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Auto-El Elipsometer

Equipment Standard Operating Procedure

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1. **Purpose**
    1.1. To measure thickness and index of refraction on transparent films.

2. **Reference Documents**
    2.1. Auto-El Elipsometer manual

3. **Equipment**
    3.1. Tweezers
    3.2. Reference monitor (NIST Sample)

4. **Materials**
    4.1. N/A

5. **Protective Equipment**
    5.1. Eye Protection: safety glasses must be worn at all times.
    5.2. Hand Protection: vinyl or latex gloves.

6. **Engineering and/or Administrative Controls**
    6.1. The auto-El Elipsometer is located in the front of the lab.
    6.2. The tool owner and check off person is Brian Vanderelzen.
    6.3. Only authorized user may operate this piece of equipment.

7. **Procedure**

7.1. Program Number
  7.1.1. To find the Ns and Ks of any substrate:04
    7.1.1.1. On GaAs substrates the Ns is about 3.781 and the Ks is about 0.423.
    7.1.1.2. On InP substrates the Ns are about 3.499 and the Ks is about 0.437.
    7.1.1.3. On silicon substrate the Ns is about 3.858 and the Ks is about 0.018.
    7.1.1.4. It is best to measure any substrate prior to depositing any material to have a more accurate starting point.

7.2. Initialization (system is off or needs to be reset)
  7.2.1. Let the laser warm up for fifteen (15) to thirty (30) minutes when the system is off.
  7.2.2. Turn on the monitor.
  7.2.3. Display will prompt "Insert Sample", press "cont"
    7.2.3.1. Place the NIST sample on the stage and press "cont". The wafer should be located next to the system.

Part No. A11188 Serial No. 3162
Thickness 1137 ± 3Å
Ref. Index 1.466 ± .002
Measure Routine 2
Calc. Routine 10

  7.2.4. Display prompts, "align sample", and press "cont."
  7.2.5. Use the joystick to position the sample under the laser beam; a bright spot will be at the cross hair and inside the small circle on the monitor.
  7.2.6. Press "cont"
  7.2.7. Display prompts "up comp", press "cont"

  7.2.8. Compensator slides up, press "cont"
  7.2.9. Display prompts "down comp", press "cont"
  7.2.10. Compensator slides down, press "cont"
  7.2.11. Display prompts "run, learn, cont"
  7.2.12. Remove initialization sample.

7.3. Making a measurement
  7.3.1. Load sample onto stage, material side up.

7.3.2. There should be a program that fits your needs, check chart next to system or in drawer next to system.
7.3.3. Press “run”
7.3.4. Enter pattern number; this tells how many readings you would like to take. See chart.
7.3.5. Enter the program number.
7.3.6. Enter data that program may ask for. This is program dependent.
7.3.7. The system will start a printout, and then start the measurement.
7.3.8. Retrieve data from top of system (hard copy).
7.3.9. Display prompts “run, learn, cont”
7.3.10. Remove your sample.

7.4. Program Log and Pattern Number

7.4.1. Program Log

Application	File
Find t and n of transparent film on any substrate	01
Find t of transparent film on any substrate, fixed n	02
Find Ns and Ks of substrate	03
2 layer transparent film on Si	04
Single Transparent film on Si, 6328A, Measure routine 2	19
Single Transparent film on Si, 6328A, Measure routine 2, Fixed Index	20
Single Transparent film on Si, 5461A, Measure routine 2	21
Single Transparent film on Si, 5461A, Measure routine 2, Fixed Index	22
Single Transparent film on Si, 4050A, Measure routine 2	23
Single Transparent film on Si, 4050A, Measure routine 2	24
Single Transparent film on Si, 4050A, Measure routine 2, Fixed Index	25
Single Transparent film on Si, 6328A, Measure routine 3	26
Single Transparent film on Si, 6328A, Measure routine 3, Fixed Index	27
Single Transparent film on Si, 5461A, Measure routine 3	28

Single Transparent film on Si, 5461A, Measure routine 3, Fixed Index	29
Single Transparent film on Si, 4050A, Measure routine 3	30
Single Transparent film on Si, 4050A, Measure routine 3, Fixed Index	31
Poly over Transparent film on Si, 6328A, Measure routine 2	32
Poly over Transparent film on Si, 6328A, Measure routine 3	33
Optical contents of substrate, Measure routine 2	34
Optical contents of substrate, Measure routine 3	35

7.4.2. Pattern Log

Application	**File**
Single Point, Sample Center	20
5 points, Sample Center	21
5 points, 100mm Sample	22
9 points, 100mm Sample	23
20 points, 100mm Sample	24
5 points, 125mm Sample	25
9 points, 125mm Sample	26
20 points, 125mm Sample	27
5 points, 150mm Sample	28
5 points, 150mm Sample	29
5 points, 150mm Sample	30
Joystick Enabled, (no stored pattern)	91
Keyboard Coordinate Entry (No stored pattern)	92

7.5. Program the Auto-El

7.5.1. In this section, you will be able to tailor make a program to suit your needs. You may choose one of the empty spots on the program log to save your program.

7.5.2. Display prompts “run, learn. Cont”

7.5.2.1. Press “learn”

7.5.2.2. Display prompts, “learn program”, press enter.

7.5.2.3. Display prompts “program file number”.

7.5.2.3.1. Locate an empty slot on the program log. Enter that file number; be sure to record it in the program log.

7.5.2.3.1.1. Do not make this a cryptic code. All users must be able to use program if needed.

7.5.2.3.1.2. Do not make a new program if one already exists. There is a limited amount of space.

7.5.2.4.Display prompts, “measuring routine number”, choose from the table below.

7.5.2.4.1. Routine 2 is recommended for highest accuracy.

Meas Routine Number	Zones	Speed	Accuracy	Keyboard Entries
1	1	Fastest	Lowest	None
2	2	Slowest	Highest	None
3	2/1	Medium	Medium	None
5	2/1	Fast	High	Std. Delta Psi
6	1	Fastest	Hogh	Delta Psi Offset
0	Bypass	Bypass	Bypass	Delta Psi

7.5.2.5. Display prompts, “calculating routine number”

7.5.2.5.1. Determine what it is you want to calculate. See table below.

To Calculate	Select	Enter Exact Parameters	Enter Estimated Parameters
Single Layer Transparent Films on Silicon Substrates (Lambda = 6328A, Phi = 70, NS = 3.858 KS = 0.018)			
TU, NU	10	None	Spec Thickness
TU	11	NU	Spec Thickness
Any Transparent Single layer film on any substrate			
TU, NU	12	Lambda, Phi, NS, KS	NU, Spec Thickness
TU	13	Lambda, Phi, NS, KS, NU	Spec Thickness
Two Layer Transparent film on a Silicon Substrate (Lambda = 6328A, Phi = 70, NS = 3.858 KS = 0.018)			
TU	21	NU, TL, NL	Spec Thickness
TU, NU	22	TL, NL	NU, Spec Thickness
TU , NL	23	NU, NL	NL, Spec Thickness
TU, TL	27	NU, NL	TL, Spec Thickness
Two Layer transparent film on any substrate			
TU, NU	24	Lambda, Phi, NL, TL, NS, KS	NU, Spec Thickness
TU, NL	25	Lambda, Phi, NU, TL, NS, KS	NL, Spec Thickness
TU	26	Lambda, Phi, NU, NL, TL, NS, KS	Spec Thickness
TU, TL	28	Lambda, Phi, NU, NL, NS, KS	TL, Spec Thickness
Single Layer Absorbing Film			
TU, NU	31	Lambda, Phi, KU, NS, KS	NU, Spec Thickness
TU, KU	32	Lambda, Phi, NU, NS, KS	KU, Spec Thickness
TU	33	Lambda, Phi, NU, KU, NS, KS	Spec Thickness
Two layer absorbing Films			
TU, NU	41	Lambda, Phi, KU, NL, KL, TL, NS, KS	NU, Spec Thickness
TU, KU	42	Lambda, Phi, NU, NL, KL, TL, NS, KS	KU, Spec Thickness
TU, NL	43	Lambda, Phi, NU, KU, KL, TL, NS, KS	NL, Spec Thickness
TU, KL	44	Lambda, Phi, NU, KU, NL, TL, NS, KS	KL, Spec thickness
TU, NL	45	Lambda, Phi, NU, KU, NL, KL, NS, KS	TL, Spec Thickness

TU	46	Lambda, PHI, NU, KU, NL, KL, TL, NS, KS	Spec Thickness

Polysilicon over Single film on Silicon
(Lambda = 6328A, Phi = 70, NS = 3.858 KS = 0.018)

TU, NU, KU	49	NL, KL, TL	Spec Thickness	Restriction: Routine may only be used to calculate with DELTA, PSI measured at 6328A wavelength and 70 degree angle of incidence

Substrate Optical Contents

NS, KS	70	Lambda, Phi	None

7.5.3. Display prompts “printer format number”, enter 2
7.5.4. Display prompts “serial output format”, enter 1
7.5.5. Display prompts “ indent option”, enter 0
7.5.6. The display will then ask you to enter a series of exact parameters for your sample. DO NOT enter these parameters, press “defer” for each parameter.
7.5.7. When done, the display will prompt “run, learn, cont”

8. **Waste Products**

8.1. Broken wafers shall be disposed of, in broken glass bin.

- **Report all accidents (injuries, spills, fires) to the SSEL On Call or other SSEL staff. For emergencies during non-business hours, call the SSEL Emergency Response Team at (734) 764-4127 or Department of Public Safety at (734) 763-1131.**