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# CIRCULAR MICROSTRIP TEXTILE ANTENNA

**Prof. Kiran Rathod[1], PranjalGupta[2], Bhavik Janjmera[3], Suchit Patel[4], Jignesh Bhagat[5]**

Dept. of Electronics and Tele-Communication Engineering,

Mumbai University, Mumbai-400 098, India

[1]kiranrathod@gmail.com, [2]iverson45@gmail.com, [3]bhavikjanjmera@gmail.com

***Abstract***

***The speed of technology and its evolution with the help of human efforts and his thinking is growing like wildfire. Also the man machine relation has further taken forward big technical leaps in the world of Antenna and Microwave Technology. In near future we will see clothing and textile material to be lined up for antenna technology and together will be known as "Smart Clothes". In this paper, circular microstrip for wearable application is been designed. This wearable is used to meet Bluetooth specifications and has been developed by using copper conducting parts and electrotextile (smart clothes). In this case jeans or cotton materials are used.***

***Keywords***—circular patch antenna, wearable antenna, radiation pattern, fabric characterization,gain.

## I. Introduction

Advances in communication and electronic technologies have enabled the development of compact and intelligent devices that can be placed on human body or implanted inside it.The new generation of textile has the capability to conduct electricity and at the same time is wearable. There are much more applications involved if an antenna is made that are totally wearable. We use this new property of conductivity in textile material to implement the wireless functions to clothing. In general, the antennas are made of metal which are highly conductive and also is solid structured which is fixed and hence give the stable output. The challenge with textile antenna is that, because the antenna is purely textile with the radiating element as well as dielectric material and ground being textile, which can be folded and twisted, output stability is the major factor that should be taken into consideration.There are some applications at present, where the antennas are used to continuously monitor the biometric data of human body. In order to do this, they need to be so close to the human body all the time so that they can continuously monitor the biometric data and send the information to the outside world. If the antenna is hard it is not suitable to always keep them attached with the human body as they can make some harm due to their physical structure.

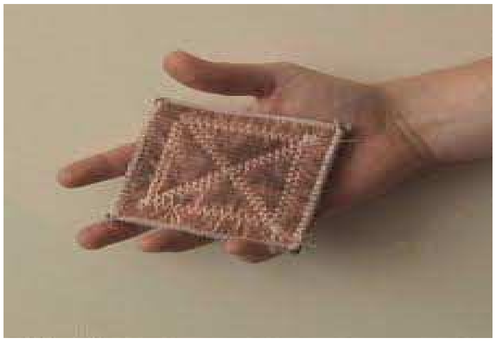

**Fig.1. Wearable Antenna**

If the antenna is made of textile material they will not make any harm to human body and will be totally wearable. This is the main motivation This has led humans to introduce special networks called Body Area Networks (BANs). This BANs will be a great boost in future for many purposes and interested area being healthcare and emergency services like military applications etc. This antenna is designed to work at 2.45GHz.A comparison between different textile material and their effect on gain, radiation efficiency has also been presented The simulation software Zeland IE3D is used to simulate the antennas. This software uses Method of Moment technique. It solves the entire electromagnetic phenomenon related with the antenna by using integral method. This approach gives a very accurate simulated result.

## II. Antenna Design Procedure

The reason of using circular microstrip antenna is that it occupies less physical area as compared to rectangular antenna, in application of arrays circular geometry is preferred. The basic structure is shown in figure 2, comprising of thin conducting circular microstrip on a insulating dielectric substrate backed by ground plane. Also it necessary to know the exact value of dielectric constant of substrate (textile material) chosen.

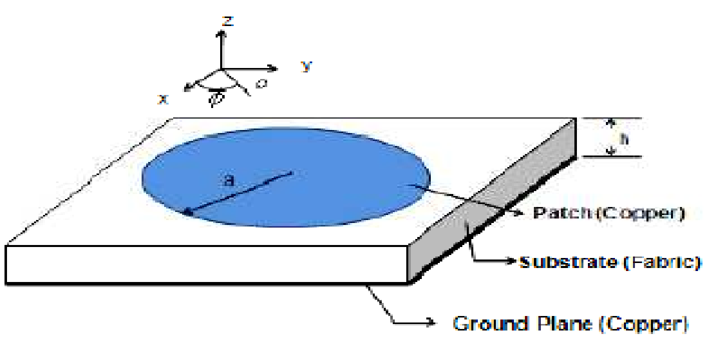


**Fig.2. Circular Patch Antenna**

**Table 1**

| |
|---|
| • Resonance Frequency (fr) = 2.45GHz. |
| • Height of Substrate (h) = 2.84 mm. |
| • Relative permittivity ($\varepsilon_r$) = 1.67. |
| • Loss Tangent (tan δ) = 0.02. |

The resonant frequency for the dominant mode of propagation, in case of circular patch antenna is written as:

$$(f_r) = \frac{1.81412}{2\pi a\sqrt{\mu\varepsilon}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The formula for effective radius is,

$$a_{e=}a\left\{1 + \frac{2h}{\pi a\varepsilon_r}\left[\ln\left(\frac{\pi a}{2h}\right) + 1.7726\right]\right\}^{1/2} \ldots\ldots\ldots\ldots(2)$$

The effective length can also be calculated by equating the area of circulat microstrip antenna with area of rectangular antenna. The length *L* of the RMSA is taken as diameter 2*a* of the CMSA, which is important fromthe field variation point of view. The width*W*of the RMSA is then calculatedby equating its area with that of the CMSA, which comes out to be $W = \pi a/2$. From the effective dimensions of rectangular microstrip antenna, $a_e$ can be obtained as

$$a_e = \sqrt{\frac{L_e W_e}{\pi}} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

An infinite ground plane is assumed to avoid (i) back lobes in radiation pattern of the antenna, (ii) to reduce diffraction and scattering effects at the edges of the ground plane and to (iii) minimize the undesirableeffects of surface waves.

## III. Simulation Results

The simulation is carried out between 2 GHz to 3GHz frequency.

A. **Farfield Radiation Pattern**.

The farfield radiation pattern of circular microstrip antenna is

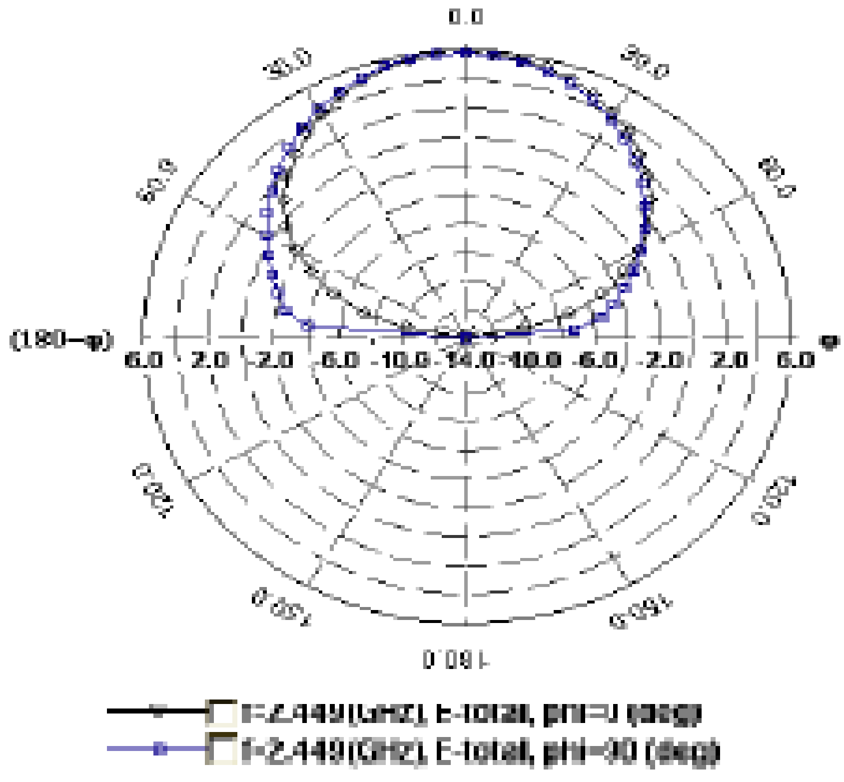


**Fig. 3. Radiation pattern**

B. **Gain and efficiency**

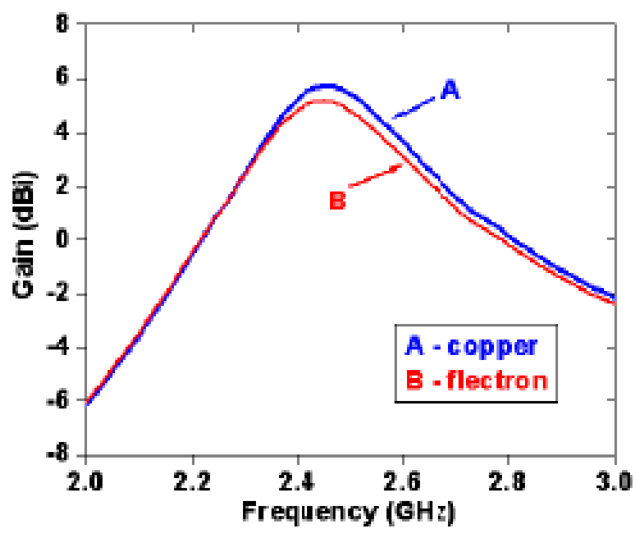


**Fig. 4. Gain vs frequency using two different materials.**

C. **Directivity vs Frequency.**

The directive gain obtained is 8.26 dB and power gain is 5.75 dB at design frequency of 2.45 GHz.

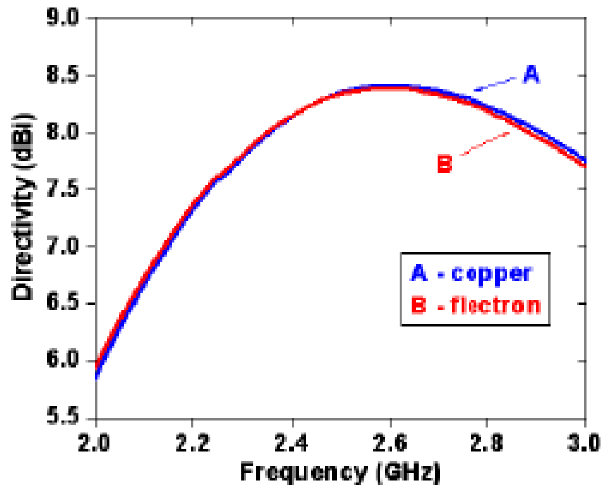


**Fig. 5. Directivity vs frequency.**

**D. Efficiency vs frequency.**

The efficiency for case 1 is 56.12% and for case 2 is around 50%.

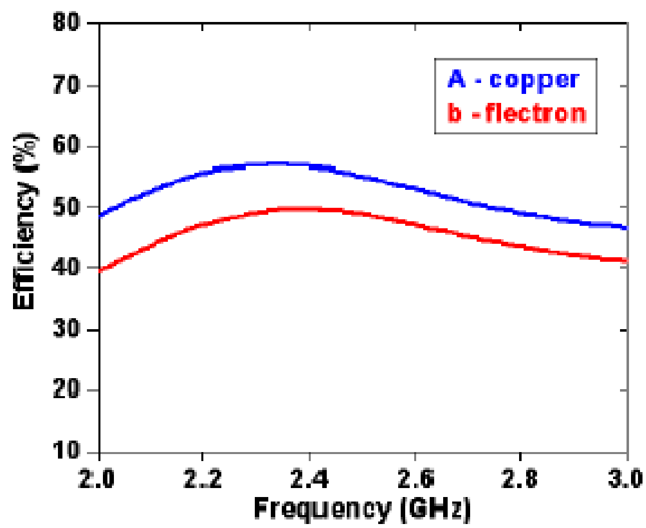


**Fig. 6. Efficiency vs frequency.**

**E. Comparison with other antennas.**

For an identical design, Circular microstrip antenna gives similar performance characteristics as that of rectangular microstrip antenna. The main advantage being that it occupies less physical area as compared to rectangular microstrip antenna.Various physical parameters for design in Appendix 1.

## IV. Conclusion

From the results obtained of this antenna we conclude that a circular microstrip antenna is better option for wearable applications as it also occupies less physical area. The performance parameters of this textile antenna is comparable to copper based microstrip antennas and they are easy to build and drapable.We also conclude that textile microstrip antenna are very good alternatives to standard PCB substrate antenna for different applications. WEARABLE ANTENNAS ARE THE FUTURE.

## References

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**Appendix 1**

**Physical design parameters**

| Design Parameters | Antenna # 1 | Antenna # 2 | Antenna # 3 | Antenna # 4 |
|---|---|---|---|---|
| Resonant Frequency | 2.45 GHz | 2.45 GHz | 2.45 GHz | 2.45 GHz |
| Substrate Dielectric Constant | 1.51 | 1.47 | 1.44 | 1.48 |
| Substrate Thiclness(mm) | 3.0 | 3.0 | 2.85 | 3.0 |
| Loss Tangent Of Substrate | 0.02 | 0.02 | 0.01 | 0.02 |
| Materials Used For Ground Plane and Patch | Copper | Copper | Copper | Copper |
| Insulating Fabric Material Employed | Wash Cotton | Curtain Cotton | Polyester | polycot |