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

During the last 40 years, Airbus has continuously and progressively introduced composite technology in aircrafts, as a result of a successful and accumulated experience in this field.

However, continuous R&D effort in composites is key to maintain their competition in Airframe field for future Airbus programs.
Material use in Airbus Aircrafts

From A320 family...
Material Breakdown (%)

...To A350 XWB
Material Breakdown (including Landing Gear) (%)
### Overview of current composite technologies for Airframe

<table>
<thead>
<tr>
<th>Thermoset Prepreg (epoxy + CF, tape / fabric)</th>
<th>Performance benchmark → <strong>Cost challenge!!</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Process: ATL / AFP lay-up + autoclave curing</td>
<td>Primary structure, wide use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dry CF textile / Resin (epoxy) infusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost attractive → <strong>Performance challenge to reach prepreg!!</strong></td>
</tr>
<tr>
<td>Process: dry textile lay-up + Liquid Resin Infusion + oven / tool curing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thermoplastics (PEEK/PEKK + CF prepreg / tape)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High performance, low use → <strong>Cost &amp; use increase challenges – Big parts!!</strong></td>
</tr>
<tr>
<td>Process: prepreg lay-up (+oven/autoclave) ; press forming, injection moulding…</td>
</tr>
</tbody>
</table>
Key composite research areas

3rd generation of COMPOSITE materials

NEOs – Incremental development

Performance & Multifunctionality

- Damage tolerance
- Conductivity
- Damping…

Cost Reduction

- Fiber
- Matrix
- Prepreg
- …

Reuse & Recyclablity

- Thermoset: uncured or cured
- Thermoplastic
- Dry Fibers

Processability

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

Composite Materials development

- Fiber
- Matrix
- Prepreg
- …
### Performance – Thermoplastic materials development

<table>
<thead>
<tr>
<th>Processing $T^a$</th>
<th>Material</th>
<th>Basic / technology development</th>
<th>1st generation Applications</th>
<th>2nd generation Application</th>
</tr>
</thead>
</table>
| 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 | 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 | | | |

Towards long term

June 2015
Multifunctional composites: key development

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

**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
Cost reduction

**TECHNOLOGY DEVELOPMENT**

Towards less testing
- Qualification New Approach
- Quality Control Approach
- New Precursor Technologies for Carbon Fiber

Towards low cost building blocks
- High Tow Fibers
- New Resins
- Pre-Impregnated Architecture
Cost reduction: building blocks

Fiber
- Higher fiber tows → industrial fiber
- Precursor → main focus
  - Lower cost polymers
  - Biosources: lignin, Spinifex grass
- New architecture
  - Interleaf system
  - Resin content tailoring
  - Higher areal weight

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

Prepreg
- Towards 50K
Reuse & Recycling

Composite Materials Must Get RECYCLABLE

Reduction of raw materials residue

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

Recycling of composite raw materials

Reuse of residue non cured material

Scrap → Cut Scrap → After processing → Carbon Fiber

0% Resins
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.
Thank you for your attention

Presentation Prepared by:

- Jose Sánchez Gómez – Composite Materials Senior Expert, ESCAA
- Ivan Gayoso – Composites Procurement, PMCC
- Tamara Blanco – R&T Composite Materials, ESCRNM