

Anti-glare Solution

DAS Solar

June 2023

www.das-solar.com

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01

Glare Analysis



Glare: Unsuitable brightness distribution in view with extreme brightness contrasts, resulting in visual discomfort and visual conditions that reduce the visibility of objects.



In actual application, glare is mainly caused by the reflection of outdoor strong light on lenses or other surfaces, which has impact on the eyes and causes eye discomfort, and the glare may cause danger during driving or outdoor sports.

Glare is often evaluated by Unified Glare Rating(UGR), a way International Commission on Illumination (CIE) used to measure the psychological parameters of the subjective response of light emitted by lighting devices in indoor visual environments to the human eye.

$$UGR = 8 \cdot \log \left(\frac{0.25}{L_{Background}} \right) \sum_n \left(\frac{L^2 \omega}{p^2} \right)$$

L: Brightness of each lighter of the observer (cd/m²)

L_{Background}: Brightness of background(cd/m²)

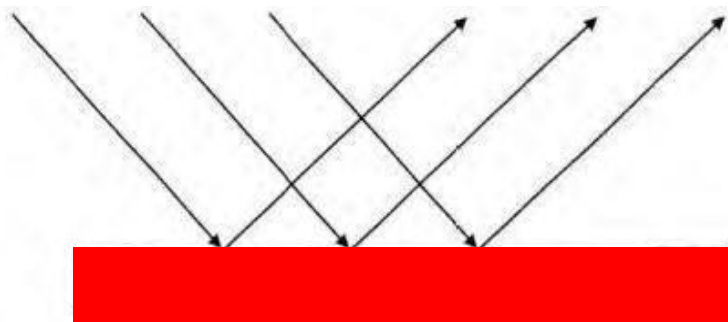
ω: The stereoscopic angle of each lighter to the observer

P: Position index of each individual lighter

02 Anti-glare Solution

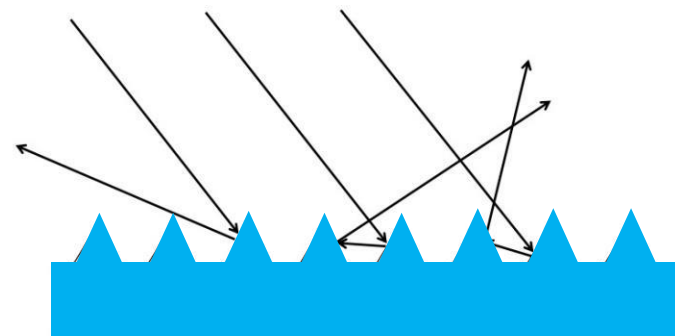


Anti-glare Theory: Increase the roughness of the glass surface, turn specular reflection into diffuse reflection, and avoid the reflected light from concentrating together to achieve the anti-glare function.



(a) 光滑玻璃表面的镜面反射

Specular Reflection



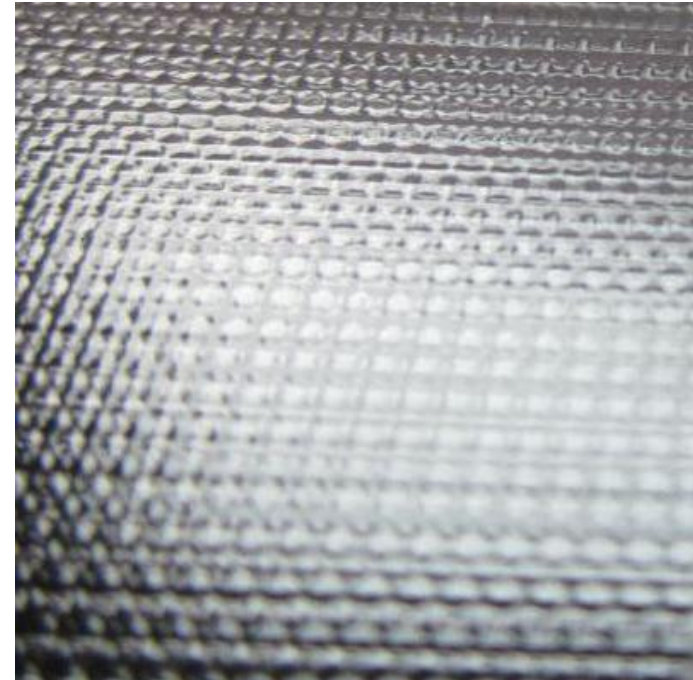
(b) 粗糙玻璃表面的绒面反射

Diffuse Reflection

Anti-glare glass: Prepare an undulating pyramid shape on the surface of glass to increase the roughness of the module surface and avoid glare。

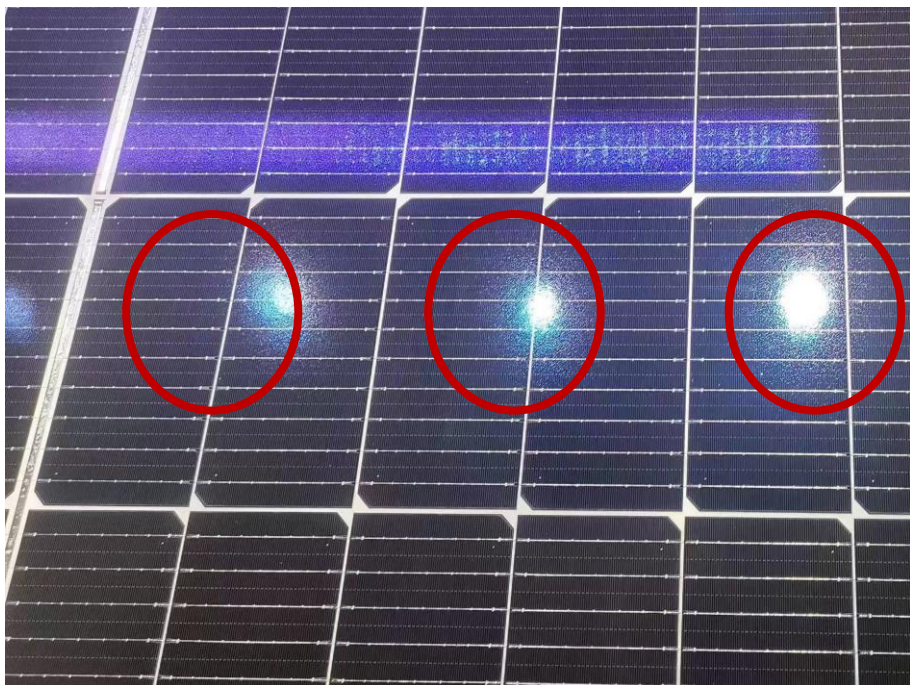


Surface of normal PV glass

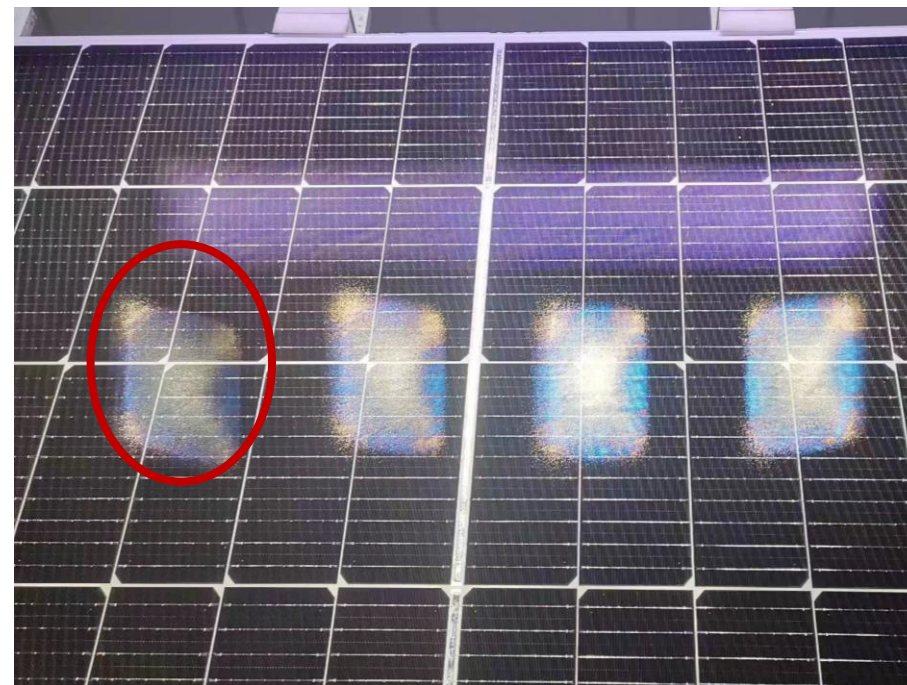


Surface of anti-glare PV glass

Anti-glare glass can turn the light reflected by the component into diffuse reflection, thus avoids the dazzling light spots caused by the concentrated reflection light.



Normal PV module



Anti-glare PV module

03 Test Result

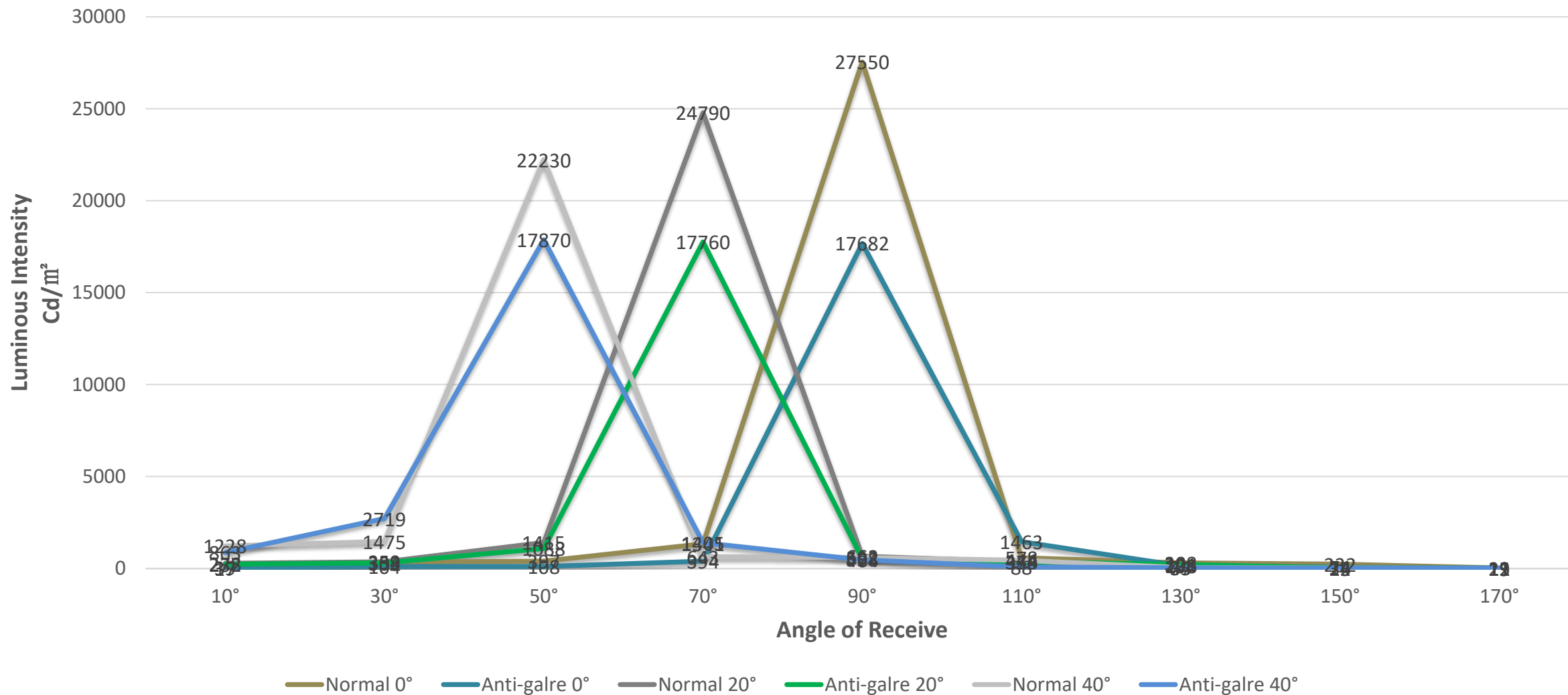


Inspection	Items	Standard	Tolerance	Inspection Result		
Dimension Inspection	Length.mm	1716	+1/-2	1716	1716	1716
	Width.mm	1128	+1/-2	1128.5	1128.5	1128
	Thickness.mm	2	±0.2	2.03	2.02	2.02
	Chamfer.mm	1.0-4.0		3	3.5	3.2
	Diagonal Tolerance.mm	Diagonal 1		2049	2049.2	2049
		Diagonal 2		2049	2049	2049.1
	Entirety Bow.mm	< 0.5		0.22	0.25	0.22
Basic Parameters	Partial Bow.mm	< 0.5		0.35	0.35	0.35
	Toughness.μm	0.3~1.2 um		0.711	0.663	0.768
	transmittance	93.80%		93.88%	93.89%	93.89%
	Hardness	≥3H		OK	OK	OK
	Residual Gum Content	Pressing 20cm ² 3M tape, Residual gum < 1cm ²		OK	OK	OK
	Thickness of AR Coating	120±20		125	128	125

According to the glare test report from CPVT (China Photovoltaic Test Center) in May 2023, DAS Solar Anti-glare module has an apparent decrease on glare compared with normal module.

Module	Angle of incidence (°)	Angle of Receive(°)									
		10	30	50	70	90	110	130	150	170	
Standard DH108NA	0	39	334	397	1341	27550	578	308	232	25	Luminous Intensity (cd/m²)
Anti-glare DH108NA		17	104	108	394	17682	1463	138	74	19	
Standard DH108NA	20	278	359	1415	24790	662	374	74	34	12	
Anti-glare DH108NA		232	303	1088	17760	528	358	221	25	11	
Standard DH108NA	40	1228	1475	22230	643	592	444	45	22	11	
Anti-glare DH108NA		863	2719	17870	1405	464	88	37	14	11	

Anti-glare Test

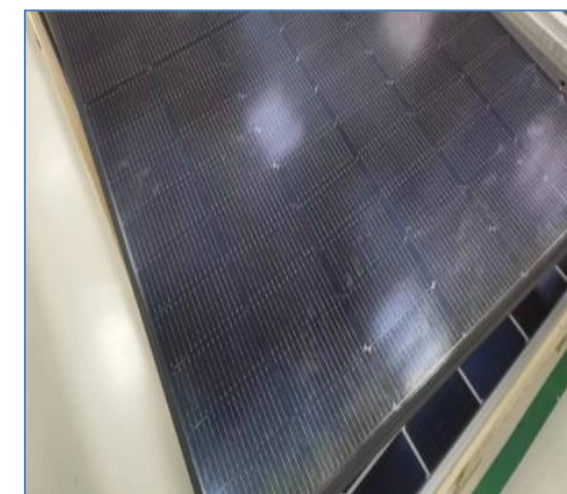


Items	Standard	Test Result	Judgement
Clean Test	$\leq 1\%$	0.18%	PASS
Acid Resistance Test	$\leq 1\%$	0.24%	PASS
Salt Spray Test	$\leq 1\%$	0.28%	PASS
Thermal Cycle Test	$\leq 1\%$	0.28%	PASS
Humidity Freeze Test	$\leq 1\%$	0.24%	PASS
Damp-Heat Test	$\leq 1\%$	0.39%	PASS
UV Test	$\leq 1\%$	0.19%	PASS
Dust and Sand Test	$\leq 1\%$	0.49%	PASS
Ammonia Resistance Test	$\leq 1\%$	0.32%	PASS
PCT 48H	$\leq 1\%$	0.48%	PASS
Adhesion Test	Level 0	Level 0	PASS
Boiling Water Adhesion Test	Level 0	Level 0	PASS
Heat Impact Test	No damage	No damage	PASS
Hail Test	No damage	No damage	PASS
Static Mechanical Load Test	No damage	No damage	PASS

- Anti-glare modules pass the inspection test and reliability test.

Reliability Test

Items	Sample	Pmax (before test)	Pmax (after test)	Degradation	Judgement
25mm Hail Test	#1	423.02	422.24	0.18%	PASS
4 inner mounting holes Static Mechanical Load Test (+5400-2400)	#2	424.95	421.62	0.78%	PASS
4 outer mounting holes Static Mechanical Load Test (+2400-2400)	#3	422.67	420.88	0.42%	PASS
¼ Clamps Static Mechanical Load Test (+5400-2400)	#4	422.645	422.548	0.02%	PASS



Conclusion



- Anti-glare PV glass with multi-pyramids shaped surface can be adopted to achieve the anti-glare of PV module.
- Both DAS Solar anti-glare module and the anti-glare PV glass used have passed the reliability tests.
- Compared with normal module, DAS Solar Anti-glare module has an apparent decrease on glare.

THANK YOU