Synthesis of Stable Acyl Nitroxides

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Summary The preparation and isolation of several acyl t-alkyl nitroxides is reported.

Recent e.s.r. observations on alkoxycarbonyl t-butyl nitroxides[1] led us to conclude that such radicals might be sufficiently stable to be isolated. Acylation of *N*-t-butylhydroxylamine with ethyl chloroformate was therefore investigated, and this gave, depending on experimental conditions, up to 30% of mono-*N*-acylated product (**1a**). Oxidation of (**1a**) by nickel peroxide suspended in benzene yielded, as the sole product (t.l.c.), a blue oil which, on dilution with benzene, had an e.s.r. spectrum identical with that previously reported[1] for nitroxide (**2a**).† The blue product slowly decomposed giving, in an apparently clean

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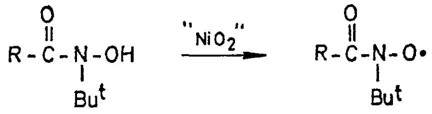
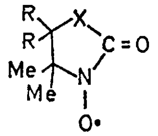
† *N*-Acylation[2] and arylation[3] of t-butylhydroxylamine, followed by oxidation of the products to nitroxides detectable by e.s.r. has been described previously, but examples of stable acyl nitroxides have apparently not been reported. As a group, acyl nitroxides may be more stable than previously recognised. For example, nickel peroxide oxidation of a dilute solution of *N*-hydroxyphthalimide in benzene gives[4] the corresponding diacyl nitroxide[5] (e.s.r.), which decays only slowly even after oxidant has been removed. Previous indications were that this was a particularly short-lived species.[5]

reaction, *N*-t-butyl-*O*,*N*-bisethoxycarbonylhydroxylamine and nitrosobutane.



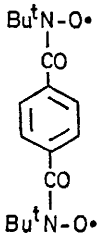
(1) (2)

a; R = EtO
b; R = Ph
c; R = *p*-PhC_6H_4
d; R = $CH_3(CH_2)_{14}$



(3)

a; R = H, X = O
b; R = Me, X = NH



(4)

N-Acylation of t-butylhydroxylamine with benzoyl chloride, followed by nickel peroxide oxidation, similarly gave (**2b**) as a green oil, and repetition of this sequence with *p*-phenylbenzoyl chloride gave (**2c**), a green solid, m.p. 59°, [λ_{max} 360,645 nm (ϵ 232,33)]. These aroyl nitroxides seemed to be indefinitely stable either alone or at room temperature in benzene.

O-Acylation of t-butylhydroxylamine usually predominates over *N*-acylation. For example, a maximum of 5% *N*-acylation was achieved in experiments with dimethylcarbamoyl chloride, and with benzoyl chloride *N*-acylation accounts for only 20% of the product. The problem of selective *N*-acylation has in part been overcome by the sequence *O*-acetylation, *N*-acylation, and hydrolytic removal of the acetyl group. This approach provides a superior route to *N*-benzoyl-t-butylhydroxylamine (**1b**), and has also permitted the synthesis from terephthaloyl chloride of the biradical (**4**), a green solid m.p. 84—85°. A similar approach using palmitoyl chloride led to the isolation of the palmitoyl nitroxide (**2d**), a moderately stable blue oil.

In an attempt to determine whether the instability of (**2a**) was due to spontaneous fragmentation into nitroso-compound and alkoxycarbonyl radical,[6] the two fragments were incorporated into a ring in (**3a**), which was obtained from $HOCH_2C(Me)_2NHOH$ by reaction with phosgene and subsequent oxidation. The product, a blue oil, decomposed more rapidly than did (**2a**), and yielded a complex mixture of products. This result is reminiscent of the instability of the (yellow) nitroxide (**3b**) which decomposed on attempted isolation,[7] although in that case the NH group affords a potentially labile reaction site. Preliminary kinetic studies with (**3a**), and with the much shorter-lived *p*-anisyl ethoxycarbonyl nitroxide, have yielded fractional orders of reaction, and suggest that a more complicated decay scheme than either unimolecular fragmentation[6] or a direct bimolecular process[8] may be operating.

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[1] C. M. Camaggi, R. J. Holman, and M. J. Perkins, *J.C.S. Perkin II*, 1972, 501.
[2] H. G. Aurich and K. Stork, *Tetrahedron Letters*, 1972, 555.
[3] H. G. Aurich and K. Kabs, *Angew. Chem. Internat. Edn.*, 1970, **9**, 636.
[4] M. J. Perkins and B. P. Roberts, unpublished observations.
[5] H. Lemaire and A. Rassat, *Tetrahedron Letters*, 1964, 2245; A. Calder, A. R. Forrester, and R. H. Thomson, *J. Chem. Soc.* (*C*), 1969, 512.
[6] A. R. Forrester, M. M. Ogilvy, and R. H. Thomson *J. Chem. Soc.* (*C*), 1970, 1081.
[7] E. F. Ullman, L. Call, and J. H. Osiecki, *J. Org. Chem.*, 1970, **35**, 3623.
[8] T. R. Oliver and W. A. Waters, *J. Chem. Soc.* (*B*), 1971, 677.