# Preliminary Simulation Results of Selective Emitter based Silicon Solar Cell

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*The lower cost solar cell reduces prices per watt, that can be achieved by the etches back method, so we have done single time Phosphors Diffusion on uniform mesh p-type Silicon wafer to reduce diffusion price but not at the cost of its efficiency. A n-type diffusion has been carried out on a fine mash p-type Silicone wafer having thicknesses 300 µm, resistivity 1 Ω-cm, by using $P_2O_5$ gas as a diffusion source at constant diffusion parameters like temperature, source concentration and diffusion time to make Selective Emitter Silicon solar cells by using etches back method, in which etch active area behave as a conventional solar cell. We also screened different parameters of a solar cell under AM 1.5 spectra using SSUPRM4 a tool in advance semi-conductor device simulator Silvaco.*

**Keywords**: Etch back, SSUPRM4.

## 1. INTRODUCTION

A commercial silicon solar cell involve single diffusion step in its fabrication process but light diffusion gives a shallow emitter and high sheet resistance [1]. In this case surface recombination is very low but there are problem related with semiconductor metal contact that is not ohmic, so if there is more contact resistance, that reduce relative fill factor and efficiency [2]. For heavy diffusion we can get a deep emitter and low sheet resistance due to defects metal semiconductor contact is ohmic but surface recombination increases due to which we will get poor spectral response and less efficiency [3]. This problem can be solved using structure named as selective emitter that produced high doped region and less light interaction with doped region.

Silvaco offers complete and well-integrated simulation software for all aspects of solar cell technology like S-Pisces, Blaze, Luminous, Device3D, Luminous3D. S-Pisces is an advanced 2D device simulator for silicon based technologies that incorporates both drift-diffusion and energy balance transport equations. Blaze simulates 2D solar cell devices fabricated using advanced materials. It includes a library of binary, ternary and quaternary semiconductors. Luminous and Luminous3D are advanced 2D and 3D simulator specially designed to model light absorption and photo generation in non-planar solar cell devices. Exact solutions for general optical sources are obtained using geometric ray tracing [4,5].

## 2. SIMULATION

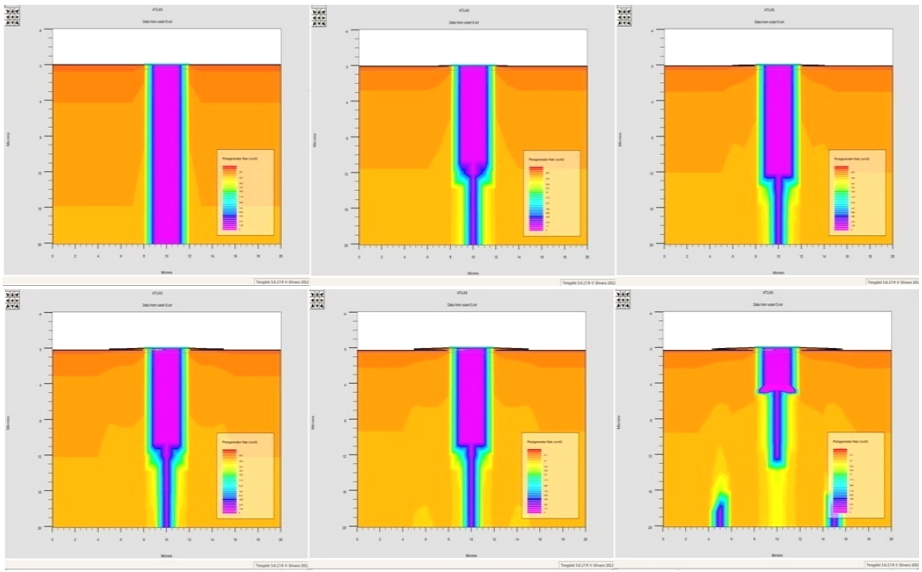
We have designed p-type, thickness of 300 µm, resistivity of 1Ω-cm and of uniform mesh Silicon wafer. That was diffused on Aluminum film with thickness 0.5 µm for 30 minutes at $1000^0$C Temperature, 5.0 x $10^{19}$ atom/$cm^3$ source concentrations, Nitrogen flow of 2 litter/min with Nitrogen ambient gas called Sample S1. For Second Sample (S2), etch S1 with 0.050 µm thickness in active area. For third sample (S3) etch S1 with 0.100 µm thickness in active area, for fourth Sample (S4) etch active area of S1 with 0.150 µm thickness, fifth (S5) and sixth (S6) samples are prepared by etching of S1 etch with 0.175 µm and 0.200 µm in active region respectively [4,5].

## 3. MEASUREMENT

We measured the Junction depth after etching active area surface, surface concentration of net dopant in active area, Spectral Response with 300 nm-1200 nm spectra light beam and photo-generation contour maps with 300 nm-1200 nm spectra light beam, I-V Characteristics in light of etch sample and used sample mathematical definition of $J_{sc}$, fill factor and efficiency of cell for calculation of all parameter of cell [4,5].

## 4. RESULT AND DISCUSSION

S1 S2 S3



S4 S5 S6

**Fig. 1:** Photo generation contour maps of Sample S1 to S6.

Figure 1 represents the photo generation contour maps with 300 nm-1200 nm spectra light beams for S1 to S6. In these maps we observed that in first sample (S1) the photo generation below the contact is zero and constant. In second sample (S2) the photo-generation below the contact is zero but it show decrement in photo-generation as we toward high etching concentration. High value of etching parameter causes uniform photo generation that result reduction in surface of emitter [2]. Figure 2 shows spectral response by red colour for sample S1 and by blue colour for S6. From Figure 2 we concluded that spectral response has increased with surface etching in active region. It is not increases linearly but it shows sharply increment in spectral response curve.

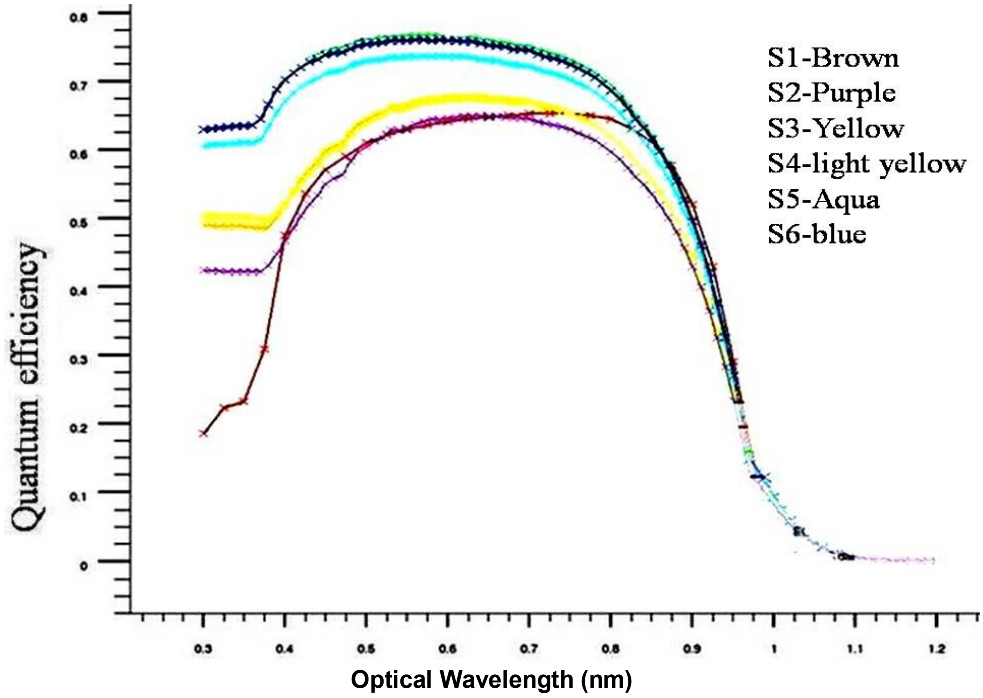



**Fig. 2:** Spectral response of each Sample S1 to S6.

Figure 3 shows I-V luminous characteristics S1 to S6 by Red colour for S1 and yellow colour for S6. This figure gives a clear picture that current density increases with surface etching depth but maximum voltage ($V_{oc}$) remains approximately constant. The Junction depth after etching active area surface, surface concentration of net dopant in active area and all parameter of cell i.e. short circuit current ($J_{sc}$), fill factor and efficiency of S1 to S6 given in Table 1. Surface concentration and junction depth decreases with etching. $J_{sc}$ of cell, efficiency, open circuit voltage is increased with etching. But in S6 efficiency as well as open circuit voltage decreases because junction depth is less than 0.3 μm and n-type region is smaller than previous samples that results less photo-generations in active n-type area and less efficiency.

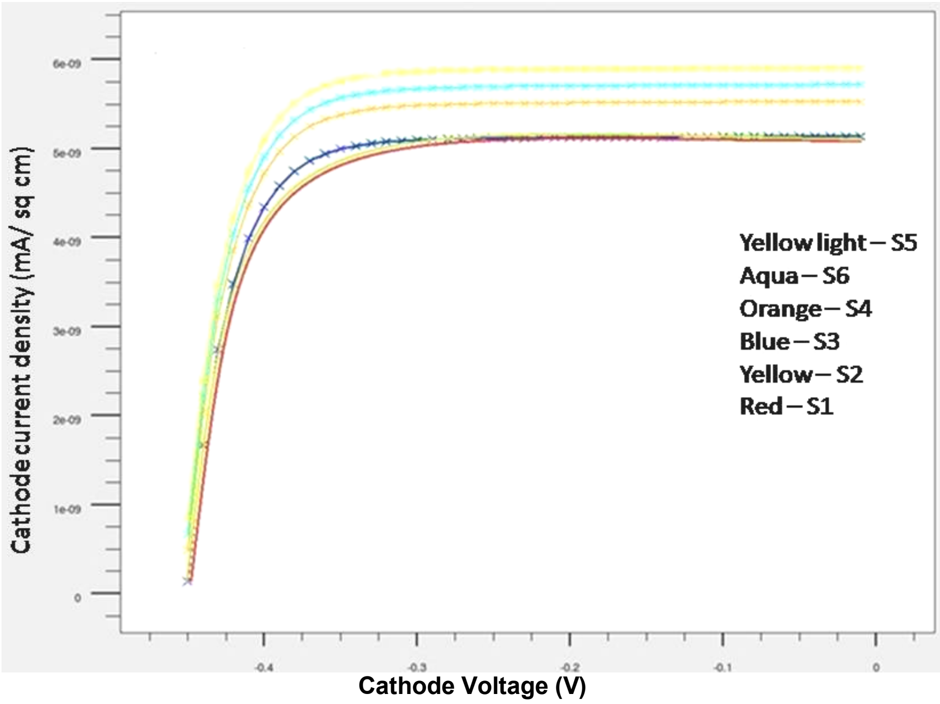



**Fig. 3:** Illuminated I-V Characteristics of each sample S1 to S6.

**Table 1:** Various parameters of devices

| Sample Number | Junction Depth of active region (μm) | Surface concentration (atom/cm$^3$) | $V_{OC}$ (Volts) | $J_{SC}$ (A/cm$^2$) | Fill Factor (%) | Efficiency (%) |
|---|---|---|---|---|---|---|
| S1 | 0.50164 | 1.77e19 | 0.45034 | 30.9472 | 77.85 | 8.357 |
| S2 | 0.45164 | 9.23e18 | 0.45073 | 31.5597 | 77.87 | 8.367 |
| S3 | 0.40164 | 9.17e18 | 0.45075 | 31.7102 | 77.87 | 8.387 |
| S4 | 0.35104 | 8.87e18 | 0.45256 | 31.7167 | 77.86 | 8.412 |
| S5 | 0.30164 | 8.87e18 | 0.45444 | 31.7367 | 77.91 | 8.414 |
| S6 | 0.27667 | 3.87e18 | 0.45039 | 30.7465 | 77.85 | 8.312 |

## 5. CONCLUSION

We tried single diffusion archive for a larger junction depth to get a good commercial silicon solar cell by etch back method [6]. After etch emitter got a low resistivity emitter but after certain limits, selective emitter silicon solar cells by etch back method blue response of cell increase in same manner, efficiency also increase as we go to the depth till to junction depth is higher or active area is lager. In case of more than certain limit of junction depth spectral response decreases hence cells efficiency also decreases. This is a challenge to achieve etching emitter to an optimum limit.

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