Composites in Aerospace – Future Challenges, Needs and Opportunities

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Airbus Group Innovations is part of Chief Technical Officer Organization.
Airbus Group Innovations - Key Figures

- Over 1000 Researchers, Scientists, Engineers
- 20 sites around the world
- Located in 12 countries
- More than 100 new patent applications every year
Overview

- Composites in Civil Aircraft
- Composites for Helicopters
- Composites for Defence & Space
- Future Flying
- Conclusion
Composites use in Airbus aircrafts - growing

During the last 40 years, Airbus has continuously and progressively introduced composite technology in aircrafts.
A350XWB – Optimised Material Mix

A350-900 Material Breakdown (%)
Including Landing Gear

Composite 53%
Al/Al-Li 19%
Steel 6%
Titanium 14%
Misc. 8%

Titanium
- High load frames
- Door surroundings
- Landing gear
- Pylons
→ No corrosion tasks

CFRP
- Wings
- Centre wing box and keel beam
- Tail cone (Section 19)
- Skin panels
- Frames, stringers and doublers
- Doors (Passenger & Cargo)
→ No corrosion & fatigue tasks

* For comparison: A330 = 11%

A350XWB – Composite Parts – Industrial Challenge
Future Civil Aircraft Market

20-year demand by category

Worldwide Demand
Single-aisle: 20,242
Twin-aisle & VLA: 8,984

A330 neo – Further Composite Applications

12% fuel burn saving per trip
More seats
More range
14% fuel burn savings per seat

[Ref.: http://www.agoravox.fr/actualites/europe/article/et-121-commandes-et-intentions-154689
http://www.flightnews.info; www.airbus.com]
Future Aircraft Configurations – Advanced Engine and Aircraft Configurations

Advanced Engine and Aircraft Configurations
→ Engine Integration into a full CFRP rear end section and pylon, including tail cone and APU

Hybrid Laminar Flow Control
→ Operational Excellence
→ Manufacturing
→ Materials

Demonstration of Radical Aircraft Configurations
Innovative Physical Integration - Cabin-System-Structure

Disruptive fuselage architectures by an integrated structure, automated system installation and cabin elements

- Multidisciplinary integration for integrated structural, system, and cabin elements

- Elements and architectures which integrate formerly separated functions from structures, system installation and cabin

- Testing technologies for integrated functional and mechanical demonstrator

[Referenz: Clean Sky 2, Information Day, Brussels, 28th of March 2014]
Integration Cabin Systems Structure – Interface Technologies

Simplify the integration of systems either by:

- reducing part counts
- reducing labour time
- improving systems`specific efficiency

[Referenz: Clean Sky 2, Information Day, Brussels, 28th of March 2014]
Exemplary Needs to Advance Technologies (to match ramp-up in production and service)

Improved part production: Automated Fiber Placement / Automated Tape Lying
  Lay-up rate
  Material cost
  Reduced material waste

Process Chain Engineering
  Process Control and Robustness
  In-line Process Quality Assurance
  Reduced number of processing steps

Automated Structural Repair

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Exemplary Needs to Advance Technologies
(to match future aircraft requirements)

Dramatic Cost Reduction
  Low cost materials, Fast lay-Up
  Curing / Consolidation
  No waste / scrap

Lean Process Chain (from fibre to final integrated part)
  Dramatic reduced number of process interfaces

„Green“ Materials“
  REACH Safe, HSE optimised systems, bio sourcing, recycling

High Volume Capabilities
  Production rate today 46 AC/m; Increase to 60 AC/m possible*

Advanced Integrated Structures and Assembly
  Surfacing (including LSP, Electrical Bonding, Paint, etc.)
  Easy installation of wiring, etc.

Materials Perspectives

Integrated functions from systems / cabin / structure
Focus on enabling technologies: NDT/NDT/SHM, surface, assembly

Best eco-efficient material mix

Short term

2015 Composite and metallic cost effective materials

EDP Electro deposition of paint

Composites automation

 ✓ quick wins: develop cost effective materials for short term implementation
 ✓ improve collaboration with material suppliers
 ✓ Improve the buy-to-fly ratio by enabling new ways of processing
 ✓ Establish materials for net shape manufacturing

Mid term

ACI Airbus Composite Materials Initiative
One “dream” spec for 3 levels of performance (H-M-L)

Long term

2025

Smart fastening

Quality assessment of adhesive bonding in primary

Fire Safety Design concepts (structural integrity in case of fire)

Multifunctional materials

Integrate functions from systems / cabin / structure

Barriere-breaking new materials

Graphene

Composite and metallic cost effective materials

ACI Airbus Composite Materials Initiative

Growing Use of Composites in Helicopters

EC135 – Light/Medium HC

NH90 – Medium/Heavy HC

Super Puma – Medium/Heavy HC

Secundary Structure
Carbon-Aramid Fibre
Sandwich
Primary Structure
Carbon Fibre Sandwich
Monolith
GFRP Sandwich
Metal
Plastics (PMMA)

EC135 – Light/Medium HC

NH90 – Medium/Heavy HC

Super Puma – Medium/Heavy HC
Trends for the Composites Usage in Helicopters

% of structural weight

Year of first flight

B0 105
AS 355
BK 117
EC 135
SK75/76
NH90 (EC)
BA609/V-22
Tiger (EC)
CH-53K
AW169**
EC 175
AH X4

Military Helicopters

Civil Helicopters

Future Heavy Transport

*Ref.: http://intercepts.defensenews.com/2014/05/sikorskys-king-stallion-rollout-come-to-the-ch-53k-party/
Airbus Helicopters – Coming Soon: X4

→ Replacement of AS365/EC155;
→ Material Mix: Advanced Metal and Advanced Composite Mix (Cost & Weight Optimum)
→ Increasing Material Requirements (e.g. Design driven)

[Ref.: http://www.ainonline.com/aviation-news/ainalerts/2013-12-05/eurocopter-x4-design-details-emerge]
Future Fast HC Configurations – Major Challenges

Weight, weight, and weight… Even more crucial than for helicopters, why?

- Additional components: wing and propellers
- Strong engines & power train
- Cruise: low drag, high Lift-to-Drag ratio
- Hover/ vertical flight: efficiency & manoeuvrability
- Operating cost (per kg payload/km)
- Recurring cost

Needs and Opportunities HC

Cost @ low weight Performance
  Low cost processing of high performance materials

Flexible Automation
  Productivity of automated equipments

Increasing physical Requirements (extended missions, new engines)
  Enlarged Temperature Range
  Erosion or Abrasive Requirements
  Impact performance (e.g. Canopy, sub-floor, floor)

Reproducibility and Process Robustness
  Automation as key aspect to increase reprocibility
  „First-time-right“ – Design-to-manufacture
Airbus Defence & Space – Products Portfolio

Eurofighter

A400M

A330- MRTT

et de transport

Ariane5

Automatic Transfer Vehicle (ATV)

Satellites

Ref.: http://airbusdefenceandspace.com
ADS - New Products: Zephyr

Zephyr is a High Altitude Pseudo-Satellite (HAPS).

Running exclusively on solar power and flying at high altitudes above the weather and above conventional air traffic, it fills a capability gap between satellites and UAVs.

Like no other means they allow focus on a specific area of interest (which can be hundreds of miles wide) while providing it with satellite-like communications and ISR (Intelligence, Surveillance & Reconnaissance) services over long periods of time without interruption.

- Ultra Light Weight Materials key for long flights
- Low cost and high reproducibility
- Specific multifunctional requirements on structure

[Ref.: http://www.uasvision.com/2014/04/24/airbus-defence-and-space-launches-high-altitude-pseudo-satellite-zephyr-8-programme/]
Electrical Flying – From E-Fan to E-Thrust and the Role of Composites

**E-FAN**

*Full electric aircraft*

1-2 PAX

E-Fan 2.0 (4 PAX)

- Ultra Light Weight Materials key (batteries)
- Specific multifunctional requirements on structure; Electrical properties, high temperature capability
- Low cost and high reproducibility

[Referenz: Luft- und Raumfahrt: Airbus demonstriert Elektroflugzeug, 2014]
Conclusion

→ Carbon Composites are everywhere in aeronautics today due to their weight saving potentials

→ Cost improvements are envisaged throughout the industries in short/mid-term projects

→ Cost and Performance predictability is key („As-build“ simulation will give opportunities of robust and risk reduced industrialization)

→ Future concepts lead to raising requirements requiring high performance materials

→ Advanced composite solutions are giving opportunities which will make the difference