Generation of Electricity with A Transparent Light Absorber

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• Introduction

Today, many people have implemented traditional Si solar cells on top of their homes, businesses, and many other places of interest. Its theoretical power efficiency value (33.16%) is being approached as new photovoltaic technology has been developed. Solar farms are an amazing way to harvest clean and efficient energy, however, due to the area needed for an effective solar farm, they are very limited. In big cities, solar farms are not currently viable due to the lack of surface area on the roofs of buildings. Meanwhile, buildings across the nation account for 40% of all electricity usage, and 76% of greenhouse gas emission in the United States. One solution to these problems would be to replace the windows of these buildings with transparent solar cells. Not only would the buildings be self-sustaining, but this would also contribute to a greener world. Here we synthesize a new type of TiO_2, an inorganic semiconductor that allows a large amount of visible light transmittance while absorbing, and using, energy from UV and IR light. We tested this new TiO_2 utilizing various experimental methods and believe it may serve as a viable material in transparent solar cells.

• Motivation

- Creating sustainable and energy-efficient buildings
- Self charging mobile devices and automobiles
- Cleaner skies with less light pollution from spacecraft

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Mobile devices:
• Transmittance > 80-90%

Automobiles windows:
• Windshield transmittance > 80-90%
• Front side transmittance > 70%
• Back side and rear > 55%

Building windows:
• Transmittance 70 - 90%

Solar panels for space crafts:
• ideally transmittance > 80-90%

• Electrodeposition

Electrodeposition is a process by which electrical current is used to reduce metal cations onto an electrode. In this research, we use electrodeposition to coat FTO (fluorine doped tin oxide) glass with a layer of our new TiO_2.

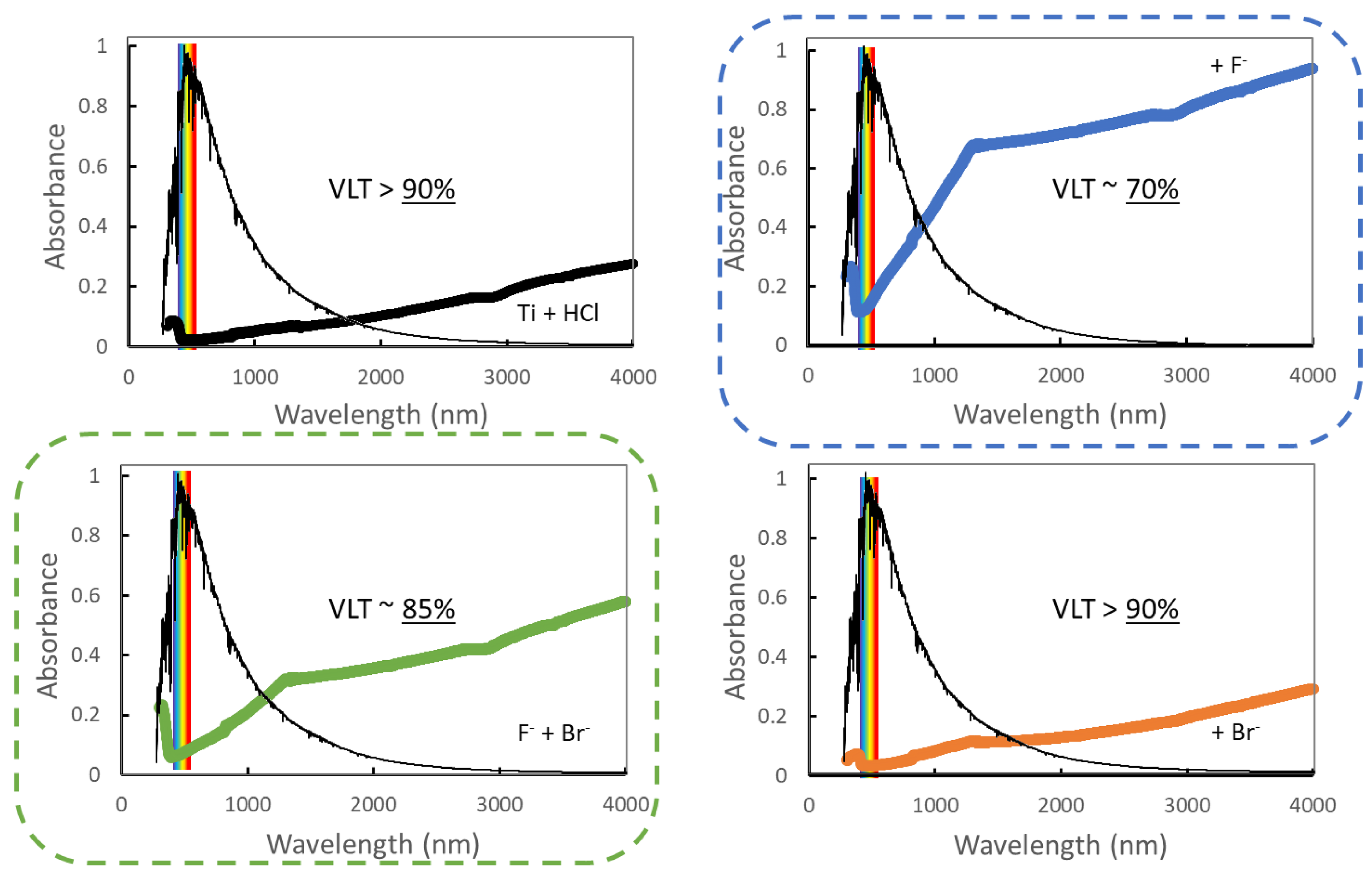
Ohmmeter to measure resistance | *Working electrode with FTO Glass* | *Electrodeposition taking place* | *FTO Glass with a TiO_2 coating*

• Optical Properties

We measure the absorbance and transmittance of our materials using UV-Vis and IR spectroscopy. In doing so we can see the absorption spectra of our chosen material, in this case the TiO_2

Our UV-Vis study showed that F^- could significantly increase the overall light absorption while Br^- could suppress the *visible light* absorption. Therefore, we mixed F^- and Br^- to fine tune the optical properties.

Anions effect on overall light absorption



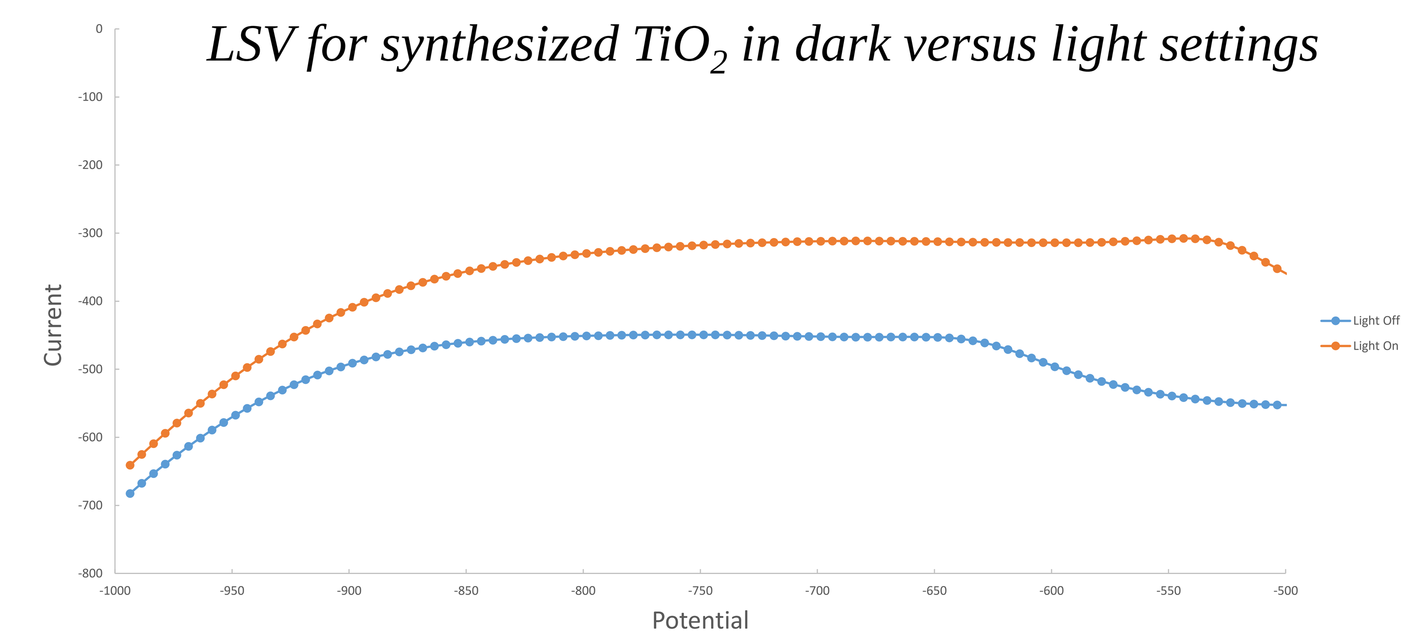
• Experimental Setup

We use a solar simulator lamp that is equipped with a monochromator for our experiments. The monochromator allows us to pick specific wavelengths of light to shine onto a surface.

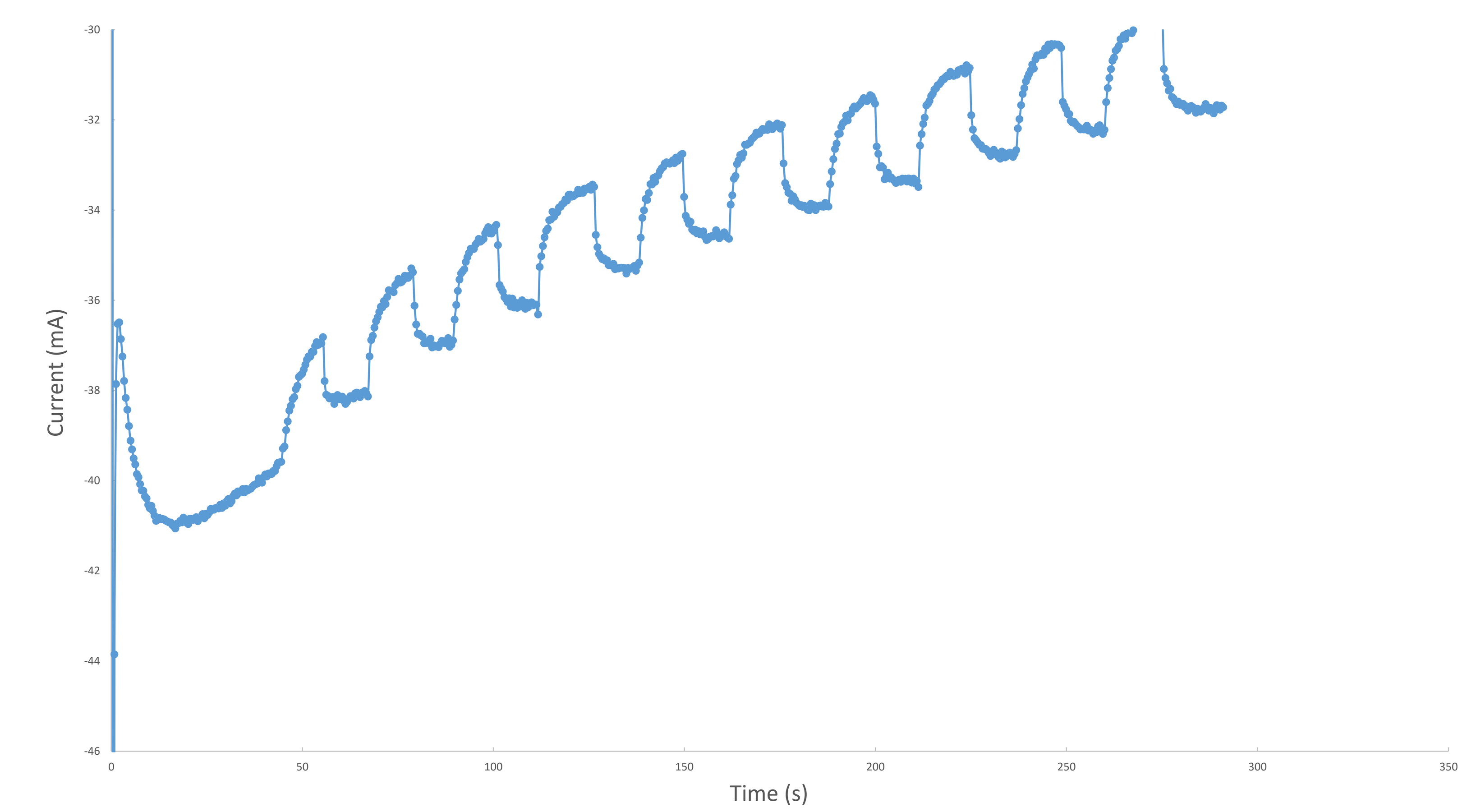
• Light-to-Electricity Tests

- Linear Sweep Voltammetry: In these tests, we scan a range of potentials in order to test the current at each set potential. With the comparison of light on and off, we can see the evident light current when lamp is turned on.

LSV for synthesized TiO_2 in dark versus light settings



- Constant Potential Scan: In these tests, we scan one specific chosen potential over a given period. As we scan, we alternatively turn on and off light to see the produced current as the light is shining on our material.



• Conclusion

As more buildings, cars, mobile devices, and spacecraft are made, the need for newer forms of energy increases. When repeatedly exposed to high intensity light, the synthesized TiO_2 consistently showed increases in current. Our research demonstrates that the TiO_2 has great potential in being a viable candidate for transparent solar cells.

• Acknowledgements

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• References

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