IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X
PP 59-64
www.iosrjournals.org

Synthesis of Lanthanum Doped Magnesium Ferrite As Jointed Substrate Material To Design And Develop Micro Strip Patch Antenna For ISM Band Application

[1,]K. Raja , [2,]D. John Pragasam , [3,]Vasant Naidu
[1] PG Student, Sethu Institute Of Technology, Kariapatti, Tamil nadu, India
[2] Assistant Professor, Sethu Institute Of Technology, Kariapatti, Tamil nadu, India
[3]professor, Sethu Institute of Technology, Kariapatti, Tamil nadu, India

Abstract: A new engineering materials was found using sol-gel auto composition route method, the material was lanthanum doped magnesium ferrite $MgLa_xFe_{2-X}0_4$ (X= 0.05, 0.08, 0.1, 0.15), this composite ferrite was prepared by sol-gel auto composition method and sintered at a temperature of 1050^{o}C in a microwave furnace. In order to enhance the electrical and magnetic behavior of this material as required for designing Microstrip Patch Antenna (MPA). The structural, size of the particles, morphological were investigated by X-Ray Diffraction (XRD), E-DAX and SEM. The VSM studies confirm the Magnetic properties by analyzing the change in magnetic saturation. The material was identified as N-type semi-conductor behavior by semi-conductance test. In this proposed work, we will investigating the properties of the new engineering materials and found that it's suitable for microstrip patch antenna to be designed and particularly suits for ISM band (2.4 GHz). The designing and analysis of rectangular microstrip patch antenna is presented, the operating frequency of antenna is 2.4 GHz, the dielectric constant and resonant frequency of the antenna is 2.246, 2.4 GHz respectively. The simulation results of antenna are done by the help of ADS Software (Version 2009). In this paper, the effects of different types of antenna parameters like return loss, Directivity, Antenna gain, impedance etc. are also studied.

Key Words**:** *Advance Designing System (ADS), Dielectric constant, Directivity, Microstrip Patch Antenna (MPA), Return Loss.*

I. INTRODUCTION

With the wide spread creation of wireless communication technology in recent years, the demand for compact, low profile and broadband antennas has increased significantly. To meet the requirement, microstrip patch antennas (MPAs) have been proposed. MPAs are widely used in wireless communication applications because of their low profile, lightweight, low cost and compatibility with integrated circuits [1]. However, the conventional MPA has a disadvantage of a narrow bandwidth. There are numerous and well-known methods of increasing bandwidth of this type of antennas, and amongst the most common ways are increasing the thickness of the substrates and using a low dielectric constant substrate material [2] [3]. However, the bandwidth and the size of an antenna are generally mutually conflicting properties, that is, improvement of one of the characteristics normally results in degradation of the other. A thick dielectric substrate having a low dielectric constant is more desirable as it provides better efficiency, larger bandwidth, and better radiation[4] [5]. There are numerous substrates that can be used for the design of MPAs and their dielectric constants are usually in the range of $2.2 \leq \varepsilon r \leq 12$[7]. MPAs radiate primarily because of the fringing fields between the patch edge and the ground plane. The radiation increases with frequency increase and using thicker substrates with lower permittivity, and originates mostly at discontinuities. The dielectric constant is the ratio between the stored amount of electrical energy in a material and to that stored by a vacuum. It is also a measure of the degree to which an electromagnetic wave is slowed down as it travels through the insulating material[8][9] are used in capacitors to store more electrical charge than vacuum. The lower the dielectric constant is, the better the material works as an insulator, and the better an insulator, the better it resists electrons from being absorbed in the dielectric material, creating less loss [10]. Radio frequency (RF) applications are characterized by the need for low dielectric losses, low leakage, and low and uniform dielectric constant accompanied by a low layer count. Choosing a material based on its dielectric constant characteristics and losses usually dominates over other considerations [11] [12]. This paper analyses the effects of different types of antenna parameters like return loss, Directivity, Antenna gain, impedance etc. are also studied by design of rectangular MPA. A MPA was designed to operate at a resonant frequency of 2.4GHz. Simulations were carried out using ADS (Advance Designing Systems). This is one of the problems that researchers around the world have been trying to overcome. In this project, we have tried to increase the directivity and gain of the patch antenna. It has been noticed that there is some significant increments in directivity and gain measurements. Section II describes about design parameters of rectangular microstrip patch antenna. Section III describes about the simulation result of microstrip patch newly fabricated material.

II. DESIGN OF RECTANGULAR MICROSTIP PATCH ANTENNA

The rectangular microstrip patch antenna is usually made of a conducting material. The rectangular microstrip patch antenna is parallel to the ground plane. The rectangular microstrip patch and the ground plane are separated by substrate. The basic configuration of the rectangular microstrip patch antenna is described in fig1

There are three essential parameters for the design of a rectangular microstrip patch antenna as follows,

Frequency of operation: The resonant frequency of the rectangular microstrip patch antenna must be selected appropriately. The resonant frequency chosen for this design is 2.4 GHz.

Dielectric constant of the substrate: The lanthanum doped magnesium ferrite, dielectric material is analyzed to yield better antenna parameter output. A substrate with a high dielectric constant ($\varepsilon r=2.249$) is chosen since it reduces the dimension of the antenna.

Height of the substrate: The height of the dielectric substrate is selected from 2 to 5mm. In this design, height of the substrate is 2.15mm

The specifications for the design purpose of the structure are as follows

Type of antenna: Rectangular Microstrip Patch antenna

Resonance frequency: 2.4 GHz

Input impedance: 146.24 Ω

Feeding method: Microstrip Line Feed

The design procedure of rectangular microstrip patch antenna is as follows

The Length and Width of the microstrip patch antenna is calculated by the Microstrip Patch Calculator,

The Effective dielectric constant can be expression as,

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left(1 + \frac{12h}{W}\right)^{-0.5}$$

The Feed width of the Rectangular Patch Antenna is calculated by using the formula,

$$\sqrt{\varepsilon_{reff}} \times 50 = \frac{120\,\Pi}{\varepsilon_{reff}\,[\frac{W_m}{h} + 1.393 + 0.667\ln(\frac{W_m}{T} + 1.447)}$$

The Actual Length is obtained by and its shown in table 1,

III. SIMULATION RESULT

In this design, lanthanum doped magnesium ferrite coated over the dielectric with dielectric constant of 2.249 is used. The resonant frequency of the design is chosen as 2.4GHz. The height of the substrate is 2.15mm. From above data, length and width of the patch is derived as 39.41mm and 48.02mm. The length and width of the feeding point is 15 mm and 2.09mm. Simulation result of the return loss is given below fig 3,The patch antenna designed for 2.4 GHz which yields return loss of -12.858 dB. The impedance matching of the rectangular patch antenna is also analyzed and the result is shown in fig 4. In fig 4, curve touches center point of the circle which denotes that VSWR is 1. Hence power reflection is less and power radiation is high.A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. This power variation as a function of the arrival angle is observed in the antenna's far field [1]. In this case, along the z-axis, which would correspond to the radiation directly overhead the antenna, there is very little power transmitted. In the x-y plane (perpendicular to the z-axis), the radiation is maximum. These plots are useful for visualizing which directions the antenna radiates. The total power radiated was 0.000219 Watts.

A plane electromagnetic (EM) wave is characterized by travelling in a single direction (with no field variation in the two orthogonal directions)[9]. In this case, the electric field and the magnetic field are perpendicular to each other and to the direction the plane wave is propagating.

A polarized wave does not need to be along the horizontal or vertical axis. For instance, a wave with an E-field constrained to lie along the line shown in Figure 7 would also be polarized.

IV. FIGURES AND TABLES

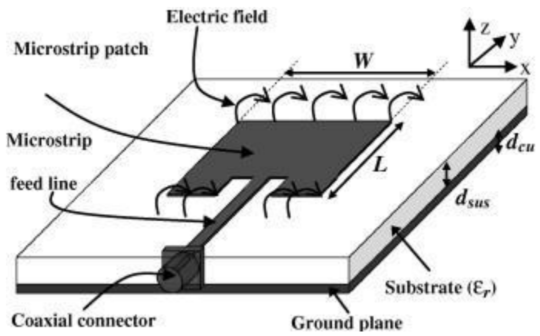

Fig 1: Basic configuration of the rectangular microstrip patch antenna

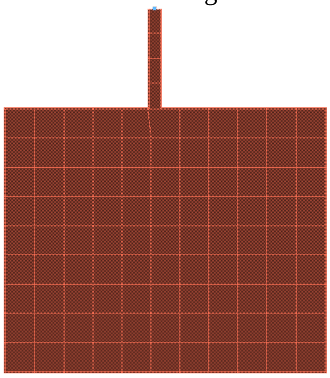

Fig 2: PCB Layout Design for Microstrip Patch Antenna (Thickness h=1.75mm, Resonance frequency=2.4 GHz, RT Duroid used as Dielectric substrate)

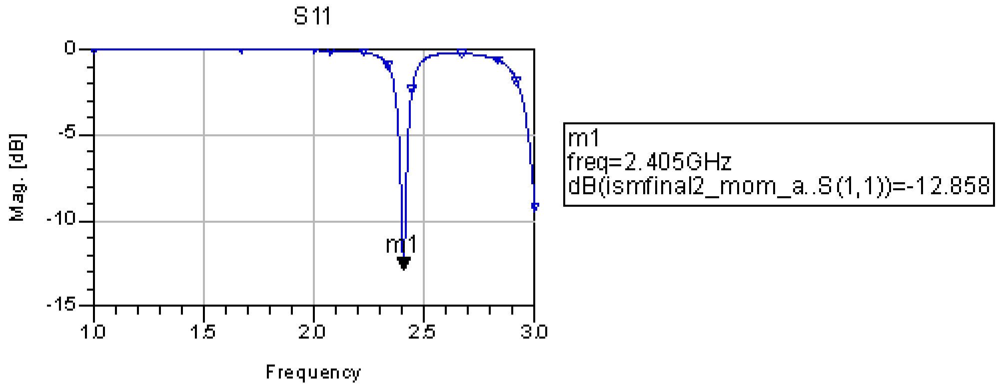

Fig 3: Simulation results of return loss operating frequency 2.4 GHz using ADS software

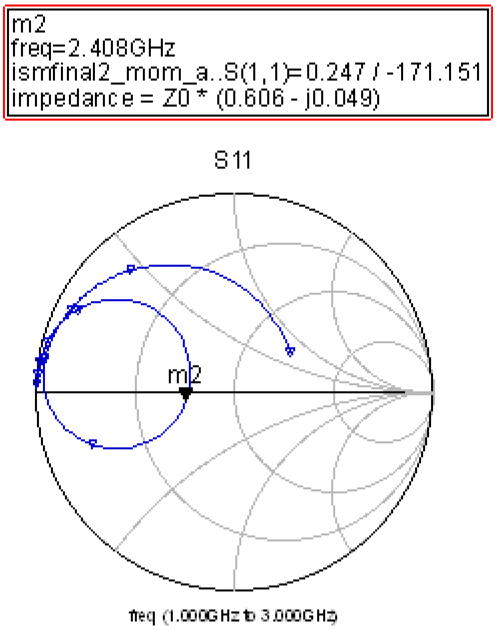

Fig 4: simulation result of Impedance Matching

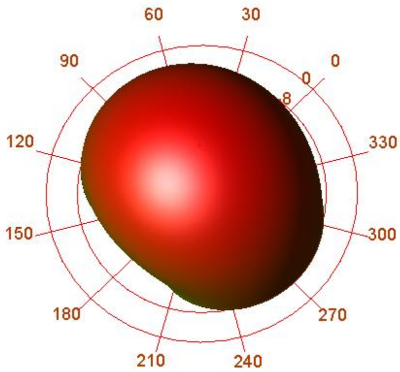

Fig 5: 3-D Radiation Pattern of the Rectangular Microstrip Patch Antenna using ADS.

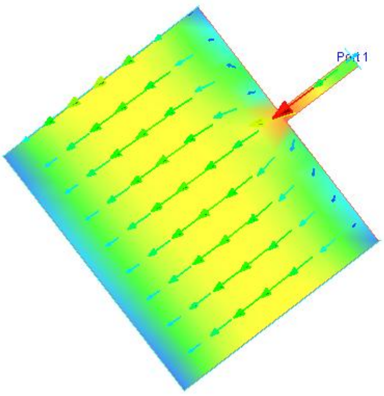

Fig 6 (A): Radiation intensity of the patch with time instants

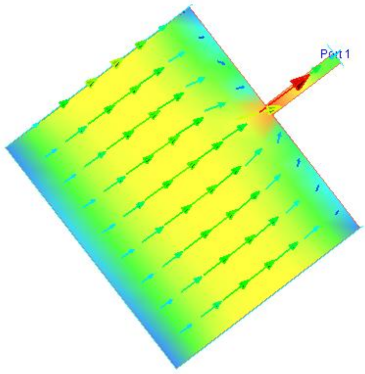

Fig 6 (B): Radiation intensity of the patch with time instants

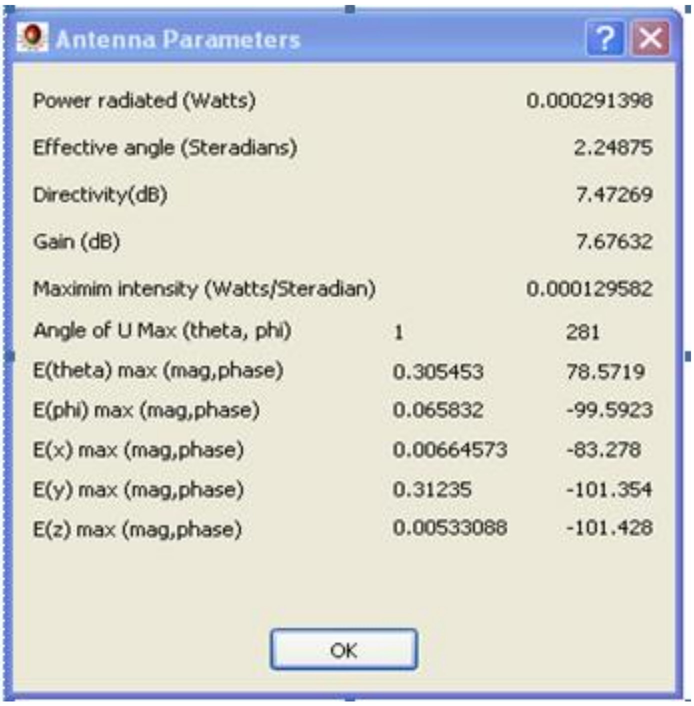

Fig 8: Antenna Parameters

Table 1: Dimension of Microstrip

Dimension	Value
Di-Electric Constant	2.246
Length of the patch Antenna	39.41 mm
Width of the Patch Antenna	48.02 mm
Height of the substrate	2.15 mm
Width of the Feed	2.09 mm
Length of the Feed	15 mm

V. CONCLUSION AND FUTURE SCOPES

From the simulations, it was clearly shown in figure 8 that the Maximum of 7.4 dB gain was obtained using lanthanum doped magnesium ferrite coated over RT Duroid 5880 substrate material which a dielectric constant of 2.242, From this paper, it can be clearly seen that substrate material and specifically the dielectric constant effectively determines the performance of a rectangular microstrip patch antenna. The research motivation of this project is to design rectangle patch antenna for ISM band which operates at 2.4 GHz. ADS electromagnetic simulator is used for design and simulation of patch Antenna. The square patch antenna with 50Ω line feed has been designed. The antenna gain is 7.67 dB, directivity is 7.472, return loss -12 dB, From the radiation pattern, it is observed that use of amplitude taper maintained the SLL within the maximum scan angle limit, which is an added advantage for ISM band application. Simulations and results of the microstrip patch antenna have provided a useful design for an antenna operating at the frequency of 2.4 GHz for the ISM band applications at the same time we introduced the new engineering materials and its properties was studied. The path of future experiment is to decrease the return loss to some good extend more over there is more concentration on increasing gain and directivity.

VI. ACKNOWLEDGEMENT

I am greatly indebted and coverage my most sincere thanks my guide Dr.Vasant Naidu Ph.d., Prof. & Dean, R&D for his kind patronage and helping me in the evaluation of this project work on Nano ferrite materials, and for his invaluable guidance in solving the problems which stood in my way with his keen interest leading to the success.

REFERENCE

[1] Mutiara *et al*, (2011). “Design of Microstrip Antenna for Wireless Communication at 2.4 GHz”. *Journal of Theoretical and Applied Information Technology*, Vol. 33, No. 2, pp. 184-192.
[2] Vasant Naidu et.al.(2011) “Mg Sm Ferrite for Nano structured E-Shaped Patch Antenna studies” International Journal of computer application, Volume 30– No.5,pp 45-50.
[3] Ali Dheyab and Karim Hamad (2011). “Improving Bandwidth of Rectangular Patch Antenna using Different Thickness of Dielectric Substrate” *ARPN Journal of Engineering and Applied Sciences*, Vol. 6, No. 4, pp. 16-21.
[4] Balanis, Contantine A. (1997). “*Antenna Theory – Analysis and Design”*. John Wiley & Sons Inc., 2nd Edition, pp. 722- 751.
[5] Vasant Naidu et.al. (2011) “Magnetic Properties of Nano Crystalline Nickel, Samarium doped Zinc Ferrite” ,International Journal of Computer Applications, pp. 0975 – 8887.
[6] Dafalla (2004). “Design of a Rectangular Microstrip Patch Antenna at 1GHz. *RF and Microwave Conference”*, Subang, Selangor, Malaysia, pp. 145-149.
[7] D. D. Sandu *et.al.*(2003). “Microstrip Patch Antenna with Dielectric Substrate. *Journal of Optoelectronics and Advance Materials”,* Vol. 5, No. 5, pp. 1381-1387.
[8] Indrasen Singh *et al* (2011). “Microstrip Patch Antenna and its Applications: a Survey”. *Int. J. Comp. Tech. Appl.*, Vol.2, pp. 1595-1599.
[9] K. Guney and N. Sirikaya (2004). ”Adaptive Neuro-Fuzzy Inference System for Computing of the Resonant Frequency of Circular Microstrip Antennas”. *Aces Journal*, Vol. 19, No. 3, pp. 188-197.
[10] Ahamed Maruf *et.al.*(2012). “Rectangular Microstrip Patch Antenna at 2GHz on Different Dielectric Constant for Pervasive Wireless Communication” *International Journal of Electrical and Computer Engineering*, Vol. 2, No. 3,
pp. 31-39.
[11] Saeed, A. Rashid and K. Sabira (2005). Design of Microstrip Antenna for WLAN. *Journal of Applied Sciences 5*, Asian Network for Scientific Information, pp. 47-51.
[12] T. Durga Prasad *et.al.*(2011). Comparisons of Circular and Rectangular Microstrip Patch Antennas. *International Journal of Communication Engineering Applications*, Vol. 2, No. 4, pp. 187-197.