



Materials Engineering 270
Methods of Thin Film Deposition
Fall 2007

COURSE OBJECTIVES

The goal of MatE 270 is to develop expertise in thin film deposition techniques. This will include understanding the physics and chemistry behind sputtering, evaporation, chemical vapor deposition, and electroplating. Upon completion of the course, you will be able to critically evaluate each technique and determine the best for certain applications. You will also be able to understand how and why the critical process parameters for each deposition technique influence thin film properties. You will understand why materials, deposition techniques, and process parameters are chosen for specific applications.

COURSE INFO

Class: Th 6:00-8:50 pm, E329

INSTRUCTOR INFO

Dr. Stacy Gleixner
408-924-4051

gleixner@email.sjsu.edu

Office Hours: Mon & Th 1-2 p.m. in E385B; Tues 10 a.m-noon in E385B; Wed 1-2 p.m. in E221

I am also available after class on Thursday evenings, by phone, or by appointment. Feel free to call or send e-mail to set up an appointment for another time if you can't come during regular office hours.

ONLINE RESOURCES

This course will conduct all of its communications outside of class using WebCT. You will be able to send questions to your instructors using WebCT for both lecture and lab. You will also be able to send messages to the rest of the class and to both sections. All of the online resources such as homework and exam solutions will be at WebCT. To get into your account at WebCT you must be enrolled in the course. Go to the WebCT site to start your account now!

REQUIRED TEXT

Thin Film Deposition: Principles & Practices, by Donald L Smith, McGraw Hill Inc (1995). ISBN: 0-07-058502-4

Another good text with similar material: Materials Science of Thin Films: Second Edition, by Milton Ohring, Academic press (2002). ISBN: 0-12-524975-6

ACADEMIC HONESTY

Your own commitment to learning, as evidenced by your enrollment at San Jose State University, and the University's Academic Integrity Policy, requires you to be honest in all your academic coursework. Faculty members are **required** to report all infractions to the Office of

Student Conduct and Ethical Development. The policy on academic integrity can be found at http://sa.sjsu.edu/student_conduct.

Strict standards of academic honesty will be enforced in this class. Students who plagiarize any portion of their lab reports will receive an F (0) on that report with no chance of make-up and be reported to the University. Plagiarism constitutes copying *any portion* of report from textbooks, papers, websites, previous years' reports, or the reports of other students. Homework assignments that you turn in must have been worked out entirely by you. You can study with friends and work out the problem together, but you must then independently work it through and record your own work. *Students who provide their homework or reports to other students such that they can be copied are also committing a breach of academic honesty. This includes leaving your work on shared computers, leaving your flash drive where others can copy it, etc.* If you wish to help other students learn the material, studying together is acceptable as long as each individual goes on to produce their own independent work.

For more information about avoiding plagiarism in written reports, see: <http://www.indiana.edu/~wts/wts/plagiarism.html>.

IN CLASS ACTIVITIES & READING DISCUSSIONS

There will be frequent in class activities. You are expected to come to class prepared to participate. To do this, review your lecture notes from last time and complete the assigned readings. Also, bring a calculator. We will begin each class with a discussion of the assigned readings. Please come prepared with at least one question to talk about with the class. There will also be a number of invited guest speakers to the class. Your attendance and active participation (in the form of questions) is required.

WEBCT DISCUSSIONS

We will be using the WebCT discussion board to continue to learn and apply the material outside of class. All students are expected to participate in the discussions. To participate, you can post questions, answer other postings, or refer students to related links and applications you found. Full participation would be a minimum of one thoughtful posting per week.

HOMEWORK

Homework must be submitted on the due date by the start of class period. No late assignments will be accepted. Your name must be listed in the upper right hand corner of the assignment. You are encouraged to work together on the assignment. However, you must pass in individual homework solutions. You are required to list the names of the students you worked with below your name in the upper right hand corner of your packet. Groups can be no larger than 3 students. If similar solutions are passed in by multiple students but they do not state they worked together, all the students will receive a 0 on that assignment.

You must have actively participated in solving everything you pass in and have a full understanding of the solution you submitted. Copying partial or complete answers from other students is unacceptable. You will receive a 0 on the assignment and be reported to the University if you copy any portion of the homework or if you allow your homework to be copied.

Test questions will target material learned through the homework. If you do not fully understand the solutions you pass in, you not only risk getting a 0 on that assignment but you will not be able to answer the related questions during the tests. This will significantly affect your overall grade! **Come to office hours if you are having trouble doing the homework yourself.**

PROJECTS

In order to develop expertise in the diverse field of deposition, three projects have been designed to investigate the field from several different angles. Your papers/presentations must be well written. They will be graded on both content and speaking/writing quality.

INDIVIDUAL REPORT: MATERIALS DEPOSITION IN A SPECIFIC INDUSTRY

A 4-6 page report (12 point font) is due at the start of class on 9/13. You will then be given a fellow students report to review. You will be able to revise your report based on the review. On 9/27 you must turn in the original paper, the review, and your revised paper.

In this report, you will detail how thin film deposition is used in an industry. You may choose any industry **except the integrated circuits industry**. Some possible industries you could use are magnetic hard drives, MEMS (microelectromechanical systems), biomedical (coatings for surgical tools and implants), energy (fuel cells, H storage), machining (coatings for parts and tools), or aerospace (heat resistant coatings for satellites and shuttles). You must use at least three technical journal articles (not websites). Your paper should include:

- an introduction to the field
- what materials are deposited (and why)
- what deposition techniques are used and why those specific techniques are preferred
- some areas that are being researched in this field (like alternative materials or deposition techniques)
- references (proper notation is required: use the CME thesis guideline format)

GROUP ORAL PRESENTATION: ALTERNATIVE MATERIALS/ ADVANCED RESEARCH TECHNIQUES

A maximum 20 minute group presentation will be given. Your topic, a list of references, and the planned division of work are due on 9/13. On 9/20, you will be assigned your presentation date. The talk needs to discuss one current thin film deposition advanced research topic from several different angles. Some ideas are to investigate alternative materials such as high κ or low κ dielectrics; new deposition techniques that are being invented such as atomic layer epitaxy; or issues important to manufacturing in a certain industry such as environmentally friendly manufacturing or large scale production. The content of your talk must be based on at least 6 technical journal articles (not websites). Your talk must use PowerPoint and should cover:

- introduction & background specific to your industry, material, and technique
- in depth discussion of the different components (such as material options, deposition techniques)
- summary/ conclusion

GROUP PAPER: DIFFERENT DEPOSITION TECHNIQUES

You will be assigned groups of three. A 10-15 page paper (12 point font) is due on 10/18. Your topic, a list of references, and the planned division of work are due on 11/29. Your group needs to discuss three different ways to deposit the same film (for example: silicon dioxide that is thermally grown, sputtered, and deposited via CVD). Your paper must use at least 6 technical journal articles (not websites). The paper should cover:

- introduction to your material: when and why it is used, what film properties are important (like uniformity, resistivity...)
- discussion of each deposition technique including equipment and process parameters
- comparison of the different techniques: what are the advantages and disadvantages of each technique, what applications use which techniques...
- topics being researched on this material (alternative techniques, optimizing process parameters...)
- summary/ conclusion
- references (proper notation is required: use the CME thesis guideline format)

GROUP DYNAMICS

You need to plan in advance (and pass in with your topic and references) how the work will be divided. This includes administrative tasks such as who will coordinate and run the meetings, who will piece together the presentation or report, who will do the proofreading or editing. The content should be divided up so that each person is researching one specific area as well as preparing another section of the report (such as the introduction, comparison of the different topics, summary, references...). The assignments will be graded based on content and the professional quality of your presentation or report. They must appear to be a group effort. All overheads and sections of the written report must use the same format, the sections must flow well together, and the project must be proofread. Your individual grade for the group presentation and report will be a scaled version of the overall group grades for these assignments. The participation of each team member will be evaluated on the due date of the assignment by myself and the other teammates. Detailed team performance guidelines and grading criteria will be handed out prior to the due date of these projects.

TURNITIN.COM

All papers must be completely written in your own words. It is not acceptable in engineering technical writing to copy directly from a source, even if you reference the source. All papers must be submitted to turnitin.com before the due date (as well as submitting a hard copy in class). The papers will not be graded until they are uploaded. Instructions for turnitin.com are:

1. Go to www.turnitin.com
2. If you don't already have an account, click on "Crate a user profile"

To add this course,, click on "Enroll in a course" and use:

class ID:	1960087
enrollment password:	deposition

GRADING METHOD

Course Element:	% of Course Grade:
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Homework	10%
In-class activities	5%
WebCT Discussions	5%
Individual Report	10%
Team Oral Report	10%
Team Written Report	10%
Midterm	20%
Final Exam	30%
Total	100

Total Course Score	Letter Grade
≥ 90	A-
≥ 80	B-
≥ 70	C-
≥ 60	D-
< 60	F

Plusses and minuses will be added for students earning A, B or C and falling within the top or bottom 3 points of the grade range, respectively.

ACCOMMODATION FOR STUDENTS WITH DISABILITIES

If you need course adaptations or accommodations because of a disability, or if you need special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with DRC to establish a record of their disability.

Frequently Asked Questions on WebCT

(designed by Professor John Lee, MAE)

1. **Where do I log in?** The appropriate login page is <http://sjsu.webct.com/>. Logging in from this site will display all courses for which your WebCT ID is active.
2. **What is my WebCT ID?** Your WebCT ID is the same as your SJSU ID, W followed by 7 digits. For example, "W1234567". DO not use, for example, "001234567". The WebCT ID is case sensitive, so uppercase W is required.
3. **What is my password?** Your password by default is the current semester, for example "fall" or "spring". However, if you have used WebCT for a different class in the recent past, the password may be as you left it previously. Password is case sensitive. You should change the password the first time you log in.
4. **Why am I unable to log in?** If you get the message "You entered an incorrect username or password." even though you are sure you are using the right WebCT ID and password, it is possible your SJSU ID was never entered into the WebCT global database, or it may have gotten deleted after the end of a semester. In this case send email to your instructor with your SJSU ID and specifically mention the error message.
5. **Why can't I access my class even though I can log in?** You have to be activated within in each relevant WebCT class. Even though you may be registered in a class according SJSU Records and Registration, the instructor may not have activated your WebCT ID. In this case contact the instructor, give your SJSU ID, and state that you are able to log into WebCT but are unable to access the particular class.
6. **How do I change my password?** As soon as you log in, the very next welcome screen (that lists all your WebCT-registered classes) has a button labeled "Password settings".
7. **Is my password the same for all my classes?** Yes. Your WebCT ID has one password, and the same password works for all classes for which your WebCT ID is valid.
8. **How do I autoforward WebCT Mail?** At the top level of the Mail tool in WebCT, there is a button called "Message settings", from which you can specify any external email address (gmail, yahoo, hotmail, etc.). Autoforwarding is highly recommended because it saves you from having to log in to WebCT in order to receive messages.
9. **Why can't I download the file associated with a link?** Two common reasons: (1) The instructor has to issue a fresh "Update" command. (2) Your browser or firewall needs your permission before downloading. In Case 1, send an email to the instructor and include the specific error message. In Case 2, check your browser's download restrictions; Internet Explorer often displays a message toolbar under the menu bar.
10. **Can I create my own WebCT ID?** The user interface allows you to create one, but in general your class instructors will only use the official one that matches your SJSU ID. So in general it is pointless to create an arbitrary new WebCT ID.
11. **Why can't I add my class even though I've logged in?** In general your WebCT ID is recognized in a class only if it was pre-loaded based on SJSU Records and Registration or if your instructor specifically added your WebCT ID to the course. In most cases you can not add yourself to a course.
12. **How do I include the original message when replying to WebCT Mail?** When viewing a message, use the "Quote" button rather than the "Reply" button. To send to multiple recipients, use the "Forward" button instead.
13. **Why can't I download the attachment in a WebCT Mail message forwarded to my external mail?** Forwarded messages from WebCT Mail don't actually contain the attachment. This is a limitation, but also a benefit in terms of managing disk space and protecting against malicious email content.
14. **Where can I get more help?** If your question is not answered in these frequently asked questions, you should contact the help services at <http://online.sjsu.edu/>.

CLASS SCHEDULE

Date	Topic	Assigned Reading	Assignments Due
Week 1 8/23	Overview of Thin Films in Microelectronics Review of Materials Science Thermo and Kinetics	Ch 1	
Week 2 8/30	Gas Kinetics & Vacuum Science	Ch 2 & 3	
Week 3 9/6	Evaporation, MBE	Ch 4	PSE 1
Week 4 9/13	Physics and Chemistry of Deposition	Ch 5 & 6	Individual Report Due Group Oral Topics & Ref Due
Week 5 9/20	Thermodynamics & Kinetics of CVD	Ch 7	Review of Individ Report Due
Week 6 9/27	CVD	Ch 7	PSE 2 Revised Individual Report Due
Week 7 10/4	Midterm		Midterm
Week 8 10/11	Electroplating	Handouts	
Week 9 10/18	Plasma background Industry Speaker: Materials Issues in Microelectronics	Ch 8 & 9	PSE 3 Group Paper Topic & Ref Due
Week 10 10/25	PVD: Sputtering Group A presentations	Ch 8 & 9	
Week 11 11/1	PECVD Group B presentations	Ch 8 & 9	PSE 4
Week 12 11/8	Etching and cleaning issues in deposition Group C presentations Industry Speaker: Deposition and Applications of C Nanotubes	Handouts	
Week 13 11/15	Factors in Research and Design of Reactors	Handouts	
Week 14 11/22	No Class: Thanksgiving Holiday		
Week 15 11/29	Evening at Stanford: Tours and Talks on Advanced Deposition Techniques	Handouts	Group Final Paper
Week 16 12/6	Materials Analysis	Ch 10	PSE 5
12/13	Final: Thurs 12/13: 5:15-7:30pm		