



**SOLVAY**

asking more from chemistry®

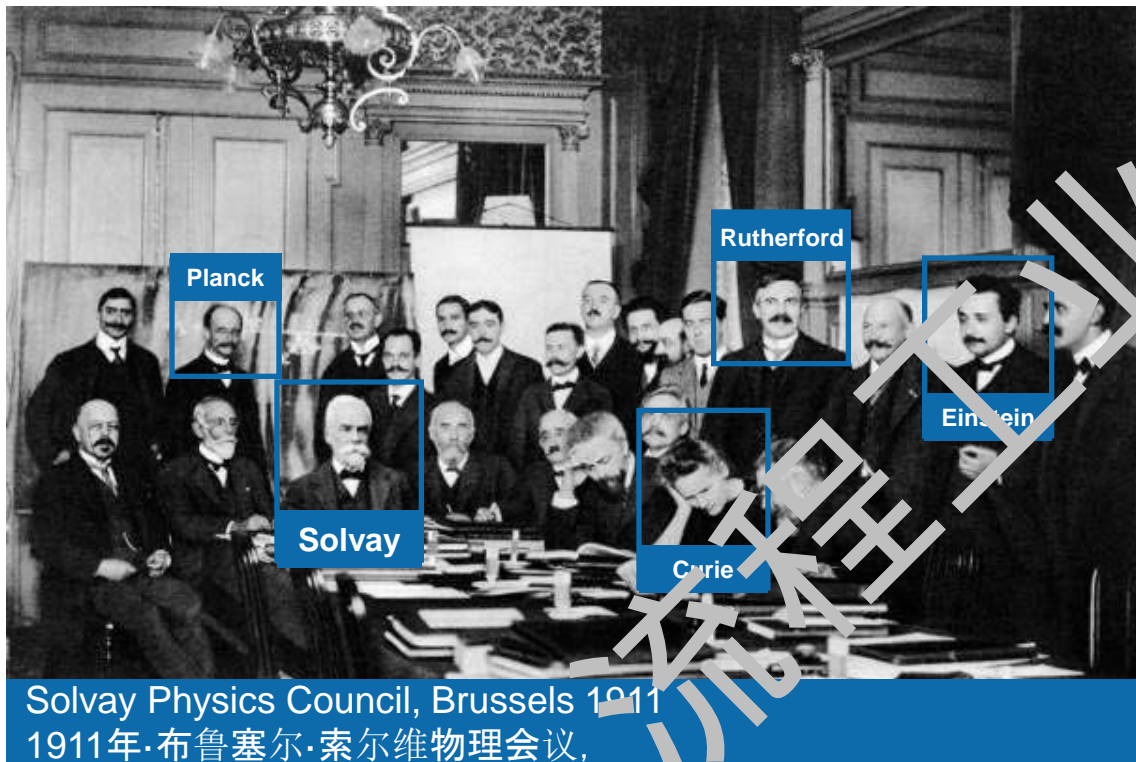
# Solvay Specialty Polymers for the Chemical Process Industry

索尔维特种聚合物在化工行业的应用

**SPECIALTY  
POLYMERS**

# Solvay – 150 years of Passion

## 索尔维-150年精神传承



### Solvay Group today : 索尔维集团

- HQ Brussels, BE  
总部位于比利时布鲁塞尔
- CAC40 & BEL 20 listing  
CAC40&BEL20股指股票  
~12b€ turn over  
营业额120亿欧元
- ~29000 employees  
约29000员工

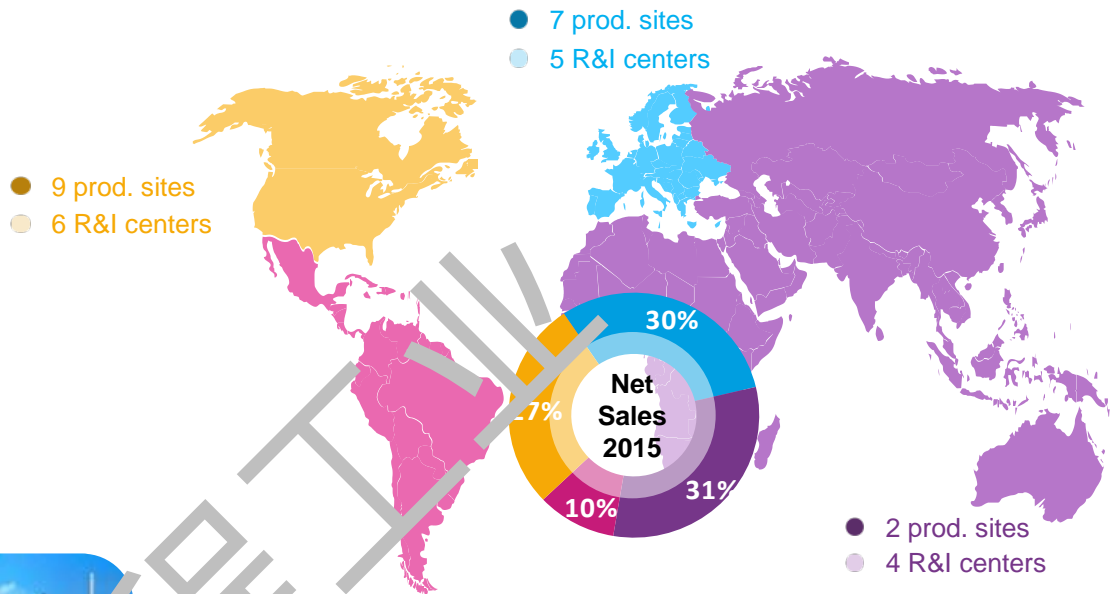
150  
YEARS

Founded in 1863: 150 years  
of passion and tradition for Science  
索尔维建立于1863年：150年以来对科学精神传承

# Specialty Polymers at a Glance

## 特种聚合物一览

### Multiple end markets 多个终端市场

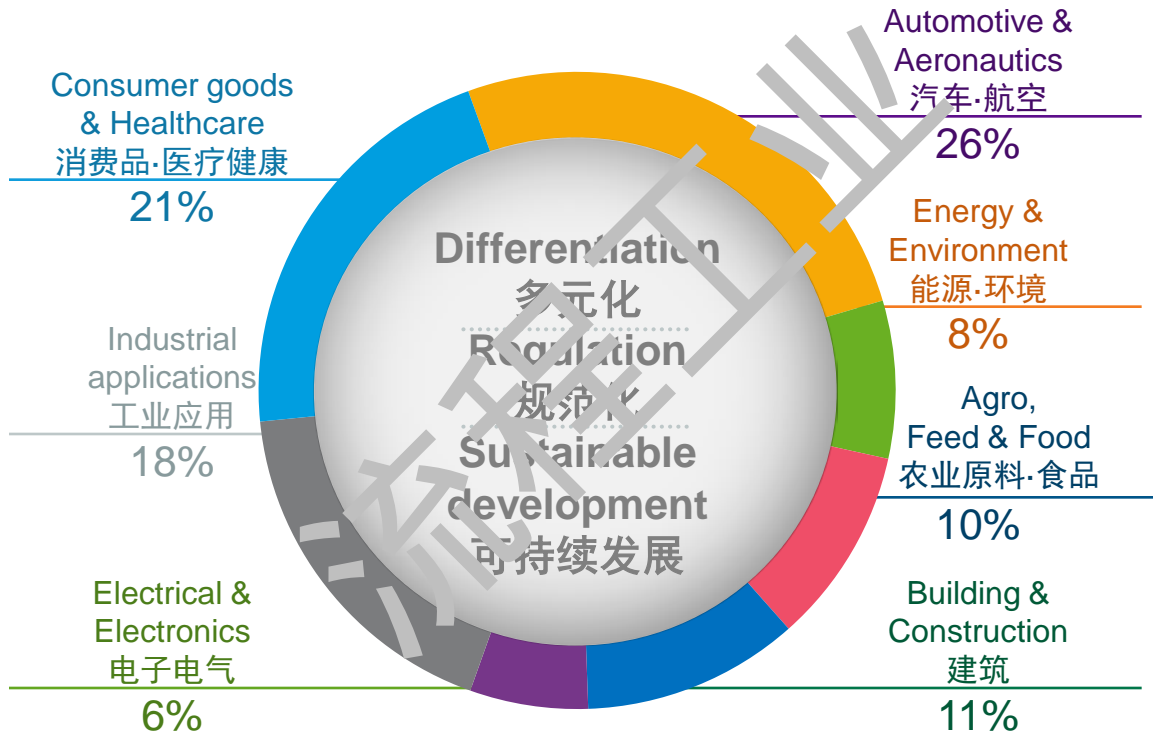
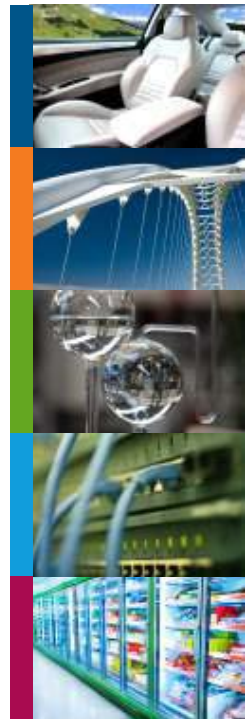
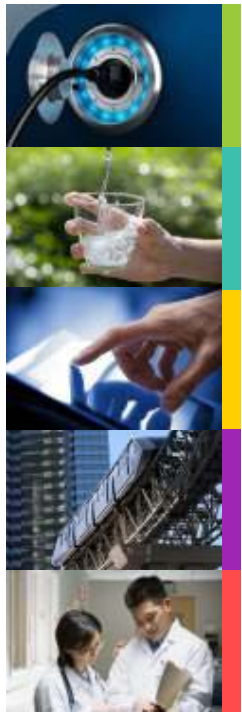


### Business Strengths 企业优势

50+	Proprietary Technologies	专有技术
300+	Commercial Employees	商业员工
500+	R&I Specialists	研发专家
1500+	Products	产品
2700+	Employees Worldwide	全球范围员工
3300+	Patents in Force	专利
4000+	Customers	客户

# Serving Well-diversified and Highly Dynamic Markets Resulting in Superior Growth

## 高速的增长源自多元化服务和高度动态的市场



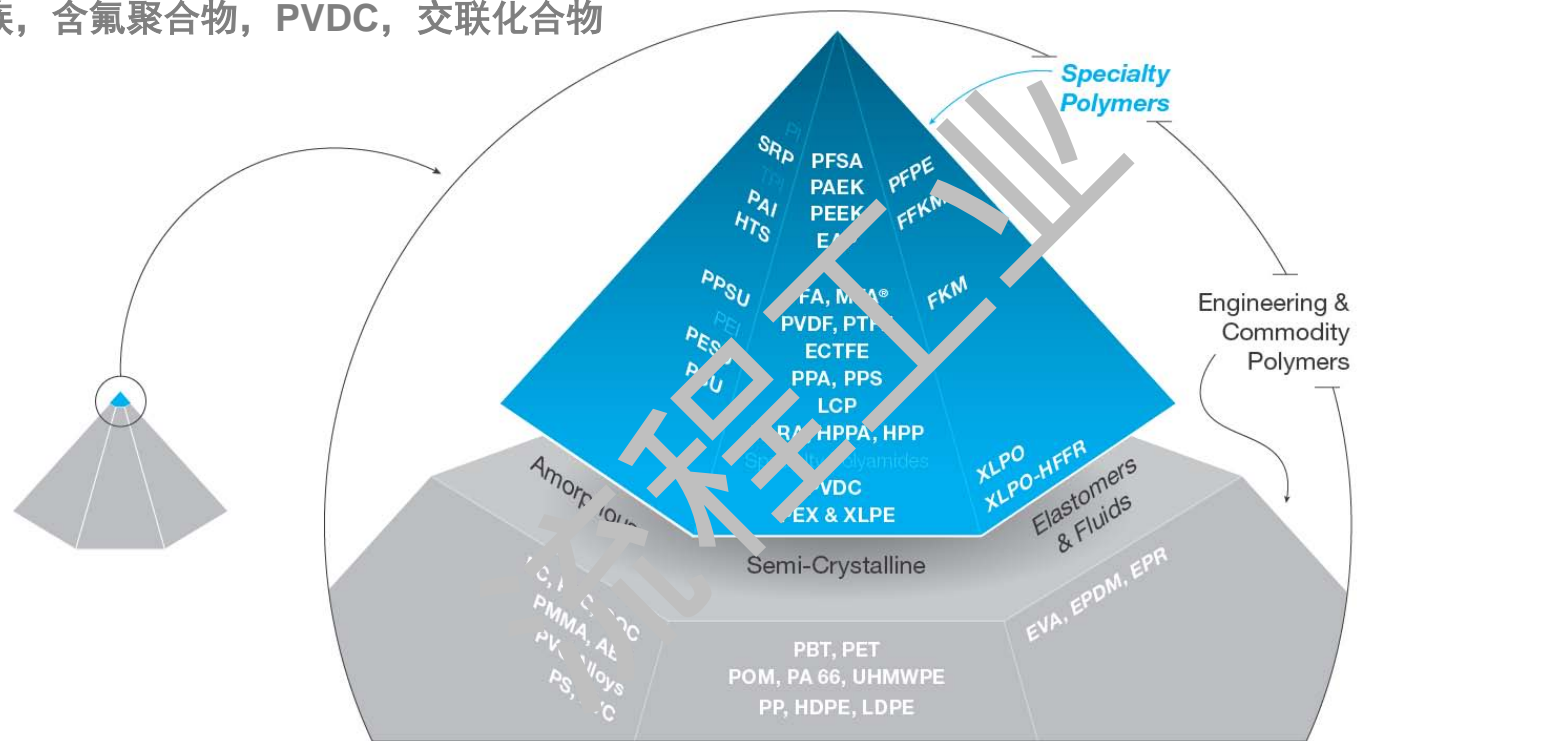
Distribution of 2015 net sales  
Pro forma 2015 figures including Cytec (unaudited)

# Solvay's Comprehensive Portfolio

## 索尔维综合投资组合

Aromatics, Fluoropolymers, PVDC, Cross-Linkable Compounds

芳香族, 含氟聚合物, PVDC, 交联化合物



### Performance Attributes

Temperature Resistance 耐高温 | Chemical Inertness 化学惰性 | Weathering Resistance 耐候 | Corrosion Protection 防腐 | Water Repellency 疏水 | Stain Repellency 抗污 | Electrical Inertness 电绝缘 | Non-Flammability 阻燃 | Fatigue Resistance 抗疲劳 | Biocompatibility 生物相容  
 Extractables 可萃取 | Self-Cleaning 自清洁 | Transparency 透明 | Heat Transfer 导热 | Processability 可加工 | Toughness 韧性 | Elasticity 弹性  
 Barrier 阻隔 | Tribology 耐磨 | Release 不粘 | Color 调色

# Product Families 产品系列

Over 1500 material solutions sold in more than 35 product lines

>35条产品线超过1500种产品解决方案

## SOLVIVA® BIOMATERIALS FOR IMPLANTABLE DEVICES

- Eviva® PSU
- Proniva® SRP
- Veriva® PPSU
- Zeniva® PEEK

## CROSS-LINKABLE COMPOUNDS

- Cogegum® XLPO-HFFR
- Polidan® PEX
- Polidan® XLPE
- Polidienne® XLPO

## FILMS

- Ajedium™ Films

## FLUORINATED ELASTOMERS

- Tecnoflon® FKM Base Resistant
- Tecnoflon® FKM Ionic Curable
- Tecnoflon® FKM Peroxide Curable
- Tecnoflon® FKM Peroxide Curable for Low Temperature
- Tecnoflon® PFR FFKM

## FLUORINATED FLUIDS

- Fomblin® HC PFPE
- Fomblin® PFPE Lubricants
- Galden® PFPE
- Solvera® PFPE

## FLUOROPOLYMERS

- Algoflon® L PTFE Micronized Powders
- Algoflon® PTFE Dispersions
- Algoflon® PTFE Fine Coagulated Powders
- Algoflon® PTFE Granulars
- Halar® ECTFE
- Hyflon® PFA/MFA®
- Polymist® PTFE Micronized Powders
- Solef® PVDF

## *Fluoropolymers for Coatings*

- Halar® ECTFE
- Hyflon® PFA/MFA®
- Hylar® PVDF
- Hylar® 5000 PVDF for Architectural Coatings

## FUNCTIONAL FLUIDS

- Fluorolink® PFPE
- Fomblin® PFPE Functional

## LIQUID CRYSTAL POLYMERS

- Xydar® LCP

## POLYAMID-IMIDES

- Torlon® PAI

## POLYAMIDES, AROMATIC

- Amodel® PPA
- Ixef® PPARA
- Kevlar® HPPA

## POLYESTERS, HIGH-PERFORMANCE

- Lavanta® HPP

## POLYKETONES, AROMATIC

- AvaSpire® PAEK
- KetaSpire® PEEK

## POLYMER PROCESSING AIDS

- Solef® 11010 PVDF
- Tecnoflon® NM Powder

## POLYPHENYLENE

- PrimoSpire® SRP

## POLYPHENYLENE SULFIDE

- Ryton® PPS

## POLYVINYLIDENE CHLORIDE

- Diofan® PVDC
- Ixan® PVDC

## SPECIALTY MATERIALS

- Aquivion® PFSA
- EpiSpire® HTS
- Hyflon® AD
- Solef® 80 000 e-PVDF
- Solvene® EAP
- Torlon® AI
- Virantage® PESU

## SULFONE POLYMERS

- Acudel® modified PPSU
- Radel® PPSU
- Udel® PSU
- Veradel® PESU

# Solvay's Unique Solutions Portfolio

## 索尔维独有的产品方案

Broadest portfolio + Innovation leader = Best Solution Provider

最宽泛的产品组合 + 领先的创新 = 最佳解决方案供应商

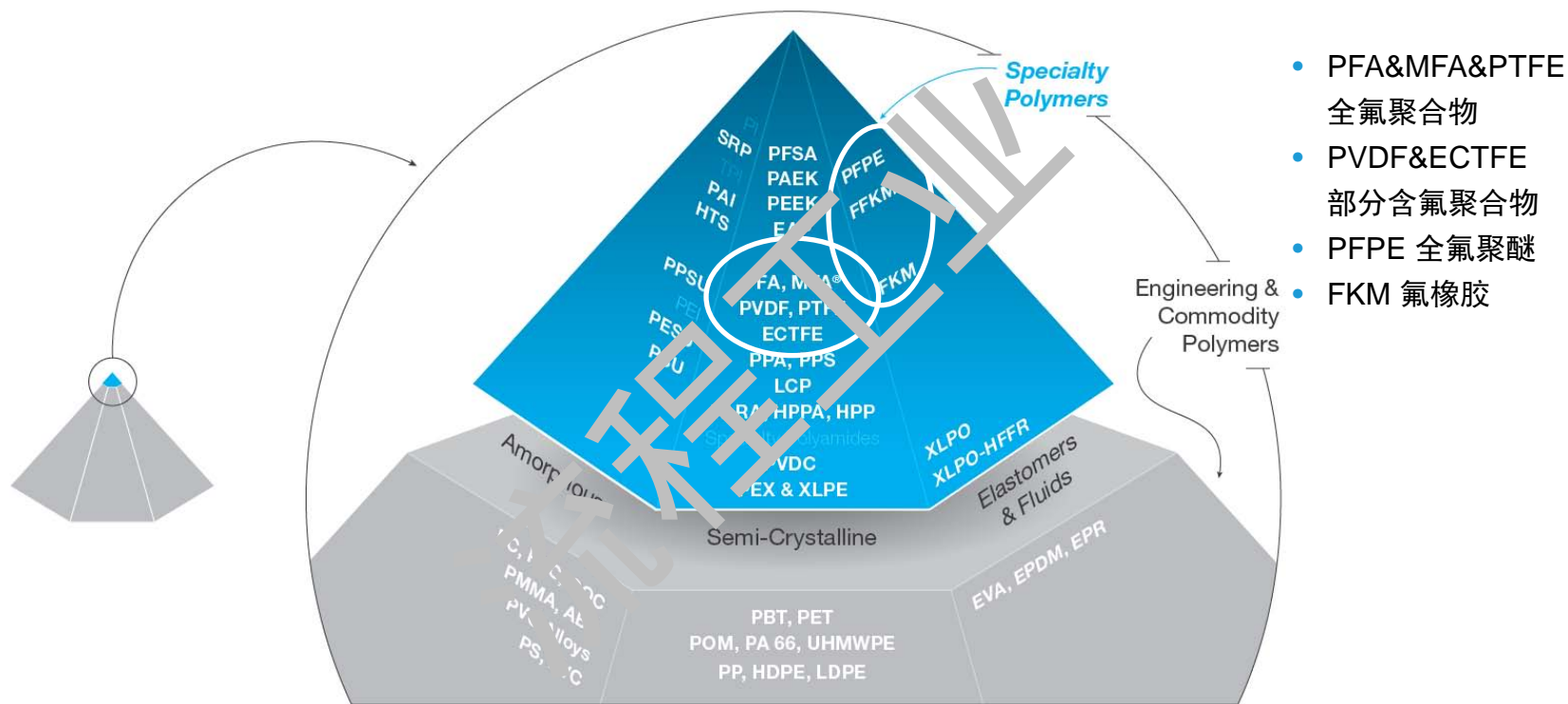
	Aromatics 芳香族						Fluoropolymers 含氟聚合物					High-Barrier Polymers 高阻材料	X-Linkable Compounds 可交联聚合物
	LCP	HPPA	PEEK	PAI	PSU	PPS	PTFE	PVDF	PFA	FKM	PFPE	PVDC	XLCP
Smart Devices 智能设备	●	●	●		●	●		●		●	●		
Healthcare 医疗健康		●	●		●		●					●	
Oil & Gas 石油天然气		●	●	●		●		●	●	●	●		●
Renewable Energy 可再生能源			●		●	●		●		●	●		●
Advanced Transportation 先进交通工具	●	●	●	●	●	●	●	●	●	●	●		●
Water 水					●			●					
Automotive 汽车		●	●	●	●	●	●	●	●	●	●		●
Others 其他	●	●	●	●	●	●	●	●	●	●	●	●	●

■ Currently produced in Asia 在亚洲生产
 ■ On-going investments in Asia 亚洲投建中

# Solvay's Comprehensive Portfolio 索尔维综合投资组合

## Products for CPI

### 应用于化工行业的特种聚合物产品



## Performance Attributes

Temperature Resistance 耐温 | Chemical Inertness 化学惰性 | Weathering Resistance 耐候 | Corrosion Protection 防腐 | Water Repellency 疏水 | Stain Repellency 抗污 | Electrical Inertness 电绝缘 | Non-Flammability 阻燃 | Fatigue Resistance 抗疲劳 | Biocompatibility 生物相容  
 Extractables 可萃取 | Self-Cleaning 自清洁 | Transparency 透明 | Heat Transfer 导热 | Processability 可加工 | Toughness 韧性 | Elasticity 弹性  
 Barrier 阻隔 | Tribology 耐磨 | Release 不粘 | Color 调色



# Definition Fluoropolymers – Starting from Fluorspar

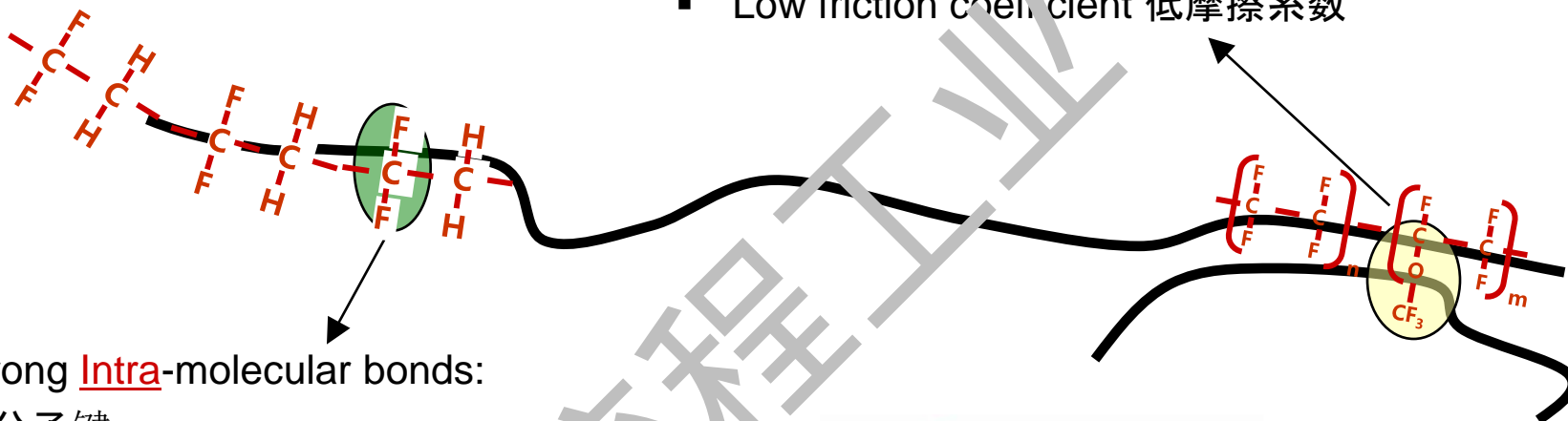
## 含氟聚合物定义-从萤石开始



Weak Inter-molecular interactions:

分子间作用力小

- Low Mechanical properties 机械性能低
- Low friction coefficient 低摩擦系数



Strong Intra-molecular bonds:

强分子键

- High thermal resistance 高耐温性
- High chemical resistance 强耐化学性

## The role of Fluorine

### 氟素



fluorspar from Solvay's mine in Namibia  
索尔维在纳米比亚的萤石矿

9	18.9984
-188.2	-1
-219.6	<b>F</b>
1.505	
1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>5</sup>	
<b>Fluorine</b>	

# Definition of Fluoropolymers – Types of FPs

## 含氟聚合物定义-氟聚合物种类

- **Partially fluorinated polymers 部分含氟聚合物**

- Balance between mechanical properties and chemical resistance 机械性能和耐化学性均衡

⇒ PVDF, ECTFE, PCTFE, ETFE, PVF, THV

- **Fully fluorinated polymers 全氟聚合物**

- Outstanding chemical resistance, temperature resistance and electrical insulation properties, similar to PTFE

卓越的耐化学性，耐高温性和电绝缘性能，与PTFE类似

⇒ PTFE, PFA, MFA®, FEP

- **Characteristics of Fluoropolymers**

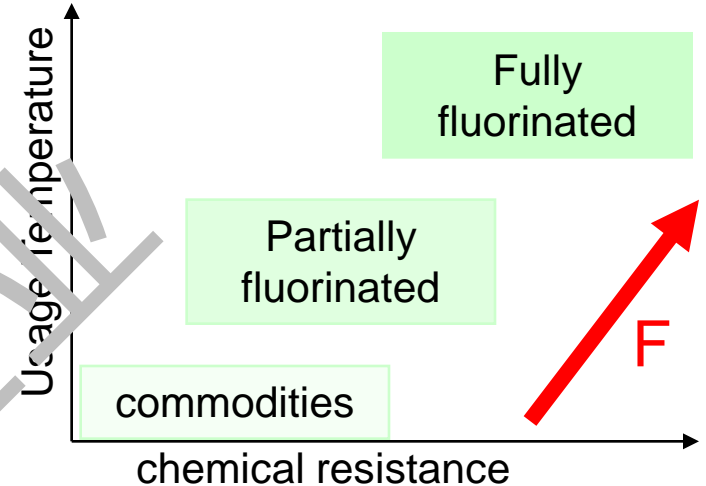
### 含氟聚合物特征

- chemical, temperature and UV resistance 耐化学性，耐高温性和耐UV性能
- fire resistance 阻燃
- low surface tension 低表面能
- low friction coefficient 低摩擦系数
- high purity 高纯度
- electrical insulation 电绝缘性能



- **Applications 应用**

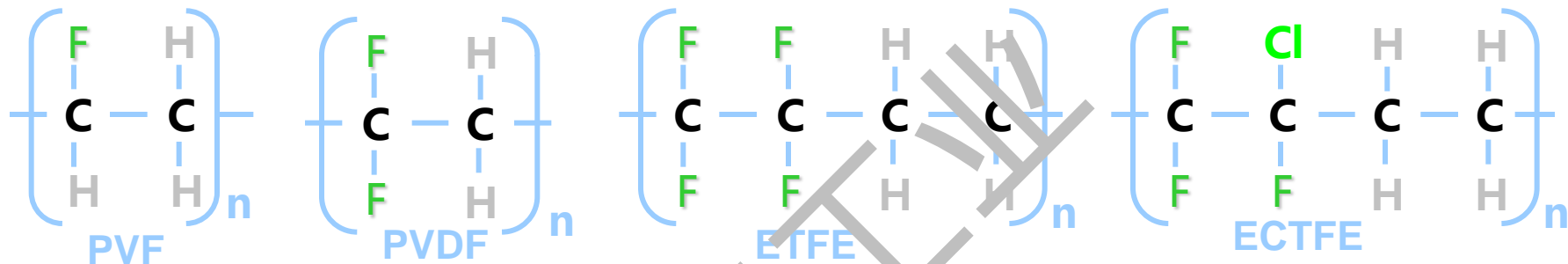
- chemical process industry 化工
- Semiconductor industry 半导体
- Oil & Gas Installations 石油&天然气
- Water treatment 水处理
- Architecture, PV 建筑，光伏
- Li-ion Batteries 锂电池
- Wire & Cable, ... 电线&电缆



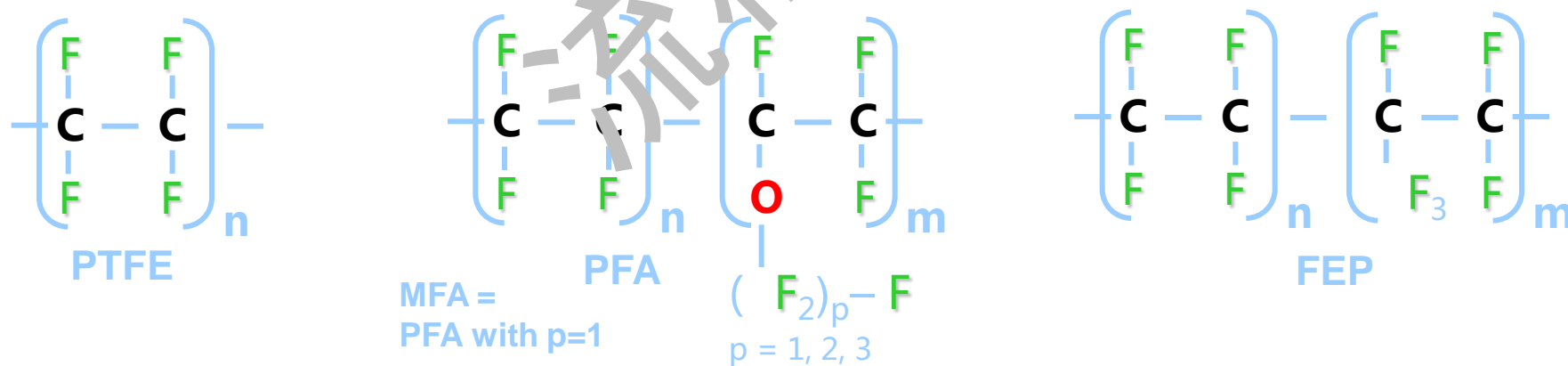
# Definition of Fluoropolymers – Types of FPs

## 含氟聚合物定义-氟材料种类

- Partially fluorinated : C, F, H, Cl, ..., modification
- 部分氟化: C, F, H, Cl, ..., 改性



- Fully fluorinated : C, F, O, ... no H, modification
- 全氟化 : : C, F, O, 无H改性



# Partially-Fluorinated Polymers 部分含氟聚合物

Solef<sup>®</sup> PVDF  
Halar<sup>®</sup> ECTFE

- Thermal resistance up to 150°C  
耐温高达150°C
- Low permeation to most gases and fluids  
对绝大部分的气体和液体的低渗透性
- Good chemical resistance  
良好的耐化学性
- High abrasion resistance  
高耐磨性能
- Good pressure resistance  
良好的抗压性能
- Anti stick properties  
抗粘性能

## Key Applications 主要应用:

- Pressure piping systems including pipes, fittings, valves, flow meters, ...  
压力管路系统, 包括管道, 配件, 阀门, 流量计等
- Corrosion protection liners on metal substrate  
金属基材的防腐衬层
- GFR laminates with glass fiber reinforced plastics  
玻璃钢层压板材
- Cable insulation 电缆绝缘
- Chimney lining 烟囱衬壁
- Lining of reaction vessels  
反应容器衬里
- Class 8 hazardous materials transport  
第8类危险品运输



由Agru提供

# Fully-Fluorinated Polymers 全氟聚合物

Algoflon® PTFE

Polymist® PTFE

Hyflon® PFA

Hyflon® MFA®

- Thermal resistance up to 260°C  
耐温性高达260°C
- Chemical inertness 化学惰性
- Excellent electrical properties  
卓越的电性能
- Thermal stress crack resistance  
耐热应力开裂
- Low permeation 低渗透性
- Abrasion resistance 耐摩擦性能
- Non-flammability 阻燃性能

## Key Applications 主要应用：

- Chemical tubing 化工管路
- Loose liners, fix point liners and glued liners on steel 活动衬套，固定点衬和钢粘衬  
Duct laminate with glass fiber reinforced plastic 玻璃钢层压板材
- Wire & Cable insulation 电线电缆绝缘
- O-rings and sealings O型圈和密封件
- Highly resistant filters and fibers  
高抗过滤器和纤维
- Class 8 hazardous materials transport  
第8类危险品运输



由Quadrant EPP提供

# Fluoro/Perfluoroelastomers 含氟/全氟橡胶

Tecnoflon® FKM  
Tecnoflon® FFKM

- Thermal resistance from -40°C to 300°C  
耐温范围 -40°C到300 °C
- Chemical inertness  
化学惰性
- Excellent compression stress relaxation performance  
优异的抗压力松弛性能

## Key Applications 主要应用

- Seals, O-rings, gaskets  
密封件, O型圈, 垫片
- For harshest chemicals and for highest temperatures  
应用于最苛刻的化学和高温场合



# Fluorinated Fluids 氟流体

Fomblin® PFPE

Galden® PFPE

- Continuous service from -100°C to 290°C  
连续使用温度从-100°C到290 °C
- Total inertness  
完全惰性
- Low weight loss  
低重量损失
- No miscibility with hydrocarbon compounds and H<sub>2</sub>O  
与碳氢化合物与水不互溶

## Key Applications 主要应用

- Lubricants  
润滑油
- Greases  
润滑脂
- Dielectric fluids  
电介质
- Highly inert heat exchanger fluids  
高惰性换热器流体



# Fluorinated Polymer Coatings 含氟聚合物涂料

- Halar® ECTFE
- Hyflon® PFA  
For electrostatic powder coating  
静电喷涂
- Halar® ECTFE  
For spray coating 喷涂
- Halar® ECTFE  
For rotolining / rotomolding 滚衬/滚塑

- **Comprehensive product portfolio**  
产品组合
- **Good chemical resistance**  
良好的耐化学性
- **Anti-stick properties**  
抗粘性

## Key Applications 主要应用

- Anti-corrosion coatings 防腐涂层
- Anti-stick coatings 防粘涂层
- Seamless metal lining 无缝金属衬套
- Linings in particular for complex shapes like centrifuges, rotors, sieves, glove boxes, heating cabinets, heat exchangers, ...

尤其常用于复杂形状如离心机，转子，筛网，手套箱，烘箱和热交换器等





由Fisher提供





# Applying Fluoropolymers – classical ways in CPI

## 氟塑料在化工行业的经典应用

Items 项目	Way of resin processing 树脂加工方式	Parts 零部件	Pictures 实物图
self standing items 自撑体	<p>Melt processing: extrusion, injection, compression, roto-, blowmolding, ... Welding to connect FP layer thickness variable (pressure) 熔融加工：挤出，注塑，模压，滚塑，吹塑等，氟塑料焊接厚度可调（压力）</p>	<p>pressure pipes, fittings, valves, pump bodies, reservoirs ... 压力管道，管件，阀，泵体，箱体等</p>	
Application on Glass Fiber Reinforced Plastic – Lining 应用于玻璃钢衬层	<p>Melt processing of a fabric backed part 熔融加工织物背衬 Glueing of the part to the glass fiber reinforced plastic 玻璃钢部件胶合 Welding 焊接 FP layer <math>\geq</math> 3 mm 氟材料层厚<math>\geq</math>3mm (permeation 渗入)</p>	<p>tanks, tubing systems, Scrubbers, pumps, ... 槽罐，管道系统，洗涤器，泵等</p>	

# Applying Fluoropolymers – classical ways in CPI

## 氟塑料在化工行业的经典应用

Items 项目	Way of resin processing 树脂加工工艺	Parts 零部件	Pictures 实物图
<p><b>Application on metal (Steel, Alu) – Lining</b> 应用于金属内衬 (钢材, 铝材)</p>	<p>Melt processing of a fabric backed part 织物背衬熔融加工 Glueing 胶合 Welding 焊接 FP layer <math>\geq 3</math> mm 氟塑料层 <math>\geq 3</math>mm (permeation 渗透)</p>	<p>Tanks, piping systems, very large items, ... 槽罐, 管道系统, 大型部件</p>	
<p><b>Application on metal (Steel, Alu) – coating</b> 应用于钢材, 铝材的涂覆</p>	<p>Coating (Electrostatic Powder Coating) or a primer and a top coat directly on the metal 直接在金属上涂覆 (静电粉末涂覆) 底涂和面漆 FP layer <math>\leq 1</math> mm 氟材料层厚 <math>\leq 1</math>mm</p>	<p>Tanks, exhaust systems, mixers, drying boxes, centrifuges 槽罐, 排气系统, 混料器, 干燥箱, 离心机等</p>	

# Applying Fluoropolymers – classical ways in CPI

## 氟塑料在化工行业的经典应用

Items 项目	Way of resin processing 树脂加工工艺	Parts 零部件
Application on metal (Steel, Alu) – Rotolining 应用于钢材，铝材的滚塑	Melt processing directly on the part by Rotolining 在零部件上直接熔融滚塑加工 FP layer $\geq 1$ mm (permeation) 氟塑料层厚度 $\geq 1$ mm(渗入)	Pipes, valves, pumps, complex shapes 管道，阀门，泵，复杂形状

# Applying Fluoropolymers – environmental protection

## 氟塑料-环境保护

Items 项目	Way of processing 加工工艺	Parts 零部件
Protective layers (on metal, glass, polymers, concrete, ...) 保护层（金属，玻璃，聚合物，混凝土）	<ol style="list-style-type: none"> <li>Coating with solvent PVDF in solution 溶剂型PVDF溶液涂覆</li> <li>Coating with PVDF latex 水性PVDF涂覆</li> <li>Adhesion of protective film 保护膜粘接</li> <li>FP layer <math>\leq 0,025</math> mm 氟材料层厚<math>\leq 0.025</math>mm</li> </ol>	Protective films and coatings for outside 外层保护膜和涂覆



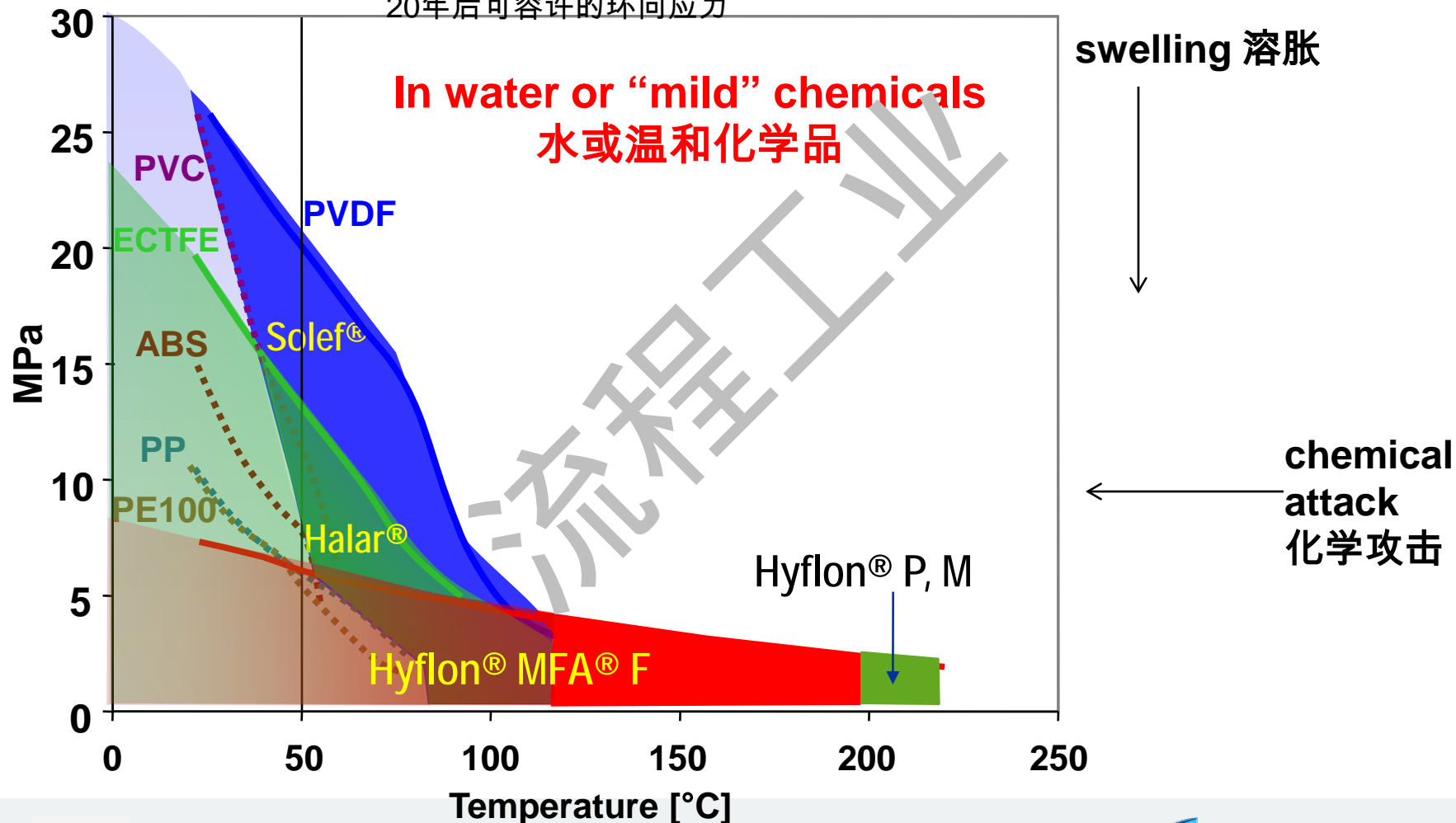
# Connection techniques

## 连接技术

- Fluoropolymers can be easily welded. Thus welding is the preferred connection technique :  
含氟聚合物容易焊接，因此焊接是首选连接技术
  - butt welding, 对接焊
  - HPF welding, 高频焊接
  - IR welding, 远红外焊接
  - BCF welding, 无缝焊接
  - hot gas welding, 热风焊接
  - ultrasound welding, 超声焊接 ...
- Mechanical connections are also widely used, involving O-rings in FKM or FFKM, depending on the media involved  
机械连接也应用广泛，包括FKM或FFKM O型圈，取决于涉及的介质

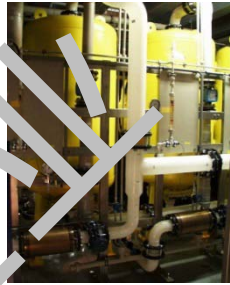


# Pressure resistance for pressure pipes 压力管道耐压性能

Admissible hoop stress after 20 years  
20年后可容许的环向应力



# Examples-Pressure piping systems

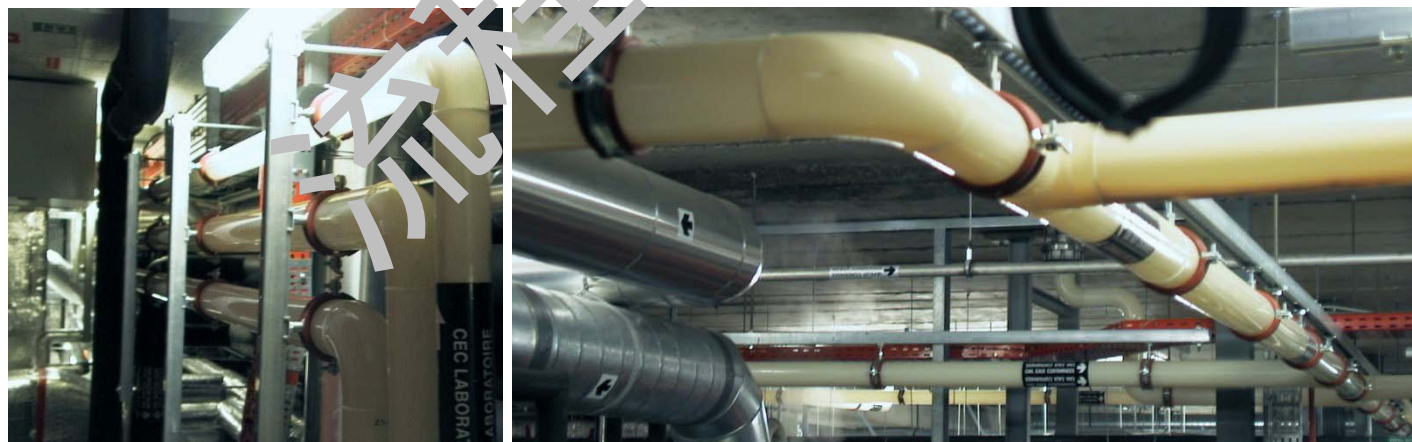
## 应用案例-压力管道系统

polymer	Max size 最大尺寸	Connection 连接	Applications 应用
PVDF	Up to 400 mm (Agru, GF) 达到400mm	welding (butt, IR, BCF) SDR 33 and SDR 21 焊接 (对接焊, 红外焊接, 无缝焊接)	 <p>Source : Agru Kunststoff technik, Austria</p>
ECTFE	Up to 160 mm (Agru) 达到160mm	welding (butt, IR, BCF) SDR 21 焊接 (对接焊, 红外焊接, 无缝焊接)	 <p>Source : <a href="http://media.chemline.com/">http://media.chemline.com/</a></p>
PFA	Often 32 mm, max 50 mm (Entegris, Saint Gobain, ...) 通常为32mm, 最大 为50mm	Often Flair connection, welding possible (butt, IR, BCF) 通常为弗莱尔连接, 也 可焊接 (对接焊, 红外 焊接, 无缝焊接)	 <p>Source : <a href="http://www.processsystems.saint-gobain.com/">http://www.processsystems.saint-gobain.com/</a></p>

# Example: Pressure Pipes for Pharmaceutical Production

## 应用案例：制药生产压力管道

- Polio vaccine fabrication (major pharmaceutical company in Belgium)  
脊髓灰质炎疫苗制造（比利时龙头制药公司）
- Dimensions d50 to d90mm  
尺寸50到90mm
- Butt fusion  
热熔对接焊



由Agru Kunststofftechnik提供

# Example: Liner Pipes in Chlorine Chemistry

## 应用案例：氯碱工业衬管

### Requirements 要求:

- Tanks, reactors and columns for production of  $\text{Cl}_2$ , 32% HCl and NaClO  
 $\text{Cl}_2$ , 32%浓盐酸及NaClO 生产用的槽罐，反应釜和塔
- Pressure 0,4MPa, temperature 90°C and longer lifetime than CPVC  
压力 0.4MPa，温度：90°C.较CPVC（氯化聚氯乙烯）更长使用寿命

### Solution 解决方案:

- Symalit® (ECTFE) GK bonded to FRP gives temperature resistance up to 160°C  
Symalit® (ECTFE) GK与FRP复合，可以实现高达160°C耐温性能
  - Leads to a multiple of the life time of CPVC  
达到CPVC数倍的使用寿命
  - Provides more safety  
更好的安全性

### In Service 运行

- Since summer 2004  
从2004年夏至今



由Quadrant EPP and Teknoplus提供



# Example: Liner Pipes in Green Liquor Piping

## 应用案例：绿液管道衬管

- Pulp industry works with Green Liquor ( $\text{NaCO}_3$ ,  $\text{NaOH}$ ,  $\text{NaS}$ ,  $\text{NaSO}_4$  in  $\text{H}_2\text{O}$ )  
纸浆工业用到的绿液（ $\text{NaCO}_3$ ,  $\text{NaOH}$ ,  $\text{NaS}$ ,  $\text{NaSO}_4$  的 $\text{H}_2\text{O}$ 溶液）
- Corrosion problem and scaling problem with metal pipes  
金属管道的腐蚀问题和结垢问题
- Successful use of ECTFE piping for Green Liquor in yempe-inland mill in Texas in 1990  
1990年，ECTFE管成功应用于在Texas的yempe-inland厂绿液
  - Very good condition found after 5 y of service  
运行5年工况良好
- Weyerhaeuser mills in 2009 spill collection tank  
2009年Weyerhaeuser厂的溢出液收集槽
  - No deposit on the Halar® ECTFE surface after 1 year of service  
运行1年后Halar® ECTFE表面无积垢

### 6 Months of Green Liquor Exposure 绿液运行6个月的效果对比



1.5" Thick Deposit on Carbon Steel  
1.5英寸厚的积垢在碳钢上



No deposit on Halar® ECTFE pipe  
Halar® ECTFE管无积垢

# Example: Coated Pipes

## 应用案例：管道涂层

- FM 4922 corrosive fume exhaust ductwork in semiconductor fabs (IC, LCD, LED, PV)  
FM 4922认证半导体工厂腐蚀性气体排烟管路
- Seawater inlet valves in desalination plants:  
海水淡化工厂进水阀门
  - Halar<sup>®</sup> ECTFE coated blades of a butterfly valve after 6 months in service, while high alloy steels completely corroded under the same conditions after 3 months already  
运行6个月的Halar<sup>®</sup> ECTFE涂层蝴蝶阀片（右下图）  
同样条件下，高合金钢3个月后已经完全腐蚀



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