Design of solar cell antenna (SOLAN) in different AgHT-8 patch shape for reflection co-efficient, gain, power and directivity compared with existing AgHT-4 and ITO

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***Abstract*— Solar cell antenna is a combination of Solar cell and Microstrip antenna. SOLAN design is mainly used in autonomous property for transceiver. RF and Optic are the two intelligence components used to design the SOLAN. It generates DC power supply when light falls on the surface of AgHT-8 and penetrates towards the solar cell. Similarly EM wave falls on the surface of AgHT-8 and produce RF signal. By using SOLAN we can calculate reflection co-efficient, gain and power for different shapes, size and design when compared with existing AgHT-4 and ITO.**

***Index Terms*— Solar cell antenna (SOLAN), AgHT-4, AgHT-8, ITO, ADS, transceiver, hybrid.**

I. INTRODUCTION

Solar cell antenna is used in different application such as environmental monitoring system, vehicular communication and Satellite systems. SOLAN is used in "satellite communication"[1], "metal plate of solar supports UMTS Pico-cell base station"[2], "mesh patch antenna and circular grid antenna are used for car wind shields"[3-5], "optically transparent wide band antenna supports communication system"[6-12], SOLAN array antenna power is more due to "RF and Optic intelligence"[13].

II. SIMILARITY BETWEEN ANTENNA AND SOLAR CELL

Compare with Microstrip antenna and solar cell, ground plate, coaxial port, subtract are similar. In upper part of the solar cell, silicon wafer is used for light reception and in microstrip antenna metallic plate is used for receiving EM waves as shown in "figure 1". In SOLAN design, the solar cell is placed under the micorstrip antenna. A transparent conducted coated film (AgHT-8) is placed in microstrip antenna for penetrating light towards the solar cell. It generates both DC supply and RF wave due to falling of light and EM wave shown in "figure2".

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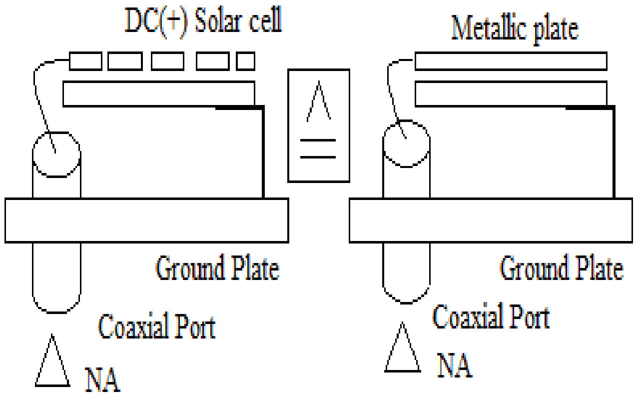

Figure1 Similarity between Micro strip antenna and solar cell

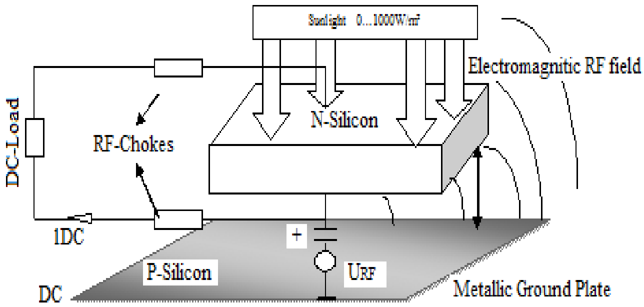

Figure 2 SOLAN Radiation of electromagnetic waves and direct current generation

III. EQUIVALENT CIRCUIT OF SOLAN

Solar cell equivalent circuit is specially simulated in electronic work bench for measuring power (P), current (I) and voltage (V). Microstrip antenna equivalent circuit are separately simulated and the same output is measured. Finally both microstrip and solar cell circuits are combined and output is measured. While comparing both outputs, combination of microstrip and solar cell equivalent circuit produces high voltage (V), current (I) and power (P). The simulation of SOLAN in Electronics work bench provides the following values of "current (I) =872.8mA Voltage (V) =8.728mV and Power (P) =7.6177984mW" were measured as shown in "figure 3".

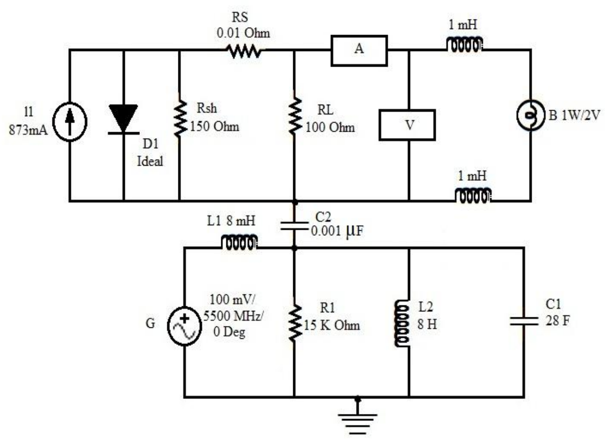

Figure 3 combined equivalent circuit of solar cell and microstrip antenna.

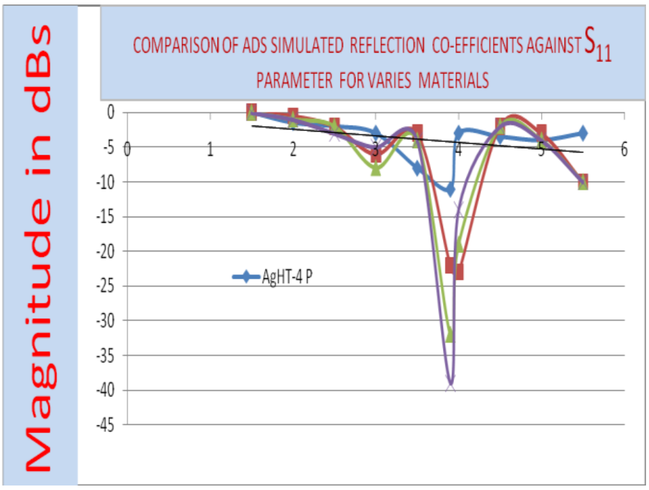

Figure 4 Comparison of reflection co-efficient for different AgHT-8 SOLAN with AgHT-4 and ITO

IV. Solar Cell Integration with Microstrip Antenna for Different AgHT-8 Patch Shape

The common equation used to design the AgHT-8 patch antenna dielectric layer is called Perspex and the equations depends on patch length(L), width(W), substrate height(h), frequency(f) and also length(L_{st}) and width(W_{st}) of the Microstrip are designed from following equations.

$L=0.49\lambda_0/\sqrt{\varepsilon_r}$

For square patch

L=W

$\varepsilon_{reff}=(\varepsilon_r+1/_2)+(\varepsilon_r-1/_2)[1+12\ h/w]^{-1/2}$

$f = c / 2(L+h)\sqrt{\varepsilon_{reff}}$

Width of the Microstrip line

$W_{st}= ((377/ Z_{line}\sqrt{\varepsilon_r})-2)t$

Length of the strip

$L_{st} = \lambda_0/4\sqrt{\varepsilon_r}$

For all AgHT-8 patch shape

L=19mm, w=19mm, ε_r=2.6, h=3mm, w_{st}=1.8mm, L_{st}=33mm, f=1.5 GHz to 5.5GHz

V. Comparison among SOLAN made AgHT-8 Patch, AgHT-8 Mesh Patch, AgHT-8 Hybrid Patch with Existing AgHT-4 and ITO

A. *Reflection co-efficient of all SOLAN*

The Reflection co-efficient of the SOLAN integrated with different patch sizes are simulated with ADS and summarized in “table 1” with frequency range from “1.5GHz to 5.5GHz”. The table clearly shows that the Hybrid patch provides better reflection co-efficient compared to the remaining listed sizes, reflection co-efficient is low radiation is high which is clearly shown in “figure 4”.

Frequency (GHz)	AgHT-8 Patch S_{11}(dB)	AgHT-8 MESH Patch S_{11}(dB)	AgHT-8 HYBRID Patch S_{11}(dB)	AgHT-4 Patch S_{11}(dB)	ITO Patch S_{11}(dB)
1.5	0	0	0	0	0
2	-0.5	-1	-1	-1.5	-0.5
2.5	-2	-2	-3	-2	-2
3	-6	-8	-5	-3	-6
3.5	-3	-4	-4	-8	-4
3.9	-22	-32	-39	-11	-35
4	-23	-19	-14	-3	-10
4.5	-2	-2	-2	-3.5	-2
5	-3	-4	-4	-4	-3
5.5	-10	-10	-10	-3	-10

Table 1 Reflection co-efficient values of AgHT-8 SOLAN in different patch shape with AgHT-4 and ITO

B. *Gain of all SOLAN*

The Gain of the SOLAN with different patch size is simulated with ADS is summarized in “table 2”. It is clearly noted that the Hybrid patch provides better gain compared to the others, gain high signal strength is more and it is shown in the “figure 5”.

AgHT-8 PATCH G(dB)	AgHT-8 MESH PATCH G(dB)	AgHT-8 HYBRID PATCH G(dB)	AgHT-4 PATCH G(dB)	ITO Patch G(dB)
2.21492	2.19715	2.24068	2.16715	2.23976

Table 2 Gain values in dB of SOLAN with different shapeAgHT-8 with AgHT-4 and ITO

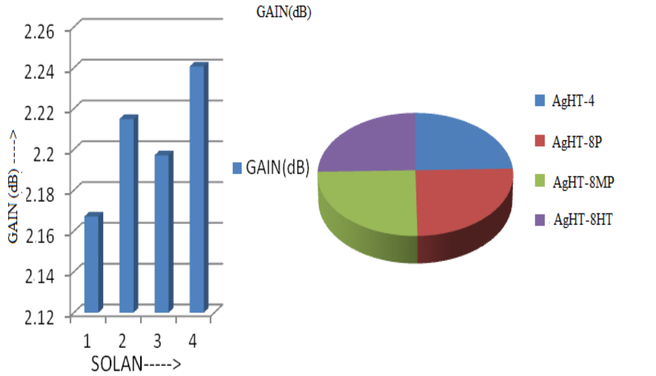

Figure 5 Comparison of Gain for different AgHT-8 SOLAN with AgHT-4 and ITO.

C. Power of all SOLAN

The Power of the SOLAN with different patch size is simulated with ADS are summarized in “table 3”. It is clearly shows that the Hybrid patch provides better Power compared to the others, Power high signal strength is more and it is shown in the “figure 6”.

AgHT-8 PATCH P(W)	AgHT-8 MESH PATCH P(W)	AgHT-8 HYBRID PATCH P(W)	AgHT-4 PATCH P(W)	ITO PATCH P(W)
0.000027877	0.000027991	0.0000283	0.000026723	0.0000282822

Table 3 Power values in Watt of AgHT-8 SOLAN with different shape Compared with AgHT-4and ITO.

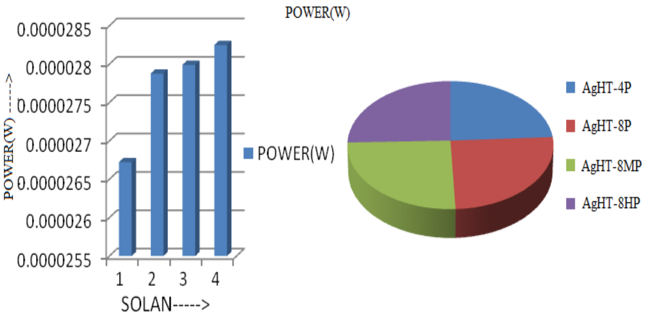

Figure 6 Comparison of Power for different AgHT-8 SOLAN with AgHT-4 and ITO.

D. Directivity of all SOLAN

The Directivity of the SOLAN with different patch size is simulated with ADS are summarized in “table 4”. It is clearly observed that the Hybrid patch provides better Directivity compared to the others, Directivity high signal strength is more one direction and it is shown in the “figure 7”.

AgHT-8 PATCH D(dB)	AgHT-8 MESH PATCH D(dB)	AgHT-8 HYBRID PATCH D(dB)	AgHT-4 PATCH D(dB)	ITO PATCH D(dB)
6.65147	6.65163	6.65431	2.53	6.65414

Table 4 Directivity values in dB of AgHT-8 SOLAN different shape Compared with AgHT-4 and ITO.

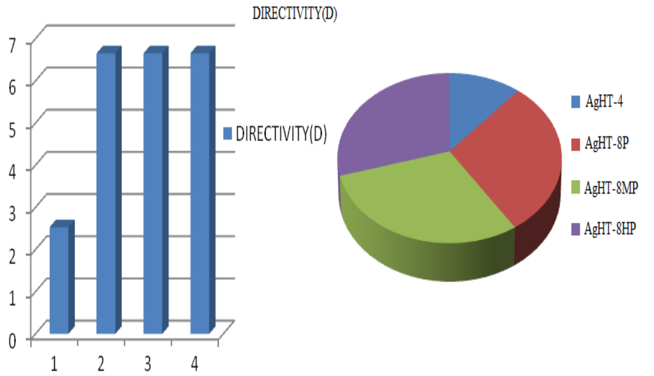

Figure 7 Comparison of Power for different AgHT-8 SOLAN with AgHT-4 and ITO.

E. Model of SOLAN

The SOLAN design was simulated in ADS and its two or three dimensional and real hardware was designed, implemented and tested as shown in Fig.8.

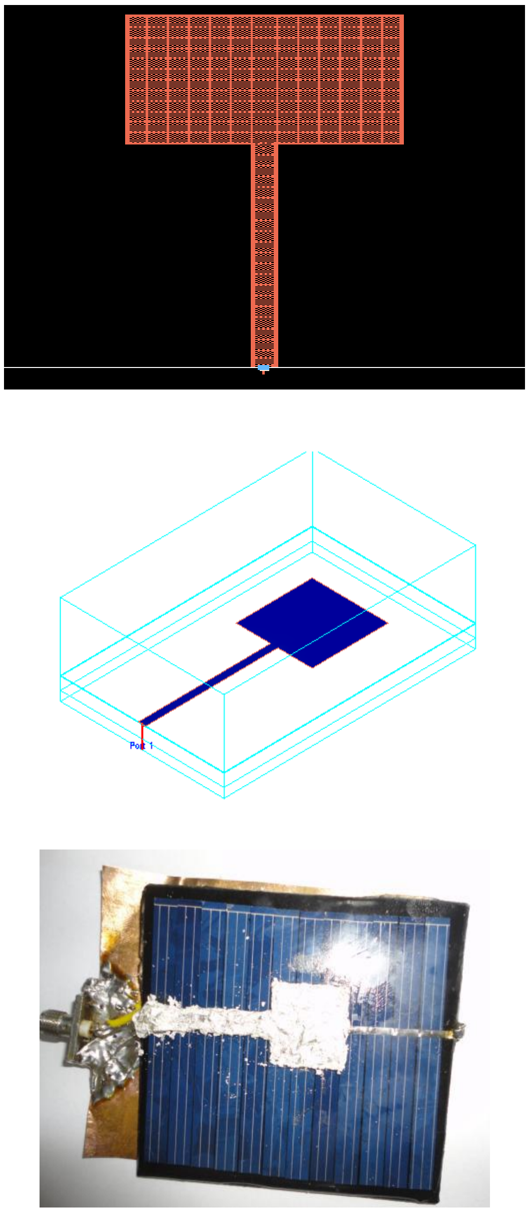

Figure 8 simulated and real model of AgHT-8 patch SOLAN model

VI. COMPARISON OF AGHT-4 AND ITO WITH AGHT-8

AgHT is highly conductive coated films and it is used in EM/RF wave. AgHT plays an important role in material science application. AgHT-8 is better than AgHT-4 and ITO because surface resistance of AgHT-8 is high. It produces high reflection co-efficient when compared with AgHT-4 and ITO. Due to high reflection co-efficient, the radiation is high when compared with AgHT-4 and ITO.

VII. CONCLUSION

The different SOLAN types were simulated using ADS software and the results obtained and compared with existing AgHT-4 and ITO. Among the obtained results the AgHT-8 hybrid patch SOLAN outperforms others, compared to other shapes. Because AgHT-8 hybrid patch has more transparent conducting film. Hence the AgHT-8 hybrid patch SOLAN antenna can be used as basic platform for many communication applications and it can also be used as a transceiver for RF signal and to generate direct current. The resonance frequency of the SOLAN depends on the patch size.

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