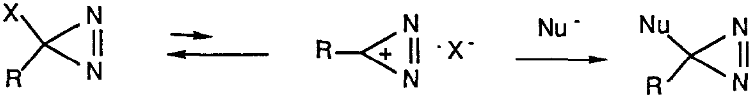
Tetrahedron Letters,Vol.28,No.47,pp 5801-5804,1987 0040-4039/87 $3.00 + .00
Printed in Great Britain Pergamon Journals Ltd.

3-FLUORO-3-TRIFLUOROMETHYLDIAZIRINE

William P. Dailey
Department of Chemistry
University of Pennsylvania
Philadelphia, PA 19104-6323

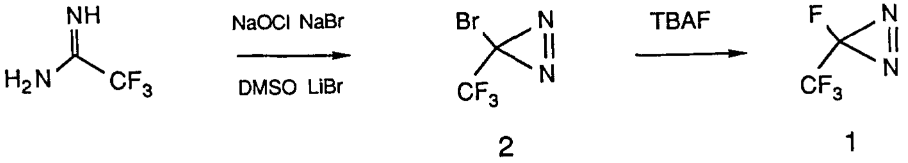
Summary: Treatment of 3-bromo-3-trifluoromethyldiazirine with fluoride ion produces 3-fluoro-3-trifluoromethyldiazirine in 60% yield. Tetrafluoroethylidene can be trapped upon thermolysis of the diazirine.

The development of the "diazirine exchange" reaction by Moss and coworkers has led to the ready synthesis of several new or hitherto difficulty accessible diazirines.[1]



There is theoretical[2] as well as experimental[3] evidence which suggests that this exchange reaction proceeds via a tight ion pair intermediate which is captured by the externally added nucleophile. Although this implies that diazirinium cations are intermediates in the reaction, there have been no reports on the spectroscopic detection of these species.[4] In addition, ab initio calculations[5] have predicted a "negative delocalization energy" for the parent diazirinium cation suggesting instability.

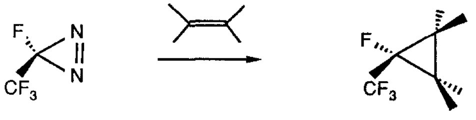
As part of our research program on fluorinated carbenes, we desired to prepare 3-fluoro-3-trifluoromethyldiazirine (**1**). A diazirine exchange reaction using the known 3-bromo-3-trifluoromethyldiazirine[6] (**2**) with fluoride ion seemed a worthwhile, though low probability reaction since a trifluoromethyl group would surely hamper any mechanism proceeding through a cationic intermediate.[7] We wish to report in this communication that the diazirine exchange reaction with fluoride proceeds in good yield under the standard "diazirine exchange" reaction conditions.[1]



3-Bromo-3-trifluoromethyldiazirine[6] (**2**) was prepared in 30% yield from trifluoroacetamidine[8] under the standard graham[9] conditions (DMSO saturated with bromide ion and sodium hypochlorite solution (Clorox) with added bromide). There was also formed a small amount of 3-chloro-3-trifluoromethyldiazirine[6] (about 5% of the isolated product). Substitution of freshly made sodium hypobromite solution for the bromide ion doped sodium hypochlorite solution gave a very poor yield of product. The reason for this observation, which is reproducible, is unclear. Replacement of bromide with fluoride ion in the Graham reaction produced only 3-chloro-3-trifluoromethyldiazirine; there was no trace of **1**.

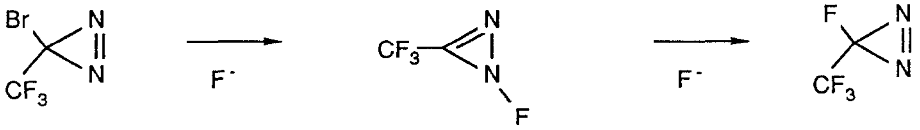
Treatment of **2** with two equivalents of tetrabutylammonium fluoride (TBAF) in dry acetonitrile for two days at -25°, gave a 50% yield of 3-fluoro-3-trifluoromethyldiazirine **1** along with about 20% recovered starting material. The identity of **1** was confirmed by nmr, ir, and mass spectroscopy and was further confirmed by conversion to tetrafluoroethylidene (see below). A more convenient procedure for the preparation of **1** was to stir an acetonitrile solution of **2** with two equivalents of TBAF at room temperature overnight. In this manner a 60% yield of almost pure **1** was obtained.

Diazirine **1** is a convenient precursor to tetrafluoroethylidene.[10] Thermolysis of **1** for 10 minutes at 170° in the gas phase with two equivalents of 2,3,-dimethyl-2-butene produced 1-fluoro-2,2,3,3-tetramethyl-1-tri fluoromethylcyclopropane (**3**) which was isolated by preparative gas chromatography in 30% yield. The identity of **3** was established on the basis of nmr (both ^{1}H and ^{19}F), ir and mass spectral data.



3

The powerful destabilizing effect of a trifluoromethyl group on an adjacent[7] or nearby[11] cationic center is well documented. By analogy to other work[7,11], if the present reaction proceeded via a cationic intermediate, it should be on the order of 10^5 times slower than that of a 3-alkyl-3-bromodiazirine. While we have not yet done any competition or kinetic studies, the mere fact that the fluoride exchange reaction of **2** proceeds under conditions similar to those of alkyl and aryl derivatives suggest that a cationic intermediate is unlikely. We propose that the reaction of **2** with fluoride proceeds via a double S_n2' reaction, a mechanism first suggested by Graham, although we have no proof.



Studies on the mechanism of this reaction are underway and will be reported at a later time. A matrix isolation study of **1** as a source of tetrafluoroethylidene is in progress.

3-Fluoro-3-trifluoromethyldiazirine

To a vigorously stirred solution of 3.5g (31 mmol) of trifluoroacetamidine,[8] 15.0 g (172 mmol) of lithium bromide and 150 mL of DMSO in a 5 liter three necked flask was added a solution of 300 mL of sodium hypochlorite solution (Clorox) and 150 g (1.45 mol) of sodium bromide over the course of one minute. The volatile products were continuously pumped (0.1 mm) through a train of two traps, the first one cooled in dry ice/acetone and the second in liquid nitrogen. After 10 minutes, the reaction was stopped and 1.80 g (30%) of 3-bromo-3 trifluoromethyldiazirine was obtained in the last trap. Gc analysis indicated that there was about 5% of 3-chloro-3-trifluoromethyldiazirine also present.

A solution of TBAF (25 mmol), prepared by evaporation of 23 ml of a 1.1 **M** solution of TBAF in THF (Aldrich) followed by addition of 5 ml of dry acetonitrile, was placed into a 500 ml round bottom flask equipped with a Teflon high vacuum stopcock. The flask was frozen and evacuated and 2.5 g (13 mmol) of 3-bromo-3-trifluoromethyldiazirine was added. After warming to room temperature, the solution was stirred for 14 h. The volatile products were fractionated under vacuum through a series of three traps maintained at -78°, -100°, and -196°. A 60% yield of 3-fluoro-3-trifluoromethyldiazirine collected in the last trap and 0.5 g of recovered starting material collected in the middle trap. 3-Fluoro-3-trifluoromethyldiazirine is a gas at room temperature and has the following spectroscopic properties: ^{19}F nmr ($CDCl_3$, ppm upfield from $CDCl_3$): 74.8 (3F, d, J=4.8hz), 172.4 (1F, q, J=4.8hz); IR (gas): 1595, 1360, 1225, 1085 cm^{-1}; uv (gas): 316 nm; MS: 109, 100.

CAUTION: Diazirines are potentially explosive as neat liquids or solids and should be handled accordingly.

Acknowledgements. We thank Professor D. M. Lemal for providing us with experimental details for the preparation of **2** and are grateful to the Research Fund at the University of Pennsylvania and the donors of the Petroleum Research Fund, administered by the American Chemical Society for partial financial support.

References

1. D.P. Cox, R.A. Moss, J. Terpinski, *J. Am. Chem. Soc.* **1983, 105,** 6513; R.A. Moss, M. Fedorynski and J. Terpinski, *Tetrahedron Lett.,* **1986, 27,** 419; R.A. Moss, M. Fedorynski, G. Kmiecik-Lawrynowicx and J. Terpinski, *Tetrahedron Lett.* **1986, 27,** 2707; R.A. Moss, M. Wlostowski, J. Terpinski, G. Kmiecik-Lawrynowicz and K. Krogh-Jespersen, *J. Am. Chem. Soc.,* **1987, 109,** 3811.

2. K. Krogh-Jespersen, C.M. Young, R.A. Moss and M. Wiostowski, *Tetrahedron Lett.,* **1982, 23,** 2339.

3. R.A. Moss, J. Terpinski, D.P. Cox, D.Z. Denney and K. Krogh-Jespersen, *J. Am. Chem. Soc.* **1985, 107,** 2743.

4. R.A. Moss, J. Wlostowska, W. Guo, M. Fedorynski, J.P. Springer, J.M. Hirschfield, *J. Org. Chem.* **1981, 46,** 5048.

5. K. Krogh-Jespersen, *Tetrahedron Lett.* **1980, 21,** 4553.

6. M.W. Grayston and D.M. Lemal, *J. Am Chem. Soc.* **1976, 98,** 1278.

7. T.T. Tidwell, *Angwe, Chem. Int. Ed. Engl.* **1984, 23,** 20.

8. W.L. Reilly and H.C. Brown, *J. Am. Chem. Soc.* **1956, 78,** 6032.

9. W.H. Graham, *J. Am. Chem. Soc.* **1965, 87,** 4396.

10. For another source of tetrafluoroethylidene, see: D. Seyferth and G.J. Murphy, *J. Organometal. Chem.* **1973, 52,** C1.

11. P.G. Gassman and J.B. Hall, *J. Am. Chem. Soc.* **1984, 106,** 4267.

(Received in USA 17 August 1987)