

Alkylation of Enol Silyl Ethers with Vinylthionium Ions generated from 1,1- and 1,3-Bis(phenylthio)propenes.

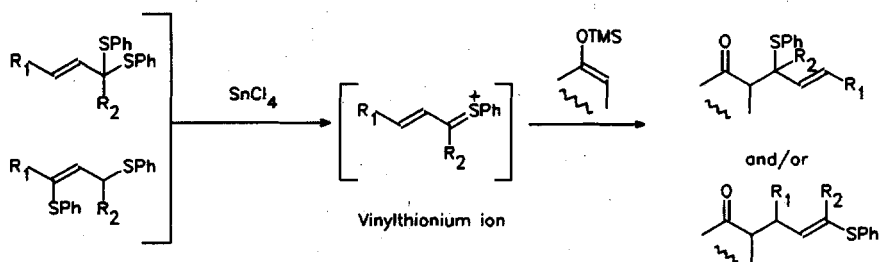
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Abstract: Vinylthionium ions generated from 1,1- and 1,3-bis(phenylthio) propenes alkylate enol silyl ethers regioselectively under mild reaction conditions with tin tetrachloride.



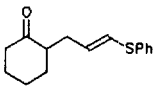

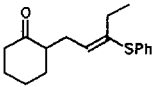
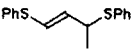
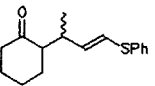
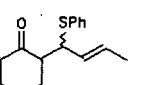
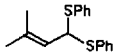
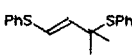
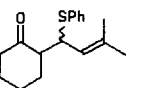
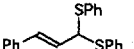
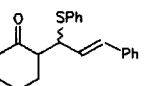

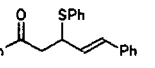

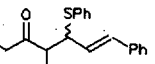
We have previously reported¹ that enol silyl ethers are readily alkylated by vinylthionium ions generated from allylic sulfoxides under Pummerer reaction conditions. However, competing reactions, such as elimination and base-interception, were observed to occur in a number of cases, thus limiting the generality of the reaction^{1,2}. In an attempt to overcome these problems and thus extend the application³ of vinylthionium ions in organic synthesis, we have investigated 1,1- and 1,3-bis(phenylthio)propenes as precursors to these reactive alkylating agents. (Scheme 1). The 1,1-bis(phenylthio)propenes are readily prepared by thioacetalisation of α,β -unsaturated carbonyl compounds (specifically those bearing bulky substituents at the β -carbon) with thiophenol (2 eq.) and phosphorus pentoxide (2 eq.); or by Wittig reactions of 2,2-bis(phenylthio)aldehydes⁴. The 1,3-bis(phenylthio)propenes can also be prepared by the phosphorus pentoxide catalysed addition of thiophenol to α,β -unsaturated carbonyl compounds, or by utilisation of any of a number of previously reported⁵ methods.



Scheme 1

A typical experimental procedure involves treating a dichloromethane solution of the enol silyl ether (1.3 eq.) and the 1,1- or 1,3-bis(phenylthio)propene (1.0 eq.) with 1 equivalent of tin tetrachloride at -20°C for one hour. Subsequent quenching with a saturated sodium bicarbonate solution and extraction with dichloromethane (3 x 30mL) yields a crude mass which is purified by column chromatography to give the pure product as a colourless oil.

Table 1. Reaction of Enol Silyl Ethers with 1,1- and 1,3-Bis(phenylthio)propenes

Entry	1,1- and/or 1,3-bis(phenylthio)propene	Silyl Enol Ether	Product(s) ^{a,b}	Yield ^c
1				20
2		"		42
3		"	 	23 41 → 64
4	 40 : 60 	"		94
5		"		71
6	"			62
7	"			74

a. Where applicable, only the E-isomers were isolated (by 200MHz ^1H NMR)

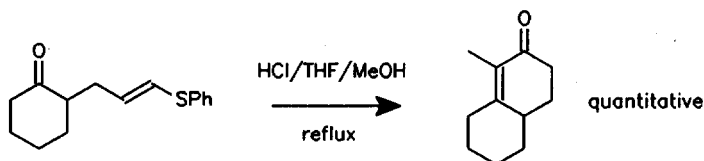
b. Diastereomers were obtained in approximately statistical ratios (by 200MHz ^1H NMR)

c. Isolated yields after column chromatography (8 Hexane : 2 Dichloromethane)

As is evident from Table 1, the alkyl substitution pattern of the vinylthionium species⁶ strongly influences both the yield and the regiochemical outcome of the reaction. Yield increases with alkyl substitution⁷, presumably due to increased stability of the vinylthionium ion, although the yields for entries 1 and 2 may have been reduced by tin tetrachloride or silica-gel induced product decomposition. For example, if 3 equivalents of Lewis acid were used, none of the desired product was isolated. Thus it is important that only a single equivalent of the Lewis acid is added to the reaction mixture to maximise the yield of the desired product. This is contrary to the analogous reactions of simple thioacetals/ketals in which 2-3 equivalents of Lewis acid are often recommended.

Furthermore, as substitution and hence steric bulk at the γ -carbon increases, so alkylation occurs preferentially at the α -carbon to give the allyl sulfides regioselectively (except entry 3).

The products are readily manipulated, using existing methodology, to give compounds of considerable synthetic utility. For example, the vinyl sulfides can be hydrolysed⁸ to give the Robinson annulation products in one step (Scheme 2), and the allylic sulfides can be converted to $\alpha,\beta,\gamma,\delta$ -unsaturated carbonyl compounds by base induced elimination⁹.



Scheme 2

Thus when combined with our earlier efforts in this field^{1,2}, a useful and convenient carbon-carbon bond forming methodology emerges. In addition, this work complements the existing anionic chemistry of bis(alkyl and arylthio)propenes¹¹.

REFERENCES AND NOTES

- (a) R. Hunter and C.D. Simon, *Tetrahedron Lett.*, **1986**, 27, 1385.
 - (b) R. Hunter, L. Carlton, P.F. Cirillo, J.P. Michael, C.D. Simon, and D.S. Walter, *J. Chem. Soc. Perkin Trans. I*, **1989**, 1631.
- R. Hunter and C.D. Simon, *Tetrahedron Lett.*, **1988**, 29, 2257.
- For a recent example see M. Harmata, V.R. Fletcher, and R.J. Claassen II, *J. Am. Chem. Soc.*, **1991**, 113, 9861.

4. (a) R. Verhé, N. de Kimpe, L. de Buyck, and N. Schamp, *Synthesis*, **1984**, 46.
(b) L. Duhamel, J. Chauvin, and A. Messier, *Tetrahedron Lett.*, **1980**, 21, 4171.
5. For example, see: (a) E.J. Corey, B.W. Erickson, and R. Noyori, *J. Am. Chem. Soc.*, **1971**, 93, 1724. (b) T. Cohen, D.A. Bennett, and A.J. Mura, Jr., *J. Org. Chem.*, **1976**, 41, 2506.
6. The Lewis acid activated reactions of enol silyl ethers with thionium ions are postulated to occur via an S_N1 mechanism (See: I. Mori, P.A. Bartlett, C.H. Heathcock, *J. Org. Chem.*, **1990**, 55, 5966). We consider that the enhanced stability of vinylthionium ions can only increase the preference for reaction via such a mechanism.
7. A similar trend has been observed in the reactions of 1-(trimethylsilyloxy)-cyclohexene with selenium stabilised allylic carbocations. L. Hevesi and A. Lavoix, *Tetrahedron Lett.*, **1989**, 30, 4433.
8. T. Takeda, A. Nakayama, T. Furukawa, and T. Fujiwara, *Tetrahedron Lett.*, **1990**, 31, 6685.
9. (a) T. Ishihara, T. Shinozaki, and M. Kuroboshi, *Chem. Lett.*, **1989**, 1362. (b) B.M. Trost and E. Murayama, *J. Am. Chem. Soc.*, **1981**, 103, 6529.
10. Satisfactory analytical and/or spectroscopic data were obtained for all compounds reported.
11. M.R. Myers and T. Cohen, *J. Org. Chem.*, **1989**, 54, 1290, and 5.

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