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Hexagonal Shaped Body Wearable Textile Antenna on EBG Substrate Material

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Abstract- In this paper, a hexagonal shape wearable antenna is presented .the proposed antenna is having EBG structure embed in the inner substrate layer. The antenna resonates at 2.45 GHz. When antenna is incorporated with EBG cell structure, it shows improvement in gain by 1.9 dB and 33% bandwidth improvement. The EBG structure consists of just a 3x3 elements but reduces backward radiations considerably. The various characteristics parameters of antenna are presented. Simulations are done on Zeland IE3D simulation software.

Index Terms- wearable antenna, hexagonal shape, textile fabric, electromagnetic band gap (EBG) structure

1. INTRODUCTION

Wearable antenna is similar to any other patch antenna but it is dedicated to work while being worn. The advancement in wireless technology leads to fabrication of different wearable antenna on different fabric substrate [4]. The radiating element will always be a conductor in my case it is copper and the substrate will be different textile (clothing) materials such as nylon, cotton, polyester etc. now a days it is one of dominant area of research in microwave antenna design. The main benefit of hexagonal shape patch is its reduced parasitic capacitances because of its gradual tapered shape as compare to the rectangular patch antenna.

As the antenna will be worn to the body hence it is compulsory to reduce the backward radiations, and for that purposes EBG (electromagnetic band gap) material is used, because backward radiations may be harmful to our body tissues. When backward radiating waves incident to the body tissue it increase the normal body temperature which may cause damage to the body organs. Hence EBG substrate material is very important for the design of body wearable antenna in order to reduce the backward wave related problems. Hence EBG material acts as HIS (high impedance surface) to reduce the backward radiations [5].Researchers uses different shapes of EBG structures but the prime focus should be reduction in backward radiations and hence increase in radiation pattern and gain of the antenna. Many papers have been reported different wearable antenna operating in single frequency band [1-3].

Paper compares the results of hexagonal patch antenna on textile substrate and when hexagonal patch is incorporated with EBG material. The design works around the center frequency 2.45 GHz in the (2.4-2.5 GHz) frequency band. The feeding technique used is inset feeding and the textile material used is felt which is having permittivity 1.38 and loss tangent 0.023 and the ground plane is a zelt conductor having conductivity 1e+006 s/m[6]. The design has been simulated using electromagnetic simulator IE3D software of Zeland Corporation.

2. Characteristics of the fabric used for the textile antenna design

The textile fabric used must have the following characteristics for the textile antenna design.

- Resistance of fabric should be same throughout the whole area i.e. homogeneous fabric is required.
- For minimum losses its resistance should be lower (around 1ohm/square).
- As antenna has to be worn on body so the fabric should be conformable and flexible.

Dielectric constant and loss tangent of textile fabric that are common in use as clothing materials are shown in table.1

Table 1. Substrate materials with their dielectric constant and loss tangents [6].

material	silk	tween	panama	felt	moleskin	PTFE
Single layer thickness(mm)	0.58	0.685	0.347	1.1	1.17	11.66
permittivity	1.75	1.69	2.12	1.38	1.45	2.05
Loss tangent	0.012	0.0084	0.018	0.023	0.05	0.0017

The permittivity of the fabric ranges between 1.17 to 2.12 and loss tangent in worst case 0.05. Therefore there is no major problems arises due to fabric. Zelt is used as conducting ground material which is made by plating cu-tin on high quality nylon which has conductivity of 1e+006 s/m. Major advantage of zelt fabric is that it is tear resistant, durability and easy to handle or wash.

3. Antenna design: The designed antenna will be operated for the central frequency 2.45 GHz with about 2.5% of bandwidth. Figure1 shows the side view of antenna structure over the EBG substrate.

The antenna is basically fabricated with two layer substrates, at the bottom “zelt” conducting ground plane is present. Then 3x3 square ring EBG elements will be placed over 2.2mm thick felt substrate to reduce the backward radiations. EBG elements acts as high impedance surface. Then over this EBG elements again felt substrate of thickness 1.1 mm is glued in order to isolate the hexagonal patch with the EBG elements.

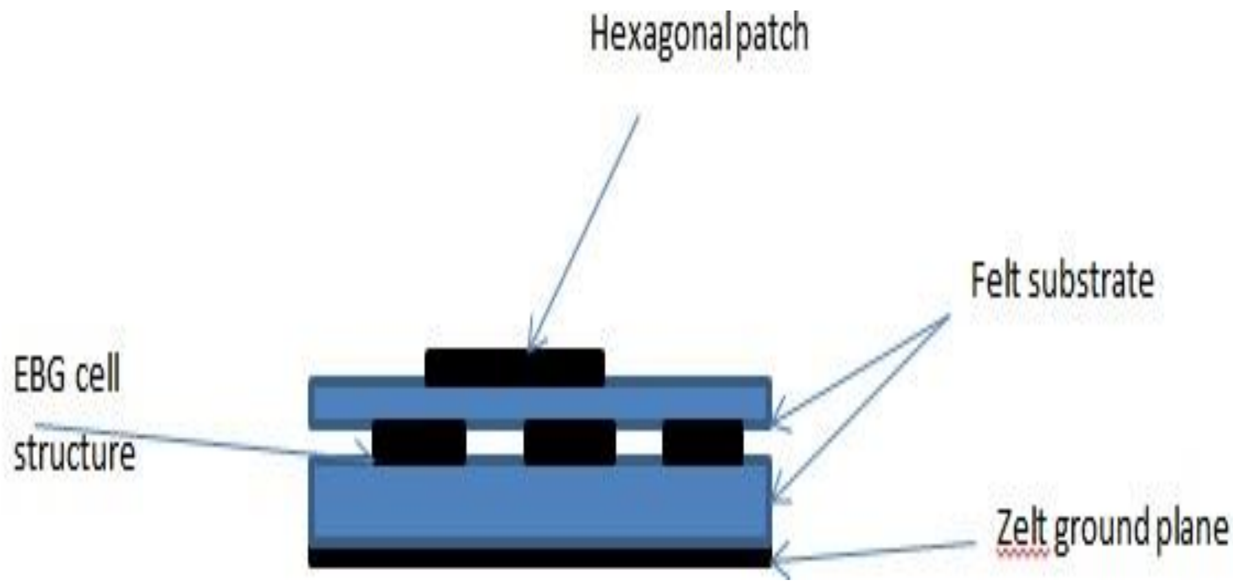
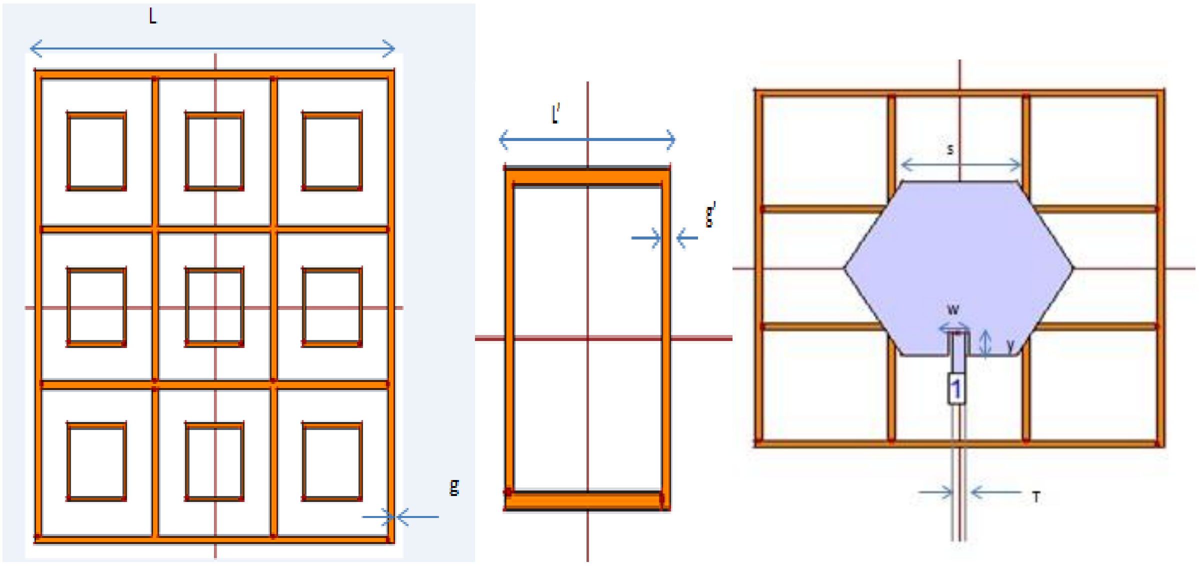


Fig.1. side view of antenna

To achieve better gain and radiation efficiency EBG structure has been designed as pictured in fig2(a) where antenna uses felt substrate of thickness 2.2mm with dielectric constant 1.38 and loss tangent 0.023. Where L=116 mm (square shape of EBG) and g=2mm.The shape of antenna is hexagon as shown in fig.2.



(a) (b) (c)

Fig.2.(a) EBG structure on felt substrate, overall size of EBG is 116x116 mm and inner gap (g)=2 mm. (b)each cell dimension is L'=19x19mm and g'=2mm (c) S=32.6, W=6,X=20,Y= 6.5 and T= 3.9

4. SIMULATION RESULTS AND DISCUSSION.

Fig.3 and 4 shows the various results (return loss, radiation pattern) of antenna in its two configurations i.e. normal hexagon and when it is incorporated with EBG structure. Reflection co-efficient and radiation patterns without EBG is shown in fig.3. (a) Reflection coefficient, (b) Elevation radiation pattern (c) azimuth radiation pattern at 2.45 GHz:

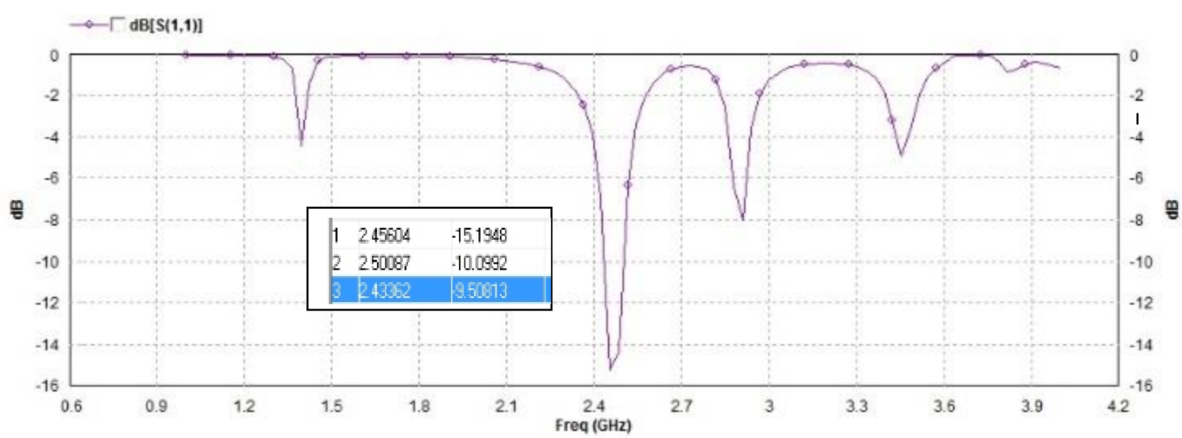


Fig. 3(a). Reflection coefficient (s11) of hexagonal patch.

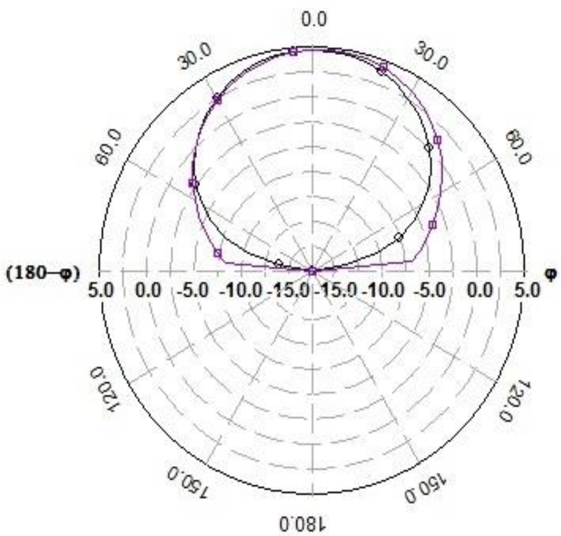


Fig.3(b). Elevation radiation pattern

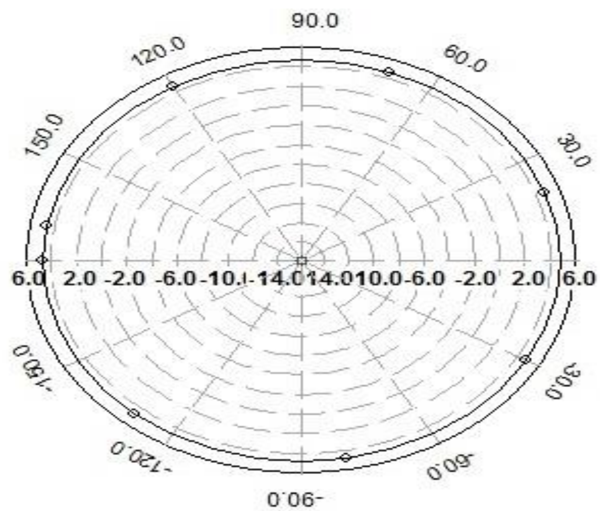


Fig.3(c). Azimuth gain radiation pattern

Fig.4(a) Reflection coefficient, (b) Elevation radiation pattern (c) azimuth radiation pattern at 2.45 GHz when antenna is loaded with EBG:. Table.3 shows the comparison of reflection coefficient, gain and bandwidth of antenna in both configurations.

Gain of antenna in EBG case is 1.9dB higher as compare to the gain of normal textile patch. Our main purpose to use EBG is to reduce backward radiations and hence improved gain is obtained. In addition to this 33% improvement in bandwidth is achieved.

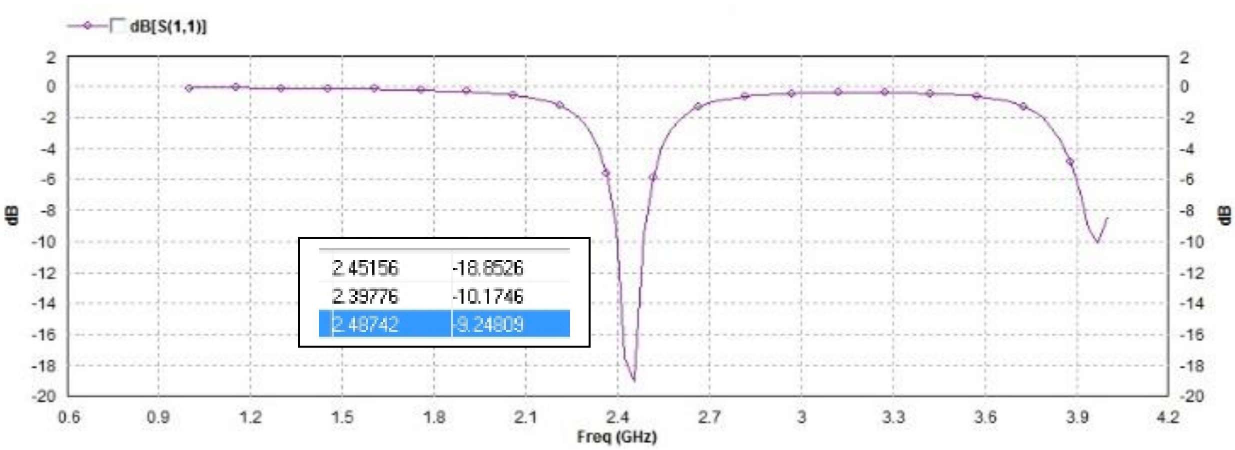


Fig.4(a). Reflection coefficient (s11) when hexagonal patch is incorporated with EBG.

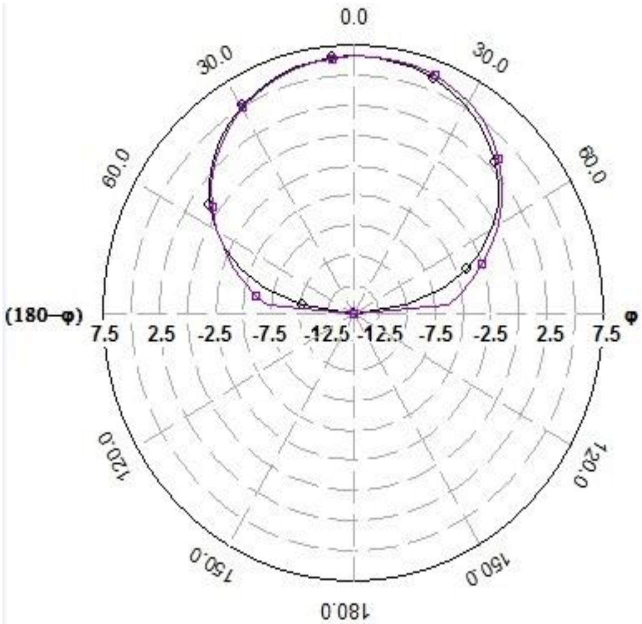


Fig.4(b). Elevation radiation pattern at 2.45ghz

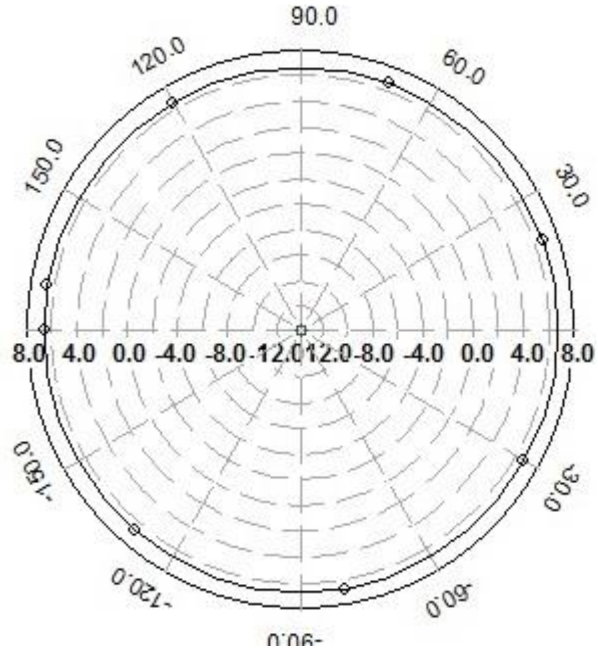


Fig.4(c). Azimuth radiation pattern at 2.45GHz

Table: 2: Parameters comparison of purposed antenna with normal hexagonal textile patch

antenna parameters → / configuration ↓	Reflection coefficient (s11) in dB	Gain of antenna (dB)	Bandwidth (MHZ)
Normal hexagonal	-15.1948	4.6	67.25
Incorporated with EBG	-18.8526	6.551	89.5

5. CONCLUSION

The paper demonstrates a wearable antenna incorporated with EBG structure that will operate at 2.45 GHz frequency band which is dedication to for wireless communication. A very good antenna gain and bandwidth we achieved with the proposed antenna. Both the antenna operates at 2.45 GHz with operating bandwidth of 2.75% for normal antenna and 3.65% for EBG incorporated antenna. Here the EBG structure is a 3x3 element structure used to reduce the backward radiations. Proposed antenna works in ISM band particular to the Bluetooth application.

Wearable antenna has myriads of application in bio-medical application so it has a wide scope for researchers, mainly in portable antenna design.

References:

1. P. J. Massey, "Mobile phone fabric antennas integrated within clothing," *Antennas and Propagation, 2001. Eleventh International Conference on (IEE Conf. Publ. No. 480)*, Manchester, 2001, vol.1, pp. 344-347.

2. Salonen, P., Keskialammi, M., and Sydanheimo, L.: ‘A low cost 2.45 GHz photonic band gap patch antenna for wearable systems’. IEE 11th Int. Conf. on Antennas and Propagation (ICAP2001), Manchester, UK, 2001, Vol. 2, pp. 719–723.

3. Tronquo, A., Rogier, H., Hertleer, C., and Langenhove, Van L.: ‘Robust planar textile antenna for wireless body LANs operating in 2.45 GHz ISM band’, Electron. Lett.,2006 , 42, (3), pp. 142–143.

4. Ankita Priya, Ayush Kumar and Brajlata Chauhan. Article: A Review of Textile and Cloth Fabric Wearable Antennas. International Journal of Computer Applications 116(17):1-5, April 2015.

5. P. O. Salonen, F. Yang, Y. UCLA Rahmat-Samii, and M. Kivikoski, “WEBGA—Wearable electromagnetic band-gap antenna,” in Proc. IEEE Antennas Propagat. Int. Symp., 2004, vol. 1, pp. 455–459.

6. S. Zhu and R. Langley, "Dual-Band Wearable Textile Antenna on an EBG Substrate," in *IEEE Transactions on Antennas and Propagation*, vol. 57, no. 4, pp. 926-935, April 2009.