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SHEATH OSCILLATIONS IN DC DISCHARGES

Dr. D. Gabor of the Department of Electrical Engineering, Imperial College, London, presented some interesting experimental evidence bearing on the stability of D.C. discharges at a Conference on the Physics of Ionized Gases held on March 23-25 at University College, London. (A brief account of the discussions of the conference is given in Technical Report, ONRL-40-53 which may be obtained from the Technical Publications Office, Office of Naval Research, Code 740, Washington 25, D.C.).

The work described by Dr. Gabor was carried out jointly with Mr. E.A. Ash and Mr. D. Dracott. A technique was employed which has fallen into disuse since its original application by Aston and J.J. Thomson in 1913, namely, the use of an electron beam to probe the region of interest within a discharge. The Imperial College group performed their experiment on a low pressure mercury arc. The electron beam passed through two apertures on opposite sides of the discharge tube. Beyond these good vacuum was maintained so that the beam's deflection could be observed on a fluorescent screen without interference by ions. The electron energy was about 1000 ev and a weak, well collimated, beam was used. The discharge tube was provided with a movable wall constituting a plane which was set parallel to the beam direction. Thus the beam could be passed close to the movable wall and parallel to it in order to study the behavior of the boundary sheath on the wall. Consequently it was possible to explore the properties of the sheath without inserting a metal probe of the Langmuir type which itself constitutes a boundary.

It was found that the beam experienced a mean deflection in passing through the sheath which was in reasonable agreement with the deflection obtained from calculations of the Langmuir-Mott-Smith type. However, the deflection was oscillatory and corresponded to a violent oscillation of the boundary sheath with an amplitude exceeding the electron temperature. Work is in progress to determine the frequency of oscillation exactly. However, the fact that the oscillation sustains itself indicates that the frequency should not be much different from that corresponding to the time taken for an average electron to dive into the sheath and emerge from it. Dr. Gabor points out that large as this phenomenon is, it could not be discovered with conventional metal probes because the oscillations are of the longitudinal type with virtually no magnetic field and so are unable to transfer appreciable energy to an external circuit.

The possibility that the observed oscillations in the boundary layer may have been excited by the incident electron beam was suggested in the discussion following Dr. Gabor's talk. Gabor pointed out that he had considered this question and had varied the intensity of the probing electron beam from 0.01 to 100 microamps without noting a variation in the oscillation, a result which provides some plausibility against stimulation of the oscillation by the probe. This work at Imperial College is in process of elaboration, and it will be interesting to see whether the oscillation is confined to low pressure mercury arcs only or is a general property of the D.C. discharge.

BIRMINGHAM PROTON SYNCHROTRON

The 1 Bev proton synchrotron at the University of Birmingham begun in 1946 by Prof. M.L. Oliphant, is now nearing completion. After Prof. Oliphant's departure to Australia in 1950, synchrotron construction was carried out under the direction of his successor, Prof. P.B. Moon. More recently, Prof. W.E. Burcham joined the staff and has assisted in supervising work on the accelerator.

It is remarkable the the Birmingham machine was assembled with the limited staff and finances available. It is understood that to date not more than £250,000 ($700,000) has been spent. Except for the motor generator

set which provides direct current for magnet excitation, the machine was built almost entirely by the staff of the Physics Department at Birmingham. The magnet which is 32 ft. in diameter and made of $\frac{1}{2}$" C-shape plates, 8 ft. square, was assembled by two technicians of the department without outside help.

The present status of the machine is that the magnet has been pulsed to full field successfully, the platinized ceramic vacuum chamber employed has been found to give exceedingly good vacuum (7×10^{-7}mm Hg), and the RF system is complete. Injection at 500 kev from a high tension set has been successfully achieved and the beam has been traced through one revolution in a static field (227 gauss). The work in the near future will be principally pulsed operation. A profile must be cut for the aluminum condenser rotor, matching closely with the build up of the magnetic field. Because of the low injection energy, the RF frequency variation required during acceleration is very large (1:28) and it is reasonable to expect that considerable effort may be needed to insure successful control over this range. There is no definite target date for final completion of the machine, however it is hoped that it will be in operation by the end of this year.

The group of physicists actively engaged on the machine and their fields of responsibility are as follows: Magnet - Dr. Symonds; Vacuum - Dr. Riddiford; Injector - Dr. Ramm; Radio Frequency - Dr. Hibbard. Dr. Hibbard has described in detail the synchrotron design and constructional progress in an article in Nucleonics (Vol. 7, p.30, Oct. 1950).

A DEVICE FOR RECORDING CLOUD CONDITIONS

Professor Renato Cialdea at the University of Rome, is studying the application of a novel observational device to meteorological problems. The device consists of a photocell pointed at the north polar region of the sky with a simple telescope. A polarizer rotates slowly in front of the photocell, and the resulting photocurrent is recorded with a DC amplifier. The north polar region is at substantially 90° to the sun at all times, and accordingly if the sky is perfectly clear the light is about 92 per cent polarized. This condition is recorded as a

sine wave at the frequency of rotation of the polarizer and with a minimum light value near zero.

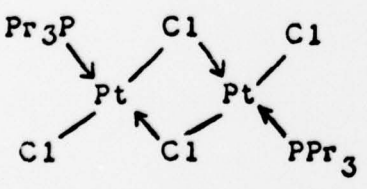
The presence of haze serves to diminish but not to destroy the polarization; it also serves to increase the average brightness. The presence of clouds destroys the polarization completely. The density of the clouds can be estimated from the absolute value of this unmodulated signal. The presence of cumulus clouds is shown by the intermittent appearance of a sine wave when the instrument sees the blue sky between the clouds.

This simple apparatus can be built for small cost and will operate unattended for many days. The resulting record can easily be divided into a number of categories descriptive of the prevailing cloud conditions. Numerical studies based on such observations should yield valuable meteorological information of a quantitative nature in a field which has previously been purely qualitative.

GEOMETRICAL ISOMERISM AND SIMPLE REACTIONS OF ETHYLTHIOL BRIDGED COMPLEXES OF PLATINUM AND PALLADIUM

Dr. J. Chatt (Butterwick Research Laboratories, Imperial Chemical Industries, Ltd.) is continuing his work on the nature of the coordinate link (cf. ESN 6, 251 (1952)), and has recently studied the ethylthiol-bridged complexes of platinum and palladium. When the tetrachloro compound (I) is treated with an excess of ethylthiol, the two bridging chlorine atoms are replaced by SEt groups to yield a mixture of the trans- and cis-symmetrical isomers of the dichloro compounds (II) and (III) respectively.

I



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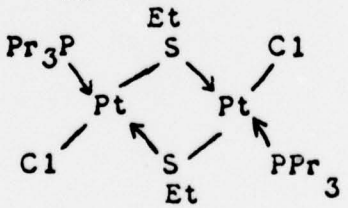
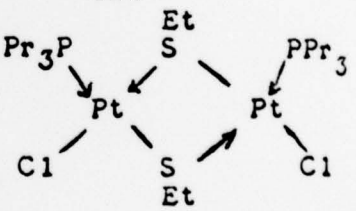
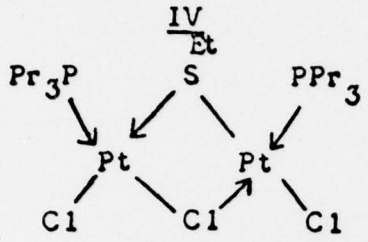


III



Both isomers remain unchanged in benzene solution at room temperature but the trans changes into the cis isomer in boiling benzene solution or under the catalytic influence of tri-n-propylphosphine. The dithio-bridged complexes are not attacked by amines in boiling benzene. Compound (I)

will further react with the dithio compounds (II) and (III) to yield the trichloro compound (IV).



This compound is attacked in solution by amines as if it existed in equilibrium with a mixture of the above dithio compounds and the tetrachloro compound. The tetrachloro compound has a trans configuration but in solution it exists in equilibrium with about 2 per cent of its cis isomer. This equilibrium appears to be established by a very slight reversible dissociation at the bridge to give the unstable species Pr_3PtCl_2. The corresponding mono and diethylthio bridged palladium complexes also have cis configurations. The cis isomers were found to be surprisingly stable relative to the trans isomers when sulfur occupies one or both of the bridging positions, a fact which seems to indicate some strong directing influence in the Pt-S-Pt-S and Pd-S-Pd-S rings. The configurations of these compounds were determined by dipole moment measurements. With the exception of the tetrachloro compound, none of these complex compounds have been prepared before.

CATALYZED DECOMPOSITION OF HYDROGEN PEROXIDE

The catalase-catalyzed decomposition of hydrogen peroxide has been studied by Professor J.A. Christiansen (Copenhagen) who has suggested the following mechanism:

$$\text{Catalase} + H_2O_2 \rightleftharpoons [\text{Catalase} \cdot H_2O_2]$$

$$[\text{Catalase} \cdot H_2O_2] + H_2O_2 \longrightarrow O_2 + 2\,H_2O + \text{Catalase}$$

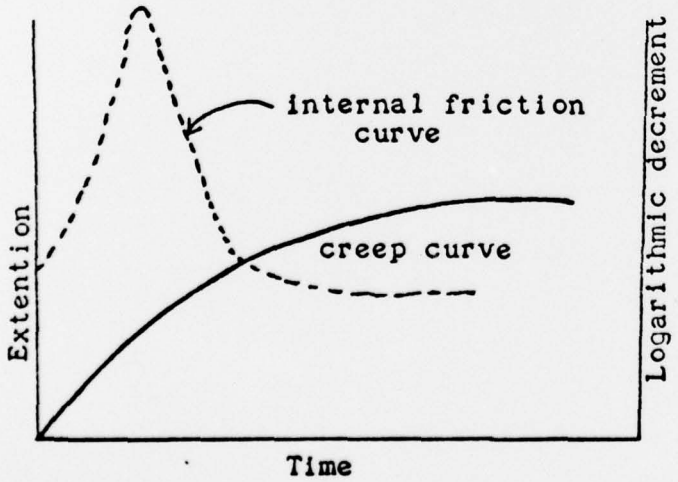
The reaction has been shown to be first order up to the point where the concentration of peroxide is so low that the dissociation of the catalase-peroxide complex becomes appreciable. Azide ion retards the reaction but it remains

first order with the reciprocal of the velocity constant directly proportional to the azide-ion concentration. It appears from this work that complexes of catalase with two peroxide molecules are not stable, decomposing immediately to oxygen and water whereas the complex involving one peroxide molecule and one azide ion is relatively more stable.

POLYGONIZATION DURING CREEP OF METALS

There has been some controversy as to the nature of the process of subgrain formation during the creep of metals. Some investigators including Wood believe that the grains fragment directly, while others consider the process to be that of polygonization; i.e., bending of lattice planes and agglomeration of the dislocations into localized regions which become the boundaries of subsequent subgrains. The adherents of the former view contend that the usual polygonization which is obtained upon annealing a cold-worked metal cannot occur in creep where the stress action and annealing take place simultaneously.

Dr. A.H. Sully (Fulmer Research Institute, Stoke Poges) has recently conducted some experiments which may clarify the issue and support the view that polygonization occurs during creep. Using wires of pure aluminum he has made internal friction and X-ray diffraction measurements during the course of primary creep at 250°C. The internal friction tests were performed by using the torsional pendulum technique. The logarithmic decrement and creep curve are shown in the following figure.



It is seen that the internal friction goes through a maximum during primary creep and it was found that the peak represents about a 5-fold increase in logarithmic decrement.

An X-ray diffraction pattern of the specimen at the internal friction peak showed asterism of the Laue spots indicating the presence of strain but no subgrain formation. X-ray photograms taken on the specimens at a point in time beyond the internal friction peak gave sharply split Laue spots corresponding to a polygonized structure.

It thus appears that polygonization does occur during creep rather than direct fragmentation. One possible criticism of Sully's technique, however, is that he did not use a microbeam X-ray technique; and if his beam were much finer, it might have been possible to detect the existence of subgrains earlier in the creep process at a time corresponding to the internal friction peak.

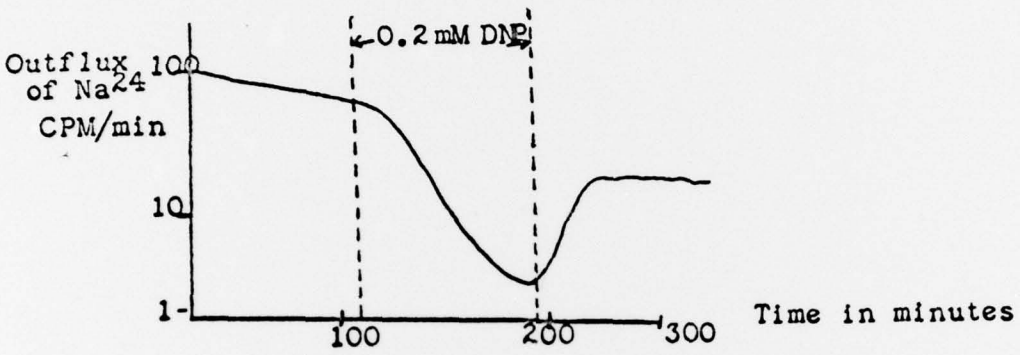
SODIUM MOVEMENT ACROSS THE CELL MEMBRANE

At a meeting of The Physiological Society held University College, London, on 20-21 March, Dr. A.L. gkins and Dr. R.D. Keynes of the Physiology Laboratory, ridge University, presented the results of two interesting investigations yielding information on the transfer of ions across cell membranes. The giant axons from loligo or sepia were loaded with Na^{24} by stimulation in a radioactive medium. These axons were then washed with an inactive solution and the decay of their radioactivity was followed by measuring the rate at which Na^{24} appeared in the external medium. The rate of appearance of Na^{24} in the medium (see Figure) showed that in a normal medium there was an outward movement of sodium from the axoplasm against the concentration and potential gradients.

If 0.2 mM dinitrophenol (or 1 to 10 mM cyanide or 3 mM azide) are added to the external medium, the outflux of Na^{24} decreases gradually to about 5 per cent of its initial value (see Figure). The sodium influx is much less affected by these external media, only being reduced to about one-half of its initial value. The marked reduction of sodium outflux in the poisoned axon is not accompanied by any loss in excitability, nor are the resting and acting potentials changed by more than a few mV. The results show that the recovery process in cephalopod

axons can be dissociated from the mechanism responsible for the conduction of impulses, and that the process most closely linked with the metabolism is most severely affected by the poison.

A description of other work presented at this meeting is given in Technical Report, ONRL-44-53 available from the Technical Publications Office, Code 740, Office of Naval Research, Washington 25, D.C.



TECHNICAL REPORTS OF ONRL

The following reports have been forwarded to ONR, Washington, since the last issue of ESN. Copies may be obtained from the Technical Publications Office, Code 740, Office of Naval Research, Washington 25, D.C.

ONRL-38-53 "Physiological Research in Belfast and Dublin" by J.L. Nickerson

ONRL-41-53 "Research on Semiconductors and Ferroelectrics in Zurich" by J.R. Reitz

ONRL-42-53 "Magnetism and Related Research at the Universities of Sheffield and Nottingham" by J.R. Reitz

ONRL-44-53 "The Physiological Society Meetings at University College, March 20-21, 1953" by J.L. Nickerson

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