A REVIEW PAPER ON TECHNIQUES AND DESIGN OF METAMATERIAL ABSORBER

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Abstract - *Metamaterials as they shows unusual electromagnetic wave characteristics that cannot be found in nature are widely used in many engineering applications like negative refraction [1], superlens [4], cloaking [3], antenna miniaturization [2] and so on. In this review paper a survey is conducted on commonly used techniques and different types of designs which is used by author to achieve peaks at different frequency range for an ultrathin, wide band ,affordable metamaterial absorber.*

KeyWords: **Metamaterial absorber, Absorbtion, Unit-cell, Frequency**

1. INTRODUCTION

In recent years, electromagnetic (EM) metamaterials have gain significant research interests because of their attractive properties. Several important applications, such as super lens [4], cloaking [3], antenna miniaturization [2], absorption and many more have been proposed over the wide EM spectrum covering from microwave to visible regimes. Metamaterials are the artificially developed materials which shows the properties which cannot be available in natural materials like negative refraction index[1], clocking behavior[3], backward propagation, and reverse Doppler effects. Metamaterials shows the unique properties due to physical structure of the composite material irrespective of the chemical properties of the material.

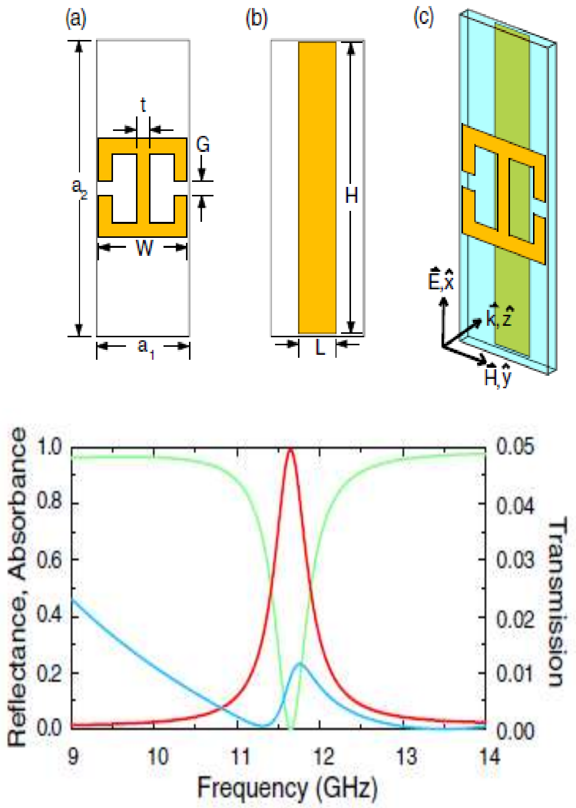
Generally, microwave absorbers are extensively used in many applications to reduce the electromagnetic interference in microwave components. But the large thickness (~λ/4) of the conventional microwave absorber structure is one of the major disadvantages. Metamaterial structure are used to remove this disadvantages and can add more benefits over it, where the ultra-thin structures having periodic unit cells can be used to obtain near unity absorption through ohmic and dielectric loss.

To develop an Metamaterial absorber with good absorption characteristics different shapes are still being researched for constant improvement and better results. It was found that some geometry might have a wider bandwidth or better absorption characteristics than others at particular microwave frequencies.

2. LITERATURE SURVEY

2.1 N.I. Landy, S. Sajuyigbe, J.J. Mock, D.R. Smith, and W.J.Padilla "PERFECT METAMATERIAL ABSORBER":

Metamaterial absorber has been firstly proposed by Landy that shows maximum absorption at the frequency of 11.65 GHz with 96%.In this design, a single unit cell of the absorber consist of two distinct metallic elements at the front side there is split ring resonator and at the back side there is split-wire. Electric coupling was supplied by the electric ring resonator. This element consisted of two standard split ring resonators connected by the inductive ring parallel to the split-wire.

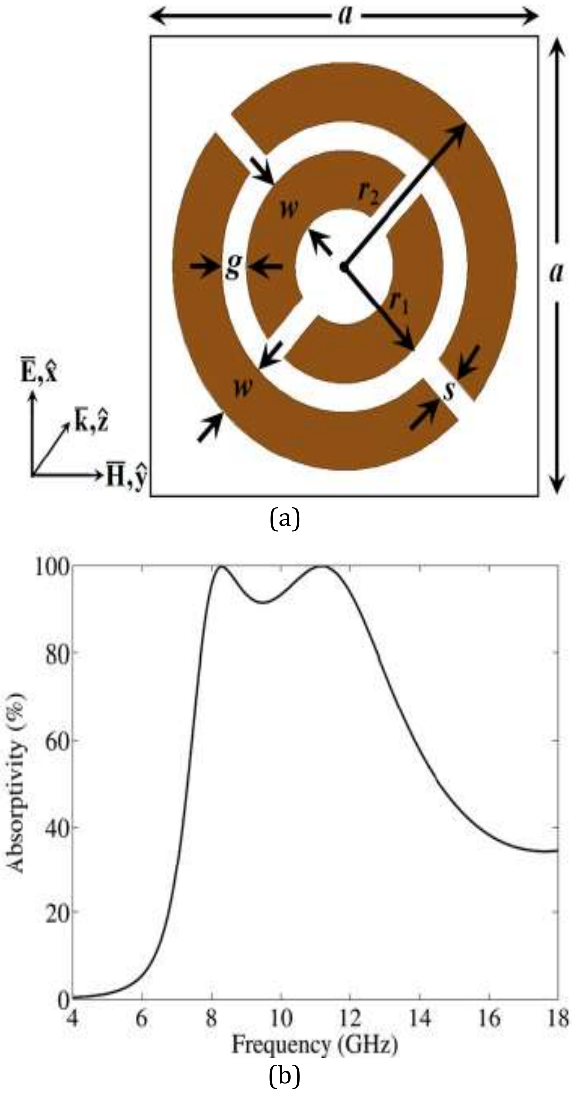


(d)

Figure.1 (a)Electric resonator (b)Cutwire (c)Unit cell (d)Simulated result showing Absorbtion,Reflection and Transmission

2.2 S.Bhattacharya, S.Ghosh, D.Chaurasiya and V. Srivastava "AN ULTRAWIDEBAND ULTRATHIN METAMATERIAL ABSORBER BASED ON CIRCULAR SPLIT RINGS"

In this paper, the unit cell of the proposed structure is composed of two concentric circular split rings of copper at the top of a dielectric substrate and having copper laminated at the bottom. It shows absorption bandwidth from 7.85 to 12.25 GHz with 90% absorbtion covering the entire X-band under normal incidence. FR-4 substrate has been used as dielectric with thickness of 2 mm and top and bottom metallic patch is of copper wth thickness 0.035mm.The top layer consist of two circular split rings have been embedded one inside another, where the outer ring provides dual-band absorption and the bandwidth is considerably increased by the inner one.



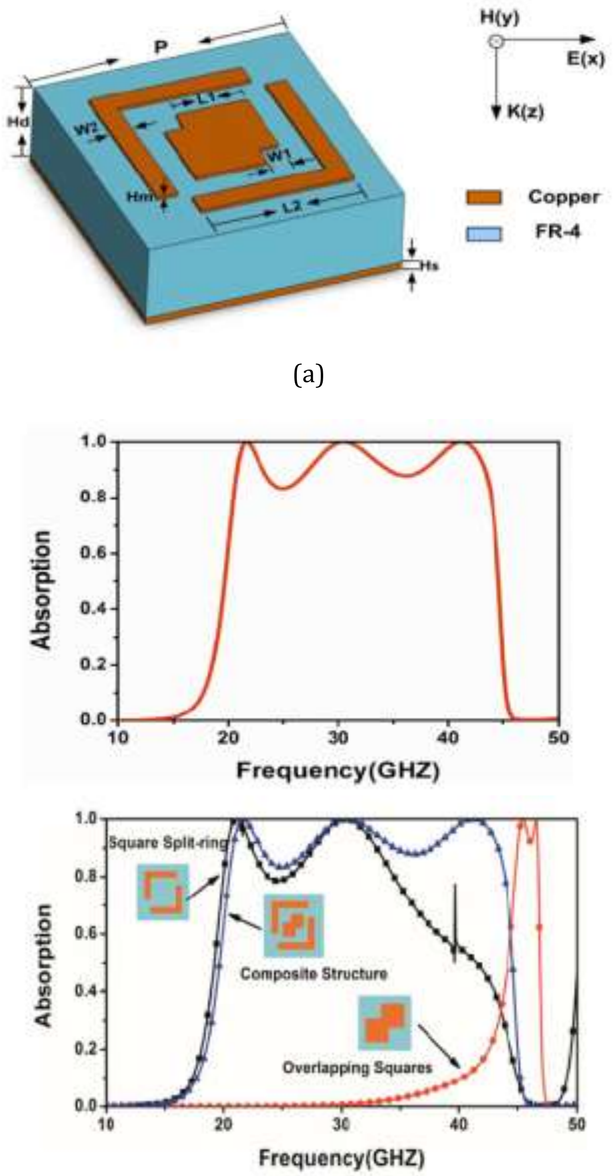
(a)

(b)

Figure.2 (a) Front view of the proposed ultrawideband ultrathin unit cell structure with geometrical dimensions:a=7.1, r1=1.8, r2=3.15, w=0.9, g=0.45, s=0.4(units:mm) (b) simulated absorptivity responses.

2.3 Wang Xin,Zhang Binzhen,Wang Wanjun,Wang junlin,and Duan Junping "DESIGN AND CHARACTERIZATION OF AN ULTRABROADBAND METAMATERIAL MICROWAVE ABSORBER"

This paper presents the design, simulation, fabrication, and performance of an ultrabroadband metamaterial absorber at microwave frequencies. The unit cell of this design is composed of the combined metallic resonance structure of two overlapping squares, as well as a square split-ring and a continuous copper ground plane of copper having 0.01 mm thickness at the top of an FR-4 dielectric layer of 0.9mm thickness. The simulated absorption performance of the proposed structure for the normal incidence EM wave shows absorbtion of over 83% from 20.59 GHZ to 43.73 GHZ. Three distinct absorption peaks can be clearly observed at 21.438 GHZ, 30.41 GHZ, and 42.367 GHZ with the absorption ratios of 99.97%, 99.99%, and 99.94%, respectively.



(a)

(b)

Figure.3 (a)Unit cell (b)Absorbtion graph

2.4 S.Bhattacharya, S.Ghosh, D.Chaurasiya and V. Srivastava "A Broadband Wide Angle Metamaterial Absorber for defense Applications"

In this paper, a single-layer structure is proposed which can be used as C-band metamaterial absorber. The unit cell of proposed structure consist of two simple L-shaped patches placed diagonally. The metallic L shaped Patches made of copper and backside of the structure which is completely copper laminated is having a thickness of 0.035 mm and are separated by a single layer of 3.2 mm thick FR-4 substrate. It shows an absorption bandwidth of 2.6 GHz ranging from 4.6 to 7.2 GHz covering the entire C-band with more than 90% absorptivity level.

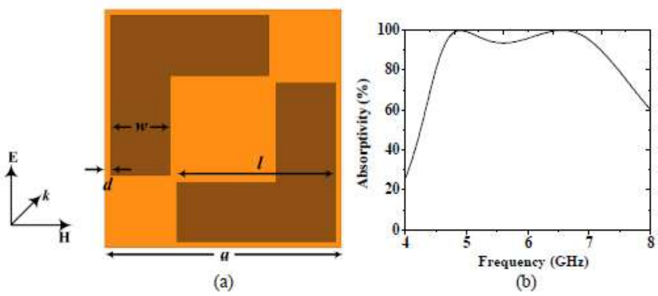


Figure.4 (a)Front view and (b)absorbtion of proposed absorber (a=10mm, w=2.5mm, d=0.25mm, l =6.7mm)

3. CONCLUSION

In this review paper survey of designs and techniques of a Metamaterial Absorber has been done. The limitations of conventional Metamaterial Absorber characteristics can be improved by using one of any above mentioned technique. A metamaterial absorber depends on few parameters like design of patches at the top of structure, material used, dimensions of unit cell and interested frequency range. There are some problems like bandwidth enhancement, complexity of structure, reduction of gain etc. that demands researched to be done to have some concrete solution to work the design efficiently. The review work is done on the different techniques to design Metamaterial absorbers and to get the different characteristics.

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