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微纳技术与精密机械

6-PSS型光学元件精密轴向调节机构

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摘要: 设计了一种采用6-PSS型并联机构的光学元件精密轴向调节机构, 以使光刻物镜中光学元件的调节行程达微米级, 调节精度达纳米级。将6-PSS型并联机构中的6个移动副改进为3个, 减少了驱动器的使用数量, 提高了轴向调节机构的可靠性; 设计了一种圆角薄柔性铰链结构作为6-PSS型并联机构中的球铰副, 实现了轴向调节机构的结构一体化, 简化了光机组件的装调过程, 提高了机构的机械精度; 利用空间矢量法分析了机构输入构件与输出构件之间的位置关系, 推导出了机构的传动比表达式, 为机构主要结构尺寸的选取提供了依据。轴向调节机构的验证试验结果表明: 机构传动比的理论计算值接近于实测值; 轴向调节机构的调节行程为74.4 μm , 调节精度在40 nm以内, 满足光刻物镜中光学元件轴向调节机构的使用需求。

关键词: 光刻物镜 光学元件 调节机构 并联机构 一体化结构 6-PSS

Precise axial adjustment mechanism with 6-PSS type of optical elements

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Abstract: A precise axial adjustment mechanism based on 6-PSS type parallel mechanism was designed to realize the stroke adjustment in micrometer sizes and the accuracy adjustment in nanometer sizes for optical elements in a photolithographic objective lens. The amount of the prismatic pairs in the 6-PSS type parallel mechanism was improved into 3 from 6 to decrease the usage number of the actuators and increase the reliability of the axial adjustment mechanism. A fillet thin flexure hinge was designed as the spherical hinge in the 6-PSS parallel mechanism to realize monolithic configuration of the axial adjustment mechanism, by which the alignment process of the optical-mechanical components was simplified and the mechanical accuracy of the mechanism was improved. Based on space vector method, the position relationship between input components and output components of the adjustment mechanism was analyzed and the expression of transmission ratio was derived to provide a basis for determining the primary structural dimension of the axial adjustment mechanism. Verification test results of the axial adjustment mechanism show that the numerical result of the transmission ratio is in good agreement with the experimental one; the adjustment stroke of the axial adjustment mechanism is 74.4 μm and the adjustment accuracy is within 40 nm, which satisfies the operation requirement of the photolithographic objective lens.

Keywords: Lithography objective Optical component Adjustment mechanism Parallel mechanism Monolithic configuration 6-PSS

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