

UNIVERSITY OF ILLINOIS
College of Engineering
Department of Materials Science and Engineering

Spring 2025: **MSE 402**
KINETIC PROCESSES IN MATERIALS

Instructor	Pascal Bellon, 312D MSEB, 265-0284, bellon@illinois.edu
TAs	Soumyajit Jana, sjana3@illinois.edu Guanhua Qiao, gqiao4@illinois.edu Gillian Nolan, gnolan2@illinois.edu (computational modules)
UG-TA	Christian Papachristodoulou, ccp5@illinois.edu
Lecture	Tu-Th 9:30 – 10:50 am, Room 1024 Chemistry Annex
Recitation	Tu 5:00 – 6:30 pm (1024 Chemistry Annex): Quizzes (5-5:45 pm): 2/4, 2/18, 4/1, 4/15, 4/29 Assignments due by 5 pm: 1/31, 2/14 (CM1), 2/28, 3/28 (CM2), 4/11, 4/125 Problem reviews: 1/28, 2/25, 3/4, 4/8, 4/22 Overview for computational modules: 2/11(CM1), 3/25 (CM2)
Office Hours	Pascal Bellon: 4 - 5 pm, Thursday, 312 MSEB and by appointment TAs: 5 - 7 pm, Wednesday, Sidney Lu MEB 1043 Computational modules: 5-6 pm, Wednesday and Thursday, CER 322
Websites	https://canvas.illinois.edu ; campuswire.com
Grading	1 midterm exam (Tuesday 3/11, 5-6:30 pm, TBD) = 20% 1 final exam (Tuesday 5/13, 7:00-9:30pm, TBD) = 35% In-class activities (iClicker, ...) = 10% Homework assignments (6, drop lowest) = 15% Quizzes (5, drop lowest) = 20%

There is no recitation session on Tuesday Jan. 21st evening.

There will be exam review sessions on Tuesday, March 4th and May 6th, from 5 to 6 pm.

COURSE OUTLINE (29 SESSIONS)

(relevant chapters or sections of textbooks:

RO'H=Ryan O'Hayre; P&E= Porter and Easterling

BAC=Balluffi, Allen and Carter; MEH=Mehrer)

- I. **Introduction (1 session)** (RO'H Chap. 1)
- II. **Review of thermodynamics (2)** (RO'H Chap. 2, P&E Chap. 1)
- III. **Chemical reaction kinetics (3)** (RO'H Chap. 3)
- IV. **Diffusion (8)**
 - a. Phenomenological treatment (3) (RO'H Sec. 4.0-4.4)
 - b. Atomistic treatment (2) (RO'H Sec. 4.5, P&E Chap. 2)
 - c. Diffusion in crystalline alloys (1) (P&E Sec. 2.3-2.4)
 - d. Diffusion in ionic compounds (1) (MEH Chap. 26)
 - e. Diffusion in polymers and glasses (1) (BAC Chap. 10)
- V. **Interfaces (4)**
 - a. Surfaces and interfaces (2) (RO'H Sec. 6.4, P&E Sec. 3.1-3.3)
 - b. Interfacial reactions (2) (RO'H Chap. 5)
- VI. **Phase Transformations (7)**
 - a. Nucleation and growth (3) (RO'H Sec. 6.5-6.7, P&E Sec. 4.1)
 - b. Solidification (2) (RO'H Sec. 6.8, P&E Sec. 4.2-4.3)
 - c. Spinodal decomposition (1) (RO'H Sec. 6.3, P&E Sec. 5.5.5)
 - d. Displacive transformations (1) (RO'H Sec. 6.9, P&E Chap. 6)
- VII. **Microstructural evolutions (4)**
 - a. Capillarity and coarsening (2) (RO'H Sec. 7.1-7.3)
 - b. Sintering and grain growth (2) (RO'H Sec. 7.4-7.5, P&E Sec. 3.3)

Required textbook: **Materials kinetics fundamentals**, Ryan O'Hayre (Wiley, 2015).

Additional books (Grainger reserves):

Phase transformations in metals and alloys, D. A. Porter and K. E. Easterling, 669.94P833p (online)

Diffusion in solids, P. G. Shewmon, 531.7SH5D1989

Difussion in solids, Helmut Mehrer, Springer (available online)

Atom movements: Diffusion and mass transport in solids, J. Philibert, 530.415 P536D:E

Kinetics of materials, R. W. Balluffi, S. A. Allen, W. C. Carter, 620.11292B214k (online)

Kinetic Processes: Crystal Growth, Diffusion, and Phase Transitions in Materials, K. A. Jackson, 530.136J132k2010 (online)

Kinetic theory in the earth sciences, A. C. Lasaga, 551.9L33k

Mathematics of diffusion, J. Crank, 541.341C85M1979

Physical Chemistry, R. J. Silbey, R. A. Alberty, 541.3A1148p2001

Polymer Chemistry, P. C. Hiemenz, 547.7 H532p2007

IN-CLASS PARTICIPATION

We will use iClicker for in-class participation. iClicker is a response system that helps me gain real time feedback and gives everyone a chance to participate in class. Your iClicker participation and answers will go toward your grade for in-class activities.

We will use iClicker Cloud and the iClicker Student App to submit answers during in-person lectures. Four important points:

- Make sure that you use your @illinois.edu email address when you create a “Student” account in iclicker.com.
- Make sure that you are ready to use iClicker starting on Tuesday January 21th and no later than Thursday January 30th.
- The course you want to join in iClicker.com is <https://join.iclicker.com/AKWW> .
- Your participation points will be prorated by the number of sessions for which you did not have an excused absence. The 5 lowest scores will be dropped. The points will be equally weighted between participation and correctness.

QUIZZES

There will be five quizzes throughout the semester (roughly one every two weeks), all taking place on Tuesday evenings during the recitation session. You will take these quizzes in person in class during the first 45 minutes of the recitation session on that day. Your overall quiz grade will be the average of your four best scores.

HOMEWORK ASSIGNMENTS

There will be 6 homework assignments throughout the semester (roughly one every two weeks), each due on Friday by 5 pm. Late assignments will not be graded. You will complete these assignments through the Compass website. Your overall assignment grade will be the average of your 5 best scores.

EXAMS

There will be 90 minutes midterm exam on Tuesday, March 11th, 5-6:30 pm (so during the recitation session of that week), and the final exam will take place on Tuesday, May 13th, from 7:00 to 10:00 pm, (per University schedule for final exams) in rooms that will be announced later. These exams will be in-person exams.

ABSENCES

Excused Absence Request Form: <https://forms.illinois.edu/sec/1391097089>

Regular attendance is very important for your progress and success in this course. Excuses from assessments will be considered in the following circumstances:

- (a) Illness.
- (b) Personal crisis (e.g., car accident, required court appearance, death of a close relative).
- (c) Religious observance.
- (d) Required attendance at an official UIUC activity (e.g., varsity athletics, band concert).

In all cases you must complete the online Excused Absence Request Form and upload a scan of the official written documentation explaining your absence. This form helps to organize all requests to ensure that nothing is overlooked or lost via email or more informal communications.

In cases (a) or (b) please provide some form of documentation via the online form within 2 weeks of the due date of the missed assessment, but no later than reading day (May 2). In cases of extended or unusual illness, late submission of excuse documentation will be considered. See

<http://odos.illinois.edu/community-of-care/student-assistance-center>.

In case (c) please notify the instructor by completing an Excused Absence Request form at least one week prior to the due date of the missed assessment.

In case (d) an official letter from the designated university official must be submitted via the online form at least one week prior to the due date of the missed assessment.

If you will not be able to take a quiz due to illness or any other reason, you must send email to your professor at the earliest possible opportunity. Quizzes may be rescheduled at the discretion of the instructor but may involve a new scenario.

Notwithstanding the above, at the professor's discretion you may be required to make up any excused work or attend substitute instruction or assessment.

EMERGENCY RESPONSE RECOMMENDATIONS

Emergency response recommendations can be found at the following website:

<https://police.illinois.edu/em/run-hide-fight/>. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. <http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/>.

ANTI-RACISM AND INCLUSIVITY

The intent is to raise student and instructor awareness of the ongoing threat of bias and racism and of the need to take personal responsibility in creating an inclusive learning environment.

The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to Campus Belonging Resources (<https://diversity.illinois.edu/diversity-campus-culture/belonging-resources/>). Based on your report, Members of the Office of the Vice Chancellor for Diversity, Equity & Inclusion staff will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.

ADDITIONAL IMPORTANT TOPICS

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/#confidential.

Other information about resources and reporting is available here: wecare.illinois.edu.

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: <http://studentcode.illinois.edu/>.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: <https://studentcode.illinois.edu/article1/part4/1-401/>. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Religious Observances

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at <https://odos.illinois.edu/community-of-care/resources/students/religious-observances/> to request appropriate accommodations. This should be done in the first two weeks of classes.

Disability-Related Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to <https://www.disability.illinois.edu>. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting "Request an Academic Screening" at the bottom of the page.

Family Educational Rights and Privacy Act (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See <https://registrar.illinois.edu/academic-records/ferpa/> for more information on FERPA.