Solid Optics

Optical Properties of Solids. Edited by F. Abeles. Pp. 1026. (North-Holland: Amsterdam and London, 1972.) Dfl. 200; $62.50.

THIS book is described on its inside cover as giving "an up-to-date account of the most recent advances in the field (optical properties of solids) . . . suitable both for graduate students and for those engaged in more advanced research". It contains eleven chapters written by various authors who have made substantial original contributions to the fields they review. Most of the articles were completed in early or mid-1968 and, in the four or five years since then, there have been many important developments which research workers cannot afford to ignore. The book will thus be primarily used as a source book for graduate and final year undergraduate courses on the optical properties of solids and perhaps also as an introduction to the field for new research workers. The editor points out in the preface that any textbook on solid state theory contains at least a few paragraphs devoted to optical properties. Sadly, most of the solid state physics tests used for final year undergraduate courses rarely do more than this and usually give virtually no account of the intrinsic optical properties of solids and the use of optical spectroscopy as a powerful tool to probe the electronic structure of both pure materials and crystal defects. This situation should improve as more books like this one become available.

The first chapter of this book gives a short review of some of the approximations used in the analysis of the optical properties of solids and this is followed by a good basic treatment of the intrinsic optical properties of semiconductors which, unfortunately, includes only three references to papers published later than 1967 and thus does not cover most of the advances made in this field during the last five years. Chapter 3, written by the editor, gives a valuable critical review of the optical properties of metals, including alloys, liquid metals and superconductors, and is much more up-to-date with even a few references to work published in 1971. This is followed by a chapter on modulated reflectance by B. O. Seraphin, a pioneer in this field, which contains a perceptive conceptual account of the relationship between intrinsic optical spectra and calculations of the electronic structure of solids. It includes a survey of the most important modulation techniques and their potential contributions to band structure analysis.

Chapters 5 and 6 give short accounts of the optical properties of non-crystalline solids and excitons respectively while chapter 7 describes magneto-optical properties of solids, principally metals and semiconductors. This is followed by a chapter on photon-photon interactions in solids which has sections on multiphonon optical transitions, anharmonic effects, alloys and the effects of impurities (but with no discussion of laser Raman spectroscopy). Chapter 9 gives a balanced review of the optical properties of colour centres in alkali halides to 1968 with 400 to 500 references. There is no discussion of related topics such as the production of colour centres by radiation and, sadly, no reference to the many interesting developments that were described at the Reading conference in 1971. This is followed by a chapter on photoemission which describes the experimental techniques needed to obtain reliable spectra and surveys experimental results on metals and semiconductors. The final chapter, on second order optical processes in solids, covers the theoretical and experimental aspects of non-linear effects such as second harmonic generation, optical mixing and so on and, finally, a section on the theory of dipole susceptibilities in perfect crystals.

In a comprehensive text of this kind one would have expected to find chapters on the intrinsic optical properties of ionic crystals, and of crystals with layer structures, the use of isotropic and anisotropic stress and, particularly, the use of synchrotron light sources to obtain information on electronic transitions involving core levels and energy states away from the forbidden gap. The chapter on excitons could well have included at least some experimental data on exciton spectra and a discussion of topics such as exciton-phonon complexes and the effects of external perturbations on exciton spectra. The rather isolated chapter on colour centres might have been accompanied by a chapter on the optical spectra of impurity ions in solids. It is sad that an expensive and comprehensive book of this kind could not be more up-to-date or, at least, that other authors did not append notes on developments to 1971 of the kind that were provided for the chapters on magneto-optical properties and photoemission. There is now a clear need for a new volume on the optical properties of solids which will also cover the progress made since 1968 and in which the principal experimental techniques (modulation, synchrotron, magneto-optic, pressure, photoemission spectroscopy and so on) are all described but in which the information obtained by all these techniques on the electronic structure of each of the different classes of materials is also described together in detail. This volume will be an authoritative and well-written source book for this future work and, in the meantime, should be a useful addition to most science libraries.

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Polymer Structure

X-Ray Diffraction by Polymers. By M. Kakudo and N. Kasai. Pp. xii+464. (Kodansha: Tokyo; Elsevier: Amsterdam, London and New York, 1972.) Dfl. 125; $39.

THE growing role of synthetic polymers in present day technology, and the realization that their useful properties depend largely on their semi-ordered molecular texture, is one of the factors that have led to the publication of books dealing specifically with the complex problems involved in the study of this texture by X-ray diffraction methods.

Another equally effective incentive is provided by the spectacular contributions of X-ray diffraction methods to our understanding of the structures of the natural polymers on which life is based; for these too are often semi-ordered. The highly ordered arrangements of molecules in crystals, and in the limited crystalline regions in polymers, are accessible by the well established methods to be found in textbooks of X-ray crystallography; but to deal in a quantitative way with the range of partially ordered textures from distorted crystalline to entirely amorphous (often in one and the same specimen), considerable extension of the mathematical treatment is necessary.

This latest contribution in this field is a translation of a recent Japanese textbook. It covers most aspects of the subject thoroughly and would provide an investigator with an adequate theoretical background for tackling the whole range of problems likely to be encountered. But it naturally has its own viewpoint which controls the treatment and the space allotted to different aspects; the emphasis is on the physics of X-ray diffraction rather than on polymer structure. It contains less information on the results of X-ray studies of molecular texture than other books of similar scope and intention published in the last few years; examples are naturally used in the exposition, but are treated only in so far as is necessary to display the methods. There is very little about the stereochemistry of polymer molecules or the relation between the properties of polymer specimens and such features as the proportion of crystalline material or the orientation of crystalline regions. This attitude is fair enough in view of the book's title, but inevitably makes it less interesting to polymer people than other books which devote more space to examples and the bearing of results on our understanding of polymer properties.

The book is divided into three sections: fundamental, experimental and analytical. It contains in its fundamental section more about the properties of X-rays than its rivals, and the development of the theory of diffraction