

EFFICIENT SYNTHETIC METHODOLOGY FOR
1-(PHENYLTHIO)CYCLOPROPYLSILANES, PRECURSORS OF
1-(LITHIO)CYCLOPROPYLSILANES¹

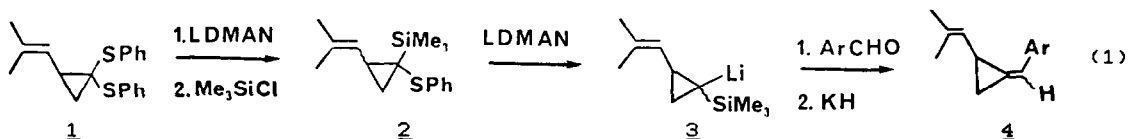
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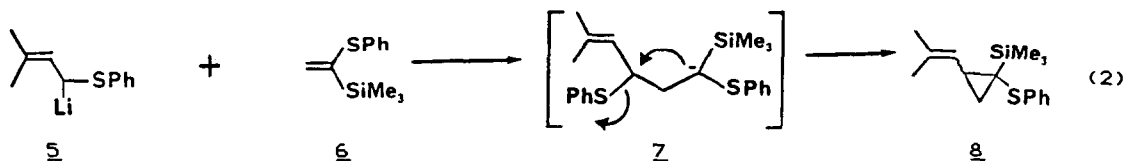
Abstract Two one flask connective methods for preparing 1-(phenylthio)-cyclopropylsilanes, precursors of 1-(lithio)cyclopropylsilanes, are described.

Previous work² from this laboratory demonstrated that reductive lithiation of 1-phenylthio-1-(trimethylsilyl)cyclopropanes (e.g. 2) with 1-(dimethylamino)-naphthalene (LDMAN) produces 1-lithio-1-(trimethylsilyl)cyclopropanes (e.g. 3), which can be readily transformed to synthetically useful alkylidene- and allylidene-cyclopropanes (e.g. 4) when used in the Peterson olefination.³ The substrates for the lithiosilane production were prepared by reductive lithiation of 1,1-bis(phenylthio)cyclopropanes (e.g. 1) followed by silylation (eq 1).



We now report two different one flask connective methods for directly preparing 1-phenylthio-1-(trimethylsilyl)cyclopropanes possessing various substitution patterns. These procedures should render 1-(lithio)-cyclopropylsilanes easily accessible.

One method takes advantage of the discovery⁴ that sulfur stabilized anions are capable of executing an intramolecular S_N2 reaction on a carbon atom at the 3-position resulting in the displacement of a thiophenoxide ion and the production of a cyclopropane ring. We have found that several sulfur stabilized anions (e.g. 5) are capable of nucleophilic attack on 1-phenylthio-1-(trimethylsilyl)ethene (6),⁵ readily available⁶ by deprotonation and silylation of commercial phenyl vinyl sulfide, to generate a new anion (e.g. 7) which undergoes the intramolecular cyclopropanation (eq 2).



The attacking anion was generated by treatment of its conjugate acid with *sec*-butyllithium in THF in the presence of TMEDA at -20 to 0 °C, a THF solution of 6 was added at the same temperature, and the mixture was allowed to warm to ambient temperature over a 3 hour period. In all but one case,⁷ the yields range from satisfactory to excellent (Table).

Previous work from this laboratory had shown that sulfur stabilized anions attack ketene bis(phenylthio)acetal to yield cyclopropanone thioketals by an analogous process.⁸ It is of interest that the allylic anion 9⁹ attacks the ketene thioacetal both at the ring terminus and at the exocyclic terminus (ratio 1:3) whereas the reaction with 6 occurs exclusively at the less hindered exocyclic terminus; presumably, the greater steric bulk of the trimethylsilyl group compared to the phenylthio group is responsible for the greater regioselectivity in the case of 6. The same increase in bulk can explain why anion 10 attacks 6 only at the reflux temperature of THF whereas it attacks ketene thioacetal below room temperature.

The second one flask connective method involves the attack of the deprotonation product 12¹⁰ of phenylthio(trimethylsilyl)methane¹¹ upon an epoxide (e.g. 11) to provide a trans alkoxide (e.g. 13) which, upon treatment with benzenesulfonyl chloride (0 °C, 30 min) followed by *sec*-butyllithium (2 eq) and TMEDA at 0 °C, yields the cyclopropane (e.g. 14, eq 3; Table).¹² Cyclooctene oxide and cyclododecene oxide were resistant to attack by 12 even at the reflux temperature of THF; the adduct of 12 with CuI and BF₃¹³ was also incapable of opening cyclooctene oxide. A similar procedure, using bis(phenylthio)methyl lithium was reported by Seebach for the preparation of certain cyclopropanone thioketals.^{14,15}

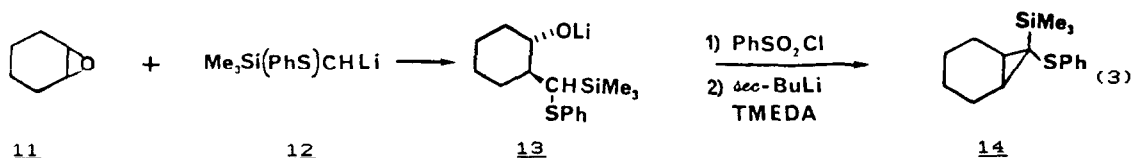
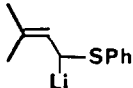
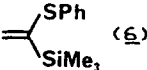
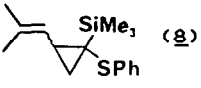
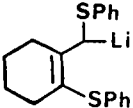

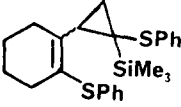
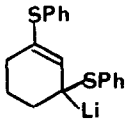

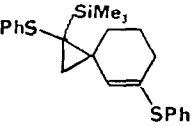
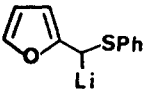






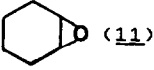
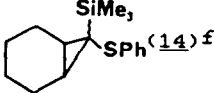




TABLE One-Flask Preparations of 1-Phenylthio-1-(trimethylsilyl)cyclopropanes

Nucleophile	Electrophile	Product ^a	Yield, %
 (5) ^b	 (6)	 (9)	100
 (9) ^b	 6		80
 (10) ^b	 6		88 ^c
 ^d	 6	 e	0
$(\text{PhS})_2\text{CHLi}$	 6		76
$\text{Me}_3\text{Si}(\text{PhS})\text{CHLi}$ (12)	 6		97
<u>12</u>	 (11)	 (14) ^f	69
<u>12</u>			59

^aExcept where otherwise stated, products capable of diastereoisomerism were obtained as mixtures. ^bRef. 8 and citations therein. ^cThe reaction only occurred upon heating at reflux in THF overnight. ^dPrecursor prepared from the alcohol by treatment with diphenyldisulfide and tributylphosphine.¹⁶ ^eSee text. ^fA 3.5:1 mixture of exo-trimethylsilyl to endo-.

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References and Notes

1. Taken in part from the Ph.D. thesis of J.P. Sherbine, University of Pittsburgh, 1985.
2. T. Cohen, J.P. Sherbine, J.R. Matz, R.R. Hutchins, B.M. McHenry, and P.R. Willey, *J. Am. Chem. Soc.*, **106**, 3245 (1984).
3. Another use for these anions has also been briefly explored. L.A. Paquette, K.A. Horn, and G.J. Wells, *Tetrahedron Lett.*, **23**, 259 (1982). L.A. Paquette, G.J. Wells, K.A. Horn, and T.H. Yan, *Tetrahedron* **39**, 913 (1983).
4. T. Cohen and W.M. Daniewski, *Tetrahedron Lett.*, 2991 (1978); T. Cohen and J.R. Matz, *J. Org. Chem.*, **44**, 4816 (1979).
5. Nucleophilic attack on **6**: D.J. Ager, *Tetrahedron Lett.*, **24**, 95 (1983).
6. B. Harirchian and P. Magnus, *J. Chem. Soc., Chem. Commun.*, 522 (1977).
7. We have no explanation for the baffling failure of the anion from 2-(phenylthiomethyl)furan to react at room temperature or at reflux. In the room temperature experiment, the anion was shown to be unchanged by quenching with a deuterium source. Mainly starting material was recovered from the higher temperature run but the reaction mixture was black.
8. T. Cohen, R.B. Weisenfeld, and R.E. Gapinski, *J. Org. Chem.*, **44**, 4744 (1979).
9. Available in three steps from cyclohexanecarboxylic acid. T. Cohen, R.E. Gapinski, and R.R. Hutchins, *J. Org. Chem.*, **44**, 3599 (1979).
10. Methylolithium (1 eq) and TMEDA (1.5 eq) in THF, 1.25 h, 0 °C. This is a variation of a procedure by D.J. Peterson, *J. Org. Chem.*, **33**, 780 (1968).
11. Thioanisole was deprotonated by butyllithium and TMEDA (1 eq each) for 20 min at 0 °C and the anion was treated with trimethylsilyl chloride for 30 min at -78 °C. This is a variation of a procedure of H. Gilman and F. J. Webb, *J. Am. Chem. Soc.*, **62**, 987 (1940).
12. In the case of **10**, the ring closure took 3 h whereas, in the case of cyclopentene oxide, the mixture was stirred overnight.
13. Y. Yamamoto, S. Yamamoto, H. Yatagai, Y. Ishihara and K. Maruyama, *J. Org. Chem.*, **47**, 119 (1982).
14. M. Braun and D. Seebach, *Chem. Ber.*, **109**, 669 (1976).
15. The structures of all new compounds are consistent with their ¹H NMR, IR, and mass spectra and their determined exact masses.
16. I. Nakagawa and T. Hata, *Tetrahedron Lett.*, 1409 (1975).

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