Procedure Title: Step Height Calibrations (15030C) using Form Talysurf
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1 Scope

This procedure determines the step height of calibration specimens by mechanical comparison to NIST calibrated standards. Step height specimens in the range of 1 µm and larger are measured using the Form Talysurf profilometer and are covered under this procedure.

2 References

J.F. Song and T.V. Vorburger, Standard Reference Specimens in Quality Control of Engineering Surfaces, *J. Res. NIST* **96**, 271 (1991).

Stylus-laser surface calibration system, T.V. Vorburger, J.F. Song, C.H.W. Giauque, T.B. Renegar, E.P. Whitenton, and M.C. Croarkin, Precision Engineering 19, 157 (1996).

3 General

Operating instructions and manuals are located near all instruments, giving easy access to reference guides.

This procedure is not significantly sensitive to temperature and can be performed whenever the temperature is stable between 18 ℃ and 22 ℃.

4 Procedure

1. Power Up
   1. Insure all equipment is powered up. Make sure laser is turned on. The instrument needs at least an hour of warm up time before measurements are performed.

2. Logging On
   1. Log onto Windows using the proper user name and password.
   2. Start the Form Talysurf *Ultra* software. User name is **Admin**, and there is no password.

3. Instrument Ball Calibration
   1. Place calibration ball on stage. Make sure red dot is pointing in the 3 O'clock position.
   2. If necessary, to ensure the reference bar is dirt free, move the traversing unit in its whole range, from about (0 – 5) mm to about (115 – 120) mm, at least two cycles.
   3. Align ball with stylus in the X and Y axis by eye as close as possible.
   4. Contact surface.

5. Perform Autocrest X. Precision should be 0.02mm and data length should be 0.5mm.
6. Perform Autocrest Y. Precision should be 0.04mm, data length 0.5mm, and spacing 0.1mm. "Initial Crest Position" should equal the current Y stage position.
7. "Calibrate -> New" using "NIST Standard Ball". The name of the calibration file should include the date performed. e.g.: 01-01-2008. "Auto-adjust Z height" should be checked. "Autocrest X" in measurement window should be selected, but not "Autocrest Y". Gauge range should be set to 80%.
8. Once the calibration is complete, check to make sure that the *Pt* value is smaller than 0.15 µm. If it is larger, the calibration must be repeated. Perhaps just measuring again will solve the problem. If not, the surface of the ball may need to be cleaned, if any upward spikes are present (dirt, contamination, etc.). Or perhaps another X or Y autocrest may need to be performed if any downward deep valleys are present.
9. Once a successful calibration has been completed, print the calibration. This will be retained in the File Copy of the Calibration Report folder.

4. Check Measurement using NIST Step Height Master
   1. A NIST Step Height Master will be used for checking the calibration of the instrument. It should be of similar or slightly larger height to that of the customer step height specimen to be measured. For instance, if a customer specimen of 5 µm is to be measured, the NIST 9.9813 µm step should be used. (it is closest to in size, and slightly larger than, the customer step)
   2. Place the appropriate step standard on the stage.
   3. Align stylus tip with the top edge of the step standard measurement region. If the step to be measured is a "double sided" step, the stylus tip should be positioned at the top left edge of the plateau or groove.
   4. Ensure that the Y stage is in a good location to reach the measured area of the specimen. If not, you may need to shift the specimen on the stage in the Y direction.
   5. Contact surface and verify again that the tip is in the appropriate location.
   6. In the *Ultra* software, click **View** -> **Folders**. Browse to the Surface Calibrations directory, then to "Checks", and then to the type of specimen being used (e.g.: 9.9813 µm Standard). Create a new folder in this directory and name it to today's date.
   7. Select this folder as the active folder. **It is important to make sure the data that is taken will be stored in this folder**.
   8. Open Windows Explorer and browse to the "Surface Calibrations" directory. The full path is: C:\Work\Data\Surface Calibrations. Browse to "Checks", and then to the type of specimen being used (e.g.: 9.9813 µm Standard). Create a new folder in this directory and name it to today's date. This is where the exported data will eventually be stored.
   9. Still within Windows Explorer, browse back to "Surface Calibrations", and then to "Export Temp". Ensure that the folder is empty.
   10. From the *Ultra* software, browse to "Surface Calibrations" and then to "Programs". Open the appropriate check program for the standard being used.
   11. Run the program by clicking the green arrow "play" button. Follow the directions of the program.
   12. During the measurement procedure, monitor the profiles as they are measured, and the exported files. The exported files will be temporarily saved to the "Export Temp"

directory, visible in Windows Explorer. You will also need to close some of the profile windows from the Ultra software if too many are open at one time.

13. After the measurements are completed, remove the specimen from the stage.
14. In Windows Explorer, move the exported files from the "Export Temp" directory to the one that was created under **Surface Calibrations\Checks\ .. **
15. Verify that the exported files were moved to the correct location.

5. Measure Customer Specimen
   1. Place specimen on stage.
   2. Align stylus tip with the top edge of the step standard measurement region. If the step to be measured is a "double sided" step, the stylus tip should be positioned at the top left edge of the plateau or groove.
   3. Ensure that the Y stage is in a good location to reach the measured area of the specimen. If not, you may need to shift the specimen on the stage in the Y direction.
   4. Contact surface and verify again that the tip is in the appropriate location.
   5. In the Ultra software, click **View** -> **Folders**. Browse to the Surface Calibrations directory, then to "Step". If there is not already a folder created with the calibration folder number, do this now: In the Step directory, create a folder with the calibration folder number and company name. e.g.: **123456-06 ABC Inc.** Under this folder, create a folder for the roughness patch and serial number you are working on and name it such. eg: **3 um SN 12345**. In the case where a decimal point is required (e.g.: **0.35**), use an underscore instead (e.g.: **0_35**).
   6. Select this folder as the active folder. **It is important to make sure the data that is taken will be stored in this folder**.
   7. Open Windows Explorer and browse to the "Surface Calibrations" directory. The full path is: C:\Work\Data\Surface Calibrations. Browse to the "Step" folder. If there is not already a folder created with the calibration folder number, do this now: In the Roughness directory, create a folder with the calibration folder number and company name. e.g.: **123456-06 ABC Inc.** Under this folder, create a folder for the customer step height standard and serial number you are working on, and name it such. e.g.: **3 um SN 12345**. This is where the exported data will eventually be stored.
   8. Still within Windows Explorer, browse back to "Surface Calibrations", and then to "Export Temp". Ensure that the folder is empty.
   9. From the *Ultra* software, browse to "Surface Calibrations" and then to "Programs". Open the appropriate roughness program for the standard being measured.
   10. Run the program by clicking the green arrow "play" button. Follow the directions of the program.
   11. During the measurement procedure, monitor the profiles as they are measured, and also the exported files. The exported files will be temporarily saved to the "Export Temp" directory, visible in Windows Explorer. You will also need to close some of the profile windows from the *Ultra* software if too many are open at one time.
   12. If any profiles appear to be bad, make a note of it. These position(s) may need to be manually re-measured later.
   13. After the measurements are completed, remove the specimen from the stage.
   14. In Windows Explorer, move the exported files from the "Export Temp" directory to the one that was created under **Surface Calibrations\Roughness\ .. **

15. <u>Verify that the exported files were moved to the correct location.</u>

6. <u>Re-Check Measurement using NIST Step Height Master</u>
   1. The NIST Step Height Master that was used for the Check procedure will now be used for re-checking the calibration of the instrument.
   2. Place specimen on stage.
   3. Align stylus tip with the top edge of the step standard measurement region. If the step to be measured is a "double sided" step, the stylus tip should be positioned at the top left edge of the plateau or groove.
   4. Ensure that the Y stage is in a good location to reach the measured area of the specimen. If not, you may need to shift the specimen on the stage in the Y direction.
   5. Contact surface and verify again that the tip is in the appropriate location.
   6. In the *Ultra* software, click **View** -> **Folders**. Browse to the Surface Calibrations directory, then to "Re-Checks", and then to the type of specimen being used (e.g.: 9.9813 µm Standard). Create a new folder in this directory and name it to today's date.
   7. Select this folder as the active folder. **It is important to make sure the data that is taken will be stored in this folder**.
   8. Open Windows Explorer and browse to the "Surface Calibrations" directory. The full path is: C:\Work\Data\Surface Calibrations. Browse to "Re-Checks", and then to the type of specimen being used (eg: 9.9813 µm Standard). Create a new folder in this directory and name it to today's date. This is where the exported data will eventually be stored.
   9. Still within Windows Explorer, browse back to "Surface Calibrations", and then to "Export Temp". <u>Ensure that the folder is empty</u>.
   10. From the Ultra software, browse to "Surface Calibrations" and then to "Programs". Open the appropriate re-check program for the standard being used.
   11. Run the program by clicking the green arrow "play" button. Follow the directions of the program.
   12. During the measurement procedure, monitor the profiles as they are measured, and also the exported files. The exported files will be temporarily saved to the "Export Temp" directory, visible in Windows Explorer. You will also need to close some of the profile windows from the *Ultra* software if too many are open at one time.
   13. After the measurements are completed, remove the specimen from the stage.
   14. In Windows Explorer, move the exported files from the "Export Temp" directory to the one that was created under **Surface Calibrations\Re-Checks\ .. **
   15. <u>Verify that the exported files were moved to the correct location.</u>

7. <u>Post measurement data collecting</u>
   1. It is now necessary to perform the step height calculations, and generate the Calibration Report.
   2. Close *Ultra* software and run the "Main Menu.vi" LabView program.
   3. It will prompt you to enter a directory and files to analyze. Also you will need to select whether the step to be analyzed is a "single sided" or "double sided", and the type of algorithm to be used.

4. Open the check and re-check data files and analyze with the NIST step height algorithm. The average step height value calculated from the re-check measurements will be used in the control chart for that NIST Step Height Master. The results from the check and re-check measurements should also be compared to each other. Enter the average step height value of the Re-Check measurements into the appropriate control chart, which is located on the mxnet file server:
   \\mel.nist.gov\mel\mxproj\surfmet\Surface Calibrations\Control Chart
5. Open the data files for the customer's step height standard and analyze with the appropriate step style and algorithm. The NIST algorithm is used for all calculations except for "triple steps" or for those steps that show large form deviations in the plateau or groove regions. The ISO algorithm should be used for those, and a note of this should be included in the calibration report.
6. After the analysis is performed, click "Create Excel" from the Main Menu.vi program and the data will be sent to an Excel Appendix B Step Height template file. Enter the required header information into the yellow cells, such as date, specimen ID, check standard, etc.
7. When complete, save the Appendix B Step Height file to the directory where the relevant data is stored. Make sure to name the file appropriately. Eg: **Appendix B – 3um SN 12345 ABC Inc.xls**
8. Print the Appendix B Step Height file. Also save the file to a memory stick, transfer to a network PC, and copy to the appropriate folder on the mxnet file server:
   \\mel.nist.gov\mel\mxproj\surfmet\Surface Calibrations\step height
9. From the step height results, determine which position/trace resulted in the highest value, and which one resulted in the lowest value. Once those are determined, print out the corresponding profiles of those measurements. These will be included in the Appendix B data.

8. <u>Finish</u>
   1. The measurement/analysis process is now complete, and the final report can be started.
   2. If no more measurements are to be taken, close any programs that are running and log off of the computer.