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## **Book Reviews**

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### **1 Fullerene Polymers, Synthesis, Properties and Applications**

**by: N. Martín and F. Giacalone**

**Published 2009**

**by Wiley-VCH Verlag GmbH & Co. KGaA**

**P.O. Box 10 11 61, 69451 Weinheim, Boschstrasse 12,**

**69469 Weinheim, Germany, 332pp**

**ISBN: 978-3-527-32282-4 (Hardcover)**

Although polymer science is by now well developed and may be considered perfectly established, this is not the case for polymers containing fullerenes. Only having emerged over the past decade, the combination of fullerenes and polymer chemistry is a new interdisciplinary field aimed at achieving novel fullerene-based architectures with unprecedented properties and a wide range of applications.

Written by an outstanding team of experts in the relevant areas of research, this book is based on a new classification of the different types of fullerene polymers according to their chemical structures.

The book contains 12 chapters, compiling the different types of polymers bearing fullerenes, which have been organised according to the position of the fullerene units within the polymer (side-chain, main-chain, end-capped or star polymers), or, alternatively, focusing on a specific aspect where the combination of fullerenes and polymers has created a new scenario from structural (fullerene-containing helical polymers) or applied (electroactive C<sub>60</sub>-polymer systems or polyfullerene-based organic solar cells) viewpoints. Furthermore, because of the tremendous advance experienced by systems in which fullerenes and polymers are brought together by means of supramolecular interactions, a chapter has been specifically dedicated to this new type of materials governed by non-covalent forces. The mosaic is completed with the presence of two chapters devoted to related chemical systems such as C<sub>60</sub>-based dendrimers and liquid crystals endowed with fullerenes, as well as a final chapter in which the polymers are associated with carbon nanotubes, instead of fullerenes, as another form of carbon nanostructures.

In the book the following chapters are included: Fullerene-containing polymers: an overview, main-chain and side-chain C<sub>60</sub>-polymers, Acrylate and methacrylate C<sub>60</sub>-end-capped polymers, Semi-interpenetrating polymer networks involving C<sub>60</sub>-polymers, Star-shaped polymers with a fullerene core, Fullerene-containing helical polymers, Electroactive C<sub>60</sub>-polymer systems, Polyfullerenes for organic photovoltaics, Fullerene-containing supramolecular polymers, Fullerene-rich dendrons and dendrimers, Liquid crystalline fullerodendrimers and fullero(codendrimers), Polymers based on carbon nanotubes.

They hope that this volume will serve not only the specialists but also as a reference work for a broad audience of non-specialists by gathering together a large part of the extensive literature related to this field.

Covering all aspects, from different classes, to their synthesis and applications in material science, this volume is of great interest to polymer and synthetic chemists, but also for material scientists and industrial chemists.

## **2 Introduction to Polymer Analysis**

**by: T.R. Crompton**

**Published 2009**

**by Smithers Rapra Technology Limited**

**Shawbury, Shrewsbury, Shropshire, SY4 4NR, UK, 418pp**

**ISBN: 978-1-84735-384-9, ISBN: 978-1-84735-385-6**

Practically, all of the major newer analytical techniques (and many of the older classical techniques) have been used to examine plastics and their additive systems. Because so many polymers are now used commercially, it is also advisable when attempting to identify a polymer to initially classify it by carrying out at least a qualitative elemental analysis and possibly a quantitative analysis and, in some cases, depending on the elements found, to carry out functional group analysis.

Identification of a polymer (particularly copolymers or terpolymers) is often not as simple as this, and obtaining a detailed picture of the microstructure of the polymer is necessary. Techniques that may be used, in addition to elemental and functional group analysis, include spectroscopic techniques such as infrared, nuclear magnetic resonance, proton magnetic resonance, and systematic investigations by pyrolysis-gas chromatography.

The following chapters are included in the book:

- Types and properties of polymers: Production of synthetic resins, polycondensation reactions, polymerisation reactions.
- Determination of elements: Non-metallic elements, metals: destructive techniques, non-destructive methods.
- Functional groups: Hydroxy groups, carboxyl groups, ester groups, carbonyl groups, ether groups, alkoxy groups.
- Determination of monomer ratios in copolymers: IR spectroscopy, NMR spectroscopy, pyrolysis-gas chromatography.
- Sequencing of monomer unit in polymers: Sequencing in homopolymers, sequencing in copolymers.
- Stereoisomerism and tacticity: Tacticity of polypropylene, syndiotactic polystyrene (sPS), polyvinyl chloride (PVC), Poly(n-butyl methacrylate).
- Regioisomerism: Polypropylene, propylene-1-ethylene copolymer.
- Determination of end groups: Polypropylene oxide, polyvinyl chloride, Polyethylene, polyethylene terephthalate, polyisobutylene.

- Types of unsaturation: Unsaturation in homopolymers, unsaturation in copolymers, ozonolysis techniques.
- Polymer branching: Spectroscopy, vacuum radiolysis, pyrolysis based techniques, size-exclusion chromatography (SEC).
- Block copolymers.

The book gives a thorough exposition of the current state-of-the-art of polymer analysis and, as such, should be of great interest to those engaged in this subject in industry, university research, and general education. It is also intended for undergraduate and graduate chemistry students, and those taking courses in plastics technology, engineering chemistry, materials science and industrial chemistry. It will be a useful reference work for manufacturers and users of plastics, the food and beverage packing industry, engineering plastics industry, plastic components manufacturers, pharmaceutical industry, and the cosmetics industry.

### **3 Mechanical Behaviour of Materials**

**by: M.A. Meyers and K.K. Chawla**

**Published 2009**

**by Cambridge University Press**

**32 Avenue of the Americas,**

**New York, NY 10013-2473, USA, 880pp**

**ISBN: 978-0-521-86675-0 (hardback)**

Courses in the mechanical behaviour of materials are standard in both mechanical engineering and materials science/engineering curricula. These courses are taught, usually, at the junior or senior level. This book provides an introductory treatment of the mechanical behaviour of materials with a balanced mechanics-materials engineering students. The book covers metals, polymers, ceramics, and composites and contains more than sufficient information for a one-semester course.

This book is a spinoff of a volume titled *Mechanical Metallurgy* written by these authors and published in 1984 by Prentice-Hall. Ceramics, polymers, composites, and intermetallics are nowadays important structural materials for advanced applications and are comprehensively covered in this book. Each chapter contains, at the end, a list of suggested reading: readers should consult these sources if they need to expand a specific point or if they want to broaden their knowledge in an area. All chapters contain solved examples and extensive lists of homework problems. These should be valuable tools in helping the student to grasp the concepts presented.

A balance mechanics-materials approach and coverage of the latest developments in biomaterials and electronic materials, the new edition of this popular text is the most thorough and modern book available for upper-level undergraduate courses on the mechanical behaviour of materials. Kept mathematically simple and with no extensive background in materials assumed, this is an accessible introduction to the subject.

New to this edition:

- Every chapter has been revised, reorganised and updated to incorporate modern materials whilst maintaining a logical flow of theory to follow in class.
- Mechanical principle of biomaterials, including cellular materials, and electronic materials are emphasised throughout.
- A new chapter on environmental effects is included, describing the key relationship between conditions, microstructure and behaviour.
- New homework problems included at the end of every chapter.

In the textbook, the following chapters are included:

- Materials: Structure, properties, and performance: introduction, monolithic, composite, and hierarchical materials, structure of materials, strength of real materials.
- Elasticity and viscoelasticity: introduction, longitudinal stress and strain, strain energy (or deformation energy) density, shear stress and strain, Poisson's ratio, more complex states of stress, graphical solution of a biaxial state of stress: the Mohr circle, pure shear: relationship between  $G$  and  $E$ , anisotropic effects, elastic properties of polycrystals, elastic properties of materials, viscoelasticity, rubber elasticity, Mooney-Rivlin equation, elastic properties of biological materials, elastic properties of electronic materials, elastic constants and bonding.
- Plasticity: introduction, plastic deformation in tension, plastic deformation in compression testing, the Bauschinger effect, plastic deformation of polymers, plastic deformation of glasses, flow, yield, and failure criteria, hardness, formability: important parameters, muscle force, mechanical properties of some biological materials.
- Imperfections: Point and line defects: introduction, theoretical shear strength, atomic or electronic point defects, line defects.
- Imperfections: interfacial and volumetric defects: introduction, grain boundaries, twinning and twin boundaries, grain boundaries in plastic deformation, other internal obstacles, nanocrystalline materials, volumetric or tridimensional defects, imperfections in polymers.
- Geometry of deformation and work-hardening: introduction, geometry of deformation, work-hardening in polycrystals, softening mechanisms, texture strengthening.
- Fracture: Macroscopic aspects: introduction, theoretical tensile strength, stress concentration and Griffith criterion of fracture, Griffith criterion, crack propagation with plasticity, linear elastic fracture mechanics, fracture toughness parameters, importance of  $K_{Ic}$  in practice, post-yield fracture mechanics, statistical analysis of failure strength.
- Fracture: Microscopic aspects: introduction, fracture in metals, fracture in ceramics, fracture in polymers, fracture and toughness of biological materials, fracture mechanism maps.

- Fracture testing: Introduction, impact testing, plane-strain fracture toughness test, crack opening displacement testing, J-integral testing, flexure test, fracture toughness testing of brittle materials, adhesion of thin films to substrates.
- Solid solution, precipitation and dispersion strengthening: introduction, solid-solution strengthening, mechanical effects associated with solid solutions, precipitation- and dispersion-hardening, dislocation-precipitate interaction, precipitation in microalloyed steels, dual-phase steels.
- Martensitic transformation: introduction, structures and morphologies of martensite, strength of martensite, mechanical effects, shape-memory effect, martensitic transformation in ceramics.
- Special materials: Intermetallics and foams: introduction, silicides, ordered intermetallics, cellular materials.
- Creep and superplasticity: introduction, correlation and extrapolation methods, fundamental mechanisms responsible for creep, diffusion creep, dislocation creep, dislocation glide, grain-boundary sliding, deformation-mechanism maps, creep-induced fracture, heat-resistant materials, creep in polymers, diffusion-related phenomena in electronic materials, superplasticity.
- Fatigue: introduction, fatigue parameters and S-N curves, fatigue strength or fatigue life, effect of mean stress on fatigue life, effect of frequency, cumulative damage and life exhaustion, mechanisms of fatigue, linear elastic fracture mechanics applied to fatigue, hysteretic heating in fatigue, environmental effects in fatigue, fatigue crack closure, the two-parameter approach, the short-crack problem in fatigue, fatigue testing.
- Composite materials: introduction, types of composites, important reinforcements and matrix materials, interfaces in composites, properties of composites, load transfer from matrix to fibre, fracture in composites, some fundamental characteristics of composites, functionally graded materials, applications, laminated composites.
- Environmental effects: Introduction, electrochemical nature of corrosion in metals, oxidation of metals, environmentally assisted fracture in metals, environmental effects in polymers, environmental effects in ceramics.

Providing a conceptual understanding by emphasising the fundamental mechanisms that operate a micro- and nanometre level across a wide-range of materials, reinforced through the extensive use of micrographs and illustrations, this is the perfect textbook for a course in mechanical behaviour of materials, in mechanical engineering, and materials science.

**4 Computational Methods for Multiphase Flows in Porous Media****by: Z. Chen, G. Huan and Y. Ma****Published 2006****by SIAM Society for Industrial and Applied Mathematics****3600 Market Street, 6th Floor, Philadelphia,****PA 19104-2688, USA, 549pp****ISBN: 10 978-654-32 Numerical computing**

This book offers a fundamental and practical introduction to the use of computational methods, particularly finite element methods, in the simulation of fluid flow in petroleum reservoirs. In the presentation, the authors have attempted to introduce every concept in the simplest possible setting and to maintain a level of treatment that is as rigorous as possible without being unnecessarily abstract. In developing numerical methods, a brief discussion of the basic concepts has been given in the text as needed, and the reader is referred to appropriate references for more details. They have not attempted to give any mathematical proofs, but rather we review multiphase flow equations and computational methods to introduce the basic terminologies and notation. They have attempted to present a thorough discussion of practical aspects of these subjects in a consistent manner, and to focus on the mathematical formulations of these equations and on applications of the computational methods to their solution.

This book covers four major topics (flow and transport differential equations and their numerical solutions, rock and fluid properties, numerical methods, and linear system solvers), eight applications (single phase flow, two-phase flow, flow of black oil type, volatile oil flow, compositional flow, non-isothermal flow, chemical compositional flow, and flows in fractured porous media), and six special topics (welling modelling, up scaling, history matching, parallel computing, oil recovery optimisation, and surface network systems). Each chapter ends with bibliographical information and exercises.

In the book, the following chapters are included: Introduction: petroleum reservoir simulation, numerical methods, linear system solvers, solution schemes, numerical examples, ground water flow modelling, basin modelling; flow and transport equations: introduction, single phase flow, two-phase immiscible flow, transport of a component in a fluid phase, transport of multicomponents in a fluid phase, the black oil model, a volatile oil model, compositional flow, non-isothermal flow, chemical compositional flow, non-isothermal flow, chemical compositional flow, flows in fractured porous media; Rock and fluid properties: rock properties, fluid properties, temperature-dependent properties; Numerical methods: finite difference methods, standard finite element methods, control volume finite element methods, discontinuous finite element methods, mixed finite element methods, characteristic finite element methods, adaptive finite element methods; Solution of linear systems: tridiagonal systems, Gaussian elimination, ordering of the nodes, CG, GMRES, ORTHOMIN, BiCGSTAB, preconditioned iterations, preconditioners, practical considerations; Single phase flow: basic differential equations, one-dimensional radial flow, finite element methods for single phase flow, bibliographical remarks; Two-phase flow: basic differential equations, one-dimensional flow, IMPES and improved IMPES, alternative differential formulations, numerical methods for two-phase flow, miscible displacement; The black oil model: basic differential equations, solution techniques, comparisons between solution techniques, the second SPE project: coning problems; The compositional model:

basic differential equations, solution techniques, solution of equilibrium relations, the third SPE project: compositional flow; No isothermal flow: basic differential equations, solution techniques, the fourth SPE project: steam injection; Chemical flooding: basic differential equations, surfactant flooding, alkaline flooding, polymer flooding, foam flooding, rock and fluid properties, numerical methods, numerical results, application to a real oilfield; Flows in fractured porous media: flow equations, the sixth SPE project: dual porosity simulation; Well modelling: analytical formulas, finite difference methods, standard finite element methods, control volume finite element methods, mixed finite element methods, well constraints, the seventh SPE project: horizontal well modelling; Special topics: upscaling, history matching, parallel computing, oil recovery optimisation, surface network systems.

Computational science and engineering is widely accepted, along with theory and experiment, as a crucial third mode of scientific investigation and engineering design.

This book can be used as a textbook for graduate and undergraduate students in geology, petroleum engineering, and applied mathematics, and as a reference book for professionals in these fields, and scientists working in the area of petroleum reservoir simulation. It can also be used as a handbook for employees in the oil industry who need to understand modelling and computational methods and by researchers in hydrology, environmental remediation, and some areas of biological tissue modelling.

## **5 Tutorials in Metamaterials**

**by: M.A. Noginov and V.A. Podolskiy**

**Published 2012**

**by CRC Press**

**Taylor & Francis Group, Boca Raton, London,**

**New York, 6000 Broken Sound Parkway, NW,**

**Suite 300, Boca Raton, FL 33487, USA, 293pp**

**ISBN: 978-1-4200-9218-9**

Metamaterials – composite media with unusual optical properties – have revolutionised the landscape of optical science and engineering over the past decades. Metamaterials have transformed science – friction – like concepts of super resolution imaging and optical cloaking to the realm of science laboratories, and further promise to transform these into the realm of our everyday life.

The new era of optical metamaterials calls for the development of experimental and theoretical methods capable of analysing optical behaviour on the multitude of scales, starting from the nanometre scale of individual inhomogeneity, and moving on to the micrometer of the metamaterial, and to an even larger scale of the metamaterials – based device. Future progress in the areas of photonics, plasmocnics, and metamaterials critically depends on our ability to answer this call.

The book contains the following chapters:

- linear and non-linear metamaterials
- fabrication of optical metamaterials
- microwave metamaterials: selected features and sample applications

- dielectric metamaterials
- metamaterials with optical gain
- anisotropic and hyperbolic metamaterials
- radiative decay engineering in metamaterials
- bianisotropic and chiral metamaterials
- spatial dispersion and effective constitutive parameters of electromagnetic metamaterials.

This book is a collection of self-contained tutorials describing metamaterial photonics aimed at upper undergraduates and graduate students, as well as experts in physics and engineering who are willing to familiarise themselves with the state of the art in the metamaterials research. It starts with the most general reviews and progresses to more specialised topics.

**6 Electromagnetic Waves, Materials, and Computation with MATLAB®**  
**by: DK. Kalluri**  
**Published 2012**  
**by CRC Press, Taylor & Francis Group**  
**Boca Raton, London, New York, 6000 Broken Sound Parkway,**  
**NW, Suite 300, Boca Raton, FL 33487, USA, 860pp**  
**ISBN: 978-1-4398-3867-9**

Electromagnetic waves, materials, and computation with MATLAB® takes an integrative modern approach to the subject of electromagnetic analysis by supplementing quintessential ‘old-school’ information and methods with instruction in the use of newer commercial software such as MATLAB® and methods including FDTD.

The following chapters are included:

- *Part I electromagnetics of bounded simple media*: Electromagnetics of simple media, Electromagnetics of simple media: One-dimensional solution, Two-dimensional problems and waveguides, Three-dimensional solutions, Spherical waves and applications, Laplace equation: Static and low-frequency approximations, Miscellaneous topics on waves.
- *Part II Electromagnetic equations of complex media*: Electromagnetic modelling of complex materials, Artificial electromagnetic materials, Waves in isotropic cold plasma: Dispersive medium. Spatial dispersion and warm plasma, Wave in anisotropic media and magnetoplasma, Optical waves in anisotropic crystals, Electromagnetics of moving media.
- *Part III Electromagnetic computation*: Introduction and one-dimensional problems, Two-dimensional problem, Advanced topics on finite-element method, Case study ridged waveguide with many elements, Finite-difference time-domain method, Finite-difference time-domain method simulation of electromagnetic pulse interaction with a switched plasma slab, Approximate analytical methods based on perturbation and variational techniques.

Delving into the electromagnetics of bounded simple media, equations of complex media, and computation, this text includes:

- appendices that cover a wide range of associated issues and techniques
- a concluding section containing an array of problems, quizzes, and examinations
- a downloadable component for instructors including PowerPoint TMI slides, solutions to problems, and more.

Striking a balance between theoretical and practical aspects, internationally recognised expert Dikshitulu Kalluri clearly illustrates how intuitive approximate solutions are derived. Providing case studies and practical examples throughout, he examines the role of commercial software in this process, also covering interpretation of findings. Kalluri's extensive experience teaching this subject enables him to streamline and convey material in a way that helps readers master conceptual mathematical aspects. This gives them confidence in their ability to use high-level software to write code, but it also ensures that they will never be solely dependent on such programmes.