Reflective Efficiencies of Materials for Applications of Bifacial Solar Cells

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Abstract

The bifacial solar cell is superior to its monofacial predecessor due to its ability to convert both incident light and reflected light into energy. The scattering of the reflected light is affected by the property of the material on which it is interacting. In the first experiment, reflective efficiencies compared to the angle of reflection were explored for different grit of sandpaper in order to develop an understanding of how surface texture impacts reflectivity. Then material that would typically be used in construction are explored using the same techniques. As the world becomes more energy efficient, it's important to understand what building materials should be used to increase solar cell efficiencies.

Background

In modern day construction, solar cells are used to produce energy for homes, businesses, and cities [2]. It is a clean energy that harnesses the light produced by the sun and converts it into usable electricity.

Figure 1. Side view of T.J Day hall, Linfield College, McMinnville Oregon.

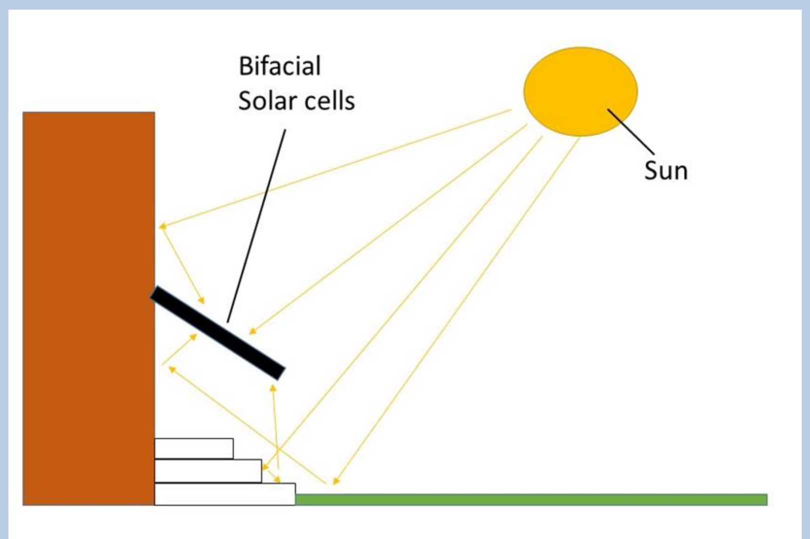

Figure 2. Illustration of Bifacial solar cells absorption of light

Theory

As light is incident upon a material, it reflection is based on the characteristics of the surface's roughness. The efficiency of the reflection is given by the equation

$$\eta = \frac{Reflected\ Power}{Incident\ Power} \times 100.$$

Furthermore, it is expected that the scattering demonstrates behavior similar of normal distribution that can be described as

$$f(\theta) = Ae^{-\beta\theta^2}.$$

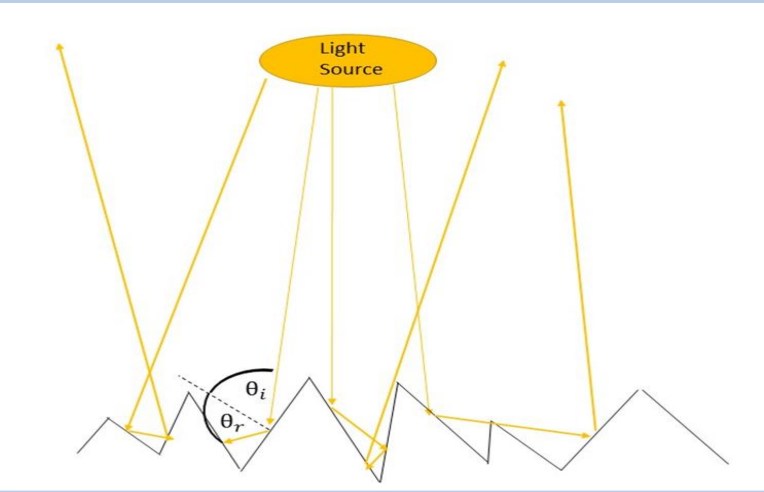

Figure 3. Illustration of light incident on surface of some arbitrary roughness. The light reflects off of the surface determined by the law of reflection.

Experiment

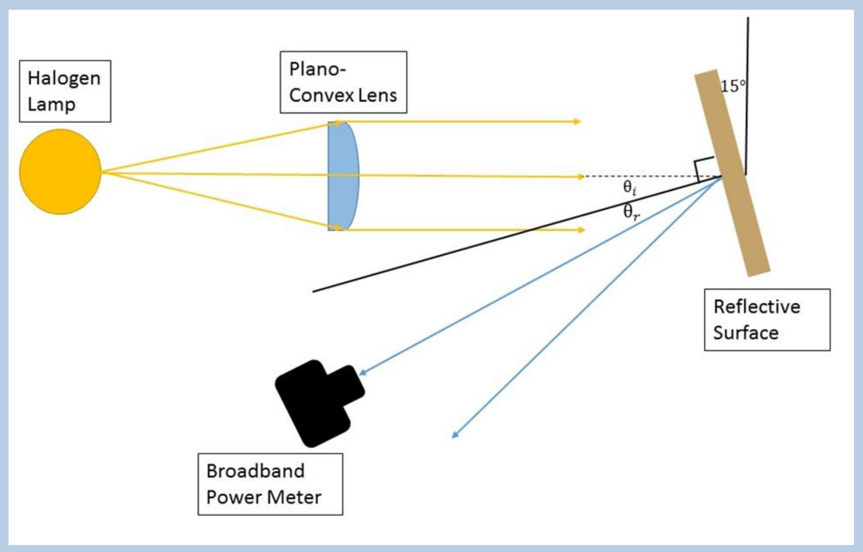

Figure 4. Experimental model for measuring the reflective power for various surfaces.

The halogen lamp is the source that generates the light. The light is then collimated as it passes through the convex lens. As the light comes in contact with the reflective surface it scatters from angles 0 to 90 degrees.

Results

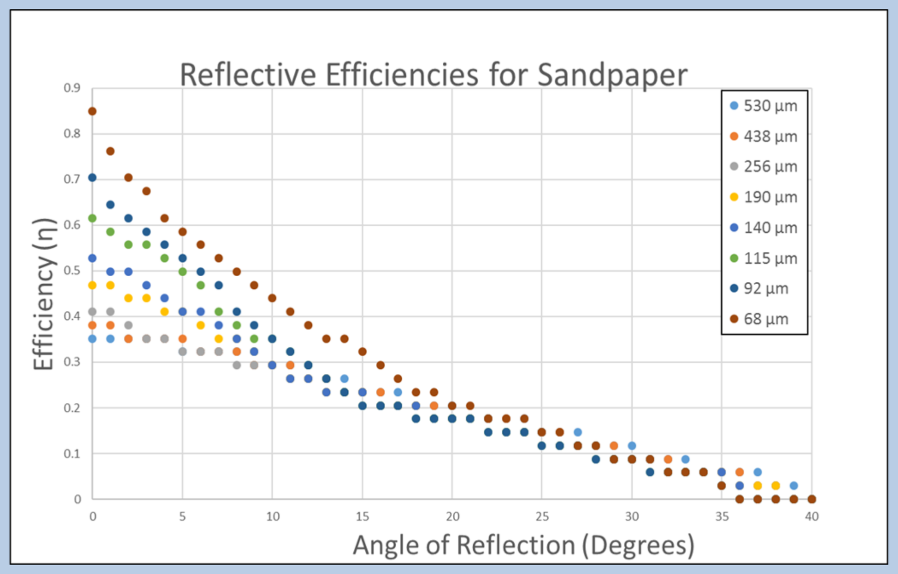

Figure 5. Measurements for the efficiency of reflection by different grit of sandpaper (in terms of average particle diameter) are compared to the angle of reflection.

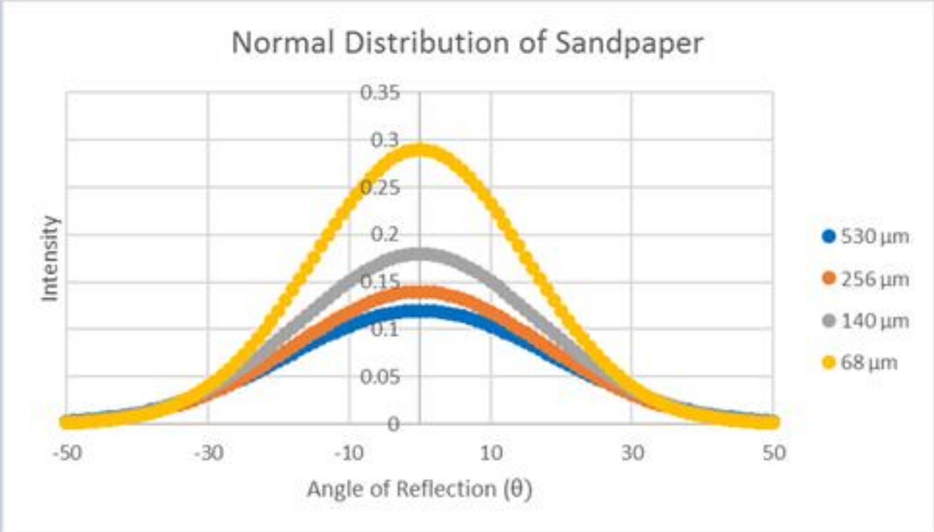

Figure 6. The calculated normal distribution curves for the sandpaper samples

Material	Beta	Average particle diameter (µm)
Red Brick	0.00149	581
Red Brick painted White	0.00215	80
Wood	0.00181	85
Wood Painted White	0.00221	74

Table 2. Beta and average particle diameter values calculated based on measurement for the construction materials.

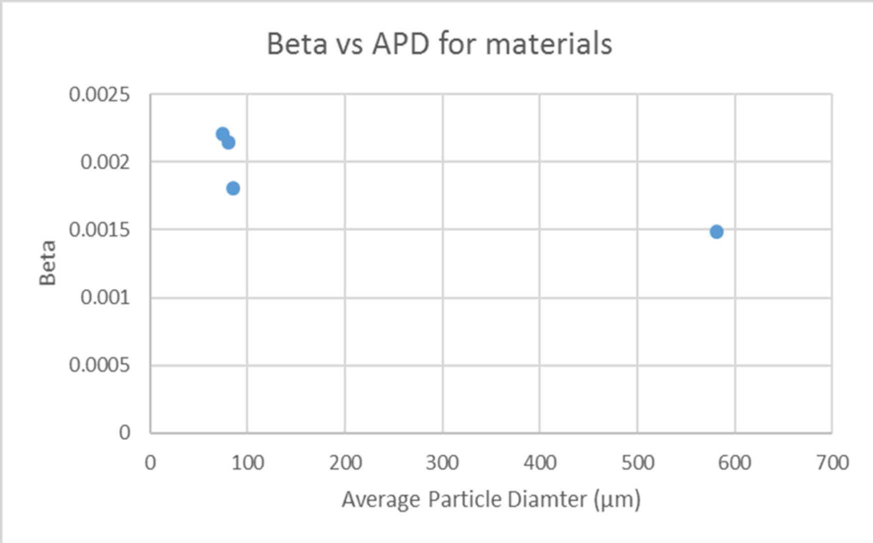

Figure 7. The calculated particle diameters for each material measured and is plotted against their beta value.

Future Work

The current model is simple and more complexities need to be added. Taking the experiment to the field and testing it with actual bifacial solar cells would be a first step. Also, looking at the orientation of the materials relative to the solar cell would be interesting. Another factor to consider would be the zenith angle and how light dispersion through the atmosphere Lastly, investigating at it from a business standpoint and compare the cost to reflective efficiencies.

References

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Acknowledgements

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