Next Generation Combat Aircraft Technologies - NGCAT

ACRONYM: SUPERSTATE

Title: advanced deSign and manUfacturing Processes for complEx cuRved aeroStructures wiTh integrATed kinEmatics

Duration of the project: 01/05/2025 – 01/02/2028

Key words: complex curved aerostructures, titanium AM by Direct Energy Deposition, hybrid structures (CFRP-Ti), Dry Fibre Placement, RTM

Total budget: 5.035.400 €

of which RHID contribution:

4.678.000 €

PROJECT DESCRIPTION

SUPERSTATE is a Belgian collaborative research and innovation project that aims to investigate and develop novel design and manufacturing processes for complex curved aerostructures for next-generation defence systems. These systems—such as those envisioned e.g. for the Future Combat Air System (FCAS)—require highly integrated, curved structural components that combine aerodynamic efficiency, low radar observability, modularity, and embedded functionalities like structural health monitoring (SHM). Traditional manufacturing methods often fall short in delivering such advanced features in a cost-effective, scalable, sustainable and timely manner.

To address this challenge, SUPERSTATE develops two complementary and non-competing manufacturing routes, each tailored to different material systems and structural requirements. Therefore, the project is structured around two parallel workstreams, both targeting Technology Readiness Level 5 (TRL5), with the goal of delivering validated proof-of-concept demonstrators.

Workstream 1 focuses on full titanium aerostructures manufactured using Directed Energy Deposition (DED) additive manufacturing. This process enables the creation of near-net-shape components with integrated kinematic features, significantly reducing material waste/cost, lead time, and post-processing effort. The workstream includes conceptual and detailed design of a selected complex-shaped aerostructure with integrated kinematic features, process development, simulation, and full-scale proof-of-concept production of such a titanium aerostructure with integrated mechanical functionality. The demonstrator will showcase the feasibility of producing complex, high-performance titanium parts with embedded features in a single manufacturing chain.

Workstream 2 explores hybrid titanium–carbon fibre reinforced polymer (CFRP) structures using advanced composite manufacturing techniques such as Dry Fiber Placement (DFP) and Resin Transfer Moulding (RTM). This hybrid approach combines the strength and durability of titanium with the lightweight and design flexibility of composites. Next to activities related to design and proof-of-concept, tooling development, draping optimization, and RTM processing, this workstream further investigates surface activation methods for titanium, integration of fibre optic sensors for SHM, and simulation of the RTM process to ensure manufacturability and performance. The hybrid proof-of-concept demonstrator will validate the integration of metallic and composite elements into a single, functional aerostructure.

In addition to the technical workstreams, SUPERSTATE includes generic work packages focused on project coordination, data management, and exploitation. ASCO serves as the overall project coordinator, ensuring effective collaboration across the consortium and alignment with strategic objectives. The project also includes a strong emphasis on dissemination, exploitation, and valorisation, with the aim of preparing both manufacturing routes for future integration into next-generation defence systems, such as FCAS Phase 2, where they are expected to mature to TRL6 and beyond. The project will also explore synergies between the two workstreams, such as the potential use of DED titanium inserts in hybrid CFRP structures.

The SUPERSTATE consortium brings together a diverse and complementary group of industrial and academic Belgian partners: ASCO, Guaranteed, Sirris, KU Leuven, Com&Sens, Coexpair, Coexpair Dynamics, Safran Aero Boosters, and AdditiveLab (as a key subcontractor). This multidisciplinary team combines expertise in additive manufacturing, composite processing, structural design, simulation, sensor integration, and aerospace structural/kinematical engineering. Each partner contributes unique capabilities to ensure the success of the project and the industrial relevance of its outcomes.

By the end of the project, SUPERSTATE will deliver two validated, TRL5-level manufacturing routes for complex curved aerostructures—one fully metallic and one hybrid. Each route will demonstrate advantages in terms of performance, cost, lead time, sustainability and integration potential for these typical aerostructures, compared to conventional manufacturing methods. These innovations will significantly enhance the competitiveness, agility, and technological leadership of the Belgian aerospace and defence manufacturing sector, paving the way for more integrated, cost/performance-efficient, and intelligent airframe solutions in future combat platforms.

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