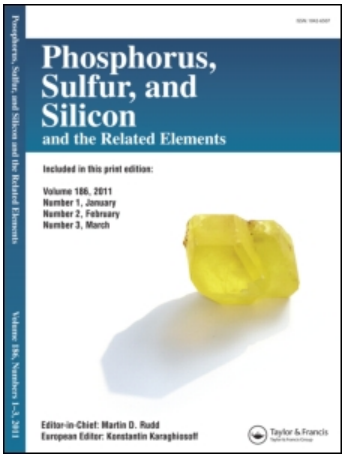


Phosphorus, Sulfur, and Silicon and the Related Elements
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

SYNTHESIS AND PROPERTIES OF A 5,6-DIHYDRO-1,3-AZAPHOSPHOLO[5,1-*b*]OXAZOLE

Raj K. Bansal[a]; Chandra B. Jain[a]; Neelima Gupta[a]; Vijaya Kabra[a]; Konstantin Karaghiosoff[b]; Alfred Schmidpeter[b]
[a] Department of Chemistry, University of Rajasthan, Jaipur, India [b] Institut für Anorganische Chemie der Universität München, München, Germany

To cite this Article Bansal, Raj K. , Jain, Chandra B. , Gupta, Neelima , Kabra, Vijaya , Karaghiosoff, Konstantin and Schmidpeter, Alfred(1994) 'SYNTHESIS AND PROPERTIES OF A 5,6-DIHYDRO-1,3-AZAPHOSPHOLO[5,1-*b*]OXAZOLE', Phosphorus, Sulfur, and Silicon and the Related Elements, 86: 1, 139 — 143
To link to this Article: DOI: 10.1080/10426509408018397
URL: http://dx.doi.org/10.1080/10426509408018397

Phosphorus, Sulfur, and Silicon, 1994, Vol. 86, pp. 139–143
Reprints available directly from the publisher
Photocopying permitted by license only

SYNTHESIS AND PROPERTIES OF A 5,6-DIHYDRO-1,3-AZAPHOSPHOLO[5,1-*b*]OXAZOLE

RAJ K. BANSAL,* CHANDRA B. JAIN, NEELIMA GUPTA and VIJAYA KABRA

Department of Chemistry, University of Rajasthan, Jaipur 302004, India

and

KONSTANTIN KARAGHIOSOFF* and ALFRED SCHMIDPETER

Institut für Anorganische Chemie der Universität München, Meiserstrasse 1, 80333 München, Germany

(Received September 3, 1993; in final form December 14, 1993)

2-Ethyl-3-phenacyl-4,5-dihydrooxazolium bromide **1** enolizes spontaneously in dimethyl sulfoxide solution. Condensation with phosphorus trichloride nevertheless involves both the methylene groups in 2- and 3-position and thus yields a five-membered ring. Hydrolysis of the resulting 1-methyl-3-benzoyl-5,6-dihydro-1,3-azaphospholo[5,1-*b*]oxazole **2** selectively opens the P—C3 bond of the azaphosphole ring to give the zwitterionic 4,5-dihydrooxazolio phosphinate **3**.

Key words: Anellated 1,3-azaphospholes; 3-alkyl-4,5-dihydrooxazolium bromides; keto/enol equilibrium; cyclocondensation with PCl_3; ^{31}P-, ^{1}H-, ^{13}C-NMR spectra; mass spectral fragmentation.

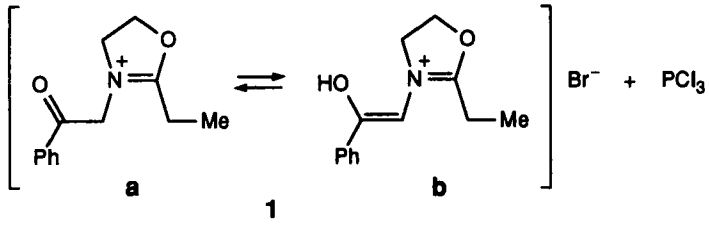
INTRODUCTION

A general way to synthesize $\sigma^2\lambda^3$-heterophospholes[1] is provided by the cyclocondensation of compounds having a suitable four-membered chain with phosphorus trichloride and triethylamine or with phosphorus tris(dialkylamide). In most cases primary or secondary amino groups or sufficiently activated methylene groups constitute the reactive ends of the four-membered chain. Following this route and starting from 1,2-dialkyl, 1-alkyl-2 amino and 1,2-diamino cycloimmonium salts we recently developed a simple and straightforward synthesis for anellated azaphospholes, including 1,3-azaphospholo[1,5-*a*]pyridines (2-phosphaindolizines),[2,3] 1,3-azaphospholo[5,1-*b*]thiazolines and benzothiazoles,[4] 1,4,2-diazaphospholo-[4,5-*a*]pyridines,[5] thiazolo[3,2-*d*][1,4,2]diazaphospholes,[6] thiazolo[2,3-*e*][1,2,4,3]-triazaphospholes[7] and 1,2,4,3-triazaphospholo[1,5-*a*]pyridines.[7,8] As compared to the dialkylcycloimmonium salts used so far 2,3-dialkyl-4,5-dihydrooxazolium salts[9,10] are less well known and it was not clear, whether they can successfully be used for the synthesis of 5,6-dihydro-1,3-azaphospholo[5,1-*b*]oxazoles. We now obtained the first representative of this ring system by the described method.

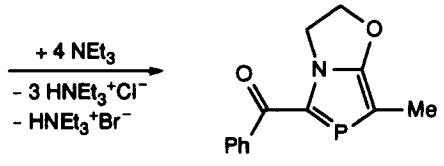
RESULTS AND DISCUSSION

The starting compound 2-ethyl 3-phenacyl-4,5-dihydrooxazolium bromide **1** is readily obtained from 2-ethyl-4,5-dihydrooxazole and phenacyl bromide as colorless

crystalline solid.[11] According to its ^{1}H- and ^{13}C-NMR spectra **1** exists in dimethyl sulfoxide solution exclusively as the enol tautomer **b**: Its N—CH= group is documented by δ^1H = 8.76 (s), δ^{13}C = 116.8 (dt), $^1J_{CH}$ = 208.4 Hz, $^3J_{CH}$ = 4.2 Hz and its —C(OH)= group by δ^{13}C = 151.1 (dt), $^2J_{CH}$ = 12.8 Hz, $^3J_{CH}$ = 4.7 Hz.[12] The oxazolinio substituent thus exerts a definitely stronger acidifying influence on the 3-methylene group than the thiazolinio substituent: For the 4,5-dihydrothiazolium bromide corresponding to **1** only the keto tautomer is observed under the same conditions.[4]



a **1** **b**



2

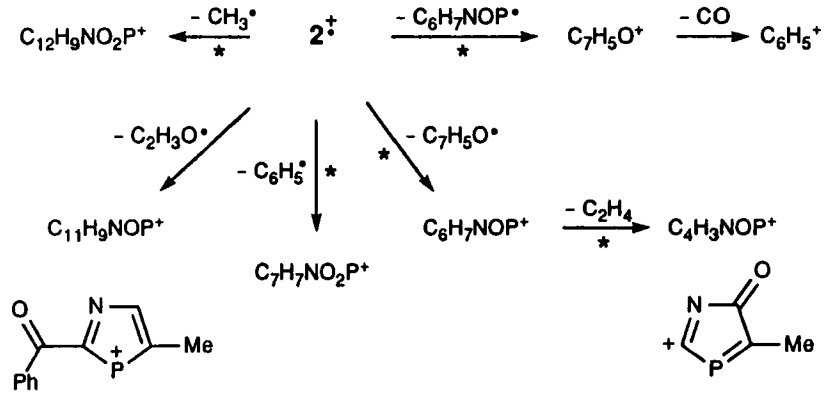
Cyclocondensation of **1** with the equimolar amount of PCl_3 and the fourfold molar amount of triethylamine in acetonitrile at ambient temperature yields the 1-methyl-3-benzoyl-5,6-dihydro-1,3-azaphospholo[5,1-*b*]oxazole **2**. The reaction is complete within 8–10 h. **2** is isolated as a pale yellow fine crystalline solid. It is readily soluble in solvents like diethylether, chloroform or acetonitrile.

The shift of the ^{31}P-NMR signal of **2** (δ = 198.5) is almost the same as that of the corresponding 5,6-dihydro-1,3-azaphospholo[5,1-*b*]thiazole (δ = 193.8[4]). Remarkably, the ^{13}C-NMR signal of C-1 (δ = 114.9) is found at substantially higher field than in similarly 1,3-disubstituted 2-phosphaindolizines (δ = 133–142)[2] and 1,3-azaphospholo[5,1-*b*]benzothiazoles (δ = 130–132).[4] A similar upfield shift of the ^{13}C-NMR signal is known for other unsaturated systems when C or S in a geminal position is exchanged for oxygen.[13]

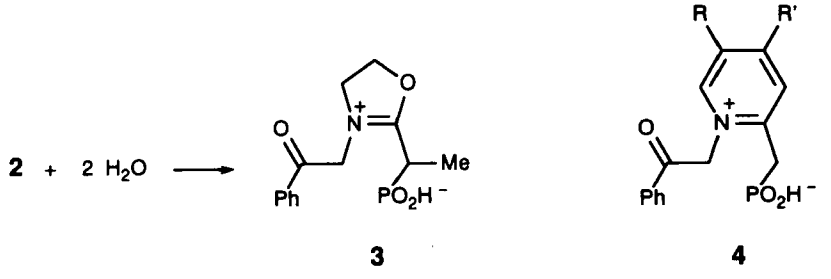
In the mass spectrum of **2** the molecular ion (m/e = 245) forms the base peak. Its fragmentation reflects the stability of the azaphosphole ring (Scheme I).

In contrast to monocyclic 1,3-azaphospholes and their benzo derivatives[1] the anellated azaphosphole **2** is quite sensitive to moisture. Like phosphaindolizines[2] it adds two equivalents of water and yields the zwitterionic dihydrooxazolio phosphinate **3** involving selective cleavage of the P—C3 bond in the azaphosphole ring. The dihydrooxazolium ring, being generally also susceptible to hydrolytic cleavage,[9] is preserved here.

Although **3** has not been isolated, its structure results unambiguously from its ^{31}P-, ^{13}C- and ^{1}H-NMR spectra. The ^{31}P-NMR signal (δ = 27.0) of **3** appears at



SCHEME I Mass spectral fragmentation of **2** and tentative interpretation of two fragments. Fragmentation steps, for which appropriate metastable ions are observed, are marked with *.



3 **4**

lower field and the P,H coupling (552.5 Hz) is slightly larger compared to those of the corresponding pyridinio phosphinates **4** (R/R′ = H/H, H/Me, Bu/H, $\delta^{31}P$ = 12–16, $^1J_{PH}$ = 535–542 Hz).[2] In **3** the *P*-bonded carbon atom has become a chiral center and as a consequence the protons of each methylene group are diastereotopic. The resulting shift difference is more pronounced for the OCH_2 protons than for the exocyclic NCH_2 protons and is much less pronounced for the endocyclic NCH_2 protons.

EXPERIMENTAL

All manipulations involving phosphorus compounds were carried out under dry nitrogen using standard Schlenk technique. Tetrahydrofuran, diethylether and acetonitrile were distilled and dried by standard procedures before use. 2-Ethyl-4,5-dihydrooxazole and phenacyl bromide are commercially available (Aldrich) and were used without further purification. Melting points were determined on a Tempo instrument and are uncorrected. NMR spectra were recorded on a Jeol FX-90-Q (^{31}P, 36.23 MHz) and Jeol EX-400 (^1H, 399.78 MHz and ^{13}C, 100.54 MHz) spectrometer. Chemical shifts are given with respect to 85% H_3PO_4 (^{31}P) as external and TMS (^1H, ^{13}C) as internal standard. The mass spectrum was recorded on a Varian-CH-7 spectrometer.

2-Ethyl-3(2-oxo-2-phenylethyl)-4,5-dihydrooxazolium bromide **1**: 2-Ethyl-4,5-dihydrooxazole (4.9 g, 0.05 mol) is added to a solution of phenacyl bromide (10.0 g, 0.05 mol) in tetrahydrofuran (40 ml) and the reaction mixture is stirred at ambient temperature (~20°C) for 2–4 d. A colorless crystalline solid precipitates, which is separated, washed with diethylether (2 × 20 ml) and dried in vacuo. Yield: 64%. M.p. 98–100°C. ^1H-NMR (d_6-DMSO): δ = 1.41 (t, $^3J_{HH}$ = 7.5 Hz, 3H; CH_3), 3.30 (q, $^3J_{HH}$ = 7.5 Hz, 2H; (2-CH_2), 3.83 (A-part of AA′MM′, *N* = 9.8 Hz, 2H; CH_2-4), 4.35 (M-part of AA′MM′, *N* = 9.8 Hz; 2H; CH_2-5), 8.76 (s, 1H; N—CH=), 7.84 (m, 2H; *o*-H), 7.5–7.6 (m, 3H; *m*-, *p*-H), 5.3

(broad s, 1H; OH). ^{13}C-NMR (d_6-DMSO): δ = 8.9 (qt, $^1J_{CH}$ = 130.3 Hz, $^2J_{CH}$ = 5.2 Hz; CH_3), 19.7 (tq, $^1J_{CH}$ = 133.6 Hz, $^2J_{CH}$ = 4.6 Hz; 2-CH_2), 51.1 (t, $^1J_{CH}$ = 145.2 Hz; C-4), 58.3 (tt, $^1J_{CH}$ = 143.8 Hz, $^2J_{CH}$ = 3.1 Hz; C-5), 116.8 (dt, $^1J_{CH}$ = 208.4 Hz, $^3J_{CH}$ = 4.2 Hz; N—CH=), 151.1 (dt, $^2J_{CH}$ = 12.8 Hz, $^3J_{CH}$ = 4.7 Hz; —C(OH)=), 124.2 (t, $^3J_{CH}$ = 7.8 Hz, C-*i*), 124.6 (m, J_{CH} not evaluated; C-*o*), 129.5 (m, J_{CH} not evaluated; C-*m*), 130.8 (dt, $^1J_{CH}$ = 163.0 Hz, $^3J_{CH}$ = 7.6 Hz; C-*p*), 167.0 (m, J_{CH} not resolved; C-2).

1-Methyl-3-benzoyl-5,6-dihydro-1,3-azaphospholo[5,1-b]oxazole **2**: A solution of triethylamine (8.1 g, 0.08 mmol) in acetonitrile (5 ml) is added to **1** (6.0 g, 0.02 mol) dissolved in acetonitrile (50 ml) with stirring. The resulting mixture is cooled to 0–5°C and freshly distilled phosphorus trichloride (2.7 g, 0.02 mol) in acetonitrile (10 ml) is added with stirring. The reaction mixture is allowed to come to ambient temperature (~20°C) and stirring is continued for another 10–12 h. After completion (checked by ^{31}P-NMR) the solvent is removed in vacuo and the residue is extracted with diethylether (2 × 50 ml). The combined extract is concentrated to 50 ml and kept in refrigerator (0°C) for 12 h, when **2** separates out as a pale yellow crystalline solid, which is filtered and dried in vacuo. Yield: 42%. M.p. 117–119°C. ^{31}P{^{1}H}-NMR ($CDCl_3$): δ = 198.5 (s). ^{1}H-NMR ($CDCl_3$): δ = 2.15 (d, $^3J_{PH}$ = 10.9 Hz, 3H; 1-CH_3), 4.70 (A-part of AA'MM'X, N = 8.3 Hz, $^4J_{PH}$ = 3.5 Hz, 2H; CH_2-5), 5.01 (M-part of AA'MM'X, N = 8.3 Hz, $^5J_{PH}$ <1.0 Hz, 2H; CH_2-6), 7.90 (m, 2H; *o*-H), 7.40 (m, 2H; *m*-H), 7.49 (m, 1H; *p*-H). ^{13}C{^{1}H}-NMR ($CDCl_3$): δ = 114.9 (d, $^1J_{PC}$ = 47.4 Hz; C-1), 143.9 (d, $^1J_{PC}$ = 58.8 Hz; C-3), 48.3 (d, $^3J_{PC}$ = 4.3 Hz; C-5), 74.7 (s; C-6), 159.6 (d, $^2J_{PC}$ = 9.5 Hz; C-8), 10.3 (d, $^2J_{PC}$ = 22.3 Hz; 1-CH_3), 185.9 (d, $^2J_{PC}$ = 22.8 Hz, CO), 139.4 (d, $^3J_{PC}$ = 1.4 Hz; C-*i*), 129.1 (d, $^4J_{PC}$ = 8.5 Hz; C-*o*), 127.9 (s; C-*m*), 131.4 (s; C-*p*). The assignment of the ^{13}C-NMR signals is based on a ^{1}H/^{13}C-correlated spectrum. MS (70 eV, 35°C): m/e = 245 (100% rel. int.) $C_{13}H_{12}NO_2P^+$, 230 (57) $C_{12}H_9NO_2P^+$, 202 (15) $C_{11}H_9NOP^+$, 168 (40) $C_7H_7NO_2P^+$, 140 (24) $C_6H_7NOP^+$, 112 (52) $C_4H_3NOP^+$, 105 (74) $C_7H_5O^+$, 77 (61) $C_6H_5^+$.

Hydrolysis of **2**: To a solution of **2** (20 mg, 0.08 mmol) in deuterochloroform (0.5 ml) water (3 mg, 0.17 mmol) is added. After 4d at ambient temperature (~20°C) the ^{31}P-NMR spectrum shows only the signal of **3**. ^{31}P-NMR ($CDCl_3$): δ = 27.0 (ddq, $^1J_{PH}$ = 552.5 Hz, $^2J_{PH}$ = 20.3 Hz, $^3J_{PH}$ = 19.3 Hz). ^{1}H-NMR ($CDCl_3$): δ = 6.87 (d, $^1J_{PH}$ = 552.5 Hz, 1H; PH), 1.25 (dd, $^3J_{PH}$ = 19.3 Hz, $^3J_{HH}$ = 7.1 Hz; 3H; CH_3), 2.86 (dq, $^2J_{PH}$ = 20.3 Hz, $^3J_{HH}$ = 7.1 Hz; 1H; CH), 4.63, 4.69 (AB, $^2J_{HH}$ = 17.6 Hz; 3-CH_2), 3.4–3.5 (AB-part of ABMN: CH_2-4), 4.30 (M-part of ABMN, $^3J_{HH}$ = 7.1 Hz, 3.8 Hz, $^2J_{HH}$ = 12.7 Hz; CH_2-5), 4.80 (N-part of ABMN, $^3J_{HH}$ = 5.5 Hz, 3.6 Hz, $^2J_{HH}$ = 12.7 Hz; CH_2-5), 7.82 (m, 2H; *o*-H), 7.39 (m, 2H; *m*-H), 7.56 (m, 1H; *p*-H). ^{13}C{^{1}H}-NMR ($CDCl_3$): δ = 43.4 (d, $^1J_{PC}$ = 71.1 Hz; CH), 9.5 (s, CH_3), 171.0 (d, $^2J_{PC}$ = 6.2 Hz; C-2), 46.1 (s; 3-C), 52.1 (s; C-4), 59.3 (s; C-5), 191.1 (s; CO), 134.6 (s; C-*i*), 129.0 (s; C-*o*), 128.2 (s; C-*m*), 133.6 (s; C-*p*).

ACKNOWLEDGEMENT

We thank the U.G.C., New Delhi for J.R.F. to C.B.J. and the Volkswagen Foundation for financial support.

REFERENCES

1. Reviews on heterophospholes: a) A. Schmidpeter and K. Karaghiosoff in "Multiple Bonds and Low Coordination in Phosphorus Chemistry" (M. Regitz and O. J. Scherer eds.), Thieme, Stuttgart, 1990, p. 258. b) A Schmidpeter and K. Karaghiosoff in "Rings, Clusters and Polymers of Main Group and Transition Elements" (H. W. Roesky ed.), Elsevier, Amsterdam, 1989, p. 307. c) R. K. Bansal, K. Karaghiosoff and A. Schmidpeter, *Tetrahedron 50* (1994).
2. R. K. Bansal, K. Karaghiosoff, Neelima Gupta, A. Schmidpeter and C. Spindler, *Chem. Ber.*, **124,** 475 (1991).
3. R. K. Bansal, V. Kabra, N. Gupta and K. Karaghiosoff, *Indian J. Chem.*, **316,** 254 (1992).
4. R. K. Bansal, R. Mahnot, D. C. Sharma, K. Karaghiosoff and A. Schmidpeter, *Heteroatom Chem.*, **3,** 351 (1992).
5. K. Karaghiosoff, R. K. Bansal and Neelima Gupta, *Z. Naturforsch.*, **47B,** 373 (1992).
6. R. K. Bansal, R. Mahnot, D. C. Sharma and K. Karaghiosoff, *Synthesis*, **1992,** 267.
7. A. Schmidpeter, F. Steinmüller and E. Ya. Zabotina, *J. prakt. Chem.*, **335,** 458 (1993).
8. R. K. Bansal, N. Gandhi, K. Karaghiosoff and A. Schmidpeter, unpublished results.
9. J. A. Trump, *Chem. Rev.*, **71,** 483 (1971).

10. M. Maguet, Y. Poirier and R. Guglielmetti, *Bull. Soc. Chim. France*, **1978,** II-550.
11. R. K. Bansal, C. B. Jain and Neelima Gupta, *J. Indian Chem. Soc.* (in press).
12. For a review on ^{1}H- and ^{13}C-NMR spectroscopical investigations of enols see: B. Floris in "The Chemistry of Enols" (Z. Rappoport ed.), Wiley, Chichester, 1990, Chapter 4, p. 148.
13. H.-O. Kalinowski, S. Berger and S. Braun, "^{13}C-NMR-Spektroskopie," Thieme, Stuttgart, 1984.