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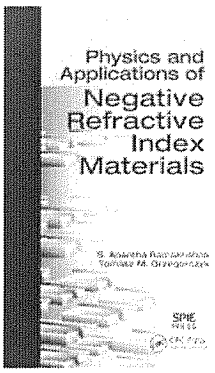
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Physics and Applications of Negative Refractive Index Materials

Published: September 26, 2008 by CRC Press
Content: 440 Pages | 140 Illustrations
Author(s): S. Anantha Ramakrishna, Tomasz M. Grzegorczyk

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Features

- Provides clear, comprehensive coverage of the entire area of metamaterials and negative refractive index
- Offers enough introductory material for beginners with an undergraduate-level background in electromagnetism and mathematics
- Discusses the most fundamental physical properties of metamaterials, including the negative refraction and its origins, modified Snell's law and modified Mie scattering, the reversed Doppler shift, reversed Goos –Hanchen shift, and reversed Cerenkov radiation
- Describes the modeling of structured materials and effective medium parameter retrieval procedures
- Presents an insightful discussion on perfect lenses and the design of super lenses with subwavelength image resolution
- Covers the propagation of waves in anistotropic media, indefinite media, and bianisotropic media
- Draws analogies between left-handed media and photonic crystals

Summary

Ever since the first experimental demonstration was reported in 2000, the interest in metamaterials and left-handed media that exhibit a negative refractive index has increased exponentially. Surveying this explosive growth, **Physics and Applications of Negative Refractive Index Materials** covers the fundamental physical principles and emerging engineering applications of structured electromagnetic metamaterials that yield a negative refraction as well as other unexpected physical properties. It provides detailed explanations on the history, development, and main achievements of metamaterials.

Making it easy to access relevant, up-to-date information on the field, the authors bring together the most important and influential papers related to metamaterials. They present the principles of negative refraction and compare the uniqueness of novel metamaterials with other media that exhibit similar properties. The book discusses the design, optimization, and testing of structured metamaterials as well as applications of metamaterials at frequencies ranging from radio wave to optical. It also explores novel concepts and phenomena, such as the perfect lens for super-resolution imaging, hyper lenses that couple the near-field to radiative modes, electromagnetic cloaking and invisibility, and near-field optical imaging.

Connecting theoretical ideas to recent experimental techniques and results, this state-of-the-art book enables an understanding of the basic principles of and research contributions to metamaterials with negative refractive index and their electromagnetic properties.

Related Titles



Optical Properties of Photonic Structures: Interplay of Order and Disorder
Mikhail F. Limonov; Richard M. De La Rue

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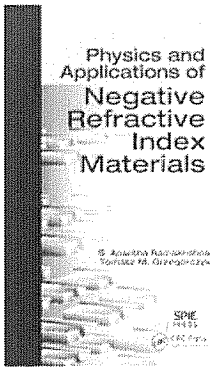
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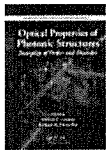
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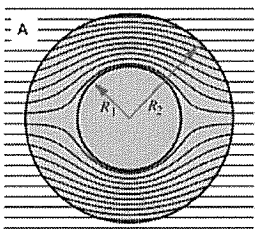
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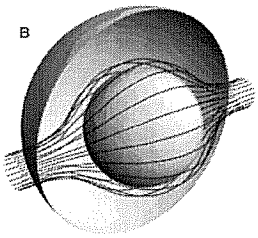
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Ştiri

Materiale cu indice de refracţie negativ





Unul dintre subiectele de prim interes în tehnologia materialelor este în ultimii ani producerea şi studiul proprietăţilor materialelor cu indice de refracţie negativ. Cercetările au depăşit deja pragul teoriei fundamentale şi au început să vizeze tot mai mult posibilele aplicaţii, două dintre ele fiind instrumentele optice fără aberaţii şi obţinerea invizibilităţii.

Se cunoaşte încă din optica clasică definiţia indicelui de refracţie al unui mediu, ca fiind raportul dintre viteza de propagare a undei luminoase în vid şi viteza ei de propagare în mediul respectiv. Cu această definiţie, existenţa unui mediu cu indice de refracţie negativ ar necesita posibilitatea ca unda luminoasă să se propage în sens invers energiei purtate de fasciculul de lumină, adică, în timp ce pulsul de lumină avansează în mediu, oscilaţia electromagnetică asociată pulsului să se deplaseze în sens invers.

Proprietăţile acestor materiale au fost descrise teoretic pentru prima dată în anul 1967 de fizicianul sovietic Victor Veselago, dar abia în anul 2002 au fost obtinute primele rezultate experimentale, cu radiatie electromagnetica de microunde. În prezent se produc primele materiale cu indice de refracţie negativ pentru lumina vizibilă şi sunt investigate (teoretic şi experimental) posibilele aplicaţii ale noii tehnologii.

Principala calitate a unui material cu indice de refracţie negativ ţine de fenomenul de refracţie a luminii, care înseamnă modificarea traiectoriei luminii la trecerea dintr-un mediu în altul. Spre deosebire de un material obişnuit, un material cu indice de refracţie negativ deviază considerabil mai mult razele de lumină, fiind suficientă pentru producerea unei lentile utilizarea unei lame paralele dintr-un asemenea material (fără curbură). În plus, utilizarea unui material cu indice de refracţie negativ conduce la obţinerea unor instrumente optice care nu au limitările intrumentelor optice uzuale, care ţin în special de imposibilitatea vizualizării unor obiecte mai mici decât lungimea de undă a luminii (cum se întâmplă în cazul unui microscop). Din acest motiv, apariţia materialelor cu indice de refracţie negativ deschide o nouă epocă în tehnologia instrumentelor optice.

Cel mai spectaculos avantaj al materialelor cu indice de refracţie negativ ţine însă de posibilitatea curbării luminii prin refracţie în jurul unui obiect îmbrăcat într-un asemenea material, aşa cum se vede şi în figură. Un asemenea obiect ar deveni invizibil pentru un observator extern, fără a fi necesară o poziţionare specială a acestuia. Dificultăţile pe care le ridică elaborarea unei asemenea tehnologii sunt deosebite, mai ales pentru că obţinerea indicelui de refracţie negativ necesită realizarea unei combinaţii la scară nanometrică între materiale cu proprietăţi electrice şi magnetice speciale. În plus, în momentul de faţă efectul de indice de refracţie negativ depinde puternic de lungimea de undă a luminii utilizate (spre exemplu, efectul se poate produce pentru lumină roşie fără a se produce pentru lumină albastră). Crearea unui material care să asigure invizibilitatea în lumină naturală necesită o plajă mult mai mare de lungime de undă, care să acopere toate culorile curcubeului.

Totuşi, implicaţiile militare ale fenomenului asigură finanţarea consistentă a cercetărilor şi promit obţinerea unor rezultate spectaculoase într-un timp nu foarte îndepărtat.

Imaginea a fost luată din articolul J. B. Pendry, D. Schurig, D. R. Smith, "Controlling Electromagnetic Fields", Science 312, 1780–1782, (2006).

4 mai 2010

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- **Studiul propagarii luminii in structuri cu indice de refractie negativ (metamateriale)**

La propagarea radiatiei electromagnetice in structurile periodice cu perioada mai mica de cateva ori decat lungimea de unda, pentru un design special ales al structurii (meta poate obtine un efect de permitivitate si permeabilitate efective a mediului negative ($\varepsilon<0$, $\mu<0$). La aceste materiale vectorul de unda **k** este antiparalel cu directia de propag Consecintele acestui efect sunt: indice de refractie negativ, refractie negativa, lentila perfecta, invizibilitate optica, etc.