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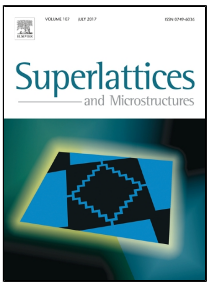

Design of ultrahigh refractive index metamaterials in the terahertz regime

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Design of ultrahigh refractive index metamaterials in the terahertz regime

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Abstract

A high refractive index metamaterial was theoretically designed in the terahertz region, and the proposed structure is to easy implementation. By decreasing the diamagnetic effect with a thin "I"-shaped metallic patch structure and drastically increasing the effective permittivity through strong capacitive coupling in the unit cell, the higher refractive index of designed metamaterial can be obtained while maintaining low losses in the resonant frequency. The physical mechanism of metamaterial possessing an enhanced refractive index is revealed by the surface current, the electric field and magnetic field distributions. Besides, the polarization characteristics and broad incident angles robustness for the high refractive index are demonstrated.

Keywords: Metamaterial, Optical material, High refractive index.

1. Introduction

Artificially electromagnetic metamaterials have attracted considerable attention because of their abnormal electromagnetic response which is not found in naturally occurring material [1-5]. Especially, the designs and experiments of the artificial metamaterials with negative refractive index through precisely controlled effective permittivity and permeability have been reported in advanced lenses and optics, or invisibility cloaks [6]. Recently, with the investigation of optical devices in transformation optics, the goal of developing metamaterials expanding the refractive index into a high positive regime has been necessary. It is known that a few naturally existing semiconductors and insulators, such as strontium titanate or lead sulphide, show a rather high peak refractive index at mid- and far-infrared frequency, other transparent materials exhibit small positive refractive indices [7]. In order to realize high refractive index metamaterials, a parallel plate capacitor with subwavelength scale have been proposed, and it exhibits a non-resonant enhancement of the effective permittivity, but the strongly diamagnetic effect simultaneously exists, leading to a small effective permeability [8]. So, the refractive index of such metamaterial cannot be greatly improved. Subsequently, a three-dimensional close-packed array of metallic cubes was reported by Wood *et al*., and they revealed that the diamagnetic response of metamtaterials come from the area subtended by the current loop [9].