OPTI 415L / 515L - Optical Fabrication and Testing Laboratory

Lab #5 Micro Interferometry and Surface Roughness

Purpose:

This lab has two sections

I]

The purpose of this section is to observe the samples provided using two different interference microscopes -- the polarization differential microscope (Nomarski) and the two-beam Mirau. White light fringes should be observed using both instruments.

II]

The purpose of this section is to measure the physical characteristics of a given lens. The parameters to be measured are the center thickness, the diameter, the edge thickness variation and the radius of curvatures of the two surfaces.

Procedure:

I]

Nomarski

• Read the attached Notes on the Nomarski microscope.

• Place the ball bearing under the objective. Before finding focus adjust the sample so it is too close to the objective, and then find focus by moving the sample away from the objective. This procedure will minimize the chances of crashing the objective into the sample. Adjust the eyepieces so you are comfortable looking at the microscope image.

• After you think the sample is in focus, move the sample to make sure the image moves and you are really looking at the sample. Adjust the angle of polarization of the incident light and note the effect of changing the direction of polarization.

• Turn the ring on the objective to move the prism and vary the path difference between the two interfering beams. Note the direction of shear.

• Repeat the above procedure for a Fresnel zone plate and any other object of interest.

Mirau

• Place the flat mirror under the objective. Before finding focus, adjust the objective so it is too close to the sample, and then find focus by moving the objective away from the sample. This procedure will minimize the chances of crashing the objective into the sample. Adjust the eyepieces so you are comfortable looking at the microscope image. The easiest way to find focus is to first put in the red filter and then close down the field stop. A bright circular region of light will be seen from the light reflected from the reference surface. Next adjust the objective-sample distance until a faint halo is seen around the bright region of light from the reference. Further adjustment of focus will cause the halo to collapse into the bright region. At this point fringes should be seen. Open the field stop to see the entire field.

• Adjust the two knobs on the objective to vary the tip-tilt of the reference surface.

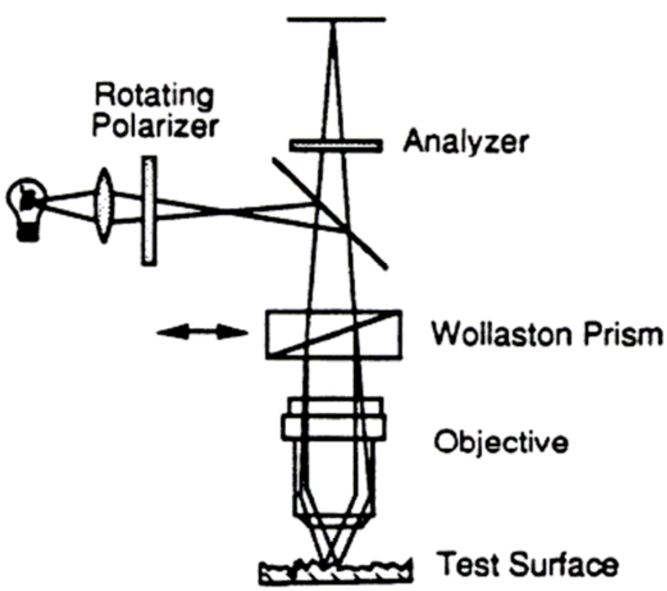
• Adjust the focus to see the fringe contrast change. Take out the red filter and look at the white light fringes. Adjust the tip-tilt and focus. You should see some beautiful colors.

• Repeat the above procedure for looking at the ball bearing, the Ronchi ruling, and any other sample you want to look at.

Notes:

Nomarski Microscope

The diagram below shows a drawing of the optical layout of a Nomarski microscope. The Nomarski microscope is sometimes called a differential interference contrast (DIC) microscope or a polarization interference contrast microscope.



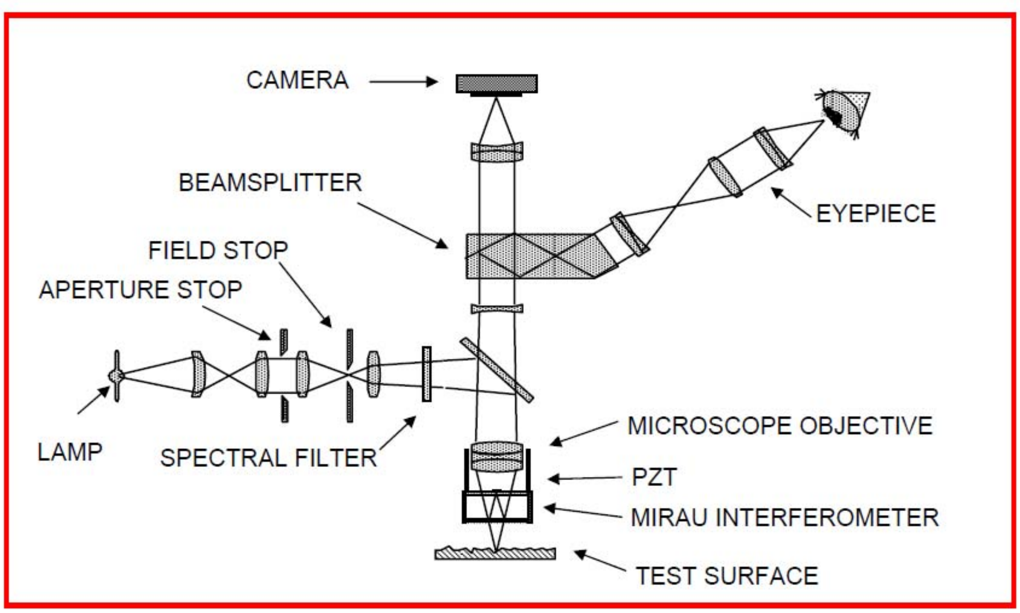
A polarizer after a white light source is used to set the angle of the polarized light incident upon a Wollaston prism. The Wollaston splits the light into two beams having orthogonal polarization, which are sheared with respect to one another. After reflection off the test surface the Wollaston recombines the two beams. A fixed analyzer placed after the Wollaston transmits like components of the two polarizations and generates an interference pattern.

The resulting image shows the difference between two closely spaced points on the test surface. The point separation (shear at the test surface) is usually comparable to the optical resolution of the microscope objective and hence only one image is seen. The image shows slope changes and it appears as though the surface has been illuminated from one side. Like a shearing interferometer, only detail in the direction perpendicular to the shear is seen. In other words, if the shear is in the x direction, only features parallel to the y-axis will be seen. Detail parallel to the x direction will not be visible without rotating the test surface or the Wollaston prism.

The path difference between the two beams can be adjusted by laterally translating the Wollaston prism. When the axes of the polarizer and analyzer are parallel and the prism is centered, the path lengths are equal and white light is seen for a perfect test surface with no tilt. When the polarizer and analyzer are crossed and the prism centered, no light gets through. When the prism is translated sideways, the two beams have unequal paths and different colors are seen. The color for a specific feature on the test surface depends upon the path difference between the two beams for that point. The color changes indicate the surface slopes. When the polarizer before the prism is rotated, the relative intensities of the two orthogonal polarized beams change, and the colors change.

Mirau Microscope

Optical Profiler for Measurement of Surface Microstructure



II]

1) Measure center thickness of given lens using the instrument provided.
2) Measure diameter of given lens using a screw gauge.
3) Measure edge thickness variation of given lens using the instrument provided.
4) Measure radius of curvatures for the given lens using a spherometer.