Atomic Transport and Defects in Metals by Neutron Scattering

Edited by C. Janot, W. Petry, D. Richter, and T. Springer
(Springer-Verlag, 1986)

This 241-page volume, with 39 contributions from a workshop in Jülich, West Germany in October 1985, covers short-range order, precipitation and growth, time-dependent experiments, hydrogen in metals, diffusion in alloys, point defects, radiation damage, voids, and bubbles. As the title suggests, the workshop focused on what understanding neutron scattering can bring to these problems. Although neutron experiments predominate, there is frequent reference to other complementary techniques, particularly transmission electron microscopy and x-ray scattering. One of the most original papers is on the direct observation of spinodal decomposition in NbH_x alloys with neutron radiography. Participants clearly found uses for neutrons outside conventional scattering.

Besides the introductory lecture by Kostorz (Zurich) and 10-page review articles by Stewart (Reading), Peisl (Munich), Weertman (Evanston), and Sinclair (Harwell), this book is very much for the experts. Certainly all subjects are covered to some extent, but the majority of the 4–5 page papers are extremely detailed and probably impossible to follow except for someone working in the field.

It seems unfortunate that more long review papers were not included for the benefit of a North American audience. The majority of neutron experiments reported here use cold neutrons (wavelengths of 4 Å and longer), which are in very short supply in North America. Only one of the 39 contributions comes from outside Europe (22 from West Germany and 10 from France). Even allowing for local bias and travel difficulties, this is an unusual distribution in a major scientific subfield. Tangible U.S. research in these fields, much of direct practical interest in metallurgical problems, is proceeding only at the National Bureau of Standards and Oak Ridge National Laboratory. This is mainly due to an absence of facilities rather than a lack of willingness. The volume should be of much interest in the United States, even if it makes scientists on this side of the Atlantic a little envious of the tools available to their European colleagues.

Reviewer: G.H. Lander is head of the basic research effort, Karlsruhe Euratom.

Process Modelling of Metal Forming and Thermomechanical Treatment

C.R. Boer, M. Rebelo, H. Rystad, and G. Schroder
(Springer-Verlag, 1986)

The widespread availability of digital computers has made possible the detailed analysis and modelling of processes such as forging, roll forming, and drawing which for many years were practiced on a strictly experimental basis. This engineering and mechanics oriented volume describes such analyses systems developed at the Brown-Boveri Research Center in Dattwil, Switzerland.

The Brown-Boveri systems employ two types of analyses. First, rigid-plastic flow theory in a "slab" approach provides approximate upper-bound solutions. These approximate solutions are used, for example, to ensure die filling in die design, selection of optimum ram speed in forging, development of variable-speed ram schedules, and prediction of allowable degree of preheat temperature non-uniformity from induction heating. Then finite element analysis (rigid-plastic isotropic work hardening with a simple temperature and rate-dependent flow stress) is used for detailed prediction of the strain distributions in formed parts.

The first section of the book presents a very readable description of the theoretical basis for these methods. The slab approach is explained well, as are the important differences between the rigid-plastic finite element analysis employed here and the more sophisticated "updated Lagrangian" finite element analysis developed elsewhere to treat full elastic-plastic deformation.

The heart of the book is three chapters which detail how these methods are applied to forging turbine blades and ribbed parts, roll forming turbine blade shapes, and drawing. The DIEDESIGN software, which is also discussed, handles difficult problems such as changes in workpiece-to-die contact which occur during forging, remeshing after substantial distortion, and prediction of the proper placement of workpiece and dies within the forging press. In roll forming, the authors describe their "lateral speed" method to design roll contours for the various passes.

The analytical methods, though approximate, have clearly been developed based on extensive experience and engineering judgment. The authors take pains to show how experiments are always used to verify the analyses.

A short chapter entitled "Physical Modelling" describes the use of plasticene, waxes, and other model materials (with proper dimensional analysis) to gain additional insight and predictions concerning metal forming behavior. Another short chapter, "Modelling of Thermomechanical Treatment," is mainly a description of heat transfer analysis of quenching operations.

The authors close by pointing to a few needs which, if fulfilled, could provide even better predictive capabilities. One of these is the incorporation into the analyses of better constitutive equations for plastic deformation behavior including anisotropy, reversed deformation, and dynamic recrystallization. This reviewer certainly has no quarrel with the desirability of such improvements. Only then will the sophisticated software systems be capable of predicting the important distributions of microstructure, properties, and in-service behavior in the formed parts.

Reviewer: Alan K. Miller, a professor in the Department of Materials Science and Engineering at Stanford University, is involved in the development of new manufacturing methods for thermoplastic matrix fiber composite materials.

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