

Syllabus
COURSE: EMA 4645, Section 061B
Title: Processing of Ceramic Materials
Fall 2013

1. Catalog Description –
Credits: 3.
Introduction to the technology and science of processing ceramic materials, including traditional clay based ceramics, modern technical ceramics, and glasses. Topics include the nature of fine particles, forming methods and consolidation by heat.
2. Prerequisites - EMA 4144
3. Course Objectives - To understand and apply the basic principles of ceramic processing, including characterization techniques, colloid and surface science, sol-gel techniques, particle mechanics, ceramic forming and sintering.
4. Contribution of course to meeting the professional component - This is a 3 credit course. It provides 3 credits towards engineering sciences.
5. Relationship of course to program outcomes - This course addresses the following MSE Program outcomes:
1 Ability to apply knowledge of mathematics, science, and engineering to materials systems. (High Coverage)
Assessment is done of the homework (use of software, spreadsheet calculations) and the three exams.
4 Ability to apply and integrate knowledge of structure, properties, processing, and performance to solve materials selection and design problems within realistic constraints. (Medium coverage)
Student's ability is measured in the exams. Students have to decide what processes they choose for what type of ceramic shape and material. They need to suggest alternative processes and materials.
7 Ability to identify, formulate, and solve engineering problems. (Medium coverage)
Questions in the exams address industrial problems that have occurred. These problems are described with everyday language that the students need to translate into engineering terminology to identify the potential engineering problems, formulate the problems and offer several solution pathways. Students are graded on the quality and quantity of their approaches.
9 Ability to communicate effectively in both oral and written form. (Low coverage)
Oral skills are practiced during the semester, where one student has to present the solution for a problem that a small group discussed. The student's oral communications skills are graded with partial credit contributing to the total credit for attendance-homework. Written skills are measured in the homework assignments.
6. Instructor – Dr. Wolfgang Sigmund. Office location: 225 Rhines Hall
Telephone: 352-846-3343 (office)
E-mail address: wsigm@mse.ufl.edu
Web site: <http://sigmund.mse.ufl.edu/classes.htm>
Office hours: Monday 1-3 pm
7. Teaching Assistant – NONE
8. Meeting Times – M,W,F 8th period
9. Class schedule - Three hours of class time each week.
10. Meeting Location – Larsen 310
11. Material and Supply Fees - None.
12. Textbooks and Software Required – Ceramic Processing, by M.N. Rahaman, CRC, Taylor and Francis,

2007. ISBN 0-8493-7285-2

You must have access to a computer and the following software to complete course assignments:

- Word processing software, such as Word.
- Spreadsheet software, such as Excel.
- Pdf writer.
- UF e-learning.

This course will use Sakai as an electronic course management system. The course website will have reading and homework assignments, updated grades, and course announcements. You can access Sakai via e-learning from <https://lss.at.ufl.edu/> by clicking on Sakai and logging in with your Gatorlink ID and password.

13. Recommended Reading –

- J. Reed, Principles of Ceramic Processing, 2nd edition, John Wiley and sons, (1995);
R. Hunter, Introduction to Modern Colloid Science, Oxford University Press, (1993);
D. W. Richerson, Modern Ceramic Engineering, Second Edition, Marcel Dekker Inc., (1992);
T. A. Ring, Fundamentals of Ceramic Powder Processing and Synthesis, Academic Press (1996);
J. W. Evans and L. C. DeJonghe, Production of Inorganic Materials, Macmillan (1991).

Supplementary reading and links to various other websites are provided and updated throughout the semester.

14. Course Outline –

A total of 40 semester hours, 27 interactive lectures and 9 graduate student presentation hours, 4 hour exams.

#	Topics	
1	Introduction to Ceramic Fabrication Processes (Chapter 1, pages 1-32) Overview of ceramic materials and processing; definition of ceramics and the distinctions between ceramic, metals, polymers; ceramic materials and products; classification by function; modern materials needs; steps in ceramic processing. Societal needs, impacts from global community on ceramic markets. Job market, outlook on ceramics in the future.	3 lectures HW 1
2	Synthesis of Powders (Chapter 2, pages 37-91) Terminology; desirable powder characteristics; preparation techniques by mechanical and chemical methods; oxide and non-oxide powders.	3 lectures Exam 1 on September 6
3	Powder Characterization (Chapter 3, pages 97-138) Physical characterization; chemical and phase composition; surface characterization.	3 lectures HW 2

4	Science of Colloidal Processing (Chapter 4, pages 141-189) Particle mechanics and particle rheology.	3 lectures
5	Sol-Gel Processing (Chapter 5, pages 193-249) Acid/base catalysis; controlled drying agents; powders; fibers; monoliths.	2 lectures Exam 2 on September 27
6	Mixing and Packing of Powders (Chapter 6, pages 253-276) Beneficiation and processing additives, comminution, batching, mixing, and granulation.	1 lecture HW 3
7	Forming of Ceramics (Chapter 7, pages 279-333) Powder consolidation and forming of ceramics, colloidal forming methods: drained techniques, direct casting and solid freeform fabrication. Pressing, extrusion, injection molding.	5 lectures Exam 3 on October 14
8	Drying, Debinding and Microstructural Characterization of Green Bodies (Chapter 8, pages 337-362)	1 lecture HW4
9	Sintering and Microstructure Development (Chapter 9, pages 365-446) Classification of sintering; importance of sintering; sintering property relationship; driving forces for sintering; diffusion; defects and defect chemistry. Mechanisms of sintering; models and sintering equations; densification; grain growth. Effects of heterogeneities; anisotropic densification; sintering; liquid-phase sintering; hot pressing; hot isostatic pressing.	5 lectures Exam 4 on October 30

Starting November graduate students will present in class with the following outline.

Expect to see pop-quizzes during this period.

November 1: Nanopowders (0-dimensional)

November 4: Nanofibers (1-dimensional)

November 6: Nanosheets (2-dimensional)

November 8+11: No classes due to Homecoming and Veteran's day:

November 13: Nanocomposites (3-dimensional)

November 15: Spark Plasma Sintering

November 18: Flash Sintering

November 20: Ceramics as energy harvesting materials

November 22: Ceramics as energy conversion materials

November 25+27: No classes due to conference.

November 29: No class due to Thanksgiving

December 2: Ceramics as energy storage materials

15. Attendance and Expectations -All students are expected to attend class. Attendance also requires participation in class by solving problems in small groups and presenting the solutions in front of the

class. Cell phones should be turned off. Reading of newspapers, work on assignments for this or other classes, or other activities that are not part of the class are not allowed during class time.

16. Grading –

Best 3 out of 4 exams	60 %
Class participation	10 %
Best 6 out of 8 pop-quizzes	10%
Homework	20 %

17. Grading Scale –

Percentage	≥92	≥88	≥84	≥80	≥76	≥72	≥68	≥65	≥62	≥59	≥56	<56
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E

Grades are not curved. There is no final exam in this class.

“C- will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx> “

18. *Requirements for class attendance and make-up exams, assignments, and other work are consistent with university policies that can be found at:*

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

Homework is due online in e-learning, no late homework will be accepted. If you have trouble with on time submission on e-learning you need to get a trouble ticket from the UF help desk before the deadline and also send an email alerting the instructor about the problem. Late submissions without trouble ticket and email alert will not be considered.

Make-up Exam Policy – There are no make-up exams since 4 exams are offered and only 3 exams are needed.

Students are required to read the chapter for the specific lecture in advance. Reading assignments are provided in the course outline. Students will be called on in class by their name to answer questions about the chapter contents. This will be graded as class participation. There are also pop-quizzes throughout the semester. Students need to participate in at least 6 pop-quizzes to get full score, assuming correct answers in each of them.

19. *Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.*

Note that failure to comply with this commitment will result in disciplinary action compliant with the UF Student Honor Code Procedures. See <http://www.dso.ufl.edu/sccr/procedures/honorcode.php>

20. *Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.*
21. *UF Counseling Services –Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
 *UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
 Career Resource Center, Reitz Union, 392-1601, career and job search services.**
22. *Software Use – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.*
23. Syllabus Changes – I reserve the right to make changes in the syllabus as needed. Any changes will be clearly announced on Sakai and in class.

Sections in italics are from the UF catalog or from college of engineering prescribed syllabus.