

CHEM8015: MATERIALS CHEMISTRY FOR ENERGY TECHNOLOGIES

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Materials Chemistry for Energy Technologies

Subject Code

CHEM - Chemistry

Course Number

8015

Academic Unit

Chemistry (CHEM)

College/School

College of Science (SI)

Course Duration

One Semester

Credit Units

3

Level

R8 - Research Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

Nil

Equivalent Courses

BCH8015 Materials Chemistry for Energy Technologies

Exclusive Courses

Nil

Part II Course Details

Abstract

This course aims to develop an understanding of chemistry concepts to design and synthesis functional materials for energy harvesting and storage technologies. Conventional and emerging chemical synthesis and material processing technologies will be introduced. The core and fundamental elements of physics, chemistry and materials science will be recognized through study of the cutting-edge high-performance energy technologies.

The lecture content will provide the chemistry of materials for energy conversion, including basics concepts and fundamentals of functional materials, chemical synthesis and materials preparation, and their materials properties. The lecture topics will be discussed in the following subjects: Photovoltaic materials and technologies including c-Si solar cells, thin film solar cell (CdTe, CIGS, amorphous Si), organic solar cells, dye-sensitized solar cells, quantum dot solar cells, perovskite solar cells; Energy storage materials technologies, battery and super capacitor; Thermoelectric solar cells; fuel cells; water splitting.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Understand the chemistry used to prepare the materials and their properties and application for energy conversion and storage	20	x	x	
2	Recognize the conventional and emerging chemical synthesis and material processing technologies for energy technologies;	20	x	x	
3	Apply chemistry concepts and principle to analyse the formulation, composition and chemical structure of functional materials;	20	x	x	x
4	Assess the current stage of existing high-performance energy technologies and conduct the analysis of their future potentials;	20	x	x	x
5	Be able to define materials properties with the key structure-property relationship and good communication in teamwork	20	x	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	Lecture	Students will describe the basic concepts and fundamentals of functional materials, chemical synthesis and materials preparation techniques, and assess the application of functional materials in energy systems.	1, 2, 3, 4, 5	26 hours in total
2	Small group presentation, Proposal report	Students will prepare group presentations and proposal reports for a selected topic	2, 3, 4	10 hours in total
3	Laboratory Exercise	Students will visit the Lab for the fabrication and tests of some energy conversion or storage devices	3, 4, 5	6 hours in total

Assessment Tasks / Activities (ATs)

ATs		CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Class discussion/ Quiz	1, 2, 3, 4, 5	15	-	Yes
2	Group presentation	2, 3, 4	25	-	Yes
3	Proposal report	2, 3, 4, 5	20	-	Yes
4	Examination	1, 2, 3, 4, 5	0	-	No

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2.5

Minimum Continuous Assessment Passing Requirement (%)

40

Minimum Examination Passing Requirement (%)

40

Assessment Rubrics (AR)**Assessment Task**

Class quiz and discussion (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Understand the concepts and fundamentals of functional materials, chemical synthesis and materials preparation, and their application

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

Group presentation (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Apply and assess the current stage of existing high-performance energy technologies through using chemistry concepts and principles

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

Proposal report (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Be able to predict and analysis development and potential of energy application

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 (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Define and analysis the chemical synthesis and material processing technologies for energy technologies

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

Class quiz and discussion (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Understand the concepts and fundamentals of functional materials, chemical synthesis and materials preparation, and their application

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Basic

Failure

(F) Notevenreaching marginal levels

Assessment Task

Group presentation (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Apply and assess the current stage of existing high-performance energy technologies through using chemistry concepts and principles

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Part III Other Information

Keyword Syllabus

Basics concepts and fundamentals of functional materials, chemical synthesis and materials preparation, and their materials properties; Photovoltaic materials and technologies including c-Si solar cells, thin film solar cell (CdTe, CIGS, amorphous Si), organic solar cells, dye-sensitized solar cells, quantum dot solar cells, perovskite solar cells; Energy storage materials technologies, battery and super capacitor; Thermoelectric solar cells; fuel cells; water splitting.

Reading List

Compulsory Readings

Title	
1	Selected research reviews

Additional Readings

Title	
1	Duncan W. Bruce, Dermot O'Hare, Richard I. Walton Energy Materials, 1st ed.; Wiley: Hoboken, 2011
2	Harry R. Allcock Introduction to Materials Chemistry 1st ed.; Wiley: Hoboken, 2008
3	Rolando R.-M, The Physical Chemistry of Materials: Energy and Environmental Applications, 1st ed. CRC Press, Florida, 2009