Tetrahedron Letters,Vol.25,No.9,pp 991-994,1984
Printed in Great Britain

0040-4039/84 $3.00 + .00

GENERATION OF 2-LITHIO-2-(METHYLTHIO)-1,3-BENZODITHIOLES, NEW CARBOXYL CARBANION EQUIVALENTS, AND THEIR APPLICATION TO THE SYNTHESES OF UNSYMMETRICAL HEXATHIOORTHOOXALATES

Charles Allan Brown[†*] and Robert D. Miller

IBM Research Laboratory, Department K34/281
5600 Cottle Road, San Jose, California 95193, U.S.A.

Charles M. Lindsay and Keith Smith[††*]
Department of Chemistry, University College of Swansea
Swansea SA2 8PP, United Kingdom

ABSTRACT: 2-Lithio-2-(methylthio)-1,3-benzodithioles are readily generated either by thiophilic addition of methyllithium to *o*-phenylenetrithiocarbonates or by deprotonation of 2-(methylthio)-1,3-benzodithioles with *n*-butyllithium in THF; these anions are protonated (aqueous NH_4Cl) or methylated (MeI) as expected, but undergo an unexpected, overall carbophilic addition reaction with cyclic trithiocarbonates to yield, after alkylation, unsymmetrical hexathioorthooxalates, compounds which have been difficult to prepare by traditional methods.

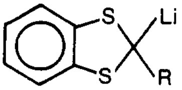
Although dithioacetal anions have been widely used as carbonyl anion equivalents for organic synthesis,[1] there have been very few reports of the use of trithioorthoformate anions (1) as the corresponding carboxyl carbanion equivalents.[2] The utilization of anions of type (1) in organic synthesis is complicated by their tendency to undergo α-elimination of a thiolate anion to give carbenes.[3] Although tris(phenylthio)methyllithium is more stable than tris(alkylthio)methyllithiums in this respect, it gives satisfactory reactions only with the more reactive electrophiles such as iodomethane, aldehydes, and chlorotrimethylsilane.[4] In some reactions, for example, those with relatively hindered organoboranes,[5,6] 2-lithio-2-alkyl-1,3-benzodithioles (2)[7] are superior to the corresponding 1-lithio-1,1-bis(phenylthio)-alkanes, presumably as a result of reduced steric requirements and greater entropic stability. Thus, we undertook to investigate the preparation of anions of type (3), which we hoped would be relatively stable yet sufficiently reactive to be of general utility for organic synthesis.

We now report two successful methods for generation of anions (3) and an unexpected, carbophilic addition reaction of these anions to cyclic trithiocarbonates, which produces, after alkylation, unsymmetrical hexakis(organylthio)ethanes (hexathioorthooxalates), compounds which have previously been extremely difficult to prepare.

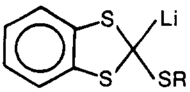
[†] Visiting scientist, University College of Swansea, Summers 1981 and 1983.
[††] Visiting scientist, IBM Research, Summer 1979.

$(RS)_3C^{\ominus}$

(1)

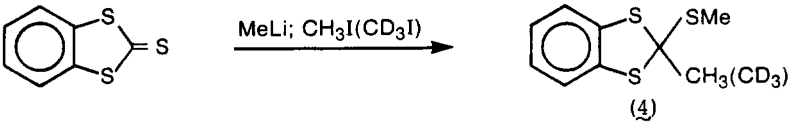


(2)



(3)

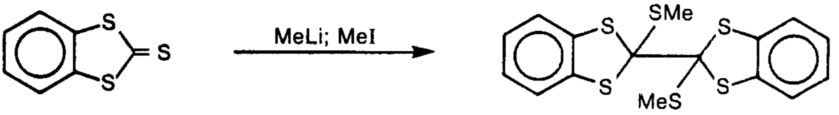
Our initial studies concerned the thiophilic addition of organolithium reagents[8] to *ortho*-phenylenetrithio-carbonate. Both phenyllithium and *tert*-butyllithium gave thiophilic additions, but the subsequent reactions of the anions exhibited complications.[9] On the other hand, addition of the trithiocarbonate to excess MeLi in THF -78° produced a solution which could be methylated with iodomethane to give 2-methyl-2-(methylthio)-1,3-benzo-dithiole (4) in essentially quantitative yield (88% after isolation and purification). That the reaction occurred *via* thiophilic addition of methyllithium was shown by working up the reaction with CD_3I instead of CH_3I, which produced 2-(trideuteriomethyl)-2-(methylthio)-1,3-benzodithiole (Eq. 1). Also, protonation of the intermediate anion using aqueous ammonium chloride produced the parent 2-(methylthio)-1,3-benzodithiole.



(4)

[1]

Reaction of *ortho*-phenylenetrithiocarbonate with 1.0 eq. of MeLi, followed by excess MeI, gave an isolated yield of (4) of only 71% along with 15% of a solid by-product, identified as the hexathioorthooxalate (5).[10] By use of a 1:2 mole ratio of methyllithium : trithiocarbonate, the reaction could be diverted completely to the formation of (5) (Eq. 2), which could be isolated in 85% yield.



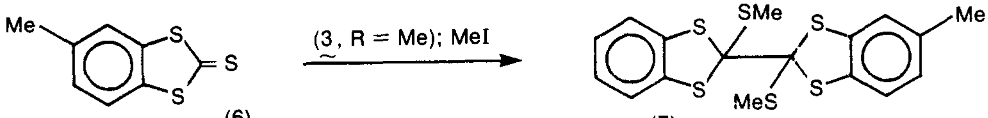
(5)

[2]

Whatever the precise details of the mechanism, it appeared that addition of anion (3, R=Me) to *ortho*-phenylenetrithiocarbonate clearly occurred in an overall carbophilic manner, a surprising result in view of the cleanly thiophilic addition of methyllithium. We are currently studying a range of different sulfur-substituted organolithium reagents in an attempt to establish at what point the changeover occurs.[9]

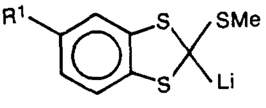
In order to establish that (5) did not result from some type of oxidative dimerization of (3, R=Me), the final alkylation step (Eq. 2) was carried out using $PhCH_2Cl$ instead of MeI. In this case, the product did indeed contain one methyl and one benzyl group. Furthermore, based on our interpretation of the reaction (*i.e.*, carbophilic addition), it appeared possible that if the reaction were carried out stepwise – initially a 1:1 reaction of trithiocarbonate and MeLi, and then a subsequent addition of a second mole of trithiocarbonate – a different trithiocarbonate could be used in the second stage, with the prospect of producing an unsymmetrical hexathioorthooxalate. Indeed, when this procedure was carried out using *ortho*-phenylenetrithiocarbonate in the first stage and its 4-methyl derivative (6) in the second, the major product was (7). Unfortunately, the product was contaminated by *ca.* 15% of (5), which proved difficult to separate.

It should be possible to improve the purity of (7) by careful control of experimental conditions. However, since (5) presumably arose from some reaction of anion (3, R=Me) with *ortho*-phenylenetrithiocarbonate during preparation of the anion, a preferable approach to obtaining pure (7) appeared to be to generate the anion by an alternative method not involving the trithiocarbonate. Thus, we looked at simple deprotonation of 2-(methylthio)-1,3-benzodithiole, which was prepared either by protonation of (3, R=Me) [prepared as above using excess MeLi – production of (5) is not a problem in the presence of a 100% excess of MeLi] or from a 2-alkoxy-1,3-benzodithiole by the method of Nakayama.[11] Indeed, treatment of this with one equivalent of *n*-butyllithium in THF at -78° gave rise to a solution of anion (3, R=Me). Treatment of this with one equivalent of (6) (Eq. 3) gave rise, after methylation, to (7) which contained no more than trace quantities of either (5) or the symmetrical dimethyl derivative, as determined by mass spectrometry.

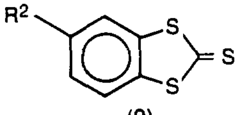


(6) (7) [3]

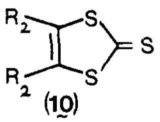
Hexathioorthooxalates which are unsymmetrical about the central C–C bond are not generally available, so this reaction, if general, could represent the first useful synthetic method for such compounds. Thus, we established the generality by reacting a variety of anions of type (8, R^1=H, Me, Cl) with aromatic or aliphatic cyclic trithiocarbonates of types (9, R^2=H, Me) and (10, R_2=Me_2, $(CH_2)_3$, H_2), respectively. The yields of the products, of types (11) and (12) are shown in the Table.



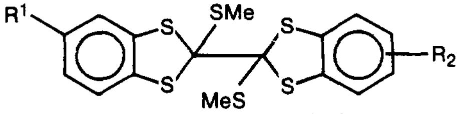
(8)



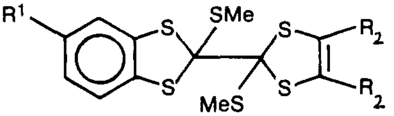
(9)



(10)



(11)



(12)

As is evident from the Table, the dibenzo derivatives (11) are invariably formed in high yield. The reactions with aliphatic trithiocarbonates give lower yields, as a result of the production of several different by-products which can be seen by TLC, but the products can be purified readily by flash-column chromatography. Only the unsubstituted aliphatic trithiocarbonate gave an alternative type of product as the major reaction product. Thus, the method appears to be quite general for production of hexathioorthooxalates of types (11) and (12). Since these compounds are readily converted into the corresponding unsymmetrical tetrathiafulvalenes (see following communication), it promises to be a useful synthetic method.

ACKNOWLEDGMENT

We thank the S.E.R.C. for a studentship (to CML).

TABLE I

Syntheses of Hexathioorthooxalates (11) and (12).

R^1 of (8)	Trithiocarbonate	Product[a]	Yield[b]
H	(9, $R^2 = H$)	(11, $R^1 = R^2 = H$)	85%
Me	(9, $R^2 = H$)	(11, $R^1 = Me$, $R^2 = H$)[c]	78%
Me	(9, $R^2 = Me$)	(11, $R^1 = R^2 = Me$)[d]	79%
Cl	(9, $R^2 = Me$)	(11, $R^1 = Cl$, $R^2 = Me$)[d]	89%
Cl	(9, $R^2 = H$)	(11, $R^1 = Cl$, $R^2 = H$)	88%
Me	(10, $R_2 = (CH_2)_3$)	(12, $R^1 = Me$, $R_2 = (CH_2)_3$)	42%
Me	(10, $R_2 = Me_2$)	(12, $R^1 = Me$, $R_2 = Me_2$)	63%
H	(10, $R_2 = H_2$)	(12, $R^1 = H$, $R_2 = H_2$)	—[e]

[a] All products were characterized by ^1H and ^{13}CNMR, mass spectrometry and microanalysis. See also Ref. 10.

[b] Yield of isolated material after crystallization from ether. More product could generally be detected in the mother liquors by TLC.

[c] When this product was prepared from (8, R^1=H) and (9, R^2=Me) (see text), the yield isolated was 73%.

[d] These products are presumably mixtures of two diastereomers, but they were not differentiated by either chromatography or NMR [^1H(100 MHz), or ^{13}C (25.1 MHz)].

[e] The main product arose from metallation of (10, $R_2=H_2$), and no attempt was made to isolate whatever small amount of desired product may have been formed.

REFERENCES

1. See, for example, O. W. Lever, *Tetrahedron* **32**, 1943 (1976); B.-T. Gröbel and D. Seebach, *Synthesis*, 357 (1977).
2. (a) W. D. Woessner, *Chem. Lett.*, 43 (1976); (b) R. E. Damon and R. H. Schlessinger, *Tetrahedron Lett.*, 1561 (1976).
3. D. Seebach, K.-H. Geiss, A. K. Beck, B. Graf, and H. Daum, *Chem. Ber.* **105**, 3280 (1972).
4. D. Seebach, *Chem. Ber.* **105**, 487 (1972).
5. S. Ncube, A. Pelter, and K. Smith, *Tetrahedron Lett.*, 1893 (1979).
6. S. Ncube, A. Pelter, and K. Smith, *Tetrahedron Lett.*, 1895 (1979).
7. S. Ncube, A. Pelter, K. Smith, S. Warren, and P. Blatcher, *Tetrahedron Lett.*, 2345 (1978).
8. P. Beak and J. W. Worley, *J. Am. Chem. Soc.* **94**, 597 (1972).
9. Discussion is beyond the scope of this short communication, but will be given when the full details of the reaction are published.
10. We have ruled out isomeric structures (refer to Ref. 9).
11. J. Nakayama, *Synthesis*, 436 (1975).

(Received in UK 22 December 1983)