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Review Paper on Microwave Absorber Using FSS

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Abstract: Microwave absorber are used in Military application, EMI reduction, Antenna pattern shaping, Radar cross reduction. Frequency-selective surfaces have been most commonly used in the radio frequency region of the electromagnetic spectrum and find use in applications as diverse as the aforementioned microwave oven, antenna radomes and modern metamaterials. One of the most important applications of FSS is hybrid radomes for radar cross section control.[1]

Keywords: Microwave Absorber, Frequency selective surfaces(FSS), radome, ferrite, magnetic resonance, stealth technology, fractal configuration.

1. INTRODUCTION

Microwaves are Electromagnetic Waves that have frequency range of 0.3 GHz to 300 GHz, with wavelengths ranging from 1m to 1mm. They obey the laws of optics and can be transmitted, absorbed or reflected depending upon type of material. Absorbers generally consist a filler material matrix. The filler consists of one or more constituents that do most of the absorbing. The matrix material is chosen for its physical properties (temperature resistance, weatherability etc). Absorbers are characterized by their electric permittivity and magnetic permeability.

Microwave absorbers are special materials that are used to reduce or absorb the energy that is present in a microwave. Microwave absorbers are used to solve a wide variety problem such as internal cavity resonance, antenna patterns shaping and high-frequency interference. Microwave absorber come in many forms which include foam, rigid epoxy, plastics or elastomers. These microwave absorbers are usually able to withstand extreme temperature and weather conditions.

A **frequency-selective surface** (**FSS**) is any thin, repetitive surface (such as the screen on a microwave oven) designed to reflect, transmit or absorb electromagnetic fields based on frequency. In this sense, an FSS is a type of optical filter or metal-mesh optical filters in which the filtering is accomplished by virtue of the regular, periodic (usually metallic, but sometimes dielectric) pattern on the surface of the FSS. Sometimes frequency selective surfaces are referred to simply as periodic surfaces and are a 2-dimensional analog of the new periodic volumes known as photonic crystals. In past decades, many studies have been carried out to realize broadband, strongly absorbing, and lightweight absorbers[4]-[6].

2. LITERATURE SURVEY

Hang Zhou[1] proposed absorptive/transmissive FSS keeps good bandpass performance at lower frequencies, and some out-of-band signals are absorbed rather than reflected. This is accomplished in three section on cst microwave studio. In I section miniaturized FSS structure is made by square substrate (F4B-2 with relative permittivity of 2.65 and a loss tangent of 0.001) with p=18mm and thickness h=1.5mm. The patch is made by three bricks, one (p-w) x (p-w) x tp brick subtracting from one brick of p x p x tp. Another patch is made by a brick of a x a x tp, then adding last two. where a=17.4mm, w=0.1mm, tp=0.005. In II section chose a magnetic film of density about 4.6 g/cm^3. In III or final section When the magnetic absorbing film is integrated with FSS in Section II, there are two different cases: One is the exciting transmission port facing the magnetic absorbing film, and the other one is transmission port facing the FSS.
From fig.2 we find that a resonant passband occurred at about 2.24GHz. The resonant frequency slightly shifts to higher frequencies as the incident angle increases for both TE and TM polarizations. Grating lobes emerged at frequencies higher than 6.0 GHz as the incident angle increases. In Fig. 3, in the low frequencies, the integrated FSS keeps good transmission performance, while in the high frequencies, the original reflection signals are absorbed. As shown in Fig. 4, in the low frequencies, the integrated FSS also keeps good transmission performance, while in the high frequencies, the reflection signals are not absorbed compared to Fig. 3.

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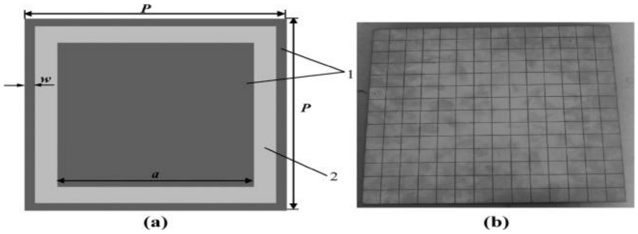

Fig. 1. The FSS is double-layer formed by capacitive patches and inductive strip and with no metallic structure on the back. 1) metallic patches; 2) substrate.(a) Top view of the unit cell. (b) Prototype of the fabricated FSS[1]

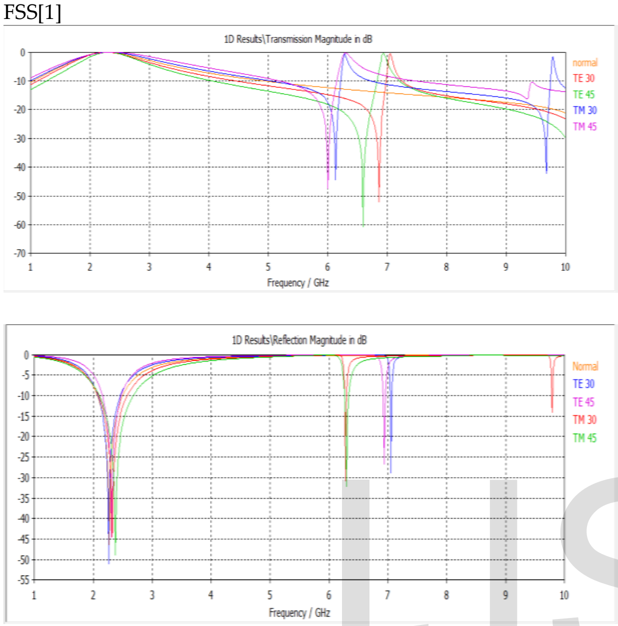

Fig .2. Frequency response of the FSS with different polarizations and incident angles(a) Transmission (b) Reflection[1]

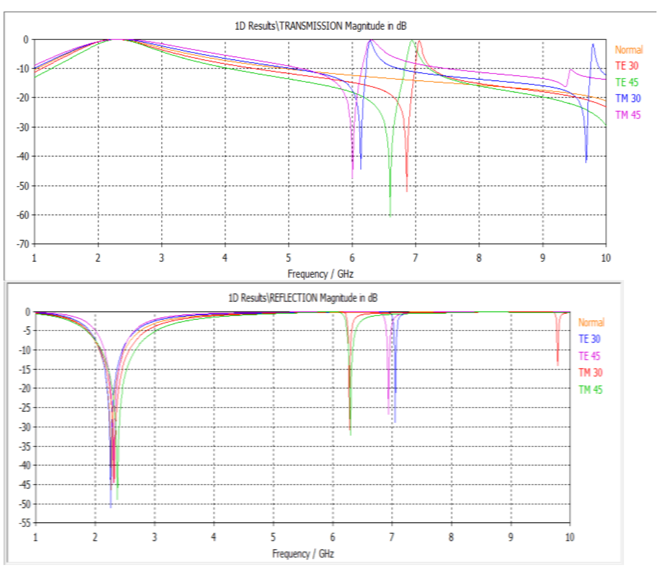

Fig .3. Frequency response of integrated FSS when transmission port facing theabsorber (a) Transmission (b) Reflection[1]

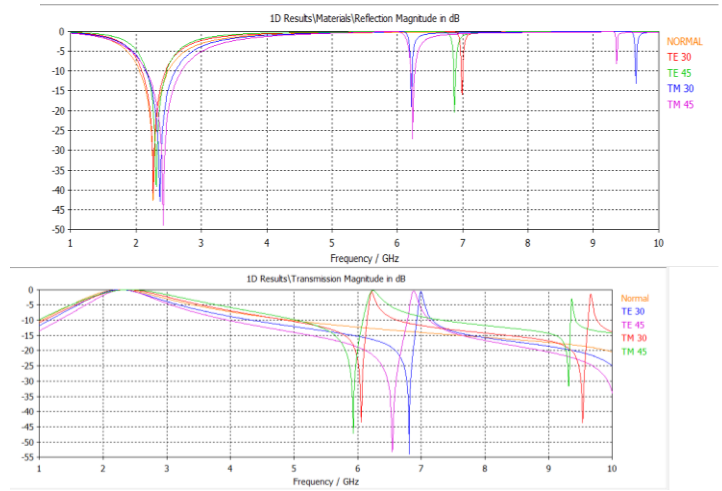

Fig .4. Frequency response of integrated FSS when transmission port facing the FSS (a) Transmission(b) Reflection[1]

Ji-Chyun Liu [2] proposed to implement a broadband microwave absorber using construction of FSS screen coated with ferrite. The structure consists of unit cells made by ferrite to coat an alumunium plate of dimension 25 x 37.5 x 0.7 mm with intervals Dx=25 mm and Dy=18.75 mm. With an angle theta= 45° of oblique incidence, there is nearly 60.4% bandwidth for the X-band in the E-field and three bands in the H-field were below -15 dB and nearly 67% bandwidth for the X-band in the E-field and five bands in the H-field are below -15 dB.

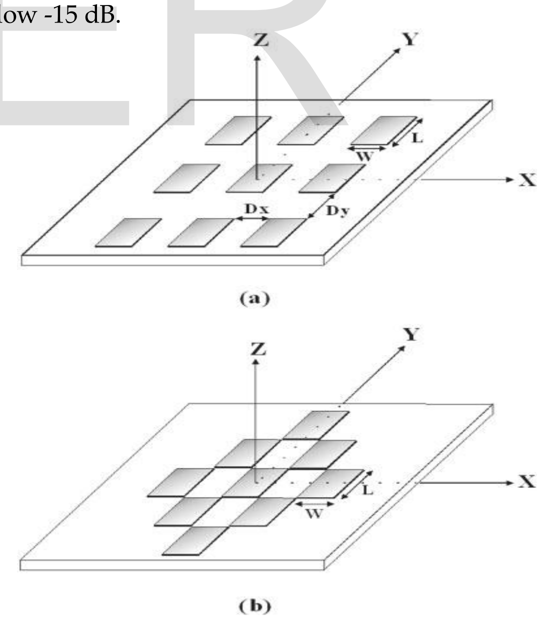

Fig. 5. FSS structures: (a) square lattice; (b) equilateral triangle lattice [2]

Liangkui Sun [3] proposed to demonstrate a design of lightweight magnetic radar absorber having broadband bandwidth in frequency range of 1-18 GHz. The low volume fraction of the absorbent makes the magnetic substrate to be lightweight, whose density is only 0.62 g/cm . Permittivity and permeability measurements of the microwave absorbent

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were performed using a method based on the TEM wave incidence on a sample inside a coaxial waveguide [7]. The operating bandwidths of 4.07–18 and 3.19–18 GHz of the single-layer and double-layer FSS-embedded RAs can be obtained, but the magnetic substrate itself has negligible wave absorbing properties. Single-layer and double-layer FSS-embedded magnetic RAs have been designed, and the bandwidths with the reflectivity below 10 dB in the frequency range of 2–18 GHz are significantly increased. The lightweight magnetic substrate with low relative permeability has negligible wave-absorbing properties, but the inserting of the lossy FSSs can greatly improve the wave-absorbing performance of the substrate.

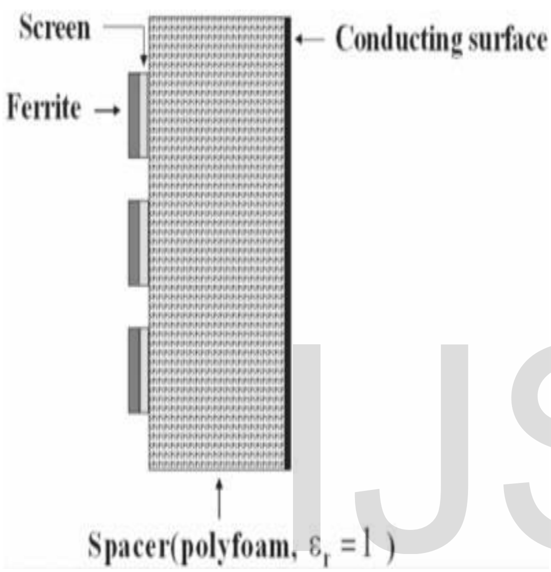

Fig.6. Side view of FSS structures[2]

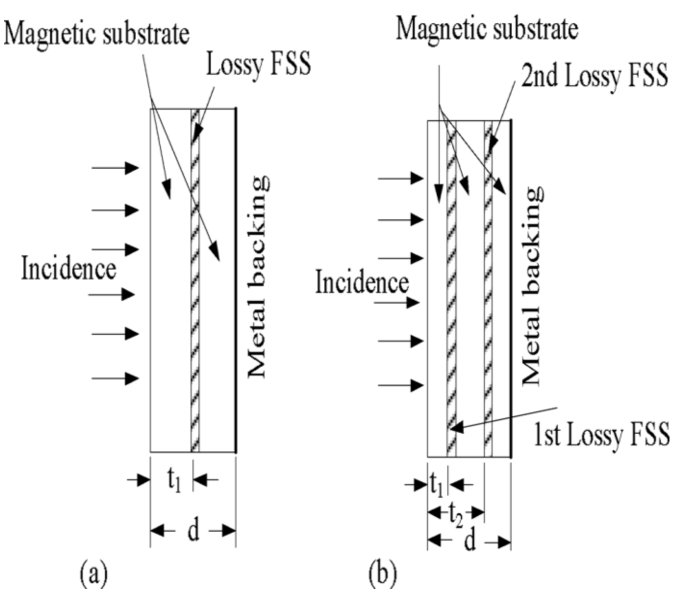

Fig. 7. Structure of the FSS-embedded RAs. (a) Single-layer instance. (b) Double-layer instance.[3]

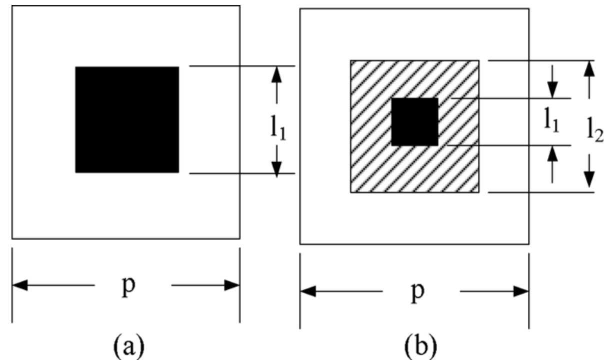

Fig. 8. Topology of the lossy FSS. (a) Single-layer FSS. (b) Double-layer FSS.[3]

Ji-Chyun Liu [8] proposed to implement a broadband microwave absorber with an FSS screen constructed using a circular fractal configuration. In the experiment, the diameter *W* of initiator circular disk in circular fractal pattern is 29.7 cm and, relatively, the diameter *d* of the generator is 9.9 cm, with a one-third fractal scale proportional to an initiator, and the process continues to create the third iterated stage of the circular fractal configuration, whose the diameter is 1.1 cm. All four patterns are fabricated using standard printed circuit technology on FR4 substrate with a dielectric constant is 4.4 and 29.7 x 29.7 x 0.16 cm dimensions to construct FSS screens. A resonance band is obtained to present the characteristics of broadband when *R*(*dB*) is between 4.5–5.5 GHz with 22% fractional bandwidth below _10 dB.

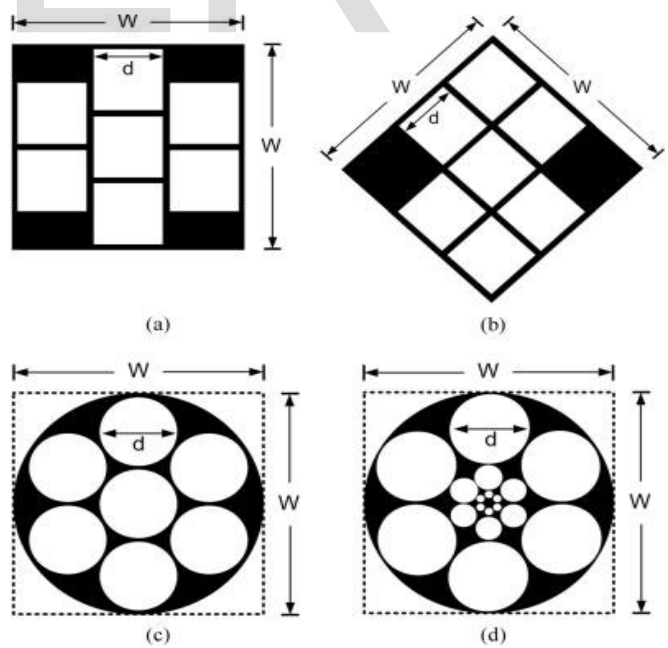

Fig. 9. FSS screens: (a) square FSS configuration; (b) rhombus FSS configuration; (c) circular FSS configuration; (d) circular fractal FSS configuration[8]

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3. CONCLUSION

This paper shows the review and survey of techniques and design for the designing of efficient absorber using FSS. By using one of any above mentioned technique some of the limitations of conventional FSS characteristics is improved. This review work is done on some characteristics implemented through different techniques. Nevertheless, useful solution are still less and suffer from different problems like complexity of structure, reduced bandwidth, reduction of gain etc. Hence, the author feels that further research and more work is needed in these areas. After searched the gap of research paper, reached at the point where is the a design has been discussed in this paper based on finite-difference time-domain method by CST Microwave studio software. In this design all the techniques will be used for analysis the parameters FSS.

REFERENCES:

[1] Hang Zhou – Experimental Demonstration of An Absorptive/Transmissive FSS With Magnetic Material, IEEE Transactions on Antennas and Propagation, Volume:13, 2014.

[2] Ji-Chyun Liu – IMPLEMENTATION OF BROADBAND MICROWAVE ABSORBER USING FSS SCREENS COATED WITH Ba(MnTi)Fe10O19 FERRITE, MICROWAVE AND OPTICAL TECHNOLOGY LETTERS , Vol. 41, No. 4, May 20 2004.

[3] Liangkui Sun – Design of a Lightweight Magnetic Radar Absorber Embedded With Resistive FSS, Volume:11, 2012.

[4] D. Yuping, Y. Yang, H. Ma, L. Shunhua, C. Xiaodong, and C. Huifeng, "Absorbing properties of -manganese dioxide/carbon black doublelayer composites," *J. Phys. D, Appl. Phys.*, vol. 41, no. 12, p. 125403, 2008.

[5] J. T. Jiang, L. Zhen, B. Y. Zhang, W. Z. Shao, andC. Y. Xu, "Improvement on electromagnetic absorbing performance of Al B O w/Co composite particles through heat treatment," *Scripta Mater.*, vol. 59,no. 9, pp. 967–970, 2008.

[6] H. Y. Chen, H. B. Zhang, and L. J. Deng, "Design of an ultra-thin magnetic-type radar absorber embedded with FSS," *IEEE Antennas Wireless Propag. Lett.*, vol. 9, pp. 899–901, 2010.

[7] Y. J. An, K. Nishida, Y. Yamamoto, S. Ueda, and T. Deguchi, "Microwave absorber properties of magnetic and dielectric composite materials," *Electron. Commun.*, vol. 93, no. 4, pp. 18–26, 2010.

[8] Ji-Chyun – Design And Analysis Of Broadband Microwave Absorber Utilizing Fss Screen Constructed With Circular Fractal Configurations, Microwave And Optical Technology Letters , Vol. 48, No. 3, March 2006.