UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Inorganic Chemistry of Formulations

2627-2-F5402Q021

Aims

General objectives

To present the basic concepts of formulation chemistry with particular focus on the role and on the type of the inorganic components used in the main industrial and scientific and technological research applications.

Knowledge and understanding

At the end of the course the student:

1. Can distinguish the type of formulation under examination on the basis of its components
2. Can clearly identify active components and compatibilizing agents in a formulation
3. Knows the main inorganic components constituting the formulations

Applying Knowledge and understanding

At the end of the course the student:

1. Can propose methods of preparation and functionalization of inorganic components for a given formulation
2. Will know the main principles related to the application of inorganic compounds in industrial formulations

Making judgments.

At the end of the course the students will be able to

· Select the more suitable synthesis/functionalization of inorganic components for their exploiting in formulations

· individuate the solutions to the main issues related to the employ of inorganic compounds in industrial formulations

Communication skills.

By the end of the course, students will be able to describe the arguments of the course and to participate in stimulating discussions.

Learning skills.

The Student is able to extend what has been learned in classes to case studies not covered during the course. He is in particular able to autonomously manage the wide technical literature dedicated to the Formulations. He knows the research tools of the dedicated literature, including patents.

Contents

The course aims at presenting the fundamental concepts required for the understanding of the role of inorganic components in complex system formulations, such as colloidal dispersions, hybrid surfaces/interfaces and self-assembled structures, which are at the heart of soft matter. Masterizing the intermolecular interactions occurring at the hybrid interfaces determines most often the properties of the materials, which are encountered in a wide range of current applications such as pharmaceuticals, automotive, cultural heritage and cosmetic industries to name but a few.

Detailed program

1. Brief introduction on the main properties of colloids:

Definition, classification and nature of the colloidal dispersions. Physical relevant characteristics of colloids (shape, dimension, aggregation, polydispersity).
Recall of the basic concepts of the physical chemistry of the interfaces. Kinetic and thermodynamic stability of the colloidal dispersions. Surface chemistry and surface charge in colloids. Diffusion, Brownian motion. Derjaguin-Landau-Vervey- Overbeek (DLVO) theory.
Aggregation and de-stabilization mechanism of a colloidal suspension: flocculation, coagulation, sedimentation, Ostwald ripening, coalescence.

2. Synthesis, functionalization, characterization and applications of colloidal nanoparticles (NPs) and other important molecular inorganic systems in formulations.

Synthetic approaches of colloidal NPs: morphology control and tuning of the surface functionalities
Examples of NPs structural, morphological and surface control via sol-gel, hydrothermal and colloidal methods (hot-injection, heating-up)
Functionalization strategies: functionalizing agents and approaches to obtain functionalized NPs and film (also connected to the employ of dip-coating, spin-coating techniques)
Preparation of hybrid organic-inorganic materials used in formulations based on functionalized particles and inorganic systems
Examples of formulations from laboratory to market also in the frame of seminars involving speakers coming from industries (e.g. NPs utilized as filler in nanocomposites for automotive, packaging, anti-icing; functionalized NPs in

nanomedicine)

Prerequisites

Sound basic knowledge inorganic, organic, and physical chemistry. Capability to handle the topics of general chemistry.

Teaching form

14 two-hours lectures, in person, Delivered Didactics
1 two-hours lecture, in remote, Delivered Didactics
1 two-hours industry visit, in person, Interactive Teaching
5 four-hours lab activities, in person, Interactive Teaching

Textbook and teaching resource

Slides available on the e-learning website

Textbooks:

1. Formulation Technology: Emulsions, Suspensions, Solid Forms. Author(s):Dr. Hans Mollet, Dr. Arnold Grubenmann 2001 WILEY?VCH Verlag GmbH
2. Introduction to Applied Colloid and Surface Chemistry. Authors: Georgios M. Kontogeorgis and Søren Kiil, 2016 Wiley & Sons, Ltd.
3. Formulation Science and Technology. Authors: Tadros, Tharwat F., 2018, De Gruyter

Semester

first semester

Assessment method

Oral interview (grade from 18/30 to 30/30) aimed at verifying the capability to recognise the specific function performed by each element introduced in a complex formulation based on their nature. In detail, the interview will be composed of:

- a brief ppt presentation deepening a topic of the course
- questions and discussion on the arguments of the course

The evaluation will take into account the ability to present knowledge clearly and concisely, to answer the

examiner's questions, and to engage in a discussion.
The final evaluation will be communicated in detail, specifying strengths and weaknesses.
The grading scale will be as follows:
• Failing grade: the minimum level of preparation was not achieved
• Passing grade (18–21): the minimum level of preparation was achieved, with several gaps
• Fair grade (22–25): a satisfactory level of preparation was achieved, with some gaps
• Good grade (26–28): a good level of preparation was achieved, with few gaps
• Excellent grade (29–30 with honors): an excellent level of preparation was achieved, with no gaps

Office hours

upon request

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | AFFORDABLE AND CLEAN ENERGY | RESPONSIBLE CONSUMPTION AND PRODUCTION