Centro Italiano Ricerche Aerospaziali

Substrate superhydrophobic and icephobic coating, method for obtaining it and substrate thus coated.

Summary:

The invention deals with the development of superhydrophobic and icephobic coatings' formulations and their application to different substrates.

Benefits:

The benefit of superhydrophobicity is to allow the water droplets impacting the aircraft surfaces to slip away before freezing during the crossing of clouds.

Problem addressed:

The formation of ice can be very dangerous to flight safety, especially in cold climates, since the ice accumulated on the surfaces of the aircraft can alter the aerodynamics, increase the weight, and reduce lift, leading in some cases to catastrophic stall situations. Currently, risks caused by the ice accretion are mitigated by using energy demanding active Ice Protection Systems (IPS), which work either preventing (anti-icing) or removing ice (de-icing). However, for a future sustainable aviation, low energy demanding IPS must be designed. Hybrid IPS, which combine active IPS with passive superhydrophobic/icephobic coatings, able to prevent, delay, and/or reduce the ice accretion, might represent a valuable solution, reducing the energy consumption and the CO_2 emissions.

Proposed use:

Developed superhydrophobic/icephobic coatings have been developed in the aeronautical field as passive IPS. However, they can be successfully employed in other fields, such as in the automotive, transport, marine, energy (wind turbines, solar panels, high voltage electrical cables), and packaging.

Technology overview:

The coating is a multilayer paint made of a primer and different nanostructured layers, applied with an aerograph and then cured. The coatings make superhydrophobic and water repellant the surfaces. At low temperature between 0 and -12°C, they reduce the accreted ice on aircraft surfaces. Moreover, it has been demonstrated that these coatings are capable of reducing ice adhesion strength, meaning they allow for easier ice detachment compared to uncoated references. Finally, they have been demonstrated to preserve metallic components from corrosion. The advantage of this treatment is the facility of making all surfaces superhydrophobic and water repellant just through the application of a coating.

Reference projects:

Coatings' design and developments have been performed in the framework of the following two projects:

1. **SMOS** (SMart On-board Systems) project funded by the Italian Ministry for Education, University and Research (MIUR) through the National Aerospace Research Program (PRORA) D.M. 305/98 art. 4 comma 1

Centro Italiano Ricerche Aerospaziali

2. H2020 Clean Sky 2 Framework (CS2), 807083—AIRFRAME ITD (GAM AIR 2018), Topic Identification Code: JTI-CS2-2015-CPW02-AIR-02-07, acronym: 699757/**SAT-AM** (More Affordable Small Aircraft Manufacturing).

Developed coatings have been/are being employed in the following projects:

1. **NATO AVT-332**: In-Flight Demonstration of Icephobic Coating and Ice Detection Sensor Technologies.
2. **C4N project** Contratto di ricerca Leonardo Velivoli-CIRA N. 8220050939.
3. Ultra Performance Wing **UP-WING** Clean Aviation Project
4. **TECH-ICE** Project funded by the Italian Ministry for University and Research (MUR) through the National Aerospace Research Program (PRORA).
5. **NATO AVT-388**: Operation of Unmanned Aerial Vehicles (UAVs) in Icing Environments.
6. *Upcoming project* **ENGRTII**: EU Next Generation Rotorcraft Technologies Project II, EDF-2024-DA-AIR-NGRT call, part of the European Defence Fund (EDF).

Intellectual property Information:

- Italian Patent n. IT102021000032444, “Rivestimento superidrofobico e ghiacciofobico di un substrato, metodo per il suo ottenimento e substrato così rivestito”, granted on 08.01.2024.
- International Patent Application N° PCT/IB2022/062672 filed on 22 December 2022, “Substrate superhydrophobic and icephobic coating, method for obtaining it and substrate thus coated” (Europe and United Kingdom).

CIRA inventors:

Filomena Piscitelli: f.piscitelli@cira.it