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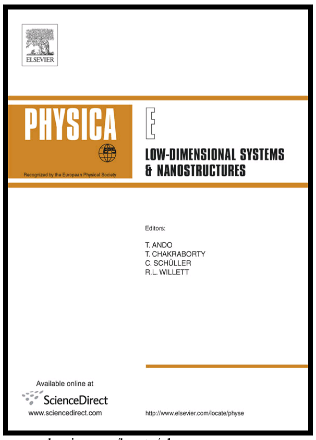

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MULTI-BAND METAMATERIAL ABSORBER TOPOLOGY FOR INFRARED FREQUENCY REGIME

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Abstract

In this paper, a new multiband metamaterial absorber design is proposed and the numerical characterization is carried out. The design is composed of three layers with differently sized quadruplets in which the interaction among them causes the multiband absorption response in the infrared frequency regime. In order to characterize the absorber and explain the multiband topology, some parametric studies with respect to the dimensions of the structure are carried out and the contributions of the quadruplets to the absorption spectrum are analyzed. According to the results, it is found that the proposed metamaterial absorber has five bands in the infrared frequency regime with the absorption levels of: 98.90 %, 99.39 %, 86.46 %, 92.80 % and 97.96 %. Moreover, the polarization dependency of the structure is examined and it is found that the design operates well as a perfect absorber with polarization independency in the studied frequency range.

Keywords: metamaterial; topology; multiband; perfect absorption; solar energy.

1. Introduction

In recent years, significant attentions have been attracted on the artificial materials (namely metamaterials) as they can dramatically manipulate the incident electromagnetic wave. In addition to the effects on the incident wave, they exhibit exotic properties (negative refractive index [1,2], invisibility cloaking [3] and so on.) which are not possible to be observed by natural materials. Due to these extraordinary properties, there are many potential application areas of metamaterials such as; sensors [4,5], switches [6], absorbers [7-25]. Among these application areas, perfect absorption is crucial for applications like micro-bolometers, sensors, thermal imagers, and solar energy utilization.

Perfect absorption can be obtained when the transitivity and the reflectivity of these materials are simultaneously reduced to zero. In this case all the incident electromagnetic radiation is absorbed by the material [8]. Although metamaterial absorbers are composed of different layers, they behave as an effective material as they are subwavelength structures with respect to the incident wave [9]. Therefore, effective parameters, which are permittivity and permeability, specify the properties of the metamaterial absorbers. Especially, these parameters can be arranged so that the effective impedance of the absorber becomes same with the impedance of the free space [10,11]. Under these circumstances, the reflected and transmitted waves are simultaneously minimized and the perfect absorption is achieved [12]. In addition, plasmon polaritons at higher frequencies can create the plasmonic resonances so that the incident wave is totally absorbed [13]. Moreover, the resonant response of the metamaterial absorbers is strongly dependent on to the geometric dimensions of the structure.