Mechanical behaviour of a multifunctional panel for de-icing systems

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Carlo Giovanni Ferro [1], Sara Varetti [2,3], Salvatore Brischetto [1] and Paolo Maggiore [1]

[1] Department of Mechanical Engineering and Aerospace (DIMEAS), Politecnico di Torino, Corso Duca Degli Abbruzzi 24, Email: carlo.ferro@polito.it
[2] 3D- New Technologies (3D-NT), Str. Carignano, 48/2, 10024 Moncalieri (TO), Italy
[3] Department of Applied Science and Technology (DISAT), Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy

Anti-ice and De-ice are critical systems on modern airplanes. The potential hazards caused by the formation of ice on the external surfaces are various: from the loss of important flight data (such as flight speed and altitude) with the icing of air probes to more severe hazards such as the locking of the movable surfaces or also increase of drag due to the changing of the aerodynamic profile. To face this problem during the years different techniques have been adopted. One of the first solution was to add on the leading edges of the wing polymeric tubes to inflate with pneumatic air source; in this manner, the ice attached to the wing is removed mechanically. Other system uses different sources such as chemical sources (glycol) but are not suitable for large aircrafts. The most diffused plant takes hot air from the engines compressor and heat the sandwich panels of the wing blowing from the inner skin. This system requires feeding tubes (generally made of aluminium), valves and complex passageways to enhance the specific heat exchange surface. The proposed solution overcomes this adding of weight introducing a single sandwich panel with a porous cellular core, that have both structural and thermal functions. This device integrates, in a single component, the passageways of the hot air and the structure of the leading edges, without welding or bonding, due to the use of Additive Manufacturing (AM). In fact, this technique allows the production of complex geometries without additional costs. Moreover, it promotes the realization of components with a great by to fly ratio due to less use of material. Selective Laser Melting (SLM) is a Powder Bed Deposition AM technology: a technique that selectively melt the powders, deposited in layers, according with STereo Lithography interface format (STL) data provided. Layers by layers the component is produced and finally extracted from the machine, separating it from the un-melted powders that can be reused. The realization of a sandwich panel with a core in trabecular structure fully exploits the potential of the technology: as said before these structures are necessary to ensure a great heat exchange between the anti-icing panel material and the hot air tapped from the engine. To further improve the efficiency of the device, a material with a great thermal conductivity, like aluminium alloys, is chosen. In particular, the components are produced with AlSi10Mg powders, a traditional casting alloy, for which the SLM machine parameters are already been optimized. AM technology allows the production of sandwich panels with a very different structure in respect to the traditional one type actually used in aerospace industry: the component is made in only one material and in one piece, without welding and polymeric bonding. It a beneficial point for both the thermo-mechanical behaviour and the final weight of the device. The present work exploits the mechanical behaviour of this porous core sandwich with a comparison between experimental results collected from experimental characterization with numerical analysis based on a dedicated finite elements model. In particular, compressive tests will be presented for the porous core together with three points bending on the complete sandwich panel.