gaining acceptance by metallurgists, for example because of its ability to reproduce in hours from a specimen cut with a hacksaw data more representative than that obtained after days on the electron microscope.

This large book of 523 pages is a collection of articles describing in detail the various fields of neutron scattering. Materials science has been equated with solid-state physics and the authors, almost without exception physicists, treat their subject with careful detail. The introductory chapter by Kostorz & Lovesey (67 pages) gives us an excellent introduction to the theory of neutron scattering, but I was disappointed that it made essentially no attempt to relate the neutron techniques to the other experimental techniques of materials science.

Other chapters are on *Crystallogrophy* (60 pages) by Jane Brown, *Phonons and structural phase transitions* (53 pages) by Currat & Pynn, *Phonons and defects* (33 pages) by Nicklow, *Small-angle scattering* (59 pages) by Kostorz, *Diffuse elastic scattering* (43 pages) by Bauer, *Polymers* (39 pages) by Julia Higgins, *Hydrogen in metals* (34 pages) by Skold, Mueller & Brun, and on *Neutron devices* (45 pages) by Freund & Forsyth. All the authors must be congratulated on achieving a consistent style, notation and level. The book will remain for many years an invaluable compendium of the neutron techniques for materials scientists.

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Physics of intercalation compounds. Edited by L. PIETRONERO and E. TOSATTI. Pp. ix + 323. Berlin, Heidelberg: Springer-Verlag, 1981. Price DM 60, US $28.

Interest in the products of intercalation reactions, during which atomic or molecular species enter the interlamellar space of a layer structure, has grown dramatically over the last decade. The prime reason for this interest is that intercalation changes the electronic properties of the matrix layers because of charge transfer between the intercalant and matrix. The intercalant may also exhibit properties not present in the bulk because of geometrical constraints imposed by the matrix. Thus the materials scientist can create synthetic metals from non-metals and synthetic superconductors from non-superconductors. However, there has been a growing awareness that the understanding of intercalation phenomena poses a challenge on a broader scientific front. For example, chemists have found that the products of these reactions are frequently compounds of well characterized composition and properties. They are interested in extending the range of known compounds, in understanding the reaction mechanisms that lead to their formation and in describing chemically the reaction products. Solid-state physicists are interested in extending the range of properties explored and in understanding and ultimately predicting such properties.

These objectives are not mutually independent and, because progress in this field demands collaboration between scientists of differing backgrounds, there has been a growth of interdisciplinary international conferences to present and discuss the latest work. There were two such conferences in 1980: one on Intercalation Compounds of Graphite in the United States and a more general conference on Physics and Chemistry of Layered Materials in Japan. The proceedings of both these conferences have been published recently, and the present volume continues this policy by presenting, as No. 38 of the *Springer Series in Solid State Physics*, the papers given at the International Conference on the Physics of Intercalation Compounds held in Trieste, Italy, in July 1981.

Unlike the two earlier publications, which are typeset, this publication uses camera-ready copy. This has allowed reference to be made to the two earlier conferences and so a significant number of references are to papers written in the eighties. Thus the editors succeed in their declared aim of providing a place where the most recent publications and up-to-date references can be found. However, although there is an index of the 87 authors and a contents list which gives the titles of 43 papers, there is no subject index. The papers, which are contributed by 39 research centres in ten countries, are grouped under six headings: (1) *Structure and general properties* (9 papers); (2) *Electronic properties* (12 papers); (3) *Stability and phonons* (6 papers); (4) *Ordering and phase transitions* (8 papers); (5) *Magnetic resonance* (3 papers); (6) *Transport, conductivity and superconductivity* (5 papers). It is a great pity that author-selected keywords were not used to provide a basic subject index for there is no simple way of discovering, for example, what materials have been studied. Moreover, the above grouping is not without its inconsistencies because some papers treat their chosen subject rather broadly.

Some 70% of the papers are experimentally based and two-thirds of these include experiments on the compounds formed when graphite is intercalated with the alkali metals Li, K, Rb and Cs. These compounds are attractive to the physicist, not only because they exhibit many interesting structural features which influence physical properties, but also because they give reproducible properties even when prepared in different parts of the world – an essential prerequisite for serious studies of physical properties.

These reactions all exhibit the phenomena of staging, where intercalated layers of constant composition are separated by n graphite layers in stage n. For the heavier alkali metals, M = K, Rb and Cs, the composition is $C_{12n}M$ for $n > 1$ so that staging can generate a large number of different compounds for study. The intercalate layer density in such compounds is lower than in stage 1 where the composition C_8M allows the intercalate to form a superlattice over the graphite surface. At these lower densities, the intercalate layer is disordered but undergoes an ordering transition, not only at low temperatures but also at moderately high pressures (~10 kbar/1 GPa). This recently discovered pressure transition, which changes the layer composition in $C_{24}K$ from $C_{12}K$ to C_8K with a corresponding change of stage number from 2 to 3 in order to preserve the overall composition, is discussed here.

The availability of highly oriented pyrolytical graphite (HOPG), a polycrystalline synthetic graphite with a common *c*-axis direction, as a waste product from X-ray monochromator production, permits the measurement of second-rank tensor properties on samples that are easily characterized by X-ray diffraction.

Electrical conductivity is the most commonly investigated second-rank tensor and the existence of pressure-induced discontinuities in the *c*-axis electrical conductivity, is reported here. Clearly pressure must now be recognized as an important parameter in controlling the physical properties of these compounds.

However, most of the experimental papers report either a property measurement at atmospheric pressure or use a combination of techniques to probe important structural parameters such as the amount of charge transfer between the intercalate and matrix structure. Thus there are papers dealing with the thermal conductivity, the *c*-axis velocity of sound and the low-temperature specific heat, as well as electrical conductivity and superconductivity. The impressive array of techniques used to probe structure include a range of spectroscopic techniques, (Raman, UPS, XPS, LEPS, SES, and Mössbauer), magnetic resonance studies (NMR and EPR), positron annihilation, Shubnikov–de Haas oscillations and inelastic neutron scattering.

The theoretical papers cover a range of topics, many of which parallel those of the instrumentalists. Thus significant progress is reported in the understanding of the band structures in the first-stage alkali-metal compounds C_8M. Other theoretical studies cover the origin and consequences of staging as well as predicted bond lengths and phonon spectra in graphite intercalation compounds. The problems of order–disorder transformations and ionic mobility are addressed by papers dealing with the behaviour of charged species in two- and one-dimensional periodic potentials. One-dimensional systems are also considered by experimental and theoretical papers dealing with polyacetylene.

Finally, this review cannot claim to be comprehensive but merely identifies themes of interest to the non-specialist reader. Such people should be aware that this book is essentially a progress report in its chosen field and that it will be necessary to consult the many references in order to get a balanced view of the physics of intercalation compounds.

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The spindle stage: principles and practice. By F. Donald Bloss. Pp. xii + 340. Cambridge University Press, 1981. 15 × 23 cm. Hard covers. Price UK £35.00 (net).

This textbook is not the first one (nor probably the last) to be written by Professor Bloss, the optical crystallographer, mineralogist and crystallographer at the Virginia Polytechnic Institute and State University. Its purpose is to teach students how to use a one-axis universal stage to obtain a complete and accurate optical description of any transparent crystal. The method rests on a simple principle: any biaxial crystal mounted *at random* on a rotation axis (*S*) lying in the plane *M* of the microscope stage can have its three optical directions α, β, γ successively brought into the plane *M* by appropriate rotations about *S*. Further rotations about the microscope axis (nicols crossed) reveal the extinction directions. It indeed follows that 'anisotropic crystals become amazingly tractable'. All optical properties are obtained by the immersion method. Examinations can be made in convergent as well as parallel light.

The *Table of contents* reveals a practical outlook. The presentation begins with a description of the equipment and the techniques of measuring and plotting. Major improvements of the commercially available spindle stage over its 1860 prototype are: the detent feature (indentations of the *S* half-circle graduation at 10° intervals) and the interchangeability of oil cells. The Wulff stereographic net, used for plotting data, is oriented with its great circles intersecting in the *EW* diameter, with which the *S* axis is made to coincide. In the next two chapters the above techniques are applied to uniaxial and biaxial crystals respectively. Then the author recalls the methods of altering the index of immersion oils by varying wavelength, temperature or both. These methods are more easily applied with the spindle stage than with the universal stage, for which they were developed. Extrapolation methods, though never used here for purposes of orientation, are applied whenever the refractive indices of the crystal lie outside the range of the immersion oils. Chapter 5, on accurate measurements of the principal indices, gives due warning of all concomitant pitfalls. We learn of an inexpensive, but serviceable, refractometer consisting of a calibrated reference crystal permanently mounted on a separate spindle stage; it and the crystal under study are bathed in the same oil at the same time. The estimated error on the value of the index ranges from ±0·0002 to 0·0005 – an improvement of one order of magnitude over current practice. Chapter 6 explains how to sharpen extinction positions. It also describes a computer program, *EXCALIBR*, which derives the orientation of the indicatrix from measured angular coordinates, calculates 2*V*, locates optic normal and bisectrices, and determines dispersion.

Chapter 7 is headed *Combined optical and X-ray studies of crystals*. Bloss's Detent Spindle is now replaced with a Supper Spindle equipped with its standard goniometer head; both adjustment arcs being set at zero, optimal measurements are carried out as before. By means of the arcs a symmetry direction is then brought along *S*, and the crystal is ready for transfer on its goniometer head to the rotation and Weissenberg instrument. A second symmetry direction, perpendicular to *S* in the plane of the microscope stage, serves for alignment for transfer to the precession camera. The Donnay Optical Analyser, which, according to Bloss, could be used instead of the Supper Spindle Stage, seems ill-suited for the procedures here described: it carries its own nicols and is too bulky to fit on a polarizing microscope stage.

Chapter 8 takes up path-difference measurements and their use in calculating birefringence. It is followed by an *Epilogue*, telling of applications of the spindle stage to