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A Performance Analysis of Solar Cell - Microstrip antenna with different materials

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Abstract-This paper describes latest achievement in solar cell and Antenna. More improvement in efficiency due to integrate solar cell with microchip antenna is known as SOLANT.First a solar cell, solar cell with simple tuning circuit and solar cell with microstrip antenna are simulated by using Electronic work bench.The voltage, current, power results are the proof for integration of solar cell with microstrip antenna. In other way a Solar cell antenna was simulated in ADS with the range of 1.5 GHz to 5.5. GHz band width. The simulation done by using copper, Mesh, AgHT-4(AgHT line of transparent, highly conductive coated films) and AgHT-8 for compression. The reflection co-efficient, Gain, Power output and Beam width are simulated and plotted in 2D and 3D. The AgHT-4 antenna give better results than others, because AgHT-4 is more transparent conducting film. So that the AgHT-4 antenna is a basic plate form for designing solar cell antenna ie SOLANT. The SOLANT is used for mobile communication , vehicular application,Bluetooth, wireless environmental monitoring and other applications. The solar cell and antenna function with costs reduction. The resonance frequency of the SOLANT depends on the patch size. Therefore SOLPLANT used trans receive RF signal and also generate the direct current.

Keywords- Microstrip antenna, solar cell, simulation, mobile communication, vehicular application , SOLANT.

I. INTRODUCTION

The Solar cell convert light energy in to electrical energy. Several solar cell available in the market .Latest achievement in solar cell is Panasonic solar cell power warning lights. Voltage, Current, .Power and Presentation of efficiency given by 3.4 V, 14.5 mA, 49.3 mw/Cm2 and 49.3%. More improvement in efficiency due to integrate solar cell and microstrip antenna[1].We take microstrip antenna a basic tool also called patch antenna to design the SOLANT [2]. The radiating elements and the feed lines are usually photo etched on the dielectric substrate. That Solar cell integrate with microstrip antenna is known as SOLANT. First a solar cell, solar cell with simple tuning circuit and solar cell with microstrip antenna are simulated by using Electronic work bench.The voltage, current, power results are the proof for integration of solar cell with microstrip antenna. We analysis of copper, meshed,AgHT-4 (AgHT line of transparent, highly conductive coated films) and AgHT-8 patch antenna to find out efficient SOLANT. The antenna parameter like reflection co-efficient, Gain, Power, Beam width are simulated and plotted. Now we conclude AgHT-4 antenna give better performance than copper patch, meshed patch antenna and AgHT-8, because AgHT-4 is more transparent conducting film than others. So that the AgHT-4 antenna is a basic plate form for designing solar cell antenna ie SOLANT.

The simulation made by ADS simulation software in 2D ,3D view. The SOLANT is used for mobile, vehicular, Bluetooth, wireless environmental monitoring, online building observations and extraterrestrial field of application like satellites. Therefore SOLANT used trans receive RF signal and also generate the direct current.

II.INTEGRATION OF SOLAR CELL WITH MICROSTRIP ANTENNA

A. Solar Cell Equvelent circuit Desigine and testing

PV cell can be modeled as a current source in parallel with diode .When there is no light present to generate any current,the PV cell behaves like a diode.As the intensity of incident light increases,current is generated by the PV cell.In an ideal cell,the total current I is equal to the current I_l generated by the photoelectric effect minus the diode current I_D,according to the equation.

$$I=I_l-I_D=I_l-I_0(e^{qv/KT}-1) \quad (1)$$

Where I_0 is the saturation current of the diode,q is the the elementary charge $1.6x10^{-19}$ Coulombs,k is a contant of value $1.38x10^{-23\ J/K}$ T is the cell temperature in Kelvin,and V is the measured cell voltage.Expanding the equation gives the simplified circuit model.Where n is the diode ideality factor,and R_S and R_{SH} represents the series and shunt resistances .

$$I=I_l-I_D=I_l-I_0(e^{q(v+I.Rs)/n.K.T}-1)-V+I.R_S/R_{SH} \quad (2)$$

The short circuit current $I_{SC,}$

$$I(at\ v=0)=I_{SC} \quad (3)$$

$$I_{SC}=I_{MAX}=I_l \text{ ---------- } (4)$$

The open circuit voltage V_{OC}

$$V(\text{at } I=0)=V_{OC} \text{ ----------}(5)$$

$$V_{OC}=V_{MAX} \text{ ---------- } (6)$$

Power (P)

$$P=VI \text{ ----------}(7)$$

Efficiency(η)

$$\eta = P_{out}/P_{in} \text{ ----------}(8)$$

$$\eta_{MAX} = P_{MAX}/P_{in} \text{ ---------- } (9)$$

Pin is taken as the product of the irradiance of the incident light, measured in W/m^2(or)1000 W/m^2

The Solar cell equivalent circuit is drawn in electronic work bench simulated and tested. We vary the shunt resistance (Rsh) , series (Rs) values to got different current(I), voltage(V), Power(P) values.

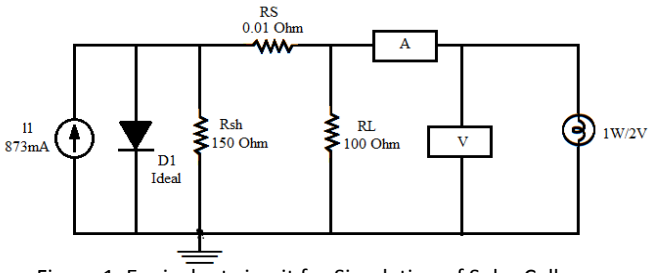


Figure 1. Equivalent circuit for Simulation of Solar Cell.

Using electronic work bench, the solar cell characteristics are simulated and one set of values in current, voltage and power 872.8mA, 8.706mV and 7.5985968 mW are plotted in fig 2.Maximum power for an V-I Sweep, The power produced by the cell in Watts can be easily calculated along the V-I sweep by the equation P=IV.I_{SC} and V_{OC} points, the power will be zero and the maximum value for Power will occur between two.

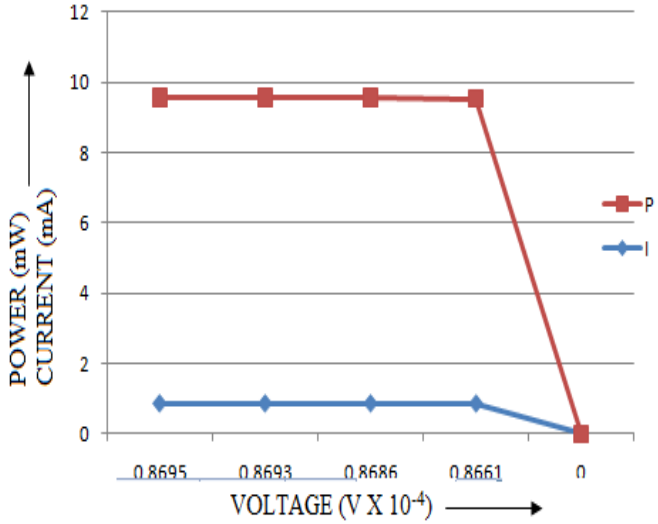


Figure 2. VI Sweep of solar cell.

Form I-V Sweep solar property satisfies. I_{SC} and V_{OC} points, the power will be zero and the maximum value for Power will occur between two.

B. Integration of solar cell with Simple antenna tuning circuit

Simple tuning circuit link with Generator example for trans receive is integrated with solar cell to give SOLANT.

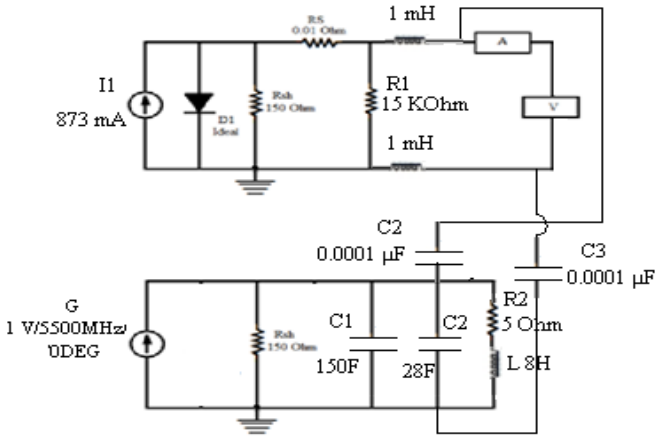


Figure 3 Simulation of Solar Cell integration with Simple antenna tuning circuit using Electronics Work bench

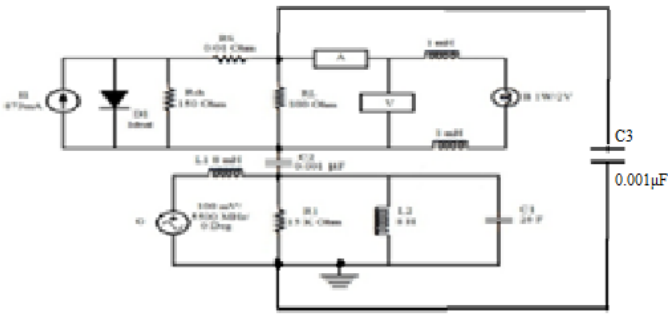
The Solar cell integration with Simple antenna tuning circuit is designed and tested in electronics work bench. The resultant

current, voltage and power values are 876.7mA, 8.766mv and 7.6851522 mW respectively.

C. Integration of Solar Cell with Microstrip Antenna

Microstrip Antenna equvelent circuit linked with solar cell to give the SOLANT. The simulation done by using electronic work bench.

Figure 4 Simulation of Solar Cell Integration with microstrip Antenna using Electronics Work bench



The Solar cell Integration with microstrip Antenna[3][4] is design in Electronics work Bench.The current ,voltage and power value given 3.723A, 36.28 mVand P=135.07044mW

III.SOLAR CELL INTEGRATION WITH MICROSTRIP ANTENNA FOR DIFFERENT MATERIALS

$$\epsilon_{\text{reff}} = \frac{\epsilon r+1}{2} + \frac{\epsilon r-1}{2} + [1 + 12h/w] \text{ ---------- } (10)$$

The common equation used to design the patch antenna dielectric layer called Perspex. Patch width height values dispense up on the above equation.

A. SOLANT *Design With Copper Patch*

The ADS Simulation results of the SOLANT design with Copper Patch .After simulation the patch can like a grid mesh formed over the copper patch.

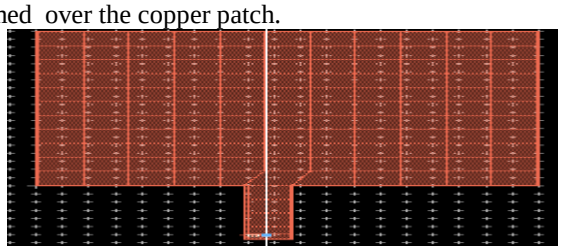


Figure 5 copper patch ADS Layout(lp=19mm,wtx=19 mm)

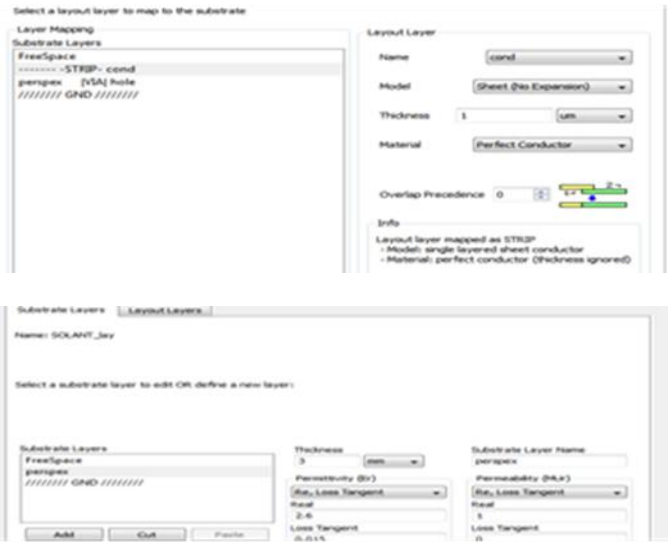


Figure 6 SOLANT with copper patch Subtracte layers (Perspex substrate of thickness=3mm, ε_r=2.6,tanδ=0.015,Frequency Band=1.5GHz-5.5 GHz, Sample point=40,port impedance=50Ω) and Layout layers.[5-7]

Copper patch Subtract layers and Layout layers are design by putting the values in the above windows.

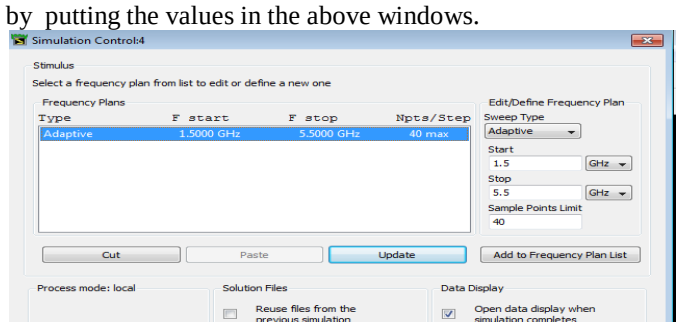


Figure 7 The ADS simulation select frequency plan for copper Patch

The simulation select frequency ,sampling points put in the above window. We have to get the Reflection co-efficient graph.

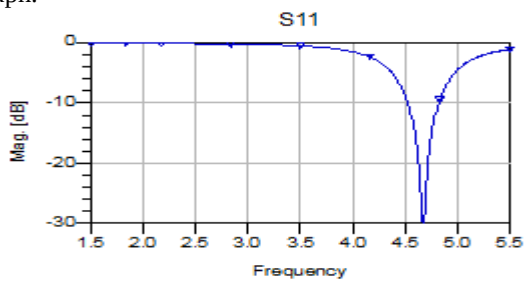


Figure 8 Reflection co-efficient of Solant with copper patch in ADS(S11)

From the Reflection co-efficient graph the copper patch radiate at 4.7 GHz Because the return loss -30 dB is very low.

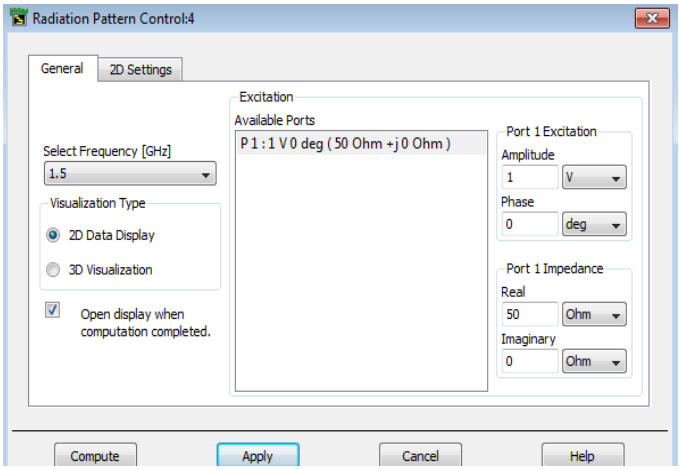


Figure 9 Radiation pattern control for copper patch with 2 D View

From the pattern control window we put a port impedance to get 2 D graph.

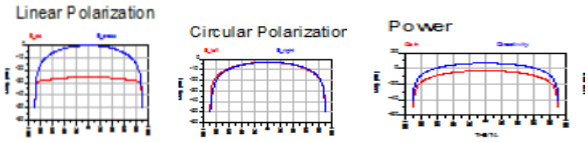


Figure 10 Radiation Pastern of SOLANT with copper patch in ADS 2 D View

From the Radiation Pastern we have to find the Beam width vales

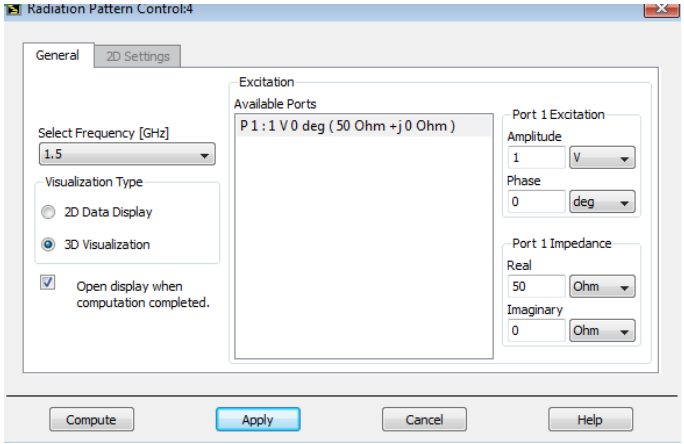


Figure 11 Radiation pattern control for copper patch with 3 D View

From the pattern control window we put a port impedance to get 3 D view and the 3 D graph.

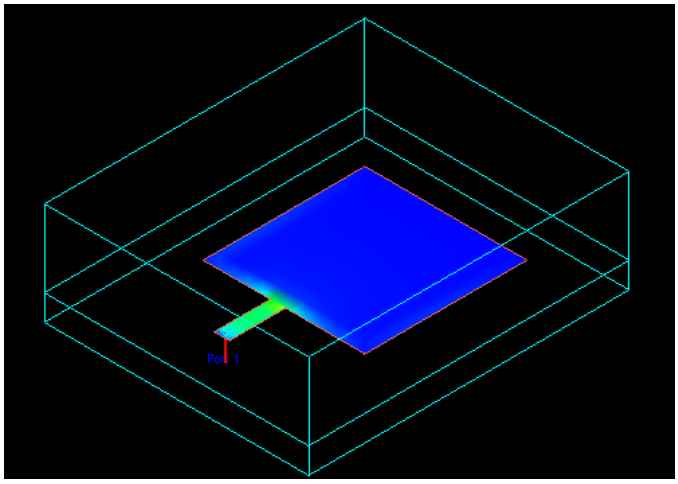


Figure 12 Solant with copper patch in ADS 3 D View

The 3D layout can be shown from the above .The layer arrangement are clearly given.

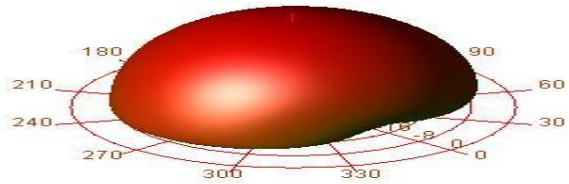


Figure 13 Radiation Pattern of Solant with copper patch in ADS 3 D View

From 3 D Radiation Pattern, we have to get the Antenna parameters that can be shown from the following diagram.

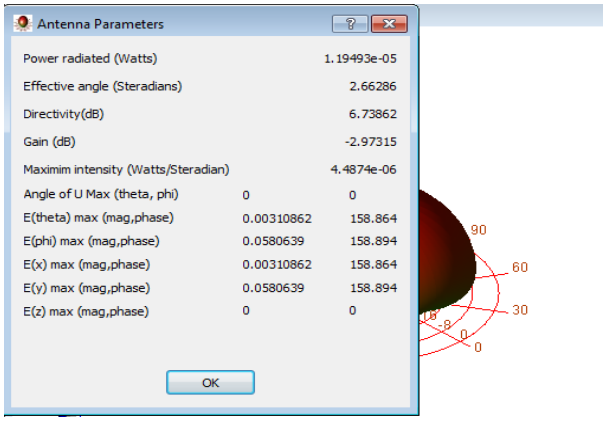


Figure 14 Radiation Pattern of Solant with copper patch Antenna parameters

To study the above parameter, we have to compare other results using different materials like Mesh,AgHT-

4 and AgHT-8.

B. SOLANT Design with Mesh Patch

The ADS Simulation results of SOLANT Design With Meshed Patch [11-13]. This technology consists of changing the microstrip patch antenna from a solid sheet of metal to a wire mesh. The ADS Simulation results of the SOLANT design with Meshed Patch.After simulation the Meshed patch can like a double grid mesh.

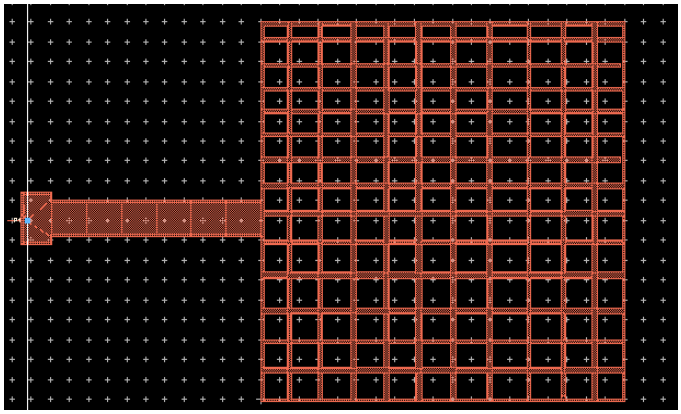


Figure 15 Solant Mesh patch ADS Layout(lp=19mm,wtx=19 mm) [8-10]

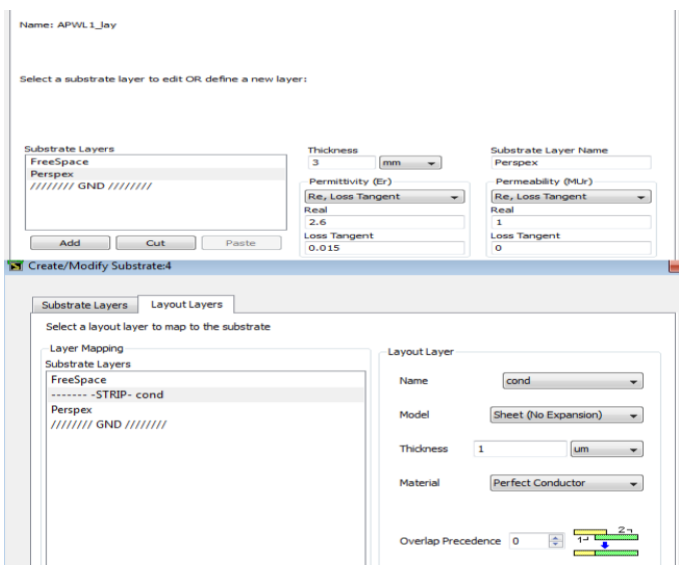


Figure 16 Solant with Mesh patch Subtracte layers (Perspex substrate of thickness=3mm, εr=2.6,tanδ=0.015,Frequency Band=1.5GHz-5.5 GHz,Sample point=40,port impedance=50Ω) and Layout layers. [5-7]

Mesh patch Subtract layers and Layout layers are design by putting the values in the above windows

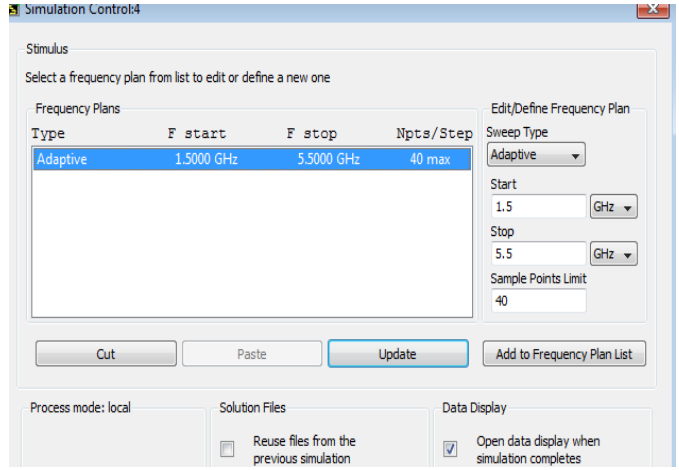


Figure17 The ADS simulation select frequency plan for mesh Patch

The simulation select frequency ,sampling points put in the above window. We have to get the Reflection co-efficient graph.

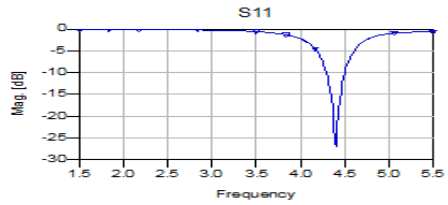


Figure 18 Reflection co-efficient of Solant with Mesh patch in ADS(S11)

From the Reflection co-efficient graph the Mesh patch radiate at 4.4 GHz Because the return loss -27 dB is very low

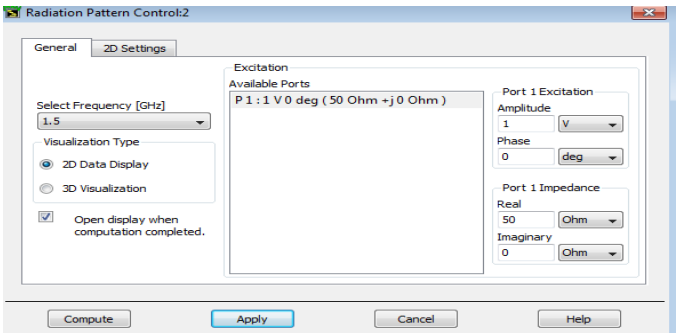


Figure 19 Radiation pattern control for Mesh patch with 2 D view

From the pattern control window we put a port impedance to get 2 D graph.

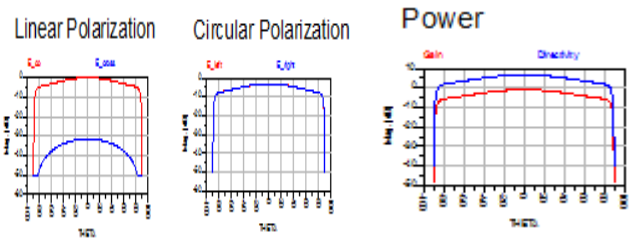


Figure 20 Radiation Pastern of Solant with Mesh patch in ADS 2 D View

From the Radiation Pastern we have to find the Beam width vales

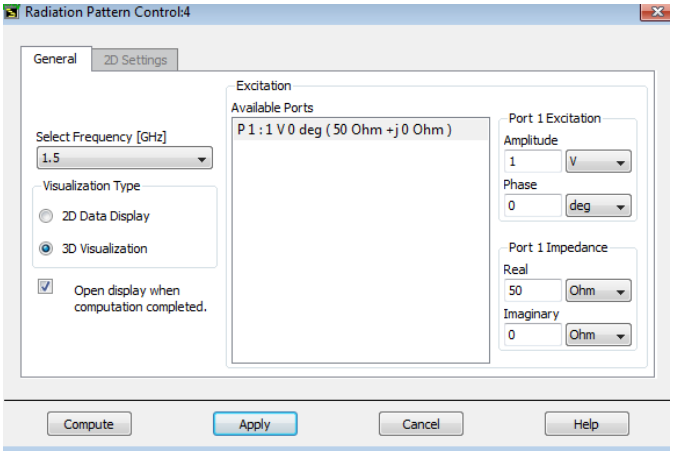


Figure 21 Radiation pattern control for Mesh patch with 3 D View

From the pattern control window we put a port impedance to get 3 D view and the 3 D graph.

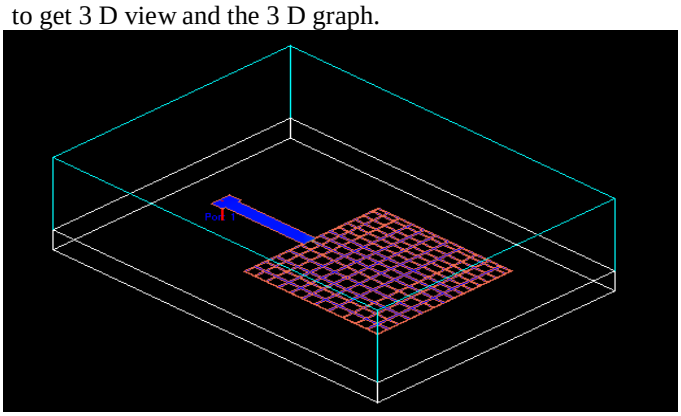


Figure 22 Solant with Mesh patch in ADS 3 D View

The 3D layout can be shown from the above .The layer arrangement are clearly given.

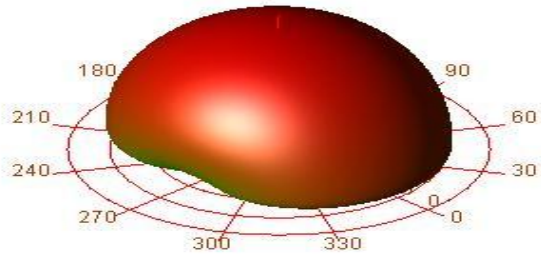


Figure 23 Radiation Pattern of Solant with Mesh patch in ADS 3 D View

From 3 D Radiation Pattern ,we have to get the Antenna parameters that can be shown from the following diagram.

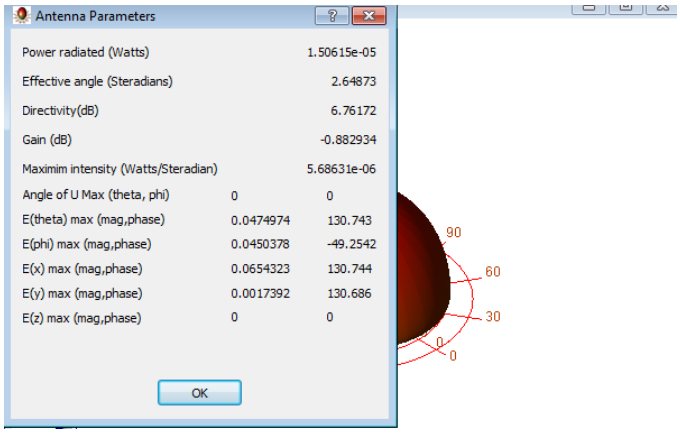


Figure 24 Radiation Pattern of Solant with copper patch Antenna parameters

To study the above parameter, we have to compare other results using different materials like copper,AgHT-4 and AgHT-8.

C.SOLANT Design With AgHT-4 Patch

The AgHT-4 optically transparent conductive film used for the transparent radiator. The ADS Simulation results of the SOLANT design with AgHT-4 Patch .After simulation the patch can like a grid mesh formed over the AgHT-4 patch.

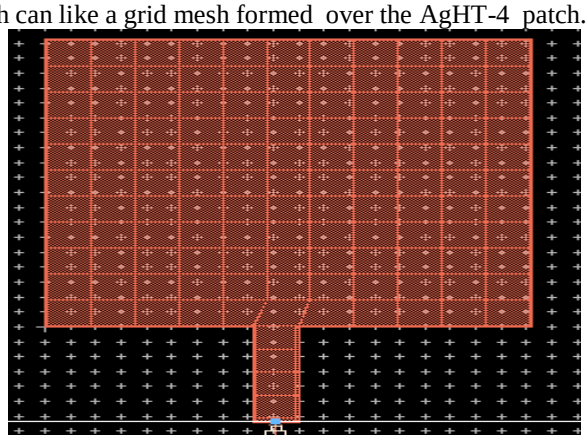


Figure 25 Solant with AgHT-4 patch ADS Layout(lp=19mm,wtx=19 mm)[14-17]

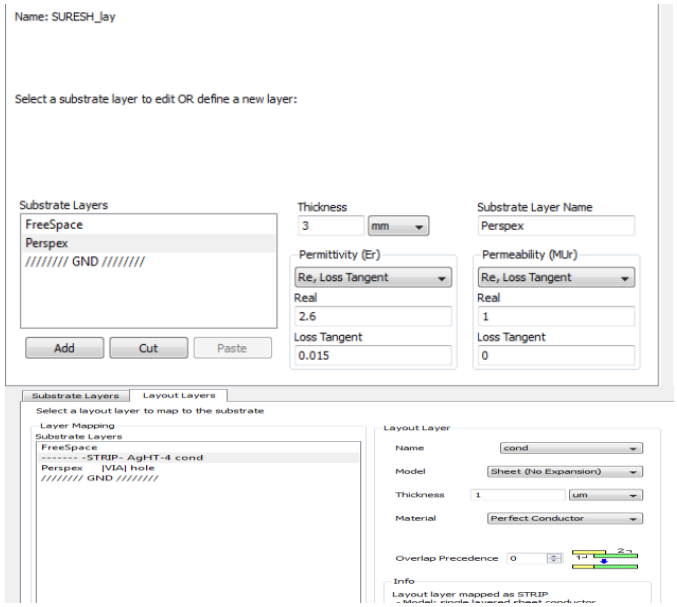


Figure 26 Solant with Aght-4 patch Subtracte layers (Perspex substrate of thickness=3mm, εr=2.6,tanδ=0.015,Frequency Band=1.5GHz-5.5 GHz,Sample point=40,port impedance=50Ω) and Layout layers.[5-7]

AgHT-4 patch Subtract layers and Layout layers are design by putting the values in the above windows.

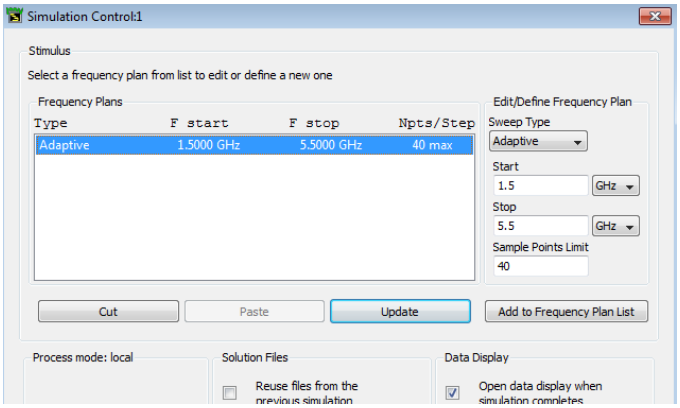


Figure 27 The ADS simulation select frequency plan for AgHT-4 Patch

The simulation select frequency ,sampling points put in the above window. We have to get the Reflection co-efficient graph.

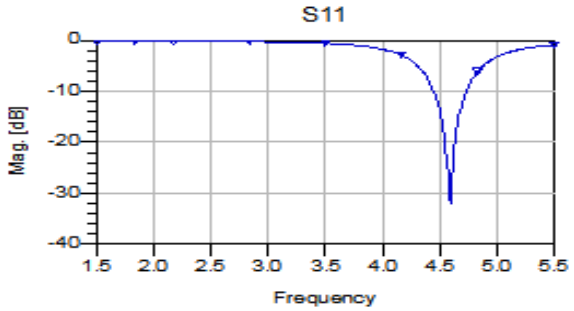


Figure 28 Reflection co-efficient of Solant with AgHT-4- patch in ADS(S11)

From the Reflection co-efficient graph the copper patch radiate at 4.6 GHz Because the return loss -32 dB is very low

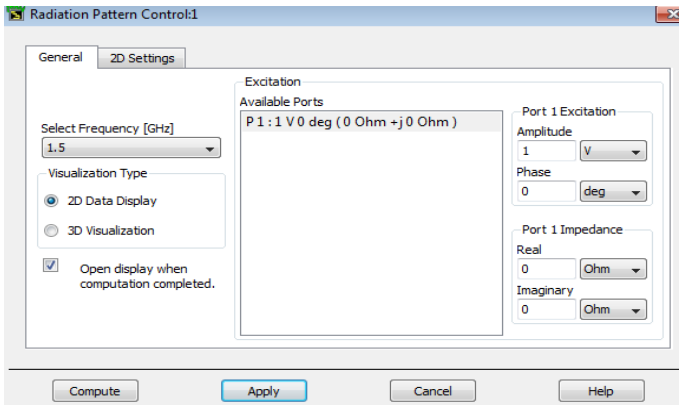


Figure 29 Radiation pattern control for AgHT-4 patch with 2 D View

From the pattern control window we put a port impedance to get 2 D graph.

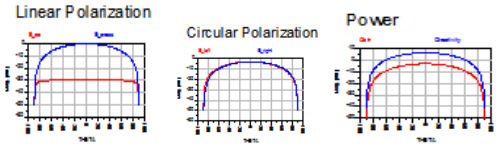


Figure 30 Radiation Pastern of Solant with AgHT-4 patch in ADS 2 D View

From the Radiation Pastern we have to find the Beam width vales

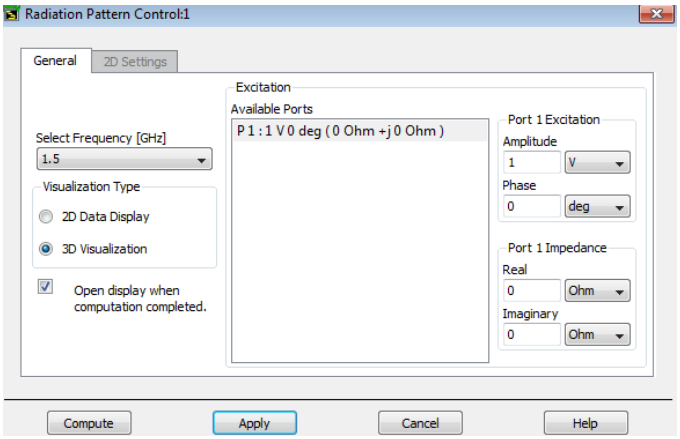


Figure 31 Radiation pattern control for AgHT-4 patch with 3 D View

From the pattern control window we put a port impedance to get 3 D view and the 3 D graph.

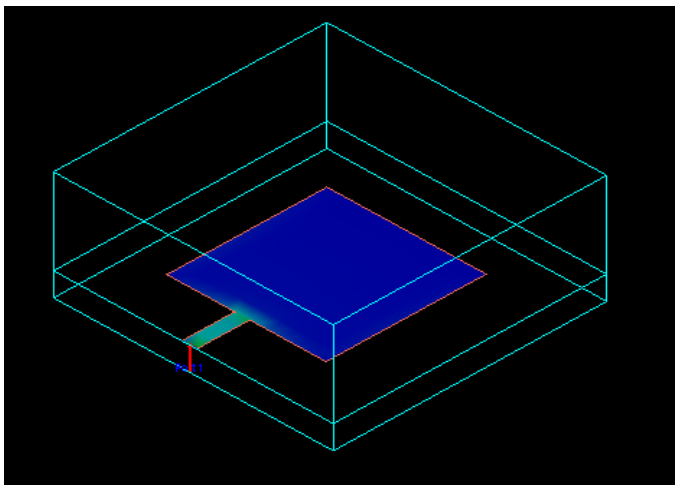


Figure 32Solant with AgHT-4 patch in ADS 3 D View

The 3D layout can be shown from the above .The layer arrangement are clearly given.

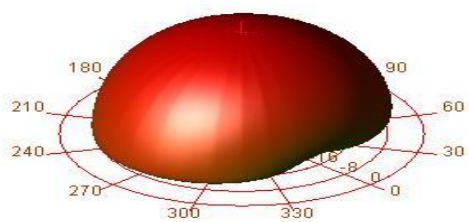


Figure 33 Radiation Pattern of Solant with AgHT-4 patch in ADS 3 D view

From 3 D Radiation Pattern ,we have to get the Antenna parameters that can be shown from the following diagram.

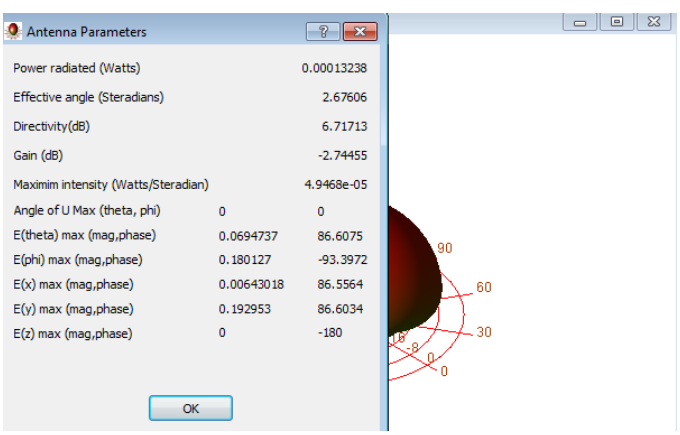


Figure 34 Radiation Pattern of Solant with AgHT-4 patch Antenna parameters

To study the above parameter, we have to compare other results using different materials like Copper,Mesh, and AgHT- 8.

D.SOLANT Design With AgHT-8 Patch

The ADS Simulation results of the SOLANT design with AgHT-8 Patch .After simulation the patch can like a grid mesh formed over the AgHT-8 patch.

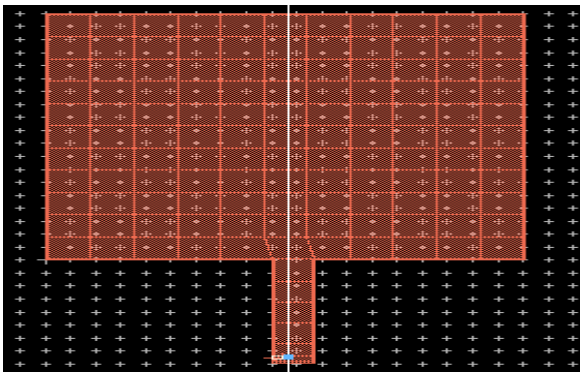


Figure 35 SOLANT with AgHT-8 patch ADS Layout(lp=19mm,wtx=19 mm)

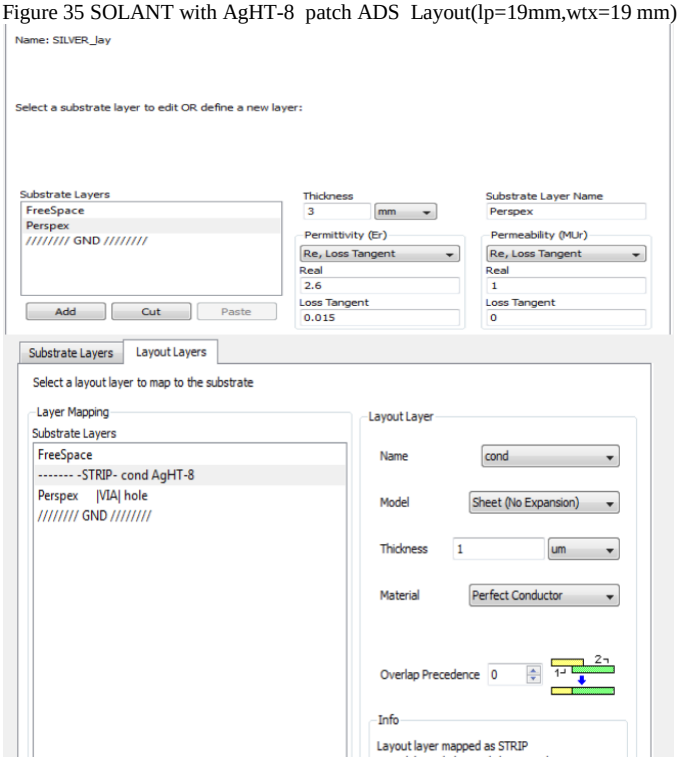


Figure 36 Solant with AgHT-8 patch Subtracte layers (Perspex substrate of thickness=3mm, εr=2.6,tanδ=0.015,Frequency Band=1.5GHz-5.5 GHz,Sample point=40,port impedance=50Ω) and Layout layers.[5-7]

AgHT-8 patch Subtract layers and Layout layers are design by putting the values in the above windows.

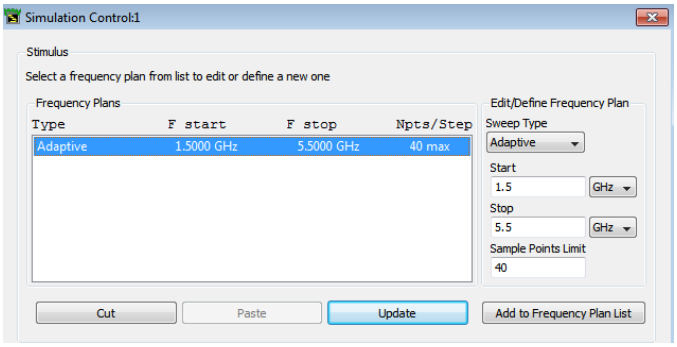


Figure 37 The ADS simulation select frequency plan for AgHT-8 Patch

The simulation select frequency ,sampling points put in the above window. We have to get the Reflection co-efficient graph.

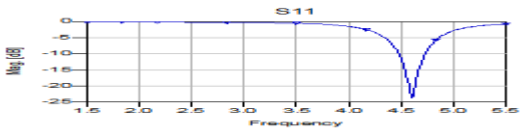


Figure 38 Reflection co-efficient of Solant with AgHT-8- patch in ADS(S11)

From the Reflection co-efficient graph the copper patch radiate at 4.6 GHz Because the return loss -24 dB is very low.

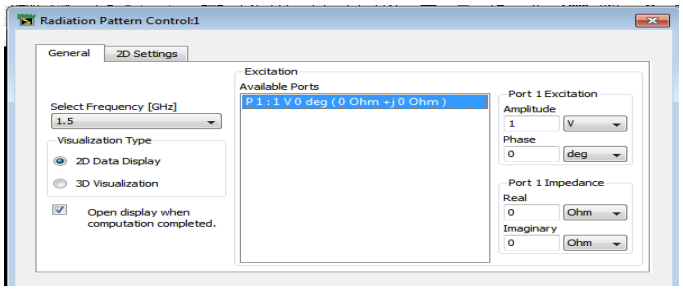


Figure 39 Radiation pattern control for AgHT-8 patch with 2 D View

From the pattern control window we put a port impedance to get 2 D graph.

Figure 40 Radiation Pastern of Solant with AgHT-8 patch in ADS 2 D View

From the Radiation Pastern we have to find the Beam width vales

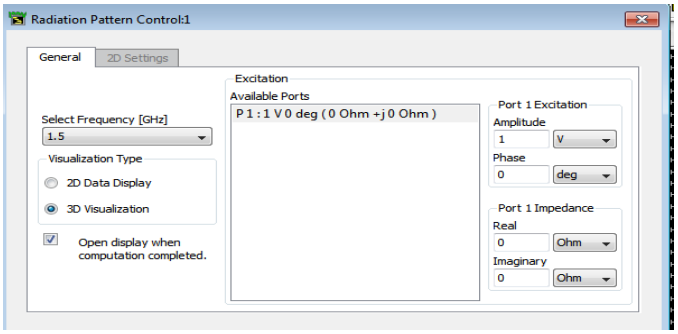


Figure 41 Radiation pattern control for AgHT-8 patch with 3 D View

From the pattern control window we put a port impedance to get 3 D view and the 3 D graph.

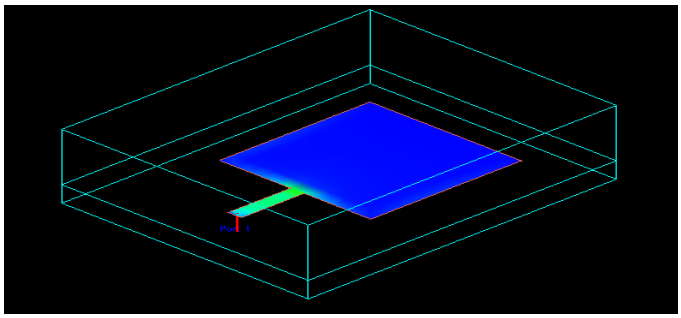


Figure 42 Solant with AgHT-8 patch in ADS 3 D View

The 3D layout can be shown from the above .The layer arrangement are clearly given.

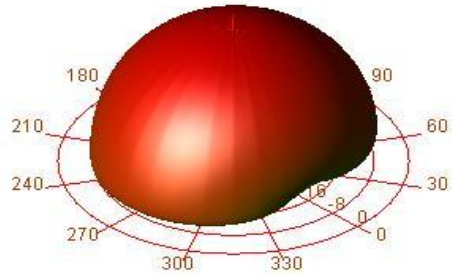


Figure 43 Radiation Pattern of Solant with AgHT-8 patch in ADS 3 D View

From 3 D Radiation Pattern ,we have to get the Antenna parameters that can be shown from the following diagram.

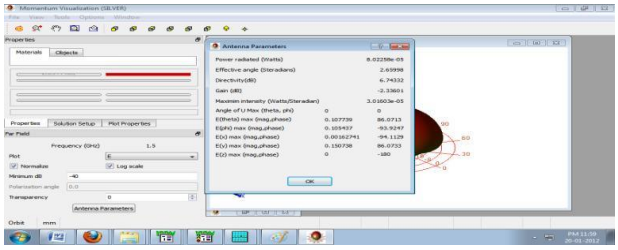


Figure 44 Radiation Pattern of Solant with AgHT-8 patch Antenna parameters

To study the above parameter, we have to compare other results using different materials like Copper,Mesh, and AgHT-4.

IV. COMPARISION OF TEST RESULS OF COPPER, MESH,AGHT-4,AGHT-8 SOLANT.

A.Reflection co-efficient of all SOLANT

Reflection co-efficient values of all SOLANT are tabulated.

From the table the comparative graph can be drawn

F(GhZ)	COPPER	MESH	AgHT-4	AgHT-8
1.5	0	0	0	0
1.8	-0.5	-0.5	-0.4	-0.5
2.2	-0.6	-0.6	-0.5	-0.6
2.8	-0.8	-0.8	-0.8	-0.8
3.5	-0.9	-0.9	-0.9	-0.9
3.8	-2	-1.8	-2	-1.8
4.2	-2.2	-5	-2.2	-3
4.4	-6	-27	-6	-6
4.6	-29	-26	-32	-24
4.7	-30	-2	-30	-14
4.8	-10	-1.8	-10	-6
5	-2	-1	-4	-3
5.5	-1	-0.9	-1	-1

From the table the comparative graph can be drawn

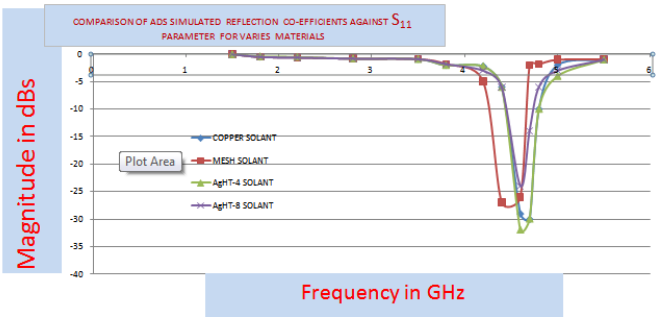


Figure 45 Comparison of reflection co-efficient for different SOLANT

The above graph return loss is very less for AgHT-4 SOLANT than compare to other SOLANT .So the return loss -32 is very low radiation is very high. We conclude AgHT-4 is best than others.

B. Gain of all SOLANT

Gain values of all SOLANT are tabulated

F(GHz)	AgHT-4	COPPER	MESH	AgHT-8
1.8	0.1	0.1	0.15	0.1
2.2	0.2	0.15	0.16	0.2
2.8	0.3	0.16	0.2	0.22
3.5	1	1	0.9	1
3.8	2	2	1	2
4.2	3	4	5	3
4.4	7	6	27	6
4.6	32	14	5	24
4.7	7	30	3	10
4.8	6	10	2	6

From the table the comparative graph can be drawn

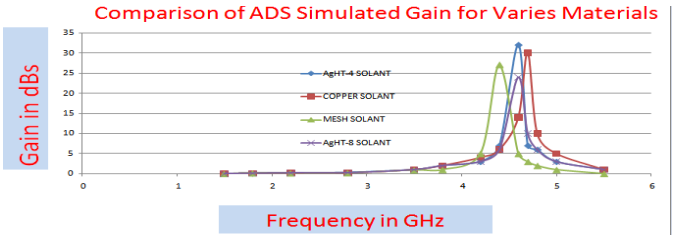


Figure 46 Comparison of Gain for different SOLANT

The above graph gain is very high for AgHT-4 SOLANT than compare to other SOLANT .So the gain 32dB is very high radiation is very high. We conclude AgHT-4 is best than others.

C. Power of all SOLANT

From the test values the comparative graph can be drawn in to way AgHT-4 gives high power. So that AgHT-4 is a best

one.

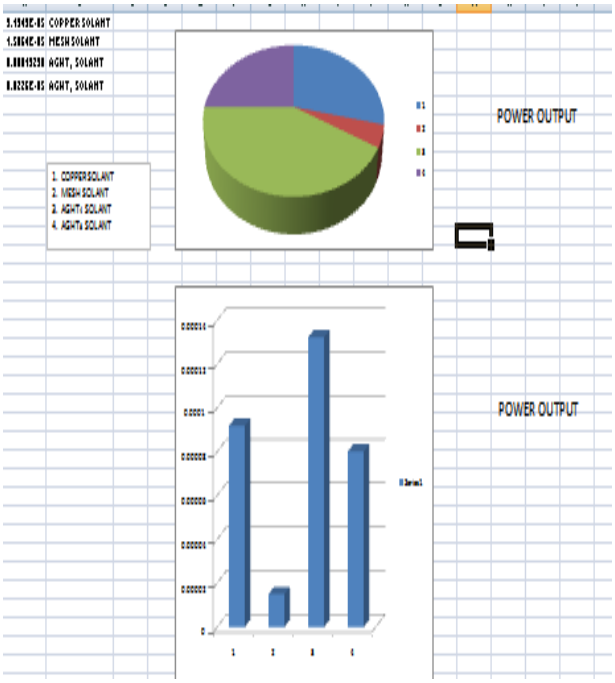
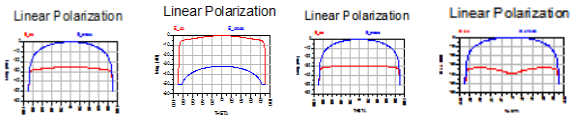


Figure 47 Comparison of Power for different SOLANT

D. Beam Width of all SOLANT



From the test values the comparative graph can be drawn in to way AgHT-4,8 gives high Beam Width .

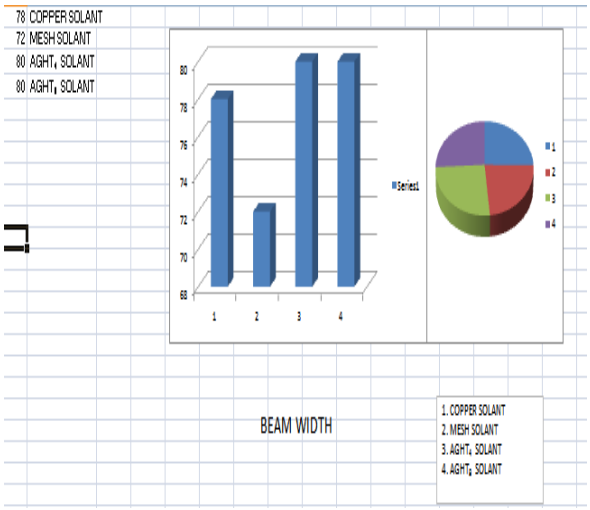


Figure 48 Comparison of Beam Width for different SOLANT

So that AgHT-4 is a best one, because AgHT-4 dominate in three comparison among four.

V. CONCLUSIONS

A Solar cell simulated by using Electronic work bench, the voltage, current, power values are noted and tabulated.Polt the graph voltage verses current and voltage verses power values.This is satisfy the solar character.Similarly do it for solar cell with simple tuning circuit and solar cell with microstrip antenna.The voltage, current, power values are compare with single solar cell. The voltage, current, power values are higher than single solar cell.It is the proof for integration of solar cell with microstrip antenna. In other way a Solar cell antenna was simulated in ADS with the range of 1.5 GHz to 5.5. GHz band width. In the layer arrangement ground plate, solar cell, Perspex and AgHT-4 layers are simulated.The same method followed by other materials like copper, Mesh and AgHT-8 for compression. The reflection co-efficient, Gain, Power output and Beam width are simulated and plotted in 2D and 3D. The AgHT-4 give better result in reflection co-efficient, Gain, Power output and Beam width. Now we conclude AgHT-4 antenna give better performance than copper patch, meshed patch antenna and AgHT-8 from the results, because AgHT-4 is more transparent conducting film. So that the AgHT-4 antenna is a basic plate form for designing solar cell antenna ie SOLANT. The SOLANT is used for mobile , vehicular,Bluetooth, wireless environmental monitoring, online building observations and extraterrestrial field of application like satellites. The solar cell and antenna function with costs reduction. The resonance frequency of the SOLANT depends on the patch size. Therefore SOLANT used trans receive RF signal and also generate the direct current.

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