Tetrahedron Letters, Vol. 33, No. 20, pp. 2845-2846, 1992
Printed in Great Britain

0040-4039/92 $5.00 + .00
Pergamon Press Ltd

The Photolysis Of Ethyl 5-Oxo-2-Phenyl-2,5-Dihydroisoxazole-4-Carboxylate In Amines And Alcohols

Kiah H. Ang and Rolf H. Prager*

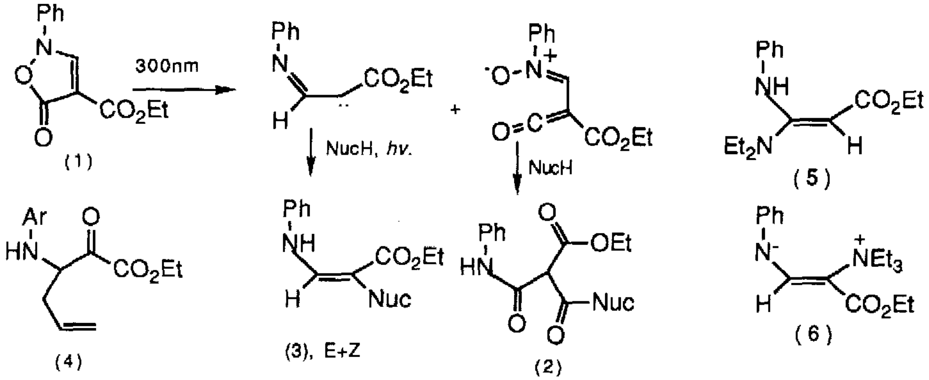
School of Physical Sciences, Flinders University, G.P.O. Box 2100, Adelaide, South Australia 5001.

Key Words: isoxazolinone; photolysis; ketene; carbene.

This paper is dedicated to Professor Herbert C. Brown on the occasion of his 80th birthday.

Abstract: Ethyl 5-oxo-2-phenyl-2,5-dihydroisoxazole-4-carboxylate(1) has been photolysed at 300 nm in a variety of alcohols and amines. The products suggest two competing photolytic pathways: reversible photoisomerisation to a ketene, and a loss of carbon dioxide to form a singlet imino-carbene.

Apart from a brief report by Sasaki and co-workers[1], no information is available on the photolysis of isoxazol-5(2H)-ones. We were interested in these compounds as possible muscle relaxants[2], and noted that they were very labile to light in either the solid state or in solution. We have investigated the fate of such compounds when photolysed at 300 nm, and have defined two major pathways for the reactions involved. Sasaki[1] suggested that photolysis involved loss of carbon dioxide to form an inimocarbene, which was trapped by methanol. We detail here our studies with ethyl 5-oxo-2-phenyl-2,5-dihydroisoxazole-4-carboxylate(1), but have examined a large number of similar compounds and find the two photolytic pathways to be general. The products of photolysis were wavelength dependent: no reaction at all occurred at 350 nm, but at 300 nm (Pyrex filter) a mixture of the ketene derived product (2) and the carbene derived product (3) was formed, the proportion depending on the nature of the alcohol (Scheme 1, Table 1). When lower wavelengths were used, or the "300 nm"[3] light was unfiltered, the proportion of the ketene derived product (2) increased.



Scheme 1

If the nucleophilicity of the alcohol was increased by the addition of pyridine, the yield of ketene derived material (2) increased, whereas addition of a small amount of acetic acid increased the proportion of carbene product (3). No hydrogen abstraction or radical derived products were noted, suggesting the carbene intermediate was exclusively the singlet: the presence of the triplet quencher and sensitiser, 9-methylanthracene and benzophenone respectively had no effect on the yields of either product. Less reactive alcohols reacted mainly with the more reactive carbene, suggesting that ketene formation was reversible. The product (3) from allyl alcohol underwent the Claisen rearrangement even at room temperature to give (4). We conclude that isomerisation of the isoxazolone to the ketene occurs rapidly and reversibly, particularly on shorter wavelength irradiation, the ketene reacting only with the more reactive nucleophiles. Loss of carbon dioxide, surprisingly, requires less energy.

Table 1. Products[a] from the Photolysis of (1) in Alcohols at 300 nm

	%(2); Nuc=OR		%(3); Nuc=OR	
Alcohol	pyrex	silica	pyrex	silica
MeOH	32	61	63	34
EtOH	64	100	37	0
1-PrOH	30	61	65	36
1-BuOH	21	71	74	24
2-PrOH	0	68	100	25
t-BuOH	0	0	96	66
allyl	0	0	76[b]	90[b]
propargyl	0	0	59	38

[a] yields of pure isolated material

[b] Claisen rearrangement product (4)

Photolysis of (1) in amines gives the expected products from the two intermediates, as shown in Table 2.

Table 2. Products from the Photolysis of (1) in Amines at 300 nm.

	%(2); Nuc=NR_2		%(3); Nuc=NR_2	
Amine	pyrex	silica	pyrex	silica
$PhNH_2$	0	0	85	95
$BuNH_2$	37[a]	80[a]	0[b]	0[b]
$tBuNH_2$	31	55	58	15
Et_2NH[c]	21	65	48	15
iPr_2NH	5	55	69	35
Et_3N	15[d]	43[d]	61[d]	21[d]

[a] ester/amine exchange occurred totally

[b] carbene derived material appears to polymerise

[c] 16% of the non-photochemical product (5) isolated

[d] products the same as from diethylamine

As expected, the more nucelophilic amines reacted predominantly with the first formed ketene, with more hindered amines such as t-butylamine or diisopropylamine giving significant proportions of carbene-derived products. Surprisingly, aniline gave only carbene products, and the reason for this is not clear at this stage. Triethylamine gave the same products as were isolated from the use of diethylamine. Presumably the intermediate betaines (e.g. (6)) lose ethylene readily.

Although the ketene derived products (2) are the same as those expected from reaction of alkoxides with (1)[4], no reaction of (1) with alcohols occurs in the dark. The reactions observed by Pepino and coworkers[5] can now be understood to be photochemical. Tables 1 and 2 indicate that photolysis of isoxazolones, in 2-propanol or t-butyl alcohol in particular, offers ready access to highly functionalised alkenes, whose chemistry has been poorly explored. In particular, these compounds may act as synthetic equivalents to the highly reactive enamynes, which undergo a variety of cycloaddition reactions.[6]

Acknowledgements: The authors are grateful for financial support from the Australian Research Council.

References and Notes.

1. Sasaki, T.; Hayakawa, K.; Nishida, S., **J. Chem. Soc., Chem. Commun.**, 1980, 1054-1055.
2. Prager, R.H.; Hung, T.V.; Janowski, W.K., **Aust. J. Chem.**, 1985, **38**, 931-937.
3. A Rayonet photochemical reactor using 16 x 8 watt tubes was used.
4. Woodman, D.J.; Borman, C.H.; Tontapanish, N.; Stonebraker, P.M., **J. Org. Chem.**, 1969, **34**, 2981-2983.
5. Pepino, R; Belgodere, E.; Bossio, R.; Parrini, V., **Chimica e Industria**, 1975, **57**, 783.
6. Bloxham, J., Della, C. P., **Tetrahedron Lett.**, 1991, 32, 4051-4054.

(Received in UK 28 February 1992)