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Comparative Study between CPA and EPA using Different Substrates

Thingbaijam Rajkumari Chanu[1], Dhanaraj Waikhom[2] and Akash Waikhom[3]
[1-3]Manipur Technical University
Email: dhanarajwaikhom2002@gmail.com, akashwaikhom2000@gmail.com

***Abstract*—In this paper we have proposed to do comparative study of circular patch antenna (CPA) and elliptical patch antenna (EPA) using Nylon fabric and Quartz substrates at fixed resonating frequency of 5GHz using co-axial probe feed technique. The simulation analysis was done by using Zealand IE3D software. The antenna parameters compared in this paper are S_{11} (Return Loss), Gain, Antenna Efficiency, 2D radiation pattern, the impedance or percentage bandwidth. The proposed antenna can be used for Wi-Fi application.**

***Index Terms*— Circular patch antenna, Elliptical patch antenna, S_{11} (Return Loss), Gain, Antenna Efficiency, 2D radiation pattern, the impedance or percentage bandwidth.**

I. INTRODUCTION

Patch antennas are the type of most commonly used printed antennas and have been widely applied in many sectors due to their advantages of being light weight, small size, low profile, low cost, large bandwidth, etc [1]. In order to reduce the size of the antenna, substrate with high dielectric constants must be used. So, Nylon fabric and Quartz substrates may be used to develop and simulate a circular patch antenna and elliptical patch antenna[3,7]. The circular patch antenna and elliptical patch antenna at the same frequency band of 5GHz may be design and can compare with respect to the different substrates and the areas to be printed. The patch antenna designs may be simulated by using Zealand IE3D software. 5GHz frequency may be use for Wi-Fi.

II. ANTENNA DESIGN

The geometry of the conventional CPA and EPA using Nylon substrate has the dimension of height (h) = 1.6 mm, dielectric constant (Ɛr) =3 .6, loss tangent = 0.0083, resonating frequency = 5 GHz and radius (r) is calculated as following:

Radius of CPA = $\frac{F}{\sqrt{1+\frac{2h}{\pi \epsilon r h}[ln\frac{\pi F}{2h}]+1.7726}}$

Where; F = $\frac{8.791\times 10^{9}}{fr\sqrt{\epsilon r}}$ = 0.926

After substituting the above values, we get: Radius of CPA = 8.47 mm. We assumed the probe radius 0.625 mm.
We assumed the radius on primary axis of EPA = 8.525 mm and radius on secondary axis of EPA = 8.1 mm. We assumed the probe radius 0.625 mm.
Similarly, Quartz substrate has the dimension of height (h) = 2 mm, dielectric constant (ε_r) = 4.2, loss tangent = 0.001, resonating frequency = 5 GHz.

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Radius of Quartz CPA = 13.72 mm and the Radius of Quartz EPA = 13.75 mm and 13.73 mm. According to the radius of Nylon CPA and EPA, the area of Nylon CPA = 2.25 cm and EPA = 2.17 cm. And according to the radius of Quartz CPA and EPA, the area of Quartz CPA = 5.91 cm and EPA = 5.93 cm.

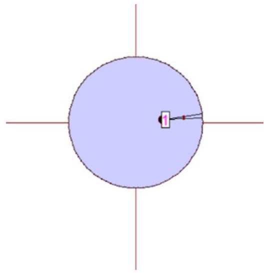


Figure 1(a): Quartz CPA

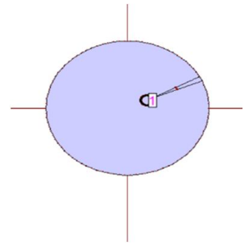


Figure 1(b): Nylon CPA

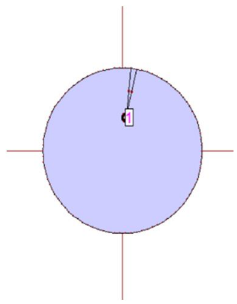


Figure 2(a): Quartz EPA

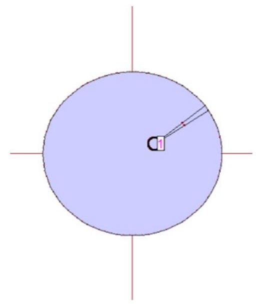


Figure 2(b): Nylon EPA

III. SIMULATED RESULTS

The proposed antenna design was simulated using the software Zealand IE3D 12.0 and plots for return loss (S_{11}), Antenna efficiency, gain; etc. The simulated results are shown below:
1.Radiation pattern: The microstrip antenna radiates normal to its patch surface. So, the elevation pattern for ϕ = 0 and ϕ = 90 degrees are important for the measurement. The simulated E-plane and H-plane pattern, 2D pattern view of the Nylon CPA and Quartz CPA and the 2D pattern view of the Nylon EPA and Quartz EPA are illustrated in Figure.

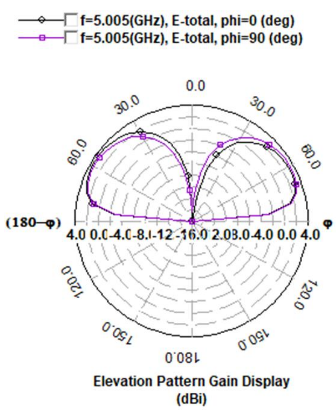


Figure 3(a): Radiation Pattern for Quartz CPA

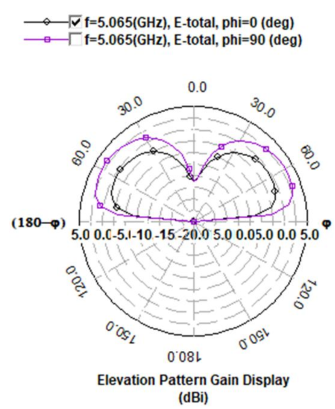
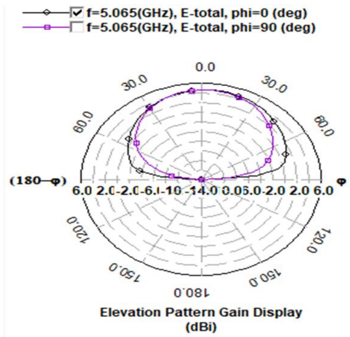


Figure 3(b): Radiation Pattern for Nylon CPA

2. Return Loss S_{11} and Bandwidth**:** Return Loss is the loss of power in the signal returned by discontinuity in transmission line. Thus, the return loss of an antenna can be calculated from return loss can be calculated from the return loss versus frequency plot. The Return Loss shown in Fig of the Nylon CPA is -31.98222 dB at 5 GHz and the Band Width obtained is 4.2% and the Quartz CPA is -35.11222 dB at 5 GHz and the Band Width



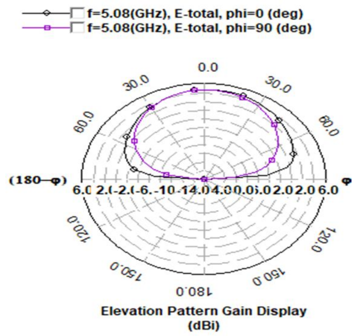
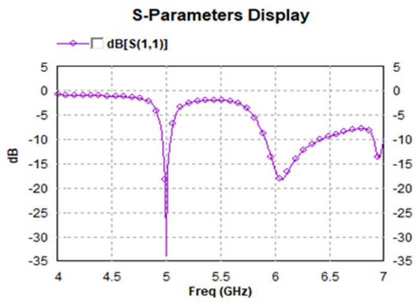


Figure 4(a): Radiation Pattern for Quartz EPA Figure 4(b): Radiation Pattern for Nylon EPA

obtained is 7.5 %. And the Return Loss shown in Fig of the Nylon EPA is -30.9466 dB at 5GHz and the Band Width obtained is 4.8 % and the Quartz EPA is -23.4867 dB at 5GHz and the Band Width obtained is 1.4444 %.



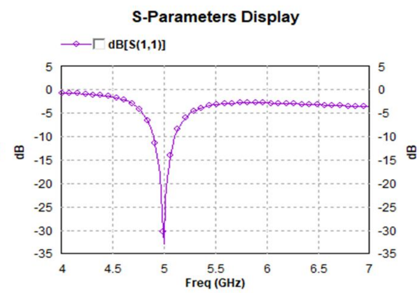


Figure 5(a) (Return Loss) graph for Quartz CPA Figure 5(b): S_{11}(Return Loss) graph for Nylon CPA

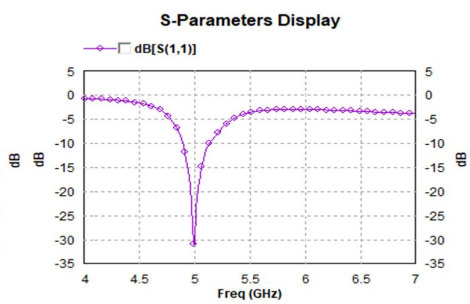
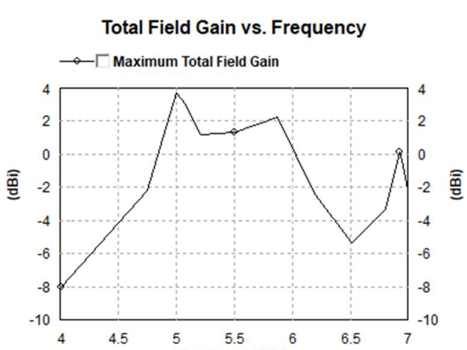


Figure 6(a): S_{11}(Return Loss) graph for Quartz EPA Figure 6(b): S_{11}(Return Loss) graph for Nylon EPA

3. Gain:



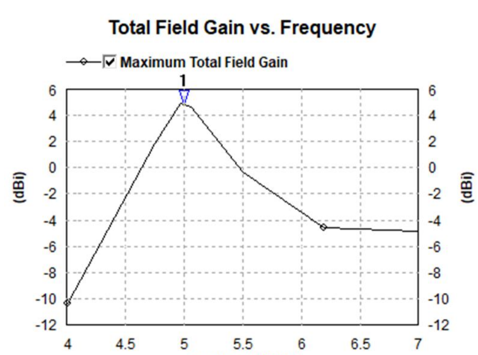


Figure 7(a): Gain for Quartz CPA Figure 7(b): Gain for Nylon CPA

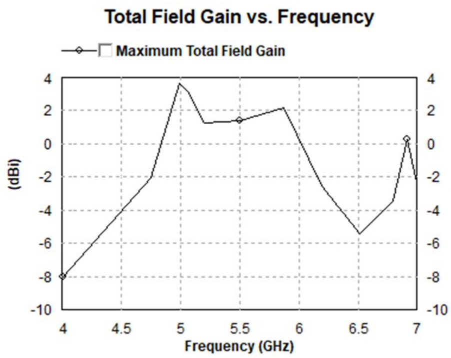


Figure 8(a): Gain for Quartz EPA

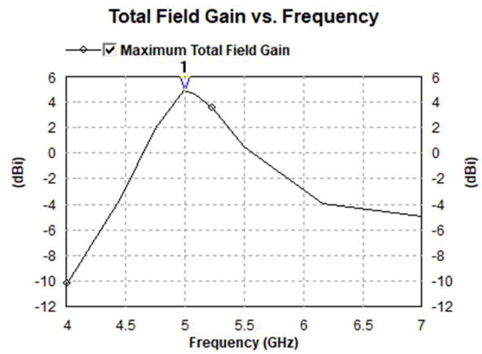


Figure 8(b): Gain for Nylon EPA

4. Comparison Table:

TABLE I: COMPARISON BETWEEN NYLON AND QUARTZ SUBSTRATE

Sl. No.	Parameter	Substrate			
		Nylon		Quartz	
		CPA	EPA	CPA	EPA
	Height (h) (mm)	2	2	2	2
	Dielectric constant (Ɛr)	3.6	3.6	4.2	4.2
	Loss tangent	0.0083	0.0083	0.001	0.001
	Radius of CPA /Major axis and minor axis of EPA (mm)	R = 8.47	a = 8.525 b = 8.1	R = 13.72	a = 13.74 b = 13.73
	Return loss (s_{11}) (dB)	-31.98222	-30.9466	-35.11222	-23.4867
	GAIN (dBi)	4.80465	4.3883	3.57836	3.57667
	Antenna efficiency (%)	61.7297	62.351	52.2842	52.6998
	Fractional bandwidth (%)	4.2	4.8	7.5	1.4444

IV. CONCLUSION

In this paper the comparative study of NYLON and QUARTZ substrates were used for designing CPA and EPA with the same resonating frequency of 5GHz. After comparison, it was found that the maximum fractional was obtained from quartz CPA. However, the antenna efficiency and the gain obtained for nylon substrate both for CPA and EPA were greater than the quartz substrate. It was concluded that the nylon substrate was more beneficial as compare to quartz substrate for CPA and EPA. And again, if we compare between CPA and EPA, we have found that EPA was better than in terms of different antenna parameters. By using quartz substrate BW is much greater but due to its fragile in nature and therefore nylon substrate is much better for fabrication. In future the fractional BW of quartz CPA and EPA may be improved by cutting slot on the patch as well as on the ground. And hence the narrow BW may be improved.

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