



## DEVELOPMENT OF MATERIALS AND PROCESSES FOR THE APPLICATION OF PIEZOELECTRIC MATERIALS IN AERO ENGINE CONTROLS

### BACKGROUND

ACARE (the Advisory Council for Aviation Research and Innovation in Europe) has set guidelines for the environmental impact of aerospace that target significant reductions in aircraft emissions. Gaseous emissions such as CO<sub>2</sub> and NO<sub>x</sub> are essentially a product of airframe and powerplant performance. A potential route to improving performance, thereby reducing emissions, is the introduction of active control technology in aero engines to increase efficiency.

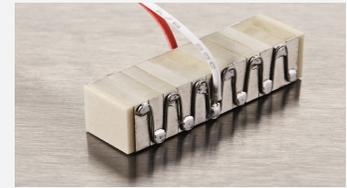
An enabler of active control techniques is the capability to manage and manipulate fluid flow, which is limited by the characteristics of existing electromechanical and hydraulic actuation devices. These limitations include frequency response, cyclic life and durability under harsh operating conditions. Piezoelectric ceramic technology has the potential to overcome some of these limitations; offering a route to highly reliable actuation devices.

### OBJECTIVE

AEROPZT will address the challenge of developing more capable piezoelectric ceramics, protective encapsulation systems and actuator designs, targeting fluid flow control challenges (e.g. lean-burn combustion fuel staging).

In this application the aim is to maintain precise control of flow between pilot-main fuel streams to enable combustion processes that reduce NO<sub>x</sub> emissions. Additional active control elements include management of lean-combustion thermoacoustic instability and lean-blow out.

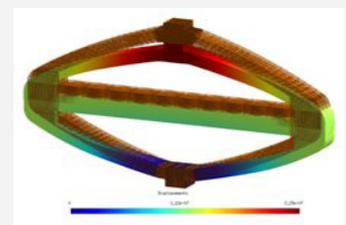
It is expected that the technologies developed within this project will have a wide range of device applications, such as direct clearance control actuation, air flow manipulation for boundary layer control and sensor devices.



High temperature multilayer actuator (MLA)  
Noliac A/S



Encapsulated Pre-stressed Piezoelectric Actuator (PPA-E)  
Cedrat Technologies SA



FEM simulation of the amplified piezo actuator (APA®)  
PoliTo



Aero Engine

## > PROJECT PARTNERS

**Plant Integrity (PI)** is a world leader in long range ultrasonics (LRU) and non-destructive testing (NDT) inspection methods for structural health monitoring (SHM) using PZT technology.

As the Coordinator for AEROPZT, PI will lead and manage the project. PI will also carry out non-destructive testing and micro-structural analysis of the piezo ceramics and the actuator assemblies.

[www.plantintegrity.com/](http://www.plantintegrity.com/)

**CEDRAT TECHNOLOGIES** is a world leading SME in smart actuators, sensors, mechatronics and detection systems.

Cedrat Technologies is responsible for the design of the Piezoelectric Actuator and associated drive to be used for the demonstration of capability in an aero engine environment.

<http://www.cedrat-technologies.com/>

**Noliac A/S**, Noliac presents a unique proficiency in the field of piezoelectric technology. It designs, develops and manufactures the total range of piezoelectric products from powders to mono- and multilayer components, through to complete plug-and-play applications. Noliac is responsible for developing/delivering the piezoceramic material for the AEROPZT project, along with designing and manufacturing the MLA device for the actuator.

[www.noliac.com](http://www.noliac.com)

**PoliTo** and the **MUL2** research team have been developing advanced structural models for the analysis of multi-layered structures and performing multi-field analysis for over 20 years.

Within AEROPZT PoliTo will develop a multi-field structural model of the actuator and perform numerical analysis and simulation of the device.

<http://www.mul2.polito.it/>

**Controls and Data Services Ltd** is part of the Rolls-Royce Group. It provides a single solution for the design, manufacture, procurement, testing and support of high-integrity, harsh environment control systems, including safety critical software, electronic, electrical and hydro-mechanical products.

<http://www.aeroenginecontrols.com>

*Controls and Data Services Ltd are the Clean Sky Joint Undertaking - Topic Manager for this project.*

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