 Hz), 128.28 (d, *J* = 2.4 Hz), 128.13 (d, *J* = 2.0 Hz), 127.48 (d, *J* = 4.1 Hz), 124.77 (dd, *J* = 100.0, 3.3 Hz), 124.58, 124.34 (dd, *J* = 102.5, 3.3 Hz), 121.07, 119.09, 115.84 – 115.61 (m), 115.60 – 115.37 (m),112.24, 75.05 (d, *J* = 64.1 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 28.45; **^{19}F NMR** (471 MHz, Chloroform-*d*) δ -105.29, -105.52; **HRMS** (ESI) m/z calcd for: $C_{26}H_{18}NO_2PBr_2$ $[M+H]^+$: 446.1116, found: 446.1118.



2-(bis(4-chlorophenyl)phosphoryl)-2-phenylindolin-3-one (3u). Yellow solid,34.2 mg, 72% yield.**^{1}H NMR** (400 MHz, Chloroform-*d*) δ 8.22 (s, 1H), 7.99–7.90 (m, 2H), 7.76 (t, *J* = 6.6 Hz, 4H), 7.48–7.38 (m, 3H), 7.36–7.28 (m, 1H), 7.27–7.20 (m, 3H), 7.17 (d, *J* = 7.6 Hz, 2H), 6.85 (d, *J* = 8.3 Hz, 1H), 6.68 (t, *J* = 7.4 Hz, 1H);**^{13}C NMR** (101 MHz, Chloroform-*d*) δ 196.90, 160.42 (d, *J* = 4.2 Hz), 139.36 (d, *J* = 3.5 Hz), 139.17 (d, *J* = 3.5 Hz), 137.88, 134.41 (d, *J* = 10.1 Hz), 133.46 (d, *J* = 10.0 Hz), 132.63 (d, *J* = 1.7 Hz), 128.66 (d, *J* = 8.5 Hz), 128.54 (d, *J* = 8.3 Hz), 128.40 (d, *J* = 2.0 Hz), 128.19 (d, *J* = 1.6 Hz), 127.56 (d, *J* = 4.0 Hz), 127.31 (d, *J* = 98.4 Hz), 126.98 (d, *J* = 100.5 Hz), 124.64, 120.91, 119.08, 112.34, 75.05 (d, *J* = 64.9 Hz); **^{31}P NMR** (162 MHz, Chloroform-*d*) δ 28.72; **HRMS** (ESI) m/z calcd for: $C_{26}H_{19}NO_2PCl_2$ $[M+H]^+$: 478.0525, found: 478.0521.



2-(bis(4-bromophenyl)phosphoryl)-2-phenylindolin-3-one (3v). Yellow solid 44.1 mg, 78% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.83 (dd, *J* = 10.7, 8.5 Hz, 2H), 7.73 (d, *J* = 7.8 Hz, 2H), 7.70 (s, 1H), 7.65 (dd, *J* = 10.7, 8.5 Hz, 2H), 7.56 (dd, *J* = 8.4, 2.3 Hz, 2H), 7.44 (d, *J* = 7.7 Hz, 1H), 7.36 (d, *J* = 6.5 Hz, 2H), 7.35–7.29 (m, 1H), 7.24 (d, *J* = 7.0 Hz, 1H), 7.20 (t, *J* = 7.4 Hz, 2H), 6.84 (d, *J* = 8.3 Hz, 1H), 6.70 (t, *J* = 7.4 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.73, 160.16 (d, *J* = 3.8 Hz), 137.89, 134.43 (d, *J* = 10.0 Hz), 133.48 (d, *J* = 9.8 Hz), 132.57 (d, *J* = 1.8 Hz), 131.58 (d, *J*= 12.6 Hz), 131.47(d, *J*= 12.1 Hz), 128.44 (d, *J* = 2.5 Hz), 128.24 (d, *J* = 1.6 Hz), 128.10 (d, *J* = 3.5 Hz), 127.86 (d, *J* = 3.5 Hz), 127.67 (d, *J* = 99.1 Hz),



127.46 (d, *J* = 4.0 Hz), 127.32 (d, *J* = 99.7 Hz), 124.67, 121.04, 119.29, 112.30, 74.85 (d, *J* = 64.4 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 28.98; **HRMS** (ESI) m/z calcd for: $C_{26}H_{19}NO_2PBr_2$ $[M+H]^+$: 565.9515 (^{79}Br), found: 565.9520.

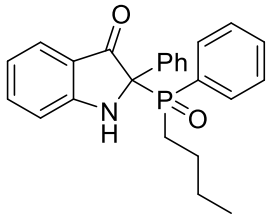
2-(bis(4-(trifluoromethyl)phenyl)phosphoryl)-2-phenylindolin-3-one (3w). Yellow solid 40.4 mg, 74% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.17 (dd, *J* = 10.7, 8.5 Hz, 2H), 7.94 (dd, *J* = 10.6, 8.5 Hz, 2H), 7.77–7.72 (m, 2H), 7.70 (dd, *J* = 8.3, 2.1 Hz, 3H), 7.49 (d, *J* = 6.4 Hz, 2H), 7.44 (d, *J* = 7.8 Hz, 1H), 7.37–7.30 (m, 1H), 7.25–7.18 (m, 2H), 6.85 (d, *J* = 8.3 Hz, 1H), 6.71 (t, *J* = 7.4 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.52 (d, *J* = 1.6 Hz), 160.09 (d, *J* = 4.3 Hz), 138.09, 134.75-134.34 (m), 133.82-133.22 (m), 133.53 (d, *J* = 9.7 Hz), 132.75 (d, *J* = 94.4 Hz), 132.61 (d, *J* = 9.5 Hz), 132.48 (d, *J* =96.4 Hz), 132.25 (d, *J* = 2.1 Hz), 128.70 (d, *J* = 2.4 Hz), 128.39 (d, *J* = 2.2 Hz), 127.60 – 127.29 (m), 125.32 – 124.83 (m), 124.73, 123.34(qd, *J* = 272.3 Hz), 121.00, 119.57, 112.29, 74.84 (d, *J* = 64.9 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 27.66; **^{19}F NMR** (471 MHz, Chloroform-*d*) δ -63.33, -63.54; **HRMS** (ESI) m/z calcd for: $C_{28}H_{19}NO_2PF_6$ $[M+H]^+$: 546.1052, found: 546.1048.

2-(bis(3-(trifluoromethyl)phenyl)phosphoryl)-2-phenylindolin-3-one (3x). Yellow solid 42.5 mg, 78% yield.**^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.29–8.22 (m, 2H), 8.16 (d, *J* = 11.3 Hz, 1H), 7.95–7.88 (m, 1H), 7.80 (s, 1H), 7.76–7.70 (m, 2H), 7.66–7.57 (m, 2H), 7.4 –7.38 (m, 2H), 7.35 (s, 1H), 7.35–7.31 (m, 1H), 7.25–7.17 (m, 3H), 6.85 (d, *J* = 8.3 Hz, 1H), 6.72–6.66 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.47 (d, *J* = 1.3 Hz), 159.90 (d, *J* = 4.1 Hz), 138.03, 136.13 (d, *J* = 9.6 Hz), 135.13 (d, *J* = 9.4 Hz), 132.09 (d, *J* = 2.1 Hz), 130.11 (dd, *J* = 9.8, 3.8 Hz), 131.02 (d, *J* = 12.4 Hz), 130.76 (d, *J* = 12.4 Hz), 129.84 (d, *J* = 96.0 Hz), 129.41 – 129.30 (m), 129.30 (d, *J* = 96.0 Hz), 129.25 – 129.17 (m), 129.08 (dd, *J* = 9.5, 3.9 Hz), 128.87 (d, *J* = 5.6 Hz), 128.78 (d, *J* = 5.2 Hz), 128.64 (d, *J* = 2.5 Hz), 128.37 (d, *J* = 2.1 Hz), 127.30 (d, *J* = 4.3 Hz), 123.42 (qd, *J* = 273.2, 27.2 Hz), 124.66, 121.15, 119.64, 112.28, 74.78 (d, *J* = 64.5 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 27.51; **^{19}F NMR** (471 MHz, Chloroform-*d*) δ -62.94, -62.98; **HRMS** (ESI) m/z calcd for: $C_{28}H_{19}NO_2PF_6$ $[M+H]^+$: 546.1052, found: 546.1050.

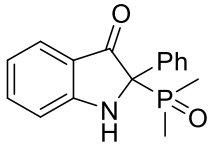
2-(bis(3,5-bis(trifluoromethyl)phenyl)phosphoryl)-2-phenylindolin-3-one (3y). Yellow solid 55.4 mg, 81% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.51 (d, *J* = 11.0 Hz, 2H), 8.29 (d, *J* = 10.9 Hz, 2H), 8.07 (s, 1H), 7.90 (s, 2H), 7.79–7.72 (m, 2H), 7.48 (d, *J* = 7.8 Hz, 1H), 7.43–7.34 (m, 1H), 7.30–7.27 (m, 1H), 7.20 (t, *J* = 7.7 Hz, 2H), 6.85 (d, *J* = 8.3 Hz, 1H), 6.75 (t, *J* = 7.4 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ

196.19 (d, *J* = 2.0 Hz), 160.08 (d, *J* = 4.8 Hz), 138.63, 133.21 (dd, *J* = 9.5, 3.2 Hz), 132.73 – 131.59 (m), 131.15(d, *J* = 95.2 Hz), 131.07 (d, *J* = 2.3 Hz), 130.60 (d, *J* = 98.0 Hz), 129.22 (d, *J* = 2.6 Hz), 128.70 (d, *J* = 2.2 Hz), 127.17 (d, *J* = 4.5 Hz), 126.80 – 126.38 (m), 124.83, 122.53 (qd, *J* = 272.9, 33.2 Hz), 120.82, 120.17, 112.33, 74.79 (d, *J* = 68.0 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 27.61; **^{19}F NMR** (471 MHz, Chloroform-*d*) δ -63.14, -63.20; **HRMS** (ESI) m/z calcd for: $C_{30}H_{17}NO_2PF_{12}$ $[M+H]^+$: 682.0800, found: 682.0798.

2-phenyl-2-(phenyl(propyl)phosphoryl)indolin-3-one (3z). Yellow solid 20.7 mg, 53% yield, mixture of diastereomer (1:1 dr). **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.02 (d, *J* = 7.8 Hz, 2H), 7.70–7.64 (m, 2H), 7.62 (d, *J* = 7.7 Hz, 1H), 7.57 (d, *J* = 8.1 Hz, 2H), 7.53 (d, *J* = 8.4 Hz, 1H), 7.48 (q, *J* = 7.2 Hz, 4H), 7.42 (t, *J* = 7.5 Hz, 2H), 7.40–7.34 (m, 4H), 7.29 (s, 2H), 7.22–7.18 (m, 2H), 7.16 (t, 2H), 7.11 (t, *J* = 7.4 Hz, 2H), 7.07 (d, *J* = 8.2 Hz, 1H), 6.84 (t, *J* = 7.4 Hz, 1H), 6.71 (d, *J* = 8.3 Hz, 1H), 6.54 (t, *J* = 7.4 Hz, 1H), 2.07–1.88 (m, 4H), 1.40–1.29 (m, 4H), 1.29–1.20 (m, 4H), 0.80 (t, *J* = 7.1 Hz, 3H), 0.73 (t, *J* = 7.2 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 196.76, 196.71, 160.18 (d, *J* = 3.1 Hz), 159.97 (d, *J* = 2.9 Hz), 137.69, 137.10, 132.92 (d, *J* = 1.9 Hz), 132.77 (d, *J* = 1.8 Hz), 132.51 (d, *J* = 8.7 Hz), 132.39 (d, *J* = 1.9 Hz), 132.12 (d, *J* = 8.8 Hz), 132.07 (d, *J* = 1.4 Hz), 128.52 (d, *J* = 1.4 Hz), 128.30 (d, *J* = 1.8 Hz), 128.09 (d, *J* = 82.6 Hz), 128.03 (d, *J* = 11.9 Hz), 127.89 (d, *J* = 11.4 Hz), 127.74 (d, *J* = 1.8 Hz), 127.68 (d, *J* = 1.1 Hz), 127.37 (d, *J* = 80.5 Hz), 127.35 (d, *J* = 3.2 Hz), 126.75 (d, *J* = 2.8 Hz), 124.82, 124.24, 121.32, 121.02, 119.17, 118.61, 112.80, 112.11, 73.99 (d, *J* = 65.7 Hz), 73.92 (d, *J* = 64.8 Hz), 24.08 (d, *J* = 8.5 Hz), 23.96 (d, *J* = 7.5 Hz), 23.95 (d, *J* = 66.2 Hz), 23.40 (d, *J* = 4.2 Hz), 22.84 (d, *J* = 4.2 Hz), 22.71 (d, *J* = 67.6 Hz), 13.57, 13.53; **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 42.95, 41.86; **HRMS** (ESI) m/z calcd for: $C_{24}H_{25}NO_2P$ $[M+H]^+$: 390.1617, found: 390.1616.



2-(dimethylphosphoryl)-2-phenylindolin-3-one (3aa). Yellow solid 23.1 mg, 81% yield. **^{1}H NMR** (500 MHz, DMSO-*d6*) δ 8.84 (s, 1H), 7.85–7.80 (m, 2H), 7.5–7.51 (m, 1H), 7.48 (d, *J* = 7.8 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.38–7.33 (m, 1H), 7.09 (d, *J* = 8.3 Hz, 1H), 6.82–6.75 (m, 1H), 1.35 (d, *J* = 13.0 Hz, 3H), 1.26 (d, *J* = 12.5 Hz, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 195.99, 160.89 (d, *J* = 4.0 Hz), 138.25, 133.79 (d, *J* = 1.1 Hz), 128.60 (d, *J* = 1.8 Hz), 128.36 (d, *J* = 2.1 Hz), 126.83 (d, *J* = 3.5 Hz), 124.63, 119.73, 118.68, 112.73, 73.75 (d, *J* = 60.8 Hz), 12.90 (d, *J* = 90.4 Hz), 12.37(d, *J* = 89.4Hz); **^{31}P NMR** (162 MHz, Chloroform-*d*) δ 48.58; **HRMS** (ESI) m/z calcd for: $C_{16}H_{16}NO_2P$ $[M+H]^+$: 286.0991, found: 286.0993.



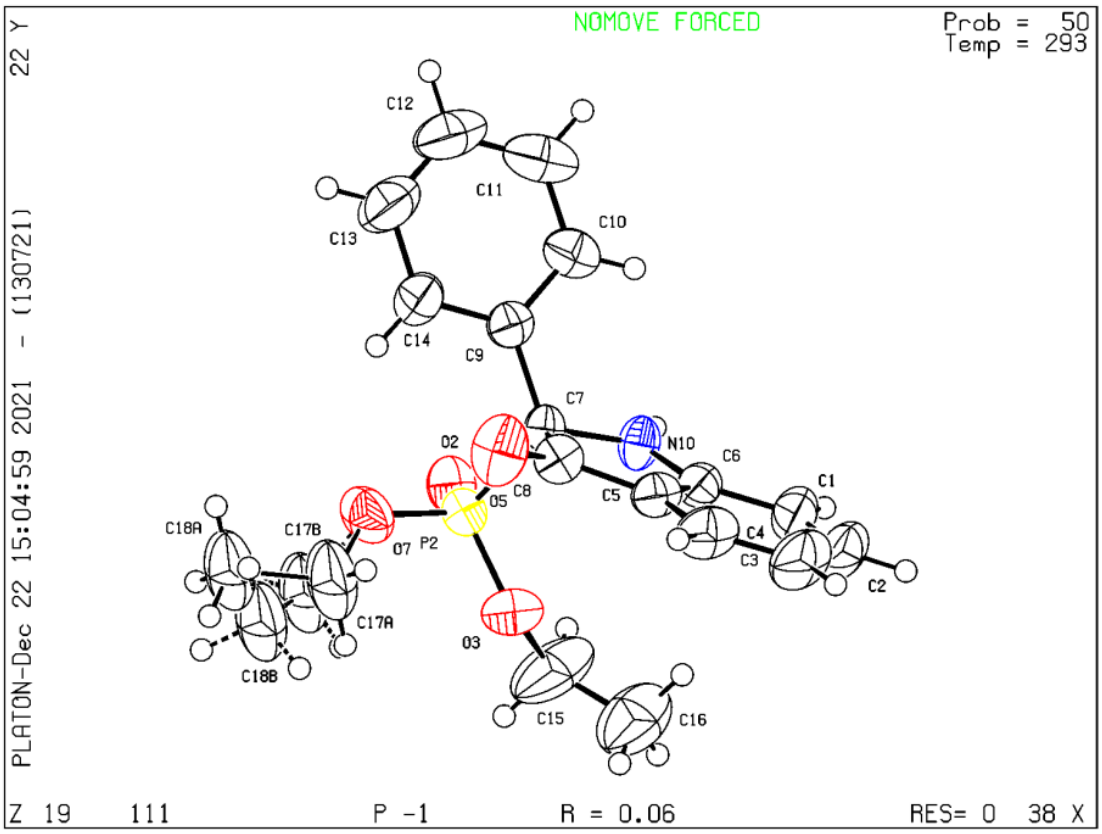
ethyl (3-oxo-2-phenylindolin-2-yl)(phenyl)phosphinate（3ab）. Yellow solid 24.6 mg, 65% yield, mixture of diastereomer (1:1 dr). **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.01 (d, *J* = 7.8 Hz, 2H), 7.71 (dd, *J* = 10.9, 7.9 Hz, 2H), 7.59 (q, *J* = 5.6, 4.2 Hz, 6H), 7.53 (t, *J* = 7.5 Hz, 1H), 7.45–7.40 (m, 1H), 7.40–7.31 (m, 7H), 7.25–7.15 (m, 6H), 6.98 (d, *J* = 8.2 Hz, 1H), 6.83–6.77 (m, 3H), 6.59 (t, *J* = 7.3 Hz, 1H), 4.07–3.98 (m, 4H), 1.29 (t, *J* = 7.0 Hz, 3H), 1.08 (t, *J* = 7.0 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 195.49, 195.08, 159.84 (d, *J* = 3.3 Hz), 159.63 (d, *J* = 3.9 Hz), 137.09, 136.97, 133.66 (d, *J* = 9.4 Hz), 133.18 (d, *J* = 9.4 Hz), 133.02 (d, *J* = 2.7 Hz), 132.87, 132.83, 132.73 (d, *J* = 2.6 Hz), 128.21 (d, *J* = 2.1 Hz), 128.15 (d, *J* = 2.4 Hz), 128.01 (d, *J* = 1.8 Hz), 127.93 (d, *J* = 3.1 Hz), 127.90 (d, *J* = 1.8 Hz), 127.88 (d, *J* = 2.3 Hz), 127.43 (d, *J* = 85.4 Hz), 127.31 (d, *J* = 3.7 Hz), 126.90 (d, *J* = 4.2 Hz), 126.41 (d, *J* = 83.5 Hz), 124.90, 124.59, 121.24, 120.87, 119.24, 118.93, 112.44, 112.07, 73.49 (d, *J* = 94.8 Hz), 73.29 (d, *J* = 91.8 Hz), 63.05 (d, *J* = 7.6 Hz), 62.65 (d, *J* = 7.3 Hz), 16.44 (d, *J* = 5.4 Hz), 16.30 (d, *J* = 5.7 Hz); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 36.21, 30.45; **HRMS** (ESI) m/z calcd for: $C_{22}H_{21}NO_3P$ $[M+H]^+$: 378.1254, found: 378.1255.

diethyl (3-oxo-2-phenylindolin-2-yl)phosphonate(3ac). Yellow solid 22.5 mg, 65% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.00–7.87 (m, 2H), 7.62 (d, *J* = 7.7 Hz, 1H), 7.50–7.42 (m, 1H), 7.37 (t, *J* = 7.5 Hz, 2H), 7.34 – 7.29 (m, 1H), 6.99 (d, *J* = 8.2 Hz, 1H), 6.84 (t, *J* = 7.4 Hz, 1H), 6.17 (s, 1H), 4.13 – 4.02 (m, 2H), 4.01 – 3.86 (m, 2H), 1.19 (t, *J* = 7.1 Hz, 3H), 1.07 (t, *J* = 7.0 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 194.67 (d, *J* = 4.0 Hz), 159.80 (d, *J* = 4.5 Hz), 137.29, 133.44 (d, *J* = 2.9 Hz), 128.34 (d, *J* = 2.6 Hz), 128.26 (d, *J* = 3.0 Hz), 126.80 (d, *J* = 4.9 Hz), 125.19, 120.62, 119.56, 112.53, 71.52 (d, *J* = 144.6 Hz), 64.59 (d, *J* = 7.7 Hz), 64.33 (d, *J* = 7.3 Hz), 16.23 (d, *J* = 5.9 Hz), 16.18 (d, *J* = 5.9 Hz);**^{31}P NMR** (202 MHz, Chloroform-*d*) δ 15.86; **HRMS** (ESI) m/z calcd for: $C_{18}H_{20}NO_4P$ $[M+H]^+$: 346.1203, found: 346.1204.

dimethyl (3-oxo-2-phenylindolin-2-yl)phosphonate(3ad). Yellow solid 20.3 mg, 64% yield. **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.95–7.89 (m, 2H), 7.67–7.62 (m, 1H), 7.51–7.46 (m, 1H), 7.39 (t, *J* = 7.6 Hz, 2H), 7.36–7.31 (m, 1H), 7.00 (d, *J* = 8.2 Hz, 1H), 6.87 (t, *J* = 7.4 Hz, 1H), 3.66 (dd, *J* = 17.4, 10.7 Hz, 6H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 194.53 (d, *J* = 3.8 Hz), 159.69 (d, *J* = 4.9 Hz), 137.50, 133.18 (d, *J* = 3.1 Hz), 128.53 (d, *J* = 2.7 Hz), 128.46 (d, *J* = 3.0 Hz), 126.67 (d, *J* = 4.9 Hz), 125.33, 120.35 (d, *J* = 1.9 Hz), 119.75, 112.60, 71.27 (d, *J* = 146.7 Hz), 54.96 (d, *J* = 7.5 Hz), 54.71 (d, *J* = 7.3 Hz)， 50.85 (s, MeOH); **^{31}P NMR** (202 MHz, Chloroform-*d*) δ 18.46; **HRMS** (ESI) m/z calcd for: $C_{16}H_{17}NO_4P$ $[M+H]^+$: 318.0890, found: 318.0887.

5. Single Crystal X-ray Structure Determinations of Compounds

Single crystal X-ray structure determinations of compound 3ac (CCDC: 2159691)



Bond precision:	C-C = 0.0045 A	Wavelength=0.71073
Cell:	a=9.8688(7) b=9.9088(7) c=10.7278(8) alpha=73.336 (2) beta=75.766 (2) gamma=60.403 (2)	
Temperature:	293 K	
	Calculated	Reported
Volume	866.99 (11)	866.99 (11)
Space group	P -1	P -1
Hall group	-P 1	-P 1
Moiety formula	C18 H20 N O4 P	C18 H20 N O4 P
Sum formula	C18 H20 N O2 P	C18 H20 N O4 P
Mr	345.32	345.32
Dx,g cm-3	1.323	1.323
Z	2	2
Mu (mm-1)	0.180	0.180
F000	364.0	364.0
F000’	364.37	
h,k,lmax	12,12,13	12,12,13

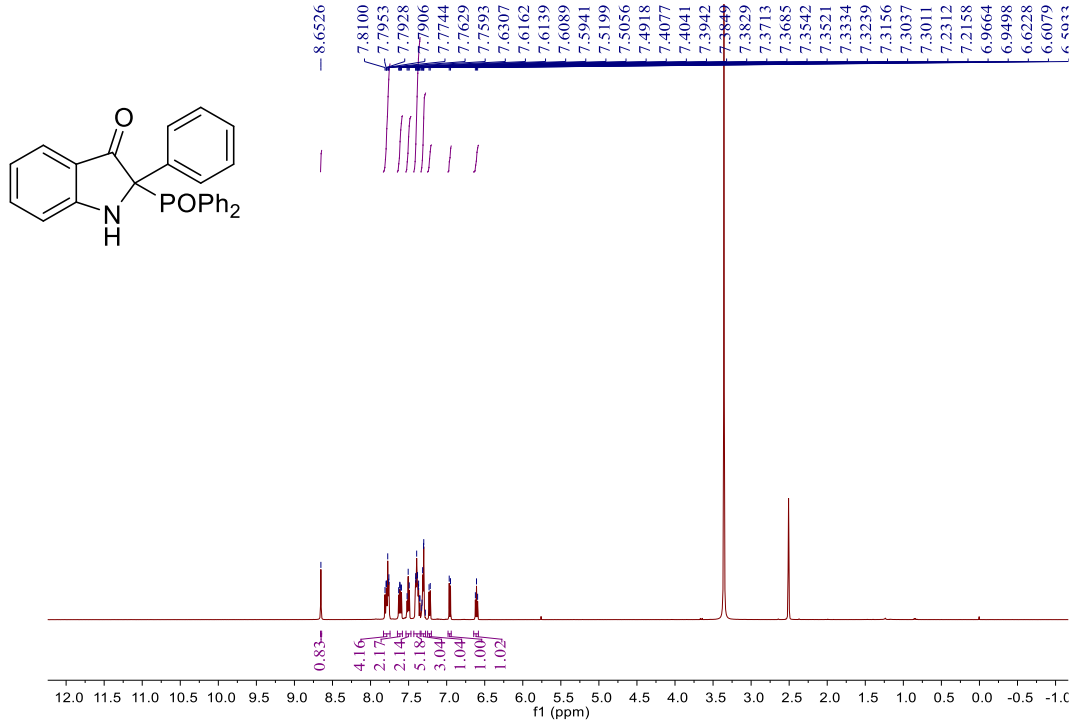
Nref	3991	3970
Tmin,Tmax	0.945,0.972	0.689,0.746
Tmin’	0.937	

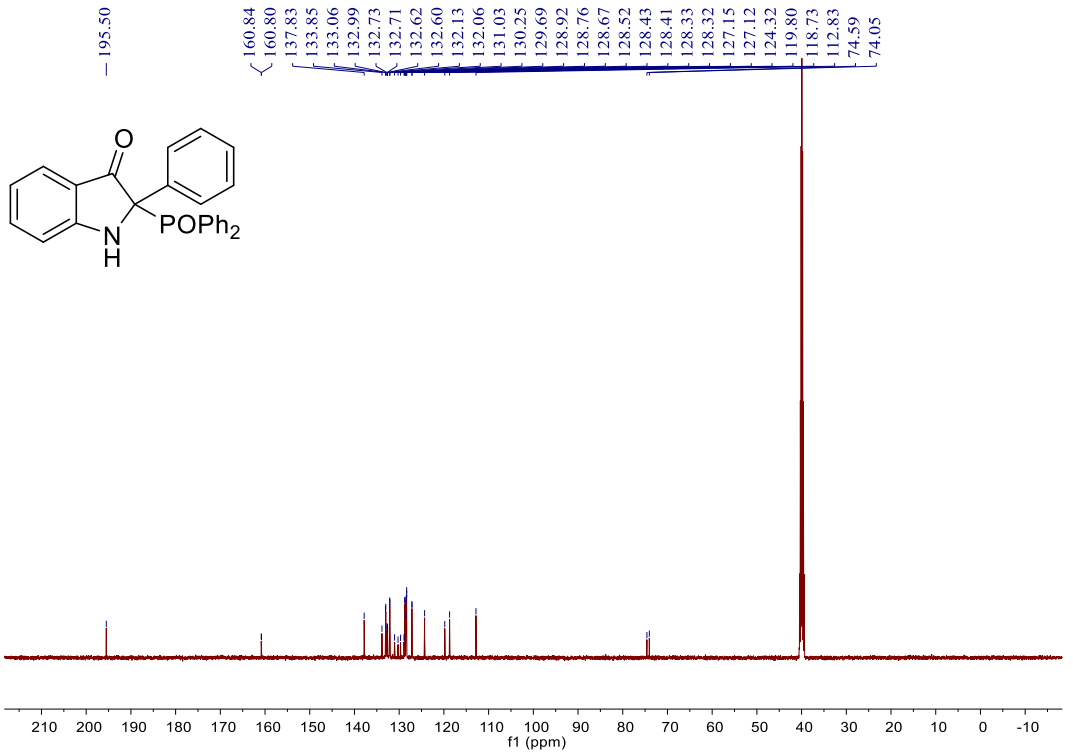
Correction method= # Reported T Limits: Tmin=0.689 Tmax=0.746
AbsCorr = MULTI-SCAN

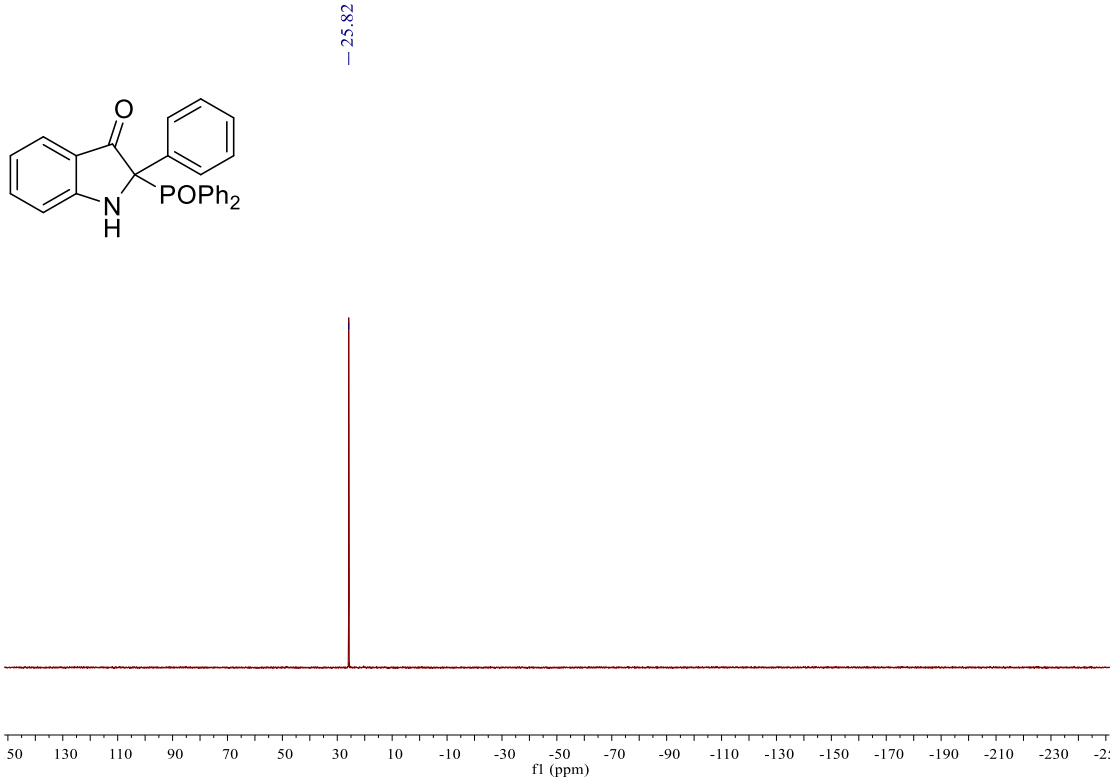
Data completeness= 0.995	Theta(max)= 27.551
R(reflections)= 0.0589(3309)	wR2(reflections)= 0.1673(3970)
S = 1.026	Npar= 221

6. ^{1}H NMR, ^{13}C NMR, ^{31}P NMR and ^{19}F NMR spectra for compounds

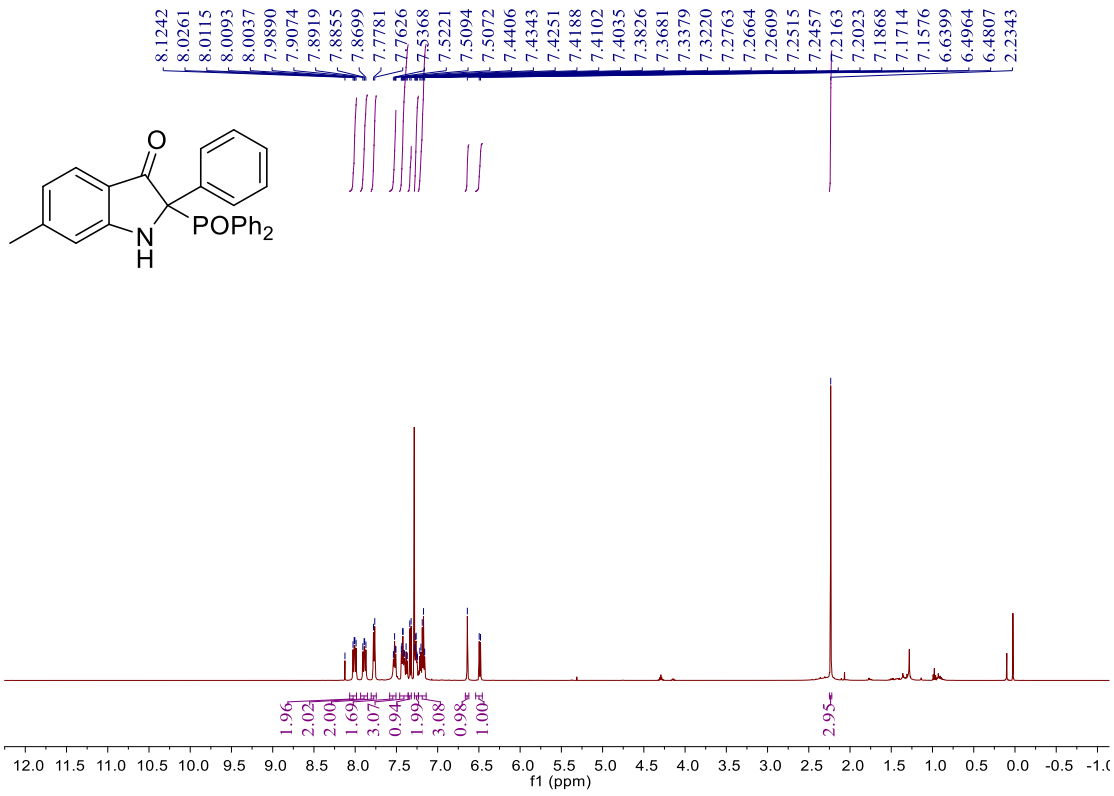
2-(diphenylphosphoryl)-2-phenylindolin-3-one (3a)

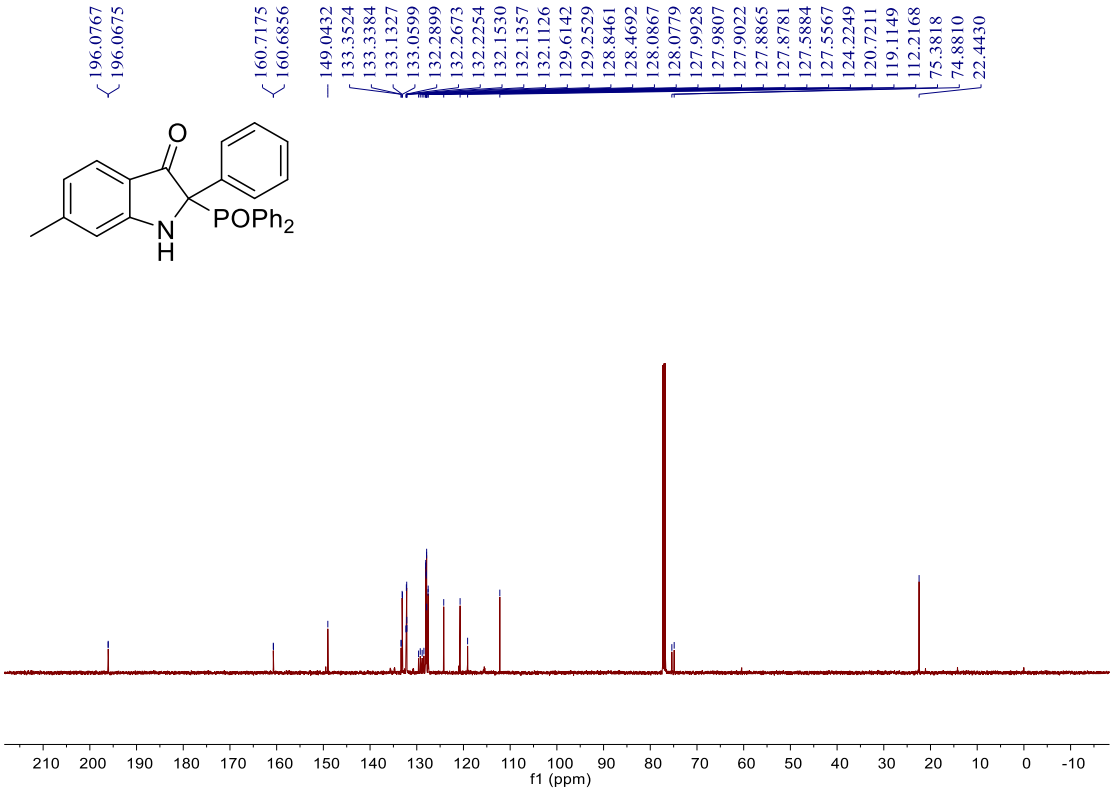


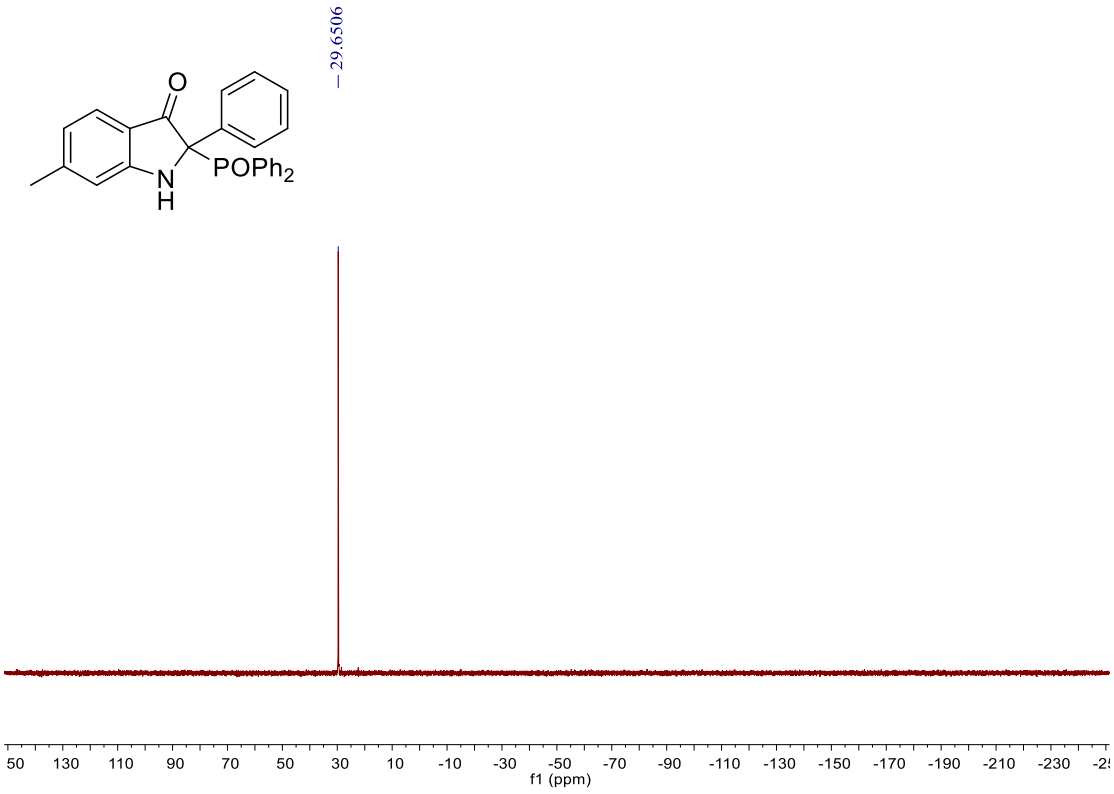




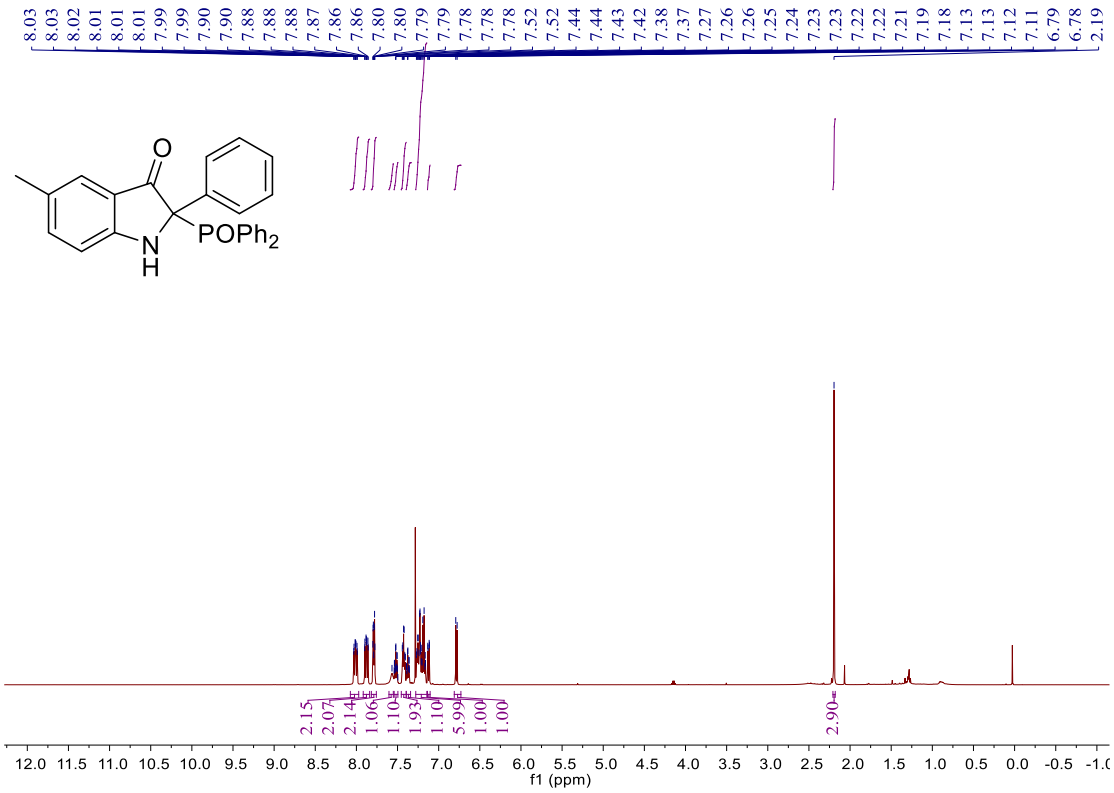
2-(diphenylphosphoryl)-6-methyl-2-phenylindolin-3-one (3b)

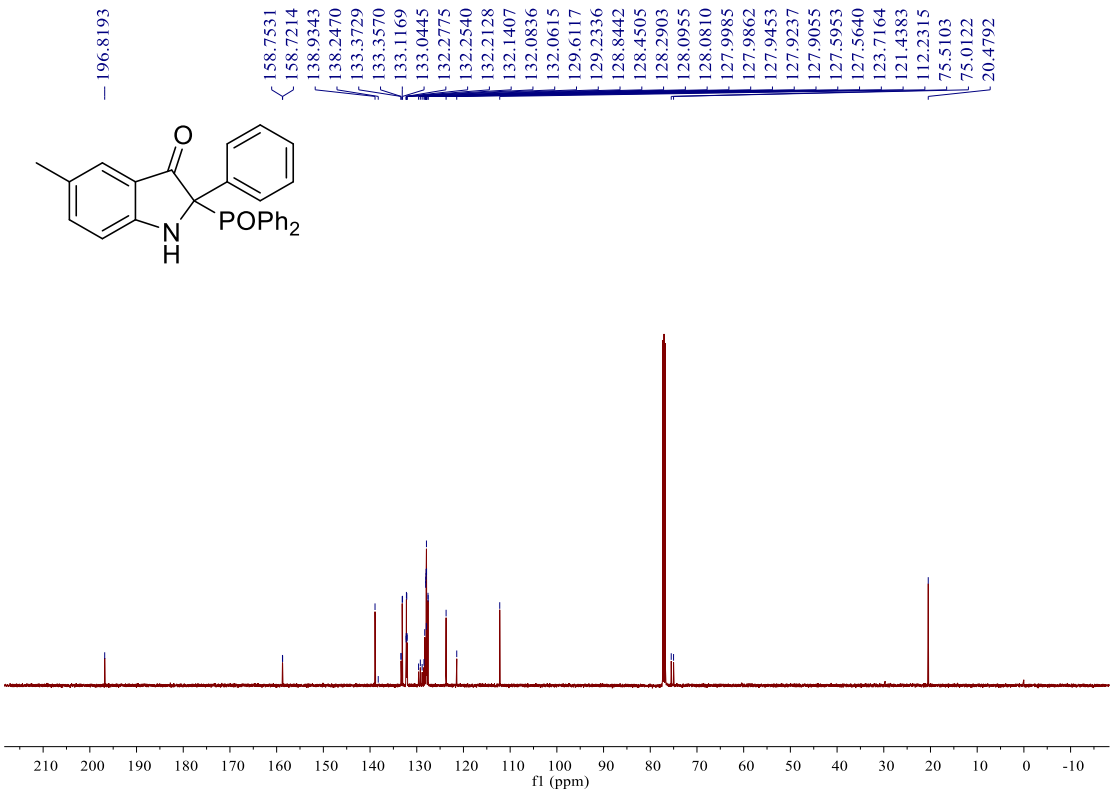


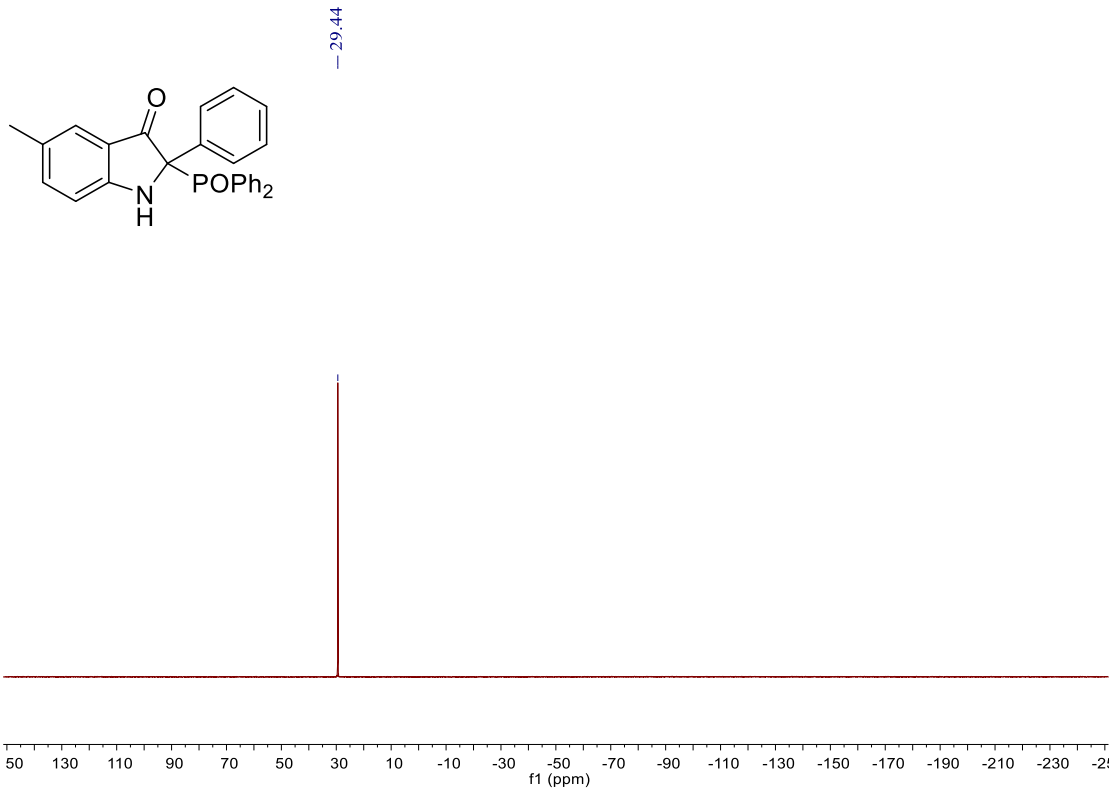




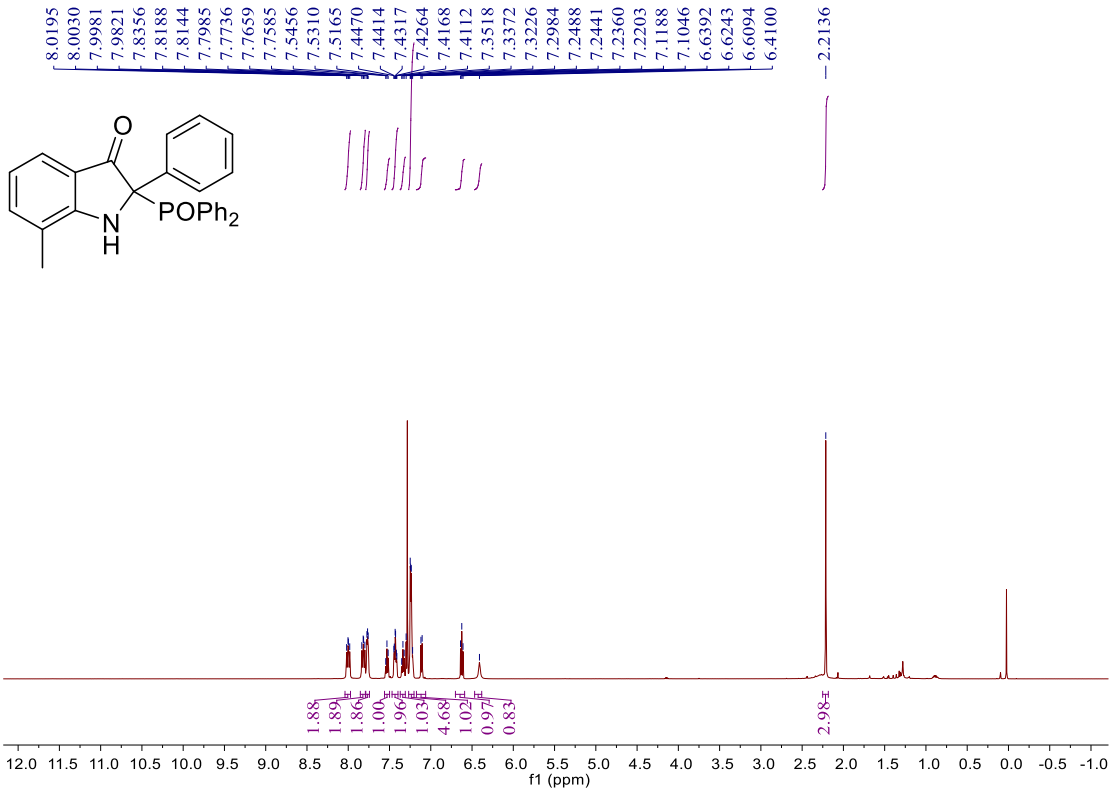
2-(diphenylphosphoryl)-5-methyl-2-phenylindolin-3-one (3c)

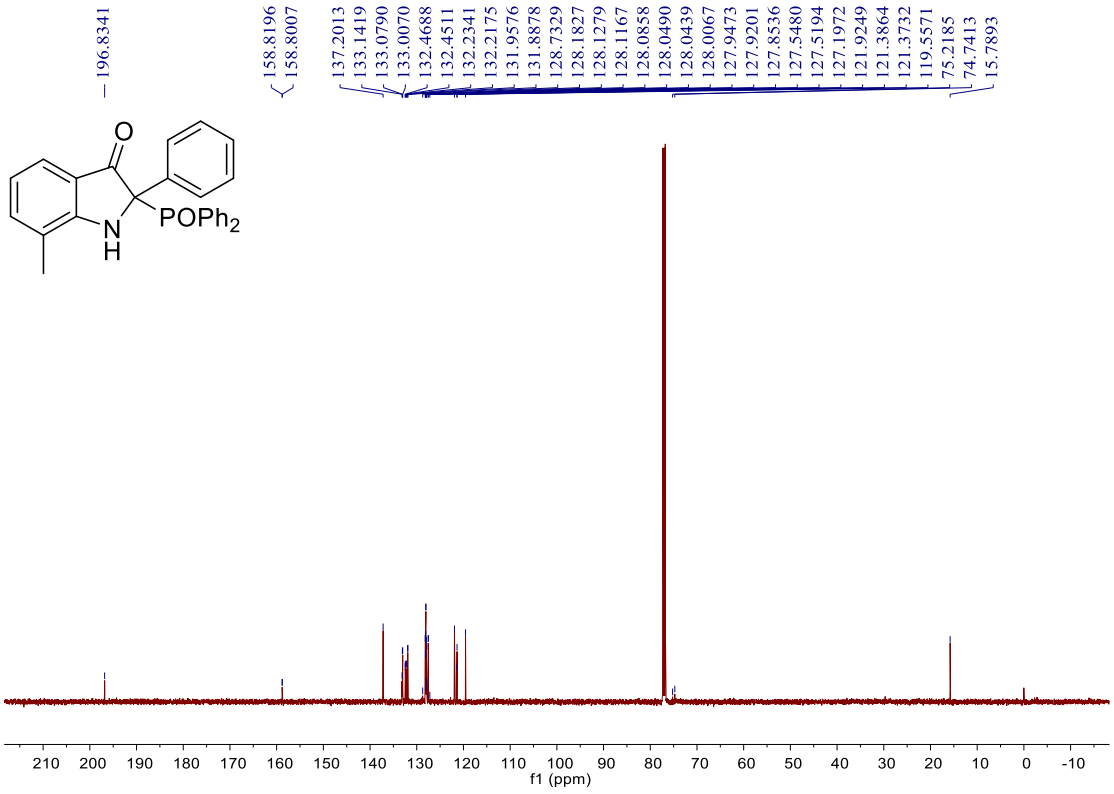

8.03 8.03 8.02 8.01 8.01 8.01 7.99 7.99 7.90 7.90 7.88 7.88 7.88 7.87 7.86 7.86 7.80 7.80 7.79 7.79 7.78 7.78 7.78 7.52 7.52 7.44 7.44 7.43 7.42 7.38 7.37 7.27 7.26 7.26 7.25 7.24 7.23 7.23 7.22 7.22 7.21 7.19 7.18 7.13 7.13 7.12 7.11 6.79 6.78 2.19
O
POPh2
N
H
2.15 2.07 2.14 1.06 1.10 1.93 1.10 5.99 1.00 1.00 2.90
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

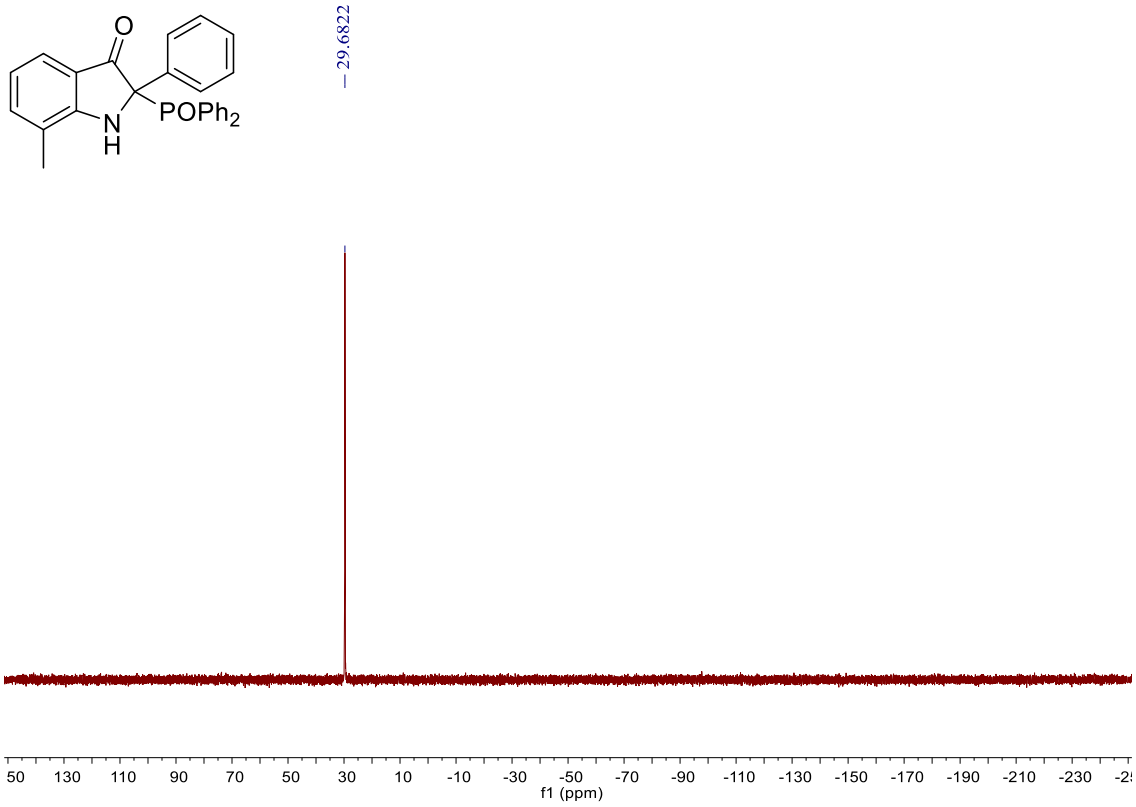

196.8193
158.7531 158.7214 138.9343 138.2470 133.3729 133.3570 133.1169 133.0445 132.2775 132.2540 132.2128 132.1407 132.0836 132.0615 129.6117 129.2336 128.8442 128.4505 128.2903 128.0955 128.0810 127.9985 127.9862 127.9453 127.9237 127.9055 127.5953 127.5640 123.7164 121.4383 112.2315 75.5103 75.0122 20.4792
O
POPh2
N
H
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



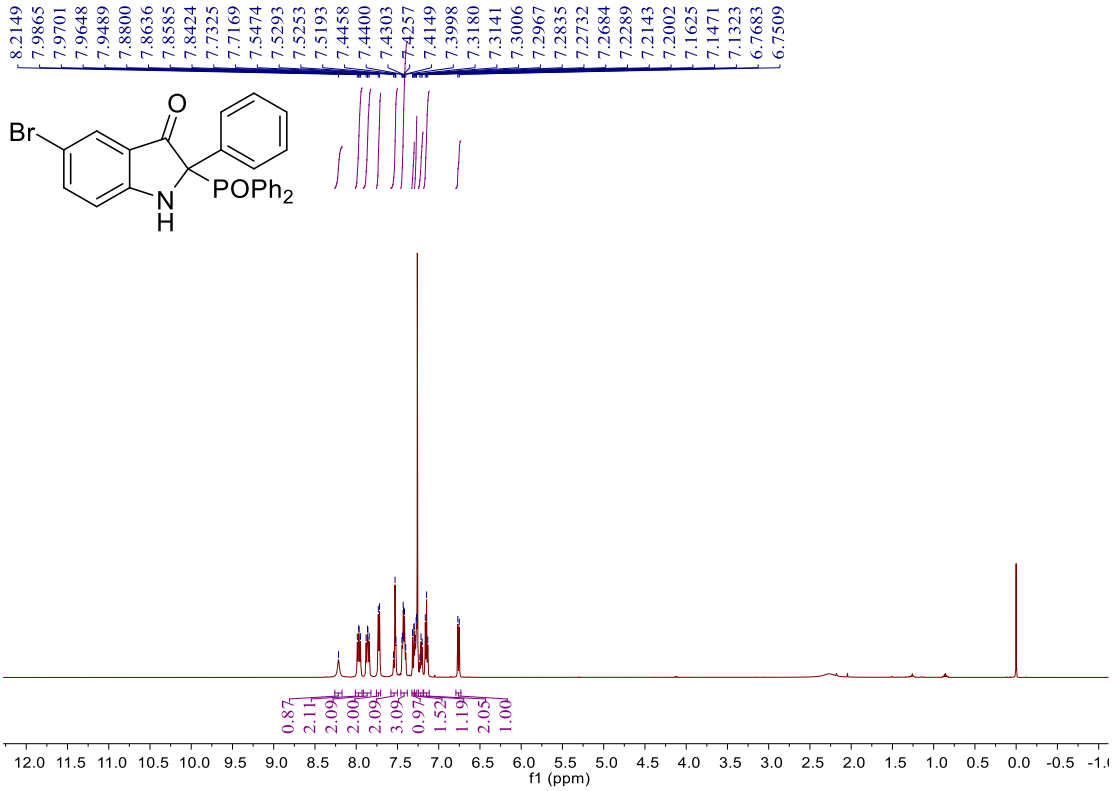
2-(diphenylphosphoryl)-7-methyl-2-phenylindolin-3-one (3d)

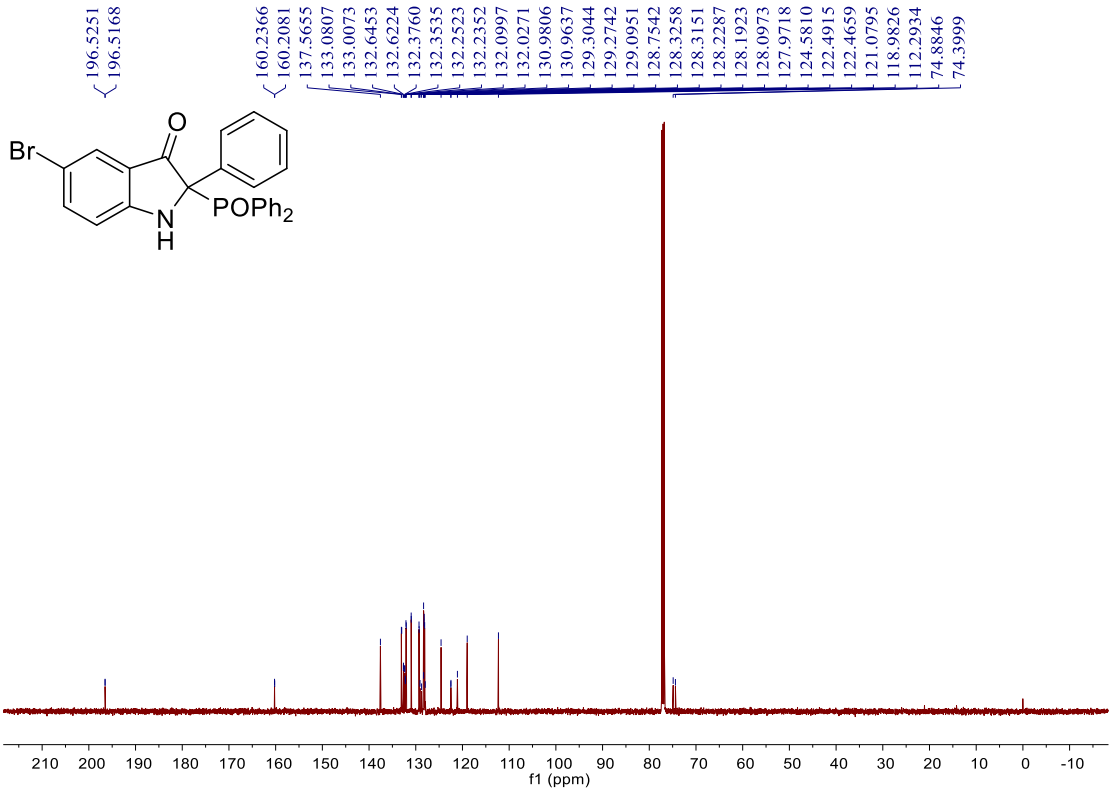


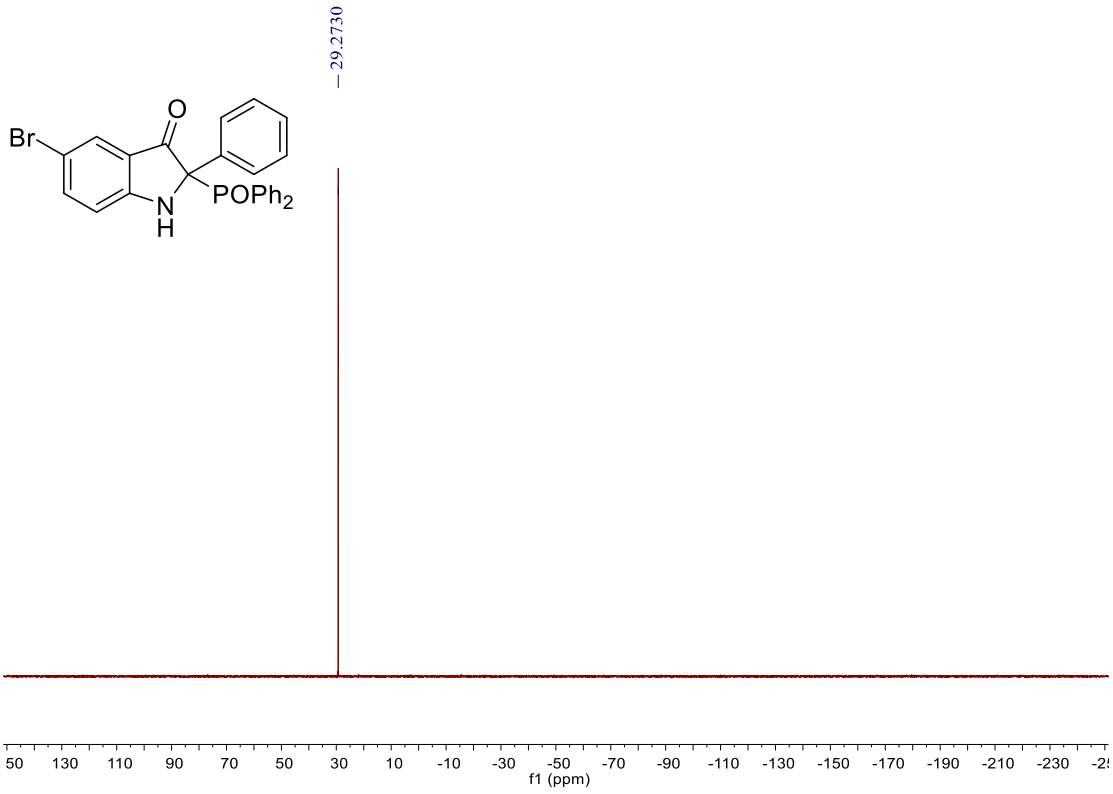

196.8341
158.8196
158.8007
137.2013
133.1419
133.0790
133.0070
132.4688
132.4511
132.2341
132.2175
131.9576
131.8878
128.7329
128.1827
128.1279
128.1167
128.0858
128.0490
128.0439
128.0067
127.9473
127.9201
127.8536
127.5480
127.5194
127.1972
121.9249
121.3864
121.3732
119.5571
75.2185
74.7413
15.7893
O
N
H
POPh2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


29.6822
O
N
H
POPh2
50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

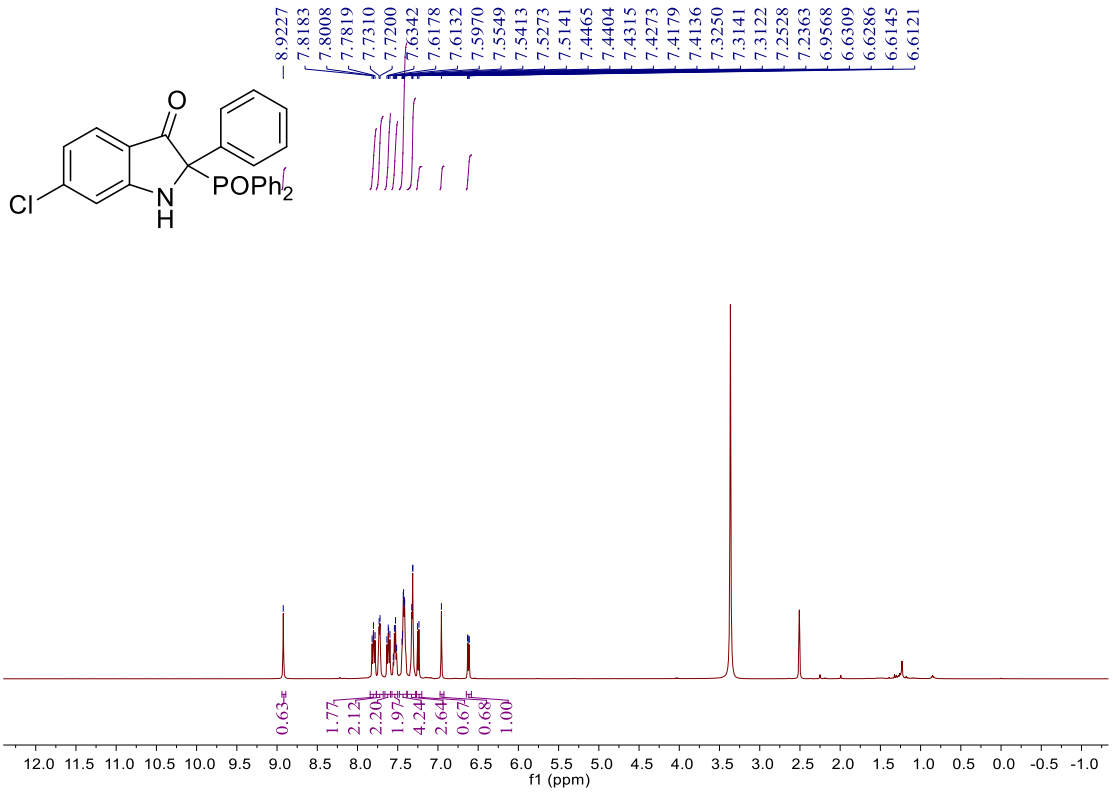
5-bromo-2-(diphenylphosphoryl)-2-phenylindolin-3-one (3e)

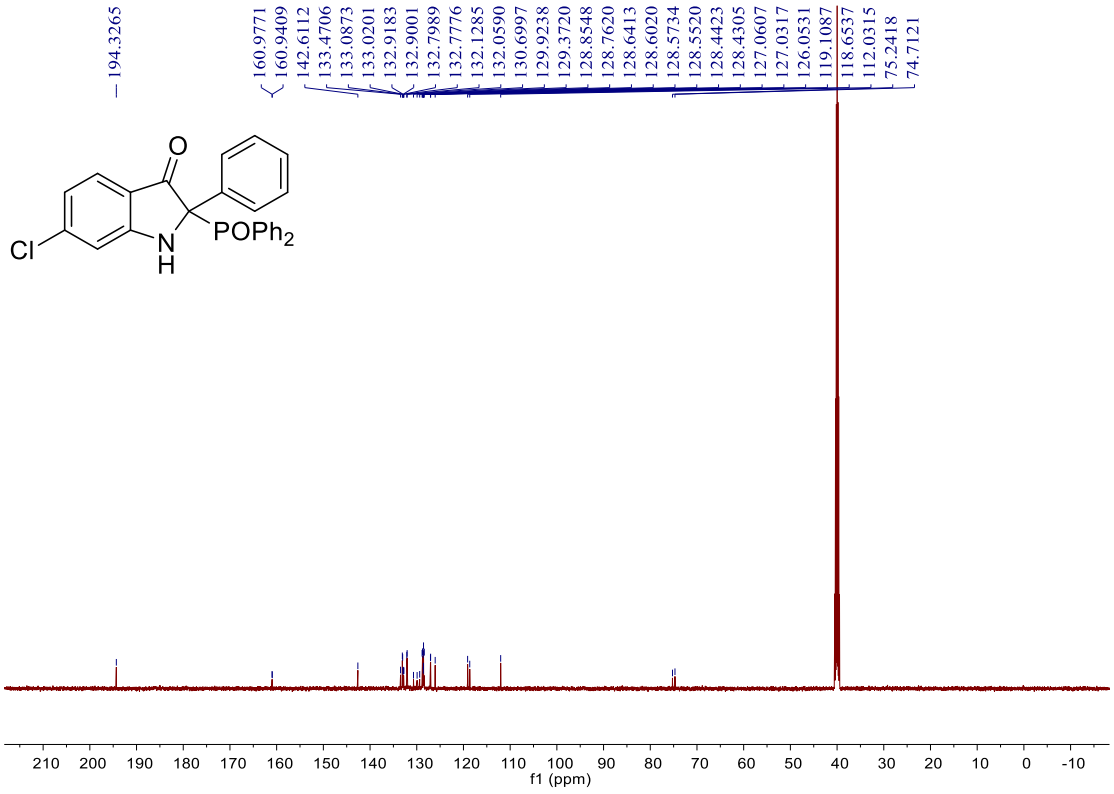


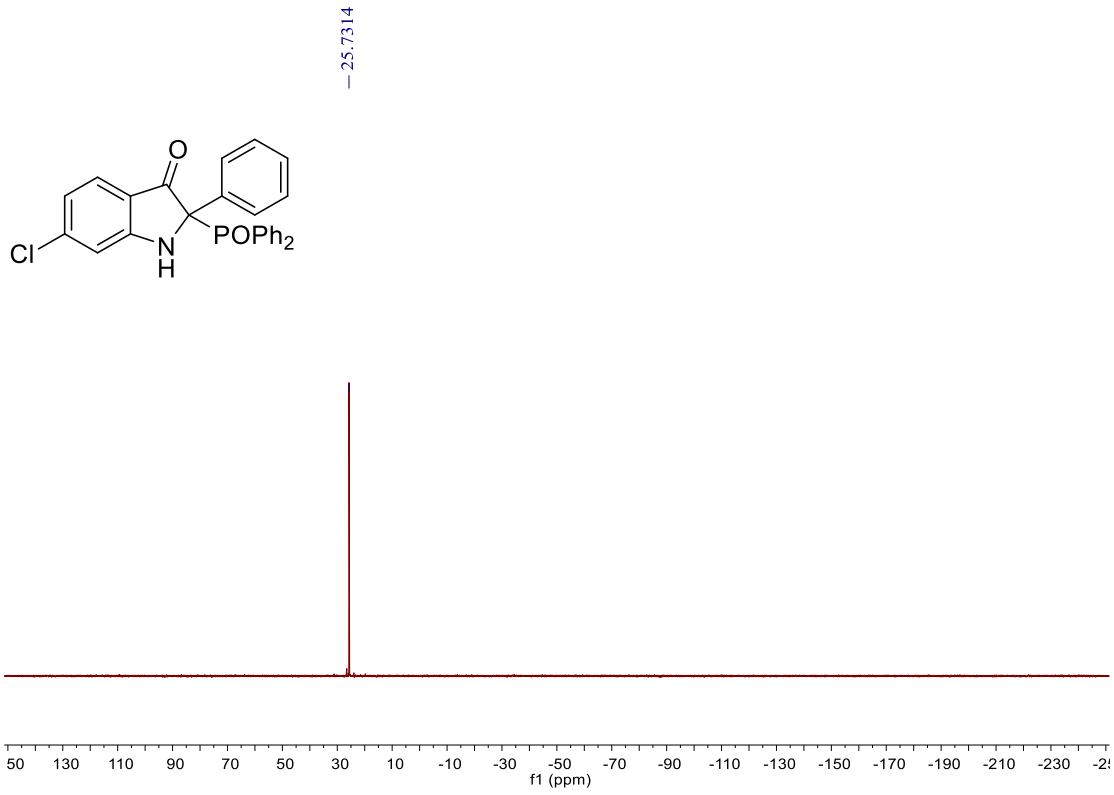




6-chloro-2-(diphenylphosphoryl)-2-phenylindolin-3-one (3f)




194.3265
160.9771
160.9409
142.6112
133.4706
133.0873
133.0201
132.9183
132.9001
132.7989
132.7776
132.1285
132.0590
130.6997
129.9238
129.3720
128.8548
128.7620
128.6413
128.6020
128.5734
128.5520
128.4423
128.4305
127.0607
127.0317
126.0531
119.1087
118.6537
112.0315
75.2418
74.7121
O
Cl
N
H
POPh2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


25.7314
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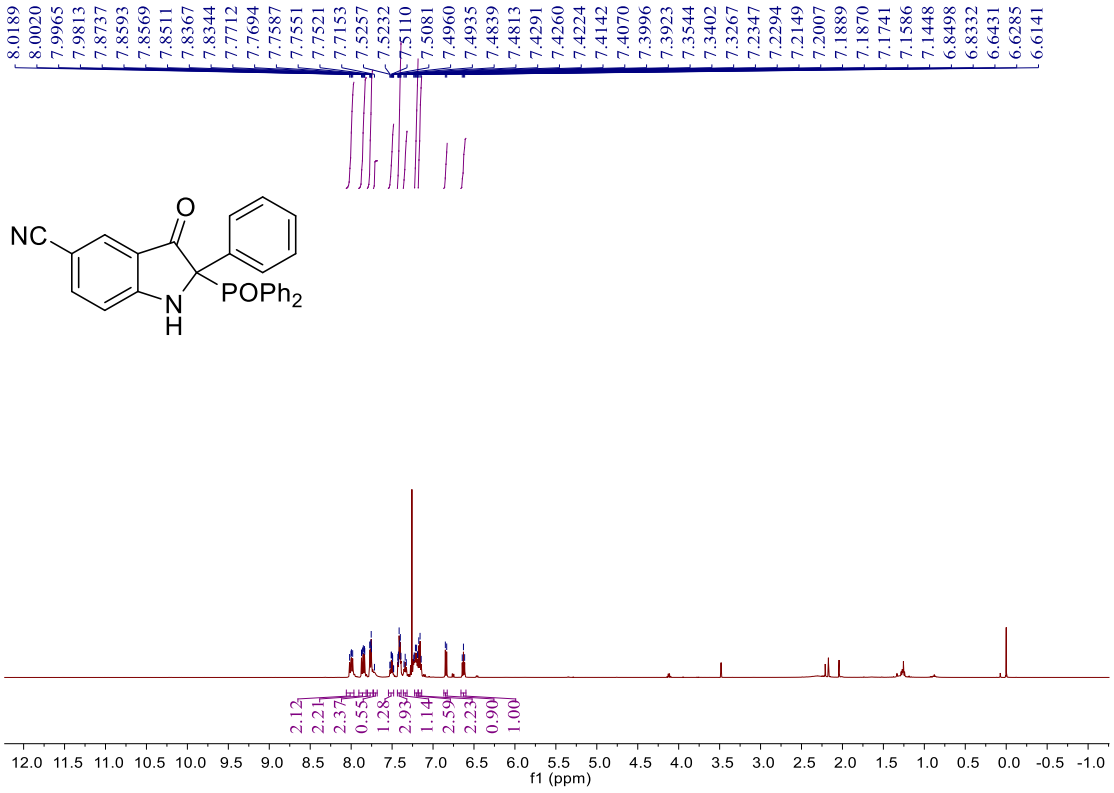
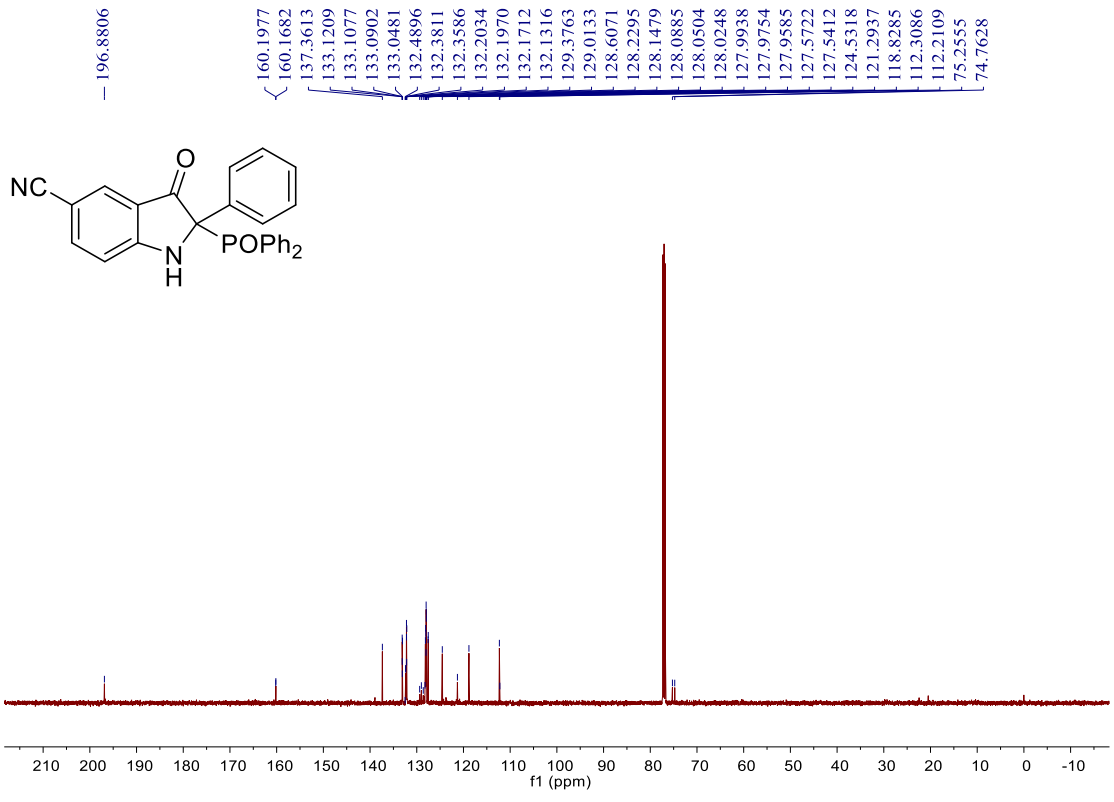
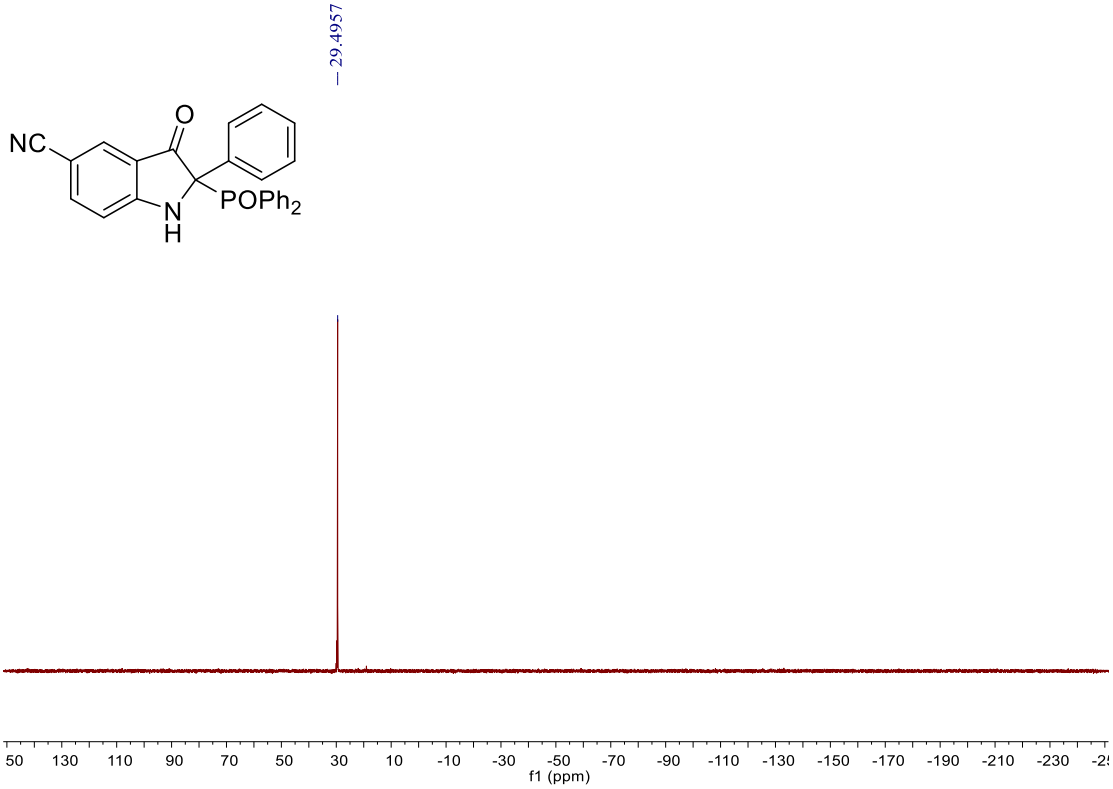
Cl
N
H
POPh2
50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

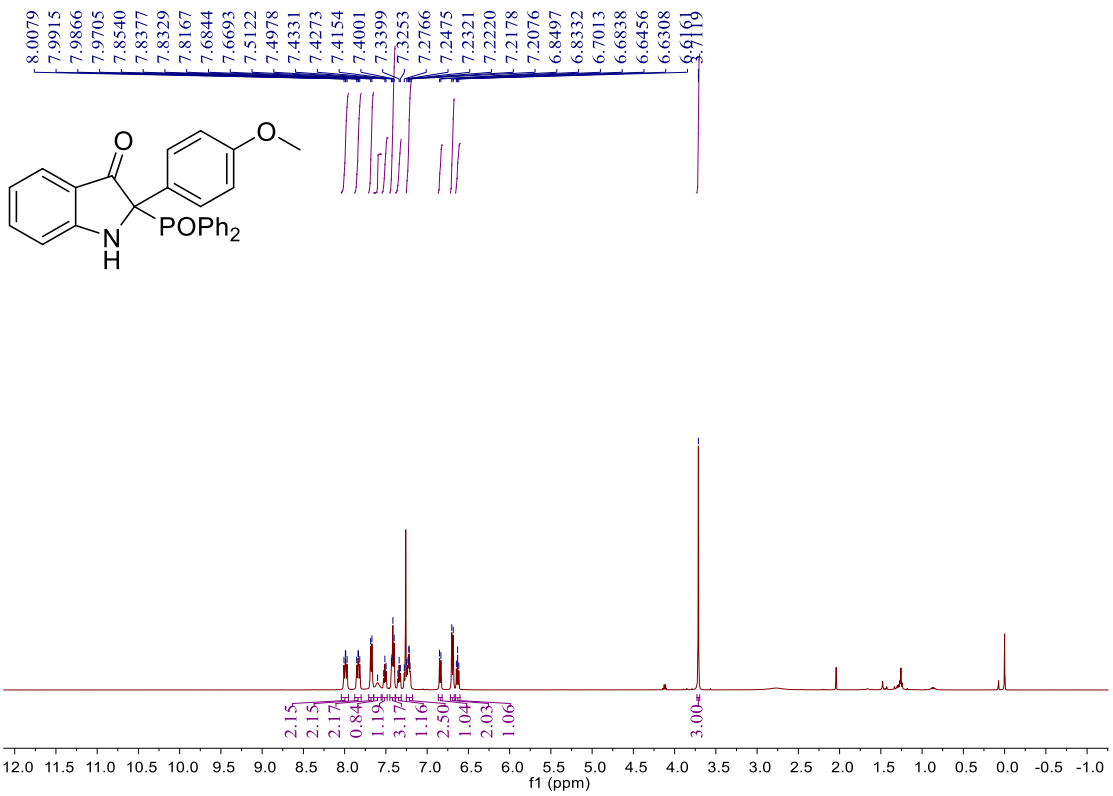
2-(diphenylphosphoryl)-3-oxo-2-phenylindoline-5-carbonitrile (3g)

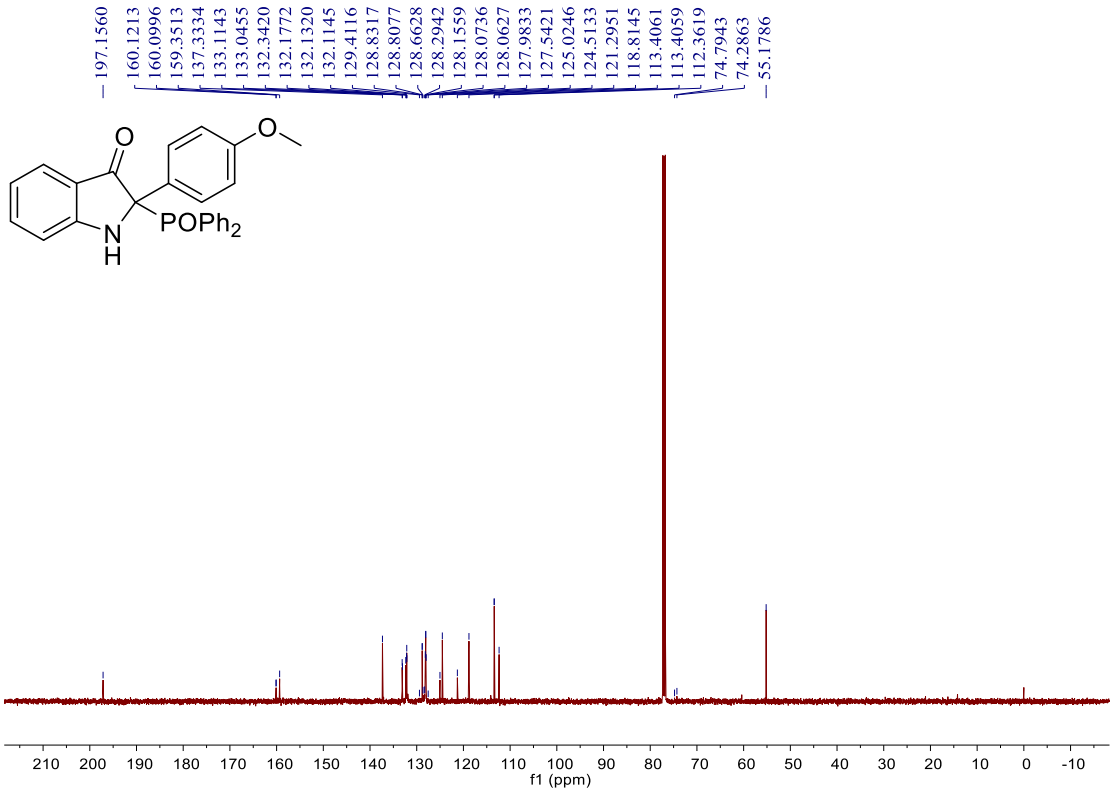






2-(diphenylphosphoryl)-2-(4-methoxyphenyl)indolin-3-one (3h)

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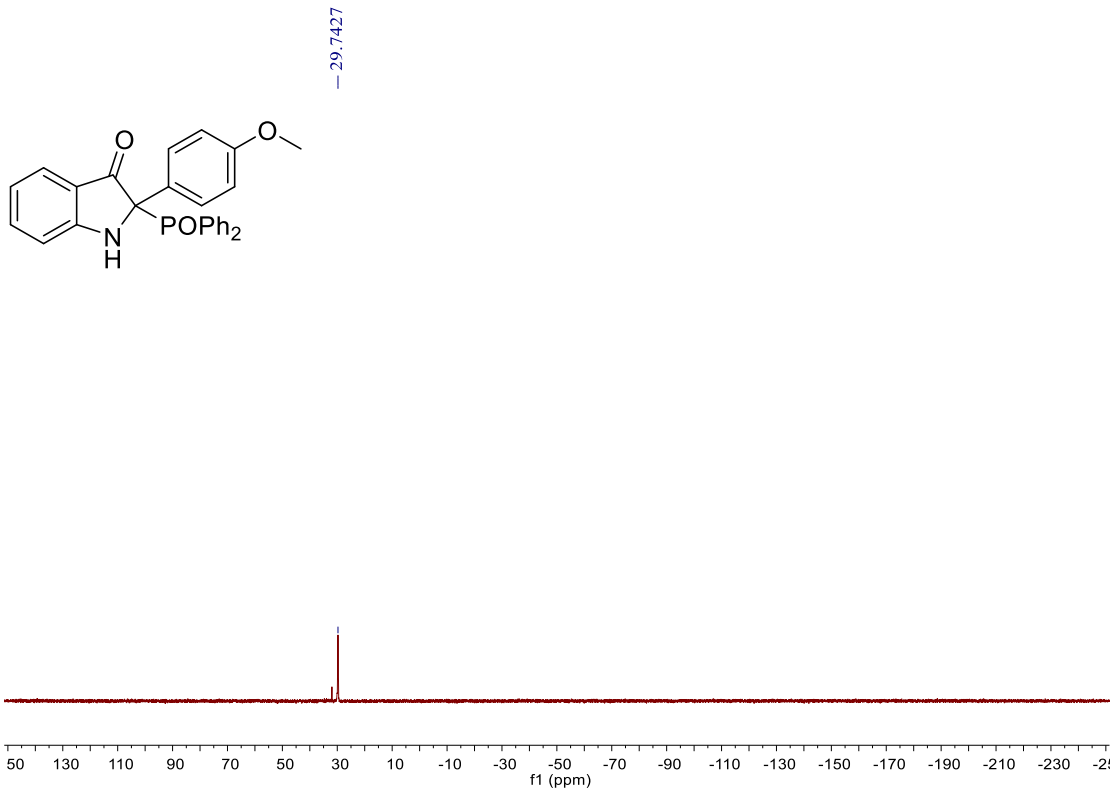
160.0996
159.3513
137.3334
133.1143
133.0455
132.3420
132.1772
132.1320
132.1145
129.4116
128.8317
128.8077
128.6628
128.2942
128.1559
128.0736
128.0627
127.9833
127.5421
125.0246
124.5133
121.2951
118.8145
113.4061
113.4059
112.3619
74.7943
74.2863
55.1786
O
O
N
H
POPh2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


29.7427
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O
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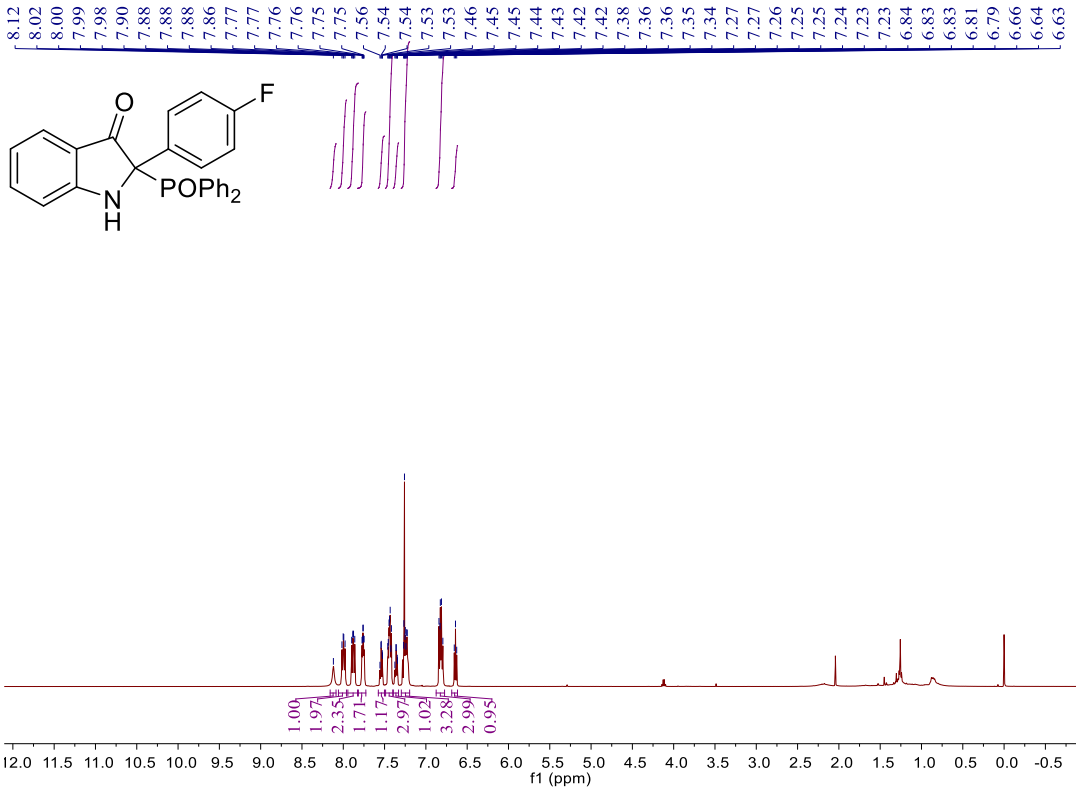
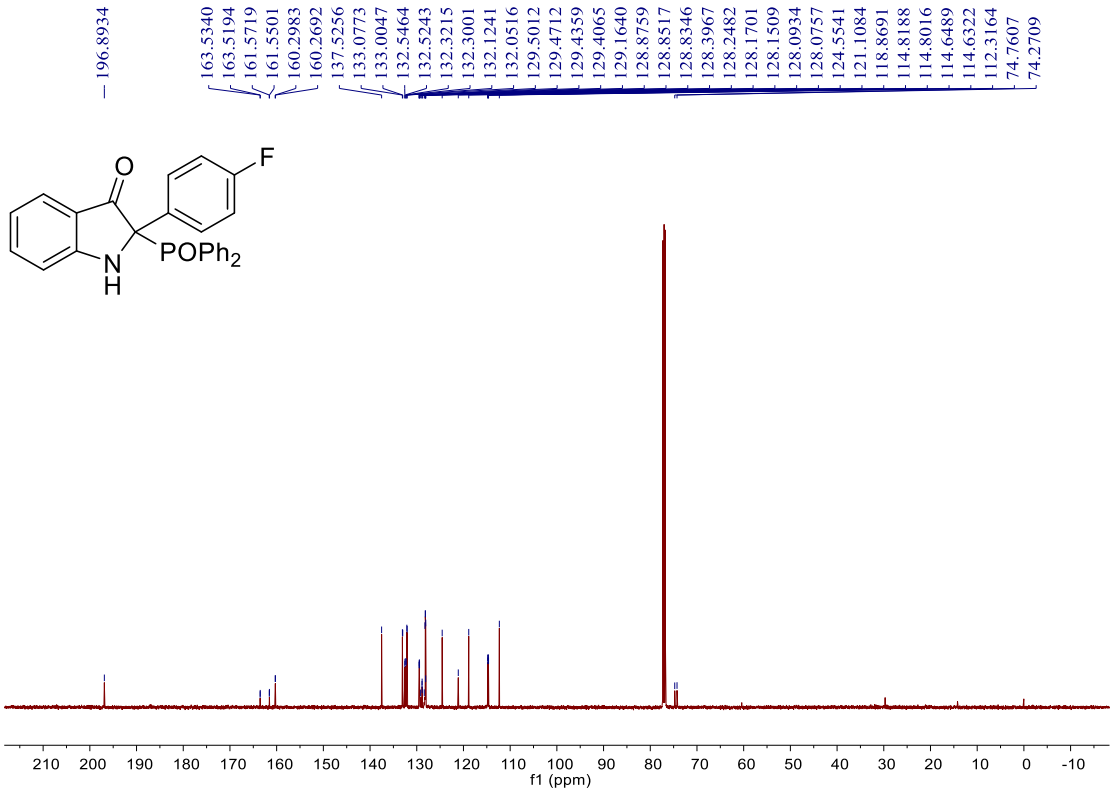
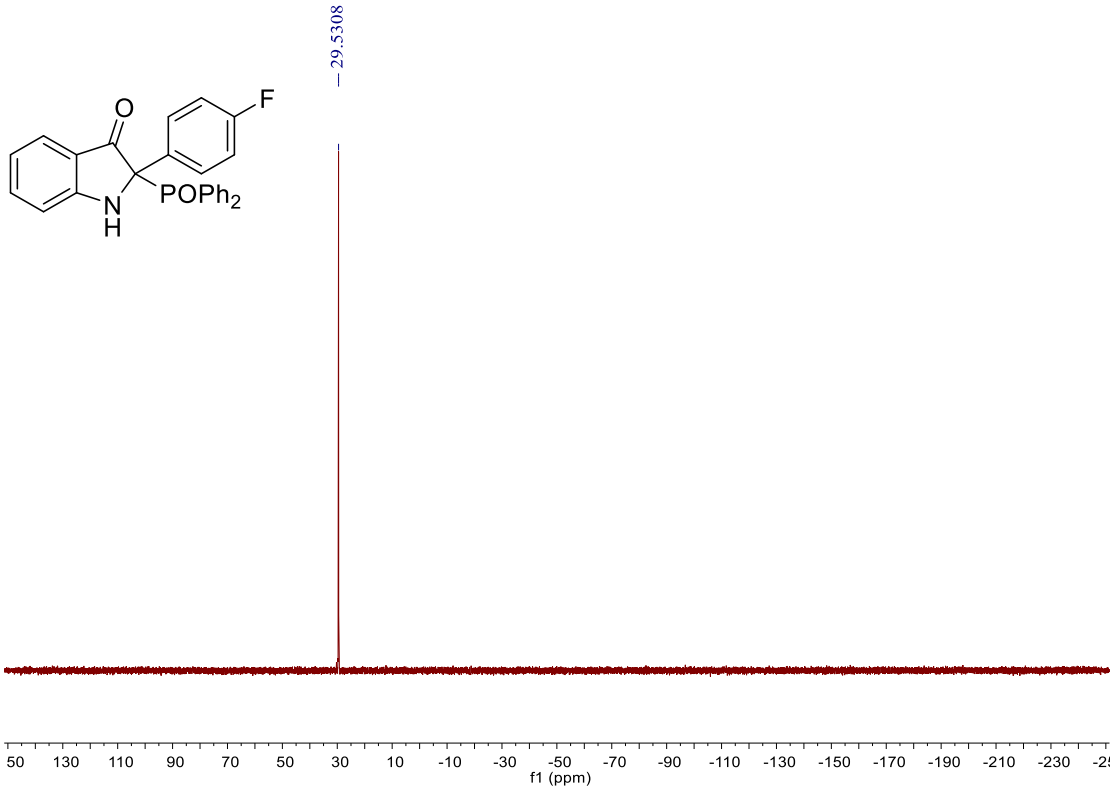
f1 (ppm)

2-(diphenylphosphoryl)-2-(4-fluorophenyl)indolin-3-one (3i)






29.5308
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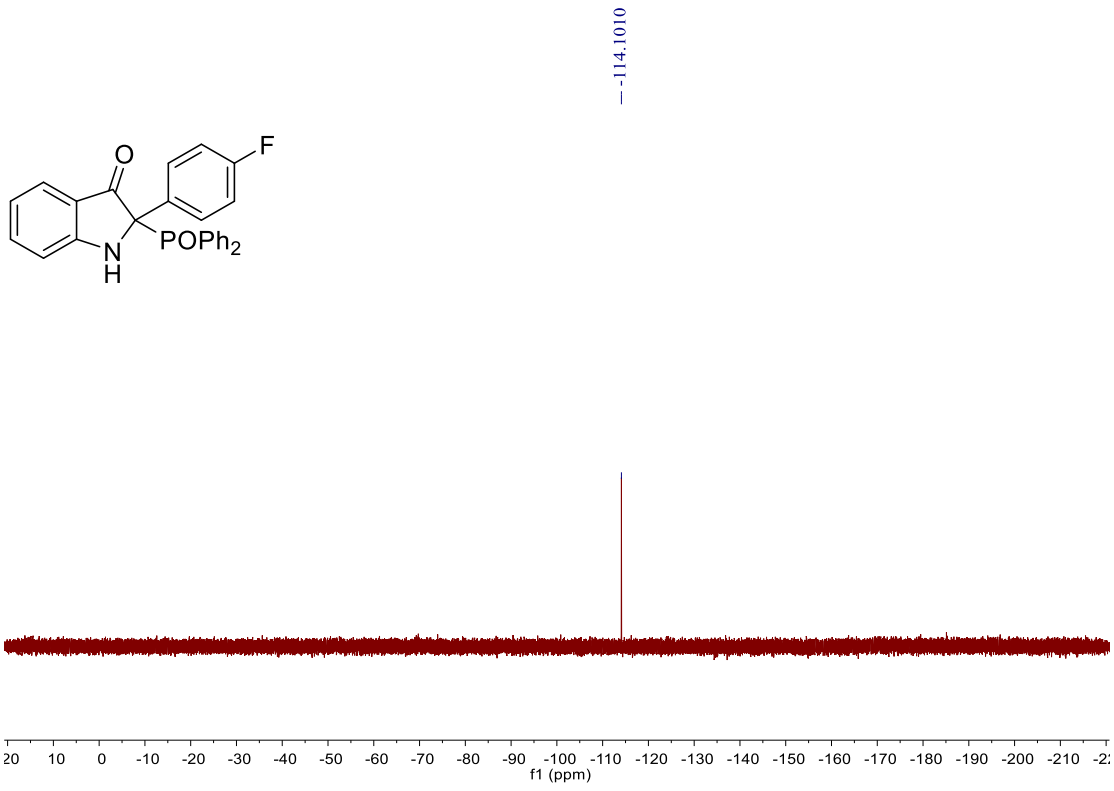
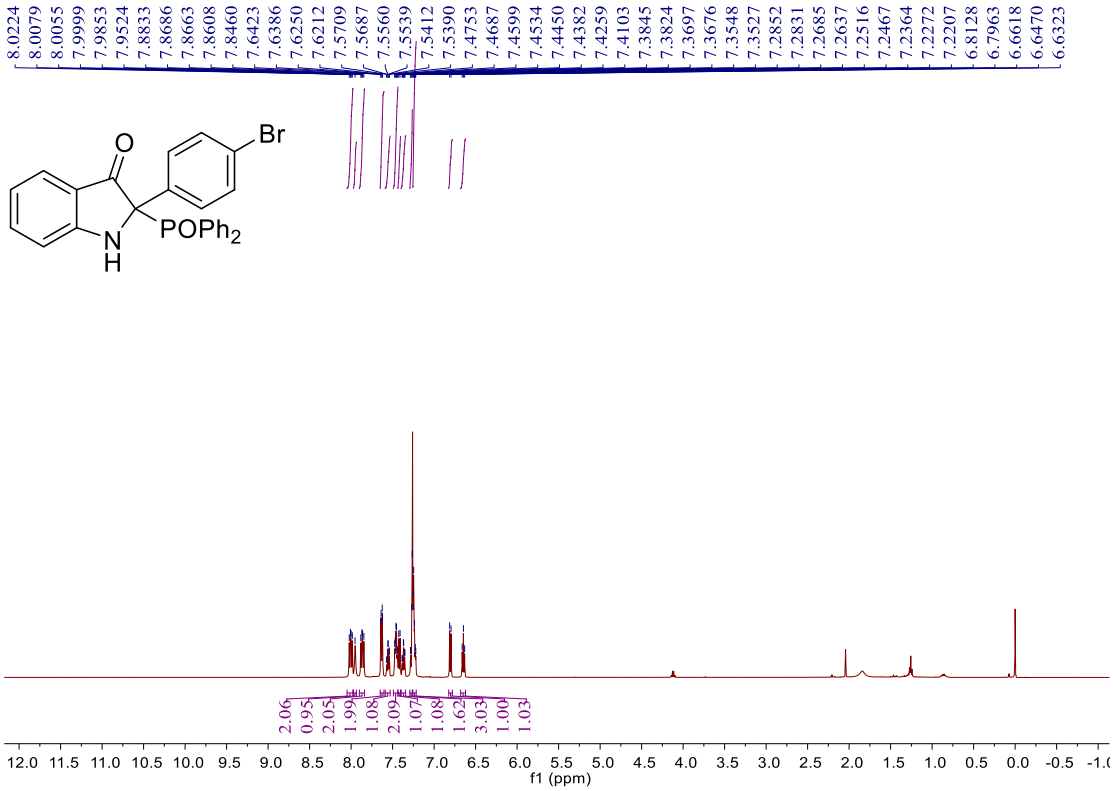
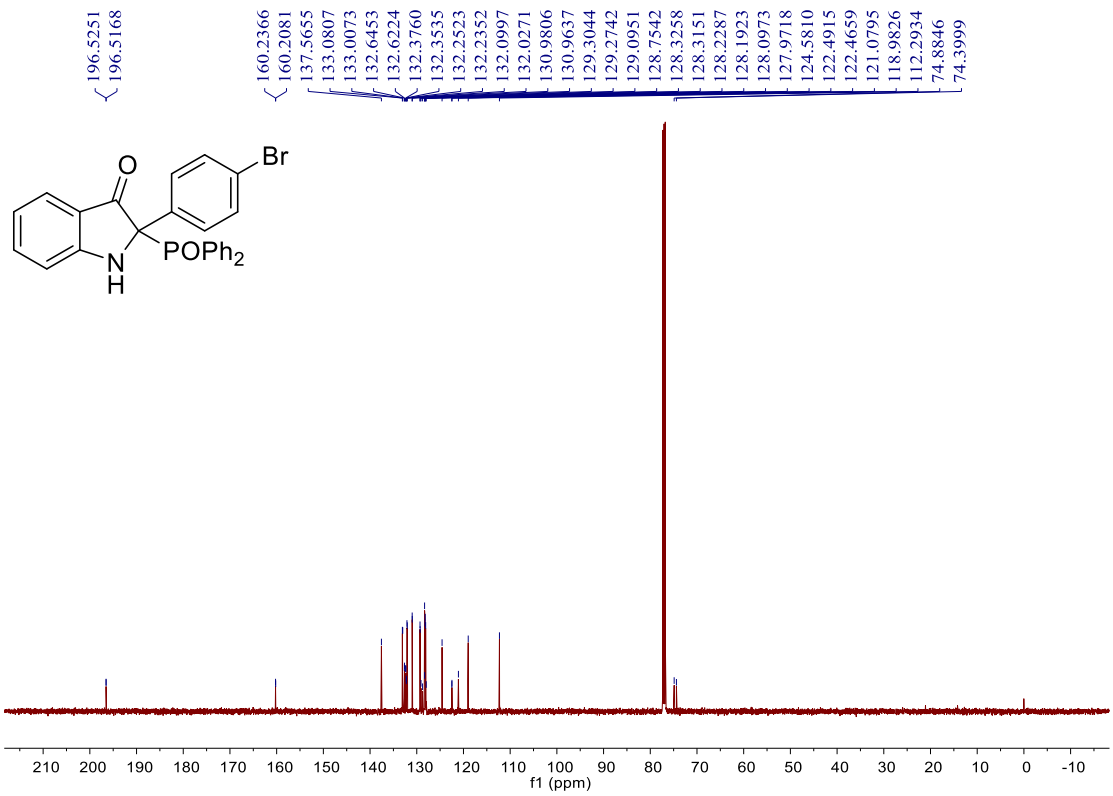
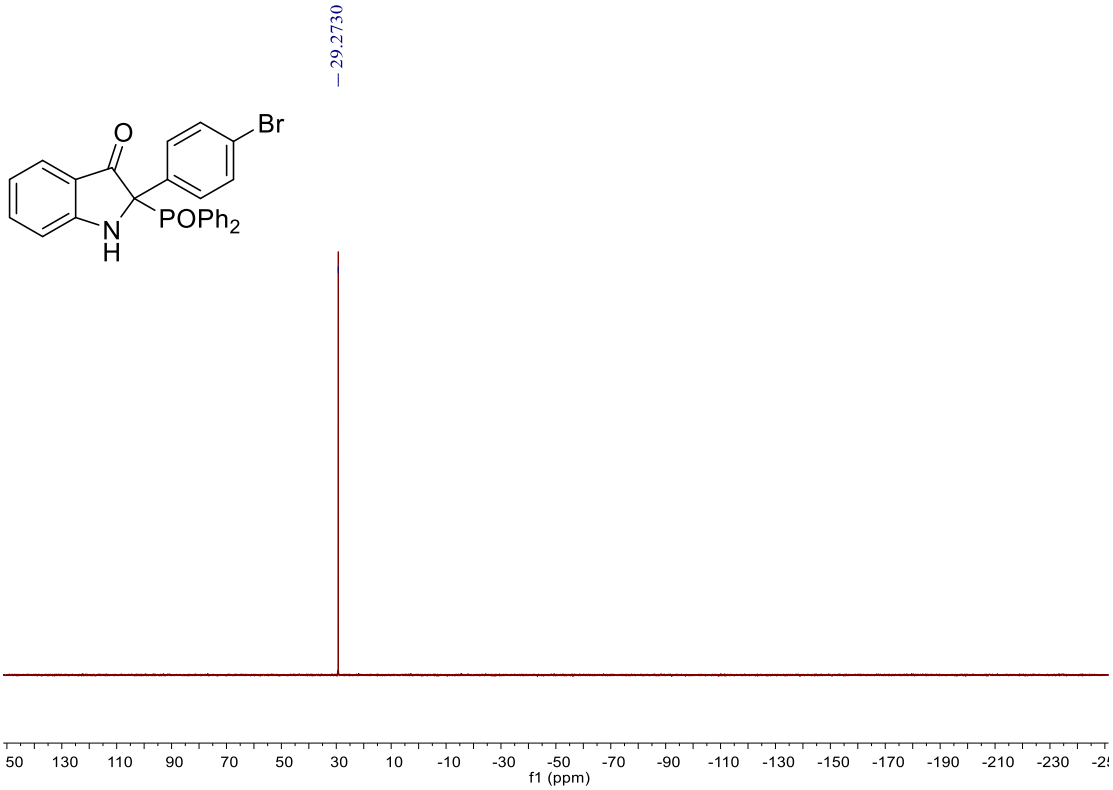
F
N
H
POPh2
50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


-114.1010
O
F
N
H
POPh2
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

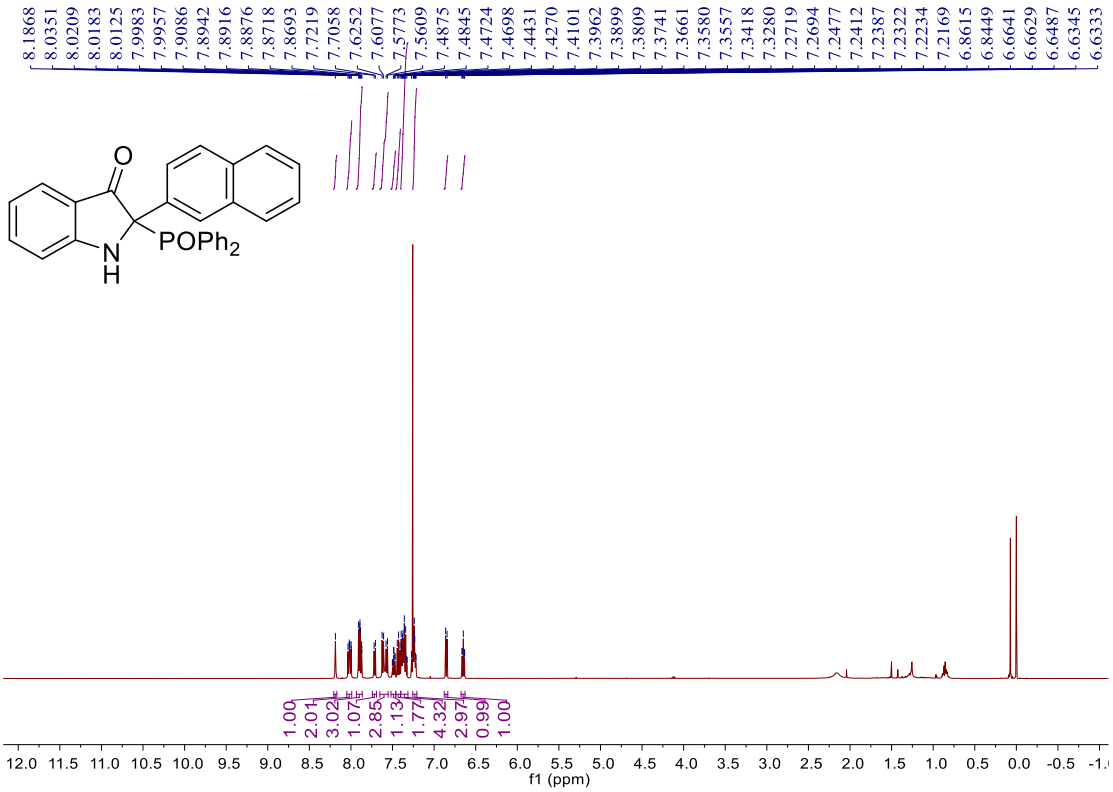
2-(4-bromophenyl)-2-(diphenylphosphoryl)indolin-3-one (3j)

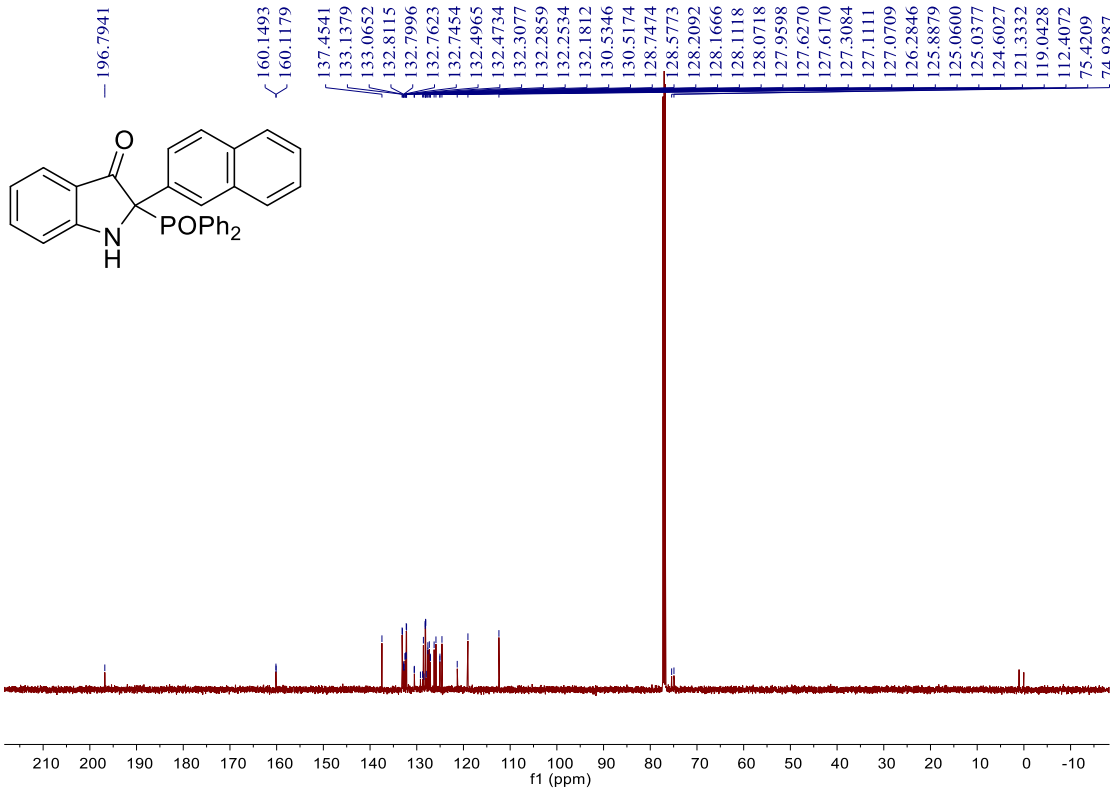






2-(diphenylphosphoryl)-2-(naphthalen-2-yl)indolin-3-one (3k)




196.7941
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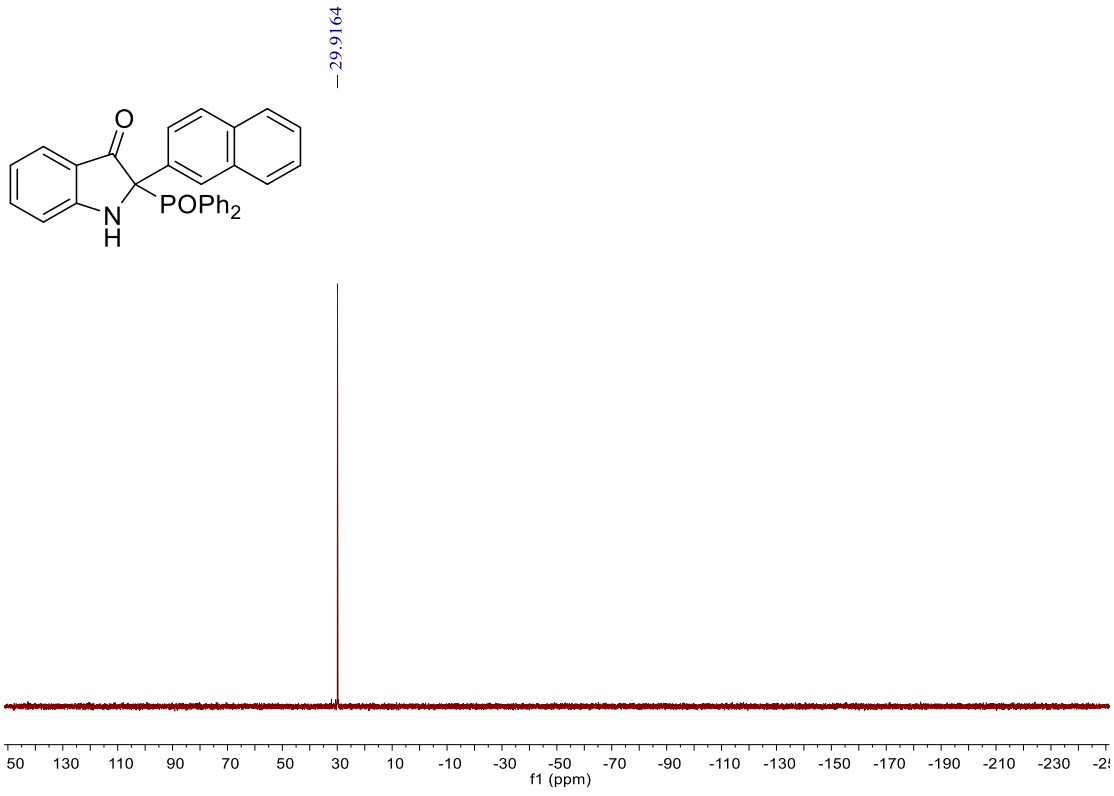
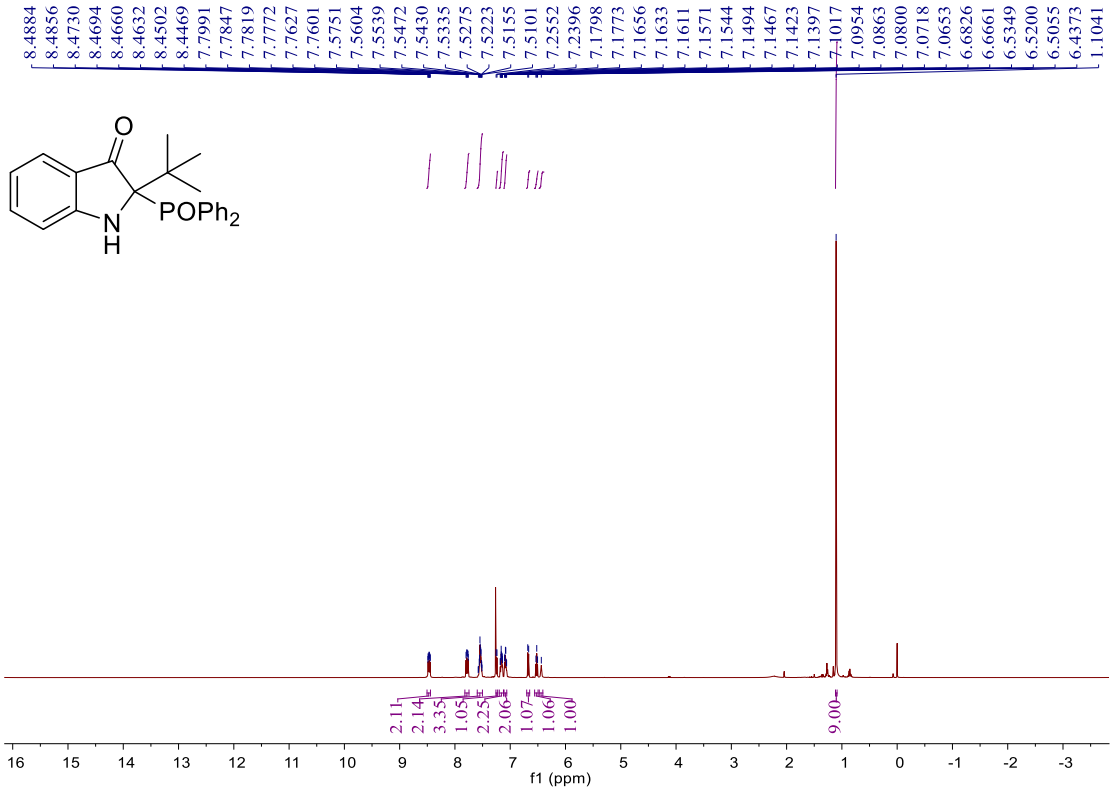
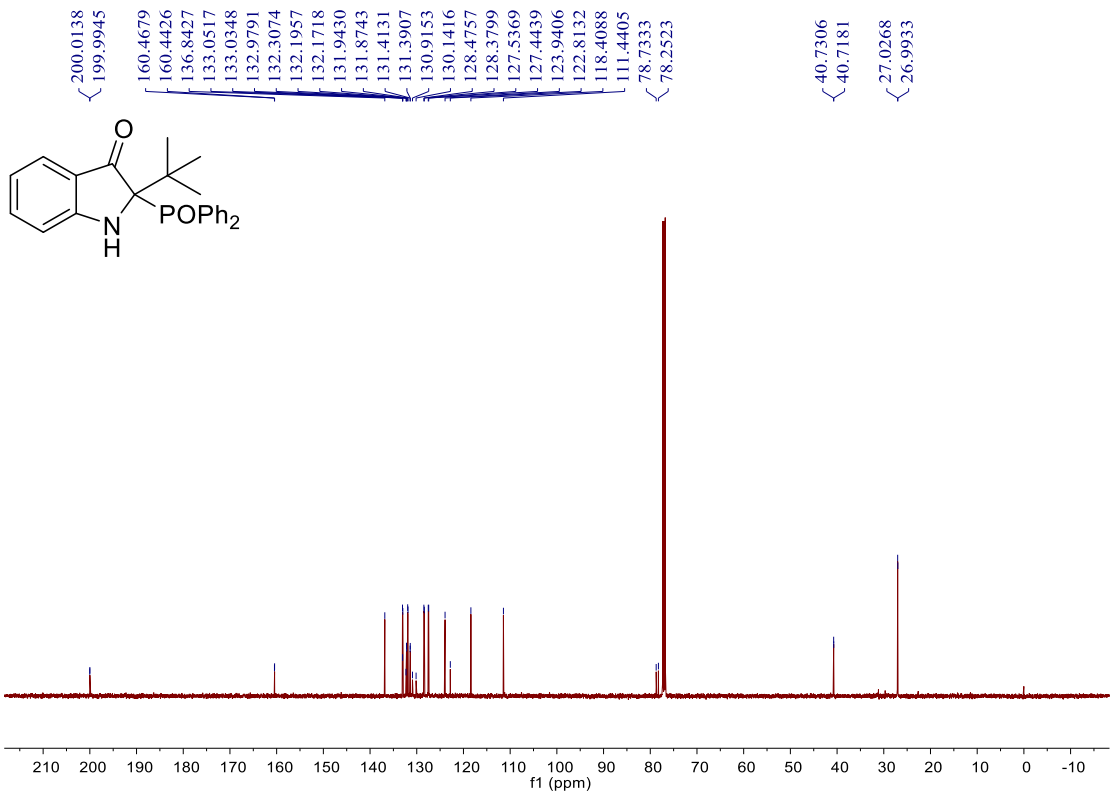
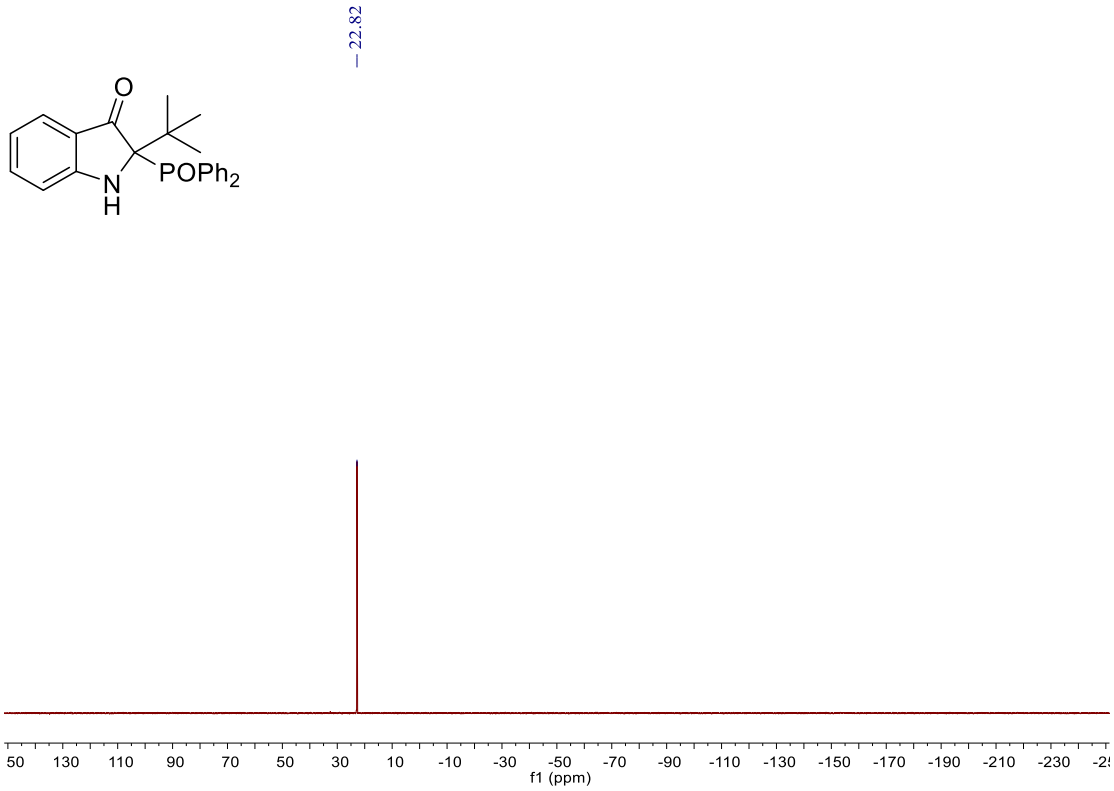
160.1179
137.4541
133.1379
133.0652
132.8115
132.7996
132.7623
132.7454
132.4965
132.4734
132.3077
132.2859
132.2534
132.1812
130.5346
130.5174
128.7474
128.5773
128.2092
128.1666
128.1118
128.0718
127.9598
127.6270
127.6170
127.3084
127.1111
127.0709
126.2846
125.8879
125.0600
125.0377
124.6027
121.3332
119.0428
112.4072
75.4209
O
N
H
POPh2
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


29.9164
O
N
H
POPh2
50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

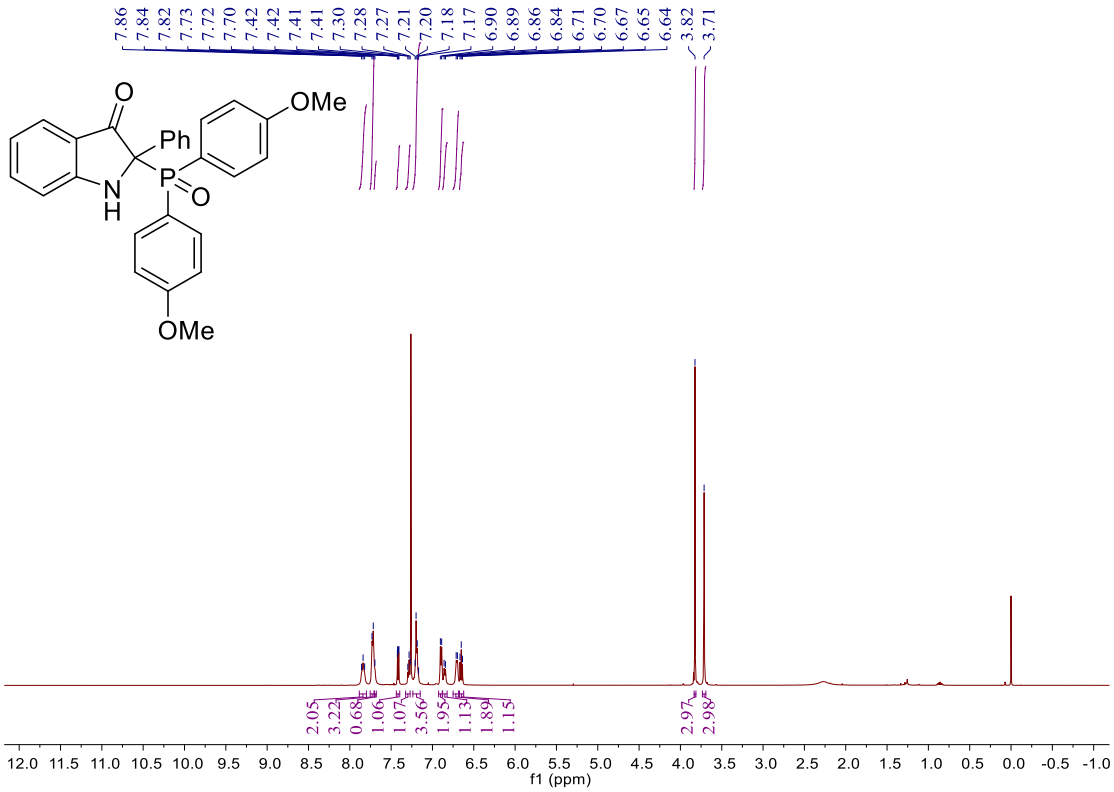
2-(tert-butyl)-2-(diphenylphosphoryl)indolin-3-one (3l).

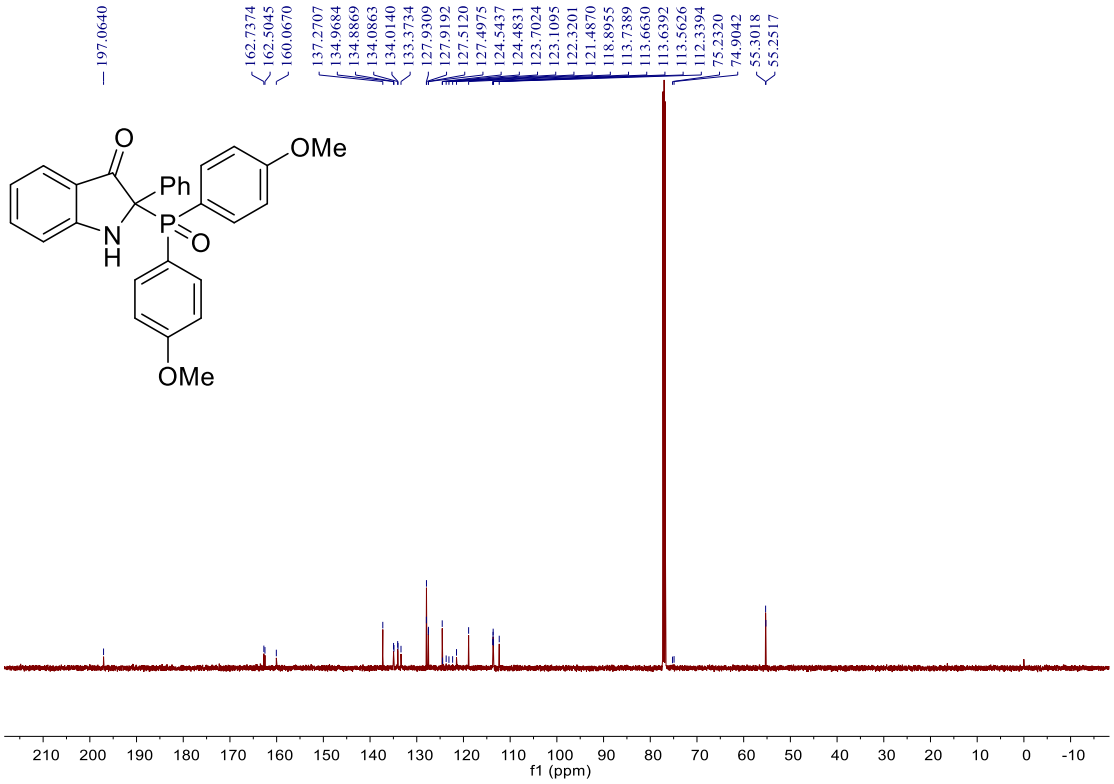






2-(bis(4-methoxyphenyl)phosphoryl)-2-phenylindolin-3-one (3m)

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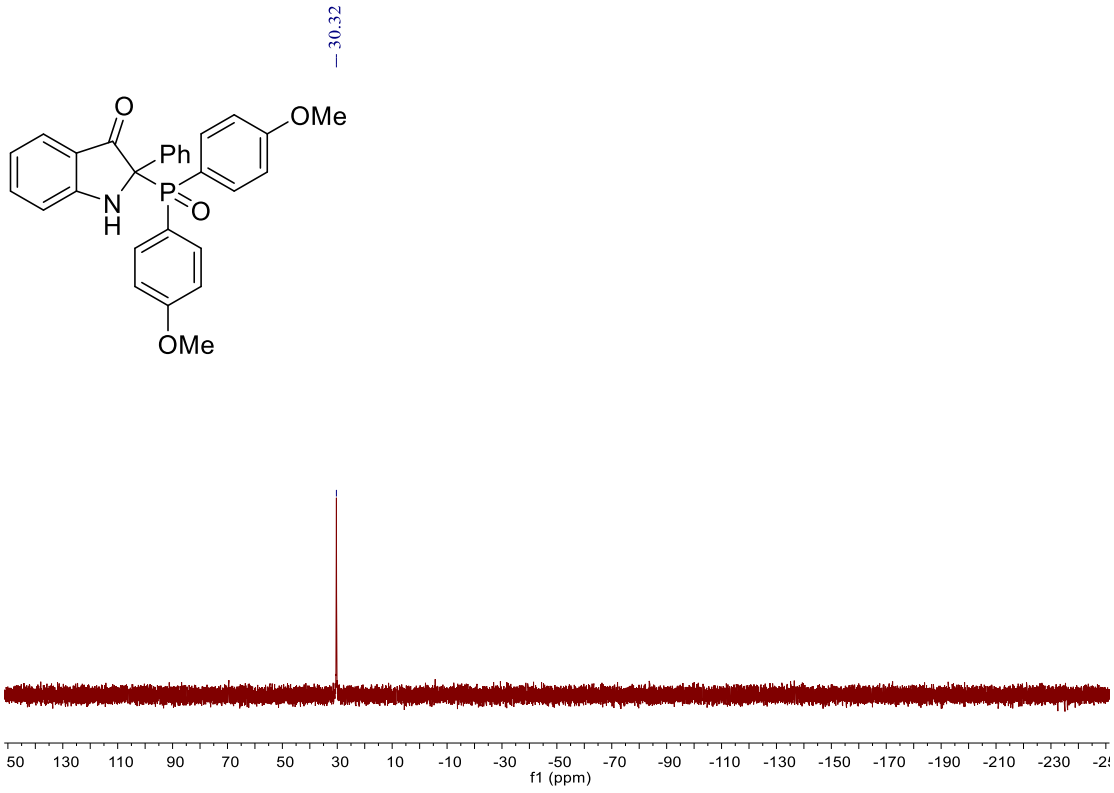
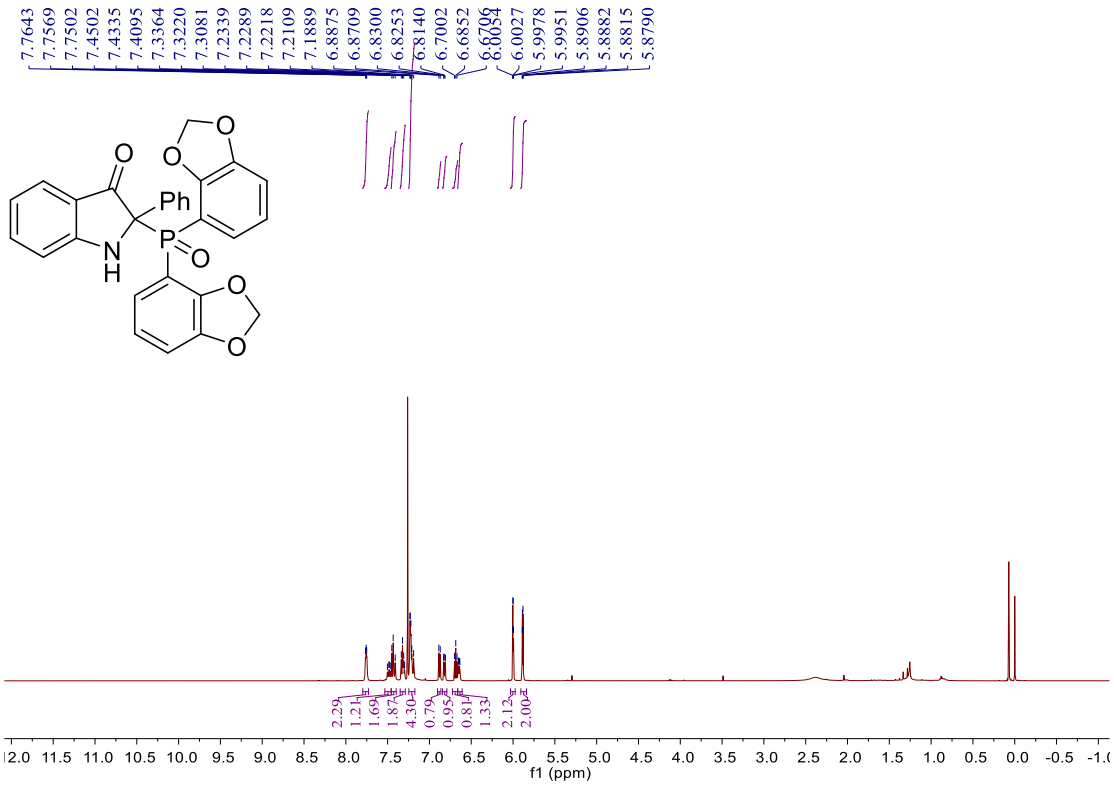
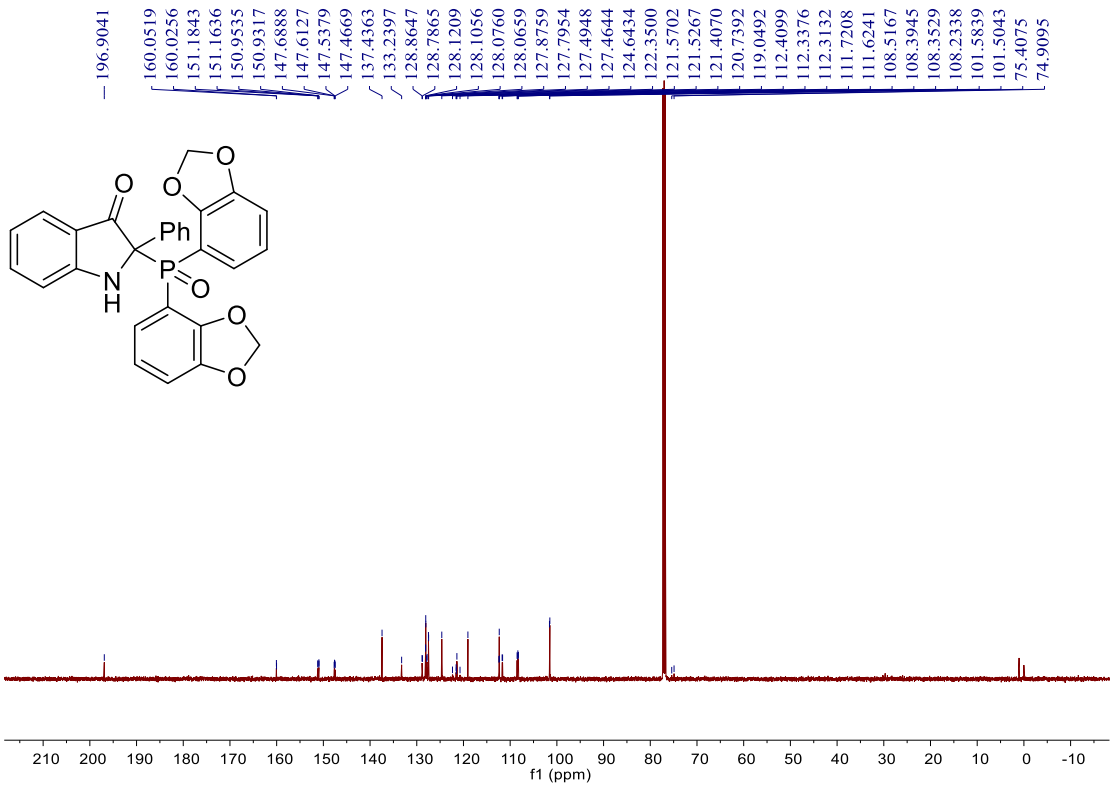
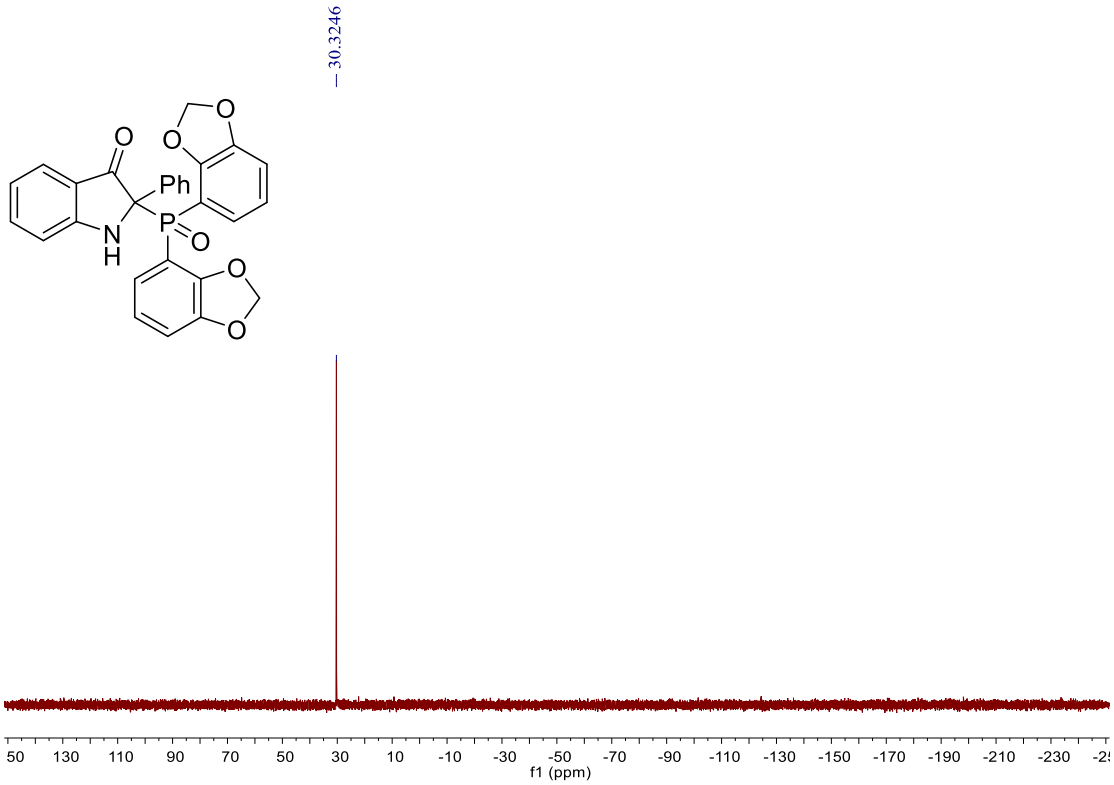
162.5045
160.0670
137.2707
134.9684
134.8869
134.0863
134.0140
133.3734
127.9309
127.9192
127.5120
127.4975
124.5437
124.4831
123.7024
123.1095
122.3201
121.4870
118.8955
113.7389
113.6630
113.6392
113.5626
112.3394
75.2320
74.9042
55.3018
55.2517
O
Ph
P
O
N
H
OMe
OMe
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


30.32
O
Ph
P
O
N
H
OMe
OMe
50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

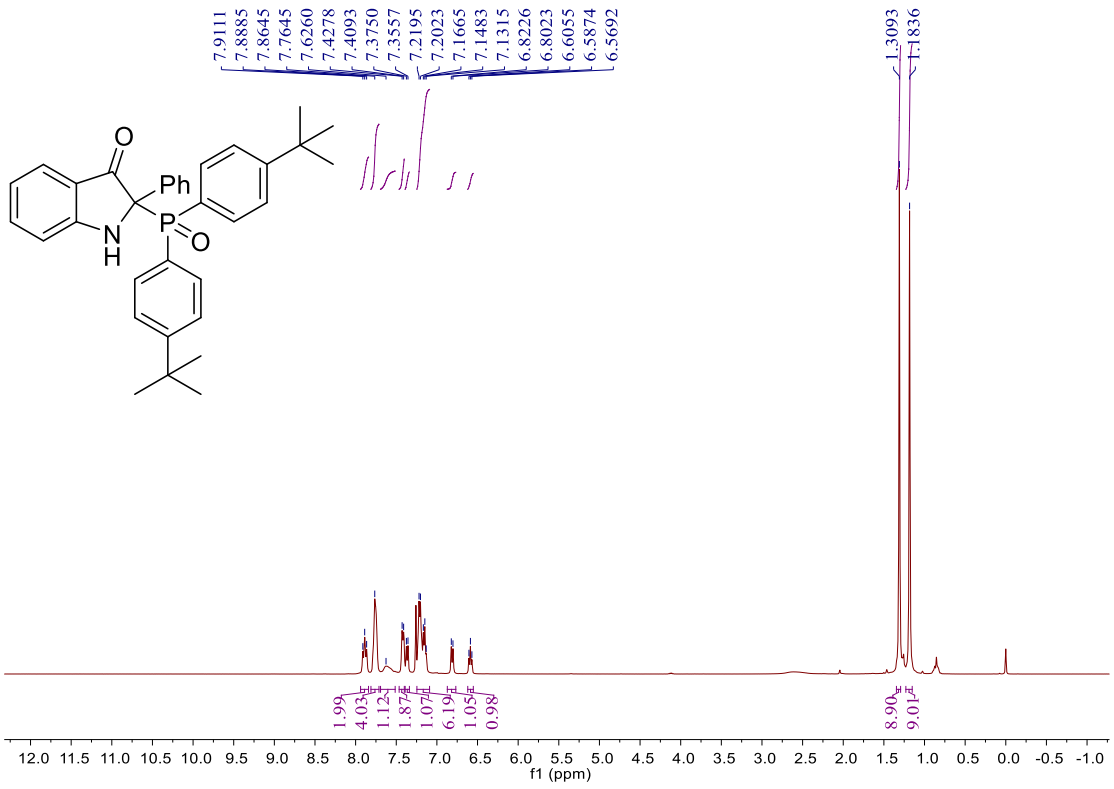
2-(bis(benzo[d][1,3]dioxol-4-yl)phosphoryl)-2-phenylindolin-3-one (3n)

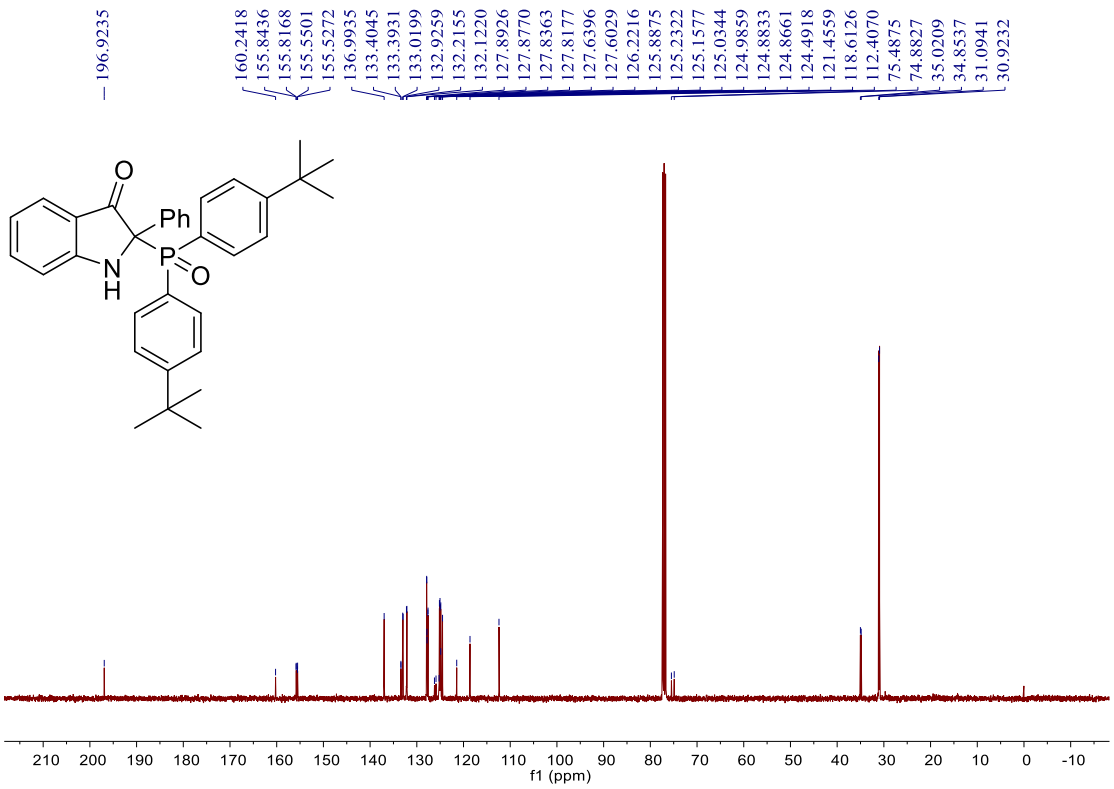






2-(bis(4-(tert-butyl)phenyl)phosphoryl)-2-phenylindolin-3-one (3o)

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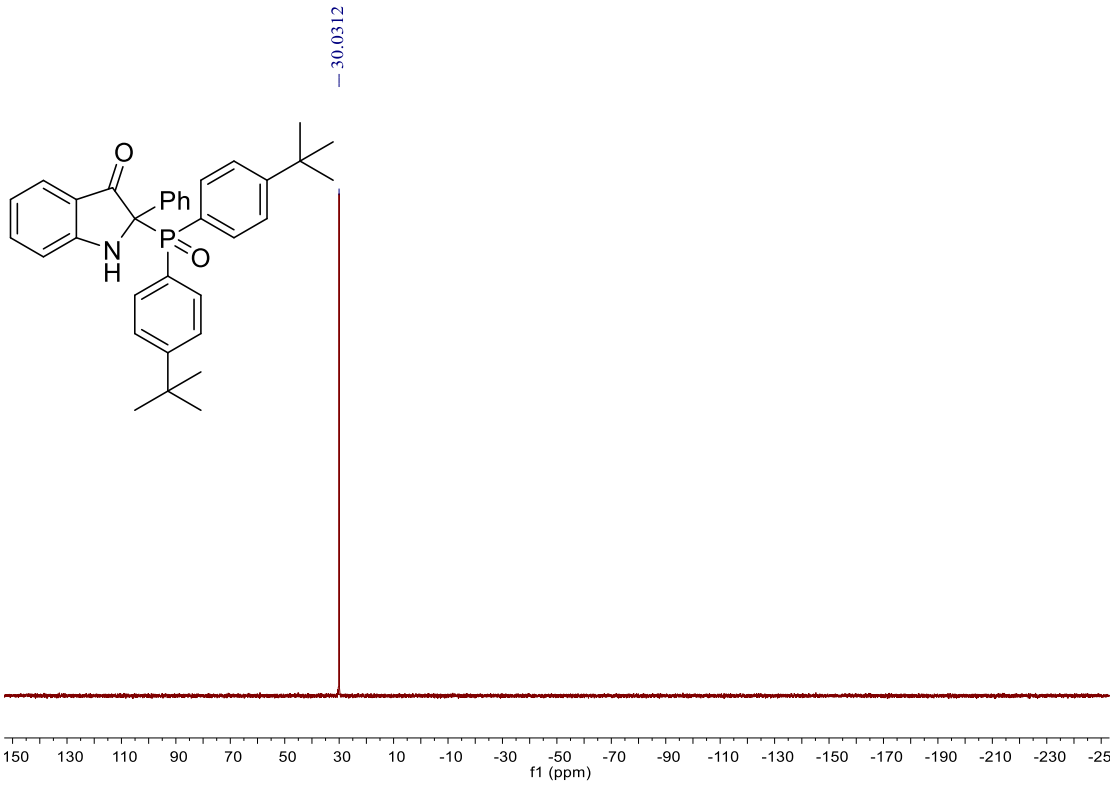
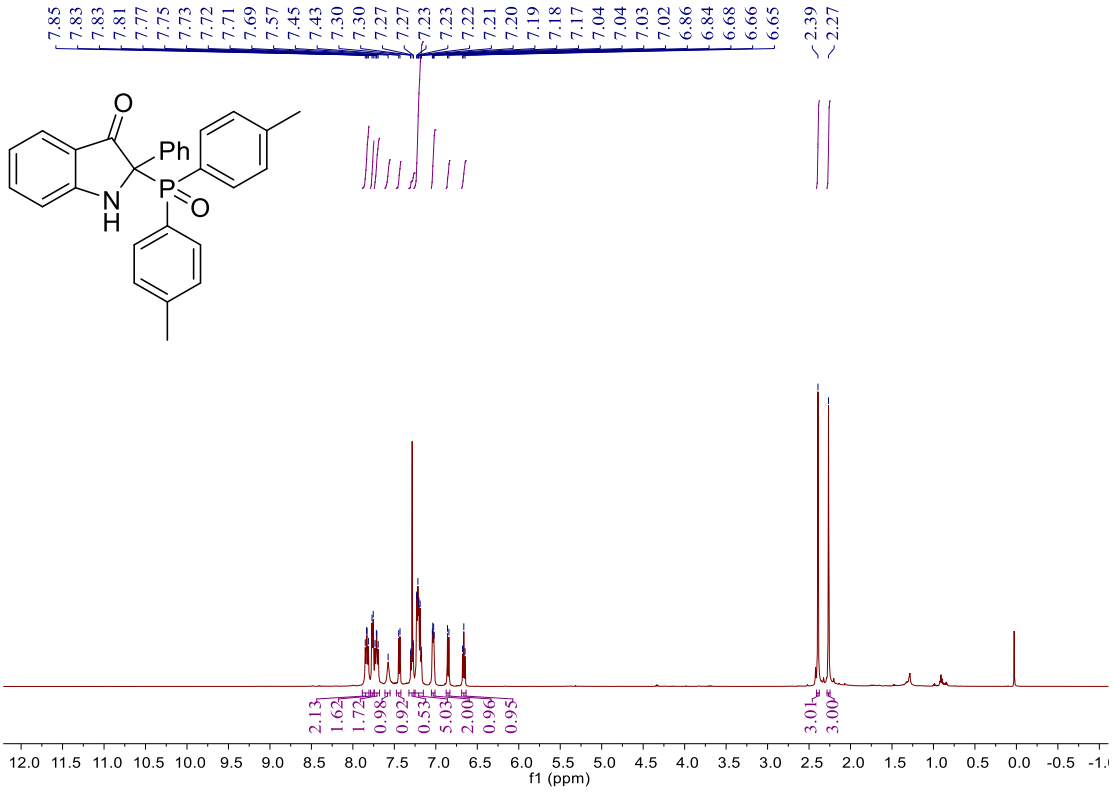
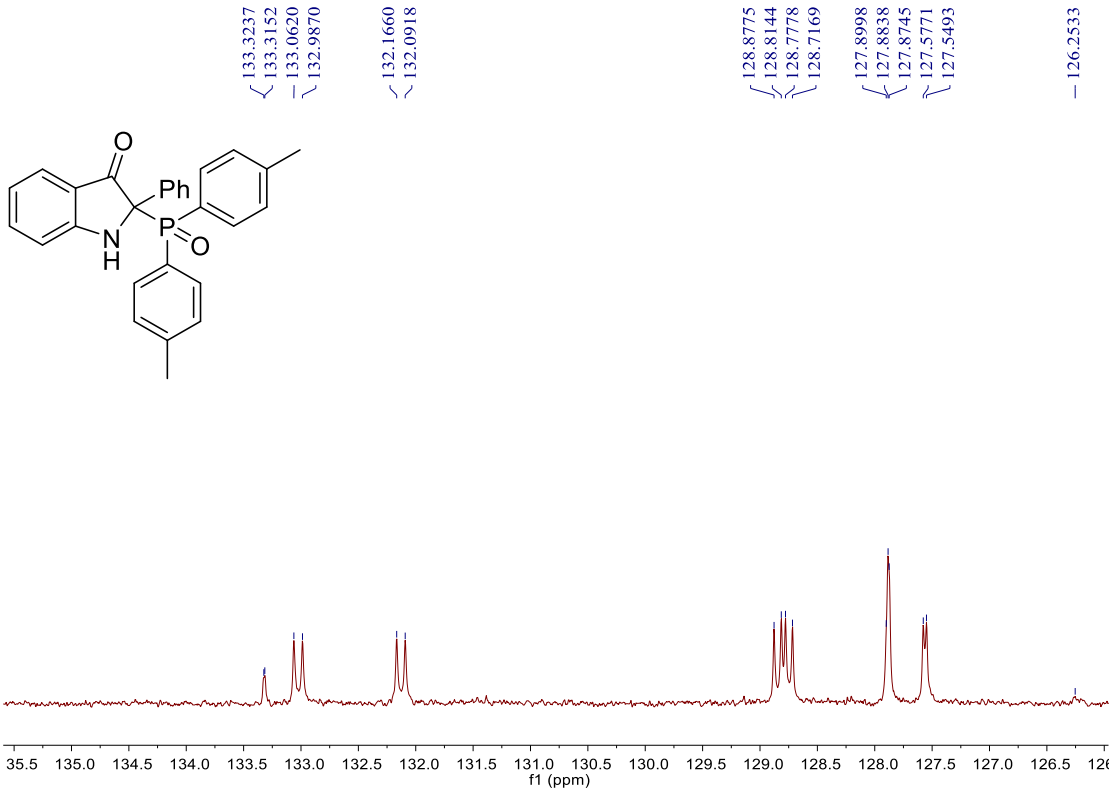
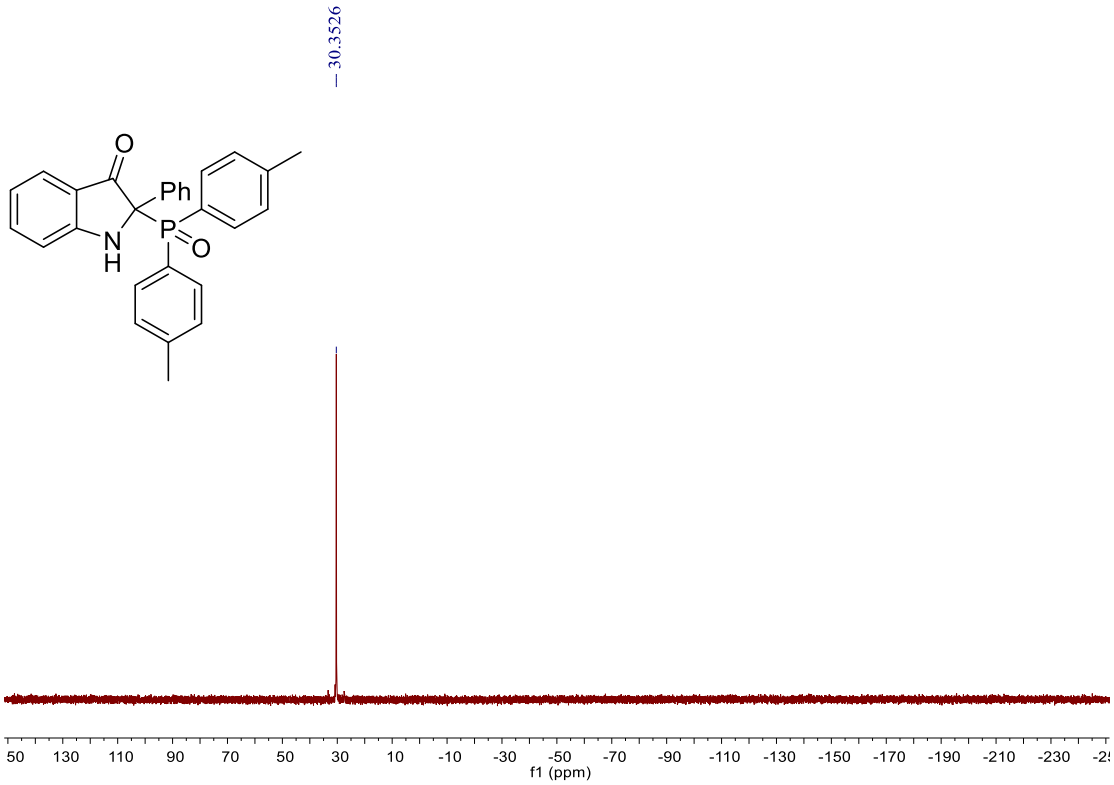
155.8436
155.8168
155.5501
155.5272
136.9935
133.4045
133.3931
133.0199
132.9259
132.2155
132.1220
127.8926
127.8770
127.8363
127.8177
127.6396
127.6029
126.2216
125.8875
125.2322
125.1577
125.0344
124.9859
124.8833
124.8661
124.4918
121.4559
118.6126
112.4070
75.4875
74.8827
35.0209
34.8537
31.0941
30.9232
O
Ph
P
O
N
H
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


30.0312
O
Ph
P
O
N
H
150 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230 -25
f1 (ppm)

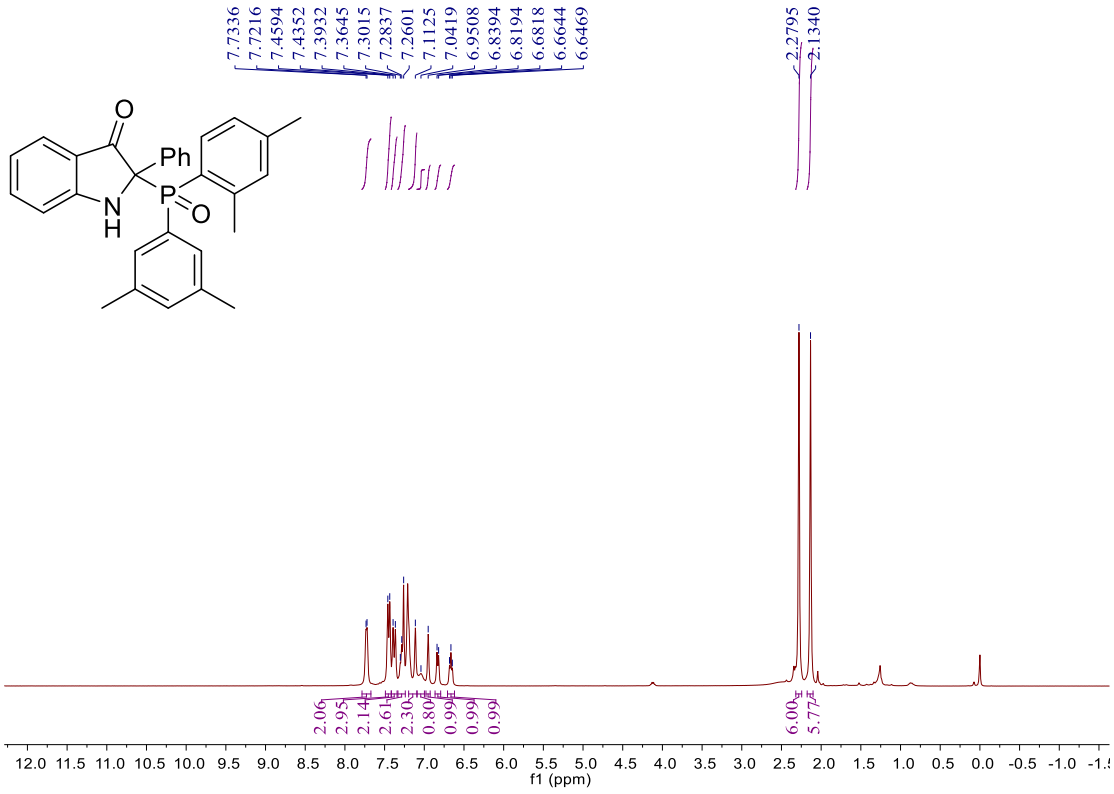
2-(di-p-tolylphosphoryl)-2-phenylindolin-3-one (3p)

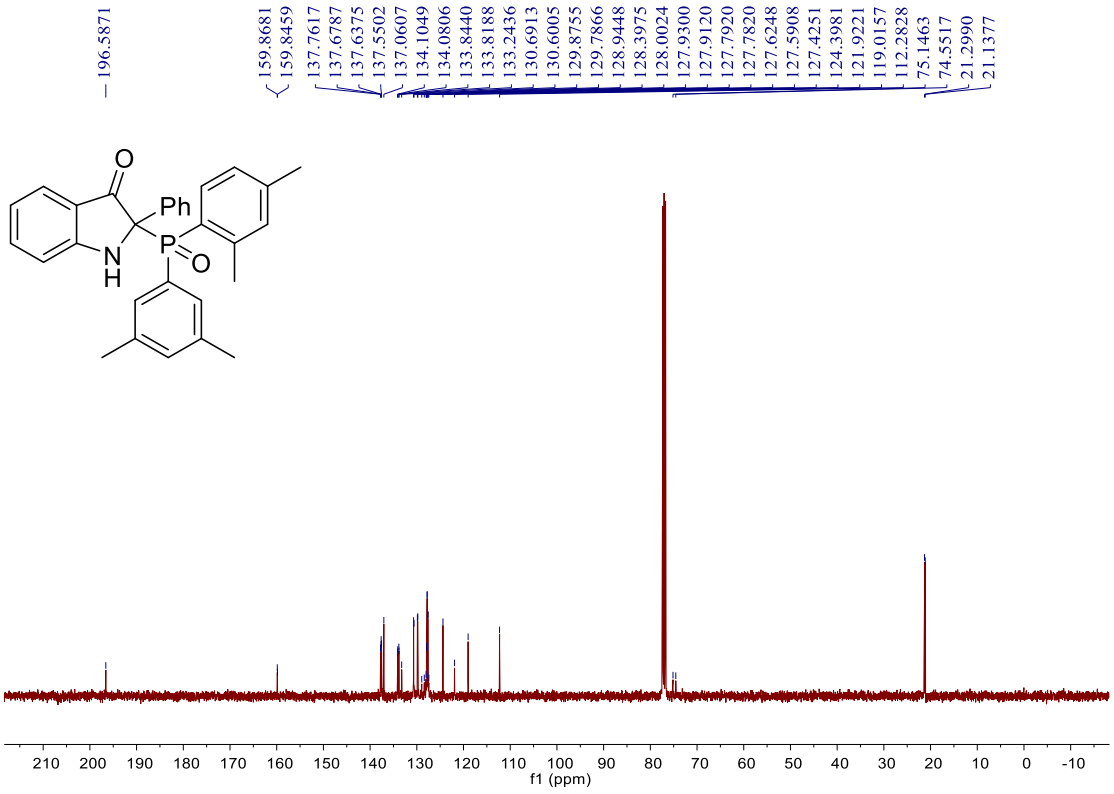






2-((2,4-dimethylphenyl)(3,5-dimethylphenyl)phosphoryl)-2-phenylindolin-3-one (3q)

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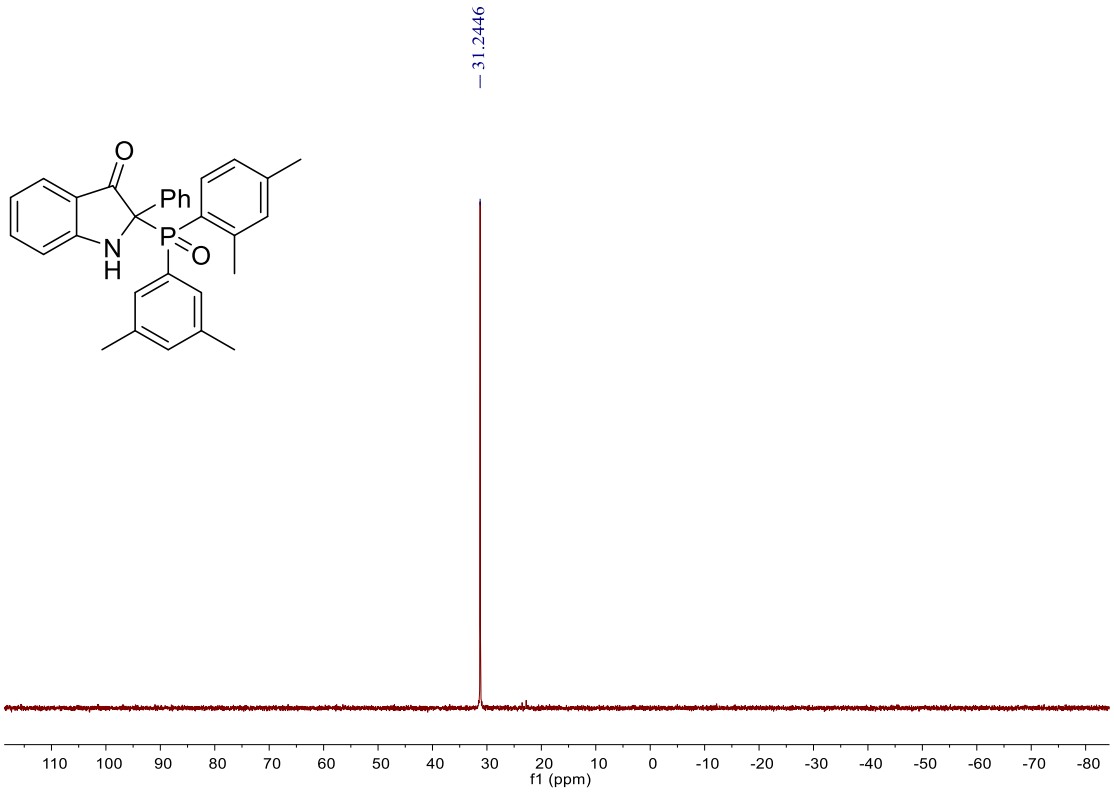
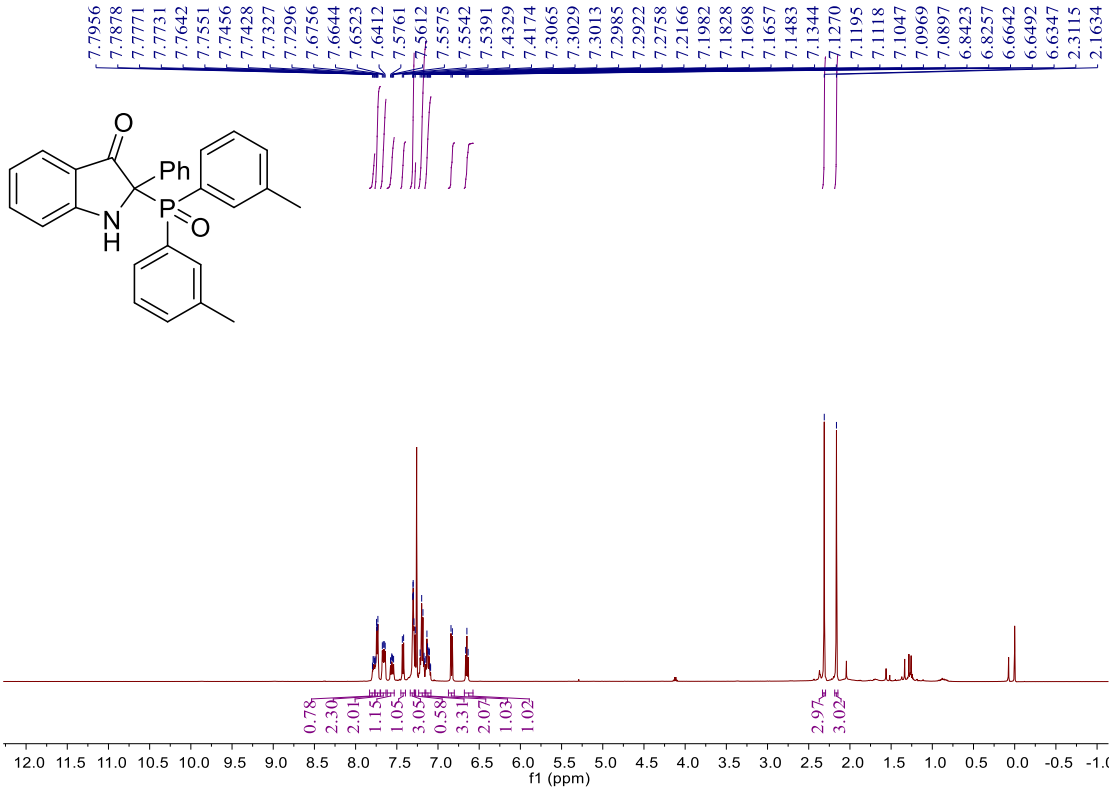
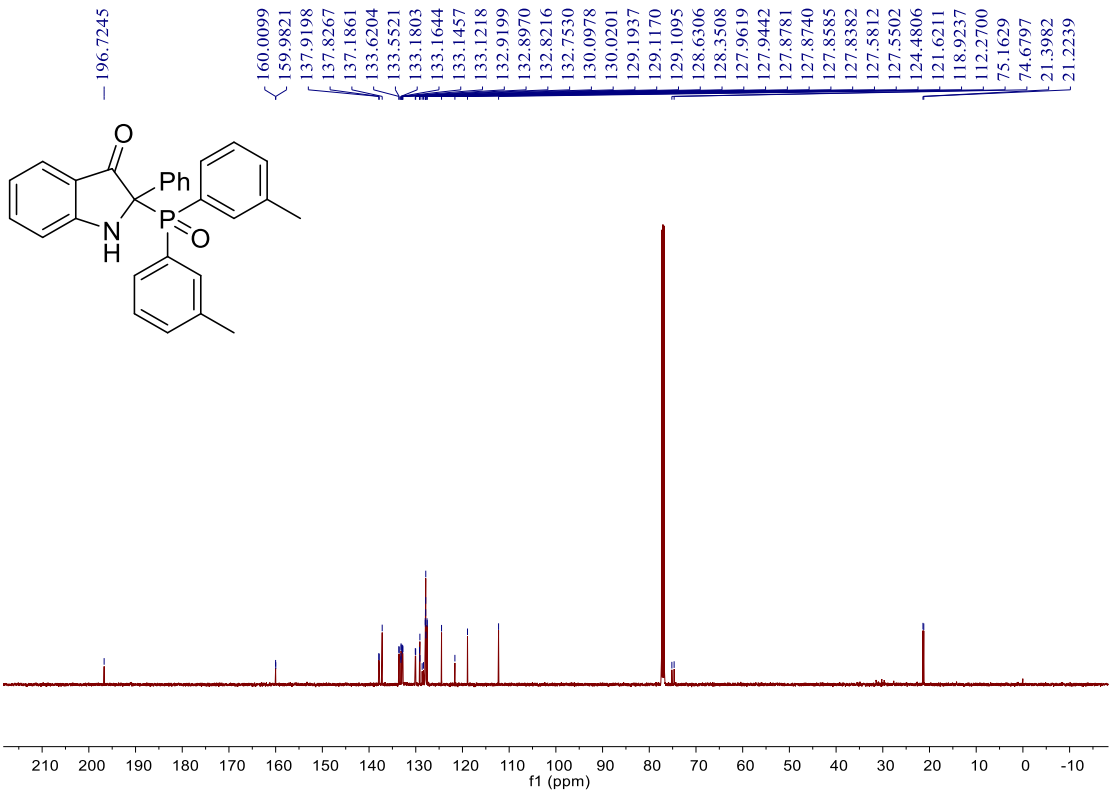
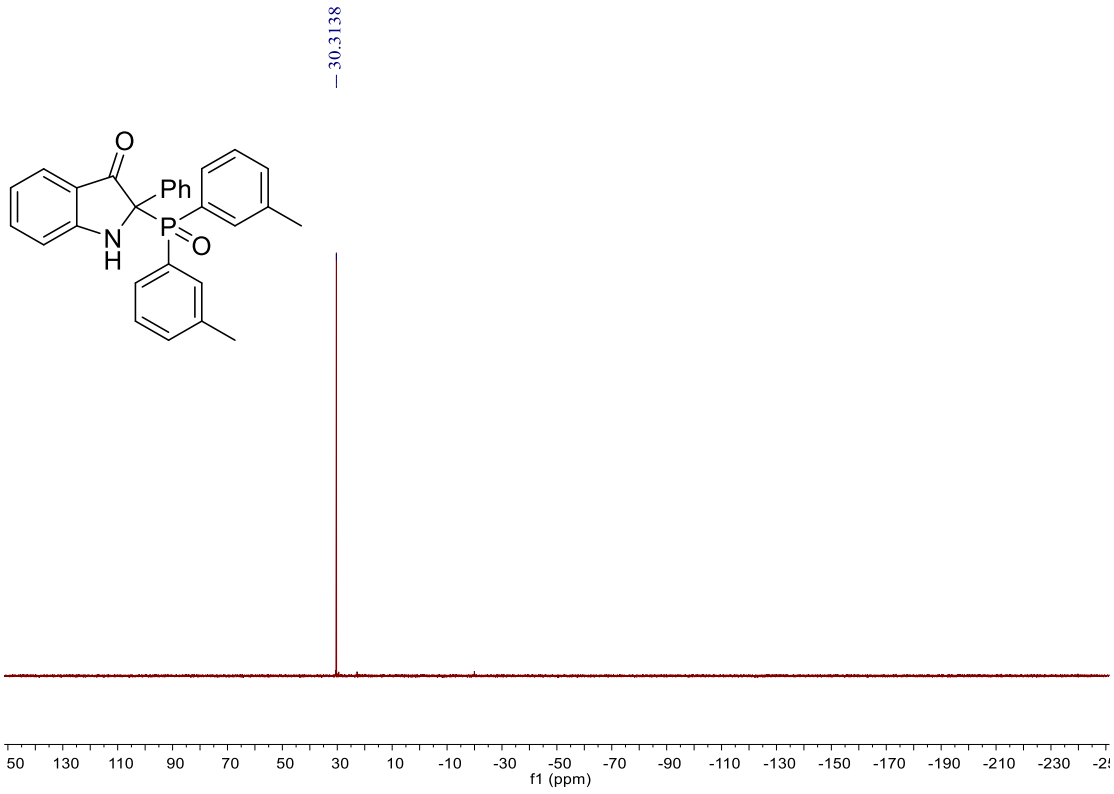
159.8459
137.7617
137.6787
137.6375
137.5502
137.0607
134.1049
134.0806
133.8440
133.8188
133.2436
130.6913
130.6005
129.8755
129.7866
128.9448
128.3975
128.0024
127.9300
127.9120
127.7920
127.7820
127.6248
127.5908
127.4251
124.3981
121.9221
119.0157
112.2828
75.1463
74.5517
21.2990
21.1377
O
Ph
P
O
N
H
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


31.2446
O
Ph
P
O
N
H
110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80
f1 (ppm)

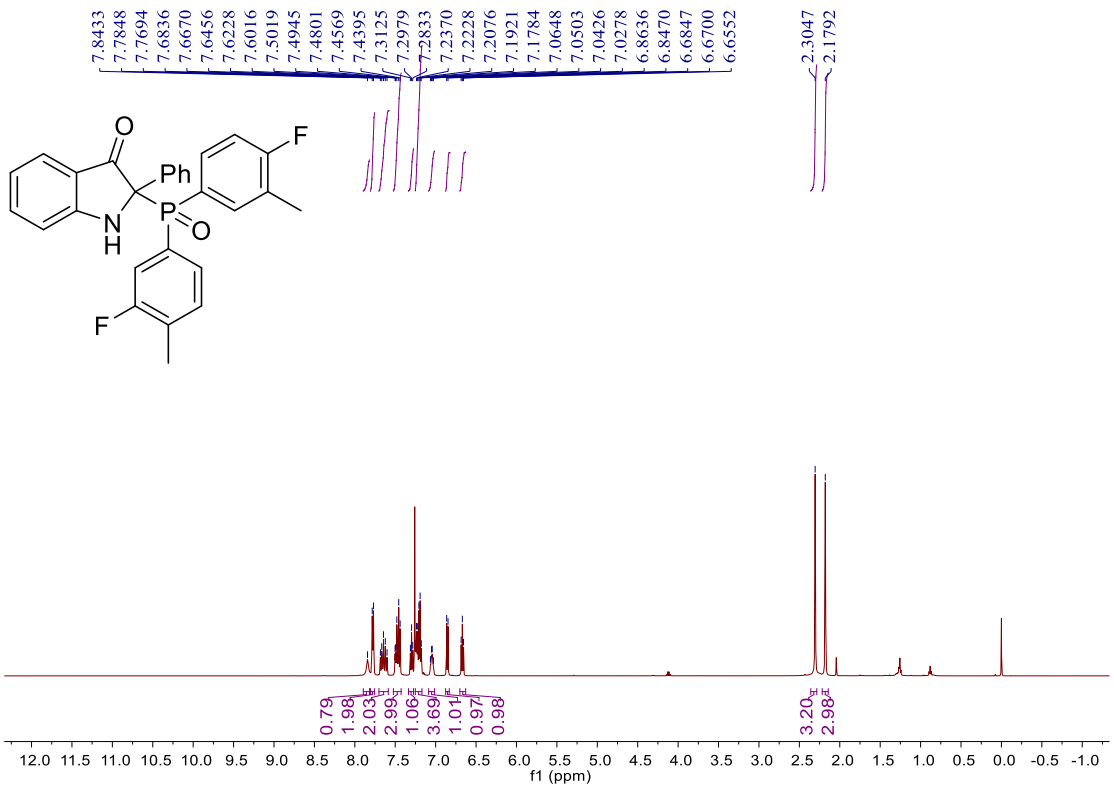
2-(di-m-tolylphosphoryl)-2-phenylindolin-3-one (3r)

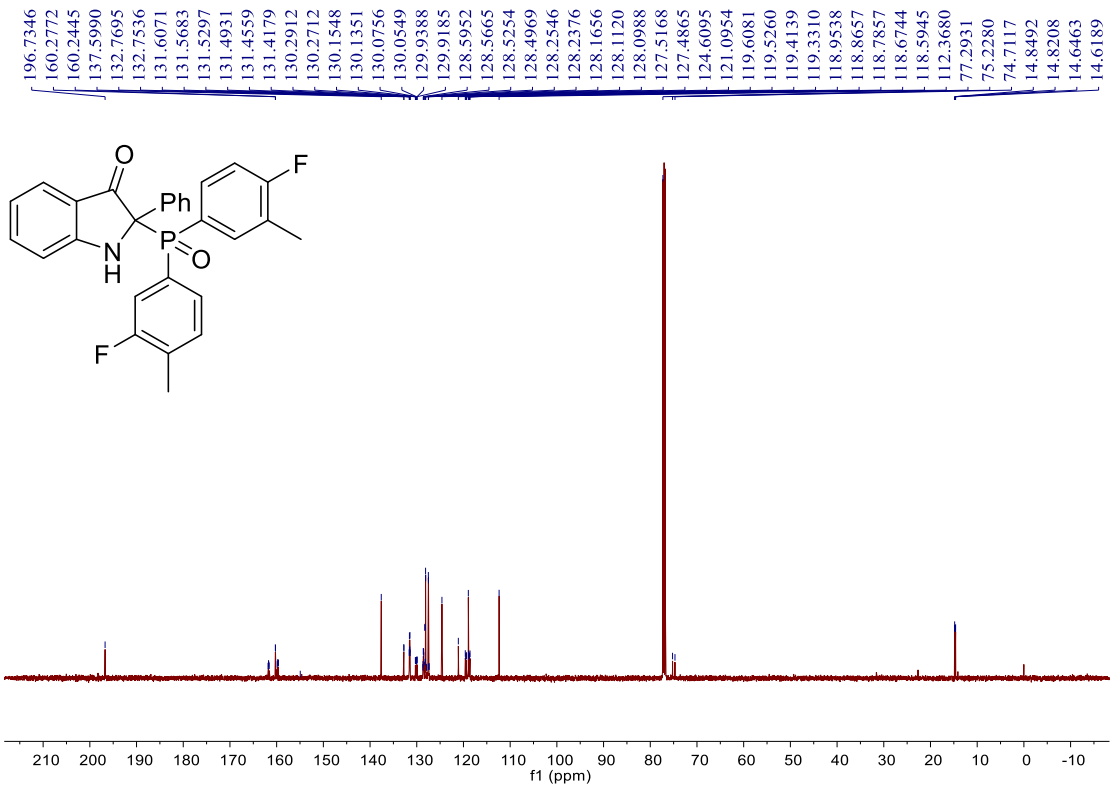






2-((4-fluoro-3-methylphenyl)(3-fluoro-4-methylphenyl)phosphoryl)-2-phenylindolin-3-one (3s)




196.7346
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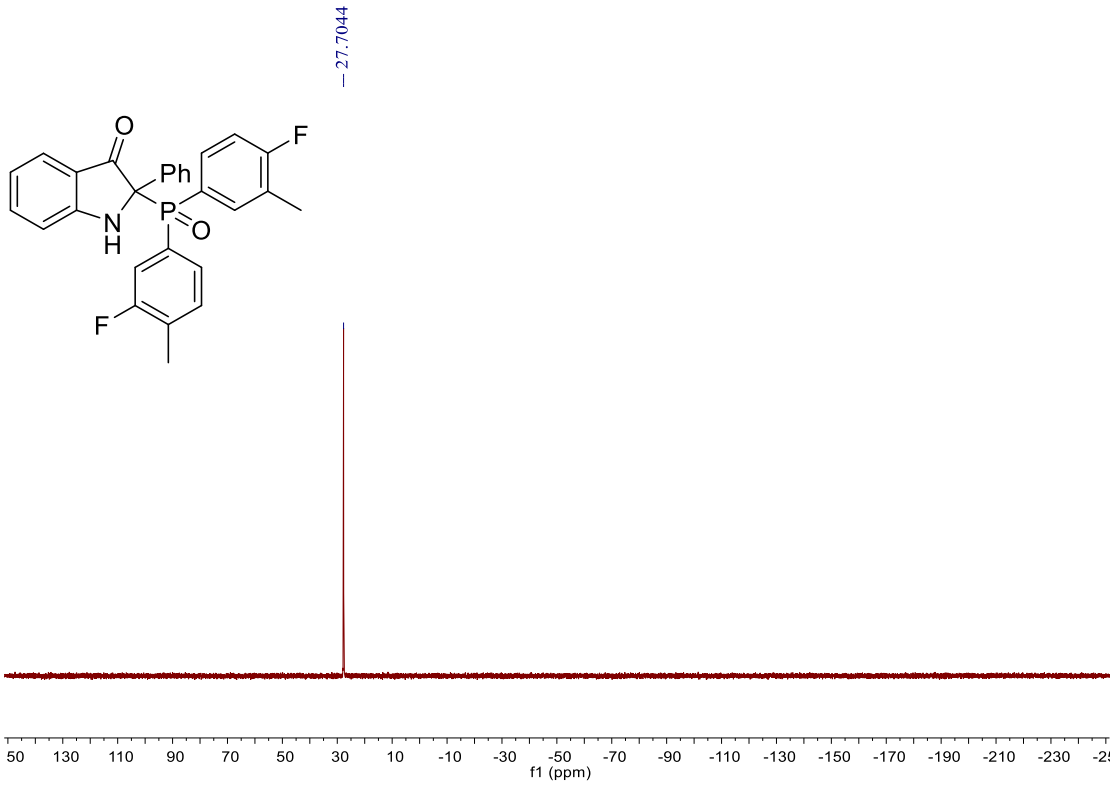
160.2445
137.5990
132.7695
132.7536
131.6071
131.5683
131.5297
131.4931
131.4559
131.4179
130.2912
130.2712
130.1548
130.1351
130.0756
130.0549
129.9388
129.9185
128.5952
128.5665
128.5254
128.4969
128.2546
128.2376
128.1656
128.1120
128.0988
127.5168
127.4865
124.6095
121.0954
119.6081
119.5260
119.4139
119.3310
118.9538
118.8657
118.7857
118.6744
118.5945
112.3680
77.2931
75.2280
74.7117
14.8492
14.8208
14.6463
14.6189
O
Ph
P
O
N
H
F
F
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


27.7044
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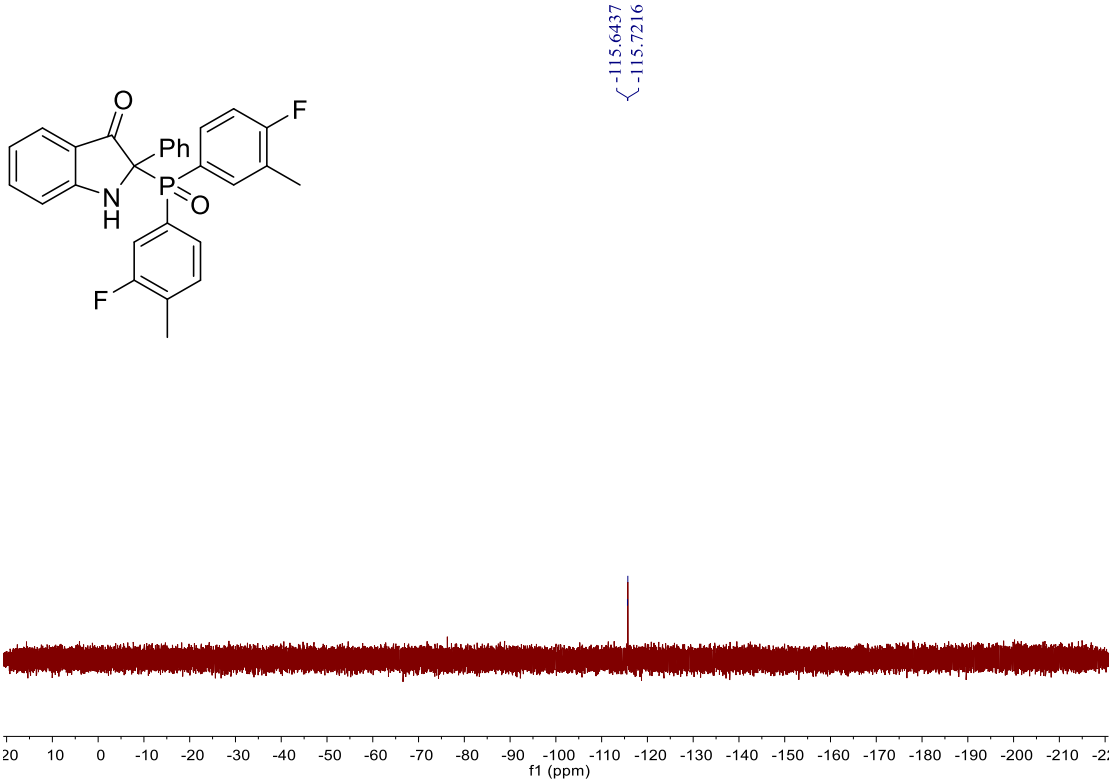
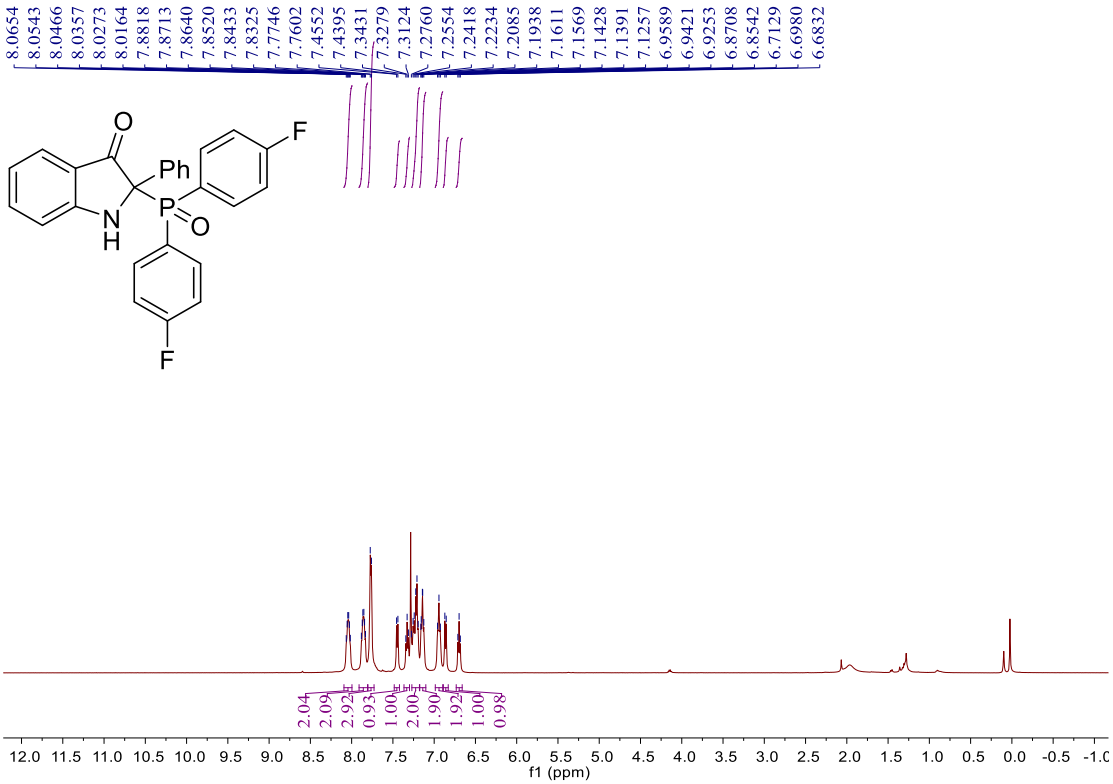
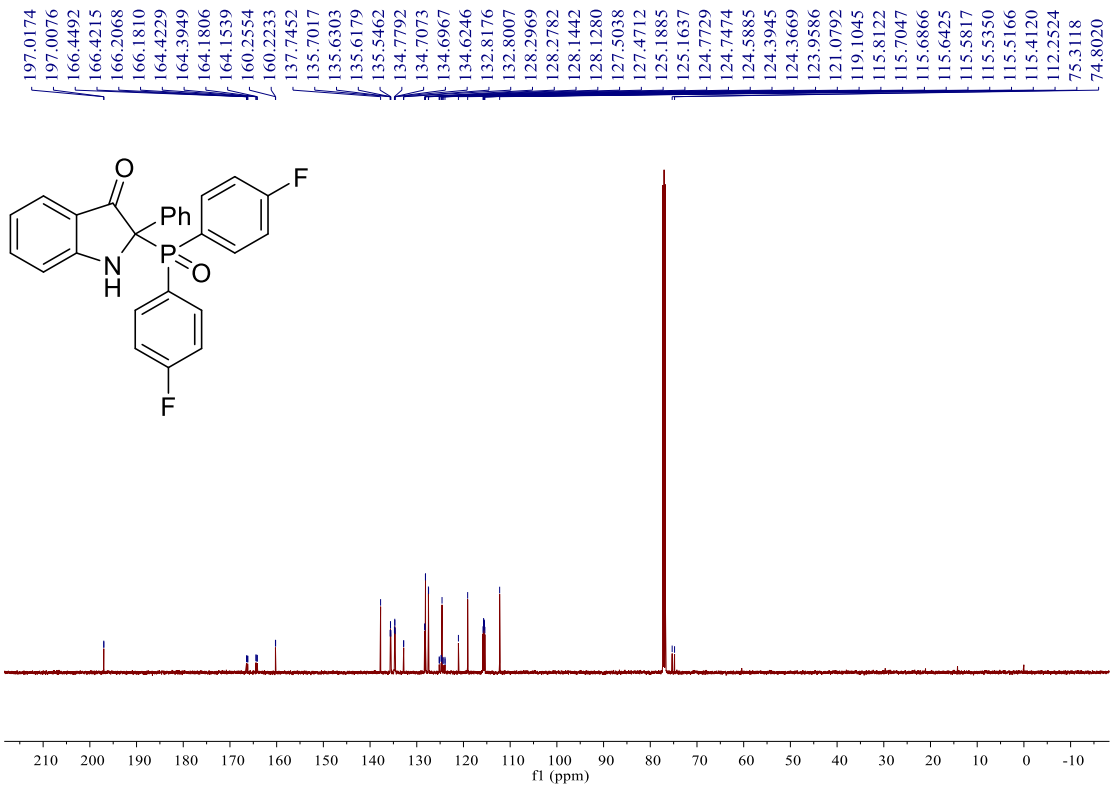
Ph
P
O
N
H
F
F
50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)



2-(bis(4-fluorophenyl)phosphoryl)-2-phenylindolin-3-one (3t)

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166.2068
166.1810
164.4229
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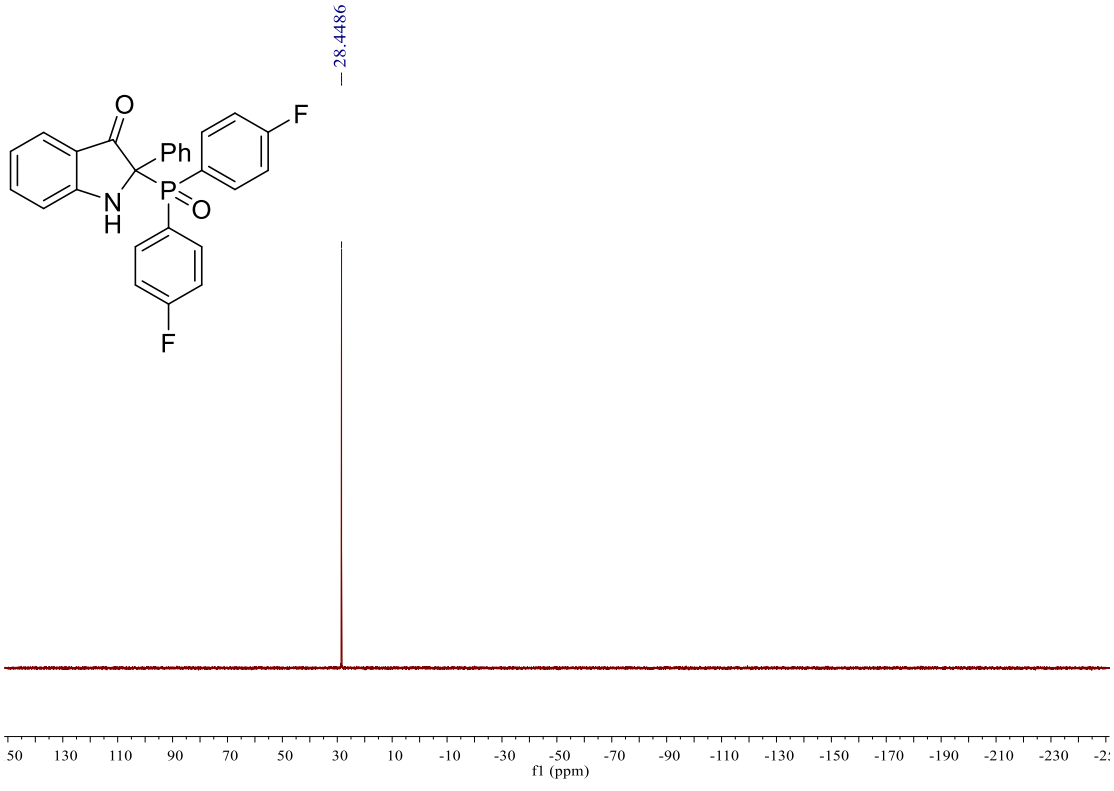
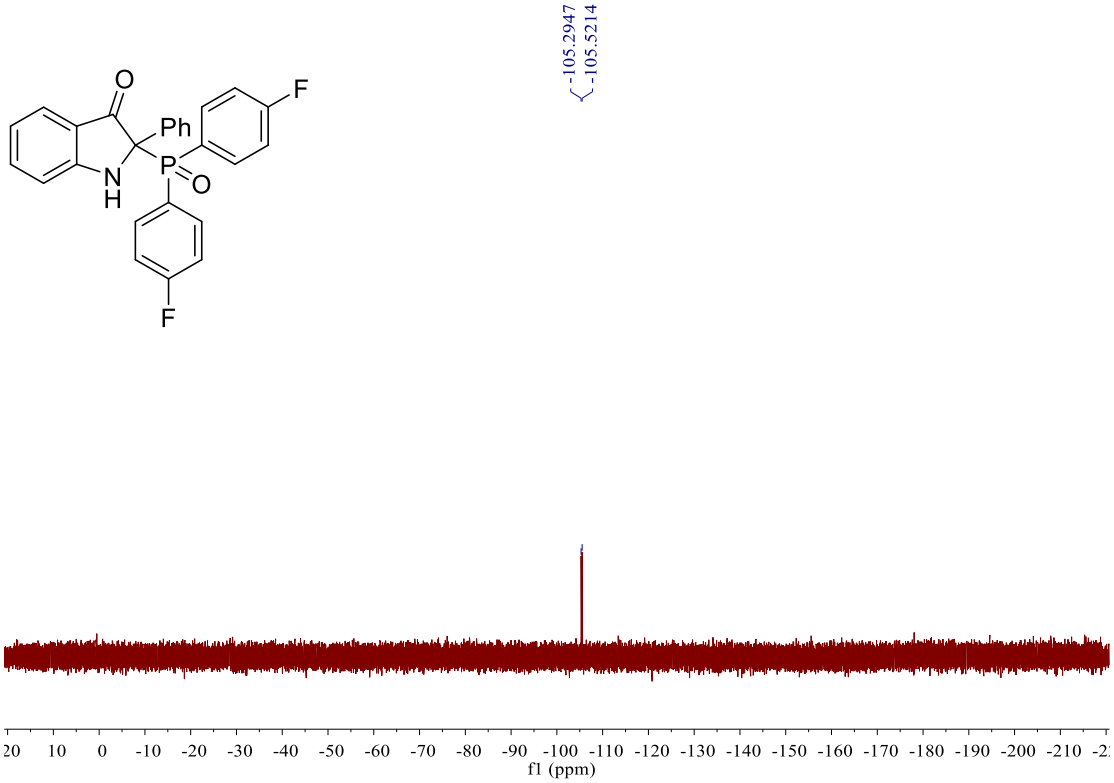
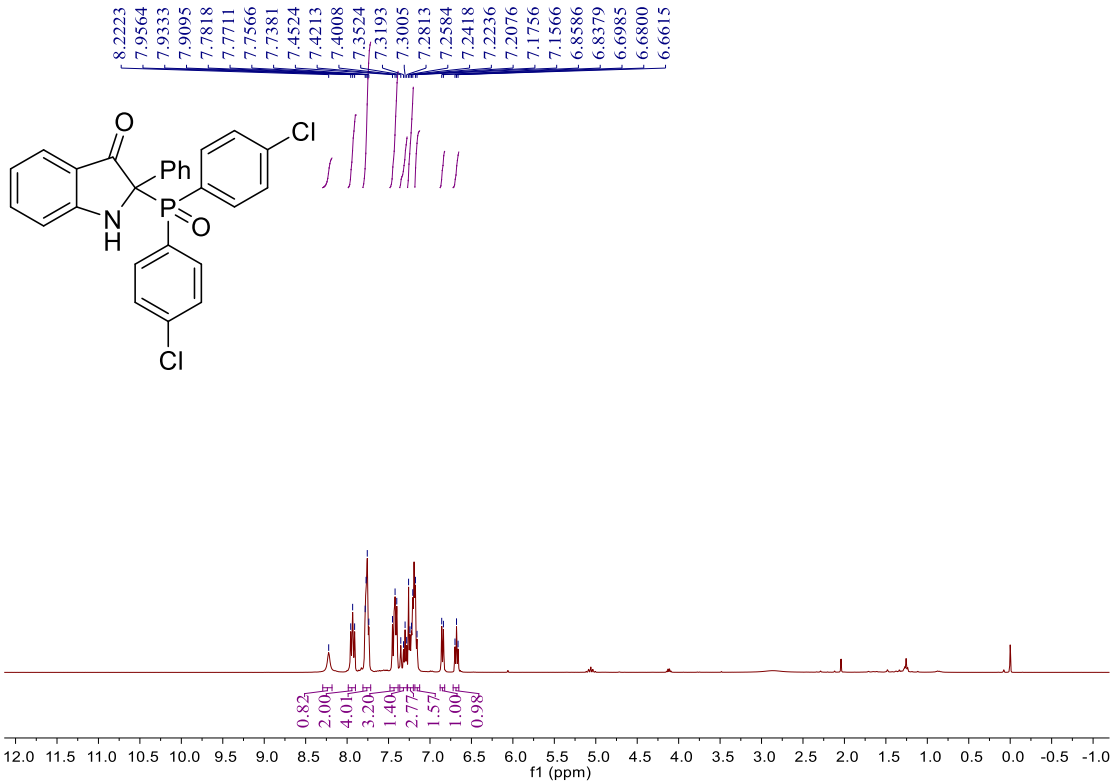
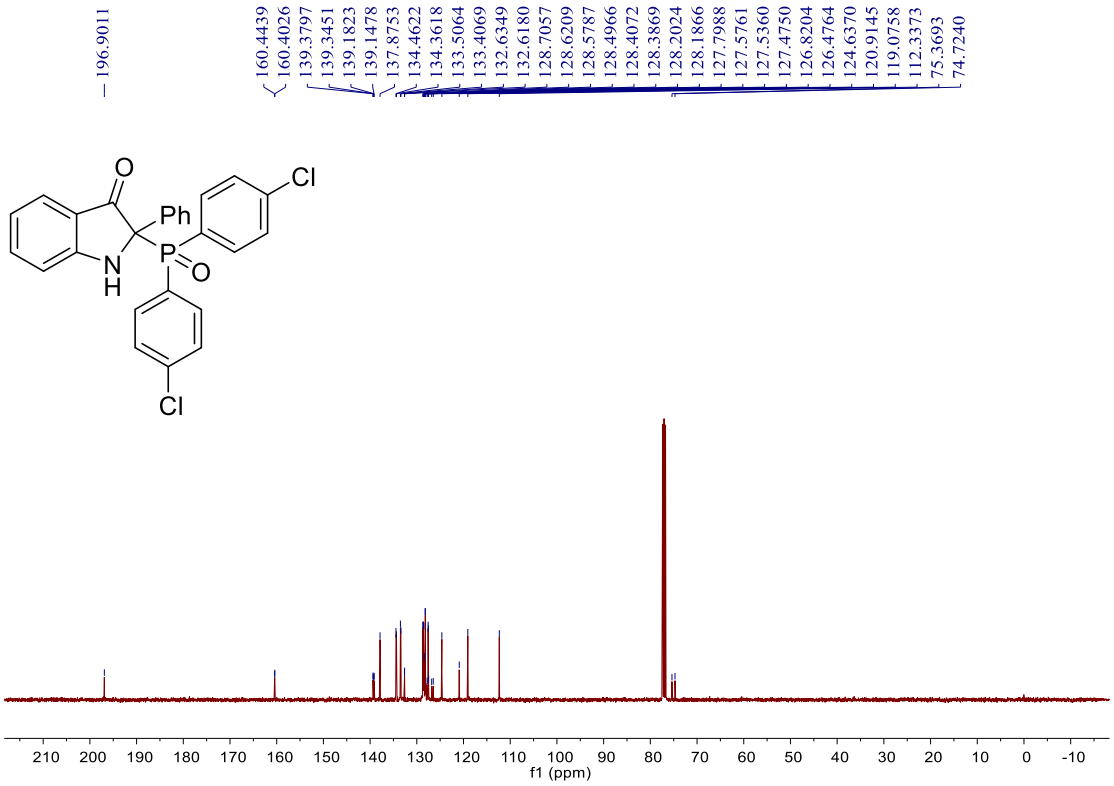
164.1806
164.1539
160.2554
160.2233
137.7452
135.7017
135.6303
135.6179
135.5462
134.7792
134.7073
134.6967
134.6246
132.8176
132.8007
128.2969
128.2782
128.1442
128.1280
127.5038
127.4712
125.1885
125.1637
124.7729
124.7474
124.5885
124.3945
124.3669
123.9586
121.0792
119.1045
115.8122
115.7047
115.6866
115.6425
115.5817
115.5350
115.5166
115.4120
112.2524
75.3118
74.8020
O
Ph
P
O
N
H
F
F
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


28.4486
O
Ph
P
O
N
H
F
F
50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)



2-(bis(4-chlorophenyl)phosphoryl)-2-phenylindolin-3-one (3u)

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139.3797
139.3451
139.1823
139.1478
137.8753
134.4622
134.3618
133.5064
133.4069
132.6349
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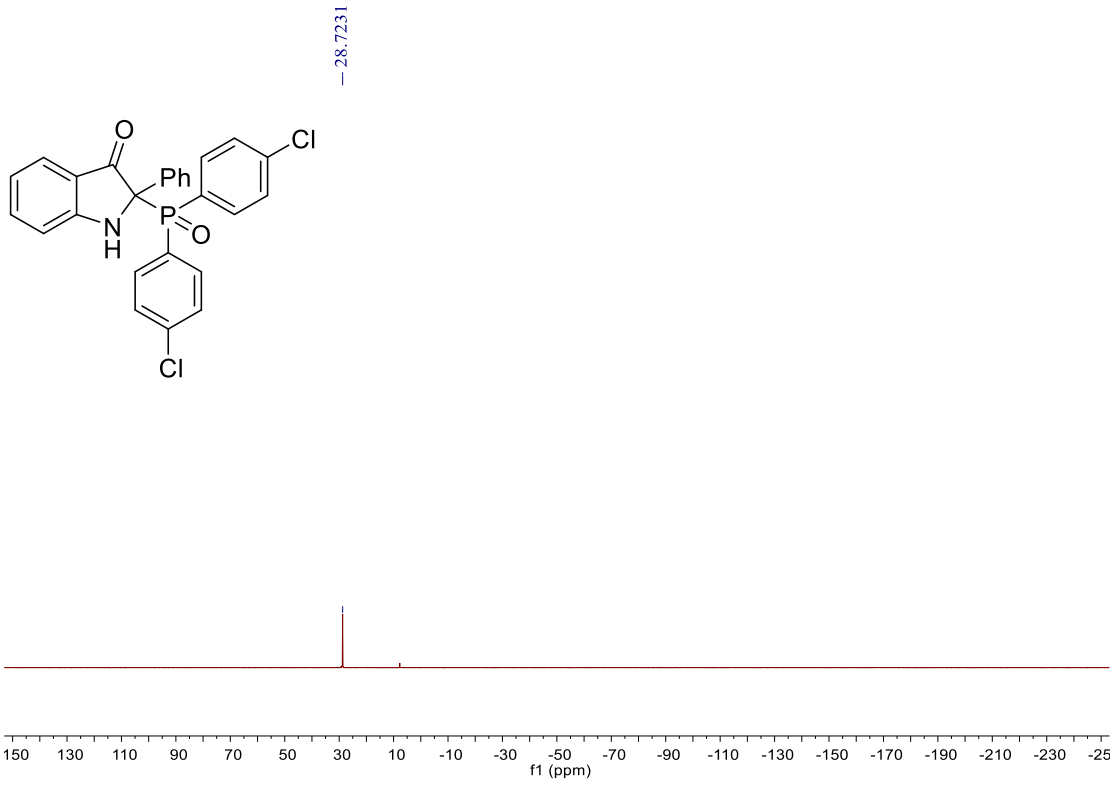
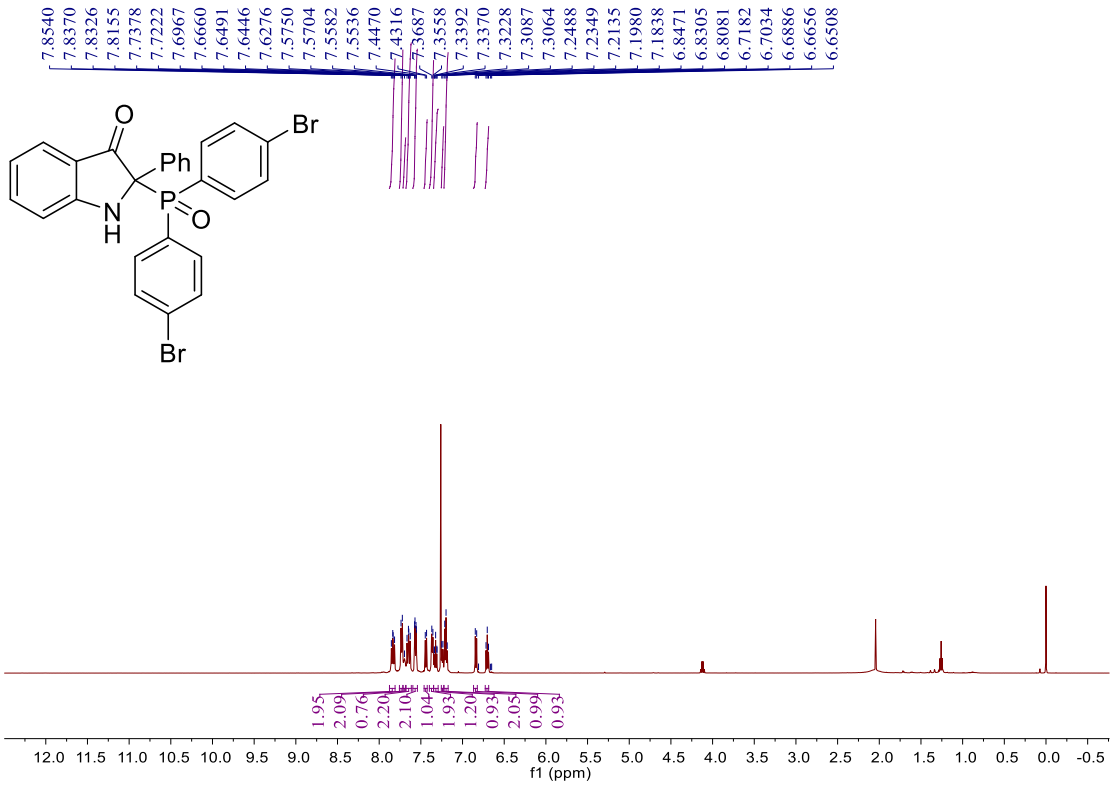
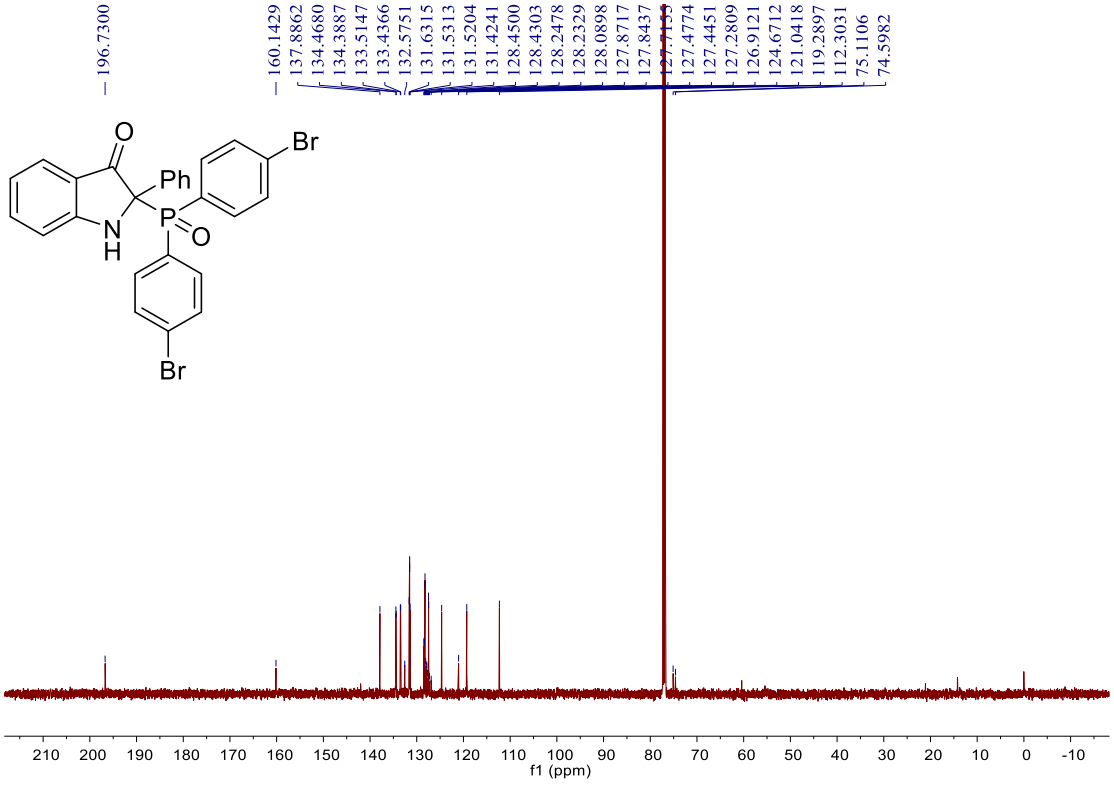
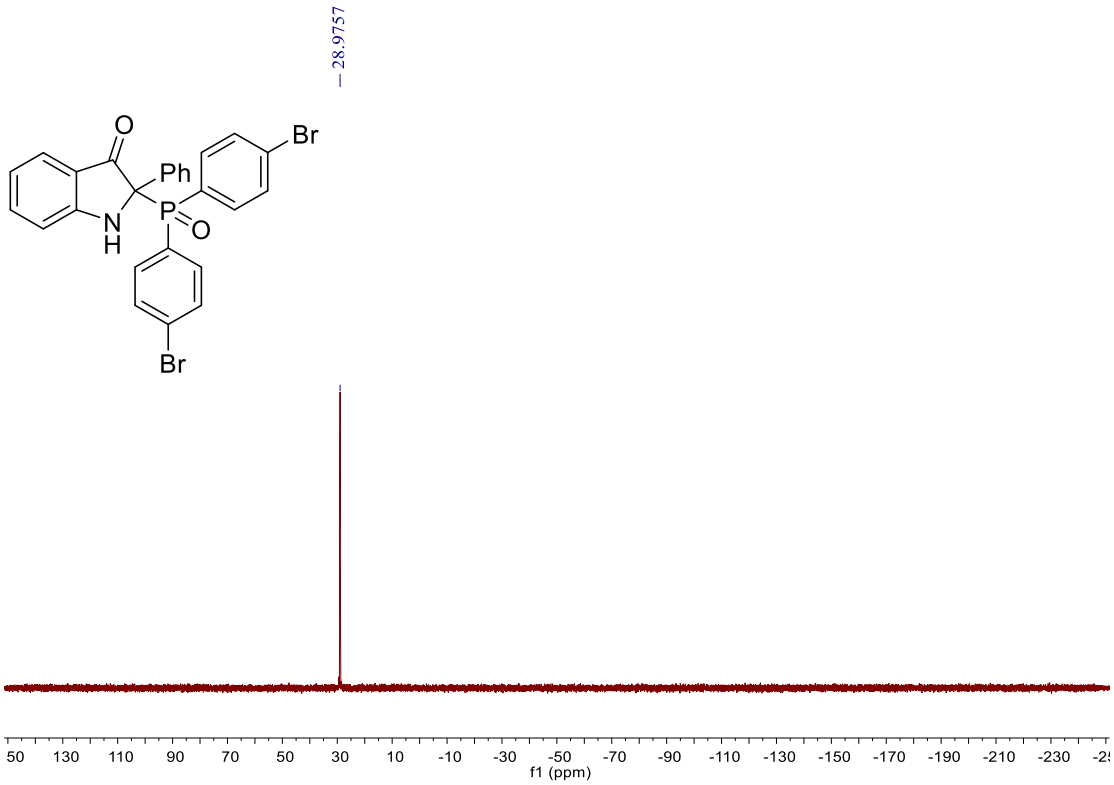
128.7057
128.6209
128.5787
128.4966
128.4072
128.3869
128.2024
128.1866
127.7988
127.5761
127.5360
127.4750
126.8204
126.4764
124.6370
120.9145
119.0758
112.3373
75.3693
74.7240
O
Ph
P
O
N
H
Cl
Cl
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


28.7231
O
Ph
P
O
N
H
Cl
Cl
150 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230 -25
f1 (ppm)

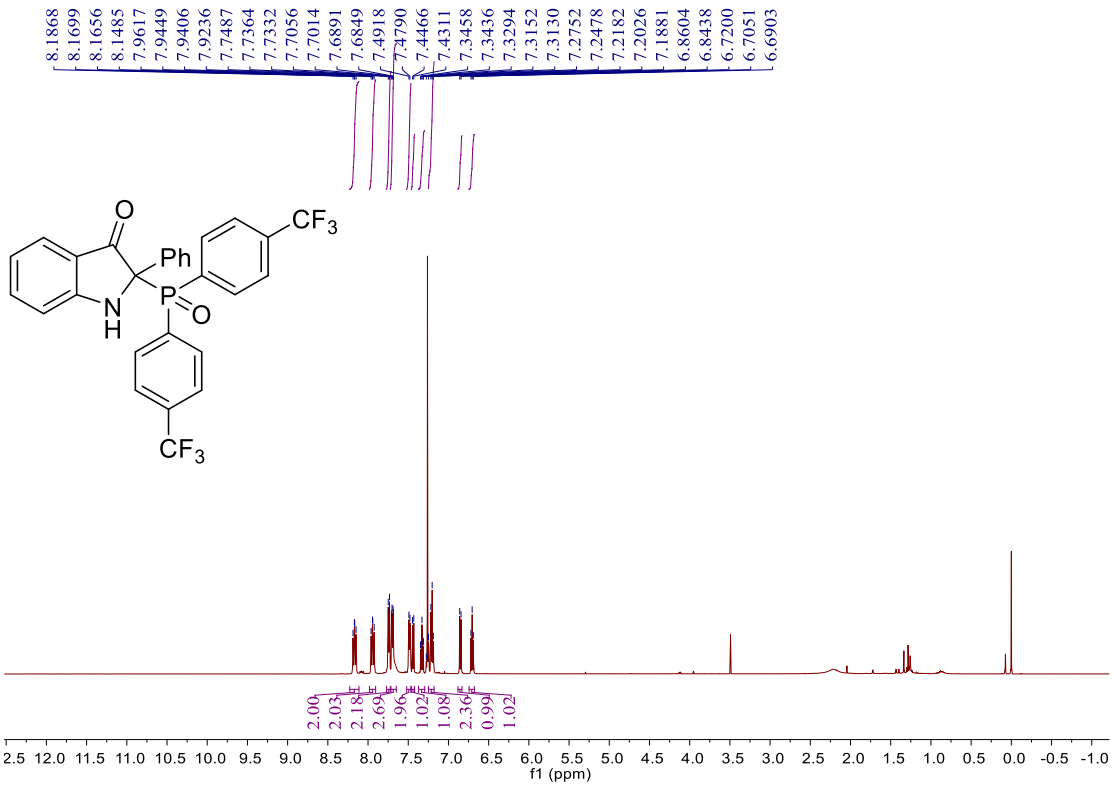
2-(bis(4-bromophenyl)phosphoryl)-2-phenylindolin-3-one (3v)

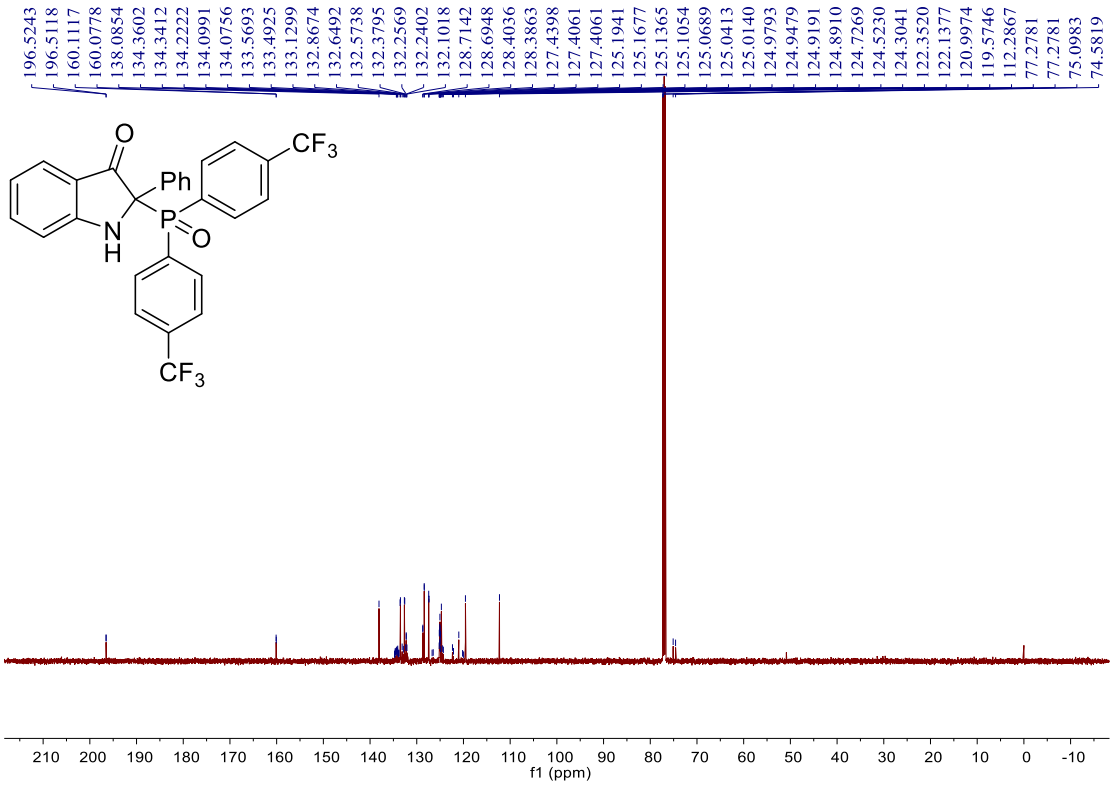






2-(bis(4-(trifluoromethyl)phenyl)phosphoryl)-2-phenylindolin-3-one (3w)

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127.4061
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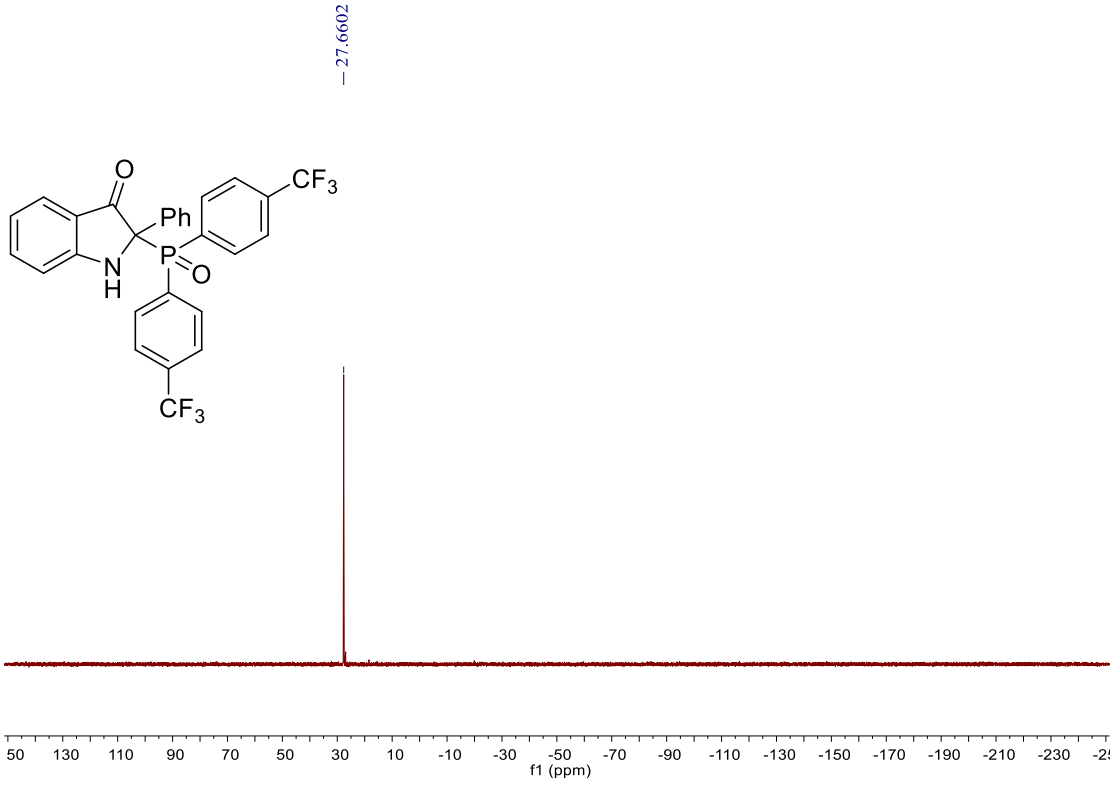
119.5746
112.2867
77.2781
77.2781
75.0983
74.5819
O
Ph
P
O
N
H
CF3
CF3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


27.6602
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P
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N
H
CF3
CF3
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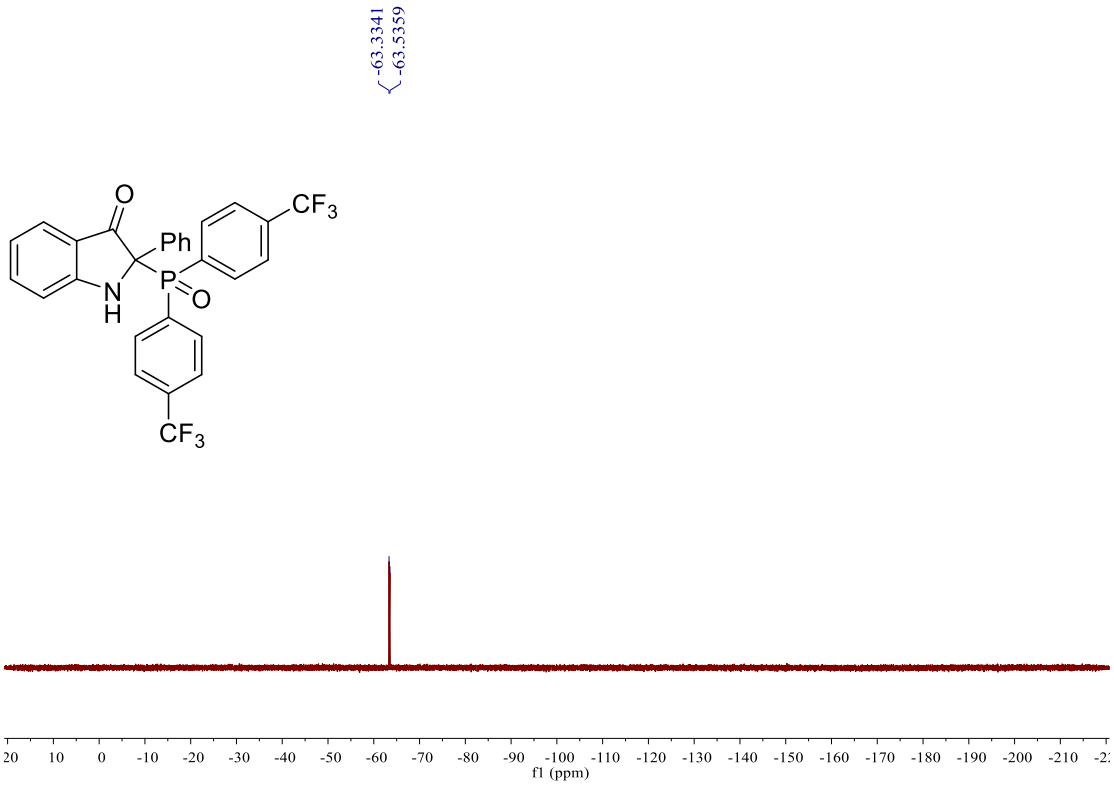
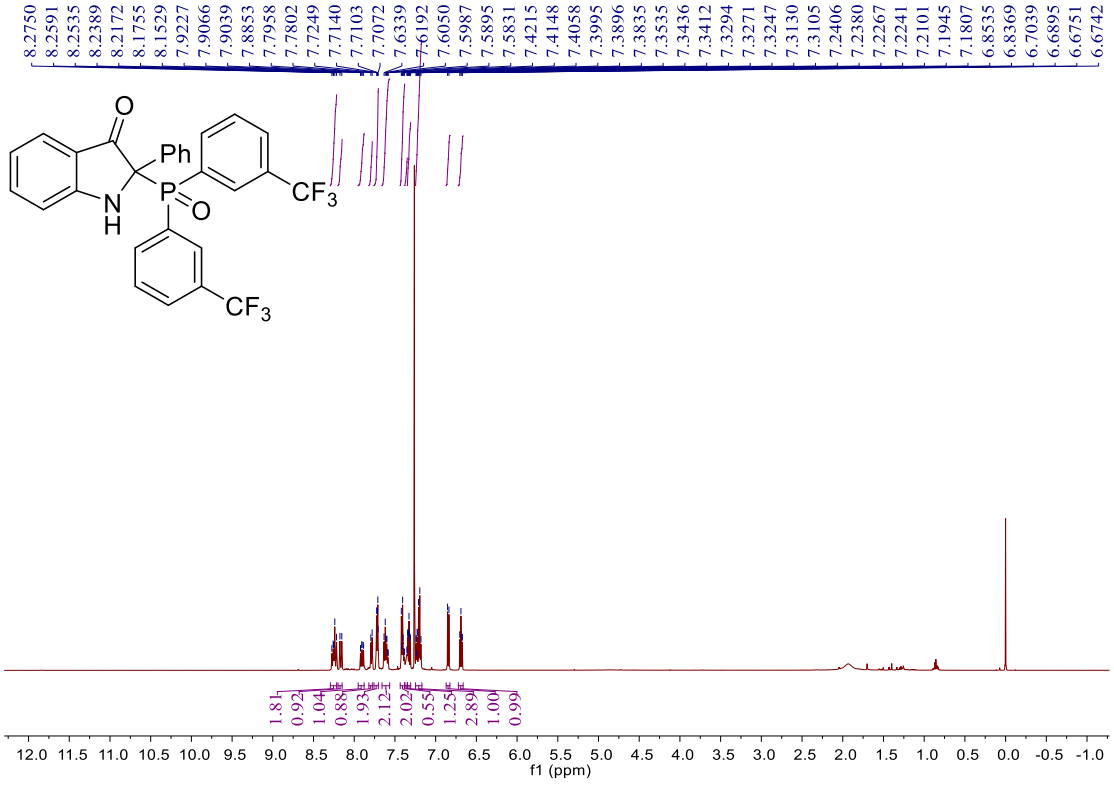
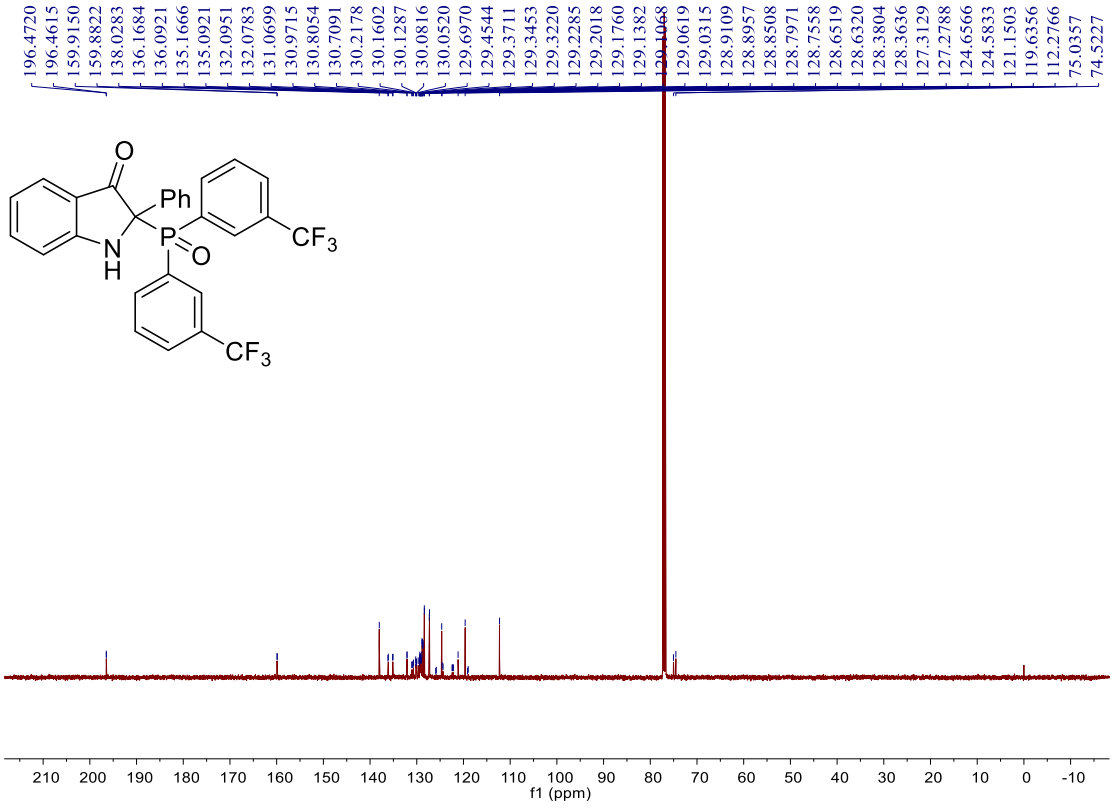
f1 (ppm)



2-(bis(3-(trifluoromethyl)phenyl)phosphoryl)-2-phenylindolin-3-one (3x)

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130.0816
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129.6970
129.4544
129.3711
129.3453
129.3220
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129.1760
129.1382
129.1068
129.0619
129.0315
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124.6566
124.5833
121.1503
119.6356
112.2766
75.0357
74.5227
O
Ph
P
O
N
H
CF3
CF3
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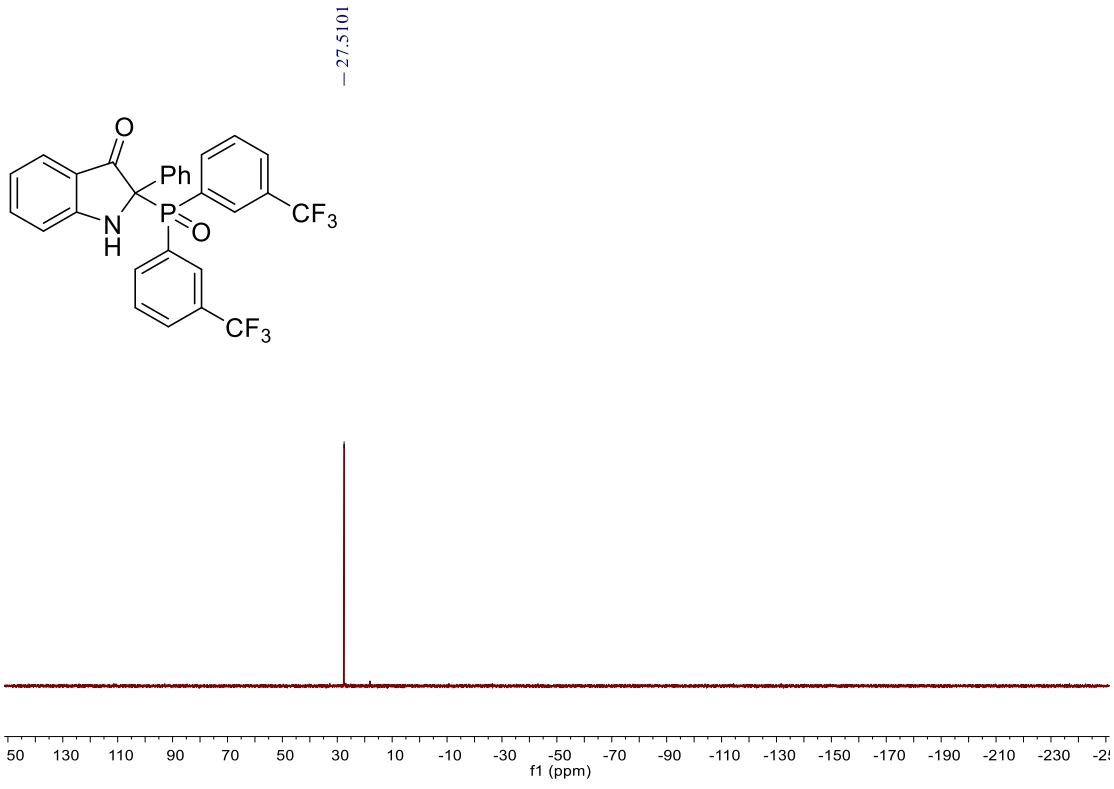
f1 (ppm)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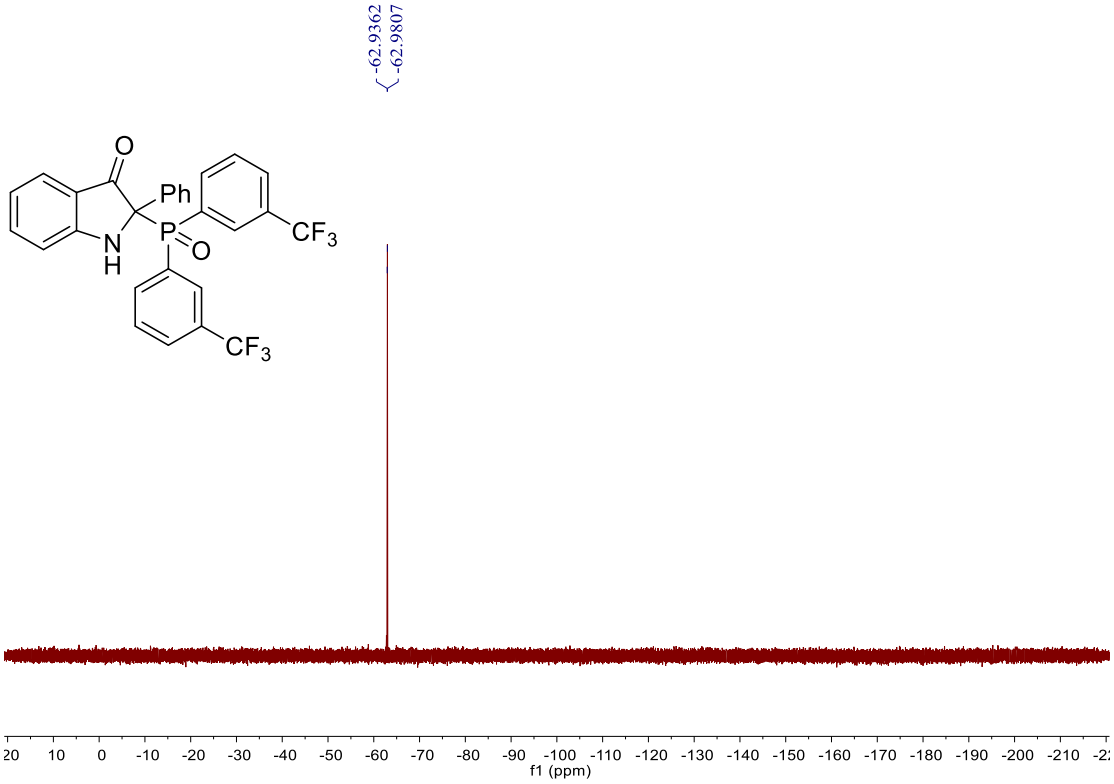
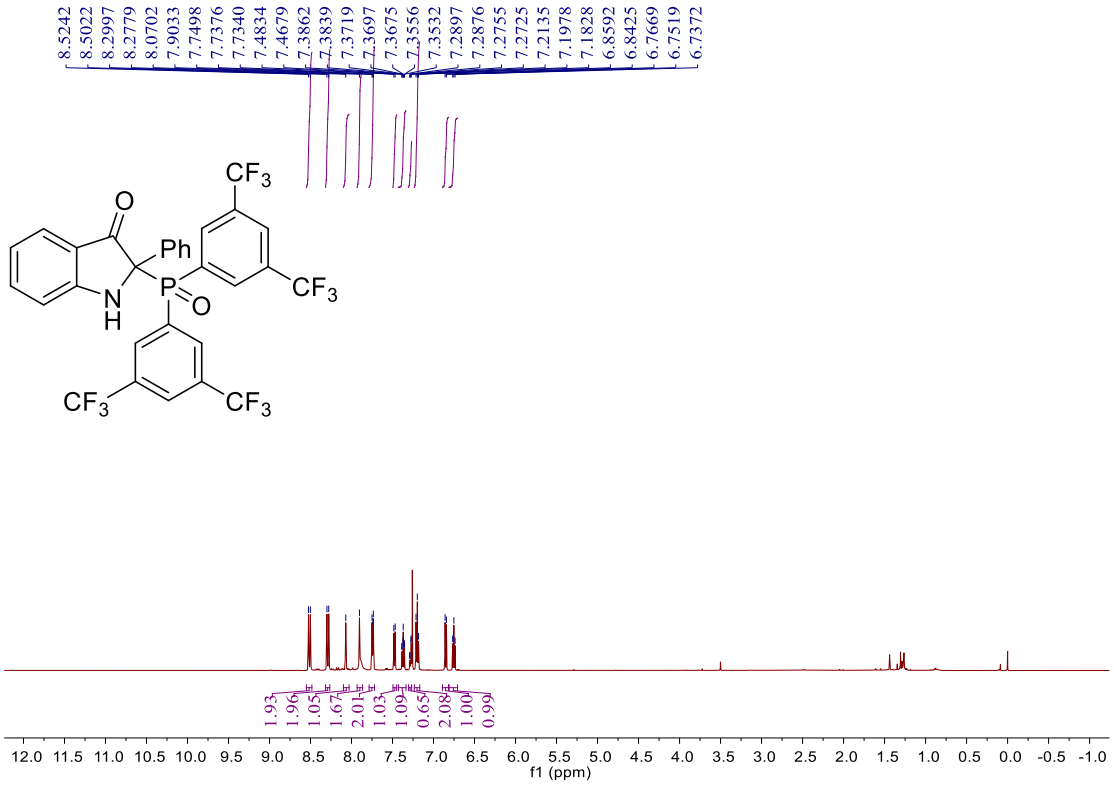
f1 (ppm)



2-(bis(3,5-bis(trifluoromethyl)phenyl)phosphoryl)-2-phenylindolin-3-one (3y)



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133.1813
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132.3164
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132.1659
132.1304
132.0800
132.0454
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131.9479
131.8952
131.6232
131.5243
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131.0609
130.9913
130.7677
130.2117
129.2292
129.2087
128.7124
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126.5544
126.5278
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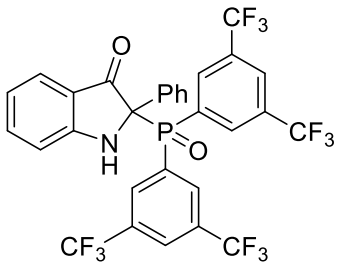
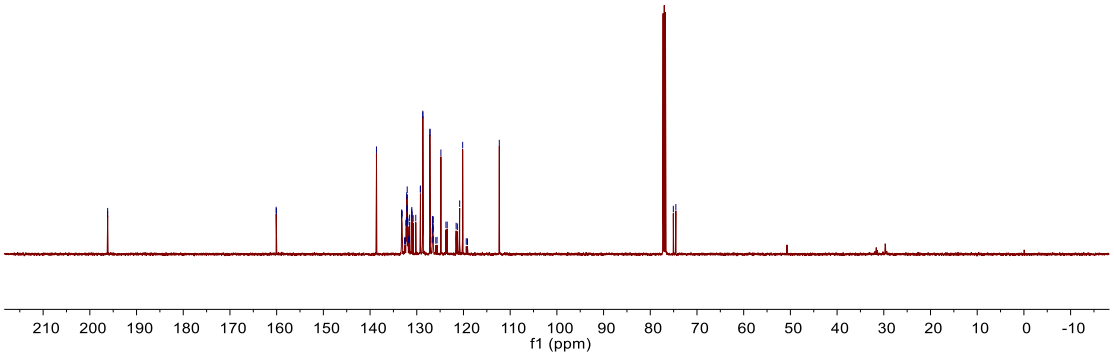
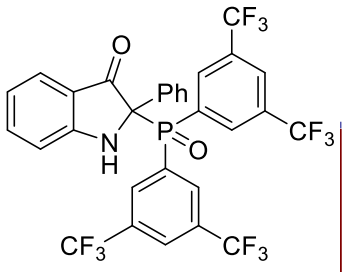
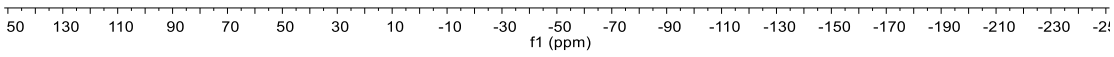
75.0635
74.5227

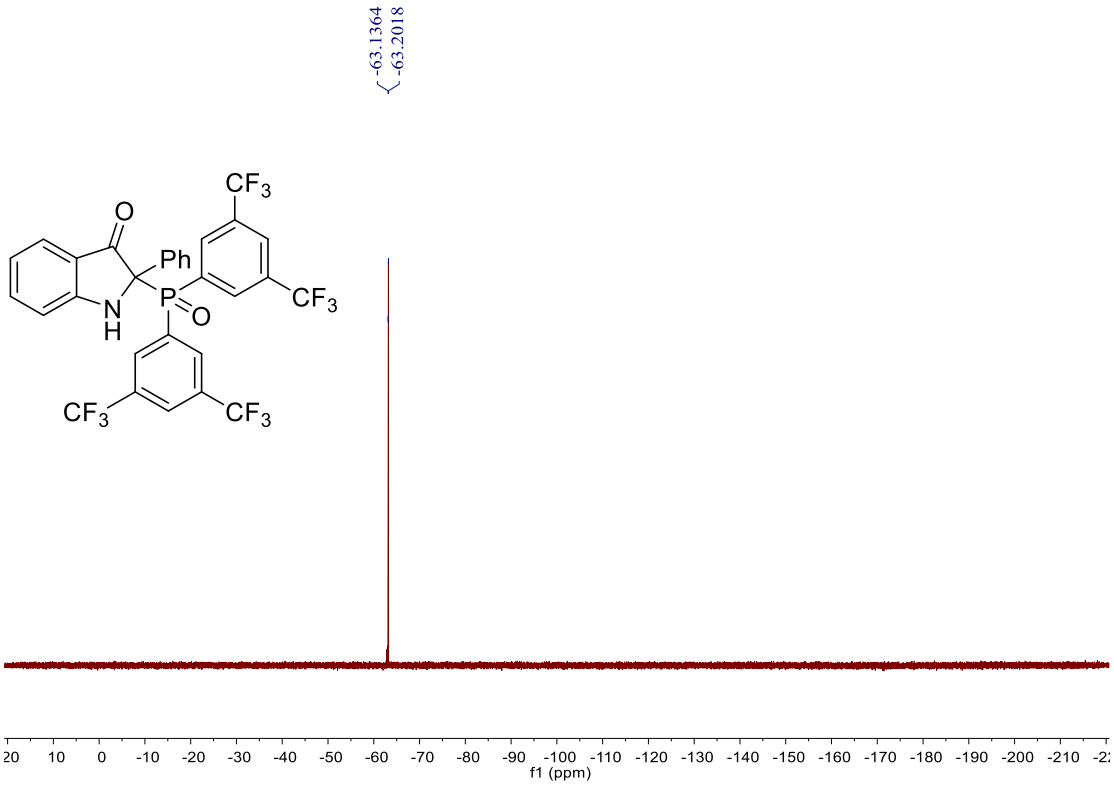




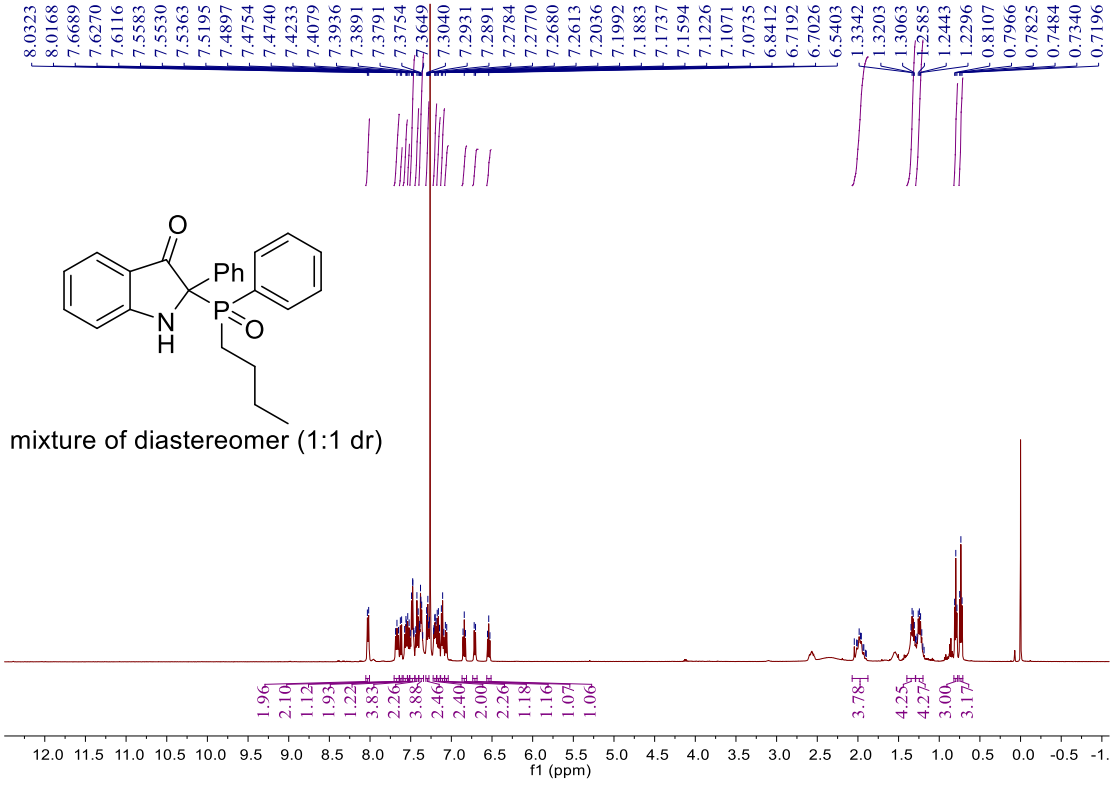
-27.6118

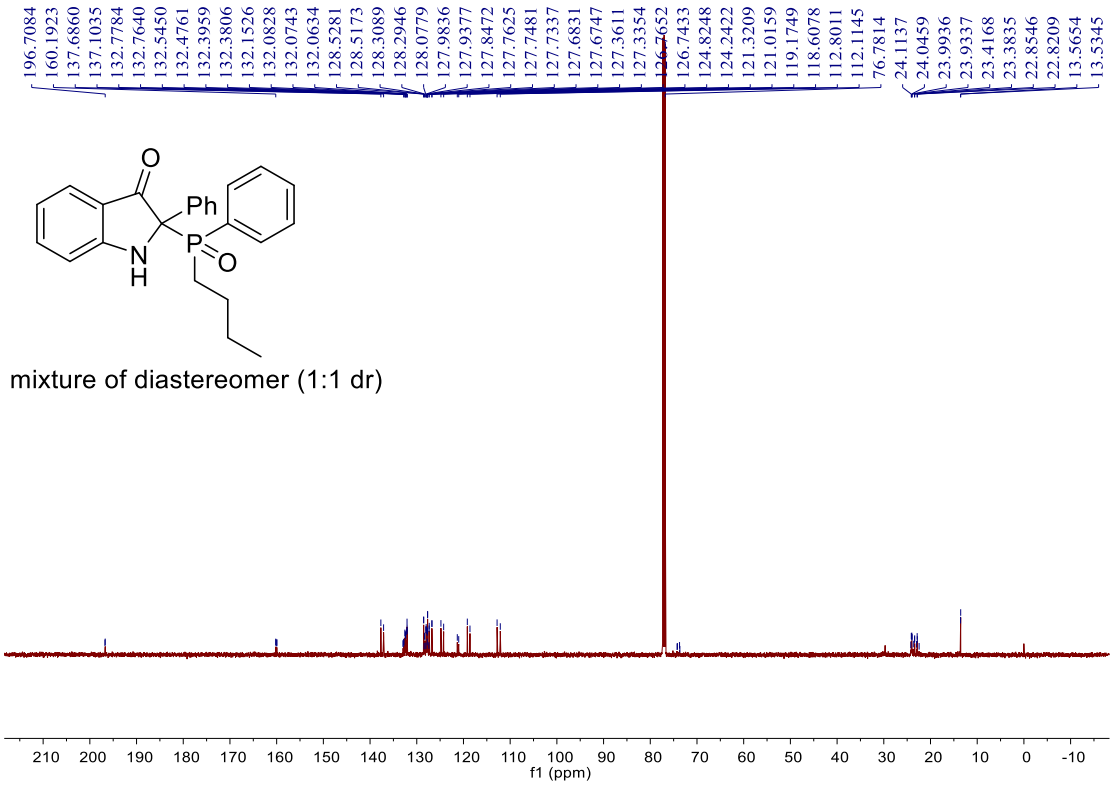




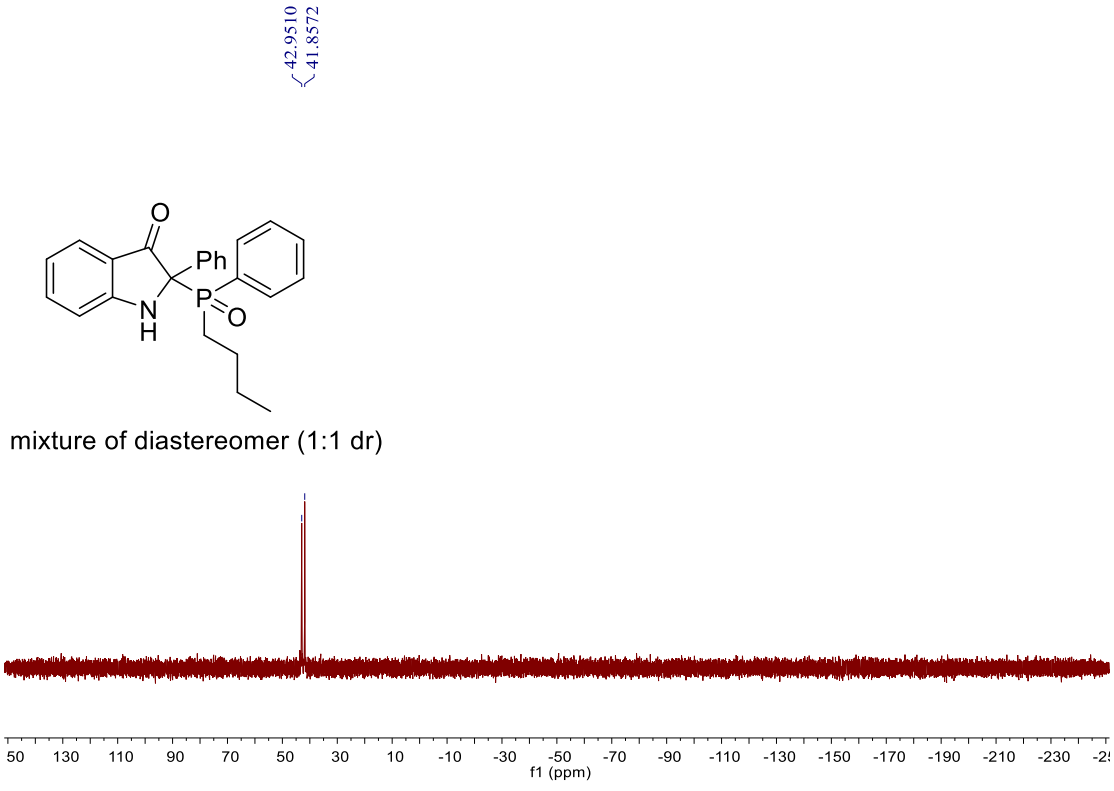


2-phenyl-2-(phenyl(propyl)phosphoryl)indolin-3-one (3z)



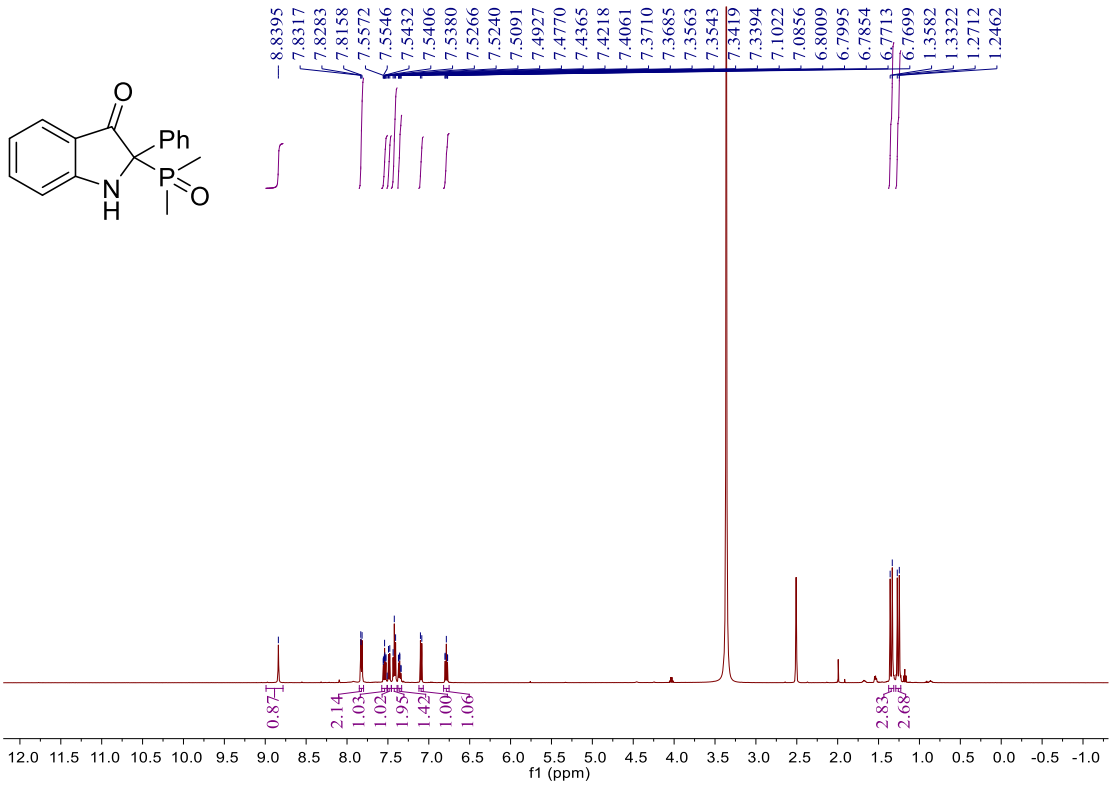


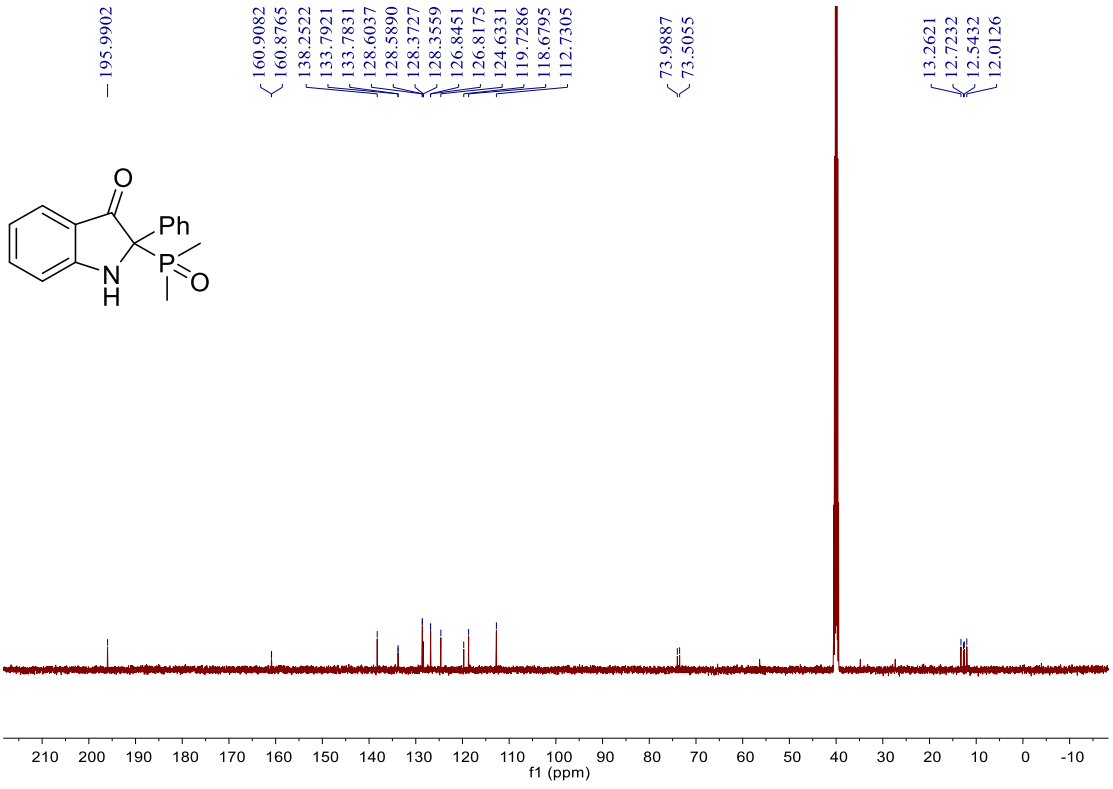
mixture of diastereomer (1:1 dr)

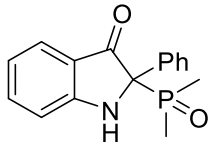


mixture of diastereomer (1:1 dr)

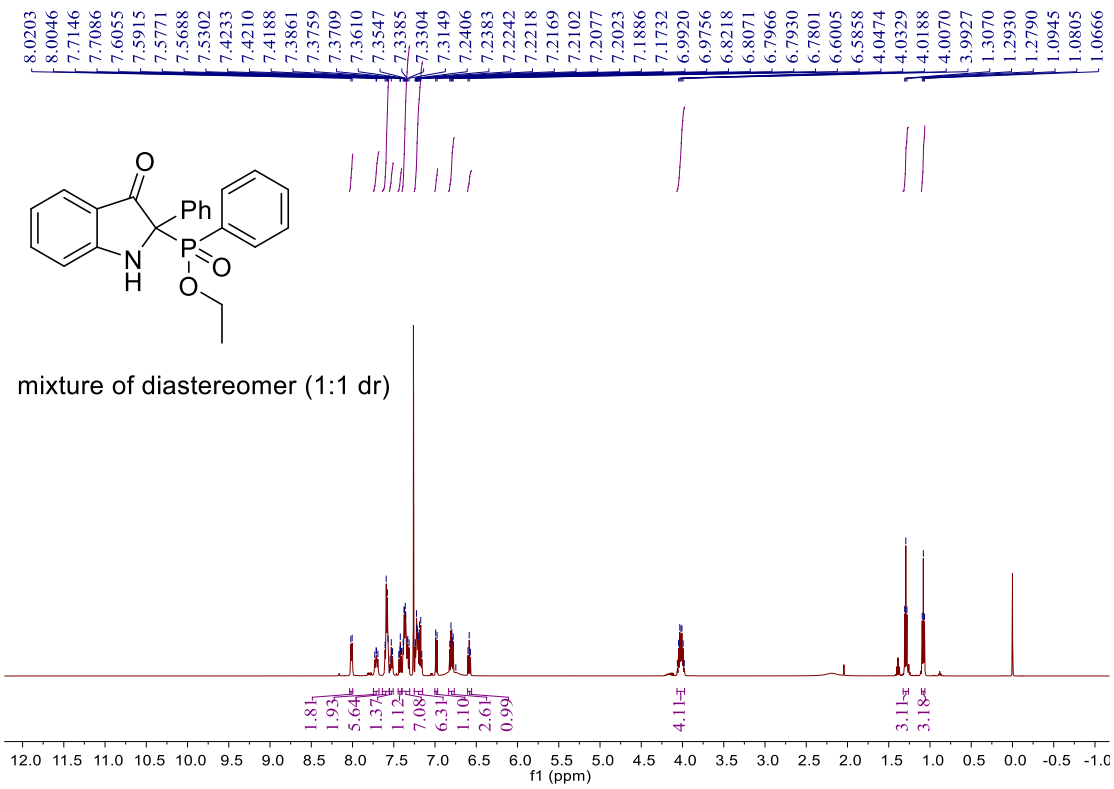
2-(dimethylphosphoryl)-2-phenylindolin-3-one (3aa).

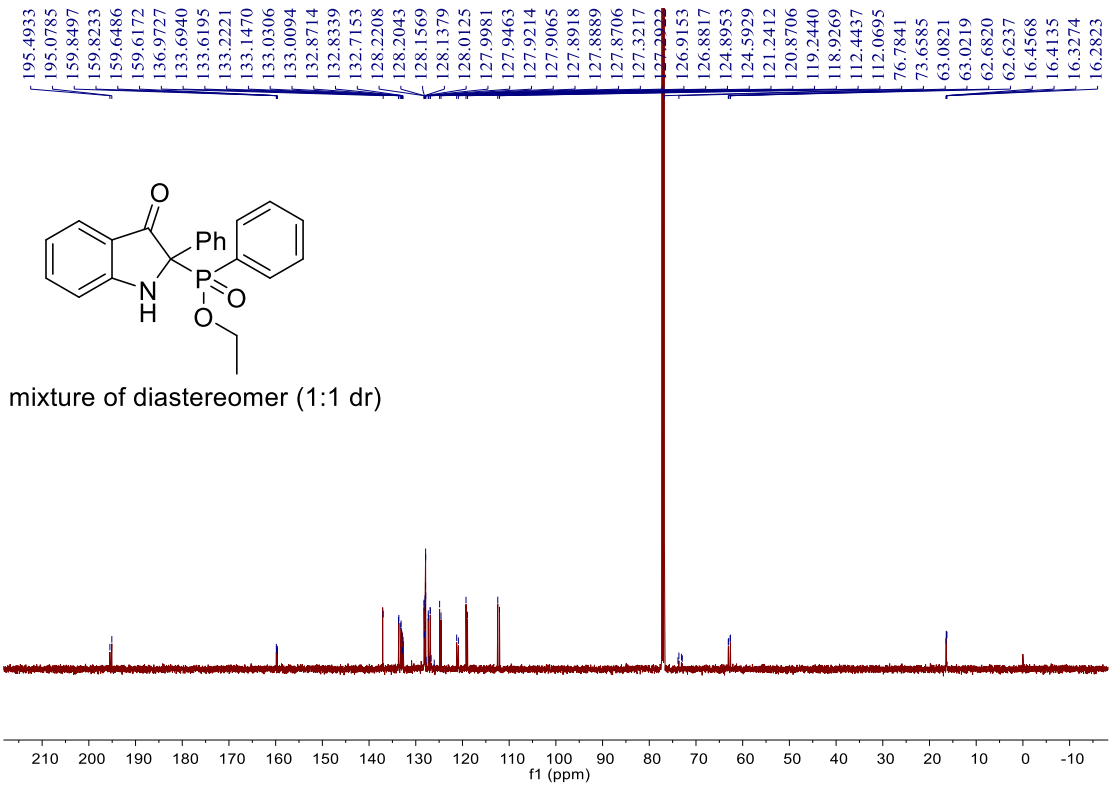




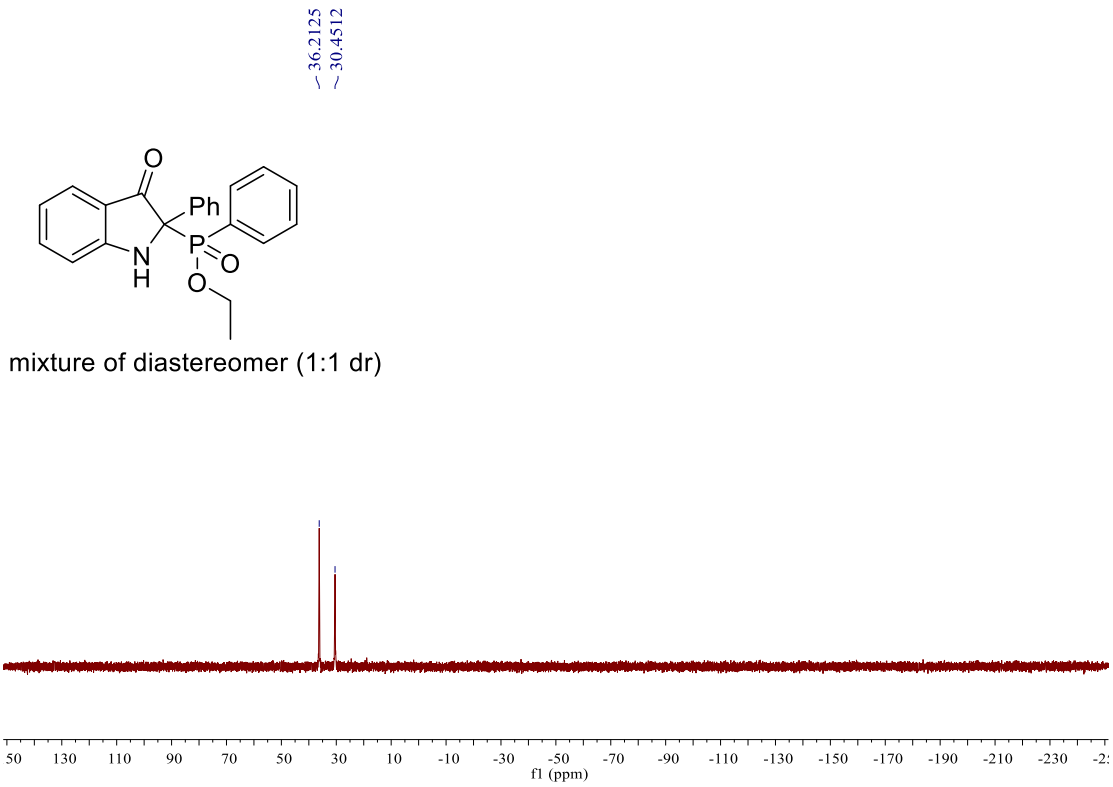


ethyl (3-oxo-2-phenylindolin-2-yl)(phenyl)phosphinate(3ab)



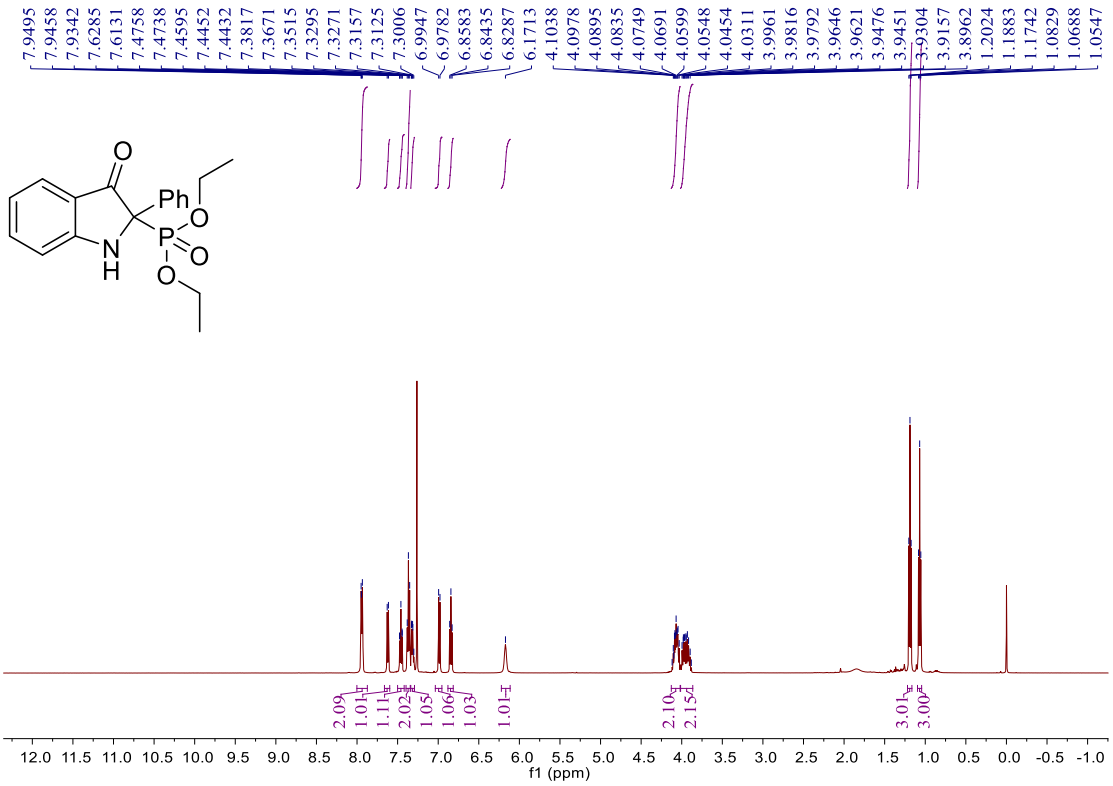


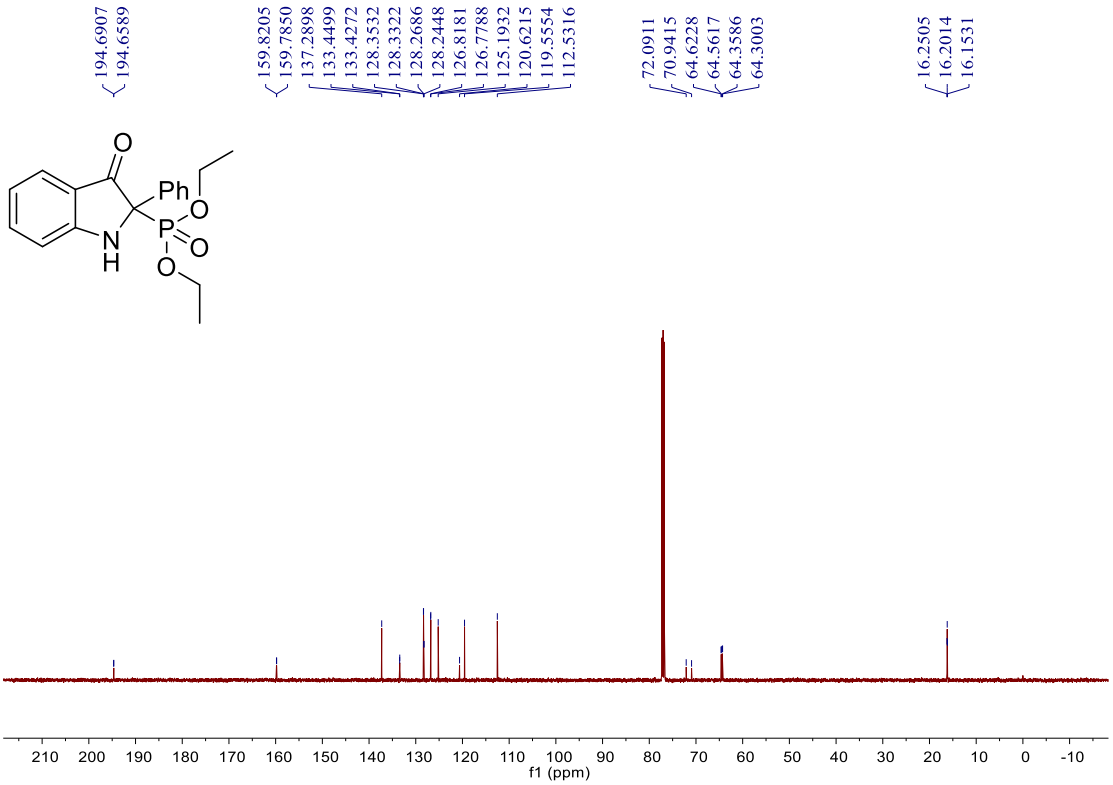
mixture of diastereomer (1:1 dr)

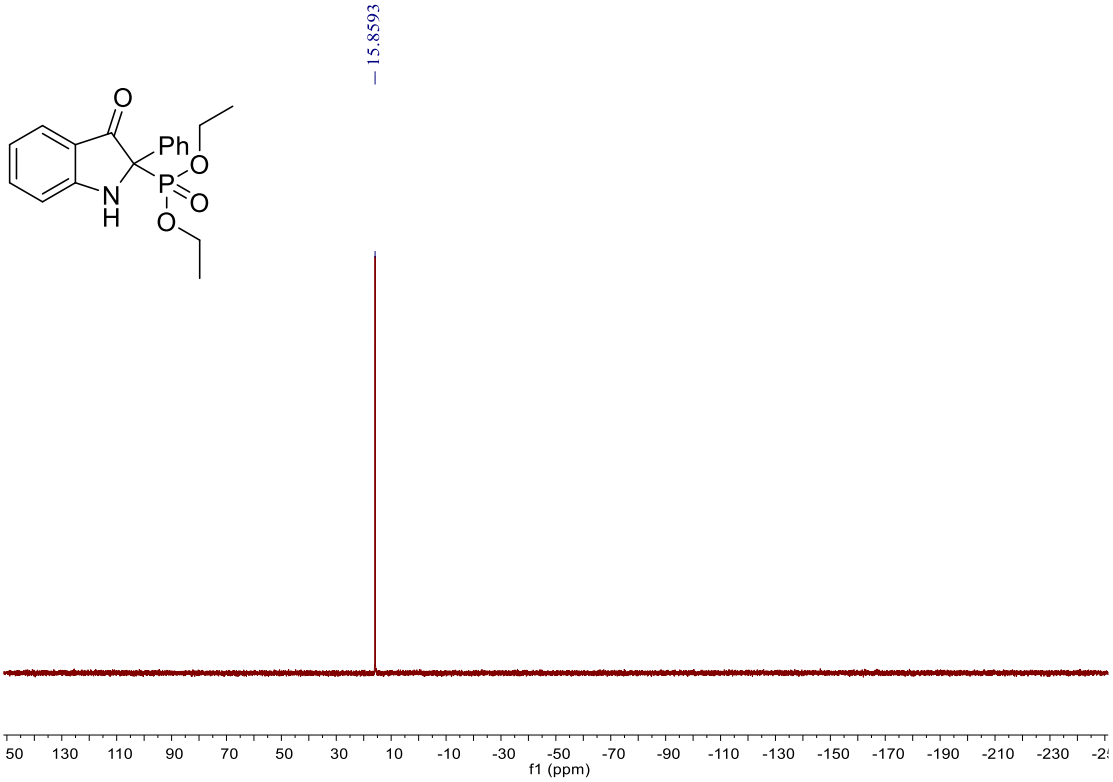


mixture of diastereomer (1:1 dr)

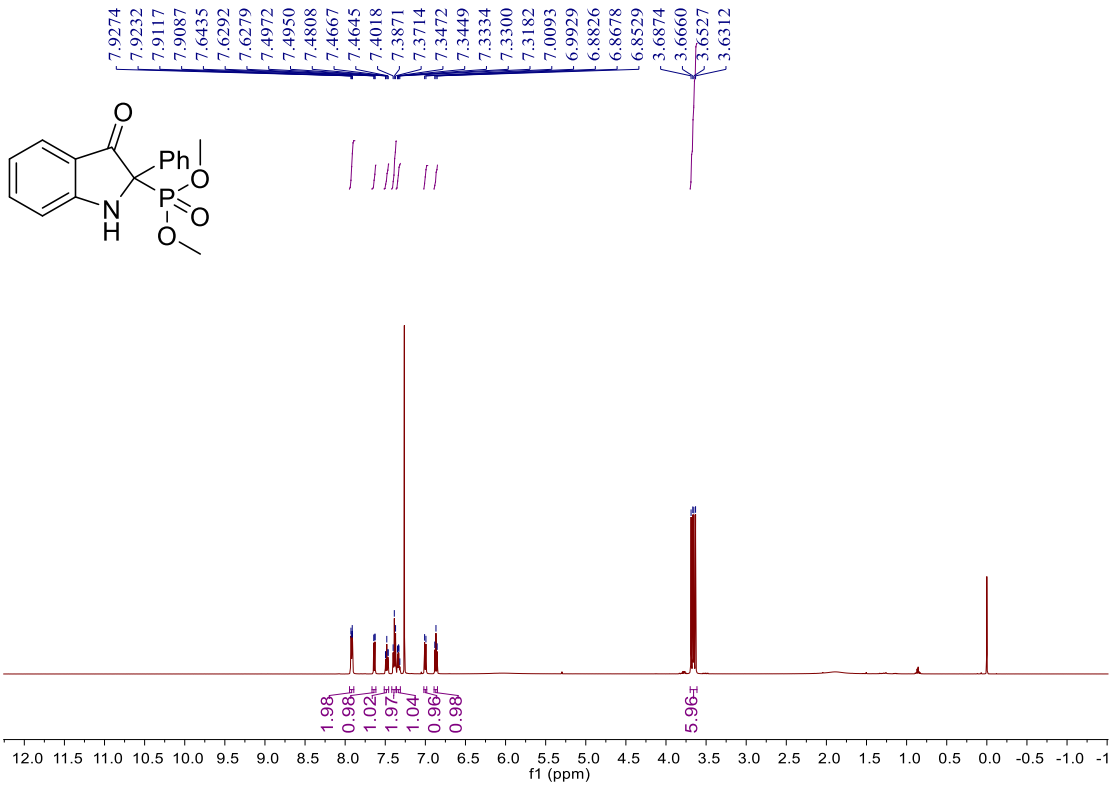
diethyl (3-oxo-2-phenylindolin-2-yl)phosphonate(3ac)

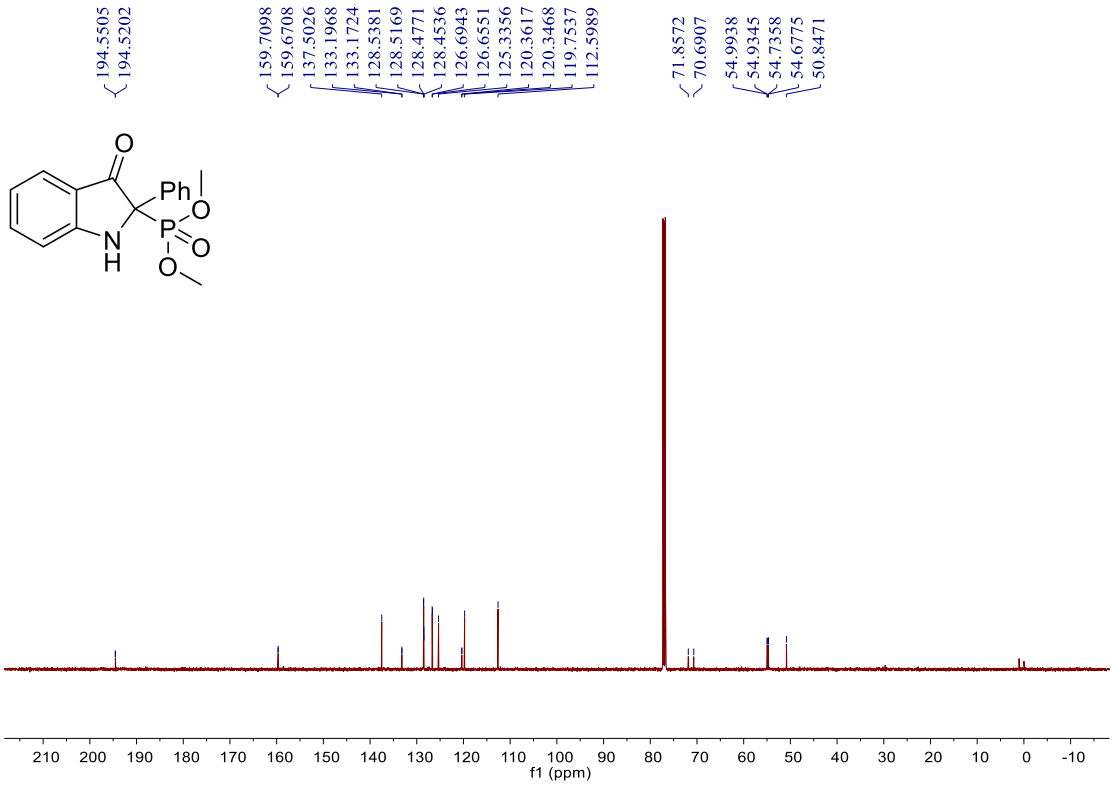






dimethyl (3-oxo-2-phenylindolin-2-yl)phosphonate(3ad).

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112.5989
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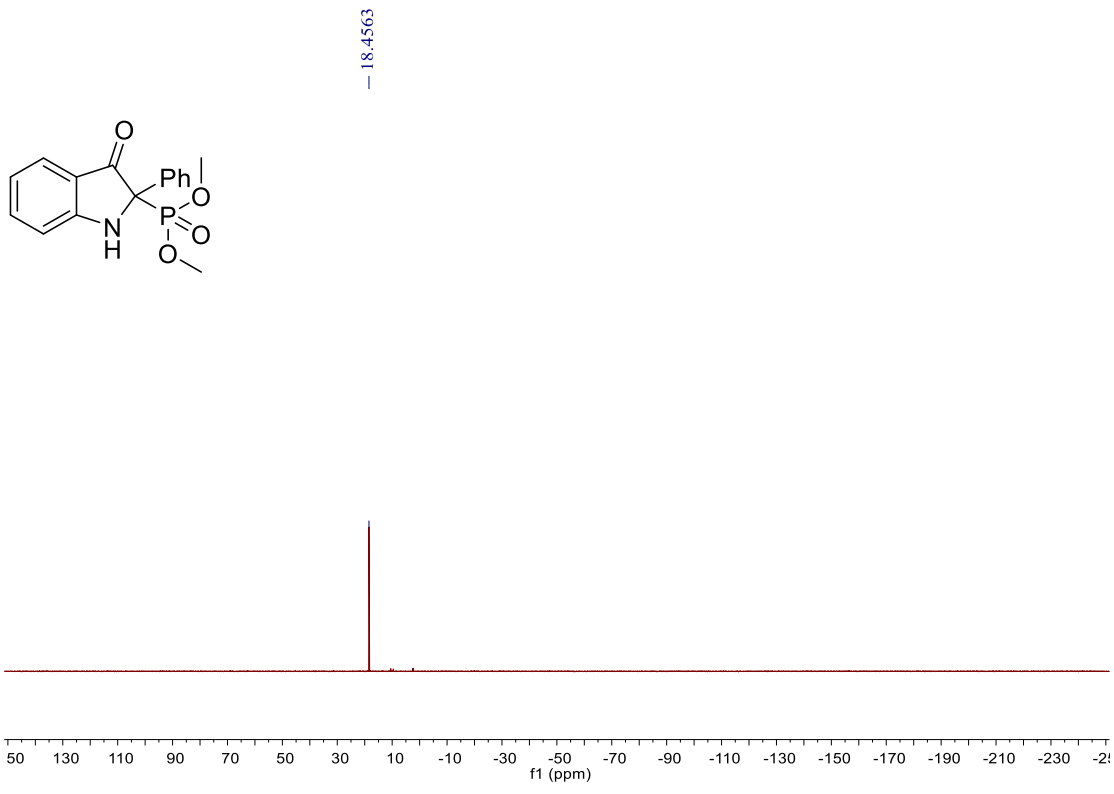
70.6907
54.9938
54.9345
54.7358
54.6775
50.8471
O
Ph
O
P
O
N
H
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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Ph
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O
50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)