Course: EMA 6448, Section 6448 (30576)

Title: Processing of Ceramic Materials

Syllabus Fall 2022

Catalog Description – *Credits: 3.*
Introduction to the science of ceramic processing, with emphasis on theoretical fundamentals. Examples of state-of-the-art industrial processes discussed.
Building on the knowledge of the technology and science of processing of modern technical ceramics students learn to critically analyze the literature and discuss fundamentals. Topics include the nature of fine particles, forming methods and consolidation by heat.
Prerequisites – None
Course Objectives – At the end of this course the students will

- understand and apply basic and advanced principles of ceramic processing, including characterization techniques, colloid and surface science, sol-gel techniques, particle mechanics, ceramic forming and sintering, and processing property relationships.
- know how to retrieve and critically read literature in science and engineering.
- have improved communication and presentation skills.

Instructor -
Dr. Wolfgang Sigmund
Office location: 225 Rhines Hall
Telephone: 352-846-3343 (office)
E-mail address: sigmund@ufl.edu
Office hours: W, 10:30-11:30 am and anytime on request via zoom. F2F meetings available on email requests.

Teaching Assistant –
NONE

Meeting Times – T 4 (10:40 to 11:30 am) R 4+5 10:40 pm – 12:35 pm

Class schedule - Three hours of class time each week.

Meeting Location – TUR 2333

Material and Supply Fees - None.

Textbooks and Software Required –
Ceramic Processing, by M.N. Rahaman, CRC, Taylor and Francis, 2017. ISBN 1498716415
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.
This course will use e-learning as an electronic course management system. The course website will have reading and homework assignments, updated grades, and course announcements. You can access e-learning at http://elearning.ufl.edu/ and log in with your Gatorlink and password.
Recommended Reading –

Supplementary reading and links to various other websites are provided and updated throughout the semester.
Homework - Homework will be assigned and is usually due back the following week. The purpose of homework is to give students an opportunity to evaluate and apply their knowledge. Students may collaborate on homework; however, the actual submitted assignment must represent their own work and preparation.
Note: Homework in its entirety must be word processed on your computer. For some problems you will require a suitable math package with graphing capability (e.g., Excel, MatLab, or others). Picture files (jpg, etc.) are not accepted. Files have to pdf, doc, docx, or pptx. Homework needs to be submitted online on e-learning. Email is not acceptable for submission of homework. Hard copies are also not accepted.

Homework will be evaluated on the following basis:

- Excellent work: 100
- Assignment acceptable: 85
- Homework submitted (showing effort): 70
- Homework submitted no or small effort: 0
- Note - late homework is not accepted: 0

Course Outline –
Class starts January 6, 2022. No classes on the following days: 3/8, 3/10. Last class April 19. All course materials must have been completed at that time.
Exams 1/27, 2/24, 3/24, 4/14.

#	Topics	Estimated # of lectures
1	**Introduction to Ceramic Fabrication Processes (Chapter 1, pages 1-17)** 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.	2
2	**Synthesis and Preparation of Powders - mechanical methods (Chapter 2, pages 19-32)** Terminology; desirable powder characteristics; preparation techniques by mechanical methods; oxide and non-oxide powders.	2
3	**Synthesis and Preparation of Powders - chemical methods (Chapter 3, pages 19-75)**	3

	Terminology; preparation techniques by chemical methods; oxide and non-oxide powders.	
4	**Synthesis of Ceramic Nanoparticles (Chapter 4, 79-87)**	2
	Exam 1 in class, 2 hours **Chapters 1-4. Pages 1 to 87**	1/27/2022
5	**Powder Characterization (Chapter 5, pages 89-131)** Physical characterization; chemical and phase composition; surface characterization.	4
6	**Science of Colloidal Processing (Chapter 6, pages 133-172)**	4
7	**Rheology of colloidal suspensions (Chapter 7, pages 175-190)** Particle mechanics and particle rheology**.**	2
	Exam 2, 2 hours, covers chapters 5 thru 7	2/24/2022
8	**Processing Additives (Chapter 8, pages 193-212)**	2
9	**Granulation, Mixing and Packing of Particles (Chapter 9, pages 213-240)** Beneficiation and processing additives, comminution, batching, mixing, and granulation.	1
10	**Forming of Ceramics (Chapter 10, pages 241-282)** Powder consolidation and forming of ceramics, colloidal forming methods: drained techniques, direct casting and solid freeform fabrication. Pressing, extrusion, injection molding.	4
	Exam covers chapters 8 thru 10	3/24/2022
11	**Additive and subtractive manufacturing of ceramics (Chapter 11, pages 285-297)** Powder consolidation and forming of ceramics, colloidal forming methods: drained techniques, direct casting and solid freeform fabrication. Pressing, extrusion, injection molding.	2

12	**Drying, Debinding, and Microstructural Characterization of Green Articles (Chapter 12, pages 299-328)**	1
13	**Principles of Sintering and Microstructure Development (Chapter 13, pages 331-394)** 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.	3
14	**Sol-Gel Processing (Chapter 15, pages 437-479)** **Acid/base catalysis; controlled drying agents; powders; fibers; monoliths.**	1
	Exam 4 covers chapters 11 thru 14	4/14/2022

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 to silent. You will need a cell phone, computer or tablet to take part in some of the quizzes. 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.

Exams

There will be 4 exams throughout the semester. Your lowest exam grade will be dropped.
Each exam of the three exams is weighted equally, and each exam will be worth **25%** of your final grade.
You have one week after the test results are posted to resolve any questions about scores and grades. No changes to your exam grade will be made after that time.

Exam Conflicts with other course exams

The official UF policy on exam conflict resolution states that when two exams conflict, the course with the higher number will take priority. There will be no exceptions to this rule.

Make-up exams

Students who do not take an exam will receive a grade of 0 for that exam. Excused absences must be consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

Syllabus Changes

The instructor reserves the right to make changes to the syllabus as needed. Any changes will be clearly announced on Canvas.

Evaluations of Grades –

3 of 4 exams (25% each, lowest dropped)	75%
Term paper	15%
Homework	10%
Total	100%

Grading Scale –

Percent	Grade	Grade Points
92.0 - 100	A	4.00
88.0 - 91.9	A-	3.67
84.0 – 87.9	B+	3.33
80.0 – 83.9	B	3.00
76.0 - 79.9	B-	2.67
72.0 – 75.9	C+	2.33
68.0 – 71.9	C	2.00
65.0 – 67.9	C-	1.67
62.0 – 64.9	D+	1.33
59.0 – 61.9	D	1.00
56.0 – 58.9	D-	0.67
0.00 – 55.9	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=4&navoid=907#grades

Grades are not curved. There is no final exam in this class.
"Graduate students need an overall GPA of 3.00 truncated and a 3.00 truncated GPA in their major (and in the minor, if a minor is declared) at graduation." For more information on grades and grading policies, please visit:

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via

https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third-party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Conduct Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

• Your academic advisor or Graduate Program Coordinator

• Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu

• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu

• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students 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.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

COVID-19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.
Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.
Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.
Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.
On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.