**Experiment No.**

**TESTING of SURFACE CHARACTERISTICS USING WHITE LIGHT INTERFEROMETER**

**6.1 Aim of the Experiment**

To study surface roughness using optical flats and white light source

**6.2 Theory**

Fig. 1 shows a simplified schematic of a coherence peak sensing interference microscope. The configuration shown in Fig. 1 utilizes a two-beam Mirau interferometer at the microscope objective. Typically the Mirau interferometer is used for magnifications between 10 and 50X, a Michelson interferometer is used for low magnifications, and the Linnik interferometer is used for high magnifications. A separate magnification selector is placed between the microscope objective and the CCD camera to provide additional image magnifications. A tungsten halogen lamp is used as the light source. Light reflected from the test surface interferes with light reflected from the reference. The resulting interference pattern is imaged onto the CCD array. Also, output from the CCD array is digitized and read by the computer. The Mirau interferometer is mounted on either a piezoelectric transducer (PZT) or a motorized stage so that it can be moved. During this movement, the distance from the lens to the reference surface remains fixed. Thus, a phase shift is introduced into one arm of the interferometer. By introducing a phase shift into only one arm while recording the interference pattern that is produced, it is possible to perform either phase-shifting interferometry or vertical scanning coherence peak sensing interferometry.

Phase-shifting interferometry has great precision, but it has limited dynamic range. It can easily be shown that for phase-shifting interferometry the height difference between two adjacent data points must be less than λ/4, where λ is the wavelength of the light used. If the slope is greater than λ/4 per detector pixel then height ambiguities of multiples of halfwavelengths exist. One technique that has been very successful in overcoming these slope limitations is to perform the measurement using two or more wavelengths. If measurements are performed



Fig. 1 Optical schematic of interference microscope used for measurment of fine surface strucuter.

using two wavelengths, λ1 and λ2, it can be shown that the maximum height difference between two consecutive data points is λeq/4, where λeq is given by



Fig. 2 The use of white light makes it possible to connect fringe orders across a step even if the step height is greater than λ/4.

Thus, by carefully selecting the two wavelengths it is possible to greatly increase the dynamic range of the measurement over what can be obtained using a single wavelength. A better approach is to use a white light source so there is no ambiguity in the fringe order number as shown in Fig.2.

An excellent way of obtaining good height measurements with large steps or rough surfaces is to use a white light source and the coherence peak sensing approach described below.

In the vertical scanning coherence peak sensing mode of operation a broad spectral width light source is used. Due to the large spectral bandwidth of the source, the coherence length of the source is short, and good contrast fringes will be obtained only when the two paths of the interferometer are closely matched in length as shown in Fig. 3. Thus, if in the interference microscope the path length of the sample arm of the interferometer is varied, the height variations across the sample can be determined by looking at the sample position for which the fringe contrast is a maximum. In this measurement there are no height ambiguities and since in a properly adjusted interferometer the sample is in focus when the maximum fringe contrast is obtained, there are no focus errors in the measurement of surface microstructure.



Focut position A Focus position B

Fig. 3 Good contrast fringes are obtained only when the interferometer paths are matched. (Sample is a micro-machined piece of silicon.)

Fig. 4 shows typical results obtained measuring a micro-groove piece of graphite.

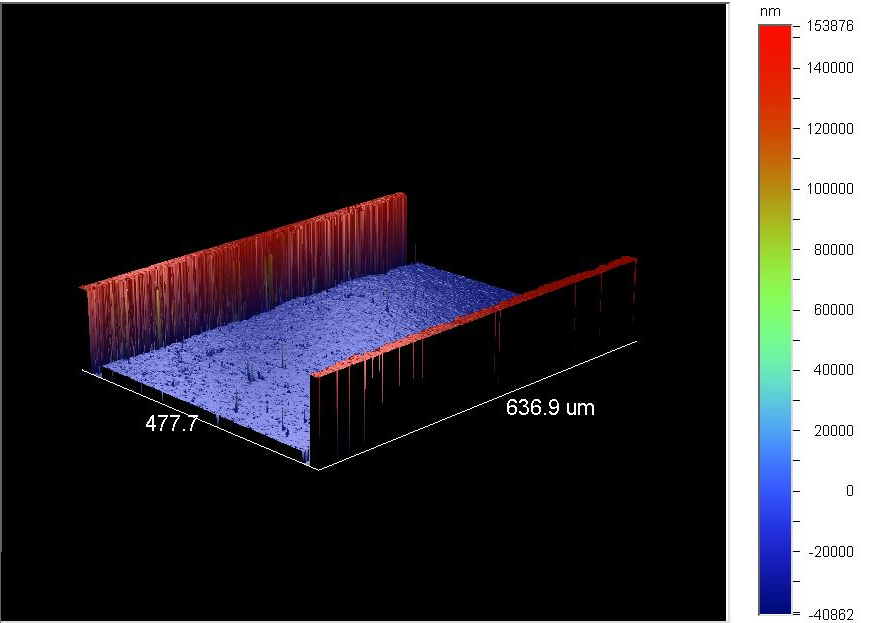


Fig. 3. 3D groove image using white light interferometer WYKO NT 9100® in VSI mode

**6.3 Procedure**

Basic sample measurement procedures are as follows-

1. Place the sample on the top of the table for measurement.
2. Open the intensity window by clicking the intensity button.
3. After this psi or vsi mode can be selected based on the sample. For rough surfaces vsi mode and for very smooth surfaces psi mode is best suited.
4. Using the slider bar at the bottom of the intensity window, adjust the light intensity to be as bright as possible to make focusing easier. If the intensity window shows red pixels, use the slider bar to lower the intensity until the image appears just below saturation.
5. Now use the rotating button to focus the object. For better focusing use slow motion while setting the focus. Fringes will appear at best focus, set the focus for 2-3 fringes.
6. Now click on new file button to start scan.
7. Repeat the same procedure for 5 samples.

**6.4 Results**

System window will give the surface roughness of the sample.

**6.5 Conclusions**

Compare the surface roughness of the same sample at two or more different locations and magnification.