Enabling Improvement in Module Energy Output by Manipulation of Opaque Backsheet Design

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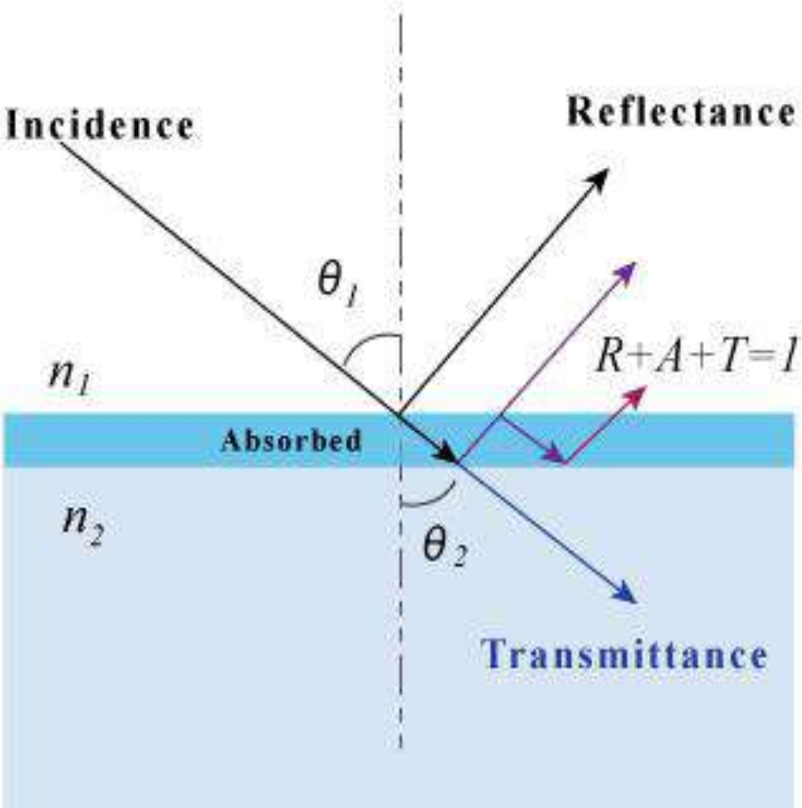
Abstract

The photovoltaic backsheet is a multilayer coated/laminate and a critical component of module construction. It is traditionally designed to protect the internal components of the module OVER TIME from the negative effects of UV radiation, moisture ingress, and other related weather issues. It also plays a significant safety function as the backsheet insulates the electric load of the module. These attributes establish backsheet traditional value. Current paper presents performance data of developed reflective backsheet. Power output as a function of backsheet reflectance is discussed in detail.

Abstract



Backsheets are designed with a certain degree of internal light reflectance (expressed as % Reflectance). A backsheet designed with a higher % Reflectance will have a greater positive impact on module energy output than a backsheet with a lower % Initial Reflectance. Such an impact can be competitively differentiating.

Materials and Methods

Backsheets and their reflectance (400-800nm) are listed in the Table below

Backsheet	Reflectance
1	5
2	73
3	84
4	90
5	93

The measurements were taken for each module/backsheet combination in triplicates, so each backsheet was tested 30 times. Modules without backsheets were tested initially to establish baseline, and were tested between changing the backsheets to ensure that cells were not damaged during backsheets removal.

Materials and Methods

10 modules (213W each) were built using Solartech Energy cells from Taiwan.
Efficiency of the cells was 15.6-16%. 156mm cells (60 total in a 6x12 array) were used.

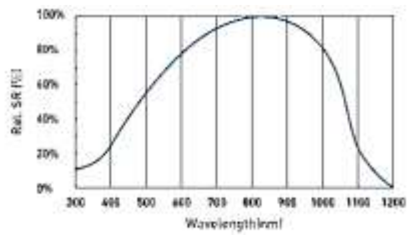
Current [mA/K]	4.71
Voltage [mV/K]	-2.02
Power [%/K]	-0.41

Solderability

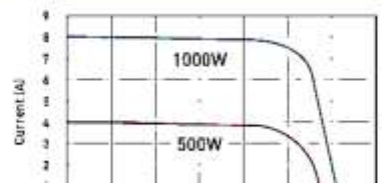
Ribbon	Sn - Pb - Ag	62 % - 36 % - 2 %
Flux	Kester	955
Soldering Temp.	Preheating Temp.	180 ~ 230°C
	Heating Temp.	180 ~ 230°C
Condition	Heating duration	3 Sec
	Applied pressure	170 ~ 200 g

Light Intensity Dependence

Intensity [W/m²]	Vmpp	Impp
1000	1.000	1.000
800	0.998	0.799
600	0.991	0.599
400	0.981	0.397



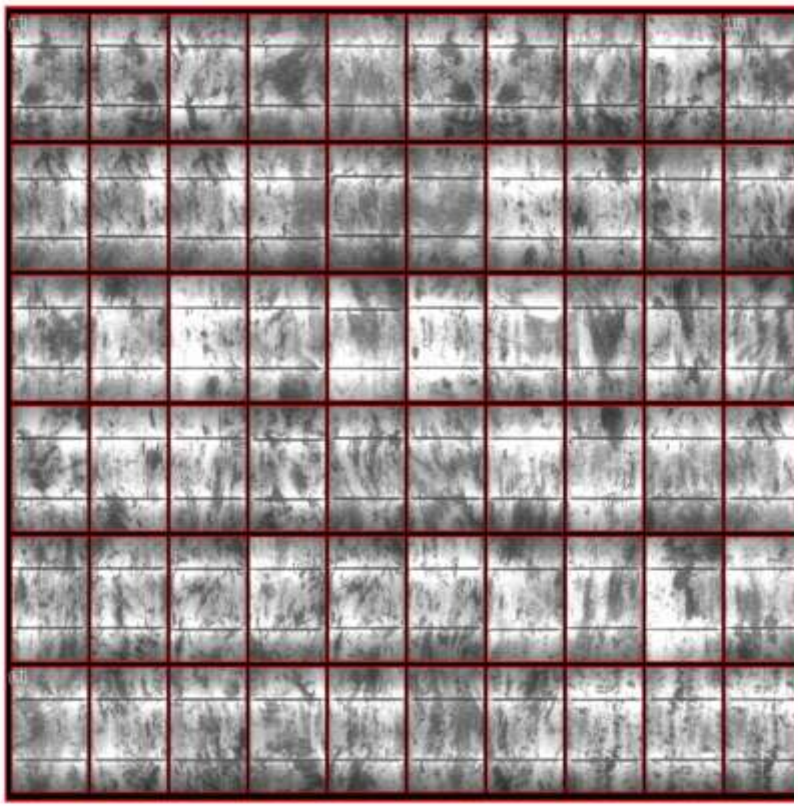
IV-Curve

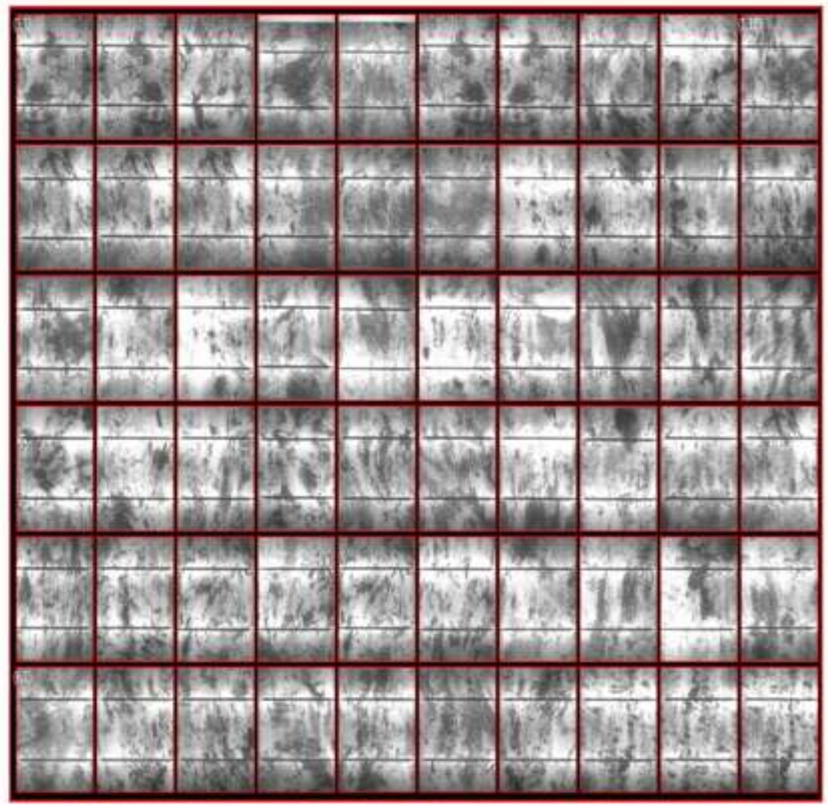


Materials and Methods

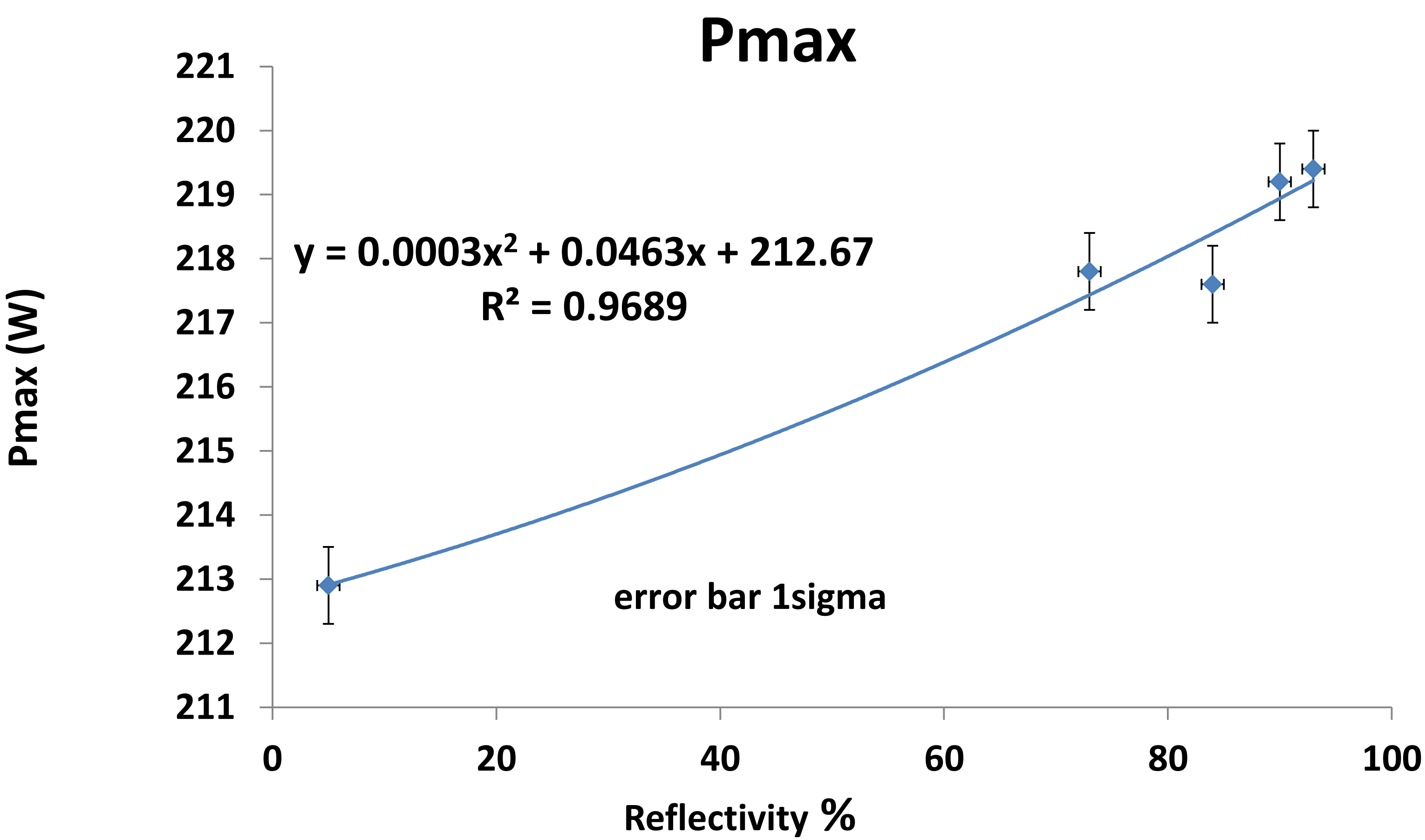
- 2mm spacing was spaced between the cells and strings. The tempered low iron glass from Borosil with dimensions 976x1633x4mm was used.
- Encapsulant STR15295P/UF with thickness on both sides .45mm / ~0.018inch was used.
- Solar simulator used was the SLP4600, and vacuum laminator SP 580.
- Vacuum lamination process was a follows. 155˚C/330sec pump/720sec press for initial lamination. Then lamination temperature was reduced to 100˚C with a 5 minute press to allow for backsheets application/removal. 976x1633mm size of backsheets was used.
- Electroluminescence after each vacuum lamination was used to ensure that no cracks were developed during backsheet removal/vacuum lamination

Results and Discussions: Electroluminescence pictures after backsheet removal

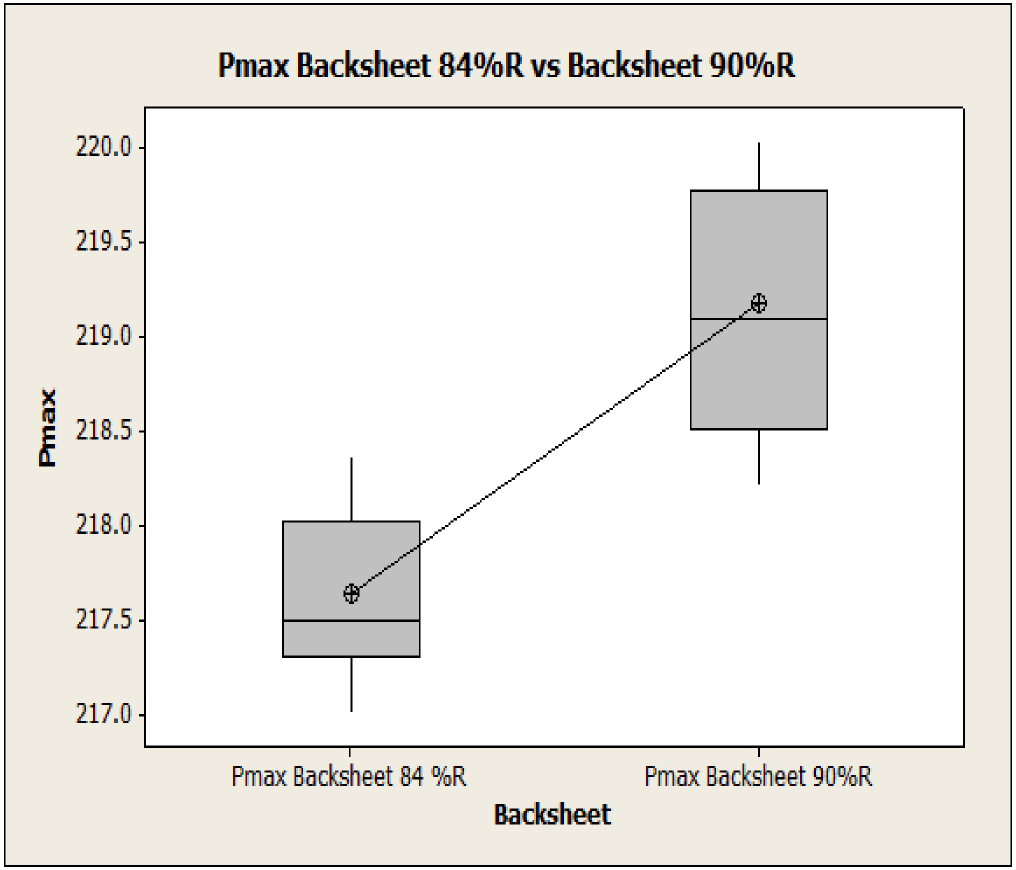




Results and Discussion: Pmax as a f(backsheet reflectivity)



Results and Discussions: Effect of backsheet reflectance on power output

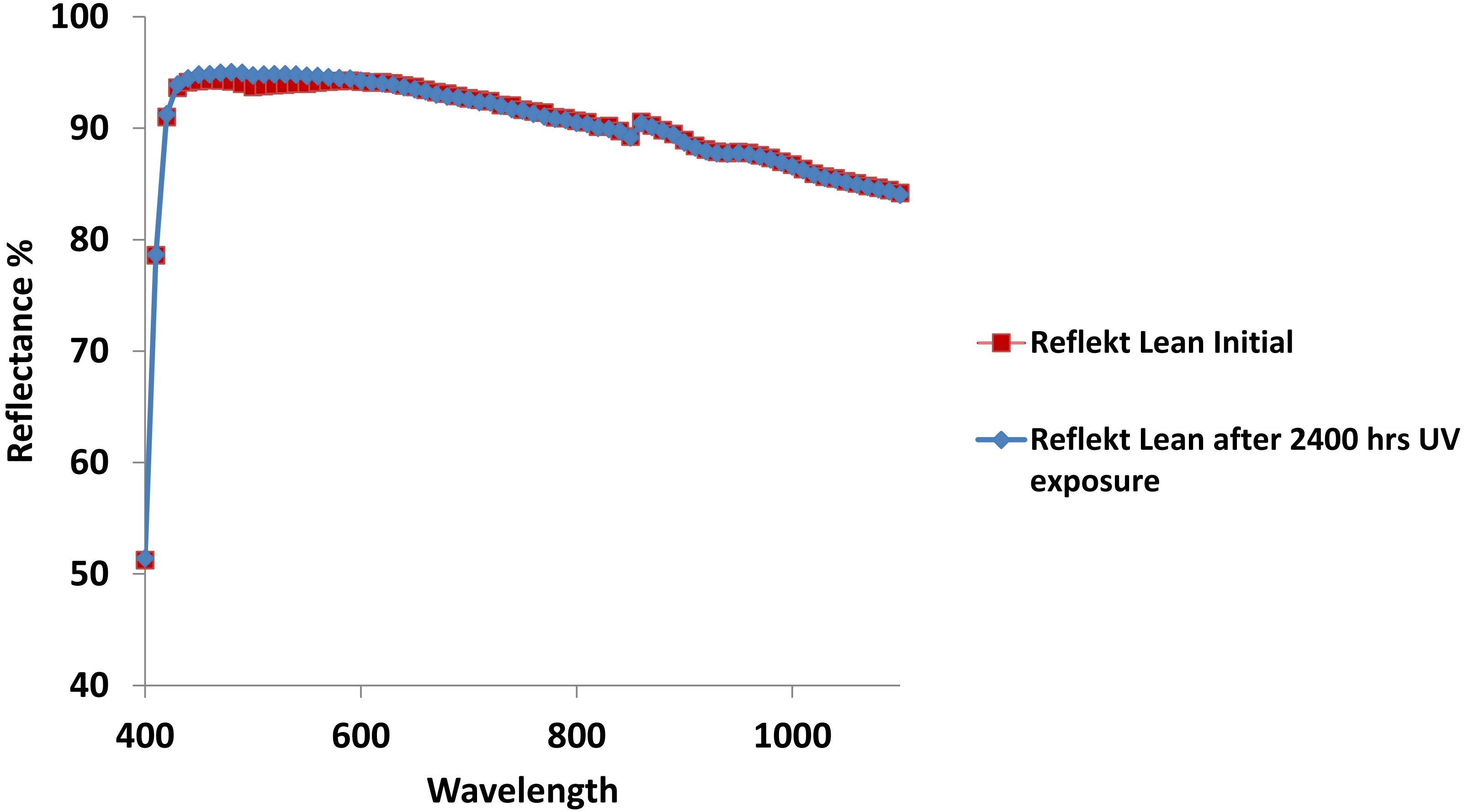


Mann-Whitney Test and CI: Pmax Backsheet 84%R, Pmax Backsheet 90%R

	N	Median
Pmax Backsheet 90%R	32	219.10
Pmax Backsheet 84%R	32	217.50

Point estimate for ETA1-ETA2 is **1.60**
95.1 Percent CI for ETA1-ETA2 is (1.20,1.82)
W = 1538.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at **0.0000**

Reflectance Longevity



Conclusions

- Backsheet reflectance does affect module power output.
- Average Pmax increase between Backsheet with 84% reflectance and Backsheet with 90% reflectance) for 10 modules is 1W, or ~0.5%
- P max increase varies from module to module
- Reflectance is not affected by UV exposure (2400 hrs)

References

- UL 746C Polymeric Materials - Use in Electrical Equipment Evaluations
- UL 1703 Flat-Plate Photovoltaic Modules and Panels
- IEC 61215/1 Crystalline silicon terrestrial photovoltaic (PV) modules Design qualification and type approval
- ASTM E424-71 Standard Test Methods for Solar Energy Transmittance and Reflectance (Terrestrial) of Sheet Materials
- ASTM D3359-09 Standard Test Methods for Measuring Adhesion by Tape Test
- ASTM D882-10 Standard Test Method for Tensile Properties of Thin Plastic Sheeting
- ASTM D903-98 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
- ASTM E308 – 08 Computing the Colors of Objects by Using the CIE System