

QUANTITATIVE DESCRIPTION OF THE MICROSTRUCTURE OF SINTERED MATERIALS

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Summary:

Sintered materials contain particles, grains and pores, interphase and grain boundaries. Depending on the details of the technological route they differ in the amount and the distribution of these elements. Such differences can be now analysed in a quantitative way using the methods of image analysis and stereology. In particular, these methods provide estimates of the number of microstructural elements of a given size (e.g. number of particles per unit volume), their shape (if applicable), and their spatial distribution. The paper describes methodology of these measurements, and how the results can be applied to optimise microstructure of sintered specimens.

Keywords:

Sintered materials, microstructure, quantitative description

1. Introduction:

Sintering is an economic technology for a growing number of ceramic and metal parts (1). On the other hand, one of the significant drawbacks of sintered materials is their reduced plasticity. As the properties of materials depend strongly on their microstructure, their fracture toughness can be improved by microstructure design. This, in turn, requires proper methods for quantification of the microstructural elements of sintered materials.

The major elements of the microstructure of the sintered materials are:

- a) grains (G) and grain boundaries (GB);
 - b) pores (P) and pore-solid boundaries (PSB);
 - c) strengthening particles (SP) and interphase boundaries (IB).
- Pores, grains and particles are 3-dimensional elements, while internal boundaries are 2-dimensional features dispersed in volume of a material in

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G. Petzow



Quantitative Description Of The Microstructure Of Materials:

The Quantitative Description of the Microstructure of Materials Krzysztof Jan Kurzydowski, Brian Ralph, 1995-07-21 This book the product of a deep collaboration between the two authors strikes a balance between the traditional approach and newly emerging techniques used to obtain a quantitative description of the microstructure of materials The Quantitative Description of the Microstructure of Materials has a unique format that sets it apart from other books The first half of the book gives a comprehensive account of the entire quantification process and presents material in a pedagogical style Numerous examples appear throughout text to illustrate the methodology A general introduction to the subject and basic concepts definitions techniques and relationships are provided Aspects of modern stereology are described in detail Image processing computer aided procedures of data analysis and the elements of a system for image analysis also are discussed at length The remaining chapters treat a series of significant examples in much more detail This part of text offers information in an easy to access reference style making it extremely useful as a guide to active researchers in the quantification guide Topics include dislocations internal and external surfaces and quantitative characterization of thin film structures The book covers geometry of grains and its effect on the properties of polycrystals Particles pores and other isolated volumetric elements of the microstructure also are discussed

Image Analysis Leszek Wojnar, 2019-08-21 Minimizing theoretical background and mathematical formalism Image Analysis sets forth the basic principles of image acquisition enhancement measurements and interpretation in a very simple form focused on applications and the properties of available tools The author lists different tasks and offers complete solutions to these tasks based on his extensive experience with the procedures described The book provides a multitude of illustrations drawings and bitmaps and serves as an outstanding resource for specialists using image analysis equipment including technicians and students

Hierarchical Materials Informatics Surya R. Kalidindi, 2015-08-06 Custom design manufacture and deployment of new high performance materials for advanced technologies is critically dependent on the availability of invertible high fidelity structure property processing SPP linkages Establishing these linkages presents a major challenge because of the need to cover unimaginably large dimensional spaces Hierarchical Materials Informatics addresses objective computationally efficient mining of large ensembles of experimental and modeling datasets to extract this core materials knowledge Furthermore it aims to organize and present this high value knowledge in highly accessible forms to end users engaged in product design and design for manufacturing efforts As such this emerging field has a pivotal role in realizing the goals outlined in current strategic national initiatives such as the Materials Genome Initiative MGI and the Advanced Manufacturing Partnership AMP This book presents the foundational elements of this new discipline as it relates to the design development and deployment of hierarchical materials critical to advanced technologies Addresses a critical gap in new materials research and development by presenting a rigorous statistical framework for the quantification of microstructure Contains several case studies

illustrating the use of modern data analytic tools on microstructure datasets both experimental and modeling *Modelling of Materials Processing* Gregory C. Stangle, 2013-11-27 This is a book about mathematical modelling It focuses on the modelling of the preparation of materials Materials are important of course in an economic sense the goods of goods and services are made of materials This provides a strong incentive to produce good materials and to improve existing materials Mathematical modelling can help in this regard Without a doubt modelling a materials processing operation is not strictly necessary Materials synthesis and fabrication processes certainly existed before the invention of mathematics and computers and well before the combined use of mathematics and computers Modelling can however be of assistance if done properly and if used properly The mathematical modelling described in this book is at its root a rather formal structured way of thinking about materials synthesis and fabrication processes It requires looking at a process as a whole It requires considering everything that is or might be important It requires translating the details of a given physical process into one or more mathematical equations It requires knowing how to simplify the equations without over simplifying them

Microstructural Characterisation of Fibre-Reinforced Composites John Summerscales, 1998-07-10 Over the last 50 years great progress has been made in developing artificial fibre reinforced composite materials generally using filaments with microscopic diameters A wide range of reinforcement forms from random arrays to fully aligned can be used for commercial applications with the microstructure being a critical factor in realising the required properties in a material This is the first up to date review of how to apply advanced microstructural characterisation techniques to fibre reinforced composites Each chapter is designed to offer both a stand alone introduction to its topic and detailed referencing for follow up research With contributions from experts from around the world the book will be an essential reference for materials scientists and research workers in industry and academia alike Comprehensive and up to date review of the microstructural features of composites Covers a wide range of microstructure characterisation techniques Materials Metrology and Standards for Structural Performance B.F. Dyson, S. Loveday, M.G. Gee, 2012-12-06 This is a contributed reference work from international authors from both industry and academia It deals with materials metrology and standards for engineering design This includes examination of metrological considerations as well as investigating the many measurement and control techniques It will be of interest to all materials scientists and engineers from graduates to experienced professionals and will be particularly useful to all those involved with measurement instrumentation **Mechanical Properties of Ceramics and Composites** Roy W. Rice, 2000-04-18 This book presents a comprehensive review evaluation and summary of the dependence of mechanical properties on grain and particle parameters of monolithic ceramics and ceramic composites Emphasizing the critical link between fabrication and ceramic performance the book covers the grain dependence of monolithic properties and the dependence of ceramic composite properties on grain and particulate parameters It includes theoretical and conceptual background pertinent models experimental results a data review discussion and a summary or recommendations Illustrations

feature microstructural details while graphs plot data on material hardness compressive strength and other pivotal variables

Materials Research Capabilities, Materials Division Lewis Research Center. Materials Division, 1986 Corrosion Science and Technology David E.J. Talbot, James D.R. Talbot, 2018-01-29 Twenty years after its first publication *Corrosion Science and Technology* continues to be a relevant practical guide for students and professionals interested in material science This Third Edition thoroughly covers the basic principles of corrosion science in the same reader friendly manner that made the previous edition invaluable and enlarges the scope of the content with expanded chapters on processes for various metals and new technologies for limiting costs and metal degradation in a variety of commercial enterprises not explored in previous editions This book also presents expertly developed methods of corrosion testing and prediction

Computational Modelling of Biomechanics and Biotribology in the Musculoskeletal System Z Jin, 2014-05-05 *Computational Modelling of Biomechanics and Biotribology in the Musculoskeletal System* reviews how a wide range of materials are modelled and how this modelling is applied Computational modelling is increasingly important in the design and manufacture of biomedical materials as it makes it possible to predict certain implant tissue reactions degradation and wear and allows more accurate tailoring of materials properties for the in vivo environment Part I introduces generic modelling of biomechanics and biotribology with a chapter on the fundamentals of computational modelling of biomechanics in the musculoskeletal system and a further chapter on finite element modelling in the musculoskeletal system Chapters in Part II focus on computational modelling of musculoskeletal cells and tissues including cell mechanics soft tissues and ligaments muscle biomechanics articular cartilage bone and bone remodelling and fracture processes in bones Part III highlights computational modelling of orthopedic biomaterials and interfaces including fatigue of bone cement fracture processes in orthopedic implants and cementless cup fixation in total hip arthroplasty THA Finally chapters in Part IV discuss applications of computational modelling for joint replacements and tissue scaffolds specifically hip implants knee implants and spinal implants and computer aided design and finite element modelling of bone tissue scaffolds This book is a comprehensive resource for professionals in the biomedical market materials scientists and mechanical engineers and those in academia Covers generic modelling of cells and tissues modelling of biomaterials and interfaces biomechanics and biotribology Discusses applications of modelling for joint replacements and applications of computational modelling in tissue engineering *Metallographic Etching, 2nd Edition* G. Petzow, 1999-01-01 An English translation of the 1994 second edition this book is an outstanding source of etchants of all types and electrolytic polishing solutions used by metallographers to reveal the structure of nearly any material ever prepared and examined The introductory text on specimen preparation and theory of etching has been expanded and updated to cover all common procedures as well as some infrequently used methods Safety procedures and precautions is a valuable addition as well **Advanced Light Alloys and Composites** R. Ciach, 1998-09-30 An expert exposition of the structural and mechanical properties of light alloys and composites bridging

the gap between scientists and industrial engineers in its consideration of advanced light materials their structure properties technology and application Includes basic problems of alloy constitution and phase transformations The aluminium alloys are the main topic of the book consideration being given to their properties casting technology thermomechanical treatment and structure Attention is also given to the magnesium alloys particularly those having rare earth metal constituents Both commercial titanium alloys and intermetallic compounds are discussed as are metallic composites The latest engineering techniques are discussed in both theoretical and practical terms

Encyclopedia of Agrophysics Jan Gliński, Józef Horabik, Jerzy Lipiec, 2011-06-07 This Encyclopedia of Agrophysics will provide up to date information on the physical properties and processes affecting the quality of the environment and plant production It will be a first up volume which will nicely complement the recently published Encyclopedia of Soil Science November 2007 which was published in the same series In a single authoritative volume a collection of about 250 informative articles and ca 400 glossary terms covering all aspects of agrophysics will be presented The authors will be renowned specialists in various aspects in agrophysics from a wide variety of countries Agrophysics is important both for research and practical use not only in agriculture but also in areas like environmental science land reclamation food processing etc Agrophysics is a relatively new interdisciplinary field closely related to Agrochemistry Agrobiology Agroclimatology and Agroecology Nowadays it has been fully accepted as an agricultural and environmental discipline As such this Encyclopedia volume will be an indispensable working tool for scientists and practitioners from different disciplines like agriculture soil science geosciences environmental science geography and engineering

[Practical Guide to Image Analysis](#) ASM International, John J. Friel, 2000-01-01 Nine international specialists contribute information about the use of image analysis procedures to evaluate microstructural features Coverage includes an historical overview of how quantitative image analysis developed the evolution of current television computer based analysis systems the scien

Characterization of Minerals, Metals, and Materials 2013 Jiann-Yang Hwang, Chengguang Bai, John S. Carpenter, Shadia Ikhmayies, Bowen Li, Sergio Neves Monteiro, Zhiwei Peng, Mingming Zhang, 2013-02-01 This collection of proceedings from one of the most popular TMS symposia explores the current progress in the characterization of materials Addressing technologies applications and innovative research these papers cover definitions of ferrous and nonferrous metals and alloys minerals advanced and soft materials and inorganic materials Extraction and environmental applications as well as surface joint and processing of metals This is a valuable reference for scientists and engineers working with materials in the minerals metals and materials industry

Information Technologies in Biomedicine Ewa Pietka, Jacek Kawa, 2010-05-29 Information Technology in Biomedicine is an interdisciplinary research area that bridges the gap between tethodological achievements in engineering and clinical requirements in medical diagnosis and therapy In this book members of the academic society of technical and medical background present their research results and clinical implementation in order to satisfy the functional requirements of

authorized physicians for the benefit of the patients An extended area is covered by the articles It includes biomedical signals medical image processing computer aided diagnosis and surgery biometrics healthcare and telemedicine biomechanics biomaterials bioinformatics Section on bronchoscopy presents the basis as well as new research studies performed in this field Papers present various theoretical approaches and new methodologies based on fuzzy sets mathematical statistics mathematical morphology fractals wavelets syntactic methods artificial neural networks graphs and many others Metallic Materials with High Structural Efficiency Oleg N. Senkov, Daniel B. Miracle, Sergey A. Firstov, 2006-04-11 In the fall of 1998 Prof Sergey Firstov invited me to the Frantcevykh Institute for Problems of Materials Science IPMS in Kyiv Ukraine to discuss possible collaborations in the area of advanced metals research During this visit a strong mutual interest was evident in a broad range of structural metals technologies and a quick friendship was established Countless subsequent emails and a reciprocal visit to the U S Air Force Research Laboratory by Prof Firstov and a team of scientists from IPMS ensued to discuss and detail a broad collaboration in the area of structural metals Two years after the initial visit a major investment by the U S Air Force Office of Scientific Research AFOSR was established to pursue the technologies defined by these interactions The annual reviews of the AFOSR Ukrainian Metals Initiative were held in late May a most beautiful time in Kyiv when the lilacs are in bright display and the air is scented with the smell of falling blossoms from the chestnut trees that line the major streets and many parks The sunny days and mild evenings provide a welcome break from winter and on weekend evenings festive crowds spill onto the Khreshchatyk Kyiv s downtown boulevard to listen to street musicians watch jugglers and comedians or simply to celebrate with friends The annual reviews featured long days of intensive discussion of technical progress followed in the evenings by the warm hospitality of the Ukrainian hosts *Proceedings of the American Society for Composites 2014-Twenty-ninth Technical Conference on Composite Materials* Hyonny Kim, D. Whisler, Z.M. Chen, C. Bisagni, M. Kawai, R. Krueger, 2014-09-17 New and not previously published U S and international research on composite and nanocomposite materials Focus on health monitoring diagnosis multifunctionality self healing crashworthiness integrated computational materials engineering ICME and more Applications to aircraft armor bridges ships and civil structures This fully searchable CD ROM contains 270 original research papers on all phases of composite materials presented by specialists from universities NASA and private corporations such as Boeing The document is divided into the following sections Aviation Safety and Aircraft Structures Armor and Protection Multifunctional Composites Effects of Defects Out of Autoclave Processing Sustainable Processing Design and Manufacturing Stability and Postbuckling Crashworthiness Impact and Dynamic Response Natural Biobased and Green Integrated Computational Materials Engineering ICME Structural Optimization Uncertainty Quantification NDE and SHM Monitoring Progressive Damage Modeling Molecular Modeling Marine Composites Simulation Tools Interlaminar Properties Civil Structures Textiles The CD ROM displays figures and illustrations in articles in full color along with a title screen and main menu screen Each user can link to all papers from the

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Materials Andreas Mortensen,2006-12-08 Concise Encyclopedia of Composite Materials draws its material from the award winning Encyclopedia of Materials Science and Technology and includes updates and revisions not available in the original set This customized collection of articles provides a handy reference for materials scientists and engineers with an interest in composite materials made from polymers metals ceramics carbon biocomposites nanocomposites wood cement fibers etc Brings together articles from the Encyclopedia of Materials Science extensive bibliographies cross referencing and indexes guide the user to the most relevant reading in the primary literature Covers areas of active research such as biomaterials and porous materials **Functionally Graded Materials** Y. Miyamoto,W.A. Kaysser,B.H. Rabin,A. Kawasaki,R.G.

Ford,2013-11-27 Seven years have elapsed since Dr Renee Ford editor in chief of Materials Technology first suggested to me to publish a book on Functionally Graded Materials FGMs She said that the FGM concept then largely unknown outside of Japan and a relatively few laboratories elsewhere would be of great interest to everyone working in the materials field because of its potentially universal applicability There was no book about FGMs in English at that time although the number of research papers review articles and FGM conference proceedings had been increasing yearly We discussed what the book should cover and decided it should present a comprehensive description from basic theory to the most recent applications of FGMs This would make it useful both as an introduction to FGMs for those simply curious about what this new materials field was all about and also as a textbook for researchers engineers and graduate students in various material fields The FGM Forum in Japan generously offered to support this publication program is very difficult for an individual author to write a book that Because it covers such a wide range of various aspects of many different materials I invited more than 30 eminent materials scientists throughout the world who were associated with FGM research to contribute selected topics I also asked several leading researchers in this field to edit selected chapters Dr Barry H Rabin then at the U S

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