A REVIEW ON MULTI BAND POLARIZATION – INSENSITIVE METAMETARIAL ABSORBER FOR EM INTERFERENCE & COMPATIBILITY

[1]Jayant Kumar Sahu, [2]Namrata Sahayam

Electronic & Communication Department,
J.E.C, Jabalpur Engineering Collage,
Jabalpur, Madhya Pradesh, India

Abstract: **This paper studys advantages of different convensional metamaterial structure absorber and their application. Metamaterial are engineered arrangement that enhance electromagmetic properties they are not found in natural materials. Research are making effort eventually become Metter of concern for wide range of microwave frequency band application. Metamaterial absorber superiority over conventional absorber due to their paper thin thickness, incredible absorptivity and ease to manufacture the absorber is constructed of a delicate periodic structures and a metallic background plane, separated by a dielectric substrate.**

In negative-index metamaterials (NIM), both permittivity and permeability are negative, resulting in a negative index of refraction. These are also known as double negative metamaterials or double negative materials (DNM). Other terms for NIMs include "left-handed media", "media with a negative refractive index", and "backward-wave media".

In optical materials, if both permittivity *ε* and permeability *μ* are positive, wave propagation travels in the forward direction. If both ε and μ are negative, a backward wave is produced. If ε and μ have different polarities, waves do not propagate.

***Keywords*: Metamaterial, microwave absorber, frequency, EM wave, polarization-insensitive**

1. INTRODUCTION

However, with growing technology, a significant research is carried out to achieve multi-band and/or bandwidth-enhanced absorbers with simultaneous polarization-insensitive and wide-angle structure has been proposed characteristics. A split ring resonator (SRR) based metamaterial absorber proposed Due to its unusual electromagnetic properties, metamaterials based structures find applications in antennas, cloaking etc [1-3]. Metamaterials based absorbers are also found to be of potential interest owing to their compactness in all frequency ranges [4-6]. Usually, electric field driven LC (ELC) resonators have been used as basic unit cell for single band, multiband as well as bandwidth-enhanced application [7-8]. Single unit cell containing ELC structure has been proposed for dual band absorption application, but it is polarization sensitive in nature [9]. The unit cell containing the structure discussed in [9] along with its orthogonally rotated prototype has been proposed to achieve polarization independent behaviour [10]. A metamaterial absorber has been presented whose unit cell contains fractal shape implemented over square loop to provide compactness. The geometrical dimensions of the loop are chosen in such a way that one of the absorption peaks is achieved in C-band and the other in X-band. The field distributions are studied at both the frequencies of absorption peaks to validate the absorption phenomena. The structure is also found to be polarization insensitive in nature owing to its symmetry over the plane of the structure. Further, the structure is studied for oblique incidences and it behaves as absorber up to 45° incident angle for both TE and TM polarizations.

2. LITERATURE SURVEY

DEVKINANDAN CHAURASIYA ; SAPTARSHI GHOSH ; S. BHAT TACHARYYA , KUMAR VAIBHAV SRIVASTAVA ; In this paper, a dual-band metamaterial absorber with bandwidth-enhancement at Ku-band is presented in microwave frequency range. The unit cell geometry comprises of two split ring resonators in the top surface of a metal-backed dielectric substrate. Simulation result shows that the structure has dual-band absorption response with one band lying in C-band and another in Ku-band with an enhanced bandwidth having full width at half maxima (FWHM) bandwidth of 1 GHz. The absorber is symmetric in design and shows polarization-insensitive behavior under normal incidence. It also shows high absorption (above 80%) for oblique incidence upto 45° under TE polarization. The proposed structure has been fabricated and absorption is measured in anechoic chamber, which shows good agreement with the simulated response. The designed absorber is ultra-thin and appears to be potentially instructive for various EMI/EMC applications. 978-1-4799-6317-1/ 2014 IEEE International Microwave and RF Conference(IMaRC).

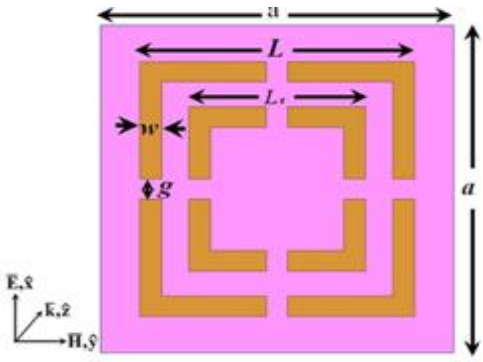

FIG-1 front view of unit cell geometry of the proposed structure

N. I. LANDY, S. SAJUYIGBE, J. J. MOCK, D. R. SMITH, AND W. J. PADILLA In this paper present the design for an absorbing metamaterial (MM) with near unity absorbance . This structure consists of two MM resonators that couple separately to electric and magnetic fields so as to absorb all incident radiation within a single unit cell layer. We fabricate, characterize, and analyze a MM absorber with a slightly lower predicted of absorbance 96%. Unlike conventional absorbers, our MM consists solely of metallic elements. The substrate can therefore be optimized for other parameters of interest. We experimentally demonstrate a peak greater than absorbance 88% at 11.5 GHz. Phys. Rev. Lett. **100**, 207402 – Published 21 May 2008

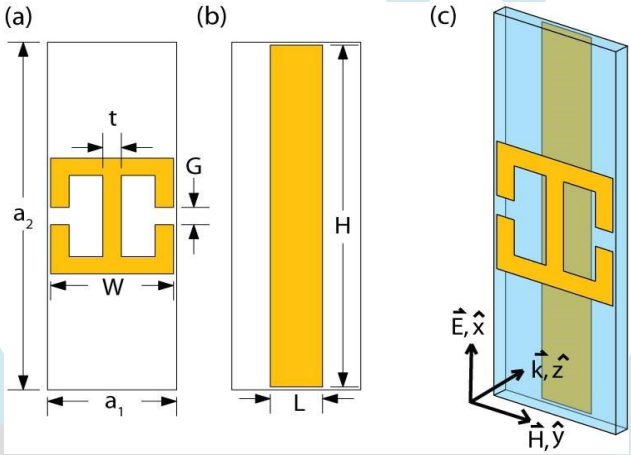

FIG. 2: Electric resonator (a) and cut wire (b). Dimension notations are listed in (a) and (b). The unit cell is shown in (c) with axes indicating the direction of propagation of a TEM wave

DEVKINANDAN CHAURASIYA; SAPTARSHI GHOSH ; KUMAR VAIBHAV SRIVASTAVA In this paper, an ultra-thin dual-band polarization-insensitive metamaterial absorber with wide-angle characteristics has been presented. The unit cell geometry comprises two circular rings with the inner one cross-connected. Simulated results show two discrete absorption peaks at 2.90 GHz (S-band) and 6.13 GHz (C-band) with absorptivities of 99.66% and 99.83% respectively, which can be used for surveillance and air defense radar applications. The proposed structure is polarization-insensitive and shows high absorption (over 80%) for wide incident angles upto 60 degree for both TE and TM polarizations. The proposed structure has been fabricated and measured, showing good agreement with the simulated responses. 978-2-87487-035-4/ 2014 IEEE European Microwave Conference.

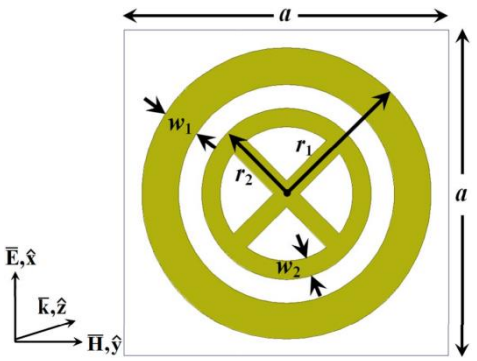

Fig. 3. Front view the unit cell structure with geometric dimensions: *a* = 23 mm, *r*1 = 10.25 mm, *r*2 = 6 mm, *w*1 = 2.6 mm and *w*2 = 1.3 mm.

SOMAK BHATTACHARYYA ; SAPTARSHI GHOSH ; ANAMIYA BHATTACHARYA ; DEVKINANDAN CHAURASIYA An ultra-thin polarization independent compact fractal shaped metamaterial absorber In this paper an ultra-thin polarization-independent compact metamaterial absorber has been proposed where the unit cell contains single fractal shaped square structure. The geometrical dimensions of the fractal structure have been designed in such a way that the structure exhibits absorption at 4.17 GHz and 11.16 GHz. Due to the four-fold symmetry of the structure, the absorber is polarization-independent in nature. The proposed structure has been studied under oblique incidences for TE and TM polarizations where it behaves as absorber upto 45° incident angles in both the cases. The structure is only 1.6 mm thick (~ λ0/17 with respect to higher absorption frequency), making it ultra-thin in nature. 978-1-4673-9536-6 / 2015 IEEE Applied Electromagnatic Conference(AEMC).

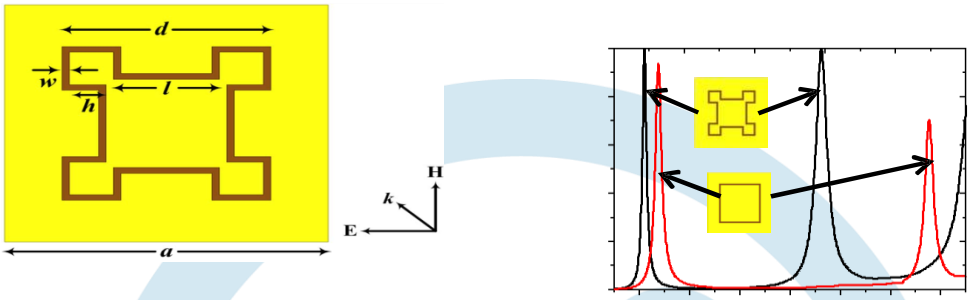

Fig. 4(a) Top view and (b) absorptivity response of the proposed dual band absorber structure (a = 15, w = 0.35, d = 9, l = 4.2, h = 1.7) (Unit: mm).

A different shaped metamaterial absorber structure has been proposed in this all article. The ultra-thin structure shows near-unity absorption for different microwave bands (S, X, C and Ku-band) aimed for radar and EMI/EMC applications. The cross in the inner ring of the structure provides larger absorbance in the higher frequency and better tunability. In this all structure is polarization-insensitive under normal incidence and shows high absorption (above 80%) for both TE and TM polarizations. Moreover, the structure has been fabricated and measured in anechoic chamber, which shows good matching with the simulated results under normal as well as oblique incidence condition. The surface current distributions have been illustrated to explain the physical insight of the absorption of the structure. The dimensions of the absorber structure can be tuned to apply in various applications like stealth technology, THz imaging and wireless communication.

3. RESULTS ANALYSIS

Results analysis has been done using previous paper where electromaganatic wave absorotion show different frequency and different band and its application.

	METAMATERIAL ABSORBER	FREQUENCY(GHz)	ABSORPTIVITY %	MICROWAVE BAND	APPLICATION
1	Dual-band absorber with bandwidth-Enhancement	7.38 GHz	99.2%	C- Band	EMI/EMC APPLICATION
		12.78 GHz	95%	Ku-Band	
		13.14 GHz	99.6%	Ku-Band	
2	Dual-band Wide Angle Metamaterial Absorber	2.90 GHz	99.66%	S-Band	RADAR APPLICATION
		6.13 GHz	99.83%	C-Band	
3	Triple-Band Metamaterial Absorber using Destructive Interference	4 GHz	95.27%	S-Band	Superlenses, Antenna miniaturization
		6.54 GHz	98.35%	C-Band	
		11.15 GHz	97.96%	Ku-Band	
4	Ultra-thin Compact Fractal Shaped Metamaterial Absorber	4.17 GHz	99.1%	C-Band	Antenna miniaturization, filers, EMI/EMC APPLICATION
		11.16 GHz	99.7%	X-Band	

4. CONCLUSION

A dual-band metamaterial absorber with bandwidth enhancement in the higher band has been presented which comprises of two concentric split ring resonators and fractal shaped metamaterial absorber. The geometric dimensions have been optimized to obtain two or three absorption peaks in different microwave bands (S, X, C and Ku-band). The Dual-band absorber with bandwidth-Enhancement the measured response shows absorption at three distinct frequencies 7.37 GH_Z, 12.77 $GH_{z,\ and}$ 13.14 GH_Z with peak absorptivities of 99.2%, 99.1%, and 99.5% respectively. An experimental FWHM bandwidth of 1.08 GH_Z is observed between 12.40 GH_Z and 13.48 GH_Z range. Dual-band Wide Angle Metamaterial Absorber results show two discrete absorption peaks at 2.90GHz (S-band) and 6.13 GHz (C-band) with absorptivities of 99.66% and 99.83% respectively, which can be used for surveillance and air defense radar application. Triple-Band Metamaterial Absorber using Destructive Interference response shows three distinct absorption peaks 4 GH_Z , 6.54 GH_Z, 11.15 GH_Z with absorptivities of 95.25%, 98.35%, and 97.97% respectively. Ultra-thin Compact Fractal Shaped Metamaterial Absorber results shown two distinct absorption peaks at 4.17 GHz and 11.16 GHz with the respective peak absorptivity of 99.1% and 99.7%.

REFERENCES

[1] D. R. Smith, W. J. Padilla, D. C. Vier, S. C. Nemat-Nasser, and S.Schultz, "Composite medium with simultaneously negative permeability and permittivity," *Physical Review Letters*, Vol. 84, Issue 18, pp. 4184-4187, May 2000.

[2] C. Caloz, T. Itoh, and A. Rennings, "CRLH metamaterial leaky-wave and resonant antennas," *IEEE Antennas and Propagation Magazine*, Vol. 50, Issue 5, pp. 25-39, 2008.

[3] S. A. Cummer, B. I. Popa, D. Schurig, D. R. Smith, and J. B. Pendry, "Full wave simulations of electromagnetic cloaking structures," *Physical Review E*, Vol. 74, pp. 036621, 2006.

[4] N. I. Landy, S. Sajuyigbe, J. J. Mock, D. R. Smith, and W. J. Padilla, "Perfect metamaterial absorber," *Physical Review Letters*, Vol. 100, Issue 20, pp. 207402, 2008.

[5] H. Tao, N. Landy, C. M. Bingham, X. Zhang, R. D. Averit, and W. J.Padilla, "A metamaterial absorber for the terahertz regime: design, fabrication and characterization," *Optics Express*, Vol. 16, No. 10, pp. 7181-7188, 2008.

[6] T. Cao, C. -W. wei, R. E. Simpson, L. Zhang, and M. J. Cryan, "Broadband polarization-independent perfect absorber using a phase- chnage metamaterial at visible frequencies," *Scientific Reports*, Vol. 4, No. 3955, 2014.

[7] S. Bhattacharyya, H. Baradiya, and K. V. Srivastava, "An ultra thin metamaterial absorber using electric field driven LC resonator with meander lines," *2012 IEEE International Symposium on Antennas and Propagation and USNC/URSI National Radio Science Meeting*, pp. 1-2, July, 2012.

[8] S. Ghosh, S. Bhattacharyya, and K. V. Srivastava, "Bandwidth- enhancement of an ultra-thin polarization insensitive metamaterial absorber," *Microwave and Optical Technology Letters*, Vol. 56, Issue 2, pp. 350-355, February 2014.

[9] S. Bhattacharyya, and K. V. Srivastava, "An ultra thin electric field driven LC resonator structure as metamaterial absorbers for dual band applications," *2013 URSI International Symposium on Electromagnetic Theory (EMTS)*, pp. 722-725, 2013.

[10] S. Bhattacharyya, and K. V. Srivastava, "Triple band polarization- independent ultra-thin metamaterial absorber using ELC resonator," *Journal of Applied Physics*, Vol. 115, Issue 6, pp. 064508, 2014. pp. 063702, 2012.