Pergamon

Tetrahedron Letters, Vol. 35, No. 30, pp. 5453-5456, 1994
Elsevier Science Ltd
Printed in Great Britain
0040-4039/94 $7.00+0.00

0040-4039(94)01081-1

Sulfur Ylide Vinylation of Halides and Mesylates

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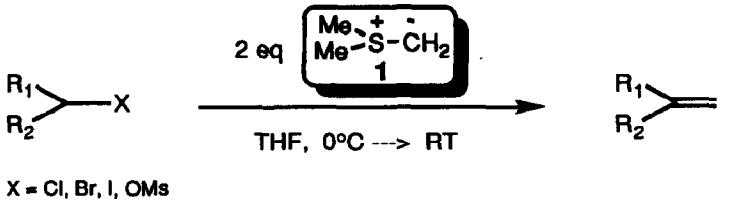
Abstract: *One-carbon homologation of benzylic, allylic, propargylic and primary halides or mesylates with dimethylsulfonium methylide affords terminal olefins in good to excellent yields.*

Dimethylsulfonium methylide **1** is widely utilized for the conversion of ketones and aldehydes to epoxides[1] or ketones to allylic alcohols[2]. In the preceeding communication, we reported that further reaction of epoxides with additional **1** leads to the corresponding homologated allylic alcohols[3]. Alkylations of sulfonium ylides with alkyl halides, on the other hand, are relatively rare and have limited synthetic applications[4]. Herein, we describe a convenient, one-pot transformation of halides and mesylates to terminal alkenes[5] using excess **1** (Scheme 1).

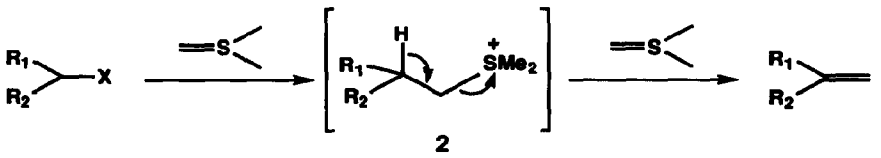


Scheme 1

The scope of the vinylation is summarized in Table 1. We found that exposure of 1-bromopentadecane to excess **1** at ambient temperature in THF resulted in a complex product mixture from which 1-hexadecene and 1-pentadecene were obtained in a combined 70% yield. However, side

reactions including simple elimination of HBr from the starting material could be completely suppressed using **1** in combination with an equivalent amount of LiI, affording 1-hexadecene[6] in 92% yield (entry 1). The reaction was compatible with several common protective groups (entries 2, 3 and 4). In the case of homobenzylic halide (entry 5), 4-allylanisole is formed preferentially. Both primary (entry 6) and secondary (entry 7) benzyl bromides homologated smoothly, even without LiI. Allylic derivatives behaved analogously to furnish useful yields of diene from the mesylate (entry 8), chloride (entry 9), and bromide (entries 10 and 11). The latter example was completely regiospecific and the product showed no tendency toward in-chain isomerization under the reaction conditions. Propargylic bromides led to the corresponding enyne in good yield (entry 12). Generally, sterically hindered systems (entry 13) proved sluggish, whereas, unactivated secondary halides/mesylates were refractory and represent a limitation of the methodology. Attemps to react **1** with α-bromoethers, α-iodostannanes or α-bromoesters failed also.

A mechanistic explanation for the observed vinylations is presented in Scheme 2. Initial displacement to give sulfonium salt **2** is followed by proton abstraction from one of the methyls, possibly by equilibrium exchange with excess ylide. E_2-type elimination via an intermolecular process or an internal cyclic intermediate gives rise to the product. Partial corroboration for this hypothesis was achieved using preformed dimethylpentadecyl sulfonium salt which readily eliminated to 1-pentadecene when treated with **1**.



2

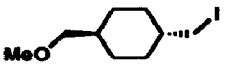
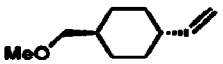
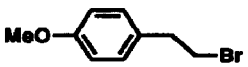
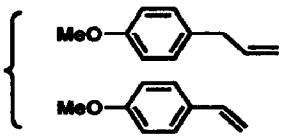
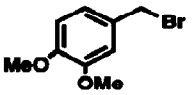
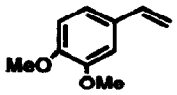
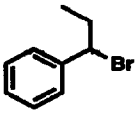
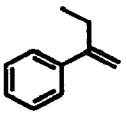
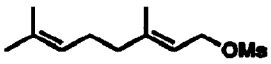
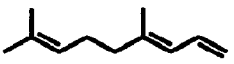
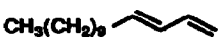
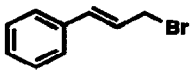
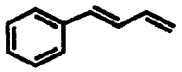
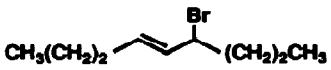
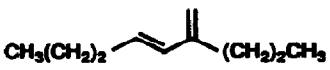
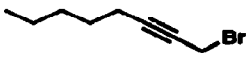
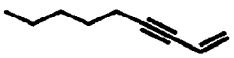
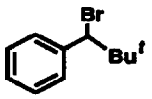
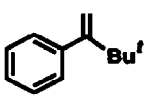
Scheme 2

Representative Procedure

To a 0°C suspension of trimethylsulfonium iodide (4 equiv, 1.36 mmol, 278 mg) and LiI (3.7 equiv, 1.26 mmol, 168 mg) in THF (5 ml) was added n-BuLi (3.7 equiv, 1.26 mmol, 0.79 ml of 1.6M hexane solution). After 30 min, 1-bromopentadecane (1.0 equiv, 0.34 mmol, 100 mg) in THF (1 ml) was introduced and the mixture was allowed to stir at ambient temperature overnight. Quenching with sat. NH_4Cl solution, ethereal extraction, concentration of the combined extracts, and passage of the residue through a pad of silica gel using hexane gave 1-heptadecene (70 mg, 92%) as a colorless oil identical in all respects with an authentic sample.

Acknowledgments: Supported financially by ARC (France), NIH (GM31278) and the Robert A. Welch Foundation (I-782). L.A. thanks MRT and J.H. the CNRS for fellowships. We are grateful to Mr A. Valleix for the mass spectroscopy analysis.

Table 1. Vinylation of Halides and Mesylates

Entry	Substrate	Product	Yield (%)*
1			92
2			80
3			87
4			80
5			70 18
6			95
7			72
8			85
9			89
10			86
11			93
12			90
13			15**

* isolated yields
** recovered starting material 80%

References and Notes

1. For example: Corey, E.J.; Chaykovsky, M. *J. Am. Chem. Soc.* **1965**, *87*, 1353-1364; Borredon, E.; Delmas, M.; Gaset, A. *Tetrahedron Lett.* **1982**, *23*, 5283-5286; Merz A.; Märkl, G. *Angew. Chem. Int. Ed.* **1973**, *12*, 845-846.

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4. Trost, B.M.; Melvin, L.S. **Sulfur Ylides, Emerging Synthetic Intermediates**, Academic Press, N.,Y.; 1975.

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6. All compounds were fully characterized by NMR (^1H,^{13}C), mass spectroscopy and combustion analysis. Spectral data for **2**: ^1H NMR (200 MHz, $CDCl_3$) δ 5.95-5.74 (m, 1H), 5.10 (d, J=15.7 Hz, 1H), 5.03 (d, J=9.8 Hz, 1H), 4.60 (t, J= 3.1 Hz, 1H), 4.00-3.60 (m, 2H), 3.60-3.25 (m, 2H), 2.36 (q_{app}, J_{app}=6.8 Hz, 2H), 1.90-1.20 (m, 6H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 135.2, 116.1, 98.7, 66.7, 62.2, 34.1, 30.6, 25.4, 19.5. **3**: ^1H NMR (200 MHz, $CDCl_3$) δ 6.00-5.50 (m, 3H), 5.02 (d, J=14.7 Hz, 1H), 4.97 (d, J=7.9 Hz, 1H), 4.63 (s, 2H), 4.00 (d, J=5.8 Hz, 2H), 3.37 (s, 3H), 2.18-2.12 (m, 4H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 138.0, 134.0, 126.3, 114.7, 95.4, 67.8, 55.1, 33.1, 31.6. **4**: ^1H NMR (200 MHz, $CDCl_3$) δ 5.78 (ddd, J=17.2, 11.3 and 6.5 Hz, 1H), 4.96 (d, J=17.2 Hz, 1H), 4.89 (d, J=11.3 Hz, 1H), 3.33 (s, 3H), 3.19 (d, J=6.4 Hz, 2H), 2.10-1.72 (m, 5H), 1.70-1.40 (m, 1H), 1.25-0.85 (m, 4H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 144.5, 111.8, 78.7, 58.8, 41.8, 37.7, 31.9 (2C), 29.5 (2C). **7**: ^1H NMR (200 MHz, $CDCl_3$) δ 7.50-7.23 (m, 5H), 5.31 (s, 1H), 5.09 (s, 1H), 2.55 (q, J= 6.5 Hz, 2H), 1.40 (t, J=6.5 Hz, 3H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 150.1, 141.6, 128.2 (2C), 127.1, 126.0 (2C), 110.9, 28.1, 12.9. **10**: ^1H NMR (200 MHz, $CDCl_3$) δ 7.48-7.20 (m, 5H), 6.83 (dd, J=15.5 and 10.3 Hz, 1H), 6.85 (d, J=15.5 Hz, 1H), 6.54 (ddd, J= 17.2, 10.3, 10.3 Hz, 1H), 5.34 (d, J= 17.2 Hz, 1H), 5.20 (d, J= 10.3 Hz, 1H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 137.1 (2C), 132.8, 129.6, 120.5 (2C), 127.6, 126.4 (2C), 117.5. **11**: ^1H NMR (200 MHz, $CDCl_3$) δ 6.07 (d, J=15.8 Hz, 1H), 5.71 (dt, J=15.8 and 6.9 Hz, 1H), 4.89 (s, 1H), 4.85 (s, 1H), 2.24-1.95 (m, 4H), 1.62-1.31 (m, 4H), 1.04-0.84 (m, 6H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 146.2, 132.3, 129.9, 112.9, 34.9, 34.4, 22.6, 21.4, 14.0, 13.7. **12**: ^1H NMR (200 MHz, $CDCl_3$) δ 5.75 (ddt, J=17.5, 10.6 and 2.0 Hz, 1H), 5.55 (dd, J=17.5 and 2.6 Hz, 1H), 5.38 (dd, J=10.6 and 2.6 Hz, 1H), 2.31 (td, J= 6.9 and 2.0 Hz, 2H), 1.68-1.16 (m, 6H), 0.91 (t, J=7.0 Hz, 3H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 125.2, 117.6, 91.1, 79.2, 31.0, 28.3, 22.2, 19.2, 13.9.

(*Received in France* 10 *March* 1994; *accepted* 3 *June* 1994)