Low Work-Function Tether Deorbit Kit

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ABSTRACT

The low work-function tether Deorbit Kit (DK) is a completely autonomous de-orbit system designed for satellites in orbit of up to 1200 km altitude. DK is bolt-on to the customer satellite before launch and activated at the end of the satellite operational life or in case of critical failure. Upon activation, DK autonomously de-tumbles the satellite, deploys a tether and carries out the satellite's de-orbiting.

The DK is based on a new Low Work-function Tether (LWT) technology. LWT consists on a long conductor tether with a coating that enhances the passive electron emission through thermionic [1] and photoelectric effects [2]. Thanks to the motional electric field, which is a consequence of the tether-to-plasma relative velocity and the presence of the ambient magnetic field, anodic and cathodic segments are developed throughout the tether. The anodic segment captures electrons as a giant Langmuir probe and the complementary cathodic segment emits the electrons back to the plasma aided by the coating, and thus yielding a steady current. The Lorentz force of the ambient magnetic field on the tether current is a drag that deorbits the satellite. The LWT interacts passively with the environment (ambient plasma, magnetic field and solar radiation) to exchange momentum with the planet's magnetosphere, thus enabling spacecraft to de-orbit without the need for consumables and power. DK includes a deployment mechanism, a telemetry and telecommand system, a complete Attitude Determination and Control system with attitude sensors (GNSS, sun sensors, magnetometer) and actuators (magneto torquers), solar panels and batteries. A novel low work-function material C12A7:e^- [3] will be applied to the cathodic segment by means of a new coating process. DK mass is less than 5% of the customer satellite's mass. Typical deorbit time of a 500kg satellite from 850 km altitude sun synchronous orbit is less than 1 year.

SENER has been working together with University Carlos III of Madrid, University of Padua and Technical University of Dresden on the development of a DK based on electrodynamic tethers since 2016. European Commission has awarded in 2018 a H2020 FET Open project with title "Electrodynamic Tether Technology for Passive Consumable-less Deorbit Kit" aiming to develop a deorbit kit based on LWT technology [4]. The project is coordinated by University Carlos III and includes in the team Advanced Thermal Devices and Fraunhofer IKTS. Currently, focus is placed on raising the technology readiness level up to TRL4 which is estimated to be reached by 2020-2021. The DK can be the mitigation game-changing technology needed to break the orbital debris proliferation vicious cycle.

References

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