MSE3111: CERAMIC MATERIALS

Effective Term
Semester A 2025/26

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 the structure and properties of ceramic materials and introduction of processing routes for engineering ceramics, with an emphasis on processing-structure-property

relationships. Students will gain knowledge of bonding, crystal structure, microstructural defects in ceramics and they are correlated with processing methodologies. Students will have a hands-on experience in the fabrication of advanced ceramic samples using mixed oxide and learn to organize the lab results into a logical 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	Describe the bonding type and crystal structure of ceramic materials.	20	x	x	
2	Explain microstructural defects at different length scales in ceramics.	20	x	x	
3	Discuss 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	Discuss the linkage between processing, structure and properties of ceramics.	20		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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Students will engage in lecture activities covering 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	Students will critically engage in interactive discussion and learning to apply basic principles to difficult homework and quiz 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

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Homeworks, quizzes	1, 2, 3, 4, 5	15	-	No
2	Lab reports	2, 4, 5	15	-	No
3	Course presentation	4, 5	5	-	No
4	Midterm exam	1, 2, 3, 4	15	-	No

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

50

Minimum Examination Passing Requirement (%)

30

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 explaining and applying 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 identify and 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. Course presentation

Criterion
Ability to read, analyze and present technical contents 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
4. 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 BaTiO3 from BaCO3 and TiO2 in air and in CO2” J. Am. Ceram. Soc. (1959) 42, 212-216
3	“Chemical processing and properties of nanocrystalline BaTiO3” Mat. Res. Soc. Symp. Proc. (1992) 271, 339-344
4	“Barium Titanate piezoelectric ceramics manufactured by two-step sintering” Jpn. J. Appl. Phys. (2007) 46, 7035

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