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SOLAR SAIL ACCELERATION BY THERMAL DESORPTION UTILIZING CARBON FIBERS, GRAPHENE, AND NANOTUBES

Abstract

Thermal desorption is a physical process of mass loss which dominates all other similar processes and it can provide additional thrust as heating liberates atoms, embedded on the surface of a solar sail. In this study we considered a solar sail coated with materials that undergo thermal desorption at a specific temperature. The microwave methods of heating to a specific temperature were considered in Refs. 1 and 2 with a ground-based microwave beamer, where the microwave power-source is stationary on the ground, or an orbital boosting method where the orbiting microwave beamer is deployed behind a solar sail in the same initial circular orbit, while in Ref. 3 was considered to use of space environmental effects such as solar radiation heating at perihelion of particular heliocentric orbits.

The gradual acceleration of a solar sail can be mitigated with the thermal desorption of various lightweight volatile coatings at several key mission phases achievable by ground based microwaves at LEO, or low Earth orbit, and adjusting trajectories for optimal utilization of solar energy at perihelion. Higher activation energy coatings can be applied via absorption while lower activation energy coating are applied afterwards by adsorption to completely saturate the sail with propellant, however, having lower activation energy coatings trapped under a higher activation energy coating could increase kinetic energy upon desorption . Integrating nanotube technology offers benefits to increased thermal desorption capabilities as well as possible significant directed thermal desorption acceleration rather than at random angles which naturally occurs. The surface coating could reach activation energy at perihelion in LEO to increase escape velocity with the easy aid of ground based microwaves. An edge on sun diving trajectory translating to a close approach flyby with complete solar sail exposure would be best for the second thermal desorption coating to enhance the escape velocity, provided the solar sail retains structural integrity under higher temperatures and stronger gravitational forces. Thus the trajectory must keep the sail at an optimal distance for safety and efficiency.

References

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