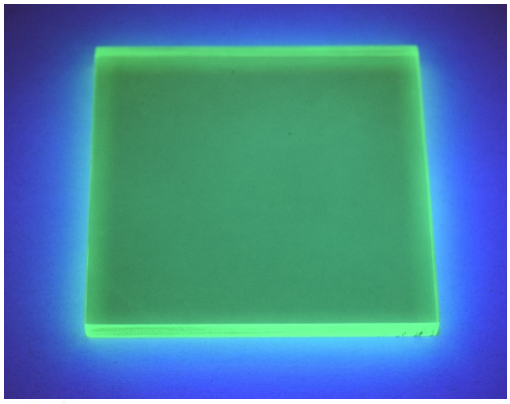
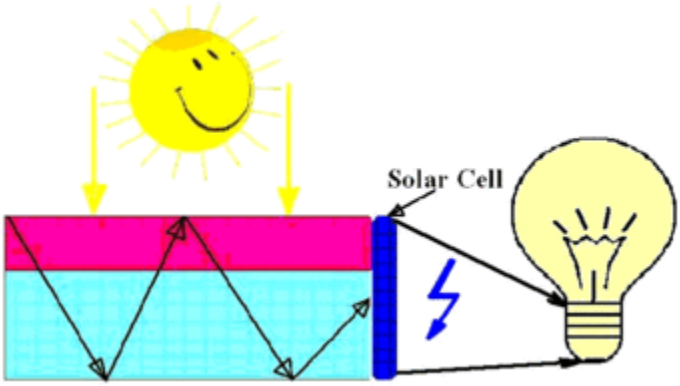
CLEAN ENERGY INSTITUTE
UNIVERSITY of WASHINGTON

Luminescent Solar Concentrator



Overview: This maker project demonstrates how fluorescent materials can be used to make a new kind of solar panel.

Background: A luminescent solar concentrator (LSC) is a transparent piece of plastic or glass that has a **fluorescent dye or quantum dots** embedded or painted on it. The dye absorbs light and then **fluoresces** creating a glow that propagates by **total internal reflection** to the edge of the sheet where the light is absorbed by a narrow solar cell. This is a promising technology because it allows a large collecting area of virtually transparent glass with a comparatively small area of expensive solar cells. The concentration factor is the ratio of the aperture to the edge. The luminescent materials can be tuned to absorb at certain wavelengths (such as ultraviolet UV) and re-emit at longer wavelengths where absorption by silicon is optimal.



Research Connection: Researchers at UW are trying to create new materials that can absorb and then emit light at different wavelengths.

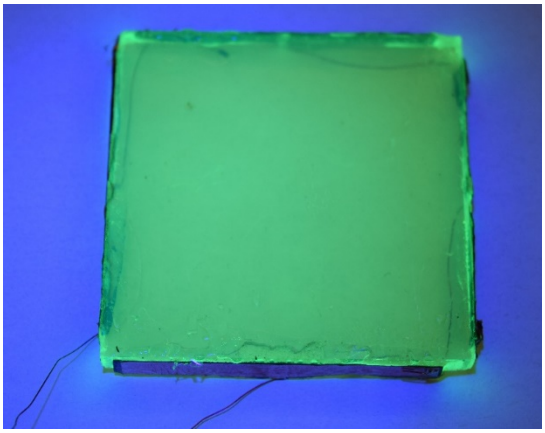
NGSS Standards: correlates to performance expectation statements and DCI, CCC, SEPs if possible.

Standard Number	Standard text
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*
MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

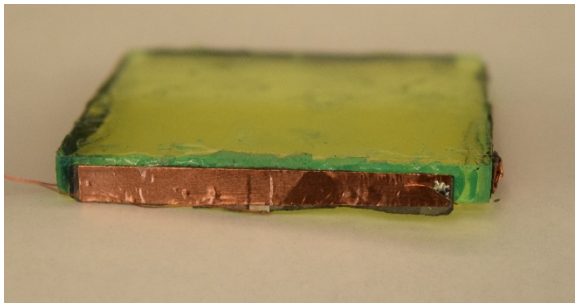
Materials:

- Fluorescent plastic or clear plastic that has been painted with fluorescent dye.
- narrow silicon solar cell
- clear epoxy
- ultraviolet flashlight

Procedure:



1. Cut out a section of fluorescent plastic approximately 3" square. Note that commercially available colored acrylic is not very clear so light in a larger sheet will not be reflected internally efficiently over the entire width of the sample. Sand and polish the edges so they will reflect light back into the cell anywhere there is no solar cell attached.
2. Purchase or cut solar cells to exactly cover the thickness of the plastic. Handle very gently—they are exceedingly brittle. If necessary scribe and break cells to make them narrow enough. (Wear goggles when handling solar cells)
3. Use conductive tape or solder a thin copper wire to the center grid of the front of the cell (the dark side). Be careful not to cover too much of the light collecting area
4. Clamp the plastic sheet in vertical position so that the top edge is level.
5. Mix a small amount of 5-minute-set epoxy enough to cover the exposed edge about 1/16" thick. Gently set the top side of the solar cell into the epoxy, facing the plastic sheet while excluding any air bubbles. The epoxy holds the cells safely in place and it also creates an "optical coupling" by removing a change in index of refraction with the plastic / air boundary which causes reflection. This allows all the light that is internally reflected to be absorbed by the cells at the edges of the sheet.
6. Wait until the epoxy is sufficiently set so the cell can't slide rotate and then rotate plastic sheet and attach a solar cell for cell for each edge.
7. Apply conductive copper tape or solder a wire to the back side of each cell. If you are soldering check the spots where the silver backing has been cleaned for easier soldering.
8. Connect the 4 solar cells in either series (for maximum voltage) or parallel (for maximum amps).



<u>Investigations with the luminescent solar concentrator</u>

1. Measure the voltage of the LSC in sunlight, under a flashlight and under a UV light.
2. Calculate the concentration ratio by dividing the area of the plastic square by the area of the solar cells. Compare the output from your LSC with a plain solar cell of the same area using the same light source. Repeat the measurements for each type of light source. Can you prove that you getting some benefit from the concentration?
3. If you have access to a spectrometer measure the color of the exciting light (uv) and the emitted light. Compare this to the spectral response of silicon solar.
4. Use a precision light measuring device such as USB probeware to determine how much light is passing through the cell and how much is generated by luminescence.
5. Experiment with the light conduction within a sample of the plastic without solar cells. How much drop off occurs with distance?

<u>Materials</u>

Plastic sheet

Fluorescent acrylic sheet 12” x 12” x .236
http://www.amazon.com/gp/product/B00U6H5U9I?psc=1&redirect=true&ref_=oh_aui_detailpage_o08_s00 $16

Solar Cells

https://www.ebay.com/itm/Aiyima-100pcs-Solar-Panel-Solars-Cell-0-5V-320mA-52x19mm-DIY-Battery-Charge/253644933160?_trkparms=aid%3D555018%26algo%3DPL.SIM%26ao%3D1%26asc%3D54443%26meid%3D3c20e77784d149f6a7aaa24e87cc3113%26pid%3D100005%26rk%3D5%26rkt%3D12%26mehot%3Dag%26sd%3D253797529270%26itm%3D253644933160&_trksid=p2047675.c100005.m1851

100 pieces 52x 19 mm $8.

https://www.ebay.com/itm/Aiyima-0-5V-100mA-10Pcs-Mini-Solar-Panel-Solar-Cells-DIY-Power-Battery-Charger/253797529270?hash=item3b1782f6b6:g:ErMAAOSw53dbZjHV encapsulated solar panel with easy to connect contacts on back, 10 for $2.81

Conducting copper tape

http://www.amazon.com/inch-yds-Copper-Foil-Tape/dp/B00CBPK0FW/ref=pd_sbs_328_2?ie=UTF8&refRID=0CPYDK51T8Z09RJRZFM7 ¼ conductive adhesive copper tape

USB Spectrometer

http://www.pasco.com/prodCatalog/PS/PS-2600_wireless-spectrometer/index.cfm $399

Videos

This videos illustrates how dyes can be painted on the surface of the glass and still emit into the glass where they are trapped by internal reflection.

https://www.youtube.com/watch?v=qCVT5RL7u0A

https://www.youtube.com/watch?v=17_DjG-grSw

https://www.youtube.com/watch?v=zi6AAHEpL2Y cutting solar cells using scribe

https://www.youtube.com/watch?v=w50OZKEKXmk cutting cells using diamond blade and Dremel tool. Use a dust mask and clean up with a vacuum frequently.

https://www.youtube.com/watch?v=ZE4GUaUU9iI cutting with dremel