RIBLETS: READY FOR APPLICATION ON NEXT GENERATION AIRCRAFTS?

Renato Tognaccini[(1)], **Benedetto Mele**[(1)], **Pietro Catalano**[(2)], **Donato De Rosa**[(2)],
Gaetano Iuso[(3)], **Salvatore Sedda**[(3)], **Maurizio Ventre**[(4)]
[(1)] *DII, Università di Napoli Federico II,*
Piazzale V. Tecchio 80, 80125 Naples, Italy, Email: rtogna@unina.it, benmele@unina.it
[(2)] *Centro Italiano Ricerche Aerospaziali,*
Via Maiorise, 81043 Capua (CE), Italy, Email: p.catalano@cira.it, d.derosa@cira.it
[(3)] *DIMEAS, Politecnico di Torino,*
Corso Duca degli Abruzzi 24, 10129 Turin, Italy, Email: gaetano.iuso@polito.it, salvatore.sedda@polito.it
[(4)] *DICMAPI, Università di Napoli Federico II,*
Piazzale V. Tecchio 80, 80125 Naples, Italy, Email: maventre@unina.it

KEYWORDS:

Aerodynamics, Drag Reduction, Riblets, Skin Manufacturing.

ABSTRACT:

Riblets are streamwise grooved surfaces able to reduce the skin friction in turbulent regime. Despite they have been successfully tested even on large commercial aircrafts, they have never been introduced in practice. However they are still the only passive drag reduction system which has the potentiality to be introduced in next generation air transport. In present paper the reasons why they still have not been adopted are discussed. In addition, it is described how we are trying to overcome the actual show stoppers within UE funded Clean Sky 2-REG Research Program. Efforts have been undertaken in Manufacturing technology, Theoretical and Experimental Aerodynamics.

1. INTRODUCTION

Following the energy crisis in the 70's, several studies involving the development of drag reduction mechanisms were made; today there is renewed interest. Indeed, current concern over environmental pollution is forcing manufacturers to reduce pollutant emissions not only in the industrial field but also in the transport sector.

One of the most interesting passive drag reduction techniques is based on the use of riblets or stream-wise grooved surfaces. These are very likely the only aircraft profile drag reduction system mature for application in the next generation aircraft [1].

Naturalistic studies had shown that the skin of fast moving sharks is covered by stream-wise microscopic ridges. In the 70's and 80's fundamental studies were performed at NASA by Walsh & Weinstein [2]. Further experiments were performed by Bechert *et al.* [3] in Germany. The tests performed by NASA showed that the mechanism of drag reduction is strictly linked to riblet shape. In particular effective results could be obtained by *V-grooved* geometries, in which riblets have sharp triangular ridges. Such riblets guarantee a maximum drag reduction of $6-8\%$. Bechert [4] showed improved performance using different, although less practical, shapes. During the 90's the experiments of Bechert and the studies of Luchini *et al.* [5] contributed to clarify the involved drag reduction mechanism. The firm 3M $\&$ Co. produced riblets as plexiglass surfaces in the form of sticky tapes which have been used on sport sailing ships with a great success (see 1987 Stars and Stripes and 2010 BMW Oracle in America's Cup). In Aeronautics, several flight tests have been performed with interesting results in term of fuel consumption reduction, but in practice riblets have never been definitely adopted. This is mainly due to manufacturing and maintenance problems. Indeed 3M riblets life cycle on an operating aircraft revealed not sufficiently long in order to recover an effective reduction of direct operating costs, taking also into account for the required additional maintenance time. In addition visual inspections required by safety maintenance are limited by the adoption of a sticky tape.

Our research team started its activities on this topic