Procurement
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3rd Generation of Composite Materials for Airframe

World Materials Forum

Workshop on Composites

Outline

Introduction

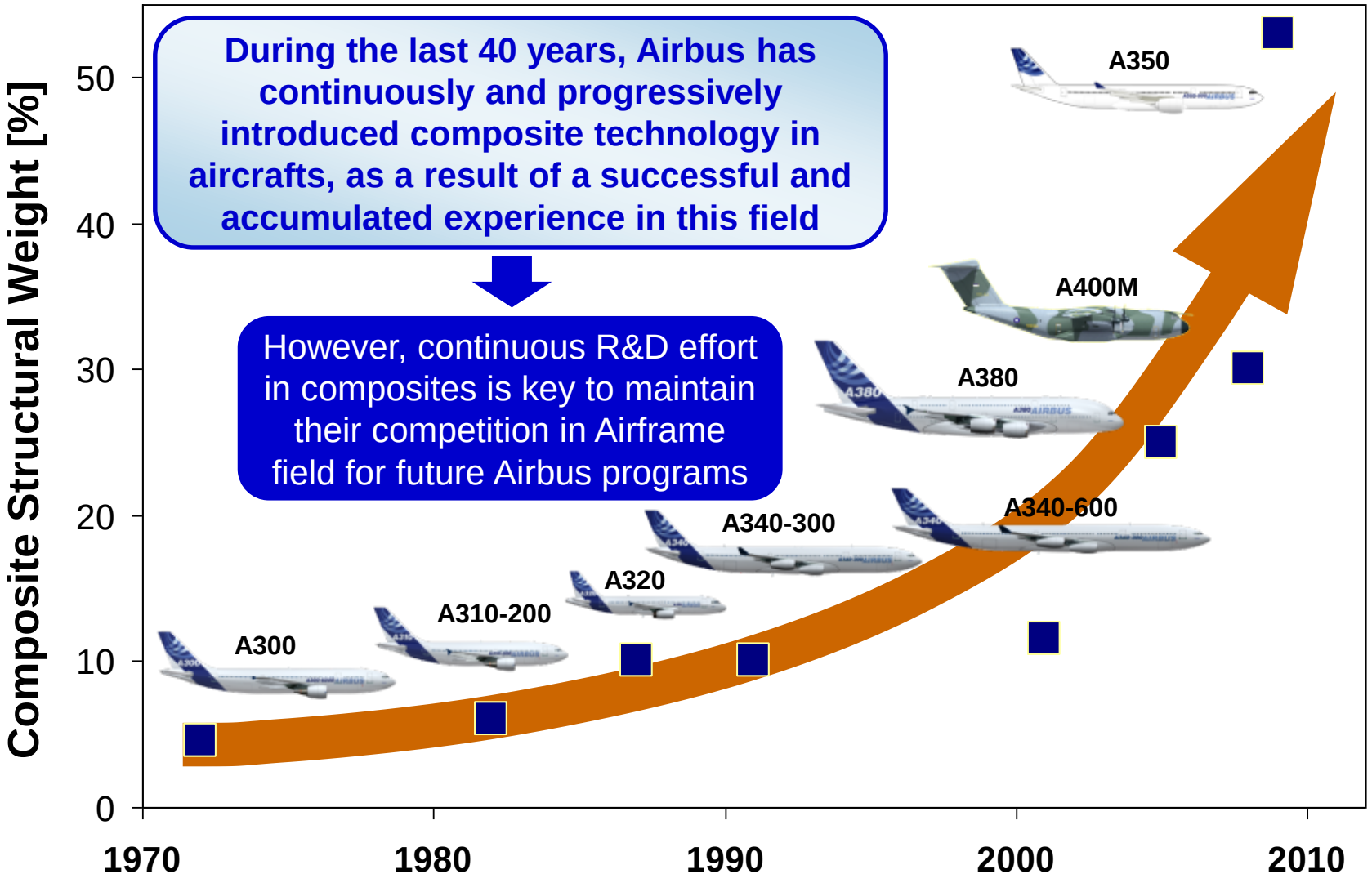
- Composite use evolution in Airbus
- Current composite technologies

Composite Airframe – Key development areas

- Cost reduction
- Performance & Multifunctionality
- Processability
- Reuse & Recyclability

Conclusions

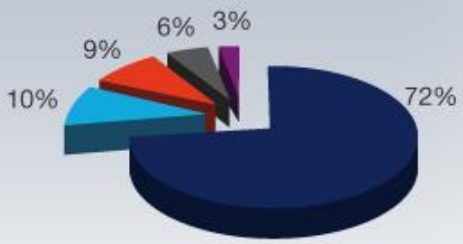
Composite use in Airbus A/C: a sustained increase



Material use in Airbus Aircrafts

From A320 family...

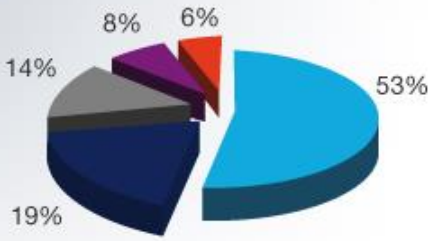
Material Breakdown (%)



- Aluminium / Aluminium-Lithium
- Composites
- Steel
- Titanium
- Misc.

...To A350 XWB

Material Breakdown (including Landing Gear) (%)



- Composites
- Aluminium / Aluminium-Lithium
- Titanium
- Misc.
- Steel

Overview of current composite technologies for Airframe

Thermoset Prepreg (epoxy + CF, tape / fabric)

Performance benchmark → Cost challenge!!





Process: ATL / AFP lay-up + autoclave curing

Primary structure, wide use

Dry CF textile / Resin (epoxy) infusion

Cost attractive → Performance challenge to reach prepreg!!




Process: dry textile lay-up + Liquid Resin Infusion + oven / tool curing

Primary structure, still less used than prepreg

Thermoplastics (PEEK/PEKK + CF prepreg / tape)

High performance, low use → Cost & use increase challenges – Big parts!!




Process: prepreg lay-up (+oven/autoclave) ; press forming, injection moulding…

Small parts, secondary structure

Key composite research areas

3rd generation of COMPOSITE materials

NEOs – Incremental development

- ✓ Damage tolerance
- ✓ Conductivity
- ✓ Damping…

Performance & Multifunctionality

- ✓ Fiber
- ✓ Matrix
- ✓ Prepreg
- ✓ …

Cost Reduction

Composite Materials development

- ✓ Thermoset: uncured or cured
- ✓ Thermoplastic
- ✓ Dry Fibers

Reuse & Recyclability

- ✓ Lay-up
- ✓ Curing
- ✓ NDI, quality control
- ✓ …

Processability

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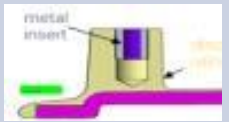
Performance – Thermoplastic materials development

Towards long term

Towards long term

TRL 3

Processing T[a]	Material	Basic / technology development	1st generation Applications	2nd generation Application

400°C	**PEKK – CF (UD tape) as alternative to PEEK - CF (reference)**	• Material screening / characterization
		• Processability evaluation:
		  • Lay-up processes, injection moulding, Over-moulding…
		  • Welding (US, Induction, resistance)
		• Multifunctionality integration: electrical conductivity, acoustic attenuation…
		• Recyclability evaluation
			Secondary structure:
			Moveables/LE/TE/ HTP/VTP structure
			 
			Pylon
			 
			 
			Floor structure
			 
				Primary structure as fuselage / cabin, wing, …
				 
				 
				
				 

300°C	**New Low melting polymer**			
TBD	**ADVANCED TP** • Thermoplastic new formulation integrating multi functionalities • Advanced assembly concept • In-situ consolidation			

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Multifunctional composites: key development

Description / Objective: Integration of non-inherent composite properties to cover other functions (ex.: electrical conductivity)

Multifunctional Composites

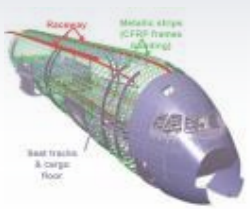
Benefit: they will mean an important step forward in terms of the main drivers of future aircraft parts, programs: **weight and cost saving**

Functions and technologies:

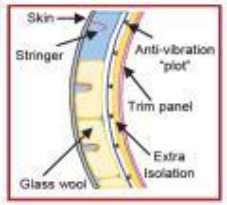
- **Damage tolerance & high energy impact resistance:** integrated shielding technologies
- **Electrical:** conductive particles, nanotechnology
- **Acoustic & vibration attenuation:** elastomeric material integration (embedded damping)
- **Erosion resistance:** elastomeric surface film…
- **Anti / de - ice:** hydrophobic / heatable coatings
- **Sensing:** sensor integration inside CFRP

Today: "mono-skill"

Composites with structural properties



Electrical structural network

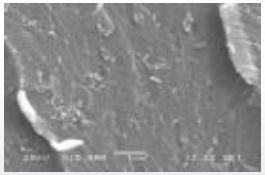


Fuselage acoustic solution

LE Erosion protection

Future: "multifunctional"

Composites with structural and functional properties



Nanodoped RTM resin

Embedded damping

CFRP coated with Cu

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Cost reduction

TECHNOLOGY DEVELOPMENT

Towards less testing

- Qualification New Approach
- Quality Control Approach

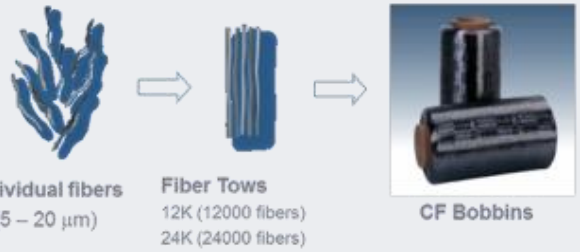
Towards low cost building blocks

- New Precursor Technologies for Carbon Fiber
- High Tow Fibers
- New Resins
- Pre-Impregnated Architecture

Cost reduction: building blocks

Fiber

- **Higher fiber tows** → industrial fiber



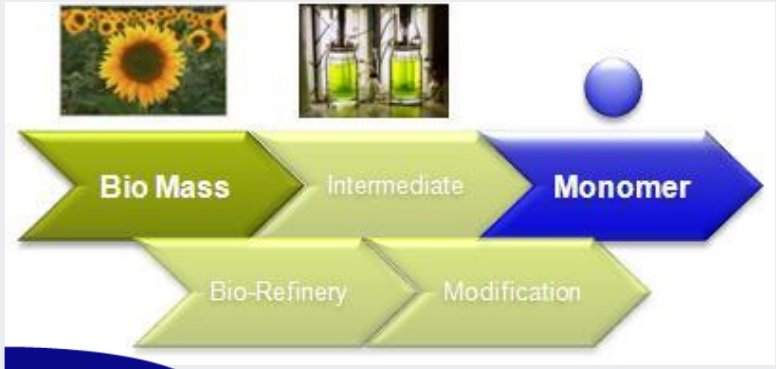
- **Precursor** → main focus

Precursor fiber (PAN): high cost

- ✓ Lower cost polymers
- ✓ Biosources: lignin, Spinifex grass

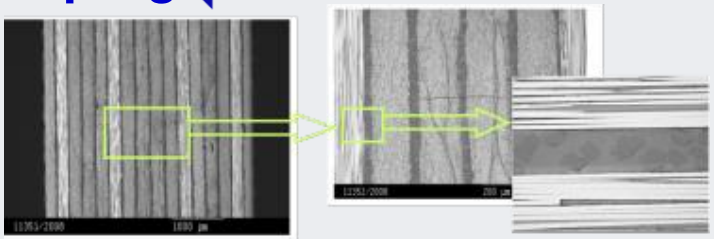
Matrix

- **Low cost polymers** → Epoxy alternative
- **Monomer** → Substitution of "Fossil"-Monomers by "bio"-monomers (Source: vegetable oils → epoxy)



Prepreg

- **New architecture**
  - Interleaf system
  - Resin content tailoring
  - Higher areal weight



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Processability

IMPROVE MANUFACTURING: HIGHER EFFICIENCY

- More Efficient Process: QUICKER LAY-UP + CURING (RAPID CURING)
- New curing approaches: COCURING, semicuring → PART INTEGRATION
- Reuse & Recycling
- Low Cost Tooling Concept
- Reduction / elimination of auxiliary materials
- New Part Design: Design to Manufacturing
- Decrease of Process Control Specimens
- On line Process & NDI Concept

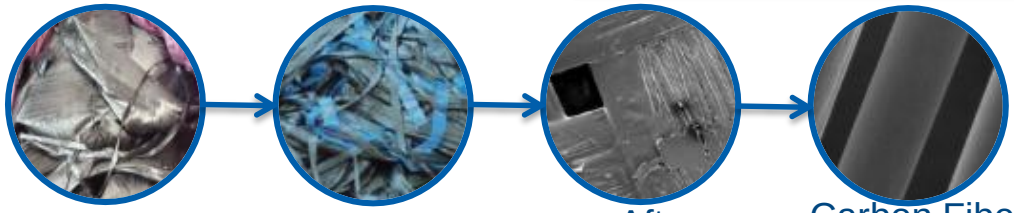
Reuse & Recycling

Composite Materials Must Get RECYCLABLE

Reduction of raw materials residue

Recycling of composite raw materials

1) Removal of resin by pyrolysis.
2) Electric Cogeneration
3) Getting fibers without sizing for TP injection moulding or matt prepregs



Scraps → Cut Scraps → After processing → Carbon Fiber 0% Resins

Reuse of residue non cured material

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Conclusions

- **Airbus has always bet on composite use** as a way to improve A/C performance and, then, save weight, until reaching more than 50% of structural weight in composite for last generation aircraft: the A350 XWB

- **Current composite technologies:** composites made of epoxy resin and carbon fibers are the predominant ones, while thermoplastic composite use in airframe is still low. In terms of composite processing: prepreg is the most used technology, followed by liquid resin infusion

- **Composite materials need to compete again with metallic materials** for airframe applications that are made of composite in last generation A/C (example: fuselage)

- **A continuous R&D effort is needed** to develop innovative composite materials and processes: **cost reduction, performance, multifunctionality, processability & reuse / recycle are key development areas** to maintain composite presence / use in commercial aeronautical field → Research community effort is key in these areas

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Thank you

for your attention

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