Plasma Processing for VLSI
Edited by: N. G. Einspruch and D. M. Brown

(Volume 8 of VLSI Electronics Microstructure Science, edited by N. G. Einspruch, 1984, Academic Press)

Plasma Processing for VLSI is an excellent resource for anyone interested in this topic. After a brief summary of the development of the field (D. L. Tolliver), the book is divided into three major sections:

1. Deposition: articles on metal and dielectric sputtering (R. S. Nowicki), PECVD of metals and silicides (D. W. Hess) and of dielectrics (T. B. Gorczyca and B. Gorowitz).

2. Lithography: articles on trilayer resist (J. B. Kruger, M. M. O'Toole, and P. Rissman), plasma sources for x-ray (D. J. Nagel) and for deep UV (A. N. Petelin and M. G. Ury).

3. Etching (more than half the book): articles on the basic principles (D. L. Flamm, V. M. Donnelly, and D. E. Ibbotson), high-pressure etching (D. L. Smith), RIE (B. Gorowitz and R. J. Saia), ion beam milling (R. E. Lee), RIBE (B. A. Heath and T. M. Mayer), plasma diagnostics (W. R. Harshbarger), emerging dry etch techniques, (Y. Horiike), and the application of dry etch to advanced device structures (T. P. Chow).

Although the organization is interesting, I might suggest that if the reader is not actively involved in plasma processing he might augment the historical introduction with a technical one. Chapter 7 of **Glow Discharge Processes** (B. Chapman, John Wiley 1980), or one of the many fine review articles by J. W. Coburn are well suited for this purpose.

The article on sputtering is a brief but worthwhile review which lends perspective to the chapters on PECVD. The trilevel article is excellent but the contributions about x-ray and deep UV sources, although clearly written, seem misplaced in a book about processing. Perhaps a review of the progress in fully dry developable resists and/or plasma stability of resist materials (with some chemistry) would be a more natural fit in the lithography section.

The main part of Volume 8 deals with dry etching. It starts with a thorough review (Flamm, et al.) and ends with an intriguing chapter about advanced applications (Chow). The organization and quality of the contributions to this section cannot be faulted. Although there is an excellent article on emerging techniques (Horiike), I feel that a few additional topics might deserve extended treatment: electron cyclotron resonance low voltage high current plasma sources, as well as a chapter on radiation damage and polymeric contamination.

In summary, the material in Volume 8 is important and well presented. The omission of certain topics is not a serious drawback; plasma processing is a rapidly advancing technology and the format of the "VLSI Electronics" series would certainly allow for inclusion in subsequent volumes.

Reviewer: Stephen M. Bobbio, Member of the Technical Staff, Microelectronics Center of North Carolina.

Preferred Orientation in Deformed Metals and Rocks: An Introduction to Modern Texture Analysis
Edited by Hans-Rudolph Wenk

(1985, Academic Press)

This volume is an outgrowth of a workshop on Deformation Mechanisms and Texture Development in Rocks, held as part of the 23rd U.S. Symposium on Rock Mechanics, Berkeley, California, in 1982. The participants from a wide variety of fields (materials science, metallurgy, geology, geophysics, and physics) recognized the need for an up-to-date review and introduction to theoretical, experimental, and analytical techniques applied in the study of the texture or fabric of materials. In the opinion of this reviewer, the editor and authors have been most successful in reaching this goal.

The volume contains 27 contributions from authors in seven countries. The book is divided into three parts. Chapters 2 through 7 present techniques and procedures with some discussion of the theory of the analysis of orientation data. Chapters 8 through 12 describe the mechanisms and processes by which polycrystalline materials deform. Chapters 13 through 26 describe the results of specific systems. Taken as a whole, the volume provides an unique, well-referenced introduction to the field of preferred orientation and will be particularly useful to workers in the field who wish to apply their techniques to other important systems. For some topics, particularly in the early chapters, the introduction is a bit too brief. As an example, the discussion of symmetry, three-dimensional point groups, and symmetry elements of the second kind (Chapter 3) requires that the reader already be very familiar with the subject or go immediately to a more expanded presentation in another source.

Chapter 8 by D. J. Barber provides a concise, well-illustrated introduction to dislocations and microstructures. The most interesting aspect of the book is the diversity of examples of specific systems which are presented in the latter chapters. There are discussions of the microstructures in metals (H. Mecking), copper-brass (J. Hirsch and K. Lücke), evaportites (H. Kern and A. Richter), ore minerals (H. Siemes and Ch. Hennig-Michaeli), carbonates (H.-R. Wenk), quartzites (G. P. Price), olivine and pyroxenes (J.-C. C. Mercier), and phyllosilicates in slates (G. Oertel).

The book is well bound, attractively printed with a reasonable quality of paper used for the electron micrographs. This volume is certainly a tribute to Professors G. Wassermann (Clausthal) and F. J. Turner (Berkeley), two of the original workers in the field of quantitative analysis of textures. I expect that this book will find wide use as a text in graduate-level seminars in departments of materials science, geology, metallurgy, and physics. This is a truly interdisciplinary presentation of a subject of wide interest.

Reviewer: Rodney C. Ewing, Secretary of the Materials Research Society, is a professor of geology at the University of New Mexico, where his principal interests are in radiation effects in crystalline materials and the crystal chemistry of complex Nb-Ta-Ti oxides.

Hydrogen Degradation of Ferrous Alloys

Edited by Richard A. Oriani, John P. Hirth, and Michael Smialowski

(1985, Noyes Publications)

The instances of documented embrittlement of ferrous alloys in some manner by hydrogen are legion. The instances of suspected or possible involvement of hydrogen in low-ductility failures are at least as numerous. The multitudinous sources of hydrogen, both internal and external, coupled with a plethora of mechanisms by which embrittling effects may manifest themselves, make the subject extremely complex.

This volume presents under one cover an impressive collection of articles dealing with many of the vast array of theoretical concepts and experimental results which bear upon the detrimental effects of hydrogen in both experimental and engineering alloys under many different types of mechanical loading and environmental conditions. The authors are generally quite well informed and, for the most part, admirably avoid the easy but often ill-conceived generalizations often seen in the extremely voluminous literature. In recognition of the importance of many areas of specialization, the editors have selected authors of the various chapters who provide backgrounds in thermodynamics, surface chemistry, electrochemistry, quantum mechanics, elasticity, plasticity and fracture mechanics. There is a reasonable lack of excessive duplication for such a multi-authored book, no doubt reflecting the care taken by the editors in assigning topics and in making available to authors at least some details of the contents of other chapters.

Section I deals with equilibrium thermodynamics. Essential items are well-covered, including an introductory chapter on the iron-hydrogen phase diagram which introduces the very important phenomenon of hydrogen trapping in internal defects and the effect of various alloying elements on solubility. A chapter follows which introduces the fugacity concept and describes the various proposed theoretical and semi-empirical equations of state with an important evaluation and comparison with data.

Chapter 3 treats hydrogen adsorption on iron surfaces and the effects of alloying elements as well as pre-adsorbed species. Electrochemical concepts so important in stress corrosion cracking are outlined in Chapter 4 and tied in with basic corrosion processes in electrolytes. Chapters 5 and 6 give analyses on elastic effects both in the bulk and at internal defects and thus introduce the crucial concept of stress effects.

Quantum mechanics enters in Chapter 7 where theoretical concepts involving hydrogen-containing clusters are discussed, and Chapter 8 concludes the section with a discussion of nickel hydride. These two chapters are not especially well integrated with the overall development and could be omitted by some readers.

Kinetic aspects are then treated in Section II with Chapters 9, 10, and 11, treating successively, absorption from the gas phase and entry from the liquid phase. Chapter 11 treats the effects of both promoting and inhibiting species. Chapters 12 and 13 treat diffusivity and trapping of hydrogen. These are of course of the greatest importance in understanding the kinetics and mechanisms of hydrogen embrittlement in its many variations. The section concludes with an interesting but somewhat peripheral discussion of anelastic effects due to hydrogen.

With fundamental concepts established, Section III begins the application to mechanical properties, including plastic-flow properties (Chapter 15), fatigue (Chapter 17) and plastic instability (Chapter 18). Chapter 16 discusses hydrogen effects on relaxation phenomena, though it is difficult to understand why this is singled out for independent discussion.

Section IV is entitled "Cracking and Failure Mechanisms" and covers various phenomena of interest, including phase transformations in the vicinity of crack tips (Chapter 20) so important in austenitic alloys, crack initiation (Chapter 22), general crack growth and the effects of environment and microstructure (Chapter 23), and intergranular crack growth (Chapter 24). The fracture mechanics discussion (Chapter 19) is important but minimally related to hydrogen effects; it would seem to fit better in the introductory material. Also, Chapter 21 on computer-simulation techniques seems a bit out of place in otherwise phenomena-oriented discussions.

Chapter 25 introduces hydrogen trapping again, but this time ties it in with effects of microstructure variations. Cracking of single crystals of iron in gaseous hydrogen is the subject of Chapter 26. In my opinion, this section suffers from a lack of adequate consideration of the extremely important question of the relation between "bulk" and crack-tip environments.

Finally, Section V treats hydrogen embrittlement as it appears in various types of commercial steels including low-carbon steels (Chapter 27), linepipe steels (Chapter 28) with emphasis on "blister-cracking," high-strength steels (Chapter 29), specialty (or ultra-high strength) steels (Chapter 30) and stainless steels (Chapter 31). These chapters are in some points a bit redundant but will no doubt be very useful references for those readers interested primarily in applications of only certain classes of steels.

In summary, though the book suffers somewhat in coherence due to its multi-author nature, overall, it does represent a good summary of this diverse field up to about 1983. It should be quite valuable for those entering the field as well as experts in various aspects of the wide-ranging phenomena of importance in the mechanical degradation of ferrous alloys by hydrogen.

Reviewer: Fred A. Nichols is Senior Technical Advisor, Materials Technology Section, Materials Science and Technology Division, Argonne National Laboratory, Argonne, IL, involved in deformation, fracture and stress-corrosion cracking of metallic alloys.

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