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微纳技术与精密机械

空间遥感相机碳纤维机身结构设计

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摘要： 针对离轴三反相机光学系统对机身结构的要求,采用碳纤维复合材料制备关键部件,设计了合适的相机机身结构。设计的离轴三反相机采用的复合材料占整机重量的32%。机身结构为非对称形,光学系统中主、次镜间距为850 mm,反射镜接口定位精度要求间隔为0.005 mm、偏心为0.005 mm、倾斜为5″。通过有限元软件对设计结果进行分析、优化和检验,完成了机身结构的优化设计。计算结果表明,该机身结构具有较好的刚度、较轻的重量,能够满足光学设计对间隔,偏心和倾斜的要求。对总装完成的相机进行了力学环境试验和热真空试验,结果证明了该相机机身结构在力、热等环境条件下稳定性良好,其一阶谐振频率在120 Hz以上,相机调制传递函数在0.2以上,满足离轴三反空间相机各反射镜对空间位置精度和稳定性的要求。

关键词： 空间遥感相机 碳纤维复合材料 机身结构 有限元分析

Design of optical-mechanical structure made of CFC in space remote sensing camera

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Abstract: For demands of optical systems in a off-axis three-mirror camera on the optical-mechanical structure, an appropriate optical-mechanical structure was designed by taking Carbon Fiber Composite(CFC) as the key components of the camera. The weight of CFC in designed camera makes up 32% that of the total system. Furthermore, this optical-mechanical structure is asymmetric, the system spacing in the primary, secondary mirror is 850 mm, and the mirror positioning accuracy demands its interval, eccentric and tilt to be 0.005 mm, 0.005 mm, and 5″, respectively. The Finite Element method was used to analyze and optimize the design, results show that the optical-mechanical structure has better stiffness, lighter weight, and can meet the requirements of optical system for intervals, eccentrics and tilts. A mechanics environmental test and a thermal vacuum test were performed, and results demonstrate that the optical-mechanical structure in the camera has excellent stability in mechanics, thermal and other environmental conditions, its first order harmonic frequencies are above 120 Hz, and the modulation transfer function is more than 0.2. These results prove that the proposed structure can provide reasonable spatial location and stability for the reflective mirrors in off-axis three-mirror cameras.

Keywords: space remote sensing camera Carbon Fiber Composite (CFC) optical-mechanical structure Finite Element Analysis (FEA)

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