MSE 891: Materials for Energy Applications
Spring 2010

Course instructors:

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Course description

The dawn of the 21st Century has starkly illuminated new challenges in the area of energy production and use: a rapidly increasing worldwide demand, dwindling supply, and the overarching threat of environmental damage due to energy utilization. These are not temporary inconveniences but rather harsh realities of a new world: energy reserves whose creation took millions of years are being depleted by an increasingly energy-hungry global society. How can science respond to these new challenges? Materials will play a central role. This course will survey in a seminar-like format the wide field of materials for energy applications. After some introductory discussions of the challenge presented by climate change and energy usage, we will explore a range of materials issues related to the development of new energy technologies and the more efficient utilization of existing energy resources. Topics to be covered include: unconventional geologic fuels and biofuels; photovoltaic materials and solar energy conversion; materials for future wind energy needs; thermoelectric materials for solid state energy conversion; materials for electrical energy storage; materials for hydrogen production, storage, and use; solid-state lighting materials; and materials challenges in nuclear energy.

Time and location

Class will meet T/Th from 10:20 - 11:40 pm in Room 2320 Engineering Building

Office hours (Morelli)
T/Th 2:30-3:30pm and by appointment. I will also respond to course-related questions and comments via email.

Grading
Your **c**ourse grade will be determined by a combination of your scores on two take-home exams, homework/attendance, a final presentation, and a final research paper, according the following distribution:

Exam I (take home, mid- to late February)	15%
Exam II (take home, mid-to late April)	15%
Homework/Attendance	10%
Final Research Presentation	30%
Final Research Paper	30%

Research Presentation/Paper
Each student will undertake an independent project focusing on a particular issue or problem related to materials for energy applications. Selection of the topic will be made in consultation with Professor Morelli. Each student will summarize his or her findings in the form of a research paper and a presentation. Details regarding the expected content of the presentation and paper will follow. Papers will be due near the end of the semester, and presentations will be given the last few days of class.

Course Outline (all dates are tentative)

Date	Topic	Description	Instructor(s)
Jan 11, 13	Introduction	The energy/climate problem: broad view	Morelli
Jan 18, 20	Module I: thermoelectric materials	Introduction; the design of thermoelectric materials	Morelli
Jan 25, 27	Module I: thermoelectric materials	Thermal and electrical transport properties; model systems	Morelli
Feb 1, 3	Module I: thermoelectric materials	Synthesis of TE materials; aspects TE devices	Morelli/Sakamoto
Feb 8,10, 15	Module II: materials issues for future nuclear energy	Radiation damage, recovery mechanisms, and creep-rupture	Bieler
Feb 17,22	Module III: photovoltaic materials	Introduction and design of materials	Morelli
Feb 24, Mar 1, 2	Module III: photovoltaic materials	Inorganic semiconductors for solar cell applications	Morelli
Mar 7 - 11	Spring Break		
Mar 15, 17	Module III: photovoltaic materials	Organic semiconductors for solar cell applications	Duxbury
March 22, 24, 29, 31	Module IV: materials issues related to hydrogen technologies	Hydrogen production, transportation, storage, and use. Fuel cells	Nicholas
April 5, 7, 12	Module V: materials for electrical energy storage	Batteries, ultracapacitors	Lai, Sakamoto, Drzal
April 14	Module VI: geologic/alternative fuels	Geology & Infrastructure of the current Hydrocarbon Economy. Alternative Sources: Shale oil, tar sands, methane clathrates	Nicholas
April 19	Module VII: materials for solid state lighting	III-V wide band gap semiconductors, phosphors	Morelli
April 21	Module VIII: other energy technologies	Geothermal, hydro, wind,…	Morelli
April 26	Module VIII: biofuels	Technologies, land use, GHGs and energy return considerations for biofuels	Dale
April 28, final exam day	Student presentations		