Next Generation Combat Aircraft Technologies - NGCAT

ACRONYM: RADSORB

Title: Metasurfaces for Low Observability

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

Key words: Stealth, RAM, Radar absorption, meta-material, RCS reduction

Budget:
1.920.812 €
of which RHID contribution:
1.815.000 €

PROJECT DESCRIPTION

The Future Combat Air System (FCAS) will rely heavily on having a small radar cross section in order to avoid detection by enemy radars. To achieve this, state of the art RAM (Radar Absorbing Material) coatings, layers or fabrics are applied on the surface of an aircraft, drone or missile.

While considered a combat proven solution, these coatings or material stacks have several drawbacks. They add a significant amount of mass to the airframe, their high performance is still relying on creating a good match between paint or layer spacing and expected enemy radar properties and while applying a paint is relatively straightforward, controlling the dispersion and consistency is not. One novel idea to achieve dispersion and absorption of radar waves is to use metasurfaces, which employ a combination of material layers with engineered surface geometries.

The goal of this project is to create these metasurfaces and apply them on metal or composite parts which will absorb and disperse radar waves. Our approach is to create a skin layer stack that can be integrated in a composite structure or bonded to a metal structure. This will make the manufacturing easier and the stealth performance more controllable. It gives also the flexibility to adjust the stealth characteristics locally where needed, whether in combination with other functionalities that can be integrated in the skin (e.g. lightning strike protection, antennas, etc). and saves weight.
It is expected that during this project, several innovative leaps will be achieved which will elevate the technology of metasurfaces for low observability from theory (TRL2) to a proven concept validated in a lab environment (TRL4), ready for further development. These envisaged results are:

- A novel manufacturing method based upon ultrashort pulsed laser machining to achieve accurate, defect free geometries in the metal/die-electric stacks to achieve the required absorption of incoming radar waves.

- A design methodology for a metasurface geometry and material stack, based upon experiments and simulations, which will greatly enhance the knowledge on this subject and allow future expansion to more application oriented developments.
- Evaluation and optimization with respect to radar frequency and wavelength of these metasurfaces.
- Feasibility testing and evaluation of consolidating the different structured metasurface layers together with a protection layer, into a ‘stealth skin’ foil without negatively affecting the stealth performance and bonding this thermoplastic ‘stealth skin’ to a metal and/or thermoset composite structure.
- Construction of a demonstration panel that can show RCS reduction, including a methodology to electrically connect panel segments in order to allow assemble into larger parts and a suitable coating technique to allow sufficient aerodynamic performance and corrosion/wear resistance.

If successful, this project will create a novel method to achieve low observability on aircraft, missiles or drones, and this within Belgium and Europe. It will open up the door for application-oriented development, in which tailored metasurfaces can be further developed to meet specific needs of the FCAS programme or any other novel military or non-military low visibility application, and this with a complete freedom to use and operate for Belgian or European OEM’s, which will create a strategic technological advantage to our own industrial base in the field of low observability, which is currently dominated by the United States and to a lesser extent Russia or China.

This project will first start with a requirements discovery phase (WP1), in which next to the radar bandwidth absorption or scattering requirements also a detailed list will be made to which any solution has to adhere to, such as corrosion or wear resistance, and more practical things such as sample sizes for the measurement campaign or manufacturing constraints. It will then proceed towards a first definition of a base cell (WP2) in which the laser texturing manufacturing process, preliminary material choices and stack definition are made based upon modelling. This is followed by the manufacturing and measurement of coupons (WP3), integrated into larger panels and conducted in an iterative fashion to allow for optimization. Essential in this work package is the electrical integration of these coupons in the panels, which will serve as a basis for future assembly.

Parallel to WP2 and WP3, a solution for the top layer, which needs to protect the metasurface and provide aerodynamic performance will be developed and evaluated with respect to radar absorption performance (WP4). After completion of the aforementioned tasks, larger demonstration panels will be constructed and assembled (WP5) and radio frequency measured (WP6). An assembly method is defined, based upon the learnings from WP3. As a final step, a valorisation path of the results towards the future applications is prepared in WP7, allowing a follow up activity with the requirements of the Belgian and European defence industry in mind.

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LINK(S)

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