

enes (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 Smailowski (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 intro-

duces 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.

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