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Author: Mr. XIANG ZHANG
China Academy of Launch Vehicle Technology(CALT), China

DESIGN AND EXPERIMENTAL VERIFICATION RESEARCH OF A CONVENIENT HIGH TEMPERATURE RESISTANCE SELF-LUBRICATING CMC HINGE FOR CONTROL SURFACE OF HYPERSONIC VEHICLE

Abstract

Thermal structure out of CMC are widely used in a range of hypersonic vehicle due to its characteristics. During re-entry, the rudders and the body flaps are the most serious part to bear aerodynamic heating and aerodynamic force, and their deformation is particularly prominent due to its large size. Therefore, it's very complicated to design the components using for control the rotation of rudder and body flap, it requiring high temperature resistance, bearing mechanical loading, rotation, and it also able to adjust the center along with the direction of deformation when the rudder deformed. A concept of rotational thermal structure made of CMC resembles a hinge, it is divided into two parts of support structure, and the part connected with the rudder rod is of spherical ring structure, which is installed in the middle of the left and right supports structure to realize the function of rotation and adjusting the center. And the left and right supports of the hinge are connect by CMC bolts, and spherical ring structure can be fixed in the middle of them. This design solve the problem of high temperature resistance insufficient of the bearing which made of metal, and the problem of CMC bearing which insufficient adjustment to deformation capacity. In order to obtain higher load capacity, lubrication performance and oxidation resistance, the test hinge is made up to C/SiC. The test sample was subjected to in a series of re-entry simulation testing cycle in the facilities of CALT/ Peking, it is heated in air condition, and simulate aerodynamic loading on it, then obtain the data of strain, stress and deformation. At the same time, the friction coefficients at room temperature and high temperature were obtained by rotating the hinge in a certain angle in a test cycle .The test parameters in air environment with maximum temperature up to 1300°C and the application of the varying mechanical loading with maximum up to 12000N, the strain can reach 5000μm. At room temperature the friction coefficient is approximately 0.55, when the temperature up to 1300°C the friction coefficient decrease to about 0.39. The experimental results show that the hinge has the property of high temperature resistance and aerodynamic loads bearing, and the friction coefficient of it decreases with the increase of temperature. This design and experimental result provide a reference and increase the technology readiness for hinge of CMC control surfaces.