FALEX MODEL 430

ELLIPSOMETER

Operation Manual
Version: 1.1

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This manual provides information and procedures to safely install, operate, and maintain the Falex Ellipsometer Test Machine (also known as the Model 430). For your own safety and protection from injury, carefully read, understand and observe the safety instructions described in this manual.

Keep this manual with the machine. If you lose this manual or need an additional copy, please contact Falex Corporation. The information contained in this manual was based on machines in production at the time of publication. Falex Corporation reserves the right to change any portion of this information without notice. This operation manual is divided into sections and addenda as listed in the 'Table of Contents'.

Safety Introduction

The following safety precautions are published for your information. This manual does not purport to detail all of the safety concerns, if any, associated with the equipment's use. It is the responsibility of the operator of this equipment to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. This machine is built with user safety in mind; however, it can present hazards if improperly operated and serviced. Follow operating instructions carefully! If you have questions about operating or servicing this equipment, please contact Falex Corporation. ***This equipment should only be operated by personnel trained by Falex or a Falex approved distributor.*** This manual may contain **HAZARD**, **WARNING**, and **CAUTION** callouts, which must be followed to reduce the possibility of personal injury, damage to the equipment, or improper service. This machine must be electronically grounded. Do not change the grounding requirements of the instrument.

Machine Safety Labels and Manual Safety Callouts

The following are safety labels placed in areas on the test machine that may be hazardous to the operator. These same symbols may be used in the manual to bring attention to safety concerns. Please take caution and understand what these labels indicate before operating the test equipment.

LASER RADIATION HAZARD: This label indicates the potential for hazardous laser radiation is present. This unit is to be serviced by trained personnel only.

LASER INTERLOCK CAUTION: This label indicates exposure to laser radiation is possible when access door is open and safety interlocks are defeated.

ELECTRICAL SHOCK HAZARD: This symbol indicates hazardous voltage is present. Turn main power button off and switch off the main breaker (right side of unit) before taking sides off of unit. This unit is to be serviced by trained personnel only.

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CAUTION OR WARNING SYMBOL: This symbol indicates a general warning or caution. A caution is important for protecting the equipment and performance. A warning is important to protecting yourself, others, and the equipment. Used in manual to bring attention to an important note or comment.

1: General Information

1.1 Technical Specifications

Machine Weight: approximately 125 pounds (56.7 kg)

Machine Footprint: 29” high × 30” wide × 21” deep (73.7 cm x 76.2 cm x 53.4 cm)

Recommended Working Space: The Falex Ellipsometer requires bench space of 42” wide x 34” deep (106.7 cm x 86.4 cm) to comfortably operate the test machine. The table should be reasonably level (1/32 in. per foot) and should be able to support the test equipment, while being free from any external vibrations. Access to the right side of the machine will allow the operator access to USB ports, a network connection and the breaker.

Utilities Requirements: The Falex Ellipsometer requires a 10 amp, 100 -240 Volt, single phase, 50/60-Hertz power source.

Wiring to test machine should follow federal, state and local wiring codes.

Note: Removal of any panels is to be done by factory trained personnel. Before removing any panels, disconnect power by turning off the circuit breaker.

1.2 Brief Description of Equipment

The Falex 430 Ellipsometer Test Machine is designed to offer consistent, precise, analytical measurement of ASTM D3241 heater tube deposits. It incorporates a laser light source optical detection system for measuring the ellipsometric parameters, tube handling assembly and computer driven software for analyzing the ellipsometric data for ASTM D3241 heater tube rating.

The following safety features are incorporated into the machine:

- The laser and all laser paths are fully enclosed in a protective housing designed to prevent human body exposure from the laser path or collateral radiation by beam or reflection exposure.
- The access door is interlocked with redundant safety limit switches to prevent exposure to laser emissions.
- Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser notice No. 50.

Falex Ellipsometer functionality consists of three (3) main areas (figure 1).

1: General Information

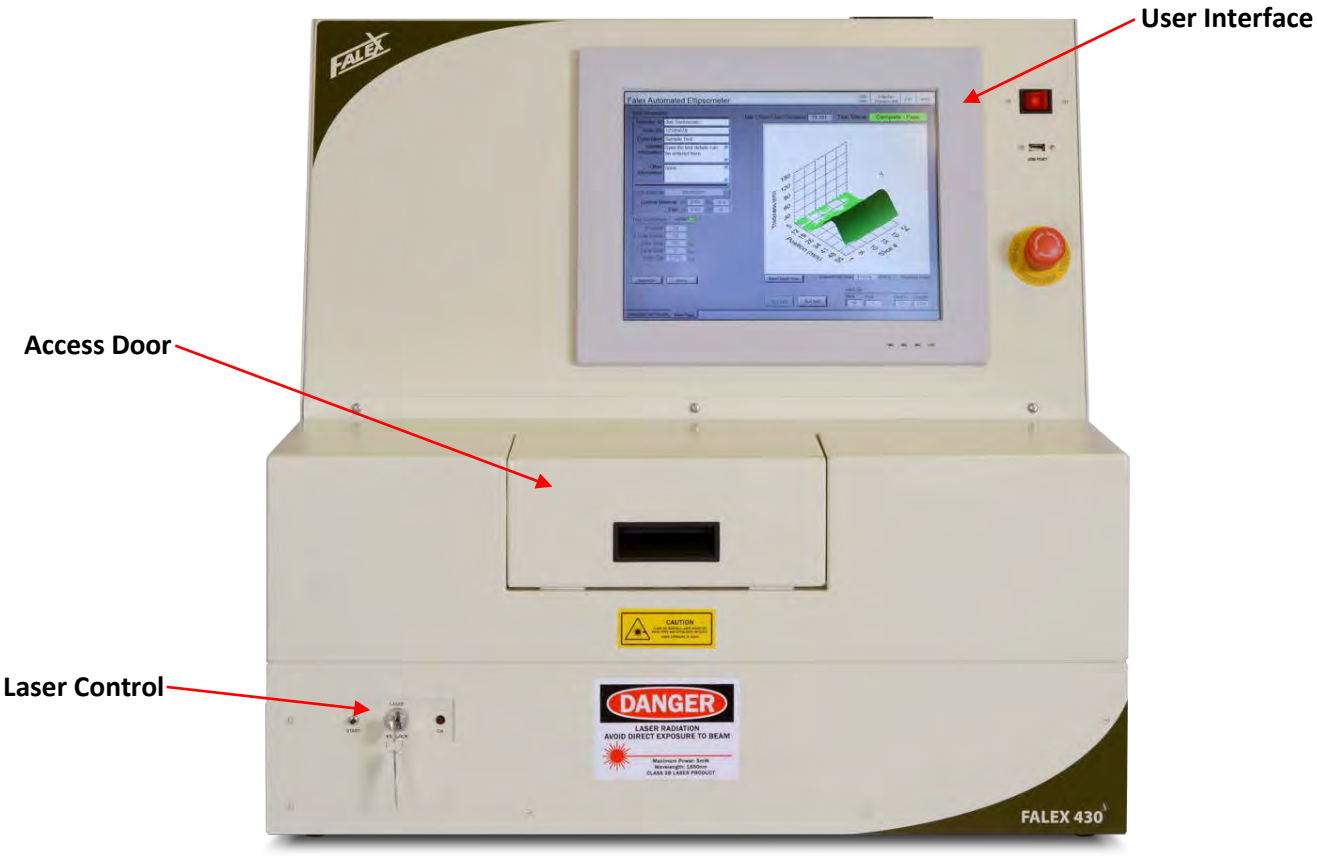

Figure 1 - Areas of Machine

1. **User Interface** – PC utilizing touchscreen functionality for configuration, control and monitoring of the test.
2. **Laser Control** – consists of keyed on/off power enable switch, laser emission indicator and laser emission start push-button.
3. **Access Door** – allows access to heater tube loading assembly for placement of the heater tube. Safety interlock limit switches interface with the door to prevent laser emission when the access door is in the open position.

The Falex Ellipsometer (model 430) has the following features (Refer to section 1.5 for the location of various components of the machine):

User Interface: A touch screen computer is located on the front of the electronic cabinet and is used as the user interface for configuration, control, and monitoring of the test.

Laser Area Access Door: Allows access to heater tube loading assembly for placement of heater tube.

Laser Emission Start Push-button: Initiates laser emission.

1: General Information

Laser Power Key Switch: Enables power to the laser.

Laser Emission Indicator: Indicates when laser emission is active.

Laser Beam Attenuator: Prevents laser emission.

Overlapping Recessed Joints/Seams: Prevents exposure to laser emissions.

Power (ON/OFF) Switch: Provides power to the entire test machine, including the user interface.

Emergency Stop Switch: A red mushroom switch (located to the right of the user interface) is to be used as an emergency stop switch in the event of an emergency. This switch should be pulled out prior to turning power on to the machine using the power switch.

Safety Interlocks: Redundant door safety limit switches prevent the laser from operating if the access door is opened. If the access door is opened during an active test, the test is aborted and laser emission is stopped.

USB Port: Three (3) USB ports exist on the machine. One (1) is located on the front of the machine and two (2) are located on the convenience outlet on the right side of the cabinet.

Convenience Outlet: On the right side of the cabinet is a convenience outlet. This outlet has two (2) active USB connections and one (1) active Ethernet connection. The Ethernet connection can be used for network connectivity. Any network configuration should only be made by a network administrator and after consulting with your Falex representative.

Note: Plugged USB ports (bottom 2) and Ethernet port (bottom) are not connected.

Power Cord: The power cord comes with a 10 Amp (110 or 220 VAC) plug direct from the factory.

Circuit Breaker: A 10 amp circuit breaker is located on the right side of the cabinet. If the breaker trips, consult an electrician or Falex representative for troubleshooting suggestions.

Alarm Horn: The alarm horn is located on the left side of the cabinet. An audible signal will be heard when a test completes, aborts or when in alarm condition.

Tube Tensioner Assembly: This is an external device that is provided to straighten a heater tube prior to being positioned into the Ellipsometer.

Calibration Tube Kit (option): This is an optional kit containing three (3) tubes with different thickness coatings to be used to verify calibration.

Remote Data Viewer Software Utility (option): This is an optional software utility that allows the operator to view copied data files on a remote PC in a graphical format similar to what is shown on the Ellipsometer user interface.

Note: 'Calibration Tube Kit' and 'Remote Data Viewer Software Utility' is not part of the general machine order and are to be purchased separately. Consult a Falex representative for purchasing information.

1: General Information

1.3 Packing List

Unpack the machine and verify it contents. Each machine comes equipped with a startup kit, which includes all the necessary items required to run the machine. Unpack the startup kit and verify its contents with the listing shown below.

QTY	PART #	DESCRIPTION	PICTURE
1	n/a	CD/Manual	
1	n/a	Laser Control Keys	
1	650-204-048	Keyboard/Mouse	
1	650-030-161 650-030-150	Power Cord 120V or Power Cord 220V	
1	430-200-001	Tube Tensioner Assembly	
1	657-430-022	Collet Wrench	

1: General Information

QTY	PART #	DESCRIPTION	PICTURE
1	657-430-023	Large Wrench (1 1/8”)	
1	657-430-024	Small Wrench (7/16”)	

1: General Information

1.4 Initial Machine Setup

Note: Refer to section 1.5 to locate areas on the machine referred to in this and future sections.

Carefully uncrate the unit and select an appropriate level bench space. The unit comes fully assembled.

Keyboard Installation - Connect to any of the active USB ports on the convenience outlet.

Note: Keyboard not required for machine operation.

Laser Control Keys – Locate the laser control unit keys in the envelope with the QC certificate and manual CD. Insert them into the laser power key switch on the front of the machine.

Power Cord Installation - Plug the power cord into an outlet appropriate for the plug (120V, 60Hz for North America, 220V 50Hz for Europe). Electrical source must have a good ground or an isolated power with ground.

Beam Attenuator/Chain Installation – Remove tape holding beam attenuator/chain in place. Tape was used to prevent beam attenuator/chain from moving around during shipment.

Note: Do not continue working with the unit until the operator has a full understanding of this machine's operation.

Configure Lab Information – When the machine is powered up, it will automatically start the user interface application. On the 'Main Page', select the 'Supervisor' button and enter '123456' to enter 'Supervisor Mode'. Select the 'Additional Test Results' tab at the bottom of the display to open the 'Additional Test Results' display. Enter the lab name, city and state associated with the location of your facility. This information will be retained and is included in all data files.

Change Supervisor Password – Refer to section 3.5.2 to change the 'Supervisor Mode' password from the default.

Printer Installation (optional) - Printing functionality exists, if a printer (sold separately) is connected and has been configured. A printer can be purchased through Falex or one can be supplied on your own. If the machine was shipped with a printer, the user interface is already configured for the printer. If the machine was not shipped with a printer and a printer is to be configured, refer to section 3.5.5.1 for printer configuration details. The printer can be connected to any of the available USB ports on the right side of the machine (figure 5). It can be positioned on either side of the machine.

1: General Information

1.5 Getting to know the Falex Ellipsometer Test Machine

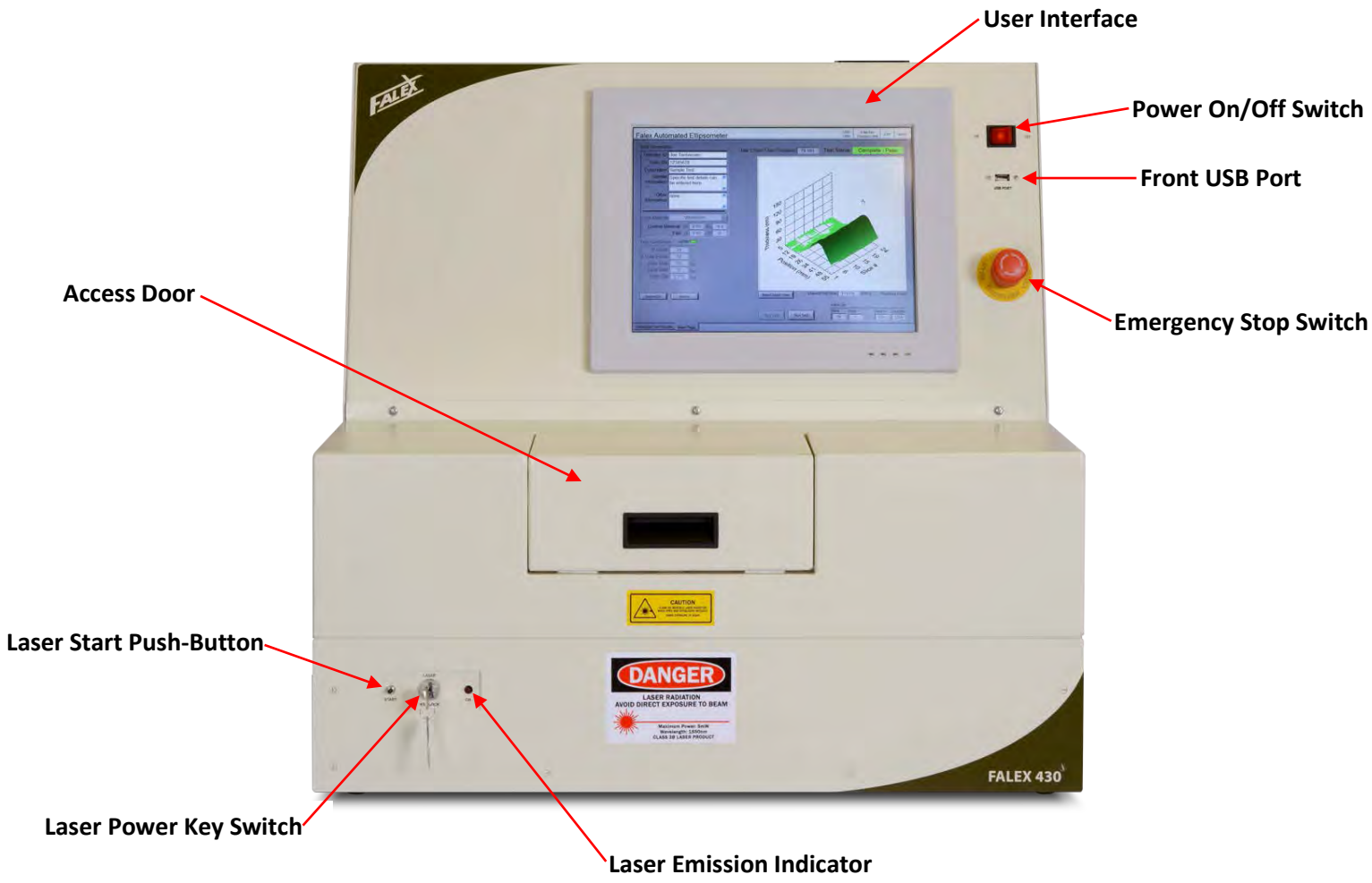

Figure 2 - Cabinet (Front)

1: General Information

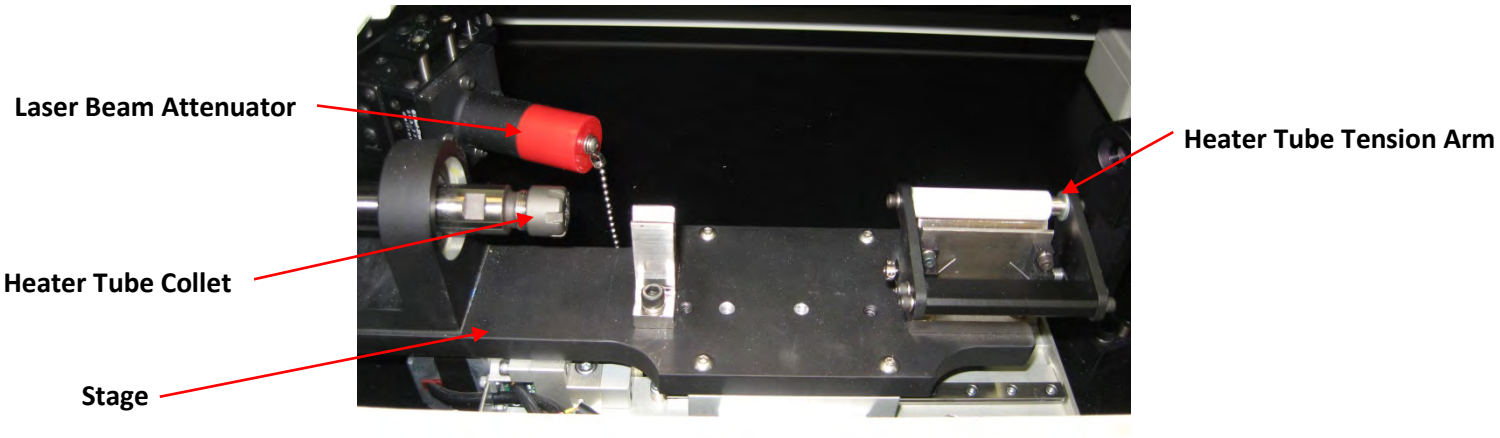

Figure 3 – Heater Tube Installation Assembly (Access Door Open)

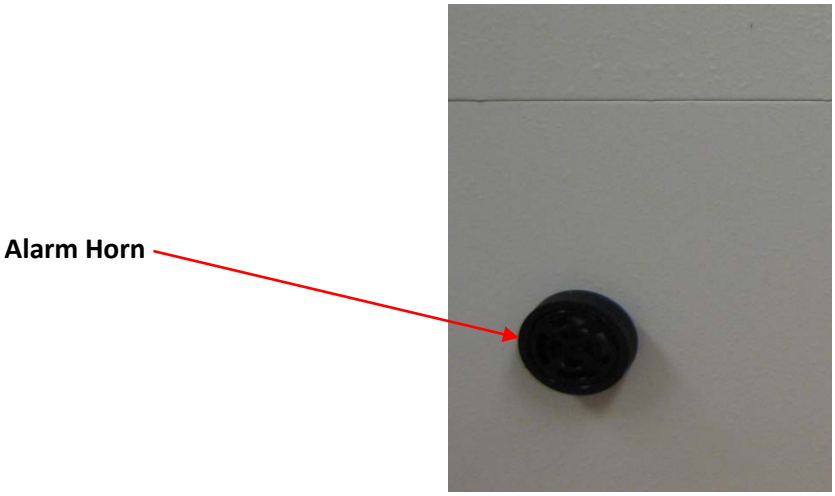

Figure 4 - Cabinet (Left Side)

Figure 5 - Cabinet (Right Side)

1: General Information

1.6 Laser Control Narrative

Initiating Laser Control

In order for the laser beam emission to be turned on, various conditions and sequences must be satisfied. These conditions and sequences are a combination of operator actions, hardwired safety interlocks and software interlocks that prevent operator exposure to laser emissions. The laser control process is explained below.

1. **Laser Master Power Control On/Off Key Switch**
   Located on the front of the Ellipsometer cabinet (protective housing), this switch enables the operator to power the laser power supply with the turn of a key. This only allows power to be applied to the laser power supply; it does not initiate laser emission. The laser power supply is inoperable when the key is removed.

2. **Laser Beam Emission Control Sequences**
   In order for the operator to begin a test that will cause the laser to emit a beam inside the protective enclosure, the laser 'Beam Blocker' cap must be removed and the laser area protective housing door must be fully closed. Once the door is closed, all of the safety interlock conditions must be met.

   The laser power supply has an internal built in safety circuit that, combined with the laser, are FDA certified. The power supply will not provide power to the laser unless the operator performs a specific sequence of operations and the Ellipsometer safety remote interlocks are satisfied. There are both hardwired and software safety interlocks incorporated into the Ellipsometer laser power supply system that must be satisfied in order to achieve a remote interlock 'Ok' status. They are:

   a. Hardwired Safety Interlock
      Both primary and secondary (redundant) laser area protective housing door limit switches must indicate the door is closed. These are wired in series with the other conditions for the laser remote interlock. The closed door position will cause each switch to close a contact. Therefore, if a contact does not close or a wire becomes open, the remote interlock cannot be satisfied, providing a fail-safe design.

   b. Software Safety Interlock
      The Ellipsometer control system monitors a second set of isolated contacts from each of the above door limit switches to indicate to the instrument control system that the laser area door is closed. The Ellipsometer operator then can see an active 'Run Test' push-button on the control system display because software checks that the proper inputs to start a test are available. The operator then can continue the initiate test process. The Ellipsometer control system monitors both of the redundant door switches (isolated from each respective door switch contact utilized in the hardwire laser safety interlock string) for a contact closure. If the door switches and other monitored Ellipsometer conditions are satisfied, an Ellipsometer safety remote interlock 'Ok' condition will close a dry contact in

the laser power supply remote hardwired interlock series string to indicate the interlock condition from the Ellipsometer is satisfied.

3. **Initiate Laser Emission**
   Once the above conditions have been satisfied, laser emission can be initiated by the operator. First, the operator is to push and release the momentary 'Start' push-button located in the laser control area on the front of the Ellipsometer cabinet (protective housing). At this time the operator will be provided a visual 'Red' LED indication warning the operator of eminent laser emission. There is a 5 second delay timing circuit that is activated before laser power is applied and laser emission is initiated. The 5 second delay will complete only if the remote safety interlock is not interrupted by turning to an off state and the operator does not use the master control keyed On/Off power enable switch to turn off the laser power and cancel the start sequence. The 'Run' test button on the software display can then be pressed by the operator. The laser power will remain active until the interlock is interrupted by test completion, test abort, or the operator turns the master control keyed On/Off power enable switch to the off position.

Laser Control During Active Test

The Ellipsometer control system can only turn 'Off' laser power by use of its remote interlock contact in the series hardwired safety interlock string. Once a test has been initiated, the Ellipsometer control system will monitor the laser power to see that the power to the laser is on. Once this has been confirmed for a minimum of 10 seconds after test start, the Ellipsometer control system will sequence the laser power off to read the dark mode output of the photo detector that senses the reflected laser light voltage output level. The following sequence is performed unless the test is aborted, laser area door is opened or indicates open, or the operator turns the master control keyed On/Off power enable switch to the off position.

1. The laser power supply remote interlock Ellipsometer contact is opened by dropping the relay coil power causing the laser power supply to turn off, while still key enabled by the operator.
2. The dark mode photo detector voltage is measured.
3. The Ellipsometer laser power supply remote interlock is re-energized satisfying the laser remote interlock condition and a pop-up display information box will appear for the operator. The pop-up display lets the operator know that the laser beam emission is to be restarted by pushing the momentary 'Start' push-button, causing a new 5 second timeout sequence to be satisfied by the laser power supply. During the time of the dark mode measurement, the laser and LED indicator are off. Once the 'Start' laser is activated, the LED Indicator again is lit.
4. If all laser power supply remote interlock conditions are met and the operator's master control keyed On/Off power enable switch is on, the laser power will be turned on again until any laser power off causes occur.

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Laser power off causes:

- Operator turns off master control keyed On/Off laser power enable switch that is the primary control of laser power and laser beam emission.
- One or more laser area protective housing door limit switches indicates door ajar to the hardwired laser power supply remote safety interlock.

Note: If the laser area protective housing is removed, the wiring to the door switches must also be removed, preventing an initiation of laser power. The Ellipsometer control system will indicate in a pop-up display box that the protective housing is open and the interlock is not satisfied.

- Ellipsometer control system sees one or more the isolated door limit switch contacts open indicating door ajar, test completed, or test aborted. This will cause the Ellipsometer to open its laser power supply remote safety interlock contact, which is wired in series with 2 redundant laser area door limit switch's normally opened contacts. These contacts are only closed when the door is closed.
- Power to the laser power supply is removed by the operator initiating an 'Emergency Stop' using the emergency push-button switch mounted on the front panel, turning power off to the Ellipsometer, or by loss of supply power.

1.7 Laser Safety

The Falex Ellipsometer (model 430) incorporates a certified class IIIB diode laser module. The laser is CE certified and CDRH certified. This section will discuss safety details when operating the laser.

Overview

The Laser is a rugged diode laser module with the following specifications:

- wavelength 1550nm
- output power 5mW
- operating voltage 5 VDC
- maximum operating current 120 mA
- beam diameter 1.5 * 5.25 mm
- beam divergence full angle <1.5*0.7 mrad

The module operates in Constant Optical Output Power Mode only. This means that if there is a change in temperature, focus, or any other dynamic that changes the output of the laser, the power supply will automatically adjust current output to compensate. It maintains a constant and stable output power.

1: General Information

The laser is factory mounted inside a protective housing. The laser power source has a front of panel permanently installed master key control switch, with a start push-button and emission indicator. There is a 5 second delayed start on laser emission after the start push-button has been pressed. Internally, there is an attached beam attenuator that can be manually applied/removed. There are safety labels on the front panel of the protective housing. If the laser is removed, modified, safety labels are removed or the power source is permanently connected (i.e. soldered, etc.) directly to the laser unit, the CDRH certification and warranty will be void.

Operation

Testing

When the system is used to perform typical application testing, the operator will not have direct exposure to the beam. Before testing, check and make sure that the beam attenuator has been removed and the protective housing access door is fully closed. When all inputs to the software are in their correct state (indicating that the machine is ready), use the master key control switch and start push-button to turn on the laser. The desired test can then be initiated using the software application. After the test is finished, turn off the laser using the master key control switch and make sure the laser emission indicator is off. The protective housing can then be opened.

Calibration Check

Calibration is not required since the positions of the optical parts are fixed. However, a calibration check can be performed to verify that the laser system is functioning accurately. Obtain a Falex Ellipsometer calibration kit (p/n 430-200-002) to verify calibration. Run a 24x50 detailed test using the three (3) calibration heater tubes from the calibration kit. If the test data shows a 5% difference from the known test results, contact your local Falex representative to schedule a service visit.

Note: Service is to be done only by Falex trained service technicians.

Note: 'Calibration Tube Kit' not part of the general machine order and is to be purchased separately. Consult a Falex representative for purchasing information.

Preventative Maintenance for laser unit

The laser module itself contains no user serviceable parts. Occasionally the optics may need cleaning depending on environmental conditions. When cleaning is required, the use of clean, compressed air is recommended to blow the optics clean. If compressed air fails, clean lens carefully with alcohol and a lint free rag or Q-tip. **Always have the master key control switch in the 'Off' position and the main Ellipsometer power switch 'Off'.**

1: General Information

Laser Safety

Caution: Use of controls, making adjustments or following procedures other than those specified herein may result in hazardous radiation exposure.

Modifications that affect any aspect of the product's performance or intended functionality will require re-certification and re-identification of the product in accordance with the provisions of 21CFR 1040.10 and 1040.11. A copy of 21CFR 1040.10 and 1040.11 can be found in FDA website:
http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?FR=1040.10
http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?FR=1040.11

Safety Label

Identification / Certification Label
Located on the right side panel of the enclosure

Warning Logotype
Located on the front panel of the enclosure

Aperture Label/Label for defeatably of interlocked protective housing
Located on the front panel of the enclosure

2: Typical Test

2.1 Overview

Note: The following is a general outline to be used along with the ASTM D3241 test method. Some steps may not pertain to the conducted test.

The following is a general description of a typical test process to be used. More detail on each step can be found in the steps that follow.

1. Prepare the heater tube for installation into the Ellipsometer (refer to section 2.2).
2. Install the heater tube into the heater tube assembly (refer to section 2.3).
3. Using the user interface, configure and start a test (refer to section 2.4).

2.2 Heater Tube Preparation

Note: Handle the heater tube by the ends only. Do not touch the center section of the heater tube where the deposit is located. Doing so will contaminate the deposit.

1. Visually inspect the heater tube that is to be tested for any foreign substance (such as dust or lint). If a foreign substance is noticed, gently try to blow off with clean dry air.

Note: Do not clean the center section of the heater tube with any cleaner or wipe it with a cloth. Doing so will contaminate the deposit.

2. Inspect the heater tube for straightness. Heater tubes can become bent during ASTM D3241 testing due to heat. One way to check this is by rolling it on a flat surface. The tube will roll on its shoulders, leaving the center section untouched. If it rolls smoothly, it is a straight tube. If the tube is bent, it will wobble when it is rolled on a flat surface. If it is determined that the tube is bent, use the supplied 'tube tensioner' to straighten the tube (figure 6). A bent tube that is installed in the Ellipsometer will affect the reflectivity of the laser beam causing data to be read inaccurately.

Figure 6 – Heater Tube Tensioner

Refer to Addendum 'C' for details on the heater tube tensioner operation.

2: Typical Test

2.3 Heater Tube Installation

1. Turn off laser power before opening the access door by turning the key switch to the 'Off' position (figure 7). The laser indicator should be off. Laser power keys can be removed when in the 'Off' position.

Figure 7 – Laser Power Key Switch in 'Off' Position

2. Push down on the black area of the tension arm to lift it off of the tube holding area (figure 8).

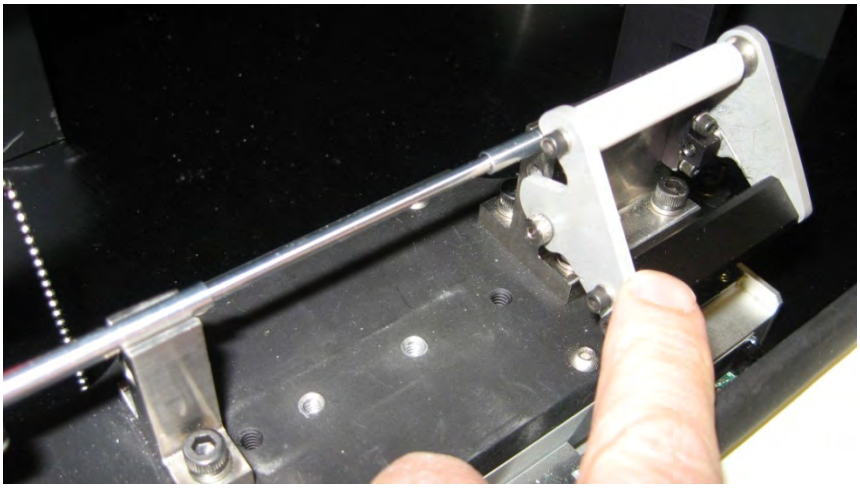

Figure 8 – Tension Arm Operation

3. Holding the heater tube by the end, carefully insert the heater tube end with the serial number into the collet on the left with only the shoulder resting on the V-block.
4. Push the heater tube into the collet until the shoulder of the tube cannot be inserted any farther. Be careful not to push to hard.
5. Position the heater tube so that the serial number is facing up.

Note: It is recommended that the heater tube be positioned in the heater tube holder the same way for each test for consistent results.

6. Tighten the collet to hold the heater tube into place.

7. Slowly release the tension arm so that the white area is in contact with the heater tube (figure 9). Gently push down on the white portion of the tension arm so that it makes good contact with the heater tube.

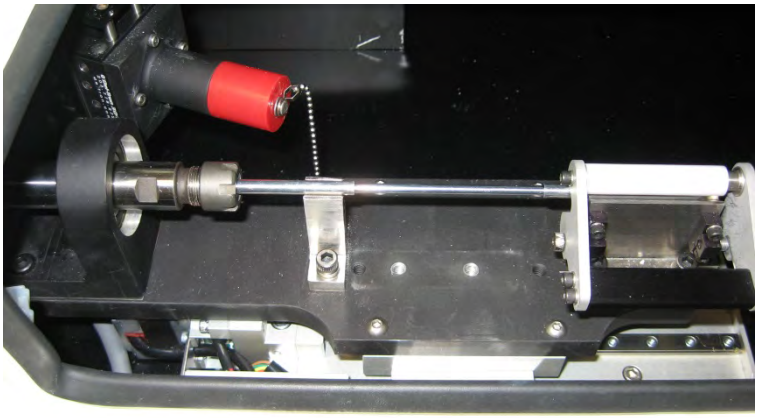

Figure 9 – Heater Tube Installation

8. Do not touch the center section of the heater tube (deposit area) at any time.
9. Remove red laser beam attenuator from laser and let it rest on base, making sure chain does not get caught in the stage movement.

Note: Failure to remove the laser beam attenuator will result in no data being read.

10. Close access door making sure redundant limit switches are depressed.

2.4 Start Test

Note: Before starting a test, install the heater tube per the instructions found in the previous sections, review this manual and the method. This section gives a general overview of using the software to run a test. Detailed explanation of the software is found in later sections of this manual.

1. Power-up the machine. Make sure emergency stop button is pulled out and then toggle the power on/off switch to the 'On' position. The user interface will boot up and the 'Main Page' (figure 10) will appear.

2: Typical Test

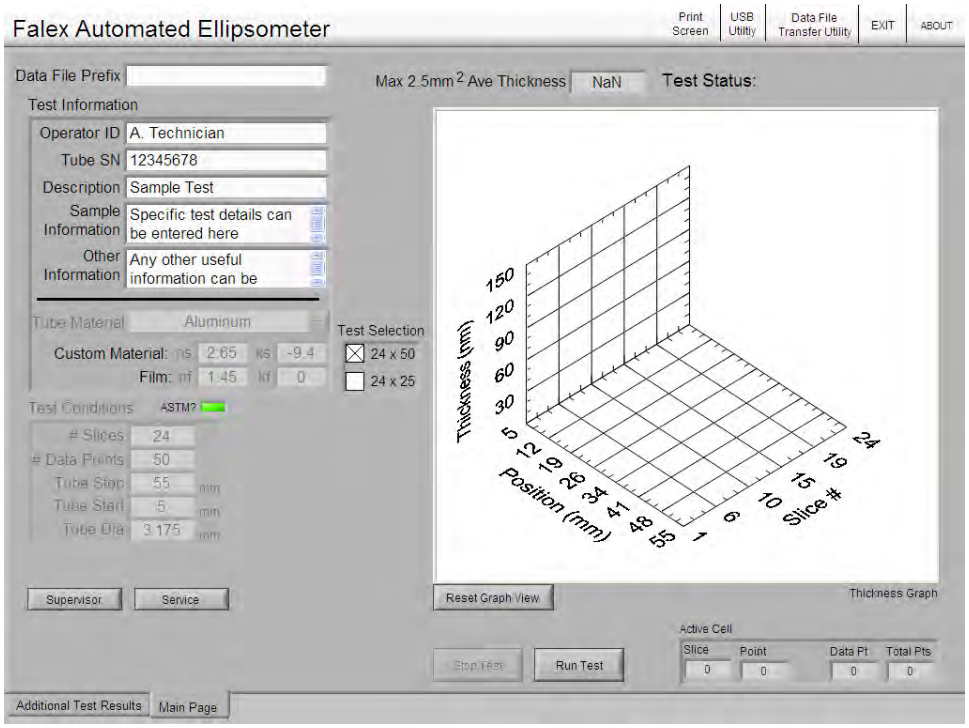

Figure 10 - Main Page

2. Enter a 'Data File Prefix' if desired. This will be added to the data file name in front of the standard date/time naming convention. This is not mandatory.
3. Fill in the associated test information in the 'Test Information' area of the display. It is mandatory that something be entered in the Operator ID, Tube SN and Description fields. All other fields are optional.
4. Verify that correct 'Tube Material' is shown for the type of heater tube that has been installed.

Note: Aluminum is the standard material for ASTM D3241 testing. Tube material can only be changed when in 'Supervisor Mode'. Refer to section 3.4 for more details.

5. Verify that the access door is closed.
6. Select the type of test to run in the 'Test Selection' area.
   - 24 x 50 - is a more detailed test and takes approximately 75 minutes to complete.
   - 24 x 25 - is a quick test and takes approximately 32 minutes to complete (default).
7. Turn the laser power key to the 'On' position.
8. Select the 'Run Test' button on the display to initiate the test sequence. A popup will appear to manually start the laser (figure 11). Do not select the 'Laser Started' button at this time.

2: Typical Test

Figure 11 – Manually Turn On Laser Popup

9. With the laser power key in the 'On' position, press the laser start push-button (next to the key switch). The emission indicator will turn red (figure 12). Laser emission will start 5 seconds after the emission indicator turns red.

Figure 12 – Laser Emission

10. Select the 'Laser Started' button on the display to initiate the test sequence. A timer popup (figure 13) will appear to let the operator know the wait period status.

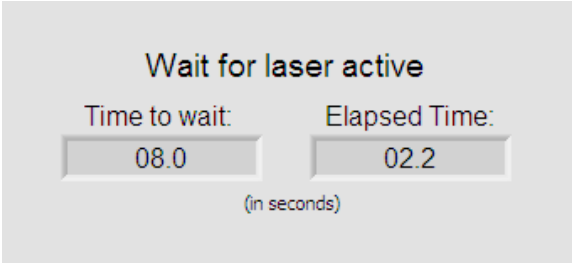

Figure 13 – Wait Timer Popup

2: Typical Test

11. After 8 seconds, a 'DC Offset Measurement Complete' popup display will appear (figure 14). Press the laser start push-button again and then select the 'Laser Started' button on the popup display. The popup display will close and the wait timer popup will appear again.

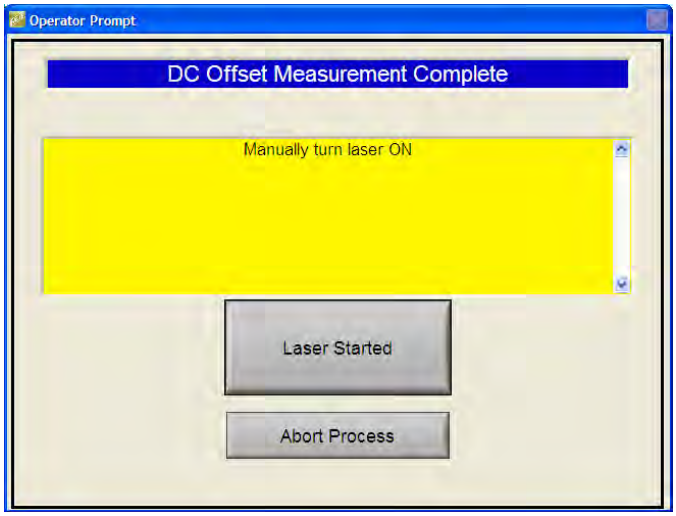

Figure 14 – DC Offset Measurement Complete Popup

12. The test will now start.
13. If any of the requirements are not met, a 'Process Error' popup display will appear. Examples of various messages that may be displayed within the 'Process Error' popup are shown below (figure 15).

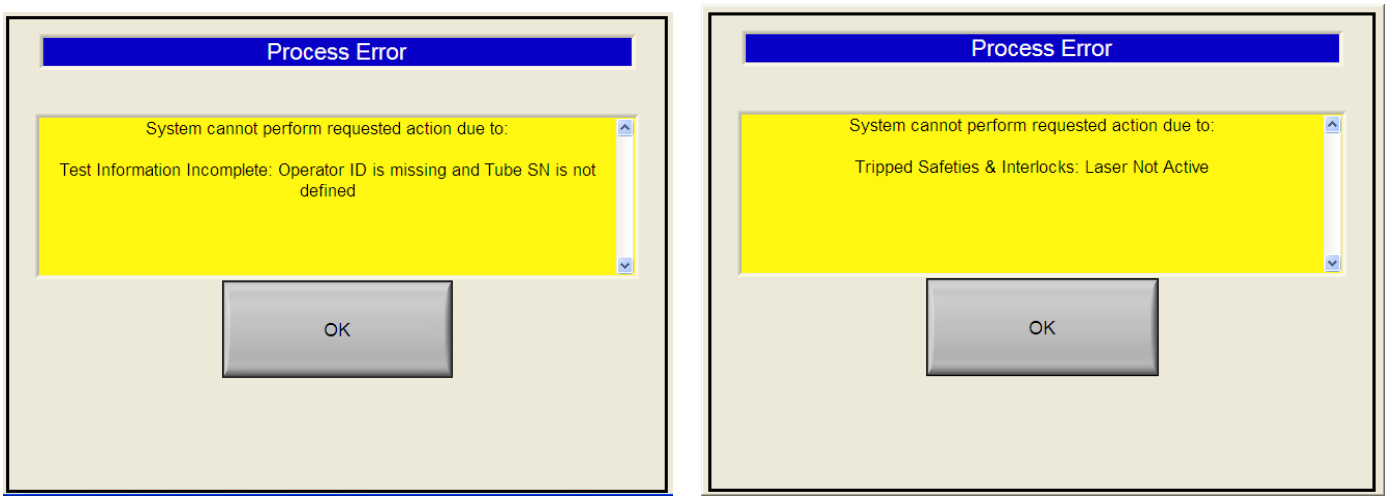

Figure 15 – Process Error Popup

2: Typical Test

14. The ‘Main Test Page’ has the following features (figure 16):
    - Dragable 3D data graph
    - Test status indication
    - Elapsed test time
    - Current measure position
    - Number of data points left to read
    - Total points that have been read
    - Test parameters
    - Real time 2.5mm^2 area average peak value (value shown during a test is using real-time non-normalized data and will change to a normalized value once the test is complete).
    - ‘Stop Test’ button which can abort the active test when selected

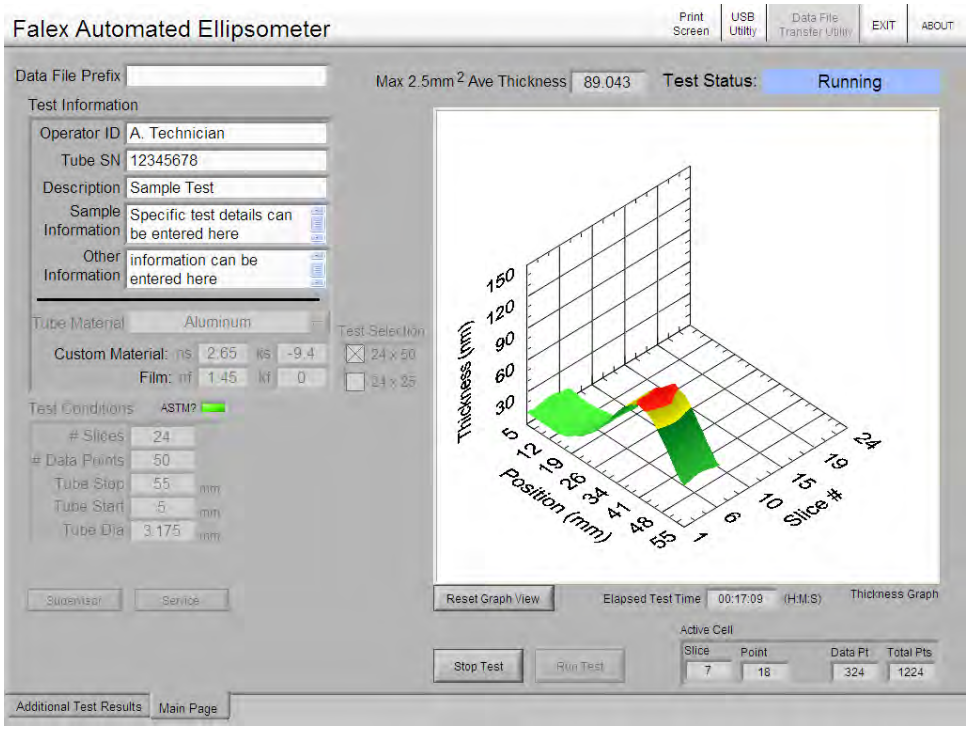

Figure 16 – Main Test Page Features

15. Upon test completion,
    - The test complete popup display will appear (figure 17). This display will include pass/fail information.
    - The alarm horn will cycle on/off until the operator selects the ‘Acknowledge’ button on the test complete popup display. The test complete popup display will close.
    - The laser and rotary analyzer will shutdown automatically.

2: Typical Test

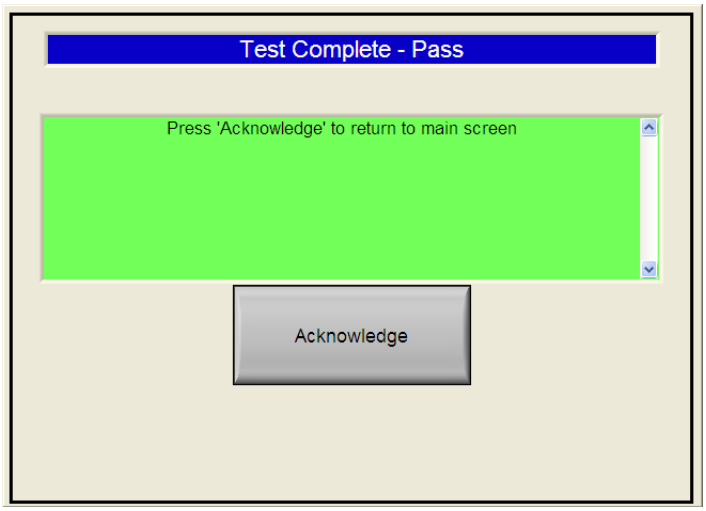

Figure 17 – Test Complete Popup

16. After the 'Test Complete' popup has closed, the final test result will be displayed on the 'Main Page' (figure 18) and the test data file will be closed. The data file can be saved to a flash drive for review on an external PC or printed (if a printer is connected and configured). A test report including the 3D data graph can also be printed (if a printer is connected and configured).

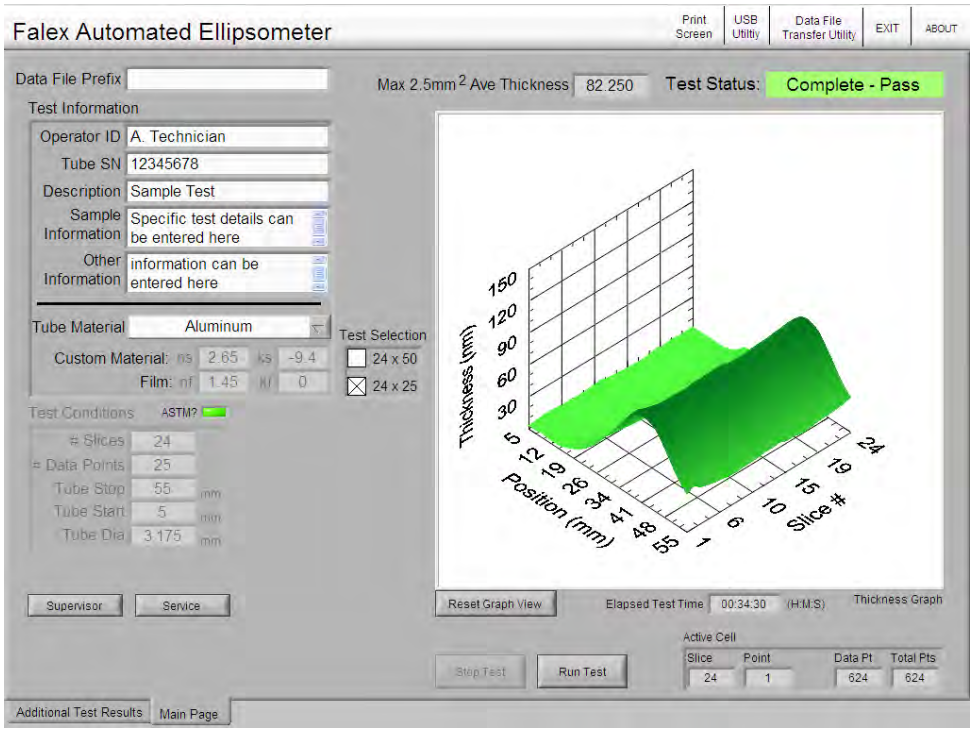

Figure 18 – Test Complete Display

17. The test is complete.

3: Detailed User Interface Features

3.1 Software Overview

The Model 430 user interface makes testing easy to setup, repeat and control. It is operated entirely under a Windows® operating system environment. It utilizes touchscreen functionality that allows items to be selected by simply touching the item with one's finger, stylus, or mouse pointer (if the supplied keyboard/mouse is connected). During testing, test data is displayed both numerically and graphically.

Software functionality captures data points and their values are saved into a data file. The data file created is saved in a format that can be opened with a standard spreadsheet or document application, once transferred to an external PC.

The user interface software application is automatically started when the machine is powered up. Should the display go to sleep, it can be reawakened by touching somewhere on the touchscreen surface. The software configuration is defaulted for ASTM D3241 testing. Configuration changes can be made with a level 1 'Supervisor Mode' password (refer to section 3.4).

3.2 Display Architecture

The displays are made up of three (3) areas (figure 19), with each area having special functionality. The various display areas are:

- Header
- Main display area
- Navigation tabs

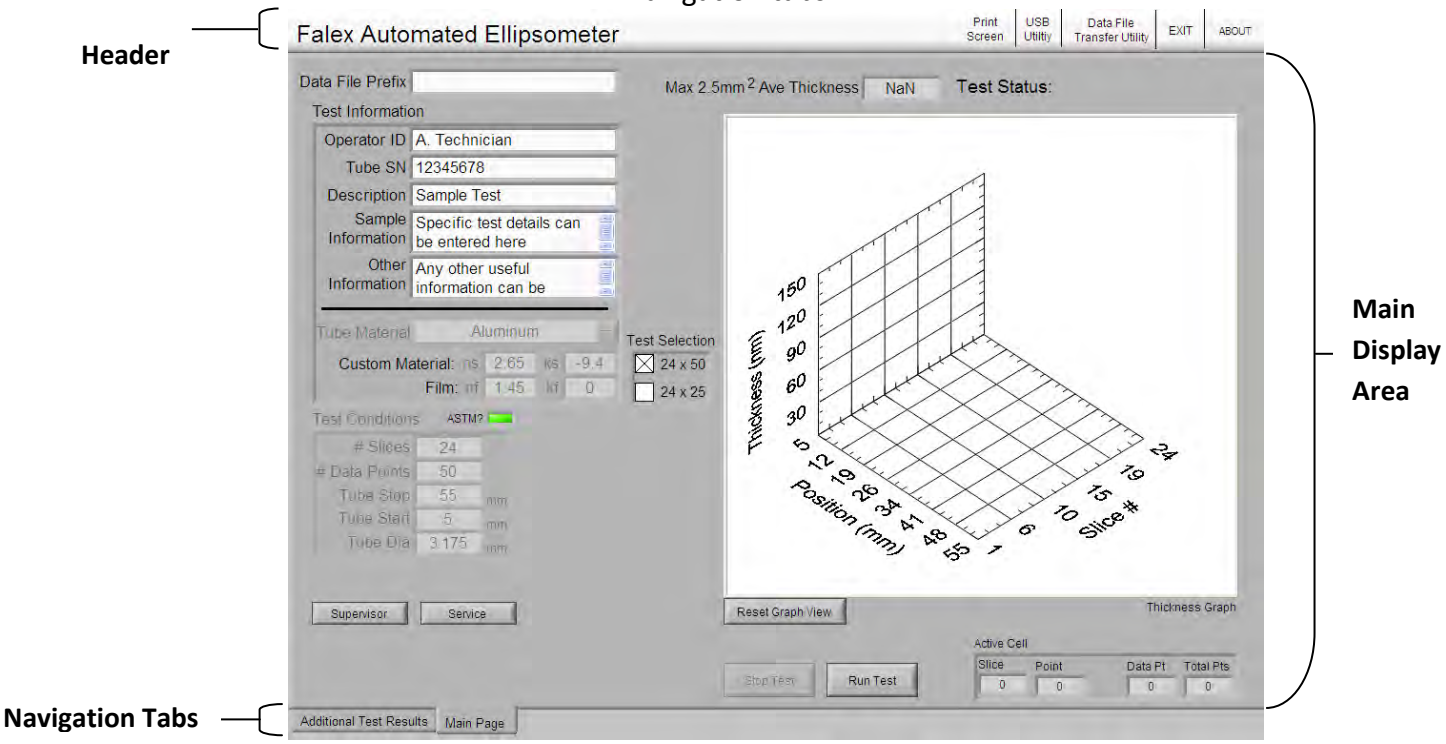

Figure 19 - Display Component Areas

3: Detailed User Interface Features

Header

The header area contains the machine name and various selections that have functionality associated with them (if enabled). Possible selections are:

- **Run Explorer** – Allows operator to launch Windows® Explorer to access various Windows® functions. Available only with a level 1 'Supervisor Mode' password. Refer to section 3.5.5.1 for more details.
- **Error File Utility** – Allows operator to view and/or copy the system error log to an attached external device. Available only with a level 1 'Supervisor Mode' password. Refer to section 3.5.5.2 for more details.
- **Print Screen** – Allows the operator to do a screen print (if a printer is connected and configured). Refer to section 3.5.5.3 for more details.
- **USB Utility** – Allows operator to safely close USB storage device communications and allow the USB storage device to be safely removed from the user interface. Refer to section 3.5.5.4 for more details.
- **Data File Transfer Utility** – Allows operator to copy or move data files to an external device or delete them from the system. Functionality also exists to allow the operator to recall a stored test for viewing and/or printing. Refer to section 3.5.5.5 for more details.
- **Exit** – Allows the operator to properly exit out of the Model 430 user interface application before machine is powered down. Refer to section 3.5.5.6 for more details.

Note: It is recommended that the user interface application be properly shutdown prior to removing the machine from power. Powering down the machine without doing so could cause data loss/file corruption and should only be done in an emergency.

- **About** - When selected, a popup will appear showing the software revision level. Refer to section 3.5.5.7 for more details.

Main Display Area

The main display area contains a 3D graph, numeric data, buttons, and enterable fields to allow the operator to configure, run and manage tests.

Navigation Tabs

The navigation tabs allow the operator to navigate to other displays by selecting the associated tab.

3.3 Functionality

Buttons, icons and enterable fields can be selected by simply touching the item to be selected with one's finger, stylus, or selecting it with a mouse (if the supplied keyboard/mouse is connected).

Buttons and enterable fields that are grayed out are not enabled (figure 20). If a grayed out button or enterable field is selected, nothing will happen. Various conditions must be met within the control software before particular buttons or fields are enabled.

3: Detailed User Interface Features

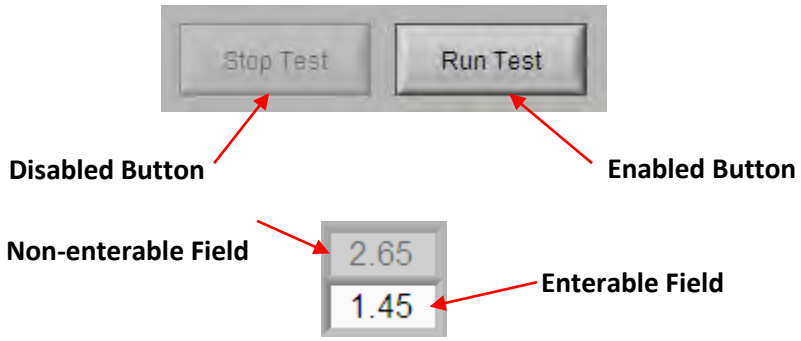

Figure 20 – Disabled functionality

Enterable fields are shown as white rectangular areas. These fields allow the operator to enter alpha-numeric information or to enter numeric information. If an alpha-numeric field is selected, a full keyboard will appear on the screen so that the information can be entered (figure 21). If a numeric field is selected, a keypad will appear so that the numeric value can be entered (figure 22). If the supplied keyboard is connected to the machine, information can be entered from the keyboard for the selected enterable field.

Figure 21 - Alpha-numeric Keyboard

3: Detailed User Interface Features

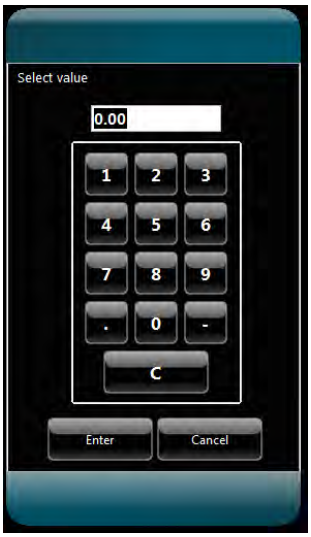

Figure 22 - Numeric Keypad

Certain actions taken by the operator require a secondary operator verification before the action is executed (figure 23). This will prevent accidental selection of critical functionality. Such actions requiring secondary verification are stopping a test, file deletion and exiting the user interface application.

Figure 23 - Operator Verification Pop-up

3.4 Password Levels

The user interface incorporates two (2) levels of passwords, each level enabling additional functionality above and beyond the typical 'Operator' mode.

Level 1 (Supervisor Mode)

This level is for supervisor access. It enables the following additional functionality:

- Ability to change 'Tube Material'
- Ability to run a 'Custom' test
- Ability to change 'Test Conditions'
- Access to Windows® Explorer interface
- Ability to export system files for factory service support
- Ability to change 'Supervisor Mode' password

3: Detailed User Interface Features

The Model 430 machine is delivered with the default level 1 password of '123456'. It can be changed in the 'Supervisor Password' area of the 'Main Test Page' when in 'Supervisor Mode'. Periodically, it should be changed for security purposes (the department supervisor is the intended facilitator of this functionality). Should the level 1 password be forgotten, contact your local Falex representative. When/where the password is required will be detailed when particular displays are discussed.

Level 2 (Service Mode)

The level 2 password is for factory and authorized service personnel use only.

3.5 Display Functionality

The following sections will describe the functionality of each display.

3.5.1 Main Page (Operator Mode)

When the 'Main Page' tab is selected, the 'Main Page' appears (figure 24). This display contains the 3D graph, numeric data, buttons and enterable fields to allow the operator to configure, run and manage tests. The functionality of the display will be discussed in detail below. Refer to section 3.5.2 for advanced features available on the 'Main Page' when in 'Supervisor Mode'.

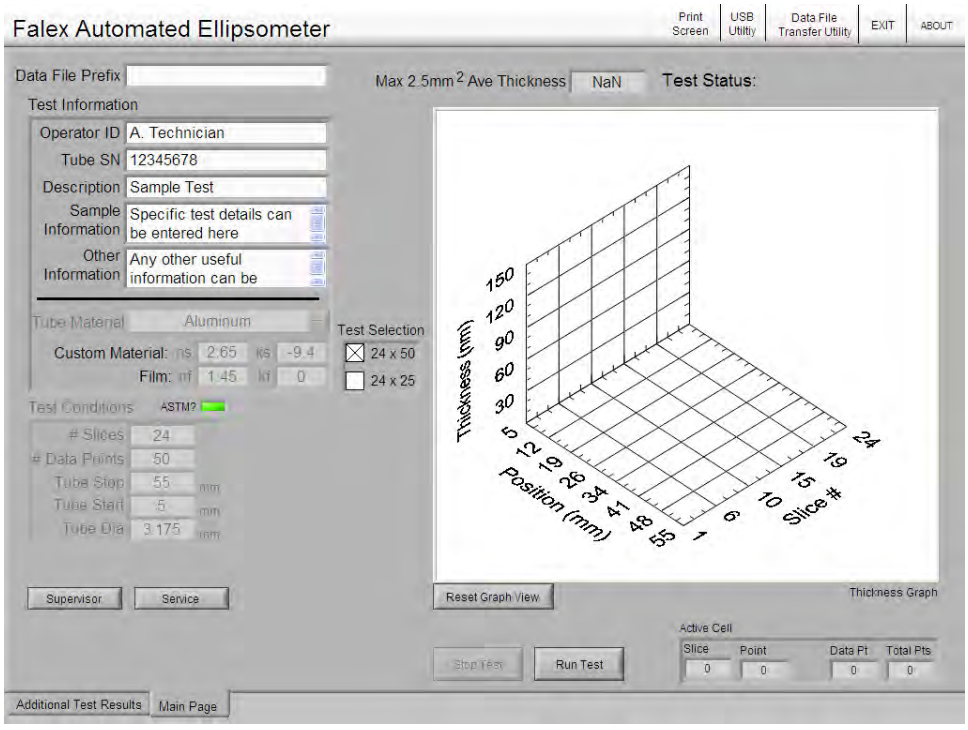

Figure 24 – Main Page (Operator Mode)

3: Detailed User Interface Features

'Test Information' Section

This area of the display allows the operator to enter general test information for the test. This information is contained in the data file. It is mandatory that something be entered in the Operator ID, Tube SN and Description fields. All other fields are optional. This information is included in the data file.

Test information that can be entered is:

- Operator ID
- Tube Serial Number
- Description
- Sample Information
- Additional Information

Select the white field to enter the information. Data can be entered using the popup keyboard on the display or using the supplied keyboard, if connected. Always hit the 'Enter' key on the keyboard to enter the data into the proper field.

Additional fields located in this area of the display are:

- **Tube Material** – This designates the type of material the heater tube being tested is made of. In 'Operator Mode', this field is defaulted to 'Aluminum'. With a level 1 'Supervisor Mode' password, additional selections are available. Refer to section 3.5.2 for details on the advanced features of 'Supervisor Mode'.
- **Custom Material** – Designates optical constants for the particular 'Tube Material' selected. These values are pre-defined for the particular material. Only a 'Custom' tube material selection allows these parameters to be modified.
- **Film** – Designates optical constants for the heater tube deposit. These values are pre-defined for the 'Tube Material' selected. Only a 'Custom' tube material selection allows these parameters to be modified.

'Test Selection' Section

This area of the display allows the operator to select the type of test to run. The 1st parameter is the *# of Slices* and the 2nd parameter is the *# of Data Points*.

- **24 x 50** - is a more detailed test and takes approximately 75 minutes to complete.
- **24 x 25** - is a quick test and takes approximately 32 minutes to complete (default).

24 x 50 Test

This is a more detailed test that will take approximately 75 minutes to complete. Upon completion of this test, if the determined Max 2.5mm^2 thickness is within tolerance of the fail limit (85nm), the 'Streak Referee' popup will appear (figure 25). 'Streak Referee' is a feature that will allow the operator to further examine the area of the heater tube where the high deposit was detected, if the operator decides to do so.

3: Detailed User Interface Features

Figure 25 – Streak Referee Popup

Selecting the 'Acknowledge' button will skip the Streak Referee test and will navigate the operator back to the 'Main' display. Selecting the 'Run Streak Referee' button will initiate the high resolution test. Using data from the detected high deposit area, test parameters are predetermined for the high resolution test on the area in question (figure 26). The suggested test area (tube start/stop) is 2mm before/after the detected high deposit area. These parameters can be changed by the operator, if desired.

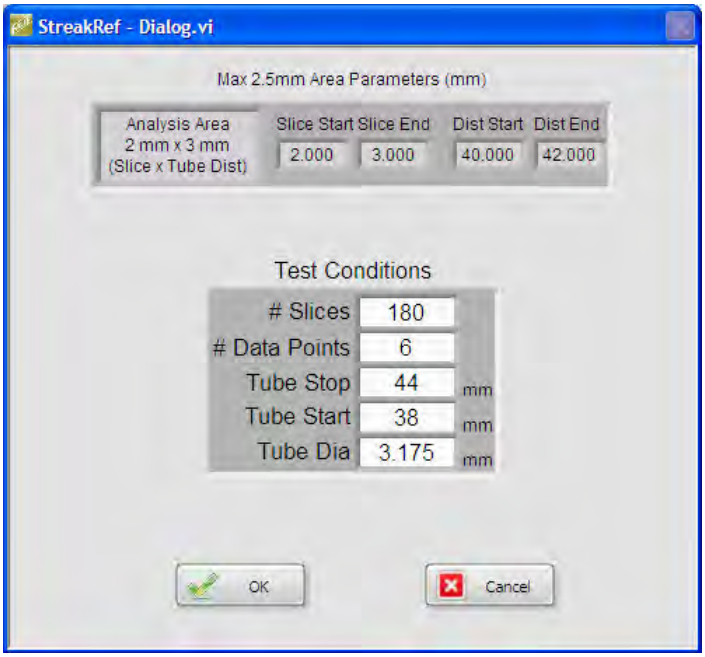

Figure 26 – Streak Referee Test Parameters Popup

3: Detailed User Interface Features

Once the 'Streak Referee' parameters are verified, selecting the 'OK' button will initiate another popup to appear so that the laser can be started (figure 27). Select the 'Laser Started' button to start the test sequence and the normal test startup procedure is to be followed.

Figure 27 – Streak Referee Laser Start Popup

<u>24 x 25 Test</u>

This is a quick test and takes approximately 32 minutes to complete. Because it is a quick test, it will not have the detailed data that a 24x50 test has. Upon completion of this test, if the determined Max 2.5mm^2 thickness is within tolerance of the fail limit (85nm), a 'Warning' popup will appear (figure 28). A recommendation is made that will allow the operator to further examine the heater tube deposit by running a 24x50 test to collect more detailed data, if the operator decides to do so.

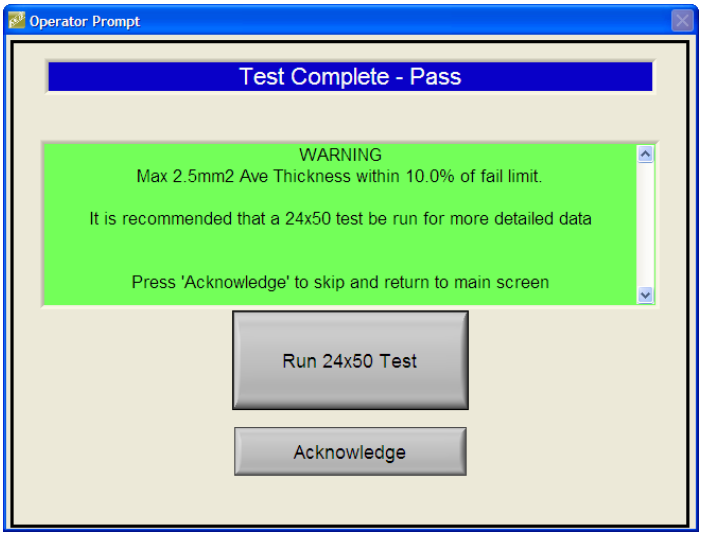

Figure 28 – 24x25 Warning Popup

Selecting the 'Acknowledge' button will skip running the 24x50 detailed test and will navigate the operator back to the 'Main' display. Selecting the 'Run 24x50 Test' button will initiate the more detailed test. The 'Manually turn on laser' popup will appear and the normal test startup procedure is to be followed.

'Test Conditions' Section

This area of the display dictates the test parameters that are defined for the particular test. They are defaulted to values required to run an ASTM D3241 test and are locked when in 'Operator Mode'. With a level 1 'Supervisor Mode' password, they become enterable. Any changes made to these parameters when in 'Supervisor Mode' cannot be saved. Refer to section 3.5.2 for details on the advanced features of 'Supervisor Mode'.

- **ASTM? Indicator** – When green, indicates that the 'Test Condition' parameters are configured for an ASTM test.
- **# Slices** – The number of data slices that will be collected (default 24). A 'Slice' is a collection of data points from the heater tube start position to the heater tube stop position on the same angle. The heater tube will then rotate 15^{o} and another slice is started. 24 slices = 360^{o} rotation on the heater tube.
- **# Data Points** – The number of data points that will be collected per slice (default 50).
- **Tube Stop** – The position on the tube in mm where the last data point for the slice is collected (default 55). Data collection stops on the left (as the tube is positioned in the heater tube holder).
- **Tube Start** – The position on the tube in mm where the first data point for the slice is collected (default 5). Data collection starts on the right (as the tube is positioned in the heater tube holder).
- **Tube Dia** – The diameter of the heater tube in mm (default 3.175).

Miscellaneous Display Features

Data File Prefix – Selection of this field allows alpha numeric characters to be entered that will be added to the front of the data file name (22 characters are allowed). This will be useful in locating specific data files. Entered characters will be added to the data file name in front of the standard date/time naming convention. This is not mandatory.

Supervisor – Selection of this button allows the level 1 Supervisor Mode password to be entered, enabling advanced features on the display (refer to section 3.5.2).

Service – Selection of this button allows the level 2 Service Mode password to be entered, enabling features available only for factory and/or service personnel.

Max 2.5mm^2 Ave Thickness – Value represents the maximum average thickness of the deposit that was found on the heater tube in nm. If this value is > 85 nm, the test result is determined to be a failure.

Test Status - Shows the status of the test. Possible descriptions are: Running, Cancelled, Complete – Pass, Complete – Fail.

Thickness Graph - The graph is a 3D representation of the deposit found on the installed heater tube. The graph can be rotated by selecting it with one's finger, stylus, or mouse pointer (if the supplied keyboard/mouse is connected). The data values displayed will be color coded as follows:

- Green - All data values ≤ 75 nm
- Yellow – Data values > 75 nm and ≤ 85 nm
- Yellow – Data values > 85 nm if the 2.5mm^2 average film thickness is < 85 nm
- Red – 2.5mm^2 average film thickness is ≥ 85 nm

Reset Graph View - Selection of this button will return the graph to its original appearance.

Stop Test – Selection of this button will stop (abort) an active test.

Run Test – Selection of this button will initiate the test sequence once the laser power key is in the 'On' position and the laser start push-button has been pressed.

Active Cell Area – Progress of the active test. The following information is displayed:

- *Slice* – The current slice being recorded.
- *Point* – The current point within the slice being collected.
- *Data Pt* – The current accumulative number of data points that have been collected for the active test.
- *Total Pts* – The total number of data points that will need to be collected for the given test (ASTM D3241 default 1200).

3.5.2 Main Page (Supervisor Mode)

When the level 1 'Supervisor Mode' password has been entered on the 'Main Page', advanced features become enabled (figure 29). Only the advanced feature functionality of the display will be discussed in detail below.

3: Detailed User Interface Features

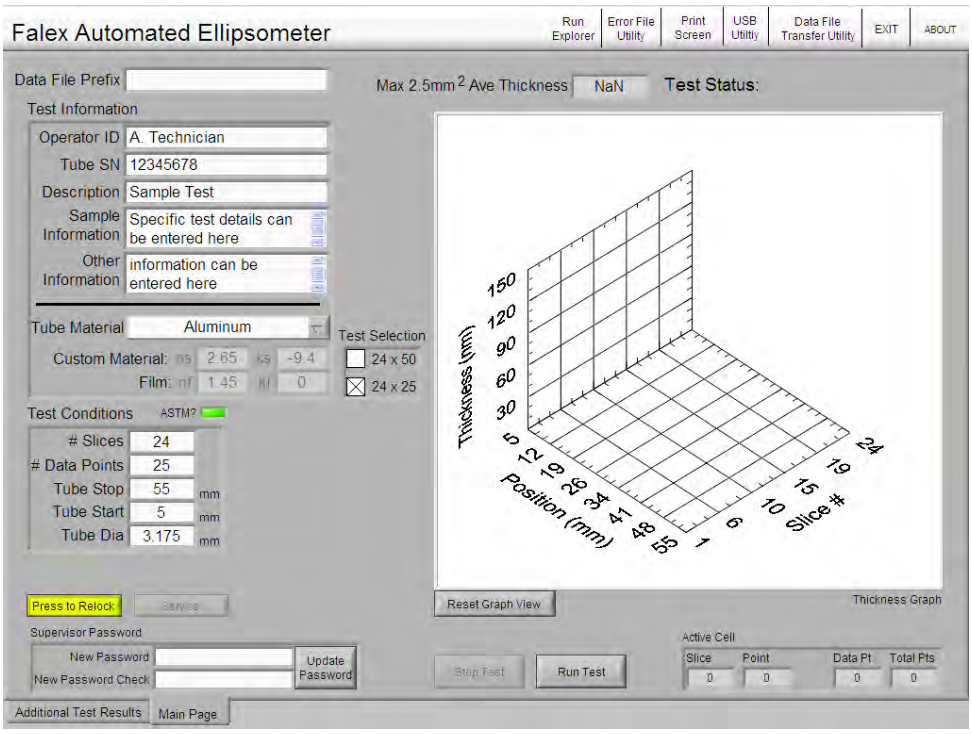

Figure 29 – Main Page (Supervisor Mode)

Tube Material – The following selections are available:

- Aluminum
- Aluminum 635nm
- 316 Stainless Steel
- 304 Stainless Steel
- 440C Stainless Steel
- Custom

Custom Material – Only when a tube material selection of 'Custom' is selected, will the fields be enabled (figure 30). They designate custom optical constants for the given tube material being used. N_x is the refractive index and K_x is the extinction coefficient of the material.

Film – Only when a tube material selection of 'Custom' is selected, will the fields be enabled (figure 30). They designate custom optical constants for the given tube material deposit. N_x is the refractive index and K_x is the extinction coefficient of the film (deposit).

Custom Test – This field becomes enabled when a tube material selection of 'Custom' is selected (figure 30). This allows the operator to save the entered custom test parameter modifications and/or custom material and film optical constants to a desired name for future recall and loading.

3: Detailed User Interface Features

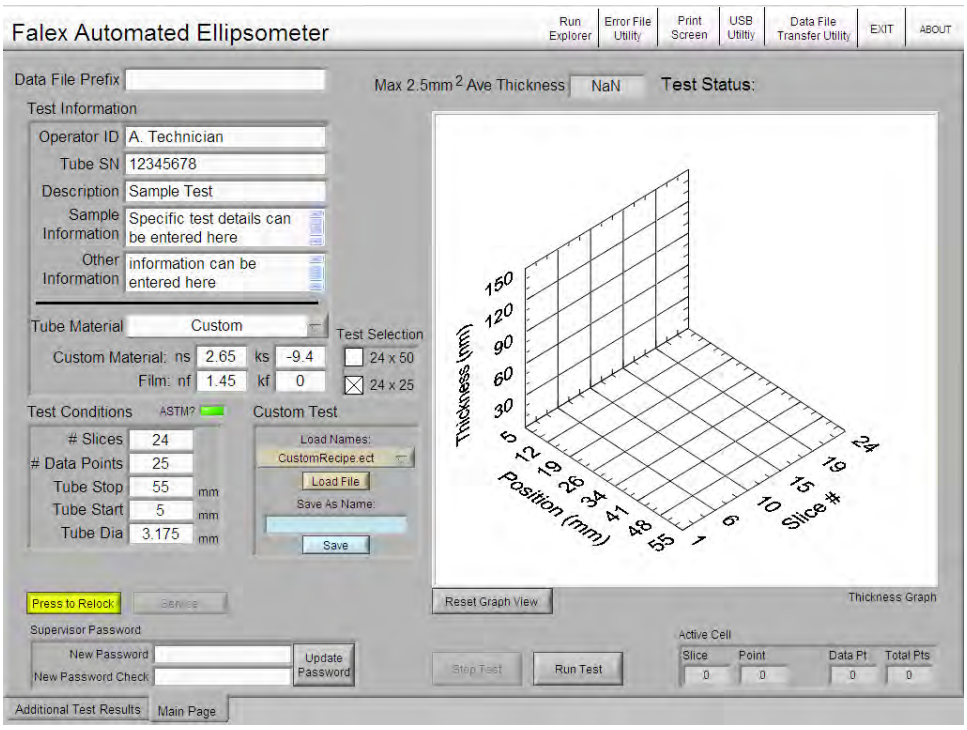

Figure 30 – Custom Tube Material Selection (Supervisor Mode)

Note: To reload standard ASTM D3241 test parameters after a 'Custom' test has been configured and completed, uncheck the selected test in the 'Test Selection' area (select opposite test) or exit out of 'Supervisor' mode .

 # Slices – Enterable range 1 – 24.

 # Data Points – Enterable range 1 – 100.

Tube Stop – Enterable range 10 – 55 mm.

Tube Start – Enterable range 5 – 50 mm.

Supervisor Password – This area allows the supervisor to change the level 1 'Supervisor Mode' password. The Model 430 machine is delivered with the default level 1 password of '123456'. It can be changed by doing the following:

- Select the white box next to 'New Password' and enter the new password.
- Select the white box next to 'New Password Check' and enter the new password again.
- Select the 'Update Password' button to finalize the password change.

Note: There are no restrictions on the length of the password or the format of the password.

Periodically, it should be changed for security purposes (the department supervisor is the intended facilitator of this functionality).

Press to Relock – Selecting this button will return the operator to the 'Operator Mode' functionality.

Note: It is recommended that Supervisor Mode be closed when its functionality is no longer required to prevent unauthorized parameter modifications from taking place.

3.5.3 Additional Test Results (Operator Mode)

When the 'Additional Test Results' tab is selected, the 'Additional Test Results' display appears (figure 31). This display contains additional graphs, numeric data, indicators and calibration information to allow the operator to manage tests. The functionality of the display will be discussed in detail below. Refer to section 3.5.4 for advanced features available on the 'Additional Test Results' display when in 'Supervisor Mode'.

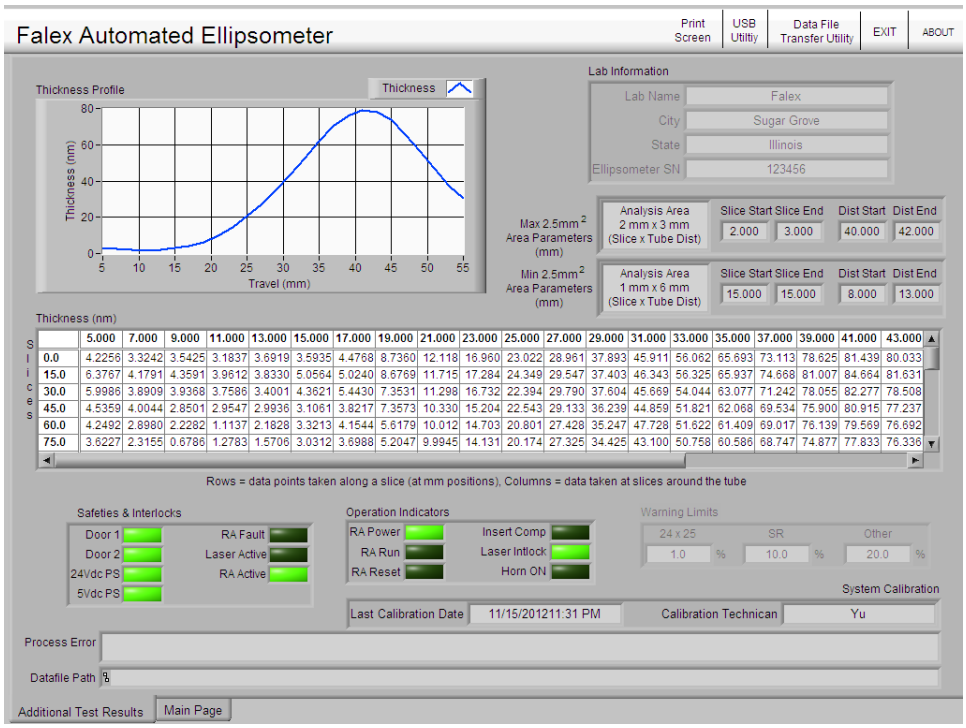

Figure 31 – Additional Test Results Display (Operator Mode)

Thickness Profile – Graph of the real time average heater tube deposit thickness of the circumference of the heater tube, based on the tabular data shown in the 'Thickness (nm)' table.

Thickness (nm) – Real time table of data points collected for each slice at the given angle. Each row is the collection of data points taken along a slice at the given mm positions shown on the top row. Each column is the collection of data taken at slices around the tube at the given angles shown in the 1st column. Use the slider bar at the bottom and at the right of the table to view additional data.

3: Detailed User Interface Features

Note: The thickness data shown during a test are real-time non-normalized data points. These will change to normalized data points at the completion of the test.

Lab Information – Details information associated with the facility where the Ellipsometer is located. It also shows the machine serial number. This information is included in the test data file. These fields are locked when in 'Operator Mode'. With a level 1 'Supervisor Mode' password, they become enterable (except serial number). Refer to section 3.5.4 for details on the advanced features of 'Supervisor Mode'.

Max 2.5mm^2 Area Parameters (mm) – The data represents details associated with the maximum average thickness area of the deposit that was found on the heater tube.

Min 2.5mm^2 Area Parameters (mm) – The data represents details associated with the minimum average thickness area of the deposit that was found on the heater tube.

Safeties & Interlocks – Status indicators of critical safety and interlock features. These indicators can be useful for machine troubleshooting purposes. They will illuminate green when the device is on, active or is in fault. Available indicators are:

- *Door 1* – Access door 'left' limit switch (must be green to run test).
- *Door 2* – Access door 'right' limit switch (must be green to run test).
- *24 Vdc PS* – 24 VDC power supply. This provides power to the majority of system components (must be green to run test).
- *5 Vdc PS* – 5 VDC power supply. This provides power to the data acquisition device (must be green to run test).
- *RA Fault* – Rotary Analyzer (RA) has faulted.
- *Laser Active* – Laser emission is active (must be green to run test).
- *RA Active* – Rotary Analyzer (RA) is active (must be green to run test).

Operational Indicators – Status indicators of key machine components. These indicators can be useful for machine troubleshooting purposes. They will illuminate green when the device is on or enabled. Available indicators are:

- *RA Power* – Rotary Analyzer is powered.
- *RA Run* – Rotary Analyzer is running.
- *RA Reset* – Not used for this model of Ellipsometer.
- *Insert Comp* – Not used for this model of Ellipsometer.
- *Laser Intlock* – Laser interlock is enabled.
- *Horn ON* – Alarm horn is on.

Warning Limits – Warning limits associated with the various test types that will generate a warning popup display to the operator. The warning popup display will appear at the end of the test if the maximum 2.5mm^2 deposit is within the percentage (%) range of the fail limit. The limit designates the percentage (%) below the fail limit (85nm) the maximum 2.5mm^2 deposit must be to trigger the warning popup. For example, if the warning limit is set to 10%, the warning popup will appear if the deposit is ≥ 76.5nm. Depending on the type of test that

was run dictates the warning popup that appears, as additional test recommendations are made.

There are three (3) warning popups that exist:

- 24x25 quick test with '24x50 Test' recommendation (figure 32)
- SR (Streak Referee) with 'Streak Referee' recommendation (figure 33)
- Other (figure 34)

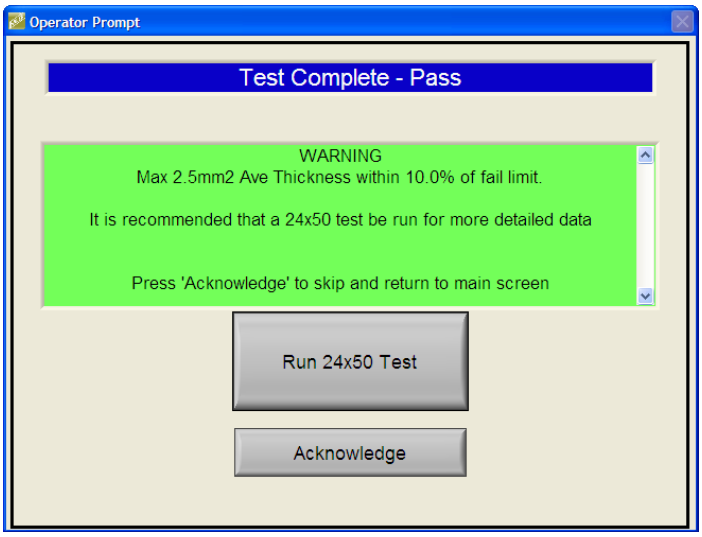

Figure 32 – 24x25 Warning Popup Display

Figure 33 – SR (Streak Referee) Warning Popup Display

3: Detailed User Interface Features

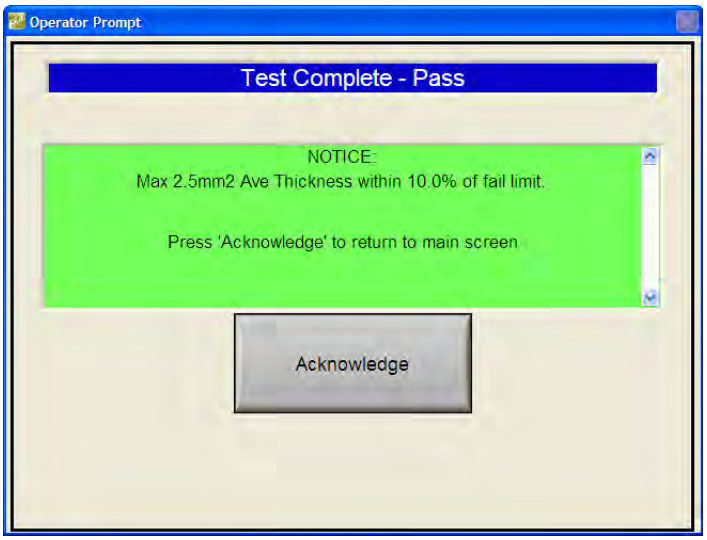

Figure 34 – Other Warning Popup Display

With a level 1 'Supervisor Mode' password, this field becomes enterable. Refer to section 3.5.4 for details on the advanced features of 'Supervisor Mode'.

System Calibration – Displays machine calibration information.

- *Last Calibration Date* – Date and time of last calibration.
- *Calibration Technician* – Technician who performed the last calibration.

Process Error – Displays any alarm that was triggered during the test.

Datafile Path – Displays the path where the test data file is located.

3.5.4 Additional Test Results (Supervisor Mode)

When the level 1 'Supervisor Mode' password has been entered on the 'Main Page' display, advanced features become enabled (figure 35). Only the advanced feature functionality of the display will be discussed in detail below.

3: Detailed User Interface Features

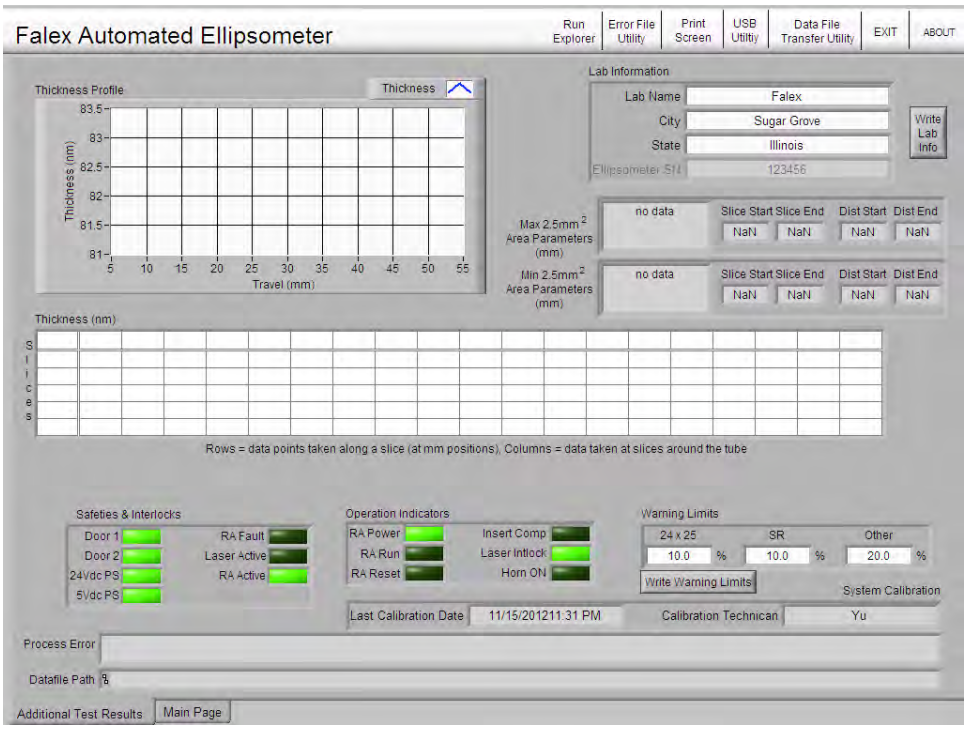

Figure 35 – Additional Test Results Display (Supervisor Mode)

Lab Information – Allows the supervisor to modify the following fields:

- Lab Name
- City
- State

Select the white box to change the contents of the field. Once any of the fields have been changed, the contents will be retained once the 'Write Lab Info' button has been selected.

Warning Level – The adjustable limit shown on the display is an operator selectable limit that allows the supervisor to modify the various 'Warning Limits'. Select the white box to change the limit. Once an adjustable limit is changed, the value will be retained once the 'Write Warning Limits' button has been selected.

3.5.5 Miscellaneous Features

Items discussed below describe various miscellaneous features incorporated into the user interface application. Many of these features are initiated by selections available on the display header.

3.5.5.1 Run Explorer

This feature allows the operator to launch Windows® Explorer to access various Windows® functions (figure 36). Available only with a level 1 'Supervisor Mode' password. This is to

allow for allow the operator the ability to access the Windows® environment with supervisor permission.

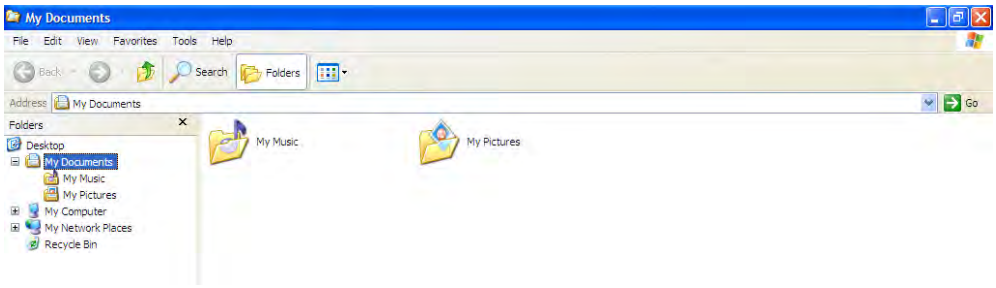

Figure 36 – Run Explorer Display

This feature can be used to access Windows® Control Panel to:

- Change the time/date
- Install printer driver
- Configure network IP address

Access to Windows® Control Panel requires that the supplied keyboard be connected. 'Control Panel' must be entered in the 'Address' line and then hit the 'Enter' key on the keyboard.

Note: Printer driver will need to be installed from a flash drive or a portable CD drive connected to a USB port.

3.5.5.2 Error File Utility

Any time an error occurs, it is written to an error file stored on the user interface. The 'Error File Utility' (figure 37) allows the operator to do the following:

- Open the file to view its contents.
- Move the file to an external device designated in the destination drive field.
- Copy the file to an external device designated in the destination drive field.
- Delete the file.

This utility is a useful tool to assist in troubleshooting the machine, should a problem exist. Once the file is copied to an external device, it can be sent to your Falex service representative for review to help in troubleshooting the problem. It is available only with a level 1 'Supervisor Mode' password.

3: Detailed User Interface Features

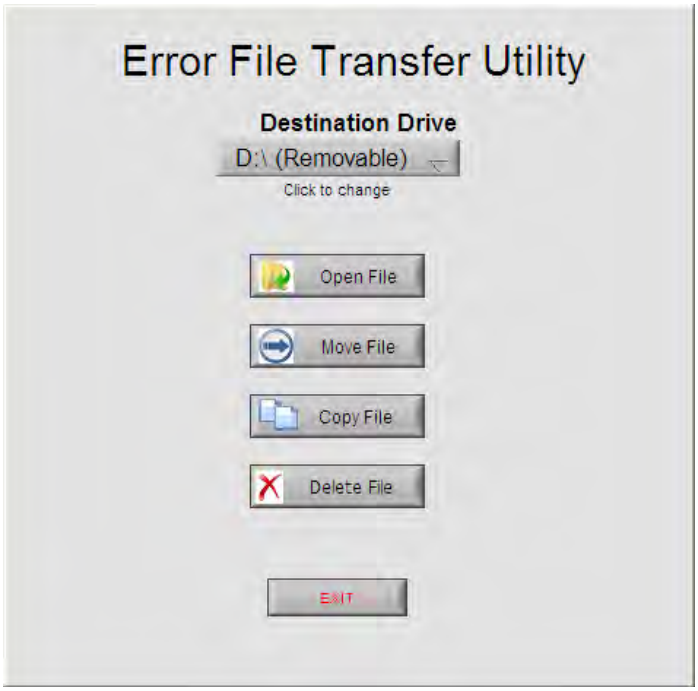

Figure 37 – Run Explorer Display

3.5.5.3 Print Screen

Selecting the 'Print Screen' function allows the operator to print the contents of the display (if a printer is connected and configured).

3.5.5.4 USB Utility

The 'USB Utility' selection (figure 38) allows the operator to safely close USB storage device communications and allow the USB storage device to be safely removed from the user interface. Always eject the flash drive by selecting the USB utility in the header portion of the display.

Note: Do not pull the flash drive out of the USB port without properly closing (ejecting) the flash drive first. Failure to do this could cause user interface lockup and/or corrupt the data stored on the flash drive. Always eject the flash drive by selecting the USB utility at the top of the display.

3: Detailed User Interface Features

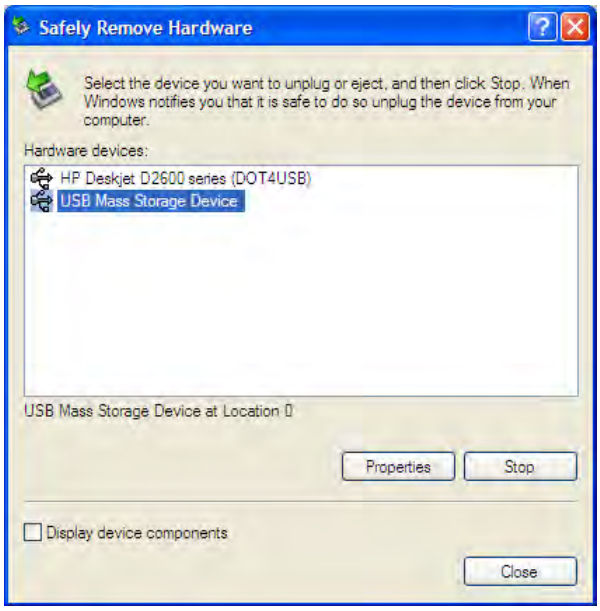

Figure 38 – USB Utility Popup

3.5.5.5 Data File Transfer Utility

The 'Data File Transfer Utility' selection allows the operator to search, move, copy, delete recall or print selected data files (figure 39).

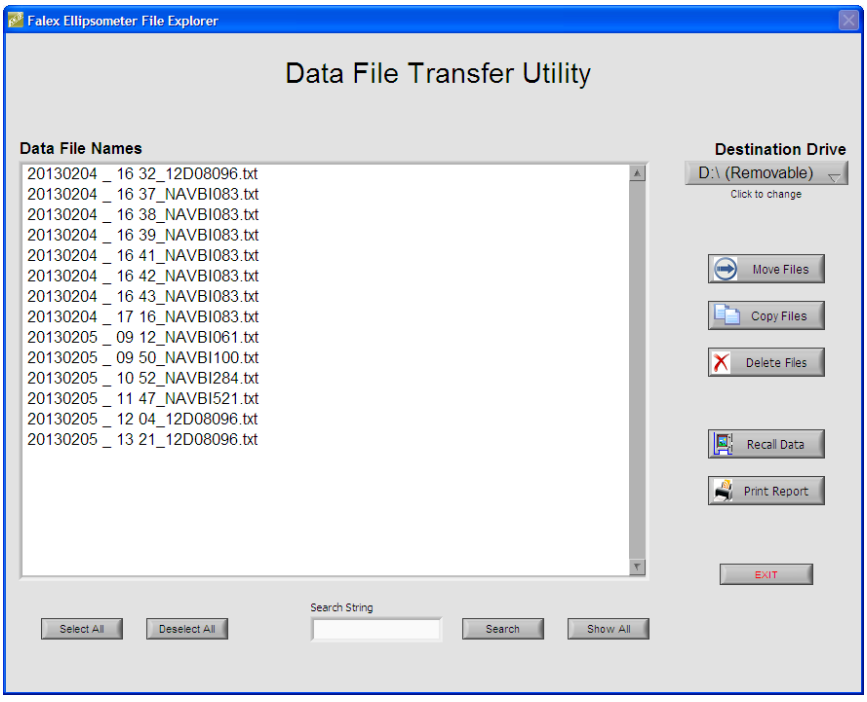

Figure 39 – Data File Transfer Utility Display

A data file can be found by scrolling through the list or by using the 'Search' function. When more data files exist than are shown on the display, selecting the slider bar on the

right side of the display and sliding it down will show the remaining files. The 'Search' function can also be used to find a specific data file. Select the white box under 'Search String', enter what to search for and select the 'Search' button.

The 'Search' function will show only the data files found for the particular entered search criteria. Select the 'Show All' button to display all data files.

Select the data file(s) that are to be transferred or deleted. Once the desired file(s) have been selected, there are a number of options available:

- 'Select All' button will automatically select all data files that are shown.
- 'Deselect All' button will deselect any data files that have been selected.
- 'Move Files' button will move the selected data file(s) to the USB drive designated in the 'Destination Drive' field.
- 'Copy Files' button will copy the selected data file(s) to the USB drive designated in the 'Destination Drive' field.

Note: The correct USB drive letter must be selected before the move/copy button is selected for the function to be successful.

Note: The USB drive can be a flash drive, external hard drive or portable CD burner (if properly configured).

Note: Do not pull the flash drive out of the USB port without properly closing (ejecting) the flash drive first. Failure to do this could cause user interface lockup and/or corrupt the data stored on the flash drive.

- 'Delete Files' button will delete the selected data file(s) from the system freeing up disk space.
- 'Recall Data' will show the test data results for the selected data file on a popup display (figure 40).
- 'Print Report' will print a test report for the selected data file (if a printer is connected and configured). Refer to Addendum 'B' to view a sample report.

The 'Data File Transfer Utility' is disabled during an active test.

Selection of the up/down arrow next to the 'Data Type' field allows the operator to select the type of data that is to be displayed. Selecting the white data field area will also show the available selections. Available selections are:

- Normalized
- Non-normalized
- SR Normalized (only available if data file contains 'Streak Referee' data)
- SR Non-Normalized (only available if data file contains 'Streak Referee' data)

Refer to section 4 (Data Files) for discussion on normalized and non-normalized data.

3: Detailed User Interface Features

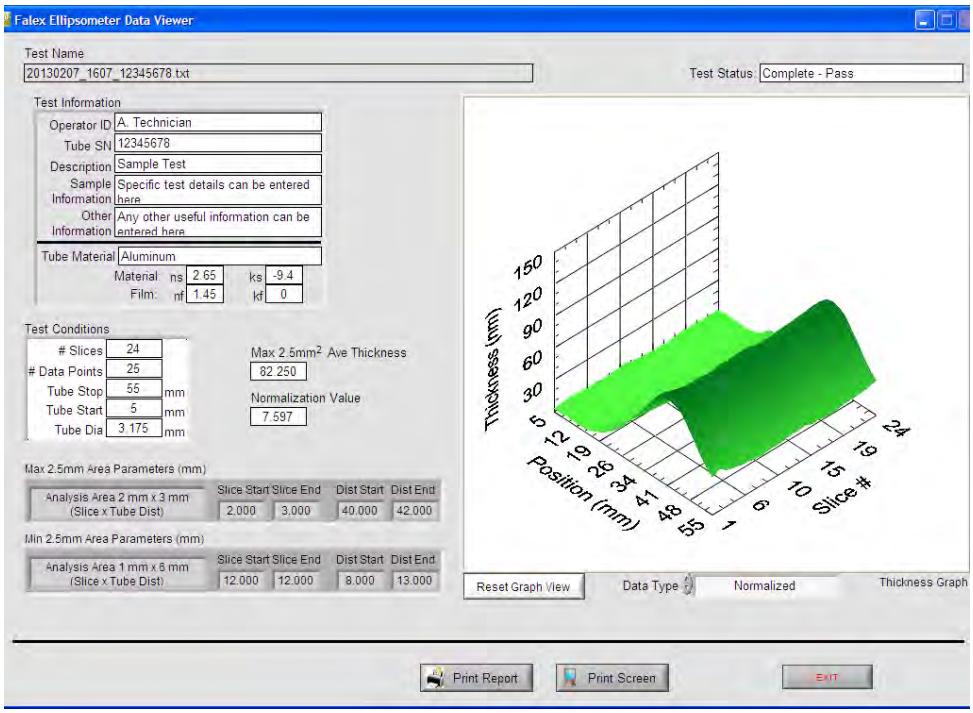

Figure 40 – Recall Data Display

3.5.5.6 Exiting User Interface Application

Selecting the 'EXIT' button on the display header will allow the operator to safely exit the user interface application before the machine is powered down. A confirmation popup will appear requiring a secondary operator verification before the action is executed. This will properly save and close any open files and/or tables before power is removed.

Note: It is recommended that the user interface application be properly shutdown prior to removing the machine from power. Powering down the machine without doing so could cause data loss/file corruption and should only be done in an emergency.

3.5.5.7 About

Selecting the 'ABOUT' button on the display header will open a popup display showing the software revision level (figure 41).

3: Detailed User Interface Features

Figure 41 – Software Version Popup

3.5.5.8 Audible Alarm Acknowledgement

An audible signal will be heard when a test completes, aborts or when in alarm condition. When the alarm horn is active, an 'Acknowledge' button will appear on the associated popup display (figure 42). Selecting the 'Acknowledge' button will acknowledge the condition and silence the alarm horn.

Figure 42 – Acknowledgement Display

4: Data Files

4.1 Data File Overview

Data files are created and stored on the user interface for at the completion of each test. They contain the data that was collected during the test. The file naming format is as follows:

PPPPPP-YYYYMMDD _ HH MM _ XXXXXXXXXX.txt

Where,

PPPPPP = operator entered prefix (22 characters max)
YYYY = year (i.e. 2013)
MM = month
DD = day
HH = hour
MM = minute
XXXXXXXXXX = heater tube serial number entered in test configuration

Data files can be copied from the machine to an external device using the 'Data File Transfer Utility', as discussed in Section 3.5.5.5. The data files are saved in a format that can be opened within a standard spreadsheet or document application, once transferred to an external PC. The data files are saved as a .txt formatted file. Test data can also be viewed on a remote PC using the optional 'Remote Data Viewer' software application (sold separately). This is a utility that can be installed on a remote PC that will allow data files to be viewed in a display similar to what is shown on the Ellipsometer user interface. Refer to Addendum 'D' for further details.

The data file consists of header information and stored data records (data table). The data table is captured and stored based on the configured test parameters (slices and data points) for the duration of the test. The data table is made up of two (2) parts: normalized data and non-normalized data.

Normalized Data

Data normalization takes the minimum 2.5mm^2 area value found and will be used to normalize the rest of the data by subtracting it from every data point. Normalization is applied at the end of the test when all data has been collected. The 3D graph shown at the end of the test has been normalized.

Non-normalized Data

Captured raw data that has not been normalized. The 3D graph is populated during a test with non-normalized data. The completed 'Non-normalized' graph can be viewed using the 'Data Recall' function. Refer to section 3.5.5.5 for details.

The header portion contains information that was entered in the 'Test Information' portion of the display for the particular test, along with other useful information determined during the test. The header portion of the data file consists of:

4: Data Files

- Operator ID
- Tube serial number
- Description
- Sample Information
- Other Information
- Tube Material
- Test Status
- # Slices
- # Data Points
- Tube Distance
- Tube Start
- Tube Diameter
- Ni
- Ns
- Ks
- Nf
- Kf
- DC Offset
- Lab Name
- City
- State
- Ellipsometer Serial Number
- ASTM Mode
- Normalized
- Normalization Value
- Normalization Area Description
- Normalization Slice Start
- Normalization Slice End
- Normalization Position Start
- Normalization Position End
- Total Volume
- Max Ave Thickness
- Max Area Description
- Max Slice Start
- Max Slice End
- Max Position Start
- Max Position End
- P/F Pass Max
- P/F Fail Min

The data table portion of the data file consists of thickness data for each slice and position (as defined in the test configuration). For an ASTM D3241 test, the slices will be from 0 - 360^{o} (increments of 15^{o}) and the position will be from 5 – 55 mm (increments of 1 mm).
Refer to Addendum 'B' for a partial sample of a data file.

5: Maintenance

5.1 Maintenance Overview

Maintenance is to be routinely performed to keep the machine operating at its peak performance and to provide consistent and accurate results. The following is a recommended maintenance schedule:

- Keep laser area free of dust. When machine is not being used, keep laser area access door closed.
- The laser module itself contains no user serviceable parts. Occasionally the optics may need cleaning depending on environmental conditions. When cleaning is required, the use of clean, compressed air is recommended to blow the optics clean. If compressed air fails, clean lens carefully with alcohol and a lint free rag or Q-tip.
- Keep the touchscreen free of dust or debris that could damage the surface.
- Do not let the user interface hard drive fill to capacity with data files. Failure to do so could crash the system. Develop a system where data files are routinely saved to an external source and deleted from the user interface.
- Should test results become suspect (i.e. not repeatable), an optional calibration tube kit can be purchased for verifying test data. This kit contains three (3) heater tubes, each having a coating with a different known thickness. Running tests with these heater tubes will determine if the machine is in need of calibration. To purchase this calibration kit or to schedule a service visit, contact your local Falex representative.

6: Addendum

Addendum A: Parts Listing

PART #	DESCRIPTION
430-200-001	Tube Tensioner Assembly
430-200-002	Ellipsometer Calibration Kit
430-300-001	Remote Data Viewer Software Utility
657-430-022	Collet Wrench
657-430-023	Large Wrench (1 1/8”)
657-430-024	Small Wrench (7/16”)

6: Addendum

Addendum B: Sample Data File / Printed Report

(Partial data file/printed report for a 24x25 test)

Operator	**A. Technician**
Tube SN	**12345678**
Description	**Sample Test**
Sample Information	**Specific test details can be entered here**
Other Information	**Any other useful information can be entered here**
Tube Material	**Aluminum**
Test Status	**Complete - Pass**
# Slices	**24**
# Data Points	**25**
Tube Distance	**55**
Tube Start	**5**
Tube Diameter	**3.175**
ni	**1.00**
ns	**2.65**
ks	**-9.40**
nf	**1.45**
kf	**0.00**
DC Offset	**0.0025**
Lab Name	**Falex**
City	**Sugar Grove**
State	**Illinois**
Ellipsometer SN	**1234567**
ASTM Mode	**Yes**
Normalized	**Yes**
Normalization Value	**7.597**
Norm Area Description	**Analysis Area 1 mm x 6 mm (Slice x Tube Dist)**
Norm Slice Start	**12**
Norm Slice End	**12**
Norm Position Start	**8**
Norm Position End	**13**
Total Volume (cm^3)	**1.659068E-17**
Max Ave Thickness	**82.250**
Max Area Description	**Analysis Area 2 mm x 3 mm (Slice x Tube Dist)**
Max SliceStart	**2**
Max Slice End	**3**
Max Position Start	**40**
Max Position End	**42**
P/F Pass Max	**75.000**
P/F Fail Min	**85.000**

Normalized Data

Slice °/Position
5.000 mm 7.000 mm 9.000 mm 11.000 mm 13.000 mm 15.000 mm 17.000 mm 19.000 mm 21.000 mm 23.000 mm 25.000 mm 27.000 mm 29.000 mm 31.000 mm 33.000 mm 35.000 mm 37.000 mm 39.000 mm 41.000 mm 43.000 mm 45.000 mm 47.000 mm 49.000 mm 51.000 mm 53.000 mm 55.000 mm

0.0 Deg 2.961462 2.365946 3.194730 2.644242 2.250593 2.652450 4.791926 7.679175 11.284490 15.914560 22.127883 28.545049 37.803877 46.234339 55.722443 66.264398 72.860618 78.764970 81.020869 79.663743 76.194899 68.300236 58.800398 49.020946 40.873640 34.907388

15.0 Deg 3.437524 2.432572 2.898258 2.739469 3.526825 2.761727 4.046020 8.280937 11.953101 17.233286 24.025840 30.680281 38.840703 48.847884 58.717753 67.687400 75.760745 80.774460 82.810754 80.326141 76.974600 68.481587 59.834048 50.288792 40.536785 38.739512

30.0 Deg 4.535111 3.441146 2.692276 2.536774 2.714616 3.532143 4.630055 7.648376 11.027144 16.460225 23.265199 29.194809 36.415889 45.172547 54.182671 63.941745 72.765433 78.930928 83.783442 80.587320 76.704504 67.934732 57.636460 49.324558 38.836020 33.608039

45.0 Deg 4.392046 2.937741 2.736856 2.989994 3.293207 5.735753 4.577152 6.933472 11.189738 15.636322 22.115001 29.262428 37.207655 44.216346 52.833740 62.790940 70.760174 76.885269 81.600778 77.459972 72.440170 64.705707 55.619182 46.534050 37.404923 31.726979

6: Addendum

60.0 Deg 3.902494 2.709415 2.177412 2.032431 2.277199 2.836343 3.807443 6.120895 9.480396 14.452644 21.878319 27.903179 35.362061 43.887609 51.071083 61.885356 69.254262 75.510264 80.927369 76.053847 71.139414 63.132102 54.414829 44.615199 36.008724 30.120541

75.0 Deg 3.004670 2.603397 1.211494 0.638821 1.699740 2.120945 3.073676 4.647707 8.743478 13.618274 20.104329 26.825870 34.196546 43.548901 50.593717 59.945605 68.650194 73.838336 79.093507 76.097485 72.071597 63.693798 53.536461 43.644073 34.926142 29.164700

90.0 Deg 3.370326 2.365868 1.171611 1.083330 1.580623 2.939234 3.450196 4.879227 8.726382 12.674380 19.574735 26.255018 34.007476 42.118713 50.194486 59.570014 69.261861 74.949454 77.545427 75.469085 70.796055 63.900759 53.656008 44.301946 35.352688 27.980908

105.0 Deg .....
120.0 Deg .....
135.0 Deg .....
150.0 Deg .....
165.0 Deg .....
180.0 Deg .....
195.0 Deg .....
210.0 Deg .....
225.0 Deg .....
240.0 Deg .....
255.0 Deg .....
270.0 Deg .....
285.0 Deg .....
300.0 Deg .....
315.0 Deg .....
330.0 Deg .....
345.0 Deg .....
360.0 Deg .....

Non-Normalized Data

Slice °/Position
5.000 mm 7.000 mm 9.000 mm 11.000 mm 13.000 mm 15.000 mm 17.000 mm 19.000 mm 21.000 mm 23.000 mm 25.000 mm 27.000 mm 29.000 mm 31.000 mm 33.000 mm 35.000 mm 37.000 mm 39.000 mm 41.000 mm 43.000 mm 45.000 mm 47.000 mm 49.000 mm 51.000 mm 53.000 mm 55.000 mm

0.0 Deg 10.558961 9.963444 10.792228 10.241741 9.848091 10.249949 12.389424 15.276674 18.881988 23.512059 29.725381 36.142548 45.401375 53.831837 63.319941 73.861897 80.458117 86.362469 88.618367 87.261241 83.792398 75.897734 66.397897 56.618444 48.471138 42.504886

15.0 Deg 11.035023 10.030071 10.495757 10.336968 11.124324 10.359226 11.643518 15.878436 19.550599 24.830784 31.623338 38.277779 46.438201 56.445383 66.315251 75.284898 83.358243 88.371958 90.408253 87.923639 84.572099 76.079086 67.431546 57.886291 48.134284 46.337011

30.0 Deg 12.132610 11.038644 10.289775 10.134273 10.312114 11.129642 12.227553 15.245874 18.624643 24.057724 30.862697 36.792308 44.013388 52.770046 61.780169 71.539243 80.362931 86.528426 91.380940 88.184819 84.302002 75.532231 65.233959 56.922057 46.433519 41.205538

45.0 Deg 11.989544 10.535240 10.334354 10.587493 10.890705 13.333252 12.174650 14.530971 18.787237 23.233821 29.712500 36.859926 44.805153 51.813844 60.431238 70.388439 78.357672 84.482768 89.198276 85.057471 80.037669 72.303205 63.216680 54.131548 45.002422 39.324477

60.0 Deg 11.499992 10.306914 9.774910 9.629929 9.874697 10.433841 11.404942 13.718394 17.077895 22.050142 29.475817 35.500678 42.959560 51.485108 58.668582 69.482854 76.851761 83.107762 88.524868 83.651345 78.736913 70.729601 62.012328 52.212698 43.606223 37.718040

75.0 Deg 10.602169 10.200895 8.808993 8.236320 9.297238 9.718444 10.671175 12.245206 16.340976 21.215772 27.701827 34.423369 41.794044 51.146399 58.191216 67.543104 76.247692 81.435834 86.691006 83.694983 79.669095 71.291296 61.133959 51.241572 42.523641 36.762198

90.0 Deg 10.967825 9.963367 8.769109 8.680829 9.178121 10.536732 11.047695 12.476725 16.323880 20.271879 27.172233 33.852517 41.604974 49.716211 57.791984 67.167513 76.859359 82.546953 85.142925 83.066584 78.393553 71.498257 61.253507 51.899444 42.950187 35.578407

105.0 Deg .....
120.0 Deg .....
135.0 Deg .....
150.0 Deg .....
165.0 Deg .....
180.0 Deg .....
195.0 Deg .....

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210.0 Deg .....
225.0 Deg .....
240.0 Deg .....
255.0 Deg .....
270.0 Deg .....
285.0 Deg .....
300.0 Deg .....
315.0 Deg .....
330.0 Deg .....
345.0 Deg .....
360.0 Deg .....

6: Addendum

Addendum C: Heater Tube Tensioner Operation

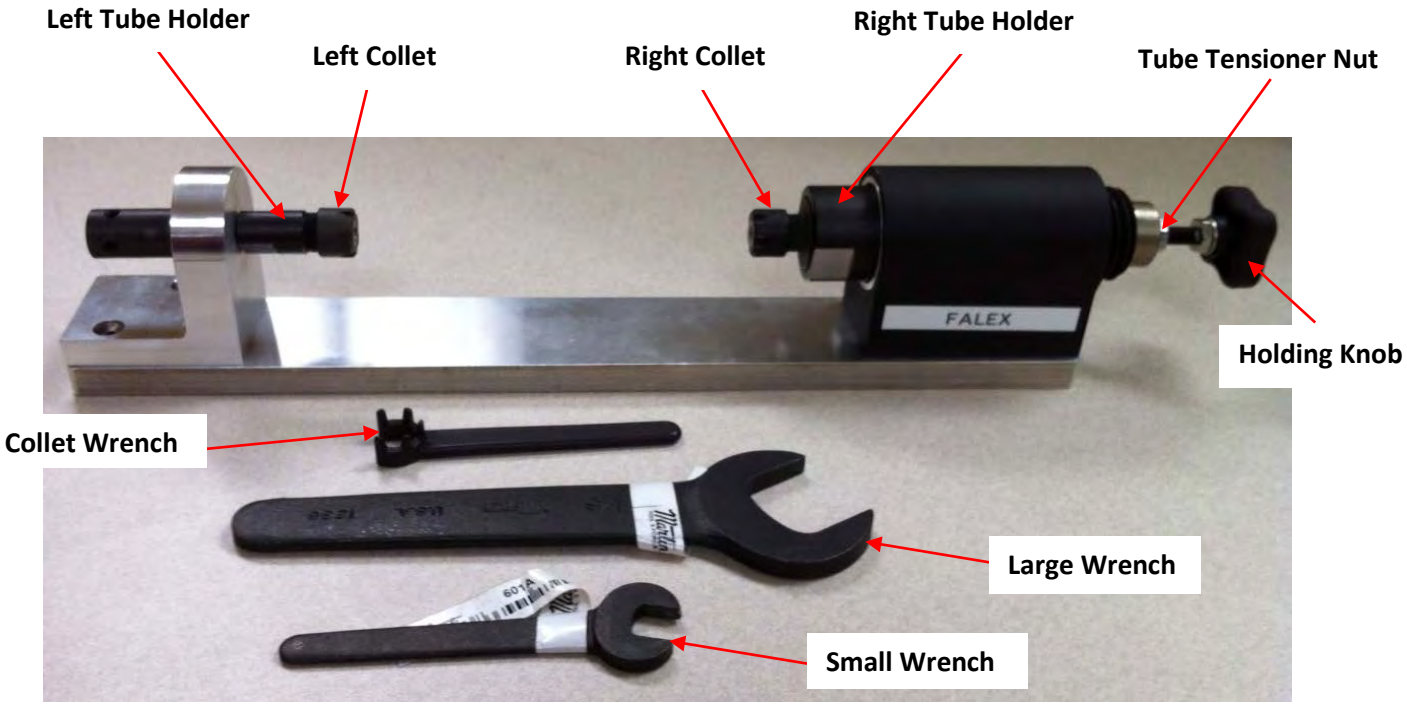

Figure C1 – Tube Tensioner assembly

The following are the steps for to straightening an Aluminum heater tube using the Ellipsometer (model 430) heater tube tensioner system:

Note: Handle the heater tube by the ends only. Do not touch the center section of the heater tube where the deposit is located. Doing so will contaminate the deposit.

1. Familiarize yourself with the Tube Tensioner assembly and associated tools (figure C1).
2. Remove both collets from the Tube Tensioner assembly.
3. Place collets on the heater tube (figure C2).

Figure C2 – Collets on heater tube

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4. Holding the heater tube by the end, carefully insert the heater tube with the serial number on the left into the left tube holder assembly. Push the tube far enough so that it can be inserted into the right tube holder assembly.
5. Hand tighten the left collet assembly.
6. Pull tube holder on right out so that it engages the heater tube. The tube holder flat (figure C3) should be completely visible. This will make sure that the tube holder has enough area to grab and hold the heater tube.

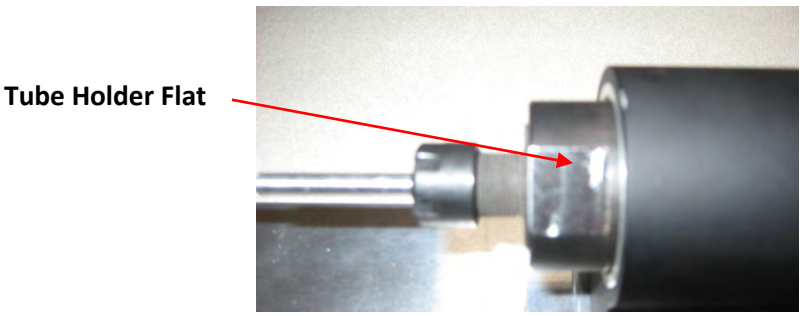

Figure C3 – Tube holder flat

7. Insert the heater tube into the right holder assembly.
8. Hand tighten the right collet assembly.
9. The heater tube should know be positioned correctly (figure C4).

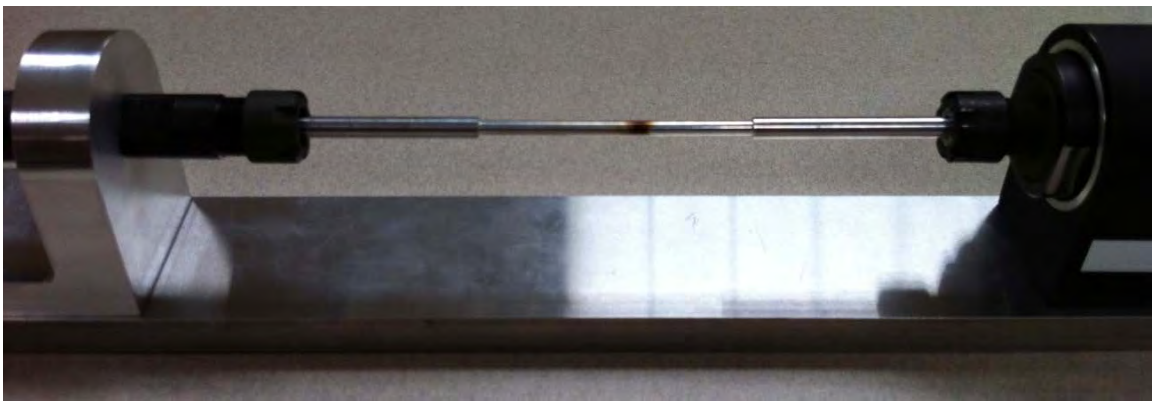

Figure C4 – Heater tube positioning

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10. Using the small wrench in conjunction with the collet wrench, tighten the left collet until snug (figure C5). Do not over-tighten.

Figure C5 – Tightening left collet

11. Using the large wrench in conjuction with the collet wrench, tighten the right collet until snug (figure C6). Do not over-tighten.

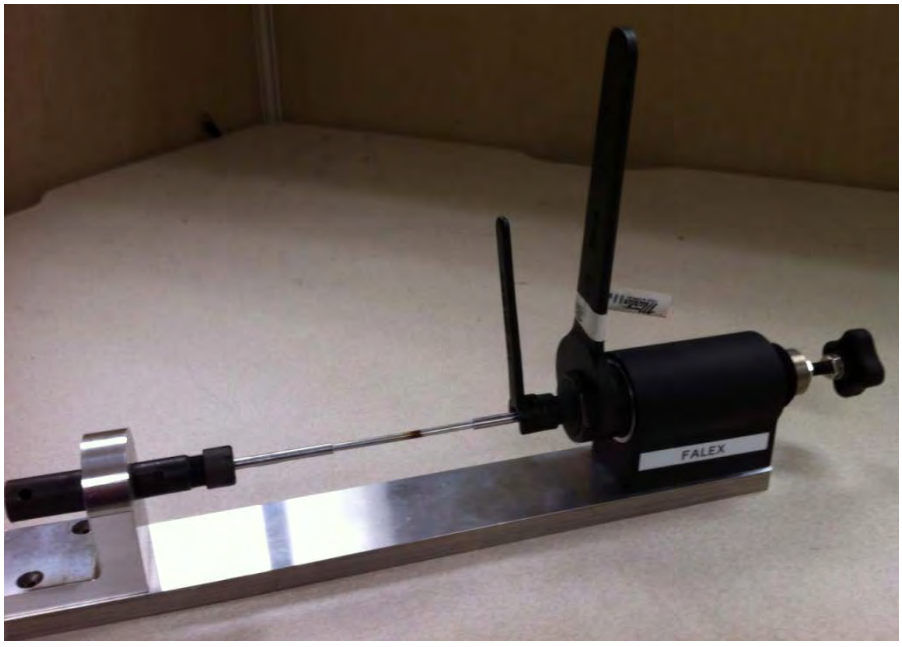

Figure C6 – Tightening right collet

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12. Using the small wrench and holding the holding knob, slowly turn the tube tensioner nut until you feel resistance (figure C7). This action will pull the tube to straighten it. This action is so slight, you will not see it.

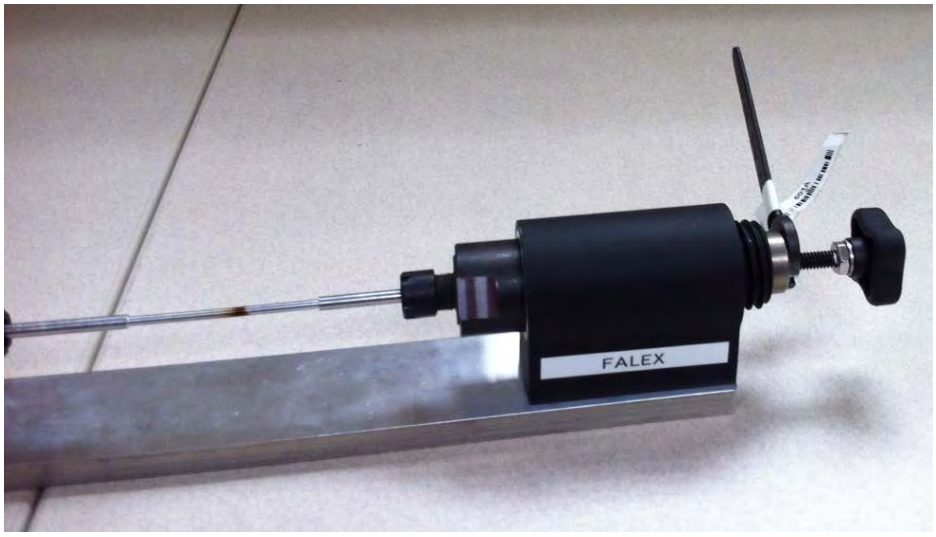

Figure C7 – Tightening right collet

13. After 10 – 20 seconds of tension, release the tension. Remove the heater tube from the tube tensioner assembly.
14. Check the heater tube for straightness. If still slightly bent, repeat the process.

Ordering Information:

Falex P/N	**Description**
430-200-001	Tube Tensioner Assembly
657-430-022	Collet Wrench
657-430-023	Large Wrench
657-430-024	Small Wrench

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Addendum D: Remote Data Viewer Operation

The 'Remote Data Viewer' software utility is an optional application that is to be installed on a remote PC that allows recall and viewing of copied data files. Contact your local Falex representative for purchasing this application (part # 430-300-001).

Install the application on the remote PC. Follow default installation directions by selecting 'Next', 'Ok', 'Finish' and 'I Accept' when asked.

Make sure that the PC has access to the Ellipsometer data files that are to be recalled (either via a flash drive inserted into the PC or by files directly copied onto the PC's hard drive).

Select the 'Falex Ellipsometer Data Viewer' icon from the computer desktop to start the utility (figure D1) to start the application.

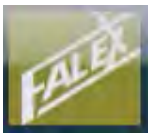

Figure D1 – Falex Ellipsometer Data Viewer Icon

A popup display will appear asking that the operator navigate to and select the data file that is to be viewed.

Once the data file has been selected, it will be shown on a display similar to what is shown on the Ellipsometer's user interface (figure D2).

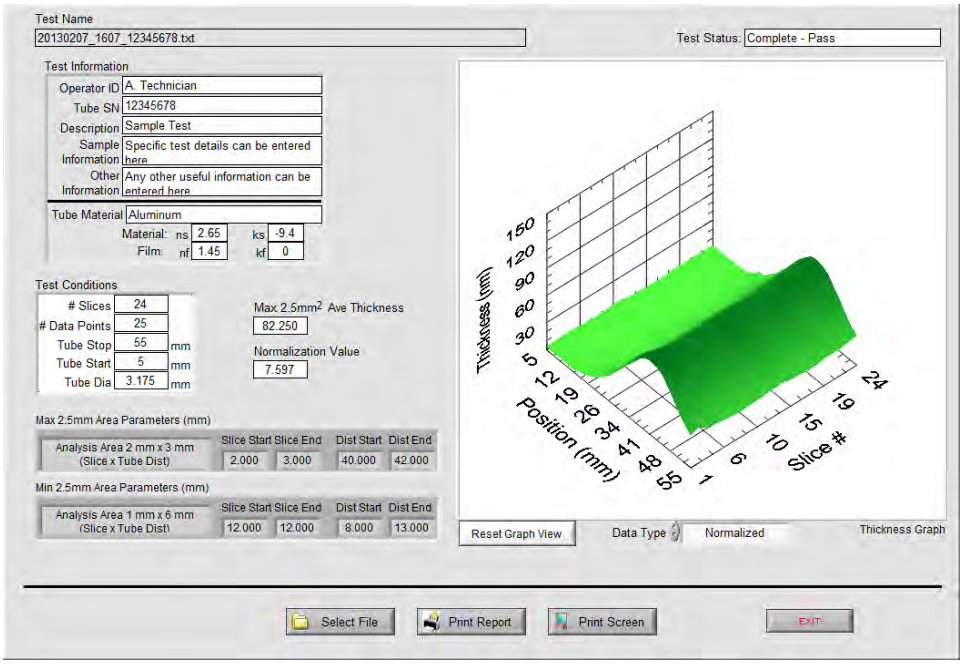

Figure D2 – Remote PC Data Viewer Utility

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From the display, the following can be done:

Thickness Graph - The graph is a 3D representation of the deposit found on the installed heater tube. The graph can be rotated using a mouse. The data values displayed will be color coded as follows:

- Green - All data values ≤ 75 nm
- Yellow – Data values > 75 nm and ≤ 85 nm
- Yellow – Data values > 85 nm if the 2.5mm^2 average film thickness is < 85 nm
- Red – 2.5mm^2 average film thickness is ≥ 85 nm

Reset Graph View - Selection of this button will return the graph to its original appearance.

Data Type – Selection of the up/down arrow on the left side of the field allows the operator to select the type of data that is to be displayed. Selecting the white data field area will also show the available selections. Available selections are:

- Normalized
- Non-normalized
- SR Normalized (only available if data file contains 'Streak Referee' data)
- SR Non-Normalized (only available if data file contains 'Streak Referee' data)

Refer to section 4 (Data Files) for discussion on normalized and non-normalized data.

Select File – Selection of this button allows the operator to select another data file to view.

Print Report – Selection of this button allows the operator to print a report (if a printer is connected and configured).

Print Screen – Selection of this button allows the operator to print the display (if a printer is connected and configured).

Exit – Selection of this button will close out of and exit the application.