

## Note

### Synthesis of bistrimethylsilylated hydroxy alkynes

M Bolourtchian <sup>a</sup>, R Zadmard <sup>a</sup> & M R Saidi <sup>\* b</sup>

<sup>a</sup>Chemistry & Chemical Engineering Research Center of Iran,  
P.O. Box 14355-186, Tehran, I R Iran.

<sup>b</sup>Chemistry Department, Sharif University of Technology,  
P.O. Box 11365-8693, Tehran, I R of Iran

Received 7 February 1997; accepted (revised) 21 January 1998

Synthesis of several bistrimethylsilyl and a tris(trimethylsilyl) hydroxyalkynes **2** is described. Addition of lithium trimethylsilylacetylene to mono- or bistrimethyl-silylated aldehyde and ketones (**1**) followed by work-up of the reaction mixture affords the desired compounds **2a-f** with good to moderate yields. The products are mixtures of diastereomers with diastereoselectivity of 50 to 68%.

Alkynols having the terminal alkynyl carbon protected with a trimethylsilyl (TMS) group are conveniently and widely used as organic synthons due to their reactivity and large variety of related synthetic transformation. Many of these silylated alkynols are biologically active, and the development of synthetic reaction is an area of active study<sup>1-5</sup>.

It is well known that silicon groups are readily, but discriminately cleaved from carbons. Terminal trimethyl-silyl group can be removed selectively in bistrimethylsilylated alkynols for further transformation.

The synthesis of silylated aldehydes and ketones has been reported earlier<sup>6-10</sup>. In this article we wish to report a mild and efficient conversion of silylated aldehyde and ketones to bis-silylated alkynols having the terminal alkynyl carbon with a TMS-group. Silylated aldehydes and ketones were prepared by different methods as racemic mixtures.

Treatment of a variety of silylated aldehydes or ketones with lithium trimethylsilylacetylide at room temperature under an atmosphere of argon furnished the expected bistrimethylsilylated alkynols **2a-f** in good to

moderate yields. Both sterically hindered and conjugated silylated aldehydes or ketones were suitable substrates (entries 3, 5 and 6), as were dialkyl and arylalkyl silylated ketones (entries 1, 2). In the case of alkynols **2a-d**, mixtures of two diastereomers were obtained with diastereoselectivity of 50 to 68%. The facial selectivity was interpreted as a result of bulky substituted groups in  $\alpha$ - or  $\beta$ -positions. The results are shown in **Table I**.

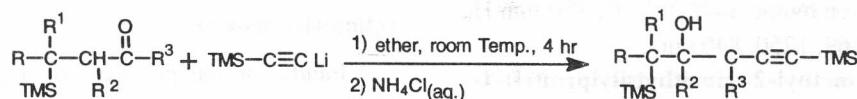
### Experimental Section

**General.** Diethyl ether was distilled from Na/benzophenone under argon atmosphere. <sup>1</sup>H NMR and <sup>13</sup>C NMR spectra were recorded on a Bruker Ac 80 spectrometer in CDCl<sub>3</sub>. IR spectra were recorded on a Perkin-Elmer model 883. The diastereoselectivity was determined by <sup>1</sup>H NMR analysis.

**General procedure for the preparation of bistrimethyl-silyl alkynols 4.** Ketone or aldehyde (2 mmoles) was dissolved in 5 mL anhydrous diethyl ether, and the mixture placed in a three-necked flask, equipped with a magnetic stirrer and a condenser. Thereafter, 0.23 g (2.2 mmoles) of 56% solution of lithium trimethylsilylacetylide in THF was added during 30 min at room temperature under an atmosphere of argon. After stirring for an additional 2 hr at room temperature, 0.15 g (3 mmoles) of powdered ammonium chloride was added, and the whole mixture stirred overnight. Water (20 mL) was added and the organic material extracted with ether (2 × 20 mL). The organic layer was dried over CaCl<sub>2</sub>, and the solvent evaporated. The pure material was obtained by bulb-to-bulb (kugelrohr) distillation. All the new products showed satisfactory C and H analyses. <sup>1</sup>H NMR and <sup>13</sup>C NMR of the major diastereomer are given in **Table II**.

**3,5-Diphenyl-1,5-bistrimethylsilyl-pent-1-yn-3-ol 4a:** A yellow viscous liquid after distillation using kugelrohr distillation unit (oven temperature 100 °C, 150 mm Hg); IR (film): 3485, 2164, 1250, 845 cm<sup>-1</sup>.

**3-Methyl-5-phenyl-1,5-bistrimethylsilylpent-1-yn-3-ol 4b:** A colourless viscous liquid, after distillation using kugelrohr distillation unit (oven temperature 100 °C, 150 mm Hg); IR (film): 3421,



**Table I** — Products from the reaction of lithium trimethylsilylacetylide with silylated aldehydes and ketones .

Entry	Starting material				Product	Yield (%)	Ratio of diastereomers
	R	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>			
1.	ph	H	H	ph	$\text{Ph}-\underset{\text{TMS}}{\text{CH}}-\text{CH}_2-\underset{\text{Ph}}{\overset{\text{OH}}{\text{C}}}-\text{C}\equiv\text{C}-\text{TMS}$ <b>(2a)</b>	75	59:41
2.	ph	H	H	CH <sub>3</sub>	$\text{Ph}-\underset{\text{TMS}}{\text{CH}}-\text{CH}_2-\underset{\text{CH}_3}{\overset{\text{OH}}{\text{C}}}-\text{C}\equiv\text{C}-\text{TMS}$ <b>(2b)</b>	70	68:32
3.	ph	H	CH <sub>3</sub>	CH <sub>3</sub>	$\text{Ph}-\underset{\text{TMS}}{\text{CH}}-\underset{\text{CH}_3}{\text{CH}}-\underset{\text{CH}_3}{\overset{\text{OH}}{\text{C}}}-\text{C}\equiv\text{C}-\text{TMS}$ <b>(2c)</b>	65	53:47
4.	ph	H	CH <sub>3</sub>	CH <sub>3</sub>	$\text{Ph}-\underset{\text{TMS}}{\text{CH}}-\text{CH}_2-\underset{\text{CH}_3}{\overset{\text{OH}}{\text{C}}}-\text{C}\equiv\text{C}-\text{TMS}$ <b>(2d)</b>	55	59:41
5.	CH <sub>3</sub>	CH <sub>3</sub>	H	$\text{CH}_2=\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}$	$\text{CH}_3-\underset{\text{TMS}}{\overset{\text{CH}_3}{\text{C}}}-\text{CH}_2-\underset{\text{C}\equiv\text{C}-\text{TMS}}{\overset{\text{OH}}{\text{C}}}-\underset{\text{CH}_3}{\text{CH}}=\underset{\text{CH}_3}{\text{C}}$ <b>(2e)</b>	66	—
6.	CH <sub>3</sub>	CH <sub>3</sub>	H	$\text{CH}_2-\underset{\text{TMS}}{\overset{\text{CH}_3}{\text{C}}}-\text{CH}_3$	$\text{CH}_3-\underset{\text{TMS}}{\overset{\text{CH}_3}{\text{C}}}-\text{CH}_2-\underset{\text{C}\equiv\text{C}-\text{TMS}}{\overset{\text{OH}}{\text{C}}}-\text{CH}_2-\underset{\text{TMS}}{\overset{\text{CH}_3}{\text{C}}}-\text{CH}_3$ <b>(2f)</b>	62	—

2165, 1249, 840 cm<sup>-1</sup>.

**2,4-Dimethyl-5-phenyl-1,5-bis(trimethylsilyl)pent-1-yne-3-ol 4c:** A pale yellow viscous liquid, after distillation using kugelrohr distillation unit (oven temperature 100 °C, 150 mm Hg); IR (film): 3441, 2165, 1252, 847 cm<sup>-1</sup>.

**5-Phenyl-1,5-bis(trimethylsilyl)pent-1-yne-3-ol 4d:** A brown liquid, after distillation using kugelrohr distillation unit (oven temperature 100 °C, 150 mm Hg); IR (film): 3397, 2169, 1250, 840 cm<sup>-1</sup>.

**6-Methyl-3-(2-methyl-2-trimethylsilylpropyl)-4-hexene-1-yne-3-ol 4e:** An orange viscous liquid, after

distillation using kugelrohr distillation unit (oven temperature 100 °C, 150 mm Hg); IR (film): 3429, 2163, 1250, 840 cm<sup>-1</sup>.

**5-Methyl-5-trimethylsilyl-3-(2-methyl-2-trimethylsilylpropyl)hex-1-yne-3-ol 4f:** A dark yellow viscous liquid, after distillation using kugelrohr distillation unit (oven temperature 100 °C, 150 mm Hg); IR (film): 3440, 2060, 1250, 839 cm<sup>-1</sup>.

#### Acknowledgement

Funds for the purchase of a gas chromatograph [Volkswagen-Stiftung, Federal Republic of Germany] is

**Table II** —  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectral data of bis- and tris-trimethylsilylated alkynols **2**

Compd	$^1\text{H}$ NMR ( $\text{CDCl}_3$ ), $\delta$ , ppm	$^{13}\text{C}$ NMR ( $\text{CDCl}_3$ ), $\delta$ , ppm
<b>2a</b>	0.00 (s, 9H), 0.24 (s, 9H), 2.16 (s, 1H), 2.84 (d of d, $J=8.9$ , 3.8 Hz, 1H), 3.38-3.55 (m, 2H), 6.70-7.88 (m, 10H).	-2.84 ( $\text{CH}_3$ ), 0.15 ( $\text{CH}_3$ ), 32.50 (CH), 45.39 ( $\text{CH}_2$ ), 74.62 (C), 90.66 (C), 125.91 (CH), 127.95 (CH), 128.17 (CH), 128.60 (CH), 129.63 (CH), 131.71 (CH), 143.97 (C), 144.56 (C).
<b>2b</b>	0.04 (s, 9H), 0.14 (s, 9H), 1.22 (s, 3H), 2.18 (s, 1H), 2.25-2.75 (m, 3H), 6.90-7.40 (m, 5H).	3.11 ( $\text{CH}_3$ ), -0.10 ( $\text{CH}_3$ ), 29.86 ( $\text{CH}_3$ ), 33.39 (CH), 43.28 ( $\text{CH}_2$ ), 70.25 (C), 109.62 (C), 113.17 (C), 124.36 (CH), 127.69 (CH), 128.52 (CH), 143.51 (C).
<b>2c</b>	0.08 (s, 9H), 0.22 (s, 9H), 0.99 (d, $J=4.1$ , Hz, 1H), 1.31 (d, $J=7.1$ Hz, 3H), 1.58 (s, 3H), 2.13-2.39 (m, 1H), 2.05 (s, 1H), 7.22 (s, 5H).	-1.17 ( $\text{CH}_3$ ), -0.01 ( $\text{CH}_3$ ), 14.06 ( $\text{CH}_3$ ), 27.61 ( $\text{CH}_3$ ), 38.70 (CH), 44.69 (CH), 72.99 (C), 103.11 (C), 107.70 (C), 124.95 (CH), 127.69 (CH), 130.73 (CH), 141.44 (C).
<b>2d</b>	0.00 (s, 9H), 0.22 (s, 9H), 1.82-2.01 (m, 1H), 2.13 (s, 1H), 3.72 (t, $J=4.5$ Hz, 1H), 4.02-4.38 (dd, $J=8.51$ , 1H), 7.15 (s, 5H).	-2.97 ( $\text{CH}_3$ ), -0.01 ( $\text{CH}_3$ ), 33.57 (CH), 60.67 ( $\text{CH}_2$ ), 78.62 (C), 106.98 (C), 124.47 (CH), 127.58 (CH), 128.29 (CH), 142.53 (C).
<b>2e</b>	0.00 (s, 9H), 0.18 (s, 9H), 0.94 (s, 6H), 1.52 (s, 1H), 1.74 (d, $J=1.4$ Hz, 3H), 1.86 (s, 2H), 1.92 (d, $J=1.19$ Hz, 3H), 5.39 (m, 1H).	-4.46 ( $\text{CH}_3$ ), -0.45 ( $\text{CH}_3$ ), 18.72 ( $\text{CH}_3$ ), 22.88 ( $\text{CH}_3$ ), 26.78 ( $\text{CH}_3$ ), 49.14 ( $\text{CH}_2$ ), 69.79 (C), 103.50 (C), 110.33 (C), 131.14 (CH), 134.49 (C).

**Table II** - *Contd***Table II** —  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectral data of bis- and tris-trimethylsilylated alkynols **2**— *Contd*

Compd	$^1\text{H}$ NMR ( $\text{CDCl}_3$ ), $\delta$ , ppm	$^{13}\text{C}$ NMR ( $\text{CDCl}_3$ ), $\delta$ , ppm
<b>2f</b>	0.00 (s, 18H), 0.17 (s, 9H), 1.02 (s, 12H), 2.17 (s, 4H), 2.28 (s, 1H)	-4.17 ( $\text{CH}_3$ ), -0.49 ( $\text{CH}_3$ ), 23.47 ( $\text{CH}_3$ ), 30.67 (C), 49.99 ( $\text{CH}_2$ ), 73.06 (C), 103.52 (C), 110.34 (C).

**Acknowledgement**

Funds for the purchase of a gas chromatograph [Volkswagen-Stiftung, Federal Republic of Germany] is gratefully acknowledged. We thank Mr M M Mojtahedi for the preparation of starting materials.

**References**

- Bridges A J, Fedij V & Turowski E C, *Chem Commun*, **1983**, 1093.
- Kuroda S, Katsuki T & Yamaguchi M, *Tetrahedron Lett*, **28**, **1987**, 803.
- Pornet J, Damour D, Randrianoelina B & Miginia, L, *Tetrahedron*, **42**, **1986**, 2501.
- Lautens M & Huboux A H, *Tetrahedron Lett*, **42**, **1990**, 3105; Soai K, *Chem Abstr*, **113**, **1990**, 171485t.
- Lutjens H, Nowotny S & Knochel P, *Tetrahedron Asymmetry*, **6**, **1995**, 2675.
- Calas R, Dounogues J & Bolourtchian M, *J Organometallic Chem*, **26**, **1971**, 195.
- Dounogues J, Calas R, Bolourtchian M, Biran C & Duffaut N, *J Organometallic Chem*, **57**, **1973**, 55.
- Dounogues J, Bolourtchian M, Calas R, Duffaut N & Picard J, *J Organometallic Chem*, **43**, **1972**, 157.
- Boulourtchian M & Saednya A, *J Sci I R Iran*, **1**, **1990**, 277.
- Boulourtchian M & Saednya A, *Bull Soc Chem Fr*, **11**, **1978**, 170.