CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Jodi T. Loo

Project Number
S0807

Project Title
Reducing The Photovoltaic Cost by Using Multijunction Concentrator Solar Cells

Abstract

Objectives/Goals
My goal is to reduce the photovoltaic cost by using the multijunction (MJ) concentrator cell as a viable energy source.

Methods/Materials
I first performed an analysis using the Excel program to determine the effect of the leakage current and the series resistance on a concentrator solar cell. The leakage current was computed using the ideal diffusion model at two sets of doping concentrations, (P=5x10^17, N=5x10^16) cm-3 , and (P=5x10^18 , N=5x10^17) cm-3 in Si. The results are compared to the junction generation-recombination current using an electron-hole lifetime of 1 nanosecond. The series resistance effect was studied at 1, 10 and 100 suns. I then performed outdoor measurements on a InGaP/GaAs/Ge multijunction cell on loan to me from the Boeing/Spectrolab using a home-built concentrator system that I designed. I measured the photo I-V at 1, 14 and 34 suns. The data are then correlated and explained by the modeling results.

Results
The measurements show that at low currents (1 sun) the MJ cell was shunted because of higher junction leakage predicted by the modeling. However, at high currents (> 100 suns) the cell performance is degraded by the series resistance (>0.1 ohm). During the experiment, I also demonstrated that this concentrator system needs a solar tracking device because it only works in the direct sun light. Furthermore, we must maintain the cell at room temperature especially at high suns. Lastly, I estimated my 2007 calendar year household electricity to be 0.15 cents/KWh. This cost is then compared to the solar electricity cost that I obtained from the Sharp Electronics website, 0.5 cents/KWh. Thus, we must reduce the solar electricity cost by a factor of three in order to be competitive with the fossil fuels.

Conclusions/Discussion
The Boeing MJ concentrator cell is $12/cell and yields 20 W at 500 suns. I would need 10 MJ concentrator modules to make a 200 W panel comparable to a conventional single junction panel ($1000/panel). Consequently, my hypothesis would be correct if I could make a concentrator module plus the MJ cell reliably by incorporating the tracking and cooling devices to be at around $30 each.

Summary Statement
I learned and demonstrated how a cost effective photovoltaic concentrator system using multijunciton cells could help increasing the efficiency of solar cell yet make solar energy more cost competitive with the fossil fuels.

Help Received
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