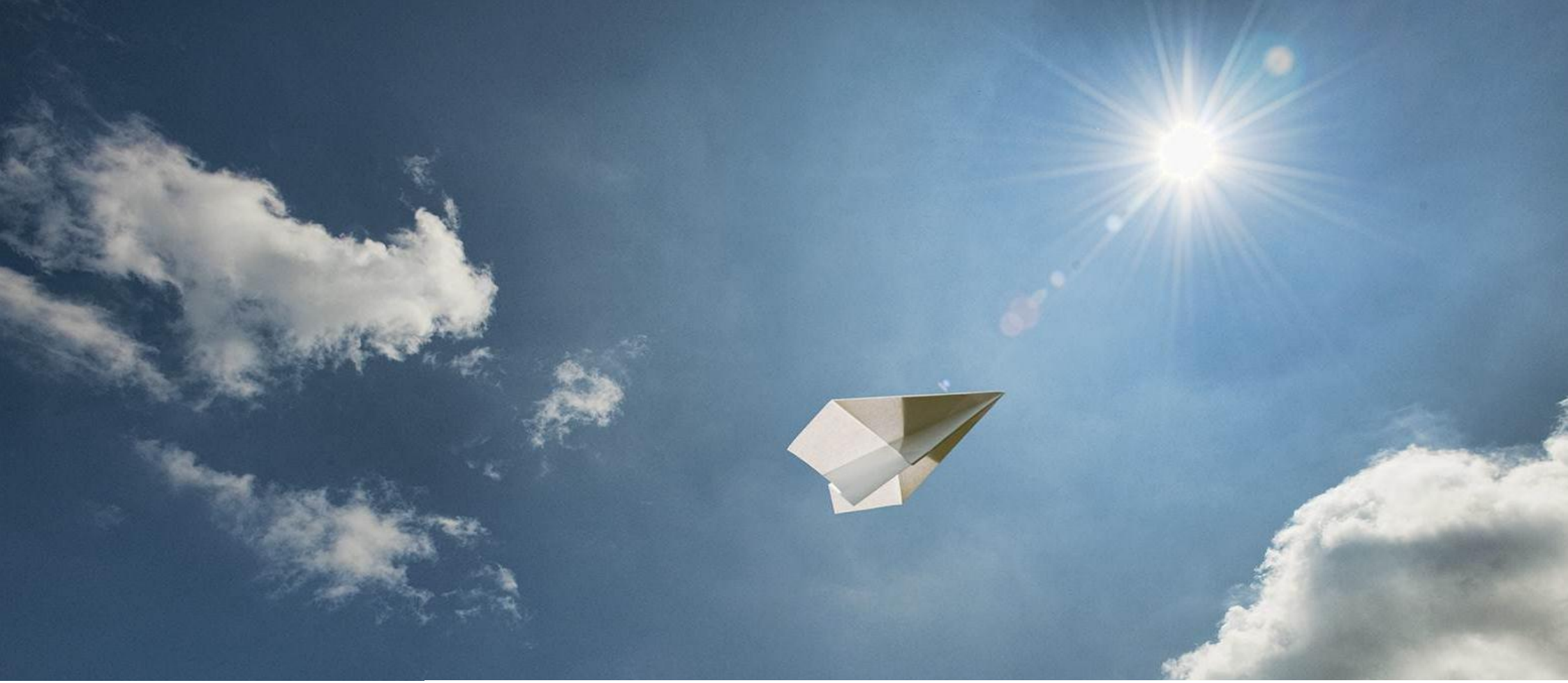

“Innovative Aluminum Lightweight Technologies for Aerospace Application”

Dr. Blanka Lenczowski / Airbus Group Innovations, Munich

AMAP Colloquium
October 6th 2016
Aachen

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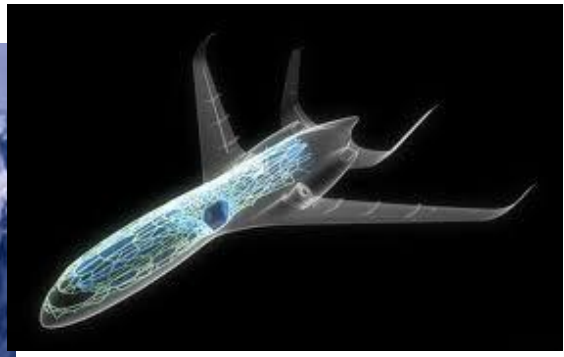
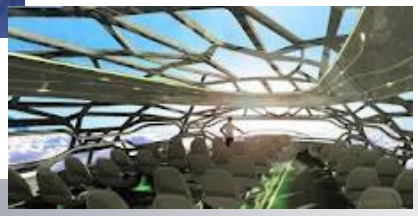
The drivers for future structure

- Increased performance
- High quality and reliability
- Increased efficiency
- Reduction of weight
- Sustainability (eco-efficiency)
- Cost Reduction !





- ✈ Innovative <u>design</u> principles
- ✈ Advanced <u>process</u>
- ✈ New material concepts

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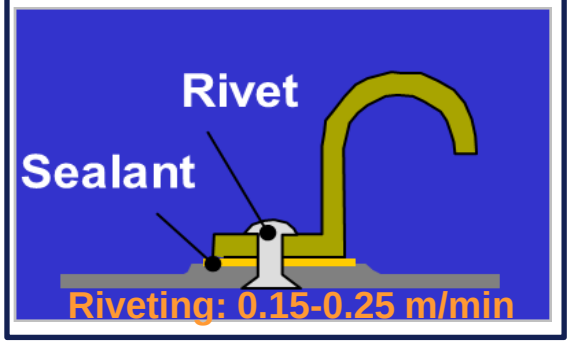
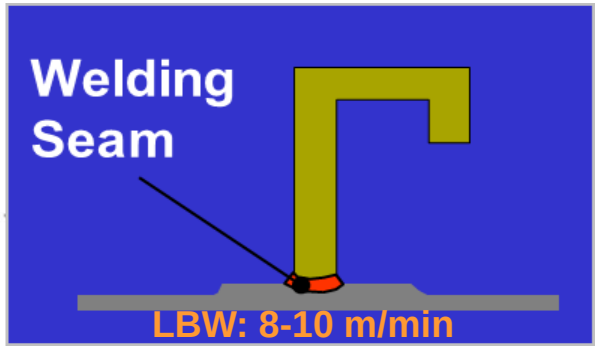
New advanced technologies & materials

Traditional Joining
Differential Design

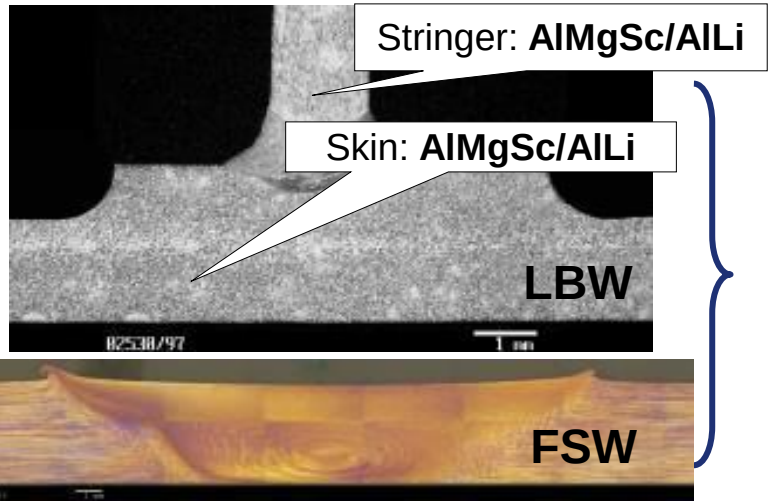


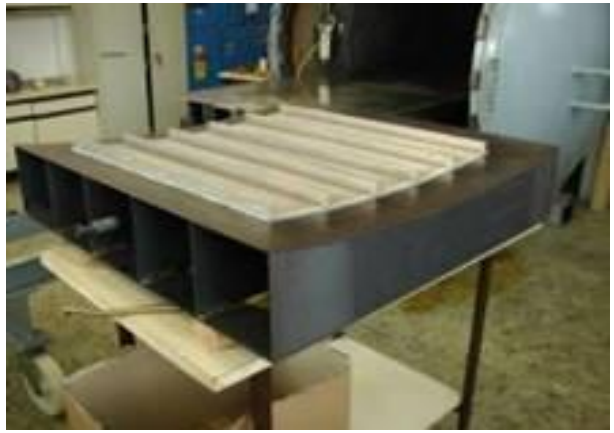
New Metallic Fuselage: *Integral Structure*

- Cost Reduction 25%
- Weight Reduction 10%
- Improved Corrosion Behaviour



New approach ➔ Welding of Mono/Mixed Materials





Target ➔ New weldable alloys for HDT Al-Structures

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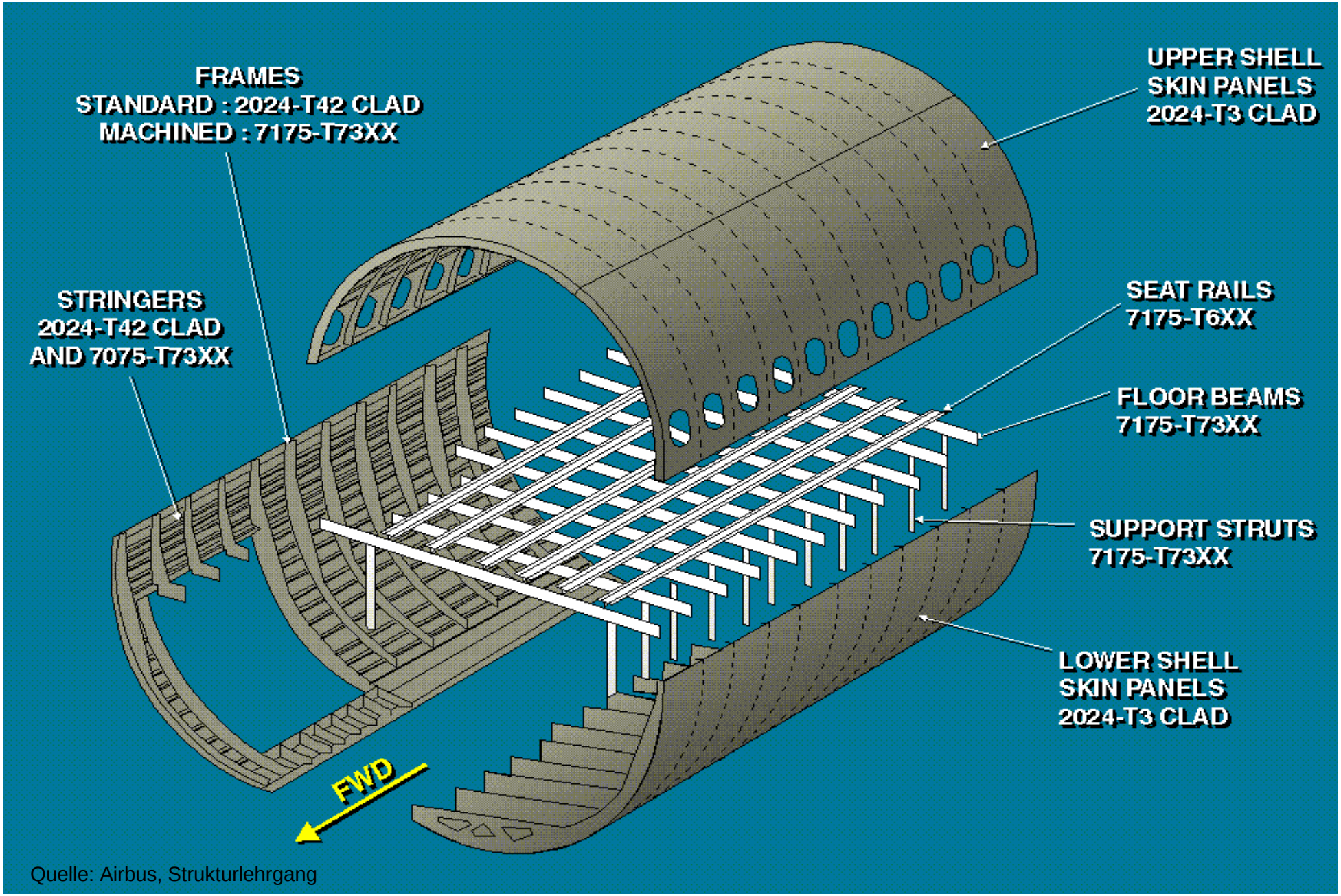
Material and technology evolution: A320



Quelle: Airbus, Strukturlehrgang

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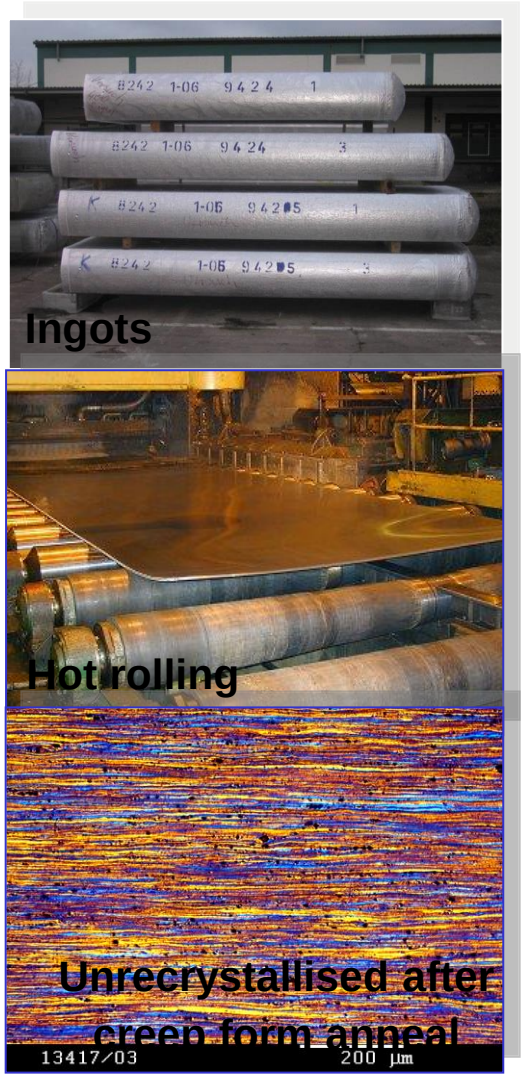
Al-Mg-Sc alloy

Status

» Corus alloy (**Ko8242/5024**)➔ Developed in national funded BMBF-Project (1996-1999) under leadership AGI IW Munich

Motivation

» 5% lower density compared to AA2024/AA2524 and 2.5% lower than AA6013
» Excellent corrosion resistance (no IGC, EXCO & SCC sensitivity)
» Excellent fusion weldability (no hot crack sensitivity)
» Excellent creep or relaxation formability at 300-350°C
» During relaxation process increase of strength in LBW fusion zone up to base material level



Quelle: Aleris

1996-1999 BMBF-Project with VILS➔ 1999 - 2011 industrialization Ko8242/ AA5024
Today ➔ Improved AA5028 (Aleris)

AIRBUS GROUP

Al-Mg-Sc alloy

Metallurgical principles of scandium addition

I. Effects of Scandium Al_3Sc:

» Grain refinement (casting & welding)

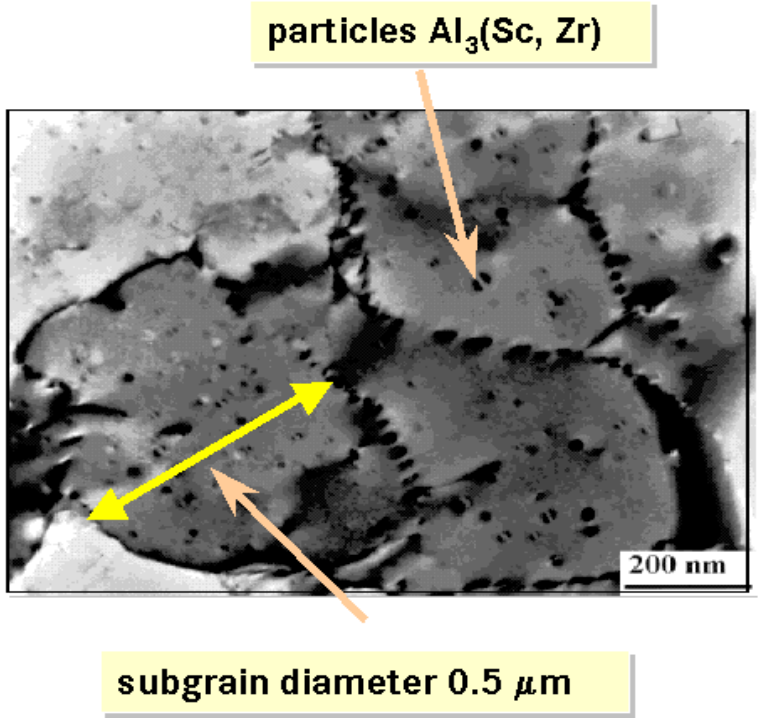
» Strengthening

» Recrystallization inhibition

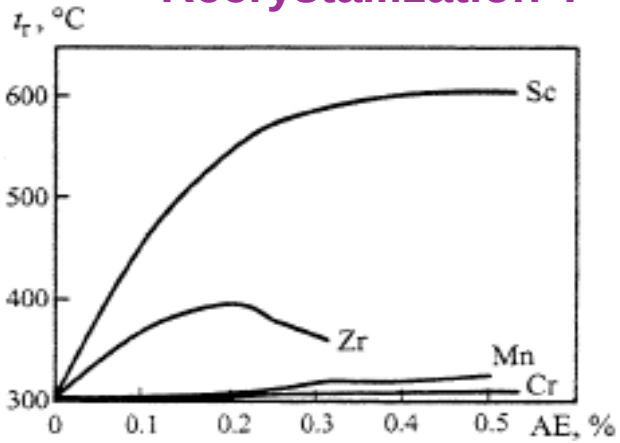
II. Effect of Scandium & Zirkonium $Al_3(Sc,Zr)$:

» Lower tendency to coagulate

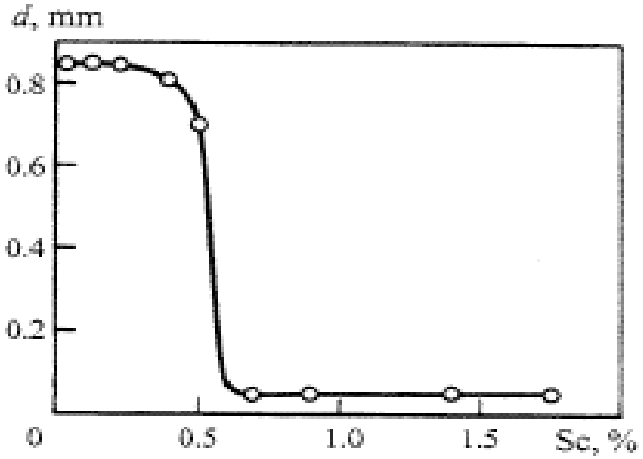
» Higher anti-recrystalisation and strengthening effect



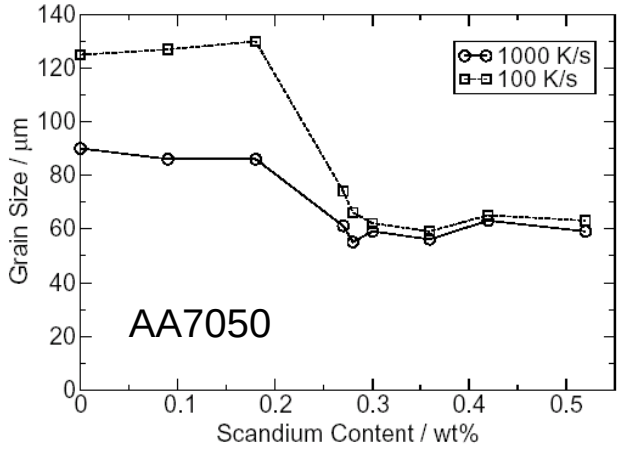
Recrystallization T



Grain size



Colling rate



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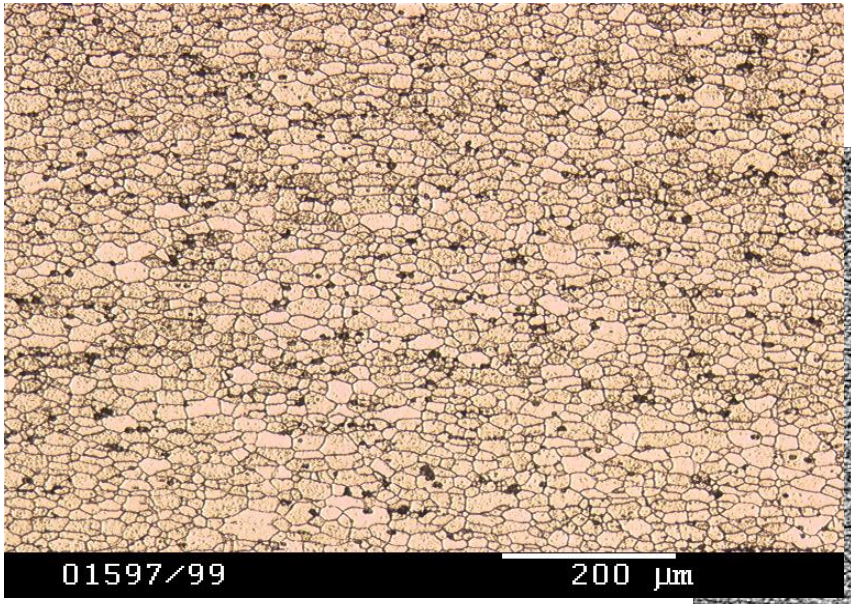
New advanced technologies & materials

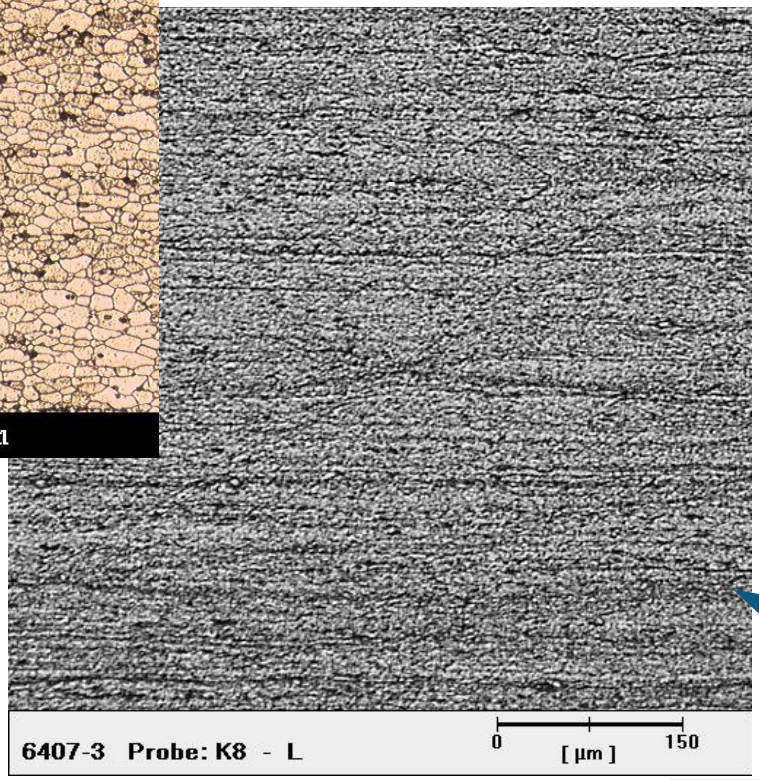
Microstructure

6013-T651

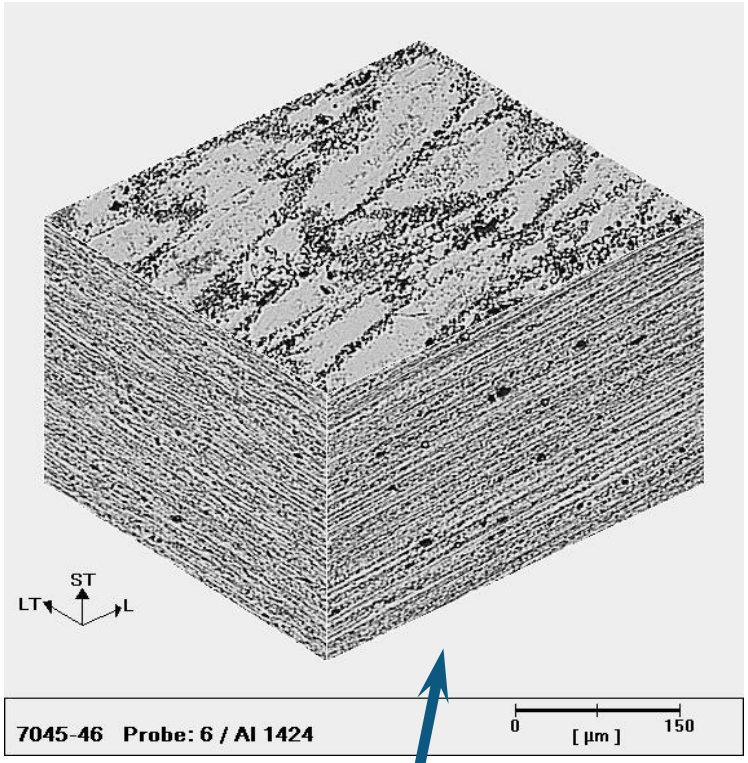


Recrystallized structure

5XXX+Sc-TX



1424-3TX



Non-recrystallized structure

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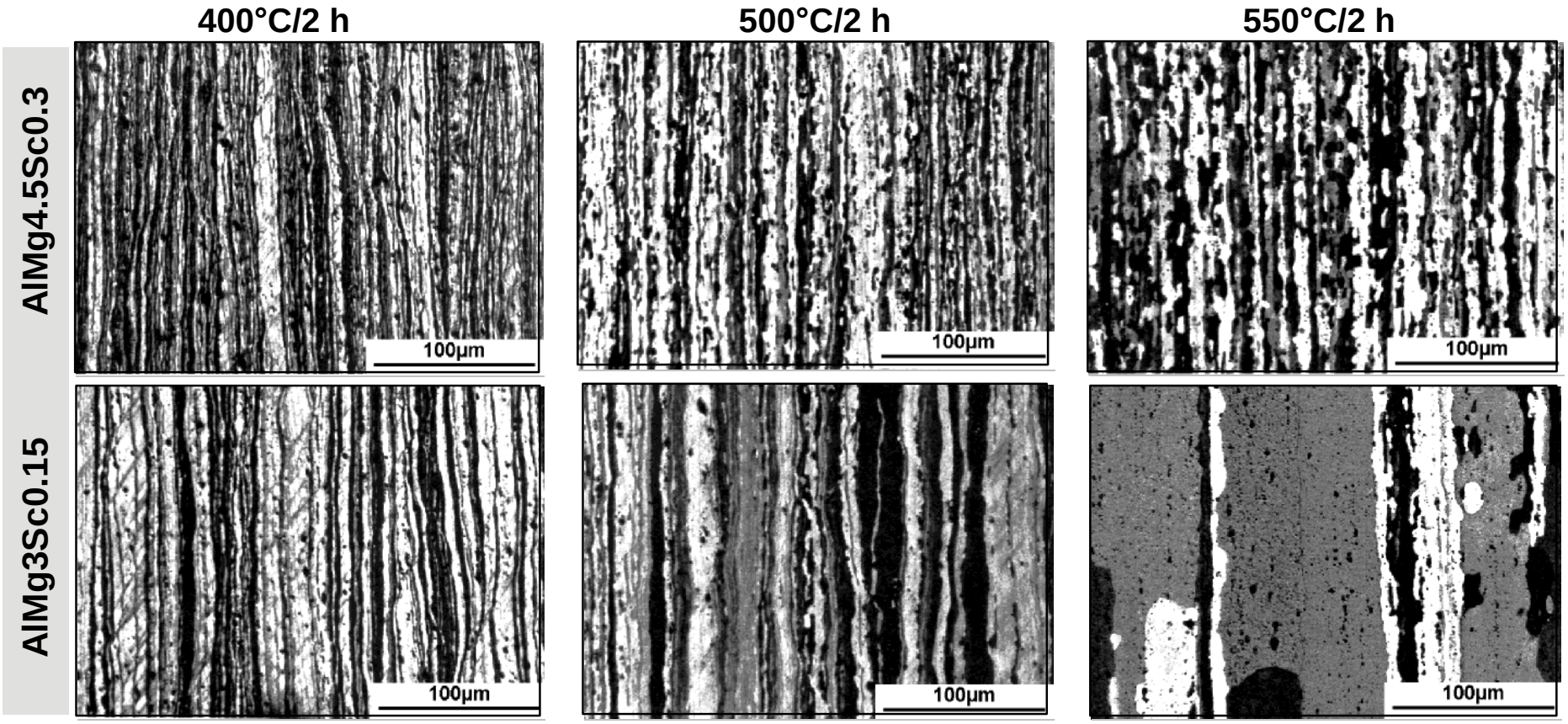
Al-Mg-Sc alloy

Al-Mg-Sc microstructure evolution ➔ Impact of temperature

Conventional casting
~10 -100 K/s



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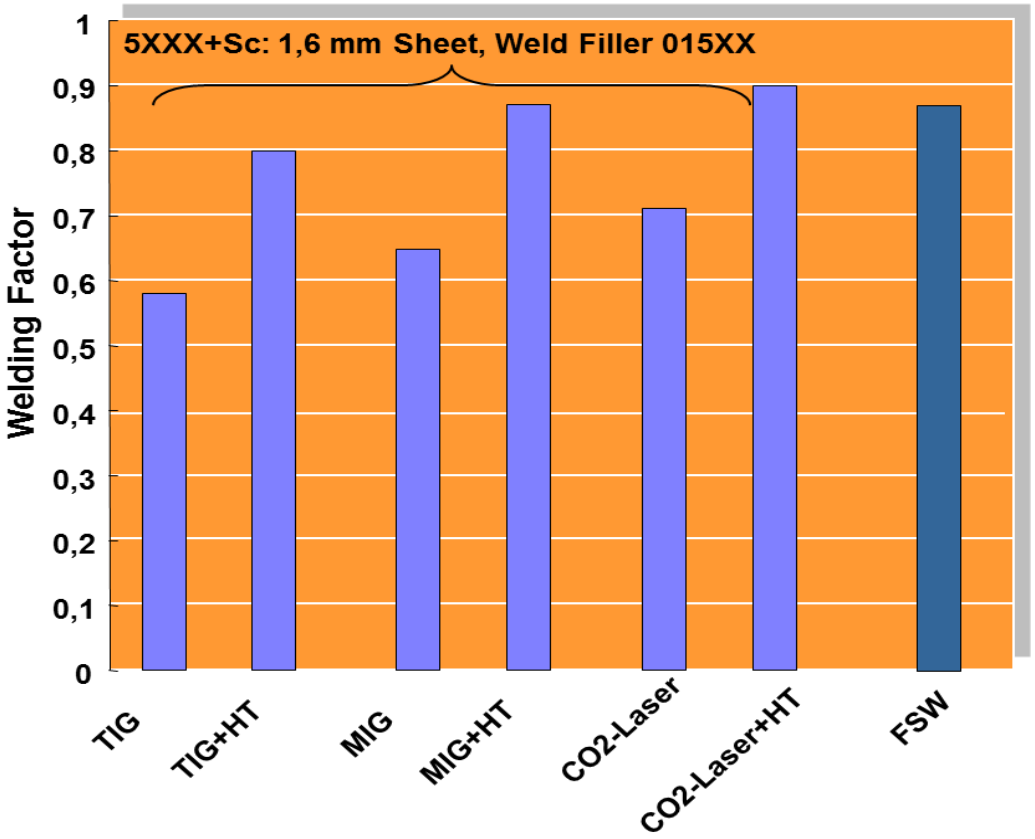
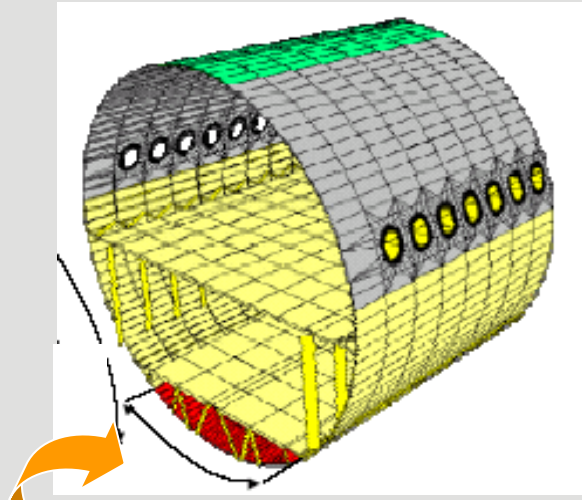
Al-Mg-Sc alloy

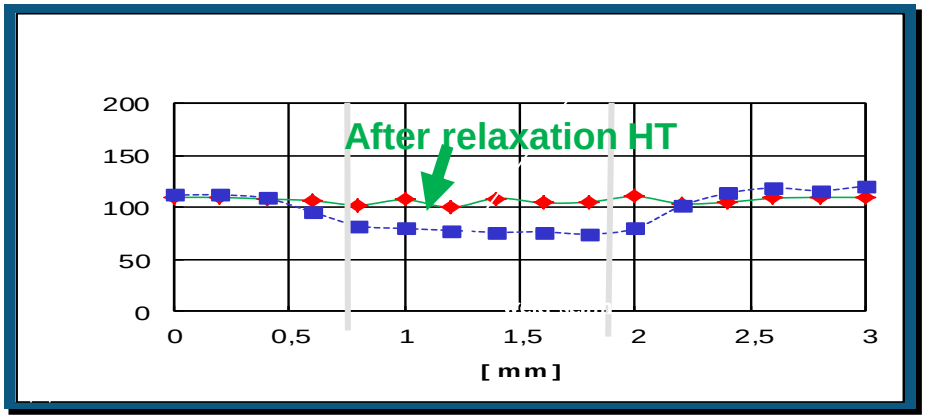
Weldability



Al-Mg-Sc shells in TANGO Barrel



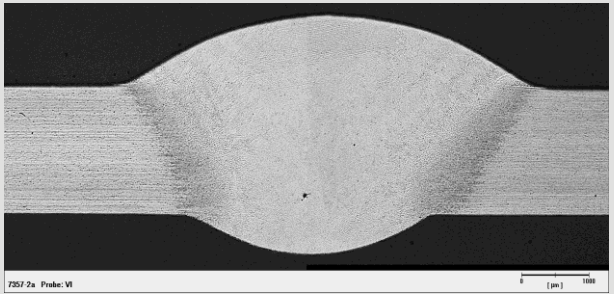
Al-Mg-Sc Skin (inc. FSW)
Al-Mg-Sc LBW Stringer



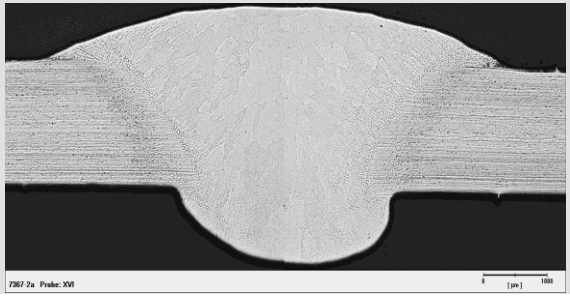
Excellent weldability!!!

Type of welding impacts the welding factor due to the cooling rate!!!

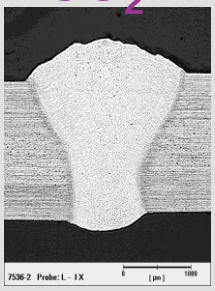
TIG



MIG



CO_2

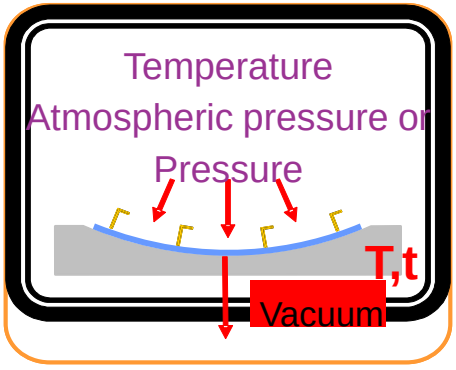


Al-Mg-Sc alloy

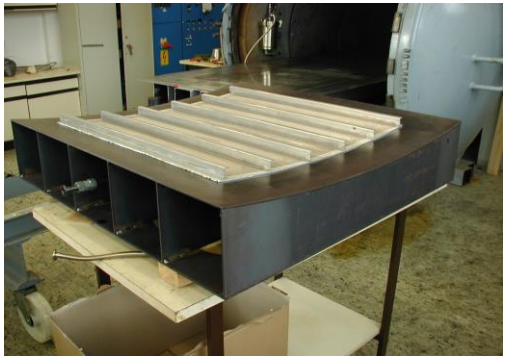
New forming technologies: Creep Forming of welded parts

1. Stringer LBW

2. Fixing the panels in the form



3. Creep forming



4. Ready

Advantages:

- LBW on flat sheet
- No spring-back
- Hardening of joint & HAZ
- Relaxation of residual stresses and distortions

Innovation ➔ Reduction of costs through reduction of manufacturing steps

PAST	NOW	FUTURE
2024 (Stretching + Riveting)	6013 (Stretching + LBW)	AlMgSc (LBW + Creep Forming)
22 STEPS	18 STEPS	9 STEPS!

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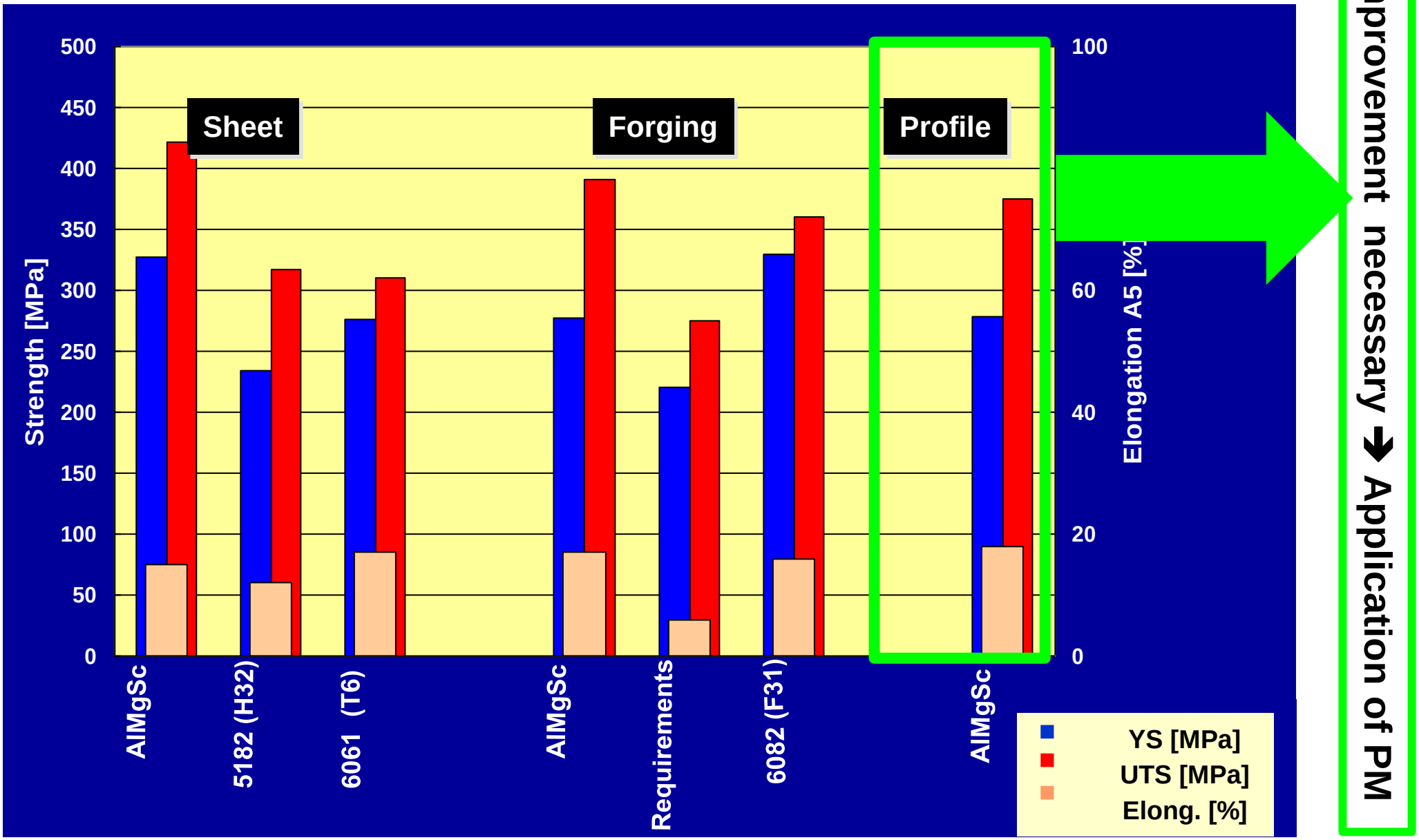
Al-Mg-Sc alloy

Mechanical Properties of Different Al-Mg-Sc Semi-Finished Products



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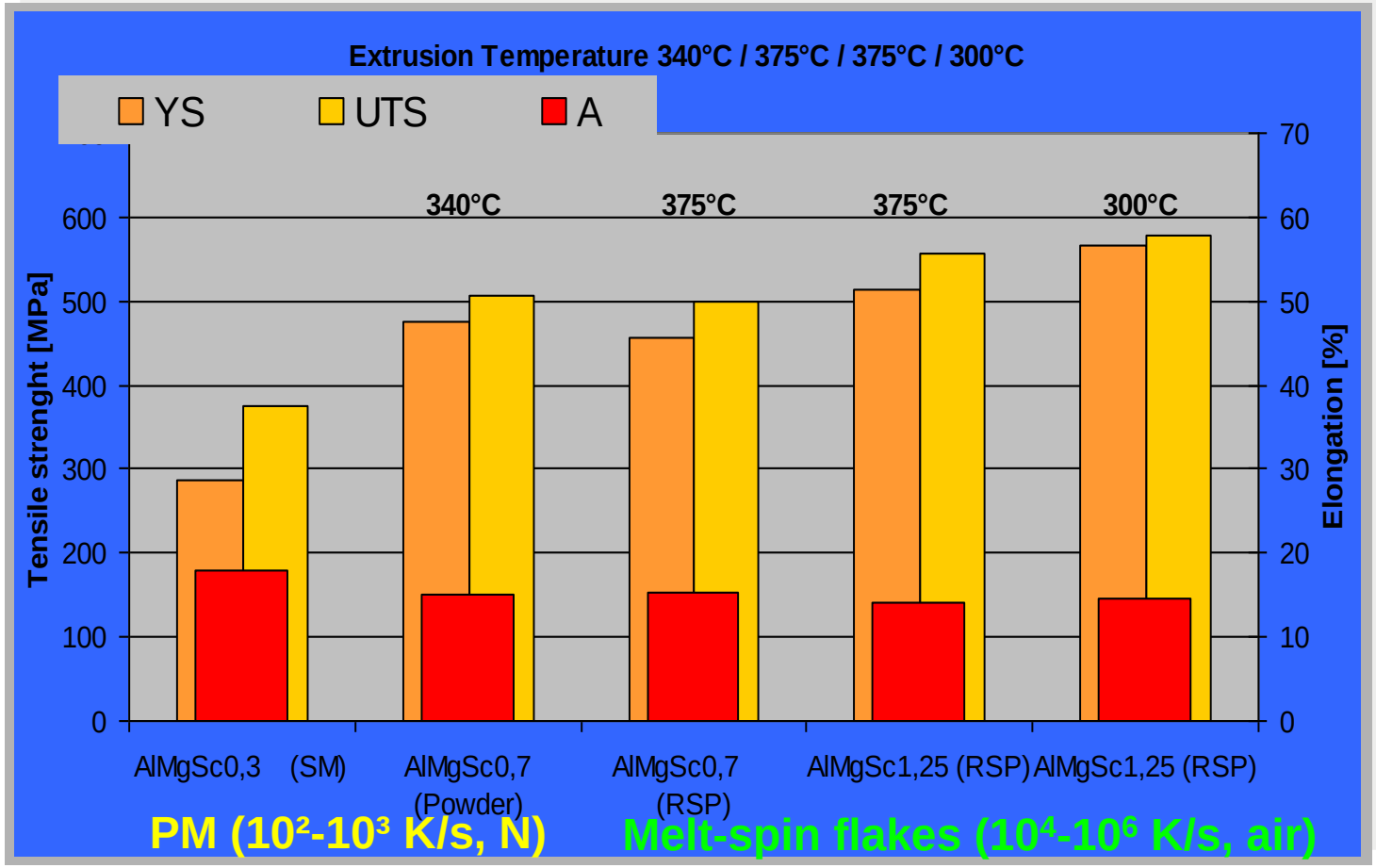
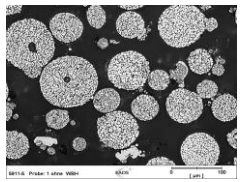
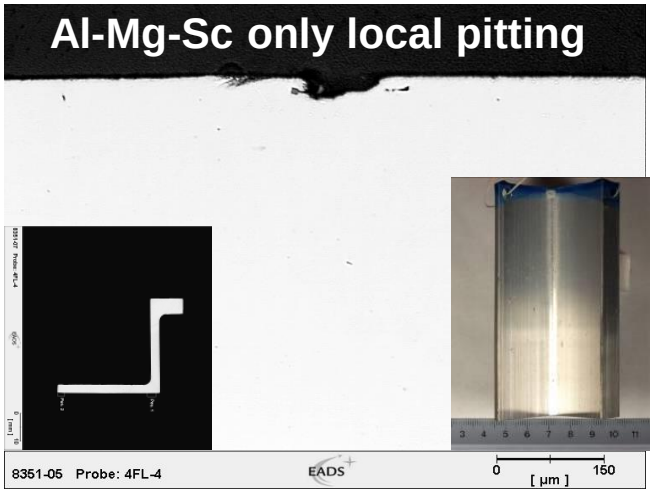
Scalmalloy®: AGI' second-generation Al-Mg-Sc material

Development of high strength PM Al-Mg-Sc material

Mechanical properties & corrosion behaviour







- High performance material with low density
- Extremely high strength combined with exceptional good notch ductility
- Better corrosion behaviour than 7xxx and new 2xxx alloys
- Application for conventional/integral design

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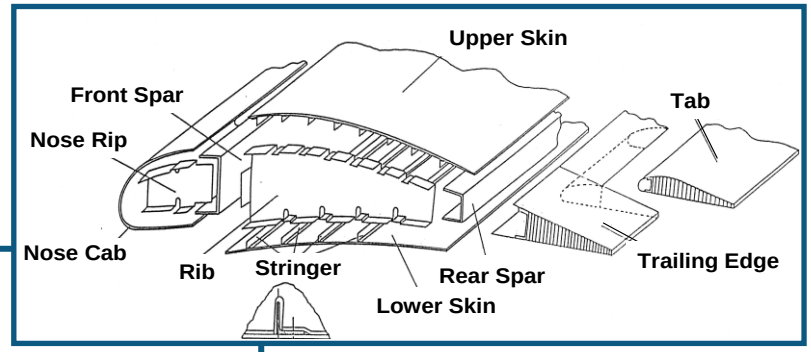
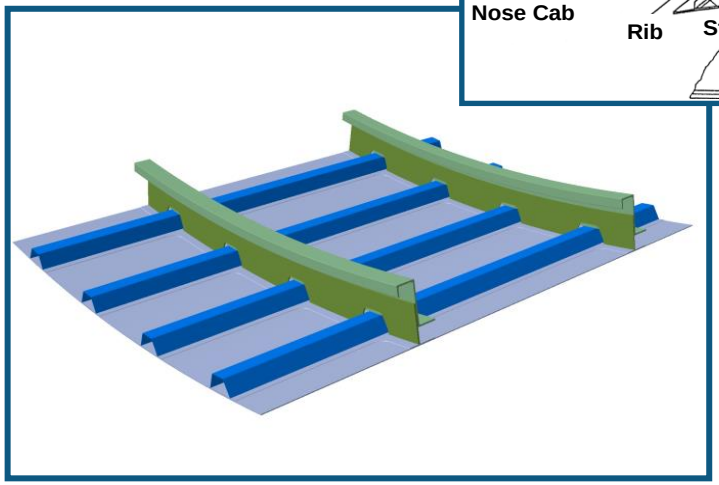
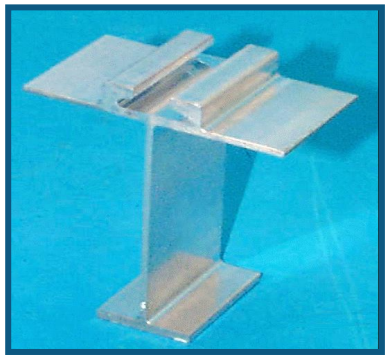
Scalmalloy®: AGI' second-generation Al-Mg-Sc material

Highlight 2006 ➔ Dr. Blanka Lenczowski / Frank Palm

- 4 year research activity results in a new class of high strength alloys with YS about 500 – 600 MPa.
- AlMgSc (*Scalmalloy®*) combines excellent strength and toughness with very high corrosion resistance







- ➢ Longer lasting profile solutions in highly corrosive environments (seat tracks, floor beams etc.)
- ➢ Welded lower shell fuselage panels with 20 – 30% higher load bearing capabilities
- ➢ Integrally designed high lift devices with improved in service behavior by lower manufacturing costs

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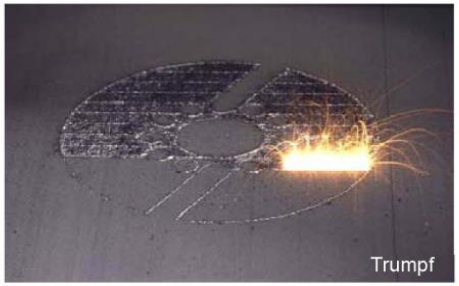
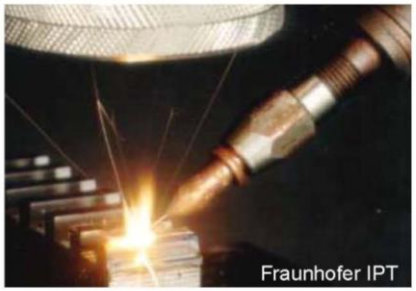
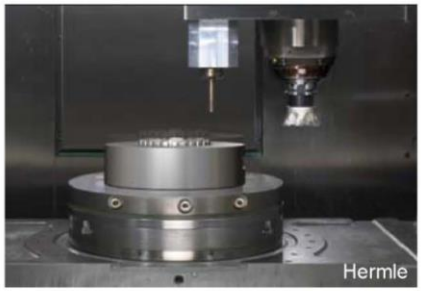
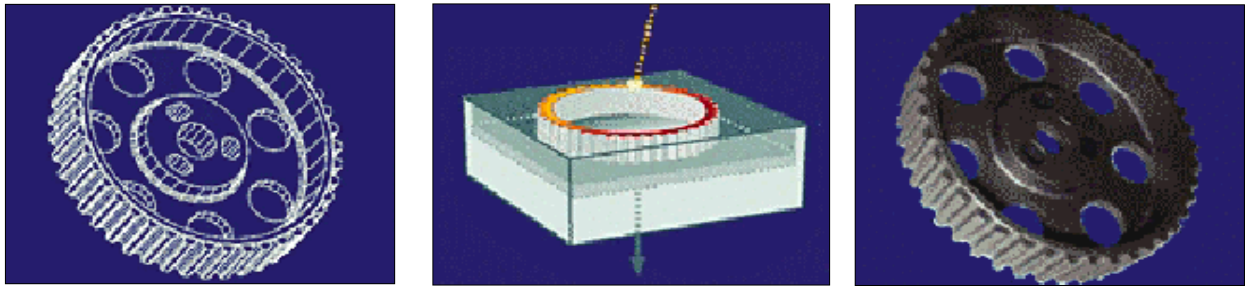
Additive Layer Manufacturing (ALM) versus castings & more

Development of loaded optimized parts by ALM

Rapid Technologie für Metalle (ALM)

Powder bed	Powder feed	Wire feed	Others
			
Laser beam based **Electron beam based**	**Laser beam based**	**Laser beam based** **Electron beam based**	**e. g. Alchemy**
Metals Ceramics Composites	Metals Composites Gradient materials	Metals Composites Gradient materials	Metals Composites Gradient materials

CAD-Model



Final Part

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Al-Mg-Sc Material Technology

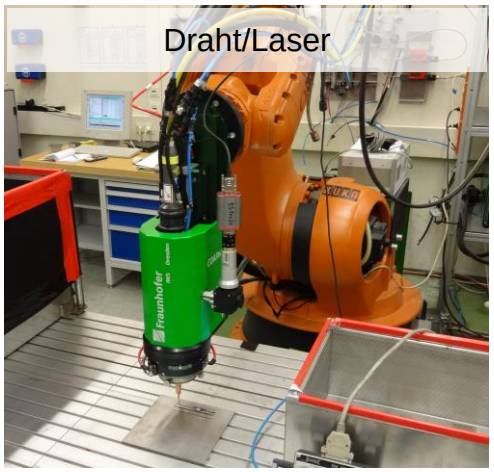
Additive Layer Manufacturing (ALM)

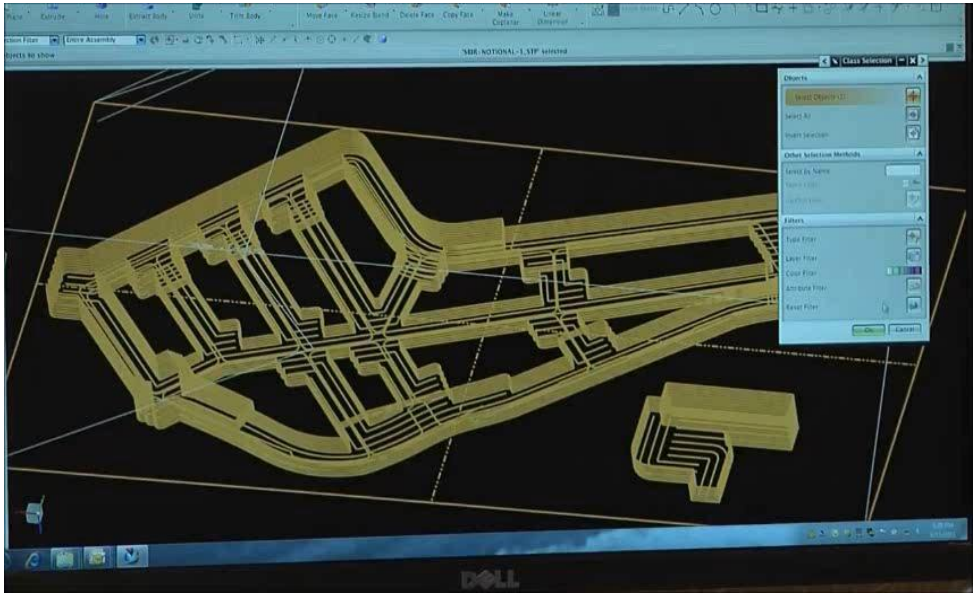
Pulver/Laser

Pulver/Elektronenstrahl

Draht/Plasma

Draht/Laser





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Al-Mg-Sc Material Technology

Technology Directions/Streams

Alloy Patents (IM):

➔ 1x Alloy with medium Mg

2x Alloys with ↑ Mg

➔ ScalmalloySc ® ➔

Strip Casting


US006258318B1

(12) United States Patent
Lenczowski et al.

(10) Patent No.: US 6,258,318 B1
(45) Date of Patent: Jul. 10, 2001

(54) WELDABLE, CORROSION-RESISTANT AIMG ALLOYS, ESPECIALLY FOR MANUFACTURING MEANS OF TRANSPORTATION

(75) Inventors: Blanka Lenczowski, Neubiberg; Rainer Rauh, Jetzendorf; Dietrich Wieser, Bonn; Gerhard Tempus, Bremen, all of (DE)

FOREIGN PATENT DOCUMENTS

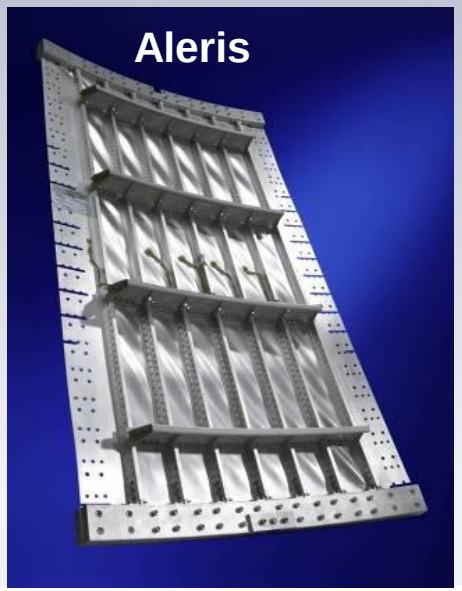
0918095 10/1993 (EP) .
0563903 5/1999 (EP) .
2717827 9/1995 (FR) .
63-179040 7/1988 (JP) .

OTHER PUBLICATIONS

Patent Abstracts of Japan of JP 63–179040 Dated: Jul. 23, 1998.

Forming Patent:

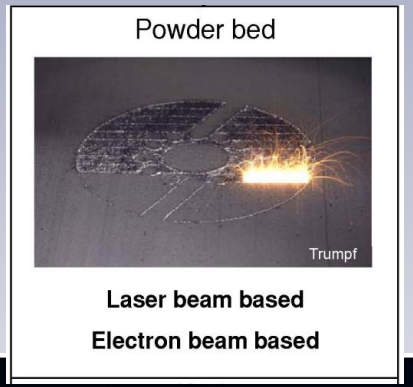
➔ 1x Creep forming of Al-structures



Alloy Process Know-How (PM)

➔ Scalmalloy ® ➔ extrusion

➔ *Scalmalloy RP for ALM*



New materials for extended product life & to enhance competitiveness

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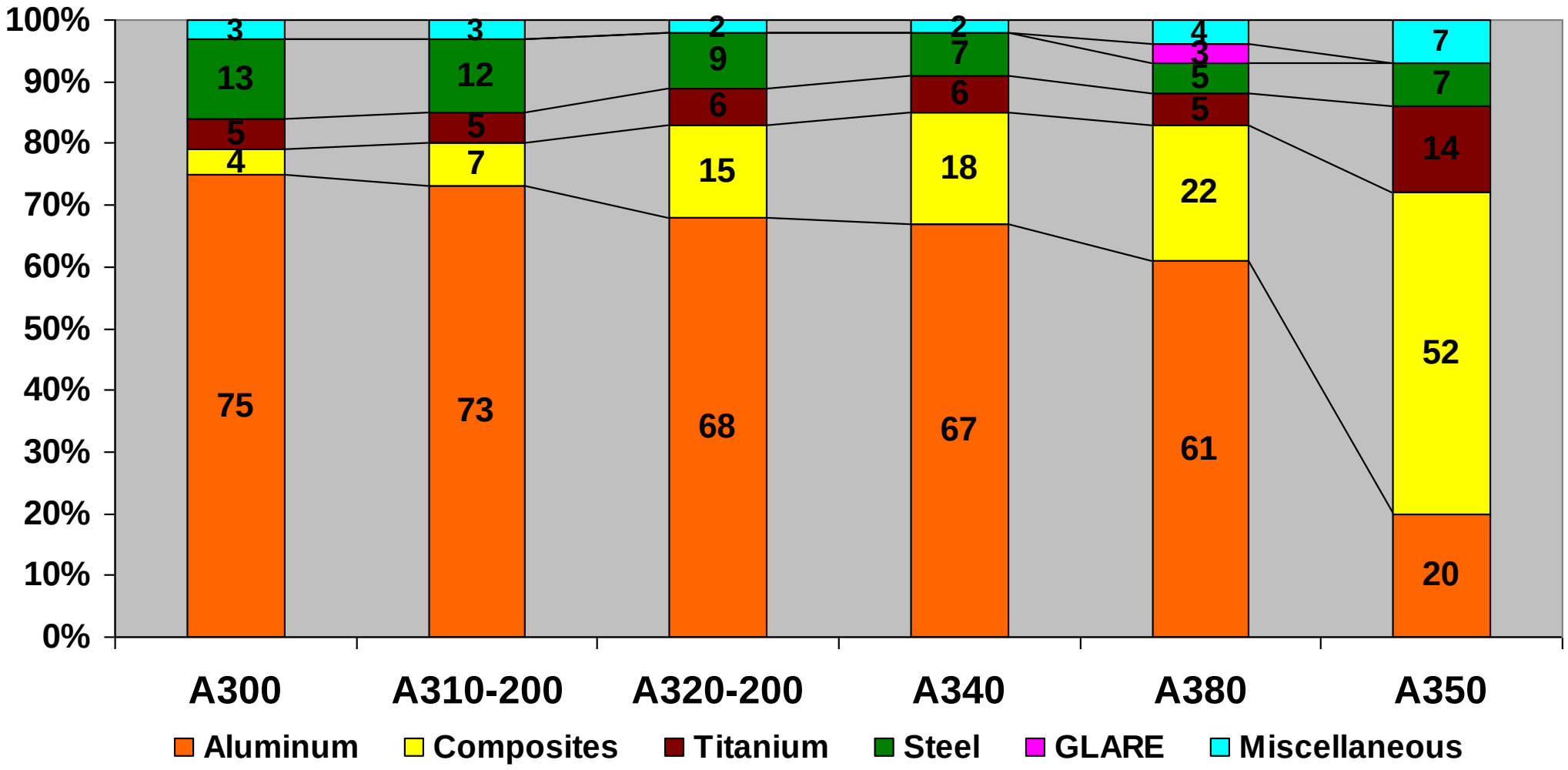
Material Distribution in the Airbus family



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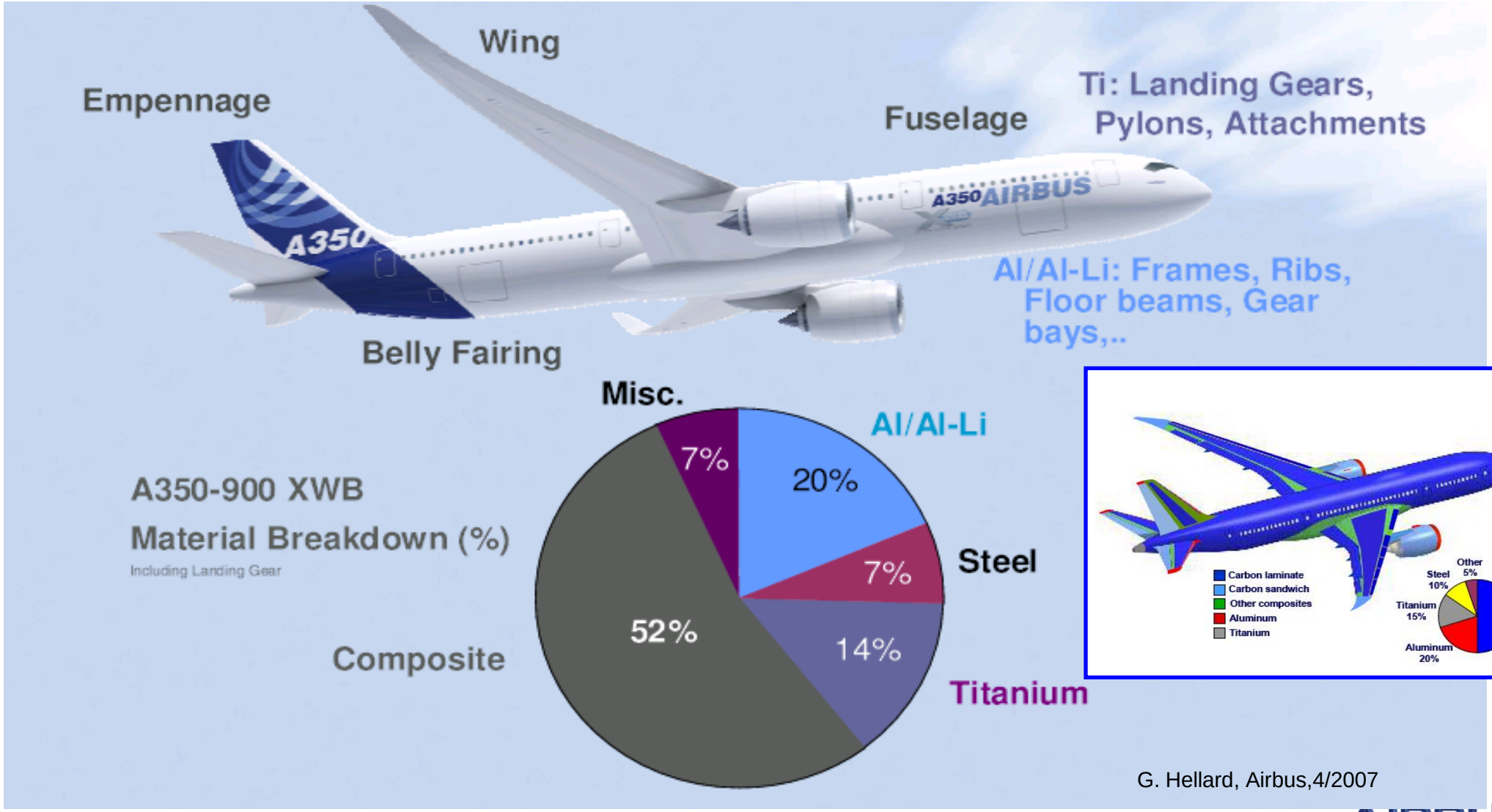
A350 XWB: Material Breakdown

A350 XWB puts the right material in the right place!



G. Hellard, Airbus,4/2007

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Thanks for your attention!

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