BOISE STATE UNIVERSITY ENVIRONMENTAL HEALTH, SAFETY AND SUSTAINABILITY	STANDARD OPERATING PROCEDURE **Bruker Dektak XT Stylus Profilometer**

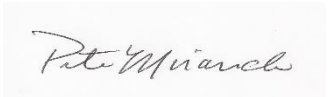
College/Dept: College of Engineering	Building/Room: RUCH 106
Laboratory Name: Idaho Microfabrication Laboratory	Revision: 1.0
Principal Investigator: Pete Miranda	Author: Terek Zimmerman

Before the worked detailed in this procedure may begin, the intended user must read and understand this document.

This document must be approved by the PI, the college's safety liaison, and EHSS.

Any changes to this document, however minor, must be submitted for approval by the PI, the college's safety liaison, and EHSS.

The "buddy system" will be in place whenever any work is conducted.

	Name, Title	Signature	Date
Intended User:			
Reviewed and Approved by:	Pete Miranda, Director - IML		4-22-20

Overview

The Bruker DektakXT® stylus surface profiler is an advanced thin and thick film thickness and height measurement tool. This system can profile surface topography and waviness, as well as roughness in the sub-nanometer range.
In addition to taking two-dimensional surface profile measurements, the DektakXT system can produce three-dimensional measurements and analyses with the 3D Mapping option. The stylus force range is from 1 mg to 15 mg which allows profiling on soft or hard surfaces. 2.0um and 12.5um radius tips are available. It has a vertical resolution of 0.1 nm. It has a vertical resolution of 0.1 nm.

Scope

This SOP reviews how to operate the Bruker Dektak XT and use it to take single scans as well as map scans and how to analyze the collected data.

Potential Hazards

☐ Chemical	☐ Thermal	☐ Hydraulic	☒ Electrical	☐ Slip/Trip	☐ Biological
☒ Mechanical	Radiation	☐ Pneumatic	☐ Fire	☐ Fall	☐ Other

Hazard Specifics:

Engineering Controls (EC)

☐ Fume hood ☐ Biosafety Cabinet ☐ Other Local Exhaust ☒ Shielding ☐ Other

EC Specifics: Case to protect sample.

Training Requirements – except for classroom lab safety, must be completed prior to performing the procedure

☒ Classroom Laboratory Safety Awareness ☐ Radiation Worker

☐ Online Safety Topics (specify):

☒ Lab/Work Group Specific Training (specify): Bruker Training and Observation session

☐ Other (specify):

Personal Protective Equipment (PPE)

☒ Safety glasses	☐ Safety goggles	☐ Face shield & safety glasses	
☐ Lab coat	☐ Apron	☐ Tyvek suit	☐ Tyvek sleeves
☒ Gloves	☒ Leg coverings	☐ Hard hat	☐ Hearing protection
☐ Respirator	☒ Shoes	☐ Fall protection	☐ Other

PPE Description:

- Regular Nitrile Gloves
- Closed Toed Shoes
- Leg Coverings (Pants)

Equipment, Materials, Supplies, & Facility Requirements

- Needs constant vacuum if using vacuum chuck.
- Needs compressed air for vibration dampening table.
- 110V Power supplied to the tool
- Computer is required to operate the tool

Handling, Work Area & Storage Requirements

- When handling samples, gloves and tweezers must be used to not contaminate the stylus.
- Refrain from resting on the table or moving the table at all while a scan is in session. It will introduce noise into the measurements.
- Leave work area as clean or cleaner than it was prior to usage.
- Do not store samples in RUCH 106, bring them to the proper research group's lab for storage.

Emergency Response Equipment & Supplies

☒ Eyewash	☒ Fire extinguisher	☒ First aid kit	☐ Calcium gluconate gel (HF use)
☒ Safety shower	☒ Fire blanket	☐ Spill kit	☐ Emergency gas shutoffs
☐ Drench hose	☐ Other:		

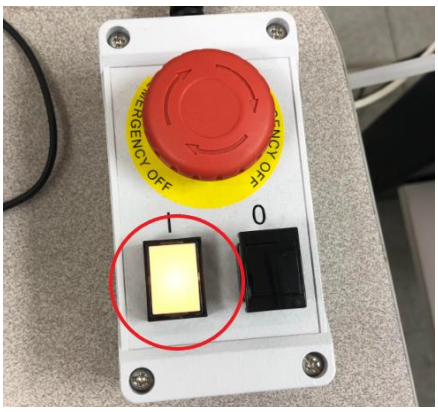
Description:

Decontamination & Waste Disposal

- If using a Biologically or Chemically hazardous material, please notify lab personnel prior to use.

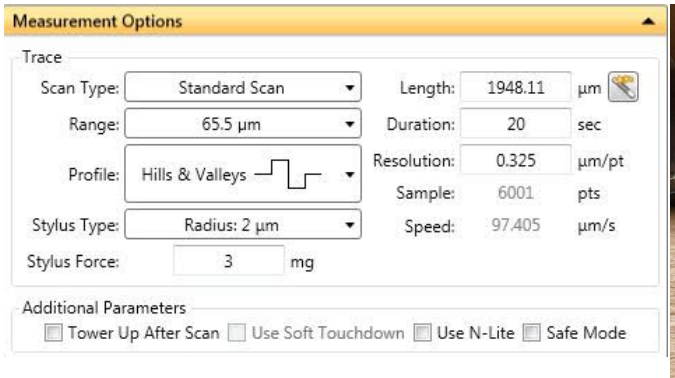
1. Log in and Software Start up.		

- **Go to the iLabs kiosk and start your session, this will allow the tool to be turned on.**
  - **If still training, ask Pete or Travis to start your session.**
- **Once the session is started, click the white button on the right side of the computer screen (Below), this will turn the tool on.**
- **Once the button is glowing, click on the Vision 64 icon (Below) on the desktop screen.**
  - **While loading it will prompt to initialize XY stage and then Theta, click 'OK' for both**
  - **Once XY has been initialized, the stage will begin to translate.**
  - **Once theta has been initialized, the lights in the tool will turn on.**



2. Setting up Measurement Options		

- **In the measurement options box in the top left corner of the screen, some settings will need to be changed depending on the sample being measured. (See Below)**
- **If only a single line is being measured, leave scan type as "Standard Scan"**
- **If the expected step height is above 2 µm, choose a larger range than 6.5 µm such as 65.5 µm because it will resolve half of the range above the initial height and half below.**
- **For stylus type, the IML is currently equipped with both 2 µm and 12.5 µm tips. To check which is in, look at the 90-degree bend on the stylus, there should be a drop of paint. Red and white is 2 µm and just red is 12.5 µm. When measuring soft films or large features, the 12.5 µm radius tip will tend to work better, and when measuring small features, the 2 µm tip will be better.**
- **For stylus force, anything between 2-10 mg is recommended for best results. If using a soft film, use a lower force, if using a hard film, higher stylus force will eliminate noise.**
- **Scan length and duration will be covered in a later step.**

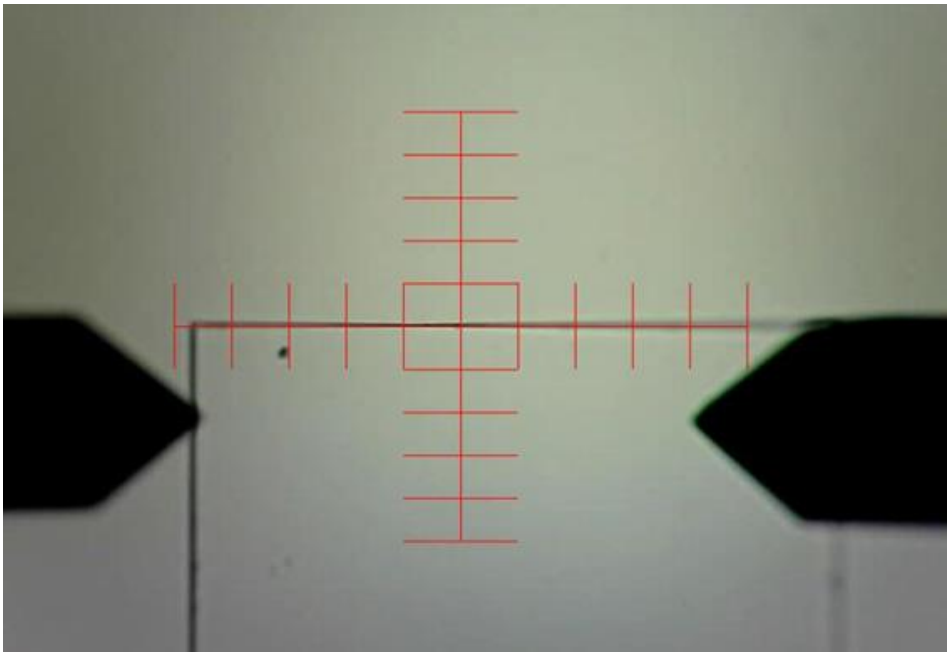


	Potential Hazards	**Mitigation, PPE, EC**
3. Loading a Sample	**Pinch points with stage motion**	**Cabinet lid, keep hands clear when stage is in motion.**

- **To bring the chuck out to a position to load samples, click the "Unload Sample" button on the bar above the camera output. (See Below)**
- **Once the chuck has stopped moving, open the tinted plastic shield and place the sample on the chuck. If measuring a line's height or a step height, try to align the line or step to be perpendicular with the stylus. It should look like the sample is the x axis, while the stylus is the y-axis. This can be adjusted later if it is not perfect, but the least adjusting possible is usually best as the chuck has typically been leveled to its current position.**
- **If needed, turn on the vacuum switches. There are two, one is located behind the computer monitor and looks like a light switch that is not in a wall. The other is a silver toggle switch inside the plastic housing on the left side of the chuck. It will have a 1 and 0 that denotes on and off.**
- **Close the plastic shield and click "Load Sample"**
- **To move the stage so the sample can be under the stylus, use the green crosshairs in the top left corner of the screen, drag the red dot around until the stylus is above the sample. This will not be seen on the screen, but the operator will have to check through the tinted plastic shield.**
- **Once it seems as though the sample is under the stylus, click "Tower Down" and if the stylus misses, note where it missed, click "Tower up" and move the stage to the correct position then bring the tower back down. Repeat as necessary.**
    - **If it misses the substrate <u>DO NOT</u> try to move the stylus over it without clicking tower up, it can break the stylus.**

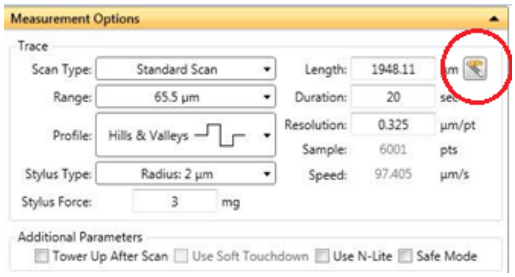
4. Aligning Sample for Measurement		

- **Use the green crosshairs at the top right of the screen to find the area that a scan is desired. (Shown Below)**
  - **If needed, the speed can be changed, medium speed is the highest recommended as it moves very quickly.**
- **It is more likely than not that the sample will be out of square with the crosshairs.**
  - **For minor adjustments use the arrows inside of the circle in the theta box to rotate it such that the horizontal crosshair is even with the line. (See Below)**
  - **For major adjustments (~15 degrees or more) raise the tower and use tweezers to make an adjustment to the sample.**



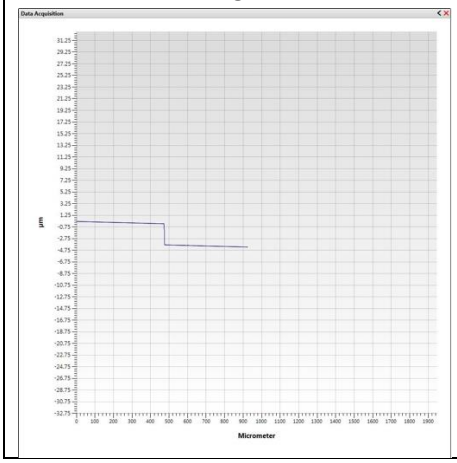
5. Setting up a Single Trace Scan		

- **To do a standard scan, set scan length to the desired distance and set a scan duration that gives a desired resolution.**
  - **If surface resolution is not a primary factor in the measurement, 1 second per 100 µm is a good rule of thumb.**
- **If scan length is not known, the teach button is very helpful. (Circled Below)**
  - **The teach function will prompt the user to go to the beginning of the scan and click 'Next', this will need to be below the area in question. The stylus only measures in the positive Y direction.**
  - **The computer will then prompt the user to go to the end of the scan. Find that location and click 'Done'.**
  - **This will update the scan length, but the user will need to adjust scan duration according to their needs.**
- **It is important to remember two things:**
  - **There will need to be a distance before and after the feature being measured. This gives the user more space for leveling when it comes time for analysis.**
  - **The stylus only travels in the Positive Y direction, this was mentioned before but it is very important to note and is often forgotten by new users.**



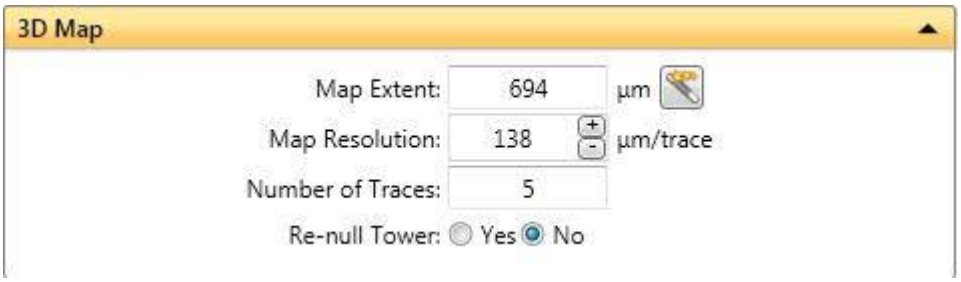
6. Leveling the Bed		

- **When a single trace scan has begun, there should be a graph that comes up on the right-hand side of the screen and shows what the profile looks like in real time, this graph will be an indicator as to if the bed is level.**
- **If the bed is level, the top of the user's substrate will not change in height at all on the graph.**
- **To level, there is a knob at the front of the stage. If the graph is tilting up, turn the knob clockwise, and if the graph is tilting down, turn counterclockwise.**
- **It is easiest if this step is done on the 65.5 µm measurement range and with a long scan time (30 sec to 1 min).**
- **The user will slowly turn the knob in the desired direction and will turn in short intervals. This will allow the user to tell if the bed is still unlevel by watching the graph.**
- **For example, it may be a 1/6 turn, then 3 seconds of watching, 1/6 turn, and so on until level. Large turns will often times result in overshooting being level.**



7. Setting up a Map Scan		

- **In the 'Measurement Options' box, change the Scan type to map scan.**
- **Follow the steps in Step 5 to set up the extent of the Y- direction for the scan.**
- **In the 3D Map box that opens when switching to map scan, map extent, resolution and number of traces can be changed. (See Below)**
- **For the map scan, it is best to use the teach button to find the extent of the X – direction.**
  - **Once teach is clicked, it will prompt to drive to the right edge of the map extent, this should be where the bottom right hand corner will be in the scan. Once found, click 'Next'.**
  - **The computer will now prompt the user to drive to the left edge of the scan, use the green crosshairs to get there and click 'Done' when there.**
- **Once the map extent is fully defined, it is easiest to change number of traces to change resolution. (Note: A large number of traces will result in a high resolution scan, but will take hours to complete.)**
- **There is a selection for re-null tower, this can be turned on to tell the computer that the beginning of every trace is zero.**

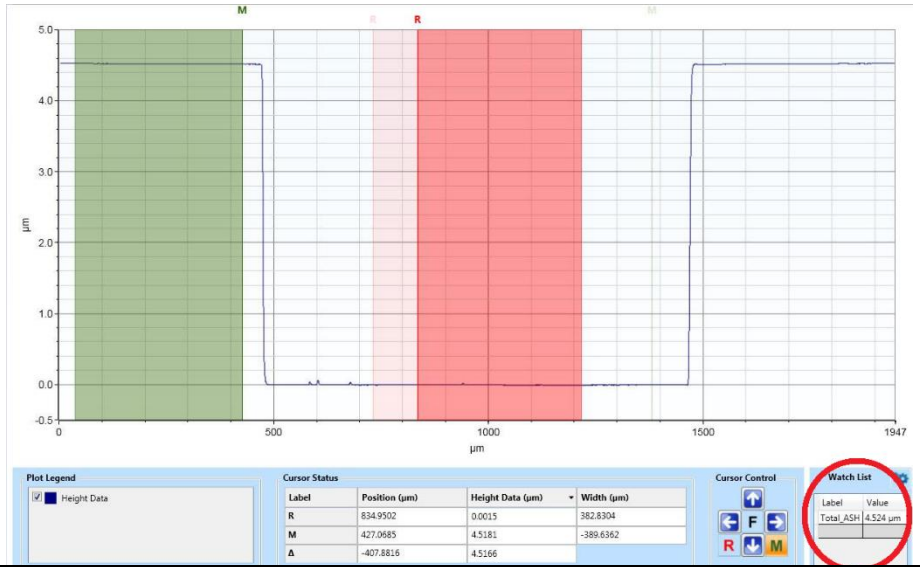


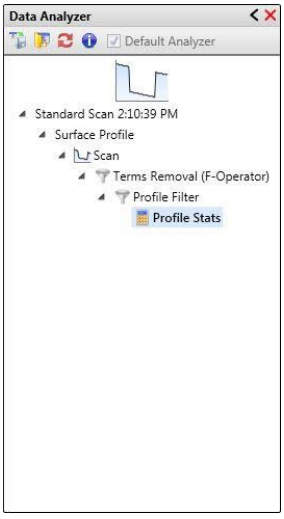
8. Starting Scans		

- **The process of starting a scan for map and standard scans are very similar**
  - **For a Standard Scan, the user will need to click the 'Single Acquisition' button**
  - **For a Map Scan, the user will need to click the 'Measurement' button.**
  - **Both are located in the top left-hand corner of the screen. (See Icons Below)**

9. Single Trace Analysis		

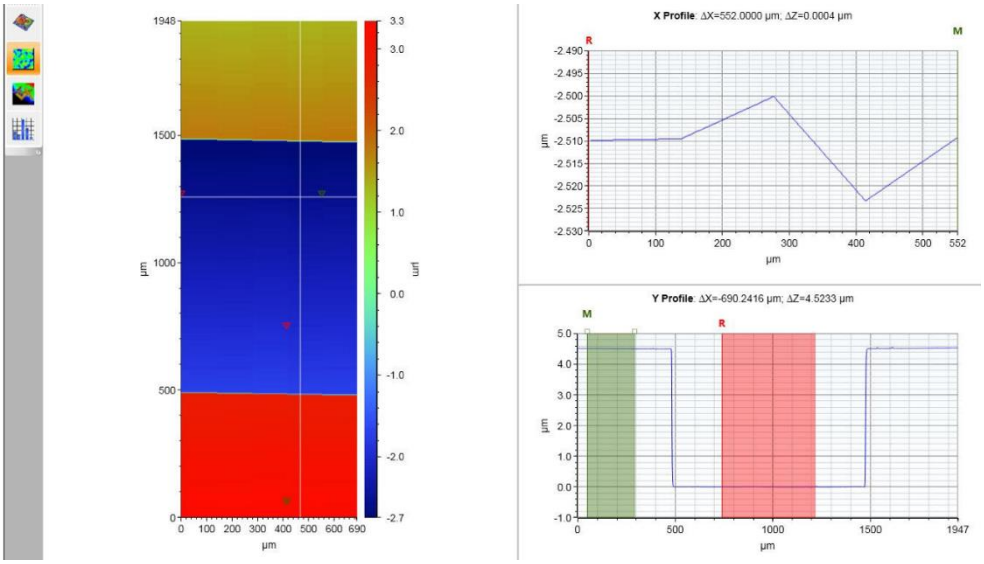
- **Once a scan has been completed, it will need to be analyzed.**
- **The first step is to go to the left hand of the screen and click <u>'Terms Removal (F-Operator)'</u> (See Below)**
  - **This will allow the user to use the data leveling function.**
- **The next step is to data level, to do so, do the following:**
  - **Drag out the R and M cursors (Reference and Measure) and place them in a region that is supposed to be flat. These can also be widened by clicking and dragging the white squares that appear under the letters.**
  - **Once the cursors are spaced out on a flat region, and 'Terms Removal (f-Operator' is highlighted right click and select the top option which is, 'Level – Two Point Linear'.**
  - **This can be repeated in different places if the leveling is not what the user desired.**
  - **If the region that is supposed to be flat is curved, try rescanning.**
- **To check a feature's height, drag one of the cursors to the feature in question and adjust width accordingly.**
- **The change in height will be in the bottom right corner in the 'Watch List' box and is labeled 'Total_ASH' the value listed is the difference of heights. (Circled under Chart Below)**
- **To the left of the Total_ASH box is the cursor stats. It will tell the user where exactly each cursor is in the horizontal and vertical directions on the scan as well as how many microns wide the cursors are.**





10. Analyzing Map Scans		

- **For a map scan, the process is nearly identical, but the user can choose where to place the cursor in the X-direction. The screen the user will see is shown below.**
- **The process for data leveling is nearly the same but the user will need to right click to get into 'Data Leveling Settings' and select 'Two Point Linear Fit', then click calculate to level.**
- **To do a large average the user can right click on the colored graph on the left side of the screen and click on cursor width and change it to a size they need. The lowest setting is seen in the picture below, but a cursor width of 100 would cover the width of the graph below and average all data.**
- **To find the change in height, it will be listed above the graph that is being analyzed. An enlarged view is shown below and is labeled 'Y-Profile'.**
- **If needed for a presentation or just a visual for the user, Vision64 has the ability to show a 3D plot of map scans.**
    - **After completing the scan, the screen below will come up, analysis can be done, but there are also four icons on the top left corner of the picture below. Click the one at the top for a 3D interactive plot.**



11. Saving Files		

- **To save files, it is best to bring a USB drive or sign into a google account on the computer to store the files.**
- **Files can be saved as the native fie type, but unless using a computer that has Vision 64, these files will not be accessible.**
- **Instead, these files can be saved as .csv files and opened with excel.**
    - **To do this, right click on the graph in question (X or Y Profile) and click export to get .csv. Analysis can then be done using excel.**
- **More commonly, users will take a snapshot of the date using the Snipping Tool on the computer and put those photos into PowerPoint Presentations.**

12. Setting up for Additional Measurements		

- **While doing analysis, the user will be in the 'Data Analysis' Tab, to remove the sample go to the 'Measurement Setup' tab at the top of the screen.**
- **This will go back to the original setup screen and will allow the user to repeat the process as many times as necessary.**

13. Shut Down Procedure		

- **Return to the 'Measurement Setup' tab**
- **Click on the 'Unload Sample' button and remove the sample from the tool.**
- **Once the sample is out, exit out of Vision 64.**
- **When the software is shut down, click the black off button that is located to the side of the illuminated 'On' button that was clicked in the beginning of the operating procedure.**
- **Now sign out of iLabs to end the session and the tool will be offline.**
- **Make sure to clean up the workspace after use.**
- **If using any kind of hazardous sample (Biological or Chemical) notify lab personnel prior to use and upon leaving so proper clean up protocol can be put into place.**