“Aerospace: Sustainability and Lightweight Materials Technology”

ALUMINIUM Business Summit 2021
Shaping a new Industrial Era

28 - 29 September 2021: Düsseldorf /Germany

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AIRBUS

Airbus is an **international pioneer** in the aerospace industry

We are a leader in designing, manufacturing, and delivering aerospace products, services and solutions to customers on a global scale.

Ambition to be the first to offer a zero-emission commercial aircraft by 2035

ZEROe concept aircraft powered by hydrogen

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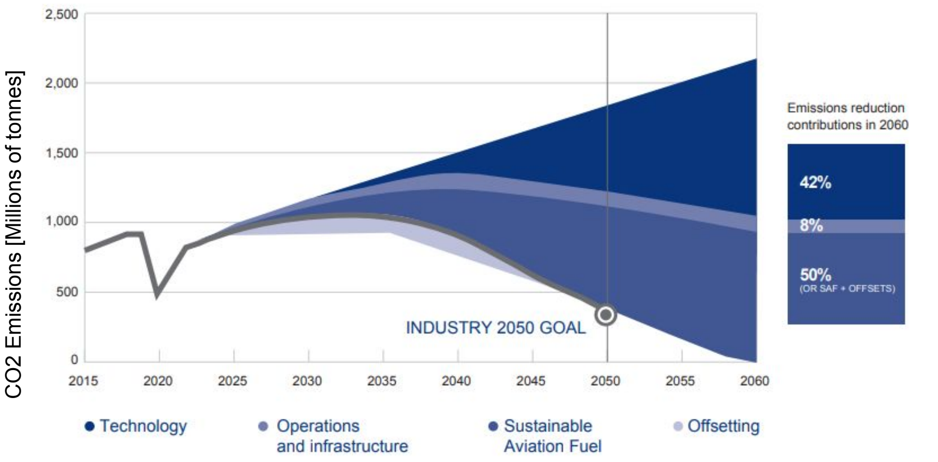
Sustainability

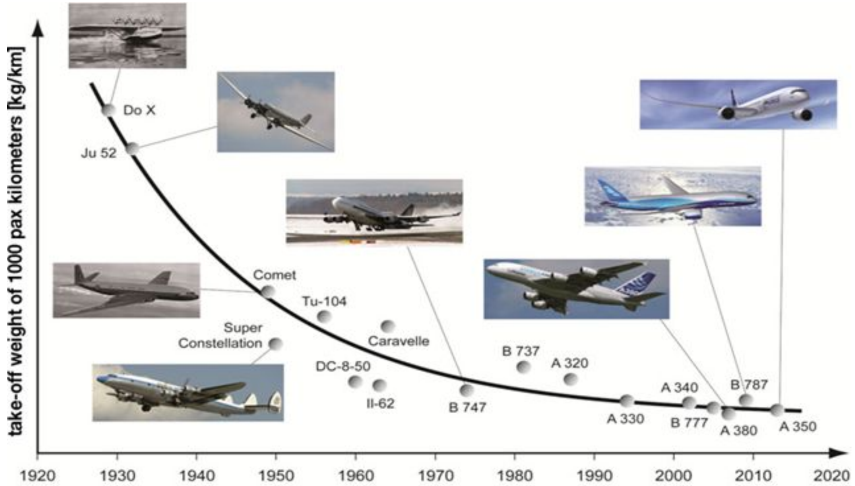
GLOBAL SUSTAINABLE AVIATION FORUM
September 2020

The Global Sustainable Aviation Forum is made possible with the support of

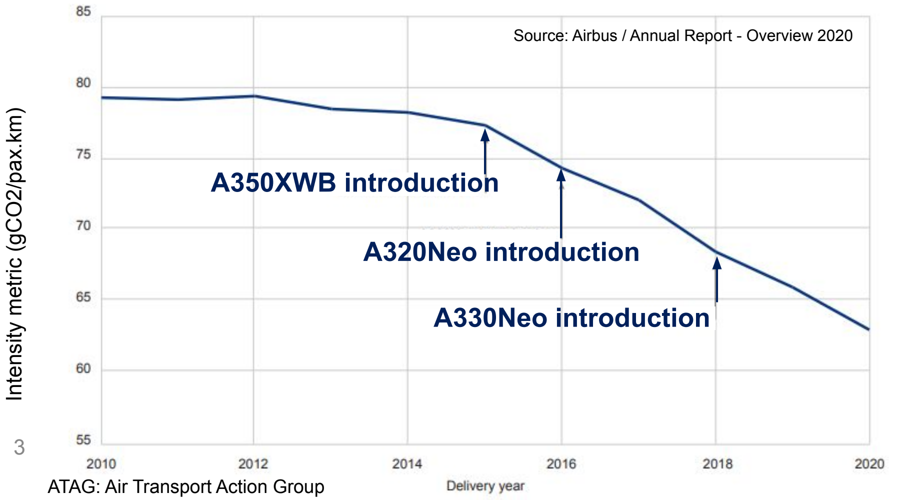
ATAG WAYpoint 2050



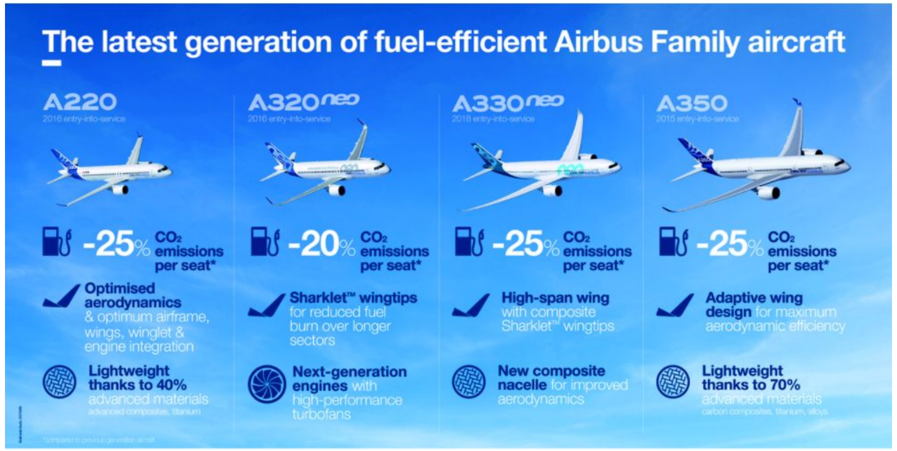
Technology & Take off Weight



Airbus reducing Emission



Design & fuel-efficient aircraft



Aviation

65.5 million jobs worldwide

3.6% on the global **GDP**

4 billion **passengers** were transported in 2018

Airbus / Annual Report - Overview 2020

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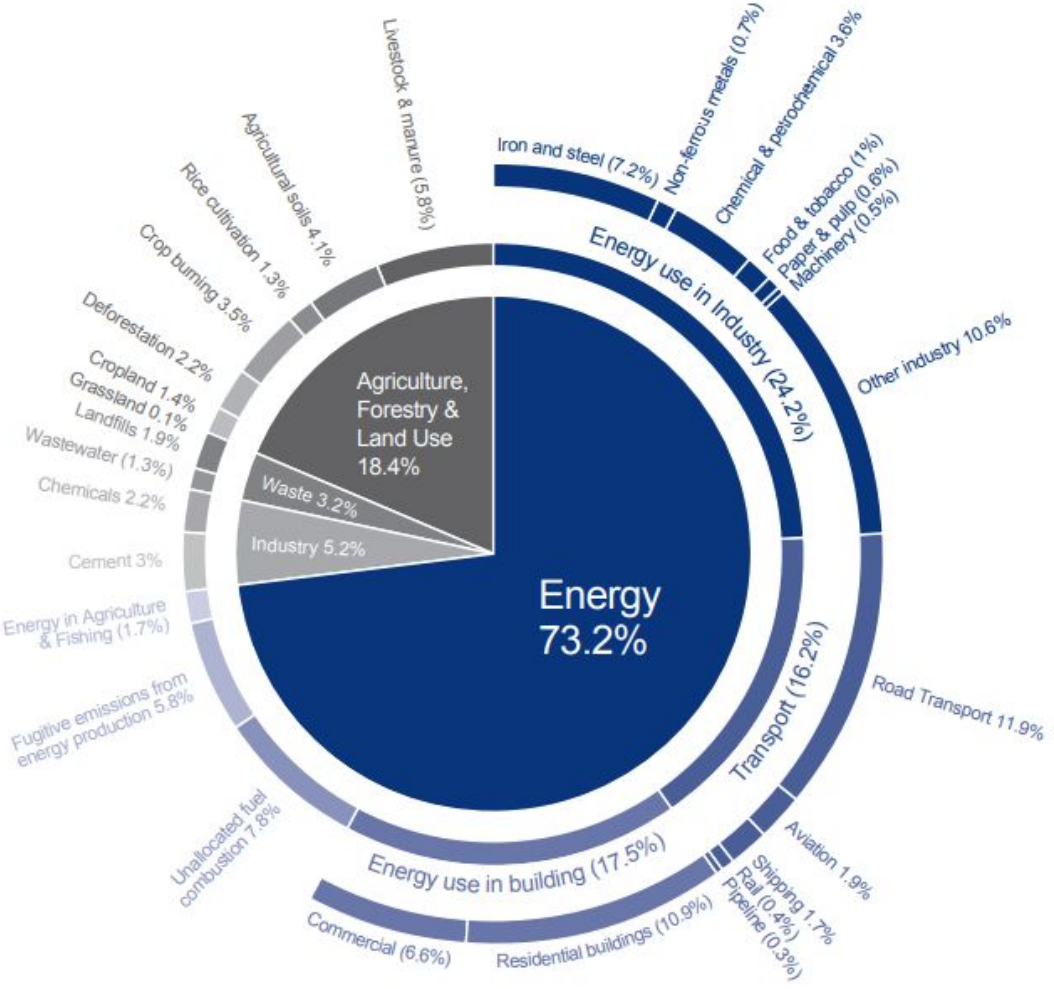
ATAG: Air Transport Action Group
GDP: Gross Domestic Product

Sustainability

Global greenhouse gas emission by sectors



Source: Airbus / Annual Report: Our World in Data with data from Climate Watch, the World Resources Institutes (2020)

Footprint reduction

"...Turning to industrial operations, the **High5+ initiative** aims to **reduce the footprint of all Airbus activities globally and across the supply chain.** It has specific targets for 2030, against a 2015 base line, **for cutting energy consumption, CO2 emissions, water consumption, volatile organic compound emissions and waste production."**

Source: Airbus / Annual Report 2020

High5+

"Sustainability is now deeply ingrained in the Company's purpose and is truly becoming part of its DNA."

Airbus / Annual Report - Overview 2020

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Next Generation & Sustainable M&P

Environmental responsibility across the entire lifecycle

Key ambitions

DECARBONISATION

ENVIRONMENTAL FOOTPRINT

CIRCULAR MODEL
ECO DESIGN
DIGITALISATION

NEW BUSINESSES

Product responsibility

The right balance between social, economical and environmental commitments.

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Airbus climate action plan

Improving fuel burn of our existing fleet

Investing in zero-emission technologies

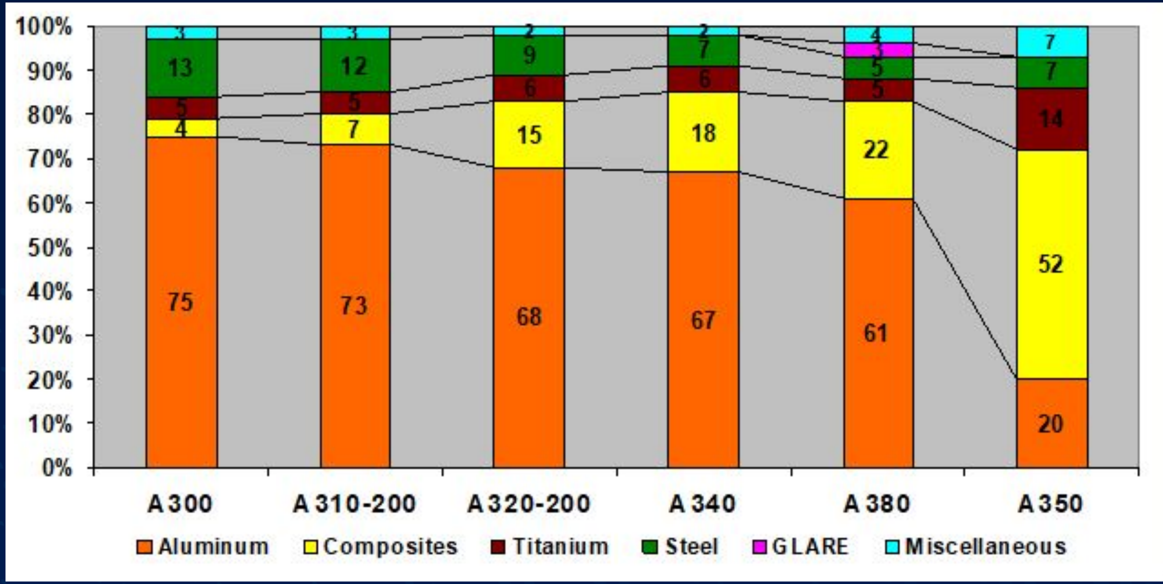
Developing sustainable alternative fuels (SAF)

Optimised day-to-day aircraft operations

Monitoring climate change

Material technologies at Airbus

Decrease of Aluminum Usage



Note: Engine, Landing Gear not included

A300/A310
- SPF Ti
- Chemical milling
- Interference bolting
- 7475 Al-alloy sheet/plate

A320
- High strength Al-castings
- 7150 Al-alloy plate (wing)
- Automated Lok bolting
- Split sleeve cold working

A330/A340
- Age forming
- High Speed Machining
- 2X24 Al-alloys
- LVER* riveting
- SPF Al

A340-600/-500
- Premium Al-castings
- 7349 Al-alloy extrusions
- Split mandrel cold working

A318
- Laser beam welding LBW
- 6013/6056 Al-alloys
- New bonding technology

A380
- Fiber Metal Laminates
- EB and extended *LBW*
- *Al-Li alloys*, Ti-alloys
- Al-alloys: 2024HDT, 7055HF
- Large die forging (7085)
- New coatings
- Larger panels

A320neo

A350
- Al-Li alloys for ribs
- CrVI free surface
- Topology optimisation

Sustainable A/C
Digital E2E supply chain

AlMgSc & Al-X-Li

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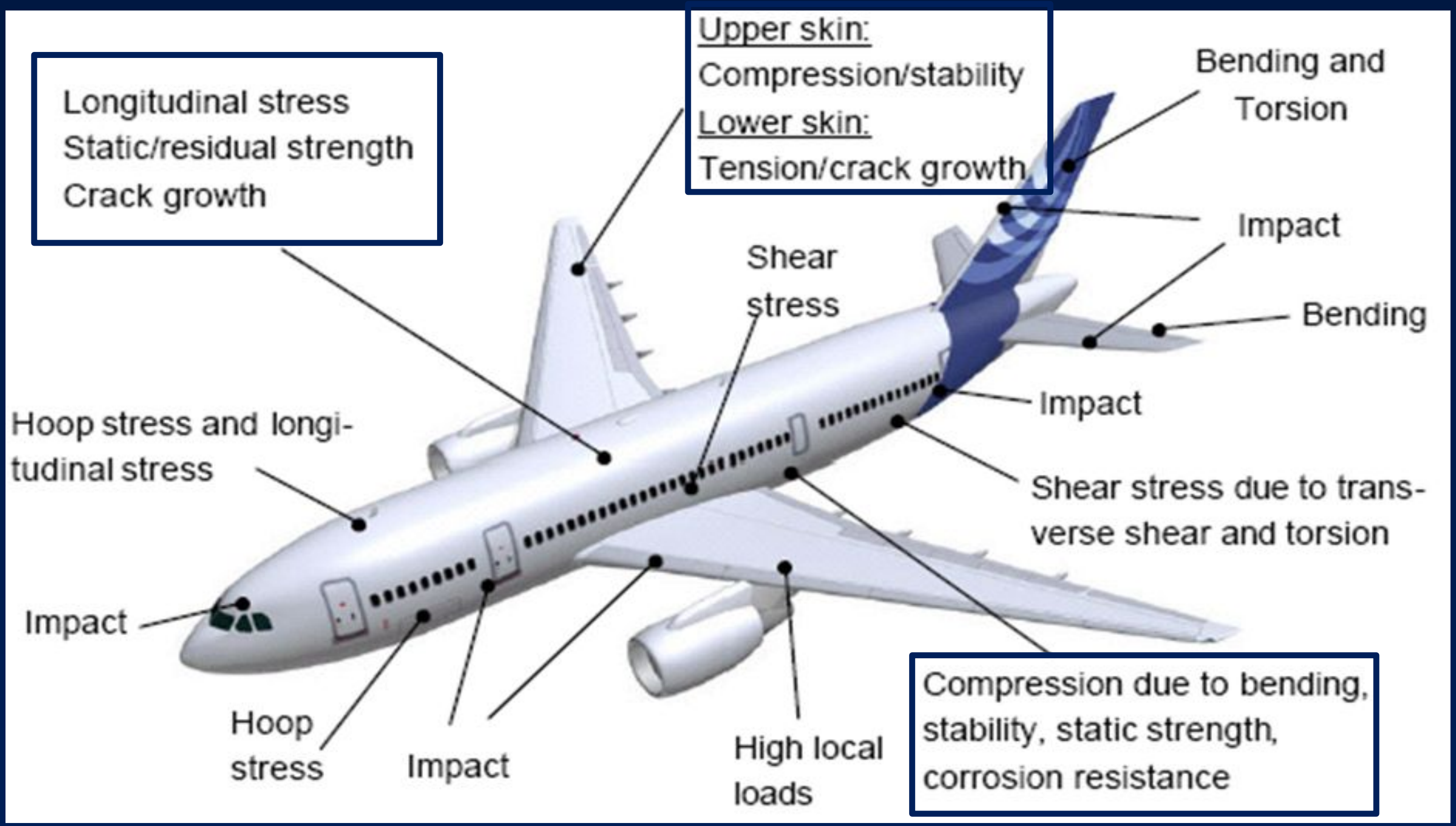
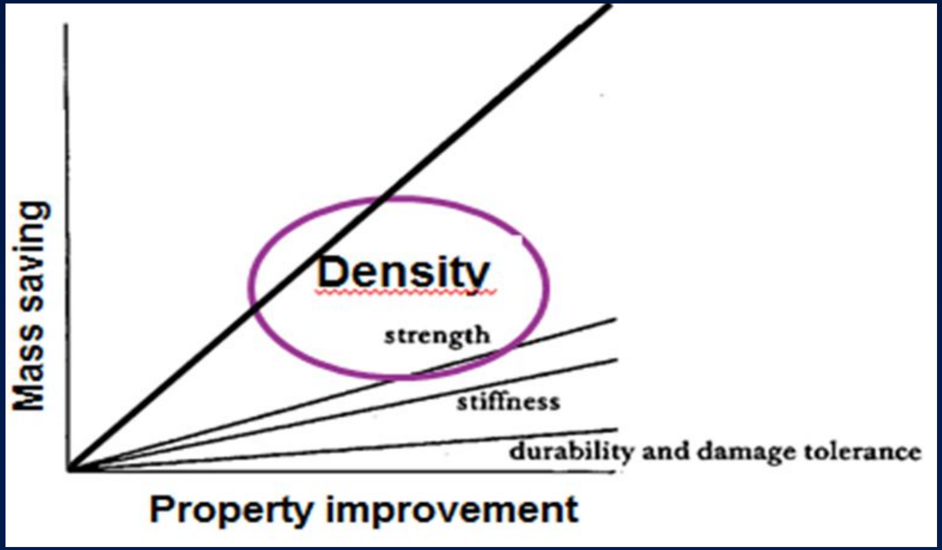
Material technologies at Airbus

Aircraft Fuselage Design – General Requirements



Weight savings & material properties



Alloy	Δρ [%]	ΔYoung's Modulus [%]
AlCuMg	-	-
AlMgSiCu	-2,5	+ 1,5
AlCuLi	-5	+11,1
AlMgSc	-4,7	+ 5,8
AlMgLi	-9,4	+11,6

⇒ Ca. 80% of SA typical fuselage is designed by fatigue, DT & reparability

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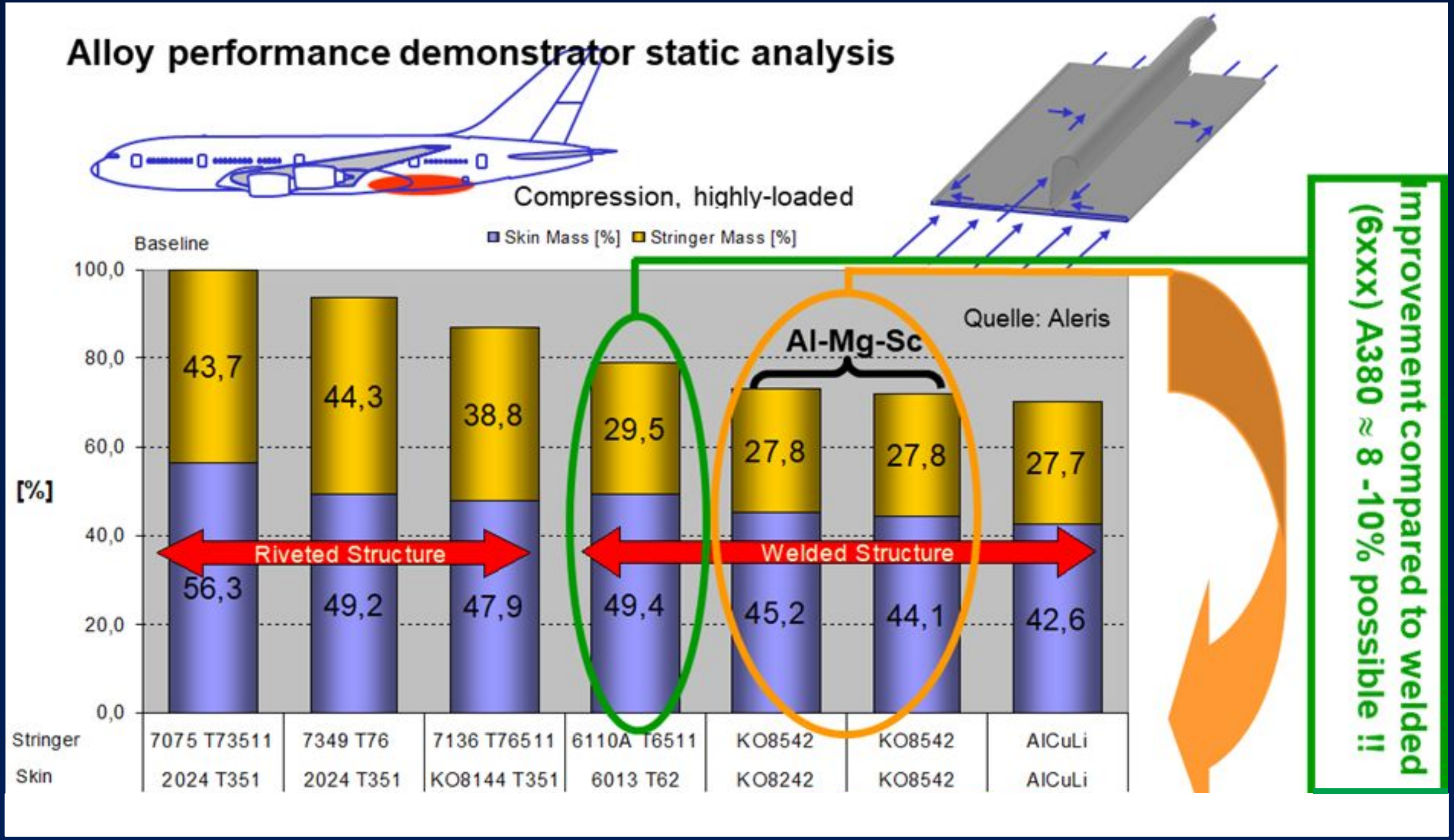
Material technologies at Airbus

New advanced technologies & materials Al-Mg-Sc & Al-X-Li



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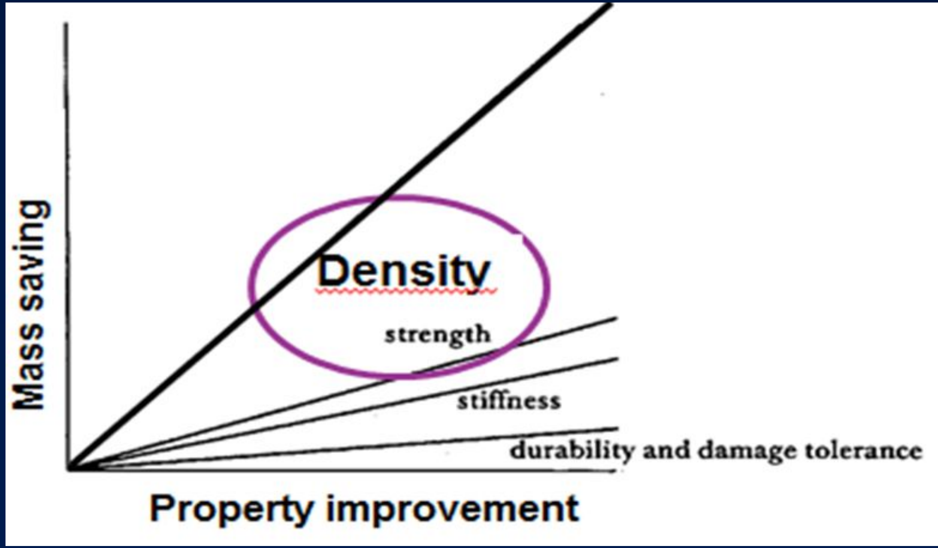

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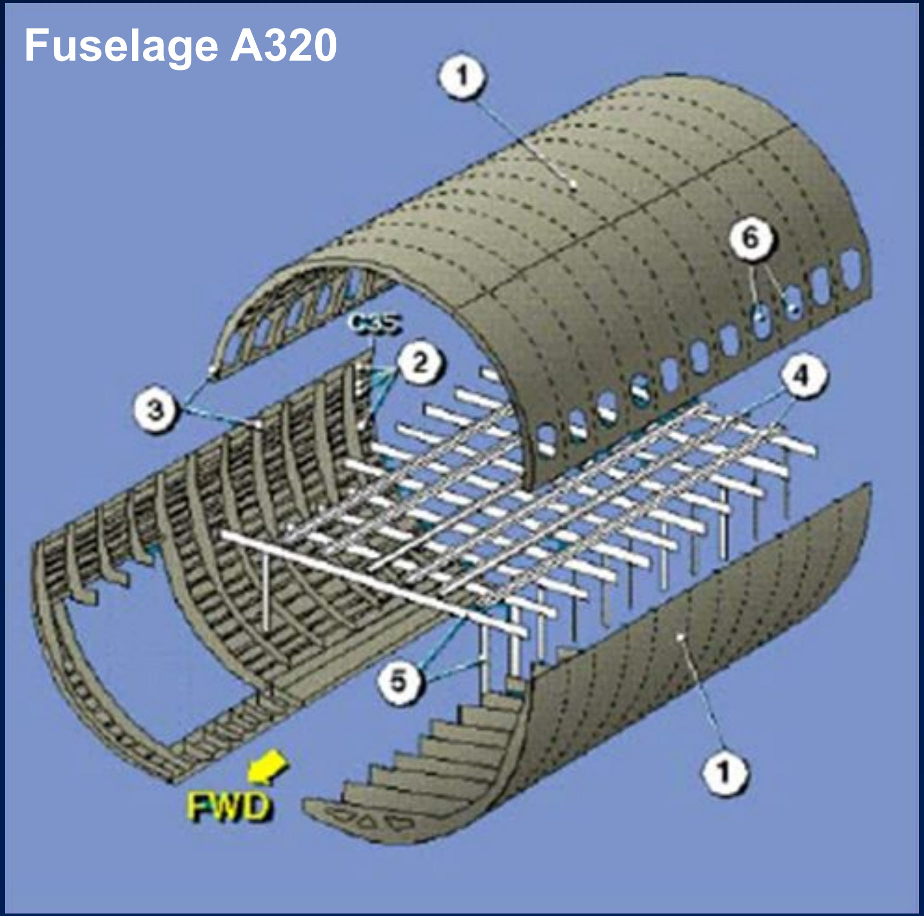
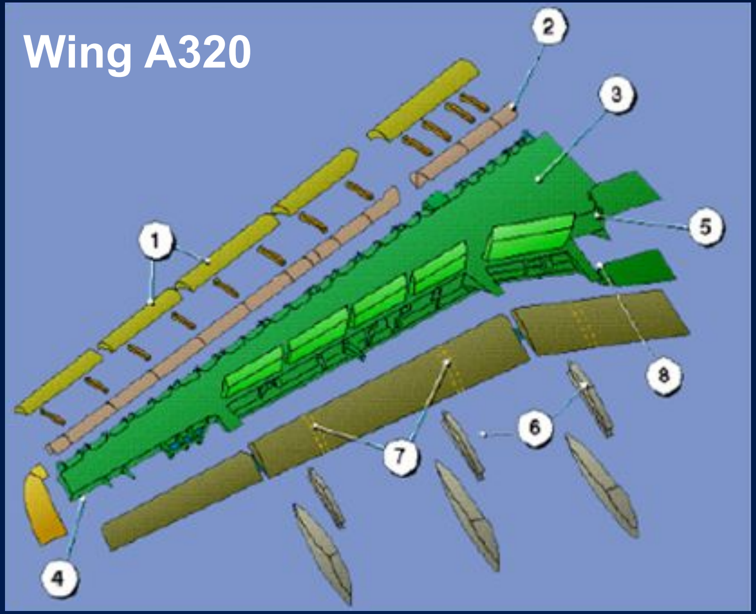
Material technologies at Airbus



1 **SKIN:** 2024 CLAD SHEET
2 **STRINGERS:**
2024 CLAD STRIP
2024 EXTRUSIONS
7075 EXTRUSIONS
3 **FRAMES**:
2024 CLAD SHEET
2024 PLATES (mach.)
7010/7050 PLATES (mach.)
7075 PLATES (mach.)
4 **SEAT TRACKS:**
7175 EXTRUSIONS
5 **FLOOR BEAMS & STRUTS:**
7175 EXTRUSIONS
6 **PAX WINDOW FRAMES:**
7175 PRECISION FORGING



1 **SLATS-SKINS & RIBS:**
2618 SHEET
2 **D-NOSE SKINS:**
2024 SHEET
3 **TOP PANEL:**
7150 PLATES & EXTRUSIONS
4 **BOTTOM PANEL:**
2024 PLATES & EXTRUSIONS
5 **SPARS & RIBS:**
7010/7050 PLATES
6 **FLAP SUPPORT:**
7175 FORGINGS
7 **FLAP TRACKS:**
A357 CASTINGS
7075 PLATES
8 **MAIN LANDING GEAR SUPPORT:**
2014 FORGINGS
7010/7050 FORGINGS

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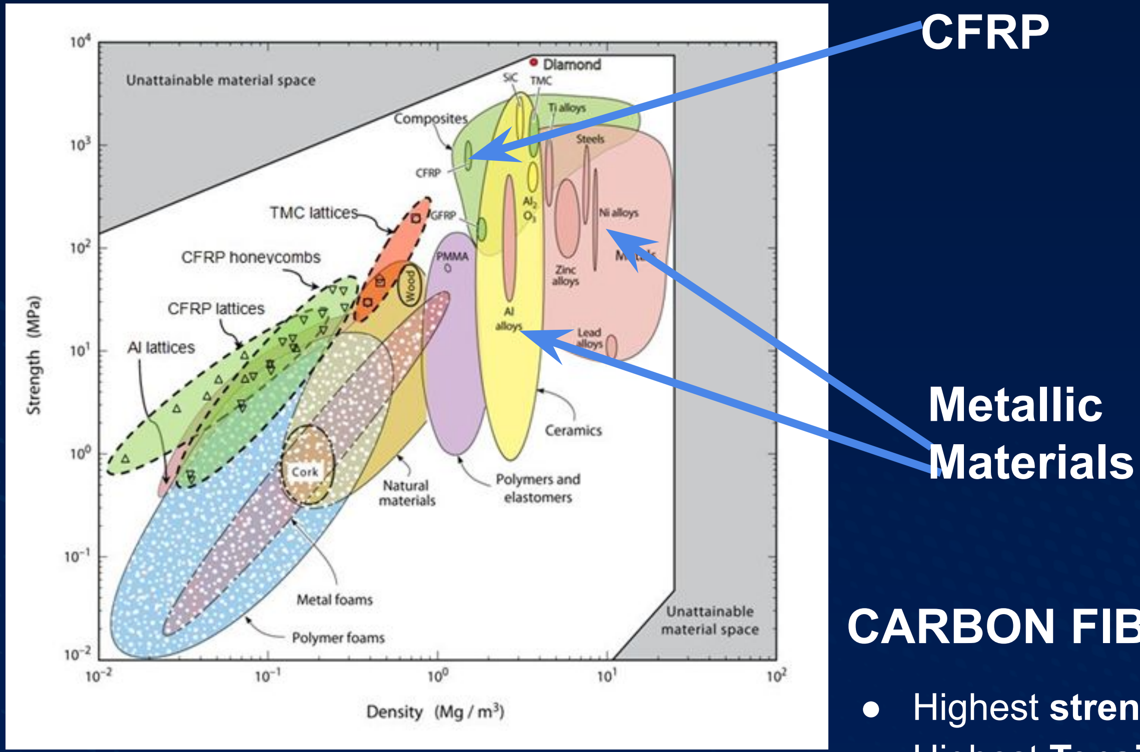
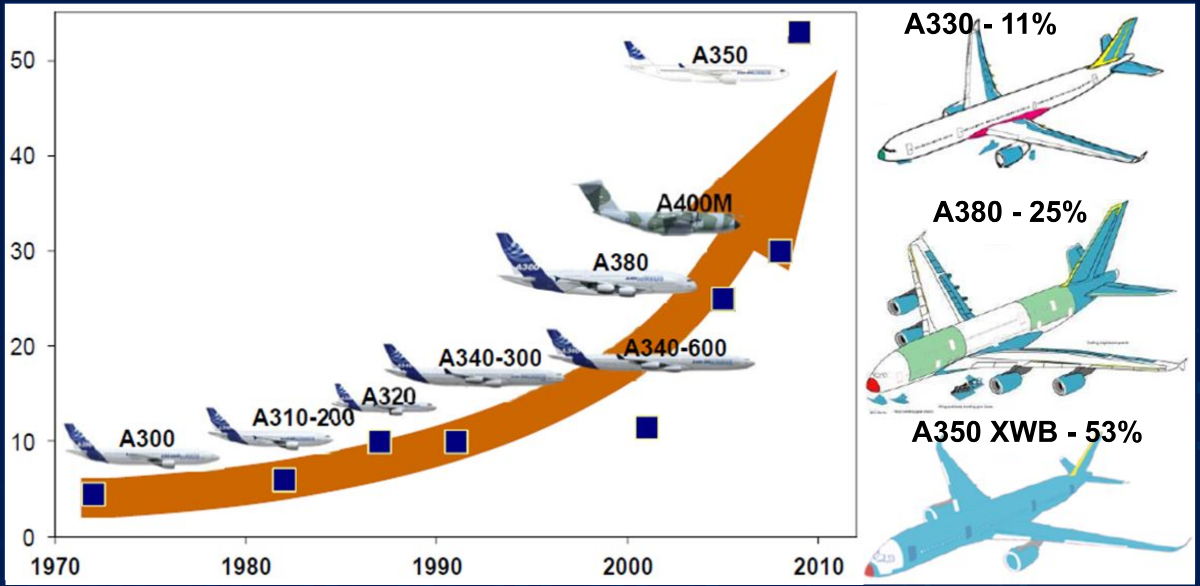
Material technologies at Airbus

Why Composite Materials?



Increase of Composite Usage



CARBON FIBRE COMPOSITE:

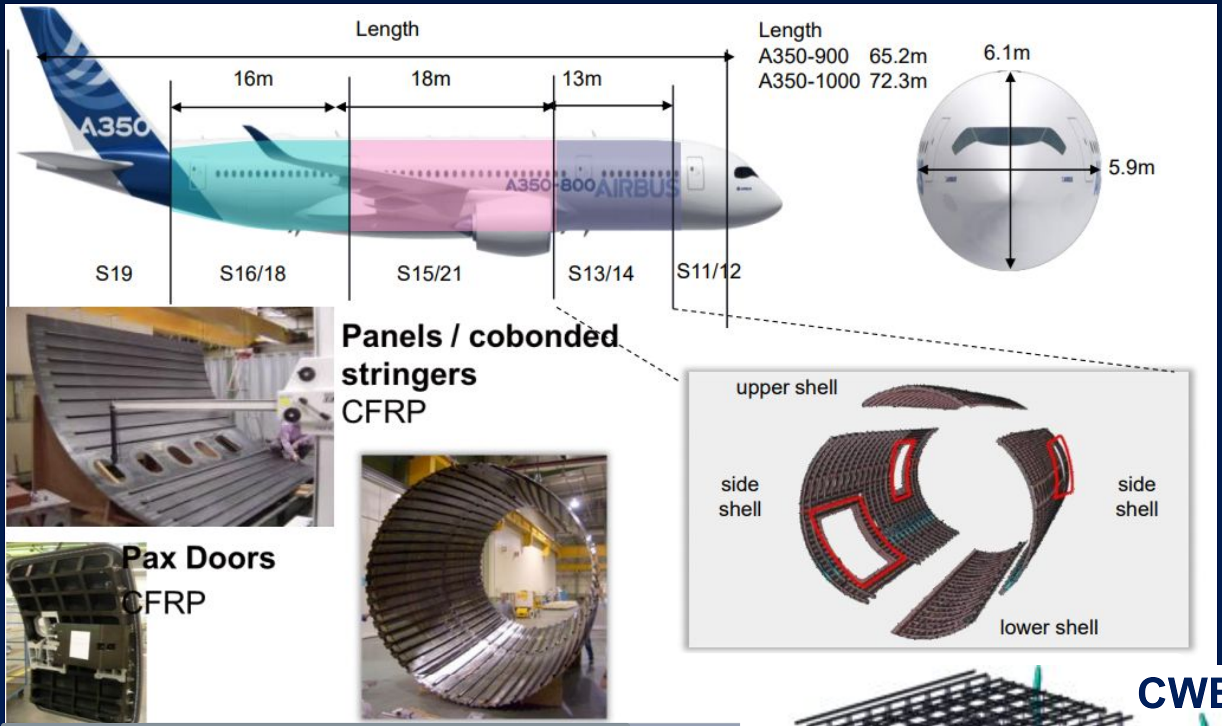
- Highest **strength-to-weight ratio**
- Highest **Tensile Strength**
- **Dimensional Stability**
- **Very good fatigue behaviour**
- Specific design possibilities, adjusting fibers direction of some layers to the applied loads

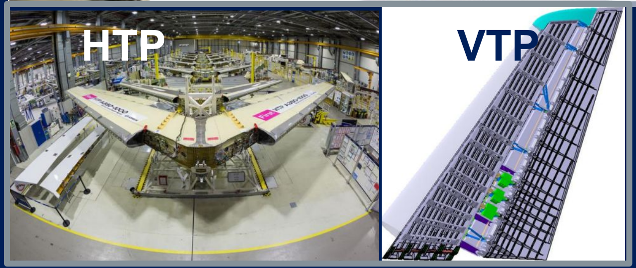
METALS & METALLIC ALLOYS:

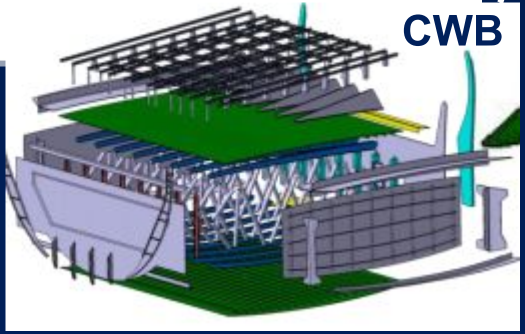
- **Static behaviour**
- **Good impact resistance**
- **Reparability**
- **Recyclability**

Material technologies at Airbus

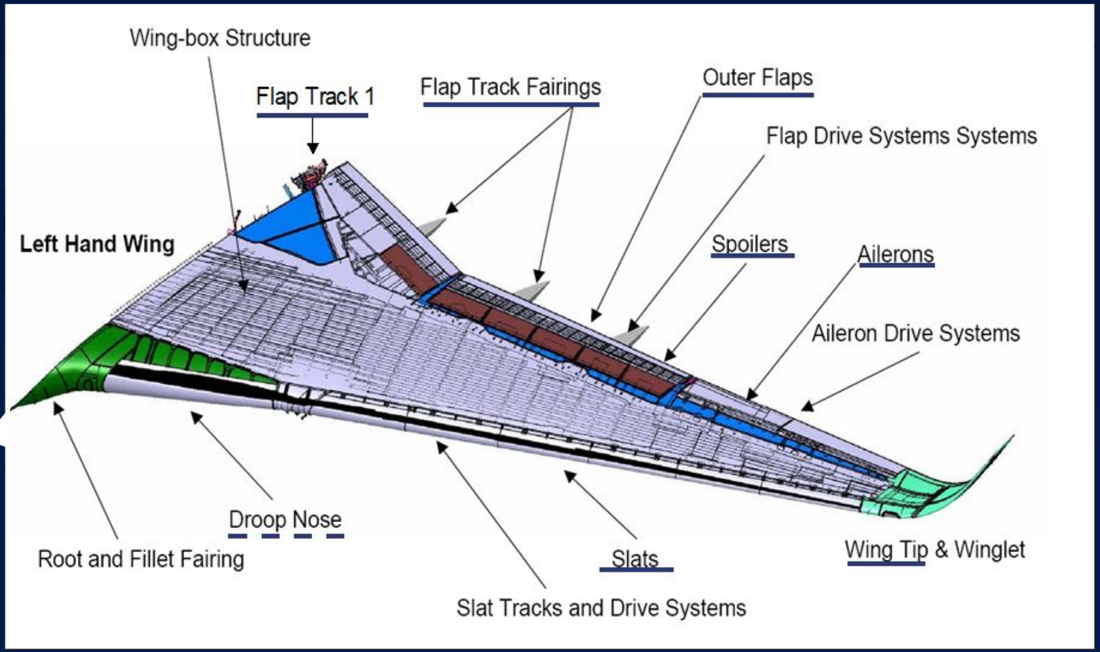
Fuselage A350XWB

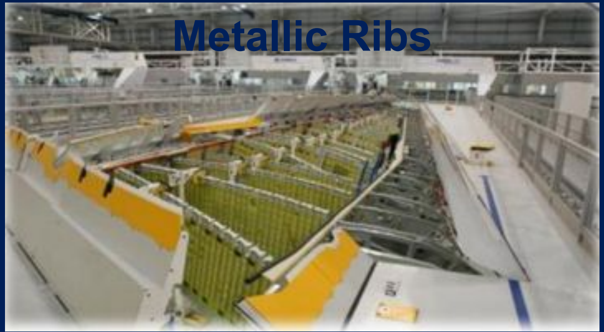


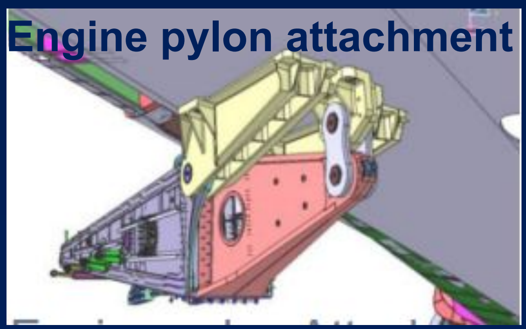




Wing A350XWB







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Example for Circularity in Metal Manufacturing

Use of recycled content

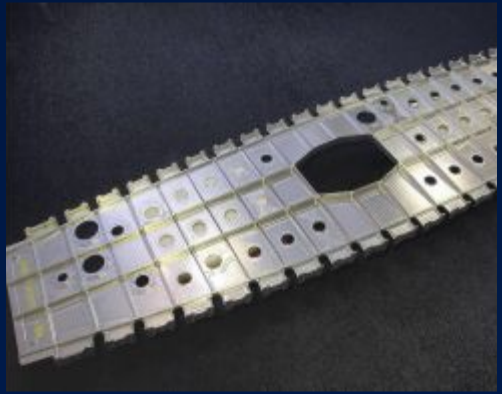
Material specifications allow the **use of recycled content** for the production of virgin material.

Dependent on the supplier and concrete metal materials **up to 70% of recycled content** is used in some aluminium or titanium alloys. This **reduces** the **extraction of materials** and **lowers the energy** footprint.

Chip recycling

Chips are collected, different materials separated from each other and sorted with respect to contamination to aim **for high value recycling**.

100% of metal chips are recycled.



Buy-to-fly reduction

Although metal chips can be recycled at high value, metal manufacturing aims to **optimize material consumption**.

The buy-to-fly ratio for some machined parts could be **reduced by a factor of 7** by innovative nesting process imposed on the supply chain.

Additive Manufacturing

3D printing is already part of our manufacturing process, and our fleet is equipped with metal and plastic parts produced by this innovative technique.

Additive manufacturing requires **30% to 55% less weight**, 90% less raw material and up to **90% less energy and water**.

Source: Christian Rückert /Airbus: AEROMAT 2021 R&T
Image sources: (1) SimoneN/Shutterstock.com; (2) Elena NICHIzhenova/Stock Photo/ID92558280

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Example for Circularity in Composite Manufacturing

Thermoset reuse

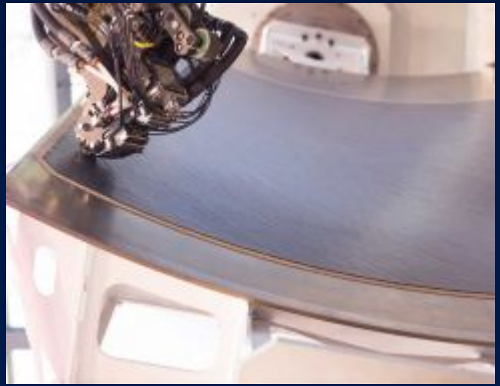
Uncured composite thermoset material at manufacturing level like cutting areas or end of spools are collected and reprocessed to be **reused** in our products.

The end of spools uncured thermoset material from the **A350 wing skins is reintroduced as gusset filler**. More than 6 tonnes of materials saved.

Thermoplastic reuse

Thermoplastic material has the great potential of **recovering fiber and resin** for reuse.

Thermoplastic foam production **cut-offs** from door- & doorframes-linings are sorted and reprocessed. Currently 4th generation qualified for initial application.



Buy-to-fly reduction

Composite manufacturing aims for **maximum efficiency in composite material consumption**. A low buy-to-fly ratio is supported by material format, nesting optimization and innovative material layup technologies.

For the A350 wing cover the **waste** could be **reduced by 30%** by introducing automated fiber placement (AFP) instead of automated tape layer (ATL).

Bio-based content

Introduction of bio-based content in composite materials is key to **move away from reliance on petrochemical industry.**

We are working in frame of **research and technology** on the production of carbon fibers from biomass captured CO2 and bio-based resins.

Source: Christian Rückert /Airbus: AEROMAT 2021 R&T
Image sources: (2) Solvay; (4) TU Munich

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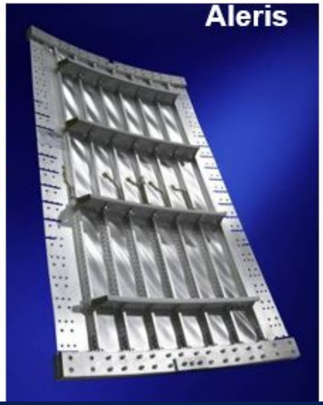
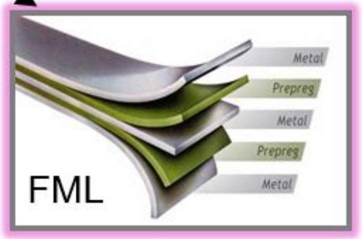
Al-X-Sc- Scalmalloys® for ALM⇒ "game-changer"

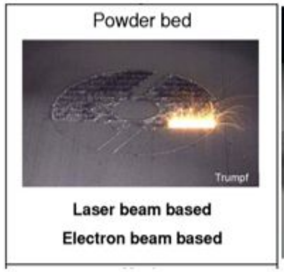
Alloy Patents (IM):
➔ 1x Alloy with medium Mg
2x Alloys with ↑ Mg
➔ ScalmalloySc ® ➔
Strip Casting

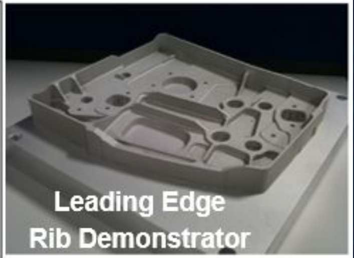
Forming Patent:
➔ 1x Creep forming
of Al-structures

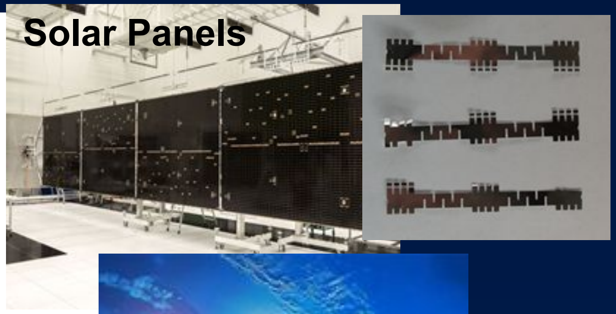




Alloy Process Know-How (PM)
➔ Scalmalloy ® ➔ extrusion
➔ *Scalmalloy RP for ALM*







- Low density
- Corrosion resistance
- Weldability
- "Creep formability"
- Thermo-stability
- Xenon ion erosion resistivity

Scalmalloy® ScalmalloySC® ScalmalloyRP®

Calciscal® Scancromal® Scantital®

12 Mg 24.31u	20 Ca 40.08u	24 Cr 52.00u	22 Ti 47.87u

1990 — Airbus Rumpf Neuer Technologie / A380

1996 — Welded A/C structure: sheet, extrusion; in. casting — Sheets 5024 / 5028 Qualification for A/C structures

2003 — PM-high strength weldable profiles

2010 — Strip casting (twin roll); "Care free A/C structures"

2012 — FML Foils for "Clad free A/C structures"

2013 — 3D-powder bed fusion FOUNDATION APWORKS

2016 — Solar cell interconnectors Xenon resistant & weldable

2021 beyond — ALM opportunities

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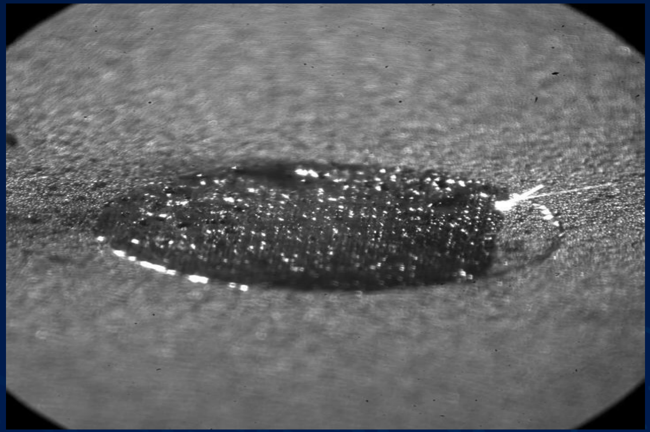
Al-X-Sc- Scalmalloys® for ALM⇒ “game-changer”

Scalmalloy®



Scancromal®

Scalmalloy® ScalmalloySC® ScalmalloyRP®

Calciscal® **Scancromal®** Scantital®

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ALM opportunities

2021 beyond

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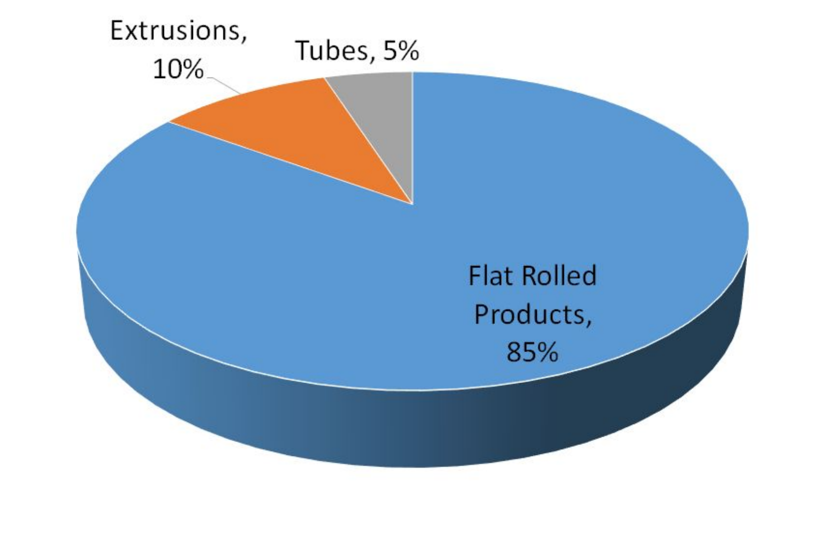
Aluminium in Airbus

KEY FIGURES

- Airbus Aluminium annual consumption: ~100kT/ Year)
- **6 Sub - products:** Plates, Sheets, Wing skins, Extrusions, Tubes and Bars.
- **Global Supply Chain**: >10 suppliers distributed in Europe, US and China

ALUMINIUM CONSUMPTION SPLIT PER PRODUCT*



* In volume
* Based on ConBid 2020 demand

ALUMINIUM GLOBAL FLOWS

- **<u>Global supply chain</u>** supporting **Local-for-local** (L4L) consumption: ~75% of demand locally optimized
- **Unbalanced** Production Vs Demand in **North America**
- **Increasing production** in **China** driven by **strategic** initiatives by Airbus

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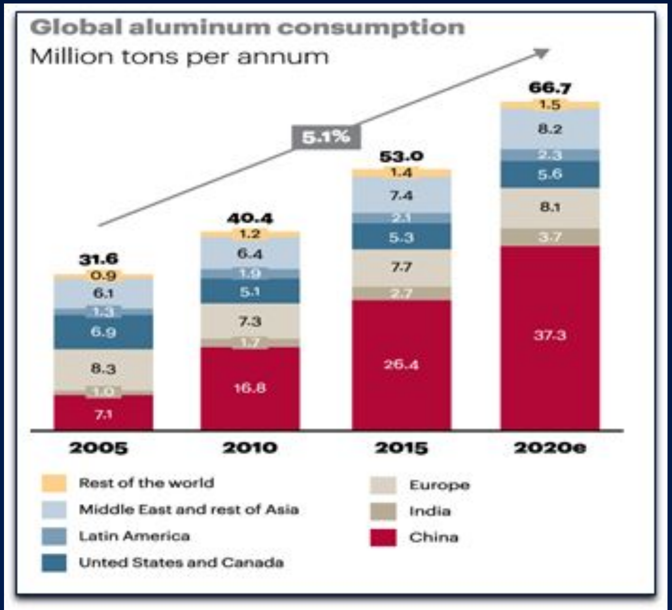
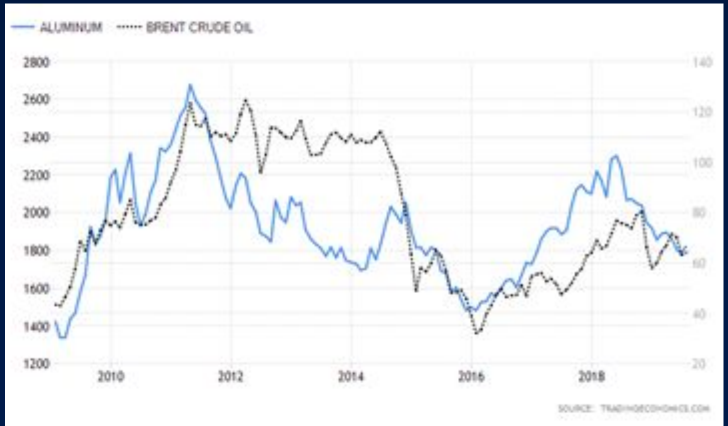
Aluminium Market Trend and Geopolitical Context



MARKET TREND & KEY FIGURES

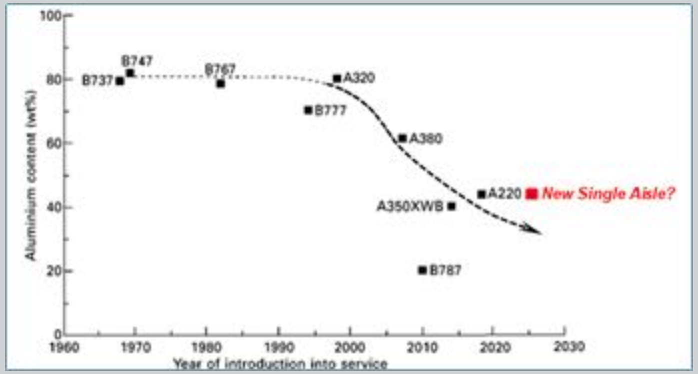
- **Global aluminium demand** is significantly **growing** *(+5.1%/year over the last 15 years)* driven by **China** and the **automotive** industry
- **Instability** of Raw Aluminium prices (e.g. LME) driven by **speculation** and Geopolitical context
- **Airbus** only represents **0.15% of the Global Demand**

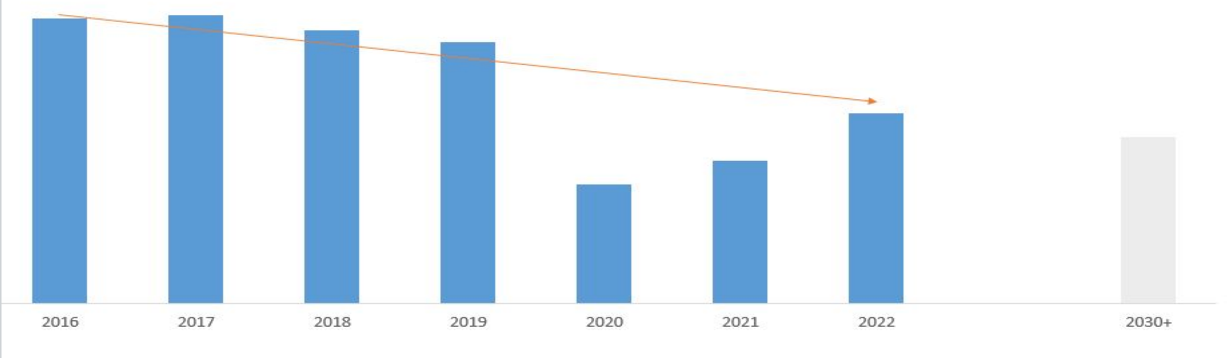


GEOPOLITICAL CONTEXT

- Global **Trade War** initiated by US administration *(+10% Aluminium imports to US)* followed by EU *(+25% on Al Sheets and Extrusions),* China and Canada led to 12 M$ over cost to Airbus in 2019
- **Brexit** will have a significant impact on both and Production

AIRBUS ALUMINIUM CONSUMPTION EVOLUTION





- **Demand decrease** expected mid and long term driven by B2F optimisation & increased use CFRP in detriment of Aluminium

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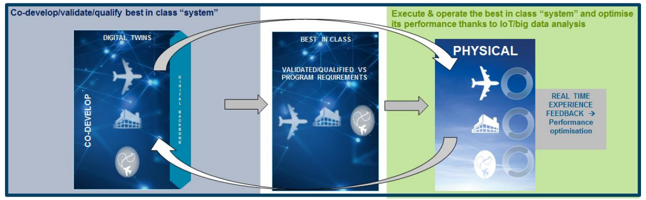
Digital Design, Manufacturing & Services

Virtual CO-Developments/Twins



Key ambitions

INCREASING CUSTOMER DEMANDS

EVOLVING SOCIETAL EXPECTATIONS

NEED FOR BREAKTHROUGH

DDMS

Step change in our operational efficiency **__across the whole lifecycle__** of our programs and products drivers to enable breakthrough.

5 pillars:

- Transformation & competences
- Modelling & simulation
- Co-development & Integration
- Digital Continuity & Tool Chain
- Product lines

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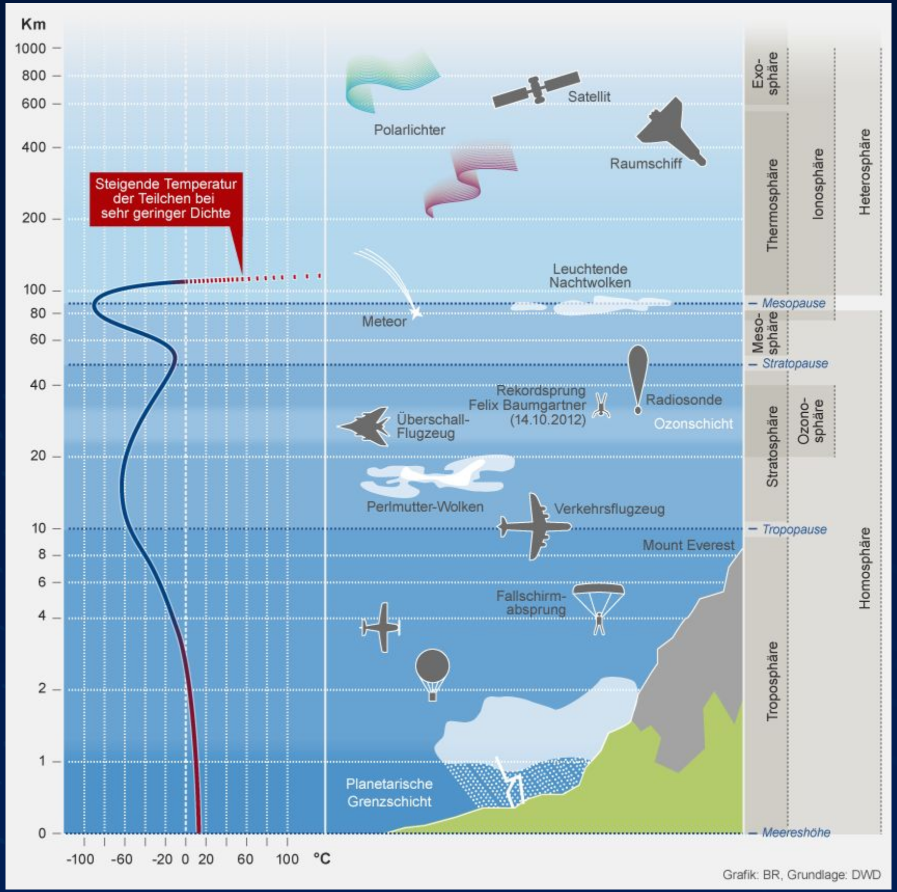
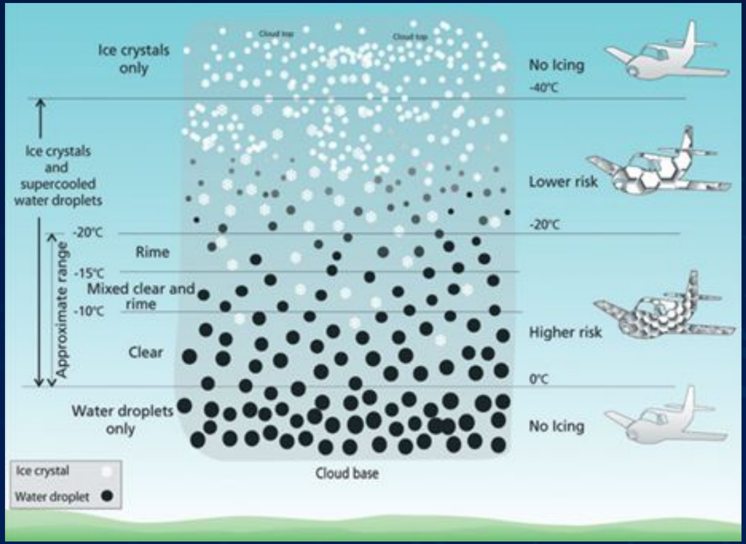
Materials Ecosystem & Sustainable drivers for M&P



In high altitude:

- Radiation (x-rays, ultraviolet,...) &
- Charged particles (galactic cosmic rays, auroral particles, solar protons)



Environment & sustainable drivers for M&P:

- Regulations
- Re-use & recycling
- Critical & Ethical materials
- B2F
- Bio-sourced materials
- LCA
- Eco-efficient ind. processes
- New sustainable technologies
- Sustainable enterprises

2020 → Materials contributing to cost reduction and performance increase

2025 → Material offering new opportunities by co-designing new products

2030 → Material multi-functional, bio-based & digital design & manufactured

>2030

Introducing ZEROe

Why Hydrogen?

Zero emission: H2 emits no CO2 * & has the potential to reduce non-CO2 emissions (i.e. NOx) & persistent contrails

Declining costs: the cost of producing H2 is likely to decline over the next decade, which will make zero-emission flying increasingly economical

Energy dense: H2 is 3x lighter than jet fuel but has a lower volumetric density, thereby requiring a different storage solution on aircraft

Disruptive technologies for:

- **Hybrid Electric Regional Aircraft**
- **Short and Medium-Range Aircraft**
- **Hydrogen-powered Aircraft**

Thank you for your attention!

Thanks to contributors:
Frank PALM; David SCHIMBÄCK/Airbus Technology / Munich / Germany

Source: Lindblad 2009, City of Future/ San Francisco; Hydro-Net

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4th International Conference on Light Materials - Science and Technology

LightMAT 2021 provides a platform for academic and industrial researchers, scientists and engineers to present and discuss the recent development and progress made in Magnesium, Aluminum, Titanium and their alloys and materials combinations.

LightMAT 2021 will be held as a Virtual Conference

Abstract submission is still possible

Submit Abstract

Register for event

180+ participants

Participants from **40+** countries

130+ abstracts

divers participant crowd

5+ exhibitors

Based on previouse LightMAT conference