

LETTERS TO THE EDITORS

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Crystal Structure of Coronene

THE structure of the coronene molecule, $C_{24}H_{12}$, is of particular interest in view of its peculiarly high symmetry (Fig. 1). With regard to electron distribution and bond-lengths, the structure should be somewhat intermediate between benzene and graphite. The optical and magnetic anisotropies of the molecule should also be of interest, and as a first stage in the accurate study of all these properties it is necessary to make a precise determination of the crystal structure.

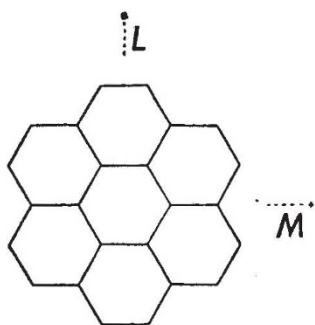


FIG. 1.

Some difficulty was experienced in growing good single crystals of the substance, but suitable specimens were finally obtained from a solution in tetrahydronaphthalene. The lath- or needle-shaped monoclinic crystals were greatly elongated along the b -axis, and in the best specimens the (001) , (100) , $(10\bar{1})$ and $(20\bar{1})$ faces were developed, the (001) usually being the most prominent. X-ray examination gave the unit cell dimensions as $a = 16.10$ A., $b = 4.695$ A., $c = 10.5$ A., $\beta = 110.8^\circ$. The $(h0l)$ reflexions are absent when h is odd, and the $(0k0)$ when k is odd. The space group is therefore $C_{2h}^5 (P_2/a)$. There are two centrosymmetrical molecules of $C_{24}H_{12}$ in the unit cell. (Density, measured 1.377, calc. 1.387.)

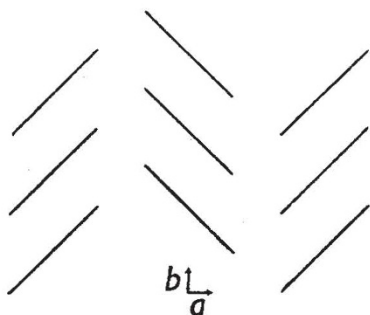


FIG. 2.

The crystal habit and especially the very short b axis are similar to those of the phthalocyanines¹, and this suggested that these large flat molecules might be similarly arranged in the crystal. Detailed analysis has now shown this to be the case. The

plane of the coronene molecule is inclined at approximately 45° to the b crystal axis, an end view of the arrangement being roughly as shown in Fig. 2. The perpendicular distance between the molecular planes is between 3.3 and 3.4 A., just a little less than the interplanar spacing in graphite (3.41 A.).

The orientation of the coronene molecules in the crystal can be stated more precisely with reference to the molecular axes L and M (Fig. 1) and their normal, N . If χ_L, ψ_L, ω_L ; χ_M, ψ_M, ω_M ; and χ_N, ψ_N, ω_N , are the angles which these molecular axes make with the a and b crystal axes and their perpendicular, then we find

$$\begin{array}{lll} \chi_L = 85.0^\circ & \chi_M = 45.3^\circ & \chi_N = 134.9^\circ \\ \psi_L = 85.1^\circ & \psi_M = 45.5^\circ & \psi_N = 44.9^\circ \\ \omega_L = 7.0^\circ & \omega_M = 97.0^\circ & \omega_N = 89.9^\circ \end{array}$$

The figures are probably accurate to within 1–2°.

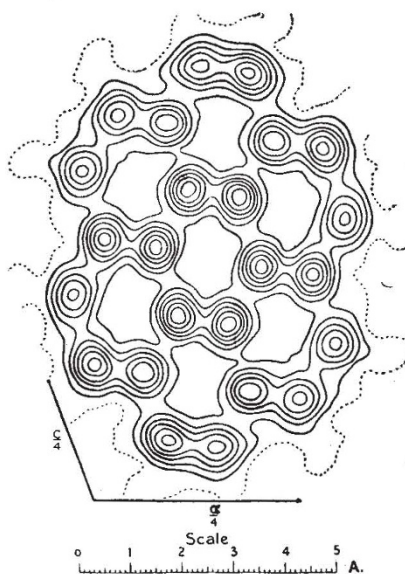


FIG. 3.

The structure is such that it is possible to compute an accurate two-dimensional projection of the electron density distribution on the (010) plane (that is, along the direction of the b crystal axis) by the method of double Fourier series. The result of this calculation is shown in Fig. 3, where each line represents a density increment of approximately one electron per A.² (the one-electron line is dotted). It will be noted that every carbon atom in the molecule is very clearly resolved, and with further refinement of the measurements and calculations it should be possible to make very accurate determinations of the interatomic distances. When allowance is made for the 45° inclination of the molecular plane to the plane of the projection (010) , it is found that the hexagons are regular, and already there are indications that the average C—C distance is slightly greater than the accepted value for benzene (1.39 A.). This distance is probably nearer to the graphite value of 1.42 A., but more accurate measurements and the inclusion of higher order terms are necessary before this can be definitely established. The Fourier series used for the calculation of Fig. 3 contained about eighty terms.

We are indebted to Mr. E. J. Bowen and to Messrs. Imperial Chemical Industries, Ltd., for specimens of the hydrocarbon coronene.

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¹ Robertson, J. M., *J. Chem. Soc.*, 615 (1935).

Crystal Structure of β -Aluminium-Magnesium Alloy

A PIECE of β -aluminium-magnesium alloy of irregular shape, when examined by the Laue method, showed all the characteristics of the Laue symmetry $m\bar{3}m = 0_h$, which proves conclusively that β Al-Mg is cubic and not hexagonal as assumed by K. Riederer¹. By means of rotation photographs the length of the edge of the unit cube was determined to be $a = 28.13$ Å. and the period of identity along a face diagonal $d = 19.93$ Å., showing that the space-lattice is face-centred. Weissenberg patterns around [100] and [110] showed that the characteristic space-group of β Al-Mg is $Fd\bar{3}m = 0_h^7$.

The unit cube of β Al-Mg is consequently the largest unit cell hitherto met with with alloys. With 19.04 Å.³ as volume per atom, the number of atoms per unit cube is found to be 1172, and is thus comparable with the numbers of atoms in crystals of complicated organic compounds.

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¹ *Z. Metallkunde*, 28, 312 (1936).

Pulsation and White Dwarfs

THE pulsation phenomenon has so far been observed only in 'super-giant' stars. However, there seems to be no theoretical reason why the phenomenon should not occur in denser stars and even in white dwarfs which are composed of *degenerate* matter. It is interesting to recall that according to current views a nova outburst is associated with a sudden collapse of the star, which after the disturbance settles down as a white dwarf. It is very likely that after such a cataclysmic disturbance the star would be left pulsating. Even if the physical conditions be not favourable for the maintenance of pulsation, yet the pulsation once started should last for a period comparable to 10^3 years. For a white dwarf the period of pulsation corresponding to the fundamental mode is easily estimated. Assuming the 'homogeneous model', the period P is given by

$$P = \left\{ \frac{9h^3}{16\pi m^{3/2} H^{5/2} G^2} \right\} \frac{1}{\mu^{5/2} M} \sim 10 \frac{\odot}{M} \text{ sec.},$$

where M is the mass of the white dwarf, h is Planck's constant, m the electron mass, H the proton mass, G the gravitational constant, μ the mean molecular weight and \odot the solar mass. In deriving the expression for the period, the effect of relativistic mechanics has been ignored. For the Stoner-Chandrasekhar critical mass the period tends to zero. The pulsation-period for a white dwarf is too small to be directly observable, and therefore the existence of pulsation in white dwarfs has to be looked for through its secondary effects.

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Thermogenic Properties of High-Frequency Currents

IN view of the interest now being taken in high-frequency heating, as a logical development of medical diathermy, successful experiments have been made in the rapid production of crustless bread, cakes and light pastries. This technique is particularly suitable for the last two named purposes. The power used was 650 watts, and the frequency 50×10^6 c.p.s. Owing to the War, further developments have not been possible.

It may be mentioned that successful experiments were made also in heating through rapidly, and in promoting the plastic flow of, kaolin ('Antiphlogistine') poultices. Our experiments indicated that this preparation is of a polar nature. It has a loss factor of about 0.118. The dielectric constant is also of high value, but this has yet to be determined.

If placed in a suitable non-metallic container, short-wave diathermy equipment may be used as a source of high-frequency current for this and many other applications of diathermy technique to medical preparations which require heating. This offers the advantage of uniform and rapid heating throughout, with a considerable saving in time.

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Tsetse Hybrids

IN 1936 I attempted to cross various species of tsetse (*Glossina*) with the idea that, should they hybridize readily, and should the resultant hybrids prove sterile, this might be tried as a measure of control. Corson had already, in 1932, obtained three offspring from crosses between male *G. swynnertoni* and female *G. morsitans*; he suggested, however, that these might not be true hybrids, but the result of parthenogenesis (see further details in the accompanying communication by Mr. F. L. Vanderplank). I obtained a number of offspring from this and other crosses, but as a slight doubt arose as to whether they were authentic hybrids, the results were never published.

The doubts arose because the females used had not come from pupæ kept isolated in single tubes, but from collections of pupæ from which the emergent imagines were cleared three times a day except during the week-end, when forty-four hours elapsed between the last clearing of the jars at mid-day on Saturday and their first clearance on Monday at 8 a.m. Females were therefore left for varying periods up to forty-four hours in contact with freshly emerged males of their own species before isolation for crossing. Though the work of Mellanby¹ rendered it very unlikely that females in such circumstances could become inseminated by their own species, a doubt did remain. Since then I have kept females similarly obtained without subsequent access to males, and none of them has shown any signs of fertility though they lived twenty-one days or more, sufficient to allow them to produce at least one larva; eighty females were dissected and none was found to have been inseminated. Mr. Vanderplank and I have both found that the external characters of *swynnertoni* are completely dominant in the offspring of these crosses, and the production of a *swynnertoni*-like fly by a *morsitans* female is conclusive evidence that a true hybrid has been obtained; recent exam-