Improving Solar Cell Efficiency

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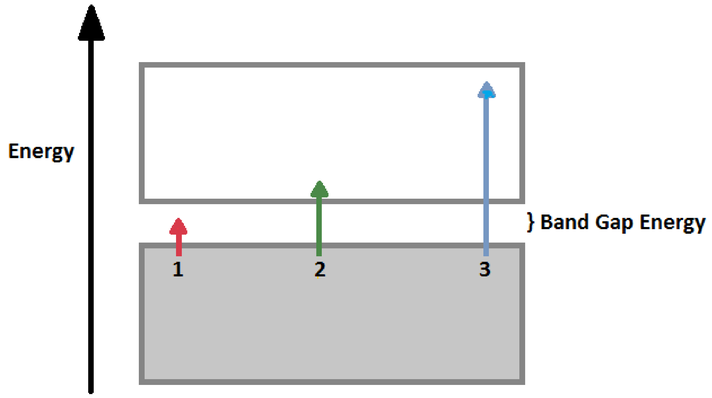
Problems With Solar Cell Efficiency

Solar cells are devices that can create an electrical current by absorbing light. While this process is useful, modern day solar cells are not very efficient at creating electrical energy.

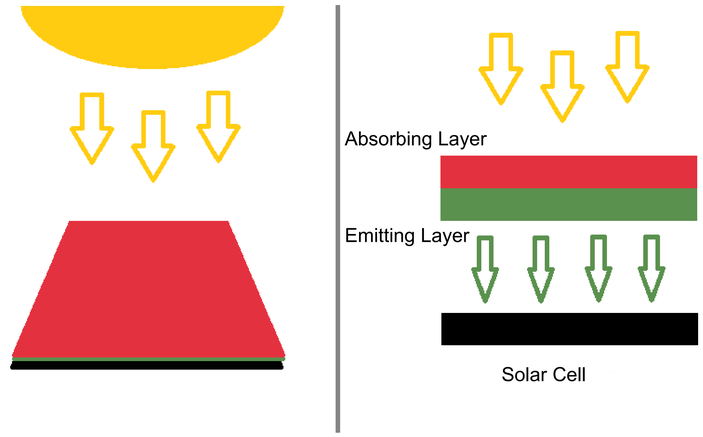
Solar cells are inefficient due to the structure of electron energy states inside of the atoms which compose the solar cell. Because of the energy differences among the states of the electrons inside of the solar cell, only certain energies of light are absorbed efficiently.



1 – Photons with energy under the BGE (band gap energy) are not able to move electrons to a higher band. Energy from this category of photons is converted into thermal energy.
2 – Photons with energy equal to the BGE are able to move electrons to the upper band with little loss to thermal energy
3 – Photons with energy over BGE can move electrons to upper band, but all energy over the BGE is converted into thermal energy

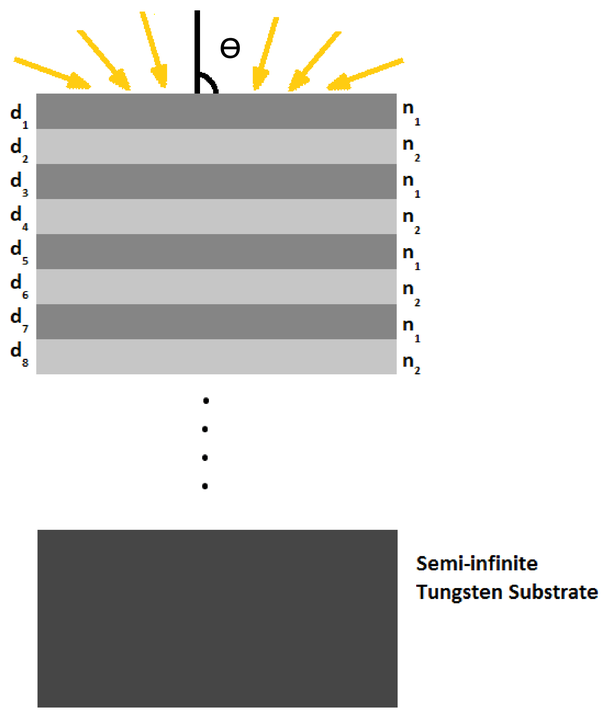
Method for Improving Efficiency

There are many methods for trying to improve solar cell efficiency. The method which our project concentrates on involves implementing a structure which is efficient at absorbing light from all frequencies and then re-emitting the light at a particular frequency. This frequency would ideally be the frequency that corresponds to the band gap energy of the material out of which the solar cell is made. In this structure, the jobs of absorbing and emitting would be assigned to two different sets of layers of the structure. The emitting layer has already been designed for many optics applications; the remaining problem to be solved is the creation of an absorbing layer.



Project Focus: Absorbing Layer

Creating an absorbing layer is a difficult task. This layer must be a highly absorptive structure at all wavelengths of incident light. Additionally, this layer must only absorb light at a narrow angular range. The creation of an absorbing layer that meets these specifications would not only allow solar cell efficiency to be improved, but could also revolutionize global energy generation.

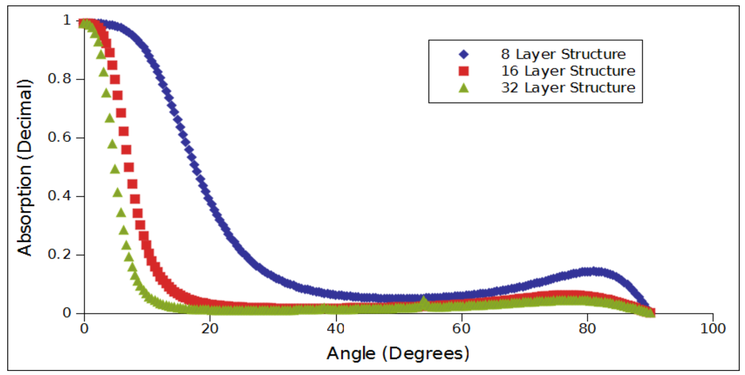


Structure of Absorbing Layer

We expand upon previous research by allowing the absorbing layer to be a non-periodic structure of alternating materials. We generate virtual structures with a program created by my mentor and his graduate student. The same program uses the matrix transfer method to calculate the optical properties of these structures and evaluate how good the structures are for our purposes with a fitness function. Using a genetic algorithm, which iterates over thousands of possible structures, the best structure is found.

Results

The graphs of absorption vs incident angle meet the specifications of being angularly selective and being highly absorptive over a defined wavelength spectrum.



Acknowledgments

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References

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