Radiation Pattern of RDRA for different Roger's materials

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ABSTRACT

Study of Radiation pattern of RDRA with Roger's material of various configurations and DRA arrays have been presented. RDRA with Roger's material (TMM$_{10}$, ε_r= 9.8) offers better radiation properties compared to another materials. RP of DRA arrays element have also been presented in this chapter with increase of arrays elements directivity increases hence better performance of DRA. Radiation pattern properties of 3-dimensional radiation patterns have been studied. RDRA with Roger's material (TMM$_{10}$, ε_r= 9.8) offers good radiation properties compared to another materials. RP of DRA arrays element have also been presented in this chapter with increase of arrays elements directivity increases hence better performance of DRA.

KEYWORDS : RDRA, Roger's material, Radiation, Directivity.

INTRODUCTION

At present, wireless market is proceeded rapidly therefore, new technologies being investigated to enhance the performance and its applications in the present spectrum. Smart antennas with controllable directionality are one of the promising candidates which allow higher reuse of channels and system performance. Specially, DRAs are devices in the form of wires, discs, or horns, whose major purpose is to receive or transmit electromagnetic waves from one place to another. DRAs are designed for the purpose to deliver/receive power from one specified direction to another specified direction and they should work satisfactorily within a specified frequency range (bandwidth) of the electromagnetic spectrum. When used as a transmitter, the antenna is excited electrically and can radiate electromagnetic waves into the open space depending on such specified needs as directivities, half-power beam widths, and main-lobe to side-lobe power ratios,' various types of antennas can be choosed. The geometric and excitation parameters of the antennas depend on its design. Mathematical expressions are readily present to explain the radiation patterns of most antennas, but approximate solutions are frequently used to explain such antenna properties as beam width and main-lobe to side-lobe power ratio.'

Theoretical Analysis

DRA designs are used to investigate the DR material performances for wideband applications. For example we will explain rectangular DRA using Roger's material.

In this study, an easy DRA excited by the probe fed is used to analyse the performance of antenna as shown in fig. 1. DR has dimensions : a=b=18 mm and d=29 mm whereas the probe-fed has length 10mm from ground and diameter 1.2mm. The DR is mounted on a Rogers RT5880 subtrate with permittivity ε_{rs} = 2.2, loss tangent of 0.0009, and thickness h = 0.762 mm. The comparative return losses of the DRA for possible DR materials are shown in fig. 2.

This fig. 2 shows the simulated reflection coefficient for rectangular DRA as a function of frequency for TMM10 (ε_r = 9.8), TMM10i (ε_r = 10) and RO3010 (ε_r = 10.2). It can be observed that the resonant frequency reduces as the permittivity of DR material increases. Hence it is found that for the rectangular DRA, with change in the permittivity of the DR material, frequency shift occur and it does not affect the another radiation properties of DRA. fig. 3 describes the 3-Dimensional radiation patter of the antenna at it resonant frequency ~3.6 GHz for various DR materials.

The peak benefit for Roger TMM10 (ε_r = 9.8) is 6.93 which is greater than another two Roger materials TMM10i and RO3010. The chapter establishes the fact that Roger TMM10 is better material for DRA development (RDRA).

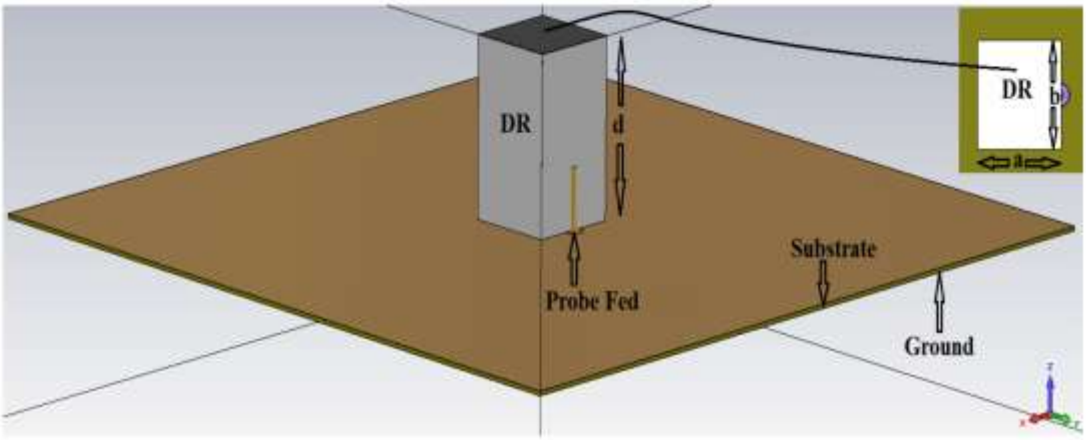

fig. 1 rectangular DRA with : a=b=18 mm and d=29mm

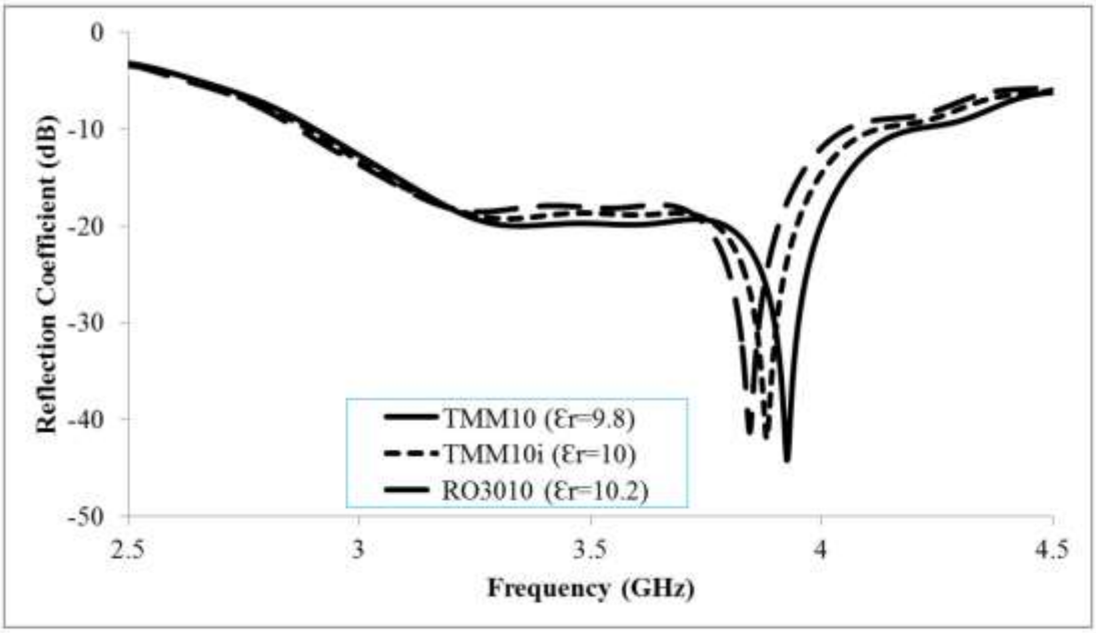

fig. 2 comparative return loss of DRA for different DR materials.

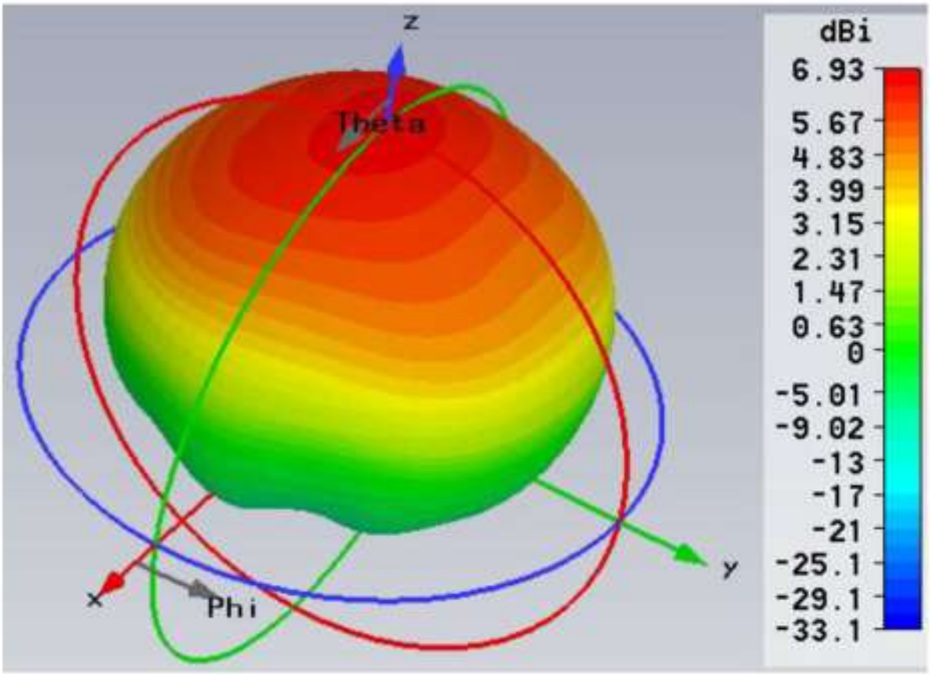

fig. 3 (a) 3-dimensional radiation pattern of RDRA at ~3.6 GHz for Roger TMM10 (ε_r = 9.8)

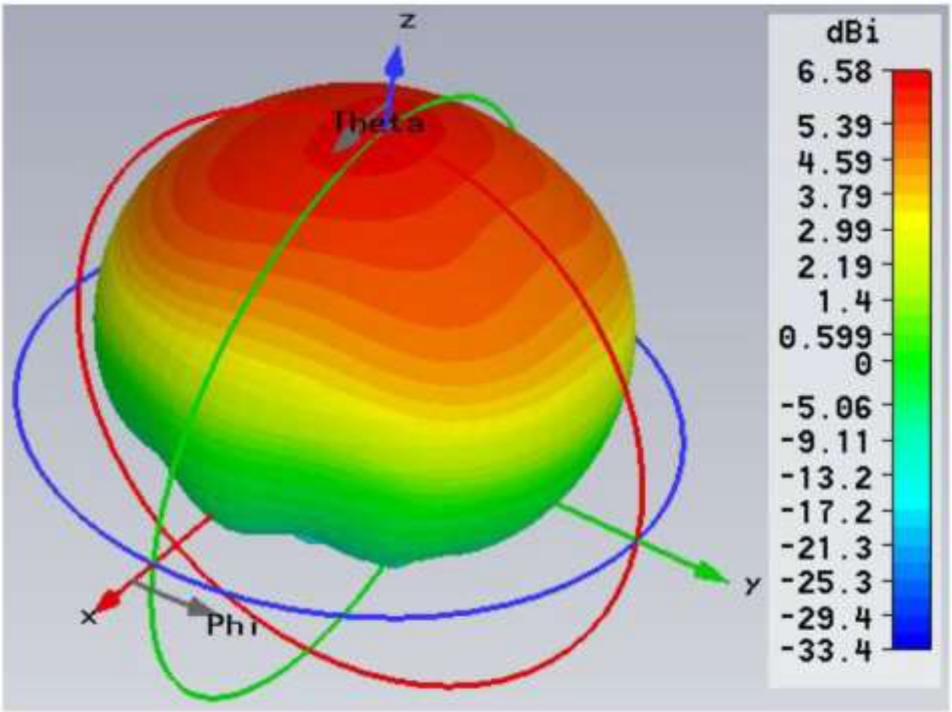

fig. 3 (b) 3-dimensional radiation pattern of RDRA at ~3.6 GHz for roger TMM10i (ε_r = 10)

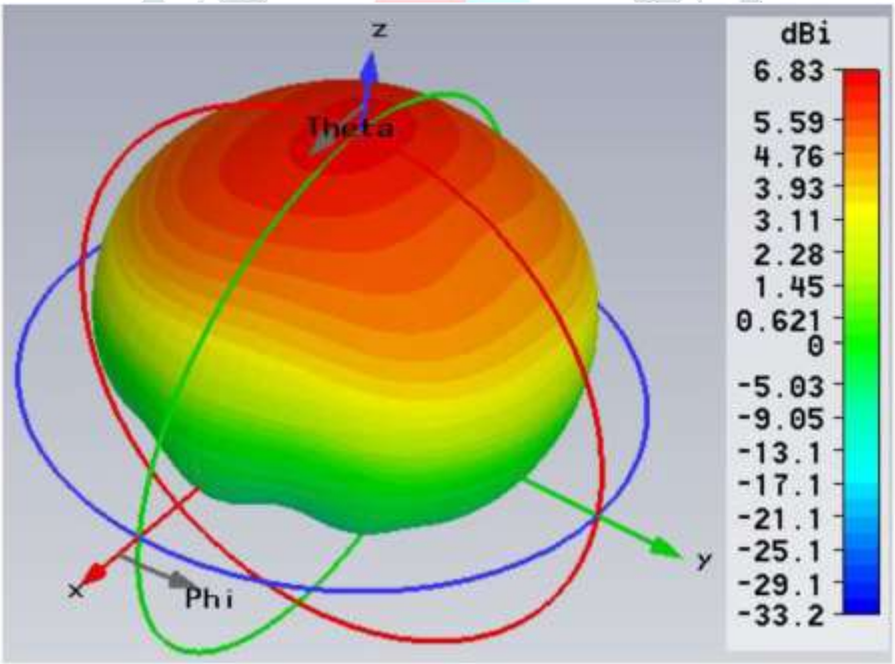

fig. 3 (c) 3-dimensional radiation pattern of RDRA at ~3.6 GHz for roger RO3010 (ε_r = 10.2)

Radiation Pattern of DRAs

The three dimensional (3-D) radiation patterns of the benefit at 3.2 GHz are shown in fig. 4 - 6 which justifies the broadside nature of the pattern. The peak benefit observed at the resonant frequecy is 1.56 dBi for rectangular DRA, 1.50 dBi for cylindrical DRA and 1.54 dBi for hemispherical DRA, respectively.

fig. 4 - 6 summarize the results for various geometries of DRA. It can be observed that the rectangular DRA not only obtains broader impedance bandwidth, but also its peak benefit is considerably higher than another DRAs. So in this work, the basic geometry that was considered for the further improvement in the design in RDRA. Thus we have establish the fact that the RDRA may be the better selection for further improvement in the design of Dielectric Resonator Antenna.

Radiation Pattern of DRA Arrays

As for other antenna arrays, the radiation pattern of a DRA array is determined by the radiation pattern of the single element and the array factor. In general, the radiated electric field in the far-field region of a DRA array can be written in the form.

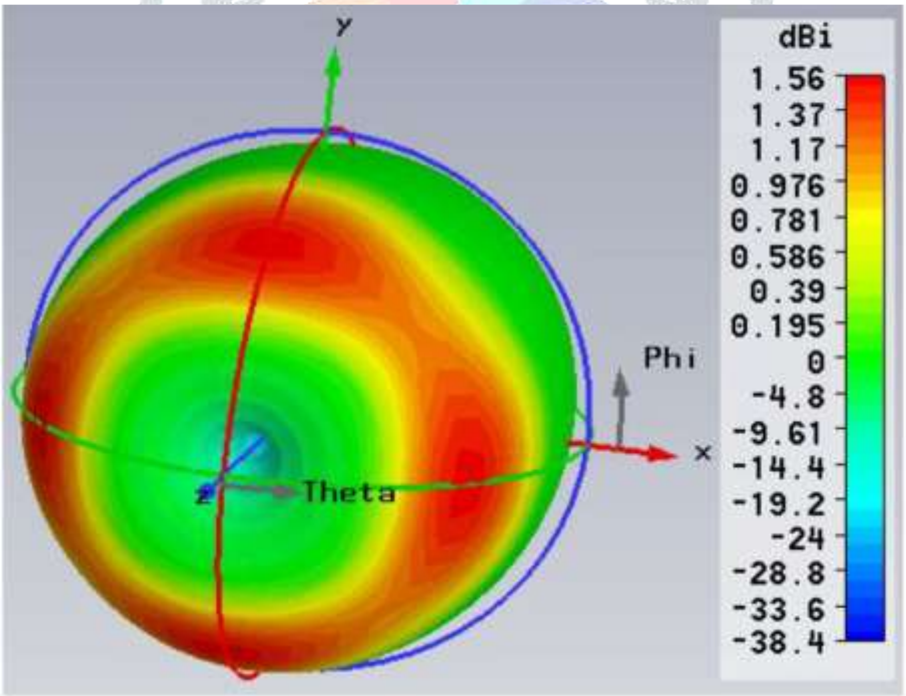

fig. 4 3-D radiation pattern of RDRA at 3.2 GHz

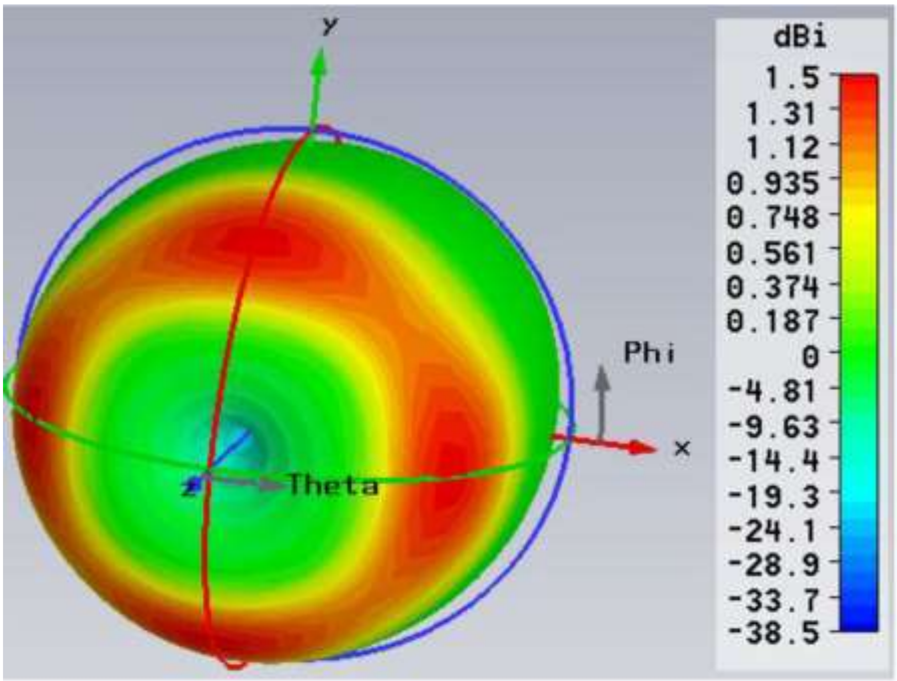

fig. 5 3-D radiation pattern of CDRA at 3.2 GHz

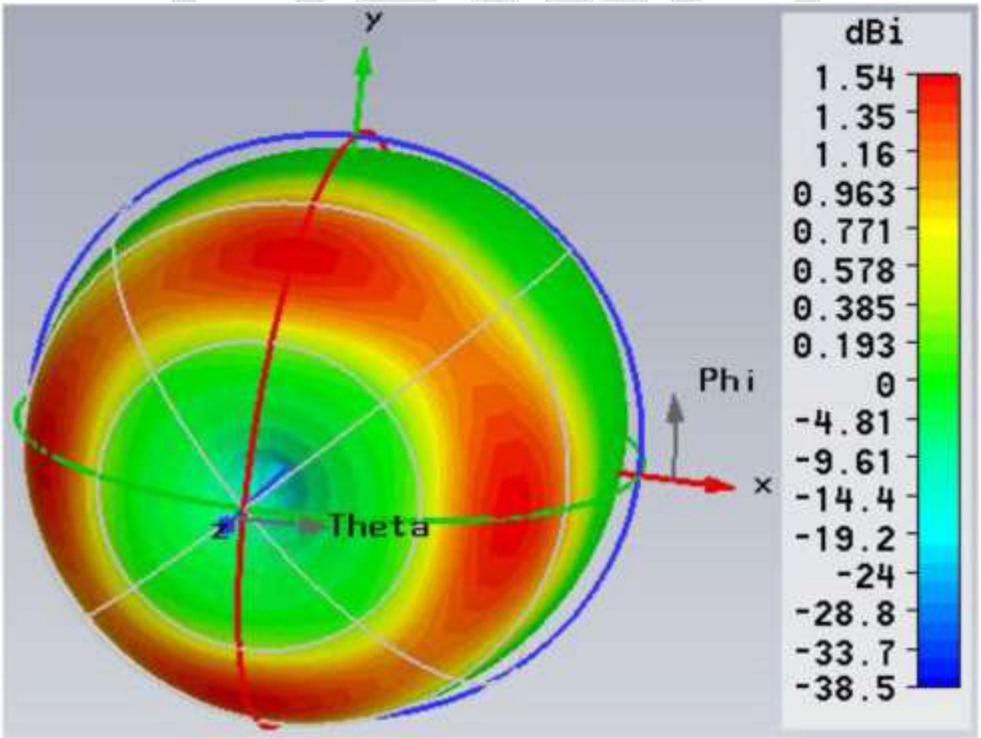

fig. 6 3-D radiation pattern of HDRA at 3.2 GHz

CONCLUSION

Study of Radiation pattern of RDRA with Roger's material of various configurations and DRA arrays have been presented. RDRA with Roger's material (TMM_{10}, ε_r= 9.8) offers better radiation properties compared to another materials. RP of DRA arrays element have also been presented in this chapter with increase of arrays elements directivity increases hence better performance of DRA.

References

1. P. R. Haddad and D. M. Pozar, “Characterisation of aperture coupled microstrip patch antenna with thick ground plane”, *Electron. Lett.*, vol. 30, pp. 1106-1107, July 1994

2. S. A. Long, M. W. McAllister and L. C. Shen, “The resonant cylindrical dielectric cavity antenna”, *IEEE Trans. Antennas Propagat*., vol. 31, pp. 406-412, May 1983

3. M. W. McAllister, S. A. Long and G. L. Conway, "Rectangular dielectric resonator antenna," *Electron. Letters*, Vol. 19, pp. 218-219, 1983.

4. M. W. McAllister and S. A. Long, "Resonant hemispherical dielectric antenna," *Electron. Letters*, Vol. 20, pp. 657-659, 1984.

[5. A.A.Kishk, *Different Integral Equations for Numerical Solution of problems Involving Conducting or Dielectric Objects and their Combination*, PhD Thesis, University of Manitoba, Manitoba, Canada, 1986.

6. Mongia, R. K. and Prakash Bhartia, "Dielectric resonator antennas-A review and general design relations for resonant frequency and bandwidth," *International Journal of Microwave and Millimeter-wave Computer Aided*

7. Nor N. M., Jamaluddin M. H., Kamarudin M. R., and Khalily M., "Rectangular Dielectric Resonator Antenna Array for 28 GHz Applications", Progress In Electromagnetics Research C, 2016, Vol. 63, 53–61,

8. Xu, Y. L., Yang H., Yu W., Liu X., Shen R., "Scattering analysis of nonperiodic composite metallic and dielectric structures using synthetic functions", *IEEE Antennas Wireless Propag. Lett.*, **2017**, vol. 16, pp. 3079-3083.