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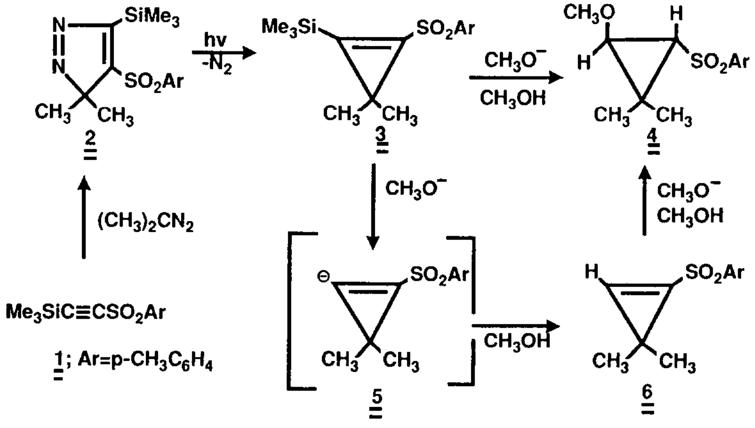
SIGNIFICANCE OF THE ANOMERIC EFFECT ON THE CONFIGURATIONAL STABILITY OF CYCLOPROPYL CARBANIONS

Albert Padwa* and M. Woods Wannamaker
Department of Chemistry, Emory University
Atlanta, GA 30322 USA

Abstract: The effect of an electron withdrawing group adjacent to cyclopropyl carbanion has been studied. The facility with which carbanion interconversion occurs can be attributed to the existence of the anomeric effect.

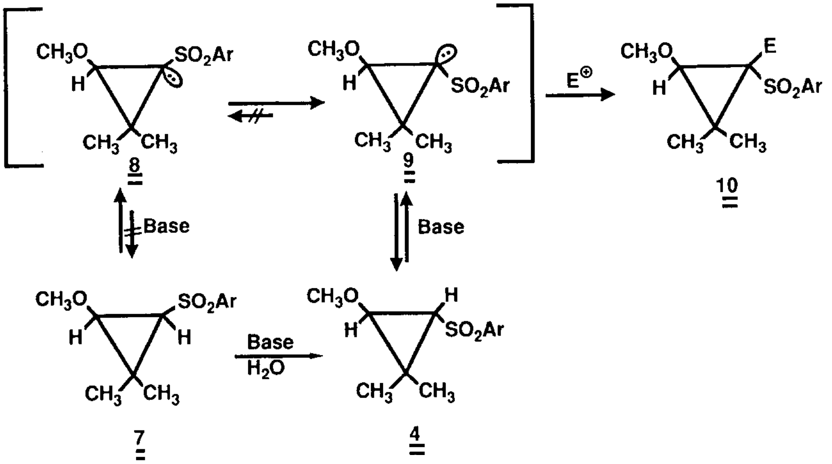
Cyclopropyl carbanions derived from optically active precursors are capable of retaining their configuration to a significant degree.[1] The calculated energy barrier for inversion of the cyclopropyl carbanion is 36.3 Kcal/mole.[2] The initial hybridization of the carbon and the constraint in a three-membered ring (I-strain) are factors which undoubtedly affect the energy barrier for racemization of the derived cyclopropyl carbanion.[3] Walborsky and coworkers have elegantly demonstrated that the configurational stability of the α-substituted cyclopropyl carbanion depends on the solvating property of the reaction medium and on the type of substituent present--whether it is a delocalizing or a nondelocalizing one.[4] The present work describes a case where substituents adjacent to the carbanionic center affect the formation and the geometry of its reaction product with electrophiles.

Silylsulfonyl substituted 3H-pyrazole **2** was readily prepared by the 1,3-dipolar cycloaddition of 2-diazopropane with alkyne **1**. Photolysis of this material in benzene afforded cyclopropene **3** in excellent yield. The reaction proceeds via cyclization of a transient vinyl carbene intermediate formed by extrusion of nitrogen.[5] Treatment of **3**

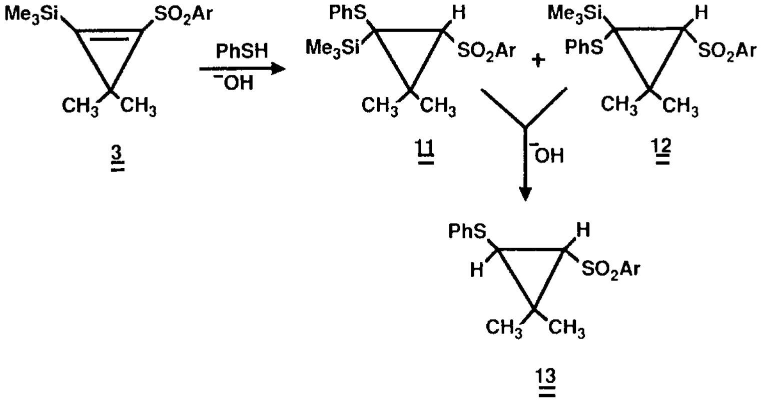


with sodium methoxide in methanol for 30 min at 25°C produced pure trans-cyclopropane 4 in 98% yield.[6] No detectable quantities of the cis isomer were present in the crude reaction mixture. A sample of the cis cyclopropane 7[6] was independently prepared by treating 1-methoxy-2-methylpropene with p-tolylsulfonyldiazomethane.[7] All attempts to isolate the desilylated cyclopropene 6 failed. Apparently, structure 6 readily reacts with methoxide under the reaction conditions used. Addition of nucleophiles to cyclopropenes containing electron withdrawing substituents has previously been reported in the literature[8] thereby providing good analogy for this step.

The cyclopropyl carbanion derived from the deprotonation of sulfone 4 with LDA at -78°C reacted smoothly with a variety of electrophiles (D_2O, CH_3I, $CH_2{=}CHCH_2Br$, $ClCO_2CH_3$) to give exclusively a single stereoisomer (10).[9,10] The same alkylated set of cyclopropanes was also formed from the cis isomer. We found that cis-7 was efficiently and quantitatively converted to trans-4 by a deprotonation-protonation sequence. Thus, the presence of the β-methoxy functionality seems to have altered a precedented behavioral pattern in that it readily facilitates cyclopropyl carbanion (8→9) interconversion even at -78°C. This may be the consequence of intramolecular chelation between the cyclopropyl lithiate and the neighboring methoxy group.[11]



The reaction of cyclopropene 3 with thiophenol and potassium hydroxide in methanol was also examined. In the presence of excess base, trans-cyclopropane 13 proved to be the exclusive product (95%) isolated. When the reaction was carried out for shorter periods of time and using an equivalent amount of base, the silyl-substituted cyclopropanes 11 and 12 (1:2) were formed in excellent yield. Both of these compounds were readily desilylated to give only 13.[12] Thus, the polarizable and softer thiophenoxide anion prefers to attack the highly strained cyclopropene π-bond. The harder and less polarizable methoxide ion, on the other hand, preferentially reacts on silicon.



Removal of the α-SiMe$_3$ group from the three-membered ring undoubtedly involves initial cyclopropyl carbanion generation.[13] Most importantly, both desilylation reactions generate only the trans isomer 13. Thus, the presence of the electronegative β-sulfonyl group also facilitates carbanion interconversion as was previously encountered with the methoxy system. We believe that these reactions are a manifestation of the anomeric effect.[14] The favored cyclopropyl carbanion (i.e. trans) will be the one which permits interaction of the carbanion lone pair with the vacant σ^* orbital on the adjacent carbon which contains the electronegative atom (or group). Such hyperconjugative interactions have been substantiated by theoretical investigations and are now well established for a variety of systems.[15] Both energetic and structural consequences are often dramatically large.

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References and Notes

(1) H. M. Walborsky and F. J. Impastato, *J. Am. Chem. Soc.*, **81**, 5835 (1959); H. M. Walborsky and A. E. Young, *ibid.*, **83**, 2595 (1961); *ibid.*, **86**, 3288 (1964).

(2) M. J. C. Dewar and M. Shanshal, *J. Am. Chem. Soc.*, **91**, 3654 (1969).

(3) D. J. Cram, "Fundamentals of Carbanion Chemistry", Academic Press, New York, N. Y., 1965.

(4) M. P. Periasamy and H. M. Walborsky, *J. Am. Chem. Soc.*, **99**, 2631 (1977); H. M. Walborsky, L. E. Allen, H. J. Traencker and E. J. Powers, *J. Org. Chem.*, **36**, 2937 (1971); H. M. Walborsky and F. Hornyak, *J. Am. Chem. Soc.*, **77**, 6026 (1955); H. M. Walborsky, A. A. Youssef and J. M. Motes, *J. Am. Chem. Soc.*, **84**, 2465 (1962); *ibid.*, **92**, 2445 (1970).

(5) M. Franck-Neumann, C. D.-Buchecker, *Tetrahedron*, **34**, 2797 (1978); M. Franck-Neumann and M. Miesch, *Tetrahedron*, **39**, 1247 (1983); *Tet. Lett.*, 2909 (1984); *ibid.*, 1409 (1982).

(6) NMR **4** (90 MHz,$CDCl_3$): δ 1.12 (s, 3H), 1.30 (s, 3H), 2.05 (d, 1H, J=3.0 Hz), 2.41 (s, 3H), 3.32 (s, 3H), 3.71 (d, 1H, J=3.0 Hz), 7.30 (d, 2H, J=7.0 Hz) and 7.80 (d, 2H, J=7.0 Hz). NMR **7**: δ 1.05 (s, 3H), 1.42 (s, 3H), 1.82 (d, 1H, J=6.0 Hz), 2,42 (s, 3H), 3.18 (d, 1H, J=6.0 Hz), 3.41 (s, 3H), 7.30 (d, 2H, J=7.0 Hz) and 7.80 (d, 2H, J=7.0 Hz).

(7) A. M. van Leusen and J. Strating, *Org. Syn.*, **57**, 95 (1977).

(8) G. Hauck and H. Durr, *J. Chem. Res.*, 180 (1981).

(9) For some related reactions of cyclopropanes carrying sulfonyl groups, see M. Pohmakotor and S. Pisutjaroenpong, *Tet. Lett.*, 3613 (1985); Y. H. Chang and H. W. Pinnick, *J. Org. Chem.*, **43**, 373 (1978).

(10) Carbanions stabilized by sulfonyl groups show high diastereoselectivity and have been characterized as pyramidalized species; B. M. Trost and N. R. Schmuff, *J. Am. Chem. Soc.*, **107**, 396 (1985).

(11) G. W. Klumpp, M. Kool, M. Schakel, R. F. Schmitz and C. Boutkan, *J. Am. Chem. Soc.*, **101**, 7065 (1979); *Recl. Trav. Chim. Pays-Bas*, **102**, 542 (1983).

(12) NMR **13** ($CDCl_3$,90 MHz): δ 1.22 (s, 3H), 1.59 (s, 3H), 2.19 (d, 1H, J=5.0 Hz), 2.30 (s, 3H), 3.00 (d, 1H, J=5.0 Hz), 7.0-7.23 (m, 7H) and 7.63 (d, 2H, J=8.0 Hz).

(13) L. A. Paquette, T. Uchida and J. C. Gallucci, *J. Am. Chem. Soc.*, **106**, 335 (1984).

(14) A. J. Kirby, "The Anomeric Effect and Related Stereoelectronic Effects in Organic Chemistry", Pergamon Press, London, 1983, Chapt. 2.

(15) S. Wolfe, M. H. Whangbo and D. J. Mitchell, *Carbohydr. Res.*, **69**, 1 (1979).

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