# Book Reviews

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## 1 Integral Materials Modeling, Towards Physics-Based Through-Process Models

**by: G. Gottstein**
**Published 2007**
**by Wiley-VCH Verlag GmbH & Co. KgaA, P.O. Box 10 11 61**
**69451 Weinheim, Boschstrasse 12, 69469 Weinheim, Germany, 295pp**
**ISBN: 978-3-527-31711-0**

This book comprises the proceedings of the final symposium of the Collaborative Research Center (SFB 370) of the Deutsche Forschungs gemeinschaft on '*Integral Materials Modeling*' which took place in Aachen, Germany, on 1–2 December, 2005. It is composed of the final reports of the projects and complementary manuscripts of renowned scientists in the field of materials modelling, covering a broad range of current simulation activities.

The projects are identified by their project numbers in their title. The manuscripts are organised such that after a list of persons involved in the SFB 370 the final through-process modelling exercises (group C) are introduced by the reports on supporting process and materials models (groups A and B) and complemented by the invited contributions. The first paper on '*Integral Materials Modeling*' gives an introduction to the philosophy, history, and 'structure of the coleing' gives an introduction to the philosophy, history, and structure of the collaborative research centre.

The book presents chapters titled:

- Introduction
- Integral materials modelling
- Aluminium through-process modelling: from casting to cup drawing
- From casting to product properties: modelling the process chain of steels
- Status of through-process simulation for coated gas turbine components
- Deformation behaviour of a plastic pipe fitting
- Modelling of flow processes during solidification
- Microstructure modelling during solidification of castings
- Coating of turbine blades
- Hot and cold rolling of aluminium sheet
- Modelling of the hot rolling process of a C45 steel

- Simulation of phase changes during thermal treatments of various metal alloys
- Deep drawing properties of aluminium sheet
- Simulation of stress response to cyclic thermal loading in thermal barrier composites for gas turbines
- Through-process multiscale models for the prediction of recrystallisation textures
- Analytic interatomic potentials for atomic-scale simulations of metals and metal compounds: a brief overview
- Selected problems of phase-field modelling in materials science
- Prediction of microstructure and microporosity development in aluminium gravity casting processes
- Enhanced 3D injection moulding simulation by implementing applied crystallisation models
- Modelling shearing of y′ in Ni-based superalloys
- Minimal free energy density of annealed polycrystals
- Modelling dynamic grain growth and its consequences
- Modelling of severe plastic deformation: evolution of microstructure, texture, and strength.

## 2 Nanotechnology, An Introduction to Nanostructuring Techniques

**by: M. Köhler and W. Fritzsche**
**Published 2004**
**by Wiley-VCH Verlag GmbH & Co. KgaA, P.O. Box 10 11 61**
**69451 Weinheim, Boschstrasse 12, 69469 Weinheim, Germany, 272pp**
**ISBN: 3-527-30750-8**

Microtechnology has changed our lives dramatically. The most striking impact is apparent in computer technology, which is essential for today's industry, and also for our individual lifestyles. Apart from microelectronics, microtechnology influences many other areas. The size of typical structures that is accessible is in the sub-micrometer range, which is at the limits of optical resolution and barely visible with a light microscope.

In nanotechnology, the primary role of classical physical principles is replaced as molecular and atomic dimensions are approached. Physical-technical and chemical aspects influence the fabrication and the use and application of nanotechnical structures on an equal basis. The effects of mesoscopic physics, a field that is influenced by and uses quantum phenomenon, complement these aspects. In contrast to classical chemistry, small ensembles or even individual particles can play a decisive role.

A clear distinction between nanostructures and microstructures is given here arbitrarily using length measurements. Nanostructures are defined according to their geometrical dimensions. This definition addresses technical dimensions, induced by external shaping processes, with the key feature being that the shaping, the orientation

and the positioning are realised relative to an external reference system, such as the geometry of a substrate. Of less importance is whether this process uses geometrical tools, media or other instruments.

The development of the natural sciences created an interest in the microworld, in order to enable a better understanding of the world and the processes therein. Therefore, the development of new microscopic imaging methods represents certain milestones in the natural sciences. The microworld was approached by extending the range available for the direct visualisation of objects through the enhancement of microscopic resolution.

The scientific understanding of the molecular world and the application of quantitative methods laid the foundations of modern chemistry. Before the quantification of chemical reactions, there was already an applied area of chemistry, for example in mining or metallurgy.

With solid materials, it is known that the properties of the surface may differ from the bulk conditions. In the classical case, the number of surface atoms and molecules is small compared with the number of bulk particles. This ratio is inverted in the case of nanoparticles, thin layers and nanotechnical elements. The properties of nanostructures are therefore more closely related to the states of individual molecules, molecules on surfaces than to the properties of the bulk material. Also, the terminology of classical chemistry is not fully applicable to nanostructures. Key terms, such as diffusion, reactivity, reaction rate, turnover and chemical equilibrium, are only defined for vast numbers of particles.

The properties of a material are controlled by the bond strengths between the particles. For shaping and joining, the processes are determined by the strength and direction of positive interactions between the joining surfaces. In classical technology and usually also in microtechnology, a separation between the bonding forces in the bulk material and the surface forces has some significance. Both internal and external bonds are based on interatomic interactions, the chemical bonds. With the dimensions of nanotechnical objects approaching molecular dimensions, a combined consideration of both internal and external interactions of a material with its environment is needed. Besides the spatial separation of a material, the orientation of the internal and the surface bonds also determine the properties of materials or of material compounds.

The book contains the following chapters:

- Introduction
- Molecular basics
- Microtechnological foundations
- Preparation of nanostructures
- Nanotechnical structures
- Characterisation of nanostructures
- Nanotransducers
- Technical nanosystems.

Through this fascinating introduction, both scientists and engineers gain insights into the ‘other side’ of nanotechnology.

**3 Friction Stir Welding and Processing VI, Proceedings of a Symposia Sponsored by the Shaping and Forming Committee of the Materials Processing & Manufacturing Division of TMS (The Minerals, Metals & Materials Society), Held during the TMS 2011 Annual Meeting & Exhibition San Diego, California, USA, February 27–March 3, 2011**
**by: R. Mishra, M.W. Mahoney, Y. Sato, Y. Hovanski and R. Verma**
**Published 2011**
**by John Wiley & Sons, Inc. Hoboken, New Jersey**
**111 River Street, Hoboken, NJ 07030-5774, USA, 431pp**
**ISBN: 978-1-11800-201-8**

Friction stir welding is a solid state joining process. It was developed and patented by TWI Ltd., UK and is capable of welding a great number of materials. These are not limited to standard light metals like A1 and Mg but also include Pb, Ti, Cu, Zn, steels [2, 3] and especially hard to weld alloys.

Although there is growing interest in FSW of steels, much of the research to date has been feasibility studies. Recently, there have been several investigations focused on developing correlations between process parameters and post-weld microstructure.

Investigating the microstructural evolution in FSW of steels is challenging. Compounding the complexity of non-uniform material flow is the allotropic phase transformation present in steels. Phase transformations not only induce internal stresses, but they mask the thermal/mechanical history of the elevated temperature phase. The combination of these makes it difficult to characterise the evolution of microstructure in FSW of steels.

Friction stir welding (FSW) is a relatively mature solid state joining technology that can be used to weld most aluminium alloys, including those that are difficult to weld using conventional fusion-based processes. This technology is of particular interest for transport applications, since welded structures are considered to offer cost and weight savings. Most commercial FSW applications use simple butt joint configurations and alternative designs such as T-sections, corner welds, box sections.

The tool material is critical in FSW of high-softening-temperature materials. The tool should meet significant requirements, i.e., it must maintain sufficient strength to constrain the material to be welded at the softening temperature, and also be resistant to fatigue, fracture, mechanical wear, and chemical reactions with both the atmosphere and the weld material.

The process is carried out by plunging a rotating tool into the material and translating it along the weld line. Heat is generated by friction at the tool surface and plastic dissipation. This softens the material to plasticised state. The material is then extruded around the tool pin and forms a weld.

The conventional tool design consists of a shoulder and a pin. An alternative design is called bobbin tools. These include a second shoulder attached to the end of the pin.

The book contains the following chapters:

- High temperature materials I
- High temperature materials II
- Aluminium and magnesium alloys I

- Aluminium and magnesium alloys II
- Friction stir processing
- Process modelling and verification
- Friction stir spot welding.

## 4 Smart Material Systems, Model Development

**by: R.C. Smith**
**Published 2005**
**by SIAM Society for Industrial and Applied Mathematics**
**3600 University City Science Center, Philadelphia**
**PA 19104-2688, USA, 501pp**
**ISBN: 0-89871-583-0**

In the present volume, the author discusses mathematical and modelling foundations for all of the basic types of material systems that make up the field of smart materials and structures. Notable features of the present volume include careful attention to on linear physically-based models exhibiting significant hysteresis (and the resulting damping) as well as treatment of numerical approximation techniques appropriate for both estimation and control design.

The field of smart materials and structures is relatively new and is known by several names: adaptronics, adaptive structures, intelligent material systems and structures, smart materials and structures and combinations of these words. Several conferences a year have been devoted to these topics since the first one was held approximately 15 years ago.

In this volume, the author current and future applications of advanced smart material systems. The text provides a comprehensive development of both linear and nonlinear models required to characterise these materials in a manner that facilitates design and control development. While the focus is primarily on piezoelectric, magnetic and shape memory material systems, the text also includes applications exploiting ionic polymers, magneto-rheological compounds and fibre optic sensors. Three classes of nonlinear models are discussed, all of which provide unified characterisation frameworks for the broad class of combined smart material systems. The book includes an extensive development of structural models based on the nonlinear constitutive models as well as a chapter on numerical techniques for approximating solutions to the structural systems.

The book contains the following chapters:

- Smart material applications
- Model development for ferroelectric compounds
- Model development for relaxor ferroelectric compounds
- Model development for ferromagnetic compounds
- Model development for shape memory alloys
- Unified modelling frameworks for ferroic compounds

- Rod, beam, plate and shell models
- Numerical techniques, glossary of terms
- Mathematical theory
- Legendre transforms, calculus of variations, mechanics
- Inversion algorithm.

In summary, this monograph will surely be of significant use to researchers and students in the engineering and material sciences as well as those in applied mathematics who are interested in modelling smart materials and structures.

## 5 Principles of Computerized Tomographic Imaging, by: A.C. Kak and M. Slaney Published 2001 by SIAM Society for industrial and applied mathematics 3600 University City Science Center, Philadelphia PA 19104-2688, USA, 327pp ISBN 10: 0-89871-494-X ISBN 13: 978-0-898714-94-4

*Principles of Computerized Tomographic Imaging* provides a comprehensive, tutorial-style introduction to the algorithms for reconstructing cross-sectional images from projection data and contains a complete overview of the engineering and signal processing algorithms necessary for tomographic imaging. In addition to the purely mathematical and algorithmic aspects of these algorithms, this book also discusses the artefacts caused by the nature of the various forms of energy sources that can be used for generating the projection data. Kak and Slaney go beyond theory, emphasising real-world applications and detailing the steps necessary for building a tomographic system.

Since the fundamental aspects of tomographic reconstruction algorithms have remained virtually the same since this book was originally published, it is just as useful today as it was in 19787. It explains, among other things, what happens when there is excessive noise in the projection data; when images are formed from insufficient projection data; and when refracting or diffracting energy sources are used for imaging.

The book contains the following chapters:

- *Introduction, signal processing fundamentals*: One-dimensional signal processing, image processing, references.
- *Algorithms for reconstruction with nondiffracting sources*: Line integrals and projections, the Fourier slice theorem, reconstruction algorithms for parallel projections, reconstruction from fan projections, fan beam reconstruction from a limited number of views, three-dimensional reconstructions, bibliographic notes.
- *Measurement of projection data – the nondiffracting case*: X-ray tomography, emission computed tomography, ultrasonic computed tomography, magnetic resonance imaging.
- Aliasing artefacts and noise in CT images.

- *Tomographic imaging with diffracting sources*: Diffracted projections, approximations to the wave equation, the Fourier diffraction theorem, interpolation and a filtered backpropagation algorithm for diffracting sources, limitations, evaluation of reconstruction algorithms, experimental limitations.
- *Algebraic reconstruction algorithms*: Image and projection representation, (ART) algebraic reconstruction techniques, (SIRT) simultaneous iterative reconstructive technique, (SART) simultaneous algebraic reconstruction technique.
- *Reflection tomography*: Introduction, b-scan imaging, reflection tomography, reflection tomography with point transmitter/receivers.

Beginning graduate students or practitioners wishing to see the development of the algorithm from the ground up, as well as anyone interested in cross-sectional imaging for a wide variety of applications, will find this book extremely useful.

## 6 Photovoltaic, Systems Engineering, Third Edition by: R.A. Messenger and J.Ventre Published 2010 by CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742, USA, 503pp ISBN: 978-1-4398-0292-2

With this fact in mind, photovoltaic systems engineering, third edition presents a comprehensive engineering basis for photovoltaic (PV) system design, so engineers can understand the what, why, and how associated with the electrical, mechanical, economic, and aesthetic aspects of PV system design. Building on the popularity of the first two editions, esteemed authors Roger Messenger and Jerry Ventre explore the significant growth and new ideas in the PV industry. They integrate their experience in system design and installation gained since publication of the last edition.

The book educates the reader about the design of PV systems so that when engineering judgement is needed, the engineer can make intelligent decisions based on a clear understanding of the parameters involved. This goal differentiates this textbook from the many design and installation manuals that train the reader how to make design decisions, but now why.

The following chapters are included in the book:

- *Background*: Introduction, population and energy demand, energy units, current world energy use patterns, exponential growth, Hubert's Gaussian model, net energy, direct conversion of sunlight.
- *The sun*: Introduction, the solar spectrum, the effect of the atmosphere on sunlight, sunlight specifics, capturing sunlight, special orientation considerations.
- *Introduction to PV systems*: Introduction, the PV cell, the PV module, the PV array, energy storage, PV system loads, PV system availability, associated system electronic components, generators, generator maintenance, generator selection, balance of system (BOS) components.

- *Grid-connected utility-interactive PV systems*: Introduction, applicable codes and standards, design considerations for straight grid-connected PV systems, design of a system based on desired annual system performance, module selection, balance of system, design of a system based on available roof space, design of a microinverter-based system, design of a nominal 21 kW systems that feed a three-phase, design of a nominal 250 kW system, system performance monitoring.
- *Mechanical considerations*: Important properties of materials, establishing mechanical system requirements, design and installation guidelines, array mounting system design, computing mechanical loads and stresses, stand-off, roof mount examples.
- *Battery-backup grid-connected PV systems*: Introduction, battery-backup design basics, a single-inverter 120 V battery-backup system based, V battery-backup system based on available roof space, battery-backup system using inverters in tandem, AC-coupled battery-backup systems, battery connections.
- *Stand-alone PV systems*: Introduction, the simplest configuration: module and fan, PV-powered water-pumping system, PV-powered parking lot lighting system, cathodic protection system, portable highway advisory sign, critical-need refrigeration system, PV-powered mountain cabin, hybrid-powered, off-grid residence, summary of design procedures.
- *Economic considerations*: Introduction, life-cycle costing, borrowing money, payback analysis, externalities.
- *Externalities and photovoltaics*: Introduction, externalities, environmental effects of energy sources, externalities associated with PV systems.
- *The physics of photovoltaic cells*: Introduction, optical absorption, extrinsic semiconductors and the PN junction, maximising PV cell performance, exotic junctions.
- *Present and proposed PV cells and systems*: Introduction, silicon PV cells, gallium arsenide cells, copper indium (gallium) diselenide cells, cadmium telluride cells, emerging technologies, new developments in system design.

Also useful for students, the text is full of additional practical considerations added to the theoretical background associated with mechanical and structural design. A modified top-down approach organises the material to quickly cover the building blocks of the PV system. The focus is on adjusting the parameters of PV systems to optimise performance. The last two chapters present the physical basis of PV cell operation and optimisation.

Presenting new problems based upon contemporary technology, this book covers a wide range of topics-including chemistry, circuit analysis, electronics, solid state device theory, and economics. It will become a relied upon addition to any engineering library.