SPACE PROPULSION SYMPOSIUM (C4)
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THERMAL STRESS AND THERMAL DEFORMATION ANALYSIS OF GRIDS ASSEMBLY FOR 30CM DIAMETER ION THRUSTER

Abstract

In order to perform simulation analysis on the structural performance of 30cm diameter ion thruster's optics, the optics was equivalently handled in structure by material mechanics and validated. Finite element method were used to study distribution of thermal stress the thermal deformation displacement of grid components with and without edge constraint condition. Related optimization measure and validation process are proposed in order to decrease the thermal deformation displacement of the 30cm diameter ion thruster's grid components. The obtained results indicate that, after the optics' being handled equivalently, the screen grid's equivalent Young's modulus is 20.79GPa, and the same parameter of the accelerator grid is 89.43GPa. When the grids are equivalent to circular plates and the edge constraints don't exist, the maximum thermal deformation of the grid caused by tensile stress is about 0.3mm, and the maximum thermal stress is about 1.5106 Pa which occurs in the center of grids, while the deformation displacement in the normal direction is nearly zero. When the grid is equivalent to the circular plate and the edge constraint condition is satisfied, the maximum deflection occurs in the geometric structural center, with screen grid deflection value being about 1.145 mm, and accelerator grid deflection value being about 0.665mm. The gap between screen grid and accelerator grid decreases to 0.48mm. Ion thruster hot grid gap test results shows the gap change is in the range of 0.5 0.55mm by comparing thruster initially with thruster stable working without beam extraction after two hours, and the theoretical results is closed to test results. Grid structure thermal deformation displacement under constraint condition will probably cause the grid focusing performance degradation and short between the grids.The thermal design optimization validation indicates that decreasing the overall temperature distribution of the structure and using the material with small thermal expansion coefficient are effective measures to reduce the thermal deformation.