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# book reviews

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**X-ray Scattering from Semiconductors**, 2nd Edition, By Paul F. Fewster. Pp. 299. London: Imperial College Press. Price 56 GBP. ISBN 1-86094-360-8.

High-resolution X-ray reflectivity and diffraction are known as a non-destructive tools for the characterization of semiconductor materials. Nowadays, they are well accepted methods in semiconductor technology and are used at different steps of device fabrication. This has increased the market for X-ray diffractometers in recent years and has initiated many innovative developments to increase the usable intensity and to improve the angular resolution of the equipment. Meanwhile, X-ray tube-based home diffractometers provide nearly the same intensity as a bending-magnet station of second-generation synchrotron sources and allow measurements which ten years ago were only possible by the use of synchrotron radiation.

For several years Paul F. Fewster has been the leading scientist of the X-ray laboratory at PANalytical Research Centre, formerly Philips Research, and was directly involved in the development and application of X-ray diffractometers for research and technology. He is one of the most versatile experimentalists in the X-ray community and has measured practically all possible kinds of semiconductor samples. Now he presents the second edition of his book *X-ray Scattering from Semiconductors* and lets us share in his huge treasure of experimental experience.

The book is subdivided into four main chapters and completed by an appendix providing helpful crystallographic relations. All chapters are self-explanatory and contain separate reference lists. In chapter 1, the author introduces the parameters that are important for device quality and can be measured by X-ray techniques, such as thickness and chemical composition, degree of relaxation, lattice distortion, crystal orientation, *etc*. Chapter 2 gives an overview of the X-ray scattering approaches necessary to understand the measurements. Starting from Maxwell equations, the author presents the basic formulae of the dynamical theory of the distorted crystal, developed by Tagaki and Taupin, which form the basis of the software tools for numerical rocking-curve simulation being implemented in nearly all commercial X-ray equipment. Although there are other books that better explain the theory, the advantage of this presentation is the application to various real-structure phenomena, like structure defects and mosaic crystals. In addition, the author's experience with the application of either the dynamical or the kinematical theory to explain experimental data becomes apparent.

Chapter 3 presents the equipment of the X-ray diffractometer. Here the author is able to refer to seven papers where he has presented particular technical solutions, since implemented in versatile laboratory equipment. He explains the construction and function of the various components, the source, the detectors, the function of various slits, and many-crystal arrangements for defining resolution and intensity. All parts together constitute the versatile multicrystal diffractometer, which he recommends for use and which, due to its excellent properties, is indeed in use in many X-ray laboratories around the world. The author provides many details on how to improve the performance of the apparatus and when to use a particular arrangement of components to solve a particular problem. The content of this chapter is the main message of the book.

In chapter 4, the longest chapter of the book, the experimental tools are applied to the characterization of various samples. Here the author is again able to draw on 22 of his own publications dealing with the characterization of particular substances. The presentation includes the practical points of measurements: what to measure, how to extract the information from the rocking curve, and what are the stumbling blocks of the experiment. Topics include the determination of wafer orientation, the orientation of net planes with respect to the surface and the determination of surface polarity. Much space is used to explain how to characterize samples with mosaicity; a problem which is not addressed to the same extent in other books dealing with similar topics. Other points considered are surface quality control and the determination of lattice relaxation by reciprocal-space mapping. Finally, one subchapter focuses on recipes for the use of automatic fitting routines. All examples presented reflect the huge wealth of experience of the author in the performance of high-resolution X-ray measurements. Although not all of the conclusions drawn by the author concerning particular problems are in full accord with the reviewer's opinion, the book is a most useful practical guide on how to use an X-ray apparatus for semiconductor analysis.

A general criticism of the book relates to its presentation. In some respects the book is not very comprehensible for a newcomer or a student. Several symbols in the formulae are not explained and sometimes appear in a neighbouring figure without reference. Other figures lack axes or axis labels, which can make it difficult to verify the evaluated parameters.

However, the book will certainly attract a large number of readers, from users who are planning to buy a diffractometer in the near future to technicians and scientists who wish to learn more about the use of a high-resolution X-ray diffractometer. For the latter community, the book is a very good guide to the improvement of experiments.

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