20CY202 INDUSTRIAL APPLICATIONS OF NANOMATERIALS AND CATALYSIS

Hours per Week :

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4	-	-	4

Course Description and Objectives:

This elective course is aimed at providing various aspects of nanomaterials and their catalytic applications with special emphasis on industrially relevant approaches. While attempting to offer a holistic picture of the industrial nanocatalytic processes, this course will allow the students to be familiar with various topics of nanomaterials and catalysis. In addition, it will also help the students understand the practices and challenges of contemporary nanocatalytic processes.

Course Outcomes:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes
1	Apply the knowledge of chemistry to learn the fundamental concepts of nanomaterials
2	Identify different characteristics of heterogeneous catalytic (and nanocatalytic) processes and their differences with homogeneous catalysis
3	Analyze various synthetic and catalytic parameters for industrially relevant metal-based nanocatalytic systems
4	Recognize the importance and the examples of non-metal-based heterogeneous catalytic (and nanocatalytic) processes
5	Assess the emerging electro- and photo-catalytic processes through various recent examples

UNIT - I :

Basics of Nanomaterials :

Definition, Classification, Difference between bulk and nanomaterials, General synthetic approaches (top-down and bottom-up), Properties, Characterization Techniques (UV/Vis, Calculation of band-gap in relation to 1D box problem, Microscopy), Aspect ratio, Applications with special emphasis on catalysis (Au/Ag catalysis), Size and shape dependent activity (example Quantum Dots)

UNIT - II:

Fundamentals of Heterogeneous- and Nano- Catalysis :

Introduction to catalysis, Differences between homogeneous and heterogeneous catalysis, Important steps in heterogeneous catalysis, Kinetics and Thermodynamic Concerns, Industrial significance

UNIT - III :

Metal-based Nanocatalysts for Industrial Chemical Transformations :

Introduction to metal/metal-oxide/sulfide/carbide nanoparticles, Synthesis and characterization, Selected catalytic reactions (noble-metal and non-noble-metal-based catalytic examples), Industrial examples,Fischer–Tropsch process, strategies to control exhaust gases (zeolite, NO_x etc.)

UNIT - IV :

Non-metal-based Nanocatalysts for Industrial Chemical Transformations:

Introduction to non-metal-based nanomaterials, Synthesis and characterization, Catalytic reactions involving silica and carbon (either as support for metal nanoparticles or homogeneous catalysts or as active catalysts), Industrial examples (automobile and petrochemical industries), Concept of carbocatalysis

UNIT - V:

Electro- and Photo-catalysis:

Electrocatalysis, Basics of electrocatalysis, Examples of electrocatalytic reactions, Recent trends in nanomaterials-based electrocatalysis (HER, OER etc.)

Photocatalysis, Basics of photocatalysis, Examples of photocatalytic reactions, Recent trends in nanomaterials-based photocatalysis (Water-splitting, artificial photosynthesis)

Text Books :

1. Nanocatalysis Synthesis and Applications: Editor(s): Vivek Polshettiwar Tewodros Asefa Print ISBN:9781118148860 |Online ISBN:9781118609811 |DOI:10.1002/9781118609811 Copyright © 2013 John Wiley & Sons, Inc.
2. Industrial Catalysis: A Practical Approach Author(s): Jens Hagen Print ISBN:9783527331659 |Online ISBN:9783527684625 |DOI:10.1002/9783527684625 Copyright © 2015 Wiley VCH Verlag GmbH & Co. KGaA
3. Nanomaterials in Catalysis, Editor(s): Prof. Dr. Philippe Serp Dr. Karine Philippot Print ISBN:9783527331246 |Online ISBN:9783527656875 |DOI:10.1002/9783527656875 Copyright © 2013 Wiley VCH Verlag GmbH & Co. KGaA

The other relevant materials (primarily research and review articles) will be distributed either as handouts or as soft copies.