Structure of the So-called *cis* Decalin

THE structures of the two stereoisomeric hydrogenation products of naphthalene and their relationship to cyclohexane were discussed by one of us in 1943¹. It was pointed out that the *trans* structure proposed by Mohr² (Fig. 1) will probably be correct, but reasons were given indicating that Mohr's *cis* structure containing two cyclohexane rings of the 'cradle' form should be rejected in favour of another structure shown in Fig. 1*b*. The carbon skeleton of both these two molecules is found in the well-known diamond lattice. Using the notation introduced in a paper dealing with the cyclohexane problem³, the two cyclohexane rings of *trans*-decalin may be said to share two π -bonds; in *cis*-decalin, however, one π -bond and one σ -bond.

The correctness of these assumptions has been proved, using the electron diffraction technique and methods of computation worked out in this laboratory and based on the rotating sector method with subsequent Fourier analysis of the molecular scattering curves obtained from microphotometer records of the diffraction diagrams. The results are therefore entirely uninfluenced by physiological effects occurring when visual methods are used.

Fig. 1. STRUCTURE OF *cis*-DECALIN: (a) ACCORDING TO MOHR; (b) ACCORDING TO BASTIANSEN AND HASSEL

FIG. 2

The two $\sigma(r)/r$ curves giving the intramolecular distribution of nuclear distances in the two isomers show a high degree of conformity. We therefore preferred to discuss the differential curve obtained by subtracting the experimental $\sigma(r)/r$ curve of the *trans* form from that of the *cis* form. We then compared this curve with theoretical curves corresponding to our π - σ model (Fig. 1*b*) of *cis*-decalin and the structure proposed by Mohr. The interval between $r = 2$ and $r = 4$ Å. would be expected to include the most pronounced differences in internuclear distances, and the three differential curves reproduced in Fig. 2 are: (1) theoretical curve for the *cis*-(π - σ) structure of Fig. 1*b*, (2) experimental curve, and (3) theoretical curve for Mohr's *cis* structure, all related to the interval mentioned.

A comparison of experimental and theoretical curves seems to settle beyond doubt that *cis*-decalin has the π - σ structure given in Fig. 1*b*. The only symmetry element being a two-fold axis of symmetry, the *cis*-decalin should exist in two optically active forms.

A more detailed report will soon be published in *Tidsskrift for Kemi, Bergvesen og Metallurgi* (Oslo).

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¹ Hassel, O., *Tid. Kemi, Bergv., Met.*, **3**, 91 (1943).

² Mohr, E., *Erdm. J. Chem.*, **98**, 315 (1918).

³ Hassel, O., *Tid. Kemi, Bergv., Met.*, **3**, 32 (1943).

⁴ Finbak, C., *Avh. Norske Vid.-Akad., Oslo, Mat. Nat. Sci. Kl.*, No. 7 (1941).

Infra-Red Emissivity of Metals at High Temperatures

A SPECIALLY designed vacuum-tight, water-cooled furnace constructed of silica and steel has been used to measure the emissivity of various metals at temperatures of 1,000°–1,500° C. and wave-lengths 1.0–4.5 μ .

The specimen, formed from a thin sheet bent into the form of a cylinder, was resistance-heated by a current of 300 amp. The intensity of the radiation from the inside and the outside of the cylinder was measured by means of a rock-salt prism spectrometer and a thermopile, and the ratio of these intensities after correction gave the emissivity. The radiation from the inside proceeded through the slit formed by leaving the two edges of the sheet specimen just a little apart when bent, so forming a slightly incomplete cylinder. The black-body so formed was not perfect and was therefore calibrated by using a specially constructed platinum sphere black-body against which it could be compared. Results were obtained for pure iron and for platinum to an accuracy of about 2 per cent.

Since the emissivity at room temperature can be found by applying Kirchhoff's law to reflectivity measurements, it is possible to deduce the temperature coefficient of emissivity in the near infra-red. This is of some importance, since it has been known for some time that a transition region must occur between the far infra-red region (where the Hagen-Rubens law predicts a coefficient equal to half the temperature coefficient of resistivity) and the visible region where the temperature variation is extremely small, and, in some cases, in the opposite direction to that predicted from electro-magnetic theory. A careful study of the literature has shown that in a number of instances results have been found indicating that, for a wave-length specific for each metal, the emissivity and reflectivity are constant over an extremely wide range of temperature. The results for tungsten given by the late Prof. Ornstein¹ furnish the outstanding example of this constancy.

TEMPERATURE COEFFICIENT OF EMISSIVITY FOR PLATINUM

Horizontal line, Hagen-Rubens theoretical limit; o, Hagen-Rubens experimental points; ●, present experimental results.

The accompanying graph, based on the present work, shows the transition region for the temperature coefficient of emissivity of platinum and indicates on extrapolation an X-point (wave-length of constancy) at about 0.93 μ . Results for pure iron give a similar straight line showing a well-defined X-point at about 1.0–1.5 μ (the uncertainty is due to inaccuracies in the available data for room temperature reflectivity). The origin of this X-point is as yet unknown. Work is at present in progress on molybdenum and nickel.

An interesting 'side-result' of these experiments has been the use of the determined efficiency curve of the cylinder black-body to correct the hitherto unexplained deviation of Ives' Standard of Visible Radiation² from other independent determinations. A description of the apparatus together with more detailed experimental results will be published elsewhere. A full summary of all previous work on the optical properties of metals with special reference to the problem of emissivity has also been made, and it is hoped that this will be published at a later date.

The above work forms part of a programme of research being undertaken for the Foundry Steel Temperature Sub-Committee of the Steel Castings Research Committee of the British Iron and Steel Research Association and the Iron and Steel Institute, and with their financial support.

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S.W. Essex Technical College,
London, E.17. April 9.

¹ Ornstein, *Physica*, **3**, 561 (1917).

² Ives, *J. Franklin Inst.*, **197** (1924).