MASC 504: Diffusion and Phase Equilibria
Spring 2016

Lectures: Monday and Wednesday 2:00 – 3:15 PM, OHE 100B

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Objectives: The objective of the course is to introduce the science and applications of thermodynamics and kinetics in materials systems. Specifically, we will address the relevance of thermodynamics and kinetics for the synthesis, physical properties and phase evolution in these systems. The content will cover a range of materials systems with the primary focus on metals, alloys, ceramics, and covalent semiconductors. Special topics on polymers, quasi-crystalline, and metastable phases will also be included.

Books: Lecture slides will be provided and will contain all the information and necessary references to learn the material. In some cases, lecture notes and excerpts from textbooks will be supplemented. Significant material will be covered from these two textbooks.

1. Phase Transformations in Metals and Alloys by David Porter and Kenneth Easterling. ISBN: 9781420062106
2. Diffusion in Solids: Fundamentals, Methods, Materials, Diffusion-controlled Processes by Helmut Mehrer. ISBN: 9783540714866.

The following books are recommended for advanced reading.

Recommended list of books:

1. Kinetic Processes: Crystal Growth, Diffusion and Phase Transitions in Materials by Kenneth Jackson. ISBN: 9783527327362
2. Phase Transitions in Materials by Brent Fultz. ISBN: 9781107067240.
3. Phase Diagrams and Heterogeneous Equilibria by Bruno Predel, Michael Hoch and Monte Pool. ISBN: 9783662092767
4. Diffusion in Condensed Matter: Materials, Methods, Models by Paul Heitjans and Jorg Karger. ISBN: 9783540720812

Course website:

We will use the Desire2learn website for all the students enrolled in the class (on campus and DEN). The link to the site is: https://courses.uscden.net/d2l/login. If you have any

trouble registering and accessing the website, please contact the DEN@Viterbi technical support at dentsc@usc.edu or 213-740-9356.

Modeling/Simulation:

The course will have small simple modeling exercises, typically in the form of simple programs using Matlab or Mathematica. These exercises will be aimed at helping you visualize diffusion profiles *etc.* and so, they are not expected to be extensive programming exercises. If you have trouble using either of these softwares, and prefer to use a different one, please get in touch with the instructor at the beginning of the class.

Grading:

Exams (2):	30% each	=	60%
Problem Sets (4) and Class participation		=	40%

Topics covered:

1) Introduction:

Kinetics and thermodynamics; Basics of Phase Transitions and Transformations.

2) Phase diagrams:

Theory of phase transitions; classifications; single component phase diagram, binary and ternary Phase diagram.

3) Diffusion:

Continuum theory of diffusion; defects and mechanisms of diffusion; mass diffusion in different materials systems (metals, alloys, semiconductors, ionic crystals and amorphous materials); beyond mass diffusion; applications of diffusion.

4) Crystals and Interfaces:

Coherent and incoherent interfaces; Grain boundaries; Domain boundaries.

5) Phase Transformations:

Nucleation and Growth; Diffusional and Diffusion-less transformation; Precipitation; Bulk processing of materials and low dimensional materials processing.

5) Meta-stability and advanced topics:

Amorphous Materials; Non-equilibrium materials processing.

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 exact 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 4 problems. The exams will be 1 hour each and will have 4-5 problems.

Tentative Timeline:
Jan 11 – First class
Jan 18 – No class (Holiday)
Jan 20 – No class (Travel)
Jan 27 – 1st problem set will be posted (For syllabus covered between Jan 11 - Feb 1)
Feb 10 – 1st problem set due in class
Feb 15 – No class (Holiday)
Feb 22 – No class (Travel)
Feb 24 – 2nd problem set will be posted (For syllabus covered between Feb 3 - 24)
Mar 7 – 1st Exam (For syllabus covered till Mar 2)
Mar 9 – 2nd problem set due in class
Mar 14 – No class (Spring break)
Mar 16 – No class (Spring break)
Mar 23 – 3rd problem set will be posted (For syllabus covered between Feb 29 - Mar 23)
Apr 4 – 3rd problem set due in class
April 11 – 4th problem set will be posted (For syllabus covered between Mar 28 - Apr 13)
April 25 – 4th problem set due in class
April 27th – 2nd Exam (For syllabus covered between Mar 9 - Apr 25)

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

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) 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!