IAF SPACE PROPULSION SYMPOSIUM (C4)
Liquid Propulsion (1) (1)

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ADDITIVE MANUFACTURED FUEL INJECTOR AS A WAY FORWARD TO IMPROVE GREEN PROPELLANT LIQUID APOGEE ENGINE

Abstract

Green propulsion, as an alternative for state-of-the-art toxic propellants like hydrazine and its derivatives, is nowadays gaining attention. It is considered as a way for future sustainability and significant cost reduction of Space missions. Agencies, New Space and Large Satellite Integrators started thinking long-term and are considering developing green propulsion modules. However, changing the propellant requires the development of new engines. Green propellants are, most likely, the right candidates for future satellite propulsion. Cryogenics are inapplicable for satellite propulsion because of long-term storage issues. Highly concentrated hydrogen peroxide is one of the most promising green propellants which can be used for satellite propulsion. In 2015 Lukasiewicz – Institute of Aviation initiated a research project GRACE, aiming at the development of a green Liquid Apogee Engine (LAE) for future spacecrafts. GRACE was funded by the European Space Agency. Realised at small iterative steps, this activity has come into the second phase (with the same funding source), aiming at optimisation of combustion efficiency and fuel film cooling. Catalytically decomposed 98% hydrogen peroxide is being applied as the oxidiser and the ignition source for 1,3-Bis(dimethylamino)propane (TMPDA), namely the fuel. The optimisation of the oxidiser/fuel injection is a critical step in the development of the engine. Complex manifolding for the fuel is a serious step forward in this process and a drawback regarding the manufacturing cost. For this reason, additive manufacturing has been identified as a potential technology to reach a compromise between performance and cost. For the green LAE, developed in the framework of GRACE phase 2, the oxidiser/fuel injector was prepared with additive manufacturing, which allows for better distribution of the fuel in the manifold. Thirty-two injection orifices in the form of like doublet were applied to provide better atomisation. The hot-fire test campaign, conducted at the internal facility of Lukasiewicz – Institute of Aviation, provided promising results in terms of the efficiency of characteristic velocity (c*). The new low-cost injector improved the engine performance with respect to its previous version, tested in the framework of GRACE phase 1. The paper includes results, discussion, and conclusions from the hot-fire test campaign of the green LAE.