

Advances in the development of the LNE metrological atomic force microscope

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Abstract

The Laboratoire National de Métrologie et d'Essais (LNE) is in charge of [developing a French national expertise in dimensional nanometrology](#). Many industries and research laboratories use SPMs and need to calibrate their instruments. It's done thanks to reference samples, whose dimensional characteristics are calibrated by a National Metrological Institute (NMI). Up to now, no French institute provides that kind of calibration. Within this context, LNE develops a home-made metrological AFM whose measurements are traceable to the national length standard. The displacement range will be 50 μm for X and Y axis and about 10 μm for Z axis. For the measurement of the tip position relative to the sample, the expected uncertainty is about 1 nm. The paper will focus on the original design of our metrological AFM and more precisely about its recent advances.

In most of metrological AFMs, one of the most important component of the uncertainty budget is the Abbe error. We took in this development a great attention in order to minimize effects of this error. To reach this goal, we achieve :

- To realize an XYZ flexure scanner with a very low unwanted rotational motion along the whole range.
- To optimize the metrology loop by using a very short metrology frame with a symmetrical design and with a very low thermal sensitivity.
- To use some differential interferometers through an original arrangement in order to minimize the metrology loop and to reduce the non-linearity effects.

Moreover, we tried to reduce the global thermal sensitivity of this home-made metrological AFM by:

- Reducing the thermal heats and producing a chamber in which the temperature stability is about few thousandth of degrees.
- Enclosing the interferometers beams.
- Dealing with some aspects of thermal design.

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