A New Thiophene Ring-opening Reaction

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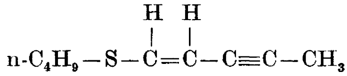
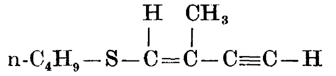
In the course of the preparation of a series of methyl-substituted trithienylphosphines [1] smaller amounts of a low-boiling fraction were obtained from the fractionation of each of the three methyl-substituted tri-3-thienylphosphines. Purification of each of these fractions by careful refractionation and finally by preparative thin-layer chromatography resulted in the isolation of pure products, shown by elementary analyses, NMR, IR, and mass spectroscopy to be the methyl-substituted 1-butylthio-1-buten-3-yne derivatives (I), (II), and (III). Furthermore, some of the corresponding methylbromothiophenes (starting material), always used in a slight excess (0.03 mol) for the preparation of the methylthienyllithium derivatives by metal-halogen interconversion, were also recovered from these fractions.



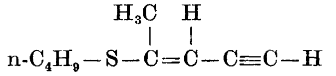
$$n\text{-}C_4H_9-S-\overset{\overset{H}{|}}{C}=\overset{\overset{H}{|}}{C}-C\equiv C-CH_3$$

(I)



$$n\text{-}C_4H_9-S-\overset{\overset{H}{|}}{C}=\overset{\overset{CH_3}{|}}{C}-C\equiv C-H$$

(II)

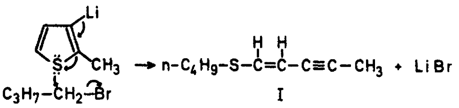


$$n\text{-}C_4H_9-S-\overset{\overset{H_3C}{|}}{C}=\overset{\overset{H}{|}}{C}-C\equiv C-H$$

(III)

Apart from the butyl proton resonances, the ^{1}H NMR spectra of (I), (II), and (III) are of the AMX_3 type with long-range couplings between all groups of nuclei (Fig. 1). The chemical shifts and coupling constants obtained by computer refinement (LAOCOON II)[2] of the first order parameters are given in Table 1; all long-range coupling constants are similar to those observed in closely related systems.[3]

The formation of (I), (II), and (III) under the conditions for the preparation of the methyl-substituted tri-3-thienylphosphines (see (Ia) in the experimental part of Ref. 1) involves an opening of the thiophene ring in the methylthienyllithium derivatives, probably caused by nucleophilic attack of the ring sulfur lone pair on butyl bromide (formed in the metal-halogen interconversion reaction) as outlined below for (I).



It is believed that the compounds (I), (II), and (III) originate from the excess of methyl-3-thienyllithium derivatives (with respect to phosphorus tribromide) always used in the preparation of the phosphines at −70° and that the ring-opening takes place when the reaction mixture is allowed to reach room temperature. Evidence for this is that none of the compounds (I), (II), and (III) have earlier been obtained from other reactions of methyl-3-thienyllithium derivatives with excess or equimolar amounts of reagents at −70°.[4,5] Furthermore, from an experiment, in which 3 equivalents of butyl bromide were added to 2-methyl-3-thienyllithium at −70° and the mixture allowed to reach room temperature overnight before hydrolysis, a 95 % yield of (I) was obtained. However, if the hydrolysis of 2-methyl-3-thienyllithium is carried out at −70°, 2-methylthiophene is obtained [4] showing the low-temperature (−70°) stability of the mixture of butyl bromide and methyl-3-thienyllithium derivative generally observed for 3-thienyllithium derivatives.[6] Some evidence for the formation of an unsaturated aliphatic product, when a mixture of 3-thienyllithium and butyl bromide was allowed to stand at room temperature for 24 h, has earlier been obtained from IR spectroscopy by Moses and Gronowitz.[6] Although no characterisation and identification of the product was given,[6] it is believed to result from the ring-opening reaction described in this note.

Experimental. The ^{1}H NMR spectra were recorded and calibrated with the aid of a Varian A-60 spectrometer, a General Radio low-frequency oscillator, and a Wavetek Dialamatic hertzmeter. The sample solutions were degassed and sealed under vacuum. IR and mass spectra were recorded on a Beckman IR-18A spectrometer and a Perkin Elmer RMU-6D mass spectrometer, respectively. Computations were performed at N.E.U.C.C., Copenhagen, on an IBM 7094 system.

Z-1-Butylthio-1-pentene-3-yne (I). From the 0.11 mol excess of 2-methyl-3-thienyllithium

Table 1. Proton chemical shifts and proton-proton coupling constants[a] for the AMX_3 system $(-S-\overset{|}{\underset{1}{C}}=\overset{|}{\underset{2}{C}}-\underset{3}{C}\equiv\underset{4}{C}-)$ of (I), (II), and (III).

Compound	Conc. (% w/w)	$\nu(1)$	$\nu(2)$	$\nu(4)$	$\nu(CH_3)$				r.m.s.[b]
(I)[c]	24 CS_2	372.03	317.78	–	116.16	$^3J_{12}$ $+9.74$	$^6J_{CH_3-1}$ -0.56	$^5J_{CH_3-2}$ $+2.39$	0.026
(II)[c]	20 CS_2	367.69	–	190.26	109.61	$^5J_{14}$ $+0.63$	$^4J_{CH_3-1}$ -1.39	$^5J_{CH_3-4}$ $+0.29$	0.018
(III)	21 CS_2	–	317.93	184.95	121.31	$^4J_{24}$ -2.40	$^4J_{CH_3-2}$ -1.42	$^6J_{CH_3-4}$ -0.62	0.015

[a] All data in Hz ($\nu_0=60$ MHz) with errors estimated to within ± 0.05 Hz; chemical shifts are referred to TMS as internal standard. The signs of coupling constants are taken from those determined in related systems.[3]

[b] Root mean square error in line positions.

[c] In the spectra of (I) and (II) the H_1 transitions are further split into triplets due to long-range coupling with the α-methylene protons of the butyl group: $^4J_{CH_2-S-CH(1)}=0.2$ Hz.

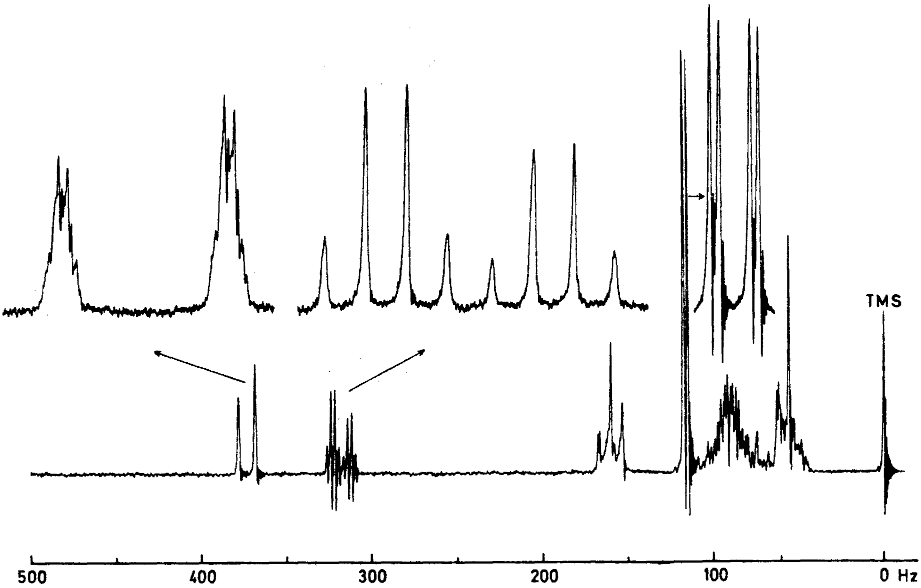


Fig. 1. 60 MHz ^1H NMR spectrum of a 24 % w/w degassed solution of Z-1-butylthio-1-pentene-3-yne (I) in CS_2. The expanded details show the resolved long-range couplings (see Table 1) in this compound.

used in the preparation of tri-(2-methyl-3-thienyl)-phosphine[1] a fraction with b.p. 50—65°/0.15 mmHg (14.5 g) was obtained. Refractionation gave pure (I) as an almost colourless liquid with b.p. 53—54°/0.2 mmHg, yield 12.4 g (73 % based on excess 2-methyl-3-thienyllithium). On storage at —20° the liquid crystallized. (Found: C 70.11; H 9.14; S 20.76. Calc.: C 70.05; H 9.15; S 20.78).

Z-1-Butylthio-1-pentene-3-yne (I). To a solution of 2-methyl-3-thienyllithium, prepared from 34.5 g (0.195 mol) of 2-methyl-3-bromothiophene in 75 ml of anhydrous ether and 128 ml of 1.52 N (0.195 mol) butyllithium at —70°, were added 82 g (0.60 mol) of butylbromide in 100 ml of anhydrous ether at —70°. The cooling bath was allowed to reach room temperature and the reaction mixture stirred overnight. The etheral solution was worked up in the usual way[1] and dried. Fractionation gave pure (I) as an almost colourless liquid with b.p. 48—49°/0.1 mmHg, yield 28.5 g (95 %).

Z-1-Butylthio-2-methyl-1-butene-3-yne (II). From 0.14 mol excess of 4-methyl-3-thienyllithium used in the preparation of tri-(4-methyl-3-thienyl)-phosphine[1] a fraction with b.p. 42—44°/0.1 mmHg of almost pure (II) was obtained; yield 5.6 g (26 % based on excess 2-methyl-3-thienyllithium). Preparative thin-layer chromatography (silica gel, 5 % ether in petroleum ether) gave (II) in a pure state as a slightly coloured liquid, which should be stored at —20°. (Found: C 69.31; H 9.12; S 20.57. Calc.: C 70.05; H 9.15; S 20.78).

Z-2-Butylthio-2-pentene-4-yne (III). From 0.10 mol excess of 5-methyl-3-thienyllithium used in the preparation of tri-(5-methyl-3-thienyl)-phosphine[1] a light yellow fraction with b.p. 42—44°/0.1 mmHg of almost pure (III) was obtained; yield 2.3 g (15 % based on excess 5-methyl-3-thienyllithium). Preparative thin-layer chromatography (silica gel, 5 % ether in petroleum ether) gave (III) in a pure state as a slightly coloured liquid, which should be stored at —20°. (Found: C 70.01; H 9.12; S 20.42. Calc: C 70.05; H 9.15; S 20.78).

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Flavonoids of *Lotus* L.

III.* Mass Spectrometric Detection of 6- and 8-Methoxy Groups in Flavonols

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During the investigation of flavonoids from *Lotus corniculatus* L. a series of new glycosides, derived from 8-methoxy-kaempferol (I) and 8-methoxy-quercetin (II), was isolated.[1,2] This paper describes a method for the detection of 6- and 8-methoxy groups in flavonols based on the mass spectra of I, II, and the related flavonols III to X (Table 1).

Flavonols usually have the molecular ion peak as base peak.[1,3] In the case of I and II, however, the base peak is due to the M—15 ion. Bowie and Cameron[4] ascribe to a *p*-quinoid structure *b* of the abundant M—15 fragments in the mass spectra of 6-*O*-methylated quercetagetin derivatives. By analogy with this we propose the *o*-quinoid structure *a* for the M—15 ions, observed as intensive peaks in the mass spectra of the 8-methoxy-flavonols I to VI.

According to our results an abundant M—15 peak in the mass spectrum of a flavonol is not necessarily indicative of a

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