Technical Elective: Materials for Energy Generation & Storage
2025 Fall

Instructor: Dr. Wenwen Xu

Office: Rm 401, New building, SCUPI

Office Hour (or by appointment): 12:00PM-2:45 PM

Email: wenwen.xu@scupi.cn

Course Description

Energy generation and storage underpin modern civilization. This course offers a survey of the materials that enable energy conversion—solar photovoltaics, fuel cells, thermoelectrics, wind/hydro/bioenergy, and nuclear/fossil systems—and energy storage—batteries, supercapacitors, and hydrogen storage. We emphasize the laws of thermodynamics, electrochemistry, structure–property relationships, and device-level trade-offs (performance, cost, safety, sustainability) so that students build a quantitative, materials-centered framework to understand energy technologies.

Course Objectives

- Build a coherent view of how materials enable energy conversion and storage across solar, fuel cell, thermoelectric, mechanical/thermal, battery, and hydrogen systems.
- Connect structure–processing–property–performance relationships to device metrics (efficiency, energy/power density, lifetime, safety, cost, sustainability).
- Apply thermodynamics and electrochemistry (First/Second Laws, Nernst, transport/kinetics) to analyze and compare energy technologies.
- Read and interpret device data, extracting quantitative figures of merit.
- Communicate technical ideas clearly in an official presentation.

Learning Outcomes

By the end of the course, students will be able to:

1. Explain operating principles of major energy conversion and storage technologies
2. Compare technologies across energy/power density, efficiency, lifetime, safety, cost, and sustainability, and identify application fit.
3. Present research ideas with clear motivation, approach, and success criteria.

Textbook:

• Kathy Lu, *Materials in Energy Conversion, Harvesting, and Storage* (Wiley, 2014).

Assessment & Grading

Attendance	10%
In-class Activities	15%
Homework	15%
Project Presentation	30%
Final Exam	30%

Late policy: Written items −10% per day late (max 5 days).

Code of Academic Conduct
Upon accepting admission to SCUPI, you immediately assume to follow the SCUPI academic integrity guidelines. See a staff in the administrative office if you are not aware of it. The guidelines should be followed in homework, examinations, and other academic work. Violations of these guidelines may result in zero points for an exam or failure of the course.

Course Schedule:

Week 1	Different energy resources and course outline
Week 2	Fossil Energy and Materials
Week 3	Nuclear Energy and Matierials
Week 4	Bioenergy Conversion and Materials
Week 5	Wind Energy Conversion and Materials
Week 6	Electrochemistry Introduction
Week 7	Solar Cells and Materials
Week 8	Fuel Cells and Materials I
Week 9	Fuel Cells and Materials II
Week 10	Mechanoelectric Energy Harvesting and Materials
Week 11	Thermoelectric Energy Conversion and Materials
Week 12	Energy Storage and Materials I
Week 13	Energy Storage and Materials II
Week 14	Hydrogen Storage and Materials
Week 15	Student Presentation I
Week 16	Student Presentation II
Week 17	Final Exam

*** This schedule may be slightly adjusted based on class performance.