



SEVENTH EDITION

PHYSICAL METALLURGY AND ADVANCED MATERIALS

R.E. Smallman • A.H.W. Ngan



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Physical Metallurgy and Advanced Materials

Seventh edition

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Preface

Physical Metallurgy and Advanced Materials has evolved from the earlier editions of *Modern Physical Metallurgy* (1962, 1970, 1985) and later editions of *Modern Physical Metallurgy and Materials Engineering* (1995, 1999). The present treatment contains much of the previous editions and follows the same overall philosophy and aims. It has, however, been updated again in both presentation and content. Additions have been made to almost every chapter, which now include a number of worked examples in the text to illustrate and emphasize a particular aspect of the subject. At the end of each chapter there is a set of questions, most of which are numerical. These are included to give the reader an opportunity to apply the scientific background presented in the chapter, but also to emphasize important material properties, e.g. elastic moduli, atomic dimensions, etc. The solutions to these problems are worked out in a Solutions Manual, which may be obtained from Elsevier by teachers and lecturers who use the book.

To keep the book a manageable size some text from the previous edition has been omitted together with associated diagrams, and some of the text has been totally recast in a different format. The early chapters are predominantly directed towards metals (physical metallurgy) but the principles are equally relevant to non-metals, which are specifically dealt with in the later chapters. Characterization using X-rays, electron microscopy, etc. is important to all areas of materials and several new techniques such as scanning tunneling microscopy (STM), atomic force microscopy (AFM), nanoindentation and so on have been described. The book ends with a focus on some newer areas which are developing rapidly and are being incorporated to a greater or lesser extent in a number of university courses. The presentation of biomaterials, sports materials and nanomaterials is very much illustrative of the essential and significant application of a wide variety of materials and associated materials science to the successful development of these new fields.

R. E. Smallman

A. H. W. Ngan

January 2007

Solutions Manual

This provides a set of fully worked solutions, available for lecturers only, to the Problems found at the end of chapters.

To access the Solutions Manual go to: <http://www.textbooks.elsevier.com> and search for the book and click on the 'manual' link. If you do not have an account on [textbooks.elsevier.com](http://www.textbooks.elsevier.com) already, you will need to register and request access to the book's subject area. If you already have an account on [textbooks](http://www.textbooks.elsevier.com), but do not have access to the right subject area, please follow the 'request access' link at the top of the subject area homepage.

About the authors

Professor R. E. Smallman

After gaining his PhD in 1953, Professor Smallman spent five years at the Atomic Energy Research Establishment at Harwell before returning to the University of Birmingham, where he became Professor of Physical Metallurgy in 1964 and Feeney Professor and Head of the Department of Physical Metallurgy and Science of Materials in 1969. He subsequently became Head of the amalgamated Department of Metallurgy and Materials (1981), Dean of the Faculty of Science and Engineering, and the first Dean of the newly created Engineering Faculty in 1985. For five years he was Vice-Principal of the University (1987–92).

He has held visiting professorship appointments at the University of Stanford, Berkeley, Pennsylvania (USA), New South Wales (Australia), Hong Kong and Cape Town, and has received Honorary Doctorates from the University of Novi Sad (Yugoslavia), University of Wales and Cranfield University. His research work has been recognized by the award of the Sir George Beilby Gold Medal of the Royal Institute of Chemistry and Institute of Metals (1969), the Rosenhain Medal of the Institute of Metals for contributions to Physical Metallurgy (1972), the Platinum Medal, the premier medal of the Institute of Materials (1989), and the Acta Materialia Gold Medal (2004).

He was elected a Fellow of the Royal Society (1986), a Fellow of the Royal Academy of Engineering (1990), a Foreign Associate of the United States National Academy of Engineering (2005), and appointed a Commander of the British Empire (CBE) in 1992. A former Council Member of the Science and Engineering Research Council, he has been Vice-President of the Institute of Materials and President of the Federated European Materials Societies. Since retirement he has been academic consultant for a number of institutions both in the UK and overseas.

Professor A. H. W. Ngan

Professor Ngan obtained his PhD on electron microscopy of intermetallics in 1992 at the University of Birmingham, under the supervision of Professor Ray Smallman and Professor Ian Jones. He then carried out postdoctoral research at Oxford University on materials simulations under the supervision of Professor David Pettifor. In 1993, he returned to the University of Hong Kong as a Lecturer in Materials Science and Solid Mechanics, at the Department of Mechanical Engineering. In 2003, he became Senior Lecturer and in 2006 Professor. His research interests include dislocation theory, electron microscopy of materials and, more recently, nanomechanics. He has published over 120 refereed papers, mostly in international journals. He received a number of awards, including the Williamson Prize (for being the top Engineering student in his undergraduate studies at the University of Hong Kong), Thomas Turner Research Prize (for the quality of his PhD thesis at the University of Birmingham), Outstanding Young Researcher Award at the University of Hong Kong, and in 2007 was awarded the Rosenhain Medal of the Institute of Materials, Minerals and Mining. He also held visiting professorship appointments at Nanjing University and the Central Iron and Steel Research Institute in Beijing, and in 2003, he was also awarded the Universitas 21 Fellowship to visit the University of Auckland. He is active in conference organization and journal editorial work.

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The contribution made by Dr R. Bishop to two previous editions of the book has helped significantly in the development of the present treatment. The authors wish to acknowledge this with thanks. Acknowledgment is also made to a number of publishers and researchers for kind permission to reproduce a number of diagrams from other works; these are duly noted in the captions.

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