Piezoelectric Based Ice Protection System: Preliminary Modelling and Experimental Results (2017)

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There are number of negative effects of ice accretion on the aircraft structures that may seriously compromise safety of aircraft operation. E.g. ice accretion may change smooth flow of air over the wing, leading to severe decrease in lift and increase in drag forces, it also may cause damage to external equipment such as antennas. Therefore, Ice Protection Systems (IPS) are of critical importance for aircraft, being one of the major safety ensuring systems on board. Increasing demands upon the aviation Industry to reduce emissions and associated net passenger mile costs are forcing designers of new aircraft to turn their attention towards more-electric aircraft (MEA) solutions. It is, therefore, anticipated that new platforms will increasingly utilise alternative electrically based technologies for IPS. Whilst large airframes have the capacity to generate significant levels of electrical power, compatible with Electro-thermal power requirements, this is not the case on smaller airframes e.g. Business Jets. Existing technologies that can provide viable Ice Protection at low electrical power employ Electro-Expulsive (EEDI) and Impulsive (EIDI) concepts for the electro-mechanical de-Icing of surfaces. These concepts however, exhibit a number of drawbacks, such as reliability, slow reaction, and change in airfoil shape. One of the possible solutions that is widely investigated in this area is based on piezoelectric effect. The present work is focused on a development of an alternative ISP on the basis of piezoelectric effect, making such systems compatible with small airframes. An extensive FEM modelling of piezo-based IPS for simplified aircraft structures (flat plates) and airfoil type structures has been performed, estimating shear stresses that can be achieved at the metal - ice layer interface. Comparing to the data available in the literature, such modelling has been performed not only for the steel based structures, but also for aluminium based structures, also considering different types of piezoelectric actuators (hard- and soft-PZT based). An icing system (simplified wind tunnel system) has been developed internally on the basis of available climatic chamber and a successfully tested for different types of aircraft structures. Finally, first prototype of a piezoelectric based IPS has been demonstrated, showing successful de-icing of two different types of ice (rime ice and glaze ice) on steel and aluminium based structures.

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