A Review paper on Metamaterial Absorber

Purvi Soni , Santosh Meena

Abstract : In this paper a brief review of various structures designed from Metamaterial Absorbers is given. Compared with conventional materials, Metamaterials exhibit some specific features that are not found in conventional material. Absorbers from metamaterials are used for the various applications such as Antennas, Clocking Devices, Super Lenses etc.

Keywords: MetamaterialAbsorber, Triple-Band, Circular Split Ring, Four-band absorption, Perfect absorber.

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1. INTRODUCTION:

With the emergence of a new field of electromagnetic, metamaterials was brought about by the demand of materials with exotic properties unattainable in nature.Metamaterials have been demonstrated to have different optical properties relying on the shapes and arrangements of the constituent elements. Different applications such as super lens, clocking, sensing and perfect absorption have been studied based on the optical resonance in metamaterials. One such property to enhance the use of metamaterial is a negative refractive index that requires both effective dielectric permittivity and magnetic permeabitlity to be negative. Some applications of negative index metamaterial(NIMs) include "perfect" lenses, sub-wavelength transmission lines and resonators, miniature antennas. Metamaterials are formed from the assembly of multiple elements fashioned from conventional materials such as plastics or glasses. These materials are arranged in repeating pattern at microscopic level or smaller scale. Metamaterials derive their property , orientation and arrangement gives them, their properties. And those materials that exhibit a negative index of refraction for particular wavelengths are kn0wn as negative index metamaterials.

2. LITERATURE SURVEY :

Wang.[1] present a four-band and polarization- insensitive terahertz metamaterial absorber formed by four square metallic rings and a metallic ground plane separated by a dielectric layer. It is found that the structure has four distinctive absorption bands whose peaks are over 97% on average.

The mechanism of the four-band absorber is attributed to the overlapping of four resonance frequencies, and the mechanism of absorption is investigated by the distribution of electric field . The frequency of each absorption peak can be flexibly controlled by varying the size of the corresponding metallic ring. The proposed is applicable to other types of absorber structure and can be readily scaled up to the structures that are working in microwave frequency range. The proposed structure has applications in detection, imaging, and stealth technology.

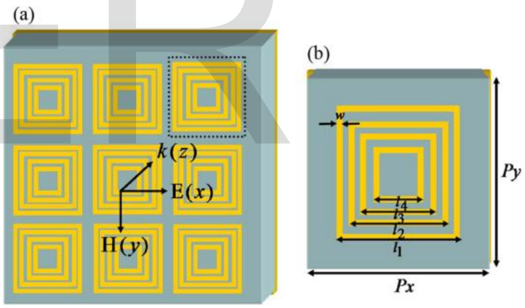

Fig 1:(a)Structure of proposed metamamerial absorber (b)unit call of structure

Saptarishi Ghosh and K.V.Srivastava[2].presented a model for making ultra wideband ultrathin metamaterial absorber. The proposed structure is composed of two concentric circular split rings imprinted on a metal-backed dielectric substrate. A 10-dB absorption bandwidth from 7,85 to 12.25 GHz covering the entire X-band has been observed in numerical simulation under the normal incidence. The absorptivity of the proposed structure have been investigated under different polarization angles as well as oblique incidence. The electromagnetic field distribution and surface current plots have been shown to analyze the absorption mechanism of the proposed structure.

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The proposed absorber has been fabricated and its performance is experimentally verified at different angles of incidence and polarization of incident electromagnetic wave. The designed absorber is compact, ultrathin and provides an alternative to construct broadband absorber for many potential applications.

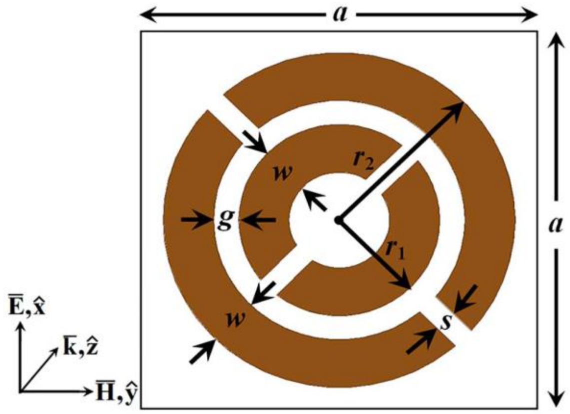

Fig 2: ultra wideband ultrathin unit call structure

Liang[3]. Presents “A triple-band compact and efficient ultrathin metamaterial with wide angle and polarization stability”. The compact single unit cell includes a metallic background plane, four groups of dipole lying around a metallic ring connected by four group of pins, and only 1mm low-cost dielectric layer. The main parameter designed absorber are investigated andoptimized to show at each of three absorption frequency points can be effectively separated adapted. The simulation results demonstrate that this absorber has good absorption rates and polarization-insensitive characteristics over wide angles of incident waves for both transverse electric(TE) and transverse magnetic(TM) in three frequency bands. The waveguide measurement method utilized to test the simulated results of three good absorption peaks.

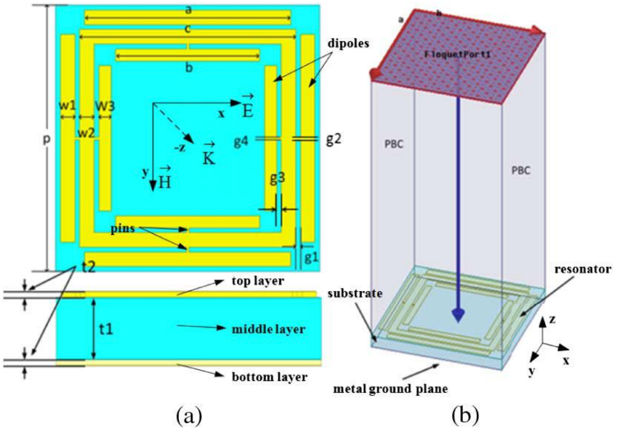

Fig 3: (a)Physical parameters of absorber cell (b) Simulation cell model

YongzhengWen[4].presents deign of infrared dual-band metamaterial absorber. The unit cell consist cross resonator ringed by four split-ring resonator spaced at a distance above a ground plane with a dielectric layer of SiO_2. The absorber shows two absorption peaks of 90.3% and 88.4% at 4.17 um and 4.86um. The multireflection interference theory is applied to explain the absorption mechanism with the gold ground plane described by Drude model. The designed absorber is insensitive to incident angle and polarization direction in a broad range, which are highly favorable feature in practical applications. The power reflection of dual-band metamaterial absorber using a microscope coupled Fourier transform infrared(FTIR) spectrometer, and the incident light was at an angle of about 30′ with respect to the normal on the sample surface. For both TE and TM polarizations, the two absorption peaks remain higher than 90% with very little shift in positions when the incident angle increases from 0 up to 60.

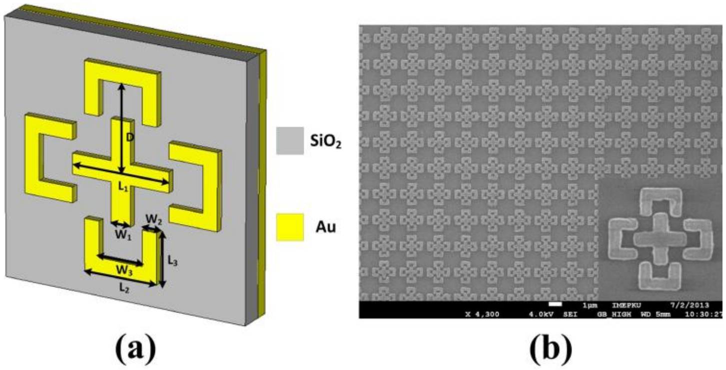

Fig 4: unit cell of dual band metamaterial absorber (b) SEM image of dual band absorber.

Zhen Wang and Ling Wang[5].propose a simple way to broaden the bandwidth of the metamaterial absorber formed by a low-conductivity square alloy patch and a dielectric layer on the top of an alloy ground plane. In this design we demonstrate an ultra-broadband and polarization insensitive absorber by simply stacking three different-sized alloy patches. Greater than 90% is obtained across a frequency range of 1.34Thz with the central frequency around 1.90THz. The relative absorption bandwidth of the device is greatly improved to 70.4%. The mechanism for the ultra broad-band absorption is attributed to the overlapping of four different but closely positioned resonance frequencies. The results of proposed alloy metamaterial absorber appear to be very useful for solar cells, detection , and imaging applications.

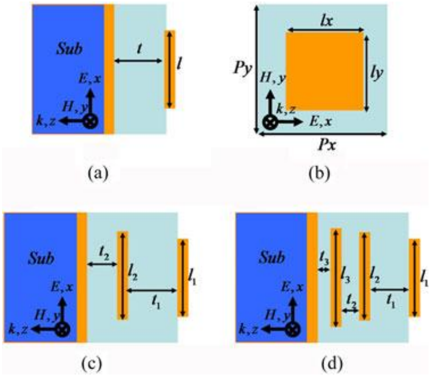

Fig: cross section(a) top view (b) of single-band alloy absorber, (c) and (d) cross section of proposed broadband and ultra-broadband alloy absorber.

3. CONCLUSION:

In this paper, a shot review of metamaterial absorber and some structures based on metamaterials and ideas has only briefly touched upon some selective research efforts associated with metamaterial absorber and its applications. These structures are designed to broaden the bandwidth of metamaterial absorber composed of a patterned square metallic patch and a metallic ground plane separated by a dielectric layer. The conductivity of the metal and the thickness of the dielectric layer determine the bandwidth of the metamaterialabsorber[6]. The proposed structures are used for many potential applications such as stealth technology, electromagnetic interference(EMI), electromagnetic compatibility(EMC) and phase imaging. The structures discussed in this paper are based on CST i.e. Computer Simulation Technique software, and are designed using Design Pro software.

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