

## ***NN'*-Dialkoxy-*NN'*-bis(trifluoromethyl)hydrazines, Novel Products from the Reaction of Alkoxy Radicals with Trifluoronitrosomethane**

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Alkoxy radicals, generated by nitrite photolysis, react with trifluoronitrosomethane to yield *NN'*-dialkoxy-*NN'*-bis(trifluoromethyl)hydrazines. An  $^{18}\text{O}$ -labelling experiment indicated complete retention of the alkoxy-oxygen atom. When the products are heated with thioglycolic acid, cracking leads to the hydroxylamines,  $\text{RO}\cdot\text{NH}\cdot\text{CF}_3$ . For the case where R is 1-adamantyl, further stepwise conversion into *O*-(1-adamantyl)hydroxylamine has been achieved.

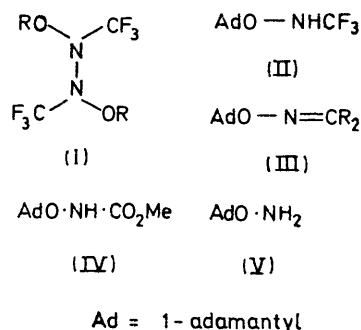
PHOTOLYSIS of nitrite esters constituted a convenient and mild method for the generation of alkoxy radicals which can then serve as key intermediates in a number of synthetic processes.<sup>1</sup> We now report that photolysis of nitrite esters in the presence of trifluoronitrosomethane leads to *NN'*-dialkoxy-*NN'*-bis(trifluoromethyl)hydrazines (I), a novel class of compounds.

1-Adamantyl nitrite in chlorobenzene-acetonitrile at  $-30^\circ$  was irradiated with a high-pressure mercury lamp

<sup>1</sup> See for example, R. H. Hesse, *Adv. Free Radical Chem.*, 1968, **3**, 83; D. H. R. Barton, T. J. Bentley, R. H. Hesse, F. Mutterer, and M. M. Pechet, *Chem. Comm.*, 1971, 912; M. P. Bertrand and J. M. Surzur, *Bull. Soc. chim. France*, 1973, 2393; R. Nougier and J. M. Surzur, *ibid.*, p. 2399; J. Allen, R. B. Boar, J. F. McGhie, and D. H. R. Barton, *J.C.S. Perkin I*, 1973, 2402.

while trifluoronitrosomethane was slowly bubbled in. When no nitrite remained, work-up gave in high yield a crystalline compound,  $C_{22}H_{30}F_6N_2O_2$  (microanalysis and molecular weight). The simplicity of the  $^1H$  and  $^{19}F$  n.m.r. spectra indicated the symmetrical dimer structure (I; R = 1-adamantyl). Similar arguments applied to the analogous product (I; R = cholestan-3 $\beta$ -yl) obtained by using cholestanyl nitrite. In both cases the highest mass peak in the mass spectrum corresponded to the species  $RO\cdot N=CF_2$ .

When heated in hexane the dimer (I; R = 1-adamantyl) underwent ready dissociation such that, in the presence of the radical trap thioglycolic acid, the sole product was the hydroxylamine (II). Spectroscopic data (see Experimental section) clearly indicated the presence of the part structure  $-NH\cdot CF_3$ . Furthermore, with 1 equiv. of base (most conveniently di-isopropylamine in hexane), the hydroxylamine (II) underwent the expected loss of hydrogen fluoride to give the difluoro-imine (III; R = F). As further proof of its structure the latter compound was converted in a stepwise manner into *O*-(1-adamantyl)hydroxylamine (V). Treatment with sodium methoxide in dry methanol gave the dimethoxyimine (III; R = OMe), which with

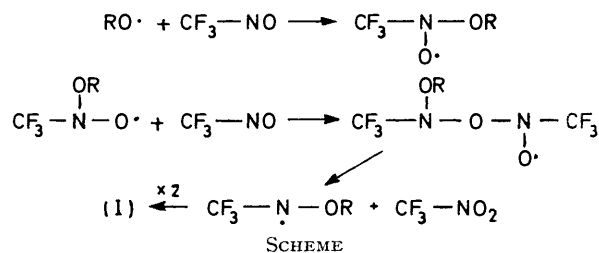


anhydrous lithium iodide in ether at room temperature afforded the carbamate (IV). Finally, hydrolysis with methanolic potassium hydroxide solution gave the required hydroxylamine (V). From a preparative standpoint the hydroxylamine (V) was best obtained by treatment of the trifluoromethylamine (II) with 3.5 equiv. of sodium methoxide in wet methanol. If the product at this stage showed i.r. absorption at  $1660\text{ cm}^{-1}$  (dimethoxy-imine) the mixture was treated with anhydrous lithium iodide prior to the final basic hydrolysis. In this manner an overall yield of 56% was obtained.

To gain insight into the mechanism of formation of the dimers (I), adamantan-1- $^{18}O$ ol was prepared by quenching of 1-bromoadamantane-silver hexafluoroantimonate complex with deuterium [ $^{18}O$ ]oxide. Mass spectrometry indicated that the dimer (I; R = 1-adamantyl), assessed as the fragment  $AdO\cdot N=CF_2$ , had the same  $^{18}O:^{16}O$  ratio as the adamantan-1-ol from

<sup>2</sup> R. J. Crawford and R. Raap, *J. Org. Chem.*, 1963, **28**, 2419; J. H. Cooley, M. W. Mosher, and M. A. Khan, *J. Amer. Chem. Soc.*, 1968, **90**, 1867; T. Koenig, J. A. Hoobler, and W. R. Mabey, *ibid.*, 1972, **94**, 2514.

which it was formed. A mechanism consistent with this result is shown in the Scheme. Dimerisation of radicals of the type  $RO\dot{N}COR'$  is well documented.<sup>2</sup>



When 1-adamantyl nitrite was photolysed in the presence of trichloronitrosomethane the only product identified other than adamantan-1-ol was the dichloroimine (III; R = Cl), produced in low yield. This was further identified by conversion into the dimethoxyimine (III; R = OMe).

#### EXPERIMENTAL

General directions are as previously described<sup>3</sup> except in the use of carbon tetrachloride as the solvent for n.m.r. measurements.

*NN'*-Bis-(1-adamantyloxy)-*NN'*-bis(trifluoromethyl)hydrazine (I; R = 1-adamantyl).—Adamantan-1-ol (2.5 g) was converted into the nitrite ester by using nitrosyl chloride in pyridine.<sup>4</sup> This nitrite was placed in a carefully dried Pyrex photolysis apparatus and dry, degassed acetonitrile-chlorobenzene (170 ml; 1:1) was added under a stream of argon. The solution was cooled to  $-30^\circ$ , the argon flow stopped, and trifluoronitrosomethane<sup>5</sup> slowly bubbled through the solution during irradiation with a 200 W high-pressure mercury lamp. After 1.5 h no nitrite remained, and 4 g of trifluoronitrosomethane had been added. The solution was purged with argon and then concentrated *in vacuo* at  $45^\circ$  to yield a pale yellow residue. This residue, in chloroform, was washed with saturated potassium carbonate solution, then treated with charcoal. The solid thus obtained was crystallised from chloroform-ethanol to give the dimer (I; R = 1-adamantyl) (80% based on adamantan-1-ol, including material from p.l.c. of mother liquors), m.p.  $150-151^\circ$ ,  $\nu_{\max}$ . 1220br and  $1065\text{ cm}^{-1}$ ,  $\delta$  1.65, 1.88, and 2.18 (each broad s),  $\phi^*$  +67.2, *m/e* 215 (highest peak; no  $M^+$ ), *M* (by osmometry) 443 (in benzene) and 439 (in chloroform) ( $C_{22}H_{30}F_6N_2O_2$  requires 468) (Found: C, 56.4; H, 6.5; F, 24.2; N, 5.7.  $C_{22}H_{30}F_6N_2O_2$  requires C, 56.4; H, 6.45; F, 24.3; N, 6.0%). Similarly, cholestan-3 $\beta$ -yl nitrite yielded the dimer (I; R = cholestan-3 $\beta$ -yl) (45%), m.p.  $188-190^\circ$ ,  $\nu_{\max}$ . 1245, 1190, and  $1010\text{ cm}^{-1}$ ,  $\phi^*$  +70.0, *m/e* 451 and 371 (no  $M^+$ ) (Found: C, 71.5; H, 9.9; F, 12.3; N, 2.3.  $C_{56}H_{94}F_6N_2O_2$  requires C, 71.45; H, 10.1; F, 12.1; N, 3.0%).

*O*-(1-Adamantyl)hydroxylamine (V).—The dimer (I; R = 1-adamantyl) (600 mg) in dry tetrahydrofuran (18 ml) was refluxed under argon with thioglycolic acid (0.9 ml) for 3 h. Hexane (60 ml) was added and the solution was washed with saturated aqueous sodium hydrogen carbonate, then water, and dried. Evaporation gave the hydroxylamine

<sup>3</sup> D. H. R. Barton, R. H. Hesse, M. M. Pechet, and T. J. Tewson, *J.C.S. Perkin I*, 1973, 2365.

<sup>4</sup> D. H. R. Barton, J. M. Beaton, L. E. Geller, and M. M. Pechet, *J. Amer. Chem. Soc.*, 1961, **83**, 4076.

<sup>5</sup> R. N. Haszeldine and J. Jander, *J. Chem. Soc.*, 1953, 4172.

(II) as an oil (570 mg),  $\nu_{\max}$  3240 (NH)  $\text{cm}^{-1}$ ,  $\delta$  5.4 (1H, q,  $J$  10 Hz,  $\text{NHCF}_3$ ),  $\phi^*$  +69 (d,  $J$  10 Hz,  $\text{NHCF}_3$ ). This hydroxylamine (II) (570 mg) in hexane (20 ml) containing di-isopropylamine (0.36 ml) was left for 0.5 h. The precipitated di-isopropylammonium fluoride was filtered off. The filtrate was evaporated and the residual oil, in chloroform, passed through a column of silica (15 g) to give the difluoro-imine (III; R = F) (440 mg, 84%),  $\nu_{\max}$  (film) 1740, 1075, and 1025  $\text{cm}^{-1}$ ,  $\delta$  2.15, 1.84, and 1.6 (each broad s), and  $\phi^*$  +91.5 and +64 (each 1F, d,  $J$  34 Hz). The difluoro-imine (III; R = F) or the hydroxylamine (II) in dry methanol containing an excess of sodium methoxide was stirred at room temperature overnight. The mixture was poured into water; filtration then gave the dimethoxy-imine (III; R = OMe) (85%), m.p. 94—96°,  $\nu_{\max}$  1660, 1315, and 1105  $\text{cm}^{-1}$ ,  $\delta$  3.8 and 3.7 (each 3H, s) and 2.3—1.6 (15H, m, adamantyl),  $M^+$  239.1517 (Calc. for  $\text{C}_{13}\text{H}_{21}\text{NO}_3$ ;  $M$ , 239.1521).

The difluoro-imine (III; R = F) or the hydroxylamine (II) in wet methanol containing sodium methoxide (3.5 equiv.) was stirred at room temperature for 3 h. Water (in excess) was added and the mixture refluxed for 2 h, then evaporated. The residue was purified by p.l.c. to give the oily carbamate (IV) (55%),  $\nu_{\max}$  3250, 1750, 1258, 1240, 1120, 1105, and 1070  $\text{cm}^{-1}$ ,  $\delta$  7.5 (1H, s, exchanged with  $\text{D}_2\text{O}$ , NH), 3.67 (3H, s, OMe), and 2.1, 1.8, and 1.6 (each broad s, adamantyl). The same compound (i.r., n.m.r.) was also obtained by treatment of the dimethoxy-imine (III; R = OMe) with anhydrous lithium iodide in ether at room temperature (demethylation by iodide ion).

The carbamate (IV) (82 mg) in methanol (2 ml) was treated with 5% potassium hydroxide solution (2 ml) and the mixture refluxed for 1 h, then evaporated *in vacuo*.

The residue was partitioned between water and ether. The ethereal layer then afforded the hydroxylamine (V) (56%), m.p. 90—93° (after purification by sublimation),  $\nu_{\max}$  3260 and 1075  $\text{cm}^{-1}$ ,  $\delta$  4.55br (2H, exchanged with deuterium oxide) and 2.2—1.6 (15H, adamantyl) (Found: C, 71.8; H, 10.4.  $\text{C}_{10}\text{H}_{17}\text{NO}$  requires C, 71.8; H, 10.25%).

*Adamantan-1- $^{18}\text{O}$ ol.*—A suspension of silver hexafluoroantimonate (5.16 g) in dry ether (75 ml) at  $-78^\circ$  under argon was treated dropwise with 1-bromoadamantane (2.9 g) in ether (60 ml). After 0.5 h deuterium [ $^{18}\text{O}$ ]oxide (0.3 ml; 60%  $^{18}\text{O}$ ) was added, and the mixture allowed to warm to room temperature. After filtration, the ethereal solution was washed with water, then dried and evaporated. Crystallisation from acetone gave adamantan-1- $^{18}\text{O}$ ol (1 g; first crop), shown by mass spectrometry ( $M^+$  154 and 152) to contain ca. 40%  $^{18}\text{O}$ .

*O-(1-Adamantyl)-N-dichloromethylenehydroxylamine* (III; R = Cl).—Photolysis of 1-adamantyl nitrite in the presence of trichloronitrosomethane<sup>6</sup> as described for the corresponding fluoro-compound, except for the addition of pyridine (1.5 ml) to the reaction mixture, afforded, after removal of all solvents *in vacuo* and selective sublimation, adamantan-1-ol and the dichloro-imine (III; R = Cl) (5%) as the only identified products. The latter had m.p. 26° (purified by sublimation at 55° and 0.3 mmHg) (Found: C, 53.15; H, 6.1; N, 5.7%;  $M^+$ , 247.0526.  $\text{C}_{11}\text{H}_{15}\text{Cl}_2\text{NO}$  requires C, 53.2; H, 6.1; N, 5.6%;  $M$ , 247.0531). Treatment with sodium methoxide in dry methanol as already described gave the dimethoxy-imine (III; R = OMe), identical with an authentic sample.

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<sup>6</sup> H. Sutcliffe, *J. Org. Chem.*, 1965, **30**, 3221.