A.Y. 2025/26
Course unit English denomination: “Inorganic Photocatalysis”
Number of ECTS credits allocated: 6.0
Language of instruction: Italian

ECTS details:
Type: core courses
Scientific Disciplinary Sector: CHEM-03/A, General and Inorganic Chemistry
Credits allocated: 6.0

Corse unit organization:
Teaching method: face to face teaching
Type of hours: Lecture; Credits: 6.0; Teaching hours: 48; Hours of individual study: 102

Syllabus:

Prerequisites: Fundamental concepts of inorganic and physical chemistry.

Targeted skills and knowledges: The goal of the course is to acquaint the students with the basic concepts and current topics in inorganic photochemistry and photocatalysis. The students will become familiar with possible applications and will be able to critically analyze a scientific report.

Examination methods: Oral exam: presentation of the material contained in a research article that is assigned by the professor (50% of total grade) followed by oral examination on the contents discussed in the lectures (50% of total grade).

Assessment criteria: At the end of the course the students should demonstrate that they acquired an understanding of photochemical processes, classical aspects of inorganic photochemistry, photocatalysis, and the ability to use them for applications in modern inorganic chemistry.

Course unit contents:

1. Historical background on inorganic photochemistry and photocatalysis. Fundamentals of photochemistry. Natural photochemical processes. Fundamentals of photoinduced electron transfer in inorganic systems. Fundamental principles, basic mechanisms (with a brief account of experimental techniques), thermodynamic and kinetic requirements of photocatalytic reactions. Homogeneous, heterogeneous/colloidal photocatalysis. Technical and experimental considerations on setup and photoreactors, scale up of processes; discussion on challenges and strategies for addressing them.
2. Molecular inorganic photocatalytic systems. Classification, properties and reactivity of excited states processes. Photoinduced electron transfer catalysis with inorganic compounds: fundamentals, general photoredox cycle, reactions. Photoredox chemistry. Fundamentals and photocatalytic applications of first-row

transition metal complexes and organometallic compounds. Examples of homogeneous photocatalytic systems.

3. Heterogeneous and semiconductor inorganic photocatalytic systems. Principles, kinetic concepts, thermodynamic requirements and mechanistic principles. General classification of reactions. Influence of heterogeneous catalyst's nature and size on chemical reactivity and selectivity. Direct and indirect semiconductor photocatalysis. One-particle and two-particles semiconductor photocatalysis. Design, classification, evaluation, modification strategies of colloidal quantum dot nanocrystals and nanostructured materials for photocatalysis (oxide-based semiconductors, metal-supported carbon nanomaterials, heterojunction nanocomposites, metal-organic frameworks). Examples of heterogeneous photocatalytic systems.
4. Overview, using classic and modern literature examples, of applications for solar energy conversion, synthesis of chemical compounds including commodity chemicals, biological systems, photovoltaics, optoelectronics, environmental remediation.

Planned learning activities and teaching methods: Class lectures. Discussion of relevant literature will be incorporated into the class. The active participation of the students during class is expected, and it will be fostered using innovative teaching methods and activities (flipped classroom, videos, quizzes, wooclap). The lectures will be delivered in Italian or English depending on the presence of international students or specific requests by the students.

Additional notes about suggested reading: Copies of slides used during class, book chapters and articles on subjects to be covered in class will be available on the course Moodle page.

Textbooks (and optional supplementary reading):

- Balzani, Vincenzo. *Photochemistry and Photophysics : Concepts, Research, Applications*. Wiley-VCH, 2014.
- Patrocinio, Antonio Otavio T., and D. (Detlef) Bahnemann, editors. *Springer Handbook of Inorganic Photochemistry*. Springer Nature Switzerland AG, 2022.
- Kisch, Horst. *Semiconductor Photocatalysis : Principles and Applications*. 1st ed., Wiley-VCH, 2015.