### Stability of Microstructure in Metallic Systems, 2d ed.

*J.W. Martin, R.D. Doherty, and B. Cantor*
*(Cambridge University Press, New York, 1997) xvi + 426 pages*
*$100.00 Cloth, ISBN 0-521-41160-2*
*$44.95 Paper, ISBN 0-521-42316-3*

This is a long overdue second edition to a book of the same name published in 1976; my copy is looking somewhat dog-eared after 17 years of use. Several topics covered only slightly in the first edition have been more comprehensively covered and an additional author (Brian Cantor) has been added. The reader will find the book useful as both a textbook (although it lacks the numerous problems that are obligatory at the end of chapters of U.S. textbooks) and as a reference book. It is worth noting for readers familiar with the first edition that some of the symbols and equations have been modified in the second edition.

The first chapter gives a general overview of phase stability in solids, presenting definitions and the appropriate fundamentals of both thermodynamics and kinetics in a concise and readable manner, and, thus, setting the stage for subsequent chapters.

Nearly all metallurgical materials are used in a metastable state and the next four chapters deal with all types of instability that can be present in microstructures, that is, chemical instability; instability arising from deformation, which leads to recovery and recrystallization; and geometrical instability, which arises from the need for phases to minimize their interfacial energies. A new chapter has been added since the first edition on "Highly Metastable Alloys" which covers alloys with highly metastable microstructures that are far from equilibrium. These include micro- and nanocrystalline alloys, low-segregation, highly supersaturated solid solutions, new metastable crystalline compounds, amorphous alloys, and quasicrystalline alloys. The new chapter covers manufacturing methods, thermodynamic constraints, kinetic constraints, and typical microstructures of highly metastable alloys. Such highly metastable alloys are typically made by one of the numerous rapid solidification methods, mechanical milling, condensation from the vapor, or deposition from supersaturated aqueous solutions either electroless or electrolytically.

While the first five chapters are well-written, they cover fairly standard material, albeit in an up-to-date readable way, that can be found in many textbooks or review papers. What I particularly found appealing was the last chapter. This is more unusual and covers a variety of instabilities that can be induced by the local environment around a material that the typical materials scientist probably does not normally consider. These include the effects of temperature gradients, gravity, electric fields, magnetic fields, and irradiation.

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### The Substance of Civilization: Materials and Human History from the Stone Age to the Age of Silicon

*Stephen L. Sass*
*(New York, Arcade Publishing, 1998) x + 291 pages, $24.95*
*ISBN 1-55970-371-7*

Writing about materials for the general public has become a growth industry of late. Ivan Amato's book, *Stuff*, reviewed in the July 1997 issue of *MRS Bulletin*, and Philip Ball's even more recent venture, *Made to Measure*, are good examples. Amato had something to say about the "empirical past" but soon moved on to modern science-based developments, while Ball restricts himself to the latter. In this latest book, Sass, a distinguished professor of materials science and engineering at Cornell University, returns to an earlier mode: human history and prehistory examined in terms of dominant materials. This was done in terms of metals only by an English metallurgist, Leslie Aitchison, in two volumes in 1960... and that may well have been the last book of this kind, although it is at the same time much longer, and more restricted in theme, than Sass's work. Sass covers stone, clay, glass, polymers, diamond, and silicon, as well as a variety of metals and one overpoweringly important family of alloys, the steels. The timespan starts more than 25,000 years ago and continues to the present day.

Sass focuses firmly on the role of materials—the problems in finding, extracting, and refining them—in governing the flavor of daily life as well as the flux of empires. He succeeds in explaining key features of his families of materials without a single line diagram (although the collection of photographs does include one sketch of polyethylene and the crystal structure of diamond), and his narrative comes alive through the inclusion of numerous anecdotes linking materials to events of the past. His high reputation as a teacher is manifestly deserved. To exemplify his approach, in his chapter on steel he begins by outlining the various historical approaches to the problem of converting pig iron into steels, then discusses selected key industrial uses for steels; austenite, ferrite, cementite, and martensite do not feature. At the end of the book, Sass speculates about some materials and applications of the near future.

Of all the recent books on materials, this one is the most accessible to readers who are genuinely nonscientists, and tempts them to persist by a canny focus on historical nuggets. It is an introduction to materials, not to materials science, and none the worse for that.

*Reviewer: Robert Cahn is a physical metallurgist turned materials scientist, currently attached in nominal retirement to Cambridge University. He has researched on intermetallics and many other metallurgical themes, has edited a number of journals and book series devoted to materials science, and has striven over the years to popularize materials science in the pages of* Nature. *He is a member of the Editorial Board and the Book Review Board of* MRS Bulletin.

### Reflection Electron Microscopy and Spectroscopy for Surface Analysis

*Z.L. Wang*
*(Cambridge University Press, New York, 1996)*
*456 pages, $95.00*
*ISBN: 0-521-48266-6*

Developments in electron microscopy and spectroscopy has had a strong influence in various fields of materials science. Going by the present-day, state-of-the-art capabilities in microscopes, spatial resolutions of <0.2 nm in imaging and energy resolution of < 0.5 eV in spectroscopy are readily available. Several proposals at this stage aim to develop microscopes using field emission sources and integrated energy filters to reach the ultimate goal of obtaining simultaneous spatial and spectroscopic resolution with sub 1 nm resolution. These will be routine instruments in a few years time, with the possibility of analyzing the position and chemistry of individual atomic columns in materials.

Scanning tunneling microscopy and spectroscopy has achieved a similar feat for surfaces, although the disadvantage of using STM/STS is that the area that can be covered is small, scanning procedure is slow, and the instrument performance is sensitive to ambient conditions.

Complimentary to imaging materials in the transmission (which provides average information that exists through the thickness of specimens) or scanning modes, alternative techniques have been developed to look specifically at surfaces (through imaging and diffraction) using high-energy electron beams. A great advantage of this method is that it can be applied to *in situ* studies of surfaces prepared, for example, by the molecular-beam-epitaxy (MBE) techniques so commonly used in semiconductor industry. Reflection electron imaging/diffraction has a long history, initiated in the very early years of the development of microscopes. It has seen an unsteady development, mainly due to the emergence and success of competing techniques such as STM, and still remains a powerfully useful technique for the characterization of thin films during *in situ* growth. Reflection electron imaging techniques harbor serious limitations because the specimens have to be single crystalline (to generate strong Bragg reflected beams) and the surfaces have to be flat (for grazing angle imaging). New developments such as energy-filtering schemes in the microscopes has made it possible to combine reflection electron microscopy (REM) and reflection high-energy electron diffraction (RHEED) with surface quantitative structure analysis using inelastically scattered electrons, such as reflection electron energy-loss spectroscopy (RHEELS). The field is mature with a lot of new instrumentation available to do imaging, diffraction, and spectroscopy, and a large number of theoretical works which has contributed richly to all microscopy techniques. A book that has collected the logistics of reflection electron microscopy to date seems quite timely.

The author has compiled literature and presented it in a logical sequence. Much of the early chapters on kinematical electron diffraction and imaging theory are repetitions from other available microscopy textbooks, but this is fine to give the audience a comprehensive reading of the subject matter. The theories of RHEED and the imaging and contrast formation mechanisms using reflected electrons from surfaces are very well-treated with appropriate comparisons to other methods of electron microscopy. The last chapter on novel techniques, however, loses the depth that the preceding chapters contain, probably because these techniques have not been so well-developed.

The book can be a good guide to graduate students who are taking surface characterization courses and an excellent reference to scientists in the field of microscopy. The book falls short of being textbook material since it is written mostly in the style of a collection of review articles rather than in a more detailed pedagogical framework. Some worked-out problems and questions at the end of each chapter could have been very useful to students and teachers. However, the number of practical examples given to illustrate different aspects of the REM techniques are reasonable. The few FORTRAN programs given at the end of the book for calculating single loss EELS spectra are very useful as well.

Unlike in fields where rapid developments can make a book quickly obsolete, this book will probably be a good reference for some time. The bibliography showing a steady rate of papers published on reflection microscopy techniques over the years is good testimony. The book is written in a simple style, very readable, and easy to understand. It contains a lot of illustrations and excellent images and a good balance of theory and experimental techniques. Overall, it is a book that any materials science or physics libraries should be holding.

*Reviewers: P.M. Ajayan, an assistant professor in the Department of Materials Science at Rensselaer Polytechnic Institute, and V. Ravikumar, a materials scientist at GE Plastics in Selkirk, New York, both received their PhD degrees in materials science at Northwestern University. Ajayan's research interests are in the areas of electron microscopy and carbon-based nanostructures. Ravikumar's research interests are in the area of materials characterization, with emphasis on morphology-property correlation of polymer blends.*