

Course Code	Course Name	Credits
26PH114	BASICS OF CRYSTAL GROWTH, THIN FILMS AND NANOTECHNOLOGY	04

### Course Objectives

- To understand fundamentals of nanoscience and nanomaterials
- To learn nucleation and crystal growth techniques
- To study thin film deposition methods (PVD & CVD)
- To explore synthesis and applications of nanomaterials

### Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Explain basic concepts of nanoscience and nanomaterials
- Understand nucleation and crystal growth processes
- Apply thin film deposition techniques (PVD, CVD)
- Analyze synthesis methods and material properties
- Identify applications of nanomaterials and thin films

### Unit 1 - Fundamentals of Nanoscience (12 Hrs.)

Definition of Nanoscience and Nanotechnologies- Uniqueness of the Nanoscale-Physical properties of Nanomaterials-Nanoscience in Nature- -Historical perspective: Lycurgus cups - ancient Maya fresco painting - Nanomaterials- classification of nanomaterials-strategies for synthesis of nanomaterials- significance of nanoscience.

### Unit 2 – Nucleation (12 Hrs.)

Primary nucleation - Secondary nucleation - Solubility, super solubility and metastable zone - Crystal growth theories: surface energy theories, adsorption layer theories, kinematic theories, and diffusion reaction theories.

### Unit 3 - Crystal Growth from Melt and Vapour (12 Hrs.)

Czochralski method - Bridgmann - Stockbarger method - Zone Melting Method - Vapour growth: direct vapour transport method, Chemical transport method.

### Unit 4 – Thin Film Deposition: Physical Vapour Deposition (12 Hrs.)

Evaporation method: Vacuum evaporation, Electron beam evaporation - DC diode sputtering, Magnetron sputtering, Reactive ion sputtering, RF sputtering - Pulsed Laser Deposition - Molecular Beam Epitaxy.

### Unit 5 - Thin Film: Deposition Chemical Vapour Deposition and Liquid Phase Deposition (12 Hrs.)

Chemical vapour deposition - typical chemical reactions - reaction kinetics - transport phenomena - CVD methods – Metal Organic Chemical Vapour Deposition - Plasma enhanced chemical vapour deposition - Langmuir-Blodgett films - Electrochemical deposition - Sol-gel films.

### Reference Books:

1. M.A. Wahab, Solid State Physics, 2nd edition, Narosa Publications, 2011.
2. R.K. Puri and V.K. Babbar, Solid State Physics, 1st edition, S. Chand & Co, 2018.
3. C. Kittel Introduction to Solidstate Physics, Wiley India Edition, 2019, 8thEdn.
4. M. Arumugam, Materials Science, Anuradha Publishers, 2004.
5. S.O. Pillai, Solid State Physics, New Age International (P) Ltd, 2018.
6. Crystallography Applied to Solid State Physics, ARVerma and ON Srivastava, 2nd edition, New Age International Publishers, 2001.
7. Solid State Physics, AJ Dekker, Macmillan India Ltd., Bangalore, 1981.

### Websites and eLearning Sources:

1. [https://onlinecourses.nptel.ac.in/noc24\\_ge56/preview](https://onlinecourses.nptel.ac.in/noc24_ge56/preview)
2. [https://youtu.be/1\\_M8FdYJJ2c?si=DtM3-ZD\\_KwH97fvE](https://youtu.be/1_M8FdYJJ2c?si=DtM3-ZD_KwH97fvE)
3. <https://youtu.be/3VeREZ5xrZc?si=cjHxjtYzSTRedXHB>

**COs and Bloom's Taxonomy Mapping – 26PH114**

<b>Course Outcomes</b>	<b>On successful completion of this course, students will be able to</b>	<b>BTL</b>
<b>CO1</b>	Recall and explain the fundamentals of nanoscience, classification of nanomaterials, and their unique properties at the nanoscale.	K1, K2
<b>CO2</b>	Explain nucleation processes, crystal growth theories, and metastable conditions in material formation.	K2
<b>CO3</b>	Apply crystal growth techniques such as Czochralski, Bridgman, and vapour transport methods in material synthesis.	K3
<b>CO4</b>	Analyze thin film deposition techniques including PVD and CVD processes and their kinetics.	K4
<b>CO5</b>	Evaluate and design suitable synthesis and deposition methods for nanomaterials in advanced applications.	K5, K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

**Relationship Matrix – 26PH114**

<b>Course Outcomes</b>	<b>Programme Outcomes (POs)</b>						<b>Programme Specific Outcomes (PSOs)</b>						<b>Mean Score of Cos</b>
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>	
<b>CO1</b>	3	2	1	1	1	1	3	2	1	1	1	1	1.58
<b>CO2</b>	2	3	2	1	1	1	2	3	2	1	1	1	1.67
<b>CO3</b>	2	2	3	2	1	1	2	2	3	2	1	1	1.83
<b>CO4</b>	2	3	3	3	2	2	1	2	3	3	2	2	2.25
<b>CO5</b>	2	3	2	3	3	3	1	2	2	3	3	3	2.50
<b>Total</b>													1.97

Mean Score: 3- High, 2- Medium/Moderate, 1-Low

