

**Project: Securing and Liability of the Repairable Aeronautical Structures by Using "intelligent" Composite Materials. Acronym: SFSAR**

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**Coordinator: STRAERO, Partners: Polytechnic University of Bucharest UPB-LEISC, INAV SA, IAR Brasov**

**Objectives:**

The general objective of the project consists in increasing the safety, monitoring and repair of the aeronautical structures, liability and their functioning, by using the new generation of composite materials called "intelligent". The purpose of the project is the development and manufacturing of a technology that the main aim is to streamline the repair and maintenance costs of the aircrafts, through direct interventions on the damaged areas. This can be achieved by rapid applying of "intelligent" composite patches based on laminate epoxy fabric structures or a hybrid multilayer and introducing the health monitoring technology of the aircraft structures by using the electro-mechanical micro systems MEMS incorporated. Using the MEMS systems conduct to real time knowing of the structural integrity of a component part of the repaired aircraft structure. The aim is to increase de safety in exploitation of the aircraft structures repaired as well as the possibility of permanent monitoring of intervention areas.

**Specific objectives of R&D from working packages:**

- O1. Study of the repair technologies and health monitoring of the structures.
- O2. Loads simulation and elaboration of the test plan.
- O3. Design and manufacturing of experimental models.
- O4. Testing the experimental aircraft structure (experimental models).
- O5. Repair technology validation of the aircraft structures.
- O6. Heath monitoring technology validation of the structure.
- O7. Results dissemination

**Summary of the project:**

The project integrates in the research on international level, on developing of some advanced materials on high aerospace industry applications, and certain developing of expansion the applications also in other fields such as: terrestrial and maritime transportation, energetic industry of unconventional resources, security of constructions, telecommunications etc. The main objective consists in increasing the safety, monitoring and repair of the aircraft structures, liability and their functioning, on base using of the new generation "intelligent" composites. The new composite materials called "intelligent" are obtain as association of "in situ" matrix, in the processing stage of a electro-mechanics micro devices, capable to supply on-line information about structural and

functional integrity of the structure. This are capable to detect some sort of strains the respond the aircraft structures that are repairable with carbon fiber and glass fiber based composites etc. and that can be permanent monitored during exploitation. Is answered as well the request of developing the new performed materials for the future transportation or for some new activities in the field of obtaining intelligent materials. The objectives of the research is referring to two distinctive groups of composite materials with anisotropic polymeric matrix, armed with bi or tridimensional glass fiber or carbon fiber fabrics and hybrid laminate metal-fiber composites ARAAL or GLARE types similar used in Hermes program. This are alternative structures composed from aluminum or titan sheets (0.2 - 0.6 mm thickness) and fabric prepregs or carbon, Kevlar or glass multidirectional fibers with high impact and fatigue properties and that are incorporated still in the processing phase of manufacturing the MEMS different micro devices. This project proposal is according to thematic aria 7.1. from PC-7, "Aircraft an air transportation". The project aims the growth of the competition of the research and national economy, reaching of some strategic objectives in the developing of top materials and technologies, achievement of technologic integrated nets in specific domains, preparing the scientific base and technologies that allow affiliating to platforms and PC7 European programs. According to this idea was build this consortium which consist in two research institutes, a Polytechnic University and an elite production company, the consortium has the competence and scientific reserve, as well as a wide experience in the new composite materials field, aspects that assure the guarantee of the integral realization of the project.

By now, on international level this top technologies are accessible just for some advanced countries. Activation the using of intelligent composite materials as well as process effects are new in the field of composite materials. This elements gives the project the freshness, complexity of the project results from the developing the manufacturing of the composite technology integrating "in situ" of MEMS, unconventional technology, which implies an wide range of knowing, effort, installations, devices and materials which leads to developing the know how in the field of health monitoring in real time of the aircraft structures. Manufacturing the composite materials with complex matrix is an special hard-working process, which increase the complexity of the project. The process of manufacturing of hybrid metallic-fiber composite materials implies: selecting the proper epoxy resins or thermoplastics adhesives, choosing and purchase of the stiffening materials (carbon fiber fabric, Kevlar, glass fiber), aluminum or titan sheets with 0.3 - 0.5 mm thickness and a difficult manufacturing process for avoiding the early delaminating or critical inter laminar tensions induction. Mechanic tests, specially the cracks propagation are hard and are lasting due elaboration the finite element models, which are used after in the project for prediction and estimating the behavior of the repairable aircraft structures. This is doable by estimating the life cycling of an aircraft structure (ex. helicopter section empennage) repaired with composite patches (glass fiber GF, carbon fiber CF...) and tested in the similar conditions on flight envelope with monitoring and sequential registration of the crack propagation imposed. The elements that justify the proposal are:

- The project has the innovative character aiming the design of advanced materials in the field of structural aircraft materials and the "intelligent" composite materials with multifunctional applications;
- The proposal is included in the European priority programs PC7 on aircraft, materials and advanced technologies;
- The related researches of the project will be the scientific base and integration technologies in European program;
- Is aimed, also, the developing of integrated technologic nets in specific fields;
- The project has the main objective manufacturing in Romania of advanced performed materials, which are accordingly with international request and standards, with application in top domains of technical industry such as aircraft industry. Beside specific applications is aimed the participation of Romania to bigger international programs on "intelligent" composite materials and MEMS.
- The project aims the disseminations of the results in Universities and in production area in the country, in an important domain, in which the delays are accented;
- Creating a team of young specialists in an advanced aircraft domain, of aircraft materials with developing the use of composite materials as a base of increasing of safety and liability of the repair processes and maintenance of aircraft structures and in general of structural constructions in the transportation, energetic etc. fields;
- The proposal respond the intended purpose followed by national politics of raising the technology competence and capacity in the material field, for Romanian increase of the industry competition and reaching the European Community level of European program integration. By proposed objectives is creating the premise of a shop or a small company to manufacture and promote in industry of this new carbonic products and forming young people in top domain of research and technology.

**Realization plan:**

Year	Stage Name	Months and term	Results	Indicators
0	1	3	4	
2008	Stage I Study of the repair technologies and health monitoring (integrity)of the structures	3 05.12.2008	Technical report +RIA	Technical study
2009	Stage II Design, simulation and manufacturing of experimental model of metallic aircraft with imposed defects and repair	8 30.08.2009	Technical report +RIA	Technical model project Model simulation Manufacturing

				the model
2009	Stage III Instrumentation with transducers and MEMS on repaired metallic aircraft structure and setup the section on experimental bench	6 30.04.2010	Technical report +RIA	Instrumentation of the model Preparing the model for testing
2010	Stage IV Elaboration and realization of the fatigue program of the repaired aircraft metallic structure	6 30.11.2010	Technical report +RIA	Elaboration the test program Realization of test program
2010	Stage V Validation of the repair technology of aircraft metallic structure with composite materials and demonstration the efficiency and effectiveness of the health monitoring of the structure with MEMS micro systems electro-mechanics	6 30.8.2011	Technical report +RIA	Validation of the repair technology Validation of the health monitoring integrated in the structure