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Bipod柔性结构在小型反射镜支撑中的应用

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Application of Bipod to supporting structure of minitype reflector

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摘要 设计了一种由3组Bipod组成的柔性支撑结构,用于提高在实际工作条件下小型反射镜的面形精度。首先,利用伴随变换建立了Bipod及由其组成的支撑结构的柔度矩阵;利用MATLAB优化Bipod的结构参数,以满足径向刚度最小时轴向刚度最大的要求。然后,对优化后的支撑结构施加力和热载荷进行了仿真验证。最后,利用zygo干涉仪验证该支撑结构的热稳定性。结果表明,Bipod柔性支撑结构在保证反射镜良好热稳定性的同时,可以有效降低外界动态载荷对反射镜的影响;不仅具有良好的动态特性,且能在力热耦合载荷下保持较好的面形。分析显示其1阶固有频率达到1 781.7 Hz,与理论计算相比,相对误差约为1%。

关键词 : 小型反射镜, Bipod, 柔性支撑结构, 柔度矩阵, 优化设计

Abstract : A flexible supporting structure composed of 3 Bipods was designed to enhance the surface accuracy of a minitype reflector in complex environments. Firstly, the flexibility matrixes of the Bipods and whole support structure were established through matrix transformation and the defining design variables of the Bipods were optimized through MATLAB to meet the requirements of maximum of the axial stiffness when the radial stiffness was minimum. The simulation verification was then performed by applying different forces and thermal loads to the optimized supporting structure. Finally, a zygo interferometer was employed to verify the thermal stability of the supporting structure. The results show that the Bipod support structure keeps a fine surface accuracy under a thermal-structural load,meanwhile providing excellent dynamic performance. Except for giving the reflector a better thermal stability, the support rigidity of the structure resists the impact of the environmental dynamic load on the reflector. Moreover, the analysis indicates that the first order natural frequency of the flexible supporting structure is 1 781.7 Hz, and the relative error is 1% as compared with that of the theoretical calculation.

Key words : minitype reflector Bipod flexible supporting structure flexible matrix optimum design

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