DIMERS OF PERCHLORO-(3,4-DIMETHYLENECYCLOBUTENE) I. $PERCHLORO-(3,4,7,8-TERAMENTILYLENE-TRICYCLO[4.2.0.0^{2,5}]$ OCTANE)

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In the course of our study on the chemistry of unsaturated chlorocarbons with a four-membered ring. it was found that the pyrolysis of perchloro-(3,4-dimethylenecyclobutene) (1) $(1, 2)$ affords, depending on the heating temperature applied, at least four different isomeric compounds, $C_{12}C_{12}$. As shown in the following chart. perchloro-(3,4,7,8-tetramethylene-tricyclo(4.2.0.0^{2,5}) octane) (II), m.p. 266. was obtained from I in 30 $\%$ yield in the pyrolysis at ca. 160. When heated to ca. 200. directly or in nitrobenzene, II was further transformed in almost the same yield to a mixtwe (III) of other isomers in which one (IIIa) with a m.p. of 215⁰ dominates over an another (IIIb), m.p. 262⁰ With the exception of its close melting point IIIb is aoubtlessly different **from 11 in** all respects. Lastly, the application of pyrolysis at ca. 250 $^{\circ}$ to III resulted in the low yield formation of the fourth isomer (IV), m.p. 273. Ill and 1V were also derived directly from I in the pyrolysis at 180-200⁰ and 250[°], respectively. Their yields were, however, much lower than those for step-by-step conversion since the direct transformation **Was always accompanied by the production of perchlorobenzene (ordinarily major)**, perchlorofulvene, perchloro-4-methylenecyclopent-l-ene and an uncharacterized glassy material with the composition of $(CCl)_{\tau}$, which is major particularly in higher temperature pyrolysis in solution. The observation of these distinguishing

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courses of dimer transformation are in accord with the results of differential thermal analysis of I, 11 and IlI, which also markedly indicate the occurrence of some drastic exothermic change in the corresponding temperature ranges.

II is almost insoluble in the ordinary organic solvent and is not sublimated under vacuum. Contrary to the thermal instability, it is stable against W-light irradiation and acid or alkaline hydrolysis. The spectral data $(\lambda_{max}^{Cyclobexane}$ 287, 299 and 312 my; ε , 28,100, 44,800 and 27,000; $\frac{Nujol}{c}$ 1610 and 1580, - $\frac{1}{2}$ group: 910 $c\overline{n}^1(2)$) suggest that the carbon skelton of perchloro- $(i\dot{i}2$ -dimethylenecyclobutane) (V) (1) must be involved in this dimer. In fact, II, as V , resisted the attack of 'liq. chlorine and was oxidized in a low yield with permanganate in acetone to perchloro-(dimethylenesuccinic) acid (2). In addition, it was confirmed that II is also formed in considerably good yield (60%) under the condition of ionic reaction mechanism; i.e., from I in dichloromethane with anhydrous aluminum chloride a't room temperature. It is, therefore, very possible that the cyclodimerization occurs, in either process from I to II, between each c_{1-2} double bond of two I's, which was reported to be most reactive $(2, 3)$ in the molecule.

II was reduced in ethanol or acetic acid by heating with zinc powder to $C_{12}C_{18}H_4$ (VI), m.p. 223-5[°] (new V_{CH} 3060 and 3050 cm¹; disappearance of 910 cm¹ band; $\lambda_{\text{max}}^{\text{EtOH}}$ 278 and 290-mu; ε , 18,100 and 10,900). The observed λ_{max} value is in good accordance with the calculated one based on that for 1,2-dimethylenecyclobutane (4). $\sqrt{1}$ was further reduced to tetramethyl derivative (VIIa), $m.p. 183^\circ$

(dec.) by hydrogenation over palladium-charcoal at room temperature. When II was directly hydrogenated with the same catalyst, VIIa was obtained in 77 $\frac{q}{p}$ yield together with minor hydrocarbon $C_{12}H_{22}$, b.p. 80°(bath)/20 mm., to which the structure VIII was assigned on the mass spectrometric basis.

The spectral data (no λ_{max} more than 215 my, ν_{max} 1680. $\delta_{\text{CH}_{2}}$ 1460 and 1380 $c^{\frac{1}{m}}$; n.m.r.: 8.12C, singlet) for VIIa are very similar to those reported by Criegee et al. (5) for $syn-$ and $anti-octamethyl$ derivatives (VIIb and VIIc, respectively). It should be noted, however, that four angular chlorine substituents are, notwithstanding their allylic position, extraordinarily inert towards the attack of reagents, such as lithium alanate, n-butyl lithium, nickel carbonyl, Raney nickel, zinc-acetic acid, liq. ammonia and potassium hydroxide under various reaction conditions. It is of striking contrast to the behavior of 3,4-dichloro-tetranethylcyclobutene in which the vicinal chlorines are very smoothly hydrolyzed or dechlorinated $(5,6)$.

The stereochemical configuration of II was speculated to be *anti-form* in terms of two junctures with central ring since the obgerved dipole moment for II was small enough to be judged nil and for VIIa as well. The conclusive detail of the crystal structure for 11 has recently been established by Furusaki et al. (7) by means of $X-ray$ analysis. From the fact that no $sym-isomer$ has been found in the pyrolysis product, it is easily assumed that the cycloaddition would be far more advantageous for the stereospecific course to anti-dimer to fulfill the spacial requirement of four (angular) chlorine atoms in the transitionary stage of central ring formation.

There exists an another remarkable difference between VIIa and VIIc in the

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mode of their ozone degradation. VIIa was cleaved in methanol-carbon tetrachloride by ozone to diketone (IX), m.p. 113-115°($y_{c=c}^{n \to 0.1}$ 1720, 1710; $y_{c=c}$ 1680; δ_{CH_2} 1380 1360 cm^- ; 8.15 τ (5H), 7.63 τ (6H), both singlet). However, the second \geq c=c ζ bond in IX strongly resisted further osonolysis even for 56 hr. passing, while VIIc was reported to suffer from either successive or exhaustive double bond cleavage.

In connection with the diketone, ketol (X_A) , m.p. 158-159⁰ 4.8-unsaturated ketone (XI) , m.p. 192-193⁰ and lactol (Xb) , m.p. 167-169⁰ were isolated and characteriesd.

Although the elucidation study of the structure for 1118, IIIb and IV is under way, it is tentatively proposed on the basis of the available data of chlorination, oxidation and selective reduction, and particularly of the very similar IR absorption between IIIa and IIIb, that the plane structure for III is perchloro- $(2,3,7,8-\text{tetramer-hylene-bicyclo}(4.2.0)\text{octa}-4-\text{ene})$ (XII).

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