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book reviews

Works intended for this column should be sent direct to the Book-Review Editor, whose address appears in this issue. All reviews are also available from **Crystallography Journals Online**, supplemented where possible with direct links to the publisher's information.

High energy electron diffraction and microscopy. By L. M. Peng, S. L. Dudarev and M. J. Whelan. Pp. 544. Oxford University Press, 2003. Price GBP 69.95. ISBN 0-19-850074-2.

This is a superb book. It is certainly the most thorough, unified and comprehensive treatment of high-energy electron diffraction (HEED) theory to appear for many years. The book provides complete coverage of reflection and transmission electron diffraction, elastic and inelastic scattering, and imaging theory. Many experimental diffraction patterns are analysed in detail.

Early chapters develop the appropriate solutions of the one-electron Schrödinger equation for an optical potential in the Bloch wave, multislice, single scattering and phase-grating limits. HOLZ diffraction is treated in detail. Diffraction by gases, glasses and liquids is treated, in addition to fluctuation microscopy. The chapter on RHEED summarizes the major contribution that this group of authors has made to that field over many years, including the theory of RHEED from a growing crystal surface. The Green function solution and semi-reciprocal formulations are given. A chapter follows on resonance effects in transmission and reflection HEED, and there is an excellent treatment of thermal diffuse scattering and diffuse scattering from point defects.

The treatment of inelastic scattering is particularly good and original, relating this to the Van Hove dynamic form factor for single scattering and, for multiple inelastic scattering, providing a full derivation of the valuable density matrix formulation (mutual coherence function), which Dudarev was perhaps the first to bring into our field from earlier Russian work. This connects solutions based on the Schrödinger equation with the incoherent multiple scattering problem, commonly described by a Boltzman transport equation. (The Poisson-weighted convolutions of Landau, Howie, Rez, Ohtsuki, Misell and Batson all solved this transport equation.) The results provide a unified treatment of the loss of coherence due to diffuse scattering, and connect with earlier work by Kainuma, Høier, Howie, Rossouw, Wang and others. This work addresses what might be considered both the first and the last outstanding problem in electron diffraction theory – a comprehensive theory of Kikuchi lines. The authors give the transverse eigenstate channelling theory for HEED in terms of the density matrix, and make the connection with proton channelling. Their work provides a complete theory, derived here from first principles, for secondary electron emission and high-angle backscattering. Channelling effects on Auger and X-ray emission are also treated.

The book also applies the theory developed in earlier chapters to the formal deduction of crystal space groups from CBED patterns and to the difficult problem of inverting dynamical diffraction patterns to crystal structures. Here a variant of tensor LEED is developed for TED and RHEED, and examples given for small perturbations from a known structure. The book ends with chapters on CCD cameras, imaging theory, exit-face wave reconstruction and the optical potential. Valuable parameterized tables of scattering factors (for atoms and ions) and Debye–Waller factors (for crystals, not atoms) are given, in addition to Fortran listings for the RHEED program and calculations of absorption coefficients.

Given the breadth of coverage, the unified and pedagogically sound nature of this book is a remarkable achievement. For materials scientists, some sections (*e.g.* the chapter on resonances) may seem a bit academic. The work on energy losses provides the best treatment of their angular dependence to be found in any textbook, but it would be a simple matter to extend this to multiple energy loss effects in spectroscopy (and their removal by Fourier log deconvolution) in a future edition, since all the relevant theoretical background is given here. About the only useful result that seems to be missing is Blackman's finding that angle-integrated two-beam intensities are independent of thickness for large thickness. The theoretical tools developed here could also be readily applied to thermal diffuse scattering in dark-field STEM imaging, which is not listed in the index. But this is a primarily graduate level textbook about diffraction, not imaging.

In summary, this is a book that all laboratories working in electron microscopy and surface science must have. It is also a highly readable textbook, which is unusually clearly written and complete. Our modern computers are now so powerful that it is only a matter of time before the more sophisticated theories of backscattering, secondary emission, inelastic scattering, channelling effects on X-ray emission and RHEED given here are programmed up by curious students in materials science and physics. In biology, too there are renewed efforts now to go beyond the simple Beer's law to quantify rather thick non-periodic images affected by multiple incoherent scattering, and so relate them to composition. Because (in addition to much else) it provides a clear treatment of the multiple inelastic scattering that forms the background in electron diffraction (and so limits accuracy), the book is a major step along the road towards accurate quantification of electron diffraction data.

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books received

The following books have 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.

Crystal growth for beginners. 2nd edition. Edited by Ivan V Markov. Pp. 564. World Scientific Press. USD 68, GBP 46. ISBN 981-238-245-3.

This book has been reviewed by D. T. J. Hurle in the April 2004 issue of *Journal of Applied Crystallography*, pages 352–353.