chloro-3-methyl-1-butyn-3-ol, 29552-15-6; methylmagnesium iodide, 917-64-6.

## References and Notes


(1) H. S. Rhinesmith, *J. Org. Chem.*, **40**, 1773 (1975).
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(3) D. D. Coffman, "Organic Syntheses", Collect. Vol. III, Wiley, New York, N.Y., 1955, p 320.
(4) Eu(fod)$_3$ = tris(1,1,1,2,2,3,3-heptafluoro-7,7-dimethyl-4,6-octadionato)-europium(III). For a general account on lanthanide shift reagents see A. F. Cockerill, G. L. O. Davies, R. C. Harden, and D. M. Rackham, *Chem. Rev.*, **73**, 553 (1973).
(5) M. Julia and J. M. Surzur, *Bull. Soc. Chim. Fr.*, 1615 (1956).
(6) The mode of formation of **8** is not clear at the moment. A blank reaction of alcohol **1** with excess methylmagnesium iodide gave no trace (<0.1%) of **8** upon workup with ammonium chloride.


# Lithiation of 4,4-Dimethyl-2-(2-thienyl)-2-oxazoline


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Numerous aromatic substituents with ortho-directing metalation abilities have been reported and their synthetic potential has been discussed.[1] The knowledge of the relative directing effect of these groups has become increasingly important for synthetic planning. For the benzene ring, a relative order of ortho-directing strength for some of these substituents has been recently established.[2] In heteroaromatic compounds, the ortho-directing group competes with the heteroatom in the aromatic ring for the site of metalation. Slocum and co-workers have recently reported[3] that the lithiation of thiophene substituted at the 2 position with strong ortho directors, such as carboxamides, sulfonamides, and dimethylaminomethyl groups, leads to metalation at the 5 position ($\alpha$-lithiation) rather than the 3 position (ortho lithiation) of the thiophene nucleous. Kauffman and co-workers, on the other hand, observed[4] that the lithiation of 2-(2-pyridyl)-thiophene leads to mixtures of 3- and 5-lithiothiophene derivatives and that the product ratio is greatly affected by the solvent of the lithiation reaction. We wish now to report that the metalation of 2-(2-thienyl)-2-oxazoline **1** in ether proceeds predominantly ortho to the oxazoline group.

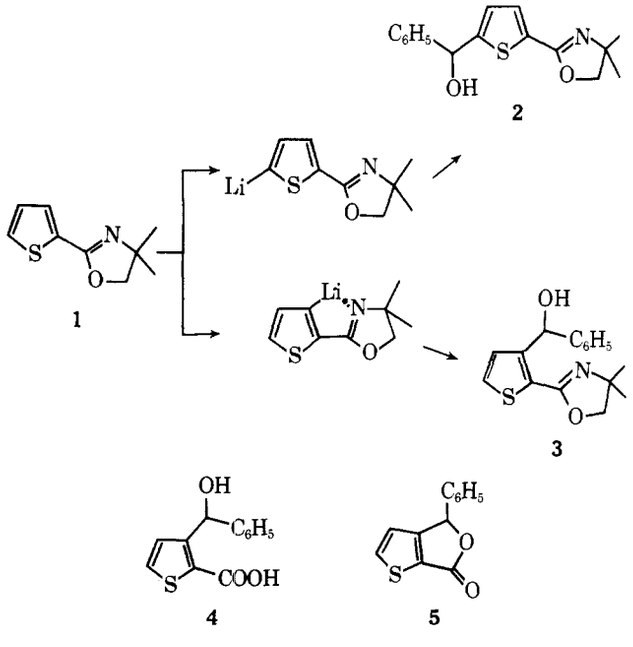


**Table I**

| Lithiating reagent | Solvent | Temp, °C | Metalation time, h | Yield, %[b] Isomer 2 | Isomer 3 |
|---|---|---|---|---|---|
| *n*-BuLi | THF | −70 | 1 | 55 | 36 |
| *sec*-BuLi | Ether | −70 | 1 | 2.3 | 81.3 |
| *n*-BuLi | Ether | −70–0 | 0.75[a] | 4.1 | 91 |

[a] 0.25 h at −70 °C and 0.5 h at 0 °C. [b] Based on the starting oxazoline **1**. Recovered oxazoline **1** constitutes the balance of the material.

This investigation of the metalation of **1** was prompted by our need for an efficient synthesis of 3-substituted thiophene-2-carboxylic acids and was based on the well-known ortho-directing ability of the oxazoline[5] group and the easy accessibility of **1**.[6] Lithiation of **1** with *n*-BuLi in ether or THF followed by condensation with benzaldehyde gave mixtures of products **2** and **3**, with the desired isomer **3** being clearly favored in ether. The metalation results are summarized in Table I. The structural assignments of the two isomers were based on their NMR spectra and were also verified by hydrolysis[6] of **3** to the acid **4** and conversion to the lactone **5**.

In synopsis, the lithiation of 2-(2-thienyl)-2-oxazoline **1** provides an efficient route to 2,3-disubstituted thiophenes. Our results, together with those of Kauffman[4] and Slocum,[3] seem to establish a relative order of ortho-directing substituents in thiophene as follows: oxazoline > pyridyl > sulfonimides, carboxamides, and dimethylaminomethyl.

## Experimental Section

**4,4-Dimethyl-2-(2-thienyl)-2-oxazoline (1).** To a solution of 2-thiophenecarboxyl chloride (100 g, 0.68 mol) in methylene chloride (200 mL) a solution of 2-amino-2-methyl-1-propanol (121.6 g, 1.36 mol) in methylene chloride (500 mL) was added dropwise while maintaining the temperature below 20 °C. The mixture was stirred at room temperature for 2 h and washed with water, and the organic layer was dried over $MgSO_4$ and evaporated. The residue was suspended in benzene (600 mL) and thionyl chloride (270.7 g, 2.28 mol) was added dropwise with stirring while maintaining the temperature below 30 °C. The stirring continued overnight, the benzene was evaporated at aspirator pressure, the residue was dissolved in water, and then the solution was basified with 1 N aqueous NaOH and extracted twice with ether. The ether extracts were dried over $MgSO_4$ and evaporated, and the residue was distilled to give 90 g of oxazoline **1**: bp 71–73 °C (0.1 mm Hg); NMR ($CDCl_3$) $\delta$ 7.63 (d of d, 1 H, $J$ = 5 and 2 Hz, 5-thienyl-H), 7.44 (d of d, 1 H, $J$ = 6 and 3 Hz, 3-thienyl-H), 7.05 (d of d, 1 H, $J$ = 5 and 6 Hz, 4-thienyl-H), 4.06 (s, 2 H, $-OCH_2$), 1.35 (s, 6 H, 2× $CH_3$). Anal. Calcd for $C_9H_{11}NOS$: C, 59.64; H, 6.12; N, 7.73. Found: C, 59.35; H, 6.29; N, 7.92.

**Lithiation Procedure.** To a solution of 4,4-dimethyl-2-(2-thienyl)-2-oxazoline (**1**) in ether or THF (5 mmol of oxazoline in 20 mL of solvent) the lithiating reagent was added dropwise at −70 °C with stirring under nitrogen. The reaction mixture was stirred at the designated temperature for the designated time, the benzaldehyde (5 mmol) was added, and the mixture was allowed to warm up to room temperature. It was poured into water and extracted with ether. The ether extracts were washed with water, dried over $MgSO_4$, and evaporated. The residue was subjected to preparative thin-layer chromatography ($SiO_2$, on $CH_2Cl_2$:EtOAc, 9:1) to give the less polar 2-(3-hydroxyphenylmethyl-2-thienyl)-4,4-dimethyl-2-oxazoline **3** [oil; $R_f$ 0.68; NMR ($CDCl_3$) $\delta$ 6.72 (d, 1 H, $J$ = 5.3 Hz, 4-thienyl-H), 6.07 (s, 1 H, PhCH–), 4.01 (s, 2 H, $OCH_2$), 1.33 (s, 3 H, $CH_3$), 1.2 (s, 3 H, $CH_3$). Anal. Calcd for $C_{16}H_{17}NO_2S$: C, 66.87; H, 5.96; N, 4.87. Found: C, 66.51; H, 6.2; N, 5.06] and the polar isomer **2** [mp 121–124 °C; $R_f$ 0.11; NMR ($CDCl_3$) $\delta$ 6.84 (d, 1 H, $J$ = 3.5 Hz, 4-thienyl-H), 6 (s, 1 H, PhCH), 4.02 (s, 2 H, $OCH_2$), 1.27 (s, 6 H, 2× $CH_3$). Anal. Found: C, 66.05; H, 6.01; N, 5.03].

**4-Phenylthieno[2,3-*c*]furan-6(*4H*)-one (5).** A mixture of the oxazoline **3** (344 mg, 0.0012 mol) and 3 N aqueous hydrochloric acid was refluxed for 10 min and evaporated under aspirator pressure. The residue was stirred with 40% aqueous NaOH (3.6 mL) at room temperature for 10 min, methanol (3.6 mL) was added, and the mixture was refluxed for 30 min. It was poured into water, acidified with 6 N

aqueous HCl, and extracted with ether; the extract was dried over $MgSO_4$ and evaporated to give crude 3-hydroxyphenylmethylthienyl-2-carboxylic acid (4), which was characterized as its methyl ester prepared from 4 by treatment with diazomethane: NMR ($CDCl_3$) $\delta$ 7.02 (d, 1 H, $J$ = 5 Hz, 4-thienyl-H), 6.42 (s, 1 H, PhCH), 3.7 (s, 3 H, $OCH_3$). The crude acid (200 mg) was dissolved in 20 mL of benzene, *N,N*-dicyclohexylcarbodiimide (170 mg) was added, and the mixture was refluxed for 30 min and evaporated. The residue was subjected to preparative thin-layer chromatography ($SiO_2$, $CH_2Cl_2$:EtOAc, 9:1) to give 160 mg of the lactone 5 as an oil: IR ($CHCl_3$) 1760 $cm^{-1}$; NMR ($CDCl_3$) $\delta$ 7.86 (d, 1 H, $J$ = 5 Hz, 5-thienyl-H), 7.35 (s, 5 H, Ph), 6.95 (d, 1 H, $J$ = 5 Hz, 4-thienyl-H), 6.31 (s, 1 H, PhCH). Anal. Calcd for $C_{12}H_8O_2S$: C, 66.63; H, 3.73. Found: C, 66.45; H, 4.11.

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**Registry No.**—**1**, 62521-42-0; **2**, 62521-43-1; **3**, 62521-44-2; **4**, 62521-45-3; **4** methyl ester, 62521-46-4; **5**, 62521-47-5; 2-thiophenecarboxyl chloride, 5271-67-0; 2-amino-2-methyl-1-propanol, 124-68-5; benzaldehyde, 100-52-7.

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(5) (a) H. W. Gschwend and A. Hamdan, *J. Org. Chem.*, **40**, 2008 (1975); (b) A. I. Meyers and E. D. Mihelich, *ibid.*, **40**, 3158 (1975).
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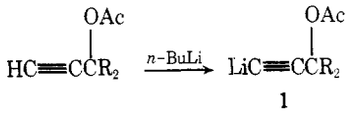
# Communications

## Preparation of Allenes and Acetylenes from Ethynylalkanol Acetates via Organoboranes

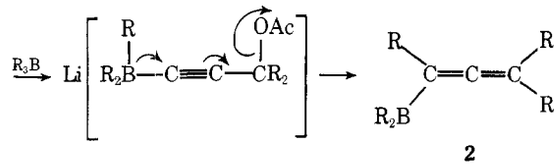
*Summary:* Sequential treatment of an ethynylalkanol acetate with *n*-butyllithium and a trialkylborane produces an allenic borane, $R_2BRC{=}C{=}CR_2$, which may be protonated to form either an allene, $RHC{=}C{=}CR_2$, or an acetylene, $RC{\equiv}CCHR_2$.

*Sir:* Allenes have conventionally been prepared from ethynylalkanol acetates through organocopper reagents.[1] However, these organocopper reagents are generally prepared from reactive organometallics which preclude the presence of many functional groups. Allenes may also be prepared from organoboranes by treatment with the lithium salt of propargyl chloride.[2] While the organoboranes can accommodate a wide variety of functional groups,[3] it is not clear that the reaction could be accomplished in the presence of these functional groups. Furthermore, this process is limited by the availability of propargyl chlorides.

We have now found that the use of the more readily available ethynylalkanol acetates[4] provides a general method for making allenic boranes (2) and, thus, allenes and acetylenes.



1

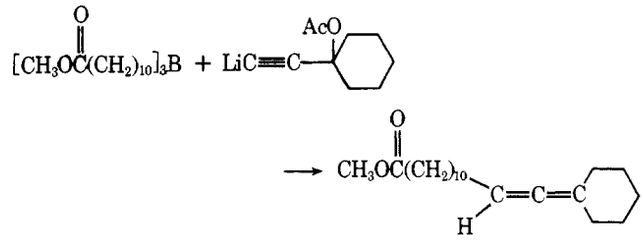


2

Formation of the desired lithium salt (1) was accomplished without interference by the acetate group by reaction of the ethynylalkanol acetate with *n*-butyllithium at low temperature (−78 or −120 °C). Addition of a trialkylborane followed by warming to room temperature and then protonation with acetic acid results in the formation of an allene.[2,5,6] The overall sequence results in the transformation of a ketone or aldehyde to an allene.

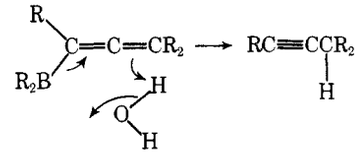
$$R_3B + HC{\equiv}CH + O{=}CR'_2 \rightarrow RHC{=}C{=}CR'_2$$

The reaction is quite general both with respect to the organoborane and the ethynylalkanol acetate (Table I). Slightly better results were usually obtained when the reaction was run at −120 rather than −78 °C. Finally, the reaction is able to accommodate an ester functionality in the organoborane with no difficulty.



3

Allenic boranes have the potential of reacting as allylic boranes, which are known to undergo a number of reactions that are unusual for vinyl- or alkylboranes, such as addition to carbonyl compounds or protonation with water.[7] Addition of water to 2 results in the exclusive formation of an acetylene. As with allylic boranes, the product presumably results from protonation with rearrangement via a cyclic process.



The overall transformation results in the reductive alkynylation of a ketone.

$$R_3B + HC{\equiv}CH + O{=}CR'_2 \rightarrow RC{\equiv}CCR'_2 \quad (\text{H on the CR'}_2)$$