

# FIDANC

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Manufacture process of structural upper skin panel highly integrated in carbon fibre reinforced thermoplastic material



#### TWENTY-THIRD INTERNATIONAL CONFERENCE ON COMPOSITE MATERIALS (ICCM23)



Manufacture process of structural upper skin panel highly integrated in carbon fibre reinforced thermoplastic material



MAR ZUAZO

Research & Development Composites

FIDAMC

# **AIRBUS**



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### **1.1 Motivation**



Upper skin panel

- Cost reduction
- Weight saving
- Mechanical properties improvements
- Reduced moisture absorption
- Reprocessed material
- Welding
- Thermo-forming









### **1.2 Target OUTCOME Thermoplastic Project**





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# **1.3 OUTCOME PROJECTS CHALLENGES**

- Eco-efficient process: reduction of consumption, weight, costs, etc.
- Manufacture with high performance thermoplastic materials.
- Improvement AFP Thermoplastic
- Development of tools for the manufacture of stringers and automatic lamination.
- Out of autoclave processes:
  - Development of processes to manufacture T stringers
  - Improved co-consolidation process, automatic lamination by in situ consolidation in one step for large structures.









#### 1.4 Background

FIDAMC has been involved since 2010 in the research of thermoplastic matrix composite materials together with AIRBUS DS and MTORRES.

Some of the research projects carried out are detailed:

ICARO & TARGET project, CENIT national programmes of CDTI.



ISINTHER project; CLEANSKY, 7<sup>th</sup> Framework Programme.













#### 1. 4 Background

• GRA project, CLEANSKY, 7<sup>th</sup> Framework Programme.



• **OUTCOME Thermoplastic Project; CLEANSKY 2**, 7th Framework Programme.











#### 2.1 Advantages of automatic lamination

SUPPORTING PRODUCTION RATES

REDUCED LABOUR/MATERIAL COSTS

LARGE COMPOSITE COMPONENTS

**REDUCED SCRAP** 

REDUCED MANUFACTURING TIME

ACCURATE FIBER PLACEMENT AT ANY ANGLE

AUTOMATIC DEBULKING

FAST SPEED OF MATERIAL DEPOSITION (>10lb/hr) [Hand lay-up 2,5lb/hr]

REPEATABILITY OF RESULTS/ACCURACY AND REPEATABILITY OF THE PRODUCTION PROCESS











### **2.2 Thermoplastic Consolidation**

Consolidation of melt-fusible thermoplastics consists of heating, consolidation, and cooling, as depicted schematically in the figure below. As with thermoset composites, the main processing variables are time (t), temperature (T), and pressure (P).



Fuente: F. C. Campbell-Structural Composite Materials-ASM International (2010)













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### **2.3 AFP Thermoplastic evolution**











### **2.4 AFP Thermoplastic**













	Regional FTB#2 Upper Skin
Material	APC2/AS4_SOLVAY (1/4" y 300 mm)
Stringers	Oven forming_T stringers witout rivets
Skin	Co-consolidation process by in situ consolidation (ISC) by automated fibre (AFP)









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### **3.1 Coupons Test**

- Material allowable\_ 70W\_120W
- Residual strength after impact
- Bolted joints
- Lightning strike protection
- Residual stress test plan
- Co-consolidation test plan













#### **3.2 Details tests**

#### CRIPPLING







#### SRO DETAIL









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FULL SCALE

GROUND TEST

ETAIL

COUPONS

### **3.3 Sub-components Tets**







#### **SRO Sub-Component**









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FULL SCALE-

UB-COMPONE

DETAILS

COUPONS

### 3.4 Upper Skin: Manufacturing process







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FULL SCALE-

COMPONENT

COUPONS

### 3.4 Upper Skin: Manufacturing process

#### STRINGERS









#### **AFP SKIN PANEL**

















#### 3.5 Upper Skin











# **4. CONCLUSIONS**

- 1. Thermoplastics are an opportunity to reduce manufacturing costs and obtain more efficient processes.
- 2. Cost savings of 15% and structural weight savings of 9% compared to the metallic equivalent.
- 3. It has been proven that by increasing the dimensions of the parts to be manufactured, technological challenges have been growing in the design and manufacture of the tooling.
- 4. Mathematical models are needed to simulate the behaviors of residual stress structures to adjust the designs of the tools.
- 5. A control system in automatic lamination processes, with high-performance thermoplastic materials, are essential to give robustness to the process.
- 6. Reversible proceses
- 7. Highly recyclable, lower environmental impact throughout the entire life cycle, from the generation of raw material, manufacturing, operation and end of life.









#### **5. WAY FORWARD**

#### **AUTOMATIC LAMINATION PROCESS**

- Improve productivity ratios in one step
- Reduction of residual stresses
- Increase the consolidation degree in AFP by in situ consolidation.

#### STRINGER MANUFACTURING PROCESS

- To study alternative manufacturing processes for stringer in order to improve the quality and production rates.
- Analize the final geometry of stringer not clamped to correct springback and torsions on tooling.











# **THANK YOU**

MAR ZUAZO RUIZ Mar.zuazo@fidamc.es





