



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Inorganic Strategies for Materials Synthesis

2627-1-FSM02Q030-FSM02Q03002

Aims

Describe and discuss relevant methods for the synthesis of functional inorganic and hybrid organic-inorganic materials, focusing on the choice of precursors and development of suitable process conditions in order to synthesize materials with the required composition, structure and physico-chemical properties.

Knowledge and understanding

Students will acquire basic knowledge about relevant advanced inorganic materials and their synthesis, including synthetic methods and physico-chemical and process parameters upon which the chemical procedures are based.

Applying knowledge and understanding

The students will be able to select approach, method and parameters best suited to fully control and optimise the synthesis of functional materials based on inorganic cores.

Making judgements

The students will be able to identify precursors and suitable process conditions in order to synthesize materials with the required composition, structure and physico-chemical properties.

Learning skills

The student will understand the fundamentals of the basic principles of inorganic synthesis and the properties of inorganic and hybrid materials, applying them correctly to the specific design of an inorganic material.

Communication skills

The students will describe orally, clearly and concisely and with correct use of language the fundamentals of synthetic procedures on inorganic and hybrid materials and their properties.

Contents

Synthesis of functional materials (films, fibers, amorphous and porous materials): solid-state reactions, synthesis of solids from the gas phase, synthesis of solids from melts and solutions at low and high temperature, sol-gel processes, hybrid and porous materials, and nanocomposites.

Detailed program

Synthesis of solid functional materials.

Solid-state reactions: ceramic method, carbothermal reduction, combustion synthesis, sintering, solid-gas reactions.

Synthesis of solids from the gas phase: Chemical Vapor Transport, aerosol processes.

Synthesis of solids from liquid phase: glasses, solvothermal and hydrothermal processes. Precipitation.

Sol-gel processes with alkoxysilanes.

Synthesis of porous materials: hybrid organic-inorganic materials (polysiloxanes, polysilsesquioxanes)). Micro-, meso-, macroporosity. Ordered porosity by templating agents: synthesis of mesoporous silica.

Hybrid organic-inorganic materials and nanocomposites.

Prerequisites

Chemistry of materials requires an interdisciplinary approach exploiting general and inorganic, organic, macromolecular and physical chemistry (thermodynamics and chemical equilibria).

An interdisciplinary foundation is thus required, including:

- General and Inorganic Chemistry.
- Organic Chemistry.
- Physical Chemistry (Thermodynamics and Chemical Equilibria).

Teaching form

24 two-hour lectures, in person (Delivered Didactics) will be given in the classroom, supported by video projection of text, schemes, diagrams, pictures and movies.

A lecture/seminar held by a researcher from a company active in the field of inorganic materials is planned.

Textbook and teaching resource

Recommended textbook:

Synthesis of inorganic materials - U. Schubert, N. Hüsing - (2019) - ebook

Reference textbooks:

Hybrid Materials: synthesis, characterization, applications, G. Kickelbick Ed.- (2007) - ebook

Functional hybrid materials - P. Gomez-Romero, C. Sanchez - (2004) - ebook

Sol-gel science: the physics and chemistry of sol-gel processing - C.J. Brinker, G.W. Scherer - (1990)- ebook Solid state chemistry. Compounds - Eds. A.K. Cheetham, P. Day - (1992)

(copies of the textbooks are available for lending from the university library)

Semester

Second semester

Assessment method

The final mark for "Strategies for Materials Synthesis" is a composite score derived from the three modules (Organic, Inorganic, and Macromolecular).

- Overall Evaluation Criteria:

The assessment is conducted via oral examinations for each module. The final grade of Strategies for Materials Synthesis course is calculated as the average of the marks obtained in its three constituent modules: Inorganic Strategies for Materials Synthesis, Organic Strategies for Materials Synthesis and Macromolecular Strategies for Materials Synthesis

During the exam, the student will be required to answer 3–4 questions over a duration of approximately 20 minutes. One of these questions will be on a topic of the student's choice. The remaining questions will focus on the topics covered during the lectures with the aim to assess the ability to rearrange the concepts. Students will be encouraged to think about the possible use of their notions in practical examples/applications (problem solving).

The evaluation criteria for the overall course are as follows:

18-21 (Sufficient): Basic understanding of concepts; can identify common synthetic methods but struggles with selection/application; limited ability to link synthesis to specific material properties.

22-24 (Good): Clear understanding of synthetic methods and their features; can select appropriate approaches for standard materials; improved use of scientific terminology.

25-27 (Very Good): Strong, autonomous grasp of synthetic strategies; effective at justifying methodology choices; confident communication of complex ideas and literature findings.

28-30 Honors (Excellent): Exceptional mastery; can devise efficient strategies for complex/novel materials; demonstrates sophisticated critical thinking and the ability to integrate knowledge into a coherent synthetic design.

Partial exams are not scheduled.

Office hours

On appointment by email: barbara.dicredico@unimib.it

Sustainable Development Goals

AFFORDABLE AND CLEAN ENERGY | RESPONSIBLE CONSUMPTION AND PRODUCTION
