

Zengtao Chen
Cliff Butcher

Micromechanics Modelling of Ductile Fracture



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**Federico M. Mazzolani, Vincenzo
Piluso, Elide Nistri, Antonio Formisano**



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Micromechanics Modelling of Ductile Fracture Zengtao Chen,Cliff Butcher,2013-04-05 This book summarizes research advances in micromechanics modeling of ductile fractures made in the past two decades The ultimate goal of this book is to reach manufacturing frontline designers and materials engineers by providing a user oriented theoretical background of micromechanics modeling Accordingly the book is organized in a unique way first presenting a vigorous damage percolation model developed by the authors over the last ten years This model overcomes almost all difficulties of the existing models and can be used to completely accommodate ductile damage developments within a single measure microstructure frame Related void damage criteria including nucleation growth and coalescence are then discussed in detail how they are improved when and where they are used in the model and how the model performs in comparison with the existing models Sample forming simulations are provided to illustrate the model s performance

Micromechanics Modelling of Ductile Fracture Zengtao Chen,Cliff Butcher,2013-04-02 This book summarizes research advances in micromechanics modeling of ductile fractures made in the past two decades The ultimate goal of this book is to reach manufacturing frontline designers and materials engineers by providing a user oriented theoretical background of micromechanics modeling Accordingly the book is organized in a unique way first presenting a vigorous damage percolation model developed by the authors over the last ten years This model overcomes almost all difficulties of the existing models and can be used to completely accommodate ductile damage developments within a single measure microstructure frame Related void damage criteria including nucleation growth and coalescence are then discussed in detail how they are improved when and where they are used in the model and how the model performs in comparison with the existing models Sample forming simulations are provided to illustrate the model s performance

Modeling of the Damage Mechanisms in AlMgSi Alloys Denis Lassance,2006 With the growth in importance of the aluminium industry has come increased demand to invest into the quality improvement of the different aluminium based hot extruded products One of the main mechanisms which can influence deformation at high temperature within the 6xxx aluminium is linked to the presence of the AlFeSi intermetallic phases These phases severely restrict hot workability when present as hard and brittle plate like precipitates b AlFeSi Damage initiation occurs in these alloys by decohesion or fracture of these intermetallic inclusions The understanding and modeling of the deformation and fracture behavior of aluminium alloys at room and at hot working temperature is very important for optimizing manufacturing processes such as extrusion The ductility of 6xxx aluminium alloys can be directly related to chemical composition and to the microstructural evolution occurring during the heat treatment procedures preceding extrusion if proper physics based deformation and fracture models are used In this thesis room temperature and hot tensile tests are adopted to address the problem xperimentally The damage evolution mechanisms is defined at various temperatures and a micromechanics based model of the Gurson type considering several populations of cavities nucleated by different second

phase particles groups is developed on the basis of the experimental observations This model allows relating quantitatively microstructure and ductility at various temperatures strain rates and stress triaxialities Finite element simulations based on an enhanced micromechanics based model are used to validate the model Finally the effect of some key factors that determine the extrudability of aluminium is also discussed and a correlation between the ductility calculations in uniaxial tension and the maximum extrusion speed is developed for one defined profile

Micromechanics and Nanosimulation of Metals and Composites Siegfried Schmauder, Leon Mishnaevsky, 2008-10-20 The strength of metallic materials determines the usability and reliability of all the machines tools and equipment around us Yet the question about which mechanisms control the strength and damage resistance of materials and how they can be optimised remains largely unanswered How do real heterogeneous materials deform and fail Why can a small modification of the microstructure increase the strength and damage resistance of materials manifold How can the strength of heterogeneous materials be predicted The purpose of this book is to present different experimental and computational analysis methods of micromechanics of damage and strength of materials and to demonstrate their applications to various micromechanical problems This book summarizes at a glance some of the publications of the Computational Mechanics Group at the IMWF MPA Stuttgart dealing with atomistic micro and meso mechanical modelling and experimental analysis of strength and damage of metallic materials In chapter 1 the micromechanisms of damage and fracture in different groups of materials are investigated experimentally using direct observations and inverse analysis The interaction of microstructural elements with the evolving damage is studied in these experiments Chapter 2 presents different approaches to the micromechanical simulation of composite materials embedded unit cells multiphase finite elements and multiparticle unit cells Examples of the application of these models to the analysis of deformation and damage in different materials are given Chapter 3 deals with the methods of numerical modelling of damage evolution and crack growth in heterogeneous materials

IUTAM Symposium on Micromechanics of Plasticity and Damage of Multiphase Materials André Pineau, André Zaoui, 2012-12-06 The IUTAM Symposium on Micromechanics of Plasticity and Damage of Multiphase Materials was held in Sevres Paris France 29 August 1 September 1995 The Symposium was attended by 83 persons from 18 countries In addition 17 young French students attended the meeting During the 4 day meeting a total of 55 papers were presented including 24 papers in the poster sessions The meeting was divided into 7 oral and 3 poster sessions The 7 oral sessions were the following Plasticity and Viscoplasticity I and II Phase transformations Damage I and II Statistical and geometrical aspects Cracks and interfaces Each poster session was introduced by a Rapporteur as follows Session I Plasticity and Viscoplasticity G Cailletaud Session 2 Damage D Francois Session 3 Phase transformation statistical and geometrical aspects D Jeulin The main purpose of the Symposium was the discussion of the state of the art in the development of micromechanical models used to predict the macroscopic mechanical behaviour of multiphase solid materials These materials consist of at least two chemically different phases present either initially or

formed during plastic deformation when a strain induced phase transformation takes place One session was devoted to the latter case Continuously strengthened composite materials containing long fibers were out of the scope of the Symposium

The Theory of Critical Distances David Taylor,2010-07-07 Critical distance methods are extremely useful for predicting fracture and fatigue in engineering components They also represent an important development in the theory of fracture mechanics Despite being in use for over fifty years in some fields there has never been a book about these methods until now So why now Because the increasing use of computer aided stress analysis by FEA and other techniques has made these methods extremely easy to use in practical situations This is turn has prompted researchers to re examine the underlying theory with renewed interest The Theory of Critical Distances begins with a general introduction to the phenomena of mechanical failure in materials a basic understanding of solid mechanics and materials engineering is assumed though appropriate introductory references are provided where necessary After a simple explanation of how to use critical distance methods and a more detailed exposition of the methods including their history and classification the book continues by showing examples of how critical distance approaches can be applied to predict fracture and fatigue in different classes of materials Subsequent chapters include some more complex theoretical areas such as multiaxial loading and contact problems and a range of practical examples using case studies of real engineering components taken from the author s own consultancy work The Theory of Critical Distances will be of interest to a range of readers from academic researchers concerned with the theoretical basis of the subject to industrial engineers who wish to incorporate the method into modern computer aided design and analysis Comprehensive collection of published data plus new data from the author s own laboratories A simple how to do it exposition of the method plus examples and case studies Detailed theoretical treatment Covers all classes of materials metals polymers ceramics and composites Includes fracture fatigue fretting size effects and multiaxial loading

Recent Trends in Fracture and Damage Mechanics Geralf Hütter,Lutz Zymbell,2015-09-01 This book covers a wide range of topics in fracture and damage mechanics It presents historical perspectives as well as recent innovative developments presented by peer reviewed contributions from internationally acknowledged authors The volume deals with the modeling of fracture and damage in smart materials current industrial applications of fracture mechanics and it explores advances in fracture testing methods In addition readers will discover trends in the field of local approach to fracture and approaches using analytical mechanics Scholars in the fields of materials science engineering and computational science will value this volume which is dedicated to Meinhard Kuna on the occasion of his 65th birthday in 2015 This book incorporates the proceedings of an international symposium that was organized to honor Meinhard Kuna s contributions to the field of theoretical and applied fracture and damage mechanics

Proceedings of the Third International Conference on Theoretical, Applied and Experimental Mechanics Emmanuel Gdoutos,Maria

Konsta-Gdoutos,2020-05-18 This book presents the proceedings of the 3rd edition of the International Conference on

Theoretical Applied and Experimental Mechanics The papers focus on all aspects of theoretical applied and experimental mechanics including biomechanics composite materials computational mechanics constitutive modeling of materials dynamics elasticity experimental mechanics fracture mechanics mechanical properties of materials micromechanics nanomechanics plasticity stress analysis structures wave propagation

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

Building Information Modeling Nawari O. Nawari,Michael Kuenstle,2015-05-01 BIM for Structural Engineering and Architecture Building Information Modeling Framework for Structural Design outlines one of the most promising new developments in architecture engineering and construction AEC Building information modeling BIM is an information management and analysis technology that is changing the role of computation in the architectural and engineering industries The innovative process constructs a database assembling all of the objects needed to build a specific structure Instead of using a computer to produce a series of drawings that together describe the building BIM creates a single illustration representing the building as a whole This book highlights the BIM technology and explains how it is redefining the structural analysis and design of building structures BIM as a Framework Enabler This book introduces a new framework the structure and architecture synergy framework SAS framework that helps develop and enhance the understanding of the fundamental principles of architectural analysis using BIM tools Based upon three main components the structural melody structural poetry and structural analysis along with the BIM tools as the frame enabler this new framework allows users to explore structural design as an art while also factoring in the principles of engineering The framework stresses the influence structure can play in form generation and in defining spatial order and composition By highlighting the interplay between architecture and structure the book emphasizes the conceptual behaviors of structural systems and their aesthetic implications and enables readers to thoroughly understand the art and science of whole structural system concepts Presents the use of BIM technology as part of a design process or framework that can lead to a more comprehensive intelligent and integrated building design Places special emphasis on the application of BIM technology for exploring the intimate relationship between structural engineering and architectural design Includes a discussion of current and emerging trends in structural engineering practice and the role of the structural engineer in building design using new BIM technologies Building Information Modeling Framework for Structural Design provides a thorough understanding of architectural structures and introduces a new framework that revolutionizes the way building structures are designed and constructed

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 *Fracture Mechanics* Fazil

Erdogan,1995 **Applications of Continuum Damage Mechanics to Fatigue and Fracture** David L. McDowell,1997 Contains papers from the May 1996 Symposium on Applications of Continuum Damage Mechanics CDM to Fatigue and Fracture Papers in Section I deal with various aspects of modeling damage in composite materials such as high temperature environmental degradation fatigue and viscous damage in metal a **Applied Mechanics Reviews** ,1978 **Mechanics of Anisotropic Materials** Jacek J. Skrzypek,Artur W. Ganczarski,2015-05-09 The book is focused on constitutive description of mechanical behaviour of engineering materials both conventional polycrystalline homogeneous isotropic or anisotropic metallic materials and non conventional heterogeneous multicomponent anisotropic composite materials Effective material properties at the macro level depend on both the material microstructure originally isotropic or anisotropic as well as dissipative phenomena occurred on fabrication and consecutive loading phase hardening resulting in irreversible microstructure changes acquired anisotropy The material symmetry is a background and anisotropy is a core around which the book is formed In this way a revision of classical rules of enhanced constitutive description of materials is required

Inelasticity and Micromechanics of Metal Matrix Composites George Z. Voyiadjis,J.W. Ju,2017-05-04 This book contains fifteen papers based on the presentations made at the symposium on Inelasticity and Micromechanics of Metal Matrix Composites held at the University of Washington USA in mid 1994 The papers represent the most recent work conducted on inelasticity and micromechanics of metal matrix composites The book is divided into two parts Part I deals with

the study of inelastic deformation in metal matrix composites while Part II tackles the micromechanical aspects of metal matrix composites. The articles discuss different aspects of these two topics ranging from purely theoretical treatments to extensive experimental investigations. Many of the papers are by prominent researchers working in this area. Proceedings of the 11th International Conference on Behaviour of Steel Structures in Seismic Areas Federico M. Mazzolani, Vincenzo Piluso, Elide Nistri, Antonio Formisano, 2024-07-02. This volume highlights the latest advances, innovations and applications in the field of seismic design and performance of steel structures as presented by leading international researchers and engineers at the 11th International Conference on the Behaviour of Steel Structures in Seismic Areas STESSA held in Salerno, Italy, on July 8-10, 2024. It covers a diverse range of topics such as behaviour of structural members and connections, performance of structural systems, mixed and composite structures, energy dissipation systems, self-centring and low damage systems, assessment and retrofitting codes and standards, light gauge systems. The contributions, which were selected by means of a rigorous international peer review process, present a wealth of exciting ideas that will open novel research directions and foster multidisciplinary collaboration among different specialists. 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 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

Concise Encyclopedia of Building and Construction Materials Fred Moavenzadeh, Robert W. Cahn, 1990 The building materials covered by the Concise Encyclopedia of Building and Construction Materials are classified in three groups structural materials semistructural materials and auxiliary materials

Sheet Metal Meso- and Microforming and Their Industrial Applications Xin Min Lai, Ming Wang Fu, Lin Fa Peng, 2018-08-06 The book presents a compilation of research on meso microforming processes and offers systematic and holistic knowledge for the physical realization of developed processes It discusses practical applications in fabrication of meso microscale metallic sheet metal parts via sheet metal meso microforming In addition the book provides extensive and informative illustrations tables case studies photos and figures to convey knowledge of sheet metal meso microforming for fabrication of meso microscale sheet metal products in an illustrated manner Key Features Presents complete analysis and discussion of micro sheet metal forming processes Guides reader across the mechanics failures prediction of failures and tooling and prospective applications Discusses definitions of multi scaled metal forming sheet metal meso microforming and the challenges in such domains Includes meso micro scaled sheet metal parts design from a micro manufacturability perspective process determination tooling design product quality analysis insurance and control Covers industrial application and examples

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