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# Perfluorobutanesulfonyl Fluoride - 1,8-Diazabicyclo[5.4.0]undec-7-ene as a Useful System in Diol-Epoxide Transformation

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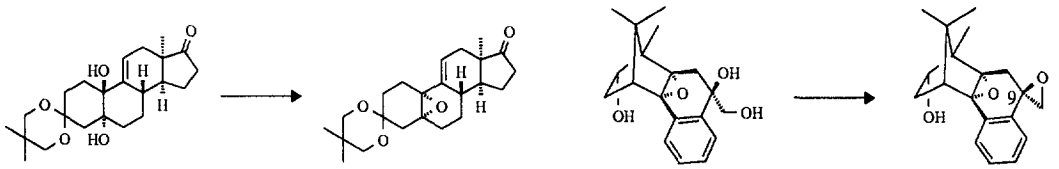
***Abstract:*** *The combination of n-perfluorobutanesulfonyl fluoride with 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) proves to be a highly efficient system for the conversion of vicinal diols into epoxides, especially well-suited in demanding situations.* Copyright © 1996 Elsevier Science Ltd

In the course of our work in the 13-retrosteroid and borneol series we encountered the problem of transforming a pair of vicinal diols into their parent epoxides. The application of existing methodology either met with failure or turned out to be incompatible with the need for multigram synthesis. Diols **1**[1)] and **3**[2)], though otherwise unrelated, commonly required a diol-epoxide conversion as a key step for further elaboration.



**1** **2** **3** **4**

The steroid case offered a particularly complicated situation in having both alcoholic functions in tertiary positions. The allylic nature of the C-10-hydroxy group and the inherent tendency towards aromatization had to be taken into account as additional obstacles.

The difficulties experienced with the borneol derivative **3** were less obvious as low reactivity and undesired regioselectivity would not be expected to appear as major drawbacks with a primary-tertiary relationship of the diol precursor. The latter case instead, derived its delicacy from steric congestion and from the presence of additional sensitive functionality.

Both intermediates were subjected to the whole array of documented procedures[3)-10)] and, indeed, two fairly satisfactory solutions were found for the steroid derivative by reacting diol **1** with either Martin sulfurane[5,6)] (diphenyl-1,1,1,3,3,3-hexafluoro-2-phenyl-2-propoxy-sulfurane, 52% yield of **2**) or the Mukaiyama reagent[8)] (2-fluoro-N-methylpyridinium tosylate, 70% yield of **2**). None of these methods could successfully be applied to the borneol case.

An additional alternative came into sight when Vorbrüggen and coworkers[11)] disclosed their combination of perfluorobutanesulfonyl fluoride/DBU as a simple and efficient system for the transformation of primary and secondary alcohols into their corresponding fluorides. Reaction mechanism and mildness of conditions suggested the application of the Vorbrüggen system to the current problems.

On reacting diols **1**[12] and **3**[13] with $C_4F_9SO_2F$ in the presence of DBU, smooth conversion took place forming the epoxides **2** and **4** within 60 min. to 36 hours. After usual workup and flash chromatography the products were obtained with respective yields of 71% (**2**) and 74% (**4**).

Although in the steroid case, the method did not result in a spectacular improvement, the clean reaction course and the subsequent ease of product isolation markedly differed from the aforementioned alternative solutions. The result for the borneol derivative was even more convincing as none of the alternatives had met with success.

In conclusion, the $C_4F_9SO_2F$/DBU system does not only favorably compare with existing methodology but may offer the key to success in delicate cases.

**References:**


1) Diol **1** is obtained by ceric ammonium nitrate catalyzed opening (THF/water[14]) of known 3,3-(2,2-dimethyl-trimethylenedioxy)-5α,10α-epoxy-estr-9(11)-en-17-one[15] and subsequent irradiation[16].
2) Triol **3** is prepared by $OsO_4$/NMO-oxidation of [4R-(4α,4aβ,10aα)]-9-methylene-3,4,4a,9,10,10a-hexahydro-1,11,11-trimethyl-4,10a-methanophenanthrene-4a-ol the synthesis of which is described in Ger.Offen DE 4 416 374 (Schering AG) based upon a procedure published by P.A. Wender, P. Mucciaro *J. Am. Chem. Soc.* **1992**, *114*, 5879-5881.
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12) To a solution of diol **1** (2.0 g, 5.12 mmol) in 25 ml of toluene and 5 ml of dichloromethane and DBU (2.24 g, 15.36 mmol) is added via syringe n-perfluorobutanesulfonyl fluoride (2.32 g, 7.68 mmol) at 0°C. After stirring for two hours at room temperature, excess DBU (2.24 g, 15.36 mmol) and sulfonyl fluoride (2.32 g, 7.68 mmol) are added successively and stirring is continued for 36 hours at ambient temperature. For workup the reaction mixture is poured into aqueous sodium bicarbonate solution and extracted with ethyl acetate. Chromatography on neutral alumina with n-hexane/ethyl acetate yields **2** (1.43 g, 71%) identical with authentic material (lit.[16]).
13) To a solution of triol **3** (134 mg, 423 µmol) in 4 ml of toluene and 190 µl DBU (1.26 mmol) is added via syringe n-perfluorobutanesulfonyl fluoride (83 µl, 460 µmol) at 0°C. Stirring is continued for 60 minutes at 0°C and workup is performed as already described for the preparation of **2**. Chromatography on silica gel with n-hexane/ethyl acetate yields 93 mg epoxide **4** (312 µmol, 73.7%). The configuration at C-9 was confirmed by NMR techniques (NOESY, COSY).
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