EMA 5001 PHYSICAL PROPERTIES OF MATERIALS
Spring 2016

Basic Information

Instructor: Dr. Zhe Cheng Phone: 305-348-1973 Email: zhcheng@fiu.edu
Office: EC3172 Office Hours: Mon, Wed, Fri 9:00-10:00 and 13:00-14:00
Class Hours: Mon, Wed, Fri 12:00-12:50
Classroom: EC1109
Prerequisite: undergraduate-level materials/engineering thermodynamics
Time offered: Spring of each year

Course Description

The physical properties of materials, focusing on principles of **kinetics** and **phase transformation** for engineering materials and their applications.

Course Objective

The main objective of EMA5001 Physical Properties of Materials is to introduce graduate-level principles and practical applications of kinetics and phase transformation for engineering materials involving phenomena including diffusion, movement of interfaces, solidification, and nucleation and growth. The course also aims to provide graduate-level training in critical thinking, mathematical analysis, and written communication skills focusing on problems of interests involving kinetics and phase transformation of engineering materials

Learning Outcomes

Through this course, students will be able to apply the principles learned in the class to solve theoretical and practical engineering problems regarding to diffusion, solidification, nucleation and growth across different engineering materials for various applications including electronics, clean energy, mechanical and thermal load bearing parts, etc. Students will recognize the limitation of thermodynamics and learn to apply knowledge in kinetics in materials processing to control desired physical properties. Finally, students will also develop the capability to critically read literature, analyze the methods used and data obtained, and propose new research questions/hypothesis through written communications.

Contents Covered

- Diffusion phenomena and theory
- Interfacial phenomena
- Solidification and nucleation
- Diffusion-based phase transformation
- Diffusionless phase transformation
- Kinetic models for phase transformation

Textbook & Other Course Materials

- Phase Transformations in Metals and Alloys, D A Porter, K E Easterling, and M Y Sherif, 3rd edition, CRC Press, (2008). ISBN 978-1-4200-6210-6 (0)
- Class notes
- Other reading materials as assigned

Grading

- Homework (10%, must be printed)
- Term paper (30%)
- Mid-term exam (30%, tentative 03/04/2016, 1st half of course content)
- Final exam (30%, 05/06/2016 at 9:45-11:45 in EC1109, 2nd half of course content)
- Final grades: A: >=90; A-: 87.0-89.9; B+: 84.0-86.9; B: 80-83.9; B-: 77.0-79.9; C+: 74.0-76.9; C: 70-73.9; C-: 67.0-69.9. D+: 64.0-66.9; D: 60-63.9; D-: 57.0-59.9; F: <57

Course Policy

- Attendance required; Turn off cell phone/pagers during class
- Students can discuss homework problems, but must independently finish it
- Grade discrepancies – resolve within the next day
- Homework will be collected; solution typically in textbook
- Accommodate "make-up" quiz, tests, or delayed term paper if proven medical necessity
- Accommodate disability (http://drc.fiu.edu/) and religious holidays
- NO cheating or plagiarizing in ANY form (Check with me if questions)
  - No excuses will be accepted
  - Will be reported and handled according to FIU policy
- Additional notes about plagiarism
  - Plagiarism in any form (e.g., use without citation, excessive use even with citation) are not tolerated and NO excuses will be accepted
  - All students are strongly encouraged to review FIU guidance about plagiarism at the following sites as well as other relevant sites:
    - **http://education.fiu.edu/plagiarism/**
    - **http://libguides.fiu.edu/plagiarism**
    - **http://www.plagiarism.org/plagiarism-101/what-is-plagiarism/**

Tentative Schedule (2016 spring)

Week	Hour	Cumulative hour	Tentative Content	Tentative Subcontent
1	2.5	2.5	Introduction/Diffusion	Introduction; Interstitial diff & Fick's 1st Law
2	1.67	4.2	Diffusion	Fick's 2nd law & solutions, Random walk model
3	2.5	6.7	Diffusion	Self and vacancy diff, Substitutional diffusion, Diffusion coefficent and mobility
4	2.5	9.2	Diffusion	Matano analysis; Short circuit diffusion; Reaction diffusion
5	2.5	11.7	Diffusion	Ambipolar diffusion; Review
6	2.5	14.2	Interfaces	Surface and Grain boundaries
7	2.5	16.7	Interfaces	Coherent and incoherent interfaces; Shape of precipitates
8	2.5	19.2	Interfaces	Review; **Midterm exam (tentative 03/04/2016)**;
9	2.5	21.7	Liquid-solid phase transform	Homogenous and heterogeneous solidification and solidification of alloys
10	0	21.7		Spring break, no class
11	2.5	24.2	Liquid-solid phase transform	Constitutional supercooling, Casting
12	2.5	26.7	Solid-state phase transform	Homogeneous & Heterogeneous nucleation
13	2.5	29.2	Solid-state phase transform	Growth; Spinodal decomposition, Coarsening
14	2.5	31.7	Solid-state phase transform	Massive, Order-disorder, Martensite transformation
15	2.5	34.2	Kinetics	Kinetic models and examples; Review
16	2.5	36.7	Flexible	
17	0	36.7		**Final exam (05/06/2016)**

Term Paper Guidelines

- Deadlines & Submission (Email submission only)
  - **03/11/2016**: 1st draft
  - **04/08/2016**: 2nd draft
  - **04/29/2016**: Final submission
    - Term paper plus major references and responses to reviewers' question/comments
- Format of Main Document
  - Times New Roman, 12 point (Figures/table may use smaller font), single space, 1 inch margin on all sides, print double-sided
  - 4 pages maximum excluding references
- Peer review process
  - Term papers (1st and 2nd version) will go through "review" process by lecturer (Dr. Cheng) and fellow students to provide feedbacks/critiques for further improvement
- Grading
  - Missing deadline: zero
  - 4 points for 1st draft
  - 4 points for 2nd draft
  - 12 points for final term paper
  - 5 points for quality of "review" provided to other students' paper (2 reviews)
  - 5 points for answering/rebutting "peer review" questions/comments
- Content
  - A detailed critique of at least two or more research papers (**must be by different research groups**) on a single problem/topic involving kinetics and/or phase transformation in materials in a specific area of interest to you.
  - It should have most of the following (but NOT necessary all)
    - Introduction
    - Background
    - Analysis/critiques on
      - Significance and why you are interested
      - Assumptions/Methodology/Mathematical derivation/Argument/Logic
      - Experimental design, data collection and analysis
      - Consistency and/or contradictions between different studies
      - Unanswered questions
      - Your own analysis/proposed research method or data analysis
    - Recommendations for future work
    - Conclusions
    - References
    - Declaration of no plagiarism

Related MME Program Outcomes

(a) Ability to apply knowledge of mathematics, science, and engineering
(e) Ability to identify, formulate, and solve engineering problems
(g) Ability to communicate effectively
(i) Recognition of the need for, and an ability to engage in life-long learning
(k) Ability to use the techniques, skills and modern engineering science necessary for engineering