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微纳技术与精密机械

计量型原子力显微镜的位移测量系统

李伟, 高思田, 卢明臻, 施玉书, 杜华

中国计量科学研究院, 北京 100013

摘要： 针对纳米结构表征和纳米制造的质量控制需要,中国计量科学研究院设计并搭建了一台计量型原子力显微镜用于纳米几何结构的测量。为了将位移精确溯源到国际单位米,研制了单频8倍程干涉仪测量位移,样品表面形貌则由接触式原子力显微镜测量。一个立方体反射镜与原子力显微镜的测头固定,作为干涉仪的参考镜。两个互相垂直的干涉仪用于测量样品与探针在*x*-*y*方向的相对位置。样品台置于具有三面反射镜的零膨胀玻璃块上,由压电陶瓷位移台驱动。另外两台干涉仪测量样品与探针在z方向的位移,探针针尖位于干涉仪光束的交点以减小Abbe误差。由于光学器件的缺陷产生的相位混合会引起非线性误差,采用谐波分离法拟合干涉信号来修正误差,修正后干涉仪测量误差减小为0.7 nm。

关键词： 原子力显微镜 纳米计量 位移测量 多倍程干涉仪 非线性

Position measuring system in metrological atomic force microscope

LI Wei, GAO Si-tian, LU Ming-zhen, SHI Yu-shu, DU Hua

National Institute of Metrology, Beijing 100013, China

Abstract: For characterizing the nanostructure and controlling nano-manufacturing quality,a metrological Atomic Force Microscope(AFM) was designed and constructed in National Institute of Metrology. To trace the displacement to the SI unit, the relative position of sample and AFM probe is measured with homodyne 8-pass interferometers and the surface topology of the sample is measured by AFM at a contact mode. A cube with mirrors is fixed on the probe as the reference mirror of interferometers, so that the relative displacement of probe in the *x* -*y* direction to the sample is measured by interferometers. The sample stage is fixed on a corner block with mirrors on three sides and driven by a piezoelectric motion stage. Two interferometers is used to measure the displacement of sample and probe in *z* direction. The probe tip is positioned in the intersection of the interferometers in 3 directions to minimize the Abbe error. As the phase mixing from the defect of optical element will cause the nonlinear error,a harmonic separation method is introduced to fit the inteferometric signals and to correct the error. The measured results show that the nonlinear error has been reduced to 0.7 nm, which demonstrates this system has better performance.

Keywords: atomic force microscope nanometrology displacement measurement multi-pass interferometer nonlinearity

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通讯作者: GAO Si-tian, PhD, research fellow at National Institute of Metrology(NIM). His current research interests include length metrology, nanotechnology and nanometrology. E-mail: gaost@nim.ac.cn

作者简介:

作者Email:

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