

SOP: General Operation of Bruker DektakXT Stylus Profiler

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General Information

The Bruker DektakXT is a stylus profile tool that is well suited to measuring thin and thick film step height measurements and profiling surface topography and waviness. In addition to measuring 2D surface profiles, the automatic X-Y / Theta stages facilities 3D mapping and programmatic measurement of up to 200 sites on samples with diameters up to 150 mm and sample heights less than 50 mm.

This system is equipped N-Lite+ Low Inertia Sensor option which allows low force engagement and scanning required to protect force-sensitive samples.

¹ SOP adapted from DektakXT Stylus Profiler User Manual ©2011

Scan Length range, without stitching, is 50 μm -- 55 mm. When using stitching, the maximum scan length is 200mm.

DektakXT Stylus Profiler Anatomy.



Figure 1 DektakXT Stylus Profiler equipped with manual X-Y stage

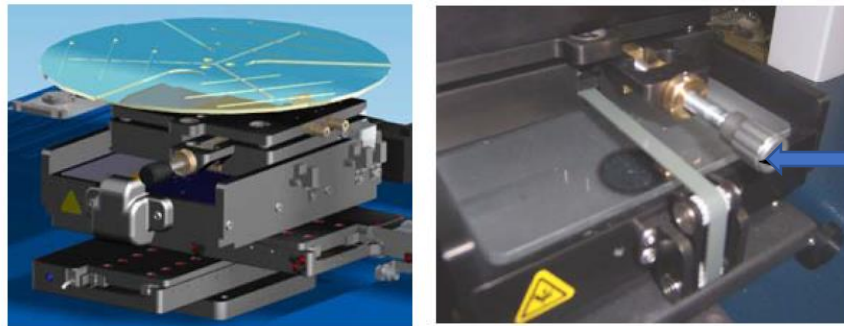


Figure 2 X-Y Auto stage with Wafer Vacuum Sample Fixture

Automatic X-Y stage, with sample vacuum sample fixture. Orange arrow indicated location of manual tilt adjustment knob.

Start Up / Powering Up the System

1. Power on DektakXT, using the Power On button located on EMO BOX. (Figure 3)
 - a. Note if the system does not energize when the Power button is pressed, make sure the “Emergency Off” button is in the on (popped up) position.
2. Turn on control computer
3. Start Vision64 Software
4. Allows the system to warm up for approximately 15 minutes before collecting the first scan.



Figure 3 Emergency Machine Off (EMO) Box

EMO box contains three controls, Emergency Off, Power On and Power Off. Black arrow illustrates location of Power On button.

Powering Down the System



1. Close Vision64 software
2. Press the black “Power Off” button on the EMO box. (Figure 3)
3. Shut down the Control Computer


General Operation

Most common Dektak surface profiler operation can be accomplished using a combination of 3 general procedure groups. These groups include sample positioning, measurement setup, and sample measurement / data acquisition.

Sample Positioning

Ensure that the Dektak system is powered on and the Vision64 software is open / connected to the tool.

1. Click "Measurement Setup" View
2. Click “Unload Sample” button  located in the live video window.
 - a. The scan tower moves to a safe position and the sample chuck will moves forward ~ 50 mm allowing convenient access to sample stage.
 - b. Note: For additional access, the XY stage can be adjusted using the instrument control panel (Figure 4)
3. Place Sample onto stage and secure with vacuum or other means.
4. Click “Load Sample” button  located in live video window.
 - a. This moves the scan stage backwards to its home position.
5. Use the stage controls (Figure 4) to position the sample/area of interest beneath the stylus.

6. Click "Tower Down" button  to lower the tower and have the stylus locate the surface.
After surface location, the stylus will move to the up position.
7. Adjust intensity slider (instrument control panel) to view the sample appropriately. Typical values of ~5% intensity
8. Adjust Theta to ensure that step height or predominate surface features are perpendicular to the Y-axis.
9. Fine adjust the XY stage. Use the XY stage control (Figure 4) to direct the area of interest to the video crosshair
 - a. Stylus position can be checked by right clicking on the live video window and selecting "lower stylus "
 - b. If the stylus is not at the correct location, right click on the live video window and select "raise stylus" and then use the instrument control window to reposition the system.

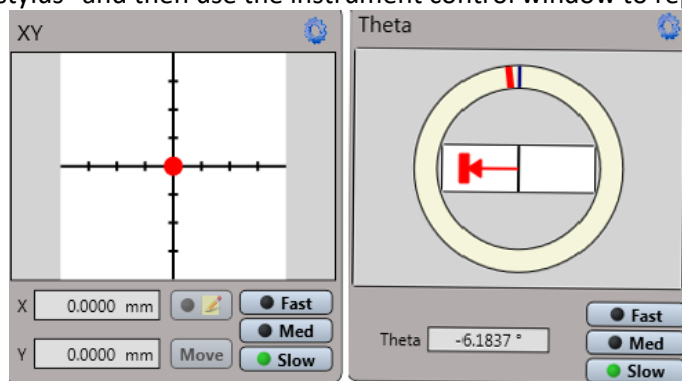


Figure 4 Auto Stage Controls X/Y & Theta

Vision64 Measurement Setup

The Measurement Setup window must be configured prior to collecting a manual or automated series of measurements. This window contains 4 sub-window sections: Measurement Options, Advanced Options, Data Stitching, and 3D Map. Most of the scan parameter can be adjusted from the Measurement Options sub-window (Figure 5). A configuration can be saved as Vision recipe.

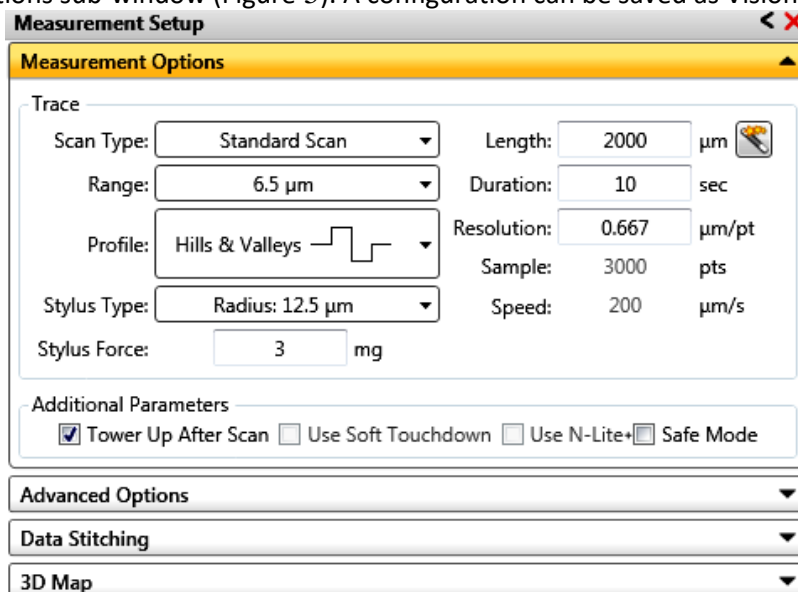


Figure 5 Measurement Setup window / Measurement Options Tab

Measurement Options sub-window (Figure 5)

1. **Select Type:** For 2D profile, select the Standard Scan option.
2. **Select Scan Range:** Select the scan range the best matches sample topography. Available scan ranges: 6.5 μm , 65.5 μm , 524 μm , or 1 mm
 - a. For example, for a $\sim 10\mu\text{m}$ step height the 65.5 μm range would be the most appropriate choice.
 - b. If the real-time data trace is maxed out, the selected scan range may be too small. (Figure 7)
 - c. Note: The greater the selected scan range, the lower the measurement's vertical resolution.

Range	Vertical Resolution
6.5 μm	0.1 nm
65.5 μm	1.0 nm
524 μm	8 nm
1 mm	15 nm

3. **Select Scan Profile.** Three scan profiles are available. Profile type affects how the scan range is apportioned.

Scan Profile Type	Typical Use Case
Valleys	90% of scan range is set below the zero line; Useful for trench measurements.
Hills	90% of scan range is set above the zero line; Useful for measuring step height measurements.
Hills & Valleys	50% of the scan range is above and below the zero line. Useful for random height distributions or when the sample tilt has not been adjusted.

4. **Select Stylus Type:** Select Radius 2 μm
5. **Select Stylus Force:** 10 mg is typically used for robust samples. 1 mg or less for soft / scratch prone samples.
6. **Set Scan Length:** The Scan Length range, without stitching, is 50 μm -- 55 mm. (When using stitching, the maximum scan length is 200mm)
7. **Set Scan Duration / Scan Resolution:** Duration is the time require to scan the scan length. This field is linked to the lateral scan resolution and can be tuned to obtain optimal data. To obtain scans with higher lateral resolution the increase Scan Duration.

Minimum Scan Speed	7 μm / sec.
Maximum Number of sample points	120,000 pts.
Maximum Scan Speed	1500 μm / sec.
Maximum Duration	400 sec.

- Rule of Thumb: Set the duration to approximately 10 seconds per 1000 μm of scan length. For example, 25000 μm scan length should use a duration of 25 seconds.
 - If the scan is too fast the measured surface may appear smoother than expected.
8. **Set Data Stitching Options:** Stitching is required when the scan length is greater than 55 mm.
 - a. Overlap Length: the amount each stitching segment overlaps. 10% is typical
 - b. Overlap Method: How the overlap segments are combined. Average typically produces the best results.

Sample Measurement

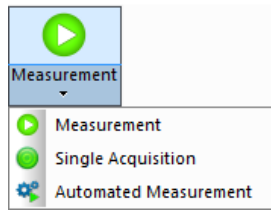


Figure 6 Measurement Button

1. **Start the Measurement:** Click the "Measurement" button located on the left side of the application ribbon. (Figure 6)
3. **Observe the Measurement & Adjust Sample Tilt / Measurement Options:** Observe the measurement on the real-time data acquisition window. If the scan displays a substantial tilt adversely affecting the scan, correct sample tilt using methods described in the Leveling the Stage section. If the sample tilt is acceptable but scanner response is still off scale, adjust Scan Range and/or Scan Type. (Figure 7)
4. **Save Data:** Save the data set using the file operation functions. Save → Dataset



Figure 7 Scan Range with inappropriate scan range / scan profile setting.

Appropriate scan range and scan profile types should be configured to prevent the stylus response from bottoming or topping out.

Leveling the Stage

To ensure optimal performance, the stage should be manually leveled. This can be accomplished by adjustment of the sample leveling knob located on the front of the XY stage (right hand side Figure 2) and the following guidelines.

- Turn the tilt adjustment knob less than 1/2 turn per adjustment cycle.
- Perform tilt adjustment & monitor the effect in the real-time window during the collection of test scans.
- If the profile trace is extremely off-level, set the Scan Range to the 524 μm , level a test scan, then reduce the scan range to an appropriate range for the sample and repeat the leveling adjustment.
- Use the slope analysis function to measure the off-level angle. When using the smallest scan range, the off-level angle should be less than $\pm 0.01^\circ$

Note: Tilt does not need to be adjusted perfectly, just well enough so that the collected data does not reach the lower or upper limits of the scan range or real time data acquisition window.

Note: If after proper tilt adjustment the scan still "tops out" or "bottoms out" adjust the scan range and/or scan profile.

N-Lite+ Option

N-Lite+ feature allows low-force engagement and scanning (down to 0.03 mg). Activating N-Lite+ and Safe Mode operation (additional parameters Figure 5) ensure scratch-free measurement of resists, polymers, and soft metals.

Anytime the stylus force is set to a value less than 1.0 mg, N-Lite+ operation is activated. N-Lite+ operation can be activated for any measurement type. For reliable & consistent low force measurements, the manual sample tilt adjustment must be well optimized.

Basic Data Analysis

Step Height Analysis

1. Acquire or open data that had a distinct step feature.
2. Select the Data Analysis view from the application ribbon.
3. Single or Double Step Identification: Determine if the step feature is a single or double step
 - a. Single Step: A feature with a single vertical edge.
 - b. Double Step: A feature with two vertical edges.
4. Setup Data Analyzer Workflow.
 - a. Add the Terms Removal (F-Operator) filter function (double click), located in the Analysis Toolbox, to the Analysis workflow.
5. Level Data: Place Cursors on Trace.
 - a. Level data: Using the right click menu of Data Analysis window and set the R (Reference) and M (Measurement) cursor positions. If desired click and drag on the R and M cursor location to widen the cursors' extents and include more data in the average height calculation used in the leveling and flattening operations.
 - i. Note the R and M cursors should be in placed in different locations along the feature to be leveled and aligned with the 0-height level.
6. Level Data: Set Terms Removal Settings.
 - a. Right click on the Terms Removal operator in the analysis workflow and select edit settings.
 - b. Select appropriate leveling type, click calculate, then close.
7. Calculating Step Height Value.
 - a. After leveling, the R and M cursors can be adjusted to the top and bottom of the step height feature. The height value can be read from the Cursor Status Dialog Table.

Surface Roughness Analysis

1. Acquire or open data for surface roughness analysis.
2. Remove Tilt / Add Profile Stats
 - a. Remove tilt using the Level Data procedure described in the Step Height Analysis Section.
 - b. Add the Profile Stats operator (double click), located in the Analysis Toolbox, to the Analysis Workflow below the Terms Removal node.
3. Add Surface Calculations: Right click on the Analytical Results table and select Append to open the Surface Profile Analysis Settings dialog. Selected desired statistical parameters, click, then close the dialog.

Dos and Don'ts

Dos

- Always position the sample so that the stylus is the only part of the stylus assembly that touches the sample.
- Keep the environmental enclosure door closed when the system is in use and idle
- Avoid vibration and shock during measurement.
- Raise tower to the maximum vertical position when system is not in use.

Don't

- Disconnect any cables when the system is powered on.