

Investigation of Circular Microstrip Patch Antenna using the Concept of Artificial Dielectric

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Abstract

Numerous Microstrip patch antennas turned enormously popular in mobile and radio wireless communication. This is because of comfort of investigation and fabrication, and their fascinating radiation features. However, they have few retreats of narrow bandwidth, low efficiency and surface wave losses. In order to get over the restrictions of microstrip antennas such as lower gain (-6 dB), narrow bandwidth (< 5%), excitation of surface waves etc, a novel solution technique; Kock W.E, evoked the substitute of conventional dielectric by artificial dielectrics. As substrates has appealed raising attention. Dissimilar to other techniques, this novel method employs the implicit properties of dielectric materials to improve microstrip antenna execution. These periodic structures have the specific characteristic of defending the propagation of electromagnetic waves for particular frequencies and directions which are determined by the shape, symmetry, size, and the material used in their building. Few artificial dielectrics structures comprise patterns engraved in the ground plane, drilled holes in dielectrics, and metallic patches arranged throughout microstrip structures.

The objectives of this paper are to design, fabricate, simulate and the novel artificial dielectrics structure operating at 2.18GHz and 3.17GHz frequency and examine the functioning of the circular microstrip antenna with and without artificial dielectrics structure. Those designs were simulated with Ansoft HFSS software. Simulated data were compared and counterpointed.

Keywords: Antenna; propagational; stucture; Ansoft HFSS software.

1. Introduction

Microstrip patch antennas have been an appealing alternative in mobile and radio wireless communication. This is because they have benefits such as conformal, low profile, low price and robust. Even so, simultaneously they have disadvantages of narrow bandwidth, low efficiency, and surface wave losses.

Recently, there have been large research exercises in the Artificial dielectric materials (ADM) structure for antenna application to inhibit the surface wave and ameliorate the radiation performance of the antenna.

In this research paper, it is aimed that the microstrip antenna having the artificial dielectric materials structure, which is set around the patch antenna. The suggested design is assessed using the Ansoft HFSS and the effectiveness of the design is equated with the traditional microstrip antenna. These patterns are simulated using Ansoft HFSS software. The patterns were then etched on RT/Deroid substrate with dielectric constant of 2.5 and height of .318cm. simulated data are equated and contrasted.

2. Microstrip Patch Antenna

Microstrip antennas turned very common in the 1970s mainly for space borne engineering. Today they are utilized for commercial and government applications. The microstrip antenna proposes conformable, low-profile, to planar and non-planar surfaces, cheap and naive to fabricate using advanced printed-circuit technology, mechanically robust when adorned on rigid surfaces and very variable in terms of frequency, resonant, polarization, impedance and patterns. Microstrip antenna properties

- Polarization
- Radiation Pattern
- Half Power Beamwidth (HPBW)
- Gain
- Voltage Standing Wave Ratio (VSWR)

3. Artificial Dielectric Materials

In the mid 1940's Kock experimentally proved that an array of parallel metal plates illuminated with a low gain radiator shapes the beam pattern similarly as a homogenous dielectric lens whose refractive index is less than unity. It was concluded that when the E-field is parallel to the plates the mode of propagation is identical as the

dominant mode in a rectangular waveguide, and the refractive index of the “lens” is $\sqrt{1 - (\lambda_0/2a)^2}$

3.1 Estimation of the effective permittivity

Effective permittivity of the artificial dielectric inclined to the formula $\epsilon_r = 1 + \frac{\frac{\alpha N}{\epsilon_0}}{1 - \frac{1}{2} \left(\frac{\alpha N}{\epsilon_0} \right)}$

4. Design Methodology

Table 1: Design parameters of microstrip antenna

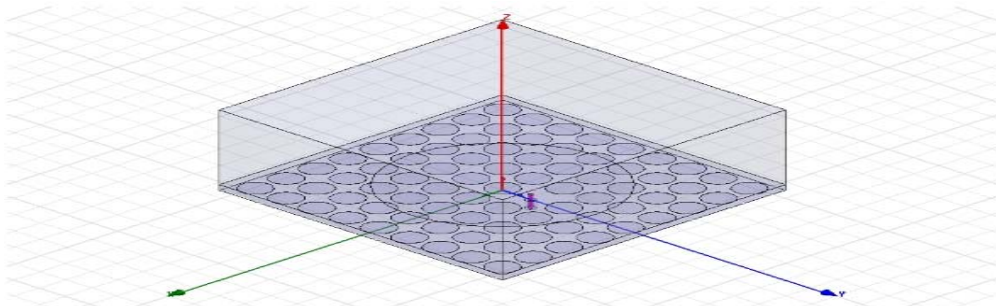
Shape	Circular
Frequency	1.41 Ghz
Dielectric constant of substrate	2.5 Rogers Ultralam 1250 (tm)
Feeding method	Coaxial probe
Height of substrate	0.318cm
Gain	4dB

4.1 Design specification artificial dielectric material

The novel ADM structure is planned to operate at frequency 2.16GHz and 3.17 GHz. For this design, the Rogers Ultralam 1250 (tm) dielectric material ($\epsilon_r = 2.5$) with dielectric loss tangent ($\tan \delta$) of 0.0015 and height of substrate (h) 0.318cm were applied. The entire ADM structure was chosen with dimension of 11cm (width, W) x 11cm (length, L) with the individual circular disc of radius 0.5cm at the middle left hand corner of the rectangular box structure. The transmission line method is chosen for analysisdeterminations.

5. Simulation Results

5.1 Disk type artificial dielectric material



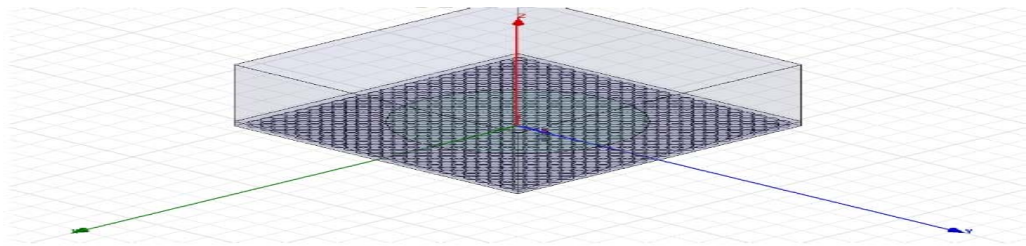


Figure 1: shows the simulation results of S11 parameter for the both ADM structure.

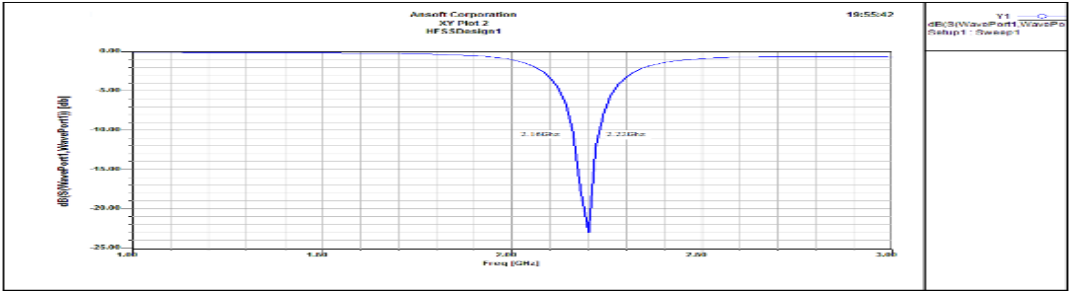


Figure 2: (a)show S11 -24.01db at 2.18 GHz for the disk artificial dielectric material

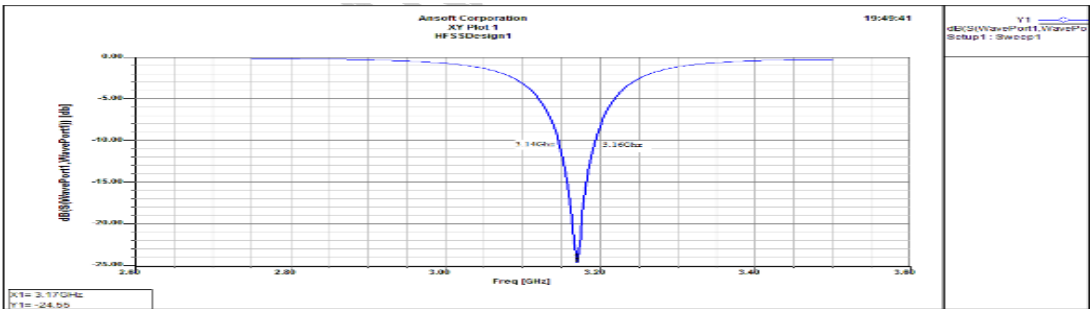
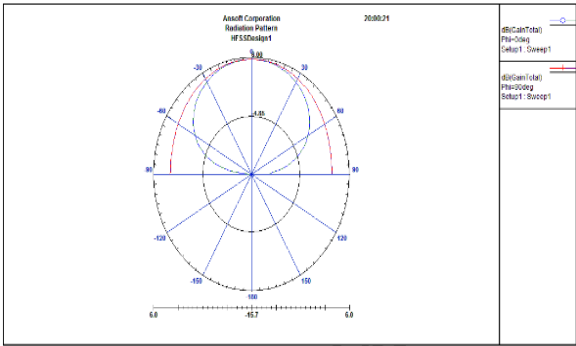


Figure 2: (b)show S11 -24.55db at 3.17 GHz for the cylindrical artificial dielectric material.

Gain of the artificial dielectric material



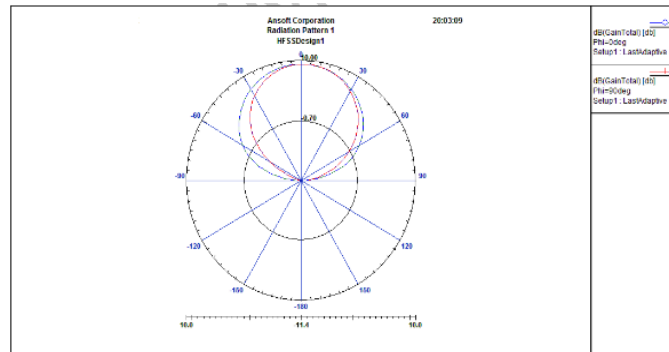
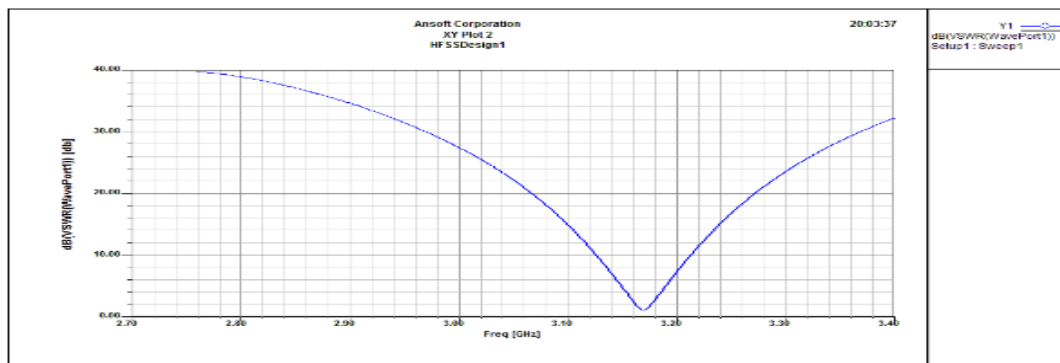


Figure 3: (a) Maximum radiation at 0°, Figure 3(b) Maximum radiation at 0°, gain = 5.984 dB for cylindrical artificial dielectric, gain = 9.984 dB for disk type artificial dielectric.

Below shows Figure 4: VSWR for artificial dielectric patch antenna. Cylindrical Type



Disk type

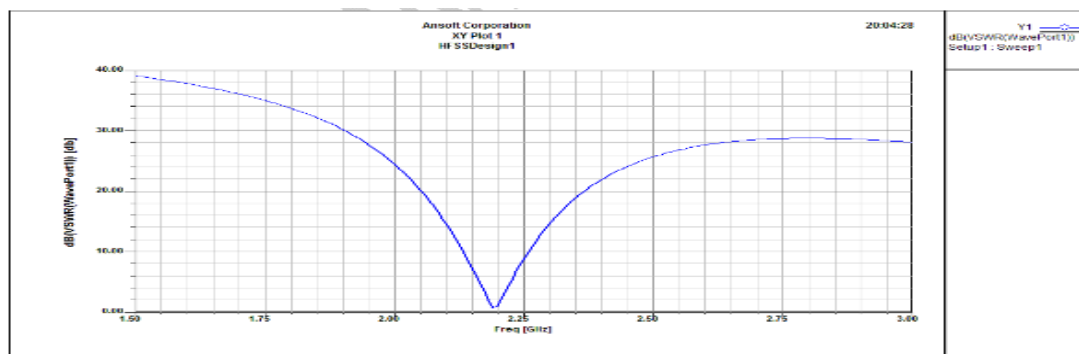


Table 2: Comparison between conventional circular microstrip antenna and microstrip antenna with ADM structure.

	Conventional microstrip	Microstrip antenna with ADMstructure (CT)	Microstrip antenna with ADMstructure (DT)
<i>Maximum radiation gain at 0°</i>	3.984dB	5.984dB	9.984dB
<i>Bandwidth of The antenna</i>	3 MHz	6Mhz	6Mhz

6. Conclusion

The aims of this research papers are to design a novel ADM structure that can function at 2.18GHz and 3.17 GHz frequency and ameliorate the functioning of microstrip antenna when ADM structure appended it. The conventional microstrip antenna was designed as a source with the radius of the patch is 3.502 cm with a coaxial probe as a feed. The S11 (input return loss) plot for microstrip antennas have a magnitude of much at 10dB at the operating frequency 2.18 and 3.17GHz, which means that the antennas had not numerous losses while transmitting the signal and improvement of bandwidth.

It is proved that the microstrip antenna with ADM structure can ameliorates the functioning of the antenna. The maximum radiation pattern confrontation of the conventional microstrip antenna versus microstrip antenna with ADM structure is evaluated to be 3.984dB compared with 5.984dB, 9.984dB.

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