Book Reviews

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Time-Resolved Diffraction. Edited by J. R. Helliwell and P. M. Rentzepis (Oxford Series on Synchrotron Radiation, No. 2). Pp. 454. Clarendon Press, 1997. Price (hardback) £85.00. ISBN 0-19-850032-7.

This volume is the second in the Oxford Series on Synchrotron Radiation and is published in hard cover for £85. The declared objectives of the editors are to assemble a selection of short reviews and examples from a variety of techniques all of which contribute to the common theme of time-resolved diffraction applied to structural studies in molecular biology and chemistry as well as materials science. The idea is an excellent one. The result is a rather 'mixed bag' of 15 chapters which should offer at least something to interest workers in these rapidly developing and new fields and will offer a starting point for new researchers. In spite of the title of the series, only one fifth of the book is concerned with synchrotron radiation with chapters covering the areas of materials science using synchrotron radiation (synchronized laser/synchrotron radiation methods to study semiconductors, surface melting and thin films together with a discussion on time-resolved Mössbauer resonant spectroscopy); a brief overview of time-resolved macromolecular crystallography; a discussion of Laue and monochromatic techniques applied to biological and chemical crystallography; a chapter on the Laue determination of a single enzyme structure (HMBS); and a comprehensive discussion on the attempts to realize Laue diffraction with 100 fs time resolution.

About one third of the book is concerned with the technologies linked to laser-produced X-ray short pulses, their applications and the techniques which depend on laser excitation for timing. This group includes chapters on laser-produced picosecond hard X-ray pulses and their applications; ultrafast X-ray diffraction and absorption using lasers; a discussion of the physical processes of laser-plasma X-ray emission and their applications in transient diffraction; and a chapter on the X-ray diffraction dynamics of (laser) shock-compressed crystals.

Around one quarter of the book describes three different time-resolved electron diffraction applications including a comprehensive review chapter concerned with time-resolved electron diffraction (TRED) applied to study the structural kinetics of excited molecules (using laser-driven pulsed electron sources); a description of time-resolved electron diffraction at surfaces using laser-based excitation methods; and a short description of time-resolved (based on down to millisecond fast-freezing methods) electron diffraction and microscopy studies of membrane proteins.

The remainder (about one fifth) of the book is comprised of three chapters on time-resolved neutron diffraction (for processes with reaction times greater than 0.5 s); the theory of ultrafast time-resolved X-ray and electron diffraction (which identifies the common ground in the analysis of X-ray and electron diffraction); and a chapter on high-performance detectors for time-resolved non-crystalline X-ray diffraction (mainly in the context of synchrotron radiation).

Overall, the book seems to provide a good feeling for the 'state of the art' in terms of the latest laser technologies for short X-ray pulse production and their scientific goals. It is somewhat less effective in the area of synchrotron radiation although it offers useful specific experiences in the field of protein crystallography and in the field of synchrotron radiation surface studies. It contains an excellent chapter on the realization of single-pulse Laue diffraction and shortcuts to 100 fs resolution using the ESRF (the European Synchrotron Radiation Facility).

There is a definitive chapter on TRED, a technique which should help give a more complete view of the coherent nuclear dynamics of laser-excited systems and a good review of time resolution applied to RHEED and LEED – activities still in their infancy. Perhaps missing is any attempt to draw together the very different short-pulse technologies and to combine their differing nomenclatures in an introductory chapter to set the scene for the newcomers to the field. There is room for an authoritative and explicit comparison between present laser and electron (or other charged-particle-based) sources and their predicted properties for the future together with observations of the role, if any, for future free-electron laser-based methods.

Nevertheless it is, overall, a useful addition to the research library with material which would be equally at home in a series on laser science and its applications. It is in an area of science which is new, interesting and must surely continue to grow rapidly.

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