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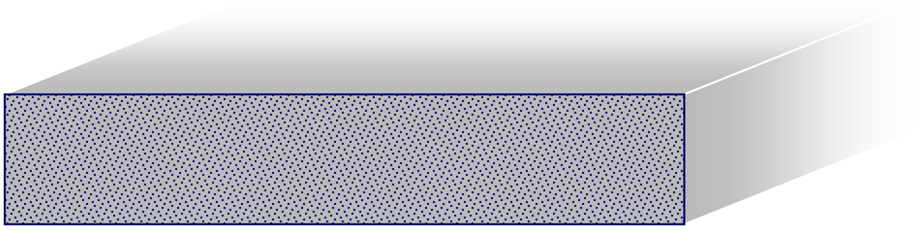
Advanced Low Observable Materials and Structure “ALOMAS”



WP0000	Management
N/A	**N/A**

☐ Meeting Minutes	☐ Documentation or Report	☐ Progress Report	☐ Final Report	☐ Executive Summary	☒ Other

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Work Package 0000

Public Summary Report

Abstract:

Public Summary Report of the EDA Project EDA - B-1192-GEM1-ERG "Advanced Low Observable Materials and Structures (ALOMAS)".

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Contributing companies	**All**
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APPROVAL SHEET

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Table of content

1. Introduction

Within the framework of the EDA project EDA-B-1192-GEM1-ERG “Advanced Low Observable Materials And Structures (ALOMAS)”, new technologies for stealth materials have been developed that help to improve future military platforms to survive in the hostile battlefields of the 21st century. In addition to this, the European materials and technologies shall secure the competitiveness of European military platforms not only due to their technical advantages, but because of their availability and cost efficiency as well.

ALOMAS is a follow on project to the former EDA-B-003-GEM1-ERG project “Advances Low Observable Materials (ALOA)”, with a different consortium set-up. Airbus Defence and Space as Prime Contractor/Leading Co-Contractor has been joined by a list of companies acting as Co-Contractors (in alphabetic order):

- FOI, Sweden
- GKN Aerospace Applied Composites AB, Sweden (now part of SAAB AB)
- NLR, The Netherlands
- SAAB AB, Sweden
- Teijin Aramid, The Netherlands
- Wehrtechnische Dienststelle für Luftfahrzeuge - Musterprüfwesen für Luftfahrtgerät der Bundeswehr (WTD 61), Germany
- Wehrwissenschaftliches Institut für Werk- und Betriebsstoffe (WIWEB), Germany

Low observable (LO) technology is a fundamental part of most future aeronautic and naval weapon systems. In general, LO technology is intended to reduce the detectability of military platforms against a variety of threat sensors, like radar, infrared, visual and acoustic detection systems. Depending on the threat sensor, LO technology consists of a combination of different technologies, ranging from shaping to special materials and structures. Even for radar low observable design of platforms, which are dominated by specific shaping requirements, stealth materials play an important role wherever LO shaping is not possible or effective (e.g. naval masts, topsides and EMC masks, leading edges, engine inlets, steps & gaps).

There is already a wide range of radar absorbing materials (RAM), radar absorbing foams, radar absorbing honeycombs, IR signature paints etc. commercially available. However, a couple of deficiencies can be noted:

1. The supplier base and the product range is limited, and the product range of most commercial suppliers has not been improved for the last couple of years.
2. There is a clear deficiency regarding structural LO materials.
3. Newer generations of materials, especially from US manufacturers, are not commercially available in Europe due to export control and confidentiality restrictions.
4. Most important, the market of structural radar absorbing materials is extremely low in Europe with negative consequences for the supplier base.

Due to the highly confidential development environment, LO material development has been subjected to national confidentiality in the pre-ALOA era. Only limited data exchange has been possible even within previous multinational programs. The result of this situation is that the market for LO materials is highly separated between the different countries, with each market volume too small to make the establishment of a stable supplier base easy. On the other hand, stealth materials alone are no longer the most sensitive aspect of a LO design. Nowadays, the critical LO know how lies more on LO platform and component design as well as on realization aspects. Therefore, there is the possibility for a higher level of cooperation on the pure material level.

Upcoming counter-stealth technologies put additional pressure on the LO technology, as increased bandwidth and multispectral treatment efficiency are required for the next generation of LO materials.

Within the precursor program EDA B-003-GEM1-ERG “Advanced Low Observable Materials (ALOA)”, requirements for LO materials have been established and necessary material candidates have been identified. These material candidates have been developed and tested on sample level.

The ALOMAS program did follow on from the research results achieved within ALOA. The main emphasis of the ALOMAS project was the improvement of materials and development tools and the increase of the Technology Readiness Level (TRL) of the materials developed in ALOA. The main goals of ALOMAS have been:

Progress of the radar and multispectral LO materials and structures to higher TRL levels by

- Further development of materials from ALOA.
    - Realization of demonstrators, e.g. realization of demonstrator components and application of multispectral paints to demonstrators.
    - Tests in relevant environment and in-service tests.
    - Development of the manufacturing technology for enlarging the scale of production.
- Improvement of absorber technology
    - Further development of LO structures.
    - Investigation of new absorption materials.
- Demonstration of environmental resistance of LO materials.

To increase the TRL levels of the present materials, demonstrators are used.

- The demonstrators reflected the application conditions.
- The demonstrator design definition was part of ALOMAS.
- Structural demonstrators for aerospace applications have been ground demonstrators.
- Coating technologies are demonstrated in a laboratory and in a real-world environment.

The project has been started officially on December 4th 2014, with the signature of the ALOMAS contract.

1.1. Management

1.2. General issues

The work breakdown structure (WBS) of the ALOMAS project as shown in Figure 1 is defined as described in the Volume 1 "Technical Proposal" of the ALOMAS proposal.

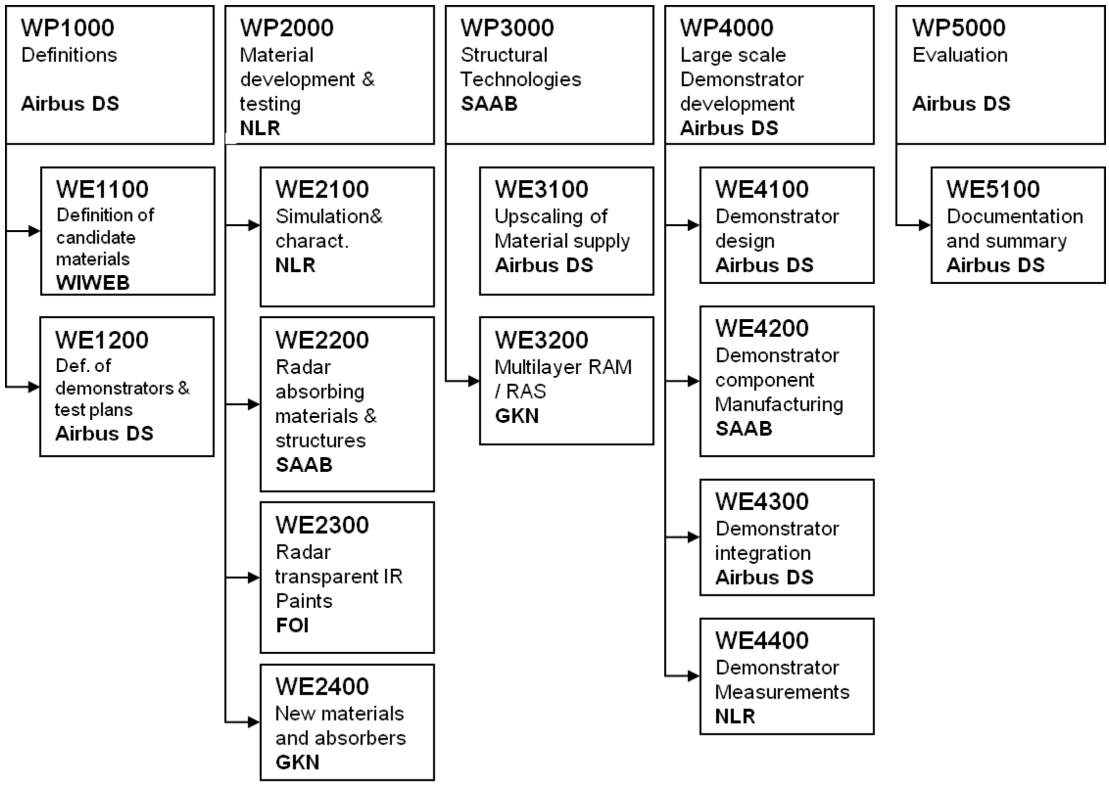

Figure 1 ALOMAS work breakdown structure.

1.3. Deliverables

The preparation of each deliverable is conducted in Work Elements and summarised in Work Package Technical Reports. Each Work Element completed with a report. A Final Report and an unclassified Executive Summary Report has been prepared.

1.4. Value

The total value of ALOMAS has been 1.510.000 € + 12.285.00 SEK + IND contr. (≈1 M€ per Nation)

2. Results from the work elements

2.1. WP 0000 Management

WP 0000 "Management" is considered a background activity with no separate WBS notation. Progress review meetings have been performed every 6 months. The meeting locations has been defined based on a rotation between the partners to evenly distribute the effort.
To reduce travelling efforts as much as possible, project meetings have been held directly in advance to the progress review meetings. For technical meetings, net meetings were used whenever possible.
As a general policy, TAMG members have been welcome to all technical and industrial meetings as well and are invited at least on a voluntary basis.

2.2. WP 1000 Definitions

As a basis for a co-operative development, common definitions and decisions have been established. Within WP 1000, these definitions and decisions have been set up.

First, candidate materials for detailed investigation in ALOMAS have been identified, with special attention to materials developed in the previous project ALOA.

To increase the TRL levels of the material and structure technologies, demonstrator components and platforms have been identified that have been investigated within ALOMAS.

For demonstrator components, typical applications of the materials and structures have been identified and demonstrator components for electromagnetic and mechanical testing have been described. Examples are:

- Large sandwich panel assemblies
- Leading and trailing edges
- Door installations

For demonstrator platforms, suitable platforms and associated test components and/or installations have been defined based on the available budget and the associated complexity. Decision was for

- Demonstration of IR coating technologies on an airborne platform (TORNADO combat aircraft).

Appropriate test plans have been established to reach the expected demonstration goals.

2.3. WP 2000 Material development & testing

The main emphasis of the project has been the improvement of materials and structures and their demonstration. Thus, the capabilities to simulate, design and manufacture radar and IR materials and structures has been investigated.

The main output of this Work Package has been the manufacturing at a quite industrial step, and performance evaluation of elementary materials for LOW observable applications (Radar and IR ones).

In order to help the materials design, the simulation tools shall be enhanced and validated. For the two main material categories,

- Dielectric and/or magnetic materials for radar application and
- Multispectral materials,

the material technology has been improved especially regarding the technology for manufacturing larger components and for enlarging the scale of production.

Pre-ALOA & ALOMAS there has been a deficiency on material models for the development of new materials. A key activity of ALOMAS has been to develop and improve the material models based on magnetic and/or conductive loss fillers.

Simulation tools have been prepared to help with the material design. Material models as well as existing design and optimization tools for multilayer absorbers have been compared in the consortium by comparison to material measurements and by common test cases, see Figure 2.

The validity of the radar signature testing in the consortium has been assured by comparison of joint test samples.

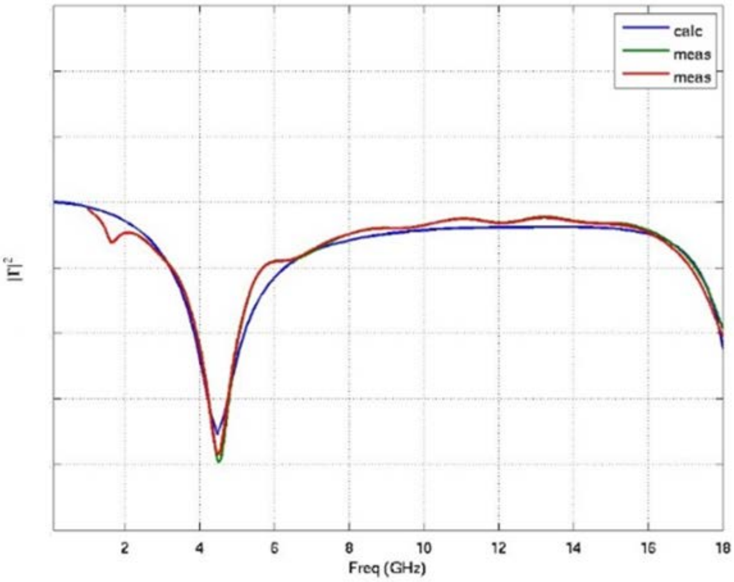

Figure 2 Example of the comparison of measured and calculated return loss of an absorber.

Two different types of LO surface coatings have been developed and/or investigated:

- Radar absorbing paints.
- Infrared camouflage paints.

Paint samples have been characterized for their mechanical and camouflage properties, see Figure 3. The radar transmitting properties of the IR paints have been optimized to make the paint compatible with RAM & RAS.

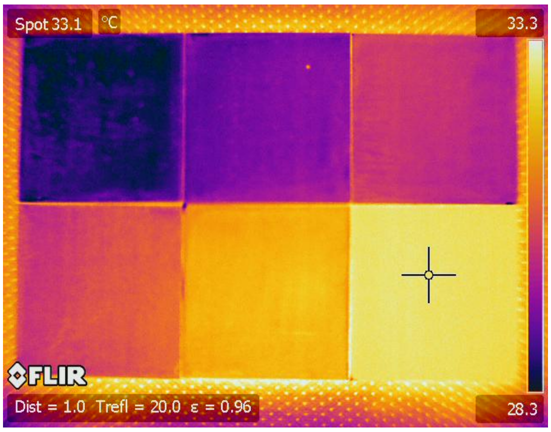

Figure 3 IR reflectance measurements of different paint samples.

2.4. WP 3000 Structural technologies

Based on the material investigations done in WP 2000, the technology for design and manufacturing of larger components and demonstrators have been developed. This includes:

- Large scale manufacturing of advanced materials with industrial processes, e.g. new honeycomb or foam materials, magnetically or dielectrically loaded preforms and prepregs.
- Manufacturing of LO material structures with complex layer sequences.
- Manufacturing with tight tolerances, both with regard to layer properties (e.g. orientation, stability of EM properties and thickness) as well as regarding interface tolerances.

Structural LO materials have been developed and tested:

- Glass fiber composites with embedded magnetic filler particles, see Figure 4.
- Thermoplastic matrix composites with magnetic fillers.
- Syntactic foams with dielectric and magnetic fillers, see Figure 5.
- Honeycombs with ohmic losses.
- High precision resistive layers.

From these materials, multi-layer composites have been designed, manufactured and tested.

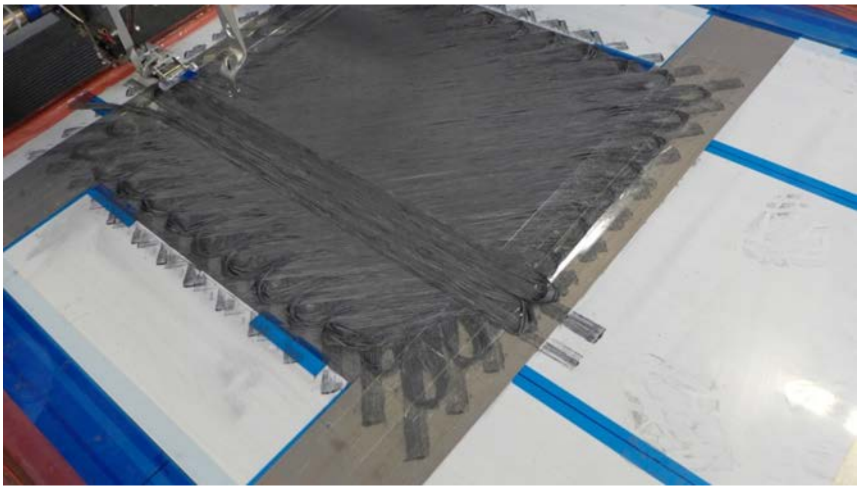

Figure 4 Glass fibre fabric with embedded magnetic filler particles during tow placement.

Figure 5 Machining of Aramid absorber foam samples.

2.5. WP 4000 Large scale demonstrator development

For the demonstrator components and platforms defined in WP 1000, the necessary designs have been established in co-operation with the respective design offices. The demonstrator components have been manufactured based on the materials developed in WP 2000 and WP 3000.

Demonstrators from the investigated materials have been developed and tested, e.g.

- Leading and trailing edge demonstrator structures, see Figure 6.
- Multilayer panels.
- Panels with integrated surface wave damping.

Radar signature measurements have been performed at different test facilities within the consortium. The radar signature results between the different test facilities have been compared to verify the validity of the measurements.

The measured radar signatures have been compared to the predictions from simulation to verify the simulation tools.

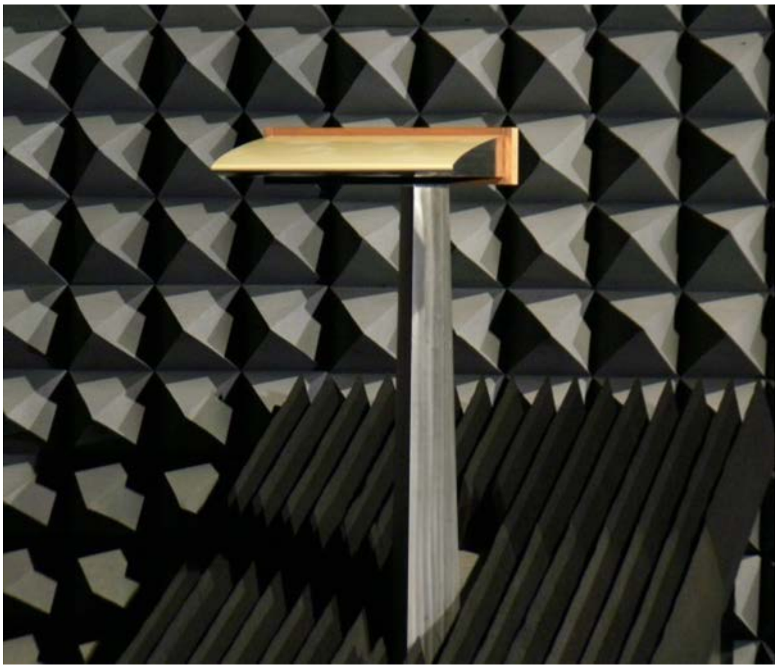

Figure 6 Leading edge demonstrator structure.

Samples of LO paints from the consortium have been applied to a German TORNADO test aircraft at the Flight Test Center of the German Air Force (WTD61), see Figure 7and Figure 8. Long term flight tests have been performed.

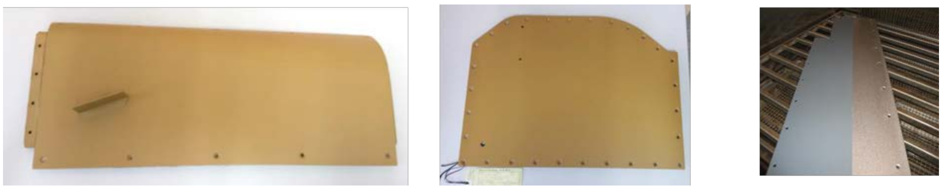

Figure 7 Doors on the TORNADO test aircraft painted with different IR paints for long term flight testing.

Figure 8 Location of the doors on the TORNADO test aircraft.

2.6. WP 5000 Evaluation

Based on the material and demonstrator data from WP 2000, WP 3000 and WP 4000 and the assessment criteria defined in WP 1000, an assessment has been performed for each demonstrator component and platform.

3. Conclusion

The ALOMAS project has been started officially on December 4th 2014, with the signature of the ALOMAS contract.

The ALOMAS program did follow on from the research results achieved within ALOA. The main emphasis of the ALOMAS project was to improve materials and development tools and to increase the Technology Readiness Level (TRL) of the materials developed in ALOA.

The main emphasis is the improvement of Low Observable (LO) materials, the required development tools and the increase of the Technology Readiness Level (TRL) of LO materials.

Simulation tools for material modelling and the design and optimization of multilayer absorbers have been developed and/or improved and validated by comparison to measurements.

New materials have been developed:

- IR camouflage paints
- Radar absorbing paints
- Composite materials with radar absorbing properties
- Radar absorbing core materials

From the new materials demonstrators have been manufactured and tested.

Long term flight test on IR camouflage paints on a fighter aircraft have been performed.