



UNSW Course Outline

MATS6107 Thermal Properties of Ceramics - 2024

Published on the 11 Feb 2024

General Course Information

Course Code : MATS6107

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 : Postgraduate

Units of Credit : 6

Useful Links

[Handbook Class Timetable](#)

Course Details & Outcomes

Course Description

This master's level course covers the processing and temperature dependent applications of ceramic materials. It aims to enhance knowledge and understanding of advanced ceramics (oxides and non-oxides) for electrical, piezoelectric, magnetic, optoelectronic, chemical, nuclear,

biological, and wear applications.

The first half of the course will focus on the fundamental structure-microstructure-property relationships and how these can be tailored through alteration of the processing conditions to fabricate optimal advanced ceramics in bulk and thin film format for use in the above applications. This will be achieved through use of case studies and examples related to the design of these advanced ceramics for superior mechanical properties (strength, modulus, and toughness), electrical (dielectric, ferroelectric, piezoelectric), magnetic (ferromagnetic, ferrimagnetic), electromechanical and optoelectronic properties. The second half of the course will focus on the temperature dependent properties of such ceramics. Particular emphasis is placed on functional properties and applications related to energy generation.

Course Aims

This course aims to develop knowledge of the relationship between structure, processing and properties and failure mechanisms of advanced ceramics in order to successfully optimize their properties to enable their applications in different fields. This will assist in designing and fabricating products from these materials in real-world applications. The parameters for designing the advanced ceramics will focus on the thermal, electromechanical, magnetic, electrical and optoelectronic properties.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Analyse the principles underlying the functional and thermal behaviour of ceramic materials.
CLO2 : Articulate the common strategies used to enhance functional performance for energy applications in ceramic materials.
CLO3 : Analyse real-life performance scenarios in the functional materials world for products made from ceramic materials.
CLO4 : Evaluate peer-reviewed literature to present a cohesive summary of advanced ceramic design and fabrication in a professional, written format.

Course Learning Outcomes	Assessment Item
CLO1 : Analyse the principles underlying the functional and thermal behaviour of ceramic materials.	<ul style="list-style-type: none">• Assignment 1• Mid-term Test• Final Exam
CLO2 : Articulate the common strategies used to enhance functional performance for energy applications in ceramic materials.	<ul style="list-style-type: none">• Assignment 1• Mid-term Test
CLO3 : Analyse real-life performance scenarios in the functional materials world for products made from ceramic materials.	<ul style="list-style-type: none">• Final Exam• Assignment 1• Mid-term Test
CLO4 : Evaluate peer-reviewed literature to present a cohesive summary of advanced ceramic design and fabrication in a professional, written format.	<ul style="list-style-type: none">• Final Exam• Assignment 1

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment 1 Assessment Format: Individual	20%	Due Date: Week 5: 11 March - 17 March
Mid-term Test Assessment Format: Individual	30%	Due Date: Week 7: 25 March - 31 March
Final Exam Assessment Format: Individual	50%	Due Date: Exam period

Assessment Details

Assignment 1

Assessment Overview

For this assignment, you will undertake a task involving the application of properties including electrical, electronic, optical and magnetic properties covered in Weeks 1-4. It is designed to introduce the students to a broader range of functionalities and practical applications of state-of-the-art ceramics and related materials and to provide summative assessment of the learning process

The assignment is typically due in Week 5 and feedback will be given two weeks after submission of the assignment and take the form of the mark for the assignment, overall comments on how the class performed, any common areas that were not answered correctly. Additionally, personal feedback and how each student performed may be given.

Course Learning Outcomes

- CL01 : Analyse the principles underlying the functional and thermal behaviour of ceramic materials.
- CL02 : Articulate the common strategies used to enhance functional performance for energy applications in ceramic materials.
- CL03 : Analyse real-life performance scenarios in the functional materials world for products made from ceramic materials.
- CL04 : Evaluate peer-reviewed literature to present a cohesive summary of advanced ceramic design and fabrication in a professional, written format.

Mid-term Test

Assessment Overview

This test is designed to assess your learning of the topics covered in Weeks 1-4. It will be 2 h in duration and is typically held in Week 7.

The format will be in person (hand-written, single chance) and will focus on application of understanding of topics gained from lectures to answer descriptive and mathematical questions related to the properties and design of the materials for these applications.

Feedback: You will receive their marks and feedback indicating what questions were answered correctly and incorrectly. Overall comments and worked solutions may be provided to the class.

Course Learning Outcomes

- CL01 : Analyse the principles underlying the functional and thermal behaviour of ceramic materials.
- CL02 : Articulate the common strategies used to enhance functional performance for energy applications in ceramic materials.
- CL03 : Analyse real-life performance scenarios in the functional materials world for products made from ceramic materials.

Hurdle rules

Satisfactory completion of the course includes the requirement to achieve at least 35% in the mid-term exam and at least 35% in the final exam, and at least 45% weighted average over the two exams.

Students who fail to achieve this will be awarded an Unsatisfactory Fail (UF) grade for the course regardless if they receive over 50% in total for the course.

Final Exam

Assessment Overview

The final exam will be held during the formal exam period. You will be expected to give short answers that will test your basic knowledge of electromechanical and electrothermal properties. The final exam will also have one numerical question where you will be asked to compute a figure of merit for a case study based on one of the electrothermal properties. Finally you will be asked to answer questions based on a journal publication covered in the class as a case study.

Feedback is available through inquiry with the course convenor.

Course Learning Outcomes

- CL01 : Analyse the principles underlying the functional and thermal behaviour of ceramic materials.
- CL03 : Analyse real-life performance scenarios in the functional materials world for products made from ceramic materials.
- CL04 : Evaluate peer-reviewed literature to present a cohesive summary of advanced ceramic design and fabrication in a professional, written format.

Hurdle rules

Satisfactory completion of the course includes the requirement to achieve at least 35% in the mid-term exam and at least 35% in the final exam, and at least 45% weighted average over the two exams.

Students who fail to achieve this will be awarded an Unsatisfactory Fail (UF) grade for the course

regardless if they receive over 50% in total for the course.

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.

Assignments:

Feedback will be given two weeks after submission of the assignment and take the form of the mark for the assignment, overall comments on how the class performed, any common areas that were not answered correctly. Additionally, personal feedback and how each student performed may be given.

Midsession exams: Students will receive their marked exams indicating what questions were answered correctly and incorrectly. Overall comments and worked solutions may be provided to the class.

Final exam: Students will receive their final mark.

Grading Basis

Standard

Requirements to pass course

Unsatisfactory Fail Grade:

Satisfactory completion of the course includes the requirement to achieve at least 35% in the mid-term exam and at least 35% in the final exam, and at least 45% weighted average over the two exams.

Students who fail to achieve this will be awarded an Unsatisfactory Fail (UF) grade for the course regardless if they receive over 50% in total for the course.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 12 February - 18 February	Lecture	Introduction Introduction to electroceramics Ferroelectric ceramic and their applications
Week 2 : 19 February - 25 February	Lecture	Ferroelectric ceramic and their applications Piezoelectric ceramics
Week 3 : 26 February - 3 March	Lecture	Piezoelectric ceramics Fibre-Optic Sensors Magnetic ceramics
Week 4 : 4 March - 10 March	Lecture	Magnetic ceramics and their applications Revision
Week 5 : 11 March - 17 March	Lecture	Introduction to Advanced Ceramic Processing Mechanical Properties of Ceramics
Week 6 : 18 March - 24 March	Other	Flexibility week Week six is known as 'flexi week', no classes are held this week to give students an opportunity to focus on assessable tasks and revising course content.
Week 7 : 25 March - 31 March	Lecture	Pyroelectric Materials and their applications
Week 8 : 1 April - 7 April	Lecture	Case studies of Pyroelectric Materials and their applications Electrocaloric Materials
Week 9 : 8 April - 14 April	Lecture	Case studies of Electrocaloric Materials
Week 10 : 15 April - 21 April	Lecture	Thermoelectric materials and their applications Case studies of Thermoelectric materials and their applications
Week 11 : 22 April - 28 April	Lecture	Revision (Optional)

Attendance Requirements

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

General Schedule Information

This course consists of 46 hours of class contact hours. You are expected to take an additional 104 hours of non-class contact hours to complete assessments, readings and exam preparation.

Course Resources

Recommended Resources

A.J. Moulson and J.M. Herbert, *Electroceramics: Materials, Properties, Applications*, 2nd Edition, John Wiley & Sons, 2003

- K. Uchino, *Piezoelectric Actuators and Ultrasonic Motors*, Kluwer Academic Publishers, 1997
- Y. Xu, *Ferroelectric Materials and Their Applications*, North-Holland, 1991
- A.V. Srinivasan and D. Michael McFarland, *Smart Structures: Analysis and Design*, Cambridge University Press, 2001

- S.O. Kasap, Principles of Electrical Engineering Materials and Devices, Revised Edition. McGraw-Hill, Boston, 2000. Göran Grimvall, Thermophysical Properties of Materials, Elsevier B.V, 1999
- R. Morrell, Handbook of Properties of Technical & Engineering Ceramics. Part 1: An Introduction for the Engineer and Designer. HMSO, London, 1989
- W.D. Kingery, H.K. Bowen, & D.R. Uhlmann, Introduction to Ceramics, 2nd Ed. John Wiley, New York, 1976.
- H. Julian Goldsmid, Introduction to Thermoelectricity, Springer, Berlin, 2016
- Tatiana Correia, Qi Zhang, Electrocaloric Materials: New Generation of Coolers, Springer, Berlin, 2014

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Lecturer	Peggy Zhang				by appointment	No	Yes
	Danyang Wang		239 Hilmer Building	02 9385 7170	By appointment	No	No
Convenor	Nagarajan Valanoor		247 Hilmer Building	9385 4263	By appointment	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 Plagiarism

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](#)