Improvement of Efficiency of Solar Cells by Designing Coating Layers

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Introduction

Silicone solar cells are widely used due to its cost and availability. Bare silicone has reflection losses up to %35 due to its refractive index. With solar coating, this reflection loss can be reduced up to %3.

Multilayer coating designs are preferred most because it reduces reflection across wide range of wavelengths. One of them is SiO2/TiO2 due to their refractive indicies and accessibility. This bilayer structure may give better results with more layer, because increasing layer number results better absorbtion performance for wide range of wavelengths. Thus the aim for this Project is to investigate repeating effect of the widely used coatings to get better performance.

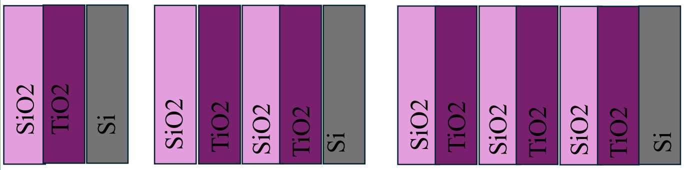

Fig 1. bilayer, double bilayer and triple bilayer coating

Transfer Matrix Method

Transfer matrix method is derived from oblique incidence at interfaces.

Each interface has incoming and reflected waves, relation between these waves' results transmission matrix, D.

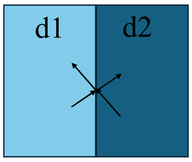

Fig 2. waves across interfaces

Each layer has incoming and reflected waves both at the front and back faces. Relation of these waves called propagation matrix, P.

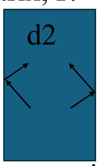

Fig 3. waves through medium

Multiplying these two matrices gives the transfer matrix 'M', the relation of the incident and reflected wave.

$$M = D_{12} \cdot P_2 \cdots D_{nn+1}$$

This mathematical tool is used for simulation of the coating.

Optimization

The efficiency in percentage is:

$$efficiency = \frac{\left(\int_{300nm}^{1200nm} r(\theta,\lambda) * S_{solar}(\lambda) d\lambda\right)}{\int_{300nm}^{1200nm} S_{solar}(\lambda) d\lambda} x100$$

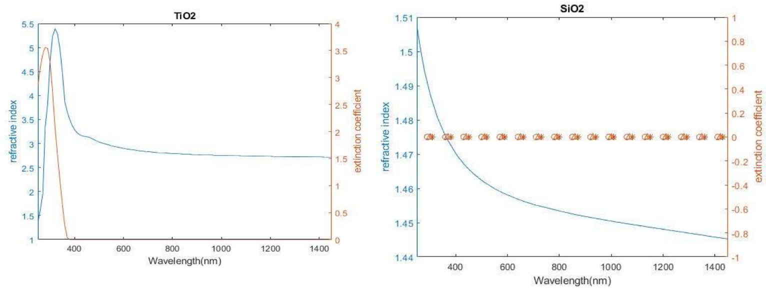

Fig 4. refractive indicies of TiO2 and SiO2

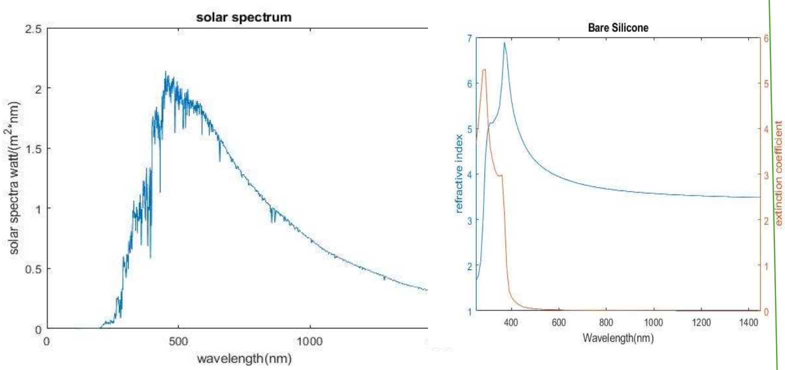

Fig 5. solar spectrum of sun and refractive index of Si

Results and Conclusion

Using single two layers(SiO2/TiO2) for coating gives good results to avoid reflection. However, repeating these two layered structures gave more satisfactory results with no significant increase in thickness. Also, the effect of angle of incidence is minimized and gives better results in all angles.

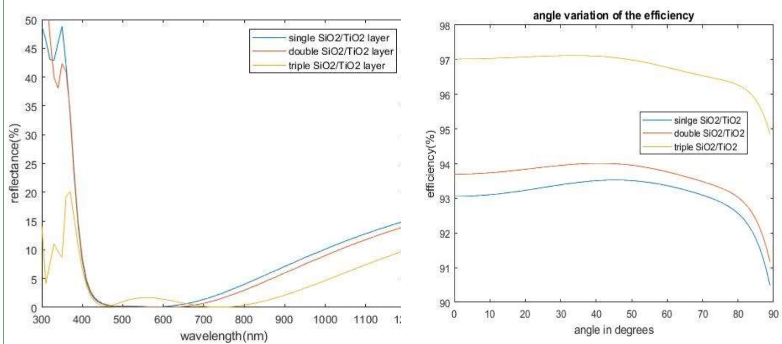

Fig 6. Simulation results of single, double and triple SiO2/TiO2

	d1(nm)	d2(nm)	d3(nm)	d4(nm)	d5(nm)	d6(nm)	Total (nm)	eff
single	105	45					150	93.53
double	102	18	4	28			152	94
triple	89	6	21	11	6	36	169	97.06

Acknowledgement

I thank my supervisor Prof. Dr. Çiğdem Seçkin Gürel for her contributions and her support for this project.