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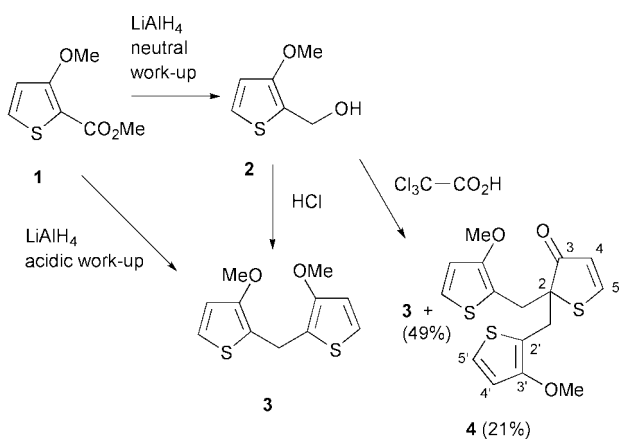
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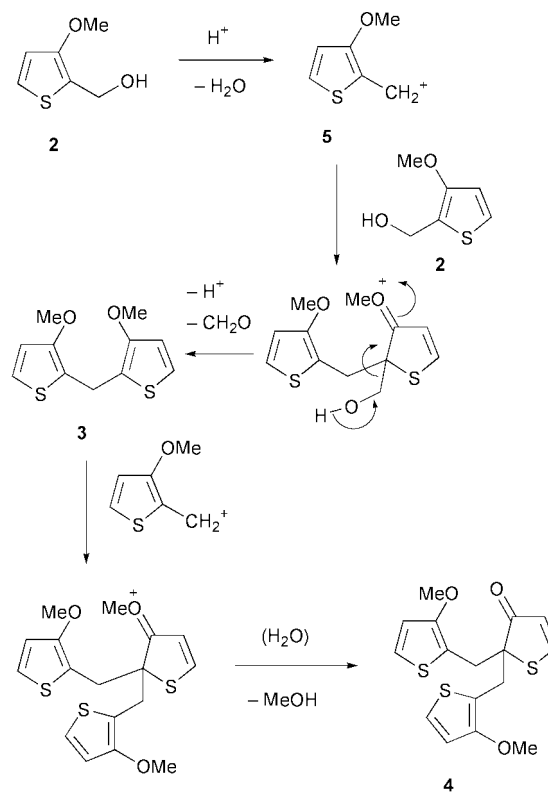
3-Methoxythiophene-2-methanol **2** undergoes condensation with elimination of water and formaldehyde under acidic conditions to give bis(3-methoxy-2-thienyl)methane **3** and a further product resulting from reaction of **3** with the thienylmethyl carbocation; the other electron-rich thiophenemethanols **8** and **10** react similarly.

We recently wanted to prepare 3-methoxythiophene-2-methanol **2** and were surprised to discover that such a simple compound was apparently unknown. Initial attempts to obtain it by LAH reduction of the ester **1** followed by a standard work-up using 2 M hydrochloric acid gave a crystalline product in 65% yield which was clearly not the required material (Scheme 1).



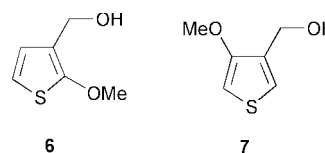
Scheme 1

Analytical and spectroscopic data showed the presence of two equivalent 3-methoxy-2-thienyl units and a single methylene group (δ_{H} 4.16, δ_{C} 21.5) and were in full accord with the dithienylmethane structure **3**.[†] By using LAH reduction of **1** with a neutral work-up and avoiding any contact with acids, **2** could be obtained in 80% yield and fully characterised, although it decomposed upon attempted distillation and was efficiently converted into **3** upon contact with acids. Although reactions of this type are well documented for pyrrole systems¹ and have recently been described for a few electron-rich furanmethanols,² we believe this to be the first example in thiophene chemistry.³ We then examined treatment of the alcohol **2** with a catalytic quantity of trichloroacetic acid in aqueous acetone, which has been reported to bring about efficient condensation of furanmethanols to give difurylmethanes,² and found that this gave **3** (49%) and a new product separable by chromatography which gave data consistent with the structure **4** (21%).[‡] This included a carbonyl group (δ_{C} 206.9, ν_{max} 1668 cm^{-1}), a highly polarised double bond (δ_{H} 8.16 and 6.02, δ_{C} 163.6 and 122.7) and a quaternary aliphatic carbon (δ_{C} 67.9). We rationalise these results by the mechanism shown in Scheme 2 in which protonation of **2** followed by loss of water gives the carbocation **5** which is highly stabilised by the electron-releasing methoxy group. Electrophilic attack of this

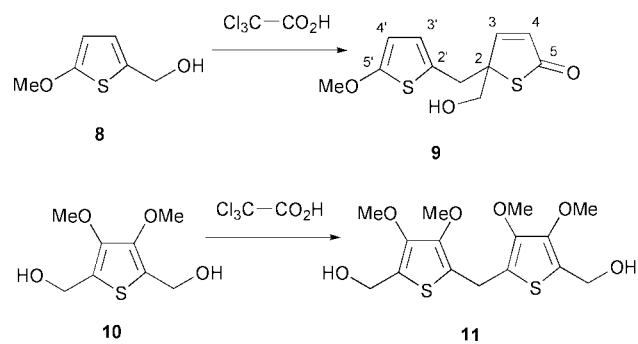


Scheme 2

on a second molecule of **2** followed by loss of formaldehyde affords the dithienylmethane **3**. If this is then attacked by a second carbocation **5** the resulting intermediate cannot regain aromaticity and so removal of "Me⁺" presumably by hydrolysis ensues to give **4**.



In an attempt to evaluate the scope of this new reaction we examined the behaviour of the isomeric alcohols **6**, **7** and **8** under the same conditions. Although **6**⁴ and **8**⁵ are known, the 3,4-isomer **7** is only mentioned briefly in a patent with no characterisation⁶ but it was readily prepared by LAH reduction of the corresponding ester.⁷ As might be expected from consideration of the relative stabilities of the carbocations corresponding to **5**, the isomer **7** was found to be completely inert to trichloroacetic acid and **6** did not react to any significant extent, but **8** did react to give a product (Scheme 3) identified as **9** (61%). Why the reaction has taken this course with loss of one methyl group rather than simply giving the bis(methoxythienyl)methane, as for **2**, is not clear.



Scheme 3

Finally by considering the pyrrole analogy, we envisaged the possibility of constructing cyclic oligomers similar to porphyrins by using a suitable electron-rich thiophene-2,5-dimethanol. The compound **10** which has only been mentioned briefly before⁸ was readily prepared by reduction of the known diester,⁹ but upon treatment with trichloroacetic acid the only product which could be identified was the “dimer” **11**. It seems possible that the oligomerisation process has been stopped after the first step by solubility factors and construction of higher oligomers by this method may require extensive optimisation of the reaction conditions.

It is likely that this reaction may be applicable to other thiophenemethanols bearing suitably placed strongly electron-releasing groups and its scope for the construction of a variety of new structures is currently being examined.

Acknowledgements

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Notes and references

† New compounds gave satisfactory microanalytical and spectroscopic data. Selected spectroscopic data: **2** δ_{H} 7.14 (1 H, d, *J* 6, 5-H), 6.83 (1 H, d, *J* 6, 4-H), 4.70 (2 H, s, CH₂), 3.85 (3 H, s, OMe) and 2.15 (1 H, s, OH); δ_{C} 155.1 (C-3), 123.3 (C-5), 119.5 (C-2), 116.4 (C-4), 58.9 (OMe)

and 56.1 (CH₂). **3** δ_{H} 7.06 (2 H, d, *J* 6, 5-H), 6.85 (2 H, d, *J* 6, 4-H), 4.16 (2 H, s, CH₂) and 3.88 (6 H, s, OMe); δ_{C} 153.7 (C-3), 121.3 (C-5), 120.4 (C-2), 116.7 (C-4), 59.0 (Me) and 21.5 (CH₂). **4** $\nu_{\text{max}}/\text{cm}^{-1}$ 1668; δ_{H} 8.16 (1 H, d, *J* 8), 7.01 (2 H, d, *J* 7), 6.78 (2 H, d, *J* 7), 6.02 (1 H, d, *J* 8), 3.78 (6 H, s, OMe) and 3.36 and 3.19 (4 H, AB pattern, *J* 13, CH₂); δ_{C} 206.9 (CO), 163.6 (C-5), 155.9 (C-3'), 122.7 (C-4), 122.5 (C-5'), 116.0 (C-4'), 114.6 (C-2'), 67.9 (C-2), 58.9 (OMe) and 33.4 (CH₂). **7** δ_{H} 7.20 (1 H, d, *J* 3, 2-H), 6.43 (1 H, d, *J* 3, 5-H), 4.57 (2 H, s, CH₂), 3.83 (3 H, s, OMe) and 2.19 (1 H, s, OH); δ_{C} 156.3 (C-4), 132.8 (C-3), 122.1 (C-2), 97.1 (C-5), 58.3 and 57.4. **9** δ_{H} 7.44 (1 H, d, *J* 9, 3-H), 6.50 (1 H, d, *J* 6, 3'-H), 6.18 (1 H, d, *J* 9, 4-H), 5.98 (1 H, d, *J* 6, 4'-H), 3.82 (5 H, s, CH₂ and OMe), 3.34 and 3.26 (2 H, AB pattern, *J* 15, CH₂) and 2.95 (1 H, br s, OH); δ_{C} 199.4 (CO), 165.6 (C-5'), 160.5 (CO-CH=CH), 132.6, 125.7 (C-3'), 123.1 (C-2'), 103.3 (C-4'), 69.6 (C-2), 66.6 (CH₂), 60.2 (OMe) and 36.0 (CH₂). **10** δ_{H} 4.65 (4 H, s, CH₂), 3.87 (6 H, s, OMe) and 2.62 (2 H, s, OH); δ_{C} 147.0 (C-3, C-4), 123.8 (C-2, C-5), 61.3 (CH₂) and 56.7 (OMe). **11** δ_{H} 4.62 (4 H, s), 4.02 (2 H, s), 3.90 (6 H, s), 3.84 (6 H, s) and 1.82 (2 H, br s); δ_{C} 148.1, 146.1, 123.7, 121.8, 61.1, 60.9, 56.8 and 23.2.

‡ Typical procedure: a solution of 3-methoxythiophene-2-methanol **2** (0.5 g, 3.5 mmol) and trichloroacetic acid (0.01 g, 0.06 mmol) in acetone–water (3:2, 30 cm³) was stirred at 40 °C under nitrogen for 2 h. The reaction mixture was poured into water (100 cm³) and extracted with diethyl ether (2 × 50 cm³). The combined organic extracts were washed with water (50 cm³), dried and evaporated to give a pale yellow–brown oil. Column chromatography of this using diethyl ether–hexane (1:9) as eluent gave the main product **3** (0.20 g, 49%) as pale brown needles, mp 54–55 °C. A second product isolated proved to be **4** (0.086 g, 21%) as a pale yellow oil.

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