USC Viterbi
School of Engineering

MASC 512: Thin Film Science and Technology
Fall 2018

Lectures: Mon, Wed 5:00 to 6:20 PM (VHE 206).

Instructor: Dr. Jayakanth Ravichandran
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Course Description: The course introduces the science and technology of thin films to graduate students. The course will cover the historical developments and motivation to achieve thin films, common synthesis techniques, materials characterization, physical properties, and applications of thin films. The students are typically with graduate standing in any of the relevant physical science or engineering disciplines including but not limited to Materials Science, Electrical Engineering, Mechanical Engineering, Chemical Engineering, Physics or Chemistry.

Learning Objectives: The course is aimed at teaching the basics of thin film science and technology, which is one of the important form of materials preparation. The course will cover the necessary basics from thermodynamics, electrodynamics, quantum mechanics, and solid state physics relevant to thin film science. The course will emphasize on the techniques, properties of materials in thin film form, and the technologies developed from these materials. At the end of this class, the student is expected to have a broad understanding of the status of thin film technology.

Recommended Preparation: Upper division or graduate level preparation in thermodynamics and quantum mechanics or solid-state physics. Students can request waiver for these prerequisites, if they have the necessary background.

Books: Lecture slides will be provided and will contain all the information and necessary references to learn the material. In some cases, lecture notes will be supplemented. Significant material will be covered from these two textbooks.

1. Smith, Donald Leonard. *Thin-film deposition: principles and practice*. Vol. 108. New York etc: McGraw-hill, 1995. ISBN: 978-0070585027

2. Ohring, Milton. *Materials science of thin films*. Academic press, 2001. ISBN: 978-0125249751

Grading:

Exams (2):	(2 x 25)	=	50%
Problem Sets (6)	(6 x 5)	=	30%
Final Term Paper		=	20%

Problem sets and Exam policy:
There will be six problem sets posted roughly at one every two weeks' interval. The homework will be due in about 10 days' time after the posting. Each homework will count for 5 points. There will be two exams, which count for 30 points each. First exam will be held close to the middle of the course and the second exam in the last week of instruction.

Final Term Paper Policy:
The final term paper will be used as a method to evaluate the student's performance and will act as the final summative performance. The students are expected to write a brief review of a selected topic in this term paper. For example, topics relevant to phase transition, and/or diffusion in novel materials. You are also expected to typeset this article in a scientific journal format (*e.g.* Nature, Science, Advanced Materials, Physical Review Letters *etc.*) and mention the journal name in the review. You are expected to write this article in under 5 pages. Use any suitable schematics derived from any source (with suitable citations). This final term paper will be due during the finals week. The breakdown for the evaluation for the term paper is as follows:

Selection of topic, and its relevance to the course	– 10%
Formatting per the journal guidelines	– 20%
Content of the review	– 50%
Figures and Caption	– 10%
References	– 10%

Topics covered and weekly breakdown of course schedule:

1) Introduction:
Why thin films? – Physics and Engineering Perspective, Materials Science basics.

2) Vacuum Technology:
Kinetic theory of gases, Vacuum systems, creation and measurement of vacuum.

3) Film growth and Phenomenology:
Symmetry, surfaces and interfaces, Thermodynamics and Kinetics of thin film deposition and growth.

4) Thin film Deposition Methods:
Physical and Chemical deposition methods, Plasma based deposition methods.

5) Characterization of films:

Structural and chemical characterization of thin films – Methods and mechanisms.

6) Thin film properties:

Thermodynamic and transport properties of thin films (Mechanical, Electrical, Thermal, Magnetic, Optical *etc.*)

7) Applications of Thin films:

Electronic, optical, mechanical, thermal, and energy applications of thin film technology.

8) Emergent research activities in thin film science and technology

	Topics/Daily Activities	**Readings and Homework**	**Deliverable/ Due Dates**
Week 1	1.1 Introduction & Review of Materials Science	Notes, Ohring Ch1	
Week 2	1.2 Review of Materials Science 2.1 Vacuum Technology	Notes, Ohring Ch1,2	Problem Set 1 is posted
Week 3	2.2 Vacuum Technology	Notes, Ohring Ch2	Problem Set 1 is due
Week 4	3.1 Thin Film Deposition	Notes, Ohring Ch3	Problem Set 2 is posted
Week 5	3.2 Thin Film Deposition	Notes, Ohring Ch4,5	Problem Set 2 is due
Week 6	3.3 Thin Film Deposition	Notes, Ohring Ch5,6	Problem Set 3 is posted
Week 7	3.4 Thin Film Deposition	Notes, Ohring Ch6	Problem Set 3 is due
Week 8	4.1 Film Growth and Phenomenology	Notes, Ohring Ch7,8	**Exam 1**
Week 9	4.2 Film Growth and Phenomenology	Notes, Ohring Ch7,8	Problem Set 4 is posted
Week 10	5.1 Characterization of Films	Notes, Ohring Ch10	Problem Set 4 is due
Week 11	5.2 Characterization of Films	Notes, Ohring Ch10	Problem Set 5 is posted
Week 12	6.1 Properties of Thin films	Notes, Ohring Ch12	Problem Set 5 is due
Week 13	6.2 Properties of Thin films	Notes	Problem Set 6 is posted
Week 14	7. Applications of Thin Films	Notes	Problem Set 6 is due **Exam 2**
Week 15	8. Emergent Activities	Notes	
FINAL			**No Final Exam/ Final Paper to be submitted in Finals Week**

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct.
http://www.usc.edu/dept/publications/SCAMPUS/gov/

Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at:
http://www.usc.edu/student-affairs/SJACS/

Sanctions include but are not limited to: grade sanctions (e.g., "F" in course) and dismissal from the academic department (see following excerpt from SJACS site).
http://www.usc.edu/student-affairs/SJACS/forms/sjacs_appa.pdf

Students with Disabilities
Any student requesting academic accommodations based on a disability is required to register with the Office of Disability Services and Programs (DSP, STU 301, 213-740-0776) each semester. You must deliver an approved DSP letter to one of the instructors as early in the semester as possible. Please see SCampus (http://www.usc.edu/dept/publications/SCAMPUS/) for additional policies that are not covered here (i.e. academic integrity, proper conduct, etc) but that do still apply!