



Rensselaer

Course Syllabus

Materials under Extreme Conditions

COURSE INFORMATION

Course Title	Materials under Extreme Conditions
Course number	MTLE 4961/MTLE 6961
Credit hours	3
Semester/ year	Spring 2012
Meeting days	M/R 12:00-1:20
Room location	TBD
Lab/discussion session location	N.A.
Webpage (if existent)	N.A.
Prerequisites or other requirements	For undergraduate students, MTLE 4100 and MTLE 4150 or equivalent. There is no prerequisite for graduate students.
INSTRUCTOR:	Yunfeng Shi/Assistant Professor
Office location:	MRC 114
Office telephone number:	518-276-6729
Office hours:	TBD
e-mail address:	shiy2@rpi.edu

COURSE DESCRIPTION

This course will review basic thermodynamic and kinetic concepts, which underpin how material behaves under extreme thermal, mechanical, chemical, electrical, magnetical conditions as well as high-energy irradiations. Engineering materials that can withstand hush environments and new materials with unique crystal structures/microstructures will be surveyed.

STUDENT LEARNING OUTCOMES

Upon completion of this class, students will be able to:

- 1) Apply basic thermodynamic and kinetic concepts to material behaviors under extreme conditions.
- 2) Understand the formation mechanism of new phases and microstructures that are unique to extreme environments.
- 3) List a number of engineering materials that can perform and sustain various harsh environments.
- 4) Evaluate recent research papers on the topics of materials under extreme conditions.

COURSE TEXT

No required book.

Recommended: **Materials Under Extreme Conditions**, Vincenzo Schettino and Roberto Bini, Imperial College Press, winter 2012.

GRADING CRITERIA

Term Paper*	40 %
Presentation*	40 %
Attendance	20 %

Letter Grade Conversion Rule:

85-100:	A
80-84:	A-
75-79:	B+
70-74:	B
65-69:	B-
60-64:	C
0-59:	F

*The grading of the term paper and presentation will be done *separately* for undergraduate students and graduate students.

COURSE TOPICS:

- Review of fundamental concepts of thermodynamic and kinetics;
- Survey of experimental and computational techniques (diamond anvil cell; spin cooling; ultrafast spectroscopy; dynamic transmission electron microscopy; quantum mechanical calculations; molecular dynamics simulations)
- Engineering materials applied in extreme environments: structural materials at high temperatures
- Engineering materials applied in extreme environments: radiation-resistance materials

- Engineering materials applied in extreme environments: spacecraft materials
- Materials under thermomechanical extremes (static vs dynamic; high-pressure phases; shock; detonation; cavitation; supercooled liquids and glasses)
- Materials under chemical extremes (interfaces in fuel cell; protective coating; novel synthesis)
- Materials under energetic flux extremes (photons; electrons; ions; FIB fabrication; meta-stable pattern formation)
- Materials under electromagnetic extremes (dielectric breakdown; new phases under extreme magnetic fields; material synthesis with extreme electromagnetic fields)

ACADEMIC INTEGRITY

Student-teacher relationships are built on trust. For example, students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments that students turn in are their own. Acts, which violate this trust, undermine the educational process. The Rensselaer Handbook of Student Rights and Responsibilities define various forms of Academic Dishonesty and you should make yourself familiar with these. In this class, all assignments that are turned in for a grade must represent the student's own work. In cases where help was received, or teamwork was allowed, a notation on the assignment should indicate your collaboration. Submission of any assignment that is in violation of this policy will result in a penalty of zero credit for the assignment. Repeated violation will lead to a Fail for the entire course. If you have any question concerning this policy before submitting an assignment, please ask for clarification.