

# MATERIALS ENGINEERING AND NANOTECHNOLOGY (LM56)

(Lecce - Università degli Studi)

## Teaching NON-FERROUS METALLURGY

GenCod A003984

Owner professor PAOLA LEO

Teaching in italian NON-FERROUS METALLURGY

Teaching NON-FERROUS METALLURGY Language INGLESE

Course year 2

SSD code ING-IND/21

Curriculum PERCORSO COMUNE

Reference course MATERIALS ENGINEERING AND

Course type Laurea Magistrale

Location Lecce

Credits 6.0

Semester Primo-Semestre

Teaching hours Ore-Attivita-frontale: 54.0

Exam type Orale

For enrolled in 2017/2018

Assessment Voto-Finale

Taught in 2018/2019

Course timetable

<https://easyroom.unisalento.it/Orario>

### BRIEF COURSE DESCRIPTION

The course clarifies the microstructure, mechanical properties, processing, physical metallurgy and engineering applications of non ferrous alloys. Particular attention is devoted to microstructure/property relationships and to the role of processing and heat treatments on the microstructure evolutions.

### REQUIREMENTS

Metallurgy basics

### COURSE AIMS

After the course the student should be able to:

- 1)Identfy the microstructural features, properties and applications of the main non ferrous alloys;
- 2)Recognize the main microstructural and mechanical features induced by casting, plastic deformation and joining methods;
- 3)Identify the role of process parameters (welding, casting, plastic deformation) on microstrucural evolution and properties;
- 4)Apply strengthening methods and heat treatments;
- 5)Recognize the role of the processing thermal cycle on the microstructure evolution.

The development of individual projects helps each student to pursue the goals.

### TEACHING METHODOLOGY

Lectures, laboratory practice, individual project

### ASSESSMENT TYPE

The exam consists of two parts:

1. first written part: the student is asked to illustrate theoretical topics
2. second part: the student is asked to discuss the laboratory topics and individual project with the lecturer.

**Lectures:**

- 1) A general introduction on the main alloys in terms of the main microstructural features, properties, applications, processing (1h)
- 2) Cristallography, defects, strengthening mechanism (3 hours)
- 3) Metallography and experimental techniques (3 hours):
  - a) Specimen Preparation for Light Microscopy
  - b) Optical microscope
  - c) Hardness test
  - d) EDS
- 4) Physical metallurgy of light alloys:
  - a) Solidification principles: microstructure, heat treatments, defects (8 hours).
  - b) Plastic deformation and solid-solid phase transformation induced by plastic deformation and heat treatments. Recovery and Recrystallization (3 hours).
  - c) Principles of age hardening (6 hours).
  - d) microstructure and mechanical evolution by processing thermal cycle (3hours)Case studies on above topics.
- 5) Aluminum alloys (4 hours)

Wrought aluminum alloy: microstructures and heat treatments, designation of alloys and temper, work hardening, non heat treatable alloys, heat treatable alloys, Joining. Applications.  
Case studies on above topics

Cast aluminum alloys: microstructures and heat treatments, designation of alloys and temper, alloys based on the Aluminum-silicon system, alloys based on the Aluminum-copper system, Aluminum-Magnesium alloys, Aluminum- Zinc-Magnesium alloys. Applications.  
Case studies on above topics.
- 6) Magnesium Alloys (2 hours)

Microstructures and heat treatments, designation of alloys and temper, Zirconium free casting alloys, Zirconium containing casting alloys. Applications.  
Case studies on above topics.
- 7) Titanium alloys (4 hours)

Alpha alloys: microstructure and properties  
Alpha/Beta alloys: microstructure and properties  
Heat treatments  
Joining Applications.  
Case studies on above topics.
- 8) New processing for non ferrous alloys: microstructure evolution and properties (9 hours):

New joining techniques: microstructures and properties  
New coatings techniques: microstructures and properties  
Three dimensional (3D) building process: microstructures and properties  
Case studies on above topics.

**Laboratory:**

- 1) Grinding, polishing, chemical etching, electrolytic etching, optical microscopy analysis, hardness test and tensile test of light alloys: applied to microstructural and mechanical characterization of the following light alloys: 2024, 7075, 6061, A357, C355, Ti-6Al-4V, WE43, AZ91 (4 hours)
- 2) As cast and as welded microstructure characterization of non ferrous alloys both heat and not heat treatable: microstructure, defects, mechanical properties (2 hours)
- 3) Solutionizing and aging heat treatment applied to heat treatable aluminum and magnesium alloys: aging curves at different holding temperatures with or without previous solution heat treatment (2 hours)

4) Deformed microstructure and Recovery and Recrystallization applied to aluminum alloys: microstructure evolution and mechanical properties (2 hours)  
5) Homogenization heat treatments (as-cast aluminum alloys) (2 hours): microstructure evolution and mechanical properties  
6) Ti-6Al-4V heat treatment (2 hours)  
Microstructure evolution and hardness of Ti-6Al-4V due to annealing from Beta phase field.  
Microstructure evolution and hardness of Ti-6Al-4V due to annealing from Alpha+Beta phase field  
Microstructure evolution and hardness of Ti-6Al-V due to air cooling from Beta phase field.  
Microstructure evolution and hardness of Ti-6Al-V due to air cooling from Alpha+Beta phase field.  
Microstructure evolution and hardness of Ti-6Al-V due to quenching from Beta phase field.

#### **Individual project**

New joining/ coating/ 3D buildings techniques applied to non ferrous alloys: microstructural and mechanical characterization of samples (6-8 hours).

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#### REFERENCE TEXT BOOKS

- [1] American Society for Metals, *Metals Handbook*, V. 15, *Casting*, Metals Park, Ohio, 1988.
- [2] J.D. Verhoeven, *Fundamentals of Physical Metallurgy*, Wiley
- [3] R.W. Hertzberg, *Deformation and Fracture Mechanics of Engineering Materials*, Wiley
- [4] M.Tisza, *Physical Metallurgy for Engineers*, ASM,
- [5] G.E Dieter, *Mechanical Metallurgy*, McGraw-Hill
- [6] I.J.Polmear, *Light Alloys*, BH
- [7] W.F.Smith, *Structure and Properties of Engineering Alloys*, McGraw-Hill
- [7] G. Lutjering, J. C. Williams, *Titanium*, Springer 2nd edition, New York
- [8] R.W. Messler, *Principles of welding*, J.Wiley & Son