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SOLAR SAILS: A COMPARATIVE STUDY BETWEEN KAPTON HN AND KAPTON B MEMBRANES

Abstract

Solar sailing is considered one of the most promising propulsion systems for interplanetary missions, and an efficient way to conduct orbital maneuver. The solar pressure acts on a large membrane that produces the propellantless thrust. The solar sail is made of lightweight-reflective materials generally fabricated by polymides with a one-side alluminum coating. The sail dimensions are conventionally huge in order to provide the proper thrust. In this work, we propose to eliminate the aluminum coating and to realize the membrane only by using polyimides. In particular, we analyze the propulsion performances of inexpensive polyimide membranes, such as Kapton HN and Kapton B. The selected polyimides films present different optical behavior due to their different sunlight reflectance: Kapton HN is semi-trasparent, whereas Kapton B is black pigmented. We perform experimental measuraments to determine the optical parameters of both films. These parameters are then used to determine the thrust of the two membranes. The solar sail that we investigate has a square geometry with dimensions of 6 m X 6 m and in thickness. The characteristic acceleration is the same for both membranes and equal to 0.01 mm/s2. Kapton HN produces a greater thrust than Kapton B, even if Kapton B exhibits a hightest emissivity. These results can be explained highlithing the be-reflective nature of the selected thin films. In order to take advantage from the high emissivity of Kapton B and enhancing the thrust modulus, we consider modifying the surface roughness of one side of the membrane. In this way, the propulsion performance can be improved by exploiting the difference of roughness between the membrane sides. Orbital simulation shows that the sail is able to maintain efficientely the station keeping in Halo orbit around the Lagrange point of the Sun-Earth system.