Supplementary Material (ESI) for Chemical Communications

Supplementary material for "A simple, general and efficient ketone synthesis *via* alkylation and dephosphinoylation of β-keto-diphenylphosphine oxides"

THF was freshly distilled from a mixture of calcium hydride and lithium aluminium hydride. Triphenylmethane was used as an indicator for THF.

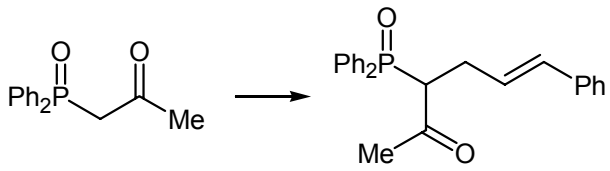
Dry Column Vacuum Chromatography (DCVC) was performed according to the published procedure[1]. Thin layer chromatography was carried out on commercially available pre-coated glass plates (Merck Kieselgel $60F_{254}$).

Proton, carbon and phosphorus NMR spectra were recorded on Bruker Avance 400 or Avance 500 Fourier Transform spectrometers using an internal deuterium lock. Chemical shifts are quoted in parts per million down field of tetramethylsilane and values of coupling constants (*J*) are given in Hz and were calculated using Mestre-C 3.9.8.0 software,[2] rounded to the nearest 0.1 Hz. Carbon NMR spectra were recorded with broad band proton decoupling and Attached Proton Test (APT) or DEPT.

Melting points were measured on a microscope hot stage melting point apparatus (C. Reichert Optische Werke AG) and are uncorrected.

Infra-red spectra were recorded on a Perkin-Elmer Spectrum One (FT-IR) spectrophotometer.

Electron Impact (EI) mass spectra were recorded on a Concept 1H double focusing magnetic sector instrument using a MACH3 data system for high resolution analysis. Electrospray (ESI) mass spectra were recorded using a Micromass Q-Toff instrument and LCMS using a Hewlett Packard HPLC system, eluting with an acetonitrile-water gradient, and in conjunction with positive and negative ion electrospray mass. Microanalyses were carried out by the staff of the University Chemical Laboratory using a CE440 Elemental Analyser from Exeter Analytical, INC.



(*E*)-3-Diphenylphosphinoyl-6-phenyl-hex-5-en-2-one (5a)

1-Diphenylphosphinoyl-propanone (0.20 g, 0.77 mmol) was dissolved in anhydrous THF (5 cm^3) with stirring. Sodium methoxide (46 mg, 0.85 mmol) was added and the solution stirred at ambient

temperature for 10 min. (*E*)-Cinnamyl bromide (183 mg, 0.93 mmol) was added and the reaction stirred at ambient temperature for 1.5 hr. The reaction was quenched with sat. aq. NH_4Cl (20 cm^3) and extracted with EtOAc (3 x 20 cm^3). The combined organic phases were were dried (Na_2SO_4), filtered and concentrated *in vacuo* to give a white amorphous solid. Purification by DCVC (id 4 cm; 20 cm^3 fractions; 2 x hexanes; 50-100% EtOAc in hexanes (v/v) – 10% increments; 1-15% MeOH in EtOAc (v/v) – 1% increments) gave 0.25 g (87%) of the *phosphine oxide* **5a** as a white powder.

mp (EtOAc, hexanes, MeOH) = 184-186 °C;

$\boldsymbol{R_f}$ = 0.43 (EtOAc);

HRMS (+ESI) *m/z* found 397.1347 ($[MNa]^+$, calcd 397.1333);

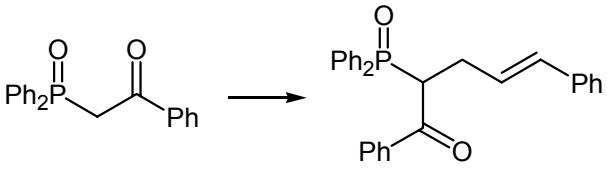
IR $\nu_{max}(CHCl_3)/cm^{-1}$ 1701 (C=O), 1437 (P-Ph) and 1181 (P=O);

^{31}P NMR (162 MHz; $CDCl_3$) δ 28.77;

^{1}H NMR (400 MHz;$CDCl_3$) δ 7.88-7.79 (m, 4H, *ortho*-PhP), 7.58-7.48 (m, 6H, *meta*- and *para*-PhP), 7.28-7.17 (m, 5H, Ph), 6.36 (d, 1H, *J* 15.5, PhC*H*=CH), 5.99 (dt, 1H, *J* 15.5 and 7, PhCH=C*H*), 3.75 (ddd, 1H, *J* 15, 11.5 and 3.5, PCH), 3.07-2.96 (m, 1H, CH_aH_b), 2.65-2.56 (m, 1H, CH_aH_b) and 2.18 (s, 3H, CH_3);

^{13}C NMR (100 MHz; $CDCl_3$) δ 204.6 (d, *J* 2.1, C2), 136.6 (*ipso*-Ph), 132.6 (Ph), 132.3*3* (d, *J* 3, *para*-PhP), 132.2*5* (d, *J* 3, *para*-PhP), 131.3 (d, *J* 9.5, *ortho*-PhP), 131.2 (d, *J* 9, *ortho*-PhP), 130.9*1* (d, *J* 99.5, *ipso*-PhP), 130.8*9* (d, *J* 100, *ipso*-PhP), 128.9 (d, *J* 12, *meta*-PhP), 128.8 (d, *J* 12, *meta*-PhP), 128.5, 127.5, 126.2, 125.8, 125.7 (Ph, C5 and C6), 57.2 (d, *J* 54.7, C3), 31.1 (C1) and 30.0 (d, *J* 2, C4);

Elemental analysis: anal. calcd for $C_{24}H_{23}O_2P_1 \cdot 0.25\ H_2O$: C, 76.07; H, 6.25. Found: C, 76.41; H, 6.19.



(*E*)-1,5-Diphenyl-2-diphenylphosphinoylpent-4-ene-1-one (5c)

2-Diphenylphosphinoyl-1-phenylethanone (0.65 g, 2.0 mmol) was dissolved in anhydrous THF (15 cm^3) with stirring. Sodium methoxide (0.11 g, 2.1 mmol) was added and the solution stirred at ambient temperature for 10 min. (*E*)-Cinnamyl chloride (0.29 cm^3, 2.1 mmol) and sodium iodide (0.32 g, 2.10 mmol) was added. The reaction mixture was stirred in the dark for 18 hr and then

quenched with sat. aq. NH_4Cl (25 cm^3), transferred to a separatory funnel with water (25 cm^3) and extracted with EtOAc (50 + 2 x 25 cm^3). The combined organic phases were washed with sat. aq. sodium thiosulfate (100 cm^3), dried (Na_2SO_4), filtered and concentrated *in vacuo* to give a yellow amorphous solid. Purification by DCVC (id 4 cm; 20 cm^3 fractions; 50-100% EtOAc in hexanes (v/v) – 5% increments; 2.5-20% MeOH in EtOAc (v/v) – 2.5% increments) gave 0.84 g (97%) of *phosphine oxide* **5c** as a yellow amorphous powder.

mp (MeOH, hexanes, EtOAc) = 154-156 °C;

$\boldsymbol{R_f}$ = 0.50 (EtOAc);

HRMS (+ESI) *m/z* found 459.1489 ($[MNa]^+$, calcd. 459.1490);

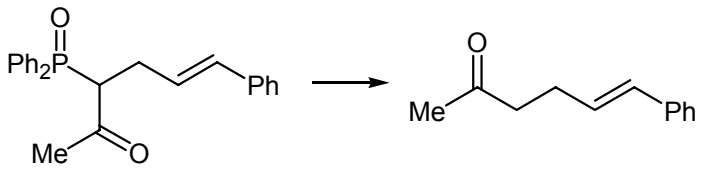
IR $\nu_{max}(CHCl_3)/cm^{-1}$ 1673 (C=O), 1438 (P-Ph) and 1173 (P=O);

^{31}P NMR (162 MHz; $CDCl_3$) δ 29.49;

^{1}H NMR (400 MHz; $CDCl_3$) δ 7.96-7.90 (m, 2H, Ph), 7.79-7.72 (m, 4H, Ph), 7.52-7.11 (m, 14H, Ph), 6.33 (d, *J* 16, 1H, CH=C*H*Ph), 6.02 (dt, *J* 16 and 7, C*H*=CHPh), 4.68 (ddd, 1H, *J* 16, 11 and 3.5, PCH), 3.20-3.07 (m, 1H, CH_aH_b) and 2.90-2.80 (m, 1H, CH_aH_b);

^{13}C NMR (100 MHz; $CDCl_3$) δ 197.4 (d, *J* 2.5, C1), 138.1 (d, *J* 0.8, *ipso-Ph*C=O), 136.8 (*ipso-Ph*CH=CH), 133.0, 132.7 (Ph and C5), 132.2 (d, *J* 3, *para*-PhP), 132.1 (d, *J* 3, *para*-PhP), 131.9 (d, *J* 9.5, *ortho*-PhP), 131.4 (d, *J* 9, *ortho*-PhP), 131.1 (d, *J* 99.5, *ipso*-PhP), 130.4 (d, *J* 99.5, *ipso*-PhP), 128.5*1* (d, *J* 12, *meta*-PhP), 128.5*02* (Ph), 128.5*00* (d, *J* 12, *meta*-PhP), 128.4, 127.3, 126.3, 126.1*3*, 126.1*2* (Ph and C4), 52.2 (d, *J* 55, C2) and 31.8 (d, *J* 2, C3);

Elemental analysis calcd. for $C_{29}H_{25}O_2P_1$ (%): C, 79.80; H, 5.77; Found: C, 79.38; H, 5.81.



(*E*)-6-Phenyl-hex-5-en-2-one (7a)

(*E*)-3-Diphenylphosphinoyl-6-phenyl-hex-5-en-2-one (**5a**) (0.14 g, 0.38 mmol) was dissolved in EtOH (10 cm^3) with heating and 4 M aq. NaOH (20 cm^3) was added. The reaction mixture was refluxed for 5.5 hr, cooled to room temperature and transferred to a separatory funnel with water (20 cm^3) and extracted with CH_2Cl_2 (3 x 20 cm^3). The combined organic phases were washed with brine (20 cm^3), dried (Na_2SO_4), filtered and concentrated *in vacuo* to give a clear yellow oil. The

product was purified by DCVC (id 4 cm; 20 cm^3 fractions; 4 x hexanes; 2-38% EtOAc in hexanes (v/v) – 2% increments) to give 61 mg (92%) of (*E*)-6-phenyl-hex-5-en-2-one **7a** as a yellow oil.

R_f = 0.25 (10% EtOAc in hexanes, v/v);

HRMS (+EI) *m/z* found 174.1047 ($[M]^+$, calcd 174.1045);

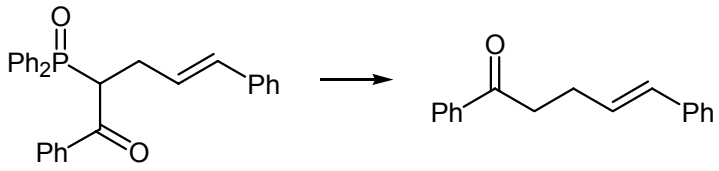
IR $\nu_{max}(CHCl_3)/cm^{-1}$ 1711 (C=O);

^{1}H NMR (500 MHz; $CDCl_3$) δ 7.33-7.18 (m, 5H, Ph), 6.40 (d, 1H, *J* 16, PhC*H*=CH), 6.19 (dt, 1H, *J* 16 and 7, PhCH=C*H*), 2.6 (t, 2H, *J* 7.5, CH_2C=O), 2.48 (q, 2H, *J* 7, CH_2CH==CH) and 2.16 (s, 3H, CH_3);

^{13}C NMR (126 MHz; $CDCl_3$) δ 208.0 (C2), 137.4 (*ipso*-Ph), 130.7, 128.8, 128.5, 127.1, 126.0 (Ph, C5 and C6), 43.2 (C3), 30.0 (C1) and 27.1 (C4);

Elemental analysis: anal. calcd for $C_{12}H_{14}O_1$: C, 82.72; H, 8.10. Found: C, 82.82; H, 8.09;

The data above is in agreement with that which has been previously reported.[3;4]



(*E*)-1,5-Diphenylpent-4-en-1-one (7c)

(*E*)-1,5-Diphenyl-2-diphenylphosphinoylpent-4-ene-1-one (**5c**) (0.50 g, 1.2 mmol) was dissolved in MeOH (10 cm^3) and KOH (0.67 g, 12.0 mmol) was added. The reaction mixture was refluxed for 4 hr cooled to room temperature, transferred to a separatory funnel with water (10 cm^3) and extracted with EtOAc (3 x 20 cm^3). The combined organic phases were dried (Na_2SO_4), filtered and concentrated *in vacuo* to give yellow needles. The product was purified by DCVC (id 4 cm; 20 cm^3 fractions; 2 x hexanes; 2.5-40% EtOAc in hexanes (v/v) – 2.5% increments) to give 0.26 g (96%) of (*E*)-1,5-diphenylpent-4-en-1-one (**7c**) as white needles.

mp (EtOAc, hexanes) = 57-59 °C (lit.,[4] 59-60 °C);

R_f = 0.43 (10% hexanes in EtOAc, v/v);

HRMS (+ESI) *m/z* found 236.1204 ($[M]^+$, calcd 236.1201);

IR $\nu_{max}(CHCl_3)/cm^{-1}$ 1684 (C=O);

^{1}H NMR (500 MHz; $CDCl_3$) δ 7.99 (dt, 2H, *J* 7.5 and 1.5, *ortho*-PhC=O), 7.57 (tt, 1H, *J* 7.5 and 1.5, *para*-PhC=O), 7.48 (t, 2H, *J* 8, *meta*-PhC=O), 7.35 (d, 2H, *J* 7, *ortho*-*Ph*CH), 7.29 (t, 2H, *J* 7.5,

meta-*Ph*CH), 7.20 (tt, 1H, *J* 7.5 and 1.5, *para*-*Ph*CH), 6.48 (d, 1H, *J* 16, CH=C*H*Ph), 6.30 (dt, 1H, *J* 16 and 7, C*H*=CHPh), 3.17 (t, 2H, *J* 7.5, CH_2C=O) and 2.69 (qd, 2H, *J* 7 and 1, CH_2CH_2C=O); **^{13}C NMR** (126 MHz; $CDCl_3$) δ 199.3 (C1), 137.5, 137.0 (*ipso*-*Ph*CH and *Ph*C=O), 133.1, 130.8, 129.2, 128.6, 128.5, 128.1, 127.1, 126.1 (Ar, C4 and C5), 38.3 (C2) and 27.5 (C3);
Elemental analysis: anal. calcd for $C_{17}H_{16}O_1$: C, 86.41; H, 6.82. Found: C, 86.09; H, 6.89;
The data above is in agreement with that which has been previously reported.[4]

References

(1) Pedersen, D. S.; Rosenbohm, C. *Synthesis* 2001, 2431.
(2) Mestre-C 3.9.8.0 software, www.Mestrec.com.
(3) Oi, S.; Moro, M.; Ito, H.; Honma, Y.; Miyano, S.; Inoue, Y. *Tetrahedron* 2002, **58**, 91.
(4) Tasuda, M.; Hayashi, K.; Katoh, Y.; Shibata, I.; Baba, A. *J.Am.Chem.Soc.* 1998, **120**, 715.