



Huntsman Advanced Materials Innovative Solutions for Composite Industry

亨斯迈创新解决方案对复合材料产业的贡献



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- **Huntsman & Advanced Materials introduction** 亨斯迈先进材料简介
- **Product portfolio for composites industry** 复合材料产业的产品组合
- **Innovative cases sharing** 创新案例分享
 - **U Box** 城市概念车
 - **Solution for ACCC** 碳纤复合芯铝导线解决方案
 - **Solution for large wind blade** 大叶片解决方案

Huntsman & Advanced Materials Introduction

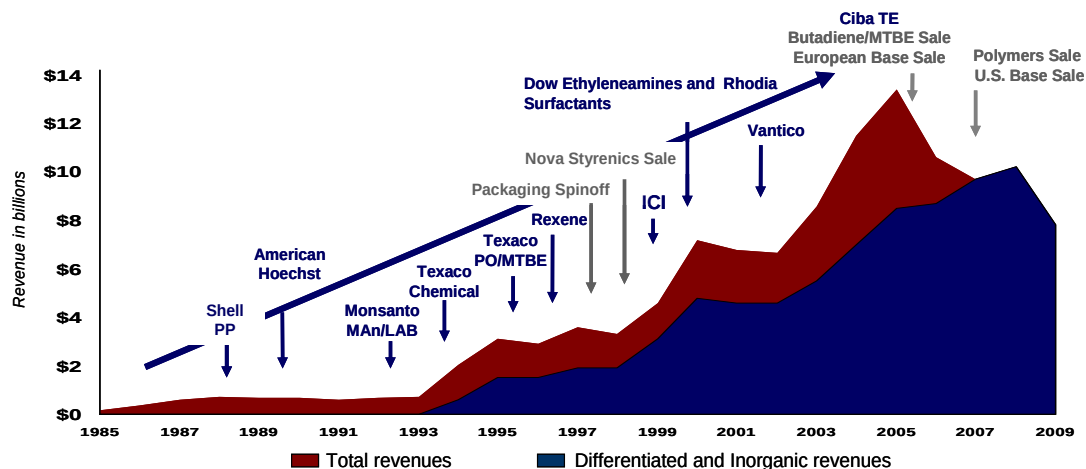
亨斯迈先进材料简介

- Huntsman Corporation 亨斯迈集团
- Huntsman Advanced Materials 亨斯迈先进材料事业部

Huntsman Corporation

亨斯迈集团

- **Started as family business**
始于家族企业
- **Grown through acquisition (>35 since 1980)**
通过收购获得成长 (自 1980 年起收购超过 35 次)
- **Sales Revenue: >\$ 11BN**
年销售收入已经大于110亿美元
- **People: 12.000**
员工总数: 12,000人



Differentiated 特殊化学品			
Polyurethanes 聚氨酯	Performance Products 功能化学品	Advanced Materials 先进材料	Textile Effects 纺织染色
MDI Polyols 多元醇 PO/MTBE TPU 热塑性聚氨酯 Systems 系统料	Performance Specialties 高性能特种化学品 Performance Intermediates 高性能中间体	Base Resins 基础树脂 Formulated Systems 配方系统 Specialty Components 精细化学组分	Apparel & Home Textiles 服装与家用纺织品 Specialty Textiles 特种纺织品

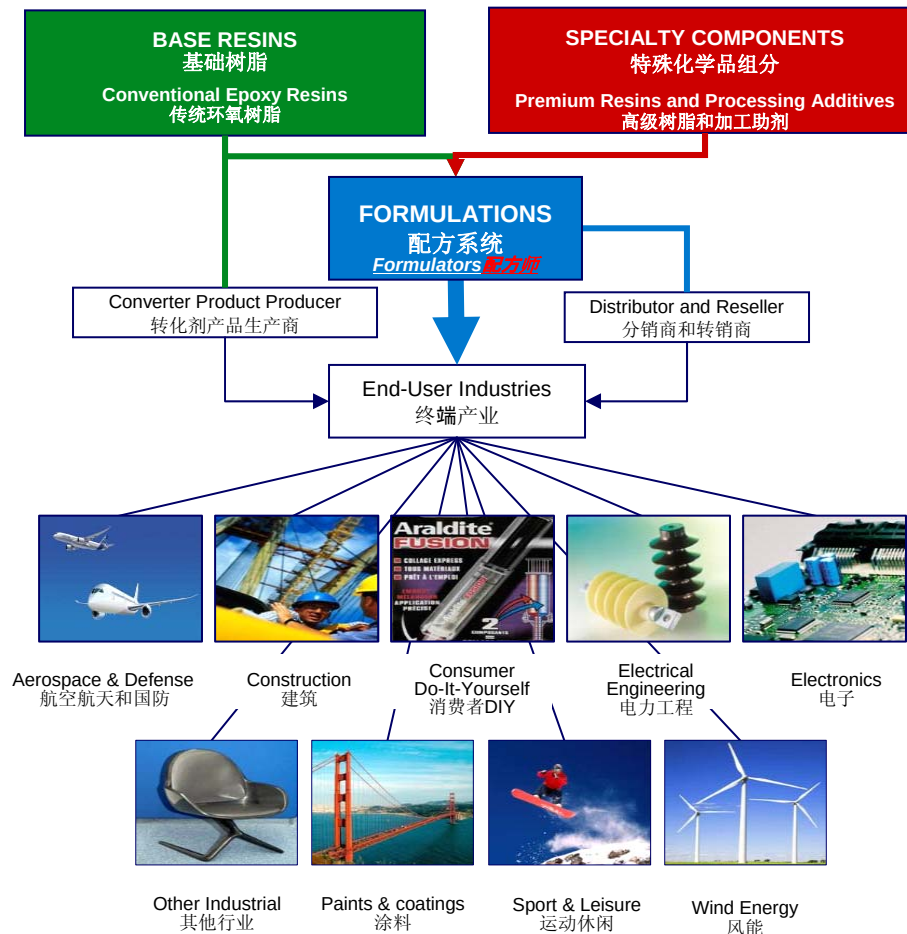
Inorganic 无机物
Pigments 颜料
Titanium Dioxide 二氧化钛

- **Organized in 5 Divisions**
以5大事业部运营
- **‘Advanced Materials’ was acquired in 2003 from Vantico (former CIBA)**
先进材料于2003年购自于泛达公司（前身为汽巴精化）
- **Key brand ‘Araldite’ introduced in 1946**
核心品牌“爱牢达”发布于1946年

Business Highlights 业务亮点

- ◆ A leading global manufacturer, marketer of differentiated chemicals and formulated systems.
一家全球领先的特殊化学品和配方体系的制造商和销售商
- ◆ Araldite® brand
爱牢达®品牌
- ◆ 3 regional headquarters
3 大区域总部
- ◆ 13 production facilities
13 家生产基地
- ◆ 2,300 employees, 80 countries, more than 1,500 products, over 2,000 customers
遍布 80 个国家, 拥有 2,300 名员工、1,500 多种产品、2,000 多家客户

Product Offering and Industry served 产品系列和服务行业



Advanced Materials 先进材料 Technology and Capabilities 技术与能力



	Product & Process Development	Customer Support*	Corporate Research
The Woodlands, TX	★	★	
Taboão da Serra, BR	★	★	
Basel, CH	★	★	★
Chennai, IN		★	
Shanghai, CN	★	★	

* Includes all Market Segments Huntsman Participates

Multifunctional Epoxy Expansion

多官能环氧树脂产能扩大



Investment in McIntosh and Monthey

Huntsman Advanced Materials, the global market leader in multifunctional epoxy resins, announced in September an expected \$50 million investment to expand capacity and capability for multi-functional epoxy resin production in the US and Europe.

A major step towards expanding one of our key product lines will be the start of in-depth engineering study at McIntosh, Alabama facility.

Once completed, the new line will boost global production of all types of multifunctional epoxy resins, serving current and future needs of customers in the aerospace and composite industries.

Aerial view of Monthey site, Valais, Switzerland

New Technology Centre in Minhang, Shanghai

上海闵行新研发中心

- 40 Million USD investment
- Integrated Corporate Technology and Innovation Center
- The state-of-the-art facility accommodating up to 400 technical experts
- Cross-divisional Synergy
- To be completed by Quarter 3 2013

四千万美元投资
亚太区技术创新中心

先进的实验设施

四百名研究人员

跨部门整合

2013年三季度落成



Product portfolio for composites industry

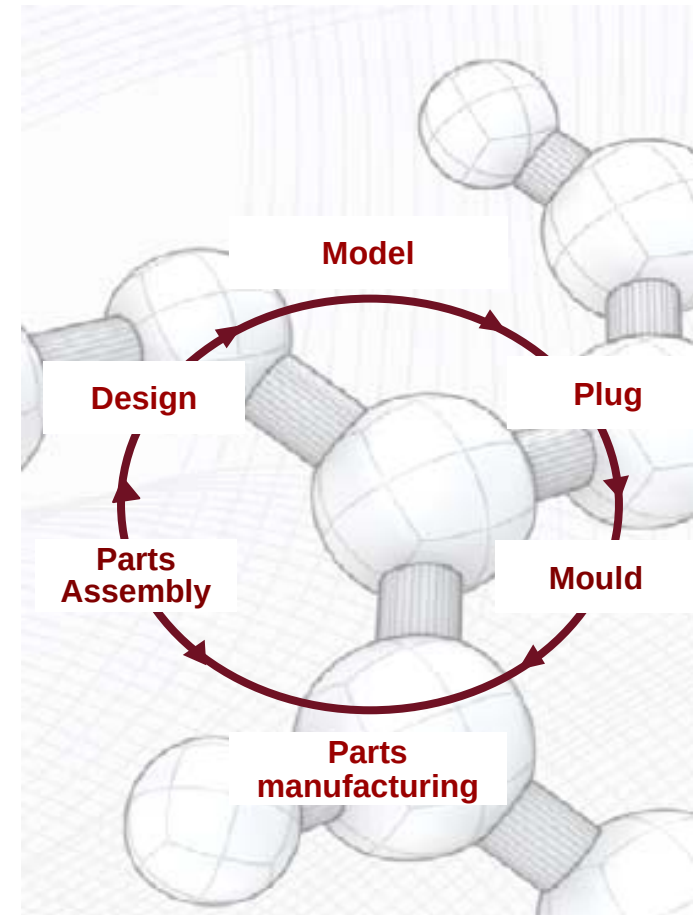
适用于复合材料产业的产品组合



Total solution for composite industries

整体解决方案

Offering Specialty Components & ready to use Formulated products



▪ Tooling

- Pastes for master models
- Mould manufacturing

▪ Parts manufacturing

- Wet lay-up
- Vacuum infusion
- Resin Transfer Mold (RTM)
- Prepreg
- Filament winding
- Expandable Epoxy System(EES)
- Pultrusion

▪ Assembly and Repairing

模具制造

主模型糊

模具生产

复材生产

手糊积层

真空导入

树脂传递模塑

预浸料

缠绕成型

发泡环氧

拉挤成型

组装和维修

Our products are extensively qualified to aircraft manufacturers' specifications (40+ years of experience)

Chemistry of components

- Multifunctional Epoxy
- Bismaleimide resins
- Polyimide resins
- Polyamideimide resins
- Cyanate Ester resins
- Benzoxazine resins

Araldite®

Matrimid®

Matrimid®

Rhodefal®

Arocy®

Araldite®

Formulated Systems

- Bonding
- Laminating
- Syntactic

Uralane® /Epibond®

Epocast®

Eposert

基础树脂

多官能环氧树脂

双马来酰亚胺

聚酰亚胺

聚酰胺-酰亚胺

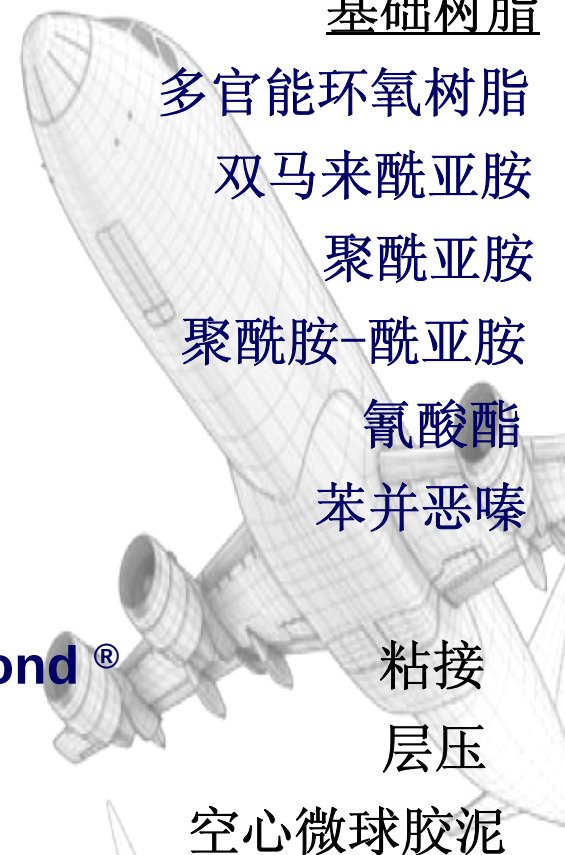
氰酸酯

苯并恶嗪

粘接

层压

空心微球胶泥



Tooling for master models

- **RenPaste**® for Seamless Modeling Paste (SMP)
- **RenPaste**® for Hand Lay Up Paste
- **RenShape**® for Epoxy board for prepreg parts
- **RenShape**® for Polyurethane board for styling
- **RenGel**® for Gelcoat

主模制造

无缝模型糊

手糊成型

环氧板材

聚氨酯板材

环氧胶衣

Tooling for mould manufacturing

- **RenCast**® for Epoxy casting system
- **RenPIM**® for Polyurethane vacuum casting system
- **RenLam**® for Wet lay-up
- **RenLam**® ; **Araldite**® for Vacuum Infusion

模具生产

环氧浇铸

低压浇铸

手糊积层

真空导入

Composites manufacturing

-- Structural, visual & function

- **Araldite®** for Wet lay-up
- **Araldite®** for Vacuum Infusion
- **Araldite®** for Prepreg
- **Araldite®** for RTM process
- **Araldite®** for EES

复材制造

结构件，装饰件和功能件

手糊积层

真空导入

预浸料

树脂传递模塑

环氧发泡



Bonding and repair

粘接和修补

- **Araldite®** for Structural adhesive
 - Epoxy adhesive
 - Polyurethane adhesive
 - Methacrylate adhesive
- **Araldite®** for repair and maintenance

结构件粘接

环氧胶

聚氨酯胶

丙烯酸酯胶

维修保养



Parts manufacturing

- **Araldite®** for Wet lay-up
- **Araldite®** for Infusion
- **Araldite®** for Filament winding
- **Araldite®** for Prepreg
- **Araldite®** for EES

复材制造

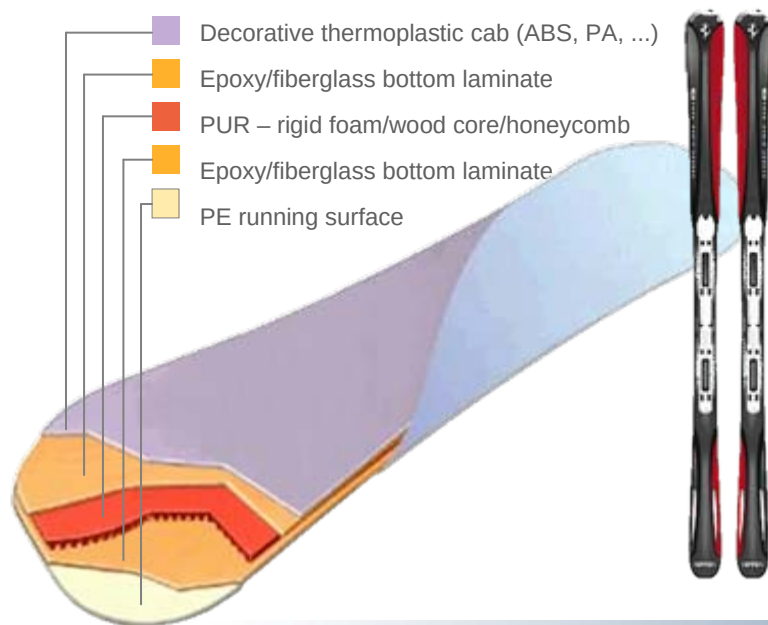
手糊积层

真空导入

缠绕成型

预浸料

环氧发泡

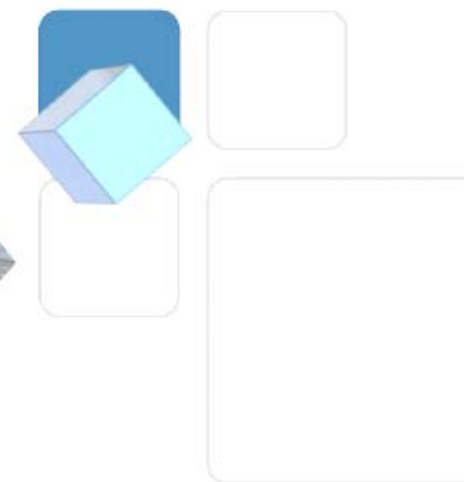
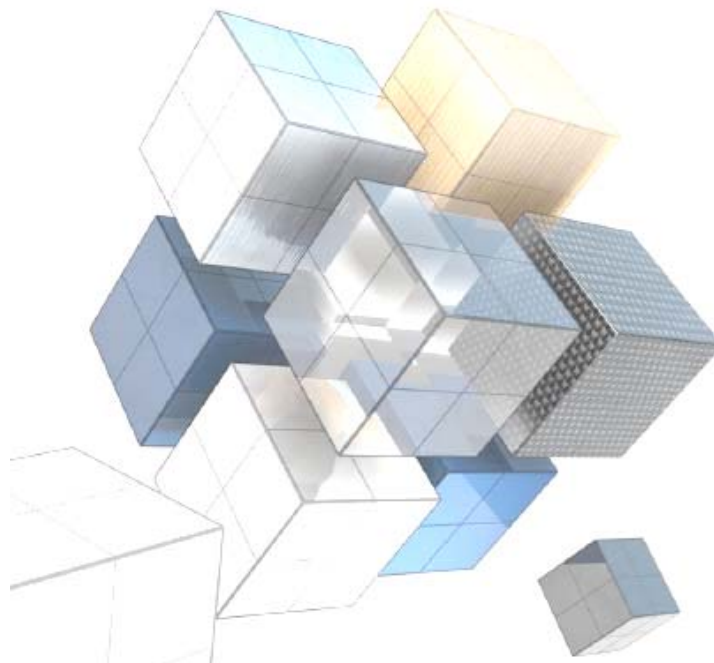


- **U Box**
- **Solution for ACCC**
- **Solution for large wind blade**

城市概念车

碳纤复合芯铝导线解决方案

大叶片解决方案



U Box



U Box (Urban Box) car

Electric car for urban goods transportation

用于市区货物运输电动汽车

Technical detail

- Autonomy
- 160 Km at 45 Km/h
- Reload time battery: overnight
- Capacity: 1 driver + 2 standard pallets

技术参数

燃料电池车

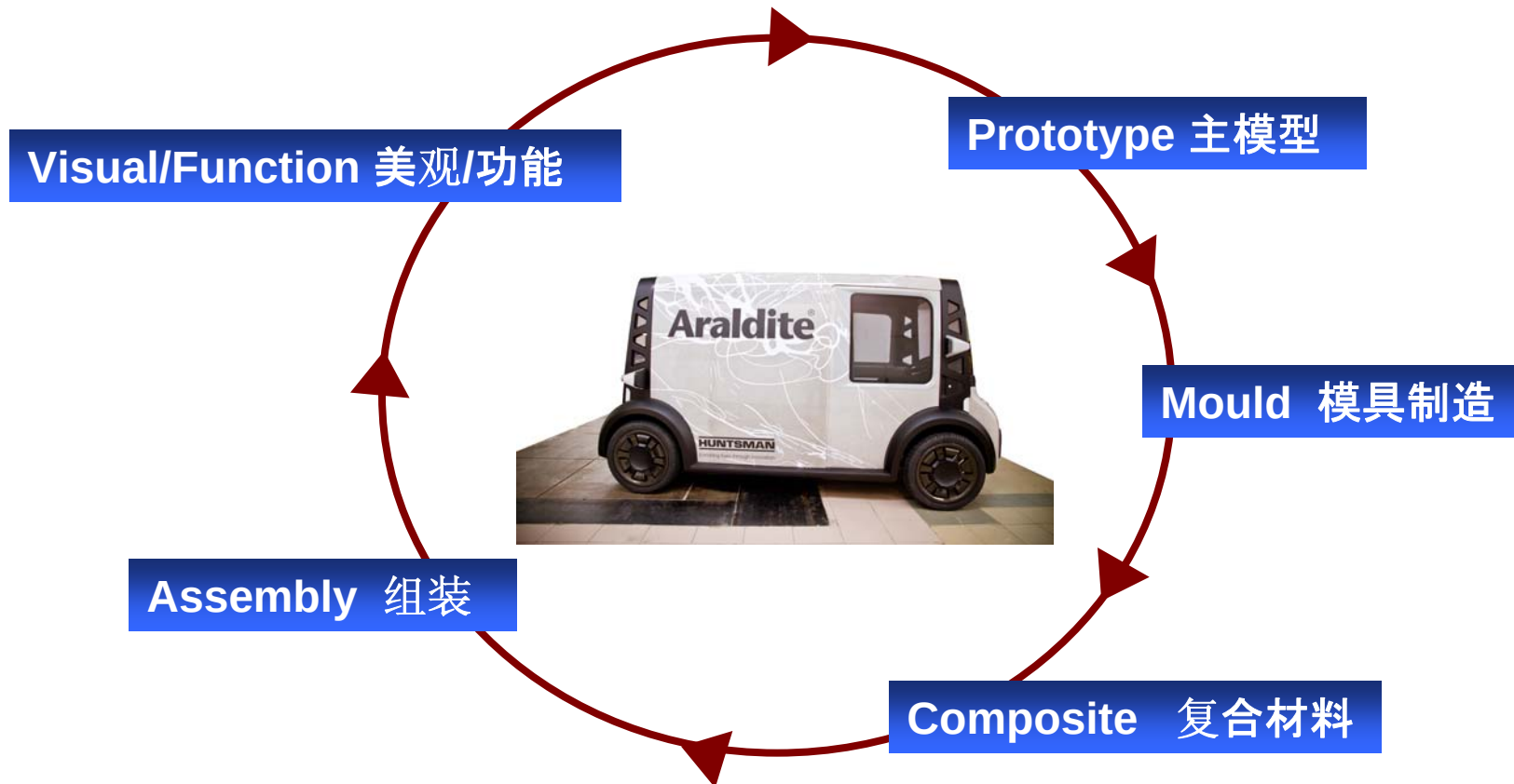
续行里程160公里(时速 45公里)

充电时间: 一整夜

运力: 一名司机 + 两拖盘货物



U Box (Urban Box) car

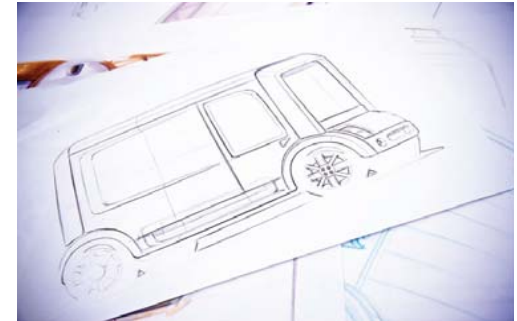


U Box (Urban Box) car

Tooling

- RenPaste® SV 4503-1 / Ren® HV 4503-1
Epoxy seamless modeling paste
- RenShape® BM 5055
Epoxy board for prepreg parts
- RenShape® BM 5025
Polyurethane board for styling
- RenCast® 6425 A / Ren® 5425 B
High toughness and durability casting system
- RenPIM® VG 5287
Polyurethane vacuum casting system

模型设计及模具制造



U Box (Urban Box) car

Composite

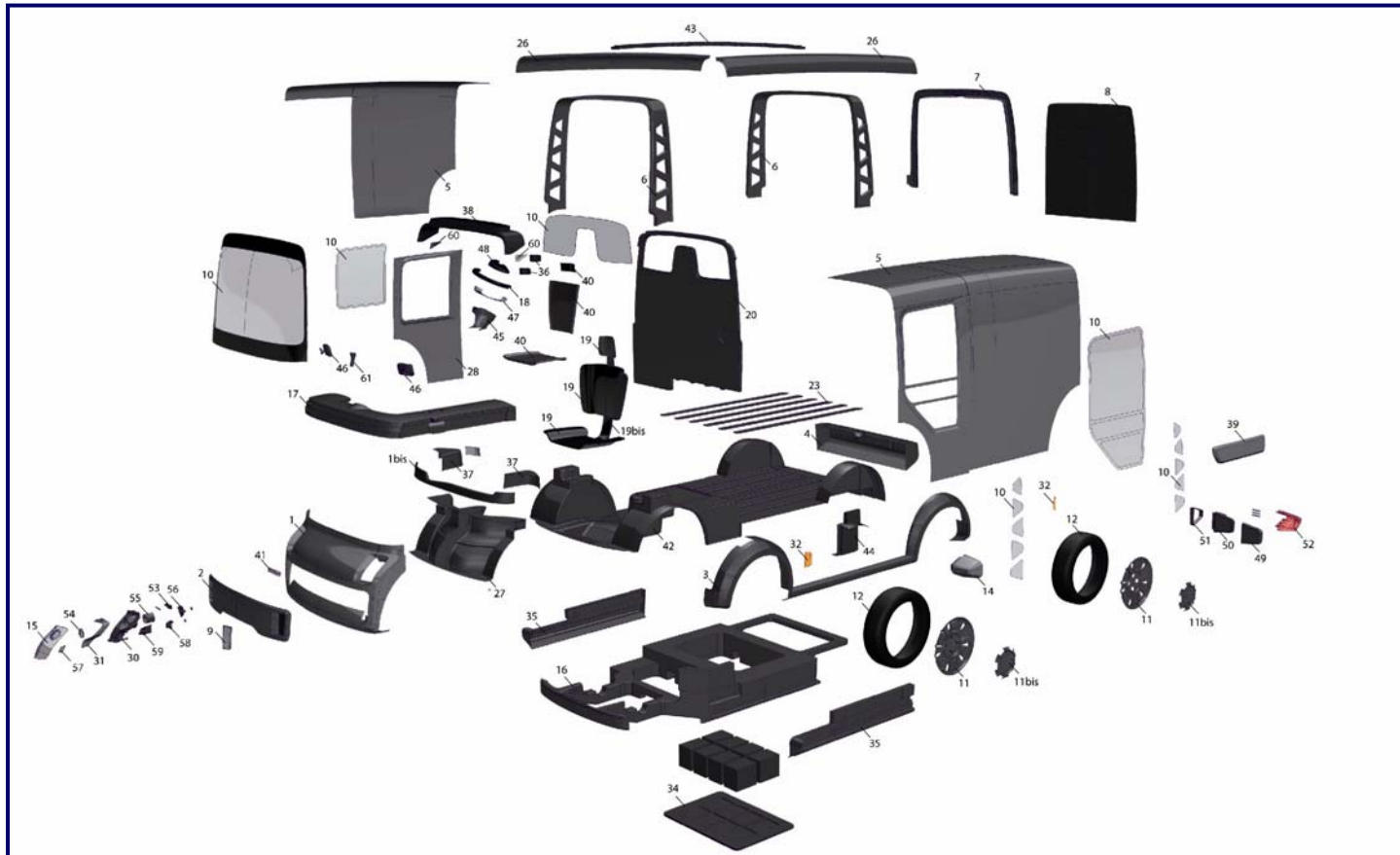
复材制造

- Araldite® LY 1564 / Aradur® 3486
Epoxy composite system for infusion
- Araldite® LY 1564 / Aradur® 3487
Epoxy composite system for infusion
- Resin XU 3508 / Hardener XB 3473
Toughened epoxy composite system for RTM
- High flexible epoxy composite system
UBOX: Infusion
- FST (Flame, Smoke, Toxicity) epoxy composite system
UBOX: Infusion

U Box (Urban Box) car

Composite parts need

复合材料部件



U Box (Urban Box) car

Assembly

组装

- **Araldite® 2015**
Toughened gap filling epoxy adhesive
- **Araldite® AW 4858 / Hardener HW 4858**
High performance epoxy adhesive
- **Araldite® 2033**
Flame retardant epoxy adhesive
- **Araldite® 2028**
Transparent polyurethane adhesive
- **Araldite® 2060 (White)**
High flexible MS (Modified Silane) adhesive
- **Araldite® 2061 (Black)**
High flexible MS (Modified Silane) adhesive



U Box (Urban Box) car

Visual & Function

美观/功能

Encapsulating

电子封装

- Araldite® CY 8767 / Aradur® HY 8767-1
Epoxy battery potting system

Surface Engineering

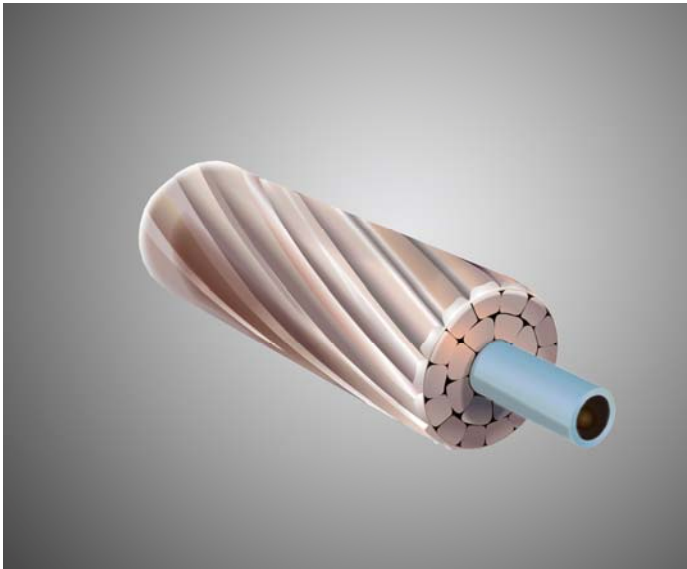
表面处理

- OLED (Organic Light Emitting Diode)
High performance thin barrier coating
- Probimer® 77 White
Halogen-free solder mask for lighting



碳纤维复合芯铝导线 (ACCC) 解决方案

Araldite® CY 5198 / Aradur® HY 5198



Araldite® CY 5198 / Aradur® HY 5198

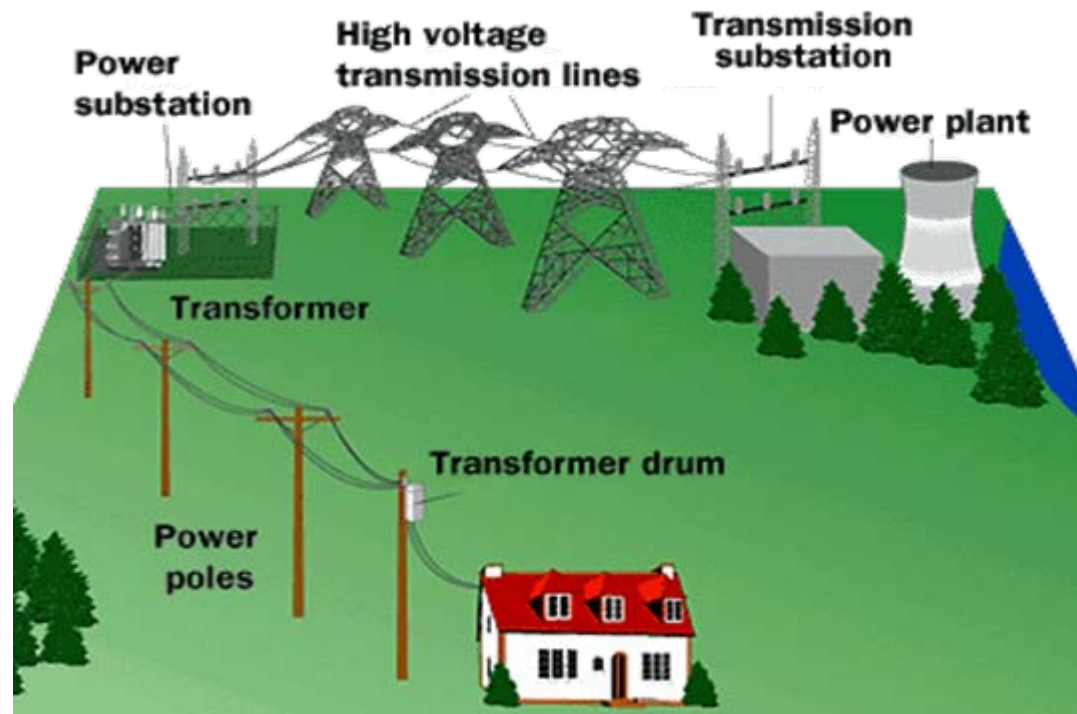
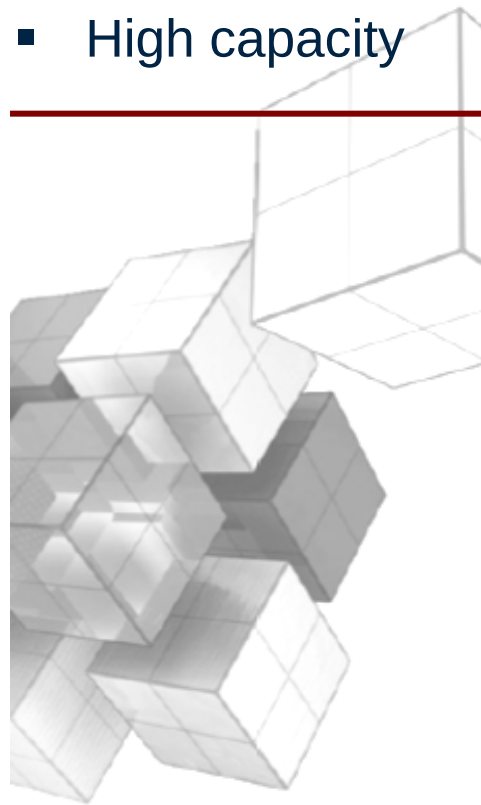
Future trend of power transmission

- Low loss
- High capacity

电力输送未来发展

低损耗

大容量



Araldite® CY 5198 / Aradur® HY 5198

Traditional cable: ACSR

传统电缆：钢芯铝导线

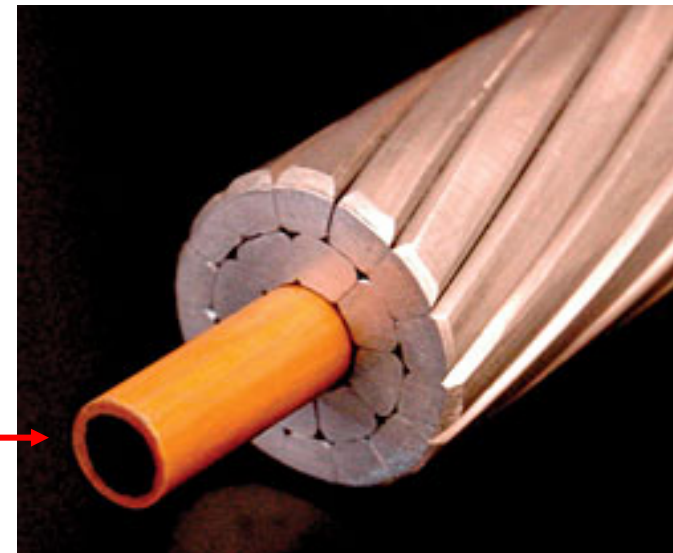
Steel core 钢芯



New type of cable: ACCC

新型电缆：碳纤维复合芯铝导线

**Composite rod
碳纤维复合芯**



Araldite® CY 5198 / Aradur® HY 5198

Composition of composite rod

Reinforced fiber

Carbon fiber (core)

- Mechanical property/density/CTE

Glass fiber (shell)

- Flexibility /insulation

High performance epoxy resin system

- Processability
- Thermal stability
- Weatherability
- CTE/insulation/density
- Flexibility/compression

碳纤维复合芯组成

增强纤维

碳纤维(芯层)

力学性能/低密度/热膨胀

玻璃纤维(外层)

韧性/绝缘性

高性能环氧树脂体系

加工工艺性能

耐热性能

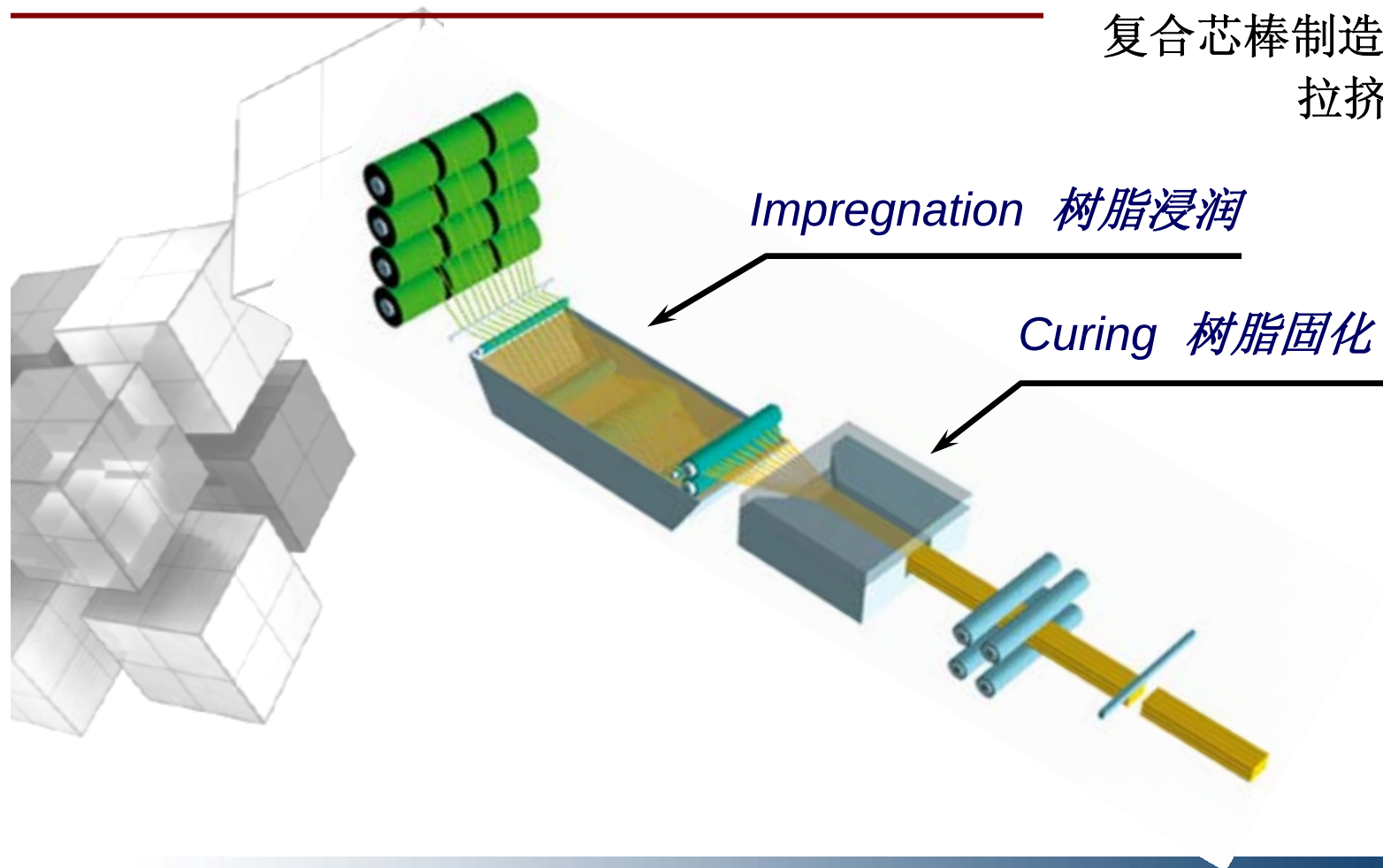
耐侯性能

热膨胀性能/绝缘性/低密度

柔韧性能/抗压性能

Pultrusion for composite rod manufacturing

复合芯棒制造工艺
拉挤成型



Performance of composite rod

碳纤维复合芯性能

Test items (rod)	测试项目(芯棒)	GB (1 B) 国标	Result 结果
0. Pultrusion speed	拉挤速度	Customer require.	0.3 ~ 1.0 m/min
1. Appearance	外观	Shiny surface	Shiny/光滑
2. Tensile strength	拉伸强度	≥ 2100 MPa	2100 ~ 2500
3. Linear thermal expansion coefficient (40℃-160℃)	线膨胀系数	≤2.0×10 ⁻⁶ m/℃	(0.03-0.05)×10 ⁻⁶ m/℃
4. Density	密度	≤2.0 g/cm ³	1.75-1.85 g/cm ³
5. Radial Compression load	径向压缩	≥30KN	32 ~ 36
6. Tg by DMA (storage modulus value)	玻璃化温度	≥190℃	194 ~ 200
7. Winding properties	卷绕	No crack with 55D	Pass/通过
8. Torsion properties (360 ° C)	扭转	No crack	Pass/通过
9. Residual TS after winding and torsion	卷绕后拉伸余量	≥ 2100 MPa	2100 ~ 2400
10. Thermal resistance of tensile strength	热老化	≥ 1995 MPa	≥ 1995 MPa
11. UV resistance properties	抗紫外	No sticky	Pass/通过
12. Salty spray test	盐雾	No corrosion	Pass/通过

Feature of product and composite rod

产品特点

Two components & low viscosity system

双组份低粘度树脂配方

Excellent processibility

优良的加工工艺性能

- Fast pultrusion speed/ long pot life
- Well equipment compatibility/product stability

拉挤速度快/操作窗口宽

设备兼容性好/产品性能稳定

Excellent thermodynamic properties

优异的热力学性能

- Hi Tg/Good weatherability & thermal stability

高 T_g /耐候性强/抗老化性能优异

Outstanding mechanical properties

优良的机械性能

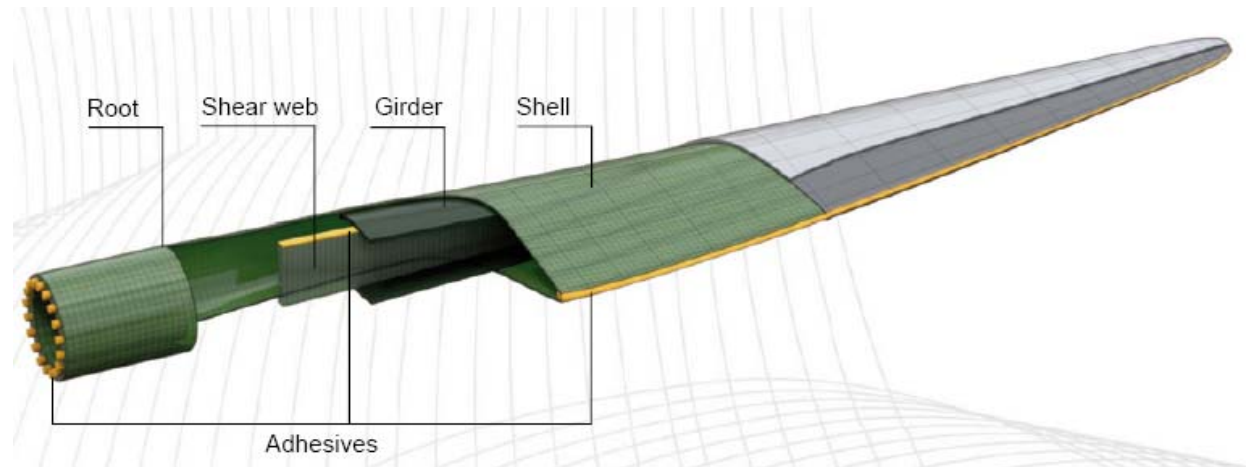
- High tensile strength
- good flexibility & anti compression

拉伸强度高

柔韧性高/抗压性能高

Huntsman solution for Large Scale Wind Turbine Blades

大型风能叶片解决方案



Solution for large blades 大叶片解决方案

Future trend of wind turbine blade

风能叶片的未来发展

- Lower manufacturing cost
- Longer blade

更低的制造成本

更大的叶片

China Wind Energy Market

目前国内风能市场

Mainstream:

市场主流

- 30 - 40 m blades
- Vacuum infusion process
- Huntsman product:

真空导入工艺

亨斯迈市场化产品

Araldite®LY1564 / Aradur® 3486/3416/3487

Araldite®LY1568 / Aradur® 3489/3491/3492

Araldite®LY1572 / Aradur® 3486/3416/3487

Solution for large blades 大叶片解决方案

Technical challenge

技术挑战

Fast Curing

- Reduce processing time
- Increase productivity
- Lower blade manufacturing cost

快速固化

减少工艺时间
提高生产效率
降低生产成本

Latency

- Longer pot-life for infusion
- Longer blade

潜伏性

更长的工艺窗口
更大的叶片

Lower exothermic

- Reduce thermal stress
- Longer blade
- Safety

低放热

减少热应力
更大的叶片
工艺安全

Solution for large blades 大叶片解决方案

LPY 11044 Vs Araldite® LY 1564/Aradur® 3486

产品性能比较

Faster curing speed

Latency compared with old system

Higher Tg

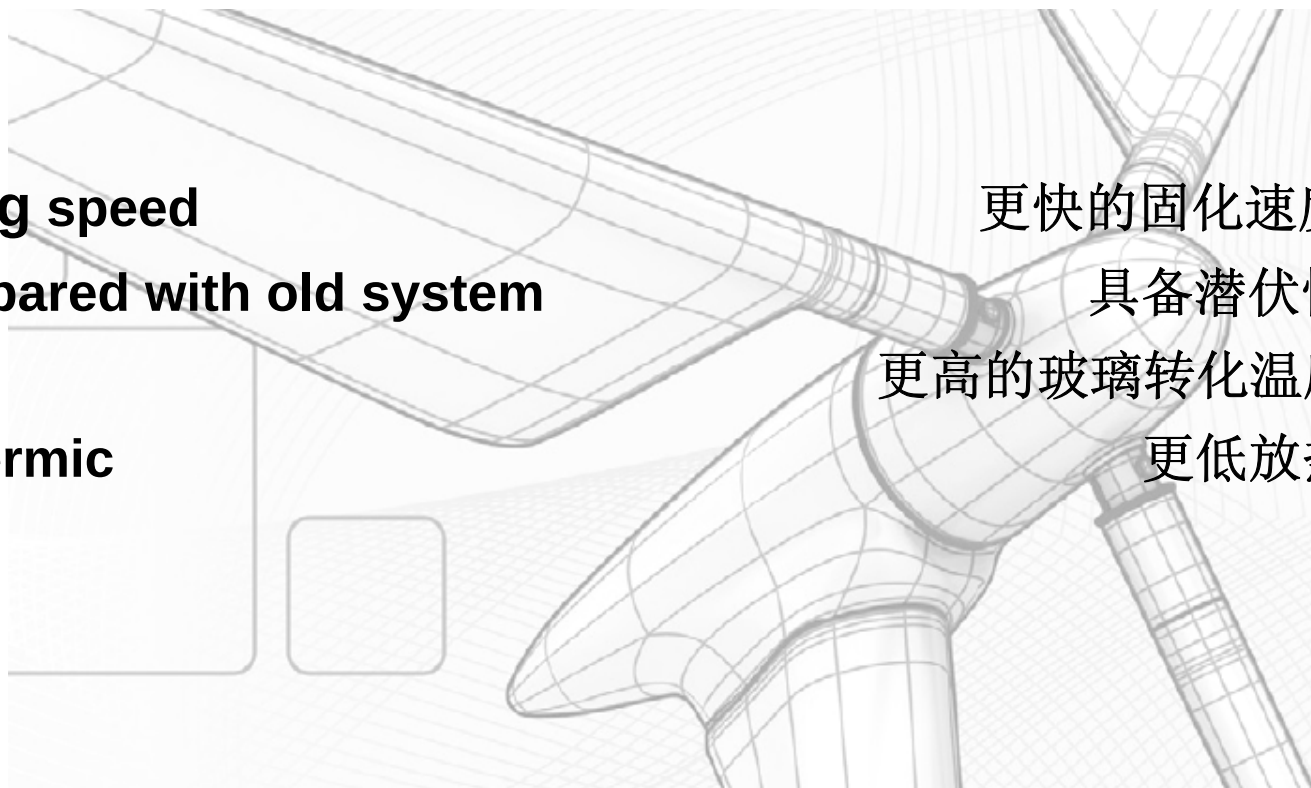
Lower exothermic

更快的固化速度

具备潜伏性

更高的玻璃转化温度

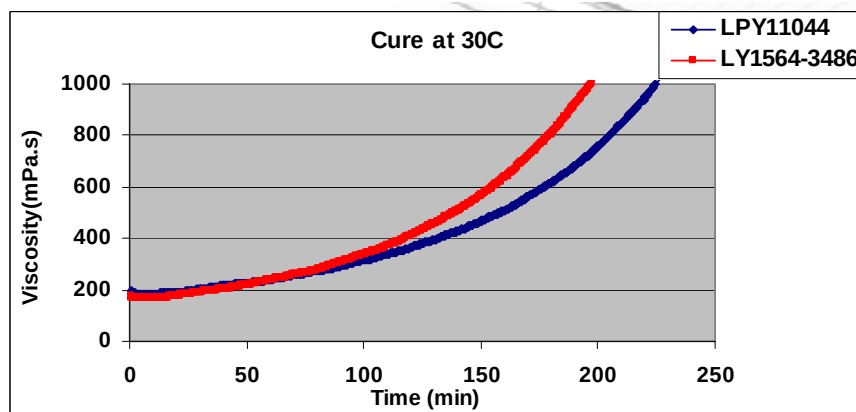
更低放热



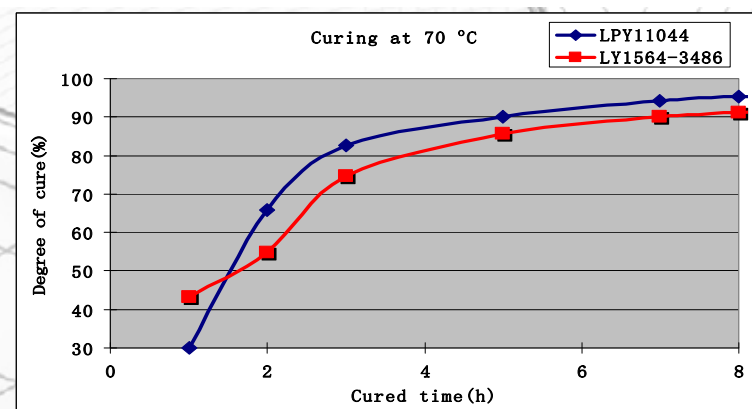
Solution for large blades 大叶片解决方案

LPY 11044 Vs Araldite® LY 1564/Aradur® 3486

产品性能比较



Latency

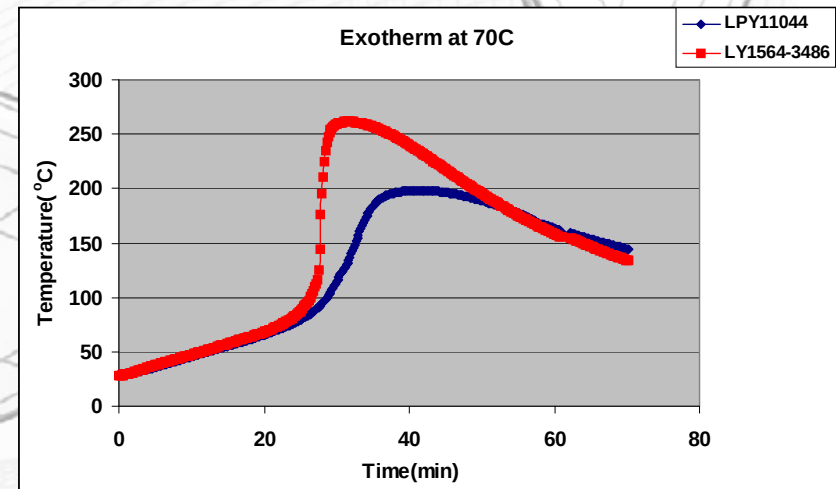
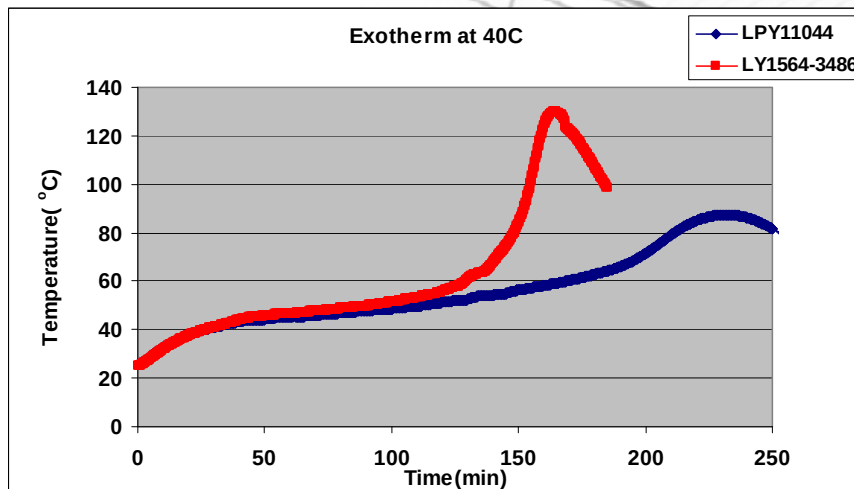


Faster curing speed

Solution for large blades 大叶片解决方案

LPY 11044 Vs Araldite® LY 1564/Aradur® 3486

产品性能比较



Lower exothermic

Solution for large blades 大叶片解决方案

LPY 11044 Vs Araldite® LY 1564/Aradur® 3486

产品性能比较

Test items		LPY 11044	LY 1564/HY 3486
Potlife	Min (23 °C, Tecam)	660 ± 30	490 ± 30
Curing condition	Temp * Time (Pre-curing + Post-curing)	70 °C * 5 hrs	70 °C * 8 hrs
DSC profile	Enthalpy (J/g)	327	451.1
	Peak temp. (°C)	125.5	124.4
	Onset Temp (°C)	89.7	85.3
Tg	(DSC, °C)	88.2	82.4
Tensile property	Strength (MPa)	65.8	65.8
	Elongation a	5.2	4.5
	Modulus (Mpa)	2801 - 2839	2870 - 2930
Compression property	Strength (MPa)	83 - 88	78 - 83
	Modulus (Mpa)	2450 - 2650	2400 - 2600



Thank You!

谢谢！

Q&A

欢迎交流！

- Backup slides

Advanced Materials in APAC

先进材料事业部于亚太区

Technology Centers located in Shanghai and Guangzhou

上海和广州技术中心

- New product creation and development
- Technical & application support
- Analytical and testing service

新产品开发
技术和应用支持
分析检测服务

Shanghai Technology Center



Panyu manufacturing and R&T complex



New Technology Centre in Minhang, Shanghai

上海闵行新研发中心

- 40 Million USD investment
- New Integrated Corporate Technology and Innovation Center
- The state-of-the-art facility accommodating up to 400 technical experts
- Cross-divisional Synergy
- To be completed by Quarter 3 2013

四千万美元投资
新亚太区技术创新中心

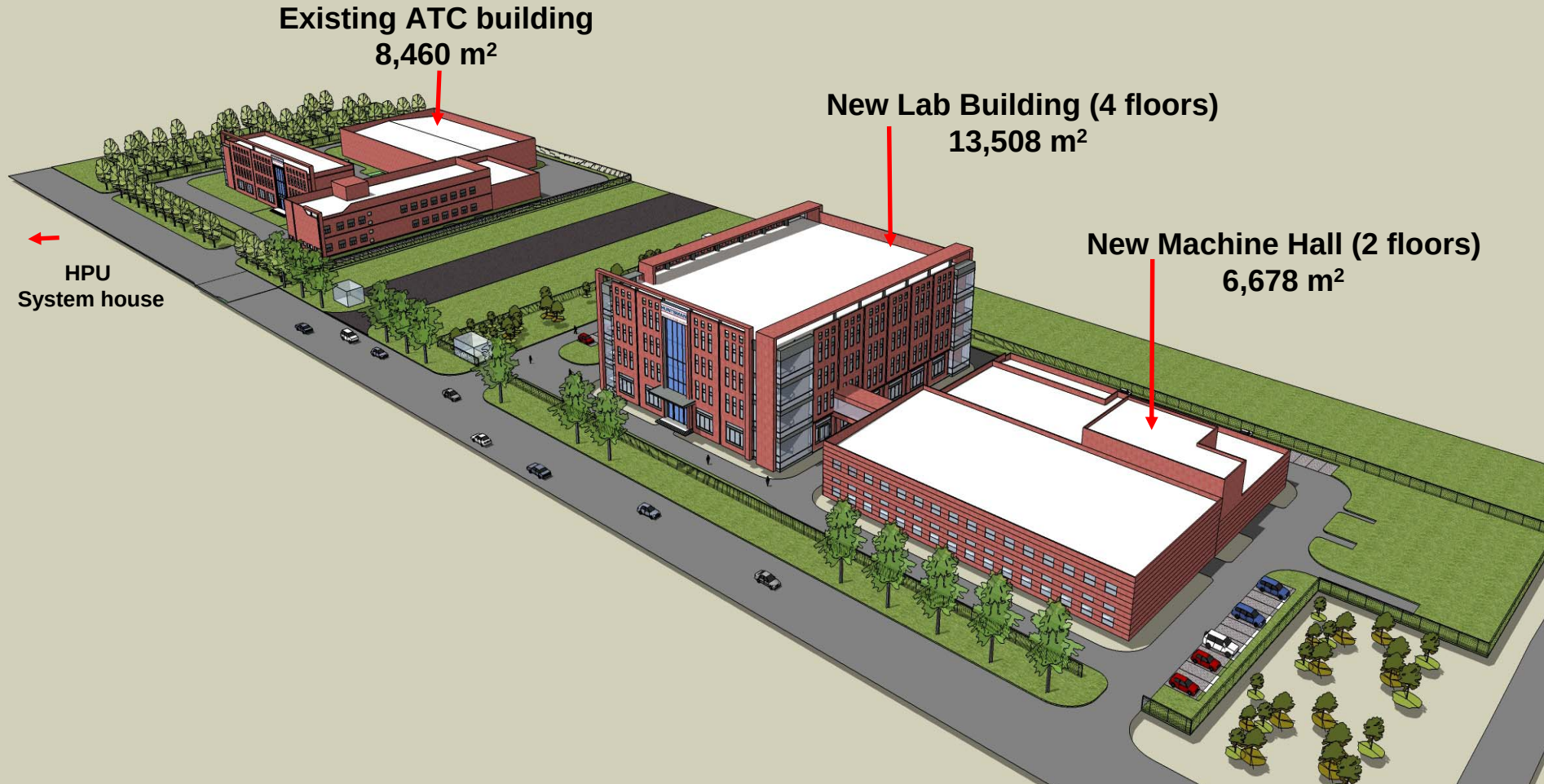
先进的实验设施
四百名研究人员
跨部门整合

2013年三季度落成



Asia Pacific Technology Centre Expansion Artist Impression

Construction area to be increased by 2.5 times



Process development located in Guangzhou

广州工艺开发部门

- Technology transfer into local manufacturing
- Ensure production process safety & efficiency
- Process safety laboratory
- Kilo laboratory
- Pilot plant
 - 2 million USD investment
 - Advanced design
 - Multi-functional operation

实验室工艺放大
确保生产工艺安全和效率

工艺安全实验室
公斤级实验室
中试工厂
两百万美元投资
先进的设计
多功能运作



Guangzhou manufacturing site (since 1995)

- Total Investment (up to 2009): USD 31.0 million
- Formulations System (FS): 16.2K MT/Y
- Epoxy Resin System (RS): 14.5K MT/Y
- Printed Circuit Boards (PCBT): 1.6K MT/Y

广州生产基地 (建于 **1995**)

总投资三千万美元(2009)
配方生产车间 16.2千吨/年
树脂生产车间 14.5千吨/年
印刷电路板车间 1.6千吨/年

Nanjing FDC

- 2 million USD investment
- Fast and flexible to deliver product

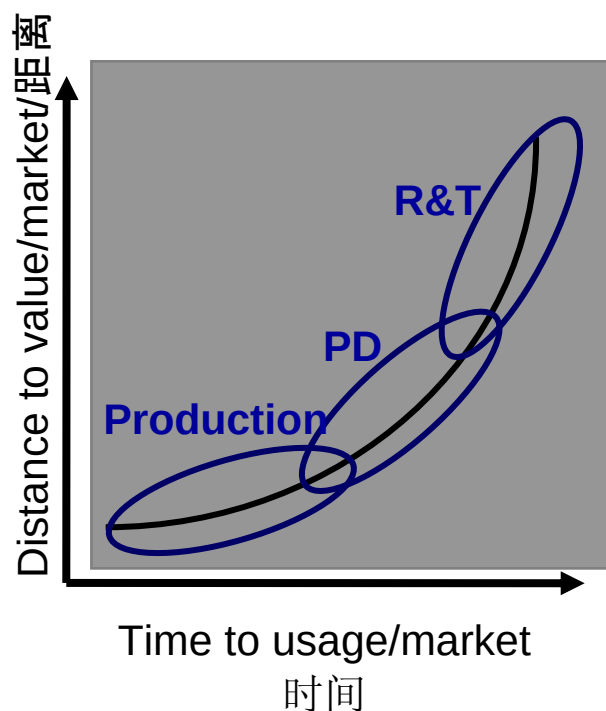
南京配方调配中心

两百万美元投资
快速灵活的生产运输



A full value chain to provide total solutions to customers

全方位的解决方案提供商



Research and technology

- Innovation
- Fundamental research
- Technical support

研发

创新

基础研究

技术支持

Process development

- Process optimization
- Scaling up

工艺开发

工艺优化

中试放大

Production

- Safety
- Quality
- Productivity

商业化生产

安全

质量

效率

Advantage of ACCC碳纤维复合芯铝导线的优点

1. 芯棒重量轻, 强度高, 对于相同直径电缆, 复合材料芯可承载多**28%**的铝导线, 以提供更大的载流容量。
2. 芯棒耐热温度高, 可提供更高电缆工作温度, 减少电力传输中的损耗。
3. 芯棒热膨胀系数小, 可减少电缆**50%**的垂挂问题, 增强地面的安全性。
4. 芯棒材质可消除电缆芯电偶腐蚀, 提高电缆的使用寿命。
5. 减少建设高压电线塔的数目。
6. 减少建设和保养费用。
7. 减少资源的消耗。
8. 最终降低成本。

构建安全, 环保, 高效节约型输电网络

复合芯棒主要性能要求

测试项目	目标值 (1B 级*)	测试方法
1. Appearance	Shiny surface	目视
2. Tensile strength	≥ 2100 MPa	试样有效拉伸长度不小于70D。，拉伸速度：1-6mm/min；仲裁速度：2mm/min
3. Radial Compression load	≥ 30 KN	截取长度为100mm的复合芯棒，以1mm/min速度平稳加载至30kN，
4. Tg by DMA(storage modulus value)	$\geq 190^{\circ}\text{C}$ (TA Q800)	3-point bending clamps; ramp temperature: from 30C to 300C at 5C/min; Frequency: 1HZ; constant amplitude: 50um;
5. Winding properties	No crack with 55D	取长度不少于200D的复合芯棒试件，在55D直径的筒体上以不大于3r/min的卷绕速度卷绕1圈，保持1分钟，其表层不开裂、不起皮。
6. Torsion properties (360° C)	No breakage With 170D	完成卷绕试验后，截取经卷绕试验的170D长度复合芯棒，一端固定在试验设备固定钳口中，另一端固定在试验设备活动钳口中，活动钳口加载40kg砝码，试样以不大于2r/min的扭转速度在导轮上做角度不小于360°的扭转，保持2分钟,再将芯线展直，其表层应不开裂，然后测试试样的抗拉强度。
7. Residual TS after winding and torsion	≥ 2100 MPa	试样有效拉伸长度不小于70D。，拉伸速度：1-6mm/min；仲裁速度：2mm/min
8. Thermal resistance of tensile strength	Residual tensile strength ≥ 1995 MPa	复合芯棒应在160C烘箱内静置400小时，并在160C的试验箱内静置1小时后在高温下测试抗拉强度。
9. UV resistance properties	No sticky;	按GB/T 16422.3—1997第3部分 荧光紫外灯的规定进行，紫外波长340nm，强度0.76W/m2，采用曝露方式1，其中每循环辐照暴露时间为4小时。复合芯棒曝露1008小时后，目测表面质量
10. Salty spray test	No corrosion	按标准GB/T 10125—1997规定的方法进行:35C $\pm$ 2C; PH:6.5-7.2 for 240h

注: * 依据2011年12月GB草稿

Araldite® CY 5198 / Aradur® HY 5198

Viscosity curve

- Initial viscosity: 600 - 1000 mPas (25 °C)
- Time to double viscosity (25 °C & 40 °C) ≥ 10 小时

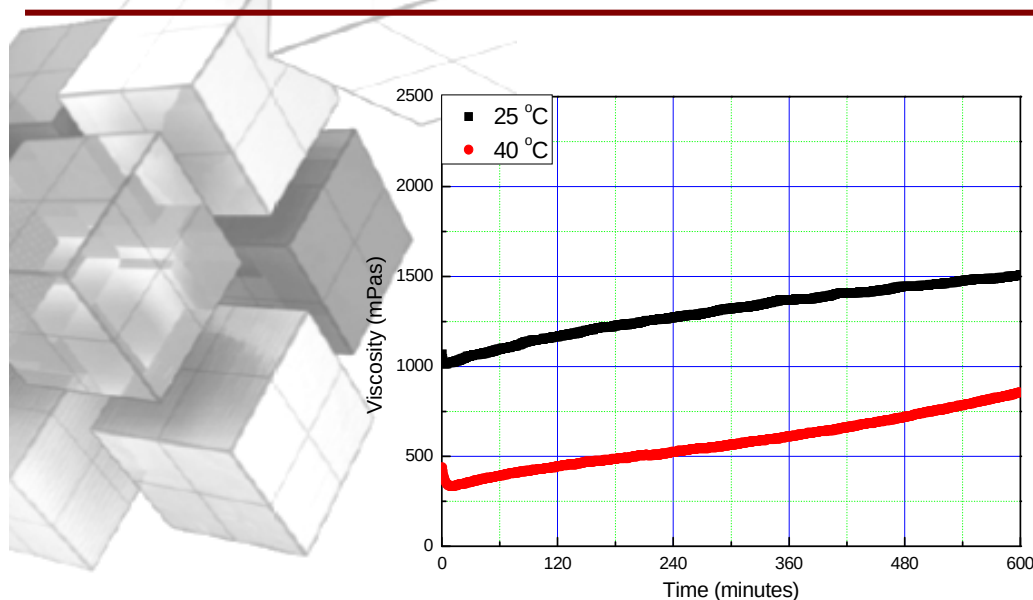
粘度增长曲线

初始粘度

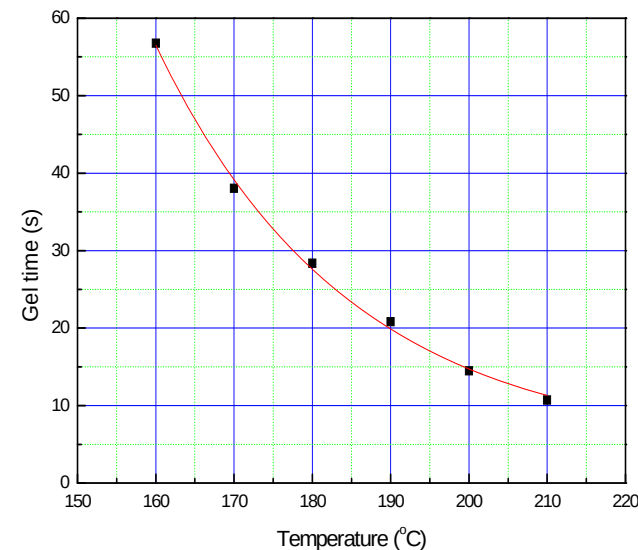
粘度倍增时间

Gel time curve

凝胶曲线



Viscosity curve/粘度增长曲线



Gel time curve/凝胶曲线

Araldite® CY 5198 / Aradur® HY 5198

Thermal & mechanical properties (Pure resin)

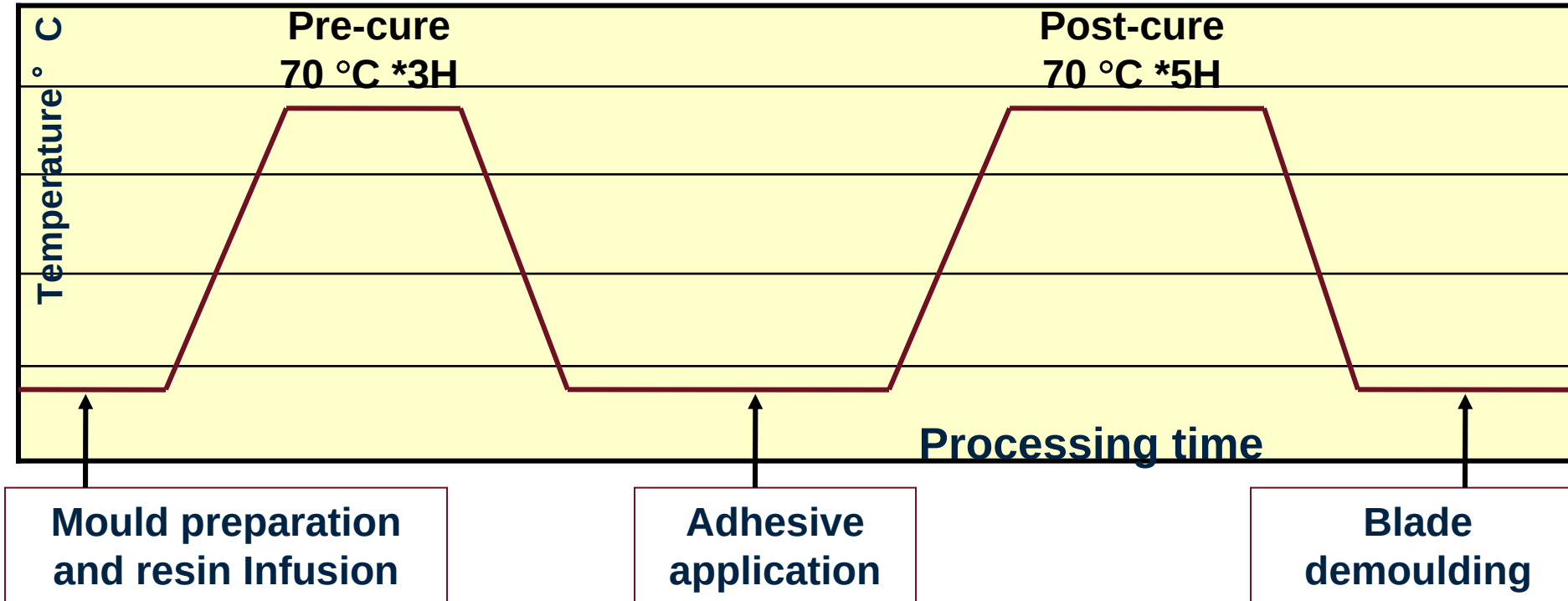
热力学和机械性能指标 (纯树脂)

Test Item		Test Method	Specification range	Unit
Tg by DMA (storage modulus)		ASTM D7028	195 - 210	°C
Tensile property	strength	ISO 527	35 - 45	MPa
	elongation		2 - 3	%
	modulus		2000 - 2400	Mpa
Flexural property	strength	ISO 178	65-75	MPa
	elongation		3.8 – 5.0	%
	modulus		1900-2300	Mpa
Compression property	strength	ISO 604	170 - 210	MPa
	elongation		25 - 35	%
	modulus		1700 - 2100	Mpa

Curing condition: 100 °C x 1h; 200 °C x 2h

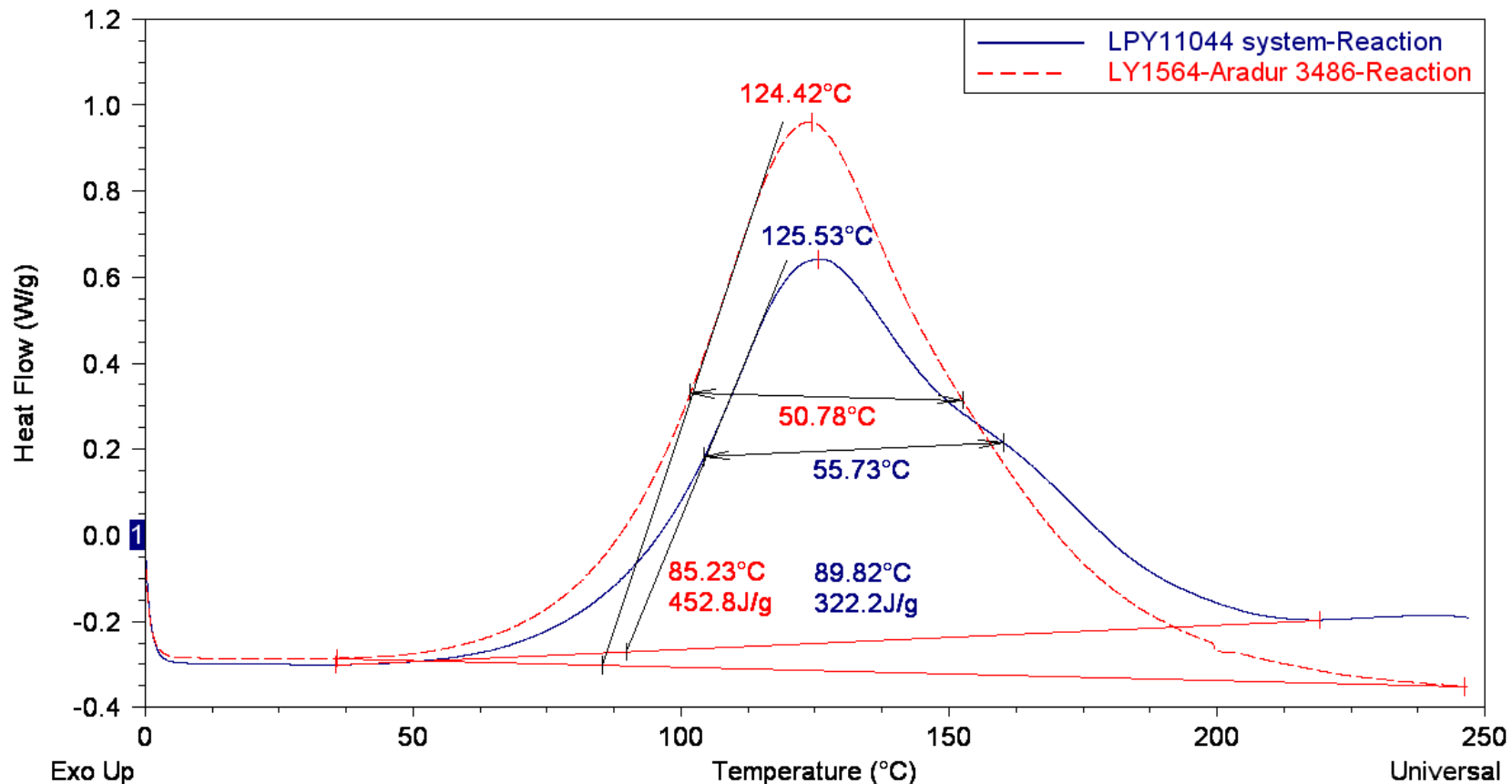
树脂固化条件

Overall blade curing process



- Infusion time: 2h (for 42m blade)
- Pre-cure time: 3h
- Post-cure time: 5h

The cause of lower exotherm



1. Wider exothermic peak
2. Slower reaction heat release