THEME [JTI-CS-2011-1-SFWA-01-035]

[Grooved paint surface manufacturing and aerodynamic testing]

Publishable Summary

Project acronym: RIFPA

Project full title: "Grooved paint surface manufacturing for aerodynamic drag reduction testing"

Grant agreement no: 296489

Reducing the friction drag is a major stake for subsonic aircrafts. For modern transonic commercial aircraft, friction contribution represents half of the total drag.

Among possible solutions, passive surface geometry seems to be particularly interesting. The effect of riblets or grooved surfaces has been demonstrated by ONERA through studies in wind tunnels and models [1].

In the 1990's, a scale one experiment was engaged by Airbus Industry on an aircraft with a vinyl coating adhesive designed by 3M company.

However, plastic stickers revealed difficult to apply and maintain, with a loss of sharpness on the edges.

Grooves directly made of paint should have a far better duration and performance than plastic stickers. Aeronautical paintings are especially aggressive and represent a significant weight compared to the useful load of airplanes.

Removing and maintaining paints are also very pollutant. Costs and immobilizations of planes for painting operations are quite important.

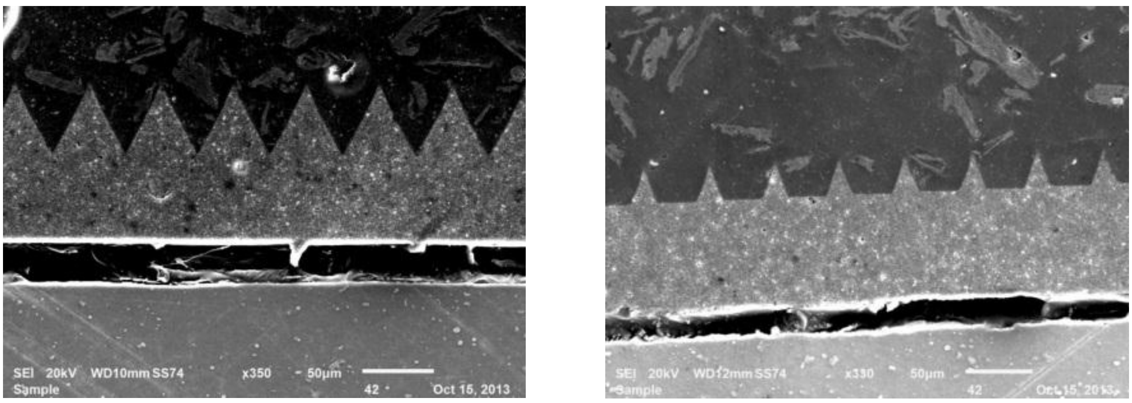
Corso Magenta brings a new approach [2]: beside liquid and powder, paint can also be considered as a finished layer, machine under controlled conditions, then applied as a protective or decorative coating.

Corso Magenta process provides an important reduction in the environmental impact: no losses during application, no VOC evaporation during application, no drying time …

Corso Magenta contribution to the JTI Clean Sky SFWA-ITD is to provide ONERA with new innovative micro grooved (riblets) painted films to evaluate the aerodynamic performances of riblet materials under transonic flow conditions.

Two different cross-sections have been produced: a "saw-tooth V-type" with an aspect ratio s/h equal to 1 (rib spacing, s=50 µm; rib height h=50µm) and a "trapezoidal-type" with s/h equal to 2, h=25µm and a peak thickness, t/s= 0.025.

Geometry is extremely precise: it represents a real issue and values are closed to expect ones in the range of accepted tolerances (Figure 1). Sample test films have been designed with a self-adhesive layer.



(a) (b)

Figure 1: SEM images of the paint film with riblet shapes (a) saw-tooth "V-type" cross section; (b) "trapezoidal-type" cross section.

The goal of RIFPA project being to perform wind tunnel campaigns, CORSO MAGENTA attends part of the tests in Modane from October 21th 2013 to October 25th 2013.

The tests have been performed at ONERA S3MA transonic wind tunnel with the existing ogive-cylinder model tested in the former ONERA T2 transonic wind tunnel which is now closed.
During the test different Mach numbers (from 0.3 to 0.8) and different stagnation pressures (from 1 to 2.5 bars) have been studied to measure associated drag friction coefficient.

To highlight the riblet effects on drag friction coefficient, a smooth cylinder has been tested as the reference.

The aerodynamic benefit of the "trapezoidal-type" riblet profile has been put in evidence qualitatively in the range of Reynolds number considered.
So, the riblet technology could be a very promising enabler for reducing fuel burn.

[1] E. Coustols and J. Cousteix, AIAA Journal, vol.32, n°2, pp 431-433
[2] Corso Magenta Patent: FR 2881681 filed in 2005