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THERMOLYSIS AND PHOTOLYSIS OF 1,3,4-OXATHIAZOLE-2-ONES: I

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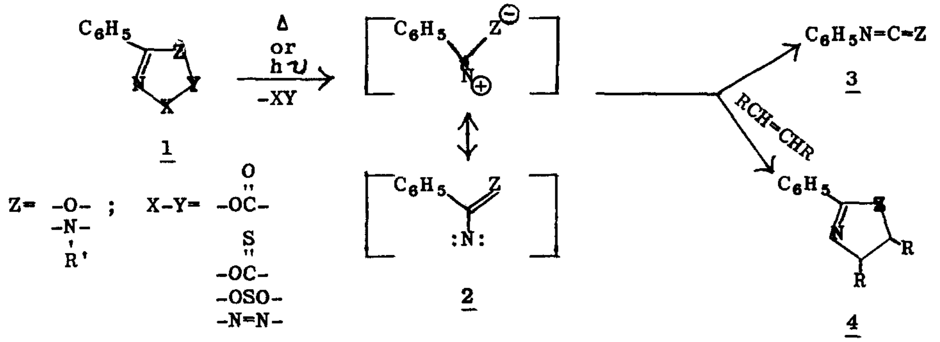
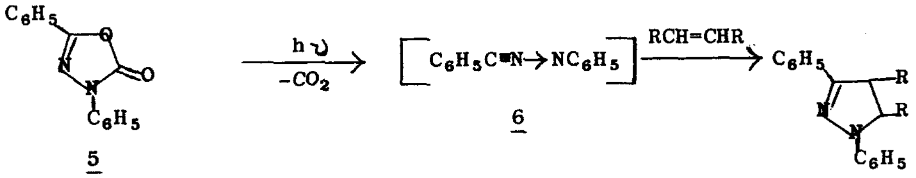
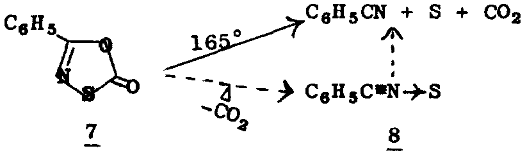
The thermolysis and photolysis of various oxazoles, diazoles and triazoles 1 have been reported (1a,1b) to generate labile 1,3-dipoles (nitrenes) 2 which subsequently rearrange to cumulene structures 3 or react with certain dipolarophiles (when present) to yield 1,3-dipolar adducts 4.



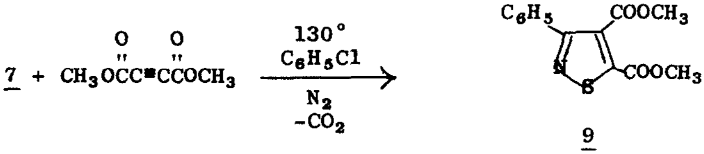
The oxadiazolone 5 is thermally stable but has been reported (1b) to undergo photolysis in the presence of dipolarophiles to yield adducts related to the nitrile imine 6.



In contrast to these results, the oxathiazolone 7 is thermally labile (2) but yields benzonitrile and sulfur instead of 3 and COS.

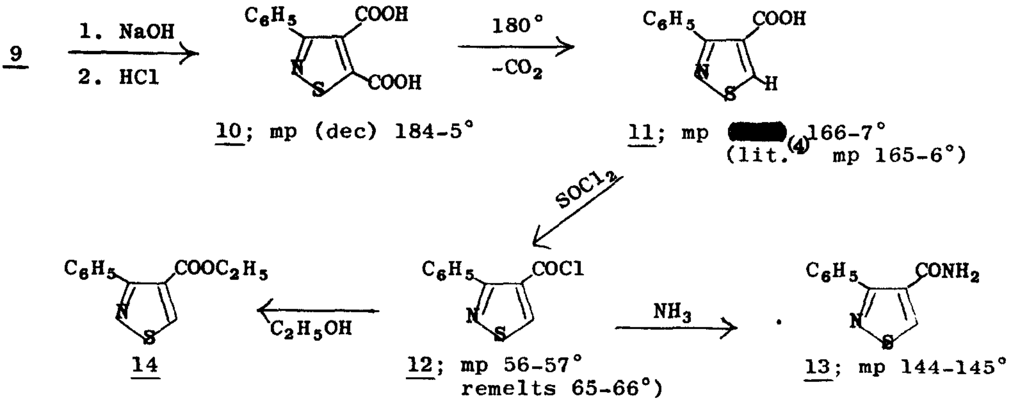


The possible intermediate formation of a thermally labile benzonitrile sulfide 8, in this decomposition is of considerable interest. We have now studied the decomposition of 7 in the presence of activated dipolarophiles and have isolated 1,3-dipolar adducts related to 8. Thus, a mixture of 7 and a one molar excess of dimethyl acetylenedicarboxylate in chlorobenzene heated at 130° produced dimethyl 3-phenylisothiazole-4,5-dicarboxylate 9, mp 72-73°, in >90% yield (glc analysis).



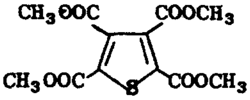
Anal. Calcd for $C_{13}H_{11}NO_4S$: C, 56.31; H, 4.00; N, 5.05; S, 11.56. Found: C, 56.47; H, 4.02; N, 4.93; S, 11.69. IR (mineral oil mull) 5.8μ (ester carbonyl); nmr ($CDCl_3$) δ3.99 (s, 3, CH_3O), 4.02 (s, 3, CH_3O), 7.6 (m, 5, ArH); mass spectrum (70 ev) *m/e* 277, 262, 246, 215, 187, 159, 135, 103, 77. The mass spectrum is indicative (3) of the isothiazole structure. Product 9 was further characterized by the degradative sequence outlined in Chart 1.

Chart 1



The infrared spectra and C, H, and N analyses of 10-14 were in agreement with the structures proposed. The mass spectrum (70 ev) of 14 was consistent with that of the methyl ester (3): *m/e* 233, 204, 188, 160, 135, 130, 116, 103, 85, 77, 63, 57.

In contrast to the results obtained with 7, a mixture of dimethyl acetylenedicarboxylate, sulfur, and benzonitrile under the same conditions produced tetramethyl thiophenetetracarboxylate 15, mp 126-127° (lit.(5) mp 126-128°).



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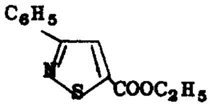

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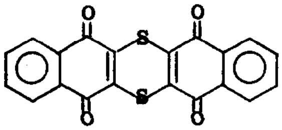

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There was no indication of isothiazole or thiazole (6) formation under these conditions. There was also no evidence for thiadiazole (7) formation when benzonitrile and sulfur were heated at 130° either in the presence or absence of amine catalysts.

A mixture of 7 and two molar equivalents of ethyl propiolate heated at 130° produced the two isomeric esters 14 and 16 each in 35% yield. The esters were readily separated by column chromatography (silica gel, 1:1 hexane-benzene). Recrystallization of 16 from hexane gave material with mp 65-66°. Anal. Calcd for $C_{12}H_{11}NO_2S$: C, 61.78; H, 4.75; N, 6.00; S, 13.74. Found: C, 61.97; H, 4.71; N, 6.06; S, 13.60.

Hydrolysis of 16 with dilute alkali produced 3-phenylisothiazole-5-carboxylic acid, mp 184-5° (lit. (8) mp 184-6°). The infrared spectrum of our product was identical with that of authentic material. The nmr spectra of 14 and 16 are readily differentiated (4) by the singlet absorptions (δ9.4 and 8.2, respectively) due to the 5- and 4- isothiazole ring protons.

An equimolar mixture of 7 and 1,4-naphthoquinone heated at 130° yielded benzonitrile and the dithiin 17, mp 306° (dec), [lit. (9) mp 302 (dec)]. Under the same conditions, however, an equimolar mixture of sulfur and 1,4-naphthoquinone did not react when heated in benzonitrile. These results suggest the possible intermediate formation of a labil adduct between the quinone and 7 or 8.

In contrast to the thermal condensation between 7 and dimethyl acetylenedicarboxylate, photolysis of these reactants (Rayonet reactor, N_2) in ethyl acetate at 2537 Å produced only benzonitrile and sulfur. Irradiation at 3000 Å or 3600 Å (in the presence or absence of the triplet sensitizer benzophenone) did not induce decomposition of 7 or adduct formation.

The formation of the isomeric isothiazoles 14 and 16 from 7 and methyl propiolate is similar to the production of the analogous isoxazoles from benzonitrile oxide (10) and is contrary to strictly ionic or radical addition reactions. Reaction *via* 8 or an intermediate complex (11) between thiazolone 7 and dipolarophile could equally well explain the results. At the present time kinetic experiments are being carried out to distinguish between these alternatives. Finally, the scope of this new condensation reaction and isothiazole synthesis is being actively investigated using a variety of oxathiazolones and dipolarophiles.

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