Electromagnetic Band Gap Structures In Antenna Engineering The Cambridge Rf And Microwave Engineering Series

This dissertation is focused on design of compact electromagnetic magnetic band-gap structures (EBG). Several popular compact techniques are introduced and analyzed with equivalent surface impedance model. A novel compact EBG structure is investigated. Compared to the conventional uniplanar compact photonic band gap (UC-PBG) structure, a size reduction of 64.7% is achieved. A distinctive band gap is observed at 2.45 GHz with around 100 MHz bandwidth and zero reflection phase. Antenna applications of this novel EBG structure, including EBG patch antenna and EBG antenna array, have been presented. Simulation results further verify its characteristic of suppressing surface waves. For the EBG patch antenna, a more focused radiation pattern is obtained compared to a normal patch antenna. For an antenna array, the presence of EBG structure reduces the mutual coupling between the two radiating elements by 6 dB.

Photonic band gap crystals offer unique ways to tailor light and the propagation of electromagnetic waves. In analogy to electrons in a crystal, EM waves propagating in a structure with a periodically-modulated dielectric constant are organized into photonic bands separated by gaps in which propagating states are forbidden. Proposed applications of such photonic band gap crystals, operating at frequencies from microwave to optical, include zero- threshold lasers, low-loss resonators and cavities, and efficient microwave antennas. Spontaneous emission is suppressed for photons in the photonic band gap, offering novel approaches to manipulating the EM field and creating high-efficiency light-emitting structures. Photonic Band Gap Materials identifies three most promising areas of research. The first is materials fabrication, involving the creation of high quality, low loss, periodic dielectric structures. The smallest photonic crystals yet fabricated have been made by machining Si wafers along (110), and some have lattice constants as small as 500 microns. The second area is in applications. Possible applications presented are microwave mirrors, directional antennas, resonators (especially in the 2 GHz region), filters, waveguides, Y splitters, and resonant microcavities. The third area covers fundamentally new physical phenomena in condensed matter physics and quantum optics. An excellent review of recent development, covering theoretical, experimental and applied aspects. Interesting and stimulating reading for active researchers, as well as a useful reference for non-specialists.

Wireless communications have become invaluable in the modern world. The market is going through a revolutionary transformation as new technologies and standards endeavor to keep up with demand for integrated and low-cost mobile and wireless devices. Due to their ubiquity, there is also a need for a simplification of the design of wireless systems and networks. The Handbook of Research on Advanced Trends in Microwave and Communication Engineering showcases the current trends and approaches in the design and analysis of reconfigurable microwave devices, antennas for wireless applications, and wireless communication technologies. Outlining both theoretical and experimental approaches, this publication brings to light the unique design issues of this emerging research, making it an ideal reference source for engineers, researchers, graduate students, and IT professionals.

Continuing advancements in electronics creates the possibility of communicating with more people at greater distances. Such an evolution calls for more efficient techniques and designs in radio communications. Emerging Innovations in Microwave and Antenna Engineering provides innovative insights into theoretical studies on propagation and microwave design of passive and active devices. The content within this publication is separated into three sections: the design of antennas, the design of the antennas for the RFID system, and the design of a new structure of microwave amplifier. Highlighting topics including additive manufacturing technology, design application, and performance characteristics, it is designed for engineers, electricians, researchers, students, and professionals, and covers topics centered on modern antenna and microwave circuits design and theory.

This overview paper presents a powerful computational engine utilizing Finite Difference Time Domain (FDTD) technique integrated with novel extrapolating algorithms to illustrate the marvels of EBG structures. The paper addresses structures such as (a) FSS structures, (b) PBG crystals, (c) smart surfaces for communication antenna applications, (d) surfaces with perfectly magnetic conducting properties (PMC), (e) creation of materials with negative permittivity and negative permeability, (f) surfaces with reduced edge diffraction effects and (g) reduction of mutual coupling among array antenna elements. Some representative applications of these structures are highlighted. In the last several years, there have been numerous published conference papers and journal articles dealing with the characterizations and applications of EBO structures. This paper is based on some of the results published by the author and his co-workers in the cited references. The reader is encouraged to perform detailed literature search to learn more about this area.

This paper shows how the design of integrated arrays can significantly benefit from Planar Circularly Symmetric (PCS) Electromagnetic Band Gap (EBG) structures. Using this technology, a phased array that scans up to 40 degrees in one dimension and that is characterized by relatively large bandwidth (BW~15%) is designed, manufactured and tested. The specific advantages coming from the use of PCS-EBGs are two fold. On one hand the losses associated to surface waves are significantly reduced. On the other hand each element of the array has a larger effective area that leads to a higher gain for the complete array when compared with a standard technology. Additional benefits are the low cross-polarization levels, the good front to back ratio, considering that the antenna does not include a backing reflector, and the low profile.

In the field of electromagnetic wave engineering, the recent interest is on Periodic structures which includes metamaterial technology, Electromagnetic Band Gap structures, etc. This text book gives a detailed study on electromagnetic band-gap structures and their applications along with the metamaterial microwave absorbers.

This book, first published in 2008, is a detailed account of electromagnetic band gap (EBG) theory, analysis and applications, ideal for researchers and engineers.

"Electromagnetic band-gap (EBG) structures, often termed frequency selective surfaces (FSSs) or photonic band-gap (PBG) materials, have found widespread applications as filters for microwaves and optical signals. Due to their frequency selective features and ease of implementation in printed circuit board (PCB) technology, EBG structures are utilized in power distribution networks (PDNs) to induce wide stopband and to provide global power/ground noise suppression. Attenuation characteristic of EBG structures within their forbidden frequency regions is examined in this thesis which ultimately provides the insertion loss obtained by inserting the EBG structure in the PDN. Bandgap characterization is efficiently achieved by applying the Bloch analysis to only one unit-cell of the EBG structure. For that purpose, two approaches have been investigated: the transmission-line (TL) technique and the finite element method (FEM). Printed-circuit EBG structures can be efficiently modeled by transmission-line circuits; thus TL techniques are widely used for their fast characterization. The developed TL model is exploited to investigate the power attenuation within the band-gap regions of PDNs containing EBG structures. A full-wave finite element code has been developed for accurate prediction of the stopband characteristics of periodic media. A number of simple periodic geometries are examined by the finite element code showing unique spectral properties of EBG structures, such as existence of evanescent and/or complex modes within their stopbands." --

In-depth analysis of the theory, properties and description of the most potential technological applications of metamaterials for the realization of novel devices such as subwavelength lenses, invisibility cloaks, dipole and reflector antennas, high frequency telecommunications, new designs of bandpass filters, absorbers and concentrators of EM waves etc. In order to create a new devices it is necessary to know the main electrodynamical characteristics of metamaterial structures on the basis of which the device is supposed to be created. The electromagnetic wave scattering surfaces built with metamaterials are primarily based on the ability of metamaterials to control the surrounded electromagnetic fields by varying their permeability and permittivity characteristics. The book covers some solutions for microwave wavelength scales as well as exploitation of nanoscale EM wavelength such as visible specter using recent advances of nanotechnology, for instance in the field of nanowires, nanopolymers, carbon nanotubes and graphene. Metamaterial is suitable for scholars from extremely large scientific domain and therefore given to engineers, scientists, graduates and other interested professionals from photonics to nanoscience and from material science to antenna engineering as a comprehensive reference on this artificial materials of tomorrow.

This volume covers the recent advances and research on the modeling and simulation of materials. The primary aim is to take the reader through the mathematical analysis to the theories of electricity and magnetism using multiscale modelling, covering a variety of numerical methods such as finite difference time domain (FDTD), finite element method (FEM) and method of moments. The book also introduces the multiscale Green’s function (GF) method for static and dynamic modelling and simulation results of modern advanced nanomaterials, particularly the two-dimensional (2D) materials. This book will be of interest to researchers and industry professionals working on advanced materials.

Provides systematic coverage of the theory, physics, functional designs, and engineering applications of advanced electromagnetic surfaces.

Since it was first published in 1995, Photonic Crystals has remained the definitive text for both undergraduates and researchers on photonic band-gap materials and their use in controlling the propagation of light. This newly expanded and revised edition covers the latest developments in the field, providing the most up-to-date, concise, and comprehensive book available on these novel materials and their applications. Starting from Maxwell's equations and Fourier analysis, the authors develop the theoretical tools of photonics using principles of linear algebra and symmetry, emphasizing analogies with traditional solid-state physics and quantum theory. They then investigate the unique phenomena that take place within photonic crystals at defect sites and surfaces, from one to three dimensions. This new edition includes entirely new chapters describing important hybrid structures that use band gaps or periodicity only in some directions: periodic waveguides, photonic-crystal slabs, and photonic-crystal fibers. The authors demonstrate how the capabilities of photonic crystals to localize light can be put to work in devices such as filters and splitters. A new appendix provides an overview of computational methods for electromagnetism. Existing chapters have been considerably updated and expanded to include many new three-dimensional photonic crystals, an extensive tutorial on device design using temporal coupled-mode theory, discussions of diffraction and refraction at crystal interfaces, and more. Richly illustrated and accessibly written, Photonic Crystals is an indispensable resource for students and researchers. Extensively revised and expanded Features improved graphics throughout Includes new chapters on photonic-crystal fibers and combined index-and band-gap-guiding Provides an introduction to coupled-mode theory as a powerful tool for device design Covers many new topics, including omnidirectional reflection, anomalous refraction and diffraction, computational photonics, and much more.

Electromagnetic Band Gap Structures in Antenna EngineeringCambridge University Press

This book is a detailed account of electromagnetic band gap (EBG) theory, analysis and applications, ideal for researchers and engineers.

An essential guide to the background, design, and application of common-mode filtering structures in modern high-speed differential communication links Written by a team of experts in the field, Electromagnetic Bandgap (EBG) Structures explores the practical electromagnetic bandgap based common mode filters for power integrity applications and covers the theoretical and practical design approaches for common mode filtering in high-speed printed circuit boards, especially for boards in high data-rate systems. The authors describe the classic applications of electromagnetic bandgap (EBG) structures and the phenomena of common mode generation in high speed digital boards. The text also explores the fundamental electromagnetic mechanisms of the functioning of planar EBGs and considers the impact of planar EBGs on the digital signal propagation of single ended and differential interconnects routed on top or between EBGs. The authors examine the concept, design, and modeling of EBG common mode filters in their two forms: on-board and removable. They also provide several comparisons between measurement and electromagnetic simulations that validate the proposed EBG filters' design approach. This important resource: • Presents information on planar EBG based common mode filters for high speed differential digital systems • Provides systematic analysis of the fundamental mechanisms of planar EBG structures • Offers detailed design methodology to create EBG filters without the need for repeated full-wave electromagnetic analysis • Demonstrates techniques for use in practical real-world designs Electromagnetic Bandgap (EBG) Structures: Common Mode Filters for High Speed Digital Systems offers an introduction to the background, design, and application of common-mode filtering structures in modern high-speed differential communication links, a critical issue in high-speed and high-performance systems.

With increase in frequency and convergence toward mixed signal systems, supplying stable voltages to integrated circuits and blocking noise coupling in the systems are major problems. Electromagnetic band gap (EBG) structures have been in the limelight for power/ground noise isolation in mixed signal applications due to their capability to suppress unwanted electromagnetic mode transmission in certain frequency bands. The EBG structures have proven effective in isolating the power/ground noise in systems that use a common power supply. However, while the EBG structures have the potential to present many advantages in noise suppression applications, there is no method in the prior art that enables reliable and efficient synthesis of these EBG structures. Therefore, in this research, a novel EBG synthesis method for mixed signal applications is presented. For one-dimensional periodic structures, three new approaches such as current path approximation method, border to border radius, power loss method have been introduced and combined for synthesis. For two-dimensional EBG structures, a novel EBG synthesis method using genetic algorithm (GA) has been presented. In this method, genetic algorithm (GA) is utilized as a solution-searching technique. Synthesis procedure has been automated by combining GA with multilayer finite-difference method and dispersion diagram analysis method. As a real application for EBG structures, EBG structures have been applied to a GHz ADC load board design for power/ground noise suppression.

This book describes the process of designing and analysing the microstrip antenna using EBG Structures. Since microstrip antennas are one of the most popular antennas that are used for high performance applications. These antennas have various advantages but they suffer from the narrow bandwidth. In order to overcome the narrow bandwidth Electromagnetic Band Gap (EBG) Structures can be used.The process of designing of the Electromagnetic Band Gap structures and various types of microstrip antennas are given in detail.

Electromagnetic band-gap (EBG) structures have noteworthy electromagnetic characteristics that include their phase variations with frequency. When combining perfect electric conductor (PEC) and EBG structures on the same ground plane, the scattering fields of the ground plane are altered because of the scattering properties of EBG structures. The scattering fields are cancelled along the principal planes because PEC and EBG structures are anti-phase at the resonant frequency. To make the scattered fields symmetrical under plane wave incidence, a square checkerboard surface is designed to form constructive and destructive interference scattering patterns to reduce the intensity of the scattered fields toward the observer; thus reducing the radar cross section (RCS). To increase the 10-dB RCS reduction (compared to a PEC surface) bandwidth, checkerboard surfaces of two different EBG structures on the same ground plane are designed. Thus, significant RCS reduction over a wider frequency bandwidth of about 63% is achieved. Another design is a hexagonal checkerboard surface that achieves the same RCS reduction bandwidth because it combines the same EBG designs. The hexagonal checkerboard design further reduce the RCS than square checkerboard designs because the reflected energy is re-directed toward six directions and a null remains in the normal direction.A dual frequency band checkerboard surface with 10-dB RCS reduction bandwidths of 61% and 24% is realized by utilizing two dual-band EBG structures, while the surfaces maintain scattering in four quadrants. The first RCS reduction bandwidth of the dual band is basically the same as in the square checkerboard design; however, the present surface exhibits a second frequency band of 10-dB RCS reduction.Finally, cylindrically curved checkerboard surfaces are designed and examined for three different radii of curvature. Both narrow and wide band curved checkerboard surfaces are evaluated under normal incidence for both horizontal and vertical polarizations. Simulated bistatic RCS patterns of the cylindrical checkerboard surfaces are presented.For all designs, bistatic and monostatic RCS of each checkerboard surface design are compared to that of the corresponding PEC surface. The monostatic simulations are also compared with measurements as a function of frequency and polarization. A very good agreement has been attained throughout.