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THE SYNTHESIS OF A 1,4-DITHIOCIN

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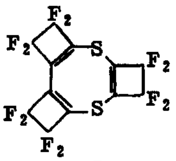
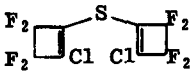
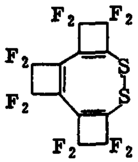
Considerable interest in 10 π-electron systems has been exhibited over the past several years. Although a number of workers have demonstrated the aromaticity of certain carbocyclic systems, those neutral heteroatom examples synthesized[1,2] have shown an apparent lack of aromatic properties. We wish to report the synthesis of 1,4-dithio-2,3,5,6,7,8-tris-(di-difluoromethylene)-cin (**I**).



I

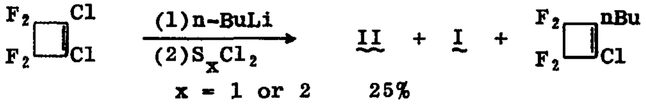


II

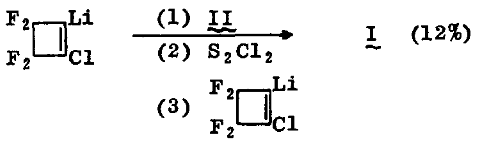


III

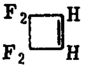
I (white needles from methylene chloride, mp 143.9-144.3°C, sealed tube)[3] has been isolated in low yield, (1) from the reaction of 1-lithio-2-chloro-3,3,4,4-tetrafluorocyclobutene[4] with either sulfur mono- or di-chloride in diethyl ether at -78°C, in addition to bis-(2-chloro-3,3,4,4-tetrafluorocyclobutenyl)-sulfide (**II**) and 1-n-butyl-2-chloro-3,3,4,4-tetrafluorocyclobutene,

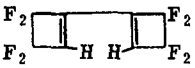


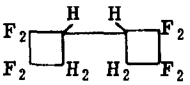
and (2) from the following sequence of reactions:

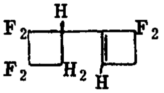


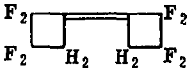
Differentiation between I and its isomer III was made on the basis of the degradation products obtained upon treatment with Raney nickel in refluxing ethanol. Work-up afforded two major products, 1,2-dihydro-3,3,4,4-tetrafluorocyclobutene (IV) (glpc retention time and mass spectrum identical to those of an authentic sample) and another compound, isolated in such a small quantity that it has not yet been positively identified. It has, however, been shown to be identical to the compound obtained by treatment of 2,2'-dihydroöctafluorocyclobutene (V)[6] with Raney nickel under similar conditions, as indicated by glpc retention time on five different columns. In all likelihood, it is either the fully saturated dicyclobutane (VI) or one of two possible mono-enes (VII or VIII).

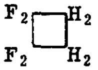

IV


V


VI


VII

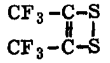
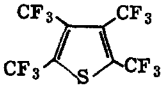
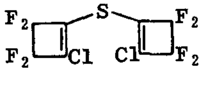
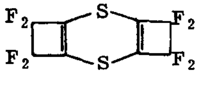

VIII


IX

It is extremely unlikely that vinylic carbon-carbon bond cleavage (of III) could occur under such mild conditions to give rise to the observed products. The fact that neither IV nor IX was isolated from the reaction of V with Raney nickel also substantiates this conclusion.

Further evidence for structure I is provided by the spectral data. The ultraviolet absorption spectrum is indicative of a highly conjugated system (see Table I). In contrast, the spectra of related systems show only comparatively weak absorptions.

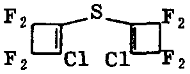
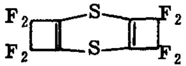
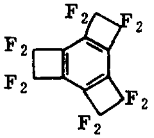
Table I. Comparative Ultraviolet Absorption Data

	$\lambda_{\text{max}}^{\text{isooctane}}$[7a]	238 nm (ε,7440), 340 nm (ε,80)
	$\lambda_{\text{max}}^{\text{ethanol}}$[7a]	231 nm (ε,4450), 242 nm (ε,4200)
	$\lambda_{\text{max}}^{\text{ethanol}}$	237.5 nm (ε,7580), 267.5 nm (ε,4350)
	$\lambda_{\text{max}}^{\text{isooctane}}$[7b]	230 nm (ε,7400), sh 221 nm (ε,6500), 245 nm (ε,3300), 370 nm (ε,65)
I	$\lambda_{\text{max}}^{\text{ethanol}}$	230 nm (ε,41,400), 237 nm (ε,23,000), 295 nm (ε,7,400), 317 nm (ε,6,500)

IR (KBr) 6.12 (d,w), 6.50(m), 7.50-9.20(s), 10.68(w), 11.05(m), 11.30(m), 11.70(s), 11.90(s), 12.55(m), 13.50(m), 16.38(m), 16.58(m), 19.58(s), 23.58(m)μ.

The ^{19}F NMR spectrum is especially informative. The presence of a ring current, commonly regarded as a criterion of aromaticity, is indicated by the chemical shift, as shown in Table II.

Table II. Comparative ^{19}F NMR Data

	Pattern (Area)	Chemical Shift,(ppm)
	A_2B_2	+ 115.90[8a]
	singlet	+ 117[7b]
	singlet	+ 104.4[8a,8b]
I	singlet (1) A_2B_2 (2)	+ 105.36[8a] + 105.88

This result is in contrast with the nmr data reported for the single previously synthesized 1,4-dithiocin[2] as well as the other neutral 10 π-electron heterocycles, in which there has been a uniform lack of downfield chemical shifts. It would appear that the planarity predicted by Balaban and Simon[10] for the parent 1,4-dithiocin has been realized in I.

I is chemically unreactive - it failed to decolorize a carbon tetrachloride solution of bromine, is inert to a refluxing methanolic solution of sodium periodate (3 days, 94% recovery), and reaction at 80-90°C for 4 days in a sealed ampoule with 20% sodium hydroxide solutions resulted in the recovery of 48% of the starting material as the only organic product, as well as sulfide, fluoride, and carbonate ions. In view of the well-known susceptibility of the disulfide linkage to attack by base,[9a] especially in fluorocarbons,[9a,9b] it is highly unlikely that the -S-S- bond is present. As further proof, I was refluxed with glacial acetic acid and zinc for one hour, and the reaction mixture was tested for the presence of thiol.[11] None was detected, even though it was obvious that reaction had occurred. The reaction mixture did show the presence of fluoride ions,[12] indicating reaction had occurred at the "allylic" positions of the ring, rather than on the nucleus itself.

All of the preliminary evidence presented here points unequivocally to structure I. Further investigations of the properties of this molecule, as well as isolation of the intermediates involved in its formation, are currently in progress.

We wish to thank the AFOSR for support of this work.

References

1. W. Schroth, K. Kränke, and J. Reinhardt, Z. Chem., 3, 119 (1963); A. P. Bindra, J. A. Elix, P. T. Garratt, and R. H. Mitchell, J. Amer. Chem. Soc., 90, 7372 (1968); S. Masamune, K. Hojo, and S. Takada, Chem. Commun., 1204 (1969); A. G. Anastassiou and J. M. Gebrian, Tetrahedron Lett., 5239 (1969).
2. W. Schroth, F. Billig, and A. Zschunke, Z. Chem., 9, 184 (1969).
3. Anal. Calcd for $C_{12}F_{12}S_2$: C, 33.0; F, 52.3; S, 14.7. Found: C, 33.0; F, 52.0; S, 14.9. [M^+ = 436 (100%)]
4. J. D. Park, C. D. Bertino, and B. T. Nakatâ, J. Org. Chem., 34, 1490 (1969).
5. Anal. Calcd for $C_8Cl_2F_8S$: C, 27.38; Cl, 20.20; S, 9.14. Found: C, 27.08; Cl, 20.18; S, 9.42. [M^+ = 350 (59%)]
6. H. E. Romine, Ph.D. Thesis, University of Colorado, 1968, unpublished results.
7. a) C. G. Krespan and B. C. McKusick, J. Amer. Chem. Soc., 83, 3434 (1961); b) C. G. Krespan and D. C. England, J. Org. Chem., 33, 1850 (1968).
8. a) $CFCl_3$ int. std., CH_2Cl_2, 94.077 MHz; b) S. K. Choi and R. L. Soulen, University of Colorado, unpublished results.
9. a) J. P. Danehy, Mechanisms of Reactions of Sulfur Compounds, Vol. II, 67 (1968). b) C. G. Krespan, J. Amer. Chem. Soc., 83, 3434; R. N. Hazeldine and R. E. Banks, Adv. in Inorg. and Radiochem., III, 415 (1961).
10. A. T. Balaban and Z. Simon, Rev. Roumaine de Chimie, 10, 1059 (1965).
11. A. L. P. Coll and A. P. Coll, Afinidad, 20(225), 150-5 (1963) CA 59, 13356b.
12. M. Hudlický, "Chemistry of Organic Fluorine Compounds," Macmillan, New York, N. Y., 1962, p 315.