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Simulation and Design of DRA Antenna to Enhance High Radiation with Gain and S-Parameters by Using Different Layers of Photonic Crystal

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ABSTRACT

In various applications, Antennas had increasing of attenuation due to attractive of features of DRA. For example, high radiation efficiency, small size, low profile, and light weight. B. Ws enhancement is available for DRA. Therefore, multi-resonance frequency can be offered by DRAS. Consequently, these frequencies can be showed (emerged) in to abroad band. Moreover, classification of DRAs can be explained in three class which are ultra wide to band (UWB. multi band and broad band). Meanwhile, the aim of this project is to investigate potential of using DRA at optical frequency. Also, evaluation of the effects of surface Plasmon (SP) on metal gp and feeding strips. Besides, these effects may affect the performance of Antenna. Therefore, using CST (computer Simulation Technology) is another object of this project, because it is useful to learn using of CST. To evaluate the value of S parameter and gain magnitude. However, the suitable design of DRA depends on these characteristics and enable us to achieve the accepted results. Therefore, simulation of antenna can be run by these properties and characteristics.

Keywords:

Introduction

One of problems in DRA simulation is reducing radiation pattern. This takes place if there are losses in ohmic properties as well as the waves of surface for different kinds of DRA. This leads to challenges in design of DRA antenna [1]. Meanwhile, the designer should be responsible for choosing a suitable value of dielectric constant, because there is inversely relationship between size of DRA and Er. Moreover, the pattern of radiation and its direction can be get from gain plot as it will explain later in the following sections. This radiation will be towards the upwards because gp. Also, it depends on the constant of dielectric. These constants of deictic take different values of numbers according to required design [2]. However, with small frequency, there will be some losses or disadvantages, but it cannot be seen in the design, especially in millimetre frequency. Following examples will explain different values of results by using boundary gp. The values were high, but when we used physical gp the values reduced due to some losses in ohm. Also, radiation would be absorpted by physical gp and not reflected perfectly. So that, the results could be decreased.

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Literature Review

Introduction

In the 1998, there were studies about Nano–plasmonics. Therefore, the source of light was gold instead of using solid fisher. So that, these experiments could be similar to some experiments with results close to these experiments [3]. Also, another experiments used silver as material to excite SP phenomena instead of gold material. That is because silver is useful for decreasing chemical reactors. Also, the parameters or parts are different compared to gold. furthermore, energy results could be changed to become similar to SP, because the silver structures. Therefore, results could be similar to each other. however, communication systems depend on DRA in some applications. Therefore. It is useful for these kinds of applications. Moreover, variety of shapes of DRA are useful to get variety of results. However, the purpose of these experiments is to get high Ɛr, as well as less complexity. For example, expanding of Ɛr with decreasing antenna size. Some equations are necessary and useful for designing, as well as choosing a suitable parameter. for example, some studies recorded increasing of Q-factor with increasing surface to volume ratio. Therefore, B.W would be increased [4]. However, to increase the ratio of deictic in antenna, some experts used water as dielectric [5]. O'Keefe and Kingsley were responsible for this issue.

Rectangular antenna

Some required measurements are used to design Antenna below with using copper conductor material, as well as port as feeding. Therefore, simulation by transmitter strip as copper conductor has been done and dielectric block was simulated with er = 9.8 (dielectric constant or relative permittivity). Therefore, Air gap was very important to keep positioning between gp and strip, as well as possible with using frequency range (1-6) GHZ.

To explain more about the properties of this antenna with suitable results that we had. We will deal with some dimensions initially as shown in table (1). Initial Dielectric Antenna Design /Using Port as feeding at 3.9 GHZ. As showed in Table (1).

Table 1: Original DRA dimensions.

Dimension	Size (mm)
DRA height	26.1
DRA width	25.4
DRA depth	14.3
Ground plane	30
Relative permittivity	Ɛr = 9.8
Strip length	10
Strip width	1

However, if we change the frequency range to 390 THZ as showed in table (2) with using suitable dimension. Then, the results that we got as follow, by using Dielectric Antenna Design at Optical frequency (390 THZ) Another example showed in table (2), by using suitable measurements to design DRA antenna. In this example we used optical frequencies at range of (0-600) THZ. So, the ratio between GHZ frequencies and THZ was 100.000. In order to improve simulation, the number of mesh elements should be decreased. So, figure (1) showed using 390 THZ as resonant frequency to get S11 magnitude of -11.4006 dB with operating B. W of 114.1. Therefore, returning to figure (2) of gain plot, radiation pattern and gain magnitude can be established.

Table 2: Design of DRA for 390 THZ with electric boundary.

Dimension	Size (μm)
DRA height	0.261
DRA width	0.254
DRA depth	0.143
Ground plane	Electric boundary
Relative permittivity	Ɛr = 9.8
Strip length	0.1
Strip width	0.01

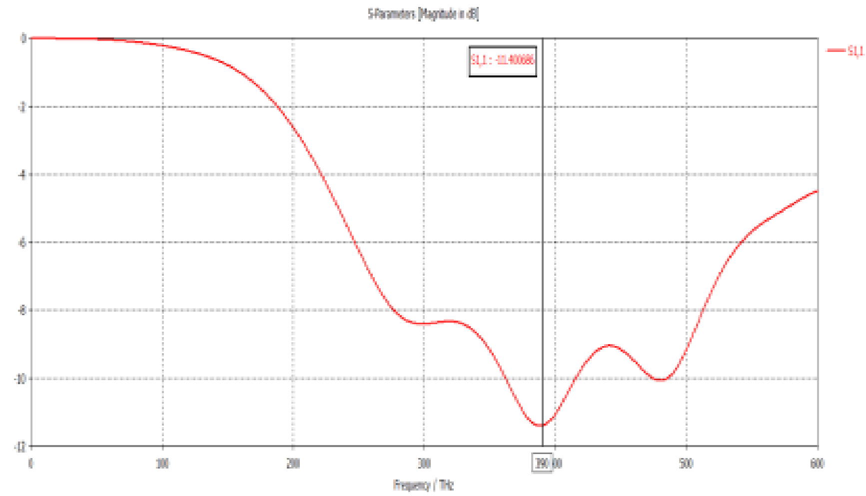


Fig.1 S11 parameter at F=390THZ

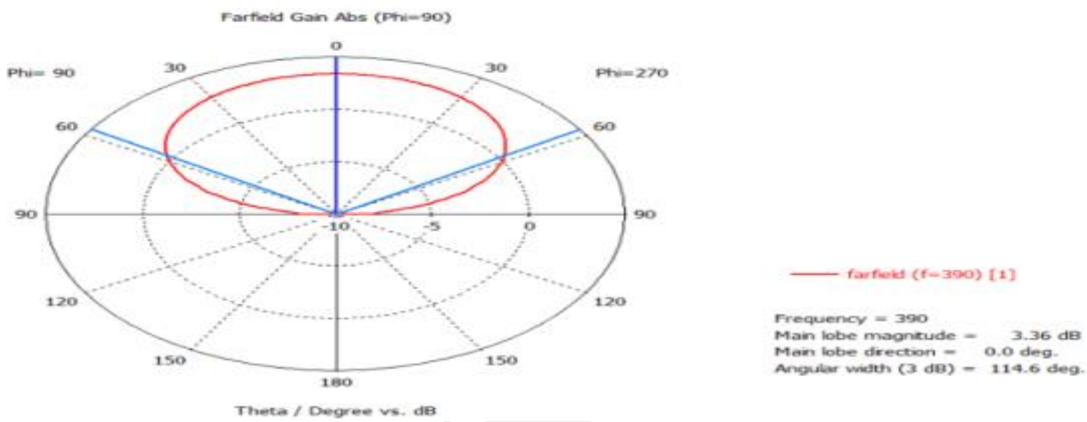


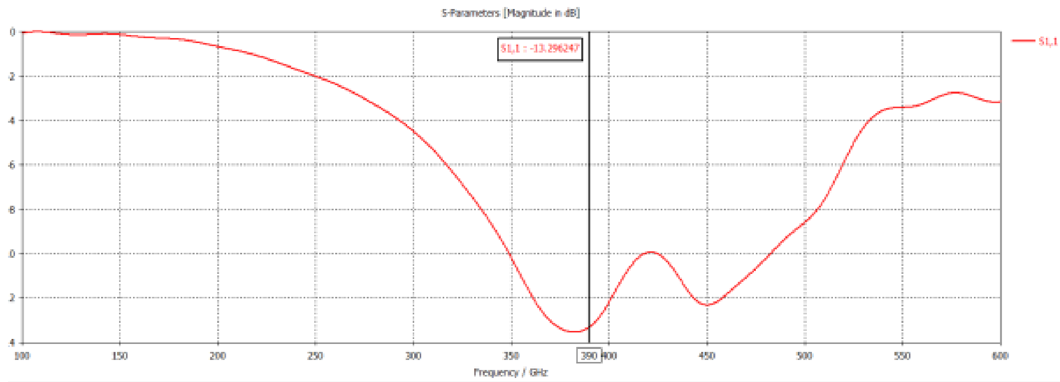
Fig.2 Gain plot at F=390THZ. With angular width (3dB) =114.6 deg

Using thick gp to couple aperture of DRA

As showed in figure (3-4) by using CST software programme to simulate, it was found S11 parameter at 390 GHZ had a magnitude of (-13.296247) dB instead of (-13.272) dB at 3.9 GHz. That means S11 parameter slightly changed to upper value with useful operating range of B. W frequency. For example, we will take Dielectric Antenna Design at frequency (390GHZ) Dimensions of DRA were explained in table (2) for designing. However, the range of frequency increased from 39 GHZ to 390 GHZ. Therefore, following example as showed in table (2) explained using gp to get acceptable results at (390) GHZ.

Table 2: Design of DRA for 390 GHZ with electric boundary

Dimension	Size (mm)
DRA height	0.261
DRA width	0.254
DRA depth	0.143
Ground plane	Electric boundary
Relative permittivity	Ɛr = 9.8
Strip length	0.1
Strip width	0. 01



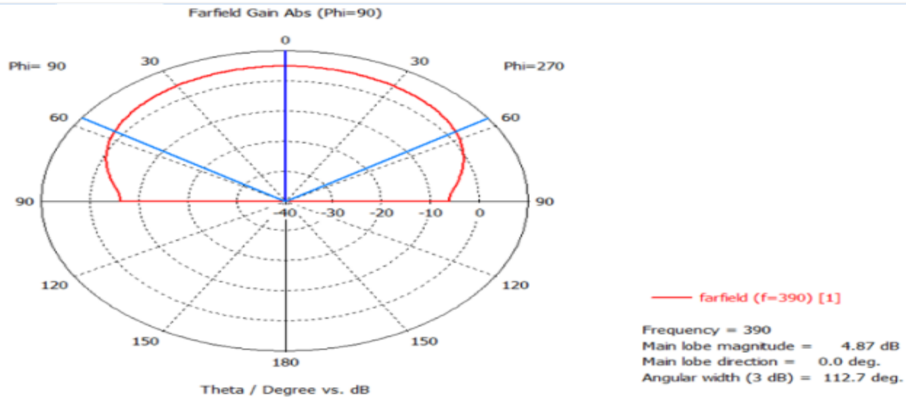


Fig.3 S11 parameter at F=390 GHZ

Fig.4 Gain plot at F=390GHZ. With angular width (3dB) =112.7 deg.

The first method to excite DRA is separation of DRA, by feeding. Therefore; this will be taken individually from each network, while the second method is different from other, because the circuits will be directly in the use not separately [6]. Moreover, changing some parameter leads to enhance radiation, such as making Ɛr with a small value.

Results of field magnitude

There is a relationship between distance and the required value. For example, when the distance decreases, this leads to improve this value with working frequency range at 170.4THZ. However, figure (23,27) showed Max Value of probe by using Gold and PEC materials together. This is referring to that; gold material is perfect conductor than the PEC material. Also, we could explain that SP has been improved at these frequencies. Table (3) showed some Dimensions of DRA. Therefore, the length of strip will be 175 nm with depth 40 nm as showed in figure (5). We noticed that, the max value of probe instate of gold material was 147.869 as showed in figure (6). It was much bigger than the value of104.268 by using PEC as showed in figure (7).

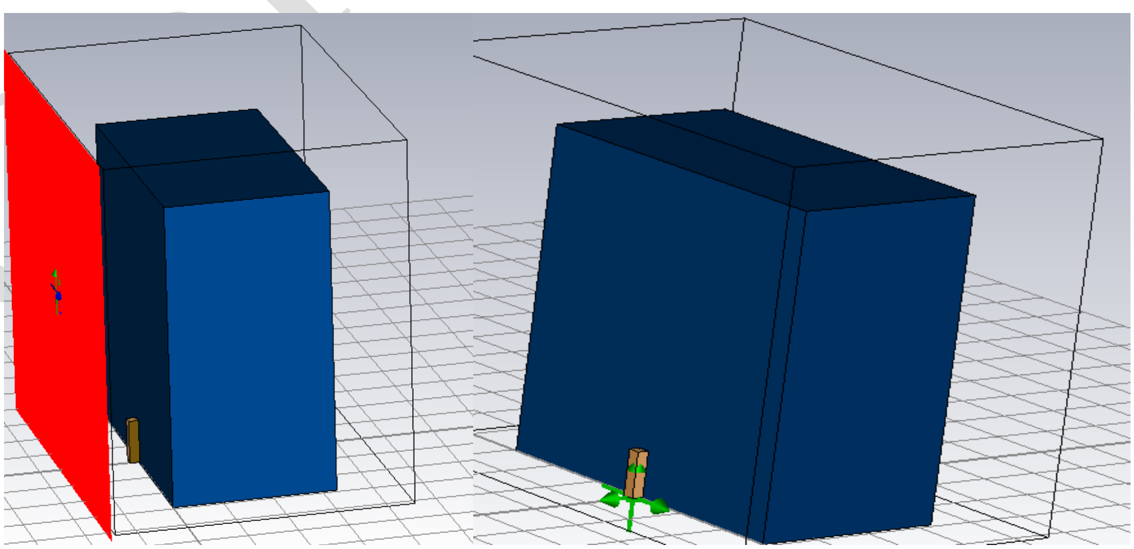


Fig.5 Design of DRA with probe and plane wave.

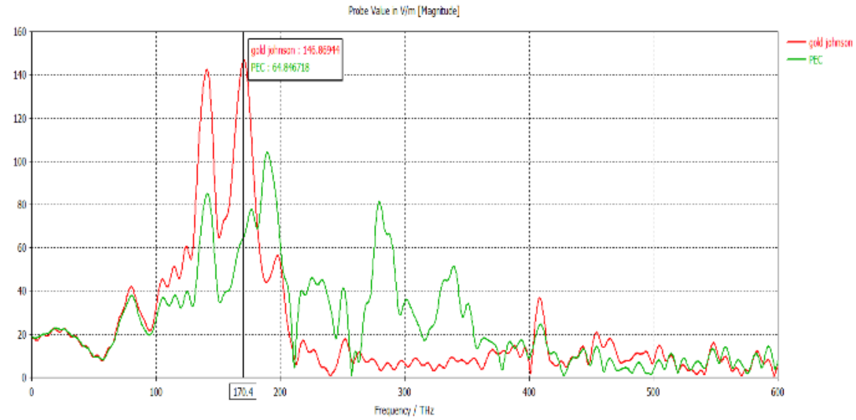


Fig.6 Max by using Gold material.

Table 3: Dimensions of DRA design in nm.

Dimension	**Size (nm)**
DRA height	1200.6
DRA width	1168.4/2
DRA depth	657.8
Ground plane	Electric boundary
Relative permittivity	Ɛr = 9.8
Strip length	175
Strip width	5

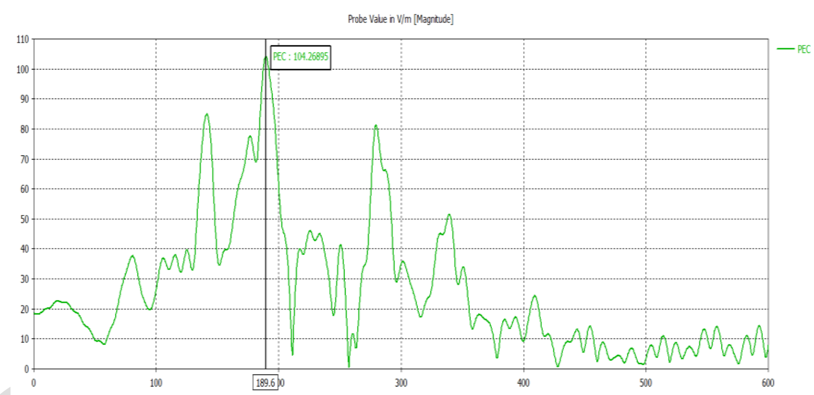


Fig.7 Max by using Gold material.

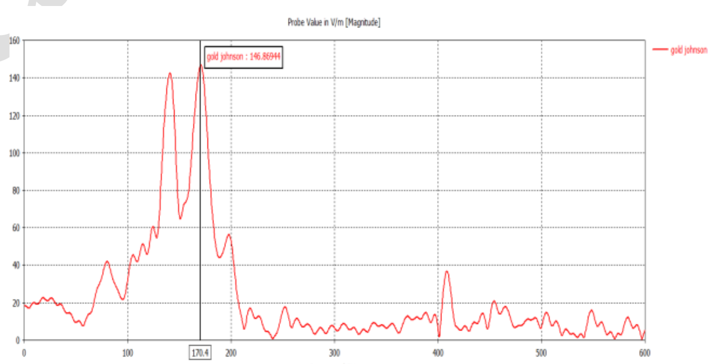


Fig.8 Max by using PEC.

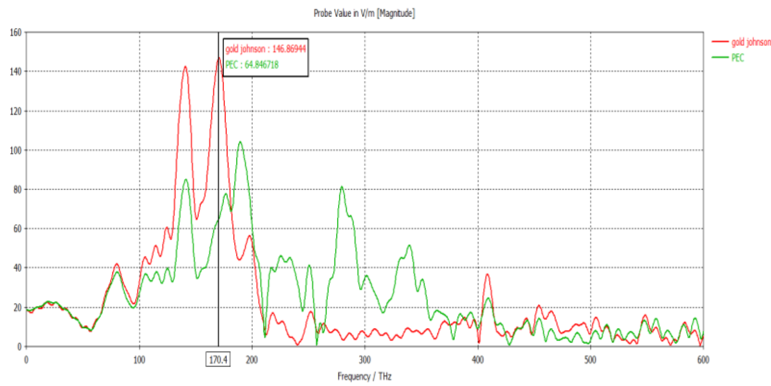


Fig.9 Max using Gold and PEC materials.

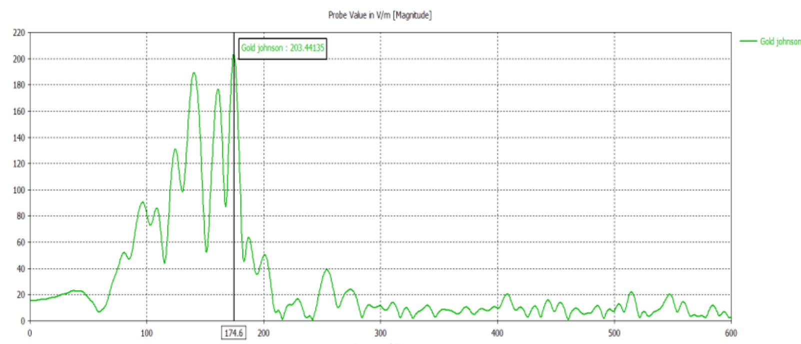


Fig.10 Max Value by using Gold material.

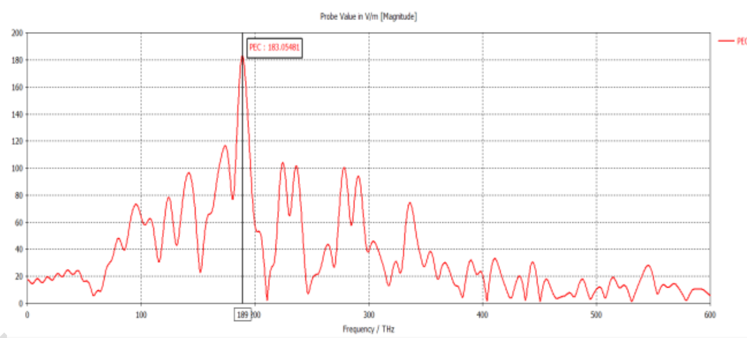


Fig.11 Max using PEC material.

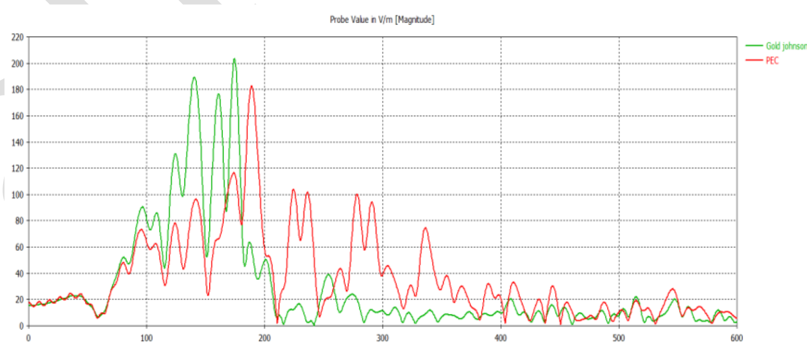


Fig.12 Max using Gold and PEC materials.

So that, the value of gain would be unchanged. However, SP has effect on some resonant frequency rather than Dimensions. However, figure (15) showed Max Value of probe by using Gold and PEC materials together. Also, figures above explained a clear increasing in some results of probe by using gold material. However, when the value of strips length decreased to L = 160 nm with still keeping gap value to 5 nm. We noticed that value of peak increased and sill high in case of gold material. This value was 273.493 v

/ m as showed in figure (13), while the value decreased to 148.873 v / m in state of PEC material as showed in figure (14).

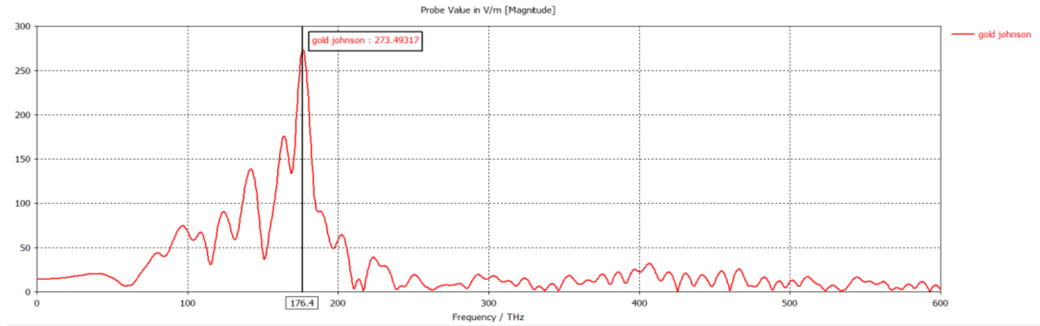


Fig.13 Max Value of probe by using Gold material. The value was 273.493 v/m.

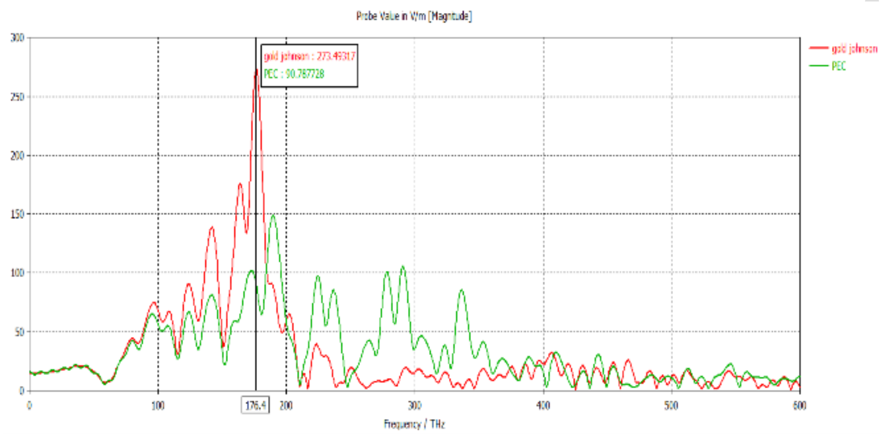


Fig.14 Max probe by using PEC material.

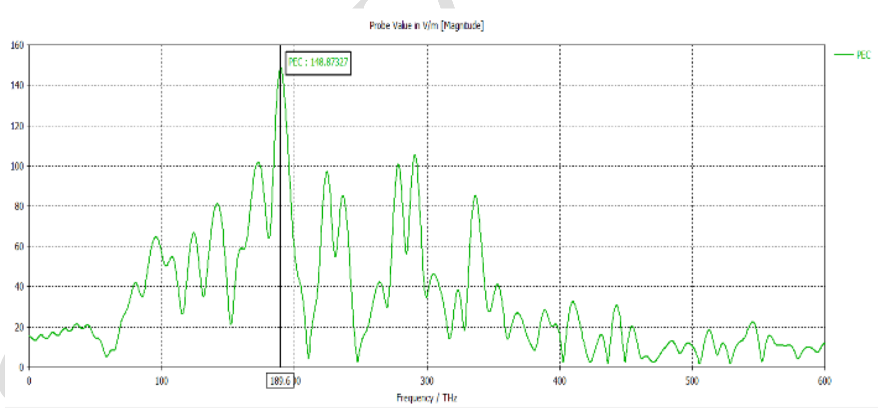


Fig.15 Max probe using Gold and PEC materials together.

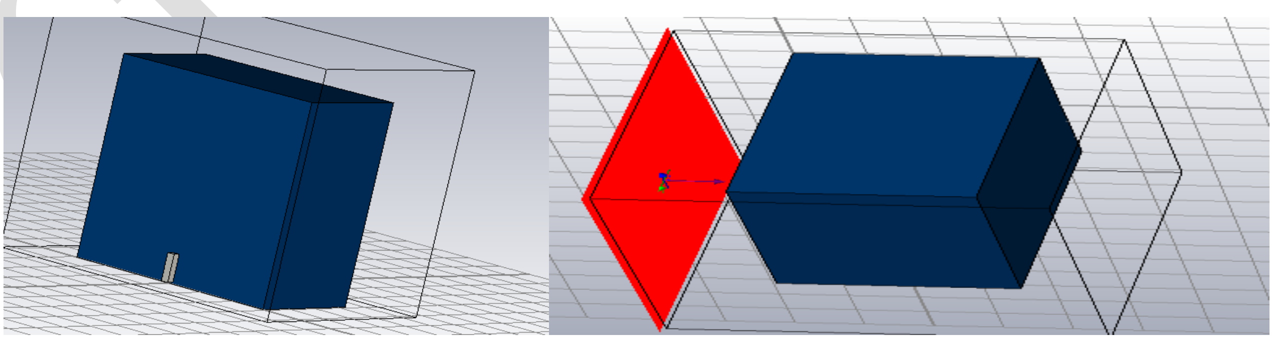


Fig.16 Design of DRA with air gap 10 nm.

However, figure (19) showed Max Value of probe by using Gold and PEC materials together.

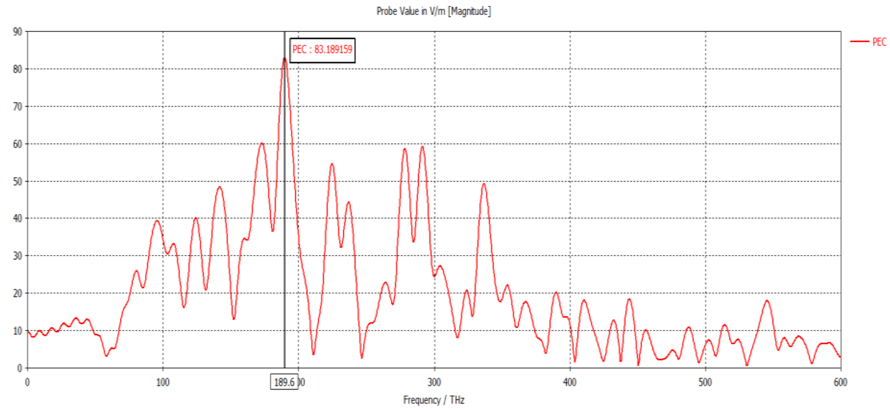


Fig.17 Max porobe using Gold material.

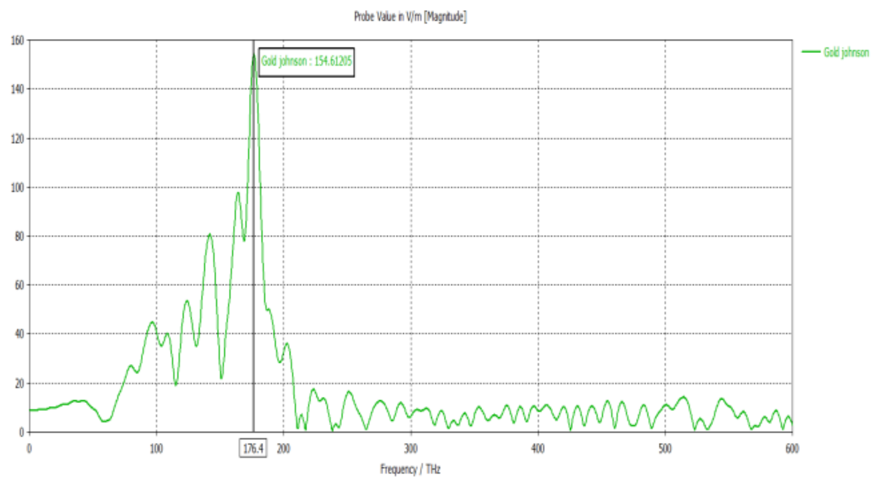


Fig.18 Max of probe using PEC material.

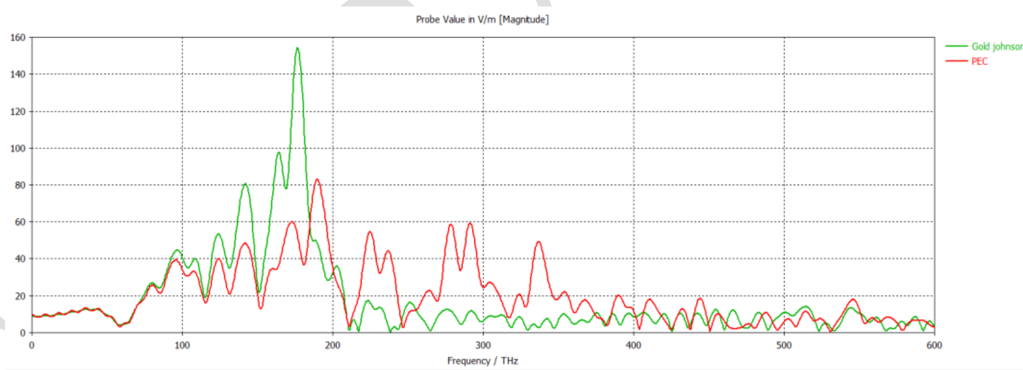


Fig.19 Max Value of probe by using Gold and PEC materials together.

That means, there is relationship between field and distance, as well as there is another relationship between the size of strip and field. So that, it could be directly proportional between them. Figure (20) showed some changes in design of DRA.

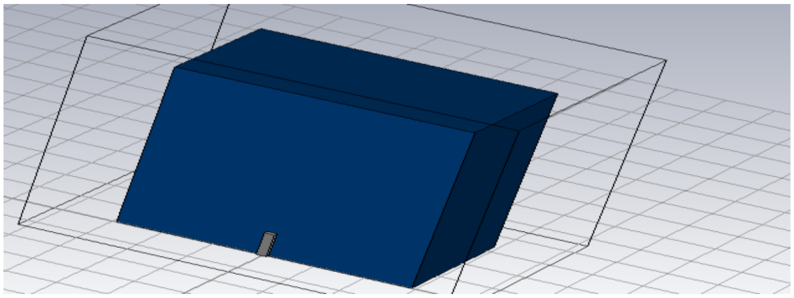


Fig.20 Design of DRA with decreasing in depth of strip to 20 nm.

However, some material is perfect conductor better than the other materials. Therefore, the results will be the best. For example, gold material is better than PEC in connection or as perfect conductor. However, figure (23) showed Max Value of probe by using PEC material. The value was 191.703 v/m. The first value of probe explained in figure (22), by using PEC. For example, the value of probe was 193.232 as showed in figure (21) by using gold material. However, the value of probe was 191.703 which was not big value as compared to the first value.

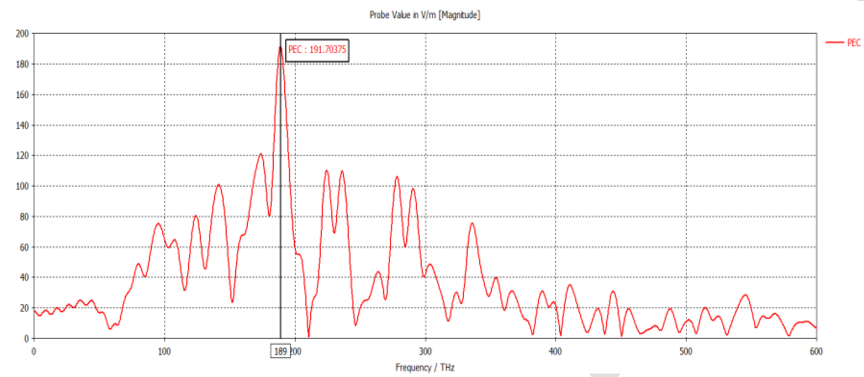


Fig.21 Max probe using gold material.

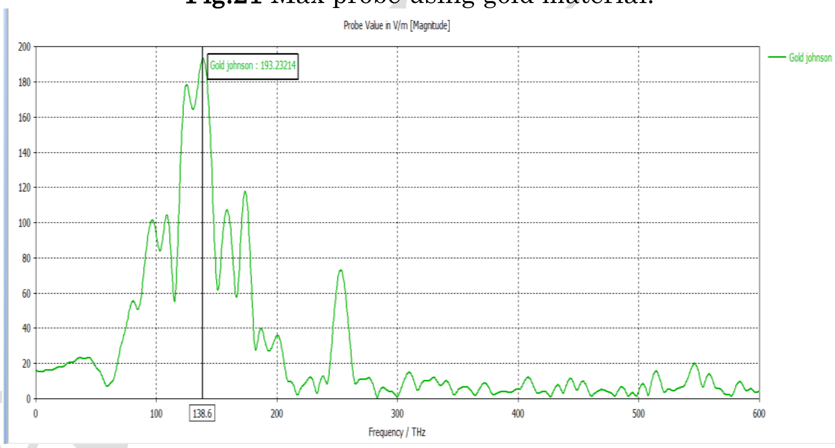


Fig.22 Max Value of probe using PEC material.

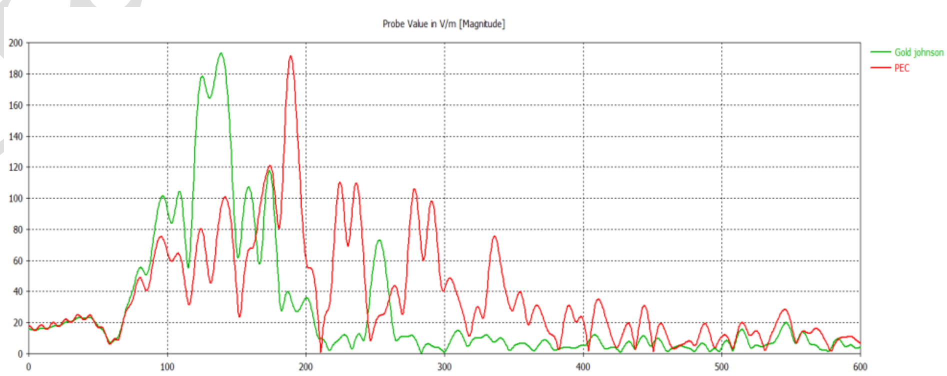


Fig.23 Max Value of probe by using Gold and PEC materials together.

However, this value increased to 10 nm, the results were good. Therefore, all of these changes used electric boundary gp. If we keep this increasing of depth of strip to 80 nm instead of 40 nm as showed in figure (24).

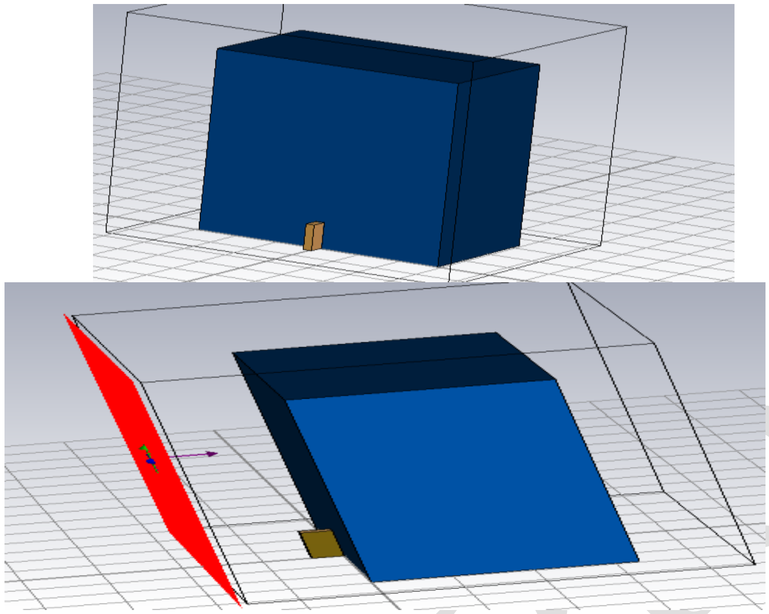


Fig.24 Design of DRA with increasing depth to 80 nm.

For example, figure (25) showed a clear increasing of probe value to 214.304 v / m by using gold material., whereas this value reduced to 153.970 v / m as showed in figure (26) in state of PEC.

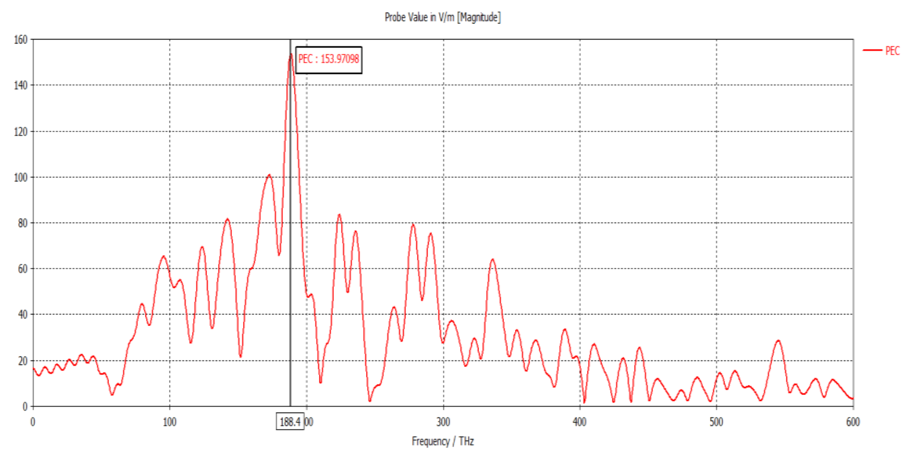


Fig.25 Max probe by using gold material.

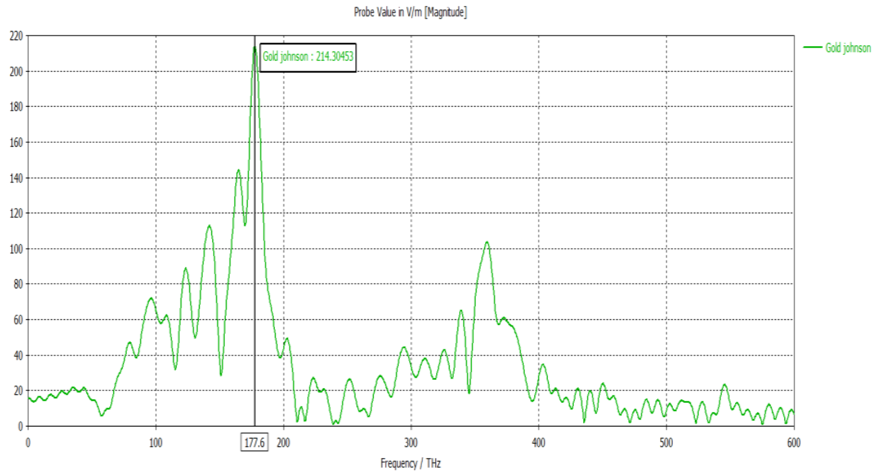


Fig.26 Max Value of probe by using PEC material.

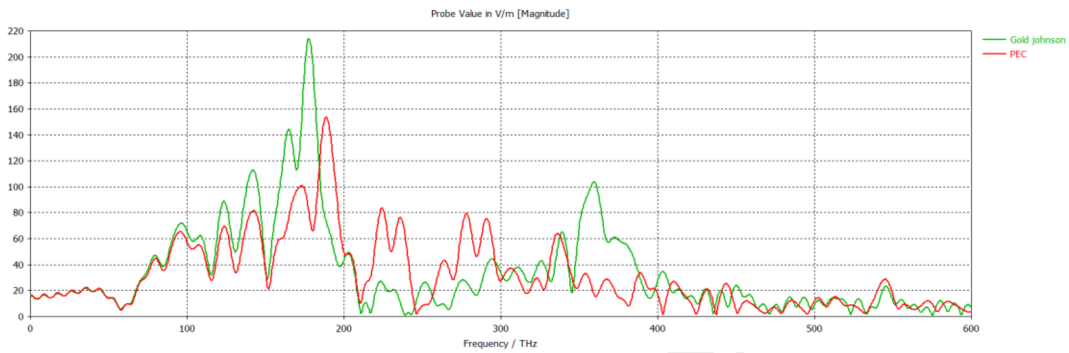


Fig.27 Max Value of probe using Gold and PEC materials together.

Using physical gp to get results of probe

Results of field values using physical gp

when, we used gp of value4000 the highest results had got while the length of strip decreasing to 160 nm as showed below. For example, table (4) explained some values of DRA with using physical gp.

Table 4: Design of DRA with these dimensions by using physical gp

Dimension	**Size (nm)**
DRA height	1200.6
DRA width	1168.4/2
DRA depth	657.8
Ground plane	Electric boundary
Relative permittivity	Ɛr = 9.8
Strip length	160
Strip width	5
Gp	4000

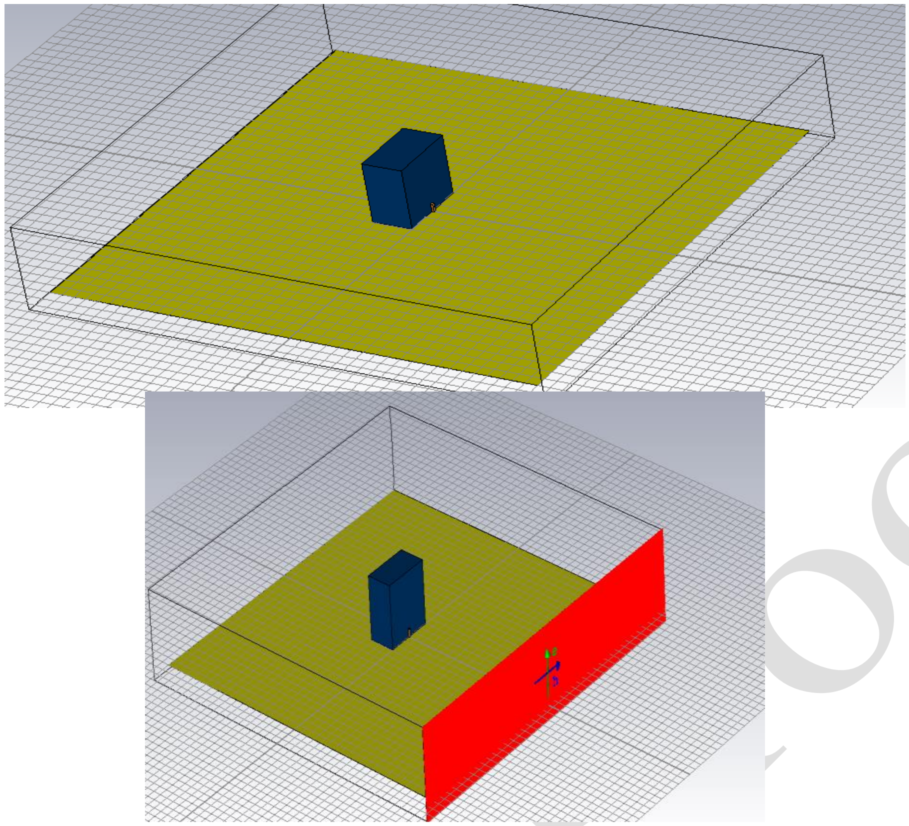


Fig.28 Using physical gp to design DRA with dimensions above.

We got the result of probe value 114.376 V /m by using physical gp with gold material as showed in figure (29), while the results decreased in case of using gp as copper material. Because, gold material is better than copper as conductor material.

Therefore, we used gp with Gold material firstly. The aim was to compare this result with the results that we got before. For example, the material of strip will be gold (Johnson) and we changed the material of gp from gold to copper as showed in figure (28). As showed in new design in figure (30)., we had another value less than the highest, but it considered the second result in case of order when we changed the depth of strip to 80 nm instead of 40nm.

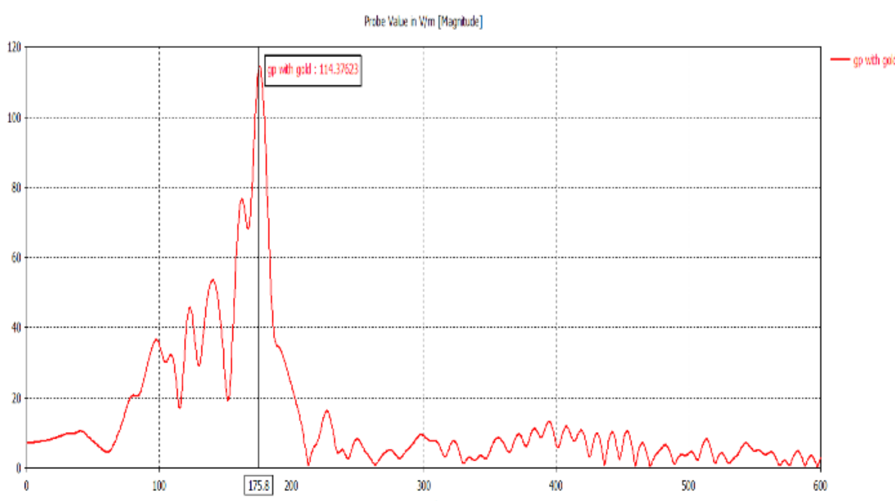


Fig.30 Design DRA with depth of strip 80nm.

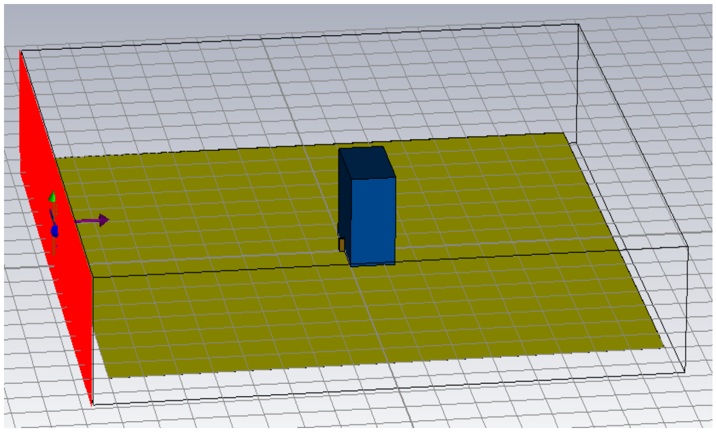


Fig.29 Max Value of probe by using gp as gold material.

Therefore, we would like to focus on the highest value we got when the length of strip decreased to 160 nm. Figure (31) showed the results were 91.43 v/m which were lower than the highest results as showed in figure (29).

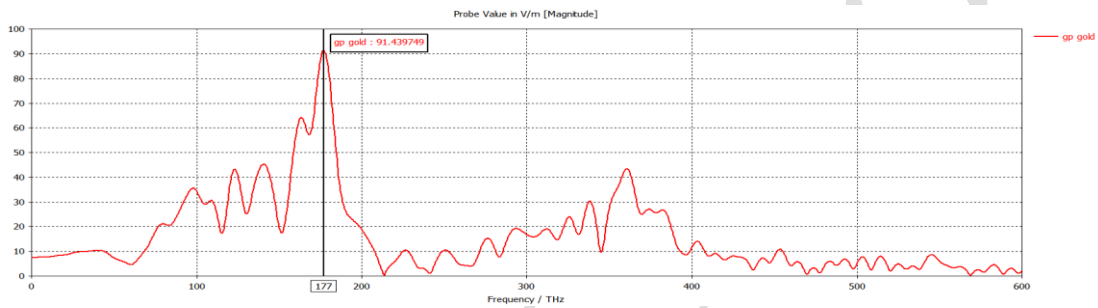


Fig.31 Max Value of probe by using gp as gold material. The value was 91.43v/m.

Examples and results we got by using photonic crystal

Therefore, the results have deduced to become (114.736v/m) with the same dimensions of DRA as showed in table (4) Then we used different structure by removing physical ground plane. This method is called photonic crystal by using different layers with different thickness and permittivity. Therefore, the Design of using two-layer photonic crystal showed in the figure (32).

As showed in examples before, we used two kinds of ground plane. The first kind related to boundary ground plane with high results we got. For example, the highest result was (273.493v/m) when the length of strip reduced to 160 nm., while the second kind of ground plane was physical gp. Therefore, table (4) showed dimensions of DRA with increasing dimensions of layers to become twice dimensions of DRA.

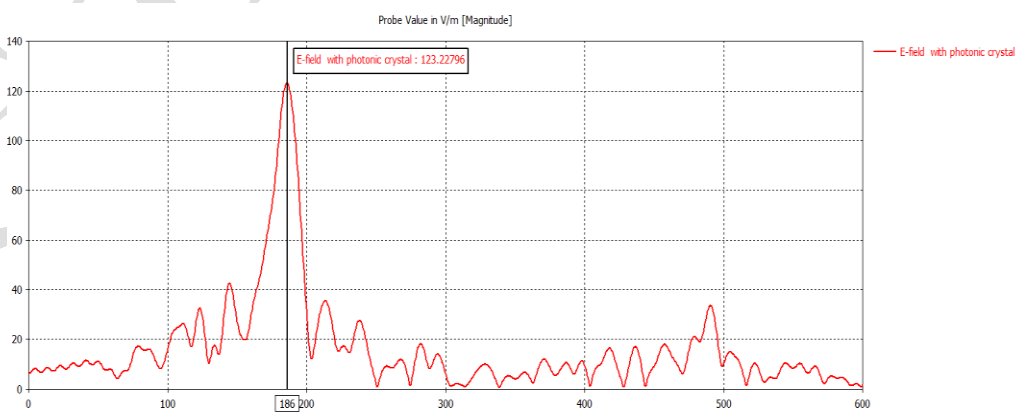


Fig.32 Design DRA using two layer of photonic crystal.

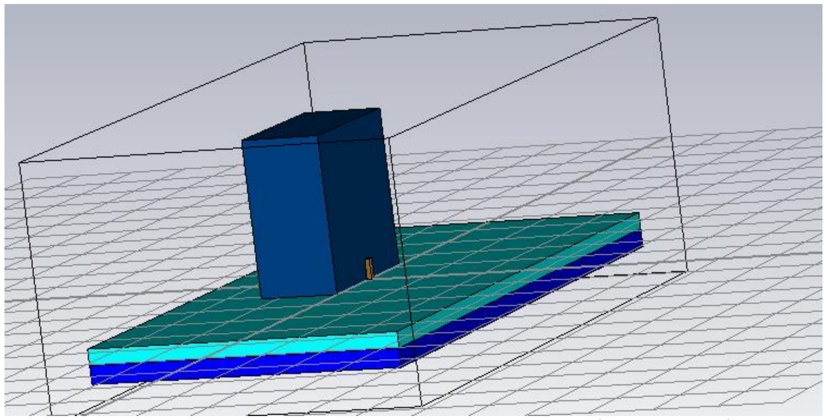


Fig.33 Max value of field using two layer (123.22v/m).

However, when the layers became four layer as explained in figure (34). That means, reflection of radiation was better than reflection in case of using physical gp. Also, the thickness of layer2 equalled to T2=142.25 with permittivity of layer two = 8. 994001. Moreover, the value of field increased to become (123.22v/m) as showed in figure (33) with using thickness equalled to T1=121.85 and permittivity for layer1=12. 257001.

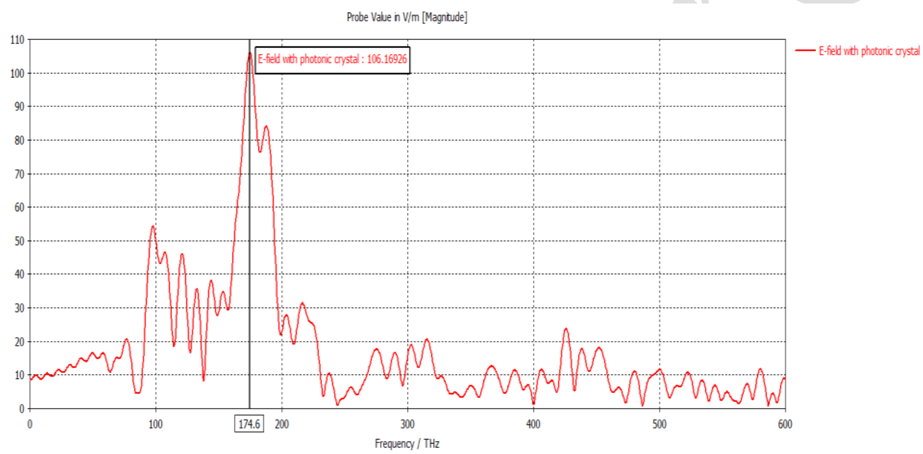


Fig.34 Design DRA using four layer of photonic.

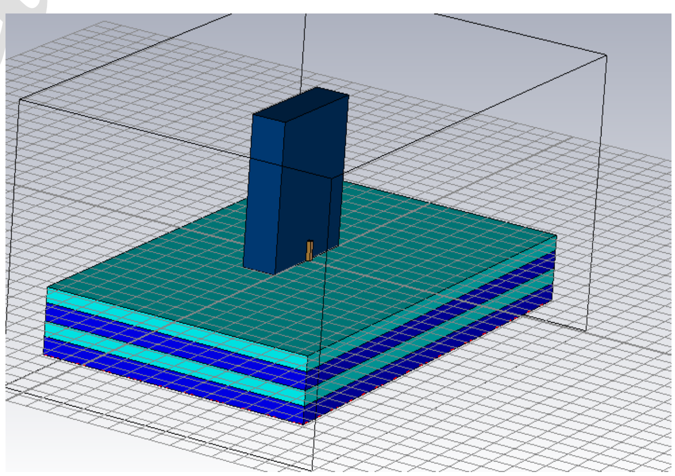


Fig.35 Max value of field by using four layer(106.16v/m).

Therefore, sometimes we need to change some parameters of strip to enhance the results. The result slightly reduced to become(106.16v/m.), but with good reflection as showed in figure (35). So that, result could be improved to become (115.65v/m) as showed in figure (37). Then, we increased the number of layers to become eleven layer as showed in figure (36).

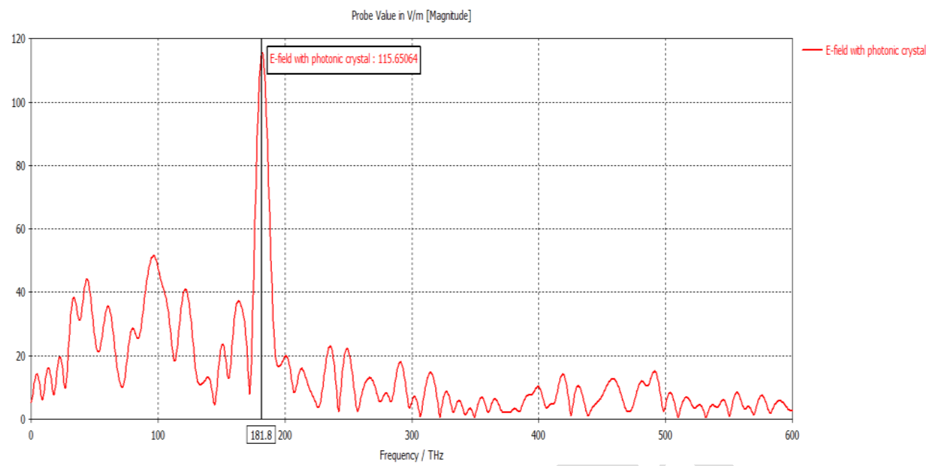


Fig.36 Design DRA using eleven layer of photonic.

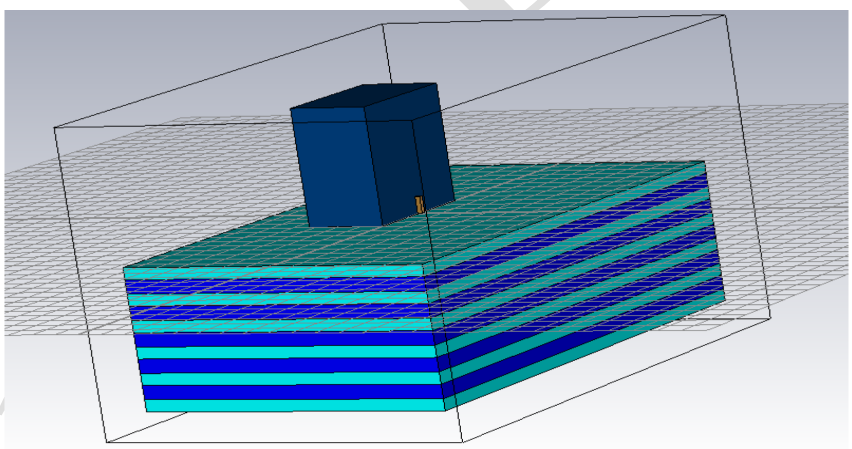


Fig.37 Max value of field by using eleven layers.

Conclusion

So that, it could be useful to improve gain, as well as radiation. Inside dielectric, emissions have controlled by photonic material [7]. These emissions could be waves of electromagnetic fields. Also, examples before explained or showed gain, radiation toward up ward direction, as well as S parameters. The value of probe was high by using gold material, whereas this value decreased by using strip as PEC material. That means, gold was perfect conductor better than PEC material. Then, we noticed the results reduced by using physical gp, because losses due to ohmic losses. That means, radiation absorption by physical gp not perfect radiated in upward direction. Therefore, it has dielectric constant as Ɛ μ with different dimensions.

As showed in previous pages, we noticed that characteristics or properties of antenna were very important to enhance the results. For example, size, B.W was important for this purpose. Moreover, some studies, suggested some solution to enhance some results, such as by coupling antenna with other antenna to improve the properties, as well as enhance radiation mode. However, some experiments focused on some properties, such as radiation, B.W, while the other researchers tested some kinds of antenna by mixing different kinds of antenna with suitable parameters. Therefore, examples before showed using physical gp and boundary (electric gp). Therefore, physical gp considered practical and in reality used, while boundary gp just has used for experiments as theoretical evaluation not exactly in reality used. However, we improved that by using photonic crystal instead of physical gp.This helped us to get perfect radiation without any absorption by gp. Photonic crystal is considered as dielectric constant.

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