UNSW Course Outline

MATS3002 Fundamentals of Ceramic Processing - 2024

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General Course Information

Course Code : MATS3002
Year : 2024
Term : Term 1
Teaching Period : T1
Is a multi-term course? : No
Faculty : Faculty of Science
Academic Unit : School of Materials Science & Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Ceramic materials are essential to a wide range of technological/societal applications including building and civil construction, energy storage and conversion, computing and electronics, and health and biomedicine. Successful use of ceramics in these areas is critically dependent on the

composition and (micro)structure of the materials which, in turn, are determined by the processing used to manufacture them. As a Materials Engineer/Scientist, you are the expert responsible for the manufacturing of ceramic products and in this course you will learn the phenomenological material behaviour that underpins ceramic manufacturing and combine this with the actual engineering technology to design ceramic manufacturing processes for specific products and devices that are used throughout society, and analyse processing problems and prescribe evidence-based solutions.

This course is a Level 3 core course in the BE(Hons)(Materials Science and Engineering) program and in the Materials Science major of BSc and BAdvSci(Hons) programs, and is also suitable for science and engineering students who need a fundamental understanding of the fabrication of ceramic materials. The course is completed as weekly lectures, self-learning online activities, and in-person laboratory classes.

Course Aims

The aim of this course is to examine the main processes and technology involved in the manufacture of selected classes of ceramic products and to develop an understanding of the fundamental chemical and/or physical phenomena that underpin each stage of ceramic processing. Foundational knowledge including heat transfer, mass transfer, kinetics, thermodynamics, and phase equilibria will be used to understand material behaviour during ceramic processing and to interpret, predict, and optimise processing routes required for the manufacturing of ceramic products as well as to solve typical processing problems.

Relationship to Other Courses

MATS3002 is a Level 3 course and is core in the BE (Hons) (Materials Science and Engineering) program and in the Materials Science major of BSc and BAdvSc(Hons) programs, and is also suitable for science and engineering students who need fundamental understanding and basic practical skills in the characterisation of materials. The course is built on learning from prior courses in materials science and chemistry with specific knowldge from prerequisite coruses of *MATS2003 Material Characterisation* (especially crystal structures, microstructures, an microstructural analysis) and *MATS2008 Thermodynamics of Materials* (especially binary phae equilibria).

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Describe the main processes and related technology involved in the manufacturing of specific classes of ceramic products.
CLO2 : Explain the fundamental chemical and/or physical phenomena that underpin each of the main stages of ceramic processing.
CLO3 : Explain and predict the effect of heat treatment conditions on the high temperature reactions of specific ceramic materials and their resultant phase composition and microstructure.
CLO4 : Perform calculations related to aspects of drying and firing processes used in ceramic manufacturing.
CLO5 : Analyse typical problems encountered in ceramic processing and propose appropriate improvements/remedies to avoid them.

Course Learning Outcomes	Assessment Item
CLO1 : Describe the main processes and related technology involved in the manufacturing of specific classes of ceramic products.	• Assignment • Laboratory Report • Mid-Session Test • Final Examination
CLO2 : Explain the fundamental chemical and/or physical phenomena that underpin each of the main stages of ceramic processing.	• Assignment • Laboratory Report • Mid-Session Test • Final Examination
CLO3 : Explain and predict the effect of heat treatment conditions on the high temperature reactions of specific ceramic materials and their resultant phase composition and microstructure.	• Assignment • Final Examination
CLO4 : Perform calculations related to aspects of drying and firing processes used in ceramic manufacturing.	• Assignment • Final Examination
CLO5 : Analyse typical problems encountered in ceramic processing and propose appropriate improvements/remedies to avoid them.	• Mid-Session Test • Final Examination

Learning and Teaching Technologies

Moodle - Learning Management System | Blackboard Collaborate

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment Assessment Format: Individual	20%	
Laboratory Report Assessment Format: Individual	10%	
Mid-Session Test Assessment Format: Individual	35%	Start Date: Not Applicable Due Date: 26/03/2024 05:00 PM
Final Examination Assessment Format: Individual	35%	Start Date: Not Applicable Due Date: Final exam is held in the UNSW Examination period at the end of Term 1.

Assessment Details

Assignment

Assessment Overview

Part 1, Psychrometry (worth 10%): You will undertake psychrometric calculations involving air-water vapour systems and apply them to mass and energy balances calculations for ceramic drying processes. This assignment will assess your understanding of psychrometry as applied to ceramic drying processes.
This part will be issued in Week 7 and will be due in Week 9. Feedback will be given within one week of the submission deadline and will include your marked assignment and overall comments on how the class performed; additional feedback may be available through inquiry with the course convenor.

Part 2, Sintering (worth 10%): You will complete descriptive and numerical problems related to the firing of ceramics. This assignment will assess your understanding of high temperature processing of ceramic materials/ products. This part will be issued in Week 8 and will be due in Week 10. Feedback will be given within one week of the submission deadline and will include your marked assignment and overall comments on how the class performed; additional feedback may be available through inquiry with the course convenor.

Course Learning Outcomes

- CLO1 : Describe the main processes and related technology involved in the manufacturing of specific classes of ceramic products.
- CLO2 : Explain the fundamental chemical and/or physical phenomena that underpin each of

the main stages of ceramic processing.
- CLO3 : Explain and predict the effect of heat treatment conditions on the high temperature reactions of specific ceramic materials and their resultant phase composition and microstructure.
- CLO4 : Perform calculations related to aspects of drying and firing processes used in ceramic manufacturing.

Detailed Assessment Description

Refer to Moodle for detailed information about this assessment task.

Laboratory Report

Assessment Overview

You will attend the following two laboratory classes (each 2 hours duration) during term:

Lab 1: examines typical ceramic raw materials and manufactured products; investigate various ceramic forming processes including dry-pressing, plastic extrusion, and slip casting and their critical operational parameters.

Lab 2: examines typical equipment used for firing ceramic materials; and complete postfiring glazing of selected ceramic products made in Lab 1.

You will undertake both individual work and group work in each lab. class.

Lab. classes will commence in Week 3 and, depending on the class size, will run until Week 9.

For each lab. class, you will submit an individual report
(maximum of 4 typewritten pages inclusive of figures, tables, etc.) to demonstrate your understanding of practical aspects of the laboratory activities including reference to any fundamental chemical and/or physical phenomena that underpin them. The report will consist of short answers to specific questions about the laboratory activities and your reflections on what was done and learnt.

The report for Lab 1 is worth 5% and is due at the end of Week 5. The report for Lab 2 is worth 5% and is due at the end of Week 9.

Feedback will be given within one week of the submission deadline and will include your marked lab. report; additional feedback may be available through inquiry with the course convenor.

Attendance at the lab. classes is compulsory. If you miss one or both lab classes without

approved UNSW Special Consideration you will not be allowed to do the missed lab. class(es) at another time nor permitted to submit a lab. report and will receive zero marks for the laboratory report.

Course Learning Outcomes

- CLO1 : Describe the main processes and related technology involved in the manufacturing of specific classes of ceramic products.
- CLO2 : Explain the fundamental chemical and/or physical phenomena that underpin each of the main stages of ceramic processing.

Detailed Assessment Description

Refer to Moodle for detailed information about this assessment task including laboratory description, submission requirements, and due dates.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Mid-Session Test

Assessment Overview

The final exam will assess your learning of aspects of ceramic processing and ternary phase equilibria covered in Weeks 1-5 and will typically include short-answer
style questions and calculations. It will be 2 hours in duration and held in Week 7.

Feedback: You will receive your marked test indicating what questions were answered correctly and incorrectly. Overall comments and example answers may be provided to the class; additional feedback may be available through inquiry with the course convenor.

You are required to achieve a mark of at least 35% in the final exam (and at least 45% weighted average for the final exam and the mid-term test) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Course Learning Outcomes

- CLO1 : Describe the main processes and related technology involved in the manufacturing of specific classes of ceramic products.
- CLO2 : Explain the fundamental chemical and/or physical phenomena that underpin each of the main stages of ceramic processing.
- CLO5 : Analyse typical problems encountered in ceramic processing and propose appropriate improvements/remedies to avoid them.

Detailed Assessment Description

Refer to Moodle for detailed information about this assessment task.

Submission notes

MT-Test is a formal invigilated in-person written exam.

Assignment submission Turnitin type

Not Applicable

Hurdle rules

You are required to achieve a mark of at least 35% in the final exam (and at least 45% weighted average for the final exam and the mid-term test) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Final Examination

Assessment Overview

The final exam will assess your learning of ceramic drying and firing aspects of ceramic processing and ternary phase equilibria covered in Weeks 7-12 and will typically include short-answer style questions and calculations. It will be 2 hours in duration and held in the formal UNSW examination period at the end of term.

Feedback: You will receive your final mark and grade for the course; additional feedback may be available through inquiry with the course convenor.

You are required to achieve a mark of at least 35% in the final exam (and at least 45% weighted average for the final exam and the mid-term test) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Course Learning Outcomes

- CLO1 : Describe the main processes and related technology involved in the manufacturing of specific classes of ceramic products.
- CLO2 : Explain the fundamental chemical and/or physical phenomena that underpin each of the main stages of ceramic processing.
- CLO3 : Explain and predict the effect of heat treatment conditions on the high temperature reactions of specific ceramic materials and their resultant phase composition and microstructure.
- CLO4 : Perform calculations related to aspects of drying and firing processes used in ceramic manufacturing.
- CLO5 : Analyse typical problems encountered in ceramic processing and propose appropriate improvements/remedies to avoid them.

Detailed Assessment Description

Refer to Moodle for detailed information about this assessment task.

Submission notes

Final Examination is a formal invigilated in-person exam.

Assignment submission Turnitin type

Not Applicable

Hurdle rules

You are required to achieve a mark of at least 35% in the final exam (and at least 45% weighted average for the final exam and the mid-term test) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

General Assessment Information

Short Extensions:

The School of Materials Science and Engineering has reviewed its range of assignments and projects to determine their suitability for automatic short extensions as set out by the UNSW Short Extension Policy. After consultation with teaching staff and examination of our course offerings we consider our current deadline structures already accommodate the possibility of unexpected circumstances that may lead students to require additional days for submission. Consequently, the School does not offer the Short Extension provision in its MATS courses but students, if needed, can apply for formal Special Consideration via the usual procedure.

Grading Basis

Standard

Requirements to pass course

You are required to achieve a mark of at least 35% in the final exam (and at least 45% weighted average for the final exam and the mid-term test) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Course Schedule

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

Please refer to Moodle for detailed information about the course schedule.

Course Resources

Prescribed Resources

No specific resources are prescribed for this course.

Recommended Resources

The following classic textbooks may be useful for students:

- M. Barsoum, Fundamentals of Ceramics, Second Edition. McGraw Hill, 2019.
- C. Burt, Sintering of Ceramics: Prominent Processes and Methods. NY Research Press, 2015.
- C.G. Bergeron and S.H. Risbud, Introduction to Phase Equilibria in Ceramics. American Ceramic Society, 2004.
- Y.-M. Chiang, D.P. Birnie, and W.D. Kingery, Physical Ceramics. Principles for Ceramic Science and Engineering. John Wiley and Sons, 1997.
- D. Ganguli and M. Chatterjee, Ceramic Powder Preparation: A Handbook. Kluwer Academic Publishers, 1997.
- R.M. German, Sintering Theory and Practice. John Wiley and Sons, 1996.
- F.A. Hummel, Introduction to Phase Equilibria in Ceramic Systems. Marcel Dekker, 1984.
- R.E. Loehman, Characterisation of Ceramics. Butterworth-Heinemann, 1993.
- W.D. Kingery, H.K. Bowen, and D.R. Uhlmann, Introduction to Ceramics, Second Edition. Wiley, 1976.
- R. König, Ceramic Drying. Novokeram, 1998.
- M.N. Rahaman, Ceramic Processing, Second Edition. CRC Press, 2017.
- M.N. Rahaman, Ceramic Processing and Sintering, Second Edition. CRC Press, 2003.
- M.N. Rahaman, Sintering of Ceramics. CRC Press, 2007.
- James S. Reed, Principles of Ceramics Processing, Second Edition. John Wiley and Sons, 1995.
- T.A. Ring, Fundamentals of Ceramic Powder Processing and Synthesis. Academic Press, 1996.
- H. Saka, Introduction to Phase Diagrams in Materials Science and Engineering. World Scientific Publishing, 2019.
- W.E. Worrall, Ceramic Raw Materials, Second Edition. Pergamon Press, Oxford, 1982.

Course Evaluation and Development

Formal student feedback about the course will be gathered from enrolled students via the myExperience survey conducted at the end of term. This feedback will be used to evaluate the running and teaching of the course as well as to make improvements in the course for the following year to improve the student experience. Students are also welcome to make constructive comments and suggestions at any time during term to course staff. Any significant feedback from the previous running of the course and how it was used to improve the course will be discussed in the first lecture.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Owen Standard		Rm 243A Hilmer Building (E10)	(02) 9065 5356	Please send email to request appointment for consultation.	Yes	Yes
Lecturer	Sorrell Chris		Rm 248 Hilmer Building (E10)	(02) 9358 4421	Please send email to request appointment for consultation.	No	No

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

Academic Honesty and Plagarism

Referencing is a way of acknowledging the sources of information that you use to research your

assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.
Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply

by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

Important note: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines