

MSE 461, Fall 2021

Electronic Materials II: **Materials and Devices for Energy Conversion**

Time: M/W/F 10-10:50 am

Format: in-person

Location: 0018 CIF (Campus Instructional Facility)

Website: compass2g

Instructor: Prof. Yingjie Zhang, yjz@illinois.edu

TA/grader: TBD

Office hour (virtual only): Wednesday 11 am – 12 pm

Credit: 3 undergraduate or graduate hours

Course description: This course introduces the fundamental mechanisms of the interconversion among solar energy, chemical energy, and electricity, and the materials processing methods for energy technologies. Solid state electronic transport and liquid-phase ionic conduction are at the heart of semiconductor devices and electrochemical systems, respectively, and are traditionally taught in separate courses using different textbooks. This course will cover both areas and discuss liquid-solid interfaces. Such unified understanding is critical for the design of photoelectrochemical devices, fuel cells, batteries, and supercapacitors. The basic device structure, operation principle, and processing techniques of these advanced energy conversion systems will also be discussed.

Prerequisite: MSE 304 or Physics 460

Textbooks:

S. M. Sze and Kwok. K. Ng, Physics of Semiconductor Devices, 3rd Edition, Wiley & Sons, 2007. (ebook available at UIUC online library)

Allen J. Bard and Larry R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Wiley & Sons, 2001. (ebook uploaded to compass2g – for this course only, avoid distribution outside this course)

Course Topics:

1. Semiconductor Device Physics and Processing

Review of the physics of semiconductors

p-n junctions

Metal-semiconductor contacts

Solar cells: fundamentals and processing techniques

2. Electrochemistry

Potential and thermodynamics of electrochemical cells

Kinetics of electrode reactions

Mass transfer by migration and diffusion

Potential sweep methods

3. Energy Conversion Devices

Photoelectrochemical devices

Photocatalysis

Fuel cells

Supercapacitors

Batteries

Grading:

Homework assignments	35%
Final project report	20%
Final project presentation	10%
Final exam (take home)	35%

Formats of assignments:

Homework, final project, and final exam will all be posted as "Assignment" in compass2g. They will need to be submitted electronically via compass2g by the deadline specified for each assignment. All of the files need to be pdf. They can be either scanned from hand-written papers, or directly generated electronically. In any case, the submitted pdf files must be clearly legible, in order to receive proper grades.

Late policy:

Homework, final project report, and completed final exams turned in within 24 hours after the deadline will be given 50% score. After 24 hours past the deadline, 0% score will be given.

COVID-19 policy:

Please show your **Building Access Status in the Safer Illinois app** or the **Boarding Pass** to the instructor every time you enter the classroom (0018 CIF). **Only the students whose Building Access Status says "Granted" will be allowed to join the classroom.** Students

are required to show only the Building Access Screen, which shows compliance without specifying whether it was through COVID-19 vaccination or regular on-campus testing.

All students, faculty, staff, and visitors are required to **wear face coverings in classrooms** and university spaces. This is in accordance with CDC guidance and University policy and expected in this class. Please refer to the University of Illinois Urbana-Champaign's COVID-19 website for [further information on face coverings](#).

Students who feel ill must not come to class. In addition, **students who test positive for COVID-19 or have had an exposure that requires testing and/or quarantine must not attend class.** The University will provide information to the instructor, in a manner that complies with privacy laws, about students in these latter categories. These students are judged to have excused absences for the class period and should contact the instructor via email about making up the work.

Students who fail to abide by these rules will first be asked to comply; if they refuse, they will be required to leave the classroom immediately. If a student is asked to leave the classroom, the non-compliant student will be judged to have an unexcused absence and reported to the Office for Student Conflict Resolution for disciplinary action. Accumulation of non-compliance complaints against a student may result in dismissal from the University.

Policy on conflicts or emergencies:

- (1) For time conflicts with other events (e.g. another scheduled exam), or an official UIUC activity (e.g. varsity athletics, band concert), please show official documentation about the conflict at least **one week** before the homework/report/exam due date. The due date will be extended if the excuses are legitimate.
- (2) If you will not be able to make it to the exam or submit HW on time due to serious illness or other emergent personal crisis (e.g. car accident) that are not described in (1), you must send an email to the instructor (yjz@illinois.edu) at your earliest convenience, and submit a statement from the professionals that are authorized to evaluate your situation (e.g. doctors, police officers). The statement needs to clearly explain that you are not physically capable of submitting the HW/report/exam on time. The due date will be extended if the excuses are legitimate.