

MS/ME 503 Kinetic Processes in Materials

Spring 2025

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Lectures: M, W: 10.10AM – 11.55AM

Location: CAS B20

Office hours: 2-3 PM Fridays

Required Textbook:

Materials Kinetics Fundamentals: Principles, Processes, and Applications, Ryan O'Hare, John Wiley and Sons Inc., 2015

Other Suggested Readings:

Essentials of Materials Science and Engineering, D. R. Askeland, and P. Phule

Diffusion in Solids, P. G. Shewmon

Chemical Kinetics, K. J. Laidler

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

Grading:

There will be 2 midterms and a final. The final is NOT cumulative. Midterm 1 will cover Lectures 1-7, and Midterm 2 will cover Lectures 8-14. The Final will cover the remaining lectures.

Grading will be as follows:

Midterm I	-	30%
Midterm II	-	30%
Final exam	-	30%
Homeworks	-	10%

Homeworks:

3 HW sets will be handed out, one for each exam (each will have the same lecture coverage as one exam). Solutions must be submitted by the deadline to get credit. Solution sets will be handed out and will be discussed in the lecture before each exam.

Academic Conduct Code:

BU's Academic conduct code can be found at:

<https://www.bu.edu/academics/policies/academic-conduct-code/>

In this class, discussing strategies to solve HW questions with others is permitted, but direct copying of solutions from others can lead to disciplinary action. Copying from other students and/or from unauthorized sources in the exams will lead to disciplinary action.

Syllabus

I THERMODYNAMICS VERSUS KINETICS

Introduction to chemical thermodynamics	1 lecture
Phase diagrams, driving force, flux	1 lecture

II KINETICS OF MASS TRANSPORT

Fick's Laws and solutions to Fick's laws	3 lectures
Interdiffusion, types of diffusivities	1 lecture
Diffusion and chemical potential, multipath diffusion	1 lecture
Atomistic models of diffusion, tracer diffusion	1 lecture
Diffusion in ionic crystals	2 lectures

III KINETICS OF CHEMICAL REACTIONS

Order of reaction, kinetics of gas/solid reactions	1 lecture
Mixed rate control, CVD, vapor phase etching	1 lecture

IV KINETICS DRIVEN BY MICROSTRUCTURE

Surface curvature, Gibbs Thompson effect	1 lecture
Grain growth, particle coarsening, sintering	1 lecture
Surface energy anisotropy	1 lecture

V KINETICS OF PHASE TRANSFORMATIONS

Nucleation and growth	2 lectures
Solidification	1 lecture
Spinodal decomposition	1 lecture