Design and Development of Improved Efficient Solar Cell using Reduced Reflection Coefficients for Silicon Based Solar Cell

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Abstract:
Efficiency improvement of solar cell has been accomplished utilizing design and simulation of hostile to reflecting covering. Hostile to Reflecting covering helps in sending new geometries shape for the assessment of various techniques to accommodate light catching every which way and empowers full space use when uniting into gadget clusters. Efficiency improvement techniques have been examined utilizing effective determination of modules and surface finishing utilizing TCAD devices. Noteworthy improvement in yield and minimization of misfortunes was accomplished utilizing gadget simulation and procedure simulation stage utilizing silvaco instruments. Multi-layer hostile to reflecting covering has been designed which can be concentrated to dissect the exhibition of system. It was seen that multi-layer covering helps in progress of accessible current for comparative light pillar under simulation.

Keywords: Anti Reflecting coating, TCAD, Device Simulation, Solar Cell.

I. INTRODUCTION

Presently the world has relied upon petroleum products for energy supply. The overall utilization of non-renewable energy sources (coal, gas and oil) is as yet expanding despite the developing worldwide attention to the natural effect of petroleum product utilization and of constrained non-renewable energy source saves. Directly increment in the cost of oil has been a most significant source of monetary issue on the planet. The essential impediment in the development of photovoltaic’s is the high absolute expense of photovoltaic establishments. To build the solar cells efficiency, we have diverse solar cell surface strategy that plans to amplify the episode photons assimilation and the get-together of photo-created bearers. Solar cell design so that the particular of the parameters so as to amplify efficiency. Generally, higher efficiencies have been accomplished by minimization of optical and electrical misfortunes of silicon (si) solar cells. PV cluster is utilizing an inverter which changes over the DC control into AC power and yield nourished into the diverse burden like engine, lighting burdens and different burdens. Modules are associated in arrangement to get a greater amount of the evaluated voltage, and afterward in parallel to meet the present determination, as appeared in Figure. 1.1.

Typically, a high transmittance and high electrical conductivity such as indium tin oxide film, a conductive polymer or a conductive nano-wire network are used for this purpose.

Silicon is a quadruple coordination atom, typically tetrahedral bonded to four adjacent silicon atoms. Tandem solar cells are attractive because they can be manufactured using a silicon single crystal with a band gap similar to, but easy to manufacture amorphous silicon.
II. SOLAR PV SYSTEM

The first Photovoltaic module was built by Bell laboratories in 1954.

Figure.2.2. Basic diagram of Photoelectric effect

Figure 2.2 shows the basic diagram of Photoelectric effect. In solar cell manufacture electric field is created by specially treating a thin semiconductor wafer. Modules are specially designed to produce voltage at a specific volt. However produced current will then depend upon the amount of light striking the module.

Figure.2.3. Representation of solar array

\[
I = I_L - I_D - I_{SH} \tag{2.1a}
\]

Where \(I\) is the total current generated by diode, \(I_L\) is photo generated current, \(I_D\) is the diode current and \(I_{SH}\) is the current through the shunt resistance. Voltage across these elements will give the value of current so

\[
V_{jun} = V + IR_S \tag{2.1b}
\]

Where \(V_{jun}\) is the voltage across the diode and shunt resistance \(R_S\); \(V=\)output terminal voltage\(I=\)output current \(R_S=\)series resistance

The value of current through diode which is given by

\[
I_D = I_0 \left\{ \exp \left[ \frac{qV_{jun}}{nKT} \right] - 1 \right\} \tag{2.1c}
\]

Where \(I_0=\)Reverse saturation current
\(n=\)diode Ideality factor
\(q=\)elementary charge
\(K=\)Boltzmann’s constant
\(T=\)absolute Temperature

The value of current through shunt resistance is given by

\[
I_{sh} = \frac{V_{jun}}{R_{sh}} \tag{2.1d}
\]

Substituting the values in Equation (1.1a), we get

\[
I = I_{L} - I_0 \left\{ \exp \left[ \frac{q(V + IR_S)}{nKT} \right] - 1 \right\} = \frac{V + IR_S}{R_S} \tag{2.1e}
\]

Figure 2.5 I-V characteristics of illuminated PV cell

Figure 2.5 shows the I-V characteristics of illuminated PV cell. As the measuring voltage vary from 0 to Voc, the performance of various data are described as-

III. DESIGN OF ANTI REFLECTING COATING

Step 1: semiconductor material is used to design crystalline silicon solar cells.
Step 2: Mesh is defined in order to specify the x and y coordinates of device structure.
Step 3: Regions are define including region number and materials of the region.
Step 4: Electrodes are defined along its position and materials of the electrodes.
Step 5: Material properties are defined.
Step 6: Doping type (n or p-type) and doping concentration in each region is specified.
Step 7: Models are added for simulation process.
Step 8: Contact and interface provided and using SOLVE statement conditions for obtaining solution is defined.
Step 9: LOG File is created and saved the I-V characteristics of the device.
Step 10: Electrical and optical properties are simulated.
Step 11: Output is plotted in Tony plot and extracted for analysis.

IV. RESULTS AND DISCUSSIONS

A schematic of a fabrication layer for a silicon solar cell structure is shown in Figure 4.1 below.
Figure 4.4. Photocurrent with respect to optical wavelength with two layer coating

Figure 4.5. Comparative Analysis of photocurrents with single layer and Multi-Layer coating.

Figure 4.6. Photocurrents without coating and with single layer and Multi-Layer coating.

Figure 4.7. Analysis of reflection coefficient with respect to anti reflecting coating.

Figure 4.8. Analysis of Absorption coefficient with respect to anti reflecting coating.

Figure 4.9. Analysis of transmission coefficient with respect to anti reflecting coating.

V. CONCLUSION

The proposed research was led on TCAD programming utilizing Silvaco Software bundle. 2D model of solar cell structure was created. The structure of gadget was created utilizing Athena apparatus and procedure simulation was finished utilizing ATLAS tool kit. The exhibition of hostile to thinking about covering was thought about parameters, for example, accessible photocurrent, ingestion coefficients, reflection coefficients and transmission coefficients. Proposed two layer hostile to reflecting covering indicated better in general outcomes as for light pillar and it tends to be fused to upgrade ghastly efficiency of solar cell. Surface finishing with hostile to reflecting covering of the photovoltaic cell, lessens the effect, yet in addition adds with the impact of a catching of light, so the development of light is reflected by the slanted surfaces in an a lot more extensive territory edges and in this way builds the length of the way of light in the material permeable. Truth be told, the inside reflection control in the silicon is higher as a result of the expansion in light points. The estimation of reflection coefficient of multi-layer covering is better as thought about than that of single layer covering and uncoated silicon cell.
VI. REFERENCES


