Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

MEMS & CHEMICAL SENSORS LAB | SPONSORED BY DST-FIST | SCHOOL OF ELECTRONICS ENGINEERING

VALUE ADDED COURSE

on

THIN FILM SCIENCE & TECHNOLOGY

17th February - 19th April 2025

About the Course:

This value-added course provides hands-on training in various industrially viable thin film deposition techniques together with the associated characterization techniques to keep the participants ready to take up fabrication as well as characterization of thin films.

Course Outcomes:

By the end of this course, participants will have the right skills and talent to deposit metal and metal oxide coatings on various substrates by thermal evaporation, magnetron sputtering and spin-coating.

Course Benefits:

- The course is open for Science & Engineering graduates.
- Helps candidates to upskill their technical knowledge towards thin film deposition and characterizations.
- Designed and developed based on the R&D needs towards building prototypes and designing solutions for some of the real world problems.
- VIT certificate upon successful completion of learning and assessment.

Eligible Participants:

UG or PG students of Physics, Chemistry, Electronics Engineering and Electrical Engineering branch.

Course Highlights:

- Substrate preparation
- Thin film deposition

⇒ RF & DC magnetron sputtering
⇒ Thermal evaporation
⇒ Spin coating

- Optical properties

⇒ Spectroscopic Ellipsometry
⇒ UV-Vis-NIR absorption spectroscopy

- Electrical properties

⇒ Hall effect
⇒ Impedance spectroscopy

Registration Fee: Rs. 500

Coordinators:

1. Dr. Zachariah C. Alex
Professor, SENSE, VIT– Vellore.

2. Dr. Samir Ranjan Meher
Associate Professor, SAS, VIT– Vellore.

Course code	**Thin Film Science and Technology**		
VACXXXX			
Prerequisite	**Elementary Thermodynamics and Materials Science**	**Syllabus version**	
		v. xx.xx	

Course Objectives

1. To introduce the basic concepts of vacuum technology, thin film deposition and applications

Course Outcome

At the end of the course student will be able to

1. Create vacuum for thin film deposition
2. Deposit thin films on a substrate by magnetron sputtering and thermal evaporation
3. Deposit thin films by sol-gel based spin and dip coating
4. Measure optical constants of thin films through spectroscopic ellipsometry
5. Fabricate thin film based sensors

Module:1	**Introduction to Thin Films:** Introduction to thin films, difference between thin and thick films, Exotic properties of Thin Films, Polycrystalline and single crystalline thin films, Hands on session on substrate (SLG, Quartz and Si) cleaning	**4 h**
Module:2	**Vacuum Components and Systems** Kinetic theory of gases, Need for vacuum, Knudsen number, Gas transport and Pumping, Vacuum pumps: Rotary pump, Diffusion pump, Turbomolecular pump, Cryogenic pump, Direct and Indirect gauges, Pirani gauge, Penning gauge, Hands on experience on vacuum pumps and gauges	**5 h**
Module:3	**Physical Vapour Deposition** Thermal evaporation, E-beam evaporation, DC and RF magnetron sputtering, Hands on experience on the deposition of metallic and oxide thin films	**5 h**
Module:4	**Chemical Route for Deposition of Thin Films** Chemical vapour deposition (CVD), Spray pyrolysis, Screen printing, Sol-gel based spin/dip coating, Hands on experience on the deposition of metal oxide and metal sulphide thin films by sol-gel based spin and dip coating	**5 h**
Module:5	**Thin Film Characterization** X-ray diffraction, Electron microscopy, X-ray photoelectron spectroscopy, Spectroscopic ellipsometry, 4-probe method for resistivity, Hall effect, UV-Vis-NIR absorption spectroscopy, Hands on experience on spectroscopic ellipsometry and Hall effect	**6 h**
Module:6	**Thin Film based Sensors** Fabrication of thin film based sensors, Humidity sensors, Toxic gas sensors, VOC sensors, Hands on experience on humidity sensing and VOC sensing	**5 h**
	Total Lecture hours:	**30 h**

Value Added Course

on

Thin Film Science and Technology

Schedule

Class 1 (Theory) (1 hr): 17th Feb 2025 (5.00 – 6.00 PM) (Monday)

Introduction to Thin Films

- Definition and classification: Thin vs. thick films
- Exotic properties and applications of thin films
- Types of thin films: Polycrystalline and single crystalline

Class 2 (Lab) (2 hrs): 19th Feb 2025 (11.00 AM – 1.00 PM)

- Substrate preparation and cleaning for thin film deposition (SLG, Quartz, Si)

Class 3 (Theory) (2 hours): 24th Feb 2025 (5.00 – 7.00 PM) (Monday)

Vacuum Components and Systems-I

- Kinetic theory of gases
- Vacuum requirements for thin films: Knudsen number
- Gas transport and pumping mechanisms

Class 4 (Theory) (2 hrs): 25th Feb 2025 (5.00 – 7.00 PM)

Vacuum Components and Systems-II

- Overview of vacuum pumps (Rotary, Diffusion, Turbomolecular, Cryogenic)
- Vacuum measurement gauges (Pirani, Penning)

Class 5 (Lab) (2 hrs): 1st March 2025 (10.00 AM – 12.00 PM)

- Operation and calibration of vacuum pumps and gauges

Class 6 (Theory) (1 hr): 10th March 2025 (5.00 – 6.00 PM)

Physical Vapor Deposition-I

- Techniques: Thermal evaporation, E-beam evaporation

Class 7 (Theory) (1 hr): 17th March 2025 (5.00 – 6.00 PM)

Physical Vapor Deposition-II

- DC and RF magnetron sputtering: Working principles and applications

Class 8 (Lab) (2 hrs): 22nd March 2025 (10.00 AM – 12.00 PM)

- Thin film deposition using thermal evaporation and magnetron sputtering

Class 9 (Theory) (1 hr): 26th March 2025 (5.00 – 6.00 PM)

Chemical Deposition Techniques

- Chemical vapor deposition (CVD)

Class 10 (Theory) (2 hrs): 29th March 2025 (10.00 AM – 12.00 PM)

Chemical Deposition Techniques

- Spray pyrolysis, screen printing
- Sol-gel based spin and dip coating

Class 11 (Lab) (2 hrs): 5th April 2025 (10.00 AM – 12.00 PM)

- Thin film deposition using sol-gel based spin/dip coating for oxide and sulfide films

Class 12 (Theory) (1 hr): 7th April 2025 (5.00 – 6.00 PM)

Thin Film Characterization-I

- X-ray diffraction (XRD), Electron microscopy (SEM/TEM)

Class 13 (Theory) (1 hr): 9th April 2025 (5.00 – 6.00 PM)

Thin Film Characterization-II

- X-ray photoelectron spectroscopy (XPS)

Class 14 (Lab) (2 hrs): 12th April (10.00 AM – 12.00 PM)

- XRD pattern analysis for thin films
- XPS analysis for thin films

Class 15 (Theory) (2 hrs): 12th April (3.00 PM – 5.00 PM)

Thin Film Characterization-III

- Spectroscopic ellipsometry

Class 16 (Theory) (2 hrs): 16th April (5.00 PM – 7.00 PM)

Thin Film Characterization-IV

- Four-probe method for resistivity
- UV-Vis-NIR absorption spectroscopy

Class 17 (Lab) (2 hrs): 19th April (10.00 AM – 12.00 PM)

- Spectroscopic ellipsometry

Class 18 (Lab) (2 hrs): 19th April (3.00 PM – 5.00 PM)

- Fabricating and testing thin-film-based humidity and VOC sensors