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NON-CONVENTIONAL NITRATION OF 2,5-DIMETHYLTHIOPHENE AND ITS 3,4-DIBROMO DERIVATIVE

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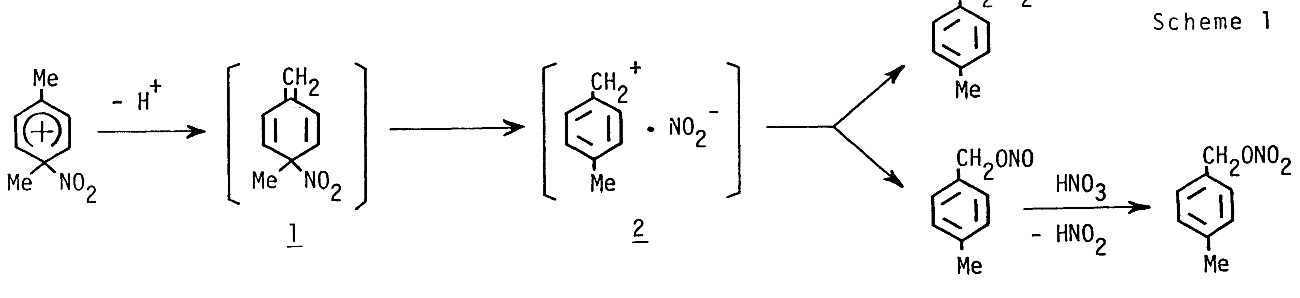
Nitration of 2,5-dimethylthiophene with copper(II) nitrate in acetic anhydride gives 2,5-dimethyl-3-nitrothiophene and 3,2'-methylene (2,5-dimethylthiophene)(5'-methylthiophene) as major products. Treatment of 3,4-dibromo-2,5-dimethylthiophene with nitric acid (d = 1.5) in dichloromethane in the presence of a catalytic amount of sulfuric acid yields 3,4-dibromo-5-methyl-2-nitrooxymethylthiophene as the sole major product.

When treated with nitric acid in dichloromethane at low temperature, polymethylbenzenes and their derivatives often undergo nitrooxylation of a side-chain to give benzyl nitrates.[1] Under similar conditions, polymethylnaphthalenes and polymethylanthracenes yield naphthylnitromethanes and anthrylnitromethanes, respectively.[2] For these side-chain reactions of arenes, we have previously proposed a heterolytic mechanism involving a methylenecyclohexadiene intermediate 1 (Scheme 1).[3] A marked change in the modes of reaction toward nitrating agents observed on going from the benzenes to naphthalenes and anthracenes has been related to the change in the development of carbonium ion character on the methylene carbon atom of intermediate ion pair 2.[2]

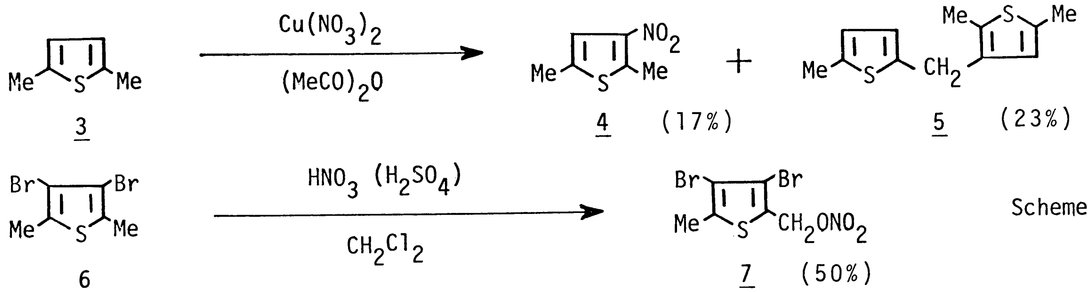
There is to our knowledge only one report in the literature pertaining to the

Scheme 1



side-chain nitration of heteroaromatic systems, where 3-methyl-2-nitromethylbenzo[*b*]thiophene is obtained from the reaction of 2,3-dimethylbenzo[*b*]thiophene with nitric acid in acetic anhydride.[4] Preferential nitration occurs at an alkyl group attached to heterocycle. As part of our continued studies on the side-chain substitution of arenes under heterolytic conditions, we report now the reaction of several polymethylthiophenes with nitrating agents.

Reaction of 2,5-dimethylthiophene 3 with copper(II) nitrate proceeded smoothly in acetic anhydride at -10 ~ -15°C and two major products obtained were identified as 2,5-dimethyl-3-nitrothiophene 4 and 3,2'-methylene (2,5-dimethylthiophene)(5'-methylthiophene) 5, respectively, on the basis of IR, PMR, and mass spectra as well as elemental analyses.[5] Although spectral examination of the crude reaction mixture showed the presence of small amounts of a nitrate ester, it could not be isolated as such. 3,4-Dibromo-2,5-dimethylthiophene 6 was comparatively stable toward the action of nitric acid alone at low temperature. In the presence of a catalytic amount of sulfuric acid, however, it underwent a facile side-chain substitution to afford a pasty solid, from which 3,4-dibromo-5-methyl-2-nitrooxymethylthiophene 7 was isolated as the sole major product.[5]



Scheme 2

Both trimethylthiophene and tetramethylthiophene were extremely reactive toward nitrating agents and failed to give any isolable products. Even with such a mild nitrating agent as copper(II) nitrate, these reactive thiophenes were converted into a complicated mixture of products which were difficult to separate.

Loss of a benzene ring from benzo[*b*]thiophene system leads to a change in the mode of side-chain reaction of thiophene nucleus from nitration to nitrooxylation. This remarkable effect of fused benzene ring parallels that observed in the reactions of benzenes and higher polybenzenoid hydrocarbons and may be taken to indicate that the side-chain reaction of the thiophenes also proceeds through a heterolytic mechanism similar to that depicted in Scheme 1.

REFERENCES

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2. H. Suzuki, H. Yoneda, and T. Hanafusa, Bull. Chem. Soc. Jpn., 47, 3106 (1974).
3. H. Suzuki, T. Mishina, and T. Hanafusa, Bull. Chem. Soc. Jpn., 52, 191 (1979).
4. F.G. Bordwell and T.W. Cutshall, J. Org. Chem., 29, 2020 (1964).
5. Compound 5 ($C_{12}H_{14}S_2$): liquid; MS m/e 222 (M^+); PMR (CCl_4) δ 2.28 (s, 3H), 2.33 (s, 3H), 2.38 (s, 3H), 3.77 (s, 2H), 6.30 (s, 1H), 6.33 (s, 1H), 6.38 ppm (s, 1H); IR (Nujol) ν_{max} 1215, 1145, 1035 cm^{-1}. Compound 7 ($C_6H_5NO_3Br_2S$): mp 50-51°C; PMR (CCl_4) δ 2.47 (s, 3H), 5.45 ppm (s, 2H); IR (Nujol) ν_{max} 1620, 1300, 880 cm^{-1}. Numerals in parentheses in Scheme 2 refer to the isolated yields of pure products.

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