Tencor Alphastep 200 Automatic Step Profiler

Contents

1. Introduction

The Alphastep 200 is a computerized step profiler with a manual X-Y stage, and a 9" video monitor which displays a magnified view of the sample and stylus during the scan, as well as scan profiles and a summary of scan data. The system has the capability of "manual" single scans only. The system allows the operator to set, and store if desired, a variety of scan parameters such as scan direction, scan length/sampling rate and vertical units (kA vs. Mm). Measurement cursors are used to level plots, obtain a variety of data, and/or to zoom in on a particular section of a scan profile. A printer is built into the system for hard copies of screen scan profiles and data.

2. System Description

2.1. General

The figure in the hard copy manual shows the main features of the system.

The top half of the system houses the printer, video monitor and its controls. The lower half has the sample chuck and the keyboard, by which the sample and data are manipulated.

2.2. Specifications

Mechanical profilometer

Scanning Stylus: 12.5-micron radius Zoom Video Microscope 40x to 120x Magnification 5 Angstrom Vertical Resolution 400 Angstrom Horizontal Resolution Tracking Force - User adjustable 1 to 25 mg Maximum Sample Dimensions - 16.5 mm thickness, 162 mm diameter

2.3. Data Display: The Alphastep 200 digitizes measurement data and stores it in memory during the scan. When the scan has been completed, a plot of the scan is displayed along with pertinent data and information on the scan characteristics. The cursors displayed on the plot are positioned by the operator to level the plot and/or obtain the desired data.

The following describes the data display as read from top to bottom:

ID# Optional identifier (up to 7 characters) for sample assigned by the user. Pressing # when the system is NOT in "Enter Mode" (see below) will allow the user to enter a number. Pressing ENT, PRINT or initiating a scan will terminate the entry. VERT Total vertical scale on plot in kA or Mm (specified by operator) Profile height at intersection with left cursor. R Profile height at intersection with right cursor. Highlighted Value Calculated difference between heights at cursors. Avg. Average profile height between cursors measured relative to the baseline.

TIR   Total Indicator Runout - difference between maximum and minimum profile
        heights for section of plot between measurement cursors.

R   Arithmetic Average Roughness, see a manufacturer's manual for details.

Area   Cross-sectional area of a profile above the base line, displayed in Mm2. The
        base line is that line which extends between the intersections of the two
        measuring cursors and the profile. Only those parts of the profile above the
        line are included in the measurement. See section 2.3 for details on how to
        display the area and the baseline.

HORIZ Total horizontal scale on plot (scan length)

        Position at left cursor on horizontal scale

R   Position at right cursor on horizontal scale

Highlighted Value Difference between horizontal positions.

        Directly under the data described above are the chosen scan length/sample density

specifications, scan time, scan direction, stylus force, and the vertical units.

2.4. Keyboard

There is a figure showing the keyboard in the hard copy manual. A brief description of key functions follows. For further information on using the keyboard, see the detailed operating procedures in Section 3.

ENT "Enter" Pressing this button will initiate/terminate "Enter Mode" in which the operator can change parameters in the scan menu.

VID   "Video" Toggles the screen between the sample display and the scan menu.

O   Moves the stage out from under the stylus to the "home" position, for loading or unloading of samples.

-       Holding this key down when a plot is on the video screen displays the cross sectional area of the profile as described under Area in Section 2.2 (Data Display) above.

.   Holding this key down when a plot is on the video screen displays the baseline of the profile as described under Avg in Section 2.2 (Data Display) above.

RESET   If pressed prior to a scan, will return measurement cursors to their position during the previous scan. Used for other miscellaneous operations, such as setting the time clock.

RANGE   Allows the user to set the scan length/sample density. The highlighted values change as either the ^ or "down arrow" key is pressed.

PLOT   Used to zoom in on a section of a profile between the measurement cursors, or to level a profile.

CUR   This key and its associated <- and -> keys allow the operator to set scan direction and place the measurement cursors.

LEVEL   Used to level the baseline of a profile.

TABLE   The ^ and "down arrow" keys will move the sample chuck up and down respectively.

FEED   Printer paper feed.

START/STOP   Starts/stops the scan.

3. Operating Procedure

3.1. Setting Scan Parameters

Up to 9 scan menus containing scan parameters can be stored in the system. It is usually convenient, however, to simply bring up the default menu and modify it to suit your needs, as follows.

1.   Make sure the power is on. Turn up the brightness.
2.   Press VID to bring up a menu.
3.   Press ENT to initiate "Enter Mode". You will see a message at the bottom of the screen "SCAN MENU may now be changed".
4.   Use the RANGE keys to select the desired scan length and sampling rate. Note how the scan time changes as you move through the options.
5.   Use the CUR (cursor) arrow keys to indicate desired scan direction. Note: this is the direction in which the stylus will move, not the substrate.
6.   Use the CUR key to toggle the vertical units (MODE) between kA and Mm.
7.   Once all the parameters are set as you want them, press ENT to leave "Enter Mode". Press VID to toggle the screen display back to the sample. You are now ready to start your scan.

3.2. Scanning a Sample

1.   Press the TABLE key to lower the substrate table. Make sure that there is enough room for your sample to clear the stylus housing when it is mounted on the chuck.
2.   Use the stage positioning knobs on the left hand side to move the stage out from under the stylus.
3.   Place your sample on the chuck.
4.   Move your sample under the stylus
5.   Press TABLE ^ key and watch the screen.   You should see your sample come into view, and the stylus lower and come to rest on the surface of your substrate. If you continue to press TABLE ^, the stylus will retract. Thus the TABLE ^ button toggles the stylus between its fully retracted and lowered position. Always retract the stylus when moving the sample.
6.   Move to your sample measurement location.
7.   With the sample in position and the desired Scan Menu parameters set, press START/STOP to initiate the scan. The sample table will automatically rise if it is not already in the up position. If it must rise more than the amount it lowered after the last scan, it will stop and START/STOP must be pressed again.
8.   The stylus will first make a short pass "away" from the section of the sample to be scanned. It will then reverse direction so that it is traveling in the direction specified in the Scan Menu. Data collection will begin when the stylus passes the

point where it was positioned prior to starting to scan. When finished, move the
table all the way down and out from under the stylus before removing the sample.

9.   To interrupt a scan, press START/STOP. The data collected to that point will be
        displayed in the usual manner.

4. Manipulating Data

After the scan, the profile is plotted on the screen with a summary of the data
displayed next to it. For many applications, this initial display will contain all
required information. When further analysis is needed, it can be performed in the
instrument's computer without having to re-scan. If the profile appears tilted,
proceed to Section 4.3 before taking any measurements.

4.1. Overriding Vertical Auto-Ranges

To change the vertical range after the scan, press the RANGE ^ or "down arrow"
key. The range is indicated in the data summary, next to the label VERT. When
the desired range is selected, press PLOT to redraw the image. The profile will be
centered vertically where it intersects the left cursor. Some of the profile may
spill of the screen at higher magnifications.

4.2. Measurement Cursors - Measuring Profile Features

On the edges of the profile are two dashed vertical lines. These are the
measurement cursors, used to make horizontal and vertical measurements off the
plot. Cursor-derived measurement data is continuously displayed in the data
summary on the left side of the screen.

The CUR button selects the cursor to be moved. You can see the active cursor
indicator appear over each cursor in turn, and then over both as you repeatedly
press this button. When both cursors are active, they will remain a fixed distance
apart as they move simultaneously. The arrow buttons will move the cursor(s) in
the direction indicated. Holding down these buttons causes the cursors to
automatically speed up for long moves.

The cursors can be returns to the ends of the scan by pressing CUR followed by ABT.
This also undoes all zooming (see below), returning to the plot displayed
immediately after the scan.

Vertical measurements are shown in the data summary under the heading VERT.
Profile heights at the cursors appear directly   beneath the label. The highlighted
area directly below shows the difference between the heights. Thus to measure a
step height, simply position one cursor so that it intersects the substrate at the base
of the step. Position the other so that it intersects the profile on top of the step. The
vertical difference shown in the highlighted area under VERT is the step height.

Horizontal measurements are shown in the data summary under the heading HORIZ. Scan positions at the cursors appear directly   beneath the label. The highlighted area directly below shows the distance between the cursors. To measure the width of a feature, position on cursor on each side of it and read the horizontal distance shown in the highlighted area under HORIZ.

Once positioned, the cursors will retain those positions for subsequent scans. They will not move unless forced to do so by a change in scan length or they are moved by the operator. If a batch of similar samples is to be tested, the cursors can be left in position and the measurement can be read directly from the data summary with minimum operator intervention.

4.3. Leveling the Plot

When the profile is plotted after a scan, a leveling program aligns the trace to the two axes to facilitate accurate measurement. Leveling cursors, vertical lines normally invisible to the user, are used to indicated two points on the profile whose heights are equal. The leveling program re-computes the measurement data to make these heights equal on the display. The rest of the profile is displayed relative to these points.

The leveling cursor are normally located at the ends other scan. If one cursor is on a surface feature higher or lower than the other cursor, the substrate will appear tilted when the program makes both cursor heights equal.

The condition described above can be corrected by moving the leveling cursors to places on the profile where the heights are equal.   Ideally, these should both be on the substrate, near the ends of the scan, although any equally high points may be used.

If the message "SCAN MENU may now be changes" is displayed, press ENT to terminate "Enter Mode".

1.   Press the orange LEVEL key. The screen will show the leveling cursors which are dotted vertical lines, instead of the dashed lines used for measurement cursors. The following message will appear at the bottom of the screen: "MANUAL LEVELING may now be changed".
2.   Position the cursor so the actual profile height is the same at each cursor. Ignore the indicate profile height. The leveling cursor are moved using the <- and -> keys in conjunction with CUR as described in Section 4.2.
3.   Press the PLOT or ENT key. The profile will be redrawn with the points under the cursors at equal heights. The horizontal positions of the leveling cursors are shown in the lower left corner of the screen.

4.   Plotting Individual Profile Features - Zoom Any portion of a profile can be magnified for close examination. Using the procedures of the previous section,

position the cursors so that they bracket the feature of interest. Press the yellow PLOT button. The display will zoom in on the bracketed region. The horizontal and vertical scales will each auto-range to provide the greatest magnification that the feature's size will allow.

The cursors will still be located at the same points on the profile after the   image is re-plotted. The profile will be positioned to place the left cursor at the left edge of the screen. The right cursor will appear in the right half of the screen after the zoom.

To return to the previous magnification after zooming, press PLOT again without moving the cursors. the cursors will remain in their most recent position. Pressing PLOT again will not cause zooming until a cursor has been moved.

To return to the screen showing the entire profile, press ABT. This undoes all zooming, but leaves the cursors at their most recent positions on the profile.

Pressing CUR then ABT undoes all zooming and returns the cursors to the ends of the scan.

4.5. Average Difference Mode

In Average Difference mode, the system computes the difference between average height measurements. When this mode is entered the currently displayed average is stored as a reference reading. The instrument displays the difference between this reference and all subsequent average height measurements. This mode remains in effect until it is exited, even if another scan is taken.

1.   Level the plot if necessary (see Section 4.3).
2.   Position the measurement cursors on the section of the profile to be stored as the reference reading.
3.   Press ENT, then the "dot" key [+].

The vertical height field will be re-labeled "dAv" for average difference. It will read "0" until the cursors are moved.

The difference between cursor heights is not shown in this mode, since the cursors are typically placed at the same profile height when an average is being taken. The reference profile section is marked with vertical lines called the average reference cursors. These cursors are drawn with large dashes and connected by bars at the top and bottom of the screen to distinguish them from the other cursors.

1. Position the measurement cursors on the profile section to be compared to the reference.

The field labeled "Avg." will show the average profile height between the

measurement cursors. The field labeled "dAv" will now show the difference between this value and the reference reading.

When the measurement cursors are moved, the average height and average difference will be updated.

2. To exit Average Difference mode, press CUR then ABT. The vertical height field will now display the difference between the cursor heights. See the hard copy manual for a figure showing the Average Difference Mode display.

4.6. Printing

There are three available printing modes: "Screen" in which the entire contents of the screen, including the plot of the profile, is printed; "Summary Data" prints out only the data shown on the left side of the screen; "Data Send" sends all data to the RS-232C
     serial output instead of the printer.

Screen and Summary Data print modes are used to make print-outs on the internal printer or on the optional remote printer. Data Send uses the RS-232C serial output to send the data to an external device such as
     an 80-column serial printer or a host computer.

Your choice of printer mode remains in effect until changed. A printout or data send can be initiated whenever the results of a scan are displayed on   the screen.

1.   Initiate "Enter Mode" by hitting the ENT key if you have not already done so.
2.   Press the white print button to change the print mode. The selection will be highlighted in reverse video.
3.   With the desired mode selected, press ENT to leave the Scan Menu, or press START/STOP to leave the Scan Menu and begin a scan.
4.   To print, press the PRINT button. To abort a printout before it is complete, press ABT.

APPENDIX A
Printer Paper Change

1.   Remove the printer cover by lifting at the front and disengaging the tab at the rear of the cover.

2.   Pull forward on the small lever located on the right of the printer in front of

the rubber roller. This will release any paper remaining in the printer.

3.   Remove the old spool from the printer.

4.   Place the new spool in the printer, orienting it so that the paper unwinds from underneath as it leaves the spool. (This is thermal paper; if you do not have the correct side facing the printer, nothing will be printed on the paper.)

5.   Insert the paper underneath the rubber roller from behind. (This is easier if the end of the paper is cut so that it tapers to a point.)

6.   The paper will emerge at the top of the rubber roller, aiming back. Pull out several inches of paper.

7.   Push the small lever back to engage the rubber roller against the paper. (The paper will not feed unless the roller is engaged.) Caution: Do not pull on the paper once the roller is engaged.

8.   Carefully replace the cover, threading the paper through the slot.

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