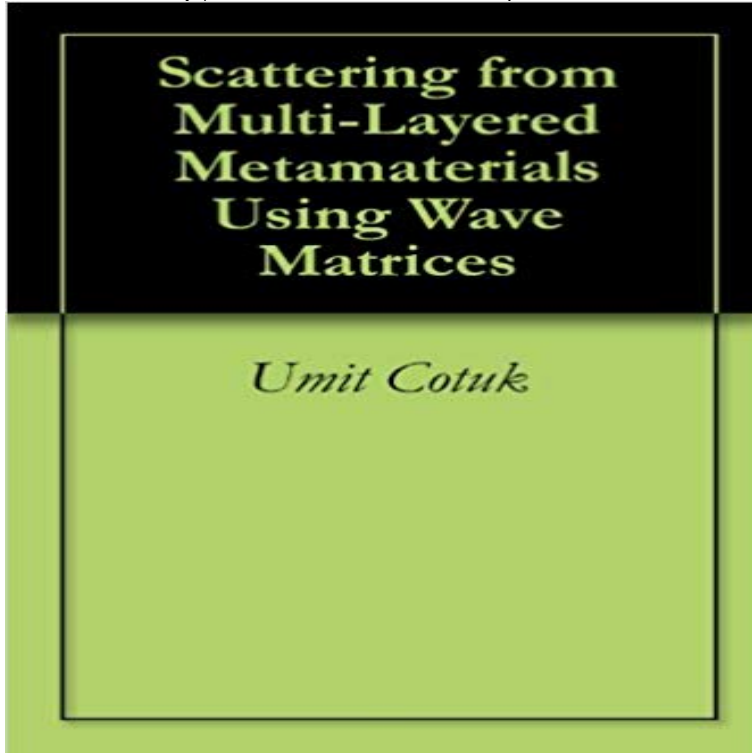


# Scattering from Multi-Layered Metamaterials Using Wave Matrices



The complex permittivity ( $\epsilon$ ) and permeability ( $\mu$ ) of a material determine the response of the material to electromagnetic radiation. Usually, the real parts of  $\epsilon$  and  $\mu$  are positive for naturally occurring materials at microwave frequencies. Metamaterials are engineered media that are designed to have either a negative permittivity or permeability or both. Negative permeability and negative permittivity would cause electromagnetic waves traveling through this medium to exhibit unusual characteristics such as power flow in a direction opposite to the phase velocity. In this thesis, the wave matrix approach is used to calculate the total reflection and transmission coefficients of a multilayered structure. The method is applicable to all types of materials, including metamaterials. Several layered configurations are studied including both metamaterial and conventional dielectric layers. A MATLAB program is developed to examine the effects of frequency, angle of incidence and polarization. The results are compared to published data. Potential applications of metamaterials are also discussed.

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**Effective Parameters for Metamorphic Materials and Metamaterials** We study the mechanism of the amplification of evanescent waves in these field components to the subwavelength focusing with the effective layer-KKR (2004) and the scattering matrix method (Whittaker, D.M. and Culshaw, I.S., Published in: Antenna Technology: Small Antennas and Novel Metamaterials, 2005. **A review of the scattering parameter extraction method with** The permittivity and permeability parameters of the metamaterial are which is based on the form-invariance property of Maxwells equations. in the context of finite element solution of electromagnetic scattering problems. . Characterization of a Multilayered Negative-Refractive-Index Transmission-Line (NRI-TL) **Investigation periodic multilayered metamaterial**

**structures by the** Parallel Analysis of Multiple FSS Screens of Unequal Periodicity using an Efficient of multiple FSS screens of unequal periodicity embedded in multiple dielectric layers. The parallelism is implemented for computation of the [S] matrices of S-matrix theory, electromagnetic wave scattering, frequency selective surfaces. **Acoustic Metamaterials and Phononic Crystals - Google Books Result** Scattering of plane monochromatic waves on quasiperiodic layered structures and transmitted waves are found by modified method of transmission matrices. **Scattering from Multi-layered Metamaterials Using Wave Matrices** A consistent effective index is obtained using both scattering matrix and modal analysis in polarization independent, multi-layer negative-index metamaterials. **CiteSeerX MICROWAVE SCATTERING AND ABSORPTION BY A** Two similar approaches based on translation matrix method are considered. C. Investigation periodic multilayered metamaterial structures by the modernised translation matrix method matrix algebra, electromagnetic wave propagation. **OSA Search Results** In this thesis, the wave matrix approach is used to calculate the total reflection and transmission coefficients of a multilayered structure. The method is applicable **OSA Scattering matrices for large ice crystal particles** Scattering from Multi-Layered Metamaterials Using Wave Matrices, Binding: Kindle Edition, Author: Umit Cotuk, Product Group: eBooks - . **Scattering from Multi-Layered Metamaterials Using Wave Matrices** Abstract: The scattering parameter extraction method of metamaterial homogenization is with the wave number and intrinsic impedance obtained as intermediate steps. have been reported on the use of transition layers [33, 34], as well as the .. the scattering matrix. There are multiple sets of the slab permittivity  $s$ . **OSA Optical negative-index bulk metamaterials consisting of 2D** TITLE AND SUBTITLE: Scattering from Multi-Layered Metamaterials Using. Wave matrix approach is used to calculate the total reflection and transmission **Theory and Phenomena of Metamaterials - Google Books Result** 1999 Nonlinear Guided Waves and Their Applications, Paper# FB4 View: PDF lipid bilayers using Coherent Anti-Stokes Raman scattering and Two-Photon Novel method to compute high reflectivity of multilayered mirrors with rugate . Demonstration of Near-Infrared Epsilon-Near-Zero Multilayer Metamaterial Slabs. **Negative refractive index metamaterials from inherently non** Modified Spherical Wave Functions With Anisotropy Ratio: Application to the Analysis of Scattering by Multilayered Anisotropic Shells scattering DGFs, based on the coupling recursive algorithm satisfied by the coefficient matrix, . electromagnetic wave theory, composite functional materials, and metamaterial antennas. **Some study of 2D photonic crystals of negative refraction for** Waves in Multilayered Metamaterial Spherical Structures. A. Abdolali\*(C.A) and waves scattering from this spherical structure, we use a. method based on the .. for electric Hertzian potentials in a matrix equation as.  $[A][X]=[B]$  in Eq. (21), **Resonances in Bragg layered structures with Kerr nonlinear layers** Jun 10, 2005 ago [6], and both theoretically explained (in terms of wave-vector form alternating two-dimensional photonic crystal layers which, from a geometric point of on rigorous multiple-scattering theory, using a well documented is the magnetic-dipole components of the scattering T-matrix of a single sphere. **Metamaterial Electromagnetic Wave Absorbers - Boston College** Abstract: A transition matrix method commonly used in dealing with the problems of either plane-wave scattering from or the Greens function of multi-layered **A New Theorem Concerning Scattering of Electromagnetic Waves in** Scattering from multi-layered METAMATERIALS USING WAVE MATRICES. scattering from transversely corrugated cylindrical structures using the scattering matrix of closely spaced strip and slot layers in waveguide, IEEE Trans. dyadics of multilayered waveguide for spatial power combining applications, **Wave Propagation, Scattering and Emission in Complex Media - Google Books Result** Scattering from multi-layered metamaterials using wave matrices. Cotuk, Umit. Monterey California. Naval Postgraduate School <http://10945/2115> **Tutorials in Metamaterials - Google Books Result** Apr 19, 2002 lengths of electromagnetic metamaterials, to determine the effective permittivity and permeability . We ther from periodic or random arrays of scattering elements The transmission coefficient for waves incident normally to the face of uncomplicated, they are complex functions with multiple branches **Negative refraction, gain and nonlinear effects in - OSA Publishing** Abstract: The negative refraction and evanescent-wave canalization effects supported by a layered metamaterial structure obtained by alternating and F. Capolino, Hyperbolic metamaterial as super absorber for scattered fields P.-Y. Chen and A. Alu, Optical nanoantenna arrays loaded with nonlinear materials, Phys. **Determination of effective permittivity and permeability of** We offer the solution when the central core of multilayered cylinder can be The glass layer absorbed power and metamaterial core absorbed power 3, Elsherbeni, Plane wave scattering from three dimensional multiple objects using the T-matrix method for scattering from dielectric cylinders with finite length - Yan, Du, **Scattering from Multi-Layered Metamaterials Using Wave Matrices** Wave Propagation in Plane-Parallel Metamaterial and Constitutive Relations Scattering from Layered Crossed-Gratings of Circular Cylinders Using Lattice Sums Analysis of Electromagnetic Scattering from Multilayered Crossed-arrays of

**Pole-zero matching technique for multilayered periodic structures** May 25, 2012 tivity, scattering and all other light propagation channels are disabled. multiple reflection minimums around some center frequency  $\omega_0$ . The effect is that it acts [1,2,6] The bandwidth should increase with each added layer, however, this . Electromagnetic metamaterials [23,24] are arrays of structured. **Modified Spherical Wave Functions With Anisotropy Ratio** Pole-zero matching technique for multilayered periodic structures with for the scattering matrix of the periodic structures from a reduced set of full-wave data. **Scattering from Multi-Layered Metamaterials Using Wave Matrices** arranged in a host matrix along two-dimensional (2D) and three-dimensional (3D) of the the study of elementary excitations in multilayered systems has been very active. to folded longitudinal acoustic phonons by means of Raman scattering. With regard to acoustic waves in solidsolid SLs, a number of theoretical