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Gaertner (LSE Stokes) Ellipsometer - Standard Operating Procedure

Badger Name:	K1 Ellipsometer LSE Gaertner	**Revision Number:**	1
Model:	LSE-USB	**Revisionist**:	Wanjohi Kimani
Location:	Bay 1 - Keller	**Date:**	March 30, 2020

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1 Scope

1.1 This document provides detailed instructions on how to properly operate the Gaertner (LSE stokes) ellipsometer.

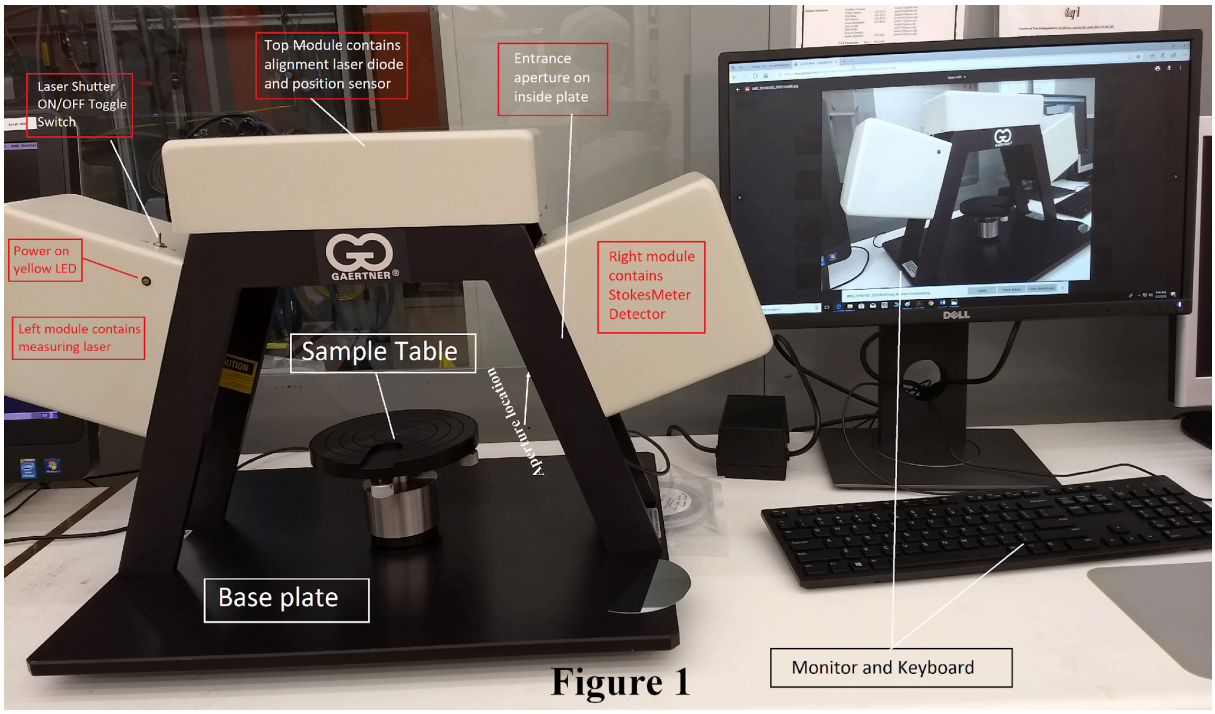


Figure 1

2 Tool Description

2.1 Ellipsometry is a non-destructive method of measuring the index of refraction and film thickness of a dielectric film on a reflecting substrate. It is a highly accurate and repeatable measurement. Ellipsometry involves illuminating the surface of a sample with monochromatic light having a known and controllable state of polarization and analyzing the polarization state of the reflected light.

2.1.1 This ellipsometer uses no moving parts (apart from the sample table) and no modulators. It quickly and accurately determines the complete polarization state of the 632.8 nm HeNe laser measuring beam at 70 º incidence angle

2.1.2 Stage can accommodate samples up to 300 mm wide

2.1.3 Sample table includes a manual tilt and table height adjustment, which is set using an alignment screen on the computer

2.1.4 GEMP Windows Software is used to measure film thickness and refractive index on a substrate or on 1, 2 or 3 known bottom layers. Films can be transparent or absorbing.

2.1.5 Two low power lasers (< 5 mW) for sample measurement (632.8nm) and alignment (670nm)

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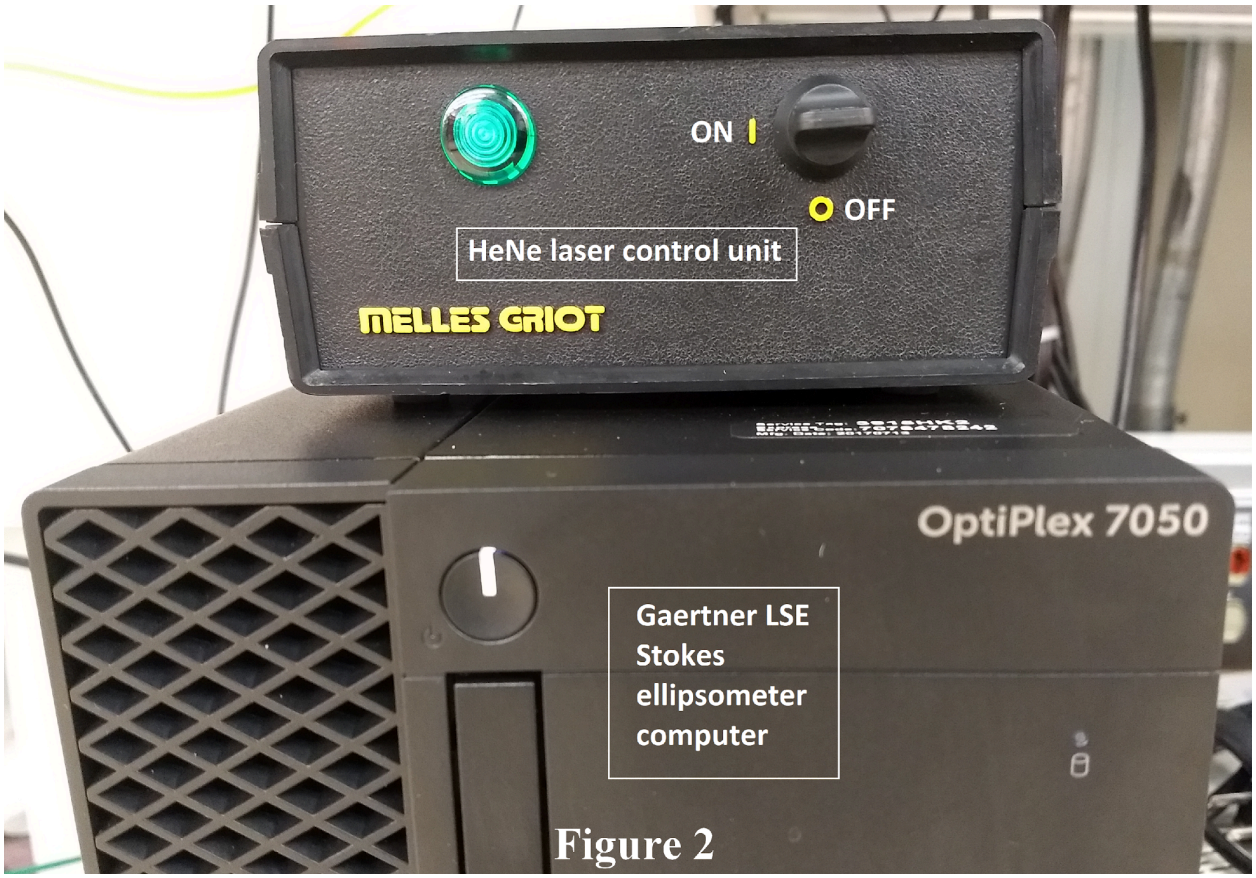


Figure 2

3 **Safety**

3.1 Avoid staring directly into the laser beam or its reflection from highly reflecting surfaces.

4 **Restrictions/Requirements**

4.1 Must be a qualified user

5 Required Facilities

5.1 115 – 120 V Electrical power

6 Definitions

7 Setup

7.1 Enable the “ellipsometer-g” in badger

7.2 Login to the ellipsometer computer using your login credentials.

7.3 Ensure that the power on the HeNe laser control unit (HCU - see Fig 2 above) is set to on. HCU unit is below the table on top the PC tower

7.4 Ensure the laser shutter ON/OFF toggle switch is set to ON (LED on left module should be yellow – see Fig 1)

7.5 Run the GEMP measurement program. Enter the measurement and calculation window by clicking on the GEMP program toolbar (see Fig 3).

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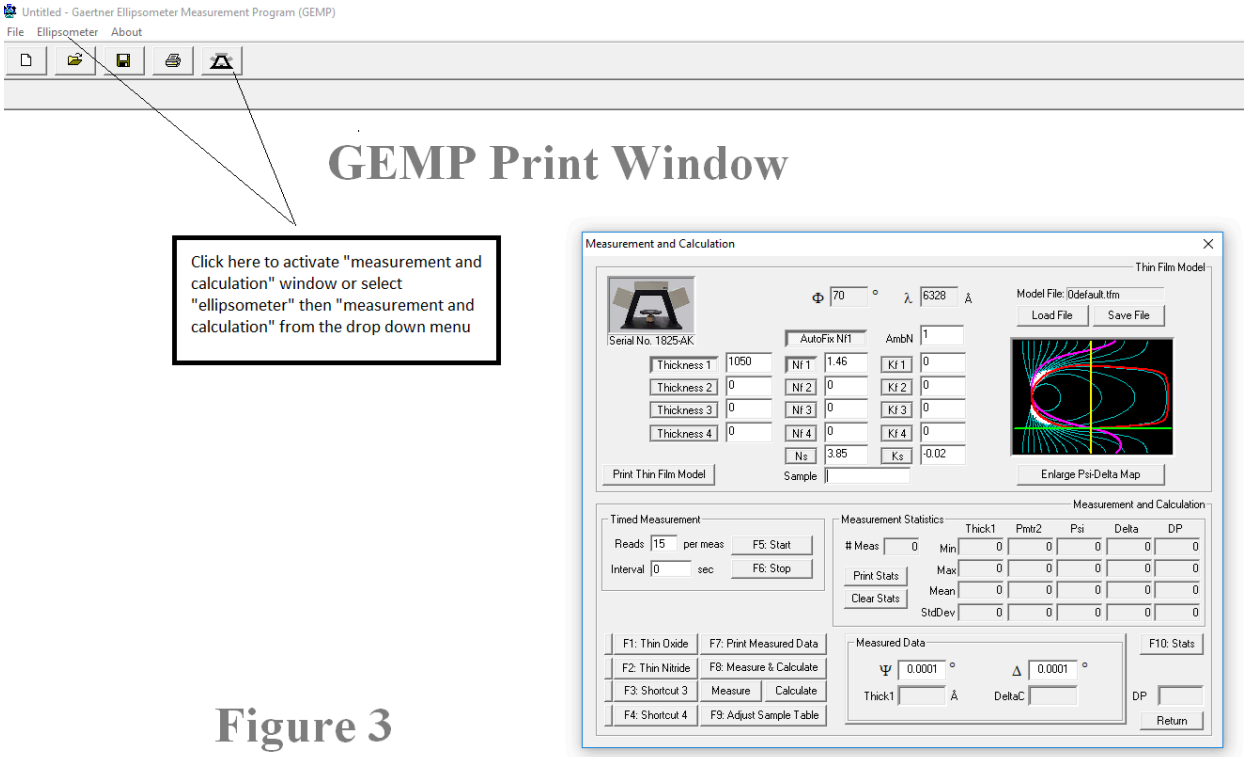


Figure 3

8 **Operating Instructions**

8.1 Place the sample in the middle of the stage with tweezers. Table rings can be used as a positioning reference. Laser beam will be easily observable before sample placement.

8.2 Click on “adjust sample table” tool bar or tap F9.

8.3 **Adjust the tilt first**: work the sample table-tilt knobs until the target cross is centered on the screen (see Fig 5).

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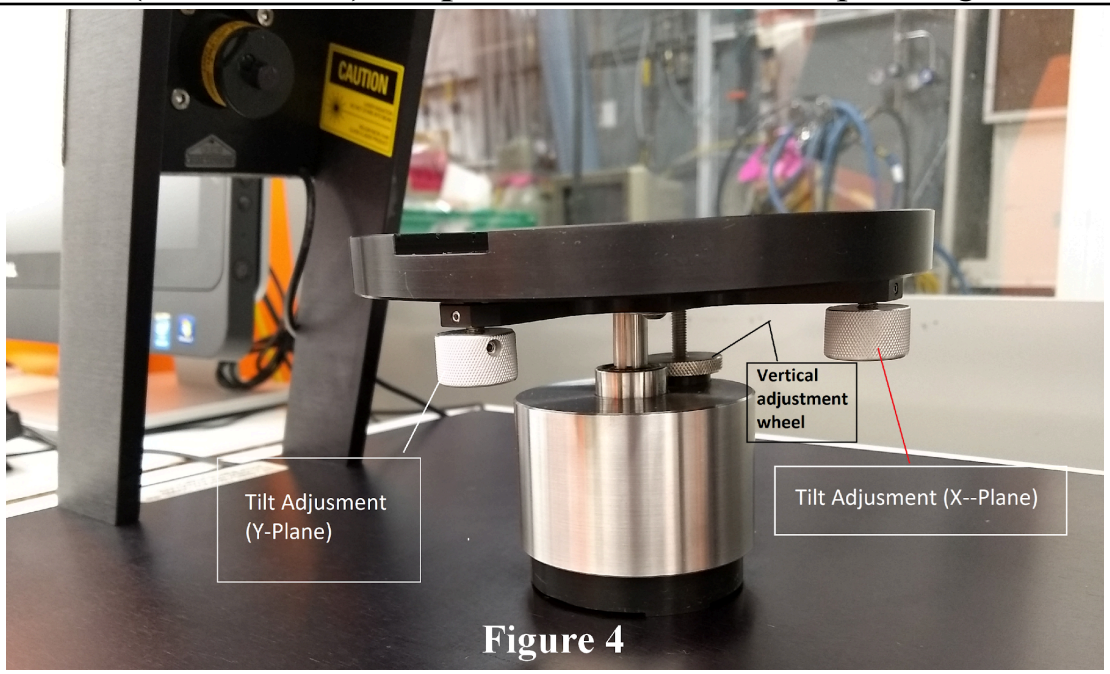
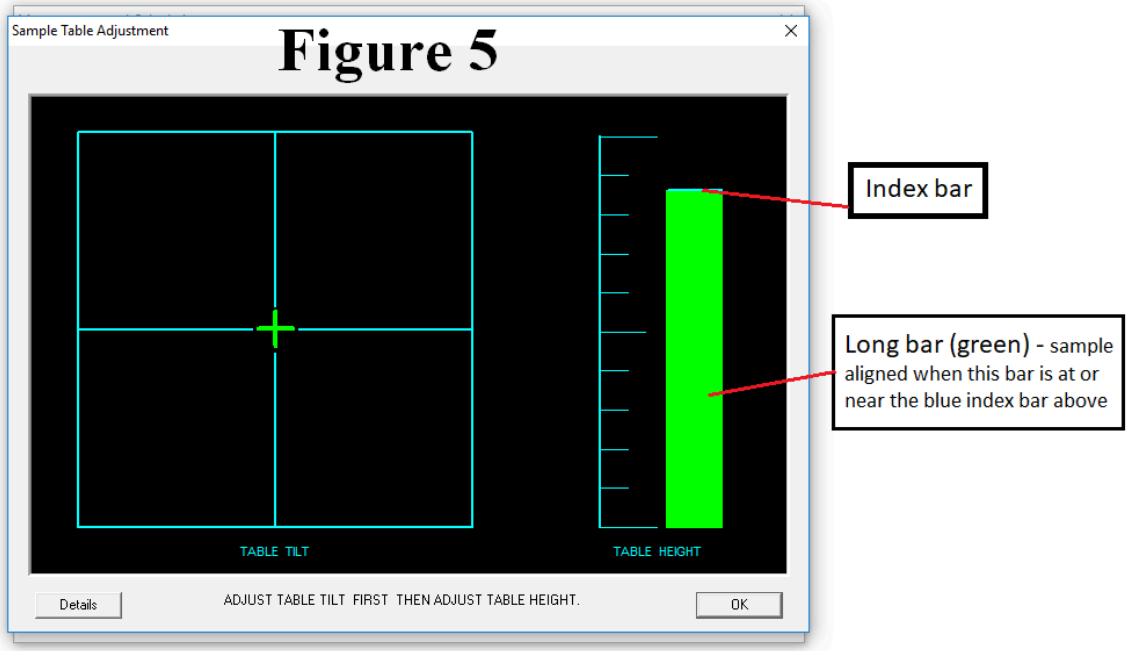


Figure 4

8.4 Second, adjust the height by using the sample table vertical adjustment wheel to obtain maximum power to the detector. This occurs when the longer green bar reaches and is even with the shorter (light blue) index bar.

8.5 The shorter index bar indicates the maximum power has been obtained; the longer bar indicates the actual power that is currently entering the aperture.

Figure 5

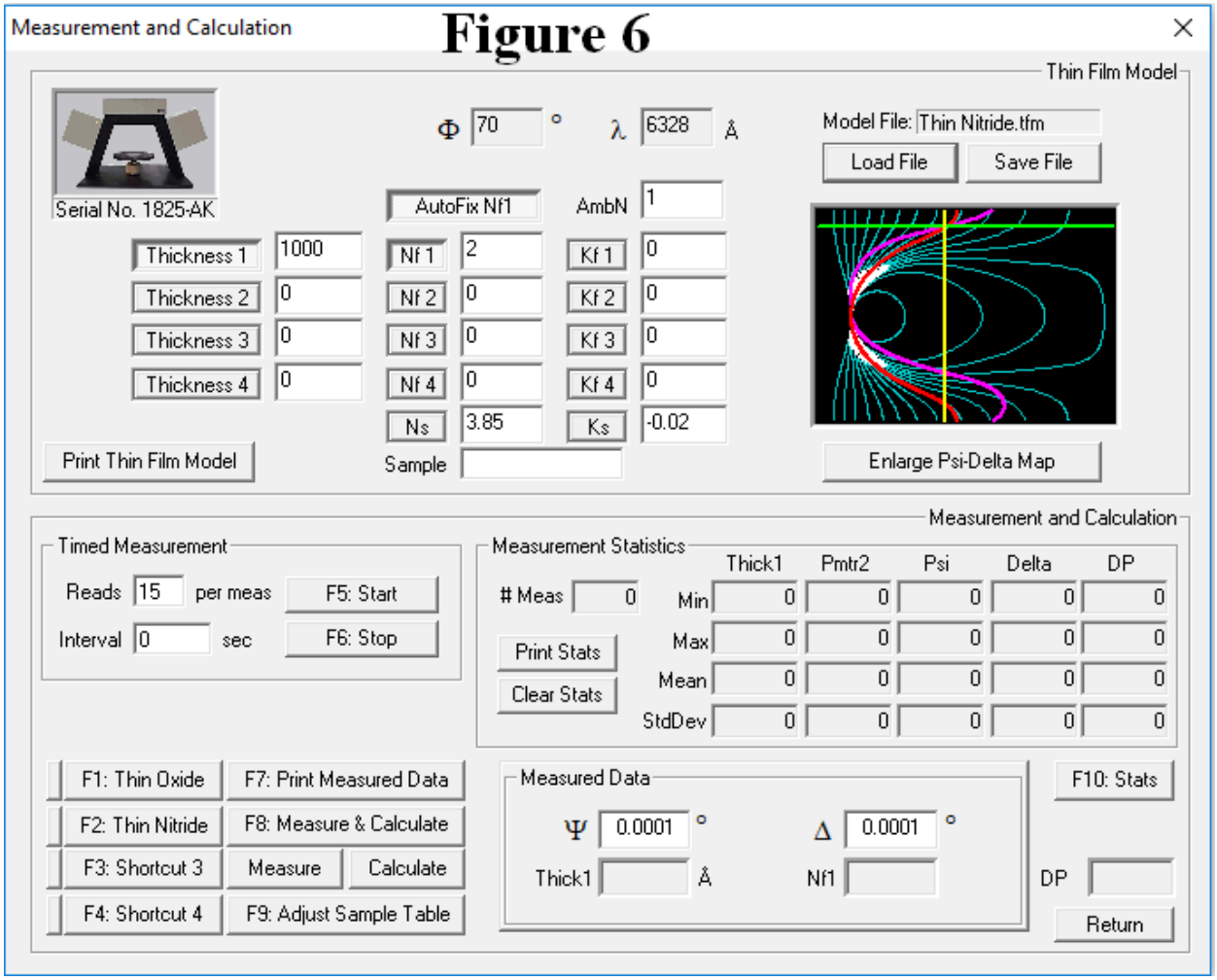


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8.6 Click OK to return to the GEMP measurement and calculation window

Figure 6: Operating controls and indicators



8.7 Select **'Load File'** button in the measurement and calculation window. Choose an appropriate recipe. If no recipe can be found for the film type you are working on, choose a similar recipe. Any of the recipes can be modified to suit your film and saved as a new model. You can also just enter expected values for Thickness, Nf and Kf.

8.8 **Important:** Click to depress the button to the left of the Thickness, NF or Kf box to measure that parameter. Unclick to fix that parameter.

8.9 Select the **'Measure and Calculate'** button or **F8**. You can also only press **"Measure"** (measures the sample Psi & Delta and displays them) or **"Calculate"** (calculates two solutions with current parameter settings using the displayed or entered Psi & Delta).

8.10 Your results will be presented on the lower right corner of the window for the

parameters you selected.

9 Additional tips

9.1 Depress the "Print Measured Data" button or press F7 to print Psi & Delta and the two solutions (if there are calculated solutions) into the GEMP print area window (see Fig 3)

9.2 Print Listing button: Prints the list of 10 film thicknesses that correspond to the measured Psi & Delta values. The user must determine through other means the correct film thickness from this list of possible film thicknesses.

10 Selected Calculation modes or combinations

10.1 Although the GEMP software permits up to 4 layers with 14 individual values to be entered into the setup fields for modeling the sample, only the 1 or 2 top unknown values can be calculated, since only 2 values (Psi and Del) are returned from the measurement.

10.2 For most users, the unknown will likely be top film thickness and film refractive index, Nf1, with all the other bottom values entered as known or as zeroes.

10.2.1 **Thickness1** *(where only Thickness1 tab is depressed)*: This mode always uses the entered value of Nf1 to calculate top film thickness. The software also calculates either the Psi or Del and compares it to the measured Psi or Del. Close agreement between the measured and calculated Psi/Del indicates correctness of the Nf1 value. This mode will give the best repeatability in thickness, and if the index value is correct, this mode gives the best and most stable film thickness measurement. This mode can be used to measure very thin films, down to 1Å.

10.2.2 **Thickness1 and Nf1** *(where both Thickness1& Nf1 tabs are depressed)*: Will always return a measured film Nf1 no matter how unstable and incorrect. Therefore the thickness values that rely on the unstable Nf1 will also be incorrect. This measurement mode is used to find an approximate value of Nf1 and thickness.

10.2.3 **Thickness1, Nf1 & Autofix Nf1** *(where Thickness1, Nf1 & Autofix Nf1 tabs are depressed)*: Calculates top film thickness1 and automatically measures the film refractive index Nf1 if it is in a good measurement range. If the index value is weak and unstable, then it automatically defaults to the entered value and is fixed.

10.2.4 **Substrate** *(where Ns and/or Ks tabs are depressed)***:** calculates the real Ns and imaginary part of the refractive index, Ks of a bare substrate. Factors such as native oxides, roughness, etc. influence the Ks values, so the user may opt to use well known published "book" values, for consistency.