



**Arizona State University NanoFab**

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# ZYGO PROFILER STANDARD OPERATION PROCEDURE

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Rev A

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## 1. Purpose / Scope

The Zygo is a 3D optical profiler which provides fast noncontact measurement of surface texture, form, and step heights. The tool provides three-dimensional measurement data of a surface using a scanning white light interferometric sensor. The interference pattern is generated by dividing the light into two paths; directing one to an internal reference surface and the other to the test surface. Due to surface irregularities, the measurement wavefront travels different distances than the reference wavefront. When the two wavefronts are recombined, the waves are out of phase and form an interference pattern. This interference pattern of light and dark bands is called “fringes”.

The Zygo scans the test part by moving the head up and down (in the Z-Axis). During the scanning process the video system captures intensities at each camera pixel. These intensities are then converted into maps that the software uses for all data analysis.

## 2. Reference Documents

A copy of the vendor manual (ZeMaps-ZeGage) is stored in the system computer.

## 3. Equipment / Supplies / Material

Computer with Microsoft Windows and ZeMaps software. The computer is not on the network and user data files other than recipies should not be stored in the hard drive.

Tweezer for handling samples.

USB thumb drive for saving user data files

## 4. Safety

Do not touch the objective lens. Dust, dirt, and fingerprints can impair the imaging capability and harm optical coatings. Drive the stage to the “unload” position before placing your sample on the stage.

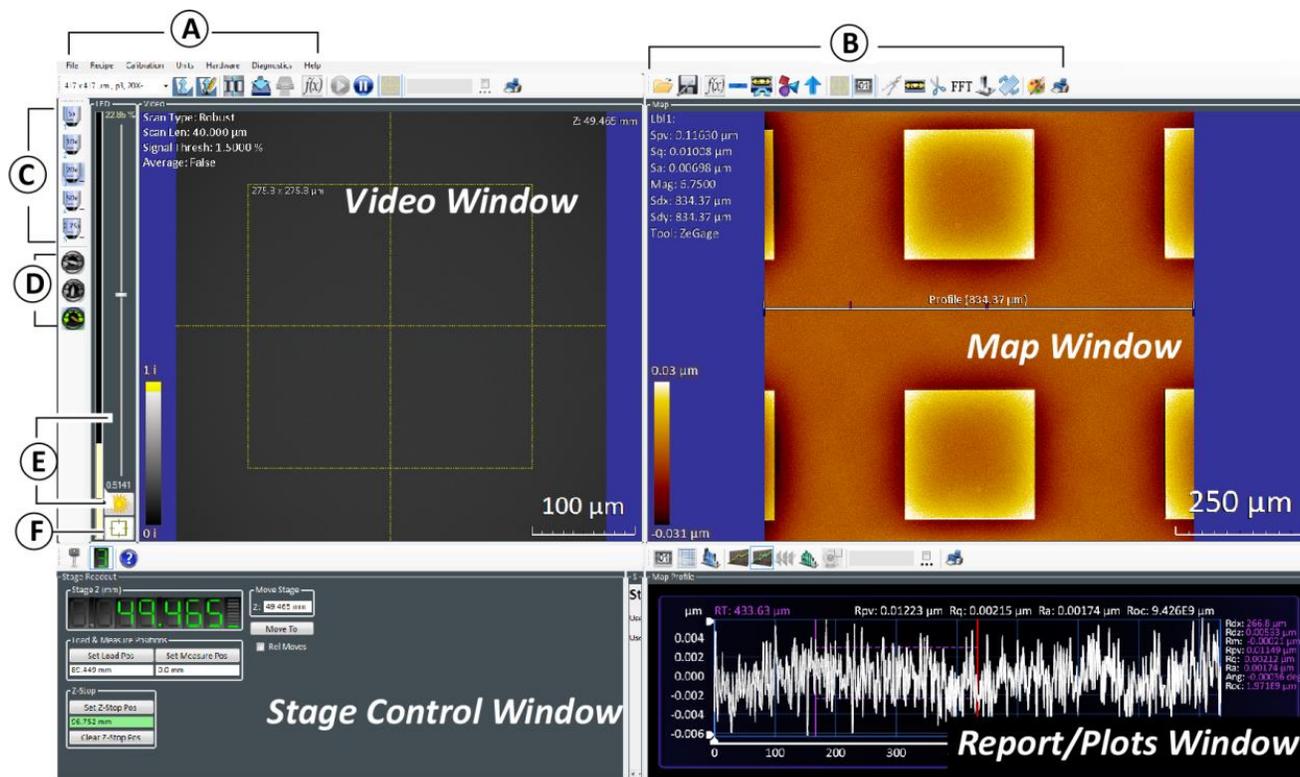
Do not crash the objective or profiler into the test part or part stage. Use caution when focusing and adjusting the z-axis. For typical wafer thickness samples make sure the Z-stop is set for 87.5mm! If you have unusually thick samples, a different Z-stop may be required. When in doubt, check with the NanoFab staff.

Keep clear of the z stage when it is moving. Keep hands, hair, and other items away from the column when the Z Stage is moving up or down.

Note the location of the Emergency Stop Button. When pressed, it stops all motion in the Z-axis.

## 5. Set Up Procedures

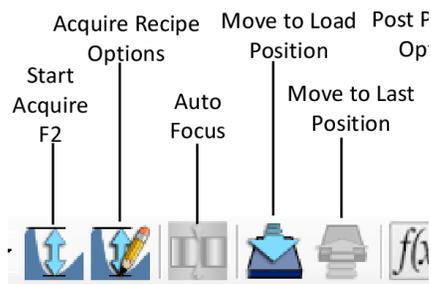
5.1. Launch the ZeMaps software application. After initializing, the monitor will show four screens illustrated below that you will use to track stage movement, acquire data, and image / manipulate that data.



5.1.1.1. Stage control window: This window displays the position of the stage and the current value of the Z-stop (which should be 87.5 mm). If the Z-stop setting is incorrect or missing (box will be red) reset the value.

5.1.1.2. Video window: This window has the load / unload stage position control, allows one to view the sample for focusing and alignment and, has controls for adjusting illumination (critical), creating the measurement recipe, and starting the scan.

5.1.1.2.1. Note the icons marked “A” above – the most useful are enlarged below.



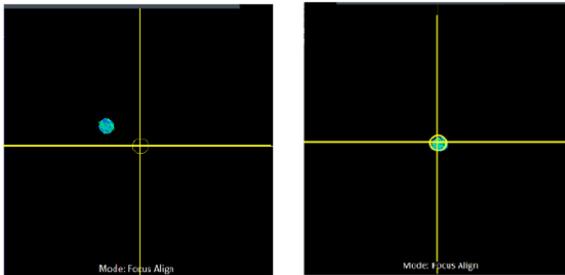
Load / Unload sample = “Move to Load Position”  
 Move sample under objective = “Move to Last Position”  
 Create recipe = “Acquire Recipe Options”  
 Make measurement = “Start Acquire F2”

5.1.1.2.2. “D” sets the joystick speed for the X/Y and Z directions. A medium speed is useful for moving around the sample to locate the area to be measured and for rough

focusing; the slow speed is necessary for fine focusing and to observe the interference fringes.

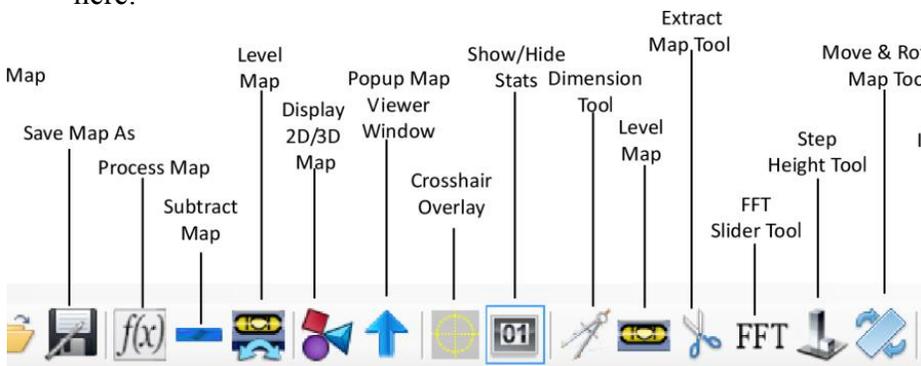
5.1.2.3. “E” light level adjustment. The adjustment is automatically made each time one clicks on the icon. Note the colored indicator bar which can be green (good), yellow (caution), or red (not good). There is also a manual slider which allows you to override the automatic illumination setting.

5.1.2.4. “F” toggles between the alignment and acquisition modes. The alignment mode provides a focusing aid as shown in the figure below:



Focusing moves the spot until it aligns within the center circle fiducial but fine focusing will still be needed. For many samples, visual focusing as is done with a microscope does equally well or better. Return to acquisition mode to make a scan.

5.1.3. Map window: This window displays 2D and 3D maps of surface data from a newly acquired measurement. There are options for saving maps and processing data. One can use the icons above the window (see “B”) or right click in the window to access a context menu for additional functionality. An expanded view of the most useful icons is shown here:



5.1.3.1. “Save Map As” is used to save a jpg file to your USB drive

5.1.3.2. “Display 2D/3D Map” is useful to check that the scan was successful and your sample appears as expected.

5.1.3.3. “Dimension Tool” places a ruler on the map to determine feature size

5.1.3.4. “Level Map” places a box or circle on the map that after resizing is used to remove tilt based on the data within the box or circle.

5.1.3.5. “Extract Map Tool” places a box or circle on the map that selects and magnifies the feature contained within.

5.1.4. Report/Plots window: Most useful for profile map plots. This map represents a slice, or profile, through the data displayed in the 2D map. Profiles can be leveled and the zoom function makes it possible to look at critical features of a part surface. Additional tools,

caliper and tag, compare segments of the line or measure height changes between points. A variety of statistics can be displayed on the plot and are accessible via the plot's context menu.

- 5.2. Check the Z-stop value and correct if necessary. Use the joystick to move the instrument in the Z axis. Once the instrument is in a safe position (87.5mm) in the Z axis, click the Set Z Stop Pos button in the Stage Control Window.

## 6. Operation Procedures

### 6.1. Making a measurement

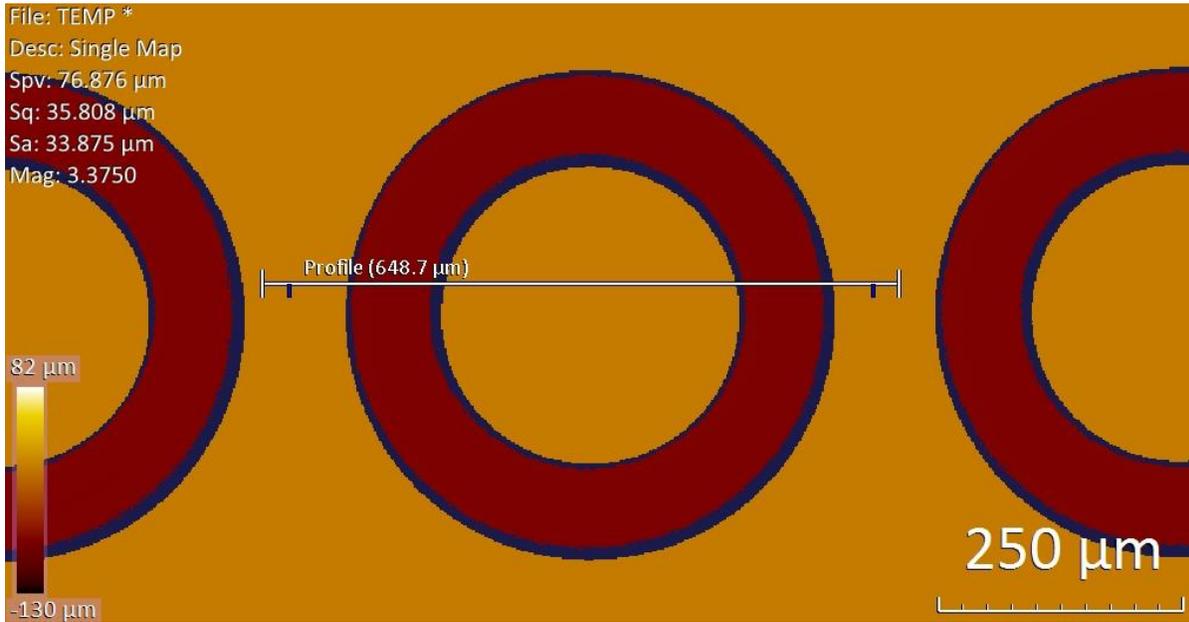
- 6.1.1. If necessary, move stage to load/unload position. Place sample on stage, then select "Move to Measurement Position" to place sample under objective.
- 6.1.2. Set joystick speed to medium for both X/Y and Z drives. Note that the Z drive is controlled by rotating the joystick, clockwise to move the Z-Stage upwards and away from the sample and counterclockwise to move the Z-Stage downward and toward the sample. Use caution when moving the head down (towards) the sample. Do not crash the objective into the sample or stage. A correct Z-stop setting will protect your sample and wallet. Visually note that the region of interest is approximately under the objective and drive the X/Y stage position as needed.
- 6.1.3. Adjust light level by clicking on the 'Light Level adjust'
- 6.1.4. Drive the stage toward the objective (Z motion) while watching the video screen until the sample begins to come in focus. Adjust the light level as needed to keep the indicator green and especially as soon as you see some sense of an image. As the objective approaches the sample the speed should be reduced to slow. You should see a clear image of the structures on your sample.
- 6.1.5. Use the X/Y stage drives to find the region of interest Adjust the light level as needed and look carefully for the appearance of fringes on the video display. With some samples, toggling to the alignment mode and / or the use of the auto focus icon may be helpful. If you use the alignment mode, remember to return to the acquisition mode before continuing.
- 6.1.6. If the sample has large step heights, focus and observe fringes at both the top and bottom surfaces, noting from the stage control window the Z heights at both top and bottom of the feature. This will help in setting the recipe scan length. You can magnify the image in the video window by right clicking to select a data area tool and then drawing a box on the screen around the region you want to enlarge – and then return to the full screen by left clicking anywhere in the window.
- 6.1.7. Create the measurement recipe. Set the scan length to be somewhat greater than the step height. The objective always moves down for the measurement, but the recipe specifies the starting focus position as top, center, or bottom of the feature. For "top", the scan moves down the specified length; for "center", the objective first moves up half the scan length, and then down the full length; for "bottom" the objective first moves up the full scan length and then down.
- 6.1.8. Perform final focus and light intensity adjustments (critical – make sure the indicator stays mostly green at both the top and bottom surfaces of your sample) and then start the acquisition either from within the recipe or using the start data acquisition icon. Once the acquisition is complete the data will be displayed in the Map and Report/Plots windows.

6.2. Analyzing the measurement data

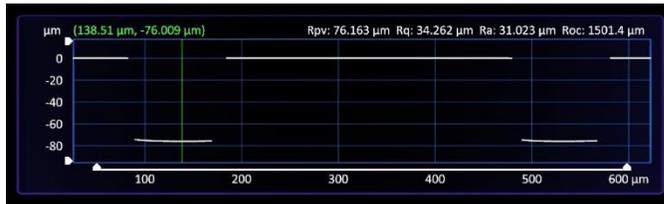
- 6.2.1. In the Map window, use the 2D/3D image tool to see if your sample appears as expected. If not, re-acquire the data, adjusting both the light level and the focus until it looks correct.
  - 6.2.2. Level your measurement data using the “Level Map” tool. This should be done on a known good level surface of your sample which will allow for good step height readings. Find a point typically on a flat surface of the mapped surface & open the “Level Map” then size it accordingly & click remove.
  - 6.2.3. If desired a specific region can be magnified using the extract map tool. Draw a box around the region to be magnified. Then turn off the extract map tool; you can return to the unmagnified image by left clicking anywhere in the Map window.
  - 6.2.4. Size measurements can be made using the “dimension tool” icon. A ruler will appear in the map window which can be moved to measure features.
  - 6.2.5. To get a profile map, right click in the Map window and “show profile tool”. Position the profile bar on the map as wanted. Note there are two small blue markers on the profile bar and the profile of the region between these two blue indicators will be shown in the plots window. These can be resized as needed.
  - 6.2.6. To level the profile, right click in the plots window, select “level using leveling tool”, and adjust the position of the yellow dotted line level box as needed. Then right click again and “turn leveling off”.
  - 6.2.7. The Y axis of the plot is adjusted by sliding the triangle shaped indicators on that axis.
  - 6.2.8. To measure a step height, right click, open tools, and select show tag tool. Move the purple cursors as desired and read the dimensional information shown to the right of the plot. Purple markers will also appear on the profile bar in the map window corresponding to the same locations.
  - 6.2.9. To measure a step width, right click, open tools, select “show caliper”. A marker will appear in the plot and can be sized as needed.
- 6.3. Saving data: Right click in the windows and “save as” using .jpg format to your USB thumb drive. Please do not store large amounts of data on the system computer.
- 6.4. Finishing up:
- 6.4.1. “Move to Load” position and remove your sample from the stage
  - 6.4.2. Close the program so that motors are disabled.

## 7. Process Data

The pictures below are examples of a map of an etched “donut” region in silicon and the corresponding profile. On the top image, the profile bar defines the cut line for the bottom image. The profile has been leveled and then the leveling tool turned off. Note the blue markers on the profile bar which correspond to the x axis triangle indicators in the plots window.



8.



**Revision History**

Effective Date	Originator	DESCRIPTION OF REVISION	Issue
06/18/15	C Tracy	Initial Release	A
			B
			C
			D
			E
			F
			G
			H