I find the explanation of the Becke line phenomenon (similar to that given in many texts) unconvincing. The workings of the Abbe and Jelley refractometers I would have thought merited explanatory diagrams. In some respects the text is very up to date, *e.g.* using a lunar rock for an illustration of feldspar twinning, but there is no mention of such methods as interference microscopy or dispersion staining, which have been developed relatively recently

The distinctive features of this book (detailed treatment of immersion methods and conoscopic observations) as compared with several other recent books on the same subject will probably appeal to many teachers of optical mineralogy dealing with intermediate and advanced geology students. Each book of this kind may serve also to remind chemists, physicists and even some crystallographers that, granted the value of chemical analysis, spectroscopy of one kind or another and diffraction studies, there is something to be gained by actually having a close look at their specimens under a polarizing microscope.

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Early papers on diffraction of X-rays by crystals. Vol. II. Edited by J. M. BIJVOET, W. G. BURGERS and G. HÄGG. Pp. xix + 484. Utrecht: Oosthoek, 1972. Price £10.80.

This work is of particular interest to the reviewer, because it is a collection of the publications he and his colleagues read and discussed during the years 1933 to 1936 when he was one of Professor Linus Pauling's graduate students in the Chemistry Department of the California Institute of Technology. The fundamental discoveries necessary for the development of the science of X-ray crystallography had been made by about 1930; the papers collected in the five chapters of the first volume of this work cover this subject matter beautifully. The second volume, which is the subject of this review, contains an intelligent selection of papers from which the early growth of the science of crystal-structure determination can be traced.

Chapter VI, the first in Volume II, contains selections from the works which eventually led to the symbols for space groups and the tables of their symmetrically related points that we use today. Some papers are included which describe how space groups could be found from X-ray diffraction patterns, and how molecular symmetry could sometimes be inferred from the space group of a crystal and the atomic content of its unit cell. Chapter VII presents most of the classic papers in which the ionic and covalent atomic radii are defined and stated. (Metallic radii were also much used in the 1930's, but no paper about them is included.) Then follows some material describing the early work on the structures of ionic crystals, together with some mention of the hydrogen bond. Chapter VIII contains papers, or fragments of papers, describing the various techniques for collecting data on the directions and intensities of X-rays diffracted by crystals, crystalline powders, and partially crystalline fibers. The Laue, powder, rotation, and Weissenberg techniques are described, and some of the structural results so obtained are presented. Chapter IX deals in a similar way with the classic works on solid solutions, random stacking of layers, and rotating groups. Some of the early work on alloys and their structures is also included in this chapter. Chapter X presents a collection of pioneering papers on crystal-structure determination. Early uses of symmetry, cell dimensions, diffracted intensities, chemical intuition, trial and error, and isomorphous replacement are all described. The increasing complexity of the structures studied during the period 1920 to 1935 is clearly brought out. The chapter ends with the first papers on X-ray diffraction by crystalline proteins. Chapter XI is a group of papers in which is traced the history of the use of Fourier series in crystal-structure determination. It starts with the working out of the electron density in alkali halides, continues with the use of signs from trial structures, and ends with the heavy-atom method. Chapter XII contains only one paper: the famous 1935 paper fully explaining the Patterson method, then tacitly limited to finding the projections of interatomic vectors onto lines or planes.

The names of the authors of all these great papers are not quoted above: to do so would have made this review too long. Their distinguished names are all in the book, of course, and most of them are familiar to every physical scientist.

An interesting example of the discovery, loss, and rediscovery of an important idea appears on the title page of Chapter XII. P. P. Ewald pointed out in 1921 that the squared magnitudes of the structure amplitudes of the X-rays diffracted by a crystal depend on the interatomic vectors and not the atomic positions. No use seems to have been made of this fact until it was rediscovered by A. L. Patterson in 1934.

By carefully reading the material in this book, a student could learn more than three quarters of what a modern X-ray crystallographer should know, and at the same time get a feeling for the excitement that existed among investigators of crystal structures in those thrilling days. He would also discover how incorrect ideas are sometimes held by very distinguished scientists, and how subsequent thought and experiment changes these ideas into others. Eventually the current ideas are evolved; these are the ones we think are correct.

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Electron microscopy in material science. Edited by U. VALDRÉ. Pp. xiii + 757. New York: Academic Press, 1972. Price £16.35, $35.00.

Electron microscopy has recently entered an exciting new phase of instrumental and interpretive development, and the current power of the method in its application to a wide range of problems in materials science is the subject of this large volume, which arises out of the International School for Electron Microscopy held at Erice in Italy in 1970. About 20 workers, who have played a leading part in bringing about the current state of the art, contributed lectures to the School's programme, which was divided into three sections: (*a*) electron optics and instrumentation, (*b*) diffraction contrast and its applications and (*c*) transfer of image information and phase contrast. Their lectures, collected together in this book, form a substantial contribution to that part of the literature of electron microscopy whose aim is to educate and instruct.

In the first section there are contributions by A. Septier (geometrical electron optics), R. Castaing (secondary ion microanalysis and energy-selecting

microscopy), A. V. Crewe (high-intensity electron guns and scanning microscopy), U. Valdré and M. J. Goringe (special stages) and K.-H. Hermann *et al.* (image recording). Septier's contribution is particularly clear and informative, containing a number of worked examples, and that of A. V. Crewe is timely in view of the great interest in field-emission electron guns.

The middle section of the book is introduced by accounts of the interaction of the beam with crystalline material by A. Howie and R. Gevers. This is followed by contributions from L. M. Brown (metallurgical information) and M. J. Makin (radiation damage studies) which demonstrate their fields of application. M. J. Goringe discusses computing methods. The final contribution to this section by Goringe and C. R. Hall contains 22 problems which range over the preceding material and enhance the value of the whole section.

In the final part of the book are lectures by F. A. Lenz (transfer of image information), F. Thorn (phase contrast) A. C. van Doorsten (amorphous and macromolecular objects), C. R. Hall (small clusters), R. H. Wade (Lorentz microscopy) and D. Wohlleben (magnetic phase contrast).

Thus the book presents a comprehensive survey of the power of the electron microscope as a tool in Materials Science. The Organizers of the School and the lecturers are to be congratulated on presenting the material in a way that will stimulate use of the power rather than reverence of it. The book is handsomely produced and strongly bound, which is well, for it will surely get the use it deserves.

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Book Received

The following book has been received by the Editor. Brief and generally uncritical notices are given of works of marginal crystallographic interest; occasionally a book of fundamental interest is included under this heading because of difficulty in finding a suitable reviewer without great delay.

Handbook of Geochemistry. Vol. II/3. Editorial board: C. W. CORRENS, D. M. SHAW, K. K. TUREKIAN, J. ZEMANN. Executive editor: K. H. WEDEPOHL. New York: Pp. 600 approx. Springer-Verlag, 1972. Price (Looseleaf binder) DM 258, U.S. $ 81.80 (Subscription, price DM 206,40, U.S. $65.50).

This work is in loose-leaf form and is issued in instalments. Each section of Volume II deals with either a single element, or sometimes a group of related elements. The sections are written by different authors and are issued as they are received by the publishers so that they must be rearranged in correct sequence by the reader. For each element there is a chemical and physical description, an account of the natural occurrence in minerals and a reference section.

Meeting Report

Conference on Phase Analysis: Identification and Quantitative Determination. Hull, 5-7 April 1972.

The Crystallography Group of the Institute of Physics devoted its 1972 Spring Conference to Phase Analysis: Identification and Quantitative Determination. The meeting, held in the Physics Department of the University of Hull from 5–7 April, covered in four sessions the following topics: phase identification and characterization, quantitative determination and data processing, instrumentation and indexing. There were 125 participants – several from abroad – drawn from industry, research laboratories and Universities.

The first session opened with an invited paper by Professor H. P. Rooksby (University of Leeds) and Dr E. A. Kellett (The General Electric Company Limited). Professor Rooksby described the unique role played by X-ray diffraction as part of an analytical partnership. The importance of the photographic method, in particular the Debye–Scherrer technique, was stressed, since in an industrial environment many specimens are not amenable to powder diffractometry. The non-destructive aspect of the Debye–Scherrer method was emphasized together with the possibilities of examination *in situ* and the importance of the additional information which may be recorded on a film.

The power of the X-ray technique when used in conjunction with other analytical methods such as microprobe analysis, emission spectroscopy, infrared absorption and even Curie-temperature measurements was illustrated by a variety of applications ranging from the non-destructive identification of small inclusions to more complex problems involving thin-film composition and semiconducting devices. It was shown that although X-ray powder methods can identify the presence of various phases, other techniques such as X-ray spectrochemical or microprobe analysis are required to obtain the atomic composition of each phase. The importance of oorrect characterization was stressed by Dr G. F. Claringbull (British Museum) in his introductory address and illustrated by Dr J. H. C. Hogg and Dr H. H. Sutherland (University of Hull) in their paper on the indium–sulphur/selenium/tellurium systems, in which they showed by X-ray single-crystal studies that four reported phases previously identified by X-ray powder methods had been assigned incorrect formulae.

An investigation of the cadmium–copper–zinc ternary system, undertaken by Mr R. D. Nicholson, Dr P. H. Spriggs and Mr K. A. Stubbs (University of Manchester) showed that the previously reported Laves phase quoted for the equi-atomic alloy Cu–Cd–Zn was an f.c.c. phase obtained during investigation of the pseudo-binary system γ-CuCd and γ-CuZn. The attempted preparation of the equi-atomic alloy resulted in two cubic phases one of which was related to δ-$CuZn_3$ by the ordered substitution of cadmium.

At a time when the uncertainty in lattice parameters is one part in 10^5 or 10^6, Mr L. Zwell (Joint Committee on Powder Diffraction Studies, Swarthmore) pointed out that often the chemical characterization and homogeneity of the materials are not known to one part in 10^4. Inaccurate data, from poorly prepared or inadequately characterized specimens, inevitably cause failure in efforts to relate various properties of materials to either the presence and quantitative distribution of phases, or the electronic structure and relative sizes of the atoms in solid solutions. He described the change in the lattice parameter of α-iron by the addition of titanium and manganese, showing how this is related to density. This work was further coordinated with Curie temperature measurements and results from shear-stress experiments. Mr Zwell made the plea for more accurate density determinations as an aid to specimen characterization – a point which was frequently made by other speakers including Dr Shirley and Professor Lipson.