

Metamaterials And Plasmonics Fundamentals Modelling Applications Nato Science For Peace And Security Series B Physics And Biophysics

Metamaterials—artificially structured materials with engineered electromagnetic properties—have enabled unprecedented flexibility in manipulating electromagnetic waves and producing new functionalities. This book details recent advances in the study of optical metamaterials, ranging from fundamental aspects to up-to-date implementations, in one unified treatment. Important recent developments and applications such as superlens and cloaking devices are also treated in detail and made understandable. The planned monograph can serve as a very timely book for both newcomers and advanced researchers in this extremely rapid evolving field.

Since the concept was first proposed at the end of the 20th Century, metamaterials have been the subject of much research and discussion throughout the wave community. More than 10 years later, the number of related published articles is increasing significantly. On the one hand, this success can be attributed to dreams of new physical objects which are the consequences of

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the singular properties of metamaterials. Among them, we can consider the examples of perfect lensing and invisibility cloaking. On other hand, metamaterials also provide new tools for the design of well-known wave functions such as antennas for electromagnetic waves. The goal of this book is to propose an overview of the concept of metamaterials as a perspective on a new practical tool for wave study and engineering. This includes both the electromagnetic spectrum, from microwave to optics, and the field of acoustic waves. Contents

1. Overview of Microwave and Optical Metamaterial Technologies, Didier Lippens.
2. MetaLines: Transmission Line Approach for the Design of Metamaterial Devices, Bruno Sauviac.
3. Metamaterials for Non-Radiative Microwave Functions and Antennas, Divitha Seetharamdoo and Bruno Sauviac.
4. Toward New Prospects for Electromagnetic Compatibility, Divitha Seetharamdoo.
5. Dissipative Loss in Resonant Metamaterials, Philippe Tassin, Thomas Koschny, and Costas M. Soukoulis.
6. Transformation Optics and Antennas, André de Lustrac, Shah Nawaz Burokur and Paul-Henri Tichit.
7. Metamaterials for Control of Surface Electromagnetic and Liquid Waves, Sébastien Guenneau, Mohamed Farhat, Muamer Kadic, Stefan Enoch and Romain Quidant.
8. Classical Analog of Electromagnetically Induced Transparency, Philippe Tassin, Thomas Koschny and Costas M. Soukoulis.

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This book discusses the active and passive radar cross section (RCS) estimation and techniques to examine the low observable aerospace platforms. It begins with the fundamentals of RCS, followed by the dielectric, magnetic and metamaterials parameters of the constituent materials and then explains various methods and the emerging trends followed in this area of study. The RCS estimation of phased array including the mutual coupling effect is also presented in detail in the book. The active RCS reduction is carefully touched upon through the performance of phased arrays, sidelobe cancellers and mitigation of multipath effect. Providing information on various adaptive algorithms like least mean square (LMS), recursive least square (RLS) and weighted least square algorithms, the authors also mention the recent developments in the area of embedded antennas, conformal load bearing antenna, metamaterials and frequency selective surface (FSS) based RCS reduction.

This book represents the first comprehensive overview over amorphous nano-optical and nano-photonics systems. Nanophotonics is a burgeoning branch of optics that enables many applications by steering the mould of light on length scales smaller than the wavelength with devoted nanostructures. Amorphous nanophotonics exploits self-organization mechanisms based on bottom-up approaches to fabricate nano-optical systems. The resulting structures presented

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in the book are characterized by a deterministic unit cell with tailored geometries; but their spatial arrangement is not controlled. Instead of periodic, the structures appear either amorphous or random. The aim of this book is to discuss all aspects related to observable effects in amorphous nanophotonic material and aspects related to their design, fabrication, characterization and integration into applications. The book has an interdisciplinary nature with contributions from scientists in physics, chemistry and materials sciences and sheds light on the topic from many directions.

This book provides an overview of the use of toroidal moments. This includes methods of excitation, numerical analysis, and experimental measurements of associating structures. Special emphasis is placed on understanding the fundamental physics, characteristics, and real-world applications of toroidal multipoles. This book also covers a variety of both planar and 3D meta-atom and metamolecule schemes capable to sustain toroidal moments across a wide range of spectrum. It discusses the implementation of innovative approaches, for exploring the spectral features and excitation methodologies, predicting the properties of the correlating metasystems in their excited states. An applicable text for undergraduate, graduate, and postgraduate students, this book is also of interest to researchers, theorizers, and experimentalists working in optical

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physics, photonics, and nanotechnology.

Most available books on computational electrodynamics are focused on FDTD, FEM, or other specific technique developed in microwave engineering. In contrast, Fourier Modal Method and Its Applications in Computational Nanophotonics is a complete guide to the principles and detailed mathematics of the up-to-date Fourier modal method of optical analysis. It takes readers through the implementation of MATLAB® codes for practical modeling of well-known and promising nanophotonic structures. The authors also address the limitations of the Fourier modal method. Features Provides a comprehensive guide to the principles, methods, and mathematics of the Fourier modal method Explores the emerging field of computational nanophotonics Presents clear, step-by-step, practical explanations on how to use the Fourier modal method for photonics and nanophotonics applications Includes the necessary MATLAB codes, enabling readers to construct their own code Using this book, graduate students and researchers can learn about nanophotonics simulations through a comprehensive treatment of the mathematics underlying the Fourier modal method and examples of practical problems solved with MATLAB codes. Theory and Phenomena of Metamaterials offers an in-depth look at the theoretical background and basic properties of electromagnetic artificial

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materials, often called metamaterials. A volume in the Metamaterials Handbook, this book provides a comprehensive guide to working with metamaterials using topics presented in a concise review format along with numerous references. With contributions from leading researchers, this text covers all areas where artificial materials have been developed. Each chapter in the text features a concluding summary as well as various cross references to address a wide range of disciplines in a single volume.

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.

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Leading experts explore the exotic properties and exciting applications of electromagnetic metamaterials. *Metamaterials: Physics and Engineering Explorations* gives readers a clearly written, richly illustrated introduction to the most recent research developments in the area of electromagnetic metamaterials. It explores the fundamental physics, the designs, and the engineering aspects, and points to a myriad of exciting potential applications. The editors, acknowledged leaders in the field of metamaterials, have invited a group of leading researchers to present both their own findings and the full array of state-of-the-art applications for antennas, waveguides, devices, and components. Following a brief overview of the history of artificial materials, the publication divides its coverage into two major classes of metamaterials. The first half of the publication examines effective media with single (SNG) and double negative (DNG) properties; the second half examines electromagnetic band gap (EBG) structures. The book further divides each of these classes into their three-dimensional (3D volumetric) and two-dimensional (2D planar or surface) realizations. Examples of each type of metamaterial are presented, and their known and anticipated properties are reviewed. Collectively, *Metamaterials: Physics and Engineering Explorations* presents a review of recent research advances associated with a highly diverse

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set of electromagnetic metamaterials. Its multifaceted approach offers readers a combination of theoretical, numerical, and experimental perspectives for a better understanding of their behaviors and their potential applications in components, devices, and systems. Extensive reference lists provide opportunities to explore individual topics and classes of metamaterials in greater depth. With full-color illustrations throughout to clarify concepts and help visualize actual results, this book provides a dynamic, user-friendly resource for students, engineers, physicists, and other researchers in the areas of electromagnetic materials, microwaves, millimeter waves, and optics. It equips newcomers with a basic understanding of metamaterials and their potential applications. Advanced researchers will benefit from thought-provoking perspectives that will deepen their knowledge and lead them to new areas of investigation.

Hyperbolic metamaterials were originally introduced to overcome the diffraction limit of optical imaging. Soon thereafter it was realized that hyperbolic metamaterials demonstrate a number of novel phenomena resulting from the broadband singular behavior of their density of photonic states. These novel phenomena and applications include super resolution imaging, new stealth technologies, enhanced quantum-electrodynamic effects, thermal hyperconductivity, superconductivity, and interesting gravitation theory analogs.

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Here I review typical material systems, which exhibit hyperbolic behavior and outline important new applications of hyperbolic metamaterials, such as imaging experiments with plasmonic hyperbolic metamaterials and novel VCSEL geometries, in which the Bragg mirrors may be engineered in such a way that they exhibit hyperbolic properties in the long wavelength infrared range, so that they may be used to efficiently remove excess heat from the laser cavity. I will also discuss potential applications of self-assembled photonic hypercrystals. This system bypasses 3D nanofabrication issues, which typically limit hyperbolic metamaterial applications. Photonic hypercrystals combine the most interesting features of hyperbolic metamaterials and photonic crystals.

The five-volume set may serve as a comprehensive reference on electromagnetic analysis and its applications at all frequencies, from static fields to optics and photonics. The material includes micro- and nanomagnetism, the new generation of electric machines, renewable energy, hybrid vehicles, low-noise motors; antennas and microwave devices, plasmonics, metamaterials, lasers, and more. Written at a level accessible to both graduate students and engineers, *Electromagnetic Analysis* is a comprehensive reference, covering methods and applications at all frequencies (from statics to optical). Each volume contains pedagogical/tutorial material of high archival value as well as chapters

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on state-of-the-art developments.

The interest towards photonic crystals and metamaterials and their strategic importance are evident in the steadily growing rate of topical publications. This title addresses that ranges topics, including aspects pertaining to modeling, phenomenologies, experiments, technologies and applications.

Phenomena of Optical Metamaterials provides an overview of phenomena enabled by artificial and designed metamaterials and their application for photonic devices. The book explores the study of active metamaterials with tunable and switchable properties and novel functionalities, such as the control of spontaneous emission and enhancement. Topics addressed cover theory, modelling and design, applications in practical devices, fabrication, characterization, and measurement, thus helping readers understand and develop new artificial, functional materials. Addresses disorder in metamaterials from the perspective of different viewpoints Introduces basic metamaterial modelling approaches and phenomena enabled by metamaterials Discusses the latest advances in metamaterials, including hyperbolic metamaterials, disorder in metamaterials, active metamaterials, quantum and atomic metamaterials This book presents a collection of extended contributions on the physics and application of optoelectronic materials and metamaterials. The book is divided

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into three parts, respectively covering materials, metamaterials and optoelectronic devices. Individual chapters cover topics including phonon-polariton interaction, semiconductor and nonlinear organic materials, metallic, dielectric and gyrotropic metamaterials, singular optics, parity-time symmetry, nonlinear plasmonics, microstructured optical fibers, passive nonlinear shaping of ultrashort pulses, and pulse-preserving supercontinuum generation. The book contains both experimental and theoretical studies, and each contribution is a self-contained exposition of a particular topic, featuring an extensive reference list. The book will be a useful resource for graduate and postgraduate students, researchers and engineers involved in optoelectronics/photronics, quantum electronics, optics, and adjacent areas of science and technology. Considered a major field of photonics, plasmonics offers the potential to confine and guide light below the diffraction limit and promises a new generation of highly miniaturized photonic devices. This book combines a comprehensive introduction with an extensive overview of the current state of the art. Coverage includes plasmon waveguides, cavities for field-enhancement, nonlinear processes and the emerging field of active plasmonics studying interactions of surface plasmons with active media.

The design and study of materials is a pivotal component to new discoveries in

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the various fields of science and technology. By understanding the components and structures of materials, researchers can increase its applications across different industries. Modeling and Simulations for Metamaterials: Emerging Research and Opportunities is a critical scholarly resource that examines the physics of metamaterials with an emphasis on negative-index metamaterials and their applications at terahertz frequencies. Featuring coverage on a broad range of topics, such as electromagnetic waves, harmonic oscillator model, and scattering analysis, this book is geared towards academicians, researchers, engineers, industrialists, and graduate students researching in the field.

Der zweigeteilte Band 3 des vierteiligen Lehrbuchs vermittelt weitere Materialien und Systeme sowie analytische Methoden und Verfahren in der Nanostrukturforschung und der Nanotechnologie. Dabei wird theoretischen und experimentellen Ansätzen sowie dem interdisziplinären Charakter des Gesamtgebiets gleichermaßen Rechnung getragen. Basierend auf etablierten Erkenntnissen aus den jeweils relevanten natur- und ingenieurwissenschaftlichen Disziplinen liegt der Fokus des Lehrbuchs auf den aktuellsten Ergebnissen aus Forschung, Entwicklung und auch Anwendung. Sehr ausführliche Behandlung struktureller, mechanischer, elektronischer, magnetischer, optischer, chemischer und biologischer Eigenschaften von Nanopartikeln. Herstellung und Anwendungen von Nanopartikeln der unterschiedlichsten Materialien. Grundlagen der zwei-, ein- und nulldimensionalen Materialsysteme. Unterschiedlichste monoatomare Schichten und ihre

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elektronischen Eigenschaften. Quantendrähte und Quantenpunkte und ihre Anwendungen in Elektronik und Optoelektronik. Metamaterialien und ihre spektakulären Eigenschaften. Superlinsen und photonische Kristalle.

Fundamentals and Applications of Nanophotonics includes a comprehensive discussion of the field of nanophotonics, including key enabling technologies that have the potential to drive economic growth and impact numerous application domains such as ICT, the environment, healthcare, military, transport, manufacturing, and energy. This book gives readers the theoretical underpinnings needed to understand the latest advances in the field. After an introduction to the area, chapters two and three cover the essential topics of electrodynamics, quantum mechanics, and computation as they relate to nanophotonics. Subsequent chapters explore materials for nanophotonics, including nanoparticles, photonic crystals, nanosilicon, nanocarbon, III-V, and II-VI semiconductors. In addition, fabrication and characterization techniques are addressed, along with the importance of plasmonics, and the applications of nanophotonics in devices such as lasers, LEDs, and photodetectors. Covers electrodynamics, quantum mechanics and computation as these relate to nanophotonics Reviews materials, fabrication and characterization techniques for nanophotonics Describes applications of the technology such as lasers, LEDs and photodetectors

Analytical Modeling in Applied Electromagnets encompasses the most complete treatment on the subject published to date, focusing on the nature of models in radio engineering. This leading-edge resource brings you detailed coverage of the latest topics, including metamaterials, photonic bandgaps and artificial impedance surfaces, and applies these concepts to a wide range of applications. The book provides you with working examples that

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are mainly directed to antenna applications, but the modeling methods and results can be used for other practical devices as well.

This book, edited by two of the most respected researchers in plasmonics, gives an overview of the current state in plasmonics and plasmonic-based metamaterials, with an emphasis on active functionalities and an eye to future developments. This book is multifunctional, useful for newcomers and scientists interested in applications of plasmonics and metamaterials as well as for established researchers in this multidisciplinary area.

This book opens a new avenue to an engendering field of applied physics, located at the “crossing” of modern photonics, electromagnetics, acoustics and material science. It also highlights the concept of “non-locality”, which proves to be not a special feature of quantum phenomena, but is shown to have an important counterpart in classical physics and its engineering applications too. Furthermore, it visualizes the physical results by means of simple analytical presentations, reduced sometimes to the elementary functions.

Contents: Introduction
Non-local Dispersion of Heterogeneous Dielectrics
Gradient Photonic Barriers: Generalizations of the Fundamental Model
Resonant Tunneling of Light Through Gradient Dielectric Nanobars
Interaction of Electromagnetic Waves with Continuously Structured Dielectrics
Polarization Phenomena in Gradient Nanophotonics
Gradient Optics of Guided and Surface Electromagnetic Waves
Non-local Acoustic Dispersion of Gradient Solid Layers
Shear Acoustic Waves in Gradient Elastic Solids
Shear Horizontal Surface Acoustic Waves on Graded Index Media
Readership: For researchers, engineers and designers of communication systems, lecturers and graduate students.
Keywords: Wave Propagation; Gradient Nanophotonics; Gradient Acoustics; Tunneling; Heterogeneous

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Dielectrics; Gradient Acoustics; Nanofilms

Key Features: It is the first systematic presentation of a newly developing branch of wave physics, containing the series of “hot” results dispersed hitherto in different journals. It's the first book, forming the cornerstones of the modern insight on the miniaturized gradient subwavelength structures. Moreover, it is the first book bringing together the physical fundamentals and mathematical basis of electromagnetic and acoustic wave processes in gradient metamaterials.

Reviews: “I recommend this book to a broad readership, including researchers and engineers as well as lecturers and graduate students, and even to designers of communication systems.” *Optics & Photonics News*

Metamaterials represent a new emerging innovative field of research which has shown rapid acceleration over the last couple of years. In this handbook, we present the richness of the field of metamaterials in its widest sense, describing artificial media with sub-wavelength structure for control over wave propagation in four volumes. Volume 1 focuses on the fundamentals of electromagnetic metamaterials in all their richness, including metasurfaces and hyperbolic metamaterials. Volume 2 widens the picture to include elastic, acoustic, and seismic systems, whereas Volume 3 presents nonlinear and active photonic metamaterials. Finally, Volume 4 includes recent progress in the field of nanoplasmonics, used extensively for the tailoring of the unit cell response of photonic metamaterials. In its totality, we hope that this handbook will be useful for a wide spectrum of readers, from students to active researchers in industry, as well as teachers of advanced courses on wave propagation.

Contents: Volume 1: Electromagnetic Metamaterials (Ekaterina Shamonina): Preface
Electromagnetic Metamaterials: Homogenization and Effective Properties of Mixtures (Ari Sihvola)
Effective Medium Theory of Electromagnetic and Quantum Metamaterials (Mário G

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Silveirinha)Hyperbolic Metamaterials (Igor I Smolyaninov)Circuit and Analytical Modelling of Extraordinary Transmission Metamaterials (Francisco Medina, Francisco Mesa, Raul Rodríguez-Berral and Carlos Molero)Electromagnetic Metasurfaces: Synthesis, Realizations and Discussions (Karim Achouri and Christophe Caloz)Metasurfaces for General Control of Reflection and Transmission (Sergei Tretyakov, Viktor Asadchy and Ana Díaz-Rubio)Scattering at the Extreme with Metamaterials and Plasmonics (Francesco Monticone and Andrea Alù)All-Dielectric Nanophotonics: Fundamentals, Fabrication, and Applications (Alexander Krasnok, Roman Savelev, Denis Baranov and Pavel Belov)Tunable Metamaterials (Ilya V Shadrivov and Dragomir N Neshev)Spatial Solitonic and Nonlinear Plasmonic Aspects of Metamaterials (Allan D Boardman, Alesandro Alberucci, Gaetano Assanto, Yu G Rapoport, Vladimir V Grimalsky, Vasyl M Ivchenko and Eugen N Tkachenko)Metamaterial Catheter Receivers for Internal Magnetic Resonance Imaging (Richard R A Syms, Ian R Young and Laszlo Solymar)Microwave Sensors Based on Symmetry Properties and Metamaterial Concepts (Jordi Naqui, Ali K Horestani, Christophe Fumeaux and Ferran Martín)Volume 2: Elastic, Acoustic, and Seismic Metamaterials (Richard Craster and Sébastien Guenneau): PrefaceDynamic Homogenization of Acoustic and Elastic Metamaterials and Phononic Crystals (Richard Craster, Tryfon Antonakakis and Sébastien Guenneau)Acoustic Metamaterial (Nicholas Fang, Jun Xu, Navid Nemati, Nicolas Viard and Denis Lafarge)Flat Lens Focusing of Flexural Waves in Thin Plates (Patrick Sebbah and Marc Dubois)Space–Time Cloaking (Martin W McCall and Paul Kinsler)Soda Cans Metamaterial: Homogenization and Beyond (Fabrice Lemoult, Geoffroy Lerosey, Nadège Kaïna and Mathias Fink)New Trends Toward Locally-Resonant Metamaterials at the Mesoscopic Scale (Philippe Roux, Matthieu Rupin, Fabrice

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Lemoult, Geoffroy Lerosey, Andrea Colombi, Richard Craster, Sébastien Guenneau, William A Kuperman and Earl G Williams) Seismic Metamaterials: Controlling Surface Rayleigh Waves Using Analogies with Electromagnetic Metamaterials (Stéphane Brûlé, Stefan Enoch, Sébastien Guenneau and

Plasmonics gives researchers in universities and industries and designers an overview of phenomena enabled by artificially designed metamaterials and their application for plasmonic devices. The purpose of this book is to provide a detailed introduction to the basic modeling approaches and an overview of enabled innovative phenomena. The main research agenda of this book is aimed at the study of modeling techniques and novel functionalities such as plasmonic enhancement of solar cell efficiency, plasmonics in sensing, etc. The topics addressed in this book cover the major strands: theory, modeling and design, applications in practical devices, fabrication, characterization, and measurement. It is worthwhile mentioning that the strategic objectives of developing new artificial functional materials require close cooperation of the research in each subarea.

Contemporary engineering design is heavily based on computer simulations. Accurate, high-fidelity simulations are used not only for design verification but, even more importantly, to adjust parameters of the system to have it meet given performance requirements.

Unfortunately, accurate simulations are often computationally very expensive with evaluation times as long as hours or even days per design, making design automation using conventional methods impractical. These and other problems can be alleviated by the development and employment of so-called surrogates that reliably represent the expensive, simulation-based model of the system or device of interest but they are much more reasonable and analytically

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tractable. This volume features surrogate-based modeling and optimization techniques, and their applications for solving difficult and computationally expensive engineering design problems. It begins by presenting the basic concepts and formulations of the surrogate-based modeling and optimization paradigm and then discusses relevant modeling techniques, optimization algorithms and design procedures, as well as state-of-the-art developments. The chapters are self-contained with basic concepts and formulations along with applications and examples. The book will be useful to researchers in engineering and mathematics, in particular those who employ computationally heavy simulations in their design work.

Non-Destructive Testing (NDT) is of worldwide significance, and is strongly related to the detection of damage in engineering structures (buildings, bridges, aircrafts, ships, pressure vessels, etc.) using non-invasive techniques (ultrasound, X-rays, Radar, neutrons, thermography, vibrations, acoustic emission, etc.). Emerging Technologies in Non-D

Electromagnetic metamaterials-from fundamental physics to advanced engineering applications This book presents an original generalized transmission line approach associated with non-resonant structures that exhibit larger bandwidths, lower loss, and higher design flexibility. It is based on the novel concept of composite right/left-handed (CRLH) transmission line metamaterials (MMs), which has led to the development of novel guided-wave, radiated-wave, and refracted-wave devices and structures. The authors introduced this powerful new concept and are therefore able to offer readers deep insight into the fundamental physics needed to fully grasp the technology. Moreover, they provide a host of practical engineering applications. The book begins with an introductory chapter that places resonant type and transmission line metamaterials in historical perspective. The next six chapters give readers a

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solid foundation in the fundamentals and practical applications: Fundamentals of LH MMs describes the fundamental physics and exotic properties of left-handed metamaterials TL Theory of MMs establishes the foundations of CRLH structures in three progressive steps: ideal transmission line, LC network, and real distributed structure Two-Dimensional MMs develops both a transmission matrix method and a transmission line method to address the problem of finite-size 2D metamaterials excited by arbitrary sources Guided-Wave Applications and Radiated-Wave Applications present a number of groundbreaking applications developed by the authors The Future of MMs sets forth an expert view on future challenges and prospects This engineering approach to metamaterials paves the way for a new generation of microwave and photonic devices and structures. It is recommended for electrical engineers, as well as physicists and optical engineers, with an interest in practical negative refractive index structures and materials.

The eighth volume in a series of handbooks on graphene research and applications The Handbook of Graphene, Volume 8: Technology and Innovations discusses the role of graphene-based applications in technological advancements. Topics include graphene materials used in circuit board repairs; RFID antenna and sensor fabrication; and wearable healthcare electronics. Chapters present detailed information on: modeling methods used in graphene research; applications of graphene-on-silicon photonic integrated circuits; the development of graphene for engineering applications; and other graphene subjects of interest to scientists, chemists and physicists.

Electromagnetic complex media are artificial materials that affect the propagation of electromagnetic waves in surprising ways not usually seen in nature. Because of their wide

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range of important applications, these materials have been intensely studied over the past twenty-five years, mainly from the perspectives of physics and engineering. But a body of rigorous mathematical theory has also gradually developed, and this is the first book to present that theory. Designed for researchers and advanced graduate students in applied mathematics, electrical engineering, and physics, this book introduces the electromagnetics of complex media through a systematic, state-of-the-art account of their mathematical theory. The book combines the study of well posedness, homogenization, and controllability of Maxwell equations complemented with constitutive relations describing complex media. The book treats deterministic and stochastic problems both in the frequency and time domains. It also covers computational aspects and scattering problems, among other important topics. Detailed appendices make the book self-contained in terms of mathematical prerequisites, and accessible to engineers and physicists as well as mathematicians.

Dielectric Metamaterials: Fundamentals, Designs and Applications links fundamental Mie scattering theory with the latest dielectric metamaterial research, providing a valuable reference for new and experienced researchers in the field. The book begins with a historical, evolving overview of Mie scattering theory. Next, the authors describe how to apply Mie theory to analytically solve the scattering of electromagnetic waves by subwavelength particles. Later chapters focus on Mie resonator-based metamaterials, starting with microwaves where particles are much smaller than the free space wavelengths. In addition, several chapters focus on wave-front engineering using dielectric metasurfaces and the nonlinear optical effects, spontaneous emission manipulation, active devices, and 3D effective media using dielectric metamaterials. Highlights a crucial link in fundamental Mie scattering theory with the

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latest dielectric metamaterial research spanning materials, design and applications Includes coverage of wave-front engineering and 3D metamaterials Provides computational codes for calculating and simulating Mie resonances

The purpose of this book is to provide an up-to-date introduction to the time-domain finite element methods for Maxwell's equations involving metamaterials. Since the first successful construction of a metamaterial with both negative permittivity and permeability in 2000, the study of metamaterials has attracted significant attention from researchers across many disciplines. Thanks to enormous efforts on the part of engineers and physicists, metamaterials present great potential applications in antenna and radar design, sub-wavelength imaging, and invisibility cloak design. Hence the efficient simulation of electromagnetic phenomena in metamaterials has become a very important issue and is the subject of this book, in which various metamaterial modeling equations are introduced and justified mathematically. The development and practical implementation of edge finite element methods for metamaterial Maxwell's equations are the main focus of the book. The book finishes with some interesting simulations such as backward wave propagation and time-domain cloaking with metamaterials. Properties of wave localization play a decisive role both in applications of engineered microstructures and in the detection of cracks and flaws. The papers in this volume give an introduction into a variety of interrelated dynamic localization phenomena occurring in elasticity, acoustics and electromagnetism. In particular, these involve surface and edge waves and also trapped modes localized near defects, shape changes and the edges of elongated waveguides. The effects of layering, prestress, anisotropy, periodic microstructures as well as various multi-field phenomena are addressed with reference to underlying industrial problems.

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The essential and up-to-date numerical, asymptotic, and analytical techniques are covered as well as relevant continuum theories that are required to make progress in, and understand wave localization and allied effects. A major focus is on a qualitative physical insight into the mechanisms of dynamic localization.

The domain of metamaterials now covers many area of physics: electromagnetics, acoustics, mechanics, thermics, or even seismology. Huge literature is now available on the subject but the results are scattered. Although many ideas and possible applications have been proposed, which of these will emerge as a viable technology will only unfold with time. This book covers the fundamental science behind metamaterials, from the physical, mathematical, and numerical points of view, focusing mainly on methods. It concentrates on electromagnetic waves, but would also be useful in studying other types of metamaterials. It presents the structure of Maxwell equations, discusses the homogenization theory in detail, and includes important problems on resonance. It has an entire section devoted to numerical methods (finite elements, Fourier modal methods, scattering theory), which aims to motivate a reader to implement them. The book is not written as a collection of independent chapters but as a textbook with a strong pedagogical flavor.

This book discusses bulk solids that derive their mechanical properties not from those of their base materials, but from their designed microstructures. Focusing on the negative mechanical properties, it addresses topics that reveal the counter-intuitive nature of solids, specifically the negativity of properties that are commonly positive, such as negative bulk modulus, negative compressibility, negative hygroexpansion, negative thermal expansion, negative stiffness phase, and negative Poisson's ratio. These topics are significant not only due to the curiosity

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they have sparked, but also because of the possibility of designing materials and structures that can behave in ways that are not normally expected in conventional solids, and as such, of materials that can outperform solids and structures made from conventional materials. The book includes illustrations to facilitate learning, and, where appropriate, reference tables. The presentation is didactic, starting with simple cases, followed by increasingly complex ones. It provides a solid foundation for graduate students, and a valuable resource for practicing materials engineers seeking to develop novel materials through the judicious design of microstructures and their corresponding mechanisms.

This book provides a comprehensive overview of the theory and practical development of metamaterial-based perfect absorbers (MMPAs). It begins with a brief history of MMPAs which reviews the various theoretical and experimental milestones in their development. The theoretical background and fundamental working principles of MMPAs are then discussed, providing the necessary background on how MMPAs work and are constructed. There then follows a section describing how different MMPAs are designed and built according to the operating frequency of the electromagnetic wave, and how their behavior is changed. Methods of fabricating and characterizing MMPAs are then presented. The book elaborates on the performance and characteristics of MMPAs, including electromagnetically-induced transparency (EIT). It also covers recent advances in MMPAs and their applications, including multi-band, broadband, tunability, polarization independence and incidence independence. Suitable for graduate students in optical sciences and electronic engineering, it will also serve as a valuable reference for active researchers in these fields.

The new concept of metamaterial is increasingly attracting the interest of physicists and

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mechanical engineers. Such materials are obtained by suitably assembling multiple individual elements but usually arranged in (quasi-)periodic substructures in order to show exotic global mechanical properties. Indeed, the particular shape, geometry, size, orientation and arrangement of their constituting elements can affect, the propagation of waves of light or sound in a manner not observed in natural materials, creating material properties which may give rise to unexpected engineering applications. Particularly promising in the design and description of metamaterials are those micro-structures which present high contrasts in their mechanical properties: these micro-structures, once homogenized, may produce generalized continuum media, for example, second gradient or micromorphic. Many scientific challenges related to the application of generalized continuum theories to the characterization and conception of high-performance metamaterials can be identified. In this book we identify and discuss four main potential fields of applications of generalized continuum theories, namely, mechanical behavior of fibrous composite reinforcements, wave propagation in metamaterials, mechanical behavior of concrete and mechanically driven remodeling of bone in presence of bio-resorbable materials. For each field, we underline how the use of a generalized continuum theory can be of help for describing how the presence of microstructure can affect the global mechanical behavior of the considered metamaterials. Covers four main fields of the application of continuum theories Learn how to apply generalised continuum theory to describe the effects of microstructure on the mechanical behavior of materials Decipher the material properties which aid your engineering applications

Metamaterials and plasmonics are cross-disciplinary fields that are emerging into the mainstream of many scientific areas. Examples of scientific and technical fields which are

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concerned are electrical engineering, micro- and nanotechnology, microwave engineering, optics, optoelectronics, and semiconductor technologies. In plasmonics, the interplay between propagating electromagnetic waves and free-electron oscillations in materials are exploited to create new components and applications. On the other hand, metamaterials refer to artificial composites in which small artificial elements, through their collective interaction, creates a desired and unexpected macroscopic response function that is not present in the constituent materials. This book charts the state of the art of these fields. In May 2008, world-leading experts in metamaterials and plasmonics gathered into a NATO Advanced Research Workshop in Marrakech, Morocco. The present book contains extended versions of 22 of the presentations held in the workshop, covering the general aspects of the field, as well as design and modelling questions of plasmonics and metamaterials, fabrication issues, and applications like absorbers and antennas.

'Nanophotonic Materials - Photonic Crystals, Plasmonics, and Metamaterials' summarizes the work and results of a consortium consisting of more than 20 German research groups concentrated on photonics crystals research over the last seven years. Illustrated throughout in full color, the book provides an overview of these novel materials, spanning the entire range from fundamentals to applications.

The unique properties and functionalities of chalcogenide glasses make them promising materials for photonic applications. Chalcogenide glasses are transparent from the visible to the near infrared region and can be moulded into lenses or drawn into fibres. They have useful commercial applications as components for lenses for infrared cameras, and chalcogenide glass fibres and optical components are used in waveguides for use with lasers, for optical

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switching, chemical and temperature sensing and phase change memories. *Chalcogenide glasses* comprehensively reviews the latest technological advances in this field and the industrial applications of the technology. Part one outlines the preparation methods and properties of chalcogenide glasses, including the thermal properties, structure, and optical properties, before going on to discuss mean coordination and topological constraints in chalcogenide network glasses, and the photo-induced phenomena in chalcogenide glasses. This section also covers the ionic conductivity and physical aging of chalcogenide glasses, deposition techniques for chalcogenide thin films, and transparent chalcogenide glass-ceramics. Part two explores the applications of chalcogenide glasses. Topics discussed include rare-earth-doped chalcogenide glass for lasers and amplifiers, the applications of chalcogenide glasses for infrared sensing, microstructured optical fibres for infrared applications, and chalcogenide glass waveguide devices for all-optical signal processing. This section also discusses the control of light on the nanoscale with chalcogenide thin films, chalcogenide glass resists for lithography, and chalcogenide for phase change optical and electrical memories. The book concludes with an overview of chalcogenide glasses as electrolytes for batteries. *Chalcogenide glasses* comprehensively reviews the latest technological advances and applications of chalcogenide glasses, and is an essential text for academics, materials scientists and electrical engineers working in the photonics and optoelectronics industry. Outlines preparation methods and properties, and explores applications of chalcogenide glasses. Covers the ionic conductivity and physical aging of chalcogenide glasses, deposition techniques for chalcogenide thin films, and transparent chalcogenide glass-ceramics Discusses the control of light on the nanoscale with chalcogenide

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thin films, chalcogenide glass resists for lithography, and chalcogenide for phase change optical and electrical memories

Recent technological breakthrough in the field of Terahertz radiation has triggered new applications in biology and biomedicine. Particularly, biological applications are based on the specific spectroscopic fingerprints of biological matter in this spectral region. Historically with the discovery of new electromagnetic wave spectrum, we have always discovered new medical diagnostic imaging systems. The use of terahertz wave was not realized due to the absence of useful terahertz sources. Now after successful generation of THz waves, it is reported that a great potential for THz wave exists for its resonance with bio-molecules. There are many challenging issues such as development of THz passive and active instrumentations, understanding of THz-Bio interaction for THz spectroscopy, THz-Bio nonlinear phenomena and safety guideline, and THz imaging systems. Eventually the deeper understanding of THz-Bio interaction and novel THz systems enable us to develop powerful THz biomedical imaging systems which can contribute to biomedical industry. This is a truly interdisciplinary field and convergence technology where the communication between different disciplines is the most challenging issue for the success of the great works. One of the first steps to promote the communications in this convergence technology would be teaching the basics of these different fields to the researchers in a plain language with the help of Convergence of Terahertz Science in Biomedical Systems which is considered to be 3-4th year college students or beginning level of graduate students. Therefore, this type of book can be used by many people who want to enter or understand this field. Even more it can be used for teaching in universities or research institutions.

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Reviews in Plasmonics 2016, the third volume of the new book series from Springer, serves as a comprehensive collection of current trends and emerging hot topics in the field of Plasmonics and closely related disciplines. It summarizes the year's progress in surface plasmon phenomena and its applications, with authoritative analytical reviews in sufficient detail to be attractive to professional researchers, yet also appealing to the wider audience of scientists in related disciplines of Plasmonics. Reviews in Plasmonics offers an essential source of reference material for any lab working in the Plasmonics field and related areas. All academics, bench scientists, and industry professionals wishing to take advantage of the latest and greatest in the continuously emerging field of Plasmonics will find it an invaluable resource.

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