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STABLE CHIRAL BUT RACEMIC PHOSPHINES (R)(R')(R")P CONTAINING TWO DIFFERENT (AMINO) SUBSTITUENTS : HIGH YIELD SYNTHESIS AND CONVERSION TO THE RESPECTIVE PHOSPHINE SULPHIDES

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Abstract : Reaction of $PhPCl_2$ with dicyclohexylamine followed by a secondary amine affords stable tertiary phosphine $(Ph)(DCA)(NR_2)P$ in good yield which reacts readily with sulphur to give the phosphine sulphide $(Ph)(DCA)(NR_2)P(S)$.

Fully asymmetric tertiary phosphines (R)(R')(R")P have assumed considerable importance in recent years because of their use in the preparation of stereospecific hydrogenation catalysts, [1,2] chiral organic synthesis [3] and in stereospecific biological activity [4]. Their syntheses in general have been achieved only by tedious and difficult preparative procedures [2]. As (amino) phosphines are known to exhibit characteristic and greater reactivity than a more common phosphine R_3P, the introduction of one or more (amino) substituents in (R)(R')(R")P will be of particular interest with regard to their reactivity and stereospecificity. Unfortunately, to date no example of a tertiary (amino) phosphine containing three different (amino) substituents is known. Recently, we have reported a facile synthesis of tertiary (amino) phosphines $(R_2N)_3P$ by a transamination route[6]. We report here the preparation by condensation route of five different tertiary phosphines (R)(R')(R")P containing two different (amino) substituents which are isolated as stable solids in good yield. It must however be mentioned that about twenty such phosphines are reported in the literature, the majority of which are liquids at room temperature and are sensitive to air, moisture and heat. Perhaps due to this, they have remained relatively inaccessible for any further study.

The synthesis of five phosphines of the type (R)(R')(R")P has been achieved by exploiting the steric bulk of the dicyclohexylamino group (DCA) [7] which replaces only one of the two chlorines in $PhPCl_2$ even when an excess of it is used in the reaction. The resulting monochloro derivative "(Ph)(DCA)PCl" reacts in the next step with the second amine (R_2NH) to produce the phosphine $(Ph)(DCA)(NR_2)P$ [Equations (1) and (2)].

$$C_6H_5PCl_2 + 2(C_6H_{11})_2NH \longrightarrow (C_6H_5)[(C_6H_{11})_2N]PCl + (C_6H_{11})_2NH.HCl \quad .....(1)$$

$$(C_6H_5)[(C_6H_{11})_2N]PCl + 2\ R_2NH \longrightarrow (C_6H_5)[(C_6H_{11})_2N](NR_2)P + R_2NH.HCl \quad .....(2)$$

[R_2N = Pyrrolidino-, C_4H_8N-(I); Piperidino-, $C_5H_{10}N$-(II); Morpholino-, OC_4H_8N-(III); N-Methylpiperazino-, $CH_3NC_4H_8N$-(IV)& hexamethylenimino-, $C_6H_{12}N$-(V)]

In a typical reaction dicyclohexylamine (13.65g;75.4mmol.) was kept stirred in the solvent mixture benzene-hexane (150ml;1:1) at 0°C (ice bath) in a 250ml side-arm flask.

Table 1 Nuclear Magnetic Resonance (Proton & Phosphorus) and Infrared spectral data of $(Ph)(DCA)(NR_2)P$

Compound No.	% yield	M.Pt. (°C)	^{31}P-nmr ≠ δ in ppm	^{1}H-nmr ; δ in ppm Δ			IR(cm^{-1})*
				Ph	DCA	$-NR_2$	
I	75	118	66.2	7.48(2) 7.30(3)	N-CH : 2.78(2) CH_2 : 1.64 & 1.16(8)	N-CH_2 : 2.98(2) & 3.22(2) C-CH_2 : 1.64	1585(w),1265(m), 1255(m),1155(s), 1112(s),1065(s), 1050(vs),1004(s), 972(s),891(s)
II	70	128	79.2	7.58(2) 7.27(3)	N-CH : 2.70(2) CH_2 : 1.64 & 1.12(8)	N-CH_2 : 2.97(4) C-CH_2 : 1.64	1582(w),1211(s), 1155(s),1105(vs), 1058(vs),960(vs), 940(vs)
III	75	122	80.1	7.55(2) 7.30(3)	N-CH : 2.78(2) CH_2 : 1.71(12) & 1.15(8)	O-CH_2 : 3.68(4) N-CH_2 : 3.05(4)	1585(w),1260(vs), 1170(vs),1109(vs), 1079(vs),1060(vs), 980(vs),952(vs)
IV	78	156	78.8	7.60(2) 7.30(3)	N-CH : 2.70(2) CH_2 : 1.60(12) & 1.20(8)	N-CH_3 : 2.4(3) N-CH_2 : 3.08(4) & 2.48(4)	2786(s),1580(w), 1286(s),1155(vs), 1110(s),1050(vs), 970(vs),950(vs)
V	70	130	82.5	7.62(2) 7.32(3)	N-CH : 2.80(2) CH_2 : 1.66 & 1.16(8)	N-CH_2 : 3.14(4) CH_2 : 1.66	1585(w),1285(m), 1270(m),1162(vs), 1115(vs),1048(s), 1012(s),972(vs), 895(vs)

* Only strong and characteristic peaks are given.

Δ Data obtained on a 270 MHz instrument ; no. of protons are indicated in brackets.

≠ Spectra are recorded (32.4 MHz) in the proton decoupled mode as $CDCl_3$ solutions w.r.t. 85% H_3PO_4 ; down field shifts are positive.

Table 2 Nuclear Magnetic Resonance (Proton & Phosphorus) and Infrared spectral data of Ph(DCA)(NR_2)P(S)

Compound No.	% yield	M.Pt. (°C)	^{31}P-nmr≠ δ in ppm	^{1}H-nmr ; δ in ppm Δ			IR(cm^{-1})*
				Ph	DCA	$-NR_2$	
VI	90	125	71.6	7.95(2) 7.35(3)	N-CH : 2.97(2) CH_2 : 1.75 & 1.13(8)	$N-CH_2$: 3.20(4) $C-CH_2$: 1.75	1275(m),1253(m),1168(vs),1158(s),1135(s),1121(s),1103(s),1052(s),996(vs),985(vs),891(s),701(vs)
VII	90	134	71.9	8.00(2) 7.50(3)	N-CH : 2.80(2) CH_2 : 1.68 & 1.16(8)	$N-CH_2$: 3.15(4) $C-CH_2$: 1.68	1192(s),1159(s),1090(vs),1042(vs),988(s),972(s),923(vs),690(vs)
VIII	95	138	71.9	8.00(2) 7.50(3)	N-CH : 3.31(2) CH_2 : 1.80(12) & 1.15(8)	$O-CH_2$: 3.75(4) $N-CH_2$: 2.95(4)	1254(s),1153(s),1113(vs),1100(vs),1062(s),990(s),980(s),930(vs),698(vs)
IX	95	182	71.4	8.13(2) 7.40(3)	N-CH : 3.43(2) CH_2 : 1.69(12) & 1.21(8)	$N-CH_3$: 2.40(3) $N-CH_2$: 3.16(4)& 2.46(4)	2686(s),1290(s),1160(s),1145(s),1128(s),1105(s),1050(s),997(s),987(vs),953(vs),702(s)
X	95	140	75.1	7.95(2) 7.36(3)	N-CH : 2.92(2) CH_2 : 1.70 & 1.13(8)	$N-CH_2$: 3.17(4) $C-CH_2$: 1.70	1275(m),1268(m),1158(s),1135(s),1121(s),1103(s),997(s),895(s),698(vs)

* Only strong and characteristic peaks are given.

Δ Data obtained on a 270 MHz instrument ; no. of protons are indicated in brackets.

≠ Spectra are recorded (109.4 MHz)in the proton decoupled mode as $CDCl_3$ solutions w.r.t. 85% H_3PO_4 ; down field shifts are positive.

$PhPCl_2$(6.60g,36.8mmol) in hexane (20ml) was added to this in a dropwise manner in half hour. It was brought to room temperature, stirred for twelve hours and filtered to remove the dicyclohexylamine hydrochloride. The filtrate was then reacted in a similar manner with two molar equivalents of the second amine and the resulting filtrate was concentrated and cooled in the deep freezer for one day to isolate the phosphine $(Ph)(DCA)(NR_2)P$.

The reaction proceeds smoothly in each case and the resulting phosphines are obtained in 70-80% yield as high melting colourless crystalline solids which are stable to air and moisture. Also, the Phosphines (I to V) are found to react exothermically at room temperature with elemental sulphur in equimolar ratio to yield the corresponding phosphine sulphides (VI to X) as colourlsess crystalline solids [Equation (3)].

$$(Ph)(DCA)(NR_2)P + 1/8\ S_8 \xrightarrow[RT]{CH_3CN} (Ph)(DCA)(NR_2)P(S) \qquad .....(3)$$

The characterisation data of the phosphines as well as their sulphides are given in Tables (1) and (2) respectively. Proton signals are found adequately resolved in the high resolution (270MHz) proton nmr spectra of all the compounds (I to X) which has greatly assisted in their characterisation. In the electron impact mass spectra of compounds I to X, a peak corresponding to the molecular ion is observed in 40-60% intensity. A comparison of their fragmentation patterns reveals many notable features[8]. Interestingly, the phosphorus chemical shifts are much narrowly spread for the phosphine sulphides (VI-X) than the phosphines (I to V).

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