An Improved Synthesis of 2-Alkynyl Sulfides

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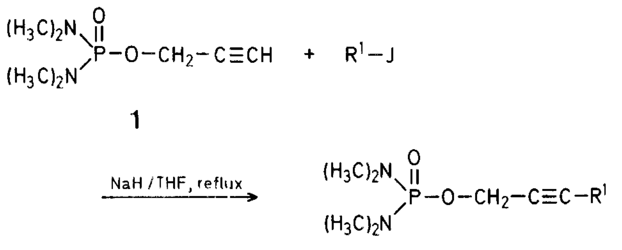
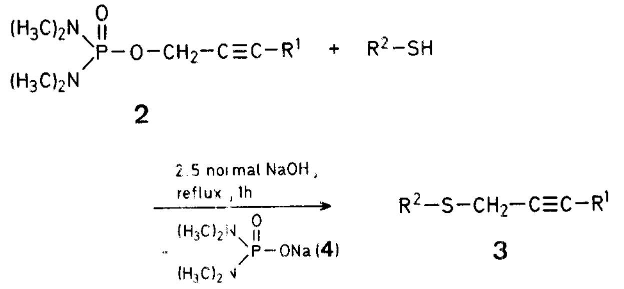
We have previously[1] reported on the C-alkylation (to give **2**, Scheme **A**) of 2-propynyl tetramethylphosphorodiamidate (**1**), which represents a structural analogue of hexamethylphosphoric triamide (HMPT). Compound **1** has been found to be useful as a combined solvent and reagent for the synthesis of propynyl derivatives such as 1-bromo-2-alkynes.



Scheme **A**

In connection with our studies on the chemical properties of the 2-alkynyl tetramethylphosphorodiamidates **2**, we now report the preparation of 2-alkynyl sulfides **3**, useful intermediates in a new synthesis of enones[2], from compounds **2**. Reaction of **2** with a thiol in refluxing 2.5 normal sodium hydroxide solution gives rise to the 2-alkynyl sulfides **3** and sodium tetramethylphosphorodiamidate (**4**) in quantitative yields (Scheme **B**).



Scheme **B**

Unsymmetrical sulfides are usually prepared by the reactions of alkali thiolates with alkyl halides[3]. However, these processes often require halides derived from alcohols,

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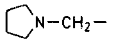
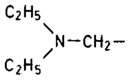
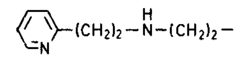
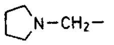
Table. 2-Alkynyl Sulfides **3**

R^1	R^2	Yield [%][a]	b.p./torr	n_D (temp.)	Molecular formula[b] or Lit. b.p./torr	^{1}H-N.M.R. ($CDCl_3$, 60 MHz)[c] δ [ppm]
H_3C	C_6H_5	96	62°/0.01	1.5891 (20°)	109°/2[7]	1.77 (t, 3H); 3.6 (q, 2H, *J*=2.4 Hz); 7.3 (m, 5H)
C_2H_5	C_6H_5	98	72°/0.01	1.5745 (19°)	$C_{11}H_{12}S$ (176.3)	1.05 (t, 3H); 2.12 (m, 2H); 3.5 (t, 2H, *J*=2.3 Hz); 7.3 (m, 5H)
n-C_3H_7	C_6H_5	98	87°/0.01	1.5646 (19°)	$C_{12}H_{14}S$ (190.3)	0.95 (t, 3H); 1.52 (m, 4H); 2.2 (m, 2H); 3.6 (t, 2H, *J*=2.4 Hz); 7.35 (m, 5H)
n-C_4H_9	C_6H_5	95	112°/0.05	1.5570 (19°)	$C_{13}H_{16}S$ (204.3)	0.7–1.6 (m, 7H); 2.15 (m, 2H); 3.6 (t, 2H, *J*=2.3 Hz); 7.3 (m, 5H)
C_6H_5	C_6H_5	91	134°/0.01	1.6412 (21°)	170°/1[7]	3.75 (s, 2H); 7.1–7.6 (m, 10H)
	C_6H_5	98	122°/0.01	1.5785 (20°)	$C_{14}H_{17}NS$ (231.4)	1.7 (m, 4H); 2.5 (m, 4H); 3.35 (t, 2H); 3.6 (t, 2H, *J*=2.1 Hz); 7.3 (m, 5H)
 $(C_2H_5)_2N-CH_2-$	C_6H_5	97	114°/0.01	1.5540 (20°)	$C_{14}H_{19}NS$ (233.4)	1.0 (t, 6H); 2.45 (q, 4H); 3.4 (t, 2H); 3.65 (t, 2H, *J*=2.1 Hz); 7.3 (m, 5H)
C_2H_5		76	115°/0.01	1.5400 (18°)	$C_{14}H_{20}N_2S$ (248.4)	1.15 (t, 3H); 1.6 (s, 1H); 2.2 (m, 2H); 2.7–3.2 (m, 8H); 3.3 (t, 2H); 7.0–7.35 (m, 2H); 7.45–7.8 (m, 1H); 8.55 (m, 1H)
	$C_6H_5-CH_2-$	95	130°/0.01	1.5700 (19°)	$C_{15}H_{19}NS$ (245.4)	1.85 (m, 4H); 2.7 (m, 4H); 3.17 (t, 2H); 3.5 (t, 2H, *J*=2.3 Hz); 3.88 (s, 2H); 7.35 (s, 5H)

[a] Yield of product isolated by chromatography.

[b] The microanalyses of the new compounds were in satisfactory agreement with the calculated values (C ±0.17, H ±0.09).

[c] Measured with a JEOL C60 HL spectrometer with TMS as internal standard.

which, especially in the case of alkynyl derivatives, may be difficult to prepare.

Dealkylation reactions of phosphorus compounds have been previously used[4] to achieve this purpose and all such reactions proceed by nucleophilic substitution. The previously published methods used thiolates[5] or high temperatures[6], both methods, however, gave rise to propargylic rearrangement of the resultant 2-alkynyl sulfides. In contrast, the present method, which is general for phosphorodiamidates bearing an electrophilic group (alkyl, benzyl, propynyl) offers the distinct advantage of the mild conditions (2.5 normal sodium hydroxide solution) and gives pure sulfides (see Table).

2-Alkynyl Sulfides 3; General Procedure:

A stirred mixture of the 2-alkynyl tetramethylphosphorodiamidate[1] **2** (10 mmol), the thiol (12 mmol), and 2.5 normal sodium hydroxide (5 ml) is heated under reflux in a nitrogen atmosphere for 1 h. The mixture is then allowed to cool to room temperature, diluted with water (50 ml), and extracted with dichloromethane (3 × 30 ml). The organic phase is dried with magnesium sulfate and the solvent is removed in vacuum. The residue is purified by column chromatography (50 cm × 3 cm) on silica gel (100 g) using hexane/ethyl acetate as eluent. In larger scale preparations the products are purified by distillation under reduced pressure.

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[1] G. Sturtz, J.-P. Paugam, B. Corbel, *Synthesis* **1974**, 730.

[2] B. Corbel, unpublished results.

[3] A. Schöberl, A. Wagner, in: Houben-Weyl, *Methoden der organischen Chemie*, 4th edn., Vol. IX, E. Müller, Ed., Georg Thieme Verlag, Stuttgart, 1955.
M. E. Peach in: *The Chemistry of the Thiol Group*, S. Patai, Ed., Interscience, New York, 1974, p. 725.
L. Field, *Synthesis* **1972**, 101.

[4] I. Nakagawa, T. Hata, *Tetrahedron Lett.* **1975**, 1409.
I. M. Downie, H. Heaney, G. Kemp, *Angew. Chem.* **87**, 357 (1975); *Angew. Chem. Int. Ed. Engl.* **14**, 370 (1975).
Y. Tanigawa, H. Kanamaru, S. I. Murahashi, *Tetrahedron Lett.* **1975**, 4655.
H. Loibner, E. Zbiral, *Helv. Chim. Acta* **59**, 2100 (1976).
W. T. Flowers, G. Holt, F. Omogbai, C. P. Poulos, *J. Chem. Soc. Perkin Trans. 1* **1976**, 2394.
K. A. M. Walker, *Tetrahedron Lett.* **1977**, 4475.

[5] P. Savignac, P. Coutrot, *Synthesis* **1974**, 818.
H. Yamamoto, Y. Kitagawa, S. Hashimoto, S. Iemura, H. Nozaki, *J. Am. Chem. Soc.* **98**, 5030 (1976).

[6] K. Pilgram, *Tetrahedron* **22**, 1241 (1966).

[7] G. Pourcelot, P. Cadiot, *Bull. Soc. Chim. Fr.* **1966**, 3016.