SUPPORTING INFORMATION

***Title*: Synthesis of arylphosphonates catalyzed by Pd-imino-Py-γ-Fe_2O_3 as a new magnetically recyclable heterogeneous catalyst in pure water without requiring any additive**

Author(s): Sara Sobhani,* Zohreh Ramezani

Table of Contents:

General information

Chemicals were purchased from Merck Chemical Company. NMR spectra were recorded on a Bruker Avance DPX-400 and 300 using deutrated $CDCl_3$ as solvent and TMS as internal standard. The purity of the products and the progress of the reactions were accomplished by TLC on silica-gel polygram SILG/UV254 plates. The BET surface area measurements were performed on a BEL-MAX (Japan) instrument at liquid nitrogen temperature. TEM analysis was performed using TEM microscope (Philips CM30). FT-IR spectra were recorded on a Shimadzu Fourier Transform Infrared Spectrophotometer (FT-IR-8300). Thermo gravimetric analysis (TGA) was performed using a Shimadzu thermo gravimetric analyzer (TG-50). Elemental analysis was carried out on a Costech 4010 CHN elemental analyzer. The morphology of the products was determined by using Hitachi Japan, model s4160 Scanning Electron Microscopy (SEM) at accelerating voltage of 15 KV. Power X-ray diffraction (XRD) was performed on a Bruker D8-advance X-ray diffractometer with Cu K_α (λ = 0.154 nm) radiation. This system was equipped with a concentric hemispherical (CHA) electron energy analyzer (Specs model EA10 plus) suitable for X-ray photoelectron spectroscopy (XPS). The content of Pd in the catalyst was determined by OPTIMA 7300DV ICP analyzer. Room temperature magnetization isotherms were obtained using a vibrating sample magnetometer (VSM, Lake Shore 7400).

Synthesis of iminopyridine

Pyridine-2-carbaldehyde (0.5 g) was added to a magnetically stirring mixture of 4-aminophenol (0.5 g) in MeOH (10 mL). After refluxing for 3 h, the mixture was cooled to room temperature. The resulting yellow crystals (iminopyridine ligand) was separated by filtration, washed with MeOH (3 × 10 mL) and dried under vacuum.

Synthesis of Schiff base immobilized on γ-Fe_2O_3 (imino-Py-γ-Fe_2O_3)

The maghemite (γ-Fe_2O_3) nanoparticles were synthesized by a reported chemical co-precipitation technique of ferric and ferrous ions in alkali solution with minor modifications.[1] Using BET method, values of 91 $m^2\ g^{-1}$ and 14.3 nm were found for surface area and mean pore diameter of γ-Fe_2O_3, respectively (Figure 1). γ-Fe_2O_3 was chloro-functionalized by the reaction with 3-chloropropyltrimethoxysilane.[2] A solution of chloro-functionalized γ-Fe_2O_3 (1.7 g) in DMF (10 mL) was added dropwise to a stirring solution of iminopyridine (0.15 g) and NaH (0.005 g) in DMF (5 mL), under Ar atmosphere at 80 °C within 1 h. The reaction mixture was stirred at 80 °C for another 24 h. The resulting Schiff base immobilized on γ-Fe_2O_3 was separated by an external magnet, washed with acetone (3 × 10 mL) and dried under vacuum. The loading amount of Schiff base was 0.28 mmol g^{-1} catalyst based on elemental analysis.

Synthesis of palladium-Schiff base complex immobilized on γ-Fe_2O_3 (Pd-imino-Py-γ-Fe_2O_3)

The synthesized Schiff base immobilized on γ-Fe_2O_3 (1.7 g) was added to a solution of palladium acetate (0.12 g) in dry acetone (5 mL). The reaction mixture was stirred at room temperature for 24 h. The solid was separated by an external magnet, and washed with acetone (3 × 10 mL) and dried under vacuum to afford Pd-imino-Py-γ-Fe_2O_3.

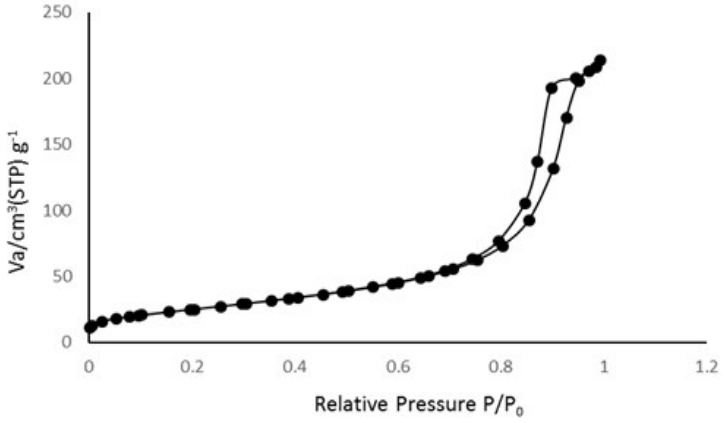


Figure 1. Nitrogen adsorption–desorption isotherms of Pd-imino-Py-γ-Fe_2O_3

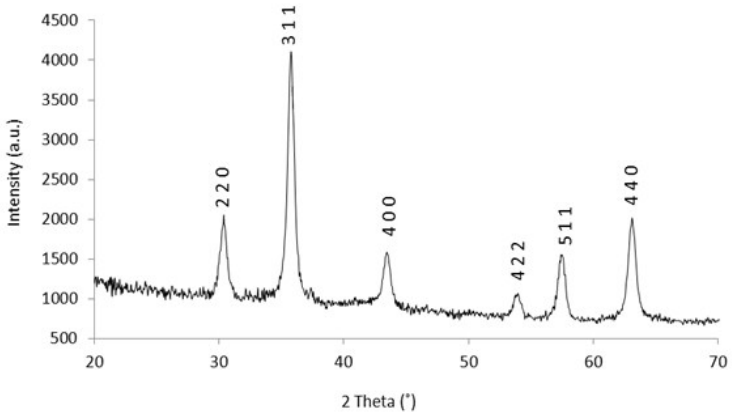


Figure S2. XRD patterns of Pd-imino-Py-γ-Fe_2O_3

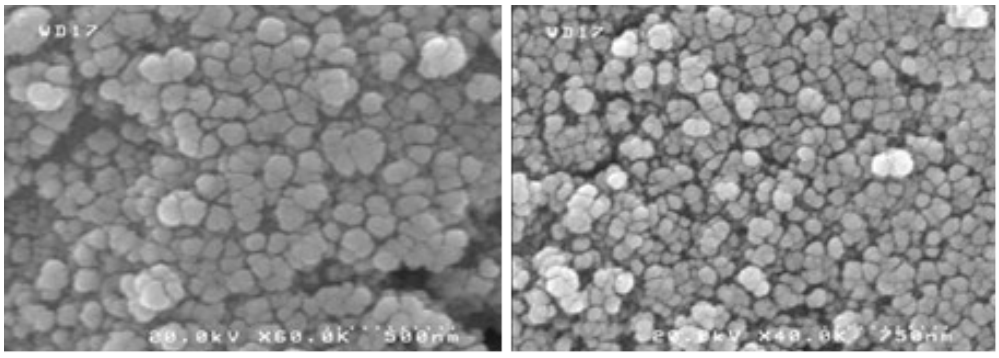


Figure S3. SEM of Pd-imino-Py-γ-Fe_2O_3

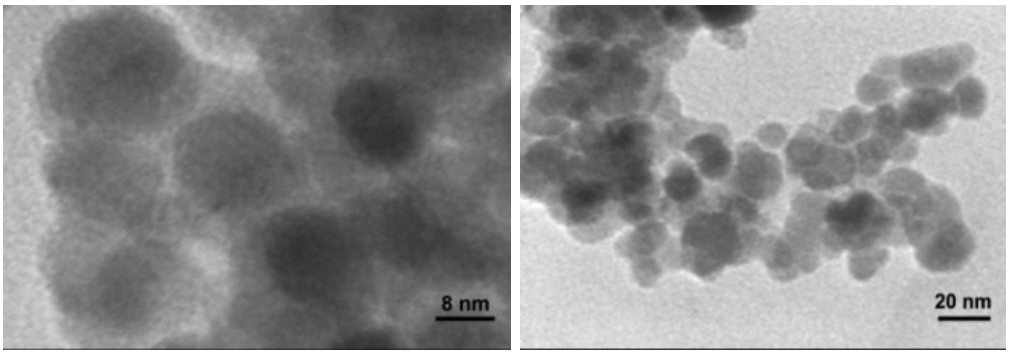


Figure S4. TEM of Pd-imino-Py-γ-Fe_2O_3

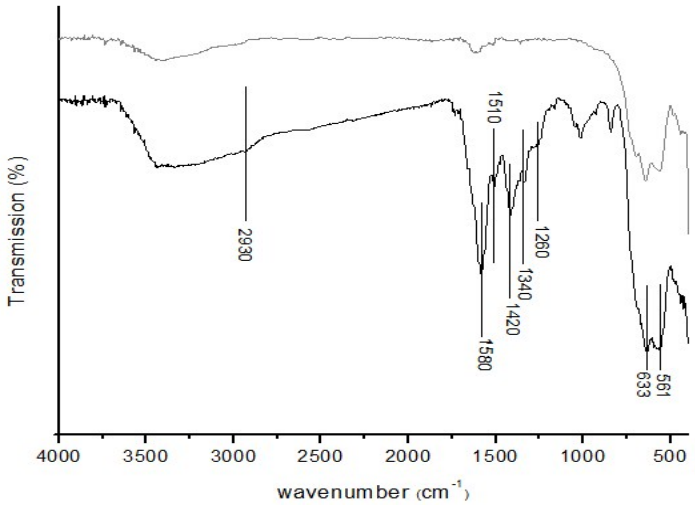


Figure S5. FT-IR spectra of γ-Fe_2O_3 (gray), Pd-imino-Py-γ-Fe_2O_3 (black)

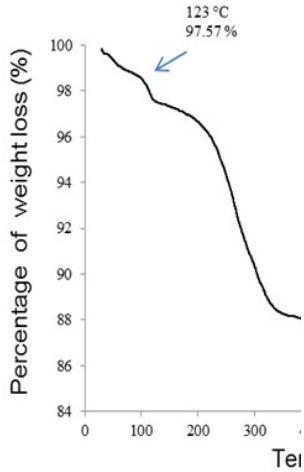
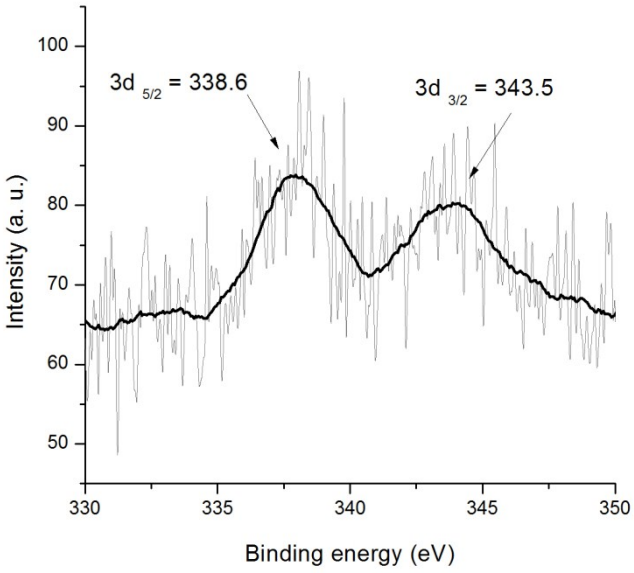


Figure (a) TGA of Pd-imino-P Fe$_2$O$_3$



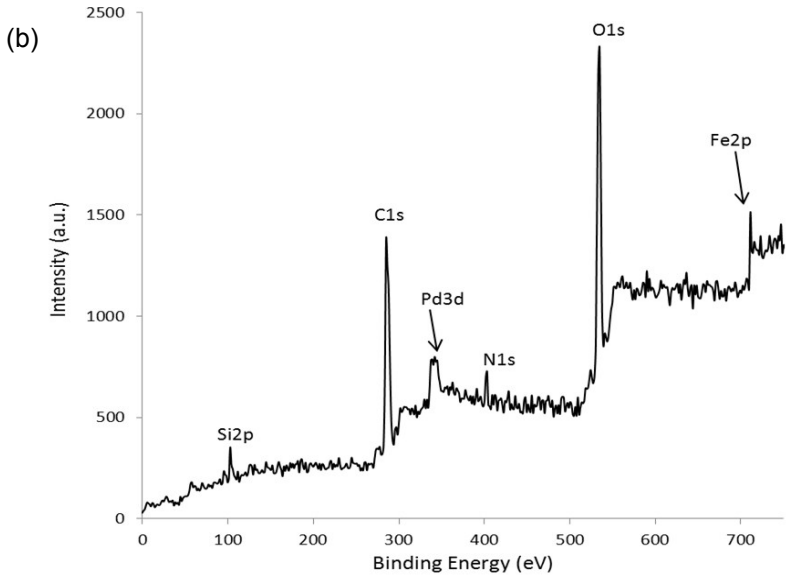


Figure S7. (a) XPS spectrum of Pd in Pd-imino-Py-γ-Fe_2O_3, (b) XPS spectrum of all elements of Pd-imino-Py-γ-Fe_2O_3

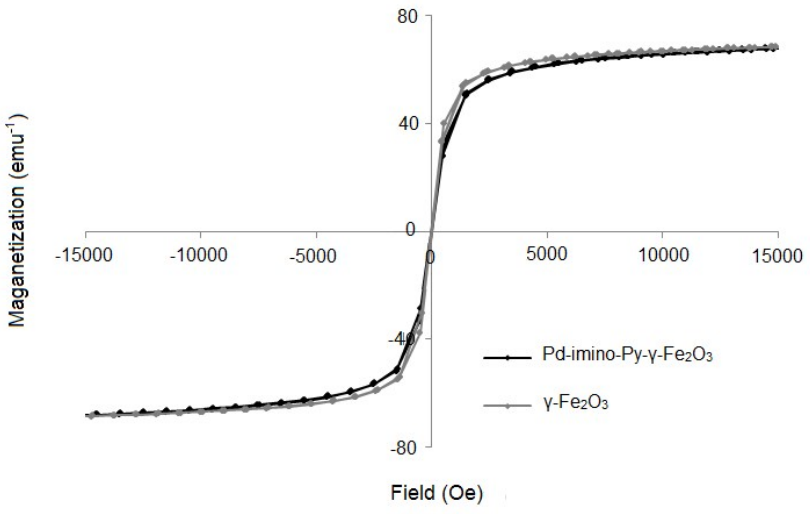
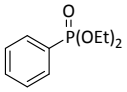


Figure S8. Magnetization curves of γ-Fe_2O_3 and Pd-imino-Py-γ-Fe_2O_3

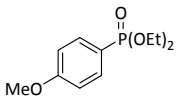
Characterization data of the products

Diethyl phenylphosphonate: Isolated as colorless oil (Table 1, entry 1: 98%, 209.7 mg; entry 3, 93%, 199.0 mg, entry 10: 88%, 188.3 mg; entry 20: 75%, 160.5 mg; entry 21: 80%, 171.2 mg)



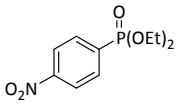
^{1}H NMR (400 MHz, $CDCl_3$): δ 1.30 (t, $J_{H,H}$ = 6.8 Hz, 6 H), 4.16-4.05 (m, 4 H), 7.47-7.42 (m, 2 H), 7.53-7.51 (m, 1 H), 7.80 (dd, $J_{H,H}$ = 13.2, $J_{H,H}$ = 8.4, 2 H), ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ 16.3 (d, J_{CP} = 7.0 Hz), 62.0 (d, J_{CP} = 5.0 Hz), 131.7 (d, J_{CP} = 10.0 Hz), 128.3 (d, J_{CP} = 186.0 Hz), 128.4 (d, J_{CP} = 15.0 Hz), 132.3 (d, J_{CP} = 3.0 Hz) ppm.

Diethyl 4-methoxyphenylphosphonate: Isolated as colorless oil (Table 1, entry 2: 95%, 231.8 mg; entry 4: 83%, 202.5 mg)



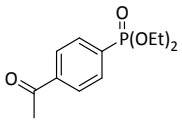
^{1}H NMR (400 MHz, $CDCl_3$): δ 1.27 (t, J_{HH} = 7.2 Hz, 6 H), 3.80 (s, 3 H), 4.09-3.97 (m, 4 H), 6.93 (dd, J_{HH} = 8.8 Hz, J_{HH} = 3.2 Hz, 2 H), 7.71 (dd, J_{HH} = 12.8 Hz, J_{HH} = 8.8 Hz, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ 16.2 (d, J_{CP} = 6.0 Hz), 55.2, 61.8 (d, J_{CP} = 6.0 Hz), 113.9 (d, J_{CP} = 16.0 Hz), 119.3 (d, J_{CP} = 193.0 Hz), 133.7 (d, J_{CP} = 12.0 Hz), 162.8 (d, J_{CP} = 4.0 Hz) ppm.

Diethyl 4-nitrophenylphosphonate: Isolated as oil (Table 1, entry 5: 92%, 238.2 mg, entry 11: 89%, 230.5 mg).



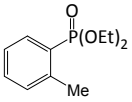
^{1}H NMR (300 MHz, $CDCl_3$): δ 1.34 (t, J_{HH} = 6.9 Hz, 6H), 4.27-4.06 (m, 4H), 8.00 (dd, J_{HH} = 12.7 Hz, J_{HH} = 8.7 Hz, 1H), 8.3 (dd, J_{HH} = 8.7 Hz, J_{HH} = 3.3 Hz, 1H) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ 16.1 (d, J_{CP} = 6.7 Hz), 16.3 (d, J_{CP} = 6.0 Hz), 62.7 (d, J_{CP} = 5.2 Hz), 123.3 (d, J_{CP} = 15.0 Hz), 133.0 (d, J_{CP} = 10.5 Hz), 135.8 (d, J_{CP} =185.2 Hz), 150.2 (d, J_{CP} = 3.7 Hz) ppm.

Diethyl 4-acetylphenylphosphonate: Isolated as oil (Table 1, entry 6: 85%, 217.6 mg).



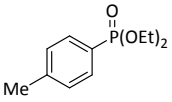
^{1}H NMR (300 MHz, $CDCl_3$): δ 1.32 (*t*, J_{HH} = 6.9 Hz, 6 H), 2.64 (s, 3H), 4.21-4.05 (m, 4H), 7.91 (dd, J_{HH} = 8.1 Hz, J_{HH} = 12.7 Hz, 2H), 8.04-8.00 (m, 2H) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ 16.3 (d, J_{CP} = 6.7 Hz), 26.85 (s, 3H), 62.4 (d, J_{CP} = 5.2 Hz), 128.0 (d, J_{CP} = 15.0 Hz), 130.4 (d, J_{CP} = 95.2 Hz), 132.0 (d, J_{CP} = 9.7 Hz), 134.61, 139.8 (d, J_{CP} = 3), 197.5 ppm.

Diethyl 2-methylphenylphosphonate: Isolated as oil (Table 1, entry 7: 95%, 216.6 mg).



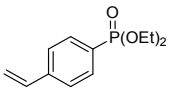
^{1}H NMR (300 MHz, $CDCl_3$): δ 1.24 (*t*, J_{HH} = 6.6 Hz, 6 H), 2.49 (s, 3H), 3.93-4.13 (m, 4H), 7.20-7.14 (m, 2H), 7.34 (t, J_{HH} = 6.0 Hz, 1H), 7.87-7.79 (m, 1H) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ 16.3 (d, J_{CP} = 6.7 Hz), 21.1 (d, J_{CP} = 3.0 Hz), 61.8 (d, J_{CP} = 6.0 Hz), 125.3 (d, J_{CP} = 15.0 Hz), 126.8 (d, J_{CP} = 183.0 Hz), 131.1 (d, J_{CP} = 14.2 Hz), 132.4 (d, J_{CP} = 3), 133.8 (d, J_{CP} = 9.7), 141.7 (d, J_{CP} = 9.7) ppm.

Diethyl 4-tolylphosphonate: Isolated as oil (Table 1, entry 8: 89%, 202.9 mg, entry 13: 93%, 212.0 mg).



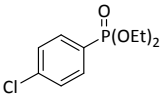
^{1}H NMR (300 MHz, $CDCl_3$): δ 1.33 (t, J_{HH} = 6.9 Hz, 6H), 2.42 (s, 3H), 4.21-4.01 (m, 4H), 7.29 (dd, J_{HH} = 8.1 Hz, J_{HH} = 3.3 Hz, 2H), 7.72 (dd, J_{HH} = 13.2 Hz, J_{HH} = 8.1 Hz, 2H) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ 16.1 (d, J_{CP} = 6.7 Hz), 16.3 (d, J_{CP} = 6.7 Hz), 21.6, 61.9 (d, J_{CP} = 5.2 Hz), 124.9 (d, J_{CP} = 188.2 Hz), 129.2 (d, J_{CP} = 15.0 Hz), 131.8 (d, J_{CP} = 9.7 Hz), 142.9 (d, J_{CP} = 3.0 Hz) ppm.

Diethyl 4-vinylphenylphosphonate: Isolated as oil (Table 1, entry 9: 78%, 187.2 mg).



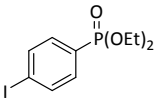
^{1}H NMR (300 MHz, $CDCl_3$): δ 1.33 (t, J_{HH} = 6.9 Hz, 6H), 4.20-4.04 (m, 4H), 5.4 (d, J_{HH} = 10.8 Hz, 1H), 5.87 (d, J_{HH} = 17.4 Hz, 1H), 6.75 (dd, J_{HH} = 17.4 Hz, J_{HH} = 10.8 Hz, 1H), 7.52-7.48 (m, 2H), 7.78 (dd, J_{HH} = 12.9 Hz, J_{HH} = 8.1 Hz, 2H) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ 16.1 (d, J_{CP} = 6.7 Hz), 16.3 (d, J_{CP} = 6.0 Hz), 62.1 (d, J_{CP} = 5.2 Hz), 116.5, 63.6 (d, J_{CP} = 6.0 Hz), 126.1 (d, J_{CP} = 15.0 Hz), 127.2 (d, J_{CP} = 187.5 Hz), 132.1 (d, J_{CP} = 9.7 Hz), 135.9, 141.4 (d, J_{CP} = 3.0 Hz) ppm.

Diethyl 4-chlorophenylphosphonate: Isolated as colorless oil (Table 1, entry 14: 98%, 244.0 mg; entry 16: 91%, 226.5 mg)



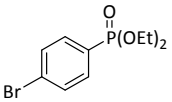
^{1}H NMR (400 MHz, $CDCl_3$): δ 1.34 (t, J_{HH} = 7.2 Hz, 6 H), 4.19-4.06 (m, 4 H), 7.46 (dd, J_{HH} = 8.2 Hz, J_{HH} = 3.6 Hz, 2 H), 7.76 (dd, J_{HH} = 12.8 Hz, J_{HH} = 8.4 Hz, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ 16.3 (d, J_{CP} = 7.0 Hz) 62.2 (d, J_{CP} = 5.0 Hz), 126.9 (d, J_{CP} = 190.0 Hz), 128.8 (d, J_{CP} = 16.0 Hz), 133.2 (d, J_{CP} = 10.0 Hz), 138.9 (d, J_{CP} = 4.0 Hz) ppm.

Diethyl 4-iodophenylphosphonate*:* Isolated as colorless oil (Table 1, entry 15: 98%, 333.2 mg)



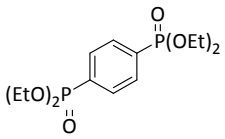
^{1}HNMR (400 MHz, $CDCl_3$): δ 1.34 (t, J_{HH} = 6.8 Hz, 6 H), 4.19-4.06 (m, 4 H), 7.54 (dd, J_{HH} = 13 Hz, J_{HH} = 8.0 Hz, 2 H), 7.85 (dd, J_{HH} = 8.2 Hz, J_{HH} = 3.6 Hz, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ 16.3 (d, J_{CP} = 7.0 Hz), 62.3 (d, J_{CP} = 5.0 Hz), 100.1 (d, J_{CP} = 4.0 Hz), 127.4 (d, J_{CP} = 189.0 Hz), 133.1 (d, J_{CP} = 10.0 Hz), 137.7 (d, J_{CP} = 16.0 Hz) ppm.

Diethyl 4-bromophenylphosphonate: Isolated as colorless oil (Table 1, entry 17: 95%, 278.3 mg).



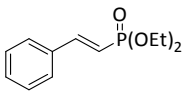
^{1}H NMR (400 MHz, $CDCl_3$): δ 1.20 (t, J_{HH} = 7.2 Hz, 6 H), 4.06-3.93 (m, 4 H), 7.32 (dd, J_{HH} = 8.4 Hz, J_{HH} = 3.2 Hz, 2 H), 7.63 (dd, J_{HH} = 13.2 Hz, J_{HH} = 8.4 Hz, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ 16.2 (d, J_{CP} = 7.0 Hz), 62.1 (d, J_{CP} = 5.0 Hz), 126.9 (d, J_{CP} = 190.0 Hz), 128.7 (d, J_{CP} = 15.0 Hz), 133.0 (d, J_{CP} = 10.0 Hz), 138.7 (d, J_{CP} = 4.0 Hz) ppm.

Tetraethyl phenylbis(phosphonate): Isolated as white powder (Table 1, entry 18: 57%, 199.5 mg; entry 19: 78%, 273 mg)



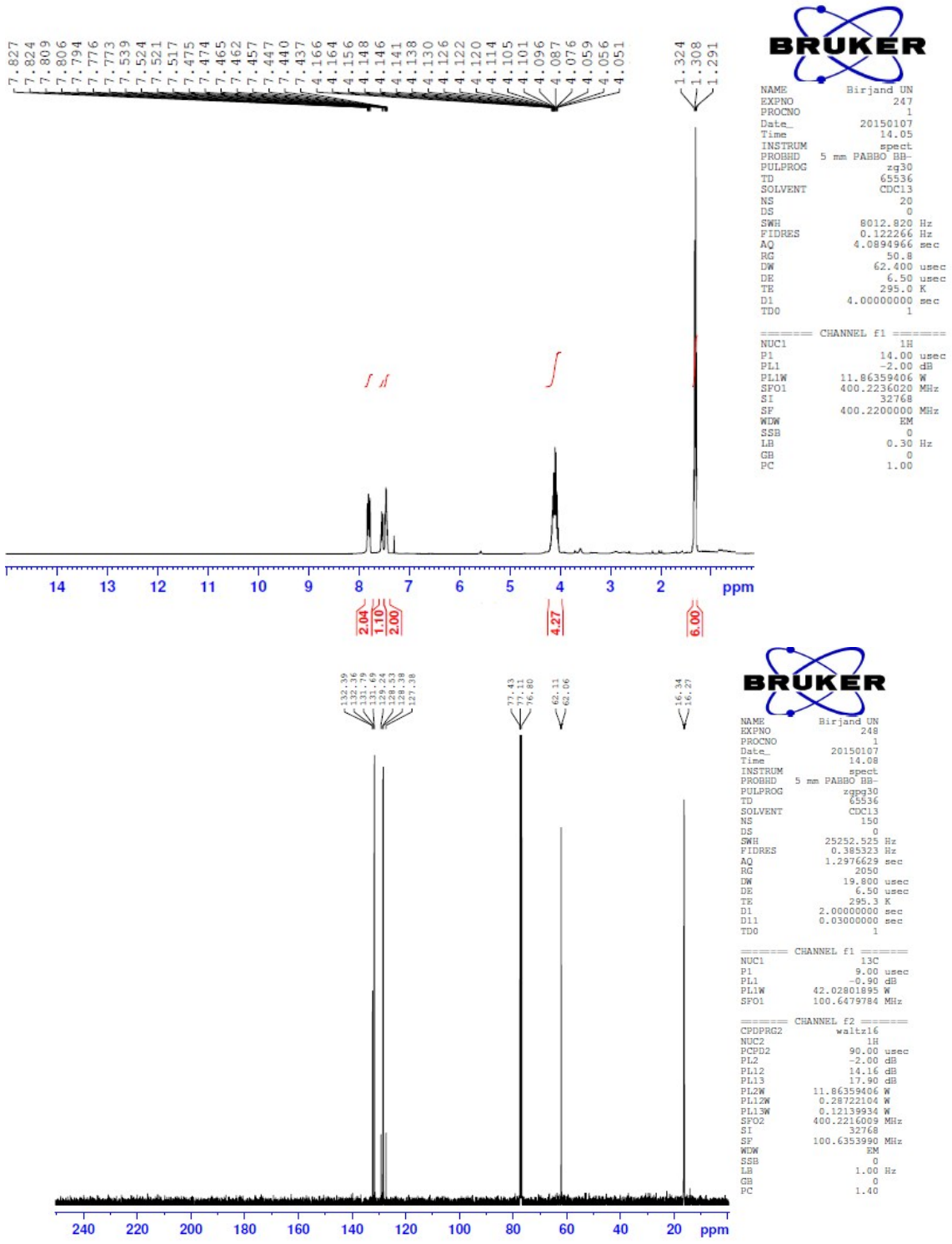
^{1}H NMR (400 MHz, $CDCl_3$): δ 1.33 (t, J_{HH} = 7.2 Hz, 12 H), 4.18 - 4.09 (m, 8 H), 7.90 (dd, J_{HH} = 10.2 Hz, J_{HH} = 6.8 Hz, 4 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ 16.3 (d, J_{CP} = 7.0 Hz), 62.4 (d, J_{CP} = 5.0 Hz), 128.0 (d, J_{CP} = 155.0 Hz), 131.6 (dd, J_{CP} = 16.5 Hz, J_{CP} = 8.0 Hz) ppm.

Diethyl 2-phenylvinylphosphonate: Isolated as colorless oil (Table 1, entry 22: 96%, 230.4 mg).

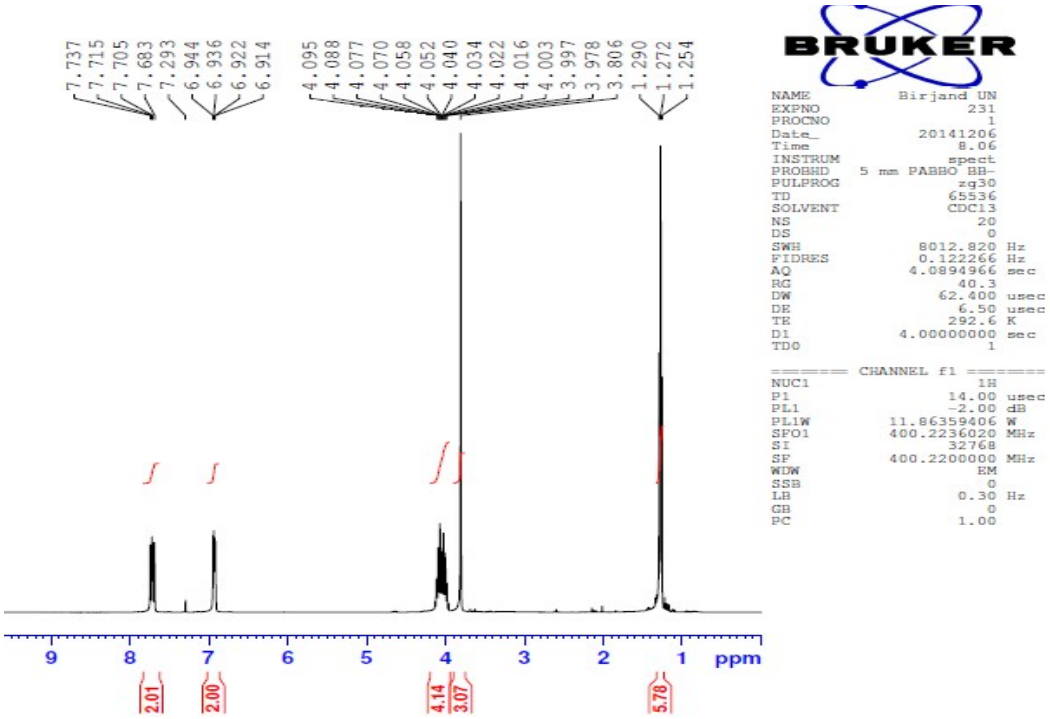


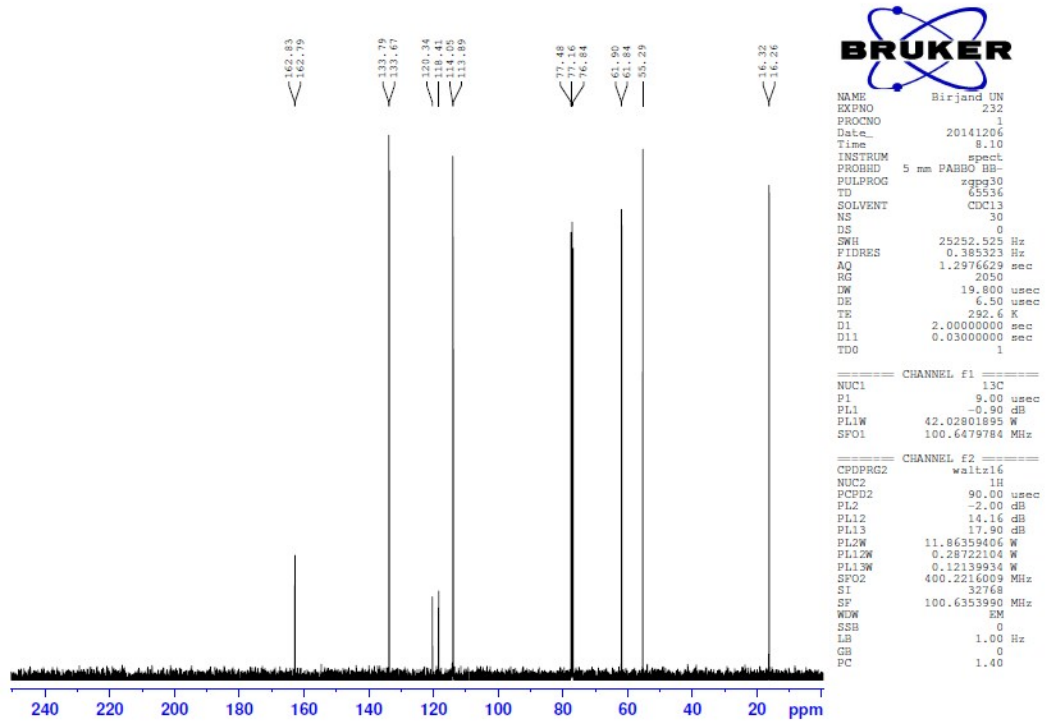
^{1}HNMR (400 MHz, $CDCl_3$): δ 1.37 (t, J_{HH}= 6.8 Hz, 6 H), 4.18-4.11 (m, 4 H), 6.3 (t, J_{HH} = J_{HP} = 17.6, 1H), 7.57-7.39 (m, 6H), ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ 16.4 (d, J_{CP} = 6.0 Hz), 61.8 (d, J_{CP} = 6.0 Hz), 113.8 (d, J_{CP} = 190.0 Hz), 127.7, 128.1, 128.8, 130.2, 134.7, 134.9, 148.7 (d, J_{CP} = 7.0 Hz) ppm.

Copies of ^{1}H and ^{13}C NMR spectra

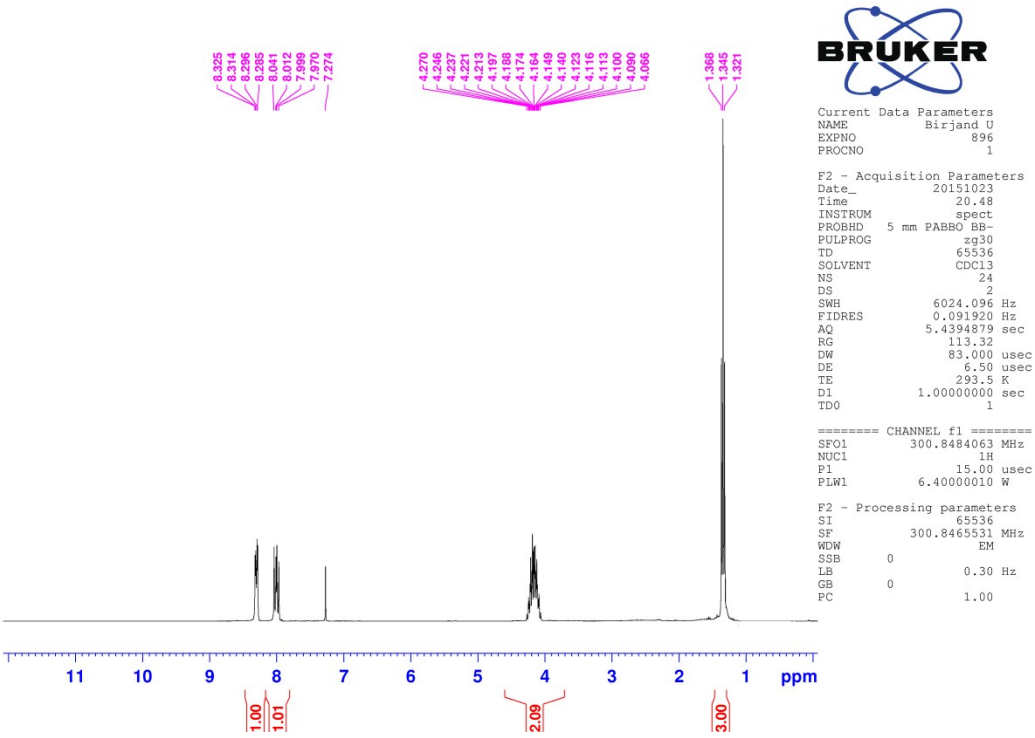


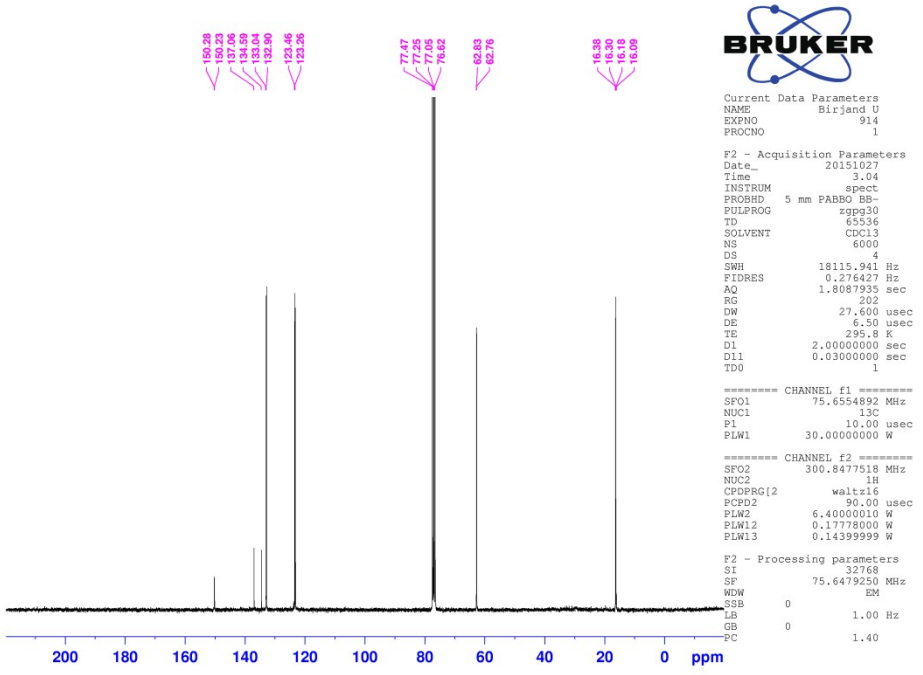
^{1}H NMR and ^{13}C NMR of diethylphenylphosphonate



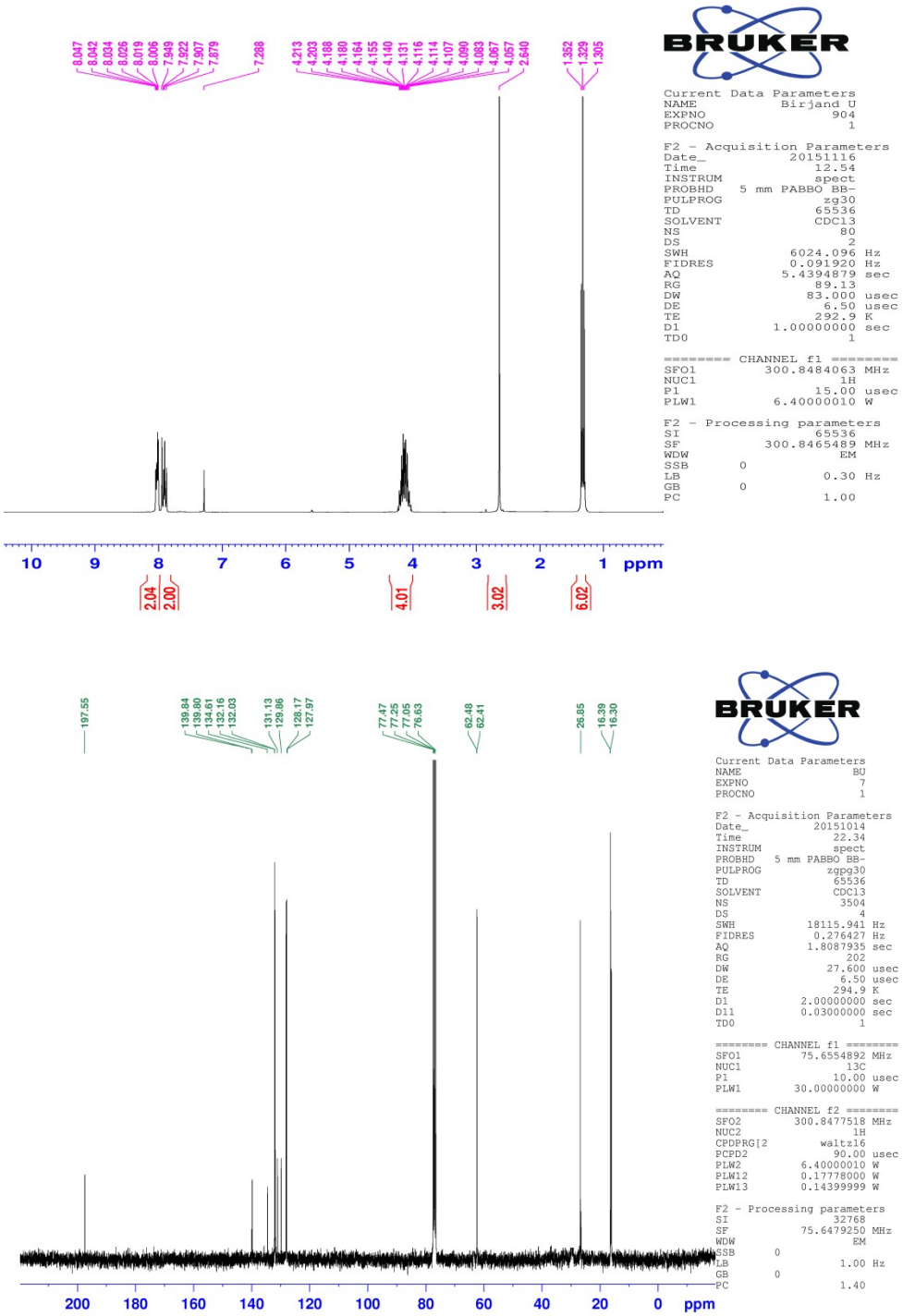


^{1}H NMR and ^{13}C NMR of diethyl 4-methoxyphenylphosphonate

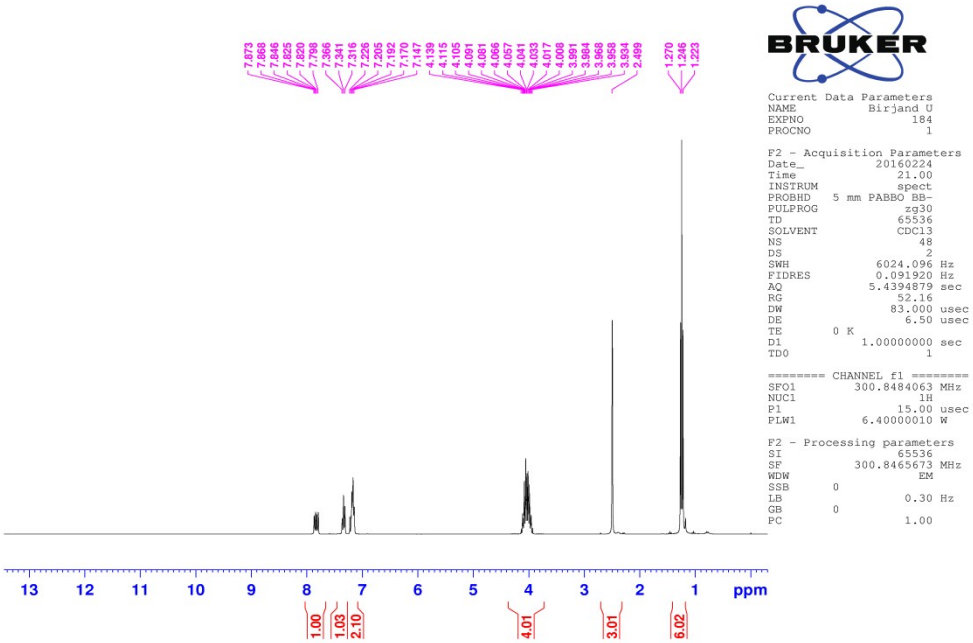


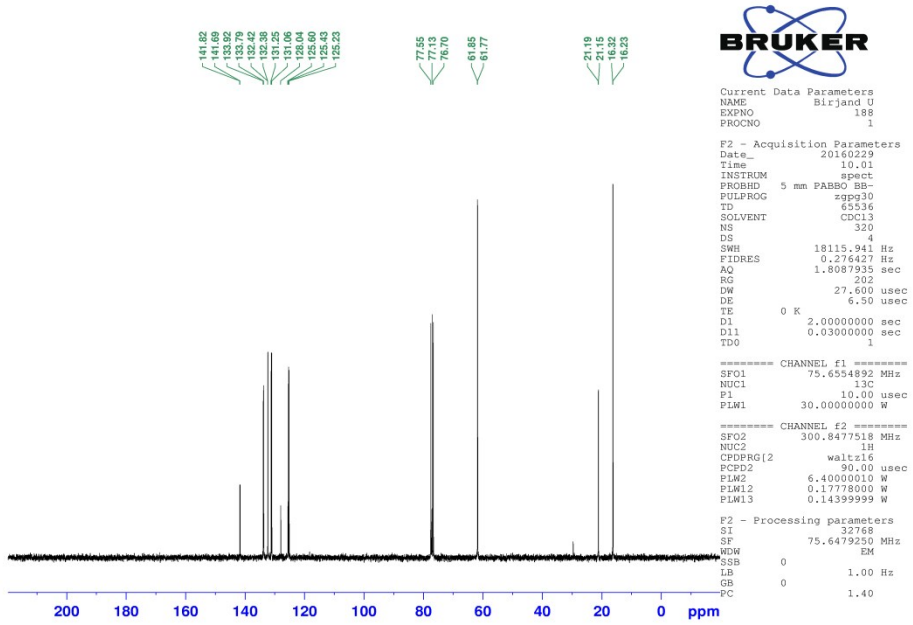


^{1}H NMR and ^{13}C NMR of diethyl (4-nitrophenyl)phosphonate

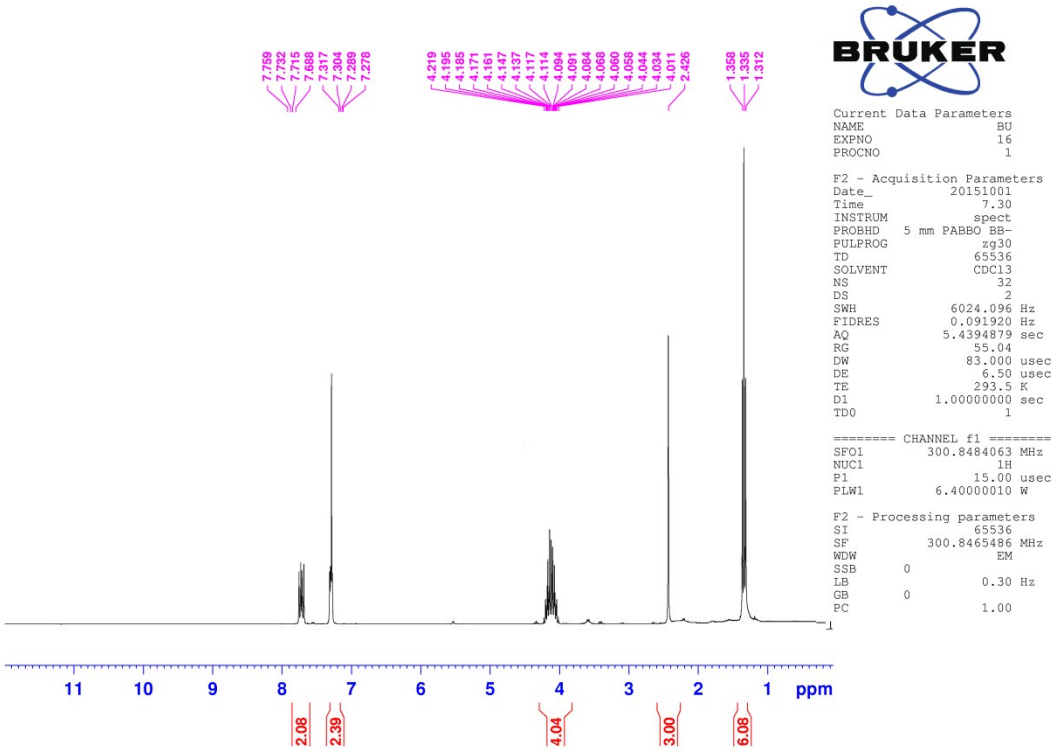


^{1}H NMR and ^{13}C NMR of diethyl 4-acetylphenylphosphonate





^{1}H NMR and ^{13}C NMR of diethyl 2-methylphenylphosphonate




```
Current Data Parameters
NAME                  BU
EXPNO                 16
PROCNO                 1

F2 - Acquisition Parameters
Date_           20151001
Time                7.30
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    32
DS                     2
SWH             6024.096 Hz
FIDRES          0.091920 Hz
AQ              5.4394879 sec
RG                 55.04
DW                83.000 usec
DE                 6.50 usec
TE                293.5 K
D1             1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          300.8484063 MHz
NUC1                  1H
P1                 15.00 usec
PLW1           6.40000010 W

F2 - Processing parameters
SI                 65536
SF            300.8465486 MHz
WDW                   EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
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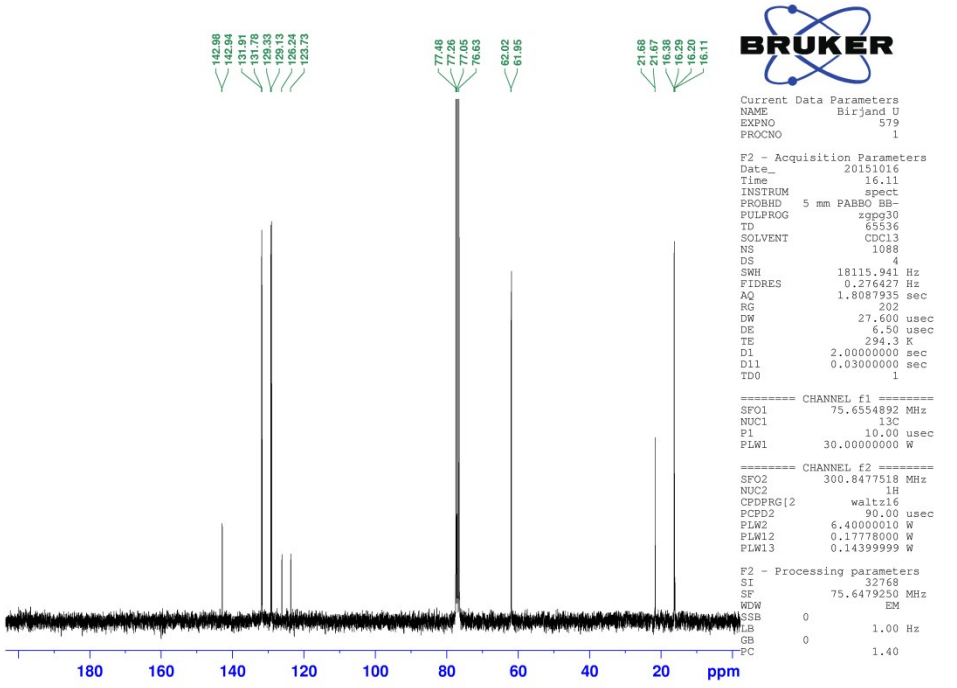


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Current Data Parameters
NAME             Birjand U
EXPNO                  579
PROCNO                   1

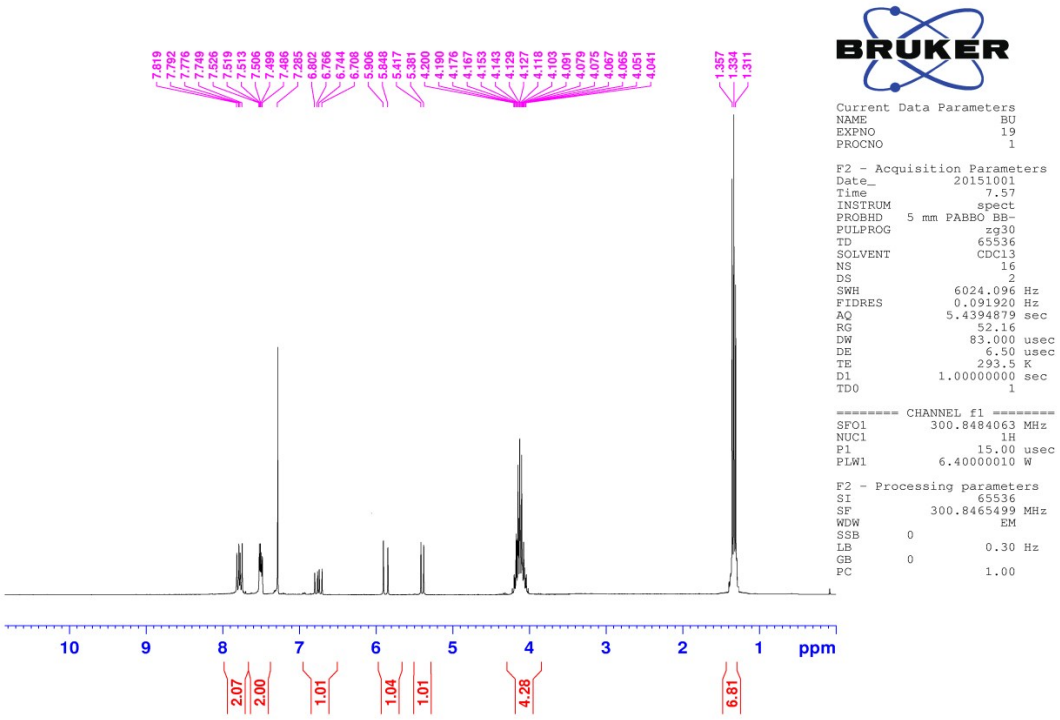
F2 - Acquisition Parameters
Date_           20151016
Time               16.11
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                  1088
DS                     4
SWH            18115.941 Hz
FIDRES          0.276427 Hz
AQ              1.8087935 sec
RG                   202
DW                27.600 usec
DE                 6.50 usec
TE                294.3 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          75.6554892 MHz
NUC1                  13C
P1                 10.00 usec
PLW1          30.00000000 W

======== CHANNEL f2 ========
SFO2         300.8477518 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2           6.40000010 W
PLW12          0.17778000 W
PLW13          0.14399999 W

F2 - Processing parameters
SI                 32768
SF            75.6479250 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```

^{1}H NMR and ^{13}C NMR of diethyl 4-tolylphosphonate



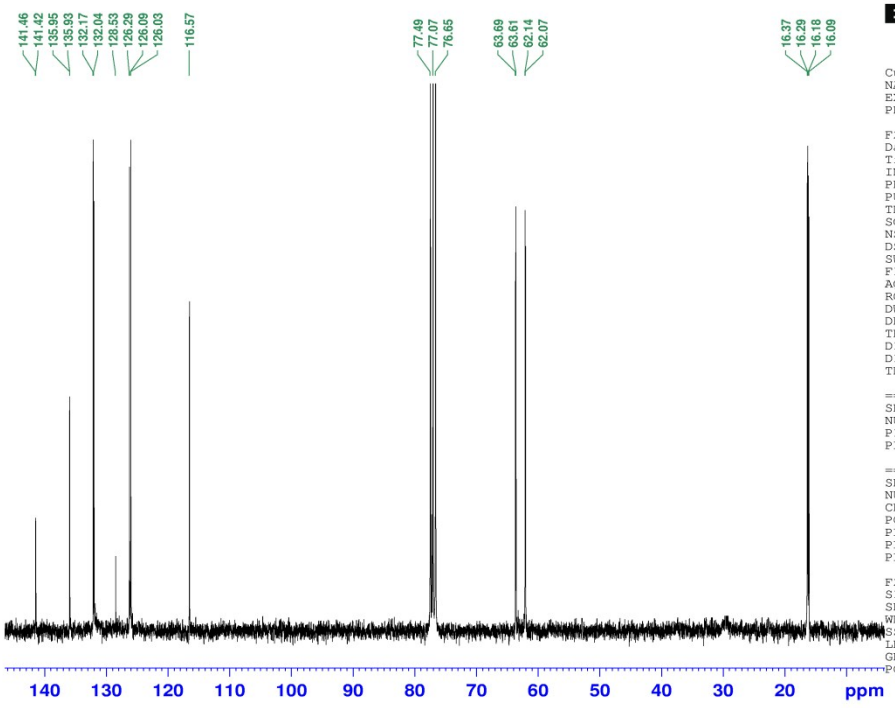
BRUKER

```
Current Data Parameters
NAME                  BU
EXPNO                 19
PROCNO                 1

F2 - Acquisition Parameters
Date_           20151001
Time               7.57
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG            zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH            6024.096 Hz
FIDRES         0.091920 Hz
AQ             5.4394879 sec
RG                52.16
DW               83.000 usec
DE                6.50 usec
TE               293.5 K
D1             1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1          300.8484063 MHz
NUC1                  1H
P1                15.00 usec
PLW1           6.40000010 W

F2 - Processing parameters
SI                65536
SF            300.8465499 MHz
WDW                  EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
```



BRUKER

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Current Data Parameters
NAME            Birjand U
EXPNO                   8
PROCNO                  1

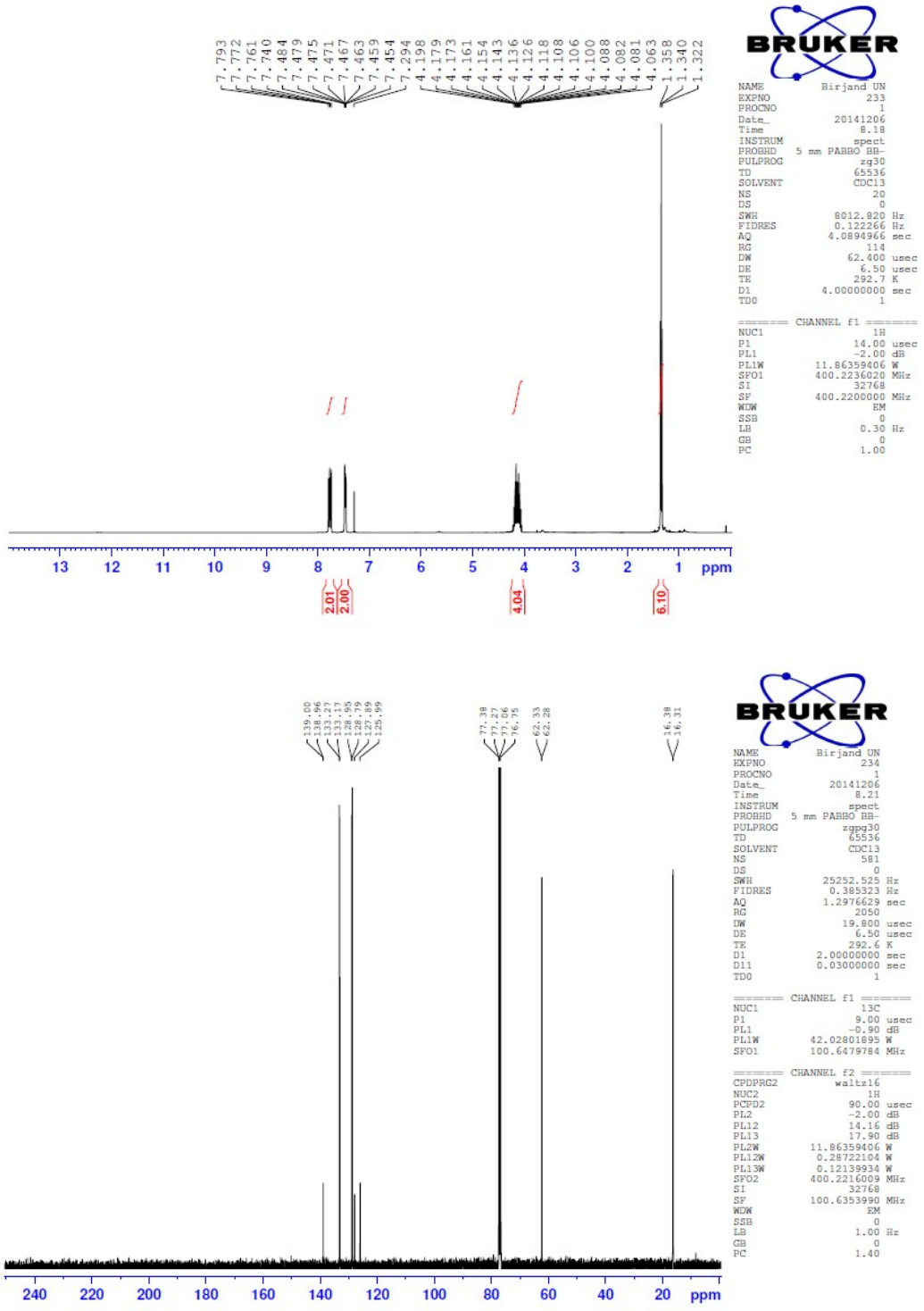
F2 - Acquisition Parameters
Date_           20151015
Time               19.01
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                 1024
DS                    4
SWH           18115.941 Hz
FIDRES         0.276427 Hz
AQ             1.8087935 sec
RG                  202
DW               27.600 usec
DE                6.50 usec
TE                294.4 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1          75.6554892 MHz
NUC1                  13C
P1                10.00 usec
PLW1          30.00000000 W

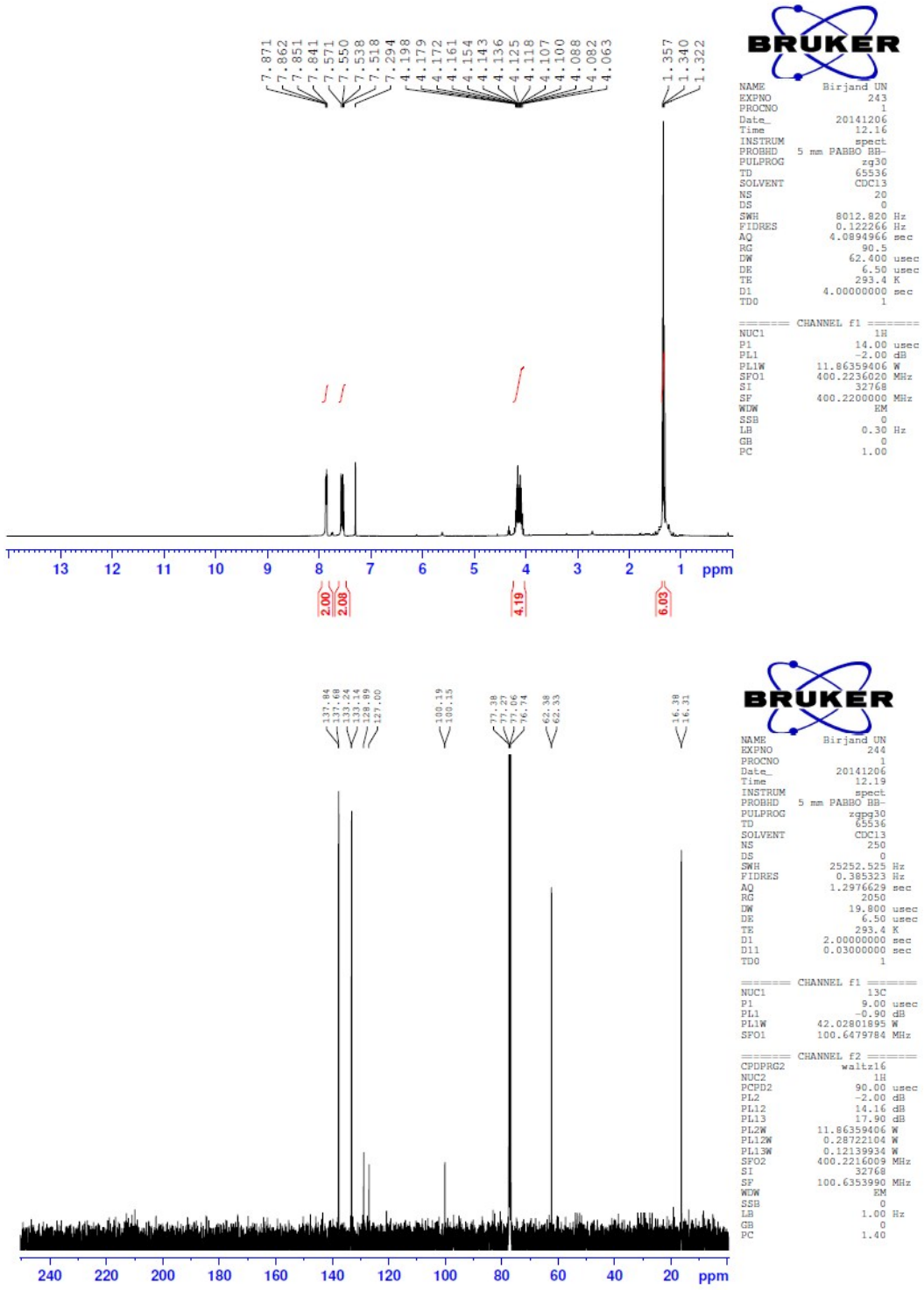
======== CHANNEL f2 ========
SFO2          300.8477518 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2           6.40000010 W
PLW12          0.17778000 W
PLW13          0.14399999 W

F2 - Processing parameters
SI                32768
SF            75.6479250 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

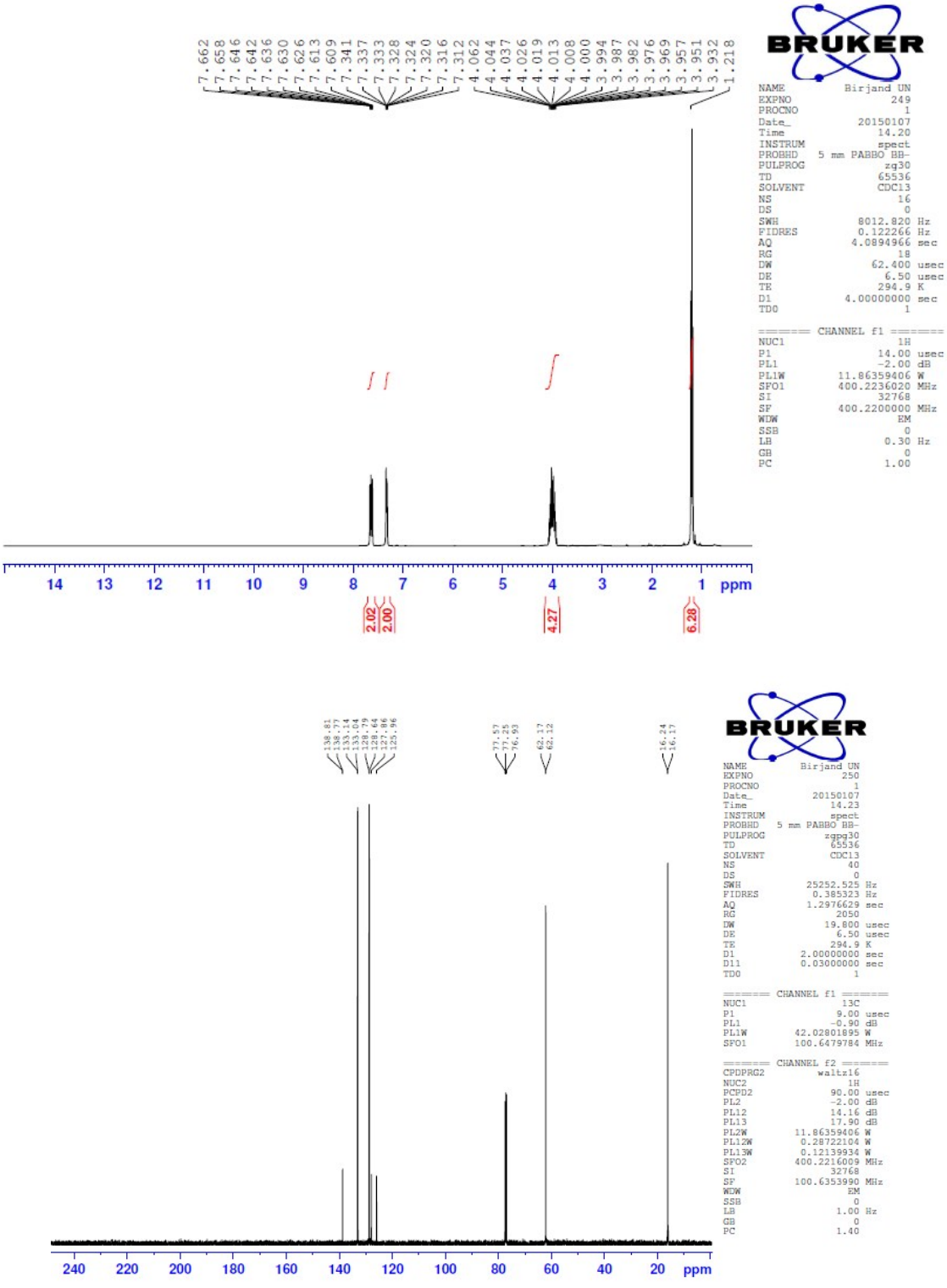
^{1}H NMR and ^{13}C NMR of diethyl 4-vinylphenylphosphonate



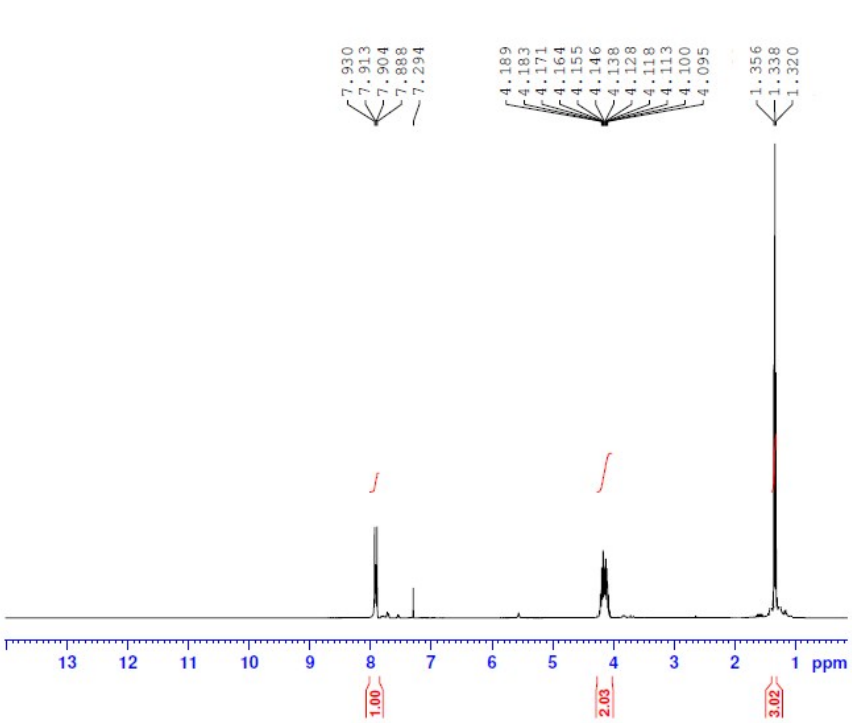
^{1}H NMR and ^{13}C NMR of diethyl 4-chlorophenylphosphonate



^{1}H NMR and ^{13}C NMR of diethyl 4-iodophenylphosphonate

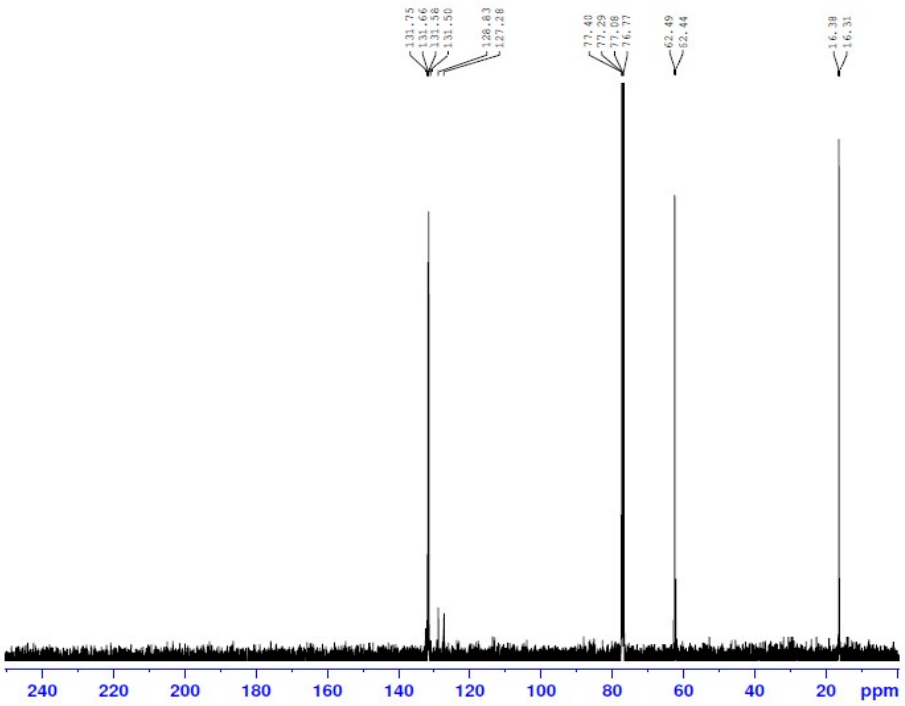


^{1}H NMR and ^{13}C NMR of diethyl 4-bromophenylphosphonate




```
NAME            Birjand UN
EXPNO                  245
PROCNO                   1
Date_             20141206
Time                 16.34
INSTRUM              spect
PROBHD   5 mm PABBO BB-
PULPROG               zg30
TD                   65536
SOLVENT              CDCl3
NS                      20
DS                       0
SWH              8012.820 Hz
FIDRES           0.122266 Hz
AQ               4.0894966 sec
RG                    50.8
DW                  62.400 usec
DE                   6.50 usec
TE                  293.0 K
D1               4.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   14.00 usec
PL1                  -2.00 dB
PL1W          11.86359406 W
SFO1          400.2236020 MHz
SI                    32768
SF            400.2200000 MHz
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    1.00
```

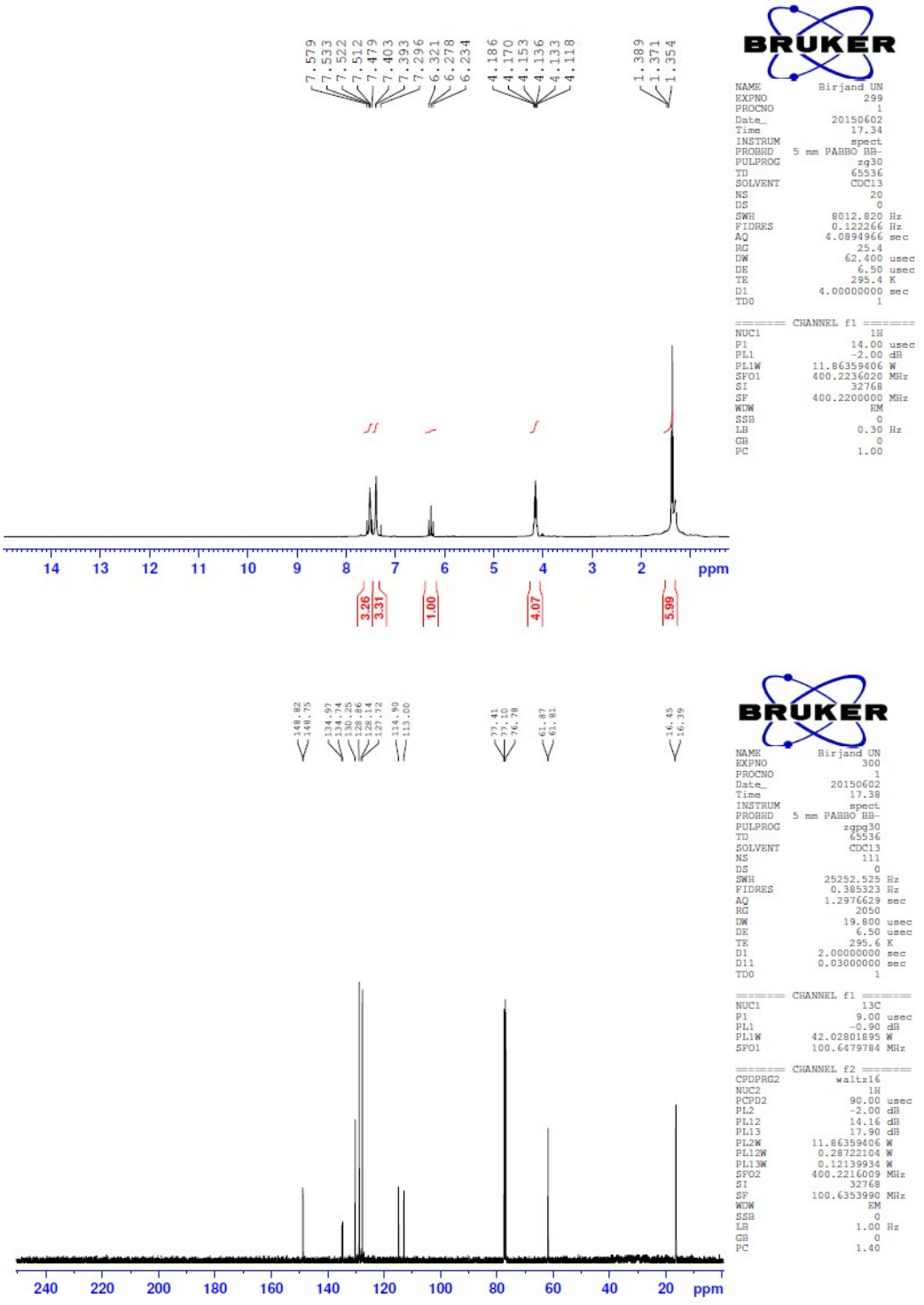



```
NAME            Birjand UN
EXPNO                  246
PROCNO                   1
Date_             20141206
Time                 16.36
INSTRUM              spect
PROBHD   5 mm PABBO BB-
PULPROG            zgpg30
TD                   65536
SOLVENT              CDCl3
NS                     320
DS                       0
SWH             25252.525 Hz
FIDRES           0.385323 Hz
AQ               1.2976629 sec
RG                    2050
DW                  19.800 usec
DE                   6.50 usec
TE                  293.3 K
D1               2.00000000 sec
D11              0.03000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                   13C
P1                    9.00 usec
PL1                  -0.90 dB
PL1W          42.02801895 W
SFO1          100.6479784 MHz

======== CHANNEL f2 ========
CPDPRG2            waltz16
NUC2                    1H
PCPD2                90.00 usec
PL2                  -2.00 dB
PL12                 14.16 dB
PL13                 17.90 dB
PL2W          11.86359406 W
PL12W          0.28722104 W
PL13W          0.12139934 W
SFO2          400.2216009 MHz
SI                    32768
SF            100.6353990 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```

^{1}H NMR and ^{13}C NMR of tetraethylphenylbis(phosphonate)



^{1}H NMR and ^{13}C NMR of diethyl 2-phenylvinylphosphonate

References

1 (a) B. Z. Tang, Y. Geng, J. W. Y. Lam, B. Li, X. Jing, X. Wang, F. Wang, A. B. Pakhomov, X. X. Zhang, *Chem. Mater*. **1999**, *11,* 1581-1589; (b) K. M. Ho, P. Li, *Langmuir* **2008**, *24*, 1801-1807.

2 S. Sobhani, Z. Pakdin Parizi, *Appl. Catal. A: Gen*. **2014**, *479,* 112-120.