

# USC Viterbi School of Engineering

MASC 599: Thin Film Science and Technology  
Fall 2016

**Lectures:** Monday and Wednesday 10:00 – 11:50 AM.

**Instructor:** Dr. Jayakanth Ravichandran  
Office: VHE 714  
Office hours: Wednesday 1:30 – 2:30 PM or by appointment  
Email: [jayakanr@usc.edu](mailto:jayakanr@usc.edu).

**Teaching Assistant:** Ms. Fanqi Wu  
Office: RTH B105  
Office hours: Monday 11:20 – 12:20 am or by appointment  
Email: [fanqiwu@usc.edu](mailto:fanqiwu@usc.edu)

**Course Description and Objectives:** 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 engineering disciplines including but not limited to Materials Science, Electrical Engineering, Mechanical Engineering, or Chemical Engineering.

**Prerequisites:** None

**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 30)	=	60%
Problem Sets (4) & Class participation	(4 x 10)	=	40%

**Problem sets and Exam policy:**

There will be two problem sets made available before the first exam and two more before the second exam. Every problem will be posted roughly after 5-6 classes (see below for

tentative schedule). The solutions to problem sets are due 2-3 weeks after they are posted. The scores will be made available typically within 2 weeks of submitting the problem sets and exams. The problem sets will typically have 5-6 problems. The exams will be 1 hour 30 minutes each and will have 4-5 problems.

**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

	<b>Topics/Daily Activities</b>	<b>Readings and Homework</b>	<b>Deliverable/ Due Dates</b>
<b>Week 1</b> 8/22	1.1 Introduction	Notes	
<b>Week 2</b> 8/29	1.2 Introduction 2.1 Vacuum Technology	Notes, Ohring Ch2	
<b>Week 3</b> 9/5	2.2 Vacuum Technology 3.1 Film Growth and Phenomenology	Notes, Ohring Ch2 Notes, Ohring Ch3	Problem Set 1 is posted
<b>Week 4</b> 9/12	3.2 Film Growth and Phenomenology	Notes, Ohring Ch3 Notes, Ohring Ch4	Problem Set 1 is due
<b>Week 5</b> 9/19	3.3 Film Growth and Phenomenology	Notes, Ohring Ch4 Notes, Ohring Ch7	
<b>Week 6</b> 9/26	3.4 Film Growth and Phenomenology	Notes, Ohring Ch8	Problem Set 2 is posted

<b>Week 7</b> 10/3	4.1 Thin Film Deposition Methods	Notes, Ohring Ch5,6	Problem Set 2 is due
<b>Week 8</b> 10/10	4.2 Thin Film Deposition Methods	Notes, Ohring Ch5,6	<b>Exam 1</b>
<b>Week 9</b> 10/17	5.1 Characterization of Films	Notes, Ohring Ch10	
<b>Week 10</b> 10/24	5.2 Characterization of Films	Notes	Problem Set 3 is posted
<b>Week 11</b> 10/31	6.1 Properties of Thin films	Notes	Problem Set 3 is due
<b>Week 12</b> 11/7	6.2 Properties of Thin films	Notes	
<b>Week 13</b> 11/14	6.3 Properties of Thin films	Notes	Problem Set 4 is posted
<b>Week 14</b> 11/21	7. Applications of Thin Films	Notes	Problem Set 4 is due
<b>Week 15</b> 11/28	8. Emergent Activities	Notes	<b>Exam 2</b>
<b>FINAL</b> Date			<b>No Final Exam</b>

### **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](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](tel: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!