KINETICS OF MATERIAL PROCESSES (3 credits) 635:307

Instructor: Lisa C. Klein, COE A225, 732-445-2096, licklein@rci.rutgers.edu

Prerequisites (by topic): Crystal Chemistry, Thermodynamics, Differential Equations

COURSE TEXT:

Required: M. W. Barsoum, FUNDAMENTALS OF CERAMICS, Institute of Physics, 2003 (primarily Chapters 6-10).

Course Objectives:

The objectives of this course are to provide the student with the following competencies:

- a. understanding a phenomenological approach to the solid state reactions involved in materials processing
- b. understanding the underlying phenomena for phase transformations and sintering
- c. understanding mechanisms and transport phenomena and their relationships to microstructures.
- d. understanding the empirical basis for Fick's Laws
- e. understanding the concepts of metastability and driving force for transformation
- f. understanding the role of nucleation and crystal growth in phase transformations
- g. understanding structure/property/processing relationships in materials.

Course Format:

This course is lecture format.

Assessment of Outcomes:

Student progress is assessed by frequent homeworks and in-class tests. Outcomes are assessed formally through examinations and student evaluation forms.

Relationship to Program Objectives:

This course contributes to integrating fundamental concepts in a manner that balances science and engineering. This course integrates chemistry and physics with processing of materials. This course complements the courses on thermodynamics and phase diagrams. With respect to ABET proficiencies it contributes to (a), (c), (e), (h), (i), and (l) through the use of real world examples and use of the scientific literature.

Course Outline

Week 1 Introduction: Goals of the Course **Defects in Materials** (Chapter 6)

Week 2	Point defects, Kroger-Vink notation
	Dislocations, Grain Boundaries
Week 3	Surfaces (Definition 4.5)
	Capillarity and Contact Angles
Week 4	Diffusion (Chapter 7)
	Quiz 1 on <u>Chapters 2-6</u>
Week 5	Non-Steady State Diffusion
	Diffusion in ionic solids
Week 6	Diffusion in solids
	Ionic conductivity
Week 7	Oxidation and parabolic rate laws
	Phase Equilibria (Chapter 8) Solid Solutions
Week 8	Quiz 2 on Chapter 7
	Kinetics (Definition 5.8)
Week 9	Nucleation
	Crystal Growth
Week 10	Glass Formation (Chapter 9)
	Precipitation
Week 11	Phase Separation
	Spinodal Decomposition
Week 12	Sintering and Grain Growth (Chapter 10)
	Initial Stage Sintering
Week 13	Intermediate Stage Sintering
	Quiz 3 on Chapters 8 and 9
Week 14	Final Stage Sintering
	Liquid Phase Sintering, Pressure Assisted Sintering

Finals Week FINAL EXAM (3 hours)

GRADING CRITERIA:

The grade in this course is made up of 8 problem sets (30%), 3 quizzes (45%) and a final exam (25%). Without prior approval, late homework will not be accepted after the end of class. Problem sets can be solved as a group, but quizzes and the exam must be individual efforts. Regular attendance is expected. Class participation is encouraged.