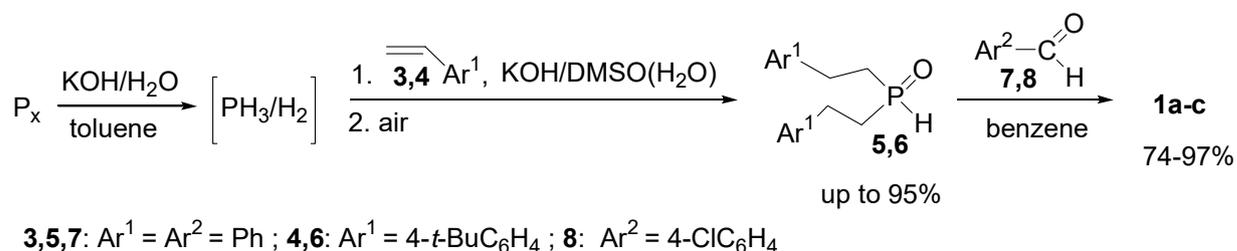


Phosphorus halide free synthesis of 1,2,3,4-tetrahydroisophosphinoline 2-oxides

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The ^1H , ^{13}C and ^{31}P NMR spectra were recorded on a Bruker AV-400 spectrometer (400.13, 100.62 and 161.98 MHz, respectively). 85% H_3PO_4 was employed as external standard for ^{31}P NMR. IR-FT spectra were taken on a Bruker Vertex 70 spectrometer. The C, H microanalyses were performed on a Flash EA 1112 analyzer, while the content of P was determined by combustion method. Melting points (uncorrected) were determined using a Kofler micro hot stage.

The starting hydroxy phosphine oxides **1a-c** were synthesized according to the Scheme S1, which includes: generation of phosphine (together with hydrogen) from red phosphorus in the aqueous KOH/toluene suspension and its further use without isolation and purification for phosphination of styrenes **3,4** in the presence of KOH/DMSO(H_2O) superbase system as described [S1,S2,S3]. In this way, bis(2-arylethyl)phosphines are formed in yields up to 87% and then are easily oxidized in air into the corresponding phosphine oxides **5,6**. The latter react with aldehydes **7,8** under mild conditions (20-60 °C) to afford tertiary *P,P*-bis(2-arylethyl)-*P*-(α -hydroxybenzyl)phosphine oxides **1a-c** in high yield.



Scheme S1

Compound **1a** is a known one [S4]. New hydroxy phosphine oxides **1b,c** were synthesized similarly. For this purpose, a solution of secondary phosphine oxide **5,6** (1.0 mmol)

and aldehyde **7,8** (1.0 mmol) in benzene (6 ml) was heated at 60 °C for 3 h, the solvent was removed under reduced pressure, the residue was washed with diethyl ether (3 x 1 ml) and dried in vacuum to give hydroxy phosphine oxides **1b,c** in 78 and 74% yields, respectively.

{Bis[2-(4-tert-butylphenyl)ethyl]phosphoryl}(phenyl)methanol (1b): colourless crystalline solid, mp 163 °C (Et₂O), isolated yield 372 mg (78%). ¹H NMR (400.13 MHz, CDCl₃) δ: 1.25 (s, 18H, Me), 1.86-1.91 and 2.10-2.17 (m, 4H, CH₂P), 2.56-2.88 (m, 4H, CH₂C₆H₄), 5.13 (d, 1H, ²J_{PH} = 8.1 Hz, CHP), 7.02, 7.25 and 7.43 (m, 13H, Ph and C₆H₄). ¹³C NMR (100.62 MHz, CDCl₃) δ: 26.54 and 26.98 (d, CH₂P, ¹J_{PC} = 59.0 and 59.6 Hz), 26.86 (CH₂C₆H₄), 31.39 Me₃C, 34.37 Me₃C, 71.94 (d, CHP, ¹J_{PC} = 76.0 Hz), 129.45 C_{c,c'} in C₆H₄, 126.58 (d, C_o in Ph, ³J_{PC} = 3.8 Hz), 127.75 and 127.85 C_{b,b'} in C₆H₄, 127.97 (d, C_p in Ph, ⁵J_{PC} = 2.6 Hz), 128.55 (d, C_m in Ph, ⁴J_{PC} = 2.0 Hz), 137.32 (C_i in Ph), 138.04 and 138.19 (d, C_a, in C₆H₄, ³J_{PC} = 13.3 and 13.5 Hz), 149.12 and 149.15 C_d in C₆H₄. ³¹P NMR (161.98 MHz, CDCl₃) δ: 50.01 ppm. FT-IR (KBr, ν/cm⁻¹): 3427, 3089, 2963, 2868, 1600, 1517, 1493, 1448, 1414, 1365, 1269, 1207, 1145, 1122, 1104, 1081, 1050, 1028, 931, 839, 813, 783, 743, 697, 565, 521, 496. Found (%): C, 78.08; H, 8.65; P, 6.21. Calc. for C₃₁H₄₁O₂P (%): C, 78.12; H, 8.67; P, 6.50.

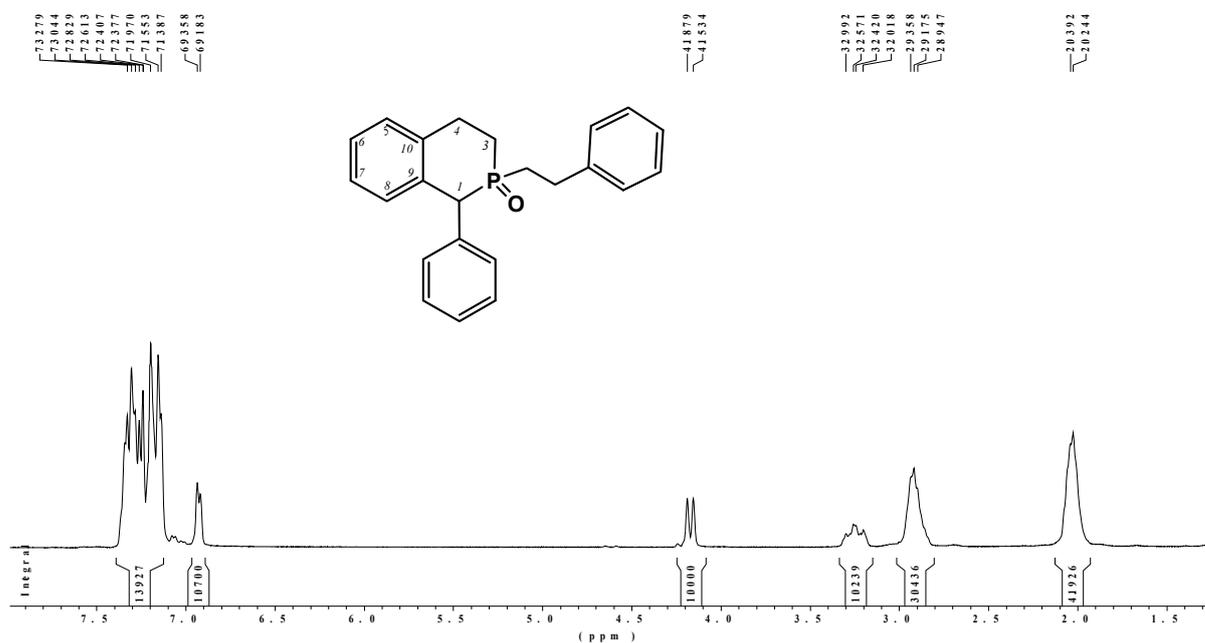
[Bis(2-phenylethyl)phosphoryl](4-chlorophenyl)methanol (1c): colorless crystalline solid, mp 165°C (hexane), isolated yield 297 mg (74%). ¹H NMR (400.13 MHz, CDCl₃) δ: 1.91 and 2.10 (m, 4H, CH₂P), 2.69-2.87 (m, 4H, CH₂Ph), 5.05 (br.s, 1H, PCH), 5.18 (br.s, 1H, OH), 7.05-7.35 (m, 14H, Ph and C₆H₄). ¹³C NMR (100.62 MHz, CDCl₃) δ: 26.76 and 26.99 (d, CH₂P, ¹J_{PC} = 60.0 and 60.2 Hz), 27.46 CH₂Ph, 71.69 (d, PCH, ¹J_{PC} = 75.5 Hz), 126.58 (C_p in Ph), 127.83; 127.87 C_{b,b'} in C₆H₄; 128.08 and 128.14 (C_o in Ph), 128.86 (C_m in Ph), 128.90 C_{c,c'} in C₆H₄; 134.16 C_i, 135.64 C_a, 140.97(d, C_a in Ph, ³J_{PC} = 11.3 Hz) C_d. ³¹P NMR (161.98 MHz, CDCl₃) δ: 49.17 ppm. IR (KBr, ν/cm⁻¹): 3398, 3176, 3030, 2935, 2868, 1600, 1492, 1450, 1412, 1319, 1261, 1216, 1131, 1053, 1013, 937, 833, 749, 751, 701, 572, 528, 494, 425. Found (%): C, 68.98; H, 6.04; P, 7.72. Calc. for C₂₃H₂₄ClO₂P (%): C, 69.26; H, 6.06; P, 7.77.

References

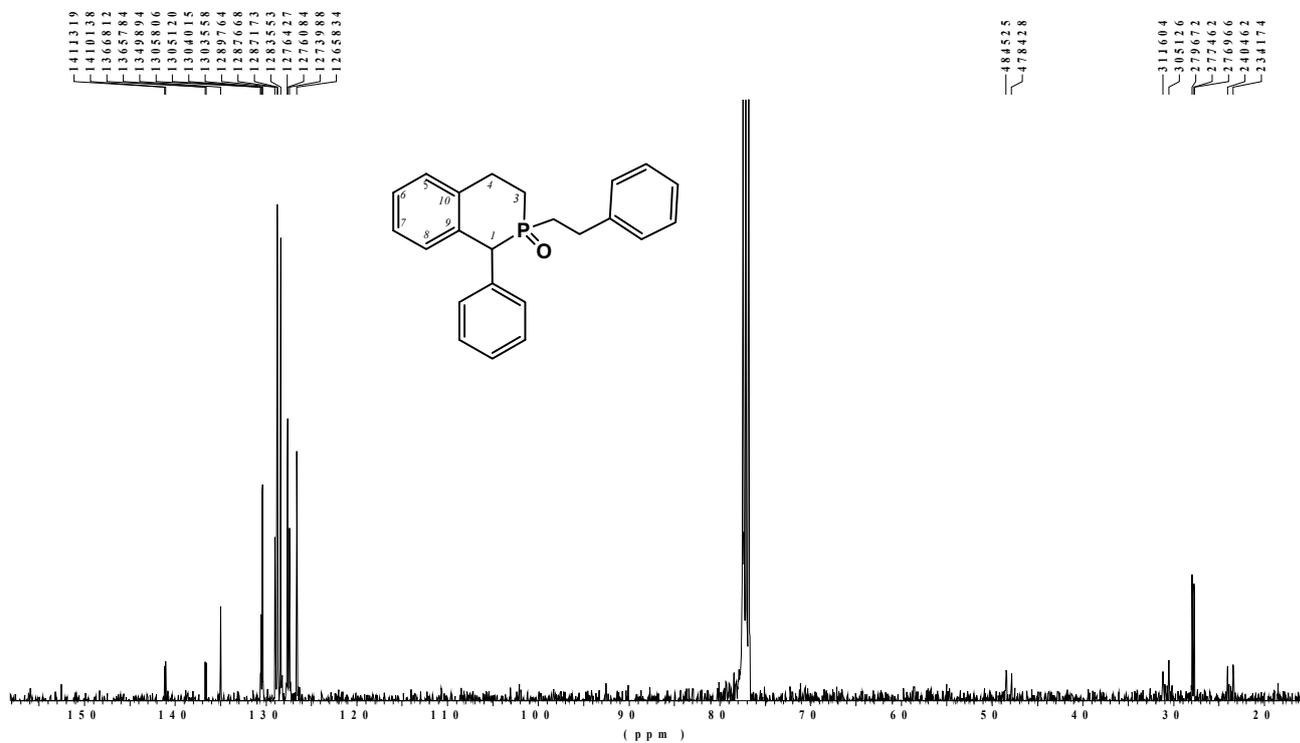
- [S1] B. A. Trofimov, L. Brandsma, S. N. Arbuzova, S. F. Malysheva and N. K. Gusarova, *Tetrahedron Lett.*, 1994, **35**, 7647.
- [S2] N. K. Gusarova, S. N. Arbuzova and B. A. Trofimov, *Pure Appl. Chem.*, 2012, **84**, 439.
- [S3] N. K. Gusarova, S. F. Malysheva, V. A. Kuimov, N. A. Belogorlova, V. L. Mikhailenko and B. A. Trofimov, *Mendeleev Commun.*, 2008, **18**, 260.
- [S4] N. K. Gusarova, N. I. Ivanova, P. A. Volkov, K. O. Khrapova, L. I. Larina, V. I. Smirnov, T. N. Borodina and B. A. Trofimov, *Synthesis*, 2015, **47**, 1611.

1-Phenyl-2-(2-phenylethyl)-1,2,3,4-tetrahydroisophospholine 2-oxide (2a)

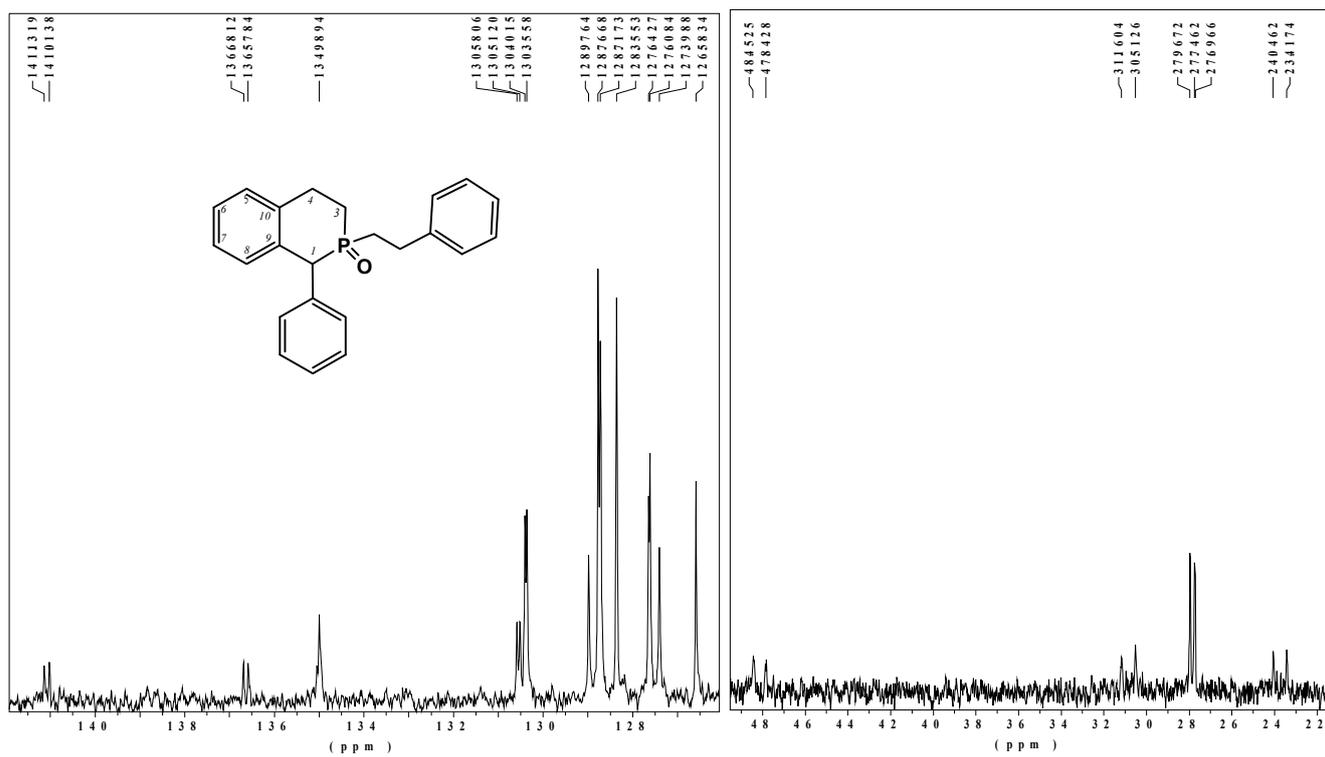
^1H NMR spectrum of **2a** (CDCl_3)



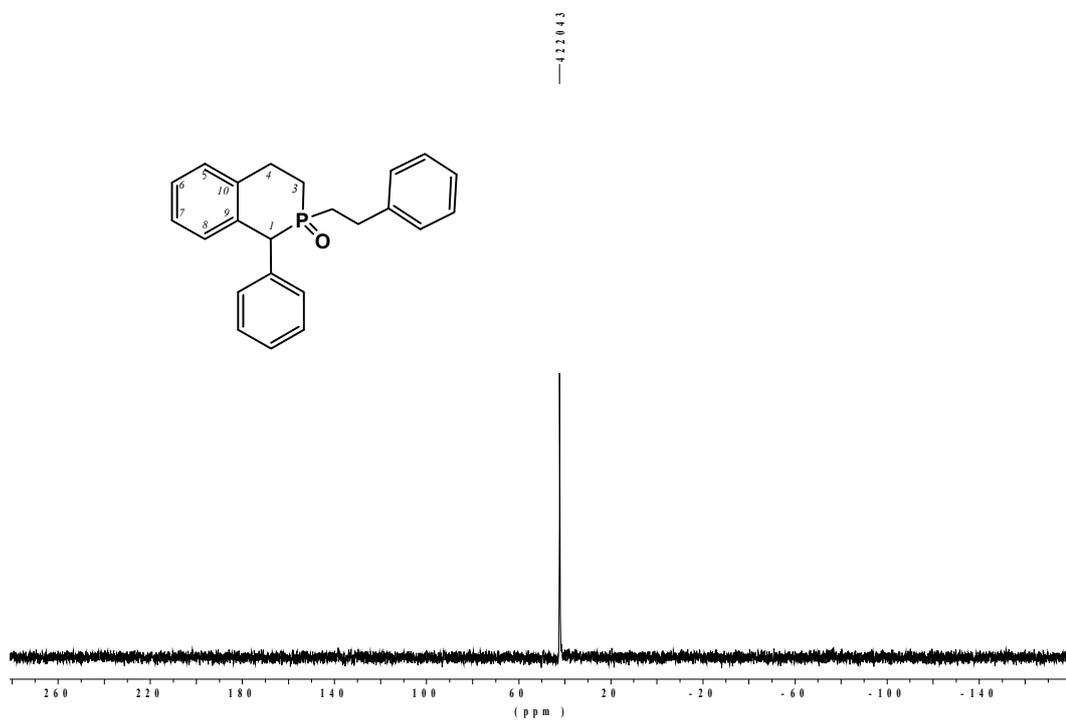
^{13}C NMR spectrum of **2a** (CDCl_3)



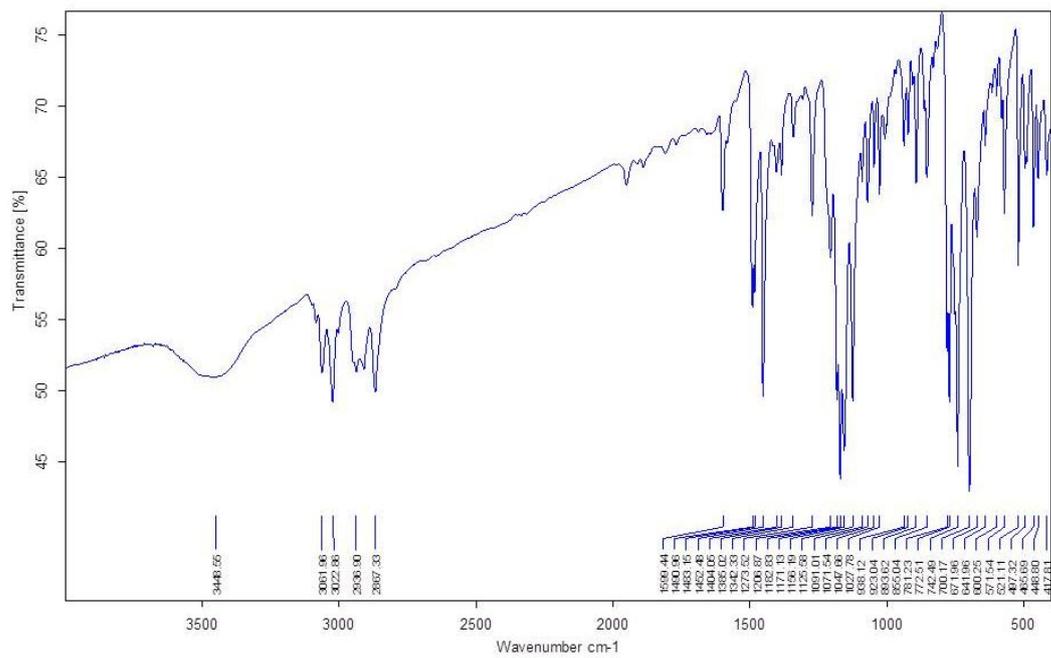
^{13}C NMR spectrum of **2a** (CDCl_3)



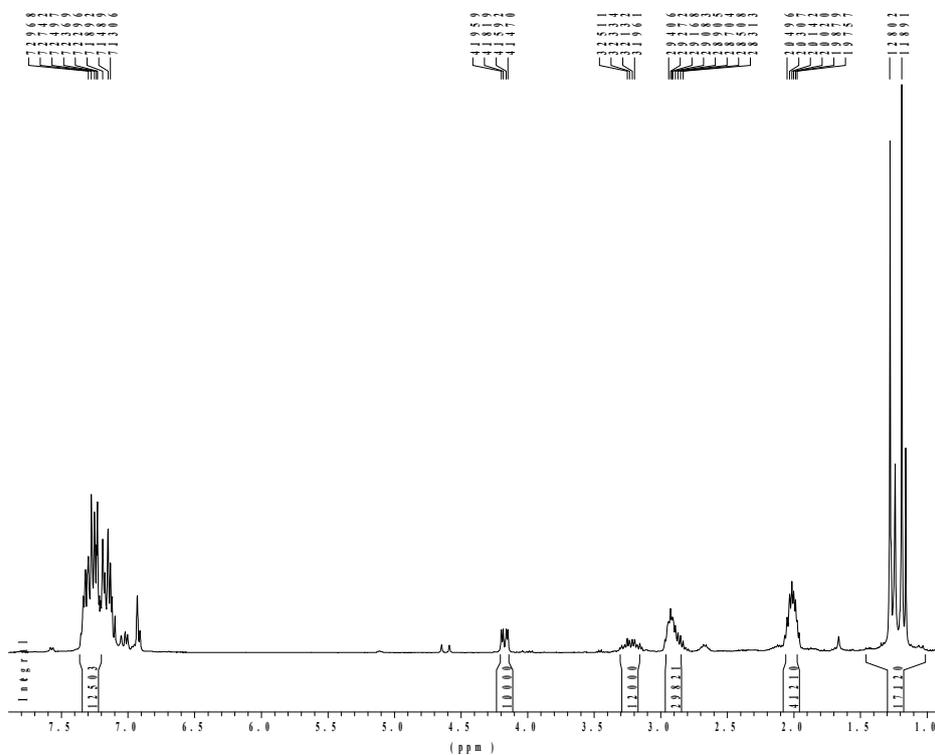
^{31}P NMR spectrum of **2a** (CDCl_3)



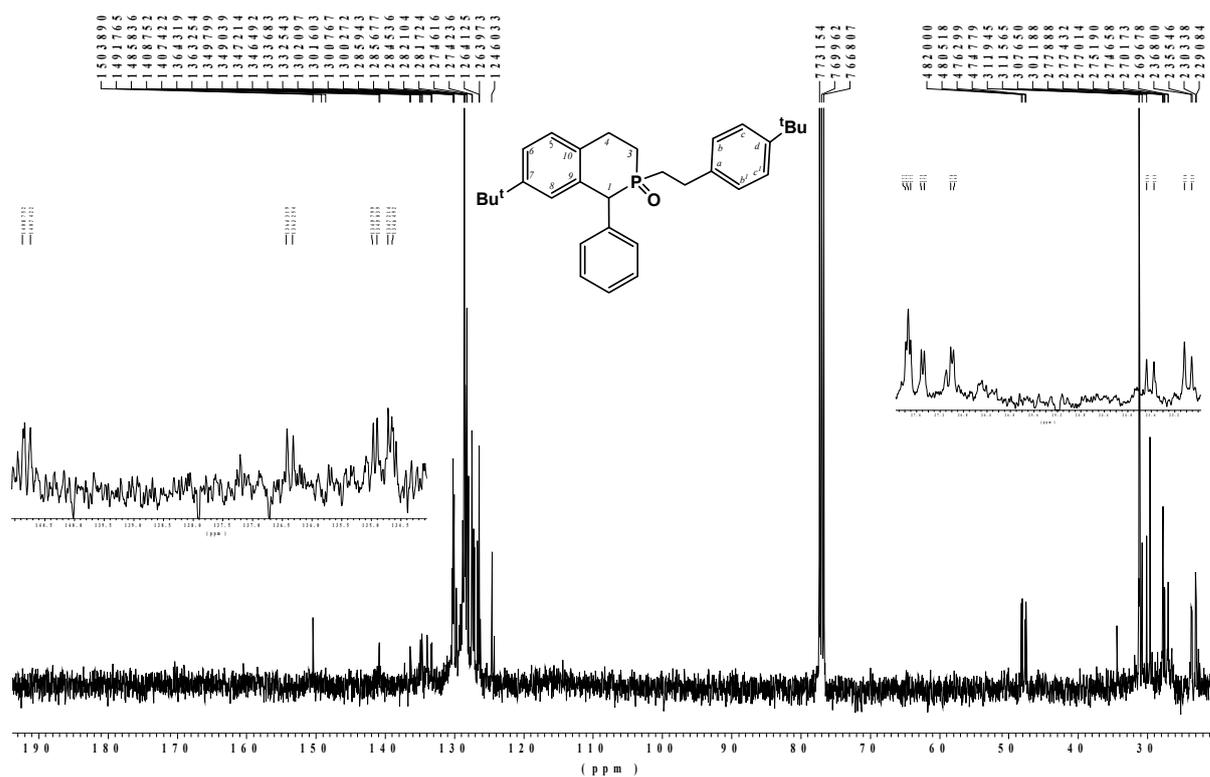
IR spectrum of **2a** (KBr)



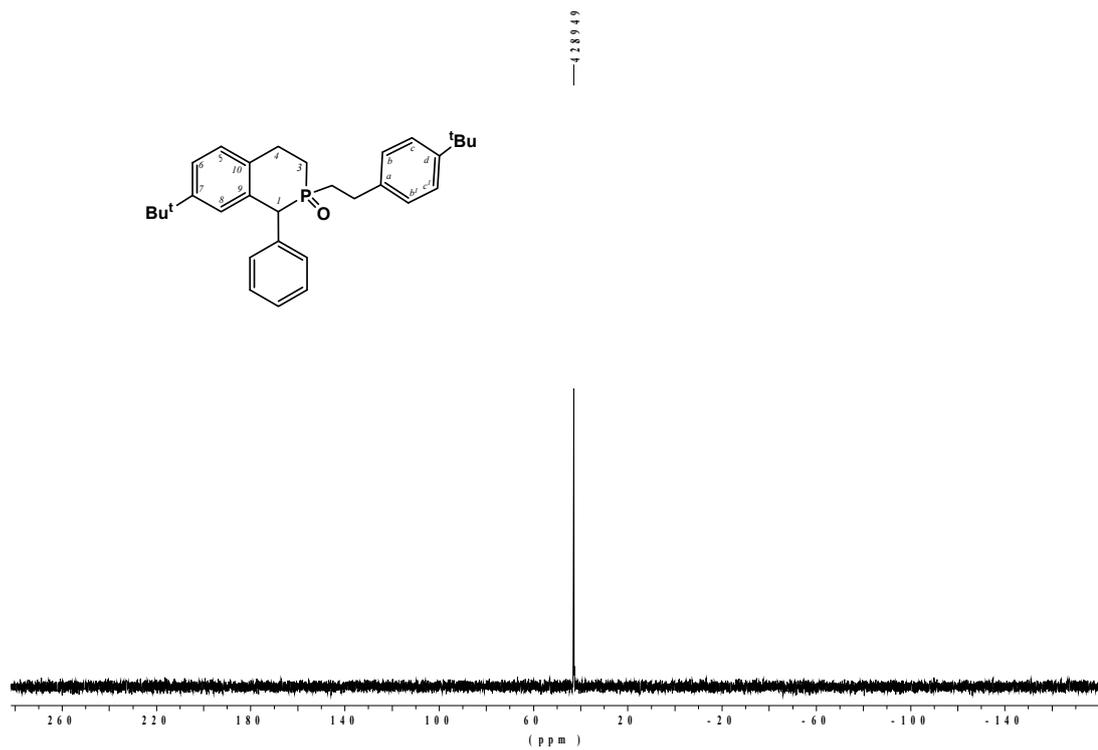
7-*tert*-Butyl-2-[2-(4-*tert*-butylphenyl)ethyl]-1-phenyl-1,2,3,4-tetrahydroisophosphinine 2-oxide (**2b**), ¹H NMR spectrum (CDCl₃)



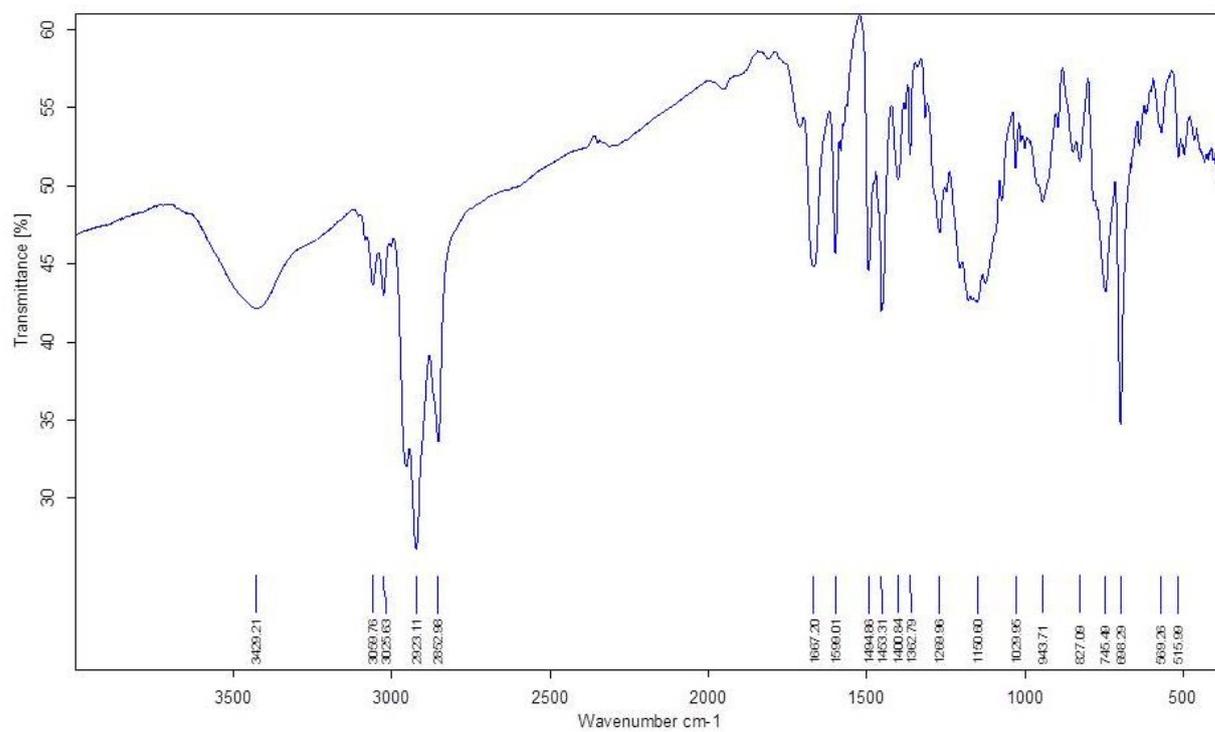
¹³C NMR spectrum of **2b** (CDCl₃)



^{31}P NMR spectrum of **2b** (CDCl_3)



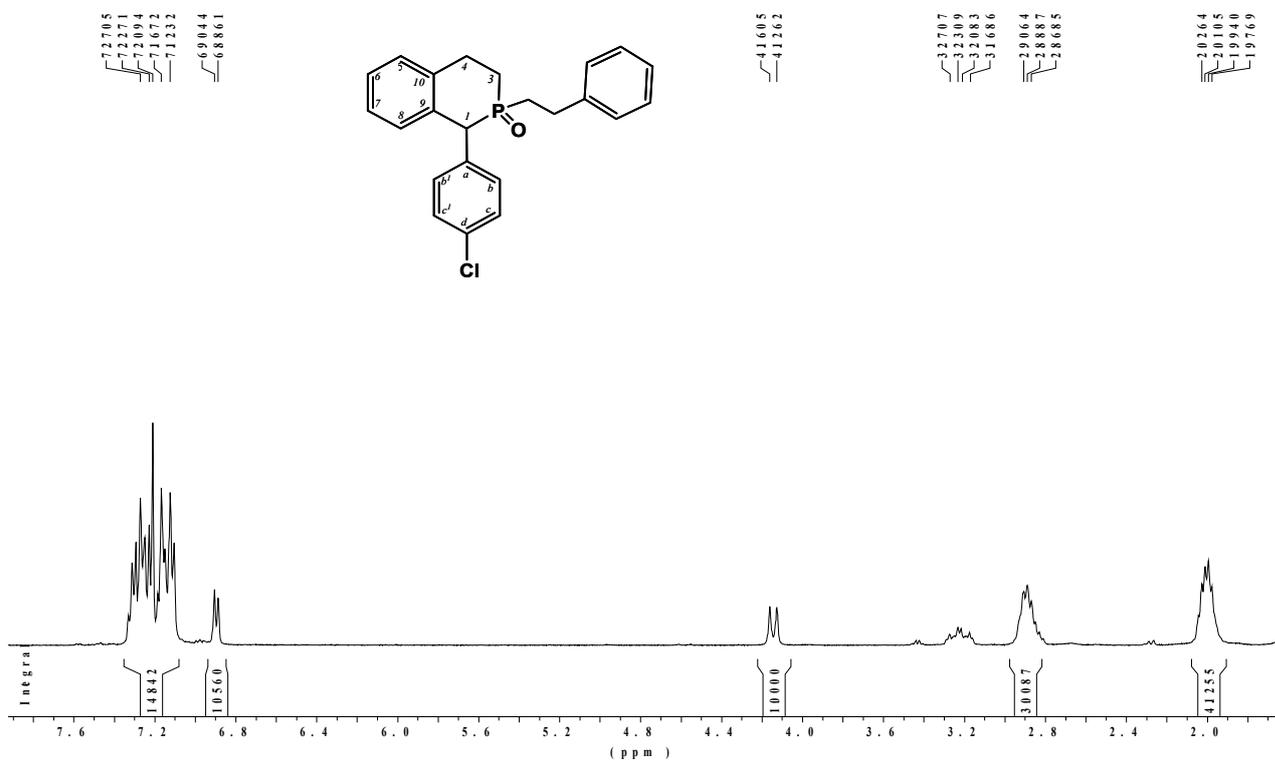
FT-IR spectrum of **2b** (KBr)



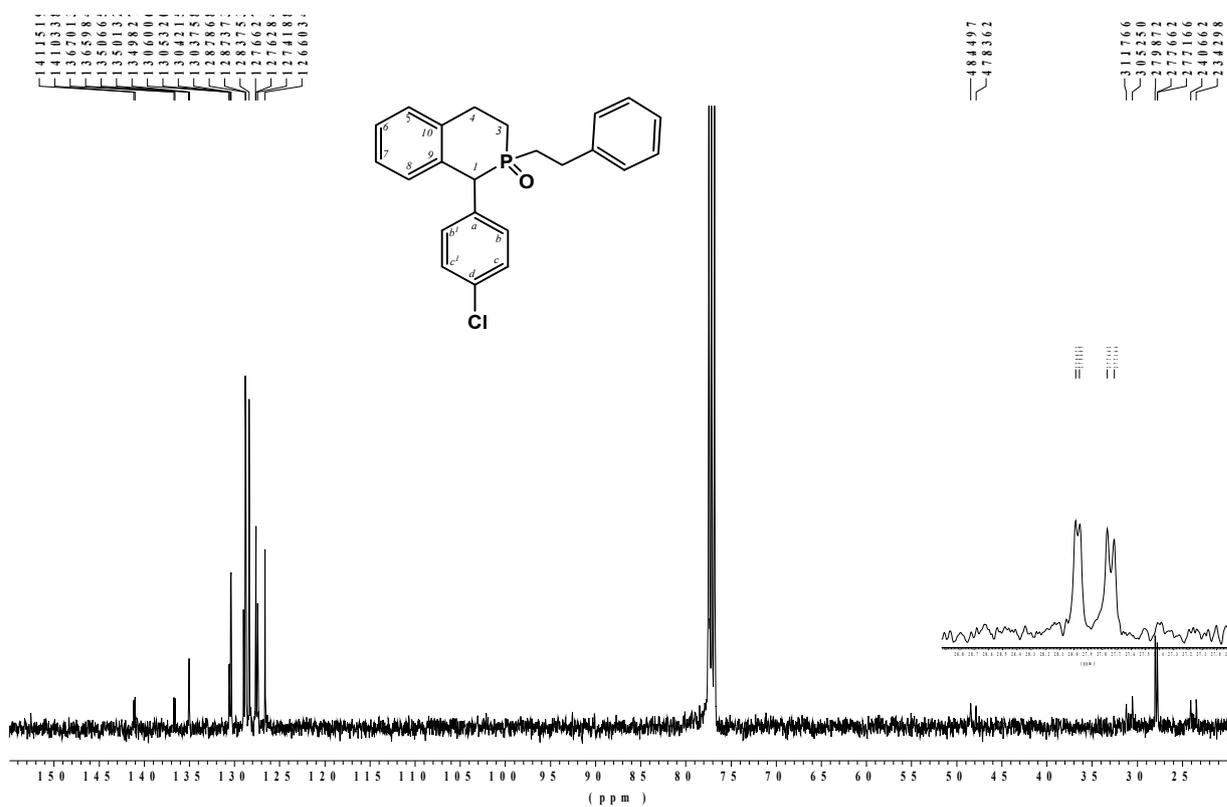
1-(4-Chlorophenyl)-2-(2-phenylethyl)-1,2,3,4-tetrahydroisosphinoline 2-oxide (2c)

¹H NMR spectrum of 2c

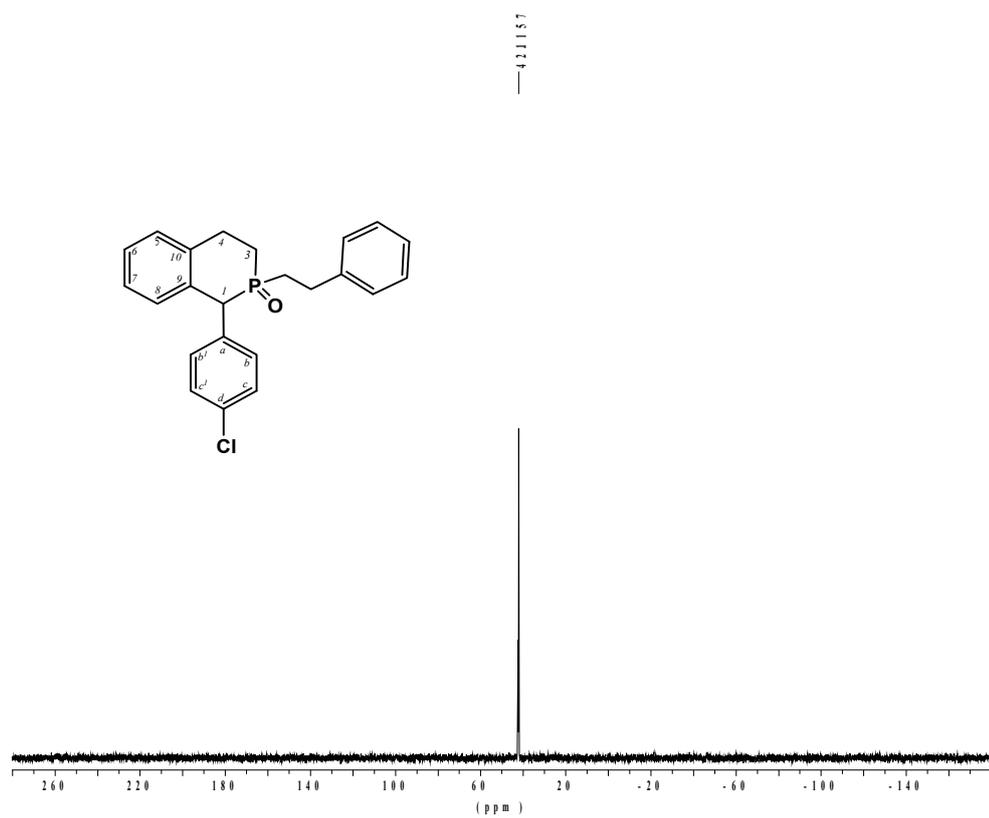
(CDCl₃)



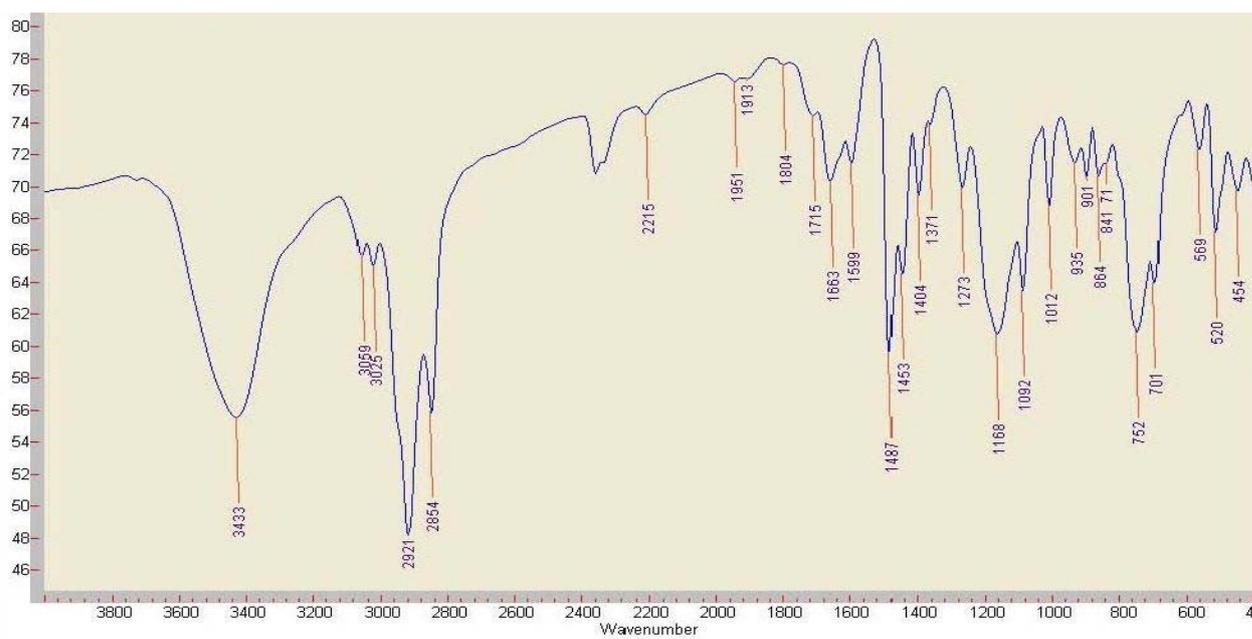
¹³C NMR spectrum of 2c (CDCl₃)



^{31}P NMR spectrum of **2c** (CDCl_3)

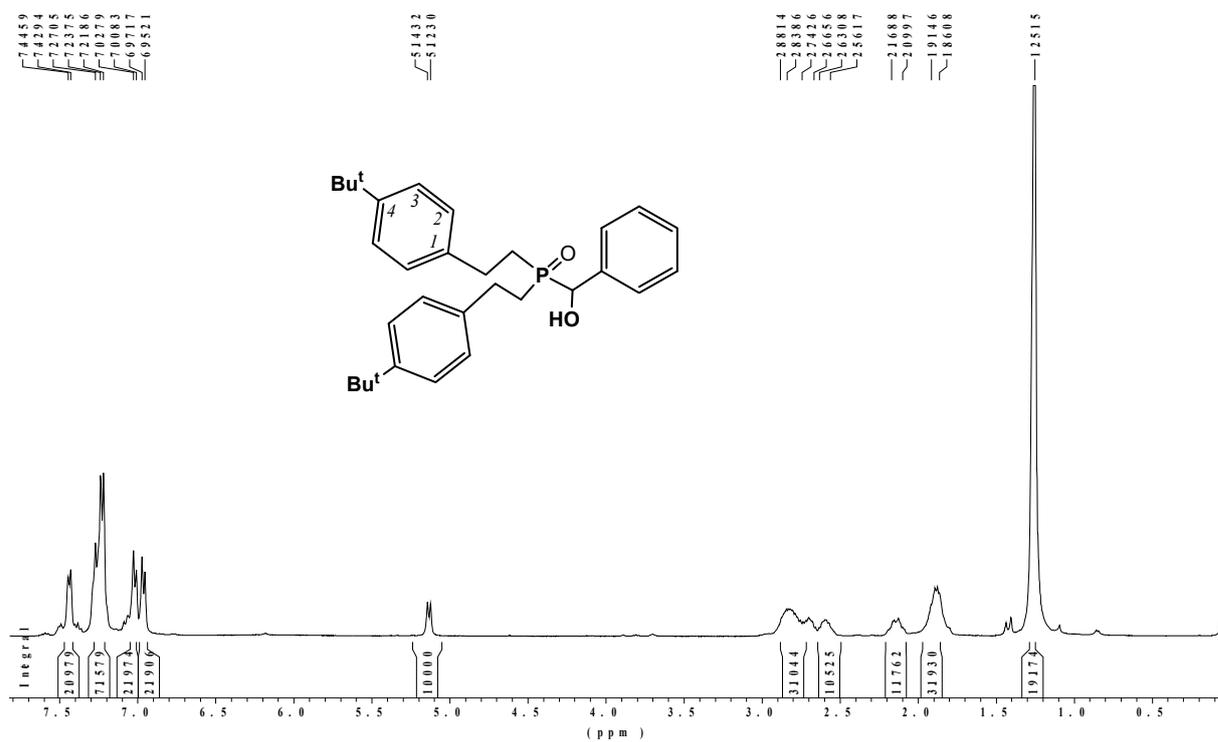


FT-IR spectrum of **2c** (KBr)

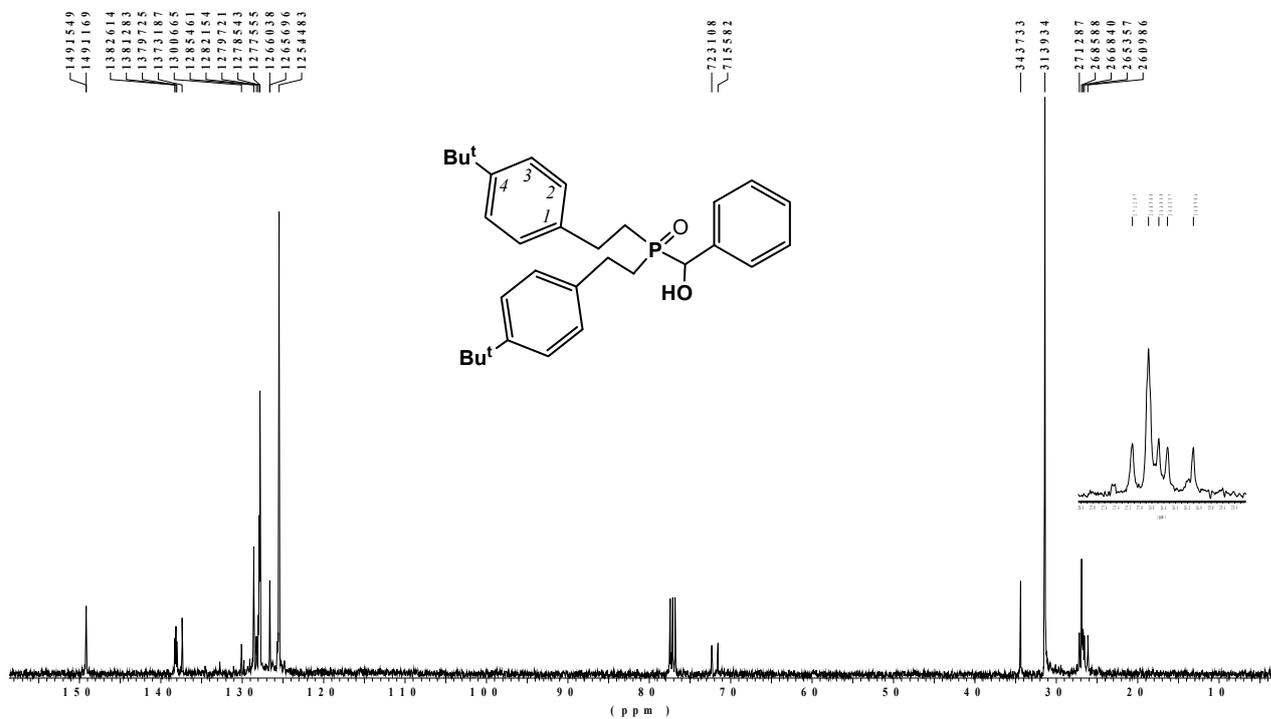


{Bis[2-(4-tert-butylphenyl)ethyl]phosphoryl}(phenyl)methanol (**1b**)

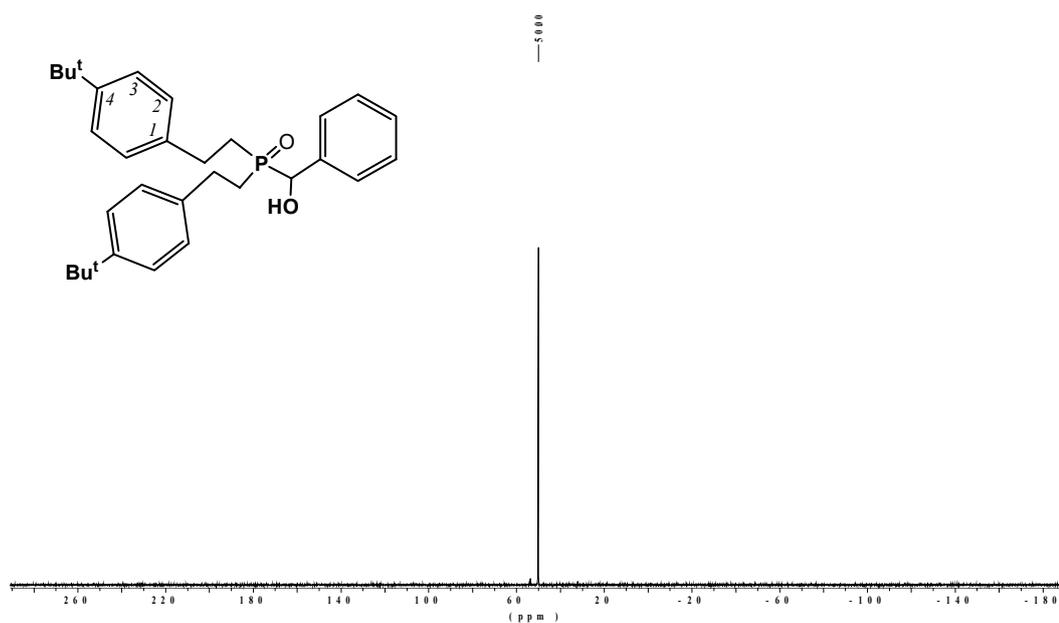
¹H NMR spectrum of **1b** (CDCl₃)



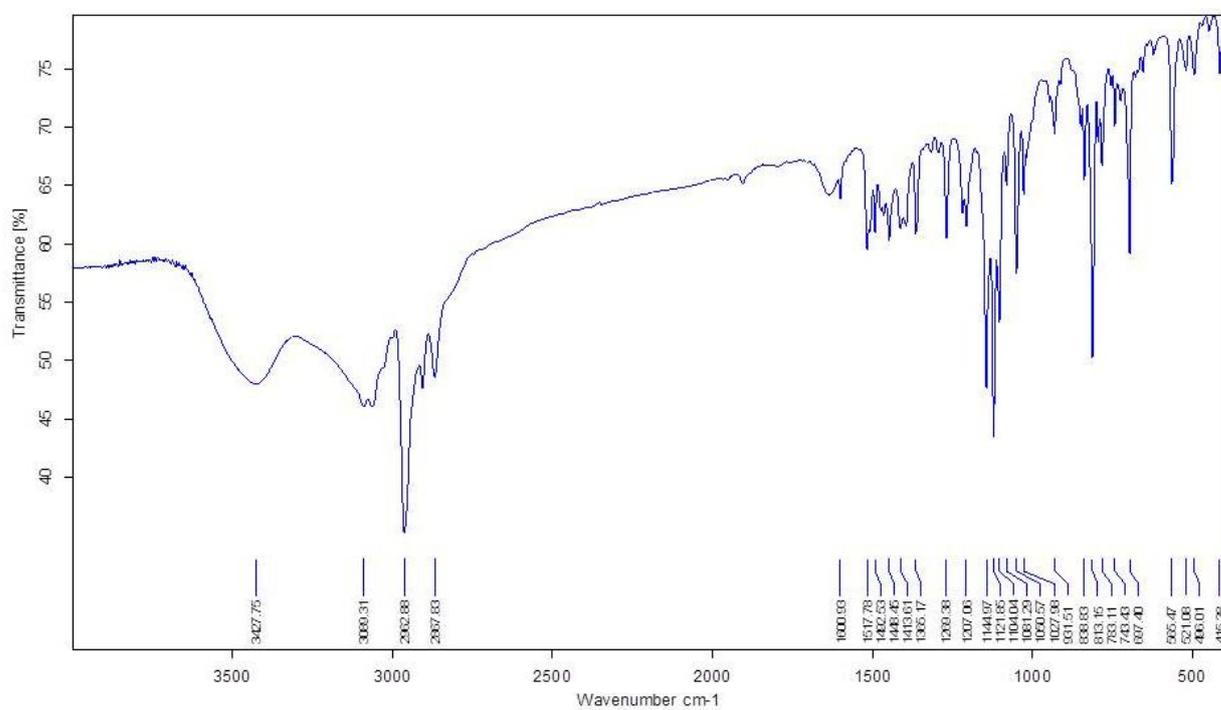
¹³C NMR spectrum of **1b** (CDCl₃)



^{31}P NMR spectrum of **1b** (CDCl_3)

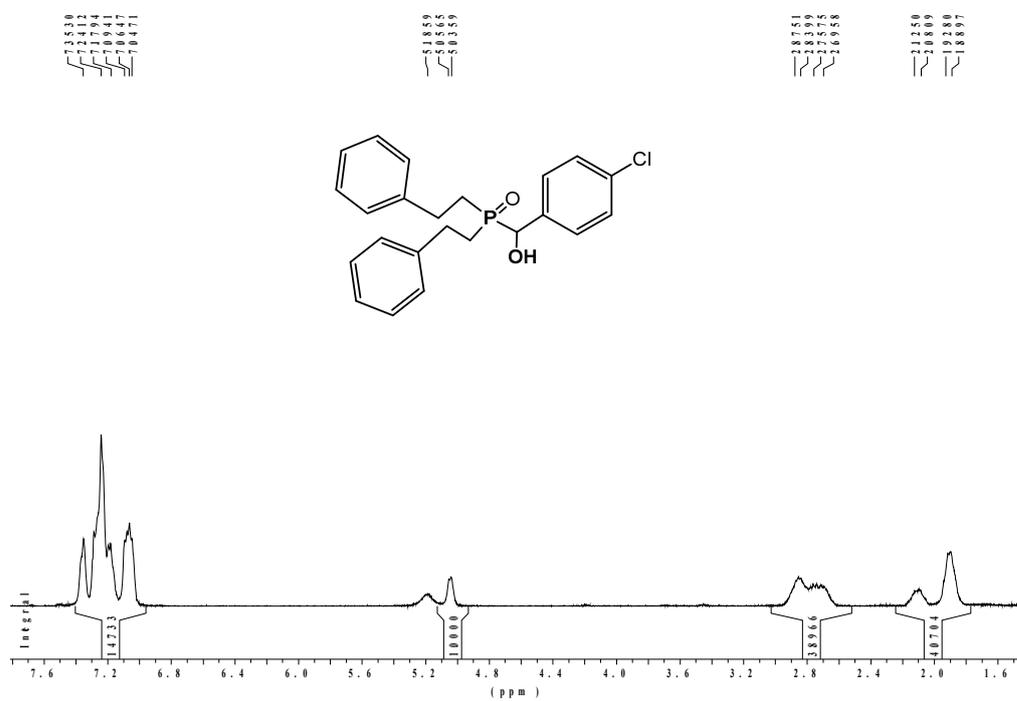


FT-IR spectrum of **1b** (KBr)

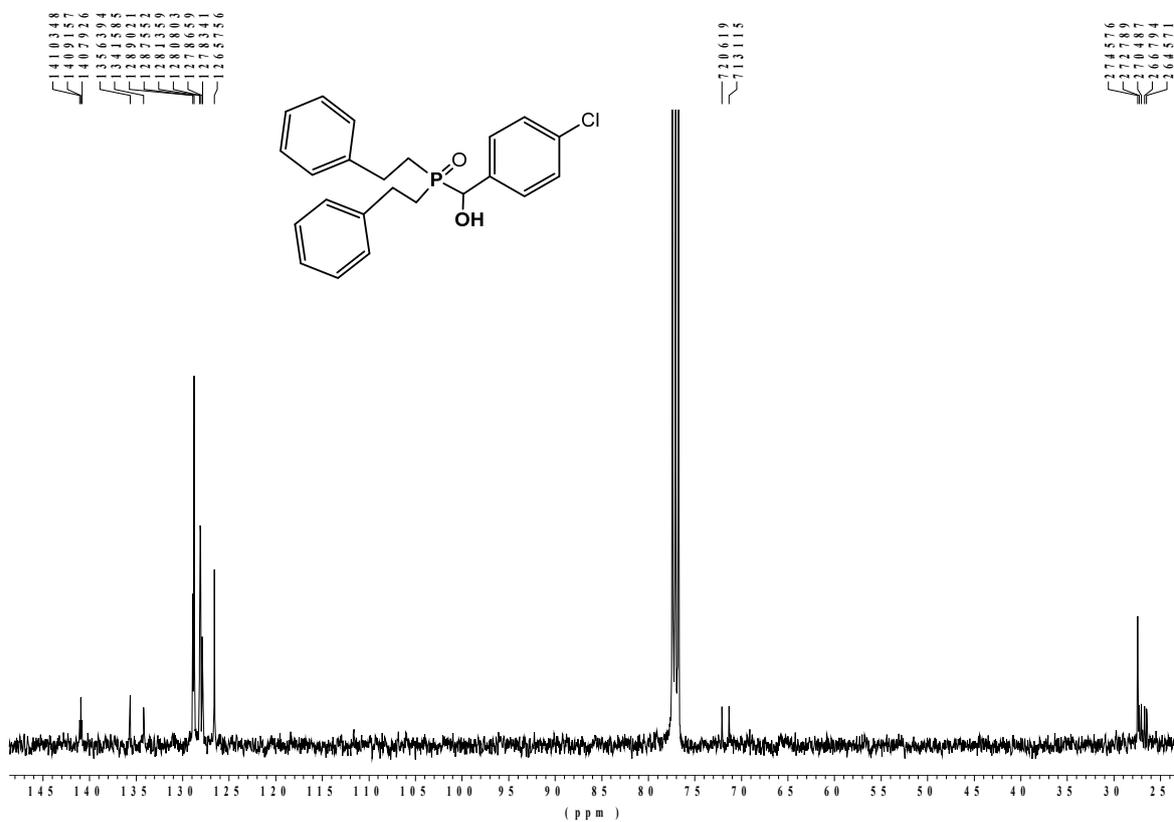


[Bis(2-phenylethyl)phosphoryl](4-chlorophenyl)methanol (**1c**)

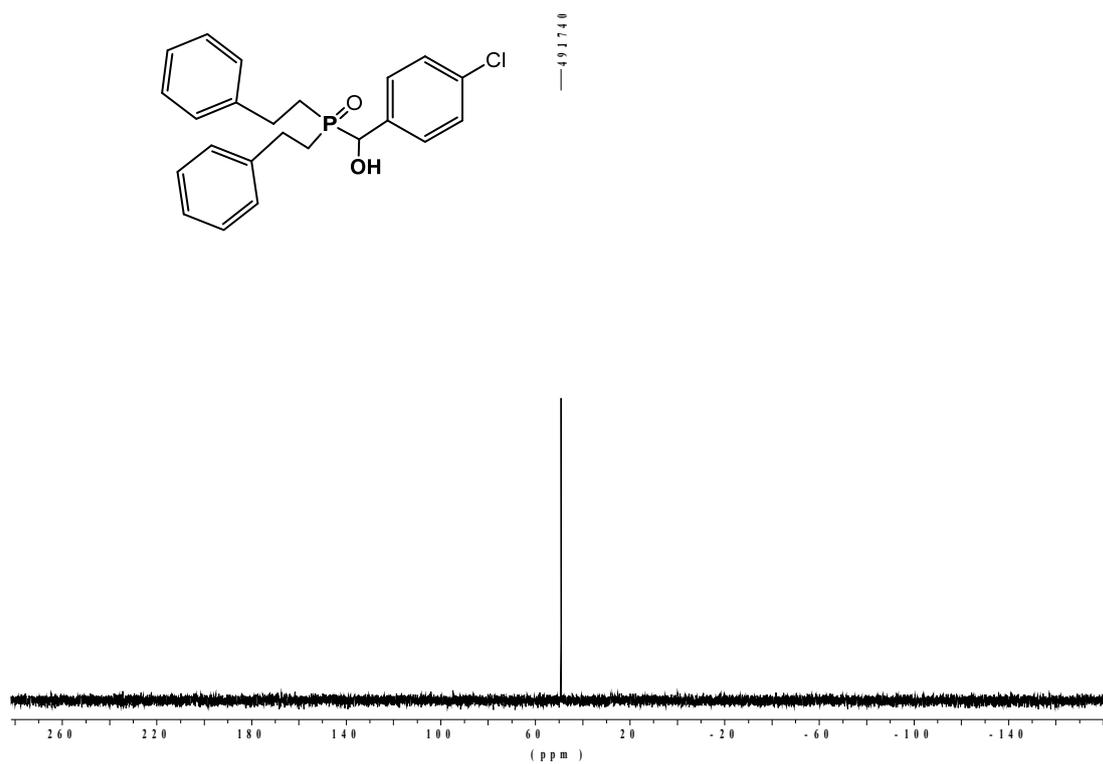
¹H NMR spectrum of **1c** (CDCl₃)



¹³C NMR spectrum of **1c** (CDCl₃)



^{31}P NMR spectrum of **1c** (CDCl_3)



FT-IR spectrum of **1c** (KBr)

