The three R’s

Being a successful _____ is going to require more than just math skills

Being well rounded raises your stock

Don’t be afraid to stand out!
Networking

Start building a professional network, use tools like LinkedIn

Go to office hours and build relationships with your professors
  Sit at the front of lectures and take advantage of any face time

Family and friends are great resource, use them
Getting involved at UCSD

Center For Student Involvement

• 492 Student organization
  • Ballroom dancing, origami, wilderness medicine...

• Engineering and Professional Societies
  • Society for Automotive Engineers
  • Society of Civil and Structural Engineers
  • Society of Women Engineers
  • Computer Science and Engineering Society
  • Institute of Electrical and Electronics Engineering (IEEE)
  • ...

[Image: Middlebury College Solar Decathlon, 2011]
Solar Decathlon

Department of Energy sponsored competition to design, build and operate solar powered homes.

Judged on:
1. Architecture
2. Market Appeal
3. Engineering
4. Communications
5. Affordability
6. Comfort Zone
7. Hot Water
8. Appliances
9. Home Entertainment
10. Energy Balance

Solar village in West Potomac Park, Washington D.C.
A brief existence on the HVAC team
Green Engineers

Engine optimization on a Ford 8-N tractor converted to run on gaseous fuels
More $, more problems

<table>
<thead>
<tr>
<th>PROPOSED EXPENDITURES</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injectors (Extended range fuel injectors - $350 each for two injectors)</td>
<td>$700.00</td>
</tr>
<tr>
<td>Hydrogen Cylinder Lease ($35 per cylinder for two cylinders)</td>
<td>$70.00</td>
</tr>
<tr>
<td>Hydrogen Cylinder Refills ($38 per cylinder for 12 refills)</td>
<td>$456.00</td>
</tr>
<tr>
<td>Methane Cylinder Lease ($35 per cylinder for two cylinders)</td>
<td>$70.00</td>
</tr>
<tr>
<td>Methane Cylinder Refills ($50 per cylinder for 12 refills)</td>
<td>$600.00</td>
</tr>
</tbody>
</table>

![Graph showing RPM vs Fuel Pressure psi]
Establishing a Repeatable Cross-Sectioning Procedure for Photovoltaic Cells

Spencer Ellis1, Bhushan Sopori2
McDermott College, McDermott, NY, National Renewable Energy Laboratory, Golden, Co1

Background
Our cross-sectioning technique uses a unique method of embedding the sample in a resin. The samples are cut and the mounting process forms an interface on the surface, which reduces edge support for the sample. The ideal area for mounting is to eliminate surface bubbles in the sample. The final step is to use a mixture of 1:1 solution of epoxy and hardener. When the sample is cut, the hardener reduces the sample in the area where the sample is mounted. This hardener will also improve the total cross-section of the cross-sections.

Results

Figure 1. Initial cross-section

Figure 2. Cross-section after cutting

Figure 3. Cross-section after hardening

Materials and Method
Samples are cut or sectioned into 3.7 in. 

c. T. in. samples, which are mounted in the mounting blocks and mounted in the center of the cavity with the hardener addition. After the sample is cut into the desired size, it is placed onto the sample holder. The sample holder is then placed into the hardener mold, which is then hardener injected into the mold. The hardener is then allowed to cure for 24 hours.

Conclusions

1. The consistency of the sample support has been improved.
2. The sample support has been improved.
3. The sample support has been improved.

Future Work

Future work will focus on improving the sample support to help improve the sample support. Additionally, the sample support will be tested to ensure that the sample support is still effective.
Si solar cells 101

The p-n junction

Absorption in indirect band gap semiconductors
http://www.lrc.rpi.edu/programs/nlpip/lightingAnswers/photovoltaic/04-photovoltaic-panels-work.asp
Mounting a sample
Improving wax-sample bond
Polishing Progression

a) 15 min 1 micron
b) 2 hr 0.3 micron
c) 3 hr 0.05 micron
d) 10 second CMP

Fig. 3. As-cut sample after wax mounting [2]
Al-Si back contact alloy

Sintered Al paste

p⁺ region

Si-Al alloy

Si rich

Al rich

20.0 μm
Back surface field

Formed by diffusion of Al into P type Si

Reduces back surface recombination

Allows for higher efficiency and thinner solar cells

Brings down cost per kWh

SEM of cross-sectioned c-Si cell at Al contact

Cross-section allows for characterization of the P⁺ region
Ag front contact metallization

Want solid contact between Ag and Si to minimize contact resistance

Glass frit
CdTe thin films

~100 times thinner than c-Si solar cells

Present unique set of challenges for cross-sectioning

Effort to avoid more toxic alternatives to Silica slurry
CdTe samples

Examples of delamination and chipping of CdTe film from glass substrate as a result of polishing procedure
Near Space Ballooning

68,018 ft. at 4:15 p.m.  104,658 ft. at 4:53 p.m.
What’s near-space?

Near-space ranges from 65,000 ft. to 330,000 ft.
Flight Prediction
Perseid meteor shower

9/13/14
Flight Path
Altitude profile

Reached a peak of 118,000 ft!

9/13/14

10/8/14
Climb vs. Time

- APRS 4
- APRS 5
- APRS 6
Recovery
Payload

Spot GPS tracker

GPS/Automatic Packet Reporting System (APRS) transmitter
Developing a sensor package

Goal:
- Pressure
- Temperature
- Humidity
- Altitude
- Accelerometer
Solar UAV

As the atmosphere becomes thinner generating lift becomes more costly, but solar power density increases.

Determine optimal altitude for a solar powered UAV to operate.

Vary depending on the semiconductor material’s band gap energy.
Module weight

Direct band gap semiconductors are more efficient absorbers

Significantly thinner and lighter cells
Characterizing a solar cell

Fundamental characteristics are contained within the I-V curve

- $V_{oc}$
- $I_{sc}$
- $J_{sc}$
- FF
- Efficiency
Cell characterization with an Arduino
Takeaway message

1. Step out of your comfort zone
2. Get involved outside of class
3. Network, network, network
4. Enjoy yourself!
A special thanks to

Dr. Bhushan Sopori at the National Renewable Energy Lab for his outstanding mentorship.

Dr. Kosmatka, Tehseen Lazzouni, and Becky Howard for their support and giving me the opportunity to be a part of the CaSG summer program.


