(Materials) Kinetics (MAT 206)

Spring 2022

Course motivation: Understanding the effect of reactions and transformations in evolving material systems. While thermodynamics tell us what the final state should be, kinetics tells us if and how the system will reach its final state. The details for how quickly or in what manner the system evolves would guide you in determining the processing of a material. Such information would also help you predict if the performance of your material would be stable during its operational lifetime. This semester we will apply kinetics in the context of understanding and controlling microstructural evolution in solid state materials.

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Office: SUNUM 1120 - 216/483-9000 (2404)

Lecture hours: Mondays 13:40-14:30 - FASS G006 (Zoom: Meeting ID: 996 6572 7787, Passcode: 715992)

Fridays 12:40-143:30 - FENS G035 (Zoom: Meeting ID: 996 6572 7787, Passcode: 715992)

Office hours: By appointment.

Midterm: 29 April 2022 (Lecture hour)

1. Lecture notes: Take notes during lecture. Only selected parts of my lecture notes will be posted onto SUCourse.

2. Exams: There will be one midterm exam. Additionally, there will be short quizzes in some lectures.

3. Term project: You will have an opportunity to demonstrate a deeper understanding of course concepts in a term project. Topic list will be posted after the Add/Drop date.

4. Grading: 40% of your course grade will be determined from the term project, 30% from in class quizzes and 30% from the midterm exam.

5. Textbook: There will not be an official course textbook. Instead, we will be developing the course from several texts, which are listed in the Course References below.

6. Course References (Supplemental reading): all items are available at the IC

a. Kinetics of Materials, by Dennis W. Readey

b. Thermodynamics of Materials, Vol. 2, by David V. Ragone

c. Phase Transformations in Metals and Alloys, by D.A. Porter & K.E. Easterling

d. Kinetics of Materials, by Robert W. Balluffi, Sam Allen, W. Craig Carter

e. Physical Chemistry, by Peter W. Atkins

7. Learning Outcomes:

a. Be able to describe atomistic models of diffusion, their practical validation, and their use in applied studies

b. Be able to build models of evolving surfaces and interfaces in the context of thermodynamic descriptions

c. Be able to describe the model of nucleation and growth for homogeneous and heterogeneous systems

d. Be able to describe models for diffusionless transformation and apply these models in practical application

Course Syllabus: (Tentative plan)

Week starting with	**Topic**
28 February 2022	Thermodynamics of solutions
7 March 2022	Equilibrium phase diagrams & chemical potential of solutions
14 March 2022	Equilibrium phase diagrams & chemical potential of solutions
21 March 2022	Diffusion
28 March 2022	Diffusion
4 April 2022	Surfaces and Interfaces
11 April 2022	Solidification & Nucleation
18 April 2022	Solidification & Nucleation
25 April 2022	Motion & Reaction Rates **Midterm:** 29 April 2022
2 May 2022	Motion & Reaction Rates
9 May 2022	Motion & Reaction Rates
16 May 2022	Reaction Dynamics
23 May 2022	Reaction Dynamics
30 May 2022	Term Project Presentations