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电容式位移传感器的线性度标定与不确定度评定

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Linearity calibration and uncertainty evaluation for capacitance displacement sensor

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摘要 图/表 参考文献 相关文章 (15)

摘要 由于光刻投影物镜装调中电容传感器的线性度指标不能够满足位移调节精度的需求,本文提出了一种提高电容传感器测量线性度的方法。该方法采用压电驱动器提供位移进给;采用高精度激光测长干涉仪校准电容传感器的线性度,提供位移反馈以保证运动控制精度。采用高阶曲线拟合方法得到拟合系数对传感器线性度进行在线标定;对标定实验中的环境、安装、机构以及控制等进行不确定度分析与评定以保证电容传感器的线性度测量精度;最后进行电容传感器线性度的标定实验。实验结果表明:本文提出的线性度标定方法能够减小各误差项对于测量结果的影响,标定后传感器线性度由0.047 14%提高至0.004 84%,近一个数量级,并且线性度重复性较高,重复性偏差为0.38 nm,全行程内线性度的合成不确定度为5.70 nm,能够满足光刻物镜中位移控制精度的需求。

关键词 : 电容传感器, 位移传感器, 标定, 线性度, 不确定度, 光刻投影物镜

Abstract : As the linearity of capacitance sensor in adjusting a lithographic projection objective could not meet the requirement of the adjustment mechanism for accuracy standard, a method to improve the measuring linearity of the capacitance sensor was proposed. A piezoelectric actuator was used to provide displacement feeding and a higher precise laser length interferometer was used to provide displacement feedback to ensure the accuracy of moving control. The fitting factors getting from the high order curve fitting were used to calibrate the linearity of the capacitance sensor online. Then, the uncertainties of the environment, installation mechanism and control were analyzed and evaluated to meet the accuracy of the linearity measurement. Finally, calibration experiments for the sensor were carried out. The experiment results indicate that the calibration method of the linearity proposed reduces the influence of the error on the measurement results. After calibration, the linearity of capacitance sensor increases from 0.047 14% to 0.004 84%, nearly an order of magnitude. Moreover, the capacitance sensor has high linearity repeatability, the deviation of repeatability is 0.38 nm, and the combined uncertainty of the linearity in the whole stroke is 5.70 nm, which meets the displacement control accuracy of the lithographic projection objective.

Key words : capacitance sensor displacement sensor calibration linearity uncertainty lithographic projection objective

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