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book reviews

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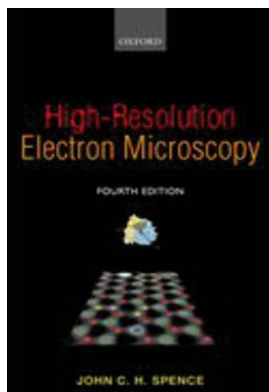

High-Resolution Electron Microscopy. By John C. H. Spence. Oxford University Press, 2013. Pp. 406. Price £75. ISBN: 978-0-19-966863-2.

The field of transmission electron microscopy (TEM) has seen a lot of exciting recent developments, such as the atomic resolution imaging of light elements using aberration-corrected instruments and also the increased availability of these instruments, the three-dimensional imaging of the atomic structure of nanoparticles, and the possibility to perform electron energy-loss spectroscopy (EELS) and energy-dispersive X-ray analysis (EDX) with atomic resolution. A new edition of the standard text by John C. H. Spence is therefore certainly called for. The content has been extensively rewritten for this fourth edition to reflect the recent developments. The first two-thirds of the book go deeply into the theoretical background of the workings of the transmission electron microscope. The effects of different settings and material characteristics are derived in an elaborate manner. The last part of the book contains practical guidelines for obtaining the best quality images. The majority of the text is of an advanced level. The reader will have most advantage from this book if she/he already has a background in transmission electron microscopy.

The first few chapters deal with the optics underlying transmission electron microscopy, *i.e.* electron, wave and Fourier optics. For those users for which TEM is still largely a black box, these chapters are highly recommended because they will give an understanding of the connection between what you see and what you have to do to improve your results.

The next section is on the basics of imaging thin crystals and the defects in their structures. It explains the differences between the different theories, approximations and methods for simulating images. This part seems to be focused on an audience that will be effectively programming calculations of images. On the other hand, this chapter also contains a section on dynamically forbidden reflections and their effect on high-resolution images, which should be read by anyone drawing any conclusions from high-resolution electron microscopy (HREM) images, as it shows that mistakes in interpretation can easily be made. At the end of the chapter different imaging effects are illustrated with many images and references to real cases.

The book further contains a complete chapter on the difficulties of radiation damage for imaging molecules. Different methods are discussed that are optimally suited to image molecules, a.o. dark-field methods or energy-filtered images. Single-atom imaging is discussed extensively, as well as single-particle tomography using cryomicroscopy.

Next, an overview is given of how structural information can be obtained from a large variety of techniques, such as using through-focus series, off-axis electron holography, ptychography and combinations of high-resolution images with electron diffraction patterns. Most readers will find here several techniques they have not used themselves yet, and this chapter is a good introduction to these techniques, with ample references for the intrigued reader. The technique of scanning TEM (STEM) imaging is elaborated in a separate, subsequent chapter.

The text also devotes attention to electron sources and compares the workings and advantages of the different possible detectors, such as CCD, image plates, film and direct detection cameras.

The book includes further a very useful chapter on how one can measure all the different parameters, such as the step size of the focus changes in the objective lens, the spherical aberration constant, the magnification, *etc*. For making accurate calculated images to compare with the experimental ones, it is imperative that all these parameters are known, and it is often not clearly explained in other TEM textbooks how to obtain these.

The last chapters are more practical chapters about the possible sources of trouble when taking HREM images that can be due to the environment in which the TEM instrument is placed. It gives a clear overview of what should be taken into consideration when intending to place a microscope in a certain room or building, as well as on the necessary maintenance of the microscope and holders to avoid deterioration of the HREM possibilities. The basic operation is explained and a few pointers are given on the alignment. The very final section holds concise information on some other techniques, such as EDX and 'atom location by channeling enhanced microanalysis', EELS, microdiffraction, convergent-beam electron diffraction, cathodeluminescence in STEM and precession electron diffraction. All these methods are discussed in a rather short manner, but references are given for the interested reader.

So to summarize, this new edition of *High-Resolution Electron Microscopy* by John C. H. Spence contains useful updates. It is not light reading, nor a quick reference guide. However, if you are looking for a thorough treatment, for example for a theoretical study or calculations or just for a deeper understanding of your experiments, then this is indeed a suitable text.

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