UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Chemistry of Inorganic Materials

1819-1-F5302Q018

Aims

Describe the synthesis of relevant inorganic and hybrid organic-inorganic functional 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.

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, mechanochemical synthesis, sintering, solid-gas reactions.

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

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, Skull melting), growth from low and high temperature solutions (solvothermal and hydrothermal processes, flux growth). Precipitation.

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

Prerequisites

General and inorganic chemistry, physical chemistry, basic knowledge of crystallography.

Teaching form

Lectures in the classroom exploit video projection of text, schemes, diagrams, plots, pictures and movies. Lecture handouts will be provided as pdf files.

Textbook and teaching resource

Recommended textbook:

Synthesis of inorganic materials - U. Schubert, N. Hüsing - (2012)

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)

Solid state chemistry. Compounds - Eds. A.K. Cheetham, P. Day - (1992)

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

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

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

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

Semester

1st semester, starting on October, 1st

Assessment method

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. The examination is performed through an oral exam without midterm tests. 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