Book Reviews

Elastic and Inelastic Scattering in Electron Diffraction and Imaging

Zhong Lin Wang
Plenum Press, New York and London (1995)

A few months ago arrived on my desk a book with a yellow and black cover illustrated with an image of a diffraction pattern. The colour was not very encouraging but I opened it, there was a hand-written dedication signed by the author, Zhong Lin Wang whom I had advised in Arizona during his first year of Ph. D. preparation. It was not that far ago, less than a decade I am sure. The title was more appealing than the cover, a very general title corresponding to one of my persistent interests since I have been involved in electron microscopy. In particular, mentioning explicitly inelastic scattering was quite stimulating.

"The aim of the book is to explore the physics in electron diffraction and imaging and related applications for materials characterization", Wang writes in his Preface. The author is then more explicit in the introduction of the book. He explains his deep interest in the theoretical tools necessary for understanding the basic mechanisms in elastic and inelastic electron diffraction and imaging and their applications in *quantitative* electron microscopy. This is the key word. Progress in instrumentation, energy filtering, image recording open a new era in quantitative electron microscopy. The data delivered by the different elastic and inelastic channels can now be discriminated and have to be compared with the relevant simulations in order to extract the new level of information (concerning the disorder, the chemistry or the electronic properties) which they carry. The book is thus devoted to a complete synthesis and description of these theoretical tools. It cannot easily be understood and followed at the first glance. On the contrary a detailed reading is required to grasp its deep content and I must confess that I have not found the time to do it. However it is obvious that I keep the book on the first row of my shelves to consult it more thoroughly in any case when I shall have to understand inelastic images or to prepare advanced lectures on that topic.

The content of the book is divided in two major parts dealing respectively with the elastically and inelastically scattered electrons from crystalline specimens. The first part consists of an elegant synthetic survey of well established material, comparing the Bloch wave, multislice and different other approaches (with a short introduction to the case of reflected high-energy electrons from bulk crystal surfaces). The second part is much more original and contains a lot of information either completely new or originating from isolated papers of restricted access. In this domain the effort developed by the author is quite impressive. He covers a lot of different aspects and I am pretty sure that everybody concerned with these subjects will find his own point of interest, even if he does not agree with everything. I must confess that my own preference goes to chapters with more restricted mathematics and an effort to interprete complex effects in simple terms. I can therefore recommend chapter 6 for his general description of inelastic scattering, pointing out the equivalency of the dynamic form factor in inelastic scattering with the potential in elastic scattering, and calculating this dynamic form factor for the different types of excitations (phonons, valence excitations, atomic inner shell excitations). I have also selected the elegant discussion of reciprocity in chapter 9, the complete discussion of the origin of the contrast in HAADF mode in the STEM mentioning clearly that Huang scattering on defects can also be relevant... Finally my favourite chapter may be chapter 13 dedicated to inelastic scattering in HREM imaging. The

author shows in particular that for a specimen thinner than the localization of valence electrons, the image made with the valence-loss electrons can be treated as if the loss has occurred at the entrance face of the crystal. It reminds me some old observations by Castaing and his coworkers, more than 20 years ago and reported in "Physical aspects of Electron Microscopy and Microbeam Analysis" (B. Siegel and D. Beaman Eds., John Wiley and Sons). The last chapter of the book points out a rather poorly investigated subject, the influence of the environment and its consequences on the fact that it may introduce fluctuations of the total energy of the system. Unluckily contrary to all the previous chapters which are concluded by a clear summary, this last chapter has no summary and it is not straightforward to extract the major consequence of this environmental factor.

Let us conclude with some of the assertions of the author in the final lines of his introduction which I fully support: "The quantitative analysis of energy-filtered elastic and inelastic diffraction patterns and images is the future direction of TEM". We have been fully convinced of that in Orsay for years and even decades, but it took quite a long time for this message to spread over the whole EM community. Better late than never! The second remark of Wang is the enormous variety of existing theories to deal with these complex effects. I can compliment him for the huge effort he has accomplished to make all of them classified and accessible to us. And I am convinced that his book is quite important for anyone wishing to cleverly use the new TEMs equipped with energy filtering devices.

Finally I cannot help quoting these words of the author: "This book was written in my spare time after working hours". Everybody who knows Zhong Lin Wang is well aware that his working hours are rather long and can imagine how little time he has devoted to his nice family.

Atlas of Backscattering Kikuchi Diffraction Patterns

D J. Dingley, K.Z. Baba-Kishi and V. Randle
published by the Institute of Physics, London (1995)

This is a quite different book of larger dimensions, purple-covered and containing a large number of schemes, drawings and micrographs. It is intended to the SEM users and therefore concerns bulk materials. The authors have gathered a wide collection of backscattering Kikuchi patterns, obtained from metallurgical, mineralogical, ceramic and semiconductor fields and including six of the seven crystal systems with different Bravais lattices and point group symmetries. A short introduction in the first part summarizes the basic principles of pattern formation and points out their use for point-group determination and phase identification.

It is a well organized document, written in simple terms with paedagocical purpose and exhibits the general qualities of all the material in electron diffraction produced by the Bristol school. And they do not forget to pay full credit to John Venables in Sussex for having introduced the technique to the scanning electron microscope in 1973 and having thus pointed the way for all future work.

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