

Photochemical Synthesis of Phenanthro[9,10-*b*]furans

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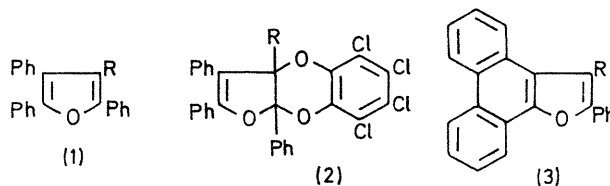
**Summary** 2,3,5-Triphenyl- and tetraphenyl-furan react with tetrachloro-1,2-benzoquinone to form adducts which undergo photolysis in propan-2-ol to give excellent yields of the 2-phenyl- and 2,3-diphenyl-phenanthro[9,10-*b*]furans respectively.

WE have previously demonstrated<sup>1</sup> that the photolysis of adducts of tetrachloro-1,2-benzoquinone and derivatives of tetraphenylcyclopentadienone gave good yields of phenanthro[9,10-*b*]furans. The synthetic use of this reaction is obvious since such a product is not formed by direct photolysis of tetraphenylcyclopentadienone.<sup>2</sup>

We now report the results obtained from studies with phenylfurans (1a) and (1b). 2,3,5-Triphenyl- and tetraphenylfuran were both treated with tetrachloro-1,2-benzoquinone to give adducts (2a)† and (2b), respectively. These adducts were photolysed‡ under nitrogen as suspensions in propan-2-ol to give excellent yields of the phenanthrofurans (3a) (85%) [ $\tau$  (CDCl<sub>3</sub>) 1.25–1.45 (2H, m), 1.90–2.15 (3H, m), and 2.25–2.65 (9H, m)] and (3b) (79%) [1.25–1.65 (2H, m) and 2.35–2.95 (16H, m)].

Subsequently it was demonstrated that the triphenylfuran (1a) did not give phenanthrenoid products on photolysis in cyclohexane-iodine. It did, however, undergo photochemical decomposition. Other workers<sup>4</sup> have shown that tetraphenylfuran (1b) behaves similarly. This result is in accord with the theoretical predictions<sup>4,5</sup> that if the

sum of free-valence indices ( $\Sigma Fr^*$ ) of the reacting centres is less than unity then photocyclisation will not take place ( $\Sigma Fr^* = 0.952$  for tetraphenylfuran<sup>4</sup>).



a; R = H    b; R = Ph

The method developed by us for these cyclisations has obvious advantages and apparently provides a route by which the electronic effects which prevent cyclisation in the parent molecules are circumvented.

All new compounds gave spectral and analytical data in accord with the proposed structures.

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† This adduct was assigned the structure (2a) on the basis of its n.m.r. spectrum which showed, in addition to aryl absorptions, a one-proton singlet at  $\tau$  4.17. This absorption is in a position comparable to that reported<sup>3</sup> for the 2,5-diphenylfuran-tetrachloro-1,2-benzoquinone adduct at  $\tau$  4.31.

‡ Photolyses were carried out under nitrogen in an immersion apparatus with a Pyrex filter and a 450 W medium-pressure mercury arc lamp.

<sup>1</sup> W. M. Horspool, *Chem. Comm.*, 1969, 467; *J. Chem. Soc. (C)*, 1971, 400.

<sup>2</sup> I. Moritani, N. Toshima, S. Nakagawa, and M. Yakushiji, *Bull. Chem. Soc. Japan*, 1967, **40**, 2129; I. Moritani and N. Toshima, *Tetrahedron Letters*, 1967, 357, 467.

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<sup>4</sup> W. H. Laarhoven, Th. J. H. M. Cuppen, and R. J. F. Nivard, *Rec. Trav. chim.*, 1968, **87**, 687.

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