Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (J. H. Robertson, School of Chemistry, University of Leeds, Leeds LS2 9JT, England). As far as practicable books will be reviewed in a country different from that of publication.

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Superconductivity of transition metals their alloys and compounds. By S. V. VONSOVSKY, YU. A. JZYMOV and E. Z. KURMAEV, translated by E. H. BRANDT and A. P. ZAVARNITSYN. Pp. xiii + 512. **Springer Series in Solid State Sciences, Vol. 27.** Berlin: Springer-Verlag, 1982. Price DM 95.00.

This book is a translated and updated version of the Russian original from 1977.

The *Introduction* deals with considerations of the occurrence of superconductivity within the elements and very different chemical compounds, of the general theory of superconducting phenomena and of the peculiarities of transition metals with respect to superconductivity. In the following two chapters the theory of strong coupling superconductors and of the interplay between magnetic moments and the superconducting state (including the coexistence of magnetic ordering and superconductivity) is outlined in detail (chs. 1–3, about 180 pages).

The treatment of superconductivity in the pure transition metals (ch. 4) and the A15 phases (ch. 6) starts with the presentation of empirical correlations between T_c and other physical properties (electronic heat capacity, Debye temperature, magnetic susceptibility and so on). The largest part of these chapters is devoted to considerations of the contribution of electronic properties (band-structure calculations) and lattice factors to the electron interaction parameter (McMillan's theory), and to calculations of the electron–phonon interaction constant, and hence T_c values, from first principles. Here, as in the case of ch. 3, the experimental facts serve as an introduction to the theoretical problems or for the confirmation or disproof of theoretical models (170 pages).

The superconductivity of transition-metal alloys (ch. 5) is described from the experimental point of view and discussed mainly within phenomenological models. Miedema's model is worth mentioning because it throws light on the importance of chemical factors (*i.e.* electronegativity) for superconducting properties (28 pages).

From the residue of intermetallics (other than A15) and compounds with superconducting properties, only those are mentioned which are studied in more detail or which are of interest with respect to high T_c values (ch. 7). The discussion of the results is restricted to a qualitative consideration of the influence of the density of states and the phonon properties on T_c (about 60 pages).

Considering the large amount of data the authors arrive at the conclusion that high T_c values cannot be explained by electronic or phonon properties alone, but are always accompanied by a more or less pronounced lattice instability. Therefore, it seems logical that the book includes a chapter on high-temperature superconductors and lattice instability (ch. 8, 25 pages). Sometimes it has the character of an outlook on pathways for further work.

From the concept of the book I cannot understand why the authors devote a particular chapter (ch. 9) to the effects of irradiation of superconductors and why they do not integrate the relevant facts in the other parts of the book as they do with superconducting phenomena in amorphous materials and thin films.

The book seems to be written for physicists, but one can recommend it to chemists and materials scientists who are interested in the present state of the 'philosophy' behind superconducting phenomena. For non-specialists and students the book may serve as a first orientation in the vast amount of literature, since the experimental facts are well presented and illustrated by clearly arranged figures.

The book is a photoprint of a type-written manuscript with few misprints. The citation of literature is well balanced and contains many references to recent reviews of special topics. The value of the book suffers from the crude subject index and from the lack of an author index. The price seems acceptable.

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Physics of defects. Edited by R. BALIAN, M. KLÉMAN and J.-P. POIRIER. Pp. xxxi + 857. Amsterdam: North Holland, 1981. Price Dfl 375.00, US$174.25.

This book consists of the text of the lectures presented at the Les Houches Summer School, France, during August 1980. It contains 14 courses and several seminar reports, which cover a wide range of problems on the physics of defects.

The investigation of imperfect crystals – in particular, of crystals containing defects – is perhaps the main direction of modern solid-state physics, which makes its results so rich and interesting. During the past few years, concepts that invoke defects have been penetrating successfully into other branches of physics – from the physics of quantum liquids and liquid crystals to the theory of elementary particles and wave processes, and into other branches of science – chemistry, geology and biology. At the same time, rather general concepts of defects as distortions of ordered structures and new general mathematical approaches giving simple and clear results applicable to various specific systems are gradually being developed. The essential character of the approach of the school at Les Houches, and of this book, is to cover a large range of defects (from dislocations in crystals to wave-structure singularities, or to dislocations and disclinations in human fingerprints) occurring in various very different systems, and to use current approaches for their analysis.

The classical problems of the physics of crystal defects are considered in the courses by J. Friedel and E. Kröner. In the first, large amounts of the results on physical concepts of the order and disorder in various condensed systems, and on such defects as walls, translation and rotational dislocations (disclinations) in crystals, are given compactly and comprehensively. Together with the abundant material known to specialists and, here, excellently presented, on the structure and mobility of these defects in crystals of various types, and their connection with the strength characteristics of solids, this review also includes a number of significant remarks useful for the specialist in this field (for example, on the thermodynamic stability of the amorphous state of small particles).

The course by E. Kröner deals with the more formal but fruitful continuum theory of defects. The author gives a consistent account of the known results of the linear continuum theory of crystals with dislocations and point defects and discusses some new results based on the use of stress functions (analogous to the vector potential in electrodynamics) and approaches which are based on the quite general nonlinear description of crystals with defects, and which use the language of differential geometry.

Considerable attention is paid in this book to defects in 'new-class' materials which have been extensively investigated in recent years. They include the amorphous metals, considered in F. Spaepen's course. In this course, the structure of these materials and possible types of defect which destroy local order are considered and, by means of concepts of defects, diffusion, plastic flow, and fracture of these amorphous materials, are analysed. Another interesting class of new structures is that of colloidal crystals. These consist of charged particles of sizes $\sim 10^{-5}$–10^{-4} cm in liquid solvents, interacting by screened electrostatic repulsion, and so forming a periodic lattice with unusual properties. The defects in such crystals and the methods of their investigation are considered in P. Pieranski's review. A short review by A. Bourett deals with electron microscopy methods of investigation of the dislocations in normal crystals.

In a number of the courses, new general mathematical approaches to the theory of defects are described. Very useful and elegant topological analysis of defects based on the concept of homotopy classes and the methods of group theory is given in the course by L. Michel. I. Dzyaloshinskii considers a general problem of deriving macroscopic equations for the medium with a large number of singularities. To solve this problem it is convenient to use exterior calculus (which deals with an antisymmetrized product of antisymmetric tensors and antisymmetrized gradients) or the gauge theory method (the method of Yang/Mills field theory). The first approach is useful for the cases when defects (*e.g.* dislocations) satisfy physical conservation laws, and the second is for those systems where analytical topological invariants do not exist (Dirac monopoles, point-like hedgehogs, singularities in ferromagnets, disclinations in multisublattice magnets). Modern differential calculus (theory of jets, concepts of maps, transversality and stratified spaces) is set out in R. Thom's mathematical course, and its use for the analysis of phase diagrams and the morphology of ordered media and their defects is discussed. The approaches of the stochastic theory of dynamic systems have been used by S. Aubry to analyse many defect structures on a model for incommensurate crystals (including devil's staircase formation).

M. Berry considers the geometric features of the singularities in scalar linear waves, and does so with much pedagogic skill, and in modern style. Main attention is paid to those features of these singularities which are generic, and maintain their structural stability under perturbation. To investigate these problems, the results of Thom and Arnold, which constitute the catastrophe theory, are very fruitful. A wide range of singularities of wave processes are considered: dislocations of wave phase fields of different kinds, caustics of ray families in the short-wave limit, and diffraction catastrophes in the asymptotic case of small but finite wavelengths. These ideas are valid for waves of different kinds (in acoustics, quantum mechanics, ocean tidal waves) and may be used in the theory of X-ray and neutron diffraction. Analogous approaches are used by J. Nye, who considers the dislocations and disclinations in electromagnetic waves and the structure of flow fields.

Defects in liquid crystals are also considered in detail in this book. The course by Y. Bouligand is a general, compact and lucid review of the structure of liquid crystals of different types, of various distortions in these crystals, forming the translational and rotational defects, and of their topological classification. W. Helfrich's course deals with more specific problems on the structures of amphiphilic mesophases containing molecules with hydrophobic and hydrophilic parts, which are considered as arrangements of intrinsic defects. Some new optical methods for the investigation of defects in liquid crystals – revealing the dislocations near phase-transition points, and mapping director fields by illumination of the specimen with a cone of light around the polarising microscope axis – are considered in the paper by S. T. Lagerwall & B. Stebler. Defects are also very essential for physical systems of another kind: magnetic garnet films. The dynamics of domain walls, lines, point defects and bubbles in such systems are considered in J. C. Slonczewski's course.

In the majority of applications, such defects as dislocations are considered as being nonequilibrium ones. However, taking into account the entropy and the interaction between defects at high temperatures, the equilibrium density of topological defects is significant, especially in two-dimensional systems. A concept intensively developed in recent years described interacting defects (vortices, dislocations, and so on), which break the stability of a system at certain temperatures, both in the two-dimensional superfluid, planar-spin or melting models, and in three-dimensional ones, as a statistical ensemble. These applications of statistical mechanics of topological defects, including the most recent achievements, are considered in the excellently written course by B. I. Halperin.

Defects in geological and biological systems are also considered in this book. In the course by R. Madariaga, earthquakes and seismic waves due to the faults of dislocation type at the plate boundaries of the earth are discussed. Y. Bouligand considers the defects in cellular and multicellular biological ordered systems. These reviews are interesting not only for the specialist.

This book comprises, on the whole, a comprehensive review of the current state of the physics of defects. It will obviously be interesting for specialists in the field of solid-state physics, crystallography, liquid-crystal physics and diffraction physics, as well as other branches of science.

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Defects in insulating crystals. Edited by V. M. TUCHKEVICH and K. K. SHVARTS. Pp. 774. Berlin, Heidelberg, New York: Springer-Verlag, 1981. Price DM 99.00, US $39.60.

The ninth conference on *Defects in insulating crystals* held in Riga in 1981 was attended by 350 participants, including 200 from the USSR. There were over 200 communications presented as posters. The Abstracts of these papers were published in a separate volume (544 pages) but the list of the titles and addresses of the authors are presented in this volume as a supplement. At the conference 37 review reports were delivered and 34 of them are the content of this book. The amount of work done on defects in insulating crystals is vast and because of the lack of recent books on the subject this collection of review papers can be well appreciated.

A chapter is devoted to the theory and models of defects with special emphasis on the vibrational structure. Then there are reviews on excitons in different types of solids. Another chapter about radiation effects in insulating crystals discusses different aspects of primary and secondary effects. A number of papers are grouped under the title *Spectroscopy*. In fact, this covers different subjects, such as color center lasers, picosecond spectroscopy, impurity centers and even Raman scattering in amorphous $PbTiO_3$. Finally, two papers are concerned with ionic mobility in alkali halides.

Professor C. Lushchik gave the summary talk in which he pointed out some subjects for future research in this field. Although this series of conferences originally concentrated on defects in alkali halides, the scope was gradually broadened to other insulating crystals. Also, the topic of research has shifted from the identification of defects to such subjects as relaxation processes, the creation mechanisms of defects, joint consideration of excitons and defects, and migration of hot defects. More and more interest is also seen in defects as probes for phonons in crystals. Although the reports can often be considered as rather short for the subjects treated they usually put the accent on the most recent developments and contain an extensive list of references.

In conclusion, it can be said that this book will be useful for all those doing research in the field of defects in ionic crystals.

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Computational crystallography. Edited by D. SAYRE. Pp. viii + 539. Oxford University Press, 1982. Price £25·00.

In a great many papers, numerous researchers (H. Hauptman, J. Karle, M. M. Woolfson, and others) provide a comprehensive review of the mathematical and physical background of the computing involved in the current techniques of diffraction-based molecular imaging.

The scientific treatise begins with the computing involved in measuring the diffraction pattern. It then deals with the phasing of the pattern by direct, Patterson, heavy-atom, and phase-refinement methods, and the use of computer graphics in the display and manipulation of molecular images, the structure refinement process and other computations important to crystallographers. At the end there is a short section on the principles of implementation.

This is an excellent book for crystallographers and physicists.

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Advances in X-ray analysis. Vol. 25. Proceedings of the 30th annual conference on the applications of X-ray analysis, Denver, Colorado, 3–7 August 1981. Edited by JOHN C. RUSS, CHARLES S. BARRETT, PAUL K. PREDICKI and DONALD E. LEYDEN. Pp. xviii + 398. New York: Plenum Press, 1982. Price US $49.50. ISBN 0-306-41008-7.

This volume constitutes the proceedings of the 1981 Denver Conference and provides a broad perspective of X-ray spectrometric and X-ray diffraction techniques, giving a valuable overview of the present-day state of the art in X-ray applications. The chosen subject of the plenary lectures was *New techniques for the future of X-ray spectrometry.* The invited speakers, who are all pre-eminent pioneers in the development of particular techniques, focus on fluorescence techniques that are at the forefront of our understanding. These techniques, which approach a full elucidation of theory and active development of practical hardware, will most probably be in commercial use by the end of the decade.

In recent years a trend has developed for the conference to alternate emphasis annually between X-ray spectrometry and X-ray diffraction. This volume contains fifty-six papers of which thirty-three are devoted to topics in X-ray spectrometry while the remainder deal with X-ray diffraction.

The contents of the book are divided into seven headed sections. The first section is devoted to XRF detectors and XRF instrumentation and include, amongst others, two papers on the performance of solid-state room-temperature energy-dispersive X-ray detectors. The current progress with