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Analysis of the mechanical performance of pin-reinforced sandwich structures Mohamed Adli Dimassi 2019-11-15 The rising demand to reduce fuel consumption and the continuous increase of materials and manufacturing costs has obliged aircraft manufacturers to boost the use of composite materials and to optimise the manufacturing methods. Foam core sandwich structures combine the advantages of high bending properties with low manufacturing costs when liquid composite processes are used. However, the use of foam core sandwich structures is not widespread in aircraft applications due to the better weight-specific performance of honeycomb cores and the susceptibility to impact loading. In this context, pin reinforcements are added to the foam core to improve its mechanical properties and its damage tolerance. This work contributes to the understanding of the mechanical behaviour of pin-reinforced foam core sandwich structures under static and impact loading. Ultrasonic scan and micro-computed tomography are used to identify the different damage modes. The effect of very low temperature on the damage behaviour under impact loading is investigated. An explicit simulation model to predict the impact response of pin-reinforced foam core sandwich structures is also proposed.
Multi-Scale Continuum Mechanics Modelling of Fibre-Reinforced Polymer Composites Wim Van Paepegem 2020-11-25 Multi-scale modelling of composites is a very relevant topic in composites science. This is illustrated by the numerous sessions in the recent European and International Conferences on Composite Materials, but also by the fast developments in multi-scale modelling software tools, developed by large industrial players such as Siemens (Virtual Material Characterization toolkit and MultiMechanics virtual testing software), MSC/e-Xstream (Digimat software), Simulia (micromechanics plug-in in Abaqus), HyperSizer (Multi-scale design of composites), Altair (Altair Multiscale Designer) This book is intended to be an ideal reference on the latest advances in multi-scale modelling of fibre-reinforced polymer composites, that is accessible for both (young) researchers and end users of modelling software. We target three main groups: This book aims at a complete introduction and overview of the state-of-the-art in multi-scale modelling of composites in three axes: • ranging from prediction of homogenized elastic properties to nonlinear material behaviour • ranging from geometrical models for random packing of unidirectional fibres over meso-scale geometries for textile composites to orientation tensors for short fibre composites • ranging from damage modelling of unidirectionally reinforced composites over textile composites to short fibre-reinforced composites The book covers the three most important scales in multi-scale modelling of composites: (i) micro-scale, (ii) meso-scale and (iii) macro-scale. The nano-scale and related atomistic and molecular modelling approaches are deliberately excluded, since the book wants to focus on continuum mechanics and there are already a lot of dedicated books about polymer nanocomposites. A strong focus is put on physics-based damage modelling, in the sense that the chapters devote attention to modelling the different damage mechanisms (matrix cracking, fibre/matrix debonding, delamination, fibre fracture,...) in such a way that the underlying physics of the initiation and growth of these damage modes is respected. The book also gives room to not only discuss the finite element based approaches for multi-scale modelling, but also much faster methods that are popular in industrial software, such as Mean Field Homogenization methods (based on Mori-Tanaka and Eshelby solutions) and variational methods (shear lag theory and more advanced theories). Since the book targets a wide audience, the focus is put on the most common numerical approaches that are used in multi-scale modelling. Very specialized numerical methods like peridynamics modelling, Material Point Method, eXtended Finite Element Method (XFEM), isogeometric analysis, SPH (Smoothed Particle Hydrodynamics),... are excluded. Outline of the book The book is divided in three large parts, well balanced with each a similar number of chapters:
Topology-Based Modeling of Textile Structures and Their Joint Assemblies Yordan Kyosev 2018-12-13 This book presents the textile-, mathematical and mechanical background for the modelling of fiber based structures such as yarns, braided and knitted textiles. The hierarchical scales of these textiles and the structural elements at the different levels are analysed and the methods for their modelling are presented. The author reports about problems, methods and algorithms and possible solutions from his twenty year experience in the modelling and software development of CAD for textiles.
The Structural Integrity of Carbon Fiber Composites Peter W. R Beaumont 2016-11-26 This book brings together a diverse compilation of inter-disciplinary chapters on fundamental aspects of carbon fiber composite materials and multi-functional composite structures: including synthesis, characterization, and evaluation from the nano-structure to structure meters in length. The content and focus of contributions under the umbrella of structural integrity of composite materials embraces topics at the forefront of composite materials science and technology, the disciplines of mechanics, and development of a new predictive design methodology of the safe operation of engineering structures from cradle to grave. Multi-authored papers on multi-scale modelling of problems in material design and predicting the safe performance of engineering structure illustrate the inter-disciplinary nature of the subject. The book examines topics such as Stochastic micro-mechanics theory and application for advanced composite systems Construction of the evaluation process for structural integrity of material and structure Nano- and meso-mechanics modelling of structure evolution during the accumulation of damage Statistical meso-mechanics of composite materials Hierarchical analysis including "age-aware," high-fidelity simulation and virtual mechanical testing of composite

structures right up to the point of failure. The volume is ideal for scientists, engineers, and students interested in carbon fiber composite materials, and other composite material systems.
Constitutive Modeling of Soils and Rocks Pierre-Yves Hicher 2013-03-01 This title provides a comprehensive overview of elastoplasticity relating to soil and rocks. Following a general outline of the models of behavior and their internal structure, each chapter develops a different area of this subject relating to the author's particular expertise. The first half of the book concentrates on the elastoplasticity of soft soils and rocks, while the second half examines that of hard soils and rocks.
Clay-Polymer Nanocomposites Khouloud Jlassi 2017-07-26 Clay–Polymer Nanocomposites is a complete summary of the existing knowledge on this topic, from the basic concepts of synthesis and design to their applications in timely topics such as high-performance composites, environment, and energy issues. This book covers many aspects of synthesis such as in- situ polymerization within the interlamellar spacing of the clays or by reaction of pristine or pre-modified clays with reactive polymers and prepolymers. Indeed, nanocomposites can be prepared at industrial scale by melt mixing. Regardless the synthesis method, much is said in this book about the importance of theclay pre-modification step, which is demonstrated to be effective, on many occasions, in obtaining exfoliated nanocomposites. Clay–Polymer Nanocomposites reports the background to numerous characterization methods including solid state NMR, neutron scattering, diffraction and vibrational techniques as well as surface analytical methods, namely XPS, inverse gas chromatography and nitrogen adsorption to probe surface composition, wetting and textural/structural properties. Although not described in dedicated chapters, numerous X-ray diffraction patterns of clay–polymer nanocomposites and reference materials are displayed to account for the effects of intercalation and exfoliations of layered aluminosilicates. Finally, multiscale molecular simulation protocols are presenting for predicting morphologies and properties of nanostructured polymer systems with industrial relevance. As far as applications are concerned, Clay–Polymer Nanocomposites examines structural composites such as clay–epoxy and clay–biopolymers, the use of clay–polymer nanocomposites as reactive nanocomposite fillers, catalytic clay-(conductive) polymers and similar nanocomposites for the uptake of hazardous compounds or for controlled drug release, antibacterial applications, energy storage, and more. The most comprehensive coverage of the state of the art in clay–polymer nanocomposites, from synthesis and design to opportunities and applications Covers the various methods of characterization of clay–polymer nanocomposites - including spectroscopy, thermal analyses, and X-ray diffraction Includes a discussion of a range of application areas, including biomedicine, energy storage, biofouling resistance, and more
Models, Databases and Simulation Tools Needed for Realization of Integrated Computational Mat. Eng. (ICME 2010) Steven M. Arnold and Terry T. Wong, Editors 2014-05-14
Multiscale Modeling of Heterogeneous Structures Jurica Sori? 2017-11-30 This book provides an overview of multiscale approaches and homogenization procedures as well as damage evaluation and crack initiation, and addresses recent advances in the analysis and discretization of heterogeneous materials. It also highlights the state of the art in this research area with respect to different computational methods, software development and applications to engineering structures. The first part focuses on defects in composite materials including their numerical and experimental investigations; elastic as well as elastoplastic constitutive models are considered, where the modeling has been performed at macro- and micro levels. The second part is devoted to novel computational schemes applied on different scales and discusses the validation of numerical results. The third part discusses gradient enhanced modeling, in particular quasi-brittle and ductile damage, using the gradient enhanced approach. The final part addresses thermoplasticity, solid-liquid mixtures and ferroelectric models. The contents are based on the international workshop “Multiscale Modeling of Heterogeneous Structures” (MUMO 2016), held in Dubrovnik, Croatia in September 2016.
Handbook of Dynamic System Modeling Paul A. Fishwick 2007-06-01 The topic of dynamic models tends to be splintered across various disciplines, making it difficult to uniformly study the subject. Moreover, the models have a variety of representations, from traditional mathematical notations to diagrammatic and immersive depictions. Collecting all of these expressions of dynamic models, the Handbook of Dynamic System Modeling explores a panoply of different types of modeling methods available for dynamical systems. Featuring an interdisciplinary, balanced approach, the handbook focuses on both generalized dynamic knowledge and specific models. It first introduces the general concepts, representations, and philosophy of dynamic models, followed by a section on modeling methodologies that explains how to portray designed models on a computer. After addressing scale, heterogeneity, and composition issues, the book covers specific model types that are often characterized by specific visual- or text-based grammars. It concludes with case studies that employ two well-known commercial packages to construct, simulate, and analyze dynamic models. A complete guide to the fundamentals, types, and applications of dynamic models, this handbook shows how systems function and are represented over time and space and illustrates how to select a particular model based on a specific area of interest.
Simulation of damage mechanisms in weave reinforced materials based on multiscale modeling Naake, Dominik Robert 2020-09-18 A weave reinforced composite material with a thermoplastic matrix is investigated by using a multiscale chain to predict the macroscopic material behavior. A large-strain framework for constitutive modeling with focus on material non-linearities, i.e. plasticity and damage is defined. The ability of the geometric and constitutive models to predict the deformation and failure behavior is demonstrated by means of selected examples.
Uncertainty Quantification in Multiscale Materials Modeling Yan Wang 2020-03-10 Uncertainty Quantification in Multiscale Materials Modeling provides a complete overview of uncertainty quantification (UQ) in computational materials science. It provides practical tools and methods along with examples of their application to problems in materials modeling. UQ methods are applied to various multiscale models ranging from the nanoscale to macroscale. This book presents a thorough synthesis of the state-of-the-art in UQ methods for materials modeling, including Bayesian inference, surrogate modeling, random fields, interval analysis, and sensitivity analysis, providing insight into the unique characteristics of models framed at each scale, as well as common issues in modeling across scales. Synthesizes available UQ methods for materials modeling Provides practical tools and examples for problem solving in modeling material behavior across various length scales Demonstrates UQ in density functional theory, molecular dynamics, kinetic Monte Carlo, phase field, finite element method, multiscale modeling, and to support decision making in materials design Covers quantum, atomistic, mesoscale, and engineering structure-level modeling

and simulation
Multiscale Modeling and Uncertainty Quantification of Materials and Structures Manolis Papadrakakis 2014-07-02 This book contains the proceedings of the IUTAM Symposium on Multiscale Modeling and Uncertainty Quantification of Materials and Structures that was held at Santorini, Greece, September 9 – 11, 2013. It consists of 20 chapters which are divided in five thematic topics: Damage and fracture, homogenization, inverse problems–identification, multiscale stochastic mechanics and stochastic dynamics. Over the last few years, the intense research activity at micro scale and nano scale reflected the need to account for disparate levels of uncertainty from various sources and across scales. As even over-refined deterministic approaches are not able to account for this issue, an efficient blending of stochastic and multiscale methodologies is required to provide a rational framework for the analysis and design of materials and structures. The purpose of this IUTAM Symposium was to promote achievements in uncertainty quantification combined with multiscale modeling and to encourage research and development in this growing field with the aim of improving the safety and reliability of engineered materials and structures. Special emphasis was placed on multiscale material modeling and simulation as well as on the multiscale analysis and uncertainty quantification of fracture mechanics of heterogeneous media. The homogenization of two-phase random media was also thoroughly examined in several presentations. Various topics of multiscale stochastic mechanics, such as identification of material models, scale coupling, modeling of random microstructures, analysis of CNT-reinforced composites and stochastic finite elements, have been analyzed and discussed. A large number of papers were finally devoted to innovative methods in stochastic dynamics.
American Society of Composites-28th Technical Conference Charles Bakis 2013-11-01 New and unpublished U.S. and international research on multifunctional, active, biobased, SHM, self-healing composites -- from nanolevel to large structures New information on modeling, design, computational engineering, manufacturing, testing Applications to aircraft, bridges, concrete, medicine, body armor, wind energy This fully searchable CD-ROM contains 135 original research papers on all phases of composite materials. The document provides cutting edge research by US, Canadian, and Japanese authorities on matrix-based and fiber composites from design to damage analysis and detection. Major divisions of the work include: Structural Health Monitoring, Multifunctional Composites, Integrated Computational Materials Engineering, Interlaminar Testing, Analysis-Shell Structures, Thermoplastic Matrices, Analysis Non-classical Laminates, Bio-Based Composites, Electrical Properties, Dynamic Behavior, Damage/Failure, Compression-Testing, Active Composites, 3D Reinforcement, Dielectric Nanocomposites, Micromechanical Analysis, Processing, CM Reinforcement for Concrete, Environmental Effects, Phase-Transforming, Molecular Modeling, Impact.
Micromechanical Analysis and Multi-Scale Modeling Using the Voronoi Cell Finite Element Method Somnath Ghosh 2011-06-23 As multi-phase metal/alloy systems and polymer, ceramic, or metal matrix composite materials are increasingly being used in industry, the science and technology for these heterogeneous materials has advanced rapidly. By extending analytical and numerical models, engineers can analyze failure characteristics of the materials before they are integrated into the design process. Micromechanical Analysis and Multi-Scale Modeling Using the Voronoi Cell Finite Element Method addresses the key problem of multi-scale failure and deformation of materials that have complex microstructures. The book presents a comprehensive computational mechanics and materials science–based framework for multi-scale analysis. The focus is on micromechanical analysis using the Voronoi cell finite element method (VCFEM) developed by the author and his research group for the efficient and accurate modeling of materials with non-uniform heterogeneous microstructures. While the topics covered in the book encompass the macroscopic scale of structural components and the microscopic scale of constituent heterogeneities like inclusions or voids, the general framework may be extended to other scales as well. The book presents the major components of the multi-scale analysis framework in three parts. Dealing with multi-scale image analysis and characterization, the first part of the book covers 2D and 3D image-based microstructure generation and tessellation into Voronoi cells. The second part develops VCFEM for micromechanical stress and failure analysis, as well as thermal analysis, of extended microstructural regions. It examines a range of problems solved by VCFEM, from heat transfer and stress-strain analysis of elastic, elastic-plastic, and viscoplastic material microstructures to microstructural damage models including interfacial debonding and ductile failure. Establishing the multi-scale framework for heterogeneous materials with and without damage, the third part of the book discusses adaptive concurrent multi-scale analysis incorporating bottom-up and top-down modeling. Including numerical examples and a CD-ROM with VCFEM source codes and input/output files, this book is a valuable reference for researchers, engineers, and professionals involved with predicting the performance and failure of materials in structure-materials interactions.
Multiscale Modeling of Additively Manufactured Metals Yi Zhang 2020-06-29 Multiscale Modeling of Additively Manufactured Metals: Application to Laser Powder Bed Fusion Process provides comprehensive coverage on the latest methodology in additive manufacturing (AM) modeling and simulation. Although there are extensive advances within the AM field, challenges to predictive theoretical and computational approaches still hinder the widespread adoption of AM. The book reviews metal additive materials and processes and discusses multiscale/multiphysics modeling strategies. In addition, coverage of modeling and simulation of AM process in order to understand the process-structure-property relationship is reviewed, along with the modeling of morphology evolution, phase transformation, and defect formation in AM parts. Residual stress, distortion, plasticity/damage in AM parts are also considered, with scales associated with the spatial, temporal and/or material domains reviewed. This book is useful for graduate students, engineers and professionals working on AM materials, equipment, process, development and modeling. Includes the fundamental principles of additive manufacturing modeling techniques Presents various modeling tools/software for AM modeling Discusses various design methods and how to optimize the AM process using these models
Multiscale Modeling Approaches for Composites George Chatzigeorgiou 2022-01-15 Multiscale Modeling Approaches for Composites outlines the fundamentals of common multiscale modeling techniques and provides detailed guidance for putting them into practice. Various homogenization methods are presented in a simple, didactic manner, with an array of numerical examples. The book starts by covering the theoretical underpinnings of tensors and continuum mechanics concepts, then passes to actual micromechanic techniques for composite media and laminate plates. In the last chapters the book covers advanced topics in homogenization, including Green’s tensor, Hashin-Shtrikman bounds, and special types of problems. All chapters feature comprehensive analytical and numerical examples (Python and ABAQUS scripts) to better illustrate the theory. Bridges

theory and practice, providing step-by-step instructions for implementing multiscale modeling approaches for composites and the theoretical concepts behind them Covers boundary conditions, data-exchange between scales, the Hill-Mandel principle, average stress and strain theorems, and more Discusses how to obtain composite properties using different boundary conditions Includes access to a companion site, featuring the numerical examples, Python and ABACUS codes discussed in the book
Science and Engineering of Casting Solidification Doru Michael Stefanescu 2015-08-27 The 3rd edition of this popular textbook covers current topics in all areas of casting solidification. Partial differential equations and numerical analysis are used extensively throughout the text, with numerous calculation examples, to help the reader in achieving a working knowledge of computational solidification modeling. The features of this new edition include: • new chapters on semi-solid and metal matrix composites solidification • a significantly extended treatment of multiscale modeling of solidification and its applications to commercial alloys • a survey of new topics such as solidification of multicomponent alloys and molecular dynamic modeling • new theories, including a theory on oxide bi-films in the treatment of shrinkage problems • an in-depth treatment of the theoretical aspects of the solidification of the most important commercial alloys including steel, cast iron, aluminum-silicon eutectics, and superalloys • updated tables of material constants.
Multiscale Modeling in Solid Mechanics Ugo Galvanetto 2010 This unique volume presents the state of the art in the field of multiscale modeling in solid mechanics, with particular emphasis on computational approaches. For the first time, contributions from both leading experts in the field and younger promising researchers are combined to give a comprehensive description of the recently proposed techniques and the engineering problems tackled using these techniques. The book begins with a detailed introduction to the theories on which different multiscale approaches are based, with regards to linear homogenization as well as various nonlinear approaches. It then presents advanced applications of multiscale approaches applied to nonlinear mechanical problems. Finally, the novel topic of materials with self-similar structure is discussed.
Stochastic-Strength-Based Damage Simulation Tool for Ceramic Matrix and Polymer Matrix Composite Structures National Aeronautics and Space Administration (NASA) 2018-05-22 Stochastic-based, discrete-event progressive damage simulations of ceramic-matrix composite and polymer matrix composite material structures have been enabled through the development of a unique multiscale modeling tool. This effort involves coupling three independently developed software programs: (1) the Micromechanics Analysis Code with Generalized Method of Cells (MAC/GMC), (2) the Ceramics Analysis and Reliability Evaluation of Structures Life Prediction Program (CARES/ Life), and (3) the Abaqus finite element analysis (FEA) program. MAC/GMC contributes multiscale modeling capabilities and micromechanics relations to determine stresses and deformations at the microscale of the composite material repeating unit cell (RUC). CARES/Life contributes statistical multiaxial failure criteria that can be applied to the individual brittle-material constituents of the RUC. Abaqus is used at the global scale to model the overall composite structure. An Abaqus user-defined material (UMAT) interface, referred to here as "FEAMAC/CARES," was developed that enables MAC/GMC and CARES/Life to operate seamlessly with the Abaqus FEA code. For each FEAMAC/CARES simulation trial, the stochastic nature of brittle material strength results in random, discrete damage events, which incrementally progress and lead to ultimate structural failure. This report describes the FEAMAC/CARES methodology and discusses examples that illustrate the performance of the tool. A comprehensive example problem, simulating the progressive damage of laminated ceramic matrix composites under various off-axis loading conditions and including a double notched tensile specimen geometry, is described in a separate report. Nemeth, Noel N. and Bednarcyk, Brett A. and Pineda, Evan J. and Walton, Owen J. and Arnold, Steven M. Glenn Research Center STOCHASTIC PROCESSES; MICROCRACKS; SIMULATION; CERAMIC MATRIX COMPOSITES; POLYMER MATRIX COMPOSITES; FINITE ELEMENT METHOD; MICROMECHANICS; SOFTWARE DEVELOPMENT TOOLS; SOFTWARE ENGINEERING; DAMAGE; BRITTLE MATERIALS; COMPOSITE STRUCTURES; CRACK INITIATION; CRACK PROPAGATION; FRACTURE MECHANICS; PROBABILITY THEORY; STRESS-STRAIN RELATIONSHIPS; STRUCTURAL ANALYSIS
Multiscale Modeling and Simulation of Composite Materials and Structures Young Kwon 2007-12-04 This book presents the state-of-the-art in multiscale modeling and simulation techniques for composite materials and structures. It focuses on the structural and functional properties of engineering composites and the sustainable high performance of components and structures. The multiscale techniques can be also applied to nanocomposites which are important application areas in nanotechnology. There are few books available on this topic.
3D Multi-scale Finite Element Analysis of the Present-day Crustal State of Stress and the Recent Kinematic Behaviour of the Northern and Central Upper Rhine Graben Thies Buchmann 2008 This thesis focuses on the contemporary stress state of a continental rift structure, the Upper Rhine Graben, and its present-day reactivation and kinematic behaviour. The graben is currently characterised by relatively slow tectonic deformation accompanied by low to medium seismicity and ongoing subsidence. In this context, the reactivation potential of pre-existing faults associated with the graben structure is one of the main goals of this thesis. Three dimensional finite element modelling is used for simulating the stress state of the study area. Based on the evaluation of the fault reactivation potential, a possible contribution of mechanical earth modelling to earthquake hazard assessment is also investigated. Another task of this thesis is the development of a method and work process for the construction of complex model geometries based on the different data types available. In order to establish a procedure that is independent of local computing and software facilities, the work-flow used is predominantly based on commercial software packages. A brief introduction is given on crustal stresses, their definition, determination and classification. Two approaches of shear failure reactivation evaluation, independent of the rheological parameter of fault surfaces, are discussed. In addition, a summary of the finite element method is given. This includes the influence of mesh quality and the implementation of contact problems as well as the ABAQUS implementation of the material models used (elasticity and elasto-plasticity). The thesis also refers to the approach of multi-scale modelling, nesting or sub-modelling using ABAQUS. The consequences of this approach on the boundary conditions and the model geometries are discussed.
Multiscale Modeling of Thermomechanical Loads in the Broaching of Direct Aged Inconel 718 Bingxiao Peng 2021-01-22 The broaching process remains an essential machining process when manufacturing fir tree slots in turbine disks for aircraft engines. The cost- and time-intensive experiment-based approach restricts the application of alternative cutting tool materials when broaching nickel-based alloys. Given the accuracy and computation time, the developed model-based multiscale approach

presents great advantages in prediction of the broaching process and thus can accelerate the development process.
Acting Principles of Nano-Scaled Matrix Additives for Composite Structures Michael Sinapius 2021-05-22 The book explores the effect of nanoscale matrix additives along the four levels of material formation, particle-resin interaction, the influence of nanoparticles on the processability of the polymer, the influence of nanoparticles on polymer curing and the influence of nanoparticles on the fiber plastic composite. Fiber-reinforced plastics have a significantly higher lightweight construction potential in components with a primary single- or biaxial stress state compared to isotropic metals. At the same time, their insensitivity to corrosion and their advantageous fatigue properties can help to reduce maintenance costs. Due to their outstanding specific mechanical properties, they are among today's high-performance lightweight construction materials. These properties make them particularly attractive in the field of mobility. However, as soon as the matrix properties dominate the mechanical properties, e.g. in the case of fibre-parallel compressive strength, significant weaknesses become apparent in the mechanical properties. Here, one approach is to significantly increase the matrix properties through nanoscale ceramic additives and at the same time to guarantee the processability of the resin.
Multiscale Modeling to Tackle the Complexity of Load-Bearing Organ and Tissue Regulation Jerome Noailly 2022-03-11
Multiscale Modeling of Heterogenous Materials Oana Cazacu 2013-03-01 A material's various proprieties is based on its microscopic and nanoscale structures. This book provides an overview of recent advances in computational methods for linking phenomena in systems that span large ranges of time and spatial scales. Particular attention is given to predicting macroscopic properties based on subscale behaviors. Given the book’s extensive coverage of multi-scale methods for modeling both metallic and geologic materials, it will be an invaluable reading for graduate students, scientists, and practitioners alike.
Micromechanics of Composite Materials Jacob Aboudi 2012-11-01 Summary: A Generalized Multiscale Analysis Approach brings together comprehensive background information on the multiscale nature of the composite, constituent material behaviour, damage models and key techniques for multiscale modelling, as well as presenting the findings and methods, developed over a lifetime's research, of three leading experts in the field. The unified approach presented in the book for conducting multiscale analysis and design of conventional and smart composite materials is also applicable for structures with complete linear and nonlinear material behavior, with numerous applications provided to illustrate use. Modeling composite behaviour is a key challenge in research and industry; when done efficiently and reliably it can save money, decrease time to market with new innovations and prevent component failure.
IUTAM Symposium on Modelling Nanomaterials and Nanosystems R. Pyrz 2008-12-21 Recent interest in nanotechnology is challenging the community to analyse, develop and design nanometer to micrometer-sized devices for applications in new generations of computer, electronics, photonics and drug delivery systems. To successfully design and fabricate novel nanomaterials and nanosystems, we must necessarily bridge the gap in our understanding of mechanical properties and processes at length scales ranging from 100 nanometers (where atomistic simulations are currently possible) to a micron (where continuum mechanics is experimentally validated). For this purpose the difficulties and complexity originate in the substantial differences in philosophy and viewpoints between conventional continuum mechanics and quantum theories. The challenge lies in how to establish the relationship between a continuum mechanical system and its atomistic counterpart in order to define continuum variables that are calculable within an atomic system.
ICCS19 19th International Conference on Composite Structures Antonio J.M. Ferreira 2016-08-01 Nowadays, it is quite easy to see various applications of fibrous composites, functionally graded materials, laminated composite, nano-structured reinforcement, morphing composites, in many engineering fields, such as aerospace, mechanical, naval and civil engineering. The increase in the use of composite structures in different engineering practices justify the present international meeting where researches from every part of the globe can share and discuss the recent advancements regarding the use of standard structural components within advanced applications such as buckling, vibrations, repair, reinforcements, concrete, composite laminated materials and more recent metamaterials. For this reason, the establishment of this 19th edition of International Conference on Composite Structures has appeared appropriate to continue what has been begun during the previous editions. ICCS wants to be an occasion for many researchers from each part of the globe to meet and discuss about the recent advancements regarding the use of composite structures, sandwich panels, nanotechnology, bio-composites, delamination and fracture, experimental methods, manufacturing and other countless topics that have filled many sessions during this conference. As a proof of this event, which has taken place in Porto (Portugal), selected plenary and keynote lectures have been collected in the present book.
Sustainable Composites for Aerospace Applications Mohammad Jawaid 2018-04-27 Sustainable Composites for Aerospace Applications presents innovative advances in the fabrication, characterization and applications of LDH polymer nanocomposites. It covers fundamental structural and chemical knowledge and explores various properties and characterization techniques, including microscopic, spectroscopic and mechanical behaviors. Users will find a strong focus on the potential applications of LDH polymer nanocomposites, such as in energy, electronics, electromagnetic shielding, biomedical, agricultural, food packaging and water purification functions. This book provides comprehensive coverage of cutting-edge research in the field of LDH polymer nanocomposites and future applications, and is an essential read for all academics, researchers, engineers and students working in this area. Presents fundamental knowledge of LDH polymer nanocomposites, including chemical composition, structural features and fabrication techniques Provides an analytical overview of the different types of characterization techniques and technologies Contains extensive reviews on cutting-edge research for future applications in a variety of industries
Fracture and Fatigue Assessments of Structural Components Alberto Campagnolo 2020-12-04 In dealing with fracture and fatigue assessments of structural components, different approaches have been proposed in the literature. They are usually divided into three subgroups according to stress-based, strain-based, and energy-based criteria. Typical applications include both linear elastic and elastoplastic materials and plain and notched or cracked components under both static and fatigue loadings. The aim of this Special Issue is to provide an update to the state-of-the-art on these approaches. The topics addressed in this Special Issue are applications from nano- to full-scale complex and real structures and recent advanced criteria for fracture and fatigue predictions under complex loading conditions, such as multiaxial constant and variable amplitude fatigue loadings.
IUTAM Symposium on Multiscale Modeling and Characterization of Elastic-Inelastic Behavior of Engineering Materials S. Ahzi

2013-04-17 The papers in this proceeding are a collection of the works presented at the IUTAM symposium-Marrakech 2002 (October 20-25) which brought together scientists from various countries. These papers cover contemporary topics in multiscale modeling and characterization of materials behavior of engineering materials. They were selected to focus on topics related to deformation and failure in metals, alloys, intermetallics and polymers including: experimental techniques, deformation and failure mechanisms, dislocation-based modelling, microscopic-macroscopic averaging schemes, application to forming processes and to phase transformation, localization and failure phenomena, and computational advances. Key areas that are covered by some of the papers include modeling of material deformation at various scales. At the atomistic scale, results from MD simulations pertaining to deformation mechanisms in nano-crystalline materials as well as dislocation-defect interactions are presented. Advances in modeling of deformation in metals using discrete dislocation analyses are also presented, providing an insight into this emerging scientific technique that can be used to model deformation at the microscale. These papers address current engineering problems, including deformation of thin fIlms, dislocation behavior and strength during nanoindentation, strength in metal matrix composites, dislocation-crack interaction, development of textures in polycrystals, and problems involving twining and shape memory behavior. On Behalf of the organizing committee, I would like to thank Professor P.
Advances on Modeling in Tissue Engineering Paulo R. Fernandes 2011-05-21 This book presents a collection of chapters describing the state of the art on computational modelling and fabrication in tissue engineering. Tissue Engineering is a multidisciplinary field involving scientists from different fields. The development of mathematical methods is quite relevant to understand cell biology and human tissues as well to model, design and fabricate optimized and smart scaffolds. The chapter authors are the distinguished keynote speakers at the first Eccomas thematic conference on Tissue Engineering where the emphasis was on mathematical and computational modeling for scaffold design and fabrication. This particular area of tissue engineering, whose goal is to obtain substitutes for hard tissues such as bone and cartilage, is growing in importance.
Multiscale Fatigue Modelling of Metals Kiarash J. Dogahe 2022-01-05 Fatigue is one of the most important failure modes of engineering components. The book presents recent research regarding the multiscale modelling of metallic materials during different stages of fatigue. The various parameters that are involved in each stage are investigated. Keywords: Fatigue Crack Initiation, Critical Resolved Shear Stress, Endurance Limit, Fatigue Crack Growth, Fatigue Lifetime Estimation, Multiscale Modelling, Paris Law, Tanaka-Mura Equation, Wöhler (S-N) Curve.
Novel Multiscale Modeling Schemes for Damage Evolution in Composite Laminates Ganesh Soni Microscale damage mechanism of the multi-layer composite laminates is one of the active areas of research. Micromechanics theory is extensively used for the prediction of elastic response and to perform damage analysis of unidirectional laminae via representative volume element (RVE). The present state of the art in the micromechanics theory is extended in this study for the damage analysis of the multi-fiber multi-layer laminates to capture the local damage mechanisms which include matrix failure, fiber-matrix debonding, fiber failure, and delamination. A multi-fiber multi-layer representative volume element (M2RVE) representing a multi-layer cross-ply laminate is developed. Each layer in the M2RVE is represented by a unit cube with multiple randomly distributed fibers of same diameter at specified angle ensuring specified volume fiber fraction. Periodic boundary conditions are applied to the all six M2RVE surfaces to model the directional periodicity. All the simulations are performed by using FE analysis code ABAQUS®. A maximum principal stress criterion is used for modeling fiber failure. Mohr-coulomb failure criterion is used for matrix failure and standard traction-separation law is used for fiber-matrix debonding and for modeling delamination between plies. Numerical results from the FE analysis are found to be in good agreement with the experimental data obtained. Note that this technique is valid for periodic structures. The periodic boundary condition is not a suitable assumption, especially in the regions of high gradients like free edges, interfaces, material discontinuities. The periodicity of simple unit cells is also unrealistic for non-uniform microstructures, due the presence of randomness, clustering or evolving micro-structural behavior. Consequently, this approach has limited utility in identifying local damage in real structural members. To address the limitations of the M2RVE, a micromacro multiscale scale multilevel model is proposed. The multilevel model is comprised of two levels, namely, microscale, and macroscale. The micro-macro model is an effective and computationally efficient technique for modeling the deformation and local damage in real composite structures.
IUTAM Symposium on Multiscale Modelling of Damage and Fracture Processes in Composite Materials Tomasz Sadowski 2006-07-06 Integrating macroscopic properties with observations at lower levels, this book details advances in multiscale modelling and analysis pertaining to classes of composites which either have a wider range of relevant microstructural scales, such as metals, or do not have a very well-defined microstructure, e.g. cementitious or ceramic composites. The IUTAM symposia proceedings provide a platform for extensive further discussion and research.
Computational Modelling of Biomechanics and Biotribology in the Musculoskeletal System Zhongmin Jin 2020-09-29 Computational Modelling of Biomechanics and Biotribology in the Musculoskeletal System: Biomaterials and Tissues, Second Edition reviews how a wide range of materials are modeled and applied. Chapters cover basic concepts for modeling of biomechanics and biotribology, the fundamentals of computational modeling of biomechanics in the musculoskeletal system, finite element modeling in the musculoskeletal system, computational modeling from a cells and tissues perspective, and computational modeling of the biomechanics and biotribology interactions, looking at complex joint structures. This book is a comprehensive resource for professionals in the biomedical market, materials scientists and biomechanical engineers, and academics in related fields. This important new edition provides an up-to-date overview of the most recent research and developments involving hydroxyapatite as a key material in medicine and its application, including new content on novel technologies, biomorphic hydroxyapatite and more. Provides detailed, introductory coverage of modeling of cells and tissues, modeling of biomaterials and interfaces, biomechanics and biotribology Discusses applications of modeling for joint replacements and applications of computational modeling in tissue engineering Offers a holistic perspective, from cells and small ligaments to complex joint interactions
Meshfree Methods for Partial Differential Equations IX Michael Griebel 2019-06-19 This volume collects selected papers presented at the Ninth International Workshop on Meshfree Methods held in Bonn, Germany in September 2017. They address various aspects of this very active research field and cover topics from applied mathematics, physics and engineering. The numerical treatment of partial differential equations with meshfree discretization techniques has been a very active research area in recent years. While the fundamental theory of meshfree methods has been developed and considerable advances of the

various methods have been made, many challenges in the mathematical analysis and practical implementation of meshfree methods remain. This symposium aims to promote collaboration among engineers, mathematicians, and computer scientists and industrial researchers to address the development, mathematical analysis, and application of meshfree and particle methods especially to multiscale phenomena. It continues the 2-year-cycled Workshops on Meshfree Methods for Partial Differential Equations.

Design and Modeling of Mechanical Systems Mohamed Haddar 2013-03-12 The 5th International Congress on Design and Modeling of Mechanical Systems (CMSM) was held in Djerba, Tunisia on March 25-27, 2013 and followed four previous successful editions, which brought together international experts in the fields of design and modeling of mechanical systems, thus contributing to the exchange of information and skills and leading to a considerable progress in research among the participating teams. The fifth edition of the congress (CMSM ?2013), organized by the Unit of Mechanics, Modeling and Manufacturing (U2MP) of the National School of Engineers of Sfax, Tunisia, the Mechanical Engineering Laboratory (MBL) of the National School of Engineers of Monastir, Tunisia and the Mechanics Laboratory of Sousse (LMS) of the National School of Engineers of Sousse, Tunisia, saw a significant increase of the international participation. This edition brought together nearly 300 attendees who exposed their work on the following topics: mechatronics and robotics, dynamics of mechanical systems, fluid structure interaction and vibroacoustics, modeling and analysis of materials and structures, design and manufacturing of mechanical systems. This book is the proceedings of CMSM ?2013 and contains a careful selection of high quality contributions, which were exposed during various sessions of the congress. The original articles presented here provide an overview of recent research advancements accomplished in the field mechanical engineering.

IUTAM Symposium on Multiscale Modelling of Fatigue, Damage and Fracture in Smart Materials Meinhard Kuna 2010-11-12 Today, multi-functional materials such as piezoelectric/ferroelectric ceramics, magneto-strictive and shape memory alloys are gaining increasing applications as sensors, actuators or smart composite materials systems for emerging high tech areas. The stable performance and reliability of these smart components under complex service loads is of paramount practical importance. However, most multi-functional materials suffer from various mechanical and/or electro-magnetical degra-dation mechanisms as fatigue, damage and fracture. Therefore, this exciting topic has become a challenge to intensive international research, provoking the interdisciplinary approach between solid mechanics, materials science and physics. This book summarizes the outcome of the above mentioned IUTAM-symposium, assembling contributions by leading scientists in this area. Particularly, the following topics have been addressed: (1) Development of computational methods for coupled electromechanical field analysis, especially extended, adaptive and multi-level finite elements. (2) Constitutive modeling of non-linear smart material behavior with coupled electric, magnetic, thermal and mechanical fields, primarily based on micro-mechanical models. (3) Investigations of fracture and fatigue in piezoelectric and ferroelectric ceramics by means of process zone modeling, phase field simulation and configurational mechanics. (4) Reliability and durability of sensors and actuators under in service loading by alternating mechanical, electrical and thermal fields. (5) Experimental methods to measure fracture strength and to investigate fatigue crack growth in ferroelectric materials under electromechanical loading. (6) New ferroelectric materials, compounds and composites with enhanced strain capabilities.

Multiscale Modelling in Sheet Metal Forming Dorel Banabic 2016-10-20 This book gives a unified presentation of the research performed in the field of multiscale modelling in sheet metal forming over the course of more than thirty years by the members of six teams from internationally acclaimed universities. The first chapter is devoted to the presentation of some recent phenomenological yield criteria (BBC 2005 and BBC 2008) developed at the CERTETA center from the Technical University of Cluj-Napoca. An overview on the crystallographic texture and plastic anisotropy is presented in Chapter 2. Chapter 3 is dedicated to multiscale modelling of plastic anisotropy. The authors describe a new hierarchical multi-scale framework that allows taking into account the evolution of plastic anisotropy during sheet forming processes. Chapter 4 is focused on modelling the evolution of voids in porous metals with applications to forming limit curves and ductile fracture. The chapter details the steps needed for the development of dissipation functions and Gurson-type models for non-quadratic anisotropic plasticity criteria like BBC 2005 and those based on linear transformations. Chapter 5 describes advanced models for the prediction of forming limit curves developed by the authors. Chapter 6 is devoted to anisotropic damage in elasto-plastic materials with structural defects. Finally, Chapter 7 deals with modelling of the Portevin-Le Chatelier (PLC) effect. This volume contains contributions from leading researchers from the Technical University of Cluj-Napoca, Romania, the Catholic University of Leuven, Belgium, Clausthal University of Technology, Germany, Amirkabir University of Technology, Iran, the University of Bucharest, Romania, and the Institute of Mathematics of the Romanian Academy, Romania. It will prove useful to postgraduate students, researchers and engineers who are interested in the mechanical modeling and numerical simulation of sheet metal forming processes.