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REMOTE PHOTOCYCLIZATION.

PHOTOCHEMICAL MACROCYCLIC SYNTHESIS WITH N-(ω-METHYLANILINO)ALKYLPHTHALIMIDES[1]

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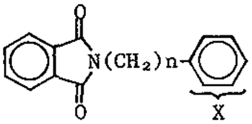
Upon irradiation a homologous series of N-(ω-methylanilino)-alkylphthalimides **4** undergo regioselective remote photocyclization to give medium- to large-sized diazacyclols **5**.

During the last decade the widespread involvement of charge-transfer complexes and exciplexes in photoreactions has been increasingly recognized and analyzed.[2] We have recently found that, in the photolysis of N-aralkylphthalimides **1** (X = electron-donating substituents), the cyclization occured best when n equaled 4, *i.e.*, when the usually unfavorable 8-membered transition state could be formed.[3] Furthermore, certain phthalimides **2** possessing a terminal sulfide function in their N-alkyl side chain undergo unusually facile regioselective remote photocyclization to give macrocyclic azathiacyclols **3**.[4] We now wish to report the new examples of the photocyclization of such bichromophoric systems in which an anilino group plays a role as the second chromophore.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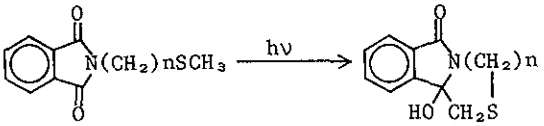
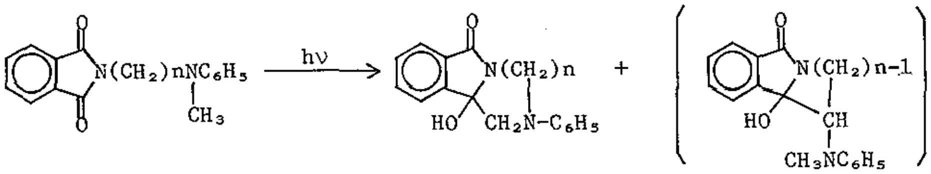

2 3

A homologous series of N-(ω-methylanilino)alkylphthalimides (4), with side chains varying from n = 1 to 12, were prepared by reactions of ω-bromoalkylphthalimides and N-methylaniline. A solution of 4 (2.4 - 3.6 M; acetone : pet. ether = 1 : 2.7) was irradiated with a 500-W high-pressure mercury lamp in a stream of nitrogen for 1.5 - 2.5 hr. As listed in Table I,[5] in all examples studied the photolysis afforded mainly the expected cyclized products, up to 16-membered (5h), as a result of C-C bond-formation between the imide carbonyl and the N-methyl group, though the isolation yields were relatively low.


4 5 6

In a representative example, the structural assignment for 5c was based on: (i) the presence of the cyclol moiety [amide (ir, $CHCl_3$, 1690 cm^{-1}), hydroxyl (3300 cm^{-1}) and a methylene (instead of methyl in 4c; NMR ($CDCl_3$), 3.95 ppm, s)]; (ii) the composition [mass m/e M^+, 294; elemental analysis] and (iii) by analogy with the previous cyclization.[4] In most cases examined (5b-h), they were readily converted by treatment with HCl-EtOH to the corresponding dehydrated products (7) in support of the postulated cyclol structures.

Much attention has recently been centered on "remote" photoreactions with regard to theoretical studies of cyclization[6] and reactions of nonconjugated bichromophoric systems.[7] In the latter molecules, processes may occur which do not take place in a solution of the monofunctional derivatives.

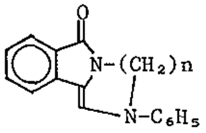
In fact, Davidson and Lewis reported that the compounds (4a-d) do exhibit charge-transfer transitions in their uv spectra.[8] In addition, the higher homologs (4e-h) also showed the similar absorption although the intensity was relatively low. However, wavelength dependency studies of this cyclization revealed that the excitation of the charge-transfer absorption region is not significant for the reaction.

Table I Photoproducts from 4

Substrate		Product 5			
4	n	ring size	mp(°C)	% yield	(starting material)
a	1	5	177 - 178.5	13	(83)
b	2	6	169 - 170.5	12	(61)
c	3	7	206 - 207.5	20	(63)
d	4	8	207.5 - 209	6[a)]	(73)
e	5	9	192 - 194	15	(66)
f	6	10	159 - 161	10	(51)
g	10	14	176 - 177	8	(16)
h	12	16	191 - 192	9	(22)

a) accompanied by 6d (mp 199 - 201°; 5 %).

It is worth noting that in a flexible system such as 4 the medium and large rings are formed with facility and regioselectivity. Tentatively the remote photocyclization may be rationalized by rapid proton transfer from an amino cation radical 8 initially formed by electron transfer by virtue of a postulated charge-transfer complex in the excited state.[9] This assumption, coupled with the results from 1[3] and 2[4], encourages applications of the "photolysis of donor-acceptor pair systems" for general synthetic purposes.



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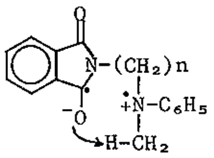

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REFERENCES AND NOTES

1 a) Photoinduced Reactions. XXXI. Part XXX: Y. Kanaoka and E. Sato, submitted. b) Photochemistry of the Phthalimide System. XVII. Part XVI: ref. 1a).

2 M. Gordon and W.R. Ware, Ed., "The Exciplex", Academic Press, New York, 1975.

3 Y. Kanaoka and Y. Migita, Tetrahedron Lett., 1974, 3693.

4 Y. Sato, H. Nakai, T. Mizoguchi, Y. Hatanaka, and Y. Kanaoka, J. Am. Chem. Soc., 1976, **98**, 2349.

5 All new compounds gave satisfactory analyses and their structures were supported by spectral (uv, ir, NMR, Mass) data.

6 M.A. Winnik, Accounts Chem. Res., 1977, **10**, 173.

7 F.C. De Schryver, N. Boens, and J. Put, "Advances in Photochemistry", eds. by J.N. Pitts, Jr., G.S. Hammond, and K. Golinick, Interscience, New York, 1977, Vol. 10, p. 359.

8 R.S. Davidson and A. Lewis, Tetrahedron Lett., 1974, 611.

9 The similar mechanism has been put forward also for intermolecular photoreactions of phthalimides and amines.[10] When this manuscript was in preparation, an analogous photocyclization of N-(dibenzylaminomethyl)-phthalimide was reported; J.D. Coyle and G.L. Newport, Tetrahedron Lett., 1977, 899.

10 Y. Kanaoka, K. Sakai, R. Murata, and Y. Hatanaka, Heterocycles, 1975, **3**, 719.

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