

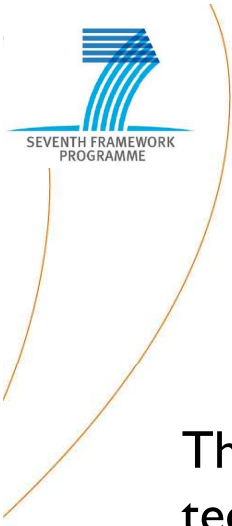
# LAYSa Project: Multifunctional LAYERS for SAfer Aircraft Composites Structures

(FP7: Contract No. ACP7-GA-2008-213267)

[www.laysa.eu](http://www.laysa.eu)

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## Summary

The overall aim of the LAYSA project is to establish the scientific and technological basis for the **development of a new multifunctional layer with ice/fire protection and health monitoring capacity to be integrated into composite structures.**

The **direct benefits** of the proposed application include:

- ✓ Improve aircraft safety and security
- ✓ Structural weight reduction and simplification of manufacturing processes and maintenance operations due to elimination of current metal mesh or foils, by replacement with multifunctional layer integrated in composite structure.



## I.1 Scientific Objectives

- ✓ To design and manufacture novel layer concept with multifunctionality based on nanomaterials, combining the following properties:
  - **Electrical/thermal conductivity** capable of distribute the necessary heat on composite surface to prevent ice formation on its surface in rough fly conditions or remove the already existing one. (Weight reduction of 99% and a power consumption reduction of 50% can be achieved)
  - **Fire resistance.** Reduced flammability (50% of reduction in Heat Release Rate HRR with respect to base composite material).
  - **Sensing** of temperature and stress by electrical conductivity variation measures.
  
- ✓ Integration, modelling and validation of multifunctional system in novel structural composite materials.



## I.2 Technological Objectives

- ✓ **Coupling of the conductivity** characteristics of the composite with **ice /fire protection** and **health monitoring** systems.
- ✓ **Development of modelling tools** which will facilitate analysis and design of multifunctional layers
- ✓ **Manufacturing and validation** of composite components with ice/fire protection, as well as sensing capabilities for real time temperature and damage assessment.

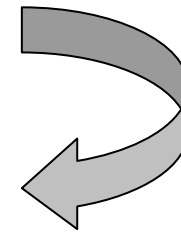
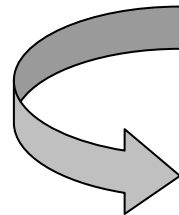
## 2. Approach

### FROM NANOTECHNOLOGY BASED PROJECTS

- Synthesis of CNTs
- Functionalisation Treatements
- Compatibilization Methods
- Dispersion Optimisation
- Adhesion Assessment
- Characterisation Procedures

### FROM COMPOSITE BASED PROJECTS

- Integration in composite structures
- Adaptation and Optimization of manufacturing processes
- Characterization Procedures
- Validation of parts



Current methods	LAYSAL improvement
<p>Electrothermal system, where heat is applied by:</p> <ul style="list-style-type: none"><li>• flexible pads adhesively bonded on the surface of composite structure,</li><li>• molding heating element (foil, film, resistance wire or mesh) into the surface of the composite structure during manufacturing process.</li></ul>	<ul style="list-style-type: none"><li>• <b>Temperature sensors are not required</b>, because of self-sensing capability of the layer.</li><li>• Important saves due to <b>simplification of manufacturing processes and maintenance operations</b></li><li>• <b>No aerodynamic performance penalties</b></li><li>• Important <b>weight reduction</b> due to elimination of heavy heating elements. Possibility of heating all aircraft composite structures</li><li>• Element bournout is not of concern because of improvement of fire resistance</li><li>• <b>Reduction in power consumption</b> due to unsurpassable current density of considered nanomaterials</li></ul>

### Current methods

- Use of additional thermal barrier coatings on the structures.
- Chemical reformulation of matrix.
- Addition of additives and fillers into the matrix.

### Technical limitations and issues

- The barrier coatings must be periodically inspected, repaired and maintained in very good conditions in order to maintain their effectiveness.
- The fillers have in many cases negative influence on the processability and mechanical properties of the resin itself.
- Chemical reformulation of the resin only achieves a partial improvement of fire properties. Combination with other method is required.

### LAYSALImprovement

- With respect to all methods, **improved fire behaviour.**
- With respect to barrier coatings, important saves due to simplification of manufacturing processes and maintenance operations
- With respect to fillers, easiness of manufacturing process and weight reduction

#### Current methods

Fiber optic or piezoelectric sensors embedded into the composite structure.

#### Technical limitations and issues

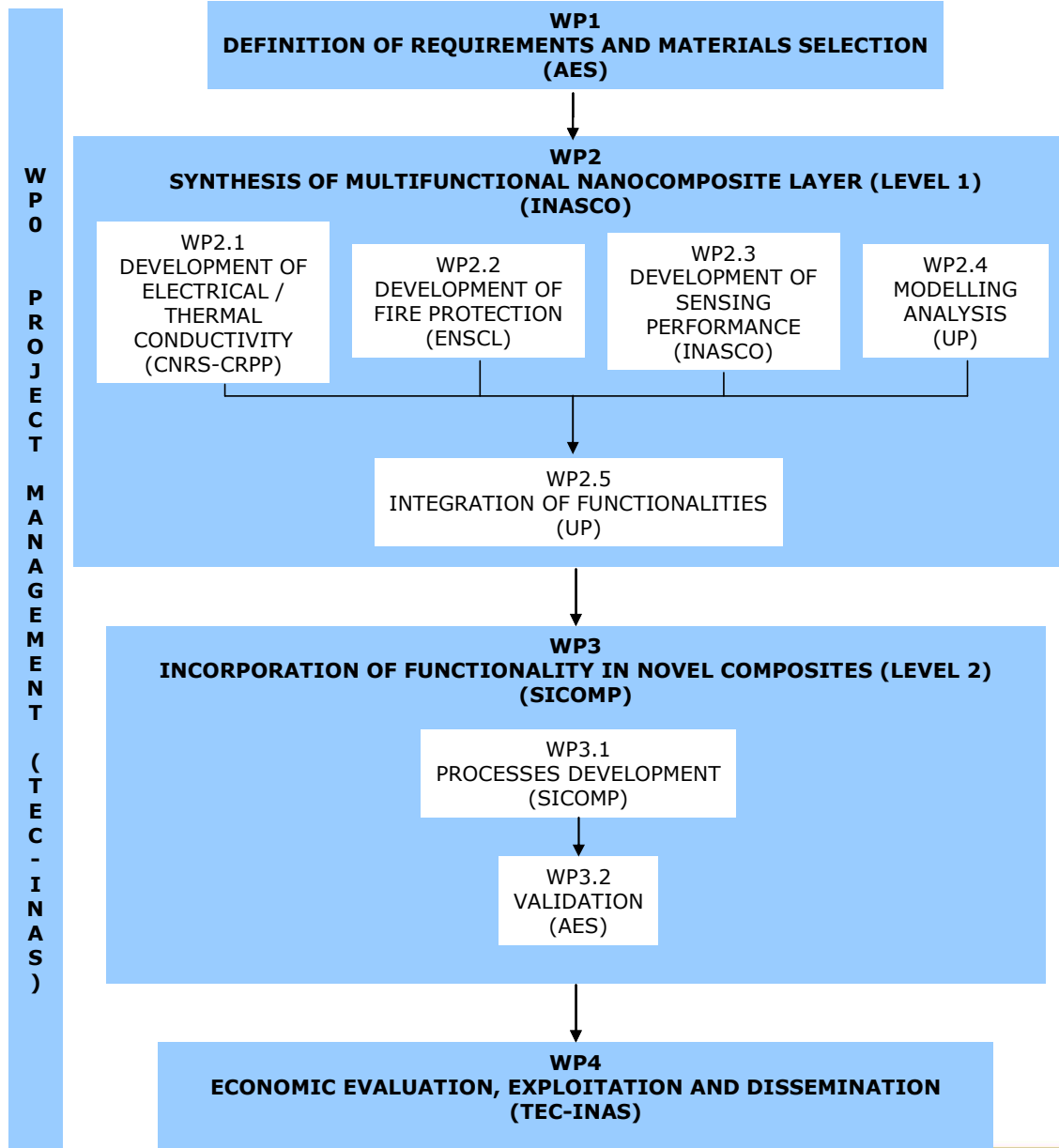
- Fiber optic diameter in many cases acts as stress concentration site, gives low strength at fiber-splicing locations, and they need for electro-optical signal conversion modules
- Piezoelectric sensors have low induced strain capability, high density, brittleness and limited fatigue life.

#### LAYSAs improvement

- The new integrated system does not have any detrimental effect on the structure and does not suffer by fatigue related problems.
- It will be possible a continuous health and usage monitoring and self-inspection; summarizing, a "**smart maintenance**" will be achieved.



# 4. S&T work plan





## 4.1 Project Technical approach



T conductive + E insulating layer  
Ice protection



E+T conductive layer  
Heating element, sensing capability



E+T insulating layer  
Thermal/fire protection



Composite structure

### Some open questions:

- ? Composite manufacturing process (RTM, autoclave)
- ? Epoxy resin type: gel-coat, film,... ( or maybe other polymer?)
- ? Nanoreinforcements: type, treatment, orientation (aligned or random), content, dispersion process (bulk, infiltration)
- ? Interaction between modelling and synthesis
- ? .....

## 5. LAYSAL Team

The LAYSAL consortium is composed of 12 organisations (5 industrial companies, 3 research centres and 4 universities) coming from 6 European countries: United Kingdom, Sweden, France, Switzerland, Greece and Spain.

### **Research organisations:**

**INASMET-Tecnia**, SICOMP, CNRS-Centre de la Recherche Paul Pascal, University of Patras, Ecole Nationale Supérieure de Chimie de Lille, University of Cranfield and University de Pau et des Pays de l'Adour)

### **Raw material manufacturers:**

ADVANCED COMPOSITE GROUP,  
HUNSTMAN

### **Technology supplier :**

INASCO, ARIES COMPLEX

### **Aeronautical end-user:**

AERNNOVA



## 6. LAYSA Markets



- ✓ **Aeronautic**
- ✓ **Automotive,**
- ✓ **Construction**
- ✓ **Energy,**
- ✓ **.....**

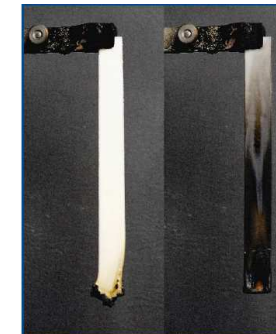


### Improving properties:

Mechanical →   
 Light-weight components  
 Safer components  
 Fuel saving

Thermal →   
 Heat dissipation  
 Fire protection  
 Ice protection

Electrical →   
 Electrostatic painting  
 Grounding, bonding  
 Lightning strike protection  
 Self-sensing



**Thank you for  
your attention**

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