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微纳技术与精密机械

基于碳纤维复合材料的空间相机高比刚度主承力板优化设计

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摘要： 提出了复合材料和金属预埋件互嵌整体成型的设计方法。根据同轴三反光学系统中光学元件的空间布局和碳纤维复合材料的工艺特点和材料属性，设计了一种碳纤维基体与钛合金预埋件互为镶嵌的相机主承力板。首先，以碳纤维复合材料基体为核心，优化设计了基体的筋格形式和厚度，并对金属预埋件进行了布局和轻量化设计；然后，分析了碳纤维主承力板的模态和变形；最后，进行了振动环境试验，验证了设计及分析的准确性。检测和试验表明，纤维主承力板的最大外接圆直径为Φ870 mm，厚度为130 mm，质量为15.6 kg，平均体密度仅为0.313 g/cm3，主承力板一阶频率达到479.2 Hz，满足了空间相机的高动态刚度、轻质量、高安装精度要求。

关键词： 空间光学相机 碳纤维复合材料 主承力板 金属预埋件

Optimizing design of CFRP based main backbone with high stiffness ratio for space camera

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Abstract: A design method of composite materials and metals embedded with each other was put forward. On the basis of the space layout of optical elements in a coaxil three-mirror optical system and the technological properties and attributes of the Carbon Fiber Reinfored Plastic(CFRP), the main backbone of the camera was designed and manufactured with CRFP and titanium by this method. First, the core body of main backbone was made up of CFRP, and the gridding and thickness were optimized with topology analysis. Then, the metal embedded parts were arranged according to an optical lens, every metal embedded parts were lightweighted and the mode and the deformation of the main backbone were analyzed. Finally, the results of design and analysis were verified by a vibration test. The experiment and test indicate that the CFRP main backbone is 15.6 kg , the circumscribed circle diameter is Φ870 mm,and the height is 130 mm.Furthermore, the average density and the first mode frequency are 0.313 g/cm2 and 479.2 Hz,respectively. These results prove that the CFRP main backbone can meet the requirements of light weight,high dynamic stability and good surface precision for space cameras.

Keywords: space optical camera Carbon Fiber Reinforced Plastic(CFRP) main backbone metal embedded parts

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