Mass Transport in Solids and Fluids

David S. Wilkinson, Cambridge Solid State Science Series, Cambridge University Press, Cambridge, London, 2000, p. 270, £ 70.00 (hardback), £ 24.95 (paperback), ISBN 0-521-62409-6 (hardback), 0-521-62494-0 (paperback)

An understanding of matter transport is vital to the successful study of processing of materials. This book is aimed squarely at undergraduate (and early postgraduate) students looking for a firm grounding in the fundamentals of matter transportation processes.

The book is split up into four parts; Part A (Chapter 1) an overview, Part B (Chapters 2, 3, 4, 5 and 6) solid state diffusion in dilute alloys, Part C (Chapters 7, 8 and 9) mass transport in concentrated alloys and fluids and Part D (Chapter 10) alternative driving forces for diffusion. The book also includes useful appendices containing details of mathematical methods, selected data and how to solve problems by developing fundamental conceptual models.

The overview contains an introduction to mass transport mechanisms. It includes straightforward coverage of diffusion mechanisms in a variety of situations. Fick's first law is also clearly presented. A useful addition to the chapter is several worked examples that serve to develop the reader's understanding. The section concludes with recommendations for further reading and several further problems. It is a shame, however, that the author did not include (at least) the numerical answers to the questions to enable students to check their working.

Part B is restricted to diffusion in the solid state involving dilute binary alloys. As in Part A, this section is liberally scattered with excellent worked examples with emphasis on 'real' engineering applications. These examples have clearly been thought though and have not been added as an afterthought. Without a doubt, they enhance the understanding of a reader.

Part C is concerned with mass transport in concentrated alloys and fluids. This section considers what happens when large concentration differences exist across a phase and how substantial changes in diffusion coefficients are accommodated. Attention is also given in this section to mass transport in fluids.

Parts A, B and C all made the assumption that only concentration gradients provide a driving force for diffusion. Part D generalises this by including all forms of free energy gradient. From this, a general theory of diffusion is well developed. This general theory is then applied to new problems, such as diffusion due to an electric field or a mechanical stress. This section also considers diffusion in multicomponent systems.

Overall, this book is written with the reader in mind. Each chapter leads the reader through the fundamentals and theories of mass transport in solids and fluids to an increasingly developed level by slowly introducing concepts and theories as required. Therefore, the early sections are quite basic and require little prior knowledge, whilst later sections are fairly advanced and extend the knowledge to a higher level.

There is something in this book for everybody, whether a novice student looking a beginners' guide or an expert looking for a reference text.

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The New Chemistry

Nina Hall (Ed.); Cambridge University Press, Cambridge, 2000, 493 pp. hardback, ISBN 0-521-45224-4, £30 ($49.95)

Overall, the book is well written and introduces a lot of new areas to the non-specialist. It covers an enormous range of subjects from new elements in the periodic table to pharmaceutical production. For this reason, the book will be relevant to a wide range of readers. Unfortunately, the fact that it covers so many different areas makes it almost impossible to review with any degree of certainty. As an example, I know that the figures for the contribution of nuclear power to electricity generation (p. 25) are exaggerated, but other stated facts, particularly in the area of biochemistry are difficult to question.

The initial introduction by Roald Hoffman made for tough reading which is perhaps not the best means of getting people's appetite whetted.

If the book is used as a reference source for information, it works well. If the book is reviewed as a whole, there are some inconsistencies between the chapters in terms of format. Occasionally, one is left with the feeling that the clarity of a chapter is not related to the complexity of the subject matter, but a reflection on the author's ability to explain things with concise clarity. Obviously some authors are going to be better at explaining concepts on an appropriate level than others, but one or two authors stop bothering to make their subjects accessible after the first or second paragraph (e.g. Chapter 9).

The other inconsistency, if the book is reviewed as a whole, relates to the amount of time spent explaining the history behind a subject. The history of a subject area may be important when looking at "new chemistry", but in some cases the history lesson was overly long and the author(s) did not justify the nostalgia convincingly enough to warrant its inclusion. In fact, with one or two chapters, you are left with the feeling that some of the topics are barely 'new chemistry' at all. As an example, Chapters 5 and 12 spend a very long time dealing with the 1900s up to 1950. Because of the overemphasis on certain areas, the length of the different chapters varies enormously. Perhaps the editor could have held the leash a little tighter to ensure consistency throughout the book. The book does seem to spend a great deal of time looking at biochemistry issues. Is this really a reflection of 'New Chemistry'? If some chapters had been thinner, there would have been the opportunity to include some other areas that would class as new. Perhaps green chemistry?

Giving references at the back end of each chapter is a good idea, but why use only 5–10 or so? I suggest that more are used with attention to inclusion of a few milestone papers and more up-to-date references to reinforce the 'newness' of the topic. The secondary author of Chapter 1 confesses that the material covered is two years out of date as a result of the primary author passing away. Apparently, the second author did not feel it was appropriate to update the contribution. Personally, speaking as a scientist, I wouldn't want my contribution to be out-of-date, for any reason, especially as this book hinges on being 'new'. I recommend that this admission be removed, because it's potentially irritating to scientists.

Some of the images are of surprisingly low quality, e.g. the periodic table on page 1, and the molecular diagrams on page 36 in 'Bonding, Atoms and Molecules'. This represents an inconsistency, since parts of the book are extremely well presented.

As first stated, the book is well written and reasonably balanced in terms of complexity of content. I am uncertain as to the target audience; hence its difficult to say whether the book will be well received in that context. The book does an excellent job of showing how the world of chemistry is inextricably linked to every other discipline, materials, mechanics, biosynthesis, medicine, agriculture and manufacturing.

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Non-linear Mass Transfer and Hydrodynamic Stability

Chr. B. Boyadjiev, V.N. Babak, Elsevier Science B.V., 2000, 500 pp., ISBN 0-444-50428-1

Mass transfer lies at the core of so much of what we observe, from transport processes in a large variety of engineering applications (evaporators, heat exchangers, absorbers to name but a few) to convection phenomena in the Earth's mantle. Yet the mass transfer enthusiast keen to get to grips with this diverse, complex subject rapidly discovers something rather extraordinary; there are a few texts on mass transfer. There are of course simple and heuristic descriptions of mass transfer in most undergraduate books, and some excellent monographs but there is virtually nothing on non-linear mass transfer and its relation to hydrodynamic stability and hence *Non-linear Mass Transfer and Hydrodynamic Stability* by Boyadjiev and Babak is a welcome addition to the existing literature.

The book is essentially a theoretical analysis of non-linear mass transfer and its strength lies in the authors' determination to keep the discussion at an advanced level. The exposition to the fundamentals of mass transfer is careful and well-suited to those new to the subject. Overall, the treatment is mathematical in style and assumes a reasonable background in classical methods of applied mathematics and transport phenomena.

The brief introduction to the basics of linear mass transfer at the beginning of the text is followed by a series of chapters on non-linear effects. Such non-linear effects and deviations from the linear theory can arise due to intensive mass transfer associated with large concentration gradients of the transferred species — this is the case of concentration dependent molecular diffusivity. Another source of non-linearity is the dependence of viscosity and surface tension on the concentration of the absorbed species. In particular, the variation of surface tension with concentration (the Marangoni effect) can lead to secondary flows at interface boundaries and hence affect the hydrodynamics of the flow. The discussion of these effects is extensive and thoughtful.

The text also covers a large variety of problems usually not included in traditional descriptions of mass transfer. For example, non-linear mass transfer in electrochemical systems with high current density (typical examples include electro-separation of metals) and non-linear mass transfer in chemically reacting systems. (This last case is obviously inherently non-linear due to the non-linearity of the chemical reaction kinetics equations). The thermocapillary Marangoni effect induced by the exothermicity of chemical reactions is also considered in detail. Finally, the book closes with an analysis of the coupling between mass transfer and fluid mechanics in the context of linear hydrodynamic stability theory of nearly parallel flows (such as laminar boundary layers). This last chapter on hydrodynamic stability is very welcome, though the chapter is, perhaps, a little brief especially considering that this is a text on non-linear mass transfer and hydrodynamic stability. In addition, the inclusion of some elements of non-linear dynamics at the beginning of the hydrodynamic stability chapter is also brief and it appears somewhat disconnected from the rest of the text, leaving the reader with the distinct impression that some of the modern non-linear dynamics and bifurcation theory concepts are not utilized in a text devoted to non-linear effects in mass transfer.

My other criticism of the book is that despite the large variety of topics discussed, there are still several important non-linear mass transfer problems which deserve special attention and have not been included here: mass transport enhancement due to Taylor–Aris dispersion, diffusive transport and anomalous diffusion in Rayleigh–Bénard convection cells (and more general transport in systems with closed