OBUDA UNIVERSITY

Doctoral School on Materials Sciences and Technologies

Institute of Technical Physics and Materials Science
Centre for Energy Research

2nd Semester Progress Report on

‘ Non-Destructive Optical Mapping Tool From Cheap Parts ’

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OUTLINE

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1. Introduction

Spectroscopic Ellipsometry (SE)

- Non-destructive, non-invasive and non-intrusive optical technique.

- Measures the relative change in polarization state of the measurement beam.

- The two SE measurable values: Amplitude ratio (**ψ)** and phase difference (**Δ)** between the **p**- and **s**-polarizations.

- which correspond to the wavelength of the light beam ‘λ’ and the angle of incidence of the beam ‘θ’ at the sample surface.

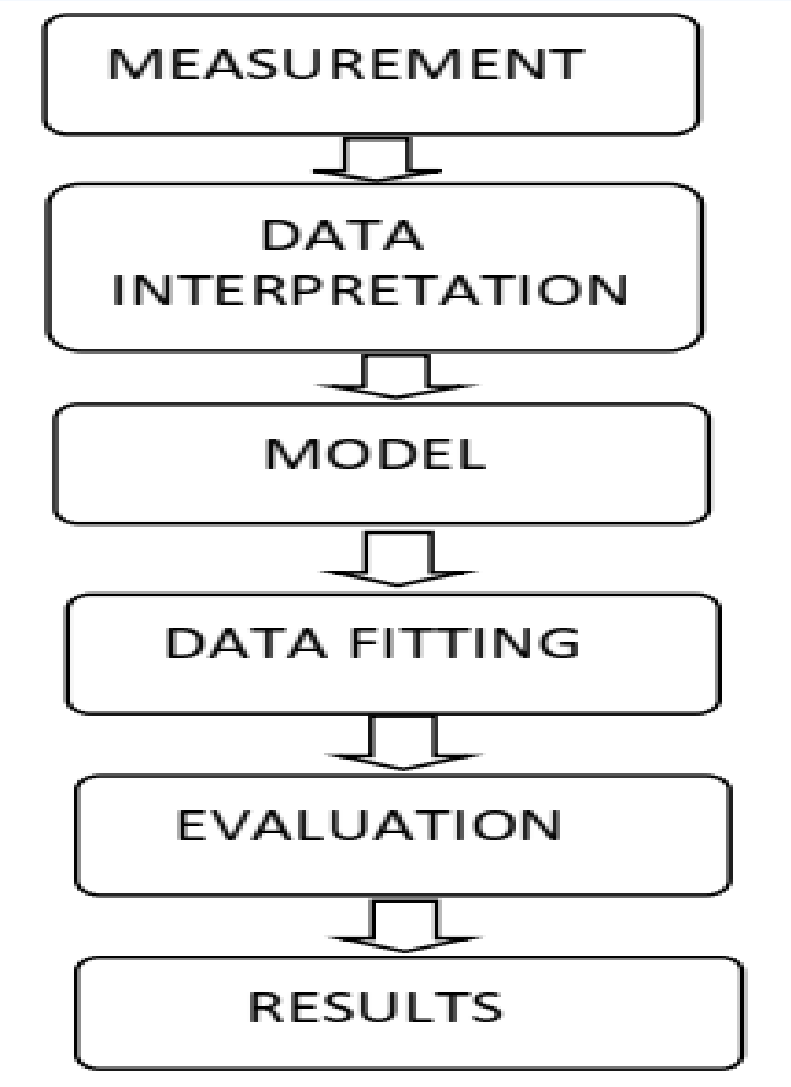


Figure 1: SE Technique Flow chart

1.1. Aim of the Research

- Making an optical mapping tool *prototype* from cheap parts like:

  Tablets, monitors and big screen LCD,LED TV

- Programming the data collection and data processing software

- Making measurements on selected samples and determining the precision of the prototype.

1.2. Research Methods

Original Concept of Prototype building using different parts

1. Light-source (LED-panel)
2. Diffuser sheet
3. Film-polarizer
4. Analyzer

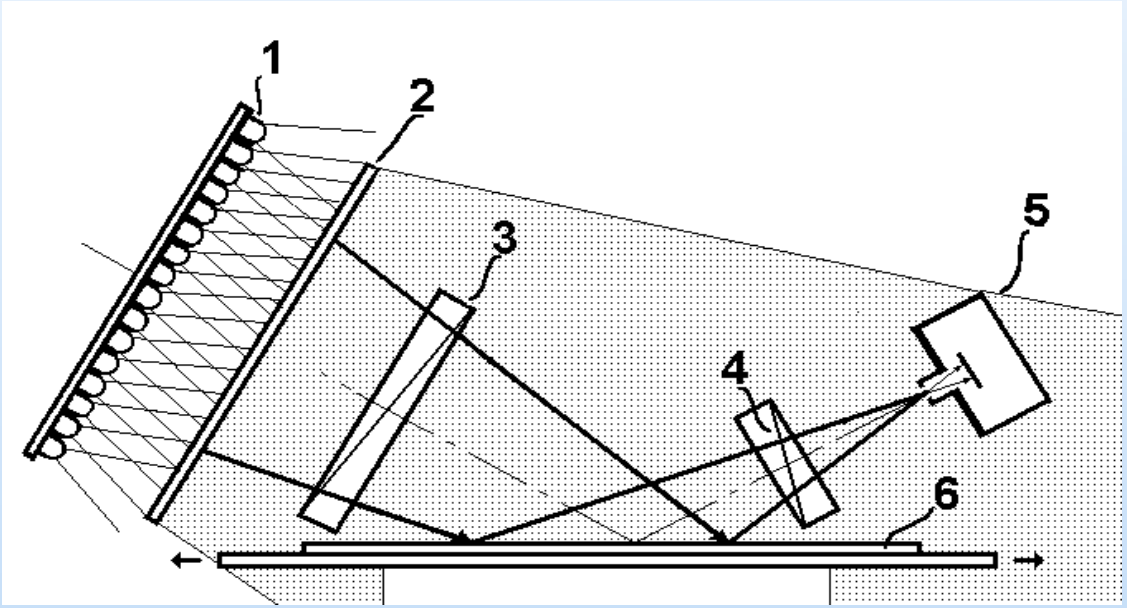


Figure 2: Original concept of the non-collimated beam ellipsometer

5. Detector (pin-hole + CCD-detector) and
6. Sample

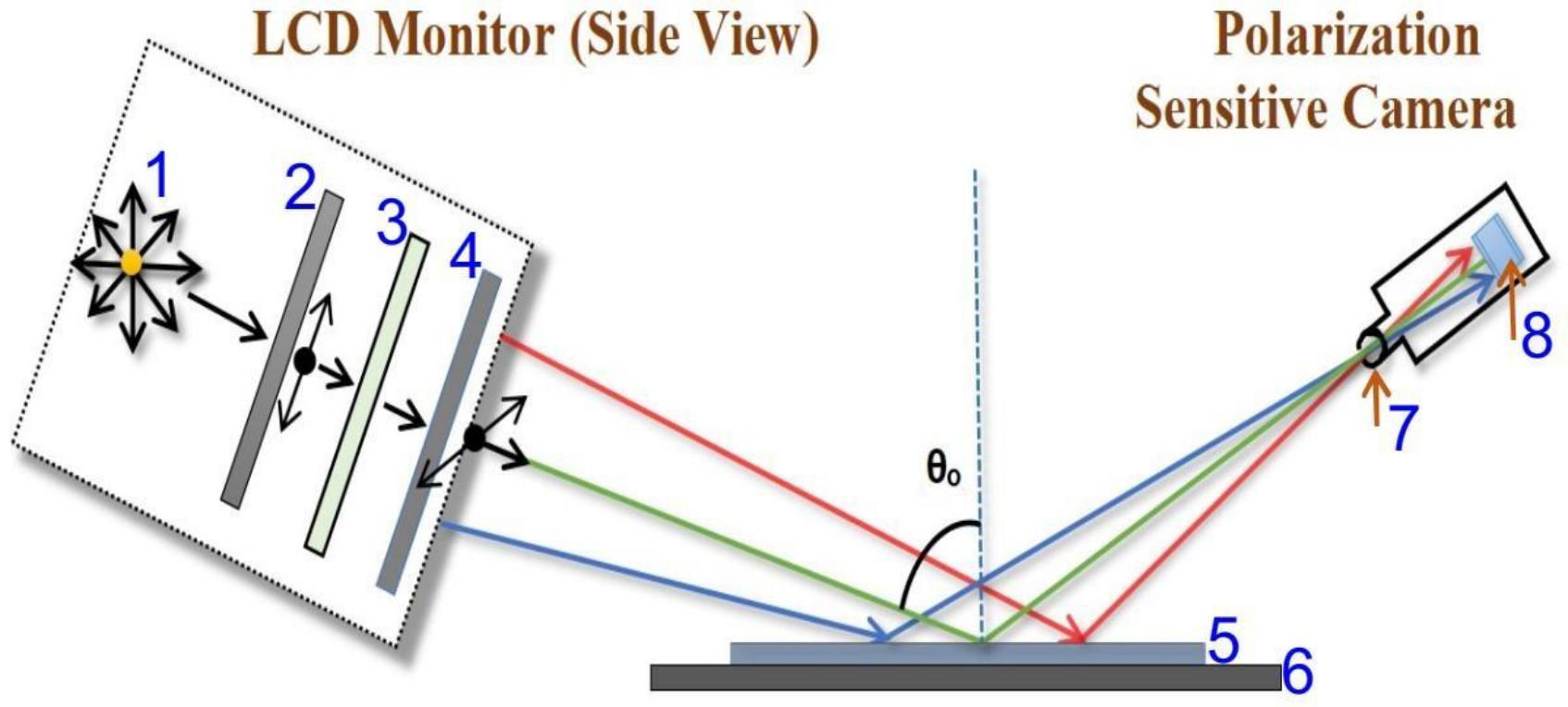


Figure 3: New concept of the non-collimated beam ellipsometer prototype from cheap parts

1) Light source **2)** Vertical polarizer **3)** Liquid crystal cell

4) Horizontal polarizer **5)** Sample **6)** Sample holder

7) Pin hole (sub-mm size) and **8)** Camera sensor

The new concept is without the rotating polarizers

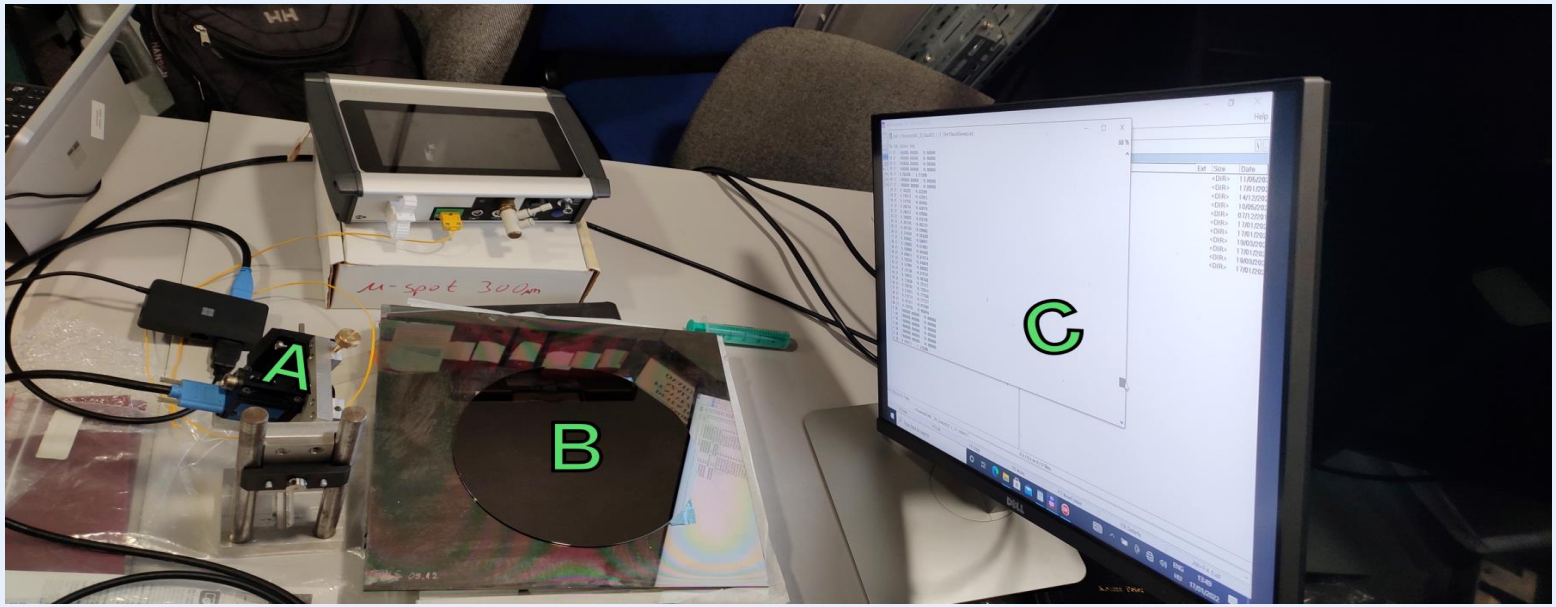
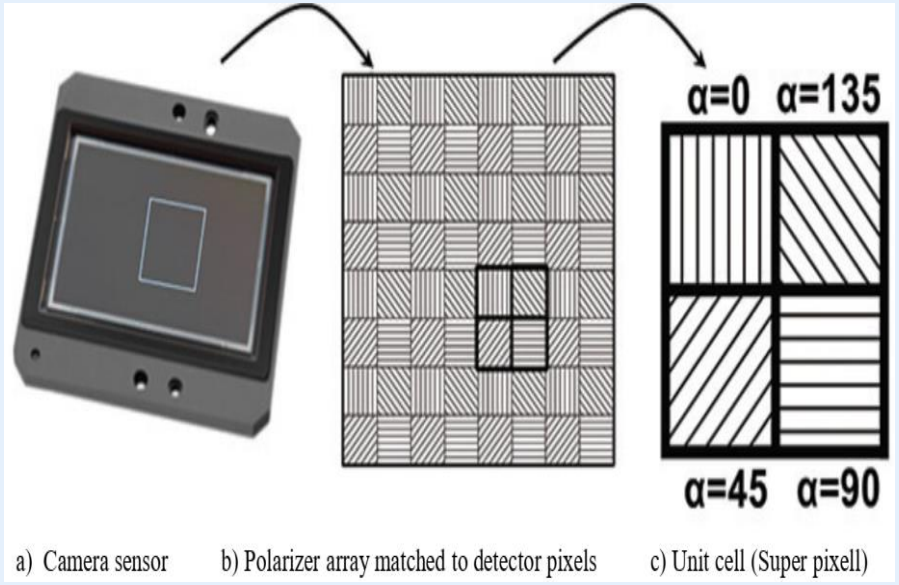


Figure 4: Experimental set up

A) Polarization sensitive camera **B)** Sample + Sample holder and **C)** LCD monitor (rotated into 45 deg. position)

A big area LCD TV serving polarized (built in polarizer sheet) RGB colored light and a polarization sensitive camera behind a pinhole



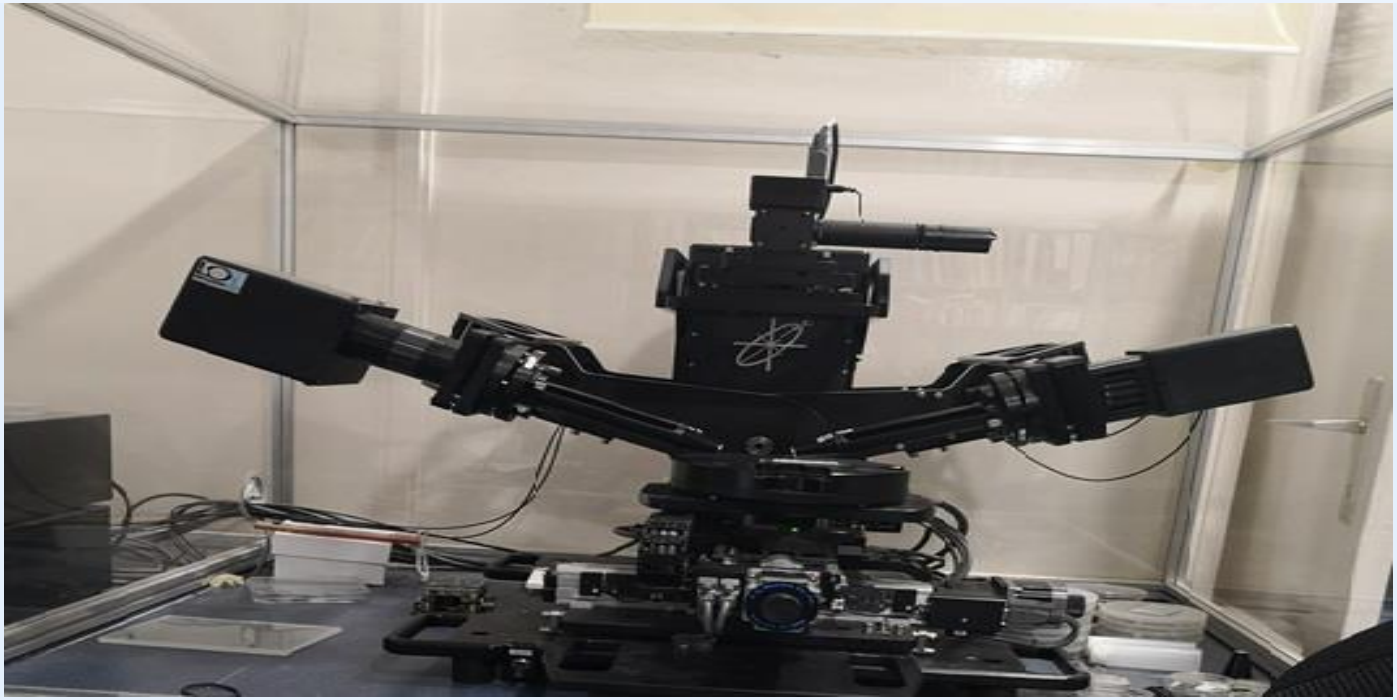
a) b)

Figure 5: **a)** Polarization sensitive camera

b) with its Schematic structure (CMOS Pregius Polarsens sensor)

- The polarization sensitive camera shown serves for polarization state data , from each position (plus 3 RGB colors in each position).
- CMOS sensor is Integrated 4-Directional Wire Grid Polarizer

1.3. Characterization methods



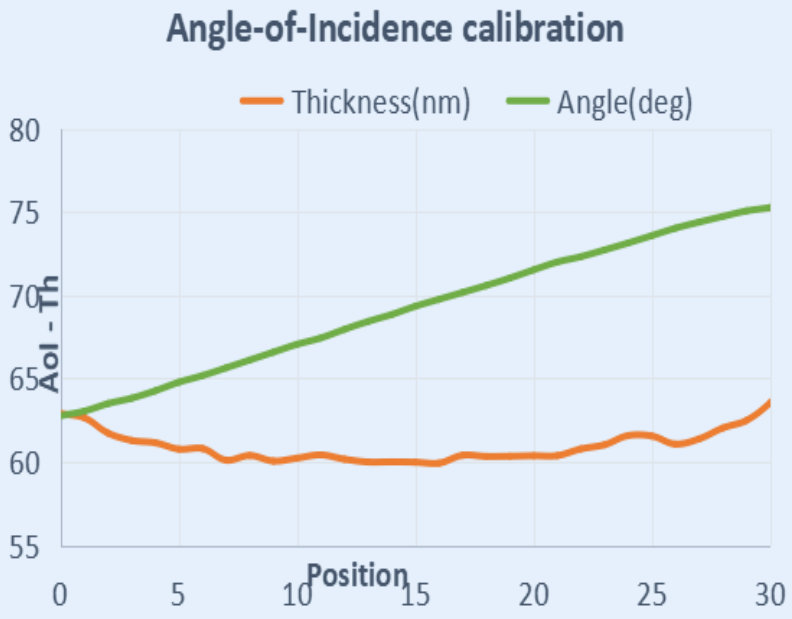
- **Figure 6**: Rotating Compensator Spectroscopic Ellipsometer (M2000DI)
- The M2000DI ellipsometer is used for control measurements.

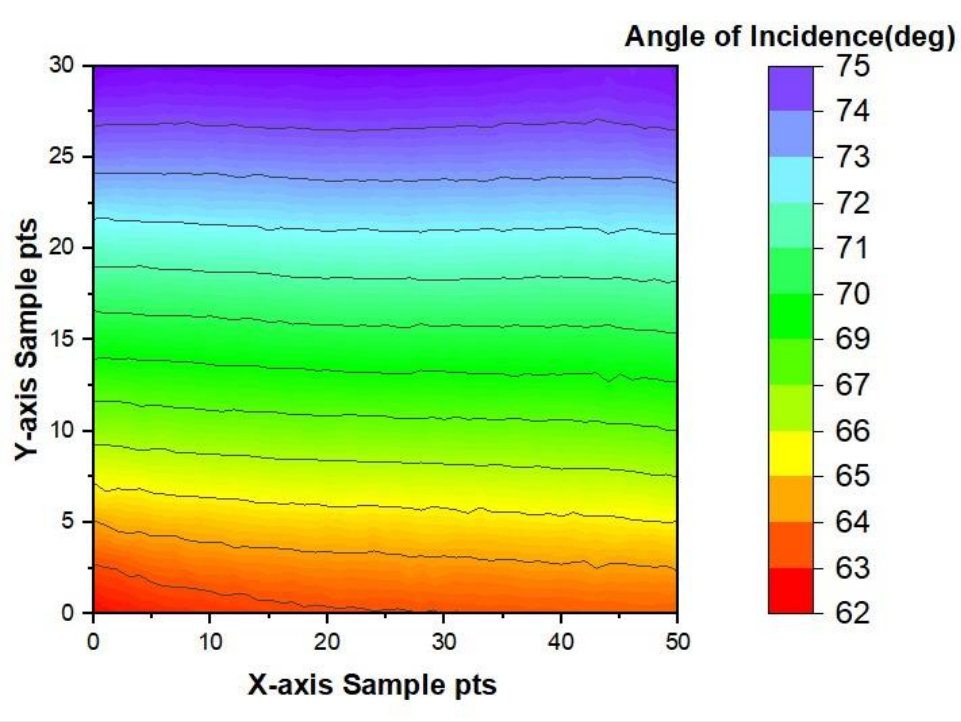
Rotating Compensator Spectroscopic Ellipsometer

- Provides fast and very accurate thin film characterization over a wide spectroscopic range like.
- Measurement of film thickness and optical constants on single or multilayer stack.
- Extreme sensitivity for very thin over layers even below 1 nm thickness
- But it is indirect analysis technique.
- Similar measurements will help the calibration of the prototype.

2. Results of the Actual Semester

- The results for the angle of incidence calibration using a 200mm diameter silicon wafer covered by a 60nm silicon dioxide layer



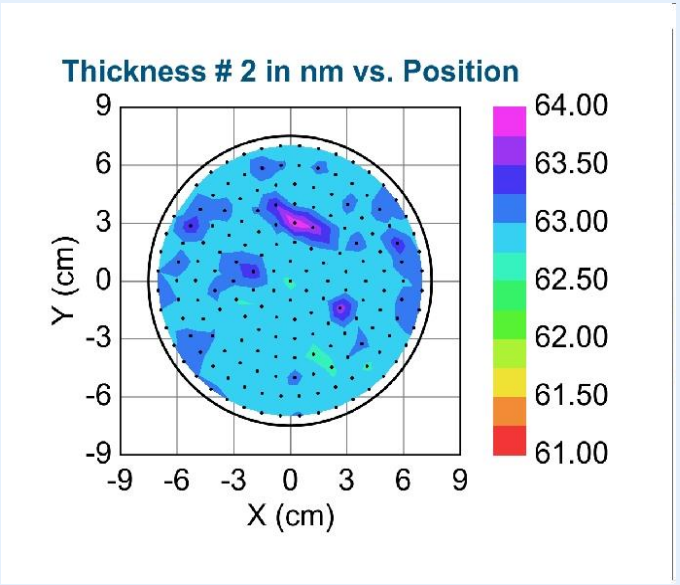


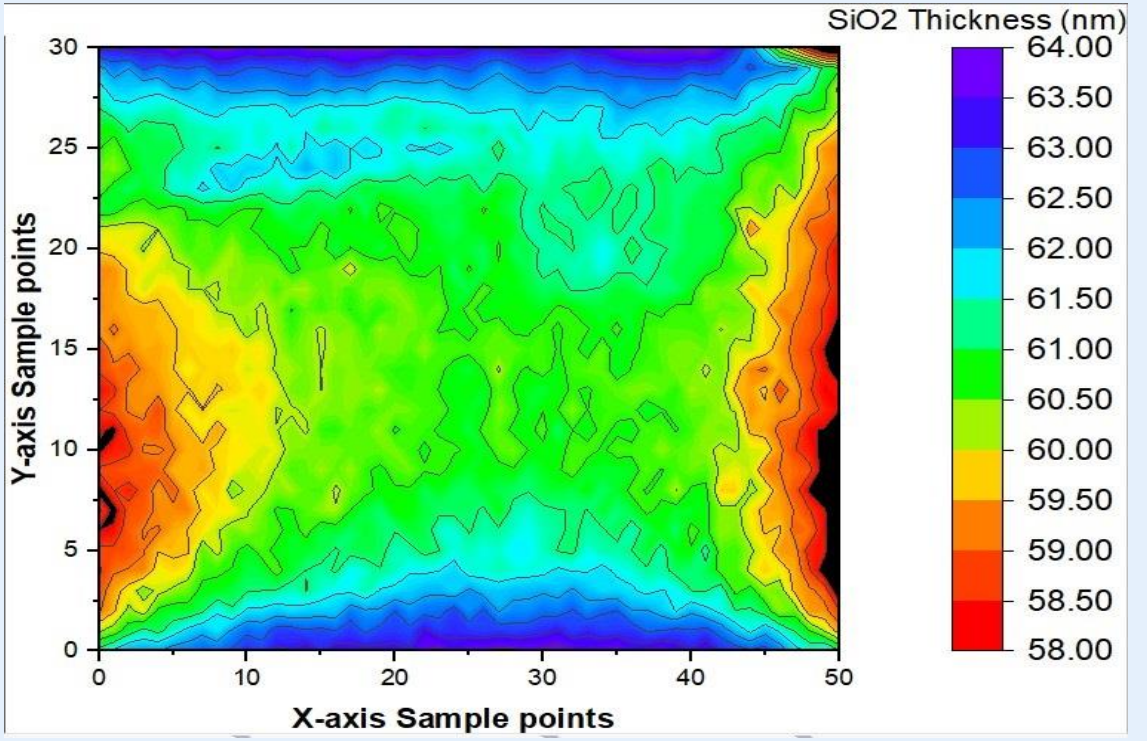
a) **b)**

Fig. 7. **a)** Angle of Incidence Calibration vs Position

b) Angle of incidence mapping versus position

- The determined thickness difference between the M2000 control measurement device and the new optical mapping tool prototype values has been recorded to be less than 2 nm.





a) **b)**

Fig. 8. a) Thickness vs Position, mapping from M2000DI control measurement

b) Thickness versus position ,mapping from the prototype tool

General View of the Prototype tool

Advantages

- The new prototype is made up of cheap parts, compared to other standard factory made counter parts.
- Wide mapping area up to 150cm is possible .

Limitations

- Only three wide wavelength bands (RGB light) are in action which narrows the range of the light band source.
- ‘0.1 degree’ angle uncertainty from the digital angle gauge used in rotation angle of the LCD monitor ,which may be estimated to contribute to the experimental result deviation from the nominal value.

Activities

Table 1. Courses completed in this actual semester

Course Nepton Code	Course Title	Instructor	Credit Points
OATVFAM1ND	Selected chapters from material testing methods I	Dr. Judit Telegdi (AFM and SEM) Dr. Erzsébet Takács (FTIR)	6
OATFEFV1ND	Semi-conductorDevices	Dr. Zsolt Jozsef Horvath	6
OATBESZ2ND	Research report II	Dr. Miklos Fried	6
OATKUTP2ND	Research project II	Dr. Miklos Fried	10
		Total	28

Conference

• The ‘ 9th International Conference on Spectroscopic Ellipsometry, (ICSE)’, from 22-28 May 2022, held in Beijing China.(Virtual Conference)

•Presented this paper in a poster session.

3. Plans For the Future Work

- As the experiment is on its early stage, different samples will be considered for;
  - Prototype precision checking
  - Further understanding of the optical mapping tool.

- Bigger samples will be made by a reactive DC magnetron sputtering system such as WO3-MoO3 mixed layers on glass.

köszönöm !