Paper ID: 38729
oral

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (5)

Author: Dr. Luca Mazzola
CIRA Italian Aerospace Research Centre, Italy, l.mazzola@cira.it

NEW THERMAL PROTECTION SYSTEMS FOR SPACE LAUNCHERS: ICEPHOBIC COATING FOR CRYOGENIC ROCKET ENGINE

Abstract

Space launch vehicles use cryogenic oxygen or hydrogen, which causes ice build-up. This could be a risk during the launch. Rockets are filled-up with cryogenic fuels several hours before launch. This, combined with the humid air found at some launch locations, lead to a non-negligible amount of ice building up on the external side of tank. The accreted ice increases the weight of the launcher and it is extremely dangerous because it falls off during launch due to extreme vibrations and air resistance and consequently the ice hits and damages the structural components below. Therefore, the formation of ice on the external surface of the space launcher when the cryogenic tank is filled with cold liquid hydrogen and liquid oxygen on the launch pad, needs to be avoided. The next generation of cryogenic tanks will be realized in composite materials for weight saving instead of metal, therefore, it is evident that the protection of the surface from the ice build-up should necessarily change and improve. The research activity, showed in this work, describes a promising light-weight coating with icephobic property to use as a novel coating for space launchers. Starting from the basic theories of the adhesion phenomena between water droplets and surfaces, the design and testing of the new sprayble icephobic coating to apply both on metallic and composite materials, are described. At the beginning, the best formulation of coating was characterized at lab-scale in order to evaluate icephobic properties using a new tool mounted on classical contact angle measurement apparatus that allows reproducing different flight condition of pressure and temperature during the different phases of the lift-off. Further, since space launchers are undergone to intense acoustic environments during launch, which induce high levels of vibration in structural elements and equipment, vibration tests were performed in order to evaluate the detachment of the ice from the new icephobic coating. Finally a complete thermo-mechanical characterization was carried out in order to determine qualitatively and quantitatively the adhesion of coating with substrate, the hardness and elastic modulus of the new coating as well as the resistance to hydraulic fluids.