

Pierre A. Deymier *Editor*

Acoustic Metamaterials and Phononic Crystals



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Acoustic Metamaterials And Phononic Crystals Springer Series In Solid State Sciences

Pierre A. Deymier



Acoustic Metamaterials And Phononic Crystals Springer Series In Solid State Sciences:

Acoustic Metamaterials and Phononic Crystals Pierre A. Deymier, 2013-01-13 This comprehensive book presents all aspects of acoustic metamaterials and phononic crystals The emphasis is on acoustic wave propagation phenomena at interfaces such as refraction especially unusual refractive properties and negative refraction A thorough discussion of the mechanisms leading to such refractive phenomena includes local resonances in metamaterials and scattering in phononic crystals

Fundamentals and Applications of Acoustic Metamaterials Vicente Romero-Garcia, Anne-Christine Hladky-Hennion, 2019-09-11 In the last few decades metamaterials have revolutionized the ways in which waves are controlled and applied in physics and practical situations The extraordinary properties of metamaterials such as their locally resonant structure with deep subwavelength band gaps and their ranges of frequency where propagation is impossible have opened the way to a host of applications that were previously unavailable Acoustic metamaterials have been able to replace traditional treatments in several sectors due to their better performance in targeted and tunable frequency ranges with strongly reduced dimensions This is a training book composed of nine chapters written by experts in the field giving a broad overview of acoustic metamaterials and their uses The book is divided into three parts covering the state of the art the fundamentals and the real life applications of acoustic metamaterials

Acoustic Waves in Periodic Structures, Metamaterials, and Porous Media Noé Jiménez, Olga Umnova, Jean-Philippe Groby, 2021-11-03 This book delivers a comprehensive and up to date treatment of practical applications of metamaterials structured media and conventional porous materials With increasing levels of urbanization a growing demand for motorized transport and inefficient urban planning environmental noise exposure is rapidly becoming a pressing societal and health concern Phononic and sonic crystals acoustic metamaterials and metasurfaces can revolutionize noise and vibration control and in many cases replace traditional porous materials for these applications In this collection of contributed chapters a group of international researchers reviews the essentials of acoustic wave propagation in metamaterials and porous absorbers with viscothermal losses as well as the most recent advances in the design of acoustic metamaterial absorbers The book features a detailed theoretical introduction describing commonly used modelling techniques such as plane wave expansion multiple scattering theory and the transfer matrix method The following chapters give a detailed consideration of acoustic wave propagation in viscothermal fluids and porous media and the extension of this theory to non local models for fluid saturated metamaterials along with a description of the relevant numerical methods Finally the book reviews a range of practical industrial applications making it especially attractive as a white book targeted at the building automotive and aeronautic industries

Discrete and Continuum Models for Complex Metamaterials Francesco dell'Isola, David J. Steigmann, 2020-03-12 Explores the relationship between discrete and continuum mechanics as a tool to model new and complex metamaterials Including a comprehensive bibliography and historical review of the field and a pedagogical mathematical treatment it is ideal for graduate students and

researchers in mechanical and civil engineering and materials science

Electronic States in Crystals of Finite Size

Shang Yuan Ren, 2017-08-31 This book presents an analytical theory of the electronic states in ideal low dimensional systems and finite crystals based on a differential equation theory approach. It provides precise and fundamental understandings on the electronic states in ideal low dimensional systems and finite crystals and offers new insights into some of the basic problems in low dimensional systems such as the surface states and quantum confinement effects etc some of which are quite different from what is traditionally believed in the solid state physics community. Many previous predictions have been confirmed in subsequent investigations by other authors on various relevant problems. In this new edition the theory is further extended to one dimensional photonic crystals and phononic crystals and a general theoretical formalism for investigating the existence and properties of surface states modes in semi infinite one dimensional crystals is developed. In addition there are various revisions and improvements including using the Kronig Penney model to illustrate the analytical theory and make it easier to understand. This book is a valuable resource for solid state physicists and material scientists.

Wave Dynamics, Mechanics and Physics of Microstructured Metamaterials Mezhlum A. Sumbatyan, 2019-05-17 This book addresses theoretical and experimental methods for exploring microstructured metamaterials with a special focus on wave dynamics mechanics and related physical properties. The authors use various mathematical and physical approaches to examine the mechanical properties inherent to particular types of metamaterials. These include Boundary value problems in reduced strain gradient elasticity for composite fiber reinforced metamaterials. Self organization of molecules in ferroelectric thin films. Combined models for surface layers of nanostructures. Computer simulation at the micro and nanoscale. Surface effects with anisotropic properties and imperfect temperature contacts. Inhomogeneous anisotropic metamaterials with uncoupled and coupled surfaces or interfaces. Special interface finite elements and other numerical and analytical methods for composite structures.

Acoustic Metamaterials and Phononic Crystals Pierre A. Deymier, 2013-01-13 This comprehensive book presents all aspects of acoustic metamaterials and phononic crystals. The emphasis is on acoustic wave propagation phenomena at interfaces such as refraction especially unusual refractive properties and negative refraction. A thorough discussion of the mechanisms leading to such refractive phenomena includes local resonances in metamaterials and scattering in phononic crystals.

Sound Topology, Duality, Coherence and Wave-Mixing Pierre Deymier, Keith Runge, 2017-08-12 This book offers an essential introduction to the notions of sound wave topology duality coherence and wave mixing which constitute the emerging new science of sound. It includes general principles and specific examples that illuminate new non conventional forms of sound sound topology unconventional quantum like behavior of phonons duality radical linear and nonlinear phenomena associated with loss and its control coherence and exquisite effects that emerge from the interaction of sound with other physical and biological waves wave mixing. The book provides the reader with the foundations needed to master these complex notions through simple yet meaningful examples. General principles for

unraveling and describing the topology of acoustic wave functions in the space of their Eigen values are presented These principles are then applied to uncover intrinsic and extrinsic approaches to achieving non conventional topologies by breaking the time reversal symmetry of acoustic waves Symmetry breaking can impart topological immunity to wave degradation from imperfection scattering and catalyze controlled coherence In the intrinsic case and the phonon representation of acoustic waves the self interaction interference of a wave through its supporting medium exposes the notion of duality in the quantum statistics i e boson vs fermion characterized by the symmetry of multiple particle states and how the quantum analogue behaviors of sound can be exploited in the form of novel sound based information transfer and processing devices By considering media that mix different types of waves the book addresses the interaction of sound with other physical and biological waves but also brings to light examples of extrinsic processes that can lead to symmetry breaking The coherent conversion of sound into other types of waves as well as the sound induced non conventional topology of elastic electronic spin and biological waves are presented in the case of media exhibiting elasto electronic photo elastic magneto elastic effects and biological mechano transduction

New Achievements in Continuum Mechanics and Thermodynamics Bilen Emek Abali,Holm Altenbach,Francesco dell'Isola,Victor A. Eremeyev,Andreas Öchsner,2019-03-13 This book presents a liber amicorum dedicated to Wolfgang H M ller and highlights recent advances in Prof M ller s major fields of research continuum mechanics generalized mechanics thermodynamics mechanochemistry and geomechanics Over 50 of Prof M ller s friends and colleagues contributed to this book which commemorates his 60th birthday and was published in recognition of his outstanding contributions

Frontiers in Materials: Rising Stars Nicola Maria Pugno,Diego Cazorla-Amoros,Jie-Sheng Chen,Guang-Ling Song,Sheikh A Akbar,Lothar Wondraczek,Alessandro Pegoretti,Seung-Bok Choi,John L. Provis,Jinn P. Chu,Krisztian Kordas,Liming Dai,2020-04-17 The Frontiers in Materials Editorial Office team are delighted to present the inaugural Frontiers in Materials Rising Stars article collection showcasing the high quality work of internationally recognized researchers in the early stages of their independent careers All Rising Star researchers featured within this collection were individually nominated by the Journal s Chief Editors in recognition of their potential to influence the future directions in their respective fields The work presented here highlights the diversity of research performed across the entire breadth of the materials science and engineering field and presents advances in theory experiment and methodology with applications to compelling problems This Editorial features the corresponding author s of each paper published within this important collection ordered by section alphabetically highlighting them as the great researchers of the future The Frontiers in Materials Editorial Office team would like to thank each researcher who contributed their work to this collection We would also like to personally thank our Chief Editors for their exemplary leadership of this article collection their strong support and passion for this important community driven collection has ensured its success and global impact Laurent Mathey PhD Journal Development Manager

Generalized Models and Non-classical Approaches in

Complex Materials 1 Holm Altenbach,Joël Pouget,Martine Rousseau,Bernard Collet,Thomas Michelitsch,2018-03-24 This book is the first of 2 special volumes dedicated to the memory of Gerard Maugin Including 40 papers that reflect his vast field of scientific activity the contributions discuss non standard methods generalized model to demonstrate the wide range of subjects that were covered by this exceptional scientific leader The topics range from micromechanical basics to engineering applications focusing on new models and applications of well known models to new problems They include micro macro aspects computational endeavors options for identifying constitutive equations and old problems with incorrect or non satisfying solutions based on the classical continua assumptions

Dynamical Processes in Generalized Continua and Structures Holm Altenbach,Alexander Belyaev,Victor A. Eremeyev,Anton Krivtsov,Alexey V. Porubov,2019-03-06 This book presents a collection of chapters on the current problems of the theory of dynamical processes in generalized continua and structures and has been compiled to commemorate the 70th birthday of Prof Dmitry Indeitsev a leading specialist in the field of dynamical processes in solids fluids and structures It discusses various applications related to Prof Indeitsev s contributions including various discrete and continuous dynamic models of structures and media as well as a number of dynamical processes in generalized media

Phonons in Low Dimensional Structures Vasilios N. Stavrou,2018-12-12 The field of low dimensional structures has been experiencing rapid development in both theoretical and experimental research *Phonons in Low Dimensional Structures* is a collection of chapters related to the properties of solid state structures dependent on lattice vibrations The book is divided into two parts In the first part research topics such as interface phonons and polaron states carrier phonon non equilibrium dynamics directional projection of elastic waves in parallel array of N elastically coupled waveguides collective dynamics for longitudinal and transverse phonon modes and elastic properties for bulk metallic glasses are related to semiconductor devices and metallic glasses devices The second part of the book contains among others topics related to superconductor phononic crystal carbon nanotube devices such as phonon dispersion calculations using density functional theory for a range of superconducting materials phononic crystal based MEMS resonators absorption of acoustic phonons in the hyper sound regime in fluorine modified carbon nanotubes and single walled nanotubes phonon transport in carbon nanotubes quantization of phonon thermal conductance and phonon Anderson localization

Dynamics of Lattice Materials A. Srikantha Phani,Mahmoud I. Hussein,2017-09-25 Provides a comprehensive introduction to the dynamic response of lattice materials covering the fundamental theory and applications in engineering practice Offers comprehensive treatment of dynamics of lattice materials and periodic materials in general including phononic crystals and elastic metamaterials Provides an in depth introduction to elastostatics and elastodynamics of lattice materials Covers advanced topics such as damping nonlinearity instability impact and nanoscale systems Introduces contemporary concepts including pentamodes local resonance and inertial amplification Includes chapters on fast computation and design optimization tools Topics are introduced using simple systems and generalized to more complex

structures with a focus on dispersion characteristics

Tensegrity Systems Fernando Fraternali, Julian J.

Rimoli, 2025-03-06 This book illustrates the unique mechanical behaviors of tensegrity systems and their applications in mechanical metamaterials space structures and biomechanical models It demonstrates that by controlling the mechanical response of tensegrity structures through internal and external prestress it is possible to adjust the speed of mechanical waves within these systems creating tunable bandgap structures Furthermore the geometrically nonlinear response exhibited by several tensegrity systems allows for the support of either compression or rarefaction solitary wave dynamics These behaviors can be effectively utilized to design novel devices capable of focusing mechanical waves in narrow regions of space as well as innovative impact protection systems After an introduction to the basic concepts and calculation methods for tensegrity systems and their minimal mass design the chapters explore the metamaterial behaviors of tensegrity systems associated with bandgap and solitary wave dynamics present a mechanical model of flexible tensegrities illustrating how harnessing the buckling of bars in such systems can result in structures with exceptional energy absorption capabilities suitable for applications such as planetary landers or lattice metamaterials and discuss the extreme mechanical behaviors achievable in tensegrity inspired lattice structures exhibiting both soft and stiff deformation modes The last chapters address the multifaceted field of biotensegrity and provide an overview of current rapid prototyping techniques for tensegrity systems along with a discussion of open questions and research opportunities in the field Acoustic and Mechanical Metamaterials

for Various Applications Fuyin Ma, Siyuan Dai, Han Jia, Yan-Feng Wang, Yong Xiao, 2022-09-23

Dynamic Equivalent

Modeling of Acoustic Metamaterials Nansha Gao, Jie Deng, 2022-10-17 This book derives physical models from basic principles studies the effect of equivalent models on the dynamic characteristics of phononic crystals and acoustic metamaterials and analyzes the physical mechanisms behind vibration and noise reduction It first summarizes the research status of vibration and noise reduction and research progress in phononic crystals and acoustic metamaterials Based on this one dimensional periodic beam two dimensional thin plate with circular hole and corresponding gradient structures are introduced and their dynamic characteristics are discussed in detail Therefore different equivalent methods for different models are proposed through theoretical analysis modal analysis and transmission rate analysis Finally a Helmholtz type acoustic metamaterial i.e a multi layer slotted tube acoustic metamaterial is studied Aiming at the low frequency band gap of this model a theoretical model for solving the inverse problem of acousto electric analogue equivalent is proposed and the effect of structural parameters on the low frequency band gap is studied using this equivalent model This book closely revolves around how to conduct equivalent research on artificially fabricated periodic structures The methods and conclusions presented in this book provide a new theoretical basis for the application of artificial woven periodic structures in the field of low frequency vibration reduction and noise reduction and are also an innovation in the discipline of vibration and noise control This book is suitable for undergraduate students graduate students and teachers in vibration and noise

majors in universities and can also provide references for engineering and technical personnel in related fields

Engineering Vibroacoustic Analysis Stephen A. Hambric, Shung H. Sung, Donald J. Nefske, 2016-02-16 The book describes analytical methods based primarily on classical modal synthesis the Finite Element Method FEM Boundary Element Method BEM Statistical Energy Analysis SEA Energy Finite Element Analysis EFEA Hybrid Methods FEM SEA and Transfer Path Analysis and Wave Based Methods The book also includes procedures for designing noise and vibration control treatments optimizing structures for reduced vibration and noise and estimating the uncertainties in analysis results Written by several well known authors each chapter includes theoretical formulations along with practical applications to actual structural acoustic systems Readers will learn how to use vibroacoustic analysis methods in product design and development how to perform transient frequency deterministic and random and statistical vibroacoustic analyses and how to choose appropriate structural and acoustic computational methods for their applications The book can be used as a general reference for practicing engineers or as a text for a technical short course or graduate course *Acoustic Metamaterials* Richard Craster, Sébastien Guenneau, 2024-11-16 The revised edition of this book offers an expanded review of acoustic metamaterials novel materials which can manipulate sound waves surface Rayleigh waves and water waves in surprising ways which include collimation focusing negative refraction passive and active cloaking sonic screening and extraordinary transmission It covers both experimental and theoretical aspects of acoustic and elastic waves propagating in structured composites with a focus on effective properties associated with negative refraction lensing and cloaking Updated chapters cover filtering effects extraordinary transmission sub wavelength imaging via tomography or time reversal techniques cloaking via transformation acoustics elastodynamics and acoustic scattering cancellation For this revised edition six new chapters have been introduced to reflect recent developments in experimental acoustics and metasurfaces including acoustic impedance gratings and mirror symmetric metamaterials phononic subsurfaces time modulated and topological crystals The latter two are illustrated by simple Python program examples The broad scope gives the reader an overview of the state of the art in acoustic metamaterials research and an indication of future directions and applications It will serve as a solid introduction to the field for advanced students and researchers in physics applied mathematics and mechanical engineering and a valuable reference for those working in metamaterials and related areas *Metamaterials in Topological Acoustics* Sourav Banerjee, 2023-10-13 As an equivalent counterpart of topological research on photonics and condensed matter physics acoustic metamaterials create an opportunity to explore the topological behaviors in phononics and physics of programmable acoustics This book introduces the topological behavior of acoustics through the novel design of metamaterials It provides valuable insight into acoustic metamaterials from multidisciplinary fundamentals to cutting edge research Serves as a single resource on acoustic metamaterials Covers the fundamentals of classical mechanics quantum mechanics and state of the art condensed matter physics principles so that topological acoustics can be easily understood by engineers Introduces

topological behaviors with acoustics and elastic waves through quantum analogue Hall effects quantum spin Hall effects and quantum valley Hall effects and their applications Explains the pros and cons of different design methods and gives guidelines for selecting specific designs of acoustic metamaterials with specific topological behaviors Includes MATLAB code for numerical analysis of band structures This book is written for graduate students researchers scientists and professionals across materials mechanical civil and aerospace engineering and those who want to enhance their understanding and commence research in metamaterials

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