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DISCOVERER: FINAL RESULTS AND OUTCOMES

Abstract

The DISCOVERER project commenced in 2017 with the aim to advance the development of key technologies to enable the commercially viable, sustained operation of satellites in very low Earth orbits (VLEO). Funded by Horizon 2020, the project ends this year. This paper will present an overview of the key achievements and finding from the project as it draws to a close.

The project set out to advance the development of, and demonstrate, several technologies with the long-term aim of enabling the commercial use of VLEO. These technologies include:

- aerodynamic materials which encourage specular scattering of the incoming flow to minimise drag and increase the performance of aerodynamic surfaces in the highly rarefied flows experienced in VLEO
- aerodynamic attitude control methods to compensate for the dynamic flow environment, especially lower in the VLEO altitude range
- atmosphere breathing electric propulsion (ABEP), combining an optimised atmospheric intake with advanced RF Helicon-based plasma thruster, for drag compensation

DISCOVERER's test satellite, the Satellite for Orbital Aerodynamics Research or SOAR, was deployed from the International Space Station in June 2021 and will re-enter the atmosphere in mid-2022. The satellite has several aims. The primary aim is to measure the induced drag and lift on different aerodynamic materials candidates in VLEO by exposing coated panels to the flow at different orientations whilst observing the induced attitude and orbit perturbations produced. Secondarily it will demonstrate the ability to perform aerodynamic attitude control, and attempt to determine thermospheric wind vectors. An overview of the results from the mission will be presented.

The project has also been developing a ground-based facility, the Rarefied Orbital Aerodynamics Research facility, or ROAR, to characterise the gas surface interaction properties of materials to atomic oxygen at orbital velocities. The facility supports the activity of identifying, developing and characterising aerodynamic materials. Parallel studies on the long-term survivability of these materials to the space environment have been on-going through exposure tests on the exterior of the International Space Station through the MISSE programme. A summary of these developments will be presented.

In support of ABEP technology, the experimental development and characterisation of an RF Helicon-based plasma thruster has been on-going, along with detailed computational modelling of aerodynamic intakes. Different from other atmosphere breathing thruster concepts, the approach has two key benefits. The thruster is contactless, removing issues of component erosion when operated in the atomic oxygen rich environment, and it produces a quasi-neutral plasma plume eliminating the need for a separate neutraliser. Again, an overview of the outcomes will be presented.

Finally, work to place these technological developments into context has also been progressed. Technology and business model roadmaps have been developed and publicised which map out the next steps

in the development of the technologies to enable commercial applications in VLEO. In parallel, systems studies of VLEO concepts are ongoing, showing the huge potential benefits of VLEO mission scenarios compared to higher altitudes. Insights in the future development of VLEO missions and technologies will be presented, and the potential implications on space policy and the sustainable use of the LEO environment considered.