

**algroup alusuisse**

*primary materials and fabricated products*

# **Aluminium Car Body Sheet: Alloys and Surface Pretreatments as System Solution**

---

## **Aluminium-Karosserieblech: Werkstoffe und Oberflächenvorbehandlungen als Systemlösung**

**Margarete Bloeck**

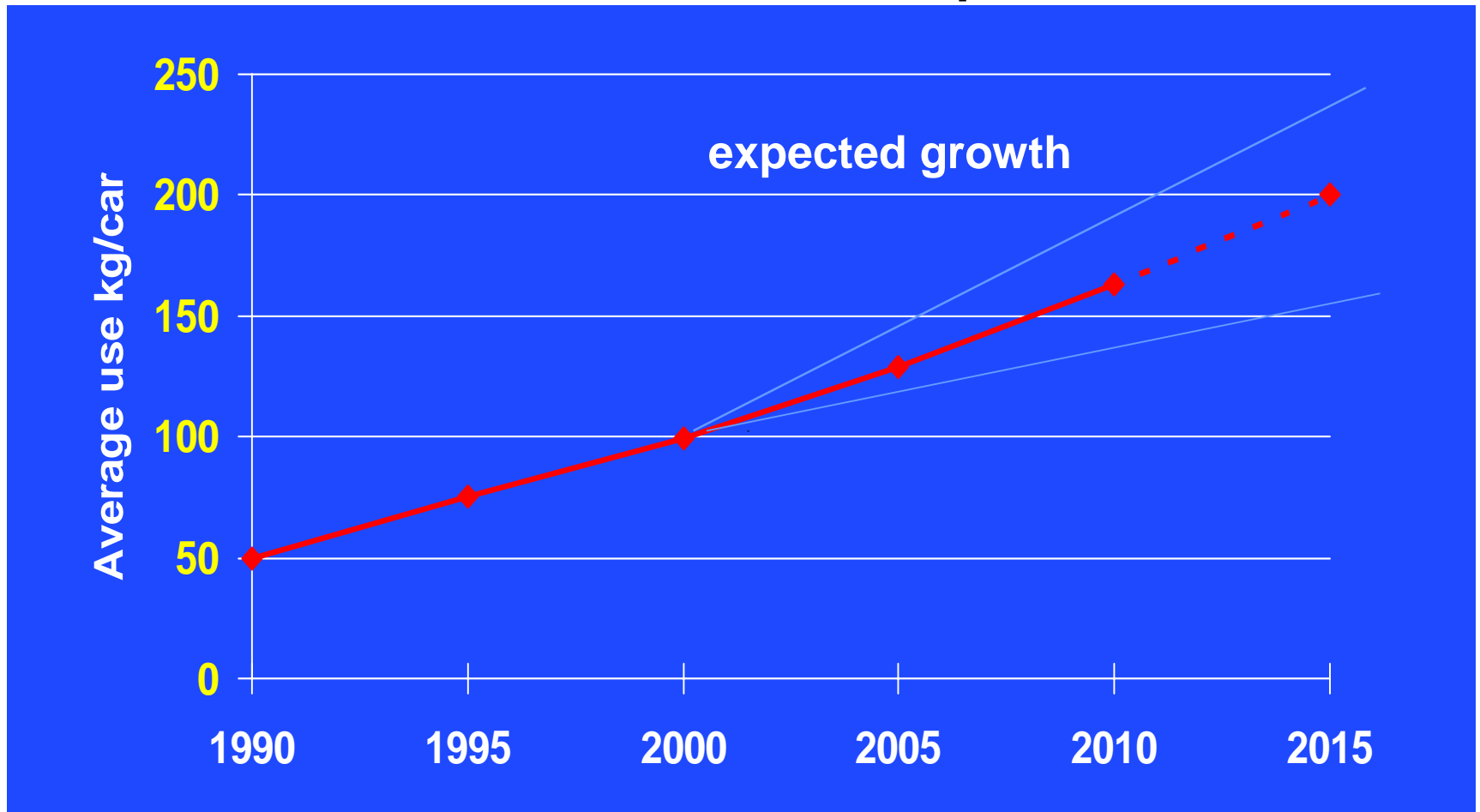
**alusuisse technology & management ltd**

**Neuhausen**

**algroup alusuisse**

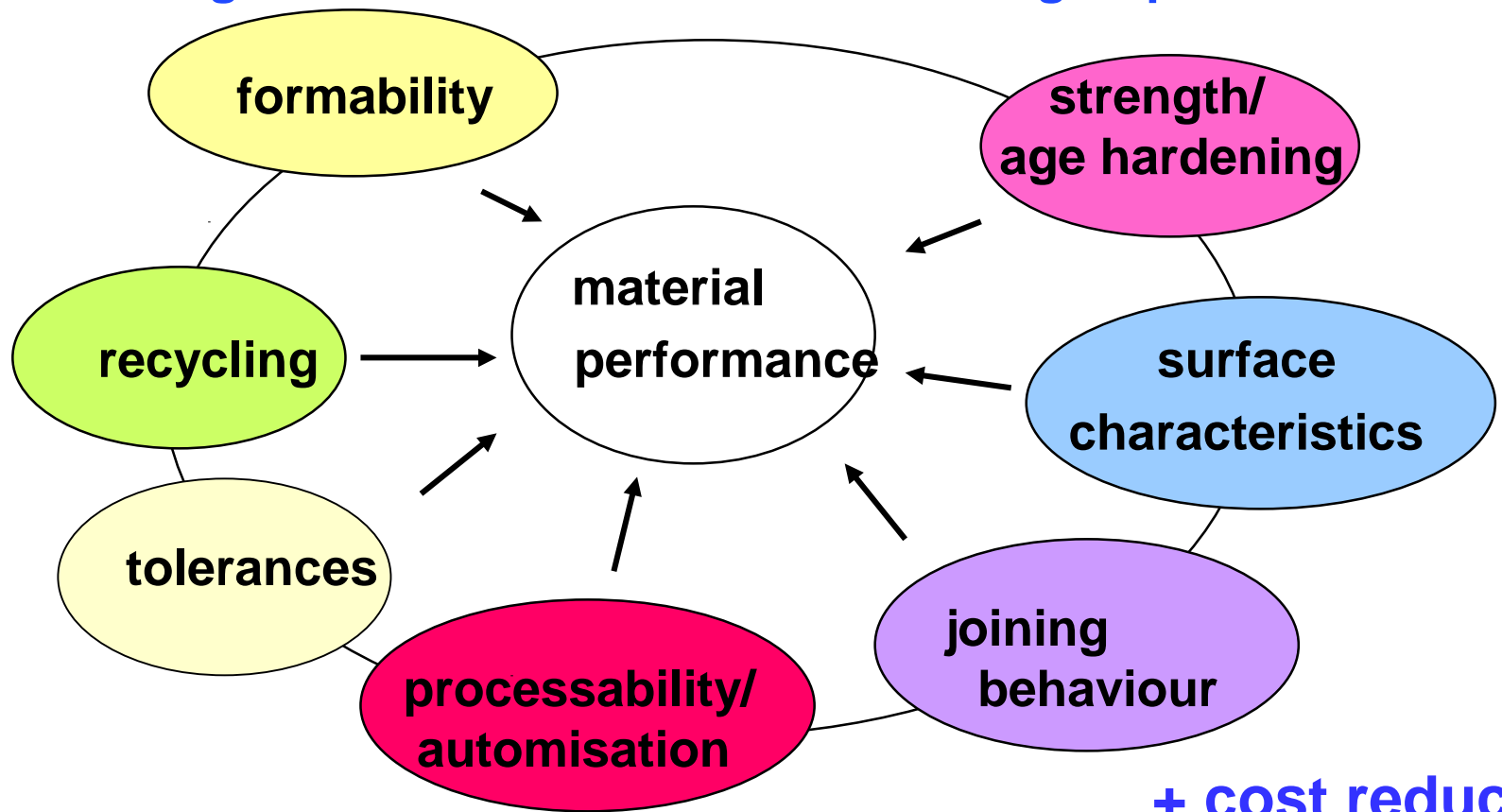
*primary materials and fabricated products*

# Average Use of Aluminium Per Car Western Europe



# Aluminium Car Body Sheet - Requirements

Increasing use of Aluminium → Increasing requirements



**+ cost reduction**

# Car producers requirements

---

**The requirements are usually specific depending on the application, the customer and his process chain**



**Tailor made solutions are offered**

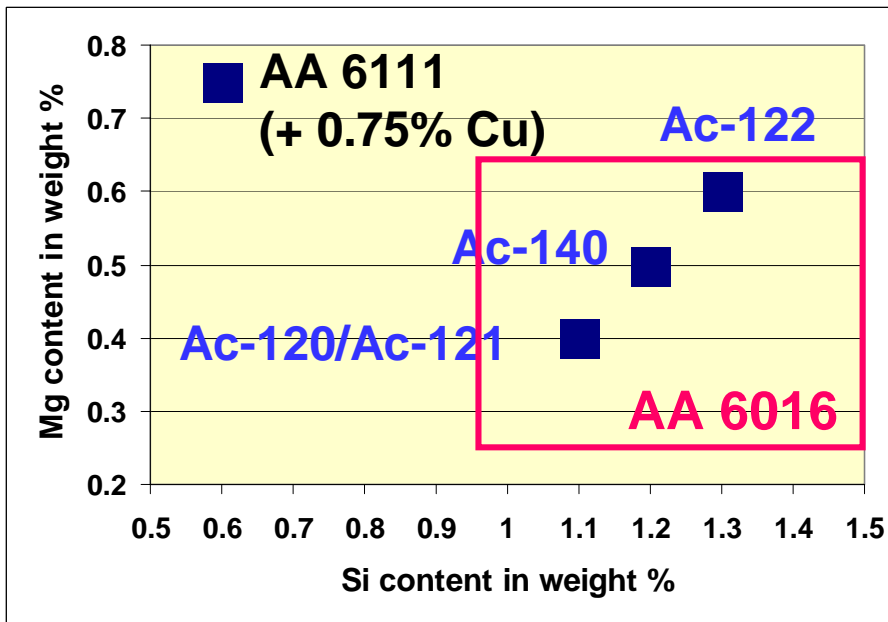
# Car body sheet system to satisfy the customers needs: overview on presentation

---

- **car body sheet alloys**
  - for outer applications
  - for inner applications
- **surface topography**
- **chemical and electrochemical pretreatments**
- **prelubrication**
- **precoatings**
  - primers
  - prelacquers

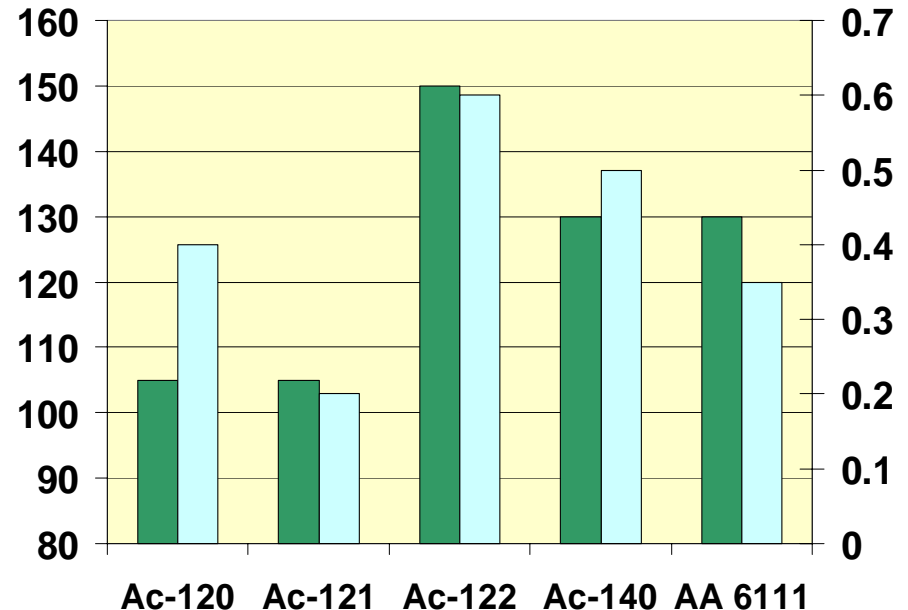
## AlMgSi car body sheet alloys for **outer** applications

- **AA 6016**: standard sheet alloy in Europe
- **Ac-120**: mostly used, **Ac-121**: for improved bendability
- **Ac-122, Ac-140**: Cu free alloys for increased strength
- **AA 6111**: standard alloy in N. America



O.2% PS, MPa

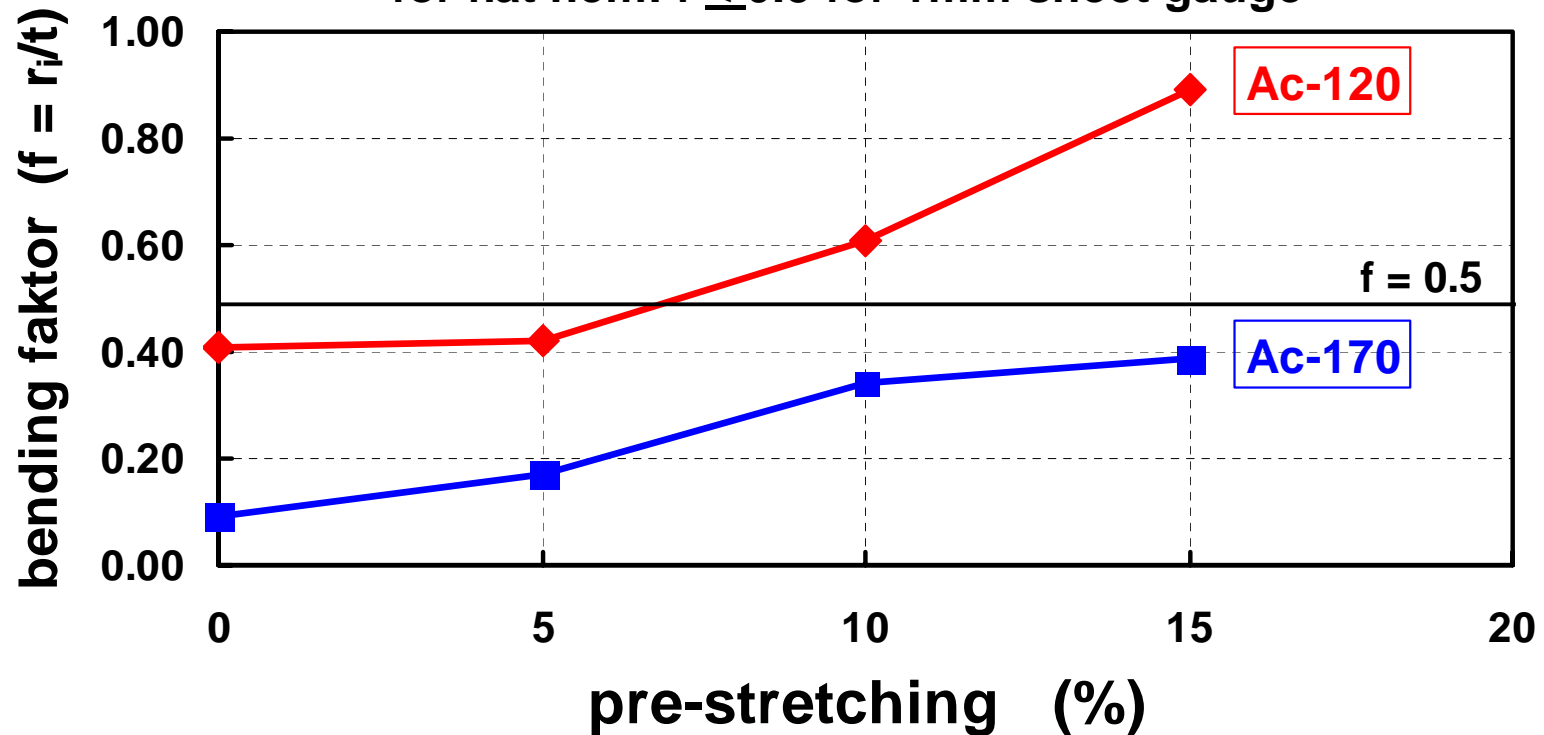
bending factor f



## Ac-170 for superior bendability

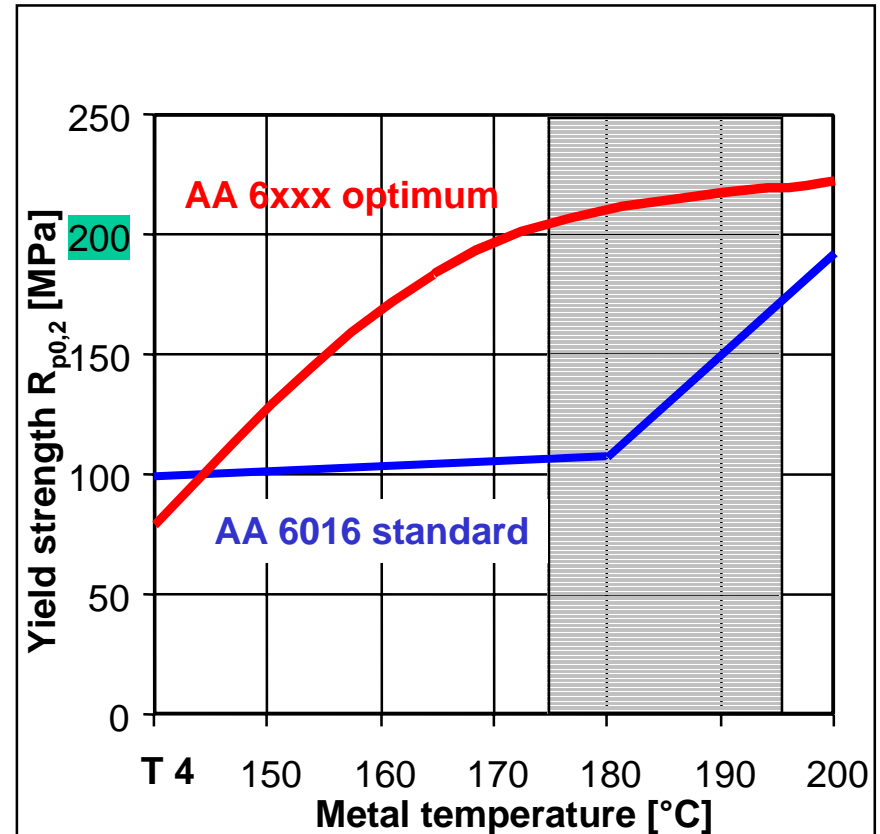
Influence of pre-stretching on bending factor of Ac-170 in comparison to Ac-120

bending longitudinal to RD, 1.0-1.2 mm sheet gauge;  
for flat hem:  $f \leq 0.5$  for 1mm sheet gauge



# Increased age hardening response for AlMgSi alloys

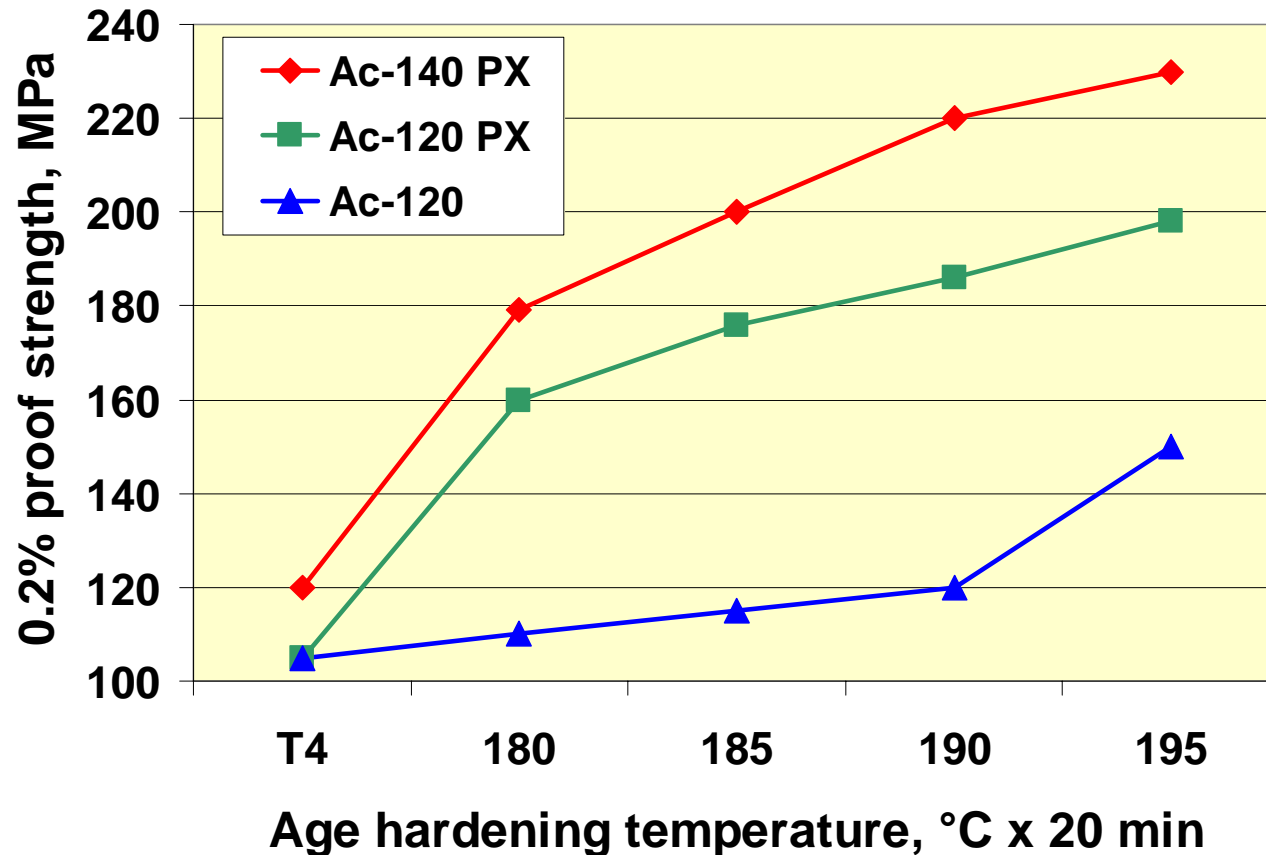
- good formability in T4 temper
- maximum increase of 0.2% PS at  $< 190^{\circ}\text{C}$   
↓  
Process reliability  
↑
- saturation of 0.2% PS at  $> 180^{\circ}\text{C}$
- high strength after e-coat curing: 0.2% PS  $\geq 200$  MPa (including 2% prestretching)



Electrocoat curing temperature range



# Increased age hardenability of AA 6016: Ac-120 PX and Ac-140 PX



## Aluminium car body sheet alloys for **inner** applications

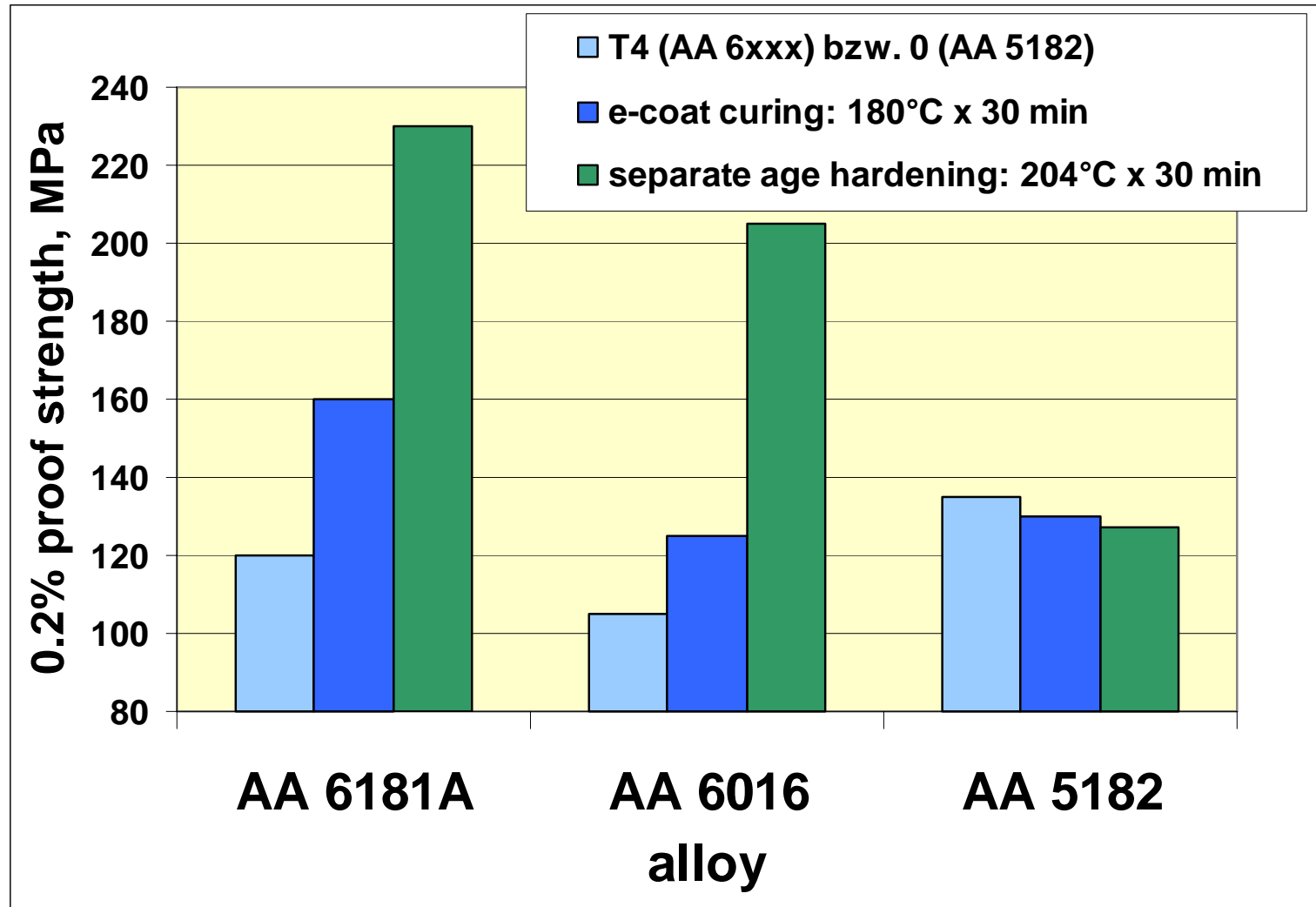
### Advantages of Ecodal-608 (AA 6181A):

- increased strength due to age hardenability --> down gauging
- no stretcher strain marks --> suitable for visible inner panels
- same alloy family as outer sheet --> easier process scrap recycling
- formability sufficient for most panels

AA	typical composition			typical tensile test data					1)
	weight%			0.2% PS	UTS	A <sub>80</sub>	n <sub>m</sub>	r <sub>m</sub>	
	Mg	Si	Mn	MPa	MPa	%			
5754	3.0		0.3	110	220	25	0.30	0.70	
5182	4.5		0.3	135	270	26	0.31	0.80	
<b>6181A</b>	<b>0.8</b>	<b>0.9</b>		<b>120</b>	<b>230</b>	<b>25</b>	<b>0.26</b>	<b>0.65</b>	

1) temper: AA 5xxx: 0, AA 6xxx: T4

# Ecodal-608 (AA 6181A): age hardenability



# Car body sheet system to satisfy the customers needs

---

- **car body sheet alloys**

- for outer applications
- for inner applications

- **surface topography**

- **chemical and electrochemical pretreatments**

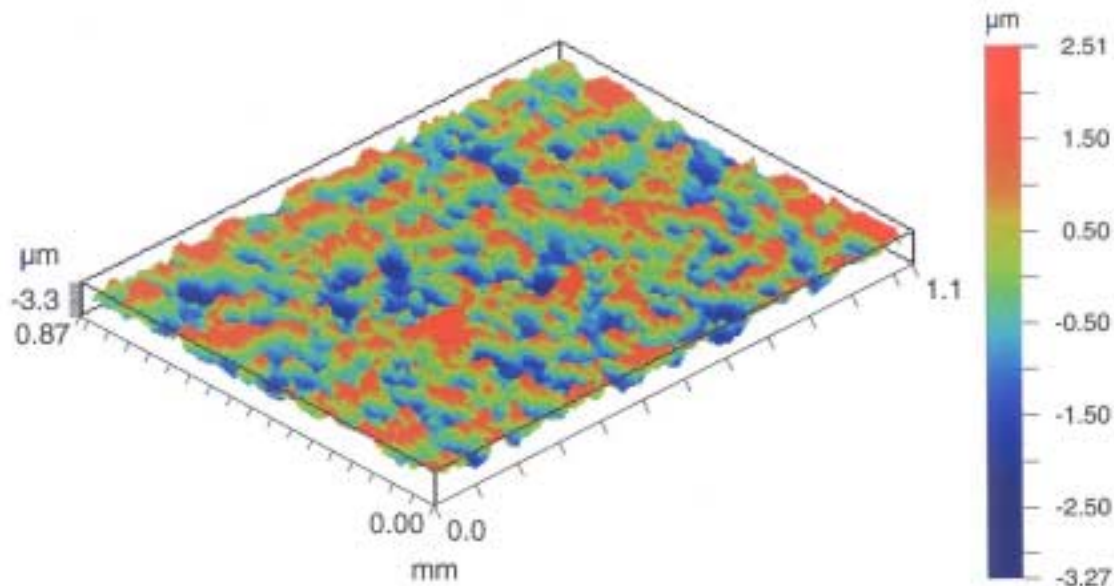
- **prelubrication**

- **precoatings**

- primers
- prelacquers

# Surface topography for car body sheet

- Established surface topography in Europe is **EDT** (Electric discharge texturing), transferred to the strip surface from texturized rolls during the last rolling pass



**3D plot of EDT structure measured by means of white light interference microscopy**

# Advantages of EDT topography

---

- **isotropic --> no directional influence on forming behaviour**
- **lubrication pockets lead to build up of hydrostatic pressure**
  - > **low and regular friction coefficient**
  - > **better formability than with Millfinish structure**
  - > **less pick-up of work piece material on the tool surface**
  - > **regular press parameters**
- **stochastic surface structure**
  - > **good lacquer appearance**

# Car body sheet system to satisfy the customers needs

---

- **car body sheet alloys**

- for outer applications

- for inner applications

- **surface topography**

- **chemical and electrochemical**

- pretreatments**

- **prelubrication**

- **precoatings**

- primers

- prelacquers

# Chemical and electrochemical

## pretreatments

Different types of pretreatments can be applied on the strip surface - depending on the customer requirements:

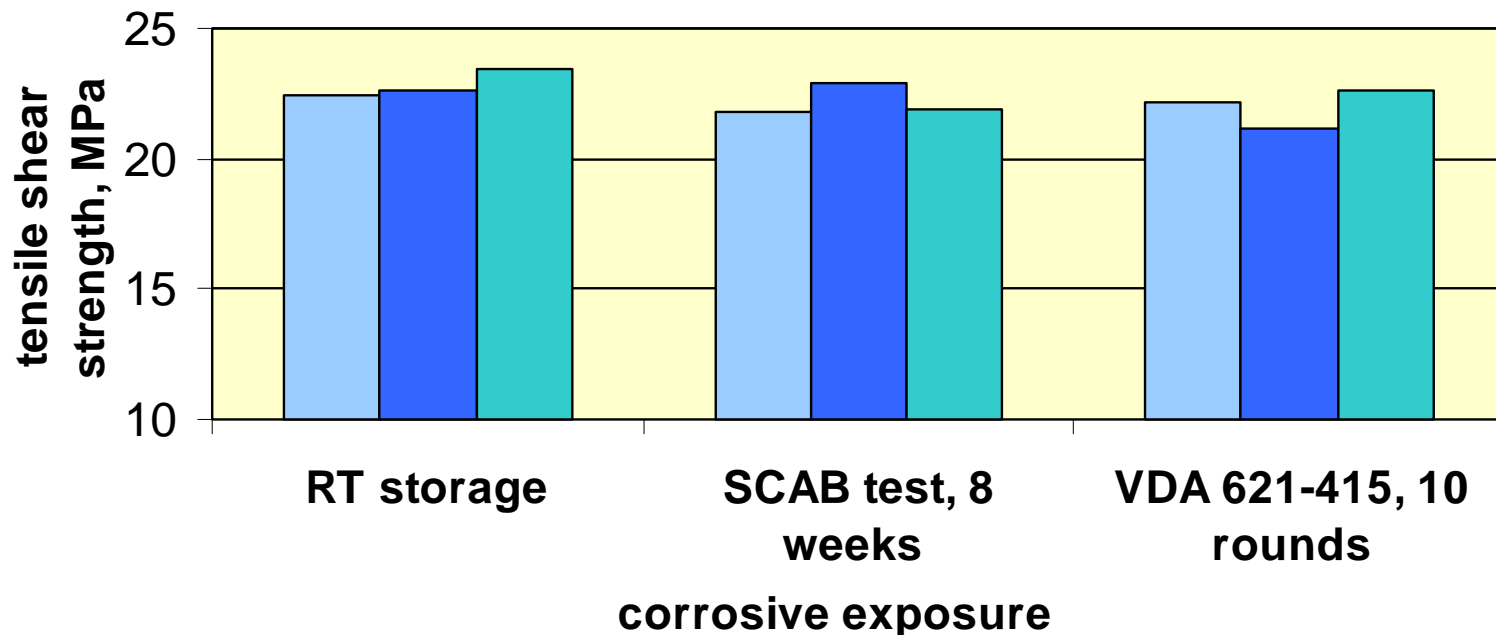
- **degreasing**
- **pickling**
- **anodisation**
- **conversion treatments, e.g.**
  - **Ti- or Ti/Zr-fluoride based agents, without or with polymer addition**
    - > mainly for hem flange bonding
    - > as pretreatment for primer or prelacquer application
  - **PT2: silicate based agent: for structural bonding**



## Influence of strip pretreatment (conversion and dry lubricants) and corrosive exposure on adhesive bond strength

**Tensile shear strength of adhesive bonds**  
alloy: AA 6016; adhesive: BM 1496

■ Ti/Zr-fluoride  
■ Ti/Zr + Alub VS  
■ Ti/Zr + Alub ZX

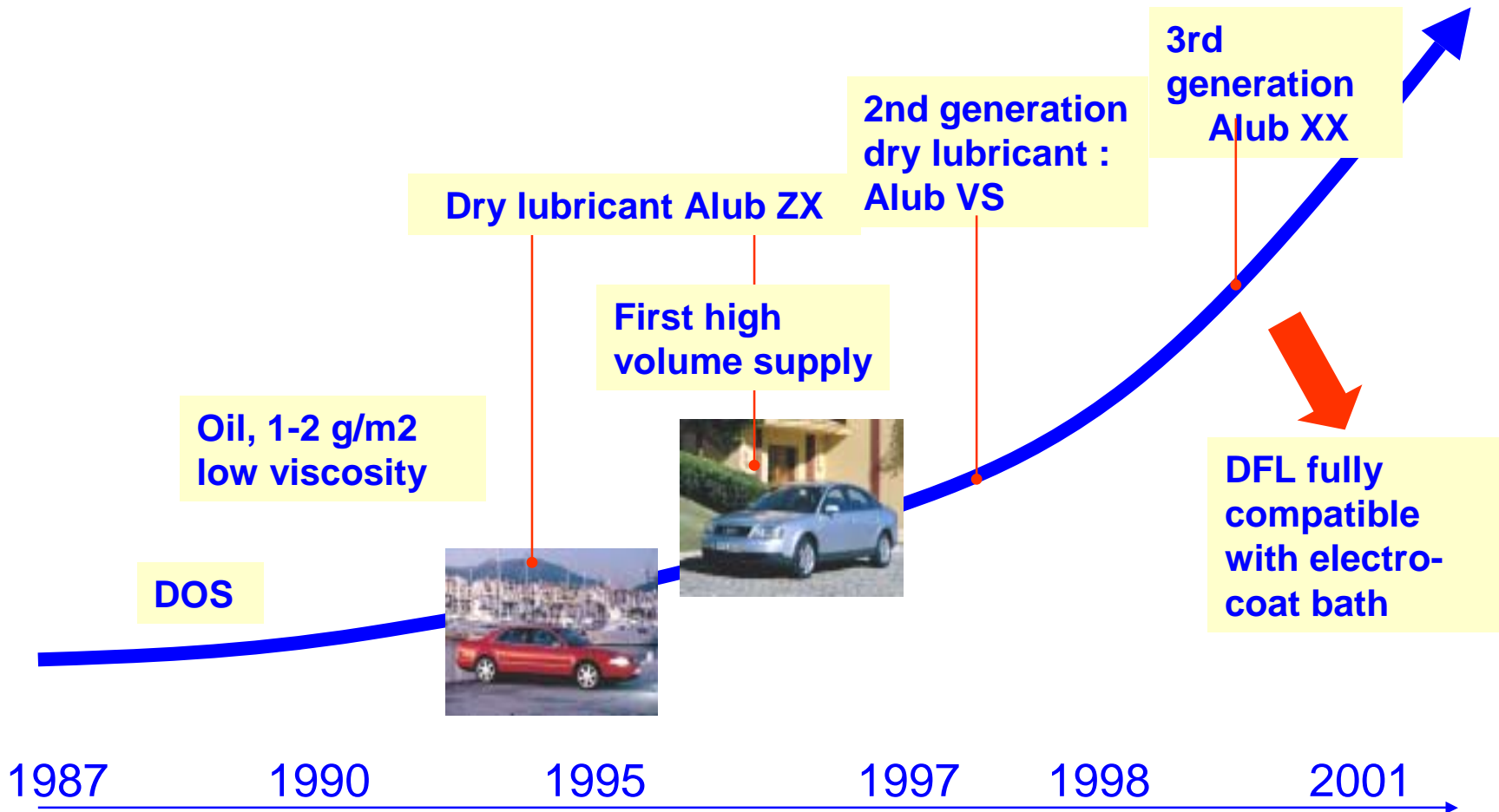


# Car body sheet system to satisfy the customers needs

---

- **car body sheet alloys**
  - for outer applications
  - for inner applications
- **surface topography**
- **chemical and electrochemical pretreatments**
- **prelubrication**
- **precoatings**
  - primers
  - prelacquers

# History of prelubricated sheet (Europe)



Source: C. Bassi, Sierre

# Advantages of dry lubricated sheet

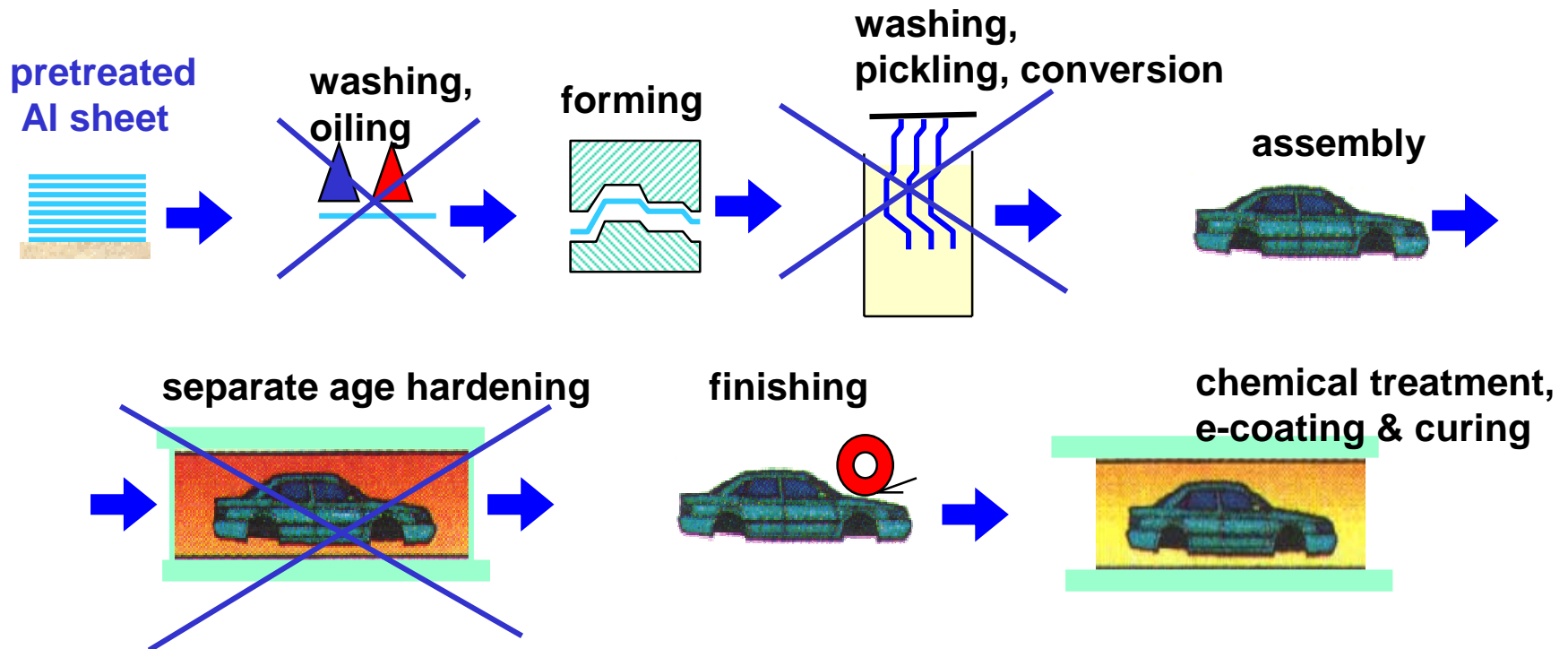
---

- surface protection during transport and storage
- automatic destacking of panels in the press shop
- no oiling operation
- no operators at line entry to remove interleave paper
- improved formability compared to drawing oil
- constant friction conditions during pressing --> robust pressing conditions
- increased stamping rate
- less problems with surface contamination
- compatible with mechanical joining and bonding
- removable with mild alkaline degreasing agents
- e-coat compatible products are available

press shop

assembly  
lacquering  
plant

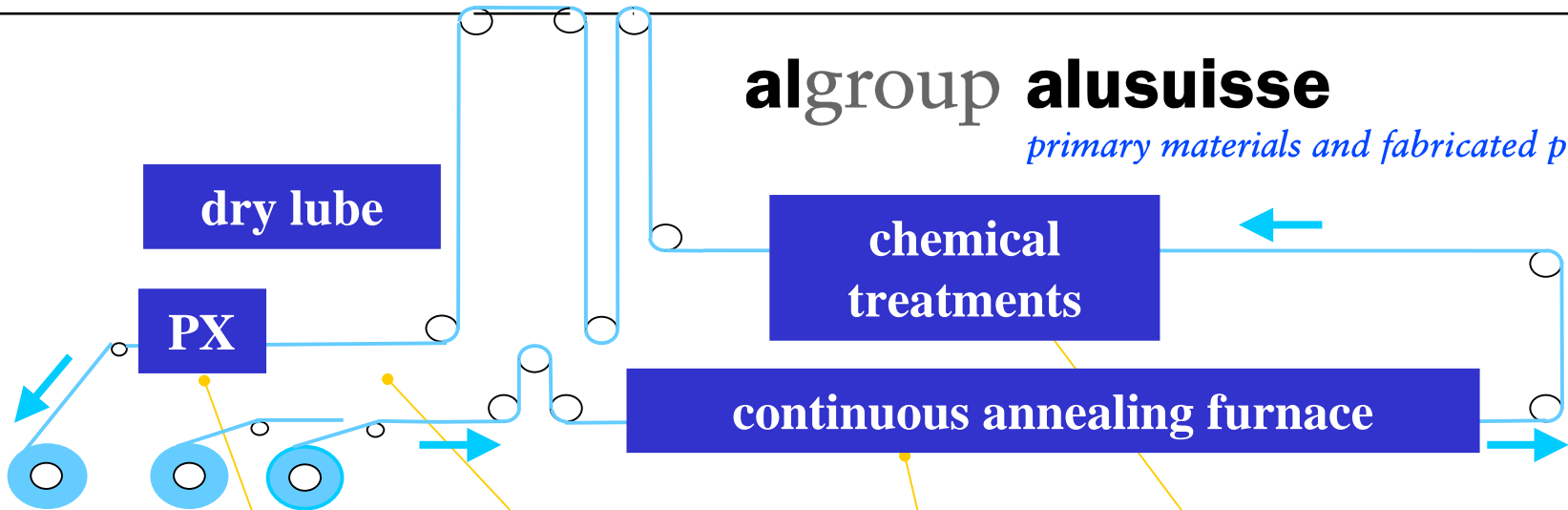
## Combination of conversion + lubrication + PX treatment on the Al strip = combination of the advantages



**Saving of process steps: „lean“ production**

**algroup alusuisse**

*primary materials and fabricated products*



## Alusuisse Combi Line (ACL), Sierre



# Car body sheet system to satisfy the customers needs

---

- **car body sheet alloys**
  - for outer applications
  - for inner applications
- **surface topography**
- **chemical and electrochemical pretreatments**
- **prelubrication**
- **precoatings**
  - primers
  - prelacquers

## Precoated sheet: primers

---

- sheet with **Bonazinc** primer coating is supplied since several years

Example:  
use of Bonazinc  
primered AA 6016  
sheet for a motor  
hood



- plant trials are in progress with a new primer: **Granocoat**



## **Advantages of primer coated sheet**

---

- **surface protection, e.g. during transport and handling**
- **improved formability (lubrication still required)**
- **protection against corrosion**
- **good basis for bonding**
- **good basis for lacquering, less influence of the Zn-phosphating conditions**
- **surface appearance of lacquered Al parts compatible with that of steel parts**

press  
shop

assembly

lacquering  
plant

## **Primer coated strip - benefit for car producer**

---

- **easier processing of Aluminium sheet on equipment optimized for steel**
- **suitable for use in mixed metal constructions steel/Zn-coated steel/Aluminium**

### **! Limitations**

- **grinding of the formed panels --> reduction of the corrosion resistance**
- **not weldable --> bonding and mechanical joining**
- **recyclability (less value of process scrap)**

# **Prelacquered car body sheet**

---

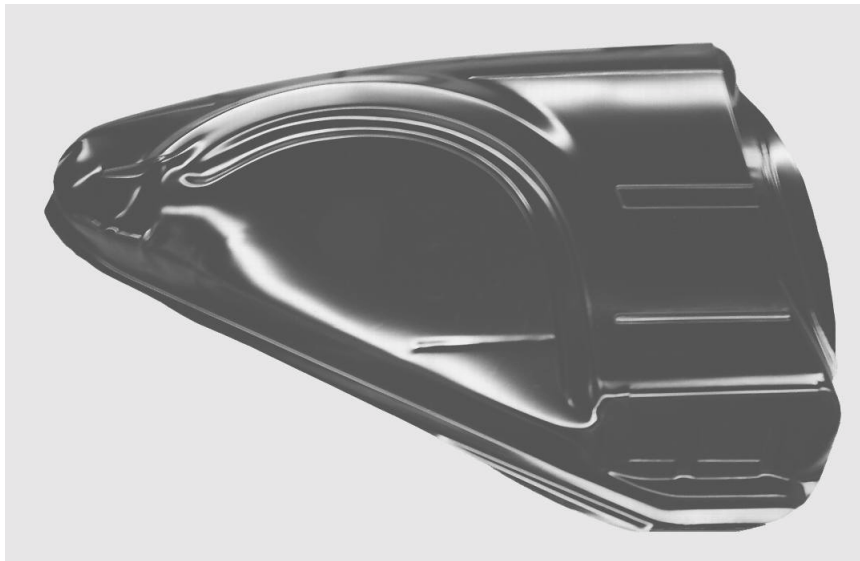
## **Status**

- **Different types of prelacquered materials have been tested in cooperation with several customers**
- **Despite promising results up to now no introduction into production**

## Panels produced out of prelacquered sheet: examples

---

- chemical pretreatment: Ti/Zr-fluoride
- prelacquer as e-coat replacement: polyurethane primer + polyurethane stone-chip resistant coating



**fender out of  
prelacquered AA 6016**



**front semi-structure out of  
prelacquered AA 5754**

# Future potential of prelacquered Al sheet

---

- **short to medium term:** use of sheets with e-coat replacement, e.g. for repair parts
- **long term:** use of sheet with e-coat and filler replacement or with full lacquer system, e.g. for mixed material car bodies with plastic panels (heat treatments limited to  $< 100^{\circ}\text{C}$ )

**Precondition:** adaptation of processing  
concept  
and equipment at car producer

# Nachterstedt

**algroup alusuisse**

*primary materials and fabricated products*

## Annealing and Finishing Line

---



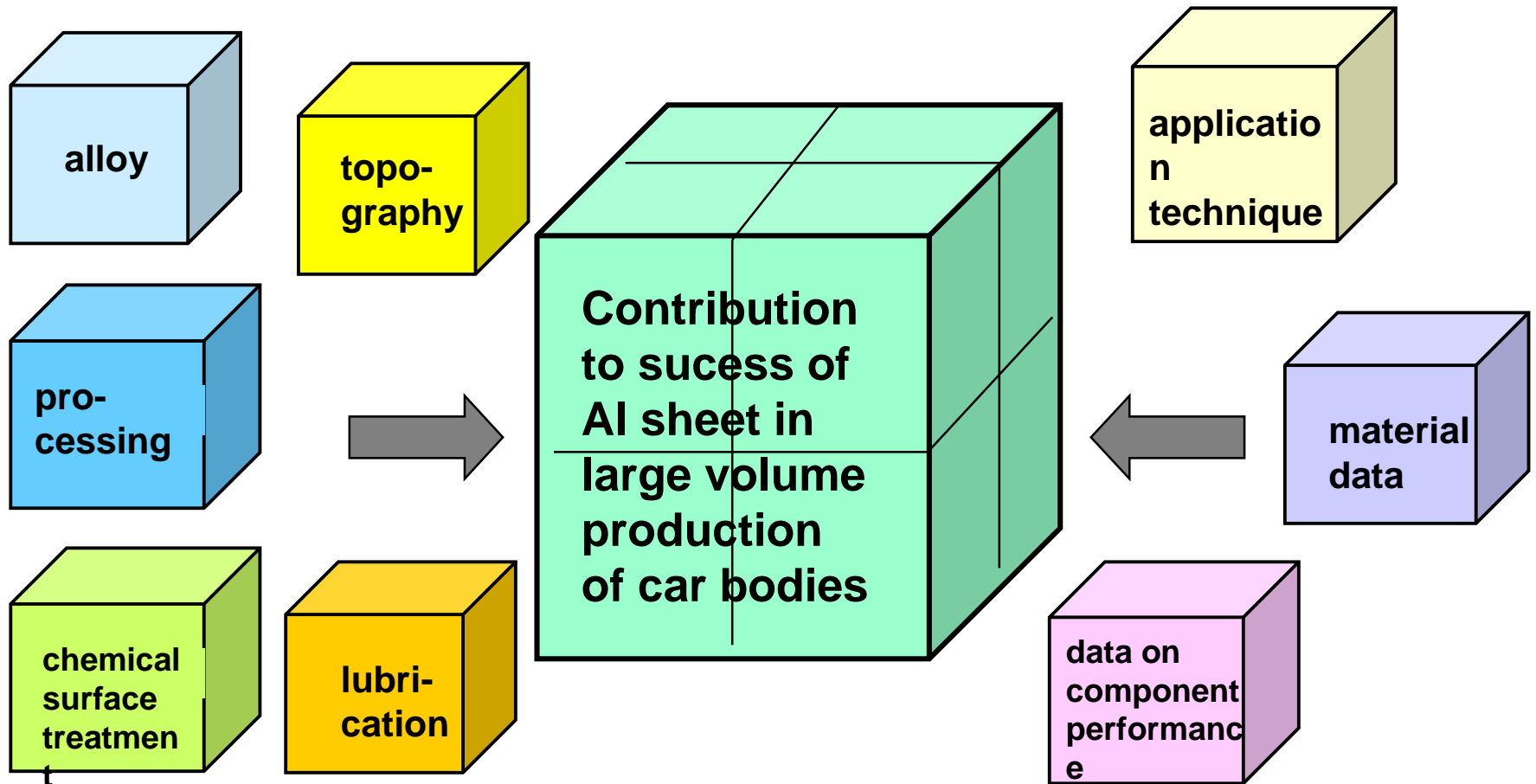
### Treatment steps

- levelling
- continuous annealing followed by air or soft water quench
- electrolytic cleaning/anodising: 0.05 - 0.20  $\mu\text{m}$
- chemical pretreatment: chemcoater, No Rinse
- precoating: primers or prelacquers, roll coater, followed by curing
- lubrication
- lamination of protective film

- strip width: 1000 - 2300 mm
- strip gauge: 0.6 - 3.2 mm
- line speed, process part: max. 150 m/min, 268 m line length
- line capacity: 100 000 t/year

# System solution according to customers needs

---



# Challenges for future developments

---

- **alloys**
  - further improved formability
  - increased strength to allow down gauging:  
1.1 mm --> 0.9 mm --> ?
  - suitable for process with e-coat curing at  $< 160^{\circ}\text{C}$
- **pretreatments: introduction of new, further improved treatments for structural bonding, e.g. strip anodisation**
- **dry lubricants with further improved property profile**
- **introduction of prelacquered sheet**