

Solar Module Composite Frame



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01

Raw Materials and Process

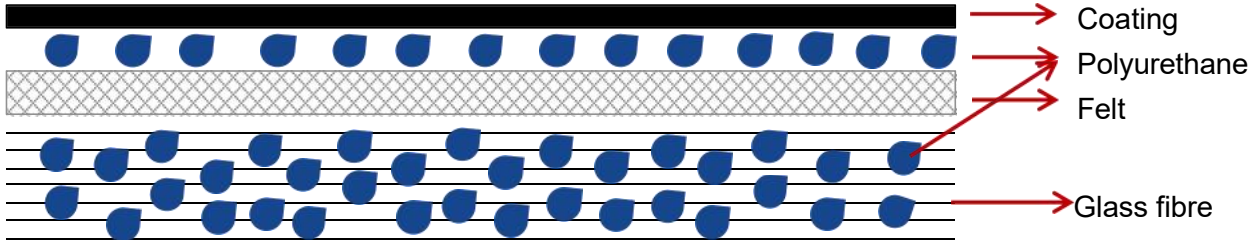


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Composition of raw materials



Corner Code

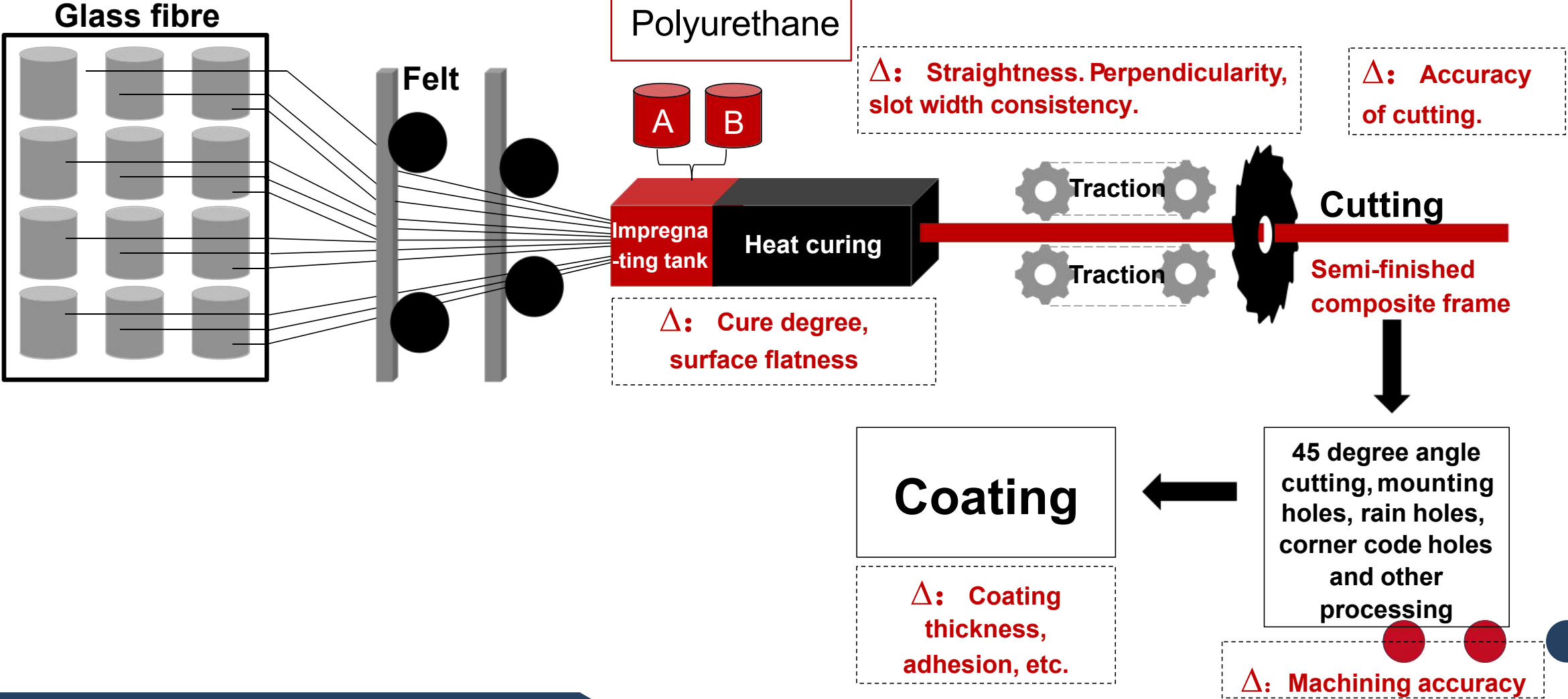


Raw Materials	Main Function
Glass fibre	Mechanical strength
Polyurethane	Matrix resin
Coating	Anti-UV
Felt	Transverse strength
Corner code	Connect



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Process flow



Basic characteristics of composite frame

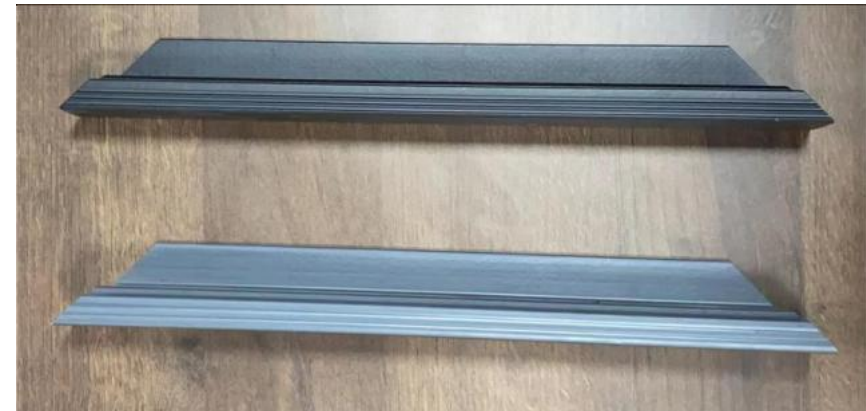
Basic properties of polyurethane

Property	Unit	Range
Density	g/cm ³	2.00~2.10
Barr Hardness (without coating)	Hba	>40
Tensile strength (MD)	Mpa	1000~1300
Bending strength (MD)	Mpa	1200~1700
Bending modulus (MD)	Gpa	≥40
Volume resistivity	Ω·m	> 10 ¹⁴
Shear strength	Mpa	50~60
Thermal deformation temperature (HDT)	°C	240~250
DH (85%Temperature and 85%humidity)	h	2000



Basic properties of coating

Property	Unit	Range/result
Thickness	μm	30~40
Glossiness/60°		<30
Color		Black or customized
Hardness		≥2H
Barr hardness		40Hba (without coating)
Adhesive force		≤ 1 (After aging)
Wear resistance/sand removal	L	>150L, or customized

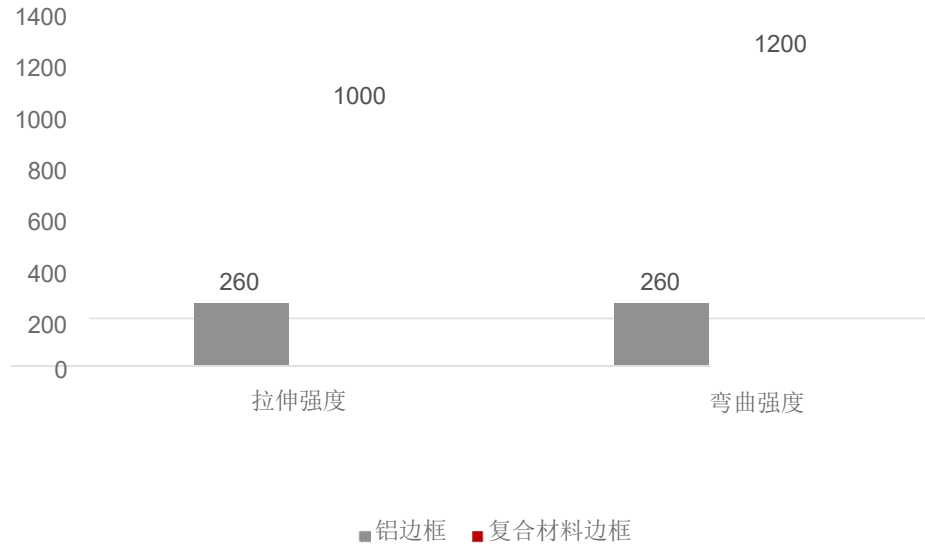


02

Advantages of GFRP Composite Frames



Advantage 1: Excellent mechanical properties, higher load resistance



2382*1134*30 Double Glass Solar Module

Static loading:

Positive pressure **7000pa** P Mounting



Negative pressure **3600pa** P **Block/ Bolt**

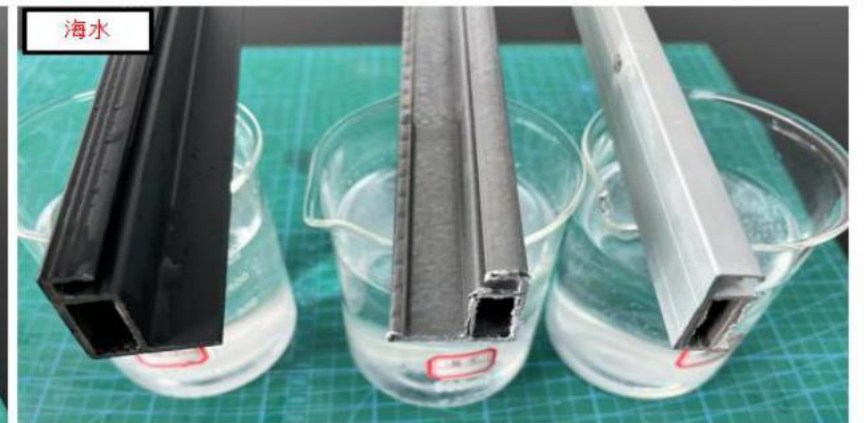
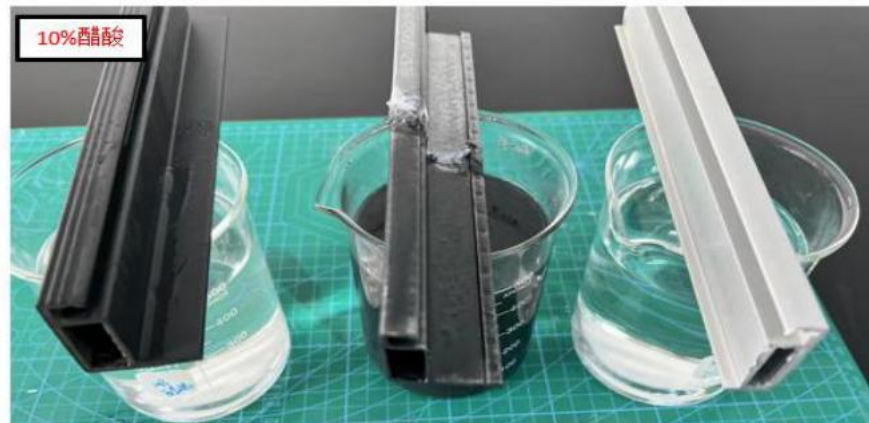
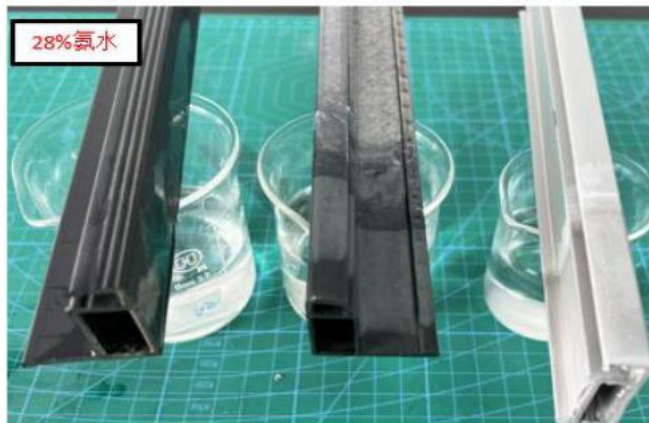
Test results:

Pressure	Cycle time	Cycle index	Wind level	Mounting
±1500	10s	20000	15	Block/Bolt



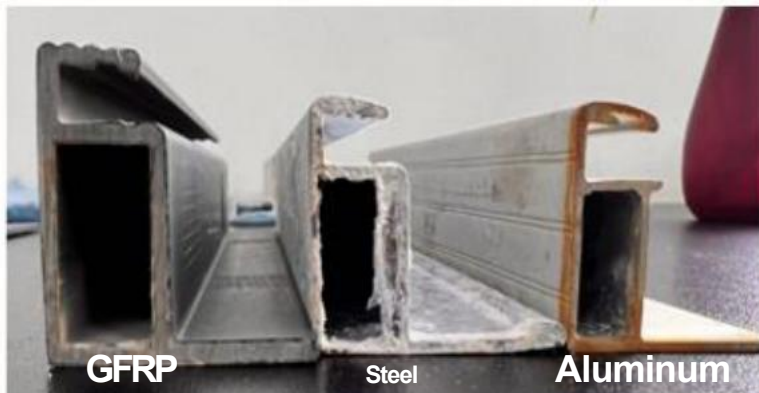
Advantage 2: Excellent chemical resistance

Solvent	Adhesive force	Fexural modulus Mpa	Modulus retention rate %	Bending strength Mpa	Strength retention rate %	Test result
Standard	0	32656	100	1358	100	
25% Ammonium hydroxide	1	30738	94.13	1255	92.44	
10% Acetic acid	0	29496	90.32	1253	92.29	
66.8% Seawater	0	29175	91.57	1307	96.27	
10% NAOH	1	30422	93.16	1217	89.64	



Advantage 3: Excellent resistance to salt spray corrosion

Sample No.	Initial			5000h					9500h				
	Adhesive force	Bending strength/ Mpa	Tensile strength/ Mpa	Adhesive force	Bending strength/ Mpa	Strength retention rate	Tensile strength /Mpa	Strength retention rate	Adhesive force	Bending strength/ Mpa	Strength retention rate	Tensile strength/ Mpa	Strength retention rate
#1	Class 0	1526	1184	Class 0	1428	93.54%	984	83.10%	Class 0	1356	88.85%	1051	88.81%
#2	Class 0	1481	1148	Class 0	1338	90.36%	1053	91.74%	Class 0	1266	85.45%	1020	88.79%
#3	Class 0	1421	1185	Class 0	1331	93.67%	1055	89.04%	Class 0	1253	88.15%	955	80.59%
#4	Class 0	1402	1141	Class 0	1270	90.56%	1042	91.34%	Class 0	1256	89.58%	978	85.70%
#5	Class 0	1450	1201	Class 0	1274	87.88%	1099	91.53%	Class 0	1302	89.81%	1041	86.67%



Appearance of different frames after salt spray test



GFRP paint adhesion testing results after salt spray resistance test




A picture of the rusty aluminum frame of the solar module from an offshore PV power station

Advantage 4: Ultra-low carbon emissions

According to the latest US EPEAT certification system (EPEAT-ULCS-2023): low carbon components < 630g/w, ultra-low carbon components <400g/w.

ATTESTATION

ATTESTATO



Product Carbon Footprint Verification Statement China

No. P2GHG 119651 0002 Rev. 00

Product Type: WL-303-B30, WL-303-B35, WL-303-B40

Product Carbon Footprint:

Product Type	Product Carbon Footprint
WL-303-B30	3.73 kgCO ₂ e
WL-303-B35	3.71 kgCO ₂ e
WL-303-B40	3.67 kgCO ₂ e

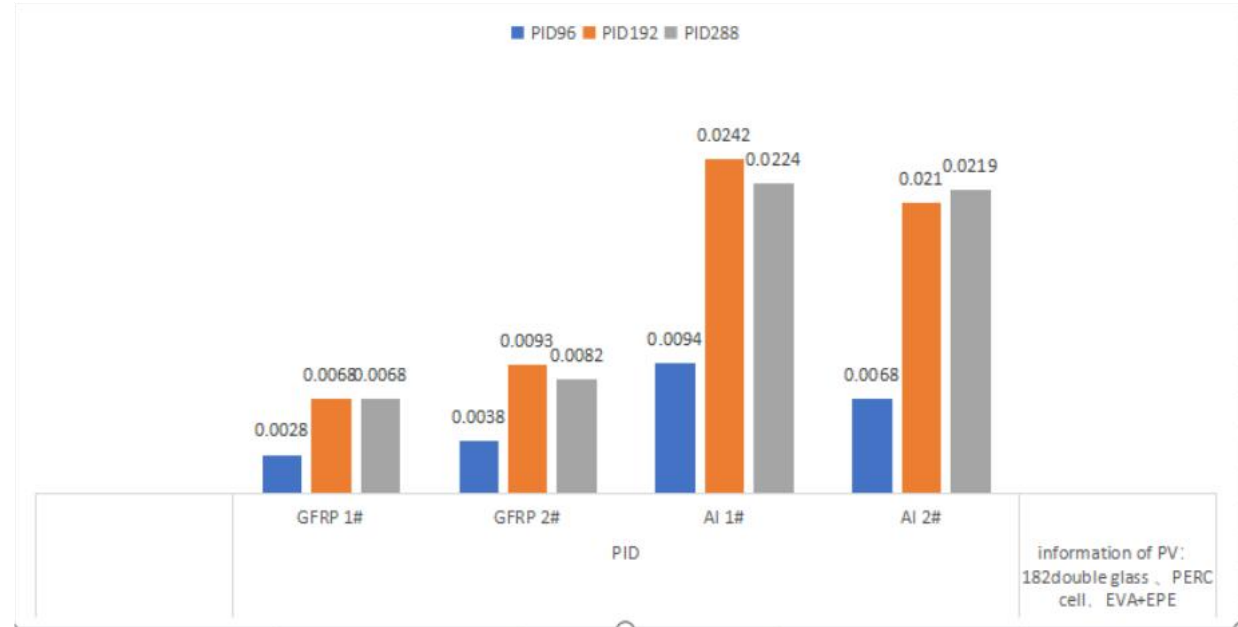
The carbon emission of this product, 3.7KgCO₂/Kg, is only **15%** of that of the aluminum frame, 24.2KgCO₂/Kg.



Advantage 5: The GFRP frame has excellent thermal insulation properties and are effective in reducing PID.

Product	PID96	PID192	PID288
	Front	Front	Front
GFRP1#	0.28%	0.68%	0.68%
GFRP2#	0.38%	0.93%	0.82%
Al frame 1#	0.94%	2.42%	2.24%
Al frame 2#	0.68%	2.10%	2.19%

Remarks: 182 double glass, PERC battery, EVA+ co- extruded, POE package, without copper foil.

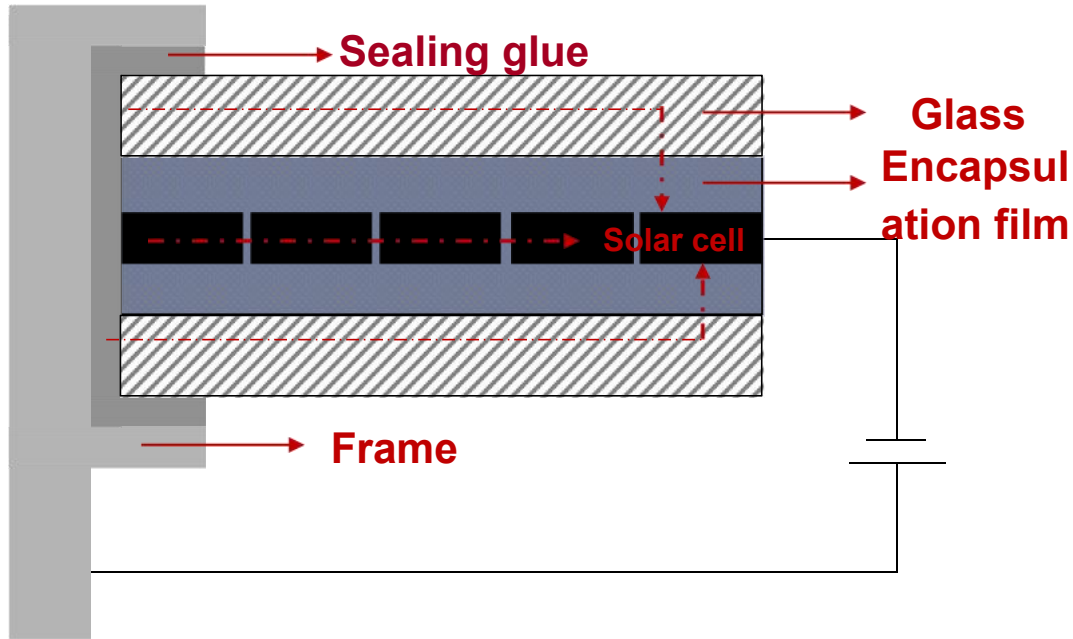


Test results shows: To compare with aluminum frame, composite frame can effectively reduce PID effect.



Excellent PID resistance

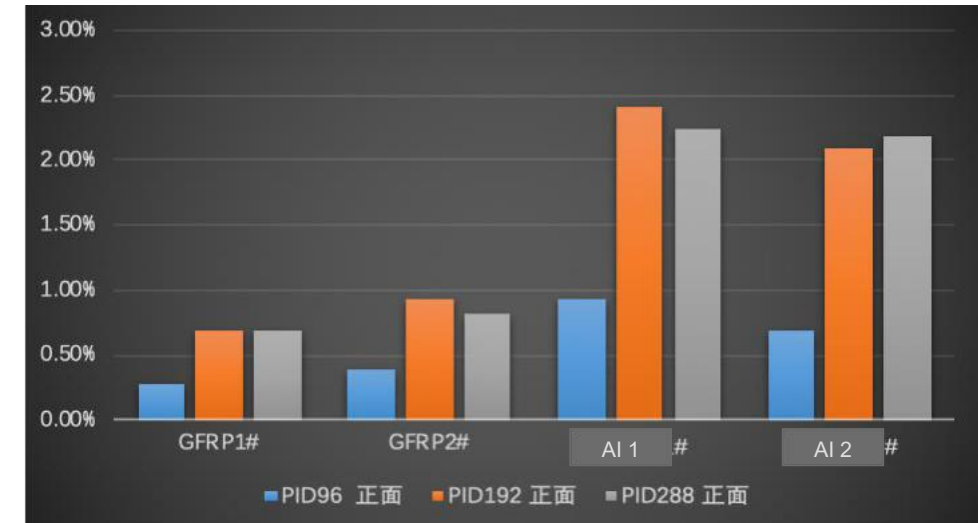
The high voltage present between the circuitry in a crystalline silicon photovoltaic module and its grounded metal bezel causes a sustained degradation of the module's photovoltaic performance, referred to as **Potential Induced Degradation (PID)**



Conditions that occurs PID phenomenon:

- High temperature/high humidity environment.
- Contamination of modules surfaces with ionic substances such as acids and alkalis.
- Voltage bias exists between the circuit and the metalgrounding bezel

Category	PID96	PID192	PID288
	Front side	Front side	Front side
GFRP1#	0.28%	0.68%	0.68%
GFRP2#	0.38%	0.93%	0.82%
AI Frame1#	0.94%	2.42%	2.24%
AI Frame2#	0.68%	2.10%	2.19%



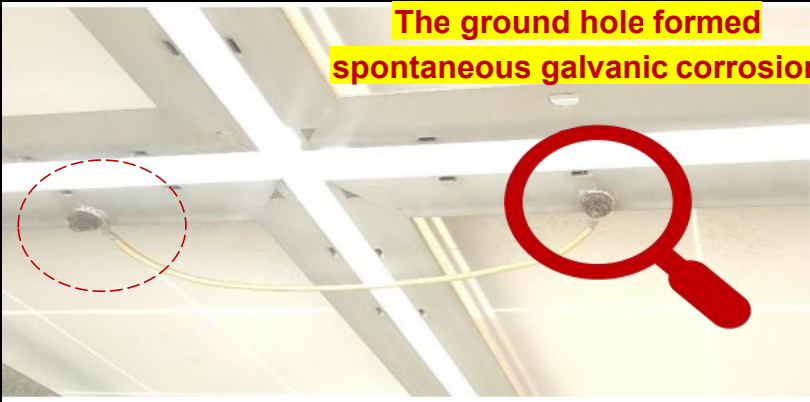
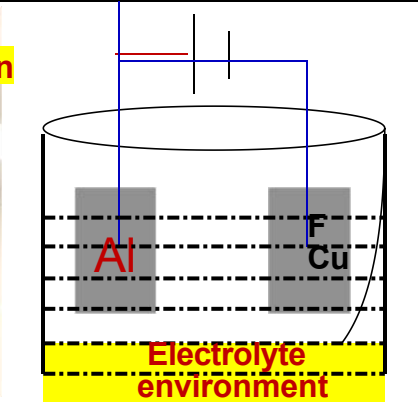


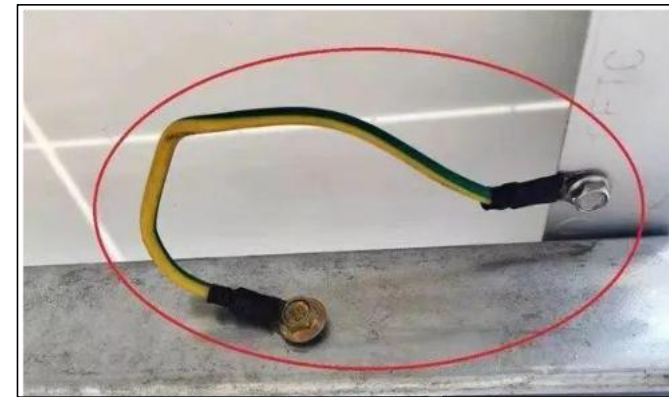
The volume resistivity of the composite frame GFRP is $>10^{14}\Omega\cdot m$, which is an insulating material and can effectively reduce the PID effect.

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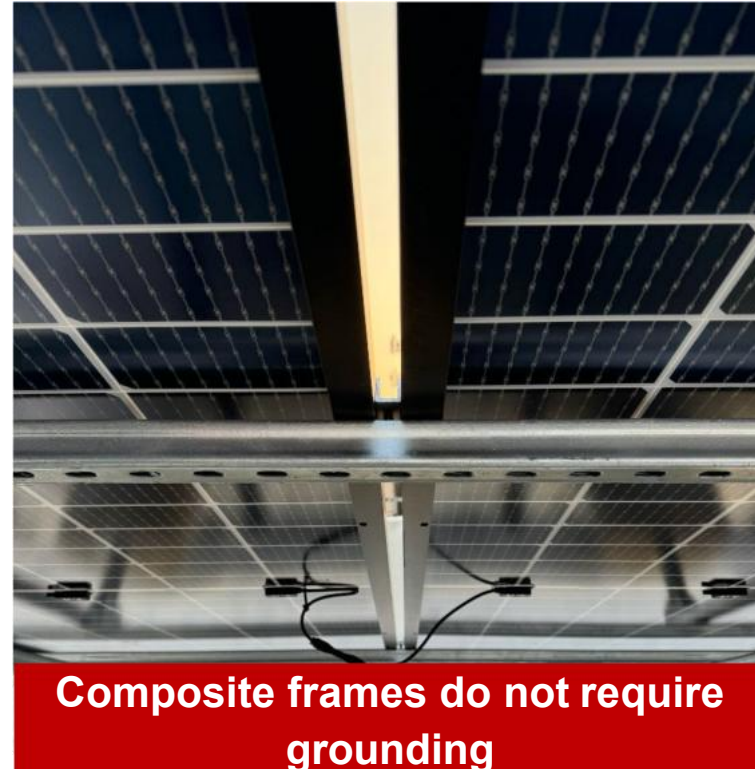
Advantage 6: Typically, strings must be connected to each other. GFRP frames are insulating materials with a volume resistivity $> 10^{14} \Omega\text{-m}$ and do not require grounding. Therefore, the use of composite frames can help reduce costs for the end user.

● There is a significant risk of grounding when metal frames to be used in offshore power plants.

Accessories	Schematic Drawing	Connection Type
		Place star washers, flat washers (Fe), and ground wires (Cu) in sequence, thread screws through the ground holes (Al), and tighten them to secure adjacent components
 <p>The ground hole formed spontaneous galvanic corrosion</p>		 <p>Al Cu Electrolyte environment</p>



| No grounding required



● Composite frame can save the EPC installation cost and O&M fee



Advantage 7: Less bending at low temperature

Type of frame	Coefficient of thermal expansion $\mu\text{m}/(\text{m}^{\circ}\text{C})$	Type of modules	25°C	10°C	-5°C	-20°C	-40°C	ΔL (mm)
Aluminum	23.2	Single glass 35	3.5	5.5	6.5	9	11.5	8
			2.5	5	5	9	10.5	8
		Single glass 30	2	4.5	2	9	12.5	10.5
			7	11	9	18	20.5	13.5
		Double glass 35	3	3.5	4	5.5	6.5	3.5
			2.5	3	3	5.5	5	2.5
		Double glass 30	1.5	4	6.5	9	10.5	9
			1	3.5	4	7	11	10
GFRP	4	Double glass 30	3	/	/	/	2.5	-0.5
			5	/	/	/	4.5	-0.5
Glass	9	/	/	/	/	/	/	



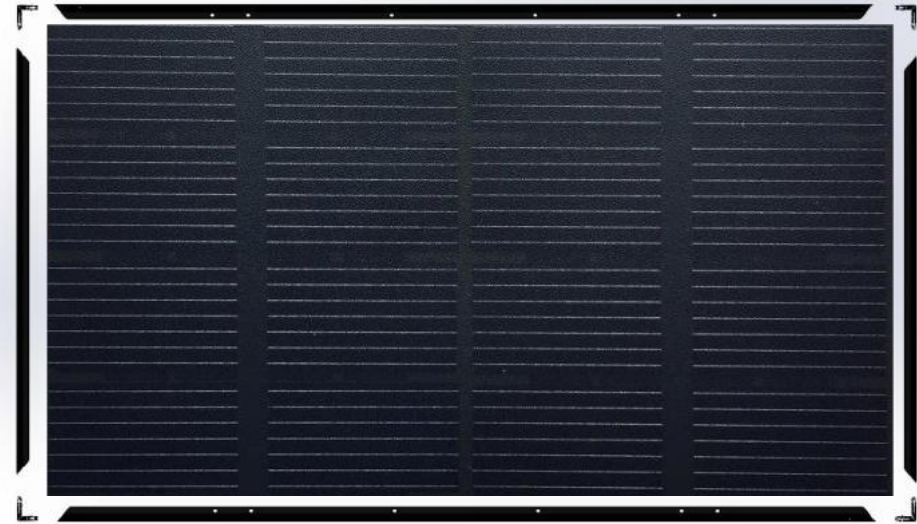
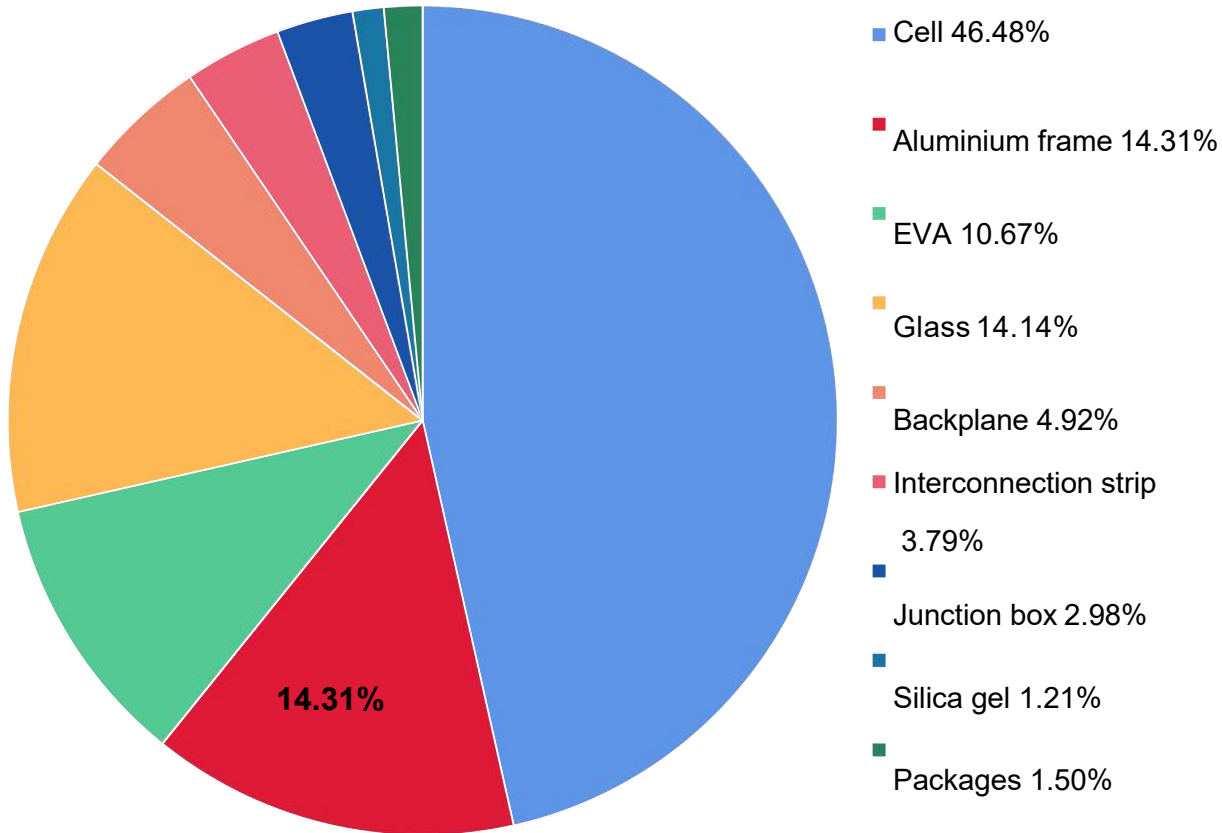
The thermal expansion coefficient of GFRP is close to that of glass, which can resist the following hazards caused by large differences in low temperature bending:

- ◆ The stress relaxation occurs in the installation of block and bolt under long-term high and low temperature cycle
- ◆ The aluminum alloy frame shrinkage and bursting glass risk under



| Advantage 8: Cost down compare with AL frame

Non-silicon cost share of PV modules



- Frame share the cost is about 13%, being already the first raw material;
- AL price is increasing, it is not come down in the future because double carbon requirement.
- some customers want to reduce the wall thickness of AL frame, it is big risk for the loading.

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Frame	Al	GFRP	Advantages
Corrosion Resistance	×	✓	Can be used in salt spray environments such as sea surface photovoltaics and mudflats.
Weather Resistance	✓	✓	/
Mechanical Properties	250Mpa	≥1000Mpa	Higher load resistance
Thermal expansion Coefficient μm/ (m*°C)	23.2	4	GFRP is closer to glass, less deformation at low temperature
Carbon emission T/CO ₂	24.2	3.7	Favorable certification of low-carbon and ultra-low-carbon modules, reduce carbon tax
Insulation Property	Conductive	Insulated	No grounding required, excellent anti-PID
Flame retardancy	/	V1	/
Density	2.7g/cm ₃	2.1g/cm ₃	Lightweight modules development
Coating Thickness	10μm	30μm~50μm	Both wear and slip resistance

03

Composite Frames Application Scenarios



The use of composite frame



GFRP Sea surface empirical base, Yantai



● Advantages:

1. Excellent resistance to chemical corrosion , such as salt spray, acid and alkali;
2. Higher load resistance, especially when sea winds are stronger and more frequent.;
3. Excellent insulation PID resistance under high temperature and high humidity at sea;
4. Insulation materials can avoid protective grounding.



Compostie frame use on the groud



● Advantages:

1. Strong load resistance, 100% rebound frame after load release;
2. The coefficient of thermal expansion is close to the glass, so the solar modules are not deformed and explosive at low temperature;
3. Low temperature coefficient, solar module can make more power at high temperature;
4. Insulation materials can avoid protective grounding.



Composite frame use at distributed power station



● Advantages:

1. Black color with excellent appearance, which can be designed in different color according to customer preference;
2. Insulation material with PID free and no leakage risk;
3. Fire rating up to A level;
4. Lighter than metal frames;



04

Solar Module Process with Composite Frame



▼ Retrofit scheme

If the sensors in the framing and gluing machines are metal sensors, they need to be replaced with capacitive sensors, no other hardware or programming modifications are required, and the replacement is compatible with aluminum frames. The price is very **cheap**.

Type of equipment	Glue machine	Frame machine
Capacitive sensor brand (recommend)	LEUZE(Germany)	LEUZE(Germany)
Compatible with aluminium frame		yes
Quantity of change	8pcs	8pcs
Remould time	30mins	30mins
Total fee	USD300.00	



▼ Solar module process with composite frame

GFRP Gluing



Quantity of gluing is same as AL frame

GFRP Framing



Good glue overflow

Curing and Transportation



Do not moving when transportation during curing

Packaging



Keep the same with AL frame

➤ The composite frame process is the same as AL frame, the process is stable.



THANKS!

Thank you for watching

