

1. Record Nr.	UNINA9910810441703321
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Titolo	Computational thermo-fluid dynamics : in materials science and engineering // Petr A. Nikrityuk
Pubbl/distr/stampa	Weinheim, Germany, : Wiley-VCH Verlag, c2011
ISBN	3-527-63608-0 1-280-66276-X 9786613639691 3-527-63607-2 3-527-63609-9
Edizione	[2nd ed.]
Descrizione fisica	1 online resource (371 p.)
Disciplina	333.79 620.11
Soggetti	Materials - Thermal properties - Mathematical models Thermodynamics - Mathematical models Fluid dynamics - Mathematical models Heat - Transmission - Mathematical models Mass transfer - Mathematical models
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Note generali	Description based upon print version of record.
Nota di bibliografia	Includes bibliographical references and index.
Nota di contenuto	Computational Thermo-Fluid Dynamics; Contents; Preface; Acknowledgments; 1 Introduction; 1.1 Heat and Fluid Flows in Materials Science and Engineering; 1.2 Overview of the Present Work; 2 Mathematical Description of Physical Phenomena in Thermofluid Dynamics; 2.1 Conservation Equations for Continuum Media; 2.1.1 Conservation of Mass; 2.1.2 Conservation of Momentum; 2.1.3 Energy Conservation Equation; 2.1.4 Conservation of Chemical Species; 2.1.5 Boussinesq Approximation; 2.1.6 Unified Form of Conservation Equations; 2.1.7 Nondimensional Form of Conservation Equations; 2.1.8 Short Summary 2.2 Boundary and Initial Conditions 2.2.1 Heat Transfer; 2.2.2 Solutal Transfer; 2.2.3 Fluid Dynamics; 2.3 Conservation Equations in Electromagnetics; 2.3.1 Maxwell Equations; 2.3.2 Induction and Poisson Equations; 2.3.3 An Example of a Low Magnetic Reynolds Number

Approximation: Rotating Magnetic Field; 3 Discretization Approaches and Numerical Methods; 3.1 The Finite Difference Method; 3.1.1 Introduction; 3.1.2 Approximation Schemes; 3.1.3 Example of Conservative Property of FDM; 3.1.4 Discretization Schemes of Unsteady Equations; 3.1.5 Example of Unsteady Diffusion Equation 3.2 The Finite Volume Method 3.2.1 Basic Concept; 3.2.2 Interpolation Schemes; 3.2.3 Linearized Form of Discretized Conservation Equation; 3.2.4 Treatment of Source Terms; 3.2.5 Boundary Conditions; 3.2.6 Comparative Study of Schemes for One-Dimensional Convection/Diffusion Problem; 3.3 Solution of Linear Equation Systems; 3.3.1 Direct Methods; 3.3.2 Iterative Methods; 3.3.3 Residuals and Convergence; 3.3.4 Multigrid Method; 3.3.5 Illustration of Iterative Methods; 4 Calculations of Flows with Heat and Mass Transfer; 4.1 Solution of Incompressible Navier-Stokes Equations 4.2 Pressure and Velocity Coupling: SIMPLE Family 4.2.1 SIMPLE; 4.2.2 SIMPLER; 4.2.3 SIMPLE with Collocated Variables Arrangement; 4.3 Illustrations of Schemes for Flow with Heat Transfer; 4.4 Complex Geometry Problems on Fixed Cartesian Grids; 4.4.1 Immersed Boundary Methods; 4.4.2 Cartesian Grid Methods; 4.4.3 Immersed Surface Reconstruction; 4.4.4 Illustration of Continuous-Forcing IBM; 5 Convection-Diffusion Phase-Change Problems; 5.1 Some Aspects of Solidification Thermodynamics; 5.1.1 One-Component Melts; 5.1.2 Binary Alloys; 5.1.3 Interface and Equilibrium 5.2 Modeling of Macroscale Phase-Change Phenomena 5.2.1 Heat Transfer in Phase-Change Systems: Fixed and Moving Grids; 5.2.2 Mathematical Models of a Binary Alloy Solidification; 5.2.3 Closure Relations for the Volume Fraction of Liquid; 5.3 Turbulent Solidification; 5.3.1 Review of Unsteady RANS Modeling of a Solidification; 5.3.2 Conditions for the DNS of Convection-Driven Solidification; 5.4 Microscale Phase-Change Phenomena; 5.4.1 Basic Modeling Concepts; 5.4.2 Modified Cellular Automaton Model; 5.4.3 Virtual Interface Tracking Model; 5.5 Modeling of Crystal Growth 5.5.1 Modeling Approaches

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## Sommario/riassunto

Combining previously unconnected computational methods, this monograph discusses the latest basic schemes and algorithms for the solution of fluid, heat and mass transfer problems coupled with electrodynamics. It presents the necessary mathematical background of computational thermo-fluid dynamics, the numerical implementation and the application to real-world problems. Particular emphasis is placed throughout on the use of electromagnetic fields to control the heat, mass and fluid flows in melts and on phase change phenomena during the solidification of pure materials and binary alloys. However

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