

V.K.I. lecture series
“Plasma Flow Control - Fundamentals, modeling and Applications”

Plasmas Devices for Aerodynamic Improvement. Examples of applications.

D. Caruana

*ONERA - Aerodynamics and Energetics Models Department (DMAE),
Centre Midi-Pyrénées, 2 av. Edouard Belin, 31055 Toulouse, France*
daniel.caruana@onera.fr

1. Introduction

With the continued objective of increasing aircraft performances whilst reducing the environmental impact, research is being carried out to find innovative solutions to influence air flow using simple actuators. If the aerodynamic configuration of future aircraft could be modified in real time in flight, then the aircraft's performances could be continually adapted to provide optimum characteristics leading to reduced fuel burn through improved lift with less drag; reduced speed with shorter and steeper landing and take-off paths to reduce ground noise and provide faster cruise speeds at higher altitudes. These active actuators could be installed on future civil aircraft, both large and regional, and could considerably simplify the design of wings both in size and also by the removal of complex control surfaces leading to a gain in aircraft weight.

Among the innovative solutions, the use of plasma technologies has shown itself to be very promising from both a performance point of view and in terms of the diversity in potential applications from external and internal flow control, combustion, enhancement and noise attenuation. The main advantages of plasmas devices are their manufacturing and integration simplicity, low power consumption, ability for real time control at high frequency and their robustness.

Numerous projects were realized, are in progress or in preparation. The main themes of studies are the detailed knowledge of the aerodynamics to be improved, of its interaction with the means of action as well as the technical realization of actuators.

PlasmAero project, Useful PLASMA for AERodynamic control, co-funded by the European commission through FP7 framework, has began last 1st October 2009 and seeks to demonstrate how plasmas actuators can be used to influence and control aircraft flow (ref. 1).

This document is inspired by the publication “Plasmas for Aerodynamic Control” referenced “Plasma Phys. Control. Fusion 52 (2010) 124045” (ref. 20) and summarizes the lecture. It will discuss the needs in aerodynamics improvement and flow control, will describe the plasma technology and the chosen plasmas devices, particularly for European PlasmAero project, will give some aerodynamic applications for civil aircraft (wing separations, wing tip vortex, boundary layer delay and fixing, buffeting, jet exhaust noise, ...). It will present PlasmAero project organization and objectives. No results from PlasmAero will be given because works are too much recent and need analysis improvement.

2. Needs for aerodynamics improvement

2.1. Aerodynamics improvement for transport aircraft

With the continued objective of increasing aircraft performance whilst reducing the environmental impact responding to the ACARE 2020 target, researches are being carried out worldwide to find innovative solutions to influence air flow using simple actuators. European projects on new technologies and innovative devices has been or is being performed (HYLTEC, ALTTA, EUROSHOCK, C-WAKE, AWIATOR, M-DAW, AEROMEMS, AVERT, SUPERTRAC, CLEAN-SKY, OPENAIR, PLASMAERO, ORINOCO, ...) with the overriding aim of improving the aircraft's aerodynamic performance by controlling air flows.