

This document covers the set-up and safe use of the Bruker Optical Profilometer. This machine is a non-contact, 3-dimensional, optical profiler that uses white light interferometric hardware. It can be used to profile reflective surfaces and thick transparent films on a reflective surface.

**1. SAFETY REQUIREMENTS**

- 1.1. Safety glasses must be worn whenever in the cleanroom, except when using a microscope or when wearing protective goggles.
- 1.2. Operate the Bruker Profilometer with all protective shields and doors in place. Do not place hands or other objects near the sample stage assembly, hand/fingers may be trapped during sample stage movement.

**2. EQUIPMENT**

- 2.1. Bruker GT-K Profilometer
  - 2.1.1. 5X Michelson interferometric objective. Working distance = 6.71mm
  - 2.1.2. 10X Mirau interferometric objective. Working distance = 7.4mm
  - 2.1.3. 50X interferometric objective. Working distance = 3.4mm
  - 2.1.4. 0.55X, 1.0X and 2.0X Field of View multiplier tubes (internal)
  - 2.1.5. Equipment sits upon a vibration isolation (floating) table.
  - 2.1.6. Sample Stage
  - 2.1.7. Manual Control Stage
  - 2.1.8. Computer and peripherals
  - 2.1.9. VLSI Step Height Standard (SHS), Bruker P/N 301-031-8.0um
    - 2.1.9.1. Model# VDS-8.0QS, S/N 10113-551, 7.788 μm

**3. TOOL CONFIGURATION**

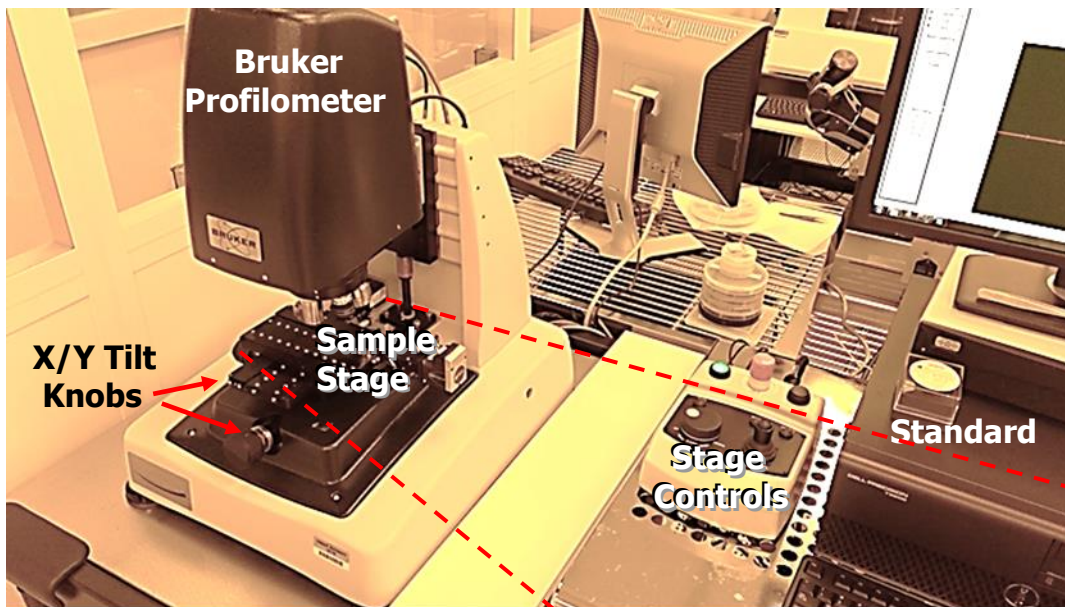


Figure 1

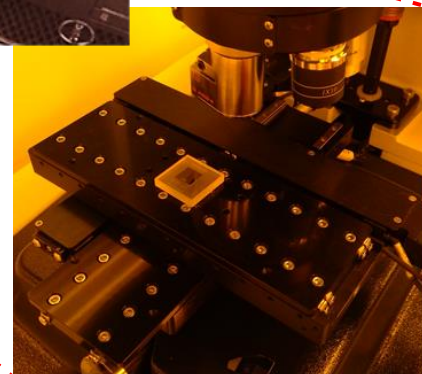


Figure 2

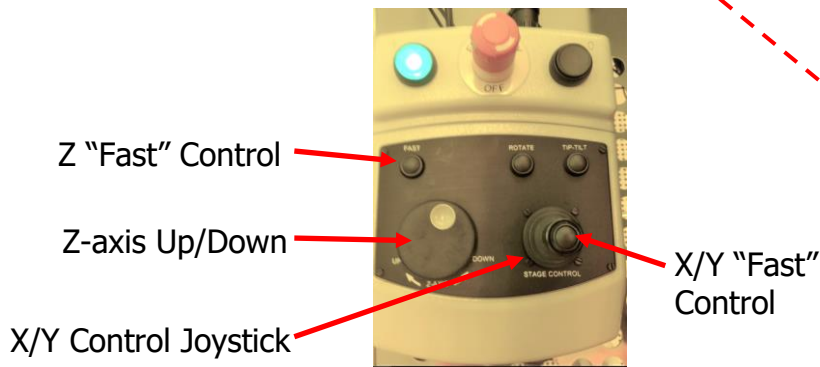


Figure 3

4. CYCLE OF OPERATION

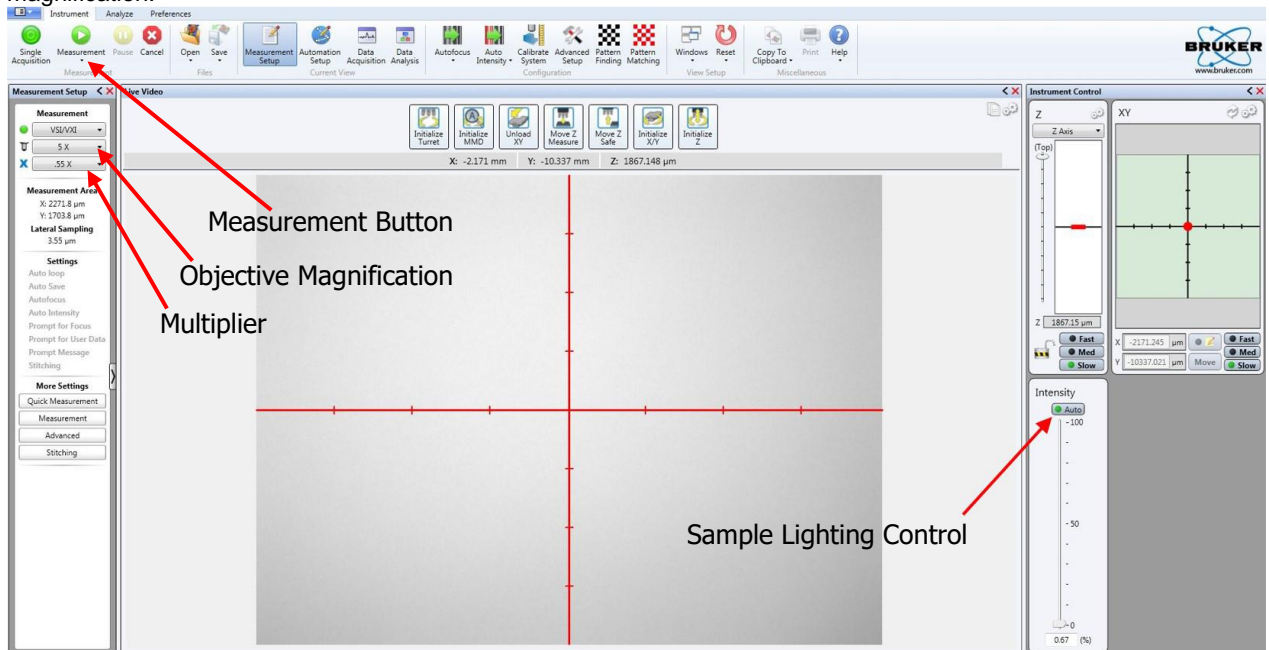
- 4.1. User must have a scheduled time through iLab prior to using the system. Enable the system in iLab.
- 4.2. Start the Vision64 software by double left clicking the icon on the Bruker control computer.
- 4.3. Verify the stage is retracted out from under the objective. If needed, use the Z-axis Up to move the objectives up from the stage or the X/Y joystick (Figure3) to move the stage out from under the objectives.

BASELINE

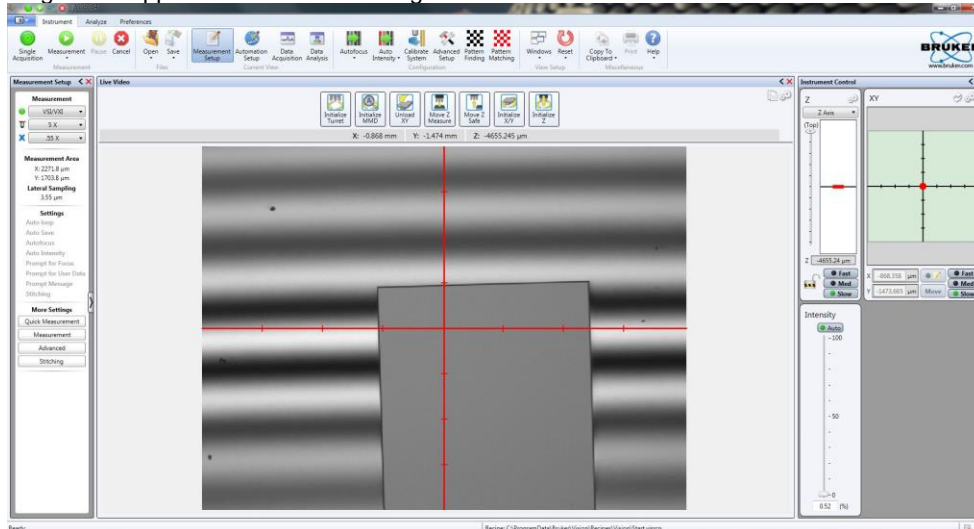
- 4.4. Place the VLSI standard on the center of the stage as shown in Figure 2
- 4.5. Verify there is adequate distance between the objective and the sample. Refer to the working distance for each objective listed in section 2, 2.1.1 – 2.1.3, for the minimum distance.
- 4.6. Move the stage back to position the sample under the 5X objective using the X/Y stage control joystick. Move the Z-axis up is needed to ensure adequate clearance between the sample and objective.

NOTE: Do not allow the sample to contact the objective at any time

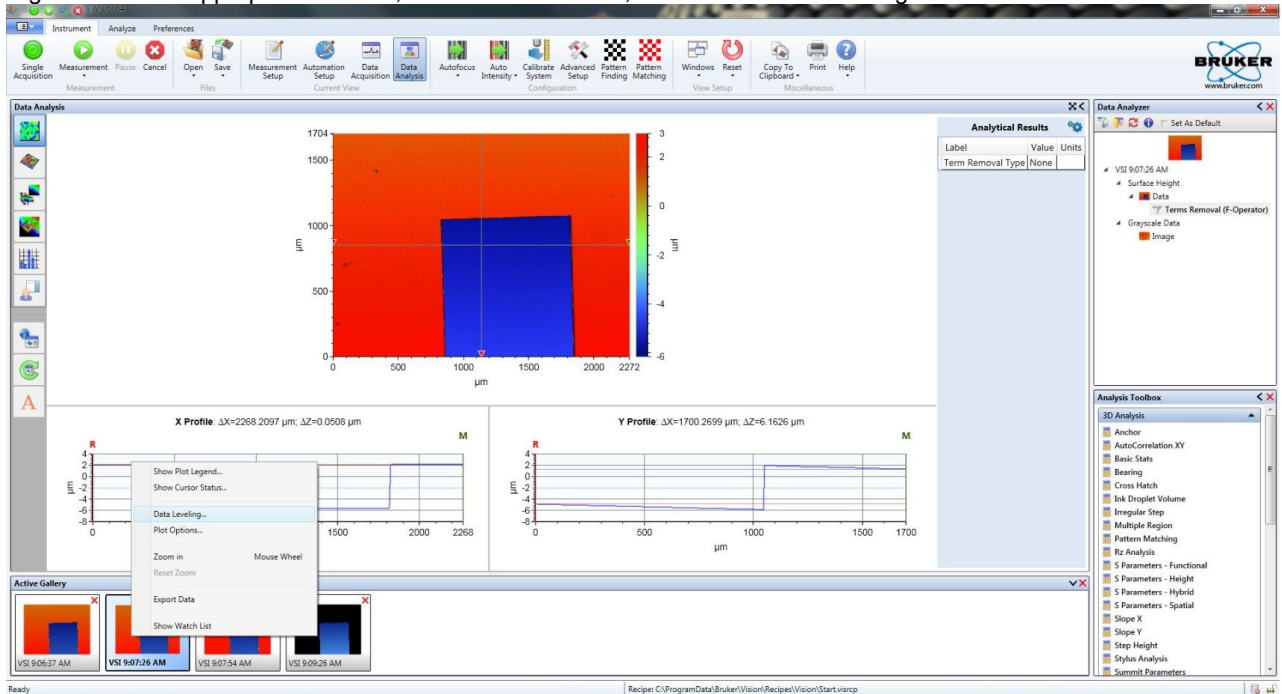
- 4.7. Enable the sample lighting by left clicking on the "Auto" button in the Intensity window so the green dot appears next to "Auto" (location shown below)
- 4.8. Select the objective lens for adequate magnification. The multiplier settings can be used to further adjust the magnification.



- 4.9. Adjust the Z-axis down to focus on the highest feature on the sample. Watch both the monitor and the sample while adjusting the Z-axis height. **Use extreme care to not make contact between the objective and the sample.**
- 4.10. Slowly adjust the Z-axis down moving the objective assembly closer to the sample until the black and white fringe lines appear on the monitor image as shown below.



- 4.11. Adjust the X and Y Tilt knobs (Figure 1) until there are 10 to 12 horizontal (or vertical) fringe lines. Off-angle fringe lines will produce a poor measurement result. *Do Not Force the tilt knobs*, they should move free and easy.
- 4.12. Verify the correct measurement mode has been selected, VSI/VXI (vertical scanning interferometry) is the default selection
- 4.13. Press the Measurement button and wait for the scan to complete, the Data Analysis Window should open
- 4.14. Position the “R” and “M” reference cursors on the same plane using the left mouse button to drag them to the proper location
- 4.15. Right click in the appropriate window, X Profile or Y Profile, and select “Data Leveling...”.



- 4.16. Select the radio button next to “Two Point Linear Fit”, press calculate and then press close.
- 4.17. Position the “R” and “M” reference cursors on the highest and lowest points of the topography to be measured. The width of the reference cursor can be expanded if an average of a plane is desired. Hover the mouse cursor over the selected reference cursor until the left/right, <->, cursor appears. Click and hold to expand the reference cursor to the desired width.
- 4.18. The “R” and “M” cursors can also be used to measure the horizontal distance between the two. This distance is displayed next to  $\Delta X$  or  $\Delta Y$  in the Profile window.
- 4.19. Please remember to raise the objective measurement head and move the sample stage out before exchanging samples.
- 4.20. There are additional analysis tools in the lower right window labeled “Analysis Toolbox”. If an option is chosen by mistake, it can be removed by right clicking on the branch in the “Data Analyzer” window and removing the branch.

**5. SUPPLEMENTAL DATA**

- 5.1. Bruker Hardware Specifications
  - 5.1.1. Capable of samples up to 6-inches (X/Y axis)
  - 5.1.2. Vertical measurement range between 1Å and 6mm
  - 5.1.3. Magnification ranges from 2.75X to 100X
- 5.2. Setup Options
  - 5.2.1. Measurement Mode
    - 5.2.1.1. VSI/VXI
    - 5.2.1.2. Thick Film
    - 5.2.1.3. PSI
    - 5.2.1.4. Intensity
  - 5.2.2. Multiplier – Changes the objective magnification
    - 5.2.2.1. 0.55X (2.75X, 5.5X, 27.5X)
    - 5.2.2.2. 1.0X (5X, 10X, 50X)
    - 5.2.2.3. 2.0X (10X, 20X, 100X)
  - 5.2.3. VSI Measurement Mode (Vertical Scanning Interferometry):
    - 5.2.3.1. Speed: Speed of the Z-axis
    - 5.2.3.2. Backscan: The Z-axis distance the objective moves beyond the focus point
    - 5.2.3.3. Length: The Z-axis distance the objective will move down
    - 5.2.3.4. Threshold: Acceptable signal-to-noise ratio for collected data. Lowering this value allows for measurement of difficult samples, although at the cost of confidence.
  - 5.2.4. PSI Measurement Mode (Phase Shifting Interferometry):
    - 5.2.4.1. Modulation Threshold: Determines the acceptable signal-to-noise ratio.
    - 5.2.4.2. Illumination: Use Green for PSI mode
    - 5.2.4.3. Reference: Always use the reference for PSI. **Never generate or view reference.**
    - 5.2.4.4. Check Intensity: Reduces the light intensity if the collector is oversaturated.
    - 5.2.4.5. Phase Unwrapping: Normally use standard. Use planar for very flat surfaces.
  - 5.2.5. Thick Film Measurement Mode
    - 5.2.5.1. *This mode of measurement requires either the user to know the film's refractive index, or for the sample to have a patterned step height so the user can approximately back-calculate the film's refractive index. For more details, look at the thick film guide on the computer desktop.*
  - 5.2.6. Stitching
    - 5.2.6.1. *To measure larger area, the Bruker features a stitching mode. This allows users to define a larger scan area. Use of this function may necessitate larger scan lengths and backscan lengths, or teaching of the autofocus feature on the top toolbar, because the substrate may go out of focus range as it experiences tilt over longer distances.*
- 5.3. Optional Probe Micromanipulator Plate
  - 5.3.1. This plate should not be attached unless in use (remove when finished)
  - 5.3.2. The plate is secured with two (2) screws tethered to the plate (do not overtightened)

**6. STARTUP and SHUTDOWN**STARTUP

- 6.1. Verify the computer is powered up
- 6.2. Verify the green lamp on the manual stage control (Figure3) is illuminated. If not, press the black button in the top right corner
- 6.3. Enable the tool through iLab
- 6.4. Double click on the Vision64 icon on the computer desktop
- 6.5. Wait for the tool to initialize

SHUTDOWN

- 6.6. Move the objective measurement head UP and the sample stage OUT before unload your sample
- 6.7. Close all of the Bruker windows by clicking on the red "X" in the upper right corner
- 6.8. Finish your iLab session and log out

**REVISION RECORD**

Reason for Revision	Date of Revision	Person Responsible
Initial Release	January 2018	Sean Rinehart
Significant revisions and changes	January 11, 2019	Dan Hosler
Format update and revisions to the Cycle of Operation section	February 26, 2020	Rich Harlan