MATERIAL BASED DESIGN OF ANTENNAS

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ABSTRACT

This project provides a detailed study of material based design of microstrip patch antennas.To generate circular polarization from a microstrip patch antenna the patch radiator is truncated. Truncating the patch radiator, we observed the changes in the parameters of the microstrip antenna in the simulation. The design is created with simulating software Comsol Multiphysics 5.2,which provides fairly reliable simulations and useful data in designing these kinds of antennas. For the construction of the antennas microstrip antenna technology is used due to its advantages such as low profile, weight and easy integration with printed circuits as demonstrated in many studies. The antennas are designed with the height of 60 mil and their dielectric substrate's relative permittivity is set to 3.38. Simulated results of several designs of the antenna are presented.

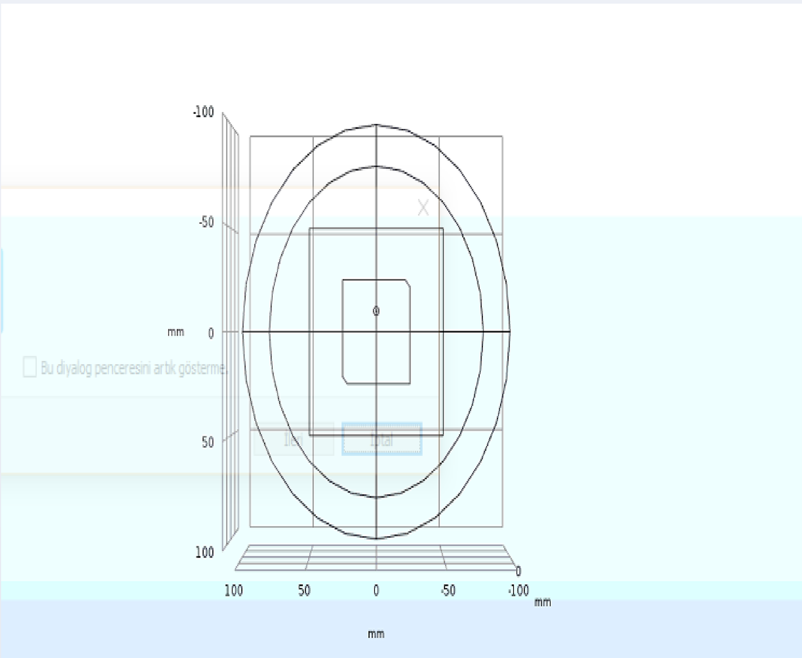

Figure 1 :Top view of microstrip antenna by using Comsol Multiphysics 5.2

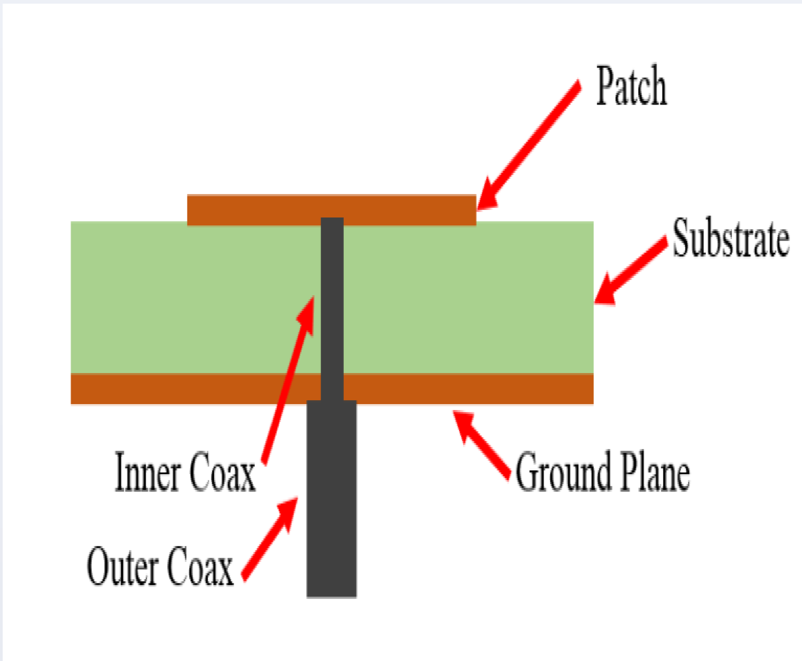

Figure 2 : Section view representation of a patch antenna

OBJECTİVES

Studying homogeneous materials based Patch Antennas using Comsol Multiphysics 5.2.

- Miniaturization structures and improving bandwidth
- Examining of changes in electric field, efficiency of antennas (S11) and radiation parameters depending on frequency
- Main vision: To satisfy stringent performance specifications for microstrip antennas explore all design freedoms: not only **geometry** but also **material composition**

PROJECT DETAILS

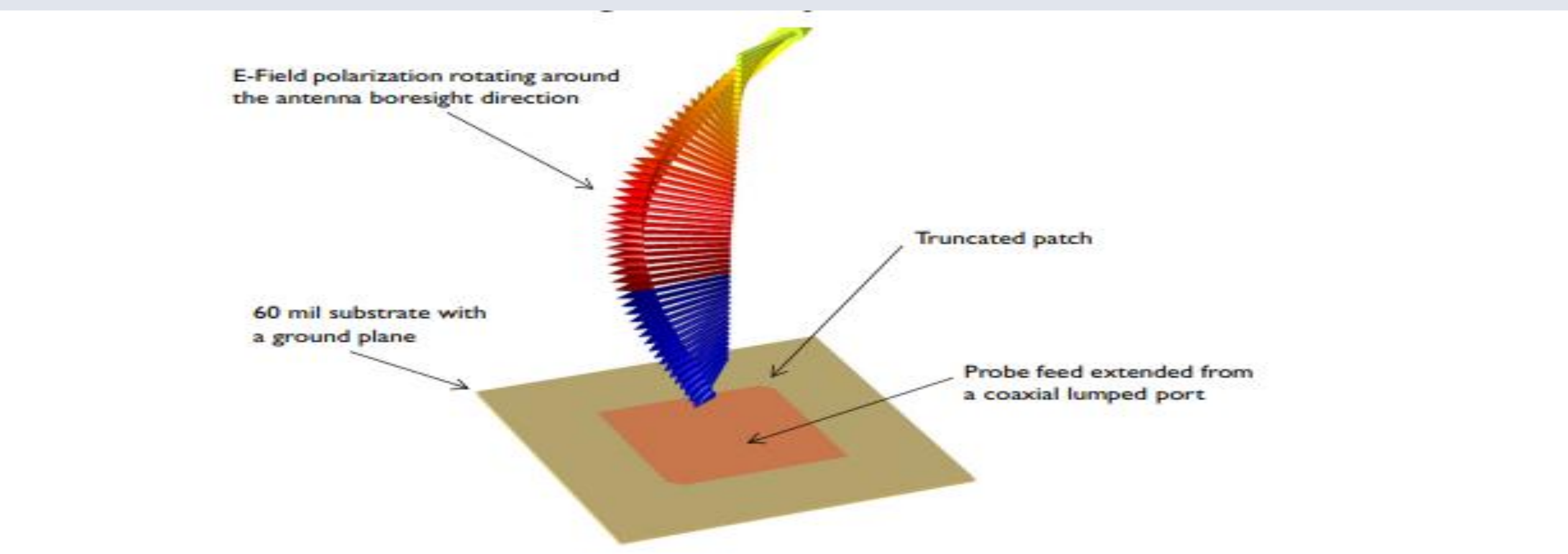

Figure 3: A truncated microstrip patch antenna fed by a probe generates circular polarization along the main radiation direction.

A circularly polarized microstrip patch antenna design begins by adding a square metallic patch on top of a 60 mil substrate with a ground plane. The patch size is approximately estimated by a half wavelength inside the substrate;

$$\frac{Co}{fo \times \sqrt{\varepsilon r}}$$

where c0 is the speed of light, f0 is frequency, and εr is the relative permittivity of a substrate. This estimated value is only an initial guess number and the size needs to be tuned precisely for the intended frequency.

The basic square or rectangular patch radiator generates a linear polarization. By truncating two diagonally paired corners of the patch, the antenna can produce a circular polarization; electric fields with a fairly equal magnitude and ~90 degree phase difference between two orthogonal components; x- and y-axis field components.

A rigid coaxial cable filled with Teflon (εr = 2.1) is added on the bottom of the substrate and the outer conductor of the coaxial cable is connected to the ground plane. The inner conductor pin of the cable is extended through the dielectric part of the substrate and shorted to the patch on the top surface. All metal parts including the patch, ground plane, inner and outer conductors of the coaxial cable are modeled as perfect electric conductors.

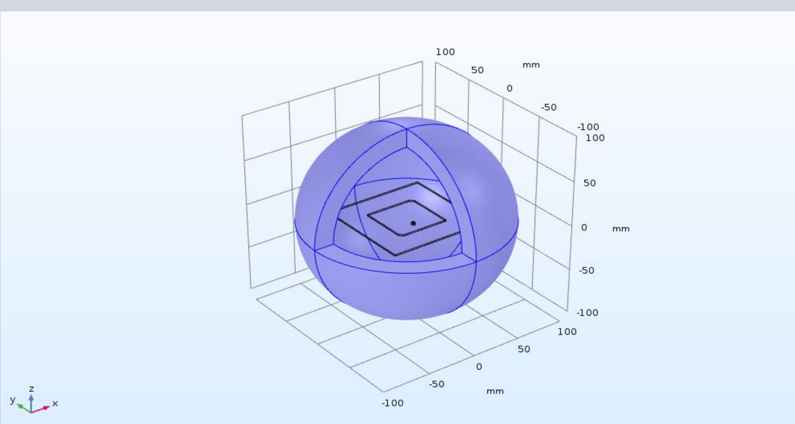

Figure 4 : Perfect Matched Layer of Antennas

- Perfect Matched layer applies a complex coordinate scalling to a layer of virtual domains.
- The antenna is modeled in a spherical air domain. The air domain is truncated with Perfectly Matched Layers (PMLs) which absorb all outgoing radiation.

PROJECT DETAILS II

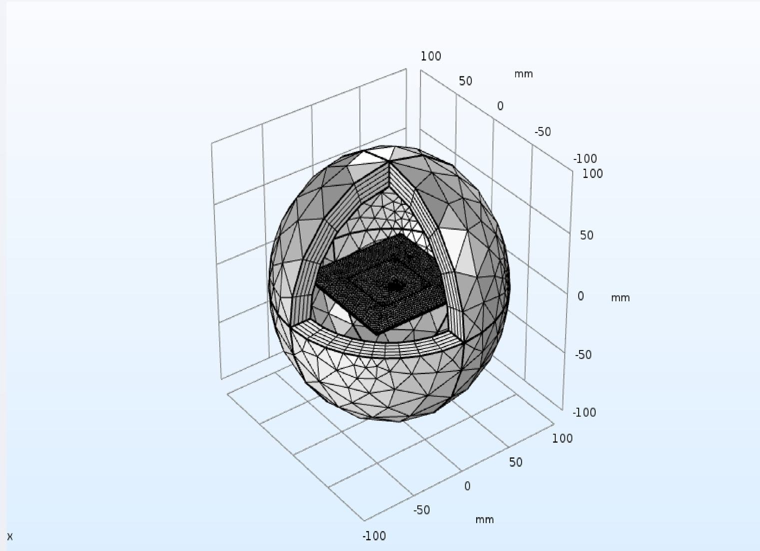

Figure 5 : Mesh analysis of patch antenna

All domains except the PMLs are meshed by a tetrahedral mesh with maximum element size of five elements per wavelength so that the wave is well-resolved. The parts in the coaxial cable are meshed more finely to provide good resolution of the curved surfaces. The PMLs are swept with a total of five elements along the absorbing direction.

RESULTS

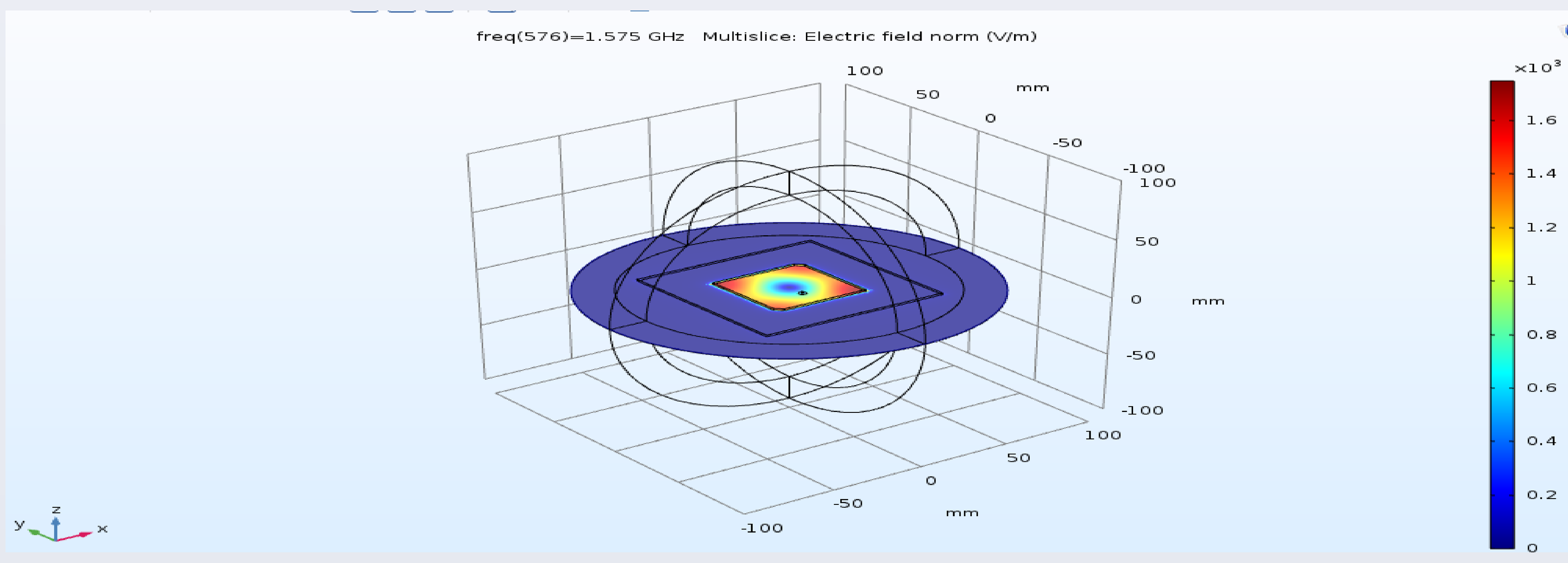

Figure 6 :Electric field analysis of patch antenna

The patch antenna shows the radiating fields confined at each corner of the patch. The antenna performs almost equally at every azimuthal angle in terms of the field intensity magnitude. Simulation results Show that this is a well-designed antenna considering its matched at the resonance frequency of **1.57 GHz.**

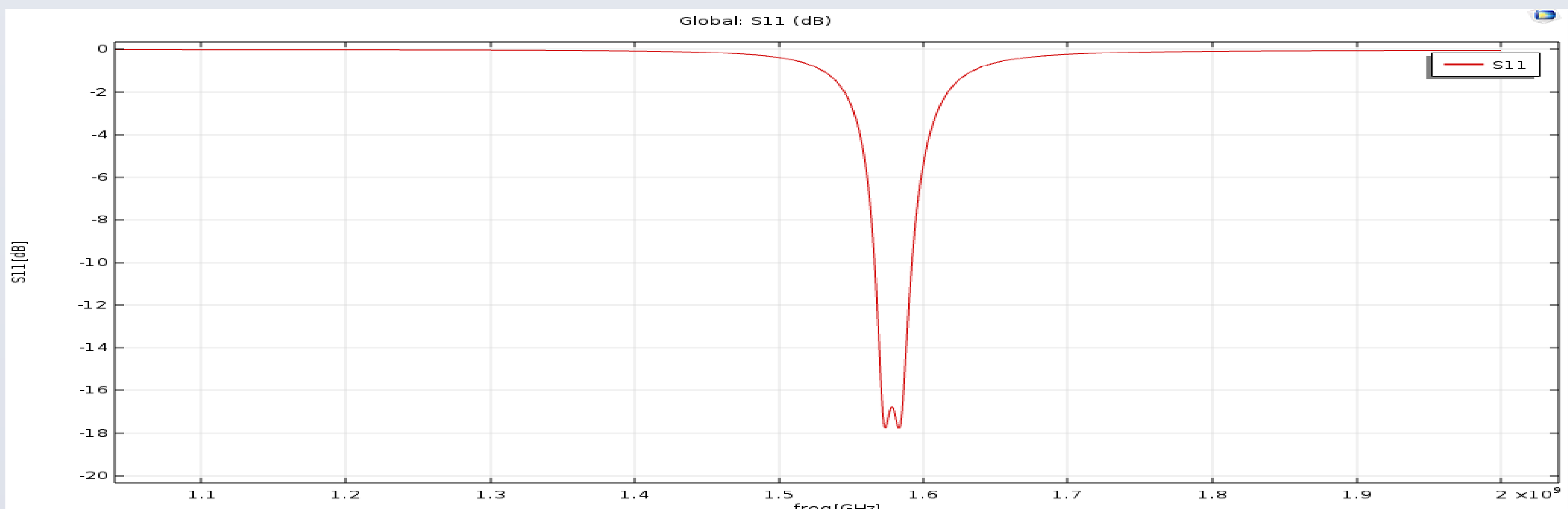

Figure 7 : S11 analysis of patch antenna

S11 parameter refers to the ratio of delivered power from lumped port to the antenna system to the power coming back to lumped port. In practice, it is important for a well performing antenna to have return loss about less than -10dB in order to characterize efficient radiation.This Project carried out resonance frequency of 1.57 GHz between 1GHz and 2GHz.Thus is , the best radiation is taking place in this frequency.

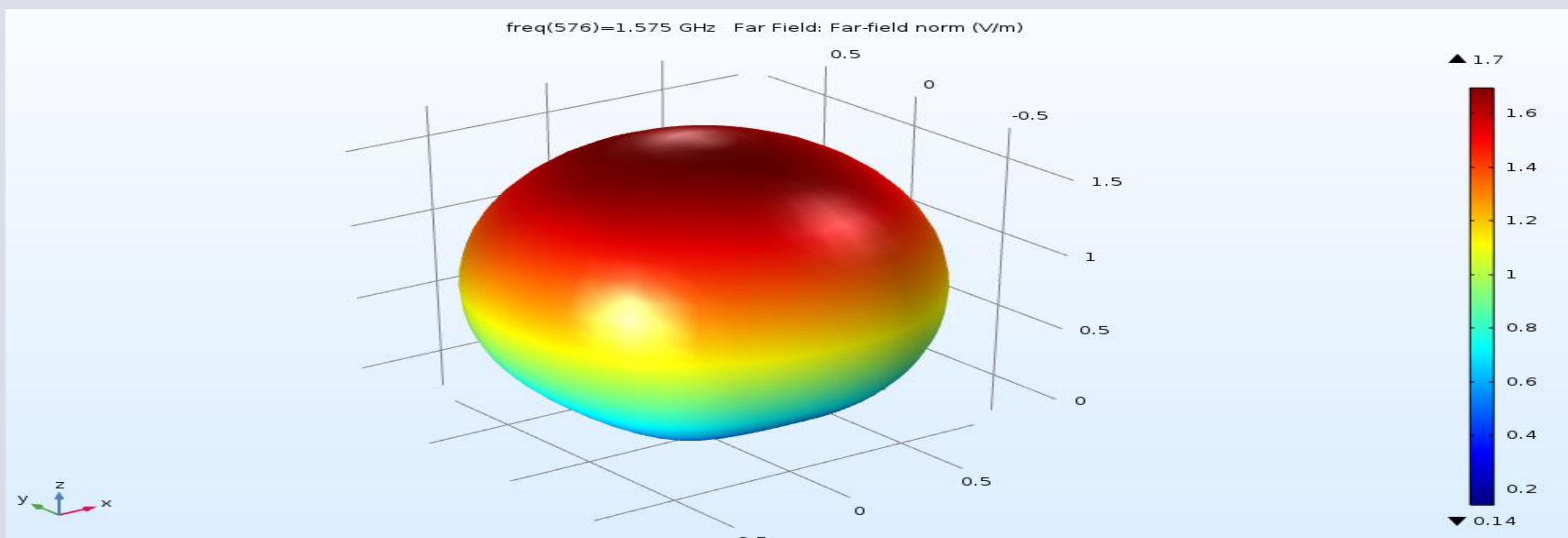

Figure 8 : The 3D far-field pattern is directed to the positive z direction due to the ground plane.

The 3D far-field radiation pattern shows that it blocks the backward radiation and make the pattern directive in the positive z-direction. Because the size of the ground plane is bigger than that of the radiating patch.

CONCLUSIONS

In this project, material based design of microstrip antennas is studied. Therefore, the patch radiator is truncated in the simulation by using Comsol Multiphysics 5.2 because generatation of circular polarization from a microstrip patch antenna is aimed. The patch antenna shows the radiating fields confined at each corner of the patch. Simulation results show that this is a well-designed antenna considering its matched at the resonance frequency of **1.5754 GHz.**

REFERENCES

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