

## Surface profile measurement techniques using optical interferometry

### 1. Outline

By analyzing the interference image signals obtained by the interference microscope, non-contact 3-dimensional microscopic-surface-profiling is achieved. Two methods are available, and a measurement resolution of 1 nm or less is possible with a height range of over 100 microns.

### 2. Two principles of surface profile measurement using optical interferometry

#### (1) Phase Shift Interferometry (PSI)

- The phase difference between the reference light and the measurement light of each point in a TV camera, is computed from the interference fringe intensities observed while giving the fixed displacements to the Z-axis of the microscope.
- The height  $h$  of each point can be obtained from the phase difference and the light wavelength  $\lambda$ .
- Since there is an ambiguity of  $2\pi N$  ( $N$  is an integer) in the phase difference, an 'unwrapping' calculation is carried out assuming that the surface height difference between the adjacent pixels is very small.
- Therefore, this method is applicable only to a surface that is sufficiently smooth compared with the light wavelength.
- Applications: Plastic Film, Optical Elements, Magnetic Heads, Polished Surface such as Metal or Si Wafer, etc.

#### (2) Vertical-Scanning white-light Interferometry (VSI)

- When a white light is used as the light source of an interference microscope, and the Z-axis of a microscope is moved continuously, the modulation of an interference fringe changes depending upon the optical path difference as shown in Figure 2.
- A 3-dimensional surface profile can be measured by finding the maximum peak position of the interference fringe modulations at each point in a TV camera.
- A revolutionary calculation algorithm to find this maximum peak position from sub-Nyquist sampled data was devised, and a measurement speed of 10 or more times faster than conventional methods has been made possible.
- This development won the SICE 2001 Technology Award from The Society of Instrument and Control Engineers (Japan).
- This method is applicable to any surface that may contain an abrupt level change.
- Applications: Semiconductor Bumps, LCD Spacers, Via Holes, MEMS, etc.

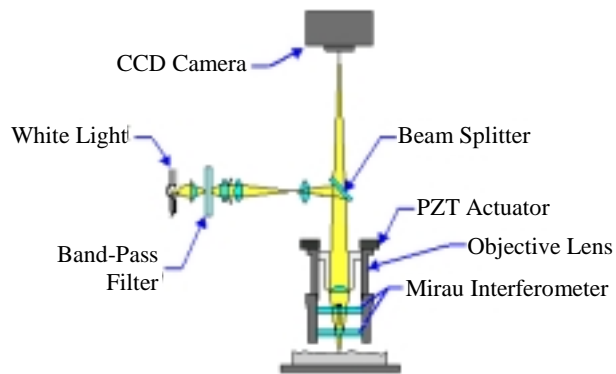


Figure 1 SP-500 Optics

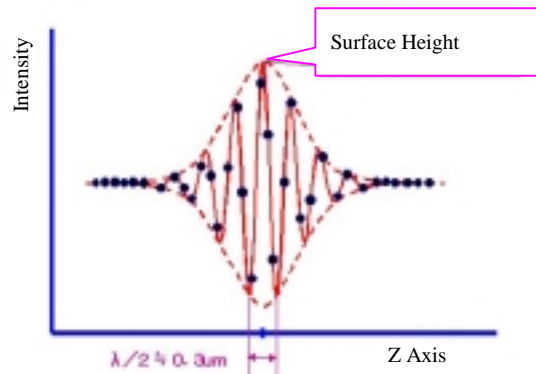


Figure 2 Interferogram of the VSI method

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