

1-Trimethylsilylallylic Alcohols as Homoenolate Precursors. Stereo- and Regio-specific Synthesis of Silyl Enol Ethers

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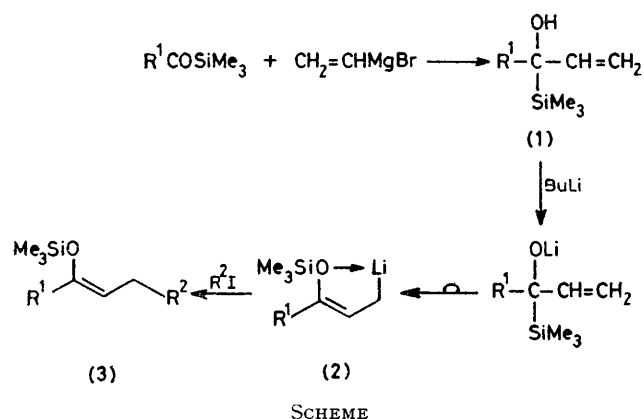
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Summary Silyl enol ethers of ketones can be prepared stereo- and regio-specifically by treating the corresponding 1-trimethylsilylallylic alcohols with butyllithium and alkyl halides.

SILYL enol ethers of ketones are versatile reagents for regioselective carbon chain extension or functionalization of ketones.¹ Recent studies have suggested that the geometry of the double bond of the silyl enol ether sometimes influences the stereochemical outcome of the reaction.² They may be prepared with moderate regioselectivity by generating the corresponding enolate under kinetically or thermodynamically controlled reaction conditions.³ However, when two types of methylene groups are adjacent to the carbonyl group they cannot be differentiated satisfactorily under the reaction conditions employed. This difficulty can be avoided by generating

the homoenolate (**2**; R¹ = alkyl) and then alkylating it. It has been shown⁴ that the homoenolate (**2**; R¹ = H or CH₂=CH-) can be generated easily by treating the parent allylic ethers with *s*-butyl-lithium, although application of a similar procedure to the alkylated allylic ethers proved difficult because of the extremely slow metallation step.

We describe here a general method for the generation of (**2**) from the 1-trimethylsilylallylic alcohols (**1**), which enables us to prepare silyl enol ethers of acyclic ketones in a stereo- and regio-specific manner. Previously, we reported a simple preparative method for acyltrimethylsilanes, RCOsilylMe₃,⁵ which, when treated with vinylmagnesium bromide, afforded the corresponding allylic alcohols (**1**) in over 90% yield. The lithium alkoxides of (**1**) undergo a ready rearrangement of the silyl group to the neighbouring oxide anion⁶ to yield the corresponding homoenolates (**3**) from which the silyl enol ethers (**3**) are formed (Scheme).



A typical experimental procedure was as follows. *n*-Butyl-lithium (2.2 mmol) was added to a hexane (2 ml) solution† of (1) (2 mmol). This was cooled to -78°C and tetrahydrofuran (THF) (10 ml) was added followed by an appropriate alkyl iodide (2.4 mmol) in THF (2 ml) and stirring for 2–3 h at -40°C . The mixture was then diluted with hexane (40 ml) pre-cooled to -78°C , and was quenched with buffer (KH_2PO_4 – NaOH) solution. From

the organic layer, the desired silyl enol ether (3) was isolated in good yield by column chromatography.‡

The geometry of silyl enol ether (3; $\text{R}^1 = \text{Pr}^n$, $\text{R}^2 = \text{Me}$) was confirmed by comparison with an authentic sample.⁷ G.l.c. and n.m.r. analysis of the product showed it to be >99.5% *Z*-isomer. High stereo- and regio-specific formation of other silyl enol ethers was obtained as shown by the chemical shifts^{2b,3a,7} of their vinylic protons (see Table).

TABLE^a

| R^1 | R^2 | Yield % of (3) | Chemical shift (δ) of vinylic proton |
|----------------------------|---------------|----------------|---|
| Pr^n | Me | 63 | 4.35 |
| Pr^n | Bu^n | 66 | 4.34 |
| PhCH_2CH_2 | Me | 74 | 4.36 |
| PhCH_2CH_2 | Bu^n | 70 | 4.37 |
| C_9H_{19} | Me | 66 | 4.37 |
| C_9H_{19} | Bu^n | 72 | 4.35 |

^a Satisfactory spectral and analytical data were obtained for all products.

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† In THF, the alcohol (1) cannot be lithiated satisfactorily because of extremely rapid rearrangement of the silyl group.

‡ The dimeric product of (2), $\text{R}^1\text{CO}[\text{CH}_2]_4\text{COR}^1$, was also formed in ca. 20% yield as a by-product, from which (3) was separated cleanly.

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