Course Outline

MATS6107

Thermal Properties of Ceramics

Materials Science and Engineering

Science

T1, 2021

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor	Prof. Nagarajan Valanoor	nagarajan@unsw.edu.au	Room 247, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 4263
Lecturer	A/Prof Danyang Wang	dy.wang@unsw.edu.au	Room 239, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 7170
Lecturer	Dr. Peggy Zhang			

2. Course information

Units of credit: 6

Pre-requisite(s): None

Timetabling website: http://timetable.unsw.edu.au/2021/MATS6107.html#S1-1189

Teaching times and locations:

Part 1	Lecture	Lecture	Lecture
Day	Monday	Wednesday	Friday
Location	Online	Online	Online
Time	09:00 - 11:00	11:00 - 13:00	09:00-11:00
Weeks	1-4	1-3,5	1-3,5

Part 2	Lecture	Lecture	Lecture
Day	Monday		Wednesday
Location	Online		Online
Time	11:00-13:00		14:00-16:00
Weeks	7, 9-10		7-10

2.1 Course summary

This course covers the thermal properties of materials, especially high temperatures ceramic materials. Emphasis is placed on enhancing the thermal stability, toughness and strength of these materials. Processing methods used to manufacture these materials will also be studied.

2.2 Course aims

The objective of the course is to familiarise students with the full range of materials, properties, applications, and design requirements necessary for the utilisation of high-performance ceramics in modern technological functions. The main design parameters that will be understood are defined by the electromechanical, magnetic, electrical, optoelectronic, thermal and electrothermal properties of advanced ceramics and related materials.

2.3 Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. Understand the principles underlying the functional and thermal behaviour of ceramic materials
2. Articulate the common strategies used to enhance functional performance for energy applications in ceramic materials
3. An appreciation of real-life performance scenarios for products made from these materials

2.4 Relationship between course and program learning outcomes and assessments

Course Learning Outcome (CLO)	LO Statement	Program Learning Outcome (PLO)	Related Tasks & Assessment
CLO 1	Understand…	3	1, 2, & 3
CLO 2	Articulate…	1	1, 2, & 3
CLO 3	An appreciation…	4	1, 2, & 3

3. Strategies and approaches to learning

3.1 Learning and teaching activities

(based on UNSW Learning Guidelines)

- *Students are actively engaged in the learning process.*
  It is expected that, in addition to attending classes, students read, write, discuss, and are engaged in solving problems on the thermal properties of materials, and in analysis and evaluation of materials' and devices' performance using electron/photon-related properties.

- *Effective learning is supported by a climate of inquiry where students feel appropriately challenged.*

  Problems involving electron theory are challenging; students will be given assignments that will motivate deep analysis of various physical phenomena in materials science and engineering.
- *Learning is more effective when students' prior experience and knowledge are recognised and built on.*

  This course is built on prior courses in ceramic processing.
- *Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts*

  Students will be asked to analyse the critical role of functional properties such as ferroelectricity and thermoelectrics in the application of advanced ceramic materials and design of novel devices.

3.2 Expectations of students

- Students must attend at least 80% of all classes with the expectation that students only miss classes due to illness or unforeseen circumstances
- Students must read through lecture notes and lab sheets prior to class
- During class, students are expected to engage actively in class discussions
- Students should work through lecture, tutorial and textbook questions
- Students should read through the relevant chapters of the prescribed textbook.
- Students should complete all assessment tasks and submit them on time.
- Students are expected to participate in online discussions through the Moodle page

4. Course schedule and structure

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.

Week	Topics	Activity
1	Introduction Introduction to electroceramics Ferroelectric Ceramics and their Applications	
2	Ferroelectric Ceramics and their Applications Piezoelectric ceramics	
3	Electro-optic Ceramics and Fibre-Optic Sensors Magnetic ceramics	Formative in-class quiz
4	Magnetic ceramics	
5		Assignment 1
6	Advanced Ferroelectrics ”Flexibility week”	”Flexibility week”
7	Pyroelectric Materials and their applications	Mid-session exam (DW)
8	Ferroelectric phase transitions	
9	Electrocaloric Materials	
10	Thermoelectric materials and their applications	Final Exam

5. Assessment

5.1 Assessment tasks

Assessment task	Description	Weight	Due date
Assignment 1:	Students are required to conduct research about electroceramics and their applications. The topics should be within the scope of electrical, electronic, optical and magnetic properties. 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 formative assessment of the learning process	20%	Week 5
Mid-term exam:	Topics: Electrical, electromechanical, magnetic and optoelectronic properties, and materials Duration: 2 hours	30%	Week 7
Final exam:	Topics: Thermal properties (heat capacity, thermal conductivity, thermal expansion) and Electrothermal properties (pyroelectric, electrocaloric, thermoelectric) Duration: 2 hours	50%	Final exam period

Further information

UNSW grading system: https://student.unsw.edu.au/grades

UNSW assessment policy: https://student.unsw.edu.au/assessment

5.2 Assessment criteria and standards

Assessment criteria and standards for each assessment tasks are available on the course Moodle page.

5.3 Submission of assessment tasks

- Requests for Special Consideration for examinations and other assessment tasks must be submitted in accordance with UNSW policy. It must be noted that merely submitting a request for Special Consideration does not automatically imply the granting of additional assessment or the award of an amended result.
- In the absence of a request for special consideration, the maximal allowable extension for a late completion of assessment tasks is 7 days (includes non-working days) from the due date for that task. The penalty for late submission is a deduction of 10%/day of the total mark for each day, or part thereof after the due date.
- Students unable to submit assignments on time or attend the mid-session quizzes or final exams on health grounds should make a request for special consideration. Information on this process can be found here: https://student.unsw.edu.au/special-consideration. Medical certificates or other appropriate documents must be included. Students should also advise the lecturer of the situation.
- Unless otherwise specified in the task criteria, all assignments must be uploaded via Moodle prior to the due date for submission.

- Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit: https://student.unsw.edu.au/disability. Early notification is essential to enable any necessary adjustments to be made.
- Rules governing conduct during exams are given at: https://student.unsw.edu.au/exam-rules

5.4. Feedback on assessment

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.

6. Academic integrity, referencing 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.[1] 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 and **plagiarism** can be located at:

- The *Current Students* site https://student.unsw.edu.au/plagiarism**,** and
- The *ELISE* training site http://subjectguides.library.unsw.edu.au/elise/presenting

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

7. Readings and 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

[1] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.

- 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

8. Administrative matters

School Office: Room 137, Building E10 School of Materials Science and Engineering
School Website: http://www.materials.unsw.edu.au/
Faculty Office: Robert Webster Building, Room 128
Faculty Website: http://www.science.unsw.edu.au/

9. Additional support for students

- The Current Students Gateway: https://student.unsw.edu.au/
- Academic Skills and Support: https://student.unsw.edu.au/academic-skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Disability Support Services: https://student.unsw.edu.au/disability-services
- UNSW IT Service Centre: https://www.it.unsw.edu.au/students/index.html