UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Chemistry of Inorganic Materials

2122-2-F5401Q042

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. Introduce the student to fundamentals of mechanisms of nucleation and crystal growth from the melt, solution and vapor.

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. This will enable the student to select approach, method and parameters best suited to fully control and optimise the synthesis of functional materials based on inorganic cores.

Contents

Synthesis of functional materials (single crystals, polycrystalline powders, 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. Fundamentals of nucleation of crystals and growth mechanisms.

Detailed program

Synthesis of solid functional materials (single crystals, polycrystalline powders, thin/thick films, fibers, amorphous and porous materials).

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

reactions.

Synthesis of solids from the gas phase: Chemical Vapor Transport, Chemical Vapor Deposition, Physical Vapor Deposition (sputtering, thermal evaporation, vapor phase epitaxy, Chemical Vapor Infiltration), aereosol processes.

Homogeneous and heterogeneous nucleation of crystals. Structure of crystal surfaces and growth mechanisms. Dependence of crystal morphology on growth parameters.

Synthesis of solids from melts and solutions: glasses, crystal growth from the melt (Verneuil, Bridgman-Stockbarger, Czochralski, Kyroupolos, Floating zone), growth from low and high temperature solutions (solvothermal and hydrothermal processes, flux growth). Precipitation.

Sol-gel processes with alkoxysilanes. Synthesis of porous materials: hybrid organic-inorganic materials (polysiloxanes, polysilsesquioxanes)). Micro-, meso-, macroporisity. Ordered porosity by templating agents: synthesis of zeolites and mesoporous silica.

Prerequisites

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

Teaching form

Lectures will be given in the classroom and in english, supported by video projection of text, schemes, diagrams, pictures and movies**.**

Textbook and teaching resource

Recommended textbook:

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

Reference textbooks:

The inorganic chemistry of materials: how to make things out of elements - P.J. van der Put - (1998)

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)

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

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

Springer handbook of crystal growth - G. Dhanaraj, K. Byrappa, V. Prasad, M. Dudley Eds. - - (2010) - **ebook**

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

Lecture handouts will be provided as pdf files uploaded on the e-learning platform.

Semester

1st semester, starting on October 2021

Assessment method

The examination is performed through an oral exam without midterm tests. The teacher assesses if and to what extent the student has reached the course objectives, through a formal knowledge-based evaluation of the general topics delivered together with selected case studies. Parameters analyzed for producing the final score are capability and fluency during the interview to illustrate in a clear and sound way the topics delivered. A positive final graduation ranges from 18/30 to 30/30 cum laude based on quality and completeness level of the answers provided by the student.

Office hours

The teacher is available for help and discussion by arranging a meeting by email to: massimo.moret@unimib.it