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EFFICIENT ANALYSIS OF DIFFERENT DIELECTRIC MATERIALS

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Abstract:- In this paper we've discussed and compared different dielectric substrate frequently utilized in designing microstrip patch antenna with the new emerging glass substrate sorts of antennas to reinforce overall efficiency of antenna. Various substrates like roger 4350 , RT Duroid, Taconic TLC, Roger RO4003, FR4 Epoxy, Bakelite are those which are always considered which studying the patch antennas. we've compared few of those with Nylon resin and Fused Quartz. A dielectric substrate may be a n insulator which is a main constituent of the microstrip structure. The dielectric constant is inversely proportional to bandwidth , lower the relative permittivity better is that the fringing achieved. Another factor which impact directly is that the loss tangent it shows inverse relation efficiently the problem here is that substrate with lower loss tangent is comparatively more costlier.

KeyWords: *Microstrip patch antenna, different dielectric substrates, epoxy FR-4*

1. INTRODUCTION

A microstrip antenna (also referred to as a printed antenna) may be a type of antenna fabricated on a computer circuit board (PCB) using microstrip techniques. it's a type of internal antenna. they're mostly used at microwave frequencies. a microstrip antenna usually consists of a patch of metal foil of varied shapes on the surface of a PCB , with a metal foil ground plane on the opposite side of the board. Most of the microstrip antennas contains multiple patches during a two-dimensional array. In recent decades Microstrip antennas are getting very popular and obviously smaller in size, thanks to their thin planar profile which may be incorporated into the surfaces of consumer products, aircraft and missiles; their simple fabrication using PCB techniques; the convenience of integrating the antenna on an equivalent board with the remainder of the circuit, and therefore the possibility of adding active devices like microwave integrated circuits to the antenna itself to form active antennas.

1.1 MICROSTRIP PATCH ANTENNA.

The most common sort of microstrip antenna is that the patch antenna (figure 1)[1]. Antennas using patches as a constitutive elements in an array also are possible. A microstrip patch antenna may be a sort of narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, almost like a computer circuit board, with endless metal layer bonded to the other side of an equivalent substrate which forms a ground plane. Common microstrip antenna shapes are rectangular, square, circular and elliptical, but any continuous shape is feasible

1.2 CRITERIA FOR SUBSTRATE SELECTION.

The very initiative in designing an microstrip antenna is to settle on an appropriate substrate. The substrate in micro strip antennas is principally needed so as to offer the mechanical support of the antenna. to supply this support, the substrate should contains a dielectric material, which cannot affect the electrical performance of the antenna, circuits and cable. Following are the parameters which should be considered while selecting the substrate material within the design of antennas:

a) Surface wave excitation

b) Dispersion of dielectric constant and therefore the loss tangent of the substrate

c) Copper loss

d) Anisotropy of the substrate

e) Effects of temperature, humidity and aging

f) Mechanical requirements: machinability, comfortability, solderability, weight, elasticity etc.

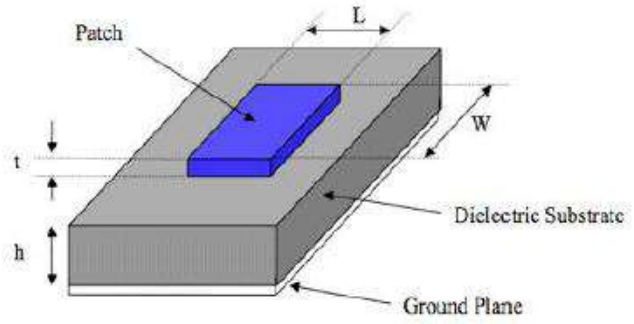
g) Cost

2. COMPARISION OF VARIOUS SUBSTRATES.

Generally, the foremost commonly used dielectric substrates in microstrip patch antenna are the epoxy FR4 and RT Duroid. Epoxy FR4 is widely used due to its low cost as compared to others and also its better

efficiency adds a plus point . We have compared these two with the opposite emerged substrates like nylon fabric and Fused Quartz. The substrate utilized in microstrip antenna varies from 2.2≤Ɛ≤12 the maximum amount as Lower the permittivity of dielectric material larger is that the size of the antenna but it achieves better efficiency and larger is that the bandwidth. a number of the substrates utilized in microstrip patch antenna are listed below.

Fig -1: Microstrip Patch Antenna.



[2]table -1: Comparision of varied substrates

substrates	Dielectric constant	Loss tangent	Resonance frequency	Return loss
FR-4	4.4	0.018	5.8 GHZ	-14.73
RT-Duroid	2.2	0.0009	10 GHZ	-
Nylon	3.6	0.0083	989 MHZ	-35.42
Fused Quartz	3.78	0.0001	2.06 GHZ	-

Substrates	Gain	Bandwidth	Size Reduction	Efficiency
FR-4	9.8	Medium	Medium	99.60
RT-Duroid	12.03	Medium	Medium	88.64
Nylon	6.11	Medium	Medium	-
Fused Quartz	5.67	Medium	Medium	-

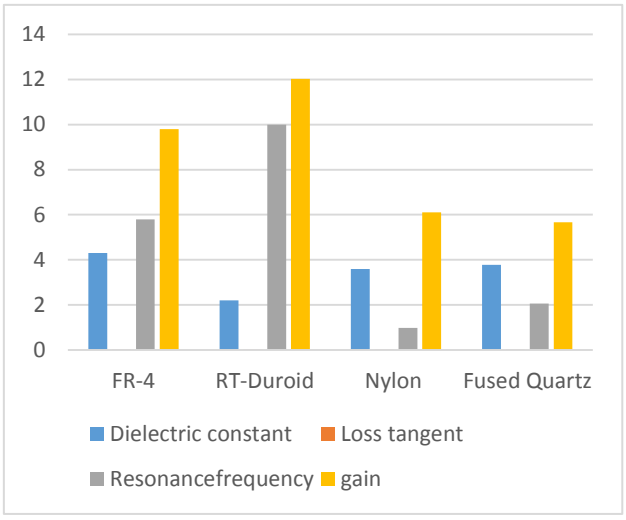


Figure 2: Comparison between different parameters of the different dielectric substrate

- EPOXY FR4[3]

  FR-4 may be a common material used for computer circuit boards. A skinny layer of copper foil is being laminated to at least one or each side of an FR-4 glass epoxy panel. These are commonly mentioned as copperclad laminates. The relative permittivity of epoxy FR4 is 4.4

- RT Duroid

  RT Duroid may be a low loss and low dielectric constant woven-glass reinforced laminate offering mechanical and electrical properties which is important in designing complex microwave structures which are mechanically reliable and electrically stable. it's mostly utilized in aerospace and defence applications. Other then this it also gives better performance in terms of gain, directivity and bandwidth.

- Nylon

  A nylon fabric may be a substrate considered among medium dielectric constant which is about 3.6. work is been done to demonstrate the antenna fabricated using Nylon fabric.

- Fused Quartz

  Fused quartz also referred to as fused silica are often metallised and etched to be used as a substrate for microstrip patch antenna. The dielectric constant of Fused Quartz is less than that of alumina which

allows higher impedance tracks or thinner substrates. The dielctric constant of Fused Quartz is 3.75

3. CONCLUSIONS

Other than the substrates mentioned above there are many more substrates available which are not found naturally. They can be developed in laboratories which may even have negative refractive index.

An antenna to work more effectively , the dielectric substrate used should have less dielectric constant, minimal return loss, size of the antenna should not exceed to a great extent and obviously greater efficiency also it should not be much costlier. . In the above table we have calculated all the parameters assuming the frequency to be at 10 GHZ and using proper formulas have found out the values.

From which we conclude that even if we compare the substrates which are being in used from decades to that which are made in use in recent times, FR-4 inspite of giving little less efficiency than RT Duroid is considered much better to be used as a dielectric subsrate due to its low cost and ease of availability. Also as compared to other substrates it gives less amount of return loss and also comparatively good gain.

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