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THE REACTION OF IMINOSULFURANES WITH DIMETHYL ACETYLENEDICARBOXYLATE

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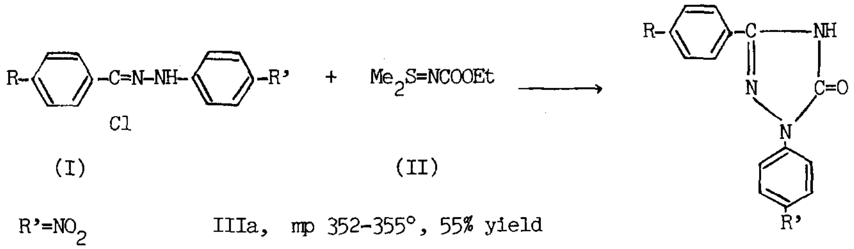
Numerous iminosulfuranes have been prepared[1,2] but little has been done in exploring their synthetic applications. In continuing studies of the reaction of ylides with 1,3-dipoles[3], a new type of reaction was found in the reaction of nitrile imines with N-carbethoxyiminodimethylsulfurane.



(I) (II) (III)

a, R=H, R'=NO_2 IIIa, mp 352-355°, 55% yield

b, R=CH_3, R'=H IIIb, mp 277-279°, 40% yield

c, R=NO_2, R'=H IIIc[4], mp 325-328°, 48% yield

When nitrile imine precursor Ia was allowed to react with excess II in benzene at room temperature, 1-p-nitrophenyl-3-phenyl-1,2,4-triazoline-5-one was isolated. The structural assignment of the triazolone IIIa was made on the basis of elemental analysis and no depression of melting point on admixture with an authentic specimen prepared by the method of Fusco and Musanto[5]. We assume that the reaction proceeds through initial formation of a sulfonium salt, which is subsequently hydrolyzed to III.

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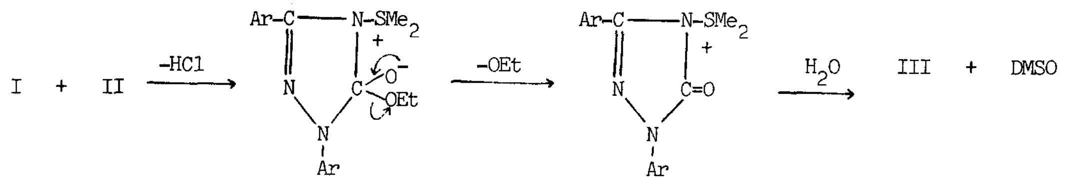


Iminosulfuranes can be hydrolyzed to sulfoxide and amines as mentioned above. This type of hydrolysis is typical of phosphonium salts, affording phosphine oxides and hydrocarbons, in contrast with sulfonium salts which normally form sulfides and alcohols[1].

Facile hydrolysis of the sulfonium salt suggests that this type of intermediate would have similar properties to those of the (DMSO + DCC + H^+) system and, in the presence of alcohols, alkoxysulfonium salts, intermediates in the oxidation of alcohols[10], would be formed. That this is indeed the case was shown in the reaction of dimethyl acetylenedicarboxylate with N-p-nitrophenyliminodimethylsulfurane (IVa) and an alcohol, as shown below.

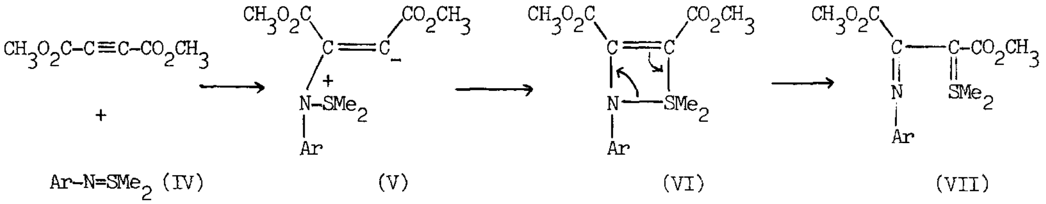
The reaction of sulfonium ylides with electrophilic acetylenes gives stable sulfonium ylides or furans[6,7]. As we now show, iminosulfurnes IV react with dimethyl acetylenedicarboxylate and the products isolated are dependent on reaction conditions.

(a) Reaction in Dry Benzene

To a stirred solution of IVa (0.01 mol) in dry benzene, dimethyl acetylenedicarboxylate (0.01 mol) in benzene (20ml) was added dropwise (2 hr) at room temperature and the mixture was stirred for an additional ten hours. The yellow precipitate was filtered and recrystallized from ethanol to yield VIIa (56%).

The structure of the stable sulfonium ylide VIIa was substantiated by elemental analysis ($C_{14}H_{16}N_2O_6S$); IR (Nujol), $\nu_{C=O}$ 1728 and 1645cm^{-1}; NMR (δ in $CDCl_3$), 3.11 (s, 6H), 3.60 (s, 3H), 3.70 (s, 3H), 6.91 (d, 2H), 8.12 (d, 2H).

The formation of VII can be rationalized as shown below:



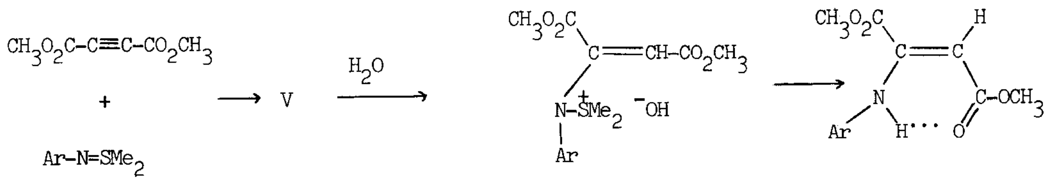
VIIa, Ar=p-$NO_2C_6H_4$, mp 210-212°, 56% yield

VIIb, Ar= m-ClC_6H_4 , mp 137-138°, 91% yield

This mechanism is analogous to that reported for the reaction of DMSO with acetylenedicarboxylate[8].

(b) Reaction in Moist Solvents

Treatment of a moist chloroform solution of IVa with dimethyl acetylenedicarboxylate was exothermic and afforded dimethyl N-p-nitrophenylaminofumalate (IXa) quantitatively. Its structure was based on the elemental analysis, IR, NMR, Mass Spectra and comparison with an authentic specimen prepared by the method of Huisgen et al[9]. This reaction is so facile that the use of commercial undried solvents gives IXa as the main product.



(IV) (VIII) (IX)

IXa, Ar = p-$NO_2C_6H_4$, mp 118-119°, 100% yield

IXb, Ar = m-$NO_2C_6H_4$, mp 99-101°, 100% yield

IXc, Ar = COOEt, mp 24-26°, (bp 132-134°/4 torr), 100% yield

It is not immediately apparent when and how the streospecific formation of IX occurs and speculation at this time is unwarranted[9].

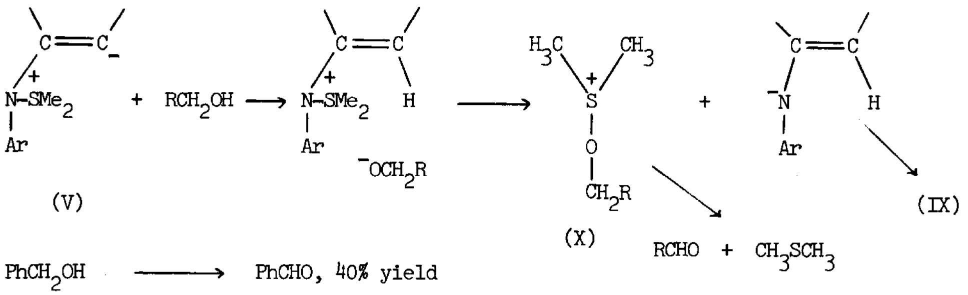
When the reaction was carried out in the presence of deuterium oxide, the vinyl proton in IXa was completely replaced by deuterium.

p-Nitrophenyliminohexadeuterodimethylsulfurane (IVa-D_6) in moist chloroform gave IXa and hexadeuterodimethyl sulfoxide, results consistent with the reaction mechanism described. Reaction of II (hygroscopic) with dimethyl acetylenedicarboxylate gave IXc quantitatively (no reaction was observed between urethane and dimethyl acetylenedicarboxylate under the same conditions).

(c) Reaction in the Presence of an Alcohol

Oxidation of alcohols to their corresponding carbonyl derivatives with (DMSO + DCC + H^+) or (DMSO + an acid anhydride)[10] proceeds via an oxysulfonium salt (X).

Reaction of IVa with dimethyl acetylenedicarboxylate in the presence of alcohols gave carbonyl compounds in only fair yields, besides VIIa and IXa. For example, oxidation of β-phenylethyl alcohol (0.01 mol) by the reagents (0.01 molar solution of each in benzene) gave β-phenylethyl alcohol (70%), β-phenylacetaldehyde (30%), IXa (85%) and VIIa (5%). Styrene could not be detected in the reaction mixture by VPC (no elimination reaction).



$PhCH_2OH$ ⟶ PhCHO, 40% yield

$PhCH_2CH_2OH$ ⟶ $PhCH_2CHO$, 30% yield

Cyclohexanol ⟶ Cyclohexanone, 18% yield

n-Butanol ⟶ n-Butyraldehyde, 15% yield

Reaction in the presence of phenol gave o-methylthiomethylphenol in 15% yield. Although the yield of oxidation product is only fair and optimum conditions have not been developed, This procedure has a certain advantage over other oxidation methods since it proceeds under neutral conditions.

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