in the case of heavily cold-worked structures, since short-circuit diffusion along dislocations will play a major role. More work is needed therefore in order to elucidate results of the kind described here from a more analytical or theoretical point of view.

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M. VON HEIMENDAHL
K. SCHNEIDER
*Institut für Werkstoffwissenschaften I
Universität Erlangen – Nürnberg,
Erlangen, Germany*

Book Reviews

The Mechanism of Phase Transformation in Crystalline Solids

Pp, 324 (Institute of Metals Monogram no. 33, 1969) £6

This monograph which records the contributed papers, as well as oral and written discussion at an International Symposium held at the University of Manchester 3–5 July 1968, represents a very definite advance in the synthesis of the various aspects of phase transformations. This was the first international conference for more than 10 years in which the mechanisms of solid state phase transformations were considered. In the interim, many new aspects of the subject have been developed and enormous strides made in the experimental techniques used. At last we are beginning to see that the fundamental changes that occur in the structure, say of a steel, are paralleled in both non-ferrous and non-metallic systems. Another important point that has emerged from this conference is the ability to classify experimental observations and their associated theories into general schemes, which enable the fundamental mechanisms of these transformations to be more clearly understood.

As may be expected the conference was dominated by papers dealing with precipitation hardening, interface controlled transformations and martensitic reactions.

In the field of precipitation hardening, it is interesting to notice the accent on studies of what happens at the grain-boundaries. This change of emphasis has no doubt been prompted by the current interest in the fracture toughness of high strength precipitation hardening materials, the properties of which are strongly influenced by grain-boundary precipitates and trace elements.

Nicholson and Lorimer introduced a new theory of precipitation hardening which is concerned with the initial growth of the G P zones at low ageing temperatures and their subsequent transformation at higher temperatures. This paper provoked a good deal of discussion about the changes which occur in multi-stage heat-treatments and the formation of precipitate free zones at the grain-boundaries. It is perhaps pertinent to ask at this point if these multi-stage heat-treatments which appear to produce good properties under laboratory conditions are a viable proposition under industrial production conditions.

A second important subject which emerged at this session was the influence of trace impurity elements on the ageing behaviour. Papers by Brooks and Hatt, and also by Wilson, emphasised that these impurities tend to slow down the ageing reaction, probably by combining with the excess vacancies in the matrix, and hence favouring the formation of the semicoherent θ'—type phases rather than the coherent θ''—type phases.

The session on martensitic reactions was introduced by an excellent review by Professor Christian on the current state of the theory, in which he emphasised the significance of the shape change and its relationship to the lattice correspondence, lattice defect theory of nucleation, the effect of pressure, the crystallographic formation theory and the fine structure of martensite. He stressed that although very substantial advances have been made in the understanding of martensite formation, and the newer experimental techniques have solved some problems, many new difficulties have been revealed which still make a general classification difficult. Liebermann appeared to disagree with this summary in a paper in which he dealt with the martensitic transformation in non-ferrous crystalline solids, and proposed a simple system for classifying all martensitic transformations and martensite-like products. This system differentiates according to the degree of atomic motion for one of the components during the transformation. Although numerous problems associated with this classification were identified in the discussion it appears to provide a basis for a unified theory.

Easterling and Swann described some interesting experiments in which they observed the martensitic reaction in defect-free precipitates of γ—iron in copper. The martensite appeared to be nucleated by matrix dislocations passing through the γ—phase on deformation.

However, during the discussion it was suggested that the evidence could be interpreted on the basis of simple mechanical twinning due to the strain in the matrix surrounding the precipitate. Crocker and Ross studied the martensitic transformation in uranium alloys. The $\beta \rightarrow \alpha$ and $\gamma \rightarrow \alpha$ transformations in this material should provide a critical test of the crystallographic theory of martensitic formation. From their results they showed that the current crystallographic theories are inadequate, and proposed the basis of a new theory based on the mechanistic approach to the structural changes produced by shear. It would therefore appear that there is still a major effort required in this area to produce a generalised theory and basis for understanding the reaction.

In the session dealing with interface controlled transformations, Hillert highlighted the current thinking on massive transformations. Papers dealing with systems such as Cu—Zn, Ag—Zn and Au—Cd provided the basis of a lively discussion as to the theory of these types of transformation. The general feeling was that massive transformations are associated with the high mobility of the incoherent surface at the superledges (about 1 μm in thickness) produced at the interface.

The current state of the theory of the bainitic reaction was reviewed by Aaronson in his paper dealing with the problem of the definitions and the mechanism of bainite formation. He attempted a classification of this type of reaction in terms of three phenom-ological theories: (i) the microstructural, which considers that bainite is formed by the precipitation of a non-lamellar dispersion of carbide in association with pro-eutectoid ferrite, (ii) the kinetic, where the bainite is formed in the temperature region between the pearlite and martensitic reactions and characterised by its own C—curve, and (iii) the surface relief theory, which defines bainite as a precipitate plate which has a composition different from that of the matrix. Aaronson recommended that the microstructural definition be adopted. Wayman and Srinivasan, however, took exception to the Aaronson theory and produced evidence that there was a definite martensitic crystallographic relationship involved in the formation of lower bainite.

Although these papers represented the main body of the conference there were also useful sessions devoted to particle coarsening, including an excellent review by Greenwood, and a paper by Ardell showing the application of the Lifshitz-Wagner theory to the precipitation in nickel-based alloys.

There were also sessions devoted to order-disorder reactions and spinodal decomposition. This latter session emphasised the increasing importance of this hardening mechanism, and examples were quoted from the systems Na_2O—SiO_2, Cu—Ni—Co, Cu—Ni—Fe, Al—Zn, Au—Pt and also from austenitic stainless steel, which indicated how widely this transformation occurs. It is interesting to speculate whether or not this mechanism will be used to provide additional hardening in alloy systems which have been developed to their limit. The main problem in the application of this transformation appears to be the severe loss of ductility reported recently (DOUGLASS and BARBEE, *J. Mater. Sci.* **4** (1969) 121).

The final session of the conference was devoted to the Fundamental Theory of Transformations and was introduced by Barrett with a paper dealing with transformations in solid gases. Perhaps the last two papers of the conference were the most significant: Weaire and Inglefield dealt with the application of the pseudo-potential approach to phase changes, and Wilkes and Hillel suggested a band structure for G P zone formation. These two papers indicate that the atomic theory approach to phase transformations is going to provide us with an exciting new way of looking at transformations.

Looking back over this conference it is apparent that there is still a lot of effort required before there is a generalised theory of phase transformations and that the important advances in our further understanding are going to depend upon the use of the high voltage electron microscope, with its ability to study "bulk" samples, and the scanning electron microscope to observe the surface changes in bulk samples which occur in a sample undergoing a phase transformation.

At a published price of £6. 0. 0, this monograph represents extremely good value and should be closely studied by all workers who are engaged on any aspect of crystallographic phase transformations.

R. A. FARRAR

Short Notices

Semiconductor Plasma Instabilities

Hans Hartnagel

(Heinemann Educational, 1969) 63*s*

The title of this work is in some ways misleading as its subject matter is concerned with a variety of semiconductor devices and phenomena not customarily associated with the word "plasma". The properties and principles of the operation of transferred electron devices (Gunn and L.S.A.), and avalanche devices are considered along with further forms of instability arising in electroacoustic materials or other types of semiconductor. Although the treatment is primarily concerned with the physics of the processes involved, the basic physics is given rather scant treatment, making reading difficult for those not already conversant with the subject.

The phenomena discussed are essentially properties of the materials involved and more attention to the materials themselves and their preparation could have been justified. Despite these shortcomings, however, the volume makes a useful contribution to the literature of a field that is at present not well served by textbooks. In particular, the up-to-date bibliography which contains 309 references is extremely valuable.

G.D.S.

Electro-slag Refining

W. E. Duckworth, G. Hoyle

Pp 178 (Chapman and Hall, 1969) 80*s*

The extraction and refining of metals are sometimes considered to be outside the area of knowledge essential to a materials scientist, and certainly to a design engineer, is It certainly true that both of these can have no more than an awareness of such special topics as the one covered by this book, but is it essential that they have some kind of informed awareness; otherwise ignorance or prejudice (such as the false notion that "slag" is a dirty word) will take over. One of the aims of this book is to make the functions and achievements of electro-slag refining more widely known so that materials scientists, metallurgists and engineers become eager and ready to receive the products of this process. The book is written by two senior members of the BISRA team that has made such a big contribution to the development of the process in the UK; it presents the state of world knowledge on this subject as it was in the year 1969.

R.L.B.