Darco was added. The mixture was filtered, concentrated, and cooled giving 10.6 g. of β-chloropropionohydroxamic acid, m.p. 104–106°. This compound gives an intense red-purple color with aqueous ferric chloride.[5] A sample was recrystallized for analysis, m.p. 106–107°.

Anal. Calc'd for $C_3H_6ClNO_2$: C, 29.2; H, 4.9; N, 11.3. Found: C, 29.7; H, 5.1; N, 11.1.

3-Isoxazolidone. One gram of β-chloropropionohydroxamic acid was dissolved in 150 ml. of water, 16.5 ml. of 1*N* sodium hydroxide (a slight excess over two equivalents) was added, and the solution was warmed to 50°. The reaction was complete after 5 min. as shown by the fact that an aliquot of the solution after acidification did not give a color with aqueous ferric chloride. The solution was concentrated to 5 ml. under reduced pressure, 8.2 ml. of 1*N* hydrochloric acid was added, and the resulting solution was evaporated to dryness under reduced pressure. The crystalline residue was extracted with ethanol. Evaporation of the ethanol left 0.70 g. of a crystalline residue which was extracted with three 100-ml. portions of boiling ether. The ether extracts were combined and concentrated to 20 ml. On cooling, 3-isoxazolidone separated as a white crystalline solid m.p. 68–70°; wt. 0.38 g. Recrystallization did not raise the melting point. The compound did not give a color with ferric chloride. However, when hydroxylamine was added first,[7] a positive test for a hydroxamic acid was obtained. The infrared spectrum in the solid state showed absorption in the 3–4 μ region, a broad absorption band at 5.8–6.0 μ and a strong 6.1 μ band. In solution (chloroform) it showed absorption at 3–4 μ and a strong band at 5.9 μ. The sample for analysis was sublimed *in vacuo*, m.p. 69–69.5°.

Anal. Calc'd for $C_3H_5NO_2$: C, 41.4; H, 5.8; N, 16.1, eq. wt. 87.1. Found: C, 41.9; H, 5.9; N, 16.6; eq. wt. 88.4.

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(7) The method of Boxer and Everett [*Anal. Chem.*, **21**, 670 (1949)] for the determination of total penicillins was used.

Reduction of *N*-Perfluoroalkyl Urethans with Lithium Aluminum Hydride

RALPH L. DANNLEY AND ROBERT G. TABORSKY[1]

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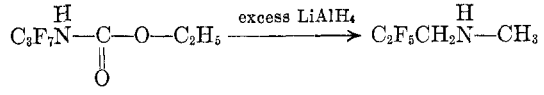
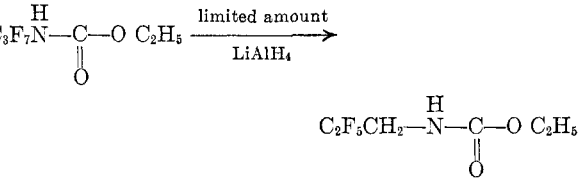
The reduction of simple N-alkyl urethans to the corresponding methylalkylamines by means of lithium aluminum hydride has been reported by several authors.[2] The present work was undertaken to determine the behavior of N-perfluoroalkyl urethans with the same reagent.

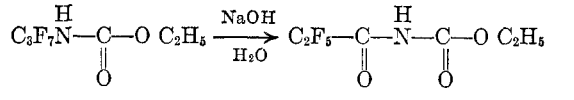
Since the reaction of perfluoroalkyl isocyanates with excess lithium aluminum hydride has been found[3] to produce 1,1-dihydroperfluoroalkylmethylamines, treatment of the corresponding urethans with an excess of the same reducing agent might be expected to give the identical amine products. This has now been confirmed, for the reaction of an excess of lithium aluminum hydride with ethyl N-*n*-perfluoropropylcarbamate and ethyl N-*n*-perfluoroheptylcarbamate produced the corresponding 1,1-dihydroperfluoroalkylmethylamines in yields of 60% and 51%, respectively.



Treatment of an N-perfluoroalkyl urethan with only a limited quantity of the hydride provided a competitive reaction in which only the most susceptible of the available functional groups could undergo reduction. Under these conditions it has been found that ethyl N-perfluoropropylcarbamate gives the corresponding N-1,1-dihydroperfluoroalkyl urethan in 63% yield. Therefore, the hydride reacts with the fluorine atoms alpha to the nitrogen in preference to the carbethoxyl group.



The hydrolysis of ethyl N-*n*-perfluoropropylcarbamate was attempted as a synthesis of ethyl N-perfluoropropionylcarbamate, a by-product in the reduction of the urethan. It was found that mild aqueous alkaline hydrolysis of the urethan gave an essentially quantitative yield of ethyl N-*n*-perfluoropropionylcarbamate.



This again emphasizes the susceptibility to displacement reactions of the fluorine atoms alpha to nitrogen. This type of reactivity has previously been observed[4] in the treatment of these urethans with alcohol.

EXPERIMENTAL

Reagents. Ethyl N-*n*-perfluoropropylcarbamate and ethyl N-*n*-perfluoroheptylcarbamate were prepared by treating the appropriate isocyanates with stoichiometric quantities of alcohol.[4] Ethereal solutions of lithium aluminum hydride were prepared in a Soxhlet apparatus and standardized by measuring the hydrogen evolved upon addition to butanol.

Ethyl N-Perfluoropropylcarbamate reduction with excess lithium aluminum hydride. A solution of 25 g. (0.0973 mole)

(1) From the thesis to be submitted by Robert G. Taborsky to the Graduate School of Western Reserve University in partial fulfillment of the requirements for the Doctor's degree.

(2) (a) Wessely and Swoboda, *Monatsh.*, **82**, 621 (1951); (b) Karrer and Nicolaus, *Helv. Chim. Acta.*, **35**, 1581 (1952); (c) Haggis and Owen, *J. Chem. Soc.*, 389 (1953); (d) Bruchhausen and Knabe, *Arch. Pharm.*, **287**, 601 (1954); (e) Dannley, Lukin, and Shapiro, *J. Org. Chem.*, **20**, 92 (1955); (f) Knabe, *Arch. Pharm.*, **288**, 469 (1955).

(3) Dannley, Taborsky, and Lukin, *J. Org. Chem.*, **21**, 1318 (1956).

(4) Dannley and Lukin, *J. Org. Chem.*, **21**, 1036 (1956).

of the urethan in 50 ml. of ether was added dropwise to 0.195 mole of lithium aluminum hydride dissolved in 140 ml. of ether. After the addition was complete, the mixture was refluxed for an hour and the excess hydride decomposed with water. A solution of 57 g. of potassium sodium tartrate in 100 ml. of water was added and, after stirring for an hour, the organic layer was separated and the aqueous layer extracted with three 100-ml. portions of ether. The combined ether solutions were dried over Drierite and distilled through a Todd spiral-wire column to give 9.6 g. (60% yield) of methyl-1,1-dihydroperfluoropropylamine (b.p. 61–62°), 1.5 g. of ethyl N-1,1-dihydroperfluoropropylcarbamate (b.p. 63–66° at 2 mm.), and 1.7 g. of nonvolatile residue.

The methyl-1,1-dihydroperfluoropropylamine was identified by conversion to the *p*-nitrobenzamide, m.p. 56–57.5° (lit.[3] m.p. 56–57°). Admixture with an authentic sample of the *p*-nitrobenzamide gave no depression of the melting point.

The intermediate fraction (b.p. 63–66° at 2 mm.) solidified on standing and after recrystallization from methanol-water had a m.p. of 57–57.5°. Mixture with an authentic sample of ethyl N-1,1-dihydroperfluoropropylcarbamate (see the following experiment) gave no depression of the melting point.

Reaction of lithium aluminum hydride with an excess of ethyl N-n-perfluoropropylcarbamate. This reaction was carried out in the same manner as the reduction just described, except that the ether solution of the hydride was added dropwise to the urethan to insure an excess of the carbamate at all times. From 25 g. (0.097 mole) of the urethan and 0.048 mole of lithium aluminum hydride were obtained 13.5 g. (63% yield) of ethyl N-1,1-dihydroperfluoropropylcarbamate (b.p. 81–83° at 16 mm.) and 6.5 g. of ethyl N-perfluoropropionylcarbamate (b.p. 102–104° at 16 mm.).

The ethyl N-1,1-dihydroperfluoropropylcarbamate melted at 57–58° after recrystallization from ethanol-water and the melting point was not depressed by admixture with an authentic sample. The authentic sample was prepared for comparison purposes by adding 0.016 mole of sodium hydroxide in 2 ml. of water to a well stirred mixture of 1.5 g. (0.008 mole) of 1,1-dihydroperfluoropropylamine hydrochloride,[5] 10 ml. of water, 5 ml. of ether, and 0.88 g. (.008 mole) of freshly distilled ethyl chlorocarbonate. The mixture, kept at 5° during the addition of the sodium hydroxide, was allowed to warm to room temperature, the organic layer was separated, and the aqueous layer was extracted with two 4-ml. portions of ether. The combined ether layers were dried over Drierite and the ether evaporated to give 1.5 g. (87.5% yield) of crude ethyl N-1,1-dihydroperfluoropropylcarbamate. One recrystallization from chloroform gave white crystals, m.p. 57.5–58°.

Anal. Calc'd for $C_6H_8F_5NO_2$: C, 32.60; H, 3.63. Found: C, 32.61; H, 3.83.

The identity of the ethyl N-perfluoropropionylcarbamate fraction (m.p. 59–60° after recrystallization from toluene) was established by admixture with an authentic sample (see the following experiment) to give no depression of the melting point.

Hydrolysis of ethyl N-n-perfluoropropylcarbamate. Addition of 5 g. (0.0194 mole) of ethyl N-*n*-perfluoropropylcarbamate to 6 ml. of 10% sodium hydroxide resulted in an exothermic reaction. When the reaction subsided, a crystalline precipitate formed which was separated by filtration and dried. This material, 4.9 g. (100% yield), melted at 60–61° (lit.[4] m.p. 60–61°) after recrystallization from toluene. The structure was confirmed by conversion to urethan and perfluoropropionamide by the method previously reported.[4]

Ethyl N-n-perfluoroheptylcarbamate reduction with excess lithium aluminum hydride. By a procedure identical with that described in the N-*n*-perfluoropropylurethan experiment, 17 g. (0.037 mole) of ethyl N-*n*-perfluoroheptylcarbamate in 35 ml. of ether were reduced with 0.09 mole of lithium aluminum hydride in 70 ml. of ether to give 6.81 g. (51% yield) of methyl-1,1-dihydroperfluoroheptylamine (b.p. 57–59° at 26 mm.; n_D^{20} 1.3120), 3.92 g. of ethyl N-1,1-dihydroperfluoroheptylcarbamate (b.p. 108–110° at 10 mm.), and 0.73 g. of nonvolatile residue.

The methyl-1,1-dihydroperfluoroheptylamine was identified by the similarity of its physical properties to those reported[3] for the amine (n_D^{20} 1.3119; b.p. 55° at 26 mm.) and by conversion to the benzamide, m.p. 63.5–64° (lit.[3] m.p. 63°).

The ethyl N-1,1-dihydroperfluoroheptylcarbamate was recrystallized from carbon tetrachloride to yield a white solid, m.p. 43–44°.

Anal. Calc'd for $C_{10}H_8F_{13}NO_2$: C, 28.5; H, 1.92. Found: C, 28.47; H, 2.00.

MORLEY CHEMICAL LABORATORY
WESTERN RESERVE UNIVERSITY
CLEVELAND 6, OHIO

(5) Haszeldine and Leedham, *J. Chem. Soc.*, 1548 (1953).

Preparation of 3-Substituted-2,5-Oxazolidinediones

ELIZABETH DYER, FRANCIS L. MCCARTHY, RICHARD L. JOHNSON, AND ELLIOTT V. NAGLE[1]

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Of the many 2,5-oxazolidinediones that have been prepared as intermediates for the formation of polyamino acids,[2] only a few contain substituents on the nitrogen. They include N-phenyl,[3] N-*p*-tolyl,[4] N-benzyl[5] and several N-alkyl groups.[6–8] None of these is a strongly electrophilic substituent. Therefore, it was of interest to study the effect of further variations in the nature of the nitrogen-bearing substituent on the ease of formation of the oxazolidinediones.

The N-substituted glycine derivatives were converted to the N-carboxy anhydrides by the phosgenation method of Farthing[9]:

$$RNHCH_2COOH \xrightarrow[COCl_2]{} O{-}CO{-}NR{-}CH_2{-}CO$$

The initial experiments in which R was *p*-methoxyphenyl were unsuccessful, since an N-chlorocarbonyl derivative was formed, which could not be cyclized. This result was unexpected, in view of the

(1) From the M.S. theses, University of Delaware, of F. L. McCarthy, 1956, R. L. Johnson, 1952, and E. V. Nagle, 1951.

(2) E. Katchalski, *Advances in Protein Chemistry*, Academic Press, New York, 1951, Vol. VI, p. 136.

(3) H. Leuchs and W. Manasse, *Ber.*, **40**, 3235 (1907).

(4) F. Fuchs, *Ber.*, **55**, 2943 (1922).

(5) W. E. Hanby, S. G. Waley, and J. Watson, *J. Chem. Soc.*, 3009 (1950).

(6) D. Coleman and A. C. Farthing, *J. Chem. Soc.*, 3218 (1950).

(7) F. Wessely, K. Riedl, and H. Tuppy, *Monatsh.*, **81**, 861 (1950).

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(9) A. C. Farthing, *J. Chem. Soc.*, 3213 (1950).