

**KraussMaffei**

*Engineering  
Passion*

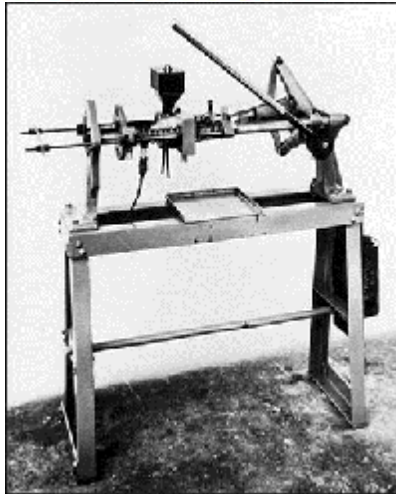
**Revolution in Pultrusion  
iPul by KraussMaffei 克劳斯玛菲拉挤技术的革新-iPul**



## KraussMaffei Represents 179 Years of Engineering History

### KraussMaffei Company History

#### KraussMaffei



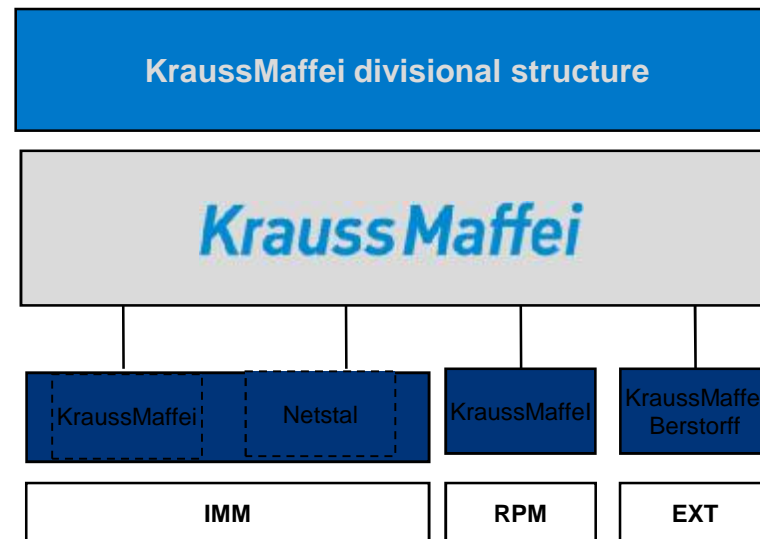
- 1838** **Münchner Lokomotivfabrik J. A. Maffei** was founded in Munich
- 1931** Krauss and Maffei merged into the **Krauss-Maffei AG**
- 1945-63** Krauss-Maffei AG developed a wide range of **diversified branches**:
  - Transportation Technology
  - Processing Technology
  - Defense Technology
  - Plastics Technology
- 1957** Construction of the **world's first large injection molding machine** capable of operating fully automatically with screw plasticization.
- 1962** First **serial production of injection molding machines** - start of export
- 1967-85** Development of **new series for injection molding machines**, especially for large part production for the automotive and electrical industry
- 1968** Development of the **injection reaction technology** for the processing of Polyurethane
- 1971** Start of extruder and **extrusion-line** production with PVC-processing



- 1857** Foundation of the Iron & Brass Foundry „Ulrich Rietmann & Cie.“
- 1922** Acquisition of the Machine Factory & Foundry **Netstal AG**
- 1945** Construction of the first **injection moulding machine**
- 1961** Relocation to **Näfels**

## KraussMaffei Group 克劳斯玛菲集团

### Corporate structure



#### Competence in three segments

- KraussMaffei and Netstal complementary brands within IMM
- Reaction moulding segment for PUR moulding
- Extrusion segment for extruding and compounding plastics and rubber

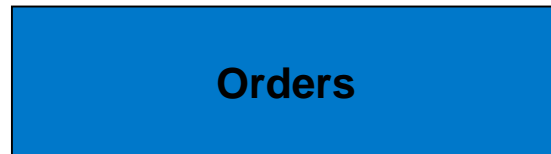
# KraussMaffei

**Largest plastic machinery producer in the world** 全球最大的塑料机械公司

KraussMaffei key data for fiscal 2013



1195M€

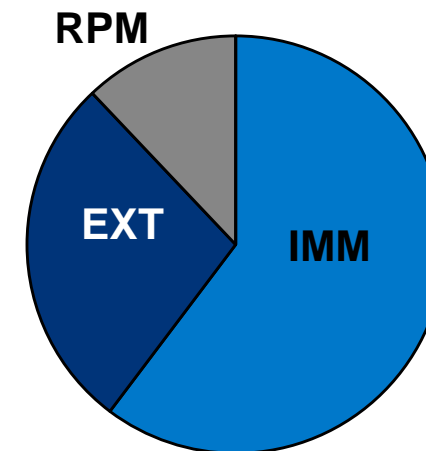


1269 M€



~ 4.484

Sales by division (fiscal 2013)



13 production plants, 42 sales offices, 50+ partner agencies

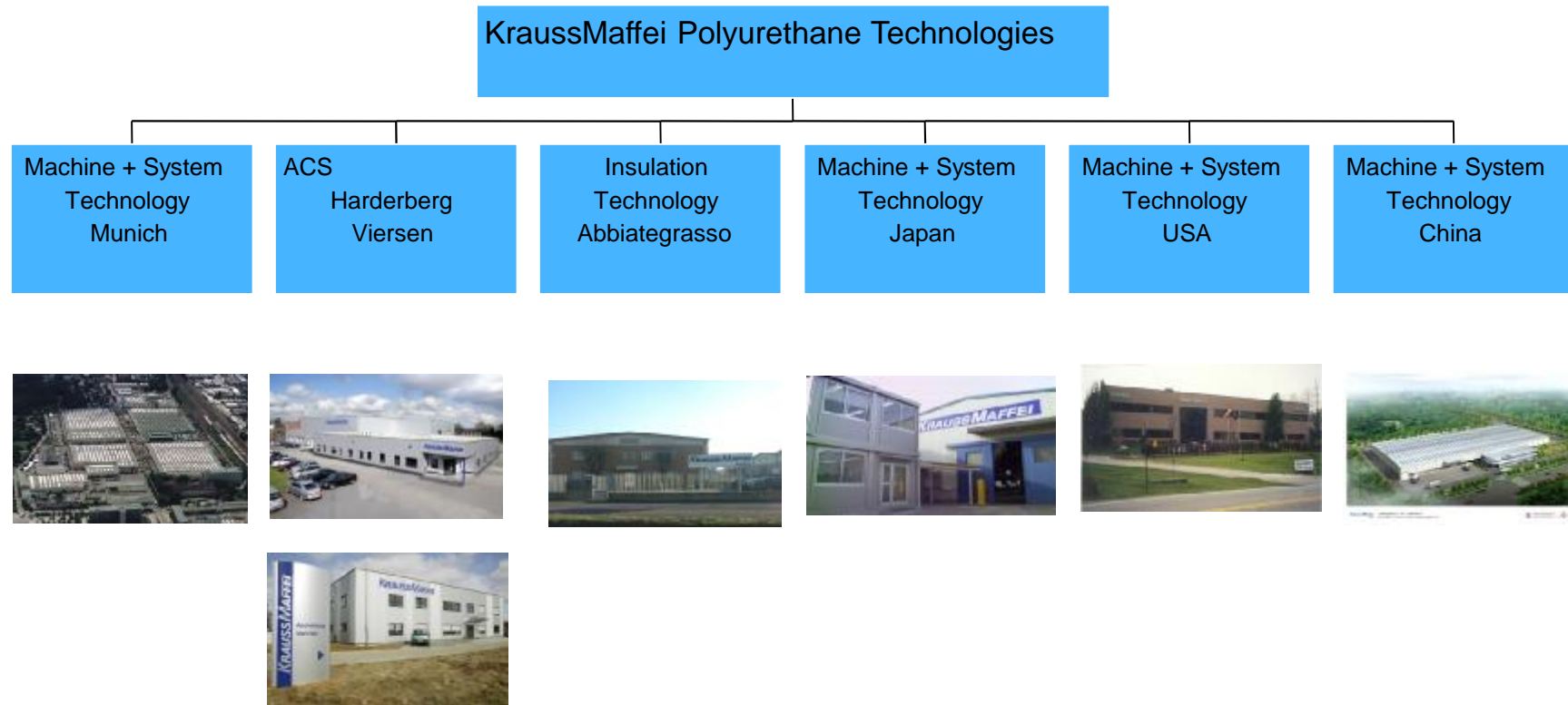
## Reaction Process Machinery Division, Milestones

### 克劳斯玛菲反应发泡部门

Set up 1968

- 2001: Reorganization Krauss\_Maffei Corporation USA  
Start of Krauss Maffei Shanghai 重组克劳斯玛菲美国  
设立克劳斯玛菲上海
- 2002: Krauss\_Maffei Italiana founded as competence-  
centre for „White appliance“ and „Insulation“  
成立克劳斯玛菲‘白电’和‘保温’部门
- 2002: Takeover engineering company from Elastogran  
收购Elastogran机械公司
- 2005: Start of Automotive Component Systems  
成立汽车部件系统部门
- 2006: Start of Krauss-Maffei Korea  
成立克劳斯玛菲韩国公司
- 2006: Start of Krauss-Maffei Japan  
成立克劳斯玛菲日本公司

## RPM Division 反应发泡部门



## Pultrusion Team 拉挤技术团队



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## Definition of Pultrusion 拉挤的定义

Pultrusion is a continuous and very efficient process to manufacture different composite profiles with easy or complex geometries. 拉挤是采用一种连续高效的方式制造简单或者复杂几何结构造型型材的工艺。

Reinforcement materials like fibers or woven or braided strands are impregnated with resin in a open bath or in an injection box. 增强材料，如纤维或者织物或者编绳，在开放的槽或者注射盒中浸润树脂。

The technology name is a combination between "pull" and "extrusion". As opposed to extrusion, which pushes the material, pultrusion works by pulling the material.

该技术的名称是单词‘拉’和‘挤’的组合。与挤出技术相反，拉挤的材料是拉出的。

## History of Pultrusion拉挤的历史

### 1944 - 1952

- First patents for processes similar to Pultrusion (Watson, Meek, White)早先的工艺专利非常类似拉挤 (Watson, Meek, White).

### 1954

- Development of Pultrusion process with glass fibers and epoxy resin (E. Kühne - Switzerland)开发出了基于玻纤和环氧树脂的拉挤工艺 ( E. Kühne – 瑞士)
- Development of Pultrusion process with glass fibers and polyesther resin (W.B. Goldworthy - USA)开发出了基于玻纤和聚醚树脂的拉挤工艺 ( W.B. Goldworthy – 美国)

### 1960

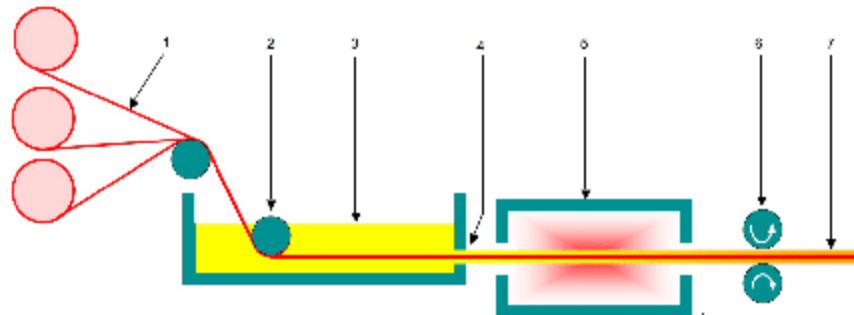
- Approx. 20 Pultrusion manufacturer located primarily in USA 大约20多家拉挤生产商主要分布在美国

### 2016

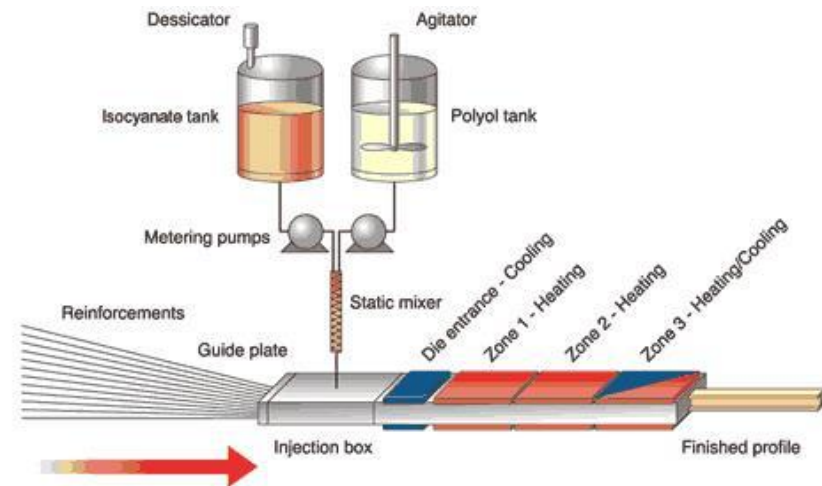
- At least 90 pultruders are serving the main markets in USA, Europe an Far East大约有90多家拉挤设备供应商服务于主美国，欧洲以及远东的要市场
- KraussMaffei has started the Revolution in Pultrusion克劳斯玛菲开启了拉挤技术的革新

## Pultrusion with open bath vs. Pultrusion with injection box 采用开放浸润槽的拉挤 vs 采用注射盒的拉挤

Open bath



Injection box



## Applications and Advantages of Pultruded Profiles

### 拉挤制品的应用和优点

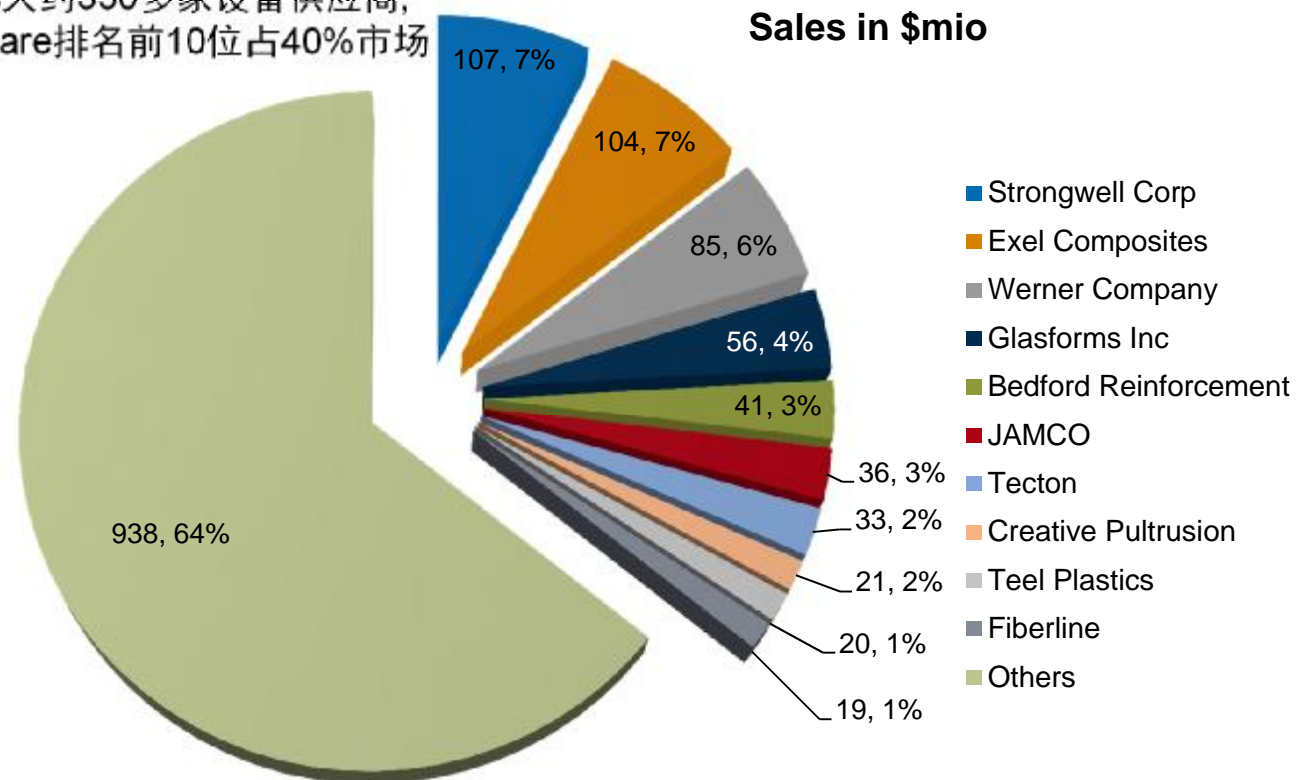
Applications应用	Advantages优点
Electronic电力	High dielectric strength and creepage current resistance; good mechanical and thermal properties高绝缘强度和耐漏电，好的机械和热性能
Machines and Plants机器和设备	Low weight, low thermal conductivity, high dimensional stability, good chemical resistance, high mechanical strength, corrosion resistance 轻质，低导热性，高尺寸稳定性，耐化学特性，搞机械强度，耐腐蚀。
Sports and Outdoor 运动和户外器材器具	Low weight, high mechanical strength 轻质和高机械强度
Automotive汽车	Low weight, high mechanical strength, corrosion resistance轻质，高机械强度，耐腐蚀
Construction建筑	Low weight, high mechanical strength, corrosion resistance 轻质，搞机械强度，耐腐蚀
Aviation 航空	Low weight, high mechanical strength, high dimensional stability 轻质，高机械强度，高尺寸稳定性

## Global Pultrusion Market in 2015 in \$ Mio. 2016年全球市场

Total Shipment was 总量 \$ 1,459 Mio.

Highly fragmented market: 高分散型市场

- Ø 350 (regional) pultruders 大约350多家设备供应商;
- Ø Top 10 = 40% market share 排名前10位占40%市场

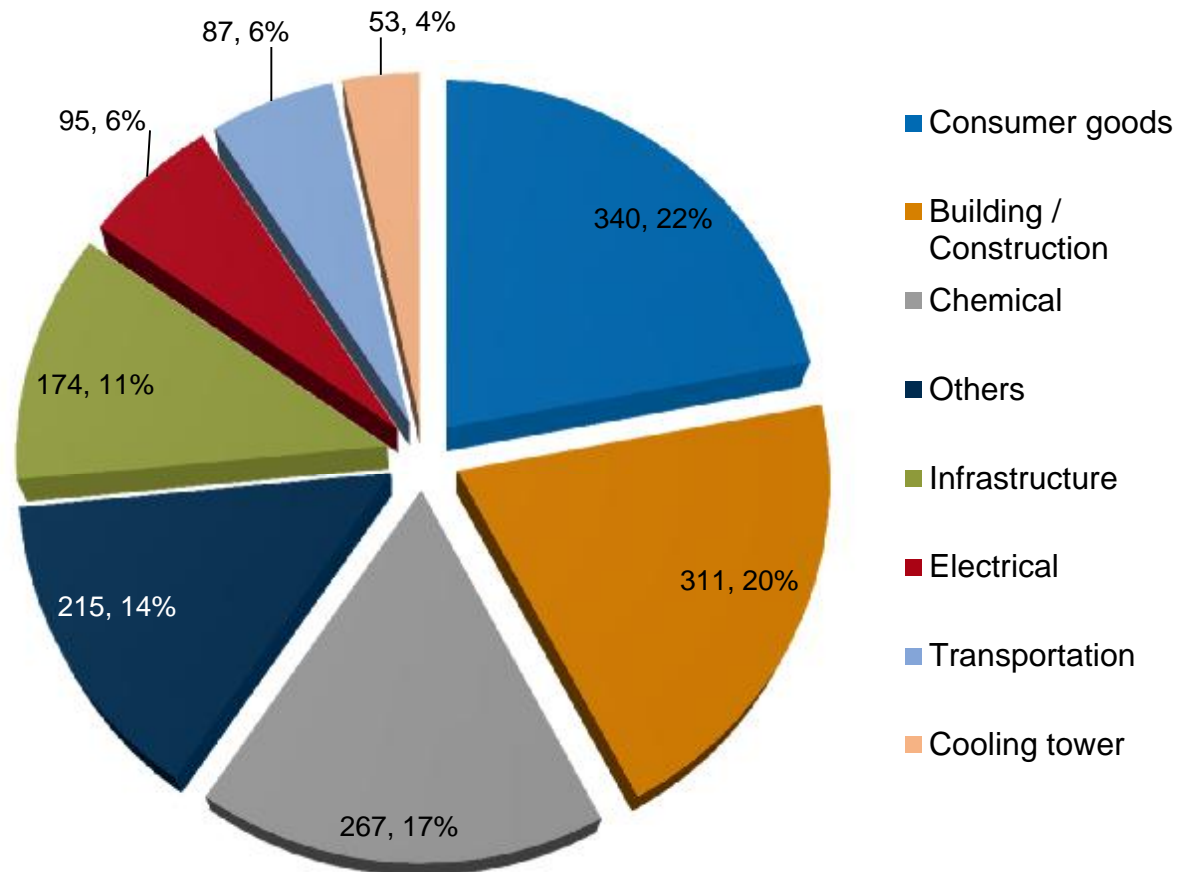


## Global Pultrusion Market by Industry in 2016 in \$ Mio 2016年全球市场.

Total Shipment was总量 \$ 1,542 Mio.

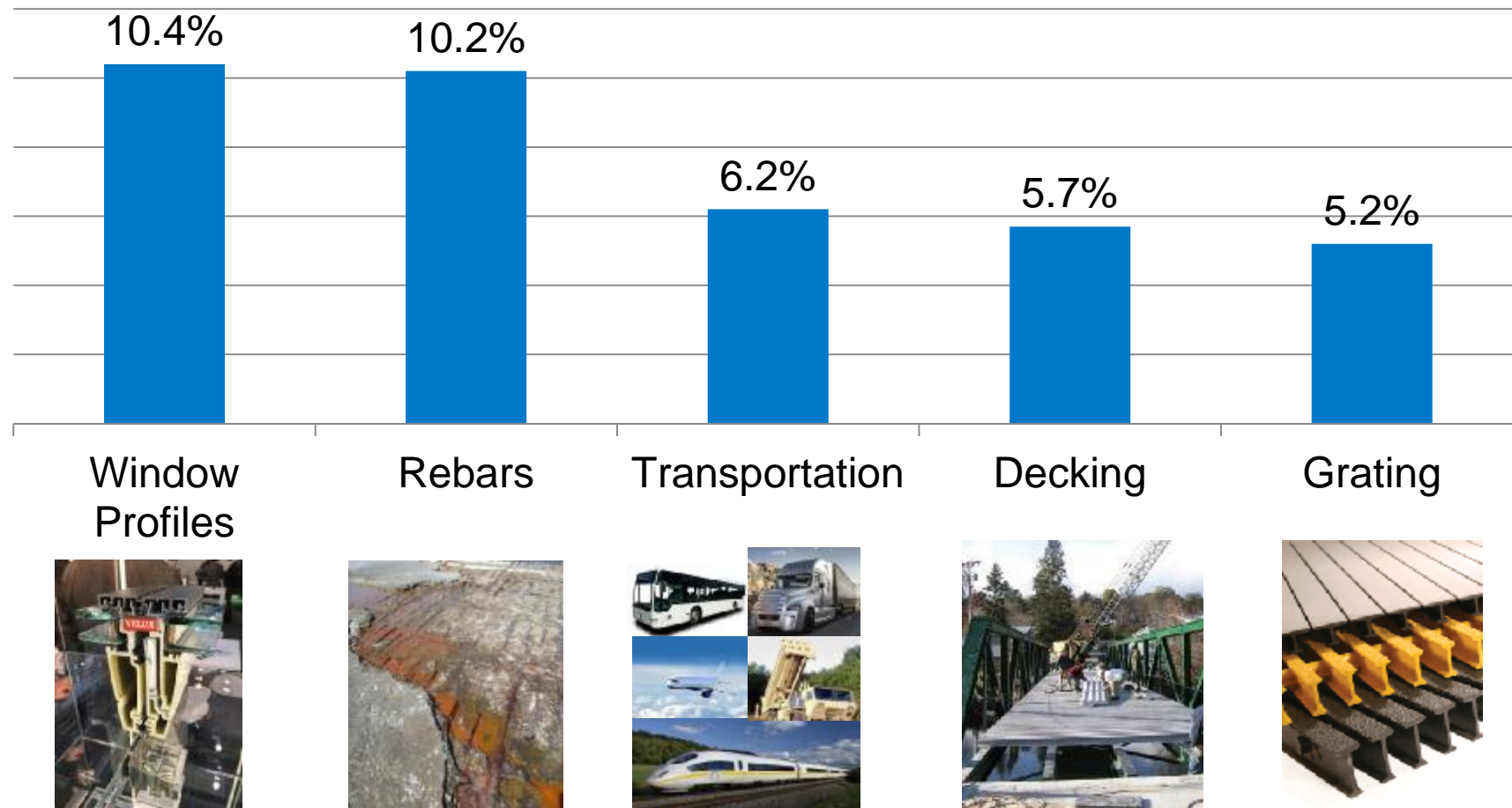
The global pultrusion market is forecast at a compound annual growth (CAGR) rate of全球拉挤市场预测年综合增长率在：

# 5,1%



## Pultrusion Market Growth / per year 拉挤市场年增量

The best performing composite applications in the global pultrusion market



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## Development of Window Profiles with PU and GF 采用PU和玻纤开发窗框

Current production speed 1,5m/min; development target 3m/min 目前是1.5m/min. 目标是3m/min.



## Characteristics of Different Window Material Types 不同材料窗的物性比较

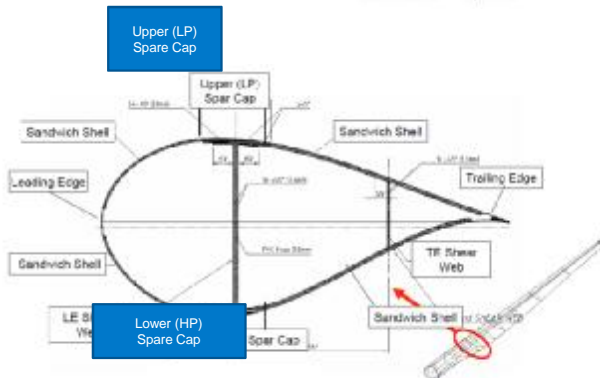
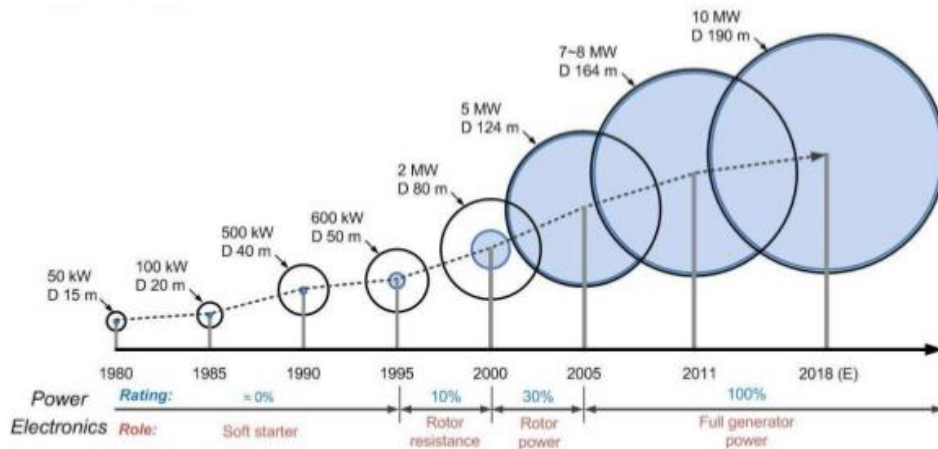
Attributes	Composites	Extruded Aluminum	PVC-U	Wood	Steel
Strength to Weight	High	High	Low	Low	High
Thermal Conductivity	Low	High	Low	Low	High
Expansion/Contraction	Low	High	High	Medium	Medium
Corrosion/Chemical Resistance	High	Medium	Medium	Medium	Low
Electrical Conductivity	Low	High	Low	Low	High
Thermal Insulation	High	Low	Medium	Medium	Low

## Development of Rebars with Epoxy and GF 采用树脂和玻纤，制造‘拉挤钢筋’



## Development for Wind turbine blade spar caps with Epoxy with CF 采用树脂和碳纤开发出风电叶片大量

Current production speed 0,4-0,5m/min; development target 1m/min  
目前0.4-0.5m/min, 目标1m/min.



Read the complete report, "[20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply](#)".

## Development for Wind turbine blade spar caps with Epoxy with CF采用树脂和碳纤开发风力机叶片大梁

Current production speed 0,4-0,5m/min; development target 1m/min 目前0.4-0.5m/min, 目标1m/min.



### Requirement of Wind Power Industry

#### Interface

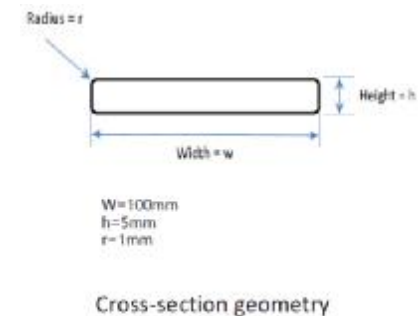
- Rough surface
- Similar  $T_g$  as infusion matrix
- Compatible matrix
- Free of internal releasing agent

#### Free of defects

- Uncured resin
- Foreign material
- Resin-rich areas
- Dry areas
- Visible indications of moisture
- In-plane and out-of-plane waves
- Low void content

#### High fiber volume content

- >60%



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**KraussMaffei iPul – Pultrusionline for Higher Speed  
克劳斯玛菲iPul-高速拉挤线**



## KraussMaffei Pultrusion Technology 克劳斯玛菲拉挤技术

### Process description 工艺描述

1. (Glass-, Carbon-, Basalt-, Aramidfiber) Rovings are pulled of the spool and funneled with guide system through the injection box. (玻纤, 碳纤, 玄武岩纤维, 芳纶纤维) 线纱被牵引并经过注射盒。
2. The low pressure metering machine is mixing and tempering the matrix system (Polyurethan-, Epoxy- or Polyimid) under the perfect process conditions inside the mixing head and inject the mixture into the injection box. 低压混合计量恒温设备 (聚氨酯, 树脂, 尼龙), 化工原料在混合头内保持完美的工艺条件, 混合后的原料注射到注射盒中。
3. Inside the injection box the fibers are impregnated with the high reactive matrix a an in mould pressure of 5 to 100 bar, before the wetted fibers pass trough the heated die with different heating zones from 100 to 250°C which cures the part to the final shape. 在注射盒中纤维被高度活性的化料浸润, 注射盒内湿纤维进入加热模头区域, 压力有5-100bar, 模头由100到250° C分区段加热, 直至产品最后形状。
4. The pulling machanism at constant speed can be realized with an electric-pneumatic Puller with grippers for complex profile geometries or with a Caterpillar for simple geometries. 恒速牵引机构 可以是用于复杂几何形状产品的的电空牵引机或者是用于简单几何形状产品的履带式牵引机。
5. The profiles could be cutted to length by a traveling cutoff saw and afterwards be coiled or packed 型材按照长度由锯切断并捆扎打包。
6. The operator panel of the Pultrusion line is regulating the process parameters and the pulling speed 拉挤线的操作面板可以直接调节工艺参数和牵引速度。

# Krauss Maffei

## Pultrusion Network 拉挤开发合作网络

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**The Future of Pultrusion 拉挤的未来!**