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Authors: Wenjun Yang, Xiaojun Liu, Wenlong Lu, Chi Hu, Xiaoting Guo

PII: S0141-6359(17)30108-3
DOI: http://dx.doi.org/doi:10.1016/j.precisioneng.2017.07.009
Reference: PRE 6619

To appear in: *Precision Engineering*

Received date: 20-2-2017
Revised date: 14-5-2017
Accepted date: 14-7-2017

Please cite this article as: Yang Wenjun, Liu Xiaojun, Lu Wenlong, Hu Chi, Guo Xiaoting.Towards a traceable probe calibration method for white light interference based AFM.*Precision Engineering* http://dx.doi.org/10.1016/j.precisioneng.2017.07.009

Towards a traceable probe calibration method for white light interference based AFM

Wenjun Yang, Xiaojun Liu, Wenlong Lu*[1], Chi Hu, Xiaoting Guo

The State Key Laboratory of Digital Manufacturing Equipment and Technology, Department of Instrument Science and Technology, School of Mechanical Science and Engineering, Huazhong University of Science and Technology, Wuhan, China, 430074

* E-mail: hustwenlong@mail.hust.edu.cn

Highlights

- A traceable probe calibration method is proposed for WLI-AFM.
- A high resolution displacement measurement system based on laser interference is constructed to obtain the vertical displacement of probe with high accuracy.
- A zero-order fringe positioning algorithm is presented to determine the position of the interference fringes on probe cantilever.
- A probe deflection model is established for the calibration relationship.
- The accuracy of the method is higher than the previous methods by certain experiments.

Abstract: Probe calibration is the basis of accurate atomic force microscope (AFM) measurement. In white light interference based AFM (WLI-AFM), the relationship between the vertical displacement of probe and the position of the interference fringes on probe cantilever should be calibrated for accurate measurement. In this paper, a traceable probe calibration method for WLI-AFM is proposed. A high resolution displacement measurement system based on laser interference is constructed to obtain the vertical displacement of probe with high accuracy. This system is used for standard displacement input for calibration and makes the measurement result traceable to optical wavelength. A zero-order fringe positioning algorithm is presented to determine the position of the interference fringes on probe cantilever. A probe deflection model is established for the calibration relationship which is continuous and can be used for measurement. While calibration is conducted, series of zero-order fringe positions are obtained corresponding to the probe displacement inputs. The data are processed by the probe deflection model to obtain the calibration relationship. The proposed method is applied in a self-developed WLI-AFM. It is verified that the accuracy of the method is higher than the previous methods by certain experiments on this WLI-AFM.

Key words: probe calibration, white light interference, atomic force microscopy, traceable measurement

1. Introduction

Calibration is an essential step for scientific instruments, which helps determine the relationship of input and output for accurate measurements[1]. For AFM, due to the microscale of the probe, it is difficult to obtain the characteristic parameters accurately by testing. So in practice, the nominal values of their characteristic parameters are usually used for measurement, which in fact deviate very much from their actual values[2, 3] and lead to unexpected error. In addition, due to the problem of wear and aging, the probe has to be changed frequently, which will lead inconsistent characteristics of the probes. Also the instrument performance is