drawn between the onset of spatio-temporal chaos in a convecting fluid and the martensitic transformation.

The potential for applying the new techniques of nonlinear dynamical systems analysis to the materials science field is clearly great. As J. Friedel notes in his preface to the volume, one of the main characteristics of materials science is that it deals with properties which often deviate easily from the continuous linearised approximation, either because the speed of a linear reaction can be varied over a very large range or because one is near to an abrupt change of some dynamic state of self organisation. The contents of the volume show how little appreciated this potential is as yet.

Hopefully the first section of this book will stimulate materials scientists studying nonlinear systems to learn more about these new techniques. This volume will give them no more than a fairly superficial introduction, but if it generates such an interest then the next conference on this subject should achieve a closer meeting of minds than this reviewer imagines took place at Aussois.

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Superalloys, Supercomposites and Superceramics

Edited by John K. Tien and Thomas Caulfield

(Academic Press, 1989), 755 pages. ISBN: 0-12-690845-1

This book is a recent addition to the Materials Science Series published by Academic Press and consists of 22 chapters authored by experts in their specialties. It should be viewed primarily as a sampling of contemporary subjects in superalloy technology, insofar as 17 of the 22 chapters deal with various aspects of superalloy research and technology. It appears that no special attempt was made by the editors to cross reference the various chapters in order to make the book more useful. While reading the book, I was constantly comparing it to the two existing volumes *The Superalloys* (1972: C.T. Sims and W.C. Hagel, editors) and the recently updated volume *Superalloys II* (1987: C.T. Sims, N.S. Stoloff, and W.C. Hagel, editors). These two volumes attempt to give a broad overview of the various important aspects of superalloy technology; and while they have some inadequacies, each volume by itself presents a comprehensive view of superalloys technology aimed at a broad audience. Unfortunately, despite a few strong chapters, *Superalloys, Supercomposites and Superceramics* as a whole does not appear to be as useful as the above two existing superalloy volumes.

Specific chapters on superalloy technology are at the same level of quality as the Sims et al. volumes. The chapters on melt processing, casting of superalloy components, single crystal superalloys, and thermomechanical processing of superalloys, are all pretty solid papers. Similarly, the chapters on cyclic deformation of superalloys, high temperature oxidation, hydrogen embrittlement of superalloys, and intermetallic compounds, are also quite comprehensive and are worthy of the reader's attention. The final four chapters on superalloy composites, ceramics and carbon-carbon composites are concise treatments, but the authors have apparently done a good job of headlining the most important comparisons of these materials to superalloys.

The most glaring problem is that there is no chapter which deals directly with "alloy design" as applied to superalloys. I am referring to the analytical methodologies—which have become increasingly sophisticated[1] during the last decade—of predicting phase stability in superalloys. The earliest versions of these phase compatibility calculations were known as PHACOMP,[2] and were developed in the 1960s in order to have a tool to predict which superalloy compositions would lead to the existence of brittle, topologically closed packed (TCP) phases such as sigma, laves, etc. which can lead to severe degradation in ductility. The book's virtual lack of any treatment of phase stability methods becomes apparent in the eleventh chapter "Creep and Stress Rupture - Long Term." The half page in chapter eleven on PHACOMP and similar methodologies is not enough to explain the importance of these techniques to superalloy technology or, in fact, explain to the reader the content of three figures in the chapter. An entire chapter on phase stability would certainly have been more useful than the chapter on modeling of ternary phase compatibility.

Unfortunately, other important superalloy subjects are not handled comprehensively. A case in point is the chapter on "Oxide Dispersion Strengthened (ODS) Alloys" (Chapter 9). This is doubly disconcerting insofar as the chapter will also be appearing in a forthcoming book *The Handbook of Metallic Composites.* The authors begin by implying that the only useful ODS alloys are the mechanically alloyed "MA" series marketed by INCO. However, a large amount of understanding and some engine experience was obtained prior to the advent of mechanical alloying with the thoria-dispersed alloys TD-Ni and TD-NiCr: these two alloys are indeed commercially available today[3] and referred to later in the chapter. The authors' treatment of grain morphology/fracture and texture development in ODS alloys are both extremely limited. One suspects they intentionally chose to ignore the results of research groups at other institutions. For example, no mention is made of MA 754's tendency for intergranular fracture under long-term creep conditions at elevated temperatures, or the recent constrained cavity growth models which examine this problem.[4] Similarly, the lack of success in attaining a <100> coarse-grained texture in the strongest ODS superalloy, MA 6000,[5,6] has been an impediment to this alloy's application. However, no mention is made of this problem. Although it is about five years old, the chapter on ODS alloys in Reference 6 provides a better overview of ODS alloys.

In summary, I would advise readers who are seeking a comprehensive treatment of superalloys to consult the two volumes by Sims et. al. For those who want to purchase a volume which examines recent trends in superalloys and future replacement materials, the most recent volume of the Seven Springs Superalloys Symposium would be a wise alternative.

References

1. M. Morinaga et al., "New Phacomp and its Applications to Alloy Design," *Superalloys 1984*, edited by M. Gell et al. (TMS-AIME, 1984) p. 523-532.

2. C.T. Sims, "Prediction of Phase Composition" in *Superalloys II*, edited by C.T. Sims, N.S. Stoloff, and W.C. Hagel (John Wiley and Sons, 1987) p. 217-240.

3. TD-Ni and TD-NiCr are still available from Sheritt-Gordon Mines, Ltd. of Canada in both powder and sheet form.

4. J.J. Stephens and W.D. Nix, "Constrained Cavity Growth Models of Longitudinal Creep Deformation of Oxide Dispersion Strengthened Alloys, *Metallurgical Transactions* **17A** (1986), p. 281-291.

5. T.E. Howson, D.A. Mervyn, and J.K. Tien, "Creep and Stress Rupture of a Mechanically Alloyed Oxide Dispersion Strengthened and Precipitation Strengthened Ni Base Superalloy," *Metallurgical Transactions* **11A** (1980), p. 1609-1616.

6. G.H. Gessinger, *Powder Metallurgy of Superalloys* (Butterworths, Ltd., 1984) p. 218.

7. D.N. Duhl, G. Maurer, S. Antolovich, C. Lund, and S. Reichman, *Superalloys 1988* (TMS, 1988).

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