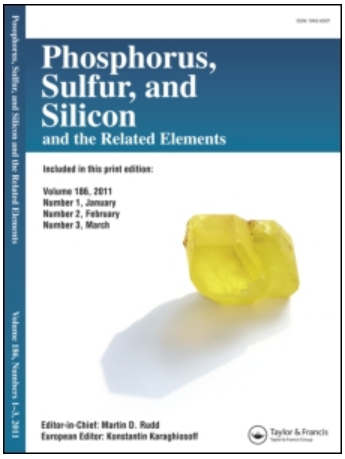


Phosphorus, Sulfur, and Silicon and the Related Elements
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

The Selective C-Mono-and C,C-Dialkylation of Thiophosphorylacetonitriles and Reactivity of the Products

Natalya M. Vinogradova; Irene L. Odinets; Oleg I. Artyushin; Konstantin A. Lyssenko; Pavel V. Petrovsky; Tatyana A. Mastryukova

To cite this Article Vinogradova, Natalya M. , Odinets, Irene L. , Artyushin, Oleg I. , Lyssenko, Konstantin A. , Petrovsky, Pavel V. and Mastryukova, Tatyana A.(1999) 'The Selective C-Mono-and C,C-Dialkylation of Thiophosphorylacetonitriles and Reactivity of the Products', Phosphorus, Sulfur, and Silicon and the Related Elements, 144: 1, 589 — 592
To link to this Article: DOI: 10.1080/10426509908546313
URL: http://dx.doi.org/10.1080/10426509908546313

Phosphorus, Sulfur and Silicon, 1999, Vol. 144-146, pp. 589-592
Reprints available directly from the publisher
Photocopying permitted by license only

The Selective C-Mono-and C,C-Dialkylation of Thiophosphorylacetonitriles and Reactivity of the Products

NATALYA M. VINOGRADOVA, IRENE L. ODINETS, OLEG I. ARTYUSHIN, KONSTANTIN A. LYSSENKO, PAVEL V. PETROVSKY and TATYANA A. MASTRYUKOVA

A.N. Nesmeyanov Institute of the Organoelement Compounds, Russian Academy of Sciences, Vavilova, 28, 117813 Moscow, Russia

The facile synthetic route to selective C-mono-and C,C-dialkylation of thiophosphorylacetonitriles by primary haloalkanes under phase transfer catalysis conditions has been developed. Using under the same conditions unsymmetric α,ω-dihaloalkanes results in different linear and cyclic products depending on the alkylene chain length. 3-Halopropylsubstituted thiophosphorylacetonitriles synthesized transform to mono-and bis-heterophosphacyclanes under elevated temperatures.

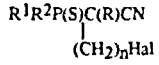
Keywords: thiophosphorylacetonitriles; alkylation; phase transfer catalysis; unsymmetric ; α,ω-dihaloalkanes; 2-oxo-1,2-thiaphospharinanes; X-ray study

INTRODUCTION

It is known that classical methods of alkylation of compounds containing the activated methylene group usually afford a mixture of mono- and dialkylated products. However when the method of phase transfer catalysis (PTC) is used the selectivity of the reaction can be often achieved. Thus, the alkylation of dialkoxyphosphorylacetonitriles with iodoalkanes proceeds as monoalkylation in CH_2Cl_2[1] and as dialkylation in the absence of solvent[2] under ion-pair extraction conditions. Monoalkylation of the derivatives

having dialkylamido groups at the P atom proceeds under the conditions of both ion-pair extraction and PTC[3]. As for thiophosphorylacetonitriles being the object of our investigation the only one example of their alkylation under PTC conditions, namely cycloalkylation by α,ω-dibromoalkanes is known from literature[4].

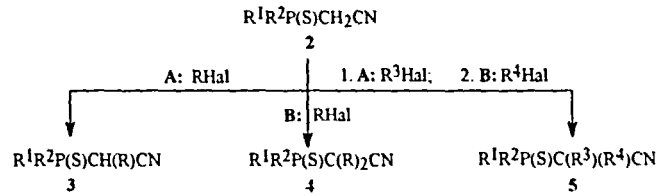
To develope the facile synthetic route to the novel C-mono- and C,C-dialkyl (ω-haloalkyl)substituted thiophosphorylacetonitriles **1**, the alkylation of thiophosphorylacetonitriles under PTC conditions has been thoroughly investigated.



1 R=H, Alk, $(CH_2)_nHal$

RESULTS AND DISCUSSION

We have found that the use of the different heterophasic systems allows to accomplish the selective C-mono- and C,C-dialkylation of thiophosphorylacetonitriles **2** in the case of primary alkyl halides. Thus C-monoalkylated products **3** were obtained in 87-95% yields conducting the reaction in the presence of excess of 50%aq.NaOH in CH_2Cl_2 regardless of the initial components ratio. In s. KOH/CH_3CN system reaction leads solely to the disubstituted derivatives **4** (93-100%). Alkylation of **2** in CH_2Cl_2 and in CH_3CN in tandem yields C,C-disubstituted compounds **5** bearing different alkyl groups. It should be noted that secondary alkyl halides react with **2** in none of the above systems.

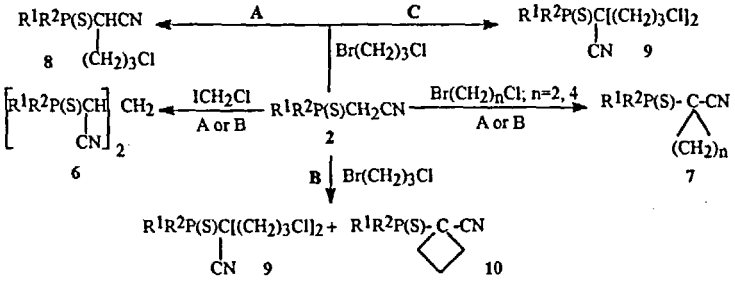


A: 50% NaOH/CH_2Cl_2; B: s. KOH/CH_3CN, cat. Et_3PhCH_2NCl (TEBA)

R^1=R^2=OEt, OPr, Ph; R^1=Me, R^2=OPr-i, OBu-iR, R^3, R^4=Me, Et, Pr, Bu; Hal=Br, I

One could expect that unsymmetric α,ω-dihaloalkanes possessing different electrophilicity of the terminal carbon atoms would interact with thiophosphorylacetonitriles as primary alkyl halides. However the result of their reaction with **2** under PTC conditions was established to depend mainly not on the heterophasic system, but on the alkylene chain length. Thus the reaction with $ClCH_2I$ leads

substantially to **6** (yield: A-50%, B-65%) while with $Cl(CH_2)_2Br$ and $Cl(CH_2)_4Br$ it occurs as cycloalkylation (yield for **7**: A-60%, B-70-100%) Besides **7** in the system A 15-25% of the monoalkylated product was obtained. Contrary to the other dihaloalkanes $Cl(CH_2)_3Br$ reacts with **2** in the system A like primary alkyl halides resulting in 3-chloropropylderivatives **8**. The reaction with this reagent in the system B yields the mixture of di- and cycloalkylated products **9**, **10**. Bis(3-chloropropyl)thiophosphoryl-acetonitriles **9** were synthesized using the excess of 50% aq. NaOH without solvent.

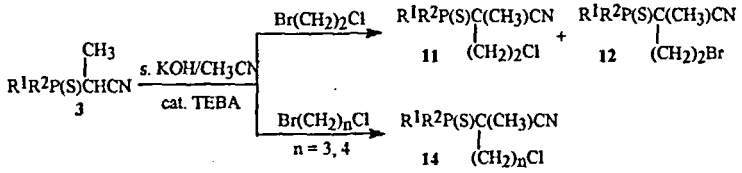


A : 50% aq. NaOH/CH_2Cl_2/TEBA; B : s. KOH/CH_3CN/TEBA; C : 50% NaOH/without solv/TEBA
R^1=R^2=OEt, OPr, Ph; R^1=Me, R^2=OPr-i, OBu-i; R^1=Ph, R^2=OEt

X-ray diffraction study of 1-diphenylthiophosphoryl-1-cyanocyclopentane **7** has shown that statistic disorder in the crystal of this compound is observed with the conformers ratio 7:3.

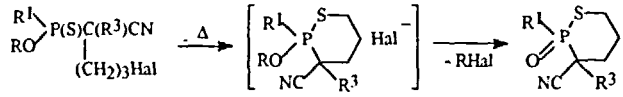
It should be noted that the increase of the substituent number results in the downfield shift in the NMR ^{31}P spectra (the cycloalkanes signals exist between that of the mono- and dialkylated products) making it easy to control the reaction course.

Secondary alkylation of methylsubstituted thiophosphorylacetonitriles **3** by $Cl(CH_2)_2Br$ leads to the mixture of compounds bearing both Br and Cl terminal atoms in nearly equal ratio (58:42). With the other chlorobromoalkanes solely 3-chloroderivatives were obtained.



Being distilled *in vacuo* 3-chloroalkyl derivatives **8** and **14** were found to afford 2-oxo-6-cyano-1,2-thiaphosphorinanes **16** (up to 70%) as an 1:1 equilibrium mixture of

two diastereomers (A, B). The mutual diastereomer conversions were examined by means of the NMR and X-ray studies.



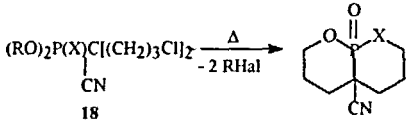
8, 14 **15** **16**

A (R, S; S, R); B (R, R; S, S)

R^1=Me, Ph, OEt, OPr, OPr-i, OBu-i; R=Et, Pr, Pr-i, Bu-i; R^3=H, Me; Hal=Cl, I

The formation of **16** may be attributed to the intramolecular S-alkylation resulted in 1,2-thiaphosphacyclanium salt followed by dealkylation. The intramolecular S-alkylation of non-functionalized analogs of the compounds under consideration was thoroughly investigated in the work of T.A.Mastryukova et al[5].

Thermal rearrangements of bis(3-chloropropyl)substituted thiophosphoryl-(phosphoryl)acetonitriles **18** result in bicyclic compounds **19** their structure being confirmed by X-ray study.



18 **19**

X=O, S

Acknowledgements

This work was financially supported by the Russian Basic Research Foundation (grant No.96-03-32992)

References

[1] E. D'INcan and J. Seyden-Penne, *Synthesis,* 576 (1975).
[2] R. Singh, *Synthesis,* 762 (1986).
[3] J. Blenchard, N. Collignon, P. Savignac and N. Normant, *Synthesis,* 655 (1975).
[4] P. V. Kazakov, I. L. Odinets, P. V. Petrovskii, L. V. Kovalenko, T. A. Mastryukova, *Bull. Rus. Acad. Sci, Div. Chem,* **39**, 1702 (1990).
[5] I. M. Aladzheva, O. V. Bykhovskaya, D. I. Lobanov et *al, Mend. Comm,* 48 (1996); I. M. Aladzheva et al, *Russ. Chem. Bull.*, **9** (1998) in press.