Course Outline

MATS4002

Design with Advanced Ceramics

Materials Science and Engineering

Science

T1, 2022

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor	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 Pramod Koshy	koshy@unsw.edu.au	Room 120, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 6038

2. Course information

Units of credit: 6

Pre-requisite(s): MATS3002

Timetabling: http://timetable.unsw.edu.au/2020/MATS4002.html

Teaching times and locations:

	Lecture	Lecture	Lecture	Laboratory
Day	Monday	Tuesday	Wednesday	Thursday
Location	Online (DW) Business School 232 (PK)	Online (DW) Business School 205 (PK)	Online (DW) Chem Sci M18 (PK)	Hilmer Building (E10)
Time	14:00-16:00	09:00-11:00	10:00-12:00	14:00-17:00
Weeks	1-10	1-10	1-10	8-10

2.1 Course summary

Design with advanced ceramics for structural, thermal, electrical, piezoelectric, chemical, catalytic, and wear applications. Fundamental structure-property relationships underlying thermal shock, mechanical strength and fracture toughness, Weibull modulus and reliability, piezo-, thermo and optoelectric behaviour, corrosion, wear/abrasion, photocatalysis. Case Studies in design and performance of ceramic materials and products.

Oxide and non-oxide advanced ceramics, design parameters, structure/microstructure- processing-properties relations, thermal properties and materials, chemical (corrosion) properties and materials, mechanical properties and materials, thermomechanical properties and materials, tribological properties and materials, electromechanical properties and materials, magnetic properties and materials, electrical properties and materials, and optoelectronic properties and materials.

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 thermal, chemical, mechanical, thermomechanical, tribological, electromechanical, magnetic, electrical, and optoelectronic properties of advanced ceramics. This will assist in building improved understanding of real-life performance scenarios for products made using these materials

2.3 Course learning outcomes (CLO)

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

1. Demonstrate an understanding the properties and characteristics of ceramics for high-performance applications.
2. Assess the range of typical properties of these materials with the aim of utilising them in high-demand designs requiring specific mechanical, thermal, electrical, and other properties.
3. Demonstrate an understanding of how to manipulate ceramic microstructures through processing in order to obtain optimal properties for different applications.

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	Demonstrate…	1.3, 1.4, 2.2, 3.2 & 3.4	2 & 3
CLO 2	Assess…	1.3, 1.4, 2.2, 3.2, 3.4 & 3.6	1, 2, 3 & 4
CLO 3	Demonstrate…	1.3, 1.4 & 3.4	1, 2, 3 & 4

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 and mechanical 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 and structural properties in the application of advanced ceramics and design of novel devices.

Lectures: The core concepts will be taught in lectures, students will have access to the lectures notes before class for annotation during the lecture. Students will be engaged in the learning process through class discussions and problem-solving questions independently and working together with partners and groups.

Labs: Experimental techniques and procedures will be taught through laboratories classes and laboratory reports following the class. Students will actively complete the experiments gaining experience of important materials testing and characterisation techniques. Students will be able to reflect on the experiments and learn to process data through the lab reports after class.

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 52 hours of class contact hours. You are expected to take an additional 98 hours of non-class contact hours to complete assessments, readings and exam preparation.

Week	Topics	Activity
1	Introduction Introduction to electroceramics Ferroelectric ceramic and their applications	
2	Ferroelectric ceramic and their applications Piezoelectric ceramics	
3	Piezoelectric ceramics Fibre-Optic Sensors Magnetic ceramics	Formative in-class quiz
4	Magnetic ceramics and their applications	
5	Introduction to Advanced Ceramic Processing Mechanical Properties of Ceramics	Assignment 1 (DW)
6	Flexibility week	Flexibility week
7	Mechanical/Tribological Properties of Ceramics Thermal Properties of Ceramics	Mid-session exam (DW) Lab/Lab Visits
8	Thermal Properties of Ceramics Thermomechanical Properties of Ceramics	Assignment 2 (PK) Lab/Lab Visits
9	Chemical (corrosion) Properties of Ceramics Nuclear Properties of Ceramics Biological Properties of Ceramics	Lab/Lab Visits
10	Revision	Lab/Lab Visits

5. Assessment

5.1 Assessment tasks

Assessment task	Description	Weight	Due date
Assignment 1:	Students are required to conduct research about the electroceramics and their applications. This is 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
Assignment 2:	Students will be required to conduct research on a topic involving materials, properties, performance, of advanced ceramic products in terms of their mechanical / tribological / thermal / thermomechanical / corrosion / biological properties for further learning on current and relevant applications and issues related to the properties and processing of these materials and formative assessment of the learning process	15%	Week 8/9
Mid-session exam:	Electrical, electromechanical, magnetic and optoelectronic properties, and materials	30%	Week 7
Final Exam:	Mechanical, tribological, thermal, thermomechanical, chemical, and biological properties	35%	Final exam period

Further information

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

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

Unsatisfactory Fail Grade:

Satisfactory completion of the course includes the requirement to achieve >35% in the mid-term exam and >35% in the final exam, and >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.

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

- UNSW operates under a Fit to Sit/ Submit rule for all assessments. If a student wishes to submit an application for special consideration for an exam or assessment, the application must be submitted prior to the start of the exam or before an assessment is submitted. If a student sits the exam/ submits an assignment, they are declaring themselves well enough to do so. 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.
- 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
- S.O. Kasap, Principles of Electrical Engineering Materials and Devices, Revised Edition. McGraw-Hill, Boston, 2000.
- D.J. Green, An Introduction to the Mechanical Properties of Ceramics. Cambridge University Press, Cambridge, 1998.
- D. Munz, T. Fett, Ceramics – Mechanical Properties, Failure Behaviour, Materials Selection. Springer-Verlag Berlin Heidelberg, 1999
- R. Morrell, Handbook of Properties of Technical & Engineering Ceramics. Part 1: An Introduction for the Engineer and Designer. HMSO, London, 1989
- W.E.C. Creyke, I.E.J. Sainsbury, and R. Morrell, Design with Non-Ductile Materials. Applied Science, London, 1982.
- J.B. Wachtman, Mechanical Properties of Ceramics. John Wiley, New York, 1996.
- S. Jahanmir, Editor, Friction and Wear of Ceramics. Marcel Dekker, New York, 1994.
- W.D. Kingery, H.K. Bowen, & D.R. Uhlmann, Introduction to Ceramics, 2nd Ed. John Wiley, New York, 1976.
- R.A. McCauley, Corrosion of Ceramics. Marcel Dekker, New York, 1995.

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/

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

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
- Assessment Implementation Procedure: https://www.gs.unsw.edu.au/policy/documents/assessmentimplementationprocedure.pdf