A Simple Synthesis of 3-Tributylstannylfuran and 3-Lithiofuran

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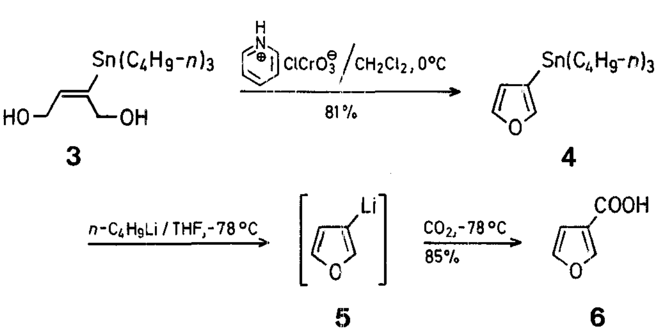
3-Tributylstannylfuran is prepared in two steps from 2-butyne-1,4-diol.

3-Substituted furans, although abundant in nature[1], have long been tiresome to make or expensive to buy[2]. We now report a simple, two-step synthesis of 3-tributylstannylfuran (**4**), which can easily be converted into 3-lithiofuran (**5**), and hence into a wide variety of 3-substituted furans.

The key reaction is the addition of Piers' stannyl-cuprate reagent[3] (**2**) to 2-butyne-1,4-diol (**1**), a very cheap starting material. The presumed vinyl-copper intermediate is quenched by the hydroxy groups, as in Piers' work with 1-alkynes and with acetylenes carrying an electron-withdrawing substituent, where alcoholic solvents achieved the same end[3]. The result is stereospecific *syn*-addition to give the (*E*)-stannylbutenediol **3** in 62% yield. Oxidation[4] with pyridinium chlorochromate gave the furan **4** directly in 81% yield. The 3-stannylfuran **4** is an excellent precursor for 3-lithiofuran (**5**), the conversion taking just over one hour with *n*-butyllithium at −78 °C in tetrahydrofuran. 3-Lithiofuran is then a convenient reagent for the synthesis of 3-substituted furans in general, either directly[5] or by way of the corresponding cuprate[6]. The present synthesis is easy, and cheap compared with syntheses based on commercially available 3-bromofuran[7]. Furthermore, substituents can be introduced directly onto the 3-position of 3-stannylfurans using Stille's reaction[8], which avoids the need for the metallation step (**4** → **5**).



An alternative and cheaper synthesis of **3** might have been available if the addition (**1** → **3**) could have been done using hydrostannylation. However, this always gave mixtures of the (*E*)- and (*Z*)-isomers of **3**, of which only the minor (*E*)-isomer (**3**) gave the furan (**4**) on oxidation. Equilibration of the mixture was also useless, because it only led to an increase in the proportion of the unwanted (*Z*)-isomer.

2-Tributylstannyl-2-butene-1,4-diol (3):

Lithium diisopropylamide (52 mmol) in tetrahydrofuran (100 ml) and tributyltin hydride (15 g, 51 mmol) are stirred at 0 °C for 30 min. The mixture is then cooled to −50 °C and copper(I) bromide/dimethyl sulphide complex (10.6 g, 51 mmol) added in small portions. The dark red solution is kept at −50 °C for 30 min, and then cooled to −78 °C. 1,4-Butynediol (**1**; 4.6 g, 53 mmol) in tetrahydrofuran (20 ml) is added slowly with stirring and the mixture kept at −78 °C for 6–8 h. Ammonium chloride solution (2 ml) is added, the mixture brought to room temperature, poured into ether (400 ml), and stirred for 5 h. The black precipitate is filtered off through silica gel, and the solution dried with magnesium sulphate and evaporated. Hexane (30 ml) is added to the residue to precipitate unreacted diol. After filtration, the solvent is again evaporated off, and the remaining product purified by flash chromatography, eluting with hexane/ethyl acetate (1/1) to give the diol **3** as a yellow oil; yield: 12.1 g (62%).

$C_{16}H_{34}O_2Sn$	calc.	C 50.94	H 9.02
(377.1)	found	51.05	8.96

I.R. (liquid film): ν = 3200, 2860, 840 cm^{-1}

^{1}H-N.M.R. ($CDCl_3$/TMS_{int}): δ = 0.8–1.7 (27 H); 3.2 (br.s, 2 H); 4.20 (d, J = 6 Hz, 2 H); 4.38 (s, 2 H); 5.85 ppm (t, J = 6 Hz, $J_{^{119}Sn,H}$ = 69 Hz, 1 H).

3-Tributylstannylfuran (4):

The stannylbutendiol **3** (4.5 g, 12 mmol) is stirred with pyridinium chlorochromate (4.15 g, 19.2 mmol) in dichloromethane (100 ml) at 0 °C for 15 min, and the mixture then poured into light petroleum (200 ml, b.p. 40–60 °C). A dark brown precipitate is filtered off through silica gel, the solvent evaporated off, and the residue purified by flash chromatography eluting with hexane to give product **4**; yield: 3.45 g (81%); b.p. 109–111 °C/0.6 torr.

$C_{16}H_{30}OSn$	calc.	C 53.83	H 8.47
(357.1)	found	53.57	8.41

^{1}H-N.M.R. (CCl_4/TMS_{int}): δ = 0.7–1.7 (27 H); 6.22 (m, 1 H); 7.08 (m, 1 H); ppm 7.45 (m, 1 H).

3-Lithiofuran (5) and Furan-3-carboxylic Acid (6):

3-Tributylstannylfuran (**4**; 0.5 g, 1.4 mmol) and butyllithium (1.4 mmol) are stirred in tetrahydrofuran (2 ml) at −78 °C for 80 min to give a solution of *3-lithiofuran* (**5**). Solid carbon dioxide (2 g) is introduced with stirring, the mixture is allowed to come to room temperature, and the solvent is evaporated to give *furan-3-carboxylic acid* (**6**); yield: 135 mg (85%); m.p. 116–118 °C (Ref.[9], m.p. 117–119 °C).

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[1] Dean, F.M. *Naturally Occurring Oxygen Ring Compounds*, Butterworth, London, 1963.

[2] *J. Org. Chem.* **1984**, *49*, back cover of issue No. 22 (2nd November 1984).

[3] Piers, E., Roztou, H.E. *J. Org. Chem.* **1980**, *45*, 4264.
Piers, E., Chong, J.M. *J. Org. Chem.* **1982**, *47*, 1604; *J. Chem. Soc. Chem. Commun.* **1983**, 934.
see also: Hibino, J., Matsubara, S., Morizawa, Y., Oshima, K., Nozaki, H. *Tetrahedron Lett.* **1984**, *25*, 2151.

[4] cf. Nishiyama, H., Sesaki, M., Itoh, K. *Chem. Lett.* **1981**, 1363.

[5] See, for example: Gronowitz, S., Sörlin, G. *Acta Chem. Scand.* **1961**, *15*, 1419.

[6] Yojima, Y., Wakita, S., Koto, N. *Tetrahedron Lett.* **1979**, 4577.

[7] We estimate that the cost of the reagents needed to prepare one mol of **3** would be £ 170, whereas one mol of 3-bromofuran costs £ 554.

[8] Shelly, F.K., Godschalx, J.P., Stille, J.K. *J. Am. Chem. Soc.* **1984**, *106*, 4833.

[9] Deady, L.V., Shouks, R.A. *Synthesis* **1972**, 571.