ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA

DIM-GITI-211 Materials Science

SEMESTER: Fall

CREDITS: 6,0 ECTS (hrs. per week.)

LANGUAGE: Spanish

DEGREES: GITI

Course overview

Strictly speaking, “materials science” involves the investigation of the relationships that exist between the structures and properties of materials.
There are three ways to define structure in a material: On an atomic level (atomic structure and interatomic bonding), the structure at microscopic level (direct observation using a microscope) and macroscopic structure.

The properties of solid materials may be grouped into six different categories: mechanical, electrical, thermal, magnetic, optical and degradation properties. These properties are related to the atomic, microscopic and macroscopic structure of the material.

In this course, the relationship between structure and properties of the materials is studied.

Prerequisites

Basic knowledge of chemistry.

Course contents

Theory:

1. **Imperfections in Solids.** Vacancies and Self-Interstitials. Impurities in Solids. Dislocations. Grain and twin boundaries. Grain size determination.
2. **Mechanical Properties.** Stress-strain relationship. Elastic Deformation. Hooke´s law. Elastic properties (Poisson’s ratio, Young modulus, shear modulus). Plastic deformation. Plastic properties (Yield strength, tensile strength, ductility, toughness). Tensile tests. Compression tests. Shear and torsional tests. True stress and strength. Hardness (Rockwell, Vickers and Brinell). Slip in single crystals.

3. **Diffusion.** Vacancy diffusion and interstitial diffusion. Diffusion and temperature. Steady-state diffusion. Nonsteady-state diffusion. Applications.
4. **Thermal properties.** Heat capacity**.** Thermal expansion. Thermal conductivity.
5. **Phase diagrams.** Solubility Limit. Phases. Microstructure. Phase equilibria. The Gibbs phase rule. Binary isomorphous systems. Binary eutectic systems. Eutectoid and peritectic reactions. The Iron–Iron Carbide phase diagram.
6. **Metal alloys.** Ferrous and nonferrous alloys. Applications.
7. **Polymer Structures.** Polymer molecules. Molecular structure. Thermoplastic and thermosetting polymers. Elastomers. Copolymers. Crystallinity. Mechanical and thermal properties of polymers.
8. **Composite materials.** Particle reinforced composites, fiber reinforced composites and structural composites.
9. **Electrical Properties.** Electrical conductivity. Energy band structures in solids. Conduction in terms of band and atomic bonding models. Conductors, superconductors and insulators. Intrinsic and extrinsic semiconductors.
10. **Corrosion and degradation of materials.** Oxidation. Electrochemical Considerations. Corrosion Rates. Passivity. Environmental Effects. Forms of Corrosion. Corrosion Prevention. Photo-degradation.

Laboratory:

P1. Mechanical properties.
P2. Grain size determination.
P3. Phase diagrams and metallography.
P4. Materials selection.
P5. Polymeric materials.
P6. Composite materials.

Textbook

- **William D. Callister, David G. Rethwisch.** Ciencia e Ingeniería de Materiales. 2º edición, 2016. Editorial Reverte.

Grading

The overall grade is obtained as follows:

Exams (minimum overall grade 5.0):

- Final exam: 60% of the final grade (minimum grade 4.0).

- Other exams 25%. Typically there is 1 mid-term exam and 1 or 2 additional short exams. They are weighted according to their duration.

Laboratory (minimum grade 5.0):

- Laboratory reports must be handed in every laboratory session and they are graded and returned: 15% of the final grade.

Additional evaluation during July (Retake):
Regular assessments and laboratory marks will be preserved

- 80% July exam (minimum grade 4.0).
- 20% Regular assessments and laboratory