华镁复材
HUAMEI COMPOSITE

Polyurethane resin

Marine project proposal

July 2026

Contents

Company profile: HUAMEI composites

Core strengths: Polyurethane in marine environments

Application 1: Anticorrosion and protective coatings

Application 2: Structural materials and key components

Application 3: Advantages for enclosure products

Applications: Enclosures and railway vehicles

Sustainability and future trends

R&D

Producti on

Sales

PU composite prepreg / PU SMC / unsaturated polyester SMC

China's first PU composite prepreg developer, with proprietary intellectual property

Address: No. 1 Yifeng Road, Shiji Township, Sihong County, Suqian, Jiangsu, China

Tel.: Mr. Sun 13601682475 / Mr. Qiao 13957356391

Core strengths: Polyurethane in marine environments

Corrosion resistance / Weather resistance / Mechanical performance / Environmental performance / Thermal insulation

Five core strengths of polyurethane resin

Corrosion resistance

Resists seawater, salt mist, acids, alkalis and other chemicals, providing a long-lasting protective barrier for marine products.

Long-term protection

Combined salt spray test



检测要求

序号	测试项目
1	循环盐雾
2	绝缘电阻
3	耐电压
4	相对电容率*
5	经向拉伸（672 小时耐盐雾后）#*
6	经向压缩（672 小时耐盐雾后）#*
7	面内剪切（672 小时耐盐雾后）#*
8	短梁强度（672 小时耐盐雾后）#*

检测结果：请参见后续页面。

批　准　　日　期　2023.12.18

林东杰
授权签字人

No. R0AEE3EC38
广东省深圳市宝安区 70 区鸿威工业园

检验检测专用章 Inspection & Testing Services

-6788-33　E-mail:info@cti-cert.com　Complaint call:0755-33681700　Complaint E-mail:complaint@cti-cert.com

Electrolyte resistance



检测要求

序号	测试项目
1	耐电解液*
2	绝缘电阻
3	耐电压
4	介电常数*
5	经向拉伸#*
6	经向压缩#*
7	短梁强度#*
8	面内剪切#*

检测结果：请参见后续页面。

批　准　　日　期　2023.11.30

林东杰
授权签字人

Carbonic acid resistance

CTI 华测检测

检测报告

报告编号 A2230529459601001O1C 第 3 页 共 8 页

测试项目 1：耐酸性

1. **测试设备**

设备名称	型 号
烘箱	FD115

2. **环境条件**

温度：（23±2）℃；湿度：（50±5）%RH

3. **测试标准：**依客户要求

4. **测试条件**

测试试剂：0.5mol/L H_2SO_4；

测试方法：点滴法（约 0.5mL）；

测试温度：（55±2）℃；

测试时间：30min；

评价内容：清水冲洗干净恢复至室温 24h 后检查样品外观。

Alkali resistance

CTI 华测检测

检测报告

报告编号 A2230529459601001O2C 第 1 页 共 8 页

报告抬头公司 江苏华镁复合材料科技有限公司

地 址 江苏省宿迁市泗洪县翊丰路 1 号

以下测试之样品及样品信息由申请者提供并确认

样品名称 黑色 9075-1270

颜色 黑色

样品接收日期 2023.10.23

样品检测日期 2023.10.23-2023.12.18

检测要求

序号	测试项目
1	耐碱性
2	短梁强度#
3	面内剪切#

Five core strengths of polyurethane resin



Weather resistance

Excellent gloss and color retention, with long-term resistance to strong UV, high humidity and repeated wet/dry cycles, slowing coating aging.

Aging resistance / gloss and color retention

检 测 报 告

R01.测试项目：耐候性测试

样品编号	HPJC2026060318-76#~90#
参考标准	依据客户要求
试验条件	A、试验条件: 1）辐照度:(0.55±0.2)W/m2@340nm; 2）暴露周期:102min 干燥,18min 喷淋; 3）滤光器:日光滤光器; 4）黑标温度:(65 土 3)° C; 5）试验箱温度:(38 土 3)° C; 6）试验箱相对湿度:(50±10)%; 7）辐射强度:1485kJ/m2,试验时间:750h。 B、测试方法: 1）针对电池包阳光所有暴露面的部件,包含电池箱上盖、非金属接插件、MSD 进行氙灯老化测试; 2）试验设备及滤光器应符合 GB/T16422.2-2022 中 5 设备的规定,从零部件的阳光暴露面选择相对平整的部分制取试验样件; 3）按照 GB/T11186 规定的涂膜颜色的测量方法计算色差△E 值; 4）按照 GB/T250 规定,对灰色样卡进行试验前后的对比,应在 D65 光源箱内进行评价; 5）按照表 6 零部件及材料氙灯老化灰卡及色差限值要求进行评价: 6）使用放大镜观察外观变化情况,按照表 7 对零部件及材料氙灯老化外观评价项目及要求进行评价; 7）按照 GB/1 9286 的规定进行漆膜附着力测定; 8）样板尺寸建议 145mm*65m。
判定要求	1）试验后非喷漆件失光率≤10%、无变色、无粉化、(十倍放大镜下)无可见开裂(裂纹、银纹、龟裂)和斑点、无发粘、无疏松状态、无分层、无翘曲变形、无溶胀、无喷霜、无析出、无变软或变硬、及其他外观不良; 2）试验后样件阳光暴露面,灰卡≥4.0(非喷漆件)。

检 测 报 告

报告编号： HPJC2026060318-18 报告日期: 2026/07/17 页码： 5 of 11



79#~81#测试中



82#~84#测试中



76#~78#灰卡示意图



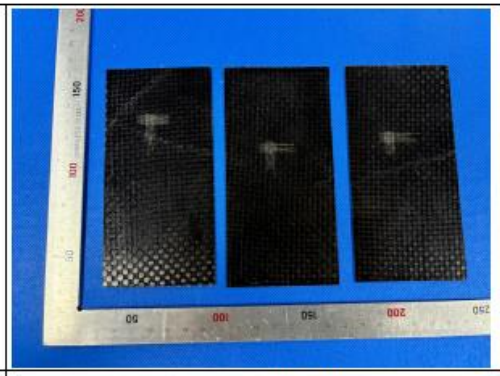
79#~81#灰卡示意图

检 测 报 告

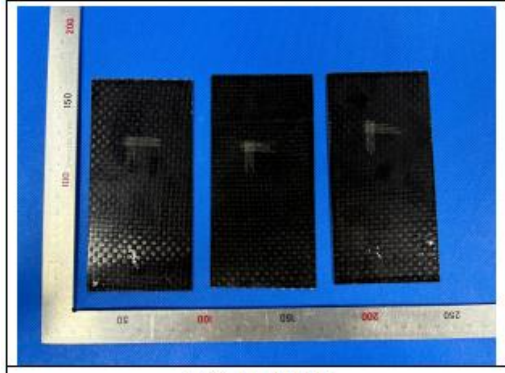
报告编号： HPJC2026060318-18 报告日期: 2026/07/17 页码： 6 of 11



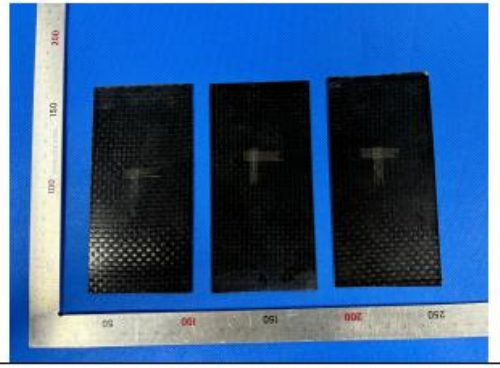
82#~84#灰卡示意图



76#~78测试后



79#~81##测试后



82#~84##测试后

No obvious change in appearance after aging test



Epoxy prepreg product after 750 hours of aging:
surface resin chalking and exposed fibers



Actual product application

Five core strengths of polyurethane resin



Mechanical performance

High abrasion resistance, toughness and adhesion withstand wave impact, friction and fatigue aging while maintaining structural integrity.

High toughness / excellent mechanics

No.	Test item	Test standard / conditions	Average	Unit	Note
1	Material	GB/T 2577-2005	51~56	%	
2	Density	GB/T 1033.1-2008	1.90	g/cm³	
3	Water absorption	GB/T 1462 Method 1	0.03	%	
4	Flame resistance	UL94 vertical burning test	Vo	/	
5	Heat deflection temperature	GB/T 1634.2-2004	160.80	℃	
6	Thermal conductivity	GB/T 3399-1982	0.04	/	
7	Insulation resistance	GB/T 31838.4-2019	>1000	MQ	
8	Dielectric withstand	GB/T 1408.1-2016	1.72	m	
9	Dielectric constant	GB/T 1409-2006	4.80	/	
10	Tensile strength	GB/T 1447-2005	364.00	MPa	
11	Tensile modulus	GB/T 1447-2005	21.30	GPa	
12	Flexural strength	GB/T 1449-2005	572.00	MPa	
13	Flexural modulus	GB/T 1449-2005	20.50	GPa	
14	In-plane shear strength	GB/T 3355-2014	161.00	MPa	
15	In-plane shear modulus	GB/T 3355-2014	60.70	GPa	
20	Notched impact strength	GB/T 1451	109.00	kJ/m²	
23	High temperature / humidity	ASTM D3039-17: 85±3℃, 82-88% RH, constant temperature/humidity, 1000 h	All 11 items comply		
24	Thermal shock	GB/T 31838.4-2019: -40~85℃ Transition within 30 min; hold 30 min at each extreme. 2 h/cycle, 500 cycles, 1000 h total.	All 11 items comply		
26	Salt spray resistance	GB/T 2423.18 (672 hours)	All 7 items comply		
31	Prohibited substances	GB/T 30512-2014	Complies	/	
32	Poisson's ratio	GB/T 1040.2-2022	0.240	/	

Test laboratory	Report number	Test specimen	Thickness (mm)	Fabric structure	Layup structure	Tensile strength (MPa)	Tensile modulus (GPa)	Flexural strength (MPa)	Flexural modulus (GPa)	Impact (kJ/m²)
Xince	ES22503180152M0000 1RM1	Epoxy GFRP	1	18# Glass fiber	0/90/0/0/90/0	519.53	23.35	502	19.5	27.1
Xince	ES22503180152M0000 2RM1	PU GFRP	1	18# Glass fiber	0/90/0/0/90/0	538.1	27.82	606	23.2	27.5
Xince	ES22503180152M0000 4RM1	PU CFRP	1	3K+UD	3K/0/90/0/90/0+3K	537.98	43.27	688	39.6	/
Xince	ES22503180152M0000 3RM1	PU GFRP	1	400 g woven roving	NA	450.48	22.55	532	19.3	/
CTI	A2230298417401C	PU GFRP	1	400 g woven roving + chopped fiber	400 g + chopped fiber + 400g	364	21.3	572	20.5	109

Five core strengths of polyurethane resin



Environmental performance

Non-toxic and harmless; meets environmental standards; clean production and recyclable.

Food-contact certification

RoHS test report

检测方法： 参考 IEC 62321-4:2013+AMD1:2017，IEC 62321-5:2013，IEC 62321-7-2:2017 和 IEC 62321-12:2023，采用 ICP-OES/AAS，UV-Vis 和 GC-MS 进行分析。

检测项目	限值	单位	MDL	A1
铅 (Pb)	1000	mg/kg	2	7
汞 (Hg)	1000	mg/kg	2	ND
镉 (Cd)	100	mg/kg	2	ND
六价铬 (Cr(VI))	1000	mg/kg	8	ND
多溴联苯之和 (PBB)	1000	mg/kg	-	ND
一溴联苯 (MonoBB)	-	mg/kg	25	ND
二溴联苯 (DiBB)	-	mg/kg	25	ND
三溴联苯 (TriBB)	-	mg/kg	25	ND
四溴联苯 (TetraBB)	-	mg/kg	25	ND
五溴联苯 (PentaBB)	-	mg/kg	25	ND
六溴联苯 (HexaBB)	-	mg/kg	25	ND
七溴联苯 (HeptaBB)	-	mg/kg	25	ND
八溴联苯 (OctaBB)	-	mg/kg	25	ND
九溴联苯 (NonaBB)	-	mg/kg	25	ND
十溴联苯 (DecaBB)	-	mg/kg	25	ND
多溴二苯醚之和 (PBDE)	1000	mg/kg	-	ND
一溴二苯醚 (MonoBDE)	-	mg/kg	25	ND
二溴二苯醚 (DiBDE)	-	mg/kg	25	ND
三溴二苯醚 (TriBDE)	-	mg/kg	25	ND
四溴二苯醚 (TetraBDE)	-	mg/kg	25	ND
五溴二苯醚 (PentaBDE)	-	mg/kg	25	ND
六溴二苯醚 (HexaBDE)	-	mg/kg	25	ND
七溴二苯醚 (HeptaBDE)	-	mg/kg	25	ND
八溴二苯醚 (OctaBDE)	-	mg/kg	25	ND

检验检测专用章
Inspection & Testing Services
SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd.
Chemical Laboratory

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3rd Building,No.889 Yishan Road Xuhui District,Shanghai China 200233 t E&E (86-21) 61402553 f E&E (86-21)64953679 www.sgsgroup.com.cn
中国 · 上海 · 徐汇区宜山路889号3号楼 邮编: 200233 t HL (86-21) 61402594 f HL (86-21)61156899 sgs.china@sgs.com

Member of the SGS Group (SGS SA)

FDA test report

SGS

检测报告

编号： SHAEC25006815301 **日期：** 2025 年 04 月 03 日

检测结果：

检测部件外观描述：

样品序号	样品编号	SGS 样品 ID	样品描述	材质（客户提供）
SN1	A.C001	SHA25-0068153-0001.C001	黑色片材	PU+玻纤

备注：

(1) mg/dm^2 = 毫克每平方分米
$mg/inch^2$=毫克每平方英寸
$\mu g/cm^2$ = 微克每平方厘米
mg/L = 毫克每升
mg/kg = 毫克每千克

(2) ℃ = 摄氏度
℉ = 华氏度

(3) < = 小于

(4) RL= 报告检出限

(5) ND = 未检出(< RL)。

US FDA 21 CFR 175.300 - 总提取物

检测方法： 参考 US FDA 21 CFR 175.300。

模拟液	检测条件	限值	单位	RL	A.C001	说明
8%乙醇	70°F，48 hrs	18	$mg/inch^2$	0.1	ND	符合
正庚烷	120°F，0.5 hr	18	$mg/inch^2$	0.1	ND	符合
蒸馏水	70°F，48 hrs	18	$mg/inch^2$	0.1	ND	符合

Five core strengths of polyurethane resin



Thermal insulation

Low thermal bridging and conductivity reduce temperature fluctuations.

Continuous thermal insulation

Thermal insulation comparison

Excellent insulation

Reduced thermal bridging

Optimized liner construction reduces thermal bridges and maintains a stable temperature inside the container.

Item	Aluminum	PU composite	Nylon thermal-break strip	PVC	Based FRP
Density (g/cm³)	2.79	2.1	1.3	1.5	1.9
Thermal conductivity (W/m·K)	160	0.34	0.30	0.35	0.45
Flexural strength (MPa)	250	>1200	80~180	30	300~400
Flexural modulus (GPa)	50~80	41.3	2~5	2.2~5	10~22
Dimensional shrinkage □ (%)	0.6	0.2	0.4	0.4	2
Linear expansion coefficient (10 K ¹)	2.2~2.4	0.5~0.8	2.4~3.5	5~8.5	0.73

Low thermal conductivity

PU prepreg liners have very low thermal conductivity, effectively reducing heat loss compared with conventional materials.

Long-lasting insulation

Stable material performance limits insulation loss during long-term use, maintaining refrigeration performance.

Small temperature fluctuations

Even with large ambient temperature changes, the liner buffers fluctuations to protect cargo quality.

Application 1: Structural materials and key components

Functional applications from sealing and vibration reduction to wind-turbine blades

Polyurethane coatings serve marine structures, ships and tanks, from conventional topcoat protection to advanced self-healing technology. They evolve from static anticorrosion to smart protection throughout the service life of offshore equipment.

Marine structure topcoats

As a topcoat in anticorrosion systems, it provides long-term protection for offshore wind equipment, bridges and piers. It combines corrosion resistance and appearance across atmospheric and splash-zone exposure.

Wind power / bridges / piers

Ships and storage tanks

Applied to cabins, ballast tanks and decks, it resists combined corrosion from minerals, fuels and seawater. It meets classification requirements and maintains operational safety and structural integrity.

Classification society certification

Advanced self-healing coating

Photothermally enhanced nanofiber/PU composite coatings rapidly self-heal under light. They overcome limits of static protection and reduce offshore maintenance costs.

Smart protection

PU elastomers and composites are used in seals, vibration reduction, blade protection and subsea buoyancy modules. Hydrolysis and pressure resistance, plus reduced biofouling, support safe operation in extreme environments.

01 - Sealing and vibration reduction

PU seals are used in ship hydraulic systems. Hydrogenation modification improves hydrolysis and pressure resistance; resistance to biofouling supports long-term subsea equipment safety.

02 - Wind-turbine blade protection

Thermoplastic PU films and elastomers improve impact and abrasion resistance at blade leading edges. They slow UV aging, extend life and reduce offshore maintenance costs.

03 - Marine buoyancy modules

PU foam provides stable buoyancy for subsea cable and pipeline modules. High hydrolysis resistance maintains performance under deep-sea pressure and protects subsea infrastructure.

Application 2: Enclosure products

Core advantages: Weather and corrosion resistance, lightweight, customization, low maintenance

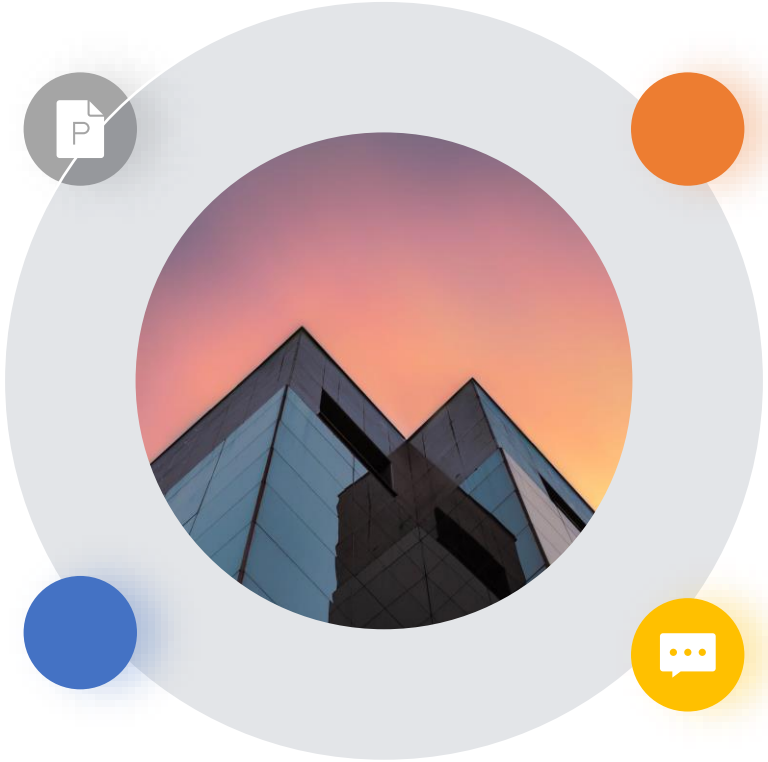
1. Aquaculture floats: cylindrical, rectangular and modular
2. FRP frame and support tubes for oyster/fish farming rafts
3. Floats for cages, floating piers and work platforms
4. Float connectors, anchors and anti-collision parts
5. Offshore photovoltaic platforms

Technical background

Problems with conventional materials

Insufficient insulation

Conventional insulation has high thermal conductivity and limited performance, increasing energy use and making energy-saving and environmental requirements difficult to meet.



Durability needs improvement

Some materials age and deform during long-term use, affecting product life and safety.

High production costs

Some high-performance insulation materials have complex, costly production processes, limiting widespread industrial use.

Environmental issues

Some insulation materials release harmful substances during production and use, polluting the environment; emissions may continue throughout product use.

Technical principles

Core principles of PU prepreg products

01 **Prepreg process**
Combining polyurethane with other materials creates high-performance liners and improves production efficiency and product quality.

02 **Polyurethane properties**
Polyurethane's insulation, strength and durability make it suitable for insulating enclosure products.

03 **Thermal insulation principle**
Polyurethane's low thermal conductivity suppresses heat transfer, providing excellent insulation.

04 **Bonding performance**
The prepreg process closely bonds PU with panel materials, increasing overall liner strength and stability.

Advantages analysis



Efficient insulation

Low thermal conductivity gives over 20% better insulation than conventional materials, reducing energy use.



Lightweight / high strength

Low density and high strength reduce container tare weight and improve transport efficiency.



Environment / sustainability

Environmentally friendly materials, pollution-free production and recyclability contribute to sustainability.



Durable / reliable

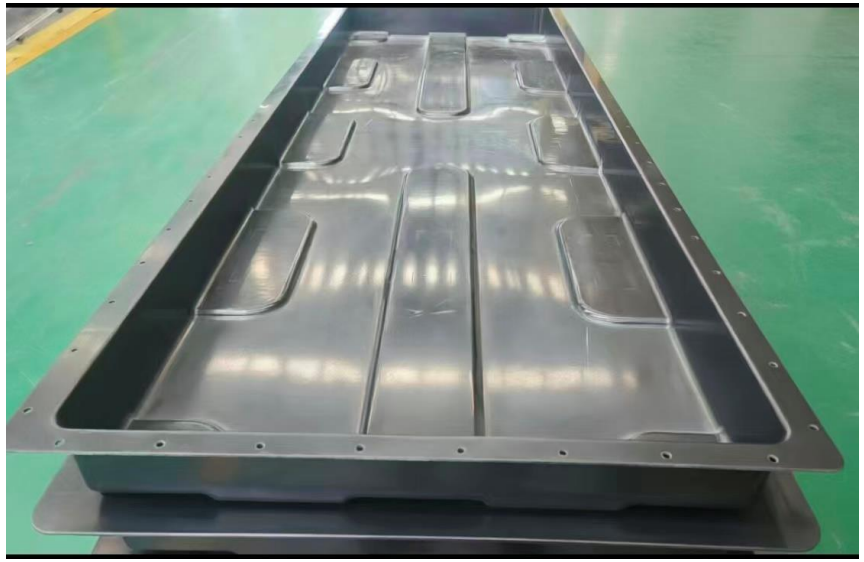
Excellent aging and corrosion resistance extend service life and reduce maintenance costs.

Comparison with similar products

Type	Material / process	Buoyancy / load	Life / corrosion / maintenance
FRP round / square tubes	Glass fiber + PU/unsaturated polyester/epoxy resin. Compression molding, hand layup, vacuum infusion, filament winding or pultrusion.	Buoyancy calculated by displacement. High stiffness suits raft frames, suspension supports and modular floats. Check joint pull-out resistance.	Design life about 15-20 years. Weather/seawater resistance, custom sections. PU prepreg panels, frames and clips. Specialist repair after damage; difficult to recycle.
HDPE hollow rotomolded Float	One-piece HDPE rotomolding; optional foam filling. SC/T 4045-2018: hollow wall □6.0 mm; airtight immersion 0.5 h.	Stable individual buoyancy. Typical rectangular-float load about 350 kg/m^2. Good toughness and impact resistance.	About 10-15 years, longer for premium products. Seawater resistant, low maintenance, recyclable. Long UV exposure causes aging; cold impact may cause embrittlement.
HDPE foam-filled float	HDPE shell + PU/EPS closed-cell foam. Typical shell thickness ≥ 5.0mm.	Foam retains some buoyancy after shell damage, providing a larger safety margin.	About 10-15 years. Slow buoyancy loss suits rough seas. More expensive than standard hollow floats.
Foam / EPS float	Polystyrene or PU foam with a plastic shell or geotextile bag.	High initial buoyancy, low cost.	Usually 3-8 years. Easily damaged, rapid buoyancy loss and fouling. Being phased down in several regions.
Steel / galvanized tube float	Steel tubes, galvanized tubes or steel drums; welded or bolted.	High load capacity; usable as frame and float.	Corrodes in seawater; regular derusting, painting and cathodic protection needed. Often lasts under 10 years; high maintenance.
Steel-plastic composite / deep-sea Float	HDPE shell + steel frame or composite structure.	Typical load □500 kg/m^2; suitable for deep-sea cages and feed platforms.	Can last over 15 years. Good wave resistance, but heavy and expensive; lifting equipment needed for installation.

Application cases

Mass-production projects



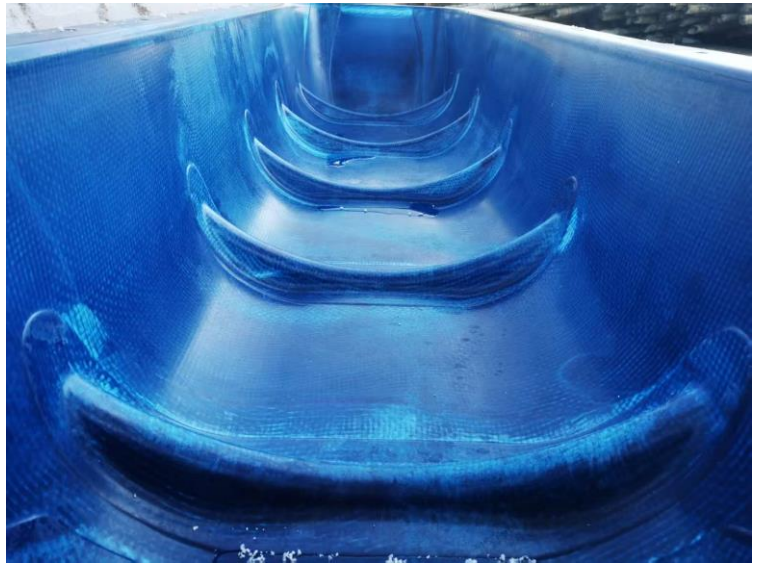




Battery-pack upper covers / energy-storage enclosures / lower railway side doors

PU floats / frames / fastening clips

PU floats, support frames and fastening clips



Polyurethane float
Polyurethane float

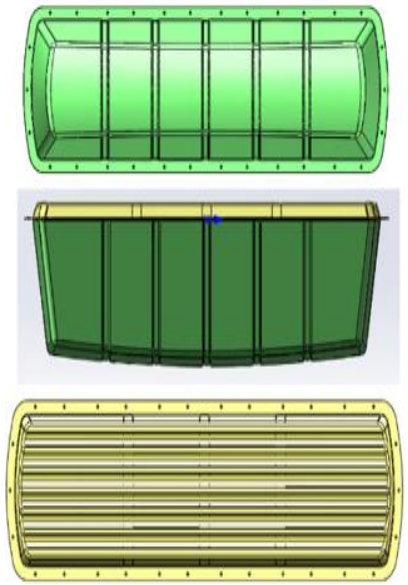


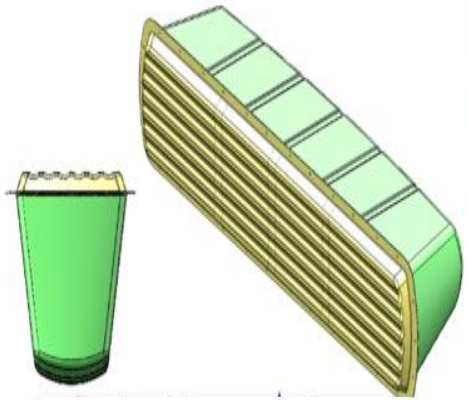
PU float frame
Polyurethane
float frame



PU connection clip
Polyurethane
connection clip

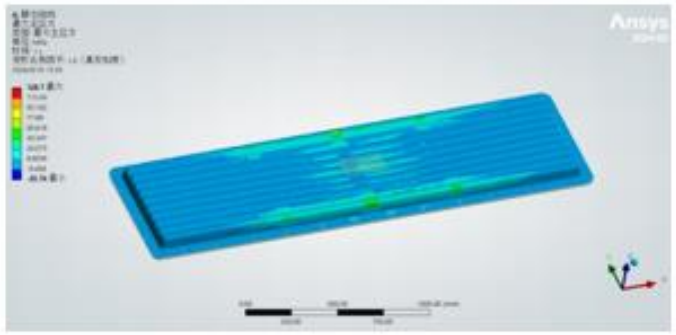
Development project





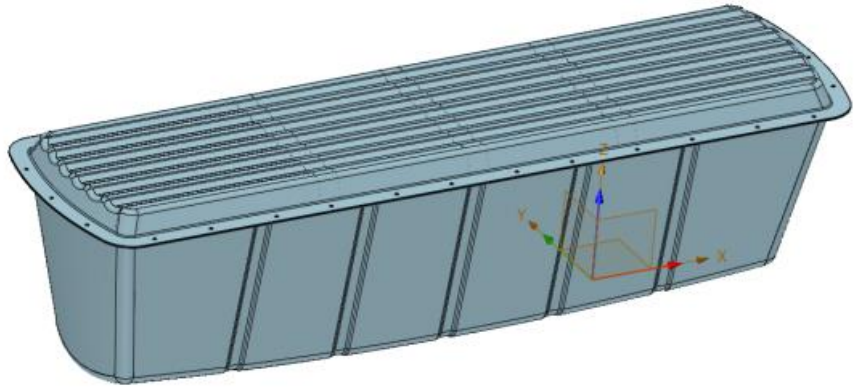
Volume approx. 800 L

Weight approx. 24.5 kg



Bottom-panel material	Load position	Max. deformation	Max. stress
PU + glass fiber	Center	23.099mm	129.7MPa
PU + glass fiber	Eccentric	20.319mm	86.567MPa
PU + glass fiber	Corner	7.3533mm	97.756MPa

7.1 Conclusion: Under pressure loading, all three positions show no fracture risk and meet the strength requirements.



Model/method: Based on customer data (20260925 revision-2.STEP). Total mass approx. 24.36 kg; length 2600 x width 720 x height

714mm.

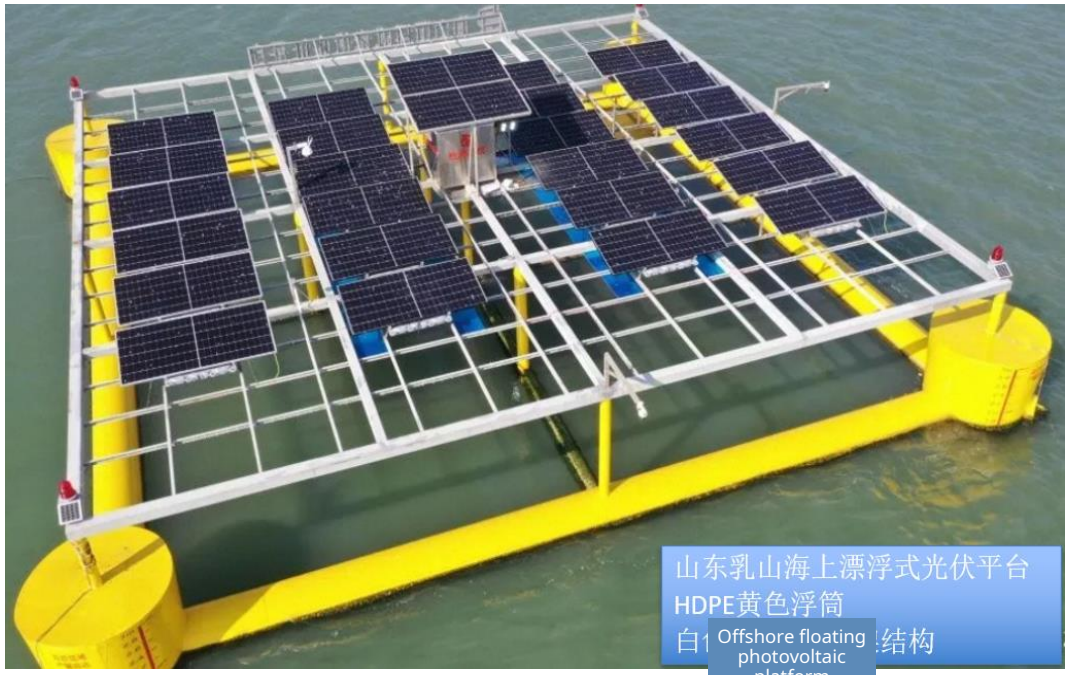
Main results / recommendations: Draft approx. 23.8 mm without top load; approx. 121.3 mm with an additional 100 kg.

Offshore aquaculture floats





Offshore photovoltaic platform





Sustainability and future trends

Technology development from bio-based materials to green recycling

Sustainability of polyurethane in marine applications

Bio-based alternatives, green antifouling and recycling improve sustainability. They retain protection while reducing environmental impact, offering greener materials for offshore renewable-energy equipment.

Bio-based materials

Plant-based PU composites show durability comparable to petroleum-based materials in real marine conditions. As sustainable alternatives for offshore renewable energy, they reduce life-cycle carbon footprints.

Lower carbon footprint

Eco-friendly antifouling

Next-generation PU antifouling coatings use controlled release to suppress marine growth and reduce ecosystem pollution, balancing protection and environmental requirements.

Controlled release technology

Green production and recycling

Green blowing agents reduce production impacts. Waste PU can be recycled chemically or mechanically to promote a circular materials economy.

Circular economy model

Summary: Polyurethane's core value in marine projects

PU is becoming a key marine-project material for anticorrosion, structures, sealing and buoyancy. Long-term protection, reliability and sustainability support safe marine transport and marine energy development.



Offshore wind and marine energy projects

Broad applications / full-life protection

Integrated marine protection from anticorrosion coatings to structural materials, and from sealing/vibration reduction to buoyancy modules.

Extreme environments / high-salinity mist

Corrosion, weather and mechanical resistance address harsh conditions including high-salinity mist, high humidity and strong UV.

Sustainable development / bio-based

Bio-based materials, green antifouling and recycling jointly balance performance and environmental requirements.

Thank you