University of Kentucky
Chemical and Materials Engineering Department

CME 599-002 / CME 780-002 Special Topics: *Advanced Materials*

Fall 2007

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Office Hour:
Wednesday 10:00 - 11:00 am
or by appointment

Time and Place: Tuesdays and Thursdays 2:00 - 3:15 pm, 110 Patterson Office Tower

Textbook: **No textbook** is required for the course. Readings will be assigned and either provided to enrolled students, provided online, or on reserve in the library. Relevant reading can be found in the following sources (available from the UK Libraries):

1. C.J. Brinker and G.W. Scherer, *Sol-Gel Science. The Physics and Chemistry of Sol-Gel Processing*, Academic Press: San Diego, 1990.
2. D.C. Bradley, R.C. Mehrotra, I.P. Rothwell and A. Singh, *Alkoxo and Aryloxo Derivatives of Metals*, Academic Press: San Diego, 2001.
3. G. Cao, *Nanostructures and Nanomaterials - Synthesis, Properties and Applications*, Imperial College Press: Hackensack, NJ, 2004. [Link to book from Knovel]
4. P. Yang (ed.), *The Chemistry of Nanostructured Materials*, Singapore, 2003. [Link to book from Knovel]

Course Description

Students taking this course will learn about the chemical synthesis and characterization of materials with advanced nanostructure and properties. Examples of the types of materials that will be discussed are nanoporous oxides (such as zeolites and mesoporous metal oxides like MCM-41), nanoparticles, inorganic thin films and membranes, nanowires, functional thin films, and self-assembled structures. Emphasis will be placed on the fundamental knowledge required to understand and control the "bottom-up" formation of these inorganic materials by polymerization, controlled precipitation, self-assembly, and controlled transport of matter and energy. The course will draw on elements of inorganic chemistry, physical chemistry, chemical kinetics, transport phenomena, and interfacial engineering to provide a survey of materials chemistry and the engineering of advanced materials.

Topics to be Covered

The following subjects are to be covered in this course, although the order and depth of each subjected will be adjusted depending on the interests of the class.

- Chemistry of silicates and silanes
- Chemistry of transition metal alkoxides and oxides
- Physical chemistry of surfaces and surface forces
- Adsorption and surface modification
- Nucleation and growth of particles and wires
- Population balance modeling and gelation
- Spinodal decomposition
- Molecular self-assembly and templating
- 3D periodic structures and their translation into materials
- Colloidal assembly of particles
- Materials deposition by controlled evaporation
- Survey of characterization techniques

Expected Outcomes

At the completion of this course, students should:

1. Understand the sol-gel chemistry of silicon and transition metal alkoxides
2. Know the types of forces that act between surfaces in solution
3. Understand the concepts of nucleation and controlled growth of particles
4. Be familiar with population balance modeling of particles and gelation
5. Understand self-assembly and its use for materials synthesis
6. Be able to apply physical chemical and transport principles to materials synthesis
7. Have a rudimentary understanding of the characterization techniques available for advanced materials
8. Write about and critically read others' reports about advanced materials

Important Dates:

August 23	First class session.
October 15	Midterm of the semester.
November 22	Thanksgiving Holiday - No Classes.
December 6	Last day of class.
December 13	Term project report due by 5:00 pm.

Exams and Project

Two exams will be scheduled during regular class periods. Dates for exams will be set at appropriate points in the course, and will be announced at least one week in advance.

In lieu of a final exam, graduate students will be required to complete a critical review of the literature in a topic area that they select. The subject should be related to the synthesis and characterization of advanced materials, and should focus on the fundamental physics and chemistry involved. The review should merely be a compilation of work done in an area, nor should it be a summary of an existing review article. One-page biweekly progress reports on the project will be required. The first should describe the project to be undertaken and will be due on September 20. Students are encouraged to consult with the instructor to help to select the topic.

Students will also be required to give a mini-lecture on a topic relevant to the course at some point in the semester. The mini-lectures will be in the second half of the semester, and can be based on the literature review (although they can also be on a more traditional topic instead). They will be evaluated by the instructor, primarily for technical content.

Avoiding Plagiarism

Students should be careful to avoid plagiarism, even if unintentional. Plagiarism includes not only verbatim copying of whole sentences or paragraphs, but also "borrowing" someone else's text and making minor changes (substituting words or rearranging phrases). This would include using the structure of another author's review as the basis for the student's term project. **Any** text or sequence of ideas taken from another source must be clearly and specifically cited. It will be far preferable to submit a report with imperfect grammar than to risk receiving an "E" in the course due to plagiarism. For more information, see the informative web site available in the chemistry department: http://www.chem.uky.edu/courses/common/plagiarism.html .

Homework Assignments

The homework assignments are an opportunity for the student to test her or his understanding of basic concepts and to develop problem solving skills at relatively little risk to their final grade. They also provide the opportunity for the instructor to monitor understanding of the material and to adjust the pace of the course. Group discussion of problems aids learning, for everyone involved. Debate of the approach to homework problems is encouraged, but students are required to independently write their solutions.

Grading

The worst possible grading scale will be:

90%-100% = A; 80%-89% = B ; 70%-79% = C ; 60%-69% = D ;

The instructor may choose to adjust this scale in favor of higher grades. The weighting of course components will be:

Homework	10%
Mini-lecture	10%
Exams (2)	20% each
Research Project	40%

Feedback

Every effort will be made to provide timely, helpful feedback to students regarding their progress and their class standing. Feedback from students about the course is also encouraged. You will have the opportunity to evaluate the course at the end, but that is too late to make improvements. Constructive criticism and suggestions to improve your learning of the material are always welcome.

CORRECTIONS, CHANGES, AND ADDITIONAL INFORMATION ARE AVAILABLE ON LINE AT:

http://www.engr.uky.edu/~srankin/CME599_AdvMater.htm