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Mathematical models for phase change problems with hysteresis effect

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Abstract

The paper deals with a phase change problem which includes hysteresis effect. The system under consideration could be applied to various biological models by choosing appropriate conditions. Numerical simulations of the behaviour of solutions are presented.

Keywords: Hysteresis

1. Introduction

In this paper, we consider the following system

$$\Theta_t + a u_t - \kappa \Theta_{xx} + \partial I_{K(u)}(\Theta) \ni F(\Theta, u) \quad \text{in } (0, T) \times (0, 1), \tag{1}$$

$$u_t - u_{xx} = f(\Theta, u) \quad \text{in } (0, T) \times (0, 1), \tag{2}$$

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Mathematical Models For Phase Change Problems

C.M. Dafermos,Milan Pokorny

Mathematical Models For Phase Change Problems:

Mathematical Models for Phase Change Problems J.F. Rodriques,2013-03-07 This monograph collects research and expository articles reflect ing the interaction and the cooperation of different groups in several European institut ions concerning current research on mathematical models for the behaviour of materials with phase change These papers were presented and discussed in a Workshop held at Obidos Portugal du ring the first three days of October 1988 and grew out of a two year period of intensive exploitation of differ ent abilities and mathematical experiences of the six participating groups namely in the University of Augsburg wh ich was the co ordination center of this project the Laboratoire Central des Ponts et Chaussees of Paris the Aristoteles University of Thessaloniki the University of Florence the University of Lisbon and the University of Oxford This project was carried out under the title Mathemat ical Models of Phase Transitions and Numerical Simulation in the framework of twinning program for stimulation of cooperation and scientific interchange sponsored by the European Community The underlying idea of the project was to create and study the mathematical models arising in applied engineering problems with free boundaries in a broad sense namely in melting and freezing problems diffusion reaction processes solid solid phase transition hysteresis phenomena mushy region descriptions contact prob lems with friction andjor adhesion elastoplastic deformations etc vi This large spectrum of applied problems have in common the main feature of brusque transitions of their qualitative behaviour that correspond in general to non classical discontinuous monotone or non monotone strong nonlinearities in the mathematical equations Mathematical Models for Phase Change Problems J.F. Rodriques,1989-09-01 Models of Phase Transitions Augusto Visintin,2012-12-06 What do you call work Why ain t that work Tom resumed his whitewashing and answered carelessly Well lI1a he it is and maybe it aill t All I know is it suits Tom Sawvc Oil CO lll IIOW Will do not mean to let 011 that you like it The brush continued to move Likc it Well I do not see wlzy I oughtn t to like it Does a hoy get a chance to whitewash a fence every day That put the thing ill a Ilew light Ben stopped nibhling the apple From Mark Twain s Adventures of Tom Sawyer Chapter II Mathematics can put quantitative phenomena in a new light in turn applications may provide a vivid support for mathematical concepts This volume illustrates some aspects of the mathematical treatment of phase transitions namely the classical Stefan problem and its generalizations The in tended reader is a researcher in application oriented mathematics An effort has been made to make a part of the book accessible to beginners as well as physicists and engineers with a mathematical background Some room has also been devoted to illustrate analytical tools This volume deals with research I initiated when I was affiliated with the Istituto di Analisi Numerica del C N R in Pavia and then continued at the Dipartimento di Matematica dell Universita di Trento It was typeset by the author in plain TEX *Mathematical Modeling Of Melting And Freezing Processes* V. Alexiades,2018-05-02 This reference book presents mathematical models of melting and solidification processes that are the key to the effective performance of latent heat thermal energy storage systems LHTES utilized in a wide range of heat transfer and industrial applications This topic

has spurred a growth in research into LHTES applications in energy conservation and utilization space station power systems and thermal protection of electronic equipment in hostile environments Further interest in mathematical modeling has increased with the speread of high powered computers used in most industrial and academic settings In two sections the book first describes modeling of phase change processes and then describes applications for LHTES It is aimed at graduate students researchers and practicing engineers in heat transfer materials processing multiphase systems energy conservation metallurgy microelectronics and cryosurgery **1999 ISES Solar World Congress** G. Grossman,2000-12-15 These volumes of Proceedings are the record of the 1999 ISES Solar World Congress held in Jerusalem Israel on the 45th Anniversary of the International Solar Energy Society The Congress was held under the theme Solar is Renewable adequately representing a meeting on the threshold of the 21st Century The event also marks the 20th anniversary of the Israeli Section of ISES founded in 1979 the year ISES celebrated its Silver Jubilee A business track under the title of Solar Means Business included presentations and discussions on market implementation of solar technology The Congress further included two panel discussions and two workshops dealing with WIRE World wide Information System for Renewable Energy and with IPMVP International Performance Measurement These proceeding consist of the Keynote Papers and presented papers

Scientific Computing and Software Raymond J. Spiteri,Joyce Reimer,2025-06-20 These proceedings present a curated collection of innovative approaches to tackling challenging problems in applied mathematics These problems often marked by instability inaccuracy and high computational cost remain at the forefront of mathematical research due to their difficulty Addressing this demand the contributions in this volume offer robust numerical methods designed to improve the accuracy and efficiency of their solutions The book originates from the Go20 Conference 2023 where established experts and emerging researchers explored cutting edge methodologies The discussions captured here situate new advancements within a broader historical and theoretical context providing a well rounded perspective on these pressing mathematical challenges Topics covered include Ordinary Differential Equations ODEs with singularities Multi dimensional and multi rate systems of Partial Differential Equations PDEs High index Differential Algebraic Equations DAEs Inverse and optimal control problems This collection is a valuable resource for researchers and practitioners working on these or related topics It offers comprehensive analyses and practical insights that bridge foundational principles with modern numerical innovations **Ultra-High Temperature Thermal Energy Storage, Transfer and Conversion** Alejandro Datas,2020-09-01 Ultra High Temperature Thermal Energy Storage Transfer and Conversion presents a comprehensive analysis of thermal energy storage systems operating at beyond 800 C Editor Dr Alejandro Datas and his team of expert contributors from a variety of regions summarize the main technological options and the most relevant materials and characterization considerations to enable the reader to make the most effective and efficient decisions This book helps the reader to solve the very specific challenges associated with working within an ultra high temperature energy storage setting It condenses and summarizes the latest knowledge

covering fundamentals device design materials selection and applications as well as thermodynamic cycles and solid state devices for ultra high temperature energy conversion This book provides a comprehensive and multidisciplinary guide to engineers and researchers in a variety of fields including energy conversion storage cogeneration thermodynamics numerical methods CSP and materials engineering It firstly provides a review of fundamental concepts before exploring numerical methods for fluid dynamics and phase change materials before presenting more complex elements such as heat transfer fluids thermal insulation thermodynamic cycles and a variety of energy conversation methods including thermophotovoltaic thermionic and combined heat and power Reviews the main technologies enabling ultra high temperature energy storage and conversion including both thermodynamic cycles and solid state devices Includes the applications for ultra high temperature energy storage systems both in terrestrial and space environments Analyzes the thermophysical properties and relevant experimental and theoretical methods for the analysis of high temperature materials Mathematical Models in Finance S.D. Howison,F.P. Kelly,P. Wilmott,1995-05-15 Mathematical Models in Finance compiles papers presented at the Royal Society of London discussion meeting Topics range from the foundations of classical theory to sophisticated up to date mathematical modeling and analysis In the wake of the increased level of mathematical awareness in the financial research community attention has focused on fundamental issues of market modelling that are not adequately allowed for in the standard analyses Examples include market anomalies and nonlinear coupling effects and demand new synthesis of mathematical and numerical techniques This line of inquiry is further stimulated by ever tightening profits due to increased competition Several papers in this volume offer pointers to future developments in this area **Differential Models of Hysteresis** Augusto Visintin,2013-06-29 Hysteresis effects occur in science and engineering plasticity ferromagnetism ferroelectricity are well known examples Modelling and mathematical analysis of hysteresis phenomena have been addressed by mathematicians only recently but are now in full development This volume provides a self contained and comprehensive introduction to the analysis of hysteresis models and illustrates several new results in this field First the classical models of Prandtl Ishlinskii Preisach and Duhem are formulated and studied using the concept of hysteresis operator A new model of discontinuous hysteresis is introduced Several partial differential equations containing hysteresis operators are studied in the framework of Sobolev spaces **Advances in Building Services Engineering** Ioan Sarbu,2021-01-04 This book provides a comprehensive systematic overview of original theoretical experimental and numerical studies in the building services engineering domain It brings together different strands of the topic guided by the two key features of energy savings and reduction of the pollutant emissions Technical economic and energy efficiency aspects related to the design modelling optimisation and operation of diverse building services systems are explored This book includes various theoretical studies numerical and optimisation models experiments and applications in this field giving an emphasis to indoor environment quality assurance energy analysis modelling and optimisation of heating systems improving the energy performance of

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CRC Handbook of Thermal Engineering Raj P. Chhabra,2017-11-08 The CRC Handbook of Thermal Engineering Second Edition is a fully updated version of this respected reference work with chapters written by leading experts Its first part covers basic concepts equations and principles of thermodynamics heat transfer and fluid dynamics Following that is detailed coverage of major application areas such as bioengineering energy efficient building systems traditional and renewable energy sources food processing and aerospace heat transfer topics The latest numerical and computational tools microscale and nanoscale engineering and new complex structured materials are also presented Designed for easy reference this new edition is a must have volume for engineers and researchers around the globe **Computational Fluid and Solid Mechanics** K.J. Bathe,2001-05-21 The MIT mission to bring together Industry and Academia and to nurture the next generation in computational mechanics is of great importance to reach the new level of mathematical modeling and numerical solution and to provide an exciting research environment for the next generation in computational mechanics Mathematical modeling and numerical solution is today firmly established in science and engineering Research conducted in almost all branches of scientific investigations and the design of systems in practically all disciplines of engineering can not be pursued effectively without frequently intensive analysis based on numerical computations The world we live in has been classified by the human mind for descriptive and analysis purposes to consist of fluids and solids continua and molecules and the analyses of fluids and solids at the continuum and molecular scales have traditionally been pursued separately Fundamentally however there are only molecules and particles for any material that interact on the microscopic and macroscopic scales Therefore to unify the analysis of physical systems and to reach a deeper understanding of the behavior of nature in scientific investigations and of the behavior of designs in engineering endeavors a new level of analysis is necessary This new level of mathematical modeling and numerical solution does not merely involve the analysis of a single medium but must encompass the solution of multi physics problems involving fluids solids and their interactions involving multi scale phenomena from the molecular to the macroscopic scales and must include uncertainties in the given data and the solution results Nature does not distinguish between fluids and solids and does not ever repeat itself exactly This new level of analysis must also include in engineering the effective optimization of systems and the modeling and analysis of complete life spans of engineering products from design to fabrication to possibly multiple repairs to end of service

Mathematical Modelling and Simulation of Electrical Circuits and Semiconductor Devices Randolph Bank,R. Bulirsch,H. Gajewski,K. Merten,2012-12-06 Progress in today s high technology industries is strongly associated with the

development of new mathematical tools A typical illustration of this partnership is the mathematical modelling and numerical simulation of electric circuits and semiconductor devices At the second Oberwolfach conference devoted to this important and timely field scientists from around the world mainly applied mathematicians and electrical engineers from industry and universities presented their new results Their contributions forming the body of this work cover electric circuit simulation device simulation and process simulation Discussions on experiences with standard software packages and improvements of such packages are included In the semiconductor area special lectures were given on new modelling approaches numerical techniques and existence and uniqueness results In this connection mention is made for example of mixed finite element methods an extension of the Baliga Patankar technique for a three dimensional simulation and the connection between semiconductor equations and the Boltzmann equations *Handbook of Differential Equations: Evolutionary Equations* C.M. Dafermos,Milan Pokorny,2008-10-06 The material collected in this volume discusses the present as well as expected future directions of development of the field with particular emphasis on applications The seven survey articles present different topics in Evolutionary PDE s written by leading experts Review of new results in the area Continuation of previous volumes in the handbook series covering Evolutionary PDEs Written by leading experts Progress in Industrial Mathematics at ECMI 2000 Angelo M. Anile,Vincenzo Capasso,Antonio Greco,2013-06-29 Realizing the need of interaction between universities and research groups in industry the European Consortium for Mathematics in Industry ECMI was founded in 1986 by mathematicians from ten European universities Since then it has been continuously extending and now it involves about all Euro pean countries The aims of ECMI are To promote the use of mathematical models in industry To educate industrial mathematicians to meet the growing demand for such experts To operate on a European Scale Mathematics as the language of the sciences has always played an im portant role in technology and now is applied also to a variety of problems in commerce and the environment European industry is increasingly becoming dependent on high technology and the need for mathematical expertise in both research and development can only grow These new demands on mathematics have stimulated academic interest in Industrial Mathematics and many mathematical groups world wide are committed to interaction with industry as part of their research activities ECMI was founded with the intention of offering its collective knowledge and expertise to European Industry The experience of ECMI members is that similar technical problems are encountered by different companies in different countries It is also true that the same mathematical expertise may often be used in differing industrial applications Clean Energy and Fuel (Hydrogen) Storage Sesha S. Srinivasan,Elias K. Stefanakos,2019-10-16 Clean energy and fuel storage are often required for both stationary and automotive applications Some of these clean energy and fuel storage technologies currently under extensive research and development include hydrogen storage direct electric storage mechanical energy storage solar thermal energy storage electrochemical batteries and supercapacitors and thermochemical storage The gravimetric and volumetric storage capacity energy storage density

power output operating temperature and pressure cycle life recyclability and cost of clean energy or fuel storage are some of the factors that govern efficient energy and fuel storage technologies for potential deployment in energy harvesting solar and wind farms stations and onboard vehicular transportation This Special Issue thus serves the need for promoting exploratory research and development on clean energy and fuel storage technologies while addressing their challenges to practical and sustainable infrastructures **Proceedings of the 5th International Symposium on Uncertainty Quantification and Stochastic Modelling** José Eduardo Souza De Cursi,2020-08-19 This proceedings book discusses state of the art research on uncertainty quantification in mechanical engineering including statistical data concerning the entries and parameters of a system to produce statistical data on the outputs of the system It is based on papers presented at Uncertainties 2020 a workshop organized on behalf of the Scientific Committee on Uncertainty in Mechanics M canique et Incertain of the AFM French Society of Mechanical Sciences the Scientific Committee on Stochastic Modeling and Uncertainty Quantification of the ABCM Brazilian Society of Mechanical Sciences and the SBMAC Brazilian Society of Applied Mathematics *Pattern Formation at Interfaces* Pierre Colinet,Alexander Nepomnyashchy,2010-03-26 The book deals with modern methods of nonlinear stability theory applied to problems of continuous media mechanics in the presence of interfaces with applications to materials science chemical engineering heat transfer technologies as well as in combustion and other reaction diffusion systems Interfaces play a dominant role at small scales and their correct modeling is therefore also crucial in the rapidly expanding fields of microfluidics and nanotechnologies To this aim the book combines contributions of eminent specialists in the field with a special emphasis on rigorous and predictive approaches Other goals of this volume are to allow the reader to identify key problems of high scientific value and to see the similarity between a variety of seemingly different physical problems Free Boundary Problems in PDEs and Particle Systems Gioia Carinci,Anna De Masi,Cristian Giardina,Errico Presutti,2016-06-22 In this volume a theory for models of transport in the presence of a free boundary is developed Macroscopic laws of transport are described by PDE s When the system is open there are several mechanisms to couple the system with the external forces Here a class of systems where the interaction with the exterior takes place in correspondence of a free boundary is considered Both continuous and discrete models sharing the same structure are analysed In Part I a free boundary problem related to the Stefan Problem is worked out in all details For this model a new notion of relaxed solution is proposed for which global existence and uniqueness is proven It is also shown that this is the hydrodynamic limit of the empirical mass density of the associated particle system In Part II several other models are discussed The expectation is that the results proved for the basic model extend to these other cases All the models discussed in this volume have an interest in problems arising in several research fields such as heat conduction queuing theory propagation of fire interface dynamics population dynamics evolution of biological systems with selection mechanisms In general researchers interested in the relations between PDE s and stochastic processes can find in this volume an extension of this correspondence to

modern mathematical physics *Energy Research Abstracts* ,1990

The book delves into Mathematical Models For Phase Change Problems. Mathematical Models For Phase Change Problems is a vital topic that needs to be grasped by everyone, from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Mathematical Models For Phase Change Problems, encompassing both the fundamentals and more intricate discussions.

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4. In chapter 3, the author will examine the practical applications of Mathematical Models For Phase Change Problems in daily life. The third chapter will showcase real-world examples of how Mathematical Models For Phase Change Problems can be effectively utilized in everyday scenarios.
5. In chapter 4, the author will scrutinize the relevance of Mathematical Models For Phase Change Problems in specific contexts. The fourth chapter will explore how Mathematical Models For Phase Change Problems is applied in specialized fields, such as education, business, and technology.
6. In chapter 5, this book will draw a conclusion about Mathematical Models For Phase Change Problems. This chapter will summarize the key points that have been discussed throughout the book.

The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. It is highly recommended for anyone seeking to gain a comprehensive understanding of Mathematical Models For Phase Change Problems.

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