Crystals

an Open Access Journal by MDPI

CiteScore: 5.0
Impact Factor: 2.4

Special Issue Reprint

Metamaterials and Their Devices, Second Edition

Edited by: YoungPak Lee

Over the most recent two decades, metamaterials (MMs) have led a revolution in new material science through the artificial arrangement of electric- and magnetic-resonance structures (meta-atoms) at the subwavelength scale. In particular, they have enriched the fundamental rules of light–matter interactions, such as slow light, super resolution, super-lensing, and electromagnetic (EM) cloaking. The main reason for the attention paid to MMs is that they are very close in appearance to real life, such as perfect absorbers. EM MMs reveal remarkable responses to the incident EM wave, such as negative-refraction index, extraordinary optical transmission, electromagnetically induced transparency-like effects, and ultra-thin and broadband absorbers. The designed structures, the structural parameters, and the properties of used materials yield the effective electric permittivity ($\varepsilon_{eff}(\omega)$) and the effective magnetic permeability ($\mu_{eff}(\omega)$) of overall MMs based on the effective-medium theory. Studies on the control of EM response and its spatial distribution and dispersion are ripe and lead to potential and almost-realized applications. There are emerging fields in MM research, such as nonlinear, switchable, gain-assisted, sensor, quantum, and coding MMs, all representing a variety of MM applications.

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