Design and Simulation of Flexible Antenna for ISM band

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ABSTRACT

In this paper we examine some of the ways to use Flexible antennas in specific fields and then discuss some of the opportunities for them to be used in day to day life as well. We then put forward the challenges in designing such flexible antenna. Overcoming those odds we design a Flexible microstrip antenna. This antenna can be efficiently be used for ISM band application. Flexible antenna technology can be largely useful for Bio-medical and communication sector.

Keywords **–Flexible antenna, Polymide, ISM band**

I. INTRODUCTION

As the technology around us is getting upgraded almost on a daily basis, there is a high degree of expectation in terms of all-round efficiency from the communication equipments. Antenna being the indivisible part of it carries lot of importance. Conventional Antenna has proved its importance in almost every field, but it has its limitation when it comes to hostile military environment or biomedical sector especially. Stretchable electronics have gained immense interest in these particular fields due to their numerous applications [1]. This technology unites various electronic components into a compatible polymer substrate that may be stretched and conformed to complex shapes depending on the application [2]. As we know if the usual materials are used in place of elastic material, they definitely end up getting damaged when stretched or confirmed. The Flexible material can be wrapped around any arbitrary shape to give the required results E.g. Cars, robots, buildings, human body, human prosthesis [3]. The basic idea is to lay thin metal films on the top of elastic substrate. These thin metal films maintain their conductivity even when they are stretched. The highly recommended stretchable material for these application is Polydimethylsiloxene(PDMS) [4].Other variants to PDMS are also suggested.

Flexible antenna technology has its significance wherever the established rigid antennas could not deliver upto the mark. Mostly Biomedical and communication sector can be immensely benefited [5]. Most of the groundbreaking technologies have emerged from the military interest research areas. Military environments are mostly hostile where the general antenna may show fatigue.

Flexible antennas made from the above mentioned fabrication approaches can withstand considerable amount of tension [6].

In the Bio-medical sector flexible antenna technology is already in the emerging state now. Stretchable thermometer, Heartbeat monitor, Flexible optical sensor can be easily found as an application in this field [7]. This technology is also used for wearable computers and smart clothes. In sports and leisure as a monitoring tool and now also in fashion.

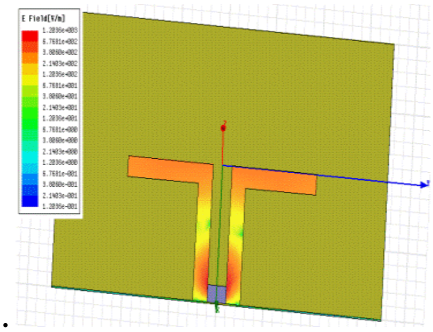
PDMS is widely used as a substrate for flexible antenna application, but Polymide can serve as an alternative. Polymide is an economical flexible material as compared to PDMS which is not easily available worldwide. It is basically used as fibre and microfilament yarn. It has good resistance to wear and tear also possesses good mechanical properties at elevated temperatures.

Gold films are the most suitable interconnects in this case but as it is most expensive also [8]. The way to replace them with other useful metal interconnects with the same useful results need to be discovered.

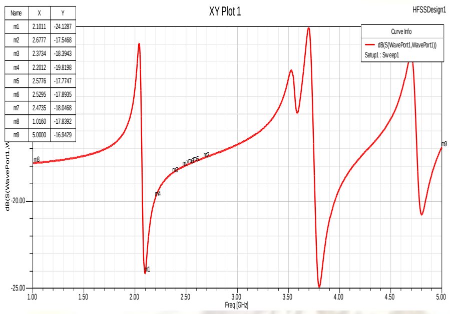
Section I issues challenges faced during the design of flexible antenna. Section II displas the proposed design overcoming the limitations. Section III provides concluding remarks.

II. CHALLANGES

When it comes to advancement of technology some trade off's has to be considered. We start with presenting a microstrip dipole antenna as shown in fig.4 made from FR4 epoxy material. The dimensions of this antenna are 94mm, 48mm and 1.6mm height. This antenna gives excellent bandwidth of 4GHz. As material itself suggests this antenna cannot be bent or stretched. Logically if we take thin film of any existent substrate material it has some degree of bent associated with it. On the other hand if we take a thick sheet of any well known elastic material say Rubber for that instance it will be difficult to confirm that sheet as we use small width substrate sheet for manufacturing an antenna. So the width and height trade off is the area of consideration when it comes to stretchable elastic technology.



a)



b)

Fig.4 a) Design of Microstrip Dipole b) Results in HFSS

We then present a same FR4 epoxy substrate dipole antenna with only 1mm thickness with other dimensions same as before. Same is to be done for an elastic substrate to make it flexible. But as shown in Fig.5 its performance completely degrades due to reduction in its thickness.

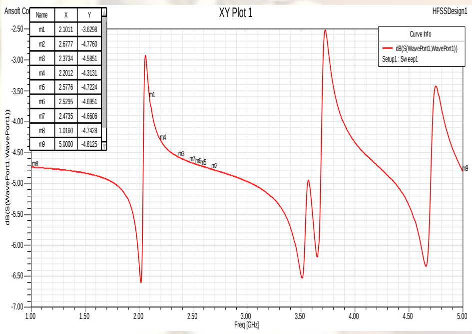


Fig.5 Inefficient Return Loss due to reduction in height

III. PROPOSED DESIGN

We propose a design of printed dipole antenna using Polymide as a substrate. This antenna is flexible due to the use of Polymide. Polymide has dielectctric constant 4.6 which is similar to FR4 material used in previous design.

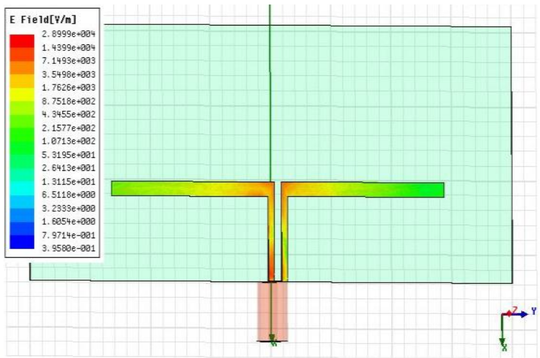
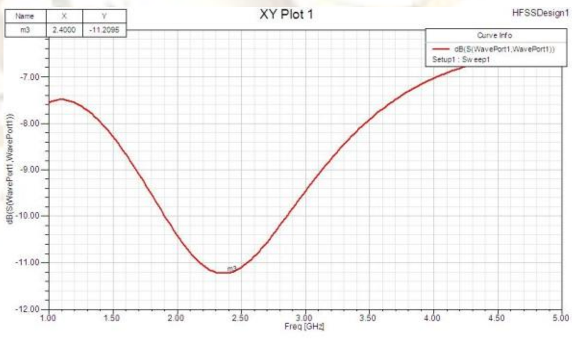


Fig.6 Current distribution of Printed Dipole with Polymide substrate

The dimensions of antenna shown in fig. 6 are given by 56mm, 35mm and .25mm, The thickness of the antenna is unbelievably low at just .25mm. This has been made possible with the help of quarter wave impedance matching. The width of the dipole strips is just 1mm. There is no ground plane required for this antenna as the second pole of the dipole acts as one.



a)

b)

Fig.7 a) Return loss b) VSWR

As the fig 7 suggests the return loss and VSWR falls exactly at the required ranges below -10 and 2 respectively at 2.4GHz which is an ISM band frequency. ISM band being Industrial, Scientific and medical band this antenna withholds its significance in all three important fields mentioned above. Most importantly it's a free band to use so cost saving is an added advantage in this case.

This antenna can be wrapped around any curvature shaped object Eg. Hand, Vehicle, Furniture. It will take the shape of that object at the same time is able to communicate to transfer as well as recieve important data. It can also be used for spying purpose. So it not only serves as the major technological upgradation in the field of antennas but also can be used in day to day life.

IV. CONCLUSION

We first discussed the importance of flexibility in antennas for modern requirements. PDMS is widely used substrate for flexible materials but Polymide can be an alternative to it. It is mostly economical as compared to PDMS. We reviewed various approaches undertaken for the fabrication of flexible antenna. Width and height of the substrate plays crucial role in the flexible technology. Using quarter wave Impedance matching we designed an flexible antenna with just .25mm thickness and successfully obtained its results in ISM band range. The designed antenna can be efficiently used specially in Bio-medical and communication fields.

REFERENCES

[1] Qing Liu, Kenneth Lee Ford, Richard Langley, Adam Robinson and Stephanie Lacour "Flexible Dipole and Monopole Antennas " European Conference on Antennas and Propagation (EUCAP) ,2011.

[2] F. Axisa et al., "Biomedical Stretchable Systems using MID Based Stretchable Electronics Technology", IEEE EMBS, France, Aug. 2007.

[3] S. P. Lacour, Joyelle Jones, Sigurd Wagner, Teng Li and Z. Suo,"Stretchable Interconnects for Elastic Electronic Surfaces", Proceedings of IEEE, Vol. 93, No.8, August 2005.

[4] S. P. Lacour, Sigurd Wagner, Zhenyu Huang and Z. Suo, "Stretchable Gold Conductors on Elastomeric Substrates", Applied Physics Letters, Vol. 82, No.15, April 2003.

[5] F. Axisa et al., "Elastic and Conformable Electronic Circuits and Assemblies using MID in polymer", IEEE Polytronic 2007, Tokio, Japan, pp. 280-286, January 16-18, 2007.

[6] F. Axisa et al., "Biomedical Stretchable Systems using MID Based Stretchable Electronics Technology", IEEE EMBS, France, Aug. 2007.

[7] D. Brosteaux, F. Axisa, J. Vanfleteren, N. Carchon, M. Gonzalez, "Elastic Interconnects for Stretchable Electronic Circuits using MID (Moulded Interconnect Device) Technology", MRS spring 2006.

[8] S. P. Lacour, D. Chan, S. Wagner, T. Li, and Z. Suo, "Mechanisms of reversible stretchability of thin metal films on elastomeric substrates", Applied Physics Letters, Vol. 88, No. 20, May 2006.

[9] M. Gonzalez et al., "Design of metal interconnects for stretchable electronic circuits", Microelectronics Reliability, elseveir, 48, 825–832, June 2008.

[10] S. P. Lacour,, T. Li,, "Compliant thin film patterns of stiff materials as platforms for stretchable electronics", J. Mater. Res., Vol. 20, No. 12, Dec 2005.