Bruker GTK SOP **10/17/17**

The Bruker ContourGT-K optical microscope measures 3D surfaces by means of White Light Interferometry. It measures step heights up to 10 mm tall, as well as transparent film layers greater than 4um thick. The stage tilts 6 degrees on the X and Y axis allowing for sidewall measurement. It has a magnification range of 2.7x to 100x.

The system also features surface roughness analysis, particle counting, and several other powerful analysis tools.

System Startup

Enable the system in iLabs, then go to the tool and open the Vision64 software package

Stage Controls

- The joystick to the side of the microscope adjusts XY position
- The button on top of the joystick allows for faster movement
- The wheel adjusts the Z position
- Rotate clockwise to raise the microscope head, or counterclockwise to lower it
- The button to the top left of the wheel increases the Z travel speed
- **Be careful not to crash the objective while focusing**

- XY and Z stage controls are in the top right of the measurement setup window
- Slow, Medium, and Fast speeds are available for both XY and Z controls
- Click and drag the mouse in the field to move the stage or microscope head
- **Be careful not to crash the objective while focusing, especially if using fast mode for Z adjustment**

- With a sample visible in the live view, double click on the live image to recenter the image

Caution: Above all else, make sure not to crash samples or the stage into the objective. If this does happen, report it immediately so staff can evaluate and recertify the equipment. All sample adjustments must be done while the sample is clear of the microscope objective.

Loading a Sample

- Bring the stage out from under the objective using XY control
- Place the sample on the stage
- Ensure you have clearance beneath the objective for your sample, raising it with Z control if needed
- Carefully return the stage to the measurement position using XY control, **taking care not to collide with the objective**
- If an adjustment to sample rotation is required bring the stage back out before rotating your sample

Lighting your Sample

- Enable Auto in the intensity control window after loading your sample
- After focusing on the most reflective part of your sample, disable Auto intensity. Double check to make sure Auto intensity is disabled during your scan.

  Note: If parts of your sample ever appear red in the video frame then the light is oversaturating the collector and must be decreased.

Focusing on your Sample

- Adjust the Z position after your sample is loaded and illuminated, **taking care not to crash the objective**
- Once your sample comes into focus continue to adjust the z position until black and white fringes appear on the screen. These are indicators of perfect focus
- Focus on the most reflective part of your sample before turning off Auto light
- Focus on the top of your sample, taking note of the z position

  Note: If your sample is severely tilted or uneven fringes may appear as a narrow band and be difficult to find. This may take some patience.

Tilting your Sample

- The stage can be tilted from -6 to 6 degrees in the X and Y direction, using the knobs on the front and right of the stage
- **Be sure not to force the knobs**
- A VSI (standard) or Thick Film measurement requires 10 or fewer visible fringes
- A VXI or PSI measurement requires 5 or fewer visible fringes

  Note: Tilt may be used to bring a 90 degree sidewall into view of the objective for measurement, or to scan slight undercuts.

Performing a Scan
Once your sample is loaded set up your scan using the following parameters:

General Settings (Left menu. For all measurement modes)

Measurement Mode: Choose between VSI/VXI, Thick Film, PSI, and Intensity

Objective: Choose 5X, 10X, 20X. Make sure you have sufficient clearance before changing.

Field of view: Multiplies objective by .55X, 1X, or 2X.

Measurement Area and Lateral Sampling: Details for your measurement.

VSI (Used for most samples except for very smooth surfaces and transparent films)

Speed: Measurement speed. 1x is fine for most measurements. Faster speeds may be required for stitched samples or automation recipes.

Backscan: Distance above your current Z position that the system will measure.

Length: Distance below your current Z position that the system will measure. Determine this either externally or by traveling down with the focus dial until fringes appear on the bottom of your sample. Note the position difference between that and the top of your sample.

Threshold: Acceptable signal to noise ratio for data collected. Lowering this value allows for measurement of difficult samples, at the cost of certainty.

Home Scanner: When set to 0% "from top" returns microscope head to the top of the sampled region. Or "the beginning of the sample." Can be used to reduce travel length on a sample. When set to 0% "from bottom" sets microscope head at the bottom of the sampled region.

Illumination: Default is usually the correct setting, but in case you want to know: White illumination is ideal for most 1x VSI measurements. It has a short fringe envelope for easy calculation of height. Green light has a narrower bandwidth and longer fringe envelope that's ideal for measuring very rough surfaces.

Reference: Generated at the factory the reference contains all aberrations in the system's lens. The aberrations are small enough to not interfere with VSI measurements. Never view or generate the reference, as changing it will affect PSI measurements.

Averaging: Takes multiple measurements and averages it. A good way to filter out vibration.

Autoscan: Stops the measurement before the length value. It will travel a user defined distance past the point where a user defined percentage of data is collected.

Processing Method: VXI (called HDVSI in the help menu) measures with less noise than VSI, but is time intensive and memory intensive.

PSI (Used for very smooth surfaces and step heights under 135 nm)

Modulation Threshold: Determines acceptable signal to noise ratio.

Illumination: Use green for PSI.

Reference: Always use the reference for PSI. **Never generate or view reference.**

Check Intensity: Reduces light intensity if the collector is oversaturated.

Phase Unwrapping: Normally use standard. Use planar for very flat surfaces.

Thick Film Mode (Used for transparent films greater than 4 um thick)
Use of thick film mode requires the user to know either 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 tool desktop.

Stitching
To measure larger areas than normal the Bruker GT-K features a stitching mode, that, when enabled allows the user 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, as the substrate may go out of focus range as it experiences tilt over longer distances.

Analyzing a Scan

Once your scan is completed you can manipulate it and analyze it using the Vision64 software. At any time you can switch between Data Analysis and Measurement Setup using the upper toolbar. You can switch between datasets using the lower toolbar.

There are several 3D Analysis tools and 3D Filters available from the software, almost all of which are described in the software's help file. In the following section I'll be talking about the most commonly used ones, as well as general navigation through Data Analysis.

On the top right side of the analysis window is the analysis recipe tree. Using this and the analysis tools and filters available you can branch out to perform multiple different analyses on samples. You can also set an analysis recipe as a default for the session, or save and reload it later (ideal if measuring multiple similar samples.)

The save data option on the upper toolbar lets you save the original measured data, either as an OPDx or ASCII file. It's recommended to keep an OPDx copy on the Bruker computer, and save an ASCII version for use on your own computer. If you go through different branches of your analysis tree you can save modified or filtered data by right clicking on the associated contour maps.

The main screen shows a **Contour Map** of your measurement by default. You can drag the green and red cursors on the map or the M and R cursors on the separate X/Y profiles below the map. Right clicking on the map allows you to change to a radial plot, polyline profile, and several other modes. Right clicking on the line profiles gives you the option to level the line

profiles, or export the data to CSV format. Right clicking on the data set lets you activate watch lists, to monitor miscellaneous values for the data. Right clicking on line profiles lets you activate watch lists to monitor slope, and other values. Basically right clicking on things opens up more functions than I can describe in this SOP. I encourage you to experiment.

The right side toolbar lets you switch between contour map, **3D Model**, histogram, and critical dimension tool. 3D model mode lets you manipulate the sample in 3D, and also has line analysis tools like the 2D X/Y profile map.

Critical dimension lets you measure 3D and lateral features on samples. This is done by creating a line datum, naming it, then using it as a reference for measuring parallelism, perpendicularity, etc.

3D Analysis
Most of the 3D Analysis tools are explained in the help file.

3D Filter
Most 3D filters are also explained in the help file. A commonly used one is Data Restore, which interpolates missing data points on samples. Note that this data is *only* interpolated, not verified by any other means.

Terms removal is used to remove tilt from a system. Removing modal tilt identifies and corrects for the most prevalent tilt in the dataset, based on point to point differences. Plane fit with a terms mask allows for the designation of a plane, and is generally the best mode to use.

Additional Notes:
The Bruker GT-K has an automation mode that allows a user to look at multiple features on the same wafer, or an entire wafer. Contact Engineering Staff for more information on this function.