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EUROPEAN SCIENTIFIC NOTES

1 September 1952 Vol. 6, No. 17

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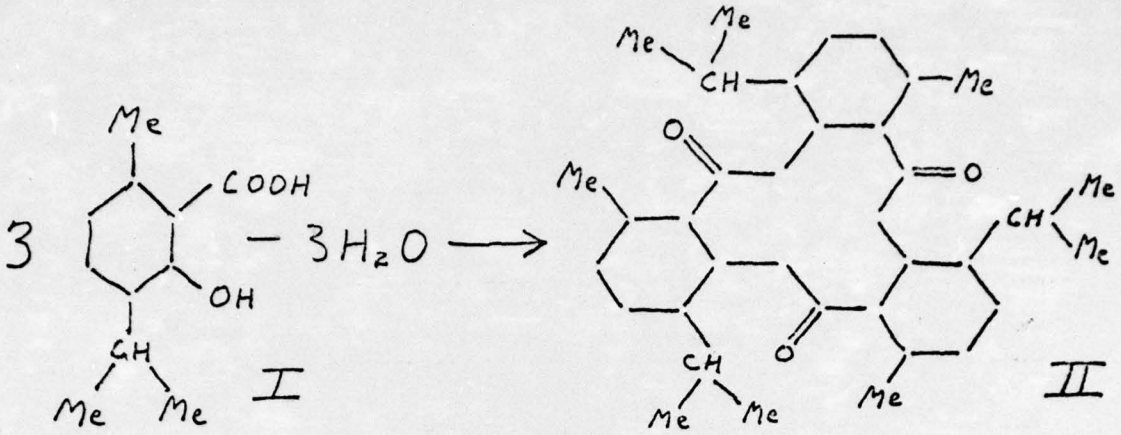
OPTICAL PROPERTIES OF PbS, PbSe, and PbTe

Mr. D.G. Avery of the Telecommunications Research Laboratory, Great Malvern, has recently measured the optical properties of a number of specimens of PbS, PbSe, and PbTe in the wavelength range 0.5-3.0 microns. The measurements were made with a double monochromator by the reflection method as described previously (Proc. Phys. Soc. B 64, 1087 (1951); B 65, 425 (1952)). The results were not consistent at short wavelengths where the method of polish seemed to make some difference. Cleaved surfaces seemed to give the best results. At three microns, consistent results were obtained yielding the following indices of refraction: PbS, 4.10 $\pm$ 0.06; PbSe, 4.59 $\pm$ 0.06; PbTe, 5.35 $\pm$ 0.10.

Seven different samples of n and p type PbS were tested having carrier concentrations from 6×10^{16} to 6×10^{19} per cc. They all displayed essentially identical optical properties in the interesting region around 3-3.5 microns where the photoconductive cut-off is found. At 0.5 - 1.0 micron, the n type samples showed a higher dispersion than the p type, but in all cases the dispersion was quite small, in contrast to germanium and silicon.

USE OF CLATHRATE COMPOUNDS FOR RESOLUTION OF RACEMIC MIXTURES

Dehydration of ortho-thymotic acid (I) has been shown by Baker, Gilbert, and Ollis to give tri-o-thymotide (II)



(J. Chem. Soc. 1443, (1952)). Upon recrystallization of (II) from any of a variety of solvents, clathrate-type complexes containing solvent of crystallization are obtained. Such solvents included light petroleum, n-hexane, and benzene. It was found by Powell and Newman (Oxford) that spontaneous resolution of tri-o-thymotide can occur during the crystallization of these clathrates. This discovery was recently discussed by Powell (Nature 170, 155 (1952)) as the basis of new methods whereby optically active materials can be obtained without the use of dissymetric substances or influences. These depend on the occurrence of crystals without a centre of symmetry but containing a screw axis.

The tri-o-thymotide molecule (II) may exist in enantiomorphous forms whose configurations are analogous to left and right handed propellers. During crystallization of the clathrate complexes the accidental configuration of the seed determines the configuration of the molecules in the growing crystal. Thus under suitable conditions of crystallization tri-o-thymotide may be recovered completely in the form of one of the pure enantiamorphs; alternatively if seeds of both enantiamorphs are present separate crystals of the two forms may develop. In the first alternative, half the molecules are converted from one form to the other, a process permitted by the low activation energy of the conversion. The optically active solution in chloroform of the benzene-tri-o-thymotide complex was found to racemize rapidly in a unimolecular process, with an activation energy of about 16 Kcal/mole.

This is of the same order of magnitude as the activation energies of racemization of typical optically active biphenyl derivatives. The processes can be considered analogous as racemization in the trimer (II) involves twisting around the single bonds bridging the three benzene rings.

Powell has shown that if crystallization of trio-thymotide occurs in a racemic solvent (e.g. dl-sec.-butyl bromide) under conditions such that one enantiamorphic form of the crystal is produced in excess, then simultaneously the solvent itself will also be resolved. This is due to the fact that for steric reasons one of the enantiamorphous forms of the solvent will be occluded preferentially in the cavities of the crystal. Powell has pointed out that the discovery of other suitable lattices among clathrate compounds will permit the extension of this technique to a wide variety of substances including molecules having no functional group suitable for resolution by formation of diastereoisomers through chemical reactions. He also suggested that this discovery of the development of optical activity in the course of a crystal growth process may yield an explanation for optical activity in nature.

It is of interest that one important extension of this separation process has recently been independently developed by W. Schlenk Jr. (Ludwigshafen, Germany). At the recent International Congress on Analytical Chemistry in Oxford he presented a paper on the application of the well known urea and thiourea inclusion compounds of straight chain aliphatic substances to the separation of optical isomers. Fractional crystallization of a urea inclusion compound with a racemic mixture of 2-chlorooctane has led, under suitably controlled conditions, to isolation of the dextrorotatory form of the solvent in 95.6 per cent purity. The efficiency of the process is increased by causing the crystallization to proceed slowly and by insuring that seeds of only one form of the crystal are present. This work will appear in The Analyst, as part of the Proceedings of the Congress.

THE EFFECT OF A DISPERSED PHASE ON THE MECHANICAL PROPERTIES OF ALLOYS

In the Metallurgy Laboratory of Cambridge University, G.C. Smith is directing work on the mechanical properties of internally oxidized alloys. These are copper or

silver base alloys containing either 0.05 or 0.25 weight per cent silicon or aluminum, which is subsequently oxidized to form a fine dispersion of SiO_2 or Al_2O_3 particles.

Previous work on this subject (ESN 5, 237 (1951)) showed that the yield strength of an internally oxidized alloy was greater than that of an unoxidized one and varied inversely with the mean spacing between oxide particles, in agreement with theories advanced by Bragg and by Orowan. Oxidized alloys were brittle, however, and this was shown to be due to segregation of the oxide at the grain boundaries rather than to the presence of oxide per se.

In the past year, torsion fatigue tests have been carried out on both single crystals and polycrystalline specimens of internally oxidized Cu - Si alloys. These tests have not been prolonged far enough to obtain true fatigue strengths but the general course of the S - N curves (stress vs. number of cycles to fracture) is well established.

For polycrystalline specimens, the S - N curve of an oxidized alloy is considerably below that of an unoxidized alloy. This decrease in fatigue resistance is evidently due to segregation of the oxide particles at grain boundaries, since an oxidized single crystal alloy has much better fatigue properties than an oxidized polycrystalline alloy. In fact, the S - N curve of an oxidized single crystal alloy practically coincides with that of an unoxidized polycrystalline alloy, if the mean particle spacing in the former is made equal to the grain size of the latter (about 150 microns for each, in the particular case studied).

In terms of the above mentioned theories, this result may be interpreted as showing the equivalence of an oxide particle and a grain boundary in preventing the free passage of dislocations. These theories postulate that the strength of a metal containing inclusions is governed by the mean spacing of the inclusions or by what might be called the mean free path in "perfect" portions of the crystal. These results thus indicate that the strength of an alloy, at least in fatigue, depends on this mean free path, whether that path is bounded by oxide inclusions or by grain boundaries.

Creep tests of internally oxidized alloys are now beginning in order to obtain some fundamental information on the effect of a dispersed phase on the creep process.

COMPUTERS AT THE INSTITUTE FOR PRACTICAL MATHEMATICS, DARMSTADT

The Institute for Practical Mathematics of the Technische Hochschule, Darmstadt, is establishing itself as Germany's academic training center for computer techniques and numerical analysis. Although possessing its own tradition, going back to the early war years, its current program derives perhaps more directly from American models than that of other establishments building computers in Germany.

Its computing facilities include a collection of several types of desk computers and bookkeeping machines, as well as numerous instrumental aids to computation such as planimeters, derivimeters, etc. A small model, illustrating the arithmetical unit of a relay computer, has been built in order to experiment with the corresponding switching circuits. The principal installation currently in operation is, however, an electromechanical differential analyzer which had been nearly completed at the end of the war and which, after short periods of sporadic operation interrupted by long ones for improvements, has been given a permanent location and form last spring. It consists of two integrators employing sharp-edged wheels, one similarity multiplier, four mechanical and four electrical adders, six drawing tables on each of which either an input curve can be followed or an output curve drawn, and finally a plug board which serves to connect the various units in accordance with the structure of the differential equation under investigation. The curve followers employ photoelectric cells with a control system holding them to one of the edges of the drawn curve, rather than to the middle of the dark band. Photoelectrically driven servos are employed throughout to prevent all but infinitesimal mechanical loads on the computing elements. Two more integrators and a second multiplier are still to be added.

In the meantime the construction of an electronic digital computer, following in its design that of the Harvard Mk IV is well under way. The machine will use a binary coded decimal notation, individual digits being transmitted serially on four parallel channels which carry the four representing binary code signals. The machine operates with a floating decimal point, and each number is characterized by the pair (a,b) in the representation $a.10^b$ where a has twelve decimal digits and sign, and b has six

binary digits and sign. Numbers and instructions are fed into the machine from punched tapes which are electrically released, arrested, and read by photoelectric means. In the arithmetic unit germanium diodes and selenium rectifiers are to be used throughout in place of tubes. The main internal memory is to be a magnetic drum backed up, however, as in the Mk IV by a high-speed buffer store, consisting of a bank of coil and permalloy core assemblies with nearly rectangular magnetization curves.

At present the adder matrix is being built; a magnetic drum has been successfully run with a pulse density of 8 per millimeter along a given track. The final version is to store 10,000 numbers and, with a rotation speed of 3000 rpm, provide a mean access time of 10 msec. Comparing this with the anticipated addition time of 0.6 msec. the inclusion of a high-speed standby memory is clearly indicated. An experimental model, with four permalloy cores has been operated at read-in and read-out frequencies of 70 kilocycles.

In accordance with his belief that, independently of current digital computer developments, the analog system will continue to have an important function to perform, Professor A. Walther, the director of the Darmstadt Institute, is now going ahead with plans for a sizable electronic differential analyzer. He intends to base this installation on an electrical condenser integrating element, notwithstanding its disadvantages of strict time dependence and mediocre accuracy. Multiplication is to employ the principle of frequency modulation with suppressed carrier, input functions will be realized as masks in cathode ray tubes, and the output is to be presented on the screen of such a tube. The entire system is to comprise 10 integrators, 5 amplifiers for multiplication with constants, 5 multiplier components, 5 input, and 6 output oscilloscopes. Short solution time and ease of manipulation, especially in the execution of parameter surveys for differential equations, are the principal advantages claimed for such an analyzer. The facility to handle input and output in the form of curves is given particular emphasis and put forth as one of the main arguments in defending the continued usefulness of analog systems.

For further information about German computer developments, see Technical Report ONRL-80-52, available from the Technical Information Office, Office of Naval Research, Washington 25, D.C.

THE ION PROBE IN AERODYNAMIC MEASUREMENTS

An ion probe for aerodynamic measurements is being investigated at the Physics Institute, Aachen, Germany, incidental to the studies of its director, Professor W. Fucks, on the general subject of electrical discharges in gases. The ion probe can be used to measure either local flow velocities or pressure changes provided the effect of the other is known to be negligible. A very small anode, maintained at a high positive potential, is located at the center of a grounded ring-shaped cathode. The potential is set at a value insuring reasonable ion mobility under the influence of the field but avoiding electrical breakdown. The gas in the region between anode and cathode may be ionized by various means, e.g. high-energy radiation supplied either by an external source or by a radioactive coating on the cathode. The method generally adopted is that of raising the tension sufficiently high to obtain a corona. Assuming gas densities to remain constant, the variations in the cathode current will be directly related to the variations in the flow velocity component normal to the plane of the cathode, the ion velocity in the direction of the field being compounded with the flow velocity. If, on the other hand, the changes in the flow velocity are such as to affect the ion capture rate of the cathode only a little, variations in gas density will produce variations in the cathode current. The ion probe is therefore specifically adapted to record velocity fluctuations in gases flowing slow enough to act like incompressible fluids (turbulence) or to measure large pressure variations attended by comparatively small changes in velocity (transient shock waves).

Work along both lines is now being undertaken after having lain dormant for two years during which time Professor Fucks was rector of the Technische Hochschule. Many probes have been made, the ring diameter of the cathode being about 7.5 mm and the anode the end of a thin platinum wire melted down in a high voltage arc to give a perfect sphere. The perfection of the spherical anode is stressed as the most important aspect of the probe. The ion concentration is highest in the immediate vicinity of the anode and therefore the registered effect is principally dependent on the flow field in this region; its flawless geometry is therefore of prime importance. Currently the ion probe is calibrated against hot wire anemometers by inserting

both instruments into the Karman vortex street behind cylindrical obstacles, both obstacle diameter and free stream velocity being varied. The ion probe is also being used for turbulence measurements in air flows at velocities up to 75 m/s. In this experiment the cathode current variations are recorded, after amplification, on magnetic tapes which are subsequently fed into a correlator in order to determine various time and space correlation coefficients. Recently the installation of a small shock tube has been completed in which the ion probe is now being calibrated for transient shock wave measurements. In all of these respects work has progressed to the point where perfect qualitative operation could be demonstrated, but no systematic quantitative results have been accumulated as yet.

THE VISUAL BEHAVIOR OF CATS DEPRIVED OF THE VISUAL AREA IN THE CORTEX

The absolute lower threshold for vision, the spectral sensitivity under dark adaptation (rod function), and the spectral sensitivity under light adaptation (cone function) have been determined in four cats by Dr. Ralph Gunter, at the Institute of Ophthalmology (London). These animals were then subjected to an ablation of their occipital areas and the sensitivity data were re-determined.

At first Gunter ablated the visual areas as mapped out by Marshall and Talbot. When the animals had recovered, there was no observable change in behavior from the normal, i.e., they would jump from tables, avoid obstacles, and show all the general behavior patterns of normal animals. The visual reflexes, as well as nystagmus, could be elicited easily. The same general results were obtained when the area, generally known as the striate area, was removed from the cortex. Under experimental conditions in a choice box, these animals showed the same ability to discriminate between lights of different intensities that they had when they were normal. All of these observations refer to conditions of light as well as dark adaptation.

Next, Gunter extended the ablations a considerable distance anteriorly as well as laterally, and in some cases removed as much as three quarters of the brain. These animals showed a striking change in behavior compared with the normal. They seemed absolutely blind in daylight, that is, they ran into obstacles, did not jump

when put on a table, showed no placing reactions of the fore-legs, and nystagmus could be elicited only with great difficulty. The pupil reaction to light was sluggish at first but returned to normal, and there was very little following movement in the eyes. All of these reflexes will be tested again.

In the choice box these animals did not learn to discriminate between different intensities of light after 2000 trials (normal learning required 200 trials). Animals which did discriminate before the operation lost this habit after the operation, and the function did not recover. This was under conditions of light adaptation. Under conditions of dark adaptation the spectral sensitivity of these animals, as well as their absolute lower threshold, were not altered significantly from the values obtained on the same animal when normal. The tentative conclusions to be drawn from these observations (pending histological examination of the brains) would be: (1) the area responding electrically to photic stimulation of the eye is not the sole center for vision, (2) cone vision (light adaptation) seems to be destroyed when an extensive amount of cortical tissue is removed, (3) rod vision (vision under conditions of dark adaptation) is not affected by this operation and does not seem therefore to be localized in the cortex.

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ULTRACENTRIFUGE STUDIES ON FOOT AND MOUTH DISEASE

During a recent meeting of the Royal Society, Sir Alan Drury reported on the work of Bradish, Brooksby, Dillon, and Norambuena in their ultracentrifuge studies on the infective and complement-fixing components in the virus system of foot and mouth disease.

The sedimentation constant of the infective particle has been found to be 70 Svedburg units as determined by a capillary method in a swinging-cup rotor of new design.

Further ultracentrifuge studies employing inclined tubes have demonstrated that up to 50 per cent of the total complement-fixing activity is associated with the infected particle. The remaining complement-fixing activity is associated with a component of sedimentation constant of eight Svedburg units. This smaller component if infective, contributes less than one part in 10^4 of the total infectivity.

HABITS OF A HONEYBEE COMMUNITY

Kalmus, Nixon, and Ribbands working at the Rothamsted Experimental Station, England, have shown that during the lifetime of every honeybee she performs a definite sequence of tasks, the oldest bees being foragers. Most bees omit some of the earlier duties. Tasks are allocated in accordance with the needs of the colony.

Widespread food transmission or food sharing was demonstrated by a tracer technique. All major tasks involve the manipulation of food, and through food transmission all bees performing any task are evenly fed. Any surplus causes the older members to leave their group and join another.

Experiments proved that foraging bees recognize hivemates by their odor which they distinguish from the odor of other honeybees. The common colony odor is derived from the food transmission which provides an identical diet with identical odorous waste products.

Food transmission is therefore the most primitive and the most important method of communication of the honeybee community.

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 Information Office, Code 250, Office of Naval Research, Washington 25, D.C.

ONRL-75-52 "Research at the Chemical Institute of the University of Heidelberg" by G.J. Szasz

ONRL-76-52 "Radioactivation Method for the Determination of Micro-Quantities of Uranium" by S.F. Singer

ONRL-77-52 "Measurement of Magnetic Moment of an Excited Nuclear State" by S.F. Singer

ONRL-78-52 "Qualitative Observations of the Visual Behavior of Cats Deprived of their Visual Area in the Cortex" by H.A. Imus

ONRL-80-52 "A Progress Report on German Computer Development" by F.J. Weyl

ONRL-82-52 "Symposium on Fatigue, The Ergonomics Research Society, College of Aeronautics, Cranfield, 24-27 March 1952" by H.A. Imus

FORTHCOMING EVENTS

The International Union for Crystallography will celebrate this year the 40th anniversary of the discovery of X-ray interference by von Laue, Friedrich, and Knipping. The X-ray analysis group of the Institute of Physics, London, is preparing a special meeting at the Royal Institution, London, for 24 - 25 October. Professor von Laue and Professor Sir Lawrence Bragg have been invited to participate. Further details can be obtained from the Institute of Physics, 47 Belgrave Square, London, S.W. 1.

On October 19, 1952, a symposium on Metallic Surfaces will be held at the Royal Institution, Albemarle Street, London, W.1. Further details can be obtained from the Secretary, The Institute of Metals, 4 Grosvenor Gardens, London, S.W. 1.

Prepared by the Scientific Staff
Submitted by Dr. S.R. Aspinall
Deputy Scientific Director

Philip D. Lohmann

PHILIP D. LOHMANN
Captain, U.S.N.
Assistant Naval Attache for Research