photographs. The remaining alignment requires rotation of the sample holder so that the normal to the diffracting planes is perpendicular to the slit edge. This rotation is, in general, less than one degree. Finally the Bragg angle is set by adjusting the ϕ motion of the quarter-circle goniometer. (The χ motion is not used and any single rotation motion can be substituted for the quarter-circle goniometer.)

Fig. 2 shows for superimposed 111 topographs of a (111)-cut silicon wafer taken with this device. The topograph was recorded using an Ilford Nuclear Plate (Type G5) with Ag $K\alpha_1$ radiation. The fact that there is no noticeable loss of resolution in this multiple exposure indicates high reproducibility of the translational motion. Dislocations whose Burgers vector is of the $\frac{1}{2}$ ⟨011⟩ type are evident. This type of dislocation is typically found in silicon (Jenkinson & Lang, 1962).

Further details about this camera can be obtained from the authors.

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Reference

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Crystallographers

The **Walter C. Hamilton Memorial Fund** has been established to provide assistance to one or more students, chosen each year, to work in the Chemistry Department at Brookhaven National Laboratory or for such other purposes related to chemical research as may be deemed appropriate by a committee appointed by Associated Universities, Inc. (operators of BNL), which will collect and administer the fund. The committee consists of Dr Gerhardt Friedlander, Chairman, (Department of Chemistry, Brookhaven National Laboratory, Upton, L. I., New York 11973, U.S.A.), Sidney C. Abrahams, David P. Shoemaker and Robert Thomas. Those wishing to participate in this memorial fund may send contributions to any committee member.

Professor **Samuel Tolansky**, who had been Professor of Physics at Royal Holloway College, University of London since 1947, died on 4 March 1973 at the age of 65. He was a Fellow of the Royal Society, an Honorary Member of the American Society for the Advancement of Science and an Honorary Fellow of the Royal Microscopical Society. The many books he wrote included the definitive works *Multiple Beam Interferometry* and *High Resolution Spectroscopy*.

Best known for his development and application of multiple beam interferometry to surface microstructure, he also made major studies of the growth, hardness and etch properties of diamonds, of lunar rock samples and of atomic nuclear spin. With expertise extending far beyond his main scientific fields, he was an accomplished lecturer and broadcaster.

Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (M M. Woolfson, Physics Department, University of York, Heslington, York YO1 5DD, England). As far as practicable books will be reviewed in a country different from that of publication.

Microscopic identification of crystals. By RICHARD E. STOIBER and STEARNS A. MORSE. Pp. vii + 278. New York:Ronald Press, 1972. Price $10.50.

The polarizing microscope is an indispensable tool for the study of rocks and minerals today just as much as in the past, but its role may be changing. It will continue to be used to identify broadly the minerals present in a transparent thin section of rock, and to note unusual features in them such as compositional zoning and twinning, and to observe textural relationships. Since chemical variations affect optical properties, it has been possible to draw up determinative curves which allow the estimation of approximate composition from accurate measurements of refractive indices, extinction angles and other optical parameters. These measurements can best be carried out by studying loose mineral grains mounted in a liquid of known refractive index – the so-called immersion method. One limitation of the method is that determinative curves usually allow for two or three chemical variables, and their use can therefore be misleading if additional chemical substituents are present in appreciable quantity. Even so, obtaining approximate compositions rapidly by microscopy has often been adequate and has certainly seemed preferable to the lengthy process of mineral separation and wet chemical analysis.

Analytical methods have advanced apace however, instrumental methods replacing bench chemistry, and now electron-probe instruments can yield rapid multi-element microanalysis from single mineral grains examined *in situ* in the same thin section as is used in the ordinary microscope for mineral recognition.

In these circumstances the reader may wonder why the authors of this book have chosen to emphasize particularly the immersion method. I think they are justified in this for two reasons. One is the simple fact that a microscope costs about £200 while a microprobe costs about £40000, so for some time to come many geologists will manage without one. The more important justification is that offered by the authors in their preface, namely that the theory and practice of single-grain optics provides a more valuable teaching exercise than the more limited investigations possible with thin rock sections, even though the latter are likely to be the most used in professional practice (sometimes in conjunction with electron-probe analysis).

Although it is the teaching of principles to which the book is clearly devoted, the approach adopted is nonetheless a practical one; so much so that, with the exposition of tactics to be employed in various situations, the book becomes more like a laboratory instruction manual. The use of conoscopic figures is given a much more expanded treatment than is usual in a book of this kind. The text is very clearly written and the layout of type and figures is pleasingly simple. Rigorous theoretical treatments are avoided, but footnotes tell the reader where to find them if required. The diagrams are more easily understood than those in many optics texts because the authors have resisted the temptation to overload them with information; simple projections are used more often than complex perspectives. There are many helpful references to published papers and other textbooks, and a useful guide to compilations of optical data.

Very few errors have been noted, but

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