

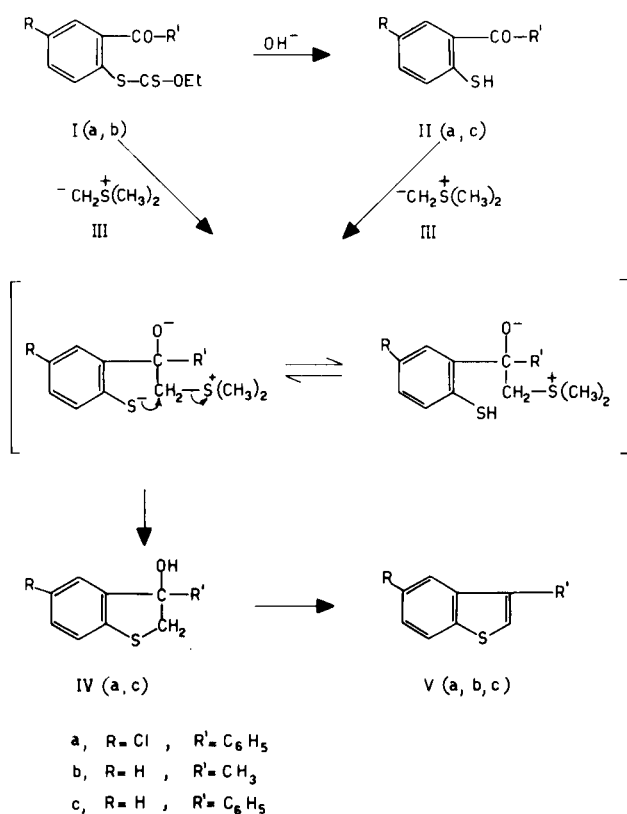
## The Reaction of Dimethylsulphonium Methylide with Aromatic *o*-Mercapto Ketones and the Corresponding Xanthates: A New Synthesis of Benzothiophenes.

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In the last few years dimethylsulphonium and dimethyl-oxosulphonium methylides have been shown to be useful tools for the synthesis of five-membered heterocycles, such as pyrrolidones (1),  $\Delta^2$ -1,2,3-triazolines (2), dihydrofurans (3,4), indoles (5), etc.

We wish now to report a new synthesis of benzothiophenes based upon the reaction of aromatic *o*-mercapto ketones (II), or their xanthates (I), with dimethylsulphonium methylide (III). The course of the reaction (6) can be outlined as follows (8):



The reaction of the ylide III with the *o*-mercapto ketones IIa,c afforded the 2,3-dihydrobenzothiophene-3-ols IVa,c in 61% and 65% yields, respectively. These compounds easily underwent dehydration to give the corresponding benzothiophenes (Va,c) by mild treatment with acid or spontaneously on long standing.

The *o*-mercapto ketones II were obtained from the corresponding *o*-amino ketones *via* the diazonium salts and the xanthates I which, in the last step of the sequence, were hydrolyzed by basic treatment (9,10). However, this last step can be omitted, for when the crude xanthates (Ia,b) were reacted with III under the same conditions as for the *o*-mercapto ketones, the expected cyclization occurred, giving 41% and 14% yields, respectively. In the case of Ia a mixture of IVa (13%) and the corresponding dehydrated compound Va (28%) was obtained. In the case of Ib the only cyclization product isolated was the 3-methylbenzothiophene, Vb. Apparently the intermediate 2,3-dihydro-3-methylbenzothiophene-3-ol (IVb), which undergoes dehydration very easily (7), spontaneously changed into Vb during the work up.

No attempt has been made to improve yields by modifying the conditions of the reactions. However, the use of xanthates directly, by-passing the isolation of the *o*-mercapto ketones, offers a useful alternate synthesis of benzothiophenes, especially when the intermediate mercapto ketones are unstable, as in the case of IIb (11).

### EXPERIMENTAL

Melting points are uncorrected. Infrared spectra were recorded with a Perkin-Elmer Model 137 Infracord spectrophotometer. Only prominent peaks are reported. Ultraviolet spectra (in 95% ethanol) were recorded on a Beckman DK2 spectrophotometer. Proton N.M.R. spectra were taken on a Varian A-60 spectrometer. Chemical shifts were measured in p.p.m. ( $\delta$ ) from TMS as internal standard. Mass spectra were measured on a Hitachi-Perkin-Elmer RMU-6D (single focus) spectrometer with an electron ionizing potential of 70 V. The samples were introduced by the "all glass heated inlet system," at 180°.

2,3-Dihydro-3-phenylbenzothiophene-3-ol (IVc) and 3-Phenylbenzothiophene (Vc).

To a solution of 26 mmoles of dimethylsulphonium methylide in DMSO (12) 2.0 g. (6.5 mmoles) of crude (70%, based on the N.M.R. spectrum) *o*-mercaptobenzophenone (9) was added while stirring and cooling at 0°. The mixture, after standing overnight at room temperature, was poured into water and extracted with ether. The extracts were combined, washed with water and dried over sodium sulphate. Evaporation of the ether gave a residue which was chromatographed on silica gel (0.05-0.2 mesh). Elution with a 93/7 mixture of hexane-ether gave 0.85 g. (61% yield) of 2,3-dihydro-3-phenylbenzothiophene-3-ol (IVc), as a viscous oil;

UV  $\lambda$  max ( $\epsilon$ ) 250 (9,500), 290 nm (2,000); IR (neat) 3300, 3040, 1590, 1495, 1450, 1345, 1265, 1170, 1030, 1000, 918, 760, 725, 702  $\text{cm}^{-1}$ ; NMR (carbon tetrachloride) two methylene doublets at 3.33 and 3.62 ( $J = 12$  Hz); OH singlet at 2.60; mass spectrum 228 ( $M^+$ ), 210  $m/e$ , base peak, ( $M^+ - H_2O$ ).

*Anal.* Calcd. for  $C_{14}H_{12}OS$ : C, 73.7; H, 5.3. Found: C, 73.3; H, 5.7.

On standing IVc underwent dehydration, affording 3-phenylbenzothiophene (Vc), identified by its UV spectrum (13) and by the lack of the OH band in the IR spectrum; mass spectrum 210, base peak ( $M^+$ ), 178 ( $M^+ - S$ ), 165  $m/e$  ( $M^+ - S - CH$ ).

2,3-Dihydro-3-phenyl-5-chlorobenzothiophene-3-ol (IVa) from the *o*-Mercapto Ketone IIa.

Compound IVa was obtained in 65% yield by the same procedure as for IVc, starting with 1.0 g. of 2-mercapto-5-chlorobenzophenone (9); m.p.  $75^\circ$  from heptane-ether; UV  $\lambda$  max ( $\epsilon$ ) 256 (10,000), 300 nm (2,500); IR (nujol) 3400, 2930, 1450, 1250, 1195, 1085, 1040, 1005, 935, 890, 827, 816, 770, 732, 707, 699  $\text{cm}^{-1}$ ; NMR (deuteriochloroform) two methylene doublets at 3.47 and 3.78 ( $J = 12$  Hz); OH singlet at 2.83; mass spectrum 244 and 246 ( $M^+ - H_2O$ )  $m/e$ .

*Anal.* Calcd. for  $C_{14}H_{11}ClOS$ : C, 64.0; H, 4.2. Found: C, 64.5; H, 4.1.

Dehydration of IVa: 3-Phenyl-5-chlorobenzothiophene (Va).

Compound IVa (0.10 g.) was dissolved in a few ml. of chloroform and two drops of concentrated sulfuric acid were added. After 15 minutes stirring the mixture was poured into water and extracted with ether. The combined extracts were washed with water and dried over sodium sulfate. Evaporation of the solvent gave a quantitative yield of Va, m.p.  $75^\circ$  from ethanol; UV  $\lambda$  max ( $\epsilon$ ) 232 (32,000), 299 (3,200), 309 nm (3,200); IR (nujol) 2900, 1470, 1450, 1415, 1240, 1140, 1078, 878, 840, 809, 805, 797, 763, 720, 701  $\text{cm}^{-1}$ ; mass spectrum 244 and 246 ( $M^+$ )  $m/e$ .

*Anal.* Calcd. for  $C_{14}H_9ClS$ : C, 68.7; H, 3.7. Found: C, 68.9; H, 3.7.

2,3-Dihydro-3-phenyl-5-chlorobenzothiophene-3-ol (IVa) and 3-Phenyl-5-chlorobenzothiophene (Va) from the Xanthate Ia.

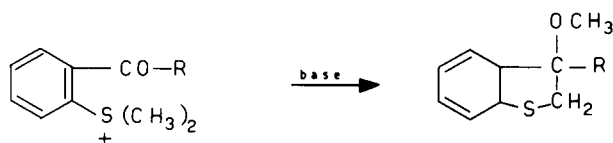
One gram (3 mmoles) of the xanthate Ia, when reacted with 13 mmoles of the ylide III in the same way as for IIa, gave 0.75 g. of a crude oil which was chromatographed on silica gel. Elution with a 99/1 mixture of hexane-ether gave 0.20 g. (28%) of pure Va. Subsequent elution with a 97/3 mixture of the same solvents gave 0.10 g. (13%) of IVa.

3-Methylbenzothiophene (Vb).

The xanthate Ib (2.4 g., 10 mmoles) (11) was reacted with 40 mmoles of the ylide III in the same way as for IIa. The product, eluted from the column with a 95/5 hexane-ether mixture, consisted of 0.20 g. (14% yield) of 3-methylbenzothiophene (Vb) and showed the same UV as reported in the literature (14) and no OH band in the IR; NMR (carbon tetrachloride),  $CH_3$  at 2.32;  $H^2$  at 6.82-6.95; 4 aromatic H at 7.0-7.8; mass spectrum 148  $m/e$ , base peak ( $M^+$ ).

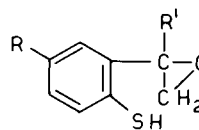
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- (6) The first step of the reaction is reminiscent of the Kroll-pfeiffer synthesis of benzothiophenes (7), which most probably involves an intermediate ylide attacking the carbonyl of an aromatic ketone:



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(8) An alternative route through an intermediate epoxide V can also be conceived (5b).



VI

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