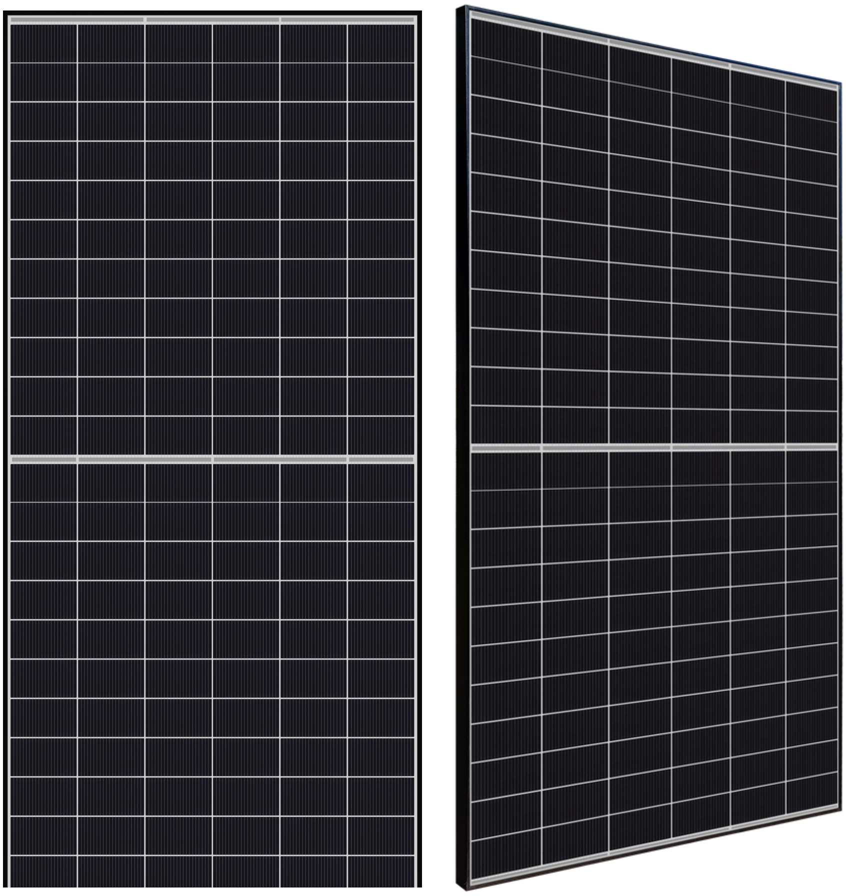

High-Performance Composite Frame Module Technical White Paper

High-Reliability PV Module Technology Based on GFRP Materials

This white paper introduces the core technology, design philosophy, and field applications of Canadian Solar's High-Performance Composite Frame Modules. By replacing conventional aluminum frames with GFRP (Glass Fiber Reinforced Polymer, with a polyurethane matrix) composite frames, these modules deliver meaningful advances in corrosion resistance, mechanical strength, electrical insulation performance, and carbon footprint — providing a more reliable, efficient, and sustainable solution for the solar energy industry.

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Chapter 1 Industry Challenges: What's Driving Module Innovation

1.1 Tougher Environments, Higher Mechanical Load Requirements

Solar PV is no longer limited to simple, flat-land installations. Today's projects span offshore platforms, coastal salt-spray zones, extreme-cold regions, heavy-snow areas, deserts, sites with large temperature fluctuations, and commercial rooftops — each placing very different demands on module structure and durability.

- Offshore & high salt-spray: Salt, humidity, and constant moisture accelerate corrosion on metal frames, degrading module performance faster than in typical land-based conditions.
- Extreme cold: Large day-to-night temperature swings cause stress concentration inside the module. When the frame and glass expand and contract at different rates, uneven stress builds up over time.
- Desert environments: Wide diurnal temperature swings create differential stress between materials, raising the risk of glass cracking and accelerating wear from wind-blown sand.
- High-humidity sites: Higher leakage currents promote PID (Potential-Induced Degradation), while moisture ingress undermines both electrical performance and long-term reliability.
- Sites with high wind loads: Higher mechanical load capacity is required, and frame joints are more susceptible to fatigue failure under repeated dynamic loads.

The common thread across all these environments is that a module's structure must remain stable under very different combinations of heat, cold, moisture, and mechanical stress — often for 25–30 years. Achieving that requires the frame, glass, encapsulant, and mounting interfaces to be designed as a coordinated system, not just a collection of individual components optimized in isolation.

1.2 The Global Low-Carbon PV Transition and Emerging ESG Compliance Challenges

The solar industry's competitive landscape is shifting. Customers and project developers once focused almost entirely on efficiency, power output, and cost. Increasingly, they also need to account for a module's carbon footprint, supply chain transparency, and lifecycle environmental impact.

Regulatory frameworks like the EU Carbon Border Adjustment Mechanism (CBAM), Environmental Product Declarations (EPDs), and green procurement standards are pushing manufacturers to demonstrate low-carbon credentials — not just for marketing, but as a hard requirement for market access, project financing, and long-term competitiveness.

Key insight: The aluminum frame alone can account for 14% of a module's total lifecycle carbon footprint. For a single large-format module, the aluminum frame may contribute 60-80 kg CO_2e/kWp of manufacturing-stage carbon emissions — making it one of the most impactful components for carbon reduction.

For module manufacturers selling into global markets, this means that carbon footprint, material traceability, recyclability, and end-of-life impact are no longer optional considerations. They are becoming core product attributes that influence procurement decisions, project approvals, and financing terms. The implication is clear: low-carbon design choices need to be built into the module from the start, not treated as an afterthought.

Chapter 2 From Problem to Solution: Why Composite Frames?

Composite frame technology addresses the root causes of the most common failure modes in traditional aluminum frame modules. Rather than applying surface treatments or patch fixes, it solves problems at the material level — by choosing a fundamentally different material with inherently better properties.

Core design philosophy: Start from intrinsic material properties, not surface treatments • Systematic improvement, not single-point optimization

GFRP (Glass Fiber Reinforced Polymer, with a polyurethane matrix) composite frames offer four key material properties — high electrical insulation performance, low thermal expansion coefficient (CTE), non-metallic composition, and high mechanical strength — that directly address the failure mechanisms of aluminum frames.

Problems & Solutions

Aluminum Frame Issue	Root Cause	Composite Frame Solution	Key Specification
PID Degradation	Conductive frame creates current leakage paths	High resistivity material eliminates leakage current pathways	Volume resistivity ≥ 10^{15} Ω·cm
Corrosion & Rust	Electrochemical reactions in metal	Non-metallic material is intrinsically corrosion-resistant	No electrochemical corrosion
High O&M Costs	Mandatory grounding; long-term corrosion maintenance	Insulating material eliminates module-level grounding requirements and reduces maintenance workload	Fully insulating material system
High Carbon Footprint	Energy-intensive electrolytic aluminum and anodizing processes	Low-energy pultrusion manufacturing; significantly less high-carbon metal	**~15–20% of aluminum frame carbon footprint**

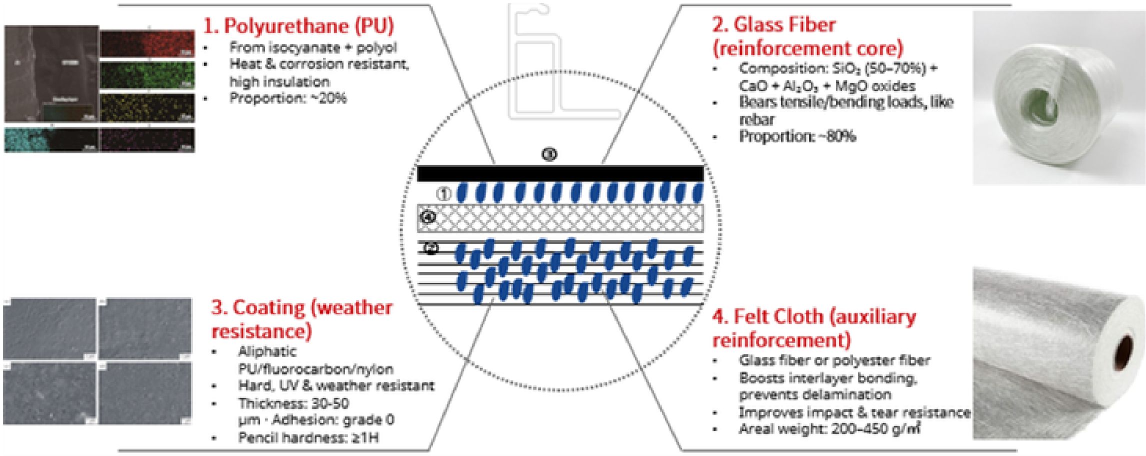
Chapter 3 Technical Overview: The Composite Frame

3.1 Material Structure

The composite frame is built around a GFRP (Glass Fiber Reinforced Polymer, with a polyurethane matrix) material system with a multi-layer structure. Each layer serves a specific function:

Layer	Function & Key Properties
Polyurethane Matrix	Provides toughness and weatherability; excellent UV resistance; good dimensional stability across temperature extremes
Glass Fiber Layer	The primary load-bearing structure; tensile strength exceeding 1,000 MPa; fiber volume fraction is precisely controlled for optimum performance
Functional Coating	Enhances UV and weathering resistance; provides surface protection and adhesion performance
Mat Layer	Improves resin impregnation and surface consistency; reinforces transverse strength and resistance to corner cracking

This layered architecture gives the composite frame a combination of high strength, flexibility, and environmental durability that no single material can achieve on its own.



3.2 Four Key Material Properties

The GFRP material system delivers four core performance advantages that directly translate into module-level benefits:

High Electrical Insulation Performance

The composite frame is a non-metallic insulating material with a volume resistivity of approximately 10^{15} Ω・cm. Unlike conductive aluminum frames, it does not form current-leakage pathways between the frame and the solar cells. This reduces the risk of ion migration and leakage current under high-humidity or high-voltage conditions — which is the fundamental mechanism that suppresses PID degradation. It also forms the physical basis for eliminating module-level equipotential bonding under applicable standards.

Thermal Expansion Compatibility with Glass

One of the most important — and often overlooked — properties of a frame material is how it expands and contracts with temperature. When the frame and the glass move at very different rates, stress builds up at the interface over hundreds of thermal cycles, eventually cracking the glass.
The composite frame has a linear CTE of approximately 4 μm/(m・°C), significantly lower than aluminum at 23.2 μm/(m・°C) and much closer to module glass at 9 μm/(m・°C). This close match greatly reduces thermally induced stress, lowering the risk of glass breakage over the module's lifetime.

Material	CTE (μm/m·°C)	Start Temp (°C)	End Temp (°C)	Length @25°C (mm)	Length @-40°C (mm)	ΔT (°C)	ΔL (mm)
Aluminum	**23.2**	25	-40	2278	2274.6	65	**3.4**
Glass	9	25	-40	2272	2270.7	65	1.3
Composite Frame	**4**	25	-40	2278	2277.4	65	**0.6**

At -40°C, aluminum moves 3.4 mm more than composite material relative to its original length — nearly 6× greater deformation. This difference in movement is directly correlated with glass breakage risk.

Intrinsic Corrosion Resistance

Since the composite frame contains no metallic components, it is not susceptible to electrochemical corrosion — the primary failure mode of aluminum frames in marine, coastal, and industrial environments. The polyurethane matrix and functional coating together provide a stable barrier against moisture, salt, and UV exposure, extending module service life in harsh conditions.

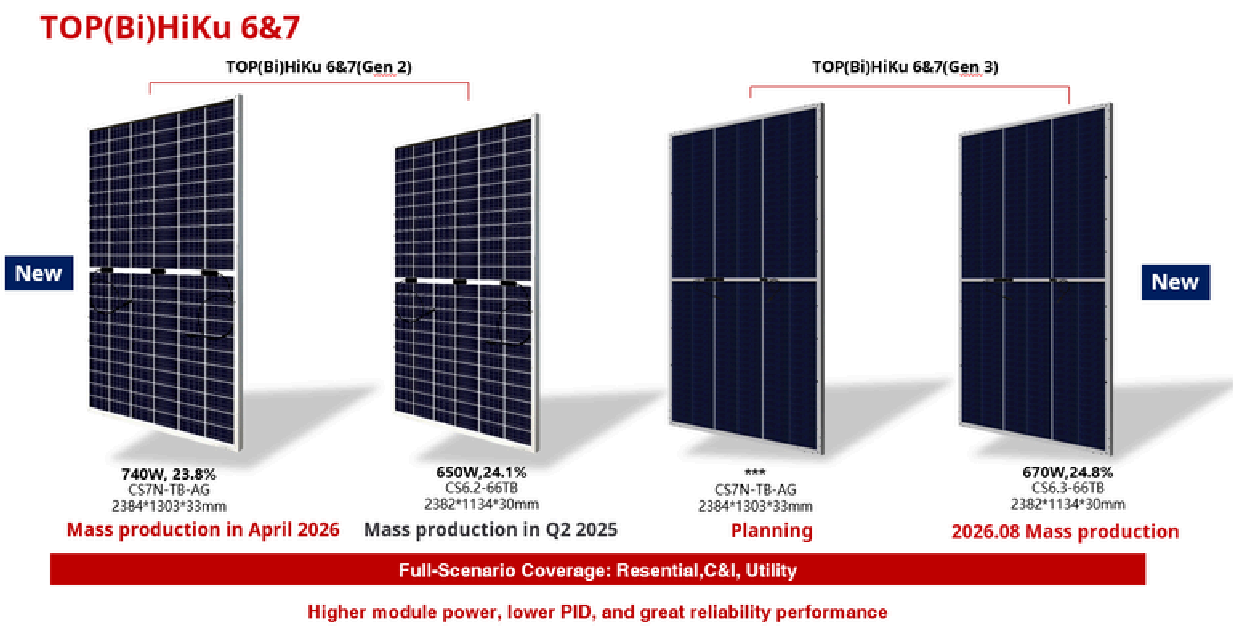
High Structural Strength

Continuous glass fibers, manufactured via pultrusion, give the frame a tensile strength of approximately 1,000 MPa — significantly higher than conventional aluminum alloy frames. This additional structural capacity improves the module's safety margin against wind load, snow load, transportation stress, and installation forces.

Chapter 4 Canadian Solar High-Performance Composite Frame Module

4.1 Product Introduction

The Canadian Solar High-Performance Composite Frame Module is purpose-built for challenging deployment environments — including offshore platforms, extreme-cold regions, high-corrosion coastal and industrial sites, and high-wind locations where conventional aluminum frame modules may struggle to maintain performance over time.
The modules use a GFRP (Glass Fiber Reinforced Polymer, with a polyurethane matrix) composite frame, manufactured via a pultrusion process that ensures consistent cross-sectional geometry, stable fiber orientation, and uniform product quality throughout production.



Canadian Solar's 210N and 182 rectangular composite frame modules have received VDE certification and are available across our TOPBiHiKu6 and TOPBiHiKu7 product platforms, covering residential, commercial, and utility-scale applications. This is not a simple material swap — it is a systematic module structural upgrade designed to deliver better reliability, lower system costs, and a stronger sustainability profile.

4.2 Product Features

The distinguishing characteristics of the Canadian Solar Composite Frame Module center on three areas:

- Environmental resilience: The module maintains stable performance in high-temperature/high-humidity, high salt-spray, extreme-cold, high-wind-load, and strongly corrosive environments — reducing long-term risks from PID degradation, frame corrosion, glass breakage, and grounding maintenance.
- Structural performance: Continuous fiber reinforcement gives the frame higher tensile and flexural strength; the CTE close to that of glass reduces edge stress under thermal cycling; the non-metallic insulating material reduces leakage current and electrochemical corrosion risks — all contributing to longer, more stable power output.
- System value: The module simplifies equipotential bonding (EPB) design, reduces installation and O&M workload, and delivers a lower carbon footprint — directly improving project economics and ESG performance.

4.3 Six Core Advantages

~1/3 PID degradation vs. aluminum frames	**~4×** Tensile & flexural strength vs. aluminum	**68%** PID suppression effectiveness
1.36% Typical LCOE reduction (100 MW plant)	**15-20%** Carbon footprint relative to aluminum frame	**-50 $kgCO_2e/kWp$** Module-level carbon reduction: $kgCO_2e/kWp$

① Lower PID Degradation

The composite frame's high electrical insulation performance reduces leakage current and ion migration. After enhanced PID testing (288 hours at 85°C/85%RH, -1,000 V), power degradation is controlled to under 1% approximately one-third that of conventional aluminum frame modules under the same conditions.

② Superior Mechanical Strength

Continuous glass fiber reinforcement gives the composite frame a tensile and flexural strength of approximately 1,000 MPa — about 4× that of standard aluminum alloy frames. This translates directly into better resistance to wind load, snow load, and the mechanical stresses of transportation and installation.

③ Lower Risk of Glass Breakage

The composite frame's CTE of approximately 4 μm/(m · °C) is far closer to that of module glass than aluminum's 23.2 μm/(m · °C). This reduces differential thermal movement between the frame and glass over thousands of heat/cool cycles, significantly lowering the probability of glass breakage — a major driver of long-term field failures.

④ No Module-Level Grounding Required — Lower System Costs

With extremely high-volume resistivity, composite frame modules can eliminate module-level equipotential bonding, reducing grounding materials, installation labor, and maintenance costs. For a 100 MW ground-mounted plant,typical LCOE reduction: 1.0% - 1.7%

⑤ Outstanding Corrosion Resistance

As a non-metallic polymer composite, the frame is completely free from electrochemical corrosion. After salt spray testing, no visible changes — no rust, yellowing, or coating delamination — are observed. This makes composite frame modules the right choice for offshore PV, coastal tidal flats, saline-alkali land, and chemical industrial environments.

⑥ Lower Carbon Emissions

Take a single large format as an example, the composite frame carries a carbon footprint of approximately 3.5 $kgCO_2e/kg$ — compared to approximately 18 $kgCO_2e/kg$ for aluminum. At the module level, switching to a composite frame reduces carbon emissions by roughly 50 $kgCO_2e/kWp$, bringing the total module carbon footprint to approximately 450 $kgCO_2e/kWp$. This improvement directly supports customers' ESG commitments and reduces exposure to future carbon costs.

In summary, the Canadian Solar High-Performance Composite Frame Module improves reliability, environmental resilience, system economics, and carbon performance simultaneously — making it a strong fit for any project where long-term performance and sustainability matter.

4.4 Product Reliability — Validation Summary

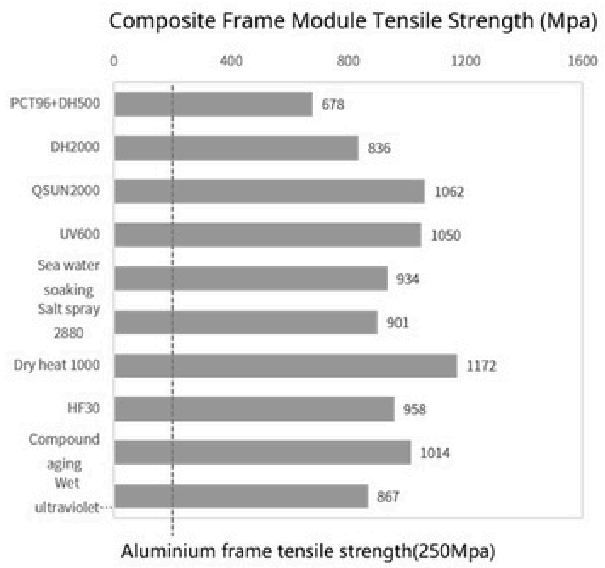
Canadian Solar has established a comprehensive, two-tier validation framework to verify the reliability of composite frame modules under real-world service conditions:

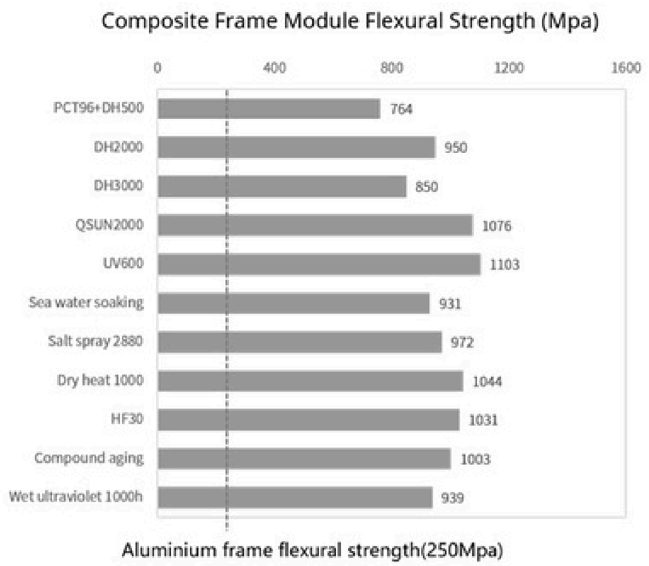
- Material-level tests: frame base material strength, coating adhesion, coating hardness, acid/alkali resistance, salt spray resistance, and strength retention after accelerated aging
- For tracker mounting applications, additional optimization and reinforcement were applied to the composite frame' s interfacial strength, further improving performance under tracker installation conditions.
- Module-level tests: mechanical load capacity, PID suppression, environmental durability, and grounding-free feasibility

4.4.1 Material-Level Validation

4.4.1.1 Mechanical Aging Tests

To confirm that the composite frame retains adequate strength after long-term outdoor exposure, Canadian Solar conducted a series of accelerated aging tests. Results show that frame material strength remained in the range of 678–1,172 MPa across all aging conditions — well above the requirements for demanding applications.





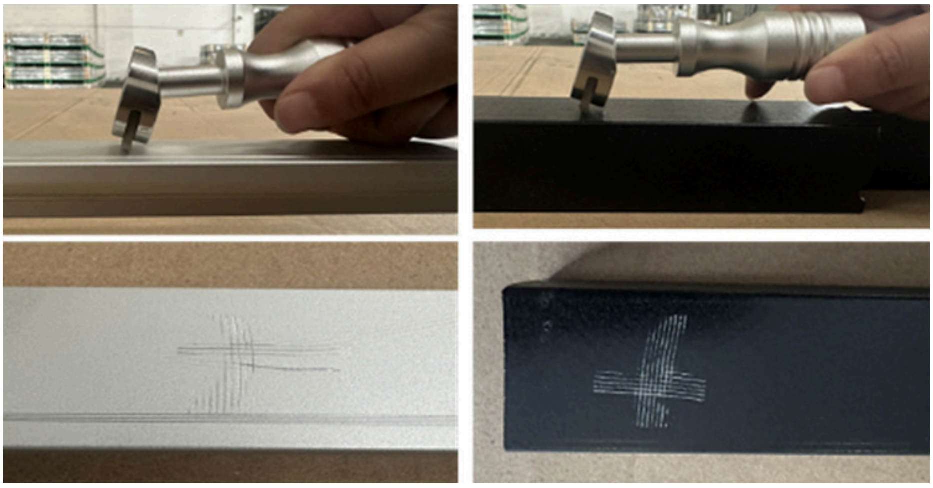
UV aging (300 hours of irradiation) and damp heat aging (per IEC standards) both showed stable performance with no measurable degradation. These results confirm that the composite frame material is designed to meet a 25-year service life.

4.4.1.2 Coating Durability Tests

Two key coating indicators were tested against national standards and benchmarked against traditional anodized aluminum frames:

Coating Adhesion (Cross-Cut Test, GB/T 9286—2021)

Sample	Coating Type	Film Thickness	Result
Composite Frame	Polyurethane	≥ 30 μm	**Grade 0 ✓**
Aluminum Frame	Anodized Aluminum AA10	–	Grade 0 ✓



Aluminum Frame (left) • Composite Frame (right)

Applicable standard requirements: T/CPIA 0081—2024 specifies Grade ⩽ 1; Canadian Solar internal standard: Grade 0. Result: composite frame achieves Grade 0 — the highest classification — matching aluminum frame performance.

Coating Hardness (Pencil Hardness Test, GB/T 6739—2022)

Sample	Coating Type	Film Thickness	Result
Composite Frame	Polyurethane	≥ 30 μm	**≥ 6H ✓**
Aluminum Frame	Anodized Aluminum AA10	–	≥ 6H ✓

Applicable standard requirements: T/CPIA 0081—2024 specifies ⩾ F; Canadian Solar internal standard: ⩾ 1H. Result: composite frame achieves ⩾ 6H — far exceeding both standards and on par with aluminum.

4.4.1.3 Corrosion Resistance Tests

Composite frame samples were exposed to acid (pH=3), alkali (pH=12), solvent, and continuous salt spray environments to verify the stability of both the coating and the substrate. Results across all tests:

Test	Conditions / Method	Result	Observation
Acid Resistance	pH = 3; appearance & color index ΔE	**Pass ✓**	ΔE < 1.5; no coating peeling, cracking, or deformation
Alkali Resistance	pH = 12; appearance & color index ΔE	**Pass ✓**	ΔE < 1.5; no coating peeling, cracking, or deformation
Solvent Resistance	Appearance & color index ΔE	**Pass ✓**	Surface remains stable; no visible anomalies
Continuous Salt Spray	Salt spray corrosive environment	**Pass ✓**	No rust, yellowing, or corrosion marks observed

Field validation in offshore projects has confirmed these lab results: composite frames show no corrosion, yellowing, coating delamination, or structural deformation after extended marine exposure. Since the material has no metallic components, there is also no risk of galvanic corrosion from dissimilar metal contact — a common failure mode for aluminum frames in saltwater environments.

GFRP Steel frame Al frame

In summary, material-level validation confirms that composite frames maintain strong mechanical performance, surface integrity, and environmental resistance across UV, damp heat, acid/alkali, solvent, and salt spray test conditions — establishing the material foundation needed for 25+ years of outdoor service.

4.4.2 Module-Level Validation

Material-level testing confirms the frame itself is robust. But in a real module, the frame works together with glass, encapsulant, solar cells, and the mounting system. Module-level validation tests the composite frame as part of a fully assembled module — assessing mechanical load capacity, environmental durability, PID performance, and grounding-free feasibility.

4.4.2.1 Mechanical Load Tests

Module-level mechanical load testing covered both static and dynamic load conditions. For fixed-tilt mounting, the modules passed 6,000 Pa front-side and 3,000 Pa rear-side static load requirements, as well as more than 10,000 cycles of stepwise dynamic loading designed to simulate wind, snow, and other real-world cyclic stresses. Compared with conventional constant-load dynamic testing, this stepwise cyclic loading approach is more stringent. For tracker mounting, Canadian Solar reinforced the lateral strength of the frame through a dedicated design while maintaining installation compatibility with conventional aluminum-frame modules. This enables easier field installation while allowing the module to withstand up to ±3,000 Pa static pressure and the corresponding dynamic load tests.

- Static load: 6,000 Pa front / 3,000 Pa rear — both passed
- Dynamic load: 10,000 load cycles simulating real-world wind and snow loads — passed with no cracks or structural issues

4.4.2.2 Environmental Reliability Tests

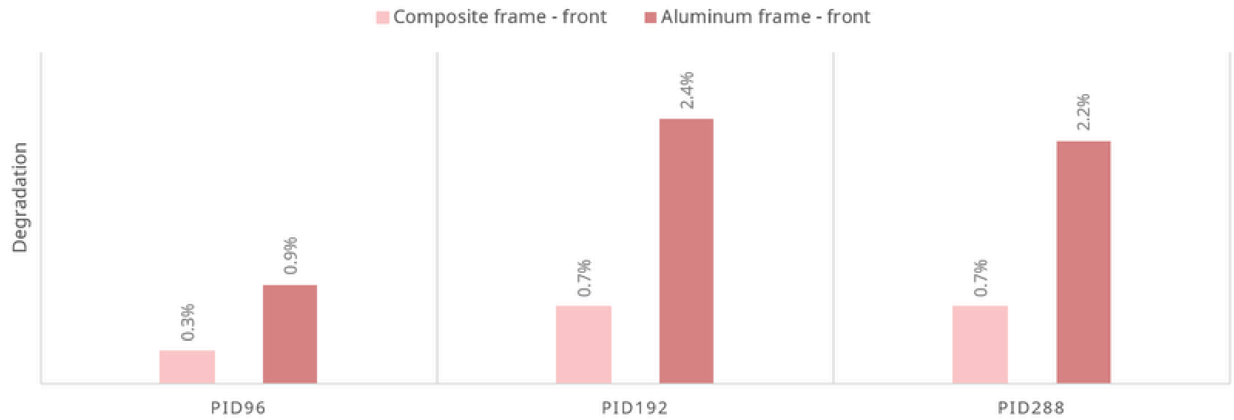
Test Category	Mounting Type	Test Conditions	Requirement	Result
Static Load	Fixed	6,000 / 3,000 Pa	Pass	**Pass ✓**
Static Load	Tracker	±3,000 Pa	Pass	**Pass ✓**
Dynamic Load	Fixed/tracker	10,000+ cycles	Pass	**Pass ✓**
Aging Test	Tracker	HF30 + static load ±2,800 Pa; HF30 + dynamic load 10,000+ cycles	Pass	**Pass ✓**

Test results show that the composite frame modules successfully passed static load, dynamic load, and post-aging load tests, with no structural issues such as cracks or deformation observed. In particular, the combined "aging + dynamic load" validation further simulates the real-world operating condition in which modules must continue to withstand cyclic wind loads after long-term service, enabling a more comprehensive assessment of the structural stability and reliability of composite frames under complex mounting scenarios and long-term operating conditions.

4.4.2.3 PID Test Results

This improvement is the direct result of the composite frame's high volume resistivity (10^{15} Ω · cm), which physically blocks the conductive pathways through which sodium ions migrate and cause PID. Power degradation is roughly one-third that of aluminum frame modules under the same test conditions.

Metric	Aluminum Frame Module	Composite Frame Module
Power degradation (PID288)	**2.20%**	**0.70%**
Degradation rate trend	Continue to increase	Very low & stabilizing
Post-test power recovery	Partial recovery	Excellent recovery
PID suppression vs. aluminum	–	**68% reduction in PID loss**



This makes composite frame modules particularly well-suited for utility-scale and floating PV projects where system voltage is high and temperature/humidity conditions are extreme — including coastal tidal flats, reservoirs, and mountainous fog-prone areas. In these high-PID-risk environments, modules can maintain more stable power output throughout their entire service life.

4.5 Product Warranty

Canadian Solar High-Performance Composite Frame Modules come with a 12-year product warranty and a 30-year power output warranty, providing customers with dependable long-term protection across all application environments.

4.6 Product Value: Quantifiable Economic & Environmental Benefits

4.6.1 Lower CAPEX and LCOE: No Module-Level Grounding Required

Conventional aluminum frames (e.g., 6063-T5 alloy) are electrically conductive. Per Chinese standard DL/T 1364—2014 and similar international codes, every aluminum-frame module must be individually grounded for personnel safety and lightning protection. This means grounding copper busbars, bonding jumpers, anti-loosening hardware, installation labor, and regular maintenance over the plant's lifetime.

> 5.3 Lightning Electromagnetic Pulse Protection
> 5.3.1 Equipotential Bonding
> 5.3.1.1 Equipotential Bonding of the PV Array:
> a) The metal frames of PV modules in each row shall be electrically interconnected with each other. The metal frames or clamps of the modules shall be reliably connected to the metal supports, and the transition resistance at the connection point shall not exceed 0.03 Ω;
> b) Each row of PV metal supports shall be grounded at least two ends;
> c) The metal frames of PV modules on the roof shall be connected to the roof air-termination system (lightning protection tape) at the nearest possible point.

GFRP composite frame modules have a volume resistivity of approximately 2×10^{15} Ω·cm — roughly 23 orders of magnitude higher than aluminum. According to the GB 47739-2026 Safety Requirements for Photovoltaic Modules, photovoltaic modules with composite frames (such as polymer or fiberglass composite frames) are explicitly marked as "not applicable" for the equipotential bonding continuity test. In other words, modules using insulated non-metallic frames are exempt from the equipotential bonding continuity test.

This difference creates a clear system-level value: by removing the need for module-level grounding, composite frame modules simplify electrical design, reduce grounding materials and installation labor, and lower long-term inspection and maintenance workload. These savings directly translate into lower CAPEX, reduced OPEX, and improved project LCOE.

The following table shows the projected cost savings for a 100 MW ground-mounted plant in China (approximately 161,000 modules, annual yield 150 GWh, baseline LCOE USD 0.0417/kWh; exchange rate: USD 1 = RMB 7.2):

Item	Unit	Value	Notes
CAPEX Savings (one-time)	USD 10k	41.7	Grounding materials + labor
Annual OPEX Savings	USD 10k/yr	5.6	EPB maintenance
25-Year OPEX Savings (NPV)	USD 10k	78.3	/
Total NPV Savings (CAPEX + OPEX)	USD 10k	**120**	/
25-Year Energy Yield (NPV)	GWh	2,114	150 GWh/yr × 14.094 discount factor
LCOE Reduction	USD/kWh	0.00057	USD 1.20M ÷ 2.114B kWh
Baseline LCOE	USD/kWh	0.0417	Industry typical value
LCOE Reduction (%)	%	**1.36%**	0.00057 / 0.0417 ≈ 1.36%

4.6.2 Lower Carbon Costs: A Real Economic Advantage

Carbon pricing is moving from a future risk to a present cost. Green procurement policies are already being applied to PV modules sold into key markets. For projects targeting Europe, Japan, Australia, and other regions with active carbon pricing, a lower module carbon footprint translates directly into lower carbon-related cost exposure and stronger competitiveness in green tenders and project financing.

Composite frames reduce carbon at both the material and manufacturing level. By replacing energy-intensive electrolytic aluminum, extrusion, and anodizing processes, the composite frame achieves a carbon footprint of approximately 3.5 $kgCO_2e/kg$ versus approximately 18 $kgCO_2e/kg$ for aluminum. At the module level, this saves approximately 50 $kgCO_2e/kWp$.

Module Carbon Footprint Breakdown (% contribution by component)

Component	Aluminum Frame Module	Composite Frame Module
Solar Cells	68.37%	76.44%
Glass	10.40%	11.63%
Frame	**13.93%**	**3.79% ↓**
EVA/POE Encapsulant	2.20%	2.47%
Other	5.08%	5.68%

Estimated Carbon Cost Savings by Region

	Carbon Cost (USD/tonne)	Al Frame Module (USD/W)	Composite Frame (USD/W)	Saving (USD/W)
Europe	83.3	0.0417	0.0375	**0.0042**
United States	53.5	0.0264	0.0236	**0.0028**
China	9.7	0.0056	0.0042	**0.0014**

**Based on Canadian Solar TOPBiHiKu7 series (66-cell, 210 mm), aluminum frame module weight 37.8 kg (frame 2.8 kg/set), composite frame module weight 38.5 kg (frame 3.5 kg/set).*

For a 100 MW project, this equates to approximately 5,000t CO_2 of avoided emissions at the manufacturing stage. Exported to Europe at an estimated carbon cost saving of USD 0.0042/W, this represents approximately USD 417k in import-related carbon cost savings alone.

Beyond direct carbon cost savings, the lower carbon footprint strengthens the module's position in green procurement tenders, improves project ESG ratings, and reduces exposure to future carbon pricing increases — all of which have real commercial value.

Chapter 5 Field Validation: Real-World Performance Data

Case 1: Yinchuan High-Irradiation Validation Base

Site and Conditions. The Yinchuan High-Irradiation Validation Base represents a typical mid-temperate continental climate, with strong wind, frequent sand exposure, about 3,000 annual sunshine hours, and total irradiation of approximately 8,400 MJ/m². The site also experiences strong UV exposure and a diurnal temperature range exceeding 55°C, making it suitable for validating composite frame modules under high-irradiation, wind-sand, and thermal-cycling conditions.

Validation Scope. Composite frame modules were monitored from November 2023 to October 2024, covering power generation, visual condition, and structural reliability.

Result. The modules remained visually intact and passed both standard 5,400/2,400 Pa and extreme 6,000/3,000 Pa load tests before and after field operation, with frame material strength remaining stable.

Case 2: Yantai, Shandong — First Offshore Floating Platform Project

Site and Conditions. The Yantai project in Shandong is China's first offshore floating PV validation platform, located approximately 7 km offshore. The site is exposed to high salt spray, high humidity, strong corrosion, sea wind, waves, and floating-platform dynamic loads, placing high requirements on frame strength and connection reliability.

Validation Scope. Composite frame modules were monitored from March 2023 to November 2023, covering system power generation, visual condition, and structural reliability.

Result. The modules maintained intact appearance and structural integrity during offshore exposure, supporting the application of composite frames in high-salt-spray, high-humidity, and dynamically loaded marine PV environments.

Conclusion

As the PV industry moves toward higher reliability, lower lifecycle cost, and stronger sustainability requirements, module frame design is becoming a key part of long-term project value. Canadian Solar's High-Performance Composite Frame Modules address these needs through GFRP composite frames that combine high insulation, low thermal expansion, corrosion resistance, and high mechanical strength.

Validated through laboratory testing, field operation, and economic analysis, these modules help reduce PID risk, glass breakage, grounding-related costs, corrosion exposure, and carbon footprint. For projects in offshore, coastal, extreme-cold, high-humidity, and utility-scale environments, composite frame modules provide a more reliable, economical, and sustainable path forward.

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