Engineering Faculty Document No. 25-02
November 4, 2002

TO: Engineering Faculty
FROM: The Faculty of the School of Materials Engineering
RE: New Dual-Level Course, MSE 548

The faculty of the School of Materials Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

MSE 548 Deposition Processing of Thin Films and Coatings
Sem. 1. Class 3, cr. 3 (Offered in Alternate Years)
Prerequisite: senior or graduate standing.

Processing and microstructural development of thin films and layered structures. Includes vapor, liquid, and reactive processing, as well as layer modification by annealing and beam techniques.

Reason: This class has now been offered three times with good enrollment, in Fall 1995 (29 students), Fall 2000 (25 students), and Fall 2002 (29 students). The School of Materials Engineering has a strong emphasis on materials processing. The purpose of this course is to develop the processing background for the films, layers, and coatings that are heavily used in all engineering and science areas, and are in virtually every final product. This course introduces the student to what types of films exist and how they are made, with some coverage of the film structures, how they behave, and how they can be analyzed. The processing and microstructural development of films and layered structures are examined. This includes vapor, liquid, and reactive processing, as well as layer modification by annealing and beam techniques. Applications from heterojunctions to hotplates and lenses to lithography are discussed.

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Alexander H. King
Head, School of Materials Engineering

MSE 548

Deposition Processing of Thin Films and Coatings

Processing and microstructural development of films and layered structures. Includes vapor, liquid, and reactive processing, as well as layer modification by annealing and beam techniques.

Goals

Students should be familiar with all major inorganic film deposition processes, and their basic function.

Students should be able to predict the most likely microstructure(s) developed by any of these processes, and be aware of how that microstructure could be assessed.

Objectives

List the detailed sequence of steps required for CVD (or sputter or MBE) film deposition, and quantify the parametric dependence of these steps.

Explain the process and film requirements to produce an epitaxial (or columnar or amorphous) film.

Discuss the differences between different evaporation processes.

Compare the advantages and disadvantages of techniques used to suppress reactivity (a) of the materials during deposition and (b) of the material with the substrate.

Explain the importance of materials and process parameters during laser annealing.

List material and process critical factors for specific films in at least three different functional classes of film applications.

Communicate in detail the importance, use, and production method of a particular functional film in a manner understandable by other students.

Explain the importance and critical issues involved in the following film deposition processes: CVD, PVD, Electrochemical, thermal spray, lithography.

Explain the broad issues involved in processing each different type of material class: metals, ceramics, polymers, semiconductors, composites, and functionally graded materials.

Assessment

Performance is assessed by homework assignments, a midterm and final examination, and a term paper.

Evaluation

Students will be evaluated based on one or two mid-term examinations, a term paper, and a final examination.

Feedback

Provided by anonymous written evaluation by students at the conclusion of the course.

Textbook

"The Materials Science of Thin Films, Deposition & Structure", by M. Ohring, 2nd ed., 2002, Academic Press, ISBN #0-12-524975-6.

Course Outline (Approximate Lecture Hours)

I. Introduction
- Thermodynamics and Kinetics (3)
- Surfaces and Interfaces (1.5)
- Vacuum Systems (1.5)

II. Vapor Deposition
- Physical Vapor Deposition
  - thermal evaporation (3)
  - ablation (1)
  - sputtering, plasma (4)
- Chemical Vapor Deposition
  - vapor delivery (3)
  - reactions and kinetics (2)

III. Microstructure and Analysis
- important features (2)
- analysis methods (5)

IV. Surface Modification
- spin coating, lithography (2)
- molecular self-assembly (1)
- reactive film formation (5)
  - oxidation
  - sol-gel
  - film/substrate reactions
- process integration (1)
- diffusion/electromigration (1)

V. Liquid-Solid Deposition
- Liquid Phase Epitaxy (1)
- Electrodeposition (2)
- Thermal Spray (2)
- Liquid Spray (1)