

Films7k.app (for 7000 NewView models)**Films.app (for all other NewView models)**

This booklet is a quick reference; it assumes that you are familiar with MetroPro software and the use of the instrument. Information on MetroPro is provided in the *MetroPro Quick-Start Guide*, OMP-0469, and the *MetroPro Reference Guide*, OMP-0347. Information herein is applicable as of MetroPro version 8.1.0.

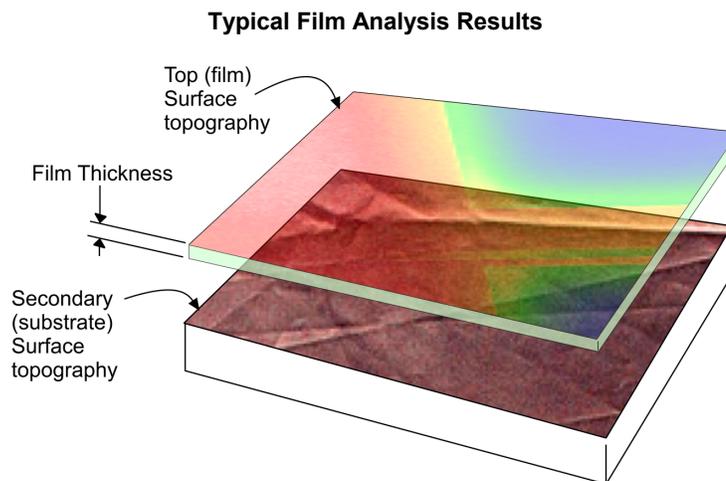
The Film Analysis Application

The Film Analysis application is designed to measure surfaces in the presence of films. It can provide results on the top surface topography and roughness, the thickness of the film, and surface topography and roughness of the lower or substrate surface. Film analysis is accomplished by a special FDA analysis function that analyzes multiple intensity modulation signals to determine the substrate and film surfaces.

The film application supports the NewView family of optical profilers. The application requires a separate Film Analysis software license to function. For information on licensing, refer to the *MetroPro Quick-Start Guide*.

Key Features:

- Measures single films from 1 μm to 50 μm thick.
- Measures semi-transparent films and substrate simultaneously.
- Films FDA (Frequency Domain Analysis) retains all modulation signals, and calculates multiple zero-order fringe locations in the scan. Traditional FDA modes ignore all but the strongest intensity modulation signal.
- Provides graphics and results for the top (film) surface, secondary (substrate) surface, and thickness results.



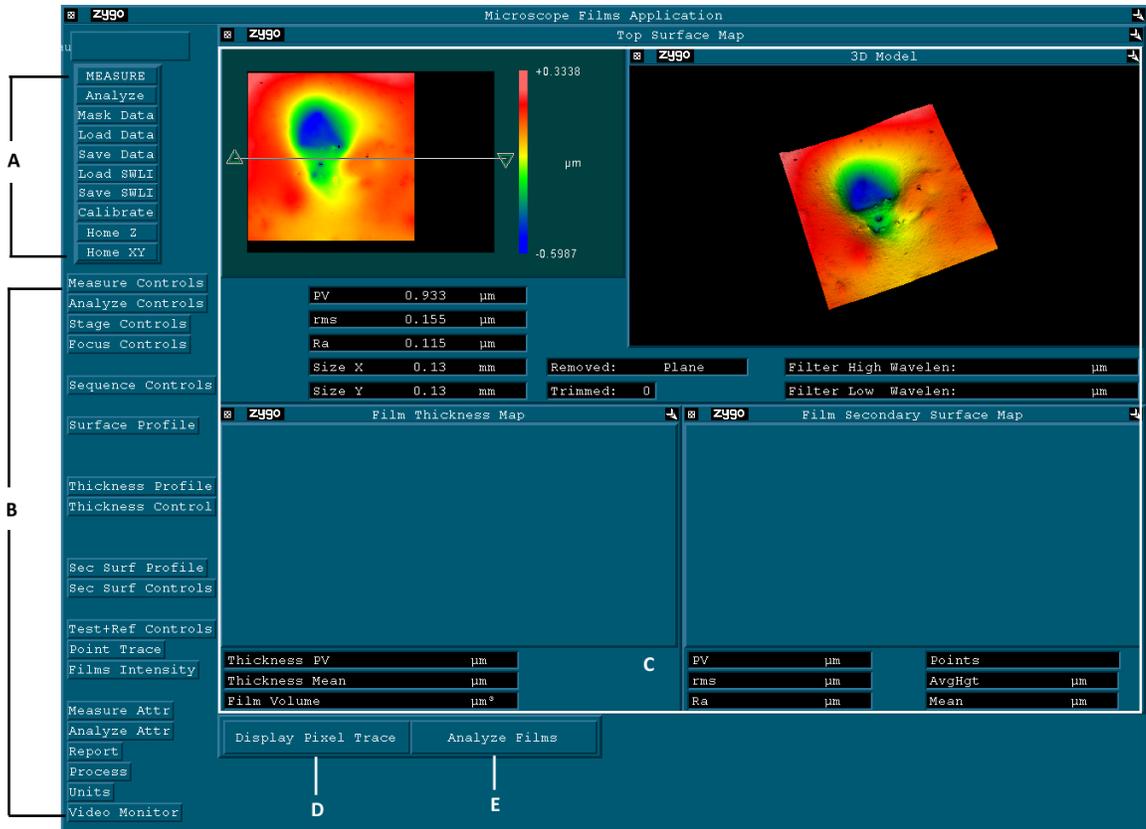
Known Limitations:

- Minimum 1 GB RAM recommended.
- Does not support bi-refringent films.

Films.app and Films7k.app

To start MetroPro, refer to the *MetroPro Quick-Start Guide*. To open either application, click on the corresponding icon. If the icon is not on the MetroPro base window, then use the Load Application command from the MetroPro Window menu to first load the application icon.

The Film Analysis Application Screen



A—Buttons which initiate an action. For example, clicking the Measure button begins the measurement process.

B—Icons which open a variety of windows used to set controls for acquisition and analysis as well as specific controls for top and secondary surfaces.

C—Area for display of graphic and numeric results for the measurement for both the top and secondary surfaces. The Film Thickness Map will display graphics and results on the area between the top and bottom surfaces when there are two surfaces. The Film Secondary Surface Map shows results for the secondary surface. These two plots will show data dropout where only one surface is found.

D—This button displays the point trace and the intensity plot for observing modulation signals.

E—This button recalculates SWLI data with changes in control settings.

Guidelines

- *Follow General NewView Instrument Guidelines –*
 - Create a system error file for the objective and zoom in use by measuring a ZYGO SiC Reference Flat and activating this function in software with the Subtract Sys Err and Sys Error File controls.
 - Perform lateral calibration by clicking the Calibrate button and measuring a ZYGO Lateral Calibration Standard to provide lateral (x and y) unit dimensions in plots and results.
 - Set the light level (press F5) when there are several fringes in the field of view.
 - Null (minimize) fringes before making measurements to improve data acquisition.
- *Perform System Characterization –* Films analysis requires the use of a system characterization (.sync) file. Creation of this file is described in the “Making a System Characterization File” section. This procedure creates a system characterization file based on the measurement or a loaded SWLI data file.
- *Save Data as SWLI for Off-Line Analysis -* To preserve all modulation signals for off-line analysis save data as a “.swl” file using the Save SWLI button.
- The Scan Length control must be set to 150 μm or less.

Instrument, Objectives, and Film Thickness

Film analysis is recommended for a subset of NewView instruments and objective combinations, and even then, it only is suggested for certain film thickness. The chart below shows this. Additionally, an instrument aperture stop is required for many measurement configurations.

Objective/System/Application Usability Matrix

| Obj | NewView 6200/7200 | | | NewView 6300/7300 | | |
|------|-------------------|----|----|-------------------|------|------|
| | TS | SS | TH | TS | SS | TH |
| 1X | ● | ● | ● | ● | ● | ● |
| 2.5X | ● | ● | ● | ● | ● | ● |
| 5X | ● | ● | ● | ● | ● | ● |
| 10X | ● | ⊗ | ⊗ | ● | ○-60 | ○-60 |
| 20X | ● | ⊗ | ⊗ | ● | ○-50 | ○-50 |
| 50X | ● | ⊗ | ⊗ | ● | ○-40 | ○-40 |
| 100X | ● | ⊗ | ⊗ | ● | ⊗ | ⊗ |

Key: TS= top surface, SS= secondary surface, TH= thickness
 ● measurement possible from 1.5 to 75 μm optical thickness
 ○-60 measurement possible from 1.5 to ## μm optical thickness
 ⊗ measurement not recommended

Aperture Stop

An aperture stop (A-Stop) is required to measure the film thickness or the secondary surface. The setting of the aperture stop varies with objective. Adhere to these guidelines:

- 1X, 2.5X, and 5X objectives- the aperture is opened (pushed in).
- 10X and 20X objectives- set the aperture as described in the next section.
- 50X objective- the aperture is closed (pull out to detent).

Setting the A-Stop for 10X and 20X Objectives

1. Select the objective.
2. Slide the A-Stop slider all the way in.
3. Place the SiC (Silicon Carbide) reference flat on the stage and focus to find fringes.
4. Obtain 7-10 vertical fringes on the SiC flat.
5. Open the Light Level window (press F4).
6. Increase light level until saturation reaches approximately 30%.
7. Close the aperture stop slider by pulling it out until the intensity readout is between 90% and 100% (green bar).
8. Click Set in the Light Level window.

Making Measurements

Making a System Characterization File

The system characterization (.syc) file records the optical properties of the instrument for the current objective and is required for all film analysis measurements.



The characterization file is specific to the objective in use and the setting of the Scan Direction control.

1. Select the objective and set the Scan Direction control to match the settings used when measuring the part.
2. Make sure that the following controls are set:
 - FDA Res: Films
 - Discr Mode: RAM
 - Films Mode: Top Surface
3. Place a ZYGO SiC Reference Flat under the objective.
4. Focus the NewView on the Flat. After finding fringes, adjust the stage tip/tilt to null the fringes. Adjust light level (press F5).
5. Click the Measure button.



The data for the characterization file can also be obtained by loading a SWLI file that was made under the conditions described above.

6. Enter the name of the characterization file in the Sys Char File control.
7. Click the Generate Sys Char File button and follow any on-screen instructions.

Making a Measurement

Adhere to the Setup, Focus, and Null instructions in the NewView operating manual.



Refer to aperture stop information on the previous page.

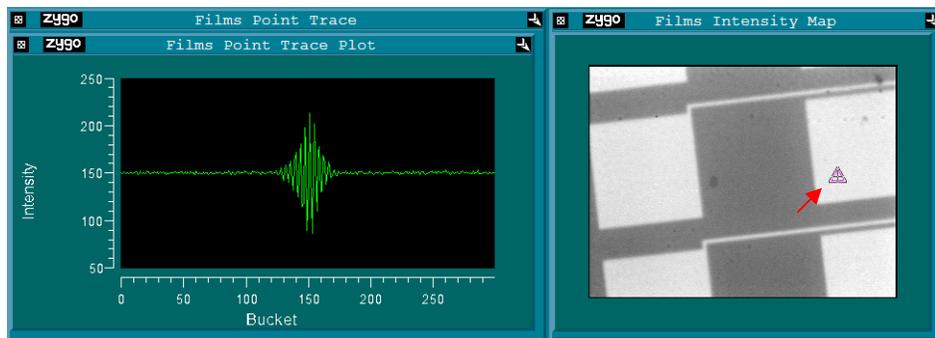
Film Analysis Data Windows

| Window | Shows | Available Analyze Functions |
|-------------------------------|---|---|
| Top Surface | Upper surface (film) results | Auto aperture, remove, trim, data fill, full data filtering, masking with Mask Editor. |
| Film Thickness | Thickness results between the top and secondary surfaces | Auto aperture, trim, data fill, low-pass data filtering, masking by applying a saved mask file. May be blank unless applicable Films Mode is selected and two surfaces are found. |
| Film Secondary Surface | Lower surface (substrate) results | Auto aperture, trim, data fill, full data filtering, masking by applying a saved mask file. May be blank unless applicable Films Mode is selected and two surfaces are found. |
| Film Point Trace | Modulation of a selected data point in the Film Intensity Map | This data window along with the Film Intensity Map is useful for determining how many surfaces exist in the data. |

Understanding Film Analysis

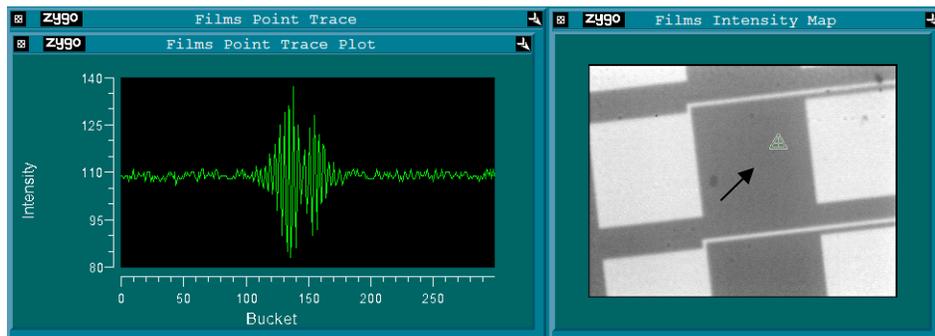
The key to film analysis is multiple modulation signals obtained during the measurement process when the FDA Mode control is set to Films. Click the Display Pixel Trace button to process and open these plots.

Films Point Trace – Single Modulation Example



The Pnt Trace slice is active in the Films Intensity Map. The triangle on the Map identifies the pixel location used to create the Films Point Trace Plot. The Point Trace Plot shows intensity modulation. The Gaussian modulation envelope depicts a single surface.

Films Point Trace – Multiple Modulation Example



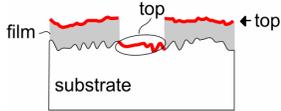
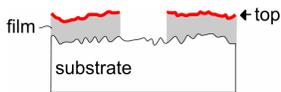
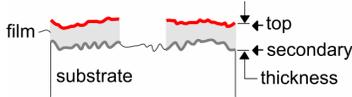
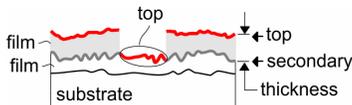
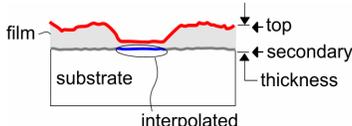
In this example, the Pnt Trace location has been moved by locating the cursor over the triangle and dragging it to another location. This Point Trace Plot depicts a dual modulation envelope and indicates that there are two surfaces.

The Films Mode Control

The Films Mode control selects what the software measures and reports. The selections for this control are described below.



Changes made to the Films Mode control can be seen by clicking the Analyze Films button.

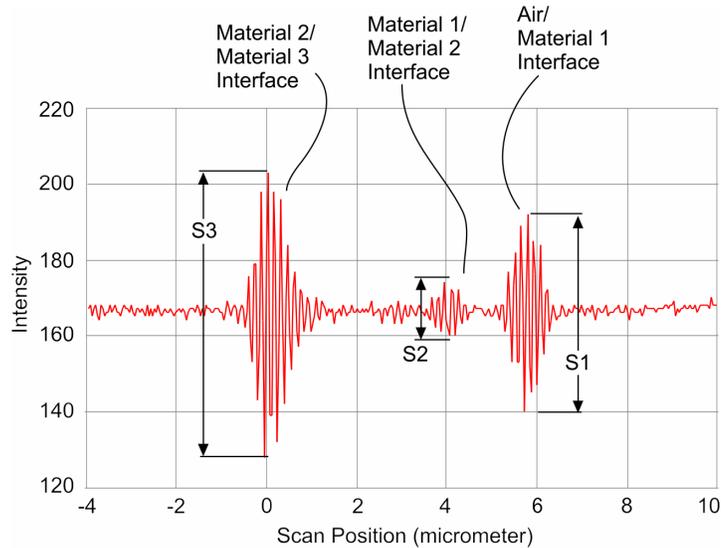
| Setting | Example | Windows with Results | Description |
|---------------------------|---|---|--|
| Top Surface |  | Top Surface | Finds the top-most detected surface, with or without the presence of films. |
| Film Top Surface |  | Top Surface | Finds the top most detected surface only when the presence of a film is detected. |
| Film Thickness |  | Top Surface, Thickness, Secondary Surface | Determines the film thickness between the two strongest reflecting surfaces. If two surfaces are not detected no thickness is reported for that pixel. |
| Top Film |  | Top Surface, Thickness, Secondary Surface | Finds the top most detected film when there is more than one film layer. If two surfaces are not detected no thickness is reported for that pixel. |
| Top Down Thickness |  | Top Surface, Thickness, Secondary Surface | Determines the top film surface by fitting a plane to the secondary surface in the areas with distinct surfaces. Secondary areas where the film is thinner than 1 μm are interpolated between the fitted plane. This analysis can provide sub-micrometer thickness results. The lower surface must be relatively flat. |

Verifying Modulation Signals for Analysis

The Bottom/Top Reflectivity Ratio Filter, Min Reflectivity Ratio, and Max Reflectivity Ratio controls can be used to verify modulation signals to use in the analysis. The modulation signal amplitude, as shown in the Films Point Trace Plot, is proportional to the reflectivity of the interface.

Typically, the uppermost interface between air and the top surface has the highest reflectivity, and each succeeding interface has decreasing reflectivity. In this typical scenario, the use of the “reflectivity ratio” controls is not necessary. However, if you want to eliminate a modulation signal from the analysis, or to select a weaker signal in place of a stronger signal, then reflectivity ratio controls are useful.

Sample Graph of Modulation Signals



For example, if you want to measure the thickness from the Air/Material 1 interface to the Material 2/Material 3 interface, choose a value for the Min Reflectivity Ratio control that indicates that signal S3 is expected to be larger than signal S1. So, set Min Reflectivity Ratio to 1.1. This automatically excludes signal S2 from the analysis since $S2 < S1$. ($S2/S1 < \text{Min Reflectivity Ratio}$)

Similarly, if you want to select the weaker signal S2 for the second interface for the analysis set the Min Reflectivity Ratio to 0.1 and the Max Reflectivity Ratio to 0.5. These values prevent the analysis from picking the much stronger signal S3 in place of S2, since $S3/S1 > \text{Max Reflectivity Ratio}$.

MetroPro Reference Listing

Many of the controls, buttons, results, and attributes unique to the Film Analysis application are described in this section. For items not listed, refer to the *MetroPro Reference Guide*.

General Application Controls

These controls are located in the Application window.

| Item | Description |
|--------------------------------------|--|
| Analyze Films button | <p>Recalculates SWLI measurement data using the present control settings.</p>  <p>The Analyze button works only with regular data sets.</p> |
| Display Pixel Trace button | Processes and opens the Films Point Trace and Films Intensity Plot windows for observing modulation signals. |
| Load SWLI button | <p>Opens a File Handler which is used to recall existing saved SWLI (Scanning White Light Interferometer) data files and load them into the application.</p> <p>To load a file, click the button. In the File Handler, click on the box with the name of the file you want to load. Click Done to close the File Handler.</p> |
| Save SWLI button | <p>Opens a File Handler which is used to specify a data file name and save the file. This function saves SWLI (Scanning White Light Interferometer) data files, with the extension “.swl”, which are much larger than standard data files.</p> <p>To save your data click the Save SWLI button. In the File Handler, click the “Current Selection” box, enter the name for the file, ending with “.swl”, and then press [Enter]. Click Done to close the File Handler.</p> |

Measure Controls (Measure Cntrl)

| Control | Description |
|--------------------|---|
| Camera Mode | Selects the effective camera size in pixels. More pixels resolve smaller details, but increase processing time. The choices available are dependent on the instrument model. |
| Discr Mode | Specifies how camera frames are processed. For film analysis this control should be set to RAM. |
| FDA Res | FDA (Frequency Domain Analysis) is a FFT (Fast Fourier Transform) method of processing surface height data from a sequence of interferograms. The settings of the FDA Res control determine the specific technique of the FDA analysis. For film analysis this control must be set to Films. |
| Min Mod (%) | Specifies the minimum modulation necessary for a valid data point. Decrease to accept areas with poor fringe contrast or low reflectivity. Increase to exclude unwanted data points. |

Measure Controls (Measure Cntrl) (continued)

| Control | Description |
|-------------------------|---|
| Scan Direction | Selects the scan direction of the objective. Settings are Upward or Downward. |
| Subtract Sys Err | Activates the subtraction of a system error file to improve measurement accuracy. |
| Sys Err File | Specifies the name of the data file to subtract from each measurement. |

Film Specific Controls (Measure Cntrl)

These controls are located in the Films Measure Controls window.

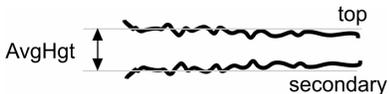
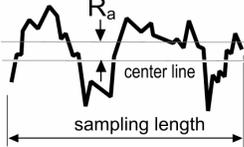
| Item | Description |
|---|--|
| Bottom/Top Reflectivity Ratio Filter | Selects whether the reflectivity of the interface surfaces are considered when calculating film analysis results. The settings are Off (default) or On. When On a filtering function is applied based on the settings of the Max Reflectivity Ratio and Min Reflectivity Ratio controls. This can be used to verify the modulation signals used in the analysis. See “Verifying Modulation Signals for Analysis.” |
| Coherence Obliquity Correction | Specifies an correction value for geometric illumination effects when analyzing films at high NA (numerical aperture). The default value is 1; the minimum value is 0. |
| Film Min Mod (%) | Specifies the minimum modulation necessary for a valid data point during film analysis. Decrease the value to accept areas with poor fringe contrast or low reflectivity. Increase the value to exclude unwanted data points. |
| Film Max Thickness | Specifies the maximum film thickness that is considered valid. This value is use to control the amount of data that is saved and used for analysis. If the value is set too low, not enough data is saved for accurate measurements. If the value is set too high, too much data is saved and analysis time increases. The default value is 0. The units are selectable. |
| Film Min Thickness | Specifies the minimum film thickness that is considered valid. Any value below this value is assumed to be in error and will not be reported. The default value is 0. The units are selectable. |
| Films Mode | Selects the film analysis mode. Choices are: Top Surface (default), Film Top Surface, Film Thickness, Top Film, and Top Down Thickness. See “The Films Mode Control.” |
| Generate Sys Char File button | Generates a system characterization file for film analysis based on the current instrument settings. System characterization files are generated by measuring a Silicon Carbide Flat. The FDA Mode control must be set to Films. The Discr Mode control must be set to RAM. When the Generate Sys Char File button is clicked, it invokes a procedure for creating the system characterization (.sync) file. |

Film Specific Controls (Measure Cntrl) (continued)

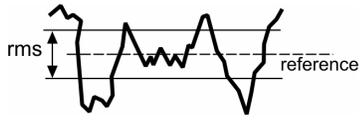
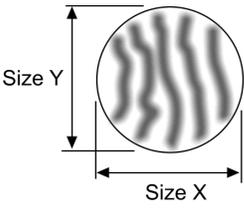
| Item | Description |
|---|---|
| Index of Refraction | Specifies the index of refraction of the film being measured. The default value is 1. |
| Max Reflectivity Ratio | The maximum ratio of the reflectivity of the bottom interface to the reflectivity of the top surface. Accepts positive values from 0 to 400. The Bottom/Top Reflectivity Ratio Filter control must be On. |
| Min Reflectivity Ratio | The minimum ratio of the reflectivity of the bottom interface to the reflectivity of the top surface. Accepts positive values from 0 to 400. The Bottom/Top Reflectivity Ratio Filter control must be On. |
| Select Default Sys Char File button | Searches the current working directory for a compatible system characterization file according to the instrument settings. It takes into account the value of the Film Max Thickness control in order to calculate a compatible system characterization file. If the Film Max Thickness control is set to zero, then it looks for a system characterization file according to the current instrument settings. |
| Select Sys Char File button | Opens a load file dialog box with default file extension “.syc” for selecting a system characterization file to be used during film analysis. The Sys Char File control is automatically updated with the file name selected from the dialog. |
| Sys Char File | Specifies the name of the system characterization file to use during film analysis. |

Results

These results may appear in multiple windows within the application. When within a data window, a result is only applicable to that particular analysis.

| Result | Description | |
|---------------|---|---|
| AvgHgt | Average Height or vertical offset between the top surface and the secondary surface. |  |
| Mean | The average distance between the highest and lowest points within the sample. | |
| Points | The number of data points or pixels in a particular analysis. | |
| PV | Peak-to-Valley is the distance between the highest and lowest points within the sample. |  |
| Ra | The average surface roughness or average deviation of all points from a plane fit to the surface. |  |

Results (continued)

| Result | Description |
|------------------------------------|---|
| rms | <p>Root-Mean-Square or rms is the deviation from the best fit shape specified with the Remove control. In other terms, it is the transmitted error relative to a reference surface.</p>  |
| Size X Size Y | <p>Size X is the dimension of the data set in the x-axis. Size Y is the dimension of the data set in the y-axis. The instrument must be calibrated for the Size X and Size Y results to display.</p>  |
| <i>Film Thickness Results</i> | |
| Film Volume | The sum of all thicknesses in cubic measurement units. |
| Thickness Mean | The average vertical distance between the highest and lowest points within the thickness map. |
| Thickness Peak | The maximum vertical distance between the best fit surface and the highest point within the sample. |
| Thickness Peak Loc X | The x-axis location in the data set of the highest point. |
| Thickness Peak Loc Y | The y-axis location in the data set of the highest point. |
| Thickness Pts in PV Spec(%) | Percentage of Points within the Peak-to-Valley specification is the percentage of valid data points within a user specified high limit for the PV result. It is linked to the Thickness PV result and displays a value only if a high limit is set on the PV result. The value shown represents the percentage of data points within the limit. |
| Thickness PV | The maximum vertical distance between the highest and lowest points within the sample. |
| Thickness Valley | The maximum vertical distance between the best fit surface and the lowest point within the sample. |
| Thickness Valley Loc X | The x-axis location in the data set of the lowest point. |
| Thickness Valley Loc Y | The y-axis location in the data set of the lowest point. |

Other Operations

| Operation | How to |
|--|---|
| Save SWLI data | Click the Save SWLI button. In the File Handler, click the Current Selection box, enter a name for the file, ending with “.swl”, and press Enter. Then click the Done button. |
| Print | Click the word “zygo” in the window you want to print or select the Print command from the window’s menu. Then click the Print button in the Print Panel. |
| Saving changes made to controls, plots, results, and windows. | You must save the application under a new name. Select the Save Application command from the Application Window menu. In the File Handler, enter a name for the file, ending with “.app” and press Enter. Then click the Done button. |
| Use or define masks | Click on the Mask Data button. Use the Mask Editor to define areas to include or exclude from the test part measurement. See the <i>MetroPro Reference Guide</i> . |
| Turn off the system | Warning! Improper shutdown may damage the instrument. Select the Quit command from the MetroPro menu; turn off power after you have shut down from within Windows. |