

and has made progress which compares very favourably with that in Britain and the United States.

In the first part of the book, following a brief historical introduction, the author presents the fundamental theory of the various thermo-electric effects and gives special attention to the problems raised by the different statistics of degenerate and non-degenerate semi-conductors. He then gives the important criteria for efficient thermojunctions and finally derives the well-known efficiency factor which is the square of the thermo-electric power divided by the product of thermal conductivity and electrical resistivity. In giving the conditions for optimum performance the text provides a very useful discussion of the influence of such effects as phonon and impurity scattering of charge carriers. As regards experimental material, mention is made of the PbSe-PbTe and the  $\text{Bi}_2\text{Te}_3$ - $\text{Sb}_2\text{Te}_3$  series as sources of efficient semi-conductors for thermo-electric devices.

To some extent the combination of two books produces repetition of material from the first part in the second part of the text; for example, the efficiency factor is re-presented. The second part includes an interesting summary of the experimental studies made on the selenides and tellurides mentioned above. As shown by other workers in the West, the principal problem is to prepare semi-conductors with suitable impurities so that a reduction in the thermal conductivity is obtained without a corresponding decrease in electrical conductivity.

In the last chapter of the book interesting examples of practical refrigerator units are given, while elsewhere examples of power generators (one suitable for mounting over a paraffin-lamp glass for supplying power to a radio set) are included. Although *n*-type PbTe-PbSe combined with *p*-type  $\text{Sb}_2\text{Te}_3$  appears to be the junction used in many refrigeration units, there is a noticeable absence of specification of the junction used in the later developments where a temperature difference of 70° C. is claimed between hot and cold junctions.

On the whole, this book is a very welcome addition to the relatively sparse collected literature on semi-conductor thermo-electric devices. It is lucidly written and shows an appreciation of the contemporary position in the West at the time of writing. It is to be hoped that more translations of Russian texts on solid state physics will quickly follow this one.

G. F. J. GARLICK

## ELECTRICAL PROPERTIES OF MATERIALS

Handbuch der Physik

Herausgegeben von S. Flügge. Band 17: Dielektrika. Pp. vi+406. 94 D.M. Band 19: Elektrische Leitungseffekte I. Pp. vi+411. 82 D.M. Band 20: Elektrische Leitungseffekte II. Pp. vii+491. 112 D.M. (Berlin: Springer-Verlag, 1957.)

THE three volumes in question are concerned with the theoretical physics underlying the electrical properties of materials, some of which have great technological importance. In general, the aim of the editors is to cover the theory as completely as possible, but several of the articles cater for the experimentalist who is looking for physical meaning, as well as for the

pure theoretician. The bibliographies given seem up to date to 1955 or 1956; as a small point of criticism it may be mentioned that there is no consistent policy as to whether references should be given in footnotes or collected at the end of each article. Some articles are in English, some in German, and one is in French. The general index at the end of each volume is given both in German and English, with translations. The printing of the mathematical formulæ is of a luxurious standard.

Volume 17 contains three articles of about equal length. The first, on "Dielectrics", by W. Fuller Brown, covers the theory of the static dielectric constant and dielectric loss. The author gives a somewhat cumbersome text-book presentation of the subject with the emphasis on formal electrostatics. There is a short section on recent work on microwaves. The article on "Electrical Breakdown", by W. Franz, in German, contains a historical survey of the subject which is somewhat out of date on the technological side, and chapters on thermal and intrinsic breakdown. The main interest of the article lies in a discussion of the different theories of intrinsic breakdown, given with a fair amount of mathematical detail. The article on "Piezoelectricity, Electrostriction and Ferroelectricity", by P. W. Forsberg, unifies its three subjects on the basis of a treatment by tensors. This presentation leads to a certain amount of repetition, but the article reviews much recent material, and contains a wealth of beautiful illustrations.

Volume 19 is written wholly in English. J. C. Slater contributes an article on "The Electronic Structure of Solids" which introduces the reader to a subject which is the basis of a large part of Volumes 19 and 20. The article is chiefly concerned with the theory of electrons in a periodic lattice in terms of the band model, and contains sections also on cohesive energies and elastic properties and on magnetism. The author frequently includes discussions in non-mathematical terms particularly where the physical meaning of approximations is concerned. The second article, by A. N. Gerritsen, "Metallic Conductivity, Experimental Part", concentrates on work after 1945. The article covers metallic conductivity as a function of physical parameters and of crystal structure and imperfections, and contains many tables and graphs. H. Jones contributes an advanced and condensed treatment of the "Theory of Electrical and Thermal Conductivity in Metals". In particular, he gives chapters on conductivity at low temperatures and the anomalous skin effect, and he treats *Umklapp* processes more fully than usual. G. F. J. Garlick, in an article on "Photoconductivity", gives a relatively short theoretical introduction and proceeds to give a tightly packed review of post-war work, largely experimental. There is little overlap between this article and the article on semiconductors in Volume 20.

About half of Volume 20 consists of an article on "Semi-conductors" by O. Madelung, in German. This is theoretical, with the emphasis on statistical thermodynamics, but the presentation caters for the experimentalist. About 100 pages are devoted to the theory of homogeneous semi-conductors in and out of equilibrium, with the emphasis on electrical conduction, while some 30 pages deal with *p-n* junctions, leading logically to the theory of transistors. Surfaces and contacts are also discussed, and the

author gives a summary of the experimental methods for the determination of the most important parameters of semi-conductors. Optical and magnetic properties are only touched on. The article on "Ionic Conductivity", by A. B. Lidiard, in English, is also theoretical with the emphasis on statistical thermodynamics and physical meaning. It gives an integrated picture of a subject the references to which are otherwise widely scattered. The author discusses intrinsic and structure-sensitive conductivity, and gives a section on alternating-current phenomena which is incidentally of dielectric interest. J. M. Stevels, in a comprehensive article in English, reviews the electrical properties of glass. He takes the structure as read and treats dielectric properties and electrical breakdown as well as electrical conduction. For the last article there is a change in physical imagery as well as in language, since the subject is concerned with liquids instead of solids, and the language happens to be French. E. Darmois, in an article on "Electrochemistry", gives a fairly comprehensive introduction to the theory of electrolytes and then reviews such less accessible subjects as electrocapillarity, the theory of the double layer, and electrokinetic phenomena.

## CONTRIBUTION OF RADIOBIOLOGY TO GENERAL BIOLOGY

### Symposium on Antibodies

Their Production and Mechanism of Action. (Given at Research Conference for Biology and Medicine of the Atomic Energy Commission. Sponsored by the Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee; held at Gatlinburg, Tennessee, April 8-10, 1957. Reprinted from the *Journal of Cellular and Comparative Physiology*, Vol. 50, Supplement 1, December 1957.) Pp. x+361. (Philadelphia: The Wistar Institute of Anatomy and Biology, 1957.) n.p.

THE biological changes produced by ionizing radiations began to be studied immediately after Röntgen's discovery of X-rays, but it is only in the past fifteen years that the research effort put into radiobiology has really gained momentum. The dividend reaped has extended far beyond original expectations, and this applied research has contributed very greatly to the progress of general biology. It is a good illustration of how fundamental discoveries can spring from researches directed to a more immediate and practical end.

The annual research symposia organized by the Oak Ridge National Laboratory since 1947, on a wide range of biological topics, have played an important part in making radiation studies an integral part of contemporary biology. The subjects chosen have shown a great awareness of the trend the researches are taking and have brought together experts just at a time when the particular subject was advancing rapidly. As an example the seventh conference of the series, in 1954, may be mentioned. It dealt with genetic recombination from different aspects, and by doing so synthesized our observations on bacterial transformation and transduction and stimulated the measuring of genetic distances in molecular dimensions. This particular conference applied the Watson-Crick model of deoxyribonucleic acid on the chromo-

somal level, and developed new concepts which have helped considerably in the analysis of various problems of cytology and genetics. In some of the symposia, such as those on genetics, the influence of radiation formed an integral part of the topic discussed; while in others, such as those devoted to the biochemistry and biophysics of important macromolecules, radiation did not enter into the main papers at all though its relevance to the subject was brought out in the well-edited discussion.

The tenth meeting, held in April 1957, and published like all the others as a supplement to the *Journal of Cellular and Comparative Physiology*, is typical. Its subject: "Antibodies: their Production and Mechanism of Action", provided an excellent forum for the discussion of the interesting problems which arose in connexion with the application of a new method, for enhancing, and in certain instances achieving, the complete recovery of experimental animals from radiation injury. The method, first suggested by the observation of Lorenz and his collaborators in 1951, consists of the transplantation of blood-forming tissues such as the bone marrow, into animals whose hæmopoietic organs are destroyed by irradiation, and has been intensively studied in many laboratories. Progress has been rapid, particularly since 1955, when D. L. Lindsley and his colleagues (Oak Ridge) demonstrated, by using genetic markers which differentiated between host and donor, that the transplanted donor tissue took over the function of blood formation. The cytological proof that the donor cells recolonize the irradiated bone marrow was provided in the following year by J. F. Loutit and his group in Harwell. Work from several centres was summarized at the conference by C. C. Congdon and T. Makinodan of Oak Ridge, J. F. Loutit, C. E. Ford and N. A. Mitchison of Britain, and by D. W. van Bekkum and O. Vos of Holland.

The discussion of the extremely intriguing immunological consequences (for example, the co-existence of two genetically different tissues in 'chimeras'; the nature of homograft reaction; the degree of cellular adaptation; the mechanism of actively acquired tolerance) was introduced by the papers of leading immunologists and biochemists dealing with fundamental aspects of immune reactions. The induction, rate of synthesis and degradation of antibodies were discussed by W. H. Taliaferro (Chicago); the nature of the antigen-antibody reaction was described by J. F. Dixon (Pittsburgh), S. J. Singer (Yale University), R. W. Wissler and his collaborators (Chicago), and the diversity of antibodies was analysed by D. W. Talmadge (Chicago). The relationship between immunological specificity and chemical structure was the subject of E. A. Kabat's (New York) presentation. R. S. Schweet and R. D. Owen (Pasadena) discussed the nature of the change which may occur in cells responsible for antibody formation, and presented a challenging scheme postulating that the foreign antigen impinges on the nuclear deoxyribonucleic acid of the host and that the process may be considered to be similar to that of bacterial transformation; while G. D. Novelli and J. A. DeMoss (Oak Ridge) considered current concepts of protein synthesis. The symposium brought together much basic information which may enable us to apply the new method in the therapy of human leukæmias, and showed that the time has arrived for discussing the mechanisms which may be responsible for cellular variation. This formed the subject of the eleventh symposium which was held in April of this year with