



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Chemistry of Ceramic Materials

2021-3-E2701Q044

---

#### Aims

Familiarize the student with the synthesis and chemical properties of ceramic materials (oxides, sulphide, carbides, etc.), crystal field theory, and the electronic structure of transition metal oxides.

#### 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

## **Textbook and teaching resource**

### **Textbook:**

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).

## **Office hours**

any time by appointment

---