UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Chemistry of Ceramic Materials

2526-3-ESM01Q014

Aims

The main objective of the course is the development of the knowledge and understanding of the fundamental concepts of the synthesis and chemical properties of ceramic materials (oxides, sulphides, carbides, etc.), crystal field theory, and the electronic structure of transition metal oxides. The student will be encouraged to apply the knowledge and understanding of such concepts to specific problems and to make judgements. During the exam, the student will be able to practice the communication and learning skills.

Contents

The course describes the class of ceramic materials (oxides, sulfides, carbides). We recall basic notions of crystal structure and give information about the synthesis of materials in form of single crystals, polycrystalline phases, amorphous structures, thin film, fibers, microporous materials. We describe techniques of direct solid state synthesis, synthesis in solution (sol-gel, precipitation, hydrothermal synthesis), preparations from gas-phase precursors (chemical vapor deposition, etc.).

The second part deals with the properties of ceramic materials: thermal properties, mechanical properties, electrical behavior, magnetic and optical properties. Various classes of inorganic materials of particular applicative importance are then presented: low-dimensional systems (intercalation phenomena), zeolites and porous materials, oxides and sulfides for catalytic applications, glasses, cements, biocompatible inorganic materials.

The third part is dealing with the properties of transition metal oxides. After an analysis of the ionic bonding, Born-Haber cycle, etc., the course introduces the crystal field theory. Then advanced theories of bonding in transition metal oxides are described (Mott-Hubbard model, magnetic insulators, metallic oxides, etc.). The nature of the band gap in transition metal oxides is analyzed with the help of spectroscopic data. Defects and non-stoichiometric materials are also described.

Detailed program

Prerequisites

Basic knowledge of general and inorganic chemistry; crystal structures

Teaching form

Lectures in classroom in italian

Textbook and teaching resource

P. A. Cox “Transition metal oxides”, Oxford.

G. Pacchioni “Dispense del corso”.

Semester

First semester

Assessment method

Oral exam. The exam is based on the fundamental concepts of the course: synthesis of ceramic materials, their structure, physico-chemical properties, electronic structure of oxides, crystal field theory, applications (ferroelectrics, low-dimensional materials, zeolites, catalysis, glasses and cements, biocompatible materials).
The exam is aimed at verifying that the student has developed reasoning methods that enable him to solve simple problems in the field of materials chemistry.

Office hours

Any time by appointment

Sustainable Development Goals

AFFORDABLE AND CLEAN ENERGY