HETEROCYCLES, Vol 14, No. 2, 1980

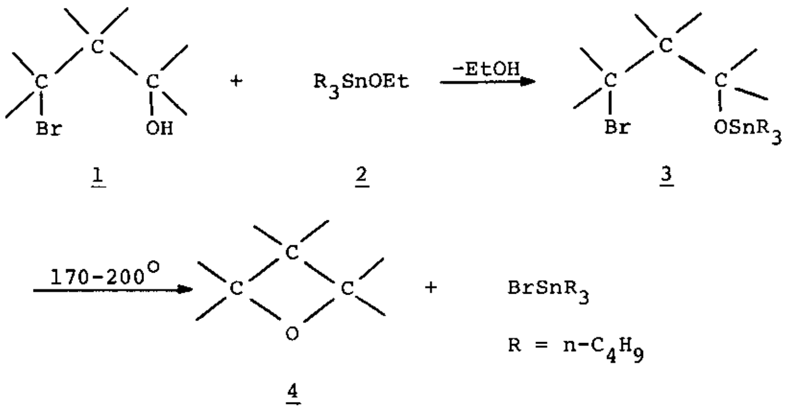
PREPARATION OF SOME SPIROCYCLIC OXETANES

A.M.S. Odeh, J.A. Usta, and C.H. Issidorides*
Department of Chemistry, American University of Beirut,
Beirut, Lebanon

Abstract - Syntheses and spectroscopic properties of some oxetanes derived from pentaerythritol are discussed.

Delmond, Pommier, and Valade[1] have described a convenient synthesis of oxetanes (4) by decomposition of the thermally unstable intermediate (3) resulting from transalkoxylation of 1,3-bromohydrins (1) with tributyltin ethoxide (2, Scheme 1).

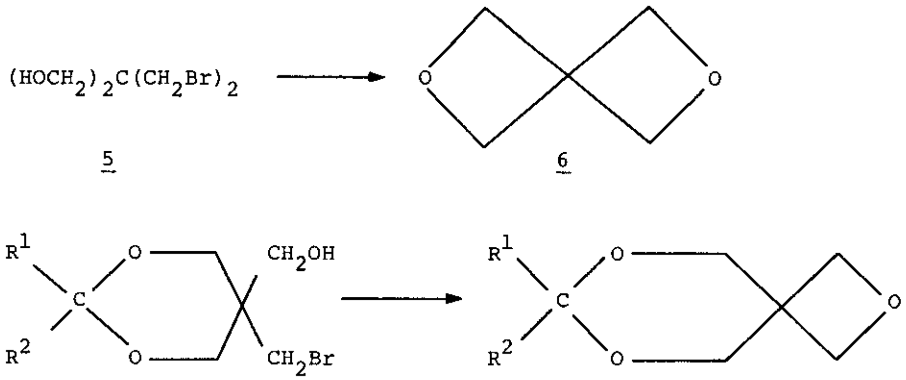
Scheme 1



In this paper we report that the method can be adapted for the preparation of spirocyclic oxetanes derived from pentaerythritol (Scheme 2). In exploratory experiments we heated tributyltin methoxide and the corresponding pentaerythrityl bromohydrin[2] at 170°, steam-distilled the reaction mixture, and extracted the distillate with ether. Because troublesome emulsions occurred during the extraction step, this approach was soon abandoned in favor of the following convenient procedure: Tributyltin methoxide and the bromohydrin were placed in a flask equipped with a mechanical stirrer, a take-off head, and a condenser set for downward distillation. The mixture was heated at 190-210° in an oil-bath for one hour to ensure complete removal of the methanol formed by transalkoxylation. The pressure was then reduced (water aspirator) and the temperature of the oil-bath was slowly raised to 260° to effect decomposition to the oxetane, which solidified in the condenser and in the receiving flask. The yields (6, 50%; 8a, 68%; 8b, 60%) are comparable to those obtained by earlier methods[3,4]. We are now looking into the possibility of improving them by utilizing trialkyltin methoxides carrying alkyl substituents larger than butyl so as to minimize occasional contamination of the oxetane by organometallic impurities.

In earlier reports[3,4] we recommended ethanolic potassium hydroxide as a dehydrohalogenating agent for pentaerythrityl bromohydrins. We now find that somewhat better yields of 6 and 8 (up to 80% for 8a) are obtained by the use of potassium tert-butoxide in tert. butyl alcohol. Sodium hydride is less convenient than potassium tert-butoxide, and gives lower yields.

Scheme 2



7

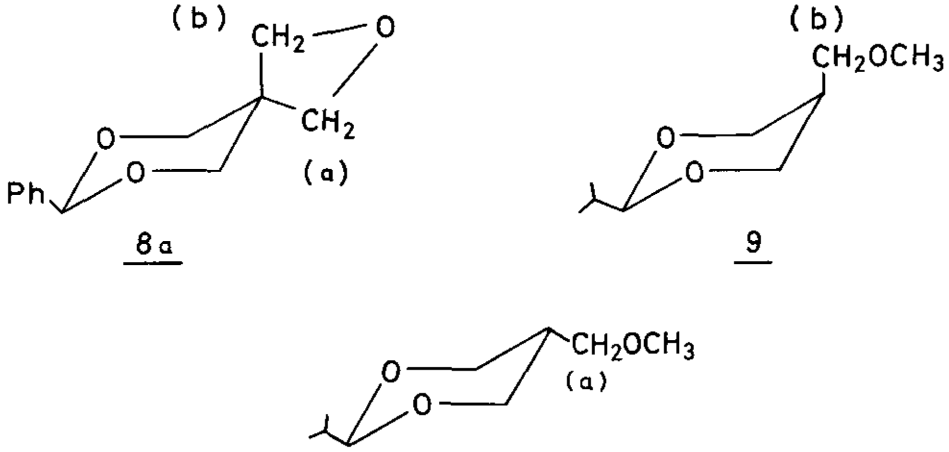
8

(a) $R^1 = H$, $R^2 = Ph$

(b) $R^1, R^2 = (CH_2)_5$

The compounds described in this study show infrared bands characteristic of oxetanes[5] at 970-980 cm^{-1}. The nmr signals (δ values, $CDCl_3$) for the methylene protons adjacent to the (oxetane) oxygen are at characteristically low field: 4.65 (singlet) for the oxetane methylene protons of 6, and 4.33 (singlet) for the oxetane methylene protons of 8b. Interestingly 8a, in sharp contrast to 8b, shows discrete singlets (4.10 and 4.63, 1:1) for its oxetane methylene protons. The preferred conformation of 8a places the phenyl substituent of the 1,3-dioxane ring in the equatorial position, and the two oxetane methylene signals must therefore arise from protons (a) and (b) resonating at 4.10 and 4.63 respectively (Scheme 3). The assignment is based on the recent finding that the methylene protons (b) of 9 resonate at lower field (δ 3.67) than the methylene protons (a) of the stereoisomeric 10 (δ 3.15)[6].

Scheme 3



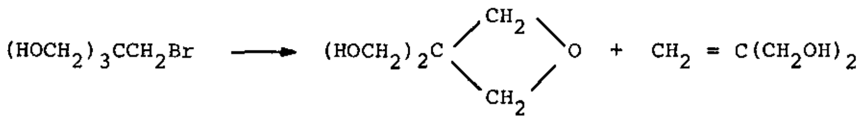
8a

9

10

During their pioneering work on the synthesis of oxetanes from pentaerythrityl halides, Govaert and Beyaert[7] noted that the oxetane (12) obtained from dehydrobromination of pentaerythrityl monobromide (11) was attended with a persistent impurity (Scheme 4). In a subsequent reinvestigation of this reaction we suggested structure 13 for this product, and attributed its formation to a fragmentation[8]. Because the original assignment was rather tenuous, we now wish to present more substantive evidence in its support. The viscous liquid (13) shows singlets at δ 3.95, 4.96 and 5.18 (vinyllic) in the ratio of 2:1:1 ($CDCl_3$). It can be readily converted (trityl chloride-pyridine) into a beautifully crystalline bistrityl ether melting at 190° (acetone), whose analysis agrees with the molecular formula $C_{42}H_{36}O_2$, and whose nmr spectrum (δ, $CDCl_3$) shows two broad singlets (3.58 and 5.22) and a multiplet (7.12) in the ratio 2:1:15. The nmr spectrum of 12 in DMSO shows clear coupling (J = 5 Hz) between the hydroxylic and the adjacent methylene protons: doublet at δ 3.50 (methylene adjacent to hydroxyl), singlet at

Scheme 4



11 12 13

4.10 (oxetane methylene), and triplet at 4.58 (hydroxylic) in the ratio of 2:2:1. It should be noted that 13 (now readily accessible by a three-step route from 5-norbornene-2-carboxaldehyde[9]) has attracted considerable attention recently because it serves as a carbonyl protecting group[10] and because its acetonide can be readily metalated to give a synthetically useful functionalized allyloxy carbanion[11].

Acknowledgment: We thank Professors Ernest L. Eliel and Moses K. Kaloustian for helpful discussions regarding the NMR spectra.

REFERENCES

1. (a) B. Delmond, J.C. Pommier, and J. Valade, *Tetrahedron Letters*, 1969, 2089.
   (b) B. Delmond, J.C. Pommier, and J. Valade, *J. Organometal. Chem.*, 1973, **47**, 337.
2. C.H. Issidorides, R.C. Gulen, and N.S. Aprahamian, *J. Org. Chem.*, 1956, **21**, 997.
3. Abdul-Rahman Abdun-Nur and C.H. Issidorides, *J. Org. Chem.*, 1962, **27**, 67.
4. R.F. Nassar and C.H. Issidorides, *J. Org. Chem.*, 1959, **24**, 1832.
5. S. Searles, Jr., "Oxetanes", in Weissberger "The Chemistry of Heterocyclic Compounds", Vol. 19, Part 2, Interscience Publishers, New York, 1964, p. 983.
6. (a) M.K. Kaloustian, N. Dennis, S. Mager, S.A. Evans, F. Alcudia, and E.L. Eliel, *J. Amer. Chem. Soc.*, 1976, **98**, 956. (b) E.L. Eliel, D. Kandasamy, and R.C. Sechrest, *J. Org. Chem.*, 1977, **42**, 1533.
7. F. Govaert and M. Beyaert, *Proc. Acad. Sci. Amsterdam*, 1939, **42**, 790.
8. C.H. Issidorides and A.I. Mattar, *J. Amer. Chem. Soc.*, 1955, **77**, 6382.
9. F. Weiss, A. Isard, and R. Bensa, *Bull. Soc. Chim. Fr.*, 1965, 1355.
10. E.J. Corey and J.W. Suggs, *Tetrahedron Letters*, 1975, 3775.
11. A.P. Kozikowski and K. Isobe, *Tetrahedron Letters*, 1979, 833.

Received, 6th September, 1979