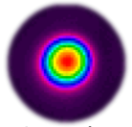
HIGH STRENGTH ALUMINIUM

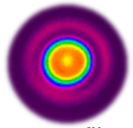
The investigations on high-strength aluminium alloys were successfully completed and process parameters for the AlSiSc alloy were developed. Compared to the previous standard alloys, the new alloy is characterized by higher strength values with constant elongation at break. In addition, these properties can still be adapted by heat treatment.

Demonstrator 1:	**Demonstrator 2:**	**Demonstrator 3:**
A330NEO Jack Actuator Bracket	A340 Hydraulic Block	A350XWB T-Mount Fitting



PRODUCTIVITY AND EFFICIENCY


Gaussian

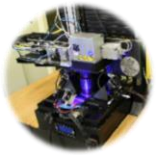

M-Profile

Parameter studies using optimized beam profiles had shown great potential for the ALM technology regarding reducing defect formation such as porosity, residual stresses and surface roughness.
The optimized profile allows achieving higher speeds and bigger hatch distances while keeping a density above 99.7 %.
This increase in build rate and power efficiency reduces the driving production costs in ALM while sustaining a more stable and robust process.

QUALITY CONTROL FOR AM

The main challenge in the in-line quality inspection of ALM parts is the complete automation of the control of both the geometry and the internal defects of the part.
A structured light sensor has been chosen to control the geometry of the part while internal defects are checked using ultrasonic techniques.

STRUCUTRAL LIGHT 3D SYSTEM



Layer-by-layer high resolution 3D digitalization opens up the potential for better understanding the additive process and therefore also for process feedback control. The system developed is capable of capturing each layer of the powder bed at a lateral resolution of 50µm with 50 million measurement points. It enables in-process quality control.

CONSORTIUM

Fraunhofer IAPT
» Hamburg, Germany

cenit
» Hamburg, Germany

AIRBUS
» Hamburg, Germany

tecnalia
» San Sebastián, Spain

UNE
» Madrid, Spain

TEKNA
» Mâcon, France

HEXAGON
» Turin, Italy

HEXAGON
» Heerbrugg, Switzerland

Enlyte Ltd.
» Gloucestershire, UK

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Project Website: www.bionic-aircraft.eu

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Increasing resource efficiency of aviation through implementation of ALM technology and bionic design in all stages of an aircraft life cycle

The Bionic Aircraft project has received funding from the European Union`s Horizon 2020 research and innovation programme under grant agreement No. 690689

www.bionic-aircraft.eu

PROJECT VISION & GOALS

To reduce the impact of the growing aviation industry on European citizens, there is the need to reduce emissions in all successive phases of an aircraft lifecycle.

AM technologies enable great weight saving potential for structural components and significant reduction of material waste during production. Studies of topology optimized and bionic lightweight structures in titanium show up to 40% weight reduction with production waste less than 10% of the initial material. With the introduction of high strength aluminium alloys even greater weight saving is possible. The weight reduction and waste reduction through the introduction of AM will significantly reduce CO_2 and NO_x emissions.

In addition to introducing optimized single components in the near future, Airbus already envisions creating entire airplanes based on concepts of biomimetic, which could only be realized by utilization of Additive Manufacturing on a broad scale and promise a weight saving of up to 30%. Furthermore, the design freedom of AM can be used to optimize the functionalities of a part, reducing emissions during aircraft operation.

- **Design guidelines** for lightweight Aluminium Additive Layer Manufactured (ALM) parts
- Automated **Bionic** Lightweight Design Process

- New high-strength ALM **Aluminium alloys**
- Highly productive ALM process with innovative **beam shaping** optics

- Integrity system for **complex ALM** parts
- Innovative **non-destructive-test methods** and repair **concepts**

- Innovative ALM-based **after-sales supply chain**
- **Recycling** for ALM parts and "out of specifications" powder

PROJECT AMBITIONS

- overcome challenges in processing high strength aluminium material with ALM
- understand complex interaction of design restrictions with geometry of the part and material
- integrate robust and flexible parameterized definition of bionic features in CAD pre-processing
- comprehend influence of various process factors and complex interaction of laser beam profile and powder
- develop an integrity system for optimized ALM parts with complex shaped biomimetic structures which works in the harsh environmental conditions of the ALM building chamber
- advance repair processes of ALM parts utilizing thermal spray or laser metal deposition when aircraft on ground (AOG)

RESOURCE EFFICIENCY CYCLE

During manufacturing
- Increase of capture efficiency for ALM powder production for aluminium by 30%

During operation
- Reduction of emissions due to average weight reduction of >30% for structural optimized ALM components

In maintenance
- Repair methods for ALM components which increase service life up to 50%
- Determination of efficient after-sales supply chains

In recycling
- Increasing recycling rate for ALM parts to 95% due to development of an efficient recycling method

BIONIC DESIGN & OPTIMIZATION

BIONIC TOOLSET

With the implementation of the feature recognition into CATIA V5 we demonstrated an automated way of working for the process step of design interpretation. The feature recognition is based on the Bionic Catalogue with a collection of parametric bionic features. This catalogue will be extended in the next month with features like a seagull feather shaft or a banana petiole.

BUILD PROCESSOR

Another major mile stone in the project was achieved with the development of a post processor for ALM machines. The post processor uses the exact slice data from CATIA V5 to generate the data needed by the ALM machine. This is the enabler for the conventional NC rework of the printed part based on exact geometry without the need to use the inaccurate, tessellated STL format.

BIONIC SUPPORTS

Two new support types for different application cases (boreholes and overhanging surfaces) were designed and experimentally compared to state-of-the-art structures. Both structures result in material saving and a better removability compared to the standard block support.

Tree support
- 88% less material consumption
- 75% time saving while support removal

Fractal lattice support
- 75% less material consumption
- 60% time saving while support removal