School of
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Surface Profile Height Measurement Using Optical Interferometry Method

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Introduction

Interferometer is one of the methods that are used for measuring surface profile with high accuracy reach to the order of 1/1000 of the wavelength of the light. The accuracy in a given interferomter depends on many factors such as the light source properties and environmental mechanical vibration. This poster illustrates a method to increase the accuracy of Linnik interferometer for nano-scale measurements.

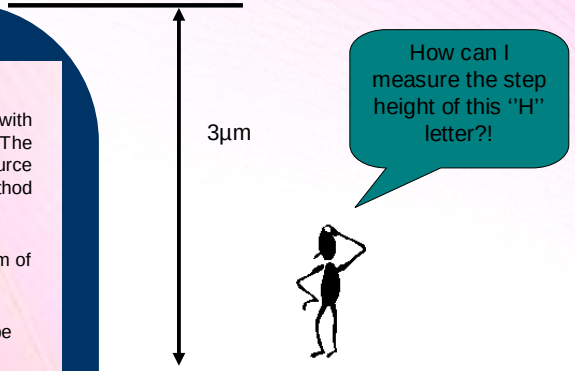
Aim

Increase the accuracy of Linnik interferometer to measure a sample with step form of 3µm height.

Objectives

In order to implement high accuracy interferometer, the following objectives can be achieved:

✓ Stabilise the interferometer mechanically to reduce the environmental turbulence.
✓ Build interferometer with a short coherence length to improve the measurement accuracy

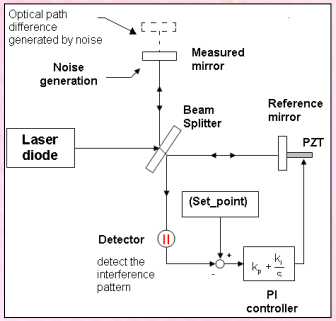


Stabilise Linnik Interferometer Using PZT

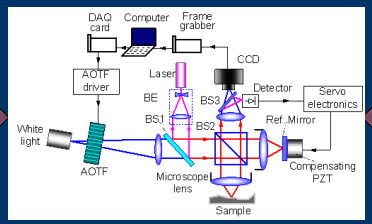
Piezoelectric transducer has been used to stabilise Linnik interferometer experimentally. PI controller was used for controlling the operation of PZT to compensate the path difference that is caused by the environmental disturbance

PI parameters

➢The calculated Kp=0.82, and the Ki=1.32msec.



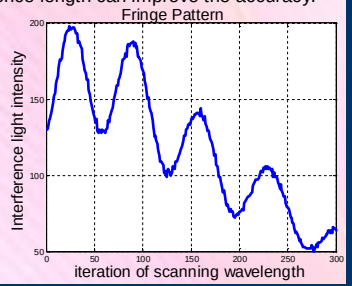
Experimental Setup



White Light Interferometer

➢ White light source has been used in interferometer to reduce the measurement tolerance because the source with short coherence length can improve the accuracy.

➢ The Halogen white light is passed through an acousto-optic tuneable filter (AOTF). The function of AOTF is to act as a dynamic band pass filter to diffract instant selective wavelength into the measurement interferometer and block the entire spectral band. The light wavelength that diffracts from AOTF was scanned from 680.8nm to 529.8nm with 0.5nm interval step and 300 interferograms were obtained.

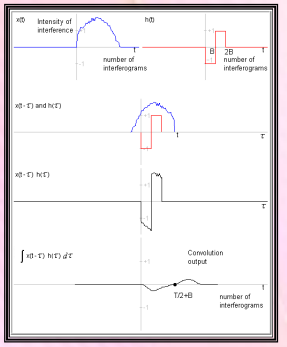


Interferogram Analysis

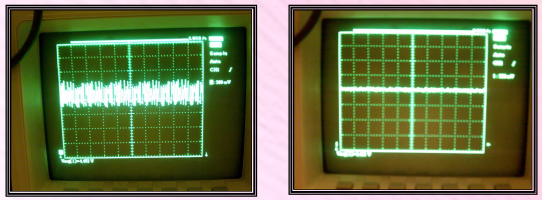
Convolution method has been used to analyse the interferograms.

➢ Design square filter with width equal to 74% of the mean fringe period. Half of filter width is (-1) amplitude while the other half is (1) amplitude.
➢ Convolute the filter with the fringe pattern.
➢ The cross zero points represent the extremum positions of fringe pattern.
➢ By identifying the extrumum positions and its number, its easy to calculate the step height thickness t:

$$t = \frac{(\text{numbe of peaks} - 1) * 2\pi}{4\pi(\frac{1}{\lambda_1} - \frac{1}{\lambda_2})}$$



Key Results — Interferometer response to the noise



Before Stabilising

After Stabilising

Conclusion and future work

❖ Sample with step height=3µm has been measured. The error of measurement is only 0.47%.
❖ The stabilisation of interferometer was crucial in the measurement to prevent the vibration exceed the coherence length.
❖ Further reading can be done in light source properties and linearity of AOTF.

Key Results — Measurement of a sample with step form of 3µm