Bromonitromethane, a Versatile Electrophile: Reactions with Thiolates

Brian R. Fishwick,[a] **David K. Rowles,**[b] **and Charles J. M. Stirling***[b]

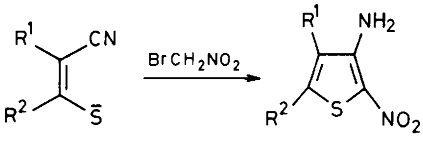
[a] *I.C.I. Organics Division, Blackley, Manchester M9 3DA, U.K.*

[b] *School of Physical and Molecular Sciences, University College of North Wales, Bangor, Gwynedd LL57 2UW, U.K.*

Thiolate ions react with bromonitromethane to give nitronate ion and, initially, sulphenyl bromide which reacts with further thiolate ion to give disulphide; when the disulphide bears an appropriately placed nitrile function, intramolecular attack by the nitronate ion at this function and subsequent intramolecular displacement of thiolate ion yields aminothiophenes.

Reactions of α-nitrohalides with nucleophiles have been investigated with a view to determining both mechanisms[1,2] and synthetic potential, particularly for thiophene derivatives.[3] Mechanistic studies have dealt largely with tertiary nitrohalides whereas synthetic work has concentrated upon primary nitrohalides and upon bromonitromethane in particular.[3,4] We have been interested in the development of aminothiophene synthesis from bromonitromethane and as part of the study have examined its reactions with a variety of nucleophiles. This simple polyfunctional molecule turns out to have a very wide range of reactivity; reactions with thiolates are discussed in this communication and those of other nucleophiles in the following one.

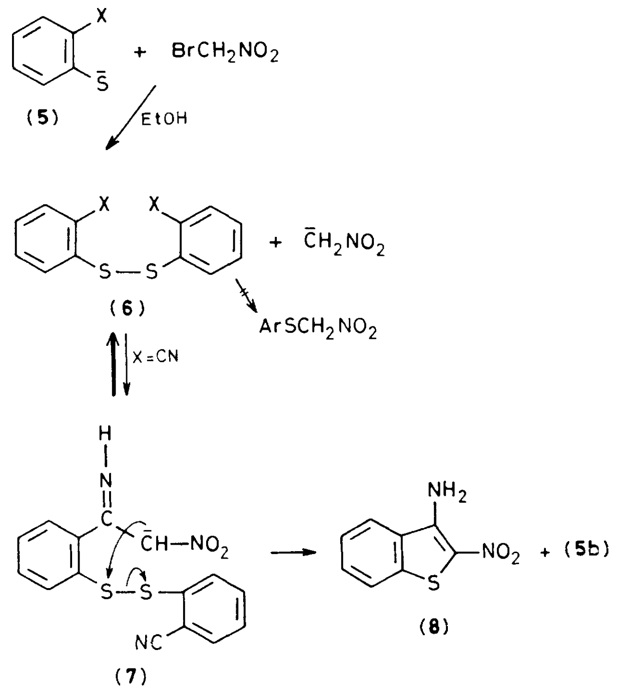
Treatment of bromonitromethane with the salts (**1**) in ethanol yields 50—70% of aminothiophenes (**2**) (Scheme 1). In these reactions a bond is ultimately formed between sulphur of the nucleophile and carbon of bromonitromethane. It is all the more surprising therefore that with simple thiolates, RS^- (**3**) [R = Ph, Et, *o*-$NO_2C_6H_4$, $EtOC(:S)S^-$] no S–C bond formation is observed and disulphides are rapidly formed in 75—95% yields. Similar results have been found by Bowman and Richardson[1] for 2-halogeno-2-nitropropanes in dimethylformamide (DMF). Formation of disulphide probably arises by attack at bromine in bromonitromethane and the sulphenyl bromide produced reacts rapidly with further thiolate ion to give disulphide [reaction (1)]. Consistent with this view is the 2:1 thiolate–nitro-compound stoicheiometry, co-formation of nitromethane, and the trapping of sulphenyl halide by



(**1**) (**2**)

R^1	R^2	Yield %
PhNH	CO_2Et	54
PhNH	CN	60
MeS	CO_2Et	30
MeS	CN	55
MeS	$CONH_2$	56
MeNH	CO_2Et	70
PhNH	SO_2Ph	49

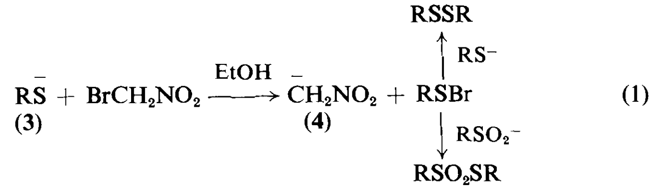
Scheme 1



a; X = NO_2
b; X = CN
c; X = H

Scheme 2

arenesulphinate ion[5] albeit in low yield. Attempts to trap sulphenyl halide with reactive alkenes[6] failed. α-Nitrosulphide, $RSCH_2NO_2$, the product of attack at carbon in bromonitromethane, is inert to thiolate and cannot lie on the pathway. Formation of amino-thiophenes involving S–C bond formation therefore requires explanation. *o*-Nitro- (**5a**) but not *o*-cyano-benzenethiolate (**5b**) (Scheme 2) gives disulphide in reaction with bromonitromethane. Disulphides (**6a**) and (**6c**) are both inert to nitronate ion (**4**) under the conditions used. This renders it unlikely that the pathway is attack by nitronate ion (**4**) at sulphur in disulphide (**6b**) with subsequent ring closure[7] to the benzothiophene (**8**). On the other hand, disulphide (**6b**) *does* react with (**4**) to give the benzothiophene (**8**) directly. We suggest therefore that the disulphide (**6b**) reacts at a cyano-group and intramolecular displacement follows as in (**7**). Such a process is also conceivable for the sulphenyl bromide (**7**; Br replaces o-NCC_6H_4S) but, because of its high thiophilicity it will have a short lifetime in the presence of thiolate ion. No reaction between benzonitrile and nitronate ion is detectable; an unfavourable equilibrium, which leaks in the direction of product, is presumably involved. 1 : 1 Thiolate–bromonitromethane stoicheiometry in formation of the benzothiophene (**8**) in contrast to 2 : 1 stoicheiometry in formation of disulphide is also consistent with this pathway.



$$\underset{(3)}{\overset{-}{RS}} + BrCH_2NO_2 \xrightarrow{EtOH} \underset{(4)}{\overset{-}{C}H_2NO_2} + \underset{\substack{\downarrow RSO_2^- \\ RSO_2SR}}{\overset{\substack{RSSR \\ \uparrow RS^-}}{RSBr}} \qquad (1)$$

For formation of disulphides, we considered the possibility of an electron-transfer pathway.[8] Thiolate ions have a strong tendency to single electron donation and nitro groups to single electron acceptance. We have carried out reactions in the presence and absence of *p*-dinitrobenzene and under illumination as well as in the dark. There were no significant alterations in disulphide yields and we consider the single electron transfer pathway less probable.

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