

MSE3111: CERAMIC MATERIALS

Effective Term

Semester A 2023/24

Part I Course Overview

Course Title

Ceramic Materials

Subject Code

MSE - Materials Science and Engineering

Course Number

3111

Academic Unit

Materials Science and Engineering (MSE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

AP2102/ MSE2102 Introduction to Materials Engineering

Precursors

Nil

Equivalent Courses

AP3111 Ceramic Processing and Microstructure Development

Exclusive Courses

Nil

Part II Course Details

Abstract

This course aims to provide students with fundamental knowledge of structure and properties of ceramic materials and introduction of processing routes for engineering ceramics, with an emphasis on processing-structure-property

relationships. Knowledge of bonding, crystal structure, microstructural defects in ceramics and they are correlated with processing methodologies will be gained. Students will have a hand-on experience in the fabrication of advanced ceramic samples using mixed oxide and learn to organize the lab results into a logic and concise report. Students will also practice reading and critical thinking on technical article on the field.

Course Intended Learning Outcomes (CILOs)

CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1 Understand the bonding type and crystal structure of ceramic materials.	20	x	x	
2 Recognize microstructural defects at different length scales in ceramics.	20	x	x	
3 Describe mechanical, thermal and electrical properties of ceramics and their correlation with defects.	20		x	x
4 Explain the working principle of and microstructure evolution during sintering. Familiarize classical processing methodologies for engineering ceramics.	20		x	x
5 Identify the linkage between processing, structure and properties of ceramics.	10		x	x
6 Practice reading technical articles on the field.	10		x	x

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1 Lectures	Explain key concepts, such as fundamental knowledge of structure, defect, properties and basic principles of processing of ceramic materials	1, 2, 3, 4, 5	3hrs/wk
2 Tutorials	Quizzes related to basic principles and working knowledge; group discussions on assigned journal papers; explanation of difficult homework problems	1, 2, 3, 4, 5	1hr/wk

3	Laboratory	Students will have a hand-on experience in the fabrication of advanced ceramic samples using mixed oxide processing and learn to organize the lab results into a logic and concise report	1, 2, 3, 4, 5	3hrs/wk
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Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Homeworks, quizzes	1, 2, 3, 4, 5	15	
2	Lab reports	1, 2, 3, 4, 5	15	
3	Term paper	1, 2, 3, 4, 5	5	
4	Midterm exam	1, 2, 3, 4, 5	15	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)**Assessment Task**

1. Assignments, quizzes, midterm test

Criterion

Capability of understanding basic principles and working knowledge of processing of ceramic materials and microstructure development

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

2. Lab reports

Criterion

Ability to explain processing-structure-property relationships

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

3. Term paper

Criterion

Ability to read technical articles with critical thinking on the field

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Examination

Criterion

Combination of assessment task 1 and 2

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

- Introduction to course
 - Course objectives
 - Important definitions
 - Overview of processing-structure-property relationship
 - Structure of ceramics
- Bonding type and crystal structure of ceramics
- Structural defects in ceramics
- Properties of ceramics
- Powder synthesis and forming technologies for engineering ceramics
- Sintering science and microstructure evolution
- Characterization for ceramic materials
- Processing-structure-property relations in ceramics

Reading List

Compulsory Readings

Title	
1	“Fundamentals of Ceramics” by M.W. Barsoum, 2003 ISBN: 0750309024
2	“Formation of BaTiO ₃ from BaCO ₃ and TiO ₂ in air and in CO ₂ ” J. Am. Ceram. Soc. (1959)
3	“Chemical processing and properties of nanocrystalline BaTiO ₃ ” Mat. Res. Soc. Symp. Proc. (1992)
4	“Barium Titanate piezoelectric ceramics manufactured by two-step sintering” Jap. J. Appl. Phys. (2007)

Additional Readings

Title	
1	M N Rahaman, “Ceramic Processing and Sintering”, Marcel Dekker (2003) TP807.R28 2003
2	W D Kingery, HK Bowen and D R Uhlmann, “Introduction to Ceramics”, John Wiley & Sons, Inc. (1976) TP807.K52 1976
3	T A Ring, “Fundamentals of Ceramic Powder Processing and Synthesis”, Academic Press (1996). TP815.R56 1996
4	J S Reed, “Principles of Ceramic Processing”, Wiley Inter-Science (1995) TP807.R36 1995
5	A P Tomsia and A M Glaeser (Ed.), “Ceramic Microstructures: control at the atomic level”, Plenum Press (1998). TA455.C43 C464 1998
6	C. Barry Carter and M. Grant Norton, “Ceramic Materials”, e-book 2013

7	W.D. Callister, D.G. Rethwisch, “Materials Science and Engineering: An Introduction” , 8th edition, W.D. Callister, D.G. Rethwisch, 2009
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