New anti-ice coating for aeronautical application

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The main problem for the aircrafts is the ice formation on a critical components (leading edge, slat, vertical tails, etc…) that decrease reliability and safety of the flights. Present methods which prevent or oppose the ice nucleation and growth are not effective and several studies are ongoing.

Passive method such as superhydrophobic and anti-icing coatings, are potentially employed to prevent the ice adhesion.

The aim of this work was to design and characterize multifunctional aeronautical coatings with anti-ice properties, high adhesion and abrasion resistance.

In order to evaluate anti-ice properties, a new way to characterize these coatings was employed. To evaluate the adhesion between the supercooled water droplet and surface, the chemical and physical properties of the surface were determined. In particular two performance indexes are taken into account: wettability and surface free energy.

The characterization of anti-ice properties are carried out through an instrument for contact angle measurements modified with a special test chamber. In the test chamber, the flight condition of pressure and temperature were reproduced. In fact, at a certain values of flight altitude, temperature is under zero degree and pressure values are reduced. The replication of these conditions represents the key to evaluate the interaction between the supercooled water droplet and surfaces in real condition.

The special test chamber was validated using a standard polymeric material such as polypropylene. It was demonstrated that a surface apparently hydrophobic below zero degree and with pressure value at sea level, in real conditions of flight, is partially hydrophilic. Therefore this useful tool gives a further added value on a characterization of the anti-ice coatings.

Contact angle measurements using this new tool, were performed on new anti-ice coating. Results corroborated the influence of temperature and in particular of pressure on the shape of the supercooled water droplet applied on the new anti-ice coating.

Mechanical tests were carried out to determine the main properties of the anti-ice coating; In particular hardness and elastic modulus were similar to those of the commercial coatings employed in aeronautical field.

On the contrary pull-off tests, carried out to determine the critical load of delamination, showed an improvement of the adhesion of the new anti-ice coating respect to the commercial one.

Finally, tests to determine the resistance to hydraulic fluids (such as Skydrol) were performed. The new anti-ice coating showed the same resistance respect to the commercial one, in addition the superhydrophobic behavior of the new coating protect it further from all types of fluids.

References

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