Wavelength Selective Photovoltaics for Low Cost Electricity Generation

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Introduction

With the increasing demand for renewable energy resources, photovoltaic (PV) technologies are being rapidly developed. These technologies include methods of generating electrical power by converting solar radiation into usable energy, commonly using solar panels. However, to generate enough energy to meet the world's electricity demands, it may be required that PV solar farms are installed in agricultural and desert areas, competing with food production, crops for biofuels, and/or the conservation of desert ecosystems. High efficiency solar cells may help with the land-use issues, but they are hard to manufacture at low costs.

This study proposes the solution of enabling wide scale development of low cost photovoltaic cell technology that can coexist on land used for algal biofuel. To do this, we compared the growth (optical density and chlorophyll *a* extraction per cell) and photosynthetic behavior (O_2 production) of different types of algae by exposing them to increasing intensities of light filtered through pink waveshifting photovoltaic (WSPV) polymer sheets. The sheets selectively absorb wavelengths between 400 and 600nm, allowing wavelengths above 600 to pass though. We will see how green algae grow under these conditions, and ultimately collect the unused light and convert it into electricity by the low cost polymer sheets.

Methods

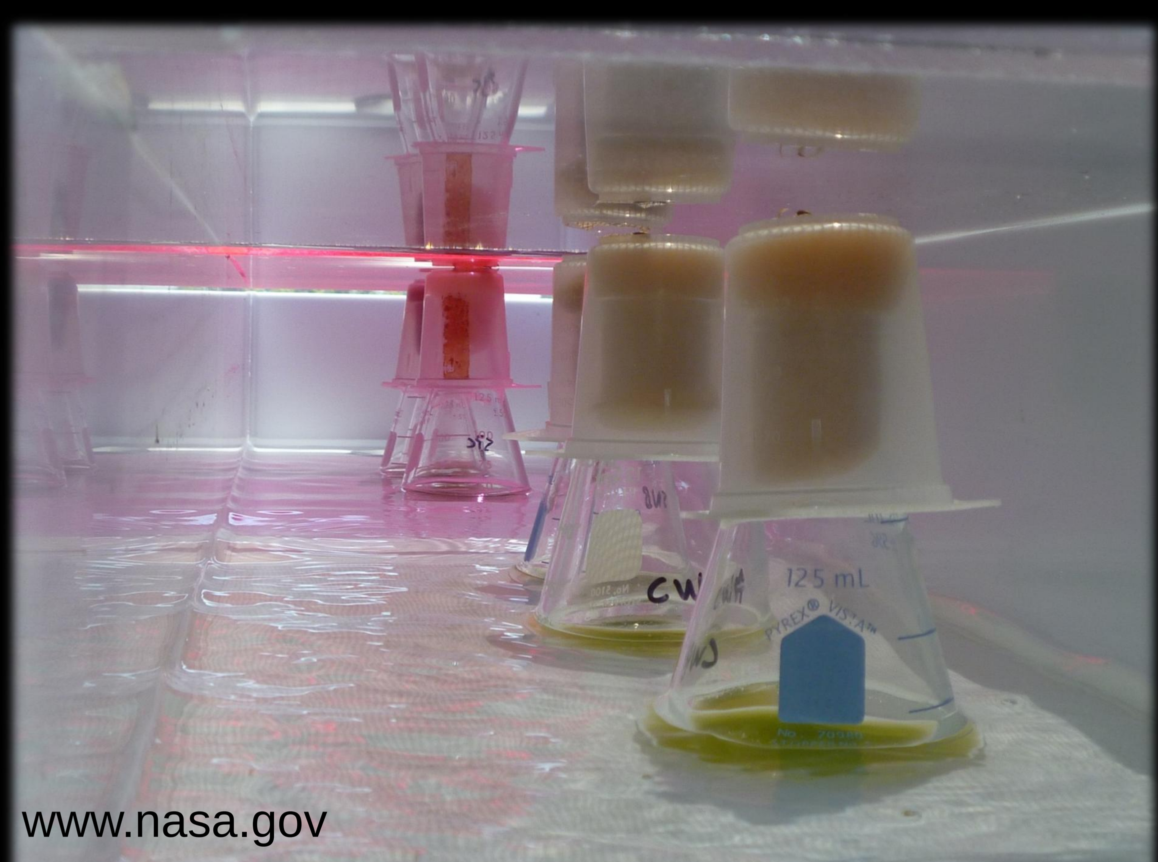
Species of algae studied:
- *Chlorella vulgaris*
- *Spirulina platensis*

Part One

-A 50ml triplicate of each specimen will be grown in:
 -Sunlight filtered by pink photovoltaic polymer sheets
 -Regular sunlight

-As these specimen are particularly light and heat sensitive, the light will be decreased using neutral density screens and they will be grown in a cool water bath.

-The optical density and chlorophyll *a* will be measured daily.



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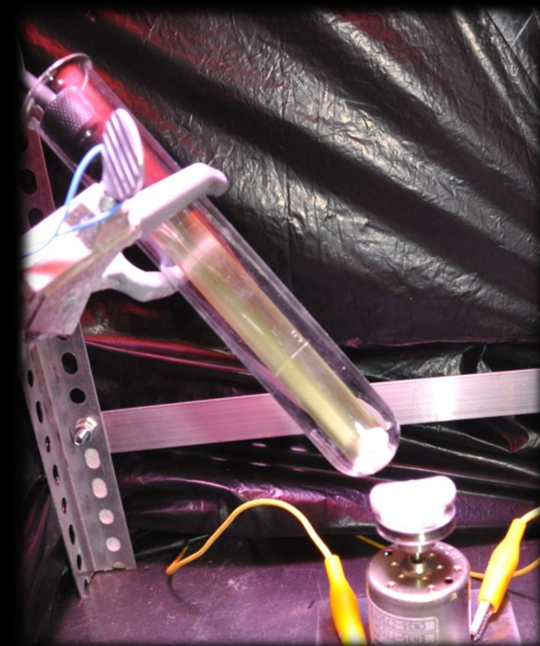
Part Two



-Photosynthetic activity of the two specimens will be monitored from darkness to 100% of white/sunlight and pink filtered light.

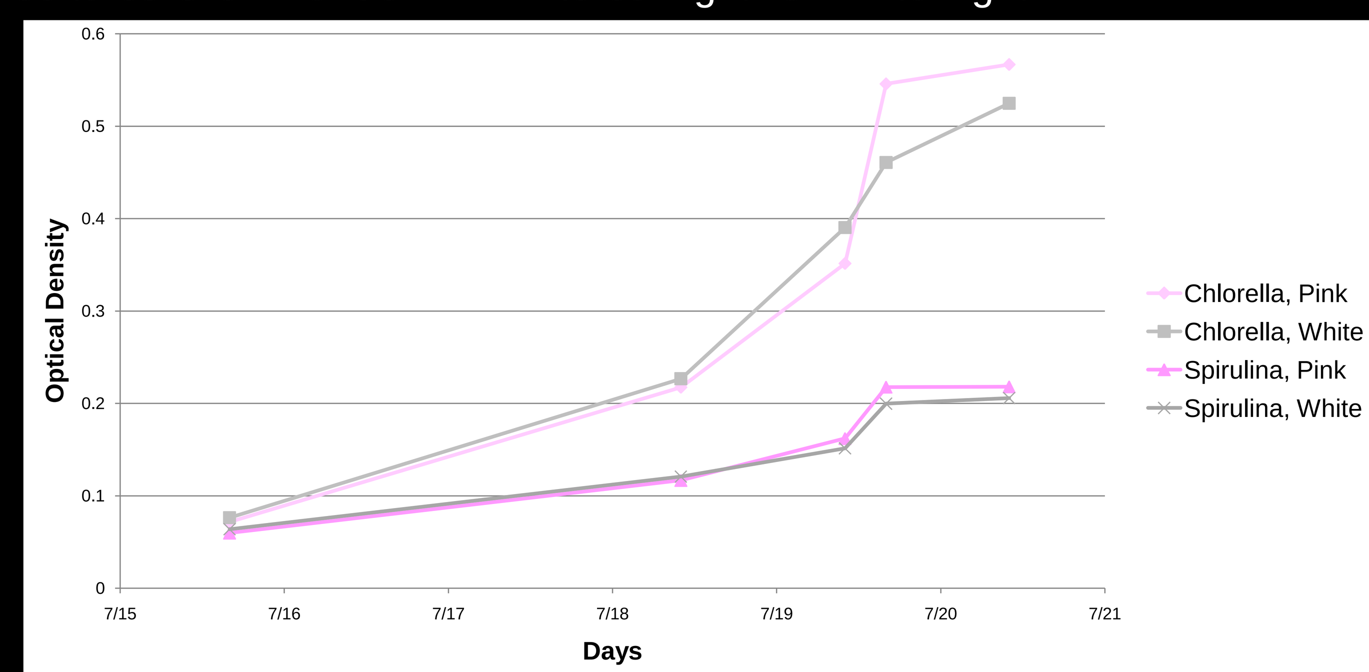
-The different light intensities will be determined by a combination of different neutral density screens and filters.

-Temperature will be kept at 26ºf and the samples will be constantly mixed to ensure proper O_2 detection in the overall sample.

Data

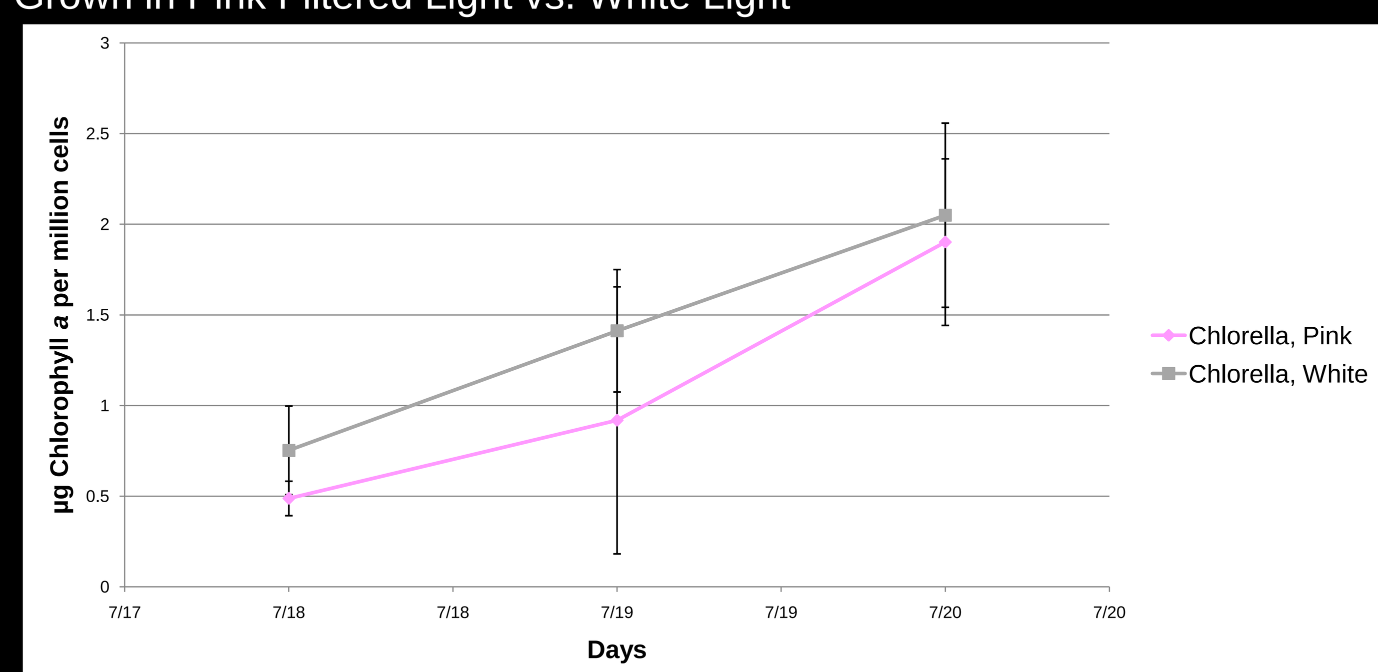
Part One

Optical Density Over Time of
Cultures Grown Under Pink Filtered Light vs. White Light



Chlorella growth higher than *Spirulina*. Growth in filtered light may be slightly higher than growth in white light.

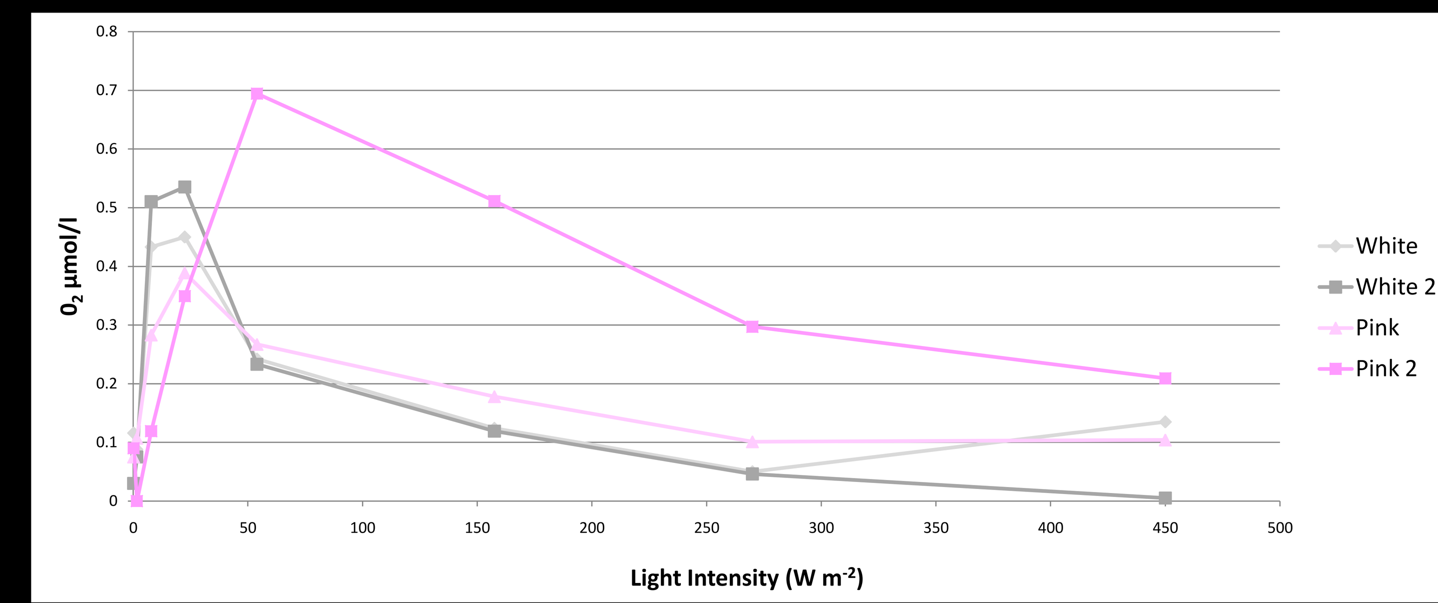
Chlorophyll Production in *Chlorella*
Grown in Pink Filtered Light vs. White Light



Chlorophyll production per cell appears lower when the culture is grown in the filtered light.

Part Two

O_2 Production in Filtered Light vs. Solar Light



These photosynthesis/irradiance curves show a peak of O_2 production at approximately 12% of simulated sunlight.

Analysis and Results

Part One

The *Chlorella* and *Spirulina* started at approximately the same optical densities and it is clear that there is higher yield of cells in *Chlorella*. Although this is only based on preliminary results, it seems that at least with these two species, algae seems to grow slightly better under the pink filtered light.

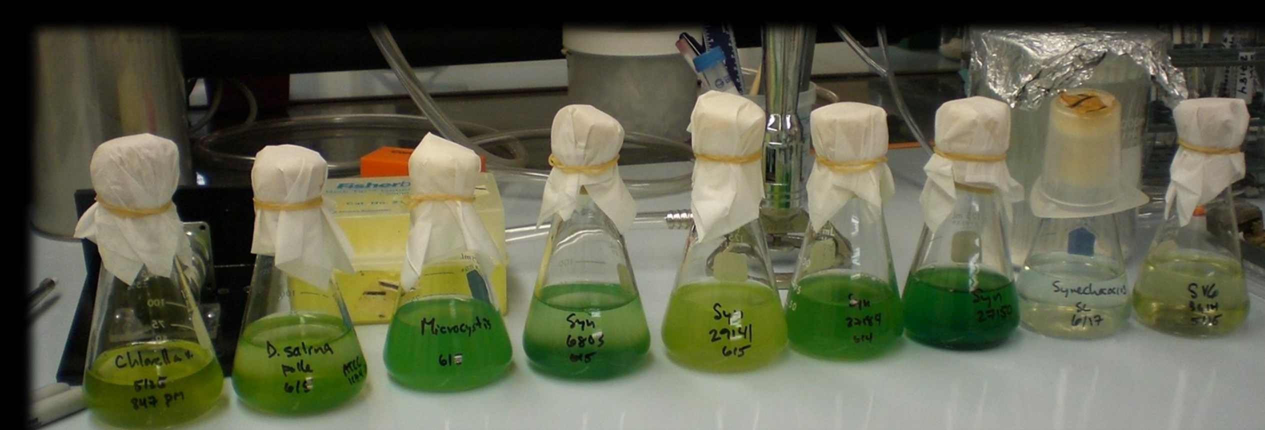
Chlorophyll A extractions done on cells grown in pink filtered light and regular sunlight show that there is a higher chlorophyll production in the cells grown in unfiltered light.

Part Two

Chlorella is sensitive to light and prefers it at lower intensities. This is evident in the peak of O_2 production at around 12% and steady drop as it approaches higher intensities of light.

Conclusion

The small differences in cell and chlorophyll production in *chlorella vulgaris* grown under sunlight filtered through pink WSPV polymer sheets and regular sunlight is a good indicator that it may be very possible to combine this photovoltaic technology with algae biofuel farms. The photosynthesis/irradiance curves show that the two species of algae studied so far produce oxygen optimally at about 15% of sunlight. This may allow for the rest of the sunlight to be collected and converted into electricity. Many other species of algae, including ones that may have high biofuel yield, will be observed in continuation of this study.



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