MSE4121: THIN FILMS

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Thin Films

Subject Code

MSE - Materials Science and Engineering

Course Number

4121

Academic Unit

Materials Science and Engineering (MSE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

AP2102/MSE2102 Introduction to Materials Engineering
AP3171/MSE3171 Materials Characterization Techniques
AP3172/MSE3172 Electronic Properties of Materials
MA2176 Basic Calculus and Linear Algebra or
MA1201 Calculus and Basic Linear Algebra II

Equivalent Courses

AP4121 Thin Film Technology and Nanocrystalline Coatings

Exclusive Courses

Nil

Part II Course Details

Abstract

The course provides fundamental knowledge on modern material syntheses in materials engineering and science. This emerging technology equips the students with knowledge in processing both pure elementary materials and compounds that can be prepared in crystal structures or amorphous forms. The course is designed as a practical guide in thin film deposition that can be used in industry and scientific research. It also stimulates ingenuity in experiment and material processing design. The course can bridge the gap between school and industry.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the fundamental growth and material parameters of thin films and nanomaterials including growth rate, surface energy, lattice parameters, density, stress, , sticking coefficient, etc.			x	x
2	Describe the various deposition methods and describe the principles related with physics and chemistry.		x	x	x
3	Apply modern techniques of deposition to prepare different materials under proper conditions.		x	x	x
4	Discuss and design processes of material synthesis to form thin films.			x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Students will engage in the lecture to explain the concepts on thin film and nanomaterial growth, the material parameters and discuss the working principles of different thin film techniques.	1, 2, 3, 4	3 hrs/wk

2	Tutorial	Student will participate in discussion, discuss more examples to consolidate the concepts studied in lecture, which help the students to understand them.	1, 2, 3, 4	1hr/wk
3	Lab work	Students will engage in the designs and working processes of some selected thin film deposition techniques.	1, 2, 3, 4	3hrs/wk

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Mid-term test	1, 3, 4	10	-	No
2	Lab work (Two Lab Reports)	2, 4	10	-	No
3	Three homework assignments	1, 4	10	-	No

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained

Assessment Rubrics (AR)

Assessment Task

1. Short quizzes

Criterion

Ability to explain the basic concepts and their applications in thin film deposition techniques

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)
Not even reaching the marginal leave

Assessment Task
2. Lab work

Criterion
Ability to understand the designs and working processes of thin film deposition systems, and to recognize the functions of the system components

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal leave

Assessment Task
3. Midterm test

Criterion
Capability on understanding the fundamentals of the growth and material parameters of thin films and nanomaterials

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal leave

Assessment Task
4. Examination

Criterion

Capability on understanding the fundamental concepts and key parameters about the growth of thin films and nanomaterials, explaining the scientific principles, applications and restrictions of deposition methods, and identifying and explaining how the principles of deposition and synthesis are applied, and solving physical and engineering problems in thin film deposition

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal leave

Part III Other Information

Keyword Syllabus

- Definition of thin films.
- Environment and molecular and plasma processes in thin film deposition.
- Cold and thermal plasma.
- Requirement for substrate. Substrate cleaning.
- Formation of thin films
- Sticking coefficient. Formation of thermodynamically stable cluster – nucleation. Growth process.
- Properties of thin films: Microstructure. Surface morphology. Film density. Stress in thin films. Adhesion.
- Mechanical, electrical, thermal, chemical, and optical properties of thin films.
- Thermal evaporation
- Resistance evaporation. Electron beam evaporation. Molecular beam epitaxy.
- Laser ablation. Synthesis of nanomaterials (nanowires, nanoribbons)
- Electrical discharges used in thin film deposition
- Mechanism of electrical discharges. I-V characteristic of electrical discharges. Townsend discharge. Glow discharge. Arc.
- Practical electric discharge configuration for deposition of thin films. Direct current electric discharges. Radio-frequency discharges.
- Physical deposition techniques
    - Direct current and radiofrequency sputtering. Magnetron sputtering. Cathodic arc deposition. Ion plating.
- Chemical vapor deposition techniques (CVD)
- Thermally activated CVD Plasma enhanced CVD. Oxidizing and nitriding. Photoassisted CVD. Plasma polymerization.
- Other processing technologies
- Pattern transfer. Reactive ion etching. Ion milling.

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	(E-book) H. Lüth, Solid surfaces, interfaces and thin films, Heidelberg, New York, Springer-Verlag, c2010. (5th ed.)
2	(E-book) D. M. Mattox, Handbook of physical vapor deposition (PVD) processing, Oxford, c2010. (2nd ed.)
3	(E-book) by P. M. Martin (Eds), Handbook of deposition technologies for films and coatings, Oxford, 2009. (3rd ed.)
4	D Clocker, S I Shah (Eds), Handbook of Thin Film Process Technology, Institute of Physics Publishing, London 1995.
5	W N G Hitchon, Plasma Processes for semiconductor Fabrication, Cambridge University Press, Cambridge 1999.
6	J L Vossen, W. Kern (Eds), Thin Film Processes II, Academic Press, Boston 1991.
7	Elshabini-Riad, A. R. Aicha, Thin film technology handbook / New York : McGraw-Hill, c1998. (TK7872.T55 E47 1998)
8	F C Matacotta, G. Ottaviani, Science and technology of Thin Films, World Scientific, New Jersey 1995