

MATSCEN 7193.2

Energy Storage Materials Design

2 credit hours

Semester / Mode: Spring 2022, In-Person

Instructors: Prof. Vicky Doan-Nguyen, doan-nguyen.1@osu.edu

Office Hours: TBA

In-person Lecture Location: Center for Electron Microscopy Digital Theater

In-person Lecture Times: Mondays, Wednesdays 12:30pm – 1:25pm

Prerequisites: MATSCEN 6730 (Thermodynamics of Materials), 6737 (Diffusion and Interface Kinetics), 6747 (Structure and Defects in Materials), or with permission of instructor

Course Overview

Course Description

Humanity's rapidly growing appetite for energy combined with the looming climate change crises are central motivators for the development of a truly sustainable materials for electrification technologies. Energy storage materials lie at the heart of electrification technologies and are the ultimate enabler for portable and stationary applications. This graduate course will, thus, cover some of the state-of-the-art energy storage electrode and ceramic electrolyte materials (i.e. cathodes and anodes for Li-ion batteries, Na-ion batteries) as well as composites (i.e. for Li-S, Na-S batteries). Foundational topics of crystallography, thermodynamics, and electrochemistry will provide a launch pad and guiding principles for screening and designing emerging materials for energy storage. Advanced characterization techniques will be covered in the context of understanding bulk energy storage materials design and interfacial phase evolution. The course will conclude with an examination of the importance of sustainability and the role of a supporting circular economy for current and emerging energy storage materials.

Course Learning Outcomes

By the end of this course, students should successfully be able to:

1. **Discuss** materials in sustainable energy storage applications and characterization techniques used to understand their crystal structures.
2. **Understand fundamentals of** crystal structure and how they correlate to electrochemical performance.
3. **Understand fundamentals of** thermodynamics and electrochemistry.

4. **Understand fundamentals of** structural evolution at the electrode-interface.
5. **Understand and discuss** needs and considerations for sustainability, recycling, and circular economy for clean energy storage technologies.

How This Course Works

Mode of Delivery

In as much as practical, this course will be delivered in person. Lectures will be delivered live in person, but will also be recorded and posted to Carmen. Student interaction will be possible both in class and on Carmen. Nonetheless, given the uncertainty of the ongoing pandemic, it is impossible to know how we will all be impacted, and thus the instructor will extend every reasonable accommodation to you to ensure a positive education experience, and the instructor requests your patience should issues arise.

Participation and Attendance

In person lecture attendance is highly encouraged, but will not be required. Lecture notes and videos will be recorded and posted on Carmen, ensuring that everyone has equal access to the course material. It is your responsibility to ensure that you avail yourself of whatever mode you choose. At the very least you are expected to log in to the course in Carmen every week to ensure you do not fall behind. **If you have a situation that might cause you to miss an entire week of class, discuss it with the instructors as soon as possible.** The instructor anticipates graduate students may have research responsibilities that arise. Thus, it is the student's responsibility to notify the instructor as to how the student will engage in the course during the missed class period.

Office Hours

Virtual office hours will be established by the instructor. You may also request meetings on a case-by-case basis.

Credit Hours and Work Expectations

This is a **two (2) credit-hour course**. According to [Ohio State policy](#), you should expect around 2 hours per week of time spent on direct instruction (e.g. lecture) and an average of 4 hours per week of homework (e.g. reading and assignment preparation) to receive a grade of (C) average.

Course Materials and Technology

Textbooks

There is no required textbook for this course. Any materials needed and/or recommended will be provided via Carmen, either in the form of PDF files or via internet link, including through the OSU Library system.

Course Technology

For help with your password, university email, Carmen, or any other technology issues, questions, or requests, contact the Ohio State IT Service Desk. Standard support hours are available at ocio.osu.edu/help/hours, and support for urgent issues is available 24/7.

- **Self-Service and Chat support:** ocio.osu.edu/help
- **Phone:** 614-688-4357(HELP)
- **Email:** servicedesk@osu.edu
- **TDD:** 614-688-8743

Baseline Required Technical Skills

- Basic computer and web-browsing skills
- Word processor (e.g. Microsoft Word, LaTeX, etc.)
- Navigating Carmen: for questions about specific functionality, see the [Canvas Student Guide](#)

Required Equipment

- **Computer:** current Mac (OS X) or PC (Windows 7+) with high-speed internet connection
- **Webcam:** built-in or external webcam, fully installed and tested, for participation in office hours and class discussions (if you choose/need to participate virtually)
- **Microphone:** built-in laptop or tablet mic or external microphone, for participation in office hours and discussions (if you choose/need to participate virtually)
- **Other (optional):** a mobile device (smartphone or tablet) or landline to use for BuckeyePass authentication, and as alternative device for participation in office hours and discussions

Required Software

- [Microsoft Office 365](#) or similar word processing / document generation software: All Ohio State students are eligible for free Microsoft Office 365 through Microsoft's Student Advantage program. Full instructions for downloading and installation can be found at <https://go.osu.edu/office365help>.

- PDF generator: All Ohio State students are eligible for free Adobe Acrobat Pro through the campus site license. PDFs can also be generated via Microsoft Office's built-in capability.

Carmen Access

You will need to use [BuckeyePass](#) multi-factor authentication to access your courses in Carmen. To ensure that you are able to connect to Carmen at all times, it is recommended that you take the following steps:

- Register multiple devices in case something happens to your primary device. Visit the [BuckeyePass - Adding a Device](#) help article for step-by-step instructions.
- Request passcodes to keep as a backup authentication option. When you see the Duo login screen on your computer, click **Enter a Passcode** and then click the **Text me new codes** button that appears. This will text you ten passcodes good for 365 days that can each be used once.
- Download the [Duo Mobile application](#) to all of your registered devices for the ability to generate one-time codes in the event that you lose cell, data, or Wi-Fi service.

If none of these options will meet the needs of your situation, you can contact the IT Service Desk at 614-688-4357 (HELP) and IT support staff will work out a solution with you.

Copyright Disclaimer

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Grading Policies

Grading Breakdown

Overall grades will be dependent on activities and assignments related to the final course project. This includes individual assignments and active participation in the peer review process. Please see assignments and peer review score distribution below.

Assignment/ Peer Review Number	Assignment/Peer Review	Points	Percentage of Total Score (%)
1	Hypothesis	10	5%
	Peer Review of Hypothesis	10	5%
2	Literature Review/Background	10	5%
	Peer review of Literature Review	10	5%
3	Work Plan	10	5%
	Peer Review of Work Plan	10	5%
4	Sustainability	10	5%
	Peer Review of Sustainability	10	5%
5	Abstract	10	5%
	Peer Review of Abstract	10	5%
6	Final Proposal	50	25%
	Peer Review of Proposal	50	25%
	Subtotal	200	100%

Late Assignments

Assignment due dates will be given on Carmen. These may be altered during the semester, as needed, and if so, advance notice will be given. Late turn-in / completion of written assignments and Q&A activities will be automatically downgraded by 10% if one day late, 30% if two days late, 60% if three days late, and 100% if four days late. For example (an assignment with 90% score that was turned in 1 day late will received a corrected score of 80% (90% - 10% late = 80%). Because of the tight schedule that will exist for peer reviews, missing your allotted time slot without prior confirmation from the instructor or verifiable excuse will necessarily incur a 100% downgrade for the peer review.

Grading Scale

The approximate course grading scale is given below. However, keep in mind that grades will be normalized based on the class average and distribution (i.e. they will be “curved”), and as such these specific numbers are not definitive. Grade cut-off values may be decreased as a result of normalization, but they will not be increased from those noted here.

> 93%	A
> 90%	A-
> 87%	B+
> 83%	B
> 80%	B-
> 77%	C+
> 73%	C
> 70%	C-
> 67%	D+
> 63%	D
< 50%	E

Instructor Feedback and Response Time

The course instructor will attempt to minimize times for providing grading and feedback on assignments, and responding to communications in general, in a timely manner to the extent possible. For written assignments you should expect feedback within **10 business days**, with the overarching goal to ensure that you have sufficient time to implement improvements and any changes into your next assignment. In as much as possible, email communications will be replied to within **24 hours during active session weeks**, excluding weekends. If the instructor has not responded to your messages within 3 business days, feel free to follow up.

Course Schedule

The tentative course schedule is provided below. Specific details may change throughout the semester, and we fully expect the topic details to evolve, but any changes in critical deadlines (e.g. assignment due dates) will be made with clear advance notice.

Start Date	End Date	Week	Note	Assignment Due (Corresponding Fridays)
1/10/22	1/12/22	1	Overview, syllabus, Foundation: thermodynamics, crystallography	
1/17/22	1/19/22	2	Foundation: crystallography	No Class on 01/17, Martin Luther King, Jr. Day, Hypothesis assignment
1/24/22	1/26/22	3	Foundation: ion conduction	Peer review of Hypothesis
1/31/22	2/2/22	4	Foundation: electrochemical characterization	
2/7/22	2/9/22	5	Li-ion battery materials	Literature Review/Background assignment
2/14/22	2/16/22	6	Li-ion battery materials	Peer review of Literature Review assignment
2/21/22	2/23/22	7	Electrode/electrolyte interfaces	Work Plan assignment
2/28/22	3/2/22	8	Sustainability	Peer review of Work Plan
3/7/22	3/9/22	9	Na-ion battery materials	Sustainability assignment
3/14/22	3/16/22	10	No Class, Spring Break 3/14 - 3/18	
3/21/22	3/23/22	11	Na-ion battery materials	Peer review of Sustainability
3/28/22	3/30/22	12	Conversion battery materials	Abstract assignment
4/4/22	4/6/22	13	Materials characterization	Peer review of Abstract
4/11/22	4/13/22	14	Materials characterization	Final Proposal
4/18/22	4/20/22	15	Materials characterization	Peer review of Proposal
4/25/22		16	Conclusion	Last Day of Class 4/25
			University Final Exam Week 04/27 - 05/23	

Other Course Policies and Information

Discussion and Communication Guidelines

There will be multiple opportunities for discussion and question / answer sessions, both via Carmen and in person, in this course. As such, the following are our expectations and guidelines to ensure that our communication as a class is effective and respectful.

- **Open channels:** We believe that clear and open communications are critical to ensuring a smooth and positive course experience. While we have worked to anticipate any potential points of confusion and complexity, it is nearly impossible to imagine every contingency. As such, we request your patience as well as your candor. If you ever have any questions or concerns, please do not hesitate to contact us.
- **Announcements:** To reduce the total number of e-mails, broad course-related communications will be posted via Carmen Announcements. Please ensure that you check in regularly and/or configure your notification settings to alert you of new postings.
- **Discussions:** Discussion Boards will be created for each section of the course. Whenever possible, questions of broad, topical relevance should be posted there where the answers and any resulting discussion can be of benefit to the entire class. We recognize that not everyone is comfortable with asking public questions, and thus private communications are also acceptable. If the question/answer is deemed to be of relevance to the entire class, we will post it anonymously into the associated Discussion Board.
- **Tone and civility:** We expect all participants in this course to maintain a supportive learning community where everyone feels safe and where people can communicate, and even disagree, amicably. We are committed to making this classroom and course virtual space equitable, inclusive, and welcoming to everyone, and we ask that everyone also work toward this goal. We will respect each other and practice civility at all times. There will be zero tolerance for bigotry and/or disrespectful language including, but not limited to, sexist, racist, homophobic, or anti-ethnic slurs.

Course-Specific Academic Integrity Policies

- **Individual assignments:** Any assignments that are not specifically denoted as group assignments, including (but not necessarily limited to) literature reviews, pre-proposals, and peer reviews must be your own personal, original work. Discussion of course concepts, ideas, and even specific coursework (except for peer reviews) with other students, the TA, and the instructors *is* strongly encouraged, but the final product of any individual assignment must be entirely your own.
- **Group assignments:** Any assignments that are denoted as group assignments are intended to be completed collaboratively. We recognize that such assignments can create additional stress with respect to division of work, taking credit, receiving grades, and understanding feedback. All work associated with such assignments must be shared equitably among all group members, and the final product should not be submitted without agreement from all group members as to its completion. We will work to make the

guidelines for group work as clear as possible for each activity and assignment, but if you have any questions or concerns please do not hesitate to ask.

- **Peer-review:** Peer-review will be an important and enlightening component of this course. Success of the peer review process requires that it be anonymous. As such, you are strictly forbidden from sharing any work that you have been assigned to review with anyone (within or outside of this course). This also includes disclosing your reviewer status to the author, and vice versa. To ensure that all reports remain as anonymous as possible, you should avoid sharing any documents with your classmates unless explicitly sanctioned by the course instructors or TA.
- **Reusing past work:** In general, you are prohibited in university courses from turning in work from a previous class to your current class, even if it is your own and even if you modify it. If you want to build on past research or revisit a topic you've explored in previous courses, please discuss the situation with the instructors.
- **Falsifying research or results:** All research (including literature review) that you will conduct in this course is intended to be a learning experience; you should never feel tempted to make your work look more successful than it really was. You will not be heavily graded on your research prowess itself, but rather on your demonstration of knowledge on the subject of interest and your presentation (report) of the work you performed.
- **Plagiarism:** Copying text from other documents, previous versions of this course (or others), or the documents associated with this course on Carmen or elsewhere is strictly prohibited and will be considered a serious form of academic misconduct. Reproduction of figures from other sources with proper attribution is allowed, but must be done properly and carefully following the standard methods of scientific / engineering technical writing. All submitted written assignments will be run through TurnItIn anti-plagiarism checking. If you're unsure about a particular situation, please feel free just to ask the instructors or TA ahead of time.

Ohio State's Academic Integrity Policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's [Code of Student Conduct](#), and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or

subvert the educational process.” Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university’s *Code of Student Conduct* is never considered an excuse for academic misconduct, so I recommend that you review the *Code of Student Conduct* and, specifically, the sections dealing with academic misconduct.

If your instructors or TA suspect that a student has committed academic misconduct in this course, they are obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university’s *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.

If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact us.

Other sources of information on academic misconduct (integrity) to which you can refer include:

- The Committee on Academic Misconduct web pages ([COAM Home](#))
- *Ten Suggestions for Preserving Academic Integrity* ([Ten Suggestions](#))
- *Eight Cardinal Rules of Academic Integrity* (www.northwestern.edu/uacc/8cards.htm)
- Advice on such matters is also available from:
 - Megan Daniels, Undergraduate Advisor, (614) 292-3145, daniels.313@osu.edu.
- Contact Megan concerning the MSE undergrad studies.
 - Mark Cooper, Graduate Coordinator, (614) 292-7280, cooper.73@osu.edu.
- Contact Mark concerning the MSE graduate studies.

Statement on Title IX

All students and employees at Ohio State have the right to work and learn in an environment free from harassment and discrimination based on sex or gender, and the university can arrange interim measures, provide support resources, and explain investigation options, including referral to confidential resources.

If you or someone you know has been harassed or discriminated against based on your sex or gender, including sexual harassment, sexual assault, relationship violence, stalking, or sexual exploitation, you may find information about your rights and options at titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu. Title IX is part of the Office of Institutional Equity (OIE) at Ohio State, which responds to all bias-motivated incidents of harassment and discrimination, such as race, religion, national origin and disability. For more information on OIE, visit equity.osu.edu or email equity@osu.edu.

Your Mental Health

A source available at s a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you find yourself feeling isolated, anxious or overwhelmed, please know that there are resources to help: ccs.osu.edu. You can reach an on-call counselor when CCS is closed at (614) 292-5766 and 24 hour emergency help is also available through the 24/7 National Prevention Hotline at 1-(800)-273-TALK or at suicidepreventionlifeline.org. The Ohio State Wellness app is also a great resource: go.osu.edu/wellnessapp.

Accessibility Accommodations

The university strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on a disability, including mental health and chronic or temporary medical conditions, please let your instructors know immediately so that we can privately discuss options. We will work with you to establish reasonable accommodations. Depending on the nature of the request, we may direct you to register with Student Life Disability Services. Please contact us as early as possible so that accommodations can be implemented in a timely fashion.

- **SLDS contact information:** slds@osu.edu; 614-292-3307; 098 Baker Hall, 113 W. 12th Avenue.

Accessibility of Course Technology

This online course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor:

- [CarmenCanvas accessibility](#)
- Streaming audio and video
- [CarmenZoom accessibility](#)
- Collaborative course tools

COVID-19 Precautions

Due to safety precautions required to minimize the potential for spreading COVID-19, MSE 5572 will operate with additional protocols than in previous years.

- If you have symptoms of COVID-19, or have been in close contact with someone who has tested positive for COVID-19, you are expected to self-quarantine, report your

symptoms and/or exposure to the instructor, and arrange to be tested. You may not return to the in-person instruction until you have tested negative for COVID-19. Your status will be kept confidential, and we will make accommodations to ensure that you will be able to continue to participate and maintain course progress.

- Health and safety requirements: All students participating in person must sign and agree to the safety and personal protective equipment (PPE) requirements. All students, faculty, and staff are required to comply with and stay up to date on all university safety and health guidance (<https://safeandhealthy.osu.edu>), which includes wearing a face mask in any indoor space and maintaining a safe physical distance at all times. Non-compliance will result in a warning first, and disciplinary actions will be taken for repeated offenses. Anyone not wearing a mask properly will be asked to leave. Anyone who fails to comply will be reported to student conduct or the university police as a disruptive person. Please don't let it come to that.
- **Failure to comply with Ohio State mask or other COVID policies in the classroom will be considered disruptive behavior.** Disruptive behavior is any activity that interferes with students, faculty, or staff and their access to an appropriate educational or work environment.