Supporting information

Cs$_2$CO$_3$-Promoted $P$-Alkylation and Reactivity of Phosphinecarboxamides

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1. General Information

Unless otherwise noted, all commercially available compounds were used as provided without further purification. $^1$H NMR and $^{13}$C NMR data analyses were performed with a Varian Mercury plus-400 and Agilent 600 MHz DD2 instruments CDCl$_3$ and DMSO-$d_6$ as solvent and tetramethylsilane (TMS) as the internal standard were employed. Chemical shifts were reported in units (ppm) by assigning TMS resonance in the $^1$H NMR spectrum as 0.00 ppm. The data of 1H NMR was reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet and br = broad), coupling constant (J values) in Hz and integration. Chemical shift for $^{13}$C NMR spectra were recorded in ppm from TMS using the central peak of CDCl$_3$ (77.0 ppm) as the internal standard. $^{19}$F NMR spectra were recorded on a Varian Mercury 400 plus instrument. Flash chromatography was performed using 200-300 mesh silica gel with the indicated solvent system according to standard techniques. Analytical thin-layer chromatography (TLC) was performed on pre-coated, glass-backed silica gel plates. Melting points were measured with an XT-4 apparatus. High-resolution mass spectra (HRMS) (ESI) were obtained with a Bruker Daltonics APEX II 47e and Orbitrap Elite mass spectrometer. Column chromatography was generally performed on silica gel (200-300 mesh) and TLC analyses were conducted on silica gel GF254 plates. All reagents were directly used from purchased without any further purification unless otherwise specified.

2. Typical Procedure for the Synthesis of 3a

\[
\begin{align*}
\text{MeO} & \quad \text{NH} \quad \text{PH}_2 & \quad \text{MeO} \\
\text{1a} & \quad \text{C}_2\text{H}_3\text{I} & \quad \text{NH} \quad \text{P} \\
& \quad \text{Cs}_2\text{CO}_3 & \quad \text{DMSO, r.t., 0.5h} & \quad \text{MeO} \quad \text{NH} \\
& \quad & \quad \text{O} & \quad \text{O}
\end{align*}
\]

$N$-(4-Methoxyphenyl)phosphanecarboxamide 1a (0.2 mmol) and iodomethane 2a (0.24 mmol, 1.2 equiv.) were added to a sealed tube charged with a mixture of Cs$_2$CO$_3$ (0.2 mmol, 1 equiv.) in DMSO (4 mL). The resulting mixture was stirred at r.t. for 0.5 h and monitored by TLC. After reaction completion, water (30 mL) was added and the solution was extracted with ethyl acetate. The organic phase was separated, dried (MgSO$_4$), filtered and concentrated. The crude product was purified by silica gel column chromatography using petroleum/ethyl acetate (4:1), to afford desired product 3a.
3. Spectroscopic Data of Compounds

\[ \text{N-(4-methoxyphenyl)-1-methylphosphanecarboxamide (3a).} \] Eluent: PE/EA = 4:1. Colorless solid (85\% yield); m.p.: 75-76 °C. \(^{1}\)H NMR (600 MHz, CDCl\(_3\)) \(\delta = 7.69\) (s, 1H), 7.39 (d, \(J = 8.4\) Hz, 2H), 6.81 (d, \(J = 8.4\) Hz, 2H), 4.02 (dq, \(J = 206.4, 7.8\) Hz, 1H), 3.76 (s, 3H), 1.36 (dd, \(J = 7.2, 3.0\) Hz, 3H). \(^{13}\)C NMR (150 MHz, CDCl\(_3\)) \(\delta = 176.7\) (d, \(J = 14.6\) Hz), 156.5, 131.0 (d, \(J = 4.1\) Hz), 121.8, 114.1, 55.4, 1.1 (d, \(J_{C-P} = 8.1\) Hz; PCH\(_3\)). \(^{31}\)P NMR (162 MHz, CDCl\(_3\)) \(\delta = -74.42\). HRMS(ESI) m/z: Calcd for C\(_9\)H\(_{12}\)NO\(_3\)P [M+H]\(^{+}\): 198.0678, Found: 198.0679.

\[ \text{1-methyl-N-phenylphosphanecarboxamide (3b).} \] Eluent: PE/EA = 4:1. Colorless solid (82\% yield); m.p.: 81-82 °C. \(^{1}\)H NMR (600 MHz, CDCl\(_3\)) \(\delta = 7.85\) (s, 1H), 7.50 (d, \(J = 8.4\) Hz, 2H), 7.29 (t, \(J = 7.8\) Hz, 3H), 7.10 (t, \(J = 7.8\) Hz, 1H), 4.05 (dq, \(J = 207.0, 7.8\) Hz, 1H), 1.37 (dd, \(J = 7.2, 3.0\) Hz, 3H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta = 177.3\) (d, \(J = 13.7\) Hz), 137.7, 129.0, 124.5, 119.9, 1.1 (d, \(J = 8.1\) Hz). \(^{31}\)P NMR (162 MHz, CDCl\(_3\)) \(\delta = -73.64\). HRMS(ESI) m/z: Calcd for C\(_8\)H\(_{10}\)NOP [M+H]\(^{+}\): 168.0573, Found: 168.0572.

\[ \text{1-methyl-N-(o-tolyl)phosphanecarboxamide (3c).} \] Eluent: PE/EA = 4:1. Colorless solid (76\% yield); m.p.: 55-57 °C. \(^{1}\)H NMR (400 MHz, CDCl\(_3\)) \(\delta = 7.71\) (s, 1H), 7.46 (s, 1H), 7.17 (t, \(J = 7.2\) Hz, 2H), 7.09 (s, 1H), 4.06 (d, \(J = 206.8\) Hz, 1H), 2.24 (s, 3H), 1.38 (s, 3H). \(^{13}\)C NMR (150 MHz, CDCl\(_3\)) \(\delta = 176.9\) (d, \(J = 10.1\) Hz), 135.5, 130.5, 129.4, 126.7, 125.5, 123.6, 17.8, 1.1 (d, \(J = 8.3\) Hz). \(^{31}\)P NMR (162 MHz, CDCl\(_3\)) \(\delta = -74.76\). HRMS(ESI) m/z: Calcd for C\(_9\)H\(_{12}\)NOP [M+H]\(^{+}\): 182.0729, Found: 182.0727.

\[ \text{1-methyl-N-(m-tolyl)phosphanecarboxamide (3d).} \] Eluent: PE/EA = 4:1. Colorless solid (81\% yield); m.p.: 68-70 °C. \(^{1}\)H NMR (400 MHz, CDCl\(_3\)) \(\delta = 8.20\) (s, 1H), 7.43 – 7.27 (m, 2H), 7.17 (t, \(J = 7.6\) Hz, 1H), 6.91 (d, \(J = 7.6\) Hz, 1H), 4.07 (dq, \(J = 208.0, 7.6\) Hz, 1H), 2.28 (s, 3H), 1.37 (dd, \(J = 7.6, 2.8\) Hz, 3H). \(^{13}\)C NMR (150 MHz, CDCl\(_3\)) \(\delta = 177.6\) (d, \(J = 15.0\) Hz), 138.9, 137.8, 128.8, 125.3, 120.8, 117.2, 21.4, 1.2 (d, \(J = 8.1\) Hz). \(^{31}\)P NMR (162 MHz, CDCl\(_3\)) \(\delta = -73.79\). HRMS(ESI) m/z: Calcd for C\(_9\)H\(_{12}\)NOP [M+H]\(^{+}\): 182.0729, Found: 182.0728.
1-methyl-N-(p-tolyl)phosphanecarboxamide (3e). Eluent: PE/EtOAc = 4:1. Colorless solid (83% yield); m.p.: 103-104 °C. ¹H NMR (600 MHz, CDCl₃) δ = 7.88 (s, 1H), 7.38 (d, J = 8.4 Hz, 2H), 7.08 (d, J = 7.8 Hz, 2H), 4.04 (dq, J = 207.0, 7.8 Hz, 1H), 2.29 (s, 3H), 1.36 (dd, J = 7.2, 3.0 Hz, 3H). ¹³C NMR (150 MHz, CDCl₃) δ = 177.0 (d, J = 13.7 Hz), 135.3, 134.2, 129.5, 120.0, 20.9, 1.1 (d, J = 8.4 Hz). ³¹P NMR (162 MHz, CDCl₃) δ = -74.01. HRMS(ESI) m/z: Calcd for C₉H₁₂NOP [M+H]⁺: 202.0729, Found: 202.0730.

N-(4-chlorophenyl)-1-methylphosphanecarboxamide (3f). Eluent: PE/EtOAc = 4:1. Colorless solid (80% yield); m.p.: 102-104 °C. ¹H NMR (400 MHz, CDCl₃) δ = 7.90 (s, 1H), 7.45 (d, J = 8.4 Hz, 2H), 7.25 (d, J = 8.8 Hz, 2H), 4.05 (dq, J = 207.2, 7.6 Hz, 1H), 1.37 (dd, J = 7.6, 2.8 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ = 177.5 (d, J = 20.4 Hz), 136.1, 129.5, 129.0, 121.1, 1.0 (d, J = 8.4 Hz). ³¹P NMR (162 MHz, CDCl₃) δ = -73.33. HRMS(ESI) m/z: Calcd for C₈H₇ClNOP [M+H]⁺: 202.0183, Found: 202.0182.

N-(3-chlorophenyl)-1-methylphosphanecarboxamide (3g). Eluent: PE/EtOAc = 4:1. Colorless solid (75% yield); m.p.: 100-102 °C. ¹H NMR (600 MHz, CDCl₃) δ = 7.61 (s, 2H), 7.34–7.30 (m, 1H), 7.22 (t, J = 7.8 Hz, 1H), 7.08 (dd, J = 7.8, 1.8 Hz, 1H), 4.05 (dq, J = 206.4 Hz, J = 7.8 Hz, 1H), 1.38 (dd, J = 7.8, J = 3.0 Hz, 3H). ¹³C NMR (150 MHz, CDCl₃) δ = 177.5, 138.6, 134.7, 130.0, 124.6, 120.0, 117.7, 1.0 (d, J = 8.3 Hz). ³¹P NMR (162 MHz, CDCl₃) δ = -73.04. HRMS(ESI) m/z: Calcd for C₈H₇ClNOP [M+H]⁺: 202.0183, Found: 202.0181.

1-ethyl-N-(4-methoxyphenyl)phosphanecarboxamide (3h, 3i). Eluent: PE/EtOAc = 4:1. Colorless solid (3h, 71% yield, 3i, 76% yield); m.p.: 45-47 °C. ¹H NMR (400 MHz, CDCl₃) δ = 7.65 (s, 1H), 7.41 (d, J = 8.4 Hz, 2H), 6.83 (d, J = 8.4 Hz, 2H), 3.93 (ddd, J = 205.2, 8, 5.2Hz, 1H), 3.78 (s, 3H), 2.00–1.75 (m, 2H), 1.29–1.18 (m, 3H). ¹³C NMR (150 MHz, CDCl₃) δ = 176.1 (d, J = 15.9 Hz), 156.5, 130.9, 121.8, 114.1, 55.4, 13.9 (d, J = 5.1 Hz), 12.3 (d, J = 7.5 Hz). ³¹P NMR (162 MHz, CDCl₃) δ = -46.56. HRMS(ESI) m/z: Calcd for C₁₀H₁₄NO₂P [M+H]⁺: 212.0835, Found: 212.0837.
1-butyl-N-(4-methoxyphenyl)phosphanecarboxamide (3j, 3k). Eluent: PE/EA = 4:1. Colorless solid (3j, 63% yield, 3k, 69% yield); m.p.: 40-42 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ = 7.55 (s, 1H), 7.41 (d, $J$ = 8.8 Hz, 2H), 6.84 (d, $J$ = 8.8 Hz, 2H), 3.96 (ddd, $J$ = 205.2, 8.0, 5.6 Hz, 1H), 3.78 (s, 3H), 1.88 (m, 2H), 2.05 - 1.73 (m, 2H), 1.63 - 1.47 (m, 2H), 0.91 (t, $J$ = 7.2 Hz, 3H). $^{13}$C NMR (150 MHz, CDCl$_3$) $\delta$ = 176.2 (d, $J$ = 15.3 Hz), 156.5, 131.0, 121.7, 114.1, 55.4, 31.5 (d, $J$ = 5.7 Hz), 23.9 (d, $J$ = 8.6 Hz), 18.4 (d, $J$ = 8.0 Hz), 13.6. $^{31}$P NMR (162 MHz, CDCl$_3$) $\delta$ = -54.82. HRMS (ESI) m/z: Calcd for C$_{12}$H$_{18}$NO$_2$P [M+H]$^+$: 240.1148, Found: 240.1147.

\[
\begin{align*}
\text{MeO} & \quad \text{N} & \quad \text{P} \quad \text{H} \quad \text{C} \\
& & & & \\
1\text{-butyl-N-(4-methoxyphenyl)phosphanecarboxamide (3j, 3k)} & \\
\end{align*}
\]

1-hexyl-N-(4-methoxyphenyl)phosphanecarboxamide (3l). Eluent: PE/EA = 4:1. Colorless solid (74% yield); m.p.: 49-50 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ = 7.54 (s, 1H), 7.39 (d, $J$ = 8.4 Hz, 2H), 6.82 (d, $J$ = 8.8 Hz, 2H), 3.94 (ddd, $J$ = 205.2, 7.6, 5.2 Hz, 1H), 3.77 (s, 3H), 2.02 - 1.71 (m, 2H), 1.64 - 1.45 (m, 2H), 1.40 - 1.22 (m, 6H), 0.86 (t, $J$ = 6.0 Hz, 3H). $^{13}$C NMR (150 MHz, CDCl$_3$) $\delta$ = 176.2 (d, $J$ = 15.8 Hz), 156.5, 130.9, 121.7, 114.1, 55.4, 31.4, 30.5 (d, $J$ = 8.1 Hz), 29.3 (d, $J$ = 5.9 Hz), 22.5, 18.7 (d, $J$ = 8.1 Hz), 14.0. $^{31}$P NMR (162 MHz, CDCl$_3$) $\delta$ = -54.79. HRMS (ESI) m/z: Calcd for C$_{14}$H$_{22}$NO$_2$P [M+H]$^+$: 268.1461, Found: 268.1460.

\[
\begin{align*}
\text{MeO} & \quad \text{N} & \quad \text{P} \quad \text{H} \quad \text{C} \\
& & & & \\
1\text{-hexyl-N-(4-methoxyphenyl)phosphanecarboxamide (3l)} & \\
\end{align*}
\]

1-heptyl-N-(4-methoxyphenyl)phosphanecarboxamide (3m). Eluent: PE/EA = 4:1. Colorless solid (70% yield); m.p.: 61-63 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ = 7.91 (s, 1H), 7.41 (d, $J$ = 8.8 Hz, 2H), 6.81 (d, $J$ = 9.2 Hz, 2H), 3.96 (ddd, $J$ = 206, 8, 5.2 Hz, 1H), 3.76 (s, 3H), 2.02 - 1.71 (m, 2H), 1.61 - 1.45 (m, 2H), 1.37 - 1.21 (m, 8H), 0.86 (t, $J$ = 6.8 Hz, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ = 176.8 (d, $J$ = 15.6 Hz), 156.7, 131.3, 122.1, 114.3, 55.7, 32.0, 31.1 (d, $J$ = 7.9 Hz), 29.7 (d, $J$ = 5.4 Hz), 29.1, 22.9, 19.0 (d, $J$ = 8.2 Hz), 14.3. $^{31}$P NMR (162 MHz, CDCl$_3$) $\delta$ = -54.70. HRMS (ESI) m/z: Calcd for C$_{15}$H$_{24}$NO$_2$P [M+H]$^+$: 282.1617, Found: 282.1619.
N-(4-methoxyphenyl)-1-(prop-2-yn-1-yl)phosphanecarboxam ide (3n). Eluent: PE/EA = 4:1. Pale yellow solid (64% yield); m.p.: 77-79 °C. ¹H NMR (400 MHz, CDCl₃) δ = 8.00 (s, 1H), 7.41 (d, J = 8.8 Hz, 2H), 6.82 (d, J = 8.8 Hz, 2H), 4.27 (ddd, J = 209.2, 7.6, 6.0 Hz, 1H), 3.77 (s, 3H), 2.85–2.66 (m, 2H), 2.13 (dd, J = 6.0, 2.8 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ = 174.2 (d, J = 16.4 Hz), 156.9, 131.0, 122.2, 114.4, 81.1, 70.5 (d, J = 5.2 Hz), 55.7, 8.7 (d, J = 11.9 Hz). ³¹P NMR (162 MHz, CDCl₃) δ = -53.24. HRMS(ESI) m/z: Calcd for C₁₁H₁₂NO₂P [M+H]⁺: 222.0678, Found: 222.0677.

1-benzyl-N-(4-methoxyphenyl)phosphanecarboxamide (3o, 3p). Eluent: PE/EA = 4:1. Colorless solid (3o, 56% yield, 3p, 73% yield); m.p.: 87-89 °C. ¹H NMR (400 MHz, CDCl₃) δ = 7.39 (s, 1H), 7.35–7.14 (m, 7H), 6.82 (d, J = 8.8 Hz, 2H), 4.15 (dt, J = 206.4, 6.8 Hz, 1H), 3.77 (s, 3H), 3.38–3.18 (m, 2H). ¹³C NMR (150 MHz, CDCl₃) δ = 174.9 (d, J = 17.9 Hz), 156.7, 139.2 (d, J = 2.0 Hz), 130.7, 128.7, 128.5 (d, J = 4.5 Hz), 126.3, 121.9, 114.1, 55.4, 25.8 (d, J = 11.4 Hz). ³¹P NMR (162 MHz, CDCl₃) δ = -44.82. HRMS(ESI) m/z: Calcd for C₁₅H₁₆NO₂P [M+H]⁺: 274.0991, Found: 274.0992.

1-cyclohexyl-N-(4-methoxyphenyl)phosphanecarboxamide (3q). Eluent: PE/EA = 4:1. Colorless solid (20% yield); m.p.: 114-116 °C. ¹H NMR (400 MHz, CDCl₃) δ = 7.77 (s, 1H), 7.41 (d, J = 8.8 Hz, 2H), 6.82 (d, J = 8.8 Hz, 2H), 3.82 (d, J = 204.4, 6.8 Hz, 1H), 3.77 (s, 3H), 2.21 – 2.12 (m, 1H), 1.98 (s, 2H), 1.80 – 1.60 (m, 4H), 1.40 – 1.26 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ = 176.3 (d, J = 17.6 Hz), 156.7, 131.2, 122.1, 114.3, 55.7, 34.1, 32.1, 31.9, 27.3, 27.2 (d, J = 9.3 Hz), 26.1. ³¹P NMR (162 MHz, CDCl₃) δ = -33.64. HRMS(ESI) m/z: Calcd for C₁₄H₂₀NO₂P [M+Na]⁺: 288.1124, Found: 288.1124.
N,N’-bis(4-methoxyphenyl)-1-methylphosphanedicarboxamide (4). Eluent: PE/EA = 2:1. Colorless solid (67% yield); m.p.: 165-166 °C. ^1H NMR (400 MHz, DMSO-d_6) δ = 10.22 (s, 2H), 7.49 (d, J = 8.8 Hz, 4H), 6.87 (d, J = 9.2 Hz, 4H), 3.70 (s, 6H), 1.45 (d, J = 3.6 Hz, 3H). ^13C NMR (100 MHz, DMSO-d_6) δ = 172.1 (d, J = 18.3 Hz), 155.2, 131.4 (d, J = 6.7 Hz), 120.6, 113.5, 54.7, 4.6 (d, J = 8.3 Hz). ^31P NMR (162 MHz, DMSO-d_6) δ = -6.31. HRMS (ESI) m/z: Calcd for C_{17}H_{19}N_2O_4P [M+H]^+: 347.1155, Found: 347.1155.

N,N’-bis(4-methoxyphenyl)phosphanedicarboxamide (5). Eluent: PE/EA = 2:1. Colorless solid (23% yield); m.p.: 135-137 °C. ^1H NMR (400 MHz, DMSO-d_6) δ = 9.52 (s, 2H), 7.41 (d, J = 8.8 Hz, 4H), 6.82 (d, J = 9.2 Hz, 4H), 4.91 (d, J = 235.2 Hz, 1H), 3.78 (s, 6H). ^13C NMR (100 MHz, DMSO-d_6) δ = 172.1 (d, J = 15.3 Hz), 157.2, 130.4, 122.6, 114.4, 55.7. ^31P NMR (162 MHz, DMSO-d_6) δ = -77.33. HRMS (ESI) m/z: Calcd for C_{16}H_{17}N_2O_4P [M+Na]^+: 355.0818, Found: 355.0818.

N-(4-methoxyphenyl)morpholine-4-carboxamide (6). Eluent: PE/EA = 2:1. Colorless solid (81% yield); m.p.: 119-121 °C. ^1H NMR (600 MHz, CDCl_3) δ = 7.20 – 7.17 (m, 2H), 6.80 – 6.77 (m, 2H), 6.65 (s, 1H), 3.74 – 3.61 (m, 4H), 3.38 – 3.36 (m, 4H). ^13C NMR (150 MHz, CDCl_3) δ = 156.0, 155.9, 131.8, 122.8, 114.0, 66.5, 55.5, 44.2. HRMS (ESI) m/z: Calcd for C_{12}H_{16}N_2O_3 [M+H]^+: 237.1234, Found: 237.1232.

S-phenyl (4-methoxyphenyl)carbamothioate (7). Eluent: PE/EA = 4:1. Colorless solid. m.p.: 95-97 °C. ^1H NMR (600 MHz, CDCl_3) δ = 7.62 – 7.57 (m, 2H), 7.44 – 7.41 (m, 3H), 7.32 (s, 1H), 7.29 – 7.26 (m, 2H), 6.81 (d, J = 9.0 Hz, 2H), 3.76 (s, 3H). ^13C NMR (150 MHz, CDCl_3) δ = 164.4, 156.6, 135.5, 129.7, 129.4, 128.2, 114.2, 55.5. HRMS (ESI) m/z: Calcd for C_{14}H_{13}NO_2S [M+Na]^+: 282.0559, Found: 282.0559.
Copies of 1H NMR and 13C NMR Spectra for Compounds

$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3a (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3b (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3c (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3d (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3e (CDCl$_3$)
\(^1\)H NMR, \(^{13}\)C NMR and \(^{31}\)P NMR Spectra of compound 3f (CDCl\(_3\))
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3g (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3h, 3i (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3j, 3k (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3l (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3m (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3n (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3o, 3p (CDCl$_3$)
$^{1}$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 3q (CDCl$_3$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 4 (DMSO-$d_6$)
$^1$H NMR, $^{13}$C NMR and $^{31}$P NMR Spectra of compound 5 (DMSO-$d_6$)
$^1$H NMR, $^{13}$C NMR Spectra of compound 6 (CDCl$_3$)
$^{1}H$ NMR, $^{13}C$ NMR Spectra of compound 7 (CDCl$_3$)