Book Reviews

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1 Multiphase Polymer-Based Materials: An Atlas of Phase Morphology at the Nano and Micro Scale

by: C. Harrats
Published 2009
by CRC Press, Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300,
Boca Raton, FL 33487-2742, USA, 232pp
ISBN: 978-1-4200-6217-5

During the past ten years, a large variety of new multiphase polymer-based materials have been studied from a morphological point of view. Simultaneously, huge progress has been achieved in microscopy. These circumstances underline the need for a reference that delineates the differences of the various types of nanostructures in multiphase polymer-based materials. *Multiphase Polymer-Based Materials: An Atlas of Phase Morphology at the Nano and Micro Scale* presents up-to-date coverage of developments in this field in a practical and easy-to-use format.

Features:

- includes a brief introduction of the basics and fundamentals in phase morphology of polymer blends
- addresses phase morphology in polymer/polymer micro and nano blends, thermosets/thermoplastics blends, and thermoplastic vulcanisates
- features images of phase morphology in filler/polymer composites and nanocomposites
- explains the various methods by which phase morphology can be directly observed
- provides microscopic photomicrographs of blend systems where the phase morphology is of the co-continuous type
- includes tools, tips, and selected scanning electron photomicrographs of the methods for the investigation of morphology.

The author sifted through an encyclopaedic amount of research to provide a selection of more than 550 microscopy images resulting from the observation of multiphase polymer-based materials. He also examines the various microscopic tools employed for the investigation of phase morphology, highlighting the advantages and disadvantages of each. The book provides a practical, straightforward approach for dealing with the

microscopic observation of phase morphology in multi-component polymer blends and nanocoposites.

In the book, the following chapters are included:

- Basics in phase morphologies of multi-component polymer-based materials: phase morphology development in polymer blends.
- Phase morphology investigation: microscopic tools, tips, and selected scanning electron photomicrographs: introduction, sample preparation for scanning electron micrography.
- Selected microscopic illustrations of phase morphology in nanocomposites: introduction, some specific aspects related to the preparation of polymer nanocomposites, mobility of polymer molecules in confined spaces of layered silicates.
- Illustrations of phase morphology other than co-continuous in polymer blends including thermoplastics/thermoplastics and thermosets/thermoplastics.
- Scanning electron microscopy illustrations of two-phase co-continuous morphologies in binary polymer blends.

A huge volume of scientific literature and industrial patents is continuously devoted to research where the interrelation of phase morphology with physical and chemical properties of the materials is considered in controlling the performance of polymer-based materials.

The focus of that book was on the research achieved in multiphase polymer blends, with an emphasis on both theoretical and experimental aspects of their formation, their properties, and their processing in relation to the parameters used in their control.

2 Characterisation of Polymers, Volume 1
by: T.R. Crompton
Published 2008
by Smithers Rapra Technology Limited
Shawbury, Shrewsbury, Shropshire, SY4 4NR, UK, 478pp
ISBN: 978-1-84735-122-7 (softback), ISBN: 978-1-84735-123-4 (hardback)

This book is intended to be a complete compendium of the types of methodology that have evolved for the determination of the chemical composition of polymers. More detailed aspects, such as sequencing of monomer units in copolymers, end-group analysis, tacticity and stereochemicial determinations, will be dealt with in this subsequent volume.

Chapters 1 to 3 provide a discussion of the methodology used for the determination of metals, non-metals and organic functional groups, respectively. Metals in polymers usually originate as catalyst remnants, adventitious impurities or processing chemicals full knowledge of which can provide useful information on the manufacturing process and source. A wide variety of techniques are now used for the determination of metals in polymers. These can be broadly divided into two groups: destructive and non-destructive

techniques. The latter includes X-ray fluorescence spectroscopy and neutron activation analysis.

Chapter 3 covers a discussion of recent work on the determination of the various types of organic functional groups that can occur in polymers.

Knowledge of the ratio in which different monomer units occur in copolymers is the next step, and methodology for determining this is discussed in Chapter 4.

Chapters 5 and 6 discuss the techniques available for composition determination of homopolymers and copolymers, respectively. Chapters 7 to 10 discuss other recent modern techniques such as X-ray photoelectron spectroscopy, atomic force microscopy, micro thermal analysis and scanning electron microscopy and energy dispersive analysis using X-rays.

Frequently, it is necessary to utilise several different techniques to obtain full compositional information, and this is discussed in Chapter 9.

In the book, the following chapters are included:

- Determination of metals: destructive techniques, non-destructive methods.
- Determination of non-metallic elements: halogens, sulphur, phosphorus, nitrogen, silica, boron, and totals organic carbon.
- Determination of functional groups in polymers: carboxyl groups, carbonyl groups, ester groups.
- Monomer ratios in copolymers: olefinic copolymers, gas chromatography, vinyl chloride copolymers, styrene copolymers, butadiene-based polymers, and styrene-butadiene-acrylonitrile.
- Analysis of homopllymers: infrared spectroscopy, Fourier transform infrared (FTIR) spectroscopy, Fourier transform Raman spectroscopy, mass spectrometry, gross polarisation magic angle spinning, gas chromatography – mass spectrometry, proton magnetic resonance spectroscopy, electron spin resonance spectroscopy, and infrared spectra.
- Analysis of copolymers: infrared spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, and mass spectrometry.
- X-ray photoelectron spectroscopy: bulk polymer structural studies, adhesion studies, carbon black studies, particle identification, pyrolysis studies, and surface studies.
- Atomic force microscopy and microthermal analysis: atomic force microscopy, and microthermal analysis.
- Multiple technique polymer studies: FTIR-nuclear magnetic resonance spectroscopy, and other technique combinations.
- Scanning electron microscopy and energy dispersive analysis using X-rays.

The book is intended for all staff who is concerned with the elucidation of polymer structure and with the provision of suitable instrumentation in polymer research laboratories including work planners, chemists, engineers, chemical engineers and those concerned with the implementation of specifications and process control.

3 The superalloys fundamentals and applications
by: R.C. Reed
Published 2006
by Cambridge University Press
32 Avenue of the Americas, New York, NY 10013-2473, USA, 388pp
ISBN: 978-0-521-85904-2, ISBN: 978-0-521-07011-9

Superalloys are unique high temperature materials used in gas turbine engines, which display excellent resistance to mechanical and chemical degradation. This book presents the underlying metallurgical principles which have guided their development and practical aspects of component design and fabrication from an engineering standpoint. The topics of alloy design, process development, component engineering, lifetime estimation and materials' behaviour are described, with emphasis on critical components such as turbine blades and discs.

Nickel-based superalloys represent a very important class of engineering material, finding widespread application for example in critical components within the gas turbine engines used for jet propulsion and electricity generation. This is due to their superior mechanical properties that are maintained to elevated temperatures. Indeed, new classes of superalloy are continually being sought by gas turbine manufacturers around for the world for applications in the hottest parts of the engine. This is because higher temperatures result in improvements to the efficiency of the engine and therefore lower fuel burn. Engine performance is a major factor in any power plant competition, which helps to explain why all the engine manufacturers spend so much money developing future generations of superalloys.

The author has provided us with a textbook covering both the fundamentals and applications of superalloy technology. This is a significant and unique achievement, especially given the broad range of subject matter dealt with. In Chapter 1, the requirement for materials capable of operating at elevated temperatures is introduced along with the historical development of the nickel-based superalloys and their emergence as materials for high-temperature applications. Chapter 2 concerns the physical metallurgy of the superalloys, with an emphasis on the details which distinguish them from other classes of engineering alloys, for example the gamma prime strengthening phase, the role of defects such as the anti-phase boundary, the unique particle-strengthening mechanisms, the anomalous yield effect and the creep deformation behaviour. Chapters 3 and 4 deal with superalloy technology an applied to two major gas turbine components of critical importance: the turbine blade and discs. Of note is the balanced coverage given to the processing, alloy design and microstructure/property relationships relevant to superalloys used for these distinct applications. Chapter 5 deals with surface coatings technologies, which are becoming increasingly critical as operating temperatures continue to rise. In Chapter 6, projections are made about the future of superalloy technology.

In the textbook, the following chapters are included:

- Introduction: Background: materials for high-temperature applications, the requirement: the gas turbine engine, the selection of materials for high-temperature applications, and summary.

- The physical metallurgy of nickel and its alloys: Composition-microstructure relationships in nickel alloys, defects in nickel and its alloys, strengthening effects in nickel alloys, and the creep behaviour of nickel alloys.
- Single-crystal superalloys for blade applications: processing of turbine blading by solidification processing, optimisation of the chemistry of single-crystal superalloys, mechanical behaviour of the single-crystal superalloys, turbine blading: design of its size and shape.
- Superalloys for turbine disc applications: Processing of the turbine disc alloys, composition, microstructure and properties of turbine disc alloys, service life estimation of turbine disc applications.
- Environmental degradation: the role of coatings: Thermal barrier coatings, overlay coatings, diffusion coatings, and failure mechanisms in thermal barrier coating systems.
- Summary and future trends: Trends in superalloys for turbine blade applications, trends in superalloys and processes for turbine disc applications, and concluding remarks.

In view of the authors, exemplary treatment of the subject, this book deserves to become the definitive textbook in the field for the foreseeable future. It is recommended to all those with an interest in the field of high-temperature materials, particularly those involved with gas turbine technology or those embarking on a higher degree in the subject. Also, since the superalloys represent a considerable success story in the field of materials science and engineering, it is recommended for use within the materials-related curricula at universities.

4 The material world
by: R. Cotterill
Published 2008
by Cambridge University Press
The Edinburgh Building, Cambridge, CB2 8 RU, UK, 576pp
ISBN: 978-0-521-45147-5

He has written this book for people interested in science who seek a broader picture than is normally found between a single pair of covers. It presents a non-mathematical description of the physics, chemistry and biology of natures materials. Although it has been written primarily as a self-contained review for the non-specialist, it can also be used as an introduction, to precede more detailed studies of specific substances and phenomena.

The general approach adopted in the text has been to proceed from the relatively simple to the more complex. After the Prologue, which provides the book with a cosmic backdrop, the story starts with single atoms and the groups of atoms known as molecules, and it continues with the cooperative properties of large numbers of atoms. The nature and consequences of symmetry in crystals have been allocated their own chapter, as have

those departures from regularity that play a key role in the behaviour of materials. Such imperfections are presented in the context of the inorganic domain, but they have counterparts in the mutations and variations inevitably present in living organisms. Water and the Earths minerals are so important to our environment that they too have been discussed in separate chapters, and the balance of the book is broadly divided into three parts, each covered in several chapters: inorganic materials, organic non-biological materials, and biological materials. The final chapter is devoted exclusively to the mind.

In the book, the following chapters are included:

- solo atoms electrons, nuclei and quanta
- atomic duets: the chemical bond
- atoms in concert: states of matter
- patterns within patterns: perfect crystals
- the inevitable flaw: imperfect crystals
- the great mediator: water
- from mine, quarry and well: minerals
- almost forever: ceramics
- monarchs of the cave: metals
- the busy electron: conductors and insulators
- a mysterious harmony: glass
- to the organic world: carbon
- strangeness in proportion: liquid crystals
- of snakes and ladders: polymers
- the vital threads: biopolymers
- the essential bag: the cell
- mortal coils: the organism
- a place in the sun: the plant
- mandatory hunter: the animal
- enchanted loom: the mind.

In this magnificent book, Rodney Cotterill weaves the main threads of physics, chemistry, biology, astronomy, earth sciences and neuroscience into a fascinating narrative tapestry stretching them from the atom, through life, to consciousness itself.

It would be gratifying if the books provision of a global view could help alleviate the scarcity of time that bedevils so many professionals these days.

5 Optimal Design of Experiments
by: F. Pukelsheim
Published 2006
by SIAM Society for Industrial and Applied Mathematics
3600 Market Street, 6th Floor, Philadelphia,
PA 19104-2688, USA, 454pp
ISBN: 0-89871-604-7

Optimal design of experiments offers a rare blend of linear algebra, convex analysis, and statistics. The optimal design for statistical experiments is first formulated as a concave matrix optimisation problem. Using tools from convex analysis, the problem is solved generally for a wide class of optimality criteria such as D-, A-, or E-optimality. The book then offers a complementary approach that calls for the study of the symmetry properties of the design problem, exploiting such notions as matrix majorisation and the Kiefer matrix ordering. The results are illustrated with optimal designs for polynomial fit models, Bayes designs, balanced incomplete block designs, exchangeable designs on the cube, rotatable designs on the sphere, and many other examples.

Since the book's initial publication in 1993, readers have used its methods to derive optimal designs on the circle, optimal mixture designs, and optimal designs in other statistical models. Using local linearisation techniques, the methods described in the book prove useful even for non-linear cases in identifying practical designs of experiments.

In the book, the following chapters are included:

- experimental designs in linear models
- optimal designs for scalar parameter systems
- Iinformation matrices
- Loewner optimality
- real optimality criteria
- matrix means
- the general equivalence theorem
- optimal moment matrices and optimal designs
- D-, A-, E-, T-optimality, 210
- admissibility of moment and information matrices
- Bayes designs and discrimination designs
- efficient designs for finite sample sizes
- invariant design problems
- Kiefer optimality
- rotatability and response surface designs.

This book is indispensable for anyone involved in planning statistical experiments, including mathematical statisticians, applied statisticians, and mathematicians interested in matrix optimisation problems.

6 Continuum Modeling in the Physical Sciences

by: E. van Groesen and J. Molenaar
Published 2007
by SIAM Society for Industrial and Applied Mathematics
3600 Market Street, 6th Floor, Philadelphia,
PA 19104-2688, USA, 228pp
ISBN: 978-0-898716-25-2

The SIAM series on mathematical modelling and computation draws attention to the wide range of important problems in the physical and life sciences and engineering that are addressed by mathematical modelling and computation; promotes the interdisciplinary culture required to meet these large-scale challenges; and encourages the education of the next generation of applied and computational mathematicians, physical and life scientists, and engineers.

Teaching mathematical modelling is a quite complicated challenge. On the one hand, one has to expose a great variety of general mathematical concepts, and on the other hand, one has to treat the principles of the field of application in some detail. It is this diversity of applicable techniques and possible applications that could seduce an author to present the subject as a long series of ingenious case studies, in which students can hardly discover any coherence. This approach could even disappoint the student, since having digested many particular models does not guarantee that one knows how to proceed when confronted with a new situation. To convince students of the power and beauty of modelling, we offer in this book and extensive exposition of general principles. Since students gain the most from a course if its structure is clearly highlighted, most chapters are devoted to central issues, such as dimensional analysis, conservation principles, balance laws, constitutive relations, stability, robustness, and variational methods. The core of these chapters will form the backbone of any course on mathematical modelling.

The book contains the following chapters:

- Dimensional analysis and scaling: mathematical models, dimensions, scaling.
- Conservation principles and constitutive relations: discrete versus continuous models, mass and heat balances in one dimension, constitutive relations in one dimension, transport theorem, mass balance in three dimensions, heat balance in three dimensions, momentum, stress in continuous media, momentum balance, constitutive relations in three dimensions, energy balance, challenging problem: shallow water waves.
- Basic concepts: state and state space, linearising, expansions in basis vectors.
- Stability and robustness: stability, stability definitions, linearisation, robustness, singular perturbations, challenging problems.
- Variational modelling: variational principles, variational approximation and restriction, variational calculus, variational restriction, scientific computing.

- Advance models: polymer dynamics and vibrating strings, fibre spinning, surface water waves, and optics.

This book aims at applications of modelling techniques, and the relevant ideas and techniques are presented via examples and exercises. The book contains a multitude of classroom examples and exercises throughout the text, and several chapters contain a section of challenging problems.

7 Rubber as a Construction Material for Corrosion Protection, A Comprehensive Guide for Process Equipment Designers

by: V.C. Chandrasekaran
Published 2010
by WILEY-VCH Verlag, Scrivener Publishing, Co-published by John Wiley & Sons, Inc.
Hoboken, New Jersey, and Scrivener Publishing, 3 Winter Street, Suite 3, LLC, Salem, Massachusetts, MA 01970, USA, 297pp
ISBN: 978-0-470-62594-1

Despite the long history of rubber as a construction material, this book is a unique publication as it comprehensively looks at the material with respect to the anti-corrosion requirements of the multitude of industries where rubber is used, both on land and offshore.

The book details the practical aspects and handling of rubber lined equipment: thin-walled structures, vacuum vessels, ducts, large diameter tanks, agitators, and fully lined pipes (both inside and outside). Moulded and fabricated products of ebonite and soft rubber as well as hand-made rubber products are shown along with vulcanisation technology, testing and inspections, measurements and standards. Several case studies are included demonstrating the preferential choice of rubber as a construction material as well as practical applications and techniques of its usage in the chlor-alkali, fertiliser, mineral processing and other core chemical processing industries, which are the largest consumers of rubber as a material of construction. The volume ends with a section on aging and prediction of service life.

In the book, the following chapters are included:

- introduction-background and reasons for using rubber as a construction material
- rubber compounding
- ebonite-problems and solutions
- rubber lining-types and application procedures
- rubbers and their relevant properties for the chemical and mineral processing industries
- design considerations for fabrication of equipment suitable for rubber lining
- chemical process plants and equipment
- processibility and vulcanisation tests

- rubber to metal bonding
- vulcanisation technology
- rubber in seawater systems
- rubber in oil field environment
- calendering of rubber and coated rubber sheets
- moulding technology
- service life of rubber-lined chemical equipment
- case studies.

Rubber as a construction material for corrosion protection will be used by chemical engineers, rubber technologists, students, research workers worldwide in the rubber industry and process industries such as fertiliser, mining and ore, oil and gas, paper and pulp, steel plants, as well as people engaged in corrosion protection. The book will also be very useful to the construction industry.

8 Magnetic Properties of Antiferromagnetic Oxide Materials

by: L. Duo, M. Finazzi and F. Ciccacci
Published 2010
by WILEY-VCH Verlag GmbH & Co. KGaA
Wiley-VCH Verlag GmbH & Co. KgaA, P.O. Box 10 11 61,
69451 Weinheim, Boschstrasse 12, 69469 Weinheim, Germany, 362pp
ISBN: 978-3-527-40881-8

This book is devoted to antiferromagnetic oxides, both in the form of surfaces and thin films, and in the form of interfaces and multilayers with other magnetic or non-magnetic materials. Films and multilayers with a thickness of a few nanometres are important examples of low-dimensionality systems that can exhibit very different physical properties with respect to their bulk counterparts. This field is testifying a great experimental effort in the production of artificial structures with original magnetic properties. An example of relevant scientific and technological interest is the rapid development in the last years of spintronics, a discipline that aims to exploit the intrinsic spin of electrons and its associated magnetic moment, in addition to its fundamental electronic charge, in solid-state devices. The actual trend toward miniaturised magnetic devices requires new investigations of low-dimensional magnetic systems from a fundamental point of view.

This book gives the first comprehensive account of these topics, bringing together experimental and theoretical methods. It is focused on the study of the magnetic behaviour of spatially confined antiferromagnetic transition-metal-oxide systems when their dimensions are scaled down to nanometric level, with particular emphasis on the growth and the magnetic characterisation through different experimental methods and theoretical modelling approaches.

In the book, the following chapters are included: Low-dimensional antiferromagnetic oxides: an overview; Introduction; Growth of antiferromagnetic oxide thin films;

Dichroism in X-ray absorption for the study of antiferromagnetic materials; Antiferromagnetic oxide films on non-magnetic substrates; Exchange bias by antiferromagnetic oxides; Theory of ferromagnetic-antiferromagnetic interface coupling; Antiferromagnetic-ferromagnetic oxide multilayers: Fe_3O_4-based systems as a model; Micromagnetic structure-imaging antiferromagnetic domains using soft X-ray microscopy.

The result is a very timely monograph for solid state physicists and chemists, materials scientists, electrical engineers, physicists in industry, and physical laboratory technicians.