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Short Notices

The Movement of Macroscopic Inclusions in Solids

Ya. Ye. Gyeguzin, M. A. Krivoglaz
(in Russian)

Metallurgy Press, Moscow (1971), 344 pp. 88 figs. 171 refs. 2r. 02K ≡ £1.01

A number of reviews and original papers have appeared on particular aspects of the diffusional movement of inclusions in solids but this is the first monograph. The book is largely devoted to the generation of diffusion rate equations for unidirectional movement in the presence of a gradient of temperature, electrical potential, stress or concentration, for modes of movement including diffusion of atoms of the matrix phase around, through or over the surface of inclusions. The mode and rate of movement are functions of the temperature and particle size. The treatment is in three sections: (1) systems in which the matrix phase is an element; (2) two-component systems including alloys and ionic compounds where the diffusion rate equations are more complex; and (3) applications to high-temperature processes.

Movement may modify coarsening in the early stages of the ageing of super-saturated solid solutions, and be responsible for the formation of depleted regions near grain boundaries. The dragging of inclusions by migrating grain boundaries or moving dislocations can also play an important part in recrystallization, grain growth, creep and sintering, and in swelling and gas release in nuclear fuels.

Further interesting relevant examples quoted by the authors are the natural purificaton of frozen sea water by the downward movement of pockets of brine, the movement of conical voids in solid NH_4Cl by a process of evaporation and condensation at rates which could be modified by surface impurities, and the motion of inert gas bubbles in reactor materials in the presence of steep temperature gradients.

The growth of corrosion films is of special interest. In, for example, growing oxide films on iron, the ions of oxygen and iron flow in opposite directions without meeting. The supposition is that one species moves by bulk diffusion and the other by surface or grain-boundary diffusion. Relevant information could be obtained by observing the movement of inclusions in the oxide film. Movement occurs only if there is a net flow of one species in the vicinity of the inclusion. Such movement has been demonstrated in ionic crystals in the presence of a potential gradient.

These examples and the appearance of this book should stimulate a greater interest in this subject and indicate the importance of the phenomenon in materials science. S.F.P.

Introduction to Phase Transitions and Critical Phenomena

H. Eugene Stanley

Clarendon Press: Oxford University Press (1971) £5.00 net, 308 pp.

This book gives a brilliant survey of the concepts and theories used in the discussion of phase transitions and critical fluctuations. For some years, there has been much activity in this field which is of interest to physicists, chemists and materials scientists. The aim of this research is to get an understanding of the different kinds of phase transition in terms of a generalized theory. Stanley's book takes into account this situation well emphasizing the analogies between fluid and magnetic transitions throughout the text. The prerequisites of knowledge are

adapted to students or to scientists entering the field. The basic thermodynamical concepts used are collected in an introductory part of the book. Part II deals with the critical point exponents and exponent inequalities. Then follows a presentation of the classical theories of co-operative phenomena (van der Waals, molecular field, Ornstein-Zernike). Part IV is dedicated to model systems, especially the Ising model and the classical Heisenberg model. The last two parts, about one third of the book, give an introduction to the points of most immediate interest: the scaling law hypothesis and the dynamic aspects of critical phenomena. Both static systems and systems fluctuating with time are treated. Additional to the treatment in the text some important concepts are presented from a more mathematical point of view in several appendices.

The research worker wanting to penetrate into the field beyond this introduction will find the collected references very useful.

H.A.

Metallurgical Chemistry

Editor: O. Kubaschewski.

Proceedings of a Symposium held at Brunel University and the National Physical Laboratory, July 1971.
H.M. Stationery Office, London, 1972. 681 pp. £5.50

This conference on Metallurgical Chemistry held in 1971 is, according to the organizers, a follow-up to the symposium held at the NPL in 1958 on the Physical Chemistry of Metallic Solutions and Intermetallic Compounds. The earlier symposium was of course a milestone in the development of the science of metals and alloys, in terms of the metallurgical uses of thermodynamics, and it brought together a number of experts studying different aspects of solutions with different techniques and theoretical approaches. Although the 1971 symposium included a number of excellent review articles and papers, it is not likely to have the impact of the previous symposium simply because the field has become more developed and there are now many books and monographs in this area.

The symposium was divided into five parts: (i) Experimental Methods, (ii) Structure and Stability (Physical Approach and Chemical Approach), (iii) Thermochemical Evaluation of Phase Boundaries and Equilibrium Diagrams, (iv) Industrial Applications, and (v) Data Compilation and Storage. One of the techniques that was just emerging at the time of the first symposium was the use of highly conducting solid-state electrolytes for determining thermodynamic data at elevated temperatures. This technique is of utmost importance and is thoroughly discussed in a review paper here by Schmalzried and mentioned in several other papers. Not only can these EMF cells be used to determine Gibbs free energy, but also to determine kinetic parameters such as diffusion constants, transference numbers and rate constants for diffusion-controlled and phase-boundary-controlled reactions.

It will be a happy day for thermodynamicists when the various thermodynamic parameters can be calculated theoretically. We are still a long way from this situation but considerable progress has been made in calculating the cohesive energies of simple metals which can be used to calculate enthalpies of solution. One interesting idea that emerged in the section "Structure and Stability" was that of the zero point entropy being associated with a crystal structure. This concept may be useful in calculating the entropy of fusion. The considerable progress which has also been made in calculating phase-diagrams from thermodynamic data is described by Kaufman and others. Clearly computing has become an invaluable technique, allowing quite complicated phase diagrams to be generated. It is possible to explore ternary plots in a realistic way without carrying out time-consuming and costly experiments, although these must necessarily be done for confirmation. The computer is also becoming indispensable for data compilation and storage.

As in the previous symposium, the published discussion made up a very important part of the Proceedings. Her Majesty's Stationery Office is to be congratulated on keeping the price of these Proceedings reasonable, for they are to be recommended to anyone working in this field.

E.L.

Atlas of Microstructures of Industrial Alloys

Metals Handbook, 8th Edn. Volume 7
American Society for Metals, Ohio (USA and Canada), Chapman and Hall, London (all other territories) 1972, £14.50, pp. 356.

Cast some industrial metallurgists away on a

desert island and ask each of them to take along their most used book – one would probably find that Metals Handbook Volume One, "Properties and Selection" was the majority choice. In fact, now there is a serious rival for this position in Volume Seven, although this volume really serves to complement rather than to compete with Volume One. It is a magnificent piece of work, it is truly an "Atlas" with nearly 3000 high quality photomicrographs (and a minimum of background information) which span the range of industrial alloys. Happily, most of these are optical micrographs, both at low and high magnifications, and the temptation to include an excess of beautiful, but irrelevant, electron micrographs has been resisted. Inevitably for readers external to the USA, there is some difficulty in that American specification numbers are used, but the relevant composition figures are always quoted and the mental conversion can easily be made. The classification scheme in terms of industrial usage, and the balance between ferrous and non-ferrous alloys, are also items that obviously could be debated, but these are minor quibbles. This Volume will prove invaluable not only in industry, but also in the teaching of undergraduate metallography courses, where its presence in the laboratory will stimulate the student to "look wide". Professor Mehl and his colleagues are to be congratulated on "Atlas of Microstructures", which provides a considerable service to the metallurgical profession, and even at the price of £14.50 represents a "best buy".

W.B.

The Japanese National Committee for Optics is arranging, under the sponsorship of the International Commission for Optics, an International Conference on Optical Methods in Scientific and Industrial Measurements which will be held in Tokyo, 26-30 August 1974.

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